CONCEPTUAL, INTELLECTUAL, AND STRUCTURAL ANALYSIS OF HYDROGEN ECONOMY THROUGH S&T POLICIES INTERVENTION.

Project undertaken in CSIR-Hydrogen Mission Program H2T

Project No. H2T/09/2022-R&A

Project Team :

Dr. Madhulika Bhati - Principal Investigator.

Dr. Jayita Biswas - Project Associate

Ms. Nishita - Project Associate

Mr. Saurav Kumar - Project Associate

CSIR-NIScPR

National Institute of Science Communication and Policy Research

Project Team

Nodal Officer

Prof. Ranjana Aggarwal
Director, CSIR-NIScPR

Principal Investigator

Dr. Madhulika Bhati
Principal Scientist, CSIR-NIScPR

Project Associate

Dr. Jayita Biswas
Ms. Nishita Kumari
Mr. Saurav Kumar
Corresponding Author email: madhulikabhati@niscpr.res.in

Cited as: "Bhati, M; Biswas, J; Kumari, N. and Kumar S. 2023. Comprehensive Hydrogen Digest – A weekly Newsletter. *Knowledge product of CSIR Hydrogen Technology Programme*. Issue No.:__; Month: __; Page No.__."

Copyright (2023) © CSIR-National Institute of Science Communication and Policy Research (CSIR- NIScPR), New Delhi

Printed & Published by CSIR-National Institute of Science Communication and Policy Research (CSIR- NIScPR), New Delhi

Disclaimer: This newsletter contains information compiled from various sources. It is only intended for informational purposes and not for commercial purposes

A message from Director, CSIR-NIScPR

CSIR-NIScPR, a constituent laboratory of CSIR is a globally respected think-tank and resource center for undertaking Science, Technology & Innovation Policy Research and Science Communication. Our mission is to promote Science Technology and Innovation policy studies and science communication among diverse stakeholders and act as a bridge at the interface of science, technology, industry and society



Within CSIR-NIScPR, the Energy, Environment, and Sustainability Division actively participate in the CSIR Hydrogen mission program. This program specifically concentrates on hydrogen research. A notable initiative of CSIR- NIScPR is the weekly e-hydrogen digest, a knowledge product of project undertaken by CSIR-NIScPR entitled ***"Conceptual, Intellectual and Structural analysis of Hydrogen Economy through S & T Policy intervention".*** This digest is distinct as it not only provides news updates but also includes valuable information about books, reports, publications, and patents related to hydrogen research. CSIR-NIScPR has successfully published 41 issues. The current document is a compilation of all these issues, which is being circulated among the research community working in the field of hydrogen research.

The primary objective of this compilation is to offer a comprehensive overview of groundbreaking research happening worldwide, as well as highlight the dedicated research efforts taking place within India. By sharing timely and relevant information, CSIR-NIScPR aims to facilitate knowledge dissemination, collaboration, and advancement in the field of hydrogen research. This compilation document serves as a valuable resource for researchers, enabling them to stay updated with the latest developments, access relevant literature, and engage with the research community in this field.

Through its initiatives and publications, CSIR-NIScPR plays a crucial role in fostering scientific research, policy formulation, and effective science communication. By actively engaging with various stakeholders and promoting knowledge exchange, CSIR-NIScPR contributes to the sustainable development of the energy and environmental sectors while keeping the scientific community informed and connected.

Director, CSIR-NIScPR

Acknowledgements

The authors extend their heartfelt appreciation to Prof. Ranjana Aggarwal, Director, CSIR-NIScPR, for her invaluable guidance, unwavering support, and motivation throughout the establishment and progress of this research project. Her insightful discussions have been instrumental in shaping the direction of this initiative. The funding for this research project under the CSIR-Hydrogen mission programme is gratefully acknowledged.

Special thanks go to Dr. Ashish Lele, Director, CSIR-NCL, and nodal officer for the CSIR hydrogen mission programme, for his valuable insights and the inspiration that led to the inception of this initiative. We are also immensely grateful to Dr. Gopinathan and our esteemed colleagues at CSIR-NCL for providing us with a fantastic platform to effectively coordinate and collaborate with other CSIR labs. Their support and cooperation have been instrumental in fostering a seamless and productive exchange of ideas, resources, and expertise.

I am deeply grateful to all my colleagues from various CSIR labs who have been actively involved in the Hydrogen mission programme. Their unwavering commitment and dedication to fostering a conducive environment for collaborative research have been pivotal in driving our project towards successful outcomes. The authors would like to express their gratitude to all the colleagues at CSIR-NIScPR, including scientists, project associates, technical, administrative, financial, stores and purchase, and printing division staff, for their dedicated assistance, which played a crucial role in successfully completing the compilation and publishing this document

Dr. Hariom Yadav and Dr. Mahesh Sharma, Senior Principal Scientists, Innovation Management Directorate (IMD), CSIR-HQ, for their contributions extending beyond mere administrative tasks; they have been true enablers, empowering researchers to pursue their scientific endeavors and contribute to the mission's objectives with zeal and dedication.

Their proactive and responsive approach to addressing challenges and ensuring the smooth flow of funds has been invaluable. Their involvement has alleviated the financial burden on researchers, fostering an environment conducive to innovation, experimentation, and groundbreaking discoveries. The authors also acknowledge the support and efficient services provided by their colleagues at CSIR Head Quarter, including those from finance, administration, and other staff involved in the mission programme. Their contribution has ensured the smooth execution of the project.

The data sources utilized for this digest encompass a variety of grey literature, such as ministry reports, newspapers, technical papers, as well as peer-reviewed journal articles is greatly acknowledge and properly cited in Newsletter

M. Bhati

(Dr. Madhulika Bhati)
Principal Investigator,
Principal Scientist, CSIR-NIScPR

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECNOLOGY PROGRAM

ISSUE. 01

September, 2022

Waste to clean fuel : Novel solutions for a new economy

This invention could be an ideal method for generation of hydrogen energy at ambient temperature and without input energy and also post consumer aluminum foil can be used.

INVENTORS- Gabriella Amberchan, Isai Lopez, Beatriz Ehlke, Jeremy Barnett, Neo Y. Bao, A'Lester Allen, Bakthan Singaram* and Scott R. J. Oliver*

SUPPORTING INFORMATION LINK- Aluminum Nanoparticles from a Ga–Al Composite for Water Splitting and Hydrogen Generation | ACS Applied Nano Materials

INTELLECTUAL PROPERTY INFORMATION-

Country Type- Patent Cooperation Treaty

Number- Reference for National Filings 2020223489

Dated- 11/05/2020

Case- 2019-755

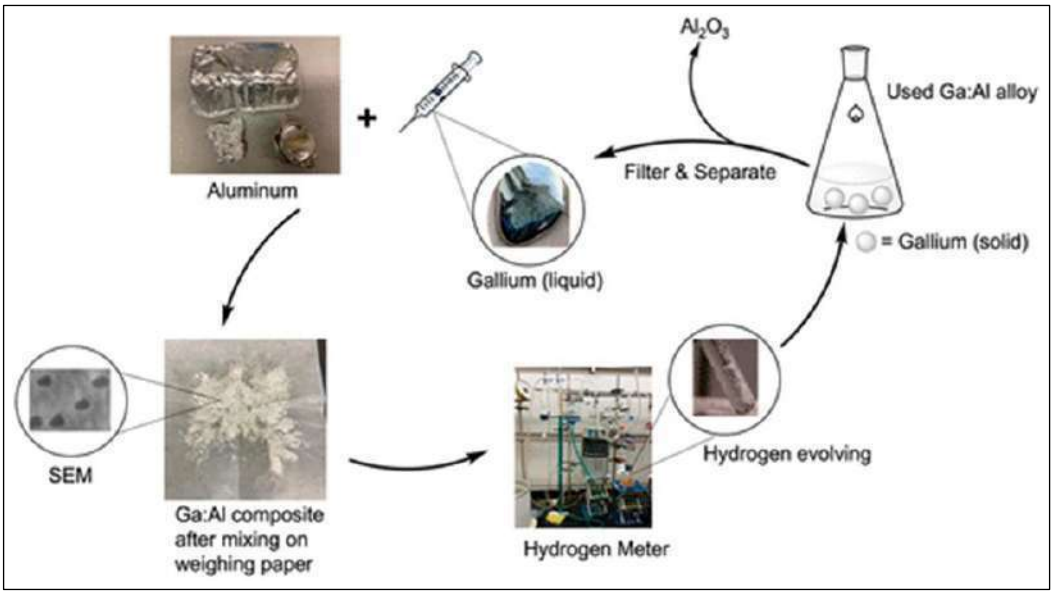
Wonder of P-Block Elements

Miracle of Opposite Numbers 13-31 Al-Ga

Scientists develop simple technology to produce hydrogen gas at room temperature. Scientists at the University of California Santa, Santa Cruz (UCSC) have developed a new method to efficiently generate hydrogen from water at ambient temperatures using Aluminium and Gallium. The research was published in the journal Applied Nano Materials in February, 2022 and has a pending US patent application.

News Link- https://indianexpress.com/article/technology/science/scientists-develop-simple-technology-to-produce-hydrogen-gas-at-room-temperature-8147006/





Inventors: Do; Robert T. ; et al. PATENT No- US20220081629

METHODS, PROCESSES AND SYSTEMS FOR THE PRODUCTION OF HYDROGEN FROM WASTE, BIOGENIC WASTE AND BIOMASS

Abstract:- Provided herein are novel devices, systems, and methods of using the same, that enable plasma-enhanced gasification of biogenic hydrocarbon waste material comprising: a geometrically designed reactor having a biochar carbon catalyst bed, together with a gas inlet system disposed around a lower section of the apparatus to supply oxidant gas generated by an integrated oxygen absorber system; to enhance the partial oxidation of biogenic hydrocarbon waste materials using exothermic heat generated by an oxidation reaction created in part by the integrated oxygen absorber system into the apparatus, in order to optimize the quantity and quality of hydrogen production in the synthetic gas produced therein. https://appft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.html&r=1&f=G&l=50&s1=%2220220081629%22.PGNR.&OS=DN/20220081629&RS=DN/20220081629

Hydrogen in Internal combustion engine

To achieve carbon neutrality, Tata Motors aims to ignite hydrogen in ICE.
Tata Motors aims to ignite hydrogen in ICE – US Pioneer Global VC DubaiHQ & Riyadh (linkedin.com)

Loop Energy says new hydrogen fuel cell more efficient than diesel engine

Hydrogen fuel cell maker Loop Energy said that its latest cell system can deliver better fuel economy than a diesel engine at current price levels. The Burnaby, British Columbia-based company said that - based on a pan-European diesel cost of $1.91 per litre on September 5 and $10 per kg of hydrogen - a truck could travel just over 111 miles (179 km) on $100 worth of fuel using its new S1200 hydrogen fuel cell system versus a little over 109 miles for an equivalent diesel truck. Loop Energy says new hydrogen fuel cell more efficient than diesel engine | Financial Post

Alstom attempts to set new distance record with hydrogen-powered train

The goal was to achieve a range of 1,000 kilometres on a single tank of hydrogen, according to Alstom. The new hydrogen trains are designed to cover approximately that distance. Alstom attempts to set new distance record with hydrogen-powered train | Business Standard News (business-standard.com)

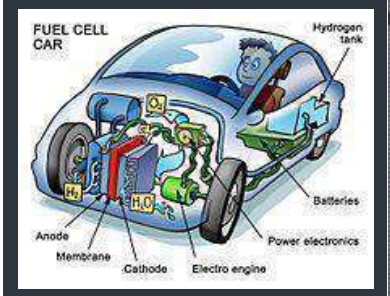
Stadler's FLIRT H_2 hydrogen train, at InnoTrans 2022.

This will be the first hydrogen-powered passenger train to operate in the US after its delivery to the San Bernardino County Transportation Authority (SBTCA) in mid-2023. SBTCA has currently ordered one FLIRT H_2 hydrogen train to join its fleet of FLIRT diesel multiple units (DMUs). The new train will run on a 9-mile route from San Bernardino to Redlands University and will perform up to 16 trips each day without refuelling. Stadler Presents FLIRT H_2 Hydrogen Train for San Bernardino | Railway-News



Ashok Leyland sees future in hydrogen-fuelled CVs

Ashok Leyland Ltd expects hydrogen-powered truck and buses to emerge as a self-sufficient green solution with commercial viability beginning in the next five years, at a time commercial vehicle makers prepare to invest in electric vehicles and natural gas and flexible fuel platforms. A potential move to reduce tax on hydrogen, particularly green hydrogen that could help eliminate import content, and its availability along certain long-haul corridors could create a positive business case for hydrogen-powered vehicles in both internal combustion (IC) engine and fuel cell variants in the next five years, N. Saravanan, chief technology officer of the Hinduja Group company, said in an interview. https://www.livemint.com/auto-news/ashok-leyland-sees-future-in-hydrogen-fuelled-cvs-11663614513319.html



Hydrogen Fuel Cell Global Market Report 2022: Rising Investments by Private and Governmental Organizations Drives Growth - ResearchAndMarkets.com

The global Hydrogen Fuel Cell market was valued at USD 14.72 Billion in 2021 and is projected to grow at a CAGR of 21.2% from 2021 to reach USD 80.48 Billion by the year 2030.

The main advantage of fuel cells over other power generation technologies is that they are very efficient, with most of the energy in the hydrogen being converted to electricity. Fuel cells also have a much lower environmental impact than other power generation technologies, as they do not produce any emissions of greenhouse gases or air pollutants.



Tevva unveils 19-tonne hydrogen electric truck

Tevva | Tevva launches in mainland Europe and unveils its 19-tonne hydrogen electric truck.

3 Hydrogen Stocks To Watch In September 2022

Hydrogen stocks are a type of energy stock that represents companies involved in the production and distribution of hydrogen fuel. 3 Giants of Hydrogen Stocks are-

Plug Power Inc.
Ballard Power Systems Inc.
FuelCell Energy Inc.

3 Hydrogen Stocks To Watch In September 2022 | Nasdaq

Posco and Greenko Partner for Green H_2 production.

The partnership will also explore opportunities in production of renewable energy in India and use of steel materials from Posco in the development of infrastructure for potential projects, the companies said in a press statement.
https://economictimes.indiatimes.com/industry/renewables/posco-and-greenko-partner-for-green-h2-production/articleshow/93931618.cms

Indian Oil eyes net zero carbon emissions by 2046

Indian Oil Corp, the country's top refiner, has set a 2046 net zero carbon emissions goal, its chairman S. M. Vaidya said at annual shareholders meet. India is aiming to reach net zero emissions by 2070.
https://economictimes.indiatimes.com/industry/renewables/indian-oil-corp-eyes-net-zero-carbon-emissions-by-2046/articleshow/93769157.cms

Advent Technologies signs MoU with Saudi based Company, Hydrogen Systems, Inc. to Distribute Fuel Cells and Hydrogen Products in the Middle East

Advent Technologies Holdings, Inc. (NASDAQ: ADN) ("Advent" or the "Company"), an innovation-driven leader in the fuel cell and hydrogen technology space, today announced it has signed a Memorandum of Understanding ("MoU") with Hydrogen Systems, Inc. ("Hydrogen Systems"), a hydrogen energy solutions company based in Riyadh, Saudi Arabia, to provide integrated hydrogen solutions and value-added support to industrial and renewable energy markets in the Middle East.
https://www.businesswire.com/news/home/20220915005629/en/Advent-Technologies-signs-MoU-with-Saudi-based-Company-Hydrogen-Systems-Inc.-to-Distribute-Fuel-Cells-and-Hydrogen-Products-in-the-Middle-East

Midwestern Partnership Backs Hydrogen as Clean Energy Source

The partnership includes Illinois, Indiana, Kentucky, Michigan, Minnesota, Ohio and Wisconsin, whose economies are dominated by agriculture and heavy industry such as steel and automobile manufacturing.
Midwestern Partnership Backs Hydrogen as Clean Energy Source (usnews.com)

Upcoming Events

Events related to Green-Hydrogen

INTERNATIONAL

H_2 EXPO & CONFERENCE
Hamburg Germany
27-30 September 2022
Daily 10:00 - 18:00 hrs, Fri 10:00 - 16:00 hrs
https://www.h2expo.com/expo-conference/conference

HYDROGEN TECHNOLOGY EXPO
EUROPE: 19-20 October 2022
Messe Bremen, Germany
https://www.hydrogen-worldexpo.com/register/
NORTH AMERICA: 28-29 June 2023
NRG Centre, Houston, Texas, USA

CONNECTING GREEN HYDROGEN JAPAN 2022
Oct 11, 9:00 AM GMT+9 – Oct 12, 5:00 PM GMT+9
SHIN YOKOHAMA PRINCE HOTEL, 3-4 Shin Yokohama, Kohoku-ku, Yokohama, Kanagawa, 222-8533 Japan
https://www.japan.gh2events.com/registration

ADIPEC 2022 STRATEGIC CONFERENCE
31st October – 3 November 2022
Abu Dhabi, United Arab Emirates
Direct Link To register in the event-
https://www.adipec.com/conferences/strategic-

Portugal embraces Commission's EU hydrogen bank idea

An EU bank to support hydrogen projects is an excellent idea for energy autonomy, said Portuguese Foreign Minister João Gomes Cravinho following the announcement made by European Commission chief Ursula von der Leyen in her State of the Union address. Portugal embraces Commission's EU hydrogen bank idea – EURACTIV.com

BMW Begins Production of Fuel Cell Powertrains, Will Be Used On The iX5 Hydrogen

For a while, it seemed like hydrogen would be the fuel of the future. However, that now seems unlikely as automakers have embraced battery electric vehicles.
https://www.carscoops.com/2022/09/bmw-begins-production-of-fuel-cell-powertrains-will-be-used-on-the-ix5-hydrogen/

Unveiling of the Urbino 18 hydrogen bus along with #SolarisTalks 2022

On 14 September 2022, at noon, Solaris's new articulated Urbino 18 hydrogen bus was shown to the public for the first time ever. Just before the official unveiling of the vehicle, the third edition of the international e-mobility #SolarisTalks conference took place.
https://www.automotiveworld.com/news-releases/unveiling-of-the-urbino-18-hydrogen-bus-along-with-solaristalks-2022/

Industry Shows Interest in Cummins' Hydrogen Engines

Cummins Inc. is developing two hydrogen-fueled internal combustion engines that are scheduled for production in 2027, but fleets and others are already signing up for them.
https://www.ttnews.com/articles/industry-shows-interest-cummins-hydrogen-engines

"World's largest" electrolyser arrives in Norway to scale up green hydrogen projects.

Norwegian HydrogenPro, a provider of solutions for producing, storing, and distributing hydrogen from renewable energy sources, has received what is said to be the world's largest electrolyser at its test facility at Herøya. https://www.offshore-energy.biz/worlds-largestelectrolyser-arrives-in-norway-to-scale-up-green-hydrogen-projects/



Bosch Is Investing $200 Million To Make Fuel Cells For Hydrogen Trucks In South Carolina

Bosch, the German conglomerate that makes everything from dishwashers to industrial software and security systems, is investing $200 million in its auto parts factory in South Carolina to produce fuel cell stacks to supply an emerging market for zero-emission trucks powered by hydrogen.
https://www.forbes.com/sites/alanohnsman/2022/08/30/bosch-to-make-fuel-cells-for-hydrogen-trucks-in-south-carolina/?sh=46d657992242

Verdagy wins the 2022 Hydrogen Impact Investment Award in the IMPACT Technology of the Year Category

Verdagy wins the 2022 hydrogen impact investment award in the IMPACT Technology of the Year Category.https://hydrogen-central.com/verdagy-wins-2022-hydrogen-impact-investment-award-impact-technology-year-category/

CONNECTING GREEN HYDROGEN MENA 2023
Conference, Exhibition & Awards
Palazzo Versace Dubai, UAE
Start: Tuesday, 14 Mar 2023 09:00
End: Thursday, 16 Mar 2023 18:00
https://www.xing-events.com/CGHM2023.html

INDIA EVENTS

INTERNATIONAL COOPERATION FOR GREEN HYDROGEN
12 Oct 2022, 2–5 pm
German Centre for Research and Innovation (DWIH) New Delhi
21, Jor Bagh, New Delhi, Delhi.
https://www.dwih-newdelhi.org/en/event/greenhydrogen/

INDIA ENERGY STORAGE WEEK (IESW) – INTERNATIONAL CONFERENCE & EXPO '23
1 May 2023, 10 am-6 May 2023, 6pm
New Delhi, India
https://indiaesa.info/events/ongoing-upcoming-events/order/default/11836

India to pitch green hydrogen, renewable financing to Singapore's Deputy PM

In line with the maiden India-Singapore Ministerial Roundtable (ISMR) to firm economic ties between the two nations last week, an Indian delegation on Tuesday will present investment opportunities in the Indian green energy sectors to the Deputy Prime Minister of Singapore Lawerence Wong, Business Standard has learnt.
https://www.business-standard.com/article/economy-policy/india-to-pitch-green-hydrogen-renewable-financing-to-singapore-s-deputy-pm-122092000229_1.html

India Plans to become Green-Hydrogen Giant to cut energy imports.

New Delhi is aiming for an annual production capacity of 25 million tons by 2047, according to people familiar with the plans who didn't want to be named as the information is not yet public. However, the number could change going forward, depending on technology and the country's demand outlook, they said.
https://economictimes.indiatimes.com/industry/renewables/india-plans-to-become-green-hydrogen-giant-to-cut-energy-imports/articleshow/93962239.cms

Australia Govt. Announces funding for nation's biggest hydrogen plant.

The Australian Renewable Energy Agency (ARENA) has announced funding for the nation's first large-scale hydrogen plant, reported Xinhua.
ARENA approved 47.5 million Australian dollars in funding for the company.
https://www.bernama.com/en/sports/news.php?id=2121092

Pennsylvania builds on clean energy momentum with launch of Energy Future PA

Recently launched Energy Future PA aims to turn Pennsylvania into a leader in hydrogen and clean energy. The non-partisan project aims to capitalise on the state's existing energy momentum as it develops one of the US' first hydrogen hubs (H_2 Hubs) and educate policymakers on the potential of hydrogen, carbon capture and storage (CCUS), wind energy and nuclear technology.
https://www.h2-view.com/story/pennsylvania-builds-on-clean-energy-momentum-with-launch-of-energy-future-pa/

EU-India Green Hydrogen Forum inaugurated.

The EU and India have set ambitious programmes and targets for wider adoption of green hydrogen. While India announced its National Hydrogen Mission last year, the EU launched the European Hydrogen Strategy in 2020. European Commissioner for Energy Kadri Simson and India's Minister for Power and Renewable Energy R K Singh Thursday inaugurated the first EU-India Green Hydrogen Forum.
https://indianexpress.com/article/india/eu-india-green-hydrogen-forum-inaugurated-8139435/



Railway Minister Ashwini Vaishnaw Says Hydrogen-Powered Trains Will Be Ready By 2023

Railway Minister Ashwini Vaishnaw on Thursday said that India is developing hydrogen-powered trains and they will be ready by the end of 2023. Speaking at an event in SOA University, Bhubaneswar, the Union Minister shared that Indian Railways is trying to connect remote and unconnected areas of the country with the railway network under its Gati Shakti Terminal Policy and work is progressing at a fast pace. "India has been able to build trains which are among the best in the world and the next big thing will be when the hydrogen-powered train is rolled out on August 15, 2023,"Railway Minister Ashwini Vaishnaw Says Hydrogen-Powered Trains Will Be Ready By 2023 (news18.com)

Alireza Keshavarz, Hussein Abid, Muhammad Ali, Stefan Iglauer

Hydrogen diffusion in coal: Implications for hydrogen geo-storage, Journal of Colloid and Interface Science, Volume 608, Part 2, 2022, Pages 1457-1462, ISSN 0021-9797, https://doi.org/10.1016/j.jcis.2021.10.050

Abstract:
Hypothesis
H_2 geo-storage is considered as an option for large scale hydrogen storage in a full-scale hydrogen economy. Among different types of subsurface formations, coal seams look to be one of the best suitable options as coal's micro/nano pore structure can adsorb a huge amount of gas (e.g. hydrogen) which can be withdrawn again once needed. However, literature lacks fundamental data regarding H_2 diffusion in coal.

Stefan Iglauer1, Hamed Akhondzadeh1, Hussein Abid1, Adriana Paluszny2, Alireza Keshavarz1, Muhammad Ali3, Ausama Giwelli4, Lionel Esteban4, Joel Sarout4, and Maxim Lebede

Hydrogen Flooding of a Coal Core: Effect on Coal Swelling

Pdf Link- https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2021GL096873?src=getftr

Abstract:
Hydrogen is a clean fuel which has the potential to drastically decarbonize the energy supply chain. However, hydrogen storage is currently a key challenge; one solution to this problem is hydrogen geo-storage, with which very large quantities of H_2 can be stored economically. Possible target formations are deep coal seams, and coal permeability is a key parameter which determines how fast H_2 can be injected and withdrawn again. However, it is well known that gas injection into coal can lead to coal swelling, which drastically reduces permeability. We thus injected H_2 gas into a coal core and measured dynamic permeability, while imaging the core via x-ray micro-tomography at reservoir conditions. Importantly, no changes in coal cleat morphology or permeability were observed. We conclude that H_2 geo-storage in deep coal seams is feasible from a fundamental petro-physical perspective; this work thus aids in the large-scale implementation of a hydrogen economy.

Stefan Iglauer

Optimum geological storage depths for structural H_2 geo-storage, Journal of Petroleum Science and Engineering, Volume 212, 2022, 109498, ISSN 0920-4105, https://doi.org/10.1016/j.petrol.2021.109498

Abstract:
Hydrogen geo-storage has been suggested as a key technology with which large quantities of H_2 can be stored and withdrawn again rapidly. One option which is currently explored is H_2 storage in sedimentary geologic formations which are geographically widespread and potentially provide large storage space. The mechanism which keeps the buoyant H_2 in the subsurface is structural trapping where a caprock prevents the H_2 from rising by capillary forces. It is therefore important to assess how much H_2 can be stored via structural trapping under given geo-thermal conditions. This structural trapping capacity is thus assessed here, and it is demonstrated that an optimum storage depth for H_2 exists at a depth of 1100 m, at which a maximum amount of H_2 can be stored. This work therefore aids in the industrial-scale implementation of a hydrogen economy.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECNOLOGY PROGRAM

ISSUE. 02

October, 2022

Recent Report

An update on Hydrogen Valleys and their role in the new hydrogen economy.



AUTHORS

UWE WEICHENHAIN
Partner
uwe.weichenhain@rolandberger.com

MARKUS KAUFMANN
Principal
markus.kaufmann@rolandberger.com

MARTIN HÖLSCHER
Consultant
martin.hoelscher@rolandberger.com

MARTIN SCHEINER
Consulting Specialist
martin.scheiner@rolandberger.com

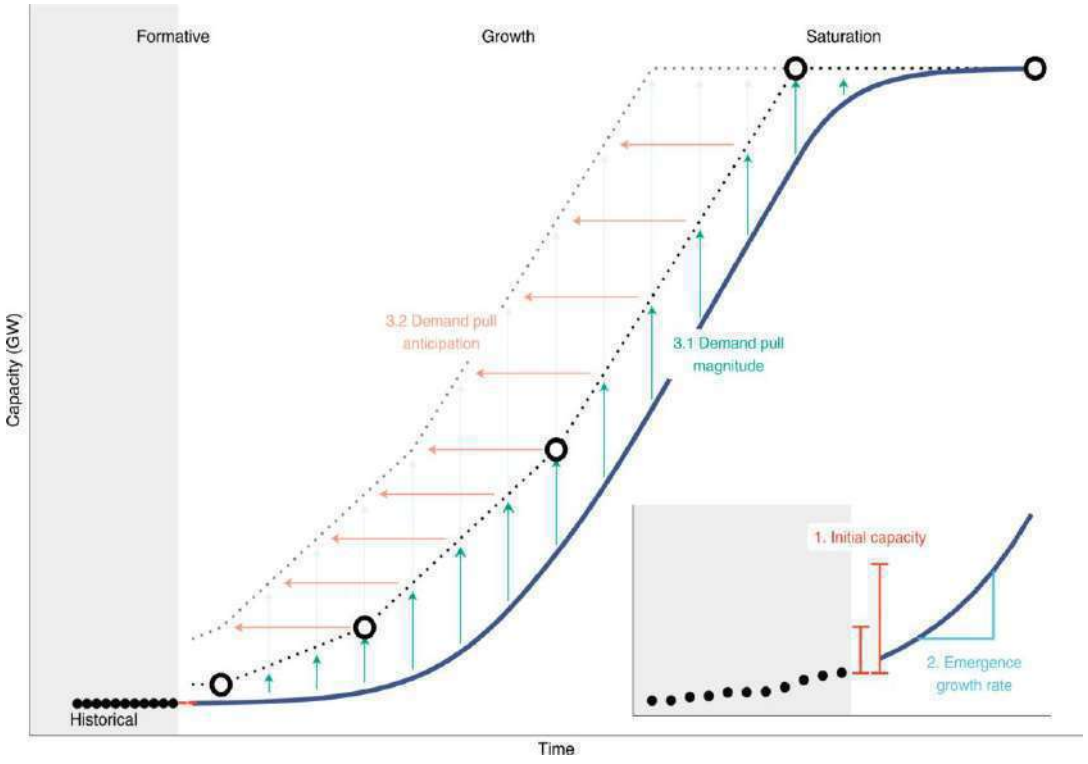
Follow the link to read the full report. Click on- Hydrogen Valleys Update Report (2022)
https://h2v.eu/analysis/reports

Short-term scarcity, long-term uncertainty weighing on green hydrogen

A group of German and US researchers claim that green hydrogen and derived electro fuels will likely supply less than 1% of final energy by 2030 in the European Union and by 2035 throughout the world, if electrolysis grows as quickly as wind and solar power did in the past.

“By 2040, a breakthrough to higher shares is more likely, but large uncertainties prevail with an interquartile range of 3.2% to 11.2% (EU) and 0.7% to 3.3% (globally),” said the researchers. They suggested that short-term scarcity and long-term uncertainty will slow investments in hydrogen end uses and infrastructure, reducing green hydrogen’s potential and jeopardizing climate targets.

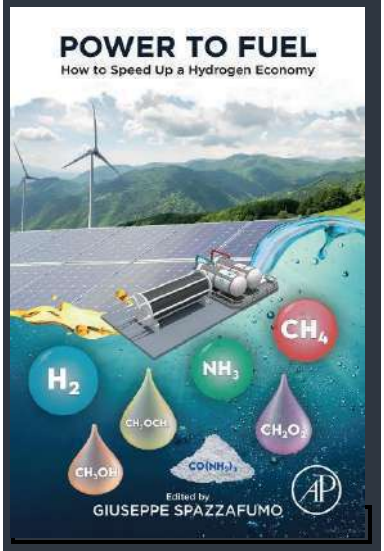
“However, historic analogues suggest that emergency-like policy measures could foster substantially higher growth rates, expediting the breakthrough and increasing the likelihood of future hydrogen availability,” the researchers said in “Probabilistic feasibility space of scaling up green hydrogen supply,” which was recently published in Nature Energy.
Full Article- (Probabilistic feasibility space of scaling up green hydrogen supply | Nature Energy)



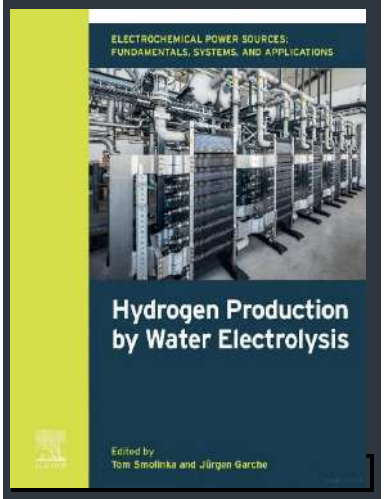
Short-term scarcity, long-term uncertainty weighing on green hydrogen – pv magazine International (pv-magazine.com)

Full Article:-

Recent Books



Spazzafumo, G. (2021) Power to fuel how to speed up a hydrogen economy. Elsevier (ISBN 978-0-12-822813-5)



Smolinka, T. & Garche, J. (2022) Hydrogen production by water electrolysis. Elsevier (ISBN 978-0128194249)

INDUSTRY NEWS

China step towards large-scale coal-to-hydrogen plant

The world's largest coal-to-hydrogen pressure swing adsorption project was officially put into operation in Yulin, Shaanxi province, which marks a major step in the green transition of China's coal industry, according to the state broadcaster China Central Television.

The coal-to-hydrogen project uses coal as the raw material, adopts the large-scale pressure swing adsorption, which is a technology to separate impurities from hydrogen streams, to generate hydrogen from the fossil fuels. It has a total hydrogen production capacity of 350,000 metric tons per year.

As an important means of efficient and clean utilization of coal resources, this technology is of great significance to China's energy security, social and economic development and ecological environment improvement, CCTV said.

The project overcomes the difficulties in design and manufacturing of large-scale coal-to-hydrogen plants, uses self-innovated patented technologies, and achieves efficient resource recycling, pollution treatment and carbon reduction, CCTV said.



https://www.chinadaily.com.cn/a/202209/20/WS63298364a310fd2b29e78bb4.html

Fortescue Doubles Green Hydrogen Spending as Europe Push Expands

Fortescue Metals Group Ltd. more than doubled planned capital expenditure for its green energy arm as it added a new project in Germany, bolstering a push to deliver cleaner fuels to Europe. First delivery of green hydrogen into the TES terminal is anticipated to take place in 2026, with the partners aiming to supply 300,000 tons in an initial phase.

https://www.bloomberg.com/news/articles/2022-10-04/fortescue-doubles-green-hydrogen-spending-as-europe-push-expands

Hydrogen fuel cell tech in trucks is front and center at IAA Transportation 2022

Andreas Gorbach, Daimler Trucks' technical chief, said "There are not elements that can compete with hydrogen,"

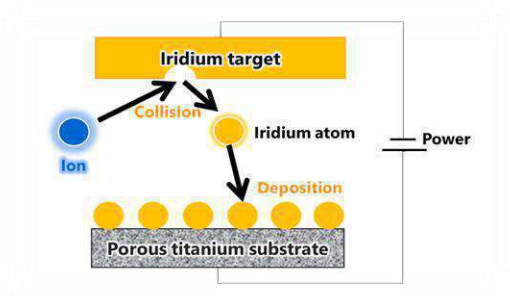
To be sure, there are still major obstacles to overcome before hydrogen fuel cell trucks can start to replace diesel tractors. There's almost no fueling infrastructure. The existing hydrogen supply chain couldn't support trucks by the hundred-thousands

https://dailynewsera.com/2022/09/27/hydrogen-fuel-cell-tech-in-trucks-is-front-and-center-at-iaa-transportation-2022/



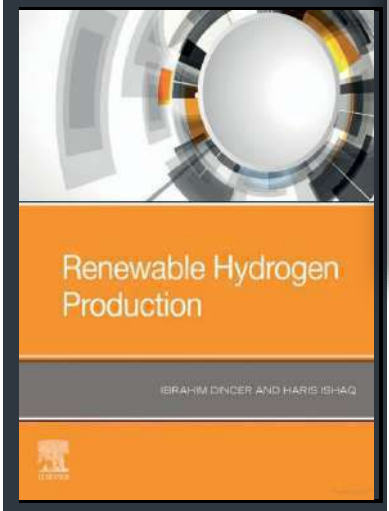
Toshiba's New Large-scale Production Technology for Electrolysis Electrodes for Hydrogen Production from Renewables Cuts Iridium Use to 1/10

Toshiba Corporation (TOKYO: 6502) has developed large-scale production technology for the electrodes that realizes high level efficiency in Power to Gas (P2G) technology, essential know-how for advancing toward a carbon neutral society, while reducing the use of iridium, one of the world's rarest precious metals, to 1/10*1.

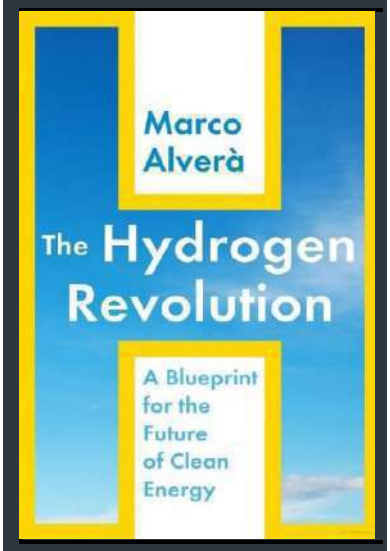


https://www.global.toshiba/ww/technology/corporate/rdc/rd/topics/22/2210-01.html

Recent Books



Dincer, I. & Ishaq, H. (2022) Renewable Hydrogen Production. Elsevier (ISBN 978-0-323-85176-3)



Alvera, M. (2021) The Hydrogen Revolution. Hachette UK (ISBN 9781529360271)



Business Secretary Jacob Rees-Mogg has spoken in favour of hydrogen for heating

Study contradicts Rees-Mogg over hydrogen for heating

A new study has cast doubt on government claims that hydrogen could be used to heat homes and so cut greenhouse gas emissions.

Study contradicts Rees-Mogg over hydrogen for heating - BBC News

Ex-CSIRO chair tempers green hydrogen hype

Hopes for green hydrogen replacing fossil fuels any time soon have been tempered by former CSIRO chairman David Thodey. Australia is increasingly looking at hydrogen to consolidate its future as one of the largest global energy exporters.

But Mr Thodey told business the process of making hydrogen with renewable or low-carbon power was not yet straightforward.

"I love green hydrogen but we have not proven that we can scale it," he said in Sydney.

https://www.sheppnews.com.au/national/ex-csiro-chair-tempers-green-hydrogen-hype/

Titan Cement Group's H2CEM green hydrogen project included in EU Hy2Use initiative

Titan Cement Group says that its H2CEM green hydrogen projection has received inclusion under the EU Important Project of Common European Interest (IPCEI) Hy2Use.

Titan Cement Group aims to achieve carbon neutrality by 2050.

https://www.globalcement.com/news/item/14686-titan-cement-group-s-h2cem-green-hydrogen-project-included-in-eu-hy2use-initiative

Essar Oil UK inks offtake deal with Vertex Hydrogen

Essar Oil UK, promoted by the billionaire Ruia brothers, has signed an offtake agreement with Vertex Hydrogen for the supply of hydrogen to the company to decarbonise its processes.

Vertex is a joint venture between Ravi and Shashi-Ruia promoted Essar Group and Progressive Energy which expects to deliver nearly 4GW of low carbon hydrogen by 2030—equivalent to 40 percent of the UK government's national target.

Essar Oil UK inks offtake deal with Vertex Hydrogen (moneycontrol.com)



Plastic Omnium to supply its full line-up of hydrogen products to Safra, France's leading manufacturer of hydrogen-powered buses

As of 2023, Plastic Omnium will collaborate with Safra to support the development of its Hycity range of hydrogen-powered buses and retrofit service converting diesel coaches to hydrogen.



Plastic Omnium to supply its full line-up of hydrogen products to Safra, France's leading manufacturer of hydrogen-powered buses - JEC Group (jeccomposites.com)

Patents

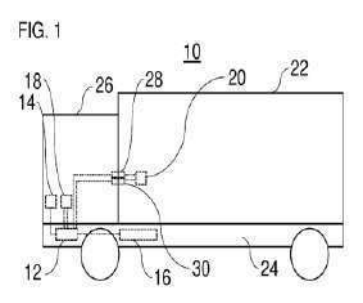
Inventor-Roman Haas, Norbert Burger, Jochen Butscher

WO 2021/148367 A1

UTILITY VEHICLE HAVING FUEL CELL DEVICE

Abstract-

The invention relates to a utility vehicle (10), preferably a truck, comprising a structure (22) or trailer (46) having a consumer (20) and a fuel cell device (12). The fuel cell device (12) is designed to be connectable as a range extender of the utility vehicle (10) and to supply the consumer (20) with electrical power and/or waste heat.



Original patent Link (available in German) WO2021148367A1.pdf (storage.googleapis.com)

Translated patent (in English)- WO2021148367A1 - Utility vehicle having fuel cell device - Google Patents

Sasol to announce green hydrogen deals with local miners soon

South African petrochemical major Sasol will announce partnerships over the next few weeks with local mining companies to supply green hydrogen for their mining operations, said by a senior company executive.

A major part of the South African government's aim to cut climate-warming gas emissions is tied to the private sector's use of green hydrogen for buses, taxis and heavy-duty vehicles such as hauling truck and forklifts in the mines.

https://energy.economictimes.indiatimes.com/news/renewable/sasol-to-announce-green-hydrogen-deals-with-local-miners-soon/94520896



Strohm inks green hydrogen MoU with Chinese offshore wind developer

Strohm, manufacturer of fully bonded Thermoplastic Composite Pipe (TCP), has signed a memorandum of understanding (MOU) with State Power Investment Corporation of China (SPIC) concerning green hydrogen. From its base near Amsterdam, the Netherlands, Strohm designs and manufactures of Thermoplastic Composite Pipe (TCP).

The two companies aim to develop solutions for offshore hydrogen generation as well as transportation. According to Strohm, its TPC technology is ideal for hydrogen applications as it doesn't corrode and it has a long-life span with zero maintenance requirements.

https://www.4coffshore.com/news/strohm-inks-green-hydrogen-mou-with-chinese-offshore-wind-developer-nid26407.html

Hydrogen Powered Bike Now on Sale in Nanjing!

China's first hydrogen-powered bicycle went on sale. The bike supports 2.5 hours of continuous riding, has a range of 55 kilometres, a maximum speed of 22 kilometres per hour and a price tag of ¥12,800.

And being the first, it's called the Alpha. Even better, it's the product of a company based right here in our very own Jiangsu Province; Yong'anhang Technology Co., Ltd., out of Changzhou City.



Meet the Hydrogen Powered Bike Now on Sale in Nanjing! | The Nanjinger

Kawasaki, Toyota join hands to develop hydrogen powered bike

The deal that the two Japanese giants, Kawasaki and Toyota, have struck entails accelerating the development of hydrogen as a sustainable alternative, improving the global infrastructure and upgrading extraction methods.

Right now, the automobile industry as a whole is grappling with switching over from fossil fuels to electrification. Hence, hybrids, as well as alternative fuel sources (such as hydrogen), make for a good bridge to electrification. At the moment, the major issue with electrification is the long charging durations and since alternative fuels like hydrogen are much easier to replenish than charging a battery, they help mitigate the problem.

https://www.autocarindia.com/bike-news/kawasaki-toyota-join-hands-to-develop-hydrogen-powered-bike-425895



Inventor-Brian D. Morrison

WO2020257646

LIGHTWEIGHT HIGH POWER DENSITY FAULT-TOLERANT FUEL CELL SYSTEM, METHOD AND APPARATUS FOR CLEAN FUEL ELECTRIC AIRCRAFT

Abstract- A lightweight, high power density, fault-tolerant fuel cell system, method, and apparatus for full-scale clean fuel electric-powered aircraft having a fuel cell module including a plurality of fuel cells working together to process gaseous oxygen from air compressed by turbochargers, superchargers, blowers or local oxygen supply and gaseous hydrogen from liquid hydrogen transformed by heat exchangers, with an electrical circuit configured to collect electrons from the plurality of hydrogen fuel cells to supply voltage and current to motor controllers commanded by autopilot control units configured to select and control an amount and distribution of electrical voltage and torque or current for each of the plurality of motor and propeller assemblies, wherein electrons returning from the electrical circuit combine with oxygen in the compressed air to form oxygen ions, then the protons combine with oxygen ions to form H2O molecules and heat.

WO2020257646A1.pdf (storage.googleapis.com)

India's 1st Ever Hydrogen Train Launching…

The Union Minister, Ashwini Vaishnav has confirmed this news and has stated that this hydrogen-powered train will be designed, developed, and manufactured indigenously.
The first hydrogen-powered train in the world was introduced in Germany last month. Ashwini Vaishnav, Minister of Railways, Communications and Electronics & Information Technology in Government of India, stated, "India has been able to build trains which are among the best in the world and the next big thing will be when the hydrogen-powered train is rolled out on August 15, 2023."



https://trak.in/tags/business/2022/09/25/indias-1st-ever-hydrogen-train-launching-on-this-date-find-out-how-it-works/

NTPC signed MoU with GE Gas Power to demonstrate the feasibility for hydrogen (H_2) co-firing blended with natural gas in GE's 9E gas turbines.

State-owned NTPC has roped in GE Gas Power to help it reduce carbon emissions at its 645 MW Kawas gas power plant in Gujarat. Both companies have entered into a Memorandum of Understanding (MoU) in this regard.
"MoU is to demonstrate the feasibility for hydrogen (H2) co-firing blended with natural gas in GE's 9E gas turbines installed at NTPC's Kawas combined-cycle gas power plant in Gujarat...and further implementation at scale across NTPC's installed units in India," GE Gas Power said in a statement.
ntpc: NTPC ropes in GE Gas Power to reduce CO2 emissions at plants in Gujarat - The Economic Times (indiatimes.com)

Avaada Group signs MoU for Rs 40,000 crore Green Ammonia plant with Rajasthan government

Avaada Group, an integrated energy platform, has signed a memorandum of understanding with the department of industries and commerce, Government of Rajasthan, to set up a green ammonia facility and a renewable energy power plant in Kota, Rajasthan.
The MoU, is part of the investment promotion strategy for the Investment Rajasthan Summit held in New Delhi.
Vineet Mittal, Chair, Avaada Group, said, "The biggest advantage of green hydrogen is that it burns clean, leaving only water vapour behind. For industries that require high-temperature heat, such as foundries and glass and steelmakers, this could be ground-breaking as it will not only replace fossil fuels with renewable sources but also produce green ammonia and a substitute for gas."
https://economictimes.indiatimes.com/industry/indl-goods/svs/chem-/-fertilisers/avaada-group-signs-mou-for-rs-40000-crore-green-ammonia-plant-with-rajasthan-government/articleshow/93758502.cms?from=mdr

Collaboration of IESA with DST for Research and Development Fellowship Program

Union Government of India's Department of Science and Technology (DST) and India Energy Storage Alliance (IESA) have announced their collaboration for Research and Development fellowship program.
As the world shifts towards clean energy, the DST-IESA Industry Research and Development Fellowship program provides a pathway for post-doctoral researchers to pursue their industrial research careers in the clean energy sector.
https://etn.news/buzz/iesa-dst-research-development-fellowship-program-details



Coppens Leo, Gargiulo, Maurizio, Orsini, Marco, Arnould, Nathalie

Achieving-55% GHG emissions in 2030 in Wallonia, Belgium: Insights from the TIMES-Wal energy system model, Energy Policy, Volume 164, 2022, 112871, ISSN **0301-4215**.
10.1016/j.enpol.2022.112871

Abstract:
The Walloon Region has undertaken the ambitious engagement to reduce its greenhouse gases (GHG) emissions up to-55% in 2030. In this context, a regional model of the energy system is a useful tool to give insights to policy makers. We address the lack of an existing integrated tool by developing a technology-rich, bottom-up model for the region. The goal of this paper is twofold: we present the model and its functioning and then we analyse a cost-optimal way to reach the-55% regional target. Firstly, we describe the methodology, discussing how we build the sectors of our model and how the optimisation works. Secondly, we run the model with a constraint on GHG emissions to assess the impact of the mitigation target. We show that the total system cost of such an ambitious mitigation scenario is only ~0.5% higher than the cost of an unconstrained reference scenario and that emissions reduction must start as soon as possible to stay on the cost-effective trajectory. Concerning technologies, windmills, photovoltaic (PV) panels and building renovations are cost-optimal solutions even with high discount rates.

Agyekumm Ephraim Bonah, Nutakor Christabel, Agwa Ahmed M, Kamel, Salah

A Critical Review of Renewable Hydrogen Production Methods: Factors Affecting Their Scale-Up and Its Role in Future Energy Generation, Energy Policy, Volume 12, 2022, 173, ISSN **2077-0375**.
10.3390/membranes12020173

Abstract:
An increase in human activities and population growth have significantly increased the world's energy demands. The major source of energy for the world today is from fossil fuels, which are polluting and degrading the environment due to the emission of greenhouse gases. Hydrogen is an identified efficient energy carrier and can be obtained through renewable and non-renewable sources. An overview of renewable sources of hydrogen production which focuses on water splitting (electrolysis, thermolysis, and photolysis) and biomass (biological and thermochemical) mechanisms is presented in this study. The limitations associated with these mechanisms are discussed. The study also looks at some critical factors that hinders the scaling up of the hydrogen economy globally. Key among these factors are issues relating to the absence of a value chain for clean hydrogen, storage and transportation of hydrogen, high cost of production, lack of international standards, and risks in investment. The study ends with some future research recommendations for researchers to help enhance the technical efficiencies of some production mechanisms, and policy direction to governments to reduce investment risks in the sector to scale the hydrogen economy up.

Yanfei Li, Farhad Taghizadeh-Hesary

The economic feasibility of green hydrogen and fuel cell electric vehicles for road transport in China, Energy Policy, Volume 160, 2022, 112703, ISSN **0301-4215**.
https://doi.org/10.1016/j.enpol.2021.112703

Abstract:
In September 2020, the Chinese central government announced a new policy to develop hydrogen energy and fuel cell applications. It emphasized fuel cell commercial vehicles rather than passenger vehicles. Such an emphasis is drastically different from the hydrogen and fuel cell strategies of other leading economies. This study aims at providing insights into the justification behind it. It develops quantitative models to conduct economic assessments of the feasibility of hydrogen energy produced from renewable energy and subsequently applied in the road transport sector in China. A well-to-wheel model is developed to estimate the carbon emissions of the hydrogen supply chain as well as that of the fuel cell electric vehicles. In the meantime, a levelised cost of hydrogen model is adopted to analyze the cost of hydrogen as storage for renewable energy. These are followed by a total cost of ownership model applied to assess the cost of owning and driving fuel cell electric vehicle, fueled by the hydrogen produced from renewables, compared to alternative vehicle powertrains, especially those fossil fuel-based. On such a basis, the relation between energy policies and the competitiveness of hydrogen produced from renewable energy and the fuel cell electric vehicle is discussed.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECNOLOGY PROGRAM

ISSUE. 03

October, 2022

HYDROGEN FROM YOUR ROOFTOP

Johan Martens, Tom Bosserez and Jan Rongé (BE)

Finalist for the European Inventor Award 2022



Invention: Green hydrogen from sunlight and air

Patent numbers:
EP3027788, EP3452638

Johan Martens, Tom Bosserez and Jan Rongé have invented a solar panel that produces clean hydrogen gas from sunlight and ambient moisture, potentially providing an alternative source of green energy for buildings around the world.

Growing market for green innovation

Martens has worked with Bosserez and Rongé on the solar hydrogen panel since 2013 and they are currently field-testing their technology. The trio plan to establish a spin-off company later this year, leaving them placed to capitalise on the green hydrogen market that is estimated to grow to over EUR 3 billion within the next five years.

EPO - Martens

DEVICE FOR HYDROGEN AND ELECTRICITY PRODUCTION

Abstract:-

Thus, there is a need in the art for an operational device that under sunlight does generate hydrogen from ambient air humidity. Present invention provides such solution, without any water oxidation co-catalyst (e.g. IrRuOx), by a hydrogen generating device comprising at least one semiconductor photoanode which surprisingly performs the water oxidation without back reaction and without deteriorated photoefficiency. In a particular embodiments this device to improve efficiency under ambient conditions of air and sunlight comprises an illumination controller, such controller can be 1) an illumination intensity controller, 2) a filter to filter out visible light to reduce dehydration or heating up and/or 3) a switch (illumination / non- illumination switch) to let follow in succession periods of illumination of the at least one semiconductor photoanode with periods of non-illumination (darkness) of the at least one semiconductor photoanode. In yet another embodiment the membrane electrode assembly (MEA) comprises incorporating hygroscopic silica. By introducing dark periods are switched with illuminations periods for instance of ca. 200- 1000s of illumination high photocuiTents are retained. The semiconductor photoanode hydrogen generating device of present invention, without water oxidation co-catalyst can combine any of the illumination controllers with the hygroscopic silica comprised in the MEA.
https://worldwide.espacenet.com/patent/search/family/050737663/publication/EP3027788A1?q=pn%3DEP3027788

HYDROGEN PRODUCING APPARATUS

Abstract:-

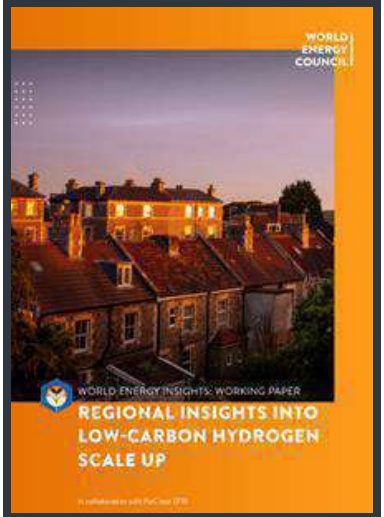
The production of one of the simplest molecules, hydrogen (H2), from water and sunlight is an attractive option for storing renewable energy. The objective of the present invention is to provide an efficient method for generating hydrogen from ambient air humidity and light as energy source. This method is carried out with an assembly of photovoltaic (PV) cells and a two compartment apparatus that can be fabricated using existing and low cost methods and devices. For keeping a satisfactory level of hydration while maintaining a device operation at sufficient temperatures, a well-designed temperature and hydration management system/strategy is employed. During the day, solar cells, connected in series in a module configuration, provide the required voltage to drive the water splitting reactions. During operation light transmitted through the PV-module is heating up a heat absorber/collector directly connected to a reversible water sorption material and water is released from this reversible water sorption material and will diffuse through the ion exchange material, thereby wetting it. During operation water is oxidized at the anode and O2 is release into air. Simultaneously H2 is produced and collected at the cathode. During the night, cool humid air circulates through the device and the reversible water sorption material can replenish. The device of present invention reaches a solar to hydrogen efficiency above 5%.

https://worldwide.espacenet.com/patent/search/family/059298147/publication/EP3452638A1?q=pn%3DEP3452638

WORKING PAPERS



https://www.worldenergy.org/assets/downloads/Working_Paper_-_Hydrogen_Demand_And_Cost_Dynamics_-_September_2021.pdf?v=1658324860



https://www.worldenergy.org/assets/downloads/World_Energy_Insights_Working_Paper_Regional_insights_into_low-carbon_hydrogen_scale_up.pdf?v=1654526979

Lhyfe to build a large-scale green hydrogen production plant in Netherland

The 200MW facility at the Delfzijl chemical cluster, in the Groningen province, will be capable of producing more than 20,000 tons of renewable green hydrogen per year.
Lhyfe aims to support companies in their decarbonisation efforts by supplying them with renewable green hydrogen using renewable electricity from the region in the electrolysis process. This 'hydrogen backbone' will be based on the soon to be abandoned Groningen gas grid. Old salt caverns will be converted to store hydrogen along the backbone, securing a steady flow of green hydrogen to the industrial users when renewable energy is not available.
The Engineer - Lhyfe to build Netherlands green hydrogen plant

Faurecia gets 213 mln euros from the EU to develop hydrogen project in France

France's Faurecia said its hydrogen technology project was granted 213 million euros ($208.72 million) of public support from the European Commission as part of the Hydrogen IPCEI programme.
The company aims to create affordable clean mobility solutions by developing and industrialising a new generation of hydrogen tanks, both gaseous and liquid, by the end of 2027, it said in a statement.
https://auto.economictimes.indiatimes.com/news/oil-and-lubes/faurecia-gets-213-mln-euros-from-the-eu-to-develop-hydrogen-project-in-france/94617295

Atura Power selects Cummins to design, manufacture 20 MW electrolyzer system for Niagara Hydrogen Centre

Atura Power has selected Cummins Inc. (NYSE: CMI) to design and manufacture the electrolyzer system for its Niagara Hydrogen Centre in Niagara Falls, Ont. This will be Ontario's first 20-megawatt (MW) green hydrogen facility.
Cummins' proton exchange membrane (PEM) electrolysis system will be manufactured at its Mississauga, Ont. facility and become the centrepiece of Atura Power's Niagara Hydrogen Centre. This electrolzer system will be powered by renewable hydroelectricity, and the carbon-free green hydrogen will then be available to industrial customers for immediate consumption.
It will also be transported and blended into the fuel stream at Atura Power's Halton Hills Generating Station, creating cleaner electricity for Ontario.
Atura Power selects Cummins to design, manufacture 20 MW electrolyzer system for Niagara Hydrogen Centre | Cummins Inc.

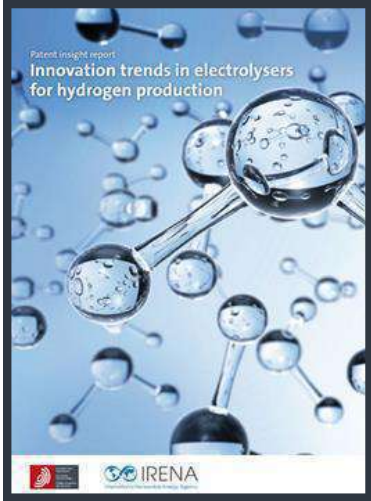


Testing of the hydrogen-powered train took place at the Scottish Rail Preservation Society

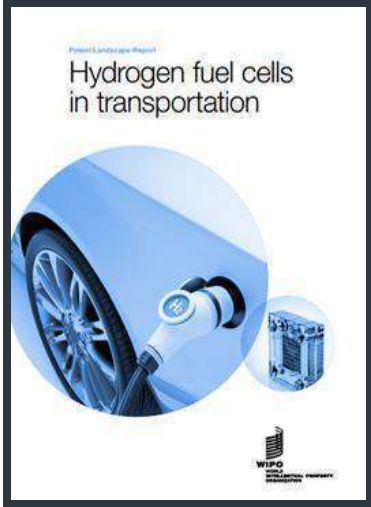
The project is a partnership between the University of St Andrews, Transport Scotland, Scottish Enterprise, Ballard Motive Solutions, Abbott Risk Consulting, ARUP, Aegis and Angel Trains.
The project entailed the conversion and re-use of a 40-year-old three-car Class 314 train to a hydrogen fuel cell electric powertrain. The ex-Class 314 train has been re-tractioned and reclassified as a Class 614 hydrogen-powered train.
Green hydrogen produced from the on-site electrolyser connected to the temporary refueller played a key role during the demonstration of the project. Refuelling infrastructure and its location will be critical to future train deployments.
Scottish hydrogen train project on track to deliver climate targets | University of St Andrews news (st-andrews.ac.uk)



PATENT REPORTS



https://documents.epo.org/projects/babylon/eponet.nsf/0/9C24662A1E0C3B7DC125883F0045C644/$File/patent_insight_report_innovation_trends_for_electrolysers_in_hydrogen_production_en.pdf



https://www.wipo.int/edocs/pubdocs/en/wipo-pub-1076-en-patent-landscape-report-hydrogen-fuel-cells-in-transportation.pdf



H2Boat orders H2 fuel cell motor from Nuvera

A memorandum of understanding (MoU) was signed by the system integrator H2Boat from Italy and Nuvera Fuel Cells from the US, a manufacturer of heavy-duty hydrogen fuel cell engines.

H2Boat orders H2 fuel cell motor from Nuvera - Green Hydrogen News (energynews.biz)

Volvo Penta partners with CMB.TECH to speed up dual-fuel hydrogen engine development

Volvo Penta, a leading global manufacturer of engines, has announced its partnership with CMB.TECH to accelerate the development of dual-fuel hydrogen-powered solutions for both on land and at sea applications.

CMB.TECH owns, operates, and designs large marine and industrial applications powered by hydrogen and ammonia – fuels that it both manufactures and supplies to its customers. Volvo Penta is a world-leading and global manufacturer of engines and complete power systems for boats,vessels, and industrial applications.

dual-fuel hydrogen-powered solutions: Volvo Penta partners with CMB.TECH to speed up dual-fuel hydrogen engine development, Auto News, ET Auto (indiatimes.com)

Ohmium, Amp Energy India collaborate on 400 MW of green hydrogen projects.

Ohmium International and Amp Energy India have collaboratedto deploy 400 MW of green hydrogen projects in the next three years. "Ohmium International, Inc, a green hydrogen company that designs, manufactures, and deploys PEMElectrolyzers, is collaborating with Amp Energy India Private Ltd, a leading renewable energy IPP (independent power producer), to deploy 400 MW of green hydrogen projects," a statement said.

Ohmium, Amp Energy India collaborate on 400 MW of green hydrogen projs - Times of India (indiatimes.com)

Demand for hydrogen expected to rise to 8 million tons by 2030, finds study

Center for Study of Science, Technology and Policy (CSTEP) examines the status of hydrogen technologies and envisages what a hydrogen economy could look like for India in the future.

The study estimates a hydrogen demand of 8 to 8.8 million tons (Mt) by 2030, which is expected to rise to 15-19 Mt by 2047. It finds that though the demand from refineries and fertiliser sectors will continue to exist, hydrogen demand will primarily be driven by the growth of green hydrogen use in sectors such as steel, heavy-duty freight, and blending in city-gas-distribution (CGD) grids.

Demand for hydrogen expected to rise to 8 million tons by 2030, finds study | Indiablooms - First Portal on Digital News Management

Massive Hydrogen Fuel Truck for Mining Industry

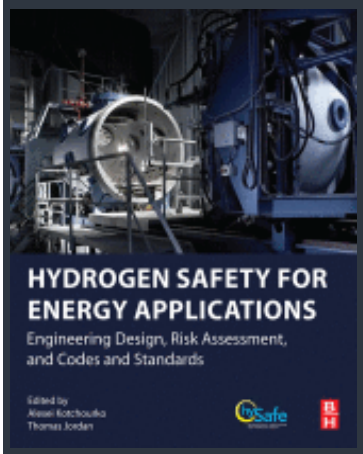
The H2-powered vehicle is meant to replace typical mining haul vehicles, which pollute heavily.The colossal hydrogen fuel truck must generate 2 megawatts of electricity per second to operate.The amount of electricity required to power the truck is about the equivalent to powering 1,500 US homes.

Massive hydrogen fuel truck to help decarbonize the mining industry - H2 News (hydrogenfuelnews.com)

RECENT BOOKS

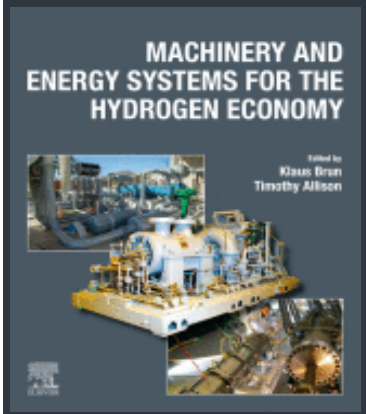
Hydrogen Safety for Energy Applications

Engineering Design, Risk Assessment, and Codes and Standards



Edited by:
Alexei Kotchourko and Thomas Jordan
https://doi.org/10.1016/C2018-0-00342-4

Machinery and Energy Systems for the Hydrogen Economy



Edited by:
Klaus Brun and Timothy Allison
https://doi.org/10.1016/C2020-0-03643-1

Norwegian Statkraft announces first UK renewable hydrogen project

The Trecwn Green Energy Hub project is slated to generate about 3 tonnes/day of renewable hydrogen. Statkraft stated that the green hydrogen generated at Trecwn will be used to power trains which could also power Pembrokshire Council's fleet of HGV lorries and local buses.
https://www.icis.com/explore/resources/news/2022/10/11/10813700/norwegian-statkraft-announces-first-uk-renewable-hydrogen-project/

'Hydrogen hub' planned for test track in Michigan



Albuquerque, N.M.- based BayoTech Inc. aims to open a "hydrogen hub" at the center by mid-2023 which is a modular hydrogen production system is being planned for the American Center for Mobility near Detroit as the vehicle test track looks to adapt its vision to the needs of its customers and the market. The company would install prefab hydrogen units capable of pumping out 1,000 kilograms of hydrogen per day, or enough to fill up 200 hydrogen vehicles.
It marks BayoTech's entrance into the market and is the first hydrogen project of its kind in Michigan as the fuel technology.
https://www.autonews.com/mobility-report-newsletter/hydrogen-hub-planned-test-track-michigan

Hydrogen Infrastructure Leader GenH2 Announces Record Number of NASA Patent Licenses

GenH2, a premier provider of hydrogen infrastructure solutions, officially confirmed that it now holds the most active NASA patent license agreements by any private company, procured through NASA's Technology Transfer Program.
"The benefit of NASA license agreements is that they allow us to deploy proven technology to our hydrogen solutions that give us a pathway to commercializing our technology as well as reduce te time to market," said Cody Bateman, Founder and CEO of GenH2. "Even though our company is only two years old, we've already accrued a historical amount of intellectual property through these license agreements."
GenH2 currently holds a record twenty NASA license agreements, specifically from the Kennedy Space Center (KSC), `the John H. Glenn Research Center (GRC) and the Marshall Space Flight Center (MSFC). GenH2 also has a record number of patents licensed by private companies at two of those centers, KSC and GRC.
Hydrogen Infrastructure Leader GenH2 Announces Record Number of NASA Patent Licenses (tmcnet.com)

Engineers Retrofit Diesel Engine to Use Hydrogen as Fuel, Develop Dual-Fuel System

Engineers at University of New South Wales (UNSW) have found success in retrofitting a diesel powertrain to use hydrogen as a fuel in order to reduce carbon emissions.
The engineering team took one and a half years to develop a dual-fuel injection system which takes 90 percent hydrogen as a fuel.The dual-fuel injection system developed by engineers retains the original diesel injection into the engine, albeit with the addition of a hydrogen fuel injection directly to the cylinder.The team also found a way to counter the high nitrogen oxide (NOx) emissions which happen with hydrogen engines. The researchers didn't put hydrogen into the engine and mix it up, instead an approach of stratified addition, i.e. more hydrogen in certain parts and less in certain parts, was followed so that NOx emissions are omitted. Eventually, the NOx emissions were reduced upto a significant stage in the dual-fuel engine.
Engineers Retrofit Diesel Engine to Use Hydrogen as Fuel, Develop Dual-Fuel System (msn.com)



National Hydrogen Mission: India to become hub of renewable hydrogen worldwide, three centres to be set up

(English version of Hindi News-Amar Ujala Newspaper)
https://www.amarujala.com/india-news/national-hydrogen-mission-india-will-become-hub-of-renewable-hydrogen-three-centers-will-be-established?pageId=1

DST, under the National Hydrogen Mission, a target has been set to produce one million tonnes of hydrogen by 2030 as renewable energy.

The plants will be ready at a cost of Rs 90 crore. This is how the work will proceed:

Phase 1- 2023-2027: According to the Ministry of Science and Technology, plants will be built for hydrogen production in the valley at a cost of Rs 90 crore.

Phase 2: 2028-2033: Storage rooms will be built in the valley. Security arrangements will also be made so that incidents can be avoided.

Phase 3: 2034-2050: Areas will be created for distribution in the valley. A separate area for hydrogen production will also be created for the cement-steel industry.



Yavatmal youths claim their car runs 250km on Rs 150 hydrogen, plan mass production

Hashal Nakshane, a farmer's son and mechanical engineer, have built a completely made-in-India electric car. The AI controlled Sonic One is claimed to run 250 km on one litre of hydrogen which costs up to just Rs 150. It is also said to have better pick-up than fossil fuel vehicles and a top speed of 200km per hour. The entrepreneurs, who call themselves "AiCars", have proved these numbers when they took it out for drive from Wani to Nagpur and demonstrated it to Union minister of road and transport Nitin Gadkari who assured support to launch it commercially. This homemade masterpiece produced in the backyard workshop of their house, was made with an investment of Rs 25 lakh; but mass production will reduce the cost. They aim to begin deliveries of these cars by 2024.
https://timesofindia.indiatimes.com/city/nagpur/yavatmal-youths-claim-their-car-runs-250km-on-rs150-hydrogen-plan-mass-production/articleshow/94690413.cms#:~:text=Harshal%2C%20a%20mechanical%20engineer%2C%20and%20his%20childhood%20friends,this%20car%20to%20run%20not%20less%20than%20250km.



Rajasthan to be first state to implement green hydrogen policy: Minister

Rajasthan Industries Minister Shakuntala Rawat said that the state would be the first in the country to implement a green hydrogen policy.Rawat was addressing the 'Future Ready Sector Conclave' as part of the Invest Rajasthan summit here. In her address, Rawat said that the state has made unprecedented progress in the field of renewable energy."Today Rajasthan is the first state in the whole country in the field of solar energy," the minister said, as she stressed on the proper use of natural resources.
Rajasthan to be first state to implement green hydrogen policy: Minister | Business Standard News (business-standard.com)

NTPC, Gujarat Gas 'blend' hydrogen for homes

Indian government-owned National Thermal Power Corporation (NTPC) and Gujarat Gas are planning an ambitious project to blend hydrogen gas with PNG.
NTPC aims to reach out to its 200-home housing colony in the city of Gujarat by using about 100 cm/d of PNG where it will initially blend hydrogen.
The company aims to roll out this project by the end of this financial year.
https://timesofindia.indiatimes.com/city/ahmedabad/ntpc-guj-gas-blend-hydrogen-for-homes/articleshow/86916730.cms

India set to achieve 450 GW renewable energy installed capacity by 2030: Ministry of New and Renewable Energy (MNRE)

MNRE in partnership with FICCI, organised a series of events, during the Climate and Biodiversity Week at Expo 2020 Dubai.
Addressing the MNRE-FICCI – SECI event, Shri R.K. Singh, Minister of Power, New and Renewable Energy said, "MNRE will work out with bids for electrolysers and that mandates for green hydrogen consumption in refining, fertilizer, piped natural gas." SECI will continue to work towards meeting the ambition of 450 GW by 2030.
Shri Bhagwanth Khuba said, "India is developing the National Green Hydrogen Energy Mission to scale up green hydrogen production and utilization across multiple sectors." India is targeting initially approximately 1 million tonnes annual green hydrogen production by 2030.
https://pib.gov.in/PressReleasePage.aspx?PRID=1762960

Foster Lubbe, Jacques Maritz, Tom Bosserez, Jan Range, Johan A Marten

A multi-perspective analysis of microclimate dynamics for air-based solar hydrogen production, Heliyon, Volume 8**,** 2022, e09883, ISSN **2405-8440**

https://doi.org/10.1016/j.heliyon.2022.e09883

Abstract:

Navigating the microclimatic environment for the optimal control of water-from-air devices could be a challenge. An example of such a device is an air-based solar hydrogen production device. Such a device promises the ability for off-grid, easily deployable and modular hydrogen production for on-site consumption. Novel analysis techniques, such as wavelet transform coherence analysis, could assist in better understanding the microclimate in which air-based hydrogen production devices might function. The analysis becomes complicated when a system is evaluated at the microclimatic level, especially when it is considered that the performance of air-based solar hydrogen devices are not only dependent on solar radiation, but also on humidity levels in the air. To get a grasp of the interactions that take place within a microclimatic system, a two-tiered approach is presented. It has been shown that relative humidity and temperature is stratified close to the ground, and that the stratification undergoes an inversion twice per day. A possible link between absolute humidity and wind direction is observed and humidity rallies are identified. Using microclimate monitoring and wavelet transform coherence analysis, an attempt is made to disentangle microclimatic variables by pointing out regions of high coherence and regions of low coherence between different variables. It is furthermore suggested that the propagation direction of a humidification process within the microclimate can be determined by considering the phase angle between relative humidity timeseries at different heights above the ground, using wavelet transform coherence analysis. It has been demonstrated that wavelet transform coherence analysis, in conjunction with a comprehensive microclimate monitoring process, could support the understanding of the complex processes that occur within the microclimatic environment and therefore support the management of water-from-air systems. In this regard a management framework is also presented.

Gianluca D'Olimpio, Sergio Santoro, Chia-Nung Kuo, Luca Ottaviano, Chin Shan Lue, Danil W. Boukhvalov, Antonio Politano

Sustainable Hydrogen Production Using Group-10 Metal Chalcogenides as Low-Cost Effective Electrocatalysts, Advanced Sustainable systems, 2022, 2200168, ISSN **2366-7486**

https://doi.org/10.1002/adsu.202200168

Abstract:

Clean hydrogen production is crucial to the prospects of the energy transition. Electrochemical water splitting is one of the most promising tools for the sustainable and efficient production of hydrogen. One of the main open challenges is the replacement of precious Pt for electrodes with new materials combining cheapness, robustness to CO poisoning, and fast reaction kinetics. Group-10 metal chalcogenides represent suitable candidates to address all main open challenges in the quest for alternative materials to pure Pt as electrocatalysts, with the further advantage of the ease of their synthesis as both bulk crystals and nanostructures. All compounds of this class of materials show surface stability, chemical inertness toward CO adsorption, and electrode durability in acidic and alkaline environments. Here, the physicochemical mechanisms ruling hydrogen production with group-10 metal chalcogenides are focused on by combining surface-science experiments and theory. Especially, the Tafel slope in Pt3Te4 nanocrystals and NiTe2 nanotubes is as low as 32 and 59 mV dec(-1), respectively, making them competitive with state-of-the-art reference materials Pt and Pt/C already in the first implementation. Moreover, the presence of massless Dirac-cone electrons in many group-10 metal chalcogenides, with an intrinsically large electron mobility, is naturally beneficial for fast electron transfer, and correspondingly, for fast reaction kinetics. These results pave the way for the advent of this new class of materials in electrocatalysis, and for sustainable hydrogen production through water splitting.

Paul C. Okonkwo, El Manaa Barhoumi, Ibrahim B. Mansir, Wilfred Emori, Himangshu Bhowmik

Effect of electrode material on the hydrogen production using a low-cost home-made alkaline electrolyzer, Vacuum, Volume 198, 2022, 110878, ISSN **1879-2715**

https://doi.org/10.1016/j.vacuum.2022.110878

Alkaline water electrolysis was experimentally performed using a low-cost homemade alkaline electrolyzer to produce hydrogen. The effect of electrode material on hydrogen production and efficiency was investigated. The results showed that although the increase in temperature increases the voltage, and current, the electrode material has a significant effect on hydrogen production. From the study, it was found that the stainless steel 316L Smaller electrode is a better choice for hydrogen production compared to the carbon steel electrode.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECNOLOGY PROGRAM

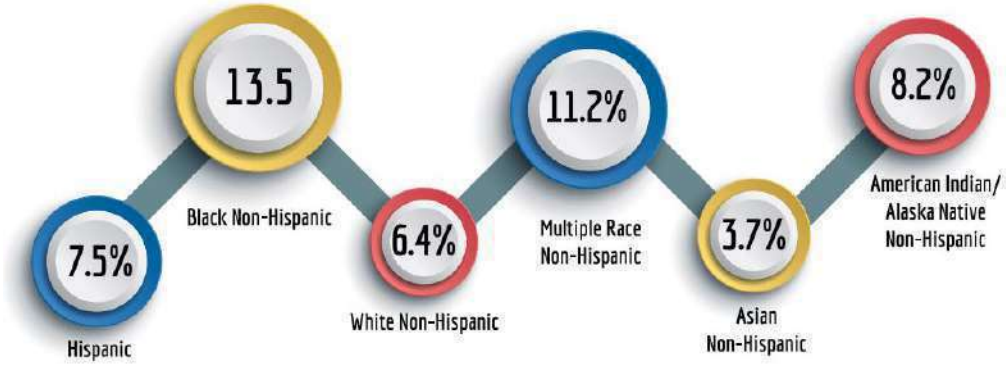
ISSUE. 04

October, 2022

HYDROGEN: TO BLEND OR NOT TO BLEND

Hydrogen blending with natural gas 'puts lives at risk.

Two doctors' groups have denounced burn of hydrogen-methane blends in indoor spaces on the grounds that it supercharges the symptoms of asthma and dementia and raises the likelihood of fatal gas explosions – saying it "puts lives at risk".



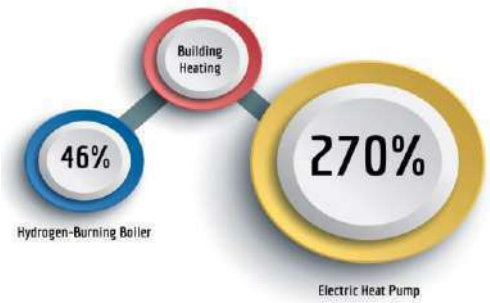
Adapted from Centers for Disease Control and Prevention, 2021[97]

Six failings of hydrogen blending – it increases greenhouse gases, it maintains dependence on unhealthy methane gas, it uses renewable energy inefficiently with little climate benefit, it increases costs, it raises safety risks and it perpetuates health inequities.

Hydrogen blending will lock in reliance on methane - Hydrogen blending prolongs the reliance on methane gas and expands the demand for it. To maximize the health benefits of mitigating climate change, the use of fossil hydrogen to heat buildings must be avoided.

Using green hydrogen for heating is an inefficient use of renewable energy- Blending hydrogen is limited by end-use appliances, blending is insufficient to meet climate targets, heat pumps are more efficient than green hydrogen, an appropriate role for green hydrogen in a low-carbon future.

Figure 1: Energy Efficiency Comparison: Heat Pumps 6x More Efficient



The Energy Transitions Commission, 2021

Blending hydrogen will increase consumer costs- Blending hydrogen with methane will increase the cost of gas-based cooking and space and water heating.

Figure 2: Cost Comparison of Three Modes of Hydrogen Production



International Energy Agency, 2019

International Hydrogen Day chosen to be on 8th October - As Hydrogen says it's my atomic weight 1.008. (10-08)

PNNL supports the mission of DOE's Hydrogen & Fuel Cell Technologies Office by exploiting the interplay of hydrogen and electrons. On October 8 of every year, scientists and engineers across the country celebrate National Hydrogen & Fuel Cell Day. The date October 8 was aptly chosen for the atomic weight of hydrogen (1.008).

https://www.pnnl.gov/events/hydrogen-day#:~:text=On%20October%208%20of%20every,weight%20of%20hydrogen%20(1.008).

Why burning hydrogen in buildings is bad for climate and health



Andee Krasner, MPH and Barbara Gottlieb

https://psr.org/wp-content/uploads/2022/07/hydrogen-pipe-dreams.pdf



India Patent trends for Hydrogen Fuel Cell for automobiles

Hydrogen fuel cell technology for transportation - patenting activity in India

We analysed around 1800 patent families related to hydrogen fuel cells in automobiles that have been filed and published in India over the past 40 years. Out of them, 68.92% have been granted while 15.96% are still in prosecution stage.

Toyota and Honda are two companies that lead in filing patents in India in this area of interest. Both these companies have been at the forefront of research related to incorporating Hydrogen Fuel Cell technology in automobiles. Honda has been testing vehicle models since the 1990s that run on Hydrogen.

We also see chemical manufacturing companies like LG and Sumitomo and fuel cell companies like Bloom Energy filing patent applications in India.

Automobile and chemical manufacturing companies are investing heavily in furthering the technology.

To see the full report-
https://evreporter.com/india-patent-trends-for-hydrogen-fuel-cells-for-automobiles/

INDUSTRY NEWS

Alpine Alpenglow- Hydrogen-powered futuristic hyper car.

On the occasion of the Paris Motor Show, Alpine presented a prototype that serves as a preview of its future sustainable sports cars: the Alpenglow, a radical hypercar equipped with an internal combustion engine capable of running on hydrogen.
Alpine Alpenglow is a single-seater vehicle with the driver's position located centrally between dual water drop-shaped hydrogen tanks.



https://auto.hindustantimes.com/auto/news/this-hydrogen-powered-concept-car-draws-inspiration-from-motorsports-41665659789496.html

MEPs call for 'coherent framework' on clean hydrogen, including nuclear

In a letter, 19 MEPs from across the political spectrum have urged the European Commission to include low-carbon hydrogen in the production targets for decarbonised hydrogen and to promote domestic production instead of imports. In its REPowerEU plan presented in May, the Commission set out an objective to develop ten million tons of renewable hydrogen and import the same amount by 2030.
https://www.euractiv.com/section/energy/news/meps-call-for-coherent-framework-on-clean-hydrogen-including-nuclear/

Hexagon Purus enters into framework agreement to deliver hydrogen distribution systems in Europe.

Hexagon Purus ASA ("Hexagon Purus"), through its wholly owned subsidiary Wystrach GmbH, a leading hydrogen systems supplier, has secured a framework agreement for delivery of hydrogen distribution systems to a leading European producer of green hydrogen.
https://finance.yahoo.com/news/hexagon-purus-enters-framework-agreement-113500350.html

University of Central Florida: UCF is developing materials to stop Hydrogen leaks like ones delaying Artemis launch

The work will have applications in hydrogen-based turbines for electricity production, hydrogen-powered space travel and storage, and transportation of hydrogen. The UCF researchers will work to develop high-temperature CMCs and nano-ceramic coatings that can contain hydrogen and be used to construct an inner wall of the combustion chamber for combusting it. "An ultra-high temperature combustion chamber is our dream project," says project principal investigator," Jan Gou, a professor in UCF's Department of Mechanical and Aerospace Engineering. "It has been long-desired for next-generation gas turbine engines, aircraft engines and rocket engines."
https://mae.ucf.edu/ucf-is-developing-materials-to-stop-hydrogen-leaks-like-ones-delaying-artemis-launch/#:~:text=U%20niversity%20of%20Central%20Florida%20researchers%20are%20developing,million%20grant%20from%20the%20U.S.%20Department%20of%20Energy.

Paris Motor Show 2022: "hydrogen revolution" HYVIA on the road

Just one year after its prototype version unveiled in October 2021, HYVIA presents at Paris Motor show 2022, the hydrogen-powered Renault Master Van H2-TECH in its production version, made in France and going on the road in Europe.HYVIA is a human, technological and industrial adventure, moving fast since its creation a little over a year ago, facing big challenges. This H2 van is produced in France and HYVIA is based in France. And the vehicle is going on the road in Europe.

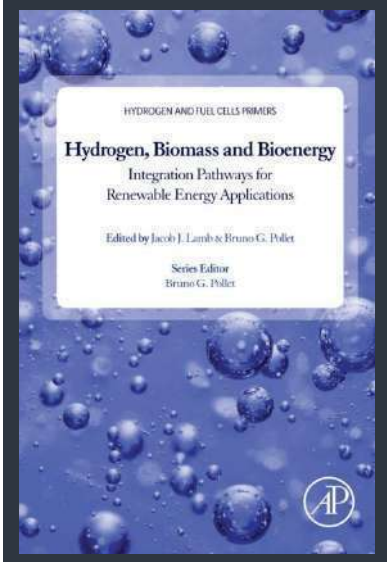


https://www.msn.com/en-za/news/other/paris-motor-show-2022-%e2%80%9chydrogen-revolution%e2%80%9d-hyvia-on-the-road/ar-AA12XibN

RECENT BOOKS

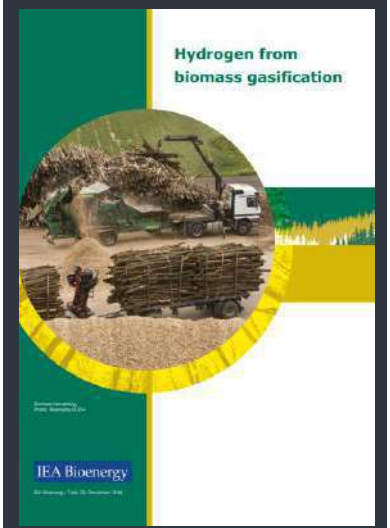
Hydrogen, Biomass and Bioenergy

Integration Pathways for Renewable Energy Applications



Edited by:
Jacob J. Lamb and Bruno G. Pollet
https://doi.org/10.1016/C2017-0-02975-0

Hydrogen from biomass gasification



Matthias Binder, Michael Kraussler, Matthias Kuba, and Markus Luisser

https://www.ieabioenergy.com/wp-content/uploads/2019/01/Wasserstoffstudie_IEA-final.pdf

This hydrogen-powered retro sports coupe Hyundai N Vision 74 is probably the coolest Korean car ever built.

Its powertrain is just as interesting as the styling. The N Vision 74 is Hyundai's latest high-performance test bed, following Veloster-based cars like the mid-engined RM19 and electric RM20e. But the N Vision 74 is the first one to use a hydrogen fuel cell powertrain, which Hyundai says is its most advanced ever. There's a 72.4-kilowatt-hour battery pack with 800-volt capability and two electric motors, both of which are mounted at the rear and provide precise torque vectoring, plus an 85-kW fuel-cell stack with a 4.2-kg tank capacity. Hyundai says the car can either be powered by just the EV setup or the full fuel-cell system together, and it has a three-channel cooling system that improves performance and efficiency.
https://www.hyundai.com/worldwide/en/brand-journal/mobility-solution/n-vision-74

Rhode Island joins bid to build multi-state 'green hydrogen hub'

New York Governor Kathy Hochul announced that Rhode Island and Maine had joined Connecticut, Massachusetts, New York and New Jersey in advancing a hydrogen hub in the region. The coalition is set to collaborate on a proposal and apply for federal funding provided by the U.S. Department of Energy as a result of last year's Infrastructure Investment and Jobs Act.
https://www.browndailyherald.com/article/2022/09/rhode-island-joins-bid-to-build-multi-state-green-hydrogen-hub

RNV orders up to 75 eCitaro with fuel cell range extender. A new depot to be built in Heidelberg.

Second order achieved for the Mercedes eCitaro Range Extender. Verkehrsbetriebe Rhein-Neckar-Verkehr GmbH (RNV), headquartered in Mannheim, is accelerating its transformation to electromobility. Delivery of 40 eCitaro G vehicles with range extender in 2023 and 2024 has now been fixed, with an additional option of 35 more articulated buses by 2027.



https://www.sustainable-bus.com/fuel-cell-bus/rnv-mannheim-ecitaro-fuel-cell-range-extender/

Hydrogen economy: Egypt to announce ambitious H2 strategy

Egypt will present a new energy vision for hydrogen at the next climate conference in Sharm el-Sheikh. Its diversified approach could enhance Egypt's geopolitical standing and become a commercial success. Egypt first started producing hydrogen around the Aswan High Dam in 1960. At the time, the second-largest economy in Africa had an underdeveloped grid, forcing it to use electricity locally and produce green hydrogen and ammonia for its fertilizer industry. Currently it consumes around 1.8 million metric tons of hydrogen, about the same as Germany.
https://www.msn.com/en-us/news/world/hydrogen-economy-egypt-to-announce-ambitious-h2-strategy/ar-AA135jmM

Green hydrogen key as Latin America hits 34GW of offshore wind by 2050

Latin America is expected to reach 34GW of offshore wind capacity by 2050, driven by the growth of off-grid green hydrogen projects and led by regional pacesetters Brazil and Colombia, Wood Mackenzie forecast.
https://www.rechargenews.com/wind/green-hydrogen-key-as-latin-america-hits-34gw-of-offshore-wind-by-2050-woodmac/2-1-1336441

Call for proposals on Hydrogen Valley Platform in India

Focus:

Hydrogen Production

Hydrogen Storage and Distribution

Hydrogen end uses – Transport

Hydrogen end uses - clean heat and power

Target:

1st phase: 2023-2027 (Activation)

2nd phase: 2028-2033 (Upscaling)

3rd phase: 2034-2050 (Market uptake)

Timelines:

Call for proposals – 03rd October 2022

Last date of submission– 30th December 2022

Submission of Project Proposals:

The Project Proposal could be submitted in the enclosed format through ONLINE MODE ONLY

www.onlinedst.gov.in

NO HARD COPY of the project proposal should be submitted

Full access link- https://dst.gov.in/sites/default/files/Call%20for%20Proposals%20%281%29.pdf

Hydrogen-powered Toyota Mirai test mule in India

As part of the alternative fuels pilot project being carried out by Toyota and the Central government, the auto maker has brought two cars into the country. The first was the ethanol-powered Corolla FFV-SHEV. And the second is the hydrogen powered Mirai. The two vehicles has been brought into the country to test if biofuel blends and green hydrogen technologies are viable options for Indians or not. While the proposition of hydrogen powered cars is exciting, India still has a long way to go before hydrogen becomes available in volumes that would make FCEVs a practical alternative.

https://timesofindia.indiatimes.com/auto/cars/hydrogen-powered-toyota-mirai-test-mule-in-india-highlights/articleshow/94878189.cms



Daimler Trucks to jump directly to hydrogen, electric vehicles from diesel

Amid the constant increase in gas prices coupled with the high CO2 levels of the fuel, Daimler Trucks, the world's largest truck maker, will avoid the compressed natural gas (CNG) segment and directly shift to hydrogen and electric solutions for the Indian market.



Daimler officials further said the company would launch 10 new BharatBenz trucks with varying gross vehicle weights, including a first-in-India 38-tonne truck.

https://www.financialexpress.com/express-mobility/vehicles/commercial-vehicles/daimler-trucks-to-jump-directly-to-hydrogen-electric-vehicles-from-diesel/2709502/

NTPC and Siemens Limited sign MoU for demonstrating Hydrogen co-firing in Faridabad Gas Power Plant

The total installed capacity of Faridabad gas power plant is 432 megawatt (MW) with two V94.2 gas turbines operating in combined cycle mode.Under this MoU, both the companies will collaborate to study the feasibility of introducing hydrogen co-firing in the plant. Based on the feasibility studies, a pilot project for 5% (by volume) hydrogen co-firing may be implemented for demonstrating the capability and the hydrogen required for the project shall be arranged by NTPC.

https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1867173

NTPC signs MoU with Mitsubishi Heavy Industries, Japan and its subsidiary

NTPC signed a Memorandum of Understanding (MoU) with Mitsubishi Heavy Industries, Japan and its subsidiary Mitsubishi Power India to demonstrate the feasibility for Hydrogen co-firing blended with natural gas in MHI 701D gas turbines installed at NTPC Auraiya Gas Power Plant in Uttar Pradesh. The total installed capacity of the Auraiya Gas Power Plant is 663 MW with four gas turbines operating in combined cycle mode.

https://energy.economictimes.indiatimes.com/news/oil-and-gas/ntpc-mitsubishi-ink-pact-to-demonstrate-hydrogen-co-firing-in-auraiya-gas-power-plant/94917466

India, France adopt roadmap for development of green hydrogen

India and France adopted an ambitious roadmap for the development of green hydrogen as part of the efforts to promote clean energy transitions and meet carbon neutrality targets. The roadmap aims at bringing the French and Indian hydrogen ecosystems together in order to establish a reliable and sustainable value chain for decarbonised hydrogen.

https://economictimes.indiatimes.com/industry/renewables/india-france-adopt-roadmap-for-development-of-green-hydrogen/articleshow/94949544.cms

Buffi, M (Buffi, Marco) ; Prussi, M (Prussi, Matteo) ; Scarlat, N (Scarlat, Nicolae)

Energy and environmental assessment of hydrogen from biomass sources: Challenges and perspectives

ISSN: 0961-9534
https://doi.org/10.1016/j.biombioe.2022.106556

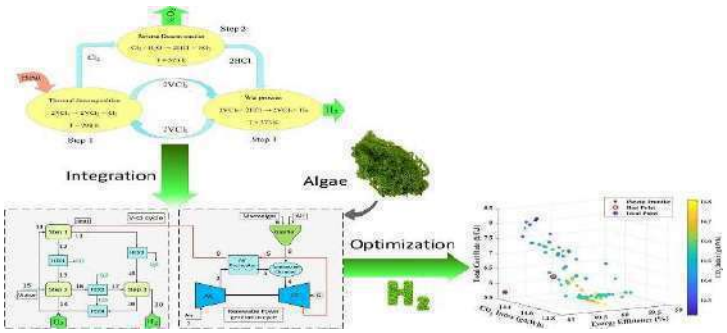
Abstract:
Hydrogen is considered as one of the pillars of the European decarbonisation strategy, boosting a novel concept of the energy system in line with the EU's commitment to achieve clean energy transition and reach the European Green Deal carbon neutrality goals by 2050. Hydrogen from biomass sources can significantly contribute to integrate the renewable hydrogen supply through electrolysis at large-scale production. Specifically, it can cover the non-continuous production of green hydrogen coming from solar and wind energy, to offer an alternative solution to such industrial sectors necessitating of stable supply. Biomass-derived hydrogen can be produced either from thermochemical pathways (i.e., pyrolysis, liquefaction, and gasification) or from biological routes (i.e., direct or indirect-biophotolysis, biological water-gas shift reaction, photo-and dark-fermentation). The paper reviews several production pathways to produce hydrogen from biomass or biomass-derived sources (biogas, liquid bio-intermediates, sugars) and provides an exhaustive review of the most promising technologies towards commercialisation. While some pathways are still at low technology readiness level, others such as the steam bio-methane reforming and biomass gasification are ready for an immediate market uptake. The various production pathways are evaluated in terms of energy and environmental performances, highlighting the limits and barriers of the available LCA studies. The paper shows that hydrogen production technologies from biomass appears today to be an interesting option, almost ready to constitute a complementing option to electrolysis.

Safari, F (Safari, Farid); Dincer, I (Dincer, Ibrahim)

Assessment and multi-objective optimization of a vanadium-chlorine thermochemical cycle integrated with algal biomass gasification for hydrogen and power production

https://doi.org/10.1016/j.enconman.2021.115132

Abstract:
A cogeneration energy system for green hydrogen and power production from algal biomass and water as renewable sources is first developed and analyzed with engineering equation solver (EES) through first and second law of thermodynamics and then, optimized through an evolutionary algorithm using the Matlab software package for higher exergy efficiency, lower cost, and lower environmental impact. The vanadium-chlorine (V-Cl) thermochemical cycle is selected for hydrogen production incorporated into cogeneration system. A novel integration of a three-step V-Cl thermochemical cycle, a Brayton power generation cycle and a biomass gasification unit fed by Cladophora glomerata macroalgae as a marine biomass is proposed and investigated in this study. Both exergoeconomic and exergoenvironment analyses are developed to evaluate the performance of the proposed cogeneration system. Also, both power generation system and thermochemical hydrogen production cycle are validated with previous studies in the literature for more accuracy. The proposed system is able to produce a 23.42 kg/h of hydrogen and a total of 885 kW power at the base case condition. Moreover, optimum values for overall exergy efficiency, total cost per unit of exergy, and environmental impacts are 60.45%, 14.46 g.CO2/kWh, 6.36 $/GJ, respectively, where pressure ratio (for Brayton cycle) is 5.87, gasification temperature is 715 °C and biomass mass flow rate is 0.8 kg/s.



Download : Download high-res image (138KB)- 1-s2.0-S0196890421013088-ga1_lrg.jpg (1365×886) (els-cdn.com)

Fatima Musa, et al..

A review in redressing challenges to produce sustainable hydrogen from microalgae for aviation industry

https://doi.org/10.1016/j.fuel.2022.125646

Abstract:

The global depletion of fossil fuel reserves and associated environmental crisis have led researchers to explore microalgal biomass which has been proven could be a promising potential as a renewable energy feedstock. Biofuels such as biodiesel, bioethanol and hydrogen can be produced from microalgae. Indeed, microalgae are best employed for hydrogen generation because the microalgal cells have high growth rate, can grow in diverse habitats and non-arable lands, can solve the fuel versus food conflicts as well as can capture and assimilate the atmospheric carbon dioxide. Hydrogen that is produced from microalgae is a clean and sustainable option to replace or complement the fossil fuel demands. The combustion of hydrogen produces only water and no greenhouse gases emission which will assuage the untoward effect on the environment. Moreover, it can also be used directly to generate electricity in fuel cells and engines. Another sector that is looking into hydrogen as a replacement for fossil fuels, is transportation inclusive of the aviation industry. The use of hydrogen as an energy carrier in airplanes offers several advantages, the burning of hydrogen in the jet engines would produce water vapour which will eliminate carbon-related emissions. However, this also comes with limitations such as new designs and larger tanks for hydrogen storage. Besides, the mechanisms of hydrogen production from microalgae are also sporadic and not well documented systematically, pre-empting researchers from exploring this new energy source inclusively. The factors affecting the microalgal hydrogen production are as well essential, but still poorly conceived, leading to the low outputs in terms of hydrogen yields from microalgae. Accordingly, this article reviews various mechanisms and methods employed for producing hydrogen from microalgae as well as the pre-treatment procedures for enhancing the rates of hydrogen production from microalgae. Furthermore, the enhancement of hydrogen yields through state-of-the-art techniques and genetic engineering the microalgal strains are also unveiled to materialize the hydrogen production at an industrial scale. This review intents to shift the paradigm from typical hydrocarbon biofuels to green hydrogen adoption, hastening the carbon neutrality target that benefits the natural environment the most.

Valerie Bei-YuanOh, Sue-FayeNg, Wee-Jun Ong

Is photocatalytic hydrogen production sustainable? – Assessing the potential environmental enhancement of photocatalytic technology against steam methane reforming and electrocatalysis

https://doi.org/10.1016/j.jclepro.2022.134673

Abstract:

In the face of the burgeoning interests toward the utilization of nanomaterials in catalyzing solar-aided chemical processes, the doubts upon the capability of these emerging low-TRL technologies in offsetting the potential environmental impacts of conventional approaches have endured for years. Despite the scarcity of commercial-level data for low-TRL process route, an extensive life cycle study is necessitated to spotlight the demerit and potential enhancement of these systems, which would be beneficial for the future process upscaling. Therein, this study conducted a cradle-to-gate life cycle assessment (LCA) on electrocatalysis and photocatalysis, with steam methane reforming (SMR) simulated as the base case. With a functional unit of 1 kg hydrogen, the results demonstrated that electrocatalysis led to the greatest climate change (GWP100), exceeding that of photocatalysis and SMR by 7.04 and 56.63 kg CO2-Eq, respectively. In contrast to photocatalysis, which has its main impact released from the catalyst synthesis stage (95.87%), the reaction phase in the electrolyzer was revealed as the major contributor (96.10%) to the resulting GWP100 in electrocatalysis, attributed to the huge consumption of aqueous electrolyte. Solid polymer electrolyte has latterly been recognized as a potential candidate to replace liquid electrolyte. In view of the existing uncertainty in inventory data of both the emerging technologies, a significant fluctuation was observed in their resulting human toxicity (HTPinf), where the large reagent i nput for large-scale catalyst synthesis was raised as a contributing factor. In line with the promoted employment of renewables, power supply of the simulated system was varied from electricity mix to hydro and wind power, resulting in an improvement of 14% and 10% to the GWP100 level of photocatalysis, and 5.33% and 3.73% to that of electrocatalysis. Hence, this spotlights the potential of incorporating renewables-sourced electricity in the production plant, which lays a promising foundation for future carbon neutrality.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 05

October, 2022

One-stop hydrogen shop: Reducing the cost of a future energy carrier

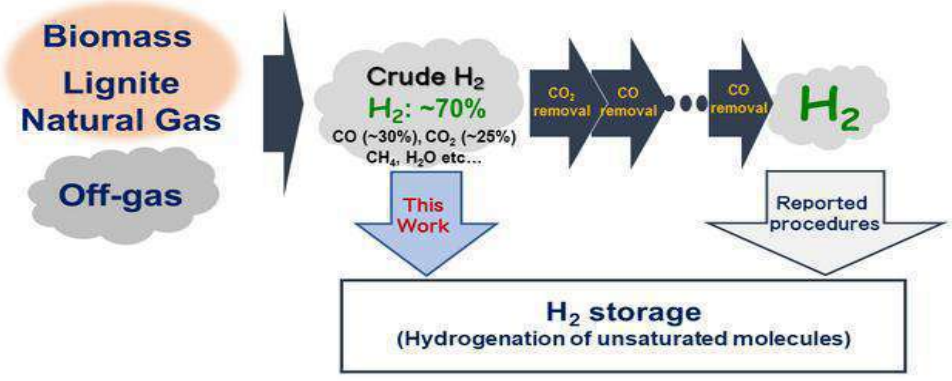
Researchers from Osaka University have simplified some long-standing challenges of processing hydrogen for use as a fuel. This work might help increase the mid- and long-term prospects of hydrogen as a sustainable energy source. Hydrogen is essential to the modern economy, and expanding its utility in a more sustainable society is a major global priority. Now, in a study recently published in Science Advances, researchers from Osaka University have made exciting progress toward eliminating many of the remaining bottlenecks in using hydrogen as an energy carrier.

The difficulty of extracting hydrogen from common contaminant gases has restricted the utility of liquid organic hydrogen carriers, the state-of-the-art for hydrogen storage. In these systems, many researchers have struggled for decades to overcome the challenge of inducing the carriers to uptake—i.e., store—hydrogen in the presence of contaminant gases. For example, "even a small amount of carbon monoxide can hinder hydrogen uptake," says Yoichi Hoshimoto, the corresponding author. "Thus, costly purification methods to isolate the hydrogen prior to storage are necessary."

To overcome these challenges, Hoshimoto and his team have synthesized shelf-stable triaryl boranes that took up hydrogen even in the presence of common contaminant gases, achieving the following ground-breaking results: hydrogen storage (with up to >99% efficiency) and subsequent hydrogen release at a purity of up to 99.9%.

"The industrial value of molecular hydrogen has long been plagued by substantial quantities of carbon monoxide and other contaminants," explains Hoshimoto. "However, in the catalytic hydrogenation method we developed, even a five-fold excess of a contaminant wasn't a problem, and hydrogen uptake and release were each achieved without using any solvents."

This work succeeded in a proof-of-concept for a novel hydrogen production method that eliminates the need for separate purification stages prior to storage, and it thus demonstrates the potential to increase the economic sustainability of hydrogen as an energy carrier. Future advances in increasing the environmental sustainability of hydrogen production—such as by obtaining it from water—will further help bring about a sustainable hydrogen-based economy.



The concept of this work. Direct use of crude hydrogen gas for catalytic hydrogenation of unsaturated molecules.

SOURCE - https://www.eurekalert.org/news-releases/968845

Main group catalysis for H2 purification based on liquid organic hydrogen carriers

AUTHORS: TAIKI HASHIMOTO, TAKAHIRO ASADA, SENSUKE OGOSHI, AND YOICHI HOSHIMOTO.

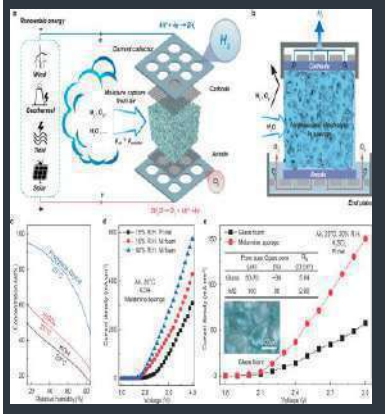
ABSTRACT: Molecular hydrogen (H2) is one of the most important energy carriers. In the midterm future, a huge amount of H_2 will be produced from a variety of hydrocarbon sources through conversion and removal of contaminants such as CO and CO_2. However, bypassing these purification processes is desirable, given their energy consumption and environmental impact, which ultimately increases the cost of H_2. Here, we demonstrate a strategy to separate H_2 from a gaseous mixture of H_2/CO/CO_2/CH_4 that can include an excess of CO and CO2 relative to H_2 and simultaneously store it in N-heterocyclic compounds that act as liquid organic hydrogen carriers (LOHCs), which can be applied to produce H2 by subsequent dehydrogenation. Our results demonstrate that LOHCs can potentially be used for H2 purification from CO- and CO2-rich crude H2 in addition to their well-established use in H2 storage.

DOI: https://doi.org/10.1126/sciadv.ade0189

Hydrogen production from the air

Jining Guo, et al.

Abstract:-
Green hydrogen produced by water splitting using renewable energy is the most promising energy carrier of the low-carbon economy. However, the geographic mismatch between renewables distribution and freshwater availability poses a significant challenge to its production. Here, we demonstrate a method of direct hydrogen production from the air, namely, in situ capture of freshwater from the atmosphere using hygroscopic electrolyte and electrolysis powered by solar or wind with a current density up to 574 mA cm−2. A prototype of such has been established and operated for 12 consecutive days with a stable performance at a Faradaic efficiency around 95%. This so-called direct air electrolysis (DAE) module can work under a bone-dry environment with a relative humidity of 4%, overcoming water supply issues and producing green hydrogen sustainably with minimal impact to the environment. The DAE modules can be easily scaled to provide hydrogen to remote, (semi-) arid, and scattered areas.



https://doi.org/10.1038/s41467-022-32652-y

INDUSTRY NEWS

BMW tests hydrogen burner at German plant, expands battery assembly lines

BMW is testing a burner able to operate on both hydrogen and gas in its paint shop in Leipzig, the carmaker said, as it also announced an 800-million-euro ($782 million) investment in new battery assembly lines at the plant. The burner, developed together with combustion technology firm Saacke to reduce carbon emissions in the production process, is able to switch from hydrogen to gas or vice versa while in use. For now, the carmaker buys hydrogen made with natural gas and buys certificates for green hydrogen, made by the same producer using electrolysers powered by renewable energy, to balance out its carbon footprint. In future, it plans to obtain green hydrogen directly into the plant through an externally run pipeline expected to be running from 2024.



https://finance.yahoo.com/news/bmw-tests-hydrogen-burner-leipzig-110508756.html

Hydrogen BMWs to be in dealerships by 2030, says chairman

BMW is set to introduce hydrogen-powered models before the end of the decade. That's according to Chairman Oliver Zipse, who said that all future models will be designed with adaptability in mind, allowing them to be driven by a number of different powertrains.



https://www.expressandstar.com/news/motors/2022/10/21/hydrogen-bmws-to-be-in-dealerships-by-2030-says-chairman/

Singapore launches National Hydrogen Strategy, could supply half of power needs by 2050

Singapore has launched its national hydrogen strategy, as the low-carbon fuel could supply half of the Republic's power needs by 2050.
Deputy Prime Minister Lawrence Wong outlined Singapore's national strategy to develop hydrogen at the Singapore International Energy Week (SIEW) 2022.
https://www.theedgesingapore.com/news/sustainability/singapore-launches-national-hydrogen-strategy-could-supply-half-power-needs-2050

ArcelorMittal partners with S Africa's Sasol to boost hydrogen economy

A partnership between ArcelorMittal SA (AMSA) and South Africa's homegrown petrochemicals giant Sasol to develop a green hydrogen hub in Saldanha Bay.
The two companies will jointly undertake studies to explore the potential of the region as an export hub for green hydrogen and derivatives as well as green steel production.
https://www.business-standard.com/article/companies/arcelormittal-partners-with-s-africa-s-sasol-to-boost-hydrogen-economy-122102201035_1.html

JCB has developed a mobile hydrogen refueller for construction sites

JCB is investing £100m in a project to produce hydrogen engines and has already developed working prototypes of a backhoe loader and Loadall telescopic handler powered by hydrogen.
The mobile hydrogen refueller represent another link to the vision of a hydrogen-powered future – providing a practical way for contractors to refuel their machines on site.

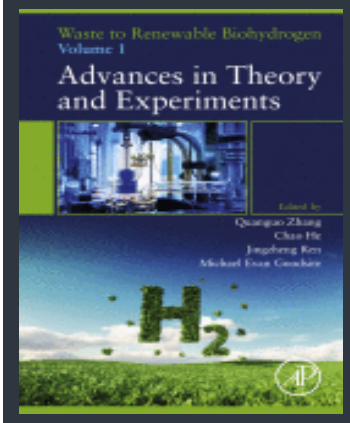


https://www.theconstructionindex.co.uk/news/view/jcb-reveals-hydrogen-bowser

RECENT BOOKS

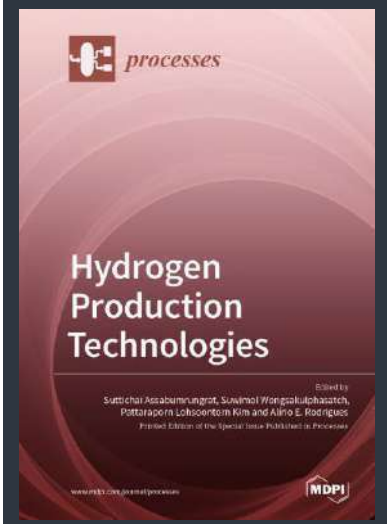
Waste to Renewable Biohydrogen

Vol. 1. Advances in Theory and Experiments



Edited by:
Quanguo Zhang, Chao He, Michael Goodsite
ISBN- 978-0-12-821659-0
https://doi.org/10.1016/C2019-0-02619-2

Hydrogen Production Technologies



Suttichai Assabumrungrat, Suwimol Wongsakulphasatch, Pattaraporn Kim-Lohsoontorn and Alírio E. Rodrigues (Eds.)

https://doi.org/10.3390/books978-3-03943-668-2

Storing hydrogen fuel in salts—a step toward 'cleaner' energy production

Researchers in ACS Central Science have developed a method to store and release highly pure hydrogen with salts in the presence of amino acids.

The reversible storage of hydrogen in solid salts has emerged as one potential way to make the fuel easier to transport and handle, but the reactions to do this require precious metals as catalysts and may produce carbon dioxide as an unwanted byproduct. So, researchers developed effective storage-release systems with both bicarbonate and carbonate salts, as well as manganese, which is a more widely available metal catalyst. The researchers found that converting bicarbonate and hydrogen into formate, and vice versa, was most effective with potassium salts, a manganese-based catalyst and lysine—an amino acid that acted as an additional promoter and reacted with carbon dioxide to capture it—at reaction temperatures below 200 F. After five storage-release cycles, the reaction system produced hydrogen with a high yield (80%) and purity (99%).

https://techxplore.com/news/2022-10-hydrogen-fuel-saltsa-cleaner-energy.html#

UK launches ‘first’ injection of hydrogen into gas-fired power station

Hydrogen will be fed into a UK gas-fired power station for the first time in a joint venture pilot backed by Centrica. The 49MW gas-fired plant is designed to meet demand during peak times or when generation from renewables is low, typically operating for less than three hours a day. Mixing hydrogen in with natural gas is believed to reduce the overall carbon intensity of the power station.

https://www.energylivenews.com/2022/10/24/uk-launches-first-injection-of-hydrogen-into-gas-fired-power-station/

RNV Oman aims to produce 1 million tonnes of green hydrogen by 2030

Second Oman plans to produce a million tons of green hydrogen by 2030 and has set up a state-owned company as part of its plan to achieve net-zero carbon emissions by 2050. Hydrogen Oman, better known as Hydrom, will be a subsidiary of Oman’s state-owned Energy Development Oman. Oman has earmarked two blocks in the southern port city of Duqm and another four blocks in Salalah to be tendered for the development of green hydrogen projects. Hydrom will oversee the development and construction of the projects, while working closely with the Oman’s Public Authority for Special Economic Zones and Free Zones to set up infrastructure such as roads, power lines and other installations.

https://www.thenationalnews.com/business/energy/2022/10/24/oman-aims-to-produce-1-million-tonnes-of-green-hydrogen-by-2030-in-net-zero-push/

Germany hails 1st delivery of 'green' hydrogen from UAE, to replace coal

Germany took formal delivery of its first, modest, batch of hydrogen from the United Arab Emirates, a "green" fuel it hopes will help replace coal and gas used by energy-intensive industries in future.



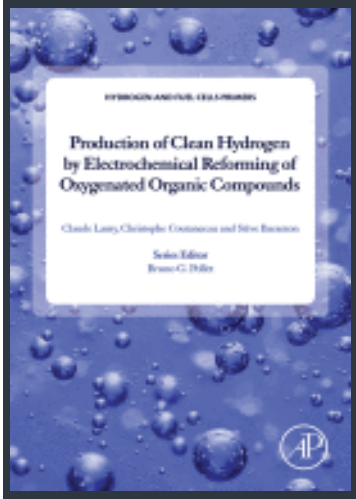
https://www.business-standard.com/article/international/germany-hails-1st-delivery-of-green-hydrogen-from-uae-to-replace-coal-122102101453_1.html

Sarawak to boost hydrogen production in shift to low-carbon economy

The Sarawak Premier said the state was intensively analysing the performance of its hydrogen production plant and refuelling station, commissioned in 2019 under a pilot research project into green hydrogen production. "Hydrogen has wide applications in our existing industries and can be exported in various forms and via different methods.

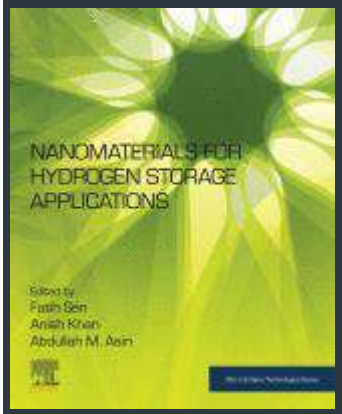
https://www.thestar.com.my/news/nation/2022/10/25/sarawak-to-boost-hydrogen-production-in-shift-to-low-carbon-economy-says-abang-jo

Production of Clean Hydrogen by Electrochemical Reforming of Oxygenated Organic Compounds



Edited by:
Claude Lamy, Christophe Coutanceau and Stéve Baranton
ISBN- 978-0-12-821500-5
https://doi.org/10.1016/C2019-0-03206-2

Nanomaterials for Hydrogen Storage Applications



Edited by:
Fatih Sen, Anish Khan and Abdullah M. Asiri

ISBN- 978-0-12-819476-8

https://doi.org/10.1016/C2018-0-02721-8

Corporates are making a beeline for green hydrogen

The firms that have already announced their intentions in green hydrogen include Larsen & Toubro (L&T), Reliance Industries (RIL), GAIL, NTPC and Indian Oil Corporation, among others. For India Inc, green hydrogen is now the buzzword as companies are making a beeline for its production, starting with for their captive uses, riding on favorable policy tailwinds and attempts to become carbon neutral.

Now at a nascent stage, commercial production plants of green hydrogen are operational in Hazira, Jorhat and Bikaner with a combined capacity of 200 tonne per annum (TPA). The government plans to increase it to 5 million TPA (MTPA) by 2030, and multiple projects planned by various public sector units and conglomerates would bring in significant capex by 2030.

https://www.financialexpress.com/industry/corporates-are-making-a-beeline-for-green-hydrogen/2730135/

Jakson Group to develop $2.8 bn green ammonia and hydrogen project in Rajasthan

To set up 3.65 lakh tpa Green Hydrogen and Ammonia plant in Kota and an integrated hybrid renewable power complex in phases. Jakson Green, part of the Jakson Group, said it had signed a Memorandum of Understanding (MOU) with the Rajasthan government to invest about ₹22,400 crore, roughly $2.8 billion , in the state to set up a Green Hydrogen and Green Ammonia project in phases. Jakson Green will set up a 3,65,000 tonnes per annum Green Hydrogen and Green Ammonia plant in Kota along with an integrated hybrid renewable power complex in a phase-wise manner, the company said in a statement.

https://www.thehindubusinessline.com/companies/jakson-group-to-develop-green-ammonia-and-hydrogen-project-in-rajasthan/article66052757.ece

India to export green energy to Singapore from 2025, Greenko-Keppel sign Hydrogen MoU

India will for the first-time export green energy from 2025, with the first shipments going to a Singapore power plant under an MoU signed by an India-based dispatchable renewables company and Singapore's energy business.

The MoU to explore opportunities in green hydrogen potential in India will see Greenko group and Singapore's Keppel Infrastructure working towards a 250,000 tonne per annum contract to be supplied to Keppel's new 600Mw power plant in Singapore.

https://economictimes.indiatimes.com/industry/renewables/india-to-export-green-energy-to-singapore-from-2025-greenko-keppel-sign-hydrogen-mou/articleshow/95076960.cms

Kerala government to elicit stakeholders' views for developing Kochi into green energy transport and hydrogen hub

The State government will meet industry players, transporters, including shippers, innovators, and start-ups, among other stakeholders, on November 3 to elicit ideas for developing Kochi into a green energy transport and hydrogen hub of the country. The State is also looking towards harnessing waves and wind along with solar power for clean energy production.

https://www.thehindu.com/news/cities/Kochi/kerala-government-to-meet-stakeholders-to-develop-kochi-into-green-energy-transport-and-hydrogen-hub/article66030633.ece



Green hydrogen, electrolyzer projects may get ₹12k cr sops

The government is expected to allocate around ₹6,000 crore each for production-linked incentive (PLI) schemes for electrolyzers and green hydrogen from the ₹20,000 crore green hydrogen mission.

After the National Green Hydrogen Mission was announced by Prime Minister Narendra Modi in August 2021, India has seen a serious push on both the policy and industry front.

https://www.livemint.com/industry/energy/green-hydrogen-electrolyzer-projects-may-get-12k-cr-sops-11666541802432.html

Xuchao Zhang, Gang Qiu, Shali Wang, Jiaxi Wu, Yunan Peng

Hydrogen Leakage Simulation and Risk Analysis of Hydrogen Fueling Station in China

https://doi.org/10.3390/su141912420

Abstract:

Hydrogen is a renewable energy source with various features, clean, carbon-free, high energy density, which is being recognized internationally as a “future energy.” The US, the EU, Japan, South Korea, China, and other countries or regions are gradually clarifying the development position of hydrogen. The rapid development of the hydrogen energy industry requires more hydrogenation infrastructure to meet the hydrogenation need of hydrogen fuel cell vehicles. Nevertheless, due to the frequent occurrence of hydrogen infrastructure accidents, their safety has become an obstacle to large-scale construction. This paper analyzed five sizes (diameters of 0.068 mm, 0.215 mm, 0.68 mm, 2.15 mm, and 6.8 mm) of hydrogen leakage in the hydrogen fueling station using Quantitative Risk Assessment (QRA) and HyRAM software. The results show that unignited leaks occur most frequently; leaks caused by flanges, valves, instruments, compressors, and filters occur more frequently; and the risk indicator of thermal radiation accident and structure collapse accident caused by overpressure exceeds the Chinese individual acceptable risk standard and the risk indicator of a thermal radiation accident and head impact accident caused by overpressure is below the Chinese standard. On the other hand, we simulated the consequences of hydrogen leak from the 45 MPa hydrogen storage vessels by the physic module of HyRAM and obtained the ranges of plume dispersion, jet fire, radiative heat flux, and unconfined overpressure. We suggest targeted preventive measures and safety distance to provide references for hydrogen fueling stations’ safe construction and operation.

Federico Ustolin, Alessandro Campari, Rodolfo Taccani

An Extensive Review of Liquid Hydrogen in Transportation with Focus on the Maritime Sector

https://doi.org/10.3390/jmse10091222

Abstract:

The European Green Deal aims to transform the EU into a modern, resource-efficient, and competitive economy. The REPowerEU plan launched in May 2022 as part of the Green Deal reveals the willingness of several countries to become energy independent and tackle the climate crisis. Therefore, the decarbonization of different sectors such as maritime shipping is crucial and may be achieved through sustainable energy. Hydrogen is potentially clean and renewable and might be chosen as fuel to power ships and boats. Hydrogen technologies (e.g., fuel cells for propulsion) have already been implemented on board ships in the last 20 years, mainly during demonstration projects. Pressurized tanks filled with gaseous hydrogen were installed on most of these vessels. However, this type of storage would require enormous volumes for large long-range ships with high energy demands. One of the best options is to store this fuel in the cryogenic liquid phase. This paper initially introduces the hydrogen color codes and the carbon footprints of the different production techniques to effectively estimate the environmental impact when employing hydrogen technologies in any application. Afterward, a review of the implementation of liquid hydrogen (LH2) in the transportation sector including aerospace and aviation industries, automotive, and railways is provided. Then, the focus is placed on the maritime sector. The aim is to highlight the challenges for the adoption of LH2 technologies on board ships. Different aspects were investigated in this study, from LH2 bunkering, onboard utilization, regulations, codes and standards, and safety. Finally, this study offers a broad overview of the bottlenecks that might hamper the adoption of LH2 technologies in the maritime sector and discusses potential solutions.

Hao Li, Xuewen Cao, Yang Liu, Yanbo Shao, Zilong Nan, Lin Teng, Wenshan Peng, Jiang Bian

Safety of hydrogen storage and transportation: An overview on mechanisms, techniques, and challenges

https://doi.org/10.1016/j.egyr.2022.04.067

Abstract:

The extensive usage of fossil fuels has caused significant environmental pollution, climate change and energy crises. The significant advantages of hydrogen, such as cleanliness, high efficiency, and a wide range of sources, make it quite promising. Hydrogen is prone to material damage, which may lead to leakage. High-pressure leaking hydrogen is highly susceptible to spontaneous combustion due to its combustion characteristics, which may cause jet fire or explosion accidents, resulting in

serious casualties and property damage. This paper presents a detailed review of the research progress on hydrogen leak diffusion characteristics, leak spontaneous combustion mechanisms and material hydrogen damage mechanisms from the perspectives of theoretical analysis, experiments and numerical simulations. This review points out that although a large number of research results have been obtained on the safety characteristics of hydrogen, there are still some deficiencies and limitations. Further research topics are clarified, such as further optimizing the kinetic mechanism of the high-pressure hydrogen leakage reaction and turbulence model, exploring the expansion and dilution law of hydrogen clouds after liquid hydrogen flooding, further studying the spontaneous combustion mechanism of leaked hydrogen and the interaction between mechanisms, and investigating the synergistic damage effect of hydrogen and other components on materials. The leakage spontaneous combustion process in open space, the development process of the bidirectional effect of hydrogen jet fuel and crack growth under the impact of high-pressure hydrogen jet fuel on the material may need to be explored next.

Ji-Qiang Li, Ji-Chao Li Li, Kyoungwoo Park, Jeong-Tae Kwon

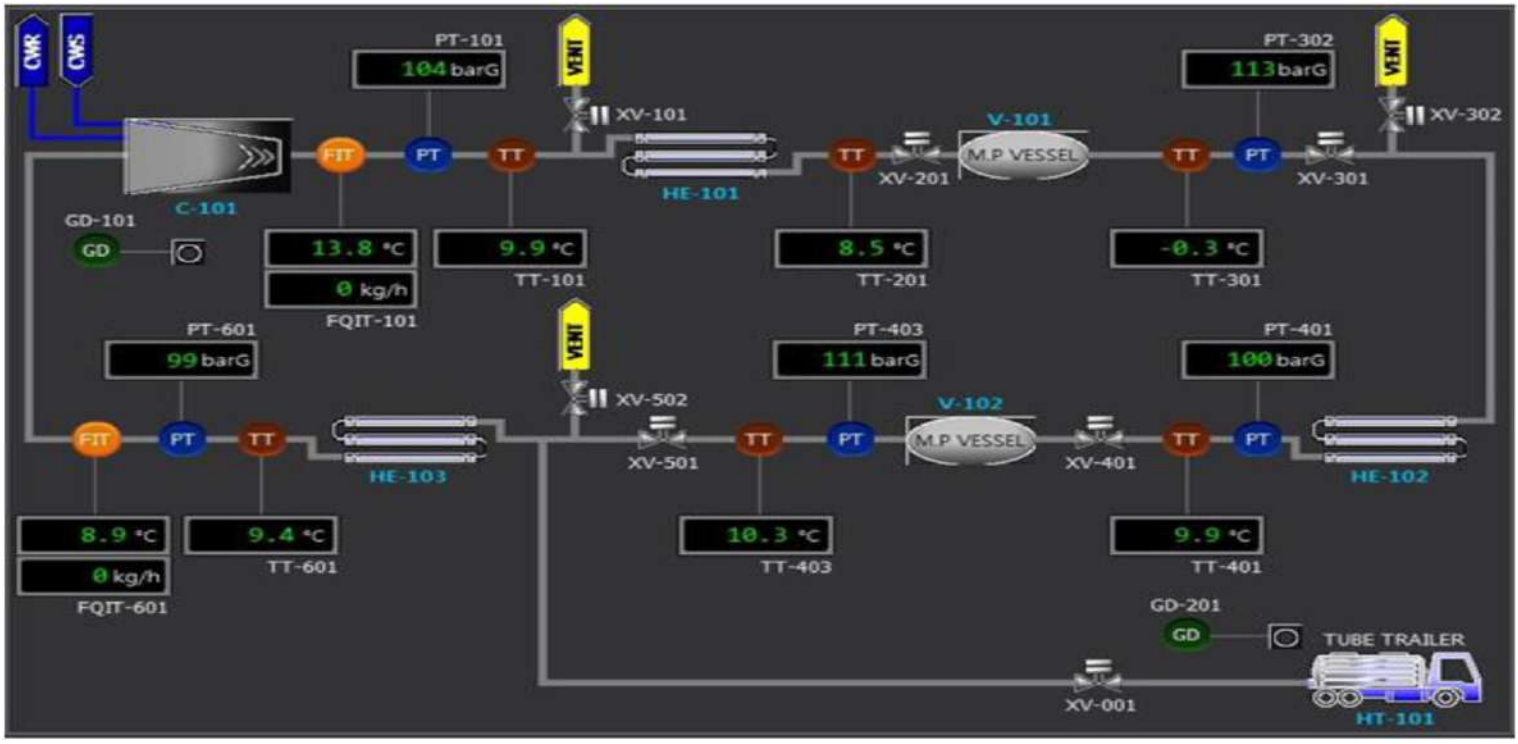
Investigation on the changes of pressure and temperature in high pressure filling of hydrogen storage tank

https://doi.org/10.1016/j.csite.2022.102143

Abstract:

Hydrogen as fuel has been considered as a feasible energy carry and which offers a clean and efficient alternative for transportation. During the high-pressure filling, the temperature in the hydrogen storage tank (HST) may rise rapidly due to the hydrogen compression. The high temperature may lead to safety problem. Thus, for fast and safely refueling the hydrogen, several key factors need to be considered. In the present study, by the thermodynamics theories, a mathematical model is established to simulate and analyze the high-pressure filling process of the storage tank for the hydrogen station. In the analysis, the physical parameters of normal hydrogen are introduced to make the simulation close to the actual process. By the numerical simulation for 50 MPa compressed hydrogen tank, the temperature and pressure trends during filling are obtained. The simulation results for non-adiabatic filling were compared with the theoretically calculated ones for adiabatic conditions and the simulation results for non-adiabatic filling were compared with the simulation ones for adiabatic conditions. Then, the influence of working pressure, initial temperature, mass flow rate, initial pressure and inlet temperature on the temperature rise were analyzed. This study provides a theoretical research basis for high pressure hydrogen energy storage and hydrogenation technology.

Hydrogen station system composition diagram.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 06

November, 2022

How the US Inflation Reduction Act will impact the economy

The Inflation Reduction Act (IRA) is widely recognized as a compelling nudge from the US government to private sector and investors to decarbonize hard-to-abate sectors. It clears the path for many climate financiers and investors to move companies towards net zero. But can its incentive-based policies work in the context of a looming recession, spiking inflation, and oil shortage?

A variety of tax credit schemes amounting to $35 billion have been set up to spur investment in breakthrough clean technologies such as hydrogen, direct air capture, and sustainable aviation fuels. According to a report by Boston Consulting Group, these incentives have levelled the cost competitiveness of traditional hydrogen production with green hydrogen (renewable energy with water electrolysis) and blue hydrogen (fossil-derived hydrogen with carbon capture). With these incentives, clean energy sources such as green and blue hydrogen will be even cheaper than traditional hydrogen by 2030.

https://www.weforum.org/agenda/2022/11/how-new-laws-meet-climate-goals/

Clean Hydrogen Fuel from Seawater

Clean hydrogen fuel is easier to produce from seawater with stable hierarchical electrocatalysts

Seawater, could become a key resource in the sustainable production of clean hydrogen fuel with use of water-splitting catalysts developed by a KAUST-led team.

During water splitting hydrogen and oxygen evolution catalysts that perform well in fresh water become less effective in seawater because of abundant ions that can promote unwanted reactions and poison catalysts.

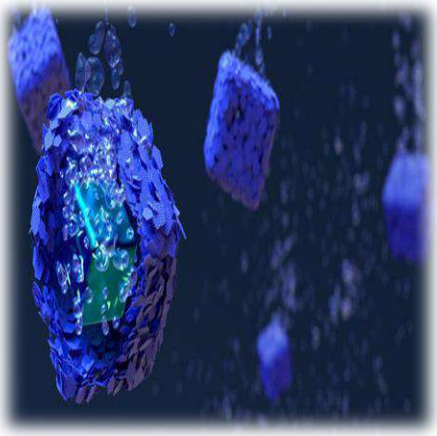
Highly corrosive chloride ions present in seawater undergo complex reactions that compete with oxygen evolution and generate harmful compounds, such as hypochlorite. Because hydrogen production hinges on stable and efficient reactions at both electrodes, these ions are a major challenge for seawater splitting.

As hypochlorite formation can occur because it demands a lower operational voltage to meet industrial needs than the oxygen evolution reaction. A nickel–iridium monolayered anode catalyst showed enhanced performance and stability in seawater. The researchers created tiny cubic reactors, in which the catalyst was encased in a molybdenum sulfide protective shell. The catalyst core consisted of a carbon-supported molybdenum-based redox active compound and featured a zeolite-like ordered nanoporous structure.

Using a metal organic framework-based approach, the researchers combined metal complex precursors with the linker imidazole in the presence of surfactant to generate zeolite-like zinc–molybdenum cubes. They mixed the resulting structures with thioacetamide in ethanol under reflux to form a cubic molybdenum oxide phase confined in a thin zinc sulfide shell. Next, they chemically converted the cubic phase into the desired molybdenum sulfide-encapsulated redox active compound at high temperature before selectively etching the zinc sulfide outer layer to yield the nanoreactors. The nanoreactors exhibited high electrocatalytic activity and stability in both fresh water and seawater. The core displayed numerous active sites that boosted hydrogen production and the shell presented several defects within its layers, especially subnanometer-sized holes that allowed water molecules to permeate and access the internal active sites. Acting as a chainmail, the shell also blocked and prevented salts from depositing on the active sites.

The researchers are now designing advanced catalysts with specific configuration to achieve a more sustainable energy conversion during seawater splitting. They are also investigating the structural evolution and behavior of the reactive centers during the catalytic process to gain in-depth knowledge of the seawater splitting technique for future advancement and mass commercialization.

https://phys.org/news/2022-11-hydrogen-fuel-easier-seawater-stable.html



National Hydrogen Mission policy's second part likely to be announced by December: MNRE officials

The union government is likely to release the second part of the green hydrogen policy in December this year, senior officials in the ministry of new and renewable energy (MNRE) said. The second part is expected to detail the economic benefits of manufacturing it.

The Ministry of Power notified the first part of the National Hydrogen Mission policy on green hydrogen and green ammonia on February 17. The second phase was under consideration by the central government's expenditure finance committee at the time and the ministry has said it will be announced soon.



Green hydrogen is produced using renewable energy through electrolysis. In the first part of the policy, the ministry waived the power transmission charges for 25 years for these units, allowed them to buy renewable power from exchanges or their own unit, and allowed these companies to bank unconsumed renewable power for up to 30 days with power distribution companies (discom). These companies will be provided open access within 15 days of application.

https://www.moneycontrol.com/news/economy/policy/national-hydrogen-mission-policys-second-part-likely-to-be-announced-by-december-mnre-officials-9312481.html

DNV awarded contract for South Korean offshore wind-to-green hydrogen project

DNV has been appointed by Elenergy Co Ltd, a South Korean renewable energy development company, as owner's engineer for its 1.5-GW fixed-bottom Chujin offshore wind project.

When completed in 2027, the Chujin plant will be the largest commercial-scale offshore windfarm in the country. Electricity from the offshore windfarm will be used to produce green hydrogen.



https://www.rivieramm.com/news-content-hub/dnv-awarded-contract-for-south-korean-offshore-wind-to-green-hydrogen-project-73526

Stellantis Hordain first plant to produce hydrogen-powered, electric and IC engine CVs

Hydrogen-powered vehicles will be assembled on the site's multi-energy line, which already produces the electric and combustion engine versions of the 'K-Zero' daily. Using a reinforced platform from body-in-white onwards, the hydrogen-powered models will then follow the usual stages of paintwork and assembly, on the same production line as combustion engine and electric vehicles, before they enter the new 8,000-square-metre facility that focuses solely on the final tuning.

https://www.autocarpro.in/news-international/stellantis-hordain-first-plant-to-produce-hydrogen-powered-electric-and-ic-engine-cvs-113150

Nikola, KeyState to collaborate on hydrogen supply

Electric vehicle maker Nikola Corp said it was working with KeyState Natural Gas Synthesis to create Pennsylvania State's first low-carbon hydrogen producer to expand supply for Nikola's fuel-cell electric vehicles.

The over 7,000-acre KeyState site is expected to be operational in 2026 and will also supply ammonia and urea for industrial and transportation markets. Nikola is also building a hydrogen fuel cell electric semi-truck with a range of up to 500 miles and a refuel time of under 20 minutes that would enable it to carry freight over longer distances.

https://auto.economictimes.indiatimes.com/news/commercial-vehicle/mhcv/nikola-keystate-to-collaborate-on-hydrogen-supply/95218225

Hydrogen fund Hy24 raises €2bn as investors seek to tap clean energy shift

A fund backed by global companies and financial institutions including TotalEnergies, Baker Hughes and Axa has raised €2bn to invest in green hydrogen projects, as it seeks to tap into growing adoption of the zero-carbon fuel.

The amount raised exceeds the €1.5bn target that Paris-based Hy24 had set when it launched in October. Hy24 is a joint fund between French private equity group Ardian and Zurich-based FiveT Hydrogen, an investment manager specialising in hydrogen investments.



https://www.ft.com/content/b47465da-6167-4da1-bafc-334a398f907a?es_id=55825201bb

US start-up explores $7.5bn blue hydrogen-ammonia production and export project in Louisiana

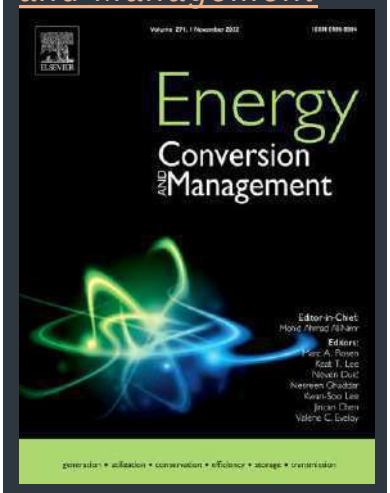
JCB US-based start-up Clean Hydrogen Works is exploring $7.5bn plans to establish a large-scale hydrogen-ammonia production and export facility in Ascension Parish, Louisiana, US.

The project, which brings together Ascension Clean Energy (ACE), Denbury Carbon Solutions, and Hafnia, plans to see 7.2 million tonnes of blue ammonia produced each year, utilising carbon capture, and sequestration (CCS).

https://www.h2-view.com/story/us-start-up-explores-7-5bn-blue-hydrogen-ammonia-production-and-export-project-in-louisiana/

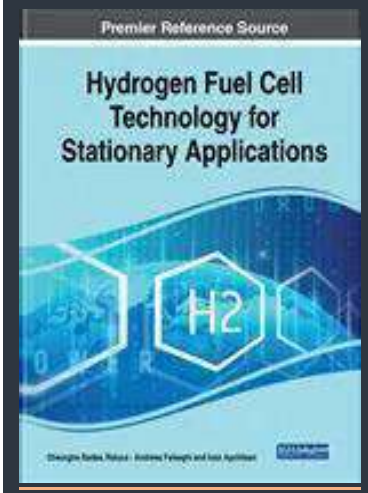
RECENT BOOKS

Energy Conversion and Management



Editor in Chief- Dr. Mohammad Ahmad Al-Nimr
ISSN: 0196-8904
https://www.sciencedirect.com/journal/energy-conversion-and-management/vol/269/suppl/C

Hydrogen Fuel Cell Technology for Stationary Applications



Gheorghe Badea; Raluca-Andreea Felseghi; Ioan Aşchilean
ISBN13: 9781799849452
https://doi.org/10.4018/978-1-7998-4945-2

UAE completes first phase of National Hydrogen Strategy

Sharif Al Olama, Under-Secretary of the Ministry of Energy and Infrastructure for Energy and Petroleum Affairs, has announced the completion of Phase I of the UAE's National Hydrogen Strategy. UAE aims to account for 25 per cent of major hydrogen markets, including India, South Korea, Japan and Germany by capitalising on its strategic geographical location as a gateway between East and West.

The UAE has launched seven strategic hydrogen production projects and is expected to produce 14 to 22 million tonnes annually by 2050.

https://gulfbusiness.com/uae-completes-first-phase-of-national-hydrogen-strategy/

Toyota's cartridge helps make hydrogen portable

Toyota has been pushing hard for hydrogen technology, and has worked to develop vehicles and infrastructure to this end. The company's latest efforts involve a toteable hydrogen cartridge – letting you take hydrogen power on the go!

The dimensions of Toyota's attractive round canisters are quite compact- 400 mm long and 180 mm in diameter. Footnotes from Toyota indicate they rely on a "high-pressure hydrogen tank," suggesting storage in gaseous form. The target weight for the canisters is 5 kg. Thus, the canisters can readily be manipulated and carried by a single person, serving as a lightweight store of energy. They come in much lighter than a typical tank of propane (~30 kg) or a full jerry can of gasoline (~25 kg).



https://hackaday.com/2022/08/02/toyotas-cartridge-helps-make-hydrogen-portable/

Green Hydrogen coalition announces hybuildtm carolinas, an initiative to accelerate an inclusive clean energy transition in North and South Carolina

The Green Hydrogen Coalition (GHC) – an educational nonprofit dedicated to advancing the role of green hydrogen to accelerate a carbon-free energy future – announced the launch of a new initiative, HyBuildTM Carolinas. This effort will catalyze momentum to achieve mass-scale, low-cost, delivered green hydrogen in North and South Carolina, driving multi-sectoral decarbonization and local economic development.

https://news.duke-energy.com/releases/green-hydrogen-coalition-announces-hybuildtm-carolinas-an-initiative-to-accelerate-an-inclusive-clean-energy-transition-in-north-and-south-carolina

Hydrogen project gets zoning green light from Corpus Christi City Council

The Corpus Christi City Council granted property rezoning that would enable what was described in records as a commercial demonstration project intended to exhibit "technology for the conversion of carbon dioxide and hydrogen into cleaner synthetic fuels and chemicals."

Carbon dioxide used in that process would be sourced from HEP's nearby gas and fractionation plant — which otherwise would have emitted the gas — while hydrogen would be derived from the plant, as well as electrolysis of water, according to officials.

https://www.msn.com/en-us/news/us/hydrogen-project-gets-zoning-green-light-from-corpus-christi-city-council/ar-AA13EjdE

UK Government boosts hydrogen buses with £26m

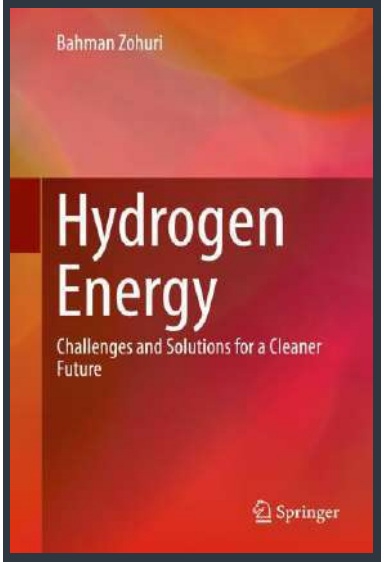
A Northern Irish bus company is receiving £26 million in funding to build electric and hydrogen buses.

Wrightbus built the world's first hydrogen double-decker bus in 2020 and is now looking to export its zero-emission buses worldwide to Australia, Germany, Italy, France and Spain.

UK Export Finance is backing the Ballymena-based business, alongside Barclays – which aims to build 3,000 buses by 2024, making up 10% of the UK's entire fleet.

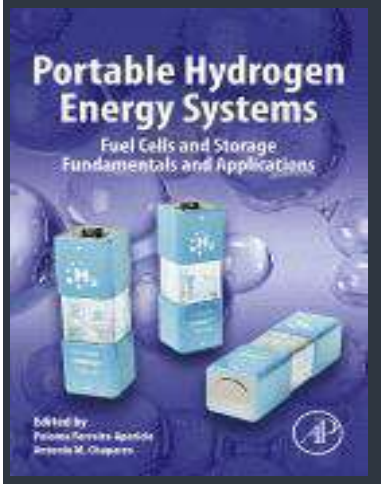
https://www.energylivenews.com/2022/11/01/government-boosts-hydrogen-buses-with-26m/

Hydrogen Energy Challenges and Solutions for a Cleaner Future



Edited by:
Bahman Zohuri
ISBN- 978-3-319-93461-7
https://doi.org/10.1007/978-3-319-93461-7

Portable Hydrogen Energy Systems Fuel Cells and Storage Fundamentals and Applications



Edited by:
Paloma Ferreira-Aparicio and Antonio M. Chaparro
ISBN- 978-0-12-813128-2
https://doi.org/10.1016/C2016-0-04605-3

Karnataka plans India's first green hydrogen cluster in Mangaluru

The upcoming Global Investors Meet (GIM) 2022 will see Karnataka emerging as the lead state in manufacturing green hydrogen in India. The State Government is planning to set up India's first green hydrogen cluster in Mangaluru.

Seven companies ACME Solar, ABC Cleantech, ReNew Power, Avaada, JSW Green Hydrogen, PETRONAS Hydrogen and O_2 Power have evinced interest to invest in Karnataka for green hydrogen manufacturing. Four of them have been cleared for investment by the State High-Level Committee and three are at the MoU stage. The total investment size (in green hydrogen) is expected to be around Rs 1.5 lakh crore. The investors have sought proximity to the Mangaluru port because they will convert green hydrogen to green ammonia and export it.

https://www.newindianexpress.com/states/karnataka/2022/oct/31/karnataka-plans-indias-first-green-hydrogen-cluster-in-mangaluru-2513358.html

Government lists 10 states for green hydrogen manufacturing

The government has identified 10 potential states that could be the key enablers in manufacturing green hydrogen in India to kickstart its National Green Hydrogen Mission, said two officials aware of the development. These include Karnataka, Odisha, Gujarat, Rajasthan, Maharashtra, Tamil Nadu, Andhra Pradesh, Kerala, Madhya Pradesh and West Bengal.

https://www.moneycontrol.com/news/business/economy/government-lists-10-states-for-green-hydrogen-manufacturing-9439561.html

When Will India get its 1st Hydrogen Car? Nitin Gadkari answers

Nitin Gadkari (Union Minister for Road and Transport) said that India is all set to manufacture Hydrogen cars and a process for the same has been started. In the current scenario, Hydrogen is produced via three methods - Black Hydrogen, Brown Hydrogen and Green Hydrogen, Gadkari said.

Green Hydrogen is produced by water "For this, we need electrolysers. They are used in separating Hydrogen from Oxygen. India has the maximum electrolysers in the world," Gadkari said.

https://zeenews.india.com/auto/zee-auto-awards-when-will-india-get-its-1st-hydrogen-car-nitin-gadkari-answers-2529726.html

Odisha CM urges L&T to set up green hydrogen units

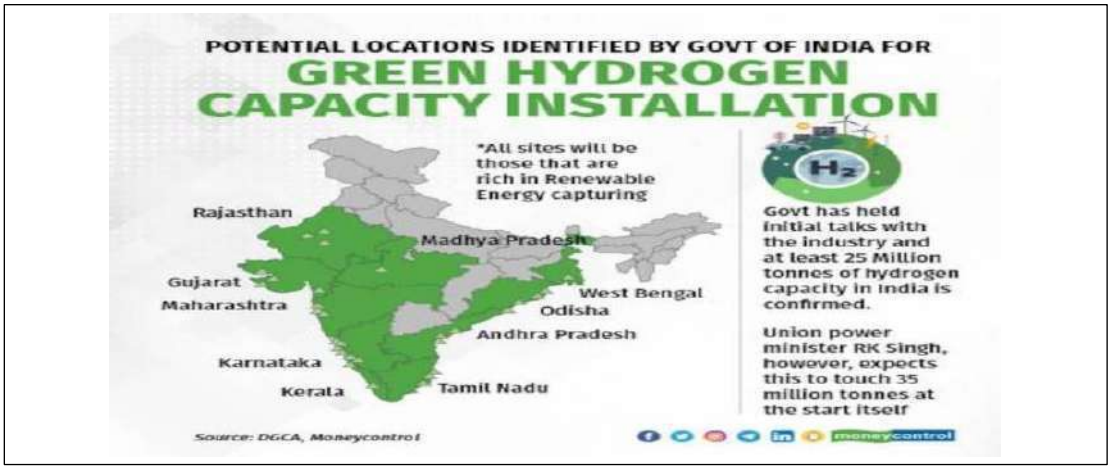
Odisha Chief Minister Naveen Patnaik urged S.N. Subrahmanyan, CEO & MD, L&T to explore the option to set up units in aerospace and defence manufacturing and green hydrogen sectors in Odisha.

https://www.canindia.com/odisha-cm-urges-lt-to-set-up-defence-manufacturing-green-hydrogen-units/

India's First Energy Festival Driving Industry

In an endeavour to set the vision for Industry-Academia led technology transformation aimed at taking India towards Net-Zero by 2047, IIT Madras Research Park along with India Energy Storage Alliance (IESA) is organising ENVISION – India's First Energy Festival at IITMRP between 3rd-5th November, 2022.

https://indiaeducationdiary.in/envision-indias-first-energy-festival-driving-industry-academia-led-technology-transformation-towards-net-zero-emissions-in-india/



Camilla Nicol Bonacina; et al

Proposal of a novel approach to reference instrument and procedure definition to measure hydrogen volume and volumetric flow in a legal metrology framework

https://doi.org/10.1016/j.measurement.2022.111882

Abstract:

International standards concerning hydrogen measurement in legal frameworks are still lacking. This study proposes a novel approach to instrument and procedure definition for the legal measurement of pure hydrogen volume and volumetric flow rate according to main international standards of metrology. A wet drum meter filled with water is chosen as reference meter. The selected reference instrumentation and procedures are replicable in other laboratories. Simulations and calculations demonstrate that hydrogen diffusivity in water have no influence on error estimations, while water evaporation is considered because it affects the volumetric flow rate measurement. The expanded uncertainty of the total metrological chain is less than 0.25%. This reference procedure allows to perform tests for error of indication of new meters both using hydrogen and other flowing gases with the same measurement principle, instrumentation and procedures, helping the development and certification processes of new products useful for the upcoming energy transition.

Xiaoni Chi; et al

Optimization of configuration for home micro-grid cogeneration system based on Wind-PV/T-PEMFC

https://doi.org/10.1016/j.egyr.2022.09.047

Abstract:

Residential energy consumption has increased rapidly with the improvement of living standards of Chinese households, in particular, heating demand in North China has a direct impact on the haze. The integration of renewable energy with the combined heat and power (CHP) technology provides an effective method to solve the household energy consumption and environmental impacts, but the construction, capacity, and cost of the system seriously affect the economy of the system, environmental protection, and operational reliability. Therefore, a family-oriented small-scale combined heat and power system was designed based on wind, photovoltaic, fuel cell, and hydrogen storage. The scheduling strategy of heat determined by power, meeting the requirements of all electrical loads and partial heat loads, and the minimum investment for the whole life cycle of 20 years was used as the objective function to design the system. Combined with the actual environmental conditions and thermoelectric load, an adaptive particle swarm optimization algorithm was improved for solving optimal allocation. The system was analyzed through thermal and power conditions, economy, the reliability of meeting the load, and other evaluation criteria in the optimal system configuration, the prediction, and evaluation of the prospects and development of the system provide basis and reference for the family cogeneration micro-grid applications.

Antonella De Corato; et al

Aggregated Flexibility from Multiple Power-to-Gas Units in Integrated Electricity-Gas-Hydrogen Distribution Systems

https://doi.org/10.1016/j.epsr.2022.108409

Abstract:

This work proposes a multi-energy vector framework to quantify the aggregated flexibility envelope from distributed energy resources (DER) including multiple power-to-gas (P2G) units. Aggregated flexibility (with respect to a reference node) is evaluated via the nodal operating envelope (NOE). The proposed framework deploys an optimization approach while modelling electricity

and gas networks constraints and their interdependency via P2G units. The gas network model is equipped with hydrogen tracking to quantify the changes in the molar composition resulting from hydrogen injection at multiple nodes. The methodology is applied to a real distribution system and results demonstrate that overlooking gas network constraints leads to P2G units' flexibility contribution overestimation. Furthermore, simultaneous operation of P2G units might be feasible from electricity network perspective but infeasible when considering the maximum hydrogen concentration to meet gas quality standards. This could be achieved if P2G units' location is properly chosen and/or gas quality standards are amended.

Moretto, Pietro; Quong, Spencer

Legal requirements, technical regulations, codes, and standards for hydrogen safety

https://doi.org/10.1016/B978-0-12-820492-4.00003-8

Abstract:

This chapter is dedicated to technical regulations, codes, and standards (RCS) for safe hydrogen technologies, systems, and products. Regulations are legally binding documents, issued by national or international authorities, standards are industry-driven and of voluntary adoption. Codes find in general a place between regulations and standards, and their specific roles and functions depend on the country and region of adoption. RCS provisions have been developed based on the knowledge of hydrogen behavior and the scientific data described in the previous chapters of this book. This chapter first describes the international RCS framework (including some national cases) and summarizes the available RCS literature on general aspects of hydrogen safety. The last two sections are dedicated to the safety of specific applications of fuel cell and hydrogen technologies, such as mobility, goods transport, power generation, and backup power, and to still existing RCS gaps and the related ongoing efforts.

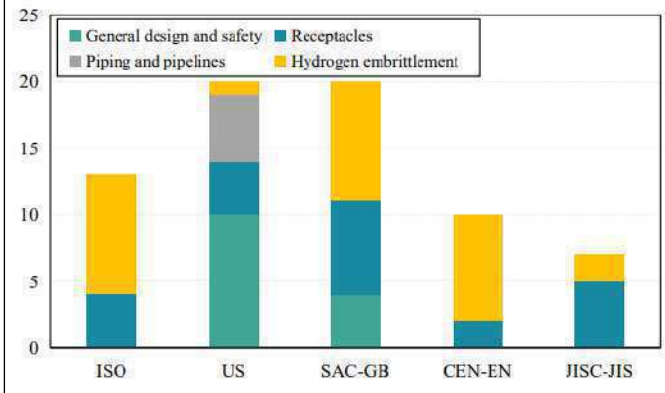
Yang, Yanmei et al

Development of Standards for Hydrogen Storage and Transportation

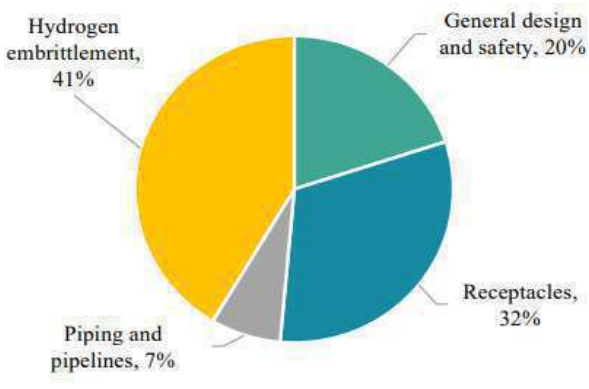
https://doi.org/10.1051/e3sconf/202019402018

Abstract:

Hydrogen storage and transportation are the intermediate link of hydrogen production and the point of end-use. Standards for hydrogen storage and transportation published by ISO, CGA, NFPA, ASME, ANSI, SAC, CEN and JISC are reviewed and analysed in this paper. Numbers of standards for hydrogen embrittlement are more than the others. Standards for hydrogen piping and pipelines are only published by CGA and ASME. Chinese GB standards are mainly focused on general design and safety, gaseous hydrogen receptacles and hydrogen embrittlement. Standards for liquid hydrogen storage receptacles and safety, hydrogen piping and pipelines, and hydrogen transportation should be emphasized. © The Authors, published by EDP Sciences, 2020.



Numbers of Standards for Hydrogen Storage and Transportation Published by Different Organizations and Countries



Distribution of Standards for Hydrogen Storage and Transportation Based on Standard Types

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 07

November, 2022

Smelly Hydrogen Sulfide Into A Cash Cow

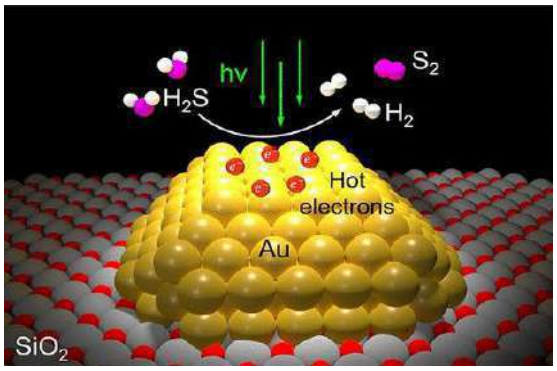
Rice University: engineers and scientists have created a sweet way for petrochemical refineries to turn a smelly byproduct into cash.

Hydrogen sulfide gas has the unmistakable aroma of rotten eggs. It often emanates from sewers, stockyards and landfills, but it is particularly problematic for refineries, petrochemical plants and other industries, which make thousands of tons of the noxious gas each year as a byproduct of processes that remove sulfur from petroleum, natural gas, coal and other products.

In a published study in the American Chemical Society's high-impact journal ACS Energy Letters, Rice engineer, physicist and chemist Naomi Halas and collaborators describe a method that uses gold nanoparticles to convert hydrogen sulfide into high-demand hydrogen gas and sulfur in a single step. Better yet, the one-step process gets all its energy from light. Study co-authors include Rice's Peter Nordlander, Princeton University's Emily Carter and Syzygy Plasmonics' Hossein Robatjazi.

"Hydrogen sulfide emissions can result in hefty fines for industry, but remediation is also very expensive," said Halas, a nanophotonics pioneer whose lab has spent years developing commercially viable light-activated nanocatalysts. "The phrase 'game-changer' is overused, but in this case, it applies. Implementing plasmonic photocatalysis should be far less expensive than traditional remediation, and it has the added potential of transforming a costly burden into an increasingly valuable commodity."

Each molecule of hydrogen sulfide gas (H2S) contains a pair of hydrogen atoms and one atom of sulfur. Each molecule of clean-burning hydrogen gas (H2) — the staple commodity of the hydrogen economy — contains a pair of hydrogen atoms. In the new study, Halas' team dotted the surface of grains of silicon dioxide powder with tiny islands of gold. Each island was a gold nanoparticle about 10 billionths of a meter across that would interact strongly with a specific wavelength of visible light. These plasmonic reactions create "hot carriers," short-lived, high-energy electrons that can drive catalysis.



In the study, Halas and co-authors used a laboratory setup and showed a bank of LED lights could produce hot carrier photocatalysis and efficiently convert H2S directly into H2 gas and sulfur. That's a stark contrast to the established catalytic technology refineries use to break down hydrogen sulfide. Known as the Claus process, it produces sulfur but no hydrogen, which it instead converts into Water. The Claus process also requires multiple steps, including some that require combustion chambers heated to about 1,500 degrees Fahrenheit.

https://indiaeducationdiary.in/rice-university-new-catalyst-can-turn-smelly-hydrogen-sulfide-into-a-cash-cow/

Naomi J. Halas; et al.

Direct H2S Decomposition by Plasmonic Photocatalysis: Efficient Remediation plus Sustainable Hydrogen Production

ABSTRACT: Plasmonic metal nanostructures have garnered rapidly increasing interest as heterogeneous photocatalysts, facilitating chemical bond activation and overcoming the high energy demands of conventional thermal catalysis. Here we report the highly efficient plasmonic photocatalysis of the direct decomposition of hydrogen sulfide into hydrogen and sulfur, an alternative to the industrial Claus process. Under visible light illumination and with no external heat source, up to a 20-fold reactivity enhancement compared to thermocatalysis can be observed. The substantially enhanced reactivity can be attributed to plasmon-mediated hot carriers (HCs) that modify the reaction energetics. With a shift in the rate-determining step of the reaction, a new reaction pathway is made possible with a lower apparent reaction barrier. Light-driven one-step decomposition of hydrogen sulfide represents an exciting opportunity for simultaneous high-efficiency hydrogen production and low-temperature sulfur recovery, important in many industrial processes.

https://doi.org/10.1021/acsenergylett.2c01755

COP 27 - Egypt

In November 2022, the Government of the Arab Republic of Egypt will host the 27th session of the Conference of the Parties of the UNFCCC (COP 27), with a view to building on previous successes and paving the way for future ambition to effectively tackle the global challenge of climate change.

ABOUT THE CONFERENCE

At COP 27, countries come together to take action towards achieving the world's collective climate goals as agreed under the Paris Agreement and the Convention. Building on the outcomes and momentum of COP 26 in Glasgow last year, nations are expected to demonstrate at COP 27 that they are in a new era of implementation by turning their commitments under the Paris Agreement into action. The conference will take place from 6-18 November 2022 in Sharm el-Sheikh, Egypt. Heads of State and Government will attend the Sharm el-Sheikh Climate Implementation Summit on 7 and 8 November. A high-level segment primarily attended by Ministers will take place from 15-18 November.

Explore More at - https://cop27.eg/#/

INDUSTRY NEWS

H2Fly advances toward Liquid-Hydrogen Flight

Germany's H2Fly has begun the integration of a liquid-hydrogen storage tank into its Hy4 fuel cell propulsion test aircraft. The Stuttgart-based company plans to begin ground testing in early 2023 and expects the four-seat HY4 to be the first electric passenger aircraft to fly on liquid hydrogen.



https://aviationweek.com/aerospace/advanced-air-mobility/h2fly-advances-toward-liquid-hydrogen-flight

Egyptian President launches Global Renewable Hydrogen Forum

In partnership with Belgium, Egypt announced the launch of the Global Renewable Hydrogen Forum, which aims at establishing a permanent platform for dialogue between hydrogen-producing countries and hydrogen-consuming countries and the private sector, organisations and financial institutions operating in this field. The dialogue's main objective is to coordinate policies and procedures and create paths for trade and investment in hydrogen, thus contributing to accelerating the pace of the just transition we aspire to have. Egyptian President Abdel-Fattah El-Sisi launched the forum at a Round Table on "Investing in the Future of Energy: Green Hydrogen", held on the sidelines of COP27.

https://www.zawya.com/en/business/energy/egyptian-president-launches-global-renewable-hydrogen-forum-uc5djik8

Alberta, federal governments commit $470M+ to blue hydrogen energy complex

The Alberta government is contributing $161 million from the Alberta Petrochemicals Incentive Program, and an additional $15 million through the Technology, Innovation and Emissions Reduction program, funded by a carbon tax on industrial emitters for the project.

https://calgarysun.com/news/local-news/feds-alberta-government-to-fund-more-than-470-million-in-new-blue-hydrogen-energy-complex/wcm/a88e06ee-7b18-4ebb-a2f0-950dd048b00d

COP27: EU and Kazakhstan partner on batteries and renewable hydrogen

The European Commission has announced a partnership with Kazakhstan on raw materials, batteries and renewable hydrogen. They signed a memorandum of understanding at the COP27 climate summit taking place in Egypt, aiming to boost the green and digital transformation of their economies and ensure the development of a "secure and sustainable supply" of raw and refined materials. The partnership seeks to identify joint projects throughout the respective value chains, including recycling and attracting private investment, increase the resilience of raw materials, battery and renewable hydrogen supply chains and decarbonise critical value chains by using renewable energy and digitalisation.

https://www.energylivenews.com/2022/11/08/cop27-eu-and-kazakhstan-partner-on-batteries-and-renewable-hydrogen/

Probat Introduces Hydrogen Power to Roasting Machines, Expands Production

German coffee roasting equipment giant Probat has developed new burner technology for heating coffee roasters using hydrogen. It represents the first broad-scale introduction of hydrogen power systems in the coffee roaster manufacturing industry, which has primarily upon natural gas, resulting in higher greenhouse gas emissions. In addition to the hydrogen introduction, Probat recently completed a roughly roughly €40 million (US$39.8 million, as of this writing) expansion to the manufacturing plant at its Emmerich, Germany, headquarters for increased roaster production.



https://dailycoffeenews.com/2022/11/08/probat-introduces-hydrogen-power-to-roasting-machines-expands-production/

Successful Case studies

Case study1:

STAND-ALONE RENEWABLE ENERGY SYSTEM BASED ON HYDROGEN PRODUCTION

A stand-alone RE system based on hydrogen production from wind and solar energy has been developed and installed at the Hydrogen Research Institute (HRI). It includes a fuel cell and both short-term and long-term energy storage devices. It is the goal of this project to demonstrate that an autonomous renewable energy system may be realized with long-term energy storage in the form of hydrogen, and that the operation of such a system is safe and reliable.

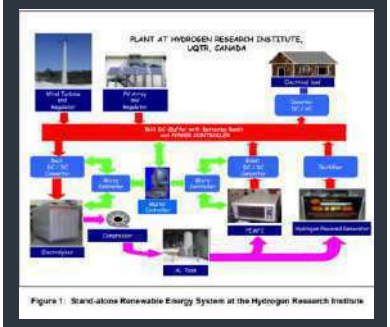


Figure 1 : Stand-alone Renewable Energy System at the Hydrogen Research Institute

https://www.ieahydrogen.org/case-studies/

Case study2:

WINDMILL – ELECTROLYSER SYSTEM FOR HYDROGEN PRODUCTION AT STRALSUND

A Multi-component Laboratory for Integrated Energy Systems has been established at Fachhochschule Stralsund –

Frontier Energy welcomes Smart Energy Council's pre-certification of 'green' hydrogen at Bristol Springs

"Frontier Energy prides itself on being a first mover and the zero-carbon pre-certification assessment will be a critical piece of the puzzle in moving this project forward," Frontier managing director Sam Lee Mohan said.

"To have this certification in place from a world leader in zero-carbon certification, the Smart Energy Council, will give our partners, shareholders and prospective green hydrogen customers confidence that our project will be 100% clean and made from 100% renewable energy."

https://www.proactiveinvestors.com/companies/news/997752/frontier-energy-welcomes-smart-energy-council-s-pre-certification-of-green-hydrogen-at-bristol-springs-997752.html

Fertiglobe and partners commission Africa's first integrated green hydrogen plant

Fertiglobe, the world's largest seaborne exporter of urea and ammonia combined, has announced the start of the commissioning of the first phase of the green hydrogen plant in Ain Sokhna, Egypt. The announcement was made during an event at Cop27 that was attended by Egyptian President Abdel Fattah El Sisi and Norwegian Prime Minister Jonas Gahr Store.

https://www.msn.com/en-ae/money/news/fertiglobe-and-partners-commission-africa-s-first-integrated-green-hydrogen-plant/ar-AA13SKKs

Shell closes UK hydrogen filling stations due to lack of demand with fewer than 500 models on the road

Having opened its first hydrogen fuelling station in Britain to huge fanfare in 2017, Shell has quietly closed all three of its UK locations due to a lack of demand from motorists.

The oil giant said the technology had 'reached its end of life' and it will now be concentrating on creating hydrogen refuellling sites for larger vehicles rather than passenger cars.

Just two hydrogen fuel cell cars have been sold to Britons - two generations of the Toyota Mirai and the Hyundai Nexo - but fewer than 500 have been bought in total, with most of these registered to businesses.



https://www.msn.com/en-gb/cars/news/has-the-plug-been-pulled-on-hydrogen-cars-shell-closes-uk-hydrogen-filling-stations-due-to-lack-of-demand-with-fewer-than-500-models-on-the-road/ar-AA13QYKy

Sasol's dream of a green hydrogen world

Plans to become a prominent global producer of the 'fuel of the future'.

Still tagged as one of the biggest polluters in the country, Sasol has once again outlined its plans to produce green hydrogen to reshape the company and the energy industry in SA. The challenge is to get it done relatively quickly, and profitably.

CEO Fleetwood Grobler says Sasol is working towards becoming a major producer of hydrogen, produced using sustainable and renewable energy sources.

https://www.citizen.co.za/news/sasols-dream-of-a-green-hydrogen-world/

COP27: Egypt, Norway unveil 100mw green hydrogen plant on Red Sea

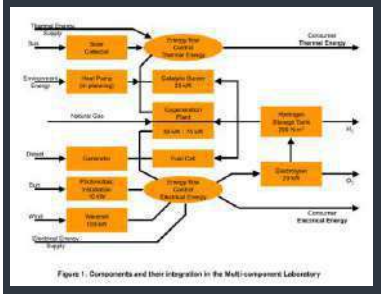
Egypt and Norway have launched the first phase of a project to establish a major green hydrogen plant in Egypt's Ain Sokhna on the Red Sea, with a capacity to produce 100MW.

President Abdel-Fattah El-Sisi of Egypt and the Norwegian Prime Minister, Jonas Gahr Støre at the launch of the project, said the launching was part of the 2022 UN Climate Conference of Parties (COP27) holding in Sharm El Sheikh, Egypt.

https://pmnewsnigeria.com/2022/11/09/cop27-egypt-norway-unveil-100mw-green-hydrogen-plant-on-red-sea/

University of Applied Sciences. This Laboratory will be used to train engineering students and to conduct research on renewable energy sources and hydrogen technology. One feature of this laboratory is a windmill–electrolyser system for carbon dioxide-free hydrogen production. This system was designed to show that the intermittent operation of an electrolyser, with a changing power input due to a changing wind speed, is possible. A process control system allows collection of data that can be used in simulation calculations. The demonstration and testing of this windmill-electrolyser system provides valuable experience in the operation and design of such integrated systems. The system is also one step towards an island solution for a hydrogen-based energy supply.

Figure 1 shows the multiple possibilities for energy conversion in the laboratory. The aim of this system is to offer the opportunity to use each piece of equipment as a single device for practical work.



https://www.ieahydrogen.org/case-studies/

India needs $300 bn more to meet 500 GW green capacity target by 2030: Report

A research showed that India will require an additional investment of over USD 300 billion to reach its goal of 500 gigawatts of renewable energy capacity by 2030. According to the Arthur D Little (ADL) study, the nation is on track to reach its objective of meeting 50% of its energy needs through renewable sources with 165 gigawatts (GW) of generation capacity already installed.

"India needs (additional) strategic investments of over USD 300 billion to achieve its clean energy capacity target of 500 GW by 2030," the study titled 'Powering India's Energy Vision 2030' said.

https://economictimes.indiatimes.com/industry/renewables/india-needs-additional-300-bn-investment-to-reach-500-gw-green-capacity-goal-by-2030-research/articleshow/95352975.cms

State govt (Maharastra) to launch hydrogen policy soon: Uday Samant

Maharashtra industries minister Uday Samant said that the state government will launch various policies in the coming days that include hydrogen vehicles, wine, and information technology. Samant said that a policy pertaining to hydrogen vehicles will be launched in the state within next few days.

“Our Prime Minister Narendra Modi said that there should be a hydrogen policy in place and Maharashtra will be the first in the country to formulate it as Union minister Nitin Gadkari is aggressively working on it and the state will have its hydrogen policy in the next eight days.

https://www.hindustantimes.com/cities/pune-news/state-govt-to-launch-hydrogen-it-and-wine-policies-soon-uday-samant-101667847614754.html

India in talks to export green hydrogen

India is in talks with the governments of other countries to export green hydrogen made in the South Asian nation, an official of its foreign ministry.

“We are in a position to make green hydrogen as our main source of energy in the future,” Prabhat Kumar, an additional secretary of the external affairs ministry, said at an industry event.

https://theprint.in/india/india-in-talks-to-export-green-hydrogen-official-says/1208222/

COP27 Summit: India supports UN's early warning systems

Union Minister for Environment, Forest and Climate Change, Bhupender Yadav, represented India at the 27th edition of the Conference Of Parties (COP27) held in Egypt. Taking to Twitter after attending the climate summit, Yadav said India fully supports the "early warnings for all" action plan unveiled by United Nations Secretary-General Antonio Guterres.

https://www.indiatoday.in/environment/story/cop-27-india-supports-early-warning-systems-bhupender-yadav-2294501-2022-11-07

Need for a unique financial vehicle to fuel green hydrogen projects growth in India

Green hydrogen has emerged as one of the biggest game-changers across the globe. The latest buzzword among net-zero energy experts, it has sparked off a green hydrogen rush in India among big companies. To go large-scale across the country, however, more work is needed. Despite the speed with which it is moving forward, India can hear the clock ticking to meet its huge target: 50 per cent of its energy requirements from renewable energy by 2030 and to become net-zero by 2070. These targets were announced by the Prime Minister of India Narendra Modi at COP26 last year. Almost a year later, it’s literally turning out to be a race against time. According to a GE-EY joint report this year, the country may require investing over $10 trillion to achieve its net-zero targets. This is especially challenging since India is among the largest carbon-dioxide emitters in the world.

https://timesofindia.indiatimes.com/blogs/voices/need-for-a-unique-financial-vehicle-to-fuel-green-hydrogen-projects-growth-in-india/

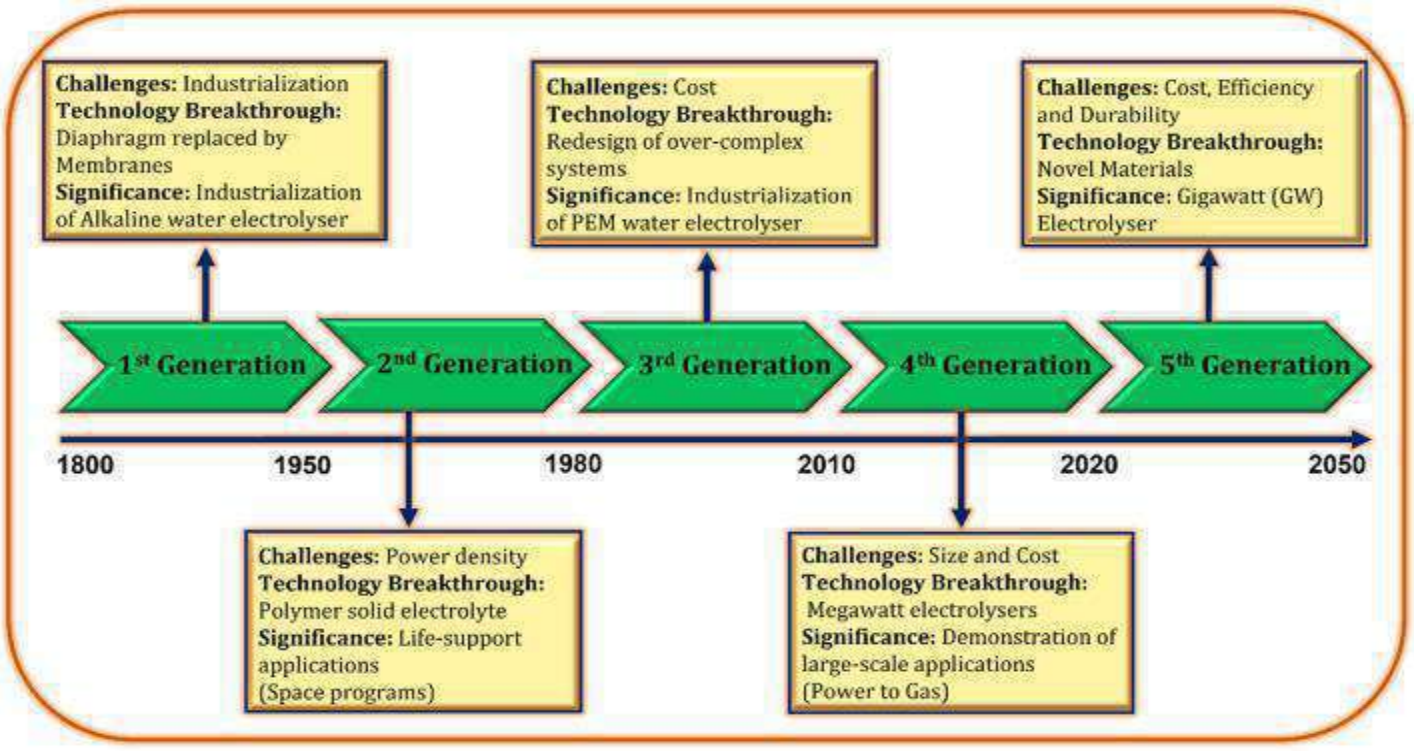
S.Shiva Kumar; Hankwon Lim

An overview of water electrolysis technologies for green hydrogen production

https://doi.org/10.1016/j.egyr.2022.10.127

Abstract:

Decarbonizing the planet is one of the major goals that countries around the world have set for 2050 to mitigate the effects of climate change. To achieve these goals, green hydrogen that can be produced from the electrolysis of water is an important key solution to tackle global decarbonization. Consequently, in recent years there is an increase in interest towards green hydrogen production through the electrolysis process for large-scale implementation of renewable energy-based power plants and other industrial, and transportation applications. The main objective of this study was to provide a comprehensive review of various green hydrogen production technologies especially on water electrolysis. In this review, various water electrolysis technologies and their techno-commercial prospects including hydrogen production cost, along with recent developments in electrode materials, and their challenges were summarized. Further some of the most successful results also were described. Moreover this review aims to identify the gaps in water electrolysis research and development towards the techno-commercial perspective. In addition, some of the commercial electrolyzer performances and their limitations also were described along with possible solutions for cost-effective hydrogen production. Finally, we outlined our ideas, and possible solutions for driving cost-effective green hydrogen production for commercial applications. This information will provide future research directions and a road map for the development/implementation of commercially viable green hydrogen projects.



Mona Wappler; et al

Building the green hydrogen market – Current state and outlook on green hydrogen demand and electrolyzer manufacturing

https://doi.org/10.1016/j.ijhydene.2022.07.253

Abstract:

Over the past two years, requirements to meet climate targets have been intensified. In addition to the tightening of the climate

targets and the demand for net-zero achievement by as early as 2045, there have been discussions on implementing and realizing these goals. Hydrogen has emerged as a promising climate-neutral energy carrier. Thus, over the last 1.5 years, more than 25 countries have published hydrogen roadmaps. Furthermore, various studies by different authorities have been released to support the development of a hydrogen economy. This paper examines published studies and hydrogen country roadmaps as part of a meta-analysis. Furthermore, a market analysis of electrolyzer manufacturers is conducted. The prospected demand for green hydrogen from various studies is compared to electrolyzer manufacturing capacities and selected green hydrogen projects to identify potential market ramp-up scenarios, and to evaluate if green hydrogen demand forecasts can be filled.

Julio José Caparros Mancera; et al

Sun, heat and electricity. A comprehensive study of non-pollutant alternatives to produce green hydrogen

https://doi.org/10.1002/er.8505

Abstract:

Water-based hydrogen production is currently an attractive research field, as it provides a greener method to produce hydrogen than existing alternatives. Green hydrogen is expected to progressively replace fossil fuels, which are highly harmful environmentally. This paper presents a critical analysis over time of the main water splitting technologies currently in use for sustainable hydrogen production. As a result of the critical analysis, all the studied techniques have been ordered chronologically in the way that it is possible to understand how new materials have driven to new techniques, more efficient and less expensive. This allows having a complete vision of these technologies. A high level of maturity has been reached in electrolysis, while other techniques still have a long way to go, although many improvements and relevant advancements have been made over the years. The paper offers a global and comparative vision of each technology. From this, it is possible to identify the different paths where efforts are needed to make water-based hydrogen production a mature, stable and efficient technology.

Aaron Hodges; et al

A high-performance capillary-fed electrolysis cell promises more cost-competitive renewable hydrogen

https://doi.org/10.1038/s41467-022-28953-x

Abstract:

Renewable, or green, hydrogen will play a critical role in the decarbonisation of hard-to-abate sectors and will therefore be important in limiting global warming. However, renewable hydrogen is not cost-competitive with fossil fuels, due to the moderate energy efficiency and high capital costs of traditional water electrolysers. Here a unique concept of water electrolysis is introduced, wherein water is supplied to hydrogen- and oxygen-evolving electrodes via capillary-induced transport along a porous inter-electrode separator, leading to inherently bubble-free operation at the electrodes. An alkaline capillary-fed electrolysis cell of this type demonstrates water electrolysis performance exceeding commercial electrolysis cells, with a cell voltage at 0.5 A cm−2 and 85 °C of only 1.51 V, equating to 98% energy efficiency, with an energy consumption of 40.4 kWh/kg hydrogen (vs. ~47.5 kWh/kg in commercial electrolysis cells). High energy efficiency, combined with the promise of a simplified balance-of-plant, brings cost-competitive renewable hydrogen closer to reality.

Hydrogen Digest

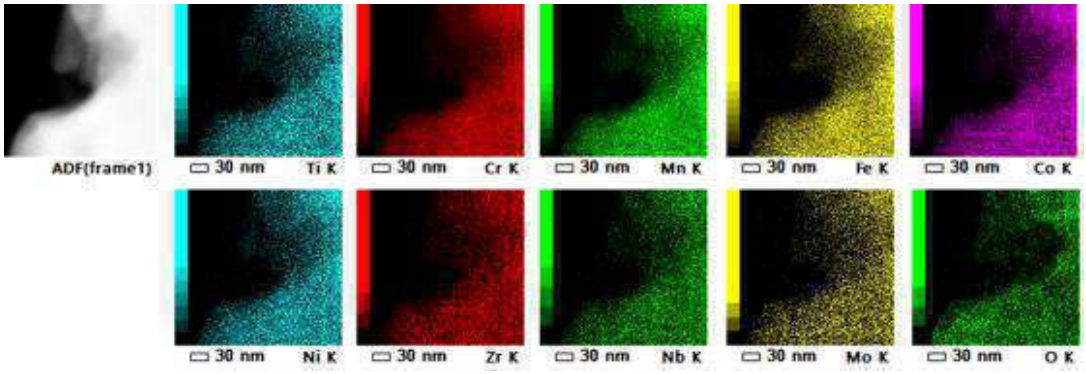
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 08

November, 2022

Non-noble catalyst for hydrogen production

Hydrogen is a promising future fuel—especially if produced from water—but the necessary noble metal catalysts are rare, expensive, and have insufficient reserves. But now, in a study recently published in Advanced Materials, researchers from the University of Tsukuba and collaborating partners have developed catalysts that can overcome the limitations of noble metals. However, the metal catalysts required to make this work—such as platinum and iridium—are scarce, costly, and don't perform as well as needed in the harsh and acidic conditions that increase the energy efficiency. Which metal can be an alternative in acidic media instead? The solution Professor Yoshikazu Ito and coworkers came up with is a surprising one: Use numerous non-noble metals, all at once.



The researchers used high-entropy alloys, which are mixtures consisting of many elements. Whereas some of these alloys can be used to generate large quantities of hydrogen, others undergo a process called oxidation (i.e., passivation) that imparts some corrosion resistance ability to the alloys. Nevertheless, as Professor Ito points out, "it's apparent that identifying which metals to use in which proportions by conventional bottom-up experiments—i.e., change/add one metal at a time—is quite time-consuming. Our top-down approach not only saves time but also provides invaluable chemical insights into the hydrogen production mechanism." Their approach involves first uniformly mixing the nine elements that constitute the alloy, then passivating the surface in acidic media, and finally applying a voltage to facilitate surface structure rearrangements that optimizes the activity of the catalyst. Experiments and theoretical calculations identified the metals that contributed to catalytic activity (e.g., iron, chromium, nickel, cobalt, and manganese) and the metals that contributed to passivation (e.g., titanium, zirconium, niobium, and molybdenum). The high-entropy alloys' remarkable performance and corrosion resistance were demonstrated in practical water electrolysis experiments. The researchers' study offers novel possibilities and new perspectives toward replacing extremely scarce noble metals, particularly iridium with a worldwide production of only 7 tons per year. With a surge in the use of water electrolyzers globally, the demand for iridium is expected to be 700 kilograms per gigawatt.

This work succeeded in providing a proof-of-concept for a novel, noble-metal-free, economically feasible hydrogen production method from water by using renewable energy. The method costs only a few hundred U.S. dollars per kilogram of catalyst and is suitable for mass-production. The application of high-entropy alloys by the researchers will allow for the production of hydrogen, batteries, and other products that would otherwise require expensive metals. https://techxplore.com/news/2022-11-non-noble-catalyst-hydrogen-production.html

Ilissa B. Ocko and Steven P. Hamburget al. *Climate consequences of hydrogen emissions*

ABSTRACT: Given the urgency to decarbonize global energy systems, governments and industry are moving ahead with efforts to increase deployment of hydrogen technologies, infrastructure, and applications at an unprecedented pace, including USD billions in national incentives and direct investments. While zero- and low-carbon hydrogen hold great promise to help solve some of the world's most pressing energy challenges, hydrogen is also an indirect greenhouse gas whose warming impact is both widely overlooked and underestimated. This is largely because hydrogen's atmospheric warming effects are short-lived – lasting only a couple decades – but standard methods for characterizing climate impacts of gases consider only the long-term effect from a one-time pulse of emissions. For gases whose impacts are short-lived, like hydrogen, this long-term framing masks a much stronger warming potency in the near to medium term. This is of concern because hydrogen is a small molecule known to easily leak into the atmosphere, and the total amount of emissions (e.g., leakage, venting, and purging) from existing hydrogen systems is unknown. Therefore, the effectiveness of hydrogen as a decarbonization strategy, especially over timescales of several decades, remains unclear. This paper evaluates the climate consequences of hydrogen emissions over all timescales by employing already published data to assess its potency as a climate forcer, evaluate the

net warming impacts from replacing fossil fuel technologies with their clean hydrogen alternatives, and estimate temperature responses to projected levels of hydrogen demand. We use the standard global warming potential metric, given its acceptance to stakeholders, and incorporate newly published equations that more fully capture hydrogen's several indirect effects, but we consider the effects of constant rather than pulse emissions over multiple time horizons. We account for a plausible range of hydrogen emission rates and include methane emissions when hydrogen is produced via natural gas with carbon capture, usage, and storage (CCUS) ("blue" hydrogen) as opposed to renewables and water ("green" hydrogen). For the first time, we show the strong timescale dependence when evaluating the climate change mitigation potential of clean hydrogen alternatives, with the emission rate determining the scale of climate benefits or disbenefits. For example, green hydrogen applications with higher-end emission rates (10 %) may only cut climate impacts from fossil fuel technologies in half over the first 2 decades, which is far from the common perception that green hydrogen energy systems are climate neutral. However, over a 100-year period, climate impacts could be reduced by around 80 %. On the other hand, lower-end emissions (1 %) could yield limited impacts on the climate over all timescales. For blue hydrogen, associated methane emissions can make hydrogen applications worse for the climate than fossil fuel technologies for several decades if emissions are high for both gases; however, blue hydrogen yields climate benefits over a 100-year period. While more work is needed to evaluate the warming impact of hydrogen emissions for specific end-use

Oak Ridge National Lab develops new hydrogen powered train engine unveiled at ORNL

ORNL unveiled a hydrogen-powered train engine. Argonne National Laboratory and Wabtec are partners in the project too. ORNL officials said its cylinder is about six times bigger than a cylinder that you find in a truck, and a train is going to have a dozen of them. ORNL officials said that North American trains emit about 87.6 billion pounds of carbon dioxide every year, but every train that changes to low-carbon energy could save about 5.6 million pounds per year. "It is a major part of our economy," Wagner said. "It's a major use of fuel. The amount of train traffic in this country is just very, very significant."



https://www.wvlt.tv/2022/11/09/oak-ridge-national-lab-develops-new-train-engine-cuts-down-carbon-emissions/

ATOME Energy hails meeting between presidents of Germany and Paraguay to discuss green hydrogen

ATOME Energy PLC (AIM:ATOM) has hailed a reported meeting between the presidents of Germany and Paraguay to discuss green hydrogen while highlighting the former's need to import gas against the backdrop of steepling energy costs.

Germany has already said it is setting aside €4bln to import green hydrogen from outside the EU.

ATOME chief executive Olivier Mussat noted: "The reported discussions... reinforce ATOME's stated ambition to be at the forefront of production of green energy at scale and being able to deliver such energy from Paraguay to Europe well in advance of other major projects."

https://www.proactiveinvestors.co.uk/companies/news/998208/atome-energy-hails-meeting-between-presidents-of-germany-and-paraguay-to-discuss-green-hydrogen-998208.html

Funding for green-hydrogen plant at Saudi Arabia's Neom almost done

Riyadh: The financing for a green-hydrogen project in Neom in Saudi Arabia - set to be one of the world's largest - may be completed in the coming months, according to ACWA Power Co. Construction of the $5 billion plant in the north-west of the kingdom has started and it's "very much on track" to be finished on schedule in 2026, Paddy Padmanathan, chief executive officer of ACWA, said in an interview.

https://gulfnews.com/business/energy/funding-for-green-hydrogen-plant-at-saudi-arabias-neom-almost-done-1.91986570

Green hydrogen to help power WA town of Denham in Australian renewable energy first

Hydrogen made from renewable energy will be used to help power an Australian town for the first time as part of a landmark trial along the country's sun-drenched west coast. Horizon Power, the state-owned regional electricity utility in Western Australia, has unveiled a pilot project that will convert electricity from a solar plant to make so-called green hydrogen in Denham, 820 kilometres north of Perth. From there, the hydrogen will be used to power a fuel cell capable of generating enough electricity to supply about 100 homes, or a quarter of the town's demand.

https://www.abc.net.au/news/2022-11-14/green-hydrogen-to-help-power-wa-town-in-renewable-energy-trial/101648728

Cummins Inc, Tata Motors team up to develop hydrogen-powered engines

U.S.-listed Cummins Inc said it has signed an agreement with Indian automaker Tata Motors to develop hydrogen-powered internal combustion engines, fuel cells and battery electric vehicle systems for commercial automobiles in India.

Several automakers, including Tata Motors, are aggressively shifting towards greener forms of energy for their vehicles as they try to reduce their dependence on fossil fuels, with India targeting net-zero carbon emissions by 2070.

https://www.business-standard.com/article/companies/cummins-inc-tata-motors-team-up-to-develop-hydrogen-powered-engines-122111401300_1.html

cases and value-chain pathways, it is clear that hydrogen emissions matter for the climate and warrant further attention from scientists, industry, and governments. This is critical to informing where and how to deploy hydrogen effectively in the emerging decarbonized global economy.
DOI-
https://doi.org/10.5194/acp-22-9349-2022

Nicola Warwick; et al.
Atmospheric implications of increased Hydrogen use

Some policy implications
Leakage of hydrogen into the atmosphere during production, storage, distribution and use will partially offset some of the benefits of a hydrogen-based economy. Minimisation of leaks needs to be a priority if hydrogen is adopted as a major energy source. Use of hydrogen provides an opportunity to reduce emissions of species which might be co-emitted during the production of carbon dioxide. Reductions in emissions of methane, carbon monoxide, volatile organic compounds and oxides of nitrogen would all provide both climate and air quality benefits. Maximising these reductions should be a further policy priority.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067144/atmospheric-implications-of-increased-hydrogen-use.pdf

Canadian-Portuguese joint venture plans $1.04 bln hydrogen plant in Sines

Canadian renewable energy company Neogreen Hydrogen and Portuguese developer of photovoltaic solar parks Frequent Summer announced plans to invest more than 1 billion euros ($1.04 billion) in a green hydrogen plant in Portugal.
So-called green hydrogen, produced using renewable electricity such as wind and solar, is seen as a key power source that can reduce pollution from long-haul transport, steel and chemical industries and power generation.
https://auto.economictimes.indiatimes.com/news/oil-and-lubes/canadian-portuguese-joint-venture-plans-1-04-bln-hydrogen-plant-in-sines/95508637

North Queensland energy super hub to power green hydrogen, northwest transmission line

The state government is planning an energy "super hub" in north Queensland that will include large-scale solar and wind farms to generate the power needed to produce green hydrogen.
Stretching from the inland town of Hughenden to Townsville, the project is designed to feed the electricity grid in Queensland's northwest. Premier Annastacia Palaszczuk said the government would partner with Fortescue Future Industries and Windlab to construct the first stage.
https://www.abc.net.au/news/2022-11-15/north-queensland-energy-super-hub-renewable-solar-wind-power/101655280

Unigel's Green Hydrogen Plant to be featured at COP27

With the objective of presenting the first green hydrogen and ammonia plant in Brazil and debating initiatives that contribute to the decarbonization of the industry, Unigel - one of the largest chemical companies in Latin America and the largest manufacturer of nitrogen fertilizers in Brazil - participates in the 27th edition of the 2022 United Nations Climate Change Conference that will take place n the city of Sharm El-Sheikh, Egypt.
https://www.tmcnet.com//usubmit/2022/11/14/9712150.htm

Saudi Aramco, Pertamina strike hydrogen and ammonia deals

Saudi Aramco and Indonesia's state-owned Pertamina have signed a deal to jointly work on projects involving the hydrogen and ammonia value chains.
Aramco said the companies signed a "memorandum of understanding (MoU) outlining future cooperation across the key pathway of the energy transition" on the sidelines of the G20 Summit in Bali, Indonesia. The agreement "involves a pre-feasibility study that aims to assess the possibility of cooperation related to the development of a clean ammonia and hydrogen value chain", the company noted.



https://www.upstreamonline.com/hydrogen/saudi-aramco-pertamina-strike-hydrogen-and-ammonia-deals/2-1-1353527

Australia's first renewable hydrogen grid

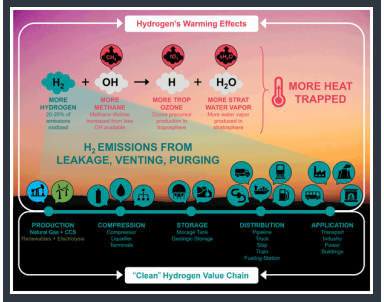
Australia's first remote renewable hydrogen microgrid has launched in Denham in Western Australia's Gascoyne region. Once fully operational in early 2023, the $9.3 million Denham Hydrogen Demonstration Plant is expected to be able to power the average demands of 100 households or 20 per cent of Denham's residents and businesses. The plant includes a 704-kilowatt (kW) solar farm, 348kW hydrogen electrolyser, and a 100kW fuel cell providing an innovative alternative to diesel generators. The project is being delivered by Horizon Power and Hybrid Systems Australia.



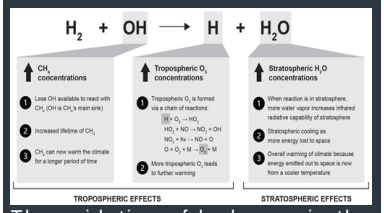
https://www.australianmining.com.au/news/australias-first-renewable-hydrogen-grid/

Climate consequences of hydrogen emissions

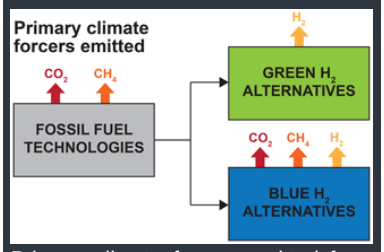
Ilissa B. Ocko and Steven P. Hamburg
Environmental Defense Fund, New York, NY, USA



https://doi.org/10.5194/acp-22-9349-2022



The oxidation of hydrogen in the atmosphere leads to increasing concentrations of greenhouse gases in both the troposphere and stratosphere



Primary climate forcers emitted from fossil fuel technologies and their clean hydrogen alternatives.

Results:-

Recent research has reported hydrogen's GWP for both tropospheric and stratospheric effects and for both 20- and 100-year timeframes, revealing that hydrogen's 100-year GWP is twice as high as previously thought, and its 20-year GWP is 3 times higher than its 100-year GWP (Warwick et al., 2022).

Cochin Shipyard Ltd to build India's first hydrogen fuel cell vessel

The Cochin Shipyard Ltd (CSL) will build the country's first indigenous hydrogen fuel cell catamaran vessel for the spiritual city of Varanasi.

The Union government, through Inland Waterways Authority of India, has signed an MoU with Cochin Shipyard for the construction of the vessel. CSL has also signed an MoU for the construction of six electric catamaran vessels for Uttar Pradesh and another two for Guwahati in Assam. The design and development of the vessel will be undertaken by CSL in collaboration with M/s KPIT, Pune.

https://www.newindianexpress.com/cities/kochi/2022/nov/12/csl-to-build-indias-first-hydrogen-fuel-cell-vessel-2517435.html

Uttar Pradesh government issues draft policy to promote green hydrogen production

The Uttar Pradesh government has issued the draft Green Hydrogen Policy-2022. The move is a precursor to rollout of the final policy that would aim to make Uttar Pradesh a 100% green hydrogen/ammonia consuming state by 2035. Turning the state into a leading green hydrogen/ammonia producer is another objective. The policy would also promote green hydrogen/ammonia production, market creation and demand aggregation. The policy will focus primarily on two major hydrogen/ammonia demand centres in Uttar Pradesh – nitrogenous (N) fertilisers and the refinery sector. It will also cover other emerging industries and applications of green hydrogen in the future.

https://www.hindustantimes.com/cities/lucknow-news/uttar-pradesh-government-issues-draft-policy-to-promote-hydrogen-production-101668273261199.html

India Hydrogen Alliance, Kerala govt to build Kochi Green Hydrogen Hub

India Hydrogen Alliance (IH2A) and the government of Kerala announced the proposal to build the Kochi Green Hydrogen (KGH2) Hub. "The proposal envisages potential capital expenditure of USD 575 million, to build a 60-tonnes per day (TPD) green hydrogen plant with a 150 MW Electrolyser, Storage and Infrastructure, which could achieve giga-watt scale and build the hydrogen economy in Kerala. https://www.livemint.com/news/india/india-hydrogen-alliance-kerala-govt-to-build-kochi-green-hydrogen-hub-11668419470493.html

Tamil Nadu to attract investment in alternative fuel segment, green hydrogen projects: Minister

The Tamil Nadu government will continue to attract investments in the alternative fuels segment and will extend support to such projects, according to S. S. Sivasankar, TN Transport Minister. He was addressing the 10th Edition of Autoserve 2022, an Exhibition on Automotive Care, Maintenance, Service, Parts & Garage Equipment. "Tamil Nadu is open to hydrogen fuel projects. We would welcome suggestions from industry in the area," he added. The Indian government is also aiming at becoming a major producer of green hydrogen, which is currently produced in small quantities in the country.

https://www.thehindubusinessline.com/news/tamil-nadu-to-attract-investment-in-alternative-fuel-segment-green-hydrogen-projects-minister/article66124886.ece

Fadnavis Holds Talks With Avaada Group For Green Hydrogen Project

Maharashtra Deputy Chief Minister Devendra Fadnavis held talks with Avaada Group for setting up a green hydrogen project worth Rs 45,000 crore in the state. It will also generate direct and indirect employment for around 12,000 persons, said Fadnavis who also holds the finance portfolio.

https://www.outlookindia.com/national/fadnavis-holds-talks-with-avaada-group-for-green-hydrogen-project-news-236663

Erisha E Mobility partners Germany's Greenbox for green hydrogen technology

Delhi-based EV maker Erisha E Mobility has partnered with Germany's Greenbox Global to establish Erisha Hydrogen India. The partnership aims to offer solutions for sustainable energy production, conversion, storage, and service systems. While Erisha will look after manufacturing a range of hydrogen technologies such as hydrogen containers, ESS, Hydrogen Gensets, hydrogen vehicles, its partner Greenbox will give technology solutions and applications.

https://www.financialexpress.com/express-mobility/erisha-e-mobility-partners-germanys-greenbox-for-green-hydrogen-technology/2806083/

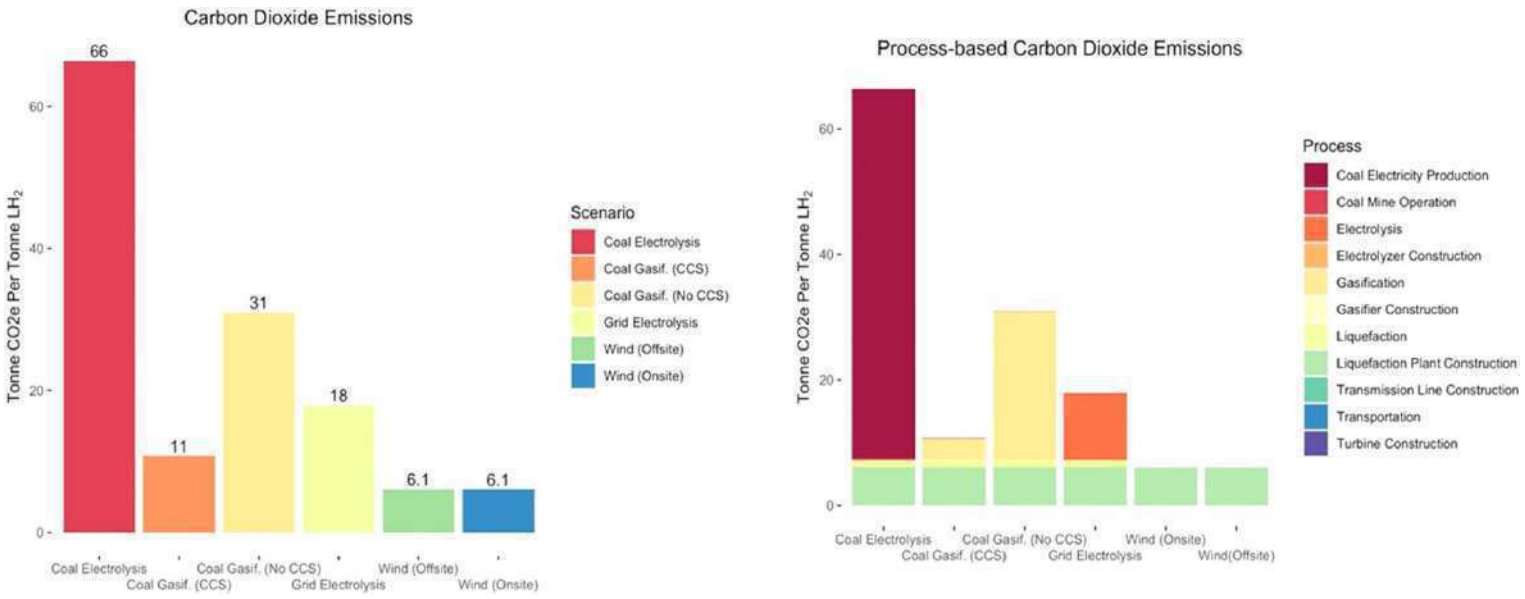
Amanda N Ullman; et al

Environmental impacts associated with hydrogen production in La Guajira, Colombia

https://doi.org/10.1088/2515-7620/ac68c8

Abstract:

The global push to decarbonize sectors of the economy and phase-out coal use has attracted a renewed interest in hydrogen. At the forefront of this debate, Colombia, the world's 6th largest coal exporter, must consider strategies to support a just transition for regions that depend economically on coal exports. However, the role of hydrogen as a part of the energy transition has yet to be examined from an environmental justice lens. A full-chain life-cycle assessment of hydrogen production is yet to be considered in Colombia. Using life-cycle assessment (LCA) methodology, we examine the greenhouse gas emissions, water consumption, and trace metal emissions associated with six potential Colombian liquid hydrogen production strategies: (1) electrolysis powered by the country's national electricity grid, (2) on-site electrolysis powered by electricity produced by a wind farm, (3) off-site electrolysis powered by electricity produced by a wind farm, (4) electrolysis powered by electricity produced from a coal-fired power plant, (5) coal gasification without carbon capture and storage (CCS), and (6) coal gasification with CCS. Upstream conversion has an outsized influence on the sustainability of a hydrogen transition in Colombia. Impact levels for wind-powered electrolysis are lower than those of the coal- and grid-powered scenarios for every impact category analyzed, apart from emissions of aluminum to air, nitrogen emissions to water, and phosphorous, nitrate, and nitrite emissions to soil. The grid-based electrolysis scenario is found to consume the largest amount of water, while coal-fueled scenarios pathways raise concerns of greater life-cycle mercury, nickel, and arsenic emissions. While coal gasification with CCS reduced gasification CO2 emissions by 35%, the CCS scenario's VOC emissions were 37% greater than gasification without CCS, given that increased levels of coal inputs were required to account for the loss of efficiency associated with the addition of CCS technology. For Colombia to benefit most from a hydrogen-based decarbonization transition with minimal environmental impacts, community-focused planning and wind-based hydrogen systems should be prioritized.



Carbon dioxide emissions per tonne liquid hydrogen produced (Left) and process-based carbon dioxide emissions (Right).

Li, Hao; et al

Safety of hydrogen storage and transportation: An overview on mechanisms, techniques, and challenges

https://doi.org/10.1016/j.egyr.2022.04.067

Abstract:

The extensive usage of fossil fuels has caused significant environmental pollution, climate change and energy crises. The significant advantages of hydrogen, such as cleanliness, high efficiency, and a wide range of sources, make it quite promising. Hydrogen is prone to material damage, which may lead to leakage. High-pressure leaking hydrogen is highly susceptible to spontaneous combustion due to its combustion characteristics, which may cause jet fire or explosion accidents, resulting in serious casualties and property damage. This paper presents a detailed review of the research progress on hydrogen leak diffusion characteristics, leak spontaneous combustion mechanisms and material hydrogen damage mechanisms from the perspectives of theoretical analysis, experiments and numerical simulations. This review points out that although a large number of research results have been obtained on the safety characteristics of hydrogen, there are still some deficiencies and limitations. Further research topics are clarified, such as further optimizing the kinetic mechanism of the high-pressure hydrogen leakage reaction and turbulence model, exploring the expansion and dilution law of hydrogen clouds after liquid hydrogen flooding, further studying the spontaneous combustion mechanism of leaked hydrogen and the interaction between mechanisms, and investigating the synergistic damage effect of hydrogen and other components on materials. The leakage spontaneous combustion process in open space, the development process of the bidirectional effect of hydrogen jet fuel and crack growth under the impact of high-pressure hydrogen jet fuel on the material may need to be explored next.

Shu, Zhiyong; et al

Motion trajectory prediction model of hydrogen leak and diffusion in a stable thermally-stratified environment

https://doi.org/10.1016/j.ijhydene.2021.10.103

Abstract:

The motion trajectory of hydrogen leakage is an essential safe issue for the application of hydrogen energy. A dimensionless fast-running motion trajectory prediction model is proposed to predict the dispersion characteristics of the buoyant jet of hydrogen leakage for the accident. The impact of different leakage angles, leakage velocity and thermal stratification of ambient air on hydrogen leakage behavior was analyzed. The new developed model was verified by experimental results in literatures. Leakage hydrogen can flow upwards freely in a uniform environment. However, it shows an oscillating trajectory at a certain height in a thermally stratified environment, which is so called “locking phenomenon”. The trajectory of hydrogen leakage is upward and hydrogen gathers at the top of the space to form stratification in a uniform environment, while the hydrogen leakage shows an oscillating trajectory at a certain height in a thermal stratification environment. With the increase of Froude number Fr, it shows that the stable height and maximum height of the leakage airflow have a trend of rising first and then falling in a thermally stratified environment. The findings are expected to give guidance in real-world situations, for example, a larger Fr value and a larger temperature gradient can lead to a decrease in the stable height in the thermally stratified environment. It is found that the fitting of the stable height with different temperature gradients satisfies the power function relationship. This work is expected to be helpful for reducing hydrogen leakage accumulation and explosion risk.

Hydrogen Digest

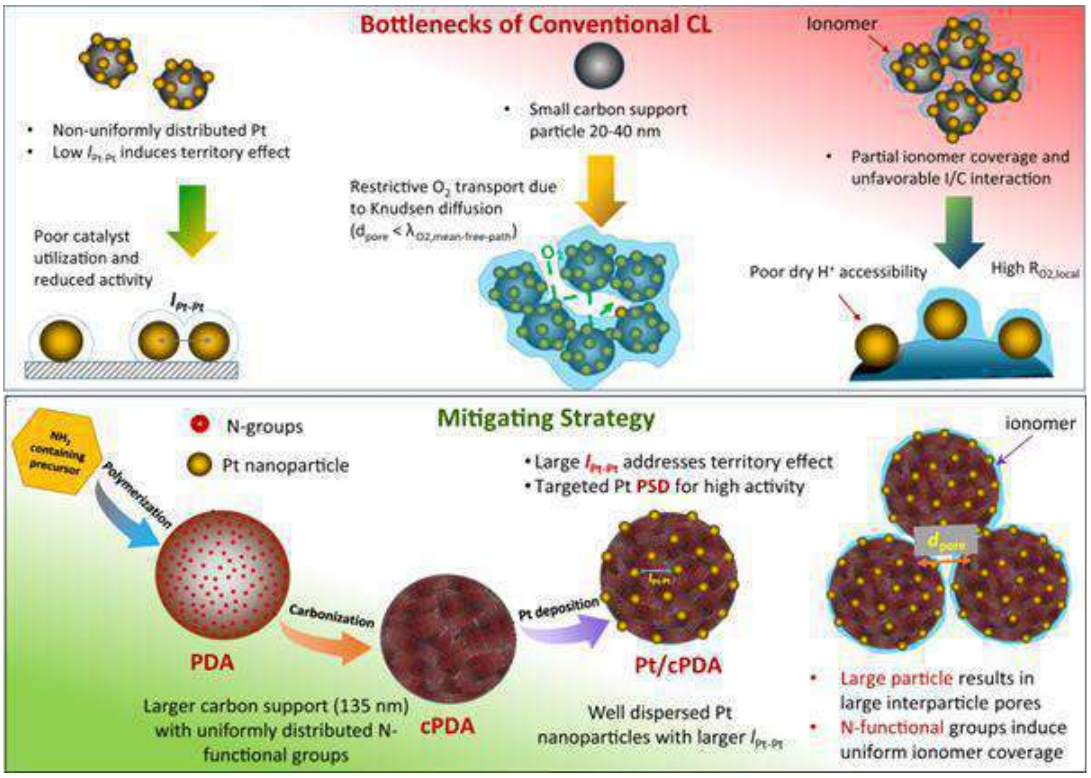
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 09

November, 2022

Get More out of Less

Researcher at Sullich school of Engineering have made a significant breakthrough towards creating higher performance and low cost fuel cell. Researcher says" We do not have new catalyst but we have better way to structure the catalyst which gives high rate of activity .



In their paper "Designing fuel cell catalyst support for superior catalytic activity and low mass-transport resistance Published in nature communication . They explained that fuel cell use a precious metal as catalyst to create the chemical reaction . Catalyst need to be attached to a catalyst support. Working against conventional wisdom, the resarcher shattered a 30-year paradigm by using a larger catalyst support , a 130-nm carbo particle rather than a 30-nm one.

Details: https://www.nature.com/articles/s41467-022-33892-8

Source: https://fuelcellsworks.com/news/significant-breakthrough-achieved-in-hydrogen-fuel-cell-technology/

Patent filing rate for green hydrogen production technologies on rise



Innovation in green hydrogen technology is reaching record highs, according to the latest report into global patent filings. While the patent filing rate for green hydrogen production via electrolysis of water has increased steadily since the 1990s, it leapt by 160% in the second half of the 2010s.

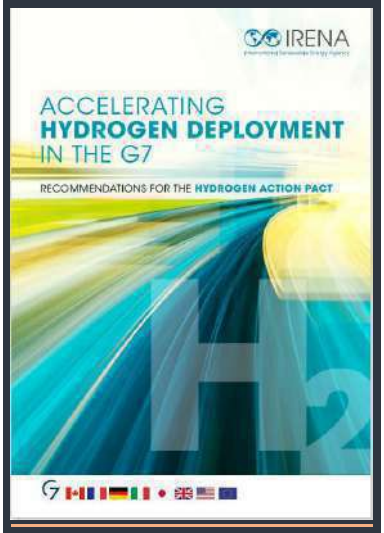
The second annual edition of the Inside Green Innovation: Progress Report 2022, from leading intellectual property firm Appleyard Lees, analyses patent filings across several key environmental issues facing the world, including energy technology and potential solutions such as green hydrogen.

Patent attorney Chris Mason, Senior Associate at Appleyard Lees, said: "Hydrogen is enjoying renewed and rapidly growing attention, particularly as its combustion produces no carbon dioxide, very little air pollution and it has the potential to decarbonise heavy industries where it's both difficult and urgent.

Patent filing rate for green hydrogen production technologies on rise (hydrogentechworld.com)

Recent Reports

Accelerating hydrogen deployment in the G7: Recommendations for the Hydrogen Action Pact



This report briefly summarises the status and outlook for hydrogen in each G7 member, including analyses of technology, costs, strategy and stated policy support for each country, and presents recommendations for accelerating global hydrogen trade.

Pillar 01: Align efforts on standards and certification
Pillar 02: Collaborate internationally and share lessons from early implementation
Pillar 03: Balance focus on supply with demand creation
Pillar 04: Promote hydrogen uptake in industrial applications
Pillar 05: Conduct outreach among civil society and industry stakeholders

ISBN: 978-92-9260-479-0

Download Report – https://www.irena.org/Publications/2022/Nov/Accelerating-hydrogen-deployment-in-the-G7

German Startup EVIA AERO Commits To Hydrogen-Powered Britten-Norman Islanders

EVIA AERO has signed a letter of intent with Cranfield Aerospace Solutions (CAeS) to increase its order for hydrogen modification kits and aircraft. As part of the agreement, the startup airline expects to receive five additional hydrogen modification kits and ten 19-seat aircraft.

The hydrogen modification kits are designed to power the nine-seat Britten-Norman Islander aircraft and come in addition to a previous order with CAeS for 10 kits.

At the Farnborough Airshow earlier this year, CAeS outlined its plans to develop a larger hydrogen propulsion system capable of powering a 19-seat aircraft on longer-range flights.



https://www.msn.com/en-us/news/technology/german-startup-evia-aero-commits-to-hydrogen-powered-britten-norman-islanders/ar-AA14jNyX

US law will crush Australia's hydrogen superpower dreams

The clean energy incentives in US President Joe Biden's Inflation Reduction Act will be "devastating" for Australia's global hydrogen superpower ambitions, warns a major renewable energy investor. Quinbrook Infrastructure Partners Australia reckons the nation should instead concentrate on becoming a green energy miner as the US turns to "friend-shoring" – favouring allies in its supply chains for critical materials – to cut out China. The fund's co-founder and managing partner, David Scaysbrook, canvassed the IRA's "very far-reaching implications" both domestically in the US "and geopolitically for the alliance between Australia and the United States" in a briefing.

https://www.afr.com/companies/energy/us-will-crush-australia-s-dreams-of-being-a-hydrogen-superpower-20221122-p5c08f

First Hydrogen Completes Successful Track Run in UK

First Hydrogen Corp. (TSXV: FHYD) (OTC Pink: FHYDF) (FSE: FIT) ("FIRST HYDROGEN" or the "Company") is pleased to showcase its hydrogen fuel cell-powered light commercial vehicles (LCV) in operation at the HORIBA MIRA Proving Ground, located near Birmingham, UK. The following link shows the LCVs in operation during its initial test runs, one in fuel-cell and one in battery electric mode (FH Track Run). The vehicles are certified for road use in the United Kingdom (UK), excluding Northern Ireland. Fleet trials with major UK operators are scheduled for January 2023. A total of 14 fleet operators in various industries are engaged to participate in the trials through the UK Aggregated Hydrogen Freight Consortium (AHFC).



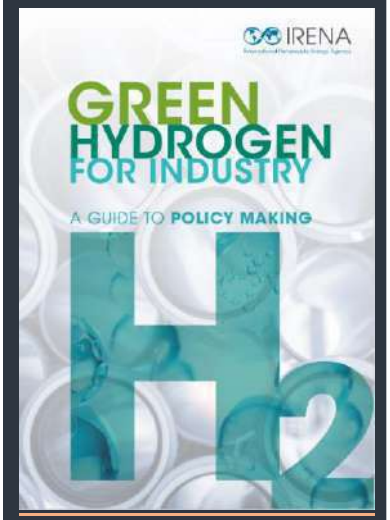
https://markets.buffalonews.com/buffnews/article/newsfile-2022-11-21-first-hydrogen-completes-successful-track-run-in-uk

Hexagon Purus receives first order for 2024 to deliver hydrogen distribution systems to Hypion in Germany

Hexagon Purus, through its wholly owned subsidiary Wystrach GmbH ("Wystrach"), a leading hydrogen systems supplier, has received its first order for hydrogen distribution systems from Hypion, a full-service provider of green hydrogen projects. Hexagon Purus' hydrogen distribution systems including its type 4 hydrogen cylinders will be used to both transport hydrogen and as mobile storage for the planned network of green hydrogen refueling stations in Germany. The value of the order is approximately EUR 2.2 million (approximately NOK 22 million) and represents the first hydrogen distribution systems order with delivery in 2024.

https://hexagongroup.com/news/hexagon-purus-receives-first-order-for-2024-to-deliver-hydrogen-distribution-systems-to-hypion-in-germany

Green hydrogen for industry
A guide to policy making



ABOUT THIS REPORT

IRENA recently published the report that outlines the main barriers to the uptake of green hydrogen and the key pillars for effective policy making. It also creates a framework for discussion about green hydrogen policy making. The IRENA report, Green hydrogen supply: A guide to policy making, examines the policy options to support the production of green hydrogen by water electrolysis, its transport, and the options for storage (IRENA, 2021a). The present report explores the challenges that green hydrogen faces in the industrial sector and the policy options available to policy makers to address these challenges.

Download Report- https://www.irena.org/Publications/2022/Mar/Green-Hydrogen-for-Industry

Linde Starts Green Hydrogen Production in Greece

Linde, the world's largest industrial gases company, said it has started producing green hydrogen at its facilities in Greece. The U.S.-German company, which supplies gases such as oxygen, nitrogen and hydrogen to factories and hospitals, said it was the first green hydrogen production in Greece.

"Linde is taking an important first step towards establishing the green hydrogen economy in Greece, allowing us to advance our sustainability agenda across the country," said Oana Reiber, General Manager of Linde Hellas.



https://esgnews.com/linde-starts-green-hydrogen-production-in-greece/

Illinois Tech joins regional hydrogen hub to combat climate change

Illinois Institute of Technology has joined a multistate, public-private coalition of 50 members dedicated to combating climate change with clean hydrogen technology. The Midwest Alliance for Clean Hydrogen (MachH2) will submit an application to the U.S. Department of Energy to develop a regional clean hydrogen production and distribution hub, with up to $8 billion to be funded under the Infrastructure Investment and Jobs Act. Under the Act, DOE will invest to catalyze investment "to form the foundation of a national clean hydrogen network that will contribute substantially to decarbonizing multiple sectors of the economy."



https://www.eurekalert.org/news-releases/971892

Network arrangements approved for hydrogen heating project

The energy regulator has approved network arrangements for a project that aims to prove that hydrogen can provide a sustainable path to household heating needs.

The H100 Fife is a project developed by SGN that plans to convert at least 270 existing natural gas-powered households in Fife from a methane-based energy source to a 100% hydrogen energy source.

The project aims to provide evidence to inform the wider rollout of 100% hydrogen use for heat on Britain's gas network.

Ofgem approved the modification proposal – the regulator has agreed to introduce arrangements into the Uniform Network Code to facilitate the use of 100% hydrogen gas needed for the project.



https://www.energylivenews.com/2022/11/22/network-arrangements-approved-for-hydrogen-heating-project/

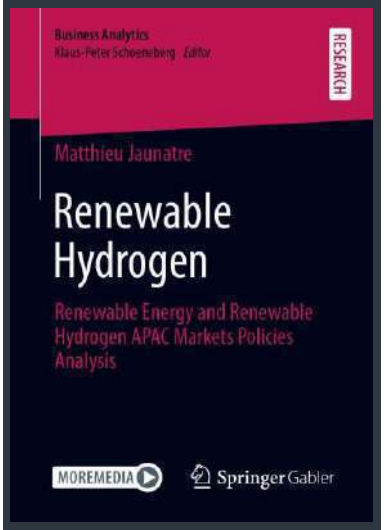
Nestlé Waters France will use the first hydrogen-powered freight train through an innovative solution developed by Alstom and ENGIE

In line with its supply chain decarbonization roadmap, Nestlé Waters will be the first company in Europe to benefit from the hydrogen fuel cell solution for massified rail freight, including renewable hydrogen supply, developed by Alstom and ENGIE. It is estimated that this project will reduce emissions by 10'000 tons of CO_2 equivalent per year, in the long term, i.e. the reduction of 90% of its current emissions. This is the equivalent to the annual emissions of more than 30'000 round trips from Paris.

https://www.prnewswire.co.uk/news-releases/from-2025-nestle-waters-france-will-use-the-first-hydrogen-powered-freight-train-through-an-innovative-solution-developed-by-alstom-and-engie-301684945.html

RECENT BOOKS:

Renewable Hydrogen Renewable Energy and Renewable Hydrogen APAC Markets Policies Analysis



Authors: Matthieu Jaunatre
https://doi.org/10.1007/978-3-658-32642-5
ISBN: 978-3-658-32642-5

New Dimensions In Production And Utilization of Hydrogen



Edited By: Sonil Nanda
https://doi.org/10.1016/C2018-0-05518-8
ISBN: 9780128231579, 0128231572

Why Mangalore is emerging as hotspot for green hydrogen projects

Mangalore's land and other infrastructure as well as the presence of a port make it a preferred location for the green hydrogen industry in Karnataka.

At the 'Invest Karnataka 2022' meet held in Bengaluru, the manufacturing segments that attracted the biggest chunk of proposals were dealing in energy—with green hydrogen emerging as the hot new sector. Green hydrogen attracted nearly a third of the total Rs 9.81 lakh crore investment committed at the event. As many as nine green hydrogen manufacturing proposals worth Rs 2.86 lakh crore were received—this, officials say, puts Karnataka's coastal region of Mangalore in the reckoning for the country's first green hydrogen cluster.

Many of the proposals received by Karnataka pertain to setting up electrolyser plants in the Mangalore region and storing the hydrogen produced in the form of ammonia. This is because storing hydrogen, which is the lightest element, as liquid or gas requires high pressure and extremely low temperatures. Liquid ammonia can be stored at -33°C.

https://www.indiatoday.in/india-today-insight/story/why-mangalore-is-emerging-as-hotspot-for-green-hydrogen-projects-2297128-2022-11-14

Indian firm to generate green hydrogen near Egypt's Suez Canal

This project is scheduled to be implemented in phases, the first of which is a pilot phase to produce 20,000 tonnes of green hydrogen, along with derivatives, annually.

ReNew Power announced that it has signed a framework agreement with Egypt to set up a green hydrogen plant in the Suez Canal Economic Zone with an investment of USD 8 billion.



https://www.freepressjournal.in/business/indian-firm-to-generate-green-hydrogen-near-egypts-suez-canal

India-Australia to share critical resources and minerals to help co-transition to net zero emission target

As the 27th Conference of Parties in Egypt comes to an end, it becomes all the more necessary to assess the status of bilateral and multilateral cooperation in climate action.

The two powerful democracies of the Indo-Pacific, India and Australia have been diversifying their partnership to include issues of global concern and climate change must take priority in the list.

There is immense potential of cooperation between the two nations when it comes to the extraction, investments as well as research and developments of critical minerals like lithium, nickel as well as green hydrogen and other rare earth minerals. Australia has a vast reservoir of not just lithium but green hydrogen as well. India could tap on to the economic investments that the Australian state is willing to make on the commercial production of green hydrogen over the period.

https://www.businessinsider.in/sustainability/news/india-australia-to-share-critical-resources-and-minerals-to-help-co-transition-to-net-zero-emission-target/articleshow/95683430.cms

Adani follow-on public offering to fund green, digital businesses

Adani may raise ₹10,000-20,000 crore through the FPO, said one of the three people cited above, all of whom spoke on condition of anonymity. "The fundraising is aimed at two things. One, to mobilize funds for new businesses such as green hydrogen, data centres and renewables; and two, to improve the company's float on stock exchanges by bringing in a wide set of new investors.

His group would invest $100 billion over the next decade, primarily in energy transition and digital opportunities, as well as sectors such as aerospace and defence, metals and petrochemicals. Of this, 70% is earmarked for energy transition. "It is our commitment to invest $70 billion in an integrated hydrogen-based value chain," Gautam Adani said ,https://www.livemint.com/companies/news/adani-follow-on-public-offering-to-fund-green-digital-businesses-11669233018114.html

Temitayo Giwa; Maryam Akbari; Amit Kumar

Techno-economic assessment of an integrated biorefinery producing bio-oil, ethanol, and hydrogen

https://doi.org/10.1016/j.fuel.2022.126022

Abstract:

The production of multiple products, in an integrated manner, encourages the full valorization of biomass feedstock and reduces waste streams. This may improve the economic outlook of the biorefinery and provide a hedge for investors. There is limited understanding of the techno-economics of an integrated, multi-product biorefinery. This study addresses this gap. In this study, we investigated an integrated, multi-product biorefinery. In addition to bio-oil, the valuable products ethanol and hydrogen are produced from fast pyrolysis by-products. We developed process models for bio-oil, ethanol, and hydrogen production from spruce woodchips in an integrated syngas fermentation and fast pyrolysis plant. Six scenarios set against a base fast pyrolysis plant were investigated, and the economic performance of each scenario was evaluated based on the rate of return. The scenarios differ in terms of the use of the non-condensable gases and the type of external fuel used for process heat. In every scenario, biochar is used for ethanol production and bio-oil is assumed to be a final product. The base case had a return rate of 7.0%, while the return rate ranged between 7.46 and 13.01% among the six scenarios. The scenario producing hydrogen from hydrogen-rich non-condensable gases and ethanol from biochar was the most profitable. The profitability was found to be most sensitive to product prices, capital cost, and feedstock cost. The study's results show that an integrated, multi-product approach to bio refining has the potential to improve the economics of bio refineries and biofuel production.

Mohammad Mohsen Soltanil; et al

Techno-economic optimization of a biomass gasification energy system with Supercritical CO2 cycle for hydrogen fuel and electricity production

https://doi.org/10.1016/j.fuel.2022.126264

Abstract:

Biomass is considered a carbon-neutral fuel and can play a significant role in obtaining sustainable energy generation. This study aims to raise the energy efficiency and reduce costs in a novel energy system that is employed to generate power, heating, cooling, fresh water, and hydrogen fuel. Based on this, municipal solid waste (MSW), wood, and paper are considered as biomass fuels of the examined system and the system performance is evaluated from a thermodynamic and thermo-economic point of view through a parametric study. In the considered system, the generated gas in the gasifier supplies the energy required to run an externally fired gas turbine module. The waste heat of the gas turbine cycle is used to run a supercritical CO2 (S-CO2) power generation cycle coupled with a heat exchanger to supply hot water and run an organic Rankine cycle (ORC) power generation cycle, as well as an absorption chiller cycle equipped with an ejector to produce cooling. In addition, the waste heat of the ORC is employed to produce fresh water through a humidification-dehumidification (HDH) desalination unit, a part of which is used to supply a proton exchange membrane electrolyzer (PEME) and the remaining is for other purposes. By considering the exergy efficiency and the levelized cost of energy (LCOE) as objective functions, a multi-objective optimization based on the genetic algorithm has been applied. An artificial neural network (ANN) plays an intermediating role in the optimization process to reduce the calculation time and raise the optimization speed. The relationship between the objective function and decision variables was analyzed using the ANN to determine the optimal point in this energy system. The results show that under optimal operating conditions, the exergy efficiency of the system with the biomass fuels of MSW, wood, and paper is equal to 41.21 %, 40.25 %, and 39.33 %, respectively. The LCOE values under the same conditions are 30.77 $/MWh, 32.06 $/MWh, and 33.6 $/MWh,

respectively. Furthermore, at the optimum point, the amount of fresh water and hydrogen production in the system with the biomass fuels of MSW, wood, and paper is equal to 1.128 kg/s, 1.058 kg/s, 0.991 kg/s, and 9.355 g/s, 9.038 g/s and 8.438 g/s, respectively. Overall, the proposed system with the biomass fuel of MSW has shown good performance in terms of thermodynamics and cost-effectiveness.

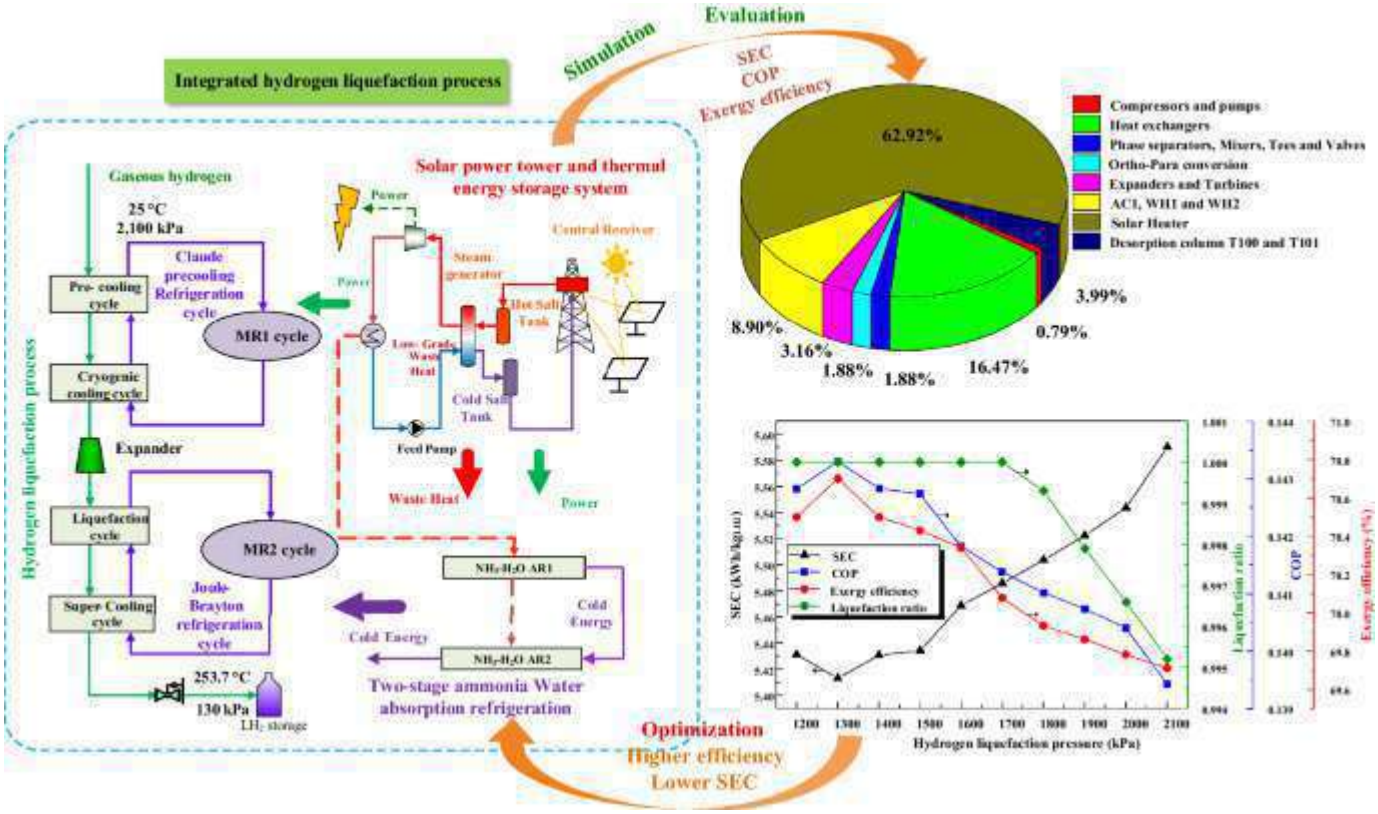
Shengan Zhang; Kaiyu Li; Guilian Liu

An efficient hydrogen liquefaction process integrated with a solar power tower and absorption precooling system

https://doi.org/10.1007/s10098-022-02423-w

Abstract:

Hydrogen is a clean and efficient energy carrier with a high energy density. Liquid hydrogen is expected to be the main form of hydrogen for large-scale storage and transportation, and its production consumes large amounts of electrical energy. A sustainable, efficient, and poly-generation hydrogen liquefaction system has been developed based on the closed Claude precooling and Joule–Brayton refrigeration cycle with mixed refrigerant, producing 367.2 tonnes of liquid hydrogen every day. In this system, a two-stage ammonia–water (NH3–H2O) absorption refrigeration system driven by waste heat precools the feed streams of compressors; a combined solar power tower generates electricity and heat, and thermal energy storage improves the system's flexibility and balances the energy production and consumption. The process performance is evaluated based on energy, energy, and sensitivity analyses. The minimum specific energy consumption, maximum coefficient of performance, and maximum energy efficiency are 5.413 kWh/kgLH2, 0.1433, and 86.99%, respectively. The net power generation values during the day and at night are 1278.85 and 1353.78 MWh, respectively.



