CSIR-National Institute of Science Communication and Policy Research (CSIR-NIScPR)

Assessment of CSIR's Technologies based on TRL Framework

India has taken a decisive shift in its policy towards innovation and entrepreneurship. This is driven by the clarion call given by the Honourable Prime Minister Sh Narendra Modi of "Make in India", "Atmanirbhar Bharat" (self-reliant India), Startup-India. Many other related policies have been articulated that has translated towards creating a new synergy among different stakeholders such as between university/ research institutes and industry. These initiatives are driven by the vision of creating world class products based on technologies developed in India that can lead to economic growth and social welfare. This among others, calls for synthesis and integration of various technologies being developed in different scientific institutions and their mapping to critical user requirements and national missions.

CSIR has developed a large number of technologies that have catalysed the growth of domestic industry across various sectors, helped to strengthen MSMEs, and has provided new opportunities for start-ups. For strengthening further its technology transfer and engaging with the industry, it becomes imperative in this context to have a critical assessment of technologies developed by CSIR. Technology Readiness Level (TRL) scale can provide a robust assessment of technologies developed by CSIR. This had motivated CSIR to use TRL scale to qualify technologies that different CSIR laboratories had developed using this scale. CSIR-NIScPR (erstwhile CSIR-NISTADS) was given assignment to revisit the exercise that was done and also to assign TRL to technologies that have been evaluated by individual CSIR laboratories that were developed later. Only technologies at TRL6 and above were to be examined. The rationale is that from this stage onwards the technology translates from typically laboratory research stage towards demonstration and calls for engagement with larger stakeholders that can lead to its commercialisation.

The study team developed a framework so that the assignment made is accepted within (where the technology is developed) and outside the system. The input data comprised of 467 technologies that were identified as TRL6 and above. This total set was based on (a) technologies at TRL6 and above in the earlier CSIR compendium, and (b) each of the CSIR laboratories that identified their technologies at TRL6 and above. Suitable care was taken so that there was no double occurrence of any technology in the selected set. These technologies were selected for evaluation.

Major Highlights

- 313 CSIR technologies that are promising (TRL6 & 7) and market-ready (TRL 8 & 9)
- Many technologies are protected by Intellectual Property Rights (IPR) filed in the US, giving India an edge in technology competitiveness.
- Among them, 61 % are most promising (TRL6 and TRL 7), and 39% are ready for market (TRL 8 and TRL 9) with huge potential for further innovation and commercialisation.
- More than half of the technologies identified are from Agriculture, Nutrition and Biotechnology (ANB) (28%) and Mining, Minerals, Metal and Materials (4M) (24%) combined.
- Various challenges were observed for transition towards higher TRL scale.

CSIR-NIScPR Approach for TRL Assessment

CSIR-NIScPR study team suitably modified the TRL scale and through a well-structured questionnaire got details of each technology identified at TRL6 and above by each laboratory. They were then classified based on eight CSIR themes viz., Aerospace, Electronics and Instrumentation & Strategic Sectors (AEISS), Agriculture, Nutrition and Biotechnology (ANB), Chemical (Including Leather) and Petrochemicals (CLP), Civil, Infrastructure and Engineering (CIE), Ecology, Environment, Earth and Ocean Sciences & Water (E3OW), Energy Conventional and Non-conventional & Energy Devices (EED), Healthcare, Biologics, Diagnostics and Genomics (HTC), Mining, Minerals, Metal and Materials (4M).

A DELPHI based approach was undertaken that led to final assignment of TRL to each of the technologies.The key steps of the process followed are briefly summarized in Figure 1 and Figure 2.

