Office of the Principal Scientific Adviser
to the Government of India

Addendum to Anthology of Science and Technology Activities

(Office of PSA)

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List of Abbreviations

A

ACBP: Annual Capacity Building Plan

AGNIi: Accelerating Growth of New India's Innovations

AI: Artificial Intelligence

APC: Article Processing Charges

B

BeST: Bengaluru Science and Technology Cluster

BEV: Battery Electric Vehicle

BTRA: Bombay Textile Research Association

C

CBC: Capacity Building Commission

C-DAC: Centre for Development of Advanced Computing

CGeM: Consultative Group on e-Mobility

CII: Confederation of Indian Industry

CoE: Centre of Excellence

CSR: Corporate Social Responsibility

D

DAHD: Department of Animal Husbandry and Dairying

DBT: Department of Biotechnology

DHSA: Dynamic Hyper-Local Source Apportionment

DPIIT: Department for Promotion of Industry and Internal Trade

DRDO: Defence Research & Development Organisation

DRIIV: Delhi Research Implementation and Innovation

DST: Department of Science and Technology

E

ETG: Empowered Technology Group

EU: European Union

F

FCET: Fuel Cell Electric Truck

FMD: Foot and Mouth Disease

G

G20-CSAR: G20-Chief Science Advisers' Roundtable

GIAN: Grassroots Innovations Augmentation Network

GSCoE: Global Sanitation Centre of Excellence

I

IBR: Indian Boiler Regulation

ICE: Internal Combustion Engine

iCET: Initiative on Critical and Emerging Technologies

ICMATS: Innovation Challenge for the Development of Machine-Aided Translation Systems

ICTS: International Centre for Theoretical Sciences

IEC: Information, Education, and Communication

IGCAR: Indira Gandhi Centre for Atomic Research

IHR: Indian Himalayan Region

IISc: Indian Institute of Science

ISRO: Indian Space Research Organisation

I-STEM: Indian Science, Technology, and Engineering Facilities Map

J

JCKIF: Jodhpur City Knowledge and Innovation Foundation

L

LCA: Life-cycle Assessment

M

MANAS: Mental Health and Normalcy Augmentation System

MeitY: Ministry of Electronics and Information Technology

MIDC: Modified Indian Drive Cycle

ML: Machine Learning

MoES: Ministry of Earth Sciences

List of Abbreviations

N

NCERT: National Council of Educational Research and Training

NDTSP: National Deep Tech Startup Policy

NFC: Nuclear Fuel Complex

NOHM: National One Health Mission

NQM: National Quantum Mission

O

OAG: One Health Action Group

ONOS: One Nation One Subscription

P

PKC: Pune Knowledge Cluster

PM-STIAC: Prime Minister's Science, Technology, and Innovation Advisory Council

PRMC: Project Review and Monitoring Committee

Q

QIST: Quantum Information Science and Technology

QED-C: Quantum Economic Development Consortium

Quad CoE-QIS: Quad Centre of Excellence on Quantum Information Sciences

R

R&D: Research and Development

RICH: Research and Innovation Circle of Hyderabad

RuTAG: Rural Technology Action Group

S

S&T: Science and Technology

SFC: Standing Finance Committee

SKA: Square Kilometre Array

STEM: Science, Technology, Engineering, Mathematics

T

TANs: Technology Advisory Notes

TCS: Tata Consultancy Services

TTC: Trade and Technology Council

U

UCOST: Uttarakhand Council of Science and Technology

UGV: Unmanned Ground Vehicles

W

WMTC: World Motorcycle Test Cycle

WTT: Well-to-Tank

WTW: Well-to-Wheels

Z

ZETs: Zero-Emission Trucks

About the Addendum to **Anthology of Science and Technology Activities**

Set up by the Government of India in 1999, the Office of Principal Scientific Adviser (Office of PSA) aims to provide pragmatic and objective advice to the Prime Minister and the cabinet in matters of Science and Technology (S&T), and plays an important role in shaping the S&T fundamentals with applied research; enabling future preparedness in emerging domains of S&T, formulating and coordinating major S&T missions; providing an enabling ecosystem for technology-led innovations and entrepreneurship; driving innovation and technology delivery for sustainable growth, fostering effective public-private linkages.

The Office of PSA released a comprehensive report titled '**Anthology of Science and Technology Activities'** in August 2023 which encompasses all the missions, activities, and key initiatives undertaken by the Office of PSA in the domain of science, technology and innovation.

Since then, there have been significant progress on some of the missions, initiatives, and activities spearheaded by the Office of PSA. This ***Addendum to the Anthology of Science and Technology Activities*** provides an update on the thematic sections discussed in the Anthology.

The Anthology of Science and Technology Activities and its Addendum cover the time period from January 2021 to December 2023.

The Anthology of Science and Technology Activities can be accessed here.

For more information, please scan the QR Code

Theme 1

Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC)

1.1 NATIONAL ONE HEALTH MISSION

National One Health Mission (NOHM), approved in the 21st meeting of PM-STIAC, aims to build integrated disease surveillance, joint outbreak response, and pandemic preparedness (for both human and animal pandemics) in India. The mission, through cross-ministerial effort, aims to coordinate, support, and integrate all the existing One Health activities in the country and bridge gaps where it is appropriate.

Milestones

Some of the Milestones in NOHM post July 2023:

1. **Convenings of the One Health Committees**

Apex Steering committee

- Fourth meeting of the Apex Steering Committee on One Health was held on August 4, 2023. The meeting, chaired by Principal Scientific Adviser (PSA) to the Government of India Professor Ajay Kumar Sood, discussed several critical components of the mission including handling disease outbreaks jointly by utilising the high-risk pathogen laboratories and employing better surveillance systems.
- The Apex Steering Committee recommended the creation of an expert committee to oversee the network of High-risk pathogen labs (BSL 3/4 labs).
- Fifth meeting of the Apex Steering committee on One Health took place on November 24, 2023 (Figure 1) and discussed the updates on-
  - Cabinet approval process of the mission,
  - Expert committee meetings on the network of High-risk pathogen labs
  - Implementation plan of Pandemic preparedness fund by Department of Animal Husbandry and Dairying (DAHD).

Expert Committee on BSL3/4 labs

- As per the recommendation of the Apex Steering Committee, the expert committee was constituted, with Lt. Gen. Madhuri Kanitkar (retd.), Vice Chancellor, Maharashtra University of Health Sciences and member of PM-STIAC, as chair.
- The expert committee has met twice since its constitution. The first meeting was held on September 25, 2023 which recommended that a questionnaire survey of the labs in the network should be conducted to understand the current capabilities of labs in disease outbreak investigation.
- The second meeting was held on November 10, 2023. It was a joint meeting where the lab-in charges were also invited to discuss on the responses submitted by them including the challenges faced in outbreak investigation.

Figure 1: PSA Prof. Ajay Kumar Sood chairs 5th Apex Steering Committee Meeting

2. Cabinet approval process of the National One Health Mission

- It was unanimously decided by the Steering Committee that the Standing Finance Committee (SFC) for the NOHM will be organised by the Department of Health Research on behalf of all stakeholder departments. The note for this meeting was prepared in close consultation with all the stakeholder departments. The SFC meeting was conducted on October 8, 2023.
- The SFC minutes for NOHM has been approved by Hon'ble Minister of Health and Family Welfare.
- The cabinet note for NOHM has been circulated for Inter-ministerial consultation.

3. Environmental surveillance workshop

- The second workshop on Environmental surveillance is scheduled to happen on January 16, 2024. The first workshop in this series was organised jointly by the Office of PSA and ARTPARK-Indian Institute of Science (IISc), Bengaluru.
- The second workshop will be organised jointly by the Office of PSA and Gujarat Biotechnology Research Centre which is an autonomous institute under Department of Science and Technology, Government of Gujarat.
- This workshop will bring together administration, practitioners and leading researchers from key national programs across human, animal, wildlife and environment sectors to explore viable frameworks for environmental surveillance.
- This workshop will create a network of practitioners to articulate key question, identify priorities and facilitate meaningful collaborations.

1.2 NATIONAL DEEP TECH STARTUP POLICY (NDTSP)

The National Deep Tech Startup Policy (NDTSP) aims to serve as a comprehensive framework for addressing the challenges faced by deep tech startups and providing definitive policy interventions to improve the ecosystem. In response to the 21st meeting of PM-STIAC's recommendation, NDSTP Consortium and a Working Group were established to develop a comprehensive policy framework catering to the requirements of the deep tech start-up community. The Office of PSA took the lead in drafting the NDTSP in consultation with many stakeholders including Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Electronics and Information Technology (MeitY), Department of Biotechnology (DBT), Defence Research & Development Organisation (DRDO), Indian Space Research Organisation (ISRO) among others.

Milestones

Some Milestones under NDTSP post July 2023 are:

During the public consultation period, which lasted from July 31 to September 22, 2023, a significant number of valuable inputs were received in response to the draft version v.3.0 of the National Deep Tech Start-up Policy – 2023. This feedback was obtained through diverse channels, including 70 submissions through the Office of PSA's website portal form (Figure 2), 34 via email, 15 derived from interactive public-private events, conferences, and roundtable consultations, and 48 originating from digital and print media sources.