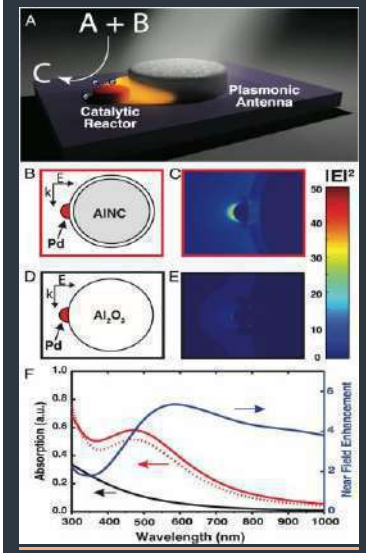
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 10

December, 2022

Heterometallic antenna−reactor complexes for photocatalysis



Abstract- Metallic nanoparticles with strong optically resonant properties behave as nanoscale optical antennas, and have recently shown extraordinary promise as light-driven catalysts. Traditionally, however, heterogeneous catalysis has relied upon weakly light-absorbing metals such as Pd, Pt, Ru, or Rh to lower the activation energy for chemical reactions. Here we show that coupling a plasmonic nanoantenna directly to catalytic nanoparticles enables the light-induced generation of hot carriers within the catalyst nanoparticles, transforming the entire complex into an efficient light-controlled reactive catalyst. In Pd-decorated Al nanocrystals, photocatalytic hydrogen desorption closely follows the antenna-induced local absorption cross-section of the Pd islands, and a supralinear power dependence strongly suggests that hot-carrier-induced desorption occurs at the Pd island surface. When acetylene is present along with hydrogen, the selectivity for photocatalytic ethylene production relative to ethane is strongly enhanced, approaching 40:1. These observations indicate that antenna−reactor complexes may greatly expand possibilities for developing designer photocatalytic substrates.

https://doi.org/10.1073/pnas.1609769113

Revolutionary photocatalyst for green hydrogen and ammonia

A fundamental breakthrough in chemistry promises to unlock ammonia as a clean fuel, and it could help decarbonize the entire chemical industry in the process. Rice University researchers have created a small, LED-powered device that converts ammonia to hydrogen on the fly. It uses a light-driven catalyst that's as efficient as expensive thermal catalysts that need thousand-degree temperatures to operate, and it's made from cheap, abundant copper and iron. And it's only the beginning of a technology that could radically reduce costs and energy use in industrial chemistry.

Ammonia is famously a better hydrogen carrier than hydrogen gas itself; each of its nitrogen atoms binds three hydrogen atoms, and while it's caustic and extremely hazardous in high concentrations, it's a stable liquid at atmospheric temperatures and pressures, and its widespread use in many industries means people have plenty of experience handling it safely under a wide range of conditions.

Ammonia might carry hydrogen exceptionally well, but if you want to use that hydrogen, you need to "crack" it to get the hydrogen out and release the harmless nitrogen back into the atmosphere. This has been difficult for two main reasons: firstly, the reaction is endothermic, so most ammonia cracking is done in large facilities operating at temperatures of at least 650-1,000 °C (1,200-1,800 °F). Secondly, the thermal catalysts required for the cracking operations are typically platinum-group metals like ruthenium – relatively rare and expensive.

With the green hydrogen movement gathering steam as a key pillar of the transition to clean energy, you can see why the Rice University team is excited to have discovered a compact and efficient way to catalyze this cracking reaction at room temperature, using nothing but copper and iron.

It comes down to photocatalytics; this team has been working for more than 30 years to develop its "antenna-reactor" plasmonic photocatalysts. These are nanoparticles of a catalyst, dotted with little clumps of an "antenna" material designed to increase the catalyst's ability to absorb light. Properly tuned, these antenna-reactor particles take in energy from ambient light – be it sunlight, or light from low-energy LEDs – and kick out short-lived "hot electrons" with enough energy to start an efficient chemical reaction even at ambient temperatures.

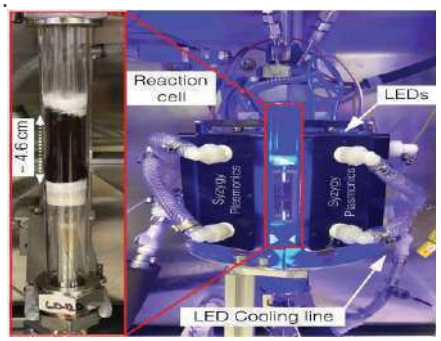
Antenna-reactor photocatalysts can be designed for all sorts of reactions. This is the same team, and essentially the same underlying idea, behind the light-powered hydrogen sulfide-to-hydrogen catalyst we wrote about a few weeks ago, for example. That one used silicon dioxide as the "reactor" catalyst, with tiny particles of gold as the "antenna" drawing energy in from light.

This ammonia-splitting photocatalyst uses iron as its reactor, and copper as its light-collecting antenna – both cheap and abundant metals, as opposed to the typical copper-ruthenium thermal catalysts used today. In lab testing, according to Rice alumnus and study co-author Hossein Robatjazi, "under illumination, the copper-iron showed efficiencies and reactivities that were similar to and comparable with those of copper-ruthenium."

Syzygy's Rigel photocatlytic reactor is about the size of a washing machine (right) but it can be deployed in banks (left)



Revolutionary photocatalyst is huge news for green hydrogen and ammonia (newatlas.com)



The small laser-powered cell used in initial lab tests (left) vs the much larger, laser-powered test rig

H2 Twin Cities…

U.S. Secretary of Energy Jennifer M. Granholm, in collaboration with the governments of Japan and the United Kingdom, announced the winners of the 2022 H2 Twin Cities program as part of COP27 activities in Sharm El-Sheikh, Egypt, to reinforce global commitment to combat climate change through the mobilization of clean and sustainable energy. H2 Twin Cities is a program under the Clean Energy Ministerial Clean Hydrogen Initiative (CEM H2I) to accelerate hydrogen progress by incentivizing the pairing of communities around the world to collaborate, share ideas, and learn from each other, particularly at the city and municipality level. These community-level partnerships between cities help connect activities where hydrogen and fuel cell technologies have energy, environmental, and economic benefits.

The winners of the H2 Twin Cities 2022 initiative are:

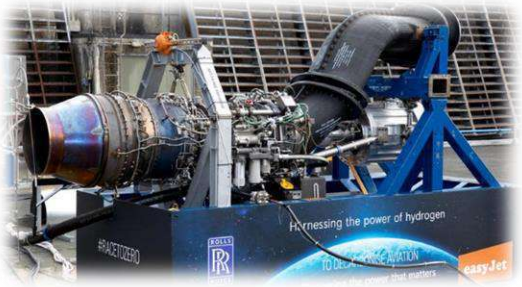
H2 – TRANS – PACIFIC team: The U.S. city of Lancaster, California, and Namie Town in Japan will serve as mentors to Hawai'i County, Hawaii, in this H2 Twin Mentor-Mentee Cities partnership.

Hydrogen is here! team: Aberdeen, United Kingdom, and Kobe, Japan, will partner as H2 Twin Sibling Cities to promote clean hydrogen growth opportunities to maximize local air quality, climate change, and supply chain benefits, and transition from traditional natural gas and nuclear power to renewable energy.

https://www.energy.gov/eere/fuelcells/articles/doe-announces-h2-twin-cities-2022-winners

Rolls-Royce tests a jet engine running on hydrogen

In a windswept corner of a military site on Salisbury Plain a small aircraft jet engine is undergoing tests that could one day lead to huge changes within the aviation industry. The engine itself is almost completely conventional. It is a Rolls-Royce AE-2100A gas turbine, a design used widely on regional aeroplanes around the world. What is wholly unusual about it is the fuel being used. This is the first time a modern aircraft engine has ever been run on hydrogen. The tests are being carried out by Rolls-Royce, in partnership with the airline easyJet.



https://www.msn.com/en-xl/news/other/rolls-royce-tests-a-jet-engine-running-on-hydrogen/ar-AA14CiWm

General Motors invests in renewable hydrogen

General Motors has entered into a joint development agreement with Nel Hydrogen to help accelerate the industrial use of their proton exchange membrane electrolyzer platform. The agreement looks to meld GM's extensive hydrogen fuel cell expertise with Nel's intimate knowledge of electrolyzers. The stated goal is to bring forwards more cost-competitive sources of renewable hydrogen.



https://www.msn.com/en-us/news/technology/general-motors-invests-in-renewable-hydrogen/ar-AA14D5GD

Rotterdam Port to house Battolyser plant for green hydrogen production

The Port of Rotterdam said it will help develop a 14,000 square metre factory for Battolyser Systems, a company that designs combined battery and green hydrogen production machines.

The port, which has announced a series of hydrogen-related deals this year, said it views the company, a spin-off from the Delft University of Technology, as an anchor for a part of the port that will be devoted to companies helping to get carbon out of supply chains.

https://auto.economictimes.indiatimes.com/news/industry/rotterdam-port-to-house-battolyser-plant-for-green-hydrogen-production/95824596

Toyota to build hydrogen fuel cell trucks in UK

The £11 million project, half-funded by the taxpayer, will lead to an initially low production run. If that proves successful, Burnaston, which builds 125,000 Corolla hybrid passenger cars a year, could be chosen as Toyota Motor Europe's home plant for hydrogen production of the Hilux and others like the Land Cruiser offroad vehicle and Toyota vans. Burnaston's sister engine plant on Deeside could become a fuel cell production facility.

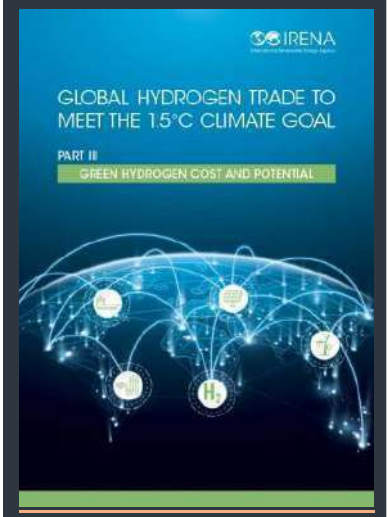
The £11 million project, half-funded by the taxpayer, will lead to an initially low production run. If that proves successful, Burnaston, which builds 125,000 Corolla hybrid passenger cars a year, could be chosen as Toyota Motor Europe's home plant for hydrogen production of the Hilux and others like the Land Cruiser offroad vehicle and Toyota vans. Burnaston's sister engine plant on Deeside could become a fuel cell production facility.

https://www.thetimes.co.uk/article/b476d54e-71a5-11ed-a188-d2cb771901d6?shareToken=e4600f7a6e132591d8a851d1b50f365c

Alfa Laval wins supply order for big Neom green hydrogen plant

Neom, the developer of a $500-billion new futuristic city in Saudi Arabia, has signed up global industry leader Alfa Laval to supply compact heat exchangers for the world's largest green hydrogen plant, being set up within its key development. Headquartered in Lund, Sweden, Alfa Laval is a leading supplier of heat exchangers to many of the main electrolyser manufacturers.

Global hydrogen trade to meet the 1.5^{0}C Climate Goal
Green Hydrogen Cost and Potential



ABOUT THIS REPORT

This report estimates the potential for green hydrogen production as a function of land availability, considering exclusion zones such as protected areas, forests, wetlands, urban centres, slope and water scarcity.

It estimates the potential for green hydrogen production as a function of land availability, considering exclusion zones such as protected areas, forests, wetlands, urban centres, slope and water scarcity. It forms part of a series of three reports focusing on global hydrogen trade in a 1.5°C scenario in 2050.

ISBN: 978-92-9260-432-5

Download Report- https://www.irena.org/Publications/2022/May/Global-hydrogen-trade-Cost

The facility, powered by renewable energy, will be part of the city of Neom, built from scratch in the northwestern desert, with the ambition of establishing a new model for sustainable living.
https://www.tradearabia.com/news/IND_403705.html

Kern attracts another 'green hydrogen' energy project

A large-scale "green hydrogen" project in Kern County has been announced that would convert 75 megawatts of photovoltaic solar power into fuel for vehicles including heavy-duty trucks.
The joint venture between an Irish-Portuguese designer of electrolysis systems called Fusion Fuel and Electus Energy, a Los Angeles company focused on regional transportation infrastructure, is proposed to be built at an undisclosed, 320-acre location at an estimated cost of about $180 million.



https://www.bakersfield.com/news/kern-attracts-another-green-hydrogen-energy-project/article_f81029a2-6cf2-11ed-bf99-b7ed95da3873.html

Meridian Energy names its preferred partner for green hydrogen project

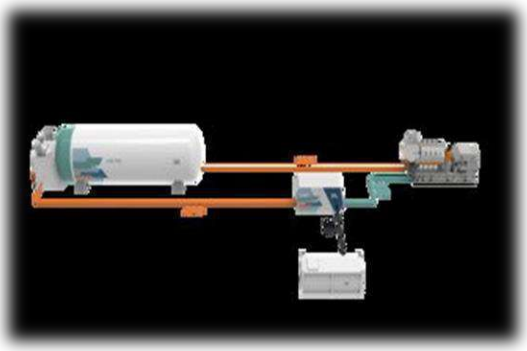
Meridian Energy has chosen Australian resource firm Woodside Energy as its preferred partner to develop a green hydrogen project in Southland.
The production of hydrogen and ammonia from renewable energy in the South Island has been touted as a suitable use of power whether or not the Tiwai Point smelter closes after 2024.
Woodside was shortlisted, along with Fortescue Future Industries, to put forward proposals for large-scale hydrogen and ammonia production using renewable energy.
https://www.msn.com/en-nz/news/national/meridian-energy-names-its-preferred-partner-for-green-hydrogen-project/ar-AA14Fvyl

First Hydrogen Selects Quebec for First Green Hydrogen Eco-System Combined Green Hydrogen Production and Zero-Emission Vehicle Assembly

First Hydrogen Corp. is pleased to announce that it has selected the City of Shawinigan, Quebec, Canada to develop its first green hydrogen eco-system.
First Hydrogen's project plan is to produce up to 50MW of green hydrogen using advanced electrolysis technology and distribute the hydrogen within the Montreal-Quebec City corridor for use with First Hydrogen's light commercial vehicles (LCV) as well as supporting other hydrogen-fuelled vehicles and applications in the region.
https://www.asiaone.com/business/first-hydrogen-selects-quebec-first-green-hydrogen-eco-system-combined-green-hydrogen

Wärtsilä and Hycamite to develop technology for onboard production of hydrogen from LNG

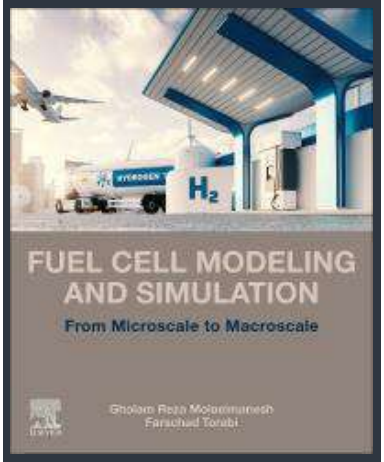
The technology group Wärtsilä has entered into a joint development agreement with Hycamite TCD Technologies, a privately-owned Finnish company specialising in the development of a pioneering technology for producing clean hydrogen and solid carbon from methane.
The two companies will work together to enable cost-effective production of hydrogen from LNG onboard marine vessels. The concept design will be ready by mid 2023 and the prototype testing unit will be ready during the second half of 2024.



https://www.h2bulletin.com/wartsila-and-hycamite-to-develop-technology-for-onboard-production-of-hydrogen-from-lng/

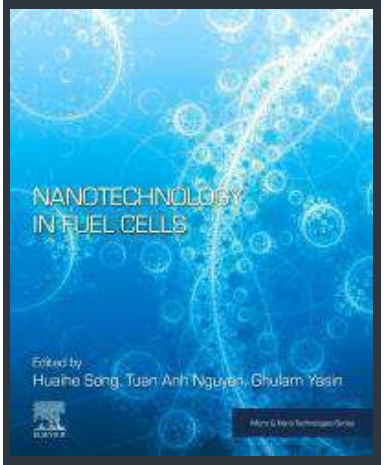
RECENT BOOKS:

Fuel Cell Modeling and Simulation From Microscale to Macroscale



Authors: Gholam Molaeimanesh, Farschad Torabi
https://doi.org/10.1016/C2020-0-02573-9
ISBN: 9780323857628

Nanotechnology in Fuel Cells



Edited By: Huaihe Song, Tuan Anh Nguyen, Ghulam Yasin
https://doi.org/10.1016/C2020-0-02464-3

eBook ISBN: 9780323897914

Paperback ISBN: 9780323857277

University of Birmingham to work in India on Railways, Hydrogen Fuels, Data Science, AI

Indian scholars will soon start discovering new research avenues in the field of Hydrogen Fuels, Data Science, and Artificial Intelligence with scholars from Birmingham University. Not only this, the research on Indian Railways will also be part of this exercise.

The University of Birmingham Vice-Chancellor, Professor Adam Tickell signed a range of Memoranda of Understanding (MoU) with the University's partners at special signing ceremonies in Bengaluru and Delhi. The agreements form a key part of the University's ongoing strategic vision to continue building meaningful education and research partnerships in India.

https://www.careerindia.com/news/university-of-birmingham-signs-mou-for-strategic-research-vision-in-india-033720.html

IIT Jodhpur researchers develop catalytic materials to produce high-purity hydrogen

The researchers at the Indian Institute of Technology Jodhpur have developed Lanthanides based perovskite nanocomposite catalytic materials for artificial photosynthesis to produce high-purity hydrogen.

"In the patented method, the researchers used natural sunlight to convert water into hydrogen and oxygen using a highly recyclable catalyst based on low-cost, simple transition metal. Dr Rakesh K Sharma, Associate Professor, Department of Chemistry, IIT Jodhpur, is the Principal Investigator of this project," as per IIT Jodhpur.

"The team has now developed a series of catalysts which can efficiently produce hydrogen under ambient conditions. The end application of this research lies in the industries, automobile and energy sectors" IIT Jodhpur said in a Statement



https://www.msn.com/en-in/news/other/iit-jodhpur-researchers-develop-catalytic-materials-to-produce-high-purity-hydrogen/ar-AA14DHwt

Hydrogen India Summit 2023

17-18th January, 2023
New Delhi, India

HIS 2023
Hydrogen India Summit
Tap into India Energy New Era

About HIS（Hydrogen India Summit 2023）

The First of its kind and the Largest congress for hydrogen leaders in India & the region.

The 1st India Hydrogen Congress will take place in person from 17-18th January 2023, The Leela Ambience Convention Hotel, New Delhi, providing an initiative platform for the national and international Hydrogen industry to discuss the optimization of India's next phase of hydrogen and green hydrogen development.

The Summit is a platform for the local industrial leaders to disseminate key messages and discuss new opportunities for development with international investors, operators, and technology providers.

http://www.indiahydrogen2022.com/

Germany announces €1 billion funding for energy transition projects in India

Ahead of German foreign minister Annalena Baerbock's visit to India in December, Germany unveiled a proposal to provide €1 billion (₹8440 crore) for energy transition projects across the country under a bilateral partnership for green and sustainable development.

The two sides agreed on the funding for more than 20 development projects over the next year during discussions. The funding, including 10% grants and 90% in the form of lines of credit, will support India's efforts in the fields of renewable energy, sustainable urban development in smart cities and sustainable use of natural resources, German ambassador Philipp Ackermann said.

Germany will also support the expansion of ecological agriculture and sustainable management of forests. The German government is currently negotiating a Just Energy Transition Partnership (JETP) between the G7 and India together with the US. This is aimed at supporting India in expanding renewable energy, improving energy efficiency and the production of green hydrogen.

https://www.hindustantimes.com/india-news/germany-announces-1-billion-funding-for-energy-transition-projects-in-india-101669827096447.html

Robert Lindner

Green hydrogen partnerships with the Global South. Advancing an energy justice perspective on “tomorrow's oil”

https://doi.org/10.1002/sd.2439

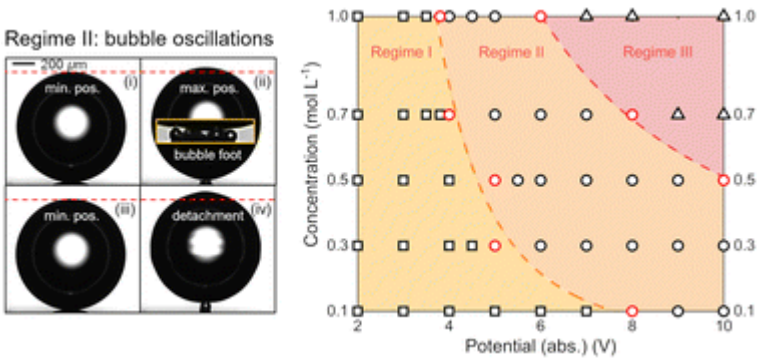
Abstract:
Fuel cells and other hydrogen-based technologies are increasingly seen as a key pillar of global decarbonization efforts. A major challenge to be overcome is the future availability of large quantities of affordable green hydrogen to supply the envisioned hydrogen economy. Several industrialized countries have formulated ambitious national hydrogen strategies that rely heavily on importing green hydrogen from other countries, including countries in the Global South that are rich in renewable energy. This paper is based on an extensive literature review and policy analysis. It provides the first structured overview of existing and emerging North–South green hydrogen partnerships and analyzes them through the lens of energy justice theory. The findings show that international collaboration has increased significantly in recent years, with a clear focus on Brazil, Egypt, India, and Morocco. Partnerships are led by both government and private sector actors and mainly take the form of pilot projects, feasibility studies, and scientific collaboration. The paper also points out that existing partnerships have several shortcomings, such as the lack of sociopolitical considerations and the dominance of donor economic priorities over sustainable development in partner countries. Finally, the paper discusses how an energy justice perspective could help improve future partnership approaches to achieve the twin goals of global climate change mitigation and sustainable development in the Global South.

Aleksandr Bashkatov; Kerstin Eckert; et al

On the growth regimes of hydrogen bubbles at microelectrodes

https://doi.org/10.1039/D2CP02092K

Abstract:
The growth of single hydrogen bubbles at micro-electrodes is studied in an acidic electrolyte over a wide range of concentrations and cathodic potentials. New bubble growth regimes have been identified which differ in terms of whether the bubble evolution proceeds in the presence of a monotonic or oscillatory variation in the electric current and a carpet of microbubbles underneath the bubble. Key features such as the growth law of the bubble radius, the dynamics of the microbubble carpet, the onset time of the oscillations and the oscillation frequencies have been characterized as a function of the concentration and electric potential. Furthermore, the system's response to jumps in the cathodic potential has been studied. Based on the analysis of the forces involved and their scaling with the concentration, potential and electric current, a sound hypothesis is formulated regarding the mechanisms underlying the micro-bubble carpet and oscillations.



Yang, JL; Chen, XF; et al

Hotspot and frontier discovery of hydrogen detection technology based on bibliometrics

https://doi.org/10.1108/SR-03-2022-0127

Abstract:

Purpose With the acceleration of global energy structure transformation, hydrogen has been widely used for its non-pollution and high efficiency, and hydrogen detection is used to guarantee the hydrogen safety. The purpose of this paper is to study the research foundation, trend and hotspots of hydrogen detection field. Design/methodology/approach A total of 4,076 literature records from 2000 to 2021 were retrieved from the core collection of the Web of Science database selected as data sources. The literature information mining was realized by using CiteSpace software. Bibliometrics was used to analyze information, such as keywords, authors, journals, institutions, countries and cited references, and to track research hotspots. Findings Since the 21st century, the number of publications in the hydrogen detection field has been in a stable stepped uptrend. In terms of research foundation, the hotspots such as core-shell structures, nano-hybrid materials and optical fiber hydrogen sensors have been studied extensively. In combination with the discipline structure and research frontier, the selectivity, sensitivity, response speed and other performance parameters of hydrogen sensors need further improvement. The establishment of an interdisciplinary knowledge system centered on materials science and electronic science will become a long-term trend in the research of hydrogen detection. Originality/value This study presents an overview of research status, hotspots and laws in hydrogen detection field, through the quantitative analysis of much literature in the field and the use of data mining, so as to provide credible references for the research of hydrogen detection technology.

Max Zhang; Xiaonan Yang

The Regulatory Perspectives to China's Emerging Hydrogen Economy: Characteristics, Challenges, and Solutions

https://doi.org/10.3390/su14159700

Abstract:

Culminating two decades of industrial planning, China is now officially moving full steam ahead towards realizing a hydrogen economy under the country's first ever Medium and Long-term Plan of the Hydrogen Industry (2021–2035). Among the relevant benchmarks established is the goal of developing a regulatory framework by 2025. This raises the question of how best to achieve a regulatory framework for China's emerging hydrogen economy. To answer this question, the discussions of this paper are further broken-down and organized across four independent, but correlated, academic questions. One, relying on the fragmented authoritarianism model, what are the impacts of China's current model of industrial development on an emerging regulated industry? Two, through a scientific and technological review, what are the characteristics of the hydrogen supply-chain most likely to present a regulatory challenge for China? Three, by analogy to the comparable experiences of China's other regulated industries, what are the possible regulatory solutions? Four, and most importantly, how best to reconcile the findings to the above questions as they relate to the regulatory challenge of developing China's emerging hydrogen economy. The results of the discussions reveal, that not all policy solutions and recommendations to the regulatory framework of the hydrogen economy should be treated equally. Rather, an integrated view of the core academic question revealed a procedural relationship among the regulatory solutions identified from the analysis above. Therefore, recognizing that each solution should synergize and correspond to different phases of regulatory development, a three-step regulatory pathway towards the hydrogen economy is proposed.

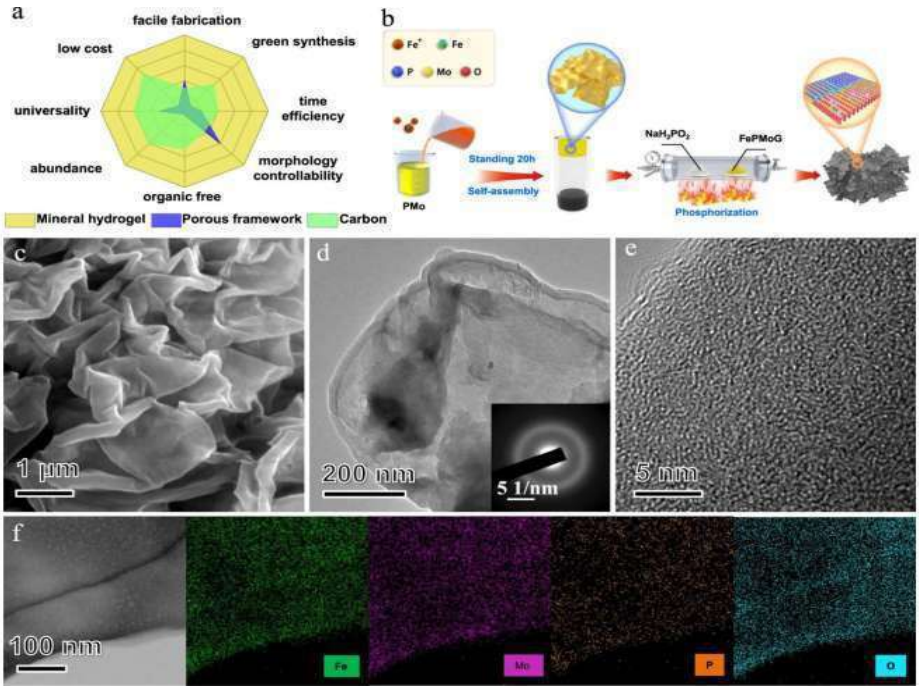
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 11

December, 2022

Team develops two novel, ultra-stable hydrogen production catalysts



Recently, a research team from City University of Hong Kong (CityU) developed a new, ultra-stable hydrogen evolution reaction (HER) electrocatalyst, which is based on two-dimensional mineral gel nanosheets and does not contain any precious metals. The catalyst can be produced in large scale and can help achieve a lower hydrogen price in the future.

A research team co-led by CityU materials scientists have developed an innovative, cost-effective and energy-efficient way to produce a highly efficient HER single-atom electrocatalyst that uses precious-metal-free mineral hydrogel nanosheets as a precursor.

"Compared with other common single-atom substrate precursors, such as porous frameworks and carbon, we found that mineral hydrogels have great advantages for mass production of electrocatalysts due to the easy availability of the raw materials, simple and environmental-friendly synthetic procedure, and mild reaction conditions," said Professor Lu Jian, Chair Professor in the Department of Mechanical Engineering (MNE) and the Department of Materials Science and Engineering (MSE) at CityU, who led the research.

Their electrocatalyst precursor is prepared using a simple method. First, solutions of polyoxometalate acid (PMo) and ferric ions (Fe3+) are mixed at room temperature, resulting in novel two-dimensional iron–phosphomolybdic-acid nanosheets. After excess water is removed by centrifugation, the nanosheets become mineral hydrogel free of any organic molecules. The process is much more convenient and economical than the previously reported processes that typically require high temperature and pressure, and longer time for the self-assembly of single-atom substrate precursors.

After a further phosphating treatment (at 500 ℃) of this mineral gel precursor, a single-iron-atom dispersed heterogeneous nanosheet catalyst ("Fe/SAs@Mo-based-HNSs") is formed, avoiding the time-consuming fabrication process of loading single atoms on the substrate.

https://phys.org/news/2022-12-team-ultra-stable-hydrogen-production-catalysts.html

Two-dimensional mineral hydrogel-derived single atoms-anchored heterostructures for ultrastable hydrogen evolution

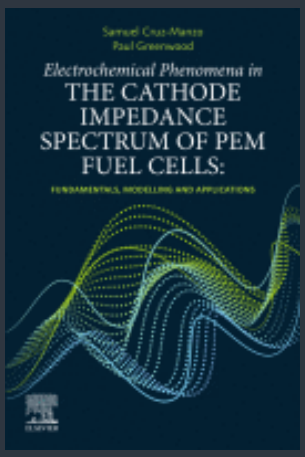
Fucong Lyu; Shanshan Zeng; et al

Abstract- *Hydrogen energy is critical for achieving carbon neutrality. Heterostructured materials with single metal-atom dispersion are desirable for hydrogen production. However, it remains a great challenge to achieve large-scale fabrication of single atom-anchored heterostructured catalysts with high stability, low cost, and convenience. Here, we report single iron (Fe) atom-dispersed heterostructured Mo-based nanosheets developed from a mineral hydrogel. These rationally designed nanosheets exhibit excellent hydrogen evolution reaction (HER) activity and reliability in alkaline condition, manifesting an overpotential of 38.5 mV at 10 mA cm−2, and superior stability without performance deterioration over 600 h at current density up to 200 mA cm−2, superior to most previously reported non-noble-metal electrocatalysts. The experimental and density functional theory results reveal that the O-coordinated single Fe atom-dispersed heterostructures greatly facilitated H2O adsorption and enabled effective adsorbed hydrogen (H*) adsorption/desorption. The green, scalable production of single-atom-dispersed heterostructured HER electrocatalysts reported here is of great significance in promoting their large-scale implementation.*

https://doi.org/10.1038/s41467-022-33725-8

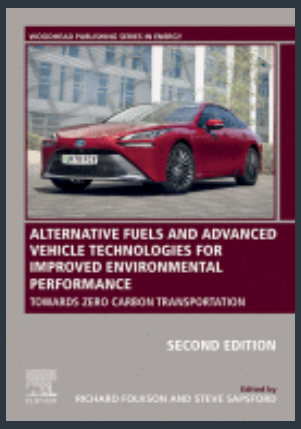
RECENT BOOKS:

Electrochemical Phenomena in the Cathode Impedance Spectrum of PEM Fuel Cells



Authors: Samuel Cruz-Manzo; Paul Greenwood
https://doi.org/10.1016/C2020-0-04038-7
ISBN: 978-0-323-90607-4

Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance



Edited By: Huaihe Song, Tuan Anh Nguyen, Ghulam Yasin
https://doi.org/10.1016/C2020-0-02395-9
ISBN: 978-0-323-90979-2

INDUSTRY NEWS

BMW begins production of small-series hydrogen-powered iX5

The BMW Group is commencing production of its BMW iX5 Hydrogen model. The first ever Sports Activity Vehicle (SAV) featuring hydrogen fuel cell technology has already completed an intensive programme of testing under demanding conditions during the development phase and will now be used as a technology demonstrator for locally carbon-free mobility in selected regions from mid-2023. The BMW iX5 Hydrogen is being built in the BMW Group's pilot plant at its Research and Innovation Centre in Munich. This is the interface between development and production where every new model from one of the company's brands is made for the first time.



https://www.autocarpro.in/news-international/bmw-begins-production-of-small-series-hydrogen-powered-ix5-113520

Toyota secures funding to develop hydrogen fuel cell version of its Hilux pickup in the UK

LONDON — A consortium led by automotive giant Toyota will receive millions in funding to develop a hydrogen fuel cell pickup truck in the U.K. In a statement, Toyota said the fuel cell-powered prototype of its Hilux pickup would be developed at its plant in Burnaston, in the East Midlands of England. Toyota Motor Manufacturing UK is heading up the consortium, which is being backed by £5.7 million (around $7 million) of industry funding and £5.6 million from the U.K. government. Thatcham Research, D2H, ETL and Ricardo are also involved in the project. Although the initiative is being led by TMUK, Toyota said "technical support" would come from Toyota Motor Europe R&D.
https://www.msn.com/en-us/money/companies/toyota-secures-funding-to-develop-hydrogen-fuel-cell-version-of-its-hilux-pickup-in-the-uk/ar-AA14P6aL

UK government backs 40-tonne hydrogen heavy goods vehicle project

HVS was awarded APC funding following a successful entry into its competition for developing automotive technologies and growing capability towards net zero. The Glasgow-based company is leading innovation in hydrogen mobility in the form of the UK's first indigenous, clean-sheet, hydrogen fuel-cell HGV (Heavy Goods Vehicle).
APC's funding, which is aimed at supporting the UK's long-term capabilities by securing long-term R&D investment in collaborative, pre-production research and development (R&D) projects, will support 50% of the project's approximate £30 million (Rs 290 crore) total cost.



https://www.autocarpro.in/news-international/uk-government-backs-40-tonne-hydrogen-heavy-goods-vehicle-project-113521

BP doubles down on hydrogen as fuel of the future

BP chief executive Bernard Looney is betting on hydrogen to power future low-carbon businesses as the governments of major economies stump up cash to develop the fuel to decarbonise. Low-carbon hydrogen already has a big fan-base and is forecast to play a major role in reducing greenhouse gas emissions from heavy industries and some forms of transport. But it is expensive to produce and often needs government support to compete against fossil fuels. The United States, for example, is offering large incentives for producing it under President Joe Biden's $430 billion Inflation Reduction Act (IRA). BP has been quick to react and is in the early planning stages to develop a large, low-carbon hydrogen hub around its Whiting, Indiana refinery, Tomeka McLeod, BP's newly-appointed head of hydrogen in the United States, told Reuters.
https://www.msn.com/en-us/money/companies/bp-doubles-down-on-hydrogen-as-fuel-of-the-future/ar-AA14UwHD

Recent Report:



ABOUT THIS REPORT

Hydrogen and its derivatives should play an important role in the decarbonisation of those sectors where emissions are hard to abate and alternative solutions are either unavailable or difficult to implement, such as heavy industry, shipping, aviation and heavy-duty transport.

The momentum behind hydrogen remained strong over the past year. Nine countries – which cover around 30% of global energy sector emissions today – released their national strategies in 2021-2022. Hydrogen demand grew in new applications, although from a very low base, reflecting accelerated deployment of fuel cell EVs, particularly in heavy-duty trucks in China. Some key new applications for hydrogen are showing signals of progress, particularly in the steel sector where announcements for new projects are growing fast just one year after the start-up of the first large pilot project for the use of pure electrolytic hydrogen in direct reduction of iron.

https://www.iea.org/reports/hydrogen

NAMX HUV vehicle with changeable hydrogen bottles unveiled

The SUV has Pininfarina design and was created by a Franco-Moroccan startup company.

NAMX recently unveiled the concept version of its first-ever vehicle, an SUV with swappable hydrogen bottles, described as an HUV with new tch and Pininfarina design. According to NAMX, there will initially be two trim levels offered from the 2025 rollout of the HUV with the changeable hydrogen bottles. The first of the trim levels will be entry-level with rear-wheel drive and 296 horsepower. It will be able to reach 62 miles per hour in 6.5 seconds and will be able to accelerate to 124 miles per hour. Prices for this model will start at $68,410.



https://www.hydrogenfuelnews.com/hydrogen-bottles-namx-huv/8556266/

Emerson's new pressure-reducing regulator improves hydrogen fuel cell system performance in commercial vehicles

A pressure-reducing regulator has been designed by Emerson for use onboard commercial hydrogen fuel cell vehicles. The dual stage and patented active seal design of the TESCOM HV-3500 hydrogen onboard regulator delivers steady pressure and constant hydrogen fuel supply to fuel cells in the full range of vehicle operating conditions, including acceleration, deceleration, stopping and idling.



https://electronics360.globalspec.com/article/18992/emerson-s-new-pressure-reducing-regulator-improves-hydrogen-fuel-cell-system-performance-in-commercial-vehicles

Toyota unveils hydrogen-powered Corolla Cross concept

The Toyota Corolla Cross H2 concept has been created to showcase that hydrogen-combustion tech can carry five passengers and their luggage.

Toyota is continuing to develop its hydrogen-powered internal-combustion engine technology through the lens of motorsport, but has now revealed its most road-going concept yet. The Toyota Corolla Cross H2 concept largely looks like a regular Corolla Cross SUV but has the powertrain of a race car. The race car in question is the hydrogen-powered GR Corolla H2 that has been competing in the Super Taikyu endurance racing series in Japan since May 2021 by the Rookie Racing division of Toyota Gazoo Racing. The powertrain was also used in a GR Yaris concept that competed in a special demonstration run during the ninth round of the World Rally Championship (WRC) in Ypres, Belgium in August this year.



https://www.carexpert.com.au/car-news/toyota-unveils-hydrogen-powered-corolla-cross-concept

Raven SR Receives €1.7 Million Grant from European Commission to Support Waste-to-Hydrogen Production Facility in Spain

Raven SR Inc. a renewable fuels company, announced today it has been awarded a €1.7 million (USD$1.75 million) grant from the European Commission for the development of a waste-to-hydrogen production facility in the Aragón region of Spain. The funding is part of a broader €14 million European Commission grant to Hy2Market, a multi-regional project led by the New Energy Coalition to research and produce hydrogen on an accelerated timeframe.

https://markets.businessinsider.com/news/stocks/raven-sr-receives-1-7-million-grant-from-european-commission-to-support-waste-to-hydrogen-production-facility-in-spain-1031955198

Kerala to become 100% renewable energy-based State by 2040

Kerala is the first State in India to include hydrogen-powered mobility in its zero emissions mobility policy. The government has constituted the Kerala Hydrogen Economy Mission to contribute strategic inputs and facilitate partnerships and collaborations towards transforming the State into a green hydrogen hub. "The production of green hydrogen is expected to be instrumental in the State's efforts to achieve carbon neutrality by 2050,'. Kerala would soon come out with a new ESG (Environmental, social, and governance)-focused industrial policy, which specifies incentives to promote responsible industrial production, he said.

The State government inked an agreement with the Agence Française de Développement (AFD – French Development Agency) for a performance-based loan of 100 million euros (₹865.8 crore) on the occasion. Rebuild Kerala Initiative (RKI) chief executive officer Bishwanath Sinha and AFD Country Director Bruno Bosle signed the agreement which is aimed enhancing the state's resilience against impacts of climate change.



https://www.thehindu.com/news/national/kerala/kerala-to-become-100-renewable-energy-based-state-by-2040-chief-minister/article66235685.ece

Airbus looking at India for green hydrogen supplies

European aerospace major Airbus is looking to source green hydrogen from markets like India, Australia and Latin America as part of its decarbonisation efforts, a senior company official said.

Airbus is currently developing a hydrogen-powered fuel cell engine for its ambitious zero-emission aircraft that will enter service by 2035. It has also signed a partnership agreement with HyPort to set up a low-carbon hydrogen production and distribution station at the Toulouse-Blagnac airport in France.



https://www.business-standard.com/article/international/airbus-looking-at-india-aus-latin-america-for-green-hydrogen-supplies-122120400224_1.html

West Bengal planning green hydrogen plant in Durgapur

West Bengal is planning to set up a green hydrogen plant in Durgapur, with the central government identifying the state as a potential region for its production, Power minister Aroop Biswas said. Speaking at the ABP Group-organised INFOCOM 2022, Biswas said nearly Rs 11,900 crore of investment has been lined for the power sector under the Centre's Revamped Distribution Sector Scheme (RDSS).

"Recently, the Union government has identified West Bengal as a potential state for green hydrogen and ammonia manufacturing zone, and the West Bengal Power Development Corporation Limited (WBPDCL) is planning to install a green hydrogen plant at Durgapur as a pilot project," he said.

https://auto.economictimes.indiatimes.com/news/industry/west-bengal-planning-green-hydrogen-plant-in-durgapur/95990553

Cummins India to be future-ready with ICE-hydrogen, CNG and LNG engines

Ashwath Ram, MD, Cummins India believes that there will be areas where IC-engine still has a lot more to offer, especially with the tighter emission norms there will be innovative solutions that will be introduced. In fact, Tata Motors recently announced a new strategic partnership with Cummins India for hydrogen engine solutions for its commercial vehicle range. Despite what many believe, the ICE-vehicles are here to stay, albeit in more cleaner and fuel agnostic. With each passing day, while there are significant innovations taking place in the electric vehicle space, the IC-vehicle industry especially in the higher tonnage and usage space, will continue to see introduction of newer energy sources. Ram speaks about introducing ICE-hydrogen engine, CNG and LNG powertrain in India.



https://www.financialexpress.com/express-mobility/cummins-india-to-be-future-ready-with-ice-hydrogen-cng-and-lng-engines/2901062/

Green hydrogen policy soon, says Hardeep Singh Puri

"India's green hydrogen policy will come sooner than expected," Puri said at the BQPrime event. "Different ministries are involved in the policy and the internal churning on the green hydrogen policy is now beginning to take shape," Puri said. The minister explained that money is pouring into India from venture capitalists for the production of green hydrogen, which is a positive sign for the economy and the green hydrogen policy.

Green hydrogen is produced using renewable energy through electrolysis. In the first part of the policy, the ministry waived the power transmission charges for 25 years for these units, allowing them to buy renewable power from exchanges or their own unit.

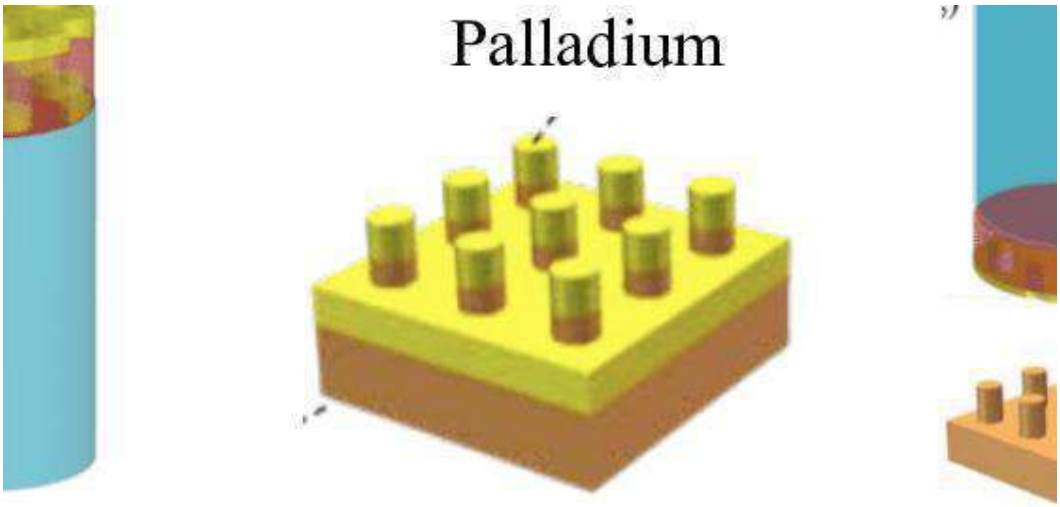
https://www.moneycontrol.com/news/economy/economy-economy/g7-price-cap-on-russian-oil-wont-impact-india-green-hydrogen-policy-soon-says-hardeep-singh-puri-9651161.html

Tala Al-Shareef

Detection Of Hydrogen Leakage Using Palladium-Based Optic Sensors

https://doi.org/10.13140/RG.2.2.11155.55841

Abstract:
In this project, a sensor-based leak detection monitoring system of hydrogen will be developed. The topic's main purpose is to increase hydrogen's safety and ensure safe transportation of units carrying all states of hydrogen. This can be done using a Palladium based sensor, which will be the focus of this report. Through understanding the behavior and the principle working of palladium, we were able to choose a design and compute a simple mathematical model for hydrogen detection by the sensor. Additional sensors will be added for the enhancement of the Pd-Hydrogen sensor.

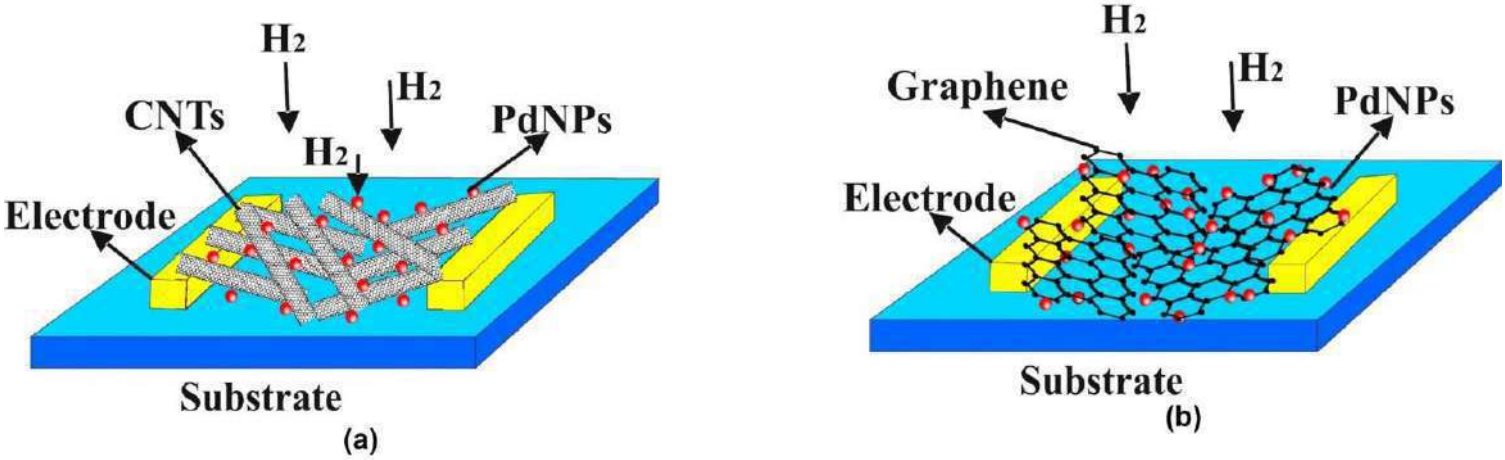


Ghobad Behzadi Pour, Leila Fekri Aval, Mehdi Nasiri Sarvi, Sedigheh Fekri Aval & Hamed Nazarpour Fard

Hydrogen sensors: palladium-based electrode

https://doi.org/10.1007/s10854-019-01190-7

Abstract:
Hydrogen sensors are transducer devices and able to convert the hydrogen concentration in the environment to an electrical signal. The detection and monitoring of hydrogen gas under the explosive limit is the essential issue for its applications as the chemical reactant and energy resource. In this study, the sensing mechanism and principle of the palladium-based hydrogen gas sensors are firstly reported. Then, the physical sensing parameter, measuring range, response time and recovery time of the different hydrogen gas sensors are also reviewed. Moreover, the high response speed hydrogen sensors are introduced for practical usages.

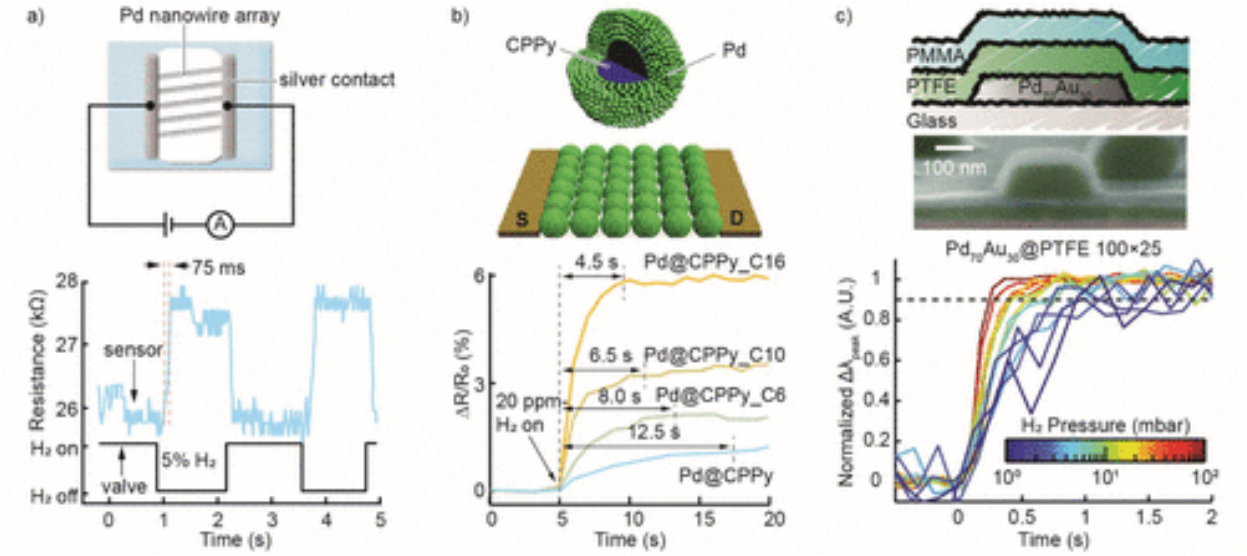


Iwan Darmadi, Ferry Anggoro Ardy Nugroho, and Christoph Langhammer

High-Performance Nanostructured Palladium-Based Hydrogen Sensors—Current Limitations and Strategies for Their Mitigation

https://doi.org/10.1021/acssensors.0c02019

Abstract:
Hydrogen gas is rapidly approaching a global breakthrough as a carbon-free energy vector. In such a hydrogen economy, safety sensors for hydrogen leak detection will be an indispensable element along the entire value chain, from the site of hydrogen production to the point of consumption, due to the high flammability of hydrogen–air mixtures. To stimulate and guide the development of such sensors, industrial and governmental stakeholders have defined sets of strict performance targets, which are yet to be entirely fulfilled. In this Perspective, we summarize recent efforts and discuss research strategies for the development of hydrogen sensors that aim at meeting the set performance goals. In the first part, we describe the state-of-the-art for fast and selective hydrogen sensors at the research level, and we identify nanostructured Pd transducer materials as the common denominator in the best performing solutions. As a consequence, in the second part, we introduce the fundamentals of the Pd–hydrogen interaction to lay the foundation for a detailed discussion of key strategies and Pd-based material design rules necessary for the development of next generation high-performance nanostructured Pd-based hydrogen sensors that are on par with even the most stringent and challenging performance targets.



JinGong; et al

MEMS-based resistive hydrogen sensor with high performance using a palladium-gold alloy thin film

https://doi.org/10.1016/j.jallcom.2022.167398

Abstract:
Hydrogen sensors have been widely used in several fields for monitoring the concentration of hydrogen and for its alarming leakage. In this study, a microelectromechanical systems (MEMS)-based resistive hydrogen sensor using a palladium-gold (Pd-Au) alloy thin film was developed, which has the advantages of low power consumption, mass production, and high performance. A sensitive alloy film was prepared by DC magnetron sputtering deposition and annealed at various temperatures. It was integrated on a patterned silicon substrate with heating and temperature detection resistances and fabricated by MEMS processes. This film exhibited the best response performance to hydrogen at annealing and working temperatures of 200 and 60 °C, respectively. The sensor exhibited a good response to hydrogen from 5 ppm to 3%. The response attained a value of 3.3%, and the response and recovery times were 22 and 160 s, respectively, for a hydrogen concentration of 3%. The sensor also indicated good repeatability, long-term stability, and high selectivity for hydrogen over other gases (sulfur dioxide, ethanol, methane, ammonia, carbon monoxide, nitrogen dioxide, and formaldehyde). Thus, it has good potential for the detection of hydrogen leakage in new energy vehicles.

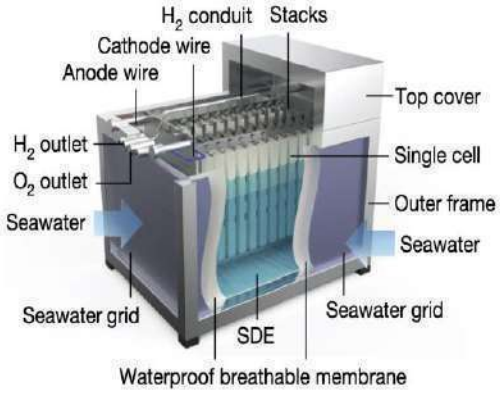
Hydrogen Digest

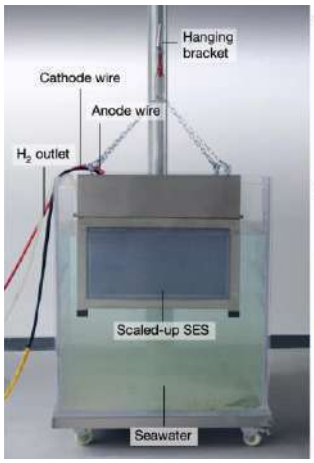
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

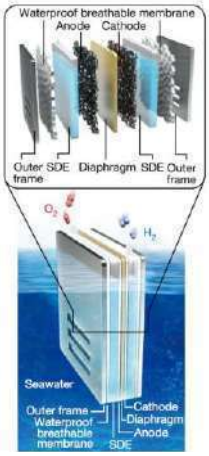
ISSUE. 12

December, 2022

Clever device efficiently splits hydrogen and lithium out of seawater





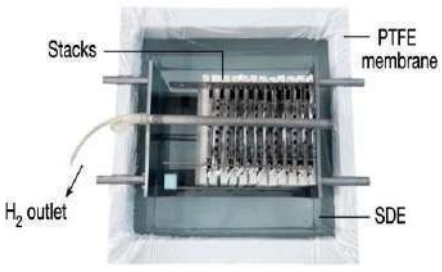


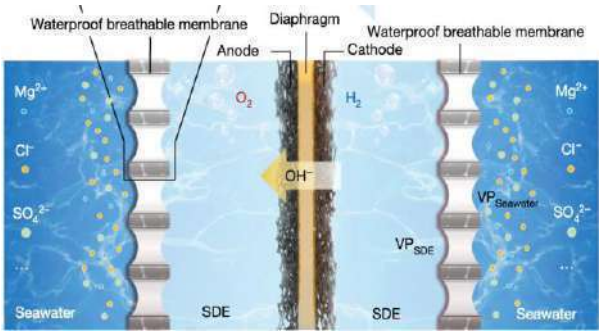
One problem with renewably-produced hydrogen is that it uses fresh water – and with a quarter of the world's population already facing severe water scarcity at least one month of every year, freshwater is an ever more finite and precious resource. So technologies that can electrolyze hydrogen out of the abundant seawater that blankets most of the planet are a vital area of enquiry.

You can desalinate seawater and then split it, but it's not a great solution; most of your input energy is lost in the desal process, and that drives up the price of the hydrogen you're making. There are also plenty of direct seawater electrolysis machines, but most die too quickly to be useful in a commercial sense; choride ions in the complex ocean brew turn into highly corrosive chlorine gas at the anode, and it eats away the electrodes and degrades the catalysts until the machine stops working.

Researchers at China's Nanjing Tech University believe they've found a way around this problem. In a study published in Nature last month, the Nanjing team demonstrated a direct seawater electrolysis machine that ran for more than 3,200 hours (133 days) without failing. They say it's efficient, scalable and operates much like a freshwater splitter "without a notable increase in operation cost."

The team's electrolyzer keeps the seawater completely separate from the concentrated potassium hydroxide electrolyte and the electrodes using cheap, waterproof, breathable, anti-biofouling, PTFE-based membranes. These membranes stop liquid water from getting through, but they do let water vapor through. The difference in water vapor pressure between the seawater side and the electrolyte side "provides a driving force for spontaneous seawater gasification (evaporation) at the seawater side."





Clever device efficiently splits hydrogen and lithium out of seawater (newatlas.com)

A membrane-based seawater electrolyser for hydrogen generation

Heping Xie; et al

Abstract- *Electrochemical saline water electrolysis using renewable energy as input is a highly desirable and sustainable method for the mass production of green hydrogen1,2,3,4,5,6,7; however, its practical viability is seriously challenged by insufficient durability because of the electrode side reactions and corrosion issues arising from the complex components of seawater. Although catalyst engineering using polyanion coatings to suppress corrosion by chloride ions or creating highly selective electrocatalysts has been extensively exploited with modest success, it is still far from satisfactory for practical applications8,9,10,11,12,13,14. Indirect seawater splitting by using a pre-desalination process can avoid side-reaction and corrosion problems15,16,17,18,19,20,21, but it requires additional energy input, making it economically less attractive. In addition, the independent bulky desalination system makes seawater electrolysis systems less flexible in terms of size. Here we propose a direct seawater electrolysis method for hydrogen production that radically addresses the side-reaction and corrosion problems. A demonstration system was stably operated at a current density of 250 milliamperes per square centimetre for over 3,200 hours under practical application conditions without failure. This strategy realizes efficient, size-flexible and scalable direct seawater electrolysis in a way similar to freshwater splitting without a notable increase in operation cost, and has high potential for practical application. Importantly, this configuration and mechanism promises further applications in simultaneous water-based effluent treatment and resource recovery and hydrogen generation in one step.*

https://doi.org/10.1038/s41586-022-05379-5

Singapore's National Hydrogen Strategy 2022.

The Singapore government has affirmed that hydrogen has the potential to be adopted across the following sectors as a low-carbon fuel or feedstock:
Maritime Sector
Power Sector
Industry Sector
Aviation Sector
Mobility Sector
Singapore's Hydrogen Roadmap:- Singapore has mapped out the key initiatives to implement its national hydrogen strategy. These initiatives appear to be modest but goes beyond mitigating the oft recited concerns of gas safety and energy efficiency.

First, Singapore will experiment with the use of advanced hydrogen technologies that are on the cusp of commercial readiness.

Second, Singapore will conduct research and development work to advance these hydrogen technologies.

Third, the Singapore government will work closely with industry and international partners to enable the formation and scaling up of supply chains for low-carbon hydrogen.

Fourth, the new infrastructure will be developed to import, store and transform hydrogen into power.

Finally, Singapore plans to harness opportunities along the hydrogen supply chain — financing, trading, certifying, transporting, storage and deployment and will also support workforce training to achieve this.

https://conventuslaw.com/report/singapores-national-hydrogen-strategy-2022/

Toyota, Thailand's CP partner on hydrogen fuel

Japan's biggest automaker says it will work with a Thai conglomerate to promote hydrogen fuel as a way to achieve carbon neutrality.
Toyota Motor announced that it will explore collaboration with Charoen Pokphand Group, whose business includes retail and livestock farming. The companies plan to produce hydrogen from biogas derived from farm waste and use it to power delivery trucks.



b
https://www3.nhk.or.jp/nhkworld/en/news/20221215_14/

NASA Awards Contract for Liquid Hydrogen

NASA has awarded a contract to Air Products and Chemicals, Inc. of Allentown, Pennsylvania, to supply up to 7.5 million pounds of liquid hydrogen to support operations at the agency's Kennedy Space Center in Florida and the nearby Cape Canaveral Space Force Station.
NASA's Kennedy Space Center is the nation's premier multi-user spaceport and the agency's main launch site. The center also is home to facilities that research and develop innovative solutions that government and commercial space ventures need for working and living on the surfaces of the Moon and other bodies in our solar system. NASA uses liquid hydrogen, combined with liquid oxygen, as fuel in cryogenic rocket engines, and the commodity's unique properties support the development of aeronautics.
https://www.nasa.gov/press-release/nasa-awards-contract-for-liquid-hydrogen

Germany to help Kenya hit 100% renewables, export hydrogen

The German government says it will provide Kenya with 112 million euros ($118 million) to help the East African nation close the gap to 100% renewable energy and produce hydrogen. Kenya aims to phase out entirely the use of fossil fuels for electricity generation by 2030. Germany's Development Ministry said that 51 million euros will be earmarked for new energy infrastructure and hydrogen production, while about 30 million euros will be used for training programs. Efforts to make Kenya's agriculture more resilient to drought will get a further 30 million euros and 1.5 million euros will be spent on anti-corruption programs.
https://abcnews.go.com/International/wireStory/germany-kenya-hit-100-renewables-export-hydrogen-95062558

Fortescue and ATCO unveil WA's first sustainable hydrogen station

The refuelling station will be based in ATCO's Clean Energy Innovation Hub in Perth. After receiving $1 million in funding from the WA Government's Renewable Hydrogen program in 2020, Fortescue and ATCO have revealed the H2 Refueller. The station, which produces renewable electricity in ATCO's Jandakot facility, will assist in Fortescue- and ATCO-related production. The two companies have also agreed to assist the WA police by supplying power to their mass of hydrogen vehicles, with the station able to refuel a Toyota Mirai for up to 500km of emissions-free travel in less than five minutes.
https://www.ferret.com.au/mining/fortescue-atco-unveil-first-sustainable-hydrogen-station/

UAE to open facility that converts waste to green hydrogen

BEEAH signed a memorandum of understanding with the Japanese gas conglomerate Air Water and the British waste-to-fuel technology firm Chinook Sciences. They will work together to develop a facility in Sharjah that will convert waste wood and plastic into hydrogen that can be used for fuel. The facility will also include a fueling station for vehicles, the official Emirates News Agency reported.



https://www.al-monitor.com/originals/2022/12/uae-open-facility-converts-waste-green-hydrogen#ixzz7nWf1Gf15

ABS grants 'world first' design approval for a compressed hydrogen carrier



The approval enables shipbuilders to provide firm quotations for the construction of the hydrogen carriers. Provaris has engaged with Clarksons to select a shipyard and expects to conclude the process early next year.
https://safety4sea.com/abs-grants-worlds-first-design-approval-for-compressed-hydrogen-carrier/

Mitsubishi Gas Chemical starts operation of PDC Machines on-site hydrogen refueling



PDC Machines revealed its on-site hydrogen refuelling system for forklift trucks at Mitsubishi Gas Chemical's Niigata Plant, Japan had kicked off its operations. The SimpleFuel™ refuelling system offers on-site hydrogen generation, storage, and dispensing, producing high purity fuel cell-grade green hydrogen, to power up to seven fuel cell forklifts at the Mitsubishi plant.
https://www.h2-view.com/story/mitsubishi-gas-chemical-starts-operation-of-pdc-machines-on-site-hydrogen-refuelling/

H3 Dynamics and Carbonix Join Forces to Build Australia's First Hydrogen VTOL Unmanned Aircraft

H3 Dynamics and Australian UAV producer Carbonix are coming together to begin development and production the first Australian hydrogen-electric VTOL (vertical take-off and landing) unmanned aircraft system (UAS). Carbonix is Australia's leading UAV manufacturer with unique expertise in advanced composite manufacturing, aerostructure design and sophisticated control systems for vertical and landing capabilities. H3 Dynamics has been working on cutting edge hydrogen UAV technology for over 15 years, and has just released a new ground-breaking hydrogen-electric nacelle technology.



https://www.businesswire.com/news/home/20221213006067/en/

Scotland unveils Hydrogen Action Plan with 25GW aspirations by 2045

Scotland has unveiled its Hydrogen Action Plan, laying out the ambition to boast a low-carbon hydrogen production capacity of 5GW by 2030, and 25GW by 2045.
In doing so, the Scottish Government has committed £100m ($123m) in funding for renewable hydrogen projects, through the Hydrogen Innovation Scheme, launched in June 2022, and the Green Hydrogen Fund, opening in 2023.
The 5GW goal translates to 17.TWh and over 450,000 tonnes of hydrogen per year, which the Government estimates is equivalent to 15% of Scotland's total 161TWh energy demand per annum.



https://www.h2-view.com/story/scotland-unveils-hydrogen-action-plan-with-25gw-aspirations-by-2045/

Toyota to Develop a Hydrogen Fuel Cell Toyota Hilux for the U.K.

CNBC claims that Toyota has secured millions in funding to produce a hydrogen fuel cell pickup truck concept in the U.K. Toyota will attempt to create a HFC Toyota Hilux in its Burnaston, England plant.



https://www.motorbiscuit.com/toyota-develop-hydrogen-fuel-cell-toyota-hilux-u-k/

Milestone moment for Highlands project that will power hydrogen trains

Getech, the stock market-listed geoenergy company, said that working alongside SGN Commercial Services, phase one has seen the successful "deconstruction" of the Highland city's former gas holder. The move paves the way to convert a natural gas holder site into a green hydrogen storage and distribution facility.



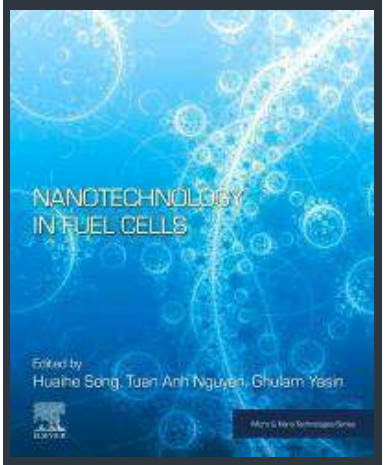
https://www.scotsman.com/business/milestone-moment-for-highlands-project-that-will-power-hydrogen-trains-3953026

Hynion opens hydrogen refuelling station in Sweden

Scandinavian hydrogen station designer, builder and operator Hynion has had the green light to run its 1,500kg hydrogen refuelling station in Ruskvädersgatan, Gothenburg, Sweden. Hynion's plan was approved by the Rescue Service in Gothenburg and has opened for trial refuelling, officially opening on December 20, 2022.
https://www.h2-view.com/story/hynion-opens-hydrogen-refuelling-station-in-sweden/

RECENT BOOKS:

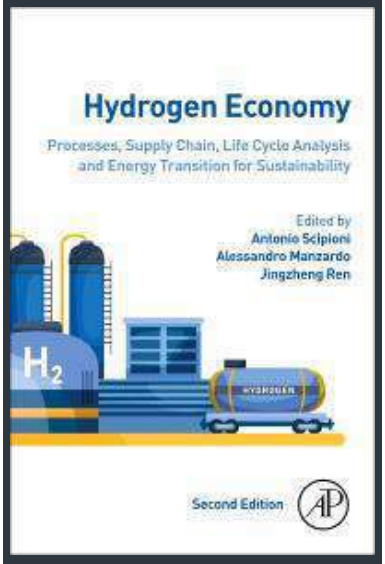
Nanotechnology In Fuel Cells



Authors: Huaihe Song, Tuan Anh Nguyen, Ghulam Yasin
ISBN: 9780323857277

Ebook ISBN: 9780323897914

Hydrogen Economy



Edited By: Antonio Scipioni, Alessandro Manzardo, Jingzheng Ren

ISBN: 9780323995146

MATHESON Wins Large Hydrogen Business in India

Nippon Sanso Holdings Corporation hereby announces that Matheson Tri-Gas, Inc. received the Award for the Supply of Hydrogen and co-product steam for a period of 20 years from Numaligarh Refinery Limited (NRL), a Public Sector affiliate of the Government of India.

MATHESON will invest in, and establish a large, multi-feed hydrogen plant to supply up to 132 kNm3/hr (285 Tons/day) to NRL's refinery units at Numaligarh in Assam, India. The engineering and construction of the plant will be executed by Larsen & Toubro Limited, India, and the reforming technology will be licensed from Topsoe A/S, Denmark. Hydrogen and co-product steam from the plant will support the highly strategic Numaligarh Refinery Expansion Project (NREP) of the prestigious Northeast development initiative of the Government of India.



https://www.businesswire.com/news/home/20221214005848/en/MATHESON-Wins-Large-Hydrogen-Business-in-India

State to get India's 1st hydrogen-powered vehicle project: CM

Chief minister Eknath Shinde said there will be a huge investment in the state for making hydrogen-powered vehicles, and positive discussions have been held with the America-based Triton Electric Vehicles (EV) company to start this project. Himanshu Patel, founder and CEO of America's Triton EV, met CM Shinde at his 'Varsha' residence.

Shinde said a Memorandum of Understanding (MoU) will be signed in this regard in the World Economic Forum (WEF) in Davos in January 2023, and all the necessary facilities will be provided to this company to start an industry in Maharashtra. CM Shinde said Maharashtra will be the first state in the country to start such a project for hydrogen vehicles.

https://auto.economictimes.indiatimes.com/news/industry/state-to-get-indias-1st-hydrogen-powered-vehicle-project-cm/96103268

Green Hydrogen: Budget 2023 must cut import duty on electrolysers to nil, demands industry

Ahead of the Union Budget 2023-24, the domestic industry has demanded that the import duty on electrolysers, used for splitting Water to produce Hydrogen, should be brought to nil.

"This single step will attract huge investment in Green Hydrogen. This will make India export hub by 2030. There is no revenue loss, as Green Hydrogen is not being produced in the country, till date," PHD Chamber of Commerce & Industry (PHDCCI) said in its budget wishlist.

Other key recommendations include bringing Production Linked Incentive (PLI) scheme for wind turbine generators and equipment manufacturing in line with the solar PLI scheme, bringing taxes on bio fuels to nil, and introducing zero GST on Green Cement and Green Steel.

https://energy.economictimes.indiatimes.com/news/renewable/green-hydrogen-budget-2023-must-cut-import-duty-on-electrolysers-to-nil-demands-industry/96245784

Vertex and Encirc sign low carbon hydrogen supply agreement

Vertex Hydrogen has announced the signing of a 'heads of terms' offtake agreement for over 300 megawatts (MW) of low carbon hydrogen with Encirc. Encirc, part of the Vidrala Group, is a leading container glass manufacturer responsible for approximately a third of the containers made for the UK and Ireland markets - around 3 billion each year. It has announced its plan to build a new ultra-low carbon furnace on its Cheshire site. The furnace will be fuelled by an energy mix of green electricity and low carbon hydrogen. "The hydrogen will be supplied by Vertex Hydrogen, as part of the HyNet low carbon industrial cluster. The furnace will be operational by 2027, and Encirc is aiming to be the first in the world to produce net zero glass bottles at scale by 2030," the company said.

VERTEXHYDROGEN

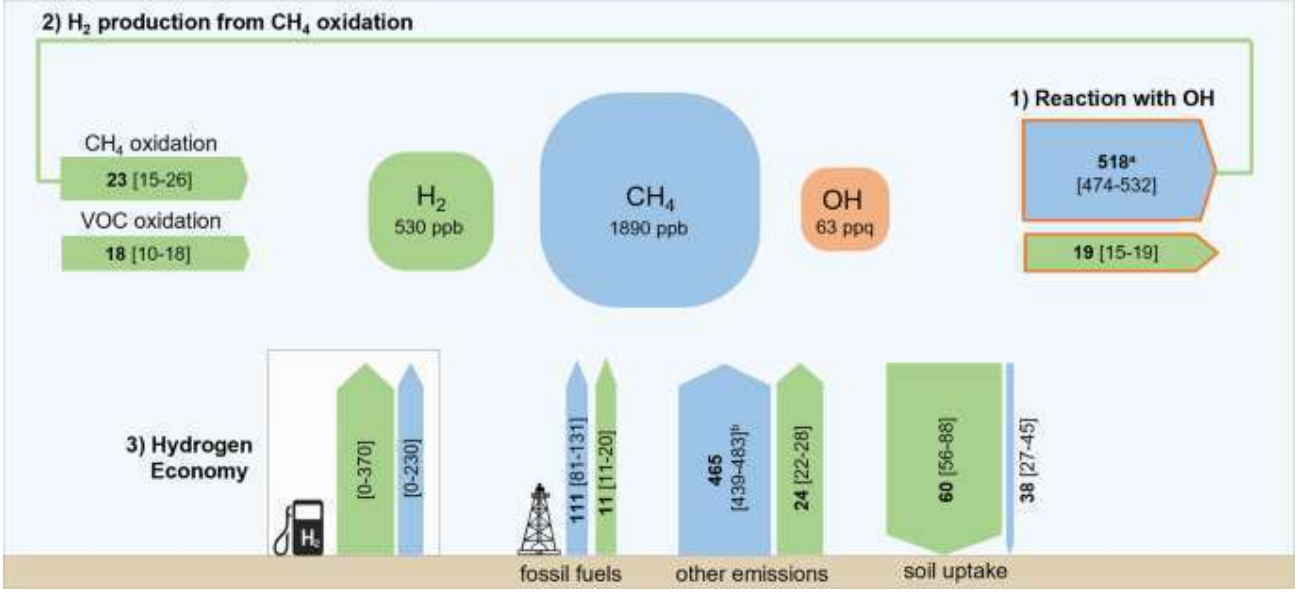
http://www.uniindia.com/~/vertex-and-encirc-sign-major-low-carbon-hydrogen-supply-agreement/Business%20Economy/news/2878947.html

Matteo B. Bertagni, Stephen W. Pacala, Fabien Paulot & Amilcare Porporato

Risk of the hydrogen economy for atmospheric methane

https://doi.org/10.1038/s41467-022-35419-7

Abstract:
Hydrogen (H2) is expected to play a crucial role in reducing greenhouse gas emissions. However, hydrogen losses to the atmosphere impact atmospheric chemistry, including positive feedback on methane (CH4), the second most important greenhouse gas. Here we investigate through a minimalist model the response of atmospheric methane to fossil fuel displacement by hydrogen. We find that CH4 concentration may increase or decrease depending on the amount of hydrogen lost to the atmosphere and the methane emissions associated with hydrogen production. Green H2 can mitigate atmospheric methane if hydrogen losses throughout the value chain are below 9 ± 3%. Blue H2 can reduce methane emissions only if methane losses are below 1%. We address and discuss the main uncertainties in our results and the implications for the decarbonization of the energy sector.



Muhammed Iberia Aydin, Ibrahim Dincer

A life cycle impact analysis of various hydrogen production methods for public transportation sector

https://doi.org/10.1016/j.ijhydene.2022.09.125

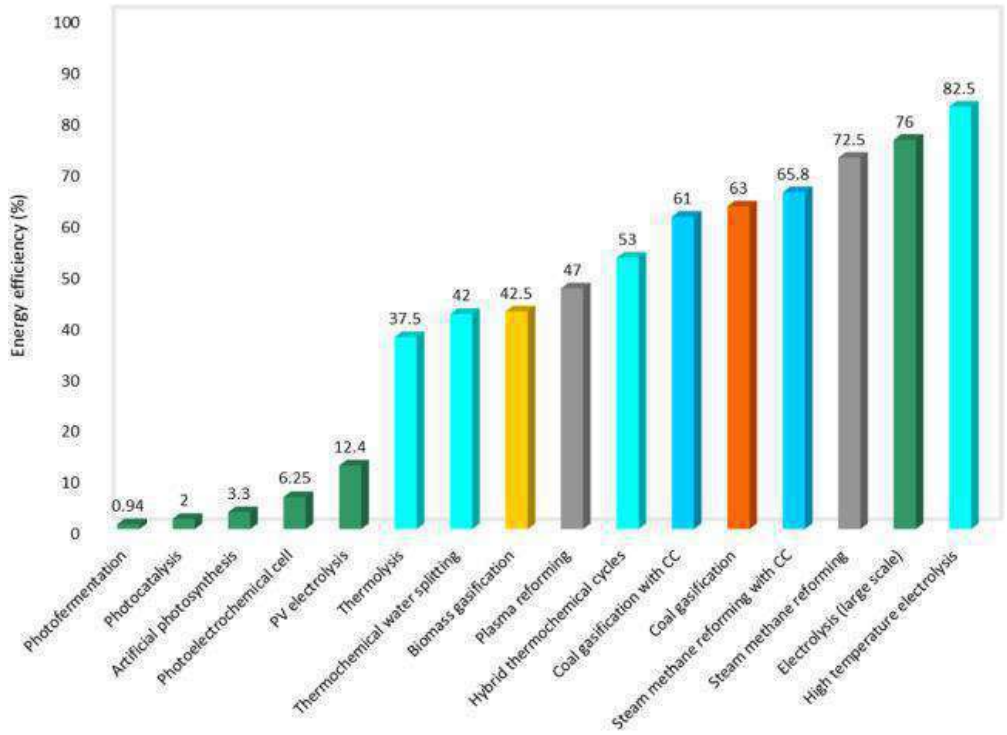
Abstract:
Reducing greenhouse gas emissions is an important task to reduce the adverse effects of climate change. A large portion of greenhouse gas emissions apparently originates from the transportation sector. Therefore, adopting cleaner technologies with lower emission footprints has become vital. For this reason, in this study, a life cycle impact analysis of hydrogen production technologies as an alternative to fossil fuels and the utilization of hydrogen in fuel cell electric buses is carried out. According to the results of this study, the operational contributions of internal combustion engines have a significant impact on life cycle impact analysis indicators. The global warming potentials of clean hydrogen production technologies result in much lower results compared to conventional hydrogen production technologies. Also, almost all indicators for biohydrogen production technologiess yield lower results because of the wastewater removal. The global warming potential results of hydrogen production methods are found to be 6.8, 1.9, 2.1, 0.5, 0.2, and 7.9 kg CO2 eq./kg H2 for PV electrolysis, wind electrolysis, high temperature electrolysis, dark fermentation, photo fermentation and conventional hydrogen production, respectively. However, the chemicals used in PV and wind turbine production increased the ecotoxicological indicators. On the other hand, hydrogen utilization in buses is a better option environmentally. The global warming potentials for PV electrolysis, wind electrolysis, high temperature electrolysis, dark fermentation, photo fermentation, conventional hydrogen, compressed natural gas bus, and diesel bus are found to be 0.060, 0.016, 0.018, 0.007, 0.006, 0.053, 0.082, and 0.125 kg CO2 eq./p.km, respectively. The results are especially important in terms of reducing the effects at the source and optimizing the systems.

Canan Acar, Ibrahim Dincer

Selection criteria and ranking for sustainable hydrogen production options

https://doi.org/10.1016/j.ijhydene.2022.07.137

Abstract:
This paper aims to holistically study hydrogen production options essential for a sustainable and carbon-free future. This study also outlines the benefits and challenges of hydrogen production methods to provide sustainable alternatives to fossil fuels by meeting the global energy demand and net-zero targets. In this study, sixteen hydrogen production methods are selected for sustainability investigation based on seven different criteria. The criteria selected in the comparative evaluation cover various dimensions of hydrogen production in terms of economic, technical, environmental, and thermodynamic aspects for better sustainability. The current study results show that steam methane reforming with carbon capture could provide sustainable hydrogen in the near future while the other technologies' maturity levels increase and the costs decrease. In the medium- and long-terms, photonic and thermal-based hydrogen production methods can be the key to sustainable hydrogen production.



P.R.Yaashikaa, M.Keerthana Devi, P.Senthil Kumar

Biohydrogen production: An outlook on methods, constraints, economic analysis and future prospect

https://doi.org/10.1016/j.ijhydene.2022.07.082

Abstract:
Utilization of hydrogen as fuel lights into various technological, economic and ecological challenges. High production cost and low yield are main drawbacks of commercial hydrogen production methods. Hydrogen production by biological methods helps to overcome these issues owing to its merit such as cost-effective, non-pollutant, recyclability and efficiency in energy conversion. Research has been conducted in utilizing cyanobacteria and algal species for producing biohydrogen utilizing solar light and other sources. Developments have been made for improving biohydrogen productivity through genetic and metabolic engineering. This review outlines the importance of biohydrogen and the constraints in producing biohydrogen in detail. Biohydrogen production can be facilitated using photolysis, fermentation and electrochemical processes. Bioreactors can be used effectively with specific designs and configuration for increasing productivity. The challenges faced during biological production and methods to overcome those demerits are also included for bringing the uncharted principles for producing biohydrogen in an efficient method.

Hydrogen Digest

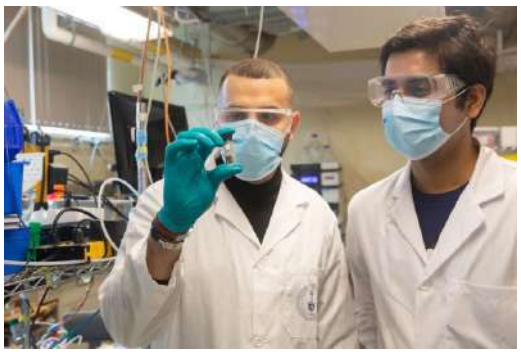
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

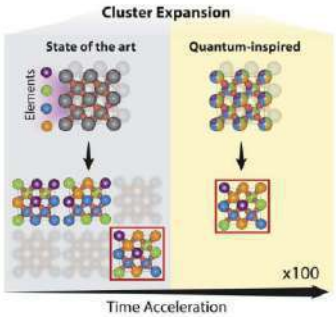
ISSUE. 13

December, 2022

Using quantum-inspired computing to discover an improved catalyst for clean hydrogen

Researchers from the University of Toronto's Faculty of Applied Science & Engineering and Fujitsu have developed a new way of searching through 'chemical space' for materials with desirable properties.





The technique has resulted in a promising new catalyst material that could help lower the cost of producing clean hydrogen.

The discovery represents an important step toward more sustainable ways of storing energy, including from renewable but intermittent sources, such as solar and wind power.

"Scaling up the production of what we call green hydrogen is a priority for researchers around the world because it offers a carbon-free way to store electricity from any source," says Ted Sargent, a professor in the Edward S. Rogers Sr. department of electrical and computer engineering and senior author on a new paper published in Matter. "This work provides proof-of-concept for a new approach to overcoming one of the key remaining challenges, which is the lack of highly active catalyst materials to speed up the critical reactions."

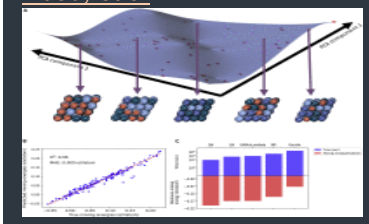
Today, nearly all commercial hydrogen is produced from natural gas. By contrast, 'green hydrogen' is a carbon-free method that uses a device known as an electrolyzer to split water into hydrogen and oxygen gas. The hydrogen can later be burned or reacted in a fuel cell to regenerate the electricity. However, the low efficiency of available electrolyzers means that most of the energy in the water-splitting step is wasted as heat, rather than being captured in the hydrogen. Researchers around the world are racing to find better catalyst materials that can improve this efficiency. But because each potential catalyst material can be made of several different chemical elements, combined in a variety of ways, the number of possible permutations quickly becomes overwhelming.

"One way to do it is by human intuition, by researching what materials other groups have made and trying something similar, but that's pretty slow," says department of materials science and engineering Ph.D. candidate Jehad Abed, one of two co-lead authors on the new paper.

Using quantum-inspired computing to discover an improved catalyst for clean hydrogen (phys.org)

Accelerated chemical space search using a quantum-inspired cluster expansion approach

Hitarth Choubisa; Jehad Abed; et al



Summary- *To enable the accelerated discovery of materials with desirable properties, it is critical to develop accurate and efficient search algorithms. Quantum annealers and similar quantum-inspired optimizers have the potential to provide accelerated computation for certain combinatorial optimization challenges. However, they have not been exploited for materials discovery because of the absence of compatible optimization mapping methods. Here, by combining cluster expansion with a quantum-inspired superposition technique, we lever quantum annealers in chemical space exploration for the first time. This approach enables us to accelerate the search of materials with desirable properties 10–50 times faster than genetic algorithms and bayesian optimizations, with a significant improvement in ground state prediction accuracy. We apply this to the discovery of acidic oxygen evolution reaction catalysts and find a promising previously unexplored chemical family of Ru-Cr-Mn-Sb-O2. The best catalyst shows a mass activity eight times higher than state-of-the-art RuO2 and maintains performance for 180 h.*

https://doi.org/10.1016/j.matt.2022.11.031

RECENT REPORT:-

Sufficiency, Sustainability, and Circularity of Critical Materials for Clean Hydrogen



Our estimates suggest that hydrogen needs to grow seven-fold to support the global energy transition, eventually accounting for 10 percent of total energy consumption by 2050. A scale up of this magnitude will increase demand for materials, such as aluminum, copper, iridium, nickel, platinum, vanadium and zinc, to support hydrogen technologies – renewable electricity technologies and the electrolyzers for renewable hydrogen, carbon storage for low-carbon hydrogen, or fuel cells using hydrogen to power transport.

This report is a joint product of the World Bank and the Hydrogen Council.

This report estimates the amount of critical minerals needed to scale clean hydrogen. In addition, it shows how incorporating sustainable practices and policies for mining and processing materials can help minimize environmental impacts. Key among these approaches is the use of recycled materials, innovations in design in order to reduce material intensities, and adoption of policies from the Climate-Smart Mining (CSM) Framework to reduce impacts to greenhouse gas emissions and water footprint.

https://hydrogencouncil.com/en/sufficiency-sustainability-and-circularity-of-critical-materials-for-clean-hydrogen/

INDUSTRY NEWS

Hydrogen infrastructure projects launched to connect Finland and Central Europe

State-owned company and transmission system operator Gasgrid Finland signed a project agreement to develop a new piece of the regional hydrogen infrastructure network. Pipelines of up to 5,000 kilometres will connect the Baltic Sea area and Central Europe by 2030.



https://www.euractiv.com/section/politics/news/hydrogen-infrastructure-projects-launched-to-connect-finland-and-central-europe/

Saudi Arabia's NEOM announces new green hydrogen plans

Saudi Arabia's NEOM has signed agreements with banks to finance a green hydrogen production plant. The NEOM Green Hydrogen Company (NGHC) also executed a letter of commitment with the Saudi Industrial Development Fund. The move is part of the kingdom's efforts to built the world's largest green hydrogen-based ammonia production plant for the futuristic city.

https://www.arabianbusiness.com/industries/energy/saudi-arabias-neom-announces-new-green-hydrogen-plans

JOHNSON MATTHEY AND HONEYWELL PARTNER TO ADVANCE LOWER CARBON HYDROGEN SOLUTIONS

Honeywell and Johnson Matthey (JM), announced they will work together to deploy low carbon1 hydrogen solutions. The companies will offer JM's innovative LCH™ technology, coupled with Honeywell's leading carbon capture technology to produce lower carbon intensity hydrogen (blue hydrogen) at scale. Ready to be deployed, this offering will provide project developers a new option for producing clean hydrogen.

https://finance.yahoo.com/news/johnson-matthey-honeywell-partner-advance-120000441.html

Nikola to sell hydrogen-powered trucks to Plug Power

Electric truck company, Nikola Corp (NASDAQ:NKLA) announced that the automaker would sell up to 75 Tre hydrogen-powered trucks over three years to fuel-cell technology developer Plug Power (NASDAQ:PLUG). Plug Power will attach its liquid hydrogen tankers to Nikola's trucks, whose deliveries will begin next year, to transport green hydrogen fuel across North America.



https://in.investing.com/news/nikola-to-sell-hydrogenpowered-trucks-to-plug-power-432SI-3454926

UAE Work begins on one of world's largest hydrogen storage facilities

Energy company SSE has begun developing an underground cavern in east Yorkshire to store hydrogen. This has been designed to to stockpile the renewable source of power during freezing, windless conditions. It will generate hydrogen using renewable energy in a 35-megawatt electrolyser, in a cavern a mile deep at an SSE site in Aldbrough on the coast. The hydrogen will power a turbine which can export power to the grid during periods of heavy demand.



https://www.thebusinessdesk.com/yorkshire/news/2103324-work-begins-on-one-of-world%e2%80%99s-largest-hydrogen-storage-facilities

White Martins receives Green Hydrogen Certificate

White Martins' Brazil plant has received the Green Hydrogen Certificate from TÜV Rheinland based on the standard H2.21.
The Linde subsidiary is the 'first company' to produce green hydrogen on an industrial scale in South America, with its plant producing 156 tonnes of green hydrogen per year.
The certificate was awarded by TÜV Rheinland following a process involving the collection of technical documentation, analysis and audits over a period of around three months.
https://www.h2-view.com/story/white-martins-receives-green-hydrogen-certificate/

Energy outlook 2023: The growth in renewables, batteries, CCS and hydrogen infrastructure

In 2023, we expect key technologies, including wind, solar, batteries, CCS and hydrogen infrastructure, to continue growing. Headwinds from supply chain disruptions and higher interest rates will likely persist, but policy support and company climate commitments suggest positive capacity growth.

https://think.ing.com/articles/new-energy-technologies-growth-in-renewables-batteries-ccs-and-hydrogen-infrastructure

Toyota's President and CEO personally brings hydrogen engine vehicle to Thai endurance race

On 17 and 18 December 2022, none other than the CEO and President of Toyota Motor Corporation - Akio Toyoda himself - took to the Chang International Circuit for the first and last few hours of the Thailand 25H Endurance race. His weapon of choice? A rare hydrogen-powered internal combustion engine vehicle (HiCEV), known as the ORC Rookie GR Corolla H2 Concept.



https://www.sgcarmart.com/news/article.php?AID=27798

SK E&S Wins Regulatory Waiver for Its Blue Hydrogen Project

SK E&S has received regulatory waiver for its project to build the world's largest blue hydrogen project in Boryeong, South Chungcheong Province.
The company had received government approval to go ahead with its plan to produce clean hydrogen using cold heat from liquefied natural gas (LNG) and build and operate liquefied hydrogen plants.



http://www.businesskorea.co.kr/news/articleView.html?idxno=106374

Nel ASA: Signs Capacity Reservation Agreement for 16 hydrogen fueling stations

Nel Hydrogen Inc., a subsidiary of Nel ASA, has signed a Capacity Reservation Agreement (CRA) with an undisclosed US energy company, for the delivery of 16 hydrogen fueling stations to be deployed in the US.
Nel is a global, dedicated hydrogen company, delivering optimal solutions to produce, store and distribute hydrogen from renewable energy.
https://mb.cision.com/Main/115/3687762/1750161.pdf

Eight new hydrogen refuelling stations planned across Europe

Spanish-based Calvera Hydrogen has announced plans to develop eight hydrogen refuelling stations across Europe. Expected to begin operating between 2023 and 2024, the stations will be accompanied by their associated hydrogen transport systems (tube trailers). The refuelling stations will have different capacities, therefore adapting to the specific needs of each customer, from 200 to 1,600kg of hydrogen dispensed per day, translating to the filling of 20 to 30 cars and 40 to 60 buses per day.



https://www.h2-view.com/story/eight-new-hydrogen-refuelling-stations-planned-across-europe/

Saudi company signs agreements for green hydrogen plant

Scandinavian Neom Green Hydrogen Co. signed agreements with a Saudi fund and banks to enable the implementation of a green hydrogen plant in the country. The project is expected to be the largest in the world and focus on exports. The plant is planned to be built in the futuristic city of Neom, which expects to receive investments of USD 500 billion
https://anba.com.br/en/saudi-company-signs-agreements-for-green-hydrogen-plant/

Ministry Of New And Renewable Energy To Improve Research In Hydrogen Based Technology

Government of India
Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy has been supporting Research, Development and Demonstration (RD&D) projects through research institutions and industry inter alia for development of vehicles that run on hydrogen fuel. Council for Scientific and Industrial Research (CSIR) through National Chemical Laboratory (NCL) has also undertaken RD&D projects on hydrogen fuel cell vehicles.

Hydrogen can be used as a fuel for vehicles through fuel cells which convert chemical energy of hydrogen to electricity or through modified internal combustion engines that can use hydrogen. Since both technologies are at pilot stage of development by the industry and not commercially tested in India, cost estimates and timelines of setting up this industry are presently not available.

National Chemical Laboratory

https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1885074

Renewable energy sector to boom with likely investments of over USD 25 billion in 2023

With an oil price shock threatening to derail economies globally, the focus has shifted to renewable energy with over USD 25 billion or Rs 2 lakh crore investment planned in India for using sunlight, water and air to produce energy. The government in 2022 aggressively pushed for the adoption of electric vehicles, the production of green hydrogen, manufacturing of solar equipment and energy storage in pursuit of its ambitious 500 GW renewable capacity target by 2030.

Addressing an event organised by industry body FICCI, Union Minister Nitin Gadkari said India is the fastest growing major economy in the world and is all set to achieve USD 5 trillion GDP by 2024-25 and the central government is aiming to boost growth and employment to achieve sustainable development. "We are also working on developing alternative, clean and green fuel like bio ethanol, bio-CNG, bio-LNG and green hydrogen," he said, adding green hydrogen is the fuel for the future.

https://economictimes.indiatimes.com/industry/renewables/renewable-energy-sector-to-boom-with-likely-investments-of-over-usd-25-billion-in-2023/articleshow/96426199.cms

India Hydrogen Alliance announce six new members

Industry body the India Hydrogen Alliance (IH2A) has announced that six new members will join the cause for India's hydrogen development. Hero Future Energies, bp, Welspun Corp, Tubacex, Climate Policy Initiative and Climate Group will work closely with the Government of India on the development of the hydrogen economy and supply chain in India. The Alliance was formed in April 2021, and it wants to attract global climate finance for the development of a large-scale hydrogen hub in India, to support the country's goals of achieving Net Zero greenhouse gas emissions by 2070.



https://www.h2-view.com/story/india-hydrogen-alliance-announce-six-new-members/

India and the Netherlands work towards Green Hydrogen Corridor

To increase its collaboration on Green Hydrogen and a `Green Hydrogen Corridor' the Dutch government is working together with India's Ministry of New and Renewable Energy and NITI Aayog. The country is also working with India to help meet its plans to have e-vehicles on the roads.

Marten van den Berg, ambassador of the Netherlands in India says: "There was a Green Hydrogen Mission from the Netherlands visiting India. The focus of the visit was on deepening cooperation with India on Green Hydrogen. Hydrogen by itself is a carrier of energy, not so much a producing energy, and India has the ambition not only to produce green hydrogen but also to export green hydrogen."

https://www.msn.com/en-in/news/other/india-and-the-netherlands-work-towards-green-hydrogen-corridor/ar-AA15u7LN

Railways to bring Vande Bharat Hydrogen train in 2023, Vande Bharat-3 sleeper train for long journey

Hydrogen trains in India: The Indian Railways are planning to introduce Hydrogen-fuel powered trains that are likely to be rolled out in December 2023. The trains will be indigenously designed and built, reports said.

The new Hydrogen-powered trains are being designed like Vande Bharat by the Indian engineers, Railway Minister Ashwini Vaishnaw said. "The design process is already going on and we should be able to roll out the first hydrogen train in the country by December 2023," he added. Apart from Hydrogen trains, the Railways is manufacturing 'Vande Metro' train which will replace those designed in 1950s and 60s, Vaishnaw said.



https://www.indiatvnews.com/news/india/railways-to-launch-vande-bharat-hydrogen-train-in-2023-vande-bharat-3-sleeper-coach-train-for-long-routes-ashwini-vaishnaw-2022-12-20-832841

John M.Low; R. Stuart Haszeldine; Julien Mouli-Castillo

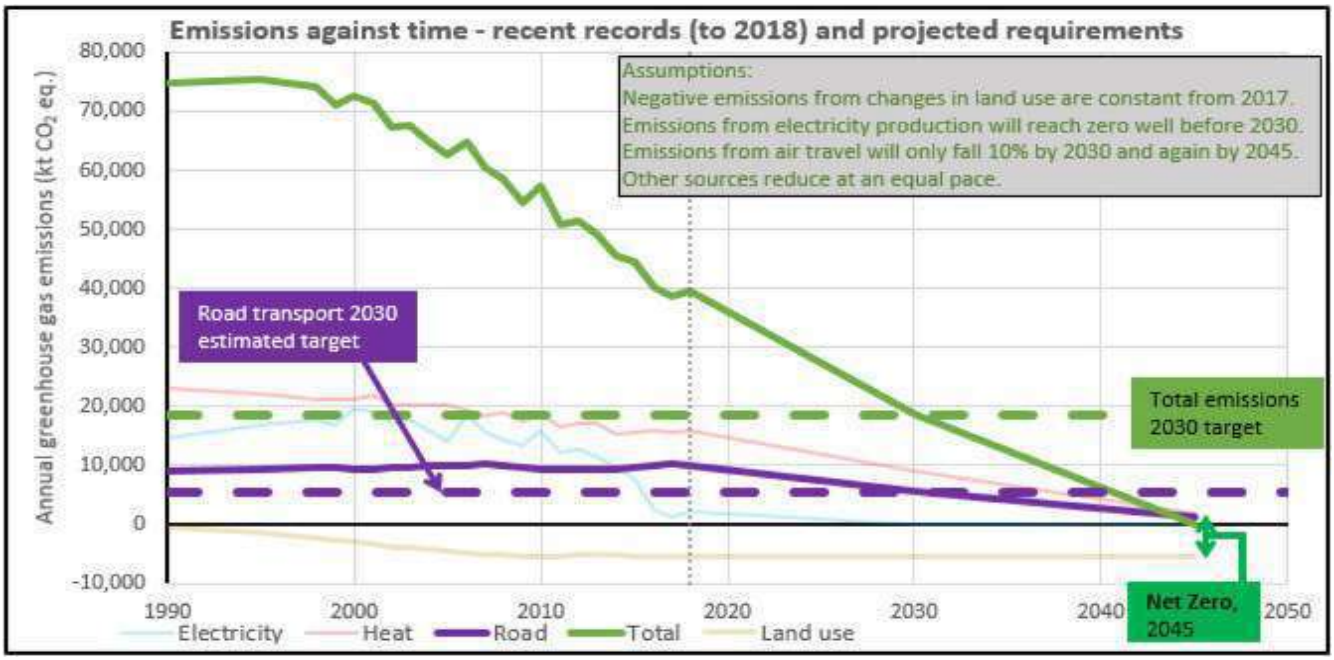
Refuelling infrastructure requirements for renewable hydrogen road fuel through the energy transition

https://doi.org/10.1016/j.enpol.2022.113300

Abstract:
Current commercially available options for decarbonisation of road transport are battery electric vehicles or hydrogen fuel cell electric vehicles. BEVs are increasingly deployed, while hydrogen is in its infancy. We examine the infrastructure necessary to support hydrogen fuelling to various degrees of market penetration. Scotland makes a good exemplar of transport transition, with a world leading Net-Zero ambition and proven pathways for generating ample renewable energy.

We identified essential elements of the new transport systems and the associated capital expenditure. We developed nine scenarios based on the pace of change and the ultimate market share of hydrogen, and constructed a model to analyse their infrastructure requirements. This is a multi-period model, incorporating Monte Carlo and Markov Chain elements.

A “no-regrets” initial action is rapid deployment of enough hydrogen infrastructure to facilitate the early years of a scenario where diesel fuel becomes replaced with hydrogen. Even in a lower demand scenario of only large and heavy goods vehicles using hydrogen, the same infrastructure would be required within a further two years. Subsequent investment in infrastructure could be considered in the light of this initial development.



Xiaolun Fang; Yubin Wang; et al.

Optimal energy management of multiple electricity-hydrogen integrated charging stations

https://doi.org/10.1016/j.energy.2022.125624

Abstract:
Hydrogen is considered promising for the replacement of fossil fuels in integrated energy systems through hydrogen energy storage (HES). This paper considers multiple electricity-hydrogen integrated charging stations (EHI-CSs) as a unit consisting of photovoltaic systems and HES systems for charging plug-in electric vehicles and refilling hydrogen fuel vehicles. In the multiple EHI-CSs unit, a set of interconnected EHI-CSs can be supplied by other EHI-CSs or power utilities and an EHI-CSs aggregator can manage the individual EHI-CSs through controllable facilities (i.e., HES system) and adjustment methods (i.e., energy transportation between subsystems). Meanwhile, a two-stage energy management system (EMS) strategy is proposed to coordinate the day-ahead scheduling and real-time dispatch. In the day-ahead scheduling stage, the aggregator minimizes the cost of the overall multiple EHI-CSs unit through optimization, and in the real-time dispatching stage, the intraday energy dispatch

based model predictive control (MPC) is carried out to minimize the penalty cost. The proposed two-stage EMS strategy is evaluated through simulations and the numerical results confirm that the proposed solution outperforms the baseline solution with additional economic benefit.

Duran Çalışır; Selcuk Ekici; Adnan Midilli; T. Hikmet Karakoc.

Benchmarking environmental impacts of power groups used in a designed UAV: Hybrid hydrogen fuel cell system versus lithium-polymer battery drive system

https://doi.org/10.1016/j.energy.2022.125543

Abstract:
This study investigates the environmental impacts of using two different power groups in a fixed-wing Unmanned Aerial Vehicle (UAV). The first power group consists of a conventional electric motor, a lithium polymer battery and a propeller. The second power group is the hybrid power group formed by adding the Proton Exchange Membrane (PEM) fuel cell. The life cycle assessment (LCA) method is applied to the configurations to reveal environmental impact values (global warming, terrestrial ecotoxicity, photochemical oxidation, acidification, eutrophication and so on). Inventory and impact analysis calculations are performed using SimaPro 9.1 software. Ecoinvent 3.6 database is employed in this software. The environmental impact assessment is made according to CML-IA Baseline and ReCiPe method. In addition, the research involves hotspot analyses for both power group configurations. Consequently, the following is noticed as a result of a transition from lithium-polymer power group to hybrid hydrogen fuel cell system; (i) the global warming reduces by 6.95%, (ii) the terrestrial ecotoxicity reduces by 6.35%, (iii) the photochemical oxidation decreases by 1.23%, and (iv) the ozone layer depletion increases by 12.44%. These days when environmental problems stand out, the effects of UAVs hybridized with fuel cells, known as a clean energy source, related with environmental problems reflect the principal of this research.

FCB Research and Consulting, Brasília, Distrito Federal, Brazil

Fuel cell rail technology review: A tool for an autonomous rail electrifying strategy

https://doi.org/10.1115/JRC2019-1223

Abstract
Rail (passenger and freight) industry has been under pressure to tackle climate change, local and noise emissions. The current available powertrain technologies to reach the reduced greenhouse (GHG) and zero local emissions demands are electric (fed from the power grid), battery and fuel cell. However, the associated infrastructure costs (electrical equipments and the required overhead catenary infrastructure) have limited the electric option to heavy loaded corridors. Battery electric powered rail vehicles could be another potential option, but their system recharging requirements might significantly limit the system's availability, thus, impacting the rail vehicle's on-the-job performance. The recent breakthrough of fuel cell technology in the heavy duty road industry (mainly transit buses), allied with its operational flexibility and environmental performance has opened the way for this groundbreaking technology in the rail industry. Fuel cells generate electricity onboard, using hydrogen or hydrogen rich hydrocarbon fuels. Electricity is, then, stored in batteries or fed directly into a rail vehicle's high voltage propulsion system. From an operational perspective, fuel cell powered rail vehicles might replace diesel ones in a one-to-one relationship, with the same range and running times, and a more efficient and less noisy powertrain. Moreover, the on-site refilling station is the only additional infrastructure element required, compared to diesel rail vehicle baselines. In short, fuel cell technology might offer a long term local zero emission alternative, fast refuelling (like diesel), flexibility, with self-electrification, integration with a renewable energy source and a quiet operation. Given their outstanding operational and environmental features, several rail market niches might be addressed by the fuel cell technology: i) light rail and trams in urban environments; ii) commuter and regional trains operating on non electrified tracks; iii) shunt or switch locomotives in rail yards (generally located on central portions of large cities or at the crossroads of major rail distribution hubs); iv) underground mining locomotives, and v) line haul locomotives. Since 2002, there has been an intense activity in the global development of fuel cell technology for the rail industry for both passenger and freight markets. This work is supposed to present, based on the compilation of information from a multitude of acknowledged sources, a review of fuel cell rail technology, followed by an overview of fuel cell rail experiences and feasibility studies, highlighting their main outcomes, as well as fuel cell technology potential to offer lower operational costs (fuel and maintenance) and improved performance for the rail industry. Copyright © 2019 ASME.

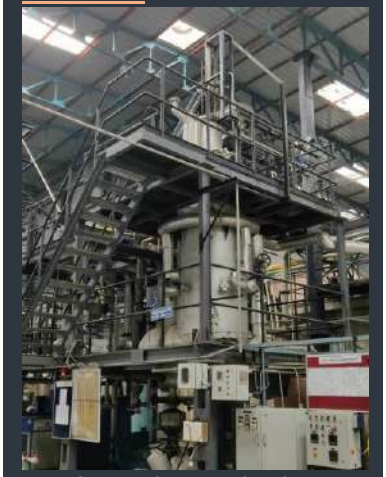
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 14

December, 2022

IISc Professor Innovates New Tech to Generate Green Hydrogen Using Biomass



An innovative technology to produce hydrogen from biomass has been developed by a team of researchers from the Indian Institute of Science (IISc).

Now, the team has found a way to extract green hydrogen from biomass, a renewable energy source.

The process consists of two steps. In the first step, biomass is converted into syngas – a hydrogen-rich fuel gas mixture – in a novel reactor using oxygen and steam. In the second step, pure hydrogen is generated from syngas using an indigenously developed low-pressure gas separation unit.

The production of green hydrogen using this process is environmentally friendly for another reason – it is carbon negative. The two carbon-based by-products are solid carbon, which serves as a carbon sink, and carbon dioxide, which can be used in other value-added products.

The project was supported by the Ministry of New and Renewable Energy

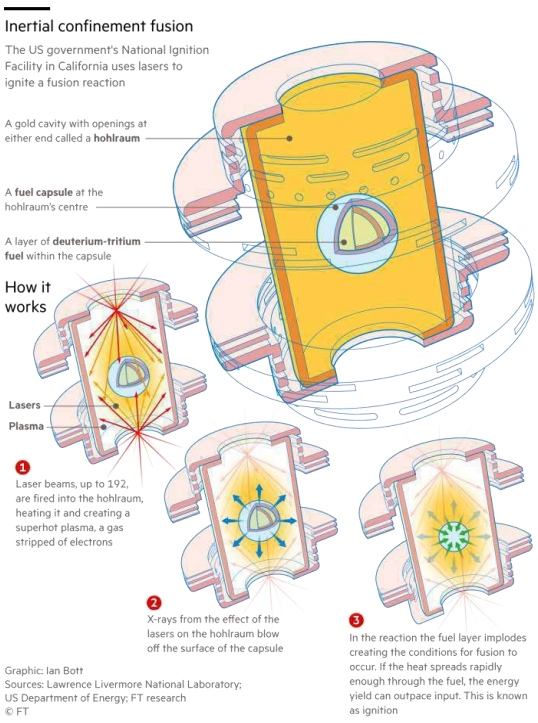
Indian Institute of Science (iisc.ac.in)

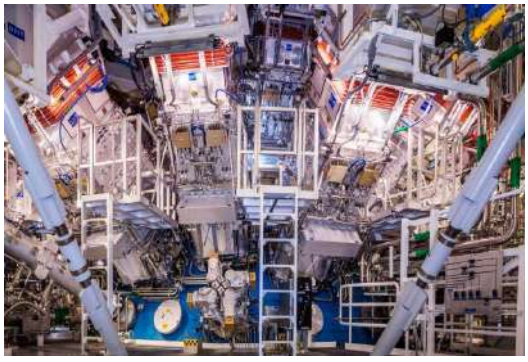
A small cup of the hydrogen fuel could power a house for hundreds of years.

US government scientists have made a breakthrough in the pursuit of limitless, zero-carbon power by achieving a net energy gain in a fusion reaction for the first time. Since 1950 Physicists have studied the fusion reaction that powers the sun, but no group had been able to produce more energy from the reaction than it consumes— a milestone known as net energy gain or target gain, which would help prove the process could provide a reliable, abundant alternative to fossil fuels and conventional nuclear energy. The federal Lawrence Livermore National Laboratory in California, which uses a process called inertial confinement fusion that involves bombarding a tiny pellet of hydrogen plasma with the world's biggest laser, had achieved net energy gain in a fusion experiment in the past two weeks, the people said.

Although many scientists believe fusion power stations are still decades away, the technology's potential is hard to ignore. Fusion reactions emit no carbon, produce no long-lived radioactive waste and a small cup of the hydrogen fuel could theoretically power a house for hundreds of years.

The fusion reaction at the US government facility produced about 2.5 megajoules of energy, which was about 120 per cent of the 2.1 megajoules of energy in the lasers, the people with knowledge of the results said, adding that the data was still being analyzed.





https://www.ndtv.com/feature/how-us-fusion-energy-breakthrough-boosts-hope-of-clean-power-5-points-3600277

RECENT WHITE PAPER:-

Water requirements for use in hydrogen production in Australia:

Potential public policy and industry-related issues



Rebecca E. Lester, Don Gunasekera, Wendy Timms and David Downie
Centre for Regional and Rural Futures, Deakin University, School of Engineering, Deakin University

CONTENTS

1. Introduction
2. Production, cost & demand outlook for hydrogen production
3. Water needs, availability and use for hydrogen
4. Impacts of failure to plan water use in hydrogen production
5. Potential public policy & industry-related issues
6. Concluding remarks
7. References

Water-energy-nexus-whitepaper.pdf (deakin.edu.au)

INDUSTRY NEWS

L&T wins EPC contract for world's largest hydrogen plant in Saudi Arabia

NEOM Green Hydrogen Co (NGHC) has named Indian contractor Larsen & Toubro (L&T) as the sub-EPC contractor for its massive green hydrogen plant in Saudi Arabia. Under the terms of the contract, L&T will execute power grid and power generation works for the plant on an EPC basis.
Located in NEOM, Saudi Arabia's $500 billion futuristic city being developed in Tabuk, NGHC's mega-plant will integrate up to 4 GW of solar and wind energy to produce up to 600 tons per day of carbon-free hydrogen in the form of green ammonia as a cost-effective solution for transportation globally. Green ammonia output is expected up to 1.2 million tonnes. The plant at NEOM is scheduled for commissioning by 2026.



https://www.oilandgasmiddleeast.com/news/lt-wins-epc-contract-for-worlds-largest-hydrogen-plant-in-saudi-arabia

H2GO Power gets AI and hydrogen storage technology funding from UK government

H2GO Power is headed toward a world first as a part of a collaboration with Baxi, and will be receiving UK government funding to lead an industrial scale demonstration of its artificial intelligence and hydrogen storage technology.
https://www.hydrogenfuelnews.com/hydrogen-storage-technology-h2go/8556572/

Africa Could Make €1 Trillion of Green Hydrogen a Year, European Investment Bank Said

Africa has the potential to produce €1 trillion ($1.06 trillion) worth of green hydrogen a year by 2035, allowing it to export the fuel and boost local industry, according to a study backed by the European Investment Bank.
https://www.bnnbloomberg.ca/africa-could-make-1-trillion-of-green-hydrogen-a-year-eib-says-1.1862142#

Korean firms will use hydrogen to charge EVs at gas stations

South Korea's oil giant SK Energy announced that it will work on providing hydrogen-based charging facilities for EVs at its gas stations. SK Energy will utilize fuel cell technology, which uses the chemical energy of hydrogen, to produce electricity with the power being supplied through charging stands. SK Energy started testing the idea of installing fuel cells at its gas stations beginning in May last year. A subsidiary of oil refining entity SK Innovation, it operates 3,000+ filling stations in Korea.



https://www.upi.com/Top_News/World-News/2022/12/29/Korea-hydrogen-charging-EV-stations/1771672330093/

North Sea gas could be the next source for hydrogen

A team of U.S. and British companies said they are interested in using natural gas from the North Sea as a feedstock to produce hydrogen, something of a darling resource during the so-called energy transition.
U.S.-based Protuem Energy and Britain's Transitus Energy entered into a letter of intent to search for opportunities in the British, Dutch, Irish and Norwegian waters of the North Sea to produce hydrogen.



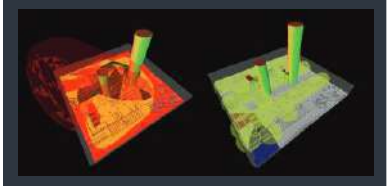
https://www.upi.com/Top_News/World-News/2022/12/22/britain-blue-hydrogen-transitus-proteum/8671671723354/

RECENT WHITE PAPER-

Working Safety with Hydrogen



As growing numbers of industries embrace the use of hydrogen it is important that the hazards of working with this fuel are understood, and the right safety measures and systems are put in place. While hydrogen is safer to handle than some other commonly used fuels (in that it disperses quickly in air and is not toxic), it is still highly combustible and is an asphyxiant gas. Its unique properties also pose special challenges, which is why, in addition to general fuel safety regulations, there are specific regulatory requirements for those working with hydrogen.



https://de.msasafety.com/working-safely-with-hydrogen?locale=en

XCMG Delivers 100 Hydrogen-Fueled Trucks to Mengxi Zhenghe Group

On XCMG, the world's top 3 construction machinery manufacturers, has delivered a batch of 100 hydrogen-fueled trucks to the end client Mengxi Zhenghe Group to aid its construction of a mine near Ordos in China's Inner Mongolia autonomous region, as part of the thousand-units hydrogen-fueled truck order that signed with Sino-Synergy Hydrogen Energy Technology ("Sino-Synergy") earlier.



https://markets.businessinsider.com/news/stocks/xcmg-delivers-100-hydrogen-fueled-trucks-to-mengxi-zhenghe-group-1031993035

Stellantis explores acquiring stake in Faurecia Michelin hydrogen JV

"Symbio's technical roadmap perfectly matches with Stellantis' hydrogen rollout plans in Europe and in the U.S.," said Stellantis CEO Carlos Tavares. "This move will foster the speed of development to bring low emission products to our customers, beyond traditional electric vehicles. We're grateful to the teams at Faurecia, Michelin and Symbio for their commitment to innovation, excellence, and collaboration as we all work to achieve decarbonised mobility."



https://www.autocarpro.in/news-international/stellantis-explores-acquiring-stake-in-faurecia-michelin-hydrogen-jv-113664

Trio of states to pursue regional hydrogen hub application

Arkansas, Louisiana, and Oklahoma will submit an application for up to $1.25 billion in funding under the federal regional clean hydrogen hubs program after the U.S. Department of Energy encouraged them to do so, their governors said. The states created the HALO Hydrogen Hub in March to compete for money appropriated by the Infrastructure Investment and Jobs Act.

https://www.bondbuyer.com/news/trio-of-states-to-pursue-regional-hydrogen-hub-application

Uniper and Masdar to build green hydrogen plant in UAE

Germany's Uniper SE is teaming up with Masdar, one of the Middle East's biggest renewable-energy firms, to make green hydrogen in the United Arab Emirates (UAE). The two companies will build a plant that will run on almost 1.3 gigawatts of solar power and is expected to produce hydrogen from 2026. Uniper's shareholders agreed a €33bil (US$35bil or RM154.7bil) rescue this week that will lead to the utility's nationalisation and avoid its collapse following a surge in natural-gas prices in the wake of Russia's invasion of Ukraine.

https://www.thestar.com.my/business/business-news/2022/12/29/uniper-and-masdar-to-build-green-hydrogen-plant-in-uae

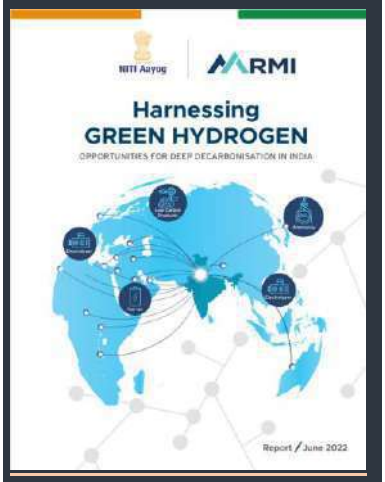
GenH2 launches ground-breaking mobile liquid hydrogen system

GenH2, an industry leader in hydrogen infrastructure solutions, announced the launch of its ground-breaking LS20 Mobile Liquid Hydrogen System, an end-to-end liquefication and storage system.

The innovative, mobile liquefaction unit offers a space-optimized, fully integrated liquid hydrogen solution to be used in a range of applications from transportation to energy backup to accelerating the use of liquid hydrogen through pilot projects and testing. It will also be utilized as a lab setting for testing material, insulation, thermodynamic properties, and use cases for their applications.

https://www.indianchemicalnews.com/compendium/genh2-launches-ground-breaking-mobile-liquid-hydrogen-system-15880

REPORTS- 2022



Topics discussed in the Report-
-The Future of Hydrogen in India
-Manufacturing Opportunities
-Export Opportunities
-Steps to make India a global hub of green hydrogen



The recent announcement of the National Hydrogen Mission signals the right intent but it needs to be complemented with further policy direction in the form of a national roadmap/strategy. The emphasis of this roadmap should be to elaborate on the government's vision for green hydrogen in multiple sectors with timelines and investment aspirations given the long-term cost advantage and multiple benefits that we have established in this report.

Harnessing_Green_Hydrogen_V21_DIGITAL_29062022.pdf (niti.gov.in)

India said to plan $2 bn incentive for green hydrogen industry

India is planning a $2 billion incentive programme for the green hydrogen industry, three sources told Reuters, in a bid to cut emissions and become a major export player in the field. The ₹180-billion ($2.2 billion) incentive aims to reduce the production cost of green hydrogen by a fifth over the next five years, said a senior government official and an industry manager working in renewable energy. It would do this in part by increasing the scale of the industry, they said.
The current cost in India is ₹300 to ₹400 per kg, said the manager. The United States and the European Union have already approved incentives worth billions of dollars for green hydrogen projects.
https://www.thehindu.com/business/india-said-to-plan-2-bn-incentive-for-green-hydrogen-industry/article66310717.ece

Pune poised to become hydrogen hub

Hydrogen economy stakeholders believe that Pune is strategically positioned to become the hydrogen hub in the country with all the necessary building blocks in place. There exists technological competence in electrolysers, fuel cells, biomass-based hydrogen, power electronics, testing and calibration, and R&D to successfully develop a Hydrogen Valley in the region. Dozens of companies are working on hydrogen fuel.
https://www.msn.com/en-in/news/other/pune-poised-to-become-hydrogen-hub/ar-AA15vcSv

Green hydrogen to be used in fertiliser industry: Nitin Gadkari

Speaking at the 121st annual session of the Merchants' Chamber of Commerce and Industry, Nitin Gadkari said, "Green hydrogen is a sustainable alternative to fossil fuels like coal and crude oil. In the near future, green hydrogen will be the source of energy in the aviation, railway, road transport, Chemical and fertiliser industries."

https://www.telegraphindia.com/business/union-minister-nitin-gadkari-bullish-on-green-hydrogen/cid/1906492

Tata Motors to showcase Hydrogen Fuel Cell and Connected Car Technologies

Tata Motors is all set to showcase its new products at the Auto Expo 2023. The company recently released a few teasers that confirm the developments of Hydrogen fuel cell and connected car technology.
The brand shared a teaser of the hydrogen fuel tank that suggests Tata Motors will display a fuel cell prototype at the Auto Expo 2023.
http://timesofindia.indiatimes.com/articleshow/96462913.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

2022 Review: Key steps taken to promote use of green fuel in India

Given the growing urgency to reduce carbon emission and cut down the use of fossil fuel, several steps are being taken on a country-wide basis. According to the 2022 year-end review by the Ministry of New and Renewable Energy, India stands fourth globally in renewable energy installed capacity and the generation from non-fossil fuel sources is now 42.26 percent of total installed generation across India.

National Green Hydrogen Mission

The goal of the National Green Hydrogen Mission was to make India the global hub of Green Hydrogen production and export. MNRE is accordingly developing the National Green Hydrogen Mission with the objectives of decarbonising major economic sectors, making India energy independent and serving as an inspiration for the global clean energy transition.
The Ministry of Power notified provisions for facilitative open access and banking of renewable energy for Green Hydrogen production vide the Green Open Access Rules.
The Ministry undertook stakeholder consultations and put forth views at international forums on regulations for certifying Green Hydrogen and its derivative fuels.
Bilateral cooperation activities on hydrogen have been initiated with several countries including USA, Germany, France, Australia, Japan and the UK.
Task forces on hydrogen have been constituted with US and Germany and India is leading active technical cooperation on Hydrogen in the Quad. MNRE is also leading the track on hydrogen under the Energy Transition Working Group for India's G-20 presidency.
https://www.financialexpress.com/express-mobility/2022-review-key-steps-taken-to-promote-use-of-green-fuel-in-india/2929722/

Xiang Yu; Chang Tan

China's pathway to carbon neutrality for the iron and steel industry

https://doi.org/10.1016/j.gloenvcha.2022.102574

Abstract:
As a hard-to-abate sector, the iron and steel industry is responsible for 22% of China's total carbon emissions and therefore plays a crucial role in achieving China's carbon peaking and neutrality target. Nearly 90% of China's iron and steel output is produced with coal-based blast furnaces, which results in high carbon emission intensity. To peak China's carbon emissions and achieve the carbon neutrality target, it is essential to accelerate the application of breakthrough technologies such as carbon capture and storage (CCS) and hydrogen-based steel-making. This paper estimates the future CO2 emissions from China's iron and steel industry in pathways that consider the influence of different technology portfolios, technology maturity, decarbonization of power systems, and future steel production output. The results show that using currently available technology, China's iron and steel industry can reduce CO2 emissions by more than 50%. However, it cannot achieve the neutrality target without using innovative technologies. By combining conventional strategies with net-zero emission technologies such as CCS and hydrogen metallurgy, approximately 80–90% emission reduction can be achieved, thus leading to a carbon neutrality pathway, which can meet the 1.5°C targets of the carbon budget limit either. In the future, carbon emissions' reduction potential will be influenced by the decarbonization of power systems and the diffusion rate of innovative technologies. To achieve carbon neutrality, it is essential to act sooner and faster.

Qiang Yue, Xicui Chai, Yujie Zhang, Qi Wang, Heming Wang, Feng Zhao, Wei Ji & Yuqi Lu

Analysis of iron and steel production paths on the energy demand and carbon emission in China's iron and steel industry

https://doi.org/10.1007/s10668-022-02234-5

Abstract:
China's crude steel output has grown rapidly since 1990, accounting for more than half of worldwide production in 2019. Iron and steel industry (ISI) in China's energy consumption and carbon emissions accounted for a higher proportion. In the context of China's "carbon peak, carbon neutrality", the ISI attaches great importance to energy conservation and emission reduction. The BF-BOF long process is far from meeting the China's policy needs in terms of energy-saving and emission-reducing targets. Therefore, the short process of EAF based on scrap steel's recycling and direct reduced iron (DRI)'s production has attracted great attention. The e-p approach and scenarios analysis method were used to research the impact of scrap steel's recycling and DRI's production on energy demand and carbon emissions of China's ISI. By 2050, scenario 4 (30% DRI based on coal gasification–gas plus 70% scrap steel for EAF) will have the lowest energy consumption (1.79 × 1011 kgce) and scenario 3 (30% DRI based on hydrogen plus 70% scrap steel for EAF) will have the lowest carbon emissions (3.42 × 1011 kg). The results show that the short process of EAF based on scrap steel recycling and DRI is an extremely important approach for the sustainable development of China's ISI in the future.

Abdulwahab Salah, Lunan Zhang, Huaqiao Tan, Feiyang Yu, Zhongling Lang, Nabilah Al-Ansi, Yangguang Li

Advanced Ru/Ni/WC@NPC Multi-Interfacial Electrocatalyst for Efficient Sustainable Hydrogen and Chlor-Alkali Co-Production

https://doi.org/10.1002/aenm.202200332

Abstract:
Rational design and construction of a new high-efficiency hydrogen evolution electrocatalyst operating stably under high temperature, strong alkaline, and high salt conditions are the key challenges for realizing economically sustainable hydrogen generation and low energy consumption chlor-alkali co-production. Herein, according to requirements of hydrogen evolution reaction (HER) electrocatalysts under chlor-alkali electrolysis conditions, a three-component Ru/Ni/WC electrocatalyst with a weak exothermic effect for the water adsorption step (ΔHH2O = −0.12 eV), low water dissociation energy barrier (ΔGb = 0.61 eV), and close-to-zero Gibbs free adsorption energy (ΔGH* = −0.03 eV) is designed through density functional theory calculations. Under the guidance of theoretical calculations, a novel multi-interface composite electrocatalyst is successfully prepared, denoted as Ru/Ni/WC@NPC (Ru wt.% = 4.13%). In a strongly alkaline medium, Ru/Ni/WC@NPC (Ru wt.% = 4.13%) records an excellent HER electrocatalytic activity with a very low overpotential (η10 = −3 mV) at 20 °C and even demonstrates exciting HER behavior

at 90 °C (η10 = +2.8 mV). Most importantly, the electrochemical test under simulated chlor-alkali electrolysis condition demonstrates better HER performance than the industrial cathode material of commercial 20% Pt/C and low carbon steel. Generally, this study reveals a new strategy and reference for constructing effective and robust HER electrocatalysts that match with the chlor-alkali industry.

Pengfei Zhou; Pengda Niu; et al.

Anodized Steel: The Most Promising Bifunctional Electrocatalyst for Alkaline Water Electrolysis in Industry

https://doi.org/10.1002/adfm.202202068

Abstract:
Electrolysis of water, especially alkaline water electrolysis (AWE), is the most promising technology to produce hydrogen in industry. However, only 4% of the total hydrogen is produced in this way because the electrode materials are expensive, inefficient, or unstable. Here, it is reported that the large-scale 3D printed martensitic steel (AerMet100) can be the bifunctional electrode for AWE with high catalytic performance, which may dramatically increase the green-hydrogen percentage in the market and provide strategic planning for energy management. It is found that the martensitic steel by fast anodization (3 min) can realize ultra-high hydrogen and oxygen evolution reactions (HER and OER), and excellent stability at high current densities. Particularly, this electrocatalyst shows a low overpotential of 3.18 V and long-term stability over 140 h at 570 mA cm−2 in overall water splitting. Additionally, the treated large-scale steel can work well under a very high current up to 20 A. This study demonstrates that martensitic steel can be commercialized as a highly efficient catalyst for industrial hydrogen production in AWE, which should provide solutions to the energy crisis and environmental pollution.

Kewei Hu; et al.

Comparative study of alkaline water electrolysis, proton exchange membrane water electrolysis and solid oxide electrolysis through multiphysics modeling

https://doi.org/10.1016/j.apenergy.2022.118788

Abstract:
This paper provides a comparative study of alkaline water electrolysis (AE), proton exchange membrane water electrolysis (PEM) and solid oxide electrolysis cells (SOEC) through multiphysics modeling. A unified multiphysics model for the three types of electrolyzers, considering current density distribution, single-phase and diphasic flow, mass transfer and temperature dependence in the electrolyzers, is derived to make a thorough interpretation of their differences in terms of I-V characteristics, cell efficiency and part-load performances. Besides, various definitions of electrolysis efficiency from different researches on PtH are compared and evaluated from thermodynamics to unify the definitions of efficiency. Main drawbacks of the cell performances are then reviewed respectively to explain the parametric gap among three types of water electrolysis.

Yusof, Siti Nurul Akmal; et al.

Oxyhydrogen Gas Production by Alkaline Water Electrolysis and the Effectiveness on the Engine Performance and Gas Emissions in an ICEs: A Mini-Review

https://doi.org/10.37934/arfmts.97.1.168179

Abstract:
The excessive use of fossil fuels and the resultant dramatic increase in pollution levels have highlighted the need for a new sustainable and environmentally friendly fuel. Hence, it is necessary to research alternatives to reduce the use of fossil fuels and the emission of greenhouse gases. Utilising oxyhydrogen (HHO) gas has been proven to achieve high engine power output and efficiency with low emissions for spark-ignited internal combustion engines. HHO gas is generated from the electrolysis of water. This paper reviews the recent research findings related to the influencing factors on the production of HHO gas using alkaline water electrolysis involving electrolyte properties, electrolyte concentration, the distance between electrolytes, and the effects of HHO gas on the engine performance and gas emissions. Using an HHO gas blend in a diesel/gasoline engine could be a viable option for lowering GHG emissions and increasing engine efficiency.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 15

January, 2023

Indian Scientists' Found New Electrolyte That Can Help Better Ammonia Synthesis

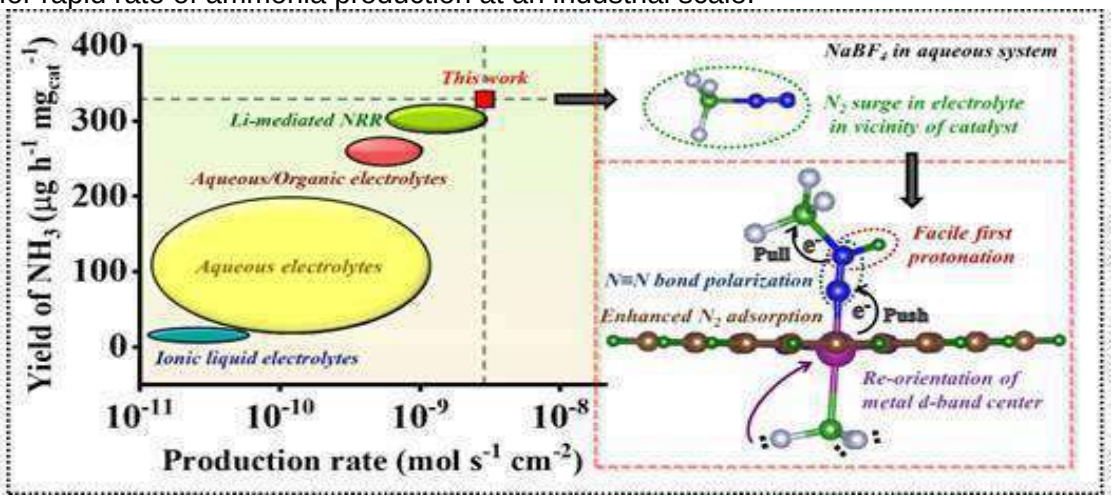
A new aqueous electrolyte that can help make electrochemical ammonia synthesis more efficient will be useful for industries producing green energy or hydrogen.

The electrochemical ammonia synthesis is largely limited by the poor solubility of nitrogen (N2) in the aqueous electrolyte environment as well as the competitive hydrogen evolution reaction. The obstacle faced was that reduction of N2 has actually occurred in the aqueous medium. In an attempt to solve these issues, the “ambient” conditions are mostly overseen. Researchers mostly work on catalyst development, while electrolyte improvisation still remains in infancy. According to a recent report, 90.7 % of the research works related to : Nitrogen reduction reaction (NRR) have focused on the suitable catalyst development, while only 4.7 % have been devoted to work on the electrolytes.

Scientists from Institute of Nano Science and Technology (INST) Mohali, an autonomous institute of Department of Science and Technology (DST), have introduced a new electrolyte called ($NaBF_4$), which not only acts as an N_2-carrier in the medium but also works as a full-fledged “co-catalyst” along with active material transition metal-doped nanocarbon (MnN4) to deliver high yield of ammonia (NH3) at absolutely ambient experimental conditions. The high production rate of NH3 approached industrial scale and exceeded almost all the standard catalysts in any other electrolyte medium. The source of NH3 was thoroughly studied and confirmed to be chiefly from the electrochemical reduction of the purged N2 gas (make it N2 saturated electrolyte to convert N2 to NH3.

This research published in the journal PNAS is a novel approach to get through the long-standing issues about the solubility of N2 in aqueous medium and achieve industrial scale production rate of ammonia by NRR at ambient condition.

This work supported by DST SERB brings an user-friendly aqueous electrolyte (NaBF4) which can encourage researchers to work more on aqueous electrolyte designing towards an even improved NRR performance of the electro catalysts. A patent has been filed for this work and the scientists are now working towards making electrolyzer for rapid rate of ammonia production at an industrial scale.



https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1888858

Lewis acid–dominated aqueous electrolyte acting as co-catalyst and overcoming N_2 activation issues on catalyst surface

Ashmita Biswas, Samadhan Kapse, Bikram Ghosh, and Ramendra Sundar Dey

Abstract:-

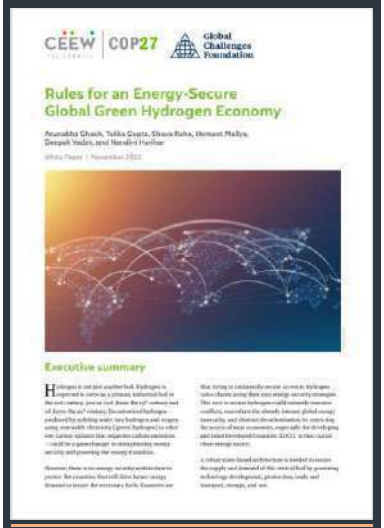
The growing demands for ammonia in agriculture and transportation fuel stimulate researchers to develop sustainable electrochemical methods to synthesize ammonia ambiently, to get past the energy-intensive Haber-Bosch process. However, the conventionally used aqueous electrolytes limit N2 solubility, leading to insufficient reactant molecules in the vicinity of the catalyst during electrochemical nitrogen reduction reaction (NRR). This hampers the yield and production rate of ammonia, irrespective of how efficient the catalyst is. Herein, we introduce an aqueous electrolyte (NaBF4), which not only acts as an N2-carrier in the medium but also works as a full-fledged “co-catalyst” along with our active material MnN4 to deliver a high yield of NH3 (328.59 μg h−1 mgcat−1) at 0.0 V versus reversible hydrogen electrode. BF3-induced charge polarization shifts the metal d-band center of the MnN4 unit close to the Fermi level, inviting N2 adsorption facilely. The Lewis acidity of the free BF3 molecules further propagates their importance in polarizing the N≡N bond of the adsorbed N2 and its first protonation. This push-pull kind of electronic interaction has been confirmed from the change in d-band center values of the MnN4 site as well as charge density distribution over our active model units, which turned out to be effective enough to lower the energy barrier of the potential determining steps of NRR. Consequently, a high production rate of NH3 (2.45 × 10−9 mol s−1 cm−2) was achieved, approaching the industrial scale where the source of NH3 was thoroughly studied and confirmed to be chiefly from the electrochemical reduction of the purged N2 gas.

https://doi.org/10.1073/pnas.2204638119

RECENT WHITE PAPER:-

Rules for an Energy-Secure Global Green Hydrogen Economy

Arunabha Ghosh, Tulika Gupta, Shuva Raha, Hemant Mallya, Deepak Yadav, and Nandini Harihar



Hydrogen is not just another fuel. Hydrogen is expected to serve as a primary industrial fuel in the 21st century, just as coal drove the 19th century and oil drove the 20th century. A robust rules-based architecture is needed to secure the supply and demand of this critical fuel by governing technology development, production, trade and transport, storage, and use.

In a decarbonised world, hydrogen must be accessible to all markets, affordable for retail and industrial consumers, available at scale to bridge the emissions gap, and acceptable as a reliable fuel source.

https://images.hindustantimes.com/images/app-images/2023/ceew-research-on-hydrogen-decarbonisation-and-energy-secure-green-hydrogen-economy.pdf

China launches Asia's first semi high-speed hydrogen train, gets 600 km range

China's CRRC Corporation Ltd. recently unveiled its first hydrogen urban train, which happens to be Asia's first hydrogen train. The hydrogen train gets a top speed of 160 km/h, and the operational range without refueling is 600 km (the record of 1175 km has been set this September by Coradia iLint serial train of Alstom in Germany). On the other hand, India is also moving fast to make its first-ever indigenous Hydrogen trains. As per various statements given by Railway Minister Ashwini Vaishnaw, India will most likely get its first hydrogen train by 2023.



https://zeenews.india.com/railways/china-launches-asias-first-semi-high-speed-hydrogen-train-gets-600-km-range-2556609.html

Germany's energy crisis powers hydrogen switch

From the moment Russian gas exports to Germany were first disrupted in June, German firm Kelheim Fibers began casting around for alternative options to keep its engines running.

As a result, the Bavarian-based firm, whose fibres are used in anything from teabags to tampons, will be able to use heating oil instead of gas starting mid-January.

The downside is that will increase carbon emissions and for longer term, the firm is considering a switch to hydrogen, which is a much cleaner energy source provided it is produced using renewable power.



https://auto.economictimes.indiatimes.com/news/oil-and-lubes/germanys-energy-crisis-powers-hydrogen-switch/96617992

CP Moving into a Hydrogen Powered Future

Canadian Pacific's experimental hydrogen-powered locomotive has successfully completed its first revenue run in Calgary, Alberta, marking a significant step towards potentially replacing diesel-electric locomotives with the technology.

The locomotive, called H2 0EL, or "hydrogen zero-emissions locomotive," uses hydrogen fuel cells and batteries to power its electric traction motors and made the run on October 28th. Canadian Pacific is using solar power to produce hydrogen at its Calgary headquarters and has a separate facility in Edmonton. The company is partnering with the Alberta government to build two more locomotives and expects to have them operating in Calgary, Edmonton, and Vancouver by the end of next year.



https://www.netnewsledger.com/2023/01/02/cp-moving-into-a-hydrogen-powered-future/

Looking to the New Year: North Dakota's Hydrogen Hub

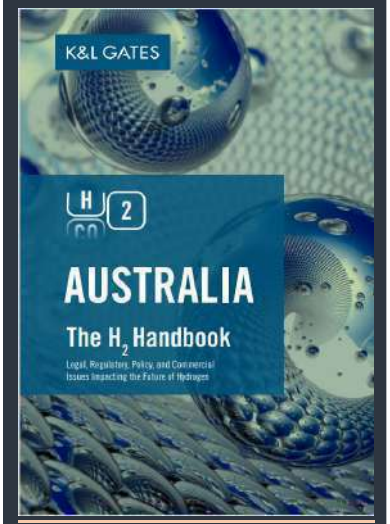
North Dakota Governor Doug Burgum announced this Fall, he has signed a memorandum of understanding with the governors of Minnesota, Montana and Wisconsin to develop a regional clean hydrogen hub to help meet the nation's clean energy, transportation, and agricultural needs. And this year, our state plans to develop this more. North Dakota, through the University of North Dakota in Grand Forks, will lead the effort for all four states. The states also agree to identify opportunities to collaborate with tribal nations. The Department of Energy says it aims to select six to 10 hydrogen hubs, with applications due by April 7 of this year. According to the state, North Dakota has a lot of ways to develop hydrogen, and we have only just begun.

https://www.kxnet.com/news/local-news/looking-to-the-new-year-north-dakotas-hydrogen-hub/

Handbooks-

AUSTRALIA: The H2 Handbook

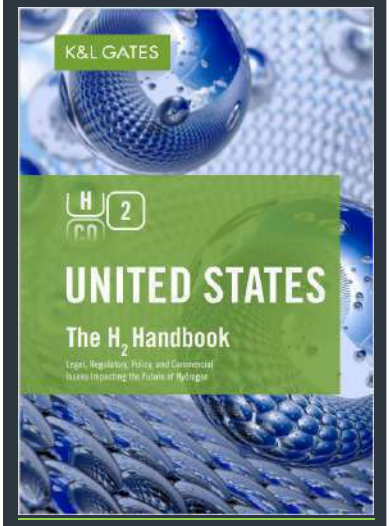
Legal, Regulatory, Policy, and Commercial Issues Impacting the Future of Hydrogen



https://marketingstorageragrs.blob.core.windows.net/webfiles/Hydrogen-Handbook-AUSTRALIA.pdf

United States: The H2 Handbook

Legal, Regulatory, Policy, and Commercial Issues Impacting the Future of Hydrogen



https://marketingstorageragrs.blob.core.windows.net/webfiles/Hydrogen-Handbook-UNITEDSTATES.pdf

Equinor and RWE to build hydrogen supply chain for German power plants

OSLO: Equinor and RWE said they planned to develop an industrial value chain for the production and use of low-carbon hydrogen, allowing Germany to reduce its reliance on coal power and thus cut CO2 emissions.
The two companies plan to build new power plants in Germany that will initially be fuelled by natural gas and later with hydrogen made in Norway from natural gas at jointly-constructed production facilities.



https://energy.economictimes.indiatimes.com/news/oil-and-gas/equinor-and-rwe-to-build-hydrogen-supply-chain-for-german-power-plants/96761553

Arkansas, Louisiana and Oklahoma encouraged to submit full application for regional clean hydrogen hubs program

The three governors established the HALO Hub, a bipartisan, three-state partnership between Arkansas, Louisiana and Oklahoma, in March of 2022 to compete for funding outlined in IIJA.
The program will appropriate up to $7 billion to DOE to develop six to 10 regional clean hydrogen hubs demonstrating the production, processing, delivery, storage, and end-use of clean hydrogen.
DOE's ultimate goal is to create a network of clean hydrogen producers, potential consumers and connective infrastructure located in close proximity that ultimately intersects and remains sustainable after DOE grants expire. The DOE application process includes two phases – the first of which was an initial broad concept pitch, due to DOE in early November.
https://www.poandpo.com/news_business/arkansas-louisiana-and-oklahoma-encouraged-to-submit-full-application-for-regional-clean-hydrogen-hubs-program/

Element 2 and Tower Group partner to bring hydrogen to south west England

The partnership connects Tower Group's locally produced green hydrogen with the infrastructure required to supply fuel to hydrogen-powered vehicles, including trucks and vans. Tower Group announced plans in late 2022 to establish hydrogen hubs in three key locations in Devon and Cornwall as part of work to develop a new hydrogen ecosystem in the South West, including sites along the critical M5 motorway and A30 trunk roads. The hydrogen hubs will have the capacity for long-term energy storage and Element 2 will provide end-to-end systems for offtakes of Tower Group-produced hydrogen as part of the agreement.
https://evfleetworld.co.uk/element-2-and-tower-group-partner-to-bring-hydrogen-to-south-west-england/

Vertex, Pilkington UK sign low carbon hydrogen supply pact

Vertex Hydrogen has signed a 'Heads of Terms' offtake agreement for low carbon hydrogen with Merseyside glass manufacturer Pilkington UK.
St Helens' Pilkington United Kingdom Limited, part of the NSG Group, has led the flat glass sector in the switch towards low carbon fuels, completing two world-first trials of hydrogen being fired in a glass furnace. "The agreement sets Vertex up to supply Pilkington UK with hydrogen as the manufacturer continues to develop low-carbon ways of manufacturing glass," the company said in a statement.
https://www.livemint.com/industry/energy/vertex-pilkington-uk-sign-low-carbon-hydrogen-supply-pact-11672846189021.html

Abu Dhabi Sustainability Week Hosts First Green Hydrogen Summit in Year of Climate Action for UAE

Abu Dhabi Sustainability Week (ADSW), the global initiative championed by the UAE and its clean energy powerhouse Masdar to accelerate sustainable development, will hold its first annual Green Hydrogen Summit this year, highlighting green hydrogen's growing importance in the global drive toward net zero.
https://www.gulftoday.ae/business/2023/01/03/adsw-to-host-first-green-hydrogen-summit-this-year

REPORT:-

Towards a Clean Hydrogen Ecosystem: Opportunities for Indo–Dutch Cooperation



TERI and Netherlands Innovation Network developed this report, which maps the opportunities and challenges for Indo-Dutch collaborations in the clean hydrogen sector. This report provides a broad overview of the current and future scenario of generation, supply, storage & handling and demand for hydrogen in India. It covers the supply situation of hydrogen in India and also assesses the potential of generating hydrogen through various resources. The report then covers progress made by Dutch stakeholders in developing hydrogen-related technologies and projects. Finally, the report focuses on identifying the opportunities for collaborative work possible.

https://www.teriin.org/sites/default/files/2022-07/Towards-a-Clean-Hydrogen-Ecosystem-report.pdf

Railways to run Hydrogen-powered trains on heritage routes

As part of the "green train" initiative, the Railway Ministry is working on a plan to convert all heritage trains into eco-friendly Green Hydrogen-powered trains.

At present 8 heritage trains, which is being operated by railways in different parts of the country. These trains currently run on either steam or diesel engines. "The Railways plans to convert these trains into Green Hydrogen-powered trains. This is part of the railways green initiative," Railway Minister Ashwini Vaishnaw, said here.



https://www.deccanherald.com/national/railways-to-run-hydrogen-powered-trains-on-heritage-routes-1177703.html

NTPC starts India's first green hydrogen blending operation in PNG network

State-owned power giant NTPC said it has started India's first green hydrogen blending operation in the PNG (piped natural gas) network of its township in Kawas, Surat.

"The project is a joint effort of NTPC and Gujarat Gas Limited (GGL). The first molecule of green hydrogen from the project was set in motion by P Ram Prasad, Head of Project, Kawas, in presence of other senior executives of NTPC Kawas and GGL," a company statement said. The green hydrogen blending has been started in the piped natural gas (PNG) network of NTPC Kawas township in Surat, it added.



https://www.zeebiz.com/companies/news-ntpc-starts-indias-first-green-hydrogen-blending-operation-in-png-network-215682

Cabinet approves National Green Hydrogen Mission with outlay of Rs 19,744 cr

The Union Cabinet, headed by Prime Minister Narendra Modi approved an initial outlay of Rs 19,744 crore for the National Green Hydrogen Mission in a bid to cut emissions and become a major exporter in the field. “The Mission aims to reduce 50 million metric tonnes of carbon dioxide emission per annum, save Rs 1 lakh crore in fossil fuel imports, set up 125 GW of RE capacity for this Mission, create 6 lakh jobs, and bring over Rs 8 lakh crore of total investment by 2030," said Union Minister Anurag Thakur in the Cabinet briefing. He added that 60-100 GW of electrolyser capacity will also be set up by 2030. To encourage manufacturing of low-cost equipment & technologies, two types of incentives will be given - incentives will be given on electrolyser manufacturing for 5 years and incentive on production of green hydrogen. Green hydrogen hubs will also be developed, said Thakur.



https://energy.economictimes.indiatimes.com/news/renewable/cabinet-approves-national-green-hydrogen-mission-to-attract-rs-8-lakh-cr-investments-by-2030/96738234

Government panel to take call on minimum purchase of green hydrogen by key sectors

The Centre is likely to set up an empowered committee or a group of secretaries to determine the mandatory green hydrogen purchase trajectory for refineries, fertiliser firms and city gas distribution companies.

The committee will determine the phase-wise minimum mandatory purchase of green hydrogen by various sectors keeping in mind feasibility and demand concerns, besides overall energy security considerations.

https://economictimes.indiatimes.com/industry/renewables/government-panel-to-take-call-on-minimum-purchase-of-green-hydrogen-by-key-sectors/articleshow/96746092.cms

Hanyu Li; Ranming Niu; et al.

Hydrogen in pipeline steels: Recent advances in characterization and embrittlement mitigation

https://doi.org/10.1016/j.jngse.2022.104709

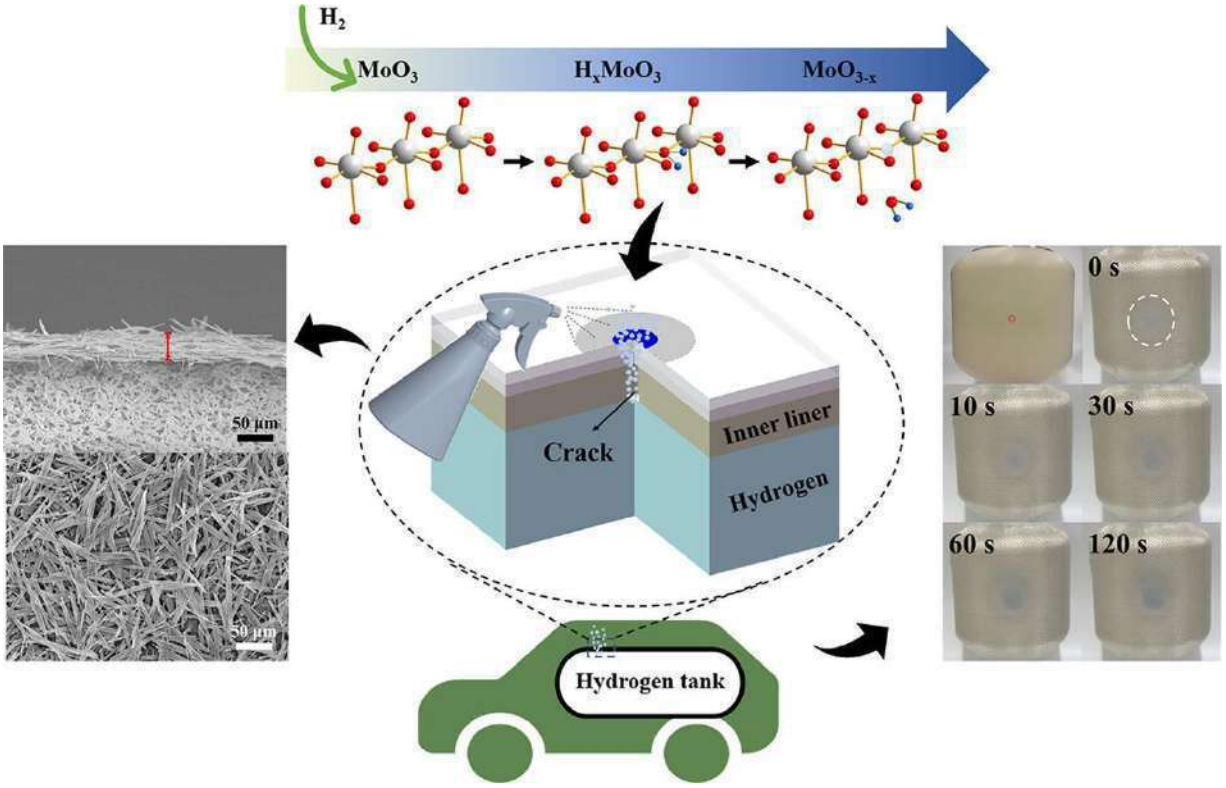
Abstract:
Hydrogen is a carbon-free fuel that can facilitate the progress of achieving net-zero emission. The use of the existing natural gas pipelines for hydrogen transport is an essential strategy to reduce the investment required for hydrogen distribution. However, gas transmission pipelines are generally comprised of steels that are susceptible to hydrogen embrittlement (HE). The failure of steel pipes can result in hydrogen leakage, which could lead to serious incidents. This review article aims to provide an overview of HE-related problems in pipeline steels, with specific emphasis on hydrogen behaviors, hydrogen embrittlement and related characterizations, and mitigation strategies.

Xiaolu Sun; Lifeng Hao; Liuyang Chen; et al.

Spray deposition of colorimetric H2 detector with Pd/MoO3 nanocomposites for rapid hydrogen leakage monitoring at room temperature

https://doi.org/10.1016/j.apsusc.2022.153878

Abstract:
Here, we demonstrate a rapidly responsive colorimetric hydrogen detector based on Pd/MoO3 nanocomposites for hydrogen leakage monitoring at room temperature. The Mo5+-rich MoO3 nanobelts are synthesized via a simple one-step hydrothermal method by adding NaCl as the mineralizer. The structure of the detector is fabricated by a general spray deposition technique, not only forming uniform porous microstructures to promote the adsorption and diffusion of H2 but also solving the issue of performance degradation in ambient conditions by the strategy of on-site fabrication for immediate detection. The detector exhibits a rapid color change which could be recognized with naked eyes within 10 s even in as low as 1% of H2 at room temperature (25 °C) owing to the high content of active absorption sites (Mo5+) and the large surface area. The detector is also tested on a hydrogen storage tank with a prefabricated defect in the inner liner and exhibits a prompt and intense color change at the exact hydrogen leakage site, demonstrating its high efficiency in the visual hydrogen leakage detection in complicated systems. The facile fabrication approach as well as the rapid visual detection strategy enable the detector extensively applicable in the hydrogen industry.

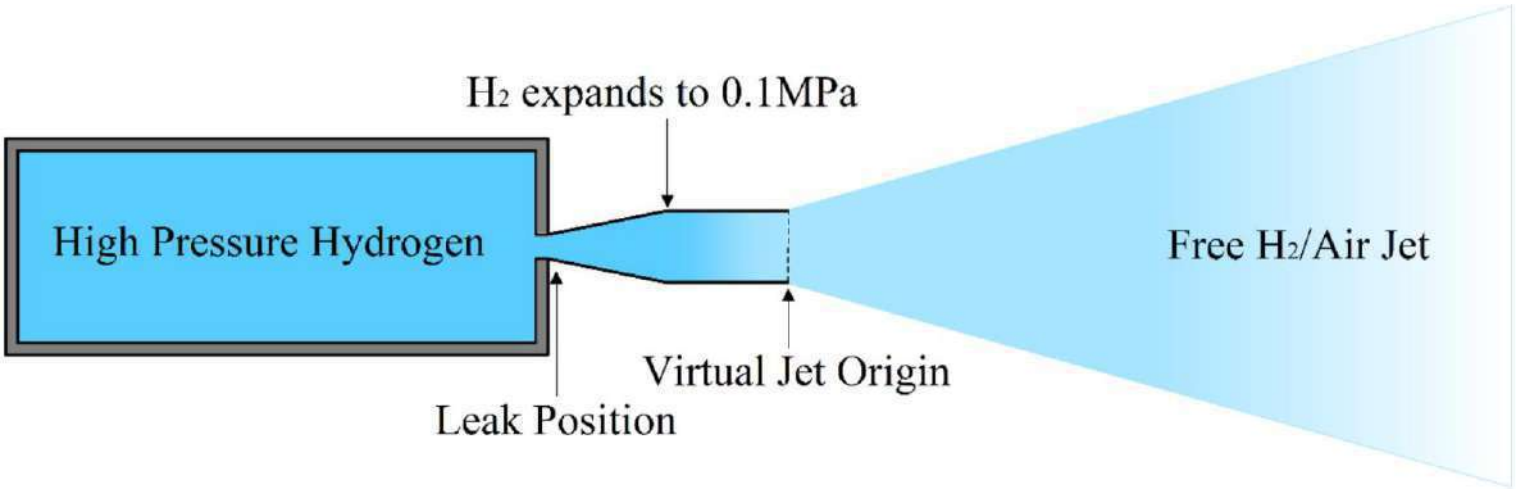


Hao Li; Xuewen Cao; Yang Liu; et al.

Safety of hydrogen storage and transportation: An overview on mechanisms, techniques, and challenges

https://doi.org/10.1016/j.egyr.2022.04.067

Abstract:
The extensive usage of fossil fuels has caused significant environmental pollution, climate change and energy crises. The significant advantages of hydrogen, such as cleanliness, high efficiency, and a wide range of sources, make it quite promising. Hydrogen is prone to material damage, which may lead to leakage. High-pressure leaking hydrogen is highly susceptible to spontaneous combustion due to its combustion characteristics, which may cause jet fire or explosion accidents, resulting in serious casualties and property damage. This paper presents a detailed review of the research progress on hydrogen leak diffusion characteristics, leak spontaneous combustion mechanisms and material hydrogen damage mechanisms from the perspectives of theoretical analysis, experiments and numerical simulations. This review points out that although a large number of research results have been obtained on the safety characteristics of hydrogen, there are still some deficiencies and limitations. Further research topics are clarified, such as further optimizing the kinetic mechanism of the high-pressure hydrogen leakage reaction and turbulence model, exploring the expansion and dilution law of hydrogen clouds after liquid hydrogen flooding, further studying the spontaneous combustion mechanism of leaked hydrogen and the interaction between mechanisms, and investigating the synergistic damage effect of hydrogen and other components on materials. The leakage spontaneous combustion process in open space, the development process of the bidirectional effect of hydrogen jet fuel and crack growth under the impact of high-pressure hydrogen jet fuel on the material may need to be explored next.



Wenhao Yuan; Jingfeng Li; et al.

Numerical investigation of the leakage and explosion scenarios in China's first liquid hydrogen refueling station

https://doi.org/10.1016/j.ijhydene.2022.04.060

Abstract:
Promoting fuel cells has been one of China's ambitious hydrogen policies in the past few years. Currently, several hydrogen fueling stations (HRSs) are under construction in China to fuel hydrogen-driven vehicles. In this regard, it is necessary to assess the risks of hydrogen leakage in HRSs. Aiming at conducting a comprehensive consequence assessment of liquid hydrogen (LH2) leakage on China's first liquid hydrogen refueling station (LHRS) in Pinghu, a pseudo-source model is established in the present study to simulate the LH2 leakage using a commercial CFD tool, FLACS. T he effects of the layout of the LHRS, leakage parameters, and local meteorological conditions on the LH2 leakage consequence has been assessed from the perspectives of low-temperature hazards and explosion hazards. The obtained results reveal that considering the prevailing southeast wind in Pinghu city, the farthest low-temperature hazard distance and lower flammable limit (LFL) -distance occurs in the leakage scenario along the north direction. It is found that the trailer parking location in the current layout of the LHRS will worsen the explosion consequences of the LH2 leakage. Moreover, the explosion will completely destroy the control room and endanger people on the adjacent road when the leakage equivalent diameter is 25.4 mm. The performed analyses reveal that as the wind speed increases, the explosion hazard decreases.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

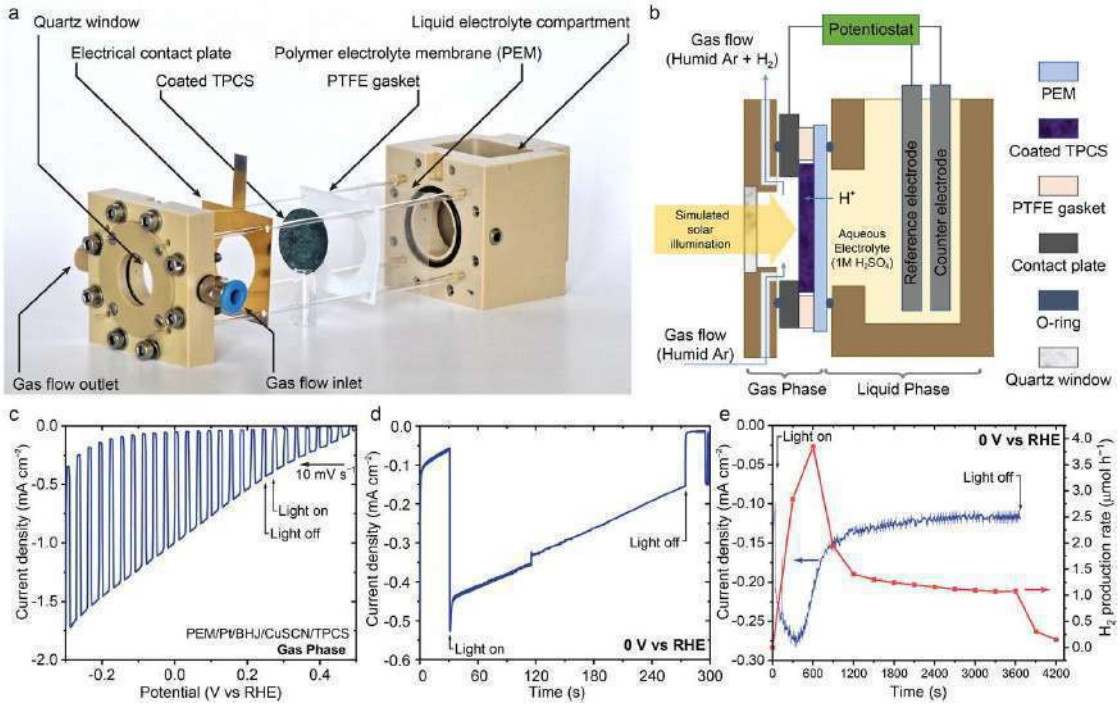
ISSUE. 16

January, 2023

Solar-powered artificial leaf produces hydrogen fuel out of thin air

Similar to photosynthesis, the process harvests water from the air to produce hydrogen gas.

In their search for renewable fossil-free fuels, Kevin Sivula's team of chemical engineers at the Ecole Polytechnique Federale de Lausanne (EPFL), in collaboration with Toyota Motor Europe, took inspiration from the way plants are able to convert sunlight into chemical energy using carbon dioxide from the air in the phenomenon known as photosynthesis. The engineers invented a solar-powered artificial leaf that is capable of harvesting water from the air for conversion into hydrogen fuel. The results are published in the latest issue of Advanced Materials.



Their ingenious yet simple system combines semiconductor-based technology with novel gas diffusion electrodes, which have two key characteristics: they are porous, to maximise contact with water in the air; and transparent, to maximise sunlight exposure of the semiconductor coating. Instead of building electrodes with traditional layers that are opaque to sunlight, their substrate is actually a 3D mesh of felted glass fibre. When the transparent electrodes are coated with a light-harvesting semiconductor material, they do indeed act like an artificial leaf, harvesting water from the air and sunlight to produce hydrogen gas. The sunlight's energy is stored in the form of hydrogen bonds.

"Developing our prototype device was challenging since transparent gas diffusion electrodes have not been previously demonstrated, and we had to develop new procedures for each step," said Marina Caretti, the lead author of the work.

The scientists built a small chamber containing the coated wafer and a membrane to separate the hydrogen gas produced for measurement. When the chamber is exposed to sunlight under humid conditions, hydrogen gas is produced.

Solar-powered artificial leaf produces hydrogen fuel out of thin air - Frontline (thehindu.com)

Transparent Porous Conductive Substrates for Gas-Phase Photoelectrochemical Hydrogen Production

Marina Caretti; Elizaveta Mensi; Kevin Sivula; et al.



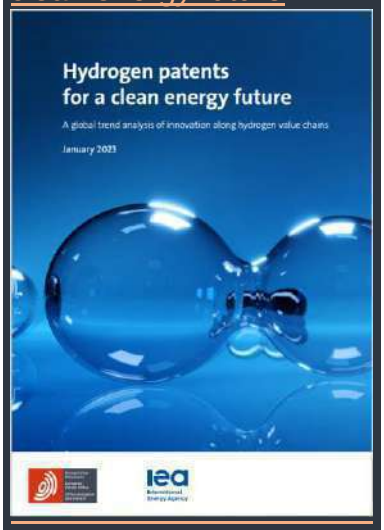
Abstract:-

Gas diffusion electrodes are essential components of common fuel and electrolysis cells but are typically made from graphitic carbon or metallic materials, which do not allow light transmittance and thus limit the development of gas-phase based photoelectrochemical devices. Herein, the simple and scalable preparation of F-doped SnO2 (FTO) coated SiO2 interconnected fiber felt substrates is reported. Using 2–5 μm diameter fibers at a loading of 4 mg cm−2, the resulting substrates have porosity of 90%, roughness factor of 15.8, and Young's Modulus of 0.2 GPa. A 100 nm conformal coating of FTO via atmospheric chemical vapor deposition gives sheet resistivity of 20 ± 3 Ω sq−1 and loss of incident light of 41% at illumination wavelength of 550 nm. The coating of various semiconductors on the substrates is established including Fe2O3 (chemical bath deposition), CuSCN and Cu2O (electrodeposition), and conjugated polymers (dip coating), and liquid-phase photoelectrochemical performance commensurate with flat FTO substrates is confirmed. Finally, gas phase H2 production is demonstrated with a polymer semiconductor photocathode membrane assembly at 1-Sun photocurrent density on the order of 1 mA cm−2 and Faradaic efficiency of 40%.

https://onlinelibrary.wiley.com/doi/10.1002/adma.202208740

RECENT REPORT:-

Hydrogen patents for a clean energy future



1. Global patenting in hydrogen is led by Europe and Japan, with the US losing ground in the period 2011–2020 and hydrogen-related innovation from R. Korea and P.R. China only starting to emerge at the international level.
2. Innovation in established hydrogen technologies is dominated by the European chemical industry, but the new hydrogen patenting heavyweights are companies from the automotive and chemicals sectors focusing on electrolysis and fuel cell technologies.
3. While hydrogen production remains almost entirely fossil fuel-based, patenting has already seen a major shift towards alternative, low-emission methods. This shift anticipates a boom for electrolysers, a field in which Europe has gained an edge in new manufacturing capacity.
4. The uneven trends in hydrogen-related patenting across technologies and regions indicate opportunities for policy action to help realise a net zero emissions future.

Hydrogen patents for a clean energy future – Analysis - IEA

China has set its sights on cornering hydrogen, another green energy market

As the world sprints to decarbonise, the next round of competition revolves around a device called an electrolyser. Companies around the world are already revving up electrolyser production, green hydrogen plants are under construction, and the industry is finally making the leap from pilot projects to industrial scale. BloombergNEF, a clean energy research group, estimates worldwide electrolyser production will need to grow 91 times by 2030 to meet demand. But many Western clean tech veterans eye the emerging competition with a queasy feeling of déjà vu. More than 40 per cent of all electrolysers made today come from China.

https://www.deccanherald.com/business/business-news/china-has-set-its-sights-on-cornering-hydrogen-another-green-energy-market-1179502.html

Spain's govt to approve green hydrogen projects regulation in Spain

Spanish Prime Minister Pedro Sanchez said his cabinet will approve a new decree to regulate the first four out of 11 green hydrogen projects to be carried out in the country.
In a speech in Madrid, Sanchez said his government will approve a 74 million-euro ($79.12 million) initial subsidy for those projects. The Prime Minister stressed that as much as 20% of the world's green hydrogen projects are located in Spain.

https://www.reuters.com/world/europe/spains-govt-approve-tues"on"-green-hydrogen-projects-regulation-spain-2023-01-09/

Tata Motor's Mission 2045: Electric, flex-fuel and hydrogen ICE

After lining up an ambitious target of achieving net-zero emissions by 2045, Tata Motors said that the company is betting big on three technologies — battery electric, hydrogen fuel cell, and hydrogen internal combustion engine (ICE) — to achieve this target.
The company is also planning to achieve a 100 per cent renewable energy goal by the end of this decade.

https://www.business-standard.com/article/automobile/electric-hydrogen-fuel-cell-top-tata-s-roadmap-to-meet-2045-target-123011201213_1.html

S11 Hydrogen-Powered Flying Race Car Showcases New Design, To Take Flight in Late 2023

French startup MACA returned to the Consumer Electronics Show (CES) in Las Vegas this year to showcase an updated S11 hydrogen-powered flying race car and share the news on when it is scheduled to take flight.
People stuck in traffic would often daydream of driving a flying car to get them to their destination without the hassle and stress of sitting idle for hours in their vehicles.



https://www.ibtimes.com/s11-hydrogen-powered-flying-race-car-showcases-new-design-take-flight-late-2023-3653076

Europe leads the pack on hydrogen technology innovation

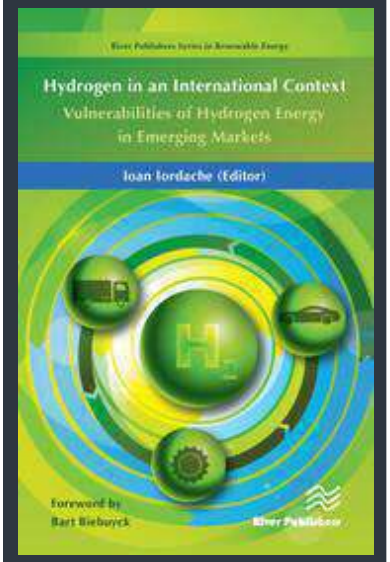
"Global patenting in hydrogen is led by Europe and Japan, with the US losing ground in the period 2011–2020," reads a report released by the European patent office (EPO) on 10th Jan.
Patents are temporary protections of intellectual property designed to reward research and development – patent filings are often used to understand the degree of innovation in a market.
Meanwhile, "hydrogen-related" innovations from South Korea and China are "only starting to emerge at the international level," it adds.



https://www.euractiv.com/section/energy-environment/news/europe-leads-the-pack-on-hydrogen-technology-innovation/

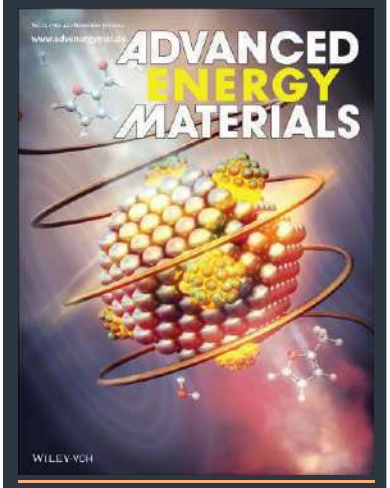
RECENT BOOKS-

Hydrogen in an International Context



ISBN- 9781003338482

https://doi.org/10.1201/9781003338482



Selective Hydrodeoxygenation

In this article, Alexis Bordet and co-workers deposited copper at the surface of ferromagnetic iron carbide nanoparticles (ICNPs) to produce a multifunctional catalytic system adaptive to an intermittent energy supply. The resulting Cu@ICNPs material can be heated by magnetic induction in an extremely rapid and localized manner, enabling the selective hydrodeoxygenation of aromatic aldehydes to aromatic alkanes under very mild conditions (100 °C, 3 bar H2).

https://onlinelibrary.wiley.com/toc/16146840/2022/12/42

INDUSTRY NEWS

Zhangjiakou's hydrogen buses popular after Games

Nearly a year after Zhangjiakou, Hebei province, co-hosted the Beijing 2022 Winter Olympic Games, 444 hydrogen-powered buses have become the preferred mode of public transportation in the city.

First used during the Olympics, the buses are able to start quickly in winter temperatures as low as -30 C in the city, which is located about 160 kilometers north of Beijing.



https://www.chinadaily.com.cn/a/202301/11/WS63be1360a31057c47eba8e98.html

Port of Corpus Christi could see potential to become a hydrogen hub

The Port of Corpus Christi has been invited by the federal government to apply to be a hydrogen hub. The hubs promote hydrogen production and create infrastructure for processing, storage, and use of clean hydrogen. Proponents believe that a hydrogen fuel cell used in an electric motor is two-to-three times more efficient than gasoline. Port of Corpus Christi Authority Chief Strategy Officer Jeffrey Pollack said that if everything goes according to plan, the city could see bright economical prospects.

https://www.kiiitv.com/article/news/local/port-of-corpus-christi-could-see-potential-to-become-a-hydrogen-hub/503-937275c0-40b1-4318-83c9-2812e9f9ea59

Topsoe and Fidelis New Energy form Carbon Neutral Hydrogen Technology Alliance

Topsoe A/S ("Topsoe") and Fidelis New Energy, LLC ("Fidelis") have entered into a global alliance for technology used for producing carbon neutral hydrogen. The alliance pairs Topsoe's hydrogen process portfolio with FidelisH2â„¢ technology for reduction of lifecycle carbon emissions in hydrogen production. Combined, the alliance solution enables the production of hydrogen from natural gas with a lifecycle carbon intensity of 0 kgCO2e / kgH_2.

https://news.webindia123.com/news/press_showdetailsPR.asp?id=1298843&cat=PR%20News%20Wire

Octopus Hydrogen, Greenergy Flexigrid partner to deliver green hydrogen to UK customers

Octopus Hydrogen and Greenergy Flexigrid have agreed and logistics partnership to see green hydrogen delivered to Octopus' UK customers.

Utilising NanoSUN mobile refueling units, Greenergy will transport Octopus produced green hydrogen to customer sites to allow storage and dispensing.

Having already completed the first delivery of the new partnership last month (December 2022), to Scottish bus manufacturer, Alexander Dennis, which H2 View understands is testing zero-emission buses, the companies have said further deliveries will take place in 2023.

https://www.h2-view.com/story/octopus-hydrogen-greenergy-flexigrid-partner-to-deliver-green-hydrogen-to-uk-customers/

Sisco Sapena launches H_2PLT, the company behind Spain's first green hydrogen microgeneration network

H2PLT, a new renewable energy company based on green hydrogen and solar energy, just began operations to create Spain's first green hydrogen micro generation network.

Founded by the entrepreneur Sisco Sapena, president and founder of the public company Lleida.net, H2PLT has developed a proprietary model that allows innovative uses of hydrogen in underdeveloped applications, such as its use as a vector for reel electrification and application in electro-power stations or hydro generators. The company seeks to promote electrified mobility and its innovative uses through "H2aX" applications and the development of small photovoltaic power plants dedicated exclusively to the generation of green hydrogen, through a model that can be replicated in a modular way in different parts of Spain and Europe.

https://www.tmcnet.com//usubmit/2023/01/11/9741257.htm

World Economic Forum

Hydrogen's star is rising as a clean energy transition fuel

Clean hydrogen is a powerful tool which can support different countries' unique needs, compliment natural endowments and interconnect regions, as reflected by 26 countries issuing national hydrogen policies. Due to hydrogens flexibility, ability to decarbonize hard-to-abate sectors, provide energy security, and redistribute renewable energy across geographies there are 680 projects in the pipeline, with each geographical region playing a key role. For example, Europe is home to 30% of hydrogen investment, whilst North America operates 80% of the global low carbon hydrogen capacity. Meanwhile, South Korea and Japan are essential in supporting the supply chain, having produced half the global fuel cell manufacturing capacity.

If all current projects are brought online, by 2030, low-carbon hydrogen capacity could reach 16-24 Mt annually, with green hydrogen from electrolysers accounting for 9-14 Mt and blue hydrogen accounting for between 7-10 Mt.

In 2022, year-on-year annual electrolyser capacity doubled to reach 8 gigawatts.

f all the new projects announced by industry are brought to life, this could reach 60 gigawatts annually by 2030. And if this happens alongside the planned scale-up in manufacturing capacities, the cost of electrolysers could fall by 70% by 2030, compared with 2022 prices

https://www.weforum.org/agenda/2023/01/hydrogen-clean-energy-

TGBL to extract Green Hydrogen from biomass and waste in Pune plant

TheGreenBillions Limited (TGBL), a company that deals in sustainable initiatives, announced it has partenered with Pune Municipal Corporation (PMC) to set up first plant in India to extract green hydrogen from biomass and municipal solid waste.

TGBL's wholly-owned subsidiary Variate Pune Waste to Energy (VPWTEPL) will manage and utilize the municipal solid waste of 350 TPD of Pune for generating hydrogen for a period of 30 years. The company is discussing with other state municipalities in India to set up similar plants.



https://energy.economictimes.indiatimes.com/news/renewable/tgbl-to-extract-green-hydrogen-from-biomass-and-waste-in-pune-plant/96867994

Auto Expo 2023: Glimpse of the Hydrogen Powered Vehicles

India's motor show is returning after a gap of three years inaugurated by Nitin Gadhkari. At least 75 launches are expected at the Auto Expo 2023, taking place at the India Expo Mart in Greater Noida. Five global launches are also set to take place.

Toyota has showcased hydrogen vehicles Corolla Cross and Toyota Mirai. The concept of Corolla Cross highlights a unique configuration where the internal combustion engine will be calibrated to take hydrogen gas as the fuel source to produce power. MG has taken the covers off a new hydrogen fuel cell electric vehicle (FCEV), called the Euniq 7. The FCEV people carrier has a 6.4kg hydrogen tank, offering a range of up to 605km. Tata Motors showcased hydrogen powered truck Prima E.55S. Hyundai also unveiled SUV (Sport Utility Vehicle) NEXO.

https://www.hindustantimes.com/car-bike/auto-expo-2023-foreign-carmakers-to-focus-on-ev-market-in-india-101673412325605.html

Sterling & Wilson Group together plans to foray into EV gear, hydrogen gensets

Sterling & Wilson Group-promoted Sterling Turbines plans to enter manufacturing of hydrogen engine gen-sets, electrolyzers and EV charging gear, as the development of the corporate target by means of home in addition to export markets in these segments.

Sterling Turbines has one of Asia's largest diesel generator manufacturing vegetation at Silvassa, Dadra & Nagar Haveli, unfolding over 10.25 acres. This facility shall be used to develop enterprise within the new segments.

https://www.siliconindia.com/news/general/sterling--wilson-group-together-plans-to-foray-into-ev-gear-hydrogen-gensets-nid-220930-cid-1.html

Reliance, Adani may bid for Modi's Rs 20,000 crore green hydrogen mission, India to open bidding by May

India will by May invite bids for subsidies for setting up green-hydrogen manufacturing and utilisation hubs, fertiliser and steel plants based on the fuel, and factories for making electrolysers, two government sources told Reuters. The bidding process is part of a first phase of a $2 billion incentive plan announced last week to boost use of green hydrogen to cut emissions and make India a major exporter in the field.

https://www.financialexpress.com/industry/reliance-adani-may-bid-for-modis-rs-20000-crore-green-hydrogen-mission-india-to-open-bidding-by-may/2944679/

Petroleum & natural gas sector to drive growth of green hydrogen in India: Hardeep Puri

Union minister Hardeep Singh Puri said the petroleum and natural gas sector will drive the growth of green hydrogen in the country as industry players will produce and consume the clean energy source for multiple purposes. The Minister of Petroleum and Natural Gas also said that oil marketing companies(OMCs) have been directed to prepare a plan in the field of green hydrogen, which he said will be submitted to the Prime Minister's Office very soon.

The minister made the remarks while addressing reporters on the sidelines of '11th CII Bio-Energy Summit' in the national capital.

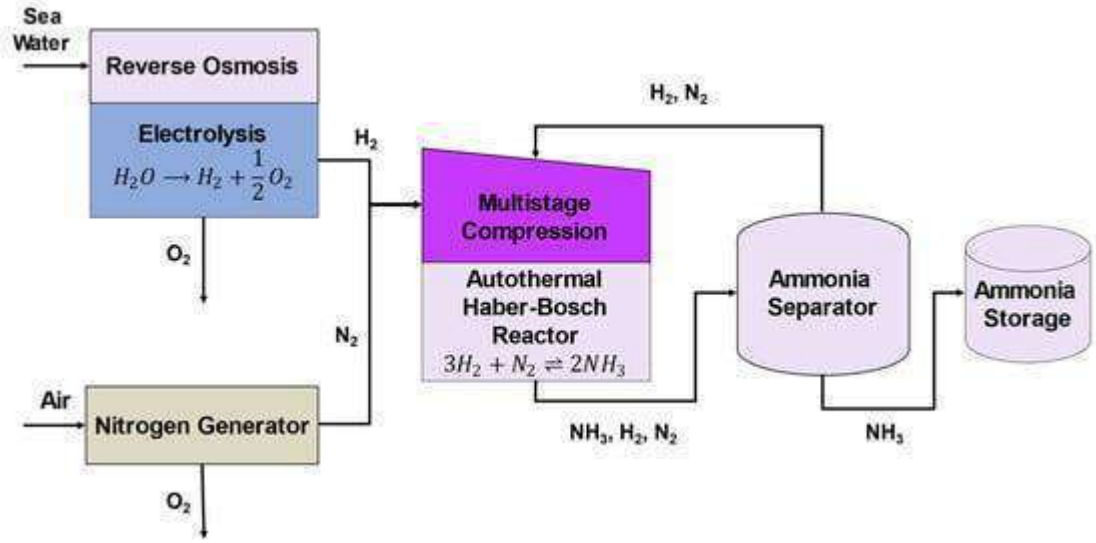
https://energy.economictimes.indiatimes.com/news/renewable/petroleum-natural-gas-sector-to-drive-growth-of-green-hydrogen-in-india-hardeep-puri/96953428

Carlo James Cunanan; Carlos Andrés Elorza Casas; et al.

Design and Analysis of an Offshore Wind Power to Ammonia Production System in Nova Scotia

https://doi.org/10.3390/en15249558

Abstract:
Green ammonia has potential as a zero-emissions energy vector in applications such as energy storage, transmission and distribution, and zero-emissions transportation. Renewable energy such as offshore wind energy has been proposed to power its production. This paper designed and analyzed an on-land small-scale power-to-ammonia (P2A) production system with a target nominal output of 15 tonnes of ammonia per day, which will use an 8 MW offshore turbine system off the coast of Nova Scotia, Canada as the main power source. The P2A system consists of a reverse osmosis system, a proton exchange membrane (PEM) electrolyser, a hydrogen storage tank, a nitrogen generator, a set of compressors and heat exchangers, an autothermal Haber-Bosch reactor, and an ammonia storage tank. The system uses an electrical grid as a back-up for when the wind energy is insufficient as the process assumes a steady state. Two scenarios were analyzed with Scenario 1 producing a steady state of 15 tonnes of ammonia per day, and Scenario 2 being one that switched production rates whenever wind speeds were low to 55% the nominal capacity. The results show that the grid connected P2A system has significant emissions for both scenarios, which is larger than the traditional fossil-fuel based ammonia production, when using the grid in provinces like Nova Scotia, even if it is just a back-up during low wind power generation. The levelized cost of ammonia (LCOA) was calculated to be at least 2323 CAD tonne−1 for both scenarios which is not cost competitive in this small production scale. Scaling up the whole system, reducing the reliance on the electricity grid, increasing service life, and decreasing windfarm costs could reduce the LCOA and make this P2A process more cost competitive.



Canan Acar; Ercan Erturk; Irem Firtina-Ertis.

Performance analysis of a stand-alone integrated solar hydrogen energy system for zero energy buildings

https://doi.org/10.1016/j.ijhydene.2022.10.051

Abstract:
This study analyzes the optimal sizing design of a stand-alone solar hydrogen hybrid energy system for a house in Afyon, Turkey. The house is not connected to the grid, and the proposed hybrid system meets all its energy demands; therefore, it is considered a zero-energy building. The designed system guarantees uninterrupted and reliable power throughout the year. Since the reliability of the power supply is crucial for the house, optimal sizing of the components, photovoltaic (PV) panels, electrolyzer, storage tank, and fuel cell stack is critical. Determining the sufficient number of PV panels, suitable electrolyzer model and size, number of fuel cell stacks, and the minimum storage tank volume to use in the proposed system can guarantee an uninterrupted energy supply to the house. In this study, a stand-alone hybrid energy system is proposed. The system consists of PV panels, a proton exchange membrane (PEM) electrolyzer, a storage tank, and a PEM fuel cell stack. It can meet the continuous energy demand of the house is sized by using 10 min of averaged solar irradiation and temperature data of the site and consumption data of the house.

Present results show that the size of each component in a solar hydrogen hybrid energy system in terms of power depends on the size of each other components to meet the efficiency requirement of the whole system. Choosing the nominal electrolyzer power is critical in such energy systems.

Faeze Moradi Nafchi; Ehsan Baniasadi; et al.

Performance assessment of a direct steam solar power plant with hydrogen energy storage: An exergoeconomic study

https://doi.org/10.1016/j.ijhydene.2022.01.250

Abstract:
Power generation and its storage using solar energy and hydrogen energy systems is a promising approach to overcome serious challenges associated with fossil fuel-based power plants. In this study, an exergoeconomic model is developed to analyze a direct steam solar tower-hydrogen gas turbine power plant under different operating conditions. An on-grid solar power plant integrated with a hydrogen storage system composed of an electrolyser, hydrogen gas turbine and fuel cell is considered. When solar energy is not available, electrical power is generated by the gas turbine and the fuel cell utilizing the hydrogen produced by the electrolyser. The effects of different working parameters on the cycle performance during charging and discharging processes are investigated using thermodynamic analysis. The results indicate that increasing the solar irradiation by 36%, leads to 13% increase in the exergy efficiency of the cycle. Moreover, the mass flow rate of the heat transfer fluid in solar system has a considerable effect on the exergy cost of output power. Solar tower has the highest exergy destruction and capital investment cost. The highest exergoeconomic factor for the integrated cycle is 60.94%. The steam turbine and PEM electrolyser have the highest share of exergoeconomic factor i.e., 80.4% and 50%, respectively.

Andrej Zvonimir Tomić; Ivan Pivac; Frano Barbir; et al.

A review of testing procedures for proton exchange membrane electrolyzer degradation

https://doi.org/10.1016/j.jpowsour.2022.232569

Abstract:
Durability of electrolyzers is one of the main challenges for their widespread commercialization, although many commercial PEM electrolyzer manufacturers claim durability up to 30,000 h or even longer. Nevertheless, their degradation processes are increasingly investigated. There is a need to promptly diagnose degradation causes by monitoring the resulting performance decay. However, a wide spectrum of procedures for degradation testing makes it difficult to compare the obtained results, thus makes their practical application unsuitable. In order to systemize the proposed testing procedures, an overview of investigations that include PEM electrolyzer degradation testing is presented here, together with a comparative analysis and a critical review. The reviewed papers are grouped in accordance to whether the degradation tests were performed under constant or dynamic operating conditions. In addition, the review includes the advances and perspectives in accelerated test development. It was noticed that incomplete or inadequate membrane initial conditioning or activation affects the obtained results and, thus, the extracted conclusions. Therefore, before conducting any relevant degradation test, it is necessary first to define and carry out a suitable activation procedure, in order to compare the results of different degradation tests and reach the correct conclusions, which should be the subject of further research.

Sumit Sood; Om Prakash; et al.

Robust diagnosis of PEM electrolysers using LFT bond graph

https://doi.org/10.1016/j.ijhydene.2022.08.007

Abstract:
A model based diagnosis for Proton Exchange Membrane (PEM) water electrolyser has been presented in this paper using Linear Fractional Transformation (LFT) bond graph technique. LFT helps in calculating the adaptive thresholds in order to make the diagnosis robust against parameters and measurement uncertainties, hence avoiding false alarms. A modular approach has been followed that allows the model to be adapted to different configurations of PEM electrolyser. The developed diagnosis has been first tested offline by injecting the faults into behavioural model of the PEM electrolyser and then implemented online for a single cell PEM electrolyser.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 17

January, 2023

Cheap, sustainable hydrogen through solar power



A new kind of solar panel, developed at the University of Michigan, has achieved 9% efficiency in converting water into hydrogen and oxygen—mimicking a crucial step in natural photosynthesis. Outdoors, it represents a major leap in the technology, nearly 10 times more efficient than solar water-splitting experiments of its kind. But the biggest benefit is driving down the cost of sustainable hydrogen. This is enabled by shrinking the semiconductor, typically the most expensive part of the device. The team's self-healing semiconductor withstands concentrated light equivalent to 160 suns.

In the end, we believe that artificial photosynthesis devices will be much more efficient than natural photosynthesis, which will provide a path toward carbon neutrality," said Zetian Mi, U-M professor of electrical and computer engineering who led the study reported in Nature.

The outstanding result comes from two advances. The first is the ability to concentrate the sunlight without destroying the semiconductor that harnesses the light.

"We reduced the size of the semiconductor by more than 100 times compared to some semiconductors only working at low light intensity," said Peng Zhou, U-M research fellow in electrical and computer engineering and first author of the study. "Hydrogen produced by our technology could be very cheap."

And the second is using both the higher energy part of the solar spectrum to split water and the lower part of the spectrum to provide heat that encourages the reaction. The magic is enabled by a semiconductor catalyst that improves itself with use, resisting the degradation that such catalysts usually experience when they harness sunlight to drive chemical reactions.

In addition to handling high light intensities, it can thrive in high temperatures that are punishing to computer semiconductors. Higher temperatures speed up the water splitting process, and the extra heat also encourages the hydrogen and oxygen to remain separate rather than renewing their bonds and forming water once more. Both of these helped the team to harvest more hydrogen.

For the outdoor experiment, Zhou set up a lens about the size of a house window to focus sunlight onto an experimental panel just a few inches across. Within that panel, the semiconductor catalyst was covered in a layer of water, bubbling with the hydrogen and oxygen gasses it separated.

The catalyst is made of indium gallium nitride nanostructures, grown onto a silicon surface. That semiconductor wafer captures the light, converting it into free electrons and holes—positively charged gaps left behind when electrons are liberated by the light. The nanostructures are peppered with nanoscale balls of metal, 1/2000th of a millimeter across, that use those electrons and holes to help direct the reaction.

This work was supported by the National Science Foundation, the Department of Defense, the Michigan Translational Research and Commercialization Innovation Hub, the Blue Sky Program in the College of Engineering at the University of Michigan, and by the Army Research Office.

Cheap, sustainable hydrogen through solar power | University of Michigan News (umich.edu)

Solar-to-hydrogen efficiency of more than 9% in photocatalytic water splitting

Peng Zhou; Ishtiaque Ahmed Navid; et al.

Abstract:-

Production of hydrogen fuel from sunlight and water, two of the most abundant natural resources on Earth, offers one of the most promising pathways for carbon neutrality1,2,3. Some solar hydrogen production approaches, for example, photoelectrochemical water splitting, often require corrosive electrolyte, limiting their performance stability and environmental sustainability1,3. Alternatively, clean hydrogen can be produced directly from sunlight and water by photocatalytic water splitting2,4,5. The solar-to-hydrogen (STH) efficiency of photocatalytic water splitting, however, has remained very low. Here we have developed a strategy to achieve a high STH efficiency of 9.2 per cent using pure water, concentrated solar light and an indium gallium nitride photocatalyst. The success of this strategy originates from the synergistic effects of promoting forward hydrogen–oxygen evolution and inhibiting the reverse hydrogen–oxygen recombination by operating at an optimal reaction temperature (about 70 degrees Celsius), which can be directly achieved by harvesting the previously wasted infrared light in sunlight. Moreover, this temperature-dependent strategy also leads to an STH efficiency of about 7 per cent from widely available tap water and sea water and an STH efficiency of 6.2 per cent in a large-scale photocatalytic water-splitting system with a natural solar light capacity of 257 watts. Our study offers a practical approach to produce hydrogen fuel efficiently from natural solar light and water, overcoming the efficiency bottleneck of solar hydrogen production.

https://doi.org/10.1038/s41586-022-05399-1

RECENT REPORT:-

Energy Technology Perspectives 2023



The Energy Technology Perspectives series is the IEA's flagship technology publication, which has been key source of insights on all matters relating to energy technology since 2006. ETP-2023 will be an indispensable guidebook for decision-makers in governments and industry seeking to tap into the opportunities offered by the emerging new energy economy, while navigating uncertainties and safeguarding energy security.

The energy world is in the early phase of a new industrial age – the age of clean energy technology manufacturing. Every country needs to identify how it can benefit from the opportunities of the new energy economy, defining its industrial strategy according to its strengths and weaknesses. Clean energy transitions offer major opportunities for growth and employment in new and expanding industries. But there are potentially risky levels of concentration in clean energy supply chains.

Energy Technology Perspectives 2023 (windows.net)

INDUSTRY NEWS

World's largest hydrogen-electric aircraft completes 10-minute flight

Masdar, ZeroAvia flew the world's largest hydrogen-electric aircraft in a step forward for sustainable aviation. The 19-seat, twin-engine Dornier 228 plane, fitted with a prototype hydrogen-electric powertrain, completed a 10-minute flight in the UK. It was part of the HyFlyer II project, a government-funded R&D program working to make small passenger planes better for the environment.



World's largest hydrogen-electric aircraft completes 10-minute flight | Engadget

Rac EV, Blade Hydrogen to test Taiwan's first fuel cell bus this year

Taiwan-based e-bus manufacturer Rac EV said on January 16 that it will start testing hydrogen fuel cell battery-powered buses this year for long travel.

https://www.digitimes.com/news/a20230117VL205/battery-green-energy.html

Nikola Develops Hydrogen Mobile Fueler to Use in 2023

Nikola Corp., announced it developed a heavy-duty, 700-bar hydrogen mobile fueler capable of direct fueling hydrogen fuel cell electric vehicles. The accepted international standard for maximum working pressure in the high-pressure hydraulic tools industry is 700 bar (10,000 psi). Nikola's hydrogen tube trailer is coupled with a capacity of 960 kg, and it can refuel customer trucks back-to-back.



Nikola Develops Hydrogen Mobile Fueler to Use in 2023 | Transport Topics (ttnews.com)

Rolls-Royce announces successful tests of mtu genset with 100% hydrogen fuel

UK-based global major power and propulsion systems group Rolls-Royce has announced that its Germany-based Power Systems business unit has successfully tested an mtu-brand generator set (genset) using 100% hydrogen fuel. The genset was a "further developed" mtu Series 4000 L64 12-cylinder gas engine.

https://www.engineeringnews.co.za/article/rolls-royce-announces-successful-tests-of-mtu-genset-with-100-hydrogen-fuel-2023-01-17/rep_id:4136

Equinor and RWE collaborate for large-scale clean hydrogen

ENERGY companies Equinor and RWE have signed a memorandum of understanding (MoU) agreeing to jointly develop large-scale value chains for low-carbon hydrogen. This cooperation will include construction of new, jointly-owned combined cycle gas turbine (CCGT) power plants and plans to build 3 GW of hydrogen-ready CCGT capacity in Germany by 2030.



Equinor and RWE collaborate for large-scale clean hydrogen - News - The Chemical Engineer

ABO Wind AG realises green hydrogen project with refuelling station

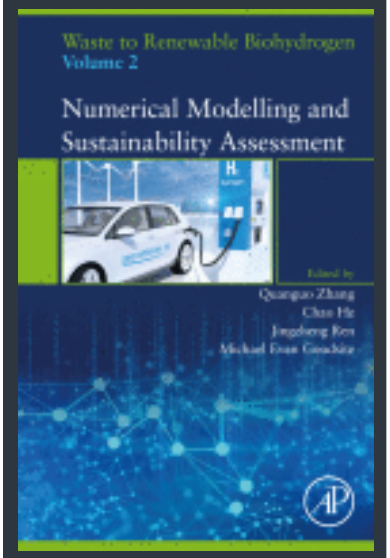
For the first time, ABO Wind will combine a wind farm with the production and use of green hydrogen: the German Federal Ministry of Digital Affairs and Transport is funding the Hünfeld-Michelsrombach project with around twelve million euros as part of the National Hydrogen and Fuel Cell Technology Innovation Programme. ABO Wind is planning the construction and operation of a wind turbine and an electrolyser with a hydrogen refuelling station for lorries and buses.

https://markets.businessinsider.com/news/stocks/eqs-news-abo-wind-ag-realises-green-hydrogen-project-with-refuelling-station-1032021823

RECENT BOOK-

Waste to Renewable Biohydrogen Volume 2: Numerical Modelling and Sustainability Assessment

Quanguo Zhang; Chao He; et al



ISBN- 978-0-12-821675-0

Waste to Renewable Biohydrogen, Volume Two: Numerical Modelling and Sustainability Assessment provides an integrated approach on the experimental, modeling and sustainability aspects of waste-to-biohydrogen systems. The book focuses on processes for waste treatment to hydrogen production, delving into modeling and simulation methodologies for the design and optimization of different processes and systems. In addition, it looks at the application of computational fluid dynamics and artificial neural networks. Finally, it addresses the economic, environmental and sustainability implications of waste-to-biohydrogen systems, covering several techniques for cost-benefit analysis, techno-economic analysis, lifecycle assessment, sustainability ranking and supply chain design.

https://doi.org/10.1016/C2019-0-03177-9

INDUSTRY NEWS

Hydrogen Utopia International agrees to develop sites with Polish energy construction specialists

Hydrogen Utopia International PLC said it has struck a deal to roll out waste-to-hydrogen facilities in Poland and Europe with fast-growing Polish energy engineer Romgos Gwiazdowscy. Also known as Romgos Grupa, the Polish company has agreed to provide funding equivalent to 3mln Polish zloty (£190,000) by contributing an appropriate property to construct an HUI facility. Romgos, which according to its website has built several gas pipelines and has expanded into general construction and renewable energy, has promised to provide cash investment funding to cover the costs of obtaining the relevant environmental consents or permits or construction permits for new special purpose vehicle (SPV) that will build the initial HUI facility as part of the partnership.

https://www.proactiveinvestors.com/companies/news/1003438/hydrogen-utopia-international-agrees-to-develop-sites-with-polish-energy-construction-specialists-1003438.html

'Tomorrow's hydrogen superpowers': Ottawa give $9.74M to Alberta sector

The Canada's government is funding Alberta's hydrogen economy to the tune of $9.74 million in a bid to position the province as a global leader in the sector. This investment will improve access to hydrogen fuels, support hydrogen product testing, attract investment to Alberta's hydrogen industry and increase the availability of quality training opportunities related to the commercialization of hydrogen technologies.



'Tomorrow's hydrogen superpowers': Feds give $9.74M to Alberta sector | Calgary Herald

Townsville hydrogen hub get $70 million boost

The Federal Government has invested $70 million towards the development of a hydrogen hub in Townsville.

The Albanese government's investment is aimed at accelerating the development of north Queensland's hydrogen industry.

The $70 million investment – which reaches $140 million with matched funding – brings the governments' total investment in the hydrogen industry to over $525 million.



Townsville hydrogen hub get $70 million boost - Energy Today (energytodaymag.com.au)

Adnoc partners with Thyssenkrupp to create new markets for hydrogen

Adnoc has signed a preliminary agreement with the engineering unit of Germany's Thyssenkrupp to create new markets for hydrogen and explore the development of projects for large-scale ammonia cracking.

As part of the deal, signed at Abu Dhabi Sustainability Week, Adnoc and Thyssenkrupp Uhde will work together to develop commercial-scale ammonia cracking plants, which are used to extract hydrogen from ammonia after transportation.

Adnoc partners with Thyssenkrupp to create new markets for hydrogen (thenationalnews.com)

Major hydrogen power test center starts operation in Southwest China

National Hydrogen Power Quality Inspection and Testing Center, an organization dedicated to boosting the development of China's hydrogen fuel-cell vehicle industry, started operation in Chongqing municipality. It can provide testing services for the whole industrial chain, including hydrogen fuel cell vehicles, critical auto parts, and hydrogen quality.

Major hydrogen power test center starts operation in Southwest China - Chinadaily.com.cn

RECENT REPORT:-

35 hydrogen trains, 500 Vande Bharat likely in Union Budget

It is being reported that the Indian Railways is likely to get an allocation of nearly Rs 1.9 lakh crore ($23 billion) in the Budget 2023-24. The Modi government is expected to give a big boost to Vande Bharat, with 500 more semi-high speed trains proposed to be added to the fleet and 35 hydrogen-fuelled trains on the cards.

According to a TOI report, in the upcoming Budget 2023, the government may announce some new trains like 35 new hydrogen-fuelled trains and around 500 new Vande Bharat trains. In addition to this, the government is also reportedly expected to roll out nearly 4,000 newly designed automobile carrier coaches and some 58,000 wagons in about next three years.

The government has also started Vande Bharat trains for various important routes. Apart from being modern and advanced, these trains are known for their speed and reducing the journey time significantly. Additionally, the railways minister Ashwini Vaishnaw also mentioned that the railways would run hydrogen-fuelled trains on some routes.

As far as the rolling stock goes, the government may reportedly spread the programme over three years and attribute it around Rs 2.7 lakh crore. However, besides the new age rolling stock, in this programme, the government may also plan to manufacture 100 Vistadome coaches and refurbishment of 1,000 coaches of premier trains.

http://timesofindia.indiatimes.com/articleshow/97103928.cms?from=mdr&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Fluitron Installs First Domestically-Built Hydrogen Dispenser in Faridabad, India

Fluitron LLC, an established developer and manufacturer of industrial-grade gas compression systems, has successfully completed the manufacturing, testing, installation and PESO (Petroleum and Explosives Safety Organization) approval for the first domestically-built hydrogen dispenser in India. This dispenser, which is capable of filling tanks at 350 bar pressure, features two nozzles for light and heavy-duty vehicles and a third nozzle for the future addition of 700 bar hydrogen dispensing. It also integrates a cascading system and pre-cooling protocols specified through international codes and standards.

https://www.easternherald.com/2023/01/17/fluitron-installs-first-domestically-built-hydrogen-dispenser-in-faridabad-india/

India aiming at capturing 10% of global green hydrogen market: Govt.

The government has put a number to its aim of being a leading exporter of green hydrogen in the world. Setting an ambitious target of capturing about 10 percent of the global green hydrogen market which is expected to touch 100 million metric tonne (MMT) by 2030, senior officials in the ministry of new and renewable energy (MNRE) informed.

https://www.moneycontrol.com/news/power/india-aiming-at-capturing-10-of-global-green-hydrogen-market-govt-9896701.htm

Davos 2023: India's ReNew Power exploring Egypt green hydrogen project

India's ReNew Power, a unit of New York-listed ReNew Energy Global Plc (RNW.O) is studying opportunities to expand into green hydrogen in India, Egypt and elsewhere, its chairman and CEO said. The firm, which now generates nearly 1.8% of India's total electricity annually, has a total capacity of 13 Gigawatts (GW) of wind and solar, including projects in the works.

https://www.reuters.com/business/energy/davos-2023-indias-renew-power-exploring-egypt-green-hydrogen-project-2023-01-16/

Green hydrogen: In 3 years, pacts worth Rs 2. 5 lakh crore inked in Karnataka

India In line with the Centre's nudge to produce and use "green hydrogen" or GH2, Karnataka, over the past three years, has signed agreements worth a staggering Rs 2.5 lakh crore with firms manufacturing GH2 and its derivitives. Projects from this sector worth Rs 73,445 crore have already received single-window clearance for implementation.

The state commerce and industries department said six agreement- two with ReNew Power Pvt Ltd, and one each with Petronas Hydrogen, ACME Cleantech Solutions, ABC Cleantech and O2 Power - have been signed to manufacture GH2 and derivatives during the period.

Green hydrogen: In 3 years, pacts worth Rs 2. 5 lakh crore inked in Karnataka | Bengaluru News - Times of India (indiatimes.com)

RIL shares can rally up to 26%, green hydrogen biz valued at $8 bn: Jefferies

While valuing Reliance Industries NSE 1.37 %' (RIL NSE 1.37 %) green hydrogen business at $8 billion, global brokerage firm Jefferies sees the Mukesh Ambani stock going up by 26% to Rs 3,100.

"We have valued RIL's electrolyzer manufacturing business at a 20% discount to the European benchmark and added the cap value of its captive H2 consumption. We discount its FY30E fair value at 12% WACC to get a Jun-23E FV of $8 billion. Any meaningful capital subsidy from the govt would aid the valuation of its green hydrogen foray," Jefferies said.

reliance share price: RIL shares can rally up to 26%, green hydrogen biz valued at $8 bn: Jefferies - The Economic Times (indiatimes.com)

India's Adani partners with Leyland, Ballard to make hydrogen fueled electric truck

India's Adani Enterprises Limited (AEL) said that it has signed an agreement with Ashok Leyland and Canada's Ballard Power to launch a pilot project to develop a hydrogen fuel cell electric truck (FCET) for mining logistics and transportation. The project led by Adani, will have Ballard supply the fuel cell engine, while Indian truck maker Ashok Leyland will provide vehicle and technical support for the project.

India's Adani partners with Leyland, Ballard to make hydrogen fueled electric truck, Energy News, ET EnergyWorld (indiatimes.com)

Asia-Pacific Tech Monitor Vol. 39 No. 4 Oct-Dec 2022

Strengthening innovation-driven inclusive and sustainable development: Aff ordable and Sustainable Clean Energy Technologies Emerging policies and business models

https://apctt.org/sites/default/files/2023-01/Affordable%20and%20Sustainable%20Clean%20Energy%20Technologies_Oct-Dec-22.pdf

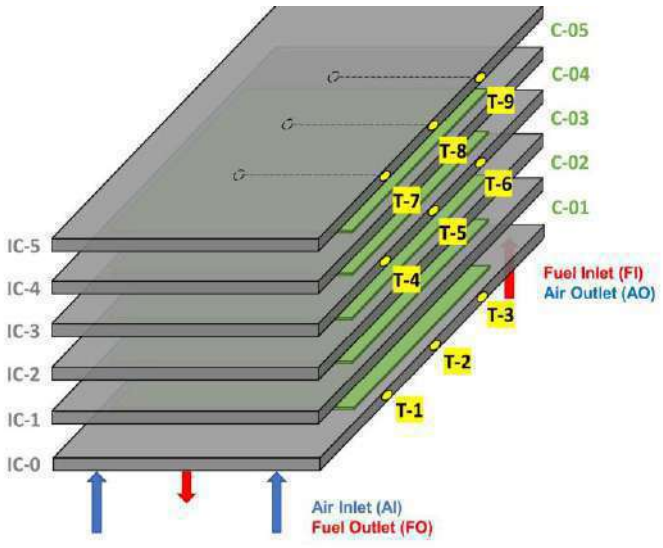
Transition to clean and renewable energy has become imperative to curb the rising GHG emissions and achieve Sustainable Development Goal 7 to ensure affordable, reliable and sustainable energy by 2030. To achieve these goals, countries need to upscale the use of renewable energy sources by upgrading existing clean energy technologies through enabling policies, regulatory frameworks and business models. The Asia-Pacific region, while being a hub for manufacturing and production, has a wide range of energy-intensive economic activities resulting in large consumption of fossil fuels. The rapidly surging energy demand in the region offers immense opportunities to adopt modern renewable energy sources and innovative technologies for clean energy such as solar photovoltaics (PV), wind energy and green hydrogen in production, manufacturing and service sectors. Renewable energy sources can also play a critical role in facilitating universal access to modern energy in the Asia-Pacific region. The share of renewable energy in total electricity production has increased to 25% in Asia and 34% in the Pacific region in 2021. Still, there are challenges in the adoption of renewable energy sources due to a lack of enabling policies, investments and availability of technologies. Vast potential for the generation of clean energy remains to be tapped.

Benjamin Königshofer; Michael Höber; et al.

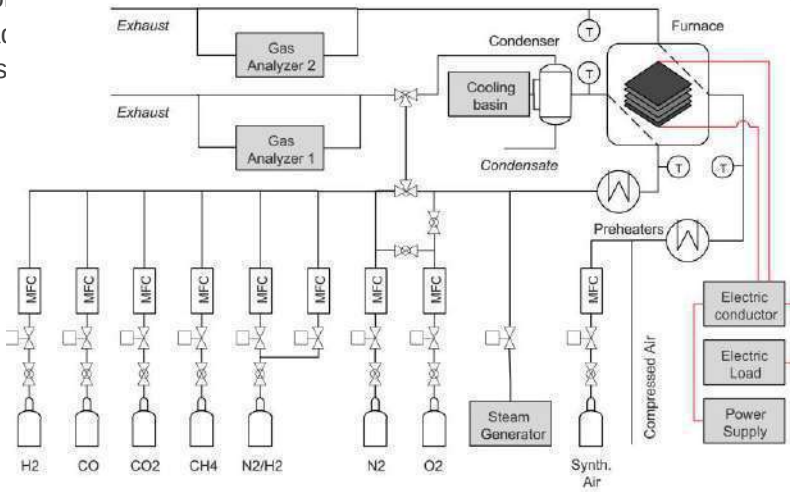
Towards strategies to mitigate degradation and regenerate performance of a solid oxide electrolyzer during co-electrolysis operation

https://doi.org/10.1016/j.jpowsour.2022.232404

Abstract:
One of the main objectives towards the broad commercialization of solid oxide electrolysis cells (SOEC) is to reduce the effects of degradation and extend the lifetime of the technology. Special industrially relevant operating conditions can, however, amplify and accelerate the degradation of SOECs, thus significantly reducing the lifetime of the technology. Nevertheless, not all degradation processes are completely irreversible, especially if they are detected at an early stage. In order to develop strategies to mitigate degradation and to regenerate performance, several experiments were performed on a five-layer SOEC stack operating in steam and co-electrolysis mode. The experiments were performed at different industrially relevant gas mixtures, reactant conversion rates and operating temperatures. The experimental results revealed different types and degrees of effects of the degradation, mitigation and regeneration strategies on the performance of the stack, which were analyzed in detail and linked to the underlying mechanisms and processes. As a result, pro
performance of SOECs could be derived and optimized. In ac
stable operation of SOECs under various operating conditions



(a) Position of thermocouples (T-X) for temperature measurement



(b) Test rig. [13]

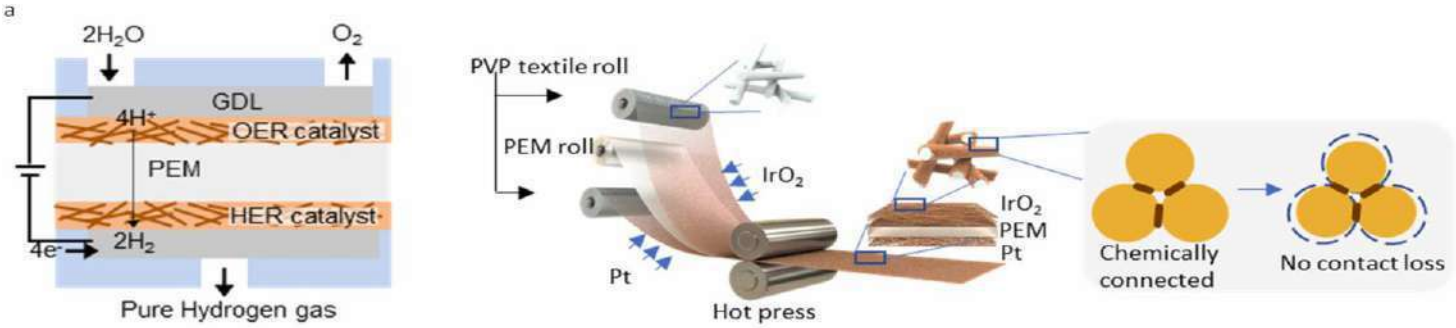
Shougo Higashi; Atsushi Beniya.

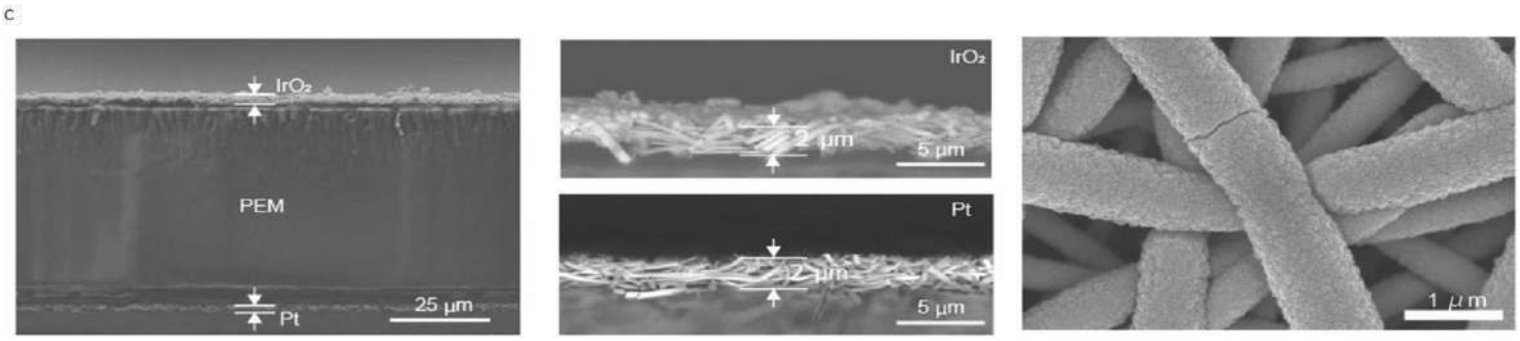
Ultralight conductive IrO2 nanostructured textile enables highly efficient hydrogen and oxygen evolution reaction: Importance of catalyst layer sheet resistance

https://doi.org/10.1016/j.apcatb.2022.122030

Abstract:

Large-scale deployment of polymer electrolyte membrane water electrolysis, which is a promising technology for green hydrogen production, requires significant reduction of Ir in catalyst layer due to its high material cost. However, as the Ir amount in the catalyst layer decreases, number of electrically-isolated-inactive catalysts increases, resulting in poor performance. Here we show that the nanostructured textiles essentially avoids the formation of such inactive catalysts, enables unprecedented long-term hydrogen evolution with ultralow Ir mass loadings at high rates. We reveal that achieved high performance is derived from the low resistivity of prepared nanostructured textile which have a unique porous, three-dimensional structure. We also show that the nanostructured textiles facilitate simple catalyst-coated membrane production, which does not require liquid-phase processes or produce chemical waste. The method we developed can also be applied to a variety of zero-gap electrochemical conversion cells that require a high-rate catalytic reactions with small amounts of catalyst.





Tao Hai; Kosar Hikmat Hama Aziz; et al.

-Neural network-based optimization of hydrogen fuel production energy system with proton exchange electrolyzer supported nanomaterial

https://doi.org/10.1016/j.fuel.2022.125827

Abstract:

In this research, we try to investigate a solar-geothermal energy system. This system includes three turbines for power production, a PEM electrolyzer for hydrogen production, and a thermoelectric for generating electricity from excess heat. In addition, the seawater will be passed through the osmotic cycle to gain fresh water. The required power for this osmotic cycle will be obtained through the energy produced by the main turbines. The generated load, hydrogen production flow rate, purified water flow rate, and heating consumption are assessed in this study. The results showed that this system can produce 3.8 megawatts of electricity as well as 8 g per second of hydrogen fuel at the operating point. Also, the energy efficiency of this system is estimated to be 19%. Afterward, machine learning methods are used to optimize designing parameters, and the optimum operating point in terms of useful power and stored fuel flow rate is obtained by a genetic algorithm. The optimum operating point of this energy system has a useful power output of 4.099 megawatts and a hydrogen flow rate of 29 g per second. In the end, the distribution of the design parameters is displayed for points of the beam curve.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

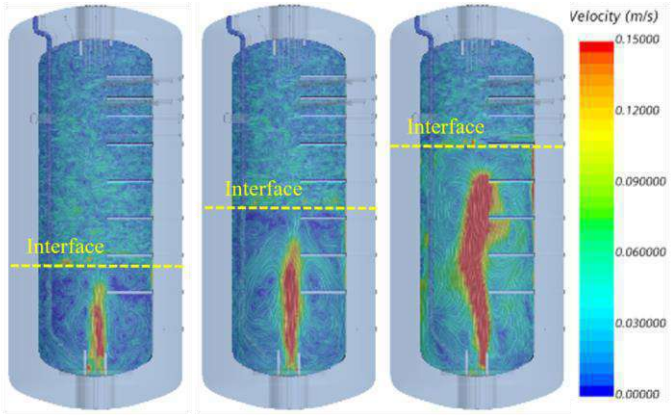
ISSUE. 18

January, 2023

Storing hydrogen in cryogenic tanks

Scientists from Pusan National University in South Korea have looked at how hydrogen could be stored in cryogenic liquid fuel tanks. They found that vaporization and thermodynamic changes represent two crucial factors in this process.

“Despite thermal insulation, the liquefied fuel in a cryotank experiences a degree of vaporization,” they explained, noting that high vaporization, measured as Boil-Off Gas (BOG), can result in excess internal pressure inside the tanks, leading to cracks and fissures.



(a) FL32 (b) FL50 (c) FL75

< Comparison of heat convection at different filling levels >

“This makes understanding and controlling BOG a key factor in cryogenic tank design,” they said in “Experimental and numerical investigation of change in boil-off gas and thermodynamic characteristics according to filling ratio in a C-type cryogenic liquid fuel tank,” which was recently published in Energy.

The South Korean research team, led by Jong-Chun Park, looked at how BOG varies with the tank filling ratio (FR), which is the ratio of the mass of liquefied fuel in the tank to the capacity of the tank at 15 C. They also used liquefied nitrogen instead of hydrogen in the experiment to validate simulation results and reduce safety risks.

“It was observed that the amount of BOG tends to increase in the form of a quadratic function based on the trend line, as FR increases,” they said, noting that vaporization increases drastically as the tanks become emptier.

Cryogenic fuel tanks maintain temperatures below -253 C to transport hydrogen as a liquid, overcoming the poor safety and storage efficiency of the current hydrogen storage methods based on high-pressure gas. The energy to cool hydrogen to a cryogenic liquid state equates to about 35% of hydrogen’s total energy.

Two primary alternative storage methods are liquid organic hydrogen carrier (LOCH) storage and conversion into ammonia. According to the researchers, the main advantage of these two methods is that the hydrogen can be stored at room temperature. The disadvantages are high energy requirements and difficulty using them for high-purity hydrogen.

The group explained that both techniques are in the early stages of development and are not ready for commercialization.

Storing hydrogen in cryogenic tanks – pv magazine International (pv-magazine.com)

Experimental and numerical investigation of change in boil-off gas and thermodynamic characteristics according to filling ratio in a C-type cryogenic liquid fuel tank

Gyu-Mok Jeon; Jong-Chun Park; et al.

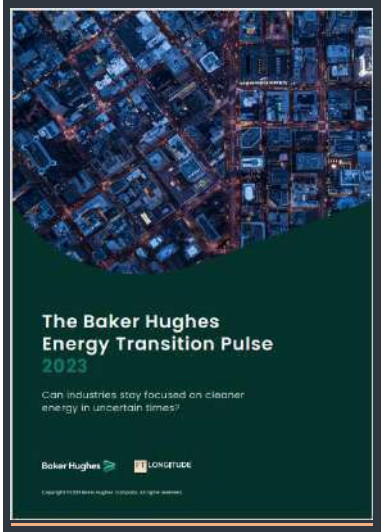
Abstract:-

This paper covers the experimental and numerical investigation of the changes in boil-off gas and thermodynamic characteristics due to filling ratio (FR) in a cryogenic liquid fuel tank. An experiment on a vertically oriented C-type fuel tank with an insulation system was carried out using LN2 to allow validation of the simulation results. The data for temperature inside the tank and mass flow rate of boil-off gas were acquired with respect to the different FRs. It was observed that the amount of BOG tends to increase in the form of a quadratic function based on the trend line, as FR increases. The simulation seemed to well express the complex physical phenomenon associated with heat transfer, heat flow, and vaporization occurring in the entire system of the tank. Especially the flow visualization of the simulated physical quantities helped to understand physical phenomena more easily, such as a mechanism of BOG caused by vaporization, which are not easy to approach in experiments. On the other hand, the BOR according to the FR showed a very slight difference of less than 3% on average compared to the experiment, which made it possible to confirm the validity of the multi-physics simulation technique.

https://doi.org/10.1016/j.energy.2022.124530

RECENT REPORT:-

The Baker Hughes Energy Transition Pulse 2023



Can industries stay focused on cleaner energy in uncertain times?

Executive summary:
A turbulent 2022 has challenged many assumptions about the energy transition. Many companies were basing their emissionsreductions promises on affordable and abundant natural gas, but Russia's invasion of Ukraine was an unforeseen driving factor that pushed natural gas prices to record highs within a matter of weeks. By mid-year, it became clear that many government and organizational strategic roadmaps to lower or zero-emissions energy needed to be revisited. "Energy markets and policies have changed as a result of Russia's invasion of Ukraine," says International Energy Agency (IEA) Executive Director Fatih Birol. "Not just for the time being, but for decades to come."
Energy Transition Pulse 2023.pdf (bakerhughes.com)

INDUSTRY NEWS

Gascade and Fluxys step up plans for North Sea hydrogen pipeline

Pipeline operators Gascade and Fluxys are stepping up the pace on plans for a green hydrogen pipeline in the North Sea by applying to the European Commission to qualify for fast-track approvals and funding. Germany and the European Union are seeking to shift future energy production more to renewables and to produce, import and market clean hydrogen, derived from carbon-free wind and solar power, to eliminate climate-warming gases.
Gascade and Fluxys step up plans for North Sea hydrogen pipeline, Energy News, ET EnergyWorld (indiatimes.com)

Spain says Germany to join hydrogen pipeline project

Madrid: Spain said agreement has been reached for Germany to join an ambitious hydrogen pipeline that will bring the "green" gas from the Iberian Peninsula to the rest of Europe. Madrid, Paris and Lisbon agreed in December to build by 2030 a major undersea pipeline to transport hydrogen from Spain and Portugal to France and eventually the rest of Europe. The pipeline linking the northeastern Spanish port of Barcelona to France's Marseille -- dubbed H2Med -- comes as Europe scrambles to reduce dependence on Russian energy following Moscow's invasion of Ukraine.
https://energy.economictimes.indiatimes.com/news/renewable/spain-says-germany-to-join-hydrogen-pipeline-project/97247467

HyTerra, Natural Hydrogen Energy to kick off testing at Nebraska, US project site

US-based HyTerra and Natural Hydrogen Energy (NH2E) have announced testing operations are set to commence next month (February 2023) at a natural hydrogen production project in Nebraska, US.
The project concerns what some describe as 'white' hydrogen, which is 'naturally occurring' geological hydrogen found in underground deposits and released through processes such as fracking, for example.
HyTerra, Natural Hydrogen Energy to kick off testing at Nebraska, US project site (h2-view.com)

Nikola and FFI sign MoU to collaborate on green hydrogen production

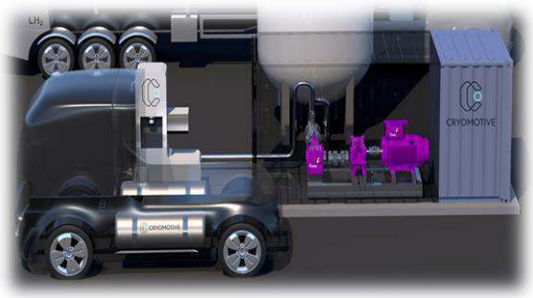
Nikola Corporation and Fortescue Future Industries (FFI) have signed a Memorandum of Understanding (MoU) to collaborate on large-scale green hydrogen production facilities in the US. Under the MoU, the two companies will evaluate the potential co-development of new green hydrogen production and related infrastructure projects. Nikola will also evaluate green hydrogen offtake opportunities from any other green hydrogen projects being pursued by FFI.
Nikola and FFI sign MoU to collaborate on green hydrogen production (h2-view.com)

Proposed $1 Billion Hydrogen fuel hub signals a new start for reenergized Hawaii agency

When new economic development director Chris Sadayasu first heard Hawaii had made it to the second round of a competition to land federal Department of Energy grants totaling $7 billion to build hydrogen fuel production facilities across the U.S., Sadayasu said he was thrilled. The general idea is to leverage $500 million of federal money with $500 million in private matching funds to raise $1 billion for hydrogen fuel development in Hawaii, Sadayasu said.
Proposed $1 Billion Hydrogen Fuel Hub Signals A New Start For Reenergized Hawaii Agency - Honolulu Civil Beat

Cryomotive, Fives to bring cryogenic pump to truck hydrogen refueling stations

CleanTech hydrogen mobility startup Cryomotive and French industrial group Fives have signed a cooperation agreement to jointly develop and validate a cryogenic pump for generating Croygas hydrogen based on Fives' cryogenic reciprocating pump technology. The Cryomec Hy-Filling pump designed by Fives will be a key component of future hydrogen refueling stations for long-haul truck and other heavy-duty transport applications.



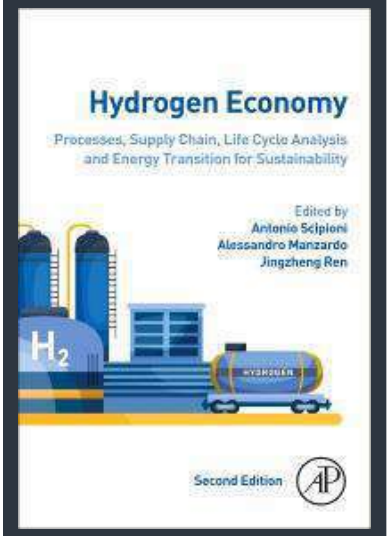
Cryomotive, Fives to bring cryogenic pump to truck hydrogen refueling stations | CompositesWorld

RECENT BOOK-

Hydrogen Economy

Processes, Supply Chain, Life Cycle Analysis and Energy Transition for Sustainability

Editors: Antonio Scipioni, Alessandro Manzardo, Jingzheng Ren



Hydrogen Economy: Supply Chain, Life Cycle Analysis and Energy Transition for Sustainability, Second Edition explores the challenges for the transition into a sustainable hydrogen economy. In this book, experts from various academic backgrounds discuss the tools and methodologies for the analysis, planning, design, and optimization of hydrogen supply chains. They examine the available technologies for hydrogen production, storage, transport, distribution, and energy conversion, providing a cross cutting perspective on their sustainability. This second edition of Hydrogen Economy is fully updated with new technologies and tools for design, optimization, assessment, and decision-making.

Hydrogen Economy - 2nd Edition (elsevier.com)

INDUSTRY NEWS

This hydrogen-powered foiling superyacht can reach 75 knots

Lazzarini, an Italian design house, unveiled their plans for a 74-meter-long superyacht powered by hydrogen fuel cells. The vessel, Plectrum, takes design cues from America's latest sailboats and features an innovative foiling system. According to Boat International, the design is inspired by the "more contemporary" America's Cup sailboats - specifically the Luna Rossa design- and will be the largest example of foiling technology installed on a yacht once built.



Lazzarini unveils Plectrum superyacht that can reach 75 knots (interestingengineering.com)

Tata Chemicals Europe inks pact with Vertex for low carbon hydrogen supply

Tata Chemicals Europe (TCE) and Vertex Hydrogen have signed an offtake agreement for the supply of over 200 megawatts of low carbon hydrogen, according to a press release on January 26.

Under the new pact, Vertex will supply TCE with hydrogen as the chemicals manufacturer continues to decarbonise its operations in the UK with a target of achieving “net zero” manufacturing by 2030.

“We have been supporters of Vertex and the low carbon hydrogen segment as a real opportunity to further reduce emissions at our world class CHP facility," TCE Managing Director Martin Ashcroft said.



Tata Chemicals Europe inks pact with Vertex for low carbon hydrogen supply (moneycontrol.com)

Centrica plans battery storage, solar and hydrogen at former gas power plant

Centrica has unveiled plans to develop a battery storage system at a former gas power station in Yorkshire, which it may co-locate with solar and hydrogen. Elsewhere, SSE is looking to co-locate a battery and solar with a wind farm in Ireland. Ireland is notably aiming to generate 80% of its electricity from renewable sources by 2030, Wind is currently the leading renewable generation method for Ireland.

Centrica plans battery storage, solar and hydrogen at former gas power plant - edie

JLEN Environmental Assets makes landmark green hydrogen investment

JLEN Environmental Assets Group Ltd celebrated its first investment in green hydrogen, after acquiring an equity stake in a project in Germany. It is a Guernsey-based closed-ended investment company, focused on environmental infrastructure. The company has acquired a 33% equity stake in Foresight Hydrogen Holdco GmbH, which in turn holds a 75% stake in HH2E Werk Thierbach GmbH.

JLEN Environmental Assets makes landmark green hydrogen investment | Financial News (lse.co.uk)

World’s Fastest Hydrogen Train Launched in China

China has unveiled a new hydrogen/supercapacitor train capable of reaching speeds of 100 mph (160 km/h), making it the fastest hydrogen-powered train to date. The train jointly developed by state-owned industrial giant CRRC (the world’s largest rail vehicle manufacturer) and Chengdu Rail Transit is China’s first hydrogen-powered train passenger train. It offers a range of 373 miles (600 kilometers) and emits nothing but water, making it a zero-emissions train.



World's Fastest Hydrogen-Powered Train Launched in China - Gizmochina

Biosystems Engineering researchers of Auburn University Work on producing Hydrogen from blended feedstock



Auburn University researchers are leading a $2 million Department of Energy grant that aims to produce hydrogen from blended feedstock, such as legacy waste coal, forest residues and municipal solid waste.

"The benefits of converting waste coal, biomass and food waste are twofold," said Sushil Adhikari, professor of biosystems engineering and principal investigator for the proposal. "First, it will help us to reduce greenhouse gas emissions from hydrogen production. Second, it will help to solve food waste problems."

The Biden Administration is focused on producing clean hydrogen at $1 per kilogram, and this goal can be reached through the use of biomass and food waste while reducing greenhouse gas emissions.

The primary objectives of the project—titled "Hydrogen Production from Modular CO2 Assisted Oxy-Blown Gasification of Waste"—are to understand how biomass, waste coal and food waste will flow into the gasifier; how biomass, coal and food waste composition will impact the gas composition and quality; and to understand the cost of hydrogen production from biomass, coal and food waste blends.

Biosystems Engineering researchers lead $2M project to produce hydrogen from blended feedstock (auburn.edu)

B20 Meet: Gujarat aims to become world centre for Green Hydrogen in next 12 years with 8 mtpa production capacity

Gujarat aims to become the world centre for green hydrogen by creating an estimated 8 MTPA production capacity in another 10-12 years, state Industries Minister Balwantsinh Rajput has said. Addressing a plenary session on "Gujarat's G20 Connect" as part of the Business 20 India Inception Meeting, Rajput said as a driving force, Gujarat will make a significant contribution to India's economic development. "By 2026-27, Gujarat aims to be a $500 billion economy and by 2030-32, a $1 trillion economy." Gujarat aims to especially focus on farsighted policies and green production processes for the new generation in alignment with the global agenda.

B20 Meet: Gujarat Aims To Become World Centre For Green Hydrogen In Next 12 Years With 8 MTPA Production Capacity (outlookindia.com)

Kerala minister to get hydrogen-filling stations to promote green fuel

THIRUVANANTHAPURAM: In a bid to promote green fuels, Union Minister of State for Petroleum, Rameshwar Teli, announced that the ministry would start hydrogen-filling stations in the state. The minister also congratulated the state government for its various initiatives to promote eco-friendly fuels. He was speaking at the Evolve-2023, a conference and expo on e-mobility and alternative fuels, in Thiruvananthapuram.