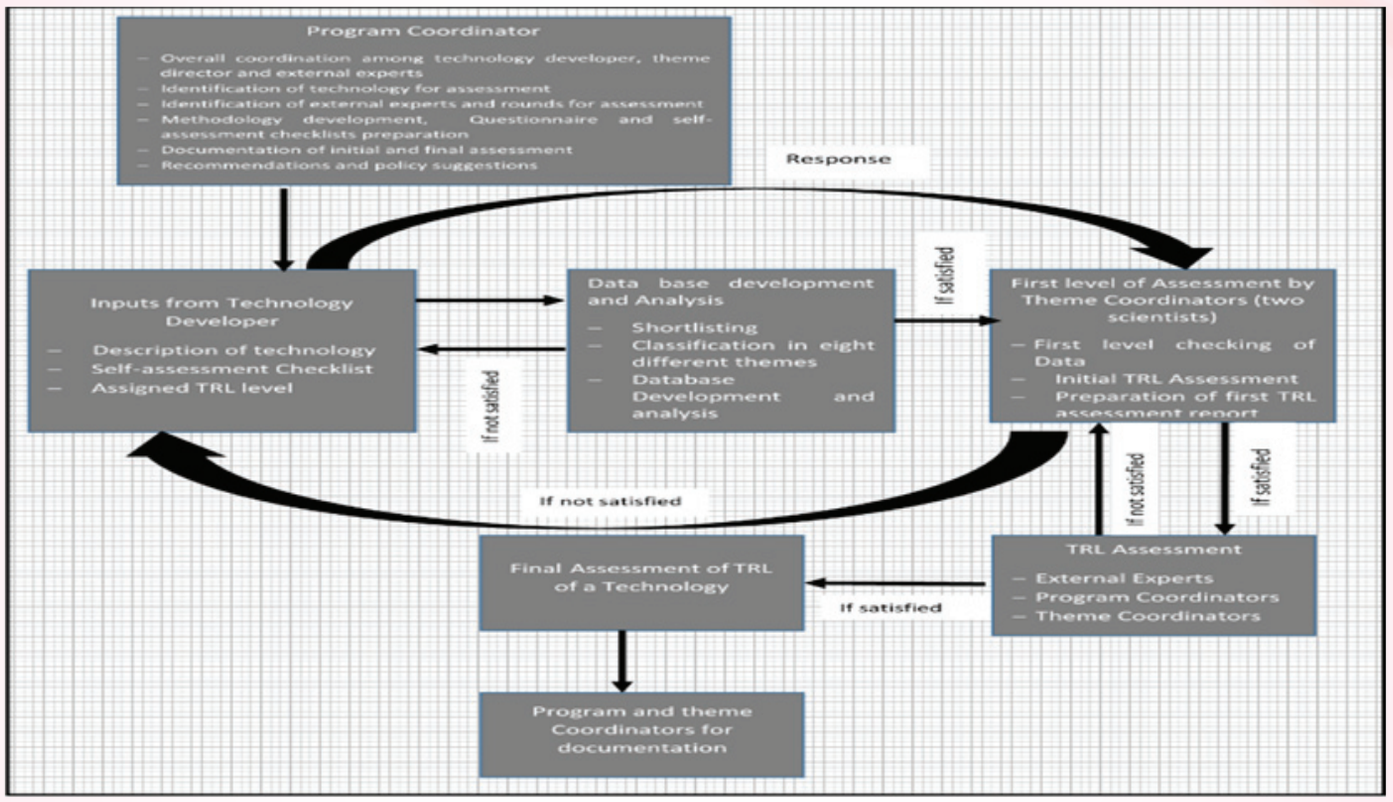

Figure 1. Flow chart of assessment process of TRL of technologies. Source: Bhattacharya et al. (forthcoming)