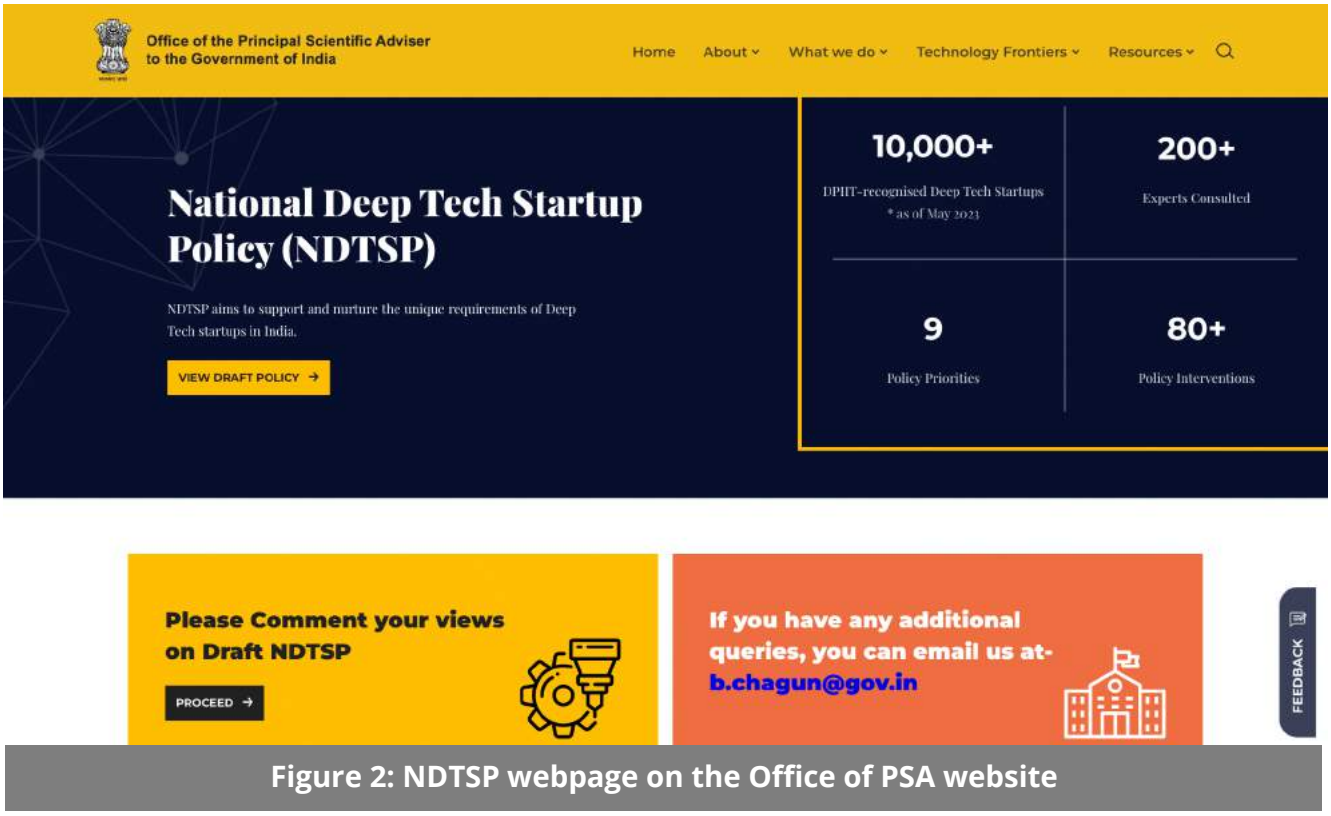


Figure 2: NDTSP webpage on the Office of PSA website

The Office of PSA took the lead in orchestrating the consultation and enhancement process for the Draft National Deep Tech Startup Policy. The Office was instrumental in facilitating both expert and public consultations. Throughout the public consultation phase, specialized sessions were convened to gather specific feedback concerning the priorities outlined in NDTSP v3.0.

During the public consultation timeframe, dedicated sessions were convened to solicit feedback on the key focus areas of NDTSP v3.0. These sessions encompassed topics such as catalyzing private investments in deep tech startups, fostering private-led fundamental and applied research (Figure 3), promoting science-based entrepreneurship and corporate-driven innovation (including incubators and accelerators), as well as regional consultations centered on Tier II/III cities (Figure 4). Furthermore, stakeholder-driven sessions were conducted to garner insights on the draft policy document. Multiple channels, including the policy website's submission form, email correspondence, public and private events, conferences, roundtable discussions, as well as digital and print media, were actively employed to gather invaluable insights and suggestions.

Figure 3: Consultation Session with CII chaired by - Ms Manmeet K Nanda, Joint Secretary, DPIIT & Managing Director & CEO, Invest India

The Office of PSA diligently incorporated all the feedback received from experts and the public into the development of NDTSP draft v4.0. Some pivotal policy components deliberated during the public consultation were further discussed with DPIIT and MeitY to incorporate their insights. The feedback received through these different channels was incorporated into the subsequent version of the NDTSP, now referred to as draft version v5.0.

Figure 4: Consultation session at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand

Subsequently, on October 20, 2023, the Office of PSA shared the revised version, along with the following documents, with DPIIT to advance the policy's process:

- NDTSP draft version v5.0, dated October 20, 2023, encompasses all feedback received after the public consultation period and internal review.
- Office of PSA's inputs on Draft Cabinet Note prepared by DPIIT.
- A consolidated summary of public and stakeholder input received up to September 22, 2023.

1.3 MISSION: SCIENCE & TECHNOLOGY (S&T) FOR SUSTAINABLE LIVELIHOOD SYSTEM

The first Inter-Ministerial Meeting of the Mission: Science and Technology for Sustainable Livelihood System, chaired by PSA Prof. Ajay Kumar Sood, was held on November 9, 2023 at the Office of PSA, Vigyan Bhawan Annexe, New Delhi (Figure 5).

The representatives from various Ministries/Departments, including DST, Ministry of Rural Development, Ministry of Panchayati Raj, Ministry of Agriculture & Farmers' Welfare, Ministry of Environment, Forest & Climate Change, Ministry of Micro, Small and Medium Enterprises, Ministry of New and Renewable Energy, Ministry of Electronics and Information Technology, Ministry of Health and Family Welfare, Indian Council of Agricultural Research, Ministry of Social Justice and Empowerment, Ministry of Fisheries, Animal Husbandry and Dairying, National Institute of Rural Development, IIT Bombay and IIT Delhi attended the meeting.

In alignment with PM-STIAC recommendations, the mission is designed with the objectives to bring sustainability in the livelihood system through Science and Technology interventions, and to strengthen the technology delivery mechanism for livelihood and quality of life. The Office of PSA will coordinate the multilateral collaborations along with DST for implementing, planning, and budgetary procedures for addressing of specific needs and priorities in the mission with support from the participating Ministries/Departments. The mission aims to pilot its initiatives across 120 sites, including PMAGY (Pradhan Mantri Adarsh Gram Yojana) villages. The envisioned deliverables include the integration of livelihood and local knowledge systems; the development of a comprehensive database and portal for efficient information access; technology requirement analysis with feasibility assessments; successful implementation of technologies; and the creation of coordination mechanisms; all underpinned by robust capacity-building measures.

Figure 5: PSA Prof. Ajay Kumar Sood, chairs the first Inter-Ministerial Meeting on Mission: Science and Technology for Sustainable Livelihood System at the Office of PSA

1.5 ACCELERATING GROWTH OF NEW INDIA'S INNOVATIONS (AGNIi)

The AGNIi Mission is a programme of the Office of PSA, under PM-STIAC, and is executed in partnership with Invest India. The mission has been instituted to engage with the Indian STI ecosystem to align with major national priorities and scouting solutions to persistent challenges through Indian technological innovations.
AGNIi establishes technology advisory partnerships with pioneering Union and state government departments/agencies on themes like climate change, counterinsurgency, disaster response, and human and rural development. The AGNIi team interacts with partner agency and follow a standard systematic process flow of; problem identification, pain points centralisation, defining problem statement in a solvable manner, doing an on-ground assessment, identification of technology array, arranging field showcases, and finally creating Technology Advisory Notes (TANs) for further implementations.

Some recent updates under TANs are:

1.5.1 INNOVATIONS FOR HANDICRAFTS AND HANDLOOM

Background

The Office of PSA's AGNIi Mission partnered with the Directorate of Handicrafts and Handloom, Kashmir, to advance the overarching goals of revitalizing and preserving India's rich crafts heritage, boosting productivity, and elevating product quality.

Objectives

The objective was to identify how technology and innovation – capabilities of which exist in India – can help strengthen and transform India's handloom and handicrafts sector and reduce the vulnerability of dependent artisan communities from the threat of machine-made products, improve artisan productivity, enhance product quality, and preserve the skills of master artisans to ensure the inter-generational continuance of the crafts. Technology can be an effective enabler that can equip artisans to compete better in global markets.

Pain points surfaced via field visits to craft clusters in Kashmir:

1. Counterfeiting of handmade products both handicraft and handloom
2. Diminishing inter-generational transfer of artistry skills resulting in 'languishing crafts'
3. Outdated machinery and processes limit the ability of the crafts to compete in global markets.
4. Ensuring product and process sustainability is a challenge.

Milestones

Field Visits

Pain points afflicting the Kashmiri Pashmina and carpet industry were surfaced by AGNIi Mission during the field visit to Srinagar. The Mission team interacted both with artisans and officials from the Directorate of Handicrafts and Handloom, Kashmir, and its allied agencies. These include interactions with – The School of Design, Craft Development Institute, Pashmina Testing Facility, and artisans in the craft clusters of Narwara, Kathidarwaza, Zadibal, Bagh Ali Mardan Khanin Srinagar (Figures 6 and 7).