Kerala minister to get hydrogen-filling stations to promote green fuel- The New Indian Express

Hydrogen fuel cell-powered buses likely to hit roads soon

Giving a major impetus to the transition from the use of fossil fuels towards clean energy resources, the Indian Oil Corporation has written to the State government of Kerala seeking its permission to pilot hydrogen fuel cell-powered buses in the State. The Indian Oil Corporation's (IOC) research and development (R&D) centre has successfully developed and test-run run 50 Ashok Leyland buses of Delhi Transport Corporation by mixing hydrogen with compressed natural gas (CNG) in order to develop H-CNG.

Hydrogen fuel cell-powered buses likely to hit roads soon - The Hindu

Adani Group To Spin Off Hydrogen, Airports, Data Centre Businesses By 2028: CFO Jugeshinder Singh

Gautam Adani's group plans to spin off businesses like hydrogen, airports and data centre between 2025 and 2028 after they achieve a certain investment profile.

Adani Enterprises Ltd, which is looking to raise Rs 20,000 crore in a follow-on share sale, is the business incubator for the group. AEL currently houses new businesses such as hydrogen, where the group plans to invest $50 billion over the next 10 years across the value chain, flourishing airport operations, mining, data centre and roads and logistics.

Adani Group To Spin Off Hydrogen, Airports, Data Centre Businesses By 2028: CFO Jugeshinder Singh (outlookindia.com)

Green Hydrogen Mission document released By MNRE in 2023 says *the Council for Scientific and Industrial Research (CSIR) played a crucial role in developing the R & D program*.

The Ministry of New and Renewable Energy (MNRE) has released a detailed document of its National Green Hydrogen Mission. The overarching objective of the mission is to make India, a global hub for production, usage and export of green hydrogen and its derivatives. It also aims to make India a leader in technology and manufacturing of electrolyzes and other enabling technologies for green hydrogen. The mission strategy comprises interventions for first, demand creation by making green hydrogen produced in India competitive for exports and through domestic consumption. Second, addressing supply side constraints through an incentive framework. Third, building an enabling ecosystem to support scaling and development.

The proposed R&D programme has been detailed in consultation with Council for Scientific and Industrial Research (CSIR). Support is proposed for identified Mission Mode Projects with short term (0-5 years) horizon.

https://mnre.gov.in/img/documents/uploads/file_f-1673581748609.pdf

Jiarui Li et al 2023

Comparative thermodynamic and techno-economic analysis of various medical waste-to-hydrogen/methanol pathways based on plasma gasification

https://doi.org/10.1016/j.applthermaleng.2022.119762

Abstract

Three novel medical waste-to-hydrogen/methanol pathways based on plasma gasification using Aspen Plus have been proposed: The first pathway is used to convert medical waste into hydrogen; the second pathway is applied to convert medical waste into methanol; the third pathway is used to convert medical waste into hydrogen & methanol. In this study, thermodynamic and techno-economic analyses were conducted to evaluate and compare the performance of three pathways. Furthermore, three schemes are assessed by comparative economic sensitivity concerning the chemical product price, electricity price, capital expenditure, and discount rate. The thermodynamic results show that process efficiency and process exergy efficiency of the third pathway can achieve 72.16 % and 66.88 %, which is higher than the first pathway (69.45 % and 65.65 %) and the second pathway (54.08 % and 50.93 %). The techno-economic results indicate that the first pathway has a shorter dynamic payback period of 3.83 years and a relatively higher net present value of 13,783.57 k$ than the second pathway (7.42 years and 5,700.32 k$) and the third pathway (5.27 years and 10,780.00 k$). This work provides novel methods and guidance for efficient and economical harmless treatment and resource utilization of medical waste.

WANG L G et al, 2023

Scalable membrane-less microbial electrolysis cell with multiple compact electrode assemblies for high performance hydrogen production

https://doi.org/10.1016/j.cej.2022.140257

Abstract:

Bio electrochemical hydrogen production via microbial electrolysis cells (MECs) is a promising method for sustainable energy production and decarbonization of energy systems. However, the application of MECs is limited by the electrochemical performance, scalability, and the cost associated with expensive materials. In this study, a scalable MEC (500 mL) with novel compact electrode assemblies and high electrode surface area to volume ratio (160 m2/m3) was designed and constructed. The use of membranes, precious metal catalyst, and current collectors with high costs was avoided. A high current density at the steady state of 49.5 ± 5.3 A/m2 was achieved using acetate as the substrate with phosphate buffer under the applied voltage of 1.01 V. The corresponding volumetric current density was 3948 ± 422 A/m3. The compact electrode assembly design limited methane production rate to 3.9 ± 0.2 L/L/D, while achieving a hydrogen production rate of 33.7 ± 1.7 L/L/D. With the suppression of microbial hydrogen consumption, the hydrogen production rate was 39.8 ± 1.9 L/L/D, higher by almost one order of magnitude than those of MECs with scaling up attempts. The compact electrode configuration reduced internal resistance to 88.5 ± 4.4 Ω cm2. The energy efficiency based on input electricity was 146 ± 7 % to 189 ± 9 % within the applied voltage range of 0.71 to 1.05 V. The results in this study demonstrated successful scaling up of high performance small MECs and offered a new possible approach of scaling up MECs by stacking high-performance subunits, with no trade-offs on electrochemical performance.

Lang p p et al.

Pyrolysis of wood waste to enhance hydrogen production on iron-based aluminum dross

https://doi.org/10.1016/j.fuel.2022.126781

Iron based on aluminum dross was prepared to enhance hydrogen production by impregnated method. The pyrolysis experiments are performed in a fix-bed reactor to obtain pyrolysis product distribution. The pyrolysis behavior of poplar on iron-based aluminum dross was studied by thermogravimetric analysis (TG), and hydrogen composition in pyrolysis gas were determined by gas chromatography (GC). The results show that iron-based aluminum dross has a significant effect on improving hydrogen generation. The iron-based aluminum dross with 6% iron on aluminum dross promotes hydrogen by 18.48% compared with poplar. The kinetic calculation shows that the activation energy increases by 20.53% at conversion rate of 0.8, indicating that iron-based aluminum dross increases the condensation reaction degree with the pyrolysis residue increasing and requires more external energy for bond dissociation at high-temperature stage. Hydrogen generation is dominated by contracting volume and diffusional theory controlled by Carbon-Oxygen-Metal (C-O-M) active intermediate during pyrolysis on iron-based aluminum dross. Pyrolysis

reactivity of poplar is improved during the reaction of A1-A4 nucleation and growth stage in low-temperature stage. The high-temperature stage follows the F3 and D3 models and the gas diffusion rate increases to enhance active intermediate generation for hydrogen production.

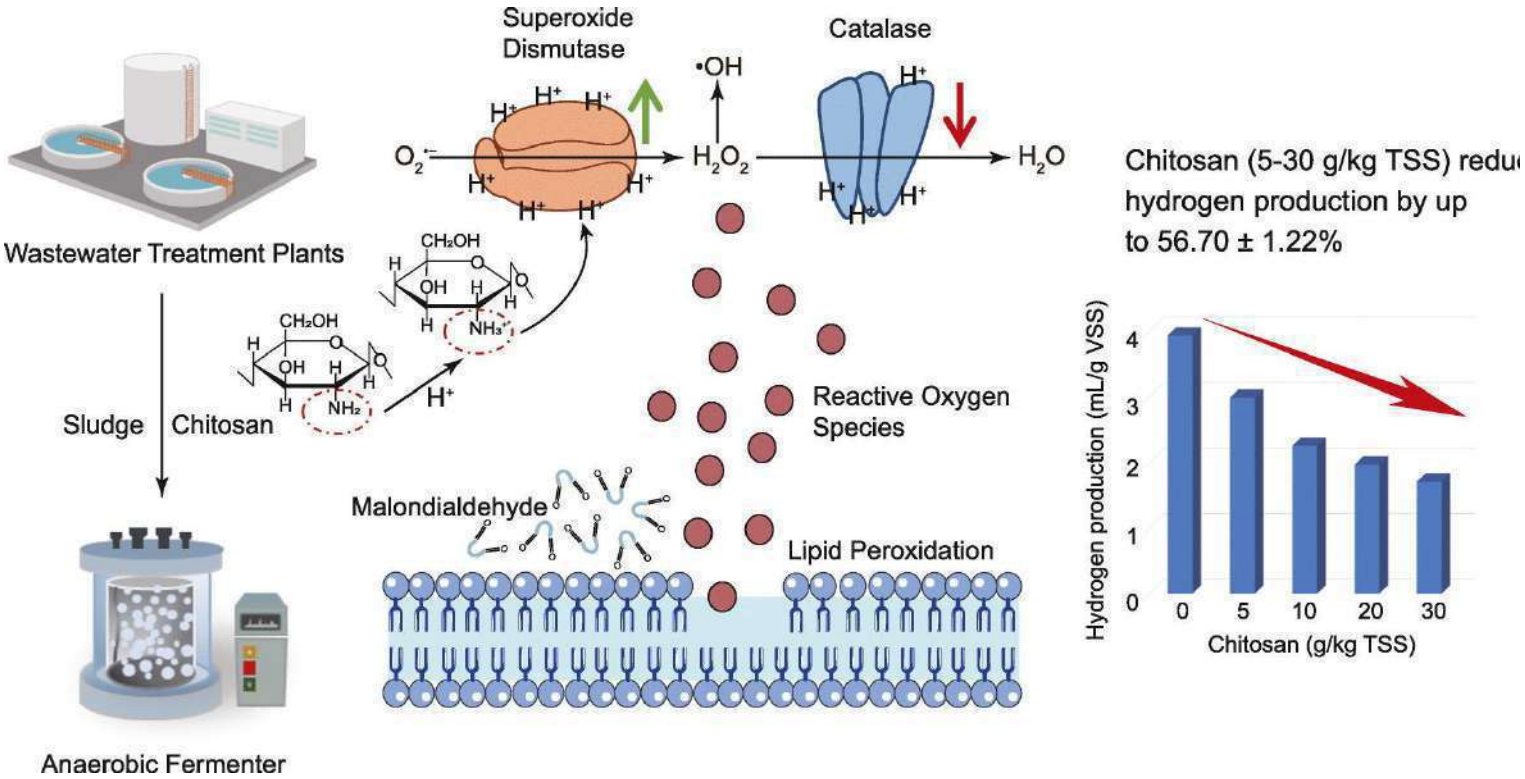
Fan F C et al

Insights into the role of chitosan in hydrogen production by dark fermentation of waste activated sludge

https://doi.org/10.1016/j.scitotenv.2022.160401

Abstract:

Chitosan is widely used as a dewatering flocculant, but whether it affects hydrogen production from sludge anaerobic fermentation is unclear. This study aimed to elucidate the role of chitosan in the dark fermentation of waste activated sludge for hydrogen production. The results showed that chitosan had a negative effect on hydrogen production from sludge. Chitosan at 30 g/kg total suspended solids reduced hydrogen accumulation by 56.70 ± 1.22 % from 3.94 ± 0.12 to 1.71 ± 0.10 mL/g volatile suspended solids. Chitosan hindered the solubilization of sludge by flocculation, which reduced the available substrate for anaerobic fermentation. In addition, chitosan interfered with the electron transport system by reducing cytochrome C and caused lipid peroxidation by inducing reactive oxygen species, thereby inhibiting the activity of enzymes involved in anaerobic fermentation. Hydrogen production was reduced because hydrogen-producing processes (i.e., hydrolysis, acidification, and acetification) were inhibited more strongly than hydrogen-consuming processes (i.e., methanogenesis, sulfate reduction, and homoacetogenesis). Furthermore, chitosan enriched the abundance of Spirochaetaceae sp. and Holophagaceae sp., which occupied the survival space of hydrogen-producing microorganisms. This study reveals the potential impact of chitosan on hydrogen production in dark fermentation of sludge and provide direct evidence that chitosan triggers oxidative stress in anaerobic fermentation.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 19

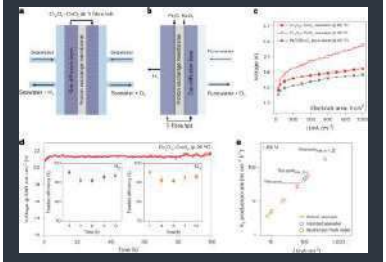
February, 2023

Seawater split to produce 'green' hydrogen

The international team led by the University of Adelaide's Professor Shizhang Qiao and Associate Professor Yao Zheng from the School of Chemical Engineering have split natural seawater into oxygen and hydrogen with nearly 100 per cent efficiency, to produce green hydrogen by electrolysis, using a non-precious and cheap catalyst in a commercial electrolyser.
A typical non-precious catalyst is cobalt oxide with chromium oxide on its surface. They used seawater as a feedstock without the need for any pre-treatment processes like reverse osmosis desolation, purification, or alkalisation. The performance of a commercial electrolyser with their catalysts running in seawater is close to the performance of platinum/iridium catalysts running in a feedstock of highly purified deionised water.
“Current electrolysers are operated with highly purified water electrolyte. Increased demand for hydrogen to partially or totally replace energy generated by fossil fuels will significantly increase scarcity of increasingly limited freshwater resources," said Associate Professor Zheng.
Seawater electrolysis is still in early development compared with pure water electrolysis because of electrode side reactions, and corrosion arising from the complexities of using seawater. It is always necessary to treat impure water to a level of water purity for conventional electrolysers including desalination and deionisation, which increases the operation and maintenance cost of the processes. Their work provides a solution to directly utilise seawater without pre-treatment systems and alkali addition, which shows similar performance as that of existing metal-based mature pure water electrolyser.
The team will work on scaling up the system by using a larger electrolyser so that it can be used in commercial processes such as hydrogen generation for fuel cells and ammonia synthesis.
Researchers have successfully split seawater without pre-treatment to produce green hydrogen. The international team was led by the University of Adelaide's Professor Shizhang Qiao and Associate Professor Yao Zheng from the School of Chemical Engineering.
They have split natural seawater into oxygen and hydrogen with nearly 100 per cent efficiency, to produce green hydrogen by electrolysis, using a non-precious and cheap catalyst in a commercial electrolyser.
A typical non-precious catalyst is cobalt oxide with chromium oxide on its surface.
They used seawater as a feedstock without the need for any pre-treatment processes like reverse osmosis desolation, purification, or alkalisation. The performance of a commercial electrolyser with their catalysts running in seawater is close to the performance of platinum/iridium catalysts running in a feedstock of highly purified deionised water.
The team published their research in the journal Nature Energy.
Current electrolysers are operated with highly purified water electrolyte. Increased demand for hydrogen to partially or totally replace energy generated by fossil fuels will significantly increase scarcity of increasingly limited freshwater resources. Seawater is an almost infinite resource and is considered a natural feedstock electrolyte. This is more practical for regions with long coastlines and abundant sunlight. However, it isn't practical for regions where seawater is scarce. Seawater electrolysis is still in early development compared with pure water electrolysis because of electrode side reactions, and corrosion arising from the complexities of using seawater. It is always necessary to treat impure water to a level of water purity for conventional electrolysers including desalination and deionisation, which increases the operation and maintenance cost of the processes.
Their work provides a solution to directly utilise seawater without pre-treatment systems and alkali addition, which shows similar performance as that of existing metal-based mature pure water electrolyser.
The team will work on scaling up the system by using a larger electrolyser so that it can be used in commercial processes such as hydrogen generation for fuel cells and ammonia synthesis.
Seawater split to produce 'green' hydrogen -- ScienceDaily

IDirect seawater electrolysis by adjusting the local reaction environment of a catalyst

Gyu- Jiaxin Guo; Yao Zheng; et al.



Abstract:-
The use of vast amounts of high-purity water for hydrogen production may aggravate the shortage of freshwater resources. Seawater is abundant but must be desalinated before use in typical proton exchange membrane (PEM) electrolysers. Here we report direct electrolysis of real seawater that has not been alkalised nor acidified, achieving long-term stability exceeding 100 h at 500 mA cm−2 and similar performance to a typical PEM electrolyser operating in high-purity water. This is achieved by introducing a Lewis acid layer (for example, Cr2O3) on transition metal oxide catalysts to dynamically split water molecules and capture hydroxyl anions. Such in situ generated local alkalinity facilitates the kinetics of both electrode reactions and avoids chloride attack and precipitate formation on the electrodes. A flow-type natural seawater electrolyser with Lewis acid-modified electrodes (Cr2O3–CoOx) exhibits the industrially required current density of 1.0 A cm−2 at 1.87 V and 60 °C

https://doi.org/10.1038/s41560-023-01195-x

India Union Budget Document : Chapter 7

CLIMATE CHANGE AND ENVIRONMENT: PREPARING TO FACE THE FUTURE

Budget clearly spell out the hydrogen vision of India in Chapter 7

With a vision to make India an energy-independent nation, and to de-carbonise critical sectors, the Government approved the National Green Hydrogen Mission on January 4, 2023 with an initial outlay of ₹19,744 crore. The Mission will facilitate demand creation, production, utilization and export of Green Hydrogen and mobilisation of over ₹8 lakh crore of investment by 2030.

The cumulative value of the green hydrogen market in India will be US$ 8 billion by 2030 and US$ 340 billion by 2050. The electrolyser market will be approximately US$ 5 billion by 2030 and US$ 31 billion by 2050. In addition, the adoption of green hydrogen will also result in 3.6 Giga tonnes of cumulative CO2 emission reduction by 2050.

Green hydrogen is also an important element of India's Long Term Low Emissions Development Strategy (LT-LEDS).

Access: https://www.indiabudget.gov.in/economicsurvey/doc/eschapter/echap07.pdf

Japan's Honda outlines hydrogen power plans to go green

Honda is expanding the use of hydrogen to include trucks and construction equipment, electricity for buildings and even outer space, not just cars on the roads.

Honda Motor Co plans a new fuel cell vehicle for sale next year, packed with a fuel cell stack developed with General Motors Co of the US, its general manager, Testsuya Hasebe, said. That will lower the cost of the fuel cell stack to a third of what it is now. By 2030, costs of Honda's fuel cells will become comparable with diesel engines, Hasebe said.

Japan's Honda outlines hydrogen power plans to go green | The Financial Express

Exxon Mobil sets large-scale hydrogen plant start-up for 2027

Exxon Mobil Corp disclosed its plan to start operations at its large-scale hydrogen plant in Texas in 2027 or 2028, Exxon's Low Carbon business president Dan Ammann said.

The unit is part of Exxon's efforts to create a new business to make money out of reducing greenhouse gas emissions from other companies looking to decarbonize their own operations. Exxon estimates 10% or more of return for the business.

Exxon has budgeted $7 billion for hydrogen, carbon capture and biofuels projects between 2022 and 2027. A final investment decision for the hydrogen project is expexted by 2024.



Exxon Mobil Corp: Exxon Mobil sets large-scale hydrogen plant start-up for 2027, Auto News, ET Auto (indiatimes.com)

Hydrogen production to ramp up in Queensland

Japan's largest oil company, ENEOS, will soon begin green hydrogen production in Brisbane. This news follows the energy giant's official opening of a demonstration plant at its Bulwer Island site in Queensland.

"ENEOS choosing Queensland for this project strengthens our position as a leading destination for investment in green hydrogen," said Deput y Premier and Minister for State Development Steven Miles.



Hydrogen production to ramp up in Queensland (bigrigs.com.au)

Johnson Matthey partners with Plug Power to boost hydrogen tech

Johnson Matthey (JMAT.L) said it was partnering in hydrogen technology with U.S.-based Plug Power (PLUG.O) until at least 2030, as the British company hones its focus on its green hydrogen-related business.

Companies globally are increasing investments in green hydrogen, a zero-carbon fuel made by using renewable power from wind and solar to split water into hydrogen and oxygen, in their quest for energy which does not add to global warming.

https://www.reuters.com/technology/uks-johnson-matthey-joins-hands-with-plug-power-hydrogen-tech-partnership-2023-01-31/

Neom Green Hydrogen Company gets Saudi operating licence

Neom Green Hydrogen Company (NGHC) - a joint venture between Saudi futuristic city Neom, global utility project developer Acwa Power and industrial gases leader Air Products - said it has secured the industrial operating licence from the Saudi Ministry of Industry and Mineral Resources.

Once completed, NGHC will be the largest at-scale green hydrogen production company in the world based at Oxagon, home to advanced and clean industries within Neom, with a next generation port and fully automated and integrated supply chain and logistics network.



Neom Green Hydrogen Company gets Saudi operating licence (tradearabia.com)

Call for proposals

on 17 January. A total of € 195 million will be made available for projects in an unprecedented drive to support the creation of cutting-edge hydrogen technologies.

Details

26 topics available

7 topics – 49M€ funding-

Renewable Hydrogen Production

5 topics – 36M€ funding

Hydrogen Storage and Distribution

3 topics – 25.5M€ funding-

Transport

4 topics – 19M€ funding-

Heat and Power

3 topics – 7.5M€ funding

Cross-cutting

2 topics – 38M€ funding

Hydrogen Valleys

Che Clean Hydrogen Partnership launches today, 17 January 2023, its 2023 call for proposals. A total of € 195 million will be made available for projects that support the creation of cutting-edge clean hydrogen technologies

https://www.clean-hydrogen.europa.eu/call-proposals-2023-open_en#:~:text=The%20Clean%20Hydrogen%20Partnership%20launches,of%20cutting%2Dedge%20hydrogen%20technologies.

INDUSTRY NEWS

RETRANSMISSION: First Hydrogen Reveals Next Generation Zero Emission LCV

First Hydrogen Corp. is pleased to announce it has received initial Generation II images, designed in collaboration with EDAG Group (EDAG). These first released images show the next generation's front and rear detail. The front view features a smart digital panel, which shows the configuration of daytime running lights (DRL) designed to give the van a recognisable face and identity, as well as outstanding visibility. The rear elevation reveals vertical taillights either side of the main cargo access point. The design follows function as it accommodates different types of doors including tailgates, barn doors and roller shutters.



RETRANSMISSION: First Hydrogen Reveals Next Generation Zero Emission LCV, Business News - AsiaOne

PNE and OMNIA sign MoU for the production of green hydrogen and ammonia in South Africa

OMNIA GROUP (PTY) LTD. and WKN WINDCURRENT S.A (PTY) LTD (WKN)., a fully owned subsidiary of German based PNE AG, have signed a Memorandum of Understanding (MoU) to evaluate the onsite production of green hydrogen and ammonia in South Africa. This new ammonia production will be powered by renewable energy from hybrid sources. The PNE subsidiary is to develop the necessary equipment to combine energy generation from wind and solar with the production of the ammonia. The objective is to produce competitively priced green ammonia in the range of up to 100,000 tonnes per annum, which would result in a saving of 180,000 tonnes per annum of CO_2 emissions.

EQS-News: PNE and OMNIA sign MoU for the production of green hydrogen and ammonia in South Africa | Markets Insider (businessinsider.com)

World's first self-driving, hydrogen-powered lorry: $8.3m funding awarded

A self-driving zero-emission heavy goods vehicle, said to be the world's first, has moved a step closer after $8.3 million (£6.6 million) worth of funding for the project was awarded. Hydrogen Vehicle Systems (HVS), a UK-based hydrogen-powered commercial vehicle innovator, is developing the HGV for the UK market through the the consortium it leads, Hub2Hub. The consortium will create a self-driving heavy goods lorry, which will begin vehicles trials in 2024. Major UK retailer Asda is a strategic partner. The £12 million ($14.8 million) venture has been selected by the Centre for Connected Autonomous Vehicles (CCAV) as a recipient for its joint industry and government-funded project.



World's first self-driving, hydrogen-powered lorry: $8.3m funding awarded (thenationalnews.com)

Air Liquide supplies mobile hydrogen refueller to Californian transit agency

Air Liquide and public transport agency Foothill Transit will deploy an operational advanced hydrogen mobile fueller (AHMF) in Pomona, California, to encourage the adoption of hydrogen for medium- and heavy-duty vehicles.

Believed to be the first deployment of its kind, the mobile refuelling station is fully integrated onto a 45-foot split axle trailer and features sustainable, cryogenic cooling technology to store renewable energy as cryogenic liquids. It uses liquid nitrogen in place of electricity for processing cooling to perform fast hydrogen fuelling. Hydrogen distributed by the unit will be supplied by Air Liquide's largest liquid hydrogen production plant that is based in North Las Vegas, Nevada.

Air Liquide supplies mobile hydrogen refueller to Californian transit agency (gasworld.com)

National Hydrogen Mission

Decarbonising India, Achieving Net-Zero Vision

(Ministry of New & Renewable Energy)



"National Green Hydrogen Mission is a landmark step towards sustainable development and creating investment opportunities for our youth." - Prime Minister Narendra Modi.



The Mission will support pilot projects in other hard-to-abate sectors like steel, long-range heavy-duty mobility, shipping, energy storage etc. for replacing fossil fuels and fossil fuel based feedstocks with Green Hydrogen and its derivatives.

doc2023110150801.pdf (pib.gov.in)

Budget 2023: Outlay of Rs 17,400 crore announced for Green Hydrogen Mission

Out of the seven 2023 Budget priorities announced by Finance Minister, Nirmala Sitharaman, one was Green Mobility. As part of Green Mobility, The Finance minister announced 200 compressed biogas plants and 300 cluster-based plants, an exemption of tax on capital goods and machinery required to manufacture lithium-ion cells for batteries used in EVs and the focus on the National Green Hydrogen Mission.



Budget 2023: Outlay of Rs 17,400 crore announced for Green Hydrogen Mission - Times of India (indiatimes.com)

Govt. targeting 5 MT of green hydrogen production by 2030: Finance Minister

The government is targeting 5 million tonnes (MT) of green hydrogen production by 2030, Finance Minister Nirmala Sitharaman announced in her budget speech. She also said that the Budget provides for Rs 35,000 crore ffor priority capital investment towards energy transition and net zero objectives. The government would support setting up of battery energy storage of 4,000 MwH, she said, adding green credit programme will be also notified under the Environment Protecrion Act.

Govt targeting 5 MT of green hydrogen production by 2030: Finance minister - Times of India (indiatimes.com)

Railways Budget: More Vande Bharat Express productions, Hydrogen-Powered trains to roll out by December, says Ashwini Vaishnaw

Indian Railway got the highest-ever capital outlay of Rs 2.40 lakh crore in Budget 2023.

The Union Minister said that Hydrogen-Powered trains will roll out by December 2023 and added that the train will be fully designed and manufactured in India, which will first run on the heritage corridor Kalka-Shimla route and its likes. In line with the government's green energy mission, the railways will install ultra-mega solar power plants to cut the dependency on electricity. He, however, said that 85 percent of railway electrification has been completed.

Railways Budget: More Vande Bharat Express productions, Hydrogen-Powered trains to roll out by December, says Ashwini Vaishnaw | The Financial Express

Govt pushes green growth with credit score regime

Treating 'green growth' as one of the seven priorities — called 'Saptarishi' (seven divine sages) guiding India through the 'Amrit Kaal' (next 25 years) — of the government, the Budget proposed a 'green credit programme' and multiple other initiatives, including a big push to sustainable farming through PMPranam, in addition to an energy transition plan.

The 'green credit programme' under the Environment (Protection) Act will incentivise environmentally sustainable and responsive actions by companies, individuals and local bodies, and help mobilise additional resources for such activities in tune with India's pitch for LiFE (lifestyle for environment) — both domestically and globally.

http://timesofindia.indiatimes.com/articleshow/97539190.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppstAdani

India To Become Energy Independent By 2047 Under National Green Hydrogen Mission

Union Finance Minister Nirmala Sitharaman presented the Economic Survey 2022-2023 at the Union Parliament on Tuesday, January 31, 2023, a day before the announcement of the Union Budget 2023. The survey mentioned several areas such as climate change and environment, prices and inflation, social infrastructure and employment, and agriculture and food management, among others. It stated India's goals to combat climate change, and the efforts made by the country to reduce emissions and promote green energy. The slogan used to mention the feats achieved in the fight against climate is 'Climate Change and Environment: Preparing to Face the Future'.

Eco Survey 2022-2023: India To Become Energy Independent By

Claudia Carrasco et al. (2022)

Critical aspects in the development of anodes for use in seawater electrolysis

https://doi.org/10.1016/j.ijhydene.2021.11.002

Abstract:
The global water crisis limits the full implementation of purified water electrolysis across the world. Thus, seawater electrolysis has been identified as a powerful option to meet the requirements for sustainable production of green hydrogen without the constraint of using pure water. As in pure water electrolysis, seawater electrolysis research has been oriented to produce a durable, electrocatalytic, and selective anode.

Even though seawater electrolysis was proposed for the first time in 1980, the research found on this topic grew exponentially in the last few years. Nevertheless, researchers do not give a clear insight about the impact that important variables have in the process of seawater electrolysis and, in particular, the anodic process. In this work, an in-depth literature review on articles reporting the development of various anode materials and the conditions in which they have been tested was carried out. The conclusions reveal a need to standardize some parameters for testing the anodes, such as simulated seawater composition, pH of the solution, the method through which parasitic reactions are measured and the choice of secondary reactions to be considered in the process. A standardization of these parameters will allow researchers to compare results, which in turn will allow collaborative work towards the goal of finding a feasible process for seawater electrolysis.

Jiang, S.; Suo, H.; Zhang, T.; Liao, C.;Wang, Y.; Zhao, Q.; Lai, W., (2022)

Recent Advances in Seawater Electrolysis

file:///C:/Users/HP/Downloads/catalysts-12-00123-v3.pdf

Abstract:
Clean technologies play a crucial role in reducing greenhouse gas emissions and protecting the climate. Hydrogen is a promising energy carrier and fuel that can be used in many applications. We explore the global hydrogen technological innovation system (TIS) by analyzing the three knowledge and technology transfer channels of publications, patents, and standards. Since the adoption of hydrogen technologies requires trust in their safety, this study specifically also focuses on hydrogen safety. Our results show that general and hydrogen safety research has increased significantly while patenting experienced stagnation. An analysis of the non-patent literature in safety patents shows little recognition of scientific publications. Similarly, publications are underrepresented in the analyzed 75 international hydrogen and fuel cell standards. This limited transfer of knowledge from published research to standards points to the necessity for greater involvement of researchers in standardization. We further derive implications for the hydrogen TIS and recommendations for a better and more impactful alignment of the three transfer channels.

M Chatenet et al; (2022)

Water electrolysis: from textbook knowledge to the latest scientific strategies and industrial developments†

DOI: 10.1039/D0CS01079K

Abstract:
Replacing fossil fuels with energy sources and carriers that are sustainable, environmentally benign, and affordable is amongst the most pressing challenges for future socio-economic development. To that goal, hydrogen is presumed to be the most promising energy carrier. Electrocatalytic water splitting, if driven by green electricity, would provide hydrogen with minimal CO_2 footprint. The viability of water electrolysis still hinges on the availability of durable earth-abundant electrocatalyst materials and the overall process efficiency. This review spans from the fundamentals of electrocatalytically initiated water splitting to the very latest scientific findings from university and institutional research, also covering specifications and special features of the current industrial processes and those processes currently being tested in large-scale applications. Recently developed strategies are described for the optimisation and discovery of active and durable materials for electrodes that ever-increasingly harness first-principles calculations and machine learning. In addition, a technoeconomic analysis of water electrolysis is included that allows an assessment of the extent to which a large-scale implementation of water splitting can help to combat climate change. This review article is intended to cross-pollinate and strengthen efforts from fundamental understanding to technical implementation and to improve the 'junctions' between the field's physical chemists, materials scientists and engineers, as well as stimulate much-

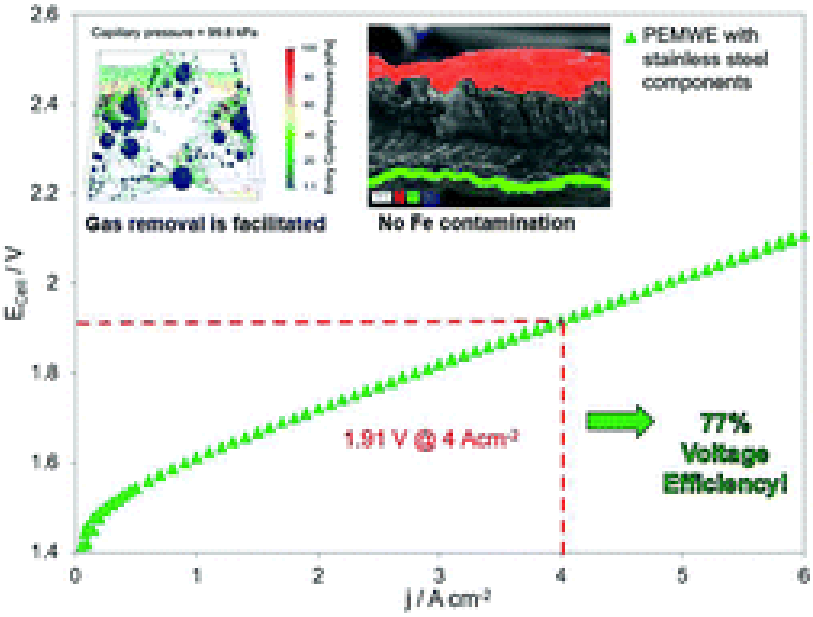
Essentials of High Performance Water Electrolyzers – From Catalyst Layer Materials to Electrode Engineering
https://doi.org/10.1002/aenm.202101998

Abstract
Proton-exchange membrane water electrolyzers (PEMWEs) will play a key role in future sustainable hydrogen production for mobility, households or chemical industry. Yet, the anode in PEMWEs, where the pivotal oxygen evolution reaction takes place, needs further improvement in terms of performance and cost. Both catalyst materials and electrode structure have to be optimized in order to inhibit degradation and reduce noble metal loadings. This review focuses on a holistic approach, covering all catalyst material, electrode structure, and transport layers within the framework of an overall electrode design, which not only optimizes the catalyst but also, all components of the electrode in conjunction. This review defines the goals for performance metrics of future PEMWEs in terms of power density and durability of the anode. Moreover, it summarizes manufacturing techniques and approaches that have a chance to be upscaled to meet the megawatt deployment of PEMWEs. The different aspects described jointly in this review such as novel catalyst system with higher intrinsic and structural performance or graded porous transport layers shall help to advance a next generation of electrodes.

A. S. Gago et al.2022

A high-performance, durable and low-cost proton exchange membrane electrolyser with stainless steel components†
https://doi.org/10.1039/D1EE02112E

Proton exchange membrane water electrolysis (PEMWE) is the most promising technology for sustainable hydrogen production. However, it has been too expensive to compete with current state-of-the-art technologies due to the high cost of titanium bipolar plates (BPPs) and porous transport layers (PTLs). Here, we report a high-performance, durable and low-cost PEMWE cell with coated stainless steel (ss) BPPs and PTLs. When using uncoated ss components in the PEMWE cell, the cell depolarizes rapidly, reaching 2 V at only 0.15 A cm^{-2}. After the application of non-precious metal coatings of Ti and Nb/Ti on the ss-BPP and ss-PTL, respectively, the current density can be increased by a factor of 13 while maintaining the same performance. Extensive physical and electrochemical characterization supported by pore network modelling shows that the Nb/Ti coating on the ss-PTL leads to efficient water and gas transport at the interface with the anode. The PEMWE cell with coated ss components was evaluated in an accelerated stress test (AST) for more than 1000 h. No sign of Fe contamination in either the membrane or the electrodes is observed at the end of the test. With our results, we demonstrate that PEMWE cells can be manufactured almost entirely in ss, facilitating an unprecedented cost reduction in this technology and advancing the widespread use of green H_2.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

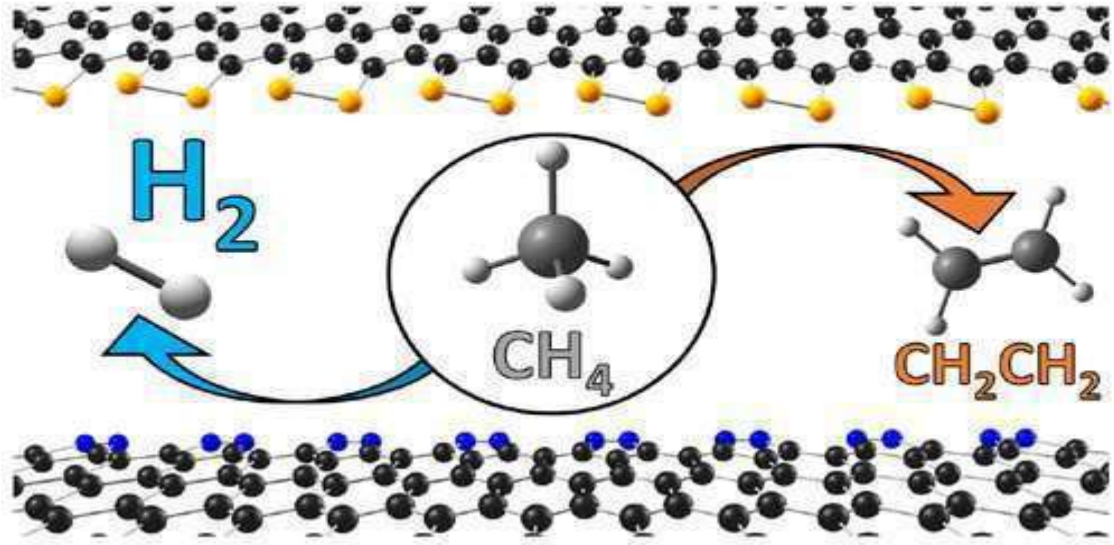
ISSUE. 20

February, 2023

Sustainable Hydrogen Production with Edge-Decorated Nanocarbons

Researchers from the University of Surrey have published a study in the journal ACS Applied Materials & Interfaces that shows promising results for the use of edge-decorated nanocarbons as metal-free catalysts for the production of hydrogen fuel. The study found that nitrogen-doped nanocarbons are particularly effective for hydrogen production and are also resistant to carbon poisoning, a common issue with catalysts in this process.

Hydrogen fuel is considered a clean and renewable energy source that has the potential to reduce carbon emissions and decrease our dependence on fossil fuels. When used as a fuel, it can power vehicles, generate electricity, and heat buildings, with water vapor being its only by-product. However, the current production of hydrogen fuel relies on fossil fuels and metal catalysts, which creates carbon emissions in the process and requires energy-intensive mining and manufacturing, which can negatively impact the environment.



The research team led by Dr. Marco Sacchi used quantum chemistry, thermodynamics, and chemical kinetics to determine the most efficient edge decoration for hydrogen production. According to Dr. Neubi Xavier Jr., the research fellow who performed the material science simulations, the results suggest that using edge-decorated nanocarbons as catalysts could be a "game-changer" for the hydrogen industry, offering a cost-effective and sustainable alternative to traditional metal catalysts. The study is a significant step towards realizing the full potential of hydrogen fuel as a clean energy source through the development of sustainable hydrogen production methods and catalytic materials.

Using edge-decorated nanocarbons for sustainable hydrogen production (phys.org)

First-Principles Microkinetic Modeling Unravelling the Performance of Edge-Decorated Nanocarbons for Hydrogen Production from Methane

Neubi F. Xavier Jr., Glauco F. Bauerfeldt, and Marco Sacchi**

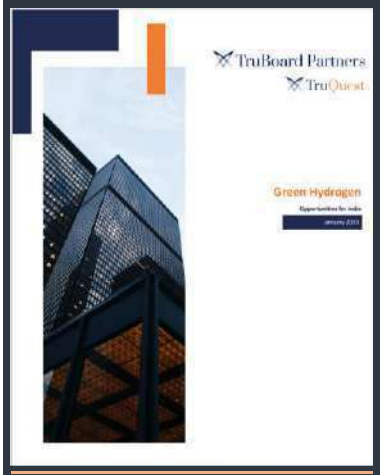
Abstract:-

The doping of graphitic and nanocarbon structures with nonmetal atoms allows for the tuning of surface electronic properties and the generation of new active sites, which can then be exploited for several catalytic applications. In this work, we investigate the direct conversion of methane into H2 and C2Hx over Klein-type zigzag graphene edges doped with nitrogen, boron, phosphorus and silicon. We combine Density Functional Theory (DFT) and microkinetic modeling to systematically investigate the reaction network and determine the most efficient edge decoration. Among the four edge-decorated nanocarbons (EDNCs) investigated, N-EDNC presented an outstanding performance for H2 production at temperatures over 900 K, followed by P-EDNC, Si-EDNC and B-EDNC. The DFT and microkinetic analysis of the enhanced desorption rate of atomic hydrogen reveal the presence of an Eley–Rideal mechanism, in which P-EDNC showed higher activity for H2 production in this scenario. Coke deposition resistance in the temperature range between 900 and 1500 K was evaluated, and we compared the selectivity toward H2 and C2H4 production. The N-EDNC and P-EDNC active sites showed strong resistance to carbon poisoning, whereas Si-EDNC showed higher propensity to regenerate its active sites at temperatures over 1100 K. This work shows that decorated EDNCs are promising metal-free catalysts for methane conversion into H2 and short-length alkenes.

https://doi.org/10.1021/acsami.2c20937

RECENT REPORT:-

Green Hydrogen Opportunities for India | January 2023



The global scenario regarding carbon emissions has become increasingly concerning in recent years, with the annual global carbon emissions rising by 6% in 2021 to reach 36.4 billion metric tonnes, their highest-ever levels. This rise was due to a recovery in manufacturing activities along with a recovery in energy demand, leading to more coal being burnt despite renewable power generation registering its largest-ever annual growth during this period. To combat global warming, countries have pledged to reduce their current emission levels and adopt technologies that provide alternatives to traditional modes of power generation and industrial production. One of the key technologies being explored to curb global emissions is green hydrogen, which is an excellent energy carrier with respect to weight and has substantial advantages over traditionally polluting resources.

India also aims to become a net-zero country by 2070 and is transitioning to a low-carbon economy with a focus on green hydrogen. This will bring benefits like reducing carbon emissions, lowering energy import bills, and utilizing the country's growing renewable energy capacity.

Green Hydrogen Report – January 2023 – Truboard Partners

INDUSTRY NEWS

South Australia's Ambitious Project to Construct the Largest Green Hydrogen Electrolyzer and Power Plant

The South Australian government has announced its plan to build a 250MW green hydrogen electrolyzer, which will be the largest in the world and 10 times bigger than existing plants. The hydrogen produced will be used to feed into a 200MW hydrogen power plant, which will also be the biggest of its kind. The project will be led by Sam Crafter, the CEO of the Office of Hydrogen Power in South Australia.



The radical plan to build world's biggest green electrolyser and hydrogen power plant | RenewEconomy

A truck carrying hydrogen fuel exploded in Delaware County

The Ohio State Highway Patrol reported a collision between a car and a truck carrying 420 kilograms of hydrogen. The resulting ignition of the hydrogen tanks in the truck's trailer caused a fire, damaging nearby traffic signals and utility lines. The explosion occurred approximately 30 seconds after the collision.



Truck carrying hydrogen fuel explodes in Delaware County, US 23 traffic light destroyed | WSYX (abc6onyourside.com)

Universal Hydrogen's Dash-300 Receives FAA Approval for Flight Testing

Universal Hydrogen, a California-based aviation company, has received experimental airworthiness certification from the FAA for its Dash-300 hydrogen-electric-powered aircraft. It is the largest of its kind and will be capable of carrying over 40 passengers using renewable fuel. The aircraft utilizes a hydrogen fuel-cell powertrain and does not use a hybrid battery, which helps reduce weight and lifecycle costs. The Dash-300 is the company's second product, started in 2020, and resembles ATR's configuration.



Largest hydrogen-powered passenger plane set to take flight | Team-BHP

Subsidiary of HHLA to Develop Concept Study for Hydrogen Bunker Station on Helgoland Island

HPC Hamburg Port Consulting, a subsidiary of Hamburger Hafen und Logistik AG, has been commissioned by the municipality of Helgoland to conduct a study for a hydrogen bunker station on the island. The aim of the study is to assess the feasibility of the island as a location for hydrogen fuel supply for shipping traffic on the North Sea and estimate the necessary investments. The study will be funded by the German Federal Ministry of Education and Research and HPC has experience in innovative energy projects in ship technologies and port infrastructure.

HHLA's subsidiary prepares concept study for a hydrogen bunker station on the deep-sea island of Helgoland (portnews.ru)

Masdar and Verbund partner on hydrogen production for Central Europe

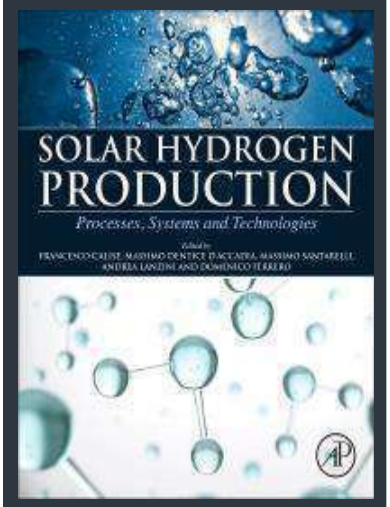
Masdar and Verbund have signed a deal to explore producing green hydrogen for the Central Europe market, specifically Austria and Southern Germany. Both companies aim to increase investment in the green hydrogen sector and meet growing demand in Europe. Verbund, which generates most of its electricity from renewable energy sources, is expanding its value chain into green hydrogen and recently partnered with ACWA Power to explore potential projects in the Middle East.

https://www.utilities-me.com/news/masdar-and-verbund-partner-on-hydrogen-production-for-central-europe

RECENT BOOK-

Solar Hydrogen Production Processes, Systems and Technologies

Edited by:- Francesco Calise, Massimo Dentice D'Accadia, Massimo Santarelli, Andrea Lanzini, Domenico Ferrero



Paperback ISBN: 9780128148532
eBook ISBN: 9780128148549

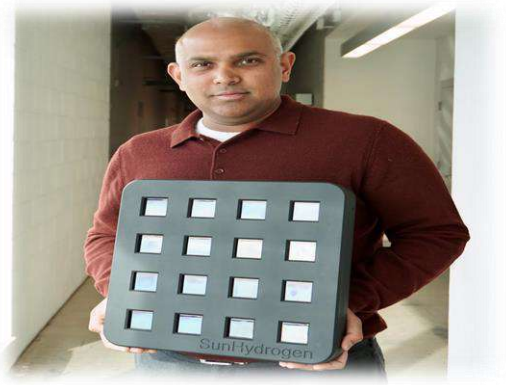
Solar Hydrogen Production: Processes, Systems and Technologies presents the most recent developments in solar-driven hydrogen generation methods. The book covers different hydrogen production routes, from renewable sources, to solar harvesting technologies. Sections focus on solar energy, presenting the main thermal and electrical technologies suitable for possible integration into solar-based hydrogen production systems and present a thorough examination of solar hydrogen technologies, ranging from solar-driven water electrolysis and solar thermal methods, to photo-catalytic and biological processes. All hydrogen-based technologies are covered, including data regarding the state-of-the art of each process in terms of costs, efficiency, measured parameters, experimental analyses, and demonstration projects.

Solar Hydrogen Production (elsevier.com)

INDUSTRY NEWS

SunHydrogen Reveals Advanced Nanoparticle-Based Green Hydrogen Generator Panel

SunHydrogen, a developer of green hydrogen technology, has published a photo of the latest nanoparticle technology. The prototype is the only self-contained hydrogen generator that splits water into hydrogen and oxygen using sunlight. The technology also supports 24-hour operation using renewable grid electricity. The company's larger panel moves them closer to producing commercial-scale hydrogen panels. SunHydrogen is working to increase production rates, improve efficiency, and overall stability of the hydrogen generators with the help of partnerships and agreements. The company's goal is to become a major supplier in the hydrogen economy.



SunHydrogen Unveils Larger Version of the World's First-Ever Nanoparticle-Based Green Hydrogen Generator — SunHydrogen

Hydrogen Refuelling Solutions to Reach Remote Industrial Sites with Mobile Stations

Enermech and Wolftank Group have partnered to bring hydrogen refuelling stations to Australia and New Zealand's industrial sectors to support the transition towards zero-emissions vehicles. The mobile hydrogen refuelling systems, supplied and maintained by Enermech, will be fast-refilled and suited for remote locations. According to McKinsey, by 2035 there could be as many as 850,000 hydrogen-fuelled trucks in Europe, requiring up to 4,800 hydrogen refuelling stations.

Mobile hydrogen refuelling stations set for remote mines and industrial sectors – pv magazine Australia (pv-magazine-australia.com)

Liquid Hydrogen Carrier Improves Safety Measures after Malfunction

The recent valve failure on the Suiso Frontier, the world's first liquid hydrogen carrier, has highlighted the need for stronger fault detection systems. The cause of the incident has been fixed, and the ship was able to complete its test journey without any further problems. The malfunction was due to a damaged automated valve caused by an incorrect specification for the control system's power supply. Despite the incident, the ship's builder, Kawasaki Heavy Industries, plans to build a commercial-scale hydrogen carrier by the mid-2020s and says there will be no impact on future construction plans. Shipping super-chilled hydrogen is seen as crucial in the fight against climate change, but it is one of many challenges in the use of hydrogen as a decarbonizing solution.



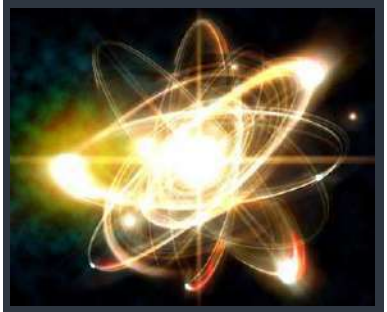
Safety improved on world's first liquid hydrogen carrier after malfunction | Reuters

EverWind Gets Approval for North America's First Green Hydrogen Facility

EverWind Fuels, a green hydrogen producer, has become the first in North America to secure permits for a commercial-scale hydrogen facility. The Canadian provincial authorities approved the conversion of a former oil storage facility and marine terminal in Nova Scotia into a green hydrogen and ammonia production hub. Green Hydrogen is being incorporated into many governments' future energy plans due to its potential to help reach emission-reduction targets. The first phase of the project is expected to be online in 2025, producing and exporting 200,000 tonnes per annum, before ramping up to 1 million tonnes per annum in 2026. The company has agreements with German energy firms E.ON and Uniper to acquire the production. The project is expected to cost around $6 billion and will be funded by debt financing from three banks and equity capital from Vichie's family office.

EverWind Fuels gets approval for North America's first green hydrogen facility - The Globe and Mail

Unlocking the Potential of Thorium: A Path to Net-Zero Energy and Hydrogen



The Bhabha Atomic Research Centre (BARC) in India is working on using thorium as a source of green energy through two technologies: the Indian high-temperature reactor (IHTR) and the Indian molten salt breeder reactor (IMSBR). The IHTR produces hydrogen through the sulphur-iodine method using a mixture of uranium-233 dioxide and thorium dioxide as fuel. The IMSBR is a 5 MW pilot project in Visakhapatnam that features a fluid fuel of thorium-based salt, which can be pumped out to increase the output of uranium-233 from thorium. The IMSBR also produces electricity through the highly efficient Brayton cycle using supercritical carbon dioxide instead of the conventional Rankine cycle, reducing water usage and increasing electricity production. Both reactors are currently in the exploratory evaluation and initial assessment stages. The establishment of the IMSBR demonstration plant in Visakhapatnam will be a significant milestone in India's pursuit of clean energy, with the introduction of the thorium cycle.

Why Thorium is key to our net zero goals - The Hindu BusinessLine

Northern Railways to Invest Rs 70 Crore in Jind Hydrogen Plant for First Hydrogen Train Operations

The Indian National Railway is pushing forward with plans to retrofit its existing Diesel Electric Multiple Unit (DEMU) trains with hydrogen fuel cells. The goal is to begin field trials for the first hydrogen train prototype on the Jind-Sonipat section of the Northern Railway during the 2023-2024 fiscal year. Efforts to procure materials for setting up a hydrogen pump in Jind and to establish the necessary infrastructure for the country's first hydrogen train are also underway.

Northern Railways: Hydrogen Plant At Jind To Cost Rs 70 Crore To Run First Hydrogen Train (swarajyamag.com)

At the India Energy Week in Bengaluru, Reliance demonstrated a hydrogen-powered truck.

Reliance Industries demonstrated a hydrogen-powered truck at the India Energy Week in Bengaluru, manufactured by Ashok Leyland. It is India's first H2ICE technology truck with "near-zero emissions" and performance "on-par" with diesel engines. Reliance and Adani Group are investing in the green hydrogen ecosystem as part of their decarbonization plans, with Reliance investing $80 billion over 10-15 years and Adani investing $20 billion over the next decade in renewable energy and component manufacturing.



Reliance showcases hydrogen-run truck at India Energy Week in Bengaluru | Business Standard News (business-standard.com)

Kerala treads cautiously on hiring hydrogen buses, KMRL told to re-tender

The Kochi Metro Rail Limited had tendered for the hiring of 10 hydrogen buses with a hydrogen fuel dispensation unit and supply of fuel, but the bid price was considered unrealistic and would add extra burden to the state. The bidder agreed to provide hydrogen at a rate of ₹991 per kg, while hydrogen could be obtained from other sources for around ₹500 per kg and the price is expected to decrease. The KMRL has been instructed to re-tender the process.

Kerala treads cautiously on hiring hydrogen buses, KMRL told to re-tender - The Hindu

EIB joins hands with India hydrogen alliance to promote green hydrogen

The European Investment Bank (EIB) will join the India Hydrogen Alliance (IH2A) and provide funding of 1 billion euros for large-scale green hydrogen projects in India, pending approval from the Indian government and EIB. The IH2A is a coalition of companies working to establish a hydrogen value chain and economy in India, and the EIB aims to support India's National Hydrogen mission to decarbonize energy, industry, and transport. The EIB and IH2A will work together to create a green hydrogen roadmap that supports India's energy transition and enhances energy security.

European Investment Bank agrees to join India Hydrogen Alliance | The Financial Express

Revolutionizing Green Hydrogen Production: A Cleantech Startup's Breakthrough with Advanced Technology

Saurabh Tembhurne, CEO of SoHHytec, has developed an efficient, durable, and cost-effective technology for solar fuel production. SoHHytec, founded in 2019, provides hydrogen and energy as a service through its artificial trees, called "Arbs," which mimic photosynthesis to produce hydrogen, energy, heat, and pure oxygen. The Arbs' photo-electrochemical device offers a higher efficiency in converting solar energy to hydrogen than traditional methods. SoHHytec operates gardens of Arbs and offers them to industrial customers for hydrogen and oxygen production while also providing heat.



How this cleantech startup is revolutionising green hydrogen production with cutting-edge technology (yourstory.com)

Fahim, I.; Mohsen, O.; ElKayaly, D

Production of Fuel from Plastic Waste: A Feasible Business

https:// doi.org/10.3390/polym13060915

Abstract:
This paper aims to conduct a feasibility study of producing fuel from plastic waste. It is a suggested approach to deal with the huge production of synthetic plastic around the world, so as to avoid its accumulation in landfills and the depletion of resources. Several types of research have addressed the conversion of plastic waste into energy, and in this study the authors focused on using pyrolysis to convert plastic to liquid oil. Accordingly, the volume of the waste was reduced significantly, and the produced liquid oil had a high calorific value in comparison to fossil fuel. The authors managed to develop a profitable business model for a facility producing fuel from plastic waste in Egypt. This project could be a very lucrative business opportunity for investors or venture capitalists interested in investing in green economy. A Business Model Canvas was used as a tool to identify how the different components of the business relate to each other.

Kai Lan & Yuan Yao (2022)

Feasibility of gasifying mixed plastic waste for hydrogen production and carbon capture and storage

https://doi.org/10.1016/j.ijhydene.2022.10.055

Abstract:
Waste plastic gasification for hydrogen production combined with carbon capture and storage is one technology option to address the plastic waste challenge. Here, we conducted a techno-economic analysis and life cycle assessment to assess this option. The minimum hydrogen selling price of a 2000 oven-dry metric ton/day mixed plastic waste plant with carbon capture and storage is US$2.26–2.94 kg^{-1} hydrogen, which can compete with fossil fuel hydrogen with carbon capture and storage (US$1.21–2.62 kg^{-1} hydrogen) and current electrolysis hydrogen (US$3.20–7.70 kg^{-1} hydrogen). An improvement analysis outlines the roadmap for reducing the average minimum hydrogen selling price from US$2.60 to US$1.46 kg^{-1} hydrogen, which can be further lowered to US$1.06 kg^{-1} hydrogen if carbon credits are close to the carbon capture and storage costs along with low feedstock cost. The life cycle assessment results show that hydrogen derived from mixed plastic waste has lower environmental impacts than single-stream plastics.

Wenlong Jia; Qingyang Ren; et al.

Analysis of hydrogen production potential from waste plastics by pyrolysis and in line oxidative steam reforming

https://doi.org/10.1016/j.fuproc.2021.107044

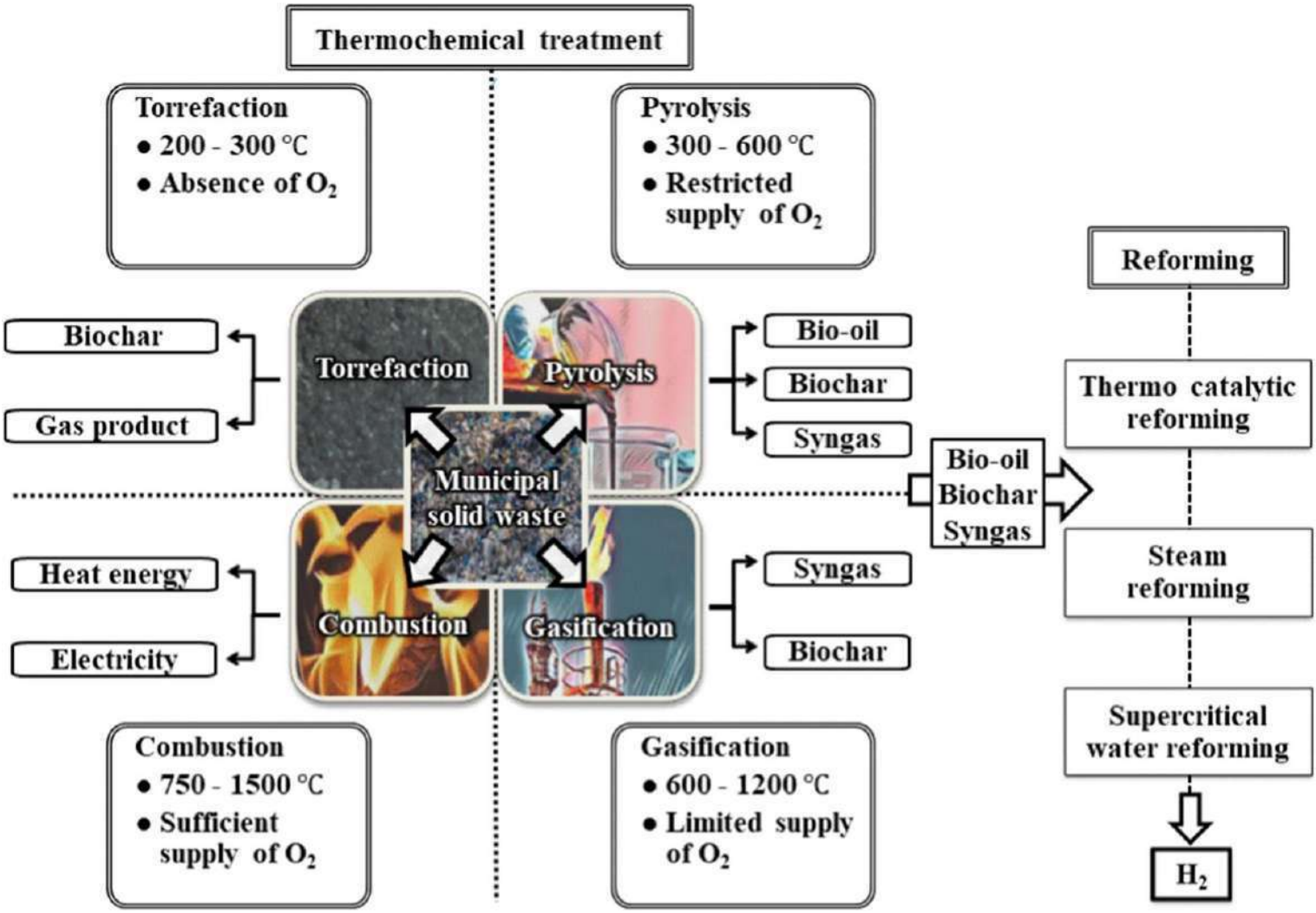
Abstract:
A study was carried out on the valorization of different waste plastics (HDPE, PP, PS and PE), their mixtures and biomass/HDPE mixtures by means of pyrolysis and in line oxidative steam reforming. A thermodynamic equilibrium simulation was used for determining steam reforming data, whereas previous experimental results were considered for setting the pyrolysis volatile stream composition. The adequacy of this simulation tool was validated using experimental results obtained in the pyrolysis and in line steam reforming of different plastics. The effect the most relevant process conditions, i.e., temperature, steam/plastic ratio and equivalence ratio, have on H_2 production and reaction enthalpy was evaluated. Moreover, the most suitable conditions for the oxidative steam reforming of plastics of different nature and their mixtures were determined. The results obtained are evidence of the potential interest of this novel valorization route, as H_2 productions of up to 25 wt% were obtained operating under autothermal conditions.

Nandhini, R., Berslin, D., Sivaprakash, B. et al (2022)

Thermochemical conversion of municipal solid waste into energy and hydrogen: a review

https://doi.org/10.1007/s10311-022-01410-3

Abstract:
The rising global population is inducing a fast increase in the amount of municipal waste and, in turn, issues of rising cost and environmental pollution. Therefore, alternative treatments such as waste-to-energy should be developed in the context of the circular economy. Here, we review the conversion of municipal solid waste into energy using thermochemical methods such as gasification, combustion, pyrolysis and torrefaction. Energy yield depends on operating conditions and feedstock composition. For instance, torrefaction of municipal waste at 200 °C generates a heating value of 33.01 MJ/kg, while the co-pyrolysis of cereals and peanut waste yields a heating value of 31.44 MJ/kg at 540 °C. Gasification at 800 °C shows higher carbon conversion for plastics, of 94.48%, than for waste wood and grass pellets, of 70–75%. Integrating two or more thermochemical treatments is actually gaining high momentum due to higher energy yield. We also review reforming catalysts to enhance dihydrogen production, such as nickel on support materials such as CaTiO3, SrTiO3, BaTiO3, Al2O3, TiO3, MgO, ZrO2. Techno-economic analysis, sensitivity analysis and life cycle assessment are discussed.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 21

February, 2023

Nitrogen-Doped Porous Nickel Molybdenum Phosphide Sheets for Efficient Seawater Splitting

Suraj Loomba; Muhammad Wagas Khan; Muhammad Haris; Seyed Mahdi Mousavi; et al.

Abstract:-

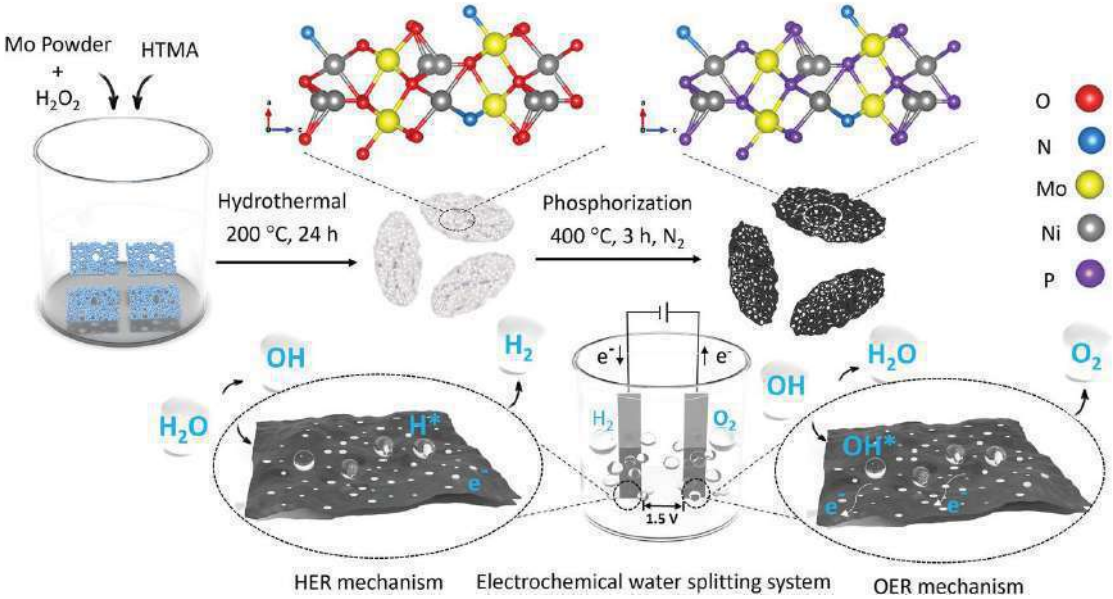
Hydrogen is emerging as an alternative clean fuel; however, its dependency on freshwater will be a threat to a sustainable environment. Seawater, an unlimited source, can be an alternative, but its salt-rich nature causes corrosion and introduces several competing reactions, hindering its use. To overcome these, a unique catalyst composed of porous sheets of nitrogen-doped NiMo3P (N-NiMo3P) having a sheet size of several microns is designed. The presence of large homogenous pores in the basal plane of these sheets makes them catalytically more active and ensures faster mass transfer. The introduction of N and Ni into MoP significantly tunes the electronic density of Mo, surface chemistry, and metal-non-metal bond lengths, optimizing surface energies, creating new active sites, and increasing electrical conductivity. The presence of metal-nitrogen bonds and surface polyanions increases the stability and improves anti-corrosive properties against chlorine chemistry. Ultimately, the N-NiMo3P sheets show remarkable performance as it only requires overpotentials of 23 and 35 mV for hydrogen evolution reaction, and it catalyzes full water splitting at 1.52 and 1.55 V to achieve 10 mA cm−2 in 1 m KOH and seawater, respectively. Hence, structural and compositional control can make catalysts effective in realizing low-cost hydrogen directly from seawater.

https://doi.org/10.1002/smll.202207310

Hydrogen straight from seawater – no desalination required



Researchers at RMIT University have developed a more cost-effective and energy-efficient method for producing hydrogen directly from seawater. The new method skips the need for desalination, which is costly, energy-intensive, and associated with carbon emissions. The traditional method of producing hydrogen uses expensive catalysts and consumes a lot of energy and water. Moreover, almost all of the world's hydrogen currently comes from fossil fuels, which is responsible for around 830 million tonnes of CO2 emissions annually. The RMIT researchers' approach uses a special type of catalyst developed specifically to work with seawater, which requires very little energy to run and could be used at room temperature. The technology has the potential to significantly bring down the cost of electrolysers, making it competitive with fossil fuel-sourced hydrogen. The researchers are working with industry partners to develop the technology further, with the aim of advancing the establishment of a thriving green hydrogen industry.



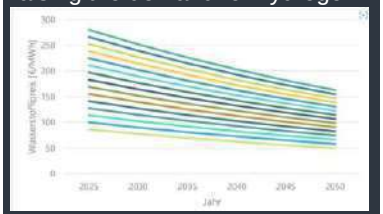
How to make hydrogen straight from seawater – no desalination required - RMIT University

Study looks at price-elastic demand for hydrogen in achieving climate goals



Preiselastische Wasserstoffnachfrage in Deutschland – Methodik und Ergebnisse (hypat.de)

A new study by Fraunhofer ISI addresses the uncertainty about the specific applications and scope of hydrogen use in achieving greenhouse gas neutrality. The study looks at the price-elastic demand for hydrogen in sectors such as industry, transport, and energy conversion. The study shows that hydrogen has an important role to play in meeting climate goals, especially in achieving greenhouse gas neutrality. However, the extent of hydrogen use is still unclear, and a key criterion is the price of hydrogen and its ability to compete with other options. The study analyzes the applications in industry, transport, and energy conversion using simulation models, and assesses these from an economic viewpoint. The study shows that the demand for hydrogen will develop in specific sectors to achieve greenhouse gas neutrality in 2045, with certain industrial applications dominating the demand for hydrogen. However, low wholesale prices are not to be expected and are therefore not likely to contribute to raising the demand for hydrogen.



How could the demand for hydrogen and its price develop up to 2045? (techxplore.com) – Original in German

China's first integrated methanol hydrogen production and refueling station begins operations

China Petrochemical Corp (Sinopec) has put into operation China's first integrated methanol hydrogen production and refueling station in Dalian, Liaoning province. The station can produce 1,000 kg of high-purity hydrogen per day using a methanol-to-hydrogen process, reducing costs by 20% by cutting down expenses in hydrogen storage and transportation. The integrated station is expected to provide a model for on-site hydrogen production in China, where the hydrogen refueling stations currently rely on tube trailers for transport, resulting in higher costs and lower efficiency. Sinopec claims that storage and transportation are the main factors limiting the development of the hydrogen energy industry in China.



China's first methanol hydrogen production, refueling station begins operations - Chinadaily.com.cn

Dutch to Build North Sea Network for Offshore Wind-Generated Hydrogen to Germany

Gasunie plans to build a hydrogen network in the German part of the North Sea for transporting green hydrogen from offshore wind farms and enable imports from Norway. The plan has been submitted to the EU for Important Project of Common European Interest (IPCEI) status, which would allow billions of euros of investment. The system would be connected to an also-planned Dutch offshore network, providing cross-border import and export options. This comes as Equinor and RWE plan to pump blue hydrogen through a pipeline from Norway to Germany by 2030, and AquaVentus aims to produce green hydrogen from offshore wind farms around the German North Sea.

Dutch plan North Sea network to pump offshore wind-powered hydrogen to Germany | Recharge (rechargenews.com)

Nikola constructing hydrogen fuel network to increase production of emission-free trucks

Nikola, an electric truck manufacturer, is building hydrogen plants and signing up producers to create a fuelling network for its zero-emission trucks. The company is negotiating with Fortescue Future Industries to extract hydrogen from water, and has already planned a storage plant with hydrogen company Plug Power. Nikola's hydrogen-powered trucks can travel up to 500 miles before refueling, and the company estimates it will build 60 fuelling stations in the US within three years. The initial offer of Nikola's trucks will come with leases that cover the cost of hydrogen fuel.



Hydrogen fuel network on Nikola's to-do list for zero-emission trucks; details here (firstpost.com)

Hydrogen Consortium to bring zero-emission aircraft to New Zealand

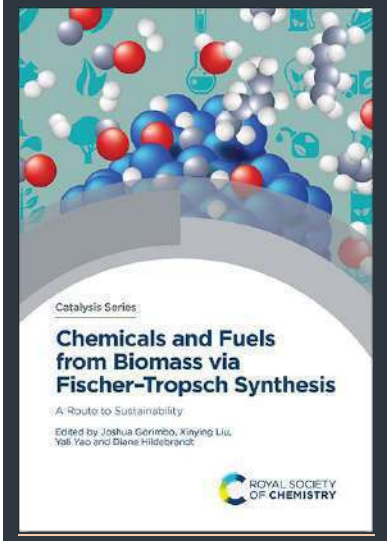
Airbus, Fortescue Future Industries (FFI), Air New Zealand, Hiringa Energy, Fabrum, and Christchurch Airport have launched a consortium to develop a hydrogen ecosystem for zero-emission aviation in New Zealand. The partners will collaborate to deploy green hydrogen-powered aircraft and support the commercial deployment of hydrogen technology. They will focus on research, examining the hydrogen supply chain, assessing the local aviation market's projected hydrogen needs, and developing policies, regulations, and incentives to promote hydrogen aviation. The second phase will involve testing hydrogen aircraft flights in New Zealand, with Air New Zealand planning to fly its first commercial demonstration flight in 2026 and replace its Q300 Turboprop fleet with low-emission aircraft by 2030. The consortium aims to make hydrogen-powered aviation a reality and lead the world in zero-emission air travel.

https://www.ttnworldwide.com/Article/344106/-Alliance-to-develop-green-hydrogen-powered-aircraft

RECENT BOOK-

Chemicals and Fuels from Biomass via Fischer–Tropsch Synthesis: A Route to Sustainability

Edited by:- Joshua Gorimbo; Xinying Liu; Yali Yao; Diane Hildebrandt



Paperback ISBN: 978-1-83916-393-7
pdf ISBN: 978-1-83916-782-9

This book explores the use of Fischer-Tropsch Synthesis (FTS) to convert biomass into chemicals as a way to reduce reliance on fossil fuels. It focuses on the challenges hindering effective biomass use and highlights key technological developments necessary for industrializing biofuels on a global scale. The book covers traditional and new biomass to hydrocarbons pathways, including catalysts, reactors, and process synthesis. It is an excellent resource for academics and practitioners working in catalysis and chemical engineering.

https://doi.org/10.1039/9781839167829

Ontario Government Establishes $15M Hydrogen Innovation Fund to Promote Clean Energy

The Ontario government has established a Hydrogen Innovation Fund of $15 million over the next three years to promote the use of hydrogen in clean energy projects. The fund will support existing and new hydrogen facilities, as well as research studies investigating the feasibility of hydrogen. Natural Resources Canada estimates that hydrogen could deliver 30% of Canada's fuels and feedstock by 2050, and create 100,000 jobs in Ontario. The Niagara Hydrogen Centre is an example of an emerging sector that will increase Ontario's hydrogen production. The government's Low-Carbon Hydrogen Strategy aims to make Ontario a leader in energy innovation and identifies potential hydrogen hubs in various locations. The fund is intended to support the growth of hydrogen as a versatile, clean fuel and to create jobs while reducing emissions.

Ontario wants to be a leader in hydrogen innovation - Sudbury News

JCB retrofits Mercedes truck with hydrogen engine.

JCB, a construction equipment manufacturer, has retrofitted a 7.5 tonne Mercedes truck with one of its hydrogen engines in just a few days. JCB Chairman, Anthony Bamford, who has been leading the company's £100m hydrogen project, was one of the truck's first test drivers. The hydrogen internal combustion engine used in the truck is the same as those powering JCB prototype construction and agricultural machines, and has the potential to be used in vehicles on the roads in the future. JCB has already produced 50 hydrogen internal combustion engines to power prototype JCB backhoe loader and Loadall telescopic handler machines. The truck in this latest project was previously diesel-powered.



JCB completes hydrogen engine retrofit | Manufacturing Manufacturing News (insidermedia.com)

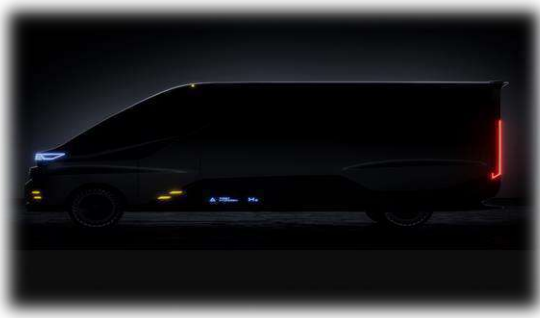
sHYp's Green Hydrogen Technology Set to Revolutionize Seawater Electrolysis

Green hydrogen technology start-up sHYp has relocated to The James Hutton Institute in Aberdeen, where it plans to expand its team to five staff by summer. The company will use the institute's analytical equipment and expertise to develop an electrolyzer capable of producing hydrogen from seawater, without desalination. sHYp's technology uses renewable electricity to split seawater into hydrogen and oxygen and can also extract by-products such as carbon dioxide and magnesium hydroxide, which could reduce the price of its green hydrogen. The company plans to help power users close to or at sea, such as ports and offshore facilities, to harness surplus offshore renewable energy by turning it into hydrogen. sHYp was recently awarded funding from the Net Zero Technology Centre to increase its staffing, and its first appointment will be an electrochemist.

Aberdeen's James Hutton Institute Hosts Green Hydrogen (marinelink.com)

First Hydrogen showcases sleek design and long range for Generation II fuel cell van

First Hydrogen has unveiled concept images for its second-generation fuel cell-powered van, developed in collaboration with global mobility engineering firm EDAG Group. The design focuses on a bolder face and identity, including the company's signature daytime running lights and vertical tail-lights. The scalable design is optimized for flexible-use large panel vans suited to commercial operation in sectors such as delivery, roadside assistance, grocery, construction and healthcare. The vehicle has a 400-600 km range and can be refueled in around five minutes, making it an attractive option for fleet operators.



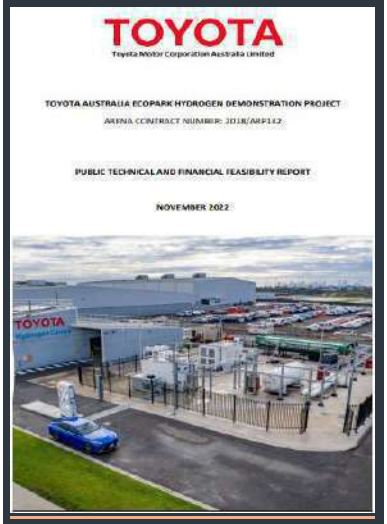
First Hydrogen gives latest teaser of next-generation van (evfleetworld.co.uk)

RECENT REPORT:-

Toyota Motor Corporation Australia Limited

TOYOTA AUSTRALIA ECOPARK HYDROGEN DEMONSTRATION PROJECT ARENA

PUBLIC TECHNICAL AND FINANCIAL FEASIBILITY REPORT



The Toyota Ecopark Hydrogen Demonstration project will transform part of Toyota Australia's decommissioned car manufacturing plant in Altona (VIC) into a renewable energy hub to produce renewable hydrogen for both stationary energy and transport energy uses.

The project aims to demonstrate the technical and economic feasibility of producing, storing, and using hydrogen sourced from renewable powered electrolysis.

toyota-ecopark-hydrogen-demonstration-public-technical-financial-feasibility-report.pdf (arena.gov.au)

INDIA NEWS

Kerala Plans to Create 'Hydrogen Valleys' in Kochi and Thiruvananthapuram

The Indian state of Kerala aims to develop "hydrogen valleys" in Kochi and Thiruvananthapuram, and achieve 30% green hydrogen blending by 2027, according to a preliminary draft of the Kerala green hydrogen policy. The government intends to set up a hydrogen hub in Kochi under the India Hydrogen Alliance and be a leading hydrogen producer and exporter, as well as 100% green hydrogen consumer by 2040. Kerala plans to offer incentives to reduce the cost of green hydrogen to below $2/kg and establish centres of excellence for R&D, among other plans.

Kerala looking to develop 'hydrogen valleys' in capital, Kochi - The Hindu

Hydrogen Fuel Cell E-Bus to Drive Net Zero Emissions by 2070, Says Oil India Limited Director (Operations).

In an interview with All India Radio at the India Energy Week 2023, Mr. Goswami expressed his belief that the future of mobility lies in hydrogen, and that small initiatives like the one being launched by OIL (Oil India Limited) will help to meet the green targets set by Prime Minister Modi. Specifically, OIL has already commissioned a Green Hydrogen Generation plant in Johrhat and has developed an e-bus under its Startup program, SNEH, that runs on a 60 KW capacity fuel cell using Proton Exchange Membrane (PEM) technology to produce electricity. The bus has a tank capacity of 21.9 kg at 350 bar pressure and is designed to accommodate 32 persons including the driver and has a wheelchair facility. The e-bus will initially run from Johrhat to Kaziranga National Park on a test basis for one year, after which it will be launched in other parts of the country. Prime Minister Narendra Modi flagged off the e-bus on the first day of India Energy Week in Bengaluru. OIL's initiative is in line with the National Hydrogen Mission and Atmanirbhar Bharat vision to encourage indigenously developed hydrogen fuel cell technology.



Oil India Limited Director(operations) says launch of hydrogen fuel cell based e-bus to achieve net zero emission by 2070 (newsonair.gov.in)

India's First Solid Waste-to-Hydrogen Plant to be Set up in Pune

The A solid waste-to-hydrogen plant, the first of its kind in India, will be set up in Pune at a cost of over Rs 430 crore. Sustainability solutions provider, TheGreenBillions Ltd (TGBL), will be responsible for setting up the plant in collaboration with the Pune Municipal Corporation (PMC). The plant is expected to treat 350 tonnes of solid waste daily by next year and produce 10 tonnes of hydrogen per day. The PMC will pay TGBL Rs 347 per tonne to treat the waste. TheGreenBillions Ltd will invest Rs 350 crore in setting up the plant and an additional Rs 82 crore for the storage facility and logistics support. The project will use plasma gasification technology to generate hydrogen from refuse-derived fuel, with support from the Bhabha Atomic Research Institute and the Indian Institute of Science, Bengaluru. The project aims to demonstrate the technological and financial feasibility of waste to hydrogen generation. The plant will be completed by November 2024, and TGBL is in talks with other state municipalities across India to set up similar plants in the future.

Country's first waste-to-hydrogen plant to be set up in Pune, said official | Business Standard News (business-standard.com)

ReNew Power to Explore Investment Opportunities in Green Hydrogen Space, Confirms Chairman

ReNew to explore investment opportunities in hydrogen segment: Chairman Sumant Sinha

ReNew, a clean energy company that is known for producing renewable energy through solar and wind-based projects, is now planning to expand its business portfolio by exploring investment opportunities in the green hydrogen space. The company's chairman, Sumant Sinha, made this announcement during a recent event in the national capital where ReNew was being re-branded. As one of the largest independent power producers in the world, ReNew aims to increase its presence in the hydrogen value chain by potentially investing in the manufacturing of electrolysers and green ammonia. Sinha confirmed that the company is indeed looking to expand its business in the hydrogen space.

ReNew to explore investment opportunities in hydrogen segment: Chairman Sumant Sinha, Energy News, ET EnergyWorld (indiatimes.com)

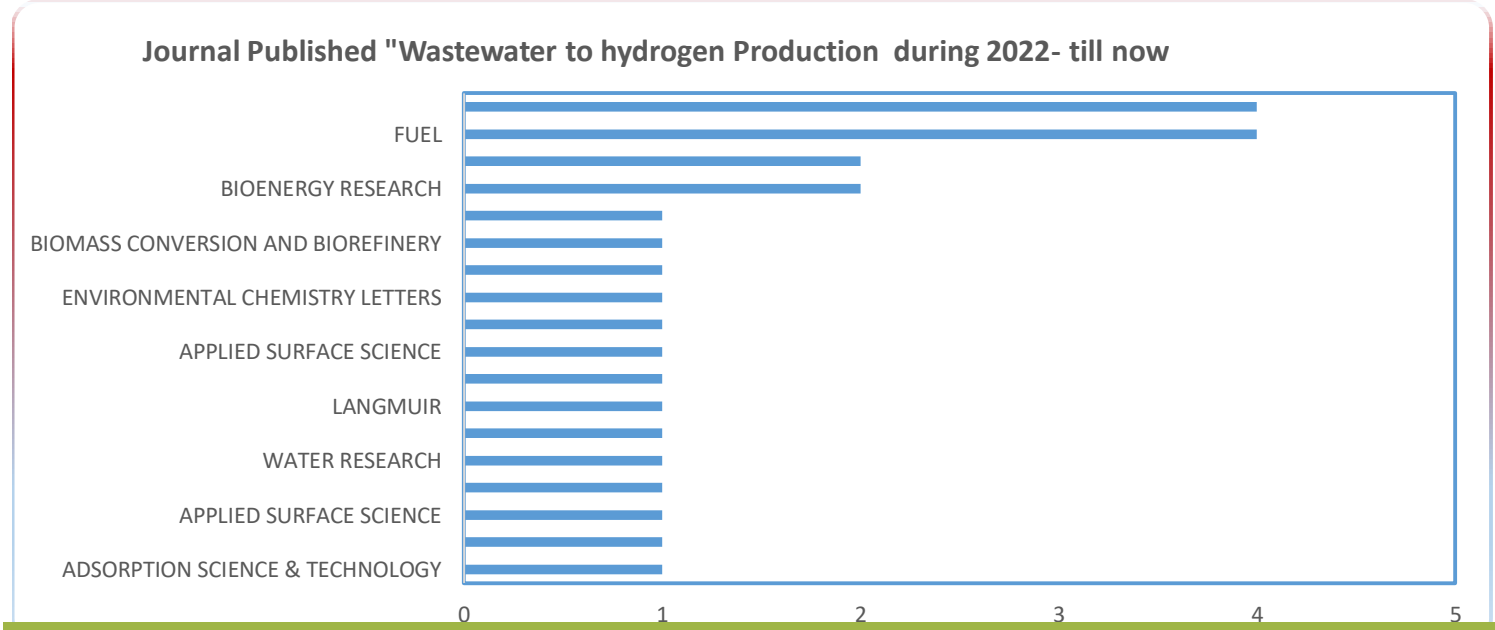
Wastewater to hydrogen Production: Snapshot of highly cited publication 2022-2023)

Wastewater-to-hydrogen (WWH) production is an emerging field of research that has gained increasing attention in recent years due to its potential to provide a sustainable and renewable source of hydrogen, which can be used as a clean energy carrier. There are several publications and research studies that explore various methods for WWH production. Here are some of the important publications and research studies published during 2022-2023 in this field

Article Title	Journal Name	DOI Link
Construction of Bi-assisted modified CdS/TiO2 nanotube arrays with ternary S-scheme heterojunction for photocatalytic wastewater treatment and hydrogen production	FUEL	http://dx.doi.org/10.1016/j.fuel.2022.124163
CdTe and Ag nanoparticles co-modified TiO2 nanotube arrays for the enhanced wastewater treatment and hydrogen production	JOURNAL OF ENVIRONMENTAL CHEMICAL ENGINEERING	http://dx.doi.org/10.1016/j.jece.2022.107207
Highly-efficient photocatalytic activity of TiO2-AC nanocomposites for hydrogen production from sulphide wastewater	INTERNATIONAL JOURNAL OF HYDROGEN ENERGY	http://dx.doi.org/10.1016/j.ijhydene.2022.02.019
Stacked titanium dioxide nanotubes photoanode facilitates unbiased hydrogen production in a solar-driven photoelectrochemical cell powered with a microbial fuel cell treating animal manure wastewater	ENERGY CONVERSION AND MANAGEMENT	http://dx.doi.org/10.1016/j.enconman.2022.115225
Emerging technologies for hydrogen production from wastewater	INTERNATIONAL JOURNAL OF HYDROGEN ENERGY	http://dx.doi.org/10.1016/j.ijhydene.2022.06.225
Consolidated bioprocessing of biomass and synthetic cadmium wastewater substrates for enhancing hydrogen production by Clostridium thermocellum-CdS complex	FUEL	http://dx.doi.org/10.1016/j.fuel.2022.123207
Reaction pathways and kinetics for hydrogen production by oilfield wastewater gasification in supercritical water	FUEL	http://dx.doi.org/10.1016/j.fuel.2022.123135
Responses of anaerobic hydrogen-producing granules to acute microplastics exposure during biological hydrogen production from wastewater	WATER RESEARCH	http://dx.doi.org/10.1016/j.watres.2022.118680
Surface functionalization of Linde F (K) nano-zeolite and its application for photocatalytic wastewater treatment and hydrogen production	APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING	http://dx.doi.org/10.1007/s00339-022-05618-6
Preparation of a Coal-Based MoS2/SiO2/GO Composite Catalyst and Its Performance in the Photocatalytic Degradation of Wastewater and Hydrogen Production	LANGMUIR	http://dx.doi.org/10.1021/acs.langmuir.2c00163
Photoelectrocatalytic degradation of wastewater and simultaneous hydrogen production on copper nanorod-supported coal-based N-carbon dot composite nanocatalysts	APPLIED SURFACE SCIENCE	http://dx.doi.org/10.1016/j.apsusc.2022.152701
Determination of Anaerobic Co-fermentation of Brewery Wastewater and Brewer's Spent Grains for Bio-hydrogen Production	BIOENERGY RESEARCH	http://dx.doi.org/10.1007/s12155-022-10486-2
A comprehensive review on bio-hydrogen production from brewery industrial wastewater and its treatment methodologies	FUEL	http://dx.doi.org/10.1016/j.fuel.2022.123594
Peroxymonosulfate activation based on Co (9) S- 8 @N -C: A new strategy for highly efficient hydrogen production and synchronous formaldehyde removal in wastewater	JOURNAL OF MATERIALS SCIENCE & TECHNOLOGY	http://dx.doi.org/10.1016/j.jmst.2022.05.023
Hydrogen production from wastewater, storage, economy, governance and applications: a review	ENVIRONMENTAL CHEMISTRY LETTERS	http://dx.doi.org/10.1007/s10311-022-01480-3
ATO/Polyaniline/PbS Nanocomposite as Highly Efficient Photoelectrode for Hydrogen Production from Wastewater with Theoretical Study for the Water Splitting	ADSORPTION SCIENCE & TECHNOLOGY	http://dx.doi.org/10.1155/2022/5628032
Hydrogen Production by Wastewater Alkaline Electro-Oxidation	ENERGIES	http://dx.doi.org/10.3390/en15165888
Hydrogen production via photoreforming of wastewater under LED light-driven over CuO@exfoliated g-C3N4 nanoheterojunction	CHEMOSPHERE	http://dx.doi.org/10.1016/j.chemosphere.2022.134649
Nanoflower-like CdS and SnS2 loaded TiO2 nanotube arrays for photocatalytic wastewater treatment and hydrogen production	CERAMICS INTERNATIONAL	http://dx.doi.org/10.1016/j.ceramint.2022.10.123

Construction of microbial electrodialysis cells equipped with internal proton migration pathways: Enhancement of wastewater treatment, desalination, and hydrogen production	**SCIENCE OF THE TOTAL ENVIRONMENT**	**http://dx.doi.org/10.1016/j.scitotenv.2022.158527**
Fabrication of Ce MOFs/Black-TNTs and CCM/Black-TNTs as high-efficiency photoelectrode for wastewater treatment and hydrogen production	SEPARATION AND PURIFICATION TECHNOLOGY	http://dx.doi.org/10.1016/j.seppur.2022.122155
Renewable Electricity and Hydrogen Production via Decentralized Wastewater Treatment Systems	ENERGIES	http://dx.doi.org/10.3390/en15238787
Bio-hydrogen production by dark anaerobic fermentation of organic wastewater	FRONTIERS IN CHEMISTRY	http://dx.doi.org/10.3389/fchem.2022.978907
Photovoltaic-driven electrochemical remediation of drilling fluid wastewater with simultaneous hydrogen production	WASTE MANAGEMENT & RESEARCH	http://dx.doi.org/10.1177/0734242X221105414
A holistic green system coupling hydrogen production with wastewater valorisation	ECOMAT	http://dx.doi.org/10.1002/eom2.12254
Development of a hybrid reaction module linked to liquid-phase plasma and electrolysis for hydrogen production with wastewater decomposition	CHEMICAL ENGINEERING JOURNAL	http://dx.doi.org/10.1016/j.cej.2022.136725
A review on photocatalytic hydrogen production potential from paper and pulp industry wastewater	BIOMASS CONVERSION AND BIOREFINERY	http://dx.doi.org/10.1007/s13399-022-02658-z
Energy Assessment and Inner Microbial Community Analysis of Internal Circulation (IC) Reactor for Bio-Hydrogen Production Using Brewery Wastewater	BIOENERGY RESEARCH	http://dx.doi.org/10.1007/s12155-021-10360-7
Effect of pharmaceutical wastewater as nitrogen source on the optimization of simultaneous saccharification and fermentation hydrogen production from paper mill sludge	SUSTAINABLE CHEMISTRY AND PHARMACY	http://dx.doi.org/10.1016/j.scp.2022.100619

The list of paper as per the citation order (highest to lowest), Overall 30 papers was retrieved published during 2022-2023(till now) in peer reviewed journals



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 22

February, 2023

Discovery of a large accumulation of natural hydrogen in Bourakebougou (Mali)

Alain Prinzhofer, Cheick Sidy Tahara Cissé, Aliou Boubacar Diallo.

Abstract:- Recent exploratory wells in Mali (Bourabougou field) targeting natural hydrogen were a success and provide a new understanding of a first test well exploited by PETROMA (Bougou-1), and a comprehension of continental hydrogen functioning systems. Based on extensive gas data of a pioneer well and preliminary geochemical data obtained from a dozen exploratory wells in the vicinity, it is possible to confirm the presence of an extensive hydrogen field featuring at least five stacked reservoir intervals containing significant hydrogen that cover an estimated area well superior to 8 km in diameter. Results underline the potential economic interest of future natural hydrogen exploitation in continental onshore areas. A "hydrogen system" is presented with a kitchen of generation in the cratonic basement. The relatively pure hydrogen reservoirs are associated with traces of methane, nitrogen and helium. The geological stratigraphic accumulation of hydrogen is linked to the presence of multi overlaid doleritic sills and aquifers that seem to play a role to disable upward gas migration and leakage. The occurrence of a mixture of gas and water acting with an artesian activity confirms the presence of over-pressured fluids. This results in a geyser-type eruptive diphasic surface fluid in many of the wells. The "gas lift" system and the presence of traces of highly unstable carbon monoxide is linked to a recent hydrogen gas charge to reservoirs from underground aquifers, erupting with associated water. The Mali wells underscore the non-fossil source of hydrogen gas and presents features of a sustainable energy. The current estimate of its exploitation price is much cheaper than manufactured hydrogen, either from fossil fuels or from electrolysis.

https://doi.org/10.1016/j.ijhydene.2018.08.193

Hydrogen Discovery in Mali Brings Hope for Clean Energy Future

Malian energy entrepreneur Aliou Diallo made a huge discovery in the town of Bourakébougou when he found a mysterious gas that shone blue in the daytime and gold at night. This gas turned out to be 98% hydrogen, which could be used to produce electricity without CO_2 emissions. Diallo's firm, Petroma, installed a pilot unit that turned the gas into electricity and produced water as an exhaust product, transforming the village into one with reliable, plentiful electricity.



In the decade since this discovery, scientists and energy companies have been scouring academia and the world for more information on underground hydrogen reservoirs, believing that a potential inexhaustible natural energy source with zero emissions has been found. In 2018, a science team published a paper on the Bourakébougou hydrogen well, which concluded that it was "possible to confirm the presence of an extensive hydrogen field featuring at least five stacked reservoir intervals containing significant hydrogen that cover an estimated area well superior to 8 km in diameter."

Unlike oil and gas, which need thousands of years to form from decomposing organic matter, hydrogen gas is constantly being made underground as water interacts with iron minerals at high pressures and temperatures. Among these iron minerals is olivine, which steals an oxygen molecule from water percolating down from Earth's surface to transform olivine into serpentinite and the water into hydrogen gas. Deposits of olivine are richest in an underground, cratonic feature called a "greenbelt," which is thought to act as Earth's hydrogen gas engine.

Hydrogen fuel has huge potential to transition off fossil fuels as it's the best currently perceived alternative for diesel or kerosene-based transport such as semi-trucks, jet aircraft, and cargo ships. Currently, the Malian wells could produce hydrogen gas at 50 cents per kilo, one-tenth of the cost of hydrogen created through electrolysis with solar, wind, geothermal, or other green energies.

Ian Munro, CEO of Helios Aragon, a startup pursuing hydrogen in the foothills of the Spanish Pyrenees, said his break-even costs might end up between 50 and 70 cents, adding that it would revolutionize energy production. Diallo started a new company called Hydroma, which now produces electricity for the area via the hydrogen reservoir, and is looking into using it as a means to create green hydrogen via electrolysis.

The discovery of this hydrogen reservoir in Mali could have a huge impact on the energy industry, with potential for inexpensive and clean energy production. It also sheds light on the importance of studying cratonic features and their potential for hydrogen gas reservoirs, as they could be key to transitioning away from fossil fuels. The implications of this discovery are vast and could lead to a more sustainable future for energy production.

First of Its Kind Discovery in Mali: Vast Reservoirs of Clean Hydrogen Gas (goodnewsnetwork.org)

RECENT REPORT

Gas control equipment malfunction on the gas tanker Suiso Frontier

Occurrence date- 25/01/2022
Location- Port of Hastings
ATSB Transport Safety Report Marine Occurrence Investigation (Short)



On 25th January 2022, a gas control equipment malfunction occurred on the liquified hydrogen tanker, Suiso Frontier, while it was berthed in the Port of Hastings, Victoria. The malfunction resulted in a gas flame briefly propagating onto the deck but it did not cause any fire or explosion.

ATSB Found- An investigation by the ATSB found that the ship's gas combustion unit's (GCU) air fan discharge damper actuators were fitted with the wrong type of electrical solenoid valves, which caused damage to the valves during service. On 25th January, one of the solenoid valves failed, leading to the fan damper closing. This caused the GCU to overheat, and the hydrogen flame inside it became unstable, resulting in the flame propagating outside the unit's vent on the ship's deck.

The investigation also revealed that the GCU control system was not equipped to detect a damper closing during operation, and automated safety controls intended to detect a malfunction to prevent such an incident did not activate in time to prevent the flame from appearing on the deck.



MO-2022-001 Final report.pdf (atsb.gov.au)

INDUSTRY NEWS

Hydrogen-Powered Flights Taking Off Soon from Birmingham Airport

ZeroAvia and Birmingham Airport have partnered to introduce hydrogen-powered airplanes for passengers. Following a successful test of its prototype hydrogen-electric engine. ZeroAvia aims to develop an aircraft capable of flying 300 nautical miles with zero emissions by 2025, making flights from Birmingham to Edinburgh, Dublin, Belfast, or the Isle of Man possible. The Birmingham Airport has pledged to become a net-zero airport by 2033, and the collaboration with ZeroAvia aims to aid this target. ZeroAvia is targeting to have an 80-seat zero-emission aircraft available for travel from the Midlands to the Mediterranean by 2027. Birmingham Airport hopes to be a central hub in a green flight network in the UK, and the first hydrogen-powered domestic passenger flight may take off from the airport in the next few years.

Hydrogen flights from Birmingham to Ibiza? - Energy Live News

LONGi Hydrogen launches new generation of electrolyzed water hydrogen production equipment ALK Hi1

LONGi Hydrogen, a wholly-owned subsidiary of China's solar giant LONGi Green Energy Technology Co., Ltd. (LONGi), officially launched its new generation of alkaline electrolyzed water hydrogen production equipment ALK Hi1 in Beijing, continuously exploring the lowest of energy consumption and redefining the height of energy efficiency. Based on the rich experience in the photovoltaic field, LONGi found that, similar to LCOE of photovoltaic, the core path is to reduce the electricity consumption of hydrogen production units, that is, for the same electricity consumption to produce more hydrogen. The lower the Levelized Cost of Hydrogen (LCOH) is, the more cost-efficient green hydrogen will be. Electricity price and energy consumption per unit of hydrogen production are the two variables that contribute to the highest sensitivity of LCOH. The full-load DC power consumption of ALK Hi1 can be as low as 4.3kwh/Nm ^{3}. It is even lower for ALK Hi1 Plus, down to 4.1kwh/Nm ^{3}, in order to adapt to hydrogen production scenarios demanding higher utilization hours. It even hits 4.0kwh/Nm^3 when the current density is 2500A/ãŽ¡.

4.0kwh/NmÂ³ - LONGi Hydrogen launches new generation of electrolyzed water hydrogen production equipment ALK Hi1 - PRN India News - Webindia123.com

£36m investment into green hydrogen pioneer GeoPura paves way for growth

A hydrogen pioneer is set to boost green skills and scale its business on the back of a £36m investment from global industry leaders.

GeoPura – which has bases in Newcastle and Nottingham – has secured the investment in a round led by GM Ventured and Barclays Sustainable Impact Capital, with participation from SWEN CP and Siemens Energy Ventures.

The funds will allow GeoPura to ramp up its green hydrogen business, which is using its hydrogen power generation technology to replace diesel-fuelled generators with its Hydrogen Power Units (HPU), helping the UK on its zero-emissions journey.



£36m investment into green hydrogen pioneer GeoPura paves way for growth - Business Live (business-live.co.uk)

South Africa's 'hydrogen valley' could create 14,000 jobs: CEO

Natascha Viljoen, the CEO of Anglo Platinum, says that South Africa's hydrogen corridor will create 14,000 jobs.

Following the company's presentation of its 2022 financial results, the CEO told MiningWeekly that the hydrogen space is ever-expanding and remains interesting.

Viljoen, in reference to the global uptake of hydrogen as a future clean universal energy source, said that it is important for South Africa as an economy to keep up to date with developments across the globe.

The hydrogen corridor forms part of South Africa's Hydrogen Society Roadmap, originally published in February 2022 by the South African Department of Science and Innovation.

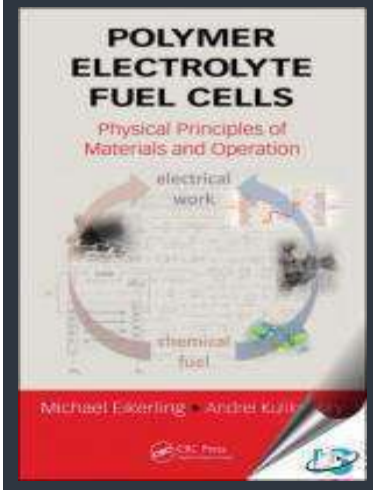
International legal firm Baker McKenzie said that the hydrogen corridor – as part of the overall Hydrogen Valley project – aims to link the Anglo-American Mokopane Platinum Mine to Johannesburg and Durban.

South Africa's 'hydrogen valley' could create 14,000 jobs: CEO (businesstech.co.za)

RECENT BOOK-

Polymer Electrolyte Fuel Cells

Edited by:- Andrei Kulikovsky, Michael Eikerling



Paperback ISBN: 978-1-83916-393-7
pdf ISBN: 978-1-83916-782-9

The book provides a systematic and profound account of scientific challenges in fuel cell research. The introductory chapters bring readers who have a scientific background, but who are not experts in electrochemical energy conversion, up to date on the urgency and implications of the global energy challenge, the prospects of electrochemical energy conversion technologies, and the thermodynamic and electrochemical principles underlying the operation of polymer electrolyte fuel cells. The book then presents the scientific challenges in fuel cell research as a systematic account of distinct components, length scales, physicochemical processes, and scientific disciplines.

Polymer Electrolyte Fuel Cells : Physical Principles of Materials and Operation, Andrei Kulikovsky, Michael Eikerling, 143985405X, 9781439854051 (standardsmedia.com)

ACME, Japan-based IHI Corporation tie up for biz opportunities in green hydrogen

Clean energy firm ACME Group and Japan's heavy-industry manufacturer IHI Corporation have collaborated to explore business opportunities of green hydrogen. The intent of this Memorandum of Understanding (MoU) is to jointly study and evaluate potential projects with respect to collaboration opportunities across the green hydrogen and ammonia value chain, including production, handling, transportation, distribution, and power generation, a statement said.
The MoU allows IHI to participate as an investor or take offtake (buy output) in one or more projects of ACME in Oman, India, the US or Egypt, it stated.



ACME, Japan-based IHI Corporation tie up for biz opportunities in green hydrogen, Auto News, ET Auto (indiatimes.com)

Proposal to build hydrogen-powered community east of Edmonton gains steam

A provincial Crown corporation announced a $2 million funding grant for the Bremner project, a proposed residential community east of Edmonton to house 85,000 people. The project aims to build environmentally conscious communities powered by hydrogen, with homes equipped with furnaces, hot water tanks, grills, and cooktops fueled by hydrogen. The grant is part of $20 million worth of grants being provided through the Alberta Hydrogen Centre of Excellence. ATCO and Qualico are planning the Bremner project, and the study for developing 100% pure hydrogen communities is ongoing. The project aims to have the groundwork completed by 2024 and the first homeowners moving in by 2025.

Proposal to build hydrogen-powered community east of Edmonton gains steam - Edmonton | Globalnews.ca

Bid to turn fashion waste into hydrogen energy

The Ethical Fashion Group (EFG) and Hydrogen Utopia International (HUI) have joined forces to address the problem of plastic pollution caused by synthetic textiles such as polyester and nylon. The partnership aims to provide clothing manufacturers, brands and retailers with a new solution that turns fashion waste into carbon-free fuels. By using HUI's waste plastic-to-hydrogen technology, EFG hopes to enable the fashion industry to become part of the solution to plastic pollution instead of contributing to it. The EFG, which was co-founded by former British Fashion Council chairman Harold Tillman, sees this collaboration as a major step forward for the industry and the planet.



Bid to turn fashion waste into hydrogen energy | Materials & Production News | News (ecotextile.com)

Ontario government launches $15-million Hydrogen Innovation Fund

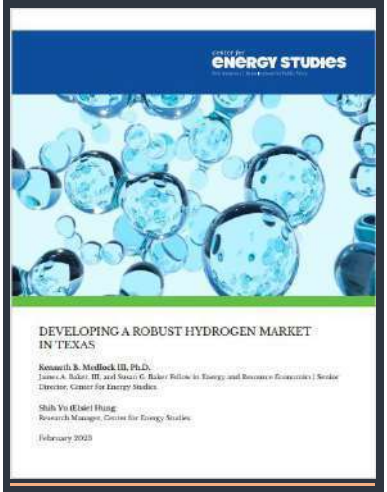
The provincial government of Ontario is providing $15 million to support the growth of hydrogen in the province's clean electricity system. The funding will be available to electric companies for hydrogen-related projects from April onwards. The province's Low-Carbon Hydrogen Strategy aims to make Ontario a clean manufacturing and transport hub, and a leader in the hydrogen economy. The strategy outlines eight concrete actions to achieve this goal. The government predicts hydrogen may account for 30% of Canada's fuel by 2050 and create up to 100,000 jobs in the province. Niagara, Halton Hills, Nanticoke, Brighton Beach, and Lambton are identified as potential hydrogen hubs. Atura Power is leading the development of a new low-carbon hydrogen production project that could help Ontario produce eight times as much hydrogen as before. The project will use a hydrogen electrolyzer system powered by renewable hydroelectricity.

Ontario government launches $15-million Hydrogen Innovation Fund | Humber News

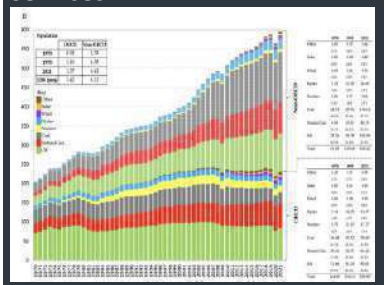
RECENT REPORT:-

Developing a Robust Hydrogen Market in Texas

Kenneth B. Medlock III, Ph.D.
Shih Yu (Elsie) Hung



The reduction of energy's carbon footprint is a driving force in energy transitions — one that is not without its challenges. In particular, the roles of legacy and scale are central and place a hyperfocus on incumbent industries to play a critical role. The role of technology is also central, and its impact will increase to the extent that it is integrated into existing energy systems to decarbonize and promote reliable, secure, cost-effective options for delivering energy services.



https://doi.org/10.25613/YKKH-8K02

INDIA NEWS

Central Salt and Marine Chemicals Research Institute (CSMCRI) has developed a membrane technology to reduce green hydrogen production cost

Central Salt and Marine Chemicals Research Institute (CSMCRI) has developed a membrane technology that is expected to drastically reduce the production cost of green hydrogen, touted to be the future green fuel. The institute has secured an international patent for this membrane and transferred the technology to a company in Gujarat. At present, companies engaged in green hydrogen production use 'perfluorinated sulfonic acid polymer membrane' which is available in the market with the brand name 'Nafion' and marketed by a Japanese company. All companies are importing this membrane. "This invention will drastically reduce the cost of hydrogen energy production. According to a rough estimate, the membrane we developed costs Rs 3,000 per sq m while the cost of the imported one is around Rs 50,000 per sq m. Around 50 to 75 sq m of the membrane is used in this process, so this will help save huge on production costs," explained Vinod K Shahi, chief scientist at CSMCRI.

New Tech To Reduce Green Hydrogen Production Cost, Auto News, ET Auto (indiatimes.com)

Goa explores innovative green tech solutions while balancing intellectual property rights

The chief minister of Goa, Pramod Sawant, announced that the government is exploring green technology solutions to mitigate the climate change crisis, including floating solar power plants, hydrogen energy, and a carbon exchange program through forests. However, he warned that intellectual property rights and patents can hinder the development and adoption of green technology, making it expensive and slow. Sawant urged innovators and companies to find a balance between recouping their investment in research and the urgency to reduce carbon emissions. He suggested licensing agreements and patent pools as solutions to balance the need for IPR protection and the adoption of green technology.

CM bets on green tech, govt to invest in solar plants, hydrogen power research | Goa News - Times of India (indiatimes.com)

India's Green Hydrogen Potential Could Help Meet Europe's Growing Demand

Stefan Kaufmann, former hydrogen commissioner of Germany and advisor, stated that India is well-positioned to contribute to Europe's green hydrogen supply chain as it is situated between Germany and Australia, both of which have already established cooperation pacts. Europe's goal to produce around 100 GW of green hydrogen by 2030 will require more imports than exports, making it necessary to look outside of Europe to regions rich in renewable energy such as India. Kaufmann highlighted that India's favorable production conditions make transport costs of green hydrogen almost negligible, which is crucial for establishing a green hydrogen supply chain over long distances. However, India may face the dilemma of using green hydrogen to decarbonize the country or exporting it. Globally, 680 major hydrogen projects with an investment of $240 billion by 2030 have been announced, indicating the trend towards the dominance of the hydrogen economy.

India perfectly situated to join Europe's green hydrogen supply chain: Stefan Kaufmann - The Economic Times (indiatimes.com)

Olectra-Reliance's 'carbon-free' hydrogen buses to ply Indian roads soon

A carbon-free alternative to traditional public transportation is here! Soon, you could witness hydrogen buses plying on roads as electric bus manufacturer Olectra Greentech Limited (OGL), in technical partnership with Reliance, is set to roll out such buses in the country.

Olectra, a subsidiary of Megha Engineering and Infrastructures Ltd (MEIL), is set to offer the next-generation transport system to the Indian market. In the wake of the depletion of natural resources and the negative impacts of air pollution and emissions, the electric bus maker has taken the initiative to accelerate the development of Hydrogen-powered buses.



Olectra-Reliance's 'carbon-free' hydrogen buses to ply Indian roads soon – Check seating capacity and more (timesnownews.com)

2022: Significant contribution of CSIR to the Core journal "International Journal of Hydrogen Energy"

Bradford's Law is an empirical law to describe the law of literature dispersion. It is applicable to measure the degree of connection between disciplines and describe the number distribution of related papers in the published journals. According to Law of Bradford: 'If the journals are arranged in descending order of the number of articles they carried on the subject, then successive zones of periodicals containing the same number of articles on the subject form the simple geometric series 1: ns: ns^2 : ns^3 .' The journals can be divided into Core Zone, Middle Zone, and Minor Zone.

In accordance with this law, "International Journal of Hydrogen Energy" is a core journal for hydrogen research, reflecting the latest development alongside high quality and density.

International Journal of Hydrogen Energy's top publishing countries in 2022. The results revealed that China, India, and Turkey are the top three countries.

Country	Publications
PEOPLES R CHINA	1558
INDIA	281
TURKEY	179
IRAN	171
SOUTH KOREA	165
USA	141
SAUDI ARABIA	103
GERMANY	94
JAPAN	93
CANADA	74

In 2022. A total of 281 publications came from India, with the CSIR contributing about 10% of those (28 Publication). The following is a list of publications in chronological order.

Article Title	Citation	DOI Link
Characteristics of hydrogen production from steam gasification of plant-originated lignocellulosic biomass and its prospects in Vietnam	43	http://dx.doi.org/10.1016/j.ijhydene.2021.11.091
An overview on progress, advances, and future outlook for biohydrogen production technology	7	http://dx.doi.org/10.1016/j.ijhydene.2022.01.156
Evaluation of in-situ formed La_2O_3-TiO_2-$La_2O_2CO_3$ nanocomposite photocatalyst for H2 production	4	http://dx.doi.org/10.1016/j.ijhydene.2022.03.2060360-3199
Preparation of functional copolymer based composite membranes containing graphene oxide showing improved electrochemical properties and fuel cell performance	3	http://dx.doi.org/10.1016/j.ijhydene.2022.03.025
Polyaniline encapsulated Ti-MOF/CoS for efficient photocatalytic hydrogen evolution	3	http://dx.doi.org/10.1016/j.ijhydene.2022.08.006
Morphological influence of graphitic carbon nanofibers by N-F dual-doping on Pt electrocatalytic activity and stability for oxygen reduction reaction in polymer electrolyte membrane fuel cells	3	http://dx.doi.org/10.1016/j.ijhydene.2022.04.163

PUBLICATIONS

Article Title	Citation	DOI Link
Enhanced hydrogen fuel production using synergistic combination of solar radiation and TiO2 photocatalyst coupled with Burkholderia cepacia lipase	3	http://dx.doi.org/10.1016/j.ijhydene.2022.02.220
Nitrogen-doped hierarchically porous carbon obtained via single step method for high performance supercapacitors	3	http://dx.doi.org/10.1016/j.ijhydene.2022.02.036
Assisting the formation of S-doped FeMoO4 in lieu of an iron oxide/molybdenum sulfide heterostructure: A unique approach towards attaining excellent electrocatalytic water splitting activity	3	http://dx.doi.org/10.1016/j.ijhydene.2022.01.165
Three-dimensional Ni/Fe doped graphene oxide @ MXene architecture as ar efficient water splitting electrocatalyst	2	http://dx.doi.org/10.1016/j.ijhydene.2022.05.204
Proton exchange membrane from the blend of poly(vinylidene fluoride) and functional copolymer: Preparation, proton conductivity, methanol permeability, and stability	2	http://dx.doi.org/10.1016/j.ijhydene.2022.02.162
Boosting photocatalytic hydrogen generation by the combination of tunable cobaloxime and covalent organic framework	2	http://dx.doi.org/10.1016/j.ijhydene.2021.12.053
Partial oxidation of methane over high coke- resistant bimetallic Pt-Ni/CeO2 catalyst: Profound influence of Pt addition on stability	1	http://dx.doi.org/10.1016/j.ijhydene.2022.09.092
Evaluation of bio-hydrogen production using rice straw hydrolysate extracted by acid and alkali hydrolysis	1	http://dx.doi.org/10.1016/j.ijhydene.2021.12.177
Optimization of Liquid Organic Hydrogen Carrier (LOHC) dehydrogenation system	1	http://dx.doi.org/10.1016/j.ijhydene.2022.06.197
CdS/CuCo2S4 dots-on-rods boosting charge separation and hydrogen evolution	1	http://dx.doi.org/10.1016/j.ijhydene.2022.05.199
Even partially amorphous Pd2Ni2P metallic glass significantly promotes hydrogen evolution electrocatalysis	1	http://dx.doi.org/10.1016/j.ijhydene.2022.05.145
Amending charge separation and migration in TiO2 nanosheet via Au nanoparticles ensemble and its synergy in photoelectrocatalytic methanol oxidation	1	http://dx.doi.org/10.1016/j.ijhydene.2022.02.195
Special emphasis towards decorating platinum nanoparticles on carbon to boost cell performance and durability for portable hydrogen-powered fuel cell stack	1	http://dx.doi.org/10.1016/j.ijhydene.2022.02.020
Preface to the special issue on International Conference on Condensed Matter and Device Physics (ICCMDP)-2021	0	http://dx.doi.org/10.1016/j.ijhydene.2022.08.116
CuWO4 as a novel Z-scheme partner to construct TiO2 based stable and efficient heterojunction for photocatalytic hydrogen generation	0	http://dx.doi.org/10.1016/j.ijhydene.2022.07.155
Hard template derived N, S dual heteroatom doped ordered mesoporous carbon as an efficient electrocatalyst for oxygen reduction reaction	0	http://dx.doi.org/10.1016/j.ijhydene.2022.03.250
Titanate quantum dots-sensitized Cu2S nanocomposites for superficial H-2 production via photocatalytic water splitting	0	http://dx.doi.org/10.1016/j.ijhydene.2022.05.091
Hard template derived N, S dual heteroatom doped ordered mesoporous carbon as an efficient electrocatalyst for oxygen reduction reaction	0	http://dx.doi.org/10.1016/j.ijhydene.2022.03.250
Titanate quantum dots-sensitized Cu2S nanocomposites for superficial H-2 production via photocatalytic water splitting	0	http://dx.doi.org/10.1016/j.ijhydene.2022.05.091
Synergetic storage of ammonia over Al quantum dots embedded graphene sheets: A first principles perspective	0	http://dx.doi.org/10.1016/j.ijhydene.2022.08.268
Insight towards kinetics and stability of carbon supported Pd-Y2O3 as cathode catalyst for polymer electrolyte fuel cells	0	http://dx.doi.org/10.1016/j.ijhydene.2021.12.232

Author : Madhulika Bhati
(Principal Scientist, CSIR-NIScPR)

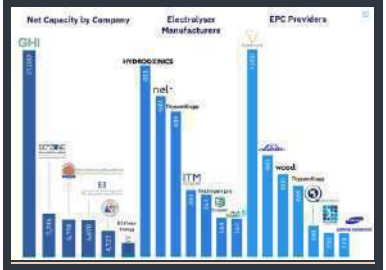
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 23

March, 2023

GlobalData: Hydrogen market to witness growth surge in 2023



According to a report by data and analytics company GlobalData, hydrogen production capacity worldwide is expected to reach 4.5 million tons per annum by the end of 2023, representing 165% growth compared to 2022. The report highlights the importance of deals trends and investments to identify leading companies driving the hydrogen market growth. The publication notes that while over 393 deals related to hydrogen were closed during 2022, the partnerships represented 66% of the deals last year, and the number of deals decreased after Q2 2022 to numbers even below those seen in the same quarter in 2021. The report also highlights that investing and raising capital was of utmost importance to develop the hydrogen economy in 2022, with M&A deals reaching $24.4 billion in monetary value, representing a 288% increase compared to 2021 levels, and venture finance deal values growing from $595.23 million to over $3,001.1 million.

GlobalData: Hydrogen market to witness growth surge in 2023 - Offshore Energy (offshore-energy.biz)

Safety technology for hydrogen infrastructure in underground space



Dr. Kim Yangkyun of the Hydrogen-infrastructure Research Cluster at KICT has developed the core safety engineering technologies for building reliable hydrogen infrastructure underground along with an active control system to mitigate the impact of possible hydrogen leaks and blasts. The new system can help control the ambient hydrogen concentration within an underground facility at all times via forced ventilation and can reduce risk up to 80% compared with similar above-ground facilities thanks to the introduction of roof-type vents that minimize blast overpressure in times of an emergency.

All risks of a potential blast should be eliminated by keeping the ambient hydrogen concentration below the Lower Flammable Limit (LFL) whenever a leak occurs. The active control system that Dr. Kim Yangkyun's research team proposed maintains the quality of the atmosphere of the enclosed space to a normal level and can prevent blast accidents at times of emergency hydrogen gas leaks. An optimized interpretation was used, including multiple factors (shape, location, intake, and outtake capacities of the inlet/outlet) to formulate the conditions for ordinary times and for an emergency where the concentration of hydrogen gas in the facility is kept below the LFL or 4% of hydrogen by volume.

If the active control system malfunctions and an explosion occurs, such an impact should be minimal. The roof-type vent of the deflagration venting system can reduce damage from blast overpressure inside the facility to a 20th. The real-scale experiment of vented deflagration conducted at KICT in 2021 showed that the maximum overpressure reduction effect could be obtained due to a sudden drop in blast overpressure when the explosion vent is bigger than the vent coefficient standard of 2.2. The effectiveness remained constant regardless of the hydrogen concentration or point of the deflagration. Another model was presented to calculate the size of the roof-type vent for the safe design of the underground hydrogen facility. The improved model was built on the minimum vent size model specified in guide NFPA68 of the US National Fire Protection Association to apply to underground hydrogen facilities.

The research team focused on the fusion of functions: ventilations in normal time and after a blast accident. Dr. Kim Yangkyun, the head of the research team said, "The dual system of active control ventilation and the roof type vent is an integrated security technology for both emergency and non-emergency situations responding to all risks incurred in an accident by making the most of the limited cross-section area of the vent."

Safety technology for hydrogen infrastructure | EurekAlert!

RECENT REPORT

Electricity market Report 2023



Abstract
Electricity is central to many parts of life in modern societies and will become even more so as its role in transport and heating expands through technologies such as electric vehicles and heat pumps. Power generation is currently the largest source of carbon dioxide (CO_2) emissions globally, but it is also the sector that is leading the transition to net zero emissions through the rapid ramping up of renewables such as solar and wind. At the same time, the current global energy crisis has placed electricity security and affordability high on the political agenda in many countries. The International Energy Agency's Electricity Market Report 2023offers a deep analysis of recent policies, trends and market developments. It also provides forecasts through 2025 for electricity demand, supply and CO_2 emissions – with a detailed study of the evolving generation mix. This year's report contains a comprehensive analysis of developments in Europe, which faced a variety of energy crises in 2022. The Asia Pacific region also receives special focus, with its fast-growing electricity demand and accelerating clean energy deployment. The IEA's Electricity Market Report has been published since 2020. Its relevance goes beyond energy and climate issues, since electricity supply impacts economies, regional development, the budgets of businesses and households, and many other areas. It is indispensable reading for anyone interested in the multifaceted importance of energy in our economies and societies today.

Electricity Market Report 2023 (windows.net)

Chinese bicycle manufacturer Yuoun unveils hydrogen-powered e-bike prototype

Chinese bicycle manufacturer, Yuoun, has presented a hydrogen-powered prototype of its e-bike. Instead of a lithium battery, the bike uses a hydrogen fuel cell and low-pressure hydrogen storage device to power its rear hub-mounted motor. Although specifics about the power source and range are not yet available, hydrogen cells are said to be more durable and energy-dense than lithium batteries, while producing zero emissions. Availability of hydrogen fuel remains a drawback. Yuoun plans to begin series production of the e-bike in March 2023 with an annual production capacity of 50,000 bikes, ramping up to 200,000 by 2025.



Chinese Firm Yuoun To Produce New Hydrogen-Powered... (inkl.com)

Toyoda Gosei Launches Large High Pressure Hydrogen Tank for Commercial Vehicles

Toyoda Gosei Co., Ltd. (TOKYO:7282) has launched a large high pressure hydrogen tank. The needs for these large tanks is expected to grow for the use on the fuel cell trucks that run on hydrogen. The new tanks are used in the mass-market light-duty fuel cell electric trucks that are being brought to the market by Commercial Japan Partnership Technologies Corporation (CJPT),1 backed by Toyota Motor Corporation, Isuzu Motors Limited, and others.



Toyoda Gosei Launches Large High Pressure Hydrogen Tank for Commercial Vehicles | Business Wire

Valencia tests hydrogen reachstacker

The Port of Valencia is testing a hydrogen-powered reachstacker, which is a type of heavy machinery used to handle shipping containers, as part of the European H2Ports project. The reachstacker is undergoing two years of testing in Valencia and is expected to produce zero local emissions. A mobile hydrogen refuelling station has been developed to supply fuel for the pilot and a hydrogen 4x4 terminal tractor that will also be tested at Valencia Terminal Europa. The project aims to validate hydrogen technologies on port machinery to provide real solutions that do not affect the performance or safety of port operations. The H2Ports project is a collaboration between the Valenciaport Foundation and the Port Authority and is financed by the European Union's Fuel Cell and Hydrogen Joint Undertaking (FCHJU) program.

Valencia tests hydrogen reachstacker, Germany. News story in Forkliftaction News

First hydrogen-operated BMW Hydrogen models hit the road

BMW has launched the first hydrogen-powered vehicles, the BMW iX5 Hydrogen, for trial and demonstration purposes globally. The hydrogen fuel cell system was developed and produced by BMW, with specialists in hydrogen technology and vehicle development working together to integrate the innovative drive and energy storage technology. The BMW Group has developed special hydrogen components, in addition to fuel cells received from Toyota Motor Corporation, to complement technological analogies to the combustion engine such as the intercooler, air filter, control units, and sensor technology. The BMW iX5 Hydrogen features a highly-integrated drive unit and a high-performance battery developed specifically for the vehicle. It also has two 700-bar tanks made from carbon-fibre-reinforced plastic that hold six kilograms of hydrogen, giving the BMW iX5 Hydrogen a range of 504 km in the WLTP cycle.



First hydrogen-operated BMW iX5 Hydrogen models hit the road | The Financial Express

UPCOMING EVENTS-

INTERNATIONAL CONFERENCE ON HYDROGEN SAFETY

September 19-21, 2023



- ICHS 2023 - The H2 Safety Event (hysafe.info)

CENTER FOR HYDROGEN SAFETY EUROPE CONFERENCE 2023



Center for Hydrogen Safety Europe Conference 2023 | AIChE

SUBMIT YOUR NOMINATIONS FOR WORLD HYDROGEN 2023 AWARDS!



Submit Your 2023 Award Nominations – World Hydrogen Summit 2023 (world-hydrogen-summit.com)

INDUSTRY NEWS

Marubeni and Saudi Sovereign Fund to Study Clean Hydrogen Production

Japanese trading house Marubeni Corp has agreed to conduct a feasibility study with the Saudi sovereign Public Investment Fund (PIF) on clean hydrogen production in Saudi Arabia. The study will explore producing clean hydrogen for domestic and international markets as Saudi Arabia looks to diversify its economy and reduce reliance on oil. PIF plans to invest over US$10 billion in eligible green projects by 2026, including renewable energy, clean transport, and sustainable water management. The country aims to reach net-zero emissions by 2060, with plans to develop carbon capture and storage hubs, and may bring forward the target if the technology allows.

Japan's Marubeni, Saudi's PIF weighing clean hydrogen production in kingdom - TODAY (todayonline.com)

BP earmarks USD 2 bln to build Spanish green hydrogen hub

BP has announced plans to invest up to 2 billion euro by 2030 to produce low-carbon hydrogen and biofuels at its refinery in Spain. The project, called HyVal, aims to develop a large plant to produce 2 gigawatts of green hydrogen and increase the refinery's biofuels production three-fold to 650,000 tonnes a year by 2030. The clean hydrogen will be used in the production of fuels and in nearby industries such as ceramics and chemicals. BP plans to reduce its oil and gas output by 25% while sharply increasing its renewable power generation and low-carbon fuel production by 2030.

British Petroleum: BP earmarks USD 2 bln to build Spanish green hydrogen hub, Auto News, ET Auto (indiatimes.com)

Hydrogen back on menu as UK fuel infrastructure takes shape

UK-based company Element 2 is preparing to launch a national network of hydrogen refuelling stations with five sites open in the next few months and 30 more "operational or under construction" by the end of the year. Element 2 has raised £6.5m so far, but two further funding rounds totalling £100m will be launched this year.

Hydrogen back on menu as UK fuel infrastructure takes shape | Autocar

Resources veteran joins green hydrogen pioneer Hysata

Green hydrogen technology company, Hysata, has appointed Dean Dalla Valle, a resources veteran, as its inaugural chair. Dalla Valle brings four decades of experience in the resources and infrastructure sectors to Hysata's board. The company aims to mass-produce hydrogen electrolysers and deliver the world's most efficient, simple, and reliable electrolyser. Hysata plans to export green iron, alumina, ammonia, and methanol while advancing the renewable energy industry. Green hydrogen is an important alternative fuel for achieving net-zero greenhouse gas emissions, particularly in steelmaking, heavy transport, fertilizers, and chemical refineries. Hysata has attracted venture capital from international investors, Hostplus, BlueScope, and Australia's green bank.

Resources veteran joins green hydrogen pioneer Hysata | Shepparton News (sheppnews.com.au)

£5.5m Transship II Project to See UK Research Vessel Powered by Hydrogen

The Prince Madog, a research vessel belonging to Bangor University in Wales, is set to undergo a retrofit with a £5.5 million hydrogen electric hybrid propulsion system that will reduce its emissions by up to 60%. The Transship II project is the largest retrofit of its kind to date and is part of the Clean Maritime Demonstration Competition Round 3, funded by the Department for Transport in partnership with Innovate UK. The new system will enable zero emission operation at slow speeds or over short distances and will reduce emissions by up to 60% in normal operation. The retrofit work is set to begin in April and is expected to take up to two years. Once complete, the vessel will receive hydrogen from the Holyhead Hydrogen Hub on Anglesey.



£5.5m Transship II Project to See UK Research Vessel Powered by Hydrogen (businessnewswales.com)

Farmers can produce 1 ton of green hydrogen every day



Dr. Pritam Singh, a hydrogen scientist at IIT-BHU, has built a pilot plant called Bijal Green Energy in Sateshgarh, Mirzapur, which produces hydrogen from crop residues. Dr. Singh said that 1 liter petrol is available for Rs.105. It gets 3.54 mega joules of energy. With this, a 100cc bike can cover a distance of 60 kms. Whereas, hydrogen equivalent to this will be available in just 80 rupees. That is, hydrogen will be available up to Rs 25 cheaper than petrol.

Dr. Singh says that many plants can be opened in Purvanchal as a pilot project and each plant here can produce up to 500 tonnes of hydrogen annually and the cost of building a 1-5 tonne h2 producing plant is estimated to be Rs 100 crore. The plant produces 99.99% pure hydrogen using Hydrogen Thermal Assorted Anaerobic Digestion (TAAD) technology.



IIT-BHU के वैज्ञानिक बोले- पेट्रोल से 25 रुपए सस्ता होगा हाइड्रोजन | IIT-BHU scientists in Varanasi said after the launch of the Green Hydrogen Mission - Hydrogen will be cheaper by Rs 25 than petrol - Dainik Bhaskar

IOC Plans to Set Up Green Hydrogen Plants at All Refineries by 2047.

Indian Oil Corporation (IOC) plans to set up green hydrogen plants at all its refineries by 2047 as part of Rs 2-lakh crore green transition plan to achieve net-zero emissions. IOC will also restructure its business to hedge volatility in the fuel business and transform petrol pumps into energy outlets that offer EV charging points and battery swapping options. The company plans to increase its refining capacity to 106.7 million tonnes per year from 81.2 million tonnes to meet rising oil consumption in India. Green hydrogen is expected to account for 50% of total hydrogen output in 5-10 years and 100% by 2040.

IOC plans to set up green hydrogen plants at all refineries by 2047; aims to achieve net zero emission - BusinessToday

Gujarat signs MoU with Ocior Energy India for INR 40,000 crore investment in green hydrogen and ammonia production

The Gujarat government has signed an MoU with Ocior Energy India for an investment of INR 40,000 crore to produce 1 million tonnes of green hydrogen and ammonia per year in Kutch district. The renewable energy project will be set up in two phases and become operational by 2030. The project is expected to create nearly 10,400 direct and indirect employment opportunities. Ocior Energy is a leading company in the field of green hydrogen and green ammonia with plans to develop 4 GW capacity green hydrogen and green ammonia projects across India, Middle East, and North Africa.

Ocior Energy India: Ocior Energy signs MoU with Gujarat govt to invest INR 40,000 cr in green hydrogen, ammonia, Auto News, ET Auto (indiatimes.com)

Danish company, Umwelt Energy, to invest $850-m in TN for green hydrogen, methanol plant

Denmark-based Umwelt Energy plans to invest $850 million to build a green methanol plant in southern Tamil Nadu, India. The plant will be fully integrated and equipped to produce 1 lakh tonnes-per-year of green methanol, using wind-solar hybrid plants to supply electricity to an electrolyser to produce green hydrogen, which will then react with carbon dioxide to form methanol. Umwelt Energy's project platforms integrate renewable power generation, electrolysis plants for green hydrogen, and eFuel synthesis plants for methanol, ammonia, kerosene, and gasoline. Meanwhile, ACME Cleantech Solutions plans to build a 1.1 mt green ammonia plant with 5 GW of solar power capacity in Tuticorin district, requiring 20,000 acres of land.

Danish company, Umwelt Energy, to invest $850-m in TN for green hydrogen, methanol plant - The Hindu BusinessLine

Essar Group to invest $1.2 billion for green hydrogen production

Essar Group has announced an investment of $1.2 billion in India for the production of low-cost green hydrogen and ammonia. The investment is part of the Group's plans to invest $3.6 billion in low carbon energy transition projects in the UK and India over the next five years. The newly formed Essar Energy Transition (EET) will create the UK's leading energy transition hub in North West England. The investment in India will create a global supply hub for low carbon fuels, including green hydrogen and green ammonia, with ammonia to be shipped to the UK, Europe, and globally. EET's investment will help deliver India's emerging hydrogen ambition. The remaining $2.4 billion investment will be made at Stanlow in the UK, supporting the government's decarbonisation policy and creating employment opportunities.

Essar Group to invest $1.2 billion for green hydrogen production | Business News,The Indian Express

India and Denmark Partner for Green and Sustainable Progress with 7 MOUs Signed

Denmark has expressed interest in working with India towards a resilient and green future, especially with India's target of achieving 500GW of non-fossil energy by 2030. During the 'Indian and Denmark: Partners for Green and Sustainable Progress Conference', seven memorandum of understanding (MoU) were signed between Danish and Indian firms in various sectors such as biomass, wind technology, and green energy solutions. Denmark's Topsoe A/S and HPCL Mittal Energy Ltd (HMEL) are exploring collaboration in CleanTech to contribute to India's growth in Green Hydrogen and its derivatives.

India, Denmark Can Embark On Green Hydrogen Future Together, Says Minister (outlookindia.com)

PUBLICATIONS (Proton Exchange membrane fuel Cell Review Papers)

(2022-2023 publications)

Proton Exchange Membrane (PEM) fuel cells are a rapidly developing technology, and there is a large body of research literature on the topic. Review papers can help researchers and practitioners keep up to date with the latest developments in the field by summarizing the current state of research.

Review papers on proton exchange membrane (PEM) fuel cells are important because they provide a comprehensive overview of the current state of research in this field, identify research gaps, and highlight areas for future research. Despite the progress that has been made in PEM fuel cell research, there are still many challenges that need to be addressed, such as improving durability, reducing cost, and increasing efficiency. Review papers can help identify these challenges and highlight areas where more research is needed.

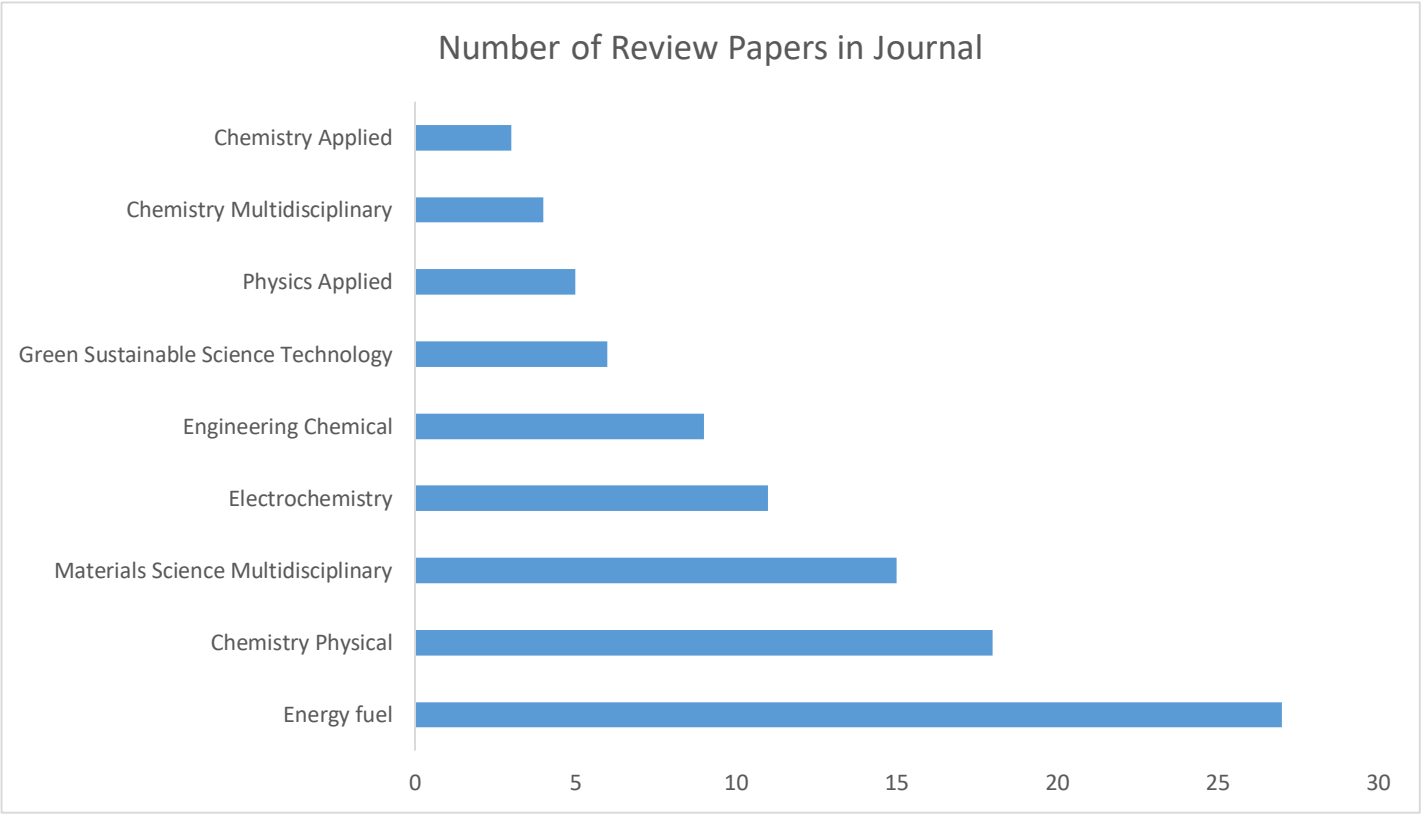
For this purpose, Authors have extracted the most recent review papers published since 2022-2023. It has been observed that China has published 30 review papers in the PEMFC field, followed by France (5) and India (4). Following is a list of highly cited review papers.

Publication	citation	DOI Link
Progress and perspectives of integrated thermal management systems in PEM fuel cell vehicles: A review	32	http://dx.doi.org/10.1016/j.rser.2021.111908
Proton exchange membrane fuel cell stack consistency: Evaluation methods, influencing factors, membrane electrode assembly parameters and improvement measures	17	http://dx.doi.org/10.1016/j.enconman.2022.115651
A critical survey of proton exchange membrane fuel cell system control: Summaries, advances, and perspectives	16	http://dx.doi.org/10.1016/j.ijhydene.2022.01.065
A review on lifetime prediction of proton exchange membrane fuel cells system	14	http://dx.doi.org/10.1016/j.jpowsour.2022.231256
A review of the microporous layer in proton exchange membrane fuel cells: Materials and structural designs based on water transport mechanism	11	http://dx.doi.org/10.1016/j.rser.2021.111998
Synthesis of PtCu-based nanocatalysts: Fundamentals and emerging challenges in energy conversion	11	http://dx.doi.org/10.1016/j.jechem.2021.05.0032095-4956/
Advancements in proton exchange membranes for high-performance high-temperature proton exchange membrane fuel cells (HT-PEMFC)	9	http://dx.doi.org/10.1515/revce-2019-0079
A review of proton exchange membrane fuel cell's bipolar plate design and fabrication process	9	http://dx.doi.org/10.1016/j.jpowsour.2022.231543
Proton exchange membranes for high temperature proton exchange membrane fuel cells: Challenges and perspectives	9	http://dx.doi.org/10.1016/j.jpowsour.2022.231386
Identification of Catalytic Active Sites for Durable Proton Exchange Membrane Fuel Cell: Catalytic Degradation and Poisoning Perspectives	9	http://dx.doi.org/10.1002/smll.202106279
Process and challenges of stainless steel based bipolar plates for proton exchange membrane fuel cells	8	http://dx.doi.org/10.1007/s12613-022-2485-5
Recent insights on iron based nanostructured electrocatalyst and current status of proton exchange membrane fuel cell for sustainable transport	7	http://dx.doi.org/10.1016/j.jechem.2022.01.035
Thermal management system for liquid-cooling PEMFC stack: From primary configuration to system control strategy	6	http://dx.doi.org/10.1016/j.etran.2022.100165
Review: Modeling and Simulation of Membrane Electrode Material Structure for Proton Exchange Membrane Fuel Cells	5	http://dx.doi.org/10.3390/coatings12081145
A Review on the Long-Term Performance of Proton Exchange Membrane Fuel Cells: From Degradation Modelling to the Effects of Bipolar Plates, Sealings, and Contaminants	5	http://dx.doi.org/10.3390/en15145081
Protective coatings for metal bipolar plates of fuel cells: A review	5	http://dx.doi.org/10.1016/j.ijhydene.2022.05.078
Recent developments of proton exchange membranes for PEMFC: A review	3	http://dx.doi.org/10.3389/fenrg.2022.956132
Structural and transport properties of ultrathin perfluorosulfonic acid ionomer film in proton exchange membrane fuel cell catalyst layer: A review	3	http://dx.doi.org/10.1016/j.jpowsour.2022.231523
Progress of g-C3N4 and carbon-based material composite in fuel cell application	2	http://dx.doi.org/10.1002/er.8398
A Review of Life Prediction Methods for PEMFCs in Electric Vehicles	2	http://dx.doi.org/10.3390/su14169842
Gas diffusion layers for PEM fuel cells: Materials, properties and manufacturing- A review	1	http://dx.doi.org/10.1016/j.ijhydene.2022.10.058
Research Progress, Trends, and Current State of Development on PEMFC-New Insights from a Bibliometric Analysis and Characteristics of Two Decades	1	http://dx.doi.org/10.3390/membranes12111103

PUBLICATIONS

Publication	Citation	DoI link
Schroeder?s paradox in proton exchange membrane fuel cells: A review	0	http://dx.doi.org/10.1016/j.rser.2022.113050
Fabrication methods, structure design and durability analysis of advanced sealing materials in proton exchange membrane fuel cells	0	http://dx.doi.org/10.1016/j.cej.2022.139995
A review on gas purge of proton exchange membrane fuel cells: Mechanisms, experimental approaches, numerical approaches, and optimization	0	http://dx.doi.org/10.1016/j.rser.2022.113071
A review of physics-based low-temperature proton-exchange membrane fuel cell models for system-level water and thermal management studies	0	http://dx.doi.org/10.1016/j.jpowsour.2022.232585
A REVIEW ON MODELING OF PROTON EXCHANGE MEMBRANE FUEL CELL	0	http://dx.doi.org/10.2298/CICEQ220126014H
A review of thermal management of proton exchange membrane fuel cell systems	0	http://dx.doi.org/10.1063/5.0127596
A comprehensive and comparative review on parameter estimation methods for modelling proton exchange membrane fuel cell	0	http://dx.doi.org/10.1016/j.fuel.2022.127080
A Review on the Numerical Studies on the Performance of Proton Exchange Membrane Fuel Cell (PEMFC) Flow Channel Designs for Automotive Applications	0	http://dx.doi.org/10.3390/en15249520
Gas Diffusion Layer for Proton Exchange Membrane Fuel Cells: A Review	0	http://dx.doi.org/10.3390/ma15248800
Pt-Based Oxygen Reduction Reaction Catalysts in Proton Exchange Membrane Fuel Cells: Controllable Preparation and Structural Design of Catalytic Layer	0	http://dx.doi.org/10.3390/nano12234173
Recent Developments on Bioinspired Cellulose Containing Polymer Nanocomposite Cation and Anion Exchange Membranes for Fuel Cells (PEMFC and AFC)	0	http://dx.doi.org/10.3390/polym14235248
Functionalized nanoclays for improved properties of composite proton exchange membranes	0	http://dx.doi.org/10.1016/j.jpowsour.2022.232083
Mechanistic insights into metal, nitrogen doped carbon catalysts for oxygen reduction: progress in computational modelling.	0	http://dx.doi.org/10.1039/d2ta05991f
PEMFC Fractional-order Subspace Identification Model	0	

According to the analysis, the most influential journals, published the PEMFC related reviews are as follows



Hydrogen Digest

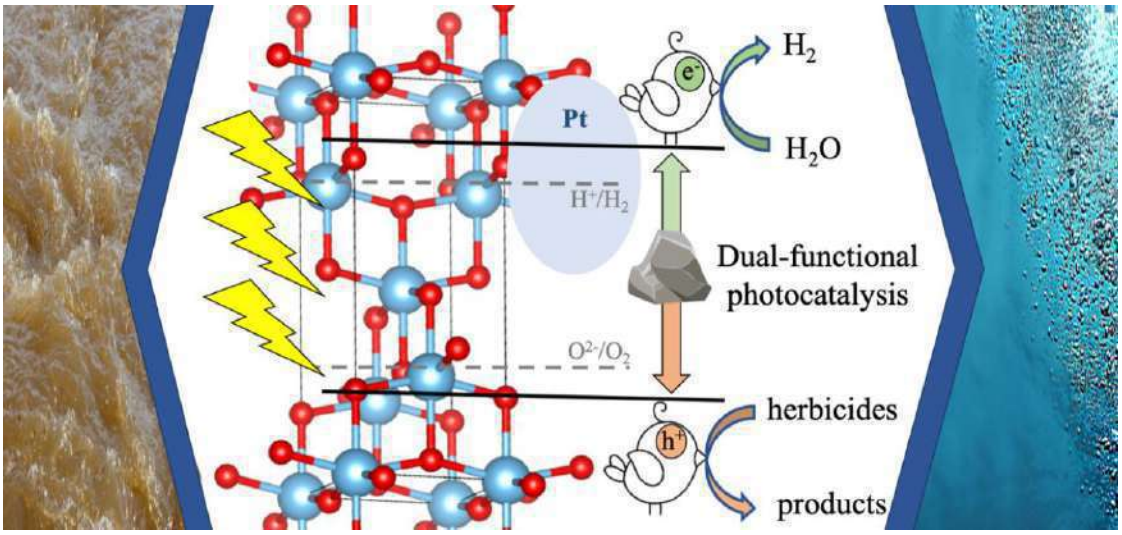
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 24

March, 2023

Oregon State catalyst that purifies herbicide-tainted water and produces hydrogen

Researchers from Oregon State University (OSU) have developed a dual-purpose catalyst that can purify herbicide-contaminated water while producing hydrogen. The catalyst is a titanium dioxide photocatalyst derived from a metal-organic framework, or MOF, that can simultaneously produce hydrogen and degrade glyphosate, a widely-used herbicide. Glyphosate is a major environmental pollutant that can contaminate water sources and harm living things. The team discovered that anatase doped with nitrogen and sulfur was the most effective photocatalyst for the dual-purpose application. Hydrogen is a clean, renewable fuel that can be produced sustainably through photocatalysis, which uses solar energy to split water into hydrogen and oxygen. This method is more sustainable than deriving hydrogen from natural gas through methane-steam reforming, which produces carbon dioxide. Hydrogen has various scientific and industrial applications, such as fuel cells for cars, the production of chemicals and plastics, and refining metals. The team's research, which was published in the journal ACS Catalysis, was funded by the US Department of Energy, the National Science Foundation, and the OSU Department of Chemistry. The collaboration included researchers from the OSU College of Engineering and HP Inc. The discovery is crucial in addressing water pollution, a global challenge that requires innovative solutions to protect the environment and human health.



Oregon State develops catalyst that purifies herbicide-tainted water and produces hydrogen | Oregon State University

Two Birds, One Stone: Coupling Hydrogen Production with Herbicide Degradation over Metal–Organic Framework-Derived Titanium Dioxide

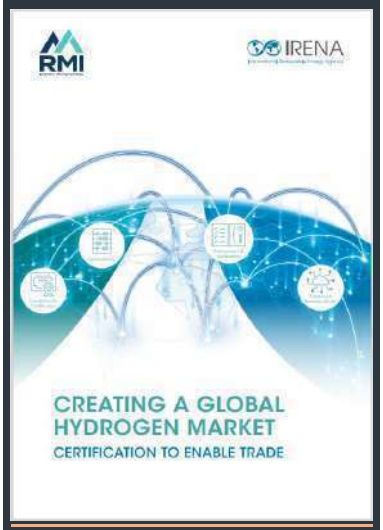
Using photocatalysis, we can purify water by removing organic pollutants through the photodegradation reaction (oxidation) and produce hydrogen (H2) through the hydrogen evolution reaction (reduction). However, we can combine these two reactions in a single process to achieve an efficient photocatalytic system. Herein, we report the dual-functional photocatalysis (DFP) on herbicide-contaminated water using TiO2 polymorphs derived from the amino-functionalized metal–organic framework (MOF), MIL-125-NH2. Heteroatom TiO2 doping led to the generation of N- and N,S-doped TiO2. Of all the pristine and doped TiO2 phases synthesized, the N,S-doped anatase (NSTA) was the best dual-functional photocatalyst in degrading glyphosate (PMG) with simultaneous H2 production at a rate of 660 µmol g–1 h–1. Nuclear Magnetic Resonance studies indicate the preferential cleaving of PMG's C–N bonds, here referred to as α and β C–N bonds, leading to the formation of glycine, formic acid, and phosphoric acid as the major degradation products. Density functional theory calculations indicate PMG's activation through the carboxy and phosphoric acid groups on the surface of NSTA and through the phosphoric acid group on the surface of TiO2-rutile. Our results suggest that the catalytic activity of NSTA can be attributed to the templated impact of the parent MOF, owing to its porosity, redshifting of the band absorption edge toward the visible region, reduced energy bandgap, surface defects, and the presence of oxygen vacancies. The binding mode of PMG to NSTA and its degradation allowed us to test the photodegradation of other herbicides, such as glufosinate ammonium and 2,4-dichlorophenoxyacetic acid. Interestingly, our MOF-derived NSTA proved to be active in purifying water when all three herbicides were combined and produced H2 with a rate of 329 µmol g–1 h–1 simultaneously.

https://pubs.acs.org/doi/10.1021/acscatal.3c00265

RECENT REPORT

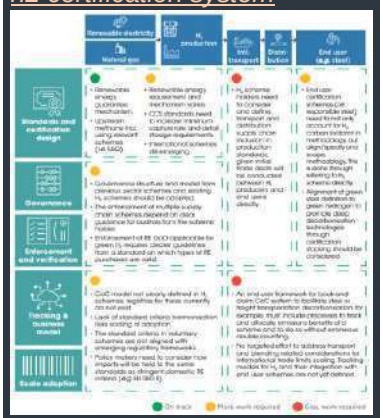
CREATING A GLOBAL HYDROGEN MARKET

CERTIFICATION TO ENABLE TRADE



The emergence of a global hydrogen market requires a cohesive certification system to ensure the required emissions reduction and aid in rapid decarbonization. The market for renewable hydrogen is likely to include a small number of importing regions, creating a situation of oligopsony, and a collaborative framework between importing and exporting countries for assessing and defining technical and ESG elements to differentiate hydrogen is required to ease market participation for producers. Harmonization of standards and rules can lead to increased visibility over the future of renewable hydrogen.

Areas to target future work in h2 certification system



Creating a global hydrogen market: Certification to enable trade (azureedge.net)

INDUSTRY NEWS

Carrier's next big leap – hydrogen-powered refrigeration

Carrier Transicold, a company specializing in refrigerated transport, has developed a new concept called Hydrogen Vector, which utilizes a fuel cell system integrated into the chassis of the Carrier Vector transport refrigeration unit. The fuel cell is powered by hydrogen tanks coupled with an electric power distribution unit, which converts the direct current into the alternating current needed to operate the refrigeration unit. The system delivers zero direct emissions without a reduction in performance or refrigeration capacity, making it an innovative system that offers 100% autonomy for installation in all types of trailers, even retrofit.



Carrier's next big leap – hydrogen-powered refrigeration - Trailer Magazine

Japan to spend $2.35bn on turning Victorian Latrobe valley coal into 'clean hydrogen'

Japan is investing $2.35bn into the Hydrogen Energy Supply Chain (HESC) project to turn coal from Victoria's Latrobe valley into "clean hydrogen" using carbon capture and storage technology. The funds will be provided through one of its partners, Japan Suiso Energy, which will own and operate a liquefaction and shipping facility at the Port of Hastings. A joint venture between J-Power and Sumitomo Corporation will supply 30,000 tonnes of clean hydrogen a year to the Port of Hastings facility. Critics have raised concerns about the project being a new fossil fuel industry, but the project's goal is to produce hydrogen clean enough to meet emerging benchmarks. The captured CO2 will be sent by pipeline to two potential offshore storage facilities in the Bass Strait. The project is looking to produce its first hydrogen before the end of the decade.

Japan to spend $2.35bn on turning Victorian Latrobe valley coal into 'clean hydrogen' | Hydrogen power | The Guardian

Hyzon Motors unveils first locally-designed hydrogen-powered truck in Australia

Australian start-up Hyzon Motors has unveiled its first locally designed and built hydrogen-powered truck, which it believes will help shift the trucking industry away from diesel vehicles. The 27-tonne truck will undergo commercial trials this year, with orders from the RACV-owned Nationwide Group and discussions with waste management groups. The company's team designed and built the trucks, which replace diesel engines with hydrogen gas tanks and a fuel cell. Hyzon has contracts to deliver prime movers to Coregas in NSW and Ark Energy in Queensland, and is building a manufacturing facility in Melbourne.



Hydrogen trucks to be launched in effort to cut diesel pollution (theage.com.au)

LNGCON 2023: Methane Electrolysis Converts LNG to CO2-free Hydrogen

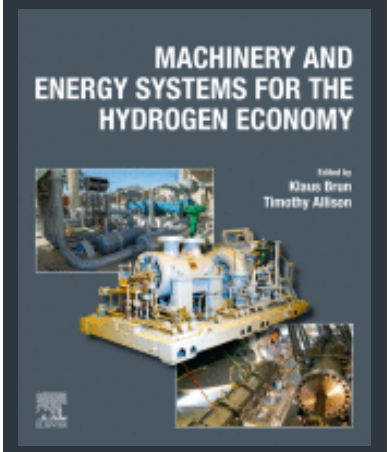
Graforce has developed methane electrolysis plants. Erected at LNG terminals or other decentralized locations, they can decarbonize LNG/LPG by converting methane into hydrogen and solid carbon. This allows large gas users to switch to clean-burning hydrogen without changing their energy supplier or method of transporting.



LNGCON 2023: Methane Electrolysis Converts LNG to CO2-free Hydrogen | Business Wire

RECENT BOOK-

Machinery And Energy Systems For The Hydrogen Economy



Description-

Machinery and Energy Systems for the Hydrogen Economy covers all major machinery and heat engine types, designs and requirements for the hydrogen economy, from production through storage, distribution and consumption. Topics such as hydrogen in pipeline transport, for energy storage, and as a power plant fuel are covered in detail. Hydrogen machinery applications, their selection criteria, economics, safety aspects and operational limitations in different sectors of the hydrogen economy are also discussed. Although the book covers the hydrogen economy as a whole, its primary focus is on machinery and heat engine design and implementation within various production, transport, storage and usage applications.

An invaluable resource for industry, academia and government, this book provides engineers, scientists and technical leaders with the knowledge they need to design and build the infrastructure of a hydrogen economy.

https://doi.org/10.1016/C2020-0-03643-1

First Flight of Regional Jet Powered by Hydrogen Fuel Cells–40-Seater is Largest Ever to Fly

A 40-seat aircraft powered by hydrogen took off for the first-ever regional passenger flight. The flight test campaign is expected to culminate in 2025 with entry into passenger service of ATR 72 regional aircraft converted to run on hydrogen. Connect Airlines signed a purchase agreement with Universal Hydrogen for 75 hydrogen powertrains for their passenger jets. The technology uses no batteries, drastically reducing costs and weight. Universal Hydrogen's retrofit conversion kit tackles existing fleets, and hydrogen fueling uses modular capsules compatible with existing freight networks and airport cargo handling equipment.



First Flight of Regional Jet Powered by Hydrogen Fuel Cells–40-Seater is Largest Ever to Fly (goodnewsnetwork.org)

EU Urges Canada to Export Clean Hydrogen to Europe

The head of the European Union, Ursula von der Leyen, has called on Canada to increase its exports of clean hydrogen to Europe as part of the continent's move away from fuel sources from Russia. Writing ahead of a visit to Canada, von der Leyen said the two nations should expand their co-operation on the energy of the future. She suggested that Canada could broaden its exports of liquefied natural gas as an interim step to more hydrogen exports. Von der Leyen said that renewable hydrogen held the greatest potential for energy co-operation between Canada and the EU, adding that it would be good for the security of supply and for the competitiveness of economies.

EU head says Canada should focus on exporting clean hydrogen ahead of Ontario visit | National Post

Collins Aerospace to lead development of hydrogen development of hydrogen tanks

Collins Aerospace will lead a consortium of companies and institutions in developing thermoplastics technology for liquid hydrogen tanks to power sustainable aircraft in the future. The consortium will include Collins Aerospace sites in several countries along with NLR, Delft University of Technology, ATR, Novotech, and Unified International. Although liquid hydrogen has higher energy content than traditional jet fuel, it requires nearly four times as much volume to match the same energy content, due to its lower specific density.

Collins Aerospace to lead development of hydrogen tanks | The Gazette

EU Head Urges Canada to Export Clean Hydrogen to Europe

The head of the European Union, Ursula von der Leyen, has called on Canada to increase its exports of clean hydrogen to Europe as part of the continent's move away from fuel sources from Russia. Writing ahead of a visit to Canada, von der Leyen said the two nations should expand their co-operation on the energy of the future. She suggested that Canada could broaden its exports of liquefied natural gas as an interim step to more hydrogen exports. Von der Leyen said that renewable hydrogen held the greatest potential for energy co-operation between Canada and the EU, adding that it would be good for the security of supply and for the competitiveness of economies.

EU head says Canada should focus on exporting clean hydrogen ahead of Ontario visit | National Post

Jersey one step closer to hydrogen-fuelled planes after successful test flight

Jersey has partnered with Universal Hydrogen to introduce hydrogen-fueled planes, and recently successfully tested the largest plane ever flown powered mainly by hydrogen. Universal Hydrogen has also signed a letter of intent with Channel Islands airline Blue Islands to introduce hydrogen aircraft conversion kits on their ATR 72 aircraft, with the aim to power ATR aircraft with hydrogen by 2025. The testing program will take two years, after which hydrogen-powered planes will be introduced. The test flight is a step towards carbon neutrality by 2050 and a sustainable future.

Jersey one step closer to hydrogen-fuelled planes after successful test flight | ITV News Channel

EVENTS:-

Connecting Green Hydrogen MENA CGHM on March 14-16, 2023 in Dubai, United Arab Emirates

Website URL: https://www.mena.gh2events.com/
Contact E-mail: marketing@h2.leader-associates.com
Location: Dubai, United Arab Emirates
Venue: Palazzo Versace
Date: March 14-16, 2023
Final Submission: March 13, 2023
Organization: Leader Associates
Connecting Green Hydrogen MENA 2023 (CGHM2023) is at the forefront of expediting the development of green hydrogen in the Middle East and North Africa, gathering policymakers, power producers, investors, suppliers, and technical service providers internationally to build business partnerships.

International Conference on Biohydrogen and Biomethane Production ICBBP on March 15-16, 2023 in London, United Kingdom

Website URL: https://waset.org/biohydrogen-and-biomethane-production-conference-in-march-2023-in-london
Location: London, United Kingdom
Date: March 15-16, 2023
Final Submission: February 14, 2023
Organization: World Academy of Science, Engineering and Technology

China Hydrogen Summit 2023 on March 16-17, 2023 in Shanghai, China

Website URL: http://www.ecvinternational.com/HydrogenEnergy/index.html
Event Type: Conference
Presentation: Hybrid
Location: Shanghai, China
Date: March 16-17, 2023
Organization: ECV International

Rs 75,000 crore investment for green hydrogen, solar, wind energy; Rs 5,000 crore green bonds

The state of Maharashtra in India has announced its budget with a focus on achieving net zero emissions target. The budget estimates an investment of Rs. 75,000 crore in the field of green hydrogen, green ammonia, solar and wind energy. The state also plans to raise Rs. 5,000 crore through green bonds to combat climate change. MoUs worth Rs. 30,000 crore have been signed in the solar, hydro and wind energy sectors, and solar power projects will be implemented in 20,000 gram panchayats. Additionally, 5,150 electric buses will be added to the Maharashtra State Road Transport Corporation fleet, along with the conversion of 5,000 diesel buses into liquefied natural gas vehicles. The budget also includes tax rebates for the purchase of new vehicles if private vehicles over 8 to 15 years old are voluntarily disposed of, and the scrapping of vehicles owned by government, semi-government, local bodies, and public enterprises over 15 years old.

Rs 75,000 crore investment for green hydrogen, solar, wind energy; Rs 5,000 crore green bonds | Mumbai News - Times of India (indiatimes.com)

Delay in green hydrogen policy in Rajasthan may hit Rs 4 lakh-crore investments

The state government of Rajasthan has yet to finalize the green hydrogen policy, despite five companies registering with Rajasthan Renewable Energy Corporation to invest around 4 lakh-crore in 2610 kilo-tonne green hydrogen projects. The final draft was completed in September, but the industry fears that if the policy is not approved soon, it may not happen due to upcoming state elections. The solar industry hopes to avoid a repeat of the failure of the equipment manufacturing sector to take off despite the largest installed capacity of solar plants in the country. The green hydrogen projects are important for creating opportunities in the sector and for creating backward and forward linkage industries. Renewable energy power constitutes 70% of the operating cost in green hydrogen production, which is used in hard-to-abate sectors such as refinery, fertilizer, cement, and steel.

Delay In Green Hydrogen Policy May Hit ₹4l Crore Investments | Jaipur News - Times of India (indiatimes.com)

Thermax enters the green hydrogen market in partnership with Fortescue Future Industries

Thermax Limited and Fortescue Future Industries (FFI) have signed a Memorandum of Understanding (MoU) to explore green hydrogen projects in India. The collaboration aims to develop fully integrated green hydrogen projects for commercial and industrial customers in India and potentially construct new manufacturing facilities to support green energy projects. The collaboration comes at a time when India's National Green Hydrogen Mission offers favourable policies and incentives for such developments. Green hydrogen is expected to help decarbonise hard-to-abate industries in India, such as refineries, fertilisers, and steel. Fortescue's expertise in managing large-scale projects in its iron ore business and constructing a world-leading Green Energy Manufacturing Centre in Queensland will be used for the project.

Thermax enters the green hydrogen market in partnership with Fortescue Future Industries - The Economic Times (indiatimes.com)

Green H2 mission norms, tender by FY24 first half

The Indian government plans to issue guidelines and a tender for incentives under the National Green Hydrogen Mission by the first half of the next financial year. The mission aims to increase India's green hydrogen production capacity to 5 million tonnes per year, with associated renewable energy capacity addition of 125 GW. The government has also floated a concept note on the offshore wind sector and is evaluating the relaxation of the approved list of models and manufacturers for solar equipment. The Ministry of New and Renewable Energy is helping expedite renewable energy projects to meet the upcoming summer demand.



Green H2 mission norms, tender by FY24 first half - The Economic Times (indiatimes.com)

Bhurat; Khushboo Swapnil; Banerjee; Tushar; Bobde; Prakash Vasantrao; Bhurat; Swapnil Sureshchandra.

https://doi.org/10.1080/15567036.2023.2174615

Effect of chemical, physical, and biological pre-treatment of food wastes on bio-hydrogen production by dark anaerobic fermentation under mesophilic conditions

Abstract:
With an overall aim of utilizing lignocellulosic food waste as feedstock for anaerobic fermentation and optimizing the reaction for improving energy output, a two-stage anaerobic dark fermentation reactor was set up. This study discusses the evaluation of different pre-treatment methods used to pre-treat the food waste before using it as a substrate for anaerobic fermentation. Five different techniques from physical, chemical, and biological pre-treatment methods, namely, autoclaving, acid pre-treatment, alkali pre-treatment, aeration, and fungal pre-treatment were used for pre-treatment of the substrate. The analysis was also evaluated by the multilevel categoric factorial design of the experiment model. The experiment found that all five pre-treatments improved the hydrogen and methane yield from the reaction. More precisely, fungal pre-treatment shows an almost 3.8-fold improvement in hydrogen yield compared to control conditions and a 1.7-fold increase in methane yield compared to control. The statistical analysis showed that the reaction time duration (day) has a more significant impact on the results than the pre-treatment technique. The model's F-Values of 24.14 for hydrogen yield and 44.34 for methane yield indicate substantially. However, the actual hydrogen and methane yields are in good accord with the DOE predicted results.

Cinar; Hasan; Tuncel; Suleyman; Kandemir; Ilyas; Gozel; Tuba

Conceptual design and optimal sizing of a small unmanned aerial vehicle with fuel cell and battery-powered hybrid propulsion system by meta-heuristic algorithms based on energy consumption

https://doi.org/10.1080/15567036.2023.2166166

Abstract:
In this paper, a new conceptual design methodology for a hybrid propulsion system consisting of the battery and hydrogen fuel cells is presented based on the minimum energy consumption of the UAV. In this context, an optimization problem with non-linear constraints is constituted to determine the wing loading, aspect ratio, stall velocity, endurance velocity, battery power, fuel cell power, maximum lift coefficient, and zero-lift drag coefficient of the UAV. The solution to this optimization problem, based on the UAV's minimum energy consumption for the endurance and cruising flight modes, is implemented by meta-heuristic algorithms: particle swarm optimization, cuckoo search algorithm, artificial bee colony, and genetic algorithm. The results of these algorithms are compared in terms of energy consumption. This article contributes to the literature on sizing fuel cell-powered small UAVs based on minimum energy consumption and comparing different metaheuristics. According to the results, the lowest power consumption of the UAV is obtained by the particle swarm optimization algorithm as 2018.63 W. Additionally, the weight ratios calculated with the parameters obtained from the sizing optimization for the UAV propulsion system components and flight stages are compared with a benchmark study in the literature. Finally, the payload weight ratio is also increased by 28.5% by sizing optimization.

Chen; Zhijie; Yun; Sining; Wu; Lan; Zhang; Jiaqi; Shi; Xingdong; Wei; Liu; Yiwen; Zheng; Renji; Han; Ning; Ni; Bing-Jie

Waste-Derived Catalysts for Water Electrolysis: Circular Economy-Driven Sustainable Green Hydrogen Energy

https://doi.org/10.1007/s40820-022-00974-7

Abstract: The sustainable production of green hydrogen via water electrolysis necessitates cost-effective electrocatalysts. By following the circular economy principle, the utilization of waste-derived catalysts significantly promotes the sustainable development of green hydrogen energy. Currently, diverse waste-derived catalysts have exhibited excellent catalytic performance toward hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and overall water electrolysis (OWE). Herein, we systematically examine recent achievements in waste-derived electrocatalysts for water electrolysis. The general principles of

water electrolysis and design principles of efficient electrocatalysts are discussed, followed by the illustration of current strategies for transforming wastes into electrocatalysts. Then, applications of waste-derived catalysts (i.e., carbon-based catalysts, transitional metal-based catalysts, and carbon-based heterostructure catalysts) in HER, OER, and OWE are reviewed successively. An emphasis is put on correlating the catalysts' structure-performance relationship. Also, challenges and research directions in this booming field are finally highlighted. This review would provide useful insights into the design, synthesis, and applications of waste-derived electrocatalysts, and thus accelerate the development of the circular economy-driven green hydrogen energy scheme.

Wan; Haiyi; Yang; Xiu; Zhou; Shiming; Ran; Lei; Lu; Yangfan; Chen; Yu'an; Wang; Jingfeng; Pan; Fusheng

Enhancing hydrogen storage properties of MgH2 using FeCoNiCrMn high entropy alloy catalysts

https://doi.org/10.1016/j.jmst.2022.11.033

Abstract:

Herein, we report the successful preparation of the FeCoNiCrMn high entropy alloy (HEA) loaded MgH2 and HEA's effect on the hydrogen storage properties of Mg/MgH2. The HEA shows high catalytic activity toward hydrogen dissociation and recombination reaction, and successfully suppressed activation energy of dehydrogenation reaction from 151.9 to 90.2 kJ mol-1. Moreover, part of Co and Ni can react with Mg, and produce Mg2Co/Mg2CoH5 and Mg2Ni/Mg2NiH4 during the hydrogen storage processes, further en-hancing dehydrogenation reaction through the "hydrogen pumping" mechanism. As a result, the MgH2 -5 wt% HEA composite can release 5.6 wt% of H 2 at 280 degrees C within 10 min, and absorb 5.5 wt% H 2 within 0.5 min at 150 degrees C. The loaded HEA shows robustness against particle aggregation, leading to stable re-versible hydrogen storage processes at least 50 times. These findings show the synergistic effects of HEA on Mg-based hydrogen storage materials, providing an additional degree of freedom for catalyst design.(c) 2023 Published by Elsevier Ltd on behalf of The editorial office of Journal of Materials Science & Technology.

Wang; Xuancheng; Jia; Yuxiao; Xiao; Xuezhang; Zhou; Panpan; et al.

Robust architecture of 2D nano Mg-based borohydride on graphene with superior reversible hydrogen storage performance

https://doi.org/10.1016/j.jmst.2022.10.059

Abstract:

Efficient technical strategies to synthesize hydrides with high capacity and favorable reversibility are sig-nificant for the development of novel energy materials. Herein, nano Mg-based borohydride, Mg(BH4)2, with robust architecture was designed and prepared by confining on graphene through a solution self-confinement method. The Mg(BH4)2 confined on graphene displays a wrinkled 2D nano layer morphology within 8.8 nm thickness. Such 2D nano Mg(BH4)2 can start dehydrogenation at 67.9 degrees C with a high capac-ity of 12.0 wt.%, which is 190.5 degrees C lower than pristine Mg(BH4)2. The isothermal dehydrogenation tests and kinetics fitting results indicate the 2D nano Mg(BH4)2 possesses much-enhanced dehydrogenation kinetics of 31.3 kJ/mol activation energy, which is only half of pristine Mg(BH4)2. The thermodynamics of the 2D nano Mg(BH4)2 is also verified by PCT tests, of which Gibbs free energy value for the confined 2D nano Mg(BH4)2 is estimated to be-18.01 kJ/mol H2, lower than-16.36 kJ/mol H2 of pristine Mg(BH4)2. Importantly, the reversibility of the confined 2D nano Mg(BH4)2 is significantly enhanced to over 90% capacity retention with relatively kinetics stability during 10 cycles. The mechanism analyses manifest that Mg(BH4)2 exhibits stable 2D nano morphology during 10 cyclic tests, resulting in the greatly re-duced H diffusion path and the improved de/rehydrogenation kinetics of the 2D nano Mg(BH4)2. Based on theoretical calculations of Mg(BH4)2 and the intermediate MgB12H12 confined on graphene, the charge transfer status of both samples is modified to facilitate de/rehydrogenation, thus leading to the significant thermodynamic improvements of the reversible hydrogen storage performances for 2D nano Mg(BH4)2. Such investigation of the Mg-based borohydride will illuminate prospective technical research of energy storage materials.(c) 2022 Published by Elsevier Ltd on behalf of The editorial office of Journal of Materials Science & Technology.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 25

March, 2023

Structural basis for bacterial energy extraction from atmospheric hydrogen

Abstract:- Diverse aerobic bacteria use atmospheric H2 as an energy source for growth and survival1. This globally significant process regulates the composition of the atmosphere, enhances soil biodiversity and drives primary production in extreme environments2,3. Atmospheric H2 oxidation is attributed to uncharacterized members of the [NiFe] hydrogenase superfamily4,5. However, it remains unresolved how these enzymes overcome the extraordinary catalytic challenge of oxidizing picomolar levels of H2 amid ambient levels of the catalytic poison O2 and how the derived electrons are transferred to the respiratory chain1. Here we determined the cryo-electron microscopy structure of the Mycobacterium smegmatis hydrogenase Huc and investigated its mechanism. Huc is a highly efficient oxygen-insensitive enzyme that couples oxidation of atmospheric H2 to the hydrogenation of the respiratory electron carrier menaquinone. Huc uses narrow hydrophobic gas channels to selectively bind atmospheric H2 at the expense of O2, and 3 [3Fe–4S] clusters modulate the properties of the enzyme so that atmospheric H2 oxidation is energetically feasible. The Huc catalytic subunits form an octameric 833 kDa complex around a membrane-associated stalk, which transports and reduces menaquinone 94 Å from the membrane. These findings provide a mechanistic basis for the biogeochemically and ecologically important process of atmospheric H2 oxidation, uncover a mode of energy coupling dependent on long-range quinone transport, and pave the way for the development of catalysts that oxidize H2 in ambient air.

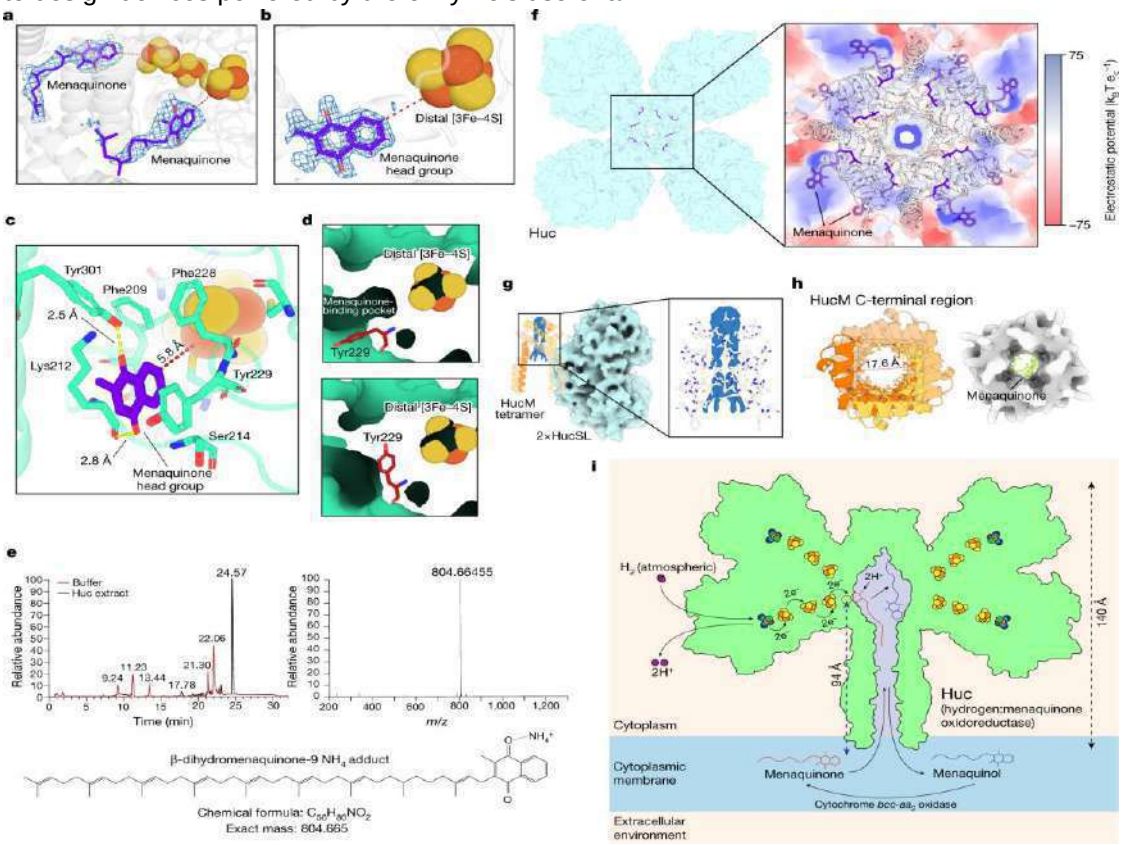
https://doi.org/10.1038/s41586-023-05781-7

Scientists find enzyme that can make electricity out of tiny amounts of

Scientists have isolated an enzyme from soil bacteria that can convert air into electricity, which they say could be developed into a renewable power source for small devices.

The Monash University research, published in the peer-reviewed journal Nature, shows that the enzyme called "Huc" can turn tiny amounts of hydrogen present in the air into an electrical current.

An enzyme is a type of protein that can speed up chemical reaction in cells. Huc is a "natural battery", the scientists said, and while their research is in its very early stages, their discovery has the potential to be a low-cost power source for small objects. "We've shown that when we isolate [Huc] in the lab we can put that into an electrical circuit and it produces electricity," co-lead researcher Rhys Grinter said. Only very small devices could be powered this way, because there are such low levels of hydrogen in the air — just 0.00005 per cent, he said. Larger objects would need an external source of hydrogen to add more electrical power. "We're looking at very small things like a biometric monitor or an environmental sensor that would need sustained levels of power," Dr Grinter said. "However if you give our enzyme more hydrogen, it will make more power. "In something like a fuel cell it could potentially produce enough power to power a wristwatch or a smartphone." "The dream", Dr Grinter said, would be to develop a power source that doesn't require much to keep it going and "basically passively powers itself from air". He said the plan was to scale up production of the enzyme and then work with engineers to design devices powered by the enzyme's use of air.

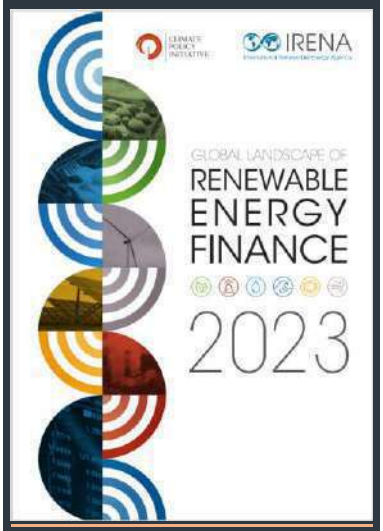


Melbourne scientists find enzyme that can make electricity out of tiny amounts of hydrogen - ABC News

RECENT REPORT

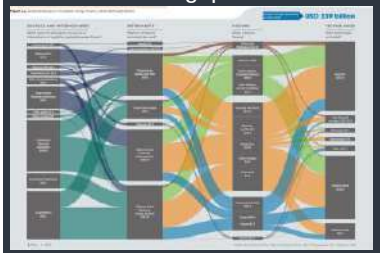
GLOBAL LANDSCAPE OF RENEWABLE ENERGY FINANCE 2023

CERTIFICATION Climate Policy Initiative IRENA



This report analyses investment trends by technology, sector, region, source of finance and financial instrument in the period 2013-2020. It identifies financing gaps to support informed policy making for the deployment of renewables at the scale needed to accelerate the energy transition.

The report finds that investments have become further concentrated in specific technologies and uses, and in a small number of countries/regions. It underscores the need to direct public funds to regions and countries that have considerable untapped potential but find it difficult to attract investment. Funding must be focused on supporting energy transition infrastructure development, as well as enabling policy frameworks to drive investment and address persistent socio-economic gaps.



Global landscape of renewable energy finance 2023 (azureedge.net)

INDUSTRY NEWS

Universal Hydrogen partners with Japanese companies to develop green hydrogen supply for aviation

Universal Hydrogen Co. has partnered with three Japan-based companies, Sojitz Corporation, Mitsubishi HC Capital Inc., and an undisclosed third partner, to develop a green hydrogen supply and logistics solution for Japanese airlines. The collaboration will identify and evaluate local hydrogen suppliers and partners, component manufacturers and suppliers, and potential customers, alongside studying marketing strategies and leasing and financing options. The goal is to develop a modular hydrogen delivery system for Japanese airlines that will enable them to scale their utilization of hydrogen-powered aircraft in the near-term. The partnership aims to solve the challenges of infrastructure, cost, and supply to achieve the joint mission of enhancing Japan's sustainability efforts.

Universal Hydrogen Announces Collaboration in Japan to Study Green Hydrogen Supply and Logistics Solutions for Japanese Airlines | Business Wire

Ballard Power Test Drives First Hydrogen LCVs

First Hydrogen Corp has collaborated with Ballard Power Systems to develop its first-generation zero-emission light commercial vehicle (LCV), using a combination of Ballard's latest LCS fuel cell stack and First Hydrogen's proprietary technology. The two Generation I vehicles are being deployed with 15 major fleet operators as part of the UK Aggregated Hydrogen Freight Consortium, including express delivery, grocery, utilities and roadside assistance. The data collected will inform future vehicle development and enable First Hydrogen to provide total cost of ownership data to prospective customers. Ballard's LCS fuel cell stack was chosen for its performance and lifetime durability to optimise the TCO and make the transition to zero-emission vehicles financially competitive.

Ballard Power Test Drives First Hydrogen LCVs, Business News - AsiaOne

Plans for new hydrogen plant move step closer in SA

The South Australian government has partnered with Trafigura, a commodity trading company that owns Nyrstar smelting operations in Port Pirie, to establish a commercial-scale hydrogen manufacturing facility in the town. The proposed plant will use a 440-megawatt electrolyser to produce 100 tonnes of hydrogen per day, with the oxygen generated being used by the Nyrstar smelter. The plant will run on renewable electricity, and the state government has provided a $2.5 million grant for early engineering designs. The government believes that the project will create job opportunities for South Australians in the short and long-term and help the state become a global leader in green hydrogen.



Plans for new hydrogen plant move step closer in SA | Port Macquarie News | Port Macquarie, NSW (portnews.com.au)

Europe's hydrogen installed capacity to skyrocket by 800% in 2023

A new report by consultancy LCP Delta predicts an 800% increase in the total installed capacity of hydrogen energy projects in Europe in 2023. This surge in investment would be the first time that the total capacity surpasses the 1GW mark. The UK and Germany are expected to play a crucial role in achieving this milestone, with 400MW of hydrogen projects each in the pipeline. However, the report warns that Europe could fall behind its rivals in the hydrogen market due to regulatory hurdles. Despite this, Brendan Murphy, Head of Hydrogen at LCP Delta, believes that with increased investor confidence, the sector will continue to develop rapidly and play an increasingly significant role in the global energy market.

Europe's hydrogen installed capacity to skyrocket by 800% in 2023 - Energy Live News

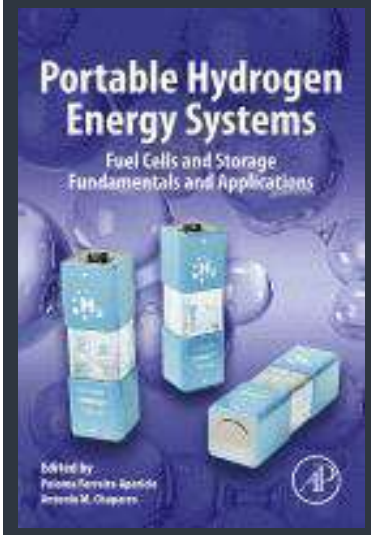
JET H2 Energy to open 10 hydrogen filling stations

JET H2 Energy plans to open 10 hydrogen filling stations in Germany and Denmark with the help of Maximator Hydrogen, supplying cars, commercial vehicles, and buses with green hydrogen. The first stations will be operational by spring 2024, and the company plans to build 250 stations in Germany, Austria, and Denmark.

JET announces plans to build 10 hydrogen filling stations in northern Europe - Global Construction Review

RECENT BOOK-

Portable Hydrogen Energy Systems



Edited by:
Paloma Ferreira-Aparicio and Antonio M. Chaparro

Portable Hydrogen Energy Systems: Fuel Cells and Storage Fundamentals and Applications covers the basics of portable fuel cells, their types, possibilities for fuel storage, in particular for hydrogen as fuel, and their potential application. The book explores electrochemistry, types, and materials and components, but also includes a chapter on the particularities of their use in portable devices, with a focus on proton exchange membrane (PEM) type. Topics cover fuel storage for these cells, in particular hydrogen storage and an analysis of current possibilities. In addition, portable fuel cell systems are examined, covering auxiliary elements required for operation and possibilities for their miniaturization. Engineers and developers of portable applications and electricity will find this book to provide fundamental information on the possibilities of portable hydrogen fuel cells, including costs and market information, for their planning, modeling, development and deployment. Graduate students and lecturers will find this to be a complementary resource in general hydrogen and fuel cell courses or in specialized courses covering portable systems.

https://doi.org/10.1016/C2016-0-04605-3

WA Water Corp signs deal with commercial green hydrogen project

The Australian Water Corporation has signed its first commercial renewable hydrogen contract with the Bristol Springs Green Hydrogen Project, owned by Frontier Energy. The project is expected to produce 4.4 million kilograms of renewable hydrogen per year when it begins production in 2025, using water from the Stirling Trunk Main and renewable energy from Frontier's solar farm. The 15-year agreement is an important step in developing Western Australia's renewable hydrogen industry, which the government is seeking to establish as a significant exporter and user of renewable hydrogen.



WA Water Corp signs deal with commercial green hydrogen project - Government News

Oman Hydrogen signs $20 billion green hydrogen agreements

Oman Hydrogen has signed 6 agreements for green hydrogen production in Oman worth more than $20 billion, the Omani state news agency reported.

The deal includes several developers from different countries and will last for seven years, the state agency added.

Oman aims to increase green hydrogen production from 32,500 to 3.75 million tonnes per year by 2040 and from 3.5 to 8.5 million tonnes per year by 2050. The country estimates that it will need a cumulative investment of $140 billion over this period to reach its production target by 2050.

https://www.oilandgasmiddleeast.com/news/oman-hydrogen-signs-20-billion-green-hydrogen-agreements

Kolon Industries Targets the Global Hydrogen Market

Kolon Industries, a South Korean company, is showcasing its specialized technologies in the water treatment and fuel cell industries at the World Smart Energy Week 2023 exhibition in Tokyo. The company is exhibiting its membrane humidifier, Polymer Electrolyte Membrane (PEM), Membrane Electrode Assembly (MEA), and a membrane material-based product called 'Vent'. Kolon Industries has been researching membranes since 1989 and began fuel cell research and development in 2006. It was the first Korean company to mass produce membrane humidifiers in 2012 and has since been supplying them to Hyundai Motor Company. The company is now expanding its application from mobility to power generation and industrial use. In addition, Kolon Industries has started mass production of PEMs since 2020 and is solidifying the foundation for mass production of MEAs.



Kolon Industries Targets the Global Hydrogen Market through a World-wide Renewable Energy Platform (lelezard.com)

Hydra Energy's $62M hydrogen production plant approved in Prince George

The Prince George city council has given initial approval to Hydra Energy's proposed hydrogen production plant and fueling station, which aims to produce hydrogen on site using city water and BC Hydro powerlines. The hydrogen produced will be primarily sold to converted transport truck operators, and the applicants hope to make Prince George into a hydrogen hub. The final approval will be considered at a future meeting.



Hydra Energy's $62M hydrogen production plant approved in Prince George - BC News - Castanet.net

EVENTS:-

Green Hydrogen Forum & Expo – Munich

Website URL: https://www.ees-europe.com/for-visitors/green-hydrogen

Venue: Messe München
Am Messeturm
München, München 81829
Germany
Start:
June 13 @ 8:00 am UTC+0
End:
June 16 @ 5:00 pm UTC+0
Event Categories:
Conference, Exhibition
ORGANIZER
Solar Promotion GmbH

Hydrogen Technology Expo North America, 28-29 June 2023, NRG Centre, Houston, Texas, USA

Website URL:
https://www.hydrogen-expo.com/
Venue Details
NRG Center
NRG Park, 1 Fannin St, Houston, TX 77054, United States
Opening Times
28 June 2023
Conference: 09:00 - 18:00
Expo: 10:00 - 18:00
29 June 2023
Conference: 09:00 - 17:00
Expo: 10:00 - 16:30
Organized by: Trans-Global Events Ltd

Hydrogen Expo – Piacenza Italy

Website URL:
https://hydrogen-expo.it/en/
Start:
May 17 @ 8:00 am UTC+0
End:
May 19 @ 5:00 pm UTC+0

Event Categories:
Conference, Exhibition
ORGANIZER
Mediapoint & Exhibitions Srl
Email:
info@mediapointsrl.it
VENUE
Piacenza Expo Center
Via Tirotti 11
Piacenza, 29100 Italy

Indian state refiners to produce 30,800 tonne/yr green hydrogen by 2030

Indian state-run refiners are setting up projects to produce 30.8 kilo tonnes a year of green hydrogen by 2030, junior oil minister Rameswar Teli told lawmakers.

India, one of the world's biggest greenhouse gas emitters, recently announced a 197 billion rupee (USD 2.4 billion) green hydrogen programme to cut the country's carbon intensity and reduce dependence on fossil fuels. Companies such as Reliance Industries, NTPC, Adani Group, JSW Energy, ReNew Power and Acme Solar have announced plans to help India meet its goal to produce at least 5 million tonnes of green hydrogen by 2030. The federal government has announced it would provide 300 billion rupees (USD 3.65 billion) to help state-run oil refiners move towards cleaner energy, a step aimed at helping the country achieve its 2070 net-zero carbon emission target. "Refineries in the country already utilise hydrogen for internal consumption which has the potential to be converted into green hydrogen," Teli said in a written reply to a lawmaker's question.
Indian state refiners to produce 30,800 tonne/yr green hydrogen by 2030, Auto News, ET Auto (indiatimes.com)

Empowered Group formed for Green Hydrogen Mission

The Indian government has established a "Mission Governance Framework" to drive the adoption of green hydrogen across various sectors. An empowered group chaired by the Cabinet Secretary and comprising secretaries from various ministries will create an incentive scheme and policy framework, open bids for green fertilizer, and call for proposals on pilot projects and R&D in 2023-24. The group will ensure inter-ministerial coordination and steer the Green Hydrogen Mission with a "whole of the government" approach.
Empowered Group formed for Green Hydrogen Mission - The Economic Times (indiatimes.com)

Himachal Pradesh to exploit renewable power potential to be a green state by 2026

Green Hydrogen will be promoted in the state to make Himachal a leading Green Hydrogen based economy and a Green Hydrogen policy will be formulated.
https://economictimes.indiatimes.com/industry/renewables/himachal-pradesh-to-exploit-renewable-power-potential-to-

Parliament Session: Green Hydrogen Mission to reduce Rs. 1 lakh crore of fossil fuel imports

India's green hydrogen production capacity is likely to reach 5 MMT per annum, contributing to a humongous reduction in dependence on imports of fossil fuels. This huge achievement of the National Green Hydrogen Mission is expected to reduce a cumulative Rs. one lakh crore worth of fossil fuel imports by 2030. Moreover, nearly 50 MMT per annum of CO_2 emissions is expected to be averted through this production and use of the targeted quantum of Green Hydrogen. The Union Minister of renewable energy & power R.K. Singh informed the Lok Sabha.
.https://newsonair.com/2023/03/17/parliament-session-green-hydrogen-mission-to-reduce-rs-1-lakh-crore-of-fossil-fuel-imports/

HYDROGEN TECHNOLOGY EXPO - 2023 Technology and Solutions for low carbon Hydrogen future:

India's must-attend exhibition and conference that is exclusively dedicated to discussing advanced technologies for the hydrogen and fuel cell industry. The event brings together the entire hydrogen value chain to focus on developing solutions and innovations for low-carbon hydrogen production, efficient storage and distribution as well as applications in a variety of stationary and mobile applications.



https://missionenergy.org/hydrogen/

Chuanbo Xu et al 2023.

https://doi.org/10.1016/j.ijhydene.2022.11.220

A robust optimization model for capacity configuration of PV/battery/hydrogen system considering multiple uncertainties

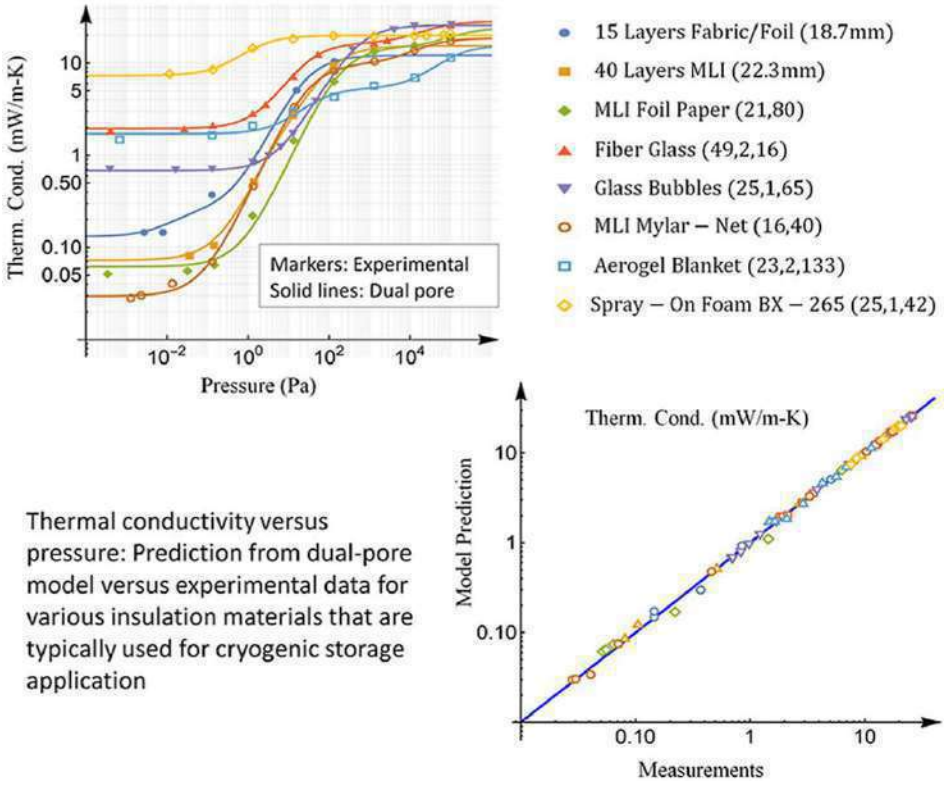
Abstract

The capacity configuration optimization of photovoltaic (PV) hydrogen system with battery has been widely concerned, but many existing studies only take hydrogen as an energy storage mode of smooth power, rather than dedicated to hydrogen production to meet the needs of chemical plants for hydrogen, and it ignores the impact of the fluctuation of PV output and the uncertainty of hydrogen demand on the system capacity configuration optimization. For overcoming this disadvantage, a PV/battery/hydrogen system is proposed, which is specially used for hydrogen production, and for the sake of system economy, the excess power will be weighed whether to store it in the battery or sell it in the green certificate trading market, and a new trading model is formed. Moreover, a robust optimization model is established to deal with the impact of PV output, green power transaction price and hydrogen demand volatility on system capacity configuration. Finally, the characteristics of the model are tested by a real case of a chemical plant in Jiuquan City, Gansu Province. The results show that the capacity configuration scheme of the proposed model can effectively resist the demand uncertainty of hydrogen, the capacity of the electrolyzer and battery can still meet the needs of the chemical plant, even if the demand of the hydrogen increases by 40%.

Ram R. Ratnakar, Zhe Sun , Vemuri Balakotaiah

Effective thermal conductivity of insulation materials for cryogenic LH2 storage tanks: A review

https://doi.org/10.1016/j.ijhydene.2022.11.130



Thermal conductivity versus pressure: Prediction from dual-pore model versus experimental data for various insulation materials that are typically used for cryogenic storage application

Abstract:
An accurate estimation of the effective thermal conductivity of various insulation materials is essential in the evaluation of heat leak and boil-off rate from liquid hydrogen storage tanks. In this work, we review the existing experimental data and various proposed correlations for predicting the effective conductivity of insulation systems consisting of powders, foams, fibrous materials, and multilayer systems. We also propose a first principles-based correlation that may be used to estimate the dependence of the effective conductivity as a function of temperature, interstitial gas composition, pressure, and structural properties of the material. We validate the proposed correlation using available experimental data for some common insulation materials. Further improvements and testing of the proposed correlation using laboratory scale data obtained using potential LH_2 tank insulation materials are also discussed

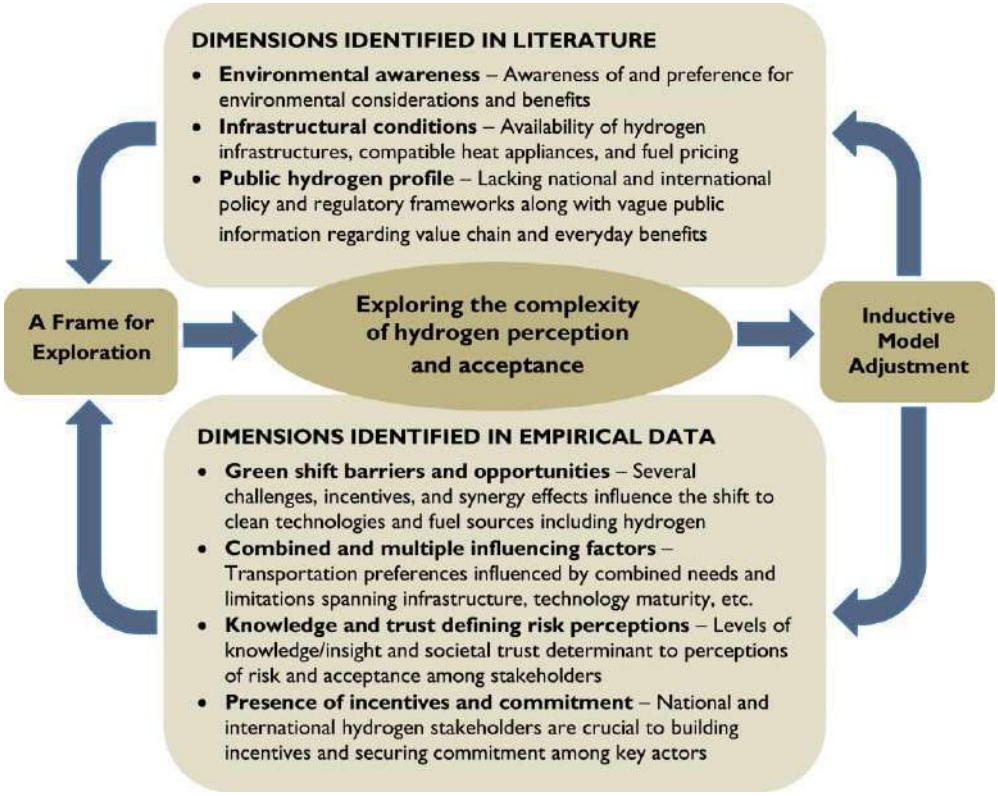
Sindre Aske Høyland , Kari Kjestveit , Ruth Østgaard Skotnes

Exploring the complexity of hydrogen perception and acceptance among key stakeholders in Norway

https://doi.org/10.1016/j.ijhydene.2022.11.144

Abstract:

This article explores the complexity of factors or mechanisms that can influence hydrogen stakeholder perception and acceptance in Norway. We systematically analyze 16 semi-structured in-depth interviews with industry stakeholders at local, municipal, regional, and national levels of interest and authority in Norway. Four empirical dimensions are identified that highlight the need for whole system approaches in hydrogen technology research: (1) several challenges, incentives, and synergy effects influence the hydrogen transition; (2) transport preferences are influenced by combined needs and limitations; (3) levels of knowledge and societal trust determinant to perceptions of risk and acceptance; and (4) national and international hydrogen stakeholders are crucial to building incentives and securing commitment among key actors. Our findings imply that project management, planners, engineers, and policymakers need to apply a whole system perspective and work across local, regional, and national levels before proceeding with large-scale development and implementation of the hydrogen supply chain.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 26

March, 2023

Super-insulator facilitates cryogenic storage of hydrogen

Japan-based Thermalytica achieved a breakthrough in the development of a super insulation material that significantly enhances the efficiency and cost-competitiveness of transporting and storing liquid hydrogen.

The patented material, TIISA (thermal insulation inflatable solid air) has high porosity and liquid-like fluidity, providing superior thermal insulation and heat shielding for applications such as liquid hydrogen logistics (both transport and storage), home window insulation, and EV battery thermal runaway mitigation. The technology is set to enter pilot production in Japan by April 2024.



TIISA is a unique silicon dioxide aerogel-like material developed by Rudder Wu, founder and CTO of Thermalytica, who has inked contracts with the Japanese government to validate its ability to reduce the amount of hydrogen boil-off losses from liquefied hydrogen storage.

In Japan, the lab scale production capacity of TIISA has reached 500kg per year. The planned pilot production capacity, set to be finished by the end of 2023 in Japan alone, will be over three tonnes. Thermalytica plans to expand commercial production to the US and Taiwan by 2025 to meet the growing demand for TIISA in these markets.

TIISA has an extremely low thermal conductivity, reaching as low as 1mW/mK at slightly reduced pressure. Additionally, when blended with conventional thermal insulation materials, the composite mixture's thermal conductivity decreases from 30-40 mW/mK to as low as 18mW/mK.

Insulation has also become a critical characteristic of materials to combat climate change and energy crisis. Applications of TIISA range from housing and construction, EV battery thermal runaway mitigation, cryogenic hydrogen transportation to national defense. The use of super insulation can help to keep liquefied hydrogen at an ultra-low temperature to reduce boil-off losses, enhancing air-conditioning efficiency, and accelerating the adoption of green energy.

Hydrogen transportation and storage is one of the promising use cases of TIISA. According to Thermalytica's estimates, the use of aerogel in hydrogen transportation and storage potentially represents US$45bn in market size by 2030. Additionally, the market size for aerogel in EV batteries is projected to be US$23bn by the same year.

Japan has made significant investments in improving the efficiency of transportation and storage of liquid hydrogen as part of the Japanese government's roadmap to carbon-neutrality. Similarly, the US Department of Energy (DOE) has also committed US$8 billion to establish regional clean hydrogen hubs (H2Hubs) across the country.

Japanese super-insulator facilitates cryogenic storage of hydrogen (gasworld.com)

AFC Energy launches ammonia to hydrogen cracker technology



AFC Energy has launched a new ammonia cracker technology to overcome hydrogen generation, storage and transport challenges. The technology aims to unlock the value of ammonia as a hydrogen carrier fuel across European and Asian energy markets while supporting the EU's sustainable energy policies and addressing energy challenges in Ukraine.

AFC Energy state the cracker's modular design and low-cost system architecture makes it readily scalable from small-scale hydrogen production to multi-million tonnes per year. It is expected to support the demand for clean hydrogen power in off-grid applications.

The announcement comes as the latest development of its Flex-Fuel strategy designed to meet the growing demand for low-cost on-site hydrogen production.

Adam Bond, CEO of AFC Energy, said, "Clean ammonia is affirmed as a preferred means of transporting hydrogen to end users, particularly in Europe and Asia, and AFC Energy is targeting these key markets to enable a faster, more widespread adoption of hydrogen where storage and transportation challenges might otherwise present short-term challenges."

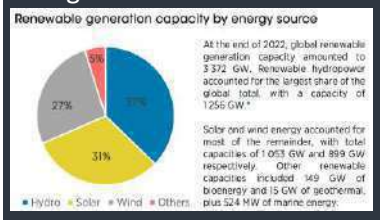
AFC Energy launches ammonia to hydrogen cracker technology (h2-view.com)

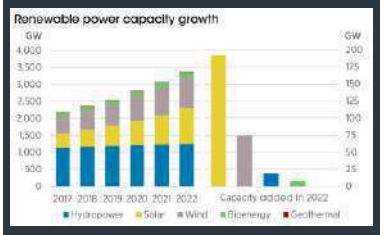
RECENT REPORT

RENEWABLE CAPACITY STATISTICS 2023



This publication presents renewable power generation capacity statistics for the past decade (2013-2022) in trilingual tables.





Solar and wind energy continued to dominate renewable capacity expansion, jointly accounting for 90% of all net renewable additions in 2022. This growth in wind and solar led to the highest annual increase in renewable generating capacity and the second highest growth on record in percentage terms.

IRENA - RE Capacity Highlights 2023.pdf (azureedge.net)

INDUSTRY NEWS

Brian Jean talks small modular reactors, pitches hydrogen after South Korea trip

The Jobs, Economy and Northern Development Minister of Alberta, Brian Jean, hopes for the development of small modular reactors (SMRs) in Alberta after a trade mission to South Korea. SMRs generate between 10 and 300 MW of energy to power small areas or industrial sites, and governments and corporations around the world are investing in the technology. Alberta has partnered with other provinces and corporations to pursue SMR technology as a clean energy option. During the trade mission, the Alberta delegates met with leaders in South Korea's government, nuclear sciences, and engineering sectors, including the Korea Atomic Energy Research Institute (KAERI) to explore the possibility of developing SMRs in Alberta. Additionally, there were discussions on the South Korean side in Alberta's hydrogen reserves, as South Korea aims to become the world's top producer of hydrogen cars and fuel cells by 2030.

Brian Jean talks small modular reactors, hydrogen in South Korea | Vermilion Standard

Toyota isn't giving up on hydrogen technology in spite of new EV focus

Toyota is focusing on developing more electric vehicles with the upcoming departure of long-time CEO Akio Toyoda. However, the company remains committed to its investment in hydrogen technology and wants to ensure that it stays a viable option. The lack of infrastructure remains a significant hurdle to making hydrogen a widespread option. The Japanese government hopes to have 800,000 fuel cell-powered vehicles on the road by 2030, with plans to increase the number of refueling stations. Other companies, including BMW, Hyundai, and General Motors, are also investing in hydrogen research. Toyota is also developing a dedicated platform for electric cars that should be ready in 2026.



Toyota isn't giving up on hydrogen technology in spite of new EV focus - Autoblog

Hydrogen Utopia agrees terms for waste-to-hydrogen facility in Longford, Ireland

Hydrogen Utopia International (HUI) has announced a joint venture with Powerhouse Energy Group for the development of a plastic waste-to-hydrogen facility in Longford, Ireland. Both companies will contribute to the costs on a 50-50 basis, with a joint venture vehicle incorporated in Ireland and owned equally by each company. Powerhouse will pay HUI a non-returnable sum of up to £400,000 in cash for identifying the project, securing the option to lease and progressing the project. HUI is starting planning, environmental and operational permitting applications for the Longford Site, working with advisers in Ireland. The deal supersedes most of the pre-existing arrangements between the two companies.

Hydrogen Utopia International agrees terms for waste-to-hydrogen facility in Longford, Ireland (proactiveinvestors.com)

UK urged to approve hydrogen blending in domestic gas network

The UK government's low-carbon gas adviser, Jane Toogood, has recommended approving the blending of hydrogen into the UK gas network this year, as long as it is demonstrably safe. The government aims to mix up to 20% of hydrogen into the gas distribution system by 2050 as part of its net-zero carbon target. Toogood, the CEO of Johnson Matthey's Catalyst Technologies business, said both green hydrogen and blue hydrogen could be blended into the gas network, but at least half should be electrolytic hydrogen. The report also called for new gas boilers to be "hydrogen ready" by 2026. The use of low-carbon hydrogen for domestic heating has polarized opinion, with some arguing it is less disruptive than fitting other low carbon heating systems, while others argue it could prolong the use of natural gas.

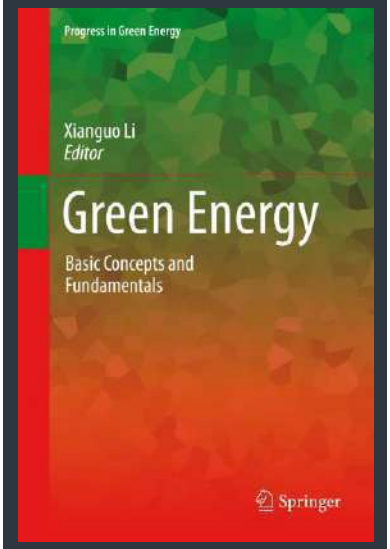


UK urged to approve hydrogen blending in domestic gas network | Financial Times (ft.com)

BOOK-

Green Energy

Basic Concepts and Fundamentals



Edited by:
Xianguo Li
Green Energy: Basic Concepts and Fundamentals addresses the need for diversity within energy systems. It focuses on the theme of energy diversity with local resources, and the integration and optimisation of conventional and alternative energy systems. The book provides a summary of the state-of-art knowledge and technology for future energy systems, covering topics such as:

• Green energy carriers;

• Emission control, reduction, and abatement;

• Energy conversation and management; and

• Energy environment interaction.

This first book in the Progress in Green Energy series will be of value to energy researchers, technology developers and professionals from policy makers to engineers, as well as to advanced undergraduate and postgraduates studying in the field.

https://doi.org/10.1007/978-1-84882-647-2

INDUSTRY NEWS

Malaysia obtains understanding for hydrogen gas investment in Indonesia

Malaysia has reached an understanding with the Indonesian government regarding the supply and investment of hydrogen gas to Nusantara, Indonesia's new capital city in East Kalimantan. The Sarawak state government has been involved in the agreement, and Malaysian Prime Minister Datuk Seri Anwar Ibrahim believes that this development will increase investor confidence. Sarawak Premier Tan Sri Abang Johari Tun Openg also expressed his satisfaction with the agreement and believes it demonstrates Indonesia's confidence in Malaysia's current administration.

BERNAMA - Malaysia obtains understanding for hydrogen gas investment in Indonesia

Escorts Kubota finds good scope for hydrogen tech in construction equipment segment

Escorts Kubota, a manufacturer of farm machinery and construction equipment vehicles, believes that hydrogen has an advantage over other emerging technologies for the CEV segment due to its torque conversion, which is better than electric. However, the challenge with hydrogen technology is that it is not yet commercially viable. The company is exploring hydrogen and electrification in its midterm plans, but there is no immediate plan to introduce electric CEVs. Escorts Kubota is not confident about ethanol as a fuel for this industry, as it is only viable for vehicles present within the premises of a plant or in an organized distribution system.



Construction Equipment Vehicles: Escorts Kubota finds good scope for hydrogen tech in construction equipment segment, ET Auto (indiatimes.com)

Nuclear hydrogen rejected by nations as 'renewable'

Seven European nations, led by Germany, have rejected the use of hydrogen derived from nuclear power as a renewable option for the transport sector. The group, which includes Austria, Denmark, Ireland, Luxembourg, Spain, and Portugal, has written a letter to the European Commission opposing France's push for the use of nuclear power in green transport targets. On the other side, Bulgaria, Croatia, Slovenia, Slovakia, Hungary, the Czech Republic, and Poland support nuclear's implementation in green transport targets. The seven signatories believe that low carbon fuels should not be incentivized through a directive on the promotion of renewable energy and that counting low carbon energy towards renewable targets would reduce climate efforts and slow down investment in renewable capacity. Talks about the EU's renewable energy directive are currently delayed due to this ongoing disagreement.

Nuclear hydrogen rejected by nations as 'renewable' - Energy Live News

Using existing infrastructure seen as vital to Chile's green hydrogen push

The Chile is planning to develop its green hydrogen industry by leveraging existing infrastructure and adopting a shared access model. Port infrastructure in Magallanes and Antofagasta regions will be used for export-scale hydrogen projects as the country shifts away from hydrocarbon and coal-fired power generation. Sharing infrastructure will reduce costs and impact, and de-risk projects. Enap, Chile's state-run hydrocarbons company, has already signed MOUs linked to planned hydrogen projects in Magallanes, and has begun an infrastructure analysis. The government is preparing a green hydrogen roadmap with three pillars: infrastructure, investment and institutions, and sustainability and local development. Chile aims to have 5GW of hydrogen capacity operating and under development by 2025 and to produce green hydrogen for under US$1.5/kg by 2030, with 25GW of electrolyzer capacity.

Using existing infrastructure seen as vital to Chile's green hydrogen push - BNamericas

EVENTS:-

HYDROGEN TECHNOLOGY EXPO - 2023

CONFERENCE - EXPO - AWARDS

Website URL: https://missionenergy.org/hydrogen/

Venue Hyatt Centric - New Delhi

25 – 26 April 2023,

Technologies & Solutions For a Low-Carbon Hydrogen Future

International Conference on Renewable Hydrogen Technologies and Applications ICRHTA on April 08-09, 2023 in Rome, Italy

Website URL: https://waset.org/renewable-hydrogen-technologies-and-applications-conference-in-april-2023-in-rome

Location: Rome, Italy

Date: April 08-09, 2023

Organization: World Academy of Science, Engineering and Technology

International Conference on Hydrogen Energy Science and Technologies ICHEST

Website URL: https://waset.org/hydrogen-energy-science-and-technologies-conference-in-april-2023-in-venice

Location: Venice, Italy

Date: April 12-13, 2023

Organization: World Academy of Science, Engineering and Technology

INDIA NEWS

Michelin India ready with hydrogen cell for deployment

Michelin India has developed a fully developed Hydrogen cell to conserve energy at its plant in Tamil Nadu. The company has invested ₹5,000 crore in the plant and is working with the government to create policies for commercial use of Hydrogen. Michelin also aims to make its plant as green as possible. Amar Variawa, Country Director of Michelin India, praised the government's hydrogen mission and shared the company's initiative to improve the durability of tires used in the Defense sector. The announcement was made at the fifth foundation day of DY Patil International University in Pune. The university's Vice Chancellor, Prof Prabhat Ranjan, highlighted the institution's innovation and growth, with student enrollment increasing from 500 to 2,600 in five years.

Michelin India ready with hydrogen cell for deployment - The Hindu BusinessLine

SECI gearing up to emerge as main aggregator in green hydrogen sector

The Solar Energy Corporation of India (SECI) is preparing to become the main aggregator in the green hydrogen sector, with detailed implementation plans under development at the inter-ministerial levels. SECI has started consultations with major players in the field and is working on drafting guidelines and standards with the Ministry. The National Green Hydrogen Mission aims to make India a leading producer and supplier of green hydrogen, reduce dependence on imported fossil fuels, create export opportunities, attract investment, and create employment and economic development. By 2030, the Mission aims to develop green hydrogen production capacity of at least 5 million metric tonnes per annum with an associated energy capacity addition of about 125 GW in the country. SECI is a central public sector undertaking under the ministry of new and renewable energy and is one of the nodal agencies for the implementation of various schemes of MNRE.

SECI gearing up to emerge as main aggregator in green hydrogen sector, Energy News, ET EnergyWorld (indiatimes.com)

Oil PSUs to set up over 30 KTPA of annual green hydrogen production capacity

The public sector undertakings in the oil and gas sector are setting up green hydrogen manufacturing units of around 30.8 kilo-tonnes per annum (KTPA) by 2030. These facilities are spread over six states—Haryana, Madhya Pradesh, Andhra Pradesh, Assam, Karnataka and Tamil Nadu, data from the Ministry of Petroleum & Natural Gas (MoPNG) said.

The largest facility is being established by Bharat Petroleum Corporation (BPCL) in Madhya Pradesh of 10 KTPA, which is scheduled to be completed by 2030.

Oil PSUs to set up over 30 KTPA of annual green hydrogen production capacity - The Hindu BusinessLine

Amplus Solar to set up distributed green hydrogen plants in Andhra Pradesh worth Rs 1,500 crore

Amplus Solar, a distributed energy company and a unit of Malaysia's Petronas Group, plans to invest around Rs 1,500 crore to set up 7.5 KPTA-distributed green hydrogen plants for industrial consumption in Andhra Pradesh. The company has reached an agreement with the Andhra Pradesh government to establish multiple decentralised green hydrogen plants in the state. The move is aimed at contributing to India's goal of being the global green hydrogen hub. Andhra Pradesh, with its mix of industries and encouraging geography, offers a larger customer base to service and has a good potential for renewable energy generation. Amplus Solar already owns and manages a portfolio of over 1.4 GW of distributed solar assets.

Amplus Solar to set up distributed green hydrogen plants in Andhra Pradesh worth Rs 1,500 crore | Zee Business (zeebiz.com)

NTPC arm inks MoU with Indian Army to implement green hydrogen projects

NTPC Renewable Energy Ltd (REL) has signed a memorandum of understanding (MoU) with the Indian Army to implement green hydrogen projects in Army establishments. The project is based on the build, own, and operate (BOO) model and aims to reduce complex logistics and dependence on fossil fuels, accelerate decarbonisation, and promote a low-carbon economy. NTPC REL will design, develop, and install renewable energy projects (solar, wind, etc.) and hydrogen energy storage systems in a phased manner. Last month, NTPC completed the transfer of 15 renewable energy assets to its arm, NTPC Green Energy.

Ntpc Arm Inks Mou With Indian Army To Implement Green Hydrogen Projects (cnbctv18.com)

Sidhartha Harichandan; Sanjay Kumar Kar; Rohit Bansal; SK Mishra; Saroj Kumar.

https://doi.org/10.1016/j.ijhydene.2022.11.024

Achieving sustainable development goals through adoption of hydrogen fuel cell vehicles in India: An empirical analysis

Abstract:
Hydrogen is a growing facilitator for a multisectoral transition to a renewable energy-based economy. Despite this, there is negligible scholarly literature examining the connections between the hydrogen economy and the Sustainable Development Goals (SDGs) established by the United Nations. In this empirical investigation, we demonstrate a correlation between adopting Hydrogen fuel cell vehicles (HFCVs) and their direct and indirect impact on SDGs (#7, 9, 11, 12, 13,14 and 15). This empirical investigation was performed based on 358 valid sample responses from the pan-India survey. Utilising structural equation modelling, the hypotheses were tested, and the research model was validated. The findings revealed that the adoption of HFCV has a positive impact on SDGs. The results confirm that policy implications significantly change public perception regarding high cost and infrastructure readiness. Keeping the finding in mind, we recommend that the fuel retailers create more hydrogen refuelling stations across the country to ease infrastructure bottlenecks. Further, governments at various levels should provide financial benefits to green hydrogen producers, fuel cell manufacturers, HFCV manufacturers, and early adopters of HFCVs in India.

M. Gopinath; R. Marimuthu

A review on solar energy-based indirect water-splitting methods for hydrogen generation

https://doi.org/10.1016/j.ijhydene.2022.08.297

Abstract:
The distinguish generation methods regarding hydrogen generation using solar energy as a triggering agent are discussed in this paper, specifically indirect techniques. Two broadly classified processes are direct and indirect. The Direct processes exhibit high thermal ef-ficiency, but their low conversion efficiency, maximum heat dissipation, and the lack of readily available heat resistive materials in abundance put the indirect processes relatively on the higher rank. The indirect methods include bio photolysis, thermochemical, photolysis, and electrolysis. There are promising features of indirect ways. Bio-photolysis provides zero pollution; the photolysis method reduces the carbon footprint in the envi-ronment; Thermochemical is meritorious in low electricity consumption due to high heat generation in the process; Electrolysis proves its worth in negligible pollution and considerable efficiency. The energy and exergy efficiency for hydrogen yielding are compared, and it is found that electrolysis has the highest energy and exergy efficiency. In terms of raw material availability, thermochemical ranks very low as compared to photolysis (abundant solar energy), bio-photolysis (a readily available bio-agent), and electrolysis (electrolytic agents to carry out the process).

Lokesh Sankhula; Rohit Srivastava

CuAl layered double hydroxide as a highly efficient electrocatalyst for the electrolysis of water into hydrogen and oxygen fuels

https://doi.org/10.1016/j.ijhydene.2022.09.197

Abstract:
The production of green H2 through water electrolysis processes has become a prominent technology to deal with energy and environmental crisis worldwide. The total energy consumption of electrolysis processes can be reduced by the development of low-cost electrocatalysts. In this paper, we report first time the synthesis of a highly efficient 2D CuAl LDH electrocatalyst to produce the green H2. The electrocatalyst was characterized with the help of various analytical instruments such as FT-IR, XRD, BET, TGA, ICP-OES, and XPS. The morphological characterization was done by SEM and TEM. The electrochemical characterization such as CV, LSV, Tafel plot, and EIS was done in acidic, basic, seawater, and alkaline seawater medium. It was found that CuAl LDH electrocatalyst exhibits a good current density of 100 mA/cm2 at a potential of 1.178 V in acidic medium and 10 mA/cm2 at 1.114V in seawater medium. It was investigated that the CuAl LDH behaves as a bifunc-tional electrocatalyst and exhibits excellent HER and OER activity in an acidic medium. The effect of temperature on the efficiency of the electrocatalyst under the above electrolyte mediums was also studied. The electrochemical data suggests that the CuAl LDH electrocatalyst can be utilized in an alkaline/PEM electrolyzer to produce the green H2 at an industrial scale with optimum cost.

Osama Majeed Butt; Muhammad Shakeel Ahmad; Teong Kai Lun; et al.

A comparative study based on performance and techno-economic analysis of different strategies for PV-Electrolyzer (green) hydrogen fueling incinerator system

https://doi.org/10.1016/j.wasman.2022.11.016

Abstract:
The integration of hydrogen in the primary energy mix requires a major technological shift in virtually every energy-related application. This study has attempted to investigate the techno-economic solar photovoltaic (PV) integrated water electrolysis and waste incineration system. Three different strategies, i.e., (i) PV + Battery (Hybrid mode with required batteries); (ii) auto-ignition (Direct coupling); and (iii) PV + Secondary-Electrolyzer (Direct coupling assisted with secondary electrolyzer), have been envisioned. The 'PV + Battery' consume 42.42 % and 15.07 % less energy than the auto-ignition and 'PV + Secondary-Electrolyzer' methods. However, the capital cost of 'PV + Battery' has been calculated to be 15.4 % and 11.8 % more than auto-ignition and 'PV + Secondary-Electrolyzer, respectively.The energy consumption relative to waste input, the 'PV + Battery' method used 80 % less energy, while auto-ignition and 'PV + Secondary-Electrolyzer' showed 70.5 % and 77.5 % less energy, respectively. Furthermore, these approaches showed a vast difference in cost-benefit for the longer run. 'PV + Battery' was forecasted to be 73.3 % and 23.3 % more expensive than auto-ignition and 'PV + Secondary-Electrolyzer' methods, respectively, for 30 years. Overall, this study can benefit from using either of these methods depending on the application, usage scale, and climatic conditions.

Rupal Jain; Narayan Lal Panwar; Sanjay Kumar Jain; Trilok Gupta.

Bio-hydrogen production through dark fermentation: an overview

https://doi.org/10.1007/s13399-022-03282-7

Abstract:
Recently, hydrogen gas is becoming the most prominent alternative fuel due to its clean and environment-friendly nature. It only delivers water as a waste product during the operation instead of emitting harmful greenhouse gases. It has a high heating value (142 MJ/kg), over 2.75 times that of other hydrocarbon-based petroleum fuels. Presently, the primary method of producing hydrogen is the steam reforming of fossil fuels, which is not economical and environmentally harmful, and fossil fuels are on the deadline to finish. Hence, alternative methods of hydrogen production are the topic of current research. Biological methods of hydrogen production were found the best for producing green hydrogen because they utilize plentiful available renewable sources as feedstock. The dark fermentation technique is becoming more famous among all biological hydrogen generation methods because of its light autonomous nature and functional ability. It has the facility to convert any type of carbohydrate-rich organic substrates into bio-hydrogen, but pure carbohydrate substances are not economical on a commercial scale. Hence, carbohydrate-rich organic waste can be easily harnessed for bio-hydrogen generation. This method yields hydrogen gas and different high-volatility fatty acids, which could be used for industrial purposes after separation or as a precursor for the bio-methanation process for biogas production. This paper defines mechanism, microbiology, affecting factors, various integration methodologies, and potential and limitations related to the dark fermentation method.

Gursahib Singh; Damunas Kalra; Rachin Goyal.

Role of hydrogen and its implications to decarbonise India

https://doi.org/10.1016/j.matpr.2021.09.162

Abstract:
Hydrogen is gaining attention as a promising future energy source. It has the potential to be a clean alternative to fossil fuels, particularly if it is produced using renewable resources. Two key concerns will be addressed by hydrogen energy, viz, reduce reliance on fossil fuels, Cut down on pollutants and greenhouse gas emissions. This paper discusses various production methodologies, as well as challenges, consequences, and control measures, as well as methods for storing and transporting hydrogen, the role of density in storage, the use of existing pipelines and mapping for transportation, and the transition to cryogenic tanks and embrittlement resistant materials in the near future. India has a favourable geographical location and vast reserves for renewable energy which makes it a suitable candidate to emerge as a green hydrogen exporter by 2030. It also discusses how India can use its resources effectively, implement policies and measures and seek international collaboration for R&D in production technology and storage capabilities and materials in order to reduce Green House Gas (GHG) emissions, cost of production, replace fossil fuels with clean energy fuels and achieve its ambitious target of decarbonising by 2050.

Hydrogen Digest

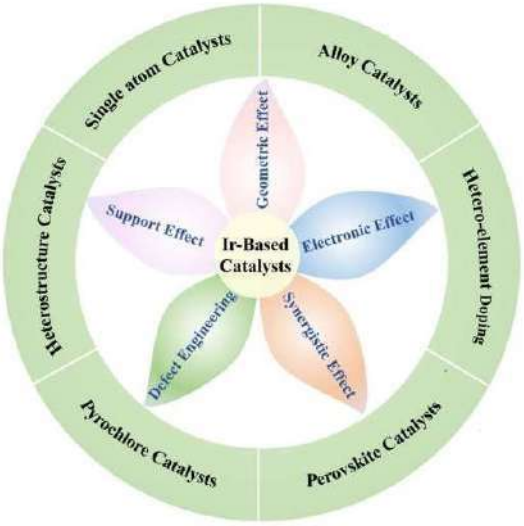
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE. 27

March, 2023

Iridium-based catalysts look set to boost efficiency of green hydrogen production

What are the challenges facing the production of clean hydrogen using wind and solar energy, and what are some of the solutions being researched?



Clean production of hydrogen through the process of electrolysis, which uses electricity to split water into hydrogen and oxygen, is extremely energy-intensive and expensive. Using wind and solar energy to power the process places a significant burden on the electrolyzers, as these energy sources are intermittent. Proton exchange membrane water electrolyzers (PEMWE) are a promising option, as they can operate at high current densities. However, the high cost of clean production of hydrogen remains a challenge.

To reduce the energy demands and cost of clean hydrogen production, a lot of research has focused on enhancing production efficiency by improving the performance of iridium-based catalysts, which can speed up the oxygen-related part of the electrochemical reaction involved in splitting water. However, the severe corrosion in the acidic environment of PEMWEs makes most non-precious metal-based catalysts unstable. Iridium-based catalysts exhibit much better catalytic stability in these harsh acidic conditions.

Recent studies have reported significant advances in the development of iridium-based catalysts for green hydrogen production, including the use of new synthesis methods and the optimization of catalyst structures and compositions. However, the high cost of iridium is a major challenge, and researchers are exploring new synthesis methods and alternative catalyst materials that can replace iridium or reduce the amount of iridium required.

The review of the state of the field published in the journal Nano Research Energy identifies research gaps that need to be filled before such catalysts can achieve commercial viability. The most successful strategy for improving the performance of iridium-based catalysts includes defect engineering, adjusting synergistic effects, and altering geometric effects. The number of exposed active sites can be increased by constructing a porous structure and introducing supports for the catalyst that promote transfer of both mass and electrons. Enhanced metal-support interaction can increase the long-term stability of the catalysts.

Review: Iridium-based catalysts look set to boost efficiency of green hydrogen production (phys.org)

Iridium-based catalysts for oxygen evolution reaction in acidic media: Mechanism, catalytic promotion effects and recent progress

Iridium (Ir)-based catalysts are highly efficient for the anodic oxygen evolution reaction (OER) due to high stability and anti-corrosion ability in the strong acid electrolyte. Recently, intensive attention has been directed to novel, efficient, and low-cost Ir-based catalysts to overcome the challenges of their application in the water electrolysis technique. To make a comprehensive understanding of the recently developed Ir-based catalysts and their catalytic properties, the mechanism and catalytic promotion principles of Ir-based catalysts were discussed for OER in the acid condition aimed for the proton exchange membrane water electrolyzer (PEMWE) in this review. The OER catalytic mechanisms of the adsorbate evolution mechanism and the lattice oxygen mechanism were first presented and discussed for easy understanding of the catalytic mechanism; a brief perspective analysis of promotion principles from the aspects of geometric effect, electronic effect, synergistic effect, defect engineering, support effect was concluded. Then, the latest progress and the practical application of Ir-based catalysts were introduced in detail, which was classified into the varied composition of Ir catalyst in terms of alloys, hetero-element doping, perovskite, pyrochlore, heterostructure, core–shell structure, and supported catalysts. Finally, the problems and challenges faced by the current Ir-based catalyst in the acidic electrolyte were put forward. It is concluded that highly efficient catalysts with low Ir loading should be developed in the future, and attention should be paid to probing the structural and performance correlation, and their application in real PEMWE devices. Hopefully, the current effort can be helpful in the catalysis mechanism understanding of Ir-based catalysts for OER, and instructive to the novel efficient catalysts design and fabrication.

https://doi.org/10.26599/NRE.2023.9120056

RECENT REPORT

ASEAN RENEWABLES:

OPPORTUNITIES AND CHALLENGES

A Joint Report by the International Energy Agency and Imperial College London



This report aims to improve financial transparency and provide more data pertaining to clean energy investments in Association of Southeast Asian (ASEAN) Member States1. Our research has conceptualized renewable energy risk and return qualitatively and quantitatively. The report further clarifies the opportunities and barriers for private sector investors, as well as priorities and potential solutions for scaling up renewables investment. Individual ASEAN countries have been analysed separately, and as constituent parts of the regional dynamic. ASEAN countries such as Vietnam, Thailand, Malaysia, Indonesia and Singapore have all committed to either netzero emissions or carbon neutrality by 2050.

https://iea.blob.core.windows.net/assets/057bafda-0c09-40fe-934c-4f2fe5e080f4/ASEANRenewables_InvestmentOpportunitiesandChallenges.pdf

Provaris Energy selected to participate in World Hydrogen 2023 Summit & Exhibition

Provaris Energy Ltd (ASX:PV1) has been selected to share its 'green hydrogen' strategy encompassing the development of projects for export using its compressed hydrogen transport solution during a prestigious international conference.