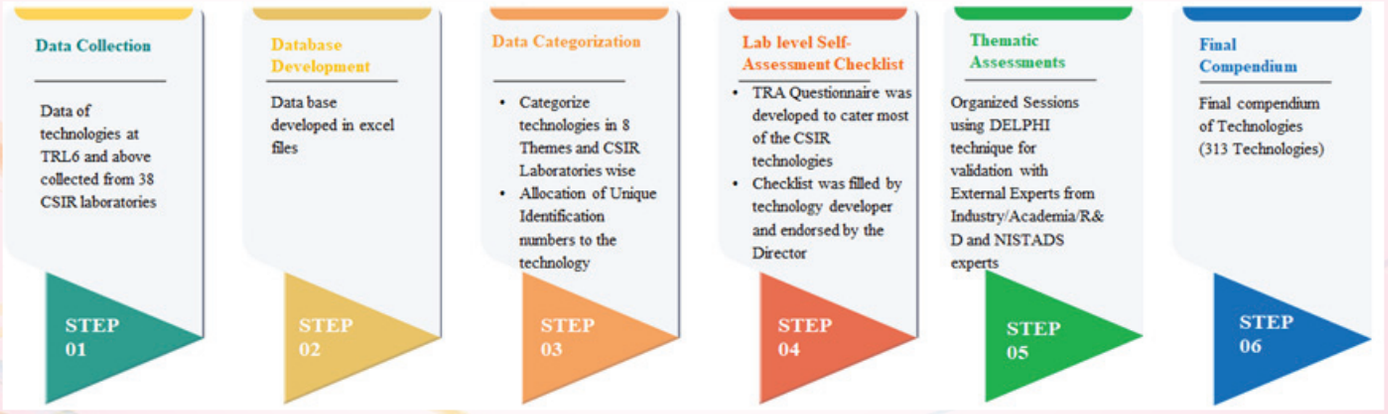

Figure 2. TRL Validation Process

Theme-wise selected technologies

CSIR-NISTADS has identified a total of 467 technologies at TRL6 and above in all eight different themes Total 313 technologies at TRL6 and above were selected for the compendium 2021 that covered technologies of 30 CSIR laboratories. Agriculture, Nutrition and Biotechnology (ANB), and Mining, Minerals, Metals and Materials (4M) themes have contributed the maximum number of technologies for the compendium. Energy theme has received a fewer technologies in comparison with other themes and also had least number of technologies selected for the compendium. Figure 3 highlights the above facts.

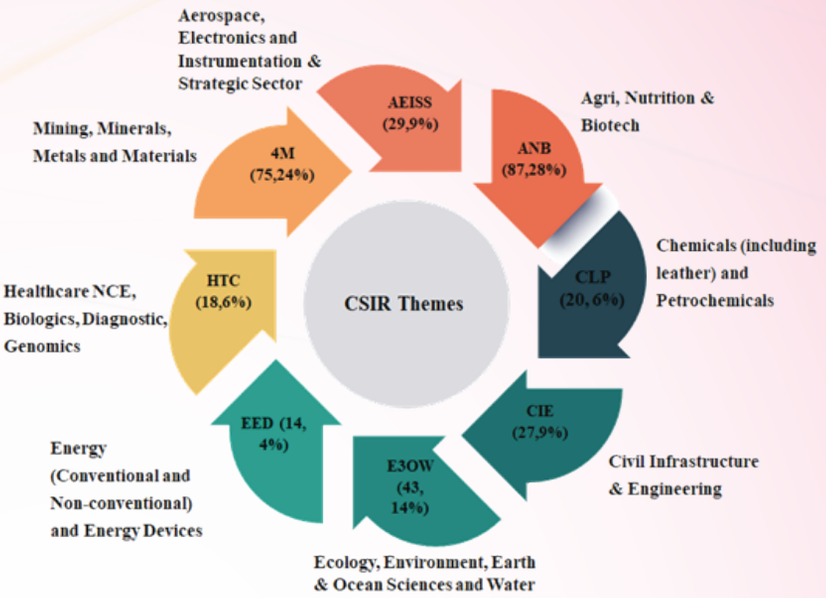

Figure 3. Share of selected technologies at TRL6 and above in different CSIR eight themes.

TRL-wise Distribution of Selected technologies

The number of selected technologies at TRL6 and TRL7, respectively, are 110 and 81. While the number of selected technologies at TRL8 and TRL9, respectively, are 51 and 71. In terms of percentage, the technologies at TRL6, TRL7, TRL8, and TRL9, respectively, are 35%, 26%, 16% and 23% of total selected technologies in the compendium (Figure 4). The share of most promising technologies (at TRL6 and TRL7) and ready for market (TRL8 and TRL9), respectively, are 61% and 39% (Figure 4).

Lab-wise selected technologies are given in Figure 5.