Field Technology Showcase and Immersion Workshop

AGNIi conducted virtual technology showcase followed by field immersion workshop to understand the problems of the artisans and field technology showcase in Srinagar, Kashmir demonstrating nine startups, three textile research institutes and three IIT-RuTAG Centres.

The event featured a diverse array of technologies spanning multiple domains, encompassing emerging and cost-effective innovations, such as Mixed Reality solutions, IoT-based sensors, QR Codes employing Physically Unclonable Functions, Machine Vision for digitizing Taleems, the mechanization of Namda art processes, and the utilization of low-cost organic dyes to bolster sustainability efforts.

Output

The learnings from the technology showcase and immersion workshop translated into a comprehensive Technology Advisory Note, which was handed over to Sh. Vikramjit Singh, Commissioner/Secretary, Industries & Commerce, Govt. Jammu & Kashmir and Directorate of Handicrafts and Handloom, Kashmir in the presence of local artisan communities on September 14, 2023.

Next Steps

1. The Directorate of Handicrafts and Handloom, Kashmir, seeks to procure Namda rollers from RuTAG IIT Roorkee.
2. In addition, the Directorate is actively pursuing collaboration with an Indian innovator to develop a computer vision-enabled machine learning algorithm for the digitization of Taleems (traditional ancient codes used in designs).
3. The Directorate plans to procure natural dyes from the Bombay Textile Research Association (BTRA) and engage in a collaborative effort with BTRA to develop natural dyes sourced from Kashmiri flora.

Collaborating Agencies

- Directorate of Handicrafts and Handloom Kashmir
- Department of Industries and Commerce, Government of Jammu & Kashmir

Figure 6: Innovators, J&K Administration & AGNIi team at the Field Technology Showcase

Figure 7: M.A Shah, Director Handicrafts & Handloom, Kashmir during Field Technology Showcase

1.5.2 ADAPTING LIVELIHOODS TO CLIMATE CHANGE IN THE INDIAN HIMALAYAN REGION

Background

The Indian Himalayan Region (IHR) faces significant challenges due to climate change. To drive technological interventions towards climate adaptation, the Office of PSA's AGNIi Mission partnered with the Uttarakhand Council of Science and Technology (UCOST). For ensuring on-ground relevance, a testbed was set up in the Champawat district, which then aims to provide a model for the entire IHR. The first phase of projects focused on Climate Adaptive Agriculture and Water Management, closely coordinated with Uttarakhand's Chief Minister's Office, culminated in the TAN handover in June 2023. The second phase focuses on Climate Adaptive Livelihoods and Forest Management.

Objectives

The project targets pain-points in various livelihood sectors:

- **Agro-Forestry:** Addressing the lack of value capture mechanisms in the supply chain.
- **Dairy:** Improving cattle insemination success rates, vaccine procurement, disease detection, milk supply, processing, storage, and market linkages.
- **Fisheries:** Adapting to rising temperatures, water contamination, and improving infrastructure and market linkages.
- **Apiary Management:** Enhancing disease detection, training, insurance, and packaging quality.
- **Horticulture:** Mitigating wildlife crop damage, pest infestations, and improving packaging and storage.

Milestones

Field Visits:
Stakeholder engagement, rigorous fieldwork, and expert consultations identified specific challenges in climate adaptive forest management and livelihoods in Champawat.

Expert Consultations:
Held at UCOST in September 2023, these validations involved experts from various prestigious organizations.

Showcase

A field showcase in Champawat demonstrated how relevant technologies could be leveraged to drive impact. It included participants from various sectors and showcased key technologies like machine vision for apiary management, Pashu Aadhar for cattle health monitoring, portable heating and cooling systems, digital platforms for market linkages amongst others (Figure 8 and 9).

Output

The learnings from the stakeholder interactions and the technology showcase have been compiled into a comprehensive Technology Advisory Note, which has been handed over to the Government of Uttarakhand on November 30, 2023 for driving technology uptake in Champawat district and subsequently across Uttarakhand.

Next Steps

1. UCOST to enable incorporation of technology uptake in the Champawat District plan and subsequently in the plans of other Districts of Uttarakhand.
2. Initiation of technology procurement by concerned District administration.
3. Scale-up of Technology advisory and interventions across Uttarakhand and subsequently to the larger Indian Himalayan Region.

Collaborating Agencies

- Chief Minister's Office, Government of Uttarakhand
- Uttarakhand Council for Science and Technology (UCOST)
- District Administration, Champawat

Figure 8: Field visit to Fishery setup in Shukhi Dhang & Consultation with District Fishery Officials, Champawat

Figure 9: Deployment of Machine Vision Enabled Cameras for Apiary Management

1.5.3 CLIMATE ADAPTIVE FORESTS

Background

The Office of PSA's AGNIi Mission in its partnership with UCOST, aimed to address critical forest-related issues such as untimely detection of forest fires, manual ground truthing, and reforestation. The forest areas of Champawat district were used as testbeds to showcase technologies in these domains.

Objectives

The project's primary goal was to identify key challenges in forest management through field visits and discussions with various stakeholders. Identified pain points include:

- Inability to detect forest fires.
- Lack of readily deployable fire-fighting methods and tools for hilly terrain.
- Time-consuming manual ground truthing in inaccessible areas.
- Challenges in seed planting and monitoring reforestation in difficult terrains.

Milestones

Field Visits:
An extensive process of stakeholder engagement, fieldwork, and expert consultations led to the identification of specific challenges in forest management and livelihoods in Champawat, IHR. Field visits were conducted in Sukhidhang, Manar, Almora, and Sitlakhet.

Expert Consultations:
Held at UCOST in September 2023, these consultations involved over 12 experts from various prestigious organizations, validating technology stacks and functional requirements.

Showcase

A field showcase was organised in Champawat to demonstrate how technologies could be leveraged to address some of these issues, with participation from innovators, research labs, district administration, and over 300 community members (Figure 10). Technologies showcased included land digitization, thermal and visible light sensors for fire detection, Unmanned Ground Vehicles (UGVs), drones for reforestation, and pelletizers for pine needles.

Output

The learnings from the stakeholder interactions and the technology showcase have been compiled into a comprehensive TAN, which has been handed over to the Government of Uttarakhand on November 30, 2023 for driving technology uptake in Champawat district and subsequently across Uttarakhand.

Next Steps

1. UCOST to enable incorporation of technology uptake in the Champawat District plan and subsequently in the plans of other Districts of Uttarakhand.
2. Initiation of technology procurement by concerned District administration.
3. Scale-up of Technology advisory and interventions across Uttarakhand and subsequently to the larger IHR.

Collaborating Agencies

- Uttarakhand Council for Science and Technology (UCOST)
- Office of PSA
- District Administration, Champawat

Figure 10: Field Technology Showcase in Champawat, Demonstration of UGV

1.6 INNOVATION CHALLENGE FOR DEVELOPMENT OF MACHINE-AIDED TRANSLATION SYSTEMS (ICMATS)

The Innovation Challenge for Development of Machine-Aided Translation Systems (ICMATS), a pilot project of the Office of PSA, is targeted at involving industry/startups to get machine-aided translation systems developed using open-source translation tools and text corpus available in the public domain including those available through the language technology platform, Bhashini built by MeitY, and help the User Agencies in domain-specific translation.

Milestones

Major Milestones since July 2023 under ICMATS are:

Post successful completion of Stage 1 (Ideation Stage) and Stage 2 (Prototype Stage), two startups are selected as finalists for Stage 3 (Solution Building Stage) – krtrimaIQ Cognitive & First Language Technologies.

The two startups will be working on building solutions in language pairs of English to following of these languages - Hindi, Tamil, Telugu and Bangla, for the user agencies National Council of Educational Research and Training (NCERT) & Vigyan Prasar in domain specific translation area.

1.7 NATIONAL QUANTUM MISSION

National Quantum Mission (NQM) is one of the missions being driven by the PM-STIAC to leverage cutting-edge scientific research for India's sustainable development. Being led by the Department of Science and Technology (DST), NQM aims to build the national quantum technology ecosystem to foster research, development, and deployment of quantum infrastructure for practical use.

Following its approval by the Union Cabinet on April 19, 2023, several steps have been taken in recent months to lay the foundations of the Mission.

Milestones

Those steps are briefly mentioned below:

In close coordination with the Office of PSA, DST organized four National State-of-the-Art Meetings on Quantum Computing Hardware (July 11, 2023), Quantum Communication (July 12, 2023), Quantum Computing Software Ecosystem (July 25, 2023), and Quantum Sensing and Metrology (August 25, 2023). In each of these meetings, four or five structured presentations were made by leading scientists and engineers on the national status of R&D in these domains, the gap areas, and ideas about bridging those gaps to realize the aims of NQM. These presentations were prepared after seeking inputs from all the active groups in the country. Over 250 researchers joined these meetings in online mode and provided additional inputs.

Theme 2

Empowered Technology Group

2. EMPOWERED TECHNOLOGY GROUP

The Empowered Technology Group (ETG) was constituted by the Cabinet as an institutionalised structure to proactively lay down, coordinate, and oversee national-level policies relating to procurement and induction, and research and development in technologies that require large outlays in resources both financial and human and to render sound and timely advice for determining direction and trajectory of Government's R&D and Technology Development Programmes. The PSA is the Chair, and his Office serves as the ETG Secretariat. The ETG comprises of the following Members:

- Chairman, Atomic Energy Commission
- Chairman, Space Commission
- Chairman, Defence Research and Development Organisation
- Secretary, Ministry of Electronics and Information Technology
- Secretary, Department of Telecommunication
- Secretary, Department of Science and Technology

Milestones

The ETG meets regularly for the evaluation of Cabinet/Expenditure Finance Committee notes and policy documents which are sent by various ministries and departments.

