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Innovation Oriented Cooperation of Centralised Research Infrastructure for South Asia

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Introduction

We live in an era where each advancement in Science and Technology is met with a challenge, be it the climate crisis, loss of biodiversity, or a virus that becomes more virulent with every new mutation it acquires. Most research endeavours in today's world need access to laboratory facilities, cutting-edge instruments and sophisticated high-end research infrastructures. Bridging the gap between aspiring researchers and the availability of resources and infrastructure is the need of the hour. South Asia is home to about 1/4th of the world's total population, among which India alone has about 62.5% of youth between 15-24 years of age¹. It becomes imperative to address this gap when we consider the magnitude of the population in the South Asian countries as a whole.

Although many governments have made considerable efforts to facilitate the sharing of research infrastructure (RI) to cater to the needs of the researchers, several challenges still prevail in terms of access to specific requirements and lack of awareness about the availability of these facilities. Optimum utilisation of publicly funded research equipment has been a concern. Several functioning instruments are either abandoned or remain unused once the projects for which these were acquired are over. The lack of skilled or trained personnel to maintain these facilities and instruments is also a persisting issue.

Establishing structures that facilitate the maintenance and sharing of RI will foster a productive research environment and get many young minds interested in science, which will, in turn, strengthen the Science, Technology and Innovation (STI) ecosystem of the nation². This policy brief highlights some essential policy interventions regarding improving access to RI among the researchers of a single country and the whole South Asian research community. It advocates for establishing a central body linked with a dedicated fund through any of the prevailing regional cooperation to manage and facilitate sharing of the RI through a mutually convenient mechanism. Promoting innovation to facilitate the reuse and sharing of existing instruments and their components is highly encouraged by bringing researchers from different STEM fields on a single platform. The policy brief also underlines a bottom-up approach toward institution-institution cooperation. It braces the institutes of eminence in the region to come to the fore and be flag bearers for sharing their infrastructure system.

Overview of the Research Infrastructure Sharing Problem

The establishment of RIs and facilities is a great boon to any country. But, the actual progress of science and the inculcation of scientific temperament in citizens would directly depend upon the efficient use of the available and existent facilities. Some of the priority problems to be addressed concerning sharing of RI in South Asian economies include:

* The authors participated in the 'Participatory Science Advice for Policy Making' workshop as part of the Grassroots Science Advice Promotion Awards 2021 by the INESA Asia to Dr Jenice Jean Goveas and Dr Moumita Koley.

1. The **large base of geographically scattered scientific stakeholders** in South Asian countries poses a difficult task in the allotment and accessibility of the few available scientific infrastructures.
2. The **existence of separate portals** for submitting an expression of interest to gain access to a particular instrument available at multiple research facilities is undesirable and creates unnecessary competition among them.
3. Currently, many facilities across the South Asian economies remain unused to their full potential. The **non-usage of a particular instrument** could be associated with several problems, such as a technical issue with the machine, skilled personnel not available, only a few researchers using it or the mere difficulty of record-keeping and administration. Sometimes, the **lack of a transparent feedback system** for the facilities also obstructs efficient sharing.
4. The **absence of efficient outreach channels to create awareness** about available infrastructure and sharing platforms highlights the problem of information asymmetry within the scientific community. Significant efforts are required to address this pressing matter.
5. **Lack of a trained workforce with the necessary skills to maintain and handle scientific instruments** is another concern that requires innovative strategies and leveraging of existing knowledge among the scientific community.
6. In general, after the project's completion or the superannuation of the faculty, the instruments attached to them are either dumped in the storerooms or sold as scraps. There is a **need to harness the potential of these sophisticated scraps that can potentially lead to many innovations**. An expert team can outline the life cycle of such instruments and ensure their optimal utilisation as a whole and each of their functional components.

Research Facilities Sharing Scenario across the World

Most shared RIs are funded, managed and operated at national levels and provide services primarily to local research communities. There have been constant demands for optimising the operation of these national RIs. It is in the context of South Asian nations, where the research budgets are limited, and governments and funding agencies face the challenge of supporting increasingly large and complex RI portfolios. While the developed countries have pondered on this matter long ago and formed consortiums, any such mechanism for regional cooperation has been lacking among the South Asian countries to date.

A few examples of worldwide national and regional cooperation for RI facilities are:

Europe:

- **The European Commission** ensures the RIs are open and accessible to all researchers in Europe and beyond, users being individual teams from academia, research institute and the business sector.
- **European Strategy Forum on Research Infrastructures (ESFRI)**: The ESFRI develop a strategic roadmap identifying investment priorities in European Research Infrastructures for the next 10-20 years.
- **European Research Infrastructure Consortium (ERIC)**: An EU legal entity that facilitates the establishment and operation of RI.
- **Promoting African European Research Infrastructure Partnerships (PAERIP)**: This EU-funded project aims to build new partnerships between Europe and Africa to share RIs.
- **Berlin University Alliance (BUA)**: The three major Berlin universities – Freie Universität Berlin, Humboldt-Universität zu Berlin, Technische Universität Berlin – and Charité – Universitätsmedizin Berlin are represented in this consortium. Effective sharing and efficient use of resources in the areas of research infrastructure and internationalisation is one of the objectives of the BUA.

United States of America:

The Department of Health and Human Services of the USA introduced a Shared Instrumentation Grant (SIG) program to make available to institutions high-priced research instruments that can only be justified on a shared-use basis. For example, the S10 (Biomedical Research Support Shared Instrumentation

Grants) is awarded to domestic public and private institutions of higher education and non-profit domestic institutions such as hospitals, health professional schools and research organisations. Every instrument awarded by this S10 grant is used on a shared basis by thousands of investigators in hundreds of institutions nationwide, thus promoting cost-effectiveness and a collaborative multidisciplinary environment.

Singapore:

Singapore National Research Foundation (NRF) introduced the National Research Infrastructure (NRI) framework in April 2015 to guide the development of selected research facilities to be operated as a national resource, open to all researchers in Singapore.

India:

India is leading two initiatives, the Sophisticated Analytical and Technical Help Institute ([SATHI](#)) and the Indian Science, Technology and Engineering facilities Map ([I-STEM](#)). SATHI aims to establish new instrumentation facility centres across the country for researchers from institutes that lack such sophisticated instrumentation. I-STEM, on the other hand, enlists the existing facilities and provides a transparent and equitable booking mechanism to the end-users. Therefore, I-STEM helps in efficiently utilising the existing infrastructure, while SATHI focuses on filling the gaps by creating new facilities.



Pakistan:

The International Centre for Chemical and Biological Sciences (ICCBS) at the University of Karachi is the national centre of excellence where samples for analysis are submitted by researchers from all over the country, with results provided to the researcher within 24 hours and billed to the University Grant Commission of Pakistan.



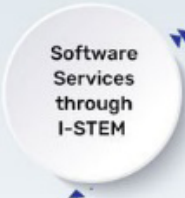
I-STEM®
Linking Researchers and Resources
Launched by the Honourable
Prime Minister of India

Indian Science, Technology and Engineering facilities Map (I-STEM)

I-STEM: Strengthen the Indigenous Development of Scientific Instruments

After establishing a National web portal through which R&D equipment in institutions across the country can be located and accessed in a transparent way, I-STEM is entering a New Phase with the following objectives –

- ▶ Working towards a more comprehensive listing of R&D facilities. Availability, and their active use
- ▶ Providing partial assistance to Tier 2 and Tier 3 institutions for the maintenance of facilities shared through I-STEM through Comprehensive AMC program
- ▶ Partial assistance to Users from Tier 2 and Tier 3 institutions who use facilities through I-STEM
- ▶ Promoting the indigenous development – especially by startups – of scientific equipment and value-added technical supplies, including software, used for R&D; enabling such development via the (national) Digital Catalogue of indigenously developed technologies and products maintained by the I-STEM portal
- ▶ Establishing regional centres for providing technical training and skill development, in part by restoring/stripping R&D equipment written off by I-STEM institutions; thus developing a stream of talent and gainful employment through maintaining and upgrading R&D facilities
- ▶ Providing access through the web to R&D software platforms to Academic Users to promote R&D and more effective instruction/learning, especially in smaller institutions.