The company has been selected by Austrade as a member of the Team Australia delegation for the World Hydrogen 2023 Summit & Exhibition, taking place from May 9 to 11 at Rotterdam Ahoy in the Netherlands.



Provaris Energy Ltd selected to participate in World Hydrogen 2023 Summit & Exhibition (proactiveinvestors.com.au)

Portugal to hold Europe's pioneering auction for piped hydrogen

Portugal is launching a pioneering auction in the second half of 2023 for the rights to sell hydrogen that will be mixed with natural gas and injected into the national gas grid. The auction aims to increase investment in hydrogen production by providing guaranteed buyers to suppliers and remove the need for multiple bilateral contracts. The system is being watched as a potential solution to the conundrum of balancing producer requirements with the desire of clients for price and supply guarantees. The auction is designed to foster hydrogen technology development in Portugal and help generate demand to kickstart the fledgling hydrogen market in Europe. Around $76 billion has been pledged to construct green hydrogen plants, but only around $6 billion had reached the final investment decision stage as of May 2022.

Portugal to hold Europe's pioneering auction for piped hydrogen - World News (wionews.com)

Hydrogen Amid green hydrogen push, Chile issues electrolyzer call

Chilean state development agency, Corfo, has launched a request for information (RFI) call targeting companies interested in fabricating or assembling electrolyzers and associated components as part of a national drive to accelerate the development of a green hydrogen and derivatives sector. Under a green hydrogen strategy, Chile aims to have 5GW of electrolysis capacity built and under development by 2025 and 25GW by 2030. Corfo seeks to identify requirements for technological development, R&D and necessary labor skills, capture business potential, location areas, infrastructure requirements, raw material supply models, and demand model requirements. Chile could potentially export electrolyzer technology to other countries in South America. The deadline for the presentation of RFI documents is June 15, and results are due to be published June 30.

Amid green hydrogen push, Chile issues electrolyzer call - BNamericas

Government of Canada supports clean hydrogen production through Budget23

World Energy GH2 congratulates the Canadian Deputy Prime Minister and Minister of Finance, Chrystia Freeland, on the release of Budget23. The budget outlines the Clean Hydrogen Investment Tax Credit and the Canada Growth Fund, which will help launch Canada's green hydrogen sector. The comprehensive tax credit will enable Canada to compete on a global level with other countries' strong support mechanisms. The implementation of contracts for difference (CfDs) is necessary to make Canada competitive with the US Inflation Reduction Act (IRA). World Energy GH2 commits to staying engaged with Finance Canada as it finalizes the details of the tax credit. Budget23 sets the stage for the establishment of a multi-billion-dollar clean hydrogen sector in Atlantic Canada, with World Energy GH2's Project Nujio'qonik being one of the largest private-sector investments in the region's history. Canada's commitment to helping allies transition to cleaner energy is reflected in the budget, sending a signal that Canada can be counted on.

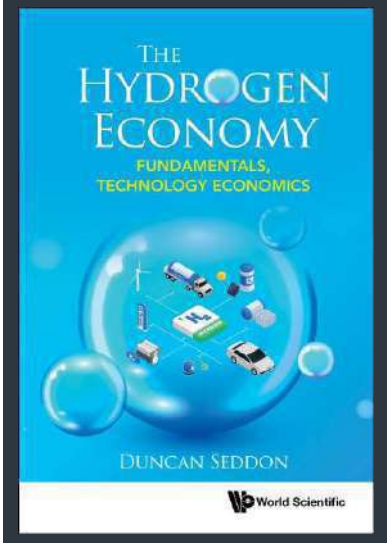


Government of Canada supports clean hydrogen production through Budget23 (lelezard.com)

BOOK-

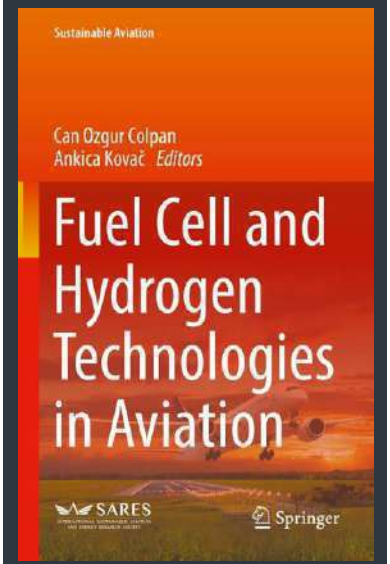
The Hydrogen Economy

Fundamentals, Technology Economies



Edited by: Duncan Seddon

Fuel Cell and Hydrogen Technologies in Aviation



Edited by: Can Ozgur Colpan, Ankica Kovač

This book explores cutting-edge topics on hydrogen and fuel cell technologies in aviation. Coverage includes comparisons with conventional technologies, hydrogen storage options, energy management strategies, life cycle assessment, and application of fuel cells in different aerial vehicle classes.

INDUSTRY NEWS

Toyota hydrogen-combustion Corolla out of race due to fire

Toyota's hydrogen-powered Corolla H2 Concept missed the first round of the Super Taikyu Series at Suzuka due to a vehicle fire during testing caused by a hydrogen leak that ignited close to the engine block due to a loose pipe joint that vibrated. The extent of the damage is unknown, and Toyota plans to review and develop safer vehicles. Instead, Toyota entered its ORC Rookie GR Yaris with a conventional 1.6-litre turbocharged petrol unit into the race. Toyota remains committed to entering the hydrogen racer into races with the goal of becoming one of the world's first to compete in a race with a car powered entirely by hydrogen.



Toyota hydrogen-combustion Corolla out of race due to fire - PerformanceDrive

German Pipeline Network Fit For Hydrogen Utilization

A study conducted by Open Grid Europe and the Materials Testing Institute of the University of Stuttgart has found that the steel pipelines in the German gas grid are suitable for transporting hydrogen without the need for major modifications. The pipelines were tested under extreme conditions and found to be equally suitable for hydrogen as they are for natural gas. This means that existing infrastructure worth around 300 billion euros can be utilized for the transportation of hydrogen at a cost of approximately 30 billion euros. This will enable millions of households and businesses to be supplied with 100 percent climate-neutral hydrogen via existing infrastructure with relatively little outlay and effort. Professor Linke has urged the German government to pave the way for the hydrogen economy in order to accelerate climate protection.

German Pipeline Network Fit For Hydrogen Utilization | Pipeline Technology Journal (pipeline-journal.net)

France's HDF Energy to develop Zimbabwe's first hydrogen plant

Zimbabwe's state-owned electricity distributor, ZETDC, has signed an MoU worth USD 300 million with French power producer HDF Energy to develop the country's first green hydrogen power plant. The plant will produce green power 24/7 and generate 178 GWh annually, providing electricity to over 220,000 people in southeastern Chipinge district. The project is expected to start construction in 2024-2025. This move is part of Zimbabwe's efforts to diversify its energy mix and reduce its reliance on Lake Kariba, which has experienced reduced power generation due to low water levels. The government is also aiming to produce over 1,000 MW from solar energy to address the country's energy deficit.



France's HDF Energy to develop Zimbabwe's first hydrogen plant (indiatimes.com)

'Hydrogen village' residents offered opt in/out choice for proposed scheme

Cadent and British Gas are offering residents in the Cheshire village of Whitby a choice to participate in the UK's first hydrogen village scheme. The proposal aims to replace natural gas with hydrogen for heating and cooking in up to 2,000 Whitby properties. After ten months of consultation, the companies have acted on feedback and will now offer residents a choice between being involved in the programme or using natural gas. Cadent will lay a parallel gas main in Whitby to transport hydrogen to participating properties while providing natural gas to opt-out properties. The companies outlined benefits such as brand new hydrogen appliances, price matching of hydrogen to natural gas, energy efficiency improvements, and free heating filters and smart thermostats for participating residents. Cadent confirmed that it will convert all residents back to natural gas at the end of the scheme, removing hydrogen appliances and installing brand new natural gas appliances free of charge.

'Hydrogen village' residents offered opt in/out choice for proposed scheme | TheBusinessDesk.com

EVENTS: -

WORLD HYDROGEN NORTH AMERICA 2023

Website URL: https://www.worldhydrogennorthamerica.com/?sso_stop=1

Venue: Marriott Marquis Houston, Texas

May 15 - 17, 2023

H2POLAND 2023

Website URL : https://h2poland.com.pl/en/

Location: Rome, Italy

Date: 16-17/05/2023

Green Hydrogen Forum & Expo – Munich

Website URL: https://www.ees-europe.com/for-visitors/green-hydrogen

Location: Messe München Am Messeturm München, München 81829 Germany

Starts- June 13 @ 8:00 am

Ends- June 16 @ 5:00 pm

ORGANIZER

Solar Promotion GmbH

NET ZERO SUMMITS 2023

Website URL: http://netzerosummits.com/

Location: Hotel Le Meridien New Delhi, Delhi

Date: 06-07 July 2023

Himachal aims to become leading green hydrogen-based economy by 2025

The government of Himachal Pradesh has signed an MoU with HLC Green Energy LLC to develop green hydrogen and make the state the first green state by 2025. The state has an advantage due to its abundance of green hydel energy and water resources. The project intends to produce 0.3 million metric tons of Green Hydrogen and 1.5 million metric tons of Green Ammonia annually and will require 20-25 acres of land in Una and Kangra. The manufacturing facility will bring in an investment of over Rs 4,000 crore and generate employment for about 2,500 individuals. The initial financial outlay for the project is Rs 19,744 crore, including research and development activities.

Himachal aims to become leading green hydrogen-based economy by 2025: CM Sukhvinder Sukhu (knnindia.co.in)

Pact inked for Rs 4,000-cr green hydrogen & ammonia project

The Himachal Pradesh government has signed a memorandum of understanding (MoU) with M/s HLC Green Energy LLC to establish a Rs 4,000-crore green hydrogen and ammonia project in Shimla. The project is part of the state's goal to become India's first "Green State" by 2026. The project aims to produce 0.3 MMT of green hydrogen and 1.5 MMT of green ammonia annually, contributing to import substitution and reducing greenhouse emissions. The project will be set up in Una or Kangra and is expected to generate employment for around 2,500 people, creating skilled manpower for nearby villages and strengthening the state's economy.



Pact inked for Rs 4,000-cr green hydrogen & ammonia project : The Tribune India

Lorry laden with hydrogen cylinders overturns near

A lorry carrying around 100 hydrogen cylinders to Kudankulam Nuclear Power Project overturned on the Tirunelveli – Kanniyakumari national highway, causing a three-hour traffic disruption. Fire and Rescue Services team sprayed water on the cylinders, which were highly inflammable, and removed the lorry with a crane. However, they were unable to remove the cylinders as they lacked the necessary equipment and expertise. Men and material from KKNPP arrived later to carry out the operation, and the fire and rescue services personnel continued to sprinkle water on the cylinders until their arrival.



Lorry laden with hydrogen cylinders overturns near Tirunelveli - The Hindu

Five firms make the PLI cut to manufacture hydrogen-powered vehicles

The Indian government has approved five companies - Ashok Leyland, Eicher Motors, Pinnacle Mobility, Tata Motors, and Booma Innovative - to manufacture hydrogen fuel cell electric vehicles under the PLI-Auto scheme. This scheme has two components - Champion OEM and Component Champion - and has attracted a proposed investment of Rs 74,850 crore. The government is relying on this scheme, along with other schemes, to promote a cleaner and more efficient electric vehicles-based transportation system. The OEMs are also working on developing hydrogen internal combustion engines for heavy commercial vehicle applications, and research and development projects on hydrogen-based engines and vehicles are being developed across the country.



Five firms make the PLI cut to manufacture hydrogen-powered vehicles – IndNews Express

Stefano Sollai; Andrea Porcu; et al.

https://doi.org/10.1016/j.jcou.2022.102345

Renewable methanol production from green hydrogen and captured CO2: A techno-economic assessment

Abstract:
This paper aims to present a pre-feasibility study of a power-to-fuel plant configuration designed for the pro-duction of 500 kg/h of renewable methanol (e-methanol) from green hydrogen and captured carbon dioxide. Hydrogen is obtained by water electrolysis employing the overproduction of renewable electricity. Carbon di-oxide is assumed to be separated from the flue gas of a conventional power station by means of an amine-based CO2 absorption system. A comprehensive process model has been developed with the support of Aspen Plus tool to simulate all the plant sections and the overall system. After the process optimization, a detailed economic analysis - based on capital and operating costs derived from commercial-scale experience and assuming a 20 -year lifetime - has been performed to calculate a levelized cost of methanol (LCoM) of 960 euro/t (about 175 euro/MWh). The analysis confirms that, today, the technology is still not competitive from the economic point of view, being LCoM more than double than the current methanol price in the international market (450 euro/t). However, it indicates that the process is expected to become competitive in a mid-term future, as a consequence of the new European policies. The study also reveals that LCoM is mainly affected by the electricity price and the electrolyser capital cost, as well as the capacity factor of the plant.

Lateef A. Jolaoso; Javad Asadi; et al.

A novel green hydrogen production using water-energy nexus framework

https://doi.org/10.1016/j.enconman.2022.116344

Abstract:
The transformation of electrical energy to hydrogen via water electrolysis consumes considerable amount of fresh water and a productive use of nontraditional water sources enhances the reliability and resilience of energy and water systems. In this study, we have designed a solid oxide electrolysis cell (SOEC) system which is an evolving hydrogen production technology at high temperatures for water electrolysis. The SOEC uses steam generated from flue gas as its feedstock and is fully integrated with numerous power production units, including coal and natural gas-fired power plants as its energy feedstock. While there is a hasten global shift away from fossil fuel, integrating its asset into this technology helps limit the risk and future losses of stranded assets and reduce the cost of investment in the new technologies. But high capital expenditures and doubt concerning the future cost and efficiency upgrade are obstacles to investing in water electrolysis. Such a detailed Levelized cost of hydrogen and techno-economic analysis is conducted to show the viability and environmental impacts of this novel technology. The results show SOEC efficiency of 97.4 % and 56.3 % as thermal-to-hydrogen efficiency of the system with a daily hydrogen production of 242,400 kg at $2.9-3.5/kg H2. The estimates show a positive gain prospect in this technology and techno-economic challenges.

Zhijie Chen; Sining Yun; et al.

Waste-Derived Catalysts for Water Electrolysis: Circular Economy-Driven Sustainable Green Hydrogen Energy

https://doi.org/10.1007/s40820-022-00974-7

Abstract:
The sustainable production of green hydrogen via water electrolysis necessitates cost-effective electrocatalysts. By following the circular economy principle, the utilization of waste-derived catalysts significantly promotes the sustainable development of green hydrogen energy. Currently, diverse waste-derived catalysts have exhibited excellent catalytic performance toward hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and overall water electrolysis (OWE). Herein, we systematically examine recent achievements in waste-derived electrocatalysts for water electrolysis. The general principles of water electrolysis and design principles of efficient electrocatalysts are discussed, followed by the illustration of current strategies for transforming wastes into electrocatalysts. Then, applications of waste-derived catalysts (i.e., carbon-based catalysts, transitional metal-based catalysts, and carbon-based heterostructure catalysts) in HER, OER, and OWE are reviewed successively. An emphasis is put on correlating the catalysts' structure-performance relationship. Also, challenges and research directions in this booming field are finally highlighted. This review would provide useful insights into the design, synthesis, and applications of waste-derived electrocatalysts, and thus accelerate the development of the circular economy-driven green hydrogen energy scheme.

V. A. Panchenko; A. A. Kovalev; et al.

Prospects for the production of green hydrogen: Review of countries with high potential

https://doi.org/10.1016/j.wasman.2022.11.016

Abstract:
The article provides a review of the current hydrogen production and the prospects for the development of the production of "green" hydrogen using renewable energy sources in various countries of the world that are leaders in this field. The potential of hydrogen energy in such countries and regions as Australia, the European Union, India, Canada, China, the Russian Federation, United States of America, South Korea, the Republic of South Africa, Japan and the northern countries of Africa is considered. These countries have significant potential for the production of hydrogen and "green" hydrogen, in particular through mining of fossil fuels and the use of renewable energy sources. The quantitative indicators of the production of "green" hydrogen in the future and the direction of its export are considered; the most developed hydrogen technologies in these countries are presented. The production of "green" hydrogen in most countries is the way to transition from the consumption of fossil fuels to the clean energy of the future, which will significantly improve the environmental situation, reduce greenhouse gas emissions and improve the energy independence of the regions. (c) 2022 Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.

Yuemeng Zhang , ORCID,Jia Wang andZhanhui Yao

Recent Development of Fuel Cell Core Components and Key Materials: A Review

https://doi.org/10.3390/en16052099

Abstract:
Fuel cells, as key carriers for hydrogen energy development and utilization, provide a vital opportunity to achieve zero-emission energy use and have thus attracted considerable attention from fundamental research to industrial application levels. Considering the current status of fuel cell technology and the industry, this paper presents a systematic elaboration of progress and development trends in fuel cell core components and key materials, such as stacks, bipolar plates, membrane electrodes, proton exchange membranes, catalysts, gas diffusion layers, air compressors, and hydrogen circulation systems. In addition, some proposals for the development of fuel cell vehicles in China are presented, based on the analysis of current supporting policies, standards, and regulations, along with manufacturing costs in China. The fuel cell industry of China is still in the budding stage of development and thus suffers some challenges, such as lagging fundamental systems, imperfect standards and regulations, high product costs, and uncertain technical safety and stability levels. Therefore, to accelerate the development of the hydrogen energy and fuel cell vehicle industry, it is an urgent need to establish a complete supporting policy system, accelerate technical breakthroughs, transformations, and applications of key materials and core components, and reduce the cost of hydrogen use.

Technical Target of bipolar plates

Characteristic	Units	2020 Target
Plate Cost	$/kW	3
Plate weight	kg/kW	0.4
Plate H2 permeation coefficient	Std $cm^3/(s\ cm^2 Pa)$@ 80 °C, 3 atm 100% RH	1.3×10^{-14}
Corrosion, anode	$\mu A/cm^2$	1
Corrosion, cathode	$\mu A/cm^2$	1
Electrical conductivity	S/cm	100
Areal specific resistance	$Ohm\text{-}cm^2$	0.01
Flexural strength	MPa	25
Forming elongation	%	40

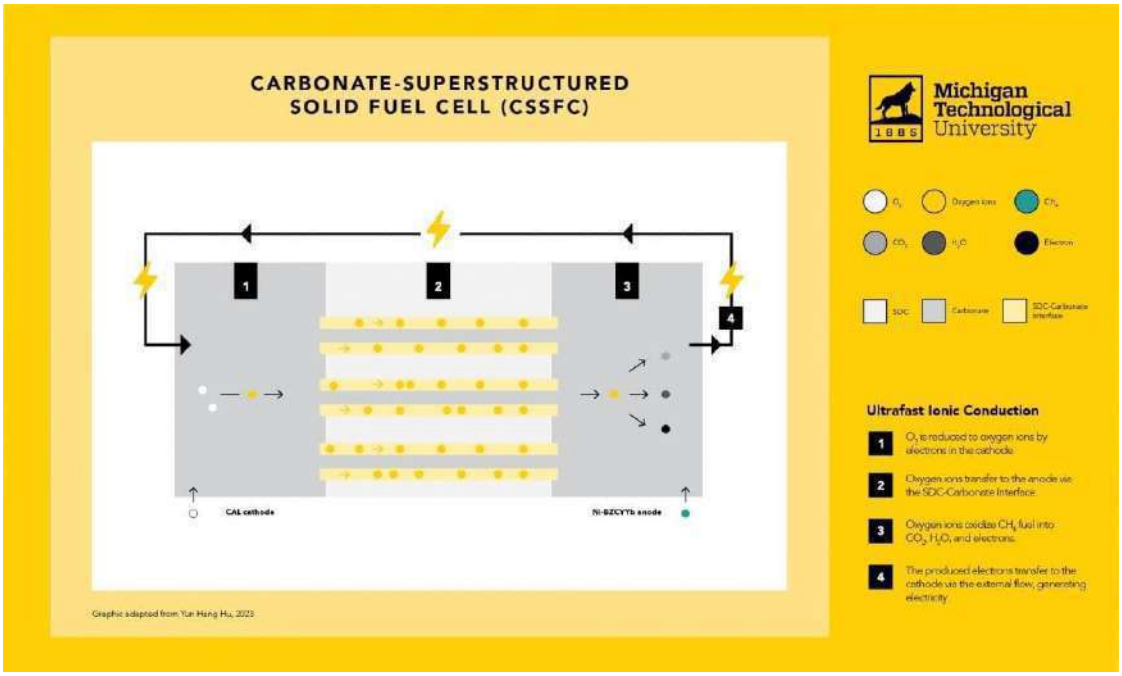
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 28
APRIL, 2023

An Energy Breakthrough: Tech Researchers Create New Type of Fuel Cell

Researchers found an ultrafast alternative to the slow oxide ion transfers of conventional fuel cells, increasing efficiency and performance by using hydrocarbon fuel directly. The commercial applications are promising



Michigan Technological University researcher Yun Hang Hu and two graduate students, Hanrui Su and Wei Zhang, took on those challenges, changing the conventional path of a fuel cell by creating an interface between the electrolyte and melted carbonate as an ultrafast channel for oxygen ion transfer.

"This allowed us to invent an entirely new type of fuel cell, a carbonate-superstructured solid fuel cell (CSSFC)," said Hu, who holds the Charles and Carroll McArthur Endowed Chair Professorship of Materials Science and Engineering in the Department of Materials Science and Engineering at Michigan Tech.

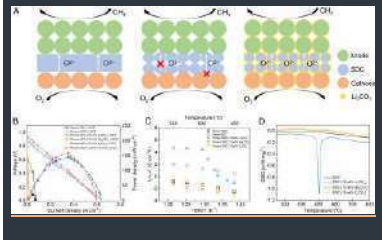
Like other fuel cells, CSSFCs have a wide array of potential uses, from providing energy to operate fuel cell vehicles and home power generation to entire power stations. Because CSSFCs are fuel flexible, they offer higher durability and energy conversion efficiency at lower operating temperatures than other types of fuel cells.

Hu, Su and Zhang had their findings, "Carbonate-superstructure solid fuel cells with hydrocarbon fuels," published in the Proceedings of the National Academy of Sciences journal.

Solid Oxide Fuel significance

Solid oxide fuel cells (SOFCs) are a promising energy conversion system due to their high energy efficiency and fuel flexibility. Lowering the operating temperature of SOFCs can minimize material degradation and enable the use of less expensive materials. However, both electrolyte and electrode resistances increase exponentially with decreasing operation temperature. This work demonstrates a carbonate-superstructured solid fuel cell (CSSFC) by in situ generating superstructured carbonate on the surface of porous electrolyte and the interface between electrodes and electrolyte, dramatically enhancing the oxygen ion conductivity and power density with hydrocarbon fuels at lower operating temperatures.

Schematic of the conventional SOFC, porous SOFC, and the CSSFC



RECENT REPORT

https://www.capgemini.com/insights/research-library/green-hydrogen/

Underpinned by a global shift towards decarbonization, hydrogen is gaining significance as an energy vector, especially for high-emission sectors that do not use electricity directly. Most organizations in this research believe that low-carbon hydrogen will be a long-term contributor to achieving emissions and sustainability goals:

- 63 percent of energy and utilities (E&U) organizations see it is as a key tool to decarbonize economies
- 62 percent of end-user organizations are looking to introduce low-carbon hydrogen to carbon-intensive parts of their business
- E&U organizations expect low-carbon hydrogen to meet up to 18 percent of energy demand by 2050 With government support, declining renewable-energy costs, rapid technological advances, and a growing focus on decarbonization and sustainable energy solutions, the demand for low-carbon hydrogen is expected to increase multifold. Sectors with traditional hydrogen applications, particularly in petroleum refining, chemicals and fertilizers, and steel, have high potential for adoption of low-carbon hydrogen. Demand for hydrogen in new applications such as long-range ground mobility (for heavy-duty trucks, coaches), long-haul aviation specifically sustainable aviation fuel (SAF), or maritime is expected to pick up.

China Petrochemical Corp to build the country's first long-distance hydrogen pipeline

China Petrochemical Corp has announced plans to build the country's first long-distance hydrogen pipeline stretching over 400km from Inner Mongolia to Beijing. The company, which is the nation's largest oil refiner and fuel supplier, claims that the pipeline will bolster China's efforts towards the green energy transition. China Petrochemical Corp is also the parent company of fuel supplier China Petroleum & Chemical (Sinopec). The pipeline will stretch from Ulanqab in the Inner Mongolia autonomous region to Sinopec's Yanshan petrochemical processing plant in Beijing. The hydrogen will be used to power green energy projects in Beijing's industrial centre. The pipeline will have a transmission capacity of 100,000 tonnes in the short term with plans to expand capacity to 500,000 tonnes. China Petrochemical Corp plans to incorporate a number of connection points across the length of the pipeline. Beijing hopes for 14% of its energy to come from renewable sources by 2025. China has set the dual target of reaching peak carbon emissions by 2030 and net-zero emissions across the country by 2060. The "west to east" pipeline forms a part of the national fuel transmission network development blueprint.



https://www.power-technology.com/news/china-petrochemical-corp-first-long-distance-hydrogen-pipeline/

Province approves second green hydrogen proposal for Point Tupper

Nova Scotia's environment minister has approved a second green hydrogen production plant in Point Tupper, N.S. Bear Head Energy plans to construct the green hydrogen and ammonia facility in the Point Tupper Industrial Park on the Strait of Canso at the same location it had once planned to build a liquefied natural gas plant.

The company will produce green hydrogen by drawing water from Landrie Lake, then using renewable energy from wind turbines to split water molecules into oxygen and hydrogen through a process called electrolysis. It will then convert the hydrogen into ammonia, which makes it easier to ship hydrogen long distances. The plant will have the capacity to produce up to 350,000 tonnes of hydrogen, which it will then convert into two million tonnes of ammonia each year before it is shipped to customers overseas. Ammonia can be used in various industrial processes, including the production of agricultural fertilizer. Interest in green hydrogen and ammonia is growing internationally as industries and governments seek alternatives to carbon-based fossil fuels.



https://www.cbc.ca/news/canada/nova-scotia/bear-head-green-hydrogen-approval-1.6807735

Brazil state deepens EU hydrogen cooperation

The Brazilian state of Piauí has entered into memorandum of understanding (MoU) agreements with companies in Europe which could lead to investment in growing the state's renewables and green hydrogen sectors. During a visit to Lisbon, Portugal, Governor Rafael Fonteles signed MoUs with German company Solar Outdoor Media, which intends to invest in Piauí. CEO Luciano Guido signed memorandum of understanding and, like other businessmen, intends to make an investment in renewable energy, especially in solar energy, for the production of green hydrogen in Piauí. Other companies to sign agreements with the state in relation to investing in growing its green hydrogen potential include Celeo Redes Brasil. All Energy has also become another strategic partner in the development of Piauí's clean energy ecosystem, after signing an MoU with the state. The company has activities that span construction and operation of wind and solar plants. Quinta Solar Energia also signed an MoU. The company already has a solar plant in the northern region of Piauí, with capacity to generate more than 1GW.

https://renews.biz/85012/brazil-state-deepens-eu-hydrogen-cooperation/

Events

World Hydrogen 2023 Summit & Exhibition

Venue: Rotterdam Ahoy, Netherlands
Date: May 9 to 11, 2023

Website:
https://www.world-hydrogen-summit.com/programme/

NET ZERO SUMMITS 2023

Website URL:
http://netzerosummits.com/
Location: Hotel Le Meridien New Delhi, Delhi
Date: 06-07 July 2023

WORLD HYDROGEN NORTH AMERICA 2023

Website URL:
https://www.worldhydrogennorthamerica.com/?sso_stop=1
Venue: Marriott Marquis Houston, Texas
May 15 - 17, 2023

H2 POLAND 2023

Website URL :
https://h2poland.com.pl/en/
Location: Rome, Italy
Date: 16-17/05/2023

Hamburg and Schleswig-Holstein Deepen Hydrogen Co-Operation – North Germany to Become Hub of Hydrogen Sector

The states of Hamburg and Schleswig-Holstein urged the German government to connect both states to the emerging European hydrogen pipeline network "Hyperlink III" at an early stage. The section from Ellund on the German-Danish border to Heidenau on the south bank of the Elbe is crucial to the energy transition as it due to supply north German industry with hydrogen. The German government must ensure that the project can go into operation by 2028. Positioning for a national port strategy Hamburg and Schleswig-Holstein also urged the German government to remove regulatory obstacles to a hydrogen sector and to establish a long-term financial framework for the required infrastructure.
https://hydrogen-central.com/hamburg-schleswig-holstein-deepen-hydrogen-co-operation-north-germany-become-hub-of-hydrogen-sector/

New Technology Could Bring Hydrogen Into The Mainstream

GH Power — a Canadian energy producer has its 1-25MW reactors use proprietary exothermic reactions to create three highly valuable green outputs: hydrogen, alumina (aluminum oxide) and exothermic heat that can be used to generate power for the grid. This smaller, modular reactor uses zero hydrocarbons and creates no carbon footprint offering flexible solutions based on the end-user. The reactor requires only a small amount of energy to start-up, and then it produces its green outputs at a cost that is significantly cheaper than existing processes such as electrolysis.
The scaled-up 25MW version of this reactor planned for the future produces the same three green outputs using either pure hydrogen or hydrogen blends of natural gas in a turbine. This blend speaks to the heart of the energy transition that is working toward the development of a turbine that can run on 100% hydrogen. With existing turbine technology, GH Power's scaled-up 25MW reactor will produce hydrogen, alumina and and exothermic heat for a carbon footprint that is 25% lower than a system that is run on pure natural gas. It's an exciting time for GH Power and its team of world-class engineers. They've successfully completed Phase 1 testing of their 1MW reactor in Hamilton, Ontario, and are reassembling it in a new facility and preparing it for commercial operations.



https://oilprice.com/Energy/Energy-General/New-Technology-Could-Bring-Hydrogen-Into-The-Mainstream.html

India extends transmission fee waiver for renewable hydrogen facilities source

India has extended a waiver of transmission fees for renewable hydrogen power manufacturing facilities commissioned before January 2031, as it seeks to become the world's cheapest producer of the fuel, a government official said. Building large-scale hydrogen and ammonia projects takes three to four years, and it was unlikely many would be commissioned by June 2025, the government official said. The country aims to produce renewable hydrogen at the lowest rate in the world, at $1-$1.50 per kilogram, down from the present $4-$5 per kilogram. Reliance Industries and Adani Enterprises have announced cost targets of $1 per kg by 2030. Larsen & Toubro, Indian Oil, NTPC, JSW Energy, ReNew Power, and Acme Solar are a few other prominent Indian corporations that have announced plans to produce renewable hydrogen. Renewable energy, including transmission, makes up 65%-70% of the expense of generating renewable hydrogen, according to industry estimates. The inter-state transmission charges range from 1-2 rupees per unit of electricity transmitted. Every one rupee decrease in renewable energy costs reduces the cost of green hydrogen by 60 Indian rupees ($0.73).

https://www.businessoutreach.in/renewable-hydrogen-facilities-source/

Safety Sensors

To facilitate hydrogen safety, NREL is testing hydrogen sensors that detect leaks and monitor gas purity at the Safety Sensor Testing Laboratory. Because hydrogen is colorless and odorless, sensors are important for safe hydrogen fueling stations, equipment, and facilities.

NREL researchers are testing fiber-optic sensor configurations resistant to electromagnetic interference. They also are testing protective and self-cleaning overlayer coatings for sensors. For remote hydrogen sensing, NREL is assessing sensor requirements and design options for innovative hydrogen sensor technologies and the feasibility of using analytic techniques.

Other sensor projects include testing wide-area visible hydrogen sensors and low-cost sensor arrays to address the transfer of instrument calibration between devices and the stability of devices over time. NREL explores the application of gettering polymer films for coating onto pipe and joined surfaces, gettering gasket materials based on Teflon composite materials, and incorporating sensor chemicals into coating and gasket materials.

https://www.nrel.gov/hydrogen/safety-codes-standards.html

Indian G20 presidency opposes watering down green hydrogen standards

India is opposed to diluting the definition of green hydrogen to include fuel produced from low carbon energy, as some developed nations have proposed in G20 meetings, Power and Renewable Energy Minister R K Singh said. In an interview with Reuters, RK Singh said India, which holds the rotating presidency of the G20, has proposed "harmonisation of the best possible standards" to regulate trade in green hydrogen, which should be produced using only renewable energy, rather than low carbon fuel.
https://economictimes.indiatimes.com/industry/renewables/indian-g20-presidency-opposes-watering-down-green-hydrogen-standards/articleshow/99219804.cms

Govt Extends Transmission Fee Waiver For Green Hydrogen Plants: Report



India has extended a waiver of transmission fee for renewable power to hydrogen manufacturing plants commissioned before January 2031.The waiver was earlier available for projects set up before July 2025, and since building large-scale hydrogen and ammonia projects takes three to four years, it was unlikely that many would have got commissioned by June 2025.The country aims to produce green hydrogen at USD 1-1.50 per kilogram, down from the current USD 4-5 per kilogram. Industry estimates show that renewable energy, including transmission, makes up 65-70 per cent of the cost of producing green hydrogen. India also plans to give green hydrogen producers incentives worth at least 10 per cent of their costs under a USD 2 billion scheme set to begin before the end of June. India's hydrogen mission is estimated to require investments worth 8 trillion Indian rupees ($98 billion) by 2030, including 125 gigawatts of non-fossil-based generation capacity and new transmission lines.
https://www.businessworld.in/article/Govt-Extends-Transmission-Fee-Waiver-For-Green-Hydrogen-Plants-Report/11-04-2023-472414/

Auction for green H2 incentives to kick off in Q1 with cap of Rs 50/kg

India's Ministry of New and Renewable Energy will hold the first tranche of auctions for incentives to produce green hydrogen and green hydrogen electrolysers in the current quarter. The winning bidder for green hydrogen will receive incentives, up to a cap of INR50 ($0.68) per kg, for three years, which will gradually taper off. Meanwhile, successful bidders for the manufacturing electrolyser tranche will receive Incentives of INR4,440 per kilowatt (kW) in the first year of production falling to INR1,480 per kW in the fifth year.
https://economictimes.indiatimes.com/industry/renewables/auction-for-green-h2-incentives-to-kick-off-in-q1-with-cap-of-rs-50/kg/articleshow/99277204.cms

India plans green hydrogen incentives of at least 10% of cost – source

In an effort to cut carbon dioxide emissions and become a major exporter in the sector, New Delhi approved this year a 174.9 billion rupee incentive plan to promote green hydrogen. The manufacturing of electrolysers, which are used to split the molecules of hydrogen and oxygen using electricity, will receive the remaining 130 billion rupees from the government's incentive plan for the sector. By 2030, India wants half of its installed electricity capacity to come from non-fossil fuel sources, and by 2070, it wants to have zero carbon emissions. According to the source, the government will begin the bidding process for firms seeking incentives before the end of this quarter. Additionally, the government anticipates supporting 3.6 million tonnes of hydrogen production capacity over the course of the scheme's first three years. According to the official, each tranche for the manufacturing of electrolyzers is likely to consist of 1,500 megawatts (MW) of capacity with a fixed incentive of 4,440 rupees per kilowatt.Through the scheme, the government expects to provide support for approximately 3,000 megawatts of annual electrolyzer capacity for five years.The first tranche will be provided in this quarter, and the next will be provided in the third quarter of 2023.

https://thesustainablebrandsjournal.com/india-plans-green-hydrogen-incentives-of-at-least-10-of-cost-source

Barik B. *et al.*

https://doi.org/10.1016/j.ijhydene.2022.12.137

Highly enhanced proton conductivity of single-step-functionalized graphene oxide/nafion electrolyte membrane towards improved hydrogen fuel cell performance

Abstract:

Acidic group functionalized graphene oxide (GO) as a filler to the state-of-art Nafion electrolytes are regarded as potential materials towards next-generation fuel cell application. However, the tedious synthesis process for GO functionalization, and aggravated chemical durability at high temperatures demands the scientific community to design suitable Nafion-based functionalized GO electrolytes with superior proton conductivity and power density at actual fuel cell conditions *i.e.,* 80 °C and 100% relative humidity (RH). Herein, a potential single-step-phosphorylated graphene oxide (sPGO) modified Nafion (sPGO/NF) is introduced to simultaneously multifold the proton conductivity, chemical durability, and power density of Nafion. Under actual fuel cell conditions, the sPGO/NF exhibits maximum proton conductivity (0.306 Scm^{-1}) which is 1.7-fold and 1.6-fold higher than that of rNF and GO/NF, respectively. Moreover, sPGO/NF achieves the maximum power density of 0.652 Wcm^{-2} (80 °C, 100% RH), much higher than the rNF (0.51 Wcm^{-2}) and GO/NF (0.53 Wcm^{-2}) at same condition.

Navakoteswara Rao V. *et al.*

A critical review on core/shell-based nanostructured photocatalysts for improved hydrogen generation

https://doi.org/10.1016/j.ijhydene.2023.01.059

Abstract:

Photocatalytic water splitting into gaseous hydrogen and oxygen in the presence of semiconductor photocatalysts under a visible spectrum of solar irradiation is one of the most promising processes for plummeting energy demands and environmental pollution. Among the successful photocatalytic materials, the core/shell nanostructures show promising results owing to their fascinating morphology that protects the surface features of the core besides the effective separation of photo-excitons resulting in an enhanced rate of hydrogen production up to 162 mmol $h^{-1}g^{-1}_{cat}$, which is a notable highest value reported in the literature. In this review, we have focused on the basic characteristics of the core-shell structure-based semiconductor photocatalytic systems and their efficient water-splitting reactions under light irradiation. Comprehensive detail on various synthesis methods of core-shell nanostructures, shell thickness-dependent properties, charge-transfer reaction mechanisms, and photocatalytic stability are highlighted in this review. Core-shell nanostructured materials have been extensively used as a photocatalyst, co-catalyst, and by coupling with supporting materials to improve the apparent quantum efficiency up to 45.6%. Besides, important photocatalytic properties that influence the redox reactions i.e., effective exciton separation, the effect of different light sources/wavelengths, surface charge modeling, photocatalytic active sites, and turnover frequency (TOF) have also been focused on and extensively described. Finally, the present and future prospects of the core-shell nanostructured photocatalysts for solar energy conversion into green hydrogen production have been expounded.

Xi Cheng *et al.*

Homojunction-Structured Cadmium Sulfide Enhances Photocatalytic Coproduction of Hydrogen and Kraft Lignin Conversion

https://doi.org/10.1021/acsaem.3c00274

Abstract:

Producing hydrogen energy and aromatic compounds simultaneously from kraft lignin under solar irradiation is a promising strategy for alleviating the energy crisis. However, the achieved photorefining process is not only limited by the complex structure of kraft lignin but also by the lack of efficient photocatalysts. Herein, we employed a simple strategy to prepare homojunction-structured cadmium sulfide with rich sulfur vacancies. The perfect lattice matching of the cubic zinc blende phase and hexagonal wurtzite phase realized the spatial separation of photogenerated electrons and holes. With the assistance of rich sulfur vacancies, the well-designed photocatalyst exhibited an unprecedented hydrogen production ability (835.8 $\mu mol \cdot g^{-1}\ h^{-1}$) and value-added phenolic compounds were also generated by decomposing kraft lignin. This work will provide a mild and sustainable pathway to produce clean energy and value-added chemicals from kraft lignin.

Yi Ge *et al.*

Power/thermal-to-hydrogen energy storage applied to natural-gas distributed energy system in different climate regions of China

https://doi.org/10.1016/j.enconman.2023.116924

Abstract:
This paper presents a novel distributed energy system (DES) with hybrid-hydrogen energy storage, in which the proton exchange membrane electrolyzer (PEMEC) and steam reforming of methanol (SRM) are used to convert surplus power and waste heat into hydrogen. To identify the feasibility of the proposed DES in different climate regions, a case study is performed to choose a rehabilitation hospital in Harbin, Jinan, Wuhan and Guangzhou of China to explore the DES optimal configurations. The mixed integer linear programming model is established and the multi-objective optimization considering annual total cost (ATC) and annual carbon emissions (ACE) is conducted by improved version of augmented ε-constraint (AUGMECON2) method for system optimal configurations. After selecting four cases among Pareto frontiers for each city, the two methods of Analytic Hierarchy Process/Shannon entropy combined with Gray Relation Analysis are performed to determine the most suitable locations. The results show that adding the SRM to DES as a hybrid-hydrogen energy storage system can improve the configuration flexibility, environmental performance and primary energy ratio compared with only-electrochemical hydrogen storage DES. The Pareto frontiers for four cities demonstrate a trade-off between ATC and ACE, and the ACE is decreased by 6.3% with ATC increased by 1.4% in Jinan. Generally, Guangzhou is the best suitable city, and Jinan and Wuhan rank second by two evaluation methods with 0.727 and 0.643 average scores, respectively. The current electricity and natural-gas prices are verified to be beneficial to Jinan to deploy the proposed DES, and Guangzhou and Wuhan present a better economic performance with the minimum ATC decreased by 11.4% and 6.58% under ideal energy prices. The results can provide useful information for hybrid-hydrogen energy storage application to DES in different climate regions.

Okubo T. *et al.*

Factors affecting the techno-economic and environmental performance of on-grid distributed hydrogen energy storage systems with solar panels

https://doi.org/10.1016/j.energy.2023.126736

Abstract:
Deployment of on-grid distributed hydrogen energy storage (HES) systems, which are more economically advantageous than off-grid systems, requires not only optimization for minimizing system costs but also analysis for clarifying the factors that affect the optimization results. In this study, an on-grid system with solar photovoltaic (PV) panels, an electrolyzer (EC), fuel cell, hydrogen tank, and compressor was modeled. This model was used to analyze the changes in the system cost and greenhouse gas (GHG) emission with an increase of device capacities under different PV capacities and self-sufficiency rates (SSRs). The analyses quantitatively showed that the optimization under massive PV implementation, which generated large amounts of surplus electricity and did not need seasonal storage for more than half a year, makes HES system more economically attractive while reducing the GHG emission. The unit cost reduction of the HES devices made the optimal EC capacity increased, which reduced the curtailment of surplus electricity. When an SSR constraint was imposed, the unit cost reduction of the HES devices decreased the optimal PV capacity while reducing the curtailment of surplus electricity. The maximum installable PV capacity in a microgrid was also discussed in terms of the electricity demand density and grid transmission capacity.

Yanfei Li *et al.*

A strategic roadmap for ASEAN to develop hydrogen energy: Economic prospects and carbon emission reduction

https://doi.org/10.1016/j.ijhydene.2022.12.105

Abstract:
The progress of hydrogen energy in terms of technologies and supply chains is appealing to member countries of the Association of Southeast Asian Nations (ASEAN). Countries with the advantages of fossil fuel resources and existing infrastructure can export grey hydrogen energy until 2025. This could help expand hydrogen-related infrastructure and form a certain level of economies of scale to prepare for the next phase of development of blue and green hydrogen energy. From 2026 to 2030, ASEAN could shift to blue hydrogen energy exports with the help of carbon capture, utilization, and storage. However, the domestic applications of hydrogen energy will remain economically uncompetitive in most ASEAN countries. After 2030, as the levelized costs of electricity for renewables decline and the share of renewable energy power increases, the cost of hydrogen energy production from surplus electricity could become even lower. Consequently, green hydrogen energy will dominate domestic downstream energy applications and exports to overseas markets.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN

ISSUE: 29
APRIL, 2023

A Solar Hydrogen System that co-generates Heat and Oxygen

A parabolic dish on the EPFL campus is easily overlooked, resembling a satellite dish or other telecommunications infrastructure. But this dish is special, because it works like an artificial tree. After concentrating solar radiation nearly 1,000 times, a reactor above the dish uses that sunlight to convert water into valuable and renewable hydrogen, oxygen, and heat.



Waste not, want not

Hydrogen production from water using solar energy is referred to as artificial photosynthesis, but the LRESE system is unique for its ability to also produce heat and oxygen at scale.

After the dish concentrates the sun's rays, water is pumped into its focus spot, where an integrated photoelectrochemical reactor is housed. Within this reactor, photoelectrochemical cells use solar energy to electrolyze, or split water molecules into hydrogen and oxygen. Heat is also generated, but instead of being released as a system loss, this heat is passed through a heat exchanger so that it can be harnessed – for ambient heating.

Industrial and residential energy

The EPFL start-up is working with a Swiss-based metal production facility to build a demonstration plant at the multi-100-kilowatt scale that will produce hydrogen for metal annealing processes, oxygen for nearby hospitals, and heat for the factory's hot-water needs.

The system could be used to provide residential and commercial central heating and hot water, and to power hydrogen fuel cells. At an output level of about half a kilogram of solar hydrogen per day, the EPFL campus system could power around 1.5 hydrogen fuel cell vehicles driving an average annual distance; or meet up to half the electricity demand and more than half of the annual heat demand of a typical four-person Swiss household.

https://actu.epfl.ch/news/a-solar-hydrogen-system-that-co-generates-heat-and/

Researchers have built a pilot-scale solar reactor that produces usable heat and oxygen, in addition to generating hydrogen with unprecedented efficiency for its size.

"With an output power of over 2 kilowatts, we've cracked the 1-kilowatt ceiling for our pilot reactor while maintaining record-high efficiency for this large scale. The hydrogen production rate achieved in this work represents a really encouraging step towards the commercial realization of this technology.
The pilot demonstration at EPFL, we have achieved a major milestone by demonstrating unprecedented efficiency at high output power densities. We are now scaling up a system in an artificial garden-like setup, where each of these 'artificial trees' is deployed in a modular fashion," says SoHHytec co-founder and CEO Saurabh Tembhurne.

References

Holmes-Gentle, I., Tembhurne, S., Suter, C. et al. Kilowatt-scale solar hydrogen production system using a concentrated integrated photoelectrochemical device. Nat Energy (2023). https://doi.org/10.1038/s41560-023-01247-2

Events

hy-fcell Canada 2023

VENUE

Vancouver Convention Centre East

999 Canada Place`

Vancouver, British Columbia BC

V6C 3C1 Canada



Green Hydrogen Forum & Expo – Munich



Website URL:

https://www.ees-europe.com/for-visitors/green-hydrogen

Location: Messe München

Am Messeturm

München, München 81829

Germany

Starts- June 13 @ 8:00 am

Ends- June 16 @ 5:00 pm

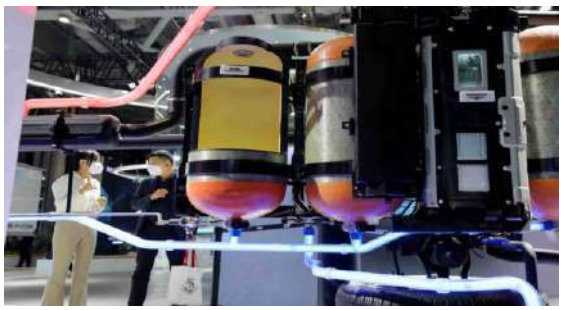
ORGANIZER

Solar Promotion GmbH

INDUSTRY NEWS

China – Hydrogen Gassed Up to Reduce Traditional Train Fuels, Hit Carbon Goals

Substantial growth prospects exist for hydrogen rail traffic in China, which would drive an industrial chain of up to trillions of yuan and further facilitate the country's carbon neutrality ambitions, said industry experts. Hydrogen energy has broad application scenarios in rail transit in China, including sightseeing trains and urban transit vehicles, as well as many engineering vehicles, said Chen Weirong, dean of the School of Electrical Engineering at Southwest Jiaotong University. As a high potential energy source for buses and heavy goods vehicles and trains, hydrogen-powered vehicles are well positioned to help China reach its emission reduction goals as a versatile zero-emission technology in rail transportation. Capable of replacing diesel volumes at a large scale by 2030, the clean fuel is expected to drive an industrial chain of up to trillions of yuan in the years to come. Diesel locomotives account for more than one-third of the country's total, undertaking major railway construction tasks, and the national electrification rate has just exceeded 70 percent, Chen said. Chinese industrial giant CRRC Corp Ltd, in partnership with Chengdu Rail Transit, introduced a new zero-emissions passenger train powered by hydrogen in February. The new train offers a travel range of 600 kilometers and is the fastest to date, with a top speed of 160 kilometers per hour. The CRRC train uses hydrogen to generate electricity in its fuel cells, emitting nothing but water as a byproduct of the power generation process. Peng Chaocai, vice-president at Sungrow Power Supply Co Ltd, said the development of hydrogen in China, as with any new technology, is subject to various challenges and uncertainties, including high production costs, limited infrastructure and the need for breakthroughs in key technologies.



https://hydrogen-central.com/china-hydrogen-gassed-reduce-traditional-train-fuels-hit-carbon-goals/

Renewables developer Amp Energy selected to lead South Australian hydrogen precinct

AMP Energy has signed an agreement to develop and build a 5 GW green hydrogen production facility in South Australia's Cape Hardy, where Iron Road is working to develop a green hydrogen and industrial port precinct with multi-commodity capability. Iron Road selected Amp Energy as the lead green hydrogen developer in what is expected to be a multi-billion-dollar, world-leading hydrogen precinct. Amp plans to develop and build 5 GW of electrolyser capacity over the next decade in the precinct, delivering more that 5m t/y of green ammonia. The partners expect the project will establish South Australia as a global leader in the production of green hydrogen and ammonia. The planned industrial hub, located in the Eyre Peninsula, will also accommodate a multi-purpose, multi-user, deep-sea port for hydrogen operations, along with mineral and grain exports. It is expected to create more than 5,000 jobs during the peak of development, and more than 1,000 once fully operational. Amp's selection marks the beginning of a nine-month exclusivity period to grow the multi-commodity and renewable energy project. The port and industrial precinct will be delivered over a number of stages.

https://www.thechemicalengineer.com/news/renewables-developer-amp-energy-selected-to-lead-south-australian-hydrogen-precinct/

Hydrogen Innovation: Project to scale AEM technology for industry applications

Research and industry have recognized the potential of alkaline AEM electrolysis and expect a fast technology development during the next decade. Fraunhofer IFAM and Sunfire, together with Canadian materials partner Ionomr Innovations, are now launching the "Integrate" research project to apply the promising technology on an industrial scale. To produce cost-effective green hydrogen, industry and energy companies need efficient electrolyzers on a large scale. Technologies such as pressurized alkaline or high-temperature electrolysis are already being installed in industrial environments. Another approach that shows great promise is the anion exchange membrane (AEM) technology.

https://www.chemeurope.com/en/news/1180203/hydrogen-innovation-project-to-scale-aem-technology-for-industry-applications.html

Events

Hydrogen Expo – Piacenza Italy

Website URL: https://www.worldhydrogennorthamerica.com/?sso_stop=1

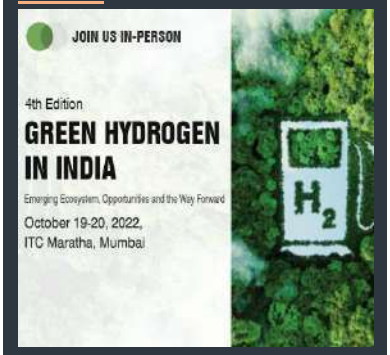
Venue: Piacenza Expo Center

Via Tirotti 11, Piacenza, Italy

May 17 @ 8:00 am - May 19 @ 5:00 pm UTC+0



4TH EDITION OF GREEN HYDROGEN IN INDIA



https://indiainfrastructure.com/events/4th-edition-green-hydrogen-in-india/

October 19, 2022 (Wednesday) - October 20, 2022 (Thursday)

10:00 AM - 05:00 PM

Venue:

ITC Maratha, Mumbai, Maharashtra

INDUSTRY NEWS

Namibia Green Hydrogen deal to be signed in May – report

Hyphen Hydrogen Energy and Namibia expect to sign the deal on the $10 billion green hydrogen project in Namibia in May. The announcement follows. President Hage Geingob's visit to Lüderitz last week, as part of a series of consultative meetings with local and industry stakeholders on Green Hydrogen projects, according to the report. In March 2023, Zawya Projects reported that the implementation agreement for the project is expected to be signed in the second quarter of this year.At full development, the project will produce 300,000 metric tonnes of green hydrogen annually from 5-6 gigawatts (GW) of renewables and 3GW electrolyser capacity. The project promoter, Hyphen Hydrogen Energy, had signed two memorandums of understanding (MOUs) in February this year with a major chemical company, name withheld, and South Korean hydrogen producer Approtium for a total annual offtake of up to 500,000 tonnes and 250,000 tonnes a year respectively.

https://www.zawya.com/en/projects/industry/namibia-green-hydrogen-deal-to-be-signed-in-may-report-nyo5gdfv

Accelerating financing for green hydrogen projects in Africa

Two hundred representatives from African governments, renewable energy and green hydrogen project developers, development finance institutions (DFIs), bilateral partners, and civil society convened in Nouakchott, Mauritania on 13-14 April at the Africa Green Hydrogen Finance Accelerator Forum.

The forum focused on solutions to finance large-scale renewable energy and green hydrogen projects in developing countries and emerging economies. The forum was organised by the Mauritania Ministry of Petroleum, Mines and Energy and the Africa Green Hydrogen Alliance (AGHA) with the support of the Green Hydrogen Organisation and UN Climate Change High Level Champions.

https://climatechampions.unfccc.int/accelerating-financing-for-green-hydrogen-projects-in-africa/

Jakson Green to develop first urban-centric green hydrogen refuelling station

Energy solutions company Jakson Green on Tuesday announced that the company is developing a Green Hydrogen fuelling station at Badarpur, New Delhi for a major power company in India. The green hydrogen fuelling station involves the establishment of a specialised and dedicated facility that will use the green energy generated on-site by a renewable hybrid to generate, compress, store, and dispense GH, utilising a hydrogen purification system. As a part of the project, the company will also incorporate a battery energy storage system (BESS) backed renewable hybrid power plant within the station, making it a completely self-sustained facility. Overseeing the entire facility, an advanced integrated control system using cutting-edge digital technology will also be put in place to supervise and monitor the fuelling station's operations. The fuelling station is expected to produce 260 kg of green hydrogen per day at a pressure of 350 bar that will be utilised to fuel up to five intercity FCEV (fuel cell electric vehicle) buses. Bikesh Ogra, CEO and Managing Director of Jakson Green Private Limited, said, "Our endeavour to establish India's largest urban centric green hydrogen refuelling station is another push to steer nation's sustainability initiatives. The project is expected to aid the recently launched National Hydrogen Mission & significantly contribute towards propelling India's low carbon quotient/journey. Project reinforces hydrogen's crucial role as a new energy transition fuel, reducing India's dependence on imported crude oil and minimizing pollution. This sets us apart as a pioneering player in green hydrogen, and we remain committed to building infrastructure that promotes hydrogen-fueled vehicles."



https://www.livemint.com/industry/energy/jakson-green-to-develop-first-urban-centric-green-hydrogen-refuelling-station-11681830838819.html

Report

CLEAN ENERGY GLOBAL MARKET OUTLOOK 2023

Clean Energy Pipeline's Clean Energy Global Market Outlook 2023 features research, data and statistics on global investment activity in the renewable energy sector, including the latest figures on project financing, M&A, capital markets, and green bonds.



https://cleanenergypipeline.com/market-reports/clean-energy-global-market-outlook-2023/

NTPC plans IPO for green energy arm

India's largest power producer, NTPC, plans to raise funds via an initial public offering (IPO) for NTPC Green Energy Ltd (NGEL) in the current fiscal year. This comes after Malaysia's Petronas withdrew its bid for a 20% stake in the green energy unit, valued at around INR60bn ($806m). NGEL is critical to drive NTPC's ambitious clean energy programme, which aims to have 60 GW of renewables capacity by 2032 on a standalone basis and 130 GW on consolidated levels.

https://economictimes.indiatimes.com/industry/renewables/ntpc-plans-ipo-for-green-energy-arm/articleshow/99474508.cms

Jakson Green developing green hydrogen refuelling station in New Delhi

Jakson Green on Tuesday said that it is developing a green hydrogen fuelling station at Badarpur in New Delhi for a major power company, which is expected to offset 3.7 tonnes of CO2 per day once operational. Besides a hydrogen purification system, the firm will set up a battery energy storage system (BESS) backed renewable hybrid power plant within the station, making it a completely self-sustained facility, the company said, a part of Jakson Group, said.The fuelling station is expected to produce 260kg of green hydrogen per day at a pressure of 350 bar. The fuel will be utilised to run up to five intercity FCEV (fuel cell electric vehicle) buses.

https://www.thehindubusinessline.com/companies/jakson-green-to-develop-green-hydrogen-refuelling-station-in-delhi/article66752031.ece

India must drive global efforts for a green hydrogen economy during its G20 presidency

The second Energy Transition Working Group (ETWG) meeting of the G20 concluded recently in Gandhinagar – effectively showcasing India as an emerging energy transition powerhouse. The creation of a green hydrogen economy is one of the key areas of deliberation under India's G20 Presidency.

India's G20 presidency is a great opportunity to mobilise member nations to work towards a globally acceptable standard and certification process. A standard framework for classifying green hydrogen and its derivatives can establish common criteria and provide a clear understanding of what green hydrogen and its derivatives are, which can then enable the development of a transparent, robust, and global marketplace. A standardised framework for defining green hydrogen and its derivatives will facilitate targeted policy interventions and provide clarity and confidence to investors, customers and suppliers.

https://www.moneycontrol.com/news/opinion/india-must-drive-global-efforts-for-a-green-hydrogen-economy-during-its-g20-presidency-10438151.html

Centre seeks proposals to develop green hydrogen innovation hubs

The focus on green hydrogen gains importance in the backdrop of India's target to install 500GW of renewable energy capacity by 2030 and achieve net zero carbon emission by 2070.

The Centre has invited expressions of interest (EoI) for developing hydrogen valley innovation clusters (HVIC) in the country. The Department of Science and Technology's guidelines define a hydrogen valley as a specific geographic region where hydrogen serves more than one end sector or application in mobility, industry, and energy. This includes all steps in the hydrogen value chain, from production, storage, and transport to distribution to various off-takers, as well as renewable electricity production from hydrogen. The government will provide up to ₹25 lakh in assistance for the preparation of detailed project reports (DPR) which must be completed within 45 days of the project's allocation. EoIs will be evaluated in May, and funding for the recommended EoIs for DPR preparation will also occur in that month. The DPRs will be evaluated and shortlisted in July, with the project expected to start in October 2023 and finish by 2028. Each HVIC will target annual green hydrogen production of up to 500 tonne through various proven technology routes, which will be considered small-scale production.

https://www.livemint.com/industry/energy/centre-invites-expressions-of-interest-for-developing-hydrogen-valley-innovation-clusters-in-india-rs-25-lakh-assistance-for-dpr-preparation-project-expected-to-start-in-october-2023-and-finish-by-2028-11681905699209.html

Yu, SH and Shao, Y.

A review on cobalt-based oxides electrocatalytic materials for electrochemical water splitting

https://doi.org/10.1007/s11581-023-04904-4

Abstract:
The development of hydrogen energy has been put on the agenda because of the increasingly serious environmental deterioration and the shortage of fossil fuels. Electrochemical water splitting is considered a promising technology for hydrogen production. Cobalt-based oxides materials have become a potential scheme as an electrocatalyst for improving hydrogen production due to its rich reserves, high stability, and cost-effectiveness. In this review, we elaborate on recent studies of cobalt-based oxides electrocatalyst materials. Our discussion covers the electrochemical mechanism and various cobalt-based oxides electrocatalytic materials under diverse improvement strategies and the challenges in structural locality characterization and performance comparison. Finally, the development of cobalt-based oxides materials as electrochemical catalysts is proposed.

Eriskin, L and Karatas, M

A semi-desirable location and sizing model for hydrogen fuel storage areas: A case study for Istanbul

https://doi.org/10.1016/j.ijhydene.2023.01.059

Abstract:
Photocatalytic water splitting into gaseous hydrogen and oxygen in the presence of semiconductor photocatalysts under a visible spectrum of solar irradiation is one of the most promising processes for plummeting energy demands and environmental pollution. Among the successful photocatalytic materials, the core/shell nanostructures show promising results owing to their fascinating morphology that protects the surface features of the core besides the effective separation of photo-excitons resulting in an enhanced rate of hydrogen production up to 162 mmol $h^{-1}g^{-1}_{cat}$, which is a notable highest value reported in the literature. In this review, we have focused on the basic characteristics of the core-shell structure-based semiconductor photocatalytic systems and their efficient water-splitting reactions under light irradiation. Comprehensive detail on various synthesis methods of core-shell nanostructures, shell thickness-dependent properties, charge-transfer reaction mechanisms, and photocatalytic stability are highlighted in this review. Core-shell nanostructured materials have been extensively used as a photocatalyst, co-catalyst, and by coupling with supporting materials to improve the apparent quantum efficiency up to 45.6%. Besides, important photocatalytic properties that influence the redox reactions i.e., effective exciton separation, the effect of different light sources/wavelengths, surface charge modeling, photocatalytic active sites, and turnover frequency (TOF) have also been focused on and extensively described. Finally, the present and future prospects of the core-shell nanostructured photocatalysts for solar energy conversion into green hydrogen production have been expounded.

Wang, G. *et al.*

Intriguing 3D micro-flower structure of $Co_{1.11}Te_2$ deposited on Te nanosheets showing an efficient bifunctional electrocatalytic property for overall water splitting

https://doi.org/10.1016/j.electacta.2023.142133

Abstract:
The development of efficient and low-cost bifunctional catalysts for electrochemical water splitting is important for future sustainable hydrogen energy deployment. In this paper, a series of composition-controlled hybrid catalysts ($Co_{1.11}Te_2$/Te) were successfully constructed by introducing different proportions of Co source into the precursor solutions during the hydrothermal synthesis of Te nanosheets(Te NSs). The experimental results show that the content of Co^{3+}active species in the hybrid materials can be adjusted by controlling the molar ratio of Co to Te, thereby significantly improving the electrocatalytic performance of the samples. Benefiting from the highest content of Co^{3+}, the large specific surface area, and the great charge transfer ability, the Te-Co-3 electrode exhibited the best catalytic activity and durability among all samples. The hydrogen evolution reaction(HER) and oxygen evolution reaction(OER) overpotentials of the electrode were only 135 and 261 mV, respectively, to drive a current density of 10 mA cm^{-2} in an alkaline environment (1 M KOH). Furthermore, it required only a cell potential of 1.56 V to achieve overall water splitting at 10 mA cm^{-2}. This work should be useful for the design and preparation of non-noble metal bifunctional catalysts.

Tetteh, DA. and Salehi, S.

The Blue Hydrogen Economy: A Promising Option for the Near-to-Mid-Term Energy Transition

https://doi.org/10.1115/1.4055205

Abstract:

Hydrogen is recently being promoted immensely as the primary energy carrier to replace fossil fuels for the envisioned environmentally friendly and sustainable future energy system, given its peculiar properties and advantages over conventional fuels and other alternative energy sources. Hydrogen is classified into various color categories based on the type of feedstock, technology, and CO2 emissions in its production pathway. This paper focuses on blue hydrogen, discussing its potential as the most promising hydrogen production pathway for the near-to-mid-term transition into a hydrogen economy. First, a comprehensive overview of the hydrogen economy is given with a detailed description of hydrogen's color-code categorization. Blue hydrogen production methods are explained, and blue and green hydrogen are compared on the subject of the grand energy transition. Furthermore, the arguments favoring blue hydrogen as the most promising alternative for the near-to-mid-term energy transition are explained. Finally, a comparative life cycle analysis (LCA) of environmental emissions and resource usage in blue hydrogen and other selected commonly used fuel production pathways is conducted using the greenhouse gases, regulated emissions, and energy use in technologies (GREET) model to analyze the potentials of the blue hydrogen production pathway. The LCA results showed that more efforts need to be committed to reducing nitrous and sulfur oxides in the blue hydrogen production pathway and improving energy and CO2 capturing efficiencies in carbon capture and storage (CCS) plants.

Li, ZY. *et al.*

Optimizing hydrogen ad/desorption of Mg-based hydrides for energy-storage applications

https://doi.org/10.1016/j.jmst.2022.08.047

Abstract:

Hydrogen energy is expected to be an "ideal fuel" in the era of decarbonization. The discovery, de-velopment, and modification of high-performance hydrogen storage materials are the keys to the fu-ture development of solid-state hydrogen storage and hydrogen energy utilization. Magnesium hydride (MgH2), with its high hydrogen storage capacity, abundant natural reserves, and environmental friend-liness, has been extensively researched. Herein, we briefly summarize the typical structure and hy-drogenation/dehydrogenation reaction mechanism of MgH2 and provide a comprehensive overview of strategies to effectively tune the thermodynamics and kinetics of Mg-based materials, such as alloy-ing, nanosizing, the introduction of additives, and composite modification. With substantial efforts, great achievements have been achieved, such as lower absorption/desorption temperatures and better cy-cling stability. Nonetheless, some pivotal issues remain to be addressed, such as unfavorable hydro-genation/dehydrogenation factors, harsh conditions, slow kinetics, incomplete dehydrogenation, low hy-drogen purity, expensive catalysts, and a lack of valid exploration of mechanisms in the hydrogena-tion/dehydrogenation process. Lastly, some future development prospects of MgH2 in energy-efficient conversion and storage have been presented, including advanced manufacturing ways, stabilization of nanostructures, the introduction of additives combined with structural modification, and utilization of advanced characterization techniques.(c) 2022 Published by Elsevier Ltd on behalf of The editorial office of Journal of Materials Science & Technology.

Zhu JB. *et al.*

Integrated process to produce biohydrogen from wheat straw by enzymatic saccharification and dark fermentation

https://doi.org/10.1016/j.ijhydene.2022.05.0560360-3199

Abstract:

In this study, different pretreatment methods, including lyophilization, hydrothermal pretreatment, and ultrasound combined with dilute alkali post-cooking, were investigated to enhance the efficiency of enzymatic saccharification and biohydrogen production of the wheat straw. All pretreatment methods could effectively remove lignin and hemicellulose while retaining cellulose, further enhancing the biomass accessibility for subsequently enzymatic saccharification and biohydrogen production. A reducing sugar concentration of 13.18 g/L was acquired when wheat straw was treated with ultrasound and dilute alkali cooking (RU). The sequential fermentative hydrogen yield of the substrate RU was 133.6 mL/ g total solids (TS), which was 5.6-fold larger than that of the raw material (23.9 mL/g TS). The study confirmed that ultrasound combined with dilute alkali cooking was an effective method, which not only provided significant guideline for improving biohydrogen production but also presented helpful direction for the efficient pretreatment of other lignocellulosic biomass.

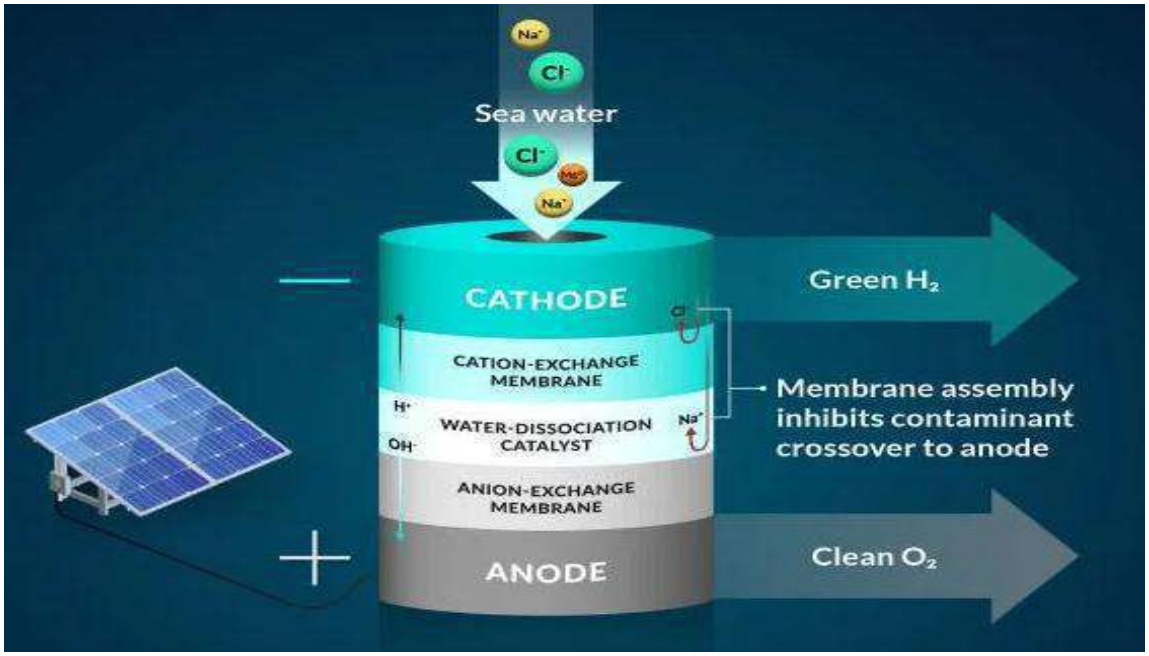
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 30
APRIL, 2023

Researchers devise new system for turning seawater into hydrogen fuel

The SLAC-Stanford team pulled hydrogen directly from ocean waters. Their work could help efforts to generate low-carbon fuel for electric grids, cars, boats and other infrastructure.



Sea water: A future solution

Seawater's mix of hydrogen, oxygen, sodium, and other elements makes it vital to life on Earth. But that same complex chemistry has made it difficult to extract hydrogen gas for clean energy uses.

Many water-to-hydrogen systems today try to use a monolayer or single-layer membrane, but study brought two layers together. And these membrane architectures allowed controlling the way ions in seawater moved in this experiment.

Hydrogen gas is a low-carbon fuel currently used in many ways, such as to run fuel-cell electric vehicles and as a long-duration energy storage option – one that is suited to store energy for weeks, months or longer – for electric grids.

Generation of H_2 and O_2 from untreated water sources represents a promising alternative to ultrapure water required in contemporary proton exchange membrane-based electrolysis. Bipolar membrane-based devices, often used in electrodialysis and CO_2 electrolysis, facilitate impure water electrolysis via the simultaneous mediation of ion transport and enforcement of advantageous microenvironments. The application in direct seawater electrolysis; show that upon introduction of ionic species such as Na^+ and Cl^- from seawater, bipolar membrane electrolyzers limit the oxidation of Cl^- to corrosive OCl^- at the anode to a Faradaic efficiency (FE) of 0.005%, while proton exchange membrane electrolyzers under comparable operating conditions exhibit up to 10% FE to Cl^- oxidation. The effective mitigation of Cl^- oxidation by bipolar membrane electrolyzers underpins their ability to enable longer-term seawater electrolysis than proton exchange membrane assemblies by a factor of 140, suggesting a path to durable seawater electrolysis.

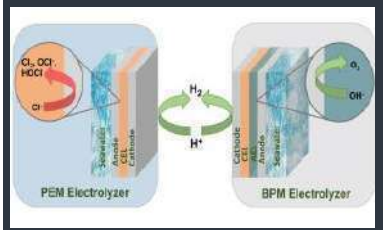
https://www6.slac.stanford.edu/news/2023-04-11-researchers-devise-new-system-turning-seawater-hydrogen-fuel

Hydrogen production with seawater-resilient bipolar membrane electrolyzers

A way to tease hydrogen out of the ocean by funneling seawater through a double-membrane system and electricity.
The innovative design proved successful in generating hydrogen gas without producing large amounts of harmful byproducts.

"The future is bright for green hydrogen technologies," said Thomas Jaramillo, professor at SLAC and Stanford and director of SUNCAT.

"The fundamental insights we are gaining are key to informing future innovations for improved performance, durability, and scalability of this technology."



References

Daniela H. Marin, Joseph T. Perryman, McKenzie A. Hubert, Grace A. Lindquist, Lihaokun Chen, Ashton M. Aleman, Gaurav A. Kamat, Valerie A. Niemann, Michaela Burke Stevens, Yagya N. Regmi, Shannon W. Boettcher, Adam C. Nielander, Thomas F. Jaramillo. 2023. Hydrogen production with seawater-resilient bipolar membrane electrolyzers,*Joule*, 7:4,765-781. https://doi.org/10.1016/j.joule.2023.03.005.

Events

World Hydrogen North America

May 15 @ 9:00 am - May 17 @ 5:30 pm UTC+0



Registration Link: https://www.worldhydrogennorthamerica.com/?utm_source=Partners&utm_medium=Listing&utm_campaign=HydrogenCentral

VENUE

Marriott Marquis 1777 Walker St, Houston, United States

Next Generation Electrolysers North America 2023

June 21 @ 8:00 am - June 22 @ 5:00 pm UTC+0



Registration Link: https://electrolyser-usa.redcabin.de

VENUE

Radisson Hotel Fort Worth North-Fossil Creek 2540 Meacham Blvd, Fort Worth, United **States**

CF Industries and NextEra Energy Resource Announces MoU for Green Hydrogen Project in Oklahoma

CF Industries Holdings, Inc. and NextEra Energy Resources, LLC announced a memorandum of understanding (MOUs) for a joint venture to develop a zero-carbon-intensity hydrogen project at CF Industries' Verdigris Complex in Oklahoma. The proposed project was included in the funding application submitted to the U.S. Department of Energy (DOE) this month by the HALO Hydrogen Hub, a three-state effort established by Arkansas, Louisiana and Oklahoma to compete for funding from the DOE's regional clean hydrogen hub program. CF Industries and NextEra Energy Resources anticipate that support for the project from the DOE program will be a key aspect of their evaluation process. A final investment decision has not been made for this project. "The use of decarbonized ammonia in agriculture offers the most certain, quantifiable and verifiable way to reduce the lifecycle carbon footprint of the food we eat," said Tony Will, president and chief executive officer, CF Industries Holdings, Inc. "We are pleased to work with NextEra Energy Resources to explore how best green hydrogen could help accelerate the adoption of low- and zero-carbon ammonia and ammonia-derived nitrogen fertilizers in the United States and contribute to decarbonizing the agriculture supply chain." "NextEra Energy Resources is committed to leading the decarbonization of the American economy, and the agriculture industry is fundamental to that goal," said Rebecca Kujawa, president and chief executive officer of NextEra Energy Resources. "We are honored to work with CF Industries to bring green hydrogen production to its Verdigris Complex while also creating additional jobs and economic benefits for the state of Oklahoma."



https://www.energetica-india.net/news/cf-industries-and-nextera-energy-resource-announces-mou-for-green-hydrogen-project--in-oklahoma

Green Hydrogen firm Ohmium closes $250-mn fundraise led by TPG Rise Climate

AMP Energy has signed an agreement to Bengaluru-based Ohmium International, a green hydrogen firm that designs, manufactures, and deploys proton exchange membrane (PEM) electrolyzer systems, on Wednesday announced the closure of a $250 million Series C growth equity financing. The round was led by TPG Rise Climate, the dedicated climate investing strategy of TPG's global impact investing platform TPG Rise, and also saw participation from Hanover Technology Investment Management and existing investors Energy Transition Ventures and Fenice Investment Group, the company said in a statement. The funding would be used to support Ohmium's expansion to 2 GW in annual manufacturing capacity and the deployment of projects for the company's growing global customer pipeline in key regions including India, the U.S., Europe and West Asia. The investment would also provide significant capital to scale Ohmium's business, including accelerating its pioneering research and development activities to reduce the cost of green hydrogen production, it further said.

https://www.thehindu.com/business/green-hydrogen-firm-ohmium-closes-250-mn-fundraise-led-by-tpg-rise-climate/article66781347.ece

European Hydrogen Bank strategy to be tested at autumn auction

The European Union will hold a pilot auction for subsidised green hydrogen contracts as it ramps up efforts to decarbonise energy supply and strengthen energy security. The auction will issue financial instruments similar to the Contracts for Difference (CFDs) that provide renewable energy developers with long-term revenue guaranteed by the state. Such contracts have worked well for wind and solar technology that feeds into an established, ready-made power market, but the hydrogen market is more complex, catering to multiple offtakers types with different needs. The European Hydrogen Bank (EHB) aims to bring down hydrogen prices by subsidizing production in a similar vein to CFD scheme introduced for renewables.

https://www.reuters.com/business/energy/european-hydrogen-bank-strategy-be-tested-autumn-auction-2023-04-27/

Events

Hydrogen Technology Expo North America

Registration URL: https://www.hydrogen-expo.com/

Venue: NRG Centre, Houston, Texas, USA

June 28 @ 9:00 am - June 29 @ 5:00 pm UTC+0



Energy companies unite to form hydrogen value chain in Germany

The companies BP, Gasunie, Nowega, NWO, Salzgitter, Thyssengas, and Uniper are connecting their hydrogen projects in north-west Germany to network Wilhelmshaven as a future location for hydrogen import and production with the industrial consumption centres in North Rhine-Westphalia and Lower Saxony. In addition to the hydrogen consumption locations of bp and Salzgitter in the Rhine-Ruhr region and in Salzgitter, other companies are to be connected to the hydrogen infrastructure in the Rhine-Ruhr region or in Salzgitter. In regard to that, Uniper said that the companies involved have signed a letter of intent (LoI). Uniper pointed out that since the companies are participating in the alliance with various hydrogen projects, they thus represent the entire H2 value chain.

https://www.offshore-energy.biz/energy-companies-unite-to-form-hydrogen-value-chain-in-germany/

China's CEEC to build green hydrogen project in Morocco

China Energy Engineering Corp (CEEC) has signed a memorandum of understanding with Saudi Arabia's Ajlan & Bros and Morocco's Gaia Energy to build a green hydrogen project in southern Morocco, France-based research firm Enerdata reported. The project comprises a 32,000 tonnes of green hydrogen plant to produce 140,000 tonnes of green ammonia annually, powered by a 2-gigawatt (GW) solar photovoltaic power plant and a 4 GW wind power plant. Once completed, the facility is expected to provide stable, clean energy to southern Morocco and Europe, the report said. In March, the Egyptian government announced that CEEC will start construction of a $5.1 billion hydrogen project in Egypt in May 2023.



https://www.zawya.com/en/projects/bri/chinas-ceec-to-build-green-hydrogen-project-in-morocco-l5kkxfkg

PASH Global, ERIH Holdings Form Joint Venture For 5-GW Green Hydrogen In Europe

Clean energy investor PASH Global and ERIH Holdings (ERIH) have formed a 50-50 JV to develop and invest green hydrogen and ammonia projects totaling 5GW of electrolyser capacity. The project will be powered by 10GW of renewable energy generation capacity such as solar, wind, and geothermal in Italy, Spain, Turkey, Greece, Serbia and Colombia by 2030. This will be entirely consumed for captive needs of round-the-clock power and intermittent energy for green hydrogen. Akin Gunduz, chief executive of ERIH Holdings, said: "Building the Next-Generation Utility is the vision of the JV.

"Without hydrogen there can be no energy transition, no climate neutrality, and no move away from fossil fuels. Within this respect, for our hydrogen-related investments, we focused on opportunities that are likely to find their way to market in the next 5–10 years and are not as dependent on substantial, coordinated long-term government subsidies that have yet to be designated or allocated."

Vine Mwense, executive director and co-Founder of PASH Global, added: "The JV presents an exciting opportunity that would bring together our unique strengths and provide a scalable platform to supply our customers with affordable, reliable and ever-cleaner energy." ERIH has been acting as the project coordinator, bringing all of the relevant parties together and organizing partnerships between customers and the system operators that will transport the hydrogen to the customer's premises. The next step is to work together with potential partners to develop commercial and technical concepts in the first two projects located in Turkey and Italy.



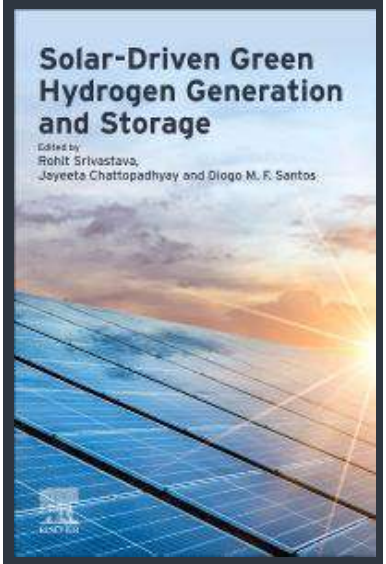
https://renews.biz/85338/uk-investors-form-5gw-green-hydrogen-jv/

Upcoming Book

Solar-Driven Green Hydrogen Generation and Storage

1st Edition - May 15, 2023

Solar-Driven Green Hydrogen Generation and Storage presents the latest research and technologies in hydrogen generation through solar energy. With in-depth coverage of three key topics, the book discusses green hydrogen technologies, solid hydrogen storage, and the applications of hydrogen energy.



Editors:

Rohit Srivastava, Jayeeta Chattopadhyay, Diogo Santos.

Paperback ISBN: 9780323995801

Link:

https://www.elsevier.com/books/solar-driven-green-hydrogen-generation-and-storage/srivastava/978-0-323-99580-1

Tata Steel begins hydrogen gas injection trial in blast furnace in Jamshedpur

Indian steel maker Tata Steel Ltd initiated trial for injecting hydrogen gas at its blast furnace in the company's flagship plant, in a move to reduce metallurgical coke usage and cut carbon emissions. The company commenced the trial injection at the plant in the eastern city of Jamshedpur, using 40% of the injection systems. The trial, expected to continue for four to five days on a continuous basis, has the potential to reduce coke rate by 10%, translating into a 7% to 10% reduction in carbon dioxide emissions per ton of crude steel produced. The trial will provide insights into operating blast furnaces with greener fuel injectants, reducing fossil fuel consumption and subsequent CO2 emissions from the blast furnace. The move to use hydrogen comes as India has set green hydrogen consumption targets for some industries like steel, in order to generate demand for cleaner fuel in its quest to reach net zero by 2070.
https://www.livemint.com/companies/news/tata-steel-begins-hydrogen-gas-injection-trial-in-blast-furnace-in-jamshedpur-11682316554026.html

Gujarat clears 1.99 lakh hectare land for Green Hydrogen Projects

Taking the lead in India's big leap towards green hydrogen manufacturing, the Gujarat cabinet approved the draft land allocation policy for green hydrogen projects. The key players, which have received in-principle approval for land parcels in Kutch and Banaskantha districts from the state government, include Reliance New Energy Limited (74,750 ha), Adani New Industries Limited (84,486 ha), Torrent Power Limited (18,000 ha), ArcelorMittal Nippon Steel India Limited (14,393 ha) and Welspun Group (8000ha). The government will accept Rs 2,998 crore as security deposits from these five companies. The total renewable power generation using green hydrogen on the proposed land is expected to be 99,814 MW with 39.95 lakh metric tonne green hydrogen production, suggest government.
https://timesofindia.indiatimes.com/city/ahmedabad/gujarat-clears-1-99-lakh-hectare-land-for-green-hydrogen-projects/articleshow/99827306.cms?from=mdr

Jharkhand Task Force on Green Hydrogen

Jharkhand aspires to harness green hydrogen to strengthen energy security and it has constituted a task force to boost the "Green Hydrogen Mission". This was stated by Jharkhand's additional chief secretary of the energy department, Avinash Kumar, during a stakeholders' meeting on "Developing Green Hydrogen Ecosystem for Jharkhand" in Ranchi, organised by the task force on Green Hydrogen Mission, Jharkhand government and Centre for Environment and Energy Development (CEED). The task force is chaired by retired Indian forest service official A.K. Rastogi and its nominated members include senior officials from energy and forest departments along with NTPC regional executive director Partha Majumdar, Central Coalfields Limited's project and planning director B. Sai Ram and Tata Steel sustainability and decarbonisation project chief Ajit Dhanraj Kothari.

https://www.telegraphindia.com/jharkhand/jharkhand-task-force-on-green-hydrogen/cid/1932379

Avaada Group raises $1bn to fund Green Hydrogen and Ammonia Ventures in India

Avaada Group has raised $1.07bn to fund its Indian green hydrogen and ammonia ventures as part of its ongoing $1.3bn fundraising plan. According to the group, Canadian-based Brookfield Renewable, through its Brookfield Global Transition Fund (BGTF) will invest up to $1bn in Avaada Venture Private Limited, while Thailand's Global Power Synergy Public Company Limited will invest $68m in Avaada Energy Private Limited for releasing debt obligations and supporting growth. Additionally, Avaada has said it is in "advanced discussions" with potential investors to raise another $200m. The Group in August last year (2022) unveiled plans for a green ammonia facility in Kota, Rajasthan, India, which could boast a capacity of one million tonnes per year. The renewable energy group says it currently operates a portfolio of 4GW with plans to reach 11GW by 2026.

https://www.h2-view.com/story/avaada-group-raises-1bn-to-fund-green-hydrogen-and-ammonia-ventures-in-india/

Luo, XJ. *et al.*

Design and fabrication of bipolar plates for PEM water electrolyser

https://doi.org/ 10.1016/j.jmst.2022.10.039

Abstract:
Hydrogen energy, whether in generation plants or utilization facilities, plays a decisive role in the mission to achieve net-zero greenhouse gas emissions, all to minimize pollution. The growing demand for clean energy carrier steadily accelerates the development of hydrogen production processes, and therein proton exchange membrane (PEM) water electrolysis is deemed a promising long-term strategy for hydro-gen preparation and collection. This review retrospect recent developments and applications of bipolar plates (BPs) as key components in PEM fuel cells and water electrolysers. The main content includes multifaceted challenges in the R&D or fabrication of BPs and potential future trends have also been proposed. Specific details cover the BPs matrix (metallic materials and carbon composites) and the surface coating types (metal and compound coatings, carbon-based coatings, and polymer coatings), as well as the influence of flow field design for mass transport. Long-term development and feasible researches of BPs are prospected. Especially in the following aspects: (1) Structural and functional integration of components, such as material fabrication and flow field geometry optimization using 3D printing technology; (2) Introduction of environment-friendly renewable energy for hydrogen production; (3) Research on hydrogen energy reversible systems; (4) Composition optimization of surface coatings based on computational materials science and (5) systematic design expected to evolve into the next generation of BPs.

Kiran, S. *et al.*

Facile Synthesis of a Nickel-Based Dopamine MOF/Multiwalled Carbon Nanotubes Nanocomposite as an Efficient Electrocatalyst for the Oxygen Evolution Reaction

https://doi.org/ 10.1021/acs.energyfuels.2c04234

Abstract:
For manufacturing hydrogen energy via water splitting is the most important consequence for the revolution of a power disaster, and a vigorous and inexpensive electrocatalyst is the most challenging task. Herein, we report a unique MOF derived nanocomposite as an electrocatalyst (Ni-DA-MWCNTs-a) fabricated through the hydrothermal method, with ultrahigh functionality for the catalytic OER. The Ni-DA-MWCNTs-a synthesized electrocatalyst displays extremely porous morphology and is characterized by a number of different techniques. The fabricated nanocomposite demonstrates an extremely low over -potential of 267 mV, with a minimum Tafel slope of 61 mV dec-1, considering the three-electron transfer process. Furthermore, the resultant nanocomposite displays the outstanding stability of 20 h and is confirmed by chronoamperometry. Hence, this work also exposed the valuable visions for the development of an inexpensive, effective, and useful electrocatalyst with an extremely small overpotential and good long-lasting durability for OER performance by utilizing 3D-MWCNTs resulting in a major alternative material derived from noble metals.

Ates, EB. and Calik, E.

Public awareness of hydrogen energy: A comprehensive evaluation based on statistical approach

https://doi.org/ 10.1016/j.ijhydene.2022.12.070

Abstract:
Climate change and environmental problems, increasing global energy demand, and un-certainties in energy supply have brought the production and use of sustainable energy resources to be crucial. Hydrogen, which is an important energy carrier, is being produced and used globally within the perspective of sustainable energy and environmental technologies. Public awareness is an important step toward the spread of hydrogen energy (HE). In the literature, while public awareness studies focus on renewable energy sources, no study that examines public awareness in the field of HE in a way that addresses different perspectives has come across. This pioneering study aims to explore public awareness of HE by analyzing survey data collected from individuals via basic statistical techniques. Findings indicate that individuals' awareness of hydrogen energy mainly varies according to their knowledge level, education level, and age group. The results of the study will provide an important perspective for all stakeholders on hydrogen energy. Especially the policymakers should consider these results to constitute the frameworks of policy without compromising any perspective of public awareness.

Nasrabadi, AM. and Korpeh, M.

Techno-economic analysis and optimization of a proposed solar-wind-driven multigeneration system; case study of Iran

https://doi.org/ 10.1016/j.ijhydene.2022.12.283

Abstract:

This paper performs a thermo-economic assessment of a multi-generation system based on solar and wind renewable energy sources. This system works to generate power, freshwater, and hydrogen, which consists of the following parts: the solar collectors, Steam Rankine subsystem, Organic Rankine subsystem, desalination part, and hydrogen production and compression unit. Initially, the effects of variables including reference temperature, solar radiation intensity, wind speed, and solar cycle mass flow rate, which depend on weather conditions and affect the performance of the integrated system, were investigated. The thermodynamic analysis results showed that the overall study's energy efficiency, the rate of hydrogen and freshwater production, and total cost rate are 33.3%, 7.92 kg/h, 1.6398 kg/s, and 61.28 $/h, respectively. Also, the net power generation rate in the Steam and Organic Rankine subsystems and wind turbines are 315 kW, 326.52 kW, and 226 kW, respectively. The main goal of this study is to minimize the total cost rate of the system and maximize the energy efficiency and hydrogen and freshwater production rate of the total system. The results of optimization showed that the energy efficiency value improved by 20.7%, the hydrogen production rate increased by 1%, and the total cost rate value declined by 2%. Moreover, the optimum point is similar to a region in Hormozgan province, Iran. So, this region is proposed for building the power plant.

Sun, T. *et al.*

S-Scheme MnCo2S4/g-C3N4 Heterojunction Photocatalyst for H2 Production

https://doi.org/ 10.3866/PKU.WHXB202212009

Abstract:

The increased global demand for energy and the enhanced deterioration of the environment are the two urgent challenges of the 21st century on the way to sustainable development for human society. Currently, green and renewable energy conversion technology has received much attention as a substitute for limited and non-renewable fossil fuels. Hydrogen energy is advantageous because of its high energy capacity (142 MJ center dot kg-1) and its production by green conversion technology, consisting of H2 reacting with O2 to generate H2O. It can establish a clean and sustainable hydrogen economic system, as well as reduce the utilization of fossil fuels and carbon dioxide emissions. Water splitting technology is an efficient approach to acquire the featured H2 energy of the green reaction (2H2O -> 2H2 + O2) through electrocatalytic and photocatalytic reactions. Photocatalysis technology, with the advantage of huge solar energy utilization, has been widely regarded as a promising method for the realization of this chemical synthesis. Among photocatalysis technologies, photocatalytic H2 production from water is considered a promising approach to obtain H2 energy due to its environmentally friendly energy conversion. However, the effectiveness of acquiring H2 energy through photocatalytic water splitting is intimately related with photocatalysts. In general, photocatalysts still face the big challenge of their low solar energy utilization efficiency, which restricts the large-scale application of photocatalytic technology to obtain H2 energy. Thus, developing highly efficient photocatalysts for H2 production is critical in promoting this technology moving forward, and obtaining renewable energy. Herein, we successfully construct the S-scheme MnCo2S4/g-C3N4 heterojunction through an expedient physical mixing process at a low temperature, which can be separately obtained via the pyrolysis process and hydrothermal method. The H2 production rate of MnCo2S4/g-C3N4 heterojunction can achieve up to 2979 mu mol center dot g-1 center dot h-1, which is 26.4 and 8.7 times higher than those of g-C3N4 (113 mu mol center dot g-1 center dot h-1) and MnCo2S4 (341 mu mol center dot g-1 center dot h-1), respectively, and presents a superior stability in three continuous cycles during H2 production tests. The high H2 production of MnCo2S4/g-C3N4 heterojunction is mainly ascribed to the following three reasons: i) The light absorption region of the heterojunction is extended to visible light. ii) MnCo2S4/g-C3N4 possesses low impedance during the reaction, high photocurrent density, and more exposed sites in solution. iii) The efficient reservation of active electron-hole pairs greatly enhances the ratio of electrons reacting with H* species to generate H2 over MnCo2S4/g-C3N4 heterojunction. This work provides an efficient approach to constructing advanced g-C3N4-based photocatalysts through hybridization with metal sulfides to form S-scheme heterojunctions.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN

ISSUE: 31
MAY, 2023

IIT Guwahati scientists develop eco-friendly catalyst for green hydrogen

Researchers at IIT Guwahati have developed a catalyst that can produce clean-burning hydrogen gas from wood alcohol, making it an attractive alternative to fossil fuels.

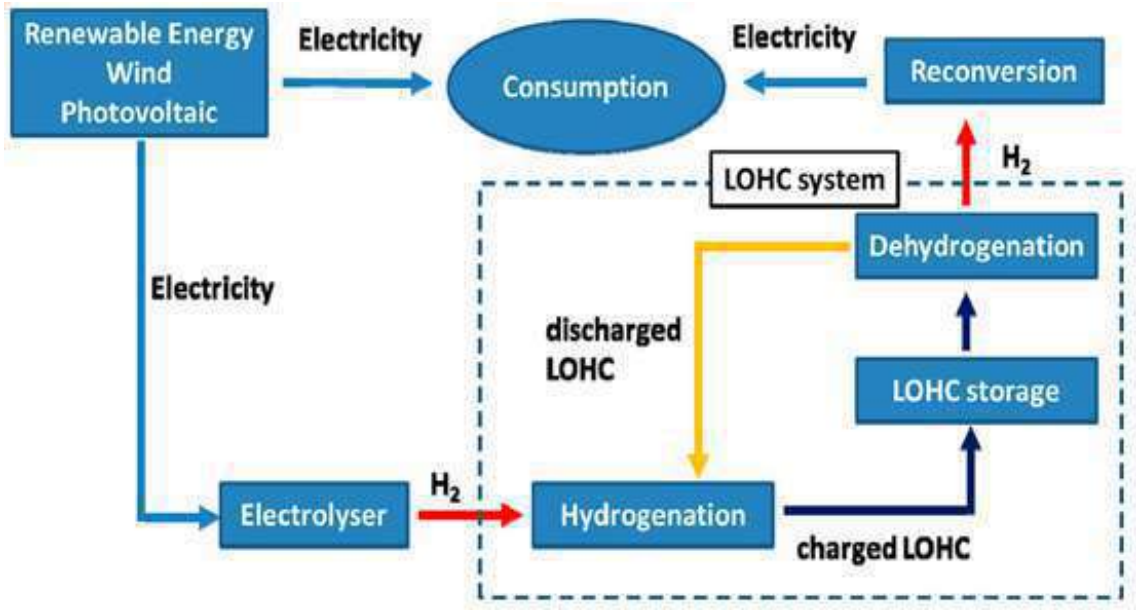


Figure: Liquid Organic Hydrogen Carriers

ADVANTAGES:

The new process not only eliminates the need for high temperatures and pressure, but it also avoids carbon dioxide emissions by producing formic acid as a by-product.

THE CHALLENGE AND THE SOLUTION:

Methanol reforming, the process of generating hydrogen from wood alcohol, has two main problems. First, it requires high temperatures (300 degree Celsius) and high pressure (, which are not energy-efficient. Second, carbon dioxide, a potent greenhouse gas, is a by-product of the reaction.

The IIT Guwahati team solved these problems by developing a pincer catalyst, which contains a central metal and specific organic ligands.The organic ligands act like the claws of a crab that hold the metal in place, making the catalyst specific and selective. As a result, the reaction produces formic acid instead of carbon dioxide at much lower temperatures. This development makes methanol a promising 'Liquid Organic Hydrogen Carrier' (LOHC) and contributes to the concept of hydrogen-methanol economy.

https://indiaeducationdiary.in/iit-guwahati-researchers-develop-a-catalyst-to-produce-sustainable-green-hydrogen-fuel-along-with-high-market-demand-formic-acid-as-by-product/

https://www.indiatoday.in/education-today/news/story/iit-guwahati-scientists-develop-eco-friendly-catalyst-for-green-hydrogen-fuel-production-2367625-2023-05-02

IIT Guwahati scientists develop eco-friendly catalyst for green hydrogen

INDUSTRY POTENTIAL

The industrial collaborator on this project, ChemDist Group of Companies, highlighted the commercial potential of this work.

The new technology has the potential to make significant strides towards achieving carbon neutrality by converting the cheaper and abundantly available organic chemical methanol into hydrogen using a cheaper catalyst, at lower temperatures and without the emission of carbon dioxide.

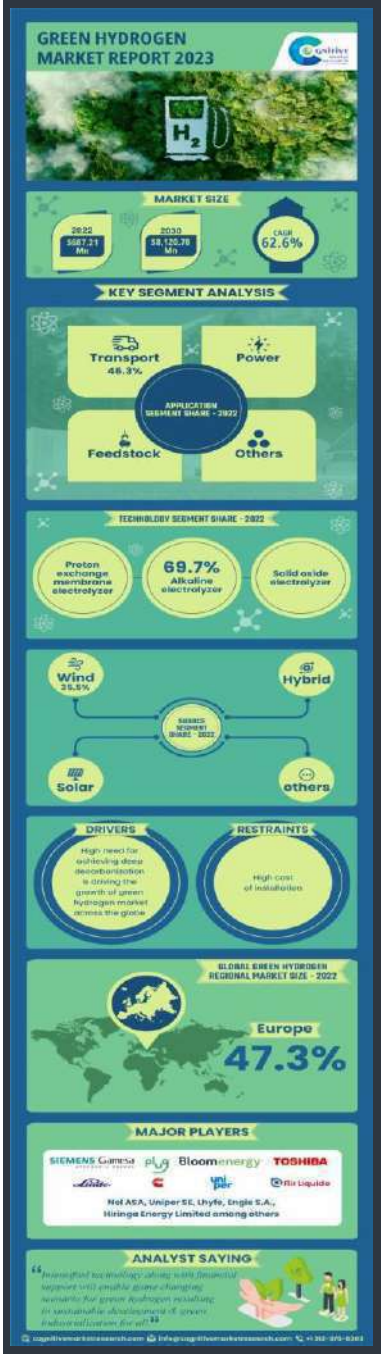
To make the catalyst reusable, the researchers loaded it on an inert support, which enabled them to reuse it over many cycles.

The researchers' findings have been published in ACS Catalysis and have been co-authored by Vinay Arora, Eileen Yasmin, Niharika Tanwar, Venkatesha R Hathwar, Tushar Wagh, Dr. Sunil Dhole, and Dr. Akshai Kumar AS.

***Energy Fuels* 2019, 33, 4, 2778–2796 Publication Date:March 11, 2019**
https://doi.org/10.1021/acs.energyfuels.9b00296

REPORT 2023

GREEN HYDROGEN MARKET REPORT 2023



Green Hydrogen Market is projected to reach USD 8,120.78 Million by 2030: Cognitive Market Research

ICRA Report Highlights Subsidies by Certain Nations Could Impact Indian Green Hydrogen Industry's Export Competitiveness

A recent report by ICRA highlights that India can become a competitive source for green hydrogen globally but subsidies by certain countries could harm its export competitiveness. According to research reports by ICRA on the Indian renewable energy sector, India has the potential to emerge as one of the most competitive sources for green hydrogen and embedded products like green steel and ammonia globally, thanks to the country's low cost of renewable power generation.However, certain subsidies offered by countries like the US and European Hydrogen Bank could adversely affect the export competitiveness of India's GH2 industry. The reports suggest that by 2050, hydrogen and fuels derived from it will contribute 17% to the global energy mix, where electrification is unviable. NITI Aayog predicts that India's domestic hydrogen demand will increase from 6 MT per annum in 2020 to 25-28 MT per annum in 2050, of which 20 MT will be contributed by the industry. The reports also highlight the need for regulatory support and incentive mechanisms to develop domestic electrolyser manufacturing and reduce the capital cost of electrolysis.

https://solarquarter.com/2023/05/03/icra-report-highlights-subsidies-by-certain-nations-could-impact-indian-green-hydrogen-industrys-export-competitiveness/

NTPC to install 20 GW RE capacity with pumped storage at AP green hydrogen hub

NTPC, which is setting up a more than ₹1 lakh crore green hydrogen hub in coastal Andhra Pradesh, will install 13.4 gigawatts (GW) of solar power and 6.6 GW of pumped storage project (PSP).

Sources said that India's largest power producer will set up a total of 20 gigawatts (GW) of renewable power capacity, including storage, which will be utilised for manufacturing green hydrogen through electrolysis. The land at Pudimadaka, a coastal village around 50 km from Visakhapatnam, has been allotted by the AP Industrial Investment Corporation (APIIC), and the project is expected to be completed by 2030, with the first half likely by 2026-27.

https://www.thehindubusinessline.com/companies/ntpc-to-install-20-gw-re-capacity-with-pumped-storage-at-ap-green-hydrogen-hub/article66799272.ece

Neste targets green hydrogen expansion at mixed-source refinery

The Finnish firm will construct a 120MW electrolyser at its Porvoo facility. This is electrolyser will provide green hydrogen energy to the plant. Neste executive vice president of oil products Markku Korvenranta said: "The green hydrogen would be primarily used in our Porvoo refinery's processes, where it would replace hydrogen produced from fossil feedstocks". Further to this, the firm is looking to partner with regional energy firm Porvoon to use heat generated in the electrolysis process for local heating.

The firm aims to make the refinery, that processes both fossil and renewable energy sources, into the leading green refinery in Europe. Korvenranta added: "Our project is one of the largest development projects to produce green hydrogen out of the European refineries, and it supports our goal to transform the Porvoo refinery to the most sustainable refinery in Europe by 2030." This company received the Important Project of Common European Interest (IPCEI) status by the European Commision for the project. This allowed the company to receive $30.5m from the Finnish government with the aim of developing hydrogen technology at Porvoo.

This is the latest development in a company-wide shift towards renewable energy. Neste's Rotterdam location was the target of a $1.9bn expansion in June 2022 to increase production of sustainable aviation fuel. The company is already Europe's largest producer of aviation-targeted biofuel.

In September, the firm began a strategic study for the viability of ceasing all oil production in the Porvoo refinery. Producing 206,000 barrels per day, Porvoo is Neste's only crude oil refinery. Instead, the company will shift its focus towards renewable feedstocks. The study found the potential for a post-phase renewable feedstock processing capacity of 2-4 million tonnes per year.

https://www.power-technology.com/news/neste-green-hydrogen-expansion-crude-oil-refinery/



Meeting

UAE AND FRANCE MEET TO BOOST COOPERATION IN HYDROGEN

The UAE Ministry of Energy and Infrastructure (MoEI) and the French Alternative Energies and Atomic Energy Commission (CEA) have held a meeting to discuss bilateral cooperation in hydrogen, as part of the UAE-France Comprehensive Strategic Energy Partnership.

TARGET:
The UAE has set a target of producing 1,000 tonnes of green hydrogen per day by 2030, while France has set a target of producing 10% of its hydrogen from renewable sources by 2023 and 20% by 2028.

Link:
https://energynews.biz/uae-and-france-meet-to-boost-cooperation-in-hydrogen/

Events

Hydrogen Africa - Green H2 Investment Forum In Paris

25 May 2023



Reserve your Seat

h2aparis@hydrogen-africa.com

DOMINICA TO DEVELOP THE CARIBBEAN'S FIRST INDUSTRIAL-SCALE GREEN HYDROGEN GEOTHERMAL PROJECT

The Commonwealth of Dominica has signed a Framework Agreement with Kenesjay Green Dominica Limited (KGDL) to establish a joint venture company for the Caribbean's first large-scale green hydrogen geothermal development. The agreement will be a significant step forward in Dominica's pursuit of sustainable economic growth through the development of green energy.

Dominica has the potential to develop over 1GW of geothermal power, and this project is part of its Green Hydrogen Industrial Development Program, which aims to monetize its vast geothermal resources for export and local consumption.

The DGDC-KGDL joint venture company will undertake de-risking activities for the project, which involves the sharing of technical resources, marketability studies, and feasibility studies. Following these activities, an investment framework for the project will be created, which will guide the creation of a special-purpose vehicle to carry out the project.

The signature of the Framework Agreement was announced during the first Hydrogen Summit, which was hosted as part of the 15th Caribbean Renewable Energy Forum in Miami, Florida, on April 26, 2023.

This project is expected to be a game-changer for Dominica, demonstrating its commitment to sustainability and reducing its reliance on imported fossil fuels. The development of green hydrogen and green energy will help to create jobs, promote economic growth, and reduce the carbon footprint of the island.



https://energynews.biz/dominica-to-develop-the-caribbeans-first-industrial-scale-green-hydrogen-geothermal-project/

https://newenergyevents.com/cref/workshops/h2-caribbean/#:~:text=Wednesday%2C%20April%2026%2C%202023%20%E2%80%93,bolster%20and%20transform%20regional%20economies.

ENAGÁS, NATURGY, AND CIP INVEST €1.7B IN GREEN HYDROGEN PLANT IN ANDORRA

Enagás Renovables, Naturgy, and Copenhagen Infrastructure Partners (CIP) have announced a joint investment of €1,700 million in the start-up of a green hydrogen production plant in Andorra, Teruel. The project, known as the "Catalina" project, will generate 425 direct jobs and as many indirect jobs.

The President of the Aragonese Government, Javier Lambán, has confirmed that the project will be of regional and general interest, and the Governing Council will approve the declaration of interest on May 17th, initiating the processing of the Plan of General Interest of Aragon (PIGA) to facilitate the investment.The project aims to produce 80,000 tons of green hydrogen from renewable energies when at full capacity. The hydrogen produced from renewable electricity generated in Aragon will be used partly to produce fertilizers in Levante, while a large part will be available in Aragon to generate an industry of high added value.

This project marks a significant step towards achieving Spain's target of 4 GW of electrolysis capacity by 2030, in line with the European Union's target of 40 GW of renewable hydrogen electrolysers by 2030. The production of green hydrogen is essential to reduce greenhouse gas emissions, contributing to the fight against climate change.

This investment by Enagás Renovables, Naturgy, and CIP represents a significant commitment to green hydrogen production, driving economic growth and providing significant employment opportunities while contributing to Spain's decarbonization efforts.



https://energynews.biz/enagas-naturgy-and-cip-invest-e1-7b-in-green-hydrogen-plant-in-andorra/

Events

Hydrogen Summit

15 June 2023

Strategies for deploying clean hydrogen at scale



Venue:

In-Person & Digital | The Carlton Tower Jumeirah, London | #FTHydrogen

Link:

https://hydrogen.live.ft.com/





NTPC to install 20 GW RE capacity with pumped storage at AP green hydrogen hub

NTPC is setting up a more than ₹1 lakh crore green hydrogen hub in coastal Andhra Pradesh and will install 13.4 gigawatts (GW) of solar power and 6.6 GW of pumped storage project (PSP). The rationale behind creating the hub is to focus on exports in South Asia, particularly for green hydrogen and green methanol. Besides, talks are on for manufacturing green ammonia here and transporting it to the UK. he land at Pudimadaka, a coastal village around 50 km from Visakhapatnam, has been allotted by the AP Industrial Investment Corporation (APIIC), and the project is expected to be completed by 2030, with the first half likely by 2026-27.NTPC is holding deliberations with domestic and international companies for manufacturing electrolysers and other green energy products and services. Besides the green hydrogen hub, the industrial area will have manufacturing facilities for new energy technologies.



https://www.thehindubusinessline.com/companies/ntpc-to-install-20-gw-re-capacity-with-pumped-storage-at-ap-green-hydrogen-hub/article66799272.ece

Hero Future Energies bets big on green hydrogen

KKR-backed Hero Future Energies plans to invest heavily in the green hydrogen and energy storage sectors in India, and will also bid for the storage projects tendered by SECI including both battery storage and pump storage. Chairman and managing director Rahul Munjal, was of the view that hydrogen is going to be mainstay of transition in mobility and electric vehicles would eventually give way for hydrogen mobility in the next 5-10 years. the company is also looking at expanding its presence in the C&I space which also wants to go to net zero.
https://www.livemint.com/companies/hero-futures-energies-bets-big-on-green-hydrogen-plans-2-projects-in-india-11682697193156.html

India's Avaada belts $1B funding for its green hydrogen, Solar PV modules projects

Avaada Group which is an integrated energy platform has secured $1.07B in funding from Brookfield Renewable and the Global Power Synergy Public Company (GPSC) to develop its green hydrogen and green ammonia operations in India.
Brookfield Renewable will invest up to $1B in Avaada Ventures through its Brookfield Global Transition Fund (BGTF) and the Global Power Synergy Public Company (GPSC) will also invest $68M in Avaada Energy to release debt obligations and boost expansion, according to the company. This fund collaboration is part of Avaada Group's $1.3B fundraising effort. According to the firm, it is also in advanced talks with possible investors to raise another $200M. This strategic partnership will leverage Brookfield's global track record, access to capital and operational expertise alongside Avaada's strong local footprint, to enable their vision for the energy transition business. Brookfield remains committed to supporting the next generation of clean energy technologies and contributing to India's net-zero aspirations
https://techfundingnews.com/indias-avaada-belts-1b-funding-for-its-green-hydrogen-solar-pv-modules-projects/

Tamil Nadu Cabinet Clears Industrial Projects Worth Rs 35000 Crore; Major Investment in Green Hydrogen By Malaysia's PETRONAS

Projects worth Rs 35,000 crore were approved during the Cabinet meeting. Among the major investments approved are the ones by Malaysia's Petronas, Switzerland's XyloNetics and Caterpillar Inc of the USA.Petronas plans to invest Rs 34,000 crore in Thoothukudi to produce green hydrogen, while XyloNetics, a Swiss company that specializes in manufacturing woodwork used in furniture, will invest around Rs 700 crore. XyloNetics will set up operations at the International Furniture Park located in the SIPCOT estate at Thoothukudi. The Cabinet also approved a company's proposal for an electric vehicle unit near Chennai with an investment of ₹70 crore. The proposals of existing players, like Caterpillar Inc., were approved. Caterpillar intends to invest Rs 400 crore to expand its construction equipment manufacturing unit in Tiruvallur district.
https://swarajyamag.com/news-headlines/tamil-nadu-cabinet-clears-industrial-projects-worth-rs-35000-crore-major-investment-in-green-hydrogen-by-malaysias-petronas

Aly, M. *et al.*

An Improved Optimally Designed Fuzzy Logic-Based MPPT Method for Maximizing Energy Extraction of PEMFC in Green Buildings

https://doi.org/ 10.3390/en16031197

Abstract:
Recently, the concept of green building has become popular, and various renewable energy systems have been integrated into green buildings. In particular, the application range of fuel cells (FCs) has become widespread due to the various government plans regarding green hydrogen energy systems. In particular, proton exchange membrane fuel cells (PEMFCs) have proven superiority over other existing FCs. However, the uniqueness of the operating maximum power point (MPP) of PEMFCs represents a critical issue for the PEMFC control systems. The perturb and observe, incremental conductance/resistance, and fuzzy logic control (FLC) represent the most used MPP tracking (MPPT) algorithms for PEMFC systems, among which the FLC-based MPPT methods have shown improved performance compared to the other methods. Therefore, this paper presents a modified FLC-based MPPT method for PEMFC systems in green building applications. The proposed method employs the rate of change of the power with current (dP/dI) instead of the previously used rate of change of power with voltage (dP/dV) in the literature. The employment of dP/dI in the proposed method enables the fast-tracking of the operating MPP with low transient oscillations and mitigated steady-state fluctuations. Additionally, the design process of the proposed controller is optimized using the enhanced version of the success-history-based adaptive differential evolution (SHADE) algorithm with linear population size reduction, known as the LSHADE algorithm. The design optimization of the proposed method is advantageous for increasing the adaptiveness, robustness, and tracking of the MPP in all the operating scenarios. Moreover, the proposed MPPT controller can be generalized to other renewable energy and/or FCs applications. The proposed method is implemented using C-code with the PEMFC model and tested in various operating cases. The obtained results show the superiority and effectiveness of the proposed controller compared to the classical proportional-integral (PI) based dP/dI-based MPPT controller and the classical FLC-based MPPT controller. Moreover, the proposed controller achieves reduced output waveforms ripple, fast and accurate MPPT operation, and simple and low-cost implementation.

Lao, JM *et al.*

Research on atmospheric pollutant and greenhouse gas emission reductions of trucks by substituting fuel oil with green hydrogen: A case study

https://doi.org/ 10.1016/j.ijhydene.2022.02.230

Abstract:
Trucks has caused serious atmospheric pollutant and greenhouse gas emissions in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), China, while substituting the truck fuel (gasoline/diesel) by green hydrogen is a critical way to solve the problems. Accordingly, we established a Hydrogen availability-Greenhouse gas and Atmospheric Pollutant emission reduction (HGAP) evaluation model. We revealed that the annual available green hydrogen energy in the GBA reached 1.36 x 1010 GJ, which could fuel all the trucks in the region. Via truck fuel substitution by hydrogen, a 45% reduction in regional greenhouse gas emissions in the GBA could achieve. The emission reductions of CO and HC by vehicles in the GBA achieved approximately 1/4, NOx was about 1/2 and PM was about 60%. We served a solution of developing without eco-sacrifice for developed, strategic yet high-emission coastal regions and countries.

Li, YF *et al.*

A strategic roadmap for ASEAN to develop hydrogen energy: Economic prospects and carbon emission reduction

https://doi.org/ 10.1016/j.ijhydene.2022.12.105

Abstract:
The progress of hydrogen energy in terms of technologies and supply chains is appealing to member countries of the Association of Southeast Asian Nations (ASEAN). Countries with the advantages of fossil fuel resources and existing infrastructure can export grey hydrogen energy until 2025. This could help expand hydrogen-related infrastructure and form a certain level of economies of scale to prepare for the next phase of development of blue and green hydrogen energy. From 2026 to 2030, ASEAN could shift to blue hydrogen energy exports with the help of carbon capture, utilization, and storage. However, the domestic applications of hydrogen energy will remain economically uncompetitive in most ASEAN countries. After 2030, as the levelized costs of electricity for renewables decline and the share of renewable energy power increases, the cost of hydrogen energy production from surplus electricity could become even lower. Consequently, green hydrogen energy will dominate domestic downstream energy applications and exports to overseas markets.

Zheng, YP *et al.*

Robust FeCoP nanoparticles grown on a rGO-coated Ni foam as an efficient oxygen evolution catalyst for excellent alkaline and seawater electrolysis

https://doi.org/ 10.1039/d2dt03857a

Abstract:
Electrochemical water splitting is a potential green hydrogen energy generation technique. With the shortage of fresh water, abundant seawater resources should be developed as the main raw material for water electrolysis. However, since the precipitation reaction of chloride ions in seawater will compete with the oxygen evolution reaction (OER) and corrode the catalyst, seawater electrolysis is restricted by the decrease in activity, low stability, and selectivity. Rational design and development of efficient and stable catalysts is the key to seawater electrolysis. Herein, a high-activity bimetallic phosphide FeCoP, grown on a reduced graphene oxide (rGO)-protected Ni Foam (NF) substrate using FeCo Prussian Blue Analogue (PBA) as a template, was designed for application in alkaline natural seawater electrolysis. The OER activity confirmed that the formed FeCoP@rGO/NF has high electrocatalytic performance. In 1 M KOH and natural alkaline seawater, the overpotential was only 257 mV and 282 mV under 200 mA cm(-2), respectively. It also demonstrated long-term stability up to 200 h. Therefore, this study provides new insight into the application of PBA as a precursor of bimetallic phosphide in the electrolysis of seawater at high current density.

Cheng, LX. *et al.*

A Review on Research and Technology Development of Green Hydrogen Energy Systems with Thermal Management and Heat Recovery

https://doi.org/ 10.1080/01457632.2023.2191435

Abstract:

This paper presents a review of recent research and development progress on green hydrogen energy systems and associated thermal management and waste heat recovery technologies. First, hydrogen production methods are briefed. Second, various electrolysis systems used for carbon free hydrogen production from renewable and nuclear resources are discussed. Then, hydrogen utilization using proton-exchange fuel cells is scrutinized. Next, hydrogen energy systems integrated with metal hydride energy storage are elaborated. A focus of this review is on thermal management and process intensification technologies for hydrogen energy systems and integrated metal hydride hydrogen storage technologies. Various process and heat transfer enhancement techniques for heat removal and utilization are presented. Advanced cooling technologies for hydrogen energy systems such as two-phase and boiling for cooling, microchannels for heat removal, CO2 air conditioner and using nanofluids for heat removal are discussed. Finally, heat recovery technologies in green hydrogen energy systems are summarized. This review has also identified future research and technology development needs for green hydrogen energy utilization, thermal management, and heat recovery systems.

Feng, Q. *et al.*

Quenching-induced surface engineering of ZnCo2O4 spinel oxide for enhanced oxygen evolution reaction

https://doi.org/ 10.1016/j.apsusc.2022.155662

Abstract:
Exploring cost-effective and high-performance electrocatalysts for oxygen evolution reaction (OER) is quite significant for utilizing renewable energies by converting them to green hydrogen energy. ZnCo2O4 spinel oxide has drawn a wide attention in water electrolysis field owing to its earth abundance, low cost and eminent electrocatalytic activity. However, it still has a great room to boost its OER catalytic activity due to the low electrical conductivity and restricted active sites of ZnCo2O4 catalyst. Herein, a facile, easy-scalable and environmental-friendly quenching method is exhibited to achieve surface Fe doped and oxygen vacancy generated ZnCo2O4 by instantaneous cooling in Fe (NO3)3 solution. As a result, the quenched ZnCo2O4 catalyst shows a vastly improved OER activity in alkaline electrolyte, only requiring an overpotential of 332 mV to reach 10 mA cm-2, which is much lower than that of un-quenched ZnCo2O4 (405 mV). Our results manifest that quenching treatment can endow an active Fe amorphous layer, a higher ratio of Co3+ states and more abundance oxygen vacancies for ZnCo2O4 spinel oxide, thus possessing a higher OER activity. Our work offers an effective path for the regulation of metal oxides and its application in energy catalysis field.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 32
MAY, 2023

Development of innovative Bio-Electrochemical technology for green hydrogen production from natural wastewater resources and maximum energy utilization through new integrated energy systems for circular economy

Development of innovative Bio-Electrochemical technology for green hydrogen production from natural wastewater resources and maximum energy utilization through new integrated energy systems for circular economy

Aim of the Project:

Development of renewable energy integrated bio-electrochemical reactor system (BEC) for green-hydrogen production and its utilization towards sustainable carbon neutral system and effective energy utilization using new integrated energy systems. In this proposed integrated energy system, green hydrogen produced from BEC process will be sent to hybrid combustion engine to produce heat and electricity. The waste heat from the combustion engine will be recovered by organic rankine cycle (ORC) and it will be used to recharge to battery to operate the motor for hybrid operation. Different AI-ML algorithm will be used to optimize and predict the operating parameters to minimize the cost end experiments.

https://www.csir.res.in/icsmforms/development-innovative-bio-electrochemical-technology-green-hydrogen-production-natural

Bioelectrochemical systems are revolutionary new bioengineering technologies which integrate microorganisms or enzymes with the electrochemical method to improve the reducing or oxidizing metabolism.

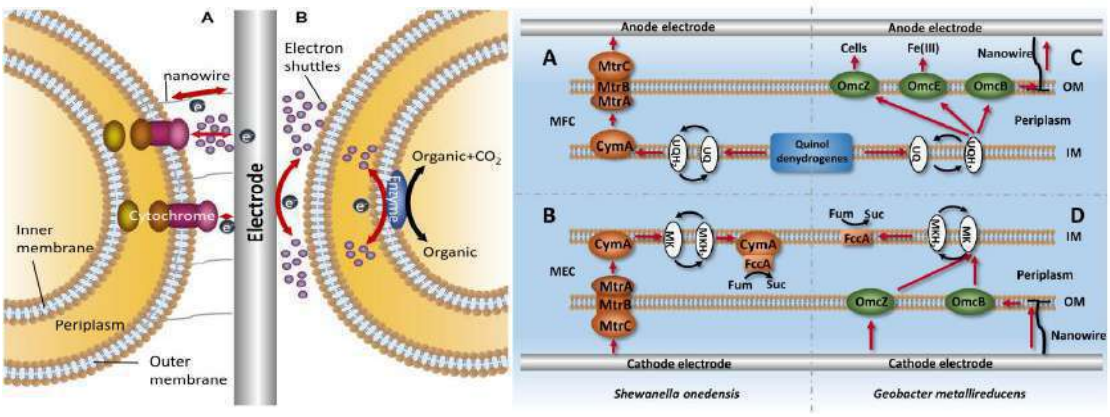


Figure: Bidirectional electron transfer between bacteria and electrodes

Scientists at CSIR -TÜBİTAK Call For Academia-Industry Cooperation Joint Project Proposals- 2022

R&D Projects funded by ISTAD under bilateral programs of CSIR (IA-05)

CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram

Aim of the Project: Development of renewable energy integrated bio-electrochemical reactor system (BEC) for green-hydrogen production and its utilization towards sustainable carbon neutral system and effective energy utilization using new integrated energy systems, using AI-ML Algorithm.

Applications of Bio-Electrochemical Technology:

Nowadays, its use as a clean energy source is yet uncommon, while its main use is in ammonia production and hydrogenation of coal and petroleum during hydrocracking of traditional fuels. The upcoming project is aiming towards green hydrogen production from natural wastewater resources and maximum energy utilization through new integrated energy systems for circular economy.

De Gioannis, G., Dell'Era, A., Muntoni, A. et al. Bio-electrochemical production of hydrogen and electricity from organic waste: preliminary assessment. Clean Techn Environ Policy 25, 269–280 (2023). https://doi.org/10.1007/s10098-022-02305-1
Front. Bioeng. Biotechnol., 31 January 2020 Sec. Synthetic Biology Volume 8 - 2020 | https://doi.org/10.3389/fbioe.2020.00010
https://www.csir.res.in/icsmforms/development-innovative-bio-electrochemical-technology-green-hydrogen-production-natural

REPORT 2023

International Green Hydrogen Report 2023

United States: International Green Hydrogen Report 2023
08-May-2023
By Tony Toranto and Nathan Barbara
Sheppard Mullin Richter & Hampton

Energy, Infrastructure and Project Finance team co-leader Tony Toranto and associate Nathan Barbara authored the "United States" chapter in the latest edition of the **International Green Hydrogen Report**, published by international law firm Bird & Bird. The 2023 edition covers the latest updates across the globe, including key jurisdictions across the United States, Europe, Asia-Pacific and Africa, highlighting key funding and support schemes, and cutting edge projects across the space.

Throughout the US chapter the legal framework for clean hydrogen in the US, opportunities for funding, the US Department of Energy (DOE) recently released National Clean Hydrogen Strategy and Roadmap, and green hydrogen projects that are kicking off stateside.

Link:

https://www.mondaq.com/unitedstates/renewables/1312820/international-green-hydrogen-report-2023

ACME, IGL ink initial pact to explore business avenues in Green Hydrogen

Diversified renewable energy firm ACME Group and city gas distribution company IGL have signed an initial pact to jointly explore potential business opportunities in Green Hydrogen.
ACME and IGL will work jointly to promote the adoption by the customers and create demand for Green Hydrogen in the country, an ACME Group statement said. The companies will also work together to explore the opportunity of setting up hydrogen generation plants including setting up electrolyzers to blend Green Hydrogen in IGL's existing pipeline networks supplying gas to households, industrial & commercial set ups and CNG for vehicles.
https://indianexpress.com/article/business/companies/acme-igl-ink-initial-pact-explore-business-avenues-green-hydrogen-8592736/

ABS and Korean Industry Leaders Collaborate on Offshore Floating Green Hydrogen Platform

The American Bureau of Shipping (ABS) has joined Korean industry leaders in the signing of a memorandum of understanding (MoU) to produce a feasibility study for a near-shore floating platform of green hydrogen production and liquefaction. The feasibility study will be included in a report from the Jeolla Province to determine the viability of developing a green hydrogen production and liquification facility at a near-shore floating platform utilising offshore wind power.The study is the latest ABS' pioneering work to support green hydrogen production, which includes an approval in principle (AIP) for HD Hyundai Group's offshore green hydrogen production platform. The Korean Government is supporting commercial-scale production of green hydrogen, with the expectation of increasing self-efficiency.



https://www.offshorewind.biz/2023/05/10/abs-and-korean-industry-leaders-collaborate-on-offshore-floating-green-hydrogen-platform/

Fortescue Future Industries secures renewable power supply from Statkraft to planned green hydrogen/ammonia project in Hemnes

Fortescue Future Industries (FFI) has secured renewable power for its proposed Hemnes green energy project, entering into a long-term Power Purchase Agreement (PPA) with Statkraft. The conditional agreement will see Statkraft supply FFI with renewable energy from the Norwegian grid to support potential plans for a 300 megawatt green hydrogen and green ammonia facility. The project also allows for further capacity to support plans for future scale-up of the site. FFI is currently assessing opportunities right across Norway for the development of green hydrogen and green ammonia and initial scoping studies have identified the Hemnes region as an area with real industrial potential for future green energy and port facilities.
FFI has an active presence in the region as it conducts further assessments into the development of large-scale green hydrogen production and has already established a strong working relationship with local authorities. FFI is also conducting several environmental, viability and social studies and is developing a project concept in line with Norwegian regulations, FFI's environmental and social policies and values, and international good practice.



https://www.globenewswire.com/news-release/2023/05/09/2664033/0/en/Fortescue-Future-Industries-secures-renewable-power-supply-from-Statkraft-to-planned-green-hydrogen-ammonia-project-in-Hemnes.html

https://www.statkraft.com/newsroom/news-and-stories/2023/fortescue-future-industries-secures-renewable-power-supply-from-statkraft-to-planned-green-hydrogenammonia-project-in-hemnes/

SURVEY 2023

thyssenkrupp nucera – Survey

thyssenkrupp nucera offers world-leading technologies for high-efficiency electrolysis plants.

Link:

https://www.bloomberg.com/press-releases/2023-05-09/survey-more-than-two-thirds-of-germans-rate-green-hydrogen-as-the-energy-source-of-the-future

Events

Hydrogen CCS & Distribution Workshop

28-29 June 2023



Venue:

Durban South Africa

Link:

https://evolve.eventoptions.co.za/register/hydrogen_workshop

Energy PSUs eye 38,000 tonnes per annum green hydrogen capacity

India's state-run oil and gas companies are targeting to build a combined green hydrogen generation capacity of 38,000 tonnes per annum by the next financial year, according to a government panel report.

The planned green hydrogen facilities would require setting up a combined electrolyzer capacity of 279 MW by 2024-25, according to the energy transition advisory committee of the petroleum ministry. Of this, Hindustan Petroleum is planning to have 115 MW capacity at its refineries in Visakhapatnam and Barmer. Gas pipeline operator GAIL is targeting a capacity of 60 MW while Indian Oil, the nation's largest refiner, aims to develop a capacity of 56 MW at its Mathura and Panipat refineries. Bharat Petroleum is targeting 25 MW capacity while Numaligarh Refinery and Mangalore Refinery & Petrochemicals are aiming for 20 MW and 3 MW respectively. Hydrogen producing capacity of state-run and private-sector refiners is projected to rise 85% to 2.5 million tonnes per annum by 2030 from 1.4 million tonnes per annum in 2020, according to the transition committee report. Indian Oil is projected to have the highest capacity of 825,000 tonnes per annum by 2030. Reliance Industries is projected to have a capacity of 529,000 tonnes per annum and HPCL of 302,000 tonnes per annum.

In India, 99% of total demand for pure hydrogen comes from refineries and fertiliser makers.

Indian refiners use about 2.1 million tonnes of hydrogen, and the ammonia sector 3.1 million tonnes annually, according to the committee. India is placing a big thrust on green hydrogen in its energy transition plan. It aims to develop green hydrogen production capacity of at least 5 million metric tonnes per annum by 2030, which would involve an investment of ₹8 lakh crore.State-run oil and gas companies are expected to play a key role in setting up green hydrogen capacity since they are already a big producer and consumer of non-green hydrogen.

https://infralive.com/web/energy-psus-eye-38000-tonnes-per-annum-green-hydrogen-capacity-2/

Honeywell announces tech to turn hydrogen and CO2 into lower-carbon aviation fuel

Honeywell International Inc (HON.O) announced a new technology to produce lower-carbon aviation fuel from green hydrogen and carbon dioxide captured from industry, which can help cut greenhouse gas emissions from aviation, one of the hardest sectors to electrify and decarbonize.

Sustainable aviation fuel, or SAF, is typically made using biomass-based feedstocks such as soybean oil and used cooking oil. Honeywell's new technology would combine green hydrogen - produced in electrolyzers from renewable energy and water - and carbon dioxide siphoned off industrial smokestacks to create lower-carbon methanol, which is then turned into fuels including SAF.

Honeywell said its process can reduce greenhouse gas emissions by 88% compared with traditional petroleum-based jet fuel. President Joe Biden's administration has targeted 3 billion gallons (11.4 billion liters) of SAF production per year in the U.S. by 2030 as part of its efforts to fight climate change.

SAF is typically two to four times costlier than petroleum-based jet fuel. It is also the latest in a series of announcements by aerospace companies trying to tackle carbon emissions from aviation, which represents some 2-3% of total emissions. Experts say radical new engine technology will not be available before next decade, meaning the near-term focus is on developing more environmentally friendly fuels.

https://www.reuters.com/business/sustainable-business/honeywell-announces-tech-turn-hydrogen-co2-into-lower-carbon-aviation-fuel-2023-05-10/#:~:text=NEW%20YORK%2C%20May%2010%20(Reuters,sectors%20to%20electrify%20and%20decarbonize

GETEC to offtake Cepsa's Spanish green hydrogen for its European industry clients

Cepsa has signed an agreement to supply green hydrogen to GETEC's industry clients in Europe.Signed at the World Hydrogen Summit & Exhibition in Rotterdam, the agreement will see the Spanish oil and gas company supply green hydrogen and its derivatives to GETEC's clients from 2026 as part of their decarbonisation goals.

https://www.h2-view.com/story/getec-to-offtake-cepsas-spanish-green-hydrogen-for-its-european-industry-clients/

Events

Connecting Green Hydrogen Europe 2023

05 July- 06 July 2023

#CGHE2023

Venue:

Riu Plaza España Madrid, Spain

Link:

https://www.europe.gh2events.com/?gclid=EAIaIQobChMI-Jg4-KjO_AIVxPl3Ch1SFwe0EAAYASAAEgIdGfD_BwE

London Hydrogen-Africa Green H2 Investment Forum

25-26 July 2023

An essential event that focuses on promoting green hydrogen investment opportunities in Africa.



Venue:

12, Arthur Street, London, UK

Link:

https://hydrogen-africa.com/london-hydrogen-africa-green-h2-investment-forum-2023/

India sets sights on green tugs in all major ports by 2025

India aims to become a global hub for green shipbuilding by 2030 and is launching a Green Tug Transition Programme as part of the strategy. The target has been set for the initial green tugs to start working in all major ports by 2025. At least, 50% of all the tugs are likely to be converted into green tugs by 2030, helping the country considerably reduce emissions as it moves towards achieving sustainable development. The effort is part of Maritime Vision Document 2030, released by Prime Minister Shri Narendra Mod, a ten-year blueprint for India's vision of a sustainable maritime sector and vibrant blue economy.

The PM Gati Shakti – National Master Plan for Multi-Modal Connectivity along with the Green Ports initiative has already accelerated the development of green logistics supply chain in the country. The country's ports aim to cut carbon emissions per ton of cargo handled by 30% by 2030. The government anticipates the mission to result in the development of a green hydrogen production capacity of at least 5 million metric tonnes (MMT) per annum with an associated renewable energy capacity addition of about 125 GW in the country.



https://www.offshore-energy.biz/india-sets-sights-on-green-tugs-in-all-major-ports-by-2025/

India's green hydrogen demand to reach 2.85 MMT/year by 2030, says USAID

USAID's South Asia Regional Energy Partnership (SAREP) says in a new report that Indian green hydrogen demand will reach 2.85 million metric tons (MMT) per year by 2030. The transition will require a total investment of $57.6 billion.

The report states that the fertilizer and export sectors will account for nearly 37% (1.02 MMT) and 29% (0.81 MMT) of the total 2.85 MMT green hydrogen demand.

Report authors assumed that 10% of India's refineries would switch to green hydrogen, 10% of existing city gas distribution pipelines would be blended with green hydrogen, 50% of ammonia-based fertilizer imports would be replaced with domestic green ammonia, and the country would meet 6% of its demand from target importing countries by 2030. To meet these green hydrogen demand estimates, the report says India will need 62 GW of additional renewable energy capacity, 29 GW of electrolyzer capacity, and 11 MMT per annum of ammonia infrastructure. This represents an estimated investment need of $36 billion, $15 billion, and $6 billion, respectively, by 2030.



https://www.pv-magazine.com/2023/05/09/indias-green-hydrogen-demand-to-reach-2-85-mmt-year-by-2030-says-usaid/

IIT Roorkee Gets New Renewable Grid Integration and Green Hydrogen Labs at the Deptt of Hydro and Renewable Energy

Prof. K.K. Pant, Director, IIT Roorkee, inaugurated two new labs – Renewable Grid Integration Laboratory and Green Hydrogen Laboratory at the Department of Hydro and Renewable Energy. HRED has developed these labs to ensure that the Department and IIT Roorkee continue to play a major role in reliable, resilient, and Atmanirbhar transition to a clean energy grid in India.

https://www.indianweb2.com/2023/05/iit-roorkee-gets-new-renewable-grid.html

Green hydrogen: Land policy framed in Gujarat

The state revenue department has announced its policy for allotting government wasteland to companies that intend to produce green hydrogen. Gujarat government has already signed MoUs with five top corporate entities for allotment of sizable pieces of government wasteland for upcoming green hydrogen projects. Government wasteland will be leased to such companies for a period of 40 years. GPCL is the nodal agency for implementing green hydrogen projects in the state.

https://timesofindia.indiatimes.com/city/ahmedabad/green-hydrogen-land-policy-framed-in-gujarat/articleshow/100116030.cms?from=mdr#:~:text=The%20Gujarat%20government%20has%20already%20signed%20MoUs%20with,such%20companies%20for%20a%20period%20of%2040%20years.

Scheepers, F. *et al.*

Cost-optimized design point and operating strategy of polymer electrolyte membrane electrolyzers

https://doi.org/ 10.1016/j.ijhydene.2022.11.2880360-3199

Abstract:
Green hydrogen is a key solution for reducing CO2 emissions in various industrial applications, but high production costs continue to hinder its market penetration today. Better competitiveness is linked to lower investment costs and higher efficiency of the conversion technologies, among which polymer electrolyte membrane electrolysis seems to be attractive. Although new manufacturing techniques and materials can help achieve these goals, a less frequently investigated approach is the optimization of the design point and operating strategy of electrolyzers. This means in particular that the questions of how often a system should be operated and which cell voltage should be applied must be answered. As existing techno-economic models feature gaps, which means that these questions cannot be adequately answered, a modified model is introduced here. In this model, different technical parameters are implemented and correlated to each other in order to simulate the lowest possible levelized cost of hydrogen and extract the required designs and strategies from this. In each case investigated, the recommended cost-based cell voltage that should be applied to the system is surprisingly low compared to the assumptions made in previous publications. Depending on the case, the cell voltage is in a range between 1.6 V and 1.8 V, with an annual operation of 2000-8000 h. The wide range of results clearly indicate how individual the design and operation must be, but with efficiency gains of several percent, the effect of optimization will be indispensable in the future.

Wilberforce, T. *et al.*

System modelling and performance assessment of green hydrogen production by integrating proton exchange membrane electrolyser with wind turbine

https://doi.org/ 10.1016/j.ijhydene.2022.12.263

Abstract:
This investigation delves into the production of green hydrogen with the aid of a polymer electrolyte membrane electrolyzer with its source of energy harnessed from wind using a vertical axis wind turbine (VAWT). The integrated numerical approach was adopted in the simulation environment of MATLAB, Simulink, and SimscapeTM to develop the compre-hensive mathematical model of the system. The component-level models are linked to the electrolyser, and wind turbines are modelled distinctively considering their efficiencies. The study first explores current types of electrolysers, from their operational characteristics to their merits and demerits. The Proton Exchange Membrane Electrolysers were recommended as the best electrolysis alternative due to their fast start-up time, and the technology being matured. Various power electronics required in connecting the energy from the wind turbine to the electrolyser was equally discussed. Some of these notable power electronics include the Permanent Magnet Synchronous Generators (PMSG), Full Bridge Diode Rectifier, as well as DC-DC Buck Boost Converter. The study was conducted at Warwickshire area as the location for the installation of the Proton Exchange Membrane Electrolyser System. It was however deduced that the performance of the electrolyser was predominant at higher temperatures but lower pressures. The intensity of wind also had a direct correlation to the overall performance of the electrolyser. In summary, for the wind turbine under investigation, at 1 bar pressure and operating temperature of 20 degrees C, 65,770 L of hydrogen was produced and this is equivalent to 4656.3 kg of hydrogen or 156.4 kWh of energy.

Fu, XY *et al.*

Bifunctional Ultrathin RhRu0.5-Alloy Nanowire Electrocatalysts for Hydrazine-Assisted Water Splitting

https://doi.org/10.1002/adma.202301533

Abstract:
Hydrazine-assisted water electrolysis offers a feasible path for low-voltage green hydrogen production. Herein, the design and synthesis of ultrathin RhRu0.5-alloy wavy nanowires as bifunctional electrocatalysts for both the anodic hydrazine oxidation reaction (HzOR) and the cathodic hydrogen evolution reaction (HER) is reported. It is shown that the RhRu0.5-alloy wavy nanowires can achieve complete electrooxidation of hydrazine with a low overpotential and high mass activity, as well as improved performance for the HER. The resulting RhRu0.5 bifunctional electrocatalysts enable, high performance hydrazine-assisted water electrolysis delivering a current density of 100 mA cm(-2) at an ultralow cell voltage of 54 mV and a high current density of 853 mA cm(-2) at a cell voltage of 0.6 V. The RhRu0.5 electrocatalysts further demonstrate a stable operation at a high current density of 100 mA cm(-2) for 80 hours of testing period with little irreversible degradation. The overall performance greatly exceeds that of the previously reported hydrazine-assisted water electrolyzers, offering a pathway for efficiently converting hazardous hydrazine into molecular hydrogen.

Zheng, YQ *et al.*

Visible light driven reform of wasted plastics to generate green hydrogen over mesoporous ZnIn2S4

https://doi.org/10.1039/d3ra02279j

Abstract:

As the global consumption of plastics keeps increasing, the accumulated plastics in the natural environment have threatened the survival of human beings. Photoreforming, as a simple and low-energy way, could transform wasted plastic into fuel and small organic chemicals at ambient temperature. However, the previously reported photocatalysts have some drawbacks, such as low efficiency, containing precious or toxic metal. Herein, a noble-free, non-toxic, and easy prepared mesoporous ZnIn2S4 photocatalyst has been applied in photoreforming of polylactic acid (PLA), polyethylene terephthalate (PET) and polyurethane (PU), generating small organic chemicals and H-2 fuel under simulated sunlight. Plastic was degraded into small organic molecules after the pretreatment, which futher acted as the substrate for photoreforming. Mesoporous ZnIn2S4 exhibits high H-2 production efficiency, strong redox ability, and long-term photostability. Furthermore, mesoporous ZnIn2S4 could overcome the hindrances of dyes and additives of realistic wasted plastic bags and bottles with high decomposition efficiency, providing an efficient and sustainable strategy for the upcycling of wasted plastics.

Huang, B. *et al.*

Dense-Packed RuO2 Nanorods with In Situ Generated Metal Vacancies Loaded on SnO2 Nanocubes for Proton Exchange Membrane Water Electrolyzer with Ultra-Low Noble Metal Loading

https://doi.org/10.1002/smll.202301516

Abstract:

Proton exchange membrane water electrolyzer (PEMWE) is a green hydrogen production technology that can be coupled with intermittent power sources such as wind and photoelectric power. To achieve cost-effective operations, low noble metal loading on the anode catalyst layer is desired. In this study, a catalyst with RuO2 nanorods coated outside SnO2 nanocubes is designed, which forms continuous networks and provides high conductivity. This allows for the reduction of Ru contents in catalysts. Furthermore, the structure evolutions on the RuO2 surface are carefully investigated. The etched RuO2 surfaces are seen as the consequence of Co leaching, and theoretical calculations demonstrate that it is more effective in driving oxygen evolution. For electrochemical tests, the catalysts with 23 wt% Ru exhibit an overpotential of 178 mV at 10 mA cm(-2), which is much higher than most state-of-art oxygen evolution catalysts. In a practical PEMWE, the noble metal Ru loading on the anode side is only 0.3 mg cm(-2). The cell achieves 1.61 V at 1 A cm(-2) and proper stability at 500 mA cm(-2), demonstrating the effectiveness of the designed catalyst.

Alom, MS. and Ramezanipour, F.

Vacancy effect on the electrocatalytic activity of LaMn1/2Co1/2O3-delta for hydrogen and oxygen evolution reactions

https://doi.org/10.1039/d3cc00961k

Abstract:

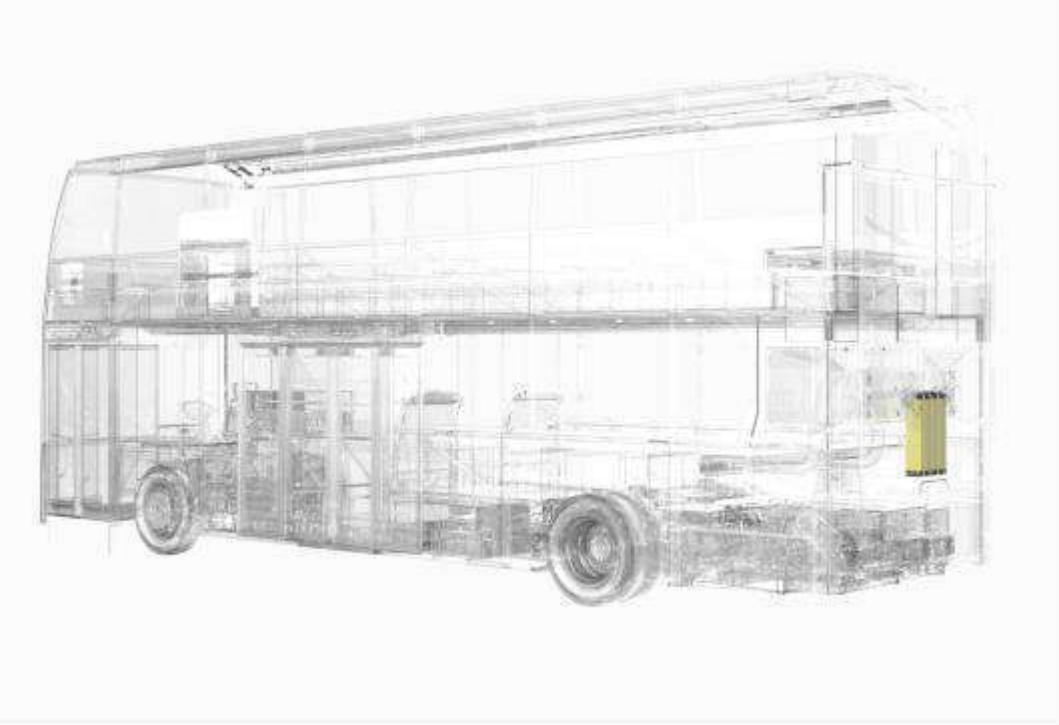
Development of efficient electrocatalysts for water splitting can be a significant step toward green hydrogen generation. In this work, a remarkable enhancement of electrocatalytic properties is achieved through the incorporation of oxygen-vacancies in a perovskite oxide, while maintaining the same structural framework. The oxygen-deficient material La2MnCoO6-delta (LaMn0.5Co0.5O3-delta) is isostructural to the parent stoichiometric material, but shows drastically enhanced electrocatalytic properties for both half-reactions of water-splitting, namely hydrogen-evolution and oxygen-evolution reactions, due to the oxygen-vacancies.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN

ISSUE: 33
MAY, 2023

NEW FUEL CELL TECHNOLOGY FOR HYDROGEN DOUBLEDECKER BUSES



Bramble Energy, an innovator in fuel cell technology, has joined forces with Equipmake, Aeristech and the University of Bath to develop a revolutionary new hydrogen double-deck bus integrating Bramble's revolutionary, low-cost **printed circuit board fuel cell (PCBFC^{TM}) technology.**

ADVANTAGES OF PCBFC TECHNOLOGY:

- Using a patented-protected printed circuit board technology, it can create bespoke fuel cell stacks in a matter of days at scale and low-cost.
- Bramble's PCB technology eliminates the requirement for a number of complex and costly components found in a typical electrochemical stack, which not only simplifies the supply chain but also does not require vast retooling for manufacture.
- The fuel cell stacks can be produced in almost any size and arrangement according to the end customer's needs.
- The result is an unparalleled cost-effective solution to supporting and accelerating the decarbonisation of public transport and to improve air quality in towns and cities around the world.

https://irishtechnews.ie/new-fuel-cell-tech-hydrogen-doubledecker-buses/

NEW FUEL CELL TECHNOLOGY FOR HYDROGEN DOUBLEDECKER BUSES

The UK-based consortium will develop a hydrogen-powered double-deck bus, using a first-of-its-kind fuel cell technology from Bramble Energy; Aeristech's high efficiency air compressor, and Equipmake's motor power electronics and battery management system. The powertrain will be optimised through vehicle simulations carried out by the University of Bath.

Bramble Energy is powering a Net Zero world – today – and is proving to be a real game changer in solving key challenges in the production of hydrogen fuel cells including: lead times, up-front investment, manufacturing cost and scalability.

Equipmake has more than 20 years' experience developing and integrating industry-leading innovative electric powertrains.

Aeristech develops high performance electric motors, inverters and oil-free compressors for a range of innovative applications.

IAAPS is a Research Institute of the University of Bath, building on a strong track record of delivering propulsion system research with impact at Bath.

Events

India Energy Technology

13 June – 14 June 2023

#IETF





Venue:

New Delhi, India.

Link:

https://10times.com/e1kd-kzd1-0s00

4th International Hydrogen Aviation Conference (IHAC 2023)

07 September 2023

#IHAC2023



Venue:

Edinburgh International Conference Centre 150 Morrison St, Edinburgh, United Kingdom.

Link:

https://lnkd.in/gywQQw_e

INDUSTRY NEWS

Australia offers industry A$2bn to scale up green hydrogen

AUSTRALIA'S government will give A$2bn ($US1.3bn) to industry to scale-up the production of green hydrogen as it seeks to become a global leader in the burgeoning sector.

The A$2bn Hydrogen Headstart initiative will cover the additional cost of producing green hydrogen from electrolysis powered by renewable energy compared to the current hydrogen market price. Green hydrogen production is significantly more costly than the conventional method of reforming natural gas, which produces emissions. The scheme aims to support two to three flagship projects that together would provide up to 1 GW of electrolyser capacity by 2030. The exact details of the scheme will be developed in the coming months, in consultation with industry. The Australian government said it will support both hydrogen production and the production of hydrogen derivatives including ammonia.

"The Inflation Reduction Act provides a deliberately technology neutral tax credit that aims to level the playing field between various low-carbon energy technologies such as solar, wind, nuclear, batteries, carbon capture, and others, by encouraging investments in the most impactful and commercially available technology," it added.Hydrogen Headstart is expected to open for expressions of interest in the first quarter of 2024. Following assessment, successful applicants will be awarded contracts and provided with ongoing payments over a 10-year period from 2026/27, said the government.
https://www.thechemicalengineer.com/news/australia-offers-industry-a-2bn-to-scale-up-green-hydrogen/

Global Hydrogen Energy LLC to Become a Publicly Traded Company Through a Business Combination With Dune Acquisition Corporation

Global Hydrogen Energy LLC ("Global Hydrogen"), which seeks to be a leader in the sustainable energy transition as a next-generation industrial gas supplier, and Dune Acquisition Corporation (Nasdaq: DUNEU, DUNE, DUNEW) ("Dune"), a special purpose acquisition company, today announced that they have entered into a definitive agreement for a business combination, which would result in Global Hydrogen becoming a publicly listed company.

The combined company will be called Global Gas Corporation upon the closing of the business combination and its common stock is expected to be listed on Nasdaq under the new ticker symbol "HGAS".

Under the terms of the Unit Purchase Agreement, Dune will complete a business combination with Global Hydrogen at a pro forma combined enterprise value of approximately $112 million (assuming no redemptions by Dune public stockholders and a Dune common share value of $10 per share).

https://www.globenewswire.com/news-release/2023/05/15/2668921/0/en/Global-Hydrogen-Energy-LLC-to-Become-a-Publicly-Traded-Company-Through-a-Business-Combination-With-Dune-Acquisition-Corporation.html

Masdar, Fertiglobe eye massive green hydrogen plant in Abu Dhabi

Emirati companies Fertiglobe and Masdar, along with French firm ENGIE, are in discussions to establish a major green hydrogen plant in Abu Dhabi

The proposed plant would have a production capacity of 100 to 200 megawatts. The green hydrogen initiative is part of Fertiglobe's ambitious agenda for the upcoming COP28 climate summit, scheduled to take place in the UAE later this year.

According to Fertiglobe CEO Ahmed El-Hoshy, the company is currently assessing additional projects aimed at green hydrogen and blue ammonia production in Abu Dhabi over the next few years. This collaboration involves ADQ, ADNOC, sMitsui, and GS Energy. The production is anticipated to commence within three years, with an annual capacity of up to one million tons.

The plant aims to produce up to 15,000 tons of green hydrogen as feedstock for producing up to 90,000 tons of green ammonia per year in Fertiglobe's existing ammonia plants.

Masdar, Fertiglobe eye massive green hydrogen plant in Abu Dhabi - Utilities Middle East (utilities-me.com)

EVENTS:

Hydrogen Technology Expo Europe 2024

Date: October 22-24

Hydrogen Technology Expo is thrilled to partner with Hamburg Messe + Congress for 2024 event



Link:

https://www.pmw-magazine.com/news/global-flagship-fair-hydrogen-technology-expo-europe-to-move-to-hamburg-in-2024.html

REPORT:

Hydrogen Leak Detection Tape Market Analysis Report 2023-2030

The global Hydrogen Leak Detection Tape market size was valued at USD million in 2022 and is forecast to a readjusted size of USD million by 2029 with a CAGR of Percent during review period.

Link:

2023-2030 Hydrogen Leak Detection Tape Market Analysis with Latest Growth Updates - MarketWatch

Pininfarina-designed Namx HUV with swappable hydrogen tanks wins Green Good Design Sustainability award

The Namx HUV is a hydrogen-powered SUV in part fuelled by removable capsules, paving the way to a seamless and carbon-free experience of mobility. It is the world's first car partially run by patented removable tank system that promises to change the paradigm of clean mobility and make hydrogen fuel widely available. The Namx HUV was designed by Pininfarina in collaboration with the De Lussac design studio. The Green Good Design Sustainability Award is a prestigious reward that aims to bestow international recognition to those outstanding individuals, companies, organisations, governments and institutions – together with their products, services, ideas and concepts – that have forwarded exceptional thinking and inspired greater progress toward a healthier and more sustainable world.



Called the HUV, it is claimed to be able to achieve a range of almost 500 miles / 800 kilometres. Along with the capsules, it is also fitted with a fixed hydrogen tank and together they power either a top-of-the-range 542bhp or entry-level 296bhp electric motor. Scheduled to be released at the end of 2025, it will be available in either top-spec four-wheel-drive or rear-wheel-drive forms. The use of capsules as secondary tanks is a breakthrough innovation that opens the door to the large-scale deployment of hydrogen for private vehicles through a new, totally decentralised, on-demand energy distribution model.

Stellantis tells UK to rework Brexit deal for car plants to remain open: Report | Autocar Professional

Honda, Suzuki, Yamaha, and Kawasaki to develop hydrogen-powered engines

In an unprecedented move, four Japanese motorcycle giants have come together to jointly develop a small hydrogen combustion engine. Honda, Suzuki, Yamaha, and Kawasaki have formed a research association called Hydrogen Small mobility and Engine technology (HySE). The top four bikemakers will be focused on researching and developing small-capacity motors and carmaker Toyota will be utilizing the knowledge for developing larger power units.While going electric may be reducing the running cost of two-wheelers by a significant margin, the cost of ownership goes much higher than a similarly specced ICE-powered vehicle.Also, with lesser mechanical components in Battery Electric Vehicles (BEVs), the number of people required to produce and maintain an EV is much less when compared to petrol-powered bikes. HySE is created to tackle these issues.



Honda, Suzuki, Yamaha, and Kawasaki to develop hydrogen-powered engines (newsbytesapp.com)

SK Ecoplant to join Canada's $4.5b green hydrogen project

SK Ecoplant, a construction and energy arm of SK Group, on Wednesday signed an agreement to participate in a $4.5 billion green hydrogen commercialization project headed by Canada, amid the Canadian prime minister's three-day state visit to Korea celebrating the 60th anniversary of diplomatic relations between South Korea and Canada. SK Ecoplant struck up a partnership with Canadian renewable energy company World Energy GH2 to participate in the first phase of the Nujio'qonik project -- a green hydrogen project scheduled to be carried out in eastern Canada to generate electricity through wind power and facilitate the production of green hydrogen.

https://www.koreaherald.com/view.php?ud=20230517000619

REPORT

INDIA HYDROGEN MARKET 2023 RESEARCH REPORT

Research report appears to cover various aspects of the market, including the strategies of top players, market segments, competitive landscape, manufacturing, and pricing structures. In this report, there is an in-depth analysis of the current state of the global India Hydrogen Market, its key drivers and challenges, and its future prospects. This study contains research on market dynamics, such as SWOT, PESTLE, and Porter's Five Forces analysis, as well as details about drivers, constraints, trends, and opportunities. These studies may assist in providing a thorough overview of the worldwide industry. Additionally, the key segments of the industry are evaluated according to their performance.

The India hydrogen market was valued at $50 million in 2017, and is projected to reach $81 million by 2025, growing at a CAGR of 6.3% from 2018 to 2025.

Link:

India Hydrogen Market Size, Analysis, Key Segments, Share, Research Report and Forecast 2030 - MarketWatch

The prospects of Green Hydrogen: India Panama's upcoming collaboration

Scrutinizing the beneficiary ramifications of green hydrogen, India and Panama have leveraged the utilization of this process as an alternative and produced sustainable energy. As a substitute fuel for shipping, the two nations are looking forward to working together in green hydrogen production, with the aim of Panama evolving as a nucleus of hydrogen and environment-friendly shipping. The commencement of this vision of Panama is fostered with India's assistance. The National Secretariat of Energy of Panama launched the "Green Hydrogen Roadmap" in the global south. The talks towards this partnership came after the Indian government's approval of Rs. 19,744 crores for the annual production of five million metric tons of green hydrogen and bringing in investment worth Rs. 8 trillion by 2030. India also plans to run its ships on green energy by involving a hybrid energy model that will comprise a mixture of solar, wind, seawater, and hydrogen.

https://www.financialexpress.com/business/defence-the-prospects-of-green-hydrogen-india-panamas-upcoming-collaboration-3088130/

SAP's GreenToken: How the software giant's new tech can power India's green ambitions

The transition to renewable energy sources away from fossil fuels is a good ambition but it can be accelerated if new fuels and energy sources can be introduced that can directly replace conventional fossil fuels without changing the machines that consume energy source. This is something the German technology giant SAP with its GreenToken technology can address, especially for the energy companies in India.



SAP's GreenToken: How the software giant's new tech can power India's green ambitions (msn.com)

Green hydrogen bunkering, refuelling facilities to be set up at all major ports by 2035

The government said green hydrogen bunkering and refuelling facilities shall be established at all major ports by 2035 to reduce the country's carbon footprint. The Ministry of Ports, Shipping and Waterways (MoPSW) in its green port guidelines, 'HaritSagar' further said that ports shall make an action plan for creating infrastructure at select ports for storage, bunkering and refuelling of green hydrogen within the targeted timelines.

Bunkering operation is a procedure for transferring oil, sludge or cargo to and from a ship.

The MoPSW also stressed that all ports shall make efforts to achieve the target of renewable energy as envisaged in Maritime India Vision (MIV) 2030/Blue Economy 2047 documents.

Share of renewable energy at Ports should exceed 60% by the Year 2030 and 90% by year 2047.



Green hydrogen bunkering, refuelling facilities to be set up at all major ports by 2035 - The Hindu

India's green hydrogen demand to reach 2.85 MMT/year by 2030, says USAID

A new report from the South Asia Regional Energy Partnership (SAREP) of the United States Agency for International Development, better known as USAID, says India's green hydrogen demand will reach 2.85 million metric tonnes (MMT) per year by 2030. India will require an investment of USD 99.4 billion under the best-case scenario where it reaches annual green hydrogen demand of 5 MMT by 2030 as targeted under the NHM.

India's green hydrogen demand to reach 2.85 MMT/year by 2030, says USAID – pv magazine Australia (pv-magazine-australia.com)

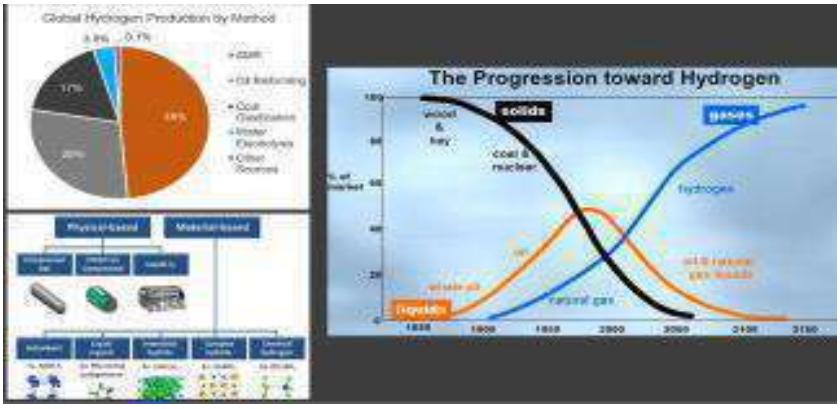
Qureshi, F. *et al.*

A State-of-The-Art Review on the Latest trends in Hydrogen production, storage, and transportation techniques

https://doi.org/10.1016/j.fuel.2023.127574

Abstract:

The transportation sector is one of the major consumers of fuel i.e., mostly relying on fossil-based fuels. With the rising energy demand and consumption of fossil fuels, the concentration of pollutants and greenhouse gases (GHGs) are increasing in the atmosphere. Hydrogen (H_2) is a well-known source of clean energy options and a better alternative to fossil fuels. It has the potential to become a promising fuel for renewable transportation by providing safe, efficient, stable, accessible, and customer-friendly energy. This is due to its many characteristics, such as energy density, high calorific value, affordability, and a wide variety of production methods. H_2 has the potential to completely replace the use of fossil fuel in internal combustion engines. The review highlights the recent advances in H_2 production, storage, and transportation. Apart from the conventional steam reforming technique i.e., producing around 85% of the world's grey H_2, several clean techniques such as partial oxidation, plasma reforming, water electrolysis, pyrolysis, and photoelectrolysis are comprehensively discussed. Despite its many advantages, H_2 storage is a significant issue. Hence, the recent advances and challenges in H_2 storage i.e., physical, and material-based techniques have been deliberated. Further, the risks involved during the production, handling, and transportation of H_2 fuel is highlighted, and the latest trends in its safety recommendations have been suggested. Finally, the techno-economic feasibility challenges and its outlook has been discussed.



Wang, XC. *et al.*

Robust architecture of 2D nano Mg-based borohydride on graphene with superior reversible hydrogen storage performance

https://doi.org/ 10.1016/j.jmst.2022.10.059

Abstract:

Efficient technical strategies to synthesize hydrides with high capacity and favorable reversibility are sig-nificant for the development of novel energy materials. Herein, nano Mg-based borohydride, Mg(BH4)2, with robust architecture was designed and prepared by confining on graphene through a solution self-confinement method. The Mg(BH4)2 confined on graphene displays a wrinkled 2D nano layer morphology within 8.8 nm thickness. Such 2D nano Mg (BH4)2 can start dehydrogenation at 67.9 degrees C with a high capacity of 12.0 wt. %, which is 190.5 degrees C lower than pristine Mg (BH4)2. The isothermal dehydrogenation tests and kinetics fitting results indicate the 2D nano Mg (BH4)2 possesses much-enhanced dehydrogenation kinetics of 31.3 kJ/mol activation energy, which is only half of pristine Mg (BH4)2. The thermodynamics of the 2D nano Mg(BH4)2 is also verified by PCT tests, of which Gibbs free energy value for the confined 2D nano Mg(BH4)2 is estimated to be-18.01 kJ/mol H2, lower than-16.36 kJ/mol H2 of pristine Mg(BH4)2. Importantly, the reversibility of the confined 2D nano Mg (BH4)2 is significantly enhanced to over 90% capacity retention with relatively kinetics stability during 10 cycles. The mechanism analyses manifest that Mg (BH4)2 exhibits stable 2D nano morphology during 10 cyclic tests, resulting in the greatly reduced H diffusion path and the improved de/rehydrogenation kinetics of the 2D nano Mg (BH4)2. Based on theoretical calculations of Mg(BH4)2 and the intermediate MgB12H12 confined on graphene, the charge transfer status of both samples is modified to facilitate de/rehydrogenation, thus leading to the significant thermodynamic improvements of the reversible hydrogen storage performances for 2D nano Mg(BH4)2. Such investigation of the Mg-based borohydride will illuminate prospective technical research of energy storage materials.

Zheng, ZW. *et al.*

Structural features of 18R-type long-period stacking ordered phase in Mg85Zn6Y9 alloy and the Ni doping effect on its hydrogen storage properties

https://doi.org/10.1016/j.jmst.2022.10.057

Abstract:

Magnesium-based alloys with 18R-type long-period stacking ordered (LPSO) structures have attracted wide attention for structural and functional applications. To understand hydrogen storage properties of 18R phase, the Mg85Zn6Y9 alloy with 94 wt. % of 18R-type LPSO phase is prepared in this work. The 18R phase has a layered structure where Y-Zn-Mg and Mg layers alternately stack along the c-axis. In the Y-Zn-Mg layers, Y, Zn and partial Mg sites are co-occupied by Y and Mg, Zn and Mg, and Mg and Zn/Y atoms, respectively. Thus the 18R phase is easily decomposed into alpha-MgH2, gamma-MgH2, YH2, YH3, C14-type Laves phase MgZn2 and minor CsCl-type Y(Mg,Zn) during ball milling under hydrogen atmosphere. After further hydrogen absorption-desorption cycling, Y (Mg, Zn) disappears gradually and C14 phase trans-forms into C15-type Laves phase. By contrast, the Mg85Zn6Y9 alloy has better hydrogen storage kinetics and cycle durability than pure Mg because of the catalytic effect of YH2 /YH3 on hydrogen absorption -desorption and inhibition role of Laves phase in Mg crystallite growth. Moreover, the introduction of Ni into Mg85Zn6Y9 sample leads to a further decrease in activation energy of hydrogen desorption from 106.39 to 96.78 kJ mol -1 due to the formation of Mg2Ni. This work not only provides new insights into structural features and hydrogen storage characteristics of 18R phase but offers an effective method for improving hydrogen storage properties.

Amanidaz, N. *et al.*

Volatile fatty acids and ammonia recovery, simultaneously cathodic hydrogen production and increasing thermophilic dark fermentation of food waste efficiency

https://doi.org/10.1016/j.ijhydene.2022.12.321

Abstract:

A combined thermophilic anaerobic bioreactor of food waste and bioelectrodialysis system was used to recover volatile fatty acids and ammonia as renewable materials and also to remove the inhibitory effect of biohydrogen production byproducts. Different configurations of bioelectrodialysis system under various amounts of inlet food waste and external electrical currents were examined were investigated to find out the best conditions for system performance. When the two anion exchange membranes (AEM) were installed on the anode and cathode sides of separation chamber, 12 mL min-1 of mixed liquid was circulated between fermenter and separation chamber, while the external energy of 2.7 V and 0.2 M NaCl as electrolyte were used in the electrodialysis chambers. As long as the food waste with 70000 mg COD L-1 was used in the fermenter, the concertation of organic acids in the recovery chamber was the highest, 507.3 mg L-1 after 24th h. As a result, 0.63 L L-1 biohydrogen and 50 mL cathodic hydrogen were produced. When a cation exchange membrane was embedded on the cathode side of the separation chamber, the ammonia concertation in the recovery chamber was the highest, 518 mg L-1, at 36th h. At the same time, the chemical oxygen demand of the anode solution was decreased by about 3600 mg L-1. This sustainable and bioelectrical system can recover organic acids and ammonia, cathodic hydrogen production, while simultaneously increase biohydrogen production and efficient even when substrate concentration was higher.

Luo, QM. *et al.*

Synergistic effects of 1T MoS2 and interface engineering on hollow NiCoP nanorods for enhanced hydrogen evolution activity

https://doi.org/10.1016/j.jmst.2022.10.044

Abstract:

Metallic 1T-phase molybdenum disulfide (1T-MoS2) shows more excellent electrocatalytic performance for hydrogen evolution reaction (HER) than semiconducting 2H-phase MoS2 (2H-MoS2). Therefore, the facile controllable synthesis of hierarchical structure with rich 1T-MoS2 is desired for highly efficient electrocatalytic performance. In this work, a simple solvothermal method is proposed to fabricate hollow NiCoP/MoS2-V heterostructure with 63.2% 1T-MoS2, in which the abundant catalytic active sites are exposed, the mass transfer properties are improved, and the electronic states are optimized. Moreover, the low energy difference between 2H and 1T phases and near zero free energy of hydrogen adsorption (AGH*) result in fast kinetics and excellent catalytic performances. Specifically, the NiCoP/MoS2-V composite exhibits enhanced HER activity with a low overpotential of 74.6 mV at 10 mA cm-2 and superior stability in alkaline electrolytes. This efficient design opens up new vistas for developing high-activity electrocatalysts.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN

ISSUE: 34
MAY, 2023

Thailand's net-zero emissions by 2050: analysis of economy-wide impacts

This study aims at exploring the economy-wide impacts of achieving net-zero greenhouse gas (GHG) emissions by 2050 in Thailand and thus developed a recursive dynamic Asia-Pacific Integrated Model/Computable General Equilibrium (AIM/CGE) model of Thailand for the assessment. The macroeconomic impacts of Thailand's net-zero GHG emission targets by 2050 are analyzed relative to its 2-degree pathway. Results indicate that Thailand should put more effort in GHG mitigation actions to achieve the emissions peak by 2025 and net-zero GHG emissions by 2050. Improvement in energy efficiency; increasing electrification; expanding renewable energy utilization; deploying green hydrogen; bioenergy; carbon capture, utilization, and storage (CCUS); and behavioral changes are the key identified pillars of decarbonization to drive Thailand towards the pathways of net-zero emissions by 2050.

Link:

https://www.researchgate.net/publication/370370186_Thailand's_net-zero_emissions_by_2050_analysis_of_economy-wide_impacts

Green hydrogen to combat climate change

Minnova Corp, details its green hydrogen strategy, innovative technology, and production processes and highlights the role that green hydrogen can play in the energy transition.



The topic of 'Climate Change' has become a global initiative supported by policymakers, investors, and consumers to reduce GHG Emissions and CO_2 Emissions.
Over 30 countries have released hydrogen roadmaps, and many more countries are working on their hydrogen and energy transition strategies. Considering the positive outlook for green hydrogen demand, this is exactly the time for smaller, innovative companies, like **Minnova Renewable Energy**, to look closely at this global market opportunity and possibly even displace larger, more established companies.

Advancements:

- Third-generation biomass gasification technology to produce a high hydrogen content (>50% H_2 by volume) clean syngas with negligible tars, nitric oxide (NOx) and sulfur oxide (SOx).
- Second initiative is working closely with MB Hydro, the provincial utility, to develop large-scale green hydrogen production via conventional electrolysis methods.

Sustainable biomass to power the global energy transition

Power generation from biomass is not new and represents 6% of global energy supply. First- and second-generation biomass reactor technologies generate heat to produce steam that, in turn, drives a turbine to generate electrical power. These systems are inefficient compared to the third-generation gasifier design. Gasification Technology includes producing green hydrogen, syngas to power, green ammonia, green methanol, and other valuable biofuels.

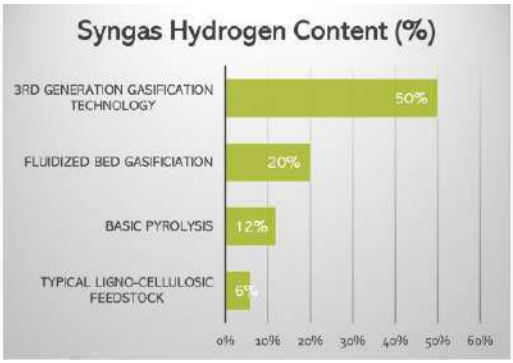


Figure: Percentage of Syngas Hydrogen Content

Operational Inputs and Outputs	Feedstock Input 10 $MW_{thermal}$
Biomass feedstock (tpa)	15 – 20k
Biomass Input ($MW_{thermal}$)	30
Syngas Production (wet, Nm^3/hr)	~10,500
Generator type[1]	Combined Cycle
Bioenergy Output Options	
Electrical Power ($MW_{electrical}$)	~2.5
Thermal Power ($MW_{thermal}$)	~10
Future Green H_2 (kg/yr)[2]	>1.4 million
Future Green NH_3 (kg/yr)[3]	>4 million
Future Green CO_2 (kg/yr)[4]	~12 million

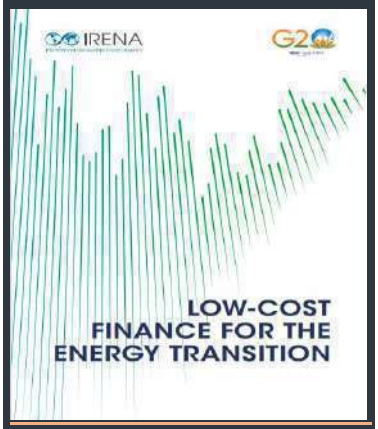
Figure: Feedstock input values

Whilst the green hydrogen market is still in its infancy, hydrogen carriers will play an important role in accelerating the pace of the transition.
https://www.innovationnewsnetwork.com/green-hydrogen-combat-climate-change/33172/

RECENT REPORT

LOW-COST FINANCE FOR THE ENERGY TRANSITION

The factors that drove down the costs of solar and wind power over the past decade offer important insights into the framework conditions and policies needed to scale up the new and emerging technologies needed for the energy transition, as well as the vital role of low-cost finance.



The lessons learnt from the success of solar photovoltaic and onshore wind can be used to accelerate the scale-up of hydrogen, offshore wind and battery storage – critical technologies for the next stage of the energy transition. Crucially, enabling innovative frameworks that reduce the transaction costs of technology transfers and facilitate foreign direct investments have played a key role in accelerating the deployment of new and critical low-carbon technologies in emerging markets.

Link:

Low-cost finance for the energy transition (azureedge.net)

INDUSTRY NEWS

Aviation will need €300bn for EU green hydrogen switch, study finds

The roll out of hydrogen planes in Europe will need €300bn of investment and require a tax on traditional jet fuels, a new study by a clean energy group finds, showing the scale of the challenge for policymakers in driving green aviation.

Airbus, the world's largest plane maker, has said it aims to fly a zero-emissions hydrogen-powered aircraft by 2035 but has cautioned about the pace of development of the necessary infrastructure.

The study published by the NGO Transport & Environment, found that the cost of developing the hydrogen supply chain in Europe would be €299bn between 2025 and 2050, largely made up of the cost of green hydrogen production, liquefaction and distribution.

The high cost would make hydrogen planes 8 per cent more expensive than jet-fuelled aircraft in 2035 unless kerosene was taxed, it estimated.



https://www.ft.com/content/1245bf5e-03be-4dd3-9326-5673d923d0bd?trk=public_post_comment-text

EEX bourse to present green hydrogen index

European energy bourse EEX will publish a green hydrogen index, called HYDRIX, from Wednesday, scaling up price discovery in future markets for renewable energy, its chief executive Peter Reitz said.

"Hydrix will unveil information about actually traded prices for green hydrogen, produced with electricity from renewable energy sources," Reitz said in an interview during the annual E-World trade fair, where the announcement was made.

"Clear price signals are the basis for the market ramp-up and further investments in the hydrogen economy."

https://www.msn.com/en-us/money/markets/eex-bourse-to-present-green-hydrogen-index-from-wednesday/ar-AA1bzdml

The future of Dutch aerospace? Meet Fokker Next Gen's hydrogen plane

Dutch aerospace pioneer Fokker is looking to make a comeback. This time however, it won't be polluting Jet, A fuel propelling the company's aircraft. Instead, in the revived guise of Fokker Next Gen, it is playing the long game and joining in on the clean-burning hydrogen hype.

With €25 million in funding from the Dutch government, and an additional EU Clean Aviation grant of undisclosed amount, Fokker is aiming at a 2035 entry into service of a clean-sheet aircraft design operating on liquid hydrogen. The plane's intended range is 2,500 km, meaning it could fly across Europe from London to Kyiv – without generating any CO_2 emissions.



https://thenextweb.com/news/future-dutch-aerospace-fokker-next-gen-hydrogen-plane

Hyphen and Namibia agree next phase of $10 bln green hydrogen project

Hyphen Hydrogen Energy has agreed a deal with the government of Namibia for the next phase of a $10 billion green hydrogen project that will export to Europe once complete, the two parties.

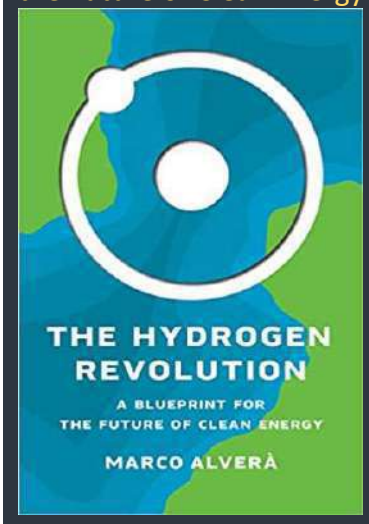
Hyphen, whose shareholders include Germany-headquartered Enertrag, was announced as the preferred bidder in 2021 for the project in the Namib Desert's Tsau //Khaeb National Park.

The feasibility and implementation agreement will be officially signed on Friday, officials said, as some community activists raised concerns over a perceived lack of transparency around the huge deal that costs as much as the country's gross domestic product.

https://www.reuters.com/business/energy/hyphen-namibia-agree-next-phase-10-bln-green-hydrogen-project-2023-05-24/

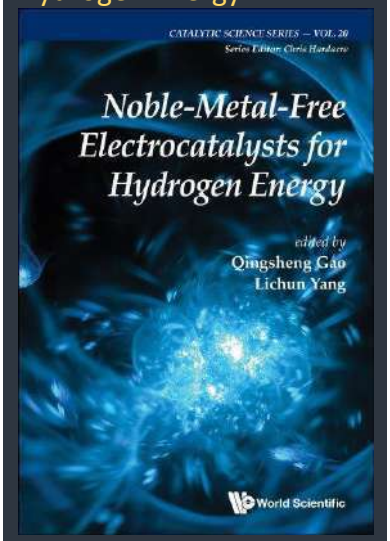
BOOKS:

Title: The Hydrogen Revolution: A Blueprint for the Future of Clean Energy



Author: Marco Alverà
Publisher: Basic Books, 2021
ISBN: 1541620429, 9781541620421

Title: Noble-Metal-Free Electrocatalysts for Hydrogen Energy



Edited By: Qingsheng Gao (Jinan University, China) and Lichun Yang (South China University of Technology, China)

Published: October 2022

https://doi.org/10.1142/q0342

German cabinet approves legal framework for hydrogen core network

The German cabinet passed a draft law to create a framework for a hydrogen core network scheduled to go into operation by 2032, as Berlin aims to move away from fossil fuels and become climate-neutral by 2045.

Germany is seeking to expand reliance on hydrogen as a future energy source both to make its economy greener and to reduce reliance on Russian gas imports, which dropped last year in the wake of Moscow's invasion of Ukraine.

https://legal.economictimes.indiatimes.com/news/international/german-cabinet-approves-legal-framework-for-hydrogen-core-network/100479688

ABB Joins Forces with Bair Energy to Develop Green Hydrogen Complex in Texas

ABB, has formed an alliance with Bair Energy as part of the Green Hydrogen and Technology Alliance. The collaboration aims to establish a major green hydrogen facility in Texas, known as the Clear Fork Texas facility, with the capacity to produce up to 132,000 kg of green hydrogen per day by 2028.

Bair Energy, recognizing ABB's expertise in automation, electrification, and digitalization, has chosen the company to provide turnkey solutions for optimizing low-cost green hydrogen production at the 1 GW facility. The first phase of the project will utilize renewable power to initially produce up to 33,000 kg of green hydrogen per day. As the facility progresses, the daily capacity will gradually increase to the target of 132,000 kg by 2028.



https://www.pollutionsolutions-online.com/news/air-clean-up/16/abb-ltd/abb-joins-forces-with-bair-energy-to-develop-green-hydrogen-complex-in-texas/60470

CSIRO trials Australia first portable, off-grid hydrogen generator

A new off-grid, portable hydrogen generator designed to produce the zero emissions fuel at the point of consumption is being demonstrated by researchers at CSIRO in what is being described as an Australian first.

The agency says a team of CSIRO scientists will build a demonstration unit based on patented technology to efficiently generate hydrogen from liquid carriers, supported by a $10 million investment over six years from Advanced Carbon Engineering.

As CSIRO explains it, the use of a liquid carrier allows hydrogen to be stored safely in tanks and transported from where it is produced – perhaps a solar or wind farm – to where the energy will be used.



https://reneweconomy.com.au/csiro-trials-australia-first-portable-off-grid-hydrogen-generator/

$117 million committed to Qld's largest renewable hydrogen project

Australia's biggest ever investment in green hydrogen has been announced today, with $117 million committed towards Queensland's largest renewable hydrogen project, located in Gladstone.

The cash injection will fund the Front End Engineering Design (FEED) for the Central Queensland Hydrogen (CQ-H2) project at Gladstone.

The part-publicly owned mega Central Queensland Hydrogen project is within the top 10 hydrogen projects in the world that are at a similar stage of development. The successful completion of the FEED will bring the project one step closer to a Final Investment Decision, planned for late 2024.

https://bigrigs.com.au/2023/05/26/117-million-committed-to-qlds-largest-renewable-hydrogen-project/

EVENTS:

GREEN HYDROGEN INDIA 2023

Date: Thu, 3 Aug 2023 - Sat, 5 Aug 2023
India Expo Centre and Mart
Venue: Greater Noida, India
Link:
https://www.tradeindia.com/tradeshows/121398/green-hydrogen-india-2023.html

International Conference on "Future of Energy with Science and Technology" 2023

FEST 2023
Future of Energy

Date: 18 - 19 Jul 2023
Venue: University of Delhi North Campus Conference Centre, New Delhi, India
Topic: Bioenergy, Waste Utilization, Green Hydrogen, Fuel cells, Photo-electrochemical water splitting / Photo-catalysts, Electrodes and Electrolytes for Hydrogen Production, Solar Energy, Wind Energy, Batteries, Energy storage, CO2 sequestration and utilization, Sustainability and Energy/ Alternative energy, Material selection, Role of IT and digitization, Nanomaterial applications, Energy Efficiency/Energy Conservation/Energy Audit, Blue Sky Ideas and Research for Sustainable Energy.
Link:
https://10times.com/e102-ksf3-hxk4

Indian Prime Minister Modi strikes new agreements on migration and green hydrogen in Australia

Indian Prime Minister Narendra Modi struck new agreements with his Australian counterpart Anthony Albanese on migration and green hydrogen, while raising concerns about attacks on Hindu temples in Sydney. The Indian diaspora accounts for only 3% of Australia's population but is the nation's fastest growing ethnic minority. Modi described the diaspora as the real strength in the growing bilateral relationship.

Modi is the only leader of the Quad nations to continue with his scheduled visit to Australia after U.S. President Joe Biden pulled out of a planned meeting of the group in Sydney to return to Washington to focus on debt limit talks. Japanese Prime Minister Fumio Kishida, who hosted a Group of Seven summit last week, later canceled his Australia trip as well. The prime ministers announced a new migration agreement that will promote two-way mobility of students, graduates, academic researchers and business people. They also agreed on the terms of reference on a bilateral Green Hydrogen Task Force that will promote cooperation on producing the gas without use of fossil fuels.

https://apnews.com/article/australia-india-modi-albanese-agreements-3b70959f01502aecb56897161d297237

India to be green hydrogen hub by 2040: Hardeep Singh Puri

India will become a major green hydrogen hub in all aspects – production, consumption and exports – by 2040, petroleum and natural gas minister Hardeep Singh Puri on Wednesday said at a CII event. "By 2040, India will be a major green hydrogen hub with demand, production, and consumption all in India, including major exporting of green ammonia and others. I am very bullish on these next 15 years," the oil minister said. Indian economy will grow beyond $20 trillion and the per capita income will grow by 10 times from now in the next 15 years.

While India has set 2070 as the deadline for its net zero commitment, several companies like Indian Oil (IOCL) and Bharat Petroleum (BPCL) have set their individual target as 2046 and 2040. As part of energy transition, ethanol blending that used to happen at 1.4% in 2014 achieved 10% target in November 2022, five months in advance.

Also, the deadline for 20% blending target has been pre-poned to 2025, ahead of earlier target of 2030.

https://www.financialexpress.com/economy/india-to-be-green-hydrogen-hub-by-2040-hardeep-singh-puri/3100858/

Punjab to come up with green hydrogen policy soon: Minister Aman Arora

To make Punjab a frontrunner in non-conventional energy production across the country, the state government will soon introduce a green hydrogen policy. Addressing the fifth National Energy Summit organised by Punjab Energy Development Authority (PEDA) in Chandigarh, Aman Arora emphasised that it was high time to shift from conventional power generation to renewable energy sources to save the earth. He said that around 3,200 MW capacity renewable energy projects, including 2000 MW capacity of solar plants, have been installed, about 21 per cent of the total installed capacity in Punjab. This share of renewable energy will be increased up to 30 per cent by 2030 to meet the targets of nationally determined contributions (NDC) and sustainable development goals (SDG).

https://indianexpress.com/article/cities/chandigarh/punjab-hydrogen-policy-aman-arora-8627922/lite/

How Gujarat is working to become India's green hydrogen hub



Aim to become a hub for green hydrogen by creating a production capacity of 8 metric tonnes per annum (MTPA) by 2035. The State Cabinet approved the allotment of 1.99 lakh hectares of land in the Kutch-Banaskantha border areas against the proposals, by the corporates that signed the MoUs, of setting up projects across 3.26 lakh hectares. The land parcels will be allotted on a 40-year lease initially. The government will provide a range of incentives to the industries investing in the State's green hydrogen projects, officials say. As per the land allotment policy, the companies must meet 50% of their green hydrogen production capacity within five years of commissioning their plants and 100% within eight years.

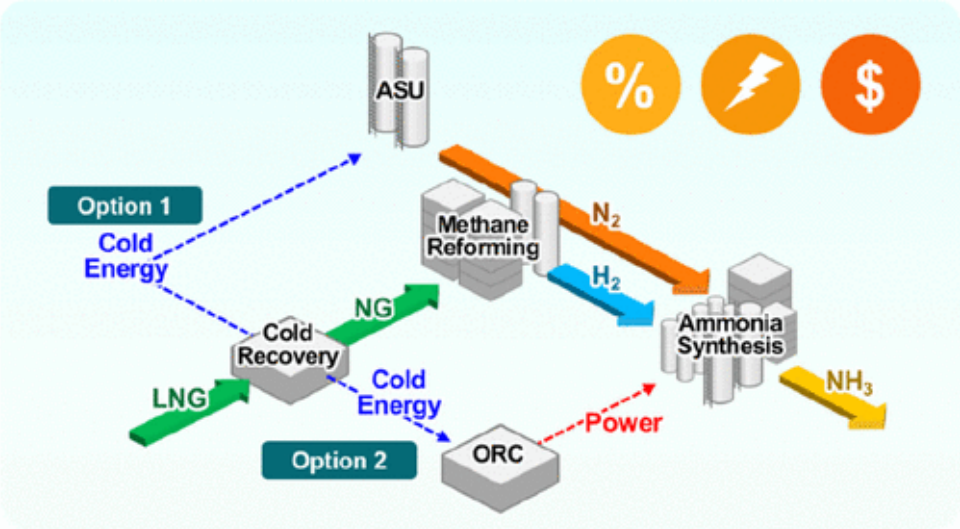
https://www.thehindu.com/news/cities/Delhi/how-gujarat-is-working-to-become-indias-green-hydrogen-hub/article66871279.ece

Kim, H. *et al.*

Advanced Design of Ammonia Production Processes from LNG: Efficient and Economical Cold Energy Utilization Methods

https://doi.org/ 10.1021/acs.iecr.3c00058

Abstract:
Efficient green energy technologies are essential for sustainable green hydrogen applications. However, economic reasons necessitate bridging technologies between fossil fuels and green hydrogen. Natural gas, the cleanest fossil fuel, can provide non-carbon containing energy resources, such as hydrogen and ammonia. Ammonia is suitable for economical hydrogen storage and transportation and for direct use as a fuel. In this study, efficient liquefied natural gas (LNG) cold energy utilization and recovery methods developed for producing ammonia are Design 1: energy production in an organic Rankine cycle and Design 2: energy reduction in an air separation unit (ASU). In Design 1, LNG cold energy is converted into power and supplied to the nitrogen compression stage for synthesizing ammonia. In Design 2, LNG cold energy is directly provided to the ASU to reduce the outlet temperature of nitrogen, which is sent to the compression stage, and the compression energy is consequently reduced. Through thermodynamic analysis, the process of LNG cold energy recovery is determined, and the energy consumption in each design is compared. Techno-economic analysis presents the cost reduction in the levelized cost of ammonia (LCOA). Compared with the base case, the energy consumption and LCOA in Design 2 are reduced by 11.54 and 23.02%, respectively.



Samanta, M. *et al.*

The Weyl Semimetals MIrTe4 (M = Nb, Ta) as Efficient Catalysts for Dye-Sensitized Hydrogen Evolution

https://doi.org/ 10.1002/aenm.202300503

Abstract:
The prevalent global energy crisis calls for searching viable pathways for generating green hydrogen as an alternative energy resource. Dye-sensitized photocatalytic water splitting is a feasible solution to produce green hydrogen. However, identifying suitable catalysts has been one of the bottlenecks in driving dye-sensitized photocatalysis efficiently. In this work, a new class of electrocatalysts is reported based on the layered Weyl semimetals MIrTe4 (M = Nb, Ta) for the Eosin Y (EY)-sensitized hydrogen evolution reaction (HER). NbIrTe4 and TaIrTe4 exhibit HER activities of approximate to 18 000 and 14 000 mu mol g (-1) respectively, after 10 h of irradiation with visible light. Time-dependent UV-Vis spectroscopy and high-pressure liquid chromatography coupled with mass spectrometry analysis shed light on the reaction dynamics and enable a deeper understanding of the observed trend in hydrogen evolution rates for MIrTe4. MIrTe4 semimetals outperform transition metal-based Weyl semimetals in terms of catalytic HER activity using EY as photosensitizer and triethanolamine as the sacrificial agent. It is hypothesized that the topology-related band inversion in MIrTe4 Weyl semimetals promotes a high density of M d-states near the Fermi level, driving their high catalytic performance. This study introduces a new class of layered Weyl semimetals as efficient catalysts, and provides perspectives for designing topology-enhanced catalysts.

Wu, DL. *et al.*

Fe-Regulated Amorphous-Crystal Ni (Fe) P-2 Nanosheets Coupled with Ru Powerfully Drive Seawater Splitting at Large Current Density

https://doi.org/10.1002/smll.202300030

Abstract:

Water electrolysis is an ideal method for industrial green hydrogen production. However, due to increasing scarcity of freshwater, it is inevitable to develop advanced catalysts for electrolyzing seawater especially at large current density. This work reports a unique Ru nanocrystal coupled amorphous-crystal Ni (Fe) P-2 nanosheet bifunctional catalyst (Ru-Ni (Fe) P-2/NF), caused by partial substitution of Fe to Ni atoms in Ni (Fe) P-2, and explores its electrocatalytic mechanism by density functional theory (DFT) calculations. Owing to high electrical conductivity of crystalline phases, unsaturated coordination of amorphous phases, and couple of Ru species, Ru-Ni (Fe) P-2/NF only requires over potentials of 375/295 and 520/361 mV to drive a large current density of 1 A cm (-2) for oxygen/hydrogen evolution reaction (OER/HER) in alkaline water/seawater, respectively, significantly outperforming commercial Pt/C/NF and RuO2/NF catalysts. In addition, it maintains stable performance at large current density of 1 A cm (-2) and 600 mA cm (-2) for 50 h in alkaline water and seawater, respectively. This work provides a new way for design of catalysts toward industrial-level seawater splitting.

Zhao, ZH. *et al.*

Defect Pyrochlore-Type Mott-Schottky Photocatalysts for Enhanced Ammonia Synthesis at Low Pressure

https://doi.org/ 10.1002/anie.202303629

Abstract:

The ambient ammonia synthesis coupled with distributed green hydrogen production technology can provide promising solutions for low-carbon NH3 production and H-2 storage. Herein, we reported Ru-loaded defective pyrochlore K2Ta2O6-x with remarkable visible-light absorption and a very low work function, enabling effective visible-light-driven ammonia synthesis from N-2 and H-2 at low pressure down to 0.2 atm. The photocatalytic rate was 2.8 times higher than that of the best previously reported photocatalyst and the photo-thermal rate at 425 K was similar to that of Ru-loaded black TiO2 at 633 K. Compared to perovskite-type KTaO3-x with the same composition, the pyrochlore exhibited a 3.7-fold increase in intrinsic activity due to a higher photoexcited charge separation efficiency and a higher conduction band position. The interfacial Schottky barrier and spontaneous electron transfer between K2Ta2O6-x and Ru further improve photoexcited charge separation and accumulate energetic electrons to facilitate N-2 activation.

Bi, SH. *et al.*

Multi-Stage Porous Nickel-Iron Oxide Electrode for High Current Alkaline Water Electrolysis

https://doi.org/10.1016/j.jmst.2022.10.044

Abstract:

Alkaline water electrolysis (AWE) is the promising technical pathway of large-scale green hydrogen production. The sluggish oxygen evolution reaction seriously hampers the water decomposition reaction kinetics for AWE, especially at high current density above 500 mA cm (-2). It is closely related with bubbles removal dynamic performance of porous electrodes. In this study, the multi-stage porous nickel-iron oxide electrode is prepared by a two-step electro-deposition method. The electrode shows good oxygen evolution reaction performance at high current density of 1000 mA cm(-2), which is attributed to both the good electro-catalytic performance of NiFeOx with nanocone structure and good bubbles removal performance of porous Ni interlayer with the curved pore channels. Bubbles motion inside the pore channels is deeply analyzed by Lattice Boltzmann simulation of gas-liquid two-phase flows, combining with the experiments. The results indicate that bubbles motion speed is faster in curved pore channels than that in straight pore channels due to the role of bubble buoyancy. It illuminates the effects of pore channel curvature on bubbles motion for porous electrodes prepared by electro-deposition. It provides the possibility of designing porous electrodes with both good electro-catalytic performance and good bubbles removal performance by the electro-deposition method, from the view of industrial applications.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 35
JUNE, 2023

Waste-Derived Catalysts for Water Electrolysis: Circular Economy-Driven Sustainable Green Hydrogen Energy

Highlights:

- Critical strategies for converting wastes to catalysts.
- Applications of waste-derived catalysts in hydrogen evolution reaction, oxygen evolution reaction, and overall water electrolysis.
- Perspectives in the development of waste-derived catalysts.

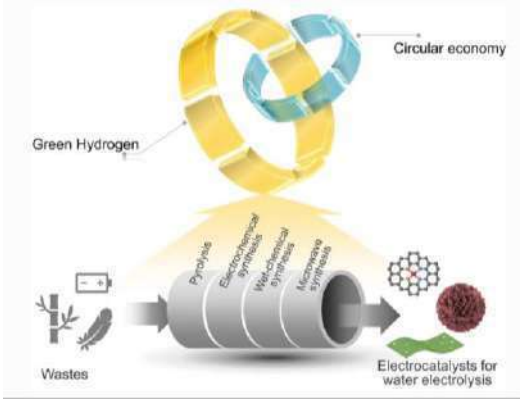


Figure: Circular economy-driven green hydrogen energy assisted by waste-derived electrocatalysts for water electrolysis

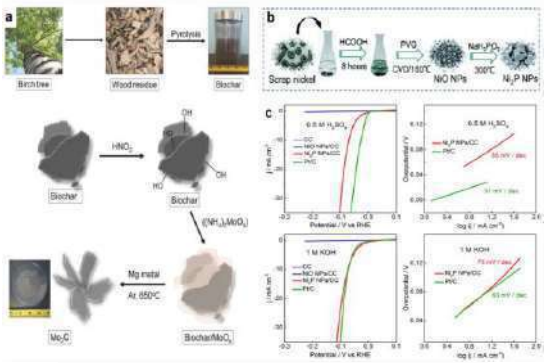


Figure: Preparation of the Mo_2C catalyst from birch tree

Strategies and its Applications:

- The sustainable production of green hydrogen via water electrolysis necessitates cost-effective electrocatalysts. By following the circular economy principle, the utilization of waste-derived catalysts significantly promotes the sustainable development of green hydrogen energy.
- Diverse waste-derived catalysts have exhibited excellent catalytic performance toward hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and overall water electrolysis (OWE).
- The general principles of water electrolysis and design principles of efficient electrocatalysts, for transforming wastes into electrocatalysts. Then, applications of waste-derived catalysts (i.e., carbon-based catalysts, transitional metal-based catalysts, and carbon-based heterostructure catalysts) in HER, OER, and OWE.

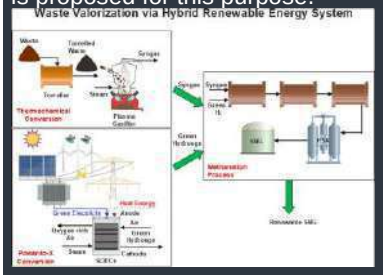
Results:

- An emphasis is put on correlating the catalysts' structure–performance relationship.
- Integrating advanced analytical, electrochemical, microscopic, spectroscopic, and computational techniques to investigate the composition-structure-catalytic performance relationship would guide the design of high-efficiency electrocatalysts.
- Useful insights into the design, synthesis, and applications of waste-derived electrocatalysts, and thus accelerate the development of the circular economy-driven green hydrogen energy scheme.
- Reutilization of ever-growing plastic wastes due to their high carbon content, large quantity, and hazardous effect on the ecosystem.
- Large-scale production of catalysts from wastes, facile and low-cost fabrication techniques are required with limited carbon emissions and low energy consumption.

Chen, Z., Yun, S., Wu, L. *et al.* Waste-Derived Catalysts for Water Electrolysis: Circular Economy-Driven Sustainable Green Hydrogen Energy. *Nano-Micro Lett.* **15**, 4 (2023). https://doi.org/10.1007/s40820-022-00974-7
https://link.springer.com/article/10.1007/s40820-022-00974-7

Efficient conversion of waste-to-SNG via hybrid renewable energy systems for circular economy: Process design, energy& environmental analysis

Developing an efficient and environment-friendly route for waste valorization is extremely significant in accelerating the transition toward a circular economy. A novel waste-to-synthetic natural gas (SNG) conversion process comprising hybrid renewable energy systems is proposed for this purpose.



Results:

- Implementation of a thermal pretreatment unit prior to the plasma gasification (two-step) is beneficial to improve the yield of hydrogen in the syngas, thereby leading to less renewable energy requirement for green hydrogen production used in the methanation process.
- This also enhances SNG yield by a factor of 30% as compared to the case without thermal pretreatment (one-step).
- The overall energy efficiency (OE) of the proposed waste-to-SNG plant is in the range of 61.36–77.73%, while the energy return on investment (EROI) ranges between 2.66 and 6.11.
- The OE of the system declines by 4.52% when 50 wt% of biomass is mixed in the fuel, whereas an enhancement of 18.33% in EROI and a reduction of 16.19% in specific CO_2 emissions are obtained.

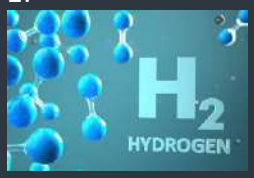
Link:
https://doi.org/10.1016/j.wasman.2023.04.041
https://www.sciencedirect.com/science/article/abs/pii/S0956053X2300332X

EVENTS:

Positioning Hydrogen 2023 Conference, Australia: An international green hydrogen event.

3rd Global Hydrogen Energy Meet
Date: November 27-29, 2023
Venue: Melbourne Convention and Exhibition Centre, Melbourne, Australia
Hydrogen technology event and exhibition in 2023.
Hydrogen is predicted to generate $700 billion in investment by 2030 in order to meet global requirements.
Energy Oceania 2023 will be held concurrently.

Day 1:



Day2:



Day3:



Link:
https://hydrogenconferenceaustralia.com/

INDUSTRY NEWS

Namibia, Hyphen sign $10bln green hydrogen project

Namibia's government and Hyphen Hydrogen Energy have signed a $10 billion agreement to develop a green hydrogen project in a bid to become a global green hydrogen production hub. The project targets production of 1 million tonnes a year of green ammonia by the end of 2027 and 2 million tonnes a year by the end of 2029.
In March, Hyphen Hydrogen Energy signed two memorandums of understanding (MOUs) with a major chemical company, name withheld, and South Korean hydrogen producer Approtium for a total annual offtake of up to 500,000 tonnes and 250,000 tonnes a year, respectively.
At full development, the project will produce 300,000 metric tonnes of green hydrogen annually from 5-6 gigawatts (GW) of renewables and 3GW electrolyser capacity.
Hyphen had previously stated that it is targeting the commencement of construction in January 2025, with commissioning of the first phase by the end of 2026.
https://www.zawya.com/en/projects/industry/namibia-hyphen-sign-10bln-green-hydrogen-project-qyn2eaax

Rockwell Automation Partners With Avid Solutions To Advance Green Hydrogen Industry

Experts predict green hydrogen (H2) will be increasingly used as a clean alternative to natural gas and to meet net zero emission commitments worldwide.
The H2 economy represents a significant change to industrial manufacturing, power generation, mobility, and societal challenges around climate change. Rockwell Automation (NYSE: ROK) recently announced a new collaboration with Avid Solutions, Inc., to help companies more efficiently and rapidly produce green hydrogen.
Rockwell technology has been key as Avid clients build and commission their first green hydrogen plants.
https://www.csrwire.com/press_releases/775671-rockwell-automation-partners-avid-solutions-advance-green-hydrogen-industry



Clifford Chance advises the Government of the Republic of Namibia on pioneering US$10bn agreement to develop sub-Saharan Africa's largest green hydrogen project

International law firm Clifford Chance has advised the Government of the Republic of Namibia (GRN) on the entry into an agreement with Hyphen Hydrogen Energy, a Namibian green hydrogen development company, to govern the development, implementation and operation of sub-Saharan Africa's largest, and its only fully vertically integrated, green hydrogen project.The total project capital investment of US$10 billion is roughly equivalent to the country's annual GDP. At full scale development, anticipated before the end of the decade, the project will produce 2 million tonnes of green ammonia annually for regional and global markets.
The pioneering Feasibility and Implementation Agreement (FIA) was signed on 26 May 2023 and governs the process under which Namibia's first green hydrogen project will be realised, as a first step in the implementation of Namibia's broader green hydrogen strategy.

https://legaldesire.com/clifford-chance-advises-the-government-of-the-republic-of-namibia-on-pioneering-us10bn-agreement-to-develop-sub-saharan-africas-largest-green-hydrogen-project/

Aker Horizons Awarded Up To NOK 135 Million In Financing From Innovation Norway For Rjukan Green Hydrogen Project

Aker Horizons ASA (OSE: AKH), a developer of green energy and industry, announced that Aker Horizons Asset Development, the company's wholly-owned asset development arm dedicated to hydrogen projects, has been awarded up to NOK 135 million in grants and loans from Innovation Norway for the green hydrogen production facility at Rjukan, in Eastern Norway. The Rjukan project will produce approximately 9 tonnes per day of green hydrogen from 20 MW electrolyser capacity. Aker Horizons plans to make a final investment decision for Rjukan by the end of 2023, with estimated commercial operation date in 2025.

https://hydrogen-central.com/aker-horizons-awarded-nok-135-million-in-financing-innovation-norway-rjukan-green-hydrogen-project/

EVENTS:

Beijing International Hydrogen Energy Technology and Equipment Exhibition

Host: Hydrogen Team
Event Start Date: 31-05-2023
Event End Date: 02-06-2023

Carbon Capture, Utilization and Storage Gordon Research Conference

Host: Hydrogen Team
Event Start Date: 28-05-2023
Event End Date: 02-06-2023

International Symposium on Solid Oxide Fuel Cells (SOFC-XVIII)

Host: Hydrogen Team
Event Start Date: 28-05-2023
Event End Date: 02-06-2023

Green Hydrogen Portal

AN INITIATIVE BY

PHD CHAMBER OF COMMERCE AND INDUSTRY

HARI DHARTI NEELA AKASH PHDCCI ENVIRONMENT COMMITTEE

Link:

https://www.greenhydrogen-india.com/

Oman's Hydrom inks three contracts for green hydrogen production

Hydrogen Oman SPC (Hydrom), an Energy Development Oman SAOC subsidiary, has signed three agreements to grant the first green hydrogen blocks with investments of over $20 billion, Oman News Agency reported. The agreements are forecast to yield a total production capacity of half a million tonnes of green hydrogen per annum from more than 12 gigawatts (GW)of installed renewable energy capacity at the three sites, each covering an area of 320 square kilometres in the Al Wusta governorate. The consortium will generate around 200 KTPA [Kilo Tonnes Per Annum] of green hydrogen from 4.5 GW of installed renewable energy capacity for planned green steel plants located in the Port of Duqm in the Special Economic Zone at Duqm (SEZAD). The second project was signed with BP Oman for the development of green hydrogen for ammonia production and export. The anticipated annual production is 150 KTPA of green hydrogen from 3.5 GW of installed renewables capacity in Block Z1-03. The third project was signed with the consortium of Green Energy Oman (GEO) for the development of green hydrogen and its derivatives. The consortium includes Oman's integrated Energy Company OQ, Oman Shell, Kuwait's energy investor EnerTech, InterContinental Energy and Golden Wellspring Wealth for Trading. The project is likely to produce up to 150 KTPA of green hydrogen from 4 GW of installed renewables capacity in Block Z1-04.

https://www.zawya.com/en/projects/industry/omans-hydrom-inks-three-contracts-for-green-hydrogen-production-evfg76qn

Ibereólica to supply renewable energy for Cepsa's green hydrogen projects

Spanish renewable energy company Grupo Ibereólica Renovables has signed an agreement to supply clean energy to Cepsa for its green hydrogen generation plants in the country. Ibereólica will supply the energy from a portfolio of up to 5GW in clean energy projects, including nine wind, four photovoltaic solar, and two hybrid wind - photovoltaic projects.

These renewable energy projects are planned to be developed in Castilla y León and Extremadura. They are currently at an advanced stage of planning and are expected to be ready for operation in 2026.

For Cepsa, the long-term energy supply agreement provides a way to sustainably power its industrial centres, particularly its green hydrogen generation projects at its energy parks in Andalusia.

https://www.power-technology.com/news/ibereolica-energy-cepsa-green-hydrogen/

Galp eyes final decision on green hydrogen plant this year



Portugal's oil company Galp (GALP.LS) hopes to take the final investment decision on its first 100-megawatt (MW) green hydrogen unit by year-end, but still needs to clarify some regulatory and tax issues. Such hydrogen is now more expensive to produce than the heavily polluting conventional method of using heat and chemical reactions to release it from coal or natural gas.

Galp wants to accelerate its decarbonisation processes and plans to allocate around 50% of its capital expenditure to low-carbon activities through 2025.

https://www.reuters.com/business/energy/galp-eyes-final-decision-green-hydrogen-plant-this-year-2023-05-31/

How E.ON Is Building Commercial-Scale Green Hydrogen Projects for a New Energy World – Forbes

E.ON has partnered with LindeLIN -0.4%, the world's largest industrial gas company, and Salzgitter, the German steel giant, to help produce steel without emitting CO2. By replacing coal with hydrogen, Salzgitter aims to deliver green steel as of 2025. E.ON recently implemented SAP S/4HANA as its new platform to promote innovation, enable new business models, and provide management with trustworthy figures to make quick decisions.

https://hydrogen-central.com/how-e-on-building-commercial-scale-green-hydrogen-projects-new-energy-world-forbes/

EVENTS:

GH2 India 2023

Second Edition
Date: 3rd -5th August 2023
Venue: Greater Noida

WHY GH2 INDIA 2023?

The 2nd GREEN HYDROGEN INDIA will be held on 3-4-5 August in Greater Noida as the biggest convergence of the best minds connected to the sector. Over the 3 days the event will run dedicated tracks on Investments for Financing Green Hydrogen, Technology Session to help identify the best mix for your business and an overarching session covering subjects like Policy, Commercial Strategy. In short the three days will empower you to define and define your Green Hydrogen strategies in a more informed way.

GH2 India 2023 will be the best opportunity in 2023 to engage directly with potential hydrogen buyers, infrastructure, energy and tech companies designing the supply chain. It will bring together key stakeholders and help fast track the growth in the hydrogen industry.

Exhibition & Conference

Link:

http://gh2summit.com/

Govt waives ISTS charges on offshore wind, green hydrogen, ammonia projects



Ministry of Power announced a complete waiver of the inter-state transmission system (ISTS) charges on the off-shore wind, green hydrogen, and green ammonia projects for 25 years. The waiver is applicable to off-shore projects commissioned on or before December 31, 2032, for a period of 25 years. However, the projects commissioned from 1st January 2033 would be given graded ISTS charges. The government also granted a complete waiver of ISTS charges for green hydrogen/green ammonia production units, which uses renewable energy (commissioned after March 8, 2019), pumped storage system or battery storage systems, or any hybrid combination of these technologies. "The projects commissioned till December 31, 2030, will be eligible for the waiver. Projects after December 31, 2030, will attract graded transmission charges thereafter," said the Ministry of Power.

https://www.business-standard.com/economy/news/govt-waives-ists-charges-on-offshore-wind-green-hydrogen-ammonia-projects-123052900964_1.html

Gujarat to Introduce Draft New Green Hydrogen Policy within Two Months

Gujarat Urja Vikas Nigam Ltd (GUVNL), the state's leading power utility, has been actively engaged in formulating the draft policy. The draft policy is anticipated to be prepared within the next two months, ensuing consultations with stakeholders and compliance with the guidelines of the Ministry of Environment, Forest, and Climate Change. To incentivize green hydrogen investments, the Gujarat government has declared a land allocation policy that avails several advantages to companies investing in the state's green hydrogen projects. According to the policy, companies must fulfill 50% of their green hydrogen manufacturing capacity within five years of the plant commencing and attain 100% capacity within eight years. The Land Policy-2023 of Gujarat targets to attain a production target of three million tonnes. annually, deriving an increased requirement of 165 billion units of renewable energy.

https://www.livemint.com/news/india/gujarat-government-to-formulate-comprehensive-policy-for-green-hydrogen-manufacturing-aiming-to-reduce-carbon-emissions-by-45-by-2030-11685099175250.html

India's L&T achieves major milestones at NEOM green hydrogen project

India-headquartered construction and engineering multinational Larsen & Toubro (L&T) said that its power transmission and distribution business has achieved major milestones for the power elements and grid packages of the world's largest green hydrogen project in NEOM, Saudi Arabia.

NEOM Green Hydrogen Company (NGHC) is setting up a mega plant to produce green hydrogen at scale for global export in the form of green ammonia with a total investment of $8.4 billion. Supported by 23 local, regional, and international banking and financial institutions, the project has now achieved full financial close and construction is moving forward.

Under the contracts, L&T will engineer, procure, and construct a 2.2 GWac PV solar plant, 1.65 GW wind generation balance of plant and a 400 MWh battery energy storage system under the power elements package. It will also construct three 380 kV switching stations, 306 KM of 380 kV overhead lines and UG cables required for the Kingdom's grid network.

https://www.zawya.com/en/projects/utilities/indias-l-and-t-achieves-major-milestones-at-neom-green-hydrogen-project-ctkey3l1

India proposes talks on international norms for 'green, clean & low-carbon' hydrogen

The draft 'G20 High-Level Principles on Hydrogen', put out by India for discussion, lays down the carbon emissions standard 'at the sight of production'. This means that emissions incidental to distribution to the end users and life-cycle greenhouse emissions are not included in the proposed standard. India has proposed a discussion on global standards for 'green, clean, and low carbon' hydrogen at the G20 Energy Transition Working Group meeting held last week, mooting an emission limit of up to 2 kg of carbon dioxide equivalent per kg of hydrogen produced.

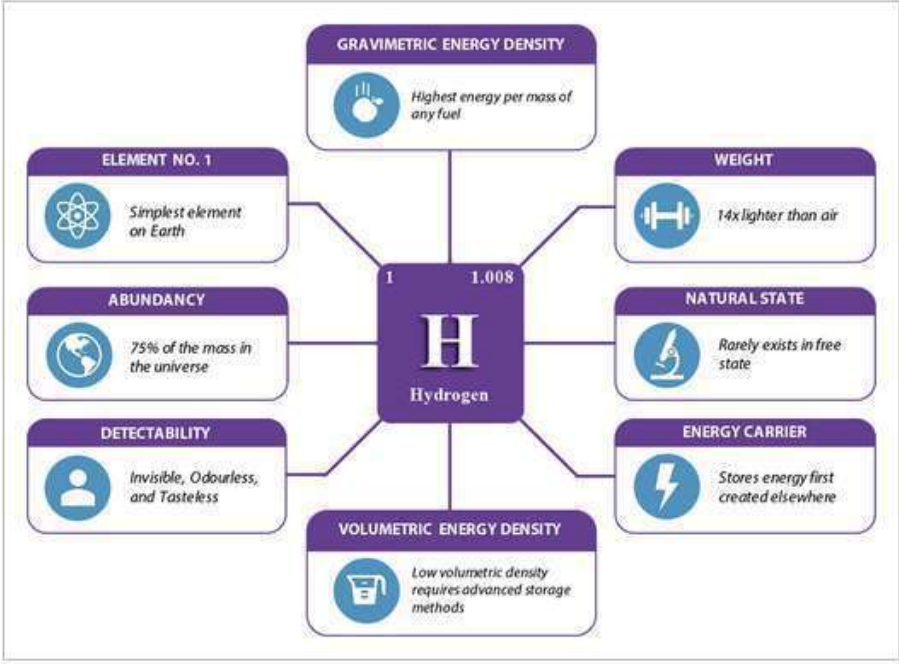
https://economictimes.indiatimes.com/industry/renewables/india-proposes-talks-on-international-norms-for-green-clean-low-carbon-hydrogen/articleshow/100456035.cms

Marszal, EM. and Smith, B.

Hydrogen hazards and gas detection-Electrolyzer case study

https://doi.org/10.1002/prs.12461

Abstract:
Hydrogen is a strong candidate for fueling the green energy transition. Hydrogen, like all stores of potential energy, can be dangerous if not handled properly. The most common, and rapidly growing, source of green hydrogen is electrolysis of water. Electrolyzers split the water molecule into hydrogen and oxygen molecules. Hydrogen is flammable while oxygen is an oxidizer. If hydrogen escapes, a hazardous condition can be generated, which may have significant safety consequences. As a result, a commonly employed safeguard is a gas detection system with automatic shutdowns. This paper presents an overview of the hazards of hydrogen generation through electrolysis, and then presents a case study of the design of a gas detection system for an electrolyzer facility. The design of the gas detection system included using gas detection mapping approaches recommended by ISA TR 84.00.07 for placement of the required detectors along with recommendations by IEC 61511 for the design of the associated automatic shutdown of the electrolyzer and return to a safe state.



Giehl, J. *et al.*

Assessment of using hydrogen in gas distribution grids

https://doi.org/ 10.1016/j.ijhydene.2023.01.060

Abstract:
Substantial changes in the energy system are necessary to achieve greenhouse gas neutrality. Green hydrogen is a key to defossilisation. Politicians frequently mention the use of hydrogen in the building sector to supply decentrally produced heat as a potential field of application. An advantage repeatedly mentioned is that the existing gas distribu-tion network infrastructure is an important asset that could still be used in the future. However, there is a lack of analyses of the conversion of gas distribution networks to hydrogen focussing on the economic implications on the costs of the distribution network infrastructure. The paper provides insights using a techno-economic model network analysis (MNA) tool called gas Distribution grId modelliNg tOol (DINO). The analysis is carried out for Germany and considers hydrogen use in all counties. The results are compared to a synthetic methane and electrification scenario. In the hydrogen scenario, the total need for distribution grids is decreasing until 2050 by at least 130,000 km. The network length of the synthetic methane scenario is slightly lower and that of the elec-trification scenario drops to zero. The annual operation costs are lower in all scenarios as gas demand and infrastructure are reduced. Nevertheless, the total annual cost in the hydrogen scenario is potentially two times higher than in the case of the synthetic methane scenario and more than four times higher than in the electrification scenario. Based on the present results, it is questionable whether an advantage of the continued use of the existing gas distribution grid infrastructure in case of synthetic gas or hydrogen scenarios exists.

Kaur, A. *et al.*

Repurposing the current collector of a car battery module into a bifunctional electrode for overall electrochemical water splitting

https://doi.org/10.1039/d3se00232b

Abstract:
Renewable power-driven electrochemical water splitting is rapidly emerging as a viable approach for producing large scale green hydrogen which is free from greenhouse gas emissions. However, there is a continuous need to develop electrocatalysts that are abundant and can be generated with minimal impact on the environment. Here, we explore the possibility of repurposing the anode current collector from a Toyota Prius battery module as a bifunctional electrocatalyst that can be used for overall electrochemical water splitting under alkaline conditions. The Ni coated iron electrode was found to have ideal properties for both the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) while also demonstrating bifunctional behaviour for both reactions upon repetitive cycling. The repurposed material also outperformed a Ni electrode of comparable surface area for both the OER and HER and demonstrated activity that is comparable to chemically synthesised Fe/Ni materials. The key aspect for enabling this behaviour was found to be the emergence of iron into the nickel coating to create a stable mixed FeNi oxide layer upon potential cycling of the electrode. This also resulted in a bifunctional electrode material that could operate between HER and OER without a loss of activity. This work indicates that not only should the active materials used in rechargeable batteries be used for recycling but that the current collectors should also be considered as potentially highly valuable components.

Li, HC. *et al.*

Preparation of carbon coated hyperdispersed Ru nanoparticles supported on TiO2 HER electrocatalysts by dye-sensitization

https://doi.org/ 10.1039/d3nj01546g

Abstract:
Hydrogen production by water-splitting is a very promising strategic energy technology and one of the most important means to obtain green hydrogen. It is of great practical significance to develop cheap and efficient electrocatalysts to replace Pt. Herein, we use the dye-sensitization strategy to load hyperdispersed Ru nanoparticles on the TiO2 surface, and then use cheap glucose for carbon coating to improve the conductivity of the material, so as to obtain an efficient HER catalyst C/Ru/TiO2. On the one hand, dye molecules can be firmly bonded to the surface of TiO2 through carboxyl groups, and on the other hand, their large steric effect can effectively inhibit the aggregation of molecules, so ruthenium nanoparticles formed after pyrolysis can be uniformly distributed on the surface of TiO2. Carbon coating also effectively solves the problem of poor conductivity of TiO2 as a support. C/Ru/TiO2 shows excellent catalytic performance for HER. In 0.5 M H2SO4, the overpotential is 69 mV at 10 mA cm(-2) and the Tafel slope is only 70 mV dec(-1). In 1 M KOH, the overpotential is only 51 mV at 10 mA cm(-2) and the Tafel slope is only 68 mV dec(-1). The dye-sensitization strategy makes it easy to realize the loading of hyperdisperse metal nanoparticles on the support surface.

Abdelgawad, A. *et al.*

Template-free synthesis of M/g-C3N4 (M = Cu, Mn, and Fe) porous one-dimensional nanostructures for green hydrogen production

https://doi.org/ 10.1016/j.jelechem.2023.117426

Abstract:
Herein, we synthesized porous one-dimensional graphitic carbon nitride (g-C3N4) doped atomically with metal atoms (M/g-C3N4) (M = Cu, Mn, and Fe) for the electrochemical and photo-electrochemical hydrogen evolution reaction (HER). This is driven by the direct acidification of an aqueous solution of metal precursors and melamine followed by pyrolysis at 550 degrees C under N2. The as-obtained M/g-C3N4 had well-defined pore sizes (5-10 nm), nanofibers (90 +/- 5 nm in width and 5 +/- 1 mu m in length) morphology, high surface area, and M atomic contents (1.7 +/- 0.2 wt.%). The HER performance is in the order of Cu/g-C3N4 > Fe/gC3N4 > Mn/g-C3N4 in terms of the overpotential, onset potential, H2 production rate, and mass/specific activity. Notably, Cu/g-C3N4 achieved turnover frequency (TOF) close to that of commercial 10 wt.% Pt/C, but higher mass/specific activity and great H2 production rate of (222.15 mu mol center dot g-1 center dot h-1). This work open the doorway for the utilization of g-C3N4 doped metal-atoms at low content in electrocatalytic and photocatalytic HER.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 36
JUNE, 2023

Chinese scientists produce desalination-free hydrogen from seawater

Chinese scientists have successfully developed a process of turning seawater into oxygen and hydrogen with the need for desalination, The South China Morning Post (SCMP) reports. If true, the process could provide an exciting avenue for producing large amounts of hydrogen for energy production at pennies on the dollar. Moreover, the entire process is powered by renewable sources like wind and solar. Moreover, the entire process is figuratively "swimming" in raw materials as it is situated on an offshore platform.

Working with seawater to make hydrogen can be challenging due to its complex composition of microorganisms and suspended particles. This can result in low electrolysis efficiency and equipment lifespan. The Chinese team, however, utilized an innovative new hydrogen production technology process that forms the platform's beating heart. The nuts and bolts were previously published in the peer-reviewed journal Nature in November 2022.

The team behind the discovery includes Xie Heping from Shenzhen University and the state-owned Dongfang Electric Corporation. The newly developed hydrogen production offshore platform, known as "Dongfu Number One," is located in the southeastern waters of China, off the coast of Fujian province. This platform is designed to endure high waves and gusts of up to a force of eight on the Beaufort scale.



“It completed a 10-day continuous operation during its inaugural run in May, marking a promising start to the prospect of offshore hydrogen production powered by renewable energy,” reported the Chinese state news agency Xinhua earlier in June.

A floating production facility measures 678 feet2 (63 m2). It has been developed to incorporate an innovative design combining a hydrogen production system with a stable offshore wind power supply system, resulting in an eco-friendly farm electrolyzing seawater into hydrogen without any adverse side effects or pollution.

“This demonstration experiment validated the device’s anti-interference capacity and produced valuable data. The project is an exemplary case of transitioning from academic achievement to industrialization,” the report said.

https://interestingengineering.com/science/hydrogen-from-seawater-without-desalination

Heping Xie, Zhiyu Zhao, Tao Liu, et al.

A membrane-based seawater electrolyser for hydrogen generation

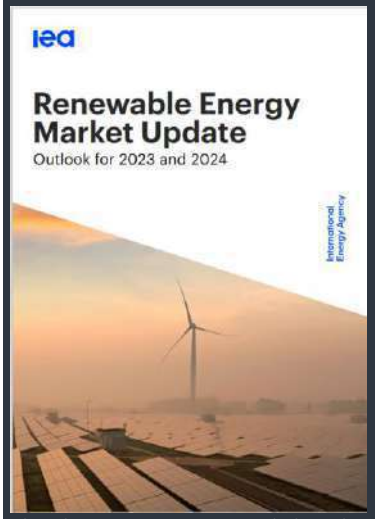
Abstract:- Electrochemical saline water electrolysis using renewable energy as input is a highly desirable and sustainable method for the mass production of green hydrogen1,2,3,4,5,6,7; however, its practical viability is seriously challenged by insufficient durability because of the electrode side reactions and corrosion issues arising from the complex components of seawater. Although catalyst engineering using polyanion coatings to suppress corrosion by chloride ions or creating highly selective electrocatalysts has been extensively exploited with modest success, it is still far from satisfactory for practical applications8,9,10,11,12,13,14.

Indirect seawater splitting by using a pre-desalination process can avoid side-reaction and corrosion problems15,16,17,18,19,20,21, but it requires additional energy input, making it economically less attractive. In addition, the independent bulky desalination system makes seawater electrolysis systems less flexible in terms of size. Here we propose a direct seawater electrolysis method for hydrogen production that radically addresses the side-reaction and corrosion problems. A demonstration system was stably operated at a current density of 250 milliamperes per square centimetre for over 3,200 hours under practical application conditions without failure. This strategy realizes efficient, size-flexible and scalable direct seawater electrolysis in a way similar to freshwater splitting without a notable increase in operation cost, and has high potential for practical application. Importantly, this configuration and mechanism promises further applications in simultaneous water-based effluent treatment and resource recovery and hydrogen generation in one step.

Link:
https://doi.org/10.1038/s41586-022-05379-5

REPORT:

Renewable Energy Market Update
Outlook for 2023 and 2024



The key areas examined by the report include the latest data and analysis on renewable power capacity additions in 2022 – globally and for major markets – as well as forecasts for 2023 and 2024.

The update will look at key topics for renewables this year and next, including how the energy crisis will affect their deployment in the EU, their impact on energy affordability, and the latest trends in the United States, China and India. It will also explore the implications of developments affecting major technologies like solar, wind and biofuels – including market dynamics, financing, energy security priorities, manufacturing and power system integration.

The report provides the IEA's latest assessment of the state of play in renewables markets since the publication of our Renewables 2022 report in December.

In exploring the most recent market and policy developments as of April 2022, our

Renewable Energy Market Update forecasts new global renewable power capacity additions and biofuel demand for 2023 and 2024. It also discusses key uncertainties and policy-related implications that may affect projections for 2024 and beyond.

Link:
https://iea.blob.core.windows.net/assets/67ff3040-dc78-4255-a3d4-b1e5b2be41c8/RenewableEnergyMarketUpdate_June2023.pdf

INDUSTRY NEWS

Japan to invest $107 billion in hydrogen supply over 15 years

Japan plans to invest 15 trillion yen ($107.5 billion) over the next 15 years to supply the country with hydrogen, the government said, as it accelerates efforts to use the gas to shift to a low carbon economy.

Around the world, countries are competing to develop hydrogen as a means of reducing emissions in some of the most difficult industries to decarbonise, such as steel production and chemical manufacture, and because of its potential usefulness in cleaning up the energy sector. Japan, which first published its Basic Hydrogen Strategy in 2017, announced a revised target to boost hydrogen supply to 12 million tonnes a year by 2040. The initial plan called for hydrogen supply in Japan to reach 3 million tonnes annually by 2030 from 2 million tonnes now. By 2050, Japan aims for around 20 million tonnes when it expects the global hydrogen market to generate $2.5 trillion in annual revenue.



https://www.reuters.com/business/energy/japan-invest-107-bln-hydrogen-supply-over-15-years-2023-06-06/

Fluxys builds new natural gas and hydrogen pipeline

Infrastructure partner Fluxys Belgium has started, in the presence of Prime Minister Alexander De Croo and Federal Minister of Energy Tinne Van der Straeten, the construction of the first dual-purpose pipeline. Initially this pipeline between Zeebrugge and Brussels will greatly increase the capacity for the security of supply of Belgium and neighbouring countries. In addition, this pipeline is ready for use to transport hydrogen. Prime Minister, Alexander De Croo and Energy Minister, Tinne Van der Straeten visited the site in Lokeren (East Flanders) 6 June, where pipes with a diameter of 1 m are pushed under the road surface.

https://www.worldpipelines.com/project-news/08062023/fluxys-builds-new-natural-gas-and-hydrogen-pipeline/

Set for take-off: Griffith joins emission-free aviation Alliance

Griffith University has joined key players in the Australian aviation and green hydrogen industries with the launch of the Hydrogen Flight Alliance (HFA) at Brisbane Airport.

The aim of the Alliance is to ensure Australia plays a leading role in the aviation industry's transition towards net-zero by 2050, and its first mission is to enable Australia's first commercial emission-free, hydrogen-powered flight between Brisbane and Gladstone in 2026. Griffith climate and aviation experts will play key roles in the lead up to this exciting outcome. Dr Emma Whittlesea, Associate Executive Director of The Climate Ready Initiative at Griffith University said: "Griffith University, through its multidisciplinary Climate Ready Initiative, Griffith Aviation, and Centre for Applied Energy Economics and Policy Research brings teaching, research and policy capability and expertise to the alliance, and are particularly interested in progressing the action learning and applied research opportunity in collaboration with project partners and other stakeholders."

https://news.griffith.edu.au/2023/06/09/lift-off-griffith-joins-alliance-for-emission-free-aviation/

Masdar Expects To Produce Over 1Mln Tons Of Hydrogen By 2030

Masdar is going to produce over 1 million tons of green hydrogen by 2030, Al Ramahi Mohamed Jameel, CEO of Masdar, said during the panel session within the Astana International Forum (AIF 2023), trend reports from the scene.

"We need to increase the penetration of clean energy, and also look into different areas. That's why Masdar is not looking only into development of solar, wind, or hydro generation. Looking into future, we believe that green hydrogen will play critical role globally," he said.

The CEO noted that the development of green hydrogen in order to decarbonize essential fields, such as mining and transportation, will significantly contribute to Central Asia's energy transition.

AIF 2023 is held on June 8-9 in Kazakhstan's Astana. With President Kassym-Jomart Tokayev's esteemed patronage, a high-level event is set to take place, revolving around the central theme of "Tackling challenges through dialogue: towards cooperation, development & progress".

https://menafn.com/1106411388/Masdar-Expects-To-Produce-Over-1Mln-Tons-Of-Hydrogen-By-2030-CEO

EVENTS:

4th International Hydrogen Aviation Conference, IHAC2023

7th September 2023, Edinburgh, Scotland.



Date: September 7

Event Category: Conference

Website:

https://www.hy-hybrid.com/ihac-2023

ORGANIZER
Hy-Hybrid Energy

Phone:
00447424312756

Email:
info@hy-hybrid.com

VENUE
Edinburgh International Conference Centre
150 Morrison St
Edinburgh, EH3 8EE United Kingdom

Asian buyers interested in hydrogen from McLeod Lake Indian Band's proposed $5 billion plant

Hydrogen was in the news last week when the B.C. government announced an agreement with the Japanese Organization for Metals and Energy Security, which paves the way for province to export new sources of low-carbon energy. That announcement came three days after the McLeod Lake Indian Band and Mitsubishi Power announced they were working together to develop a $5 billion hydrogen plant on the Kerry Lake East reserve, 80 kilometres north of Prince George. The plant would produce sustainable clean energy and export it to buyers in overseas markets trying to meet net-zero emissions targets.



https://www.princegeorgecitizen.com/local-news/asian-buyers-interested-in-hydrogen-from-mcleod-lake-indian-bands-proposed-5-billion-plant-7112417

CICERO study: Industry responds to hydrogen emissions claim

Following the findings of a study by Norwegian climate research institute CICERO that estimated the global warming effect of leaked hydrogen is almost 12 times that of carbon dioxide (CO_2) per kg emitted. The study, published in Nature Communications Earth & Environment on June 7, has said that although hydrogen itself is not a greenhouse gas (GHG), its chemical reaction in the atmosphere affects GHGs like methane, ozone and stratospheric water vapour. Despite exhausting only water vapour and oxygen, the CICERO study suggest the leaking of hydrogen from production, transport and usage is what adds to global warming.

https://www.h2-view.com/story/cicero-study-industry-responds-to-hydrogen-emissions-claim/

Malaysia can lead green hydrogen industry with China's help, says Mosti minister

Malaysia and China should work together to develop green hydrogen as a clean energy source for transportation, electricity and other uses, said science, technology and innovation minister Chang Lih Kang. "Given the declining costs of solar and wind power generation, there's a tangible opportunity for the commercial scale-up of green hydrogen production and the development of its associated supply chain," he suggested.