The ETG Secretariat undertakes evaluation of these notes in the form of expert consultations and discussions on these proposals with stakeholders, prior to the ETG meetings.

Since April 2023, eight meetings of ETG have been held so far with the 53rd meeting taking place on October 30, 2023. During these meetings, 27 Cabinet proposals and other documents have been considered. These include proposals for the mega science project i.e., Square Kilometre Array, Taxnet 2.0 (for Income Tax Department), e-courts Phase III, proposals related to the semiconductor mission, scheme and policy for promotion of Research & Development and Innovation in the Pharma- Med Tech Sector, etc.

Theme 3

City Science and Technology (S&T) Clusters

3. CITY SCIENCE AND TECHNOLOGY (S&T) CLUSTERS

Launched in 2020, the City Science & Technology (S&T) Clusters is a flagship initiative of the Office of PSA, established on the recommendation of PM-STIAC. This initiative aims to tackle local challenges through S&T interventions by bringing together academia, R&D institutions, industries, startups, and local governments.

Currently, there are seven S&T Clusters operating in Bengaluru, Bhubaneswar, Delhi, Hyderabad, Jodhpur, Pune, and the recently established Northern Region Cluster in Chandigarh, all working to find solutions to regional issues through collaborative efforts.

Milestones

Major Milestones in the year 2023, to date, are:

3.1 PROJECT REVIEW AND MONITORING COMMITTEE (PRMC) MEETINGS

The activities of the S&T Cluster are periodically reviewed by the current PRMC constituted by the Office of PSA, with members from academia, research institutions, and industry. The emphasis is placed on the clusters undertaking end-user-based, impact-driven, and collaborative R&D projects.

3.1.1 Seventh PRMC Meeting to Review the Bengaluru Science and Technology (BeST) Cluster

The seventh PRMC Meeting to review the Bengaluru Science and Technology Cluster (BeST) was held at IISc Bengaluru on July 10, 2023.

Key Takeaways

- The meeting focussed on the review of funded themes of BeST including – One Health, Health and Wellness - Digital Podiatry Kiosk, Precision Agriculture, and non-funded themes of Quantum Technology, Urban Mobility, Jet Engines.
- Other themes that were briefly discussed were Karnataka Hydrogen Valley Consortium, Active Matter and micro-robotics.

3.1.2 Eighth PRMC Meeting to review Delhi Research Implementation and Innovation (Delhi S&T Cluster)

The eighth PRMC Meeting to review the Delhi Research Implementation and Innovation (DRIIV) – Delhi S&T Cluster was held at IIT Delhi on September 29, 2023 (Figure 11).

Key Takeaways

- The themes having interdisciplinary and inter-institutional potential were reviewed by the PRMC, which included - air pollution management in Delhi, e-mobility, Artificial Intelligence (AI)/Machine Learning (ML) in healthcare, effective education, water security, and solid waste management.

Figure 11: Dr. Swati Basu, Former Scientific Secretary, Office of PSA, chairs the PRMC Meeting along with other PRMC Members and participants

3.1.3 Ninth PRMC Meeting to Review Pune Knowledge Cluster (PKC)

The ninth PRMC Meeting to review the Pune Knowledge Cluster (PKC) – Pune S&T Cluster was held at the Inter-University Centre for Astronomy and Astrophysics, Pune on October 18, 2023 (Figure 12).

Key Takeaways

- The meeting focussed on the review of themes - sustainability and environment, health, big data & AI, mobility, capacity building and education.
- Programs anchored by PKC, such as - Teach with Tech program supported by Lenovo India; and the platform for Gamified Learning in Chemistry supported by Badische Anilin- & Sodafabrik, Germany, are helping create increased curiosity towards learning STEM (Science, Technology, Engineering, Mathematics) subjects.

Figure 12: Dr. Parvinder Maini, Scientific Secretary, Office of PSA along with PRMC reviewing the progress of PKC's verticals

3.1.4 Tenth PRMC Meeting to review Research and Innovation Circle of Hyderabad (RICH)

The tenth PRMC Meeting to review the Research and Innovation Circle of Hyderabad (RICH) – Hyderabad S&T Cluster was held at T-Hub Phase-2, Hyderabad on November 24, 2023.

Key Takeaways

The meeting focussed on a review of themes- food & agriculture, life sciences, and sustainability.

3.2 FIRST JOINT MEET OF SCIENCE & TECHNOLOGY CLUSTERS HELD IN JODHPUR

The first-ever joint S&T clusters' meet, held on October 26-27, 2023, was organized by the Jodhpur City Knowledge and Innovation Foundation (JCKIF) and hosted by IIT Jodhpur in Jodhpur. The meet saw active participation from all S&T clusters, including the Bengaluru Science & Technology Cluster (BeST), Bhubaneswar City Knowledge Innovation Cluster (BCKIC) Foundation, Delhi Research Implementation and Innovation (DRIIV), Research and Innovation Circle of Hyderabad (RICH), Jodhpur City Knowledge and Innovation Foundation (JCKIF), Northern Region S&T Cluster, and Pune Knowledge Cluster (PKC). This joint meeting aimed to foster exchange and collaboration among diverse regional clusters in the fields of science, technology, and innovation.

Key Takeaways

- PSA Prof. Ajay K. Sood highlighted that the S&T clusters are a unique initiative of the Office of PSA, focusing on the translational aspects of research (Figure 13). He also emphasized the need for the clusters' sustainability in the long run.
- Referring to the recently announced draft National Deep Tech Startup Policy, Prof. Sood suggested that clusters could collaborate effectively with Deep Tech startups operating under this policy framework.
- Dr. Parvinder Maini, Scientific Secretary, Office of PSA, highlighted the S&T clusters' role as shared ecosystems and regional solution providers, while promoting competitiveness on both national and global scales. Dr. Maini emphasised the prominent role S&T clusters can play in boosting India's Global Innovation Index and contributing to the global economy.
- The two-day meet witnessed in-depth discussions on identified themes and opportunities for interdisciplinary collaboration among clusters. The themes included: Healthcare, Energy and Environment, Agritech and Nutrition, STEM Education, Livelihood through S&T, and NorthEast Impact & Industry 4.0.
- PSA inaugurated an exhibition titled 'Kalaanubhav' featuring an innovation gallery and livelihood support initiatives (Figure 14).
- Students at IIT Jodhpur also presented cutting-edge technologies and research in the field of medical technology.
- PSA launched a healthcare compendium focusing on deployable technologies (Figure 15).

Figure 13: PSA Prof. Ajay Kumar Sood chaired the meeting with participation of representatives from 7 Clusters – BCKIC, BeST, DRIIV, JCKIF, PKC, RICH, and Northern Region S&T Cluster

Figure 14: PSA Prof. Ajay Kumar Sood along with Prof. Santanu Chaudhury, Director, IIT Jodhpur at the exhibition interacting with demonstrators

Figure 15: PSA Prof. Ajay Kumar Sood launching healthcare compendium focusing on deployable technologies

Theme 4

Indian Science, Technology, And Engineering Facilities Map (I-STEM)

4. INDIAN SCIENCE, TECHNOLOGY, AND ENGINEERING FACILITIES MAP (I-STEM)

The I-STEM Web Portal, supported by the Office of PSA, is the gateway for researchers to locate the specific facility(ies) they need for their R&D work and identify the one that is either located closest to them or available the soonest. Figure 16 represents the latest statistics on the I-STEM portal.

Figure 16: Latest statistics on I-STEM Portal, since its inception

Milestones

Major milestones in the year 2023 are:

A new Chief Operating Officer was appointed.

In June 2023, the I-STEM team created a wireframe and implemented the UI (User Interface) for the startups section of the I-STEM portal. Startups have begun registrations.

Events featured 'I-STEM demonstrations' were held to provide information to over 40 research-based startups about the available facilities and modules.

A webinar series was launched to provide an online platform to the private organizations and the government ministries for organising 'competitions' and 'challenges' for researchers.

A mobile app with a user-friendly interface for equipment booking is under development.

Theme 5

Mental Health and Normalcy Augmentation System (MANAS)

5. MENTAL HEALTH AND NORMALCY AUGMENTATION SYSTEM PROLIFERATION AND WELLNESS CONNECTIVITY (MANAS WeCONNECT)

The MANAS App was developed with support and funding from the Office of PSA. It offered scientifically validated indigenous content to strengthen overall mental well-being through self-analysis.

Recent Developments

Some recent developments under MANAS since June 2023 are:

A brainstorming session was organized on June 6, 2023, to bring together innovative ideas, techniques, and solutions for the organization of 'MANAS Codethon 2023'. The meeting was attended by members from the Office of PSA, technical experts from Centre for Development of Advanced Computing (C-DAC), SETS India, and experts from research and educational institutions nominated as core members.

The MANAS Codeathon and Symposium, held from October 6-7, 2023, was organized by C-DAC Bengaluru with the following primary objectives:

- To sensitize young individuals to mental well-being, fostering collaborative innovation in designing engaging solutions, games, and content.
- To collaborate with participants from diverse backgrounds to create new ideas, interactive digital and gamified content, and other digitized information, education, and communication (IEC) materials or aids for mental wellness.
- To provide exciting opportunities for teams to join forces and demonstrate their skills, creativity, and problem-solving abilities within a competitive and collaborative environment.