Software Services through I-STEM



Indigenous Equipment Development



Skill Development Program



User friendly R&D facilities access across the country



Partial funding to Institution, Researchers and Start-ups

Proposed Solutions and Recommendations

Establishing a Central Body among the South Asian Countries for Sharing of Research Infrastructures to Strengthen Regional Cooperation

Nearly all South Asian nations lack enough resources to establish world-class RIs. In this regard, a central body and a dedicated fund may be constituted either as a part of any existing cooperation mechanisms such as SAARC or through a new cooperation mechanism to facilitate the sharing of RI facilities. The central body having representatives from the member countries may focus on the seamless linkages between the national RI facilities through a unified information system. It would boost the region's research and innovation ecosystem and develop a healthy, affordable, and sustainable STI ecosystem.

Sharing of Research Infrastructure

Instrumentation shared award schemes should be initiated with the awardee institutes to provide appropriate support for associated infrastructure, such as space to house the instrument, technical personnel and post-award service contracts for instrument maintenance and operation. Funding bodies should try to maintain uniform distribution of high-end equipment to different regions of the country. Central instrument facilities of the premier institutes/ universities should also be made accessible to all.

Premier institutes need to work in parallel with the SATHI centres to fill the gaps in the availability of RI for the smaller research institutes and universities/colleges. It should be initiated in every city/cluster (as feasible), thus creating a nodal system. Booking of the facilities (SATHI centres, I-STEM and RI facilities) should be made available through a single web portal which should be available to researchers from across the borders, based on signed MoUs and other agreements for the same. Scientific Research Infrastructure Sharing Maintenance and Networks (SRIMAN) guidelines by the Department of Science and Technology, India, aim to encourage the sharing and efficient utilisation of RI across the country.

Repairing and Reusing the Instrumental Waste

Clear policies are needed to repair, refurbish and reuse the high-cost sophisticated equipment in the maintenance contracts. Dedicated facilities with skilled instrumentation engineers under the governance of an independent statutory body are to be established across the region to take care of the repairing/ refurbishing activity for the non-functional equipment. A multipartite approach may be adopted wherein immediately upon the condemnation of an instrument, its details should be enlisted on the common portal. The instrument, then, should be transferred to the authorised facilities for exploring its repair within a stipulated time.

If irreparable, free distribution of such instruments and their constitutive spares could facilitate ease of repair and maintenance of various instruments lying unused across the country. The instruments thus generated through acquiring various constitutive spares after testing could then be made available for sale at a reduced cost (to colleges, universities and start-ups) on the website. These facilities could also accommodate the visitation charges of students/ researchers across varying engineering courses to tour the facility and include a provision (a summer programme) for access to these facilities to the students to encourage a better understanding of these instruments. Thus, laying the foundations of a 'make in the country' programme.

Addressing Lack of Awareness

The lack of awareness of the various programs and portals for sharing RI needs to be tackled through a dedicated outreach plan. It shall help with regular updates being disseminated to relevant stakeholders and raising awareness about such provisions by the governments. Through the SRIMAN program, the Indian government aims to incentivise the institutions by rating them for the extent of participation in the initiative, which would encourage them to raise awareness themselves.

Conclusion

As resource-limited countries, India and its South Asian neighbours require a framework that facilitates the availability, accessibility and sharing of state-of-the-art infrastructure with the users more efficiently. It

will enable the financially-skewed academic institutions, universities, R&D labs, start-ups, etc., to leverage the cutting-edge instrumentation that would promote high-end research and innovation for the betterment of society. The post-pandemic era has left most South Asian nations economically weaker and resource-constrained than ever before. It, therefore, calls for sharing the RI more than ever. It would require a robust and sustainable infrastructure of sharing resources and resource mobilisation, accessibility, and cost-effective and frugal innovations.

This brief proposes investment in shared RI facilities and their maintenance (repair and reuse of instruments) along with human resource training for operation and maintenance and instrumentation databases. It also advocates innovation, for example, reusing working spares from non-functional equipment, making refurbished ones and proposing buy back at a lower cost. Creating awareness amongst various stakeholders of the shared RI to increase the visibility of the facilities is another suggestion. An

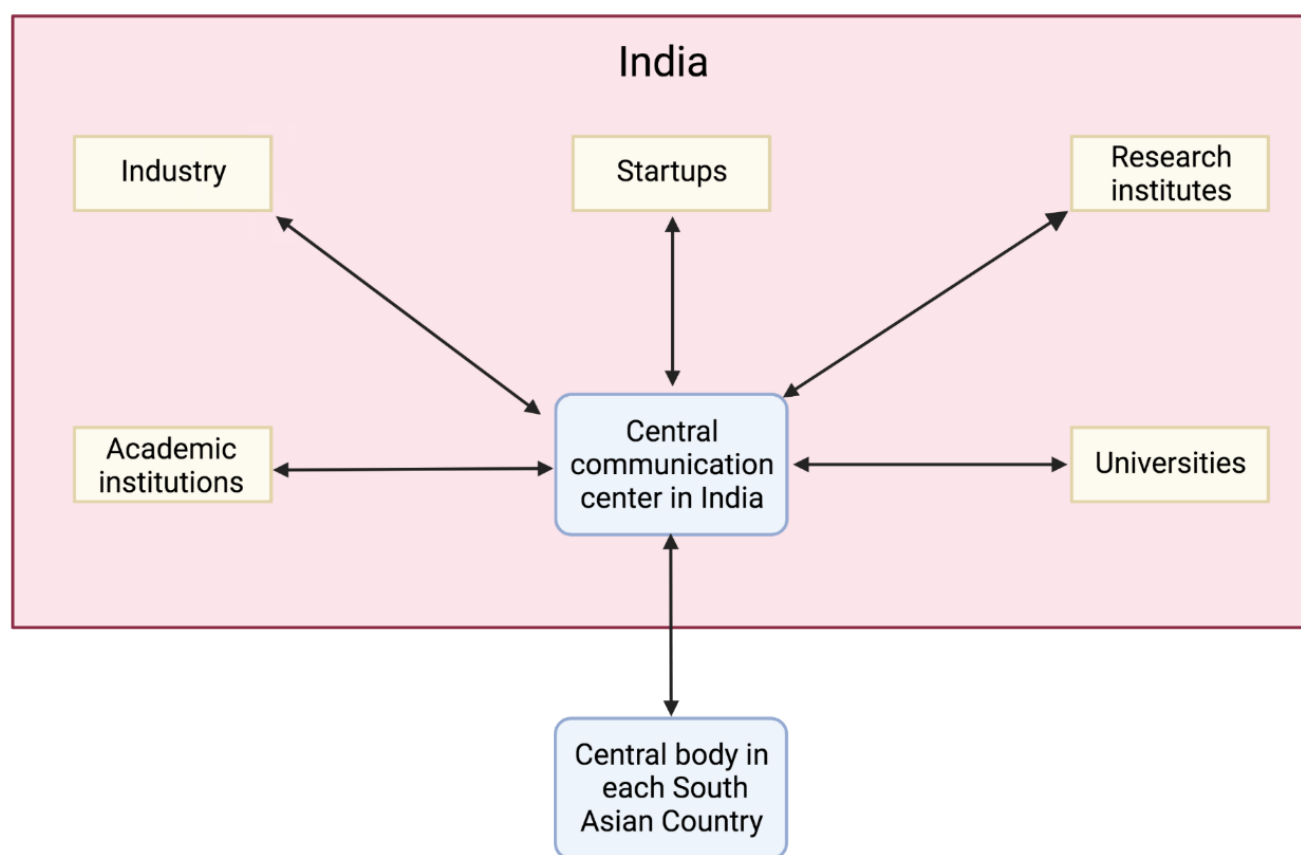


Figure 1. Structure of the Proposed Research Infrastructure Sharing Framework

updated national portal or other online tools by integrating more functions, such as maintaining a central repository/consortium housing a list of instruments, flag maintenance-related issues, sharing resources and a booking platform, is also recommended. A one-user account per department/ laboratory is proposed on the platform to avoid duplication of the booking processes.