Malaysia is blessed with abundant renewable energy resources, and is well positioned to harness its potential as a leading producer of green hydrogen, he said.

"We are striving to position Malaysia as a leading hydrogen economy by 2050," Chang announced. In order to unlock the hydrogen economy, he added, it is vital to attract more Chinese investments which will make clean energy technologies more affordable and accessible to all. "Hence we warmly welcome Chinese green foreign direct investment to invest in Malaysia," he added.

https://www.freemalaysiatoday.com/category/business/2023/06/08/malaysia-can-lead-green-hydrogen-industry-with-chinas-help-says-mosti-minister/

Middle Arm Sustainable Development Precinct includes hydrogen sourced from natural gas, documents show

Documents prepared by the Northern Territory government show so-called blue hydrogen requiring natural gas will play a significant role at the Middle Arm Sustainable Development Precinct on Darwin Harbour. The undated plans for Middle Arm were obtained by the NT Environment Centre through Freedom of Information laws, and shared with the ABC.

The documents include three scenarios for developing the precinct on Darwin Harbour, two of which set aside land for the production of green and blue hydrogen. All three include the deployment of carbon capture and storage. The NT government secured $1 million in federal funding for a feasibility study for the industrial precinct

https://www.abc.net.au/news/2023-06-07/nt-middle-arm-documents-show-hydrogen-sourced-from-natural-gas/102450284

EVENTS:

World Hydrogen Week 2023



Start:
October 9 @ 8:30 am UTC+0
End:
October 13 @ 6:00 pm UTC+0
Event Categories:
Conference, Exhibition

Website:
https://www.worldhydrogenweek.com/?utm_source=Partners&utm_medium=Listing&utm_campaign=HydrogenCentral

ORGANIZER
World Hydrogen Leaders

Phone:
020 7099 0600

Email:
jamie.bentley@greenpowerglobal.com

VENUE
World Trade Center, Rotterdam
Rotterdam, Netherlands

India Requires 56 Billion to Meet 2030 Green Hydrogen Demand



According to a recent assessment by the United States Agency for International Development (USAID), India's strategic advantages, including as its wealth of renewable energy resources, established consumer markets, and favourable investment prospects, place it in a position to become a major worldwide centre of green hydrogen.

Indian manufacturers can attain some of the lowest levelized costs for green hydrogen and green ammonia globally, estimated at $ 3,800-4,800 per tonne and $850-1,100 per tonne, respectively, by leveraging resources and constructing suitable sites as green hydrogen hubs.

Government incentives, subsidies, and mandates for its usage are anticipated to promote demand for green hydrogen even though the price gap between grey and green hydrogen is still a problem.

The National Hydrogen Mission, which was approved at the beginning of the year, serves as an example of the government's proactive attitude and furthers the sector's expansion.

https://www.constructionworld.in/energy-infrastructure/power-and-renewable-energy/india-requires-56-billion-to-meet-2030-green-hydrogen-demand/41532

Himachal signs MoU with Oil India Ltd for Green Hydrogen: CM Sukhu

Himachal Pradesh Chief Minister Thakur Sukhvinder Singh Sukhu said that the state has signed an agreement with Oil India Limited for promoting the production of green hydrogen. CM Sukhu presided over 'Enviro-Ideation Hackathon' organised by the Himachal Pradesh State Pollution Control Board (HPSPCB) at Indian Council of Agricultural Research (ICAR)-Central Potato Research Institute (CPRI), Shimla.

The state government is promoting the production of green hydrogen and has signed an agreement with Oil India Limited in this regard.

Himachal signs MoU with Oil India Ltd for Green Hydrogen: CM Sukhu – ThePrint –

IH2A submits $5-bn plan for national green hydrogen hub to govt

India Hydrogen Alliance (IH2A), a Delhi-based industry body, said it has submitted a national green hydrogen hub economic viability and development plan to the Prime Minister's Office, Cabinet Secretariat, and the Ministry of New and Renewable Energy in the Government of India. It said that the Plan has a potential to create five large national green hydrogen corporations worth $5 billion by 2030, through public-private partnerships. "The Plan seeks public finance support for green hydrogen production and offtake to create the necessary infrastructure in the initial 2024-2030 period, and publicly list the national hydrogen corporations created as a result to fund the next wave of investments to scale up the hydrogen economy," said the official press release. This is a pathway for India to accelerate green hydrogen hub development and create national infrastructure assets in a financially viable manner, said Jill Evanko, chief executive and president, Chart Industries, and founding member, IH2A.

https://energy.economictimes.indiatimes.com/news/renewable/ih2a-submits-5-bn-plan-for-national-green-hydrogen-hub-to-govt/100826619

Australia India Trade Association and UPNEDA Sign MOU for Hydrogen Centre of Excellence and Renewable Energy Collaboration

AITA's Hydrogen Centre of Excellence will serve as a hub for research, development, and training in hydrogen-related technologies.

In a significant move to foster collaboration in the field of renewable energy and hydrogen technology, the Australia India Trade Association (AITA) and the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) have signed a Memorandum of Understanding (MOU). The agreement aims to establish a Hydrogen Centre of Excellence and facilitate joint efforts in attracting renewable energy companies to Australia.

The MOU signing ceremony took place on 29th May 2023 at a UPNEDA office, Lucknow. The agreement signifies a strong commitment from Australia and India to drive innovation and sustainability in the energy sector.

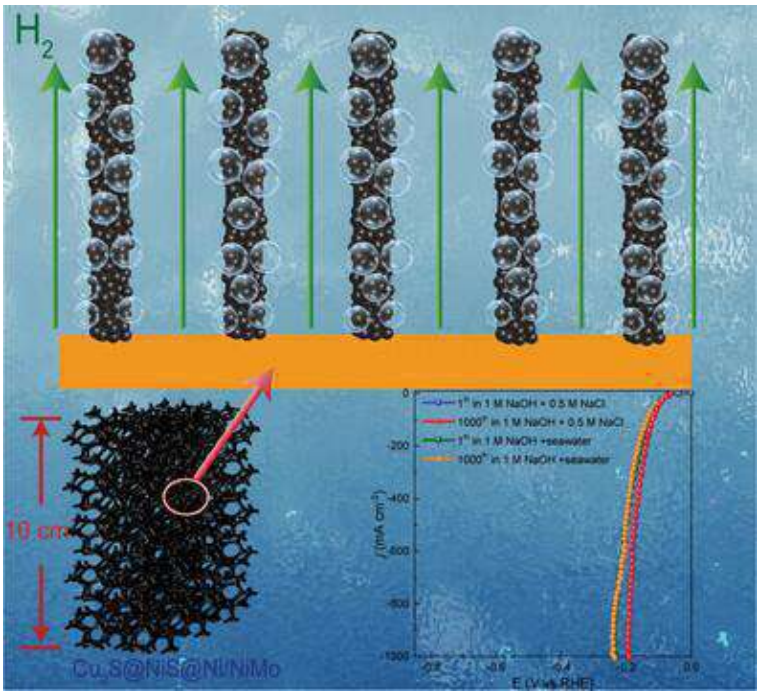
https://www.mid-day.com/brand-media/article/australia-india-trade-association-and-upneda-sign-mou-for-hydrogen-centre-23290787

Xu, WW. *et al.*

Scalable Fabrication of Cu2S@NiS@Ni/NiMo Hybrid Cathode for High-Performance Seawater Electrolysis

https://doi.org/10.1002/adfm.202302263

Abstract:
Electrochemical hydrogen evolution reaction (HER) with cost-effectiveness, high performance, and repeatable scale-up production hold promises for large-scale green hydrogen generation technology. Herein, a convenient method for scaling up Cu2S@NiS@Ni/NiMo electrocatalysts on Cu foam with high geometric area over 100 cm(2) is presented. The hybrid electrode exhibits high hydrogen evolution activity with 190 and 250 mV overpotential at 1000 mA cm(-2) and superior stability with negligible overpotential loss after over 2000 h at 500 mA cm(-2) under steady-state conditions in both artificial seawater and real seawater. Detailed characterizations and simulations demonstrate that high intrinsic activity resulting from the unique boundary interface, enhance mass transport resulting from superaerophobic nanoarray architecture, and corrosion resistance resulting from polyanion-rich passivating layers together lead to the outstanding performance. The practicability is also demonstrated in an alkaline seawater electrolyzer coupling with the hybrid electrode and stable commercial anode.



Hashim, M.

Egypt's energy balance map: a geographical perspective

https://doi.org/10.1080/14702541.2023.2212654

Abstract:
This study aims to determine Egypt's potential for energy sources, and the volume of potential energy production and consumption, balancing inputs, outputs and availability of energy. The study depends on analyzing the map of Egypt's energy balance of non-renewable and renewable energy, including oil, gas, solar, and wind energy, using UN-Energy Balance of Egypt data and the global solar and wind atlases of Egypt. It demonstrates that in 2020 Egypt's production of fossil fuels is 89.03% of the total energy production, while renewable energy production is only 10.97%. More specifically, fossil fuel consumption is 97.8% of the total consumed energy, while energy consumption from renewable sources is 2.2%. Therefore, this study recommends that further studies should be conducted to explore 'hybrid' energy sources to solve Egypt's energy crisis and to preserve the environment through clean energy sources, such as using green hydrogen and working on reducing emissions from fossil fuels. It is also recommended that there is value in employing GIS and RS applications to estimate the potential of renewable energy across the map of Egypt, and to present this information to possible investors who could expand the development of clean energy sources.

Sasidharan, S. *et al.*

Three-dimensional porous metal phosphide cathode electrodes prepared via electroless galvanic modification for alkaline water electrolysis

https://doi.org/10.1039/d3se00169e

Abstract:
Green hydrogen production from water electrolysis is crucial to propelling power-to-X strategies, and a central role in this strategy depends on innovative catalysts used in different electrolyzer technologies. The present study combines galvanic replacement and low-temperature annealing to construct a self-supported and low Ru-loaded metal phosphide electrode for efficient alkaline hydrogen evolution reaction (HER). The non-platinum electrode (catalyst + porous transport layers) fabricated over three-dimensional nickel foam (Ni2P-Ru/NF) yielded an overpotential of 40 mV for 10 mA cm(-2) in 1 M KOH during the HER and also demonstrated excellent durability under varying conditions for 48 h. A comprehensive analysis of surface characteristics followed by first principles calculations specified the factors, surface modification and active sites favoring excellent HER performance for Ni2P-Ru/NF. The most favorable hydrogen adsorption (Delta G(H*)) value, from DFT calculations, was identified for the Ru site in Ni2P-Ru, which was also very similar to the Pt/C system. Finally, the overall water splitting study performed using the Ni2P-Ru/NF catalyst as the cathode (Ni2P-Ru/NF||IrO2) showed the compatibility of the self-supported catalyst for efficient electrolysis with a noteworthy performance of 1.6 V for 10 mA cm(-2). The study showcases a potential pathway for applying very low Ru-loaded, self-supporting and carbon-free metal phosphide electrodes in commercial water electrolyzer systems for efficient green hydrogen generation.

Khan, H. *et al.*

Harvesting Green Hydrogen by Self-Propelling Built-in Electric Field Photo/Electro-catalytic Performance of DyCrO3 Nanoparticles Developed by Reverse Microemulsion Route

https://doi.org/10.1002/cnma.202300091

Abstract:
Herein, we demonstrate photocatalytic hydrogen generation and the role of sacrificial agents using multi-functional DyCrO3 nanoparticles by virtue of built-in electric field (BIEF) which helps in increasing charge separation efficiency. DyCrO3 nanoparticles synthesized by the low-cost reverse micellar approach showed high surface area (17.9 m(2)/g) and band-gap (2.01 eV) in visible region. Sacrificial agent assisted photocatalytic H-2 production of DyCrO3 nanoparticles exhibited higher selectivity towards Na2S/Na2SO3 by producing H-2 evolution of 347 mu molh-1gcat-1 ${mol\ {h}<^>{-1}{g}_{cat}<^>{-1}{\rm \ }}$ and apparent quantum yield of 6.8% than ethylene glycol and triethanolamine, respectively. The oxygen defects (observed in X-ray photoelectron spectroscopic studies) and BIEF both synergistically helped in enhancing photocatalytic activity. Moreover, the multifunctional competence of DyCrO3 nanoparticles was observed in electrocatalytic water splitting. DyCrO3 nanoparticles found to be active HER and OER electrocatalyst with low overpotential and great durability.

Samanta, M. *et al.*

The Weyl Semimetals MIrTe4 (M = Nb, Ta) as Efficient Catalysts for Dye-Sensitized Hydrogen Evolution

https://doi.org/10.1002/aenm.202300503

Abstract:
The prevalent global energy crisis calls for searching viable pathways for generating green hydrogen as an alternative energy resource. Dye-sensitized photocatalytic water splitting is a feasible solution to produce green hydrogen. However, identifying suitable catalysts has been one of the bottlenecks in driving dye-sensitized photocatalysis efficiently. In this work, a new class of electrocatalysts is reported based on the layered Weyl semimetals MIrTe4 (M = Nb, Ta) for the Eosin Y (EY)-sensitized hydrogen evolution reaction (HER). NbIrTe4 and TaIrTe4 exhibit HER activities of approximate to 18 000 and 14 000 mu mol g (-1) respectively, after 10 h of irradiation with visible light. Time-dependent UV-Vis spectroscopy and high-pressure liquid chromatography coupled with mass spectrometry analysis shed light on the reaction dynamics and enable a deeper understanding of the observed trend in hydrogen evolution rates for MIrTe4. MIrTe4 semimetals outperform transition metal-based Weyl semimetals in terms of catalytic HER activity using EY as photosensitizer and triethanolamine as the sacrificial agent. It is hypothesized that the topology-related band inversion in MIrTe4 Weyl semimetals promotes a high density of M d-states near the Fermi level, driving their high catalytic performance. This study introduces a new class of layered Weyl semimetals as efficient catalysts, and provides perspectives for designing topology-enhanced catalysts.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

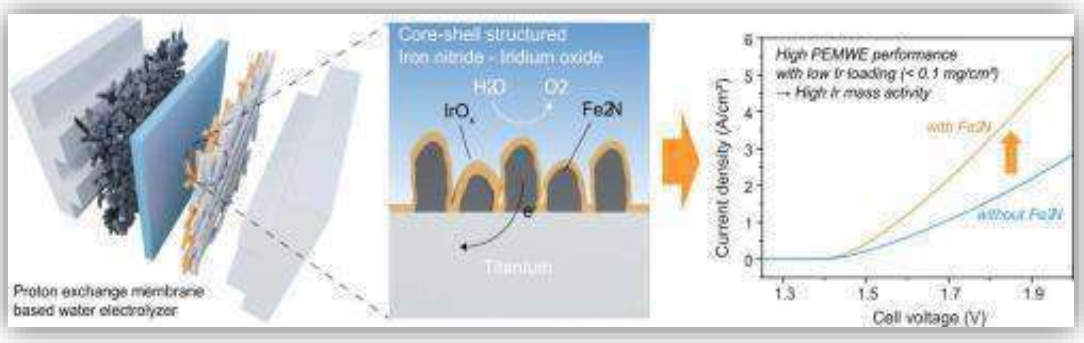
ISSUE: 37
JUNE, 2023

High–Performance Water Electrolyzer

Research Title: ***High–performance water electrolyzer with minimum platinum group metal usage: Iron nitride–iridium oxide core–shell nanostructures for stable and efficient oxygen evolution reaction***

Major Outcomes:

- To reduce the usage of rare-earth metals in a proton-exchange-membrane water electrolyzer (PEMWE), a highly active water-oxidizing anode based on a core–shell catalyst structure was developed.
- Earth-abundant metal-based iron-nitride nanostructure was adopted to support thin, electrodeposited iridium-oxide films.
- As PEMWEs with core–shell nanostructure and has substantially low ohmic and mass-transfer resistances, the introduction of Fe2N nanostructure on Ti PTL enhances the transfer of protons, water, and oxygen on the catalyst layer.
- A high Ir mass activity of 103 A/mgIr was achieved with reduced Ir loading of 0.036 mg/cm2 on the Ti PTL.
- The well-known weakness of transition-metal nitrides (TMNs) for use in PEMWEs, that is, their chemical instability in corrosive acidic environments, was overcome by carefully passivating the surfaces of the TMNs with chemically stable Ir catalyst layers. It resulted in the preparation of core–shell-structured catalysts with a stable under the PEMWE operating condition.



Conclusion:

- To develop an efficient and stable low-iridium-loaded anode for a PEMWE, the Fe2N @ EIROF core–shell–nanostructure was fabricated on a Ti PTL. Fe2N nanostructure was prepared on the Ti PTL by the hydrothermal deposition of FeOx nanorods and a sequential nitridation process.
- On the prepared Fe2N nanostructure, thin iridium-oxide layers of amount less than few tens µg/cm2 were successfully deposited using the electrodeposition method.
- The performance and stability of membrane electrode assemblies (MEAs) comprised of a conventional EIROF-coated Ti PTL and Fe_2N-coated Ti PTL were compared.

https://www.sciencedirect.com/science/article/abs/pii/S0926337323002394?via%3Dihub

Polly Martin

'Breakthrough technology will be cheapest method to produce blue hydrogen — with more than 99% CO2 capture'

Scientist behind the Allam cycle has invented a process that can apparently eliminate almost all emissions when making H2 from fossil gas.

- 8 Rivers, a company originally set up to commercialize its chief inventor Rodney Allam's design for zero-emission gas power plants, has designed a similar approach to blue hydrogen production with its new 8RH2 technology.
- The Allam cycle that he co-invented combusts natural gas with oxygen, producing a high-pressure "supercritical" CO_2 stream that can be used to drive power generation within the system — while the small amount of CO_2 that exits the cycle during each run can be easily captured owing to its pressure and purity.
- 8 Rivers' "8RH2" process similarly uses and recycles CO2 via an "oxy-fired combustor", where oxygen is added, and a "CO2 convective reformer" that takes the natural gas, and hot carbon dioxide and steam from the combustor to form a syngas — a mixture of carbon monoxide and hydrogen that is later separated.
- The hot CO2 is extracted "using a proprietary refrigeration based CO2 separation system",
- The optimized thermal efficiency for improved conversion rates, minimal power requirements and high CO2 capture rate at high concentration and pipeline pressure" compared to other methods of producing H2 from gas such as steam methane reforming and autothermal reforming (ATR).
- Most blue-hydrogen carbon capture technologies target capture rates in the range of 90-96% depending on the hydrogen production method, with ATR considered best-in-class for producing concentrated, high-pressure CO2 streams that can be easily separated from H2.

Link: https://www.hydrogeninsight.com/innovation/breakthrough-technology-will-be-cheapest-method-to-produce-blue-hydrogen-with-more-than-99-co2-capture/2-1-1457368

REPORT:

GREEN HYDROGEN MARKET BUSINESS REPORT (2022 – 2031)



Publishing Date: April-2023

KEY HIGHLIGHTS:

Comprehensive insights into the market size, trends, and opportunities in the industry.

Detailed analysis of the key drivers and challenges in the market and their impact on the growth of the market.

Detailed analysis of the pricing structure and provides insights into the pricing trends for Green Hydrogen Market.

Link:

Green Hydrogen Market Detailed Market Strategies on trends, type, and application Outlook 2023-2030 - MarketWatch

4th International Conference on Advances in Energy Research and Applications (ICAERA 2023)

Date: December 7, 2023 - December 9, 2023

Venue: Lisbon, Portugal

Link:

https://icaera.com/?gclid=Cj0KCQjw7agkBhDPARIsAKGa0oK-m0-PCpXVYkLzWpi_Ah0qZ1aex_g37lnP8srlUcrlFWQlzd4DEllaAuNjEALw_wcB

INDUSTRY NEWS

Osborne Clarke advises Foresight on new green hydrogen joint venture

Lawyers at Osborne Clarke in Bristol have advised Foresight on its involvement in a new green hydrogen joint venture - Grenian Hydrogen - to develop electrolytic hydrogen projects in the UK alongside Statkraft and Progressive Energy.

Launching with an initial development portfolio of 200MWe across seven projects in the North West and North Wales, 100MWe of which are currently in the engineering and consenting phase, Grenian will provide electrolyser technology for the initial projects.

The partnership will offer a bankable solution to major manufacturers seeking to switch away from natural gas to decarbonise operations using hydrogen. Grenian's flagship 30MWe Cheshire Green Hydrogen (CGH) project at Peel's Protos site, near Ince, has already been shortlisted by the UK Government for a 15-year Low Carbon Hydrogen Agreement (LCHA).

Chris Yeo, Bristol-based partner in Osborne Clarke's corporate team, advised Foresight on the transaction. The Western Gateway Hydrogen Delivery Pathway suggests that investing in hydrogen infrastructure within the area could see between 16,000 and 21,000 kilo tonnes of greenhouse gas emissions saved by 2050.The plan was announced at Hydrogen Gateway, a national Net Zero conference held at International Convention Centre Wales in Newport. It is led by the Western Gateway Partnership in collaboration with Hydrogen South West, the South Wales Industrial Cluster and the GW4 Alliance, which includes the universities of Bath, Bristol, Cardiff and Exeter.

Osborne Clarke advises Foresight on new green hydrogen joint venture - The Business Magazine

After Hisar pilot project, Jindal Stainless to switch to green hydrogen at Odisha plant: CSO

India's leading stainless steel manufacturer Jindal Stainless has become the country's first stainless steel company to install a green hydrogen plant. During FY2021-22, the company procured renewable energy in bulk to reduce its carbon emissions by 1.4 lakh tonnes and also aims to achieve a target of net zero emissions by 2050. Coming to corporates, Larsen & Toubro, ReNew, Indian Oil, Reliance Industries have lately shown much eagerness to diversify into green hydrogen.

In an interview to Mint's Nikita Prasad, Chief Sustainability Officer (CSO) of Jindal Stainless Kalyan Kumar Bhattacherjee, said that India is well-positioned to generate green hydrogen due to access to clean water and renewable electricity. The company also plans to set up its second green hydrogen plant at Odisha's Jajpur, after its pilot project at Hisar, Haryana.

The company has initiated the green hydrogen project in a pilot scale of 90 Nm3/hr capacity at Hisar manufacturing facility which will be operational by August 2023 and will be able to reduce the emissions about 2,700 tonnes of carbon per year. The current project is scheduled to be commissioned by August 2023. The same can scale up to 500 Nm3/hr in the next phase. The company procures ammonia and cracks it to obtain the hydrogen and nitrogen. They have already targeted setting up 200 MW of renewable energy - 100 MW at Hisar and 100 MW in Jajpur which will be accomplished within the next quarter.

After Hisar pilot project, Jindal Stainless to switch to green hydrogen at Odisha plant: CSO | Mint (livemint.com)



Kalyan Kumar Bhattacherjee, Chief Sustainability Officer, Jindal Stainless

Israeli developer joins WA green hydrogen project

Western Australian clean energy developer Infinite Green Energy has welcomed Israeli renewables giant Doral Group as an equity partner to develop and build a commercial-scale green hydrogen project that will leverage the existing 11 MW Northam Solar Farm east of Perth. Perth-based Infinite Green Energy (IGE), which earlier this year revealed it would partner with South Korean industrial major Samsung C&T to jointly develop and build the MEG HP1 green hydrogen plant, announced Doral has come onboard as the final partner in the project being developed near the Western Australian wheat belt town of Northam. The MEG HP1 project aims to build on the existing 11 MW Northam Solar Farm with the addition of a 10 MW hydrogen electrolyser and battery energy storage. Once fully operational, the facility is expected to produce up to four tonnes of green hydrogen per day for the medium and heavy transport industry.

Israeli developer joins WA green hydrogen project – pv magazine Australia (pv-magazine-australia.com)

EVENTS:

Hydrogen Tech World Expo & Conference 2024

Date: 26 & 27 June 2024

Location:
MESSE ESSEN GmbH
Messeplatz 1 45131,
Essen, Germany
Phone: + 49 (0)201 72 44-0
Website: www.messe-essen.de

Link:
https://hydrogentechworld.com/

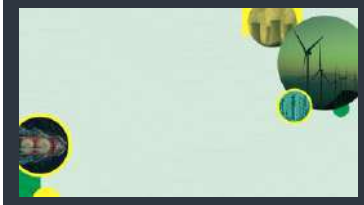
ENERGY TRANSITION SUMMIT

Date: 31 October - 2 November 2023

AIM: Accelerating progress, overcoming protectionism, managing tight capital

Agenda:

Day 1 Digital | Day 2 & 3 Digital & In-Person | Hilton Bankside, London | #FTEnergyTrans



Link:
https://energytransitions.live.ft.com/

Oort Energy Secures GBP5M Seed Funding to Decarbonise Industry with Green Hydrogen

Oort Energy, a UK-based next-generation hydrogen electrolyser developer, announced that it has closed its oversubscribed GBP5M Seed raise led by Energy Revolution Ventures (ERV), an early-stage electrochemistry specialist investor. This funding augments approximately GBP800k in non-dilutive grants awarded to the company by various UK and EU government bodies. The major Seed round investors include TRIREC, an Asian based decarbonisation fund, as well as a corporate strategic investor. The funding will support the set-up of the company's electrolyser stack manufacturing facility and the deployment of their first fully compliant demonstrator to produce green hydrogen from renewable energy. Oort Energy's patented polymer electrolyte membrane (PEM) electrolyser technology drives down green hydrogen production costs. The company has fully reinvented the stack from first principles. Combining deep material innovations with a scalable manufacturing architecture their electrolyser product delivers customers leading efficiencies at ultra-low costs.
The company has already completed the design of a 250kW stack platform and is preparing for mass manufacture. They are on track to deliver their first fully compliant containerised electrolyser solution to a customer site with commissioning planned for Q3 2023.
Oort Energy Secures GBP5M Seed Funding to Decarbonise Industry with Green Hydrogen - MarketWatch

Provaris Launches Large-Scale Green Hydrogen Production Plant with Norwegian Hydrogen

Provaris and Norwegian Hydrogen have joined forces to develop a large-scale production plant for green hydrogen in Ørskog, Ålesund municipality. With the capacity to meet local demand and supply green energy to Europe, this collaboration represents a significant milestone in Norway's journey toward a sustainable, emission-free future.
By producing 40,000 tonnes of green hydrogen annually, the facility will significantly reduce CO2 emissions, amounting to over 500,000 tonnes per year. This substantial reduction corresponds to more than 20% of the emissions for more OG Romsdal, making a remarkable contribution to combatting climate change. The hydrogen plant, when fully developed, will have a capacity of 270 MW. The initial granted capacity of 20 MW is just the beginning, with an application for an additional 250 MW capacity already submitted and in the processing stage. Norway has set ambitious targets to become a net-zero emissions country by 2050, and green hydrogen plays a vital role in achieving this goal. With a strong emphasis on renewable energy sources and the production of green hydrogen, Norway aims to be at the forefront of the global green shift.

https://energynews.biz/provaris-launches-large-scale-green-hydrogen-production-plant-with-norwegian-hydrogen/

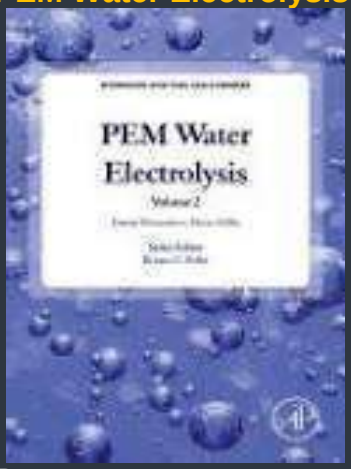
Spain energy firms look to central EU for green H2



Spanish oil company Cepsa (CPF.GQ) signed on Wednesday two agreements aimed at shipping green hydrogen between Spain and the Netherlands, a day after renewable energy giant Iberdrola (IBE.MC) took a similar step.
The two Spanish companies are vying to become green hydrogen leaders, with planned investments worth billions of euros. Green hydrogen is produced using renewable energy and is seen as key to decarbonise Europe's economy in the future. However, given its cost, green hydrogen projects in general are often not competitive without subsidies. The agreement Cepsa signed on Wednesday with Yara Clean Ammonia, which is part of Norway's Yara International (YAR.OL), will help establish a green hydrogen maritime corridor between the Spanish port of Algeciras, nearby Cepsa's green hydrogen hub, and the Dutch port of Rotterdam.
https://hydrogeneurope.eu/spain-energy-firms-look-to-central-eu-for-green-h2/

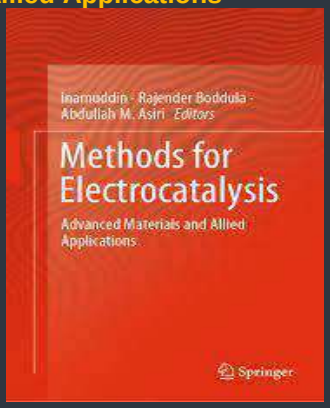
BOOKS:

PEM Water Electrolysis



By: Dmitri Bessarabov, Pierre Millet
Editor: Bruno G. Pollet
ISBN: 9780081028315, 0081028318
Published: 4 August 2018
Publisher: Elsevier Science
Language: English

Methods for Electrocatalysis
Advanced Materials and Allied Applications



Editors: Abdullah M. Asiri, Inamuddin, Rajender Boddula

ISBN: 9783030271619, 3030271617
Published:2 January 2020
Publisher: Springer International Publishing
Language: English

ANERT nominated nodal agency for green hydrogen initiatives in State

The State government has nominated the Agency for New and Renewable Energy Research and Technology (ANERT) as the State-level nodal agency for Green Hydrogen initiatives. The State government has plans to establish 'green hydrogen hubs' in Kochi and Thiruvananthapuram, stating that green hydrogen, produced using renewable energy, can play an important role in eco-friendly development and reduction of carbon emissions. The 2023-24 State budget had also announced a ₹200 crore scheme for viability gap funding, grant and equity support for setting up the hubs.

The State government has nominated the Agency for New and Renewable Energy Research and Technology (ANERT) as the State-level nodal agency for Green Hydrogen initiatives.The Power Department decision was taken on the basis of a proposal made by the Chief Executive Officer, ANERT, indicating the need for a single nodal agency for drafting and publishing the green hydrogen policy, assisting investors, developing a single-window system for approvals and a grievance redressal mechanism, and liaisoning with State and Central government agencies.

The State government has plans to establish 'green hydrogen hubs' in Kochi and Thiruvananthapuram, stating that green hydrogen, produced using renewable energy, can play an important role in eco-friendly development and reduction of carbon emissions. The 2023-24 State budget had also announced a ₹200 crore scheme for viability gap funding, grant and a draft had been circulated for discussion at a workshop organised by the Energy Management Centre (EMC), IIT-Palakkad, ANERT, and the Department of Science and Technology (DST), Government of India.



https://www.thehindu.com/news/national/kerala/anert-nominated-nodal-agency-for-green-hydrogen-initiatives-in-state/article66957964.ece

India well placed to emerge as green hydrogen hub: Hardeep Puri

India is well placed to emerge as a global green hydrogen hub and is poised to realise its full potential to create a green hydrogen ecosystem by 2030, petroleum minister Hardeep Singh Puri said. Addressing the G20 dialogue on 'India's role in the future of Energy', Puri said several estimates show India will account for approximately 25% of the global energy demand between 2020 and 2024. India's G20 Sherpa Amitabh Kant said India is seeking to promote sustainable production and consumption through building consensus on LifeStyle for Environment (LiFE) and on circular economy. "Realising the need to decarbonise industrial sectors and long distance transport, we are building consensus on standards for green hydrogen, along with a focus on biofuels & bioenergy.

India well placed to emerge as green hydrogen hub: Hardeep Puri (msn.com)

India to Soon Overtake China as Oil Demand Driver; Can Be Leader in Green Hydrogen: IEA Chief

India will soon overtake China as the largest driver of global oil demand even as it has an opportunity to become a world leader in green hydrogen production, International Energy Agency (IEA) chief Fatih Birol said. Mixing 10 per cent ethanol in petrol helped the country avoid USD 2 billion equivalent of oil imports he said. Speaking on the global energy scenario, he said last year, of all the power plants built in the world, 80 per cent were based on renewable sources of energy and the remaining 20 per cent on fossil fuels. Within renewable, solar is definitely the main chunk, he said. "For the first time, the amount of global investment going into solar is higher than the amount of investment going into oil production.

Out of the total USD 2.7 trillion investment in energy this year, USD 1 trillion is for fossil fuel and USD 1.7 trillion in clean energy sources. The clean energy investment occurs majorly in developed countries and China. Only a small portion is taking place in emerging markets and so there is a need for advanced economies, multilateral agencies and financial institutions to support clean energy investment in emerging nations.

India To Soon Overtake China As Oil Demand Driver; Can Be Leader In Green Hydrogen: IEA Chief (outlookindia.com)

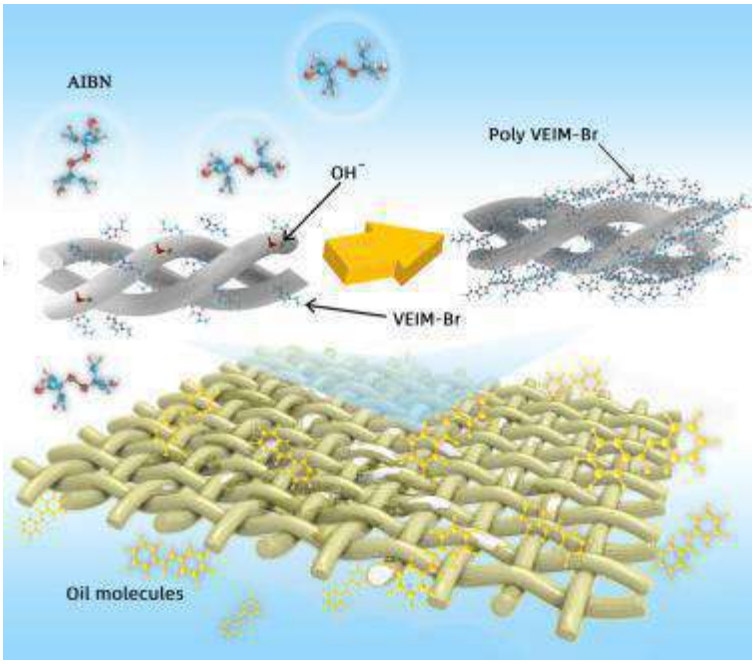
Wang, RY. *et al.*

In situ polymerized ionic liquids in polyester fiber composite membranes for detection of trace oil

https://doi.org/10.1016/j.isci.2023.106776

Abstract:

In situ trace detection on ultra-clean surfaces is an important technology. The polyester fiber (PF) was introduced to serve as the template, to which the ionic liquids were bonded by hydrogen bonding. Polymerized ionic liquids (PIL) in PF were formed by in situ polymerization with the azodiisobutyronitrile (AIBN) and IL. The trace oil on metal surfaces was enriched by the composite membrane based on similar compatibility principle. The absolute recovery of the trace oil ranged from 91%-99% using this composite membrane. In the extraction samples, desirable linear correlations were obtained for trace oil in the range of 1.25-20 mg/mL. It has been proven that a 1 cm(2) PIL-PF composite membrane can effectively extract as little as 1 mg of lubricating oil on an ultra-clean metal surface of 0.1 m(2) with the LOD of 0.9 mg/mL, making it a promising material for in situ detection of trace oil on metal surfaces.



Cai, ZX. *et al.*

Cyano-functionalized ionic porous polymer: A novel adsorbent for effectively enriching trace estrogens in water and milk

https://doi.org/10.1016/j.cej.2023.143315

Abstract:

Estrogens have been recognized as a class of endocrine disruptors. It is of utmost significance to develop a sensitive analytical method for the reliable determination of estrogen in environmental and food samples. Herein, a series of cyano-functionalized ionic porous organic polymers (CN-iPOPs) were successfully prepared for the first time using (1-imidazolyl) acetonitrile and biphenyl dichlorobenzene as building blocks via Friedel-Crafts alkylation reaction. The optimized CN-iPOPs (CN-iPOP3) displayed exceptional sorption capacity for estrogens, making it an advanced adsorbent for solid phase extraction (SPE) of estrogens. In combination, CN-iPOP3 based SPE with high performance liquid chromatography, a sensitive and reliable method was developed for determination of four estrogens in lake water and milk samples. Under optimal conditions, good linear response was obtained to be 0.09-100.0 ng mL-1 for lake water and 0.90-1000.0 ng mL-1 for milk, with detection limits (S/N = 3) of 0.03-0.05 ng mL-1 and 0.30-0.70 ng mL-1 respectively. The method recoveries were in the range of 85.0%-119.0% with the relative standard deviations lower than 7.8%. The synergistic effect of electrostatic force, hydrogen bond, 7c-7c stacking interaction and hydrophobic interaction was proved to be the main adsorption mechanism. This research provides a promising approach to design iPOP-based adsorbents for effectively enriching or removing organic pollutants.

Gao, JZ. *et al.*

Visualizing hydrogen peroxide and hydrogen sulfide fluctuations in living cells via dynamic-reversible fluorescent probes

https://doi.org/10.1016/j.cej.2023.143102

Abstract:
Visualizing the complex crosstalk between biological signaling molecules, such as H2O2 and H2S, is in an urgent demand. However, reaction with specific biomarkers makes conventional fluorescent probes inactive to further stimuli, thereby annihilating their responsiveness to the alternating existence of various targets. Herein, we engineer dynamic-reversible probes with dually responsive sites for visualizing the fluctuations of H2O2 and H2S. This designed reporter features H2O2-mediated self-immolation and H2S-initiated aromatic nucleophilic reaction to yield sulfhydryl-functionalized intermediate probe for lighting up bright NIR emissions. Importantly, the resultant intermediate probe can repeatedly cycle S-oxidation and reduction processes when successively treated with H2O2 and H2S, thus affording the fluorescence alternation at 800 nm between off and on states to visualize the intracellular coexistence and alternating existence of H2O2 and H2S. It is anticipated that this dynamic reversible probe will elucidate the interplay between H2O2 and H2S in biological redox processes.

Gong, C. *et al.*

In-situ interfacial engineering of Co (OH) 2/ Fe7Se8 nanosheets to boost electrocatalytic water splitting

https://doi.org/10.1016/j.cej.2023.143124

Abstract:
Rational design of bi-functional catalysts with desirable activity and stability remains a challenge for overall water splitting. Herein, two-dimensional Co (OH) 2/ Fe7Se8 nanosheets are prepared via self-transformation and in-situ selective selenization to construct rich heterogeneous interfaces. The in-situ interfaces induced by Fe7Se8 assist to regulate electronic structure of Co (OH) 2/Fe7Se8 heterostructure. The incorporation of Fe species along with selective selenization offer strong interfacial coupling effect between Co (OH) 2 and Fe7Se8. The in-situ formed interfaces contribute to optimized d-band center, lower energy barrier of intermediates and higher desorption capability of intermediates. Hence, the Co (OH) 2/ Fe7Se8 nanosheets exhibit superb electrocatalytic activity for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), requiring overpotentials of 183 and 278 mV at 10 mA cm-2 in 1.0 M KOH solution, respectively. In addition, the Co (OH) 2/ Fe7Se8 electrode requires only 1.62 V at 10 mA cm-2 in a two-electrode assembled electrolyzer, suggesting the promising application as overall water splitting electrocatalysts.

Li, ZY. *et al.*

Active Site Implantation for Ni (OH) (2) Nanowire Network Achieves Superior Hybrid Seawater Electrolysis at 1 A cm (-2) with Record-Low Cell Voltage

https://doi.org/10.1002/adfm.202304079

Abstract:
Direct seawater electrolysis provides a grand blueprint for green hydrogen (H-2) technology, while the high energy consumption has severely hindered its industrialization. Herein, a promising active site implantation strategy is reported for Ni (OH) (2) nanowire network electrode on nickel foam substrate by Ru doping (denoted as Ru-Ni (OH) (2) NW2/NF), which can act as a dual-function catalyst for hydrazine oxidation and hydrogen evolution, achieving an ultralow working potential of 114.6 mV to reach 1000 mA cm (-2) and a small overpotential of 30 mV at 10 mA cm (-2), respectively. Importantly, using the two-electrode hydrazine oxidation assisted seawater electrolysis, it can drive a large current density of 500 mA cm (-2) at 0.736 V with over 200 h stability. To demonstrate the practicability, a home-made flow electrolyzer is constructed, which can realize the industry-level rate of 1 A cm(-2) with a record-low voltage of 1.051 V. Theoretical calculations reveal that the Ru doping activates Ni (OH) (2) by upgrading d-band centers, which raises anti-bonding energy states and thus strengthens the interaction between adsorbates and catalysts. This study not only provides a novel rationale for catalyst design, but also proposes a feasible strategy for direct alkaline seawater splitting toward sustainable, yet energy-saving H-2 production.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 38
JUNE, 2023

Hydrogen from Mixed Plastic Waste

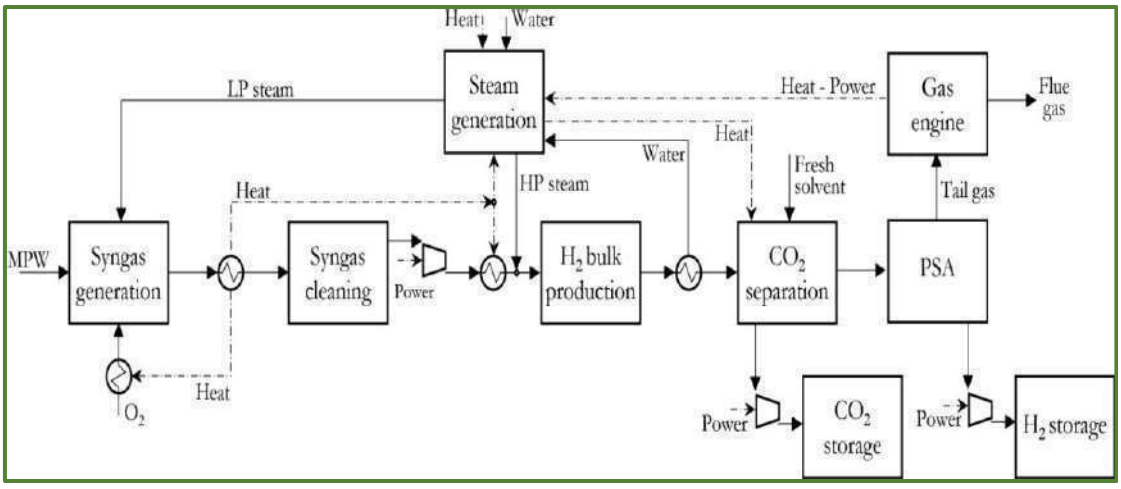
Research Title: ***The Environmental Performance of Mixed Plastic Waste Gasification with Carbon Capture and Storage to Produce Hydrogen in the U.K.***

The main goals of this work are

- Highlight the potential environmental benefits of a MPW-to-H_2 gasification with the CCS plant against the backdrop of the current disposal route via incineration
- From a future waste disposal perspective, compare MPW-to-H_2 with CCS to MPW-to-Energy (Wt E; incineration) with CCS on an environmental impact basis.

Major Outcomes:

- Hydrogen of a high purity can be produced from the advanced gasification of non-recyclable mixed plastic wastes (MPW).
- Due to the fossil nature of MPW, carbon capture and storage (CCS) capabilities need to be employed for the process to be considered a low-carbon hydrogen production route.
- Analysis for the environmental performance of a semi-commercial process that
  (a) Provides an end-of-life (EoL) for MPW,
  (b) Produces hydrogen as the main product (for sustainable manufacturing, heating, and transport applications), and
  (c) Captures carbon dioxide emissions which are injected into geological sites for permanent sequestration.



Conclusion:

The study aims to tackle the plastic waste management issue and the reliance on fossil-based fuels and chemicals by the use of hydrogen.

https://pubs.acs.org/doi/10.1021/acssuschemeng.2c05978#:~:text=Hydrogen%20of%20a%20high%20purity,low%2Dcarbon%20hydrogen%20production%20route.

By FuelCellsWorks
Vancouver, British Columbia, Canada

'Pyrolysis Technology Turns Plastic Waste into Hydrogen, Fuel Oil, Recovered Chemicals and Clean Energy'

Klean Industries Inc. ("Klean") is a specialist in pyrolysis technologies used in processing end-of-life plastics and is has updated projects on converting plastic waste into hydrogen, fuel oil, recovered chemicals, and clean energy.

THE ISSUE:

- The plastic recycling crisis is a complex issue that requires urgent actions from all Government, Industry and other stakeholders.
- It is estimated that the majority of plastic waste i.e. Approx. 90% is not recycled at all and it ends in landfills or the natural environment, including oceans, within the year of its manufactured Life.

THE SOLUTION:

- The Klean Loop™ platform has advanced pyrolysis technologies for converting waste plastics into valuable products.
- During the pyrolysis process the waste plastics are turned into reusable resources that can be recovered and integrated as "drop-in" feedstock right back from their original manufacturing supply chain.

THE BENEFITS:

The benefits far outweighs down cycling, and landfill by creating a sustainable source of energy/ Fuel that can help us reduce our reliance on fossil fuels while reducing degradation to our environment.

Link: https://fuelcellsworks.com/news/pyrolysis-technology-turns-plastic-waste-into-hydrogen-fuel-oil-recovered-chemicals-and-clean-energy/

REPORT:

Vantage Market Research Report

Report Findings:

- Alkaline electrolyzer are the leading category in the market, it can use renewable energy sources directly without incurring additional costs.
- Major contributor to greenhouse gases is the power sector.
- Green hydrogen can help to decarbonize the sector.
- By replacing fossil fuels like coal and natural gas in power generation, Green Hydrogen can reduce emissions and help achieve climate goals.

Link:

https://www.vantagemarketresearch.com/industry-report/green-hydrogen-market-0943

POSCO to sign $6.7bn green hydrogen deal with Oman



POSCO-led consortium has won a $6.7bn contract to produce green hydrogen in Duqm, Oman, sources told news agency the Korean Economic Daily. The prospective green hydrogen project will be the largest in the world. The South Korean steelmaker POSCO Group holds a 28% plurality share in the consortium's venture.

In March 2022, POSCO stated that Oman was one of the countries it was considering for hydrogen investment, and the country's officials met with POSCO earlier in 2023.

With construction scheduled for completion in 2026, the factory will produce 300,000 tonnes per year of hydrogen-based steel for various uses including heavy industry. Pohang steel complex will be the world's first steel plant to use fluidised bed reduction reactors in its production. The HyREX (Hydrogen Reduction) technology produces direct reduced iron with hydrogen, which is then melted in an electric furnace to create steel without carbon emissions. This is because the fluidised bed reactor, unlike traditional furnaces, separates the reduction and melting processes. This allows POSCO to reduce the steel with hydrogen, emitting water vapours instead of carbon dioxide before the melting process occurs separately. Similarly, the production process is more efficient because HyRex can use mined ore without POSCO having to pelletise it.

POSCO to sign $6.7bn green hydrogen deal with Oman - Power Technology (power-technology.com)

Oman awards $6.7 billion contract for world's largest green hydrogen plant

Omani authorities have awarded a $6.7-billion deal to build the world's largest green hydrogen plant in Duqm, a port town in east-central Oman, reported *The Korea Economic Daily*, citing sources familiar with the matter. Oman is planning to build one of the largest green hydrogen plants in the world in a move to make the oil-producing nation a leader in renewable energy technology.

Construction is scheduled to start in 2028 in Al Wusta governorate on the Arabian Sea. It will be built in stages, with the aim to be at full capacity by 2038, powered by 25 gigawatts of wind and solar energy.

Oman awards $6.7 billion contract for world's largest green hydrogen plant - Oil & Gas Middle East (oilandgasmiddleeast.com)

FusionOne: Clearing Up Plastic for Hydrogen Production

Hydrogen is vital in fuel cell technology, energy production, and numerous other applications. Plastic waste, produced in substantial amounts, is a significant environmental issue and a potential source of hydrogen. FusionOne, a Canada-based company, is highlighting plastic's potential as a hydrogen source through novel sustainable solutions. Its technology converts plastic waste accumulated in landfills into hydrogen and electricity.

The United States Environmental Protection Agency (EPA) and National Renewable Energy Laboratory (NREL) have assessed the harmful effects of plastic waste in terms of environmental degradation. As per EPA, plastics belong to a rapidly expanding municipal solid waste (MSW) category. While plastics are present in all main MSW fields, containers and packaging accounted for more than 14.5 million tons of plastic waste in 2018.



Plastic Waste Management Statistics in the United States. Image Credit: United States Environmental Protection Agency

Producing hydrogen from plastic wastes is a significant step in sustainable energy production. FusionOne and its novel technologies efficiently generate hydrogen from plastic wastes and provide several industries, such as the automotive and electric power generation sector, with an environment-friendly operating framework.

Advanced Recycling | Fusionone Energy Corp.

EVENTS:

CONNECTING GREEN HYDROGEN APAC 2023

THE LARGEST GREEN HYDROGEN CONFERENCE & EXHIBITION IN AUSTRALIA AND ASIA PACIFIC



Aim:

- To bring together the industry live and in person to discuss the green hydrogen agenda in Australia and the Asia Pacific.
- To provide a unique set-up where the policy-makers as well as both local and international developers, investors, experts and solution/ product providers, meet, get the market updates, debate, and learn.

Venue: Melbourne, Australia

Date: 25-26th July 2023

Link:

https://www.apac.gh2events.com/

South Africa partners with Dutch, Danish governments on green hydrogen fund

South Africa and the governments of the Netherlands and Denmark launched a $1 billion green hydrogen fund to help kick-start an industry seen as critical to the country's decarbonisation efforts. The new fund, dubbed SA-H2 and run by Climate Fund Managers, a joint venture between the Dutch development bank, FMO, and South African insurer Sanlam, will look to support South Africa's green hydrogen sector. "The SA-H2 Fund initiative will aim to secure US$1 billion in funding, to be raised directly in South Africa or indirectly via other channels," Climate Fund Managers said in a statement. South Africa's energy transition plan envisages setting up an ecosystem and export hub for green hydrogen, which is made using renewable energy and without producing greenhouse gas emissions. The nation wants to produce the fuel for use in aviation, green steel, transport and more, as well as for export to the European Union. But President Cyril Ramaphosa has said this would require 319 billion rand ($17.57 billion).

https://www.reuters.com/sustainability/climate-energy/south-africa-partners-with-dutch-danish-govts-green-hydrogen-fund-2023-06-20/

Norway Firm Produces World's First Aluminum Using Green Hydrogen

Norsk Hydro ASA has made the world's first batch of aluminum using green hydrogen in a step toward decarbonizing the production of the metal. The Norwegian producer replaced natural gas with green hydrogen during a test at its extrusion plant in Navarra, Spain. Hydro's renewable hydrogen company, Hydro Havrand, conducted the trial in partnership with Fives North America Combustion, an engineering firm with expertise in hydrogen burner technology. For more than a century, Hydro has been searching for new uses for the vast amounts of hydroelectric power that Norway generates each year. The company first found success making artificial fertilizers via a pioneering electrochemical process and later focused its attention on aluminum, which is one of the world's most energy-intensive industrial commodities to make. Now, it's betting that hydrogen could prove even more lucrative. Hydro will publish a final report from the test in the fall. The aluminum produced in the test will be utilized to make the world's first extruded profiles using hydrogen.

Norway Firm Produces World's First Aluminum Using Green Hydrogen | National Post

Buttigieg says US 'green corridors' initiative is key to cutting shipping industry emissions

An American push to establish "green shipping corridors" is key to reducing carbon emissions from the shipping industry, U.S. Transportation Secretary Pete Buttigieg said while touring the port of Yokohama near Tokyo. The U.S. is seeking to develop and strengthen partnerships with "like-minded countries" to improve maritime security and keep shipping and aviation corridors open. The International Maritime Organization, which regulates commercial shipping, wants to halve its greenhouse gas releases by midcentury and may seek deeper cuts this year. The Port of Los Angeles signed an agreement in March with port authorities of Yokohama and Tokyo to establish the so-called green shipping corridors, aiming to promote emissions reductions through use of net-zero emissions vessels and other efforts to reduce the flow of greenhouse gases from ports and shipping. It also has formed similar partnerships with Singapore and Shanghai and the U.S. has begun discussing setting up such corridors in Southeast Asia. The initiative is also under discussion by the Quad, which includes Japan, the U.S., India and Australia. It also has formed similar partnerships with Singapore and Shanghai and the U.S. has begun discussing setting up such corridors in Southeast Asia. The initiative is also under discussion by the Quad, which includes Japan, the U.S., India and Australia. Japan aims to achieve carbon neutrality in 2050, with a goal of becoming a "hydrogen society." But its hydrogen industry is still in its initial stages, and still mostly reliant on hydrogen produced using fossil fuels. Yokohama is in the midst of a "blue carbon infrastructure" project that features promoting coastal structures like sea walls that can serve as habitat for marine life while absorbing planet-warming gases emitted by the port.

Buttigieg says US 'green corridors' initiative is key to cutting shipping industry emissions - ABC News (go.com)

EVENTS:

LONDON HYDROGEN-AFRICA GREEN H2 INVESTMENT FORUM



The London-Hydrogen Africa Green H2 Investment Forum is an essential event that focuses on promoting green hydrogen investment opportunities in Africa. The forum brings together industry leaders, investors, and policymakers to discuss the potential of the African green hydrogen market, investment opportunities and challenges, and regulatory frameworks.

One particular case study that highlights the potential of green hydrogen investment in Africa is the 6 African Hydrogen Alliance Members. The 6 African Hydrogen Alliance Members are a group of six African countries, including Morocco, Egypt, South Africa, Mauritania, Namibia, and Kenya. The 6 African Hydrogen Alliance Members aim to create a green hydrogen value chain that includes production, transportation, and utilization of green hydrogen.

The forum aims to create an enabling environment for green hydrogen investment and stimulate innovation and development in the sector, which is critical to the future of the African energy landscape.

Venue: London, UK
Date: 25-26th July 2023

Link:
https://hydrogen-africa.com/london-hydrogen-africa-green-h2-investment-forum-2023/

India to produce 55 million tonnes of green hydrogen in 2050

According to a report, India will produce about 55 million tonnes of green hydrogen in 2050. However, due to a slower demand uptake profile, the country will remain a marginal importer in the coming decade. There is a need for transition to hydrogen. Rise of technologies such as solar and wind, lithium-ion batteries, and alternative fuels have paved the way for decarbonization in various end-use sectors. Hydrogen is an energy carrier and can be used for a wide array of energy and industrial applications. The opportunities and challenges of hydrogen emerge from its energy characteristics. Hydrogen's specific energy (energy content per unit of mass) is higher than most hydrocarbon fuels. But its volumetric energy density is the lowest. That means pressurisation or liquefaction is required for hydrogen to be useful as a fuel. These two properties drive the value as well as the applicability of hydrogen for the various possible end-use cases. Many sectors such as iron ore and steel, fertilisers, refining, methanol, and maritime shipping emit major amounts of CO_2, and carbon-free hydrogen will play a critical role in enabling deep decarbonization. From a price parity basis alone, green hydrogen's share of this demand could grow from 16 per cent in 2030 to almost 94 per cent by 2050. This translates to an implied cumulative electrolyser capacity demand of 20 GW by 2030 and 226 GW by 2050, promising a sizeable opportunity for indigenous manufacturing of a global emerging energy technology. The cumulative value of the green hydrogen market in India could be $8 billion by 2030 and $340 billion by 2050. Electrolyser market size could be approximately $5 billion by 2030 and $31 billion by 2050. Adoption of green hydrogen will also result in 3.6 giga tonnes of cumulative CO_2 emissions reductions between 2020 and 2050.



https://www.eqmagpro.com/india-to-produce-55-million-tonnes-of-green-hydrogen-in-2050-eq-mag/

The Key Challenges to the Widespread Classification of Green Hydrogen

Ratul Puri, Chairman, Hindustan PowerProjects Pvt Ltd, pens down challenges existing in the mass adoption of green hydrogen as an alternate energy source. The current cost of producing 1 kg of green hydrogen is between $5.5 and $6 through the process of electrolysis by using renewable sources of energy. With the usage of conventional fossil fuel, the cost of production of hydrogen is only about $1.5 per kg, which is significantly lower. Presently, the capital expenditure on electrolysers used for splitting oxygen and hydrogen is very high. The production of green hydrogen requires plenty of water. On an average, 1 kg of green hydrogen production requires around 10 - 15 liters of water. This will be an issue in non-maritime areas which will need to be addressed appropriately by respective government bodies. Infrastructure development plays an important role here. A dependable network of facilities, a network of distribution of pipelines and stations for refueling need to be created. This requires major investments and collaboration between governments and private sectors. Governments in various countries are now coming up with strategies and policies to enhance and promote the usage of green hydrogen. There is also an impetus seen to fuel demand in such countries. All this will help in the adoption and indeed the promotion of green hydrogen world over. Such efforts will soon help the planet meet its de carbonization targets within a stipulated time-line.

The Key Challenges to the Widespread Classification of Green Hydrogen - Hindustan Times

Solar-wind hybrid power plant installed in Arunachal

The Arunachal Pradesh State Council for Science and Technology in collaboration with the School of Energy Science & Engineering under IIT Guwahati installed a solar-wind power plant in Papum Pare district. The 10-KW hybrid plant system was set up at Rural Technology Demonstration Centre (RTDC) in Kimin. The system has a four-blade horizontal axis wind turbine of 5 KW capacity installed at 12-metre height from the ground level and another 5 KW- capacity solar photovoltaic panels, officials said.

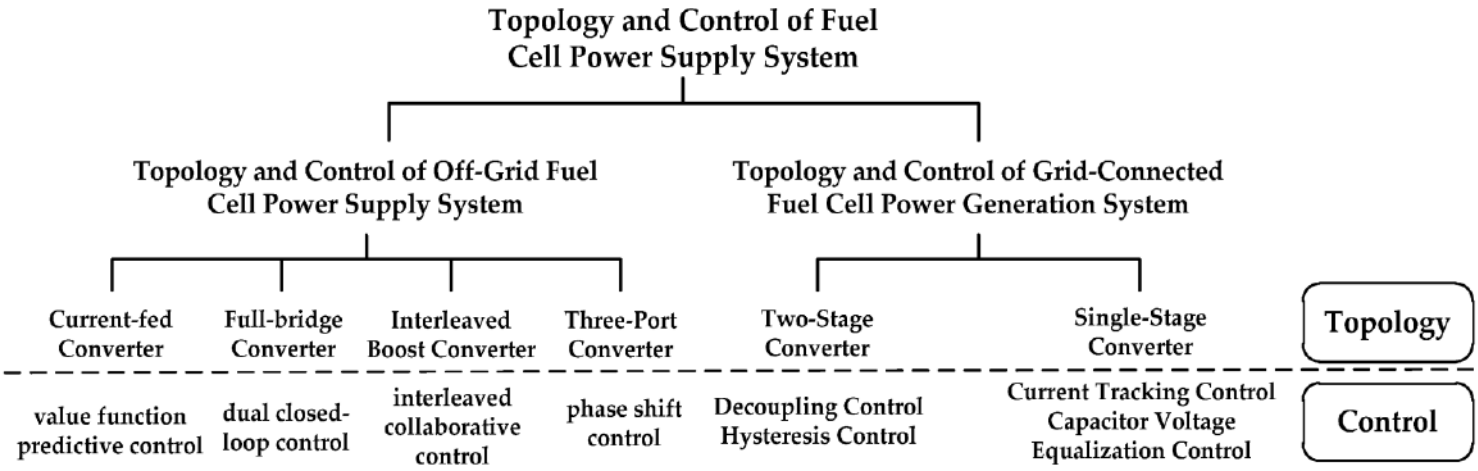
Solar-wind hybrid power plant installed in Arunachal (indiatimes.com)

Zhou, JH. *et al.*

Topology and Control of Fuel Cell Generation Converters

https://doi.org/10.3390/en16114525

Abstract:
Fuel cell power generation is one of the important ways of utilizing hydrogen energy, which has good prospects for development. However, fuel cell volt-ampere characteristics are nonlinear, the output voltage is low and the fluctuation range is large, and a power electronic converter matching its characteristics is required to achieve efficient and stable work. Based on the analysis of the fuel cell's characteristic mechanism, maximum power point tracking algorithm, fuel cell converter characteristics, application and converter control strategy, the paper summarizes the general principles of the topology of fuel cell converters. In addition, based on the development status of new energy, hydrogen energy is organically combined with other new energy sources, and the concept of 100% absorption system of new energy with green hydrogen as the main body is proposed to provide a reference for the development of hydrogen energy.

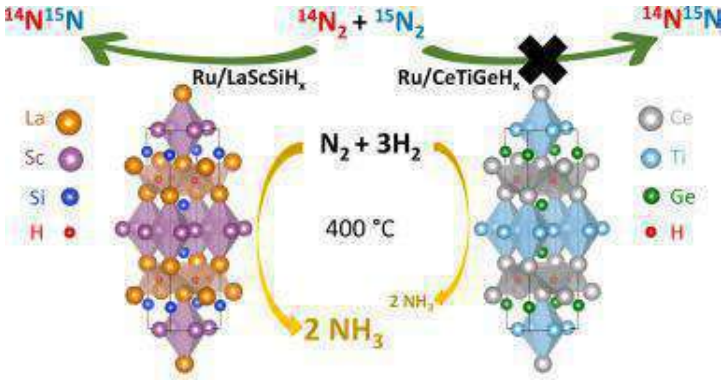


Croise, C. *et al.*

Role of hydride ion within Ru/LaScSi and Ru/CeTiGe catalysts for NH3 synthesis: A combination of DFT and experimental nitrogen isotopic exchange studies

https://doi.org/10.1016/j.catcom.2023.106689

Abstract:
The design of catalysts active for ammonia synthesis under mild conditions of temperature and pressure is a new grail for its production process based on green hydrogen and intermittent renewable energy sources. Ru/LaScSi and Ru/CeTiGe are investigated with an approach combining DFT calculations and 15N/14N homomolecular exchange experiments. Ru/LaScSi is the most active of both catalysts. It has electride-like properties which are enhanced when partially hydrogenated leading to higher activity in nitrogen equilibration reaction. Ru/CeTiGe, relatively active despite the absence of electride-like character, is proposed to produce NH3 following the associative mechanism with the assistance of absorbed H.

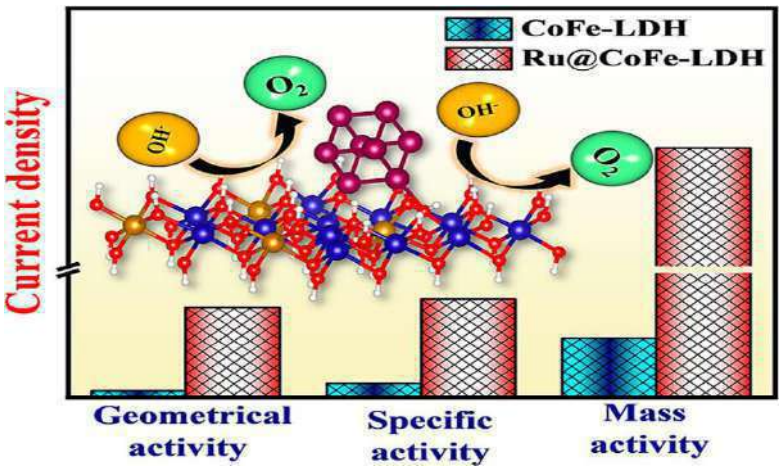


Karmakar, A. *et al.*

Regulating Surface Charge by Embedding Ru Nanoparticles over 2D Hydroxides toward Water Oxidation

https://doi.org/10.1021/acsami.3c05512

Abstract:
Exploring highly active and earth-abundant electrocatalysts for the oxygen evolution reaction (OER) is considered one of the prime prerequisites for generating green hydrogen. Herein, a competent microwave-assisted decoration of Ru nanoparticles (NPs) over the bimetallic layered double hydroxide (LDH) material is proposed. The same has been used as an OER catalyst in a 1 M KOH solution. The catalyst shows an interesting Ru NP loading dependency toward the OER, and a concentration-dependent volcanic relationship between electronic charge and thermos neutral current densities has been observed. This volcanic relation shows that with an optimum concentration of Ru NPs, the catalyst could effectively catalyze the OER by obeying the Sabatier principle of ion adsorption. The optimized Ru @ Co Fe –LDH (3%) demands an over potential value of only249 mV to drive a current density value of 10 mA/cm (2) with the highest TOF value of 14.4 s (-1) as compared to similar Co Fe-LDH-based materials. In situ impedance experiments and DFT studies demonstrated that incorporating the Ru NPs boosts the intrinsic OER activity of the Co Fe-LDH on account of sufficient activated redox reactivities for both Co and lattice oxygen of the Co Fe-LDH.As a result, compared with the pristine Co Fe-LDH, the current density of Ru @ Co Fe-LDH (3%) at 1.55 V vs RHE normalized by ECSA increased by86.58%. First-principles DFT analysis shows that the optimized Ru @ Co Fe-LDH (3%)possesses a lower d-band center that indicates weaker and more optimal binding characteristics for OER intermediates, improving the overall OER performance. Overall, this report displays an excellent correlation between the decorated concentration of NPs over the LDH surface which can tune the OER activity as verified by both experimental and theoretical calculations.



Revinova, S. *et al.*

Forecasting Development of Green Hydrogen Production Technologies Using Component-Based Learning Curves

https://doi.org/10.1016/j.cej.2023.143124

Abstract:
Hydrogen energy is expected to become one of the most efficient ways to decarbonize global energy and transportation systems. Green hydrogen production costs are currently high but are likely to decline due to the economy of scale and learning-by-doing effects. The purpose of this paper is to forecast future green hydrogen costs based on the multicomponent learning curves approach. The study investigates the learning curves for the main components in hydrogen value chains: electrolyzers and renewable energy. Our findings estimate the learning rates in the production of PEM and AE electrolyzers as 4%, which is quite conservative compared to other studies. The estimations of learning rates in renewable energy electricity generation range from 14.28 to 14.44% for solar-based and 7.35 to 9.63% for wind-based production. The estimation of the learning rate in green hydrogen production ranges from 4% to 10.2% due to uncertainty in data about the cost structure. The study finds that government support is needed to accelerate electrolysis technology development and achieve decarbonization goals by 2050.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

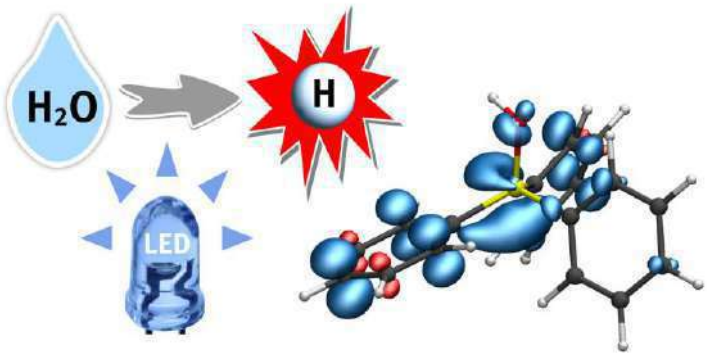
ISSUE: 39
JUNE, 2023

Chemists Develop New Method for Water Splitting

Hydrogen is seen as an energy source of the future—at least, when it is produced in a climate-friendly way.

By JingJing Zhang, Christian Mück-Lichtenfeld and Armido Studer, The Institute of Organic Chemistry at Münster University (Germany).

The main goals of this work was to produce hydrogen, water (H_2O) can be converted into hydrogen gas (H_2) by means of a series of chemical processes. However, as water molecules are very stable, splitting them into hydrogen and oxygen presents a big challenge to chemists. The team of researchers developed a photocatalytic process in which water, under mild reaction conditions, is activated through triaryl phosphines, and not—as in most other processes—through transition metal complexes. Radicals are, as a rule, highly reactive intermediates. The use of a special intermediate—a phosphine-water radical cation—as activated water, from which hydrogen atoms from H_2O can be easily split off and transferred to a further substrate. The reaction is driven by light energy.



A hydrogen atom (H) from water (H2O) is transferred to a phosphine-water radical cation under the supply of light energy (LED). This important radical intermediate can further transfer the hydrogen atom (white) to the substrate. The blue regions indicate the electron spin distribution. *Credit: Christian Mück-Lichtenfeld*

Conclusion:

- In situ-generated PR_3–OH radicals have been shown to react as HAT reagents with various alkenes and naphthalenes to give the corresponding H atom addition adduct radicals at room temperature.
- The key PR_3–OH radicals, which can be considered as formal 'free' H atoms, are readily generated through photocatalytic phosphine-mediated water activation. Thiols are used as catalytic co-reductants for the radical hydrogenation of π systems, transforming the initially generated PR_3–OH_2 radical cation intermediate, which is an efficient proton donor, into a radical hydrogen atom donor.
- The co-catalysis approach ensures that both H atoms of water can be used as H atom donors in the reduction of π systems. Considering hydrogenation of alkenes, the introduced metal-free PR_3–OH intermediate has comparable reactivity to the established transition metal-based systems, which engage in MHAT reactions. Intra- or intermolecular hydrogen atom transfer to reactive carbon- or heteroatom-centred radicals is a highly useful tool in modern synthesis for radical translocation.
- However, HAT to closed-shell systems has not been well developed and we are confident that the strategy presented here will open the door to unexplored 'H atom radical chemistry.

Zhang, J., Mück-Lichtenfeld, C. & Studer, A. Photocatalytic phosphine-mediated water activation for radical hydrogenation. *Nature* (2023). https://doi.org/10.1038/s41586-023-06141-1
https://phys.org/news/2023-06-chemists-method.html

By Robin Whitlock

'Oxford materials Technology Company announces new proprietary coating for alkaline electrolysers'

Advanced materials technology company Oxford nanoSystems (OnS) has announced a new proprietary coating, nanoFLUX, which improves the hydrogen production capacity of alkaline electrolysers by over 50 percent.

- The company believes this will be a major breakthrough in the race to drive down the production cost of zero-emission green hydrogen, delivering a significantly lower cost than current state-of-the-art coatings.
- The coating will accelerate the transition to a hydrogen economy by radically reducing production costs. It also addresses the key challenge of making green hydrogen competitive against fossil fuels.
- nanoFLUX, an advanced metallic-alloy coating applied to the electrodes, promotes the formation and release of gas bubbles within the electrolyser. This enhances the overall efficiency of the process. This innovative coating has been combined with a proprietary catalyst that accelerates the hydrogen generation reaction.

An independent assessment conducted by E4Tech (part of the ERM Group), a leading international consulting firm focussed on sustainable energy technologies, has confirmed the breakthrough cost-benefit advantage provided by nanoFLUX.

Link:
https://www.renewableenergymagazine.com/hydrogen/oxford-materials-technology-company-announces-new-proprietary-20230629

EVENTS:

2023 WORLD BATTERY & ENERGY STORAGE INDUSTRY EXPO (WBE)



Latest data show that in 2021, China's lithium battery production hit 324 GWh (up 106%), registering a output value of 600 billion RMB. The energy density of advanced ternary batteries and lithium iron phosphate batteries has reached an average of 280Wh/kg and 170Wh/kg, respectively, and the battery cycle life of key enterprises has exceeded 5,000 cycles.
Date: 8-10th August 2023
Venue: Guangdong, China

Link:
https://en.battery-expo.com/

GASTECH 2023

Gastech
Hydrogen | Climatetech
EXHIBITION & CONFERENCE
SINGAPORE EXPO | SINGAPORE | 5-8 SEPTEMBER 2023

A landmark event in the energy industry's calendar, Gastech 2023 is the world's largest meeting place for the gas, LNG, hydrogen, low-carbon solutions, and climate technologies industries. Gastech 2023 will look ahead to the future amidst an industry-wide transformation to drive progress to net zero. Industry thought leaders and innovators will gauge the outlook for the entire energy value chain during an unparalleled industry experience, over a four-day period.
Date: 5-8th September 2023
Venue: Singapore, Southeast Asia
Link:
https://www.gastechevent.com/

INDUSTRY NEWS

Germany, South Africa agree to cooperate on green hydrogen projects

Germany and South Africa on Tuesday agreed to cooperate on green hydrogen projects in the latest bid by Europe to tap into Africa's huge renewable resource potential to meet 2050 net zero targets.
Under the deal, Germany will assist in developing markets, facilitating imports and linking producers with technology partners, said Masopha Moshoeshoe, an executive in the investment and infrastructure office of South Africa's presidency.
European countries are turning to Africa to secure future supplies of the fuel, investing heavily in green hydrogen projects in countries from Namibia to Morocco and Egypt to South Africa. South Africa, the continent's most advanced economy and the world's 14th biggest emitter of greenhouse gases, has also made green hydrogen an important pillar of its own decarbonisation efforts. President Cyril Ramaphosa has said the country would need up to 319 billion rand ($17.28 billion) of investment to kick-start the industry.
So far it has received $700 billion dollars under $8.5 billion pledged to it by a group of rich countries including France, Germany, Britain, the United States and the European Union.
https://www.reuters.com/business/environment/germany-south-africa-agree-cooperate-green-hydrogen-projects-2023-06-27/

Honeywell to bring new carbon capture, hydrogen tech to India



Industrial technology solutions leader Honeywell International has developed several energy transitions and sustainability solutions to reduce carbon emissions and these technologies will soon be made available in India, says Ashish Modi, President, Honeywell India. Honeywell, with a revenue worth $35 billion, pioneered solutions in carbon capture, new-age batteries, avionics products, and next-generation refrigerants like hydrofluoroolefins (HFO). It has developed new battery solutions, next-generation refrigerant HFOs, renewable solutions to recycle and produce plastic, catalysts to increase green hydrogen production and thereby reduce cost, a new catalyst-coated membrane (CCMs) technology for Green Hydrogen production, Liquid Organic Hydrogen Carrier (LOHC), 'UpCycle' Process Technology, ethanol-to-jet fuel technology and so on, to reduce carbon footprint. Honeywell India and Navin Fluorine International, part of the Padmanabh Mafatlal Group, have formed a partnership to manufacture Honeywell's proprietary 'Solstice' range of hydrofluoroolefins (HFO) in India. HFOs are next-generation refrigerants that can replace harmful hydrofluorocarbon (HFC) and hydrochlorofluorocarbon (HCFC). Multiple global regulations stemming from the Kigali Amendment to the Montreal Protocol require the phasedown of HFCs, driving the demand for more sustainable solutions. Honeywell has already invested more than a billion dollars in research, development, and new capacity for its HFO technology. India will start to phase out HFCs in 2032.
Fortune India: Business News, Strategy, Finance and Corporate Insight

Fortune India: Business News, Strategy, Finance and Corporate Insight

The Union Road Transport and Highways Minister Nitin Gadkari has urged stakeholders that finding and using cost-effective fuels, that are also economically viable, is imperative to reduce pollution caused by vehicles. He pointed out that alternative fuels like bio-CNG and green hydrogen not only helps in reducing pollution, but also saves a lot in fuel cost. According to him, India has a potential to produce 5 million metric tonnes of green hydrogen per annum and it is the responsibility of all stakeholders to make these fuels available at cost-effective rates and create awareness for the citizens in the country. Gadkari points out that the potential of green hydrogen will be wasted unless it is available at a cheaper cost.
According to the Minister the country is facing two big challenges at present. One of which is related to import of fossil fuels amounting to lakhs of crores of rupees which, therefore, poses a big economic challenge to the country. The other is to curb pollution.
He believes that the vision of a self-reliant India and a five trillion-dollar economy will be realised as soon as possible if there is more and more production of cost-effective, pollution-free, and environment-friendly indigenous products that provide alternatives to imports and lessens all sort of pollutions in the country.
Gadkari tells industry to make alternate fuels like bio-CNG and hydrogen available at cost-effective price | The Financial Express

EVENTS:

HYDROGEN CONFERENCE 2023
NAVIGATING THE PATHS TO HYDROGEN DEPLOYMENT



Date: 20th September 2023
Venue: London, UK

Aim:

- To gain insight into project developments, forge new partnerships and be a part of the conversation that navigates the paths to hydrogen deployment
- To explore the long-term outlook for hydrogen and ammonia utilizing Wood Mackenzie's research and expert analysis
- To connect with 200+ like-minded industry professionals to share ideas on hydrogen's role in solving the energy trilemma
- To share new skills and content with your team: Build annual strategies for establishing major hydrogen trade flows.

Link:
https://www.woodmac.com/events/hydrogen-conference-2023/

Topsoe Accelerates Global Green Hydrogen Economy with AVEVA Software

AVEVA, a global leader in industrial software, driving digital transformation and sustainability, has been selected by Topsoe, a leader in carbon emission reduction technologies, helping fast-track development of the decarbonization solutions needed for the production green hydrogen and other carbon neutral fuels. Topsoe will use AVEVA Process Simulation to model its Solid Oxide Electrolyzer Cells (SOECs) with a view to optimizing their design and developing their control strategy. AVEVA Process Simulation enables growth of global hydrogen production market through faster and more efficient design of solid oxide electrolyzer cells. Topsoe will use AVEVA Process Simulation to model its Solid Oxide Electrolyzer Cells (SOECs) with a view to optimizing their design and developing their control strategy.

These industries are often referred to as the hard-to-abate sectors and include heavy transportation such as shipping and aviation but also carbon intensive industries like steel manufacturing and petrochemical production. The challenge is finding and replacing fossil fuels with carbon-free alternatives. This is where Topsoe can help, and by using Topsoe's highly efficient SOEC based electrolyzers, it's possible to produce the green hydrogen needed to decarbonize many of these carbon intensive industries. Time is of the essence, and with its flexibility, open modeling, and ease of use, AVEVA Process Simulation1 is helping accelerate the energy transition by enabling Topsoe's engineers to design and optimize their electrolyzers with increased speed and efficiency.

About AVEVA Software:

AVEVA is a global leader in industrial software, sparking ingenuity to drive responsible use of the world's resources. The company's secure industrial cloud platform and applications enable businesses to harness the power of their information and improve collaboration with customers, suppliers, and partners. Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company, which has operations around the globe, is headquartered in Cambridge, UK.

Topsoe Accelerates Global Green Hydrogen Economy with AVEVA Software | National Post

Liverpool 'green academy' opens in £1m investment

Liverpool training firm HybridTec has opened its new 'green academy' that will create a new city region army of low carbon heating system engineers. As part of a £1m investment into upskilling tradespeople in the latest sustainable technologies, HybridTec has built the academy at its existing headquarters in Aintree. In the first year alone it expects to welcome 140 apprentices and over 1,000 experienced heating engineers looking to upskill in the latest green technologies.

These include air source and ground source heat pumps, solar thermal hot water, and underfloor heating. Installation of such systems needs to accelerate if the Government is to hit its target of reaching net zero by 2050. Measuring 27,000 sq ft, the green academy gives apprentices of all ages – including those starting out in the industry or those looking to upskill – the opportunity to join its advanced apprenticeship training schemes. It also aims to assist the smooth transition to a more environmentally-friendly economy, helping workplaces meet the demand for green skilled workers. This will add to the 680 businesses HybridTec has already serviced with apprentices in the last 12 months. HybridTec managing director Sophie Gilmore said: "We are firmly aligned with the ambitions of Mayor Rotheram and the Combined Authority in leading the way to achieving net zero by 2040. "The green academy demonstrates our ongoing commitment to the net zero agenda – and will prepare a future workforce for careers in the green economy, ensuring no one in our industry is left behind." They have set their region's ambitious target to reach net zero by 2040 – at least a decade ahead of national government targets – and they believe they have the skills, capabilities, and political will to achieve it.

https://lbndaily.co.uk/liverpool-green-academy-opens-in-1m-investment/

EVENTS:

Hydrogen for Heritage Project

Aim: To operate 35 Hydrogen trains for a greener future.

Initially estimated at an expenditure of Rs 80 crores per train and Rs 70 crores per route for ground infrastructure, the project marks a significant investment in sustainable transportation. Vaishnaw further revealed that Indian Railways has awarded a pilot project worth Rs 111.83 crores for the retrofitment of a hydrogen fuel cell on an existing Diesel Electric Multiple Unit (DEMU) rake, in addition to the associated ground infrastructure. This pilot project is scheduled to operate on the Jind - Sonipat section of the Northern Railway.



Indian Railways has been steadfast in its pursuit of sustainable practices, with a focus on achieving 100 percent electrification. The introduction of hydrogen-powered trains will lend itself to the significant reduction of carbon emissions. As the trials are set to begin in March 2024, the General Manager of Northern Railway, Shobhan Chaudhry, has confirmed the timeline, providing assurance that initiative is well on track.

Link:

Indian Railways initiates "Hydrogen for Heritage" project, plans to operate 35 Hydrogen trains for a greener future (indiatimes.com)

New Delhi Set to Host Global Meet On Green Hydrogen Next Week

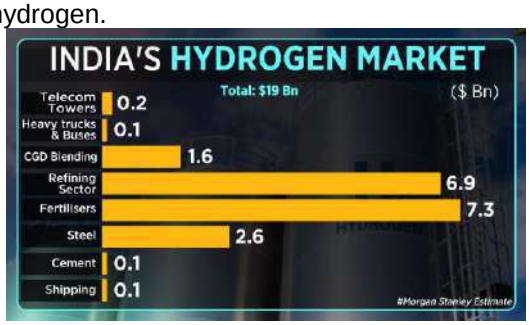
Apart from solar energy, India is also taking lead in the world in the field of new and renewable energy sources sector, and green hydrogen is certainly one of them. In that series, India is going to organise a three-day International Conference on Green Hydrogen (ICGH-2023) beginning 5th July 2023 at Vigyan Bhawan in New Delhi to bring together the global scientific and industrial community to discuss recent advances and emerging technologies in the entire green hydrogen value chain. "The conference will also guide us in determining the focus areas for R&D and on the standards and regulations needed," he said, informing that a Working Group on Standards for Green Hydrogen Manufacturing has already submitted a report comprising around 100 recommendations, to Bureau of Indian Standards and other standards-related organizations. The three-day conference will have around 25 sessions aimed at establishing a green hydrogen ecosystem, with expected participation of more than 1,500 delegates from India and abroad. Delegates will also get to hear regional perspectives on green hydrogen by the Americas, Australia, Africa, and Europe and, of course, India. The conference will also have demos, prototypes by PSUs, private companies and startups, as well as B2B and B2G meetings. The draft of the incentive scheme for electrolyzer manufacturing and part of the incentive scheme for production of green hydrogen have been finalized and will be rolled out soon. He said that the total incentives being offered under the Mission is more than Rs. 17,000 crore by 2030, which will be rolled out in tranches, so that the government will learn from the first tranche and evolve the second one.

New Delhi Set To Host Global Meet on Green Hydrogen Next Week - Oneindia News



India's hydrogen market to surge: Morgan Stanley projects $19 billion opportunity by 2030

The renewable hydrogen sector in India has attracted significant interest, with both listed and unlisted companies making substantial investments. Morgan Stanley estimates that the total addressable market for hydrogen in India could reach $19 billion by 2030, encompassing both blue and green hydrogen. Morgan Stanley's estimates indicate that the $19 billion hydrogen market in India will be divided among various sectors. The telecom space is expected to account for approximately $0.2 billion, while heavy trucks and buses will contribute around $0.1 billion. Although the usage of hydrogen in commercial vehicles may take some time to gain momentum, the city gas distribution companies are projected to create a $1.6 billion market by 2030 as they blend in green hydrogen.



The refining and fertiliser sectors will have a mandatory 25 percent usage of hydrogen, leading to a market worth between $6.9 billion to $7.3 billion. Steel is expected to be a $2.6 billion market for green hydrogen, followed by cement and shipping at $0.1 billion each. Major stakeholders are coming forth in this field, such as Reliance Industries plans to manufacture low-cost electrolysers for the production of green hydrogen for both domestic and global use. IOC is venturing into green hydrogen projects with the aim of achieving 5 percent green hydrogen production by 2027-2028 and 10 percent by 2029-2030.

Currently, the price of green hydrogen stands at $10 per kg, but it is anticipated to decrease to around $2 per kg by 2030.In fact, a recent report by the International Energy Agency (IEA) suggests that the transition to clean energy presents a significant economic opportunity in India. Clean technologies such as renewable batteries, green hydrogen, and others could create a market worth up to $80 billion by 2030. Considering Morgan Stanley's projection of $19 billion from hydrogen alone, it could contribute approximately 23-24 percent.

India's hydrogen market to surge: Morgan Stanley projects $19 billion opportunity by 2030 (cnbctv18.com)

Narayanaru, JH. *et al.*

Start-Stop Cyclic Durability Analysis of Membrane-Electrode Assemblies Using Polyflourene-Based Electrolytes for an Anion-Exchange Membrane Water Electrolyzer

https://doi.org/10.1021/acssuschemeng.2c07387

Abstract:
Highly durable trimethyl ammonium-modified poly(fluorene-alt-tetrafluorophenylene) polymer membrane and ionomer-based membrane electrode assembly for an anion-exchange water electrolyzer coupled with intermittent power sources. Highly durable anion-exchange membranes and ionomers are essential for developing cost-effective green hydrogen generation. The anion-exchange membrane and ionomer must withstand chemical attacks by OH- ions as well as nonlinear mechanical stress caused by irregular bubble formation when the electrolyzer is coupled with intermittent power sources. Herein, we examined the durability of a trimethyl ammonium-modified poly (fluorene-alt-tetrafluorophenylene) (PFT-C-10-TMA)-based membrane and ionomer under dynamic operation to evaluate its competency to couple with intermittent power sources. The durability of membrane-electrode assembly (MEA) prepared using these polymer membrane and ionomer was evaluated by performing 1000 start-stop voltage cycles in 1M KOH solution at 80 degrees C while varying the applied cell voltage. The electrochemical performances of the MEA and electrodes were simultaneously evaluated using an electrolyzer with reference electrodes, and the chemical structure of the polymer was examined before and after the durability test using NMR techniques. The MEA based on a commercial Sustainion XB-7 ionomer and X37-50 RT anion-exchange membranes showed the catalyst leaching during start-stop cycles, resulting in reduced cell performance. On the other hand, the MEAs with the PFT-C-10-TMA membrane and ionomer demonstrated promising high chemical and mechanical durability under dynamic start-stop operation, encouraging the development of electrolyzers that can function with intermittent renewable power sources.

Chavez-Angel, E. *et al.*

Exploring the Potential of Green Hydrogen Production and Application in the Antofagasta Region of Chile

https://doi.org/ 10.3390/en16114509

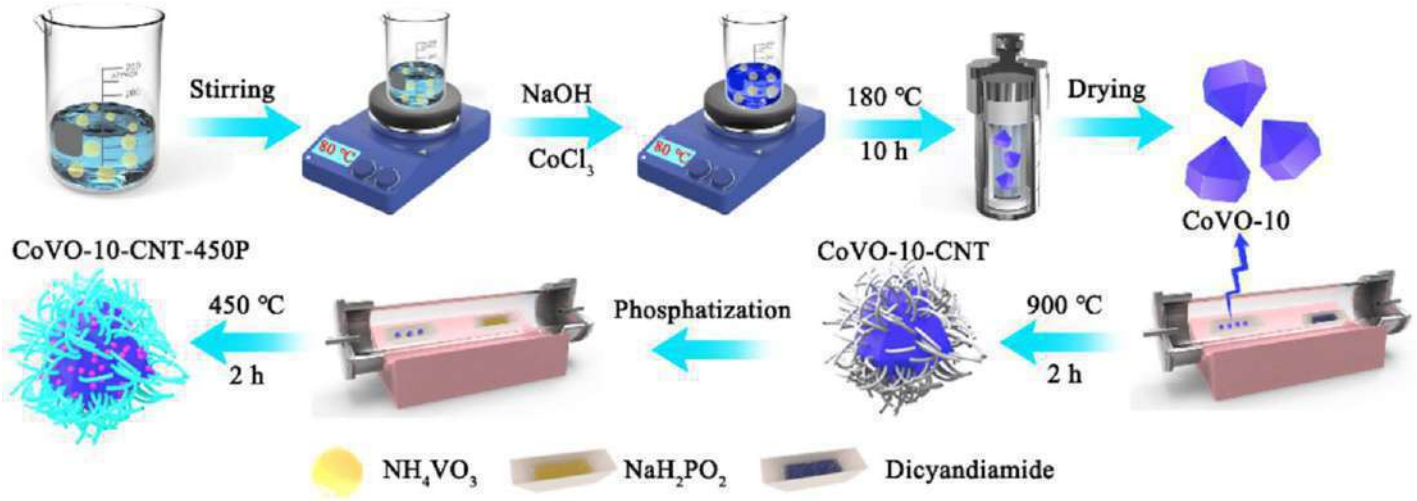
Abstract:
Green hydrogen is gaining increasing attention as a key component of the global energy transition towards a more sustainable industry. Chile, with its vast renewable energy potential, is well positioned to become a major producer and exporter of green hydrogen. In this context, this paper explores the prospects for green hydrogen production and use in Chile. The perspectives presented in this study are primarily based on a compilation of government reports and data from the scientific literature, which primarily offer a theoretical perspective on the efficiency and cost of hydrogen production. To address the need for experimental data, an ongoing experimental project was initiated in March 2023. This project aims to assess the efficiency of hydrogen production and consumption in the Atacama Desert through the deployment of a mobile on-site laboratory for hydrogen generation. The facility is mainly composed by solar panels, electrolyzers, fuel cells, and a battery bank, and it moves through the Atacama Desert in Chile at different altitudes, from the sea level, to measure the efficiency of hydrogen generation through the energy approach. The challenges and opportunities in Chile for developing a robust green hydrogen economy are also analyzed. According to the results, Chile has remarkable renewable energy resources, particularly in solar and wind power that could be harnessed to produce green hydrogen. Chile has also established a supportive policy framework that promotes the development of renewable energy and the adoption of green hydrogen technologies. However, there are challenges that need to be addressed, such as the high capital costs of green hydrogen production and the need for supportive infrastructure. Despite these challenges, we argue that Chile has the potential to become a leading producer and exporter of green hydrogen or derivatives such as ammonia or methanol. The country's strategic location, political stability, and strong commitment to renewable energy provide a favorable environment for the development of a green hydrogen industry. The growing demand for clean energy and the increasing interest in decarbonization present significant opportunities for Chile to capitalize on its renewable energy resources and become a major player in the global green hydrogen market.

Chang, HY. *et al.*

Pencil-like Hollow Carbon Nanotubes Embedded CoP-V4P3 Heterostructures as a Bifunctional Catalyst for Electrocatalytic Overall Water Splitting

https://doi.org/ 10.3390/nano13101667

Abstract:
Electrocatalytic water splitting is one of the most efficient ways of producing green hydrogen energy. The design of stable, active, and efficient electrocatalysts plays a crucial role in water splitting for achieving efficient energy conversion from electrical to hydrogen energy, aimed at solving the lingering energy crisis. In this work, CNT composites modified with CoP-V4P3 composites (CoVO-10-CNT-450P) were formed by carbonising a pencil-like precursor (Co3V2O8-H2O) and growing carbon nanotubes in situ, followed by in situ phosphorylation on the carbon nanotubes. In the HER electrocatalytic process, an overpotential of only 124 mV was exhibited at a current density of 10 mA cm(-2). In addition, as an OER catalyst, a low overpotential of 280 mV was attained at a current density of 10 mA cm(-2). Moreover, there was no noticeable change in the performance of the catalyst over a 90 h test in a continuous total water splitting experiment. The unique electronic structure and hollow carbon nanotube structure of CoVO-10-CNT-450P effectively increased the catalytic active sites, while also significantly improving the electrocatalytic activity. This work provides theoretical guidance for the design and synthetic route of high-performance non-precious metal electrocatalysts, and actively promotes the commercial application of electrochemical water splitting.



Synthetic schematic illustration of V-CoP-CNT

Joos, B. *et al.*

Facile Aqueous Solution-Gel Route toward Thin Film CuBi2O4 Photocathodes for Solar Hydrogen Production

https://doi.org/ 10.1002/adsu.202300083

Abstract:
A new benign aqueous route toward bismuth-containing photoelectrodes is proposed to eliminate the need for harmful organic solvents and/or acids. A CuBi2O4 photocathode is prepared by stabilizing the metal ions through complexation in pH neutral aqueous solutions. Merits of the proposed approach are elemental homogeneity (with unique doping possibilities) and ease of fabrication (e.g., high scalability). The prepared aqueous CuBi2O4 precursor forms a nearly phase-pure kusachiite crystalline phase free of organics residuals and capable of water reduction due to its sufficiently negatively positioned conduction band at -0.4 V versus RHE. Deposition on fluorine doped tin oxide coated glass (FTO/glass) substrates and thermal treatment leads to uniform but granular films of CuBi2O4 with excellent control over stoichiometry and thickness, owing to the facile and non-destructive synthesis conditions. Ultimately, the optimized CuBi2O4 photocathodes produce AM1.5G photocurrent densities of up to -1.02 mA cm(-2) at 0.4 V versus RHE with H2O2 as an electron scavenger, competing with bare CuBi2O4 prepared through less benign non-aqueous organic synthesis routes.

Hydrogen Digest

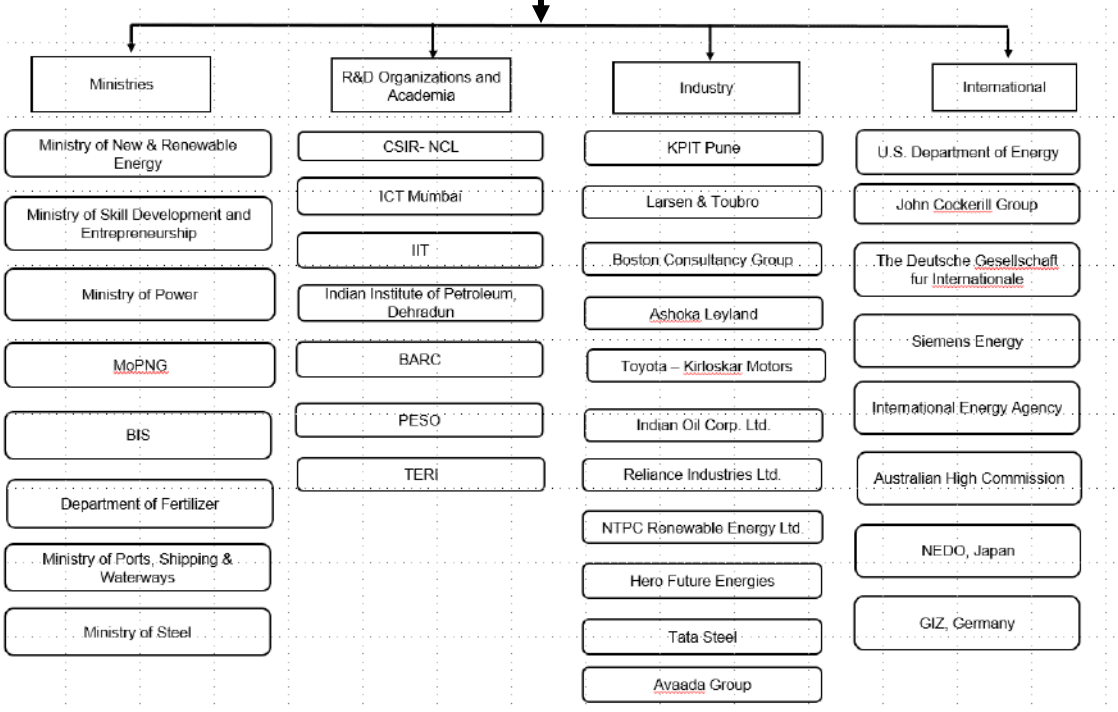
A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 40
JULY, 2023

International Conference on Green Hydrogen-2023

The International Conference on Green Hydrogen was organized for the first time by Indian Government to discuss the recent advances and upcoming technologies cross the entire green hydrogen value chain.
Venue Date: 5th – 7th July 2023
Venue: Vigyan Bhawan, New Delhi, India





INTERNATIONAL CONFERENCE ON GREEN HYDROGEN 2023

5th July 2023

Inaugral Session

Sh.Raj K Singh
Hon'ble Minister, Ministry of New & Renewable Energy Government of India

Sh. Rameshwar Teli
Hon'ble State Minister, Ministry of New & Renewable Energy Government of India

Prof. Ajay K Sood
Principal Scientific Advisor to the Government of India.

Mr. Bhupinder Singh Bhalla,
Secretary, Ministry of New & Renewable Energy Government of India

Dr. N. Kalaiselvi
Director General, CSIR & Secretary DSIR

Technical Sessions 1 &2

Hydrogen Production – Electrolysis & Biopathways

Mr. Vivek Bhide
Regional President, John Cockerill Group (Session Chair)

Prof. S Dasappa
Chair – ICER, Indian Institute of Science, Bangalore

Dr. Selvaraj Kaliaperumal,
Catalysis Division, National Chemical Laboratory

Mr. Kowtham Raj
Lead – Green Technology Development, Larsen & Toubro Ltd

EVENTS:

Hydrogen Storage, Distribution and Refuelling

Mr. Ravindra Vasisht
Independent Consultant (Session Chair)
Prof. Swati Neogi
Professor – Chemical Engineering, IIT Kharagpur
Prof. Pratibha Sharma
Department of Energy Science & Engineering, IIT Bombay
Mr. Puneet Khurana
Managing Director
Everest Kanto Cylinder Ltd
Mr. Anup S Shapeti,
Hydrogen & LNG, INOX India Limited

Hydrogen Energy Ecosystems & Assessment

Mr. Aashish Maheshwari
Associate Business Director, Evonik (Session Chair)
Mr. James Khong,
Co-Founder and COO, Galaxy FCT
Mr. Kuldeep Rai,
Executive Director
Rural Electrification Corporation Limited
Mr. Sachin Chugh,
Dy. General Manager – H2 & Fuel Cell, Indian Oil Corp. Ltd.
Mr. Loftur Thorarinsson,
Project Lead – New Energies, Mitsui O.S.K. Lines (U.K.)

Fuel Cells & Electrolyzers: Key Materials & Components

Dr. Tata N Rao
Director, ARCI (Session Chair)
Dr. N Rajalakshmi
Former Senior Scientist, Centre for Fuel Cell Technology, ARCI, IIT Madras (Virtual)
Mr. R Balu,
Head of New Projects, R&D, Thermax Ltd
Dr. Sreekumar Kurungot,
Physical & Materials Chemistry Division, NCL

World's first hydrogen-electric powered access platform

The two have agreed a three-year partnership worth £9m in the first year, that will see Niftylift manufacture and supply the zero-emission lifts at its Milton Keynes facility exclusively to Speedy Hire, alongside an additional fleet of Niftylift hybrid powered access platforms.
The machines will be delivered to Speedy Hire's Innovation Centre in Milton Keynes during July. Hydrogen-electric powered access platforms are fitted with a G20 hydrogen cylinder and fuel cell technology. This means the machines can be operated for up to five days on a single charge, with additional range available from the hydrogen fuel cell, emitting zero carbon into the atmosphere without compromising on reliability.



https://menafn.com/1106411388/Masdar-Expects-To-Produce-Over-1Mln-Tons-Of-Hydrogen-By-2030-CEO

Biden's green hydrogen plan hits climate obstacle: Water shortage

The Biden administration's climate agenda is facing an unexpected challenge in drought-prone Corpus Christi, Texas, where a proposed clean hydrogen hub would require the installation of energy-intensive, expensive and potentially environmentally damaging seawater desalination plants. The Gulf Coast port is in the running for up to $1 billion available under President Joe Biden's 2021 Infrastructure Investment and Jobs Act to create a regional hub to produce hydrogen, a low-emissions fuel made by electrolyzing water that can help decarbonize heavy-emitting industries and transportation. A hydrogen hub would require access to millions of gallons of water - a challenge in Corpus Christi which is experiencing a multi-year drought. While local officials say they can provide that water by constructing a seawater desalination plant, environmental groups and some local residents and lawmakers are lining up to oppose desalination sites.
https://energy.economictimes.indiatimes.com/news/renewable/insight-bidens-green-hydrogen-plan-hits-climate-obstacle-water-shortage/101457516

Thyssenkrupp launches hydrogen unit IPO in green push

German industrial giant Thyssenkrupp launched the IPO of its hydrogen unit Nucera today, one of the biggest European market floatations this year as interest grows in the shift to green technologies.
As countries around the world look at ways to reduce carbon emissions to help meet climate targets, hydrogen has increasingly come into focus as an alternative to fossil fuels.
Nucera produces electrolysers, which can be used to manufacture green hydrogen made using electricity obtained through renewable energy sources such as solar or wind.
Its shares started trading at €20.20 (RM102) on the Frankfurt stock exchange, slightly above the introduction price set for the stock, valuing the company at about €2.5 billion.
Nucera CEO Werner Ponikwar, speaking at the stock market before trading began, hailed the IPO as a "great achievement".
He said the company aimed to "support our customers on their way to climate neutrality... thereby shaping the new era of sustainable energy.



https://www.malaymail.com/news/money/2023/07/07/thyssenkrupp-launches-hydrogen-unit-ipo-in-green-push/78411

UK minister to launch green hydrogen tech programme on July 7

The UK's Science, Research and Innovation Minister George Freeman will on Friday launch the UK-India Hydrogen Sprint in Bengaluru, as part of collaborative efforts to develop green hydrogen technologies.

Tata Steel will be the first sponsor of the HyPartnerships Sprint series, awarding a £80,000 fund to researchers and innovators in both the countries to develop low-carbon hydrogen technologies. The initiative is aimed at supporting greener industry in India and developing technologies for improved hydrogen fuel cell performance.

EVENTS:

Hydrogen Production – Thermochemical Nuclear / Other

Prof. G D Yadav
Green Chemistry and Technology, ICT Mumbai (Session Chair)
Dr. Anjan Ray,
Former Director, Indian Institute of Petroleum, Dehradun
Dr. Srinivas Rao
Scientific Officer, Bhabha Atomic Research Centre
Mr. Jasvant Singh
Head, Development Department, Haldor Topsoe India

Hydrogen in Mobility

Prof. K A Subramanian
Professor, IIT Delhi (Session Chair)
Mr. Ravi Pandit
Chairman & Co-Founder, KPIT Pune
Mr. Sadagopan Krishnan
Sr. Vice President, Ashok Leyland
Mr. Sudeep S Dalvi
Sr. VP & Director-Technical, Toyota-Kirloskar Motors

Integrated Hydrogen Systems

Dr. J P Gupta
Managing Director, Green Hydrogen India (Session Chair)
Mr. Venkatesh M,
Chief Technology Officer, L&T
Mr. Rajat Seksaria,
Independent H2 Expert
Mr. Vishal Mehta,
Managing Director & Partner, BCG

Hydrogen in Industries

Dr. SSV Ramakumar
Director (R&D), Indian Oil Corp. Ltd. (Session Chair)
Dr. Anurag Pandey
R&D Lead, Reliance Industries Limited
Mr. Mohit Bhargava
Chief Executive Officer, NTPC Renewable Energy Ltd
Mr. Sudhir Pathak,
Head – Engineering, Hero Future Energies
Dr. Samik Nag,
Chief - Iron Making Research Group, R&D Division, Tata Steel

INDUSTRY NEWS

The UK minister has been in India since Tuesday, for the G20 Research Ministers Meeting. In Bengaluru, Freeman will also visit the new Innovating for Transport and Energy Systems (ITES) Centre at the Indian Institute of Science, which is backed by the Indian and UK governments.
https://www.deccanherald.com/city/uk-minister-to-launch-green-hydrogen-tech-programme-on-july-7-1234176.html

Netherlands' Eco-Runner XIII broke the Guinness World Record for the greatest distance driven on full tanks of hydrogen fuel.

While plug-in electric vehicles are the center of much hype, they aren't the only type of newfangled, potentially sustainable vehicle that the world's brightest minds have set their sights on. Fuel cell electric vehicles also use electricity, but instead of using a battery, they produce electricity internally using a hydrogen fuel cell. While these kinds of vehicles have been around for a while, the technology has faced plenty of challenges and hurdles—namely inefficiency and range anxiety.
However, a team of students at the Netherland's Delft University of Technology recently took a big step for hydrogen cars—and, simultaneously, broke the Guinness World Record for the greatest distance driven on full tanks of hydrogen fuel. On Sunday, June 25, the student team drove their hydrogen-fueled Eco-Runner XIII for 2,488.4 kilometers (1,546.2 miles) over the course of three days on just one kilogram of hydrogen fuel—that's about the distance between Boston and Miami. The student crew drove the 71.5 hours in rotating shifts of two hours, only stopping to switch out drivers.



https://www.popsci.com/technology/eco-runner-hydrogen-car/

Cipher Neutron Receives Purchase Order from Blade Hydrogen in Taiwan for its AEM Electrolysis Technology

Cipher Neutron Inc. ("Cipher Neutron", "CN" or the "Company") is pleased to announce that it has received an initial purchase order from Blade Hydrogen Technology Co. ("Blade Hydrogen") for a 10-Kilowatt AEM Green Hydrogen Electrolyser stack.
Blade Hydrogen is a dedicated fuel cell manufacturing and development company in Taiwan and is a spin-off of the fuel cell development department of the Industrial Technology Research Institute ("ITRI") of Taiwan. In 2022, ITRI had released a technological development plan for the application of hydrogen energy in Taiwan, in keeping with the nation's aim of achieving net zero carbon emission by 2050.
Cipher Neutron Receives Purchase Order from Blade Hydrogen in Taiwan for its AEM Electrolysis Technology (streetinsider.com)

World's first offshore green hydrogen pilot production facility now online

The world's first offshore hydrogen production facility is now online in the Atlantic Ocean, off the coast of Le Croisic, France. The platform was extensively tested on shore till May 2023 before being towed to the offshore site and restarted in just 48 hours.
As the world looks to move away from fossil fuels, hydrogen is a top choice for fueling large future projects. However, we have yet to figure out how to make large amounts of green hydrogen, which can sustainably fuel the planet's energy demands.



World's first offshore green hydrogen pilot production facility now online (interestingengineering.com)

EVENTS:

US Perspective

Chaired by

Dr. Ashish Lele,
Director, CSIR-National Chemical Laboratory

Dr Sunita Satyapal,
Director – Hydrogen & Fuel Cell Technologies Office and DOE Hydrogen Program Coordinator U.S. Department of Energy

Summary of Technical Sessions

Dr. Ashish Lele
Director, CSIR-National Chemical Laboratory

Panel Discussion on Disruptive Science & Technology

Dr. N Kalaiselvi, Director General, CSIR and Secretary DSIR (Session Chair)
Prof. Swati Neogi, Indian Institute of Technology, Kharagpur
Prof. Suddhasatwa Basu, Indian Institute of Technology, Delhi
Prof. Pratibha Sharma, Indian Institute of Technology Bombay
Prof. Prakash Vaidya, Institute of Chemical Technology Mumbai
Prof. Uttam Kumar Ghorai, Ramakrishna Mission Vidyamandir, Kolkata.
Dr. R Nandini Devi, Senior Principal Scientist, CSIR-National Chemical Laboratory

Key Speakers from CSIR at ICGH-2023

Dr. Ashish Lele
Director, CSIR-National Chemical Laboratory
Dr. Selvaraj Kaliaperumal,
Catalysis Division, National Chemical Laboratory
Dr. Sreekumar Kurungot,
Physical & Materials Chemistry Division, NCL
Dr. R Nandini Devi, Senior Principal Scientist, CSIR-National Chemical Laboratory
Dr. C S Gopinath,
Scientist H, National Chemical Laboratory
Dr. S .Venkata Mohan,
Chief Scientist, Department of Energy & Environmental Engineering, CSIR-Indian Institute of Chemical Technology (CSIR-IICT)

India Wants to Ship Green Hydrogen Abroad in Bet on Demand Surge

As nations around the world increasingly see the clean fuel as essential to the energy revolution, India hopes to become a major exporter of green hydrogen.

India presently only has research facilities for green hydrogen, not actual production capacity, but Prime Minister Narendra Modi has set a target of 5 million tonnes of annual output by the end of the decade. By exporting the gasoline, the country would earn foreign cash and boost its green image while reducing dependency on unpredictable local use.

“The demand will come largely from the export markets,” Renewable Energy Secretary Bhupinder Singh Bhalla said Wednesday at an event in New Delhi. The country can benefit from its low costs to emerge as a key supplier, he said. India has announced 48 projects so far, which would be able to produce 3.5 million tons a year if they all get off the ground. Government mandates for local consumption by industry — which developers were counting on to approach banks for funding — haven’t appeared following objections from oil refiners. Processors including Indian Oil Corp. want to produce green hydrogen at their own facilities, ensuring uninterrupted supply and saving on transport costs.

https://www.bloomberg.com/news/articles/2023-07-05/india-wants-to-ship-green-hydrogen-abroad-in-bet-on-demand-surge

Like renewable energy, Green Hydrogen in India to be cheapest in the world: RK Singh

Calling for investments in the green hydrogen sector in India, Union minister for power and renewable energy RK Singh on July 5 at an International Conference on Green Hydrogen 2023 said “Green hydrogen is the future fuel in India. Also, green hydrogen in India is going to be the cheapest compared to other countries because in we have low-cost renewable energy available in our country. It is way cheaper to set up a renewable energy plant compared to other countries and our cost of RE power is also one of the cheapest”. Renewable energy accounts for 70-75 percent of the cost of green hydrogen production. "We will help you in developing (green hydrogen) projects. We will also help you with demand as well. Come and partner with us. Like in the field of renewable energy, India shall emerge as a leader in Hydrogen also,” he said.

https://www.moneycontrol.com/news/business/like-renewable-energy-green-hydrogen-in-india-to-be-cheapest-in-the-world-rk-singh-10908721.html

India will put retaliatory barriers on green hydrogen trade, minister says

India will put up barriers in green hydrogen trade in response to other nations imposing restrictions, the nation's renewable energy ministry said at a conference on Wednesday.

As one of the world's biggest emitters of climate-warming gases, India is betting on green hydrogen to help cut its emissions and to reach its target of achieving net-zero carbon emissions by 2070. "Some countries are putting barriers on green hydrogen (trade and technology). If they are putting up barriers we will also put up barriers, then you will be losing out on our market," Power and Renewable Energy Minister R K Sing said at the International Conference on Green Hydrogen. Singh did not elaborate on what India's retaliatory barriers may be. He told the conference that Indian companies have already set plans to manufacture 3.5 million tonnes of green hydrogen. Last year, New Delhi approved a 174.9 billion rupees incentive plan for the fuel, which is made using renewable energy and without producing greenhouse gases. Prime Minister Narendra Modi has set a target to produce 5 million tonnes of green hydrogen by 2030. Earlier this year, Singh said that huge subsidies announced by some developed countries for their green hydrogen sectors can distort trade and is in violation of World Trade Organization (WTO) norms.

https://www.reuters.com/world/india/india-will-put-retaliatory-barriers-green-hydrogen-trade-minister-2023-07-05/

India in talks to supply green hydrogen to EU, Singapore

India has discussed a possible deal to supply more than 11 million metric tons a year of green hydrogen to the EU and Singapore, who in turn would invest in these Indian clean energy projects. Bilateral agreements which would allow countries to use carbon credits linked to producing so-called green hydrogen, which is made using renewable energy. Green ammonia, generally the preferred form in which the fuel is transported, is a green hydrogen derivative. "The bilateral agreements being discussed with the EU and Singapore present a significant business opportunity for Indian Green Hydrogen manufacturers," Avaada Chairman Vineet Mittal said. Indian companies such as Reliance Industries, Indian Oil & Adani Enterprises have big plans for green hydrogen. Countries around the globe are turning to hydrogen to drive a transition away from fossil fuels to address global warming.

https://www.reuters.com/sustainability/climate-energy/india-talks-supply-10-mln-tonnes-green-hydrogen-eu-2023-07-05/

Bordet, A. and Leitner, W.

Adaptive Catalytic Systems for Chemical Energy Conversion

https://doi.org/10.1002/anie.202301956

Abstract:

The rapidly growing importance of green hydrogen and renewable carbon resources as essential feedstocks for sustainable chemical value chains opens room for disruptive innovations regarding chemical production processes. The fluctuation and variability associated with non-fossil energy and raw material supply holds many challenges for catalysts to cope with the resulting dynamics. However, many new opportunities also arise once catalyst design starts to aim at performance that is "adaptive" rather than "task-specific". In this Scientific Perspective, we propose to define adaptivity in catalysis on the basis of three essential properties that are reversibility, rapidity, and robustness (R-3 rule). Promising design strategies and selected examples are described to substantiate the scientific concept and to highlight its potential for chemical energy conversion.

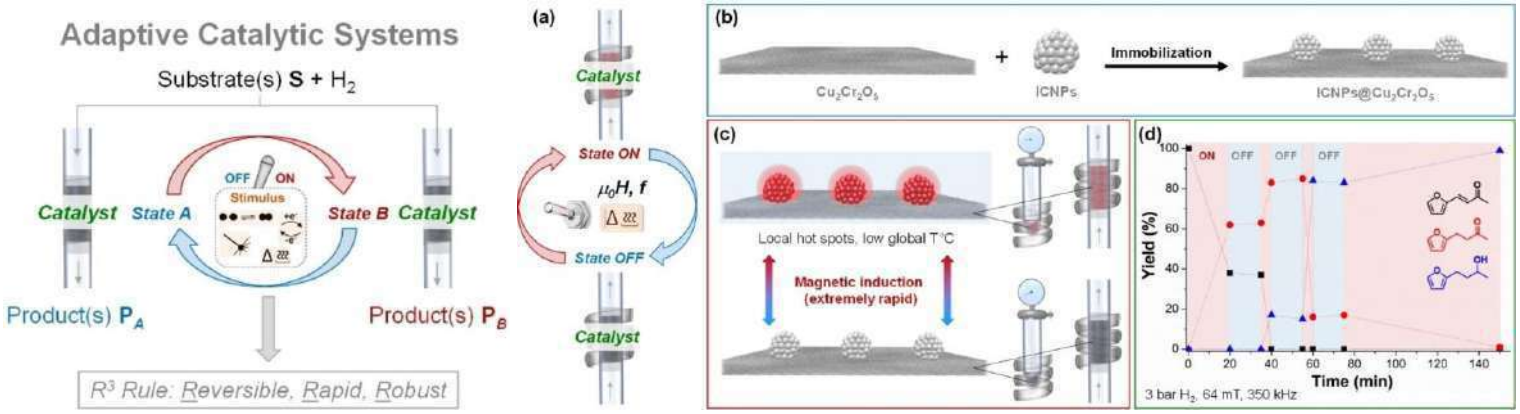


Figure: Magnetic induction heating as trigger for rapid, robust, and reversible switching of catalytic activity. Concept (a) exemplified through a recent study on the development of adaptive heterogeneous catalysts with magnetic heating capabilities (b–c) for the selective hydrogenation of aromatic ketones (d).[10] ICNPs=iron carbide nanoparticles. $\mu_0 H$=magnetic field amplitude, f=magnetic field frequency.

Beasy, K. *et al.*

Skilling the green hydrogen economy: A case study from Australia

https://doi.org/ 10.1016/j.ijhydene.2023.02.061

Abstract:

This paper explores the skills landscape of the emerging green hydrogen industry in Australia drawing on data collected from a study that gathered insights on training gaps from a range of hydrogen industry participants. A total of 41 industry participants completed a survey and 14 of those survey respondents participated in industry consultations. The findings revealed widespread perceptions of training and skilling as being very important to the industry, but under-provisioned across the sector. Data were analysed to consider the problem of skilling the green hydrogen industry and the barriers and enablers as perceived by industry stakeholders. In this paper we argue that urgent cross-sector attention needs to be paid to hydrogen industry training and skill development systems in Australia if the promise of green hydrogen as a clean energy source is to be realised.

Lin, Y. *et al.*

Operando Reconstructed Molecule Fence to Stabilize NiFe-Based Oxygen Evolution Catalysts

https://doi.org/ 10.1002/aenm.202300604

Abstract:

Economical NiFe-based oxygen evolution reaction catalysts have recently gained attention for their potential to accelerate green hydrogen production through water electrolysis. However, their practical application is limited by durability issues caused by the leaching of Fe sites during operation. Here an operando reconstructed molecule fence, that is, sulfate-anchored aromatic ring molecule, is proposed to inhibit the leaching of Fe atoms and improve the durability of NiFe-based catalysts. With this design, the sulfate not only immobilizes the aromatic ring as the protective layer to ensure long-term service but also leaves space for beneficial site exposure and mass penetration. Molecule fence-protected NiFe-based catalysts exhibit excellent stability to withstand continuous high current densities of 100 mA cm (-2) for over 2200 h and frequent current fluctuations and under start-up/shut-down events for over 200 h. Furthermore, the implementation of optimized catalysts in industrial water electrolysis equipment operates steadily for over 100 h with an energy consumption of & AP; 4.18 kWh m (-3) H-2.

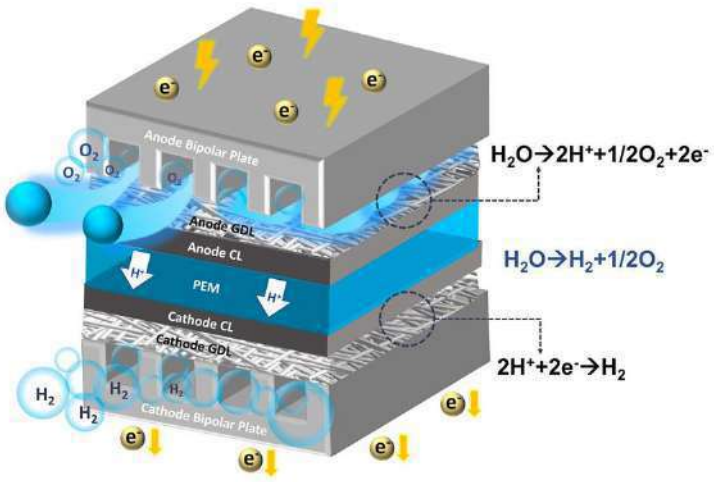
Lin, XL. *et al.*

A brief introduction of electrode fabrication for proton exchange membrane water electrolyzers

https://doi.org/ 10.1088/2515-7655/acccb1

Abstract:

Proton exchange membrane water electrolyzer (PEMWE) is a major enabler of green hydrogen production. The development of water electrolyzers is a vital step in driving the progress of a hydrogen-based economy. The system inside the electrolyzer is a zero-gap cell featuring low ohmic resistance and boosted mass transport, leading to higher energy efficiency and minimized capital cost. Besides, utilizing PEM in the electrolyzer for sustainable hydrogen production enables the system to perform with many advantages, including superior energy efficiency, higher hydrogen purity, and high flexibility. Therefore, as PEM electrolyzers continue to evolve, sustainable hydrogen production on a larger scale will be realized in the near future. This review summarizes the status quo of PEM water electrolyzers in the past four years. We will start with a brief introduction of the core of a water electrolyzer, namely the membrane electrode assembly (MEA), which will be followed by an introduction of fabrication methods of MEA, including CCM methods, catalyst-coated electrode methods, and other innovative fabrication methods. Next, we will summarize recent attempts to modify electrodes and membranes in MEAs to promote the performance of PEMWE. Subsequently, catalyst development for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) in MEA is discussed, highlighting novel HER/OER catalysts and strategies to reduce the content of noble metals. Lastly, conclusion and perspectives are provided to present a blueprint to inspire the future development of PEMWE.



Graphical illustration of a MEA and electrochemical reaction occurring at the catalyst layers

Haussermann, JJ. *et al.*

Social acceptance of green hydrogen in Germany: building trust through responsible innovation

https://doi.org/ 10.1002/adsu.202300083

Abstract:

BackgroundSocial acceptance presents a major challenge for Germany's transition to green energy. As a power-to-x technology, green hydrogen is set to become a key component of a future sustainable energy system. With a view to averting conflicts like those surrounding wind energy, we have investigated social acceptance of green hydrogen at an early stage in its implementation, before wider rollout. Our study uses a mixed-method approach, wherein semi-structured interviews (n = 24) and two participatory workshops (n = 51) in a selected region in central Germany serve alongside a representative survey (n = 2054) as the basis for both understanding social attitudes and reaching generalisable conclusions.ResultsOverall, it is possible to observe both a marked lack of knowledge and a large degree of openness towards green hydrogen and its local use, along with high expectations regarding environmental and climate protection. We reach three key conclusions. First, acceptance of green hydrogen relies on trust in science, government, the media, and institutions that uphold distributive justice, with consideration for regional values playing a vital role in establishing said trust. Second, methodologically sound participatory processes can promote acceptance, and active support in particular. Third, recurrent positive participatory experiences can effectively foster trust.ConclusionsAccordingly, we argue that trust should be strengthened on a structural level, and that green hydrogen acceptance should be understood as a matter of responsible innovation. As the first empirical investigation into social acceptance of green hydrogen, and by conceptually interlinking acceptance research and responsible innovation, this study constitutes an important contribution to existing research.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 41
JULY, 2023

Scientists develop technology to produce green hydrogen from seawater

IIT-Madras researchers have developed components for an alkaline water electrolyser that can use seawater directly to make green hydrogen. This is proposed as an alternative to the use of freshwater that is currently the key input for green hydrogen production

Research purpose:

- A team of researchers from the Department of Physics at IIT-Madras has developed a technology prototype to produce green hydrogen (GH2) from seawater in a simple and cost-effective manner.
- In a report on the approach, published in the journal ACS Applied Energy Materials, the researchers propose that the technology could support India in meet its green hydrogen target without putting pressure on fresh water, a scarce natural resource.

Aim of Research:

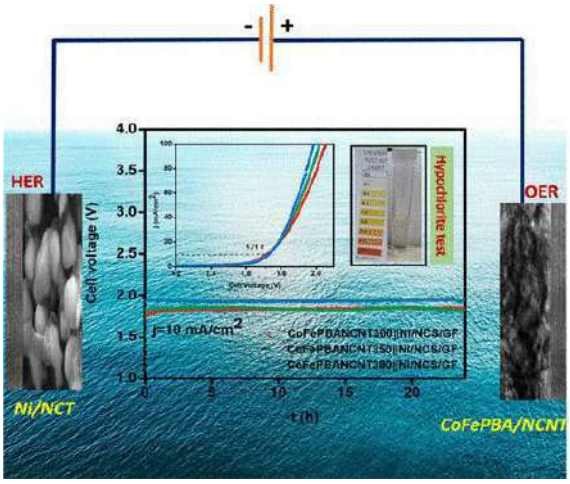
The new technology and research from IIT Madras aims to tap into the abundantly available seawater directly to make GH2, which may reduce the sole demand on freshwater. The alternative electrolyser is currently at a prototype stage and could take some time before it is commercialised. Globally, while similar research is going on, commercialisation of prototypes is limited.

Technology:

A professor at the Department of Physics at IIT Madras, Sundara Ramaprabhu, who led the team of researchers for this invention, claimed that this invention addresses the twin challenges of water scarcity and cost optimisation. The researchers used a carbon-based support material for the electrodes instead of metals to almost eliminate the possibility of corrosion.

Drawbacks:

- Chlorine corrosion
- Slow rate of hydrogen evolution
- Expensive to provide significant quantities of clean deionised water for efficient electrolysis



https://www.eco-business.com/news/scientists-develop-technology-to-produce-green-hydrogen-from-seawater/

CoFePBA Nanosheets on Carbon Nanotubes Coupled with Nickel-Encapsulated Carbon Tubules for Efficient and Highly Stable Overall Seawater Electrolysis; Anamika Ghosh, Sana Fathima T K, Dipsikha Ganguly, and Ramaprabhu Sundara. *ACS Applied Energy Materials* **2023** *6* (11), 6080-6090 DOI: 10.1021/acsaem.3c00560

Augmented Mclyzer Technology

McPhy Driving clean energy forward

New generation of **pressurized alkaline electrolysis** for large-scale platforms (multi-MW/GW).

"Augmented McLyzer" electrolyzers combine the reliability and the maturity of pressurized alkaline technology with great flexibility. They are integrated into our large-scale (multi-MW) electrolysis platforms, specifically designed for use in the industry and heavy-duty transport sectors. McPhy launched in 2018 its breakthrough "Augmented McLyzer" technology, a unique combination of our core expertise of high-pressure alkaline electrolysis and the integration of new generation electrodes with high current density (doubled compared to standard electrodes) that significantly increase the performance of equipment, all within a compact design. The solution is fully modularized and based on a 4 MW module design (McLyzer 800-30), used as a "building block". These systems produce zero-carbon hydrogen directly at 30 bar, and are designed to scale up with your operating rhythm.

https://www.directindustry.com/prod/mcphy-energy-deutschland-gmbh/product-245683-2526753.html

EVENTS:

Asia Pacific Green Hydrogen 2024

Date: 11 - 13 JUNE 2024

Venue: Borneo Convention Centre Kuching, Sarawak

https://www.h2-view.com/event/asia-pacific-hydrogen-2023-summit-exhibition/

US Hydrogen & Fuel Cells Energy Summit



Date: 27-28th September 2023

Venue: Boston - Massachusetts – USA

With the world's gaze focusing more and more on reducing emissions, and the incredible advancements in Hydrogen taking place, the time is now to explore this growing industry; the latest innovations, the state of investment and the upcoming economic opportunities.

https://www.wplgroup.com/aci/event/us-hydrogen-and-fuel-cells-energy-summit/

INDUSTRY NEWS

CPP Investments Partners With Power2X to Invest in Green Hydrogen

The partnership plans to invest an initial €130 million to accelerate the growth of Power2X as a development platform and fund green molecule projects. The investment supports Power2X's mission to become a long-term developer, owner, and operator of next-generation energy assets with a focus on green hydrogen and other clean molecules such as green methanol and ammonia. Power2X develops large-scale new energy assets and infrastructure focusing on decarbonizing industrial value chains and heavy transport in collaboration with industrial companies around the world.

The company is focused on clean hydrogen, ammonia, and methanol, with a diverse portfolio of projects that are initially prioritizing European demand. Under the terms of the deal, CPP Investments will acquire a majority interest in Power2X. CPP Investments has committed its portfolio and operations to be net zero of GHG emissions across all scopes by 2050. The organization is focused on enabling an economy-wide evolution to a low-carbon future. By joining the Sustainable Energies group's portfolio, Power2X will significantly increase its ability to lead the green molecule transition and support efforts to tackle emissions from the world's hardest-to-abate industries.

https://www.renewableenergymagazine.com/hydrogen/gt-cpp-investments-partners-with-power2x-20230712

JLEN to invest in German green hydrogen production site

JLEN Environmental Assets Group (JLEN.L) will invest up to 9.2 million euros ($10 million) in a green hydrogen production site in Germany, along with a consortium of investment funds and clean energy developer HH2E.

The production site is in Lubmin, Germany, and will be able to produce over 6,000 tonnes of green hydrogen a year during its first phase. Further development phases are expected to increase capacity to over 1 gigawatt, with annual production exceeding 60,000 tonnes of green hydrogen. The Lubmin plant will be built and operated by HH2E and will produce green hydrogen to the transport industry and large-scale energy and industrial consumers, JLEN said. A final investment decision is expected in the coming months, with construction of the plant starting straight afterwards, it added.

https://www.reuters.com/business/energy/jlen-invest-german-green-hydrogen-production-site-2023-07-10/

Adopt green hydrogen strategy now, Swiss cantons tell Bern



The Conference of Cantonal Energy Directors (EnDK) sent a letter to the Swiss government this week urging it to set up a hydrogen infrastructure in the country inspired by the European Hydrogen Backbone initiative. If Switzerland is to meet its net-zero carbon emissions targets, it must sort out how to obtain sufficient green hydrogen, a gas that can be produced from renewable energies, the 'NZZ am Sonntag' report. Hydrogen is expected to replace the use of fossil fuels by industry and for the supply of electricity.

According to the cantons, the Swiss government needs to act now. Since the country's needs cannot be met by domestic production alone, they say Switzerland must gain access to the European grid and market. They suggest in their letter, seen by news agency Keystone-SDA, that the country convert its existing transit pipeline to accommodate hydrogen. They also warn that Switzerland is being left behind by other European countries. The Hydrogen Backbone project foresees a hydrogen network crossing Italy, Austria and Germany – but not Switzerland.

Switzerland's role in the green hydrogen revolution:

The energy directors are calling for the European hydrogen grid and market to be included in exploratory talks between Bern and Brussels on an electricity agreement – or at the very least, for a joint declaration of intent stipulating the rapid opening of negotiations on Switzerland's integration into the European hydrogen market.



Adopt green hydrogen strategy now, Swiss cantons tell Bern - SWI swissinfo.ch
https://www.britannica.com/place/Switzerland

EVENTS:

HYDROGEN AMERICAS SUMMIT 2023

Date: 2-3rd October 2023
Venue: Washington, United States
https://www.h2-view.com/event/hydrogen-americas-summit-2023/

REPORTS:

Hydrogen Standards Gap Analysis



Presented by: Mr. Prashant K. Banerjee; Executive Director, SIAM (Society of Indian Automobile Manufacturers), Convenor, Hydrogen Sub Group III (MNRE)
Date: 24th April 2023
Some important standards:

- **ISO/TC 197: Hydrogen Technologies**
- **ISO/TC 58 SC 3: Gas Cylinder Design**
- **ISO/TC 220: Cryogenic Vessels**
- **ISO/TC 22: Road Vehicles**
- **ISO/TC 11: Boilers & Pressure Vessels**
- **IEC/TC 105: Fuel Cell Technologies**

https://www.energyforum.in/fileadmin/user_upload/india/media_elements/Presentations/20230424_Gap_Analysis_H2/20230424_GH2_gapanalysis_SIAM.pdf

INDUSTRY NEWS

McPhy and Technip Energies contracted for HYCC green-hydrogen plant

Djewels B.V., 100% owned by HyCC, has contracted McPhy Energy S.A. (La Motte Fanjas, France) for the electrolyzer supply and Technip Energies (Paris) for the design and construction of the planned 20 megawatt green hydrogen plant. The contract is subject to a final investment decision for the project, which HyCC aims to take later this year.

Djewels will be a state-of-art electrolysis facility located in Delfzijl, the Netherlands. The plant will be operated by HyCC using electrolysers from McPhy to produce up to 3,000 tons of green hydrogen per year from renewable power and water. The green hydrogen can be used by OCI Methanol Europe for the production of renewable methanol to reduce CO2-emissions by up to 27,000 tons per year. Other companies supporting the project include Gasunie, DeNora and Hinicio. Djewels will be the first plant at this scale using "Augmented McLyzer" technology from McPhy with higher current density, providing flexibility in production with reduced spatial requirements. This is an important development to enable the scale-up of green hydrogen production in support of the decarbonization of European industries and climate goals. Djewels is a flagship project for the Province of Groningen and the wider Hydrogen Valley in the Northern Netherlands, supporting sustainable development of regional industries. Its development was supported by the regional Waddenfonds. The project also receives support from the Clean Hydrogen Partnership (former FCH-JU) and has applied for a grant from the Dutch Ministry of Economic Affairs to support the deployment of this innovative technology.

Marcel GALJEE, Managing Director of HyCC, says: "Green hydrogen production needs to significantly scale-up in the coming years if we want to reach the European climate goals for 2030. This means we need to deploy innovative technology at scale to gain practical experience."

McPhy and Technip Energies contracted for HYCC green-hydrogen plant - Chemical Engineering | Page 1 (chemengonline.com)

Toyota to step up hydrogen fuel cells push outside Japan

Toyota has made an announcement of a breakthrough in solid-state batteries for electric vehicles. Toyota sees a much bigger business opportunity by 2030 to sell its fuel cells in Europe, China and North America compete to decarbonise and win control over energy supply chains. It also views fuel cells, with their higher energy density, as better suited for longer-range, heavy-use vehicles such as delivery trucks. The new strategy has come after Japan has missed its earlier targets in 2017. The country has built 164 hydrogen stations but has not met its target of 100 to supply green hydrogen. Toyota has also widely missed its own target to sell more than 30,000 fuel-cell vehicles annually worldwide by about 2020. Since the launch of its hydrogen-powered Mirai in 2014, it has sold fewer than 22,000 fuel-cell vehicles, including 3,924 last year. Toyota has stepped up hydrogen fuel cells outside Japan.

Toyota to step up hydrogen fuel cells push outside Japan | Financial Times (ft.com)

Federal government to spend $70 million on Newcastle 'hydrogen hub' that will power Orica

Newcastle is a step closer to becoming a hydrogen hub following a federal government commitment of $70 million. The hub will be constructed at Kooragang Island near the Port of Newcastle.

Climate Change and Energy Minister Chris Bowen visited the site on Thursday, announcing the funding for a 55-megawatt hydrogen electrolyser, which would split water into hydrogen and oxygen.



The hub is expected to produce 5,500 tonnes of hydrogen each year and create about 100 jobs. Origin Energy has partnered with explosive manufacturing company Orica to deliver the Hunter Valley hydrogen hub.

Federal government to spend $70 million on Newcastle 'hydrogen hub' that will power Orica (msn.com)

Report:

Fostering Effective Energy Transition 2023

The Energy Transition Index, which benchmarks 120 countries on their current energy system performance and on the readiness of their enabling environment, finds that while there has been broad progress on clean, sustainable energy, there are emerging challenges to the equity of the transition – just, affordable access to energy and sustained economic development – due to countries shifting their focus to energy security.

Key Highlights:

1. Global average ETI scores increased by 10% since 2014, but showed only marginal growth in the past three years.
2. Only 18% of countries in 2023 have balanced the imperatives of the energy triangle
3. Equity was compromised as the transition centered on secure and sustainable
4. The top 10 countries account for only 2% of global CO2 emissions from fuel combustion and 4% of total energy supply
5. Only 41 countries have made steady progress in the past decade

Of the 120 countries, 113 have made progress over the last decade but only 55 have improved their scores by more than 10 percentage points.

- **Sweden** leads the global rankings, followed by **Denmark** and **Norway**.
- Among the world's 10 largest economies, only **France** features in the top 10.
- The **top 10** account for 2% of energy-related CO2 emissions, 4% of total energy supply and 2% of the global population.
- Notably, large emerging centers of demand, such as **China**, **India** and **Indonesia**, have seen strong improvements.

Policies and partnerships will be at the core of shaping a balanced energy transition but only if managed effectively, by encouraging investments in clean energy, promoting innovation, encouraging energy efficiency and ensuring that the transition benefits all segments of society.

https://www.weforum.org/reports/fostering-effective-energy-transition-2023?_gl=1*1fqbsu5*_up*MQ..&gclid=CjwKCAjwwb6lBhBJEiwAbuVUSkk-sJZaqfoR3bFvj-x9yXzM9mt8EitWRIGSIDqzGhFwxhT1iybsVBoCu2cQAvD_BwE#report-nav

IIT Indore Develops Process for Production of Green Hydrogen from PET Plastic Waste

Indian Institute of Technology Indore has developed a process to produce green hydrogen gas, in large scale, from PET waste in water. The research also addresses the global issue of the recycling of PET based plastic waste by transforming 'waste to wealth'. "This method is very much in line with efforts of India towards green hydrogen production, under the National Hydrogen Mission and the global Sustainable Development Goals (SDG 7: Affordable and Clean Energy, and SDG 13: Climate Action)," a press release issued by IIT Indore said.

The Team Succeeded in Producing Purified H2 Gas (Green Hydrogen) with an effective process for the recycling of PET waste at a moderately lower temperature (160 °C). It is estimated that 33 kg of PET can generate 1 kg of hydrogen gas, which can run a hydrogen fuel cell car for 100 km. The team has been working on this project for the last 03 years, and currently several projects on hydrogen production are under progress in their research group," the release went on to add.

This work is done by the catalysis research team comprises of Ankit, Mahendra, Nirupama, and Tushar under the supervision of Prof. Sanjay K. Singh, Department of Chemistry, IIT Indore. The research work was recently published in ChemCatChem, and the group has also got an Indian Patent granted for this process. Now, the group is working to lower down the production cost and exploring the possibility to scale-up this process in collaboration with suitable industries.

https://www.freepressjournal.in/indore/iit-indore-develops-process-for-production-of-green-hydrogen-from-pet-plastic-waste

Much ado about green hydrogen

It's touted to be the next big source of energy. The Centre already has a mission in place, and a Union minister recently promoted the idea.

At the recent International Conference on Green Hydrogen (ICGH), Union minister of petroleum and natural gas Hardeep Singh Puri described green hydrogen as "an idea whose time has come". He reiterated this at the Hindustan Times event held on Tuesday, when he pointed out that the state announced a ₹19,700 crore production-linked incentive scheme to promote green hydrogen for electrolysers.

https://www.moneycontrol.com/news/business/like-renewable-energy-green-hydrogen-in-india-to-be-cheapest-in-the-world-rk-singh-10908721.html

Ethanol blending for cars is ignoring food security in India. Go for green hydrogen instead

By June 2022, almost all the petrol sold for automotive vehicles in India had achieved the 10 per cent blending target of ethanol. Earlier this year, Prime Minister Narendra Modi unveiled E20 petrol—a blend of 20 per cent ethanol with petrol. But it still has limited availability and cannot be used by vehicles that do not conform to Real Driving Emissions norms. Higher ethanol levels change mainly the plastic and rubber components of engines. While this may not be instantly noticeable in vehicles with smaller engines, you can sense a slight sluggishness in your car when you fill it with E20 fuel. The government has saved an estimated Rs 50,000 crore in foreign exchange through ethanol blending, and is projected to save Rs 30,000 crore annually with the widespread adoption of E20. Domestic production of ethanol from feedstock like sugarcane and grains will benefit Indian farmers, as Nitin Gadkari never fails to remind us. It is Atmanirbharta at its very essence.

A recent report by New Delhi-based think-tank Arcus Policy Research—one of its authors is former agriculture secretary Siraj Hussain—points out that increasing ethanol demands from the automotive industry will adversely impact both food security and land-use. It is of concern considering the role of climate change on crop patterns.

https://theprint.in/opinion/dashboard/ethanol-blending-for-cars-is-ignoring-food-security-in-india-go-for-green-hydrogen-instead/1661437/

India Unveils Draft and Roadmap for Green Hydrogen Ecosystem

The Ministry of New and Renewable Energy Sources has unveiled draft and roadmap to outline the research and development priorities for manufacturing and storing of Green Hydrogen. This roadmap and draft is issued to outline the research and development priorities for manufacturing and storing of Green Hydrogen. The main aim of this roadmap is to promote efficient, safe and cost-efficient hydrogen storage, paving the way for its widespread adoption as a clean energy source

The key objectives of roadmap and draft prepared for green hydrogen ecosystem are:

- Development of advanced storage methods
- To ensure the durability and reliability of storage systems.
- To address the safety concerns.

https://currentaffairs.adda247.com/india-unveils-draft-and-roadmap-for-green-hydrogen-ecosystem/

Marchi, CS. and Hecht, ES.

Overview of the DOE hydrogen safety, codes and standards program, part 3: Advances in research and development to enhance the scientific basis for hydrogen regulations, codes and standards

https://doi.org/10.1016/j.ijhydene.2016.07.014

Abstract:
Hydrogen fuels are being deployed around the world as an alternative to traditional petrol and battery technologies. As with all fuels, regulations, codes and standards are a necessary component of the safe deployment of hydrogen technologies. There has been a focused effort in the international hydrogen community to develop codes and standards based on strong scientific principles to accommodate the relatively rapid deployment of hydrogen-energy systems. The need for science-based codes and standards has revealed the need to advance our scientific understanding of hydrogen in engineering environments. This brief review describes research and development activities with emphasis on scientific advances that have aided the advancement of hydrogen regulations, codes and standards for hydrogen technologies in four key areas: (1) the physics of high-pressure hydrogen releases (called hydrogen behavior); (2) quantitative risk assessment; (3) hydrogen compatibility of materials; and (4) hydrogen fuel quality.

LaChance, J. et al.

Risk-informed process and tools for permitting hydrogen fueling stations

https://doi.org/10.1016/j.ijhydene.2009.01.057

Abstract:
The permitting process for hydrogen fueling stations requires demonstration that the proposed facility meets certain safety requirements. Currently, many permitting authorities rely on compliance with well-known codes and standards as evidence of a safe design. To ensure that a hydrogen facility is indeed safe, the code and standard requirements should be identified using a risk-informed process that utilizes an acceptable level of risk. This paper describes an approach for risk-informing the permitting process for hydrogen fueling stations that relies primarily on the establishment of risk-informed codes and standards. Using accepted Quantitative Risk Assessment (QRA) techniques and the established risk criteria, the minimum code and standard requirements necessary to ensure the safe operation of hydrogen facilities can be identified. To facilitate consistent risk-informed approaches, the participants in the International Energy Agency (IEA) Task 19 on hydrogen safety are working to identify acceptable risk criteria, QRA models, and supporting data.

Rivkin, C. et al.

A national set of hydrogen codes and standards for the United States

https://doi.org/10.1016/j.ijhydene.2010.03.096

Abstract:
In 2003, the U.S. Department of Energy (DOE) initiated a project to coordinate the development of a national template of hydrogen codes and standards for both vehicular and stationary applications. The process consisted of an initial evaluation to find any gaps in the existing hydrogen codes and standards, and to define the codes and standards required to fill these gaps. These codes and standards were to be developed by several standards development organizations (SDOs). This article describes the three levels of codes and standards that address hydrogen technologies for the built environment.

Level 1-Primary adopted building and fire codes.

Level 2-Hydrogen-specific codes and standards references in primary adopted code.

Level 3-Hydrogen-specific component standards referenced in hydrogen-specific codes.

Also described is the progress to date in populating these three levels with the required hydrogen codes and standards.

Kim, E. et al.

Development of Korean hydrogen fueling station codes through risk analysis

https://doi.org/10.1016/j.ijhydene.2011.07.053

Abstract:
When hydrogen fueling stations were constructed first time in Korea in 2006, there were no standards for hydrogen fueling stations. Hence the CNG (Compressed Natural Gas) station codes were temporarily adopted. In last three years, from 2006 to 2009, the studies for the development of hydrogen fueling station standards were carried out, with the support of the Korean government. In this study, three research groups cooperated to develop optimized hydrogen fueling station codes through risk analysis of hydrogen production and filling systems. Its results were integrated to develop the codes. In the first step to develop the codes, the standards for CNG stations and hydrogen fueling station were compared with each other and analyzed. By referring to foreign hydrogen fueling station standards, we investigated the potential problems in developing hydrogen fueling station codes based on the CNG station standards. In the second, the results of the high-pressure hydrogen leakage experiment were analyzed, and a numerical analysis was performed to establish the safety distance from the main facilities of a hydrogen fueling station to the protection facilities. In the third, HAZOP (Hazard and Operability) and FTA (Fault Tree Analysis) safety assessments were carried out for the on-site and off-site hydrogen fueling stations-currently being operated in Korea to analyze the risks in existing hydrogen fueling stations. Based on the study results of the above three groups, we developed one codes for off-site type hydrogen fueling stations and another codes for on-site type hydrogen fueling stations. These were applied from September 2010. Copyright (C) 2011, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

LaChance, JL. et al.

Comparison of NFPA and ISO approaches for evaluating separation distances

https://doi.org/10.1016/j.ijhydene.2012.05.144

Abstract:
The development of a set of safety codes and standards for hydrogen facilities is necessary to ensure they are designed and operated safely. To help ensure that a hydrogen facility meets an acceptable level of risk, code and standard development organizations (SDOs) are utilizing risk-informed concepts in developing hydrogen codes and standards. Two SDOs, the National Fire Protection Association (NFPA) and the International Organization for Standardization (ISO) through its Technical Committee (TC) 197 on hydrogen technologies have been developing standards for gaseous hydrogen facilities that specify the facilities have certain safety features, use equipment made of material suitable for a hydrogen environment, and have specified separation distances. Under Department of Energy funding, Sandia National Laboratories (SNL) has been supporting efforts by both of these SDOs to develop the separation distances included in their respective standards. Important goals in these efforts are to use a defensible, science-based approach to establish these requirements and to the extent possible, harmonize the requirements. International harmonization of regulations, codes and standards is critical for enabling global market penetration of hydrogen and fuel cell technologies.

Venetsanos, AG. et al.

The ADREA-HF CFD code for consequence assessment of hydrogen applications

https://doi.org/10.1016/j.ijhydene.2010.01.002

Abstract:
Application of the CFD methodology for risk assessment of hydrogen applications and associated support of regulation, codes and standards has been growing its momentum during the last years. The CFD tools applied should prove to be "adequately" validated for hydrogen applications. This contribution focuses on the hydrogen related validation work performed with the CFD code ADREA-HF. The code is a three dimensional transient fully compressible flow and dispersion CFD solver, able to treat highly complex geometries using the porosity formulation on Cartesian grids. The ADREA-HF validation effort was performed within various EC co-funded projects (EIHP, EIHP-2, HyApproval, HyPer, HySafe). Various types of hydrogen release scenarios were considered, including gaseous and liquefied releases, open, semi-confined and confined environments, sonic (under-expanded) and low momentum releases. In parallel to its validation the ADREA-HF code has been extensively used for regulations, codes and standards support.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 42
JULY, 2023

Era of "Green Hydrogen" – New Advancement Paves Way for Artificial Photosynthesis

KRISS (*Korea Research Institute of Standards and Science*) showcased the carrier transport mechanism of a photoanode with a protective film to enhance the production of green hydrogen. This advancement can aid in achieving carbon-free green hydrogen production and artificial photosynthesis.

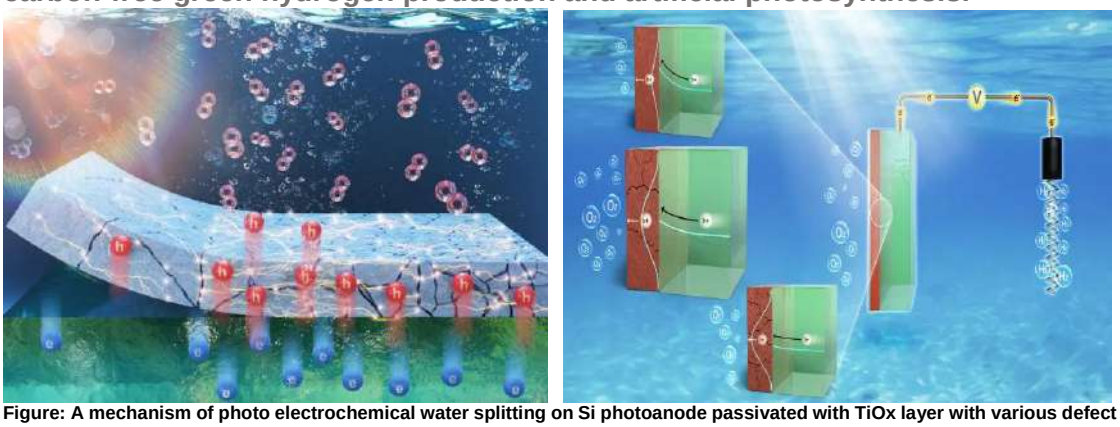


Figure: A mechanism of photo electrochemical water splitting on Si photoanode passivated with TiOx layer with various defect density. For the efficient PEC water splitting, it is crucial to balance two factors by systematically controlling the defect density in TiOx passivation layer of n-Si photoanode, which are (1) accessible density of state for carrier transportation in forbidden gap and (2) favorable interface energetics. Credit: Korea Research Institute of Standards and Science (KRISS)

Research Outcomes

- Green hydrogen is produced without carbon emissions by using renewable energy sources.
- A representative method to produce green hydrogen is photo-electrochemical water splitting using a photoanode which is directly immersed in electrolytes and can absorb sunlight.
- The photoanode directly splits contacting water into hydrogen and oxygen using absorbed solar energy. However, as the photoanode is in direct contact with an electrolyte, it is prone to surface corrosion. Surface protective coatings were deposited on the surface to prevent surface corrosion.
- Typically, oxide materials such as titanium dioxide (TiO2) are used as protective films for photoanodes. Although oxide materials are poor conductors of electricity, their conductivity can be modulated when oxygen defects, serving as a channel for charge transport, are formed.
- The key to extending the lifespan of photoanodes is to develop a protective film durable enough to prevent electrode corrosion and capable of maintaining optimal electrical conductivity by using X-ray photoelectron spectroscopy and electrochemical analysis.
- The experimental results, the photoanode without a protective film showed a rapid degradation in lifespan within an hour, causing the hydrogen production efficiency to fall below 20 % compared to the initial state.
- The photoanode with optimized protective film maintained a hydrogen production efficiency of over 85 % even after 100 hours.
- The artificial photosynthesis technology that captures carbon dioxide and converts it to a chemical energy source using solar energy is one of the examples.

Dr. Ansoon Kim, a principal researcher at KRISS Interdisciplinary Materials Measurement Institute, said, "This approach can improve photoanode lifespan by approximately 10 times and significantly contribute to the commercialization of green hydrogen. "KRISS plans to conduct further research to unveil the optimal levels of oxygen defects and underlying principles that maximize the lifespan of photoanodes.

https://scitechdaily.com/era-of-green-hydrogen-new-advancement-paves-way-for-artificial-photosynthesis/

Role of defect density in the TiO_x protective layer of the n-Si photoanode for efficient photoelectrochemical water splitting

Photo corrosion of the anode participating in photo-electrochemical (PEC) water splitting is one of the obstacles for long-term stability. To prevent photo corrosion, an "electrically leaky" thick TiO_2 film was deposited onto an n-Si photoanode surface. With modulated the defect density of the protective TiO_x $(1.98\leq x\leq 2.0)$ film with no significant change in optical and physical properties, and chemical composition.

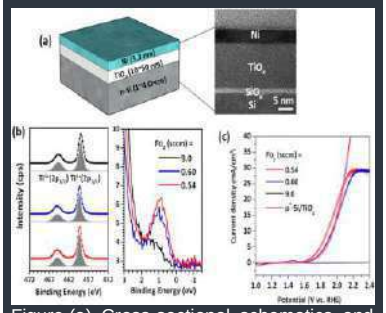


Figure (a) Cross-sectional schematics and the TEM image of the fabricated n-Si photoanode. (b) XPS spectra of the Ti 2p core level and valence band for 10 nm $TiO_{x(\leq 1.98)}$ films fabricated with different oxygen flows during sputtering. (c) Stirred cyclic voltammetry (1 sun AM 1.5G) of the n-Si photoanode protected with 10 nm $TiO_{x(\leq 1.98)}$ films in contact with 1 M KOH(aq). As a cocatalyst, 3.3 nm Ni was evaporated onto the TiO_x film.

Results:

- Modulated the defect density of the TiO_x protection layer in the n-Si photoanode without post-treatment or incorporation of impurities by using ion-beam assisted sputtering deposition.
- Fabricated TiO_x films with different concentrations of mid-gap defect states, despite no significant change in physical and optical properties of the films.
- Photoanode consisting of the 50 nm-thick TiO_x protection layer with the optimal defect density retained about 85% of the initial current density after 100 h of PEC reaction

Link:
https://doi.org/10.1039/D2TA07082K

EVENTS:

HYDROGEN BUSINESS FOR CLIMATE

DEBATE. DECIDE. DEPLOY

Venue: Belfort, France

Date: 3-4th October 2023



Aim: Climate, geopolitical and economic emergencies are converging to place the issue of hydrogen at the heart of the debate.

Obstacles: The infrastructures are being put in place, the industrial dynamic is underway, new avenues are opening up and yet obstacles remain: technological? economic? Regulatory?

Link: https://hydrogenbusinessforclimate.com/en/

World Hydrogen Week: The Global Hydrogen Event



Venue: Rotterdam, Netherlands

Date: 9-13th October 2023

The 4th annual World Hydrogen Congress returns alongside the World Hydrogen Intelligence Day and Global Hydrogen Projects Summit.

Link: https://www.worldhydrogenweek.com/?utm_source=H2View&utm_medium=affiliate&utm_campaign=Partner_Listing

INDUSTRY NEWS

"Explosions were heard:" Hydrogen bus destroyed by fire while refuelling

A hydrogen fuel cell bus was engulfed in flames while charging in California early on 18th july, but the local bus network operator says that safety mechanisms meant the fire did not spread to primary tanks at a new hydrogen fuelling station.

"The hydrogen buses were being fuelled at the time of the fire," Golden Empire Transit group said in a statement.

"One bus was destroyed and only the dispensing portion of the hydrogen fueling station was damaged. Explosions were heard and seen from the tanks on the bus that had just been filled, but the primary tanks of the actual fueling station did not ignite due to safety technology."

CEO Karen King said the situation this morning could have been worse, but credited the safety mechanisms in place and the swift action of the Bakersfield Fire Department for minimising the damage. No injuries were reported. King also said it was too soon to know the cause of the fire.



"Explosions were heard:" Hydrogen bus destroyed by fire while refuelling (thedriven.io)

Masdar, Mitsubishi, INPEX to explore world's first green hydrogen-based plastic production

Masdar, Mitsubishi Chemical Group Corporation (MCG) and INPEX CORPORATION signed an agreement to explore production of the world's first commercial-scale polypropylene made from CO2 and green hydrogen in Abu Dhabi. The green hydrogen and CO2 will be converted to e-methanol which will subsequently be converted to propylene and polypropylene.

The execution of the agreement was announced during the Japan-UAE Business Forum, in Abu Dhabi, attended by Sheikh Hamed bin Zayed Al Nahyan, Member of the Abu Dhabi Executive Council, and Japan's Prime Minister, Fumio Kishida. The three companies will investigate the techno-economic feasibility of a commercial-scale green hydrogen to e-methanol and polypropylene project.



Masdar, Mitsubishi, INPEX to explore world's first green hydrogen-based plastic production | Markets – Gulf News

Mercury proposes €200m wind farm and hydrogen plant in Mayo

Known as Firlough, the renewables project on the Mayo-Sligo border is expected to produce 4.5m kg of green hydrogen per year starting in 2025. Mercury Renewables, an energy developer based in Co Mayo and the UK, has submitted a planning application for a €200m utility-scale integrated wind farm and green hydrogen project in the north-west of Ireland to An Bord Pleanála. In an announcement on Saturday (15 July), the company said that the project will produce around 4.5m kg of green hydrogen per year. This has the potential to fuel up to 16,665 cars, 667 lorries, 1,397 buses or 125 trains annually.

Mercury proposes €200m wind farm and hydrogen plant in Mayo (siliconrepublic.com)

Tata Steel is reconsidering Dutch hydrogen plans: FD

Tata Steel in IJmuiden is reconsidering how to make its plant more sustainable and is looking at several scenarios including one that does not use green hydrogen, the Financieele Dagblad said.

In 2021, Tata announced its intention to switch to production using hydrogen instead of coal, following years of concern about pollution generated by the factory. Experts said at the time the plan was extremely ambitious and would require billions of euros in investment.

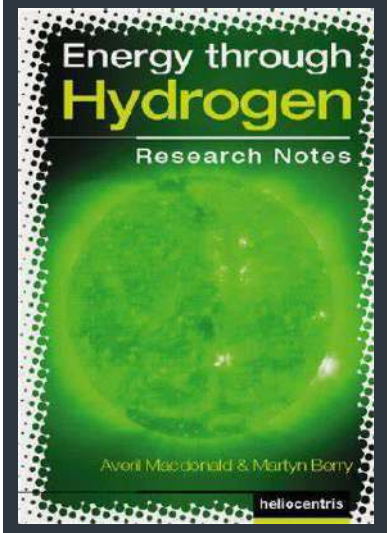
The FD says the rethink about the green plans is made plain in a report of meetings held by Tata officials with locals and other interest groups.

Tata Steel is reconsidering Dutch hydrogen plans: FD - DutchNews.nl

BOOKS:

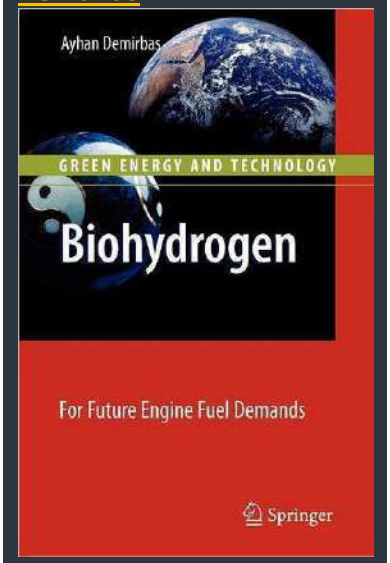
ENERGY THROUGH HYDROGEN

Research Notes



By- Averil Macdonald & Martyn Berry
www.abebooks.com

GREEN ENERGY AND TECHNOLOGY
BIOHYDROGEN
For future Engine Fuel Demands



By- Ayhan Demirbas

www.barnesandnoble.com

JCB is exploring hydrogen combustion engines for construction machinery

When we think about greening up the planet, solar panels and electric cars are often at the forefront of our mind. However, there's a whole bunch of other things out there that are spewing out carbon dioxide that also need to be cleaned up. That includes leaf blowers, lawn mowers, and yes – big equipment for construction and agricultural work!

Hydrogen can be used to produce electricity by passing it through a fuel cell, where it can then be used to power motors. Companies have explored using hydrogen in this manner to power cars and trucks. JCB initially started by looking at hydrogen fuel cells, too, but found they weren't great at delivering the instantaneous high power needed for construction machinery.



JCB Is Exploring Hydrogen Combustion Engines For Construction Machinery | Hackaday

Trucking Takes Steps towards Hydrogen Technology

Daimler Truck Holding AG is pushing a hydrogen technology as an alternative to batteries and fuel cells in the shift to zero-emission rigs. The advantage? It would be based on the truck maker's well-honed diesel engines. The world's biggest commercial vehicle maker is working on a potential partnership to develop hydrogen combustion engines — a technology long targeting only niche vehicles with heavy payloads in mining, construction or agriculture. Last week, the German company said it's ready to apply it to heavy-duty trucks once authorities classify it as zero-emission.

Trucking Takes Steps Toward Hydrogen Technology | Transport Topics (ttnews.com)

E1 to Import Canadian Hydrogen

E1, a Liquefied Petroleum Gas supplier, has secured clean ammonia from Canada. E1 plans to transport the hydrogen secured in Canada in the form of clean ammonia and use it for the hydrogen charging station business, which is currently under development.

On July 18, E1 announced that it had signed an agreement at the "Canadian Blue Ammonia Production Project Investment and Introduction Confirmation Ceremony" at LS Yongsan Tower in Seoul and will invest 10 million Canadian dollars (US$7.6 million) in the Canadian clean ammonia industry.

Through this project, E1 decided to introduce hydrogen produced from natural gas in Alberta, Canada, converted into blue ammonia to Korea. The plan is to secure and introduce 1 million tons of blue ammonia annually by 2028.

E1 to Import Canadian Hydrogen - Businesskorea

DESFA announces $1.12bn hydrogen pipeline

The operator of Greece's national grid has announced its intention to build a hydrogen pipeline connecting the country to neighbouring Bulgaria.

The proposed 540km pipeline, linking hydrogen centres in Greece and Bulgaria, will cost €1bn ($1.12bn).

Greek grid operator DESFA stated that the plans for the project have already passed an initial technical assessment from the European Commission. This will in turn make the planned pipeline eligible to become an EU Project of Common Interest as a cross border infrastructure project. In turn, this would allow it to access funding and accelerated permitting procedures.



DESFA announces $1.12bn hydrogen pipeline - Power Technology (power-technology.com)

TECHNOLOGY:

- Lhyfe is exploring ocean reoxygenation from offshore green hydrogen production by-product



- Wilo reveals off-grid green hydrogen microgrid system: H2Powerplant



- Hycamite secures €25m backing for its methane pyrolysis technology
- ITM Power awarded contract for 100MW German hydrogen project. The materials required will support the manufacturing of the 'state-of-the-art' MEP30 skids in the German project.



Link:
https://www.h2-view.com/news/electrolysers/

EVENT:

HARNESSING HYDROGEN'S POTENTIAL WITH PRAGMATISM & PACE



Venue: Kuala Lumpur
Date: DECEMBER 7 & 8, 2023
Link:
https://www.h2-viewevents.com/conference/harnessing-hydrogens-potential-with-pragmatism-pace-2023/

INDIA NEWS

HPCL setting up green hydrogen plant in Andhra: MoS Rameswar Teli

State-owned Hindustan Petroleum Corporation Limited (HPCL) is setting up a 370-tonne-per-annum electrolyzer-based green hydrogen plant at Visakh Refinery in Andhra Pradesh, Union Minister of State (MoS) for Petroleum and Natural Gas Rameswar Teli informed Parliament. The state-owned entity spent Rs 11 crore out of a total fund allocation of Rs 33 crore for this project. The scheduled completion date of the project is September this year, the minister added.

The green hydrogen mission will gradually lead to the decarbonization of industrial, transport, and energy sectors, and a reduction in dependence on imported fossil fuels, among others.India meets a sizable portion of its energy needs through imports, and this green hydrogen mission is seen as an avenue to reduce the dependence on imported fuel.

The initial financial outlay for the mission is pegged at Rs 19,744 crore, which includes research and development activities.

Under this mission, the government aims to raise annual green hydrogen production to 5 million tonnes, renewable energy capacity addition of about 125 gigawatts, attract over Rs 8 lakh crore in investments, lakhs of jobs, and most importantly over Rs 1 lakh crore cumulative reduction of fossil fuel imports.

In the Budget Speech 2021-22, Finance Minister Nirmala Sitharaman proposed launching a National Hydrogen Mission to generate hydrogen from green power sources. India has a huge edge in green hydrogen production owing to its favourable geographic conditions and the presence of abundant natural elements. In his Independence Day speech on August 15, 2021, Prime Minister Narendra Modi announced the launch of the National Hydrogen Mission. (ANI)



HPCL setting up green hydrogen plant in Andhra: MoS Rameswar Teli (webindia123.com)

REC inks MoU with Avaada Group; to invest ₹20,000 crore over five years

Avaada Group said that it has signed a (MoU) with REC under which the State-run company will invest ₹20,000 crore in the renewable energy solutions company over the next five years and was announced on the sidelines of the 4th meeting of the G20 Energy Transition Working Group (ETWG) in Goa. For over a decade, REC has extended steadfast support to Avaada, either directly or via the KfW Development Bank and World Bank line. Avaada is poised to transform India's renewable energy landscape, solidifying its role as a key contributor in the global fight against climate change.

REC inks MoU with Avaada Group; to invest ₹20,000 crore over five years - The Hindu BusinessLine

G20 ministerial meeting: India to sell green hydrogen with carbon credit



India plans to strike bilateral deals to sell green hydrogen at the G20 ministerial meeting in Goa. India will be holding bilateral meetings with eight countries namely Japan, South Korea, Singapore, Australia, USA, France, Germany and the European Union (EU) during the G20 energy transition meeting in Goa. On the margins, the 14th Clean Energy Ministerial (CEM) and 8th Mission Innovation (MI) meeting will also be held in Goa during July 19-21. The discussion will centre around building up the framework in terms of common standards, regulations, certifications and sharing of carbon credits. The 6 priority areas include energy transitions through addressing technology gaps; low-cost financing for energy transitions; energy security and diversified supply chains; energy efficiency, industrial low-carbon transitions, and responsible consumption; fuels for future; and universal access to clean energy and just, affordable, and inclusive energy transition pathways. The G20 ministerial meeting will be followed by the launch of the Green Hydrogen Innovation Centre by power minister RK Singh and the Global Biofuel Alliance by petroleum and natural gas minister Hardeep Singh Puri, both on July 22.

G20 ministerial meeting: India to sell green hydrogen with carbon credit | The Financial Express

Thangamuthu, M. *et al.*

Tungsten Oxide-Based Z-Scheme for Visible Light-Driven Hydrogen Production from Water Splitting

https://doi.org/10.1021/acscatal.3c01312

Abstract:

The stoichiometric water splitting using a solar-driven Z-scheme approach is an emerging field of interest to address the increasing renewable energy demand and environmental concerns. So far, the reported Z-scheme must comprise two populations of photocatalysts. In the present work, only tungsten oxides are used to construct a robust Z-scheme system for complete visible-driven water splitting in both neutral land alkaline solutions, where sodium tungsten oxide bronze (Na0.56WO3-x) is used as aH (2) evolution photocatalyst and two-dimensional (2D) tungsten trioxide (WO3) nanosheets as an O-2 evolution photocatalyst. This system efficiently produces H-2 (14 & mu; molh (-1)) and O-2 (6.9 & mu; molh (-1)) at an ideal molar ratio of 2:1 in an aqueous solution driven by light, resulting in a remarkably high apparent quantum yield of 6.06% at 420 nm under neutral conditions. This exceptional selective H-2 and O-2 production is due to the preferential adsorption of iodide (I-) on Na0.56WO3-x and iodate (IO3 (-)) on WO3, which is evidenced by both experiments and density functional theory calculation. The present liquid Z-scheme in the presence of efficient shuttle molecules promises a separated H-2 and O-2 evolution by applying a dual-bed particle suspension system, thus a safe photochemical process.

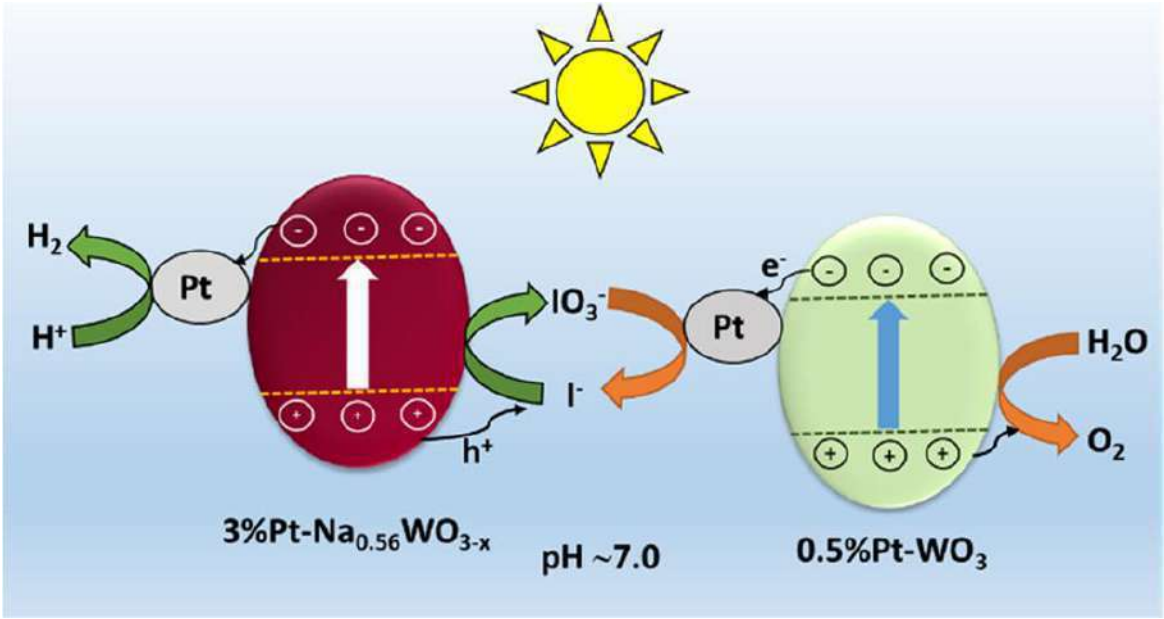


Figure: Proposed Reaction Pathway for the New WOZ Water Splitting System

Chauhan, D. *et al.*

Alkaline Water Splitting Using Hafnium-Based Stable and Efficient Bifunctional Electrocatalyst

https://doi.org/10.1002/cctc.202300562

Abstract:

The desire to achieve sustainable development goals inspired exploring green energy as a favorable alternative to hazardous fossil fuel-based energy. Alkaline water electrolysis is a promising candidate for producing low-cost pure green hydrogen; however, the efficiency of non-precious transitional metal-based catalysts is still behind noble electrocatalysts (like Pt and IrO2). To make hydrogen a next-generation fuel, the replacement of high-cost scarce noble metal is required. An attempt has been made to use a non-precious transitional bimetallic combination of hafnium nickel diselenide/ reduced graphene oxide (HfNiSe2/rGO) for HER, OER, and overall water splitting. HfNiSe2/rGO demonstrated good electrocatalytic performance; for achieving 10 mA/cm(2) of current density, the overpotential requirement is 162 mV for hydrogen evolution reaction (HER) and 320 mV for oxygen evolution reaction (OER) at 20 mA/cm(2) of current density. Similarly, a low Tafel slope is required, 49 mV dec(-1) for HER and 66 mV dec(-1) for OER in 1 M KOH with high stability. HfNiSe2/rGO also showed highly stable activity for overall water splitting, requiring only 1.56 V to attain 10 mA/cm(2) of current density. The result indicates HfNiSe2/rGO is a suitable electrocatalyst for green hydrogen generation because of its ease of production, economical, good activity, and stability towards water splitting.

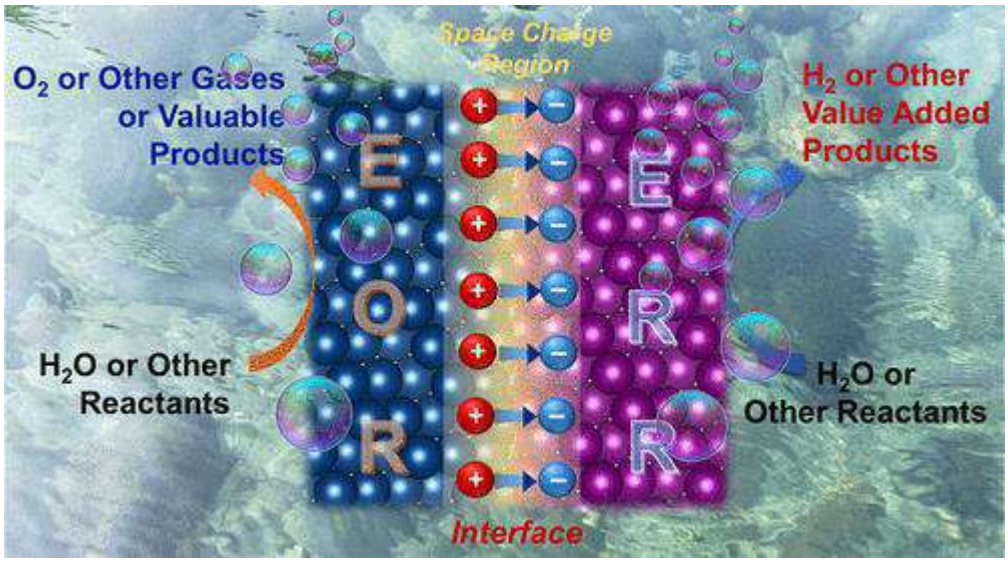
Pal, S. *et al.*

Heterojunction Engineering for Electrocatalytic Applications

https://doi.org/10.1021/acsaem.3c01058

Abstract:

Production of green hydrogen from the electrolysis of water is considered to be one of the most desirable processes to address the clean energy demand. However, a high energy barrier and an economically unsustainable nature limit the process toward practical implementation in an extensive way. The designing of an electrocatalyst accompanied by defect engineering, heteroatom doping, and strain creation are known to be effective strategies to make the process efficient. Recently, construction of heterojunctions with a combination of materials with desired band structures is considered to be a smart approach in promoting electrocatalytic activities by attaining charge redistribution and manipulating the electronic structure at the interface. The present review elaborately discusses possible heterojunctions, alteration sat the interface, insight thermodynamics, and possible causes for boosting electrocatalytic activities. The heterojunction-based electrocatalysts are found not only effective for oxygen evolution reactions and hydrogen evolution reactions, but also to be very useful toward various electrochemical oxidation reactions as well as electrochemical reduction reactions involving small molecules undergoing decomposition at very low energy. Having such a specialty, there is no doubt that heterojunction-based electrocatalysts are going to be the primary choices of researchers in coming years.



Graphical illustration

Lee, JM. And Xydis, G.

Floating offshore wind projects development in South Korea without government subsidies

https://doi.org/10.1007/s10098-023-02564-6

Abstract:

The South Korean government is encouraging the active participation of power generation companies in the offshore wind power project by announcing the renewable energy certificates (REC) weighting plan. However, from a long-term perspective, the offshore wind power must be able to generate profits without government support to demonstrate its business feasibility and attract the voluntary participation of power generation companies. This is because government support may be subject to change, depending on the internal and external political circumstances of the country. This report calculates the expected costs for a 495 MW floating offshore wind farm in South Korea's market environment and examines how the feasibility of the project shifts depending on the country's current REC weights. Furthermore, this study intends to determine whether floating offshore wind power can generate profits without the Korean government's support by calculating the expected profit in combination with the green hydrogen project. The net present value, levelized cost of energy and internal rate of return (IRR) indexes are calculated according to the project's specific particularities, such as power purchase agreement, REC weighting, distance from shore and sea depth. Based on this, an index-based comparison is revealed and the margin for profitability for such an investment is discussed. The calculation results revealed that with a decrease in capital expenditures and operating expenditure or an increase in the system marginal price under specific assumptions, the value of IRR increased.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 43
JULY, 2023

New Technology on Production of Hydrogen more efficiently by using Zinc batteries

It promises 50 percent efficiency when storing power and 80 percent when producing hydrogen – with an estimated life expectancy of ten years. Such long-term storage solutions are necessary, given the unpredictable nature of such resources. Such uncertainty has prompted authorities to maintain conventional power plants, sustain a "complex dual power infrastructure, burn fossil fuels, and hold back the transition to renewables."

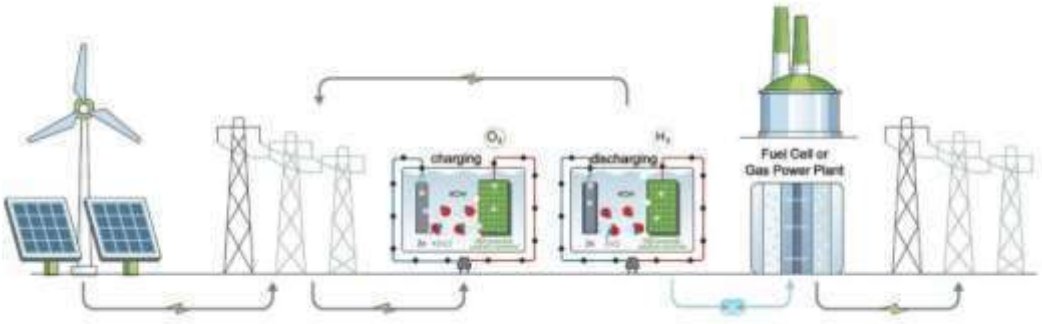


Figure: Schematic diagram (*The ZnH2 Project*)

Breakthrough: A more affordable and sustainable solution

- The traditional zinc anode battery designs served as the starting point for the research. The researchers developed an approach using alkaline water electrolysis that is significantly less expensive than conventional lithium batteries and employs commonly available, entirely recyclable components (steel, zinc, and potassium hydroxide).
- The technique additionally rendered positive that the system could manufacture hydrogen as needed. The goal of the researchers is to create a hydrogen storage device that can store energy in metallic zinc and transform it back into electricity and hydrogen when needed.
- During charging, the water oxidizes into oxygen while the zinc oxide is reduced to metallic zinc. During discharge, this reverts to zinc oxide. The water is reduced once more, releasing Hydrogen. "This is a unique combination of a regular battery and a source for hydrogen, with a total electrical storage efficiency of 50%, which is double the efficiency of other, currently preferred power-to-gas systems," Dr. Robert Hahn of Fraunhofer IZM, In-charge, ZnH2 Project.

Achievement:

In conventional electrolysis, electricity is used to split Hydrogen and oxygen; the former is then cooled, compressed, and stored in high-pressure tanks (350-700 bar) or deep cooled and liquefied. In this process, the total electricity demand is about 73 kWh/kg of Hydrogen. Hydrogen provides about 33kWh/kg once cooling and compression losses are considered. In short, electrolysis is less than 50% efficient.

In the new system, during discharge, the metallic zinc is converted into zincate, and the cell releases hydrogen and 8.3 kWh of electricity per kg of hydrogen released – improving net efficiency and reducing total power demand.

https://interestingengineering.com/innovation/this-tech-can-produce-hydrogen-on-demand-by-using-more-efficient-zinc-batteries

Hydrogen from sunlight: US researcher set conversion efficiency record

Built using inexpensive semiconductors, the device packs all components to make hydrogen and can be scaled. A research team led by Aditya Mohite, a professor of chemical and biomolecular engineering at Rice University in the US, has designed a device that can use sunlight to generate hydrogen, with a record efficiency of 20.8 percent



Still images from a video showing how the reactor works
Mohite lab/Rice University

Achieving high solar-to-hydrogen (STH) efficiency concomitant with long-term durability using low-cost, scalable photo-absorbers is a long-standing challenge. Here we report the design and fabrication of a conductive adhesive barrier (CAB) that translates >99% of photoelectric power to chemical reactions. The CAB enables halide perovskite-based photoelectrochemical cells with two different architectures that exhibit record STH efficiencies. The first, a co-planar photocathode-photoanode architecture, achieved an STH efficiency of 13.4% and 16.3 h to t60, solely limited by the hygroscopic hole transport layer in the n-i-p device. The second was formed using a monolithic stacked silicon-perovskite tandem, with a peak STH efficiency of 20.8% and 102 h of continuous operation before t60 under AM 1.5G illumination. These advances will lead to efficient, durable, and low-cost solar-driven water-splitting technology with multifunctional barriers.

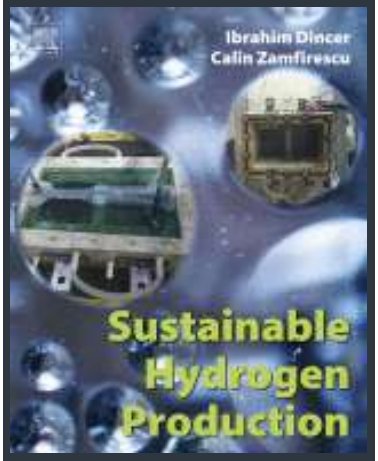
Link: https://interestingengineering.com/science/device-generating-hydrogen-using-sunlight-record

Book:

Sustainable Hydrogen Production

Authors: Ibrahim Dincer and Calin Zamfirescu

ISBN: 978-0-12-801563-6
DOI: https://doi.org/10.1016/C2014-0-00658-2



Key Features

- Addresses the fundamentals of hydrogen production using electrical, thermal, photonic, and biochemical energies.
- Presents new models, methods, and parameters for performance assessment.
- Provides historical background where appropriate.
- Outlines key connections between hydrogen production methods and environmental impact/sustainable development.

Link:

https://www.sciencedirect.com/book/9780128015636/sustainable-hydrogen-production

INDUSTRY NEWS

Spain's Enagas to gauge hydrogen appetite as it seeks EU subsidies

Spanish natural gas grid operator Enagas is to start gathering data on hydrogen supply and demand as it moves forward with plans for national and international hydrogen pipelines it expects will get significant European Union subsidies.

Enagas is positioning itself to play a major role in the Spanish and European energy transition, moving from its traditional role as natural gas grid operator to managing a network of hydrogen infrastructure.

The company is to launch a non-binding call of interest on Sept. 14 to understand who are the potential major customers and suppliers of its planned Spanish hydrogen trunk network.

https://auto.economictimes.indiatimes.com/news/industry/spains-enagas-to-gauge-hydrogen-appetite-as-it-seeks-eu-subsidies/102156716

Quebec Rails Test Hydrogen-powered Train For First Time In North America

With the successful trial of North America's first hydrogen-powered train, Quebec, Canada, has made history in environmentally friendly transportation. This innovative programme represents a big step towards lowering carbon emissions and promoting environmentally friendly rail travel. Hydrogen fuel cells power this cutting-edge locomotive, which operates while emitting just water vapour and no hazardous emissions. The trial was designed to evaluate the train's effectiveness and viability for use in the future. Environmentalists and transportation fans have expressed interest in the train's cutting-edge technology. This hydrogen-powered train offers a viable alternative to fight climate change and lessen the carbon footprint of the transportation industry, in contrast to conventional diesel-powered trains, which significantly contribute to glasshouse gas emissions.



https://www.indiatimes.com/amp/trending/social-relevance/first-hydrogen-powered-train-in-north-america-runs-on-quebec-rails-609983.html

German cabinet approves updated national hydrogen strategy

The German cabinet on Wednesday approved an updated hydrogen strategy, setting guidelines for hydrogen production and transport infrastructure plans as Europe's largest economy aims to become climate-neutral by 2045. Germany is seeking to expand reliance on hydrogen as a future to make its economy greener and after Russian gas imports dropped last year in the wake of Moscow's invasion of Ukraine. Under the updated strategy, the government raised its domestic electrolysis capacity target for 2030 to at least 10 gigawatts (GW) from a previous 5 GW. State aid is expected to be approved for around 2.5 GW of electrolysis projects this year under the strategy, which sees German hydrogen demand at 95 to 130 terawatt hours (TWH) in 2030, of which around 50% to 70% would be covered by imports. "A domestic supply that meets demand would neither make economic sense nor serve the transformation processes resulting from the energy transition as a whole," the strategy read. The strategy allows the usage of hydrogen produced through lower-carbon energy sources but limits direct government subsidies for hydrogen produced through renewables, dubbed as "green".

German Hydrogen Strategy: German cabinet approves updated national hydrogen strategy, ET Auto (indiatimes.com)

Germany seeks hydrogen-exporting friends in global south

Hydrogen is seen as a fuel of the future because it does not directly contribute to global warming. Ministers in Berlin see it as an answer for sectors such as heavy industry that are difficult to run on electricity. Germany has a target of being carbon neutral by 2045. However, hydrogen has to be split off from water before it can be burnt as fuel. Only if this is done using renewable energy is it known as “green hydrogen”.

Germany announced that it would double a target of domestic production from five gigawatts to 10 by 2030, even as it looks to imports to cover most of its future needs.

This is a huge missed opportunity to clearly prioritise green technology … instead, the government is banking on blue hydrogen indefinitely and is thereby enabling the gas sector to keep mining for fossil gas.

https://www.thenationalnews.com/world/europe/2023/07/26/germany-seeks-hydrogen-exporting-friends-in-global-south/

EVENTS:

Positioning Hydrogen 2023: The 3rd Global Hydrogen Energy Meet



Venue: Melbourne, Australia
Date: 27-29th November 2023

Hydrogen is predicted to generate $700 billion in investment by 2030 in order to meet global requirements. The investment roadmap, on the other hand, remains foggy. Uncertain policies and frameworks, the supply-and-demand dilemma, financing ambiguity, and a lack of infrastructure all impede the growth of the global clean hydrogen economy. Energy Oceania 2023 will be held concurrently and will embrace high-level plenary presentations, specialised workshops, trainings, concurrent guest lecture sessions, debate panels, and poster presentations. The event will cover all elements of energy research, from the basics of physics to the engineering of energy production, storage, and transport, as well as economics, regulations, and safety as they pertain to a future hydrogen economy.

Link: https://hydrogenconferenceaustralia.com/

Northam green hydrogen hub set to supply renewable energy to heavy vehicles

Buses, concrete mixers, rubbish trucks and road trains powered by green hydrogen could hit West Australian roads in the next 18 months.

Proponents of a new green hydrogen plant under construction in Northam, an hour east of Perth, say the facility will be the first in the country to commercially produce green hydrogen for vehicles.

Last week, the project picked up a $5-million grant from the state government to help kick things along. The project is owned by Infinite Green Energy (IGE) in partnership with Samsung C&T Engineering & Construction and Doral Energy Group.

Northam green hydrogen hub set to supply renewable energy to heavy vehicles (msn.com)

Green Hydrogen Production in South Wales Offers Exciting Energy Opportunities

Wales & West Utilities has visited a pioneering hydrogen production site in South Wales to assess the adaptions needed to transform the gas network in order to meet the Government's net zero targets. The visit to the Protium facility in Baglan Energy Park, Port Talbot, offered senior members of the Wales & West Utilities Executive team the opportunity to see the process of hydrogen production in action.

Earlier this year Protium, the leading green hydrogen company, together with partners, Fuel Cell Systems Ltd, Enapter and the University of South Wales, commenced operations to generate green hydrogen at the site, named Pioneer One. Commissioning the Pioneer One site marked a significant milestone in building a network of hydrogen generating facilities for the UK's green hydrogen infrastructure and plays host to the UK's largest integrated electrolyser – the critical technology that produces low-emission hydrogen from renewable electricity. This 100kW technology has the potential capability of displacing 111 tonnes of CO_2 per year, the equivalent to planting 4,440 trees or offsetting emissions of 113 return flights from London to New York.

Green Hydrogen Production in South Wales Offers Exciting Energy Opportunities (businessnewswales.com)

RWE, Mitsui, and Port of Tilbury sign MoU on green hydrogen projects to decarbonise port operations

RWE, one of the UK's largest power generators, along with global trading and investment company Mitsui, and the Port of Tilbury have signed a memorandum of understanding (MoU) to develop two green hydrogen projects that will help decarbonise operations at the port in Essex. The Port of Tilbury is the largest of eight ports owned by Forth Ports, and the largest multi-modal port in the South East. .

In an effort to decarbonise its operations, the Port of Tilbury will work with RWE and Mitsui on a small scale 10 MW proof-of-concept demonstrator project to produce green hydrogen that will supply its infrastructure as well as surrounding industry.

The project will be developed at a site that previously housed a coal-fired power station, and the partners will also look at options to scale up the development to 100 MW over a ten-year period. Hydrogen is seen as a promising component in helping the UK achieve its 2050 net zero ambitions, but it is not a panacea that will fix everything, the UK government has said.

RWE, Mitsui, and Port of Tilbury sign MoU on green hydrogen projects to decarbonise port operations - News - The Chemical Engineer

Azerbaijan Has Excellent Opportunity To Become Green Hydrogen Supplier To Europe



https://www.worldatlas.com/maps/azerbaijan

Europe is committed to achieving very ambitious climate targets by 2030 and achieving net-zero by 2050. Azerbaijan can free enough gas to export as much as 20bcm gas to Europe. A study was conducted by the European Bank for Reconstruction and Development (EBRD) confirmed the feasibility of producing green hydrogen in Azerbaijan.

Azerbaijan Has Excellent Opportunity To Become Green Hydrogen Supplier To Europe | MENAFN.COM

EVENTS:

European Hydrogen Week 2023

Venue: Brussels, Belgium

Date: 20-24th November 2023

In the global race to reach the Paris Agreement targets, hydrogen technologies are increasingly at the centre of attention and are now considered crucial and lucrative opportunities.

That's why more and more companies and investors are prioritising hydrogen. Yet, every business decision carries a risk and, to mitigate them, connections and knowledge-sharing are key. This event is a melting pot of powerful and influential leaders, policy makers, researchers, and end users each looking for the next big thing. Companies will find customers, investors and partners in the exhibition area as well as able to attend thought-provoking conferences.

Link:

https://euhydrogenweek.eu/

Adani meets Sri Lankan President, proposes green hydrogen project

Billionaire Gautam Adani on Friday proposed to set up a green hydrogen plant in Sri Lanka, where his conglomerate is already developing a container terminal and a 500 MW wind project. Adani met visiting Sri Lankan President Ranil Wickremesinghe to discuss ongoing projects and the new venture.

The Adani Ports and Special Economic Zone (APSEZ) is developing a USD 700 million container terminal at Colombo Port, which is a major transshipment hub in South Asia.The Adani group is also developing the Vizhinjam seaport project in Kerala, just 176 nautical miles from the Colombo port. The conglomerate's renewable energy firm, Adani Green Energy, is setting up two wind projects of 286 MW in Mannar and 234 MW in Pooneryn at an investment of USD 500 million. The projects are to be completed by December 2024.

Green hydrogen is the new project that the billionaire indicated without giving details. Green hydrogen is considered cleaner than other forms of hydrogen as it is produced by splitting water using renewable energy. Hydrogen emits water vapour when it burns.

Adani New Industries Ltd (ANIL) is targeting to produce one million tonnes of green hydrogen by 2030.

Adani meets Sri Lankan President, proposes green hydrogen project (msn.com)

Why states are considering green hydrogen for cleaner cities

The Sikkim government's effort to create a green hydrogen hub in the state is seeing interest from an unlikely organisation — The Korea Research Institute for Human Settlements (KRIHS). The reason: as soon as there is a breakthrough and green hydrogen can be generated for fuel or commercial uses, the biggest beneficiaries would be towns and cities which have to work under zero carbon norms. Today green finance is chasing large and innovative projects. The Sikkim Ministry of Industry has signed a memorandum of understanding (MoU) with the Construction Industry Development Council (CIDC), an autonomous body of the Planning Commission to work with the sector.

This project will help Sikkim tap hydel energy to create a green hydrogen hub that would make it self-sufficient in energy and manage its green goals.

With an estimated statewide population of just 6.7 lakh, this project has the potential to generate about 25,000-30,000 jobs, which would account for a large part of the employable urban youth. The jobs that are currently on the skills training agenda include production, maintenance, handling the fuel and setting up the plants among others.

Why states are considering green hydrogen for cleaner cities (moneycontrol.com)

HPCL's Green Hydrogen Plant: A Leap Towards Sustainable Energy in Andhra Pradesh



Hindustan Petroleum Corporation Limited (HPCL) has embarked on a path towards a greener and more sustainable future by constructing a green hydrogen plant in Visakh Refinery, Andhra Pradesh.

This significant move is in line with India's National Green Hydrogen Mission, which aims to establish India as a global leader in green hydrogen production, utilization, and export.

The plant is designed with an electrolyzer capacity of 370 tons per annum, marking a significant stride towards reducing India's dependence on imported fossil fuels. The plant, set to be fully operational by September of this year, is a testament to the Indian government's commitment to renewable energy.

The green hydrogen project at the Visakh refinery is a part of a larger initiative that includes solar projects in Karnataka with a total capacity of 3.6 MW. According to State Minister Rameswar Teli, state-run refiners are planning to set up projects to produce 30.8 kilotonnes a year of green hydrogen by 2030.

In conclusion, the establishment of the green hydrogen plant by HPCL is a significant step towards realising India's renewable energy aspirations. It not only aligns with the government's National Green Hydrogen Mission but also exemplifies HPCL's commitment to fueling a greener future.

HPCL's Green Hydrogen Plant: A Leap Towards Sustainable Energy in Andhra Pradesh (psuconnect.in)

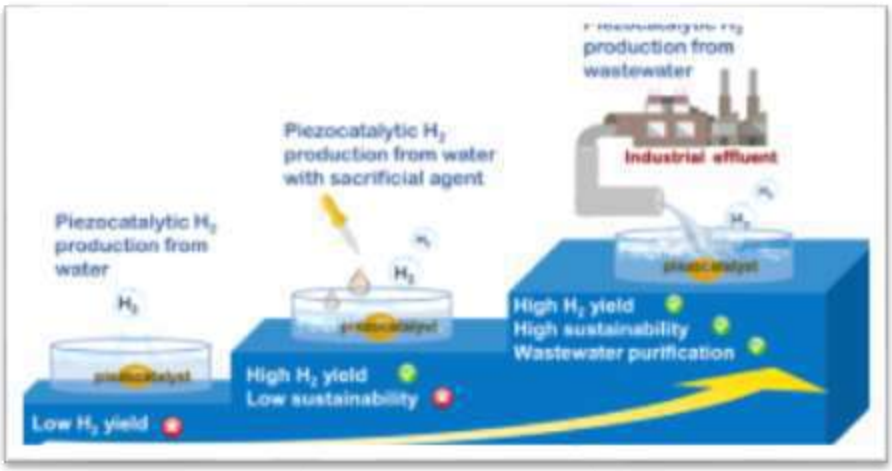
Chen, Z. *et al.*

Piezoelectric hydrogen production from aliphatic alcohols and acids in wastewater

https://doi.org/10.1007/s10311-023-01621-2

Abstract:

The growing energy demand in the context of climate change issues requires the development of green fuels such as hydrogen from water. Piezocatalytic water splitting is promising for producing green hydrogen, yet this process is often limited by low efficiency and low sustainability. Here we developed an efficient method to use wastewater directly for piezocatalytic hydrogen production. Magnetic cerium-doped bismuth ferrite was employed as the piezocatalyst to collect mechanical energy. The performance of hydrogen production was compared using different types of organic wastewaters containing alcohols, organic acids, phenols, and surfactants. Results showed a maximum hydrogen yield of 2114 & mu mol per g from a 2.5 mg per L alcoholic mixture in wastewater. This high yield is explained by the fact that alcohols act as sacrificial donors to suppress electron site recombination and the reverse reaction. Overall our findings represent a new strategy for piezocatalytic hydrogen production from wastewater.



Graphical illustration

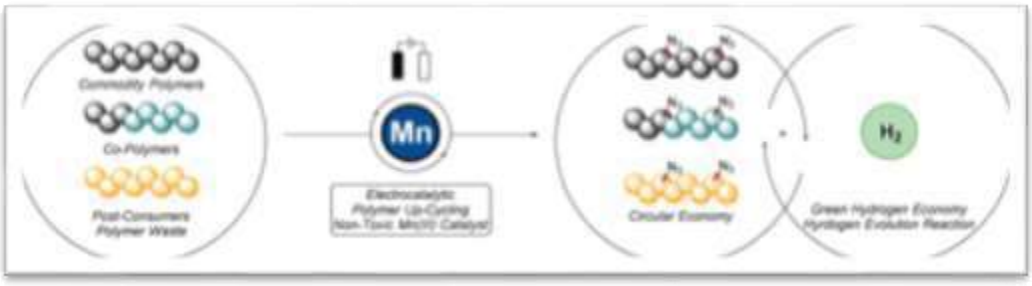
Maksso, I. *et al.*

Polymer up-cycling by mangana-electrocatalytic C (sp(3))-H azidation without directing groups

https://doi.org/10.1039/d3sc02549g

Abstract:

The chemical up-cycling of polymers into value-added materials offers a unique opportunity to place plastic waste in a new value chain towards a circular economy. Herein, we report the selective up-cycling of polystyrenes and polyolefins to C(sp(3))-H azidated materials under electrocatalytic conditions. The functionalized polymers were obtained with high retention of mass average molecular mass and high functionalization through chemo-selective mangana-electrocatalysis. Our strategy proved to be broadly applicable to a variety of homo- and copolymers. Polyethylene, polypropylene as well as post-consumer polystyrene materials were functionalized by this approach, thereby avoiding the use of hypervalent-iodine reagents in stoichiometric quantities by means of electrocatalysis. This study, hence, represents a chemical oxidant-free polymer functionalization by electro-oxidation. The electrocatalysis proved to be scalable, which highlights its unique feature for a green hydrogen economy by means of the hydrogen evolution reaction (HER).



Graphical illustration

Niepelt, R. *et al.*

The Influence of Falling Costs for Electrolyzers on the Location Factors for Green Hydrogen Production

https://doi.org/ 10.1002/solr.202300317

Abstract:

A fast and extensive build-up of green hydrogen production is a crucial element for the global energy transition. The availability of low-cost renewable energy at high operating hours of the electrolyzer is a central criterion in today's choice of location for green hydrogen production. It is analyzed how decreasing electrolyzer costs that are expected by many may influence this choice. The energy system optimization framework ESTRAM is used to find the optimum configuration of wind turbine, photovoltaic (PV), and electrolyzer capacity for covering a given hydrogen demand by locally produced green hydrogen in different European locations. It is found that PV is part of the cost-optimal solution in 96% of 1372 statistical regions in Europe. Decreasing electrolyzer costs are favoring the utilization of PV in wind-solar hybrid plants. At low electrolyzer costs, pure solar hydrogen outperforms the hybrid variant in many places if hydrogen storage is available, even with few full operating hours per year. At the same time, production costs are converging significantly. The article adds a new perspective to the discussion, as it is systematically shown how further technology development may lead to a shift in locational advantages for green hydrogen production, what should be considered to avoid stranded assets when building infrastructure.

Long, YZ. *et al.*

Cable-Car Electrocatalysis to Drive Fully Decoupled Water Splitting

https://doi.org/ 10.1002/advs.202301872

Abstract:

The increasing demand for clean energy conversion and storage has increased interest in hydrogen production via electrolytic water splitting. However, the simultaneous production of hydrogen and oxygen in this process poses a challenge in extracting pure hydrogen without using ionic conducting membranes. Researchers have developed various innovative designs to overcome this issue, but continuous water splitting in separated tanks remains a desirable approach. This study presents a novel, continuous roll-to-roll process that enables fully decoupled hydrogen evaluation reaction (HER) and oxygen evolution reaction (OER) in two separate electrolyte tanks. The system utilizes specially designed "cable-car" electrodes (CCE) that cycle between the HER and OER tanks, resulting in continuous hydrogen production with a purity of over 99.9% and Coulombic efficiency of 98% for prolonged periods. This membrane-free water splitting system offers promising prospects for scaled-up industrial-scale green hydrogen production, as it reduces the cost and complexity of the system, and allows for the use of renewable energy sources to power the electrolysis process, thus reducing the carbon footprint of hydrogen production.

Iulianelli, A. *et al.*

An integrated two stages inorganic membrane-based system to generate and recover decarbonized H2: An experimental study and performance indexes analysis

https://doi.org/ 10.1016/j.renene.2023.04.095

Abstract:

This work focuses on the utilization of a two stages inorganic membrane-based system to generate and recover decarbonized hydrogen in order to meet the targets set by the European Clean Hydrogen Partnership under the Strategic Research & Innovation Agenda 2021-2027. In the first stage, a CH4:CO2 = 60:40 mixture simulating a biogas stream is used to generate a COx-free hydrogen via steam reforming reaction carried out in a tubular Pd-Ag membrane reformer, packed with a novel non-commercial 7 wt%Ni-0.5 wt%Ru/La0.3Y0.3Zr0.4Ox catalyst, prepared by solution combustion method. The catalyst was characterized by XRD, TPR and TEM techniques. The analyses reveal well-distributed active metal particles interacting differently with the support (weakly and strongly). In particular, the XRD pattern shows the formation of perovskite and nickel oxide in addition to the pyrochlore phase. This behaviour indicates a low solubility of Ni in the pyrochlore structure. Reaction mea-surements were carried out at a temperature of 673 K, in the total pressure range between 250 kPa divided by 350 kPa, weight hourly space velocity (WHSV) of 0.2 h-1, H2O/CH4 feed molar ratio between 1.5 and 2, feeding N2-sweep gas in the permeated side. As best results of Stage 1, CH4 conversion equal to 99% (@ H2O/CH4 feed molar ratio = 2 and feed pressure of 250 kPa) and a COx-free H2 recovery of 40% were reached. In the second stage, the unpermeated stream of Stage 1 rich in hydrogen was fed to a supported Pd/Al2O3 membrane separator to further recover high grade hydrogen at the same temperature and total pressure set in Stage 1. The maximum hydrogen recovery equal to 67% was reached at 673 K and 350 kPa, with a purity of the recovered stream equal to 99.9%. The total hydrogen recovered in the permeate streams of Stage 1 and Stage 2 was equal to 80% of the total hydrogen produced during the steam reforming reaction, showing an average purity equal to 99.99%, which allowed to meet the established targets. The work further analized and discussed the experimental results of the integrated system by means of performance indexes.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 44
AUGUST, 2023

Women Shaping the Future of Green Hydrogen

Women in Green Hydrogen is on a quest to make energy transition more inclusive and diverse.

The Women in Green Hydrogen (WiGH) network was found in 2020 to address the lack of equal representation in most hydrogen industry events and to support the work and contribution of the talented women working in the sector.

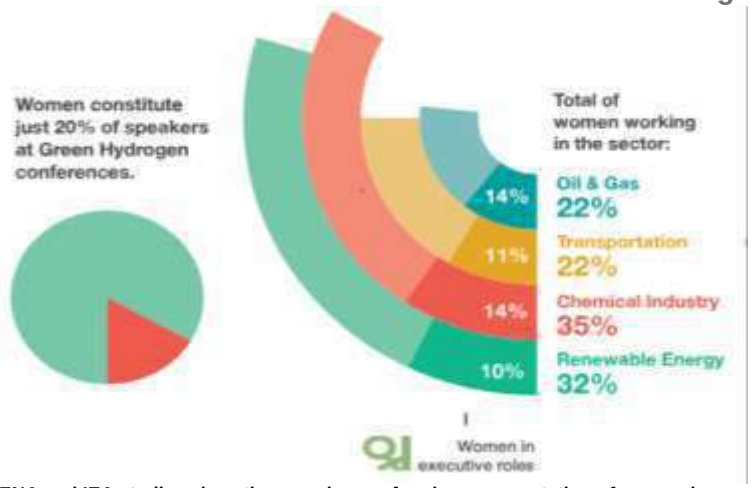


Figure: Data from IRENA and IEA studies show the prevalence of under-representation of women in green hydrogen related-industries, confirming the real need for women to be more engaged and visible.

Women in the Hydrogen and Renewable Energy Industry

As awareness about climate change and the need for cleaner energy sources continues to grow, more and more women are entering the renewable energy industry. The Hydrogen industry is one of the most promising in this transition and women have a fundamental role to play in this field, contributing to innovation, leadership, research, policy development, advocacy, and more. As these sectors continue to grow, the involvement of women is becoming increasingly important. Here are some specific roles women are taking on in the green hydrogen and renewable energy industries:

- Research and Development
- Engineering and Technology
- Innovation and Entrepreneurship
- Policy and Regulation
- Leadership and Management
- Advocacy and Outreach
- Education and Training
- Community Engagement
- Networking and Collaboration
- Sustainability and Environmental Advocacy

Efforts to encourage gender diversity and inclusion in these industries are essential for driving innovation, addressing challenges, and ensuring a sustainable future. Women's participation brings unique perspectives and expertise that contribute to the holistic development of the green hydrogen and renewable energy sectors.

https://fuelcellsworks.com/news/women-in-the-hydrogen-and-renewable-energy-industry/
https://hydrogen.revolve.media/2022/case-studies/women-shaping-the-future-of-green-hydrogen/

Connecting women in the hydrogen world

Kathrin Goldammer
Nature Energy (2023)

Kathrin Goldammer describes the founding and aims of Women in Green Hydrogen, a global network that seeks to increase the visibility and amplify the voices of women working in the sector.

Do you remember the first time you heard about hydrogen? In my life, there have been four big hydrogen moments I remember, with the most recent one clearly having the most lasting impact.

Cited As: Goldammer, K. Connecting women in the hydrogen world. *Nat Energy* (2023).
Link: https://doi.org/10.1038/s41560-023-01305-9

Women in Green Hydrogen

Promoting Diversity in Green Hydrogen

Women in Green Hydrogen is a network of passionate women working in the green hydrogen sector, with a vision to increase the visibility and amplify the voices of women working in green hydrogen.

*The network provides **a platform to connect, empower, and change.***

Diversity is essential for a sector that thrives on innovation and new ideas. Network works to promote the participation of women in conferences, expert talks, and relevant media to shape a more diverse and inclusive discourse in the world of green hydrogen. Goal is to build a **community** to foster knowledge exchange, connect women in green hydrogen, and create professional opportunities for our members.

Link: https://women-in-green-hydrogen.net/

EVENTS

H2 & FC Expo



20th International Hydrogen & Fuel Cell Expo

Date: 13-15 Sept. 2023

Venue: Hall 4 ~ 8, Makuhari Messe, Japan (Tokyo area)

H2 & FC EXPO gathers technologies for "production", "transportation", "storage", and "use" of hydrogen. Since its launch in 2005, it works as a must-attend business platform for professionals from all over the world.

Themes:

1. Solar Tech.



2. Rechargeable Batteries & Tech.



3. Smart Grid Tech.



4. Wind Power Tech.



Link:

https://www.wsew.jp/autumn/engb/lp/fc23.html?gclid=Cj0KCQjw2qKmBhCfARIsAFy8buIdAoPwiUQb3Hv9ThQmEz7H9L1dRSOS7TSgaE-yibM1FzVJN91LS_4aAq4qEALw_wcB

INDUSTRY NEWS

RIL to produce green hydrogen in two years

Reliance Industries (RIL) is laying down infrastructure for disbursement of green hydrogen from its proposed plant in Gujarat as it prepares to begin production of the fuel by 2025, three officials aware of the development said. The company, which has received 74,750 hectares of land parcel in Gujarat on a 40-year lease for its green hydrogen project, is tying up with original equipment manufacturers (OEMs) for supply of green hydrogen and laying the groundwork to retail the same through its Jio-BP outlets.

"RIL is setting up a green hydrogen dispensation infrastructure," an industry official said on condition of anonymity. "The company is targeting production of green hydrogen by 2025 and when that happens, it needs a ready infrastructure for offtake of that green hydrogen. There will be more such measures from RIL going forward".

Green hydrogen is the cleanest form of fuel when produced through renewable sources of energy. RIL aims to produce green hydrogen at $1 per kilogram by 2030. The current production economics of green hydrogen works out to be around $8-9 per kilogram as compared to less than $4 per kilograms for other traditional fuels and feedstocks.

RIL also plans to retail green hydrogen through its Jio-BP retail outlets. The company has around 1,500 retail outlets, which its plans to expand to 5,000.

RIL to produce green hydrogen in two years (msn.com)

Avaada to invest $2.4bn in green hydrogen and renewables in India over five years

India's Avaada Group has announced a $2.44 billion partnership with the Rural Electrification Corporation (REC) to invest in renewable energy projects across India during the next five years, including green hydrogen and its derivatives.

The REC agreement is one of several strategic alliances signed by Avaada Group.

The company said it is evolving into a 'sand-to-green-molecule' enterprise, with business interests ranging from manufacturing electrolysers, to renewable power generation, as well as green hydrogen and green ammonia production.

Avaada's renewable energy subsidiary, Avaada Energy, has developed a 4 GW portfolio across India and plans to reach 11GW by 2026 and 30GW by 2030.

Avaada to invest $2.4bn in green hydrogen and renewables in India over five years | Windpower Monthly

Government advances hydrogen support regime, announces latest funding awards

Government edges forward with plans to enable new hydrogen infrastructure, as funding confirmed for two zero emission transport projects in North East England

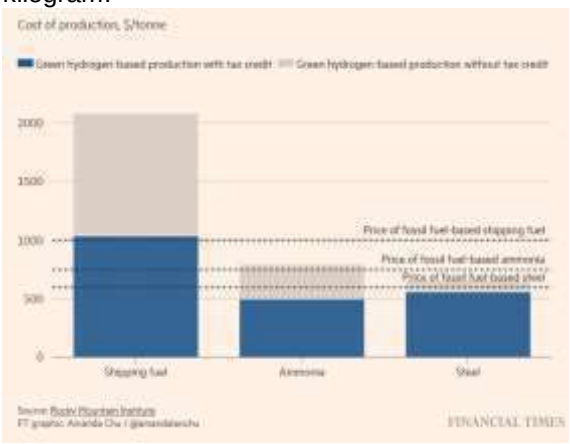
The government has taken another step towards the delivery of a new subsidy and policy regime, which is designed to drive investment in hydrogen infrastructure projects across the UK.

The Department for Energy Security and Net Zero (DESNZ) published the response to a recent consultation on hydrogen transport and storage infrastructure, including 'minded-to positions' that set out the government's intentions for the next phase of policy development.

Government advances hydrogen support regime, announces latest funding awards | BusinessGreen News

Energy groups mount campaign against tough US clean hydrogen rules

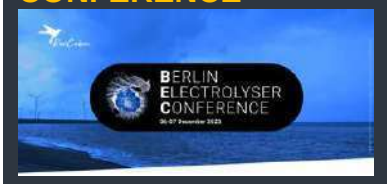
Energy companies have launched a lobbying blitz in Washington over pending rules they say will make or break the case for tens of billions of dollars' worth of investment in hydrogen fuel. The 95 per cent of US hydrogen is produced with natural gas in a process that creates large amounts of CO_2.US energy secretary Jennifer Granholm has hailed clean hydrogen as an alternative to conventional production and outlined a strategy to slash its costs by 80 per cent by 2030. The subsidies in last year's Inflation Reduction Act amount to $3 per kilogram.



Energy groups mount campaign against tough US clean hydrogen rules | Financial Times (ft.com)

EVENTS:

4th BERLIN ELECTROLYSER CONFERENCE



Date: 6-7th December 2023

Venue: Berlin, Germany

Aim: To accelerate electrolyser installations across the industrial sectors, and to significantly reduce the costs of clean hydrogen production, considerable challenges have to be overcome by industrial users of electrolysers, system manufacturers, providers of components and materials, and other stakeholders within the hydrogen economy.
The Berlin Electrolyser Conference (BEC) was founded in 2020 to bring together electrolyser specialists, engineering experts, scientific researchers and other stakeholders along the electrolyser value chain to discuss the development, manufacturing, deployment and integration of the next generation of industrial electrolysers.

Keytopics:

1. Electrolyser units, technologies, and manufacturing processes
2. Increase efficiency, and cut costs, its design, materials, and components
3. Integration of electrolysers
4. Broadening of network and enhance learning capabilities from each other.

Link:
https://electrolyser.redcabin.de/

Pa. is competing for billions to build hydrogen hubs. Will they really be green?

As part of the federal Regional Clean Hydrogen Hubs program, the U.S. Department of Energy will dole out $7 billion beginning this winter to create up to 10 different hydrogen hubs. Grants will range from $400 million to $1.25 billion and are slated to be paid to applicants over eight to 12 years. Three proposals have been submitted for projects to build hubs with infrastructure at least partly based in Pennsylvania. Coordinators say they plan to produce blue, pink, or green hydrogen — the latter of which the federal government is trying to incentivize with its own tax credit. While private organizations apply for these grants, the state is closely involved in the process. To boost the state's chances at getting hydrogen grant money, lawmakers last year successfully passed a state tax credit that would give $50 million in annual tax breaks to a company that agrees to produce hydrogen for 20 years. The effort to lure hydrogen producers has been bipartisan and has politically powerful backers like the commonwealth's building trades, which see hub construction as a promising source of jobs.

Divisions emerging over hydrogen production in Pennsylvania | Centre Daily Times

Goa working on green hydrogen energy plant: CM Pramod Sawant

In line with the government's ambitious target to decarbonise all sectors of the economy by 2050, the Goa government is in talks with Paradeep Phosphates, BITS Goa and NIT Goa to develop green hydrogen and green Ammonia plants for energy generation. Speaking at a workshop on Sustainable Energy and Environmental Solution for MSMEs and the pharmaceutical sector, Sawant said that the Goa government is working on a multi-sectoral plan to promote renewable energy and energy efficiency technologies. For industries in particular, the government of Goa is in process of adopting, several renewable energy interventions. It includes the energy, Benchmarking for industrial zone R&D and piloting the support to develop innovative energy assistance technologies. energy audits for MSME, driving the transition from fossil based energy sources to clean energy alternatives, and promoting the use of compressed biogas or biomass residue and solar thermal concentrated for industrial heating," said Sawant.

The chief minister also announced that all new power purchase agreements, signed by Goa government will be for renewable energy. "Goa has also signed a MoU to set up the ground mounted and floating solar installation. The government has also decided that 100% renewable electricity supplied will be provided to all demand sectors by 2050," said Sawant.

He urged all the pharmaceutical companies to implement the recommendation for energy efficiency technologies.

Goa working on green hydrogen energy plant: CM Pramod Sawant | Goa News - Times of India (indiatimes.com)

Mauritania seeks global partnerships for green hydrogen

Mauritania's quest for green hydrogen financing will be the focus of the upcoming MSGBC Oil, Gas & Power conference - scheduled for November 21-22 in Nouakchott, Mauritania. The conference will connect stakeholders, providing a platform for deals to be signed and investment secured.

The Mauritanian government has placed green hydrogen as a strategic development opportunity under efforts to position the country as a global hydrogen hub. However, to achieve this objective, significant investments are required.

According to a McKinsey analysis, meeting the green hydrogen goals of top African countries will require up to $55 billion in investment by 2030 and $900 billion by 2050.

The African Development Bank (AfDB) and the World Bank have emerged as top advocates for Mauritania's green hydrogen initiatives. The AfDB is supporting Mauritania in areas such as legal frameworks, local procurement requirements and green hydrogen knowledge transfer, while the World Bank has released the country's Roadmap for Low-Carbon Hydrogen Development, providing support through policy advise and frameworks. Mauritania is also looking towards the private sector to fund projects.

China is also helping Mauritania to make it a viable green hydrogen market.

Mauritiania seeks global partnerships for green hydrogen | Energy Central

EVENTS:

HYDROGEN UK ANNUAL CONFERENCE & AWARDS 2024



Date: 11-12th March 2024

Venue: Birmingham, UK



Eligibility Criteria:

The Innovation Project award recognises a company or project that has made a significant contribution to innovation in the hydrogen sector over the past 12 months. The successful company or project will demonstrate cutting edge, first-of-a-kind technologies or applications that push the boundaries. The project can be in any area of the hydrogen value chain but must demonstrate how the innovation contributes to the scalability of the hydrogen sector.

Opening Date for Entries: 31st July
Closing Date for Entries: 2nd October
Shortlisting of Finalists: 30th October
Announcement of Winners: 11th March, 2024

Link: https://hydrogen-uk.org/annual-conference-and-awards/the-awards/

INDIA NEWS

Jharkhand govt nod for country's first hydrogen fuel plant, approves Rs 354.28 crore investment

Jharkhand Govt has approved Rs 354.28 crore for the establishment of a first-of-its-kind industry.

Jharkhand Chief Minister Hemant Soren nod for the set-up of the nation's first hydrogen fuel-related plant in Jamshedpur, as per an official statement. This hydrogen plant will be the second hydrogen plant in the world. Earlier, a hydrogen engine plant was built in Germany.

Jharkhand Govt has approved Rs 354.28 crore for the establishment of a first-of-its-kind industry. It is being established in collaboration with Tata Motors Limited and American company Cummins Inc. It will be operated by Tata Green Energy Solutions Private Limited (TGESPL). Soren will soon sign MoU with M/s TGESPL.

“After the MoU, the way will be paved for the establishment of the country’s first hydrogen fuel-related industry in Jamshedpur. The latest technology of making hydrogen engines will be used, which will benefit the whole country in the coming times,” said the Jharkhand CM, according to Khabar infra.

Jharkhand govt nod for country's first hydrogen fuel plant, approves Rs 354.28 crore investment (msn.com)

Kerala receives proposals worth Rs 30,000-cr for green hydrogen and green ammonia production, export

The government of Kerala has received proposals from two large companies for setting up green hydrogen and green ammonia production plants, its export, and also for domestic use.

One of the companies has proposed to export one lakh tonnes of green ammonia to Germany from the Vizhinjam Adani port. It plans to set up an integrated renewable energy project which would meet round-the-clock (RTC) energy requirements of the green ammonia plant. The integrated renewable energy project will be a solar installation paired with a pumped hydro storage facility within the state. It will be a first-of-its-kind project in Kerala with flexibility to support state power utilities for their peak hour requirements. The pumped-storage power plant, which would provide RTC renewable energy, will be an investment of the Kerala State Electricity Board as per the state policy.

Kerala receives proposals worth Rs 30,000-cr for green hydrogen and green ammonia production, export, ET EnergyWorld (indiatimes.com)

Reliance Industries eyes green hydrogen production in 2 years; aims to bring down production cost to just $1 per kg by 2030

Reliance Industries (RIL) is taking major steps to establish green hydrogen production infrastructure in Gujarat, preparing for its ambitious plans to begin fuel production by 2025, an ET report states. According to sources quoted in the report, the company has secured 74,750 hectares of land in Gujarat on a 40-year lease for its green hydrogen project. RIL is actively partnering with original equipment manufacturers (OEMs) to secure a green hydrogen supply chain and is also laying the groundwork to distribute green hydrogen through its Jio-BP outlets.

RIL aims to achieve a significant milestone of producing green hydrogen at just $1 per kilogram by 2030. Presently, the production economics of green hydrogen are estimated to be around $8-9 per kilogram, compared to less than $4 per kilogram for traditional fuels and feedstocks.

Reliance Industries eyes green hydrogen production in 2 years; aims to bring down production cost to just $1 per kg by 2030 - Times of India (indiatimes.com)

Bosch successfully tests hydrogen-powered truck; to be showcased in early 2024

Bosch has successfully tested a hydrogen-powered truck at its campus in Bengaluru and is looking at showcasing the BS6 Phase II hydrogen-fueled truck in early 2024. Bosch has been testing components and had earlier said that pilot projects were running with hydrogen-powered trucks.

Guruprasad Mudlapur, Managing Director, Bosch and President of Bosch Group in India at its annual meeting said, “Cleaner fuels, green hydrogen and electrification take centre stage in our commitment to a climate-neutral future. This is also exemplified by the successful launch of our first hydrogen-powered demonstrator vehicle in India in June which comes after the announcement about the launch of the pilot Hydrogen Engine Testing infrastructure in Bengaluru later last year.”

Bosch successfully tests hydrogen-powered truck; to be showcased in early 2024 | The Financial Express

Zhang, LY. *et al.*

Benchmarking the pH-Stability Relationship of Metal Oxide Anodes in Anion Exchange Membrane Water Electrolysis

https://doi.org/10.1021/acssuschemeng.3c01619

Abstract:

Anion exchange membrane water electrolysis (AEMWE) is one of the most promising technologies for producing green hydrogen; however, they still suffer from durability issues. One task is to find suitable electrolyte conditions for anode catalysts that endow them with both high activity and stability. Herein, we benchmark the pH-stability relationship of four typical metal oxides as anode catalysts in the AEMWE. Their electrochemical performance and structural stability were in-depth analyzed through impedance, dissolved composition in the electrolyte, and correlated Pourbaix diagram. NiFe2O4 with the best activity and stability in the strong alkaline (pH = 14) shows terrible stability in pure water, which is then verified due to the severe Fe leaching, and it cannot be alleviated by alkaline pre-activation. Notably, Co3O4 shows comparable activity and stability to IrO2 in pure water and weak alkaline conditions. At pH = 12, it entails only & SIM; 2.18V to reach 1.0 A cm (-2) and stabilizes for 40 h, being superior to others. This work screens out suitable transition metal oxides as a substitute for noble metals and their optimal application scenarios for AEMWE. Screening of suitable transition metal oxides as alternatives to noble metal catalysts to power green hydrogen production.

Karayel, GK. *et al.*

Utilization of biomass and waste resources for renewable hydrogen production: A comprehensive study

https://doi.org/10.1080/15567036.2023.2225444

Abstract:

The current study investigates the biomass and waste-based potential for green hydrogen production in Turkey. The biomass sources are identified based on the collection of municipal, industrial, animal, agricultural, and forestry wastes. The potential of each city is estimated and discussed for a feasible hydrogen economy. Using the legitimate government data obtained from the governmental sources, the capacities of the available biomass potential for different cities in tons of oil equivalent are considered annually for the analysis and assessment. The power production is considered through using gasification and incineration systems, where the final product is hydrogen. The main idea is to prepare hydrogen maps in detail for each region in Turkey, based on the biomass energy potential through employing the gasification and incineration approaches. The results show that Turkey's total green hydrogen production potential using available biomass resources is about 1.66 megatons/year. Konya, Adana, Ankara, Sanliurfa, and Manisa are listed as cities with the highest green hydrogen production potential with an annual production of 129.53, 78.82, 64.42, 64.2, and 53.63 kilotons, respectively. The results of the study are expected to help policymakers to use renewable energies for planning and strategizing new local and global acts for the country and help to tackle fossil-fuel-based issues. This, in turn, can be considered in the context of the current policies of the local communities to supply the required energy.

Mardle, P. *et al.*

Opportunities of Ionomer Development for Anion-Exchange Membrane Water Electrolysis FocusReview

https://doi.org/ 10.1021/acsenergylett.3c01040

Abstract:

Anion-exchange membrane water electrolysis (AEM-WE) promises low cost, green hydrogen production for the future. In order to meet this potential, significant improvements to the performance and stability of catalyst layers (CLs) must be made, including the development of tailor-made ion conducting polymer materials. This Focus Review outlines the role of anion-exchange ionomers (AEIs) in CLs for enabling catalyst activation, enhancing stability toward delamination, and improving ion conduction. Detrimental effects such as inhibition of the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) and oxidative instability of the ionomer are also discussed with key findings from recent AEM-WE literature. Opportunities for future ionomer development are discussed to guide such efforts.

Shrestha, NK. *et al.*

Accelerating glucose electrolysis on Cu-doped MIL-88B for an energy efficient anodic reaction in water splitting

https://doi.org/ 10.1039/d3dt01773g

Abstract:

This work reports a promising and sustainable method for valorization of abundantly available biomass feedstocks to overcome the thermodynamic high energy barrier of the OER via glucose electrolysis as a proxy anodic reaction, thereby driving the energy-efficient water splitting for green hydrogen generation. For this, a robust and efficient MIL-88B (Fe) based electrocatalyst is engineered via Cu doping. The ultrasonically prepared Cu-doped@ MIL-88B ink when drop-cast on nickel foam (NF) produces thin nano-porous 2D-sheet like films having a thickness of ca. 300 nm and demonstrates an excellent glucose oxidation reaction (GOR) with a lower potential of 1.35 V versus RHE at 10 mA cm(-2). In addition, this electrode shows outstanding long-term electrochemical durability for 50 h and exhibits the maximum GOR current load of 350 mA cm(-2) at 1.48 V vs. RHE, while the pristine MIL-88B based electrode exhibits a current load of only 180 mA cm(-2) at the same potential bias. The remarkably higher current density after doping indicates an accelerated GOR, which is ascribed to the electronic structure modulation of the Fe nodes by Cu, thereby enhancing the active sites and charge transport characteristics of the frameworks. Most importantly, the MOF-based electrodes demonstrate the occurrence of the GOR prior to the OER at a large potential difference, hence assisting the energy-efficient water splitting for green hydrogen production.



Graphical Illustration

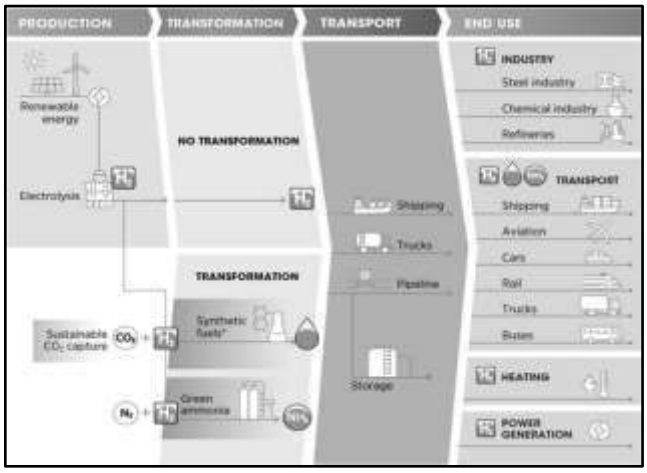
Iqbal, MS. And Rahim, ZA.

Understanding the Potential of Hydrogen as a Game-Changing Energy Source

https://doi.org/ 10.1002/ceat.202300051

Abstract:

Renewable energy and carbon neutrality by 2030 are gaining momentum with the current global economic and political endeavors. Green hydrogen has the potential to give power networks the much-needed flexibility and acts as a buffer for intermittent renewable power output, both of which might be beneficial for the future of renewable energy grids. If hydrogen proves effective, it might drastically reduce emissions of greenhouse gases. In this context, knowing the potential advantages of hydrogen is crucial. Between 2016 and 2019, technological progress occupied just 42.86 % of the total time. Innovation in this field is considered disruptive because of its high uniqueness rate (81 %). This article analyzes the most up-to-date information on the hydrogen economy (including its key benefits and drawbacks) and the potential implications of hydrogen for several businesses.



Graphical Illustration

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 45
AUGUST, 2023

New Technology for Production of Green Steel: Efficiently Decarbonizing Steel

To learn how to effectively use H2 to decarbonize the steel industry, hydrogen research needs to be conducted to find out and understand exactly how hydrogen-based direct reduction works in the manufacturing process. Binghamton University professor, Guangwen Zhou recently received a $470,700 grant to research the process on an atomic level.



Breakthrough: The process that seems simple is actually quite complex.

Traditionally, smelters produce steel by removing oxygen from iron ore through a carbothermic method that combines iron oxide with carbon and intense heat. In recent years, experimental green steel projects that use hydrogen instead of carbon-intensive manufacturing have been popping up as the steel industry seeks to lower its emissions to meet government climate targets. National Science Foundation (NSF) to conduct the steel making hydrogen research, explained that when looking at the reduction of iron oxides with hydrogen.

Achievement: Decarbonizing the steel industry is a top priority.

Zhou and his students will use Brookhaven's equipment, including an ambient-pressure X-ray photoelectron spectroscopy (AP-XPS) and environmental transmission electron microscopy (TEM), to study potential pathways to lower iron from iron oxide at temperatures above 1,000 degrees Celsius. Through their hydrogen research involving the steel process, Zhou and this team want to provide a "fundamental understanding on the basic chronology of the reaction process and its complicated transformations." Zhou said, "We can play with factors like the amount of hydrogen, the pressure or the temperature to optimize the process."

Over two billion tons of steel is produced globally every year. Steel is not only one of the world's most important industrial materials, but it also accounts for 7 – 11% of all human-made greenhouse gas emissions. To put this into greater perspective, if the steel industry was a country, it would rank as the fifth-largest producer of CO2 emissions in the world.

https://www.hydrogenfuelnews.com/hydrogen-research-steel-zhou/8560117/

Hydreen, part of Luxembourg-based cruise liners firm, ties up $2 bn for India's green hydrogen market

Hydreen, a fairly new entrant in the green hydrogen space and part of HLC Holdings, a Luxembourg-based cruise liners company is betting big on the green hydrogen market.



The company is already running two projects in Himachal Pradesh and Kerala and has tied up a $2-billion investment to set up green hydrogen and green ammonia plants in five other states and will start on two more projects in the next six months. -Sumit Chowdhury, CEO.

Each plant will have a capacity of 250 MW. Whether it will be a green hydrogen or green ammonia plant depends on the captive requirements from state-to-state. The ammonia from these plants is planned to be exported as well.

The cost of green hydrogen is largely dependent on the cost of power and cost of land. The reduction in the significant deposit by government if curtailed will encourage reduction of the cost overall.

This sector of the industry is not viable today given the market rates for green as compared to the gray hydrogen, the government needs to nurture it to scale where the source of energy does not matter in order to achieve climate change goals.

Link:
https://energy.economictimes.indiatimes.com/news/renewable/rajasthan-over-50-renewable-energy-firms-can-renew-contract-with-discoms/102522285

EVENTS

INDIA NET ZERO FORUM 2023

Date: September 29, 2023
Venue: New Delhi
Aim:

- To explore innovative strategies, technologies, and policies to achieve these ambitious targets and address the pressing challenges of climate change
- Will explore the concept of Net-zero and its importance in addressing environmental, social, and economic challenges
- To provide a comprehensive overview of sustainability and its key dimensions, as well as highlight some of the best practices and strategies for achieving net-zero ambitions.

Link: https://energy.economictimes.indiatimes.com/india-netzero-forum?ag=LBNetzero

INDUSTRY NEWS

Reliance Industries eyes green hydrogen production in 2 years; aims to bring down production cost to just $1 per kg by 2030

Reliance Industries (RIL) is taking major steps to establish green hydrogen production infrastructure in Gujarat, preparing for its ambitious plans to begin fuel production by 2025. According to sources quoted in the report, the company has secured 74,750 hectares of land in Gujarat on a 40-year lease for its green hydrogen project. RIL is actively partnering with original equipment manufacturers (OEMs) to secure a green hydrogen supply chain and is also laying the groundwork to distribute green hydrogen through its Jio-BP outlets.

RIL aims to achieve a significant milestone of producing green hydrogen at just $1 per kilogram by 2030. Presently, the production economics of green hydrogen are estimated to be around $8-9 per kilogram, compared to less than $4 per kilogram for traditional fuels and feedstocks. RIL has planned an investment of $10 billion in capex to build a new energy ecosystem. Over the past several months, RIL has formed strategic partnerships with OEMs to supply green hydrogen. Through its partnership with Ashok Leyland, RIL plans to retrofit engines for the company's fleet of trucks. RIL contracts a fleet of around 45,000 vehicles that are used for its refining and marketing operations. RIL also has plans to retail green hydrogen through its Jio-BP retail outlets. With around 1,500 outlets already in operation, RIL aims to expand the network to 5,000, making green hydrogen easily accessible to the public, the report said.