Milestones

On October 6, 2023, out of the 588 participants who formed 223 teams for the MANAS Codeathon, 27 finalist teams were selected and invited to demonstrate their innovative solutions, interactive content, games, applications, and algorithms related to mental well-being to the Jury Committee (Figure 17).

Figure 17: Dignitaries, winners and Runners of MANAS Codeathon 2023

In the MANAS Symposium held on October 7, 2023, the inaugural address was delivered by Dr. Parvinder Maini, Scientific Secretary, Office of PSA in the presence of Smt. Sunita Verma, Scientist G, MeitY, GoI, and Shri. Magesh Ethirajan, Director General, C-DAC, along with other dignitaries. During the MANAS Symposium on 'Mental Health and Wellness', experts engaged in insightful discussions, sharing their knowledge and perspectives on the critical subject matter (Figure 18). Lt Gen Dr. Madhuri Kanitkar (Retd), Vice Chancellor of Maharashtra University of Health Sciences, delivered the valedictory address online, and participants in each track of the Codeathon were awarded grand prizes.

Figure 18: Expert discussion during the MANAS Symposium on "Mental Health and Wellness".

Key Outcomes

The Codeathon yielded a diverse array of outcomes aimed at enhancing mental well-being. These included interactive content designed to engage and inform individuals on the subjects, such as IEC materials, mobile applications dedicated to offering convenient tools, and algorithms designed to address and provide solutions for mental health challenges. These outcomes collectively contribute to a more comprehensive and accessible approach to mental well-being and support.

Theme 6

Mega Science Vision

6. MEGA SCIENCE VISION

The periodic national consultative Mega Science Vision Exercise to lay down a roadmap for participating in mega science projects elsewhere in the world or establishing some such projects on Indian soil — viz. the Mega Science Vision (MSV)-2035 Exercise —, is being facilitated by the Office of PSA this time. It is currently underway in six disciplines, viz. Nuclear Physics, High Energy Physics, Astronomy and Astrophysics, Accelerator Science & Technology and Applications, Climate Research, and Ecology and Environmental Science.

Milestones

Important milestones achieved in recent months are mentioned below:

The MSV-2035-Nuclear Physics Report was completed by the national Nuclear Physics community under the leadership of Tata Institute of Fundamental Research, Mumbai, and was submitted to the Office of PSA. It was uploaded on the Office of PSA website and further steps were initiated to disseminate it widely.

Discussions were held with the Drafting and Working Groups working on the MSV-2035-Reports on Astronomy & Astrophysics, Accelerator S&T, and Applications and Climate Research for further modifications in the drafts.

Theme 7

Rural Technology Action Group (RuTAG)

7. RURAL TECHNOLOGY ACTION GROUP (RuTAG)

The Office of PSA launched RuTAG 2.0 in April 2023 with the objectives of connecting with stakeholders, to identify grassroots innovations, developing demand-driven technologies, validating prototypes, and commercializing technologies for national and global markets. The Office of PSA has allocated funding support to five project implementing agencies for a period of 36 months.

In this phase, RuTAG 2.0 is currently in progress with the following five institutions:

i) Indian Institute of Technology Bombay
ii) ICAR – National Academy of Agricultural Research Management, Hyderabad
iii) Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu and Kashmir
iv) Indian Institute of Technology Roorkee, and
v) Indian Institute of Technology Delhi

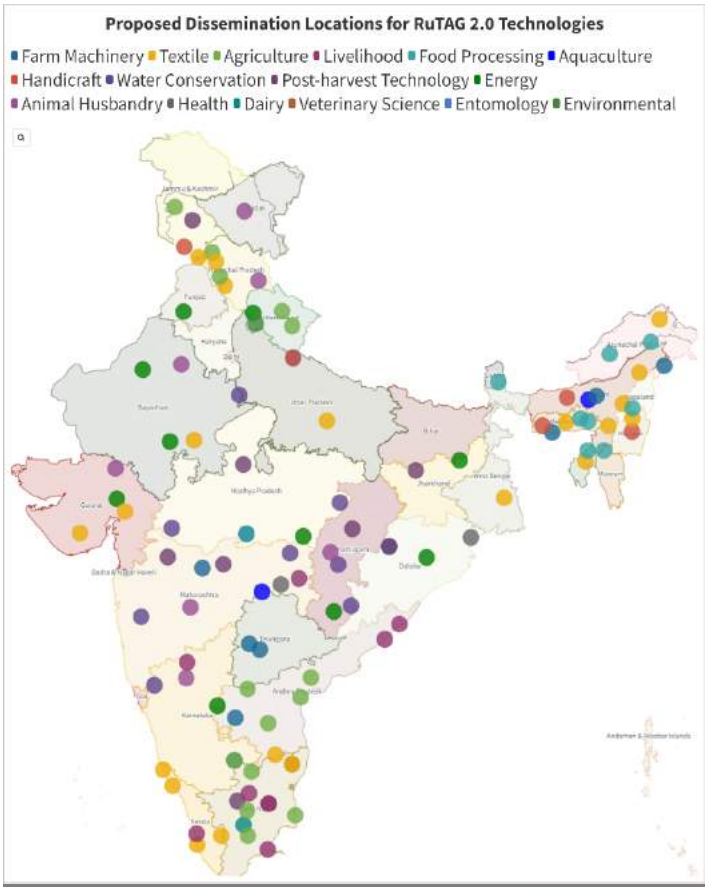


Figure 19: Geographical Spread of Proposed Dissemination Locations for RuTAG 2.0 Technologies

These project-implementing agencies have proposed an impressive total of 75 technologies across a wide range of sectors, encompassing agriculture, textiles, energy, livelihood, post-harvest and food processing, water conservation, animal husbandry, aquaculture, dairy, environmental conservation, healthcare, and more. The anticipated dissemination of these innovative technologies' spans over 25 states and two Union Territories, ensuring widespread impact as depicted in Figure 19.

Initiating RuTAG 2.0 project activities, ICAR-NAARM conducted an accelerator mentorship program for selected innovators from November 22-24, 2023 at ICAR-NAARM, Hyderabad.

Further, RuTAG, IIT Roorkee organized a two-day training programme "Wool Processing-Raw Wool to Fabric," on December 20-21, 2023, at IIT Roorkee. The workshop aimed to empower artisans, especially women, in the wool sector through small-scale wool processing. Practical sessions, demonstrations, and discussions were also conducted, aligning with the commitment to rural socio-economic development and sustainable technologies.

Theme 8

Techno-Economics

8.1 EVALUATION OF INNOVATION EXCELLENCE INDICATORS OF PUBLIC-FUNDED R&D ORGANISATIONS

In 2019, the Office of PSA initiated a study to capture and assess innovation indicators within publicly funded Research and Development (R&D) labs. The goal was to comprehensively and quantitatively understand the contributions of these institutions, building upon the initial framework developed by NITI Aayog. This initiative aimed to evaluate the absolute and relative strengths and weaknesses of these labs, enabling them to re-evaluate their mission and research output in accordance with the current national requirements and goals. The first round of the study concluded in March 2022.

Milestones

In October 2023, the second round of the study was duly approved by the competent authority featuring an expanded scope that encompasses about 394 publicly funded R&D laboratories, as against 193 laboratories covered in the first round.

On November 3, 2023, the Techno-Economic unit convened the kick-off meeting for the second round and considered the implementation plan presented by the Confederation of Indian Industry (CII) which has been re-engaged as the knowledge partner for this round. In accordance with this plan, the framework for the evaluation and assessment of the participating laboratories is under revision. This inter-alia covers 62 indicators that were used in the first round.

The contact details of the labs that are going to be surveyed are being collated and the survey instrument for data collection (online portal) is also under updation.

Collaborating Agencies

- Office of PSA
- Stakeholder Ministries/Departments in GoI
- Confederation of Indian Industry (CII)

8.2 STATE GOVERNMENT R&D BUDGET

The role of the State Governments is crucial in boosting the Gross Domestic Expenditure on Research and Development (GERD). It serves as an integral component in the National Research and Development (R&D) ecosystem. The primary goal of R&D Budgeting by States is to institutionalize a mechanism to capture and disclose the R&D expenditure of the concerned state/UT department/subject-wise, a practice that is currently not in vogue.

Milestones

The Office of the PSA took up the initiative and approached the Reserve Bank of India (RBI) to collect, collate and publish R&D expenditure data of different States/UTs drawing from their respective state budgets.

In response to this initiative of the Office of the PSA, RBI in its latest flagship publication titled "State Finances: A Study of Budgets 2023-24" published on December 11, 2023 (Figure 20) included a dedicated section on States' Expenditure on R&D under Chapter II: Fiscal Position of the State Governments.

In this section, R&D expenditure data of 10 States and UTs is covered. They are Bihar, Haryana, Jammu & Kashmir, Karnataka, Odisha, Puducherry, Rajasthan, Sikkim, Tamil Nadu, and West Bengal.

The analysis of the data of these 10 states/UTs indicates an enhancement in the overall quality of expenditure by the States during the post-pandemic period. Notably, there has been an increase in the proportion of spending on health-related R&D, while expenditure on agricultural research has seen a decline.