There is also a need to establish a central body/ forum overseeing the functioning of the RI facilities across the country in coordination with the Central and State institutions. Cultivating a sustainable shared resource platform will help nations to prepare for future public health emergencies more efficiently without posing tremendous pressure on a country's health care system. As a way forward, if the model proves to be successful at a national level, it should be recommended to other South Asian countries through the regional alliance to agree on cooperation across borders to share the National RI facilities. It will encourage and facilitate sharing of RI at a great cross-country level and cater to the needs of partner countries, while fostering friendly scientific and international relations among the South Asian economies.

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Green Hydrogen: An Invisible Molecule for the Sustainable Energy Future

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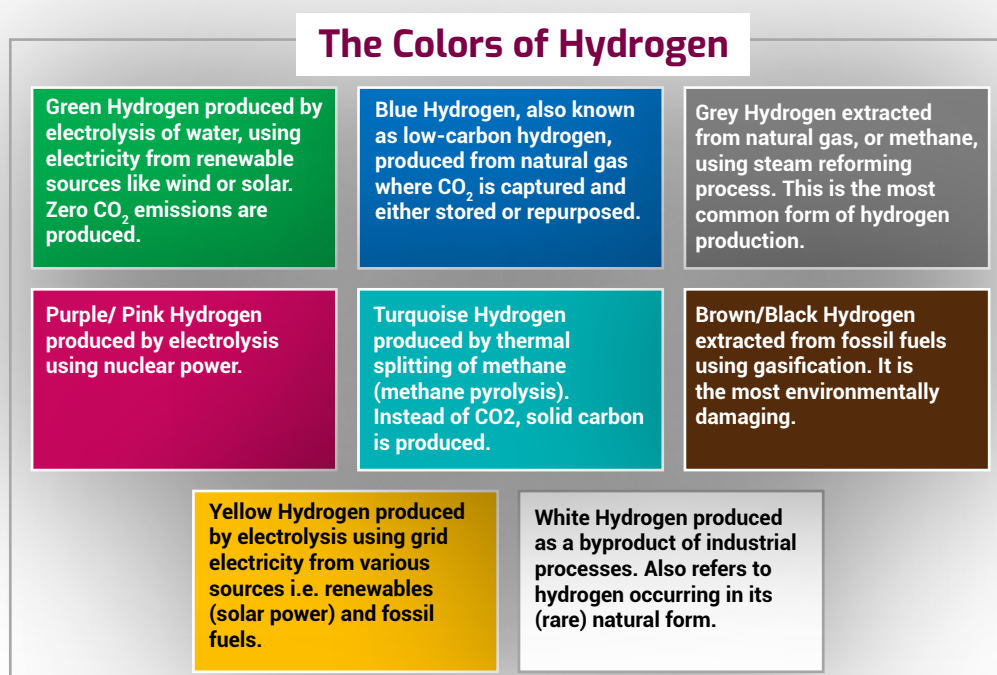
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Across the globe, the way energy is created, processed, stored and used in its different forms is changing dramatically. The mass awareness regarding the need to transition to a society where energy production and consumption should not result in climate change or pollution is increasing globally. Green hydrogen, i.e., hydrogen generated from renewable power, connects renewable energy to several end-use applications. In future, green hydrogen – due to its involvement with solar and wind energy – has a considerably larger potential than fossil fuels. As far as decarbonisation is concerned, green hydrogen is the sole zero-carbon option for hydrogen production. Green hydrogen can be transformed into various energy carriers such as ammonia, methanol, methane, and liquid hydrocarbons once it is produced at scale and at a low cost.¹ The energy

stored in hydrogen can be converted into electricity by fuel cells, which have a wide range of transportation applications, as seen in Fuel Cell Electric Vehicles (FCEVs), including heavy-duty transport vehicles such as trucks, buses and ships.² Green hydrogen can also minimise greenhouse gas (GHG) emissions in industries that currently use hydrogen generated from fossil fuels.



Green hydrogen, like other forms of energy production, has its own set of difficulties. These include the current higher expenses involved in its production across the entire value chain, from electrolysis to transportation and fuel cells; the lack of existing infrastructure for transportation and storage; and higher energy losses which demand higher wind/solar deployment rates.³

India is one of the countries with the optimal weather conditions for green hydrogen production and hence, the potential to produce cheaper green hydrogen as compared to [blue hydrogen](#) by 2025.⁴ It creates the possibility of trading globally low-cost green hydrogen from the best renewable resources to regions with limited land or renewable potential in the long run.

Current Status of Green Hydrogen in India

Self-reliant India (*AatmaNirbhar Bharat*), is the motto with which our country has progressed in the past two years, since the outbreak of the Coronavirus pandemic, proving that it is more than just a phrase for display, but an attitude and sentiment that flows throughout the country. On 15 August 2021, Indian Prime Minister announced the launch of the National Hydrogen Mission (NHM) intending to cut down carbon emissions and increase the use of renewable sources of energy. Moreover, at the COP 26 session in Glasgow last year, he pledged to make India a net-zero country by 2070. Recently, while addressing a webinar on 'Energy for Sustainable Growth', he [stated](#), "Ample availability of renewable energy power gives India an inherent advantage, it can be a global hub of green hydrogen."

Amitabh Kant, the CEO of NITI Aayog, on 26 April 2022 at the Raisina Dialogue [remarked](#) that India has brought down the cost of renewable energy and can be the cheapest producer of the green hydrogen in the world. In the renewable sector, from 2014 to 2018, India has spent 42 billion USD in driving down the costs by employing renewable technologies at scale.⁵

In India, hydrogen is already widely employed, mostly as an industrial feedstock for the production of ammonia-based fertilisers. The majority of hydrogen is produced via Steam Methane Reforming (SMR), which results in more CO₂ emissions. Though Carbon Capture and Storage (CCS) technology can seize these emissions significantly, it is at an incipient stage in India. Electrolysis, in which water splitting is achieved through electricity, is an alternate method of hydrogen production. The Nangal Facility in India boasts of one of the first large-scale alkaline electrolyser plants in the world, producing hydrogen from electricity way back in 1962.⁵

On 17 February 2022, the Ministry of New and Renewable Energy (MNRE) released a framed [Green Hydrogen Policy](#) in response to the raised concerns over the requirement to reduce emissions "especially in the hard to abate sectors."

Some of the [frameworks](#) outlined by the Government of India (GoI) are as follows:

- From the projects commissioned before 30 June 2025, a waiver of inter-state transmission charges will be granted for 25 years to the producer of green hydrogen.
- Open access for sourcing of renewable energy will be granted to the green hydrogen plants within 15 days of receipt of application complete in all respects. The charges will be laid down as per GoI rules.
- Land in renewable energy parks can be allotted for the manufacture of green hydrogen.
- Green hydrogen plants can be set up in any "Manufacturing Zones" as proposed by the GoI.
- Green hydrogen manufacturers will be allowed to set up bunkers near Ports for storage for export/use by shipping. The land will be provided by the port authorities at applicable charges.
- MNRE will set up a single portal for all statutory clearances and permissions required for the manufacture, transportation, storage and distribution of green hydrogen. The concerned agencies/authorities will be requested to provide the clearances and permissions, preferably within 30 days from the date of application.