Reliance Industries eyes green hydrogen production in 2 years; aims to bring down production cost to just $1 per kg by 2030 (msn.com)

Japan enters Namibia's green hydrogen rush

Japan has joined the ranks of countries investing in Namibia's abundant natural resources after the two countries yesterday signed agreements on green hydrogen and rare earth minerals.

This is after Hyphen Hydrogen Energy and Itochu, a major Japanese trading and investment firm, inked a groundbreaking agreement at State House. Japan joins various global investors, such as the European Union, Germany, Finland and The Netherlands, in signing agreements with Namibia for their green hydrogen ambitions. At the core of this collaboration lies the Hyphen project, poised to become Namibia's sole fully vertically integrated green hydrogen project. By 2029, the ambitious venture aims to churn out two million tonnes of green ammonia annually, destined for both regional and global markets.

Namibia's trade ministry also signed an agreement with Japan's Ministry of Economy, Trade and Industry as well as the Japan External Trade Organisation (Jetro) to facilitate trade and investment between the two countries.

Japan enters Namibia's green hydrogen rush - The Namibian

China releases first guideline on standards of hydrogen energy industry

China's first national-level construction guideline for the standards of the hydrogen energy industry chain was jointly released. The guideline builds a standard system for the production, storage, transport and use of the hydrogen energy. The goals of the guideline include accelerating the formulation of relevant technical standards and improving the international standardization on hydrogen energy, according to a statement on the website of the State Administration for Market Regulation.The guideline for hydrogen energy adds fuel to the country's new-energy and green development sectors. It is also a supplement to the plan on the development of hydrogen energy for the 2021-35 period. As shown in the plan, China will put in place a relatively complete hydrogen energy industry development system by 2025, the Xinhua News Agency reported. China is currently the largest hydrogen producer in the world, with an annual output of 33 million tons, accounting for about 30 percent of global production, according to Xinhua. The country's hydrogen energy market is expected to reach 43 million tons by 2030, read an estimate from the China Hydrogen Alliance.



China releases first guideline on standards of hydrogen energy industry - Global Times
https://www.britannica.com/place/China

EVENTS

Green Hydrogen India

Date: Wed, 13 Sep 2023 - Fri, 15 Sep 2023
Venue: India Expo Centre and Mart Greater Noida, India
About:
This is a three-day conference and exhibition on green hydrogen in Greater Noida. It will provide a unique opportunity to learn about the latest developments in the industry, network with key stakeholders, and explore the commercial opportunities for green hydrogen.
Exhibitor Product Profile:
Low-carbon hydrogen production Storage solutions Infrastructure solutions Electrolyzers Energy conversion Compression technology Catalysts Hydrogen from biomass Hydrogen-Power and Power-to-X Carbon capture, utilization and storage (CCUS) and hydrogen Membrane solutions Storage systems Industrial plant technologies Liquefaction technologies Advanced materials and composites Gasification technology Test, simulation and evaluation Safety systems Hydrogen fuels Hydrogen injectors Line assemblies Fuel-cell control units Heating with hydrogen Fuel cell components and auxiliaries Thermal management Electrocatalysts Fuel cell manufacturing and assembly Refueling solutions Internal combustion assistance (ICA) for cleaner diesel engines in HGVs.
Link:
https://www.tradeindia.com/tradeshows/121398/green-hydrogen-india-2023.html

INDUSTRY NEWS

Germany Ditches Plan To Run 'World's First' Hydrogen Train Network, Replaces With Electric

Back in 2022, Germany made a lot of buzz in the world of urban mobility by announcing the world's first network of hydrogen trains. The state of Lower Saxony in Germany ordered 14 hydrogen trains to be made by French company Alstom and operated by regional rail company LNVG on routes between the northern towns of Cuxhaven, Bremerhaven, Bremervoerde, and Buxtehude. However, a report now states that the local transport authority has announced its plans to operate 102 battery electric trains from 2029 onwards.



https://zeenews.india.com/railways/germany-ditches-plan-to-run-worlds-first-hydrogen-train-network-replaces-with-electric-2647203.html

Bramble Energy's new HQ to house hydrogen innovation hub

Bramble Energy has opened its new headquarters in Crawley, West Sussex, which includes a hydrogen innovation and development hub.
The move represents a multi-million-pound investment for the company which launched in 2016.
Founded as a university spin-out, then developed in the garage of co-founder and CEO Dr Tom Mason, Bramble Energy has rapidly gained momentum with its fuel cell technology based on printed circuit board (PCB) technology.
Business growth has led to the demand for a larger facility that can accommodate Bramble Energy's projected expansion and support the scale up of its technology to transform the hydrogen fuel cell industry.
The facility, Atrium Court, spans almost 34,000 square feet, more than three times the size of its previous premises. It will accommodate
https://www.fleetnews.co.uk/news/latest-fleet-news/electric-fleet-news/2023/08/10/bramble-energy-s-new-hq-to-house-hydrogen-innovation-hub

A Moss Landing-based green hydrogen startup landed a $73M Series B

Green hydrogen technology developer Verdagy Inc. has raised a $73 million Series B funding round.
The Moss Landing startup has developed an industrial-scale electrolyzer, a device that separates hydrogen and oxygen out from water. The company's device, dubbed eDynamic, is designed to cut the cost of green hydrogen — hydrogen produced in sustainable ways, without the use of fossil fuels. Verdagy plans to use its new funds to ramp up production and commercialization of eDynamic, it said in an press release. "We have shown that our core technology works and Verdagy is ready to scale globally," company CEO Marty Neese in the news release. Hydrogen by itself is the ultimate clean fuel and has a wide array of applications, including powering cars and power plants and manufacturing steel. However, the vast majority of hydrogen produced today is derived from fossil fuels and much of it is used to refine oil, according to the U.S. Department of Energy. Verdagy is aiming its electrolyzer at companies who rely on fossil fuel-produced hydrogen who want to reduce their carbon footprint. As part of its production ramp-up, the startup plans to open a 100,000 square-foot factory in the Silicon Valley in the first quarter, Bloomberg reported.
https://www.bizjournals.com/sanjose/news/2023/08/08/green-hydrogen-startup-verdagy-scores-73m-series-b.html

Iverson eFuels AS, ECOnnect Energy sign technology pact for Norwegian Hydrogen and Green Ammonia plant

Iverson eFuels, a joint venture between Hy2Gen, CIP and Trafigura, and ECOnnect Energy to propose a technical jettyless ammonia transfer solution. To further mature the outlined IQuay C-Class solution for Project Iverson, ECOnnect Energy has been requested to conduct a pre-FEED study. Iverson e-Fuels will also monitor the development of several multiple bunkering solutions that can enable the safe and flexible transfer of ammonia to ships and flexible transfer of ammonia to ships and is expecting this market to grow in the next years.
https://energy.economictimes.indiatimes.com/news/renewable/iverson-efuels-as-econnect-energy-sign-technology-pact-for-norwegian-hydrogen-and-green-ammonia-plant/102507530

EVENTS

Digital Power Utilities Summit 2023



Date: 25th August 2023

Venue: The Park, New Delhi

About:

- The energy sector is undergoing a rapid transformation driven by four key factors known as the 4 D's: De-carbonization, De-regulation, De-centralization, and Digitization. These drivers are significantly impacting the industry and shaping its future direction. The interplay of these factors presents both opportunities and challenges for India's Energy Sector.
- The Digital Power Utilities Summit on 25th August 2023 convenes industry leaders, policymakers, energy PSUs, and solution providers to discuss the transformative landscape of the sector.

Link: https://events.eletsonline.com/digital-energy/#agenda

Gautam Adani prepared to go solo on hydrogen mega-project in India

Adani's first green hydrogen venture is a $5 billion integrated facility that will also include manufacturing plants for wind turbines and solar modules and renewable generation capacity. India's Gautam Adani is prepared to go it alone in spending billions of dollars on developing green hydrogen in India, after TotalEnergies SE put a plan to partner in the venture on hold. The French energy giant had agreed to buy a 25% stake in Adani New Industries Ltd. for an undisclosed sum to help fund green hydrogen projects in India, as the world's third-largest polluter seeks to decarbonize.

Adani's first green hydrogen venture is a $5 billion integrated facility that will also include manufacturing plants for wind turbines and solar modules and renewable generation capacity. The project is a starting point for the group's longer term plan to invest more than $50 billion through the end of the decade in developing the fuel.

https://www.business-standard.com/companies/news/gautam-adani-prepared-to-go-solo-on-hydrogen-mega-project-in-india-123081000471_1.html

India And Saudi Arabia Initiate Talks On Collaborative Green Hydrogen Initiatives



India's National Green Hydrogen Mission sets forth an ambitious goal of achieving a minimum annual production capacity of five million metric tonnes of green hydrogen by 2030, utilizing renewable energy sources.

Conversely, sources revealed that Saudi Arabia's endeavors in clean hydrogen are anticipated to focus on technologies that result in low carbon emissions. These discussions encompass the exploration of investment prospects, the exchange of technological knowledge, and cooperative efforts in research and development.

https://solarquarter.com/2023/08/09/india-and-saudi-arabia-initiate-talks-on-collaborative-green-hydrogen-initiatives/

Jet fuel manufacturing unit, green hydrogen plant on CIAL's cards

Cochin International Airport Ltd (CIAL) will have a jet fuel manufacturing unit built by BPCL Kochi unit that can cater to its fuel requirements. An initial round of discussions between the stakeholders of BPCL and Industries Minister P Rajeeve took place in Thiruvananthapuram on Tuesday in this regard.

Synthetic fuels, also known as e-fuels, can make a significant contribution to decarbonizing the aviation sector. The government aims to declare 'net-zero carbon Kerala' by 2050, and as part of that, various campaigns have been initiated in other sectors, including agriculture, road transportation, etc. Indian aviation is the third-largest and fastest-growing market in the world.

Minister P Rajeeve, said that the meeting also discussed setting up a 'Green Hydrogen Plant', jointly with BPCL, CIAL, and Ashok Leyland. "The move is to provide a sustainable mobility option to CIAL by adapting to hydrogen buses. Ashok Leyland will provide hydrogen buses to CIAL, and it can use the produced hydrogen fuel to operate the buses on the runway," said a source.

Jet fuel manufacturing unit, green hydrogen plant on CIAL's cards (msn.com)

India's Ocior Energy commits $4 billion for Egypt hydrogen production



India-based Ocior Energy has unveiled ambitious plans to channel up to $4 billion into green hydrogen production in Egypt, according to media reports. The green hydrogen project has reached preliminary contract agreements and is located in Suez Canal Zone, an ideal location for production of competitive green ammonia. The Suez Canal economic zone in Egypt encompasses four distinct industrial zones: East Port Said, West Qantara, East Ismailia, and Sokhna. Forecasts from the Egyptian government anticipate foreign direct investment in green hydrogen to reach around $81.6 billion by 2035.

India's Ocior Energy commits $4 billion for Egypt hydrogen production - Utilities Middle East (utilities-me.com)

Xiao, YH. *et al.*

Engineering Cu1.96S/Co9S8 with sulfur vacancy and heterostructure as an efficient bifunctional electrocatalyst for water splitting

https://doi.org/10.1016/j.jmst.2022.12.042

Abstract:

Defect and interface engineering have been recognized as efficient strategies for developing high-performance electrocatalysts. However, it is still challenging to couple defect and interface engineer-ing in transition metal sulfides and understand their dynamic evolution process during electrocatalysis. Herein, we developed one-step pyrolysis of bimetallic sulfide to construct S vacancy-rich Cu1.96S/Co9S8 heterostructure by controlling the critical decomposition temperature. The as-synthesized Cu1.96S/Co9S8 exhibits excellent bifunctional electrocatalytic performance, with a low overpotential of 99 and 200 mV at 10 mA cm (-2) towards hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) in 1.0 mol/L KOH electrolyte, respectively. A symmetric two-electrode cell with Cu1.96S/Co9S8 delivered a current den-sity of 10 mA cm (-2) at a low voltage of 1.43 V and showed long-term stability for 200 h. A series of in/ex-situ techniques revealed that the electrochemical reconfiguration only appeared in the OER process, resulting in the CoOOH/CuO and SO4 (2^-) species promoting OER performance. Meanwhile, the S vacancy and heterostructure interface in Cu1.96S/Co9S8 were proved to optimize the electronic structure and the adsorption of intermediates for HER by density function theory (DFT) simulations. This work provides a promising strategy to construct metal sulfides with rich defects and heterogeneous interfaces and under-stand their dynamic evolution process for electrochemical storage and conversion devices.

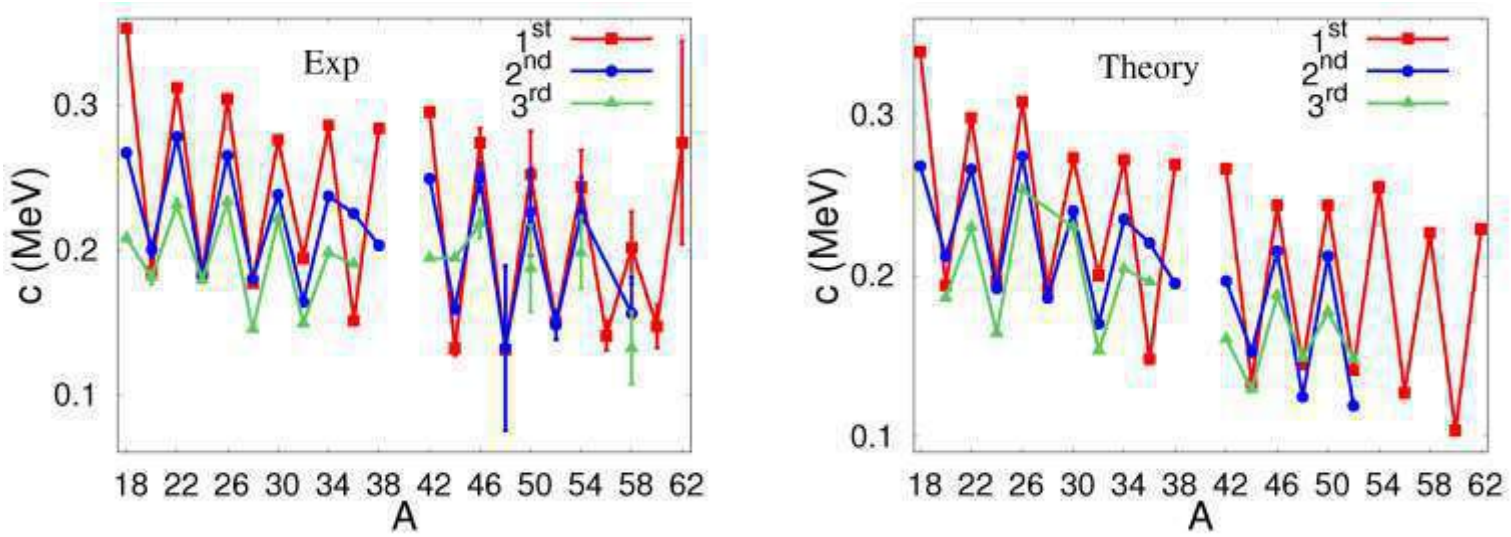
Hoferichter, M. *et al.*

On the role of isospin violation in the pion-nucleon cr-term

https://doi.org/ 10.1016/j.physletb.2023.1380010370-2693

Abstract:

In recent years, a persistent tension between phenomenological and lattice QCD determinations of the pion-nucleon cr-term crnN has developed. In particular, lattice-QCD calculations have matured to the point that isospin-violating effects need to be included. Here, we point out that the standard conventions adopted in both fields are incompatible, with the data-driven extraction based on the charged-pion mass, but lattice-QCD conventions relying on the mass of the neutral pion to define the isospin limit. The corresponding correction amounts to AcrnN = 3.1(5) MeV when evaluated in chiral perturbation theory with low-energy constants determined from a Roy-Steiner analysis of pion-nucleon scattering as well as crnN itself. It reduces the tension with lattice QCD, and should be included in the comparison to phenomenological determinations. We also update the extraction from pionic atoms accounting for the latest measurement of the width of pionic hydrogen, crnN = 59.0(3.5) MeV, and provide the corresponding set of scalar couplings of the nucleon.



Graphical illustration

Zhu, XQ. *et al.*

Enhanced dehydrogenation properties of MgH2 by the synergetic effects of transition metal carbides and graphene

https://doi.org/ 10.1088/1361-6528/acd259

Abstract:

Transition metal carbides show remarkable catalysis for MgH2, and the addition of carbon materials can attach excellent cycling stability. In this paper, Mg-doped with transition metal carbides (TiC) and graphene (G) composite (denoted as Mg-TiC-G) is designed to assess the influence of TiC and graphene on the hydrogen storage performance of MgH2. The as-prepared Mg-TiC-G samples showed favorable dehydrogenation kinetics compared to the pristine Mg system. After adding TiC and graphene, the dehydrogenation activation energy of MgH2 decreases from 128.4 to 111.2 kJ mol (-1). The peak desorption temperature of MgH2 doped with TiC and graphene is 326.5 degrees C, which is 26.3 degrees C lower than the pure Mg. The improved dehydrogenation performance of Mg-TiC-G composites is attributed to synergistic effects between catalysis and confinement.

Hata, K. *et al.*

Optimization of dissolved hydrogen concentration for mitigating corrosive conditions of pressurized water reactor primary coolant under irradiation (1) evaluation of water radiolysis

https://doi.org/ 10.1080/00223131.2023.2239810

Abstract:

A major subject for evaluating the corrosive conditions in the pressurized water reactor (PWR) primary coolant is to determine the optimal hydrogen concentration for mitigating primary water stress corrosion cracking (PWSCC) without adverse effects on major structural materials. An analytical method combining water radiolysis and electrochemical corrosion potential (ECP) analyses was proposed for evaluating the corrosive conditions in PWR primary coolant. These procedures originally developed for boiling water reactors (BWRs) were successfully extended to PWRs with different water chemistry parameters, including pH, temperature, and radiation qualities, after minor changes in the original procedures and major input parameters, such as the inclusion of the effects of alpha radiolysis and Li+ (Na+) and H+ effects for the anodic polarization curve. This study discusses the results of water radiolysis analysis for PWR primary coolant, and the characteristic behavior of hydrogen peroxide (H2O2) as a function of hydrogen inlet concentrations in PWR primary coolant conditions (higher pH and & alpha;-ray irradiation). A possible reaction scheme involving e (aq)(-) was proposed for H2O2 suppression under alkaline conditions. The corrosive conditions were discussed in the following publication, using ECP as the major index for PWR corrosive conditions.

Ouyang, WB. *et al.*

Magnetic transitions of hydrogenated H (x) CrO2 (x=0-2) monolayer from a ferromagnetic half-metal to antiferromagnetic insulator

https://doi.org/ 10.1088/1361-648X/acccc6

Abstract:

Two-dimensional (2D) transition metal oxide monolayers are currently attracting great interest in materials research due to their versatility and tunable electronic and magnetic properties. In this study, we report the prediction of magnetic phase changes in H (x) CrO2 (0 <= x <= 2) monolayer on the basis of first-principles calculations. As the H adsorption concentration x increases from 0 to 0.75, H (x) CrO2 monolayer transforms from a ferromagnetic (FM) half-metal to a small-gap FM insulator. When x = 1.00 and 1.25, it behaves as a bipolar antiferromagnetic (AFM) insulator, and eventually becomes an AFM insulator as x increases further up to 2.00. The results suggest that the magnetic properties of CrO2 monolayer can be effectively controlled by hydrogenation, and that H (x) CrO2 monolayers have the potential for realizing tunable 2D magnetic materials. Our results provide a comprehensive understanding of the hydrogenated 2D transition metal CrO2 and provide a research method that can be used as a reference for the hydrogenation of other similar 2D materials.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 46
AUGUST, 2023

Breakthrough Coating Technology to Accelerate the Adoption of Green Hydrogen

nanoFLUX® Technology

ONS
Oxford nanoSystems

nanoFLUX is an innovative metallic-alloy coating with an optimal combination of large surface area, high porosity and dense nucleation sites. This novel surface structure increases the rate and efficiency of chemical and physical processes involving the generation of gas bubbles at a surface. nanoFLUX enables systems such as electrolysers and two-phase heat exchangers to be made smaller, lighter and more efficient – and at lower cost.
It can improve the performance of systems used for:

- Hydrogen Generation
- Heat Transfer

Advantages:

- nanoFLUX is applied via an economical and highly scalable electro-plating process.
- It is compatible with a wide range of substrates, including copper, aluminum, nickel, stainless steel, semiconductor materials such as silicon, and wide band-gap materials like ceramics.
- The process is low energy, does not involve high temperatures and is based on environmentally-friendly, low-cost materials.

Link:
https://oxfordnanosystems.com/technology/



New coating technology could drive down cost of zero-emission green hydrogen

Advanced materials technology company Oxford nanoSystems (OnS) has developed a new coating technology which could 'significantly' reduce the cost of electrolysers used in the green hydrogen process. Oxford nanoSystems (OnS), an advanced materials technology company, has announced a major breakthrough in the race to drive down the production cost of zero-emission green hydrogen.

- According to the company, its nanoFLUX coating improves hydrogen production capacity of alkaline electrolysers by over 50%.
- Efficiency is improved by applying the metallic-alloy coating to the electrodes, promoting the formation and release of gas bubbles within the electrolyser.
- The formation of these gas bubbles is due to the unique dendritic surface structure that forms a network of microcavities.
- Because the gas bubbles are released from the electrode surface at a much faster rate, the effective area available for the hydrogen evolution reaction is maximised, in turn reducing energy losses caused by the build-up of bubbles.
- The company has managed to accelerate the hydrogen generation reaction by combining the nanoFLUX coating with a proprietary catalyst.
- Set to play a crucial role in achieving Net Zero, hydrogen could be key to decarbonising critical sectors such as transportation, heavy industry and aviation.
- Producing hydrogen using excess energy from renewable sources maximises their output, but – according to OnS – industry recognises that the promise of green hydrogen will require significant reductions in production costs.
- If these costs can be realised, the green hydrogen industry may achieve a projected installed capacity of over 100GW by 2030.

Link:
https://www.gasworld.com/story/new-coating-technology-could-drive-down-cost-of-zero-emission-green-hydrogen/
https://www.azonano.com/news.aspx?newsID=40300#:~:text=nanoFLUX%2C%20an%20advanced%20metallic%2Dalloy,accelerates%20the%20hydrogen%20generation%20reaction.

EVENTS

Connecting Green Hydrogen Europe

CONNECTING GREEN HYDROGEN EUROPE

Conference & Exhibition #CGHE2024



Date: 25 - 27 June 2024

Venue: IFEMA Madrid, Spain

Connecting Green Hydrogen Europe 2024 (CGHE2024) is the largest and most influential Green Hydrogen event in Europe, bringing together the entire hydrogen value chain to accelerate the hydrogen economy.

Will be hosted in IFEMA Madrid on 25th-27th June 2024, this extraordinary platform unites a formidable assembly of over 5,000 attendees, comprising industry leaders, energy ministers, CEOs, and an impressive cohort of 100+ exhibitors.



Link:

https://www.europe.gh2events.com/download-post-event-report

INDUSTRY NEWS

Houston Energy Firm to Produce Clean Hydrogen With Natural Gas at West Virginia Facility

A Houston energy transition company is planning a $2 billion investment to produce clean hydrogen with natural gas in West Virginia, a project estimated to create up to 800 permanent jobs.

Once it clears regulatory hurdles, Fidelis New Energy will locate its Mountaineer GigaSystem facility on 1,000 acres (400 hectares) in Point Pleasant along the Ohio River in Mason County.

The project would be built in four phases with each one producing more than 500 metric tons of hydrogen per day. Operations are expected to begin in 2028, the governor said.

The hydrogen would power the company's data center campus planned for the site and also be transported for other industries such as greenhouses, transportation and steel production, Justice said.

Under the company's plan, the project would remove and annually store about 10 million metric tons of carbon dioxide emissions underground, beneath state forests, wildlife management areas and other state-owned properties.

https://www.usnews.com/news/best-states/west-virginia/articles/2023-08-16/houston-energy-firm-to-produce-clean-hydrogen-with-natural-gas-at-west-virginia-facility

(LEAD) SK E&S signs MOU with KOSPO for green hydrogen partnership

SK E&S Co., the natural gas power unit of South Korea's SK Group, signed a preliminary agreement with a local utility company Thursday for a partnership on the production and utilization of green hydrogen.

Under the memorandum of understanding with the Korea Southern Power Co. (KOSPO), they will work together to produce green hydrogen and green ammonia based on renewable energy sourced from South Korea or overseas and use them as fuel for power plants operated by KOSPO, SK E&S said in a release. SK Plug Hyverse, SK E&S' hydrogen venture with U.S. Plug Power, will also join the partnership.

(LEAD) SK E&S signs MOU with KOSPO for green hydrogen partnership | Yonhap News Agency (yna.co.kr)

Oman welcomes world's first liquefied hydrogen ship as it aims to boost fuel capacity

Oman welcomed the world's first liquefied hydrogen carrier ship Suiso Frontier at Sultan Qaboos Port in Muscat. The Japanese tanker, which reached the Gulf nation as part of its Middle East tour, was manufactured by the Kawasaki Heavy Industries and it is operated by Shell Japan.

With cargo capacity of up to 1,250 cubic metres, the ship is considered an experimental station on which to boost research and development in the field of hydrogen. It was built at a cost of nearly $359 million.

The sultanate is on track to become one of the largest producers of hydrogen in the world by 2030, the International Energy Agency said in a June report.



Oman welcomes world's first liquefied hydrogen ship as it aims to boost fuel capacity (thenationalnews.com)

Orsted shelves plans to tap giant offshore wind farm for green hydrogen

Orsted has paused plans to tap one of the world's largest offshore wind farms – the UK's 1.3GW Hornsea 2 – for green hydrogen production.

The Danish group and partner Phillips 66 said they will withdraw funding bids from the Gigastack project led by hydrogen specialist ITM Power, which aimed to deploy a 100MW H2 electrolyser onshore.



https://www.rechargenews.com/wind/orsted-shelves-plans-to-tap-giant-offshore-wind-farm-for-green-hydrogen/2-1-1502161

EVENTS

Hydrogen 2024

Accelerate hydrogen from pilot to scale

The world's most senior hydrogen event



Date: March 2024

Venue: Amsterdam

Five Key Themes to Scale-up the Hydrogen Economy:

1. Leadership and initiatives to unlock the global hydrogen economy
2. Financing hydrogen and securing off-take agreements
3. Production and development – scaling from mw to gw
4. Infrastructure for storing and transporting hydrogen
5. The ammonia opportunity

Link:

https://events.reutersevents.com/renewable-energy/hydrogen-europe

INDUSTRY NEWS

Aerospace firms join hands to further liquid hydrogen fuel systems

Sustainable air travel is a critical step in achieving net zero targets around the world. Under a 1.5-degree scenario, aircraft emissions are anticipated to more than triple by 2050, consuming up to one-quarter of the global carbon budget.

In a mission to find a viable alternative to fossil fuels, aerospace manufacturers Marshall, GKN Aerospace, and Parker Aerospace have signed a Memorandum of Understanding (MoU) to investigate liquid hydrogen fuel system technologies for the next generation of zero-emission aircraft.

According to the firm, hydrogen propulsion, whether by fuel cells or combustion, is seen as a vital option for the aviation sector to meet its target of net zero emissions by 2050.



https://interestingengineering.com/transportation/aerospace-firms-join-hands-to-further-liquid-hydrogen-fuel-systems

South Korean company to develop hydrogen production project in Australia

While Korea Zinc Company has announced it will begin commercial production of green hydrogen in Australia next year (2024), according to local news.

Pulse News Korea reported that the company is initially targeting the production of around 140 tonnes per year of green hydrogen, accompanying a 124MW solar power plant on the production site.

Korea Zinc's subsidiary, Ark Energy Corp, will begin the commercial operations of the green hydrogen plant in Townsville, Queensland, Australia in the first half of 2024, before verifying the performance and safety through trial operations in the latter stages of the year. By 2030, the company plans to produce 280,000 tonnes of green hydrogen at the plant.

South Korean company to develop hydrogen production project in Australia (h2-view.com)

Simple Kitchen Ingredient Might Revolutionize Hydrogen Storage

One of the most promising renewable energy carriers is clean hydrogen, when it is produced without fossil fuels. It's a promising idea because the most abundant element in the universe is hydrogen, found in 75 percent of all matter. Moreover, a hydrogen molecule has two paired atoms – Gemini twins that are both non-toxic and highly combustible. Hydrogen's combustive potential makes it an attractive subject for energy researchers around the world.

That combustive potential and the storage issues are subject to intense research.

At Pacific Northwest National Laboratory (PNNL), a team is investigating hydrogen as a medium for storing and releasing energy, largely by cracking its chemical bonds. Much of their work is linked to the Hydrogen Materials-Advanced Research consortium (HyMARC) at the Department of Energy (DOE).



Simple Kitchen Ingredient Might Revolutionize Hydrogen Storage | OilPrice.com

3 UW hydrogen research proposals selected for seed funding

Three University of Wyoming research proposals recently were selected to receive seed funding through the Hydrogen Energy Research Center's Hydrogen Production and Transportation for Wyoming initiative.

The funding, available through the UW School of Energy Resources, is part of Phase II of a funding initiative to promote and facilitate hydrogen research among current UW faculty members and researchers that will be applicable in Wyoming. In 2022, H2ERC issued a request for proposals on hydrogen energy, in which topics of interest included all supply chain levels, such as hydrogen production, use, transportation and storage.

3 UW hydrogen research proposals selected for seed funding | Local News | wyomingnews.com

EVENTS

INDIA ENERGY WEEK 2024

UNDER THE PATRONAGE OF

MINISTRY OF PETROLEUM AND NATURAL GAS

SUPPORTED BY

FIPI

Federation of Indian Petroleum Industry

Date: 6-9 February 2024
Venue: Goa, India
Collaboration: Held under the patronage of the Ministry of Petroleum & Natural Gas, Government of India, and officially supported by the Federation of Indian Petroleum Industry (FIPI).
Aim: India Energy Week 2024 will showcase India's achievement as a catalyst for global economic growth with billions of dollars of investment needed to facilitate India's energy transition and achieve its net-zero goals. Building on the incredible success of the 2023 edition, inaugurated by the hon'ble Prime Minister of India Shri Narendra Modi, India Energy Week 2024 will welcome policy makers, business leaders and energy experts to uncover new opportunities and strengthen partnerships.

Link: https://www.indiaenergyweek.com/

Gautam Adani to go solo on hydrogen project as TotalEnergies SE might sit out: Report

As per the June 2022 announcement, TotalEnergies had agreed to take 25 per cent equity in Adani New Industries Ltd (ANIL). Billionaire Gautam Adani may not tie up with TotalEnergies as of now for developing the green hydrogen project in India, a report by Bloomberg News claimed. Adani's first green hydrogen venture is a $5 billion integrated facility, which will include manufacturing plants for wind turbines and solar modules and renewable generation capacity. TotalEnergies had announced its partnership with the Adani group in June 2022.Both the companies had outlined a capex plan of $50 billion to set up a 2.5 million metric tonnes per annum (mmtpa) of green H2 manufacturing capacity over the next 10 years, with the first phase of 1.0 mmtpa expected to be commissioned before 2030. Though TotalEnergies did not sign a contract.
As part of the partnership announced in June 2022, ANIL was to contribute its knowledge of the Indian market, execution capabilities, operations excellence, and capital management philosophy, whereas TotalEnergies was to bring its understanding of the global market, credit enhancement and financial strength to lower the financing costs along with expertise in underlying technologies. ANIL had plans to manufacture green hydrogen and its downstream products such as ammonia, urea, methanol, and ethanol at its Khavda and Mundra SEZ facilities. The Khavda site has a land bank of 71,000 acres, which has a large-scale renewable deployment potential of 20 GW due to its high wind and solar resource potential.
The company's revenue from operations came was at Rs 25,438 crore, dropping by 38 per cent from Rs 40,844 crore reported during the previous corresponding quarter, the flagship company said in an exchange filing. Adani Enterprises attributed the fall to correction in coal prices.

TotalEnergies

https://www.businesstoday.in/latest/corporate/story/gautam-adani-to-go-solo-on-hydrogen-project-as-totalenergies-se-might-sit-out-report-393638-2023-08-10

https://totalenergies.in/

Top 5 Companies Green Hydrogen companies in India

India, a rapidly growing economy with energy needs of its own, is not lagging behind in embracing this clean energy revolution. The Indian government, along with visionary businesses, is leading the charge in green hydrogen production.

1. **Oil India**



The groundbreaking achievement is the inauguration of India's inaugural green hydrogen plant, strategically positioned in Assam. By harnessing an ingenious fusion of Alkaline and PEM technologies, this facility has an exceptional installed capacity of 10 kg per day. It also has aspirations to augment capacity to 30 kg per day.

2. **Reliance Industries**



Renowned globally as the largest producer of grey hydrogen. Aim: complete its transition by 2025 and achieve net-zero emissions by 2035.

3. **GAIL**



Aim: Construct the largest PEM (Proton Exchange Membrane) electrolyser plant in the country.

4. **Indian Oil Corporation**



Leveraging the potency of solar energy, biomass gasification, and bio-methanation, IOC is poised to establish a 7 KTPA electrolysis plant by 2025.

5. **Bharat Petroleum Corporation**



Aim: Establishment of a cutting-edge 1 MW electrolyser manufacturing facility, slated for completion by 2025 which will be powered by advanced alkaline electrolyser technology.

https://timestech.in/top-5-companies-green-hydrogen-

Yang, YF. *et al.*

Self-Assembled Au/CuS Nanoparticles for Targeted Imaging and Multimodal Therapy of Breast Cancer

https://doi.org/10.1021/acsanm.3c02130

Abstract:

With the rapid development of nanotechnology, many multifunctionalbionanoplatforms have been developed for cancer treatment. Here, we have developed targeted multimodal nanoparticles for breast cancerimaging and treatment. Using a solvent-induced self-assembly technique,we prepared a nanomaterial (Au/CuS NPs) composed of gold nanoclusters(Au NCs) and copper sulfide nanoparticles (CuS NPs). The compositenanoparticles possess both the bioimaging ability of Au NCs and thephotothermal properties of CuS NPs. To target folate receptors overexpressingbreast cancer cells, we modified the nanoparticle surfaces with folic acid. Furthermore, we easily loaded doxorubicin into the nanoparticlesusing electrostatic interaction and hydrogen bonding, achieving adrug encapsulation efficiency of 47.8%. In vitro experimentsshowed that the prepared composite nanomaterials had excellent fluorescence imaging ability and a better ability to kill MDA-MB-231 cells than single drug or photo thermal treatment alone. This multifunctional system, which combines fluorescence imaging, photo thermal treatment, and targeted drug delivery, has great potential for cancer diagnosis and treatment.

Yan, X. *et al.*

Filling the Gap: Atomically Precise Metal Nanoclusters-Induced Z-Scheme Photosystem toward Robust and Stable Solar Hydrogen Generation

https://doi.org/10.1002/adfm.202303737

Abstract:

Atomically precise metal nanoclusters (NCs) represent a promising generation of metal nanomaterial because of characteristic atomic stacking mode, abundant catalytic active sites, and molecular-like discrete energy band structure. However, crafting metal NCs-dominated photocatalytic systems with mediated charge transport pathways for photoredox catalysis is in the infant stage and their photocatalytic mechanisms remain elusive, which is largely hampered by the ultra-short charge lifetime, generic instability, and complicated electronic structure of metal NCs. In this study, the smart construction of all-solid-state metal NCs-transition metal chalcogenides quantum dots (TMCs QDs) Z-scheme artificial photosystems for robust and stable solar-to-hydrogen conversion is demonstrated. The concurrent favorable photosensitization efficiency of metal NCs and TMCs QDs synergistically stimulate the unexpected Z-scheme charge transport pathway, which significantly boosts the anisotropic spatial vectorial charge transport/separation, giving rise to considerably enhanced visible-light-responsive photocatalytic hydrogen generation performances along with favorable stability. This study would push forward the prosperity of exploring metal NCs-based photosystems for solar-to-hydrogen conversion.

Yang, X. *et al.*

High-Yield Gold Nanohydrangeas on Three-Dimensional Carbon Nanotube Foams for Surface-Enhanced Raman Scattering Sensors

https://doi.org/ 10.1021/acsomega.3c01802

Abstract:

Recently, carbon nanomaterial-supported plasmonic nanocrystalsused as high-performance surface-enhanced Raman scattering (SERS) substrates have attracted increasing attention due to their ultra-highsensitivity of detection. However, most of the work focuses on the design of 2-D planar substrates with traditional plasmonic structures, such as nanoparticles, nanorods, nanowires, and so forth. Here, were port a novel strategy for the preparation of high-yield Au nanohydrangeason three-dimensional porous polydopamine (PDA)/polyvinyl alcohol (PVA)/carbonnanotube (CNT) foams. The structures and growth mechanisms of thesespecific Au nanocrystals are systematically investigated. PDA playsthe role of both a reducing agent as well as an anchoring site forAu nanohydrangeas' growth. We also show that the ratio of surfactantKBr to the gold precursor (HAuCl4) is key to obtain thesestructures in a manner of high production. Moreover, the substrateof the CNT foam-Au nanohydrangea hybrid can be employed asSERS sensors and can detect the analytes down to 10(-9) M.

Mu, LT. *et al.*

Research Progress on Deep Eutectic Solvents and Recent Applications

https://doi.org/ 10.3390/pr11071986

Abstract:

In this study, the classification, composition, preparation methods, and performance parameters of deep eutectic solvents (DESs) and their recent applications in natural product extraction, drug delivery systems, trace metal determination, nanomaterial synthesis, and electrochemistry are systematically summarised through the literature of recent decades, using DESs and applications as keywords. The hydrogen bond acceptors (HBA) of DESs are mainly quaternary ammonium salts (e.g., choline chloride) or amphoteric ions (e.g., betaine); the hydrogen bond donors (HBD) are mostly compounds such as urea, polyols, and sugars. Their melting points are related to hydrogen bonding, their polarities are higher than most ionic liquids, and their viscosities are generally in the range of 0.01-5 Pa & BULL;s. Compared with traditional organic solvents and conventional ionic liquids, DESs have higher solubility, with their ability to dissolve metal oxides and insoluble drugs, and have good biodegradability. DESs have high extraction rates in flavonoids and phenols, can increase drug solubility in drug delivery systems, can effectively extract and perform pre-concentration of metals in trace metal determination, can synthesise new nanomaterial, and can be used as electrolytes for electrochemical reactions in electrochemistry. This paper collates the relevant literature on the physicochemical properties and multi-field applications of DESs, which provides a deeper understanding of DESs and looks forward to the future development of DESs

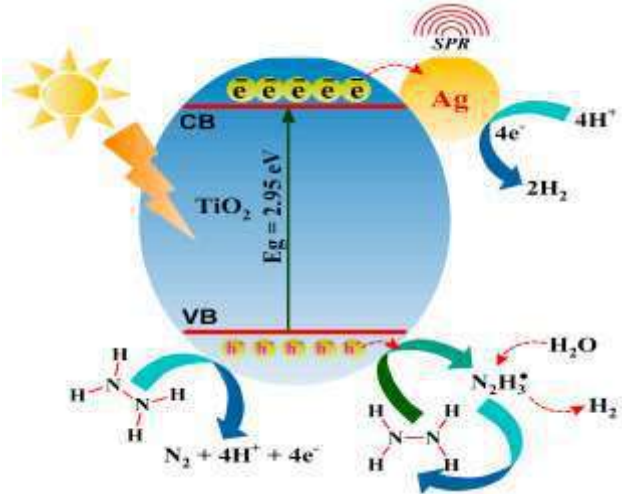
Althabaiti, SA. *et al.*

Selective Thermal and Photocatalytic Decomposition of Aqueous Hydrazine to Produce H-2 over Ag-Modified TiO2 Nanomaterial

https://doi.org/ 10.3390/nano13142076

Abstract:

An Ag-modified TiO2 nanomaterial was prepared by a one-pot synthesis method using tetra butyl titanate, silver nitrate, and sodium hydroxide in water at 473 K for 3 h. X-ray diffraction, scanning electron microscopy, and transmission electron microscopy were used to determine the structure and morphology of the synthesized Ag-modified TiO2 nanomaterial. The diffuse reflectance UV-visible and photoluminescence spectroscopy results revealed that metallic Ag nanoparticles decreased the optical band gap and photoluminescence intensity of the TiO2. In addition, the Raman peak intensity and absorbance were increased after Ag modification onto TiO2. The photocatalytic efficiency of the synthesized samples was tested for decomposition of aqueous hydrazine solution under visible light irradiation. The photocatalytic efficiency of Ag-modified TiO2 nanomaterials was higher than that of bare TiO2 and Ag metal NPs due to the synergistic effect between the Ag metal and TiO2 structures. In addition, the surface plasmon resonance (SPR) electron transfer from Ag metal particles to the conduction band of TiO2 is responsible for superior activity of TiO2-Ag catalyst. The Ag-modified TiO2 nanomaterials offered a 100% H-2 selectivity within 30 min of reaction time and an apparent rate constant of 0.018 min(-1) with an activation energy of 34.4 kJ/mol under visible light radiation.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 47
AUGUST, 2023

Tubular Solid Oxide Electrolysis (tSOE)

Efficient solid oxide electrolysis technology to produce green hydrogen and syngas for decarbonisation of various energy sectors.



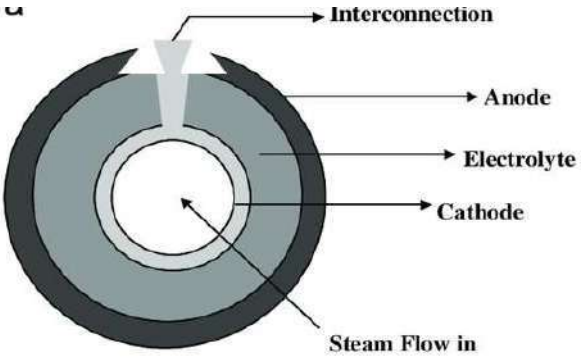


Figure: Tubular Solid Oxide Electrolyser

Australian Government and international policies are continuously emerging to support a green hydrogen industry. A global target of low-cost hydrogen (below $2/kg) is currently in place to help industries achieve decarbonisation goals by adopting hydrogen at scale.

Tubular solid oxide electrolysis (tSOE) technology produces hydrogen by electrolysing water using a combination of heat and electricity. This allows 30 per cent less electricity consumption (<42 kWh/kg of hydrogen) compared to existing alkaline and polymer electrolyte membrane (PEM) electrolyser technologies (~60 kWh/kg of hydrogen).Its cell materials and configuration also allow for simplified, low-cost manufacturing processes.

The technology is being commercialised through the creation of a new company. We are seeking interest from strategic and industrial investors who are interested in supporting the growth of Australia's hydrogen industry.

Benefits of the Technology:

- simplified structural design with less sealing requirements
- lower manufacturing cost
- higher durability
- lower cost of balance of plant
- high operating efficiencies (by avoiding associated costs of hydrogen recycling required in the conventional electrolysers).
- Also allows operational flexibility with a fully-reversible design made possible by symmetrical cell configuration. This allows the technology to be equally suitable for combined heat and power (CHP) applications.
- Importantly, its ability to integrate with upstream and downstream processes can make this technology highly efficient, for example in ammonia and methanol production.

Applications:

Because hydrogen and syngas (H2/CO) are established feedstocks for the production of value-added chemicals and fuels, the technology has a wide range of applications across *industries, including steel, ammonia, petrochemical, methanol and heavy transport.* The technology can also be used *directly in industry where there is demand for hydrogen in the process*, eliminating the cost and technical challenges of storing and transporting hydrogen at scale.

https://www.csiro.au/en/work-with-us/ip-commercialisation/marketplace/tubular-solid-oxide-electrolysis

Ni, M., Leung, M. K. H., & Leung, D. Y. C. (2008). Technological development of hydrogen production by solid oxide electrolyze cell (SOEC). *International Journal of Hydrogen Energy*, *33*(9), 2337–2354. https://doi.org/10.1016/j.ijhydene.2008.02.048

PATENT

Patent ID: RU2655671C2
Russia

Title:
Battery of tubular solid-oxide elements with thin-layer electrolyte of electrochemical device and battery connection node of tubular solid-oxide elements (options)

Field: **Electrochemistry.**

Substance:
Invention relates to high - temperature electrochemical devices based on solid oxide elements (SOE)- elements with a solid electrolyte.

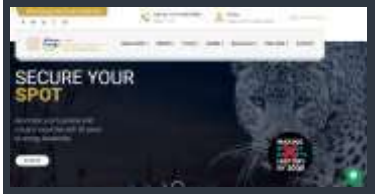
Effect:
Technical result is the creation of a battery in which the tubular fuel assemblies are connected in series with current, providing improved mass and electrical characteristics, the process ability of assembly of the battery itself, as well as a solid oxide device based on it, with the ability to service and replace the defective battery.

Area of use
The group of inventions relates to electrochemical devices (ECUs), such as electrochemical current generators on fuel cells, oxygen pumps, electrolyzers, converters,etc. devices based on solid oxide cells (TOE) - cells with solid oxide electrolyte.
More precisely, to the design of the battery of tubular TOE with a thin-layer solid electrolyte and the nodes (connections) of the TOE into the battery.

Link:
https://patents.google.com/patent/RU2655671C2/en

EVENTS

African Energy Week (AEW) 2023



Venue: CTICC, Cape Town, South Africa

Date: 16 – 20 October 2023

Aim: To showcase latest technologies and innovations to over 5,000 delegates.

Link:

https://aecweek.com/

26th World Energy Congress

Venue: Rotterdam, the Netherlands

Date: 22nd April 2024 – 25th April 2024

Aim: Marking the beginning of the centenary of the World Energy Council, this most prestigious and influential global event, hosted at the highest political level, welcomes leaders from all corners of the world as they come together to enable solutions and deliver impact under the theme 'Redesigning Energy for People and Planet'.

Link:

https://www.worldenergy.org/experiences-events/events/entry/26th-world-energy-congress-rotterdam-netherlands

INDUSTRY NEWS

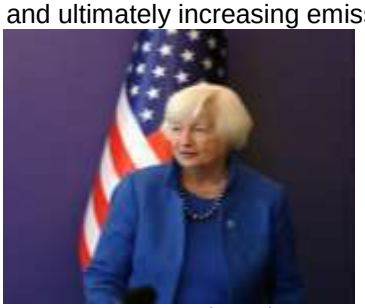
Where is the Treasury's guidance for the US clean hydrogen production tax credit?

The department appears to have missed a one-year deadline to issue regulations set out in the Inflation Reduction Act. A year and a day ago, the Inflation Reduction Act entered into force, setting out a clean hydrogen production tax credit of up to $3/kg and a deadline for regulations or other guidance on lifecycle greenhouse gas emissions to be issued "not later than [one] year after the date of enactment".

They argue that they will bump up the cost of making the molecule by requiring extra investment in new zero-carbon power generators and limiting the amount of time an electrolyser can be switched on.

The criteria have also been criticised by some Democratic senators as overly restrictive to the take-off of green hydrogen as an industry.

Environmental advocacy groups on the other hand have called for these rules in order to prevent a situation in which electrolysers draw renewable electricity off the grid that would otherwise be used directly, leading to extra fossil fuel-fired power generation to meet demand and ultimately increasing emissions.



https://www.hydrogeninsight.com/policy/where-is-the-treasurys-guidance-for-the-us-clean-hydrogen-production-tax-credit-/2-1-1502009

HSBC's green hydrogen partnerships unveiled by FM

HSBC India has forged strategic alliances with the Indian Institute of Technology (IIT) Bombay and Shakti Sustainable Energy Foundation (SSEF) to propel innovation in Green Hydrogen.

These partnerships are backed by a grant of Rs 15 crore to enhance the efficiency, cost-effectiveness, and scalability of green hydrogen. The partnership aims to prioritize green hydrogen as a strategic alternative fuel and realize India's vision of an energy-independent nation.

The collaboration with IIT Bombay aims to stimulate breakthroughs in green hydrogen technology by enlisting researchers, students, and scientists across IITs.

This initiative targets key challenges encompassing green hydrogen production, storage, transportation, and utilization.

Additionally, the partnership with SSEF zeroes in on specific Indian states to drive real-world applications of green hydrogen in industrial clusters. By evaluating policy, technological, and financial solutions, this collaboration is set to amplify the impact of green hydrogen across diverse sectors. In essence, HSBC's strategic partnerships are poised to accelerate India's journey towards a sustainable energy landscape, fostering innovation and sustainability in tandem.

HSBC's green hydrogen partnerships unveiled by FM (msn.com)

New CSIRO company pursues hydrogen game changer for heavy industry

Hadean Energy, a novel company co-founded by CSIRO and RFC Ambrian has a mission to accelerate industrial decarbonisation.

Australia's national science agency, CSIRO, and corporate advisor RFC Ambrian have co-founded Hadean Energy, a new company to commercialise cutting-edge technology that can produce hydrogen with 30 per cent less electricity and help to decarbonise heavy industry.

CSIRO will trial the technology at BlueScope's Port Kembla Steelworks to demonstrate the equipment at pilot scale in an industrial environment.

CSIRO's tubular solid oxide electrolysis (SOE) technology efficiently produces hydrogen by electrolysing water using a combination of heat and electricity and promises to significantly reduce hydrogen production costs and industry emissions through process efficiencies. The International Energy Agency estimates demand for hydrogen is expected to increase 138 per cent by 2030, but high production costs and energy inputs are key challenges for producing green hydrogen. Dr Sarb Giddey, lead scientist on hydrogen research at CSIRO, said the development of tubular SOE technology at CSIRO is a key project aimed at producing more affordable and efficient hydrogen to help industry dramatically reduce emissions.

"CSIRO's SOE technology has the potential to produce hydrogen at a higher efficiency and lower cost for integration with industrial processes," Dr Giddey said. "It allows industrial waste heat to be integrated back into the industrial processes, which decreases the electrical energy required to produce hydrogen or syn-gas by up to 30 per cent.

https://www.csiro.au/en/news/All/News/2023/August/Hadean

EVENTS

Smart Energy India Expo

Co-located with

9th Smart Cities INDIA EXPO

Venue: Pragati Maidan

New Delhi, Delhi

Date: 17–19 Jan 2024

The Smart Energy Expo India, one of the Co- located Expo of 9th Smart Cities India is instrumental in connecting India's fast-growing renewable energy sector. The expo serves as the premier B2B platform to drive businesses and citizens into a sustainable energy transition.

Green Energy is at the center of India's road map to sustainable growth and development as India paves way to become the third-largest energy consumer with rapid urbanization and industrial economic growth. Solar & EV infra as a renewable energy source is fast-tracked in the country along with adoption of Green Hydrogen & Alternative Fuels as the country aims to reach its net zero targets by 2047.

Link:

https://www.smartenergyindiaexpo.com/

Zero emissions aviation company and energy group enter hydrogen supply partnership

US-UK zero carbon emissions aviation company ZeroAvia and United Arab Emirates (UAE) clean energy group Masdar have entered a partnership to examine the production and supply of hydrogen at key locations.

Initially, the partnership will concentrate on European and North American projects, but will also explore opportunities to set up clean flight operations in the UAE.

ZeroAvia is developing greenhouse gas emissions-free propulsion systems for aircraft, using hydrogen fuel cells in combination with electric motors, and recently completed its first flight test campaign for its initial ZA600 system, using a modified Dornier Do 228 twin-engine commuter aircraft. These systems will require hydrogen as fuel. And this hydrogen has to be, and can be, produced in a green manner, using renewable energy.

A 90-seat airliner using a ZeroAvia propulsion system would need 1 t of hydrogen for each short regional flight. So, even a small commercial airport could have a daily demand for more than 100 t of hydrogen.

To be of practical use, the company's propulsion systems must be supported by an adequate and reliable supply of hydrogen at all the airports from and to which the aircraft powered by them are operating.

To this end, ZeroAvia is working with a number of major energy companies to ensure that its airline customers can get the hydrogen fuel they require, as soon as 2025.

Masdar is seeking, by being a 'smart first mover', to become a global leader in green hydrogen, with a target of producing 1 000 000 t/y of green hydrogen by 2030. It will do so by investing in and developing strategic projects, and establishing, in key markets, scalable platforms.

Masdar is also deeply committed to helping the UAE to achieve its national green hydrogen ambitions. The UAE is seeking to produce 1 400 000 t/y of green hydrogen by 2031 and 15 000 000 t/y by 2050.

Zero emissions aviation company and energy group enter hydrogen supply partnership (engineeringnews.co.za)

Texas port could be home to green hydrogen and ammonia plant



A 245-acre site at the Port of Victoria, Texas, could become a major green hydrogen and green ammonia production center.

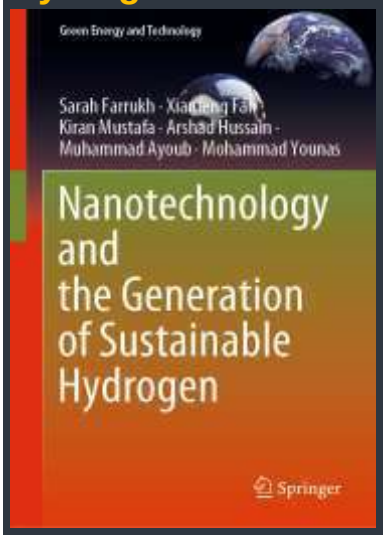
The Victoria County Navigation District and Acme Greentech Ventures Americas Inc., a wholly owned subsidiary of India's Acme Group have entered into an option agreement that will see Acme conduct due diligence and feasibility studies to develop an integrated green hydrogen and ammonia facility of up to 1.2 MMTPA at Port Victoria, resulting in significant potential investments and jobs.

Acme is one of the largest solar power producers in India. It built the world's first fully integrated green ammonia plant in 2021 which is currently producing around five tons of green ammonia daily. "As the world's energy consumption continues to increase, we are committed to providing clean and sustainable energy to help secure that future demand," said Acme chairman Manoj Upadhyay. "Both the port's geographical position as well as the transport and logistic options to access the markets make for an ideal location for our plant. Additionally, Victoria's business-friendly community has been wonderful to work with and we look forward to further collaborating to potentially develop both jobs and green energy in the region." "We have recently made great infrastructure investments at the port to keep us competitive and ensure our commitment to bring new jobs and industry to our community," said Sean Stibich, executive director at the Port of Victoria. Victoria County Navigation District says that the proposed Acme project also has the possibility of bringing in a much-needed 345 kV power line, as well as a support industry with a large private investment. The port now has over 510 acres under option at its Texas Logistics Center.

Texas port could be home to green hydrogen and ammonia plant - Marine Log

BOOK

Nanotechnology and the Generation of Sustainable Hydrogen



Authors:
Sarah Farrukh, Xianfeng Fan , Kiran Mustafa, Arshad Hussain, Muhammad Ayoub, Mohammad Younas

Year: **2021**
Series Title:Green Energy and Technology
DOI-
https://doi.org/10.1007/978-3-030-60402-8
Publisher:
Springer Cham
ISBN 978-3-030-60401-1

About This Book:

This book explains the aspiring vision of a sustainable hydrogen generating system which employs nanotechnology one way or the other and presents a detailed update on research activities, achievements and challenges. It explores how nanotechnology is reshaping science in general and how this can be applied to the generation and storage of hydrogen energy.

This book begins by highlighting the importance of hydrogen a source of sustainable energy and its impact on the technical advances of fuel cells, internal combustion engines, batteries and power plants. The book depicts the role of nanotechnology in the development of sustainable hydrogen.

India's green hydrogen pilot gathers steam, economics yet to add up

FY24 is shaping up to be the year when numerous Indian companies are putting their green hydrogen ambitions into motion, albeit at the pilot stage. As this progresses, industry insiders and experts note that demand and financial closures remain elusive.

Earlier this month, top executives from Adani Enterprises revealed to analysts that work on their electrolyser manufacturing unit is likely to commence either in the current or next quarter. The conglomerate is not alone in initiating its green hydrogen pilot.

Larsen & Toubro (L&T), Indian Oil Corporation, and Renew Power are anticipated to form a joint venture (JV) company in the coming weeks, said Subramanian Sarma, whole-time director and senior executive vice president (Energy) for L&T.

Construction work is underway at Reliance Industries' Giga complex in Jamnagar, which will also accommodate the planned electrolyser manufacturing unit, as per sources. Sandeep Kumar Gupta, chairman for state-owned GAIL India, told shareholders on Wednesday that the company's 10 MW green hydrogen production unit, the largest in India, with a daily capacity of 4.3 tonnes at Vijaipur in Madhya Pradesh, is anticipated to be commissioned by December. L&T has plans to establish a gigawatt-scale manufacturing facility for electrolysers in India.

https://www.business-standard.com/companies/news/india-s-green-hydrogen-pilot-gathers-steam-economics-yet-to-add-up-123082300805_1.html

Abhay Lodha Of Topworth Evaluates: Green Steel Helps India Move Toward Greener Future

Steel is an energy source that is not renewable, an alternative is needed to balance the use of traditional and non-conventional energy sources. The Chairman and Founder of Topworth Group and companies Abhay Lodha, sees this transition from traditional steel to green steel as a remarkable step that will address a meaningful sustainable future. Green steel is really important for sustainable development because it helps reduce the amount of CO2 released by the steel industry. Green steel uses low-carbon technology like hydrogen direct reduction or molten oxide electrolysis to reduce CO2 emissions, which helps reduce climate change and opens up new economic opportunities for renewable energy and clean tech.

Production of Green Steel:

Green steel is produced using low-carbon primary technologies such as hydrogen direct reduction (HDR), molten oxide electrolysis (MoE), carbon capture and storage (CCS), and electric arc furnaces (ECF) using recycled scrap steel, wind, and solar.

Green Steel is more sustainable as compared to traditional steel. Green steel production uses renewable and recyclable scrap steel. Traditional steel production accounts for 7% of global greenhouse gas emissions, while green steel production reduces energy consumption. The use of scrap steel reduces raw material requirements, and the promotion of sustainable development, contributing to the preservation of natural resources in green steel production.

Challenges:

Challenges associated with the production of green steel are high costs, limited tech availability, and a reliable hydrogen supply chain. With the carbon price between $70 and $100/t CO2, it costs 20-30% more to make green steel than it does to make regular steel. But renewable energy is getting cheaper, and low-carbon processes are becoming more profitable.

So, green steel is the promising pathway towards sustainable green and clean future.

Abhay Lodha Of Topworth Evaluates: Green Steel Helps India Move Toward Greener Future (ndtv.com)

India govt sets emission limit for hydrogen to qualify as 'green'

The Indian government has set an emission limit of two kilogram carbon-dioxide for every kilogram of hydrogen produced to be classified as "green" from renewable sources, the Ministry of New and Renewable Energy said. "With this notification, India becomes one of the first few countries in the world to announce a definition of Green Hydrogen," the ministry said in the statement, which detailed what emissions would be accounted for.

India wants to become a global hub for the production of green hydrogen and is aiming for annual production of 5 million metric tons of the fuel by 2030, which would cut about 50 million metric tons of carbon emissions and save more than $12 billion on fossil fuel imports.

Earlier this year, officials told Reuters India, which holds the rotating Group of 20 presidency this year, was suggesting a 1 kg CO2 emissions limit for green hydrogen, half of the threshold value. Although first production is expected only in 2026, India has been negotiating bilateral agreements with the European Union, Japan and other countries to start exporting the fuel.

India govt sets emission limit for hydrogen to qualify as 'green' | Reuters

Azadnia, AH. *et al.*

Green hydrogen supply chain risk analysis: A European hard-to-abate sectors perspective

https://doi.org/10.1016/j.rser.2023.113371

Abstract:

Green hydrogen is a tentative solution for the decarbonisation of hard-to-abate sectors such as steel, chemical, cement, and refinery industries. Green hydrogen is a form of hydrogen gas that is produced using renewable energy sources, such as wind or solar power, through a process called electrolysis. The green hydrogen supply chain includes several interconnected entities such as renewable energy providers, electrolysers, distribution facilities, and consumers. Although there have been many studies about green hydrogen, little attention has been devoted to green hydrogen supply chain risk identification and analysis, especially for hard-to-abate sectors in Europe. This research contributes to existing knowledge by identifying and analysing the European region's green hydrogen supply chain risk factors. Using a Delphi method 7 categories and 43 risk factors are identified based on the green hydrogen supply chain experts' opinions. The best-worst method is utilised to determine the importance weights of the risk categories and risk factors. High investment of capital for hydrogen production and delivery technology was the highest-ranked risk factor followed by the lack of enough capacity for electrolyser, and policy & regulation development. Several mitigation strategies and policy recommendations are proposed for high-importance risk factors. This study provides novelty in the form of an integrated approach resulting in a scientific ranking of the risk factors for the green hydrogen supply chain. The results of this study provide empirical evidence which corroborates with previous studies that European countries should endeavour to create comprehensive and supportive standards and regulations for green hydrogen supply chain implementation.

Zhang, SH. and Zhang, N.

Review on integrated green hydrogen polygeneration system --Electrolysers, modelling, 4 E analysis and optimization

https://doi.org/10.1016/j.jclepro.2023.137631

Abstract:

Green hydrogen production by water electrolysis is sustainable and carbon-free for energy storage. This paper introduces recent development in integrated green hydrogen polygeneration. Throughout this review, theoretical concepts, design types, and recent developments related to the integration of Alkaline Electrolysis (AE), Proton Exchange Membrane Electrolysis (PEME), and the Solid Oxide Electrolysis Cell (SOEC) are summarised. This review evaluates the thermodynamic efficiency and economic impact of green hydrogen production integrated with different energy sources, energy storage and power cycles. Compared with two kinds of commercially applied methods (AE and PEME), SOEC is the state-of-the-art method to produce hydrogen, which can be integrated with external heat to reduce energy consumption. SOEC avoids the inevitable energy loss in AE and PEME, which leads to low-temperature waste heat evaluated as exergy destruction rather than utilized. The overall efficiency improvement of SOEC systems is over 10%. In most cases, the efficiency is always over 70%, and over 80% in some cases, which exceeds the typical values of 20%-60% from AE and PEME systems. The produced hydrogen can be stored and transported, as well as being used as a feedstock for chemical production, forming a polygeneration system with multiple energy sources, desalination, and fuel production. The latest lifetime of SOEC was predicted at 50,000 h or more, which is the minimum requirement to be commercially competitive. In the literature review, 80.4% of papers chose exergy efficiency as assessment index, compared with 67.9% of energy efficiency. And 58.9% of them chose genetic algorithm to complete multi-objective optimization.

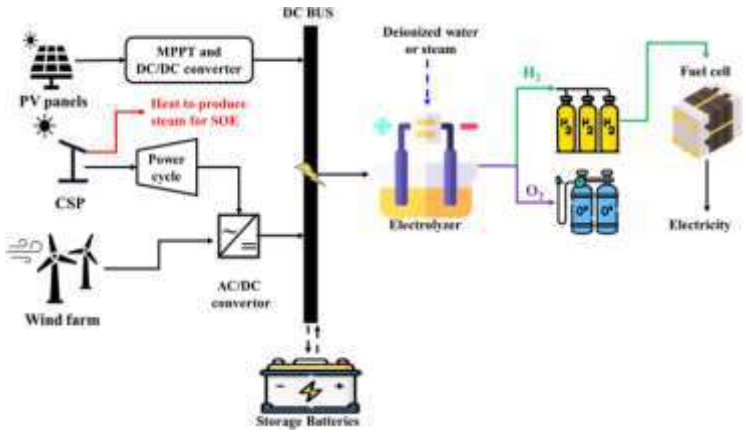


Fig: The schematic diagram for solar/wind hydrogen production systems

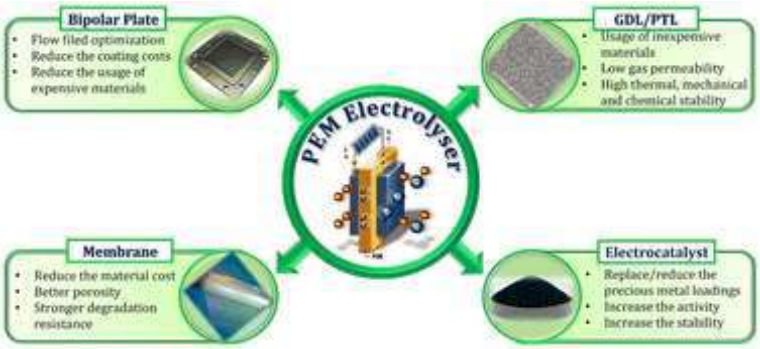
Kumar, SS. *et al.*

Recent advances in hydrogen production through proton exchange membrane water electrolysis - a review

https://doi.org/10.1039/d3se00336a

Abstract:

Proton exchange membrane (PEM) water electrolysis is recognized as the most promising technology for the sustainable production of green hydrogen from water and intermittent renewable energy sources. Moreover, PEM water electrolysis has several benefits such as compact system design with high operating current density, high hydrogen purity, greater energy efficiency and rapid response when combined with renewable energy sources. However, the use of costly electrocatalysts and cell components leads to expensive and limited commercial applications. In this review, various water electrolysis technologies and their technical specifications including hydrogen production costs were briefly summarized from a commercial perspective. Furthermore, we have mainly focused on PEM water electrolysis including recent developments in cell components such as membranes, gas diffusion layers, bipolar plates, and electrocatalysts. Moreover, some of the most effective results also were described and the research gaps and their challenges for cost reduction and commercialization were identified. Furthermore, we concluded by outlining our thoughts and potential solutions for future research directions that should be pursued to develop inexpensive electrocatalysts and cell components for efficient production of green hydrogen. This review aims to provide possible directions and a road map for future research and development towards the development of inexpensive PEM electrolysers.



Graphical Abstract Representation

Wan, CZ. *et al.*

Amorphous nickel hydroxide shell tailors local chemical environment on platinum surface for alkaline hydrogen evolution reaction

https://doi.org/10.1038/s41563-023-01584-3

Abstract:

Elaborated catalysts design can substantially enhance performance under unfavourable reaction conditions. Amorphous nickel hydroxide proton sieve used to modify local chemical environment on a platinum surface results in unprecedented performance for alkaline hydrogen evolution reaction.

In analogy to natural enzymes, an elaborated design of catalytic systems with a specifically tailored local chemical environment could substantially improve reaction kinetics, effectively combat catalyst poisoning effect and boost catalyst lifetime under unfavourable reaction conditions. Here we report a unique design of 'Ni(OH)(2)-clothed Pt-tetrapods' with an amorphous Ni(OH)(2) shell as a water dissociation catalyst and a proton conductive encapsulation layer to isolate the Pt core from bulk alkaline electrolyte while ensuring efficient proton supply to the active Pt sites. This design creates a favourable local chemical environment to result in acidic-like hydrogen evolution reaction kinetics with a lowest Tafel slope of 27 mV per decade and a record-high specific activity and mass activity in alkaline electrolyte. The proton conductive Ni(OH)(2) shell can also effectively reject impurity ions and retard the Oswald ripening, endowing a high tolerance to solution impurities and exceptional long-term durability that is difficult to achieve in the naked Pt catalysts. The markedly improved hydrogen evolution reaction activity and durability in an alkaline medium promise an attractive catalyst material for alkaline water electrolysers and renewable chemical fuel generation.

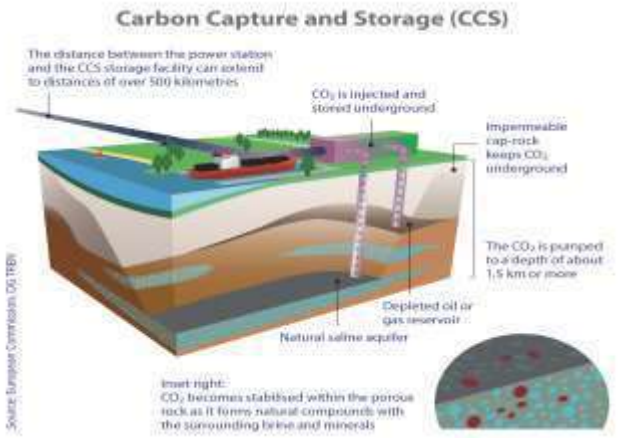
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 48
AUGUST, 2023

What Role Will Membranes Play in Carbon Capture?

CCUS is a central part of every industrial decarbonization roadmap. Membranes are a very attractive solution. They can offer an energy efficient route to gas separation, which is a large advantage in any techno economic analysis, but that is not the complete picture. Membranes have several limitations; most significantly, polymeric membranes have a pay-off between permeability and selectivity.



In post-combustion carbon capture, the main separation is CO_2/N_2. IDTechEx provides critical, independent analysis on both the fields of CCUS and gas separation membranes. In their reports, "Carbon Capture, Utilization, and Storage (CCUS) Markets 2023-2043" and "Gas Separation Membranes 2023-2033" technology roadmaps, benchmarking studies, market forecasts, and interview-based player profiles are provided. Amine scrubbing is the most typically employed and what many benchmark against, but there are many others at various levels of commercial maturity. Solid sorbents are stepping into the limelight; in particular, metal-organic frameworks (MOFs) are gaining significant momentum in the industry.

Incumbent membranes may not be suitable as the primary approach, but material and engineering developments are progressing out of the lab and into promising commercial trials.

Technology developments: Advanced membrane materials and hybrid system solutions gain commercial traction.

There are a wide range of membrane materials including polymeric, ceramic, metallic and composite variants. There are also essential considerations to both their form factor (such as hollow fiber or spiral wound) and ultimately how they are incorporated into the industrial process (including flow rate, operating temperature, and pressure difference) to meet the necessary separation requirements.

Polymer membranes, including cellulose acetate, polyimide and polysulfone, dominate the current market. In the polymeric space there are numerous advancements for both direct material use or inclusion as part of a composite, the latter seeing some key developments in both thin-film composite (TFC) membranes and mixed matrix membranes (MMM); fixed site carriers (FSC), polymers of intrinsic microporosity (PIMs), polybenzimidazole (PBI) based membranes and more have all seen promising early signs for commercial adoption.

Beyond polymer membranes, there is a wide range of alternatives that typically offer either higher selectivity (through their transport mechanisms) or advantageous physical properties, such as operating temperature or resistance to contaminants. This includes metallic membranes, carbon-based membranes, ceramic membranes, and earlier-stage examples such as dual-phase membranes.

https://www.idtechex.com/en/research-article/what-role-will-membranes-play-in-carbon-capture/29769
https://www.idtechex.com/en/research-report/gas-separation-membranes-2023-2033/940

Membrane materials targeting carbon capture and utilization
Chen *et al.*

Abstract

Over the past decades, fossil fuel combustion has emitted large quantities of CO_2 into the atmosphere, resulting in global climate change. Nowadays, it's considered a feasible strategy to capture CO_2 from some significant point sources. Three main strategies have been developed, namely post-combustion, pre-combustion, and oxy-fuel combustion. Recent research indicates that the membrane technology for CO_2 capture has become competitive compared withconventional technologies be cause of the improved separation performance in materials and process designs. This paper mainly reviews the progress and breakthroughs of membrane materials for the three gas separation systems corresponding to the CO_2 capture strategies. Besides, the CO_2 utilization by the membrane process has also been highlighted.



Area of Research:

- Membrane performance is an essential parameter of the membrane separation process, which is greatly affected by membrane materials, manufacturing process and operating conditions.
- Industrial application perspective, membrane materials should be evaluated under complicated and stringent separation situations in the real world
- Membrane cost, efficient integration, and process intensification with other facility systems is also required.

Link:
https://doi.org/10.1016/j.advmem.2022.100025

EVENTS

2ND ANNUAL HYDROGEN CONNECT SUMMIT



Date:

6-7th September 2023

Venue:

Brisbane Convention & Exhibition Centre Glenelg St

The World class Summit program has been designed by industry, for industry. H2Q is taking ownership of the conversation.

Aim:

To fetch the most pertinent topics facing Queensland & Australia's hydrogen community engaging leading hydrogen experts to share intelligence and insights throughout this exciting journey. Connecting business and stimulating both domestic and international growth is the priority.

The main objective is to tackle challenges, scaling- up and securing offtakers to improve green hydrogen economy.



Link:

https://hydrogenconnect.com.au/?utm_source=H2View&utm_medium=Banner&utm_campaign=Media_Partner&utm_id=Hydrogen%20Connect%20Summit&utm_content=H2Q

INDUSTRY NEWS

First US Gulf offshore wind auction to fuel region's green hydrogen push

The U.S. Gulf Coast region, the nation's primary offshore source of oil and gas, has cheap electricity and lacks state mandates for renewable energy procurement, making it an unlikely place to expand one of the most expensive forms of clean energy. That is why players in the nascent U.S. offshore wind industry are looking beyond the grid when the Biden administration holds the first-ever offshore wind auction in the Gulf of Mexico eyeing the sale instead as a way to fuel a new green hydrogen supply chain for the region's vast industrial corridor.

The Gulf Coast auction would be a break from previous federal offshore wind lease sales, held mainly in the Northeast, where developers have spent billions of dollars on acreage for projects meant to link into lucrative power markets and access state-level subsidies for carbon-free electricity.

The Interior Department's Bureau of Ocean Energy Management (BOEM) will auction three areas off Louisiana and Texas to offshore wind developers. Companies qualified to bid at sale include units of companies already established in the U.S. offshore wind industry like Shell (SHEL.L), Invenergy and TotalEnergies (TTEF.PA).

The American Clean Power Association, a trade group that represents offshore wind and other renewable energy developers, also said to BOEM that green hydrogen would "increase market viability of offshore wind."

Those states have passed laws that require utilities to buy power from offshore wind projects - mandates considered critical for a technology that is estimated to produce electricity at twice the cost of a natural gas plant. Northeast states also boast some of the highest power prices in the country, making expensive offshore wind more competitive.

The tax credits for hydrogen in President Joe Biden's Inflation Reduction Act have made the proposition of pairing offshore wind with hydrogen production more attractive. Lacy McManus, an executive with the economic development agency Greater New Orleans Inc, which is leading a federally-backed project to create a green hydrogen "cluster" in South Louisiana, said the region's existing petroleum industry could provide a ready market as they seek to satisfy investor demands to lower their carbon intensity.

https://www.reuters.com/sustainability/first-us-gulf-offshore-wind-auction-fuel-regions-green-hydrogen-push-2023-08-28/

University Of Sheffield To Be Biggest Green Hydrogen Producer

The University of Sheffield is set to produce more green hydrogen than any other UK research centre. Sheffield's Energy Institute is installing a new hydrogen electrolyser – technology that produces hydrogen by splitting water into hydrogen and oxygen. The equipment will be used in research to develop and test new hydrogen-based sustainable aviation fuels (SAFs). The electrolyser, from IMI Remosa under the new brand IMI VIVO, is being installed in the University's Sustainable Aviation Fuels Innovation Centre (SAF-IC) – the UK's first R&D facility that is able to develop, test, validate and help certify new fuels all in one location. The facility, along with the new electrolyser, gives the UK much-needed R&D capabilities in SAFs and can play a major role in helping reduce the environmental impact of air travel.

SAFs are seen as a vital step in reducing global carbon emissions. The aviation industry is responsible for around seven per cent of total carbon emissions in the UK alone and this number is growing fast. Aviation's reliance on fossil fuels makes it a challenging sector to decarbonise and new fuels are subject to strict standards and regulations before they can be approved for use. Researchers from Sheffield will work with partners in the aviation industry to develop new hydrogen and CO2-based fuels that meet these strict standards. They will also work with other industries across the UK to help them switch fuels and decarbonise.

With the new electrolyser, the University is capable of producing nearly 140Nm^3 per hour of green hydrogen with storage capacity of 1450Nm^3 – equivalent to the electricity required to power 200 homes. The University is also part of a consortium led by Virgin Atlantic that is set to lead the world's first 100 per cent SAF transatlantic flight, which is scheduled to fly later this year (28 November 2023). South Yorkshire is fast becoming the UK's leading hub for sustainable aviation R&D. The equipment that has been installed at the University is a PEM-based green hydrogen electrolyser from IMI Remosa under the new brand IMI VIVO. This will prove vital to upgrade the University of Sheffield's R&D capabilities, to help break the aviation industry's reliance on fossil fuels.

https://indiaeducationdiary.in/university-of-sheffield-to-be-biggest-green-hydrogen-producer/

EVENTS

INDUSTRY TRANSITION 2023



SEIZE NET ZERO MOMENTUM. DELIVER INDUSTRIAL-SCALE GROWTH

Date:
12-13th September 2023

Venue:
Pittsburgh, USA



Leaders from across the 'hard-to-abate' industries sit at the precipice of an industrial-scale decarbonization opportunity. Momentum behind net zero ambitions is rapidly translating into decarbonization contracts, as the urgency behind reaching collective net zero ambitions ramps up. Industrial decision makers navigating this transformation are faced with the challenge of embedding sustainability whilst tackling institutional path dependency, high investment cost and risk, permitting barriers and untested paths to tackling shared scope 3 emissions. Collective challenges require collective solutions - decarbonized heavy industry will only be possible through new alliances and cross-industrial partnerships.

Link:

https://events.reutersevents.com/energy-transition/industry-usa

INDUSTRY NEWS

James Cropper claims breakthrough in hydrogen energy technology

James Cropper's subsidiary TFP Hydrogen Products has taken a step forward in developing clean energy in its manufacturing process.

The division has launched the TFP Hydrogen Modular Production Unit, said to be a solution that "represents a significant stride towards enabling rapid scalability for PEM electrolyser manufacturing". The papermaker added: "Leveraging TFP Hydrogen's proprietary coating technology, the MPU is strategically designed to operate in close proximity to customers and component suppliers, streamlining the supply chain for PEM electrolyser manufacturers. By shortening the supply chain and optimising logistics, the MPU significantly augments response rates while ensuring uninterrupted operations. Furthermore, the MPU can be swiftly commissioned and fully operational within six to 12 months."



James Cropper claims breakthrough in hydrogen energy technology (packagingnews.co.uk)

Ampol reveals plans to build hydrogen service stations

Ampol announced its partnership with OneH2 on Monday, revealing the companies would work together to speed up the use of hydrogen in the Australian market and help to cut emissions from heavy transport. The news comes weeks after rival BP opened the first hydrogen refuelling facility at an Australian service station and after a CSIRO report warned the industry needed to ramp up hydrogen investments or risk falling behind progress overseas.

Ampol international and new business executive general manager Brent Merrick said the company's partnership was an important step in expanding greener transport options in Australia and giving companies the confidence to invest in new vehicles.

Ampol reveals plans to build hydrogen service stations | Shepparton News (sheppnews.com.au)

Hyzon motors successfully completes first customer demo of liquid hydrogen fuel cell electric truck

Hyzon Motors Inc. (Hyzon) (NASDAQ: HYZN), a high-power hydrogen fuel cell technology developer and global supplier of zero-emission heavy-duty fuel cell electric vehicles, Performance Food Group, Inc. (PFG) (NYSE: PFGC), one of the largest food and foodservice distribution companies in North America, and Chart Industries, Inc. (Chart) (NYSE: GTLS), a leading global manufacturer of highly engineered equipment servicing multiple applications in the clean energy and industrial gas market, today announced successful completion of Hyzon's first commercial run with a liquid hydrogen fuel cell electric vehicle (LH2 FCEV). Starting in Temple, TX, the truck completed deliveries to eight PFG customers near Dallas, TX, travelling over 540 miles on a 16-hour continuous run including over 100-degree Fahrenheit temperatures. The run – further than the distance from Sacramento to San Diego – demonstrates the viability of on-board liquid hydrogen to fuel long-distance, zero-emission transport.

Hyzon motors successfully completes first customer demo of liquid hydrogen fuel cell electric truck | Markets Insider (businessinsider.com)

First Cymru trials hydrogen bus in Bridgend

HyBont hydrogen bus has been trialled with bus operator First Cymru as part of a two-week pilot to offer a cleaner alternative to conventional diesel buses. The bus has been travelling from the First Cymru depot in Brynmenyn Industrial Estate across routes 72, 74 and 76. Drivers have been trained to use the vehicles, including learning how to refuel them at Hyppo Hydrogen's depot in Neath Port Talbot. The bus runs on locally produced green hydrogen from Port Talbot. By 2028, Welsh Government has a target for all Wales buses to be zero emission. Supporting the bus trial is Marubeni Europower, which is the company bringing forward proposals for the HyBont green hydrogen project in Bridgend. Tomoki Nishino, chief executive and president, said: "Hydrogen fuelled buses offer a practical solution for communities to decarbonise public transport and immediately improve air quality and reduce carbon emissions. These trials are great news for Bridgend as they could lead the way for cleaner public transport."

First Cymru trials hydrogen bus in Bridgend | Insider Media

EVENTS

HYDROGEN ONLINE CONFERENCE



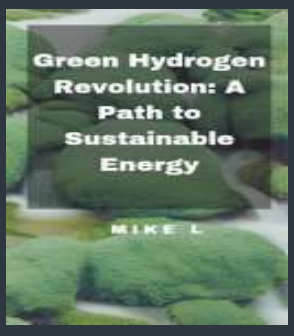
The World's Largest Online Hydrogen Event

Online Event

Date: 25th October

The HOC 2023 is the largest online hydrogen event in the world. 24 hours of hydrogen knowledge and inspiration online.
Host of the HOC: The HOC is hosted by Mission Hydrogen, a leading hydrogen online marketing company.
The Hydrogen Online Conference 2023 is the 24 hours nonstop, across all time zones, 30+ world-class speakers, interactive booths, thousands of hydrogen pioneers live, Q&A sessions.
Link:
https://hydrogen-online-conference.com/

Book:



Mike L, 26-May-2023 - 224 pages
Title: "Green Hydrogen Revolution: A Path to Sustainable Energy"
ISBN: 9798223194934
Link:
https://books.google.co.in/books/about/Green_Hydrogen_Revolution.html?id=r0T9zwEACAAJ&source=kp_book_description&redir_esc=y

Indian Oil Corporation To Establish First Green Hydrogen Plant In Panipat



Indian Oil Corporation Limited (IOCL) has embarked on a journey to establish its inaugural green hydrogen production facility in Panipat, with a formidable capacity of 10,000 tonnes per annum (10 Kilo Tonnes per annum). This significant endeavour is slated to become operational within the next 2.5 years. Recent developments reveal that IOCL has opened international bids to construct the plant adjacent to its Panipat refinery on company-owned land. With an impressive 10 KTA capacity, this plant is positioned to emerge as one of India's largest green hydrogen facilities, as per a document accessed by News18.
In 2021, IOCL unveiled plans to establish two green hydrogen plants: a 5 KTA capacity unit at the Mathura refinery and another with a 2 KTA capacity in Panipat. However, the latest updates saw the Mathura project being relinquished. According to the most recent tender specifications, the Panipat plant will now be elevated to a 10 KTA capacity. Green hydrogen assumes a pivotal role in India's ambitious pursuit of achieving net-zero emissions by 2070, a commitment made by Prime Minister Narendra Modi during the previous climate summit (COP) in Glasgow.
IOCL stands as the steward of 11 refineries across India, collectively boasting a refining capacity of 80.7 million metric tonnes per annum (MMTPA), equivalent to 1.6 million barrels per day. This capacity stands as the most extensive among all refining entities in the nation. The corporation further boasts an extensive network of pipelines, stretching over 14,000 kilometres, facilitating the smooth transportation of both crude oil and refined products nationwide. The chosen site for the forthcoming green hydrogen facility is nestled between the Panipat Refinery and the Panipat Naphtha Cracker area, situated on IOCL-owned land within the vicinity of the Panipat Refinery Complex. The selected bidder will shoulder the responsibility of providing gaseous green hydrogen to IOCL at the designated delivery point.
Indian Oil Corporation To Establish First Green Hydrogen Plant In Panipat - News18

Green Shift | India's green hydrogen standards & deep ocean mission

Associate Editor M Ramesh takes us through the Ministry of New and Renewable Energy's announcement of green hydrogen standards, and India's ambitious deep-sea mission.
Unveiled on the 18th of August 2023, the green hydrogen standards set forth by the Ministry of New and Renewable Energy mark a significant stride towards sustainable energy in India.
Exploring the implications of this announcement, this video elaborates on the conditions under which hydrogen produced in India will be classified as 'green,' based on strict emissions thresholds.
The standards, which require emissions to stay below two grams of carbon dioxide equivalent per kilogram of hydrogen, are applicable to both water electrolysis and biomass processing methods, excluding hydrogen production via microbial processes. India's allocation of a substantial area in the central Indian Ocean basin for mineral exploration. Polymetallic nodules, abundant in valuable metals like copper, manganese, cobalt, and nickel, are set to play a key role in India's pursuit of sustainable energy. The three-phase mission, scheduled for launch in January 2024, aims to uncover these resources through deep-sea collection and analysis.
Green Shift | India's green hydrogen standards & deep ocean mission - The Hindu BusinessLine

ONGC backs its net zero goal with ₹2 tn

State-owned ONGC plans to invest around ₹2 trillion towards its energy transition efforts until 2038, said chairman and chief executive Arun Kumar Singh. The company had announced its plans to invest ₹1 trillion over the next seven years on energy transition initiatives. They have announced scope 1 and scope 2 transitions by 2038. It requires ₹2 trillion. ₹1 trillion will be invested by 2030 and it has various parts. Primarily initial expenditure will be to reduce the Scope 1 first and then we go to Scope 2.
So there are two parts. "It has all the components, from green ammonia to solar and hydrogen. It has PSP and then you have offshore. Everything is there," Singh added.
Addressing the shareholders, he said the firm is charting a roadmap for opportunities in renewables and low-carbon sectors and plans to scale up its renewable portfolio to 10 GW by 2030.
ONGC backs its net zero goal with ₹2 tn | Mint (livemint.com)

Komiya, H. *et al.*

Electrolyte Engineering Applying Concentrated Chloride Ions with Mixed Buffer Solutions for a Versatile High-Productivity Water-Splitting System

https://doi.org/10.1021/acssuschemeng.3c02322

Abstract:

Developing highly active electrocatalysts and conductive electrolytes can boost the overall water-splitting efficiency in the presence of chloride ions. Seawater electrolysis is an attractive way for green hydrogen production; however, it faces challenges in efficiency loss because of the over potentials in the oxygen evolution reaction (OER) and the hydrogen evolution reaction (HER), high concentration over potential, and high ohmic potential(iR) drop. Here, our electrolyte engineering approach led to the introduction of a highly conductive Cl--containing borate/carbonate mixed buffer electrolyte. At a borate/carbonate molar ratio of 1.0, this electrolyte has a new apparent pK (a) (pK (a,app)) of pH 9.8. While a typical water electrolysis system removes Cl- to avoid competitive Cl- oxidation, we intentionally utilized concentrated Cl- to improve conductivity, reaching around 50 S m(-1) at 353 K, making the value competitive with 30 wt % KOH (& SIM;130 S m(-1)).In this mixed buffer electrolyte with Cl-, the performances for HER using RuNiO (x) H (y) /Ni felt and for OER using CoFeO (x) H (y) /Ti felt were, respectively, optimized by electrolyte engineering, tuning the concentration of cations and operating pH. The two electrodes, highly conductive electrolytes, and newly adopted polyether sulfone separator led to a zero-gap cell that worked stably at 2.00 V and 500 mA cm(-2) with106 mV iR loss and unity gas faradaic efficiency for 80 h under non-extreme pH conditions. This study provides a new design of electrolyte engineering for seawater splitting.

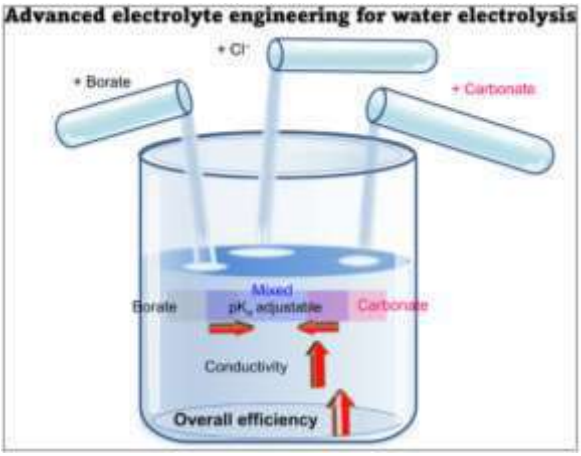


Fig: The schematic diagram for solar/wind hydrogen production systems

Hsu, CM. *et al.*

Azetidines with All-Carbon Quaternary Centers: Merging Relay Catalysis with Strain Release Functionalization

https://doi.org/ 10.1021/jacs.3c06710

Abstract:

Given the importance and beneficial characteristics of decoratedazetidines in medicinal chemistry, efficient strategies for theirsynthesis are highly sought after. Herein, we report a facile synthesisof the elusive all-carbon quaternary-center-bearing azetidines. Byadopting a well-orchestrated polar-radical relay strategy, ring strainrelease of bench-stable benzoylated 1-azabicyclo[1.1.0]butane (ABB)can be harnessed for nickel-catalyzed Suzuki Csp(2)-Csp(3) cross-coupling with commercially available boronic acids in broad scope (>50 examples), excellent functional group tolerance,and gram-scale utility. Preliminary mechanistic studies provided insights into the underlying mechanism, wherein the ring opening of ABB witha catalytic quantity of bromide accounts for the conversion of ABBinto a redox-active azetidine, which subsequently engages in the cross-couplingreaction through a radical pathway. The synergistic bromide and nickelcatalysis could intriguingly be derived from a single nickel source(NiBr2). Application of the method to modify natural products,biologically relevant molecules, and pharmaceuticals has been successfully achieved as well as the synthesis of melanocortin-1 receptor (MC-1R)agonist and vesicular acetylcholine transporter (VAChT) inhibitor analogues through bioisosteric replacements of piperidine with azetidinemoieties, highlighting the potential of the method in drug optimization studies. Aside from the synthesis of azetidines, we demonstrate the ancillary utility of our nickel catalytic system toward the restricted Suzuki cross-coupling of tertiary alkyl bromides with aryl boronic acids to construct all-carbon quaternary centers.

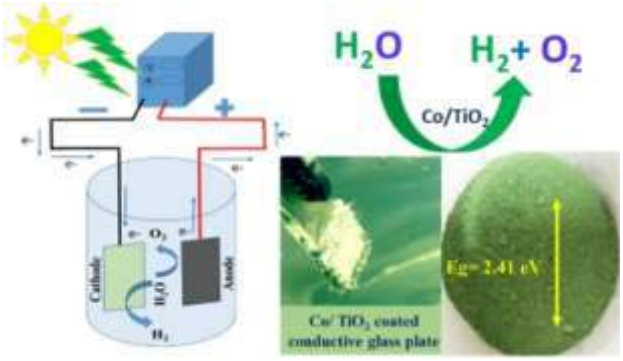
Pandey, PH. *et al.*

A stable and robust electrode using Copious metal oxide composite for green hydrogen production

https://doi.org/ 10.1002/slct.202301557

Abstract:

The exploration of inexpensive and copious materials for water splitting has not come to an end even though a lot of materials has been synthesised to cope with the high overpotential and Tafel slope. The present manuscript demonstrates fabrication and performance studies of Co3O4 and TiO2 composite (CTC) catalyst coated electrode for electrochemical water splitting. The use of CTC (Co3O4@TiO2) showed the band gap of 2.41 eV which is found to be suitable for efficient water splitting reaction. The electrode fabrication was done using CTL coated FTO glass that provided a stable cathodic electrode for overall water splitting. The detail electrochemical studies of CTC electrode were performed in 1 M KOH electrolyte solution in a three-electrode system. The CTC exhibited lowest Tafel slope value for both hydrogen evolution reaction (HER) of 51 mV/dec and oxygen evolution reaction (OER) of 166 mV/dec, calculated at 10 mA/cm(2). Moreover, the highest current density 66.59 mA/cm(2) at 0.20 V and 85.84 mA/cm(2) at 1.85 V was observed for HER and OER, respectively. The significantly low overpotential 104 mV for HER and 240 mV for OER at 10 mA/cm(2) depicted the efficiency of catalyst. The chronoamperometry study showed no significant loss in the activity CTC coating upto 32 h. Thus, the CTC coated electrode is found to be an excellent, stable and robust electrocatalyst for economical green H-2 production.



Graphical Abstract Representation

Cazula, BB. *et al.*

Performance Study of Ni/Si-MCM-41 Catalysts, Synthesized with Different Silica Sources, and their Application on Methane Dry Reform to Produce Green Hydrogen

https://doi.org/ 10.21577/0103-5053.20230133

Abstract:

The present work carried out an extensive and deepened study regarding the physicochemical characteristics of two Si-MCM-41-type supports, synthesized employing two distinct silica precursors, tetraethyl orthosilicate (TEOS) and rice husk ash (RHS), with the dispersion of nickel on the surface of the catalytic support. The direct influence of the active phase dispersion was analyzed, making a relationship with the formation of coke and with its performance on methane dry reform (DRM). The catalysts were prepared with 5, 10, and 20% (m/m) of Ni by wet impregnation method (with excess solvent), calcined at 800 oC for 6 h, and characterized by the techniques of scanning electron microscopy and energy dispersive spectroscopy (SEM/ EDS), transmission electron microscopy (TEM), Brunauer-Emmett-Teller (BET)/Barret-JoyerHalenda (BJH), X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), temperature-programmed ammonia desorption (TPD-NH3), and H2-temperature-programmed reduction (TPR). The DRM experiments were carried out at 800 & DEG;C for 24 h with a 1:1 CH4:CO2 molar ratio. Analyzes of gaseous products were performed in gas chromatography (GC) and the coke produced was estimated by temperature-programmed oxidation (TPO). The best reaction results were obtained for catalysts with 20% nickel, which were selective and stable within 24 h of reaction. Comparing the TEOS and RHS catalysts for 20% Ni, the DRM results were very similar. The catalysts on RHS support demonstrated a significant low formation of coke, which can be considered negligible in a 24 h reaction.

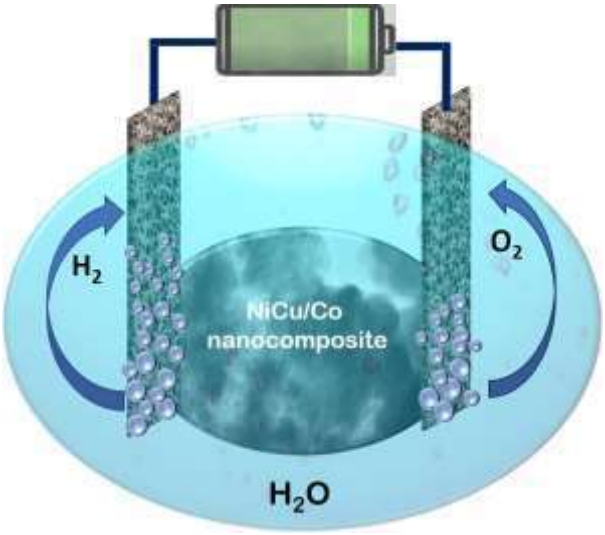
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 49
SEPTEMBER, 2023

Nanocomposite-Based Electrocatalyst for Alkaline Overall Water Splitting at Low Cell Voltage for Hydrogen Production

The diminishing conventional energy resources based on fossil fuels and their related environmental consequences have drawn attention around the world toward the development of renewable energy resources. These renewable energy resources may not fulfill the entire energy demands of world's mass population; however, they limit the effects of greenhouse gases as well as air pollution caused by the fossil fuel burning.



Overall water splitting using composite of NiCu dealloyed nanoparticles on hierarchical Co nanosheets in an electrolyzer. The current source is a 1.5 V battery. Credit: Ankur Kumara and Sasanka Deka

Among alternative resources, hydrogen is considered to be the cleanest energy carrier. However, hydrogen does not exist in its pure state in nature, like oxygen, and has to be produced from hydrogen-containing resources such as natural gas (methane), coal, biomass and water by reforming, thermal decomposition or electrolysis. Hydrogen is envisaged as a possible replacement for fossil fuels. Production via power from renewable energy (using wind power, solar power, and hydropower, wave power or similar) is termed as "**green hydrogen**." In this scenario, splitting water into hydrogen and oxygen using renewable electricity in an electrolyzer on the surface of a robust electrocatalyst is one proposed technique.

Need for a robust electrocatalyst

- The process of water spitting to produce affordable green hydrogen still remains sluggish due to limitations related to efficient electrocatalysts.
- Water splits at 1.23 V. However, in practical terms, this value is greater than 1.5 V (meaning wastage of additional energy). This minimum energy is theoretically required to break the water molecule.
- Expensive noble- and precious-metal-based electocatalysts, for instance, Pt, Pd, Au, Rh, Ir, etc., are used in the electrolyzer for this process.

Problems Faced

a. The half-cell reaction is an uphill reaction where four electrons are involved and where most of the energy is required apart from the energy loss associated with the resistivity of different components (electrolyte, connections, catalyst, etc.) of the electrolyzer.
b. The expensive catalysts often lose their activity due to surface degradation.

In these conditions, a cheap and affordable yet highly active and stable electrocatalyst is required for such water splitting reaction.

New Developments

Sasanka Deka and team, designed and developed a new nanocomposite-based, highly efficient, yet still cost-effective electrocatalyst for overall water splitting. A nanocomposite is a homogeneous mixture of two or more materials present in the nanometer range. The present nanocomposite is a nanoarchitecture based on NiCu dealloyed nanoparticles on hierarchical Co nanosheets, that can split water at 1.46 V with great stability.

https://phys.org/news/2023-08-nanocomposite-based-electrocatalyst-alkaline-cell-voltage.html

BICHLOR DELIVERS SUPERIOR ELECTROLYSER EFFICIENCY

Significant progress towards safer and more efficient industrial electrolysers

Abstract

Over the past decades, fossil fuel combustion has emitted large quantities of CO_2 into the atmosphere, resulting in global climate change. Nowadays, it's considered a feasible strategy to capture CO_2 from some significant point sources. Three main strategies have been developed, namely post-combustion, pre-combustion, and oxy-fuel combustion. Recent research indicates that the membrane technology for CO_2 capture has become competitive compared withconventional technologies be cause of the improved separation performance in materials and process designs. This paper mainly reviews the progress and breakthroughs of membrane materials for the three gas separation systems corresponding to the CO_2 capture strategies. Besides, the CO_2 utilization by the membrane process has also been highlighted.



Area of Research:

- Membrane performance is an essential parameter of the membrane separation process, which is greatly affected by membrane materials, manufacturing process and operating conditions.
- Industrial application perspective, membrane materials should be evaluated under complicated and stringent separation situations in the real world
- Membrane cost, efficient integration, and process intensification with other facility systems is also required.

Link:

EVENTS

2ND ANNUAL HYDROGEN CONNECT SUMMIT



Date:

6-7th September 2023

Venue:

Brisbane Convention & Exhibition Centre Glenelg St

The World class Summit program has been designed by industry, for industry. H2Q is taking ownership of the conversation.

Aim:

To fetch the most pertinent topics facing Queensland & Australia's hydrogen community engaging leading hydrogen experts to share intelligence and insights throughout this exciting journey. Connecting business and stimulating both domestic and international growth is the priority.

The main objective is to tackle challenges, scaling- up and securing offtakers to improve green hydrogen economy.



Link:

https://hydrogenconnect.com.au/?utm_source=H2View&utm_medium=Banner&utm_campaign=Media_Partner&utm_id=Hydrogen%20Connect%20Summit&utm_content=H2Q

INDUSTRY NEWS

First US Gulf offshore wind auction to fuel region's green hydrogen push

The U.S. Gulf Coast region, the nation's primary offshore source of oil and gas, has cheap electricity and lacks state mandates for renewable energy procurement, making it an unlikely place to expand one of the most expensive forms of clean energy. That is why players in the nascent U.S. offshore wind industry are looking beyond the grid when the Biden administration holds the first-ever offshore wind auction in the Gulf of Mexico eyeing the sale instead as a way to fuel a new green hydrogen supply chain for the region's vast industrial corridor.

The Gulf Coast auction would be a break from previous federal offshore wind lease sales, held mainly in the Northeast, where developers have spent billions of dollars on acreage for projects meant to link into lucrative power markets and access state-level subsidies for carbon-free electricity.

The Interior Department's Bureau of Ocean Energy Management (BOEM) will auction three areas off Louisiana and Texas to offshore wind developers. Companies qualified to bid at sale include units of companies already established in the U.S. offshore wind industry like Shell (SHEL.L), Invenergy and TotalEnergies (TTEF.PA).

The American Clean Power Association, a trade group that represents offshore wind and other renewable energy developers, also said to BOEM that green hydrogen would "increase market viability of offshore wind."

Those states have passed laws that require utilities to buy power from offshore wind projects - mandates considered critical for a technology that is estimated to produce electricity at twice the cost of a natural gas plant. Northeast states also boast some of the highest power prices in the country, making expensive offshore wind more competitive.

The tax credits for hydrogen in President Joe Biden's Inflation Reduction Act have made the proposition of pairing offshore wind with hydrogen production more attractive. Lacy McManus, an executive with the economic development agency Greater New Orleans Inc, which is leading a federally-backed project to create a green hydrogen "cluster" in South Louisiana, said the region's existing petroleum industry could provide a ready market as they seek to satisfy investor demands to lower their carbon intensity.

https://www.reuters.com/sustainability/first-us-gulf-offshore-wind-auction-fuel-regions-green-hydrogen-push-2023-08-28/

University Of Sheffield To Be Biggest Green Hydrogen Producer

The University of Sheffield is set to produce more green hydrogen than any other UK research centre. Sheffield's Energy Institute is installing a new hydrogen electrolyser – technology that produces hydrogen by splitting water into hydrogen and oxygen. The equipment will be used in research to develop and test new hydrogen-based sustainable aviation fuels (SAFs). The electrolyser, from IMI Remosa under the new brand IMI VIVO, is being installed in the University's Sustainable Aviation Fuels Innovation Centre (SAF-IC) – the UK's first R&D facility that is able to develop, test, validate and help certify new fuels all in one location. The facility, along with the new electrolyser, gives the UK much-needed R&D capabilities in SAFs and can play a major role in helping reduce the environmental impact of air travel.

SAFs are seen as a vital step in reducing global carbon emissions. The aviation industry is responsible for around seven per cent of total carbon emissions in the UK alone and this number is growing fast. Aviation's reliance on fossil fuels makes it a challenging sector to decarbonise and new fuels are subject to strict standards and regulations before they can be approved for use. Researchers from Sheffield will work with partners in the aviation industry to develop new hydrogen and CO2-based fuels that meet these strict standards. They will also work with other industries across the UK to help them switch fuels and decarbonise.

With the new electrolyser, the University is capable of producing nearly 140Nm^3 per hour of green hydrogen with storage capacity of 1450Nm^3 – equivalent to the electricity required to power 200 homes. The University is also part of a consortium led by Virgin Atlantic that is set to lead the world's first 100 per cent SAF transatlantic flight, which is scheduled to fly later this year (28 November 2023). South Yorkshire is fast becoming the UK's leading hub for sustainable aviation R&D. The equipment that has been installed at the University is a PEM-based green hydrogen electrolyser from IMI Remosa under the new brand IMI VIVO. This will prove vital to upgrade the University of Sheffield's R&D capabilities, to help break the aviation industry's reliance on fossil fuels.

https://indiaeducationdiary.in/university-of-sheffield-to-be-biggest-green-hydrogen-producer/

EVENTS

INDUSTRY TRANSITION 2023



SEIZE NET ZERO MOMENTUM. DELIVER INDUSTRIAL-SCALE GROWTH

Date:
12-13th September 2023

Venue:
Pittsburgh, USA



Leaders from across the 'hard-to-abate' industries sit at the precipice of an industrial-scale decarbonization opportunity. Momentum behind net zero ambitions is rapidly translating into decarbonization contracts, as the urgency behind reaching collective net zero ambitions ramps up. Industrial decision makers navigating this transformation are faced with the challenge of embedding sustainability whilst tackling institutional path dependency, high investment cost and risk, permitting barriers and untested paths to tackling shared scope 3 emissions. Collective challenges require collective solutions - decarbonized heavy industry will only be possible through new alliances and cross-industrial partnerships.

Link:

https://events.reutersevents.com/energy-transition/industry-usa

INDUSTRY NEWS

James Cropper claims breakthrough in hydrogen energy technology

James Cropper's subsidiary TFP Hydrogen Products has taken a step forward in developing clean energy in its manufacturing process.

The division has launched the TFP Hydrogen Modular Production Unit, said to be a solution that "represents a significant stride towards enabling rapid scalability for PEM electrolyser manufacturing". The papermaker added: "Leveraging TFP Hydrogen's proprietary coating technology, the MPU is strategically designed to operate in close proximity to customers and component suppliers, streamlining the supply chain for PEM electrolyser manufacturers. By shortening the supply chain and optimising logistics, the MPU significantly augments response rates while ensuring uninterrupted operations. Furthermore, the MPU can be swiftly commissioned and fully operational within six to 12 months."



James Cropper claims breakthrough in hydrogen energy technology (packagingnews.co.uk)

Ampol reveals plans to build hydrogen service stations

Ampol announced its partnership with OneH2 on Monday, revealing the companies would work together to speed up the use of hydrogen in the Australian market and help to cut emissions from heavy transport. The news comes weeks after rival BP opened the first hydrogen refuelling facility at an Australian service station and after a CSIRO report warned the industry needed to ramp up hydrogen investments or risk falling behind progress overseas.

Ampol international and new business executive general manager Brent Merrick said the company's partnership was an important step in expanding greener transport options in Australia and giving companies the confidence to invest in new vehicles.

Ampol reveals plans to build hydrogen service stations | Shepparton News (sheppnews.com.au)

Hyzon motors successfully completes first customer demo of liquid hydrogen fuel cell electric truck

Hyzon Motors Inc. (Hyzon) (NASDAQ: HYZN), a high-power hydrogen fuel cell technology developer and global supplier of zero-emission heavy-duty fuel cell electric vehicles, Performance Food Group, Inc. (PFG) (NYSE: PFGC), one of the largest food and foodservice distribution companies in North America, and Chart Industries, Inc. (Chart) (NYSE: GTLS), a leading global manufacturer of highly engineered equipment servicing multiple applications in the clean energy and industrial gas market, today announced successful completion of Hyzon's first commercial run with a liquid hydrogen fuel cell electric vehicle (LH2 FCEV). Starting in Temple, TX, the truck completed deliveries to eight PFG customers near Dallas, TX, travelling over 540 miles on a 16-hour continuous run including over 100-degree Fahrenheit temperatures. The run – further than the distance from Sacramento to San Diego – demonstrates the viability of on-board liquid hydrogen to fuel long-distance, zero-emission transport.

Hyzon motors successfully completes first customer demo of liquid hydrogen fuel cell electric truck | Markets Insider (businessinsider.com)

First Cymru trials hydrogen bus in Bridgend

HyBont hydrogen bus has been trialled with bus operator First Cymru as part of a two-week pilot to offer a cleaner alternative to conventional diesel buses. The bus has been travelling from the First Cymru depot in Brynmenyn Industrial Estate across routes 72, 74 and 76. Drivers have been trained to use the vehicles, including learning how to refuel them at Hyppo Hydrogen's depot in Neath Port Talbot. The bus runs on locally produced green hydrogen from Port Talbot. By 2028, Welsh Government has a target for all Wales buses to be zero emission. Supporting the bus trial is Marubeni Europower, which is the company bringing forward proposals for the HyBont green hydrogen project in Bridgend. Tomoki Nishino, chief executive and president, said: "Hydrogen fuelled buses offer a practical solution for communities to decarbonise public transport and immediately improve air quality and reduce carbon emissions. These trials are great news for Bridgend as they could lead the way for cleaner public transport."

First Cymru trials hydrogen bus in Bridgend | Insider Media

EVENTS

HYDROGEN ONLINE CONFERENCE



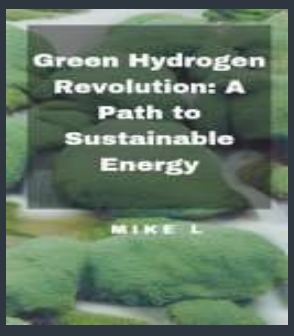
The World's Largest Online Hydrogen Event

Online Event

Date: 25th October

The HOC 2023 is the largest online hydrogen event in the world. 24 hours of hydrogen knowledge and inspiration online.
Host of the HOC: The HOC is hosted by Mission Hydrogen, a leading hydrogen online marketing company.
The Hydrogen Online Conference 2023 is the 24 hours nonstop, across all time zones, 30+ world-class speakers, interactive booths, thousands of hydrogen pioneers live, Q&A sessions.
Link:
https://hydrogen-online-conference.com/

Book:



Mike L, 26-May-2023 - 224 pages
Title: "Green Hydrogen Revolution: A Path to Sustainable Energy"
ISBN: 9798223194934
Link:
https://books.google.co.in/books/about/Green_Hydrogen_Revolution.html?id=r0T9zwEACAAJ&source=kp_book_description&redir_esc=y

INDIA NEWS

Indian Oil Corporation To Establish First Green Hydrogen Plant In Panipat



Indian Oil Corporation Limited (IOCL) has embarked on a journey to establish its inaugural green hydrogen production facility in Panipat, with a formidable capacity of 10,000 tonnes per annum (10 Kilo Tonnes per annum). This significant endeavour is slated to become operational within the next 2.5 years. Recent developments reveal that IOCL has opened international bids to construct the plant adjacent to its Panipat refinery on company-owned land. With an impressive 10 KTA capacity, this plant is positioned to emerge as one of India's largest green hydrogen facilities, as per a document accessed by News18.
In 2021, IOCL unveiled plans to establish two green hydrogen plants: a 5 KTA capacity unit at the Mathura refinery and another with a 2 KTA capacity in Panipat. However, the latest updates saw the Mathura project being relinquished. According to the most recent tender specifications, the Panipat plant will now be elevated to a 10 KTA capacity. Green hydrogen assumes a pivotal role in India's ambitious pursuit of achieving net-zero emissions by 2070, a commitment made by Prime Minister Narendra Modi during the previous climate summit (COP) in Glasgow.
IOCL stands as the steward of 11 refineries across India, collectively boasting a refining capacity of 80.7 million metric tonnes per annum (MMTPA), equivalent to 1.6 million barrels per day. This capacity stands as the most extensive among all refining entities in the nation. The corporation further boasts an extensive network of pipelines, stretching over 14,000 kilometres, facilitating the smooth transportation of both crude oil and refined products nationwide. The chosen site for the forthcoming green hydrogen facility is nestled between the Panipat Refinery and the Panipat Naphtha Cracker area, situated on IOCL-owned land within the vicinity of the Panipat Refinery Complex. The selected bidder will shoulder the responsibility of providing gaseous green hydrogen to IOCL at the designated delivery point.
Indian Oil Corporation To Establish First Green Hydrogen Plant In Panipat - News18

Green Shift | India's green hydrogen standards & deep ocean mission

Associate Editor M Ramesh takes us through the Ministry of New and Renewable Energy's announcement of green hydrogen standards, and India's ambitious deep-sea mission.
Unveiled on the 18th of August 2023, the green hydrogen standards set forth by the Ministry of New and Renewable Energy mark a significant stride towards sustainable energy in India.
Exploring the implications of this announcement, this video elaborates on the conditions under which hydrogen produced in India will be classified as 'green,' based on strict emissions thresholds.
The standards, which require emissions to stay below two grams of carbon dioxide equivalent per kilogram of hydrogen, are applicable to both water electrolysis and biomass processing methods, excluding hydrogen production via microbial processes. India's allocation of a substantial area in the central Indian Ocean basin for mineral exploration. Polymetallic nodules, abundant in valuable metals like copper, manganese, cobalt, and nickel, are set to play a key role in India's pursuit of sustainable energy. The three-phase mission, scheduled for launch in January 2024, aims to uncover these resources through deep-sea collection and analysis.
Green Shift | India's green hydrogen standards & deep ocean mission - The Hindu BusinessLine

ONGC backs its net zero goal with ₹2 tn

State-owned ONGC plans to invest around ₹2 trillion towards its energy transition efforts until 2038, said chairman and chief executive Arun Kumar Singh. The company had announced its plans to invest ₹1 trillion over the next seven years on energy transition initiatives. They have announced scope 1 and scope 2 transitions by 2038. It requires ₹2 trillion. ₹1 trillion will be invested by 2030 and it has various parts. Primarily initial expenditure will be to reduce the Scope 1 first and then we go to Scope 2.
So there are two parts. "It has all the components, from green ammonia to solar and hydrogen. It has PSP and then you have offshore. Everything is there," Singh added.
Addressing the shareholders, he said the firm is charting a roadmap for opportunities in renewables and low-carbon sectors and plans to scale up its renewable portfolio to 10 GW by 2030.
ONGC backs its net zero goal with ₹2 tn | Mint (livemint.com)

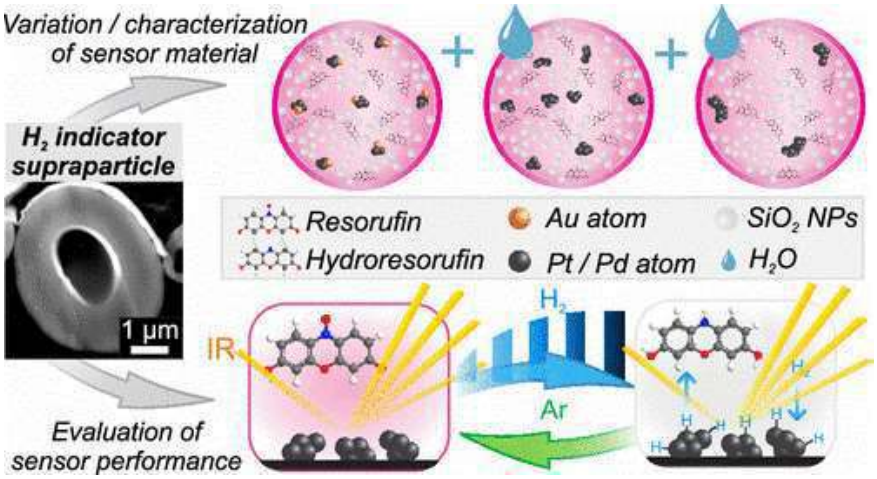
Zhang, KL. *et al.*

Molecular and Structural Insights into H-2 Indicator Supraparticles: Lowering the Limit of Detection by Tuning Incorporated Catalyst Nanoparticles

https://doi.org/ 10.1021/acs.chemmater.3c01105

Abstract:

With the increasing interest in H-2-based energy storage, H-2 detectors gain significant importance. Here, we report on safe, i.e., spark-free, reliable, and highly reactive gasochromic H-2 indicator supra particles (SPs). They are assembled from different types of noble metal nanoparticles (NPs), SiO2 NPs, and the dye resazurin via spray-drying. Their sensing principle is based on the adsorption and activation of H-2 on catalytically active noble metal NPs incorporated in the mesoporous supra particulate framework. Upon stepwise hydrogenation of resazurin molecules with molecular mobility via activated H species, the indicator displays a fast color change visible to the naked eye. We investigate the effect of incorporating different catalytically active NPs into indicator SPs on their sensor performance at different H (2) concentrations. We find that the size and material of the catalyst NPs have a strong influence on the sensor response of the H-2 indicator as it changes the amount of activated H species available in the system. Enhancing the amount of interstitial H (2) O in the mesopores of the SPs increases their reaction volume but impairs the reproducibility of their sensor response. Among the studied materials, dispersed Pt NP-containing SPs give the overall best results in terms of overall performance toward H-2 detection.



Graphical Abstract Representation

Liao, LL. *et al.*

Multi-site trifunctional hydrangea-like electrocatalysts for efficient industrial-level water/urea electrolysis with current density exceeding 1000 mA cm(-2)

https://doi.org/ 10.1007/s40843-023-2544-5

Abstract:

Splitting water into hydrogen by electrolysis using renewable electricity is one of the promising routes for green hydrogen production. The key dilemma for this electrochemical route is the extremely high overpotentials required for oxygen evolution reaction at the anode. Innovative strategies are desirable to fabricate inexpensive metal-based multifunctional catalysts with robust catalytic performance and large-current durability for electrochemical hydrogen production in freshwater or urea-containing water. Here we report the rational design and synthesis of hydrangea-like CoP/Ni3FeN heterostructure arrays as excellent multifunctional electrocatalysts for both alkaline water and urea electrolysis. This catalyst presents superb trifunctional catalytic activities and outstanding large-current durability in basic media, requiring ultralow potentials of -0.160, 1.538 and 1.419 V to facilitate hydrogen, oxygen evolution and urea oxidation reactions (HER, OER and UOR) at an extremely large current density of 1000 mA cm(-2), respectively. Remarkably, the as-constructed two-electrode cells using this electrocatalyst as both the cathode and anode demand extremely low cell voltages of 1.577 and 1.668 V to deliver 500 mA cm(-2) stably for urea and water electrolysis, respectively, suggesting its superb activity and outstanding stability for trifunctional catalysis. Operando Raman spectroscopic studies in combination with density functional theory calculations validate that the CoP/Ni3FeN hybrid can greatly facilitate the formation of active metal (oxy)hydroxide species for both OER and UOR, and also reduce the adsorption energy barriers of *H2O and *H intermediates for HER. This work provides an effective pathway for developing multifunctional catalysts for electrochemical hydrogen production at low voltages whenever fresh or urea-containing water is available.

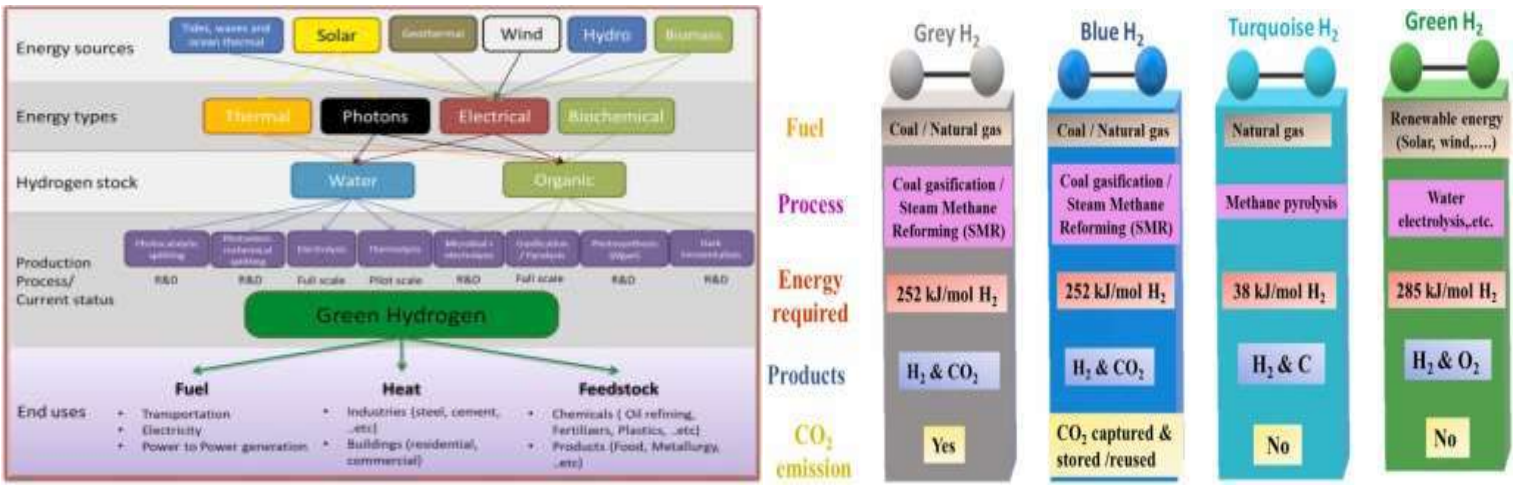
Olabi, AG. *et al.*

Green hydrogen: Pathways, roadmap, and role in achieving sustainable development goals

https://doi.org/10.1016/j.psep.2023.06.069

Abstract:

The United Nations Sustainable Development Goals (UN-SDGs) provide a unique opportunity to achieve sustainable development and reduce climate change impact. Decarbonizing the energy system is a key approach to achieving the energy balance. Recently, green hydrogen has become the most promising energy source for decarbonizing energy systems. Therefore, determining the different production methods of green hydrogen, their economics, and their environmental impacts is essential to all stakeholders. Additionally, understanding the role of green hydrogen in achieving the different SDGs is vital for policymakers and decision-makers. Thus, this study reviewed the common hydrogen production methods. The prospect of achieving the SDGs has also been investigated, and the most relevant keywords were presented. Finally, a list of indicators (guidelines) to increase the green hydrogen contribution to the SDGs was provided. The provided indicators will assist the stakeholder in increasing the integration of green hydrogen into the SDGs and reduce the trade-off.



Graphical Abstract Representation

Lin, JK. *et al.*

Macroporous Carbon-Nitride-Supported Transition-Metal Single-Atom Catalysts for Photocatalytic Hydrogen Production from Ammonia Splitting

https://doi.org/ 10.1021/acscatal.3c02076

Abstract:

Ammonia (NH3) splitting to hydrogen (H-2) is a promising route for on-site production of green hydrogen energy; however, the application is limited due to high-cost noble-metal-based catalysts and high operating temperature of the endothermic nature. Herein, we develop a series of macroporous carbon nitride-supported single-atom transition metal (TMs-MCN, TMs: Co, Mn, Fe, Ni, Cu) catalyst panels for solar light-driven photocatalytic gaseous NH3 splitting. Under ambient reaction conditions, the optimized Ni-MCN shows an H-2 production rate of 35.6 & mu; mol g(-1) h(-1), much superior to that of MCN and other TMs-MCN. Such enhanced photoactivity is attributed to the presence of Ni-N-4 sites, which improve the optical properties, accelerate charge carrier separation/transfer, and boost NH3 splitting kinetics of the catalysts. Density functional theory calculations further reveal that the Ni-N-4 sites can effectively modify the electronic structure of the carbon nitride. Compared with other metal sites, the Ni-N-4 site possesses moderate NH3 binding strength and the lowest energy barrier to facilitate the formation of key intermediates *NH + *H. These findings provide valuable guidelines for the rational design of single-atom catalysts toward energy- and cost-effective photocatalytic NH3 splitting for H-2 production.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 50
SEPTEMBER, 2023

Revolutionizing hydrogen production with LSGM-based solid oxide electrolysis cells: An innovative approach by sonic spray

$La_{1-x}Sr_xGa_{1-y}Mg_yO_{3-\delta}$ (LSGM) has emerged as an important candidate electrolyte because of its superior ionic conductivity with a value of 0.1 S/cm at 1073 K.

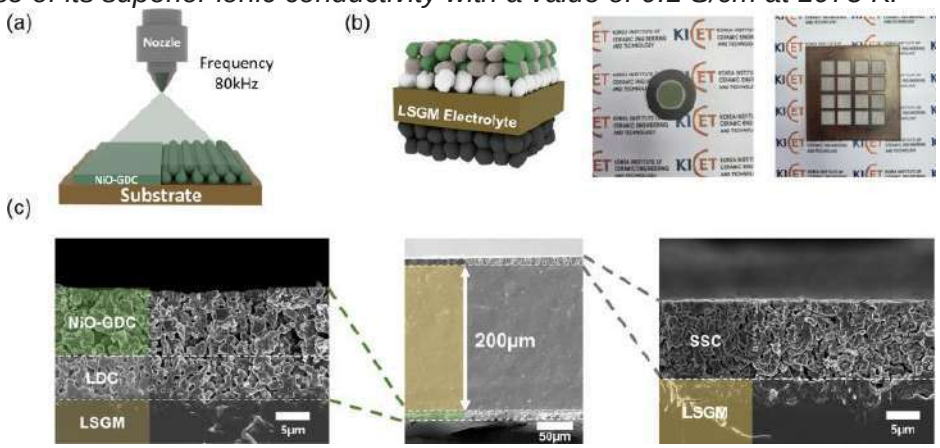


Figure: LSGM Based Electrolysis Method using nozzle spray technique

Water electrolysis is typically classified into alkaline exchange membrane (AEM), proton exchange membrane (PEM), and solid oxide electrolysis cell (SOEC) technologies. SOECs benefit from favorable thermodynamic and kinetic considerations compared to AEM and PEM because of their high-temperature operation. The thermodynamic benefit is associated with a decrease in the molar Gibbs energy of the reaction as the temperature increases while the molar enthalpy remains almost constant.

Advantages of LSGM based SOEC:

The new material $La_{1-x}Sr_xGa_{1-y}Mg_yO_{3-\delta}$ (LSGM), discovered by Ishihara *et al.* has attracted much attention because of its high ionic conductivity and negligible electrical conductivity. In Ishihara's work, he compared the conductivities of different electrolytes, which confirmed that LSGM ranked second place followed by Bi2O3-based oxides. Considering that Bi_2O_3-based oxides are less thermally stable, LSGM can be evaluated to be a good electrolyte.

Similar to SOFCs (Solid Oxide Fuel Cells), a perovskite electrolyte with high ionic conductivity, such as LSGM, could be adopted in SOECs as a prospective solution.

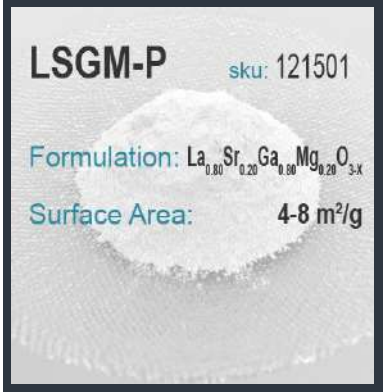
LSGM is expected to become the electrolyte for next-generation electrolysis cells. LSGM electrolytes can be prepared by the tape-casting method, and this electrolyte fabrication method has an advantage in controllable thickness that can reflect the researcher's demand.

Benefits of Using Nozzle Spray Method:

1. The ultrasonic wave makes the electrode material slurry deagglomerate and disperse while passing through the spray nozzle, and then it is sprayed on the substrate. The whole process can be conducted without touching the cell, and its non-contact property makes it easy to coat a fragile electrolyte.
2. It can pile the particles as thick as wanted. Using this method itself improved the performance of the cell in our self-test. In addition to that, the synergistic effect of LSGM and sonic spray is expected to have even higher performance.
3. A combination of LSGM electrolyte and the sonic spray technique was highlighted as a cell-fabrication method leading to better performance.

https://doi.org/10.1016/j.electacta.2023.142751

Lanthanum Strontium Gallium Magnesium Oxide Powder (LSGM-P)



Description of LSGM Electrolyte:

Lanthanum strontium gallium magnesium oxide (LSGM) is a ceramic electrolyte material with high ionic conductivity. LSGM is used as an electrolyte membrane for improving SOFC performance or reducing operating temperature.

LSGM has an ionic conductivity that is approximately twice that of yttrium stabilized zirconia (YSZ-8). This LSGM powder is well suited for use in tape casting, ink formulation, pellet pressing and other ceramic manufacturing processes.

Formulation: $La_{0.80}Sr_{0.20}Ga_{0.80}Mg_{0.20}O_{3-X}$
Surface Area: 4-8 m^2/g

Link:
https://fuelcellmaterials.com/products/powders/electrolyte-powders/electrolyte-ceramic/lanthanum-strontium-gallium-magnesium-oxide-powder/

EVENTS

Crash course: hydrogen expertise in 3 days

Online Conference
Date: September 26th – 28th, 2023
Organizer: The DVGW, Germany; the competence network in the gas and water sector.
Key Subjects:

- Value chain from production to application
- Political and legal framework
- Development of future H_2 network planning
- How can municipal utilities benefit from the energy transition?

There remain open questions about production, use, legal framework and financing. The issue is now given the highest priority at the political level. This program is going to provide insights into experiences, the political, legal framework and funding and financing options.

Target Groups

- Manufacturers/suppliers/system operators and manufacturers/component manufacturers
- Hydrogen project manager
- Head of Network Operations
- Municipal utilities and utilities
- Specialists and managers: industry, transport and heating sectors

Download link for Program:
https://www.dvgw-kongress.de/medien/PDF/Programm_Crashkurs_Wasserstoff.pdf

Link:
https://www.dvgw-kongress.de/veranstaltungen/gas/crashkurs-wasserstoff

INDUSTRY NEWS

JCB bets big on hydrogen engines on road to zero carbon

British construction equipment manufacturer JCB is betting big on hydrogen technology, as it rolled out its 50th hydrogen combustion engine off the production line as part of the development process.
With an investment of 100 million pounds and a team of 150 engineers working on the project for nearly two years, the company is already powering prototype backhoe loaders and load all telescopic handlers with its hydrogen engines. Recently, it also unveiled a mobile refuelling bowser — designed and built in-house — to take the fuel to the machines. The tanker has enough hydrogen to fill 16 hydrogen backhoe loaders and is able to be transported either on the back of a modified Fastrac tractor or on a trailer. At the heart of the project is the UK's legally binding requirement to reach net zero emissions by 2050.
"The JCB engineering team has done a fantastic job to develop a brand-new hydrogen engine. They have gone back to first principles to completely re-design the combustion process to work for hydrogen. In doing so, they have achieved two major things — secured JCB's place in history as the first construction equipment company to develop a fully working combustion engine fuelled by hydrogen and steered us towards the production of a landmark 50 hydrogen combustion engines," said JCB chairman Lord Bamford.
The company is also eyeing India, which is its largest market outside Europe, to manufacture its hydrogen combustion engines. In India, JCB has been making engines since 2011, so hydrogen combustion engines are an exciting prospect for the company.
"Hydrogen is a mobile fuel, perfect for the Indian market. In line with the Government of India's National Hydrogen Mission, as the hydrogen economy develops in India, the opportunity for this zero CO2 fuel for use in construction machinery is significant," said Deepak Shetty, CEO and managing director of JCB India. JCB's commitment to reducing emissions goes back almost 25 years and the latest diesel engines designed to comply with European Stage-V regulations have already delivered a 97% reduction in NOx emissions since 1999 and a 98% reduction in particulates. As part of its hydrogen development, JCB also investigated its use in fuel cells and in July 2020, unveiled the construction industry's first ever hydrogen powered excavator – a 20-tonne 220X. Consequently, hydrogen engine seemed to be the technology to go the zero-carbon way.
"Hydrogen combustion engines also offer other significant benefits. By leveraging diesel engine technology and components, they do not require rare earth elements and critically, combustion technology is already well proven on construction and agricultural equipment. It is a technology which is cost effective, robust, reliable and well known throughout not just the construction and agricultural industry, but the whole world," added Bamford. The company aims to increase exports from its unit in India, where every second construction machine sold is a JCB, from 10% five years ago to 45% of its output this year, said Graeme Macdonald, its chief executive officer.
JCB bets big on hydrogen engines on road to zero carbon | The Financial Express

£1million-Plus Investment in Nottingham-Based Alternative Fuel Hub, by Hydrogen Storage System Pioneers Luxfer Gas Cylinders

Luxfer Gas Cylinders, which is a division of Luxfer Holdings PLC, is a world-leading manufacturer of high-pressure aluminium and composite cylinders. Its Nottingham manufacturing base produces up to one million cylinders each year and is home to alternative fuel specialists who have embedded world-first hydrogen-powered systems into buses, trucks, trains, boats, tractors and even drones. This new purpose-built facility will produce Multiple Element Gas Containers (MEGCs), with the very first units available from summer 2024.
Available in 20-foot, 40-foot and 45-foot solutions, the G-Stor™ Hydrosphere range can store between 0.5 and 1.4 tonnes of clean gas and transport it to where it's needed, opening up access to hydrogen for companies targeting greener operations. With appropriate filling speeds and maximum gas capacity critical to suit different virtual gas pipeline requirements, Luxfer has drawn upon the engineering excellence of its global teams in the UK, Canada and North America, and can offer its trusted G-Stor™ Pro Type 3 cylinder, or the newly launched G-Stor™ Go Type 4 technology.
An investment of more than £1million in Luxfer Gas Cylinders' European base in Nottingham will establish a new production facility to support 'virtual' gas pipelines that can distribute hydrogen across the UK and Europe as well as support the hydrogen economy and champion alternative fuel adoption though virtual gas pipeline options.
£1million-Plus Investment in Nottingham-Based Alternative Fuel Hub, by Hydrogen Storage System Pioneers Luxfer Gas Cylinders (azocleantech.com)

EVENT

European Zero Emission Bus Conference



Date: October 09 – 12 2023
Venue: Brussels Expo Centre, Brussels
The 2023 event will be organised concurrently with @Busworld Europe 2023 in Belgium capital city of Brussels. ZEB 2023 will call on European manufacturers, policy makers and operators to scale up their zero emission ambitions to become global leaders in the transition to a zero-emission society. The conference will be held for over four days, including networking opportunities and access to the Busworld Europe exhibition.

Link:
https://h2-international.com/events/
https://zebconference.eu/

REPORT

Steel Decarbonisation in India



Joint Report by (IEEFA) and JMK Research & Analytics
Date: September 2023

Link:
https://ieefa.org/articles/green-steel-taxonomy-key-kickstart-decarbonisation-indias-steel-sector

Green hydrogen for steelmaking in India will only catch up by 2050, says report



India's plan to decarbonize its steel industry will take longer than anticipated, with green hydrogen becoming the primary fuel for steel making in the country only by 2050, a report by two research institutes.

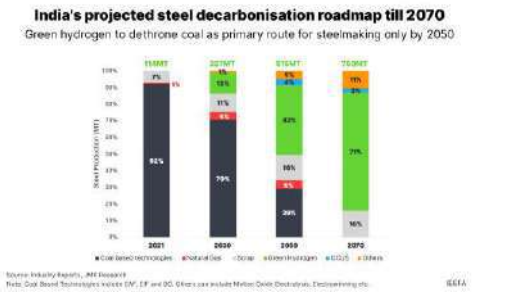
According to the report, Steel Decarbonisation in India, brought out by Institute for Energy Economics and Financial Analysis (IEEFA) and JMK Research, the shift towards green steel will be longer because the cost of green hydrogen needs to come down, while a price penalty must be imposed on carbon emissions for Indian steelmakers to switch to hydrogen-based steelmaking. Strict enforcement of renewable purchase obligations (RPOs) on the steel sector can also help in the greater use of clean energy that would clear the path for successful transition to net zero, the report said.

Greening India's steel industry is important as the statistics on steel production suggests that carbon emission intensity of India's steel industry is much higher than global standards. As per an assessment done by JMK and IEEFA, the domestic steel sector accounts for about 12% of India's carbon dioxide emissions, with an emission intensity of 2.55 tonne of carbon/tonne of crude steel compared with the global average of 1.85 tonne of CO2/tonne of crude steel. Apart from the challenge of net zero transition, green steel production has also become important because of global measures such as EUs Carbon Border Adjustment Mechanism (CBAM) that proposes to put tax on embedded carbon imports from various sectors, including steel, aluminium, cement, hydrogen, electricity, and fertiliser from January 1, 2026. To promote active usage of green steel, the research report said, the government can mandate the use of such steel in public infrastructure and nudge the private sector through the use of green steel certificates, tradable in the national carbon market, to offer them a new revenue stream.

It is expected that challenges towards green transition of Indian steel sector will allow coal to remain as the primary fuel for steelmaking for more than a decade and will only be replaced in the latter part of the 2030 to 2050 period.

There are multiple technology pathways that could help in the transition from traditional methods to low emission intensity technology like green hydrogen, renewable energy, carbon capture, usage and storage technology with Blast Furnace (BF)/Basic Oxygen Furnace (BOF) or Direct Reduced Iron (DRI)-Electric Arc Furnace (EAF), scrap-based Electric Arc Furnace (EAF) etc. Of these technologies, the green hydrogen-based route is the cleanest method of producing steel. However, green hydrogen is expensive and investing in the technology could render steelmakers uncompetitive as they sell a highly commoditised product. The most important initiative is the National Green Hydrogen Mission (NGHM), under which the Ministry of Steel has been allocated 30% of the pilot project budget, i.e., ₹14.66 billion ($ 177 million), to promote the use of green hydrogen in steelmaking. The three different scenarios have been discussed very briefly in the report.

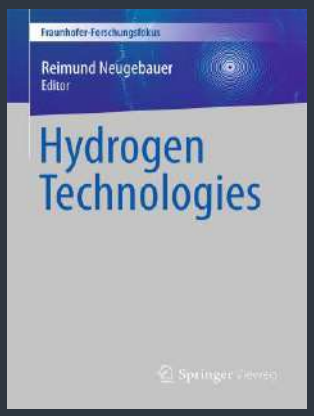
The government has taken initiatives to decarbonise the steel sector, including the Steel Scrap Recycling Policy 2019, the Perform, Achieve and Trade (PAT) scheme and the announcement of 13 task forces by the Ministry of Steel for developing a green steel roadmap. "India's steel industry contributes to around 2% of its gross domestic product, but also accounts for 12% of its carbon dioxide (CO2) emissions. The decarbonisation of the sector is at a nascent stage. To aid the industry in making the right investments, the government needs to define green steel since there is no legal definition for the same," said the report. The green hydrogen-based route is, therefore, likely to completely replace coal and natural gas-based conventional technology.



Green hydrogen for steelmaking in India will only catch up by 2050, says report | Mint (livemint.com)
https://ieefa.org/articles/green-steel-taxonomy-key-kickstart-decarbonisation-indias-steel-sector

BOOK

Hydrogen Technologies



Bibliographic Information:

Book Title: Hydrogen Technologies
Editors: Reimund Neugebauer
Publisher: Springer Cham
eBook Packages: Energy, Energy (R0)
Copyright Information: Springer Nature Switzerland AG 2023
Hardcover ISBN: 978-3-031-16296-1
Published: 27 February 2023
Softcover ISBN: 978-3-031-16006-6
Due: 12 March 2024
eBook ISBN: 978-3-031-22100-2
Published: 07 March 2023
Edition Number: 1
Number of Pages: XIII, 469
Number of Illustrations 177 b/w illustrations

About the Book: Fraunhofer-Gesellschaft presents the knowledge and experience it has acquired along the entire value chain of the hydrogen economy. This encompasses materials and system development, production, system upscaling, energy sector applications, emission-intensive industry processes and mobility, as well as the practical, overarching issues of safety, standardization and service life.

Link:
https://link.springer.com/book/10.1007/978-3-031-22100-2

Adani Enterprises share price: Step-down subsidiary to market green hydrogen in Japan

Adani Global Pte Ltd., Singapore, a step-down, wholly-owned subsidiary of Adani Enterprises announced a 50-50 Joint Venture with Kowa Holdings Asia Pte Ltd., Singapore. The subsidiary of Adani Group's flagship company will utilise the JV for sales and marketing of green ammonia, green hydrogen and its derivatives. These products will be marketed in Japan, Taiwan and Hawaii.

"JV with Kowa for green hydrogen marketing is a natural and strategic extension of Adani Group's long-standing marketing and trading relationship with Kowa," the exchange filing said. Adani New Industries Ltd, the green hydrogen platform of the Adani Group is currently implementing a 1 million metric tonnes per annum (MMTPA) green hydrogen project in phases in Gujarat. The initial phase is likely to start production by the financial year 2027. The New Industries unit plans on increasing the capacity to up to 3 MMTPA of green hydrogen in the next ten years, with an investment of $50 billion.

Additionally, Adani Wind, the wind energy solutions division of Adani New Industries received a certificate for India's largest wind turbine generator. The 5.2 MW turbine generator has received type certification from WindGuard GmbH.



Adani Enterprises share price: Step-down subsidiary to market green hydrogen in Japan (cnbctv18.com)

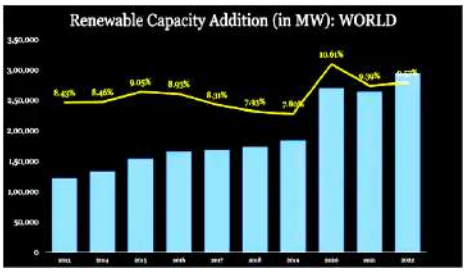
NTPC Green Energy, Nayara Energy ink pact to explore opportunities in green hydrogen space

NTPC Green Energy Limited (NGEL) has entered into an agreement with Nayara Energy to explore opportunities in the green hydrogen space. The memorandum of understanding (MoU) was signed between NGEL CEO Mohit Bhargava and Nayara Energy Head-Technical Amar Kumar. NTPC Green Energy Limited is a subsidiary of energy major NTPC. NGEL CEO Bhargava said green hydrogen would be a crucial element of India's clean energy future, and with this partnership, the company will explore and implement cutting-edge technologies to produce green hydrogen. NTPC, under the Ministry of Power, is India's largest power utility having a total installed capacity of over 73 gigawatts (GW). NTPC Group has a plan to build a renewable energy capacity of 60 GW.

https://economictimes.indiatimes.com/industry/renewables/ntpc-green-energy-nayara-energy-ink-pact-to-explore-opportunities-in-green-hydrogen-space/ articleshow/ 103 5 85 1 61.cms

G20 Summit: Promise to triple global renewable energy capacity by 2030 a significant step, but with challenges

A commitment to work towards tripling of global renewable energy capacity by 2030 is the most significant climate-related outcome from the G20 meeting. According to an assessment by the International Energy Agency earlier this year, this single measure could result in an avoidance of 7 billion tonnes of carbon dioxide emissions by 2030.



Source: IRENA

Tripling of capacities within seven years is an ambitious task, nonetheless. The current global installed capacity of renewable energy is just short of 3,400 GW. In 2022, about 295 GW of new capacity was added, the highest ever. To triple the total capacity by 2030, the world would have to add nearly 1,000 GW of new capacity every year.

But even if the tripling target is achieved by 2030, it alone would not be sufficient for the 1.5 degree Celsius goal. According to current projections, the greenhouse gas emissions in 2030 would exceed the 1.5 degree Celsius compatible levels by about 24 billion tonnes of CO2 equivalent. Renewable energy, if tripled, would be able to avoid only 7 billion tonnes of CO2 equivalent, or less than one third of what is required. G20 countries have the ability to galvanise the global action.

https://indianexpress.com/article/world/climate-change/g20-summit-triple-global-renewable-energy-capacity-2030-challenges-8934610/

Dai, HM. *et al.*

Co-partial oxidation of acetic acid, methanol, and ethanol in an integrated porous media with efficient heat recirculation: Green hydrogen production and its expansion method

https://doi.org/10.1016/j.jclepro.2023.138122

Abstract:

Green energy from biomass contributed to substituting the traditional fossil fuels and environmental protection. To explore the hydrogen production from bioethanol with the industrial by-products, a porous media burner integrated with a heat-recirculating tube was designed to realize the efficient vaporization of ethanol. Then the partial oxidation characteristics of ethanol were investigated with the acetic acid and methanol addition at different operating conditions. The results indicated that the acetic acid and methanol addition inhibited hydrogen production but promoted methane production. Compared with pure ethanol, the heating values of syngas were decreased by 3.41 and 0.64 MJ/Nm^3 with the acetic acid or methanol content of 20%. The highest yields of hydrogen and carbon monoxide were achieved at 43.94% and 66.45% respectively when the ratio of acetic acid content to methanol was 5:15. Nevertheless, blended fuels achieved more syngas production at higher equivalence ratios and velocities. The hydrogen concentration of the blended fuel reached the maximum of 21%, exceeding that of pure ethanol by 1.6% when the velocity was 22 cm/s. The corresponding results provided a theoretical reference for the industrial application of bioethanol.

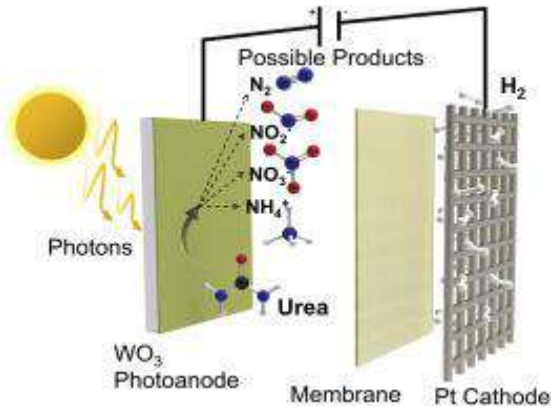
Rioja-Cabanillas, A. *et al.*

Solar photoelectrocatalytic oxidation of urea in water coupled to green hydrogen production

https://doi.org/10.1016/j.jclepro.2023.138200

Abstract:

In past decades, the intensification of human activities has led to an increase in pollution and energy demand. Photoelectrochemical systems have emerged as an alternative for the decentralized management of domestic wastewater with the potential of recovering energy while degrading pollutants such as urea. Tungsten oxide (WO_3) has been traditionally used for water splitting, but the use of this material for the removal of waste from water coupled to hydrogen production is not deeply known until now. This contribution shows an exhaustive and systematic investigation on WO_3 photoanodes for the photoelectrochemical oxidation of urea and the generation of hydrogen, with insights on the reaction mechanism, detailed nitrogen balance investigation of the process, and analysis of the performance compared to well-accepted materials. The WO_3 platelets were successfully synthesized in situ on fluorine doped tin oxide glass by a hydrothermal method. The performance of WO_3 was compared to titanium dioxide (TiO_2) as a benchmark. The photocurrent was enhanced for both electrodes when urea was added to the electrolyte, with WO_3 showing one order of magnitude higher photocurrent than TiO_2. The WO_3 electrode showed a peak incident photon-to-current efficiency of 43% at 360 nm and a much greater rate constant for urea oxidation (1.47×10^{-2} min^{-1}), compared to the TiO_2 photoanode (16% at 340 nm and 1.1×10^{-3} min^{-1}). The influence of different reactor configurations was also evaluated testing one- and two-compartment back-face irradiated photoelectrochemical cells. Hydrogen was generated with a Faradaic efficiency of 87.3% and a solar-to-hydrogen conversion efficiency of 1.1%. These findings aim to contribute to the development of technologies based on the photoelectrochemical production of hydrogen coupled with the oxidation of pollutants in wastewater.



Essahili, O. *et al.*

Overview of advanced research in luminescent solar concentrators for green hydrogen production

https://doi.org/10.1016/j.solener.2023.111859

Abstract:

The generation of green hydrogen is emerging as a significant player in overcoming urgent clean fuel needs, eliminating CO_2 emissions, and reducing fossil fuel dependency. Integrating luminescent solar concentrators as a type of PV-assisted water electrolysis looks promising, especially for integrating PV-Cells or panels in a built-up environment or in mobile applications for green hydrogen production. However, in terms of overcoming the challenges, they present a paradox with low cost, simplified manufacturing, and ease of application, on the one hand, and low efficiencies and voltage, on the other. An increased efficiency necessitates further advanced investigation. Whilst luminescent solar concentrators (LSCs) are still in the early stages of being used in this field, we offer our perspective in this review of their potential to vastly improve the efficiency and performance required for water splitting by way of design modification and engineering.

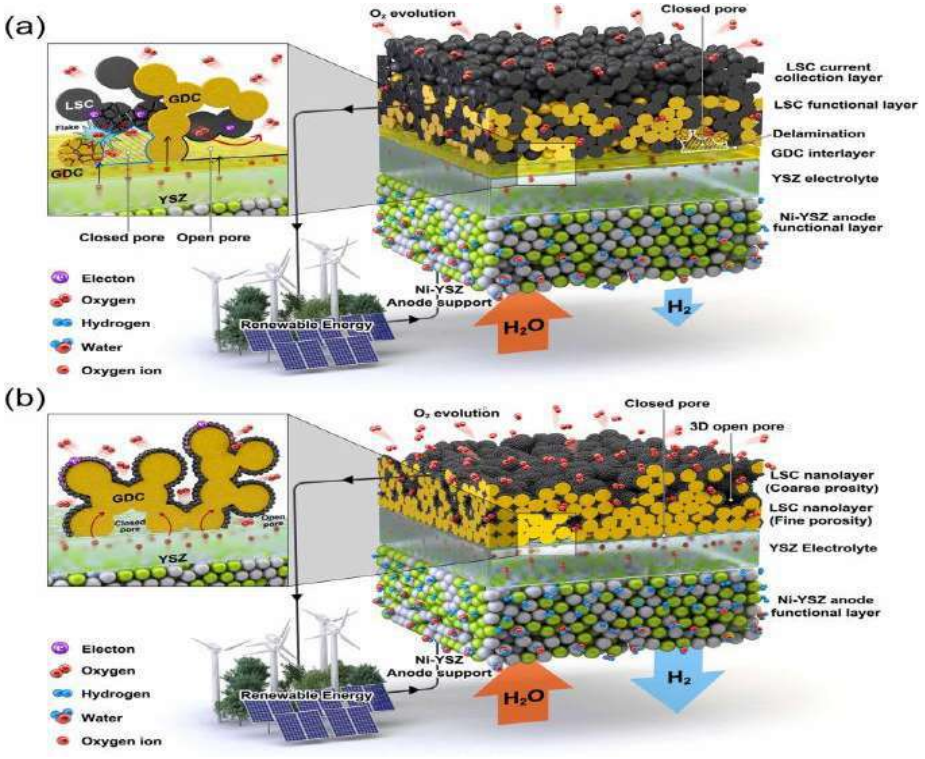
Rehman, SU. *et al.*

Designing the nano-scale architecture of the air electrode for high-performance and robust reversible solid oxide cells

https://doi.org/10.1016/j.apcatb.2023.122784

Abstract:

Herein, an innovative $La_{0.6}Sr_{0.4}CoO_3$ (LSC) nanostructured air electrode, having superior catalytic activity and exceptional robustness against critical interfacial delamination-induced degradation, is reported. A ~50 nm thin LSC air electrode decorated onto a porosity graded $Gd_{0.1}Ce_{0.9}O_2$ backbone via ultrasonic-assisted infiltration showed significantly flourished ORR and OER kinetics with prolific electrochemical performance compared to the cell with conventional LSC air electrode. The SOC showed maximum power density of 2.24 W cm^{-2} in the fuel cell mode and maximum current density of 4.57 A cm^{-2} at an operating voltage of 1.6 V in the electrolysis mode at 750 °C. Results of the reversible cycling and galvanostatic stability tests indicate excellent durability, which is attributed to the elimination of detrimental O_2 pressure evolved at the air electrode/electrolyte interface. Sited among the highest performances till date, this study provides a realization of a tremendously durable SOC design for the production of green hydrogen and electricity.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 51
SEPTEMBER, 2023

Researchers develop efficient catalyst for green hydrogen generation

The new catalyst will reduce the cost of the electrolysis process used to produce hydrogen from electricity.



Researchers from City University Hong Kong and Imperial College London have announced the development of a catalyst that makes hydrogen production easier.

Producing hydrogen via electrolysis, powered by renewable energy, allows the renewable energy to be stored and transported for later use. Typically, platinum is used as a catalyst in the electrolysis reaction, but this material adds significant cost.

The researchers have developed a catalyst that uses as little platinum as possible, which they say can be "cheaply scaled for mass use".

Professor Anthony Kucernak, said "The UK Hydrogen Strategy sets out an ambition to reach 10GW of low-carbon hydrogen production capacity by 2030. To facilitate that goal, we need to ramp up the production of cheap, easy-to-produce and efficient hydrogen storage. "The new electrocatalyst could be a major contributor to this, ultimately helping the UK meet its net-zero goals by 2050."

The newly developed electrocatalyst involves dispersal of single atoms of platinum on a sheet of molybdenum sulphide. Researchers claim that this is in fact more efficient than typical catalysts with higher concentrations of platinum.

Link:

https://www.power-technology.com/news/researchers-develop-efficient-catalyst-green-hydrogen-generation/magnesium-oxide-powder/

Phase-dependent growth of Pt on MoS2 for highly efficient H2 evolution

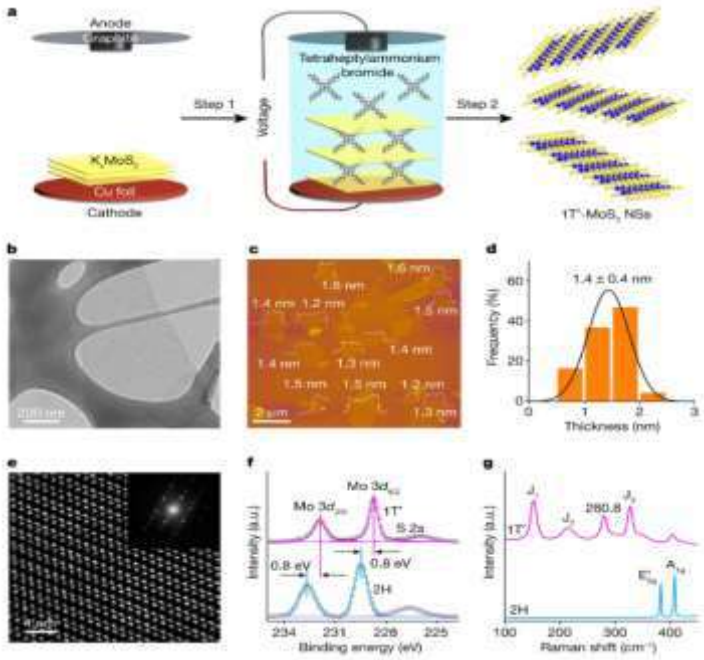


Figure: a, Schematic illustration of preparing 1T′-MoS2 NSs from KxMoS2 crystals through the electrochemical intercalation (step 1) and subsequent exfoliation (step 2). b,c, TEM (b) and atomic force microscope (AFM) (c) images of the exfoliated 1T′-MoS2 NSs. c, The height profiles and measured thicknesses of 1T′-MoS2 NSs (insets). d, Thickness distribution histogram of 1T′-MoS2 NSs measured by AFM (1.4 nm is the mean thickness, and 0.4 nm is the s.d.). e, HAADF-STEM image of a typical 1T′-MoS2 NS. The corresponding fast Fourier transform pattern is shown in the inset. f, XPS spectra of exfoliated 1T′-MoS2 NSs and 2H-MoS2 NSs. The empty dots and the solid curves represent the experimental XPS data and the corresponding deconvoluted spectra, respectively. g, Raman spectra of exfoliated 1T′-MoS2 NSs and 2H-MoS2 NSs. a.u., arbitrary unit.

- Crystal phase is a key factor determining the properties, and hence functions, of two-dimensional transition-metal dichalcogenides (TMDs). The TMD materials, explored for diverse applications, commonly serve as templates for constructing nanomaterials and supported metal catalysts. However, how the TMD crystal phase affects the growth of the secondary material is poorly understood, although relevant, particularly for catalyst development.
- In the case of Pt nanoparticles on two-dimensional MoS_2 nanosheets used as electrocatalysts for the hydrogen evolution reaction7, only about two thirds of Pt nanoparticles were epitaxially grown on the MoS_2 template composed of the metallic/semimetallic 1T/1T′ phase but with thermodynamically stable and poorly conducting 2H phase mixed in. Here we report the production of MoS_2 nanosheets with high phase purity and show that the 2H-phase templates facilitate the epitaxial growth of Pt nanoparticles, whereas the 1T′ phase supports single-atomically dispersed Pt (s-Pt) atoms with Pt loading up to 10 wt%.
- The Pt atoms in this s-Pt/1T′-MoS_2 system occupy three distinct sites, with density functional theory calculations indicating for Pt atoms located atop of Mo atoms a hydrogen adsorption free energy of close to zero. This probably contributes to efficient electrocatalytic H2 evolution in acidic media, where we measure for s-Pt/1T′-MoS_2 a mass activity of 85 ± 23 A mg^{-1}_{Pt} at the overpotential of −50 mV and a mass-normalized exchange current density of 127 A mg^{-1}_{Pt} and we see stable performance in an H-type cell and prototype proton exchange membrane electrolyser operated at room temperature. Although phase stability limitations prevent operation at high temperatures, we anticipate that 1T′-TMDs will also be effective supports for other catalysts targeting other important reactions.

https://doi.org/10.1038/s41586-023-06339-3

EVENTS

Global Virtual World Energy Storage Day Event 2023



Date: 22nd September 2023

With a rising focus on the effective integration of renewable energy, the importance of electric vehicle and reliable, resilient energy supply, energy storage is becoming an increasingly important tool in the electricity ecosystem.
With Energy Storage rising to the forefront of industry developments, World Energy Storage Day is commemorated on 22nd September every year by various global industry stakeholders, policy makers, think tanks and associations to acknowledge its importance across the globe.

Highlights:

Global Startup Showcase 3.0 2023



Global Energy Storage Skilling Movement



Link:
https://www.energystorageday.org/

INDUSTRY NEWS

Europe's Rules On Ammonia-To-Hydrogen Kit Spark Investor Alarm

Hamburg-based Mabanaft Group — via its subsidiary Oiltanking Deutschland — and the US's Air Products & Chemicals Inc. have drawn up plans to build a facility for converting ammonia into hydrogen at the German port by 2026. But the project is stalled amid ongoing discussions with the EC, according to people familiar with the issue.

The Commission said the legislative procedure is ongoing, with the final design of the regulatory framework subject to change. The tussle is important because hydrogen — which is converted into liquid ammonia for easier transportation — is seen as a key tool to decarbonize some of the most energy-intensive sectors. The fight pits the principles of fair competition against the needs of businesses.
https://www.bqprime.com/business/europe-s-rules-on-ammonia-to-hydrogen-kit-spark-investor-alarm

Toyota and VDL Groep launch hydrogen fuel cell truck for European logistics operations

This first demo truck will undergo road testing to identify opportunities for improvements ready for the next stage in the programme. VDL Groep is preparing four more fuel cell trucks, which will be used by Toyota's logistic providers VOS Transport Group, CEVA, Groupe CAT and Yusen. These transportation companies will contribute to the project by using the hydrogen trucks on their daily routes in Belgium, France and the Netherlands. The four routes each have at least one hydrogen refuelling station (HRS), together with back-up provisions if required.
The cooperation between all parties is expected to consolidate learnings on how to deploy fuel cell trucks on public roads and contribute to Europe's ecological energy transition.



https://www.autocarpro.in/news-international/infineon-launches-intelligent-tyre-pressure-monitoring-sensor-116725

JCB bets big on hydrogen engines on road to zero carbon

British construction equipment manufacturer JCB is betting big on hydrogen technology, as it rolled out its 50th hydrogen combustion engine off the production line as part of the development process.
With an investment of 100 million pounds and a team of 150 engineers working on the project for nearly two years, the company is already powering prototype backhoe loaders and loadall telescopic handlers with its hydrogen engines. Recently, it also unveiled a mobile refuelling bowser — designed and built inhouse — to take the fuel to the machines. The tanker has enough hydrogen to fill 16 hydrogen backhoe loaders and is able to be transported either on the back of a modified Fastrac tractor or on a trailer.



JCB bets big on hydrogen engines on road to zero carbon | The Financial Express

New California factory to manufacture green hydrogen electrolyzers

Verdagy, a provider of water electrolysis electrolyzer technologies for large-scale industrial applications, announced its new facility opening in Newark, California, with more than 100,000 sq. ft. of advanced manufacturing space.
Verdagy's Silicon Valley factory will be one of the first to manufacture advanced water electrolyzers in large volumes in the United States. The commencement of operations at Verdagy's facility will start in Q1 2024. Verdagy's customers are in heavy industries such as chemicals, ammonia/fertilizer, steel, and e-fuels which all require large amounts of green hydrogen. The decision to expand Verdagy's manufacturing capabilities in California comes at a time when the state is prioritizing the development of its hydrogen economy and becoming a federally funded hydrogen hub, as outlined in Governor Gavin Newsom's Hydrogen Market Development Strategy.
https://www.renewableenergyworld.com/hydrogen/new-california-factory-to-manufacture-green-hydrogen-electrolyzers/

EVENTS

2023 National Summit on Combined Heat and Power



Date: November 15 & 16, 2023

Venue: Hyatt Regency Crystal City Hyatt hotel in Arlington, VA, Washington, D.C.

The Combined Heat and Power Alliance, the leading national voice for the deployment of combined heat and power (CHP) and waste heat to power (WHP), is hosting its 4th annual National Summit on CHP in the Washington D.C. area. This in-person conference will convene industry experts, government leaders, policymakers, utilities, climate advocates, and other members of the clean energy community to discuss future pathways for CHP deployment.

Link:

https://www.ghcoalition.org/affiliate-events-1
https://chpalliance.org/2023-summit/

CII Energy Conclave Northern Region

Date: 19th October 2023

Venue: New Delhi, Delhi, India

Theme: "Exploring the New Energy Transition Trends - Sustainable Energy Options for India,"

Link:

https://cam.mycii.in/OR/EventDetailOR.html?id=E000062671

INDUSTRY NEWS

Not Tesla But 500 Hydrogen Powered Toyota Cars Will Ply In Official Feet For 2024 Paris Olympics & Paralympics

Japanese carmaker Toyota has revealed that it will be supplying Paris with 500 units of Mirai, which is a hydrogen fuel cell electric vehicle and has zero tailpipe emissions. Toyota shares the objective of Paris 2024 of reducing the carbon emissions of the games by -50 percent (compared to previous games).
Toyota as the official worldwide partners of the 2024 Olympics & Paralympics has announced that the company will be supplying the global sporting event with 500 units of its hydrogen fuel cell electric vehicle, Mirai to help decarbonise the sporting spectacle.



https://www.timesnownews.com/auto/not-tesla-but-500-hydrogen-powered-toyota-cars-will-ply-in-official-feet-for-2024-paris-olympics-paralympics-article-103859207

GRSE Signs Pacts With Foreign Companies For Hydrogen Fuel Cell

Defence shipbuilder Garden Reach Shipbuilders and Engineers (GRSE) on Wednesday said it has entered into non-binding MoUs with foreign companies for the development of a hydrogen fuel cell ferry and the sale and service of medium-speed engines, particularly for the Indian Navy and the Indian Coast Guard.
GRSE, in its communication to the bourses, stated that it has signed two non-binding MoUs at the Defense and Security Equipment International (DSEI) Exhibition in London, which are of a confidential nature.
The Kolkata-based shipbuilder has signed a MoU with Lloyd's Register for the development of a hydrogen fuel cell ferry and with Caterpillar Inc.
https://planet.outlookindia.com/news/grse-signs-pacts-with-foreign-companies-for-hydrogen-fuel-cell-news-415996

Study finds model that improves hydrogen station availability

According to researchers, letting station managers use a predictive model that helps them anticipate maintenance needs could boost consumer confidence in driving hydrogen-powered vehicles. According to researchers, letting station managers use a predictive model that helps them anticipate maintenance needs could boost consumer confidence in driving hydrogen-powered vehicles. Stations that close for unannounced maintenance decrease customer access to hydrogen and may hinder the adoption of these sorts of fuel cell electric vehicles, according to the study. The implementation of a prognostics health monitoring (PHM) model might enable hydrogen stations to reduce these unplanned incidents.



Hydrogen Stations USA: Study finds model that improves hydrogen station availability, ET Auto (indiatimes.com)

Lexus hydrogen-powered ROV uses Toyoda Gosei tanks and plastic recycling tech

Along with prototypes of the LM, LBX and GX, Lexus also announced the start of a customer experience program aimed at the future practical application of the ROV Concept (ROV), which features a Lexus first hydrogen-powered engine. In developing the ROV, the goal is to offer a distinctive driving experience not possible with regular passenger cars.



3 UW hydrogen research proposals selected for seed funding | Local News | wyomingnews.com

EVENT

World energy congress 2024

Date: 22-25th April 2024

Venue: Rotterdam Ahoy, Rotterdam, Netherlands

From 22-25 April 2024, all eyes will be on Rotterdam as more than 7,000 international energy stakeholders convene for the 26th World Energy Congress. Marking the beginning of the centenary of the World Energy Council, this most prestigious and influential global event, hosted at the highest political level, welcomes leaders from all corners of the world as they come together to enable solutions and deliver impact under the theme 'Redesigning Energy for People and Planet'.

The 26th World Energy Congress will explore the role of connected energy societies in driving forward global energy transitions in today's less predictable, more turbulent and faster shifting world. The Congress will provide unparalleled opportunities to engage in leadership dialogue and innovative thinking with peers. With more than 60 sessions and 100 exhibitors across 30,000 sqm. of exhibition space attracting 18,000 attendees over four days, the Congress connects and inspires experienced and future energy leaders and practitioners from around the world.

Link:

https://www.worldenergy.org/experiences-events/events/entry/26th-world-energy-congress-rotterdam-netherlands

INDIA NEWS

IIT Madras to work with Industries on R&D and developing testing/validation standards in 'Green Hydrogen'

Indian Institute of Technology Madras (IIT Madras) along with IITM Research Park is going to work with industries and research institutes on industrial R&D needs, skill development, creating incubators, testing/validation standards and policy advocacy in the 'Green Hydrogen' sector.

This is part of the 'Hydrogen Valley Innovation Cluster in Tamil Nadu' (HVIC-TN) initiative, which comprises nearly 30 companies working in the hydrogen sector, IIT Madras Research Park, Guidance Tamil Nadu and Tamil Nadu Industrial Development Corporation (TIDCO) besides a few consulates.

A key outcome expected from this initiative is to make HVIC-TN the hub of industrial R&D requirements to bring green hydrogen at an economical price and scale. This initiative is expected to contribute significantly towards the National Green Hydrogen Mission.

In keeping with the Department of Science and Technology's (DST) vision to transform India into an energy-independent nation by 2047, it is providing funding for Research, Development and Demonstration (RD&D) activities essential for small-scale demonstration by enhancing the readiness of technologies in green hydrogen value chain.

HVIC-TN will act as a platform for stakeholders in the hydrogen sector to network and enable faster green hydrogen adoption and transition. The cluster will also serve as a nodal agency, think tank, and knowledge partner in the State to attract or support any initiatives in the hydrogen sector. In addition, to enable seamless access to networks between countries, connections through consulates of various countries are enabled.

IIT Madras will cover the entire value chain of hydrogen starting from generation, storage, and transportation to utilization. CXO-level representation from more than half the industry partners attended the meeting on the campus. The industries discussed and delineated their company's role and contributions to the HVIC.

Tamil Nadu power is already 50% green and HVIC will improve this further with green hydrogen, Dr. TRB Rajaa, Hon'ble Minister for Industries, Investment Promotion and Commerce, Government of Tamil Nadu, said.

https://www.iitm.ac.in/happenings/press-releases-and-coverages/iit-madras-work-industries-rd-and-developing

CM approves Rajasthan Green Hydrogen Policy-2023 draft to push clean energy

Rajasthan Chief Minister Ashok Gehlot has approved the draft of 'Rajasthan Green Hydrogen Policy-2023' and a notification in this regard will be issued soon. The state government has taken the decision keeping in mind clean energy production, future needs and climate change, according to a release. Rajasthan Green Hydrogen Policy-2023' is being brought to encourage investors and search for clean energy sources in the state. Chief Minister Gehlot has approved the policy draft. Notification will be issued soon by the Energy Department, the release said.

Under the policy, companies producing green energy will get various types of subsidies. Employment opportunities will also increase in the state. Under this policy, the state government will provide various facilities to encourage investors.

CM approves Rajasthan Green Hydrogen Policy-2023 draft to push clean energy (business-standard.com)

Green hydrogen will cut cost of energy to Rs 6 per unit: Minister R K Singh

Speaking at the special ministerial session of the Fourth International Conference & Exhibition on Clean Energy, Singh said that the cost of green hydrogen would be cheapest in India and that it would become a viable energy storage alternative.

"The average price of power in the energy exchange has recently been Rs 8 per unit, so if our cost for round-the-clock renewable energy comes to Rs 6 per unit, we are in business. Around 88,000 MW renewable energy capacity is under construction and our plan is to add 50,000 MW of renewable energy capacity every year. We are already emerging as an exporter. The world will come to rely on us more and more. So, all those who are setting up capacity have made a good bet. At the same time, we need to keep ourselves at the leading edge of technology," he added. He also said that India is going to emerge as the biggest exporter of solar cells and modules and that more grid capacity is being added. The theme of the special ministerial session, held on the closing day of the two-day summit, was 'Global Champions for Advancing Clean Energy Innovation & Manufacturing'.

Green hydrogen will cut cost of energy to Rs 6 per unit: Minister R K Singh, ET EnergyWorld (indiatimes.com)

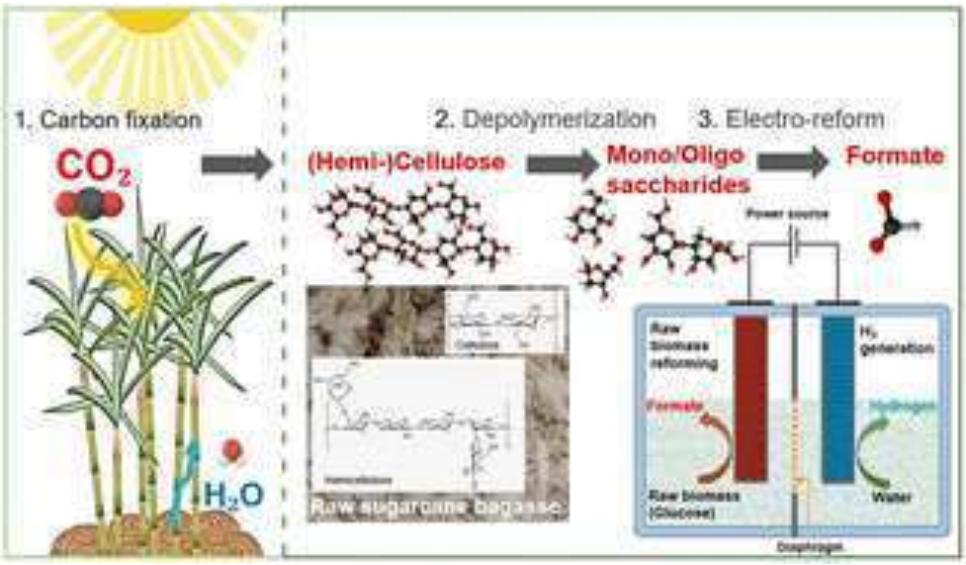
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 52
SEPTEMBER, 2023

Green hydrogen generation assisted by electroreforming of raw sugarcane bagasse waste

An efficient and environmentally friendly pretreatment–electrochemical upcycling process for sugarcane bagasse waste to cogenerate green hydrogen and formate.
Lee, LQ. et al. 2023



Graphical representation showing green hydrogen generation assisted by electroreforming of raw sugarcane bagasse waste

Highlights of the Research:

- Biomass is widely acknowledged as a renewable and abundant substitute for fossil fuels that is considered CO_2-neutral.
- Thermal process-based energy extraction without proper carbon capture and storage still dominates biomass utilization and inevitably results in CO_2 emission.
- To develop a greener biowaste utilization method, a biomass-derived small molecules were reported to be electrochemically reformed into valuable chemicals in a green process under ambient conditions.
- The reforming of raw biomass is still challenging, owing to its rigid and chemically stable structure, thus, direct electroreforming of sugarcane bagasse waste for cogeneration of green hydrogen and valuable chemicals is reported.
- Due to suppressed oxygen evolution it avoided hydrogen–oxygen mixture formation, the present electroreforming process could be directly driven by photovoltaic electricity, presenting a safe and low-carbon route to green hydrogen and chemicals from raw biomass.
- Life cycle assessment as an addition shows that the electroreforming upcycling process driven by photovoltaic electricity and waste heat affords the lowest global warming potential amongst various process configurations, including conventional waste management methods, promising for decarbonisation and sustainable development.

Lee, L.Q., Zhao, H., Lim, T.Y., Junyu, G., Ding, O.L., Liu, W., & Li, H. (2023). Green hydrogen generation assisted by electroreforming of raw sugarcane bagasse waste. *Green Chemistry*. https://doi.org/10.1039/D3GC01603J

Sugarcane bagasse: a biomass sufficiently applied for improving global energy, environment and economic sustainability
Ajala, EO. et al.



Highlights:

- Sugarcane bagasse (SCB) has been identified as a biomass that is abundantly available and can be harnessed for various applications.
- To optimally utilise SCB for its numerous applications, pre-treatment and hydrolysis are important processes.
- Various biofuels such as bio-ethanol, bio-methane, bio-hydrogen and bio-butanol have been successfully produced using SCB as a feedstock.
- Apart from being a source of energy, SCB is a sustainable feedstock for the productions of adsorbent, briquette, ceramic, concrete and composite.
- The SCB is a biomass that can be sufficiently applied for improving global energy, environment and economic sustainability.

Citation:

Ajala, E.O., Ighalo, J.O., Ajala, M.A. *et al.* Sugarcane bagasse: a biomass sufficiently applied for improving global energy, environment and economic sustainability. *Bioresour. Bioprocess.* **8**, 87. https://doi.org/10.1186/s40643-021-00440-z

EVENTS

Hydrogen & P2X 2024



Date: 19 – 20 June 2024

Venue: Copenhagen, Denmark

5th European Conference Hydrogen & P2X 2024 will bring together top-level experts from gas producers, chemical and cement industries representatives, power and transmission operators, business analytics, government officials and regulators, storage and transport companies, service providers, projects representatives, technology providers, equipment manufacturers, renewable energy consultancies.

Key Topics:
Updates on targets from the EU's REPowerEU
Innovations in Hydrogen's impact on achieving Net Zero goals
The newest and cutting-edge advancements, solutions, and innovations
Introducing Hydrogen to the current gas network
Scaling up and reducing Hydrogen production costs
Case studies on existing and planned Power-to-X projects and infrastructure
Green Hydrogen as a potential clean substitute for carbon-heavy fuels
Ensuring low-carbon technologies for P2X products
Markets for the development of Fuel Hydrogen, Ammonia, and Hydrogen Fuel Cells
H2 safety technology and regulations

Link:
https://fortesmedia.com/hydrogen-p2x-2024,4,en,2,1,34.html

INDUSTRY NEWS

Mercedes-Benz GenH2 Truck cracks 1,000km mark with one fill of liquid hydrogen

Daimler Truck has successfully demonstrated that hydrogen fuel-cell technology can be the right solution to decarbonise flexible and demanding long-haul road transportation. A public road-approved prototype of the Mercedes-Benz GenH2 Truck completed Daimler Truck's 'HydrogenRecordRun' covering 1,047km of distance driven with one fill of liquid hydrogen. Powered by a cellcentric fuel-cell system and equipped with a liquid hydrogen fuel tank system, the run September 25 in the afternoon at Mercedes-Benz Truck's Customer Center in Woerth am Rhein and finished on September 26 in Germany's capital city Berlin.



https://www.autocarpro.in/news-international/mercedes-benz-genh2-truck-cracks-1000km-mark-with-one-fill-of-liquid-hydrogen-116957

Hydrogen refuelling stations, buses operational in Peninsular Malaysia next year

The first hydrogen refuelling stations and hydrogen public buses are expected to be operational in Peninsular Malaysia next year, the minister of science, technology and innovation said, reported The Star. With Sarawak already embracing hydrogen vehicles and trams, it was only proper for the peninsula to embark on a similar effort to tap into the clean energy source, Minister Chang Lih Kang said.
"The peninsula is poised to establish its first hydrogen station next year, alongside the introduction of several hydrogen cars and public buses. Once the first hydrogen refuelling station is operational, we will introduce multiple hydrogen vehicles for trial runs and deploy public buses powered by hydrogen," Chang told the daily.
https://paultan.org/2023/09/27/hydrogen-refuelling-stations-buses-operational-in-peninsular-malaysia-next-year-10000-stations-by-2025/

Rolls-Royce's Hydrogen Research Project Achieves Historic Milestone

In a groundbreaking development, Rolls-Royce has achieved a remarkable milestone in its hydrogen research project, setting a world industry first. This endeavor represents a significant stride towards pioneering hydrogen combustion engine technology, capable of propelling various aircraft, including those in the narrow-body market segment, starting from the mid-2030s. Partnering with easyJet, Rolls-Royce has been relentless in its commitment to spearheading the aviation industry's transition to hydrogen as a fuel source. Collaborating with Loughborough University in the UK and the German Aerospace Centre Deutsches Zentrum für Luft-und Raumfahrt (DLR), Rolls-Royce has unveiled a pivotal engine technology breakthrough that brings us closer to making hydrogen a viable aviation fuel. The pivotal test involved a full annular combustor of a Pearl 700 engine at DLR in Cologne, powered entirely by hydrogen, and it demonstrated that hydrogen can be combusted under conditions that mimic maximum take-off thrust.



https://www.financialexpress.com/business/defence-rolls-royces-hydrogen-research-project-achieves-historic-milestone-3255528/

Morocco aims to become key player in green hydrogen

Morocco has voiced ambitious plans to become North Africa's top player in the emerging "green hydrogen" sector, with plans to export the clean-burning fuel to Europe. Morocco, which already runs large solar power plants, also hopes to harness green hydrogen -- the kind made without burning fossil fuels -- for its sizeable fertiliser sector. Around 1.5 million acres (6,000 square kilometres) of public land -- nearly the size of Kuwait -- have been set aside for green hydrogen and ammonia plants. King Mohammed VI has hailed a national green hydrogen plan dubbed l'Offre Maroc (the Moroccan Offer) and called for its "rapid and qualitative implementation".

EVENTS

Global Wind Energy Council

Date: 24 - 26 October 2023

Venue: Marina Bay Sands, Singapore

ACES 2023 in its 10th staging, will take place from 24-26 October at Marina Bay Sands, Singapore, and part of the Singapore International Energy Week (SIEW). Themed “Clean Energy for a Clean World”, ACES supports the region’s net zero ambitions and the need to accelerate just clean energy transition with appropriate technologies, policies and financing.

The conference program includes renewable energy strategies focussing on Solar and Storage, Energy Efficiency, Green Hydrogen, Decarbonising Carbon Markets, Trading and Carbon Capture, Utilisation & Storage (CCUS). GWEC is a Supporting Organisation of ACES 2023.

Asian Governments are making their efforts towards achieving the Net Zero target of 2050. $2 trilion infrastructure investments are needed for sustainable transition and to close the region’s 3-4 Gt gap to Paris-aligned annual emissions.

Link:

https://gwec.net/asia-clean-energy-summit-2023/

https://www.asiacleanenergysummit.com/home

INDUSTRY NEWS

Essar Energy Transition Starts Construction At Second Hydrogen Plant In U.K.

Essar Energy Transition Hydrogen, earlier known as Vertex Hydrogen, has started construction work at the second hydrogen plant that will meet the local industrial and power demand in the U.K. The plant will have a peak power generation capacity of 1,000 megawatts and will produce 230,000 tonnes of low-carbon hydrogen. The hydrogen plant, claimed to be the largest in the U.K. and one of the largest in the world, will be completed in phases, with the first phase expected to be over in the next seven to eight months.



https://www.bqprime.com/business/essar-energy-transition-starts-construction-at-second-hydrogen-plant-in-uk

Universal Hydrogen Celebrates 250th Order for Its Hydrogen Regional Aircraft Products

Universal Hydrogen Co. celebrated a major commercial milestone when an order from an unnamed customer pushed the total order book for its regional product to 250 aircraft. The company has been taking orders for regional aircraft conversion kits that replace the existing kerosene-burning gas turbines on ~50-60 passenger regional aircraft starting with the ATR 72 with hydrogen fuel cells and an electric motor. The kit also reconfigures the aircraft to accommodate Universal Hydrogen’s liquid hydrogen fuel modules and the orders include an agreement to supply hydrogen fuel services for the aircraft. The company’s unique modular fueling system uses standard cargo handling equipment for hydrogen handling and fueling, meaning that every airport is hydrogen-ready without costly infrastructure upgrades.

https://www.businesswire.com/news/home/202309260

Clean Tech Co. Partners With European Hydrogen Producer

Jericho Energy Ventures Inc. announced that its European partner, Exogen Hydrogen Solutions, has signed a memorandum of understanding with a leading European producer and supplier of renewable hydrogen to offer decarbonization solutions for industrial steam, district heating, and mobility applications on the continent.

Lhyfe inaugurated its first green hydrogen production site in 2021 and has five more under construction. It said it plans to achieve 3 gigawatts (GW) of installed capacity of hydrogen production by 2030.

"Green hydrogen has become highly relevant for decarbonizing industrial steam, district heating, and logistics," Lhyfe Vice President of Sales and Business Development Philippe Desorme said.

"By partnering with Exogen, we expect a significant expansion of our green hydrogen production output over time while also opening a completely new market segment for us."

https://www.investorideas.com/news/2023/renewable-energy/09262European-Hydrogen.asp

PLIDCO Launches New Line of Hydrogen-Compatible Fittings

The Pipe Line Development Company (PLIDCO), the leader in pipeline leak repair and maintenance fittings, announced today a new range of products for use with hydrogen pipelines in response to the emerging transition toward hydrogen and other alternative energy sources. Designed for onshore and subsea high-pressure emergency pipeline repairs and routine pipeline maintenance applications, PLIDCO’s products are ideal for hydrogen, oil, gas, water, chemical, steam, slurry and other piping systems. Its high-pressure fittings are designed and manufactured to meet the highest quality standards, following ASME/ANSI codes and adhering to a strict quality control program.



https://www.businesswire.com/news/home/20230925622149/en/

EVENTS

International Conference on Clean Energy and Electrical Systems



Date: April 5-7, 2024

Venue: Kyoto, Japan

The 6th International Conference on Clean Energy and Electrical Systems will be held in Kyoto, Japan on April 5-7, 2024, which will be organized by Ritsumeikan University, Japan.
CEES covers a broad range of clean energy and electrical systems topics, and it will continue the tradition of the past editions organized in Vancouver, Nanjing, Tokyo. Electricity will play a huge role in the development of clean energy. The future development trend of energy must be towards the direction of clean energy, and the ecological and economic benefits it brings will be immeasurable.

Centered at Theme "Empowering a Sustainable Future"

Conference Highlights:
Keynote Speeches
Technical Sessions
Poster Presentations
Industry Exhibitions
Networking Opportunities

Link:
http://www.cees.net/

INDIA NEWS

IndianOil unveils India's first green hydrogen-run bus that emits just water



India's top oil firm IOC on September 25 unveiled the nation's first green hydrogen-powered bus that emits just water as it takes the lead in bringing out unrivaled tools to replace fossil fuels. Indian Oil Corporation (IOC) will produce close to 75 kg of hydrogen by splitting water using electricity from renewable sources. This hydrogen will be used to power two buses which will ply across the national capital region for trial runs. IOC's R&D Centre at Faridabad is producing green hydrogen for the pilot run. Four cylinders with a capacity of 30 kg can run the buses for 350 km. As much as 50 units of renewable electricity and 9 kg of deionized water are needed for the production of one kilo of green hydrogen.
Mr. Puri said by the end of 2023, IOC will scale up the number of buses to 15. IOC will undertake operational trials of 15 fuel cell buses powered by green hydrogen on the identified routes in Delhi, Haryana, and UP. Under this programme, the first set of 2 fuel cell buses was launched. Upon the launch of the two buses, a cumulative mileage of more than 3 lakh kilometers will be covered for long-term assessment of performance and durability of the new technology. India has one of the largest synchronous grids in the world, capable of handling intermittent renewable energy and it has achieved 'One Nation-One Grid-One Frequency'. Mr. Puri said recently the world's first BS 6 (Stage II) Electrified Flex Fuel vehicle prototype was launched that encompasses both the flex fuel engine as well as an electric powertrain that offers higher use of ethanol combined with better fuel efficiencies.
The global demand for hydrogen is expected to increase by four to seven times to 500-800 tonne by 2050.Domestic demand is expected to increase by four times, from the current 6 tonne at present to 25-28 tonne by 2050. Oil and gas PSUs shall produce around 1 million tonne per annum of green hydrogen by 2030.

IndianOil unveils India's first green hydrogen-run bus that emits just water - The Hindu

Kolkata based GRSE signs MoU with UK firm for green energy efficient hydrogen fuel carrier

Kolkata based shipbuilding firm, GRSE, while participating in a defence equipment fair in London has signed an MoU with a UK's maritime services company Lyod's Register for developing a hydrogen fuel cell ferry and another MoU with US based Caterpillar Inc for a potential collaboration in the production, sale and service of marine engines for the Indian Navy and Indian Coast Guard. Union minister for Ports, Shipping and Waterways, Sarbananda Sonowal had unveiled the government's plan to build hydrogen-fueled electric vessels last year. GRSE is already working on a zero-emission passenger ferry that will be a prototype of more such green vessels to ply on river Hooghly. The India Pavilion was inaugurated by Shri Vikram Doraiswami, India's High Commissioner to the UK on September 12. The DSEI Exhibition is an important global event that connects armed forces across the world with equipment manufacturers. It is a great opportunity for companies to attract customers beyond its country's shores, while building partnerships with others.
GRSE was among the five Defence Public Sector Undertakings that participated at India Pavilion of Defence and Security Equipment International (DSEI) exhibition in London, held between September 12 to September 15. The other four companies that showcased the technological prowess and advanced capabilities were Munitions India Ltd (MIL), Advanced Weapons & Equipment India Ltd (AW&EIL), Yantra India Ltd (YIL) and Bharat Dynamics Ltd (BDL).
Acknowledging close ties between UK and India, James Cartlidge, UK's minister of state for defence procurement and D Johnson, UK's Minister of State for Investment, visited the India Pavilion. Cdr Shantanu Bose, IN (Retd.), Director (Shipbuilding), GRSE, along with other senior officials interacted with the visiting dignitaries and senior management of global OEMs. It was during the exhibition that two memorandums of understanding (MoUs) were signed by GRSE.

Kolkata based GRSE signs MoU with UK firm for green energy efficient hydrogen fuel carrier (msn.com)

Yang, HY. and Ahn, YH.

Analysis of electrification and its greenhouse gas reduction potential in the industrial sector of Korea using mixed methods

https://doi.org/10.1016/j.jclepro.2023.138160

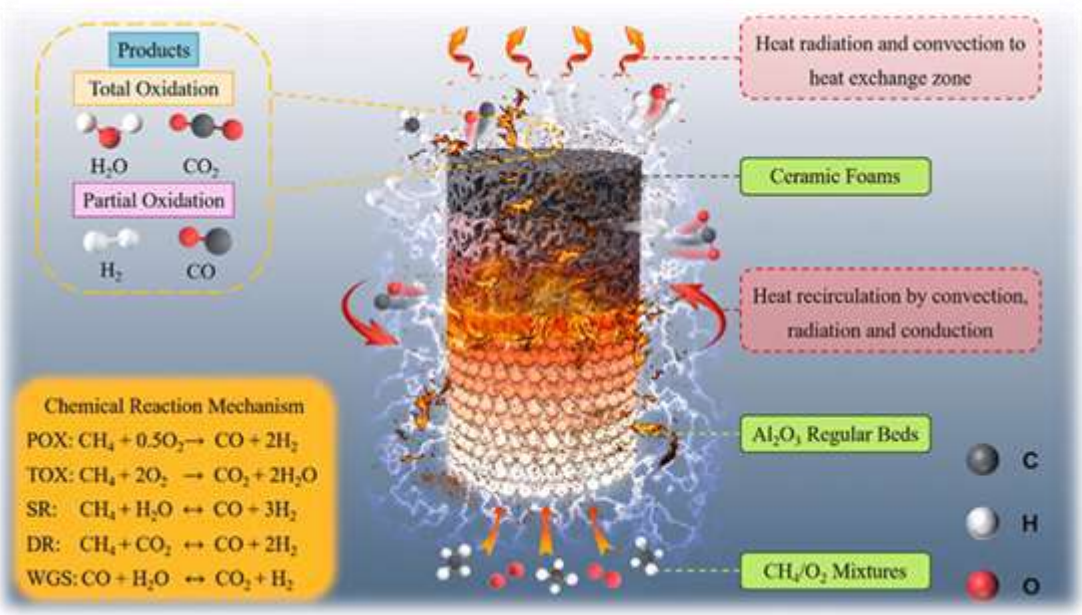
Abstract:
Carbon neutrality has heightened the necessity for deep decarbonization in the industrial sector, emphasizing the significance of ambitious mitigation measures, including system-level energy and material efficiency, carbon capture and utilization, electrification, and green hydrogen utilization. Electrification, particularly in the hard to-abate industrial sector, emerges as a critical tool assuming the power sector's decarbonization. This study aims to evaluate Korea's industrial sector electrification potential and its greenhouse gas (GHG) reduction potential by 2050. To achieve this, we employ a mixed-method approach, integrating quantitative methods, such as the Iterative Proportional Fitting Procedure (IPFP) for data consistency, energy forecast, and elasticity of substitution models, along with a qualitative method involving energy experts through the Delphi technique. The results indicate an estimated 41% electrification potential for Korea's industrial sector by 2050, with a potential GHG reduction of approximately 26.3% compared to the Business-as-Usual emissions.

Dai, HM. *et al.*

Co-partial oxidation of acetic acid, methanol, and ethanol in an integrated porous media with efficient heat recirculation: Green hydrogen production and its expansion method

https://doi.org/ 10.1016/j.jclepro.2023.138122

Abstract:
Green energy from biomass contributed to substituting the traditional fossil fuels and environmental protection. To explore the hydrogen production from bioethanol with the industrial by-products, a porous media burner integrated with a heat-recirculating tube was designed to realize the efficient vaporization of ethanol. Then the partial oxidation characteristics of ethanol were investigated with the acetic acid and methanol addition at different operating conditions. The results indicated that the acetic acid and methanol addition inhibited hydrogen production but promoted methane production. Compared with pure ethanol, the heating values of syngas were decreased by 3.41 and 0.64 MJ/Nm3 with the acetic acid or methanol content of 20%. The highest yields of hydrogen and carbon monoxide were achieved at 43.94% and 66.45% respectively when the ratio of acetic acid content to methanol was 5:15. Nevertheless, blended fuels achieved more syngas production at higher equivalence ratios and velocities. The hydrogen concentration of the blended fuel reached the maximum of 21%, exceeding that of pure ethanol by 1.6% when the velocity was 22 cm/s. The corresponding results provided a theoretical reference for the industrial application of bioethanol.



Bekkering, J. and Nap, JP.

Energy self-sufficiency and sustainability in a defined neighbourhood: Bio-methanation to green gas can outperform green hydrogen

https://doi.org/ 10.1016/j.enconman.2023.117370

Abstract:

In Europe, green hydrogen and biogas/green gas are considered important renewable energy carriers, besides renewable electricity and heat. Still, incentives proceed slowly, and the feasibility of local green gas is questioned. A supply chain of decentralized green hydrogen production from locally generated electricity (PV or wind) and decentralized green gas production from locally collected biomass and biological power-to-methane technology was analyzed and compared to a green hydrogen scenario. We developed a novel method for assessing local options. Meeting the heating demand of households was constrained by the current EU law (RED II) to reduce greenhouse gas (GHG) emissions by 80% relative to fossil (natural) gas. Levelised cost of energy (LCOE) analyses at 80% GHG emission savings indicate that locally produced green gas (LCOE = 24.0 euroct kWh-1) is more attractive for individual citizens than locally produced green hydrogen (LCOE = 43.5 euroct kWh-1). In case higher GHG emission savings are desired, both LCOEs go up. Data indicate an apparent mismatch between heat demand in winter and PV electricity generation in summer. Besides, at the current state of technology, local onshore wind turbines have less GHG emissions than PV panels. Wind turbines may therefore have advantages over PV fields despite the various concerns in society. Our study confirms that biomass availability in a dedicated region is a challenge.

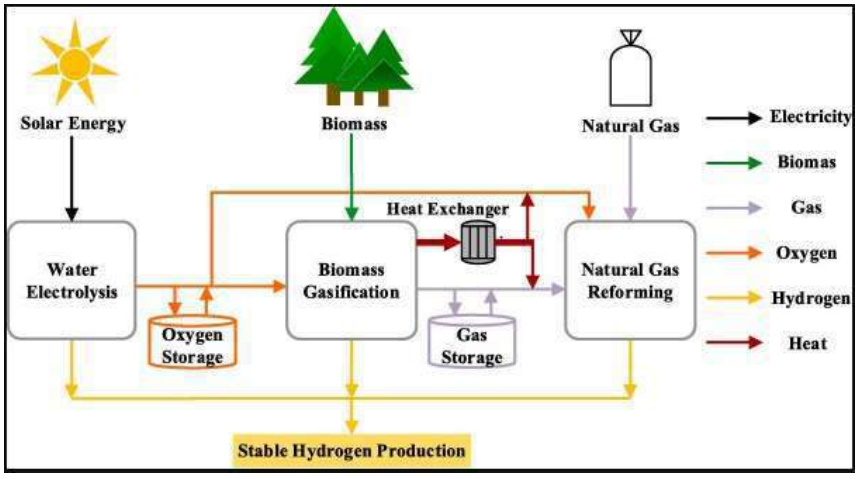
Zhu, MS. *et al.*

Optimal integration of electrolysis, gasification and reforming for stable hydrogen production

https://doi.org/ 10.1016/j.enconman.2023.117400

Abstract:

Engineering industries such as petroleum and petrochemicals have strict requirements for the stability of hydrogen supply to ensure the safety and reliability of system operations. However, relying on a single hydrogen production technology is insufficient to meet the requirements of both stable and green hydrogen. This study proposes an integrated hydrogen production system combining water electrolysis, biomass gasification, and natural gas reforming to achieve stable and green hydrogen. To capitalize on the advantages of the individual technologies, the integration among the different hydrogen production methods considers not only energy but also materials. As a by-product of water electrolysis, oxygen can create a pure oxygen atmosphere for biomass gasification and natural gas reforming, thereby considerably improving the energy conversion rate. The heated gases from the biomass gasification transport thermal energy to the natural gas reforming. Stable and maximized hydrogen production can be achieved through optimal coordination of the three hydrogen production technologies and storage devices. Optimization models are built for each component, and case studies show that the proposed integrated system exhibits energy efficiency of 64.19 %, which is 9.87 % higher than the 54.32 % efficiency of single-energy hydrogen production, and achieves a 67 % carbon emission reduction compared with the existing industrial technology. The integrated system proposed in this study provides a solution for stable hydrogen production under the broad requirement of carbon neutrality, and it will provide valuable guidance for future integrated hydrogen production system development and offer information that is of interest to operators and investors.



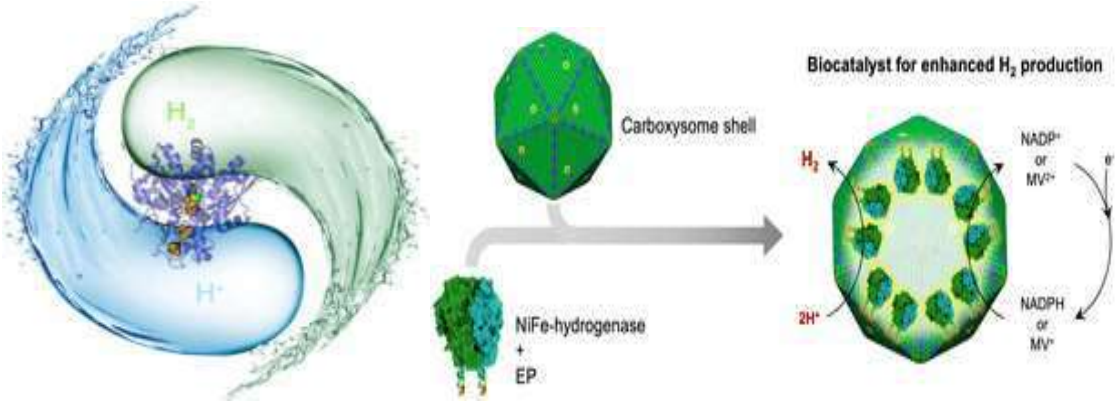
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 53
OCTOBER, 2023

Hydrogenase as the basis for green hydrogen production and utilization

Hydrogenase is a paradigm of highly efficient biocatalyst for H_2 production and utilization evolved in nature.



A dilemma is that despite the high activity and efficiency expected for hydrogenases as promising catalysts for the hydrogen economy, the poor oxygen tolerance and low yield of hydrogenases largely hinder their practical application.

Hydrogenases in Hydrogen Production and Utilization

In these years, the enigmas surrounding hydrogenases regarding their structures, oxygen tolerance, mechanisms for catalysis, redox intermediates, and proton-coupled electron transfer schemes have been gradually elucidated; the schemes, which can well couple hydrogenases with other highly efficient (in) organic and biological catalysts to build novel reactors and drive valuable reactions, make it possible for hydrogenases to find their niches.

Hydrogenases are microbial metalloenzymes capable of catalyzing the reversible interconversion between molecular hydrogen and protons with high efficiency, and have great potential in the development of new electrocatalysts for renewable fuel production. Many microorganisms have evolved special metalloenzymes, namely hydrogenases, to produce molecular hydrogen from protons and electrons using inexpensive and abundant metals. Three major phylogenetical classes of hydrogenases have been identified based on their active site metals: [Fe]-hydrogenases, [FeFe]-hydrogenases and [NiFe]-hydrogenases.

These enzymes have intrinsic limitations, such as high sensitivity to oxygen and pH and poor thermostability. To address these issues and enhance hydrogen production, many strategies have been implemented, including integrating hydrogenases into immobilization matrixes or scaffolding materials. A new hybrid catalyst has been made by sequestering [NiFe]-hydrogenase-1 from *Escherichia coli* (EcHyd-1) within the recombinant shell of the α-carboxysome from a chemoautotroph *Halothiobacillus neapolitanus*. This catalyst exhibits a substantial increase in hydrogen evolution under aerobic and anaerobic conditions compared to unencapsulated EcHyd-1 hydrogenases. Shell encapsulation results in improved oxygen tolerance and thermos stability of functional [NiFe]-hydrogenase cargos in hydrogen production.

Ji, H., Wan, L., Gao, Y., Du, P., Li, W., Luo, H., Ning, J., Zhao, Y., Wang, H., Zhang, L., & Zhang, L. (2023). Hydrogenase as the basis for green hydrogen production and utilization. *Journal of Energy Chemistry*, *85*, 348–362. https://doi.org/https://doi.org/10.1016/j.jechem.2023.06.018

Jiang, Q., Li, T., Yang, J., Aitchison, C. M., Huang, J., Chen, Y., Huang, F., Wang, Q., Cooper, A. I., & Liu, L.-N. (2023). Synthetic engineering of a new biocatalyst encapsulating [NiFe]-hydrogenases for enhanced hydrogen production. J. Mater. Chem. B, 11(12), 2684–2692. https://doi.org/10.1039/D2TB02781J

Microbiology of underground hydrogen storage

As the energy demand of the growing world population rises, we are challenged with transforming our energy system from fossil fuel towards renewable. Different types of underground hydrogen storage (UHS) can be used or considered depending on the storage period and demand.
The aim of this Research Topic is to draw attention to possible microbially induced challenges in the storage of hydrogen in the subsurface. What influence can microbiological processes have on the storage of hydrogen? What consequences can occur, what products can arise (e.g., toxic or corrosive H2S), how can the risk be reduced, and how can we model, simulate in the laboratory, or predict the potential risks?

Different microorganisms (both Bacteria and Archaea) can be present which is highlighted by all of the contributions of this Research Topic (Liu et al.; Schwab et al.; Strobel et al.; Tremosa et al.). Hydrogen is a universal energy carrier also for microbes and can be used as an electron donor by various microbial groups. In addition to a potential loss of the hydrogen (and thus economic loss), biological processes can also cause other potentially hazardous/ costly/ environmentally important consequences like H2S formation, CH4 formation, biological plugging, corrosion and can cause various geochemical reactions. The three microbial metabolisms of biggest concern are sulfate reduction, methanogenesis and acetogenesis.

Citation:

Dopffel, N., An-Stepec, B. A., de Rezende, J. R., Sousa, D. Z., & Koerdt, A. (2023). Editorial: Microbiology of underground hydrogen storage. Frontiers in Energy Research, 11. https://doi.org/10.3389/fenrg.2023.1242619

EVENTS

All-Energy Australia 2023

Date: 25-26 October 2023

Venue: MCEC, Melbourne

All-Energy Australia is the country's largest and most anticipated event in the clean energy sector's annual calendar.

All-Energy Australia is organised from RX Global All-Energy Australia will be co-located with Waste Expo Australia, offering visitors access to learn about renewable energy and waste management solutions.

At RX, they're serious about sustainability. They are founding members of the Net Zero Carbon Events pledge to make the company, shows and the wider events industry net zero. We commit to being Net Zero by 2040 and to make a 50% reduction in greenhouse gas emissions by 2030.

In 2023 they will publish their pathway to net zero, setting out a reduction strategy with key milestones for all the shows. Given the complex nature of supply chain and the emissions associated with show, it is only by working together as an industry that they will be able to reduce the impact. They are building a company of net zero heroes to take action and ensure a sustainable future. It's only by working together as a renewable energy industry that they will achieve their goals.

Link:
https://www.all-energy.com.au/

INDUSTRY NEWS

First hydrogen-fueled bus hits two counties in trial run

The green, zero-emission public transport system uses a hydrogen-fuelled bus that is currently running between Haverfordwest and Carmarthen. The 322 trial began on Tuesday, September 26, and runs on selected days until Monday, October 9. The bus is being operated with the support of Pembrokeshire and Carmarthenshire County Councils, the bus operator Taf Valley Coaches and the private hire operator, Hyppo Hydrogen Solutions. The bus is fuelled by locally produced electrolytic green hydrogen - made from renewable electricity and water - supplied by Protium from their installation at the University of South Wales Hydrogen Centre in Baglan. The H2 City Gold electric bus is provided by Caetano Bus UK with the HyQube hydrogen refueller provided by Fuel Cell Systems Ltd. The bus has an equivalent range to that of a conventional diesel vehicle and takes a similar time to refuel. It uses a refuelling point similar to the garage forecourt that we are all familiar with.



https://www.westerntelegraph.co.uk/news/23834779.first-hydrogen-fuelled-bus-hits-two-counties-trial-run/

Equinix and NUS College Explore the Viability of Hydrogen for Sustainable Power Generation

Developing alternate renewable power sources is vital to maintaining uptime for data centers, ensuring global connectivity and business continuity remain uninterrupted. Equinix, Inc., the world's digital infrastructure company, together with the Department of Electrical and Computer Engineering and Centre for Energy Research & Technology (CERT) under the College of Design and Engineering (CDE) at the National University of Singapore (NUS), today announced the results of their green hydrogen fuel technology study. Developing alternate renewable power sources is vital to maintaining uptime for data centers, ensuring global connectivity and business continuity remain uninterrupted. Equinix, Inc., the world's digital infrastructure company, together with the Department of Electrical and Computer Engineering and Centre for Energy Research & Technology (CERT) under the College of Design and Engineering (CDE) at the National University of Singapore (NUS), today announced the results of their green hydrogen fuel technology study.

https://www.siliconindia.com/news/general/equinix-and-nus-college-explore-the-viability-of-hydrogen-for-sustainable-power-generation-nid-225739-cid-1.html

World's first liquid-hydrogen electric aircraft flight

The world's first piloted flight of an electric aircraft powered by liquid hydrogen has taken place. H2FLY, the Stuttgart, Germany-based developer of hydrogen-electric powertrain systems for aircraft, today (7 Sep) announced it has successfully completed several trips. The H2FLY team say they have carried out four flights from Maribor, Slovenia, powered by liquid hydrogen as part of its flight test campaign, including one flight that lasted for over three hours. They believe the flights lay the foundation for long-range, emissions-free flight, with liquid hydrogen doubling the range of the HY4 aircraft to 1,500km, compared to using gaseous hydrogen. The flights were completed with H2FLY's piloted HY4 demonstrator aircraft, fitted with a hydrogen-electric fuel cell propulsion system and cryogenically stored liquid hydrogen that powered the aircraft. Compared with pressurised gaseous hydrogen storage (GH2), the use of liquified, cryogenic hydrogen (LH2) enables significantly lower tank weights and volume, therefore leading to increased aircraft range and useful payload. The company say: "Results of the test flights indicate that using liquid hydrogen in place of gaseous hydrogen will double the maximum range of the HY4 aircraft from 750 km to 1,500 km, marking a critical step towards the delivery of emissions-free, medium- and long-haul commercial flights."
https://omaha.com/partners/video-elephant/life-entertainment/entertainment/worlds-first-liquid-hydrogen-electric-aircraft-flight/video_439eaa77-1b66-58d0-b082-3df58de40ef2.html

https://www.legit.ng/business-economy/1555835-morocco-aims-key-player-green-hydrogen/

EVENTS

Hydrogen Technology Expo

25-26 April 2024, Hyatt Centric - Janakpuri, New Delhi

Date: 25-26 April 2024,

Venue: Hyatt Centric-Janakpuri, New Delhi

Hydrogen Technology Expo - 2024, India's only Expo on Hydrogen & Fuel Cell Technologies, in its 2nd annual edition and a must-attend exhibition and conference that is exclusively dedicated to discussing advanced technologies for the hydrogen and fuel cell industry. The event brings together the entire hydrogen value chain to focus on developing solutions and innovations for low-carbon hydrogen production, efficient storage and distribution as well as applications in a variety of stationary and mobile applications.

Link:

https://missionenergy.org/hydrogen2024/

3rd Global Hydrogen Energy Conference and Exhibition

Date: November 27-29, 2023

Venue: Melbourne Convention and Exhibition Centre, Melbourne, Australia

Link:

https://hydrogenconferenceaustralia.com/

Hystar to expand electrolyser factory as it seeks to boost hydrogen production

A company that makes electrolysers to produce hydrogen is planning to develop in Norway what will be one of the world's largest factories, in a sign of the growth of the industry. Norwegian company Hystar is planning to expand its plant in Høvik, near Oslo to a capacity of 4GW a year, up from 50MW today. Electrolysers are used to split hydrogen from water and are in growing demand as countries around the world look to start replacing fossil fuels with hydrogen. Hystar is also in talks over developing a large new factory in the US, encouraged by the support on offer for hydrogen development in the Inflation Reduction Act. The International Energy Agency estimates that about 170GW a year of global electrolyser production capacity would be required by 2030, up from an estimated stated 14GW of capacity in 2022.

https://www.ft.com/content/756c223c-0199-43e7-811c-3816bc3052e0

Hydrogen-powered drones could patrol remote stretch of I-90

Imagine a system that could provide public safety, emergency medical services, law enforcement, fire abatement and communications in one small fleet of hydrogen powered UAVs (unmanned aerial vehicles) that are able to stay in the air up to 13 hours and to be on call day or night in any weather. These drones would work as communication conduit in dead zones, infrared cameras looking for missing persons, camera video to watch in real time events up to 400 feet below them. They could carry medical supplies to the scene of an accident or parts or tools needed for an emergency. Now think of the first 33 miles of I-90 from Lookout Pass in the Mineral County during the winter, which is one of the most dangerous sections of the interstate in the nation. Arne Thompson, Managing Partner of AB Aero Partners in Seattle, is in the drone business.

https://finance.yahoo.com/news/hydrogen-powered-drones-could-patrol-035900445.html?fr=sycsrp_catchall for-Its-Hydrogen-Regional-Aircraft-Products

Electric Hydrogen is the green hydrogen industry's first unicorn

Electric Hydrogen (EH2), a Massachusetts-based green hydrogen technology company, has just become green hydrogen's first unicorn, with a $380 million Series C raise that brought its valuation up to $1 billion. That round also brought EH2's total funding to roughly $600 million, per Crunchbase data. The startup is backed by heavy hitters like Microsoft's Climate Innovation Fund, United Airlines, BP and Fortescue Metals. The funds will be used to expand production capacity of its electrolyzers, according to a spokesperson for the company. Electrolyzers are devices that use a process called electrolysis to split water (H2O) into its constituent elements, hydrogen (H2) and oxygen (O2). They are expensive and consume tons of renewable energy to make a small amount of hydrogen. EH2 says it has figured out a way to produce more hydrogen at a cheaper price.



https://sg.finance.yahoo.com/news/electric-hydrogen-green-hydrogen-industrys-213719537.html

Electric Hydrogen raises USD 380 mn in latest funding round

Hydrogen start-up Electric Hydrogen (EH2) said on Tuesday it has raised $380 million in an oversubscribed Series C financing round. The funding was led by Fortescue, Fifth Wall and Energy Impact Partners and included new investors BP Ventures, Oman Investment Authority, Temasek, Microsoft's Climate Innovation Fund, the United Airlines Sustainable Flight Fund among others. The company did not immediately respond to request for details on the valuation at which the amount was raised. EH2 has raised over USD 600 mn since its founding in 2020. Green Hydrogen is touted as the clean-energy alternative to existing fossil fuels and major corporates are investing millions in an attempt to decarbonizing their operations, fleets and factories.

https://auto.economictimes.indiatimes.com/news/industry/electric-hydrogen-raises-usd-380-mn-in-latest-funding-round/104147657

EVENTS

World Hydrogen Week

Date: 9 - 13 October 2023

Venue: Rotterdam

World Hydrogen Week [WHW] is the epicentre for innovation within the hydrogen industry, and your chance to connect with over 3,000 senior hydrogen pioneers across 5 days of premium content and unrivalled networking. Make sure you're in attendance as we accelerate hydrogen projects up to and beyond final investment decision.

Focused insights on the opportunities, markets, supply chains and end use applications within hydrogen derivatives are available at World Hydrogen Congress and World Hydrogen Intelligence Day sessions.

Link:

https://www.worldhydrogenweek.com/

Renewable Thermal Collaborative Summit



Date: October 19-20

Venue: Park Hyatt hotel, Washington, DC

Link:

https://www.renewablethermal.org/rtc-summit/

INDIA NEWS

State-run agency suggests mandatory green hydrogen norms for oil refineries

State-run Bureau of Energy Efficiency (BEE) has proposed mandatory green hydrogen norms for oil refineries, seeking to push the country's target of having an annual production of 5 million tonnes (MT) of the fuel by 2030. BEE has suggested giving refineries three years to meet green hydrogen obligations. BEE, which comes under the ministry power, serves as the nodal authority for accrediting agencies monitoring, verifying, and certifying green hydrogen production projects. BEE made the proposal during its seventh Public Advisory Committee Meeting in September.

BEE's proposal comes at a time when state-run Indian Oil Corporation (IOC) is setting up its first green hydrogen unit with a capacity of 10 KTA (thousands of tonnes per annum) at a refinery in Panipat. In August, IOC invited global tenders for setting up the unit which will utilise green hydrogen produced by using renewable power and integration of an existing network at the refinery. The new unit will have a green hydrogen generation unit of 1,250 kilogram per hour. "Nobody knows what the cost of green hydrogen is. So far, nobody has set up any plants. Unless any plant of reasonable scale is established, then only we will know about the cost. There are no specific pilot plans of reasonable size," Bakre said. Green hydrogen is considered to be key in meeting India's net-zero emission target by 2070.

https://www.business-standard.com/economy/news/bureau-of-energy-efficiency-suggests-green-hydrogen-norms-for-refineries-123100300784_1.html

Govt identifies three ports to export green hydrogen, ammonia and methanol

In order to accelerate the target of hydrogen exports, the shipping and port ministry has identified three major ports —Kandla, Paradip and Tuticorin — as hubs for green hydrogen, green ammonia and green methanol in the next seven years. Now the necessary infrastructure will be developed at these ports to facilitate storage, handling and bunkering of green hydrogen, green ammonia and their derivatives. India targets to develop capacity for exporting about 5 million tonnes per annum of green hydrogen and its derivatives by 2030. Sources said the Odisha government is in the process of allotting land around Paradip Port to manufacturers of green hydrogen and its derivatives.

The port authority plans to develop common infrastructure facilities for the green hydrogen project such as dedicating a berth to handle ammonia and other derivatives. It has requested the shipping ministry for a grant of Rs 325 crore for this purpose.

The Deendayal Port Authority (Kandla) has invited the global Expression of Interest (EOI) to assess the response of developers and market players in production, storage and sale of green hydrogen and green ammonia.

The VOCPA port of Tutocorin has earmarked 500 acres of land for development of green hydrogen hub and port authorities have sent a proposal to the government for grant and viability gap funding developing infrastructure.

Govt identifies three ports to export green hydrogen, ammonia and methanol (msn.com)

India's hydrogen demand projected at 12 mmtpa by 2030; prices expected at $2-2.5/Kg

India's hydrogen (H_2) consumption is poised to reach 12 million metric tons per annum (mmtpa) by 2030, with prices projected to be in the range of $2-2.5 per kilogram, according to a report from Emkay Global Financial Services. India's current hydrogen consumption stands at an estimated 6 mmtpa, with specific figures fluctuating between 5 and 7 mmtpa. Oil refineries account for 3.0 mmtpa of this figure, using hydrogen primarily for fuel desulfurization and the conversion to higher-value products. Another 2.5 mmtpa serves the ammonia production process, vital for urea and other fertilizer outputs. The residual consumption is distributed among the steel and chemical industries. The predominant source of hydrogen for these industries is gray hydrogen, produced from natural gas by Steam Methane Reforming which results in notable emissions.

The GoI has outlined a target for a 40% share of the anticipated 12 mmtpa demand by 2030 to be met by green hydrogen equivalent to 5 mmtpa.

The move towards green hydrogen is also seen as a strategic step to diminish India's import dependence. Presently, significant imports of commodities like natural gas, ammonia-urea, and coking coal contribute to the country's trade balance. Localized green hydrogen production offers an avenue to reduce these imports. Emkay's report further indicates potential shifts in demand from sectors beyond the primary consumers, highlighting the steel and transport sectors as possible areas of growth in hydrogen usage in the coming years.

India's hydrogen demand projected at 12mmtpa by 2030; prices expected at $2-2.5/kg, ET EnergyWorld (indiatimes.com)

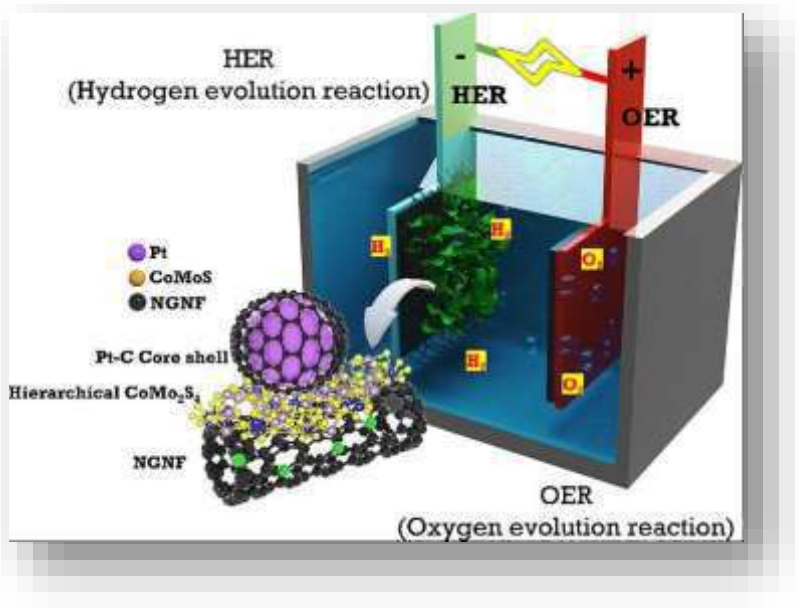
Vijayapradeep, S. *et al.*

Novel Pt-carbon core–shell decorated hierarchical CoMo2S4 as efficient electrocatalysts for alkaline/seawater hydrogen evolution reaction

https://doi.org/10.1016/j.cej.2023.145348

Abstract:

Electrochemical water electrolysis is a prominent method of green-hydrogen fuel production. Tailored nanostructures of Pt-based electrocatalysts have high priority in hydrogen production. Herein, we fabricated carbon encapsulated Pt core-shell supported CoMo2S4-NGNF as an efficient electrocatalyst for the hydrogen evolution reaction (HER). The novel carbon-encapsulated Pt core shells improved the long-term durability. The Pt@CoMo2S4-NGNF hybrids displayed overpotentials of 27 mV to achieve a current density of 10 mA cm-2 in 1.0 M KOH and outstanding durability of 100 h. When Pt@CoMo2S4-NGNF||IrO2 was employed in overall seawater electrolysis applications, it required 1.54 V to achieve a 10 mA cm-2 current density. Additionally, we evaluated the electronic structure and HER mechanism of Pt@CoMo2S4 & CoMo2S4 using density functional theory (DFT) calculations. This work illustrates the possibility of designing an effective, long-lasting, and scalable electrocatalyst for the electrolysis of alkaline and seawater to produce pure hydrogen.



Asif, M. *et al.*

Recent advances in green hydrogen production, storage and commercial-scale use via catalytic ammonia cracking

https://doi.org/10.1016/j.cej.2023.145381

Abstract:

Sustainable societal growth relies on the efficient storage, transportation, and use of renewable energies. Considerable progress has been made in sustainable hydrogen production via water electrolysis and biomass conversion, but hydrogen storage and transportation remain major challenges for commercial-scale applications. Owing to its high hydrogen content and energy density, ammonia is a promising zero-carbon energy carrier for large-scale energy storage. Therefore, the transformation of renewable hydrogen into ammonia is a promising strategy for effective hydrogen transportation and storage. Unlike the direct combustion of ammonia, which can produce NOx, catalytic cracking into nitrogen and hydrogen provides an environmentally friendly method for hydrogen regeneration. Herein, recent advances in effective ammonia decomposition via various processes, including electrochemical, photochemical, and, particularly, thermochemical routes, are summarized. In addition, hydrogen separation techniques and techno-economic analyses of the ammonia and hydrogen economy are discussed. The main objective of this review is to provide a conceptual framework for effective ammonia cracking to yield pure hydrogen as a clean fuel for developing futuristic and sustainable energy solutions.

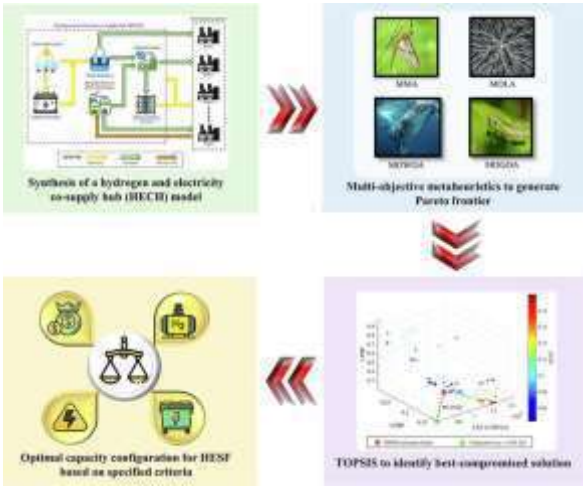
Goh, QH. *et al.*

Modelling and multi-objective optimisation of sustainable solar-biomass-based hydrogen and electricity co-supply hub using metaheuristic-TOPSIS approach

https:// 10.1016/j.enconman.2023.117484

Abstract:

The utilisation of biomass and solar energy for green hydrogen production offers potential benefits in reducing carbon emissions and enhancing energy security, aligning with global sustainability efforts. However, research is still limited in optimising hybrid renewable energy systems that leverage biomass and solar energy for a balanced co-supply of hydrogen and electricity in industrial settings. In addition, the identification of optimal capacity configurations for these systems can be challenging, due to supply-demand variations and conflicting design objectives. For the first time, we demonstrate the use of a two-stage multi-objective metaheuristic-Technique for Order of Preference by Similarity to Ideal Solutions (TOPSIS) method for the design of a solar-biomass-based hydrogen and electricity co-supply hub (HECH), based on the consideration of economic, supply stability, and waste energy generation aspects. Through a proposed case study in Felda Taib Andak, Malaysia, the best compromised solution for capacity setup is successfully determined. Among the metaheuristics screened, the TOPSIS-assisted multi-objective mayfly algorithm (MMA) provides the most preferred capacity arrangement, minimising the total annualised cost (TAC) to USD 9.43 mil. /yr and hydrogen and power supply probabilities (LHSP and LPSP) to 0.188 and 0.328, respectively. The MMA-TOPSIS approach also reduces the potential energy waste probability (PEWP) of HECH down to 0.09. The study also discusses the feasibility of battery and hydrogen storage during critical periods such as low and high biomass feed supplies. Overall, the outcomes of this research offer guidance to the engineers in optimising HECH designs, which sets the groundwork for low-carbon energy development in biomass-related industrial ecosystems.



Gado, MG. *et al.*

Potential of prospective plans in MENA countries for green hydrogen generation driven by solar and wind power sources

https://doi.org/ 10.1016/j.solener.2023.111942

Abstract:

This study is focused on exploring the potential of green hydrogen production in distinctive geographical locations in the Middle East and North Africa (MENA) by leveraging solar and wind energies. Those locations include Egypt, Morocco, and the Gulf region, as prospective hydrogen hubs. The current mathematical model has been developed using Matlab/Simulink and validated with the respective literature. Using realistic meteorological data of those cities, the hourly hydrogen yield, energetic and exergetic efficiencies have been predicted. A levelized cost of hydrogen and carbon dioxide mitigation has been examined. Besides, a holistic map of hydrogen cost depending on a widespread spectrum of solar radiation and wind speed has been developed. The results demonstrate that hydrogen production rates using solar energy are staggering compared to those using wind energy, specifically for the economic zone of Ain Sokhna in Egypt. The results reveal that Hurghada has a significant hydrogen cost of 4.4 $/kg, notably by exploiting wind energy. Using solar energy, Aswan and Salalah have a distinguished hydrogen cost of 5 $/kg, while NEOM, Hurghada, Al Maktoum, and Duqm have a hydrogen cost of 5.1 $/kg. Based on environmental perspectives, exploiting solar energy can alleviate 47.6 tons/year in Aswan, while harnessing wind resources in Hurghada mitigates 77.9 tons of annual carbon dioxide emissions.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 54
OCTOBER, 2023

Quantum technology promises green hydrogen revolution

Innovative quantum technology was unveiled recently that has potential to revolutionize green hydrogen production on a massive scale. Developed by the Green Keplerate Team at Banaras Hindu University (BHU), this innovation promises to enhance the production of green hydrogen. In a ceremony at BHU in Varanasi, Dr. Anita Gupta, the Head of The Climate Change (CC) at the Department of Science and Technology (DST) Ranjith Krishna Pai, a Scientist and Director of the CC at DST, and Prof. R. R. Sonde, chairman of the expert committee at IIT Delhi, inaugurated this pioneering technology. The event saw the presence of distinguished experts from various domains from all corners of the country.

The masterminds behind this transformative technology, Dr. Somenath Garai and S. Srikrishna presented the numerous environmentally friendly applications of Green Hydrogen and the new innovation of introducing a next-generation quantum-powered featuring a charge transfer system, and high proton availability and mobility, to drive quantum catalytic processes for energy generation.

This revolutionary technology, developed under the project titled "Boosting the H2 Economy by Harnessing the Merits of Quantum Encapsulation Chemistry:

The Hydrogen and Fuel Cell program in the Clean Energy Research Initiative is currently awaiting patent approval. The photochemical reactor's state-of-the-art design includes an integrated illumination assembly and external concave reflective panels that maximize the utilization of solar energy. The team ingeniously engineered a continuous electron-coupled proton supply system, incorporating an electron injector mechanism that utilizes industrial metal waste. After rigorous optimization, the team achieved an impressive production rate of approximately 1 liter per minute of Green Hydrogen for every 10 grams of Quantum Photocatalysts at the laboratory scale.

The high purity of the hydrogen gas produced can be used directly without the need for additional purification. This feature significantly enhances the cost-effectiveness of this revolutionary technology. This innovation opens up a wealth of possibilities, spanning various sectors, including energy production, transportation, and agriculture.

The Green Keplerate Team envisions the potential of storage-free, direct hydrogen internal combustion engine technologies and has already demonstrated its applicability in automobiles with a range of engine capacities and functionalities. This ongoing project, funded by DST, promises to bring these innovations to the forefront of the green energy revolution.



Quantum technology promises green hydrogen revolution | DD News (ddinews.gov.in)

Materials Research Directions toward a Green Hydrogen Economy: A Review

Abstract:

A constellation of technologies has been researched with an eye toward enabling a hydrogen economy. Within the research fields of hydrogen production, storage, and utilization in fuel cells, various classes of materials have been developed that target higher efficiencies and utility. This Review examines recent progress in these research fields from the years 2011–2021, exploring the most commonly occurring concepts and the materials directions important to each field. Particular attention has been given to catalyst materials that enable the green production of hydrogen from water, chemical and physical storage systems, and materials used in technical capacities within fuel cells. The quantification of publication and materials trends provides a picture of the current state of development within each node of the hydrogen economy.

https://doi.org/10.1021/acsomega.2c03996

EVENTS

New World Green Hydrogen Summit MENA 2023 – Dubai



Date: 25th – 26th October 2023

Venue: Dubai

Key Topics to be discussed:

Policies & Regulation
Emerging Technologies
Infrastructure development
Green Hydrogen Investment
Industrial Applications of GH2
Green Hydrogen in Transportation & Mobility
Navigating the GH2 Supply Chain
International Collaborations and Partnerships
GHSO 2023 is the largest Green Hydrogen event in the MENA region. Global decision makers in policy, finance, tech and industry will come together for discussions geared towards driving economies of the future and advancing energy solutions that can sustainably meet the energy demands of our growing population.

Register using this link: https://forms.office.com/pages/responsepage.aspx?id=YiutavRH2kypbLUlmVqUeNNUlvnSlvtNkJqKke9joYhUQ1ICRkJXNE5aUTVFREozRUE3WkkzU1oxUy4u

Links:

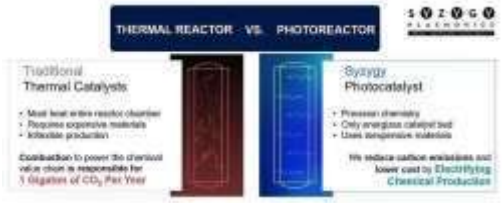
https://hydrogen-central.com/event/new-world-green-hydrogen-summit-mena-2023-dubai/

INDUSTRY NEWS

MHI Invests in Syzygy Plasmonics to Advance Hydrogen Production and CO2 Utilization

Mitsubishi Heavy Industries, Ltd. (MHI) announced that it has invested in Syzygy Plasmonics, Inc. (Syzygy), a startup company headquartered in Houston, Texas, that is developing photocatalytic technology for hydrogen production and CO2 utilization solutions. The investment has been executed through Mitsubishi Heavy Industries America, Inc. (MHIA).

By collaborating with and investing in partners with innovative technologies, MHI Group is working to build a hydrogen ecosystem and a CO2 ecosystem that can contribute to the realization of a decarbonized society. Through this investment, Mitsubishi Heavy Industries will support Syzygy's efforts to develop innovative alternative technologies that will lead to the diversification of both ecosystems.



https://www.azocleantech.com/news.aspx?newsID=34117

China's first hydrogen fuel cell ship completes maiden voyage

The hydrogen fuel cell power demonstration ship Sanxia Qingzhou 1 (Three Gorges Hydrogen Boat No 1) completed its maiden voyage at the Three Gorges Visitor Center (Wharf 9) in Yichang, Hubei province, on the morning of Oct 11, 2023, marking a breakthrough in the application of hydrogen fuel cell technology in inland vessels. It is estimated that the hydrogen powered ship is expected to save 103.16 tons of fuel oil per year and reduce carbon dioxide emissions by 343.67 metric tons compared with traditional oil-powered ships.

The hydrogen powered ship has a steel and aluminum composite structure, with a total length of 49.9 meters, a width of 10.4 meters and a depth of 3.2 meters. Its hydrogen fuel cell rated output power is 500 kilowatts, realizing an endurance of up to 200 kilometers. After delivery, the ship will be responsible for traffic, inspection, emergency and other work in the Three Gorges reservoir area and river section between the Three Gorges and Gezhou Dam.



http://www.chinadaily.com.cn/a/202310/12/WS6527650ba31090682a5e820a.html

President Biden to announce funding for a regional 'clean energy' hydrogen hub

Pa., N.J., and Del. secure funding for a "hydrogen hub" as part of the Biden administration's plan to tackle climate change. But climate activists say it's a false solution. Imagine The Mid-Atlantic Clean Hydrogen Hub (MACH2) for Southeastern Pennsylvania, South Jersey, and Delaware has secured $750 million in federal funding, according to a Reuters report. A second planned hub for western Pennsylvania, Ohio, and West Virginia, called the Appalachian Regional Clean Hydrogen Hub (ARCH2), is also on the list of projects funded by the 2021 bipartisan infrastructure bill, which included $7 billion for six to 10 hydrogen projects across the country.

https://whyy.org/articles/hydrogen-hub-pennsylvania-delaware-new-jersey-biden-administration/

EU seeks co-op with Uzbekistan in green hydrogen projects, Slovenian MFA says

Executives of the North Adriatic Hydrogen Valley project are seeking cooperation with Uzbekistan in the field of green hydrogen production, a source at Slovenian Ministry of Foreign Affairs told Trend.