The data obtained from the participating states has also highlighted that the states primarily allocate expenditures in the areas of medical services, health, family welfare, sanitation, and agricultural research.

Collaborating Agencies

- Office of PSA
- Reserve Bank of India (RBI)
- State Governments

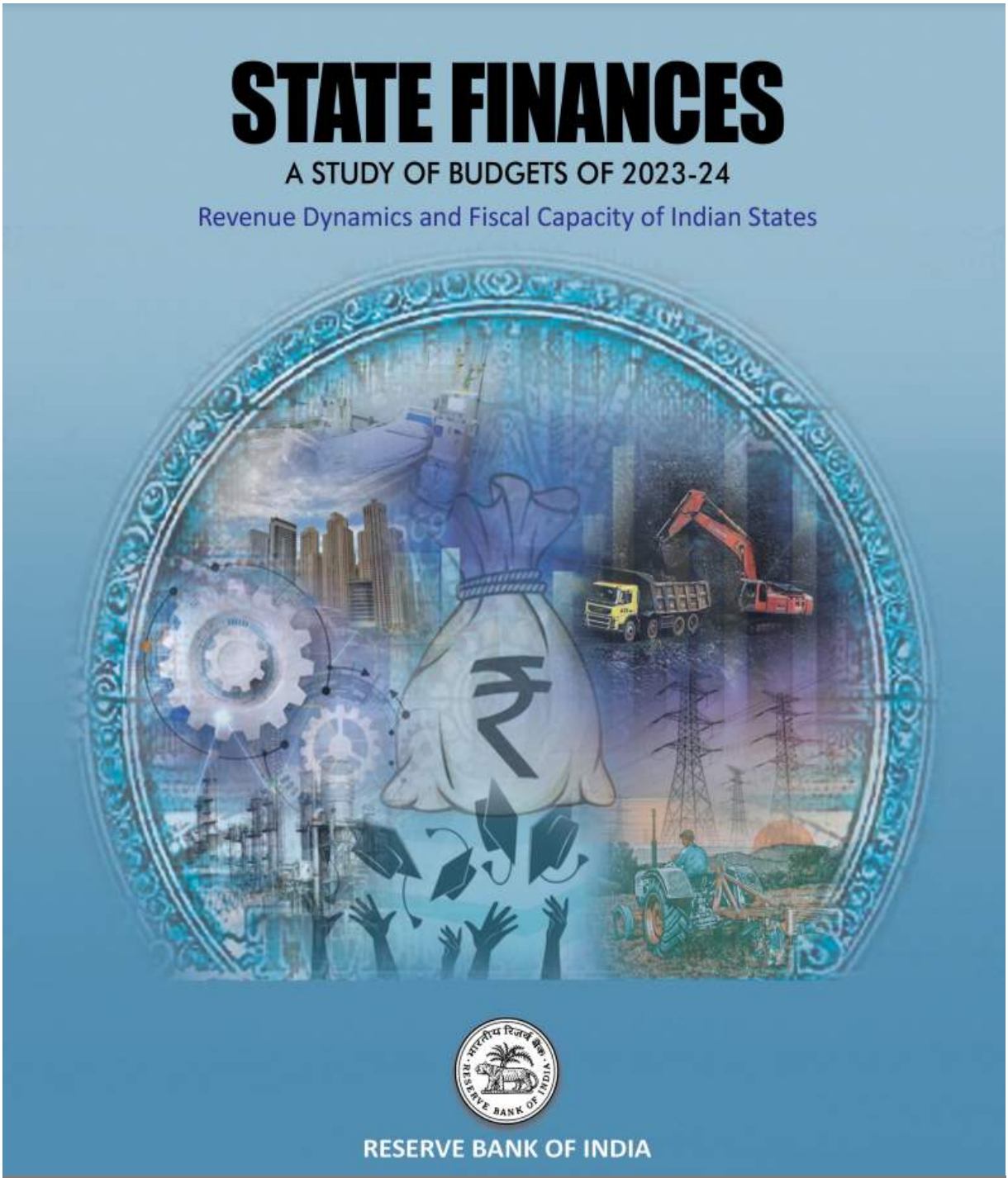


Figure 20: State Finances: A Study of Budgets 2023-24

The report can be accessed *here*:

For more information, please scan the QR Code

Theme 9

Science and Technology Capacity Building

9. SCIENCE, TECHNOLOGY, INNOVATION (STI) CAPACITY BUILDING

The STI-CB Cell, a collaborative initiative between the Office of PSA and the Capacity Building Commission (CBC), is playing a pivotal role in enhancing the capacity of India's scientific workforce. The cell's focus on upskilling and future training, as well as its tailored interventions for junior and senior-level scientists, is essential to ensuring that India's scientific community remains at the forefront of global innovation. The curated Annual Capacity Building Plan (ACBP) provides a comprehensive and data-driven roadmap for building the capacity of scientists at all levels, across a wide range of S&T disciplines. The ACBP's calendarized structure and focus on both training and non-training interventions make it a valuable resource for both scientists and S&T institutions.

Milestones

Between August 2023 and December 2023, STI-CB cell has been part of:

ACBP launch of Ministry of Earth Sciences (MoES) by Honourable Minister of Earth Sciences Shri Kiren Rijiju and Secretary of MoES Dr. Ravichandran on September 14, 2023 at Prithvi Bhavan, as seen in Figure 21.

Figure 21: Launch of MoES Annual Capacity Building Plan

STI-CB Cell visited the GSI office, Hyderabad to present and brief about the ACBP process and capacity building exercises to the Director General and Senior staff members of the Geological Survey of India. Also, a compendium of iGOT courses by GSI was launched.

STI-CB Cell coordinated an "Emerging Technology for Digital Transformation" online workshop for all government staff with the Wadhwani Institute of Technology and Policy that highlighted the usage of regenerative AI in the government. The details of the workshops are mentioned below:

Date	Department	Workshop Title
5 June 2023 & 7 June 2023	ISRO	Emerging Technologies Workshop at ISRO Headquarters
7 Aug 2023 & 8 Aug 2023	ISRO	Emerging Technologies Workshop at NRSC, Hyderabad
12 Sept 2023 & 13th Sept 2023	ISRO	Emerging Technologies Workshop at Space Application Centre
6th Nov 2023 & 7th Nov 2023	MoES	AI for digital transformation (as seen in Figure 22)
8th Nov 2023 & 9th Nov 2023	MoES	Data Driven Decision Making

Figure 22: AI workshop at ISRO

Theme 10

Important Initiatives

10.1 ONE NATION ONE SUBSCRIPTION

The One Nation One Subscription (ONOS) initiative is aimed at providing access to scholarly research content to all individuals in the country. ONOS intends to acquire national licenses for e-journal/database subscriptions from most of the prominent STEM and social sciences publishers and database providers by combining multiple institutional and consortia-based subscriptions. Concessions on Article Processing Charges (APCs) for open access publications is also envisioned as part of ONOS. Implementation of ONOS, which is expected to benefit all academic and R&D institutions including universities, colleges, research organisations in the country, will be done in a phased manner.

Milestones

The negotiations for commencement of ONOS from January 1, 2024 were held on October 11-12, 2023 and on October 25, 2023.

Negotiations were held with 41 publishers (journals, citation databases and standards) who are commonly subscribed by the 10 library consortia in the country. These include prominent STEM and social sciences publishers like Elsevier, Springer Nature, Taylor & Francis, Wiley, etc.

All concerned ministries and departments will be notified about further steps to be taken regarding their library subscriptions with the selected publishers by end of the year.

Collaborating Agencies

- Department of Higher Education
- Department of Science & Technology
- INFLIBNET Centre, Gandhinagar

10.2 CONSULTATIVE GROUP ON E-MOBILITY (CGeM)

The logistics sector, vital for efficient goods movement, faces significant expansion, with a projected fourfold increase in freight volume by 2050, 70% of which is attributed to trucking. To meet this demand and reduce environmental impact, there's an urgent shift towards zero-emission trucks (ZETs), such as battery electric trucks, hydrogen fuel cell electric trucks, and hydrogen internal combustion engine trucks as they promise improved efficiency, lower costs, and environmental benefits.

After releasing the Technology Roadmap for ZET in March 2023, the office has constituted a committee to study the Delhi-Jaipur corridor for a pilot and scaled ZET deployment. Rocky Mountain Institute is collaborating on groundwork and modelling for the study. The Delhi-Jaipur corridor is chosen as a model corridor to assess various ZET technologies' cost, viability, and operability. The report evaluates seven infrastructure technologies viz Fast Charging, Ultra-Fast Charging, Battery Swapping, Catenary, Induction Charging, Hydrogen (H2) Internal Combustion Engine (ICE) and H2 Fuel Cell Electric Truck (FCET). The two deployment phases considered are (i) a pilot with 100 trucks by 2025 and (ii) a scaled operation of 5,500 trucks by 2030. The analysis encapsulates costs, advantages, challenges, and optimal use scenarios, ensuring stakeholders are well-equipped to navigate the sustainable freight transport future.

Key Takeaways

The key takeaways from the report are:

1. Fast charging stands out for its manageable charging schedules and high technology readiness level, but it comes with a trade-off of reduced payload capacity due to large batteries and extended charging downtime. This technology is best suited for fleets with overnight depots, well-defined routes with set start and end points, and readily available downtime for charging. It is ideal for volume-constrained loads such as white goods and auto parts.
2. Ultra-fast charging offers quicker refuelling time but introduces high peak demand and associated grid costs. It is best deployed along highly travelled trucking corridors where infrastructure can have high utilization and ample upstream power availability, catering to volume-constrained loads like white goods and e-commerce.
3. Battery Swapping offers rapid refuelling, but it comes with the drawback of high spare battery costs and the need for battery standardization. It is suitable for fleets conducting frequent trips under closed-loop systems and with limited downtime for charging, serving volume-constrained loads such as white goods, e-commerce, and auto parts.