These policies will boost and strengthen the steps taken in the direction of green hydrogen production. In recent years, transportation has emerged as the fastest-growing end-use industry, and India is poised to invest heavily in transportation infrastructure, including motorways, railways, metro lines, as well as airports and ports. At the CSIR-National Chemical Laboratory in Pune, the Council of Scientific and Industrial

Research (CSIR) and KPIT successfully [tested](#) India's first hydrogen fuel cell (HFC) prototype car, powered by an indigenously produced fuel cell stack. On 30 March 2022, Mr Nitin Gadkari – Union Minister for Road Transport and Highways, in an attempt to raise awareness about FCEVs and green hydrogen, [arrived](#) at the parliament in a green hydrogen-based electric car. This new sector has the potential to produce millions of high-quality, green employment in addition to helping to decarbonise transportation and energy since a total of 11% of CO₂ emissions in the country come from the transportation sector.⁶

Moreover, the power ministry has recently [announced](#) to manufacture 5 million tonnes of green hydrogen per annum by 2030, aiming to make India a production and export hub for the fuel.

According to The Energy and Resources Institute (TERI)⁷, the annual production of hydrogen is roughly 6.7 million tonnes, and the annual demand is expected to rise by 23 million tonnes in 2050, with the majority of consumption from fertiliser factories and refineries. If the net-zero carbon target is to be met, its production must [increase](#) to 28 million tonnes by 2050 and 40 million tonnes by 2060. Hydrogen has the potential to save 162 billion USD worth of imports for India – 112 billion USD in crude imports, 9.6 billion USD in natural gas/LNG imports, 23.6 billion USD in coal imports, 16.2 billion USD in petroleum products imports, and 775 million USD in ammonia imports.⁸ The current price of hydrogen in India is 4.5 to 5.3 USD per kg. The cost uniformity can be achieved only when green hydrogen is produced at 2 USD per kg.⁹ The GoI further [announced](#) that with effect from 2023-24, 10% of refinery hydrogen demand (increasing to 25% in the following five years) and 5% of hydrogen demand for fertiliser production (increasing to 20% in the following five years), should be met with renewable hydrogen.

India, thus, has the opportunity to lead the shift by providing the necessary funds, a good policy framework and technology-driven breakthroughs for green hydrogen generation.

Ensuring the Development of the International Hydrogen Market and Ways to Enhance Cooperation with other Countries

At the Dubai Expo 2020, India as a [step](#) toward exploring areas of collaboration invited the GCC (Gulf Cooperation Council) member countries for investing in the hydrogen energy sector. India is expecting to direct foreign [investments](#) of up to 120-160 billion USD annually, and with already established India-GCC relations, opportunities like these need to be capitalised on. The GoI has [allotted](#), in the Union Budget 2021-22, INR 25 crores for the hydrogen energy development. On the same track, the GCC countries have also heavily invested in hydrogen energy development and seek to become the largest exporter of green hydrogen to European and East Asian markets.

A major concern for GCC countries in manufacturing hydrogen is the incompatibility of electrolyzers with saline water. The seawater must be desalinated before electrolysis. India and GCC countries have the opportunity to enhance their cooperation in this domain. Several Indian research groups are focusing on [producing](#) hydrogen from seawater. For example, the CSIR-Central Electrochemical Research Institute (CECRI) is working on the design of electrodes and electrolytes for seawater hydrogen generation, and the Centre for Fuel Cell Technology at the International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) in Chennai is working on seawater electrolysis.

The Indian government has further progressed in developing indigenous transition fuel: hydrogen compressed natural Gas (H-CNG/Hythane). The Indian Oil Corporation Limited (IOCL) has [initiated](#) an H-CNG project in order to diversify the energy mix of the country.

Similarly, GCC countries have an abundance of solid waste due to their rising consumption patterns that can be employed to make hydrogen. The Indian Institute of Science (IISc), Bangalore, the National Institute of Technology (NIT), Rourkela, the Indian Institute of Chemical Technology (IICT), Hyderabad, and the National Institute of Technology (NIT), Raipur are conducting [research](#) on the production of Bio Hydrogen from solid waste, paving the way for collaboration between India and GCC countries, especially the UAE, which produces the world's highest daily per capita municipal solid waste. The GCC countries, particularly Saudi Arabia and the UAE, have invested in improving CCUS, and there is an opportunity for Indian institutes working on the subject to interact in terms of information/ technology transfer. Likewise, these countries have made significant expenditures on FCEV, and the linkages can help Indian research groups.

Challenges and Solutions to Advance Green Hydrogen Technology in India

Green hydrogen is supposed to hugely benefit India's energy industry considering its progress in the renewable energy sector. But it is marred with critical challenges which India needs to overcome for unstoppable growth in this sector.

Firstly, the hydrogen energy budget of our country is inadequate in terms of setting up initial infrastructure. Moreover, the cost-related aspects of electrolyzers and research in this direction need stimulus in view of the fact that it is a vital facility for converting renewable energy into green hydrogen. While scale-up is imperative to reduce costs, technological innovation is crucial to increase the technology's performance (i.e., its efficiency and lifetime). It can be accomplished by the use of new catalysts and configurations, design standardisation and equipment mass production.¹⁰

Additionally, to promote, encourage and develop the growth of hydrogen energy and its applications in the country, strengthening societies like the Hydrogen Association of India (HAI) and Indian Association for Hydrogen Energy and Advanced Materials (IAHEAM) is necessary.

Zero-carbon hydrogen energy technologies would have been widely embraced in the last two decades, if investor enthusiasm alone could foresee the future of hydrogen power. Many technological and financial roadblocks that impeded early hydrogen attempts are now being used to inform new methods for launching the new energy economy. From government policies and incentives to technological and infrastructure advances, enabling a cost-effective shift to hydrogen energy is at the heart of India's decarbonisation efforts.

However, there is a prerequisite for a safety framework, and the Petroleum and Explosive Regulatory Board is expected to formulate a comprehensive Hydrogen Safety Management Plan soon. An all-inclusive study of the water footprint of hydrogen production, leakage and related ozone depletion assessment and use of noble metals need to be done.

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Knowledge Flow Network: Can it bridge the gaps for the Open Science ecosystem?

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Introduction

The world is driven by the power of scientific knowledge and moving towards Knowledge-based economies. Empowering the knowledge creation process is even more critical for Lower Middle Income countries (LMICs) to avoid the middle-income trap and address increasing income disparities. However, the mode of action to push knowledge-based economies will differ from country to country. India being a youthful country, its strength lies in human capital and this resource should be harnessed for scientific innovation. They should be trained in specialised skills to create, disseminate, and apply knowledge for growth. Seamless access to knowledge is imperative in building human capital and hence, the country needs an open science environment. [Open Science](#) is a way to promote universal and equitable access to knowledge and quality scientific data. Access to scientific data is a vital enabler of the knowledge economy and promotes reproducible and trustworthy science, which is essential for progress. At this point, the country needs robust and coordinated government policies to access research data.

The significant loopholes in the current state of data sharing and access in India lie in the scattered nature of the available resources, the lack of structured policies, and the stakeholders' lack of awareness regarding the existing policies. Currently, there is no dedicated policy in India to promote open access to research data. Moreover, there are inconsistencies between different policies and executive initiatives like the National Data Sharing Accessibility Policy (NDSAP, 2012), [Shodhganga](#), [National Digital Library](#) of India, [Biological Data Storage, Access and Sharing Policy](#) of India, and National Knowledge Network (NKN). All these policies and initiatives are seeking to address different aspects of open access to Indian research. But in reality, these have led to redundancy and confusion among the researchers. Hence, it is essential to integrate these resources and platforms and have similar data-sharing practices. Enhanced access to

Importance of a Research Data Sharing Policy for Stakeholders

- A researcher may benefit from the specific information that should be known ahead of time to comply.
- Institutes/ Universities may benefit by creating & facilitating the process for researchers and generating quality output from their Institutes.
- The public may know exactly what research data can be reused by them and how?
- Funding/ Managing bodies may be able to advance the process of developing national open-access policies and infrastructures for access to research data.