The ministry noted that, the project's high-level objective is the creation of a hydrogen-based economic, social and industrial ecosystem based on the capacity of the quadruple helix actors, including science, policy, industry and society. To fulfill these objectives, the NAHV project involves a well-rooted partnership of 34 organizations (of which 2 in Hydrogen Europe, 3 in Hydrogen Europe Research), covering the transnational Central European area of 3 territories - Slovenia, Croatia and Friuli Venezia Giulia Autonomous Region in Italy, demonstrating cross-border integration of hydrogen production, distribution and consumption, and exchange.

https://en.trend.az/casia/uzbekistan/3810422.html

EVENTS

Future of Hydrogen Trade



Date: 28th November 2023

Online Conference "Future of Hydrogen Trade" will be organized on 28th of November at 11am EST by Sowa Solutions and it will take a closer look on trading part of hydrogen business.

The conference will start with giving an overview of hydrogen strategies which were adopted in USA, UK, EU, Latin America, Canada, India and China.

The overview of this strategies will be given so the audience could get a sense of how much CO2 emission is made by using a traditional grey hydrogen and how much decrease in CO2 emission will be achieved by implementing mentioned strategies.

A closer look will be taken on certification scheme which exist at the moment and what needs to be done in future as well as trade routes which exist in the world and which countries are biggest exporters or importers of green hydrogen.

Link:

https://sowasol.com/future-of-hydrogen-trade

Yamaha Buggy Unveiled With Hydrogen-Burning Combustion Engine

Scheduled to start with the first press day on October 25, the 2023 Japan Mobility Show will be more than just about cars as companies will also present other types of mobility solutions. Yamaha has announced it'll attend the event formerly known as the Tokyo Motor Show with motorcycles, scooters, and e-bikes as well as other concepts featuring more than two wheels. Pictured below, the existing YXZ1000R has been converted to run on hydrogen while keeping the internal combustion engine. It's a recreational off-highway vehicle (ROHV) serving as an attempt to maintain the benefits of an ICE but with zero emissions. Yamaha wants to "keep the unique appeal of these engines alive, such as their sound and feel when on the go, well into the future."



https://www.msn.com/en-nz/news/other/yamaha-buggy-unveiled-with-hydrogen-burning-combustion-engine/ar-AA1i1QaD

Consortium runs world's first hydrogen-powered gas turbine

Paris: A European consortium said it had in a world first successfully tested a gas turbine fully powered by hydrogen, opening the way to slashing carbon emissions in energy-intensive industries like cement. Hydrogen has been touted as a potential alternative to the polluting fossil fuels primarily responsible for the greenhouse gas emissions warming the planet. But technical challenges, high costs and a lack of infrastructure have hampered its development, while the amount of emissions it saves has generated debate depending on the production methods.

Consortium runs world's first hydrogen-powered gas turbine, Energy News, ET EnergyWorld (indiatimes.com)

Middle East's first Hydrogen Train to begin trail run this week!

Prince Abdulaziz bin Salman, Saudi Arabia's Minister for Energy, announced on Sunday that the Middle East's inaugural hydrogen train will commence trial runs this week, a Reuters report said. Addressing the UN MENA Climate Week in Riyadh, he said, "It will be on trial for the next week, and hopefully for the next few months, marking the debut of the first hydrogen train in the Middle East."



https://www.financialexpress.com/business/infrastructure-middle-easts-first-hydrogen-train-to-begin-trail-run-this-week-all-you-need-to-know-3266684/

First-of-its-kind hydrogen stand-alone power system

With funding from the Department of Energy, Environment and Climate Action (DEECA) Victoria, Boundary Power has developed a relocatable, hydrogen integrated stand-alone power system (HiSAPS).

On 9 October 2023, the Victorian Minister for Climate Action, Energy and Resources, Lily D'Ambrosio, visited the Ampcontrol manufacturing site in Ringwood to see the demonstration unit in action, powering the internal lighting of the LED manufacturing facility.

Stand-alone power systems are designed to generate electricity through solar PV and batteries, using a back-up diesel generator during poor weather conditions. As part of the drive towards net zero, non-carbon emitting forms of back-up power, such as green hydrogen, are needed.



https://www.energymagazine.com.au/first-of-its-kind-hydrogen-stand-alone-power-system/

EVENTS

HYDROGEN TECHNOLOGY EXPO - 2024



CONFERENCE + EXPO

25 – 26 April 2024, Hyatt Centric - New Delhi

HYDROGEN TECHNOLOGY EXPO - 2024, in its 2nd annual edition and a must-attend exhibition and conference that is exclusively dedicated to discussing advanced technologies for the hydrogen and fuel cell industry. The event brings together the entire hydrogen value chain to focus on developing solutions and innovations for low-carbon hydrogen production, efficient storage and distribution as well as applications in a variety of stationary and mobile applications.

More than 60+ exhibitors, 25+ speakers and over 1,000+ attendees will come together to discuss, and see, the latest technologies and engineering solutions, advanced materials, manufacturing equipment, infrastructure, as well as test and evaluation tools and services to finally commercialize hydrogen as a mainstream provider of clean, renewable energy.

Register - https://missionenergy.org/hydrogen2024/

Govt releases roadmap for national green hydrogen mission

The new and renewable energy ministry has unveiled a R&D roadmap for the "National Green Hydrogen Mission", which seeks to provide guidance for developing a vibrant research and development ecosystem which can help commercialise green hydrogen and contribute to India's ambitious climate and energy goals.

It focusses on developing new materials, technologies, and infrastructure to improve the efficiency, reliability, and cost-effectiveness of green hydrogen production, storage, and transportation.

The roadmap was unveiled on October 7 by the Ministry of New and Renewable Energy to commemorate the World Hydrogen and Fuel Cell Day, which is observed annually on October 8.



https://auto.economictimes.indiatimes.com/news/industry/govt-releases-roadmap-for-national-green-hydrogen-mission/104275424

India and Saudi Arabia Ink MoU for Green Hydrogen Development On World Hydrogen Day

India and Saudi Arabia signed a MoU in Riyadh on Sunday afternoon in the fields of Electrical Interconnections, Green / Clean Hydrogen and Supply Chains. This MoU aims to establish a general framework for cooperation between the two countries in the field of electrical interconnection; exchange of electricity during peak times and emergencies; co-development of projects; co-production of green/clean hydrogen and renewable energy; and also establishing secure, reliable and resilient supply chains of materials used in green/clean hydrogen and the renewable energy sector.

https://www.timesnownews.com/auto/india-and-saudi-arabia-ink-mou-for-green-hydrogen-development-on-world-hydrogen-day-article-104292013

Oil India plans green hydrogen valley foray, eyes geothermal exploration

Describing Oil India Ltd (OIL) as an integrated energy company, its chairman and managing director (CMD) Ranjit Rath said that the company is looking at investing in a range of clean energy sectors and is planning to set up green hydrogen valleys along with exploring the geothermal potential in Himachal Pradesh. In an interview to Mint, OIL CMD Ranjit Rath said that company has partnered with IIT Guwahati to set up a green hydrogen valley in the northeast and is in talks with IIT Bhubaneshwar for another such project in Odisha. He also said that in its conventional exploration and production (E&P) business the company is now eyeing deeper drilling and exploration with plans to reach 6,500 metres. And this includes, out efforts in terms of bioethanol, that is 2G ethanol. Our efforts to reduce gas flaring by creating infrastructure for evacuation of natural gas. And feeding it to the northeast gas grid and the national gas grid. This also includes displacing the diesel component in our operational area by natural gas.

https://www.livemint.com/news/india/oil-india-plans-green-hydrogen-valley-foray-eyes-geothermal-exploration-11696621371359.html

India-EU-TTC seek ways of collaboration between India and EU on green hydrogen

The India-European Union (EU) Trade & Technology Council (TTC) Working Group 2 (WG2) convened a two-day international workshop on “Green & Clean Energy Technologies” during October 10-11, 2023. The workshop was organized Ministry of New and Renewable Energy (MNRE).

India-EU-TTC is strategic coordination and engagement on trade and technology between India and Europe. It was formally announced on 25 April 2022 after the bilateral cooperation meeting between Prime Minister Narendra Modi and the President of the European Commission Ursula von der Leyen. Within the framework of the TTC, three working groups have been set up.

Session stressed on the need for a harmonized method to address plastic litter. It proposed developing standards for specific technologies under each of the thematic topics.

India-EU-TTC seek ways of collaboration between India and EU on green hydrogen | DD News

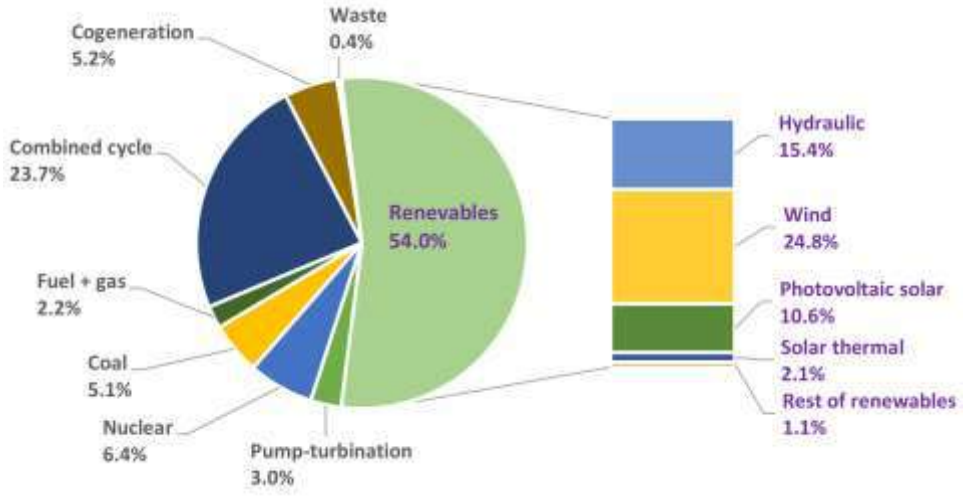
Laura M. Valle-Falcones, Carlos Grima-Olmedo, Luis F. Mazadiego-Martínez, Antonio Hurtado-Bezos,Sonsoles Eguilior-Díaz and Ramón Rodríguez-Pons

https://doi.org/10.3390/app12126081

Green Hydrogen Storage in an Underground Cavern: A Case Study in Salt Diapir of Spain

Abstract:

The Poza de la Sal diapir is a closed circular depression with Cretaceous Mesozoic materials, formed by gypsum, Keuper clays, and a large extension of salt in the center with intercalations of ophite. The low seismic activity of the area, the reduced permeability and porosity of the salt caverns, and the proximity to the Páramo de Poza wind park, make it a suitable place for the construction of a facility for underground storage of green hydrogen obtained from surplus wind power. The design of a cavern for hydrogen storage at a depth of 1000 m takes into account the differences in stresses, temperatures, and confining pressures involved in the salt deformation process. During the 8 months of the injection phase, 23.0 GWh can be stored in the form of hydrogen obtained from the wind energy surplus, to be used later in the extraction phase. The injection and extraction ratio must be developed under the conditions of geomechanical safety of the cavity, so as to minimize the risks to the environment and people, by conditioning the gas pressure inside the cavity to remain within a given range.



Mohammad Younas, Mashallah Rezakazemi, Muhammad Saddique Arbab, Jehangir Shah, Waheed Ur Rehman

https://doi.org/10.1016/j.ijhydene.2022.01.184

Green hydrogen storage and delivery: Utilizing highly active homogeneous and heterogeneous catalysts for formic acid dehydrogenation

Abstract:

Significant technological revolution which allows the use of hydrogen as an efficient energy carrier and mitigates the use of fossil fuels is a crucial need of the day. Much attention has been paid to cope with the recent, reversible, and sustainable hydrogen storage technologies. Among recent strategies, formic acid (FA) has been marked as an efficient liquid chemical for hydrogen storage. The liquid organic hydrogen carriers are based on some vital characteristics that particularly reduce toxicity and consist of maximum hydrogen with efficient recyclability. This review summarizes the recent reports, studies, and investigations concerning the hydrogen production from dehydrogenation of FA, which is almost free of carbon monoxide and is considered as an excellent material in fuel cell (FC) technology. A comprehensive critical review is carried out to link the latest research progress for subsequent achievements and to investigate both the homogeneous and heterogeneous catalysts. Among these catalysts, the main focus is on precious and non-precious metals that have been progressively increased during the past decade. Furthermore, the recent developments in the generation of high-pressure hydrogen gas and its practical applications have been highlighted for better understanding.

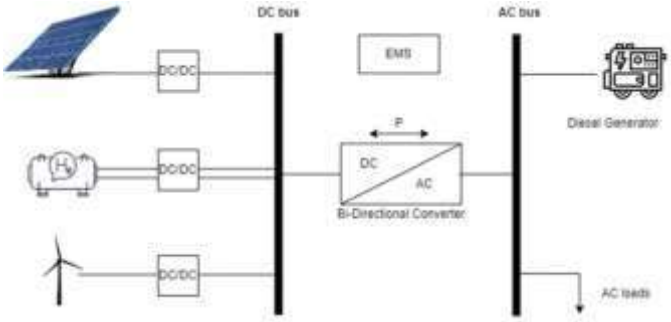
Rawan A. Abdelsalam; Youssef S. Abdallah; Nour M. Shabar; Omar A. Afifi; Mostafa H. Fouda; Amgad A. El-Deib

https://doi.org/10.1109/CPERE56564.2023.10119587

Energy Management and Techno-Economic Optimization of an Isolated Hybrid AC/DC Microgrid with Green Hydrogen Storage System

Abstract:

This paper proposes a hybrid AC/DC microgrid consisting of Photovoltaics (PV) panels, wind turbines (WT), a diesel generator (DG), and a hydrogen storage system. An energy management system (EMS) algorithm using MATLAB and Simulink was designed to efficiently manage equipment in the Hybrid Microgrid with aim of maximizing the contribution of renewable sources and minimizing the operation of the diesel generator. A sensitivity analysis of the installed capacity for both PV and Wind was performed and it was found that the optimum ratings were 300 kW, and 200 kW for the PV and Wind respectively. The optimum size of the tank to achieve the minimum levelized cost of electricity (LCOE) was determined to be 40 kg of stored H2, this would achieve an LCOE of 1.565EGP/kWh which is lower than the LCOE of 2.213EGP/kWh in case the load is completely dependent on the diesel generator. The optimum ratings of the electrolyzer, fuel cell, and diesel generator were found to be 150 kW,100 kW, and 250 kW respectively. In addition, a sensitivity analysis was carried out for different parameters of the system such as project discount rate and annual increase rate in fuel price. Moreover, the carbon dioxide (CO2) emissions of the load on the diesel generator alone and the micro-grid are 9.187× 105 kg/ year and 2.557×105 kg/ year respectively. Using the proposed sizing of the micro-grid leads to a decrease in emissions by around 72.44 % per year.



Amir Reza Razmi, Amir Reza Hanifi, Mahdi Shahbakhti

https://doi.org/10.1016/j.renene.2023.118996

Design, thermodynamic, and economic analyses of a green hydrogen storage concept based on solid oxide electrolyzer/fuel cells and heliostat solar field

Abstract:

Green hydrogen production is facing challenges in balancing economic feasibility with sustainability. Employing efficient hydrogen production designs and benefiting from the potential of hydrogen storage provide two promising strategies to mitigate the economic constraints associated with green hydrogen production. This paper proposes a novel hybrid design for green hydrogen production/utilization based on efficient high-temperature units, including heliostat solar field, solid oxide electrolyzer cell (SOEC), and solid oxide fuel cell (SOFC). The proposed system is comprehensively investigated from thermodynamic and economic perspectives, along with conducting a case study based on hourly electricity prices and actual solar data. The system demonstrates a hydrogen production rate of 7.76 ton/day using the SOEC and a power generation of 54.3 MWh in the SOFC for peak demand shaving, yielding an overall round trip efficiency of 74.2%. The case study results indicate that the economic feasibility is significantly compromised if all the produced hydrogen is sold at prices below 2.75 $/kg; while, implementation of hydrogen storage for peak shaving can yield a promising payback period of less than 2 years. The hydrogen and hourly electricity prices, along with the duration of peak times, are the other critical factors that affect economic viability.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY

ISSUE: 55
OCTOBER, 2023

Catalyst with 7.9x Higher Activity for Hydrogen Production

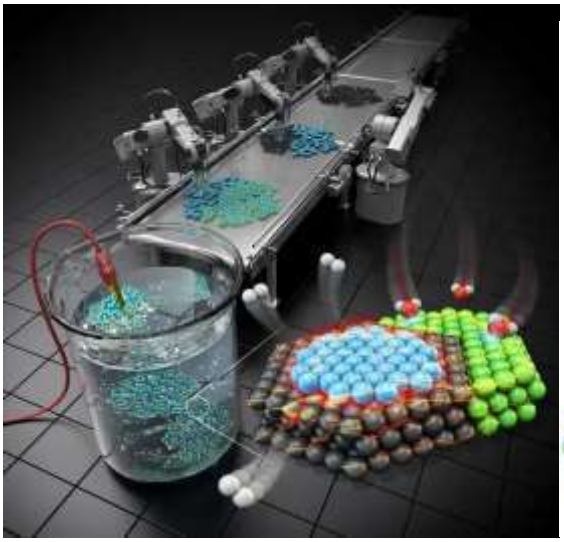
Innovative Researchers have developed an advanced platinum nanocatalyst that significantly improves hydrogen production efficiency. This breakthrough hybrid catalyst showcased enhanced activity and stability, with potential applications for hydrogen-powered vehicles.

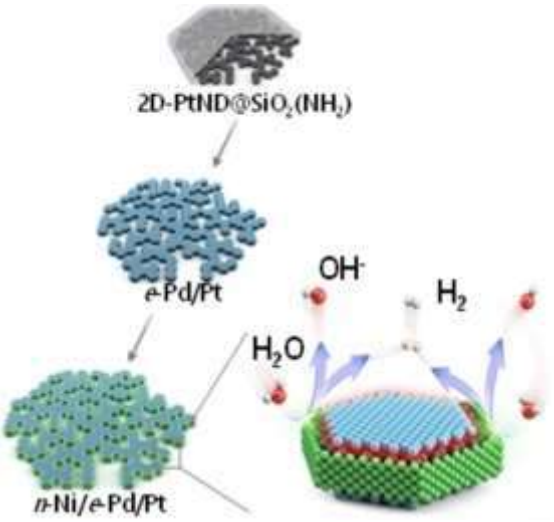
According to data from the Ministry of Land, Infrastructure, and Transport of Korea, there were approximately 30,000 hydrogen-powered vehicles registered by 2022, representing a threefold increase compared to 2018. However, the country only has 135 hydrogen fueling stations.

For hydrogen to be more accessible for vehicles and to be recognized as a reliable energy alternative, it's essential to bring down the production costs of hydrogen, ensuring it's economically viable. Central to this objective is optimizing the efficiency of the electrolysis-hydrogen evolution process, which produces hydrogen from water.

Breakthrough in Hydrogen Production

Recently, a team of researchers comprising Professor In Su Lee, Research Professor Soumen Dutta, and Byeong Su Gu from the Department of Chemistry at Pohang University of Science and Technology (POSTECH) achieved a significant improvement in the production efficiency of hydrogen, a green energy source, through the development of a platinum nanocatalyst. They accomplished this feat by depositing two different metals in a stepwise manner. The findings of their research were published in Angewandte Chemie, the esteemed journal that focuses on the field of chemistry.





Green Energy Breakthrough: Scientists Develop Catalyst With 7.9x Higher Activity for Hydrogen Production (scitechdaily.com)

Harmonious Heterointerfaces Formed on 2D-Pt Nanodendrites by Facet-Respective Stepwise Metal Deposition for Enhanced Hydrogen Evolution Reaction

Abstract:
The performance of nanocrystal (NC) catalysts could be maximized by introducing rationally designed heterointerfaces formed by the facet- and spatio-specific modification with other materials of desired size and thickness. However, such heterointerfaces are limited in scope and synthetically challenging. Herein, we applied a wet chemistry method to tunably deposit Pd and Ni on the available surfaces of porous 2D−Pt nanodendrites (NDs). Using 2D silica nanoreactors to house the 2D-PtND, an 0.5-nm-thick epitaxial Pd or Ni layer (e-Pd or e-Ni) was exclusively formed on the flat {110} surface of 2D−Pt, while a non-epitaxial Pd or Ni layer (n-Pd or n-Ni) was typically deposited at the {111/100} edge in absence of nanoreactor. Notably, these differently located Pd/Pt and Ni/Pt heterointerfaces experienced distinct electronic effect to influence unequally in electrocatalytic synergy for hydrogen evolution reaction (HER). For instance, an enhanced H2 generation on the Pt{110} facet with 2D-2D interfaced e-Pd deposition and faster water dissociation on the edge-located n-Ni overpowered their facet-located counterparts in respective HER catalysis. Therefore, a feasible assembling of the valuable heterointerfaces in the optimal 2D n-Ni/e-Pd/Pt catalyst overcame the sluggish alkaline HER kinetics, with a catalytic activity 7.9 times higher than that of commercial Pt/C.

https://doi.org/10.1002/anie.202307816

EVENTS

Future Of Utilities: Smart Energy





Date: 8 – 9 November, 2023

Venue: London

About the Conference:

Plenty of networking:

1. Every major UK energy company
2. Dedicated networking breaks
3. An electric after party
4. AI-powered app

Impactful, problem-solving sessions: With keynotes, panels, case studies and roundtables, key takeaways at Future of Utilities: Smart Energy will be frequent, engaging and digestible.

Inspirational speaker line-up: Hear first-hand from C-Suite speakers with the likes of OVO, UK Power Networks, and National Grid taking prominent keynotes throughout a packed agenda.

Board-level hot topics:

1. Choose from 3 stages
2. Sessions designed following comprehensive research with senior energy executives.

Link:

https://futureofutilities.com/events/smart-energy/

INDUSTRY NEWS

OMCs to prepare joint roadmap on green hydrogen push, to tap cleaner fuel

Oil-marketing companies (OMCs) may soon submit a joint road map for the adoption of green hydrogen to accelerate their energy transition plans, officials said.

The Ministry of Petroleum and Natural Gas Ministry has asked OMCs to submit a detailed plan to increasingly adopt green hydrogen and provide a leg-up to their energy transition plans, the officials said.

Public-sector undertakings (PSUs) under the ministry target to produce more than 1 million tonnes (mt) of green hydrogen by 2030.

"The ministry has been meeting OMCs to ensure ways to boost green hydrogen production in the country. A joint road map will not only ensure better coordination in mapping demand but also enable OMCs to help each other in technical assistance," the official said.

In August, IOCL invited global tenders to establish its first green hydrogen generation plant at the Panipat refinery. At 10 KTA (thousands tonnes per annum) capacity, the project is envisaged to be created over the next 30 months.

Indian Oil Corporation Limited (IOCL) is testing hydrogen-enriched natural gas, or HENG, to be carried in natural gas pipelines. In theory, the two can be mixed in any proportion, but typically, HENG in the range of 10 per cent to 20 per cent hydrogen by volume represents the most-promising near-term option. IOCL plans to mix the green hydrogen produced with grey hydrogen that is produced during naptha or natural gas for captive purposes in secondary processing units.

Meanwhile, Bharat Petroleum Corporation Limited is setting up a 20-megawatt green hydrogen unit at its refinery in Bina, Madhya Pradesh, to meet its captive hydrogen requirements.

Hindustan Petroleum Corporation (HPCL) is reportedly setting up a 370 mtpa green hydrogen plant at its Visakhapatnam refinery in Andhra Pradesh.

In July, Petroleum Minister Hardeep Singh Puri had said the PSUs had not restricted themselves to activities only within India. Case in point, a consortium of HPCL and green energy provider ACME has submitted bids in response to green hydrogen/ammonia-related tenders in Germany and Oman.

OMCs to prepare joint roadmap on green hydrogen push, to tap cleaner fuel (business-standard.com)

We have already tied up with electrolyser suppliers for our planned 1,000 MW green hydrogen plants: Mohit Bhargava, CEO, NTPC-REL



Green Hydrogen blending is one good option to give green hydrogen a boost in India, NTPC Renewable Energy's Chief Executive Officer, Mohit Bhargava told *ETEnergyWorld* in an exclusive interview. NTPC-REL has an ongoing pilot project in Ladakh for green hydrogen mobility. Bus trial runs are completed in the hydrogen mobility pilot project in Ladakh. The green hydrogen facility for production and dispensation is under construction and will be done by November this year. The target is to do 1.5 GW of renewable energy capacity this year and our capital expenditure will be about Rs 10,000 crore. This capex amount includes ongoing and also pipeline projects for next year.

Out of this 1.5 GW, largely the capacity will be for solar energy. About 150 MW is for wind projects and the rest is all solar. The wind capacity is a part of hybrid projects only.

Blending is a good option to give green hydrogen a boost in India but it still has some technical aspects which is why we are going step-by-step like in our CGD blending project in Kawas. The blending will go up to 20 per cent. Hydrogen transportation is a big challenge. The usage of hydrogen for a common person at a retail level is not much as of now. It will be by 2028 or 2030 that we will see large-scale usage of green hydrogen.

Out of the target of 60 GW capacity, it is working on a pipeline of 20 GW of renewable energy projects. Of this, 3.3 GW is operational, and over 7 GW is under-construction. There is a hope to place orders for the balance 10 GW also in the next 10-12 months. The aim for a large part to be operational is 2026.

We have already tied up with electrolyser suppliers for our planned 1,000 MW green hydrogen plants: Mohit Bhargava, CEO, NTPC-REL, ET EnergyWorld (indiatimes.com)

EVENTS

CARBON ZERO CONFERENCE ASIA

Date: November, 2023 | Friday

Venue: Pride Plaza | New Delhi

The Asia-Pacific region produced 17.74 billion metric tons of carbon dioxide emissions in 2021.
India is the 2nd largest producer of carbon emissions whereas it stood 3rd in the global standings. C0CA will emphasize on the best practices, challenges, issues and strategy adopted in providing the best carbon emissions reductions and net zero goal.

Key Topics:



The latest strategies and practices by CCUs
Updates on national and global policy that could decarbonize ASIA
Roadmap 2025 - What's shaping ecosystems for net zero
Impact on manufacturing, services and sustainable living
Future of markets and market expectations
Role in the environment
How the evolving COVID-19 pandemic has affected the industry in multiple ways.

Link:

https://coca.apic.co.in/

MCSA welcomes launch of pilot hydrogen vehicle project

As countries around the world reduce their environmental footprint by reducing greenhouse gas emissions and address climate change concerns, green hydrogen is a vital component in the shift towards green energy sources.
For South Africa, which is the largest supplier of platinum group metals (PGMs), the use of green hydrogen in the auto sector is an important development that could generate demand of up to 5 Moz of PGMs a year if fuel cells are used in 10% of the global car market. This will underpin job security for the 175,000 people employed in the PGM mining sector. South Africa's production of PGMs in 2022 amounted to 269.5 tonnes, 5.5% lower than the 285.3 tonnes recorded in 2021. Export volumes for the entire basket of the six metals that comprise PGMs fell by nearly 13% to 230.7 tonnes in 2022 from 264.6 tonnes the year before. Local sales volumes were 15.7 tonnes in 2022, a 24% increase from 12.6 tonnes in 2021.
For South Africa's PGM sector, the green hydrogen economy provides a critical market for their metals to continue playing an important role in greening the economy. The Council and its members are engaged in the early stages of a project to understand the role the local mining industry can play in South Africa's nascent green hydrogen economy and to encourage the use of PGMs. The project between Anglo American Platinum, BMW and Sasol is an important development for the industry as the hydrogen fuel cell powered BMW iX5 performs in real-world conditions. Anglo American Platinum provides the PGMs used to make hydrogen and convert it to electricity. Sasol will provide the mobile refuelling system.
This project comes soon after the launch of the world's largest mine haul truck with a 290-tonne payload by Anglo American at the Mogalakwena platinum mine in Limpopo. Sasol produced its first green hydrogen at its Sasolburg facility in June. Green hydrogen, which is created from renewable energy sources, is a source of electricity for use in fuel cells to power heavy duty transport, aviation, shipping as well as industrial processes in making steel, cement, and chemicals. Green hydrogen can play a major role in South Africa's economy and its transition to cleaner energy sources.

MCSA welcomes launch of pilot hydrogen vehicle project (miningreview.com)

Biden to announce seven new hydrogen hubs to drive green energy ahead of 2024 elections



President Joe Biden is set to announce the establishment of seven new 'hydrogen hubs' across the United States, as part of a broader strategy to bolster the economy through green energy initiatives in preparation for the 2024 election, according to Reuters.
The President will make this announcement in Philadelphia, revealing the selected regions that secured $7 billion in funding following a competitive bidding process aimed at promoting the production of clean hydrogen fuel.
These regions include some in pivotal electoral battleground states.
The primary objective of these hydrogen hubs is to put the US on a path to produce 50 million metric tons of clean hydrogen fuel by 2050.
According to the White House, this plan is expected to yield "tens of thousands of high-quality jobs, enhance the country's energy security, and address the pressing climate crisis."
These hydrogen hubs are planned for strategic locations across the country, including California, Texas, the U.S. East Coast, the Midwest, the Pacific Northwest, the Appalachian mountain region in the northeast, as well as the northern states of Minnesota, North Dakota, and South Dakota.
This hydrogen hub initiative is a component of President Biden's broader $370 billion Inflation Reduction Act (IRA), which offers substantial subsidies to support clean energy technologies.
As part of this effort, President Biden has made a commitment to expand production capacity for low- and zero-carbon emission sources, often referred to as 'blue' and 'green' hydrogen.

Biden to announce seven new hydrogen hubs to drive green energy ahead of 2024 elections (msn.com)

EVENTS

India Energy Conclave 2023

Theme: Global Energy Transition Trends: Sustainable Energy Options For India – Target Carbon Neutral – 2070

Date: 23rd -24th November 2023

Venue: Scope Convention Centre, Lodhi Road, New Delhi, India

Energy is vital for development, economic growth and wellbeing of mankind. It is one of the major drivers of any growing economy like India and is an essential building block of economic development. Availability, affordability and security of supply of energy besides creation of adequate infrastructure to serve everyone in the country are the challenges for India for sustainable growth.

Several studies & scenarios on possible future energy transition trends suggest that by 2050 contribution of fossil fuel and renewable energy sources in primary energy mix would be about 50:50. Over 190 countries, NGO's, international organizations under the support of United Nations have deliberated and suggested action plan under COP15 and COP26 for countries and companies to follow.

Link:

https://energyconclave.in/

THDCIL and IIT-Delhi Sign MoU to Advance Green Hydrogen, Recycling, and EV Research

THDC India Limited (THDCIL), a central public sector enterprise, and IIT Delhi have agreed to collaborate on research and development in areas such as electric car batteries, green hydrogen, geothermal technologies, and waste management and recycling. The institution said that the country's biggest power producer, THDCIL, will collaborate with IIT Delhi to undertake research studies, pilot projects, and consultancy engagements headed by academic members.

The MoU was signed last week by S. K. Chauhan, HoD (RD) from THDCIL, and Prof. Naresh

Bhatnagar, Dean (RD), IIT Delhi. The deal will be in effect for five years. According to the institute, these collaborative efforts will cover a wide range of research domains, including but not limited to energy conservation, alternatives to lithium-ion storage batteries, nanotechnology for electric vehicle batteries, green hydrogen, geothermal technology, climate change issues, waste management/recycling, water management/conservation, vortex-induced vibrations, tunneling techniques, biofuels, grid stability improvements, and various other topics.

"THDCIL has committed to providing comprehensive financial support for operational expenses and the cost of research and development activities. This support will empower IIT Delhi to continuously undertake RD projects on mutually agreed terms, cementing their role as a knowledge partner in collaborative research efforts", Vishnoi said. According to the agreement, IIT Delhi will provide critical infrastructure assistance and access to scientific, engineering, and technological skills. These tools will be critical in supporting RD efforts that are aligned with the institute's academic interests. According to the statement, this involvement is targeted at both fundamental and translational research answers. Furthermore, the institution will incorporate additional faculty members from important areas and efficiently promote joint activities. (ANI)

https://www.businessoutreach.in/thdcil-and-iit-delhi/

India to investment Rs 36.6 lakh crore in green infra in FY24-30 period: CRISIL

India's infrastructure spending is on the rise, including that on green infrastructure. A new report by CRISIL states that India will spend nearly Rs 143 lakh crore on infrastructure in seven fiscals through 2030. This is more than twice the Rs 67 lakh crore spent in the previous seven from financial year 2016-17 (FY17). And of the total Rs 143 lakh crore, around Rs 36.6 lakh crore will be green investments. Interestingly, there is a rise of 5x in green investments compared with FY17-23. And the investments in the green space in India will be led by renewable energy (Rs 30.3 lakh crore), followed by transportation (Rs 6.3 lakh crore). Prominent sectors such as roads and power are expected to remain major contributors, while relatively nascent ones such as EVs, solar, wind, and hydrogen will pick up pace.

The share of renewable energy in total capacity is estimated to grow 4x between fiscals 2023 and 2030. Solar will account for half of the incremental non-fossil generation. There is a growing need to leverage emerging technologies such as 'floatovoltaics' (floating solar), offshore wind technology and green hydrogen.

The hydrogen sector is poised to attract substantial investments, estimated at Rs 1.5 lakh crore between FY24 and FY30, driven by government incentive schemes. Mandates for green hydrogen use and incentive schemes will be important here considering the cost of production of green hydrogen is twice that of fossil-based hydrogen.

"CRISIL expects India's gross domestic product to grow at an average 6.7 per cent through [FY31] to be the fastest-expanding large economy. Per capita income is seen rising from $2,500 now to $4,500 by [FY31], creating a middle-income country. This growth will be underpinned by massive all-round infrastructure development, with sharp focus on integrating sustainability," says Amish Mehta, Managing Director & CEO, CRISIL Ltd.

CRISIL has also launched CRISIL InfraInvex, which incorporates environmental sustainability in the index framework to reflect its increasing importance in investment decisions. It highlights the massive funding need that can be met through accelerated bond market activity, greater foreign investment interest and robust equity markets. The share of EVs in India's overall automobile sales is likely to reach around 30 per cent by 2030.

India to investment Rs 36.6 lakh crore in green infra in FY24-30 period: CRISIL (msn.com)

Meda, US (Meda, Ujwal Shreenag); Rajyaguru, YV (Rajyaguru, Yashesh Vijay); Pandey, A (Pandey, Aditi)

https://doi.org/10.1016/j.ijhydene.2023.03.430

Generation of green hydrogen using self-sustained regenerative fuel cells: Opportunities and challenges

Abstract:

The ever-increasing energy demand, depleting fossil fuel reserves, and rising temperatures due to greenhouse gas emissions have necessitated the transition towards the generation of green and clean energy through renewable energy sources. Solar energy is one such renewable energy source that has received significant attention owing to its abundance and inexhaustibility. However, solar energy alone cannot replace fossil fuels in the energy portfolio. There exists a need to develop another clean energy source that can potentially act as an alternative to conventional fuels. Hydrogen proves to be an ideal candidate in this domain and can be sustainably generated by water electrolysis by powering the electrolyzer using solar energy. The hydrogen thus synthesized has net zero carbon emissions and is a suitable asset for decarbonizing the environment. This review encompasses the generation of hydrogen using PV-Electrolyzer systems and addresses the challenges associated with the same. Overcoming these drawbacks can ensure a strong position for hydrogen as an alternative fuel in the energy infrastructure. By employing electrolyzers that are fueled by renewable energy and then using that hydrogen to feed a fuel cell, this study aims to clarify the potential and constraints of producing green hydrogen.

Egeland-Eriksen, T (Egeland-Eriksen, Torbjorn); Flatga, J (Flatga, Jonas) ; Ulleberg, O (Ulleberg, Oystein); Sartori, S (Sartori, Sabrina)

https://doi.org/10.1016/j.ijhydene.2023.03.471

Simulating offshore hydrogen production via PEM electrolysis using real power production data from a 2.3 MW floating offshore wind turbine

Abstract:

This work presents simulation results from a system where offshore wind power is used to produce hydrogen via electrolysis. Real-world data from a 2.3 MW floating offshore wind turbine and electricity price data from Nord Pool were used as input to a novel electrolyzer model. Data from five 31-day periods were combined with six system designs, and hydrogen production, system efficiency, and production cost were estimated. A comparison of the overall system performance shows that the hydrogen production and cost can vary by up to a factor of three between the cases. This illustrates the uncertainty related to the hydrogen production and profitability of these systems. The highest hydrogen production achieved in a 31-day period was 17 242 kg using a 1.852 MW electrolyzer (i.e., utilization factor of approximately 68%), the lowest hydrogen production cost was 4.53 $/kg H2, and the system efficiency was in the range 56.1-56.9% in all cases.

Frisch, ML (Frisch, Marvin L.); Thanh, TN (Thanh, Trung Ngo); Arinchtein, A (Arinchtein, Aleks); Hager, L (Hager, Linus); Schmidt, J (Schmidt, Johannes); Brückner, S (Brueckner, Sven); Kerres, J (Kerres, Jochen); Strasser, P (Strasser, Peter)

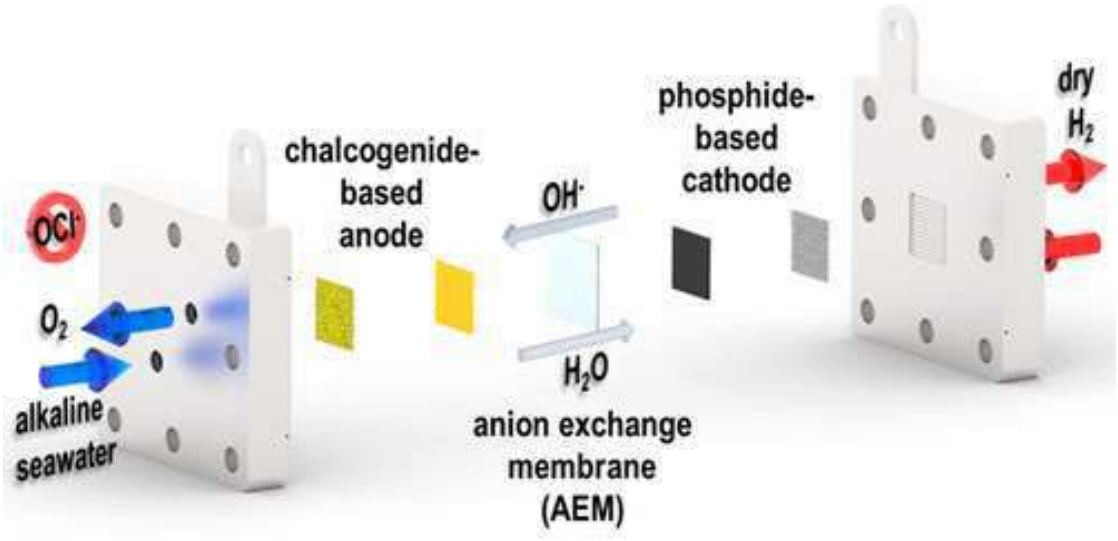
https://doi.org/10.1021/acsenergylett.3c00492

Seawater Electrolysis Using All-PGM-Free Catalysts and Cell Components in an Asymmetric Feed

Abstract:

In arid coastal zones, direct seawater electrolysis appears particularly intriguing for green hydrogen production.

State of-the-art direct seawater electrolyzers, however, show unsatisfactory performance and rely on large amounts of platinum - group metals (PGMs) in the electrodes or hidden as transport layer coatings. Herein, we report an asymmetric-feed electrolyzer design, in which all cell components consist of PGM - free materials. Cobalt- and nickel- based phosphides/chalcogenides not only serve as active and robust electrocatalysts but also are put forth as porous transport layer (PTL) surface coatings enhancing selective seawater splitting performance. In a systematic design study at the single-cell level, we report the integration of our catalysts and PTLs into a membrane-electrode assembly (MEA) using a customized, terphenyl-based anion-exchange membrane (AEM). The presented entirely PGM-free electrolyzer achieves industrially relevant current densities of up to 1.0 A cm(-2) below 2.0 V-cell in standardized alkaline seawater and dry cathode operation.



Li, QH (Li, Qihao); Villarino, AM (Villarino, Andres Molina); Peltier, CR (Peltier, Cheyenne R.) et.al.

https://doi.org/ 10.1021/acs.jpcc.3c00319

Anion Exchange Membrane Water Electrolysis: The Future of Green Hydrogen

Abstract:

Hydrogen-derived power is one of the most promising components of a fossil fuel-independent future when deployed with green and renewable primary energy sources. Energy from the sun, wind, waves/tidal, and other emissions-free sources can po w e r water electrolyzers (WEs), devices that can produce green hydrogen without carbon emissions. According to recent International Renewable Energy Agency reports, most WEs employed in the industry are currently alkaline water electrolyzers and proton-exchange membrane water electrolyzers (PEMWEs), with similar to 200 and similar to 70 years of commercialization history, respectively. The former suffers from inherently limited current densities due to inevitable gas crossover, operates using corrosive (7 M) alkaline solutions, and requires large installation footprints, while the latter requires expensive and scarce precious metal-based electrocatalysts. An emerging technology, the anion-exchange membrane water electrolyzer (AEMWE), seeks to combine the benefits of both into one device while overcoming the limitations of each. AEMWEs afford higher operating current densities and pressures, similar Faradaic efficiencies when compared to PEMWEs (>90%), rapid ramping/load-following responsiveness, and the use of non-noble metal catalysts and pure water feed. While recent reports show promising device performance, close to 3 A/cm2 for AEMWEs with 1 M KOH or pure water feed, a deeper understanding of the mechanisms that gover n device performance and stability is required for the technology to compete and flourish. Herein, we briefly discuss the fundamentals of AEMWEs in terms of device components, catalysts, membranes, and long-term stability/durability. We provide our perspective on where the field is going and offer our opinion on how specific performance and stability tests should be performed to facilitate the development of the field.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 56
OCTOBER, 2023

A Porous Skeleton-Supported Organic/Inorganic Composite Membrane for High-Efficiency Alkaline Water Electrolysis

Hydrogen energy is a truly renewable and clean energy source. Alkaline water electrolysis (AWE) is the most promising technology for green hydrogen production currently.

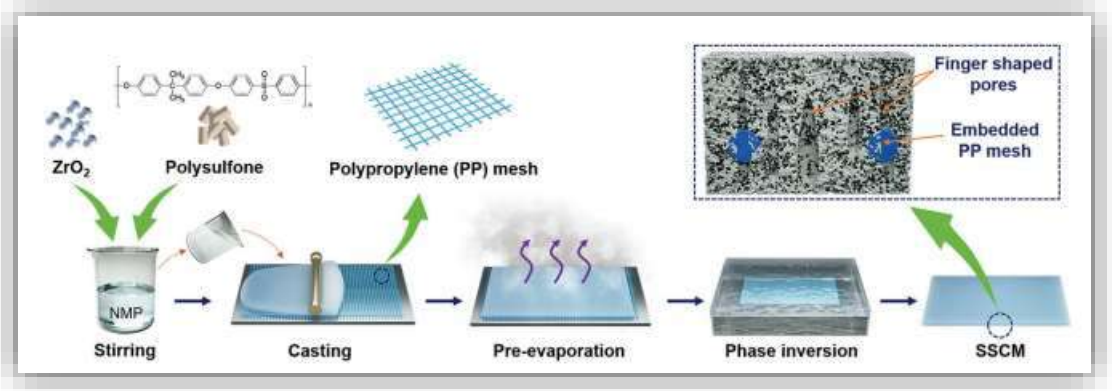


Figure: Scheme of the preparation of the porous skeleton-supported organic/inorganic composite membrane.

Focus of Research:

- In the AWE process, the critical part of an alkaline electrolyzer is the membrane, which acts to conduct hydroxide ions and block gases.
- Developing low area resistance, high bubble point pressure and highly stable membrane for high-performance AWE is still a challenge. Herein, porous skeleton-supported composite membranes via the blade-coating method for advanced AWE are prepared.
- The porous skeleton-supported composite membranes are successfully prepared via a blade-coating method. The synergistic effect of the PSU matrix, ZrO2 nanoparticles, and PP mesh endow the SSCMs with a hydrophilicity surface, ultra-low area resistance, and excellent mechanical properties.
- The porous composite membranes, besides having hydrophilic surface, also show ultra-low area resistance (≈0.15 Ω cm^2), ultra-high bubble point pressure (≈27 bar) and excellent mechanical properties (tensile stress, ≈14 MPa).
- By using commercial catalysts, the composite membranes exhibit a current density of up to 1.9 A cm^{-2} at the voltage of 2 V in 30 wt% KOH solution at 80 °C and achieve ultra-high H_2 purity (up to 99.996%) when applied in AWE.
- The composite membrane can operate for more than 1600 h without performance attenuation, demonstrating excellent stability. This study opens up the feasibility of preparing high-performance AWE membranes for large-scale hydrogen production.

Outcomes of Research:

The pre-evaporation process further increases the bubble point pressure of the SSCM to ≈27 bar, which allows the SSCM to achieve ultra-high H2 purity (up to 99.996%) when used for alkaline water electrolysis. This work not only demonstrates that the SSCM shows remarkable advantages for large-scale applications, but also paves the way for the rational design of efficient membranes with high-performance water electrolysis.

https://doi.org/10.1002/adfm.202309871

Electrifying the future: the advances and opportunities of electrocatalytic carbon dioxide reduction in acid

-Zhang *et al.* (2023)

Transforming carbon dioxide (CO_2) into products using renewable electricity is a crucial and captivating quest for a green and circular economy.

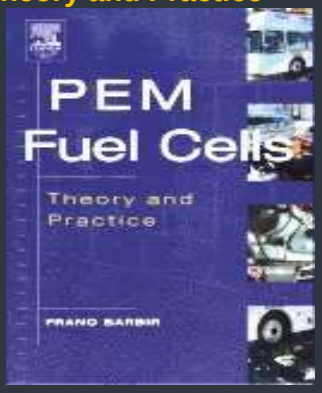
Compared with commonly used alkali electrolytes, acidic media for electrocatalytic CO_2 reduction (CO_2RR) boasts several advantages, such as high carbon utilization efficiency, high overall energy utilization rate, and low carbonate formation, making it a compelling choice for industrial applications.
However, the acidic CO_2RR also struggles with formidable hurdles, encompassing the fierce competition with the hydrogen evolution reaction, the low CO_2 solubility and availability, and the suboptimal performance of catalysts.
This review provides a comprehensive overview of the CO2RR in acidic media. By elucidating the underlying regulatory mechanism, we gain valuable insights into the fundamental principles governing the acidic CO_2RR.
Furthermore, we examine cutting-edge strategies aimed at optimizing its performance and the roles of reactor engineering, especially membrane electrode assembly reactors, in facilitating scalable and carbon efficient conversion.
Moreover, we present a forward-looking perspective, highlighting the promising prospects of acidic CO_2RR research in ushering us towards a carbon-neutral society.

Link:

https://www.sciengine.com/SCC/doi/10.1007/s11426-023-1799-y;JSESSIONID=63f61121-9370-4535-bbc1-e55a3fa0f016

Books

PEM Fuel Cells
Theory and Practice



Author: Frano Barbir
ISBN: 978-0-12-078142-3
Language: English

Description:
Fuel cells are electrochemical energy conversion devices that convert hydrogen and oxygen into water, producing electricity and heat in the process and providing fuel efficiency and reductions in pollutants. Demand for this technology is growing rapidly. Fuel cells are being commercialized for stationary and portable electricity generation, and as a replacement for internal combustion engines in automobiles. Proton Exchange Membrane (PEM) fuel cells in particular are experiencing an upsurge. They have high power density and can vary their output quickly to meet shifts in power demand.
It covers the fundamental aspects of fuel cell design, electrochemistry of the technology, heat and mass transport, system design and applications to bring this technology to professionals at all levels.

Key Features

- Comprehensive guide for engineers, researchers and policymakers
- Covers theory and practice of PEM fuel cells
- Contains hundreds of original illustrations and real-life engineering examples.

DOI:
https://doi.org/10.1016/B978-0-12-078142-3.X5000-9

Australian Hydrogen Company planning $100 M facility in Mesa Del Sol

New hydrogen investments are coming to New Mexico.

Gov. Michelle Lujan Grisham and other state leaders traveled to Syndey, Australia to officially announce plans for a new hydrogen manufacturing facility and research campus in Mesa Del Sol. Officials with Australia-based Star Scientific Ltd. signed a letter of intent to begin an intensive planning process, according to the governor's office. Company leaders say they are looking for roughly 50 acres to build a new factory along with design offices, research laboratories and administrative buildings. The company is planning to invest $100 million into the project which is expected to bring 200-250 new jobs to the metro. Officials say they want to break ground in early 2025.

https://www.kob.com/new-mexico/australian-hydrogen-company-planning-100m-facility-in-mesa-del-sol/

Suzuki showcases hydrogen-powered Burgman maxi-scooter

Suzuki revealed its hydrogen-fueled Burgman test scooter at the ongoing Japan Mobility Show in Tokyo.

The maxi-scooter, with a sleek design and large dimensions, is based on the existing Burgman 400 ABS model. The prototype features a 70Mpa hydrogen tank, likely to be situated beneath the floorboard and connected directly to the engine. The official launch of the production model is expected to take some time. Suzuki intends to incorporate the hydrogen engine into the existing Burgman 400 ABS using a combustion system rather than a fuel cell.



https://www.newsbytesapp.com/news/auto/hydrogen-powered-suzuki-burgman-revealed-at-the-japan-mobility-show/story

Toyota Crown Sedan FCEV – larger, luxury version of hydrogen-powered Mirai; Japan launch in November

The current Toyota Crown is split into four versions, namely the Crossover, Sport, Estate and Sedan, the last of which is pictured here at the ongoing Japan Mobility Show. This Crown Sedan is the only version that will be available as a FCEV (fuel cell electric vehicle) and is built on the same platform as the second-generation, hydrogen-powered Mirai.
Slated to be launched in November this year, the Crown Sedan measures It measures 5,030 mm long, 1,890 mm wide, 1,470 mm tall and has a wheelbase that spans 3,000 mm. The obvious comparison is against the previous iteration of the Crown that was only offered as a sedan, and that model is smaller as it is 4,910 mm long, 1,800 mm wide, 1,455 mm tall and with a wheelbase of 2,920 mm.



https://paultan.org/2023/10/26/toyota-crown-sedan-fcev-on-display-at-jms/

Kazakhstan To Supply Green Hydrogen To EU Via Middle Corridor

Hyrasia One and Semurg Invest (the owner and operator of the Sarzha Multifunctional Marine Terminal at Port Kuryk, Mangystau region of Kazakhstan) signed a Memorandum of Cooperation (MoC) to ship green hydrogen and ammonia through Port Kuryk, Trend reports. By signing the Memorandum of Understanding, both parties agreed to collaborate closely in order to connect the green hydrogen and ammonia project Hyrasia One to Sarzha MMT at Port Kuryk, as well as to develop a new logistics focal point along the Global Gateway route in the Caspian Sea region. Up to 2 million tons of green hydrogen or 11 million tons of green ammonia are expected to be supplied to worldwide markets from the Mangystau region in south-western Kazakhstan in 2032.

https://menafn.com/1107314284/Kazakhstan-To-Supply-Green-Hydrogen-To-EU-Via-Middle-Corridor

Researchers find potentially cheaper way of hydrogen transport –

Researchers in Japan have created a novel material capable of storing hydrogen energy in a more efficient and cost-effective manner, as part of the ongoing drive to transition humanity away from fossil fuels and towards more ecologically friendly energy sources.

The new hydrogen energy carrier can even store energy at ambient temperature for up to three months. Furthermore, because the material is nickel-based, it is quite inexpensive. **The findings were published in Chemistry--A European Journal.** As humanity fights the growing climate problem, one option that academics are focusing on is the shift to alternate energy sources such as hydrogen. "We have been working on developing new materials that can store and transport hydrogen energy," explained Professor Seiji Ogo of Kyushu University's International Institute for Carbon-Neutral Energy Research who led the research team. "Transporting it in its gaseous state requires significant energy. An alternative way of storing and transporting it would be to 'split up' the hydrogen atoms into its base components, electrons and protons." There are a series of enzymes called hydrogenases that catalyze hydrogen into protons and electrons and can store that energy for later use, even at room temperature," continued Ogo. "By studying these enzymes our team was able to develop a new compound that does exactly that."

Link:

https://news.webindia123.com/news/Articles/Science/20231026/4133252.html

Solar PPA to boost QLD hydrogen industry

Stanwell Corporation has signed a Power Purchase Agreement (PPA) with ACCIONA for 100 per cent of the output of its planned Aldoga Solar Farm for 15 years, for a total of 380MW. The Aldoga Solar Farm is strategically situated within the Gladstone State Development Area (SDA), which was established by the Coordinator General, and on land developed by the Queensland Government's Economic Development Queensland (EDQ). The solar farm is a significant milestone in the Queensland Government's commitment to renewable energy targets, playing a pivotal role in harnessing clean and sustainable power sources to achieve the region's renewable energy goals. The Aldoga Solar Farm is just one facet of Queensland's growing network of clean energy hubs. These hubs, located within Queensland's SDAs, have been crafted to provide an optimal environment for businesses to establish and flourish within the realm of clean energy. These hubs not only ensure seamless integration and operation for new-generation clean energy businesses but also come with comprehensive and continuous support from EDQ.

https://www.energymagazine.com.au/solar-ppa-to-boost-qld-hydrogen-industry/

Australian hydrogen company boss joins PM on Biden visit to explore US clean energy opportunities

The chief executive of an Australian company that builds commercial-scale electrolysers to split water into hydrogen and oxygen will join a business delegation accompanying the prime minister's four-day official visit to the US to explore clean energy opportunities created by the Biden administration's US$369bn Inflation Reduction Act. Paul Barrett, the chief executive of Hysata, says the company expects to ramp up to as much as one gigawatt of capacity annually within years. We've delivered ahead of time, ahead of budget and we're ramping up really rapidly with the space to do it," Barrett said, referring to the company's new site near Port Kembla, south of Sydney.

https://www.theguardian.com/environment/2023/oct/24/paul-barrett-ceo-hysata-hydrogen-company-joins-australian-pm-anthony-albanese-joe-biden-visit-us-clean-energy

Towngas committed to work with government on new hydrogen energy projects

The Hong Kong and China Gas Company Limited (Towngas) said it is committed to collaborating with the government on hydrogen energy projects as it supports the proposed policy measures for the promotion and use of new hydrogen energy sources in Hong Kong. Don Cheng Hill-kwong, Head of Commercial – Hong Kong Utility of Towngas, said Towngas is "actively engaging in discussions with stakeholders regarding various hydrogen energy applications, whilst maintaining close contact with the Government." The new policy presented a timeline for the application of hydrogen energy in Hong Kong, jumpstarting the development of the market's hydrogen economy. Towngas' support of the policy continues its commitment to carbon neutrality and Hong Kong's "30-60" dual carbon goals. Peter Wong Wai-yee, managing director of Towngas, assured that with the entire group's support of the new energy policies. Towngas will also advance the development of its hydrogen energy trail projects.

https://asian-power.com/regulation/news/towngas-committed-work-government-new-hydrogen-energy-projects

Engineering professor to build water-splitting device for hydrogen production

A team at the Yale School of Engineering and Applied Sciences is designing a device to produce green hydrogen — hydrogen that is not sourced from fossil fuels or nuclear power and is manufactured in a scalable way.

Led by Shu Hu, assistant professor of chemical & environmental engineering, the device proposal submitted to the U.S. Department of Energy, or DOE, is one of 22 projects receiving a total of $42 million in funding from the agency. All the projects contribute to the DOE's goal of reducing the cost of green hydrogen to one dollar per one kilogram in one decade.

"We're building, essentially, an unprecedentedly large device," said Hu. "It's a device that is the size of a laptop. And previously, it was very small, like the size of a coin. It's at least 10 times, or even 100 times bigger than [current hydrogen producing devices]." Scaling the size of existing hydrogen producing devices would reduce the devices' efficiency, Hu said. Existing devices are also impractical to manufacture at scale, so efficiently producing large amounts of green hydrogen required a ground-up redesign.

https://yaledailynews.com/blog/2023/10/26/engineering-professor-to-build-water-splitting-device-for-hydrogen-production/

Without rigorous rules, India's green hydrogen push could spike emissions: Research

India's green hydrogen mission is gaining momentum with the government recently unveiling a Rs 400 crore R&D Roadmap. India has a 2030 production target of 5 million metric tonnes (MMT) of green hydrogen per annum.

New research suggests that the embodied carbon emissions from "green" hydrogen that is generated from grid-powered electrolysis could be much higher than the emissions from traditional "grey" hydrogen produced from fossil fuels.

In a brief titled 'Green Hydrogen: Promises & Pitfalls', Climate Risk Horizons cautions that so-called green hydrogen produced without stringent energy accounting standards would not be climate friendly and could in fact be many times worse than traditional grey hydrogen produced from fossil fuels.

The 2030 target of 5 MMT of green hydrogen would require about 250 TWh of electricity, which is approximately 13 per cent of India's current electricity generation.

If even some of this electricity comes from India's coal-powered grid, it will drive significant additional emissions into the atmosphere. Seventy per cent of India's electricity generation is coal-based.

The Ministry of New and Renewable Energy (MNRE) recently notified emission thresholds for green hydrogen production, but the accounting and certification methods are yet to be finalized.

https://energy.economictimes.indiatimes.com/news/renewable/without-rigorous-rules-indias-green-hydrogen-push-could-spike-emissions-research/104721382

IIT Madras to work with Industries on R&D and developing testing/validation standards in 'Green Hydrogen'

Indian Institute of Technology Madras (IIT Madras) along with IITM Research Park is going to work with industries and research institutes on industrial R&D needs, skill development, creating incubators, testing/validation standards and policy advocacy in the 'Green Hydrogen' sector.

This is part of the 'Hydrogen Valley Innovation Cluster in Tamil Nadu' (HVIC-TN) initiative, which comprises nearly 30 companies working in the hydrogen sector, IIT Madras Research Park, Guidance Tamil Nadu and Tamil Nadu Industrial Development Corporation (TIDCO) besides a few consulates.

A key outcome expected from this initiative is to make HVIC-TN the hub of industrial R&D requirements to bring green hydrogen at an economical price and scale. This initiative is expected to contribute significantly towards the National Green Hydrogen Mission.

In keeping with the Department of Science and Technology's (DST) vision to transform India into an energy-independent nation by 2047, it is providing funding for Research, Development and Demonstration (RD&D) activities essential for small-scale demonstration by enhancing the readiness of technologies in green hydrogen value chain.

HVIC-TN will act as a platform for stakeholders in the hydrogen sector to network and enable faster green hydrogen adoption and transition. The cluster will also serve as a nodal agency, think tank, and knowledge partner in the State to attract or support any initiatives in the hydrogen sector. In addition, to enable seamless access to networks between countries, connections through consulates of various countries are enabled.

IIT Madras will cover the entire value chain of hydrogen starting from generation, storage, and transportation to utilization. CXO-level representation from more than half the industry partners attended the meeting on the campus. The industries discussed and delineated their company's role and contributions to the HVIC.

Tamil Nadu power is already 50% green and HVIC will improve this further with green hydrogen, Dr. TRB Rajaa, Hon'ble Minister for Industries, Investment Promotion and Commerce, Government of Tamil Nadu, said.

https://www.iitm.ac.in/happenings/press-releases-and-coverages/iit-madras-work-industries-rd-and-developing

CM approves Rajasthan Green Hydrogen Policy-2023 draft to push clean energy

Rajasthan Chief Minister Ashok Gehlot has approved the draft of 'Rajasthan Green Hydrogen Policy-2023' and a notification in this regard will be issued soon. The state government has taken the decision keeping in mind clean energy production, future needs and climate change, according to a release. Rajasthan Green Hydrogen Policy-2023' is being brought to encourage investors and search for clean energy sources in the state. Chief Minister Gehlot has approved the policy draft. Notification will be issued soon by the Energy Department, the release said.

Under the policy, companies producing green energy will get various types of subsidies. Employment opportunities will also increase in the state. Under this policy, the state government will provide various facilities to encourage investors.

CM approves Rajasthan Green Hydrogen Policy-2023 draft to push clean energy (business-standard.com)

Green hydrogen will cut cost of energy to Rs 6 per unit: Minister R K Singh

Speaking at the special ministerial session of the Fourth International Conference & Exhibition on Clean Energy, Singh said that the cost of green hydrogen would be cheapest in India and that it would become a viable energy storage alternative.

"The average price of power in the energy exchange has recently been Rs 8 per unit, so if our cost for round-the-clock renewable energy comes to Rs 6 per unit, we are in business. Around 88,000 MW renewable energy capacity is under construction and our plan is to add 50,000 MW of renewable energy capacity every year. We are already emerging as an exporter. The world will come to rely on us more and more. So, all those who are setting up capacity have made a good bet. At the same time, we need to keep ourselves at the leading edge of technology," he added. He also said that India is going to emerge as the biggest exporter of solar cells and modules and that more grid capacity is being added. The theme of the special ministerial session, held on the closing day of the two -day summit, was 'Global Champions for Advancing Clean Energy Innovation & Manufacturing'.

Green hydrogen will cut cost of energy to Rs 6 per unit: Minister R K Singh, ET EnergyWorld (indiatimes.com)

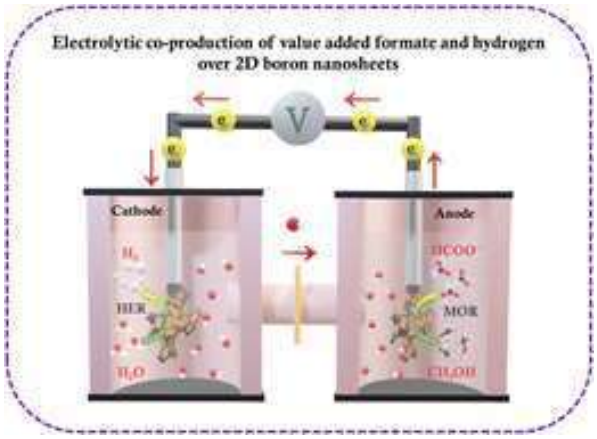
Sathyaseelan, A. *et al.*

Value-added methanol electroreforming coupled with green hydrogen production at the edge interface of 2D boron nanosheets

https://doi.org/10.1039/d3ta03513a

Abstract:

Electrocatalytic water splitting has been regarded as a promising technology for the production of ultrapure hydrogen (H2) in this decade. Nonetheless, the efficiency of the water splitting is severely hampered by the sluggish anodic oxygen evolution reaction (OER). The coupling of thermodynamically favourable anodic oxidation reactions (small molecule oxidations) is an innovative strategy to overcome these critical challenges in conventional technology. Herein, we demonstrate the use of liquid phase exfoliated 2D boron nanosheets (eBNSs) as an efficient non-noble electrocatalyst for a traditional/hybrid water electrolyzer. The physico-chemical studies revealed that the exfoliation of boron sheets leads to a decrease in lateral size, layer numbers and an increase in surface area without affecting their crystallinity. Benefitting from the increased surface and edge interfaces, the eBNSs showed enhanced electrocatalytic activity towards the hydrogen evolution reaction (HER) (146 mV), OER (291 mV) and methanol oxidation reaction (MOR) (190 mV) to meet 10 mA cm-2 which is better than that of bulk boron. The eBNS/NF-4 hybrid electrolyzer (HER + MOR) requires 1.55 V (@10 mA cm-2) to electrosynthesis value added formate and hydrogen with a 160 mV lower voltage compared to a conventional electrolyzer (HER + OER). Furthermore, the real time hybrid water electrolyzer (in an H-type cell) delivers superior H2 production with 93% faradaic efficiency. Overall, this work demonstrates the use of non-noble 2D eBNSs as a potential candidate for next generation energy-efficient green H2 production systems. Electrolytic co-production of value-added formate and hydrogen over 2D boron nanosheets.



Graphical Abstract Representation

Chang, JL. *et al.*

Self-supported amorphous phosphide catalytic electrodes for electrochemical hydrogen production coupling with methanol upgrading

https://doi.org/ 10.1016/j.jcis.2023.05.173

Abstract:

Efficient catalytic electrodes for cathodic hydrogen evolution reaction (HER) and anodic oxygen evolution re-action (OER) are pivotal for massive production of green hydrogen from water electrolysis, and the further replacement of kinetically sluggish OER by tailored elecrooxidation of certain organics is a promising way to co-produce hydrogen and value-added chemicals via a more energy-saving and safer manner. Herein, amorphous Ni-Co-Fe ternary phosphides (NixCoyFez-Ps) with different Ni: Co: Fe ratios electrodeposited onto Ni foam (NF) substrate were served as self-supported catalytic electrodes for alkaline HER and OER. The Ni4Co4Fe1-P electrode deposited in solution at Ni:Co:Fe ratio of 4:4:1 displayed low overpotential (61 mV at-20 mA cm 2) and acceptable durability for HER, while the Ni2Co2Fe1-P electrode fabricated in deposition solution at Ni:Co:Fe ratio of 2:2:1 showed good OER efficiency (overpotential of 275 mV at 20 mA cm 2) and robust durability, the further replacement of OER by anodic methanol oxidation reaction (MOR) enabled selective production of formate with 110 mV lower anodic potential at 20 mA cm 2. The HER-MOR co-electrolysis system based on Ni4Co4Fe1-P cathode and Ni2Co2Fe1-P anode could save 1.4 kWh of electric energy per cubic meter of H2 relative to mere water electrolysis. The current work offers a feasible approach to co-produce H2 and value-upgraded formate via an energy-saving manner by rational design of catalytic electrodes and construction of co-electrolysis system, and paves the way for cost-effective co-preparation of more value-added organics and green hydrogen via electrolysis.

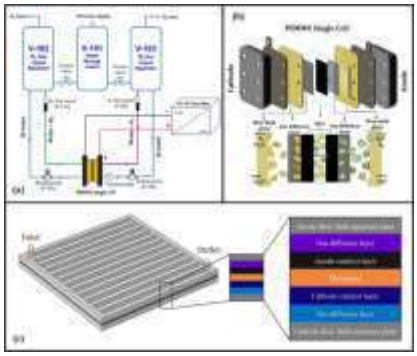
Kumar, SS. *et al.*

Experimental and simulation of PEM water electrolyser with Pd/PN-CNPs electrodes for hydrogen evolution reaction: Performance assessment and validation

https://doi.org/ 10.1016/j.apenergy.2023.121565

Abstract:

Water electrolysis using a proton exchange membrane (PEM) offers a sustainable solution for green hydrogen production from intermittent renewable energy sources. However, the utilization of costly electrode materials and cell components has resulted in expensive hydrogen production costs and limited its commercial applications. Furthermore, the management of gas-liquid flow and thermal distributions presents significant challenges in the operation of PEM water electrolysers. In this study, a COMSOL Multiphysics model was developed for a 25 cm2 single cell PEM water electrolyser with parallel flow field configurations to investigate its performance including operating principles, mechanisms, and ion transport properties. Subsequently, the model was validated with in-house experimental data at different operating conditions. Impressively, it effectively predicted the current-voltage polarization curves, demonstrating strong correlation with the experimental data. For a more rigorous comparison between experimental and numerical simulation, the normalized root mean square deviation was calculated for current-voltage polarization curves at various temperatures, ranging from 30 degrees C to 80 degrees C. The deviation was observed to be around 1.1% across all the temperatures, an acceptably low error value. In addition, the model was used to analyze the reactant flow and thermal distributions. This work can provide both experimental and simulation support for the selection and optimization of operating conditions, including flow fields in PEM water electrolysers.



Graphical Abstract Representation

Zhang, RD. *et al.*

Analysis and forecast of the substitution potential of China's wind power-hydrogen production for fossil fuel hydrogen production

https://doi.org/ 10.1016/j.jclepro.2023.138410

Abstract:

The predominant utilization of fossil fuels for hydrogen production in China leads to substantial carbon emissions, posing a challenge to China's objective of achieving carbon neutrality. With the rapid development of wind power in China, hydrogen can be produced through water electrolysis powered by wind-generated electricity. This process offers the potential to gradually replace the hydrogen production from fossil fuel (grey hydrogen), thus promoting the low-carbon transformation of China's hydrogen energy industry. However, further investigation is required to determine the potential displacement of grey hydrogen through the production of hydrogen from wind power in China in the future. To address this issue, this study first obtained wind speed data for the entire China region from the MERRA-2 database. Subsequently, based on the wind speed data for each specific area, the wind turbine model with the lowest power generation cost was selected from the eight available wind turbine models. On this basis, the mixed integer linear programming method is used to construct the cost analysis model of wind power-hydrogen production (WPHP). Based on the local wind power generation data, calculations are performed to determine the optimal installed capacity of the wind turbine, electrolyzer, and hydrogen storage tank within the WPHP system. Additionally, the optimal scheduling of the WPHP system is determined. These optimizations collectively result in the best WPHP cost. Based on this research, the optimal cost of WPHP for each geographical grid in China can be calculated and compared with the local grey hydrogen cost. The analysis reveals that in some areas of Xinjiang, Gansu, and Guizhou, exhibit low costs of wind power. This suggests that the substitution of grey hydrogen with WPHP can be achieved in these areas. Based on technological progress and changes in carbon trading prices, this paper predicts that WPHP in China could potentially replace 16.35-28.69 million tons of grey hydrogen by 2040. Moreover, by 2060, WPHP in China is projected to replace 76.72-92.01 million tons of grey hydrogen. According to the sensitivity analysis conducted, it has been determined that the efficiency of the electrolyzer and the price of the wind power equipment exert the greatest impact on the cost of hydrogen production.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 57
NOVEMBER, 2023

France Uncovers Massive White Hydrogen Deposit

Researchers have discovered a potential natural hydrogen deposit under the coalfields of thr northeastrn French Lorraine region- possibly World's largest reserve of this gas!, estimated to be between 6 million and 250 million metric tons of hydrogen.



Jacques Pironon and Phillipe De Donato, both directors of research at France's National Centre of Scientific Research, were assessing the amount of methane in the subsoils of the Lorraine mining basin using a "world first" specialized probe, able to analyze gases dissolved in the water of rock formations deep underground.

What Is White Hydrogen And How It Is Useful?

- White hydrogen is the naturally produced gas present in the Earth's crust. Though, it is the most abundant element in the universe, it generally exists combined with other molecules.
- White hydrogen is relatively new to scientists. In 2018, a well in Mali producing 98% hydrogen gas brought the attention of scientists to the resource.
- Its deposits have been found across the world, including in the US, Eastern Europe, Russia, Australia, France and other countries. It is estimated that globally there could be tens of billions of tons of white hydrogen.
- Hydrogen is pitted as the most potential clean energy source for industries like aviation, shipping and steel-making. Hydrogen produces only water when burned making it more environment-friendly energy source than solar or wind energy.

Why Is The Discovery Special?

Until recently, scientists believed that mass amounts of Hydrogen could only be produced in labs. There were several types of hydrogen categorized by colours on the basis of their origin. For instance, "gray" Hydrogen is made from methane gas, "brown" from coal, "blue" hydrogen is similar to gray but with captured emissions. The most eco-friendly hydrogen is "green" hydrogen, which is produced using renewable energy to split water.

This is why white hydrogen, which is potentially abundant and untapped can be source of clean-burning energy. The discovery has also proved that Hydrogen can found naturally and doesn't always require any of the energy-intensive processes.

The clean energy source is also cheaper as the estimated cost of *white hydrogen would be around* **$1 per kilogram**, while *green hydrogen costs* about **$6 per kilogram**

https://oilprice.com/Energy/Energy-General/France-Uncovers-Massive-White-Hydrogen-Deposit.html
https://www.news18.com/explainers/scientists-have-discovered-white-hydrogen-beneath-france-how-it-can-help-save-the-earth-8642119.html
https://fuelcellsworks.com/news/throwback-thursday-story-worlds-largest-deposit-of-white-hydrogen-discovered-in-france/
https://edition.cnn.com/2023/10/29/climate/white-hydrogen-fossil-fuels-climate/index.html

Recent Advances in White Hydrogen Exploration and Production: A Mini Review

-Joseph *et al.* (2023)

The quest for natural or white hydrogen exploration and production emanates from the growing interest in clean, carbon-free hydrogen energy.

Countries all over the world are beginning to formulate legislation to promote hydrogen production as a way of combating global warming occasioned by climate change. Currently, all avenues for producing hydrogen are either very expensive or environmentally unsustainable.

White hydrogen in commercial accumulations might produce cheaper and more environmentally sustainable hydrogen energy, thus providing a viable alternative to other forms of renewable energy.

Despite its potential to become the cheapest hydrogen source, published literature on its occurrence, sources, accumulation, generation processes, and recovery methods are scarce.

Consequently, little is known regarding white hydrogen sources, accumulation, and extraction. This study reviewed the various sources and forms in which white hydrogen can exist in nature.

The various processes by which white hydrogen is produced and extracted have also been presented. This work aimed to offer new perspectives and direction for future research on white hydrogen exploration and production. Furthermore, the current challenges of white hydrogen exploration and production, and its future outlook, were also presented.

Citation:

Aimikhe, Victor & Eyankware, Emmanuel. (2023). Recent Advances in White Hydrogen Exploration and Production: A Mini Review. Journal of Energy Research and Reviews. 13. 64-79. 10.9734/jenrr/2023/v13i4272.

EVENTS

Net Zero India Summit

Date: 7-8th December 2023

Venue: Yashobhoomi, IICC, Dwarka, New Delhi

Mission Net Zero India Summit presents a vibrant, inclusive and high-impact platform for Energy Sector to meet and collaborate for meaningful policy dialogues, share industry insights, showcase innovations and accelerate partnerships for a common goal of achieving decarbonized Economy for India by 2070. The Summit draws its strength from years of connections & interactions with the Experts and Veterans from various Energy domains like Renewables, Oil & Gas and Mobility who has been a crucial part of previously held forums powering Mission Net Zero India Summit 2023.

Conference Tracks:

1. Empowering India's energy sector to achieve Net Zero
2. A to Zero: Accelerating India's leadership in renewables
3. Next Mobility: Pathway to decarbonizing the transport sector

The Summit focuses on the discussion on achieving India's energy transition and decarbonization with reliability, affordability, sustainability and energy independence.

Link:
https://www.missionnetzeroindia.com/

INDUSTRY NEWS

Saverglass Sets New Industry Standards with Successful Hydrogen Combustion Trials in Pursuit of Sustainable Glass Production

Saverglass, the world's leading manufacturer and decorator of luxury and high-end glass bottles for wines and spirits, is achieving a significant milestone in its commitment to carbon reduction. The company's Sustainable Research & Development Department recently spearheaded groundbreaking hydrogen combustion trials at its Feuquières industrial site in France, marking a pivotal moment in the glass industry's journey toward greener production practices.

"Decarbonization is a fundamental component within Saverglass' Sustainable Research & Development Department. This trial empowers us to push the boundaries, advance our roadmap, and complement our repertoire with innovative technical solutions," said Frédéric Dupuis, Director of Research and Development at Saverglass Group."Our confidence in integrating hydrogen as a core element of our production process stems from its potential to significantly reduce carbon emissions while establishing novel industry standards for eco-conscious glass manufacturing."

Saverglass Sets New Industry Standards with Successful Hydrogen Combustion Trials in Pursuit of Sustainable Glass Production (lelezard.com)

Energy Co. Partners With US Co. To Build Its Hydrogen Boilers

The Jericho Energy Ventures Inc. announced it has signed a memorandum of understanding (MOU) with Kansas-based Superior Boiler to manufacture its zero-emission hydrogen boiler. The Dynamic Combustion Chamber™ (DCC) boiler was designed by Jericho subsidiary Hydrogen Technologies. It burns hydrogen and oxygen in a vacuum chamber to create steam with no greenhouse gases or other pollutants. Superior Boiler is a leading manufacturer of Scotch Marine Firetube boilers, industrial watertube, and high-efficiency boilers and equipment. It has shipped more than 21,000 boilers throughout the United States and worldwide.

"Superior Boiler is among the most respected and trusted manufacturers of boilers and thermal equipment globally," Jericho Chief Executive Officer Brian Williamson said. "They share our deep commitment to safety, quality, and the environment. Superior's Kansas manufacturing hub, located in the heart of the nation, is ideally positioned for efficient delivery of the DCC™ throughout all lower 48 states and beyond."

https://www.investorideas.com/news/2023/energy/10311Jericho-Energy-Ventures.asp

Universal Hydrogen Showcases Airside Fueling Logistics for ATR-72 and H2AmpCart at Toulouse Blagnac Airport F50 Operational Gate

Displayed today, the hydrogen modules for the H2AmpCart have a discrete form-factor to those utilized in the aircraft and are being built and tested to support the year-end availability of the fully-functional demonstrator H2AmpCart. By bringing the hydrogen and charger directly to the eGSEs on the airport aprons, the costly process of driving long distances to a central charging station is removed. Universal Hydrogen's H2AmpCart hydrogen modules are filled away from the airport with green hydrogen, and transferred to the airport landside leveraging existing intermodal freight infrastructure. From there, the modules are loaded onto a trailer for safe and efficient transportation to any location airside of the airport, facilitating opportunistic charging of eGSEs between operations. The trailer is then connected to the H2AmpCart with Universal Hydrogen's purge-less quick connect system. This approach optimizes GSE operations and minimizes downtime.



https://menafn.com/1107314284/Kazakhstan-To-Supply-Green-Hydrogen-To-EU-Via-Middle-Corridor

EVENTS

Green Hydrogen Summit



Date: 17 - 18 April 2024

Venue: Dom Pedro Hotel, Lisbon, Portugal

The fifth annual Green Hydrogen Summit will return to Lisbon as Portugal's premier green hydrogen event to inspire and educate delegates on how to take advantage of the opportunities green hydrogen will offer financially and environmentally and provide the connections to make it possible.

Link:

https://greenhydrogen.solarenergyevents.com/

PowerUp Virtual Expo



Date: December 12 – 13, 2023

Key Topics:

1. Renewable energy and energy storage
2. Sustainability assessment and eco-innovation
3. Tools/test and measurement
4. Solid-state technology

Link:

https://energy.powerup-expo.com/?utm_source=google&utm_medium=cpc&utm_campaign=energy23s&gclid=CjwKCAjwkY2qBhBDEiwAoQXK5QNHQTpw8dicViVxTZ0iXUvCutvrfAa_zMZKs5xZrkQEGYj5F5q_WBoCccQQAvD_BwE

INDUSTRY NEWS

OX2 eyes using hydrogen from two of world's largest offshore wind projects for e-fuels

Nordic developer OX2 and Finnish limestone products maker Nordkalk are considering tapping into two of the world's largest offshore wind projects – the 5.5GW Aurora and the 3.9GW Pleione-Ran arrays off the Swedish Baltic Sea island of Gotland – for the production of e-fuel.

The e-fuel could be used in Nordkalk's own facilities, but also for shipping and other industries and to make Gotland a hub for green growth and development.

https://www.rechargenews.com/wind/ox2-eyes-using-hydrogen-from-two-of-worlds-largest-offshore-wind-projects-for-e-fuels/2-1-1545167

AM Green looks to raise $1 billion to expand green hydrogen manufacturing

AM Green, a hydrogen and ammonia producer owned by the founders of Indian renewable company Greenko Energy Holdings, is planning to raise around $1 billion to fund its growing business, according to people familiar with the matter.

The firm is working with an adviser on the fundraising to bolster its ability to produce green hydrogen and other chemical compounds, the people said, asking not to be identified as the information is private. AM Green aims to build a million tonnes a year of green methanol capacity, one of the people said. Singapore sovereign wealth fund GIC Pte and the renewable energy arm of Malaysian state oil giant Petronas Nasional Bhd. announced an investment in AM Green Ammonia Holdings. The project is set to produce 5 million tons of green ammonia a year, the statement showed.



https://www.financialexpress.com/business/express-mobility-am-green-looks-to-raise-1-billion-to-expand-green-hydrogen-manufacturing-3293330/

L&T joins the Hydrogen Council as a Steering Member

Reaffirming its commitment to a cleaner and more sustainable future, L&T has joined the Hydrogen Council, a powerful and diverse global CEO-led coalition of 140+ multinational companies dedicated to advancing the role of hydrogen in the global energy transition.

S N Subrahmanyan, Chairman & Managing Director of Larsen & Toubro (L&T), said: "L&T has been at the forefront of developing sustainable solutions, and we recognise hydrogen as a key driver in our journey towards a clean energy future. By collaborating with like-minded global leaders and leveraging our decades long experience in hydrogen, we are eager to contribute to the platforms provided by the Hydrogen Council to further its mission and objectives." L&T joins the council alongside two other members. Welcoming the new members, Yoshinori Kanehana, Chairman of Kawasaki Heavy Industries, Ltd., and Co-Chair of the Hydrogen Council, said: "The ethos of these three new members aligns with the Hydrogen Council's vision for hydrogen to foster the clean energy transition for a better, more sustainable, and more resilient energy future."

https://www.larsentoubro.com/pressreleases/2023-11-03-lt-joins-the-hydrogen-council-as-a-steering-member/

Hydrogen is a green fuel despite small warming effect from pipe leaks

Hydrogen leaked into the atmosphere from pipes or storage tanks indirectly acts as a greenhouse gas, but there are still significant climate benefits to be had if we switch from burning fossil fuels to burning clean hydrogen.

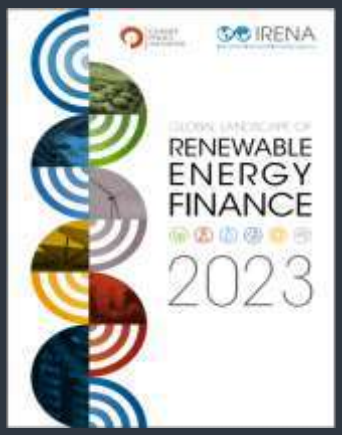
When burned, hydrogen emits only water vapour and heat. If produced with clean energy, hydrogen fuel offers a carbon-free way to power processes that are difficult to run on electricity, such as steel-making.



https://www.newscientist.com/article/2400577-hydrogen-is-a-green-fuel-despite-small-warming-effect-from-pipe-leaks/

REPORT

IRENA Report on 'Global Landscape of Renewable Energy Finance, 2023'



Citation: IRENA and CPI (2023), Global landscape of renewable energy finance, 2023, International Renewable Energy Agency, Abu Dhabi.

ISBN: 978-92-9260-523-0

This report has been re-issued since its original release date in February 2023. This revised digital imprint incorporates updated data.

The report was edited by Fayre Makeig.

For further information or to provide feedback: publications@irena.org

This report can be downloaded from www.irena.org/publications

Link:

https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf?rev=6213e7fa55ec4991a22514572e7996c5

AM Green looks to raise $1 billion to expand green hydrogen manufacturing

AM Green, a hydrogen and ammonia producer owned by the founders of Indian renewable company Greenko Energy Holdings, is planning to raise around $1 billion to fund its growing business, according to people familiar with the matter.

The firm is working with an adviser on the fundraising to bolster its ability to produce green hydrogen and other chemical compounds. AM Green aims to build a million tonnes a year of green methanol capacity.

Singapore sovereign wealth fund GIC Pte and the renewable energy arm of Malaysian state oil giant Petronas Nasional Bhd. announced an investment in AM Green Ammonia Holdings, according to a statement confirming a Bloomberg News report. The project is set to produce 5 million tons of green ammonia a year, the statement showed. Green ammonia and hydrogen are expected to play a bigger role in electricity generation, shipping and hard-to-abate industries like oil refining, chemicals, fertilizer and steel in the coming years. In India, which is aiming for net zero by 2070, AM Green joins heavyweights Adani Group and Reliance Industries Ltd. in making ambitious investments in such technologies. AM Green, founded by Anil Chalamalasetty and Mahesh Kolli, is developing production capability for molecules including green hydrogen, green ammonia, biofuels, green caustic soda and e-methanol, the announcement showed. Greenko, the Hyderabad-based solar, wind and hydro power company also started by Chalamalasetty and Kolli, has received backing from GIC as well as sovereign wealth fund Abu Dhabi Investment Authority, its website shows.

AM Green looks to raise $1 billion to expand green hydrogen manufacturing - Express Mobility News | The Financial Express

India's green hydrogen move may worsen pollution if steps are not in place, says study



India's plans to produce so-called 'green hydrogen' — where the gas is produced without resulting in fossil fuel emissions — might end up worsening pollution if proper checks and balances are not in place, according to a study by environmental and energy think-tank, Climate Risk Horizons (CRH).

As of August 2023, India's total renewable energy (RE) capacity (excluding hydropower dams bigger than 25 MW) stood at 131 GW; the 2030 green hydrogen plan thus envisages adding an equivalent RE capacity by 2030. This is over and above the 500 GW of RE capacity that India has committed to install by 2030 as part of its Nationally Determined Contribution under the Paris Agreement. To put that in perspective, India installed only 15 GW of new solar and wind capacity in 2023, against the 45 GW per year needed to reach the 2030 target.

Green Hydrogen Standard: The MNRE has defined green hydrogen as hydrogen produced in a way that emits no more than 2 kg of carbon dioxide per kg of such hydrogen. Currently, producing 1 kg of 'grey hydrogen', as it is known, ends up emitting 9 kg of carbon dioxide. "While a detailed methodology is awaited, the definition as it stands leaves a lot to interpretation," said CRH's chief executive Ashish Fernandes, in the report. "India's ambitious renewable energy target of 450 GW by 2030 already requires huge investment. The green hydrogen mission will require an additional 125 GW of RE. The MNRE needs to guard against the risk that finance for RE projects that would otherwise decarbonise the electricity grid will instead be diverted to produce green hydrogen. This would delay India's journey to net zero, undermine a nascent industry, and deny States and electricity consumers the cost benefits that cheap renewable energy has to offer," Mr. Fernandes said. There is further requirement of installation of renewable energy capacity worth 125 GW (1 GW is 1,000 megawatts) and the use of 250,000 gigawatt-hr units of power, equivalent to about 13% of India's present electricity generation.

Several large power utilities in India — including Reliance Industries, the Adani Group, and the National Thermal Power Corporation — have announced ambitious plans to scale up green hydrogen production. The Centre's green hydrogen mission has committed nearly ₹20,000 crore to develop and expand the industry.

India's green hydrogen move may worsen pollution if steps are not in place, says study - The Hindu

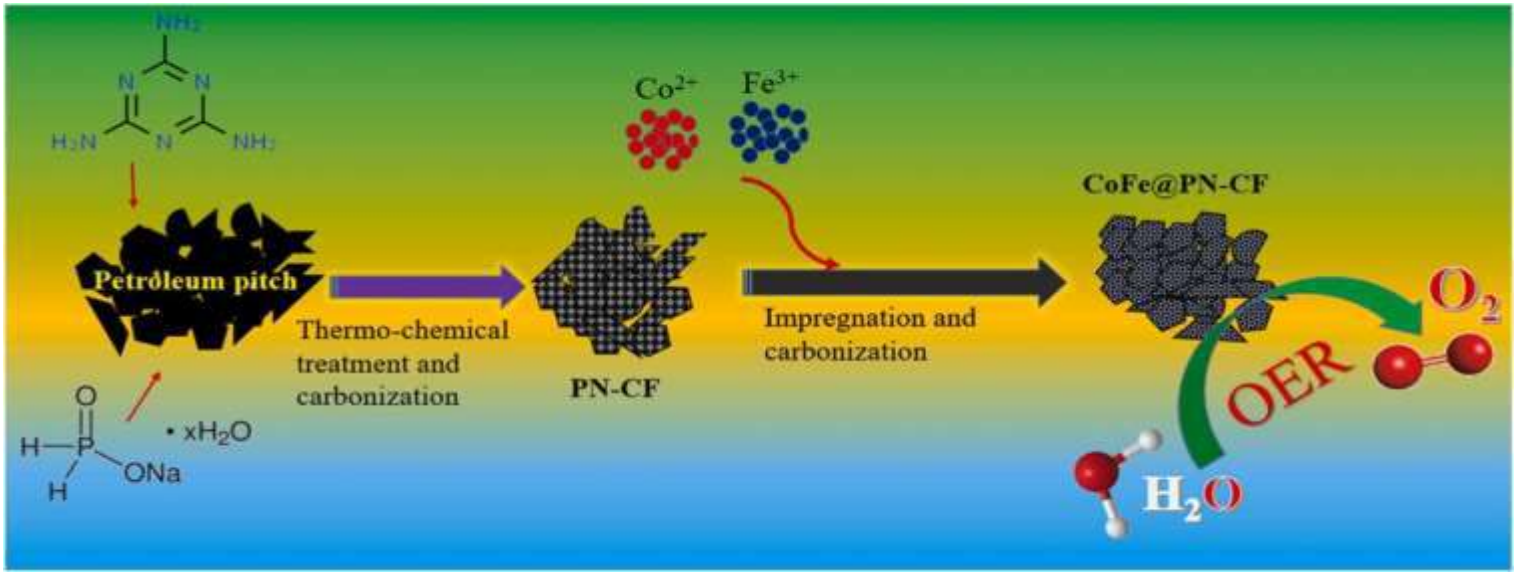
Gebreslase, GA. *et al.*

CoFe-loaded P, N co-doped carbon foam derived from petroleum pitch waste: An efficient electrocatalyst for oxygen evolution reaction

https://doi.org/10.1016/j.cattod.2022.12.022

Abstract:

Designing and developing affordable, high-performance, and stable electrocatalysts for oxygen evolution reaction (OER) is decisive for pragmatic water electrolysis to produce green hydrogen energy. In this work, we report cobalt and iron incorporated in phosphorus and nitrogen co-doped carbon foam (CF) derived from petroleum pitch as a promising electrocatalyst for alkaline OER. The P, N heteroatoms co-doped carbon foam (PN-CF) was first synthesized via thermo-chemical treatment of low-cost petroleum pitch in the presence of melamine (N source) and sodium hypophosphite (P source) precursors, followed by carbonization. Then, mono and bimetals of Co and Fe were impregnated into the as-prepared composite carbon foam (PN-CF) substrate, followed by further carbonization. Among the different catalysts, the bimetallic CoFe integrated with the PN-CF (CoFe@PN-CF) reveals an outstanding electrocatalytic activity (320 mV overpotential at j = 10 mA center dot cm(-2)), low Tafel slope (48 mV center dot dec(-1)), and excellent durability during OER measurement in 1 M KOH aqueous solution. The superb performance of the CoFe@PN-CF catalyst stems from the synergetic effect of the bimetals confined on phosphorus and nitrogen co-doped carbon foam support with high specific surface area, highly porous structure, and formation of graphitic domains, which enhances the electrical conductivity. This work sheds light on the potential for valorizing petroleum pitch and provides a facile synthesis approach to synthesizing a low-cost, high-performance, and durable electrocatalyst for alkaline OER.



Graphical Abstract Representation

Durakovic, G. *et al.*

Are green and blue hydrogen competitive or complementary? Insights from a decarbonized European power system analysis

https://doi.org/10.1016/j.energy.2023.128282

Abstract:

Hydrogen will be important in decarbonized energy systems. The primary ways to produce low emission hydrogen are from renewable electricity using electrolyzers, called green hydrogen, and by reforming natural gas and capturing and storing the CO2, known as blue hydrogen. In this study, the degrees to which blue and green hydrogen are complementary or competitive are analyzed through a sensitivity analysis on the electrolyzer costs, and natural gas price. This analysis is performed on four bases: what is the cost-effective relative share between blue and green hydrogen deployment, how their deployment influences the price of hydrogen, how the price of CO2 changes with the deployment of these two technologies, and whether infrastructure can economically be shared between these two technologies. The results show that the choice of green and blue hydrogen has a tremendous impact, where an early deployment of green leads to higher hydrogen costs and CO2 prices in 2030. Allowing for blue hydrogen thus has notable benefits in 2030, giving cheaper hydrogen with smaller wider socioeconomic impacts. In the long term, these competitive aspects disappear, and green and blue hydrogen can coexist in the European market without negatively influencing one another.

Zhang, HH. *et al.*

Material challenges in green hydrogen ecosystem

https://doi.org/10.1016/j.ccr.2023.215272

Abstract:

Green hydrogen (H2) is one of the most promising candidates to combat the global energy crisis because of its high energy density, sustainability and abundance on earth. Large-scale green H2 ecosystems that empower the global transition towards a carbon-neutral energy society are highly desired, yet challenging, to be deployed. Limitations such as relatively low production and storage efficiencies from renewable technologies, high transportation and utilization costs and safety concerns regarding H2 handling greatly restrain the development of green H2 ecosystems. Revolutions in materials science and technology are crucial to tackle these issues and construct practical green H2 ecosystems. Though reviews focus exclusively on the material development in individual sectors of the H2 ecosystem, they lack a review focusing on the material challenges and advances in the green H2 ecosystem in a comprehensive and instructive manner. It is pivotal to providing constructive and universal solutions for common material challenges in green H2 technologies, bringing together efforts from all relevant fields and exploring new opportunities and breakthroughs. Herein, this review features cutting-edge material advances and identifies the critical material challenges throughout the entire green H2 ecosystem, including renewable H2 production, purification, storage, transportation, application and safety and cost management. Promising strategies proposed in material progress in the past five years are analyzed to address the material challenges and provide practical and goal-oriented approaches to the material revolution in green H2related technologies. In-depth insights into cost management are also covered in this review to inspire the translation of advances in materials science into practical large-scale green H2 ecosystems. This is the very first comprehensive and goal-oriented review that presents an overall picture of the entire green H2 ecosystem, as well as the role and specific material requirements and advancement in each part of the ecosystem. In this way, this review will identify the current bottlenecks or fundamental challenges that require urgent breakthroughs in the entire green H2 ecosystem instead of focusing on a particular part so that more effort can be directed to those directions to achieve fast advancement. It will pave the way for building up a green and sustainable H2 economy in the near future.

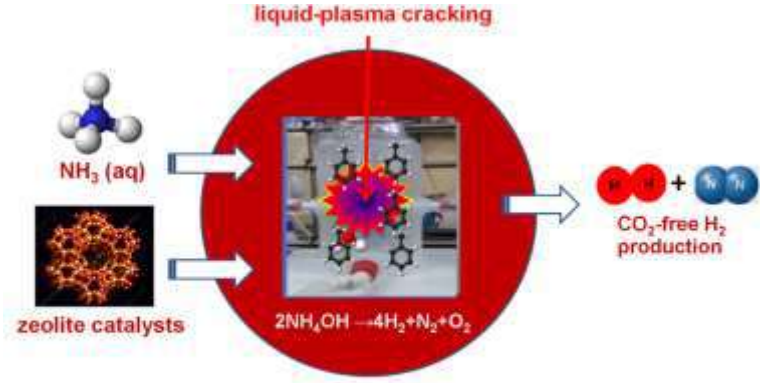
Chung, KH. *et al.*

Green hydrogen production from ammonia water by liquid-plasma cracking on solid acid catalysts

https://doi.org/10.1016/j.renene.2023.119052

Abstract:

In this study, a method for producing green hydrogen from ammonia water using plasma cracking was proposed. Solid acid catalysts, FAU and MFI zeolites, were used as catalysts. Zeolites were prepared by varying the Si/Al molar ratio to investigate the relationship between the acid sites of the catalyst and the reaction activity. The plasma was directly discharged into the ammonia water to generate hydrogen from the decomposition of ammonia. The gaseous products from the ammonia decomposition by plasma were mostly hydrogen with some nitrogen. No CO2 was produced. Even when the catalyst was not injected, approximately 100 L/h of hydrogen was produced only by plasma discharge. The injection of the FAU or MFI zeolite catalysts improved the hydrogen production rate. The rate of hydrogen production obtained from the decomposition of ammonia water by catalyst and plasma irradiation was the highest for the FAU zeolite with the highest number of acid sites. The hydrogen production rate tended to increase in proportion to the number of acid sites in the catalyst.



Green H_2 production from ammonia water using liquid-phase plasma

Graphical Abstract Representation

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 58
NOVEMBER, 2023

HGenium Unveils First-of-Its-Kind Technology for Green Hydrogen Production

HGenium, Inc., an exciting new technology entrant in the rapidly growing green hydrogen industry, company's breakthrough thermochemical water splitting process at the 2023 AIChE conference (American Institute of Chemical Engineers) in Orlando, Florida.

HGenium's unique technology enables green hydrogen to be produced using readily available materials and processing equipment with a wide variety of heat energy sources.

Key benefits of a thermochemical approach include:

- A wide array of heat sources can be used, such as concentrated solar, nuclear, and industrial production process heat, widening the potential commercial cases for using a thermochemical process versus electrolysis;
- The almost 70% lower cost of heat over thermal based electricity opens the possibility of improved overall economics for many use cases; and
- Storing heat has inherent safety and cost benefits over electricity storage.

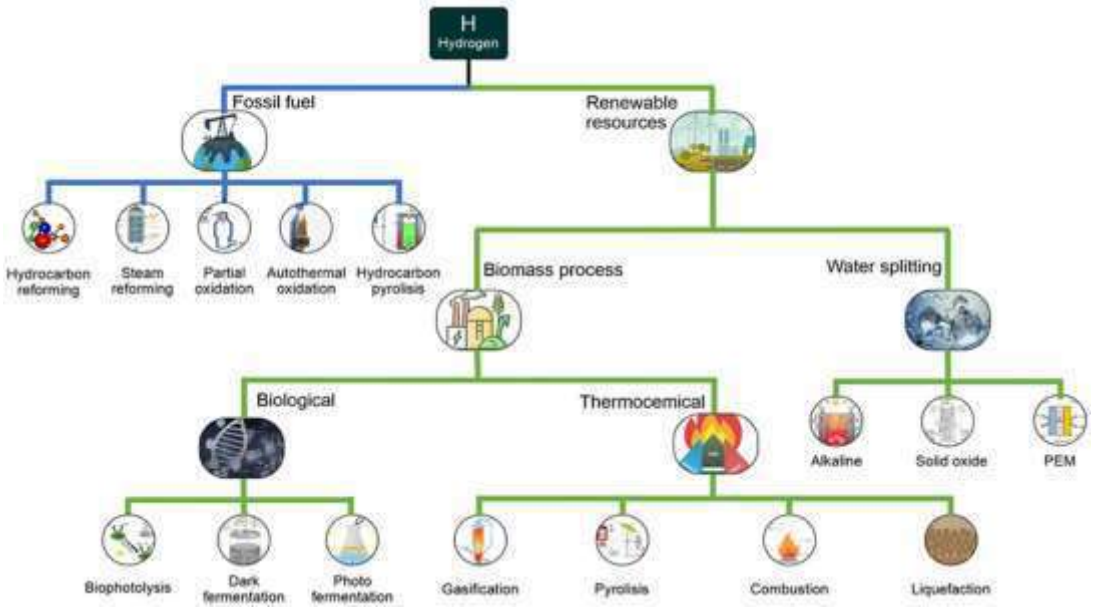
A pilot plant project is underway, with operations targeted for the second half of 2024 to be followed with construction of a commercial scale demonstration unit in 2025-26. These steps will position the company and its partners to most efficiently launch commercial units at substantial capacities in the future.

Citation:

https://finance.yahoo.com/news/hgenium-unveils-first-kind-technology-140000177.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAAjq5nT47E42zm1k_3Wjsb8MwZT4jDIFhDLSH2NEvpQrt74ipaIUlT4pCtkg2Jgu5zaPgo4NCarST4DbbTzW9iMNofFBCOl41SYnANwZRPzs-5uRE02BQM4Tfc7itO44-ci8nQTFPReNvQz5jDDWxgSzzbAwCkyM3OnORreSEz6W

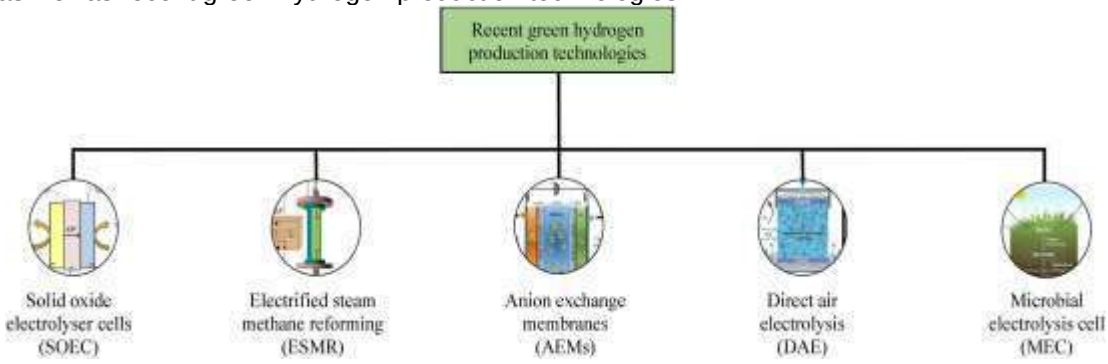
Recent Advancement & Assessment of Green Hydrogen Production Technologies

There are different types of hydrogen represented by different colors. But there is a growing demand for green hydrogen worldwide as it is capable of becoming future fuel.



The different color codes of hydrogen along with the costs, efficiency, recent hydrogen production technologies, advantages and disadvantages and implications for future has been discussed in the review.

The review also focuses on different policies and strategies of government of various countries as well as recent green hydrogen production technologies.



In current research, the Solid Oxide Electrolysis Cell (SOEC) has been shown to outperform the other electrolysis techniques with other promising ones include Anion Exchange Membrane (AEM) and Electrified Steam Methane Reforming (ESMR). SOECs have a longer start-up time as well as low cost because of the ceramic material used as the electrolyte. These have a TRL 6 – 7 technology which indicates that this technology is ready for commercialization.

Green Hydrogen plays a pivotal role in mitigating emissions and climate change and align with the Sustainable Development Goals.

Zainal, B. S., Ker, P. J., Mohamed, H., Ong, H. C., Fattah, I. M. R., Rahman, S. M. A., Nghiem, L. D., & Mahlia, T. M. I. (2024). Recent advancement and assessment of green hydrogen production technologies. Renewable and Sustainable Energy Reviews, 189, 113941. https://doi.org/https://doi.org/10.1016/j.rser.2023.113941

EVENTS

Mercom India Renewables Summit 2024 Where Policy and Ambition Turn to Action

Date: July 25 – 26, 2024

Venue: Hyatt Residency, New Delhi

Mercom is an internationally recognised clean energy research and communications firm that brings a global perspective to the local market.
This will bring insights to the government's clean energy goals.

Link:
https://www.mercomindia.com/event/renewables-summit-2024

Renewable Energy Summit 2023

Date: 20th December 2023

Venue: India Habitat Centre, New Delhi

The event will witness the best of the minds representing the global, regional and the Indian energy industry convening around an ambitious and modern agenda covering the most significant topics for discussion including India's G20 presidency as an energy opportunity.

Link:

https://et-edge.com/conferences/renewableenergy/

GE Joins Green Hydrogen Power Plant Project

GE Vernova is joining Duke Energy in its development of an "end-to-end green hydrogen system" at the latter's DeBary plant, near Orlando, and starting up in 2024. It will be the first plant in the U.S. to produce and use green hydrogen to power a gas turbine for peaking power applications, when the grid requires additional electrical generation. Green hydrogen is an industrial gas fuel produced from water by electrolysis using renewable energy, so that it generates no polluting emissions.
GE Vernova will modify the 7E gas turbine gas turbine infrastructure at the DeBary plant, including the fuel handling systems, valves, and piping compatible with higher blends of hydrogen operation and up to 100% hydrogen (by volume).



https://www.americanmachinist.com/news/article/21277022/partners-developing-green-hydrogen-power-plant-ge-vernova

NEOM get first set of wind turbines for mega green hydrogen plant

NEOM Green Hydrogen Company (NGHC), the company that is building the world's largest green hydrogen plant, has announced that it has received the first delivery of wind turbines at the Port of NEOM in northwest Saudi Arabia. A milestone in the construction and development of the mega project, the first set of wind turbines was successfully delivered on October 8, and are now being transported via road to the Wind Garden site near Gulf of Aqaba where they will be assembled and installed. According to NGHC, additional turbines are expected to be delivered by the end of the year, with its Wind Garden ultimately featuring more than 250 to directly power the green hydrogen plant via a dedicated electricity transmission grid.
https://www.tradearabia.com/news/IND_415433.html

Hydrogen-Powered Revolution in Serbian Steel

Chinese company HBIS GROUP is set to pioneer the use of hydrogen as an energy source in its Serbian iron and steel plant, marking a historic leap in the EU candidate country's journey towards energy efficiency and green transformation.
The impending introduction of hydrogen as an energy source in HBIS GROUP's Serbian iron and steel plant is a milestone that promises to redefine the industry's landscape. This pioneering initiative not only aligns with global efforts to reduce carbon emissions but also demonstrates the company's commitment to a sustainable, greener future. Serbia's endorsement of this project reinforces the significance of collaborative efforts between corporations and governments in achieving environmental responsibility.



https://www.steelguru.com/steel/hydrogen-powered-revolution-in-serbian-steel

B.C. eyes green hydrogen economy with cross-country partnership

A continent won't keep British Columbia from partnering with Newfoundland and Labrador when it comes to developing a hydrogen economy. That was the message Premier David Eby and his counterpart Andrew Furey of Newfoundland and Labrador were trying to send when they signed a statement of co-operation Tuesday afternoon local time in St. John's. "We are coastal provinces, we have significant energy resources and potential, we have a shared interest in the growing hydrogen sector in particular and low-carbon energy future, generally," Eby said, adding that B.C. is home to about 50 per cent of Canada's hydrogen businesses, a legacy of Burnaby-based Ballard Power System.
https://www.abbynews.com/news/bc-eyes-green-hydrogen-economy-with-cross-country-partnership-6842739

EVENTS

India Energy Storage Week

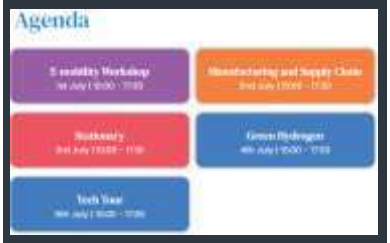
Date: July 1st to 5th 2024

Venue: IICC (India International Convention and Expo Centre), New Delhi, India

An international conference and exhibition on Energy Storage, E-Mobility, Charging Infrastructure, Green Hydrogen & Micro grids. It is India's premier B2B networking & business event focused on renewable energy, advanced batteries, alternate energy storage solutions, electric vehicles, charging infrastructure, Green Hydrogen, Battery Manufacturing & Supply Chain and micro grids ecosystem.

7th IESA Industry Excellence Award

2nd July - 6 to 10 pm



Link:

https://www.energystorageweek.in/

Canada firm to build C$4 billion green hydrogen project in Quebec -source

Montreal-based renewable energy firm TES Canada H2 Inc. will build a C$4-billion ($2.9 billion) green hydrogen project in Quebec that is expected to create 200 permanent jobs and reduce 3% of the province's carbon emissions by 2030, a source familiar with the project told Reuters on Thursday. TES Canada, a unit of Tree Energy Solutions, is expected to make an announcement on the project on Friday with Canadian Industry Minister Francois-Philippe Champagne, the source said, declining to be named because details are not yet public. The green hydrogen project will use a wind and solar farm to produce most of the energy it needs, and it will create over 1,000 temporary jobs during the construction period, in addition to permanent positions, the source said. The project will produce 70,000 tonnes of green hydrogen annually from 2028 - about a third of which will be dedicated to decarbonizing long-haul transportation, and the remaining will be used to produce electric renewable natural gas, the source said.

https://www.msn.com/en-ca/news/canada/canada-firm-to-build-c-4-billion-green-hydrogen-project-in-quebec-source/ar-AA1jFZl0

Namibia Initiates Africa's Inaugural Decarbonized Iron Plant using only Green Hydrogen

One of the most polluting sectors of the global economy is steelmaking, which is attempting to switch from coal-fired facilities to decarbonized iron. The Namibia Investment Promotion and Development Board (NIPDB) released a statement stating that the Oshivela project in western Namibia has the support of the German federal government, which has contributed 13 million euros. The project will generate 15,000 tonnes of iron annually using renewable energy sources without emitting any carbon emissions. Iron is traditionally reduced in blast furnaces by adding coke from hard coal, which emits a lot of CO2. Steel manufacturing today accounts for around one-eighth of worldwide CO2 emissions and strongly contributes to climate change. A direct reduction plant does not utilize coke as a reducing agent and instead employs natural gas or hydrogen.

https://iafrica.com/namibia-initiates-africas-inaugural-decarbonized-iron-plant-using-only-green-hydrogen

Yanmar Delivers Its First Maritime Hydrogen Fuel Cell System

Yanmar Power Technology Co., Ltd. (Yanmar PT), a subsidiary of Yanmar Holdings Co., Ltd, has made its first delivery of its newly commercialized maritime hydrogen fuel cell system, introduced in August 2023. This system was supplied to the passenger ship Hanaria, operated by MOTENA-Sea, a company backed by Mitsui O.S.K. Lines, Ltd. and other investors. The Hanaria is Japan's first hybrid passenger ship to use both hydrogen and biodiesel. The vessel operates with an on-board electric propulsion system that powers the ship's drive using generated electricity. Yanmar PT took charge of the ship's comprehensive power system design, incorporating two hydrogen fuel cells, batteries, biodiesel generators, power management system, propulsion equipment, remote monitoring, and other elements.



https://www.marinelink.com/news/yanmar-delivers-first-maritime-hydrogen-509364

Air Products to build Europe's largest blue hydrogen plant in Netherlands

Air Products and Chemicals said on Monday it will build, own and operate a carbon capture and carbon dioxide (CO2) treatment facility at its existing hydrogen production plant in Rotterdam, Netherlands.

The facility is expected to be on-stream in 2026, and the resulting "blue" hydrogen product would serve Exxon Mobil's Rotterdam refinery and additional customers via Air Products' hydrogen pipeline network system.

Air Products, which supplies industrial gases to sectors ranging from electronics and manufacturing to food and beverages, said this will be the largest blue hydrogen plant in Europe once operational.

https://auto.economictimes.indiatimes.com/news/industry/air-products-to-build-europes-largest-blue-hydrogen-plant-in-netherlands/105029727

WEBINARS

Materials Science for H2 Applications

Going live: November 14th, 2023, 16:30 (GMT) | 8:30 (PST) | 11:30 (EST)
Brought by:

Transporting and storing H2 as a liquid is more efficient, but at its point of use, H2 is a gas. As a result, two phenomena can impact metals used in hydrogen systems:

1. Low–temperature embrittlement
2. Hydrogen embrittlement

It is critical to remember that materials matter for hydrogen containment. Fluid systems made with specifically formulated, high-quality stainless steel can better resist the challenges inherent to hydrogen containment. In this webinar, **Chuck Hayes**, Global Technical Lead for Clean Energy at Swagelok, will discuss how a focus on materials science can address and overcome these challenges.
Link:
https://www.gasworld.tv/showcase-webinar-materials-science-for-h2-applications/

In Conversation with Green Hydrogen Systems

Going live: November 30th 2023 | 14:30 (GMT)

Empowering Europe: A Case Study on Green Hydrogen Synergy – From High Performance Electrolysers to Zero Emission Distributed Power

Link:
https://www.gasworld.tv/80-technology-pillar-electrolysers-special/

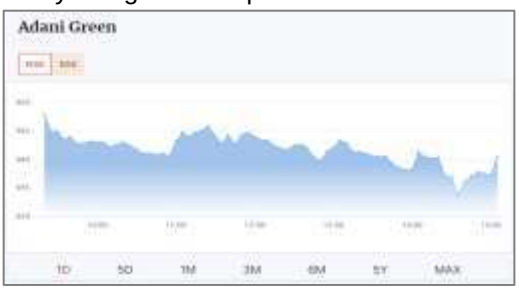
INDIA NEWS

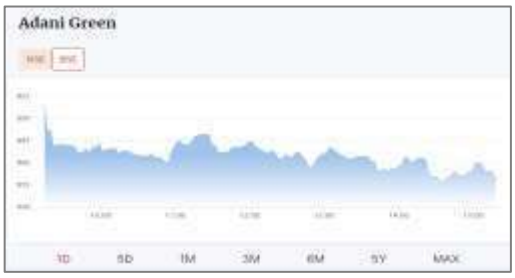
Green hydrogen production from Indian power grid to yield 30 kg CO2 per kg hydrogen: V K Saraswat, member, NITI Aayog

Hydrogen production through electrolysis from the Indian power grid would yield about 30 kg of carbon dioxide emissions per kg of hydrogen, according to V K Saraswat, member, NITI Aayog. He said that in comparison, blue hydrogen produced from natural gas reformation is estimated to emit 1.7 kg CO_2 per kg hydrogen. “The production of green hydrogen will have a lower carbon footprint than blue hydrogen only when the grid reaches 90 per cent carbon-free power generation. Thus, adopting blue hydrogen will eventually lay the path for green hydrogen with incremental greening of source electricity,” Saraswat noted in his presentation.
In August 2023, the ministry of new and renewable energy issued the Green Hydrogen Standard for India. It defined green hydrogen as having a well-to-gate emission – including water treatment, electrolysis, gas purification, drying and compression of hydrogen – of not more than 2 kg CO2 equivalent per kg of hydrogen produced. Green hydrogen is green, considering the energy source perspective linked to production, but is not carbon neutral in true sense, he said. Saraswat further noted that joint research and development projects on cost reduction, cross-border partnerships, and technology transfer agreements would result in strengthening of technology and workforces. Regarding the options of nuclear energy assisted hydrogen production, he said that it needs to be considered in order to meet large demands in a sustainable way. “India may employ a closed nuclear fuel cycle with large-scale thorium utilisation. This opens the opportunity for high temperature small modular reactors,” he added. He said that R & D activities at The Bhabha Atomic Research Centre – country’s premier nuclear research facility headquartered in Trombay, Mumbai – are targeting challenging technologies for high temperature nuclear reactors using thorium-based fuel and capable of supplying process heat at 1,000 degree Celsius.
Green hydrogen production from Indian power grid to yield 30 kg CO2 per kg hydrogen: V K Saraswat, member, NITI Aayog, ET EnergyWorld (indiatimes.com)

Adani Green crosses 8.4 GW mark, becomes India's largest RE company

Adani Green Energy Ltd (AGEL) has become India's largest green energy company as it reached the 8.4 gigawatt (GW) installed capacity mark last week. Company executives told this paper that AGEL commissioned a 0.15 GW solar power park in Rajasthan, which helped it surpass the 5 GW capacity for solar and 8.4 GW overall.
Among its peers, ReNew is closest with 8.3 GW, followed by Tata Power and Greenko Energies with close to 4 GW capacity each. State-owned NTPC has a 3.2 GW green energy capacity. At 5 GW, AGEL also operates the country's largest solar portfolio.





"AGEL’s management has guided that it plans to commission between 2.8 GW to 3 GW in the current financial year (FY24), with a capital expenditure of approximately Rs 14,000 crore in the current financial year," said a senior executive. The company's upcoming projects will be located in the states of Rajasthan, Gujarat, Andhra Pradesh, and Karnataka, according to the company's various corporate presentations. AGEL announced earlier this year an ambitious target of achieving 45 GW of renewable energy capacity by the year 2030.
According to the company executives, close to 97 per cent of AGEL's capacity is under long-term fixed tariff Power Purchase Agreements (PPAs) of 25-year duration and an average portfolio tariff of Rs 3.02 per unit.
https://www.business-standard.com/companies/news/adani-green-crosses-8-4-gw-mark-becomes-india-s-largest-re-company-123110600741_1.html

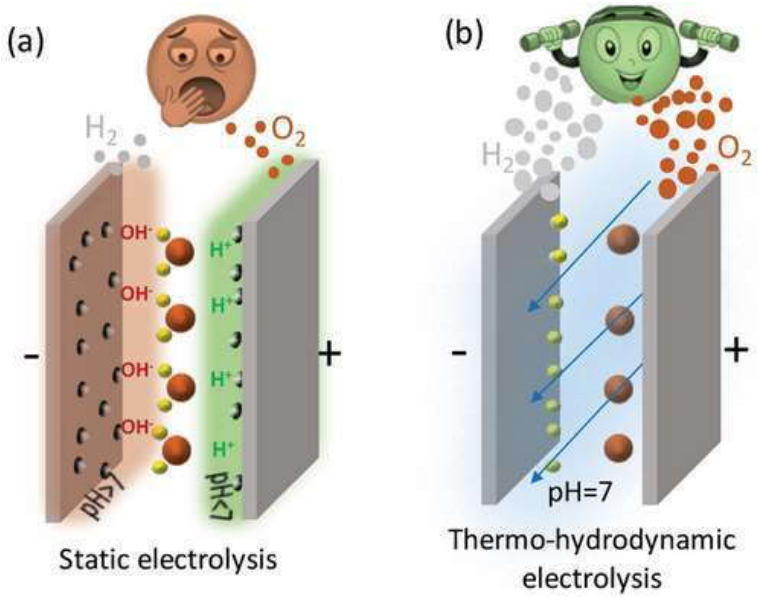
Bahuguna, G. and Patolsky, F.

Enabling Unprecedented Ultra-Efficient Practical Direct Seawater Splitting by Finely-Tuned Catalyst Environment via Thermo-Hydrodynamic Modulation

https://doi.org/10.1002/aenm.202301907

Abstract:

Direct sea water splitting as a source of clean renewable energy is indeed a holy grail and necessitates the invention of unprecedented avenues. Toward this goal, for the first time, the effect of thermo-hydrodynamic processes modulation (electrolyte flow and heating) on water splitting reactions, through the controlling of the nanocatalyst surface environment, is studied thoroughly. A catenated sulphur type-nickel polysulphide-based single crystalline, high surface area 3D electrocatalyst (NiS (2)pS(x)(surface)), with surface-enriched oxygen evolution reaction (OER, Ni3+) and hydrogen evolution reaction (HER, pS(n)(2-)) catalyzing species, is prepared by a single-step process. Thermo-hydrodynamic processes-induced electrochemical analysis demonstrates a dramatic improvement in the electrocatalytic performance of the catalyst, by both flow and temperature modulation. Decoupling contributions from the electrolyte and electrodes heating demonstrate an intrinsic electrode property influence on the overall temperature-dependent electrochemical performance. Furthermore, a chlorine-phobic behavior of the NiS(2)pS(x)(surface) catalyst is observed, even at 80(degrees)C, for direct seawater oxidation, confirming the electrocatalyst potential for direct seawater splitting. Notably, a cell voltage of 1.39 V (at 10 mA cm (-2)), reaching industrially practical large-scale of >500 mA cm (-2) is observed for additive-free direct seawater splitting, which is the lowest reported cell voltage to date, even for alkaline additive-based electrolysers. Consequently, an alternative approach for direct seawater splitting is realized and can be universally extended to any present-day electrocatalyst platform.



Graphical Abstract Representation

Siracusano, S. *et al.*

Ce-radical Scavenger-Based Perfluorosulfonic Acid Aquivion® Membrane for Pressurised PEM Electrolysers

https://doi.org/ 10.3390/polym15193906

Abstract:

A Ce-radical scavenger-based perfluorosulfonic acid (PFSA) Aquivion (R) membrane (C98 05S-RSP) was developed and assessed for polymer electrolyte membrane (PEM) electrolyser applications. The membrane, produced by Solvay Specialty Polymers, had an equivalent weight (EW) of 980 g/eq and a thickness of 50 mu m to reduce ohmic losses at a high current density. The electrochemical properties and gas crossover through the membrane were evaluated upon the formation of a membrane-electrode assembly (MEA) in a range of temperatures between 30 and 90(degrees) C and at various differential pressures (ambient, 10 and 20 bars). Bare extruded (E98 05S) and reinforced (R98 05S) PFSA Aquivion (R) membranes with similar EWs and thicknesses were assessed for comparison in terms of their performance, stability and hydrogen crossover under the same operating conditions. The method used for the membrane manufacturing significantly influenced the interfacial properties, with the electrodes affecting the polarisation resistance and H2 permeation in the oxygen stream, as well as the degradation rate, as observed in the durability studies.

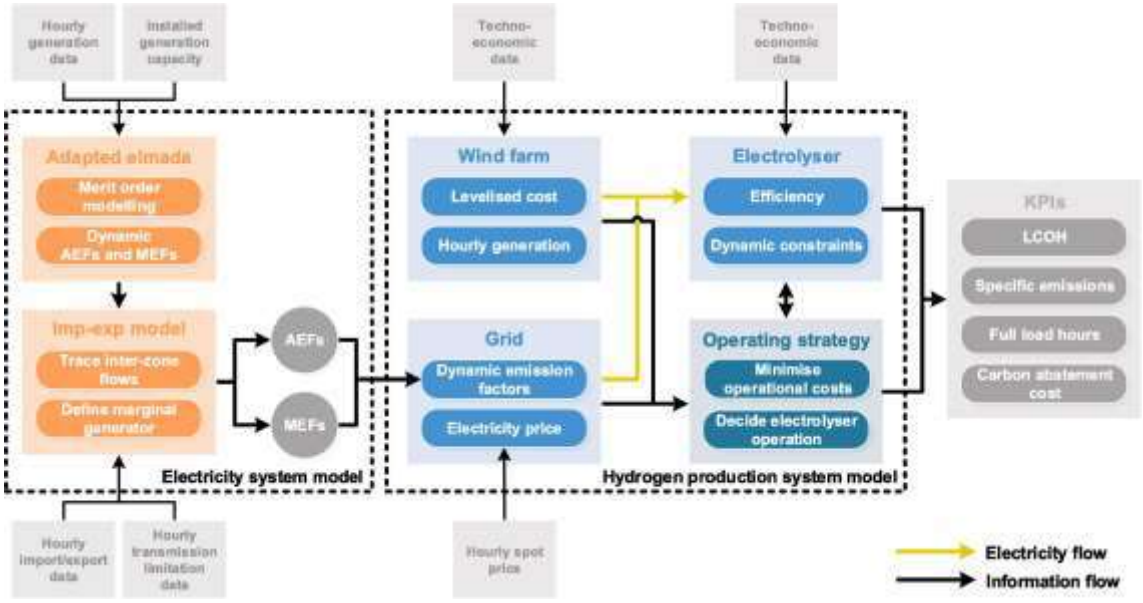
Engstam, L. *et al.*

Grid-supported electrolytic hydrogen production: Cost and climate impact using dynamic emission factors

https://doi.org/ 10.1016/j.enconman.2023.117458

Abstract:

Hydrogen production based on a combination of intermittent renewables and grid electricity is a promising approach for reducing emissions in hard-to-decarbonise sectors at lower costs. However, for such a configuration to provide climate benefits it is crucial to ensure that the grid electricity consumed in the process is derived from low-carbon sources. This paper examined the use of hourly grid emission factors (EFs) to more accurately determine the short-term climate impact of dynamically operated electrolysers. A model of the interconnected northern European electricity system was developed and used to calculate average grid-mix and marginal EFs for the four bidding zones in Sweden. Operating a 10 MW electrolyser using a combination of onshore wind and grid electricity was found to decrease the levelised cost of hydrogen (LCOH) to 2.40-3.63 euro/kgH2 compared with 4.68 euro/kgH2 for wind-only operation. A trade-off between LCOH and short-term climate impact was revealed as specific marginal emissions could exceed 20 kgCO2eq/kgH2 at minimum LCOH. Both an emission-minimising operating strategy and an increased wind-to-electrolyser ratio was found to manage this trade-off by enabling simultaneous cost and emission reductions, lowering the marginal carbon abatement cost (CAC) from 276.8 euro/tCO2eq for wind-only operation to a minimum of 222.7 and 119.3 euro/tCO2eq respectively. Both EF and LCOH variations were also identified between the bidding zones but with no notable impact on the marginal CAC. When using average grid-mix emission factors, the climate impact was low and the CAC could be reduced to 71.3-200.0 euro/tCO2eq. In relation to proposed EU policy it was demonstrated that abiding by hourly renewable temporal matching principles could ensure low marginal emissions at current levels of fossil fuels in the electricity mix.



Graphical Abstract Representation

Wei, JC. *et al.*

Electrochemical advanced oxidation processes using PbO2 anode and H2O2 electrosynthesis cathode for wastewater treatment

https://doi.org/10.1016/j.psep.2023.07.091

Abstract:

The assessments of a novel electrochemical advanced oxidation process are presented, where PbO2 anode and H2O2 electrosynthesis cathode are simultaneously used in one system. The anode is & beta;-PbO2 coated on a titanium substrate. The cathode is fabricated by rolling the activated Vulcan XC-72R carbon catalyst and PTFE binder on the titanium current collector as the catalyst layer and water-repellent layer, according to different carbon/PTFE ratios. Different electrolysers are used to evaluate the synergistic contributions of the PbO2 anode and H2O2 generated cathode on the pollutant degradation process. The contributions of both direct anodic oxidation and indirect oxidation can be observed. The synergy of the PbO2 anode and H2O2 on-site generated cathode can significantly enhance the oxidation ability and COD removal. Almost all COD in the real pesticide wastewater and dye wastewater can be removed using a PbO2-H2O2 batch electrolyser, which is run at a cell voltage of 3.0 V and at room temperature. The reaction mechanisms in both chloride-containing and sulfate-containing wastewater are discussed particularly.

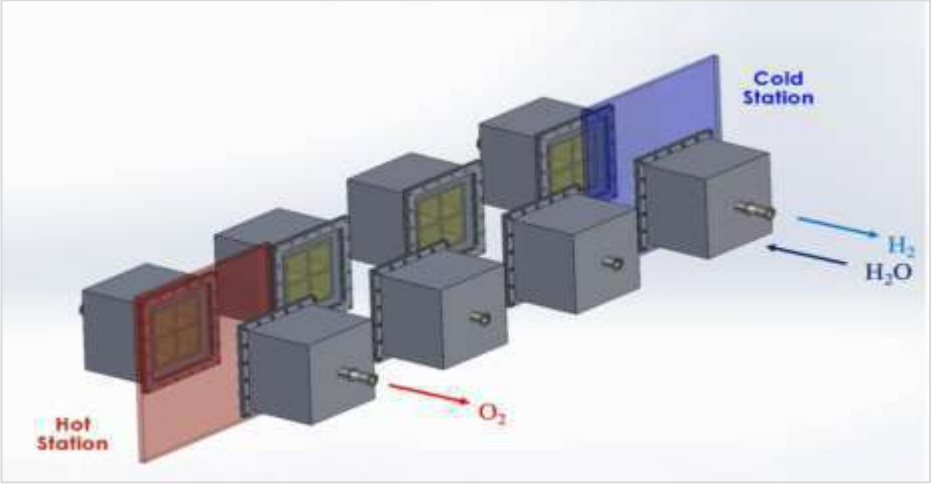
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 59
NOVEMBER, 2023

MIT Design Would Harness 40 Percent of the Sun's Heat to Produce Clean Hydrogen Fuel

Conventional systems for producing hydrogen depend on fossil fuels, but the new system uses only solar energy. The MIT engineers lay out the conceptual design for a system that can efficiently produce "solar thermochemical hydrogen." The system harnesses the sun's heat to directly split water and generate hydrogen — a clean fuel that can power long-distance trucks, ships, and planes, while in the process emitting no greenhouse gas emissions.



Hydrogen is largely produced through processes that involve natural gas and other fossil fuels, making the otherwise green fuel more of a "grey" energy source when considered from the start of its production to its end use. In contrast, solar thermochemical hydrogen, or STCH, offers a totally emissions-free alternative, as it relies entirely on renewable solar energy to drive hydrogen production. But so far, existing STCH designs have limited efficiency: Only about 7 percent of incoming sunlight is used to make hydrogen. The results so far have been low-yield and high-cost.

MIT system would be paired with an existing source of solar heat, such as a concentrated solar plant (CSP) — a circular array of hundreds of mirrors that collect and reflect sunlight to a central receiving tower. An STCH system then absorbs the receiver's heat and directs it to split water and produce hydrogen. This process is very different from electrolysis, which uses electricity instead of heat to split water.

Process at Solar Stations:

At the heart of a conceptual **STCH system** is a two-step thermochemical reaction.

- H_2O in the form of steam is exposed to a metal which grab oxygen from steam, leaving H_2 behind. This metal "oxidation" is similar to the rusting of iron in the presence of water, but it occurs much faster.
- Once **H_2 is separated**, the oxidized (or rusted) metal is reheated in a vacuum, which acts to reverse the rusting process and regenerate the metal. With the oxygen removed, the metal can be cooled and exposed to steam again to produce more hydrogen. This process can be repeated hundreds of times.
- The system as a whole resembles **a train of box-shaped reactors running on a circular track**. In practice, this track would be set around a solar thermal source, such as a CSP tower. Each reactor in the train would house the metal that undergoes the redox, or reversible rusting, process.

https://indiaeducationdiary.in/mits-innovative-design-could-unlock-40-of-solar-heat-for-clean-hydrogen-fuel-production/
https://news.mit.edu/2023/mit-design-harness-suns-heat-produce-clean-hydrogen-fuel-1016

Partners to study hydrogen production using Rolls-Royce SMR

ULC-Energy of the Netherlands has signed an agreement with Denmark's Topsoe and the UK's Rolls-Royce SMR to jointly investigate the production of hydrogen using Topsoe's Solid Oxide Electrolysis Cell (SOEC) technology with both electricity and heat produced by a Rolls-Royce SMR nuclear power plant.

The joint investigation will include a valuation of the operational flexibility of the Rolls-Royce SMR in combination with Topsoe's proprietary SOEC technology in the future energy market.

The Technology:

- The electrolysis takes place at a high temperature, which means that less electricity is needed to produce hydrogen,
- Nuclear power plants can produce energy on average up to 95% of the time, significantly higher than alternative variable energy sources; and nuclear energy can supply heat as well as electricity,
- By using heat directly, energy losses in the steam turbine can be avoided thus increasing the effective energy capacity of the nuclear power plant above its electric power rating.

The Rolls-Royce SMR nuclear power plant when required, can switch to deliver power to the grid, providing back-up to variable power sources when these sources are not available. ULC-Energy said this is expected to be a competitive solution compared with alternatives, like long-duration energy storage solutions or hydrogen combustion for electricity generation.

This study demonstrates the synergy between Topsoe's SOEC technology and nuclear. SOEC is a modular design that leverages high-temperature electrolysis that enables industrial-scale production of clean hydrogen using clean energy.

Link:
https://www.world-nuclear-news.org/Articles/Partners-to-study-hydrogen-production-using-Rolls

REPORT

World Energy Employment 2023



Published:
November 2023

About the Report:
The second edition of the World Energy Employment (WEE) report tracks the evolutions of the energy workforce from before the pandemic, through the global energy crisis, to today. The report provides a comprehensive stock-take of energy employment with estimates of the size and distribution of the labour force across regions, sectors, and technologies. The dataset provides granularity on workers along the entire energy value chain, covering fossil fuel supply, bioenergy, nuclear, low-emissions hydrogen, power generation, transmission, distribution, and storage; and key energy-related end uses, including vehicle manufacturing and energy efficiency for buildings and industry, among other segments. WEE 2023 includes for the first time employment data for the extraction of selected critical minerals, including copper, cobalt, nickel and lithium. WEE 2023 explores in depth the risks of skilled labour shortages and how this may influence the outlook for the industry and includes new analysis on skills, certifications, wages, and job postings.

Link:
IEA (2023), World Energy Employment 2023, IEA, Paris https://www.iea.org/reports/world-energy-employment-2023, License: CC BY 4.0

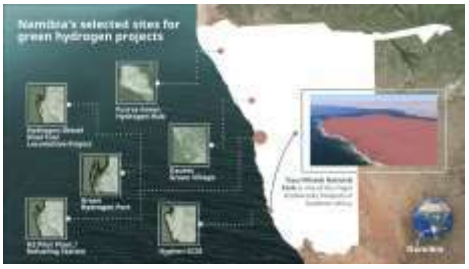
Global green hydrogen business establishes Yorkshire base in UK expansion

France-headquartered multinational, Lhyfe, has expanded its UK operation to South Yorkshire with the aim of accelerating the roll-out of the environmentally friendly gas across the region. Lhyfe, which already has a base in Newcastle, is exploring various production sites and partnerships nationwide.
Its new Sheffield office, in the Wizu Workspace in the city centre, will be headed by renewable energy expert Stuart Sinclair.
Lhyfe is also keen to establish links across academia with high-profile hydrogen fuel switching research projects underway at the University of Sheffield.
The gas can support the deep decarbonisation of the UK economy, particularly in hard-to-abate sectors such as heavy industry, including steelmaking, and transport.
Lhyfe produces renewable green hydrogen through water electrolysis, powered by renewable energy — primarily wind and solar power. Water is fed into the electrolyser, which is split into hydrogen and oxygen meaning the only by-product is oxygen. The hydrogen is then compressed and transported locally from the production unit to consumers across the region, providing an alternative to fossil fuels.
The company's inaugural plant at Pays de La Loire has been operating since the second half of 2021, and an additional six sites across Europe are currently under construction.
Lhyfe wants its production capacity to reach up to 22 tons of green hydrogen per day by the end of 2024 and up to 80 tons per day by the end of 2026. Colin Brown, UK and Ireland country manager, said: "Renewable green hydrogen production offers significant decarbonisation options for a range of organisations, and there is extraordinary potential in Sheffield. "This new office is in line with our ambitious UK deployment plans and we felt it was the right time to establish a base here."
https://www.thebusinessdesk.com/yorkshire/news/2116683-global-green-hydrogen-business-establishes-yorkshire-base-in-uk-expansion

Shades of green hydrogen: EU demand set to transform Namibia



Backed by the EU, Namibia has a US$20 billion plan to export green hydrogen. Keen to secure pole position in the global race for green hydrogen, last year the EU began reaching agreements with prospective producers. One of the most trumpeted deals was signed with Namibia on the sidelines of Cop27 in Sharm el-Sheikh, Egypt.
Namibia is seeking $20 billion of investment in green hydrogen – more than its entire GDP of $12 billion in 2022. Government authorities are negotiating funding options with the EU.



Perched between the Namib desert and the Atlantic Ocean, Lüderitz is named after a German colonist. It was the centre of a diamond rush in 20th century and of a colonial history that repressed indigenous Africans.
Hyphen's plans show an initial 5GW of wind turbines and solar panels to supply power, according to the project's factsheet published by the Namibian government. An electrolysis plant will split the water into hydrogen and oxygen, before the hydrogen gas is converted into liquid ammonia. A new deepwater port will accommodate tankers to ship the end product around the world. The company aims to produce 300,000 tons of ammonia a year, commissioning the first phase by 2026, Hyphen's website says.
"No green energy project can be implemented without some environmental impact and Hyphen's objective is to minimise environmental impacts to the largest extent possible," Hyphen CEO Marco Raffinetti said in an interview with Climate Home.
Under the memorandum of understanding signed in Sharm el-Sheikh, the EU will provide technical expertise, trade incentives and, crucially, help to secure infrastructure finance.
Moments after von der Leyen and Geingob inked their deal, the European Investment Bank promised loans of up to €500 million ($528m) for renewable hydrogen investments in Namibia. Since the initial announcement, European institutions, Namibian government officials and private actors have been working out the details of the partnership. Hyphen is looking for €100 million to start work on the project.
https://www.climatechangenews.com/2023/11/15/green-hydrogen-namibia-europe-japan-tax-biodiversity-impacts

EVENTS

Annual India Coal Conference 2023



Date: November 21-22, 2023

Venue: Hotel Le Meridien, New Delhi, India

At its core the 5th edition of the conference plays an integral role in connecting industry-leading coal suppliers, traders, and consumers from around the world, whilst facilitating thought-provoking conversations that drive the coal industry forward. This year's conference places a spotlight on the growing opportunity for coal in India as industry leaders join us in New Delhi and witness over 500+ Delegates from over 15 countries to explore opportunities and make new connections.

Link:
https://icc-2023.com/

INDIA ENERGY CONCLAVE

Theme: Global Energy Transition Trends: Sustainable Energy Options For India – Target Carbon Neutral – 2070
Date: 23rd -24th November 2023
Venue: Scope Convention Centre, Lodhi Road, New Delhi, India
IEC 2023 invites the submission of abstracts for the presentation in the conference to be held during 23rd -24th November 2023

Link:
https://energyconclave.in/

Fortescue one step closer to green hydrogen production

The Brazilian State Environment Council has approved Fortescue's environmental impact study for the production of green hydrogen at the Pecém Industrial and Port Complex in Ceará. "This is an important step for our project at the Pecém Industrial and Port Complex and will allow us to continue moving forward to make the green hydrogen industry a reality in Brazil and the state of Ceará," Fortescue Latin America president Agustín Pichot said.
Fortescue Latin America environment manager Gianpaola Ciniglio said that the approval showed the state of Ceará's commitment to environmental sustainability and economic growth.
"This process aimed to ensure compliance with local environmental requirements and international standards of good practice," Ciniglio said. "It also allowed Fortescue to deepen the study of the natural and social environment to continue the development of our project with great commitment, and thus acquire its preliminary environmental licence."
Once constructed, the plant will have final production capacity of 837 tonnes per day of green hydrogen, based on consuming 2.1 gigawatts of renewable power. Operations at the plant are expected to begin in 2027.
https://www.australianmining.com.au/fortescue-one-step-closer-to-green-hydrogen-production/

TESCanada H2 announces plans for Québecois green hydrogen project



TESCanada H2 Inc. a Canadian developer of innovative projects aimed at accelerating the energy transition, had announced plans for the Projet Mauricie renewable hydrogen project. Totalling CAN$4 billion in investments for the region, the Projet Mauricie consists of the construction of an electrolyser and renewable energy production assets.
Upon its commissioning in 2028, the project will produce 70 000 t of green hydrogen exclusively dedicated to Québec end users.
With the aim of reducing annual carbon dioxide (CO_2) emissions by 800 000 t, it is amongst the largest decarbonization projects announced in Québec to date. Approximately 1/3rd of the green hydrogen produced will be dedicated to decarbonising long-haul transportation, which accounts for nearly 10% of Québec's annual emissions. The remaining volumes will be used to produce e-NG (electric renewable natural gas), a sustainable drop-in solution for hard-to-abate industries. TES Canada's project alone will contribute to achieving 3% of Québec's GHG reduction targets by 2030.
The majority of the project's energy needs will be met by its own 1 GW wind and solar farm. Considering Québec's energy context, the project's behind-the-meter assets will minimize the energy drawn from Hydro-Québec's grid, while also offering optimization opportunities, including loadshedding during peak winter periods.
TESCanada H2 announces plans for Quebecois green hydrogen project | Energy Global

Provaris Energy advances green hydrogen supply chains in Europe



Illustration of Small-Scale Tank Designs for 1, 5 and 10 tonne hydrogen capacity

A key milestone has been achieved for the Prototype Tank program underway in Norway, with Prodtex completing the design for a multi-layered carbon-steel prototype tank to be constructed and tested in the first quarter of 2024. The prototype testing will be performed by SINTEF, a recognised research facility in Norway. Upon successful completion of prototype testing, Provaris will achieve a Final Class Approval stage for the ship design. In addition to these developments, Provaris Energy has expanded its intellectual property portfolio with the design of new small-scale hydrogen storage tanks. Extension of tank IP with the design of new small-scale hydrogen storage tanks for onshore and maritime solutions (1 to 10-tonne capacity) provides the company with commercialisation opportunities in 2024.
https://www.proactiveinvestors.com/companies/news/1033298/provaris-energy-advances-green-hydrogen-supply-chains-in-europe-1033298.html

EVENTS

Energy Security Conference 2023



Date: 24th November 2023

Venue: The Ashok hotel, New Delhi

Securing Energy Security is a worldwide priority. Energy security essentially emanates from continuous access of energy sources at sustainable prices to cater economic and commercial growth of a country. Growing climate change concerns, depleting oil reserves and increasing oil prices, however, complicates the process of energy security. There is an ongoing new discourse of debate on energy transition and energy security. With higher energy access, India's energy consumption will grow to 1075 million tonne oil-equivalent (mtoe) by 2040. This creates the need to reduce import dependency while securing the overseas supply of not only crude oil and other minerals that are not available in the country but also requires the promotion of other forms of energy with ample storage facility.

Confederation of Indian Industry with the support of Ministry of External Affairs and under the esteem guidance of Ministry of Petroleum and Natural Gas, Government of India is organizing Energy Security Conference. The focus of the discussion will be energy transition, gas-based economy, climate change, sustainability and energy storage.

Link:

https://cam.mycii.in/OR/EventDetailOR.html?id=E000063591

INDIA NEWS

Gensol Engineering emerges lowest bidder for NHPC's green hydrogen mobility project, shares up 3%

Renewable energy and electric mobility solutions provider Gensol Engineering Ltd. announced that it has emerged as the lowest bidder for the Kargil Green Hydrogen Mobility Station EPC Project of hydropower major NHPC. Gensol Engineering has bagged the project in collaboration with Matrix Gas & Renewables Ltd (Matrix), the company said in an exchange filing.

Reacting to the latest development, shares of Gensol Engineering gained as much as 2.96% to hit a high of ₹830 in morning session.

Under the project, Gensol will develop a 500-kW grid-connected, ground-mounted solar power project that will provide energy to the hydrogen refueling station at Kargil in Ladakh.

The project is aimed at operating hydrogen fuel cell-powered buses in the Ladakh region which is in line with the government's ambitious initiative for green hydrogen energy.

The project is expected to be completed in 12 months from the issuance of the work order, Gensol said.

Gensol Engineering is a part of the Gensol group, providing engineering, procurement, and construction (EPC) services for solar power plant development.

Gensol has also established an electric vehicle manufacturing plant in Pune for the development and production of electric three wheelers and four wheelers.

It recently bagged an order for the supply of 300 Electric Vehicles to Orissa Renewable Energy Development Agency (OREDA). It also made its international foray with EPC projects in the UAE.

https://www.cnbctv18.com/market/gensol-engineering-emerges-lowest-bidder-for-nhpc-green-hydrogen-mobility-project-share-price-18335881.htm

THDC India Inks Pacts To Develop 3,270 MW Renewable Energy Projects In Karnataka

The Uttarakhand-based company signed two memoranda of understandings with Karnataka Power Corporation Limited (KPCL) and Karnataka Renewable Energy Development Limited (KREDL) in Bengaluru. "These collaborative efforts encompass the development of a diverse range of projects, spanning ground-mounted, floating solar projects, and hybrid projects including pumped storage projects (PSPs) with a cumulative capacity of around 3,270 MW," Vishnoi said in a company statement. "This strategic alliance not only underscores THDCIL's commitment to clean energy but also signals a promising trajectory for the region's energy landscape with the collaboration of leading power entities of Karnataka," Vishnoi said.

THDCIL has a portfolio of 10 projects (hydro, thermal, wind & solar) with a total capacity of 4,516 MW.

'Green Diwali': Adani Electricity powers Mumbai with 100% renewable energy for 4 hours

Adani Electricity Mumbai made history on November 12 by powering the city with 100 per cent renewable electricity for four hours, from 10:00 AM to 2:00 PM. This is the first time that a major Indian city has been powered entirely by renewable energy for such a long period of time. Adani Electricity Mumbai achieved this feat by using a combination of solar and wind energy from its renewable energy portfolio. The company also worked with the Maharashtra Electricity Regulatory Commission (MERC) to ensure that the grid was stable and that there were no disruptions to power supply.

The "Green Diwali" initiative was launched by Adani Electricity Mumbai to raise awareness about the importance of renewable energy and to encourage people to switch to green energy sources. The company also offered a discount on electricity bills to consumers who opted for its green energy tariff during Diwali.

In 2023, the company claims to have successfully satisfied up to 38 per cent of its consumers' electricity requirements from renewable sources, and its commitment remains unwavering to reach the target of 60 per cent by 2027.

Kandarp Patel, Managing Director of Adani Electricity, said: "Achieving 100 per cent Renewable Energy is a First and a significant milestone in Mumbai's Energy Transition, demonstrating that Renewables can significantly power Mumbai City with Reliable and Sustainable Electricity at competitive Tariffs. By lighting up Mumbai with Renewables, we not only celebrate the festival of lights but also the festival of a sustainable future." Adani Electricity Mumbai serves over three million consumers in Mumbai and its suburbs, and it has a reliability rate of 99.99 per cent, which is among the highest in the country.

https://www.msn.com/en-in/money/topstories/green-diwali-adani-electricity-powers-mumbai-with-100-renewable-energy-for-4-hours/ar-AA1jQBsW

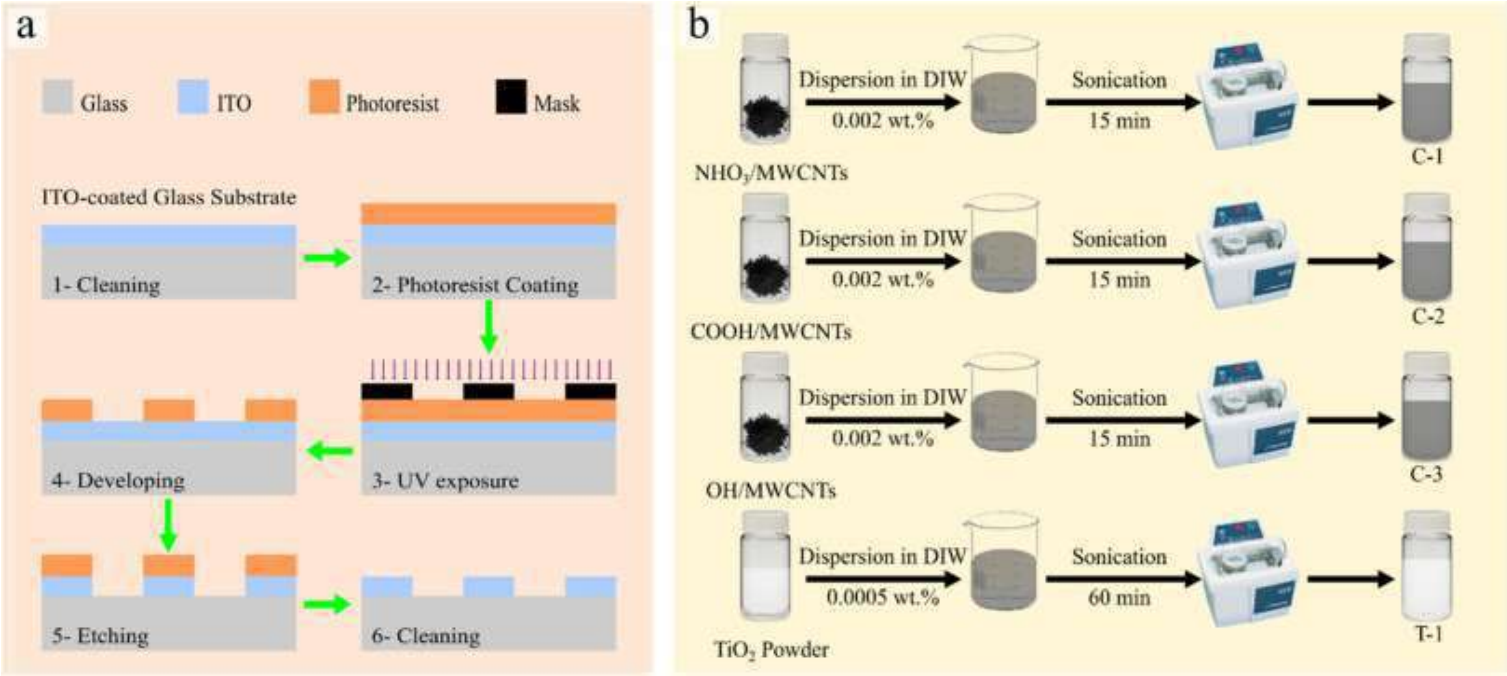
Abdulhameed, A. and Mahnashi, Y.

Fabrication of carbon nanotube/ titanium dioxide nanomaterials-based hydrogen sensor using novel two-stage dielectrophoresis process

https://doi.org/10.1016/j.mssp.2023.107794

Abstract:

The porosity and large surface area of carbon nanotubes (CNTs) made them a candidate active material for gas sensing applications. However, the responsivity and sensitivity of CNTs toward hydrogen are lower than those of metal oxide semiconductor materials such as TiO2. The addition of TiO2 to CNTs is found to increase the sensitivity of the resulting composite material at the expense of increasing the resistance. This paper presents a new dielectrophoresis (DEP) process to fabricate nanoparticle-based hydrogen sensors at room temperature. The simple and low-cost process is based on tuning the AC signal frequency to deposit different nanoparticles in stages, forming a composite sensing layer across interdigitated electrodes (IDE). The sensing layers have been characterized using field emission scanning electron microscopy (FESEM), energy-dispersive X-ray (EDX), and atomic force microscopy (AFM). Sensors fabricated with only CNTs showed low resistance and weak sensitivity of less than 2%. The sensitivity has increased to 3.42% when CNTs are deposited together with TiO2 in a single stage. However, the sensor shows high resistance because TiO2 particles interrupt the conduction paths of CNTs. A high sensitivity of 15.78% and a low resistance of similar to 524 Omega have been achieved when CNTs are deposited individually in the first stage, and followed by depositing the TiO2 in the second stage. This work provides a proof-of-concept that the two-stage DEP enhances the performance of the sensor in terms of sensitivity and resistance compared to single-stage DEP, which is highly desirable in fabricating composite and multi-layer sensing materials.



Graphical Abstract Representation

Liang, SQ. *et al.*

Nickel-nitride composite: An eco-friendly and efficient alternative to platinum for electrocatalytic hydrogen production

https://doi.org/10.1016/j.apcatb.2023.123008

Abstract:

Water electrolysis using the hydrogen evolution reaction (HER) is a promising method for sustainable hydrogen production. Platinum-based catalysts have traditionally been the most efficient HER catalysts, but their scarcity and sluggish water dissociation limit their practical applications. Here we report on a novel super hydrophilic catalyst of nickel supported on nickel molybdenum nitride (Ni/Ni0.8Mo4.2N6) that outperforms platinum-based nanomaterials. Despite the low catalytic activity of Ni or Ni0.8Mo4.2N6 alone, their optimized composite exhibits exceptional HER activity, with respective 500% and 150% increases in the exchange current and turnover frequency compared to commercial Pt/C. Density of states calculations reveal a decrease in electron density of the supported nickel in Ni/Ni0.8Mo4.2N6, leading to a lower free energy of the HER. These findings demonstrate a powerful electron-engineering strategy for designing supported electrocatalysts with outstanding performance for the HER and related processes.

Chen, SB. *et al.*

Multi-metal electrocatalyst with crystalline/amorphous structure for enhanced alkaline water/seawater hydrogen evolution

https://doi.org/10.1016/j.jcis.2023.07.048

Abstract:
The development of well-defined nanomaterials as non-noble metal electrocatalysts has broad application prospect for hydrogen generation technology. Recently, multi-metal electrocatalysts for hydrogen evolution reaction (HER) have attracted extensive attention due to their high catalytic performance arising from the synergistic effect of multi-metal interaction. However, most multi-metal catalysts suffer from the limited synergistic effect because of poor interfacial compatibility between different components. Here, a novel multi-metal catalyst (Ni/MoO2@CoFeOx) nanosheet with a crystalline/amorphous structure is demonstrated, which shows high HER activity. Ni/MoO2@CoFeOx exhibits an ultra-low overpotential of 18, 39, and 93 mV at 10 mA cm-2 in alkaline water, alkaline seawater and natural seawater, respectively, which outperformances most of the state-of the-art non-noble metal compounds. In addition, the catalyst shows exceptional stability under 500 mA cm-2 in alkaline solution. In-situ Raman and other advanced structural characterization confirms the excellent catalytic activity is mainly contributed by: (1) the strong synergistic effect of multi-metal components provides multiple active sites in the catalytic process; (2) the crystalline/amorphous interface in Ni/MoO2@CoFeOx boosts the catalytically active sites and structure stability; (3) the crystalline phase enhances the intrinsic conductivity greatly; and (4) the amorphous phase provides abundant unsaturated sites for improved intrinsic catalytic activity. This work provides a feasible way to design electrocatalyst with high activity and stability for practical applications.

Mondal, B. *et al.*

A resistance-driven H_2 gas sensor: high-entropy alloy nanoparticles decorated 2D MoS_2

https://doi.org/10.1039/d3nr04810a

Abstract:
The need to use hydrogen (H2) gas has increasingly become important due to the growing demand for carbon-free energy sources. However, the explosive nature of H2 gas has raised significant safety concerns, driving the development of efficient and reliable detection. Although 2D materials have emerged as promising materials for hydrogen gas sensing applications due to their relatively high sensitivity, the incorporation of other nanomaterials into 2D materials can drastically improve both the selectivity and the sensitivity of sensors. In this work, high-entropy alloy nanoparticles using non-noble metals were used to develop a sensor for H2 gas detection. This chemical sensor was realized by decorating 2D MoS (2) surfaces with multicomponent body-centered cubic (BCC) equiatomic Ti-Zr-V-Nb-Hf high-entropy alloy (HEA) nanoparticles. It was selective towards H-2, over NH3, H2S, CH4, and C4H10, demonstrating widespread applications of this sensor. To understand the mechanisms behind the abnormal selectivity and sensitivity, density functional theory (DFT) calculations were performed, showing that the HEA nanoparticles can act as a chemical hub for H2 adsorption and dissociation, ultimately improving the performance of 2D material-based gas sensors.

Nyabadza, A. *et al.*

A review of physical, chemical and biological synthesis methods of bimetallic nanoparticles and applications in sensing, water treatment, biomedicine, catalysis and hydrogen storage

https://doi.org/ 10.1016/j.cis.2023.103010

Abstract:
This article provides an in-depth analysis of various fabrication methods of bimetallic nanoparticles (BNP), including chemical, biological, and physical techniques. The review explores BNP's diverse uses, from well-known applications such as sensing water treatment and biomedical uses to less-studied areas like breath sensing for diabetes monitoring and hydrogen storage. It cites results from over 1000 researchers worldwide and >300 peer-reviewed articles. Additionally, the article discusses current trends, actionable recommendations, and the importance of synthetic analysis for industry players looking to optimize manufacturing techniques for specific applications. The article also evaluates the pros and cons of various fabrication methods, highlighting the potential of plant extract synthesis for mass production of capped BNPs. However, it warns that this method may not be suitable for certain applications requiring ligand-free surfaces. In contrast, physical methods like laser ablation offer better control and reactivity, especially for applications where ligand-free surfaces are critical. The report underscores the environmental benefits of plant extract synthesis compared to chemical methods that use hazardous chemicals and pose risks to extraction, production, and disposal. The article emphasizes the need for life cycle assessment (LCA) articles in the literature, given the growing volume of research on nanotechnology materials. This article caters to researchers at all stages and applies to various fields applying nanomaterials.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 60
NOVEMBER, 2023

New "Ultra Stainless Steel" Could Improve Green Hydrogen Production

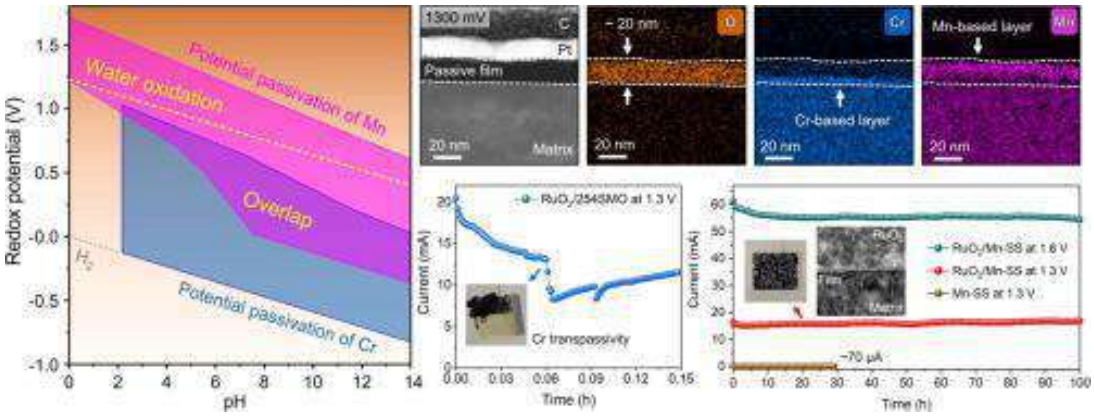
A research project led by Professor Mingxin Huang at the Department of Mechanical Engineering of the University of Hong Kong (HKU) has made a brand-new breakthrough over conventional stainless steel and the development of stainless steel for hydrogen (SS-H2).

This marks another major achievement by Professor Huang's team in its 'Super Steel' Project, following the development of the anti-COVID-19 stainless steel in 2021, and ultra-strong and ultra-tough Super Steel in 2017 and 2020 respectively.

The new steel developed by the team exhibits high corrosion resistance, enabling its potential application for green hydrogen production from seawater, where a novel sustainable solution is still in the pipeline. The performance of the new steel in salt water electrolyser is comparable to the current industrial practice using Titanium as structural parts to produce hydrogen from desalted seawater or acid, while the cost of the new steel is much cheaper.

The discovery has been published in Materials Today in the paper titled "A sequential dual-passivation strategy for designing stainless steel used above water oxidation." The research achievements are currently applying for patents in multiple countries, and two of them has already been granted authorisation.

Since its discovery a century ago, stainless steel has always been an important material widely used in corrosive environments. Chromium is an essential element in establishing the corrosion resistance of stainless steel. Passive film is generated through the oxidation of chromium (Cr) and protects stainless steel in natural environments. Unfortunately, this conventional single-passivation mechanism based on Cr has halted further advancement of stainless steel. Owing to the further oxidation of stable Cr2O3 into soluble Cr(VI) species, tranpassive corrosion inevitably occurs in conventional stainless steel at ~1000 mV (saturated calomel electrode, SCE), which is below the potential required for water oxidation at ~1600 mV.



https://www.technologynetworks.com/applied-sciences/news/new-ultra-stainless-steel-could-improve-green-hydrogen-production-381200

A sequential dual-passivation strategy for designing stainless steel used above water oxidation

Abstract:
Stainless steel is critical material used in a wide variety of industries. Unfortunately, current development of stainless steel has reached a stagnant stage due to the fundamental limitation of the conventional Cr-based single-passivation mechanism. Here, we show that, by using a sequential dual-passivation mechanism, substantially enhanced anti-corrosion properties can be achieved in Mn-contained stainless steel, with a high breakdown potential of ~1700 mV (saturated calomel electrode, SCE) in a 3.5 wt% NaCl solution. Specifically, the conventional Cr-based and counter-intuitive Mn-based passivation is sequentially activated during potentiodynamic polarization. The Cr-based passive layer prevents corrosion at low potentials below ~720 mV(SCE), while the Mn-based passive layer resists corrosion at high potentials up to ~1700 mV(SCE). The present "sequential dual-passivation" strategy enlarges the passive region of stainless steel to high potentials above water oxidation, enabling them as potential anodic materials for green hydrogen production via water electrolysis.



https://doi.org/10.1016/j.mattod.2023.07.022

EVENTS

Powering the Future by Renewable Energy



Date: December 12-13

Description

PowerUP Energy is a virtual conference and exhibition focusing on power electronics and energy trends.
As the world's population grows, the demand for a new approach to energy also grows, pushing us toward more sustainable ideas. Engineering in the areas of energy is critical for the sustainability of the environment and the global economy.
Power devices will improve system performance in all high-voltage industrial applications, including energy-saving ones. The demand for innovative technologies and devices has grown as a result of the increasing importance of power quality in distribution systems and the widespread integration of renewable energy sources.
This event is bringing the latest developments in energy engineering, debated by global industry leaders across keynotes and technical talks. The conference is also dedicated to exploring how we can rapidly accelerate the pathway to net-zero carbon emissions.

Links:
https://energy.powerup-expo.com/?utm_source=google&utm_medium=cpc&utm_campaign=energy23s&gclid=CjwKCAiAjfyqBhAsEiwA-UdzJM6V1lLfa1VfQtx8a8SXVAAY3YdouUDEMFDJpSzntr8XNiASrkTXDhoCSg8QAvD_BwE#Registration

INDUSTRY NEWS

GE Vernova and Next Hydrogen partner on green hydrogen production

GE Vernova's power conversion business and Next Hydrogen Solutions will combine their technology offerings to produce green hydrogen.

Under terms of a signed Memorandum of Understanding (MoU), Next Hydrogen's electrolysis technology will complement GE Vernova's power system offering.

The integration of GE Vernova's power conversion technology will provide Next Hydrogen's electrolysers with direct current power sourced from renewable energy sources, including solar, wind, and hydro.

It is hoped that the duo's technologies will be fully aligned for the forthcoming generation of Next Hydrogen electrolysers, which are scheduled to launch in 2024.



https://www.gasworld.com/story/ge-vernova-and-next-hydrogen-partner-on-green-hydrogen-production/2130632.article/

Plans for huge hydrogen pipeline to Germany poised to bring billion pound boost to economy

Britain and Germany are in talks about building a 400 mile long pipeline under the North Sea to carry hydrogen to mainland Europe. Two people familiar with the discussions have said Germany's Vice-Chancellor Robert Habeck raised the idea with Business Secretary Kemi Badenoch during a meeting earlier this month.
Berlin has its eyes on British hydrogen as it searches for ways to reach net zero and break its dependence on fossil fuels. Vladimir Putin's war in Ukraine also pushed Germany into finding the means of breaking its reliance on Russian gas. According to Politico, the pipeline idea is at an early stage, with a route either going straight from Britain to Germany or flowing via Norway.
https://www.express.co.uk/news/uk/1837158/scotland-germany-hydrogen-pipeline-plan

DOE Announces up to $44M in Funding for Critical Clean Energy Technologies

The U.S. Department of Energy (DOE) is seeking applications for the Fiscal Year 2024 (FY24) Core Laboratory Infrastructure for Market Readiness (CLIMR) Lab Call. An estimated $37.7M–$44.7M is expected to be available to fund all projects solicited in this lab call pending FY24 appropriations and program direction. The total funding amount available will be applied once an official FY24 DOE budget is passed.
The FY24 CLIMR Lab Call represents the combined effort of 14 different DOE program offices, including the Hydrogen and Fuel Cell Technologies Office and the Office of Technology Transitions (OTT), marking the highest number of participating offices in a CLIMR lab call to date.
https://www.energy.gov/eere/fuelcells/articles/doe-announces-44m-funding-critical-clean-energy-technologies

Honda reveals next-gen hydrogen fuel cell system prototype designed to power FCEVs, CVs and construction machinery

Will display a prototype of its next-gen hydrogen fuel cell system at European Hydrogen Week in Brussels from November 20-24; the compact, powerful system is designed to offer exceptional durability and versatility across a variety of uses including within FCEVs, CVs, construction machinery, and in stationary power stations. On display at the Brussels Expo from November 20-24, the compact, yet powerful system has been designed to offer exceptional durability and versatility across a variety of uses – including within fuel cell vehicles (FCEV), commercial vehicles, construction machinery, and in stationary power stations. Honda offers a vision of collaborating with business and technology partners to expand applications of the fuel cell system and encourages all potential collaboration partners to visit stand I90 in Hall 7 during the Hydrogen Week Expo. Honda is currently working with a number of companies, who are developing products in the outlined application areas, to aide with the packaging phase and integration of the fuel cell system in development programmes.
https://www.autocarpro.in/news-international/honda-reveals-next-gen-hydrogen-fuel-cell-system-prototype-designed-to-power-fcevs-cvs-and-construction-machinery-117909

Event –

Canadian Hydrogen Convention 2024

A New Era for Canadian Energy is Now

April 23-25, 2024

Edmonton Convention Centre - Edmonton, Canada

Canadian Hydrogen Convention - North America's Premier Hydrogen Event

As the largest event in Canada showcasing hydrogen as a key enabler to reach net-zero emissions by 2050, the Canadian Hydrogen Convention is the only annual meeting place for energy executives, government officials and Indigenous leaders to convene to build Canada's low-carbon energy future. This must-attend show will offer a unique perspective for the entire Canadian supply chain to discuss innovations and solutions for low-carbon hydrogen production, storage, utilization, and hydrogen's future as a key fuel.

With billions of dollars being invested into the development of an at-scale, clean hydrogen economy, Canada has all the resources it needs to position itself as a global hydrogen superpower. As hydrogen's future as a key fuel in the global energy system continues to expand, the Canadian Hydrogen Convention will once again take place in April 2024 in Edmonton, Alberta.

Link:

https://www.hydrogenexpo.com/

Register:
https://www.hydrogenexpo.com/register/

Bramble Energy and EDAG Group sign MoU on digital integration of hydrogen fuel cell

Bramble Energy has signed an MoU with the EDAG Group, a globally leading, independent engineering services provider that combines excellent engineering with the latest technology trends, to collaborate on the development of a digital integration of its patented printed circuit board fuel cell (PCBFC) into EDAG's electric vehicle storage platform. The digital investigation will involve the design of a customised fuel cell stack as well as the overall system layout fitting the EV platform (incl. batteries, hydrogen storage and FC stack with major BoP components), with clear vehicle simulation data providing evidence for its feasibility.



https://energy.economictimes.indiatimes.com/news/renewable/bramble-energy-and-edag-group-sign-mou-on-digital-integration-of-hydrogen-fuel-cell/105458721

TAFE launches electric tractor and showcases hydrogen range at Agritechnica 2023

TAFE (Tractors and Farm Equipment), a leading manufacturers and exporter of tractors from India is betting big on alternate energy mix. The company recently launched its electric tractor and displayed a hydrogen tractor marking its debut at Agritechnica 2023, the world's largest trade fair for the agriculture segment.



https://www.financialexpress.com/business/express-mobility-tafe-launches-electric-tractor-and-showcases-hydrogen-range-at-agritechnica-2023-3312604/

EU launches first green hydrogen auction with ceiling price of €4.50/kg

The European Union has launched its first green hydrogen auction with a maximum price of €4.50 ($4.91)/kg. The approved projects will receive subsidies for a decade, alongside revenue from hydrogen sales, and must start production within the next five years. The European Commission has launched the first hydrogen auction supported by the European Hydrogen Bank. Renewable hydrogen producers can apply for support in the form of a fixed premium per kilogram of hydrogen produced. This should close the gap between the production price and the price that consumers are currently willing to pay in a market where non-renewable hydrogen production is still cheaper. Bidders have until Feb. 8, 2024, to submit their proposals through the EU tenders and financing portal. Bids must be based on a proposed price premium per kilogram of renewable hydrogen produced, up to a ceiling price of €4 .50/kg.



https://www.pv-magazine.com/2023/11/24/eu-launches-first-green-hydrogen-auction-with-ceiling-price-of-e4-50-kg/

ADNOC opens the region's first high-speed green hydrogen refueling pilot station

ADNOC, announced that it has opened "H2GO", the region's first high-speed green hydrogen pilot refueling station, to test a fleet of zero-emission hydrogen-powered vehicles. The station, which is located on land provided by Masdar City and operated by ADNOC Distribution, will create green hydrogen from water using an electrolyser powered by clean grid electricity. The hydrogen supplied at the pilot station will be certified as "green" from solar sources by the International REC Standard, an internationally recognized certification organization. The pilot will be used to gather data to understand the long-term viability of hydrogen vehicles in the UAE.

https://www.zawya.com/en/press-release/companies-news/adnoc-opens-the-regions-first-high-speed-green-hydrogen-refueling-pilot-station-q2z1opym

Event:-

International Hydrogen & Fuel Cell Conference 2023

Conference

Ramada Plaza JHV Varanasi, Varanasi, India

Timings

4:00 PM - 8:00 PM (Dec 03) (General)

9:00 AM - 5:00 PM (Dec 04) (General)

"Moving From Grey to Blue & Green Hydrogen"

The 10th edition of the International Hydrogen & Fuel Cell Conference (IHFC-2023) is being held at Ramada Plaza by JHV Wyndham, Varanasi (India) by the Hydrogen Association of India from 3-5 December 2023. The conference is supported by the International Association of Hydrogen Energy (IAHE), USA, and with unconditional support from many Corporate Houses, Government Bodies, and Institutes of good repute working in the field of hydrogen energy.

Entry Fees

Paid Ticket Starts from 11000 INR

Exhibit Booth Cost Starts from 100000 INR

Organizer

Hydrogen Association of India

https://10times.com/e1kr-17xs-09fk

Gensol Secures EPC Contract for Green Hydrogen-Based Mobility Station in Ladakh

Engineering and consulting firm Gensol Engineering has won an engineering, procurement, and commissioning (EPC) contract from NHPC to set up a pilot project for a green hydrogen-based mobility station in Kargil, Ladakh. The project aims to power two hydrogen fuel cell buses within the region. The tender was floated in JUne. Gensol secured this project with Matrix Gas and Renewables, a natural gas aggregator and hydrogen infrastructure developer, which will oversee the EPC of dual electrolyzers. The project entails the installation of two units, each with a capacity of 30 Nm3/hour. The estimated daily hydrogen production target is 40 kg, ensuring a minimum purity level of 99.97%.

https://www.mercomindia.com/gensol-epc-contract-green-hydrogen

Tamil Nadu in process of developing green hydrogen hub, says Industries Minister Rajaa

The Tamil Nadu minister said that the electric vehicle sector would get tremendous visibility during the forthcoming Tamil Nadu Global Investors Meet to be held in January next year. Tamil Nadu was leading the green energy transition revolution and was in the process of developing a green hydrogen hub, Industries Minister TRB Rajaa said on Tuesday. Tamil Nadu was leading the green energy transition revolution and was in the process of developing a green hydrogen hub, Industries Minister TRB Rajaa said. At the India EV Conclave event organised on the theme 'Electrifying Tomorrow: Navigating the EV Transition", he said 50 per cent of installed energy capacity in the state was green and the government was targeting to increase it to 75 per cent. "Tamil Nadu is leading the green energy transition revolution. The government's commitment and efforts were acknowledged with the 'UN Promotion Award 2023 for Excellence in Scaling Up Energy Transition Investments' at the recent World Investment Forum held in the UAE," he said. "We are in the process of developing a green hydrogen hub.

https://www.indiatvnews.com/tamil-nadu/news-industries-minister-rajaa-on-developing-green-hydrogen-hub-electric-vehicle-conclave-mk-stalin-latest-news-2023-11-23-904092

Finland, India discuss hydrogen electrolyzer production in India

India and Finland have discussed manufacturing of green hydrogen electrolyzers in India, said Finnish minister for international trade Ville Tavio in an interview with Mint amid Indian hopes to develop itself as a green hydrogen hub. The matter came up during Tavio's meeting with power minister R.K. Singh. India announced a Production Linked Incentive (PLI) scheme this year for green hydrogen production and for manufacturing electrolyzers. Tavio told Mint that Finland is also keen to expand nuclear research and technology collaboration with India, given Finland's expertise in the field.

Lappeenranta Technical University (LTU), a Finnish research university, is currently carrying out nuclear research with an Indian partner university, Tavio said. He emphasized that Finland is keen to expand these university-level nuclear research collaborations. Mint had earlier reported that LTU was writing a paper on small and medium nuclear reactors with India's National Institute for Advanced Studies (NIAS) for the G20 Summit. India has expressed its interest in developing the technology for small reactors, given the importance of nuclear power to its energy mix. Earlier this year, Finland's former minister for foreign trade and development cooperation Ville Skinnari highlighted the possibility of more bilateral cooperation on this technology.

Tavio, who was accompanied by a delegation of clean-tech companies, also met with officials from India's Epsilon Advanced Materials. The battery materials firm has plans to set up a facility in Finland, said Tavio. Epsilon had signed an MoU in 2022 with the Finnish Minerals Group to explore setting up an anode material production plant in Finland.

Finland hopes to build up more private sector collaboration in the renewable energy space, particularly through the creation of a new working group on sustainability. Tavio was also in India to talk on Finland's DESI (Digitalization, Education, Sustainability, Innovation) initiative—an India-specific export promotion programme unveiled this year. During his visit, Tavio met with commerce minister Piyush Goyal and G20 sherpa Amitabh Kant. He also attended the 2nd CII India Nordic Baltic Business Conclave in New Delhi.

https://www.livemint.com/news/india/finland-india-discuss-hydrogen-electrolyzer-production-in-india-11700748605327.html

Parveenkumar, TR. *et al.*

Performance and Emission Characteristics for Karanja Biodiesel Blends Assisted With Green Hydrogen Fuel and Nanoparticles

https://doi.org/10.1115/1.4062526

Abstract:

Extensive efforts are being made to produce and use a variety of alternative energies in order to meet the rising global energy demand. The main purpose of this research was to evaluate the mass fuel burnt, emissions, and performance properties of biodiesel made from non-edible karanja oil along with hydrogen and nanoparticles in a standard diesel engine. Upon experimental evaluation, it was determined that the transesterified karanja oil retained all of its vital physicochemical properties within the specified tolerances. The emission and performance characteristics of karanja biodiesel blended with nanoparticles and hydrogen fuel were assessed at different engine loads ranging from 0% to 100%. The uniform amount of nanoparticles and hydrogen was incorporated into test fuels. Al2O3 nanoparticles of 50 ppm were used in this study and hydrogen of 5 L/min was supplied to the engine. K20NH test fuel had the maximum brake thermal efficiency and less brake-specific fuel consumption compared to the other fuel blend. The emissions were considerably reduced on karanja oil, nanoparticles, and hydrogen-blended biodiesel except for nitrogen emission compared with conventional diesel fuel. In this study, the utilization of karanja, nanoparticles, and hydrogen-blended biodiesel showed a promising alternative to fossil fuels due to reduced emission and enhanced performance characteristics.

Wei, HL. *et al.*

Synthesis of Pure-Phase Ni_2P Nanocatalysts via Phosphorus Ligand Selection for Efficient Hydrogen Evolution Reaction

https://doi.org/10.1002/celc.202300426

Abstract:

Developing facile and low-cost synthetic methods of high-active platinum group metal-free electrocatalysts is essential for green hydrogen production primarily based on water electrolysis. We adopted a facile solution-based synthetic approach to prepare nickel phosphide nanoparticles (NP) and systematically studied the role of phosphorus ligands in the synthesis. Pure-phase Ni2P NPs were obtained by selecting the proper phosphorus ligands, which tuned the structures of the product. The Ni2P nanowire, prepared using triphenyl phosphite, exhibited the best activity and stability in acidic, neutral, and alkaline media for hydrogen evolution reaction (HER), indicating the advantages of the nanowire structure to the performance. In the acidic medium, it only required overpotential values of 100 and 167 mV to achieve the HER current densities of 10 and 100 mA cm(-2), respectively. Furthermore, the overpotential increased only by 26 mV during the 50-hour stability test, indicating potential for device application. It was also demonstrated that the on-site generation of insoluble nickel salts (e. g., hydroxides, phosphates, etc.) on the surface resulted in lower activity and stability in neutral and alkaline media than in acid.

Ruhnau, O. and Schiele, J.

Flexible green hydrogen: The effect of relaxing simultaneity requirements on project design, economics, and power sector emissions

https://doi.org/ 10.1016/j.enpol.2023.113763

Abstract:

In many net-zero energy scenarios, electrolytic hydrogen is a key component to decarbonize hard-to-abate sectors and to provide flexibility to the power sector. In current energy systems that are not yet fully decarbonized, however, the hydrogen ramp-up raises the concern of increasing power sector emissions. To avoid such additional emissions, recent EU regulation defines requirements for electrolytic hydrogen to qualify as green along three dimensions: the additionality, the proximity, and the simultaneity of renewable electricity generation. Focusing on the temporal dimension, this article investigates the effects of a strict hourly simultaneity requirement, full temporal flexibility, as well as simultaneity exemptions in the current EU regulation. We develop a model of a renewables-hydrogen project, consisting of individual wind turbines, solar panels, hydrogen electrolysis, and hydrogen storage. As a novelty, the model optimizes not only dispatch but also investment decisions, and we expose it to different regulatory conditions. We show that a flexible definition of green hydrogen does not necessarily increase power sector emissions. By contrast, requiring hourly simultaneity implies that rational investors build much larger wind turbines, hydrogen electrolyzers, and hydrogen storage than needed-meaning additional costs and embedded carbon, underutilized assets, and a potential slow-down of green hydrogen deployment. These adverse effects can only partially be mitigated by including solar panels and by the EU simultaneity exceptions. We argue that current energy transition trends further lower the risk of increasing power sector emissions under a flexible definition of green hydrogen and recommend this as the way forward for a sustainable hydrogen policy.

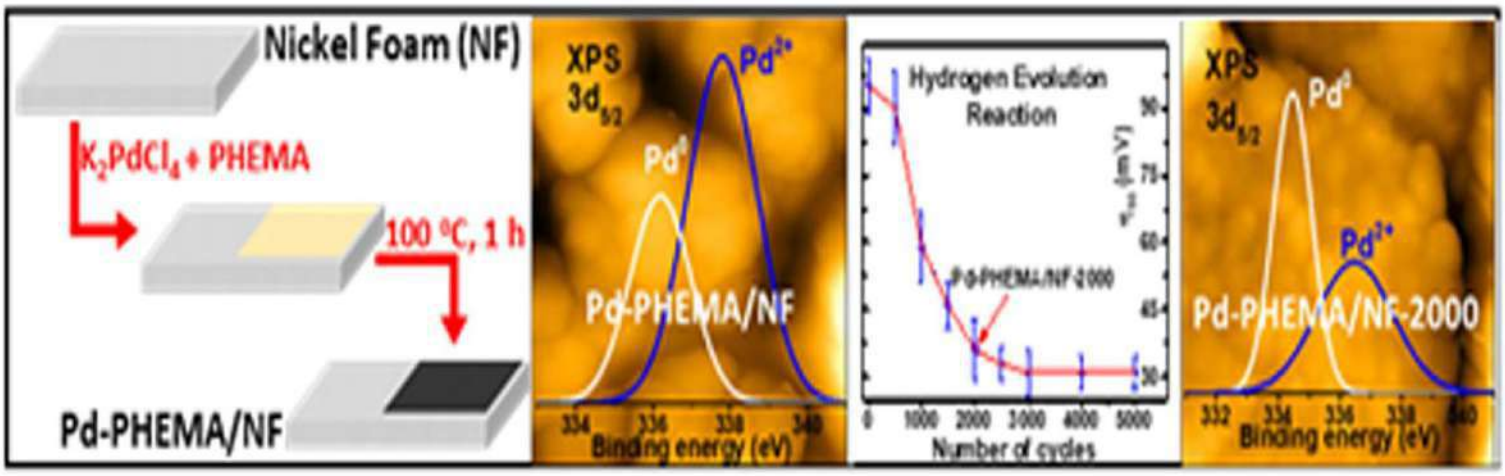
Bovas, A. *et al.*

An In Situ Fabricated Hydrogel Polymer - Palladium Nanocomposite Electrocatalyst for the HER: Critical Role of the Polymer in Realizing High Efficiency and Stability

https://doi.org/ 10.1002/chem.202302593

Abstract:

Development of general and simple designs of catalytic electrodes for the hydrogen evolution reaction (HER) is critical. The present work demonstrates the multiple roles played by a hydrogel polymer in the fabrication and activity enhancement of the nanoelectrocatalyst. A nanocomposite thin film of Pd with the insulating hydrogel, poly(2-hydroxyethyl methacrylate) (PHEMA), is fabricated through a facile in situ process, the polymer itself functioning as the reducing/stabilizing agent in the formation of Pd nanoparticles. Pd-PHEMA on Ni foam enables efficient HER in alkaline medium with a low overpotential; the polymer enables the electrocatalysis by its swelling and confinement of the electrolyte. Most significantly, when the electrode is subjected to an optimized cycling protocol, the overpotential decreases steadily, reaching an impressively low value of 36 mV (@10 mA cm(-2)). A low Tafel slope (68 mV dec(-1)), high exchange current density, Faradaic efficiency and TOF (3.27 mA cm(-2), 99 %, 122.7 h(-1)), and extended stability are achieved. Detailed investigations reveal the active role of the polymer in the evolution of the nanocatalyst, itself undergoing favorable morphological changes. The study illustrates the widened scope for developing efficient and stable catalytic electrodes with hydrogel polymers and unique features that promote the generation of green hydrogen.



Graphical Abstract Representation

Ummer, AC. and Al-Betar, ARF.

Dispersed cobalt oxide on non-conductive zeolite assembly for electrocatalytic water splitting

https://doi.org/ 10.1007/s10008-023-05718-0

Abstract:

Electrochemical water splitting has been undergoing wide investigations due to their significance toward economic production of green hydrogen. Cobalt oxide catalysts are prepared via two different synthesis methods, and these bulk oxides are characterized and studied for water splitting reaction in alkaline medium. Further, similar supported catalysts are prepared using zeolites as support materials. All the samples are characterized using N2 adsorption X-ray diffraction, electron microscopic morphology, temperature programed reduction using hydrogen, etc., and the results are discussed. The performance of cobalt and cobalt-based zeolite hybrid electrocatalyst toward water splitting. Both oxygen and hydrogen evolutions were investigated. The hybrid materials were prepared chemically using co precipitation and direct calcination protocols. The prepared electrocatalyst proved to have low overpotential, high current density, high electrochemical surface area, and enhanced hydrogen/oxygen evolution performance.

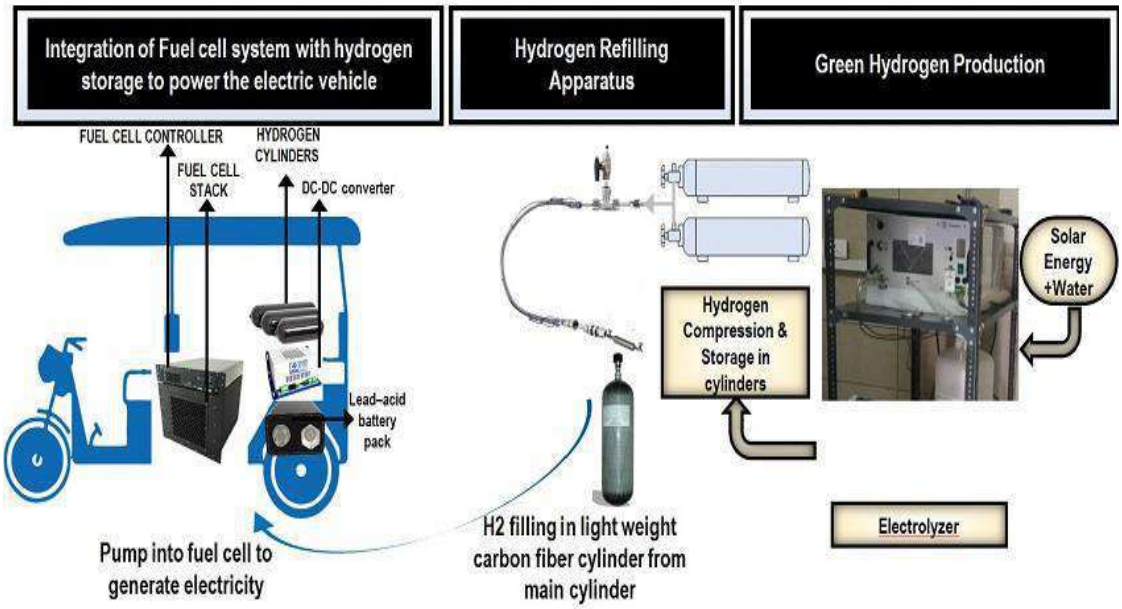
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 61
DECEMBER, 2023

Green Hydrogen-Fueled Vehicle Unveiled at IIT-Jammu

With an aim to foster self-reliance and energy independence for the nation, Dr. B. Satya Sekhar's research group at the Department of Mechanical Engineering at IIT Jammu has successfully showcased a green hydrogen-based fuel cell-powered vehicle, supported by the institute. This mission aims to foster self-reliance and energy independence for the nation.



The vehicle incorporates a hydrogen-based Proton Exchange Membrane (PEM) fuel cell, a hydrogen storage tank, and **a DC-DC converter**, collectively forming an innovative and eco-friendly transportation solution.

One of the remarkable features of this development is the substantial reduction in charging time. The team has successfully **brought down the charging time from an initial eight hours to a mere five minutes**, enhancing the efficiency and practicality of the E-vehicle.

Hydrogen-based energy holds the promise of a closed and pollution-free chemical cycle for energy infrastructure. The PEM fuel cell, in particular, initiates the process with hydrogen and oxygen, producing water, which is then reversed to extract hydrogen and oxygen. This stands in stark contrast to traditional gasoline-fuelled engines that emit carbon dioxide and other pollutants into the atmosphere.The ongoing work includes the development of a medium-pressure hydrogen compressor, further contributing to advancements in green hydrogen technology.

This accomplishment showcases IIT Jammu's commitment to fostering cutting-edge research and innovation in the realm of sustainable energy solutions.

https://www.iitjammu.ac.in/post/green-hydrogen-fueled-vehicle-unveiled-by-dr-b-satya-sekhar
https://www.dailyexcelsior.com/green-hydrogen-fuelled-vehicle-unveiled-at-iit-jammu/
https://statetimes.in/iit-j-breakthrough-green-hydrogen-fueled-vehicle-unveiled/

Sustainable Development of Energy, Water and Environment Systems in the Critical Decade for Climate Action

In this critical decade for climate action, rapid and far-reaching transitions depend on the choices and actions that are taken now and in the near-term. Integrated approaches that advance the sustainable development of energy, water and environment systems have crucial roles in enabling shifts in direction and better protecting the life-support systems of the planet. Urban energy systems and energy communities involve an emphasis on replacing gas boilers and utilising waste heat, solar-assisted district heating networks, local energy communities, and addressing energy and transport poverty. New advances within the energy-water nexus focus on the energy and water footprints of data center operation and efficient energy production from wastewater treatment. For energy management and system efficiency, load management, deep reinforcement learning, control strategies and optimisation, and combustion processes are among the advances. A focus on advancing technology development and deployment completes the special issue based on new heat exchanger designs with inspiration from nature, high-temperature heat pumps in the industry, and advances in hydrogen technologies and deployment. The future depends on succeeding for the climate collectively and championing system integration.

https://www.researchgate.net/figure/Distribution-of-new-original-articles-across-the-eight-themes-of-the-SDEWES-2022-special_fig1_374367956

EVENTS

The International Conference on Advances in Renewable and Green Energy Technology (ICARGET 2023)

Date: 07 - 08 Dec 2023

Venue: Guru Ghasidas University, Bilaspur, India

Platform for scientists, engineers, and practitioners from around the world to come together and share their knowledge and insights in the field of renewable and green energy.

The collaboration between Department of Mechanical Engineering of Guru Ghasidas Vishwavidyalaya and the Solar Energy Research Institute (SERI) at the University Kebangsaan Malaysia underscores the international significance of this event. ICARGET 2023 plays a role in advancing the transition towards a cleaner and more sustainable future. It invites everyone from academia, R&D establishments, and industry professionals who have worked on renewable and green energy to take this invaluable opportunity and present their research findings and insights.

Link:

https://icarget2023.com/

https://10times.com/e144-xhhk-2rf9

INDUSTRY NEWS

Metso Upgrades Pilot Testwork Facility for Hydrogen Use in Smelting Applications

"The use of green hydrogen is one means by which the smelting industry is pursuing to decarbonize metal production. Therefore, we are very excited about the new opportunities our pilot testwork facility offers to support our customers. We can now perform smelting trials utilizing fossil fuel substitutes, including gaseous hydrogen (including co-firing with natural gas), biochar or consumer waste streams such as Tyre Derived Fuel (TDF). Several potential clients have already expressed interest in exploring the applicability of hydrogen as a fuel and/or a chemical reductant to decrease the carbon footprint of their respective metallurgical processes," says Jacob Wood, Technology Manager, TSL Smelting at Metso.

In Metso's Ausmelt® TSL pilot testwork facility, the behaviour and efficiency of gaseous hydrogen as both a fuel and reductant can be examined across a wide range of processing conditions. Testwork conducted in the plant will also play a crucial role in furthering knowledge relating to the safe storage, distribution and combustion of hydrogen in direct-fire applications.

https://www.azocleantech.com/news.aspx?newsID=34342

Technip Energies and John Cockerill Reach Closing of Rely, a New Company Dedicated to Integrated Green Hydrogen and Power-to-X Solutions

Technip Energies and John Cockerill acknowledge the need to accelerate technology development to support net-zero ambitions. The creation of Rely responds to this urgent need to scale up green hydrogen and power-to-X(1) solutions to decarbonize hard-to-abate industries. Rely offers end-to-end large-scale solutions, from pre-Final Investment Decision services including technical and financial advisory through to proprietary technologies, project execution, and operation and maintenance. Rely also fuses a commitment to a standardized approach, developing a unique portfolio of solutions for project of 100MW capacity and above, leveraging the technology and engineering expertise of its parent companies.

https://www.businesswire.com/news/home/20231129233075/en/

Saudi's ACWA Power, PowerChina break ground on green hydrogen plant in Uzbekistan

Saudi-listed ACWA Power and Chinese state-owned PowerChina have broken ground on the first green hydrogen plant in Central Asia, the companies said.

The plant, in Uzbekistan, will produce 3,000 metric tons per year of green hydrogen and will be powered by a wind farm, according to announcements on the companies' websites on Thursday. The hydrogen will be used to produce 500,000 tons per year of ammonia fertiliser, replacing 33 million cubic meters of natural gas. PowerChina, the general contractor for the project, said it was the company's first overeas green hydrogen project and also the first in Central Asia to reach the implementation stage.



https://www.zawya.com/en/business/energy/saudis-acwa-power-powerchina-break-ground-on-green-hydrogen-plant-in-uzbekistan-xu86rsjd

First Hydrogen Showcases FCEV with Europe and UK's Largest Companies

First Hydrogen Corp. (TSXV: FHYD) (OTC Pink: FHYDF) (FSE: FIT) ("FIRST HYDROGEN" or the "Company") is please to announce twenty-one (21) fleet operators & industry specialists, from Europe and UK, attended the Company's Track Day at the HORIBA MIA proving grounding in England. Held on Tuesday October 31, attendees included fleet managers from the grocery sector with participants from Asda and Sainsbury's, parcel delivery company DPD, NHS England, VINCI Group, mining conglomerate Anglo American, and Network Rail. Several utilities providers including Wales & West Utilities, Northern Gas Networks, SGN & National Gas were also present.

https://markets.businessinsider.com/news/stocks/first-hydrogen-showcases-fcev-with-europe-and-uks-largest-companies-1032857249

EVENTS

9th International Conference on Advances in Energy Research (ICAER) 2023

Event Date:

12th December 2023 - 9:15am to 14th December 2023 - 5:45pm

Venue:

Victor Menezes Convention Centre (VMCC), IIT Bombay, Mumbai

The Department of Energy Science and Engineering (DESE, IIT Bombay is organizing the 9th International Conference on Advances in Energy Research (ICAER) at IIT Bombay from 12th to 14th December 2023.

The rapid depletion of natural resources and the adverse changes in climate put forward great challenges for researchers.

Here, the conference provides an excellent platform to know, exchange new ideas, and understand the challenges related to the energy sector at large. We are certain that ICAER 2023 would be exciting and would continue the tradition of immense scientific discussion.

Link:

https://www.ese.iitb.ac.in/icaer2023/

INDUSTRY NEWS

Tawasul Transport drives green innovation by launching first hydrogen-powered taxi in Abu Dhabi

The Emirate of Abu Dhabi is set for its first green-hydrogen-powered smart taxi experience. Tawasul Transport, a leading transport company, is collaborating with ADNOC, the Integrated Transport Center (ITC) and Al Futtaim Motors, to create this trailblazing sustainable urban mobility initiative. Tawasul Transport, together with Al Futtaim Motors, will provide the operational data, including kilometers driven, green hydrogen consumption, operating hours and clean refueling procedures. By adopting a transparent data-driven approach, operational efficiency can be improved while accelerating the integration of sustainable and innovative transport solutions.



Tawasul Transport drives green innovation by launching first hydrogen-powered taxi in Abu Dhabi | Corporate-news – Gulf News

Zero-emission hydrogen-fuelled city bus in Abu Dhabi

A China-based technology company, which designs and develops zero-emission commercial vehicles, is set to bring its customised hydrogen-powered city buses to Abu Dhabi.

Wisdom Motor inked a cooperation agreement with the Integrated Transport Centre (ITC) of the Department of Municipalities and Transport (DMT) in Abu Dhabi to provide green mobility solutions to the emirate through its distributor Emirates Global Motor Electric (EGME), part of the Al Fahim Group. The 12-metre hydrogen fuel cell city bus has a driving range of 500km and reduces 105kg of carbon emissions per 100km of travel.

https://www.msn.com/en-ae/news/other/look-zero-emission-hydrogen-fuelled-city-bus-in-abu-dhabi/ar-AA1kMuwj

Hydrogen under the spotlight, CCS back in fashion

As the six-month Spanish EU Council presidency draws to a close – and the von der Leyen Commission reaches the end of its five-year term – legislators in Brussels are busy closing as many files as possible, hoping to push the last remaining parts of the European Green Deal past the finishing line before the European Parliament goes into recess for the June EU elections.

This resulted in a frenzy of legislative activity last week, with a string of parliamentary votes Monday and Tuesday – on the right to repair, certification of carbon removals, net-zero emission technologies, and CO2 emissions from trucks. But the Parliament wasn't quite done yet. On Wednesday (22 November), MEPs gave their blessing to a report by Belgian MEP Frédérique Ries that saw targets for reuse scaled back and bans on unnecessary packaging removed. Greens, predictably, were unhappy, reports Kira Taylor.



Hydrogen under the spotlight, CCS back in fashion – EURACTIV.com

Mitsubishi Power operates gas turbine with 30pc hydrogen fuel co-firing

Mitsubishi Power, a power solutions brand of Mitsubishi Heavy Industries (MHI), successfully executed a fuel blend of 30 per cent hydrogen and natural gas demonstration at partial load and full load using a grid-connected state-of-the-art 1,650°C class J-series Air-Cooled (JAC) gas turbine.

The demonstration took place at the T-Point 2 Combined Cycle Power Plant Validation Facility with a rated output of 566 megawatts (MW) within Takasago Hydrogen Park, within its Takasago Machinery Works in Takasago City, Hyogo Prefecture in west central Japan. Using hydrogen produced at Takasago Hydrogen Park, this demonstration was the world's first power generation test on a large frame gas turbine using a fuel mixture of 30 per cent hydrogen while connected to the local power grid and using hydrogen produced and stored on the same site.

https://www.tradearabia.com/news/OGN_416315.html

EVENTS

Vibrant Green Energy Expo 2023



Date: 21st – 23rd Dec. 2023

Venue: Vigyan Bhavan, Science City, Ahmedabad

VGEE is India's Most Prominent Solar & Renewable energy B2B Exhibition focusing on solar energy, wind energy, bio energy, energy storage & hybrid vehicles.

The Forthcoming Vibrant Green Energy Expo-2023 is estimated to attract exhibitor & trade visitors around the world. It's a platform to network with influential client & generate referrals to whom you can market your brand and connect to a wider audience.

VGEE will offer an opportunity to meet, network, and make connections with the renewable energy community with three days of uninterrupted business. Join us to drive your business forward in 2023 and beyond.

Key Segments

Solar Energy
Energy Storage
Hybrid Vehicles
Wind Energy
Bio – Energy

Link

https://vgeexpo.com/

Kutch ports fuel green hydrogen mission

Kutch in Gujarat is a crown jewel in the port sector of not just the State but the entire country too. Deendayal port (DP) in Kandla, a major port under the control of the Centre, and the Adani group's Mundra port have contributed in huge measure to the region's prosperity. The two ports, separated by 75 km, together handled 476 million tonnes (MT) of cargo — Mundra 339 MT; and DP 137 MT — in 2022-23.

An added boost to the region's economic development is the upcoming green hydrogen hub with massive investment from both ports — nearly ₹1.45 lakh crore from DP and $50 billion from the Adani group — over the next ten years, depending on market conditions. At the Global Maritime India Summit 2023, held in Mumbai in October, the Deendayal Port Authority (DPA) entered into 13 memorandums of understanding (MoUs) with leading companies engaged in the development of green hydrogen, its derivatives, and associated infrastructure.



https://www.thehindubusinessline.com/economy/logistics/kutch-fuels-green-hydrogen-mission/article67574630.ece

Pilot project on hydrogen blending begins

Adani Total Gas Ltd, the city gas joint venture of billionaire Gautam Adani's group and French energy giant Total Energies, has started blending green hydrogen in natural gas they sell to households for cooking purposes and industries as fuel in Ahmedabad. The percentage of green hydrogen, produced by splitting water using renewable electricity, to be blended in gas will gradually be increased to 8 per cent, the company said in a statement.

"As part of the project, ATGL will employ the latest technologies to blend green hydrogen (GH2) with natural gas for over 4,000 residential and commercial customers at Ahmedabad, Gujarat," it said. GH2 is produced using electrolysis of water with electricity generated by renewable energy. Hydrogen blending is less carbon intensive than burning gas but has the same heating capabilities.

https://www.thehansindia.com/business/pilot-project-on-hydrogen-blending-begins-841233?infinitescroll=1

Green hydrogen & AI will be new buzzwords at COP28. That's the key to India's energy goals



The role of artificial intelligence in the optimisation of energy transition and production of green hydrogen is likely to be the buzz in the run-up to COP28 in Dubai and the 10th Vibrant Gujarat Global Summit. India faces several challenges in the quest to achieve its energy transition goals. There are apprehensions over resilience, scaling, and return on investments, all of which should be addressed at the COP28 meet, along with the myriad ways in which AI could provide solutions at scale. India will need approximately 115 GW of renewable power and around 50 billion litres of freshwater to meet the National Green Hydrogen Mission's (NGHM) target of producing 5 million metric tonnes per annum of green hydrogen by 2030, according to the 2022 EY India-SED Fund report.

This would necessitate active participation in public policy consultations and the utilisation of AI-powered forecasting techniques to meticulously assess both best and worst-case scenarios.

Using AI algorithms and smart data analysis, along with a software-focused automation system based on the IEC61499 standard (for interoperability and portability), could help streamline complicated production processes.

This technology can predict and manage factors like temperature and pressure, making the manufacturing process more efficient, safer, better, and cost-effective, and speed up bringing products to market. In India, using biomass for green hydrogen production is allowed. However, this process generates carbon emissions, says a study by environmental and energy think-tank, Climate Risk Horizons. To address this, policymakers need to speed up the adoption of carbon capture, utilisation, and storage (CCUS) for decarbonisation.

AI can help reassess these incentives based on energy sources, emission exposure, and net-zero targets. It can also predict energy demand patterns and detect faults in hydrogen production processes.

Green hydrogen & AI will be new buzzwords at COP28. That's the key to India's energy goals (msn.com)

Kannaiyan, K. *et al.*

Perspectives for the green hydrogen energy-based economy

https://doi.org/10.1016/j.energy.2023.129358

Abstract:

Hydrogen as an energy vector offers enormous potential compared to other renewable energy routes in the deep decarbonization of industrial sectors. However, globally, developments across the entire hydrogen value chain are still emerging. The specific facets of hydrogen energy, like production, storage, transportation, applications, and policies, are individually evaluated. Nevertheless, a comprehensive viewpoint on the prospects and challenges across the entire hydrogen value chain is essential, and such holistic information is rare. This study ad-dresses the knowledge gap by mapping the potential of the hydrogen economy from an all-rounded perspective. In addition to the advancements in materials, wastewater recycling and the use of microbes or enzymes in electrolysis, offer potential alternative routes to support a hydrogen-based economy. Significant technological advancements are warranted for safe hydrogen transportation and storage. A vast network of refueling stations is essential for hydrogen fuel penetration in the transportation sector, and conducive governing policies are needed to decarbonize heavy industries. Lastly, government incentives are crucial to promote the socioeconomic acceptance of the transition from fossil fuels to green hydrogen.

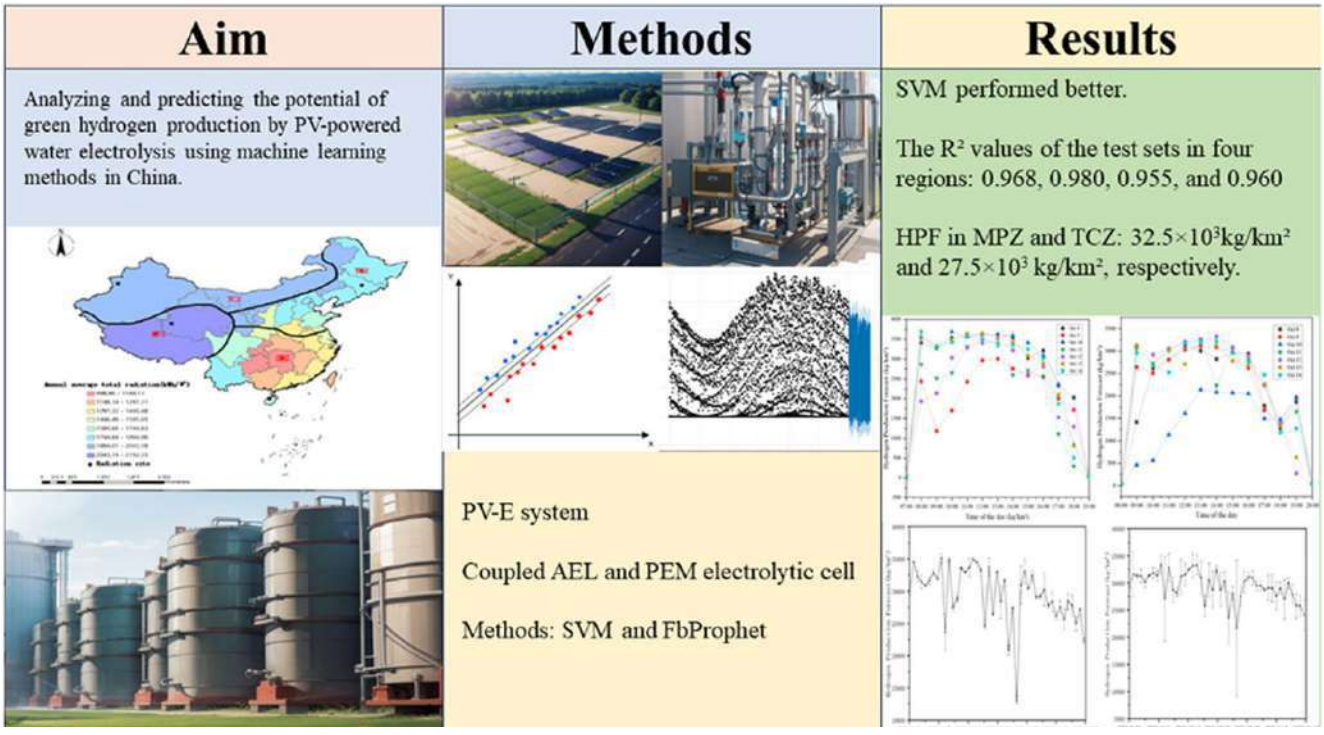
Cheng, GS. *et al.*

Analysis and prediction of green hydrogen production potential by photovoltaic-powered water electrolysis using machine learning in China

https://doi.org/10.1016/j.energy.2023.129302

Abstract:

With the background of energy saving and emission reduction, hydrogen production needs to be gradually changed from gray hydrogen to green hydrogen. Photovoltaic water electrolysis is a good method for producing green hydrogen, and its potential in China needs to be explored. The focus of this study is to analyze and predict the potential of green hydrogen production by photovoltaic-powered water electrolysis using machine learning methods in China. For this purpose, a photovoltaic-electrolysis (PV-E) system was selected to forecast the hydrogen production. Among the two selected algorithms, the non-time series algorithm SVM performs better than FbProphet. The R2 values of the test sets in four regions are 0.968, 0.980, 0.955, and 0.960. The RMSE values of the test sets in four regions are 81.3 kg/km2, 31.4 kg/km2, 71.1 kg/km2, and 70.0 kg/km2. The predicted daily hydrogen production in the two regions with higher radiation, MPZ and TCZ, are 32.5 x 103 kg/km2 and 27.5 x 103 kg/km2, respectively. Combined with the unused land area in the two districts, it is expected that the annual hydrogen production can be as high as 8.3368 x 109 t and 1.0259 x 1010 t. This study demonstrates the viability and environmental friendliness of green hydrogen generation using photovoltaic-powered water electrolysis in China.



Chae, JP. *et al.*

A Proton exchange membrane water electrolysis cell model for analyzing the effects of liquid water supply characteristics on cell performance

https://doi.org/10.1016/j.electacta.2023.143218

Abstract:

Proton exchange membrane water electrolyzers (PEMWE) have significant potential for green, high-purity hydrogen production. This study proposes a pseudo-two-dimensional cell-level model that considers all the physical characteristics involved in water electrolysis (WE), such as electron transport in the electrodes, proton transport in the membrane electrode assembly (MEA), water transport between the anode and cathode, gas diffusion in the porous electrodes, two-phase transport in the porous electrodes, and flow channel (FC), including the channel pressure drop and heat conduction across the cell. Liquid water dispersion at the electrode/channel interface is proposed based on a geometrical analysis of the bubble patterns inside the anode channel. The model was validated against the experimental data. The simulation results showed the effects of the liquid water supply characteristics on the cell operation, demonstrating that uniform water, temperature, and pressure distributions on the cell are required for higher performance. Furthermore, efficiency maps with operating constraints under different conditions provide basic guidelines for determining the optimum point of PEMWE operation. The proposed model is appropriate for extensive analysis of physical phenomena inside the PEMWE and rapid simulation for cell optimization.

Pajares, A. *et al.*

Methodology for energy management strategies design based on predictive control techniques for smart grids

https://doi.org/10.1016/j.apenergy.2023.121809

Abstract:

This article focuses on the development of a general energy management system (EMS) design methodology using on model-based predictive control (MPC) for the control and management of microgrids. Different MPCbased EMS for microgrids have been defined in the literature; however, there is a lack of generality in the proposed that would facilitate adapting to new architectures, energy storage system technology, nature of the bus, application, or purpose. To fill this gap, a novel general formulation that is parameterizable, simple, easily interpretable, and reproducible in different microgrid architectures is presented. This is the result of the development of a novel methodology, which is also presented. It considers the state space formulation of the controller from the initial modelling phase, from the dynamics of the energy storage systems represented by their models to the subsequent definition of the optimisation problem. This is developed through the design of the general cost function and the formulation of constrains, by means of general guidelines and reference values. To evaluate the performance of the developed methodology, simulation tests were carried out for four different microgrid architectures, with different applications and objectives, also considering different generation conditions, demand profiles, and initial conditions. The results showed that, with some simple guidelines and regardless of the case study, the developed MPC controller design methodology can address the technical economic optimisation problem associated with energy management in microgrids in an easy and intuitive way.

Tahir, M.

Nanoconfined Ti3C2@in-situ-grown TiO2 and ruthenium triphenylphosphine (Ru-II) coupled g-C3N4 to construct RuP-Ti3C2@TiO2/ EC3N4 dual function nanocomposite for enhancing photocatalytic green hydrogen production

https://doi.org/ 10.1016/j.cej.2023.146680

Abstract:

Nanoconfined 2D Ti3C2 MXene@ in-situ grown TiO2 and ruthenium (II) complex (triphenylphosphine, RuP) were synchronously attached with exfoliated g-C3N4 to fabricate a RuP-Ti3C2@TiO2/EC3N4 dual function nanotexture for photocatalytic solar hydrogen production. The Ti3C2@TiO2 was obtained through HF etching, whereas 48 h of etching time was optimal, enabling the highest H2 production through TiO2 photoexcitation. The nanoconfined Ti3C2@TiO2 coupled with EC3N4 boosted 2.34 folds more H2 production due to TiO2/EC3N4 heterojunction formation with Ti3C2 as a cocatalyst to trap and transport charge carriers. Coupling ruthenium complex (RuP) was beneficial to inject excited electrons to enhance EC3N4 photoactivation under visible light, whereas Ti3C2 cocatalyst accepted the photogenerated electrons from EC3N4 through in-situ grown TiO2. The optimized RuP-Ti3C2@TiO2/EC3N4 exhibited a H2 production rate of 1772 mu mol g-1 h-1, which was 2.91, 5.16 and 18.02 folds higher than using RuP/EC3N4, Ti3C2/EC3N4 and EC3N4 samples, respectively. The synergistic effect of RuP with Ti3C2@TiO2 promoted H2 evolution without any deactivation of surface stability due to providing excited electrons and preventing their recombination over the exfoliated nanotexture of g-C3N4. Using this new approach to constructing dual-function heterojunctions, it is attractive to excite semiconductors and can increase the lifetime of photoinduced charge carriers. This work provides a facile strategy and new design approach to develop highly efficient and low-cost photocatalysts for future solar energy-assisted sustainable energy conversion systems for different applications.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 62
DECEMBER, 2023

Energy Performance Assessment of a Solar-Driven Thermochemical Cycle Device for Green Hydrogen Production

Solar H_2 production is considered as a potentially promising way to utilize solar energy and tackle climate change stemming from the combustion of fossil fuels – Song et al. (2023)

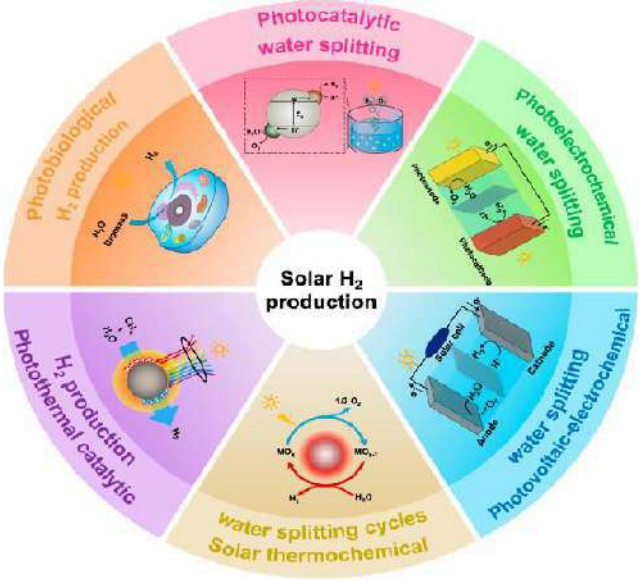


Table: Key Benefits and Critical Challenges of Different Approaches of Solar H2 Production

Approaches For Solar H2 Production	Key Benefits	Critical Challenges
PC Water Splitting	• Most Ideal Method For Solar H2 Production • Low Complexity • Clean And Sustainable	•Low Light Conversion Efficiency •Unsatisfactory Stability •Requirement For Gas (H2 And O2) Separation
PEC Water Splitting	•Highly Efficient •Low Environmental Impact	•High Cost •High Complexity •Unsatisfactory Stability
PV-EC Water Splitting	• Mature Technology And Commercially Viable • Easily Scalable • Highly Efficient • Long Lifetime	• High Cost • High Complexity • Relatively High Environmental Impact For Manufacturing The PV Cell
STC Water Splitting Cycle	• Highly Efficient • Relatively Low Cost • Reliable And Viable	• Requirement For An Effective Solar Collector • Requirement For Acid And Heat-Resistant Materials • Efficient And Robust Reactor Design
PTC H2 Production From Methane Reforming	•Feasible Technology •High Conversion Efficiency •H2 Produced With High Purity •Mitigation Of Catalyst Deactivation By Light	• High Operation And Maintenance Costs • High CO2 Emmisions
PB H2 Production	•Uses Low Light Intensities And Wide Spectrum Of Light •Uses Water Or Abundant Org. Substrates Derived From Waste •Clean And Sustainable	• Low Light Conversion Efficiency • Requirement For Anaerobic Photo-Bioreactors • High Cost

Photocatalytic, photo-electrochemical, photovoltaic−electrochemical, solar thermochemical, photo-thermal catalytic, and photo-biological technologies are the most intensively studied routes for solar H2production. The trend of efficiency shows that the highest solar-to-H2 efficiency, amounting to~32%, is obtained for photovoltaic−electrochemical systems, followed by photo-electrochemical systems (~19%), then photocatalytic and photo-biological systems (1−3%), and finally solar thermochemical systems (<1%). It seems that only photovoltaic−electro chemical systems have the potential to guarantee the long-lasting durability of more than 10 years for practical solar H2 production.

https://pubs.acs.org/doi/10.1021/acsenergylett.1c02591

Encapsulation of few-layered MoS2 on electrochemical-treated BiVO4 nanoarray photoanode: Simultaneously improved charge separation and hole extraction towards efficient photoelectrochemical water splitting

Bismuth vanadate (BiVO4) photoanode shows great potential for photoelectrochemical (PEC) water splitting but still suffers from the sluggish surface reaction kinetic and high charge loss. Further strengthening the intrinsic charge transport for the improvement of solar-to-hydrogen conversion becomes the top priority. Herein, an innovative highly-oriented E-BiVO4/MoS2 heterojunction photoanode is rationally designed and fabricated via directly encapsulating few-layered MoS2 nanosheets on electrochemical-treated BiVO4 (E-BiVO4) nanopyramid arrays. Systematic studies reveal that the electrochemical reduction process can create oxygen vacancies on BiVO4 lattice, thereby increasing the overall carrier concentration, and boosting the bulk and surface charge separation efficiencies. Meanwhile, the introduction of MoS2 as a heterojunction helps build the unidirectional charge transfer channels for further facilitated surface hole extraction and oxidation kinetics, synergistically devoting to the significantly enhanced PEC activity and photostability.

Link:

Peng, Z., Su, Y., Ennaji, I., Khojastehnezhad, A., & Siaj, M. (2023). Encapsulation of few-layered MoS2 on electrochemical-treated BiVO4 nanoarray photoanode: Simultaneously improved charge separation and hole extraction towards efficient photoelectrochemical water splitting. Chemical Engineering Journal, 477, 147082. https://doi.org/https://doi.org/10.1016/j.cej.2023.147082

EVENTS

BIOGAS Convention & Trade Fair 2023



Date: 12 to 14 December 2023

Venue: Exhibition Centre in Nuremberg

The BIOGAS Convention & Trade Fair in 2021 still had to take place under corona conditions, partly online, partly in presence. Therefore, are now particularly looking forward to our biogas trade fair and conference in 2023. Compressed biogas can be used to produce green hydrogen.

Product Index:

Planning / Manufacturing of Biogas plants
Manufacturing/Supply of plant components
Substrate provision
Agricultural engineering/Biomass logistics
Services/Consulting
Information
Miscellaneous

Link:

https://www.biogas-convention.com/en/exhibition/

INDUSTRY NEWS

Masdar and Verbund to develop green hydrogen plant in Spain

United Arab Emirates (UAE) state-owned renewables developer Masdar signed a deal on Thursday with Austrian electricity provider Verbund to develop a green hydrogen plant in central Spain.

Under the deal, the two companies will analyse the feasibility of building one of Europe's largest green hydrogen production plants in Spain's Castilla-La Mancha region, which is already home to an array of renewable energy projects.

The hydrogen plant would aim to help decarbonise hard-to-abate industrial sectors across Europe. The green hydrogen produced at the plant could have the potential to displace up to one million tonnes of carbon emissions annually, Masdar said in a press statement.

https://www.msn.com/en-us/news/other/masdar-and-verbund-to-develop-green-hydrogen-plant-in-spain/ar-AA1laOpp

Bhutan Green Hydrogen Roadmap launched

The Bhutan Green Hydrogen Roadmap was launched at the Bhutan Pavilion during the 28th Conference of Parties, COP28. The Roadmap is part of Bhutan's commitment to advancing the development of a green hydrogen economy to meet its energy and climate goals, and to remain carbon-neutral through 2050 and beyond. The launch was followed by a discussion on green hydrogen development opportunities in Bhutan from a commercial and marketing perspective. Green hydrogen is considered to be the cleanest and most sustainable energy source that can produce electricity, power industry, and enable transportation. It doesn't generate any polluting emissions into the atmosphere.

The Roadmap sets goals for hydrogen pilot projects and plans to match hydrogen generation with demand. It also outlines expert advisory groups and creates an investment packet to promote green hydrogen projects in Bhutan and demonstrate its energy strategy globally.

https://www.bbs.bt/news/?p=195395

Green knowledge-exchange tender out to boost hydrogen acceleration in South Africa

The knowledge-exchange tender has been called by the German sustainability organisastion Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), which is a long-standing promoter of green hydrogen development in South Africa, through the Hydrogen South Africa project.

GIZ, working on behalf of the German Ministry for Economic Cooperation and Development, is inviting bids from companies with a local South African presence.

Despite the promising conditions for the development of a green hydrogen economy in South Africa, many are finding the uptake far less widespread than it could be and want any challenges that continue to persist to be tackled with urgency.

The GIZ tender is aimed at improving networking among institutions engaged with green hydrogen research, innovation and development within the Southern African region, where Namibia is certainly catching the eye. To be built in Namibia in the next ten months is a green hydrogen pilot plant and refuelling facilities to gain scientific insights into the implications of upscaling green hydrogen technologies.

https://www.miningweekly.com/article/green-knowledge-exchange-tender-out-to-boost-hydrogen-acceleration-in-south-africa-2023-12-08

Acwa Power to develop green hydrogen project in Indonesia

Saudi-listed Acwa Power, a private water desalination company, is set to develop green hydrogen facility in Indonesia with PT Perusahaan Listrik Negara (PLN), Indonesia's state-owned electricity provider and PT Pupuk Indonesia, a state-owned fertiliser and chemical producer.

The announcement was made on the sidelines of 28th United Nations Climate Change Conference (COP28) underway in Dubai. Acwa Power CEO Marco Arcelli signed the agreement with PLN's CEO Darmawan Prasodjo and Rahmad Pribadi - CEO of Pupuk Indonesia Holding Company.

https://www.tradearabia.com/news/OGN_416543.html

EVENTS

POWERGEN International 2024

Date: 23.01.2024 - 25.01.2024

Venue: Orlando, USA, New Orleans Ernest N. Morial Convention Center

The Largest Networking and Business Hub for Power Generation Professionals. POWERGEN International® exhibition and summit serves as a business and networking hub for 8,000 electricity generators, utilities and solution-providers engaged in power generation. This immersive and interactive face to face event experience is more important than ever as POWERGEN is committed to providing a platform to discuss in-depth challenges faced by all energy stakeholders and helping them find a path from where the industry is now to where the new emerging and leading trends will take it.

Bringing together power producers, utilities, EPCs, consultants, OEMs, and large-scale energy users, it serves as a platform to explore innovative solutions amid the shift towards cleaner and more sustainable energy sources. POWERGEN fosters a progressive environment for our core audience, supporting their evolution, while also attracting new energy professionals embracing the clean energy movement towards Destination 2050.

Links:

https://expotobi.in/powergen-international

https://www.powergen.com/event-info/about-powergen

Green Hydrogen Project Secures Top Prize at Curtinnovation Awards

A new and cost-effective way to extract green hydrogen from untreated water has won the highest prize at this year's Curtinnovation Awards, named the Griffith Hack Overall Winner.

The water electrolysis method developed by Curtin University Professor Zongping Shao and PhD candidate Ms Jiayi Tang works on unpurified water sources, including seawater. Their approach uses an alternative catalyst that costs just one tenth of existing methods and could produce green hydrogen at 60 % of the current cost.

Curtin Deputy Vice-Chancellor Research, Professor Melinda Fitzgerald congratulated the new generation of innovators. The green hydrogen project was one of 10 bold new products and services named winners at the Curtinnovation Awards 2023 event, including a deployable sensor system capable of flying under the radar to track aircraft and satellites, a theory based chatbot designed to support mental health in young people, an AI-driven model to predict the quality of a pineapple that doesn't damage the fruit, and a leading national education platform that is improving access to school content.The annual Curtinnovation Awards recognise Curtin's commitment to transforming exceptional research into new products and services that benefit the community, with leading research acknowledged across Curtin's Faculties of Science and Engineering, Health Sciences, Business and Law and Humanities.

The two existing methods for extracting hydrogen from water have their limitations: one process requires ultrapure water and an expensive catalyst, the other requires significantly higher energy inputs for the same level of hydrogen production. Curtin researchers have created a new water electrolysis method that employs unpurified water sources, including sea water. Their approach uses an alternative catalyst that costs just one tenth of existing methods, calculated to offer up to a 38% cost saving in hydrogen production. This exciting development could be a cost effective, plentiful source of hydrogen that contributes to the achievement of global zero carbon goals.

Green Hydrogen Project Secures Top Prize at Curtinnovation Awards – India Education | Latest Education News | Global Educational News | Recent Educational News (indiaeducationdiary.in)

Azerbaijan Working On Projects To Export Green Hydrogen, Ammonia

Azerbaijan is actively engaged in initiatives to export green hydrogen and ammonia through collaborative projects with international energy companies, said Parviz Shahbazov, the Minister of Energy, Trend reports.

The country, in partnership with these entities, aims to generate approximately 19 GW of power for the production and export of green energy, hydrogen, and green ammonia by 2031-2037, he added.

Speaking at an event on renewable energy investment opportunities in Azerbaijan, Shahbazov highlighted the commencement of green energy partnerships with seven international companies.

"Azerbaijan is committed to becoming a hub for green growth and achieving a clean environment by 2030, identifying this as a key national priority for social and economic development. This strategic policy framework lays the groundwork for a successful energy transformation in the region.

https://menafn.com/1107537744/Azerbaijan-Working-On-Projects-To-Export-Green-Hydrogen-Ammonia

Swinburne And CSIRO Unveil Cutting-Edge Renewable Hydrogen Refuelling Station

Swinburne University of Technology's Victorian Hydrogen Hub (VH2) and Australia's national science agency, CSIRO have today launched a state-of-the-art clean hydrogen refuelling station, purpose-built for enabling hydrogen research. The $2.5 million refuelling station uses green hydrogen produced with electricity from renewable sources that allows hydrogen cars to travel over 600km emissions-free on a full tank.

Located at CSIRO's Clayton site in Victoria, the station showcases the real-world application of hydrogen and will be used to demonstrate hydrogen's utility for transport.

It will also be used to test emerging hydrogen technology and train the next generation on the use of hydrogen stations to ensure Australia remains internationally competitive.

https://indiaeducationdiary.in/swinburne-and-csiro-unveil-cutting-edge-renewable-hydrogen-refuelling-station/

EVENTS

Hydrogen Technology Expo 2024

Date: 23 – 24 October 2024

Venue: Messe Hamburg, Germany

The world's largest suppliers trade fair for hydrogen technologies, materials, components, and engineering solutions

The Hydrogen Technology Expo Europe is the must-attend conference and exhibition that is exclusively dedicated to discussing advanced technologies for the hydrogen and fuel cell industry. The event will bring together the entire hydrogen value chain to focus on developing solutions and innovations for low-carbon hydrogen production, efficient storage and distribution as well as applications in a variety of stationary and mobile applications.

Hydrogen Technology Expo Europe will provide the industry with a unique opportunity to meet more than 650 suppliers to the advancing hydrogen sector in Europe. Find the latest technology, components, raw materials, test and evaluation tools, and engineering solutions providers in the exhibition hall and network with a wide range of industries looking to adopt hydrogen and fuel cell technology to decarbonise their industry.

Link:

https://www.hydrogen-worldexpo.com/

Submit bids for green hydrogen, electrolyser mfg projects by Dec 12: Govt



In January 2023, the Union Cabinet approved the National Green Hydrogen Mission (NGHM) with an outlay of Rs 19,744 crore with an aim to make India a global hub for manufacturing this clean source of energy.

The mission is expected to lead to development of 5 Million Metric Tons per annum of green hydrogen production capacity by 2030, New and Renewable Energy Minister R K Singh said in Lok Sabha. "Request for selection (RfS) has also been issued for selection of green hydrogen producers for setting up production facilities of 4,50,000 tonnes for green hydrogen in India under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme (Mode-1-Tranche-I) on July 10, 2023. Last date for submission of bids is December 12, 2023," he said.

Singh further said that December 12, is also the last date for submission of bids for the selection of electrolyser manufacturers for setting up 1.5 GW annual electrolyser manufacturing capacities under SIGHT Scheme (Tranche-I) issued on July 7 2023.

The mission aims to develop India as a global hub for production, usage and exports of green hydrogen and its derivatives. It is expected to promote multilateral engagement and collaboration with various international efforts in hydrogen and fuel cells.

Singh further said that India and Saudi Arabia signed an MoU in the fields of electrical interconnection, green/clean hydrogen and supply chains on October 8, 2023. The G20 New Delhi Leaders' Declaration affirmed G20 High Level Voluntary Principles on Hydrogen' to build a sustainable and equitable global hydrogen ecosystem that benefits all nations. The Ministry of Ports, shipping and Waterways has identified three major ports -- Deendayal, Paradip and V.O. Chidambaranar (Tuticorin) Ports to be developed as hydrogen hubs, he said. A Working Group has also been constituted under the chairmanship of Secretary, Ministry of New & Renewable Energy (MNRE).

https://www.business-standard.com/industry/news/submit-bids-for-green-hydrogen-electrolyser-mfg-projects-by-dec-12-govt-123120700781_1.html

Workshop on green hydrogen held at NSI

A workshop on 'Production of Green Hydrogen from Sugar Industry- Opportunities and Challenges' was held on Wednesday at National Sugar Institute, Kanpur. Demonstration of a pilot plant based on production of green hydrogen from compressed bio-gas was made at the Experimental Sugar Factory of the institute. Sanjay Khatal discussed the contribution Indian Sugar Industry can make in bio-energy sector and to the national economy.

Dr. Gaurav Mishra, while discussing the National Green Hydrogen Mission targets informed that by 2030, it would enable saving of Rs 1 lakh crore, creation of 6 lakh jobs, investment to the extent of 8 lakh crores and reducing carbon dioxide emissions to the extent of 50 million metric tonnes per annum. In his presentation, Chief Executive Officer, Pagnism Innovations private limited, Dr. Mahesh Pagnis gave detailed information about the "Rudra" technology developed for converting compressed bio-methane into hydrogen and carbon black. Every 100 kg of compressed bio-methane is going to yield about 25 kg of green hydrogen and 75 kg of carbon black. The methane pyrolysis is carried out in a specially designed reactor under controlled conditions and after considering revenues from carbon black, the cost of production of green hydrogen in considered to be cheaper as compared to conventional electrolysis process, said Dr. Pagnis.

Workshop On Green Hydrogen Held At Nsi | Kanpur News - Times of India (indiatimes.com)

Kerala allocates over Rs 12,500 cr for phase-I green hydrogen valley, green transport corridor

Kerala has allocated over Rs 12,400 crore for green transport corridor and Rs 90 crore for phase-I of the green hydrogen valley project. The state is planning to develop two green hydrogen valleys in Kochi and Thiruvananthapuram. The proposal has been submitted to the Department of Science and Technology (DST), Ministry of Science and Technology, for the Kochi valley and preparation of proposal is ongoing for the Vizhinjam project. Kerala also aims to transform its major transport corridors – the west coast canal, coastal and hill highways – into green economic trade corridors.