4. Catenary and induction technologies limit downtime due to en-route charging, use smaller battery packs, and charge batteries in motion, but they face uncertainties regarding infrastructure costs, technology lock-in, and lower technology readiness levels. Catenary is best for fleets deployed along short, closed-loop corridors near infrastructure catering to heavy loads like construction aggregates. Meanwhile, induction technology caters to fleets along short, closed-loop corridors near infrastructure catering to heavy loads like construction aggregates but has limited real-world demonstrations.
5. Hydrogen-based solutions, including H2 ICE and H2 FCET, offer minimal payload penalties for applications like bulk goods and rapid refuelling time, but they come with drawbacks such as high fuel costs, emissions of NOx, and limited demonstrations. These technologies are suitable for fleets traveling long distances requiring minimal downtime and serving heavy bulk loads like construction aggregates, blue metal, and cement.

It can be said carefully that the choice of technology for freight transportation depends on specific use cases and trade-offs between each technology must be examined in the context of its application and operational needs.

Milestones

The report was shared with Shri Nitin Gadkari, the Honourable Minister of Road Transport and Highways (Figure 23). A meeting was held under his chairmanship to discuss the recommendations outlined in the report. The meeting was attended by representatives from the Office of PSA, MNRE, Ministry of Road Transport and Highways, and domain experts. The report was subsequently published by the Office of PSA and can be accessed *here*.

For more information, please scan the QR Code

This report is an addendum to the document titled 'Technical Roadmap for Deployment of Zero-Emission Trucking in India Technology Roadmap' published in March 2023 by the Office of PSA.

Figure 23: H'nble Minister Shri Nitin Gadkari takes review meeting to discuss recommendations on report

Theme 11

International Engagements

11.1 G20-CHIEF SCIENCE ADVISERS' ROUNDTABLE

India's G20 Presidency successfully achieved another milestone with the introduction of the G20-Chief Science Advisers' Roundtable (G20-CSAR). The initiative was introduced as a new addition under the G20 framework during India's Presidency and was led by the Office of PSA. This historic endeavour marked the first time that the Government Chief Science Advisers and nominated equivalents were convened under the G20 framework to deliberate on the need for an inclusive science advice mechanism for evidence-informed policymaking globally.

G20-CSAR began with its planning meeting in January 2023. Under the initiative, a series of four intersessional meetings, nine side events, and multiple bilateral and plurilateral discussions were organized leading to the second meeting of G20-CSAR in August 2023.

The second convening of G20-CSAR took place from August 27-29, 2023 at Mahatma Mandir Convention Centre in Gandhinagar, Gujarat (Figure 24) bringing together Chief Science Advisers and their counterparts from G20 and invitee countries. The meeting also had participation from two international organisations - WHO and UNESCO. Delegates around the table delved into the four agenda items and discussed the draft Outcome Document. Expressing their vision for the initiative, the discussions were centered around the four agenda topics: (i) Opportunities in One Health for better disease prevention, control, and pandemic preparedness (ii) Synergising global efforts to expand access to scholarly scientific knowledge (iii) Diversity, Equity, Inclusion, and Accessibility (DEIA) in Science and Technology Ecosystem (iv) Creating an inclusive, continuous, and action-oriented Global Science Advice mechanism. Following the comprehensive discussions, the G20 and invitee country delegates adopted the Outcome Document and Chair's Summary.

Figure 24: Second Meeting of G20-CSAR in Gandhinagar, Gujarat

The summit began with the G20-CSAR delegation visiting the majestic Modhera Sun Temple in Gujarat's Mehsana district where a cultural event featured a light and sound show and a cultural performance celebrating India's Chandrayaan-3 mission. Following this, delegates were received at the gala dinner hosted by the Honourable Chief Minister of Gujarat, Shri Bhupendrabhai Patel, as seen in Figure 25.

Figure 25: State cultural event at Modhera Sun Temple hosted by Honourable Chief Minister of Gujarat

On the day of the meeting, G20-CSAR delegates experienced traditional bazaar set up by artisans and weavers from Gujarat at Mahatma Mandir Convention Centre (meeting venue), as seen in Figure 26. Later in the evening, they explored Dandi Kutir, India's largest museum dedicated to Mahatma Gandhi's life and teachings.

Figure 26: Traditional Bazaar at the meeting venue in Gandhinagar for Second G20-CSAR meeting

In a baton passing ceremony (Figure 27), the initiative was passed on to Brazil. Now, as the leadership baton passes from India to Brazil, the aim is to foster ongoing deliberations and provide a platform where members and international organizations can come together to address multidisciplinary issues. The collective vision is to offer synergistic science advice and employ Science Diplomacy to promote collaboration among various stakeholders.

Figure 27: G20-CSAR Chair and PSA Prof. Ajay Kumar Sood passing the Baton of G20-CSAR to Prof. Marcia Barbosa Vice Minister, MCTI, Brazil

Milestones

The CSAR Secretariat organized four intersessional meetings in August 2023 to converge on the Outcome Document leading up to the second meeting of G20-CSAR. These four meetings held on August 3rd, 9th, 18th, and 27th respectively, played a crucial role in driving inputs and deliberations that shaped the Outcome Document.

G20-CSAR held nine side events across the country to engage a wider community in discussions related to its agendas. Six of these side events were hosted by S&T Clusters in Bhubaneswar, Hyderabad, Delhi, Pune, Bengaluru, and Jodhpur. Two events in Delhi were hosted by the Office of PSA- led G20-CSAR Secretariat and the Netherlands Innovation Network India to further the conversation on Inclusive Global Science Advice.

The nine side events are listed below:

1. CII Global Science, Research and Innovation Summit

The Confederation of Indian Industry, in partnership with the Office of PSA, NITI Aayog, CSIR, TIFAC, IGSTC, DRDO, and IIT Delhi organised the 'CII Global Science, Innovation, and Research Summit' on May 2, 2023. The event was organized as part of the CII National Technology Mission, aimed at fostering investment in R&D, promoting Industry-Academia-Research-startup collaborations, and encouraging Women in STEM fields. One of the noteworthy aspects was a special panel on 'Nurturing Future-Ready Skilled Workforce.

2. Bhubaneswar City Knowledge Innovation Cluster

Bhubaneswar City Knowledge Innovation Cluster (BCKIC) Foundation, in collaboration with DBT-Institute of Life Sciences (DBT-ILS), Bhubaneswar, convened a roundtable on June 29, 2023, addressing key issues on the theme 'Diversity, Equity, Inclusion, and Accessibility in Science and Technology' (Figure 28). This event attracted approximately 100 attendees, including representatives from the State S&T Ministry, scientists, researchers, administrators, and students, all contributing their perspectives to the discourse. The deliberations focussed on integrating diverse fields for inclusiveness and accessibility, this included 'Women in STEM', 'Grassroot Innovators', 'Innovations for better Health', 'Women Entrepreneurship' as well as understanding the ground requirements from field.

Figure 28: G20-CSAR Side Event on Diversity, Equity, Inclusion, and Accessibility in Science & Technology (S&T) in progress at DBT ILBS, Bhubaneswar

3. Research and Innovation Circle of Hyderabad

Research and Innovation Circle of Hyderabad (RICH) organized a workshop titled 'Synergizing Global Efforts to Expand Access to Scholarly Scientific Knowledge Roundtable' under the umbrella of G20–CSAR. The workshop took place on July 5, 2023, at the International Institute of Information Technology Hyderabad and was attended by 42 distinguished scientists, representing 27 research institutions across various fields. With a primary objective of enhancing collaboration and knowledge exchange among industry professionals, the workshop provided a platform for in-depth sub-thematic deliberations, enabling participants to engage in extensive discussions and formulate action plans. These efforts aimed at coordinating actions to achieve open access to scholarly knowledge generated through publicly funded research (Figure 29).

Synergizing Global Efforts to Expand Access to Scholarly Scientific Knowledge: A workshop under the aegis of G20–Chief Science Advisers' Roundtable Concludes Successfully

Hyderabad , July 11, Research and Innovation Circle of Hyderabad (RICH), the S&T city cluster for the Office of the Principal Scientific Adviser to the Government of India, hosted a workshop on 'Synergizing Global Efforts to Expand Access to Scholarly Scientific Knowledge Roundtable', under the aegis of G20–Chief Science Advisers' Roundtable (G20–CSAR) today.

The workshop was attended by 42 eminent scientists representing 27 research institutions spanning various domains. These scientists deliberated and formulated action plans for synchronising efforts to achieve open access to the scholarly knowledge created by publicly-funded research. The objective of the deliberation was to create a future where access to scholarly scientific knowledge is not limited by geographical boundaries or economic constraints for the growth of science.While the G20 nations collectively contribute approximately 85% of the world's scientific knowledge, challenges persist in the dissemination of research due to high subscription costs and limited accessibility. These barriers, coupled with exorbitant article processing charges (APCs) imposed by journals, hinder the progress of open access initiatives.

For discussing various aspects of the topic in question, the workshop participants were divided into three sub-thematic groups: Access, Data Repository, and Quality of Research and Publication. During the roundtable discussions, eminent researchers and scientists shared their valuable inputs across the three sub-themes.