* The authors participated in the 'Participatory Science Advice for Policy Making' workshop as part of the Grassroots Science Advice Promotion Awards 2021 by the INGSA Asia to Dr Jenice Jean Goveas and Dr Moumita Koley.

data, information and knowledge would immensely help not only researchers but the whole society. At this point, a comprehensive open research data-sharing policy – dedicated to creating a collaborative and accessible research ecosystem in India is a prerequisite.

The draft Science, Technology, and Innovation Policy ([STIP](#)) 2020 intends to create a streamlined research ecosystem for which it envisions a central repository of all the data generated in the STI ecosystem. The idea of a central, accessible research data platform in India is not new, and we can find it spread across Indian policies and laws like NDSAP and STIP draft 2020.

The collaborative and open data sharing of COVID-19-related research is a recent example of how the cooperation and participation of a large pool of researchers helped to generate giant strides in science and technology. Various other projects like Computer vision data, Human genome project, neurological diseases, etc. also have revealed how open access to data and the underlying cooperative spirit can enrich research.

Indian researchers annually produce a huge amount of data. Much of the data holding academic and research value simply languishes with labs and researchers due to lack of accessibility. This necessitates a common platform for research data that is accessible, collaborative and scalable for nurturing more robust evidence-based publicly-funded research ecosystems.

The following elements are essential strategies to consider while formulating an open research data sharing policy and knowledge flow network.

Specifics of the Policy	
Features	Scope
Research data	Research data covered by the policy may include data from institutional researchers, independent researchers, NGOs, analysts, metadata and raw data. Bio-medical data may be anonymised and de-identified to avoid ethical concerns.
Exceptions to research data	Type of data may be stored privately and should not be made publicly available. Provisions must be there to classify such sensitive data such as health records, data related to defense & security, etc.
Open access to research data	Open access involves various activities aiming to remove the barriers to sharing research data. Research data should be as open as possible, human and machine-readable, without violating the privacy & confidentiality of private and sensitive data.
Infrastructure for data storing	Infrastructure for data storing must state the position on the use of data storing platforms. Data storing platforms are the means for sharing data with the community. Discipline-specific platforms with tags for interdisciplinary or multidisciplinary approaches are preferred to general repositories whenever available. Data storing platforms may include Digital data repositories, Physical data warehouses, metadata repositories, Data-lakes and Data-marts. National repository networks connecting localised/ institutional platforms provide research data and services.
Incentives for researchers	Innovative incentives that distinguish open practices over the existing system. The current system is biased towards the number of publications in prestigious journals, which does not inspire researchers to provide early and open access to their research data.
Data sharing/ Management plan	Open services and infrastructure should use standards and best practices to ensure international interoperability in repositories so that the data can be assessed, discovered and reused by humans and machines. Provisions must be added to spruce the data periodically to eliminate redundant and sensitive data. Investments are needed, not only to build a system but to maintain it.

Mandates of data sharing	Precise instructions about specific data sets with a graded plan on using the data with indexing and searchability on the web are essential. Information such as <i>Private sharing</i> of Sensitive data and Personal data with anonymity and informed consent where Data Use Agreements may be considered; <i>Suggestive sharing</i> for Independent Researchers, NGOs, Analysts; <i>Mandatory sharing</i> for Institutional researchers. Interoperable standards and best practices must be enforced at the Institute and National levels as per the international standards. A researcher has a right to use their data first-hand and share the extent of their data at their will, but with a rational time frame of restrictions.
Process of data authentication	Statement on the need for data authentication, where a peer review of data at the Institutional level is anticipated, along with the expectations of peer reviewers in their assessment of data files. A step of data authentication may help build trust in the data produced and help build a reputation for the Institute to produce relevant research.
Awareness programs	Research data sharing remains a new concept, and common questions can be answered by Programs and Initiatives among researchers and citizens to make them aware about the role of open access to research data, infrastructure, mandates and the sharing process.

Recommendations

The policies should focus on FAIR (Findable, Accessible, Interoperable, and Reusable) guidelines for data sharing and ethical and inspiring usage of accessible data to sustainably continue the research data flow system. The policies should [facilitate](#) building tools, infrastructures, and services for open data access, sharing and supporting legal and governance structures to effectively cater to all the stakeholders. Only then can the purpose of open research data sharing and access achieve its full potential. Following are some recommendations for creating a knowledge flow network, amalgamating structures based on the needs of all those involved in the research ecosystem, including researchers, authors, editors, referees, funders, citizens, etc.:

1. To better understand **the concerns and obstacles of the stakeholders, a survey** might be a good starting point in any country, as was done by Bezuidenhout et al. (2016) in Africa¹ or by Springer Nature and [figshare](#) in collaboration with Digital Science.²
2. **Interconnected Data and Regulatory Framework:** Currently, in India, some domain-specific open data repositories and digital platforms, and institutional library collections are already available. However, they are neither well-organised nor used widely. There is also a lack of associated structured policies for their usage.³ As a first step to building a solid foundation for a successful exchange of research knowledge and ideas, a thoroughly-strategised network should be **sculpted by interlinking the repositories and other scientific platforms** (as shown in Fig. 1).
3. **Research Institutional Libraries with Data storage facilities:**
 - 3.1 To avoid overloading the scientists/researchers and remove the infrastructural burdens, the institutional libraries can have Data Management Bodies (DMBs), who would be the field experts on data sharing architecture. It will also help to **bridge the digital gap for scientists**.
 - 3.2 Institutions can make raw data and metadata submission to the DMBs mandatory post-publication of an article or completion of a thesis project. Researchers should **sign data availability statements** after publishing a work/thesis, including the reason for not sharing anything if there are such occurrences (depending on the nature of data, viz. sensitive/private/legal or any other specific reason).
 - 3.3 Although Institutional DMBs will have full access to raw data and metadata, they may apply a **case-specific low-barrier mechanism** before sharing and making them openly accessible hereafter. The filters can be based on the negative list defined by a consensus between the researchers, organisations, and the government (on privacy, national security, and Intellectual Property Rights (IPR)).
 - 3.4 **Discipline-specific data sharing standards** should be well-defined nationwide: Since research data from diverse fields have different formats and time-dependent importance, discipline-specific

standards should be followed. For example, in the case of clinical research data, necessary deidentification of candidates/patients may be set as a norm, or research data of varying subjects and natures may have different embargo times before being openly shared.

3.5 Since these libraries will be the first point of submission of research data and metadata, appropriate **copyright licenses/ persistent and unique identifiers** (viz. DOI, Handle) for citations should be provided as done in [Harvard Dataverse](#), [Zenodo](#) - CERN and the [University of Michigan Library](#).