Kerala allocates over Rs 12,500 cr for phase-I green hydrogen valley, green transport corridor, ET EnergyWorld (indiatimes.com)

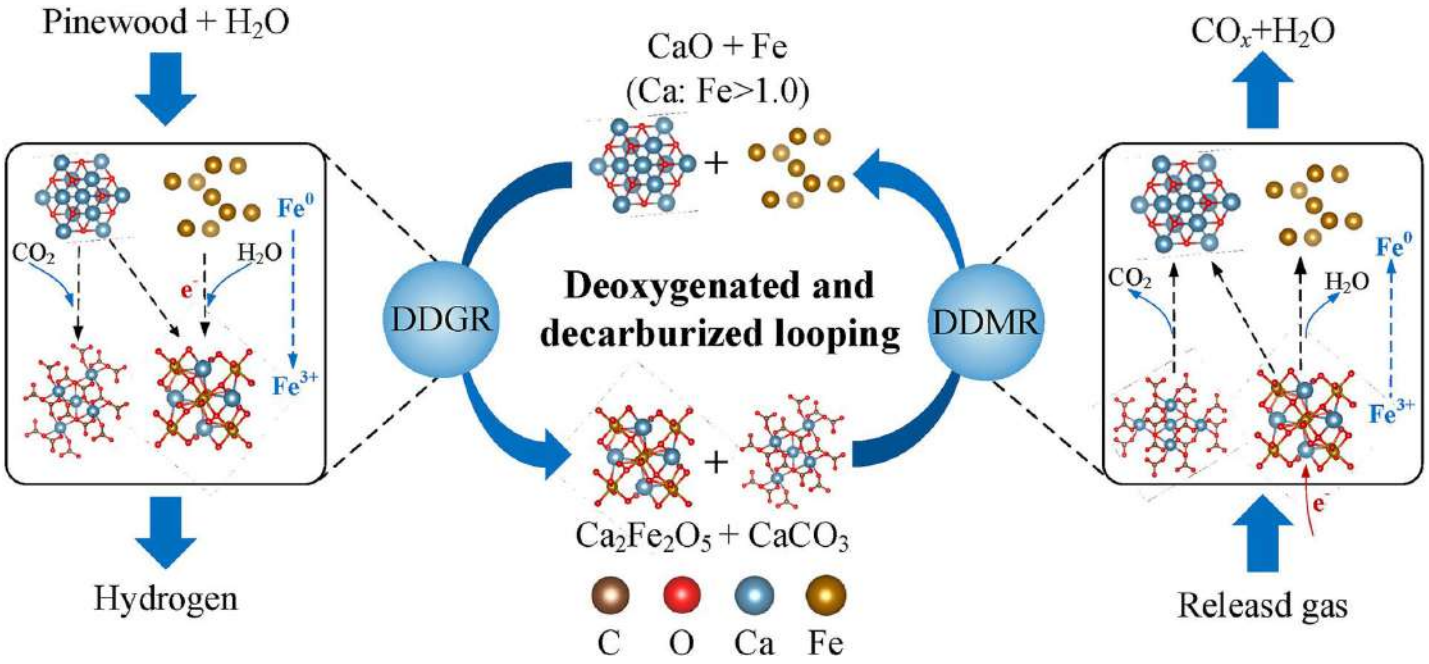
Sun, Z. *et al.*

Simulation of the deoxygenated and decarburized biomass cascade utilization system for comprehensive upgrading of green hydrogen generation

https://doi.org/10.1016/j.renene.2023.119504

Abstract:

Steam gasification of biomass is of great significance for achieving efficient hydrogen-rich syngas production. However, the yield and the quality of H-2 in the product require further improvements. In this study, a strengthened biomass cascade utilization system via synergistic deoxygenation and decarburization is investigated. The system is composed of a deoxygenated and decarburized gasification reactor and a deoxidizer and decarburizer material regenerator. In the gasification reactor, a series of deoxidizer and decarburizer materials, CaO-Fe (Ca: Fe > 1.0), are applied for accomplishing high-quality hydrogen production; In the regenerator, the deoxidizer and decarburizer material is regenerated (CaCO3+ Ca2Fe2O5 -> CaO-Fe) with released gas utilization. The effects of gasification temperatures, Ca/Fe, H2O/C, and (CaO + Fe)/B mole ratios are evaluated by Aspen Plus, achieving comprehensive optimization of the parameters. The H-2 yield reaches 68.16 mol s(- 1) kg(-1) biomass and the H-2 concentration is up to 93.58 vol%, which increases by 254.45 % and 109.87 % compared with the results without deoxygenation and decarburization. Additionally, the deoxidizer and decarburizer material can be completely regenerated via released gas reduction, thereby ensuring the consistent looping of the entire system. This paper sheds light on the synergistic deoxygenation and decarburization methodology for biomassto-hydrogen generation, which provides a robust guidance for further experiments in the future.



Arthur, T. *et al.*

Integration of waste heat recovered from water electrolysis to desalinate feedwater with membrane distillation

https://doi.org/ 10.1016/j.jwpe.2023.104426

Abstract:

The production of green hydrogen from water electrolysis results in hot water which must be cooled using a heat exchanger to avoid process inefficiencies. Concomitantly there exists a demand for purified water to ensure the electrolysers operate successfully. Thus, the hypothesis was that if the waste heat was used to desalinate feedwater using membrane distillation (MD), then the process may be improved. Therefore, a thermally integrated electrolyser and MD system was designed, constructed, and operated. The MD unit successfully employed waste heat from water electrolysis to provide high quality water (conductivity of 2.8 mu S/cm) extracted from brine solutions (up to 70,000 mg/L) for use in the water electrolysis process. Indeed, at the maximum rate of hydrogen production the amount of desalinated water produced was 20 % more than the amount of water consumed by the electrolysis unit. The water flux in the MD system was 5 L per square meter per hour (LMH) and the process water recovery was 0.1 %. This study validated previous models relating to the potential benefit of integrating MD to remove excess heat producer during electrolysis processes. Future research should focus on determining if the replacement of the existing heat exchanger in the electrolysis system with a membrane distillation heat exchanger provides operational and economic benefits.

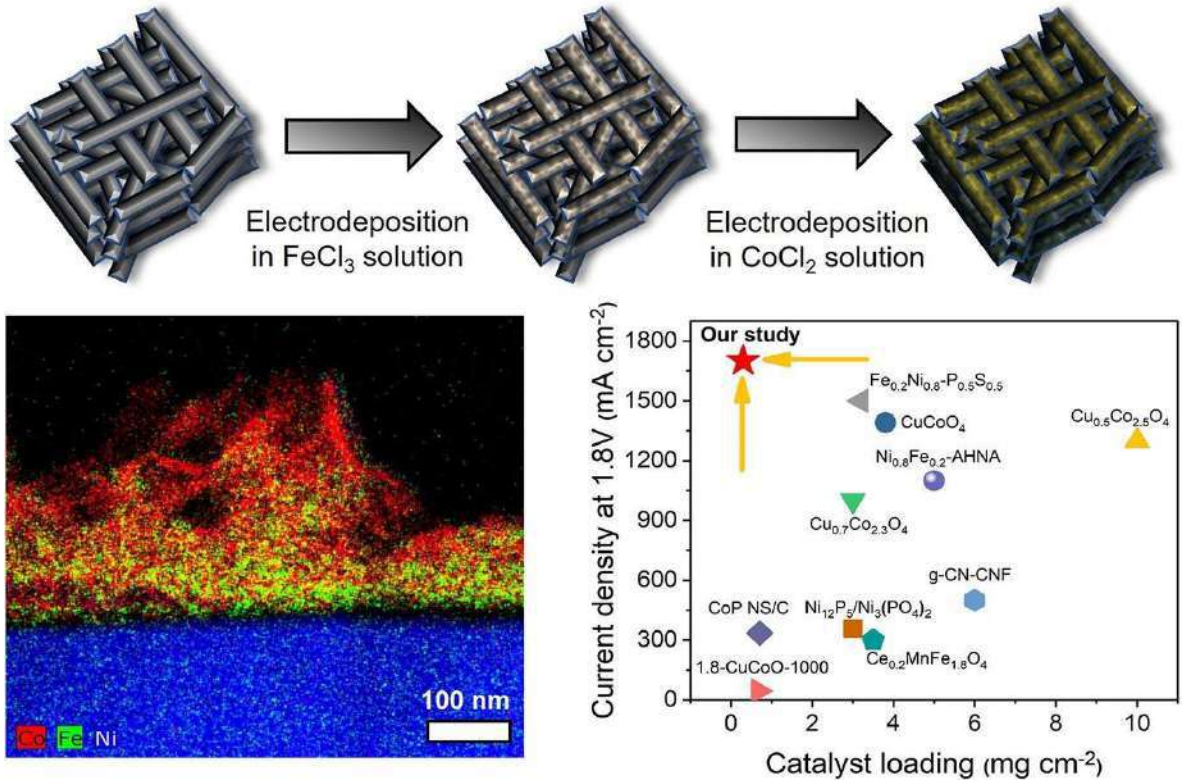
Han, S. *et al.*

Superior performance of an anion exchange membrane water electrolyzer: Sequential electrodeposited Co-based oxygen evolution catalyst

https://doi.org/ 10.1016/j.cej.2023.146713

Abstract:

Green hydrogen production in the anion exchange membrane water electrolysis (AEMWE) field requires catalysts for the oxygen evolution reaction (OER) with high performance, low cost, and ease of fabrication. Here, we report a sequential electrodeposited Co-based electrode supported on FeOxHy (Fe@Co) as a superior anode in alkaline media. The Fe@Co electrode exhibited an overpotential of 184 mV at 10 mA cm-2 with a Tafel slope of 44 mV per decade in 1 M KOH solution. In an AEMWE single-cell, it showed a current density of 1,780 mA cm-2 at 1.8 V at 50 degrees C, outperforming the state-of-the-art OER catalysts. This notable OER performance was attributed to the Fe-based support, which not only increased the active sites and oxidation state of Co but also formed Fe active sites. By comparing with other support materials and adjusting the method for synthesizing Fe, it was confirmed that Fe@Co has the highest OER activity. Our discovery and analysis of the sequential electroplating strategy provide an innovative perspective in the field of non-noble-metal AEMWE, which is a step forward toward cost-effective green hydrogen generation for the oncoming hydrogen economy.



Ayala-Cortés, A. *et al.*

Upgrading of biomass-derived solar hydrothermal bio-oils through catalytic hydrodeoxygenation in supercritical ethanol

https://doi.org/ 10.1016/j.jece.2023.111395

Abstract:

The use of concentrated solar energy as the heat source to perform hydrothermal liquefaction (HTL) of biomass is a promising alternative to improve the thermal efficiency of the process and reduce the environmental impact of the use of fossil fuels. However, the HTL of lignocellulosic biomass produces a bio-oil that still requires an upgrading treatment to improve its properties as fuel. In the present work, bio-oils obtained from solar hydro thermal liquefaction of Agave and corncob were upgraded for the first time by hydrodeoxygenation (HDO) in supercritical ethanol using a Mo2C catalyst supported in carbon nanofibers. The main results showed yields up to 69% of the upgraded bio-oil and a deoxygenation grade of 71%, with HHV values around 35 MJ/kg for most of the upgraded bio-oils. Moreover, it was observed that HDO treatment of the solar bio-oils can produce upgraded bio-oils with chemical properties and yields similar to those produced by conventional thermochemical methods, which opens the door to extend the use of concentrated solar technologies for the whole process: from biomass thermochemical conversion to its upgrading into drop-in fuels.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 63
DECEMBER, 2023

Tata Starbus Fuel Cell EV: India's first Hydrogen Fuel Cell bus



The Tata Starbus Fuel Cell EV is India's first Hydrogen Fuel Cell bus, indigenously designed and developed by Tata Motors. It is a modern state-of-the-art mass mobility solution for urban transport requirements. With zero-emission and noiseless operations, the newly designed fuel cell bus meets the requirement for cleaner public transport vehicle. It offers modern features like improved safety, easy of boarding with its low entry and comfortable seats. It is the perfect solution for future urban mass mobility as it benefits all stakeholders and helps curb air-pollution.

Features:

- Fuel cell Hydrogen bus with zero emissions for clean air
- Fatigue-free driving without clutch and gear shifting
- Regenerative braking for high efficiency
- Electronic Braking System (EBS) and Electronic Stability Control (ESC) for higher safety
- Compliant with Advanced Driver Assistance System (ADAS) like Driver Monitoring System (DMS), Lane Departure Warning System (LDWS), Tyre Pressure Monitoring System (TPMS) and Frontal collision avoidance system
- Roomy interiors which can be customised as per the application and regulations
- High safety and security with Intelligent Transport System (ITS)
- New generation telematics for efficient and user-friendly vehicle maintenance and tracking
- Passenger information system with destination boards and audio announcements
- Stylised interior and exterior with, plush interior lighting
- Utility provisions like charging ports, Wi-Fi hotspot for on-the-go connectivity

Performance:

Max. Speed: 70-75 kmph
Grade-ability: 17% at rated GVW
Range: ~250 to 300km scalable as per requirements.

HV System:

Fuel System Type: Compressed Hydrogen Gas, Tank type: 4 Cylindrical of TYPE III
H_2 Filling: 10 min at 350 Bar.

https://autoexpo.tatamotors.com/products/commercial/starbus-fuel-cell-ev-features.aspx

Tata Motors Scores India's First Green Hydrogen Fuel Cell EV Approval

The Automotive Research Association of India (ARAI) has granted Tata Motors the country's first Green Hydrogen Fuel Cell EV approval for their TATA STARBUS 4/12 FCEV model. ARAI announced that it had awarded the CMVR Type Approval certificate to Tata Motors Ltd. for their Green Hydrogen Fuel Cell EV (Bus).

This approval makes Tata Motors the first OEM (Original Equipment Manufacturer) in India to receive a Type Approval certificate in full compliance with all notified provisions of CMVR. Reji Mathai, Director of ARAI, presented the certificate to Rajendra Petkar, President & CTO of Tata Motors during a ceremony attended by senior leadership teams from both organizations.

Why It Matters: This development comes at a time when Tata Motors' has been looking at expanding its alternate fuel offerings. Earlier in the month, the Tata Group company announced partnering with BPCL to set up 7,000 EV charging stations across the country.

The approval of the Tata Starbus 4/12 FCEV also comes on the heels of the company announcing a 3% price hike for all its commercial vehicle offerings starting Jan 1, to offset the impact of past input costs.

Price Action: Tata Motors' share price was down 0.24% to trade at ₹719.10.

Link:

https://www.msn.com/en-in/autos/news/tata-motors-scores-indias-first-green-hydrogen-fuel-cell-ev-approval/ar-AA1lmYns

EVENTS

Americas Energy Summit & Exhibition



Date: January 16 - 19, 2024

Venue: Ernest N. Morial Convention Center, New Orleans, Louisiana

The 20th Americas Energy Summit & Exhibition, formerly known as the Americas LNG & Gas Summit & Exhibition, will be held at Ernest N. Morial Convention Center, New Orleans, Louisiana from January 16 - 19, 2024.

This year's event is poised to be a hub for pivotal discussions concerning the future of energy. It will serve as a dynamic platform where thought leaders and innovators from the LNG, gas, and hydrogen value chains can come together to exchange ideas. Moreover, it will play a central role in catalyzing international investments by showcasing the abundant natural gas resources present in the Americas.

The US plays a crucial role in ensuring the security of the global energy supply as the largest LNG exporter in the world. Louisiana is uniquely positioned to benefit from existing energy infrastructure whilst also becoming a hub for investment in blue and green hydrogen. Against this backdrop, New Orleans will play host to over 3,000 attendees from 50 countries over four days to drive industry transformation.

Link:

https://www.americasenergysummit.com/

INDUSTRY NEWS

UK government backs plan to ban gas and 'hydrogen-ready' boilers

The UK government has formally backed plans to ban gas and "hydrogen-ready" boilers from new build homes in England from 2025, in a long-delayed consultation on low-carbon building standards.

The proposals could mean heat pumps being installed as standard as part of measures to make all new homes "net zero ready" from 2025.

The consultation rules out the use by housebuilders of all fossil fuel heating systems including gas, hybrid heat pumps and hydrogen-ready boilers, after a finding that there was "no practical way to allow the installation of fossil fuel boilers while also delivering significant carbon savings".

The net zero standards are considered key to the government's plan to meet its legally binding target of net zero emissions by 2050. However, the consultation has been delayed amid growing controversy over the government's links to the housebuilding sector.

https://www.theguardian.com/business/2023/dec/13/uk-government-backs-plan-ban-gas-hydrogen-ready-boilers-newbuilds-2025

UK government invests £2 billion in green hydrogen projects

The UK government has announced £2 billion (€2.3 billion) in government funding over the next 15 years for 11 major hydrogen projects. Confirmed suppliers will receive a guaranteed price from the government for the clean energy they supply.

The government said this represents the largest number of commercial scale green hydrogen production projects announced at once anywhere in Europe.

Unlike blue hydrogen, which is formed using fossil fuels and capturing the carbon emissions, green hydrogen is made by using renewable energy to split water – helping provide cleaner fuel for energy intensive industries and transport, added the government. Minister for Energy Efficiency and Green Finance, Lord Callanan, said: "Today's funding commitment represents a monumental step forward in helping producers to deliver a fuel of the future today, backing businesses to go greener.

https://www.bioenergy-news.com/news/uk-government-invests-2-billion-in-green-hydrogen-projects/

Cop28 climate summit accelerates hydrogen deals

Deals in the hydrogen sector gathered pace on the sidelines of the Cop28 climate conference in Dubai as companies raced to boost the production of the fuel, seen as key to reducing emissions in sectors such as shipping and steel manufacturing.

Several companies announced plans to set up hydrogen projects or boost the international trade of low-carbon fuel as industries worldwide look to reduce their reliance on fossil fuels.

Most of the announcements have been centred around the UAE and the Middle East and North Africa region, which has the potential to be a global hydrogen hub, Javier Cavada, president and chief executive of Mitsubishi Power Emea, told The National.

"We can see the Emirates [and] Saudi Arabia positioning themselves. They are looking at … renewables production and [the] hydrogen value chain," he said.

That includes the production and export of hydrogen as well as blending the fuel with other elements, he added.

https://www.thenationalnews.com/business/energy/2023/12/14/cop28-climate-summit-accelerates-hydrogen-deals/

GM and Komatsu collaborate on hydrogen fuel cell-powered mining truck

Lightweight and quick to refuel, hydrogen fuel cells are ideal for electrifying applications traditionally powered by diesel engines. Hydrogen provides an effective method to package large quantities of energy onboard the vehicle, without compromising payload carrying capacity.

Additionally, fuel cells provide an excellent zero tailpipe emissions solution for vehicles with extreme hauling requirements, like the Komatsu 930E mining truck, with its nominal payload of 320 tons. These vehicles typically operate at a single mine throughout their life, which simplifies the challenges of sizing and deploying an effective hydrogen refuelling infrastructure to service the vehicle fleet.

"At GM, we believe fuel cells can play an integral role in a zero-emissions future, helping to electrify heavier-duty applications, beyond passenger vehicles," said Charlie Freese, executive director of GM's Global HYDROTEC business.

https://www.autocarpro.in/news-international/kia-to-launch-its-global-pbv-business-at-ces-2024-in-las-vegas-118240

EVENTS

HYVOLUTION PARIS

Date: January 30, 31 & February 1, 2024

Venue: Paris Porte De Versailles, France

The ground-breaking Hyvolution exhibition is now the world's leading hydrogen event and meeting place for key international business and political players. Convinced that the development of hydrogen hinges on the development of its uses, Hyvolution is making cross-disciplinary solutions the cornerstone of its offer.

Link:
https://paris.hyvolution.com/en

Genera-Energy & Environment International Fair 2024

Date: 06.02.2024 - 08.02.2024

Venue: Madrid, Spain, Feria de Madrid

The International Energy and Environment Trade Fair, GENERA, the largest commercial platform for this industry, with the support of the Institute for Energy Diversification and Saving, IDAE (Ministry for Ecological Transition and the Demographic Challenge) as well as with the renewed backing of the main agents of this important economic sector.
Link:
https://www.ifema.es/en/genera
https://expotobi.in/genera

Hydrogen car maker NAMX to use ICE technology for its HUV

Choosing ICE technology for hydrogen-powered transportation is in line with market-leading approaches taken by automotive giants. Alongside established firms, NAMX is banking on a proven and time-tested technology that has benefited from decades of investment and continuous enhancements.
In addition, Hydrogen Internal Combustion Engine vehicles (HICE) do not face the main drawbacks of Fuel-Cell electric vehicles (FCEV), which rely on rare earth metals. Internal Combustion Engines ensure greater stability and predictability when it comes to production costs, shielding the company and its customers from the price fluctuations associated with the supply of rare minerals. Hydrogen combustion engines also boast higher robustness and versatility compared to fuel cells, as they eliminate the need for high-purity H2, which entails regular replacement of air and hydrogen filters and can accommodate lower-quality, cheaper hydrogen. These distinctive features position Hydrogen Internal Combustion Engine vehicles as a sustainable, cost-effective, and functional choice throughout their lifecycle.



https://www.autocarpro.in/news-international/hydrogen-car-maker-namx-to-use-ice-technology-for-its-huv-118190

Oman-Korea partnership to boost green hydrogen sector

The partnership between Oman and South Korea in the green hydrogen sector offers substantial mutual gains for both countries, leveraging each other's strengths and capacities. This was the message from speakers at the Korea-Oman Green Hydrogen Strategic Forum 2023 held on the sidelines of the Green Hydrogen Summit. The Second Korea-Oman Green Hydrogen Strategic Forum was hosted by the Korean Embassy at Crowne Plaza, Oman Convention and Exhibition Center (OCEC). The forum aimed at increasing the level of understanding of the strategies and policies of Korea and Oman in the green hydrogen sector.
In his opening remarks, H E Kiejoo Kim, Ambassador of the Republic of Korea to Oman, said, "Since last year's Korea-Oman Green Hydrogen Strategic Forum, there has been substantial progress and the delivery of initiatives. The development of the hydrogen economy is gaining worldwide momentum as a strategic opportunity to effectively address the energy trilemma, i.e., environmental sustainability, energy equity, and energy security."
Oman-Korea partnership to boost green hydrogen sector (muscatdaily.com)

World's First Hydrogen-Powered Tugboat Is Ready to Operate at the Antwerp-Bruges Port

The Hydrotug 1 is a truly pioneering vessel in maritime transportation. It's not only the first hydrogen-powered tugboat in the world but also the largest vessel powered by hydrogen right now. It was developed by CMB.TECH, a shipping and clean-tech company, recently made its official debut at the Port of Antwerp-Bruges in Belgium, where it will demonstrate its green prowess.
The new tugboat is a double-hulled, 30-meter-long (98.4 feet) boat with a 65-ton bollard pull. Its main innovation is the integration of combustion engines that burn hydrogen together with conventional fuel. These are the V12 dual-fuel mediums-speed engines made by BeHydro, a joint venture between CMB.TECH and ABC. The two 2MW engines come with an EU Stage V-compliant after treatment.
As a result, the Hydrotug 1 promises a 65% reduction in fuel consumption and the elimination of emission levels equivalent to that of 350 cars per year. This large vessel can store 450 kg (992 lbs) of compressed hydrogen on its deck. The hydrogen is stored in 54 Type 3 cylinders that are installed in six stillages.



https://www.autoevolution.com/news/worlds-first-hydrogen-powered-tugboat-is-ready-to-operate-at-the-antwerp-bruges-port-226085.html

EVENTS

Egypt Energy Show 2024

Date: 19 - 21 February 2024

Venue: Egypt International Exhibition Center

Held under the patronage and participation of His Excellency Abdel Fattah El Sisi, President of the Arab Republic of Egypt, EGYPES (Egypt Energy Show) is at the heart of dynamic, fast growing energy conversation welcoming 35,000+ energy stakeholders from across the energy value chain to meet, connect and explore business-critical avenues for growth. Following COP27 held in Egypt in 2022 and COP28 in the UAE, the upcoming edition of EGYPES is set to address international net-zero agendas, and drive thought leadership and collaborations for the sustainable production of oil and gas, decarbonisation, and highlight the many opportunities that a responsible energy transition will unlock.

EGYPES provides a unique platform for interaction between leading NOCs, IOCs, IECs and service providers. Leading energy companies from around the world convene and bring industry leading technologies and solutions to the region's largest oil, gas and energy event. EGYPS delivers real buying power from across the world to Egypt. Gain direct access to the primary stakeholders involved in the region's upcoming projects investing more than $1 billion in the oil and natural gas sector in the Western Desert region of Egypt.

Link:

https://www.egypes.com/
https://www.egypes.com/exhibition/about-the-exhibition-old/

Rs 11 lakh spent under Green Hydrogen Mission to date against Rs 100 cr provision in FY24

The government has incurred an expenditure of Rs 11 lakh under the National Green Hydrogen Mission to date against the revised estimates of Rs 100 crore for 2023-24, Parliament was informed. The Ministry of New & Renewable is implementing the National Green Hydrogen Mission, approved by the Union Cabinet on January 4, 2023, with an outlay of Rs 19,744 crore from 2023-24 to 2029-30, Union Power and New & Renewable Energy Minister R K Singh said in a written reply to the Rajya Sabha.
The overarching objective of the Mission is to make India a Global Hub for the production, usage and export of Green Hydrogen and its derivatives. Revised estimates for the Mission for 2022-23 were Rs 1,00,000 and there was no expenditure in 2022-23, he stated. Revised estimates for the Mission for FY 2023-24 are Rs 100 crore and expenditure is Rs 11 lakh to date, the minister told the House.
About assessment regarding the impact on cost escalation resulting from the implementation of a Uniform Renewable Energy Tariff (URET), Singh told the House in another written reply that the procedure for implementation of URET was issued by Ministry of Power on October 25, 2023, however, the actual implementation of URET is yet to be initiated and hence Government has not conducted any such assessment. Singh further explained that the intermediary procurer is a trader, buying RE power from the RE Power Generators as per the tariff-based competitive bidding (TBCB) guidelines and selling the same to one or more distribution licensees, who in turn supply power to consumers in their area of jurisdiction and have public service obligation.
Therefore, the minister stated that the intermediary procurer does not have any direct public service obligation.
In another reply to the House, Singh stated that so far, 72.02 GW of Solar Power Projects have been installed.
The government has set a target of achieving 500 GW of installed capacity from nonfossil fuels by 2030, in line with the Prime Minister's announcement at CoP-26, including from solar energy, he stated.

Rs 11 lakh spent under Green Hydrogen Mission to date against Rs 100 cr provision in FY24 (moneycontrol.com)

India Hydrogen Alliance expands membership with key global energy players

The India H2 Alliance (IH2A) has added seven new industry members to its ranks after inducting Torrent Power, Synergen Projects, Godawari Power and Ispat, Technip Energies, HSBC Bank, Bureau Veritas and Newtrace.
The announcement follows submission of the $5bn National Green Hydrogen Hub Economic Viability and Development Plan and the $50bn Hydrogen Equipment and Exports Report, submitted by the IH2A to the Government of India. Jillian Evanko, President and CEO of Chart Industries and Founding Member of IH2A, said, "We welcome the seven new members to the India Hydrogen Alliance."
"This marks a significant step forward and is a mark of investor interest in building the green hydrogen economy in India." This optimism was echoed by Abhishek Agrawal, Executive Director of Godawari Power and Ispat Ltd, who said the company looks forward to working closely with the India Hydrogen Alliance members and partner organisations to accelerate decarbonisation of the Indian metals and steel sector.
https://www.gasworld.com/story/india-hydrogen-alliance-expands-membership-with-key-global-energy-players/2131548.article/#:~:text=The%20India%20H2%20Alliance%20(IH2A,Bank%2C%20Bureau%20Veritas%20and%20Newtrace.

GreenH Electrolysis Entered into a Contract to Build a Hydrogen Production and Refuelling Station to Power India's First Hydrogen Train

Indian Railways has awarded a contract to Medha for a pilot project to retrofit Diesel Electric Multiple Unit rake, on the Sonipat-Jind section, from diesel to a hydrogen-powered train, as a first step to achieving India Railways' net zero emissions goal. GreenH will provide the necessary equipment from its newly constructed PEM electrolyzer manufacturing plant in Jhajjar District, Haryana. The Hydrogen production and refueling station is expected to deploy a comprehensive system to both produce Hydrogen and refuel the trains on a daily basis. To achieve the first stage, a 1 MW electrolyzer, supplied by GreenH, will operate round the clock with an expected capacity of 420 kg/day of hydrogen.
https://www.business-standard.com/content/press-releases-ani/greenh-electrolysis-entered-into-a-contract-to-build-a-hydrogen-production-and-refueling-station-to-power-india-s-first-hydrogen-train-123121200456_1.html

Menz, S. *et al.*

Physical system behavior and energy flow analysis of a solar driven hydrogen production plant based on two-step thermochemical redox cycles

https://doi.org/10.1016/j.ijhydene.2023.06.112

Abstract:

Two-step thermochemical water splitting using concentrated solar power offers promising potential for green hydrogen production as a part of a future sustainable energy economy. In this study, a system and energy flow analysis of a large scale 250 kW reactor prototype is presented by using a complex 3D-simulation model. Thus, the physical dynamic system behavior and potential efficiency improvements are discussed with respect to plant design and operational strategy. Regarding the plant design, different kind of heat losses as well as the influence of reactor design parameters and material modifications are analyzed. Regarding the operational strategy, crucial control parameters as cycle durations, temperatures, and mass flow rates are varied in a broad range and analyzed with respect to plant efficiency. By comparing commonly used operational strategies, the temperature swing operation turns out to be by far more efficient than any isothermal or near isothermal operation for the current plant concept.

Lo Basso, G. *et al.*

From landfill to hydrogen: Techno-economic analysis of hybridized hydrogen production systems integrating biogas reforming and Power- to-Gas technologies

https://doi.org/ 10.1016/j.ijhydene.2023.07.130

Abstract:

In the new hydrogen economy, bio-hydrogen derived from organic material can represent an opportunity to valorise current waste management systems. The present work deals with innovative systems for producing hydrogen from landfill gas combining Power-to-Gas plants and biogas reforming. To do so, Pressure Swing Adsorption (PSA) and Chemical Absorption (CA) have been assessed for biogas upgrading. Furthermore, both high-temperature electrolysis by SOECs (solid oxide electrolysis cell) and low-temperature electrolysis by PEM (proton exchange membrane) and Alkaline electrolysers are pre-sented. The simulation results are compared in terms of Levelized Cost of Hydrogen (LCOH) at stack price and after compression and storage. Assuming a capacity factor equal to 70%, the potential hydrogen production rate in such hybrid configurations ranges between 26 and 28 kgH2/h. Furthermore, the LCOH turns out to be in a range between 1.9 and 3.3 euro/kgH2. Considering 2030 forecast, LCOH below 2 euro/kgH2 at stack is feasible.

Shi, ZJ. *et al.*

Progress of ultrafine noble metal nanocatalysts regulated by confining engineering for water electrolysis

https://doi.org/ 10.1016/j.jelechem.2023.117900

Abstract:

Water electrolysis has been considered a promising technology for producing sustainable green hydrogen fuel energy. Noble metal nanocatalysts have exhibited widely recognized activities for electrocatalysis. However, the high cost of producing hydrogen by noble metal limits the widespread adoption of this fuel. The key to reducing the usage lies in reducing the size of noble metals to the atomic scale to offer rich active sites and unique electronic structures to enhance their catalytic activity. Generally, the charge transfer between the host support and guest materials by confining engineering can improve the catalytic activity, as well as overcome the aggregation and/or structural degradation of guests. In contrast to previous reviews involving electrochemistry under confinement, or confined nonprecious metal-based catalysts, our review offers a scientific analysis of the structure-activity relationship in the development of platinum group metals via confinement engineering for water splitting. Our discussion covers diverse confinement strategies including space confinement, space-electrostatic confinement, and space-coordination confinement with a special focus on the advances in the coordination-confinement (pyrolysis) strategy for ultrafine noble metal nanostructures. Finally, we put forward future development directions including hydrogen spillover path, in situ characterization, and electrical double layer atomic/molecule structure analysis in confined metal-based electrocatalysts for water electrolysis.

Li, DY. *et al.*

In Situ Regulating Cobalt/Iron Oxide-Oxyhydroxide Exchange by Dynamic Iron Incorporation for Robust Oxygen Evolution at Large Current Density

https://doi.org/10.1002/adma.202305685

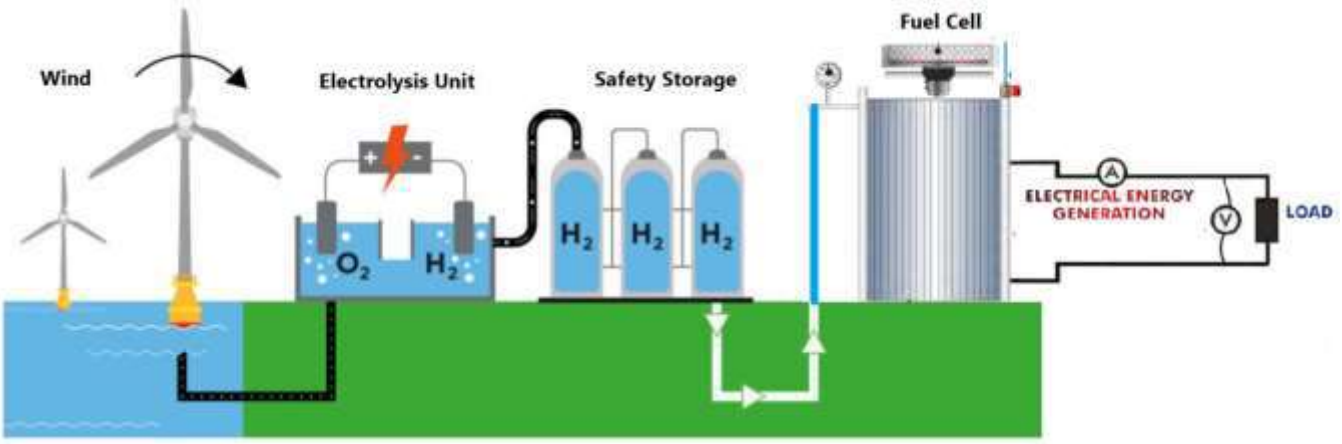
Abstract:
The key dilemma for green hydrogen production via electrocatalytic water splitting is the high overpotential required for anodic oxygen evolution reaction (OER). Co/Fe-based materials show superior catalytic OER activity to noble metal-based catalysts, but still lag far behind the state-of-the-art Ni/Fe-based catalysts probably due to undesirable side segregation of FeOOH with poor conductivity and unsatisfied structural durability under large current density. Here, a robust and durable OER catalyst affording current densities of 500 and 1000 mA cm-2 at extremely low overpotentials of 290 and 304 mV in base is reported. This catalyst evolves from amorphous bimetallic FeOOH/Co(OH)2 heterostructure microsheet arrays fabricated by a facile mechanical stirring strategy. Especially, in situ X-ray photoelectron spectroscopy (XPS) and Raman analysis decipher the rapid reconstruction of FeOOH/Co(OH)2 into dynamically stable Co1-xFexOOH active phase through in situ iron incorporation into CoOOH, which perform as the real active sites accelerating the rate-determining step supported by density functional theory calculations. By coupling with MoNi4/MoO2 cathode, the self-assembled alkaline electrolyzer can deliver 500 mA cm-2 at a low cell voltage of 1.613 V, better than commercial IrO2(+)||Pt/C(-) and most of reported transition metal-based electrolyzers. This work provides a feasible strategy for the exploration and design of industrial water-splitting catalysts for large-scale green hydrogen production. An exceptional and stable oxygen-evolving electrocatalyst is developed from self-reconstruction of amorphous bimetallic FeOOH/Co(OH)2 microsheet arrays through a mechanical stirring strategy, yielding a current densities of 500 and 1000 mA cm-2 at low overpotentials of 290 and 304 mV. This catalyst rapidly reconstructs into Co1-xFexOOH species through in situ iron incorporation into CoOOH as confirmed by in situ X-ray photoelectron, Raman spectroscopic studies, and theoretical calculations.image.

Maciel, LBB. *et al.*

Environmental studies of green hydrogen production by electrolytic process: A comparison of the use of electricity from solar PV, wind energy, and hydroelectric plants

https://doi.org/10.1016/j.ijhydene.2023.05.334

Abstract:
In this paper is developed an environmental comparison analysis associated with electrolytic process of hydrogen production using renewable electricity generated by solar photovoltaic (PV), wind energy, and hydroelectric systems. The electrolytic process and the electricity generation are particularly explained, and the global warming potential (GWP) and greenhouse gases (GHG) emissions are analysed, highlighting advantages and disadvantages associated with the production of green hydrogen. The hydrogen production processes are compared considering those different scenarios, enabling the determination of pollutant emissions factors, as the equivalent dioxide carbon and ecological efficiency. As a conclusion, the sustainability study using environmental analysis showed that electricity from renewable sources (wind, solar and water) have ecological impacts on hydrogen production. Comparatively, the best level of ecological efficiency obtained was in the production of green hydrogen from electricity from hydroelectric plants, followed by wind and photovoltaic (PV) plants.



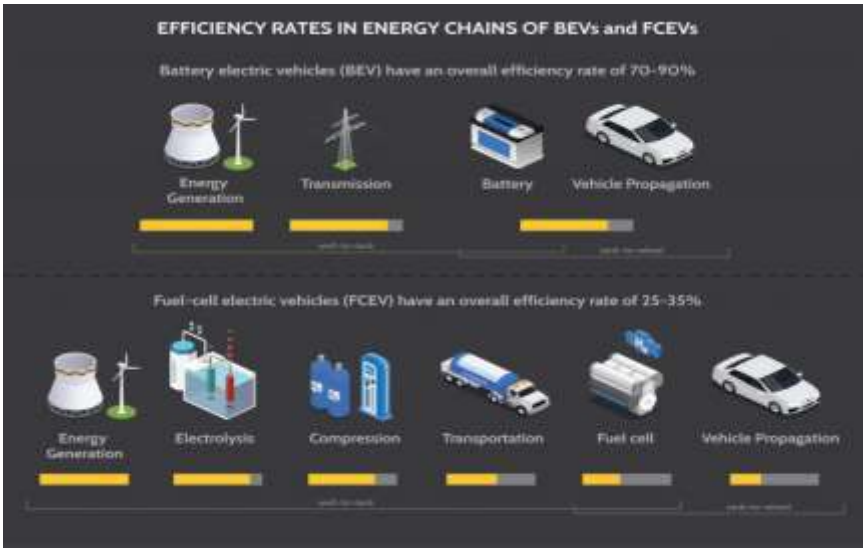
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 64
DECEMBER, 2023

Hydrogen vs Battery- The Technology Choice Conundrum

Energy diversification model where both battery and hydrogen infrastructures co-exist will mean better energy security, more stable grid. The world has grown comfortable with the ecosystem of internal combustion engines. The shift towards greener energy is the need of the hour, thus, Battery electric vehicles (BEV) and fuel-cell electric vehicles (FCEV) are opted which come with their own set of pros and cons.



The term 'well-to-wheel' is used for life cycle assessments of fuels, including all phases from extraction of raw materials to their use in the vehicle. There are two components to the well-to-wheel assessment: Well-to-tank and tank-to-wheel. Well-to-tank includes fuel / electricity generation and transport / transmission, and tank-to-wheel is about the use of the fuel.

Performance:

FCEVs are way less energy efficient than BEVs, when only the life-cycle of the fuel (battery and hydrogen) is considered. For battery electric, there are losses during electricity transmission as well as heat generation, making the entire energy chain ***80-90 per cent efficient***.

Battery Efficacy (weight vs driving range):

Indicates that when it comes to carrying more weight and travelling farther, fuel-cells are more efficient. Batteries are heavy and expensive and they take longer to charge than refuelling the vehicle. Example: The battery with a ***250 kilometre range*** in India (Tata Tiago electric vehicle) can weigh upto ***100-130 kgs*** with a charging time of upto ***4-5 hours from 0-100 per cent***. A 450 km range battery (MG ZS EV) can weigh ***upto 250 kgs***. On the contrary, ***the weight of FCEVs changes negligibly with range***. A vehicle that can run for 250 kms will weigh about the same as a vehicle with a ***450 km driving range***.

Future Prospects:

Augmentation of the hydrogen refuelling network will help take the pressure off electricity grids in cities. An energy diversification model where both battery and hydrogen infrastructures co-exist will also mean better energy security and a more stable grid.

The extent of diversification will depend on market growth, consumer choice and behaviour, the grid capacity as well as the respective development in technologies for both BEVs and FCEVs to make economic sense.

https://www.downtoearth.org.in/blog/renewable-energy/why-hydrogen-vs-battery-debate-doesn-t-need-a-winner-the-technology-choice-conundrum-86712

Understanding the emissions from 'zero-emission vehicles'

Shubham Srivastava, ENERGY

Governments across the world have set time-bound targets to phase out internal combustion engines (ICE) that run on fossil fuels and increase the percentage of zero-emission vehicles (ZEV) in their vehicle mix.

At COP26, India promised to derive half of its power requirements from renewable sources and subsequently bring down the carbon intensity of its economy to under 45 per cent by 2030.

India has also signed a declaration during the UN summit to switch to 100 per cent zero-emission cars and vans by 2030-40.

Murky yet 'cleaner'

The one point that critics have been trying to hammer home is that both the BEV and FCEV ecosystems rely on dirty energy sources dependent on fossil-fuels, nullifying the environmental benefits derived from using these vehicles. For this reason, environmentalists & researchers have drawn flak for advocating ZEVs as a solution to reduce the carbon footprint of the transport sector. The electricity used to charge BEVs come from the grid and the hydrogen in FCEVs is largely produced using natural gas.

Future Prospects:

International Council on Clean Transportation, a US-based non-profit, estimated the life-cycle emissions of passenger cars with ICE, BEV and FCEV cars in four regions of the world, including India.

The study assumed that the cars will be used for 15 years, with a lifetime mileage of 165,000 kilometres (for sedans) or an annual mileage of 11,000 kms. The mileage was assumed to decrease 3 per cent every year.

With a solely renewable energy-based grid, BEVs were found to emit 83 per cent less greenhouse gases compared to petrol vehicles.

FCEVs that use grey hydrogen released 16 per cent less emissions than gasoline ICEs

Blue hydrogen FCEVs emitted 48 per cent lower than petrol ICEs, the researchers found. With green hydrogen, the emissions went down by 68 per cent.

Link:

https://www.downtoearth.org.in/blog/energy/why-hydrogen-vs-battery-debate-doesn-t-need-a-winner-understanding-the-emissions-from-zero-emission-vehicles--86645

EVENTS

Renewable Energy Expo - Chennai 2024

Date: February, 16 - 19, 2024

Venue: Chennai Trade Centre, Chennai, India

"The Largest & Premium International Renewable Energy Event Of The Year" The Renewable Energy Expo in Chennai aims to boost regional growth through technology and product sharing. It brings together businesses, associations, agencies, and research organizations to showcase the potential of the renewable energy industry. The event is timely given the global trend towards solar power and green energy investment.

Highlights

- Discover new markets, business leads & prospective partnerships.
- Industrial & Municipal buyers will find qualified suppliers.
- Showcase innovative products, solutions and contemporary technologies
- Boost brand image & extent visibility to new heights.

Link:

https://10times.com/renewable-energy-expo-chennai

INDUSTRY NEWS

Egypt: Green hydrogen project to be powered by wind, solar energy

On 20th December, ACWA Power and the Egyptian government inked the deal. This follows the MoU that was signed between the two parties on 7 December 2022 to outline the development of the first phase of the green hydrogen project in Egypt with a capacity of 600,000 tonnes-per-year of green ammonia. The project's investment is in excess of $4 billon, with the intention of scaling up to a second phase with a potential capacity of two million tonnes-per-year. The agreement was signed between ACWA Power and The Sovereign Fund of Egypt (TSFE), the Suez Canal Economic Zone (SCZone), the Egyptian Electricity Transmission Company (EETC), and the New and Renewable Energy Authority (NREA).

https://www.esi-africa.com/renewable-energy/solar/egypt-green-hydrogen-project-to-be-powered-by-wind-solar-energy/

Hyundai could build its retro hydrogen sports car after all – report

A hydrogen Hyundai sports car is reportedly coming in 2026, based on the retro N Vision 74 concept. Korean outlet ETNews reports word from industry sources the 596kW coupe will debut in the first half of 2026 and be limited to 100 units. 70 examples will be available to purchase publicly, while the other 30 are reportedly going to be reserved for racing. This news comes after Hyundai executives said earlier this year the project wasn't going into production. However, Hyundai recently trademarked the N74 name, while Hyundai N vice president Till Wartenberg told CarExpert he personally wishes to see "that car in the near future on the street" but it needs "a lot of discussion".



https://www.msn.com/en-au/motoring/news/hyundai-could-build-its-retro-hydrogen-sports-car-after-all-report/ar-AA1lP9dr

Hyundai to Reveal Its Vision For AI, Hydrogen & Software At CES 2024 in Las Vegas

Hyundai will unveil its vision for hydrogen energy & ecosystem along with AI and software under the company's theme 'Ease every way' for building a sustainable future of mobility at the upcoming CES 2024. The CES 2024 is scheduled to take place from January 9th to 13th next month in Las Vegas, Nevada, US. Hyundai will showcase their new vision for hydrogen, AI and software for the future at media day on January 8th 2024. The company will also be broadcasting live from the event via their global YouTube channel. Hyundai has announced that it is all set to unveil its vision for hydrogen energy & ecosystem along with AI and software under the company's theme 'Ease every way' for building a sustainable future of mobility at the upcoming CES 2024. The CES 2024 is scheduled to take place from January 9th to 13th next month in Las Vegas, Nevada, US.



https://www.timesnownews.com/auto/hyundai-to-reveal-its-vision-for-ai-hydrogen-software-at-ces-2024-in-las-vegas-article-106173621

Egypt, Saudi Arabia's Acwa power sign $4bln green hydrogen deal - Egyptian cabinet

CAIRO - Egypt has signed a $4 billion deal with Saudi Arabia's Acwa power company to develop a green hydrogen project, Egypt's cabinet said in a statement on Wednesday.
Following this agreement, a work plan will be drawn up to develop the first phase of the green hydrogen project, with a production capacity of up to 600,000 tons annually of green ammonia, the statement added.

https://www.zawya.com/en/business/energy/egypt-saudi-arabias-acwa-power-sign-4bln-green-hydrogen-deal-egyptian-cabinet-j9h6lswq

EVENTS

International Conference on Hydrogen Production and Storage ICHPS

Date: ***January 07-08, 2024***
Venue: ***Tokyo, Japan***



Short Name: ICHPS
Event Type: Conference
Presentation: Physical
Program URL:
ttps://waset.org/conferences-in-january-2024-in-tokyo/program

Organization:
World Academy of Science, Engineering and Technology

Objectives
The International Research Conference is a federated organization dedicated to bringing together a significant number of diverse scholarly events for presentation within the conference program. Events will run over a span of time during the conference depending on the number and length of the presentations. With its high quality, it provides an exceptional value for students, academics and industry researchers.

Website URL:
https://waset.org/hydrogen-production-and-storage-conference-in-january-2024-in-tokyo

INDUSTRY NEWS

Rolls-Royce and easyJet Propel Aviation into the Future with Groundbreaking Hydrogen Engine Tests

Rolls-Royce just kicked off some groundbreaking tests on hydrogen research, teaming up with easyJet. They're aiming to be leaders in developing hydrogen-powered engines for planes, especially those in the narrow body market, starting from the mid-2030s. At their facility in Solihull, UK, Rolls-Royce is now testing cryogenic liquid hydrogen pump systems. The goal is to solve a tricky engineering problem – taking super cold liquid hydrogen at really low pressure, below -250°C, and then pressuring it up so it can be pumped into an engine to burn.
Rolls-Royce sees three big challenges in making hydrogen work for planes: burning the fuel, delivering it to the engine, and integrating it smoothly with the engine. All of this has to be proven safe.



https://www.msn.com/en-in/news/other/rolls-royce-and-easyjet-propel-aviation-into-the-future-with-groundbreaking-hydrogen-engine-tests/ar-AA1lPGuo

First Hydrogen launches FCEV vehicle program in North America

After successful UK vehicle trials, First Hydrogen has announced the launch of its new hydrogen-powered fuel cell vehicle (FCEV) program for North America. The North American (NA) program will align with the company's expansion plan and the maturity of Quebec's hydrogen ecosystem. First Hydrogen intends to develop two additional demonstrator FCEVs to showcase to potential North American fleet customers. First Hydrogen will also continue its trial program in the United Kingdom with interested fleet operators.
https://www.msn.com/en-us/news/technology/first-hydrogen-launches-fcev-vehicle-program-in-north-america/ar-AA1lO2BA

Kawasaki's Hydrogen-Powered Ninja H2 HySE Bike

In a move towards sustainable transportation, Kawasaki has recently taken the wraps off its groundbreaking prototype, the Ninja H2 HySE, touted as the world's first hydrogen-powered sports bike. Kawasaki unveiled the H2 HySE during the Group Vision 2030 conference.
Kawasaki's foray into hydrogen power has not been a solo venture. The company has collaborated with industry giants Yamaha, Suzuki, Honda, and Toyota under the umbrella of the 'HySE' Consortium. This collective effort aims to revolutionize the motorcycle industry by developing hydrogen-powered vehicles.
While the automotive world has been buzzing with advancements in electric and automated vehicles, hydrogen power has been a less-explored territory in the motorcycle segment. Kawasaki's H2 HySE seeks to change that narrative by introducing a cutting-edge hydrogen fuel cell system to the sports bike segment.



https://www.news18.com/auto/kawasakis-hydrogen-powered-ninja-h2-hyse-bike-all-you-need-to-know-8708321.html

Omni Tanker, Lockheed Martin complete composite hydrogen storage tank project

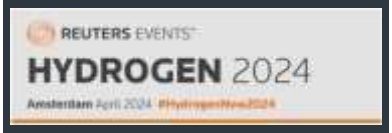
Australian composites manufacturer Omni Tanker (Smeaton Grange) announces the development of two new carbon fiber composite tanks for the transport of cryogenic and liquid hydrogen and helium.



https://www.compositesworld.com/news/omni-tanker-lockheed-martin-complete-composite-hydrogen-storage-tank-project

EVENTS

Hydrogen 2024



Start:
April 9, 2024

End:
April 10, 2024

Event Categories:
Conference, Europe, Production, Refueling, Vehicles

VENUE
Leonardo Royal Amsterdam City
Paul van Vlissingenstraat 24
Amsterdam, Noord-Holland
1096 BK Nederland

ORGANIZER
Reuters Events

It's all happening for hydrogen, with 1,000 projects worth more than $320 billion being announced as a new industrial revolution is forming.

However, less than 10% of projects have reached financial investment decision. To create market certainty and commercialize the industry must:

• Achieve long-lasting off-taker commitment between producers and off-takers.

• Form hydrogen standards to incentivize market formation and ensure visibility for investors.

• Develop a world class infrastructure backbone to move and store hydrogen.

Website URL:
https://events.reutersevents.com/renewable-energy/hydrogen-europe

India Sees Numerous Bids for Government Incentives under US$2 Billion Green Hydrogen Scheme

Fourteen companies, including Acme Cleantech, Avaada GreenH2, Bharat Petroleum Corp, CESC, Greenko ZeroC, JSW Energy, Reliance Industries, Sembcorp Green Hydrogen, and Torrent Power, have submitted bids for incentives under India's Green Hydrogen Mission. Additionally, 20 companies, such as Adani Group, Acme Cleantech Solutions, Advait Infratech, Bharat Heavy Electricals, Jindal India, Larsen & Toubro, Ohmium Operations, Reliance Industries, and Waaree Energies, have entered bids for incentives related to electrolyser manufacturing, as announced by the Solar Energy Corporation of India (SECI). SECI operates as a Central Public Sector Undertaking (CPSU) under the administrative jurisdiction of the MNRE. Established on September 20, 2011, its primary objective is to facilitate the execution of the National Solar Mission (NSM) and its specified targets. SECI is the sole CPSU dedicated to the renewable energy sector.
https://www.india-briefing.com/news/india-sees-numerous-bids-for-government-incentives-under-us2-billion-green-hydrogen-scheme-30609.html/

21 Companies Bid For Centre's Incentives to Manufacture Electrolysers, 14 Companies for Green Hydrogen

Around 21 companies have sent their bids for the government's incentives to set up 3.4 GW of annual capacity for manufacturing electrolyser, a critical component required for hydrogen production. As per reports, Reliance Electrolyser Manufacturing, Adani New Industries, L&T Electrolysers and Bharat Heavy Electricals are among the 21 companies that have bid for the government's incentives. According to an official statement, the bids came in response to a tender bySECI, inviting players for setting up 1.5 GW capacity for electrolyser manufacturing. The bids were invited on July 7 this year. On July 10, state-owned SECI also invited bids for selection of green hydrogen producers for setting up production facilities of 4,50,000 tonnes of green hydrogen under the SIGHT Scheme.
https://knnindia.co.in/news/newsdetails/sectors/21-companies-bid-for-centres-incentives-to-manufacture-electrolysers-14-companies-for-green-hydrogen

Export-oriented green hydrogen projects may get fiscal support, multi-locational SEZs on the table

The government is looking at a demand to amend a rule that prevents renewable energy plants set up for captive consumption in Special Economic Zones (SEZs) from receiving tax breaks. The tweak, which is before the Ministry of Commerce, could potentially allow export-oriented green hydrogen projects to avail fiscal benefits for setting up and operating renewable energy plants used for the production of green hydrogen. The commerce ministry is also looking at notifying SEZs that can be spread out across multiple locations, specifically for green hydrogen projects. These suggestions were made by green hydrogen developers at a meeting on October 19 with the Ministry of New and Renewable Energy (MNRE), where officials from the Ministry of Commerce were also present, according to the meeting minutes accessed by The Indian Express through the RTI.
https://indianexpress.com/article/business/export-oriented-green-hydrogen-projects-may-get-fiscal-support-multi-locational-sezs-on-the-table-9067384/

Govt entities, others taking steps to aid Green Hydrogen Mission: R K Singh

Various government-owned entities including NTPC and GAIL are taking a number of steps to aid the ambitious National Green Hydrogen Mission by setting up projects, Parliament was informed on Thursday. In January, the Centre approved the mission with an outlay of Rs 19,744 crore. The Ministry of New and Renewable Energy is implementing the mission which aims to make India the global hub for production, usage and export of green hydrogen and its derivatives, Union Minister R.K. Singh told the Lok Sabha in response to a question. On the present status of adoption of green hydrogen in the country, the minister for new and renewable energy said, GAIL Ltd has started India's maiden project of blending hydrogen in city gas distribution grid. He said two per cent by volume of hydrogen is being blended in CNG network and 5 per cent volume of hydrogen is being blended into network at city gas station of Avantika Gas Limited (AGL) at Indore in Madhya Pradesh.
https://energy.economictimes.indiatimes.com/news/renewable/govt-entities-others-taking-steps-to-aid-green-hydrogen-mission-r-k-singh/106196822

Cao, YH. *et al.*

Coupling effect and electronic modulation for synergistically enhanced overall alkaline water splitting on bifunctional Fe-doped CoBi/CoP nanoneedle arrays

https://doi.org/10.1016/j.jcis.2023.08.175

Abstract:

Designing bifunctional electrocatalysts with high efficiency and low cost for water splitting is urgently required for the production of green hydrogen. Herein, a bifunctional iron-doped cobalt borate/cobalt phosphide hybrid supported on nickel foam (Fe-CoBi/CoP/NF) was fabricated via hydrothermal and phosphating process. Benefit from the unique nanoneedle architecture for faster mass transfer, the existence of borate on CoBi for accelerating proton transfer, the moderate adsorption of H* species on CoP, Fe doping and the synergistic effect between CoBi and CoP, Fe-CoBi/CoP/NF hybrid exhibits a low overpotential of 137 mV and 260 mV at 100 mA cm-2 for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), respectively. Moreover, Fe-CoBi/CoP/ NF||Fe-CoBi/CoP/NF also presents a low cell potential of 1.65 V@100 mA cm-2 for overall alkaline water splitting and excellent durability (128 h) without decay. This work provides a new insight into the design of bifunctional electrocatalysts simultaneously through the morphological engineering and heteroatomic doping.

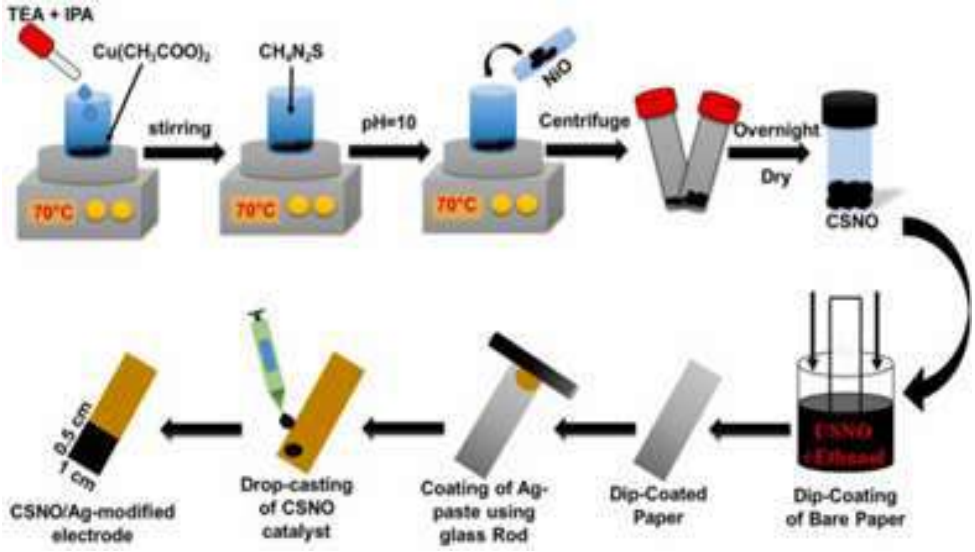
Thakkar, HK. *et al.*

Photo-sensitive CuS/NiO heterostructure electrocatalysts for energy-saving hydrogen evolution reaction at all pH conditions

https://doi.org/ 10.1016/j.ijhydene.2023.06.014

Abstract:

Heterostructures based on transition metal chalcogenides/oxides have gained significant interest in the application of electrochemical hydrogen evolution reaction (HER) due to their distinct characteristics and excellent electrocatalytic activity. Herein, we developed an earth-abundant, low-cost, and light-sensitive CuS/NiO (CSNO) heterostructure electro-catalyst via a facile co-precipitation method and fabricated it on silver-modified con-ducting cellulose paper for HER. Under all pH level, the performance of the visible light -sensitive HER catalyst has been examined. With the illumination of light, HER performance at all pH, which conserves energy has been seen. In basic media, the value of overpotential was improved to-290 mV vs RHE at 20 mA/cm2 under light-illuminating conditions. Similarly, with light illumination, the overpotential of the CSNO10/Ag- modified paper is reduced to-363 mV and-312 mV vs RHE in an acidic and in a near-neutral medium, respectively. In addition to that, the values of the Tafel slopes and charge -transfer resistance also decreased indicating relatively faster HER kinetics in the presence of light at all pH levels. Also, The CSNO10 electrode exhibits stability of more than 24 h in 1 M PBS with an overpotential of-368 mV vs RHE at 20 mA/cm2. The overall performance of the CuS/NiO heterostructure is a good sign to be explored it as a low-cost and efficient electrocatalyst for the large-scale production of green hydrogen (H2).



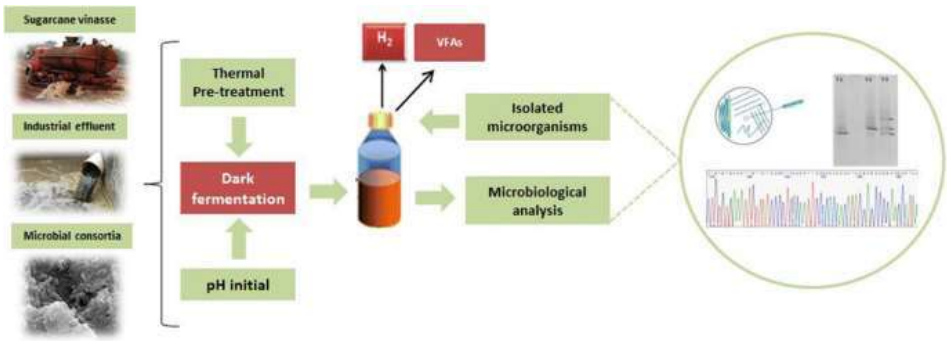
Hidalgo, D. *et al.*

Comparative effect of acid and heat inoculum pretreatment on dark fermentative biohydrogen production

https://doi.org/ 10.1016/j.envres.2023.117433

Abstract:

This study delves into the impact of various pretreatment methods on the inoculum in dark fermentation trials, specifically exploring thermal shock at different temperatures (60, 80, and 100 degrees C) and durations (15, 30, and 60 min), as well as acid shock at pH 5.5. Initial acidification of the substrate/inoculum mixture facilitates H2 generation, making acid shock an effective pretreatment option. However, it is also observed that combining thermal and acid pretreatments boosts H2 production synergistically. The synergy between thermal and acid pretreatments results in a significant improvement, increasing the overall hydrogen production efficiency by more than 9% compared to assays involving acidification alone. This highlights the considerable potential for optimizing pretreatment strategies. Furthermore, the study sheds light on the critical role of inoculum characteristics in the process, with diverse hydrogen-generating bacteria significantly influencing outcomes. The established equivalent performance of HCl and H2SO4 in inoculum pretreatment demonstrates the versatility of these acids in shaping the microbial community and influencing hydrogen production. The analysis of glucose conversion data highlights a prevalence of butyric acid in all trials, irrespective of the pretreatment method, emphasizing the dominance of the butyrate pathway in hydrogen generation. Additionally, an examination of the microbial community offers valuable insights into the intricate relationships between temperature, pH, and microbial diversity. Bacteroidota established its dominance among the bacterial populations, with a relative abundance exceeding 20-25% in the raw inoculum, and this dominance further increased following the treatment. Thermal and acid pretreatments result in significant shifts in dominant microbial communities, with some non-dominant phyla like Cloacimonadota and Spirochaetota becoming more prominent. These shifts in microbial diversity underscore the sensitivity of microbial communities to environmental conditions and pretreatment methods, further highlighting the importance of understanding their dynamics in dark fermentation processes.



Santhosh, CR. and Sankannavar, R.

A comprehensive review on electrochemical green ammonia synthesis: From conventional to distinctive strategies for efficient nitrogen fixation

https://doi.org 10.1016/j.apenergy.2023.121960

Abstract:

Ammonia (NH3) is an excellent transition fuel of green hydrogen and a future contender in the energy market. However, industrial NH3 production currently depends on the unsustainable and energy-intensive Haber-Bosch process. Hence, developing a viable and efficient method to produce NH3 economically has become a new challenge for researchers as its demand surges with each passing decade. Ammonia production from renewable energy sources can power the globe without emitting carbon. The electrochemical method of NH3 has emerged as an appealing strategy for sustainable NH3 production under mild conditions. However, this approach presents several challenges related to activating the highly stable N equivalent to N bond, choice of electrolytes, proton source, etc. This study explores electrochemical methods with distinctive approaches that have been reported, which include redox-mediated processes, lithium cycling electrification, integrated plasma technology, phosphonium proton shuttling, and more. A comprehensive analysis of the underlying principles, experimental parameters, challenges, and potential applications are discussed for each method. It also assesses the recent electrocatalyst advancements employed for effective N2 fixation and their corresponding electrocatalytic performance. Finally, it emphasises the ongoing research efforts to overcome barriers and enable the widespread adoption of renewable grid energy systems for powering N2 gas electrolysis in green NH3 production.

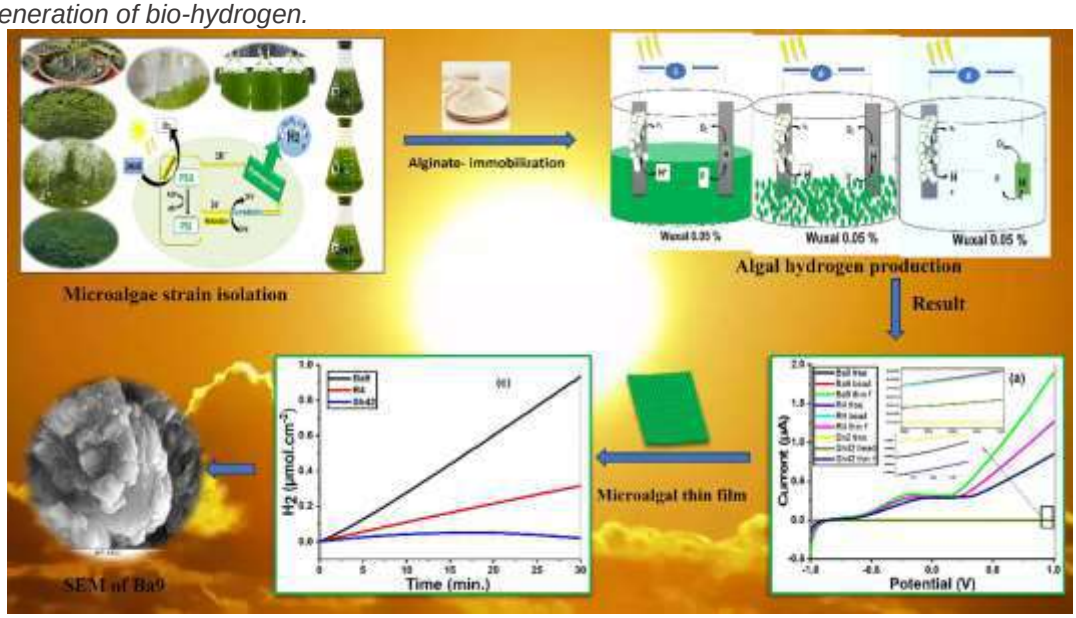
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 65
DECEMBER, 2023

New Insights into Enhancement of Bio-Hydrogen Production through Encapsulated Microalgae with Alginate under Visible Light Irradiation

The production of green hydrogen is a promising alternative to fossil fuels. The current study focuses on the design of microalgae as a catalyst in bio-electrochemical systems for the generation of bio-hydrogen.



About:

- Target could be achieved by optimizing different parameters, including strains of microalgae, different optical filters, and their shapes. ***Synechocystis* sp. PAK13 (Ba9), *Micractinium* sp. YACCYB33 (R4), and *Desmodesmus intermedius* (Sh42)** were used and designed as free cells and immobilized microalgae for evaluating their performance for hydrogen production.
- **Alginate** was applied for immobilization not only for protecting the immobilized microalgae from stress but also for inhibiting the agglomeration of microalgae and improving stability.
- Different modalities, including **FTIR, UV, and SEM**, were performed for the description of selected microalgae.
- The conversion efficiencies of the immobilized microalgae were evaluated by incident photon-to-current efficiency (IPCE). Under optical filters, the optimum IPCE value was ~ 7 % at 460 nm for immobilized Ba9.
- Number of hydrogen moles was calculated to be 16.03 mmol h^{-1} cm^{-2} under optical filters.
- The electrochemical stability of immobilized Ba9 was evaluated through repetitive 100 cycles as a short-term stability test, and the curve of chrono-amperometry after 30 min in 0.05 % wuxal at a constant potential of 0.9 V for 30 min of all studied samples confirmed the high stability of all sample and the immobilized Ba9 has superior activity than others.

Conclusion:

The performance of bio-hydrogen generation were studied through the designing different shapes of microalgae .Free and immobilized microalgae were studied. The three selected microalgae strains were cultivated, collected the biomass, and estimated the optical density (OD) under normal conditions. The immobilized microalgae shapes were fabricated via using the alginate immobilization method to improve their efficiency for hydrogen generation under solar light

https://www.sciencedirect.com/science/article/abs/pii/S0141813023041673

Bioprocess strategies to augment bio-hydrogen production from algae

Nageshwari, K *et al.*, FUEL

About:

Drastic climatic changes and health hazards, in the recent years, due to combustion of fossil fuels has elicited the need to find sustainable and economical fuel alternatives. Hydrogen gas is a versatile energy carrier that can be used for transportation, electricity generation, and industrial processes. It does not produce greenhouse gases or other pollutants when used, making it a promising alternative to fossil fuels. Among the feedstocks used for hydrogen production, algae are found to be a potential source due to their high growth rate, ability to grow in diverse environments, and ability to produce hydrogen via the process of photosynthesis.



However, current hydrogen production rates using algae are low, and strategies to improve these rates are needed. This review is aimed to investigate and evaluate different strategies to enhance bio-hydrogen production using algae. In addition, the prospects of using macro and microalgae as feedstocks have been elucidated. The recent advancements, research gaps and future scopes of this research have been highlighted. Overall, the discussion of the various strategies can provide valuable information for the development of cost-effective and sustainable hydrogen production methods.

Conclusion and future scopes

Carbon neutrality, energy-effective and sustainability are the three main attributes that popularized biohydrogen production from algae. Technical challenges for large-scale implementation of algae-derived biohydrogen should be overcome. For examples, the firmness of the algal cells affects its hydrolysis efficiency via dark fermentation and photo-fermentation.

Link:
https://www.sciencedirect.com/science/article/abs/pii/S0016236123015351

EVENTS

-Conference-

Annual Southern African Coal Conference 2024

Start:
31.01. 2024
End:
02.02. 2024

Event Categories:
Power & Energy

VENUE
Capetown, South Africa, The Westin Cape Town

ORGANIZER
IHS Markit

Overview interest facts - Annual Southern African Coal Conference 2024

Annual Southern African Coal Conference, Acknowledged as the foremost professional and business development event for the African and Asia Pacific coal export markets, this year's event features a full program of informed discussion and debate centering around the industry's most impact topics, coupled with several opportunities for interaction and relationship building with your current and future customers.

Link:
https://expotobi.in/south-african-coal-export-conference

Chinese carmaker BYD overtakes Tesla as world's most popular EV maker

The automaker is poised to surpass Tesla Inc. as the new worldwide leader in fully electric vehicle sales. . When it does — likely in the current quarter — it will be both a symbolic turning point for the EV market and further confirmation of China's growing clout in the global automotive industry.

In a sector still dominated by more familiar names like Toyota Motor Corp., Volkswagen AG and General Motors Co., Chinese manufacturers including BYD and SAIC Motor Corp. are making serious inroads. After leapfrogging the US, South Korea and Germany over the past few years, China now rivals Japan for the global lead in passenger car exports. Some 1.3 million of the 3.6 million vehicles shipped from the mainland as of October this year were electric.

The mainland as of October this year were electric. "The competitive landscape of the auto industry has changed," said Bridget McCarthy, head of China operations for Shenzhen-based hedge fund Snow Bull Capital, which has invested in both BYD and . "It's no longer about the size and legacy of auto companies; it's about the speed at which they can innovate and iterate. BYD began preparing long ago to be able to do this faster than anyone thought possible, and now the rest of the industry has to race to catch up."

The passing of the EV sales crown also reflects the shift in competitive dynamics between Tesla's Elon Musk, the world's richest executive, and BYD's billionaire founder Wang Chaunfu.

When a Tesla owners' club shared a clip in May of Musk snickering at BYD's cars during a 2011 appearance on Bloomberg Television, Musk wrote back that BYD's vehicles are highly competitive these days."



https://energy.economictimes.indiatimes.com/news/power/mg-motor-india-partners-with-zeon-electric-to-expand-ev-charging-network/106320619

Half of Russia's 2023 oil and petroleum exports went to China

Half of Russia's oil and petroleum exports in 2023 will have gone to China while India's share has risen in two years to 40%, Russia's state news agencies cited Deputy Prime Minister Alexander Novak as saying in remarks published on Wednesday.

"The main partners in the current situation are China, whose share has grown to approximately 45-50%, and, of course, India," said Novak, who is in charge of Russia's energy sector.

"Earlier, there basically were no supplies to India; in two years, the total share of supplies to India has come to 40%."

Novak added that Europe's share in Russia's crude exports has fallen to about 40-45%.

https://energy.economictimes.indiatimes.com/news/oil-and-gas/half-of-russias-2023-oil-and-petroleum-exports-went-to-china/106314283?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

World's biggest nuclear plant in Japan to resume path towards restart

Japan's nuclear power regulator on Wednesday lifted an operational ban it imposed on Tokyo Electric Power's massive Kashiwazaki-Kariwa power plant two years ago, clearing the path for it to resume a process towards a restart.

Tepco has been eager to bring the world's largest atomic power plant back online to slash operating costs, but a resumption still needs local consent in Niigata prefecture, on the Sea of Japan coast.

With capacity of 8,212 megawatts (MW), the plant has been offline since around 2011, when the Fukushima disaster prompted the eventual shutdown of all nuclear power plants in Japan at the time.

In 2021, the Nuclear Regulation Authority (NRA) barred Tepco from operating Kashiwazaki-Kariwa, its only operable atomic power station, due to safety breaches including the failure to protect nuclear materials and missteps that led to an unauthorised staff member accessing sensitive areas of the plant.

Citing improvements in the safety management system, the NRA on Wednesday lifted a corrective actions order that had prevented Tepco from transporting new uranium fuel to the plant or loading fuel rods into its reactors - effectively blocking a resumption.

https://energy.economictimes.indiatimes.com/news/power/worlds-biggest-nuclear-plant-in-japan-to-resume-path-towards-restart/106315064?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

EVENTS

-Exhibition-

Intersolar North America 2024

Start:
17.01. 2024
End:
19.01. 2024

Event Categories:
Power & Energy

VENUE
San Diego, USA, San Diego Convention Center

ORGANIZER
Solar Promotion GmbH

Overview interest facts - Intersolar North America 2024

Join for Intersolar North America, the premier solar event that connects innovators and decision makers in the solar and energy storage industry. With a dynamic exhibition floor and robust conference program, Intersolar North America provides solar and energy storage vendors and professionals a platform to advance business, expand education, and drive networking.

Website URL:
https://expotobi.in/intersolar-north-america

Analysis: Germany swaps Russia for Norway in gas supply dependence

Germany's decision to make Norway its biggest gas supplier, culminating in a deal this week that will cover a major chunk of its industrial needs, means it has replaced the formerly dominant Russia with another equally dominant supplier. The risk of deliberate supply disruption of gas from a friendly country may be much lower, but Germany could find itself at the mercy of technical issues, analysts say. Since supply disruptions linked to Russia's invasion of Ukraine, Germany, Europe's largest economy, has substituted huge volumes of Russian gas through deals with Norway, Europe's biggest gas producer. It has also agreed supply deals with liquefied natural gas (LNG) traders. On Tuesday, German state-owned energy firm Sefe and Norway's Equinor announced a 50 billion euro ($55 billion) gas deal that will provide a third of the industrial gas Germany needs. The deal consolidates Norway's position as Germany's main supplier that it has held since Gazprom suspended direct deliveries via the Nord Stream pipeline from Russia to Germany in 2022. It will take Norway's share of Germany's gas supplies to around 60%, comparable with the amount Russia used to account for. Tobias Federico, analyst at Berlin-based consultancy Energy Brainpool, said politically stable countries such as Norway still carried "a risk of renewed dependence". "Germany should learn from the mistakes of the past," he said, saying LNG could increase diversification. Phillip Steinberg, head of the economic stabilisation and energy security unit in Germany's Economy Ministry, has also said the country was at risk from over-reliance.



https://energy.economictimes.indiatimes.com/news/oil-and-gas/analysis-germany-swaps-russia-for-norway-in-gas-supply-dependence/106202135?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-23&dt=2023-12-23&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

EKA Mobility to partner with Mitsui, VDL Groep; plans joint investment of Rs 850 cr

Electric vehicle maker EKA Mobility on Wednesday said it has entered into a part nership with Japan's Mitsui & Co., Ltd and VDL Groep of the Netherlands with a proposed joint investment of over USD 100 million (around Rs 850 crore) in phases. Under the cooperation, EKA Mobility will receive significant and strategic investments from Mitsui and technological support and an equity partnership from VDL Groep, a leading Dutch technology firm, the company said in a statement. It, however, did not elaborate on the financial details of the partnership. "With a joint investment of over USD 100 million in phases, the cooperation will position India as the global manufacturing and sourcing hub for electric vehicles," the statement said.



https://energy.economictimes.indiatimes.com/news/power/eka-mobility-to-partner-with-mitsui-vdl-groep-plans-joint-investment-of-rs-850-cr/106314984?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

A detour of 8,000 kilometers highlights shipping's chokepoints

A gas tanker's long, circuitous journey is highlighting the toll that war and climate change are taking on the shipping industry. Pacific Weihai loaded in Houston on Dec. 14 with a cargo of liquefied petroleum gas intended for Ningbo, China, a route that should typically take 30 days. Instead, it faces an additional 15 days at sea, 8,000 kilometres in travel distance and potentially $1.8 million in shipping rates to avoid two key chokepoints that are upending global trade. Normally, ships carrying LPG from US shale fields to plastics-making refineries in China use the Panama Canal, a journey that would take about 30 days and cover nearly 20,000 kilometres.

https://energy.economictimes.indiatimes.com/news/oil-and-gas/a-detour-of-8000-kilometers-highlights-shippings-chokepoints/106314676?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

EVENTS

-Exhibition-

Solar India 2024

Start:
17.01. 2024

End:
19.01. 2024

Event Categories:
Power & Energy, Alternative Energy, Solar Power

VENUE
New Delhi, India, Delhi Pragati Maidan

ORGANIZER
Exhibitions India Group



OVERVIEW INTEREST FACTS - SOLAR INDIA 2024

The Solar India expo will focus on products, services and solutions pertaining to Rooftop solar, Ground mounted solar, Battery storage, solar cities, Smart villages, Micro grids, Street lighting, Energy efficient products, Government initiatives etc.

Website URL:
https://expotobi.in/solar-india

Adani Green, TotalEnergies finalize 1,050 MW renewable energy JV; raises $300 million

Adani Green Energy Limited (AGEL) and TotalEnergies have completed their joint venture (JV), a significant move adding 1,050 MW to India's renewable energy capacity. The announcement comes following the binding agreement in September 2023, which saw TotalEnergies investing USD 300 million for a 50% stake in a subsidiary of AGEL.

“With this transaction, TotalEnergies has reinforced its strategic alliance with AGEL and support in enabling AGEL’s target of 45 GW capacity by 2030,” Adani Green said in a statement.

The JV portfolio, a mix of solar and wind projects, includes 300 MW of operation assets, 500 MW under construction, and 250 MW in the development phase, distributed across various locations in India. This development is a key part of AGEL’s strategy to reach a target capacity of 45 GW by 2030. AGEL, leading the renewable energy sector in India, operates an 8.4 GW renewable energy portfolio across 12 states. The company's initiatives have been pivotal in offsetting over 41 million tonnes of CO2 emission.

TotalEnergies' investment in the JV aligns with its strategy to expand its renewable energy footprint in the Indian market. AGEL's operational practices, recognized for being water positive for plants over 200 MW, single-use plastic-free, and achieving zero waste-to-landfill, underscore its commitment to sustainable development.

https://energy.economictimes.indiatimes.com/news/renewable/adani-green-totalenergies-finalize-1050-mw-renewable-energy-jv-raises-300-million/106314263?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

NTPC plans to list green energy vertical in next 1-2 years: CMD Gurdeep Singh

State-owned NTPC is looking towards listing its green energy vertical in the next 1-2 years, as it anticipates higher demand going forward, its chairman and man aging director Gurdeep Singh said on Wednesday. He also said that the entity is expecting a 30-40 per cent rise in capex to cater to increased power demand in the country.

"Maybe I think (an IPO) down the line in next one to two years... as we add capacity and there is a pipeline of growth," Singh said in response to a question on whether the company was looking for listing its green energy vertical.

He was participating in a panel discussion "An Indian Tomorrow," at the 10th SBI Banking & Economics Conclave here. "We would definitely be looking forward. And that's our thinking process... I think down the line about a year or two, we will be going for listing'," he added.

Singh said NTPC is making power demand stable as per the consumption, adding, "I can assure that as demand goes up again... we will make sure that the power supply is available, and it is affordable as well as reliable power."

Noting that in the last few years energy security has also become paramount, he said while coal-based plants is not a problem, the usage has to be controlled, focussing on solar and hydrogen- based power.

He said that in the next 5-7 years, the fossil and non-fossil fuels' capacity at the entity should be almost equivalent.

https://energy.economictimes.indiatimes.com/news/renewable/ntpc-plans-to-list-green-energy-vertical-in-next-1-2-years-cmd-gurdeep-singh/106336161?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-28&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

Meenakshi Energy becomes wholly-owned arm of Vedanta

Anil Agarwal-promoted Vedanta on Wednesday said Meenakshi Energy Ltd has become its wholly-owned subsidiary. The National Company Law Tribunal had earlier approved Vedanta's acquisition of Meenakshi Energy for Rs 1,440 crore.

"Meenakshi has allotted 10,00,000 fully paid-up equity shares of Rs 10 each amounting to equity capital of Rs 1 crore to the company, consequent to which, Meenakshi has become a wholly-owned subsidiary of the company with effect from December 27," Vedanta said in a regulatory filing. Vedanta had earlier said that it will acquire bankrupt thermal power company Meenakshi Energy for Rs 1,440 crore through an insolvency process.

Meenakshi Energy Ltd is a 1,000-MW coal-based power plant located at Nellore, Andhra Pradesh.

https://energy.economictimes.indiatimes.com/news/oil-and-gas/meenakshi-energy-becomes-wholly-owned-arm-of-vedanta/106336608?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2023-12-28&dt=2023-12-

Norvaisa, e. *et al.*

Assessment of decarbonization possibilities in Lithuania's chemical industry

https://doi.org/10.1080/15567249.2023.2214912

Abstract:

The main objectives of this paper are to present the developed model and to explore and discuss the decarbonization possibilities of the Lithuanian chemical industry. The sector has high energy consumption and struggles to achieve emission reductions. The developed model is based on a bottom-up modeling approach representing the industry's current and emerging technology mix. We conclude that the deep decarbonization of Lithuania's chemical industry is technically feasible under certain conditions. The deployment of carbon capture technology is necessary to decrease carbon dioxide (CO2) emissions by at least 40% in 2030. To achieve deep decarbonization of the sector, green hydrogen as feedstock for ammonia production should be utilized before 2050. Decarbonization scenarios cause an increase of undiscounted costs by more than 618-3132 million Euros depending on CO2 reduction targets when cumulated over the 2018-2050 period. The ammonia production facility should cover a substantial share of these costs until 2030, which could negatively affect its competitiveness.

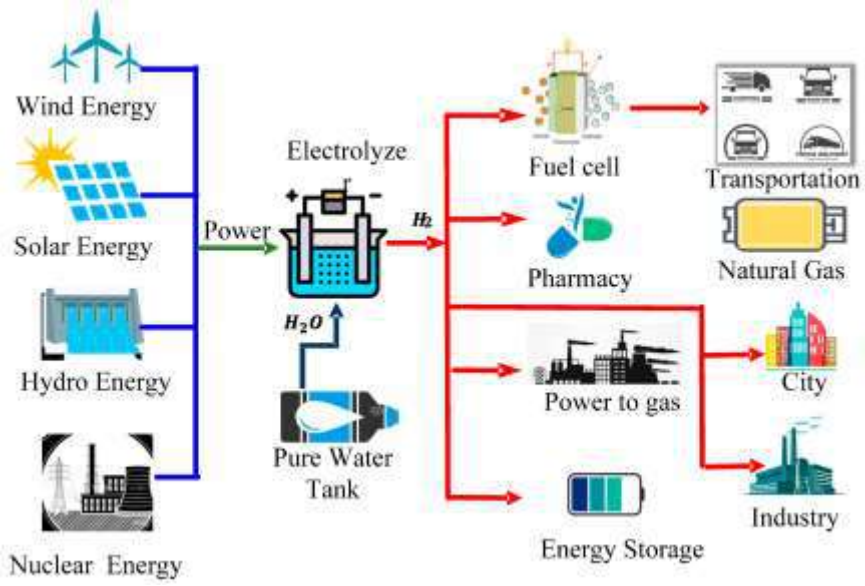
Ceylan, C. and Devrim, Y.

Green hydrogen based off-grid and on-grid hybrid energy systems

https://doi.org/10.1016/j.ijhydene.2023.02.031

Abstract:

This study aims to evaluate a green hydrogen (H2) based hybrid energy system (HES) from solar and wind renewable energy sources. The proposed HES contains PV panels, wind turbines and a proton exchange membrane water electrolyzer. Meteorology data such as solar radiation, temperature and wind speed were obtained from Atilim University Incek Campus Meteorology Station (Ankara, Turkey). The designed HES has been examined as both grid-connected and off-grid. In the grid-connected system, the electricity requirement of the load is supplied by the sun and wind, and the surplus energy produced is stored by producing H2 using an electrolyzer. In the off-grid HES, the electricity requirement of the load is completely provided by the proton exchange membrane fuel cell (PEMFC). In this system, the electrolyzer produces the H2 needed by the PEMFC with the energy provided by solar and wind energy. According to the results, 20,186 kWh of energy is produced annually in the on-grid and 3273 sm3 of H2 is stored. The off-grid system is investigated for Design-1 and Design-2 using two different wind turbine (WT) rated power. In Design-1 and Design-2, annually 95,145 kWh and 83,511 kWh of energy are produced annually 17,942 sm3 and 14,370 sm3 H2 are stored, respectively. When the on-grid and off-grid systems are examined; levelized cost of energy (LCOE) was calculated as 0.223 $/kWh for the on-grid system and 0.416 $/kWh and 0.410 $/kWh for Design-1 and Design-2 for off-grid systems, respectively.



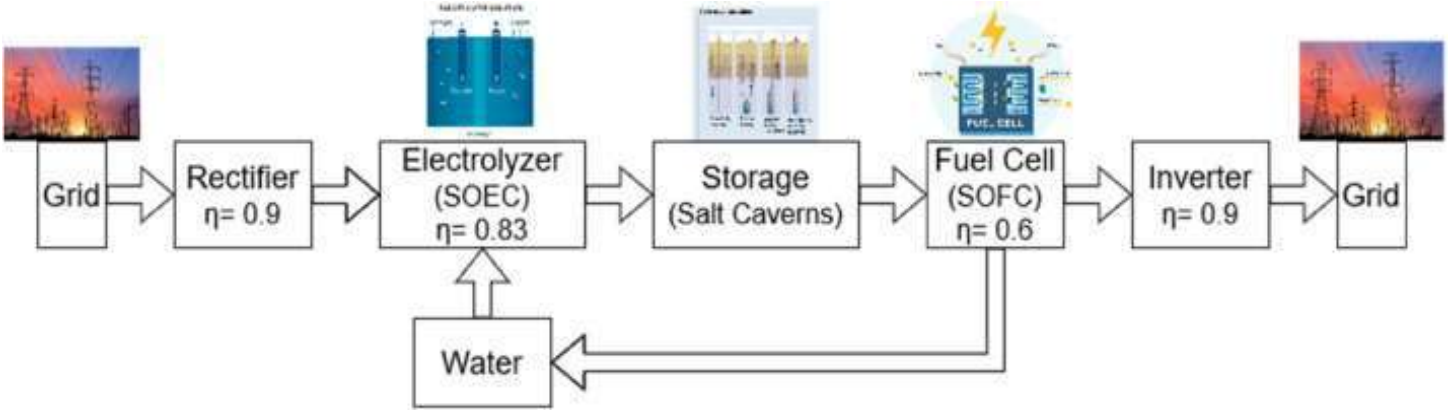
Bryan, J. *et al.*

Modeling and design optimization of carbon-free hybrid energy systems with thermal and hydrogen storage

https://doi.org/10.1016/j.ijhydene.2023.03.135

Abstract:

With increasing demand for carbon-free power to mitigate climate change, hybrid energy systems (HES) is expected to play an instrumental role in the coming decades. The study is focused on replacing all coal and natural gas electricity generation in the state of Texas with solar, wind, and nuclear power. As an integral part of the designed nuclear-renewable hybrid energy system (N-RHES), both thermal and hydrogen storages are used to provide daily short-term and seasonal energy storage. Each subsystem is dynamically modeled in Dymola/Modelica with hourly wind speed and solar irradiance data entering the wind turbine and solar PV modules. Using Year 2020 data, the N-RHES is collectively controlled to meet hourly energy demand of the state. Aiming to minimize the system's levelized cost of energy (LCOE) while meeting the demand at all times of the year, an optimization algorithm is developed to find an optimum design point of the system. The optimized LCOE of the system was found to be $73.04/MWh, which results from 61 Natrium nuclear power plants, 5317 3.2-MW wind turbines, and 307.9 km2 of solar PV panels. While this optimized LCOE is greater than the current LCOE, it provides carbon-free electricity for the entire state of Texas. According to the design, most of the demand is met by nuclear power with the rest being a near even split between wind and solar power. Although the stored hydrogen in salt caverns contributed only to a small portion of the total electricity production, it provides a large amount of green hydrogen to future clean energy markets.



Al-Mahgari, AM. *et al.*

Pressurized green hydrogen from water electrolysis: Compression before or after electrolysis? A comparison among different configurations

https://doi.org/ 10.1016/j.est.2023.109251

Abstract:

Storing the intermittent renewable energy in the form of green hydrogen is the key pathway toward achieving a complete shift to renewable energy dependence. This study compared and examined various settings to produce hydrogen from water electrolysis, considering pressure and temperature effects over a broad range that covers both liquid and steam phases. Pressurized and atmospheric electrolysis at low and high temperatures were investigated under both isothermal and multistage isentropic post-electrolysis gas compression. Modeling and analysis based on established correlations and equations of state were used to estimate the system's overall power requirements for each scenario. Increasing the operating temperature significantly reduced the electrolysis work while the pressure had an opposite effect, especially at low pressures. The results conclude that compressing liquid water, heating, then electrolyzing requires less overall energy than atmospheric electrolysis followed by product gases compression. This was valid for isothermal or isentropic compression despite the fact that the isothermal required the least work. The difference between pre-and post-electrolysis compression scenarios becomes greater at high pressure and temperature values. For instance, to obtain hydrogen at 25 degrees C and 50 bar, the power saving from pressurized electrolysis was 2.5% compared with atmospheric electrolysis followed by gas compression, which increased up to 20% at 600 degrees C and 200 bar. This indicates that high pressure steam electrolysis integrated with renewable systems leads to producing green hydrogen ready to store, transport, or use at less cost and complexities, especially with a cheap heat source or waste heat utilization.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 66
JANUARY, 2024

UPEI researchers focus on producing hydrogen from UV rays, sawdust and potato peelings

Potato idea captures a lot of interest, coming from a province known for its spuds. Researchers at UPEI are looking for new ways to produce hydrogen to replace fossil fuels and combat the impacts of climate change. – Nancy Russel, CBC News.



Figure: The goal of the Project is to use UV light to split water into hydrogen and oxygen. (Shane Hennessey/CBC)

About:

One project is working to extract hydrogen from waste products, including sawdust, potato peelings and an invasive aquatic species called tunicate. Yulin Hu is an assistant professor in the Faculty of Sustainable Design Engineering at UPEI. Moving to P.E.I. inspired Hu to look for local waste products, including potatoes and tunicate, an invasive species that plagues the mussel industry on the Island. "I started to realize the potato industry is a very big part of the province, and when you are processing the potato you're going to generate a lot of the waste," Hu said. "So we started doing the ***simulation of using the potato waste to produce the hydrogen***. And the simulation results can tell us that actually the potato waste is really promising."

The project received funding of $142,500 over five years in the form of a Natural Science and Engineering Council of Canada (NSERC) discovery grant.

Hu said Cavendish Farms in New Annan, P.E.I., has been converting potato waste into biogas for more than a decade to fuel the fry facility, but the process she uses will be different, as the hydrogen can be used in many different ways. At P.E.I. hydrogen could be used to synthesize nitrogen fertilizers, and then help the agriculture industry there.

In general we are trying to convert all different kinds of the organic waste, especially with a focus on P.E.I., and then convert it into a product that could potentially benefit the province.

In Another program, Nasim Mia, used use UV light to split water into hydrogen and oxygen. “The main things that intrigued us is looking for alternative fuels for our future generations, and the other thing is the carbon emissions, which is damaging our environment," Mia said. "So these are the two things that really intrigued us to work on green energies, so that we can find the alternative fuel sources."

https://www.cbc.ca/news/canada/prince-edward-island/pei-upei-research-hydrogen-from-waste-1.7060808

UP Scientists Pioneer Mpumalanga Study Unveiling Natural Hydrogen Gas Beneath Earth’s Surface

Scientists at the University of Pretoria (UP) are leading a study of natural hydrogen gas discovered under the Earth’s surface in Mpumalanga – a source of renewable energy that could contribute to the national energy budget and help address the energy shortage in South Africa. While it is still too early to know how much of an effect the discovery could have on the country’s national energy landscape if exploited, the scientists have envisaged small “stand-alone” generation units (powering generators with a capacity of about 20 kilowatts) for local domestic or minor industrial use. However, recent stories in Europe suggest that some natural hydrogen resources might be much bigger than originally thought. This discovery was made as part of the HyAfrica project undertaken by a consortium of partners within the European Union (EU) and African Union (AU).Recent samples taken in Mpumalanga currently fall under the natural/“white” hydrogen category.

Link:

https://indiaeducationdiary.in/up-scientists-pioneer-mpumalanga-study-unveiling-natural-hydrogen-gas-beneath-earths-surface/

EVENTS

HYDROGEN AMERICAS 2024 SUMMIT & EXHIBITION





Date: 11 – 12 June 2024

Venue: Ronald Reagan International Trade Center, Washington D.C.

Having established itself as the premier gathering for the global hydrogen community in the Americas region, the Hydrogen Americas 2024 Summit & Exhibition will return to Washington D.C. on 11 – 12 June 2024, co-hosted by the Sustainable Energy Council (SEC) and the U.S. Department of Energy (DOE).

In the U.S., the National Clean Hydrogen Strategy and Roadmap is in place to reinforce their pivotal position within the global hydrogen economy through hydrogen projects which will generate $140 billion per year in revenue and 700,000 jobs by 2030.

Link:

https://www.hydrogen-americas-summit.com/

INDUSTRY NEWS

ISRO successfully flight-tests hydrogen fuel cell

ISRO said that it has successfully flight-tested a fuel cell to assess its operation in space and to collect data to facilitate the design of systems for future missions. Powering missions with efficiency and emitting only water, these fuel cells are the future for power production in space habitats, the national space agency headquartered here said. Vikram Sarabhai Space Centre/ISRO successfully tested a 100 W class Polymer Electrolyte Membrane Fuel Cell based Power System (FCPS) in its orbital platform POEM3, launched onboard PSLV-C58 on January 1. "The objective of the experiment was to assess Polymer Electrolyte Membrane Fuel cell operation in space and to collect data to facilitate the design of systems for future missions," ISRO said in a statement. During the short duration test onboard POEM, 180 W power was generated from Hydrogen and Oxygen gases stored onboard in high pressure vessels.

https://economictimes.indiatimes.com/news/science/isro-successfully-flight-tests-hydrogen-fuel-cell/articleshow/106563256.cms

Hyundai, Kia, Gore to develop electrolyte membrane for hydrogen fuel cell systems in CVs

Hyundai Motor Company (Hyundai Motor), Kia Corporation (Kia) and W. L. Gore & Associates (Gore) signed an agreement at the Mabuk Eco-Friendly R&D Center, Korea, to collaborate on the development of advanced polymer electrolyte membrane (PEM) for hydrogen fuel cell systems.

The joint effort between the parties will encompass key aspects of PEM development. The goal of this collaboration is to develop an advanced PEM for next-generation fuel-cell electric commercial vehicles.

A hydrogen fuel cell utilises PEM to conduct protons between two electrodes. The PEM blocks the direct combination of incoming hydrogen and oxygen gases, facilitating the selective conduction of protons and, in turn, generating an electrical current to power a vehicle. The PEM technology plays a crucial role in determining the performance and durability of the fuel cell system.

https://www.financialexpress.com/business/express-mobility-hyundai-kia-gore-to-develop-electrolyte-membrane-for-hydrogen-fuel-cell-systems-in-cvs-3356129/

Jakson Green to ship first green hydrogen electrolyser in few months

Jakson Green, an energy transition platform, will be shipping out their first green hydrogen electrolyser in a couple of months and is in advanced stages of partnering with technology providers for electrolyser manufacturing, its Managing Director and Chief Executive Officer, Bikesh Ogra, told ETEnergyWorld. “We are evaluating partnerships and have narrowed down a small pool of companies who are currently under evaluation for various technologies including PEM, AEM, or alkaline,” he said in an exclusive interaction. Ogra added that the company will be shipping out their first electrolysers in a couple of months and the full-fledged production will begin in the next fiscal year. These partnerships will be for both, manufacturing in India as well as abroad. “We are, therefore, in advanced stages for partnering with technology providers for green hydrogen electrolyser manufacturing,” he said. The firm launched a 100-megawatt (MW) electrolyser manufacturing plant a few months back, which it now plans to raise to one gigawatt capacity, added Ogra. The company is also in touch with maritime shipping lines to supply them with green mthanol on ports.

https://energy.economictimes.indiatimes.com/news/renewable/jakson-green-to-ship-first-green-hydrogen-electrolyser-in-few-months/106388870

Amazon begins to produce own hydrogen fuel to power vehicles

Amazon has announced plans to produce hydrogen fuel at its fulfillment centres and has partnered with hydrogen company Plug Power to install the first electrolyser (equipment that can split water molecules to produce hydrogen) at a fulfillment centre in the state of Colorado in the US. E-commerce giant Amazon has unveiled ambitious plans to manufacture its own hydrogen fuel, marking a significant step toward greening its logistics operations. Teaming up with hydrogen company Plug Power, Amazon is set to kickstart this initiative by installing its inaugural proton exchange membrane electrolyser at a fulfillment center in Colorado, USA.



https://www.zeebiz.com/companies/news-amazon-begins-to-produce-own-hydrogen-fuel-to-power-vehicles-270372

EVENTS

2nd Annual Hydrogen India Summit 2024

Date: 23 - 24 Jan 2024

Venue: New Delhi, India

The 2024 edition of this event is set to be bigger and better than ever before, with double the number of attendees and a larger event floor to accommodate the growing demand for this important industry.

Highlights

- National Green Hydrogen Mission; International Cooperation; Policy Framework & Investment;
- Steel, Metallurgy, Refining, Petrochemical, Fertilizer, Fuel Cell, Transport Vehicles, Hydrogen Storage

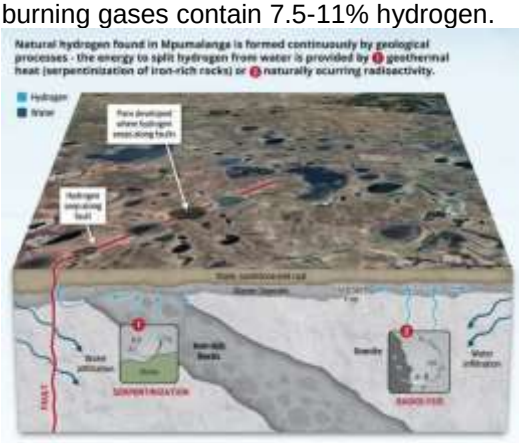
Links:

https://isa-ghic.org/2nd-annual-hydrogen-india-summit-2024

https://10times.com/e1k5-3x2x-0sgp

Study Reveals Ground-breaking Discovery of Underground Hydrogen in Mpumalanga

Hydrogen is considered a fuel of the future due to it emitting zero emissions. This infographic explains the impact of this discovery as well as some interesting facts about hydrogen and the different forms of it. Natural hydrogen reaches the surface of the Earth at Yanartas in southwestern Turkey, where flames have been burning continuously for atleast 2500 years. These burning gases contain 7.5-11% hydrogen.



https://indiaeducationdiary.in/study-reveals-groundbreaking-discovery-of-underground-hydrogen-in-mpumalanga/

Azerbaijan Is Capable Of Producing Hydrogen At Cost-Effective Prices - World Bank

Azerbaijan has the ability to produce "green" and "blue" hydrogen at economically advantageous prices. According to Azernews, Roland Price, Regional Director of the World Bank (WB) for the South Caucasus, said this in an interview with Trend. "I have already mentioned that Azerbaijan has enormous potential, especially in terms of the abundance of solar and wind resources. This implies significant opportunities for the production of green and blue hydrogen at economically advantageous prices. We expect to witness such developments in the mid-2030s," she said. The Regional Director mentioned that this is a relatively new area with developing technologies. "What's remarkable is the government's active engagement with private sector stakeholders to discuss developments in the sector.

https://menafn.com/1107686250/Azerbaijan-Is-Capable-Of-Producing-Hydrogen-At-Cost-Effective-Prices-World-Bank

Global Hydrogen Combustion Engine Market Poised for Remarkable Growth, Anticipates US$ 46.31 Billion Valuation by 2033 with a Strong 9.78% CAGR

Experiencing notable expansion, the global hydrogen combustion engine market foresees a robust Compound Annual Growth Rate (CAGR) of 9.78% throughout the forecast period. As of 2023, the market's estimated worth is approximately US$ 18.22 billion. However, the market's allure lies in the anticipation of a significant surge, projecting a remarkable valuation of US$ 46.31 billion by 2033.

The widespread adoption of hydrogen combustion engines is fueled by a confluence of factors. Government initiatives, particularly those advocating for fuel cell vehicles, emerge as pivotal catalysts in propelling industry growth. These initiatives encompass financial incentives, regulatory backing, and the establishment of hydrogen fueling station infrastructure, collectively fostering a conducive environment for the widespread acceptance of hydrogen-powered vehicles. The trajectory of this market is poised to revolutionize the automotive industry, contributing to a more sustainable and environmentally conscious future.

https://www.fmiblog.com/2024/01/04/global-hydrogen-combustion-engine-market-poised-for-remarkable-growth-anticipates-us-46-31-billion-valuation-by-2033-with-a-strong-9-78-cagr/

Heraeus Precious Metals commits to the hydrogen economy

Germany-based Heraeus Precious Metals says it has established a new dedicated Hydrogen Systems business line as of the start of the year, signaling its commitment to the hydrogen economy. Heraeus Precious Metals is part of the Heraeus Group and covers the value chain from trading to precious metals products to recycling. It has expertise in all platinum group metals as well as gold and silver. The company offers a portfolio of products that are used in the automotive, chemicals, semiconductor, pharmaceutical, hydrogen and jewelry industries. Heraeus Precious Metals' Hydrogen Systems business provides a range of precious metal-based products for electrolyzers and fuel cells.

https://www.recyclingtoday.com/news/heraeus-precious-metals-establishes-hydrogen-systems-business-line/

EVENTS

ACHEMA 2024



Date: 10 - 14 June 2024

Venue: Frankfurt am Main, Germany

ACHEMA is an ideal platform for young businesses to come into contact with players within the global process industry. With the Start-up Area we provide a location tailored to the specific needs of young entrepreneurs.

Special Show at ACHEMA 2024

Hydrogen

Hydrogen will play a central role for the energy transformation and climate neutrality, and for the process industry it is a key element. The industrial transformation towards a hydrogen economy is a challenge of its own. Current developments and solutions will be addressed in the ACHEMA special show.

Link:

https://www.achema.de/en/

Alva's foundation gets patent for AIET's Hydrogen Fuel Cell technology

The Controller of Patents, Intellectual Property of India, has granted a patent to Alva's Education Foundation, Moodbidri, for its Hydrogen Fuel Cell (HFC) technology. A press release from the foundation here said the technology was a collaborative effort spearheaded by team leader Richard Pinto and implemented through Alva's Institute of Engineering and Technology.

The innovative patent, titled 'Hydrogen Fuel Cells Having Enhanced Performance with Nafion Proton Exchange Membrane Optimally Exposed to Ultraviolet Rays' (patent number 201941035383), represents a significant leap in sustainable energy solutions, with a commitment to doubling the electric power of hydrogen fuel cells compared to conventional hydrogen fuel cells. Collaboration with experts from the Indian Institute of Technology, Bombay, and Tata Institute of Fundamental Research, Mumbai — namely Siddhartha Prakash Duttagupta and Ganesh Prabhu — further enriched the innovative aspects of the patent, the release said.

https://www.thehindu.com/news/cities/Mangalore/alvas-foundation-gets-patent-for-aiets-hydrogen-fuel-cell-technology/article67706260.ece

NHPC Signs MoU With GPCL, Govt. Of Gujarat; To Invest ~ Rs. 4,000 Crores In Proposed 750 MW Kuppa Pumped Hydro Storage Project

Taking a step forward towards clean and green energy, NHPC has signed an MoU with Gujarat Power Corporation Limited, Government of Gujarat for investment in the proposed 750 MW Kuppa Pumped Hydro Storage Project. As per the MoU, NHPC will invest an estimated Rs. 4000 crores in the proposed project, situated at Chhota Udaipur, Gujarat. NHPC and the Government of Gujarat plan to develop and utilize pumped hydro storage projects as an effective solution for energy storage. The implementation of this project will create significant employment opportunities and boost the local economy. The MoU was signed at the Secretariat in Gandhinagar, Gujarat under the aegis of "Vibrant Gujarat", on 3rd January, 2023. The agreement was signed by Managing Director, GPCL, Government of Gujarat, Shri Arun Mahesh Babu and Executive Director, Renewable Energy and Green Hydrogen, NHPC, Shri V.R. Srivastava; in the august presence of Chief Minister of Gujarat, Shri Bhupendra Patel and Energy Minister, Government of Gujarat, Shri Kanubhai Desai. The MoU aims to contribute towards the national objective of clean and green energy, i.e. attainment of 500 GW of renewable energy capacity by 2030 and "Net Zero" target by 2070. NHPC Limited is India's leading hydropower company. NHPC has a total installed capacity of 7,097.2 MW of renewable energy (including wind and solar) through its 25 power stations, including 1,520 MW through subsidiaries. At present, NHPC (including subsidiaries and Joint Venture companies) is engaged in construction of 15 projects with an aggregate installed capacity of 10,449 MW.

https://indiaeducationdiary.in/nhpc-signs-mou-with-gpcl-govt-of-gujarat-to-invest-rs-4000-crores-in-proposed-750-mw-kuppa-pumped-hydro-storage-project/

EnVision 2024: Tamil Nadu sets bold 75% renewable energy ambition

In a decisive push for sustainable energy, Tamil Nadu's Minister for Industries, Investment Promotion, and Commerce, Dr. T.R.B. Rajaa, unveiled the state's bold ambition to enhance its renewable energy capacity to 75%. "Tamil Nadu is currently at 50% green energy, with a combination of 40% solar and 50% wind energy. We are pushing to increase this to 75%," the minister said at the inauguration of EnVision, India's first energy festival, held at IIT Madras. The two-day event, hosted by IIT Madras Research Park and the India Energy Storage Alliance (IESA), attracted over 500 delegates to discuss and accelerate India's transition to sustainable energy. Dr. Rajaa also spoke about the initiatives for green hydrogen and offshore wind energy with plans for a 10 GW deployment. EnVision, beyond being a discussion forum, is set to be a catalyst in India's transition to clean energy, with over 50 top energy voices from various sectors participating. The conference covers over 10 thematic areas crucial for renewable energy technology commercialization, including green buildings, solar manufacturing, and climate policy. The event also showcases the latest climate tech solutions, demonstrating India's commitment to achieving its net-zero energy ambitions. The two-day conference features brainstorming sessions on solar technology, micro-nuclear energy, and heating and cooling systems, all geared towards reducing greenhouse gas emissions. Additionally, a workshop focusing on 'Lab to Market for Net-Zero technologies' is part of the event's agenda.

https://energy.economictimes.indiatimes.com/news/renewable/envision-2024-tamil-nadu-sets-bold-75-renewable-energy-ambition/106546206

Zhao, YJ. *et al.*

Substances and energy metabolism of green Hydrogen-Assisted/ Coal-Methanol-Olefin-Polyolefin system using ecological network methodology

https://doi.org/10.1016/j.ces.2023.119385

Abstract:

It is crucial to comprehend the complex interconnections among units in coal chemical industry for its lower carbon and efficient transformation. This understanding can help identify priority nodes for optimization in the pursuit of lower carbon emissions and improved efficiency. Ecological network analysis method is employed to study the substances and energy metabolism in the coal chemical industry treating it as a superorganism comprising numerous intricate metabolic processes. Network utility analysis and network control analysis are conducted to evaluate the substances and energy metabolism of the coal-methanol-olefin-polyolefin (CMOP) system and green hydrogen-assisted CMOP (GH-CMOP) system, applying an innovative perspective and meth-odology. Key units for significant improvements in C/H/O and energy metabolism are disclosed. The GH-CMOP system shows better cascade utilization of C/H/O and energy, but hydrogen-carbon ratio adjustment has less impact on the overall metabolic utility relationships. Therefore, both systems need process route modifications to enhance substances and energy use.

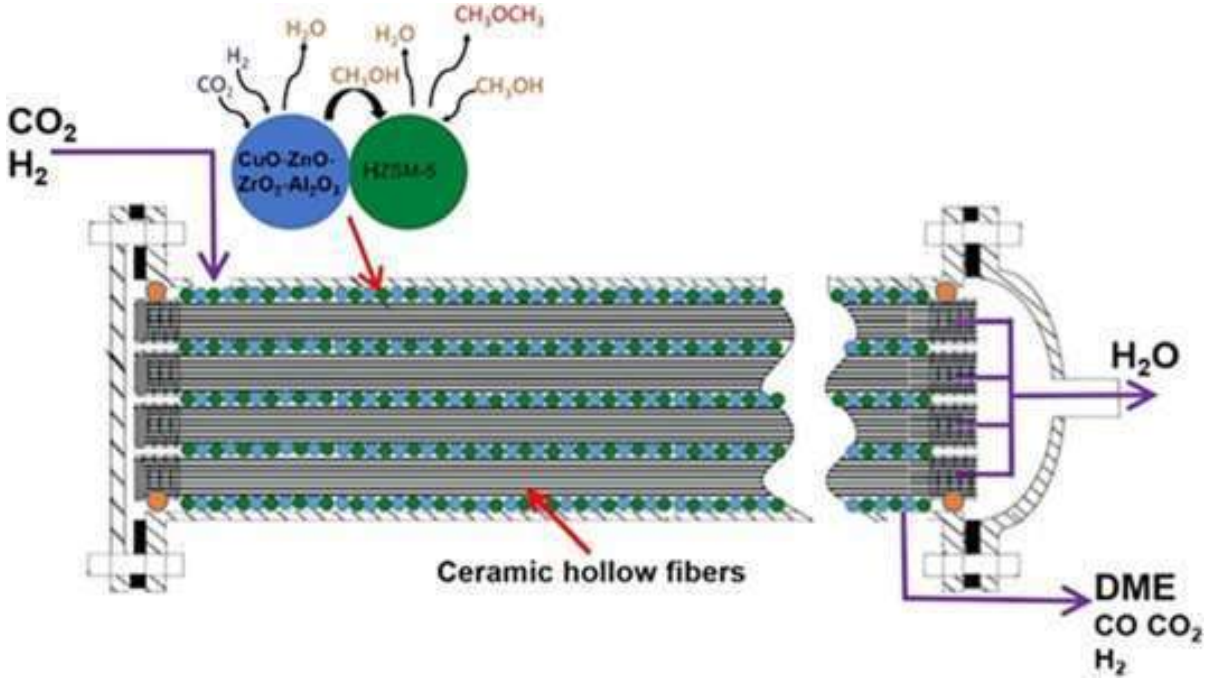
Peinado, C. *et al.*

Review and perspective: Next generation DME synthesis technologies for the energy transition

https://doi.org/10.1016/j.cej.2023.147494

Abstract:

Renewable dimethyl ether (DME) is expected to contribute to the decarbonization of several sectors, including domestic heat supply and transport. The shift of the carbon source used for the production of DME from fossil to renewable, such as biomass, waste or captured CO2, entails an industrial challenge in terms of reactors, operation regimes, catalysts and product purification, with strong technical and economic repercussions. In this work, we review the latest developments on this topic, focusing on the direct synthesis of DME, and especial attention has been paid to the separation-enhanced technologies for DME production, including the Sorption Enhanced DME Synthesis (SEDMES). We address other aspects that are often neglected, such as the impact of heat and mass transfer phenomena, which become increasingly relevant in processes in which several reaction and sorption stages occur in the same reactor. We also include a techno-economic section that gives insight in the feasibility of several renewable DME production processes. Finally, we review the most recently deployed installations for renewable DME production, at commercial or pilot scale, as a model of the near-future of the DME industry.



Pivetta, D. *et al.*

The role of hydrogen as enabler of industrial port area decarbonization

https://doi.org/10.1016/j.rser.2023.113912

Abstract:

To meet environmental goals while maintaining economic competitiveness, worldwide ports have increased the amount of renewable energy production and have focused in optimizing performances and energy efficiency. However, carbon-neutral operation of industrial port areas (IPA) is challenging and requires the decarbonization of industrial processes and heavy transport systems. This study proposes a comprehensive review of decarbonization strategies for IPA, with a particular focus on the role that green hydrogen could play when used as renewable energy carrier. Much information on existing and future technologies was also derived from the analysis of 74 projects (existing and planned) in 36 IPAs, 80 % of which are in Europe, concerning hydrogenbased decarbonization strategies. The overall review shows that engine operation of ships at berth are responsible of more than 70 % of emissions in ports. Therefore, onshore power supply (OPS) seems to be one of the main strategies to reduce port pollution. Nevertheless, OPS powered by hydrogen is not today easily achievable. By overcoming the current cost-related and regulation barriers, hydrogen can also be used for the import/export of green energy and the decarbonization of hard-to-abate sectors. The technical and economic data regarding hydrogen-based technologies and strategies highlighted in this paper are useful for further research in the field of definition and development of decarbonization strategies in the IPA.

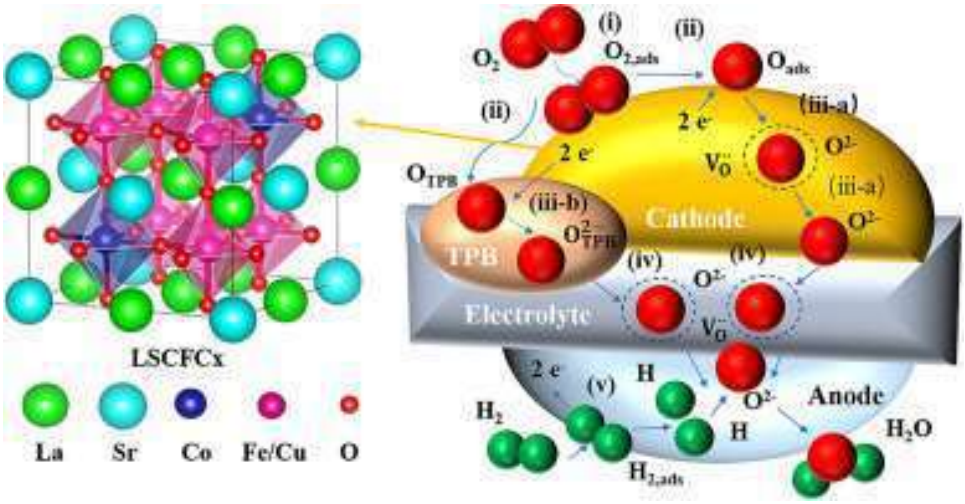
Jia, WH. *et al.*

Alternative B-site-doped $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}$-x$MxO_3$ (M = Ni, Cu, Nb; x=0, 0.1, 0.2) as innovative cathode material for LT-SOFC with enhanced charge transfer and oxygen ion diffusion

https:// 10.1016/j.apenergy.2023.122096

Abstract:

Although La0.6Sr0.4Co0.2Fe0.8O3 (LSCF) owns a high level of maturity as a cathode material for intermediate and high-temperature SOFCs, there still exists tremendous potential for it to be employed under an efficient low temperature working conditions. Since the charge transfer and oxygen ions diffusion act as pivotal obstacles to realizing the operation of LT-SOFCs (below 600 degrees C), the B-site doping elements (Ni, Cu, Nb) in commercial LSCF are selected using the first-principles calculation. Based on the theoretical findings, the novel Cu-doped La0.6Sr0.4Co0.2Fe0.8-xCuxO3 (LSCFCx, x = 0, 0.1, 0.2) cathode materials are synthesized with exploring the phase structure, valence states of the elements, and thermogravimetric properties. Among different doping elements, Cu doping could facilitate the electrochemical performance of LSCFCx cathode by the enhancement of electrons at B-site and enrichment the of oxygen vacancies. Arising from the inspiring charge transfer and the accelerating oxygen ion transportation, Cu-substitution yields superior activity than other LSCF doping elements.The polarization resistant and activation energy values for LSCFC0.2 cathode attenuates more than 71% and 35% in contrast to the undoped LSCF cathode, respectively. The maximal power density of the anode-supported single cells utilizing LSCFC0.2 cathode outputs 0.594 W center dot cm-2 at 600 degrees C and promotes over 41% than commercial LSCF at the same condition. These results conclusively point to a practical Cu-doping strategy for the development of highly efficient cathodes for LT-SOFCs.



Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 67
JANUARY, 2024

Scientists create green sustainable fuel from whisky distilling waste

Researchers at the Heriot-Watt University in Edinburgh used wastewater from the whisky distilling industry to produce green hydrogen, which is a type of sustainable fuel. They did this by developing a new nanoscale material — a particle is about one-10,000th the diameter of a human hair. This allowed distillery wastewater to replace fresh water in the green hydrogen production process. This nanoparticle is called nickel selenide and it treats the wastewater. This produced similar or slightly higher quantities of green hydrogen compared to fresh water, according to the university. “It takes 9kg of water to produce every 1kg of green hydrogen. Every 1 litre of malt whisky production creates about 10 litres of residue. To help protect the planet, we need to reduce our use of fresh water and other natural resources. So our research focused on how to use this distillery wastewater for green hydrogen production with a simple process that removes waste materials present in the water,” said Sudhagar Pitchaimuthu. The research team is now working on developing their own electrolyser prototype and scaling up production of the nickel selenide nanoparticles.

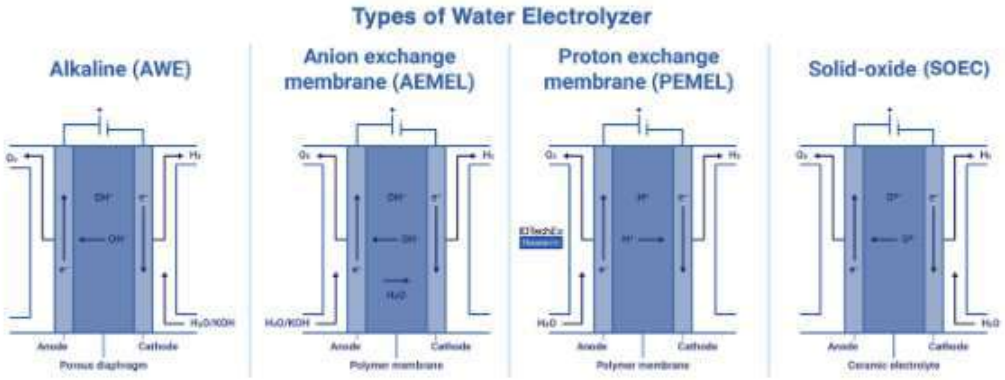
Link:

https://indianexpress.com/article/technology/science/scientists-whisky-wastewater-green-hydrogen-9102103/

Materials for Green Hydrogen Production 2024-2034: Technologies, Players, Forecasts

Material requirements for electrolyzer stacks including AWE, AEMEL, PEMEL & SOEC. Granular 10-year market forecasts for electrolyzer components. Review of incumbent & advanced materials, stack designs, manufacturing technologies, key players.

- Idrissov et al. 2024.



About:

IDTechEx forecasts substantial growth in the electrolyzer component sector, projecting a market value of US$31.7 billion by 2034. This expansion is attributed to the expanding green hydrogen industry, where electrolyzers are indispensable. This comprehensive IDTechEx report delves into the current and prospective materials and components utilized in the four main water electrolyzer technologies: alkaline water electrolyzer (AWE), proton exchange membrane electrolyzer (PEMEL), anion exchange membrane electrolyzer (AEMEL), and solid oxide electrolyzer (SOEC). It further offers stack costs broken down by component for the AWE, PEMEL and SOEC stacks. In addition, granular 10-year market forecasts, quantifying material and component demand intonnes, square meters (m^2), and US$ million annually are presented for these three electrolyzer stacks.

The need for green hydrogen and advanced electrolyzer technologies

Global activities in the hydrogen sector have intensified, with a unified drive from governments, industries, and corporations to transition to a hydrogen economy for decarbonizing sectors that are difficult to electrify directly. Green hydrogen - produced through water electrolysis powered by renewable energy - has emerged as the frontrunner solution, propelled by governmental ambitions to establish substantial gigawatt (GW) scale electrolyzer manufacturing and green hydrogen production capacities by the end of this decade.

The pivot to green hydrogen transcends the goal of sustainable hydrogen production - it is a strategic move to decarbonize industries where electrification is not feasible, such as heavy industry (e.g. petroleum refining) and various transportation sectors (e.g. shipping).

Critical role of materials and components in electrolyzers

At the heart of the green hydrogen revolution lies the evolution of materials and components within electrolyzer technologies. Advancements in this area are pivotal, aiming to boost electrolyzer efficiency, extend longevity, and mitigate reliance on scarce materials. For example, innovations in PEMEL technology, such as catalysts with reduced iridium content, could significantly alleviate supply chain vulnerabilities associated with iridium's limited availability. Components analyzed include membranes, catalysts, electrodes, porous transport layers (PTL), gas diffusion layers (GDL), bipolar plates, coatings, gaskets, and end plates, offering insights into their current and future states.

https://www.idtechex.com/en/research-report/materials-for-green-hydrogen-production-2024-2034-technologies-players-forecasts/970

EVENTS

Smart Energy Week 2024

Tokyo Show [March]



Date: Feb. 28 (Wed) / 29 (Thu) / Mar. 1(Fri), 2024

Venue: Tokyo Big Sight, Japan

World's Leading Exhibition for Renewable Energy

Renewable energies are expected to play a greater role in achieving carbon neutrality by 2050.

Smart Energy Week gathers a full range of renewable energy technologies such as hydrogen and fuel cells, solar power, rechargeable batteries, smart grids, wind power, biomass, zero-emission thermal power generation, etc. Smart Energy Week is a exhibition where the latest technologies, information and people gather to accelerate the business in the energy industry.

Email ID:

wsew.jp@rxglobal.com

Contact Number:

+81-3-6739-4119

Link:

https://www.wsew.jp/spring/en-gb/lp/sew24.html?utm_source=google&utm_medium=cpc&utm_campaign=sew24_search&gad_source=1&gclid=CjwKCAiA1-6sBhAoEiwArqlGPsC1_cwQFDu-OCGdHEA3xLcFmnt6HWG4AhowTPKB0ju7XhrrKo2v9hoCYFkQAvD_BwE

Modi meets top CEOs, discusses made-in-India vehicles to green hydrogen

PM on Tuesday met some of the top global CEOs on the sidelines of the Vibrant Gujarat Summit as he lured investments across sectors to boost the economy and create jobs. A day before inaugurating the Vibrant Gujarat Global Summit on January 10, the prime minister met executives of Suzuki Motor Corp, Micron Technology and AP Moller and discussed industry issues and investment opportunities. Modi and Toshihiro Suzuki, Representative Director & President, Suzuki Motor Corp, "discussed Maruti Suzuki's plans to make India a strong player in the global automotive market by exporting Made in India vehicles, along with deploying global best practices related to vehicle scrapping and vehicle recycling into India," the Prime Minister's Office said in a post on X. US chip making giant Micron has started construction of a USD 2.75 billion semiconductor factory in Sanand, about 40-km from Ahmedabad. The plant, which will focus on transforming wafters into ball-grid arrays (BGA) integrated circuit packages, memory modules and solid-state drives, is expected to be ready by December this year.



https://energy.economictimes.indiatimes.com/news/renewable/modi-meets-top-ceos-discusses-made-in-india-vehicles-to-green-hydrogen/106667420?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2024-01-10&dt=2024-01-10&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

GE Power India gets Rs 10 crore order from NTPC

GE Power India Limited on Tuesday said it received an order worth Rs 10.3 crore from state-owned NTPC. . The order is to be completed in 10.5 months, the company said.

GE is a leading player in engineering, manufacturing, project management and supply of products and solutions for power generation and transmission infrastructure requirements.



https://energy.economictimes.indiatimes.com/news/power/ge-power-india-gets-rs-10-crore-order-from-ntpc/106683229

Energy firms to test CO2 capture in Brazil undersea oil field

Paris: A consortium of Brazilian ian, British, French and Chinese energy firms will test new technology aimed at capturing CO2 in an undersea oilfield off Brazil in an effort to reduce emissions, TotalEnergies. The pilot unit will separate oil from CO2-rich natural gas at the bottom of the ocean and reinject the gas directly into the reservoir, the French oil major said. TotalEnergies said the high pressure subsea separation (HISEP) technology has the potential to reduce the intensity of greenhouse gas emissions "while increasing the field production capacity". Energy firms and oil producing countries are banking on controversial carbon capture and storage technology as part of efforts to slash emissions. Environmentalists say the costly technology, which is still in its infancy, serves as an excuse to keep drilling for oil and gas instead of phasing out of fossil fuels -- the biggest contributors to climate change. Nations agreed at the UN's COP28 climate summit in Dubai last month to transition away from fossil fuels and accelerate the deployment of renewable energy along with carbon capture technology. The HISEP technology will be tested in the Mero field, which is operated by Brazil's Petrobras in partnership with TotalEnergies, British oil major Shell, China National Offshore Oil Corporation and China National Petroleum Corporation. The field is located in the Santos basin off the coast of Brazil, at a depth of 2,100 metres (6,900 feet) under a thick layer of salt. Its reserves have been estimated between eight to 12 billion barrels of crude by Brazil's National Petroleum Agency.

https://energy.economictimes.indiatimes.com/news/oil-and-gas/energy-firms-to-test-co2-capture-in-brazil-undersea-oil-field/106658903?action=profile_completion&utm_source=Mailer&utm_medium=newsletter&utm_campaign=etenergy_news_2024-01-10&dt=2024-01-10&em=amF5aXRhYmlzd2FzLm5pc2NwckBnbWFpbC5jb20=

EVENTS

Hydrogen 2024



Date: 9 - 10 April

Venue: Amsterdam, The Netherlands

Reuters Events: Hydrogen 2024, the world's most senior hydrogen event

Aim of the event:

- Achieve long-lasting off-taker commitment between producers and off-takers.
- Form hydrogen standards to incentivize market formation and ensure visibility for investors.
- Develop a world class infrastructure backbone to move and store hydrogen.
- Capitalize on the $208 billion per year ammonia opportunity to extend the hydrogen value chain.

Industry defining themes for 2024

•Set the global hydrogen standard
•Secure offtake agreements and financing
•Produce at scale
•Develop the infrastructure backbone to store and transport hydrogen
•Unlock clean ammonia to enable the hydrogen economy

Link:

https://events.reutersevents.com/renewable-energy/hydrogen-europe

INDUSTRY NEWS

CESC forays into green hydrogen domain

CESC Ltd, a power utility under the RP-Sanjiv Goenka group, is entering the green hydrogen domain. The group's subsidiary, CESC Projects Ltd, emerged as the successful bidder to establish a 10,500-tonne per annum green hydrogen production facility.

This initiative came through a tender invited by the Solar Energy Corporation of India Limited. Notable contenders in this bid in different categories were ACME Cleantech, Sembcorp, Greenko, Avaada, Reliance Industries, JSW Energy and the Adani group. Sources indicate an initial focus on the east coast for the green hydrogen capacity, with plans to engage with several agencies for pre-feasibility studies post the selection process. Industry experts estimate an investment of roughly Rs 500 crore for such a venture. CESC is now focusing majorly on green energy, added sources. "We are doing a study by a reputed organisation on green hydrogen. Making our company as green as we can is our objective," Goenka said. Goenka also said that the company intends to explore renewable energy avenues, focusing on distribution, especially considering that the majority of CESC's current power generation relies on thermal sources. The company operates a 750 MW generating station at Budge Budge and a 135 MW generating station at Garden Reach. In addition, Haldia Energy Limited, a 100% subsidiary of the company, operates a 600 MW generating station at Haldia, with a long-term power purchase agreement to sell its power to CESC. During 2023, the total generation from these plants was 10,185 million units, of which 93.8% came from Budge Budge and Haldia. CESC's Kolkata distribution infrastructure serves 3.5 million customers in Kolkata, Howrah and Hooghly.
Cesc Forays Into Green Hydrogen Domain | Kolkata News - Times of India (indiatimes.com)

EET Hydrogen's plans for UK's largest hydrogen production hub given green light

Cheshire West & Chester Council has approved groundbreaking plans by EET Hydrogen for the first large-scale, low carbon hydrogen production plant (HPP1) in the UK located at the Stanlow Manufacturing Complex in Ellesmere Port, Cheshire.

Consisting of two plants (HPP1 and HPP2), the hydrogen hub will enable local industrial and power generation businesses to switch from fossil fuels to low carbon energy. This will help to reduce the North West's carbon emissions by 2.5 million tonnes every year -- the equivalent of taking 1.1 million cars off the roads. EET will develop the hydrogen hub in phases with the first plant (HPP1) at 350MW capacity, the second (HPP2) at 1,000MW capacity and an overall target capacity of 4,000MW+ by 2030. These plants are critical to meet the UK's hydrogen and industrial decarbonisation targets and enable the critical hydrogen infrastructure.

The development is a key pillar of HyNet -- the UK's leading industrial decarbonisation cluster. Construction is anticipated to start on HPP1 in 2024 with low carbon hydrogen produced at the site by 2027. Richard Holden, HPP1 Project Manager at EET Hydrogen, said. "This is the largest low carbon hydrogen project in the UK and one of the most advanced in the world. It is a vital piece of the North West's journey to net zero, underpinning HyNet and providing the opportunity for manufacturers in the region to decarbonise their processes and support UK jobs.
https://in.investing.com/news/eet-hydrogens-plans-for-uks-largest-hydrogen-production-hub-given-green-light-3968574

Global Hydrogen Generation Industry Report 2023: Market Trends with Historical Revenue Data for 2022, Estimates for 2023, Forecasts for 2024, and CAGR Projections through 2028ResearchAndMarkets.com

Key Attributes

Report Attribute	Details
No. of Pages	260
Forecast Period	2023 - 2028
Estimated Market Value (USD) in 2023	$166.7 Billion
Forecasted Market Value (USD) by 2028	$271.1 Billion
Compound Annual Growth Rate	10.2%
Regions Covered	Global

Global Hydrogen Generation Market is projected to reach a value of $271.1 billion by 2028 from $166.7 billion, growing at a CAGR of 10.2% during 2023-2028. Using 2022 as the base year, the report provides estimated market data for 2023 through 2028. This report also offers insights on drivers and opportunities for the market, which were gathered through primary and secondary research. Hydrogen generation from sea water is not taken into consideration while doing this report.
https://www.businesswire.com/news/home/20240108182165/en/Global-Hydrogen-Generation-Industry-Report-2023-Market-Trends-with-Historical-Revenue-Data-for-2022-Estimates-for-2023-Forecasts-for-2024-and-CAGR-Projections-through-2028---ResearchAndMarkets.com/

EVENTS

Conference on Fuels of Future 2.0



Date: January 16, 2024

Venue: Hotel The LaLit, New Delhi

ASSOCHAM is conducting a Conference on Fuels of Future 2.0 - Converging Towards Greener Growth on January 16, 2024 in New Delhi to explore the aforementioned and related concerns.

Biofuels are becoming more popular by generating energy from organic materials such as algae, crop waste, and even municipal solid waste. These materials not only minimize our reliance on non-renewable resources, but they also have the potential to solve waste management issues. Another possibility is green hydrogen, which includes electrolyzing water using renewable energy sources such as wind and solar electricity. Battery technology advancements are also influencing the future of fuels. Electric vehicles powered by lithium-ion batteries have already begun to change the way we travel. These activities are supported by government programs under Atmanirbhar Bharat, such as the Ethanol Blended Program, Green Hydrogen Policy, FAME Scheme, New Electric Vehicle Policy, Coal Gasification, and others, which are assisting the country in strengthening its energy security.

Link:

https://krishijagran.com/events/conference-on-fuels-of-future-20/

Green hydrogen can enable energy transition in India's net-zero journey: WEF report

In a detailed analysis of what it will take to make green hydrogen a credible energy pathway in India, the WEF report said, "Green hydrogen can enable energy transition as India takes its net-zero journey towards 2070 while supporting its growing energy needs." The report by the World Economic Forum, written in collaboration with Bain & Co, recommended five areas that can benefit from public-private interventions in expediting the adoption of green hydrogen in India.

Hydrogen produced through the electrolysis of water and powered by renewable energy, which is known as green hydrogen, is considered a clean, flexible and versatile energy carrier that can also help address the tension between energy supply and climate change, the report said. India is currently the third-largest economy in the world in terms of energy needs, and the country's demand for energy is set to surge. The demand is estimated to grow 35 per cent by 2030. In 2022, India's energy import bill was pegged at USD 185 billion, a figure that is sure to rise if the country continues to supply its growing energy demand through traditional methods.

At the same time, India set a commitment to achieve net zero by 2070 at the United Nations Climate Change Conference in Glasgow (COP26), held in 2021. The WEF report said green hydrogen is critical to help meet India's energy security needs while reducing emissions in hard-to-abate sectors on the path to net zero. Currently, India produces 6.5 million metric tonnes per annum (MMTPA) of hydrogen, predominantly for use in crude oil refineries and fertiliser production. The National Green Hydrogen Mission has set a target for the production of 5 MMTPA of green hydrogen by 2030 - equivalent to roughly half of India's projected overall hydrogen demand of 11 MMTPA at that time. According to the report, India's renewable energy potential can support its goals for green hydrogen growth but needs rapid capacity addition. Although, most of the country's current hydrogen supply is grey hydrogen, which is produced using fossil fuels in a process that creates CO_2 gas emissions, many expect sizeable production of green hydrogen to take effect beginning in 2027 and after, according to the report.

https://energy.economictimes.indiatimes.com/news/renewable/green-hydrogen-can-enable-energy-transition-in-indias-net-zero-journey-wef-report/106712788

Punjab must be made hub of producing green hydrogen, says Gadkari

Union Minister Nitin Gadkari described hydrogen as the fuel of the future and said Punjab should be made an international hub of producing the green fuel. He also urged Punjab farmers not to burn stubble, saying the crop residue can be used in producing ethanol, hydrogen, and Compressed Natural Gas (CNG) for their further use as fuel. The minister for road transport and highways was addressing a gathering after inaugurating and laying foundation stones of 29 national highway projects worth Rs 4,000 crore in Punjab. Green hydrogen can be made out of crop residue like wheat straw, paddy straw, bagasse, Gadkari said, adding that efforts are on to keep the cost of 1 kg hydrogen to below USD 1. Gadkari said during a recent meeting he had urged Punjab Chief Minister Bhagwant Mann to make the state an international hub of producing green hydrogen as the state has stubble and biomass. He said hydrogen can be used in running railway engines, airplanes, trucks, buses, and cars. The Union minister said farmers in Punjab need to be made 'Urjadaata' (energy provider). Gadkari asked farmers not to burn stubble. "We have got a technology whereby bitumen can be made from stubble," he said, adding that a project will be started in Haryana where one lakh litres of ethanol and 150 tonne of bitumen will be made from one lakh tonne of paddy stubble. He further said a few companies have also come up with ethanol-powered bikes and auto-rickshaws. The minister said Indian Oil will also set up 300 ethanol pumps in the country.

Punjab must be made hub of producing green hydrogen, says Gadkari (msn.com)

Vibrant Gujarat: Essar Group to set up 1GW green hydrogen project in Jamnagar

Essar Group is setting up a 1-gigawatt green hydrogen project (1,000 megawatt) in Gujarat's Jamnagar, besides expanding its ports and power businesses in the western state, said Prashant Ruia, Promoter Director, Essar Group. In December 2023, Essar signed an MoU with the Gujarat government to develop the project, involving an estimated investment of Rs 30,000 crore. The Essar Group representative Prashant Ruia informed that the company has so far invested more than Rs 150,000 crore in Gujarat. "Basically, India is now really one of the most important investment destinations in the world," he asserted. (ANI)

Vibrant Gujarat: Essar Group to set up 1GW green hydrogen project in Jamnagar (webindia123.com)

Qusay, H. *et al.*

Assessment of industrial-scale green hydrogen production using renewable energy

https://doi.org/10.1177/09576509231219339

Abstract:

The global pivot towards sustainable energy solutions necessitates a closer examination of green hydrogen production using renewable energy sources. This study aimed to assess the feasibility and efficiency of green hydrogen production on an industrial scale using solar and wind energy in Diyala city, Iraq. Experimental weather data, including solar irradiance, ambient temperature, and wind speed, were meticulously collected throughout 2022. The analysis indicated that, for wind energy, the optimum electrolyser capacity that matched a 1.5 MW wind turbine achieved a hydrogen production of 11,963 kg/year, with associated costs of $8.87/kg. In contrast, when focusing on solar energy, the ideal electrolyser capacity harmonizing with a 2 MW solar photovoltaic generated a notably higher hydrogen output of 94,432 kg/year at a more competitive cost of $6.33/kg. These findings underscore the potential economic advantages of solar-based green hydrogen production over wind-based methods in Diyala city. Furthermore, the significant difference in hydrogen production yields between the two methods emphasizes the need to optimize renewable infrastructure based on location-specific renewable resources. This study offers valuable insights into tailoring green hydrogen production strategies in regions with similar climatic conditions to Diyala and serves as a blueprint for future renewable energy-driven hydrogen production initiatives.

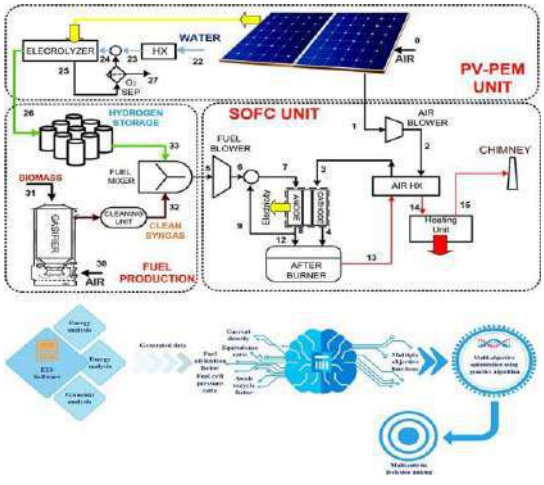
Mehr, S. and M. Ilkhani.

Thermodynamic modelling and optimisation of a green hydrogen-blended syngas-fueled integrated PV-SOFC system

https://doi.org/10.1016/j.applthermaleng.2023.121506

Abstract:

Developing an effective energy transition roadmap is crucial in the face of global commitments to achieve net zero emissions. While renewable power generation systems are expanding, challenges such as curtailments and grid constraints can lead to energy loss. To address this, surplus electricity can be converted into green hydrogen, serving as a key component in the energy transition. This research explores the use of renewable solar energy for powering a proton exchange membrane electrolyser to produce green hydrogen, while a downdraft gasifier fed by municipal solid waste generates hydrogen-enriched syngas. The blended fuel is then used to feed a Solid Oxide Fuel Cell (SOFC) system. The study investigates the impact of hydrogen content on the performance of the fuel cell-based power plant from thermodynamics and exergoeconomic perspectives. Multiobjective optimisation using a genetic algorithm identifies optimal operating conditions for the system. Results show that blending hydrogen with syngas increases combined heat and power efficiency by up to 3%, but also raises remarkably the unit product cost and reduces carbon dioxide emissions. Therefore, the optimal values for hydrogen content, current density, temperatures, and other parameters are determined. These findings contribute to the design and operation of an efficient and sustainable energy generation system.



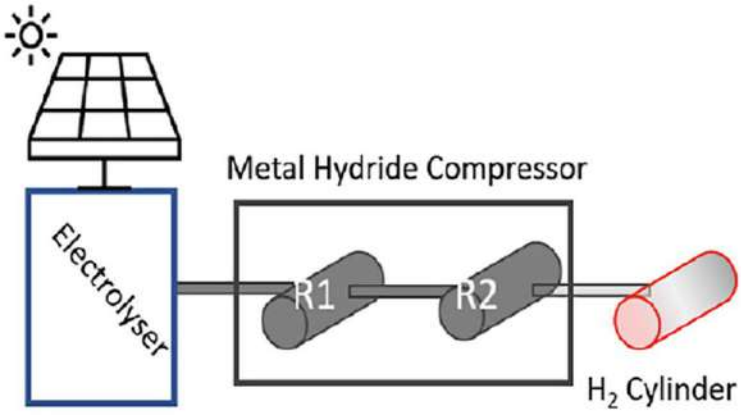
Barale, J. *et al.*

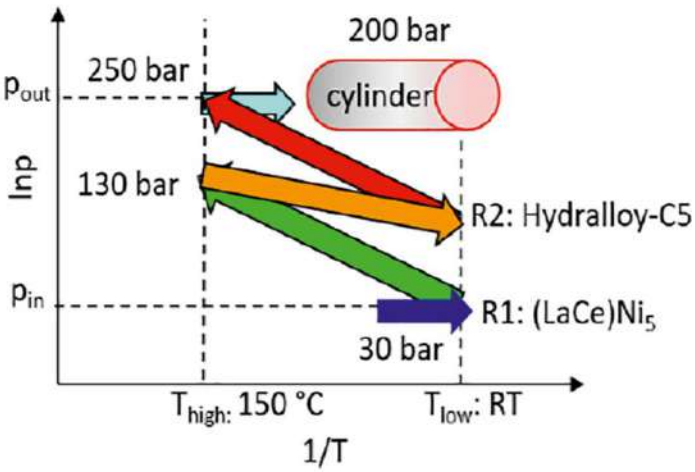
A metal hydride compressor for a small scale H2 refuelling station

https://doi.org/10.1016/j.ijhydene.2023.05.155

Abstract:

The use of hydrogen as energy vector implies the development of the necessary infrastructures for hydrogen handling. A two-stage metal hydride compressor was developed and integrated in a small-scale hydrogen refuelling station at prototype level. In this work, the compression on site of green hydrogen using metal hydrides is exhaustively presented taking into account all the necessary aspects to bridge the gap between the laboratory and the real application. In particular, all aspects for the setting up of a metal hydride compressor, i.e. selection and characterization of selected metal hydrides, sizing of the plant components, design and the tests aimed to optimize the working performances are presented and deeply discussed, including energy consumption and efficiency necessary to build up a commercial system. The compressor employs two commercial alloys, i.e. a La0.9Ce0.1Ni5 from Labtech in the first stage and the Hydralloy-C5 from GfE in the second one. Working between room temperature for absorption and 150 °C for desorption, the hydrogen produced by the electrolyser at 28 bar is compressed up to 250 bar, resulting in a compression ratio of about 9. The metal hydride compressor has a final power consumption of 614 W, of which 85 W are linked to the hydrogen sorption reactions, while other contributions come from the pumps involved in the plant and the dissipations. The compressor presents an isentropic efficiency of about 11% for less than 1 kg of powder in each stage and an average H2 flowrate of 104 Nl/min is observed. The performances of the plant were optimized and maintained for a working time of about 245 h.





Qusay, H. *et al.*

Large-scale green hydrogen production via alkaline water electrolysis using solar and wind energy

https://doi.org/10.1016/j.ijhydene.2023.05.126

Abstract:

The study provided a precise technique for comparing wind and solar solutions for large-scale production of green hydrogen. A one-year experimental dataset depicting the wind speed and solar irradiance with a precision of 1 min. The carbon footprint study was conducted, and indicators were applied and evaluated for the purpose of standardising the performance assessment technique for renewable-based hydrogen production systems, such as the electrolyser capacity fulfilled by wind turbines and solar photovoltaic power plants. On the basis of the considered capacities of 2.5 for wind turbines and solar photovoltaics for cost estimating findings, the obtained optimum electrolyser capacity can match the energy produced by the wind turbine power plant, which is 1.5 MW, which can produce hydrogen at a rate of about 11,963 kg/year at 8.87$/kg, and the obtained optimum electrolyser capacity can match the energy produced by the solar photovoltaics power plant, which is 2.0 MW, which can produce hydrogen at a rate of about 94,432 kg/year at 6.33 $/kg. Further, the polynomial relation between hydrogen production and electrolyser capacity has been destroyed. The method used is easily adaptable for testing large-scale applications such as industrial plants, as well as any hydrogen requirements and environmental conditions.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 68
JANUARY, 2024

Integrating Human Waste with Microbial Fuel Cells to Elevate the Production of Bioelectricity

-Pandit, C. et al.

Due to the continuous depletion of natural resources currently used for electricity generation, it is imperative to develop alternative energy sources. Human waste is nowadays being explored as an efficient source to produce bio-energy.

Human waste is renewable and can be used as a source for an uninterrupted energy supply in bioelectricity or biofuel. Annually, human waste such as urine is produced in trillions of liters globally.

Utilizing the waste to produce bioenergy is bio-economically suitable and ecologically balanced. Microbial fuel cells (MFCs) play a crucial role in providing an effective mode of bioelectricity production by implementing the role of transducers.

MFCs convert organic matter into energy using bio-electro-oxidation of material to produce electricity. Over the years, MFCs have been explored prominently in various fields to find a backup for providing bioenergy and biofuel.

MFCs involve the role of exoelectrogens which work as transducers to convert the material into electricity by catalyzing redox reactions.

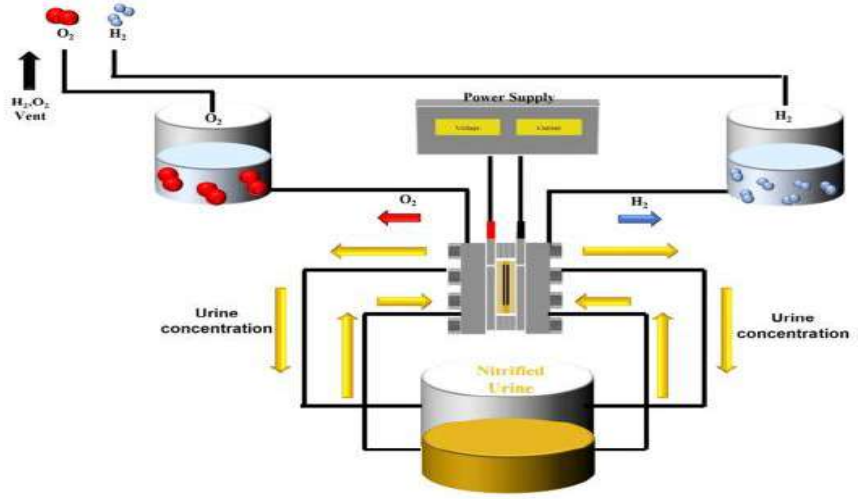
Human waste is useful for producing electricity and how this innovation would be beneficial in the long term, considering the current scenario of increasing demand for the supply of products and shortages of natural resources used to produce biofuel and bioelectricity.

Link:

Pandit C, Thapa BS, Srivastava B, Mathuriya AS, Toor UA, Pant M, Pandit S, Jadhav DA. Integrating Human Waste with Microbial Fuel Cells to Elevate the Production of Bioelectricity. BioTech (Basel). 2022 Aug 22;11(3):36. **doi:** 10.3390/biotech11030036

Human urine electrolysis for simultaneous green hydrogen and liquid fertilizer production for a circular economy: A proof of concept

Study explores a novel process for hydrogen production and urine concentration using water electrolysis, employing a hydrophobic membrane and hydrogel electrolyte. - Im, K. et al. 2024.



About:

The process utilizes a hydrophobic membrane to provide pure water from human urine, while simultaneously producing hydrogen through electrolysis, and concentrating urine for liquid fertilizer production. A suitable hydrogel electrolyte was developed, with polyvinyl alcohol (PVA)-based hydrogels and varying potassium hydroxide (KOH) concentration, showing efficient ion conductivity. The PVA-KOH 30 wt % hydrogel incorporating melamine exhibited promising performance in cell testing, achieving a current density of 204.35 mA/cm2 at 2 V. Long-term electrolysis tests indicated sustained efficiency, although a decline in current density during 96 h was attributed to hydrophobic membrane fouling. Nonetheless, the hydrogel electrolyte demonstrated minimal fouling, successfully concentrating the urine about 5 times. This concentrated urine serves as liquid fertilizer, while the produced hydrogen acts as an energy source, and the oxygen can be recycled for use in a membrane bioreactor (MBR), establishing a sustainable energy cycle system.

How the Technology works

Electrochemical wastewater electrolysis using renewable energy as input is a highly desirable and sustainable technique for the mass production of green hydrogen, but its practical viability is seriously challenged by insufficient durability because of the electrode side reactions and corrosion issues arising from the complex components of wastewater such as human urine. The aim to develop a novel process that utilizes urine not only as a resource for fertilizer but also for hydrogen production to ensure self-energy generating liquid fertilizer production as a proof-of-concept (PoC). Nitrified urine from a membrane bioreactor (MBR) was concentrated while simultaneously producing hydrogen through urine electrolysis.

Achieved by employing a hydrophobic porous membrane made from polytetrafluoroethylene (PTFE), which acts as a gas-path interface, and utilizing a concentrated potassium hydroxide (KOH) solution as a self-dampening electrolyte (SDE). This innovative design enables the selective passage of water vapor while completely blocking the infiltration of liquid urine and impurity ions. Water vapor diffuses through the membrane to the SDE side, where it is re-converted into liquid form through absorption by the SDE.

It paves the way for sustainable energy management, urine-based fertilizer production, and resource recovery, contributing to the concept of a circular economy.

Im, K., Park, M., Kabir, M. M., Sohn, W., Choo, Y., Shon, H. K., & Nam, S. Y. (2024). Human urine electrolysis for simultaneous green hydrogen and liquid fertilizer production for a circular economy: A proof of concept. *Desalination*, *570*(117059), 117059. https://doi.org/10.1016/j.desal.2023.117059

EVENTS

The 3rd China Hydrogen Summit 2024

ECV GREEN HYDROGEN

Date: May 16-17, 2024

Venue: Shanghai, China



HIGHLIGHTS

Future Outlook for China's Hydrogen Industry

New Opportunities for the Hydrogen Industry with the Restart of CCERs

Hydrogen-fired Gas Turbines Power Green Power Sector

Renewable Green Power to Hydrogen Accelerates Petrochemical Industry to Carbon Neutrality

Hydrogen-Electric Coupling Reconstructs Zero-Carbon New Energy

Analysis of Green Hydrogen Demonstration Project Business Model

Intelligent Digital Technology Drives Safe, High-Speed Growth in Hydrogen Industry

Hydrogen Fuel Cell Vehicles: The Next Generation of New Energy Commercial Vehicles

Link:

https://www.ecv-events.com/ads/HydrogenEnergy/index.php?cci=13&gclid=CjwKCAiAkp6tBhB5EiwANTCx1FTJiMcipGKDLel2MHSw2_gLffpl9jBDFj1emw-jUN1or80EvpaDcxoCNhYQAvD_BwE

INDUSTRY NEWS

Australia invests $45.9m in Bell Bay Hydrogen Hub

The Australian Government is providing around $45.9m (A$70m) in investment for the development of the Bell Bay Hydrogen Hub in Northern Tasmania, bringing the total investment in the project to around $196.8m (A$300m).

In a statement, the Department of Climate Change, Energy, the Environment and Water said the hydrogen hub will enable the production of up to 45,000 tonnes of green hydrogen annually.

The project will also create 740 job opportunities for energy specialists including engineers and technicians. The construction will also employ local skilled trades such as concreters, plumbers, fitters, and electricians.

The department added that Tasmania has a natural advantage in green hydrogen production attributed to its long history of clean energy production.

https://asian-power.com/project/news/australia-invests-459m-in-bell-bay-hydrogen-hub

ZeroAvia is exploring cryo-compressed hydrogen to produce longer-range planes

Hydrogen-electric plane aviation technology developer ZeroAvia is exploring a form of energy-dense fuel to develop aircraft that can refuel faster and potentially fly farther. The company has signed a memorandum of understanding with hydrogen tech startup Verne to co-develop the plane integrations.

Following a series of milestones in the past decade, ZeroAvia sits closer than ever to delivering commercial operations of hydrogen-electric planes en route to its goal of achieving a 40- to 80-seat aircraft with up to 700 miles of range by 2027. We've already seen the company achieve experimental flight certificates from the CAA in the UK and the FAA in the US, and it's been one year since it completed its first flight with a 19-passenger hydrogen-electric plane.



https://electrek.co/2024/01/16/zeroavia-exploring-cryo-compressed-hydrogen-longer-range-planes-electric/

GM and Komatsu collaborate on hydrogen truck

Komatsu is putting its weight behind hydrogen fuel cells as a low carbon alternative to diesel engines as it can package large quantities of energy onboard a vehicle without compromising payload carrying capacity. Mining trucks like the Komatsu 930E, which has a nominal payload of 290 tonnes, typically operate at a single mine throughout their life, which simplifies the challenges of sizing and deploying an effective hydrogen refuelling infrastructure to service a vehicle fleet. Komatsu's fuel cell-powered mining trucks will provide an additional route to decarbonisation beyond battery-trolley or battery- static charging systems, without the need for additional charging infrastructure within mines.



https://www.theconstructionindex.co.uk/news/view/gm-and-komatsu-collaborate-on-hydrogen-truck

Funding boost for Tees Valley hydrogen transport projects

The Tees Valley has received £7m of government funding to decarbonise deliveries by lorries. The money will be used to build a hydrogen refuelling station for zero emission HGVs near Middlesbrough for cleaner, greener deliveries locally. More than half of the UK's hydrogen is already produced in the area.

Hydrogen can be produced, stored and used to generate heat and electricity without producing any greenhouse gases or air pollutants. The Tees Valley Combined Authority will use £300,000 to run a competition for local colleges to run hydrogen skills training. Tees Valley Mayor, Ben Houchen, said: "Our area is leading the way in developing the cleaner, healthier and safer transport of the future. This is another great example of how we are creating innovative solutions, such as greener deliveries to our supermarkets.

https://www.itv.com/news/tyne-tees/2024-01-17/funding-boost-for-hydrogen-transport-projects

EVENTS

INDIA ENERGY WEEK 2024, GOA

Date: 6-9 February, 2024

Venue: Goa, India

Location: IPSHEM-ONGC Training Institute
P.O. Via Velim, Betul, South Goa, Pin - 403723, India

Building on the success of the 2023 edition, inaugurated by the Hon'ble Prime Minister of India Shri Narendra Modi, India Energy Week 2024 returns from 6 – 9 February 2024 in Goa, India.

Held under the patronage of the Ministry of Petroleum & Natural Gas, Government of India, and officially supported by the Federation of Indian Petroleum Industry (FIPI), India Energy Week 2024 will be India's largest and only all-encompassing energy exhibition and conference, bringing together the entire energy value chain, and will serve as a catalyst for India's energy transition goals.

India Energy Week will be a truly global gathering, convening policymakers, business leaders and energy pioneers to collaborate, discover new opportunities and strengthen partnerships.

Link:

https://www.indiaenergyweek.com/event/2fe24000-628c-4f45-a85e-4e8ed44d433c/summary?utm_source=googlesearch&utm_medium=cpc&utm_campaign=India&utm_term=integralmedia&gclid=CjwKCAiAkp6tBhB5EiwANTCx1Fss65E8o77C5cqYAcjjVnposOiMG1SkSb7ISbPdt_syKtcZfdk8oRoCsgAQAvD_BwE

INDUSTRY NEWS

INEOS GRENADIER QUARTERMASTER PICKUP: HYDROGEN PROTOTYPE REVEALED

The automotive industry has been buzzing with news on the latest hydrogen-powered prototype, the INEOS Grenadier Quartermaster Pickup. This innovative vehicle is a testament to the ever-growing demand for sustainable transportation solutions and showcases the potential for hydrogen fuel cell technology in the off-road and utility sectors.
The Grenadier Quartermaster Pickup is designed by INEOS Automotive, a subsidiary of the UK-based chemicals company, INEOS. Known for their commitment to developing cutting-edge and environmentally-friendly alternatives to traditional fuels, INEOS has taken a significant step forward in demonstrating the viability of hydrogen technology for commercial vehicles.



https://www.thetechedvocate.org/ineos-grenadier-quartermaster-pickup-hydrogen-prototype-revealed/

Cheshire Council approves UK's largest hydrogen hub by EET Hydrogen

Cheshire West & Chester Council approved EET Hydrogen for the construction of the UK's largest hydrogen production hub consisting of two plants (HPP1 and HPP2), located at the Stanlow Manufacturing Complex in Ellesmere Port, Cheshire. The phased development targets a capacity of 350MW for the first plant (HPP1), 1,000MW for the second (HPP2), and an overall target capacity exceeding 4,000MW by 2030. The construction of HPP1 is expected to commence in 2024, with low carbon hydrogen production anticipated by 2027. The initiative is expected to contribute to an annual reduction of 2.5 million tonnes of carbon emissions in the North West, equivalent to removing 1.1 million cars from the roads.
https://energy.economictimes.indiatimes.com/news/renewable/cheshire-council-approves-uks-largest-hydrogen-hub-by-eet-hydrogen/106719506

Multi-million funding for hydrogen refuelling hub and fuel cell commercial vehicles

The programme, funded a £7m injection from the Department for Transport and supported by private investment, will deliver a publicly accessible green hydrogen refuelling station. This will be located near Middlesbrough and built by fuel distributer Exolum. It will also showcase the first large-scale deployment of fuel cell electric commercial vehicles and HGVs in the UK as part of the Tees Valley Hydrogen Vehicle Ecosystem (HYVE) Consortium. As the selected HGV leasing partner within the consortium, Novuna Vehicle Solutions will work alongside German manufacturer Quantron AG to build, fund and manage the in-life maintenance of more than 20 fuel cell electric HGVs ranging from 4.2 to 27 tonnes deployed in the project.



https://evfleetworld.co.uk/multi-million-funding-injection-for-hydrogen-refuelling-hub-and-fuel-cell-commercial-vehicles/

Tasmanian hydrogen hub locks in $70 million federal funding boost

The Australian government has formalised a $70 million (USD 49.95 million) investment to help develop the Bell Bay Hydrogen Hub in northern Tasmania with construction of the project scheduled to commence this year with completion planned for early 2028.
https://www.pv-magazine-australia.com/2024/01/19/tasmanian-hydrogen-hub-locks-in-70-million-federal-funding-boost/

EVENTS

12th World Environmental Education Congress (WEEC), 2024

Date: 29 Jan – 2 Feb, 2024

Venue: Abu Dhabi, UAE

As the venue is the reflection of the event, the latest edition of WEEC will be taking place at Abu Dhabi National Exhibition Centre (ADNEC) as the venue support and practices sustainability in numerous ways. ADNEC is committed to ensure the sustainable development of the Meetings, Incentives, Conferences & Exhibitions (MICE) industry in the UAE, regionally and worldwide. Being among the first UAE entities to make a Net Zero Carbon Events pledge and winning multiple sustainability awards, ADNEC is leading the industry as it actively promotes and advocates for environmentally friendly industry efforts throughout the value chain. ADNEC Group has pledged to produce Net Zero Carbon Footprint events by 2050 with the vision of supporting and creating a greener future within the MICE industry. This pledge also supports the UAE's Net Zero by 2050 Strategic Initiative to reduce carbon emissions. UAE is the first country to make a Net Zero pledge in the MENA Region. This also reflects positively on the event as the vision and values work in line with ADNEC's sustainability pledge making it the perfect host for the 12th edition of WEEC.

Link:

https://www.weec2024.org/en/congress/sustainability/

India & world's 2024 techscape

Technology grabbed the limelight last year in India and in the world. The year 2023 was marked by techrelated advancements across multiple avenues like AI, space tech, cloud technology, remote working, and sustainability. The gamechanger was generative AI with its Midas touch on the techno-industrial landscape.

2024 Techscape & Trends

In 2024, India will continue treading the path of rapid technological advancement.

1. Hydrogen as an energy carrier
2. Electric vehicle advancements
3. Sustainability as a focus
4. Pharmaceutical advancements
5. The next-gen trio – Web 3, metaverse & IoT

Trendspotting in AI and generative AI for the year

India is poised to become a leader in Gen AI and will leverage its robust IT sector and skilled workforce.

1. Human-centric AI approach
2. Upskilling and reskilling in AI
3. Policy & regulations
4. Role of Engineers

India & world's 2024 techscape (msn.com)

Budget 2024: India's budget set to ignite green hydrogen boom with strategic fiscal push

Industry insiders suggest that the forthcoming will lay down the groundwork for an increase in subsidies, particularly for sectors that are best positioned to leverage green hydrogen, such as refining and fertilization. The move is designed to amplify domestic demand and foster a robust supply chain for the eco-friendly energy variant. Investments are also anticipated in creating a comprehensive infrastructure for green hydrogen transportation. The Budget 2024 is likely to outline the development of clusters and pipelines that would not only reduce transportation costs but also enhance the supply chain's efficiency. To stimulate innovation and private sector investment, the government may extend tax credits and incentives for research and development in the green hydrogen sector. These measures are intended to match global initiatives and position India at the forefront of renewable energy technology. Export infrastructure is also expected to see a significant enhancement, with the Budget possibly detailing plans for the development of port facilities and the establishment of international standards for green hydrogen derivatives. Such measures would be critical in transforming India into a key exporter in the global green hydrogen market.

On the domestic front, the Budget may announce direct subsidy schemes and capex support for industries ready to transition to green hydrogen. This support is anticipated to catalyze the adoption across various sectors, boosting in-house demand, and fostering developments in green hydrogen by-products, including the burgeoning green steel industry. This potential fiscal framework in the Budget, reflective of the strategic recommendations from the "Green Hydrogen: Enabling Measures Roadmap for Adoption in India" report by the World Economic Forum and Bain & Company, could herald a new era for India's energy sector. It suggests a future where India not only meets its energy requirements sustainably but also asserts itself as a pioneer in the global transition to a low-carbon economy. The report, released recently, has been instrumental in highlighting the potential pathways and strategies for India's transition to a green hydrogen economy, offering a blueprint that the Budget is likely to draw upon.

https://energy.economictimes.indiatimes.com/news/renewable/budget-2024-indias-budget-set-to-ignite-green-hydrogen-boom-with-strategic-fiscal-push/106848949

MOUs signed to develop mechanism for Global Hydrogen Trading in GIFT City

The International Financial Services Centre (IFSC) at GIFT City has announced a strategic collaboration with the Indian Gas Exchange (IGX) and Gujarat State Petroleum Corporation (GSPC) to establish a Global Hydrogen Trading Mechanism. This initiative, set to be the second of its kind globally, places GIFT City at the forefront of the emerging green hydrogen economy. "A key aspect of this collaboration is the subsequent launch of the Global Hydrogen Price Index, a benchmark that will play a pivotal role in price discovery and market information on the burgeoning green hydrogen market in India. This mechanism is expected to enhance transparency, boost investor confidence, and facilitate the growth of the green hydrogen market on a global scale," it said in a statement. The objective of GIFT IFSC is to develop and promote trading of global securities including commodities and create a leadership in deriving price for such globally traded commodities. GSPC jointly with Indian Gas Exchange will develop a mechanism to create an index for Hydrogen and attract global institutions to trade in GIFT IFSC.

https://www.msn.com/en-in/money/markets/mous-signed-to-develop-mechanism-for-global-hydrogen-trading-in-gift-city/ar-AA1n62Ju

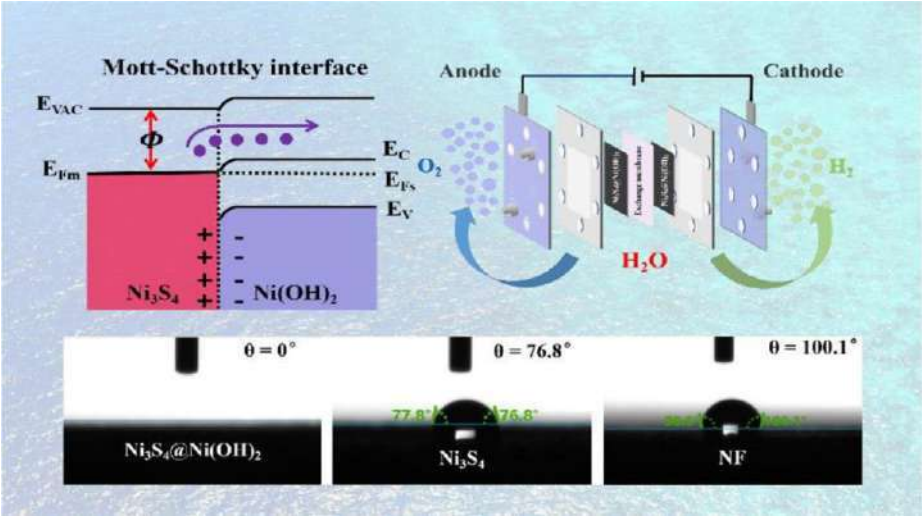
Chai, HM. *et al.*

Triple roles of Ni $(OH)_2$ promoting the electrocatalytic activity and stability of Ni_3S_4@Ni$(OH)_2$ in anion exchange membrane water electrolyzers

https://doi.org/10.1016/j.jcis.2023.10.021

Abstract:

Developing high performance and durable electrocatalysts is crucial for the practical application of large-scale water splitting under high current density. Here, we constructed a Mott-Schottky heterojunction bifunctional electrocatalyst coating of Ni3S4 with Ni $(OH)_2$ thin film supported on Ni foam substrate (Ni_3S_4@Ni $(OH)_2$) for anion exchange membrane water electrolyzers (AEMWEs). Remarkably, the eta 500 is as low as 274.6 mV toward the hydrogen evolution reaction and 423.8 mV toward the oxygen evolution reaction. AEMWEs deliver a stable performance that achieves current densities of 500 and 1000 mA cm-2 at a cell voltage of 1.84 and 1.95 V, respectively. In particular, the Ni_3S_4@Ni$(OH)_2$ exhibits durable stability for 100 h at 500 mA cm^{-2} without significant degradation and uses 0.75 kW ⋅h of electricity less than commercial Ni foam electrode to produce each standard cubic meter of hydrogen gas at 500 mA cm^{-2}. The excellent performance is ascribed to the triple roles of Ni$(OH)_2$, which prevent the inner Ni3S4 from decomposing during the reaction process, promoting the dissociation of water and formation of adsorbed hydrogen intermediate and accelerating electron transfer ability due to the Mott-Schottky heterojunction between Ni$(OH)_2$ and Ni_3S_4. This work sheds light on the development of advanced bifunctional electrocatalysts based on non-precious transition metals for AEMWEs.



Kenez, MC. and Dincer, I.

Development and assessment of an offshore-based integrated hydrogen production and liquefaction system

https://doi.org/ 10.1016/j.applthermaleng.2023.121574

Abstract:

The conventional hydrogen production methods depending on fossil fuels raise sustainability concerns. Therefore, there is a crucial need to develop sustainable and energetically self-sufficient hydrogen production processes. In this paper, an integrated hydrogen production and liquefaction system is developed to meet the hydrogen energy needs of communities. For this purpose, the present integrated system is considered and applied to the Hornsea Wind Farm, being developed off the east coast of the East Coast in the North Sea. The system aims to produce gaseous hydrogen by an electrolyzer and liquefy it by utilizing the energy input coming from a wind farm. The thermodynamic analysis is performed for the overall system and its components using energy and exergy methods through balance equations. Furthermore, the parametric evaluations are implemented to investigate the effects of varying operational conditions and design parameters on some key energy and exergy performance indicators. Under the specified conditions, the current study obtains the following results: an overall energy efficiency of 70.45 %, an overall exergy efficiency of 57.32 %, and a specific energy consumption of liquefaction plant (SEC) of 62.24 kWh/kg-LH2. Moreover, the levelized cost of H2 for the plant is found to be $7.28/kg. This research also reveals the primary sources of exergy losses by providing valuable insights to enhance the system's exergetic performance with some potential optimization opportunities. Furthermore, this study is expected to help achieve a more sustainable and decarbonized energy future with green hydrogen production and liquefaction for use.

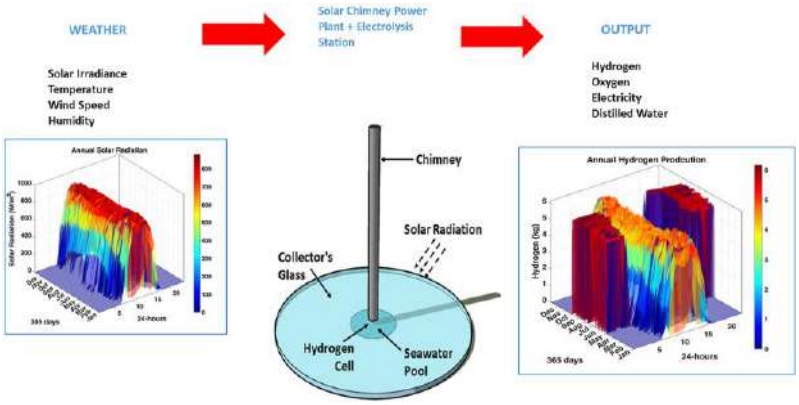
Abdelsalam, E. *et al.*

Sustainable production of green hydrogen, electricity, and desalinated water via a Hybrid Solar Chimney Power Plant (HSCPP) water-splitting process

https://doi.org/10.1016/j.ijhydene.2023.06.165

Abstract:

This work presents a novel sustainable approach to producing desalinated water (Wdes), green hydrogen (GH2) and electrical energy (Eelc) using Hybrid Solar Chimney Power Plant (HSCPP) coupled with a water-splitting (WatSp) process. The HSCPP consists of a collector, absorber, chimney, bidirectional turbine outfitted with a seawater pool, and water electrolysis (Watelc) cell. The HSCPP harnesses solar energy to heat the air under the collector creating air movement within the structure, passing the bidirectional turbine, and producing Eelc. Sprinklers were fitted within the structure to operate the HSCPP as a cooling tower (CT) in the absence of solar radiation (Solirr). The Watelc cell directly uses the produced Eelc for the production of Hydrogen (PH2) and oxygen (PO2), while the condensed water at the chimney's inner walls was also collected as Wdes. Results revealed that the continuous operation of the HSCPP has an average annual Eelc of 633 +/- 10 MWh that could be efficiently used to generate 21,653 kg of GRH2, 173,244 kg of O2 as well as 190,863 tons of Wdes. The overall efficiency of the HSCPP for the PH2 was found to be 18:5%, which is higher than Solar PV (max-6%) and geothermal Rankine (max-15%). These high efficiencies rank this technology as competitive with other renewable hydrogen production technologies. In conclusion, HSCPP has a promising future as a novel and sustainable solar tower technology to produce hydrogen.



Boretti, A.

Assessing the value of hydrogen thermal energy storage and electric thermal energy storage in NEOM city

https://doi.org/10.1016/j.ijhydene.2023.10.116

Abstract:

A large community such as NEOM City which is supposed to be powered only by wind and solar renewable energy requires a significant amount of energy storage. Given the limitations of the current energy storage technologies, from the total storable energy to the time this energy is stored, from the cost to the technology readiness level, it is important to provide assessments of continuing evolving alternative technologies. The cases of electric (external) thermal energy storage (eTES), and hydrogen thermal energy storage (hTES), are here considered. eTES is based on warming up a molten salt by using an electric resistance. The molten salt is then used to warm up a power cycle fluid for dispatchable energy production running a thermal power cycle. eTES suffers from round trip efficiency below 50 % but may handle a larger amount of energy at a lower cost compared to lithium-ion battery energy storage. eTES may benefit from integration with concentrated solar power with (internal) thermal energy storage. hTES is then based on green hydrogen production by electrolyzers, storage of the hydrogen in tanks, and combustion of the hydrogen to warm up a power cycle fluid for dispatchable energy production running a thermal power cycle. Of cost more difficult to estimate, also depending on the deployment of electrolyzers and round trip efficiencies below 50 %, hTES has the benefit to permit the storage of any amount of energy even over long time scales such as those needed to compensate for seasonal variability. Before electrolyzers provide the due amount of green hydrogen, the combustion power plant can be run with natural gas, delivering if not zero CO2 emission, certainly the lowest life cycle CO2 emission for dispatchable electricity at present. Finally, eTES and hTES can be coupled with each other, and also integrated with waste-to-energy (WTE) systems, for a more comprehensive and sustainable approach based on common.

Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 69
JANUARY, 2024

Fine Gas Purification Approaches for High Purity Hydrogen Production from Ammonia

Study aims to evaluate the state-of-the-art in purifying hydrogen from green ammonia. Current technology gaps are also identified and an outlook is given toward new innovative approaches.

– Bandlamudi, GC. et al. 2024.



About:

Green ammonia contains 17.8% of H-2 and enables efficient liquid storage and transport of hydrogen produced from renewable electricity. Back-conversion of ammonia to hydrogen may be carried out by several routes, whereby thermal ammonia cracking is one of the most efficient approaches. In the conversion of ammonia at high pressures, it is only possible to achieve complete conversion at very high temperatures (approximate to 800 degrees C). Therefore, the separation of ammonia in the low percentage range (e.g., <0.001%) is an important task.

For mobility applications wherein, polymer electrolyte membrane fuel cells are to be fed with cracked H-2 (from NH3), fine purity must be achieved, in agreement with ISO 14687-2. In such a context, ammonia is particularly important, with a permissible concentration of 0.100 ppm.

The main feasible routes for ultrafine purification are presented and discussed with regard to efficiency, availability, and cost, namely, 1) permeation membranes and 2) absorbents, as well as a third route via 3) biological scrubber.

The Technology

Hydrogen purification is a crucial link from H_2 production to H_2 utilization. Stable, reliable, and low-cost H_2 sources represent a base for large-scale applications of fuel cell vehicles such as heavy-duty road traffic. Thus, high-efficient and low-power H_2 purification technologies for fuel cell vehicles play an important role in the development of the H_2 energy industry.

Hydrogen purification techniques for ammonia removal from outlet product gas of ammonia-cracker encompass a range of methods, including membrane-based separation, solid-state absorbents, fluid-type absorbents, natural and biodegradable absorbents, and biological scrubbers. Membrane-based separation techniques offer efficient and selective hydrogen purification.

Metal hydride separation on the base of palladium membranes is reasonably effective in separating gas sources; however, high cost and durability issues related to embrittlement limit industrial application. Commercially available membranes still require care and purification steps to remove contaminants before they reach the final step. Thin film approaches for Pd membranes will reduce cost.

Limitations

Industrial-scale implementation of other new membrane technologies is still hard to foresee. Amine salts are cost-efficient bulk absorbents for the separation of ammonia from cracker outlet gases. After removal of ammonia, however, other gas mixture components, i.e., nitrogen, must be removed in a second step. NH_3 separation from solid-state amine salts must therefore be combined with other purification approaches to finally obtain fuel cell quality H_2. Introduction of a second stage of H_2 purification (after the solid-state purifier) will, however, be associated with additional costs.

Bandlamudi, G. C., Wetegrove, M., Warr, L. N., Wartmann, J., & Kruth, A. (2024). Fine gas purification approaches for high purity hydrogen production from ammonia. *Energy Technology*. https://doi.org/10.1002/ente.202301023

Hyundai Engineering Launches High Purity Hydrogen Production Using Ammonia

Hyundai Engineering, a plant engineering affiliate of Hyundai Motor Group, is making forays into the high purity hydrogen production business using ammonia, which is widely seen as a next-generation eco-friendly raw material. The company said that it had signed an investment agreement with local startup AAR to promote the commercialisation of an 'ammonia decomposition hydrogen production system.'

The system produces high-purity (99.99 percent) hydrogen by decomposing ammonia through a spontaneous electrochemical reaction without generating carbon dioxide. The ammonia decomposition hydrogen production method developed jointly by Hyundai Engineering and AAR can produce hydrogen with minimal energy input by decomposing ammonia in the state of aqueous solution through a spontaneous electrochemical reaction.

Unlike existing production methods, this system can produce high-purity hydrogen without a separate hydrogen separation process. Since ammonia is not bulky, the hydrogen production system with a size equivalent to one container can produce 300 kilograms of hydrogen a day, thereby offering higher price competitiveness.

Link:

https://chemindigest.com/hyundai-engineering-launches-high-purity-hydrogen-production-using-ammonia/

EVENTS

World Hydrogen MENA 2024



Date: **February 26 @ 8:00 am - February 29 @ 5:00 pm UTC+0**

Venue: Dubai, UAE

The event brings together the entire hydrogen value chain across MENA and the rest of the world to accelerate global clean hydrogen development. With favourable geographic conditions for renewables and an established traditional energy export sector, the region has an exceptional opportunity to become a global clean hydrogen powerhouse.

Building on the success of our 2022 & 2023 congresses and coming just a few short months after COP28, our 2024 programme will feature 100+ expert speakers and 500 attendees from across MENA, Europe and Asia, coming together to tackle the latest developments, challenges and opportunities facing hydrogen in the region.

Key topics include:

- Compiling net zero strategies across the region
- How to secure finance and investment on your projects
- Discover how to generate local demand and guarantee offtake agreements domestically and internationally
- Scaling-up to giga scale projects for export
- Hydrogen storage and distribution strategies

Link:
https://www.worldhydrogenmena.com/event/67c9368f-17eb-4b0e-9a54-6fd5aab88dcc?amp=%2c&utm_campaign=partner_listing&utm_medium=affiliate&utm_source=HydrogenCentral

INDUSTRY NEWS

Chinese carmaker plans world's biggest green hydrogen-to-methanol project

A subsidiary of Chinese auto company Geely has secured approvals for a green methanol project that could reach 100 million tonnes of annual production capacity, requiring about 20 million tonnes a year of green hydrogen, according to local reports.



https://www.hydrogeninsight.com/production/chinese-carmaker-plans-world-s-biggest-green-hydrogen-to-methanol-project/2-1-1586770

Hexagon Purus ASA: Hexagon Purus opens new hydrogen infrastructure and systems manufacturing hub in Weeze, Germany

Hexagon Purus ASA: Hexagon Purus opens new hydrogen infrastructure and systems manufacturing hub in Weeze, Germany. Hexagon Purus, a world leading manufacturer of zero-emission mobility and hydrogen infrastructure solutions, has expanded its primary manufacturing facility in Weeze, Germany for engineering and production of hydrogen infrastructure products including systems for distribution, refueling and stationary storage. Hexagon Purus is ramping up its capacity to meet growing customer demand for hydrogen infrastructure solutions as the world transitions to clean energy sources. The existing 11,000m2 state of the art facility in Weeze is now expanded to 16,000m2. The capacity expansion approximately doubles Hexagon Purus' annual production capacity of type 4 high-pressure hydrogen infrastructure solutions.
0QJ RT TG: 0,787 Euro 0 (0,51 %) (finanznachrichten.de)

Giant Green Hydrogen Energy Islands To Host 100 Gigawatts Of Offshore Wind

The offshore wind industry is expected to pick up steam over the next 25 years with 500 gigawatts in the water by 2050. As for where all those gigawatts will go that's an open question. New onshore facilities and transmission lines will have to suck up all that power and hand it off to somebody, somewhere, and that means a whole new battle over land use. Or not, as the case may be. A new venture has emerged with an ambitious proposal to build uncork the looming bottleneck with a network of 10 offshore green hydrogen plants.



https://cleantechnica.com/2024/01/21/green-hydrogen-offshore-wind-energy-north-baltic-sea/

BP Ventures into Green Hydrogen Production in a Strategic Move

In a noteworthy strategic move, BP, a prominent global player in the oil and gas industry, is actively broadening its portfolio to incorporate green hydrogen—an environmentally sustainable fuel source with the potential to substantially curtail carbon emissions. Green hydrogen production hinges on the electrolysis of water, utilizing electricity derived from renewable sources like wind and solar power. This shift towards investing in green hydrogen aligns with BP's overarching strategy to metamorphose from a traditional oil company into an integrated energy entity. This article delves into BP's active engagement in green hydrogen initiatives, assesses the ramifications for the energy sector, and offers insights into the challenges and prospects associated with this transformative endeavor. BP has unmistakably underscored its dedication to green hydrogen through various projects and partnerships. Collaborating with Orsted, a Danish energy firm, BP is actively involved in the development of a substantial green hydrogen production facility in Germany.
https://www.chemanalyst.com/NewsAndDeals/NewsDetails/bp-ventures-into-green-hydrogen-production-in-a-strategic-move-24677

EVENTS

SMART ENERGY WEEK 2024



Date: 28 February, 2024 (Wed)- 1 March, 2024 (Fri)

Venue: Tokyo Big Sight, Japan

(Tokyo Big Sight 3 Chome-11-1 Ariake, Koto City Tokyo, 135-0063 Japan+)

ORGANIZER:
RX Japan Ltd.
Email:
wsew.jp@rxglobal.com

SMART ENERGY WEEK gathers a full range of renewable energy technologies such as hydrogen and fuel cells, solar power, rechargeable batteries, smart grids, wind power, biomass, zero-emission thermal power generation, etc.
Smart Energy Week is an exhibition where the latest technologies, information, and people gather to accelerate business in the energy industry.
Register now– https://www.wsew.jp/spring/en-gb.html

SMART ENERGY WEEK consists of-

- H2 & FC EXPO (Formerly FC EXPO) 2024 [March] - 21st Int'l Hydrogen & Fuel Cell Expo
- PV EXPO 2024 [March] - 18th Int'l Photovoltaic Power Generation Expo
- BATTERY JAPAN 2024 [March] - 16th Int'l Rechargeable Battery Expo
- 15th SMART GRID EXPO [March]
- WIND EXPO 2024 [March] - 13th Int'l Wind Energy Expo
- 9th BIOMASS EXPO
- ZERO-E THERMAL EXPO - 8th Zero Emission Thermal Power Generation Expo

Link:
https://www.wsew.jp/spring/en-gb.html

INDUSTRY NEWS

Plug Power jumps on govt loan, liquid green hydrogen production start

Plug Power (PLUG.O), opens new tab said that it has secured over $1 billion in government funding and started producing liquid green hydrogen at its Georgia plant, sending the company's shares up about 20% in morning trade. The hydrogen fuel cell firm said it has finalized a term sheet negotiation with the U.S. Department of Energy (DoE) for a $1.6 billion loan facility. The company has been facing liquidity issues amid supply challenges in the liquid hydrogen market in North America, and had raised going concern doubts in November. It also planned a $1 billion equity raise earlier this month.
"This funding, when received, will support the development construction and ownership of up to six hydrogen production facilities, significantly advancing green hydrogen deployment in the United States," CEO Andrew Marsh said during an investor call.
https://www.reuters.com/markets/commodities/plug-power-starts-liquid-green-hydrogen-production-2024-01-23/

IEA downgrades green hydrogen growth forecast

The IEA's 2023 annual renewables report constitutes bad news for green hydrogen, with 2023 forecasts for capacity growth significantly more gloomy than the previous year's.
While almost all regions are still expected to increase the amount of renewable energy capacity dedicated to hydrogen production by 2028, the pace of growth is now less optimistic than in the 2022 report. The 2023 forecast is 35 per cent lower than in 2022 "due to downwards revisions for all regions except China".
In 2023, the pace of bringing planned projects to final investment decisions was "slow", finds the global energy watchdog, due to a lack of off-takers and higher production costs caused by rising inflation. Of the 360GW of renewable energy-powered electrolyser projects due to come online before 2030, just 3 per cent (12GW) have reached financial close or started construction, the IEA finds.
https://www.meed.com/iea-significantly-downgrades-green-hydrogen-growth-forecast

New type of water splitter could make green hydrogen cheaper

To wean itself off fossil fuels, the world needs cheaper ways to produce green hydrogen—a clean-burning fuel made by using renewable electricity to split water into hydrogen and oxygen. Now, researchers report a way to avoid the need for a costly membrane at the heart of the water-splitting devices, and to instead produce hydrogen and oxygen in completely separate chambers.
As a lab-based proof of concept, the new setup—reported this month in Nature Materials—is a long way from working at an industrial scale. But if successful, it could help heavy industries such as steelmaking and fertilizer production reduce their dependence on oil, coal, and natural gas.
"This is an innovative concept," says Shannon Boettcher, a chemist at the University of Oregon who was not involved with the new study. Boettcher adds that the new design appears to work efficiently with variable amounts of electricity, an advantage that could make it easier to pair with the intermittent power supplied by wind and solar farms.
https://www.science.org/content/article/new-type-water-splitter-could-make-green-hydrogen-cheaper

Nickel, cobalt may help produce hydrogen from urea

Researchers at the Worcester Polytechnic Institute in the US have developed a material to remove urea from water and potentially convert it into hydrogen gas. By building this material of nickel and cobalt atoms with carefully tailored electronic structures, the group has unlocked the potential to enable these transition metal oxides and hydroxides to selectively oxidize urea in an electrochemical reaction. In 2021, around 180 million metric tons of urea were produced worldwide. But urea-rich agricultural runoff and municipal wastewater discharge cause eutrophication–harmful algal blooms and hypoxic dead zones that adversely impact the aquatic environment and human health. At the same time, the unique characteristics of urea make it a potential hydrogen storage medium that could offer viable on-demand hydrogen production. For instance, urea is non-toxic, has high water solubility, and has high hydrogen content (6.7% by weight). Thus, urea electrolysis for hydrogen production is more energy-efficient and economical than water electrolysis.
https://www.mining.com/nickel-cobalt-may-help-produce-hydrogen-from-urea/

EVENTS

H2POLAND & NetZero Forum 2024



Date: 24 April – 25 April, 2024
Venue: MTP Poznań Expo Głogowska 14 Poznań, 60-734 Poland.
ORGANIZER: Grupa MTP
Email: h2poland@grupamtp.pl

Central European Hydrogen Technology Forum H2POLAND and Central European Decarbonization Forum NetZero are the first trade fair in Poland and Central and Eastern Europe devoted entirely to hydrogen and decarbonization technologies. The forums are meetings where discussions about the future of decarbonization and the European economy play a key role.

Why exhibit at H2POLAND and Net Zero?

- Take part in the largest and most prestigious decarbonization event in Central Europe
- Present your products and services
- Meet new potential customers and exchange insights in a highly targeted environment
- Present your brand as a leader in the growing energy transition market
- Save costs and time necessary to discover and establish new business opportunities
- Be part of the decarbonization in Central and Eastern Europe

H2POLAND & NetZero Forum is visited by industry representatives:

- Heavy industry and manufacturing
- Transportation, fuel cells, storage and batteries
- Government and self-government officials
- Economy, investment and trade
- Transmission, distribution and power generation
- Suppliers of process parts and systems
- Engineering, procurement and construction
- Representatives of organizations, chambers and trade associations

Link:
https://h2poland.com.pl/en/

INDIA NEWS

Green Hydrogen Dreams: Big Businesses Eye $1 Per-Kg Goal, But Hurdles Linger

Recently, two Indian big businesses sounded the alarm on the high production costs inhibiting the scalability of green hydrogen as a clean fuel. In a blog post for the World Economic Forum (WEF), Gautam Adani, the head of Adani Group, said the cost of green hydrogen must significantly decrease from the current $3-$5 per kg to $1 per kg for widespread adoption. Similarly, Reliance Industries Ltd (RIL) chairman and managing director Mukesh Ambani, has outlined his company's vision to bring down the cost of hydrogen to less than $1 for 1 kg in 10 years — the '1-1-1 target' for GH2 (green hydrogen). Green hydrogen is the hydrogen produced via electrolysis, the splitting of water into hydrogen and oxygen with electricity generated from renewable energy sources, such as solar or wind. It is essential for decarbonisation: to replace fossil fuels in steelmaking, ammonia production for fertilisers and possibly shipping and trucking — processes which are difficult to electrify. Producing green hydrogen is expensive as it entails considerable capital cost in terms of the manufacture of electrolysers, the amount of fresh water and electricity, which makes up 60-70 per cent of green hydrogen's cost. Yet, for green hydrogen to fulfil these roles, its production cost must decline similarly to renewables. As an illustration, the cost of electricity generated from solar panels in 2011 stood at Rs 15 per kilowatt-hour and has now plummeted to Rs 1.99 per unit — the lowest in the world.
https://www.mercomindia.com/gensol-epc-contract-green-hydrogen

Cummins Group in India showcases fuel-agnostic platform at SIAT 2024

Cummins Group in India (Cummins), one of the leading power solutions technology providers in the country, is participating in the Symposium on International Automotive Technology (SIAT) 2024 in Pune. Aligned with its Destination Zero decarbonization strategy, Cummins is set to showcase Made in India, industry-first, next-generation fuel-agnostic platform, along with the innovative Single Module Aftertreatment system at the event. Destination Zero is Cummins' strategy to go further and faster in minimizing the greenhouse gas (GHG) and air quality impacts of its products. Anchored in its commitment,
https://www.indiatvnews.com/tamil-nadu/news-industries-minister-rajaa-on-developing-green-hydrogen-hub-electric-vehicle-conclave-mk-stalin-latest-news-2023-11-23-904092

Cummins is pursuing a dual-path approach – acting today to reduce emissions from internal combustion engines while simultaneously investing in the development of new, zero-emissions products, to help customers navigate through the energy transition.



https://auto.economictimes.indiatimes.com/news/auto-technology/cummins-group-in-india-showcases-fuel-agnostic-platform-at-siat-2024/107115757

Budget 2024: Navigating India's hydrogen challenge for Sustainable Energy Future

Additional incentives to taper the operating costs, transmission, and distribution (T&D) costs, wheeling charges for electricity and specific local duties and taxes like goods and service taxes can also be provided through specific policies and incentives. The Union Budget 2023 made substantial inroads in the green hydrogen sector by planning an outlay of INR 19700 crore particularly under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Programme, which alone had an allocation of INR 17,490 crore. India's pursuit of creating a future propelled by sustainable energy has led to significant impetus on green hydrogen, which has been identified as a key element in decarbonizing various industries. The upcoming 2024 Union Budget is being eagerly awaited as it holds the potential to address critical challenges faced by the green hydrogen sector, particularly in the manufacturing process. Since hydrogen has a pivotal role to play in decarbonisation of refinery and fertilizer sectors, addressing the price point in relation to production of green hydrogen can be provide a key lever to bring in a wider adoption of the fuel. Industrial representatives have thus asked for support and incentives to reduce cost of production of green hydrogen to around $1 per kilogram, from the current range of $3-$5 per kilogram. Essentially, benefits and sops to reduce the cost of electrolysers and supply of electricity.
https://energy.economictimes.indiatimes.com/news/renewable/budget-2024-navigating-indias-hydrogen-challenge-for-sustainable-energy-future/107104276

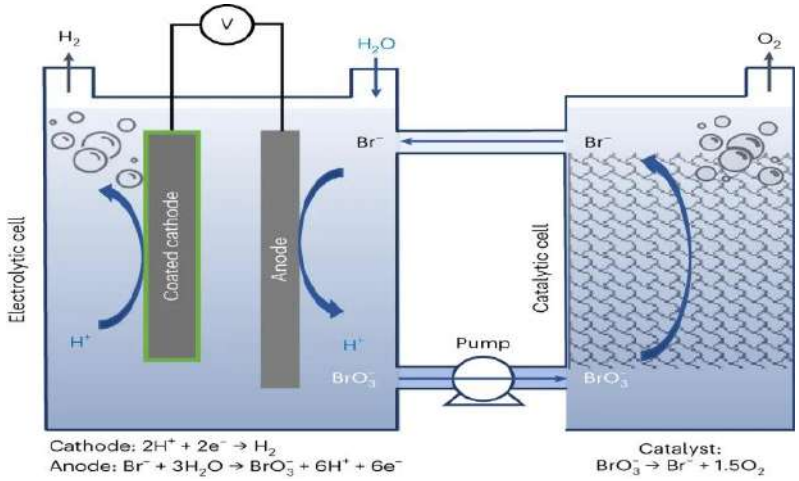
Slobodkin, I. *et al.*

Electrochemical and chemical cycle for high-efficiency decoupled water splitting in a near-neutral electrolyte

https://doi.org/10.1038/s41563-023-01767-y

Abstract:

Green hydrogen produced by water splitting using renewable electricity is essential to achieve net-zero carbon emissions. Present water electrolysis technologies are uncompetitive with low-cost grey hydrogen produced from fossil fuels, limiting their scale-up potential. Disruptive processes that decouple the hydrogen and oxygen evolution reactions and produce them in separate cells or different stages emerge as a prospective route to reduce system cost by enabling operation without expensive membranes and sealing components. Some of these processes divide the hydrogen or oxygen evolution reactions into electrochemical and chemical sub-reactions, enabling them to achieve high efficiency. However, high efficiency has been demonstrated only in a batch process with thermal swings that present operational challenges. This work introduces a breakthrough process that produces hydrogen and oxygen in separate cells and supports continuous operation in a membraneless system. We demonstrate high faradaic and electrolytic efficiency and high rate operation in a near-neutral electrolyte of NaBr in water, whereby bromide is electro-oxidized to bromate concurrent with hydrogen evolution in one cell, and bromate is chemically reduced to bromide in a catalytic reaction that evolves oxygen in another cell. This process may lead the way to high-efficiency membraneless water electrolysis that overcomes the limitations of century-old membrane electrolysis. Hydrogen produced by water splitting using renewable electricity is key to achieve net-zero carbon emissions. Decoupling hydrogen and oxygen evolution reactions during electrolysis is attractive but efficiency and operational challenges remain. A process producing hydrogen and oxygen in separate cells and supporting continuous operation in a membraneless system is now proposed.



Tsai, ZN. *et al.*

Pro-aromatic Dihydroquinazolinones - From Multigram Synthesis to Reagents for Gram-scale Metallaphotoredox Reactions

https://doi.org/10.1002/asia.202301004

Abstract:

Dihydroquinazolinone (DHQZ) has recently been harnessed as a ketone-derived pro-aromatic reagent extensively employed in (metalla) photoredox reactions as versatile group transfer agents. In this work, we outline a column chromatography-free protocol for the multigram-scale synthesis of pro-aromatic DHQZs as well as its use in a gram-scale nickel/photoredox dual-catalyzed cross-coupling in single-batch, photoflow, and simultaneous multiple smaller batches. While the single-batch approach leveraged moderate yields, a simple plug-flow photoreactor also exhibited amenable productivity (up to 45 % yield) despite the use of a heterogeneous base. Meanwhile, performing the metallaphotoredox-catalyzed reaction in multiple smaller batches in an improvised photoreactor facilitated high yields of up to 59 % and good reproducibility, implying a convenient alternative in the absence of photoflow setups. This study reports the synthesis of 2,2-disubstituted dihydroquinazolinone (DHQZ) from diketone in a multigram scale (up to 16 grams yield). DHQZ is also applied in the detailed gram-scale metallaphotoredox-mediated benzoylation of aryl halides through a single batch, photoflow, and multiple smaller batches protocol image.

Armaroli, N. *et al.*

Hydrogen as an energy carrier: constraints and opportunities

https://doi.org/ 10.1515/pac-2023-0801

Abstract:
The use of molecular hydrogen (H-2) in the energy sector faces several technical and economic hurdles related to its chemical and physical properties, particularly volumetric energy density and mass. The production, transport and storage of hydrogen, both in gas and liquid form, are intrinsically inefficient and expensive. Moreover, the mass production of green hydrogen would preferably use surpluses of renewable electricity that will be largely available not before the next decade. To fulfill the great potential of H-2 in the decarbonization of the global economy - which should greatly accelerate - applications must be carefully selected, favoring for instance hard-to-abate sectors with respect to low-temperature residential heating or long-distance transportation versus light duty vehicles. In the meantime, research on production, transportation and storage of H-2 must substantially leap forward.

Jordan, T.

Multimodal Hydrogen Hub in the Fessenheim Innovation Region

https://doi.org/10.1002/cite.202300240

Abstract:
Within the framework of a binational feasibility study, concepts for the introduction of sustainable technologies in the innovation region of Fessenheim and, based on these, various approaches to action for Franco-German demonstration projects were developed. The overarching goal is the development of a sustainable and future-oriented CO2-neutral economic region. The transformation of society and the economy towards a renewable energy supply and sustainable use of resources, combined with the creation of future-oriented jobs, is strongly promoted by the use of hydrogen as an energy carrier. Sustainably produced "green" hydrogen enables the almost immediate substitution of fossil hydrogen in industrial processes, the seasonal storage of renewable electricity and the flexible and efficient coupling of different energy sectors. The proposed pilot projects cover the entire value chain with green hydrogen, building on the specific regional characteristics and conditions.

Khalvati, MA.

Marginal lands as an important potential to produce biohydrogen

https://doi.org/ 10.1016/j.ijhydene.2022.04.080

Abstract:
One of the promising approaches for hydrogen production is agricultural biomass crops conversion, which is a renewable-based clean and abundant resource. The main objective of the current study is to assess the contribution of soil beneficial microbes in improving salt tolerance along with the evaluation of possible hydrogen production from sorghum plant biomass. High salinity concentrations in soil stimulate plant roots to enhance the plant desire for symbiosis and association with vesicular-arbuscular mycorrhizal fungi (VAM). Among the VAM species, *G.mosseae* is one of the significant and effective VAM species, which contribute to plant salinity resistance by expanding leaf salt potential and accumulating nutrients leaves in comparison to other soil microorganisms in plants. Morphological characters of these plants show a higher biomass production during saline conditions up to 2000 kg/ha. Biomass production in the specific alternative thermochemical and biological processes are suggested and finally, gasification processes were chosen as the optimal method which can be practically applied to produce hydrogen from sorghum plants. By producing 10,000 kg biomass in three harvesting periods of Sorghum, almost 3000 kg biomass for bio-hydrogen production can be obtained. This could be an appropriate resource for obtaining biofuels, particularly bio-hydrogen from 3 million hectares of unbearable or poor quality lands in a country such as Turkey by producing 9 million tons of Hydrogen. Obtained data gives an overview of these technologies for hydrogen production from biomass yielding to 28.2 gH2/100 g biomass or 33.17 to 44.26 (gH2). Producing green hydrogen from plants biomass is relatively cheaper, compared to chemo-industrial methods. Achieving the immobilization factors in bioprocesses for microorganisms is obtained in this study. Consequently, hydrogen productivity of the bioprocess can be enhanced by using porous support materials which provide high biomass holding capacity and help better gas retrieve in the process.

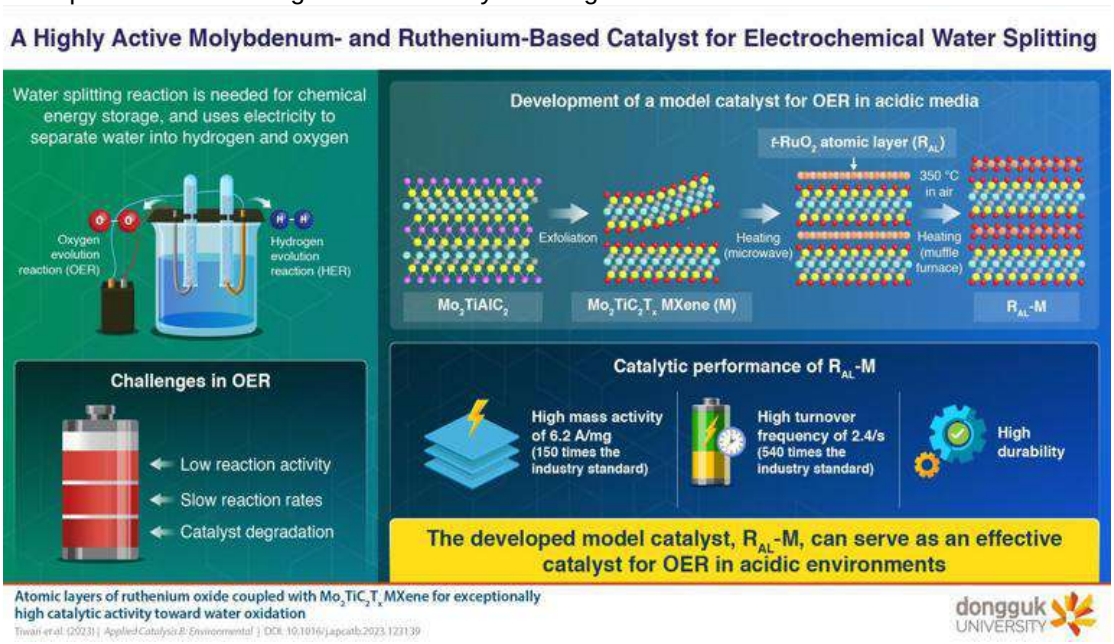
Hydrogen Digest

A KNOWLEDGE PRODUCT OF CSIR HYDROGEN TECHNOLOGY PROGRAM

ISSUE: 70
FEBRUARY, 2024

Beyond Carbon: Scientists Design A New Catalyst to Generate Green Fuel from Water

Globally, the transition to greener sources of energy requires the use of efficient catalysts for fuel generation reactions. Now, scientists at Dongguk University have synthesized an efficient catalyst for the oxygen evolution reaction — a component of water-splitting process that produces hydrogen and oxygen. The catalyst, synthesized using molybdenum and ruthenium, exhibits high activity, reaction rates, and durability, opening doors to the cost-effective and large-scale production of next-generation catalysts using diverse materials.



Their study was made available online on July 29, 2023, and published in Volume 339 of Applied Catalysis B: Environmental on December 15, 2023. According to Prof. Han, “Carbon materials are crucial for commercial acidic polymer electrolyte membrane water electrolyzers. At high voltages, however, carbon atoms degrade in strongly acidic media, necessitating the need for new catalyst materials beyond carbon materials.”

The study involved implanting ruthenium oxide into a two-dimensional molybdenum carbide to create a catalyst (Mo2TiC2Tx MXene) with high mass activity, turnover frequency, and durability. Calculations also indicated that the ruthenium sites had a strong affinity towards oxygen species, which enhanced the reaction. These findings are significant, as the global aim is to achieve 80% renewable electricity by 2050. Hydrogen and oxygen have diverse industrial applications, spanning clean fuel, power generation, chemical production, and life-support systems. Notably, more than 90% of hydrogen is in petroleum recovery and refining (47%) and ammonia production (45%) alone. The transportation sector will also benefit. Elaborating on this, Dr. Tiwari says, “The need for decarbonizing the transportation sector makes hydrogen a promising alternative. Going ahead, fuel cell vehicles are expected to efficiently convert hydrogen into electrical energy, emitting only water, with longer driving ranges than battery electric vehicles. Additionally, hydrogen fuel cells do not need recharging and don’t degrade if hydrogen fuel is present, unlike in batteries,” observes Dr. Tiwari.

This study thus serves as a guide for researchers to create new catalysts for acidic water oxidation. It also sheds light on achieving cost-effective, large-scale catalyst production using diverse materials, such as dual-transition metal catalysts.

https://www.msn.com/en-gb/money/technology/beyond-carbon-scientists-design-a-new-catalyst-to-generate-green-fuel-from-water/ar-BB1hwTqo?ocid=finance-verthp-feeds#

Atomic layers of ruthenium oxide coupled with Mo2TiC2Tx MXene for exceptionally high catalytic activity toward water oxidation

Progress in acidic water splitting has remained limited because of low oxygen evolution reaction (OER) activities, sluggish reaction kinetics, and severe catalyst degradation. Thus, a highly active and durable OER catalyst is required for the commercialization of acidic water electrolyzers. The t-phase ruthenium oxide atomic layers implanted on Mo2TiC2Tx MXene (RAL-M) as a model electrocatalyst for the OER in acidic media exhibits a remarkable mass activity (6.2 A mg^{-1}), excellent turnover frequency (TOF; 2.4 s^{-1}), and negligible loss of durability after 22 h in a two-electrode cell configuration. The mass activity and TOF of RAL-M are 150 times (RuO2-Premetek Co.) and 540 times (RuO2-Sigma-Aldrich) greater than the industrially adopted electrocatalysts at pH 0.48. Computational calculations show that the ruthenium active sites of RAL-M have a strong affinity to oxygen species (e.g., OH*, O*, and OOH*), which efficiently adapts water dissociation and favors both the adsorbate evolution and lattice oxygen mechanistic pathways to accelerate the OER.

Link:

Tiwari, J. N., Umer, M., Bhaskaran, G., Umer, S., Lee, G., Kim, M. G., Lee, H.-K., Kumar, K., Vilian, A. T. E., Huh, Y. S., & Han, Y.-K. (2023). Atomic layers of ruthenium oxide coupled with Mo2TiC2Tx MXene for exceptionally high catalytic activity toward water oxidation. Applied Catalysis B: Environmental, 339, 123139. https://doi.org/https://doi.org/10.1016/j.apcatb.2023.123139

EVENTS

Connecting Green Hydrogen APAC 2024

Empowering the Green Hydrogen Transition in Australia and APAC

Date: 9-11 July 2024

Venue: MCEC, Melbourne

The largest and most influential Green Hydrogen event in Australia and the APAC region. Co-located with Australia Wind Energy 2024, this momentous gathering will take place at MCEC Melbourne, uniting clean energy enthusiasts and industry leaders under one roof.

Link:
https://www.apac.gh2events.com/

HyVolution Paris, 7th Edition

Date: 30th, 31st Jan and 1st Feb 2024

Venue: Paris Expo, Porte De Versailles, France

An Economic, a Political, and an International Symposium

Link:
https://landing.hyvolution.com/2024/?utm_campaign=Expobiogaz_save_the_date&utm_medium=email&utm_source=email_visiteurs

INDUSTRY NEWS

BASF and Envision Energy to accelerate conversion of green hydrogen and CO2 into e-methanol

Backed by their respective expertise, the two companies aim to optimize the process of producing e-methanol from green hydrogen and CO2, paving the way for a more sustainable energy landscape. This collaboration will see BASF provide its cutting-edge SYNSPIRET catalyst technology, which Envision Energy will integrate with its innovative energy management system. The two organisations plan to demonstrate the viability of the advanced process design next year, at Envision Energy's Chifeng site in Inner Mongolia, China.

Envision Energy will design a process package that maximizes the efficiency of the catalyst technology while fully enabling the dynamic conversion of green hydrogen and CO2 into e-methanol, in sync with the onstream time of wind power. Envision Energy will leverage its pioneering AIoT (Artificial Intelligence of Things) platforms to optimize the novel, dynamic mode of chemical plant operation.

https://www.autocarpro.in/news-international/basf-and-envision-energy-to-accelerate-conversion-of-green-hydrogen-and-co2-into-e-methanol-118912

Green Hydrogen Pioneer Plug Power To Build 6 Plants with Big US Loan

The U.S. Energy Dept. is set to finalize by the end of March a $1.6-billion loan to clean energy technology firm Plug Power Inc. to build six U.S. green hydrogen production plants, company executives told analysts and investors on Jan. 23. Construction would start in the second half of 2024, with plans to produce 500 tons per day domestically by the end of 2025.



https://www.enr.com/articles/58068-green-hydrogen-pioneer-plug-power-to-build-6-plants-with-big-us-loan

QLD Government to invest $70m to develop Townsville Hydrogen Hub

The Federal Government is investing up to $70 million to develop the Townsville Region Hydrogen Hub in north Queensland, creating regional jobs and supporting Australia's future as a renewable energy powerhouse.

The project delivers on the Government's election commitment to establish a hydrogen hub in North Queensland.

It will create at least 200 direct job opportunities for local electricians, plumbers, fitters and concreters during construction, as well ongoing jobs in technical and engineering roles.



https://www.manmonthly.com.au/qld-government-to-invest-70-million-to-develop-townsville-hydrogen-hub/

Omega Seiki Mobility plans hydrogen-powered SCVs with French technology

Domestic electric mobility firm Omega Seiki Mobility (OSM) plans to manufacture green hydrogen-powered small commercial vehicles, including three-wheelers, in the country and has partnered with a French company.

The joint entity Hydrogen Intelligence SA will be based in France, with a subsidiary in India. OSM Founder Uday Narang on Tuesday told PTI that the entity is looking to raise USD 25 million from the US and European markets to expand its business.

Hydrogen Intelligence SA will be showcasing a hydrogen-powered three-wheeler at the ninth edition of the three-day hydrogen show, Hyvolution, which commenced in Paris on Tuesday, Hydrogen Intelligence co-founder and OSM founder Uday Narang said.

https://www.moneycontrol.com/news/business/omega-seiki-mobility-plans-hydrogen-powered-scvs-with-french-technology-12160381.html

EVENTS

4th Hydrogen Congress for Latin America & the Caribbean

H2LAC 2024

Date: June 5 - 7, 2024

Venue: W Santiago, Chile

The region's largest green H2 event - H2LAC - to Chile and to the leader of Latin America's hydrogen industry. Chile launched its hydrogen strategy over two years ago and has since announced more than 60 projects. The country is squarely positioned, like H2LAC, at the vanguard of hydrogen development in LAC.

Zooming out, the region as a whole is moving forward faster than anticipated. National roadmaps have recently been published in Argentina, Panama and Ecuador, and Brazil is studying $30 billion in low-carbon hydrogen projects. But while the opportunities are huge, key challenges still remain, not least the development of local demand to sustain and scale the industry.

Co-hosted by the Inter-American Development Bank, H2LAC is the hub for this transformative market. Gathering the full ecosystem - from governments and finance providers to off-takers, developers and technology providers - H2LAC is where the market meets, moves and transacts. Join us on the journey. Join us at H2LAC 2024.

Link:

https://newenergyevents.com/h2lac/

INDUSTRY NEWS

Morocco's ONEE Teams up with Nareva & GE Vernova to Convert Laâyoune Power Plant to Green Hydrogen.

Morocco's National Office of Electricity & Drinking Water (ONEE) has partnered with GE Vernova's Gas Power business and Nareva to decarbonize Laâyoune Power Plant, which is powered by three GE Vernova 6B heavy-duty gas turbines. The project, first of its kind in Africa, will enable the North African Kingdom to generate carbon-free electricity using green hydrogen instead of heavy fuel oils. Under an agreement signed lately by the partners, GE Vernova pledges to help Laâyoune Power Plant deliver electricity generated using 100 percent green hydrogen produced at Nareva's Laâyoune wind farm to support Morocco's expansion of renewable installed capacity from its current share of 40% to of 52% by 2030.

ONEE, Nareva and GE Vernova will undertake techno-economic evaluation studies to convert the 99 megawatts (MW) Laâyoune Thermal Power Plant, currently fueled by heavy oil fuel to hydrogen. The study is expected to be completed in two years and consists of exploring an integrated solution that incorporates the full production value chain to deliver 100 percent hydrogen by volume to the gas turbine for peak demand periods.

https://medafricatimes.com/34034-moroccos-onee-teams-up-with-nareva-ge-vernova-to-convert-laayoune-power-plant-to-green-hydrogen.html

Spain can produce around 2.5 million tonnes of green hydrogen per year by 2030, Enagas CEO says

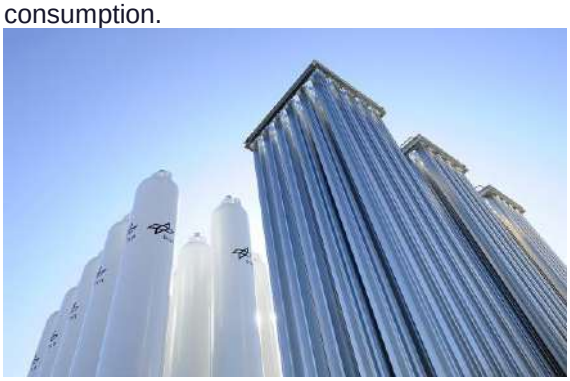
Spain can produce around 2.5 million tonnes of green hydrogen per year and reach a 23.3 gigawatt electrolysis capacity by 2030, Arturo Gonzalo, the CEO of Spanish gas grid operator Enagas (ENAG.MC), opens new tab said on Wednesday, during a conference to disclose the results of a call for interest for projects. He said he based his estimate on existing mature projects. Under this scenario, the expected consumption of green hydrogen would reach 1 million tonnes per year by the end of the decade.

https://www.reuters.com/business/energy/spain-can-produce-around-25-million-tonnes-green-hydrogen-per-year-by-2030-2024-01-31/

Rystad tips Australian projects to help propel global green hydrogen growth

Rystad Energy has countered the International Energy Agency's (IEA) recent "reality check" for the green hydrogen sector, predicting that the momentum behind renewable-based hydrogen will gather pace in 2024 as global renewable energy capacity continues to expand rapidly.

Activity in the clean hydrogen sector is "surging" globally, fueled by maturing policies and early commercial-scale projects, including here in Australia, according to international energy consultancy Rystad Energy. Artem Abramov, head of clean tech research at Rystad Energy, said he expects hydrogen projects will take off in 2024 driven by large-scale projects in Australia as well as the Middle East and Africa, along with maturing policies in Europe and the United States. "2024 promises more than just momentum, it's a year of clarity," Abramov said, noting that several key feasibility studies are to be completed, which he expects will reveal promising new use cases for hydrogen consumption.



https://www.pv-magazine.com/2024/01/29/rystad-tips-australian-projects-to-help-propel-global-green-hydrogen-growth/

Baker Hughes Celebrates New Hydrogen Milestones

With an aim to accelerate its transition into a hydrogen economy, Baker Hughes has successfully achieved several milestones to support its ambitious goal. This includes the launch of a new hydrogen testing facility in Italy for validation of its Nova LT industrial turbines to run blends all the way up to 100 % hydrogen. Florence/Italy – Baker Hughes announced several milestones to support the growth of the hydrogen economy, as part of the company's broader strategy in new energy.

https://www.process-worldwide.com/baker-hughes-celebrates-new-hydrogen-milestones-a-d2d58512991d6b611a64f23fabc7ecab/

EVENTS

Go Hydrogen – 2nd Business Summit



Date: 21-22 February 2024

Venue: Antwerp
HILTON ANTWERP OLD TOWN
Groenplaats 32, 2000
Antwerpen, Belgium

Go Hydrogen is a business summit with a practical, "hands-on" approach that covers all components of the hydrogen value chain: production, storage and transportation, usage (off-takers), and technology.

Hydrogen is often called the "champagne of the energy transition" due to its premium price. Will hydrogen always be the fuel of the future, or will it become the fuel of today within our lifetimes?

At the 2nd Go Hydrogen Summit in Antwerp, there will be discussion about what is needed to build a hydrogen supply chain that is reliable, sustainable, and affordable, what are the barriers and how can one overcome them.

While the primary focus is on green hydrogen projects, but the discussion also includes blue hydrogen and other types.

Link:

https://globuc.com/go-hydrogen/

ReNew mulls Rs 26,400 cr green H2 project

ReNew is planning to invest Rs 26,400 crore for a green hydrogen project in Kerala, according to a report of ET Energy.

The 220-kilo-tonnes-per-annum (KTPA) green hydrogen project will be used to produce 1,100 KTPA of green ammonia, the report added. It will be powered by a 2 GW capacity electrolyser, which is 14,000 million units of power annually from 5 GW to 6 GW renewable energy plants, ETEnergyworld claimed quoting unnamed officials.

The proposed project, near the Vizhinjam port, aims to make the produced green hydrogen suitable for export. It is planned to be executed in three phases, with the first phase having a capacity of 100 KTPA of green hydrogen derivative, followed by phases 2 and 3 with 500 KTPA capacity each. The estimated timeline for each phase is between 36 to 42 months.

The investment amount of INR 26,400 crore excludes the renewable energy captive generation facility. In November 2022, the company also entered into a framework agreement with Egypt for a green hydrogen plant in the Suez Canal Economic Zone, involving an $8 billion investment. This initiative aligns with India's National Green Hydrogen Mission, which aims to establish a 5 MTPA green hydrogen production capacity by 2030 and encourage the export of green hydrogen and its derivatives.

Green hydrogen production, characterized by zero carbon emissions, is considered a preferable method for decarbonizing industries that heavily rely on hydrogen. Presently, 93% of hydrogen consumption occurs in refineries and fertilizers, but by 2030, hydrogen is anticipated to play a significant role in sectors such as steel, mobility, and fuel blending.

https://www.msn.com/en-in/money/markets/renew-mulls-rs-26400-cr-green-h2-project/ar-BB1hpwdL

Maharashtra Inks MoUs for Green Hydrogen Projects Worth ₹2.76 Lakh Crore, Aims to Create 63,900 Jobs

1d

The Maharashtra government signed Memorandums of Understanding (MoUs) for seven projects proposing the production of green hydrogen with an investment of Rs 2,76,300 crore. The projects are expected to create 63,900 jobs in the state. Deputy CM Devendra Fadnavis said, "Maharashtra is the first state to make effective policy on green hydrogen. PM Narendra Modi Ji has aimed to decarbonise India by 2030. Green hydrogen is a technology which will keep balance of environment and energy." He also appealed to citizens to give suggestions on the policy made by the state government. NTPS Green Energy, Avada Geen Hydrogen, Renew E Fuels, Inox Air Products, LNT, Green Tech, JSW Green Hydrogen, Welspun Godavari GH2 are the seven production companies to invest in the state. The total hydrogen production capacity of the seven projects will be 910 KTPA, leading to an annual reduction of 511 crore kg in carbon emission.

MoUs signed to erect a steel plant- Apart from that, the state government has also signed MoUs worth Rs 40,000 crore with ArcelorMittal Nippon Steel India to erect a steel plant with a capacity of 6 MTPA which would create 20,000 direct and indirect jobs.

Maharashtra Inks MoUs For Green Hydrogen Projects Worth ₹2.76 Lakh Crore, Aims To Create 63,900 Jobs (msn.com)

Budget 2024: India needs investment appetite for green energy



The Indian power sector is now at a critical juncture. On the one hand we must meet the growing energy needs of the country, and on the other hand fulfill the ambitious energy transition-related goals. There is an urgent need to increase RE capacity addition from the present level of 15 GW per year to 50 GW per year, along with a tripling of investments. The upcoming Union Budget 2024 is an opportune time to make suitable provisions for increasing the investment appetite in the sector. The expectations are as follows:

-Scaling up finance
-Relaxing norms for improving investment climate
-Streamlining land acquisition process and Right of Way (RoW) issues
-Viability Gap Funding for Battery Energy Storage Systems
-Capital Subsidy for Smart Grid implementation and other technologies
-Reduction in Taxes & Duties for promoting domestic manufacturing
-Boosting R&D and capacity building

https://economictimes.indiatimes.com/industry/renewables/budget-2024-india-needs-investment-appetite-for-green-energy/articleshow/107270249.cms

Tong, Y. and Chen, PZ.

Nanostructure engineering of ruthenium-modified electrocatalysts for efficient electrocatalytic water splitting

https://doi.org/10.1039/d3ta07230d

Abstract:

Electrochemical water splitting is a promising and effective strategy for the production of green hydrogen (H2). However, its energy efficiency and large-scale application for industrial requirements are greatly restricted owing to its sluggish reaction kinetics. The utilization of highly efficient noble metal ruthenium (Ru)-based materials is critical for the improvement of water splitting. Considering the high cost and low reserves of metal Ru, the development of efficient approaches to reduce its usage while improving its catalytic performance is essential. Massive efforts have already been devoted to design advanced Ru-modified electrocatalysts by nanostructure engineering and have achieved significant progress in water splitting. Thus, a comprehensive and fundamental summary is urgent but has not previously been reported. In this review, we present a systematic summary of the nanostructure engineering of Ru-modified electrocatalysts for efficient electrocatalytic water splitting. The current reported effective nanostructure strategies are divided into the design of single-atom sites, doping, alloying and heterogeneous interfacial structural engineering. The internal relationship between material structure and catalytic performance and the in-depth catalytic mechanism of Ru-modified electrocatalysts are further discussed, which may be beneficial for the exploitation of other advanced materials for H2 generation by overall water splitting.

Stiber, S. *et al.*

Racing for Green Hydrogen Economics with Polymer Electrolyte Water Electrolysis - How to Be Achieved

https://doi.org/ 10.1002/cite.202300177

Abstract:

For renewable hydrogen production, polymer electrolyte membrane water electrolysis is the most promising technology. However, the technology is not yet competitive with conventional hydrogen production in terms of cost. The impact of cost reduction options on CAPEX and OPEX is investigated. Depending on the hours of operation, the main cost factor is the production and manufacturing of components or the price of electricity. Clearly a tremendous need to implement low-cost electrolysis cells on a large scale to bring green hydrogen production costs to a level 1-3 euro kg-1 hydrogen.

Hydrogen produced from renewable energies will play a key role in the energy transition as a versatile energy carrier. Polymer electrolyte water electrolysis is the most auspicious technology for hydrogen production. The article provides a solution to the question of how this can be optimized in terms of costs.

Nasser, M. and Hassan, H.

Egyptian green hydrogen Atlas based on available wind/solar energies: Power, hydrogen production, cost, and CO_2 mitigation maps

https://doi.org/ 10.1016/j.ijhydene.2023.09.127

Abstract:

The current work aims to construct an Egyptian Atlas for green hydrogen production uti-lizing water electrolysis powered by the available wind (wind turbines, WTs) and solar (PV panels) energies based on Egypt's climatic conditions. Different maps are constructed, including the power density (kWh/m2), hydrogen density (kg/m2), production cost ($/kg), and CO2 mitigation (kgCO2/m2). The weather data (Solar radiation, ambient temperature, and wind speed) of all 27 Egyptian governorates are fed into MATLAB code for one-year analysis. Five scenarios are adopted for power production having the same used land surface: the system is operated by PV only (S1), WTs only (S2), area of PV equal to WTs (S3), area of PV double WTs (S4) and area of PV half WTs area (S5). The results show that S1 has the highest hydrogen production, followed by S4, while S2 has the lowest value. The highest power and hydrogen densities are 378.4 W/m2 and 57.1 kg/m2 in Sohag Gover-norate, and the lowest values are 7.342 W/m2 and 0.12 kg/m2, respectively, in New Valley Governorate. The lowest LCOH of each configuration is 3.27 $/kg in Sohag for S1, 1.017 $/kg in Red Sea for S2, 2.60 $/kg in Red Sea for S3, 2.91 $/kg in Red Sea for S4 and 2.14 $/kg Red Sea for S5. Finally, the amount of CO2 mitigation ranges from 1.16 to 57.1 kgCO2/m2. Egypt is an excellent opportunity for lower-cost investment in green hydrogen production

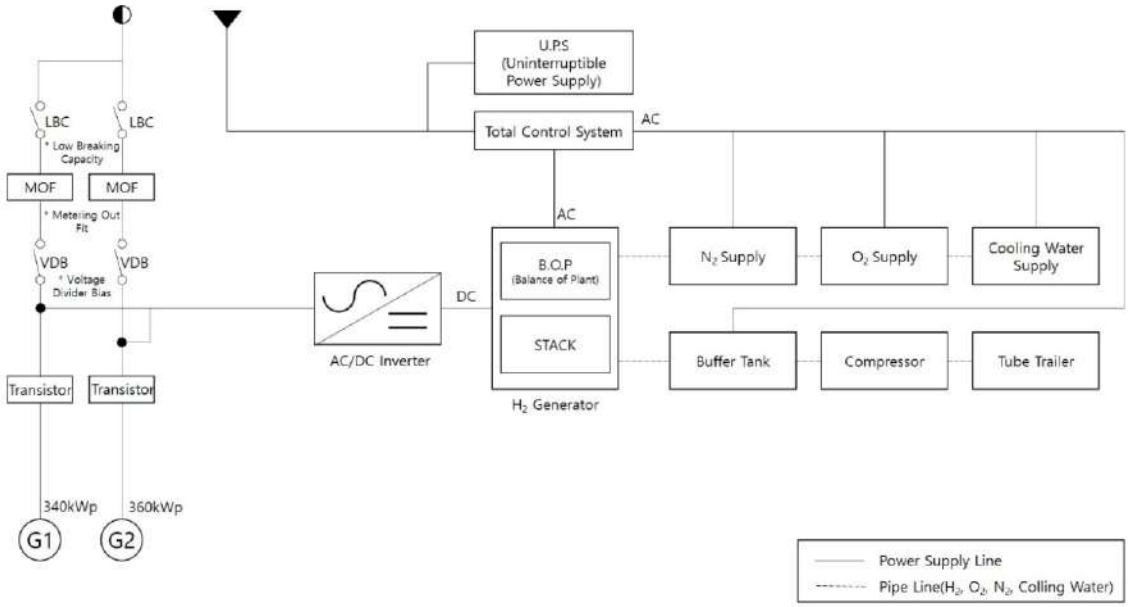
Song, H. *et al.*

Design and Optimization of an Alkaline Electrolysis System for Small-Scale Hydropower Integration

https://doi.org/ 10.3390/en17010020

Abstract:

Alkaline electrolysis systems are currently considered to be suitable for large-scale hydrogen production. Previous research has primarily focused on integrating renewable energy sources such as solar and wind into water electrolysis systems. However, intermittent issues stemming from the sporadic nature of renewable energy sources have led to the introduction of energy storage systems (ESSs) to address these intermittent challenges. Extensive research has been conducted on the efficiency and operational aspects of these systems. In contrast to other renewable energy sources, hydropower offers the advantages of stable output and high utilization, making it a promising solution for overcoming intermittent issues. In this study, we propose the design of an optimized alkaline electrolysis system tailored for small-scale hydropower generation. This approach allowed us to confirm the efficiency of a small-scale hydropower-based hydrogen production facility and the analysis of hydrogen production costs under diverse scenarios. Notably, the optimal selling price per kilogram of hydrogen was determined to be USD 15.6 when the operational time exceeded 20 h, albeit indicating a challenging market supply. Under the consideration of various scenarios and government subsidies, this study revealed that a USD 10/kgH2 subsidy or 24 h of continuous operation achieved break-even points in the sixth and eighth years, respectively. Ultimately, the findings underscore the necessity for essential measures, including government backing and technological advancements in small-scale hydropower facilities, to enhance the economic viability of the green hydrogen market in South Korea.



Sutar, SV. *et al.*

Hydrogen production using hybrid six-step copper-chlorine thermochemical cycle: Energy and exergy analyses

https://doi.org/ 10.1016/j.ijhydene.2023.10.111

Abstract:

The hybrid thermochemical copper-chlorine (Cu-Cl) cycle for water splitting, developed as a novel approach to produce green hydrogen, has gained greater attention. A series of close-loop reactions makes the process environmentally friendly. A newly developed hybrid six-step Cu-Cl cycle consists of thermochemical, electro-chemical, and a unit operation of spray drying. The present paper analyzes the configuration of the six-step Cu-Cl cycle thermodynamically. Studies on many factors are carried out to determine the cycle's total energy and exergy efficiency. The modeling and simulation of the six-step process was done by Aspen Plus. The six-step cycle was found to have an energy and exergy efficiency of 38.94 % and 52.74 %, respectively. The effect on exergetic efficiency with ambient temperature and cycle temperature variation was also investigated. The enhancement in the effectiveness of six steps Cu-Cl cycle could be possible from the current study analysis using thermal recovery and minimizing exergy destructions.

Program at a Glance

Vertical	Research Focus	Labs Involved
Vertical 1	Hydrogen Generation	• *Advanced Materials And Process Research Institute* (AMPRI), • *Central Electrochemical Research Institute* (CECRI), • *Central Electronics Engineering Research Institute* (CEERI), • *Central Glass and Ceramic Research Institute* (CGCRI), • *Central Mechanical Engineering Research Institute* (CMERI), • *Central Scientific Instruments Organisation* (CSIO), • *Institute of Minerals and Materials Technology* (IMMT), • *National Chemical Laboratory* (NCL), • *National Institute For Interdisciplinary Science and Technology* (NIIST) • *National Metallurgical Laboratory* (NML)
Vertical 2	Hydrogen Storage	• *Central Glass and Ceramic Research Institute* (CGCRI), • *Central Mechanical Engineering Research Institute* (CMERI), • *Indian Institute of Petroleum* (IIP), • *National Chemical Laboratory* (NCL), • *National Institute For Interdisciplinary Science and Technology* (NIIST) • *National Metallurgical Laboratory* (NML)
Vertical 3	Hydrogen Utilisation	• *Central Electrochemical Research Institute* (CECRI), • *Central salt and marine chemical research Institute* (CSMCRI), • *National Environmental Engineering Research Institute* (NEERI), • *National Chemical Laboratory* (NCL)
Vertical 4	**Hydrogen Intellectual Property Mapping**	• *Unit for Research And Development of Information Products* (URDIP), • ***National Institute of Science Communication and Policy Research (*NIScPR)***

***CSIR-NIScPR** is actively involved in H_2 Technology Program & disseminate through our weekly Hydrogen-Digest. Our other knowledge products are Policy briefs, Country status reports. Made available on request.
Request may be sent to the PI & copy to director@niscpr.res.in





CSIR-NIScPR emerges as a globally respected think-tank and resource center for undertaking Science, Technology & Innovation Policy Research and Science Communication. Our mission is to promote Science Technology and Innovation policy studies and science communication among diverse stakeholders and act as a bridge at the interface of science, technology, industry and society.

Our Mandate

- *Policy advocacy on identified Techno-Socio-Economic issues.*
- *Establishment of a repository of data, information, road-maps and policy documents related to science, technology and innovation activities.*
- *Providing linkage of communication in the form of research journals in different areas of Science Technology & Innovation.*
- *Disseminating Science Technology & Innovation information to Society.*

PROJECT TEAM:

Dr. Madhulika Bhati, Principal Scientist (madhulikabhati@niscpr.res.in)

Dr. Jayita Biswas, Mr. Saurav Kumar and Ms. Nishita, Project Associates.

For further information:

Director, CSIR- NIScPR

Dr. K.S. Krishnan Marg, Pusa, New Delhi-110012

Phone No: +91 11-25843227; Fax: +9111-25846064, Email: director@niscpr.res.in

Visit us: www.niscpr.res.in

Disclaimer: This newsletter contains information compiled from various sources. It is only intended for informational purposes and not for commercial purposes