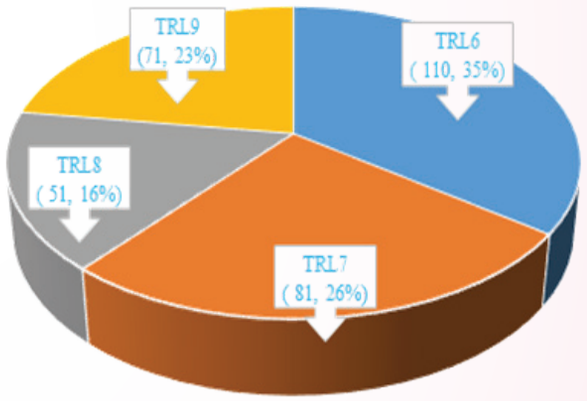

Figure 4. Share of selected technologies at TRL6, TRL 7, TRL 8, and TRL 9.

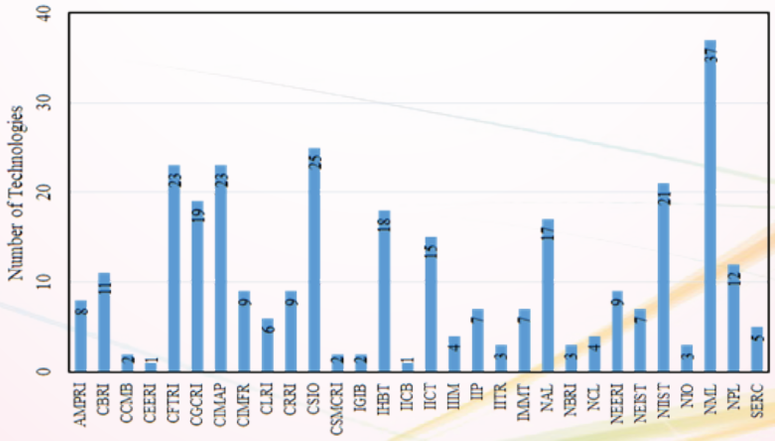

Figure 5. CSIR Lab wise distribution of selected technologies at TRL6 and above.

Policy Recommendations

The assessment exercise that led to the assignment of TRLs of the technologies developed by CSIR at different levels has shown many positive aspects:

- At the base level of TRL6 and TRL 7, several innovative and futuristic technologies exist which can be tapped for further up-gradation and translation.
- Many technologies have reached levels 8 and 9 that have huge potential for further innovation and commercialization.
- The average cost of technologies at TRL 7 was found to be very high, this evidence calls for a further revisit of the technologies stuck at TRL6 and TRL 7 for over a period of time.
- It also underlines a need for a further revisit by the developing laboratory that can engage with other CSIR laboratories for technologies that are in TRL6 and TRL 7, particularly those have not moved ahead to higher TRL levels over a period of time.
- New complementary skills, new approaches, and other technology inputs from other.
- CSIR laboratories can push the translation towards higher TRLs.
- CSIR needs to explore the 'OPEN Innovation' approach, which calls for developing strategic linkages with industry to develop the technologies further. New models like co-production, equity sharing can be explored to strengthen the open innovation approach.
- Labs with technologies that have not moved to higher TRLs levels over a period of time can be strengthened in terms of expertise, skills, and new approaches through collaboration.

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This policy bulletin is a product of the CSIR Compendium of Technologies 2021 conceptualised and developed by CSIR-NIScPR (erstwhile CSIR-NISTADS). It is the first kind of rigorous exercise to evaluate the TRLs level of technologies at TRL6 and above developed by CSIR and aiming to validate the TRLs level using DELPHI Method. The CSIR Compendium of Technologies provides the list of technologies with validated TRLs and brief description of technologies in eight different themes as well as also CSIR Laboratory-wise.

Source Reference

1. Ranjana Aggarwal, Vipan Kumar, Sujit Bhattacharya, Shiv Narayan Nishad and Vinayak. CSIR Compendium of Technologies 2021, CSIR-NIScPR, New Delhi
2. Bhattacharya, S., Kumar, V., Nishad, SN. Technology Readiness Level: An Assessment of the Usefulness of this Scale for Translational Research. Productivity Journal (Forthcoming)

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