3.6 In the long run, there could be further modifications such as tracking the user and usage of data and metadata.

4. **Discipline-specific repositories:** Following the submission to local Institutional libraries, shareable data should be additionally linked to discipline-specific repositories based on subject-specific defined standards. **Funding agencies can make this a mandate.** Likewise, data and metadata from independent researchers, NGOs and citizen science should be directly deposited here. A registry/archive portal (like [re3data](#) or Indian Science and Technology Archive of Research (INDSTA; as suggested in draft STIP 2020)) can function as an aggregator for all these data from different subject-based repositories to be easily accessible to everyone. Independent researchers or common masses can send out their queries for additional data through this portal.
5. As a long-term goal, a **Central directory**, with bulletin boards and popular science articles, science news, etc., appended to the relevant research articles, data, and metadata from the National Archive, will be hugely beneficial. It would create an interdisciplinary platform fostering more collaborative work. Such Central directories can be the Global Knowledge Exchange Point (Fig. 1).
6. This system of knowledge flow from institutions to the Central directory could be **dynamically monitored, for gap recognition and necessary interventions**, by a National STI Observatory (to be established as a recommendation in the draft STIP 2020). Hence, there should be flexibility in the up-gradation of policies based upon the experience of multiple institutions and repositories. It should also include methods/ protocols for data management and security plans to keep up with the new formats of data storage, etc., and also be able to quickly train DMBs. There could be help from private organisations for these purposes and joining forces for continuous maintenance.
7. **Acquiring and allocating resources to build and maintain the framework:** For constructing and maintaining an elaborate and well-weaved network, policies should also focus on the economic factors and seek external investments. Fortunately, as mentioned above, many domain-specific repositories and platforms (e.g., [India Biodiversity Portal](#), [Clinical Trials Registry](#), [India Environment Portal](#), [ICAR Research Data Repository](#)) already exist in our country, which if clubbed together as parts of this network will reduce the cost significantly. Besides, private organisations will also benefit from the openly shared government funded data. Hence, there should be policies where the government can support their Corporate Social Responsibility funds in the open science framework building and maintenance.
8. **Financially and technologically support storage of ever-expanding data:** Additionally, the system would need a mechanism to safeguard data in the physical format and the repositories.
9. **Easier information extraction:** It would require creating digital platforms non-technical, interactive (searchable and indexable), and inclusive so that they are easily usable and understandable by people outside the research niche. It would promote citizen science and multidisciplinary projects with greater involvement of all stakeholders, even if they are not field experts.
10. **Educating stakeholders about the available research knowledge flow system:** Awareness regarding the whole knowledge flow cycle has to be increased amongst the stakeholders. Active policies should support familiarising researchers and citizens with the two-way routes (participatory and institutional approaches) in the research knowledge flow cycle (Fig. 1).
11. **Rewards and recognition systems to nurture openness.** If researchers' value, employability and funding are still judged based on the number of publications in high-impact journals, then scientists will remain hesitant in sharing data openly due to the fear of their data being misused without getting the due credit. Hence, it is crucial to revisit the researchers' evaluation policies- putting more weight on the

open sharing of data and collaborations⁴ (as recommended by [DORA](#) and also adopted by the [European Research Council](#)). Simultaneously, all National Journals could have alternative scooping protection plans for scooped projects due to open data sharing (as currently with PLOS Journals [Complementary Research Policy](#)). This is especially important for developing countries that are adopting open data sharing policies, yet lacking in research infrastructure compared to developed nations, whose research progression speed is faster.

12. **Incentivising citizens** who ideate new work from the openly accessible data would encourage participation by citizens, further strengthening the top-down knowledge flow framework as a positive feedback loop.

To improve the productivity and dynamicity of the ecosystem, we suggest the following:

1. Building a well-knit knowledge flow network (as in Fig. 1) interconnecting different repositories with research articles/thesis with their data, metadata, codes, and related general articles;
2. Defining specific standards of shareable data in a more domain-specific manner;
3. To incorporate newer policies to raise awareness and openness amongst the stakeholders;
4. To bring in supportive legal structures for open sharing of data to avoid misuse;
5. To join hands with private organisations to maintain different platforms and repositories;
6. Investing in infrastructure, training, education, digital literacy and capacity building;
7. To encourage innovative approaches and methodologies to strengthen the open science research ecosystem.

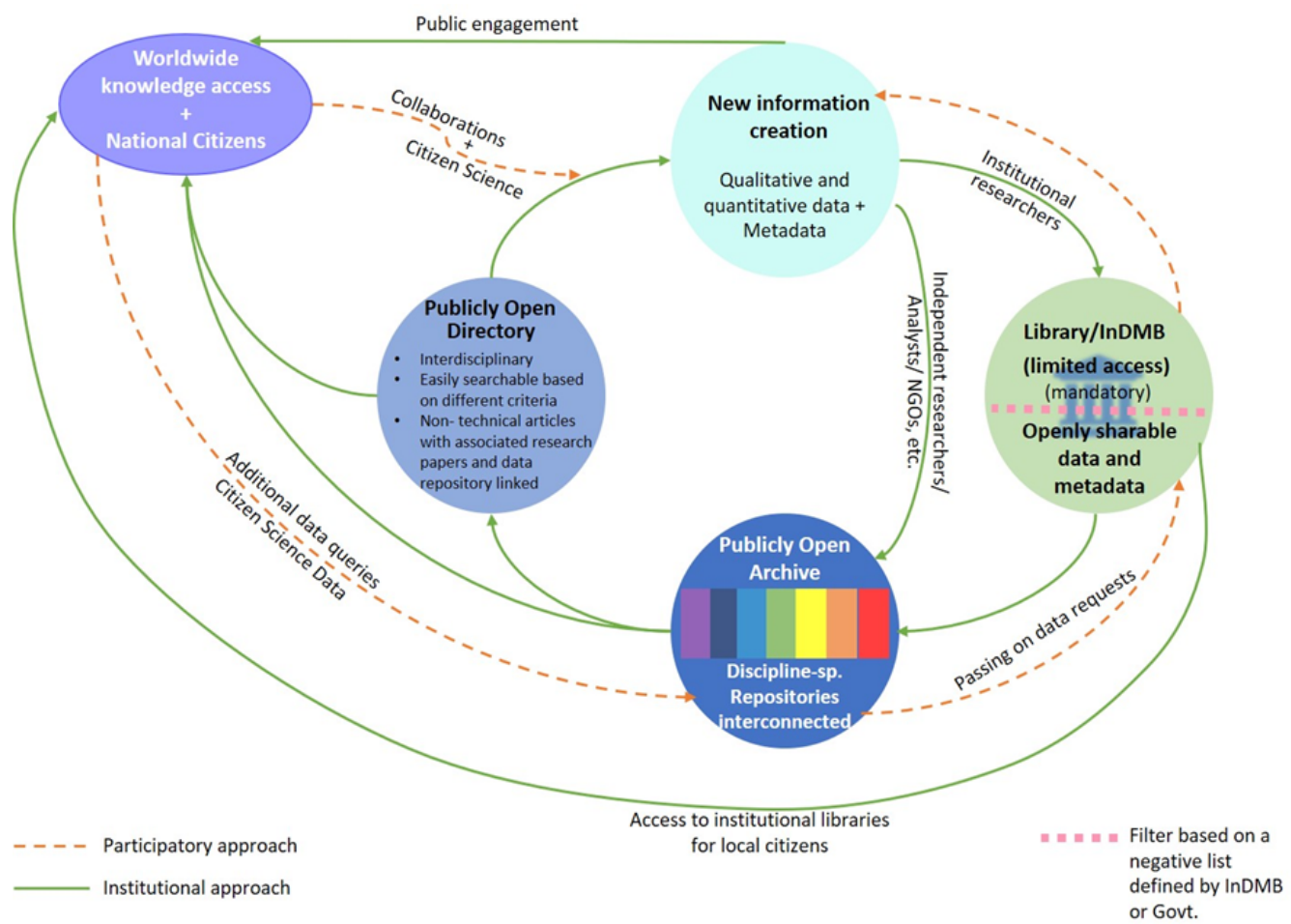


Figure 1. Structural framework for open data sharing of government funded research work

Conclusion

The future success of this open synergistic system will largely depend on its ability to respond to the diverse needs of its stakeholders efficiently. By implementing these changes, we hope to imbibe a culture of research and innovation, with a balance between open science mindset and Intellectual property rights, which is crucial in today's fast-moving world. It would demonstrate the benefits of sharing and accessing open data, as some of these changes have been beneficial to the [European Union](#) and other developed countries. Recently, the National Institute for Health and Care Research, United Kingdom, [launched](#) an open-access publishing platform to allow researchers to "rapidly" publish any research information, including incremental findings, case reports and even negative findings. The platform, called [NIHR Open Research](#), would also include links to all supporting data, allowing reanalyses, replication and reuse, as well as making it easier for researchers to collaborate. India should also make concerted efforts, as suggested in this policy brief, to develop and boost its open science ecosystem. Since the South Asian countries share similar socioeconomic backgrounds, even though here we have focussed on Indian Open Science policy changes, such a data-sharing network can be expanded and useful for the entire South Asian research ecosystem like the [Research data alliance](#), an intergovernmental data network sharing between the European Union, US and Australia.

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Science Diplomacy in 2022: More Cooperation or More Division?

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This article is an extension of what was discussed during the [WebDebate](#) 'Science diplomacy in 2022: More Cooperation or More Division?' held on **5 April 2022**. It was organised by Diplo within the framework of the International Forum on Diplomatic Training (IFDT).



The session was moderated by **Dr Katharina E. Höne** (Director of Research, Diplo) and the speakers were **Dr Kimberly Montgomery** (Director of International Affairs and Science Diplomacy, American Association for the Advancement of Science (AAAS)) and **Mr Alexis Roig** (CEO of SciTech DiploHub and Barcelona's Chief Science and Tech Envoy).

The main focus of this debate was to understand the nuances of Science Diplomacy and to deliberate on the following formidable yet important questions:

- What are the current trends in science diplomacy?
- What actors, topics and challenges are becoming more relevant in 2022?
- Will we see more cooperation or more divisions?
- How can the practice of science diplomacy contribute to cooperation across divides and even in the face of conflict?

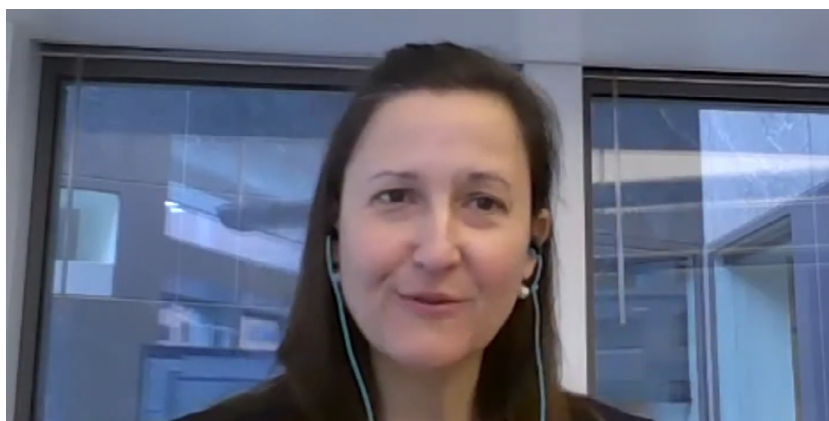
To begin with, Dr Hone highlighted the importance of Science Diplomacy and how the concept is rapidly evolving and creating an impact on strengthening relationships and connections between different nations based on science and technology. She also stated a few famous examples of unexpected cooperation and scientific collaboration between rival countries, such as SESAME (Synchrotron-Light for Experimental Science and Applications in the Middle East), an experimental facility in Jordan, whose founding members include Bahrain, Cyprus, Egypt, Iran, Israel, Pakistan, the Palestinian Authority and Turkey. Another historical example quoted by her was the famous 'Apollo–Soyuz handshake' during the 'space race' and the 'Cold War' between the USA and the Soviet Union. Thus, Science diplomacy is believed to be one of the tools to foster collaboration among states and other stakeholders. It can lead to improved mutual understanding and more peaceful international relations.



Dr Katharina E. Höne, Director of Research, Diplo

Science Diplomacy: Current Trends and Limitations

Science diplomacy is developing and changing in the last couple of years with new emerging trends. Major areas were pointed out in which science diplomacy has changed in recent years. The first was **regional expansion** and it was elucidated with the help of two cases: 'Apollo–Soyuz handshake' and the SESAME project in the Middle East. Dr Montgomery remarked that the national governments have increased their focus and are forming new strategies for science diplomacy. She mentioned a recent visit of a French Ambassador to the USA, where he discussed France's Science Diplomacy strategies which are focused on boosting partnerships between research institutes and public diplomacy by supporting research, development and innovation. Likewise, many countries are looking forward to fostering international scientific cooperation with countries having challenging relationships and an **evidence-based foreign policy**.



*Dr Kimberly Montgomery, Director, International Affairs and Science Diplomacy,
American Association for the Advancement of Science*

Recent years have seen many countries like France weigh in on the major issues of multilateral science diplomacy like global health care and climate change resulting in significant achievements like the Paris agreement. It can be safely said that science and technology have moved from the sidelines to the forefront and have become an inevitable part of foreign affairs. A better partnership between international institutes, supporting R&D and innovation has been noticed. Nations, even those with challenging relationships with each other, now look forward to fostering scientific collaboration almost as a foreign policy goal. An upsurge in the relevance of science in foreign affairs is mainly to look for solutions to global challenges like climate change, human rights, etc.

Even though the pandemic has propelled anti-global activities leading to a decline in international trade, investments and mobility, an opposite trend has been seen in science diplomacy in the last two years. International cooperation in science and technology has greatly intensified as the pandemic revealed and reinforced the urgent need for scientific collaboration between countries. As a result, even the general public, i.e., people other than those working directly in science diplomacy, now have a better understanding of the role of this field.

Another trend that has been noticed is an increase in the relevance of cities' urban / city ecosystems in the quest to go global while remaining anchored in national and domestic matters. Cities not only foster diversity but also have a certain degree of autonomy and are the hub of academia, science and technology and provide a significant amount of economic output. Barcelona is the forerunner in the city-led new strategies in science diplomacy, replacing old diplomatic structures and agendas which may not be relevant anymore in the digital era. Other cities like New Mexico, Shenzhen and Geneva are quick to follow the trend of 'global cities', which marks a paradigm shift in science diplomacy. A new multilayered landscape has emerged in 2019-22, and these few years have changed the scenario for years to come.



Mr Alexis Roig, CEO of SciTech DiploHub and Barcelona's Chief Science and Tech Envoy

The discussion also highlighted the significance of emerging technologies. While they are developing at an incredible speed and have the potential to solve national and global problems, they come with their share of considerable risks and unique challenges to science diplomacy. They deal with many diverse fields like AI, data science, blockchain, metaverse, etc., that have diverse applications. They may pose risks to cyber and national security like developing new weapons, phishing, malware, etc. and can cause an increase in disagreement and tension between nations. Due to the daily evolving and dynamic nature of these emerging technologies, it is necessary to draft regulations and security checks to prevent these risks. Emerging technologies should be encouraged while balancing good relations between nations. Hence, it is essential to have open dialogues between the scientific and foreign affairs community. Things can also move in the right direction if partnerships between non-government people and diplomats from national, state and city governments are encouraged. Diplomats and policymakers may not comprehend the technologies or over/under-estimate their impact without expert advice from the scientific community.

Science diplomacy has varying roles to play in difficult moments of active conflict or war. The official relationship between the US and Cuba (separated by just 90 miles of ocean) has been frozen for a long duration. But it is assumed that allowing scientists to work together and share data can have breakthroughs like developing vaccines for infectious diseases. Science diplomacy in times of mistrust, such as during the Cold War, can be instrumental in easing tension and building a bridge of understanding between nations. However, it is difficult to see science diplomacy playing an active and direct role during actual war or invasion. Its role in times of active conflict as currently between Russia and Ukraine is unclear and yet to be assessed in detail. In these dark times, we might not be able to build a new international business and economic relationships, but it should be tried hard to maintain whatever structure possible. National and subnational politics cannot be ignored or removed from the discussion, but the focus must be on cooperation between scientists. Politics has an ever-changing landscape as national parties change, which can heal or upset international relationships.

Conclusion

Science diplomacy is a fast-growing field in international relations and can become a force of good in the world. However, it can not just automatically lead to international cooperation and more peaceful relations between countries. 'Will science diplomacy survive the Russia-Ukraine conflict?' Now is the time to ask such questions which make us uncomfortable, but we need to rethink the answers as a lot of cooperation between nations is required to come up with solutions for global challenges like climate change, health, food and cyber security, and sustainable development. In the Q&A session of the web debate, attendees asked similar thought-provoking questions. For example: in this age of a multipolar world, mistrust, mis or disinformation, do institutes also shut down communication? Such conflicts put science diplomats in a difficult position. The attendees also wondered if scientists have the necessary diplomatic skills. Such debates are vital to spreading awareness. Training, skill and capacity building of next-generation scientists in international affairs and diplomacy can bridge the gap between scientific and diplomatic communities.

News //

National Data Governance Framework Policy

The Ministry of Electronics and Information Technology (MeitY), Government of India, released a revised draft titled "National Data Governance Framework Policy" (NDGFP). The new draft is a replacement for the now-scrapped 'India Data accessibility and Use policy'. The objective of the policy is to transform and modernise the government's data collection, improve governance and enable an Artificial Intelligence (AI) and data-led research and

start-up ecosystem in the country. It also aims to ensure greater citizen awareness, participation, and engagement. The NDGFP standards and rules will ensure Data security and informational privacy. The draft policy is available at: https://static.psa.gov.in/psa-prod/psa_custom_files/National%20Data%20Governance%20Framework%20Policy_26%20May%202022_compressed.pdf

Canada launches New Innovation Agency

The Canadian government announced creating a new innovation agency with an investment of Can\$1 billion (about US\$780 million) over the next five years. The budget would also include many other innovation measures, including a Can\$15-billion Canada Growth Fund aimed at stimulating private investment in low-

carbon industries and restructuring supply chains. Canada will also spend an extra C\$45 million to boost its semiconductor industry. The unit will be based on innovation agencies in Finland and Israel.

MoUs Signed //

ONGC inks MoU with Norway's Equinor to collaborate on E&P, Clean Energy

Oil and Natural Gas Corporation Limited (ONGC) signed a Memorandum of Understanding (MoU) with Equinor ASA, the Norwegian state-owned multinational energy company. The MoU was inked on 26 April 2022 in New Delhi for collaboration and partnership in areas of upstream Exploration & Production, midstream, downstream and Clean energy options, including Carbon Capture Utilization & Sequestration (CCUS). As per the agreement, both

ONGC and Equinor will collaborate with each other in the field of upstream oil and gas, midstream, marketing and trading, besides exploring further options in low carbon fuel, renewables, Carbon Capture Storage (CCS) as well as CCUS opportunities in India. The MoU is valid for two years under which both companies have agreed to work together in the areas identified.

NTPC Signs MoU with Energy Vault for Gravity-based Energy Storage Technology

NTPC Ltd., India's largest power utility, on 27 April 2022 announced signing an MoU with Energy Vault

Holdings, Inc., a leader in sustainable, grid-scale energy storage solutions. The objective of the MoU

is to collaborate and formalize a long-term strategic partnership for deployment of Energy Vault's EVx™ gravity-based energy storage technology and software solutions based on the outcome of a

joint feasibility study. The technology also offers beneficial utilization of coal ash for manufacturing of composite blocks for Energy Vault's gravity based energy storage system.

Investment Incentive Agreement between the Government of India and the Government of United States of America

On 23 May 2022, the Government of India and the Government of the United States of America signed an Investment Incentive Agreement (IIA) at Tokyo, Japan. IIA has been signed, to keep pace with the additional investment support programmes, offered by the Development Finance Corporation of Government of USA (DFC), such as debt, equity

investment, investment guaranty, investment insurance or reinsurance, feasibility studies for potential projects and grants. It is expected that signing of IIA would lead to enhanced Investment support provided by DFC in India, which shall further help in India's development.

Announcements //////////////////////////////////////

Call for Special Issue: "New Dimensions of Science Diplomacy for the Twenty-First Century"

Submission deadline: 2 August 2022

Further information at:

https://fisd.in/sites/default/files/2021-09/Science%20Diplomacy_Call%20for%20Papers_F.pdf

Call for Applications: "Science Diplomacy online course"

Submission deadline: 5 September 2022

Further information at:

<https://www.diplomacy.edu/course/science-diplomacy/#howtoapply>

Call for Special Issue: "Gender and Socially-Inclusive Approaches to Technology for Climate Action"

Submission deadline: 17 February 2023

Further information at:

https://www.mdpi.com/journal/sustainability/special_issues/Gender_and_Socially_Inclusive_Approaches_to_Technology_for_Climate_Action

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Call for Proposals //////////////////////////////////////

Call for Mobility Plus Project Proposals

Last Date: July 12, 2022

Further information at: <https://www.csir.res.in/call-mobility-plus-project-proposal>

United States-India Educational Foundation (USIEF) 2023-2024 Fulbright Fellowships for Indian Citizens

Last Date: July 15, 2022

Further information at: https://www.csir.res.in/sites/default/files/Flyer_2023-2024%20Fulbright%20Fellowships%20for%20Indian%20Citizens_Final.pdf

IUGG Grants Program – SPECIAL CALL – IYBSSD2022

Last Date: July 31, 2022

Further information at: http://iugg.org/programs/2022-2023_IUGG_GP_SpecialCall_Guidelines.pdf

DST DFG joint call on International Research Training Groups (IRTG) 2022

Last Date: August 1, 2022

Further information at: <https://dst.gov.in/sites/default/files/DST-DFG-IRTG-Announcement-2022%20%281%29-converted.pdf>

Indo-Swedish Joint Call for Proposals within Circular Economy

Last Date: August 18, 2022

Further information at: <https://dbtindia.gov.in/sites/default/files/Call%20text%20CE%20Sweden%20India.pdf>

Call for Accelerating CCUS Technologies (ACT4)

Last Date: September 12, 2022

Further information at: <https://dst.gov.in/sites/default/files/DST-Accelerating%20CCUS%20Technologies%20%28ACT4%29%20Call%20and%20Indian%20Funding%20Guidelines-Deadline%2012-09-2022.pdf>

International R&D and Pilots collaboration for Multinational Corporates (MNC's) and Health Centers

Last Date: September 19, 2022

Further information at: <https://www.innovationisrael.org.il/en/opencall/international-rd-and-pilots-cfp>

CEPI's Open Calls for Proposals

Last Date: December 31, 2022

Further information at: <https://dbtindia.gov.in/sites/default/files/CEPI%27s%20Open%20Calls%20for%20Proposals.pdf>

Forthcoming Events //////////////////////////////////////

CFP.10th ESHS Conference: "Science Policy and the Politics of Science"

Date: September 7–10, 2022

Further information at:
<https://eshsbrussels2022.com/>

World Science Forum 2022

Date: December 8–9, 2022

Further information at:
<https://globalyoungacademy.net/events/world-science-forum-2022/>



This Science Digest is open to new ideas, valid criticism and constructive feedback. If there is any science diplomacy/ policy related event which requires wider outreach, please share it with us. We welcome your articles/ feedback/ suggestions at scidip@niscpr.res.in

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