Various open access models were deliberated. The green open access model stood out as the preferred choice.

Figure 29: Newspaper Coverage on the G20 Side Event by RICH, Hyderabad

4. Office of Principal Scientific Adviser to Government of India

A dialogue on 'Institutionalising Global Science Advice' was organized under the aegis of G20-CSAR on July 6, 2023 by the Office of PSA at Vigyan Bhavan Annexe, New Delhi. The central focus of the dialogue was the imperative of 'Strengthening and Institutionalising Science Advice for Global Policy.' The dialogue witnessed participation of stakeholders and representatives from pertinent government departments, foreign missions in India, academia, and policy institutions. Dr. Parvinder Maini, Scientific Secretary, Office of PSA delineated India's Science Advice mechanism and its institutional framework. Following the talks, a fishbowl-style discussion ensued, where the invited experts articulated their perspectives on institutionalizing the science advice mechanism and delineated the pivotal role of G20-CSAR.

5. Pune Knowledge Cluster

Pune Knowledge Cluster (PKC) organised a G20-CSAR side event focusing on One Health, Disease Surveillance, and Pandemic Preparedness on July 10, 2023, at IISER Pune. The event was attended by 94 participants from 43 diverse organizations including hospitals, research institutions, civic bodies, foundations, startups, and industries. In the event, the importance of building and scaling up the Wastewater Surveillance frameworks for variety of diseases was discussed. The role of foundations in aiding the Government of India initiatives to enable successful implementation of disease surveillance programs, building communication tools for handling crises, standardised data collection methods, intelligent data sharing were also deliberated (Figure 30).

Figure 30: Dr. Priya Nagaraj, CEO, PKC with the distinguished speaker panel at the G20-CSAR Side event

6. Bengaluru Science & Technology Cluster

Bengaluru Science & Technology (BeST) cluster organized a roundtable discussion on July 21, 2023 on the topic 'An Institutional Mechanism for Inclusive, Continuous, and Action-Oriented Global Science & Technology Policy Dialogue'. Approximately 22 attendees including experts from diverse backgrounds, and delegates from Switzerland, France, Netherlands, and Israel converged for a focused discussion on urban mobility and quantum technology. The key challenges in S&T policy that were identified are: difficulties in conducting data-informed science; 'language' barriers between scientists and non-scientists; limited workforce in cutting-edge S&T; and navigating intellectual property rights and country-specific regulations.

7. Delhi Research Implementation and Innovation

Delhi Research Implementation and Innovation (DRIIV) organized a G20-CSAR side event on August 8, 2023 on the topic 'Role of Open Access in Equitable Climate and Health Action: Prevention, Response, and Financing,' under the aegis of G20-CSAR. The conference emerged as a vital platform for fostering global dialogues and collaborations concerning the intricate synergy between climate and health. This event highlighted the indispensable role that open access to data, research, and resources plays in crafting equitable solutions to climate change mitigation challenges. Dr. Parvinder Maini, Scientific Secretary, Office of PSA, graced the event with a keynote address, illuminating the core objectives of the conference and emphasizing the imperative for collective action in the face of these pressing challenges (Figure 31).

Figure 31: Dr. Parvinder Maini, Scientific Secretary, Office of PSA launched the DRIIV Handbook at the event

8. Jodhpur City Knowledge and Innovation Foundation

Jodhpur City Knowledge and Innovation Foundation (JCKIF) and IIT Jodhpur organized two-day G20-CSAR side events on 'Diversity, Equity, Inclusion, and Accessibility in Science & Technology (S&T), with a focus on Plan and Policy for S&T Powered Global Action' and 'One Health for Well-being of All' on August 19 and 20, 2023 respectively. The event on Day 1 included an engaging Panel Discussion on Social Inclusion and Diversity, as well as Livelihood, Regional Diversity, and Science & Technology. These sessions, led by experts, facilitated profound discussions, enhancing attendees' understanding of these critical topics and encouraging collaborative dialogue among participants. The objective of the Day 2 event was to convene prominent experts, researchers, policymakers, and practitioners from across the nation to collectively address issues concerning One Health for the Well-being of All.

9. Netherlands Embassy in partnership with the Office of PSA

A seminar on Diversity, Equity, Inclusion, and Accessibility in Science & Technology was jointly organized by the Kingdom of Netherlands Embassy in India and the Office of PSA on August 30, 2023. This event served as a follow-up to the G20-CSAR emphasizing the ongoing collaboration between the Netherlands and India in shaping a diverse, inclusive, and accessible scientific landscape. Hosted by Ambassador Marisa Gerards, the event featured enlightening keynotes from prominent figures, including Scientific Secretary Dr. Parvinder Maini, Director General of TERI Vibha Dhawan, and Professor Wiebe Bijker from NWO in the Netherlands. The seminar delved into the significance of epistemic justice, the diversity of people and knowledge, and global cooperation in the realm of Science and Technology.

11.1.1 Dialogue 2023: Expanding Science and Technology Horizon

The Office of Principal Scientific Adviser to the Government of India and the Indian IISc, Bengaluru jointly hosted *Dialogue 2023: Expanding Science and Technology Horizon* Summit Bengaluru on November 18, 2023. The inaugural session featured a keynote address by PSA Prof. Ajay Kumar Sood speaking on the theme 'Expanding S&T Horizon: Within and Beyond'. He spoke about India's key technological missions and their convergence toward socio-economic progress. Prof. G. Rangarajan, Director, and Prof. T.A. Abinandanan, Head of Policy Units at IISc Bengaluru, also joined the inaugural session (Figure 32).

Figure 32: PSA Prof. Ajay Kumar Sood delivers keynote address at Dialogue 2023

The forenoon sessions were focused on the theme of 'Shaping Technological Futures' featuring discussions on the topics, 'Ethics of Disruptive Technologies' and 'Charting Global Technology Competitiveness'. The afternoon sessions were focused on the theme, 'Science, Technology and Society' featuring a workshop on 'Diversity of Knowledge: People and Practice' and a popular talk on 'Perception of Science'.

The first session in a dialogue format hosted a conversation between two experts in the broader technology space; Dr. Sharad Sharma, Co-Founder of iSPIRT who brought the technology development angle, and Prof. Nimmi Rangaswamy who brought the ethical angle of technology's impact on society. The two speakers spoke about technological advancement, ethical principles, and anticipatory governance when looking at disruptive technologies. Both speakers, while focusing on some of the key emerging technologies, touched on the technology life cycle and how ethical and governance deliberations form a critical layer (Figure 33).

Figure 33: Panel discussion on first session 'Ethics of Disruptive Technologies'

The second session featured a special address by Shri Abhishek Singh, IAS, President & CEO of the National e-Governance Division and MD & CEO of Digital India Corporation, followed by a panel discussion. Mr. Singh spoke about India's success with initiatives during the G20 Presidency and India's assuming Chair for Global Partnership on AI. While speaking on the Digital Public Infrastructure Initiative and India's pitch for taking DPIs globally, he added focus on India's tech competitiveness globally and shaped the tone for a panel discussion that followed this address. The panel hosted eminent speakers including H.E. Alex Ellis, High Commissioner of the United Kingdom to India;

Ms. Nivedita Mehra, Managing Director, US India Strategic Partnership Forum (USISPF); and Ms. Wiebke Doerfler, Managing Director, The Bavarian-Indian Centre for Business and University Cooperation. Speaking on various technological advancements, the panelists added on various strategies countries use to strengthen technological competitiveness. They deliberated on the key principles of trust and dependency which shape most global cooperation on technology. The panel concluded with panelists speaking about India's tech partnerships with various countries that they represented.

The workshop on Diversity of Knowledge had two segments of lightning talks from eminent speakers followed by an open panel discussion where speakers and participants engaged in a free-flowing exchange of thoughts (Figure 34). In the first segment, Prof. Wiebe Bijker, Professor Emeritus of Maastricht University, challenged the conventional view of knowledge as a hierarchical scale by presenting various examples and perspectives from practitioners. This segment also featured presentations by Dr. Annapurna Mamidipudi of the Technical University of Berlin, and Ms. Uzramma, Co-founder of Handloom Futures Trust, Hyderabad, capturing the plurality of knowledge from both academic and practitioner viewpoints. In the second segment, Prof. Anil K. Gupta, Founder of Honey Bee Network, SRISTI, and GIAN, as well as Visiting Faculty at IIM-Ahmedabad & IIT-Bombay, shared a narrative of 'from sink to source,' highlighting the importance of treating local knowledge holders as valuable sources of knowledge in our policies. This segment also featured talks by Dr. Viswajanani Sattigeri, Head of CSIR-Traditional Knowledge Digital Library, on policy perspective on integrating traditional knowledge systems; and by Dr. Anamika Dey, CEO of Grassroots Innovations Augmentation Network, on viewing the diversity of knowledge through a gender lens.

Figure 34: Workshop on Diversity of Knowledge

The summit concluded with a closing plenary session through a popular talk on 'Public Perception of Science' delivered by Prof. Shubha Tole, Senior Scientist and Dean at Tata Institute of Fundamental Research, Mumbai (Figure 35). The session was chaired by Prof. Navakanta Bhat, Dean, Division of Interdisciplinary Sciences, IISc Bengaluru. In her talk, Prof. Tole shared insights and recommendations on strengthening public understanding of science, highlighting the importance of science outreach and the need for building suitable capacity in academic institutions.

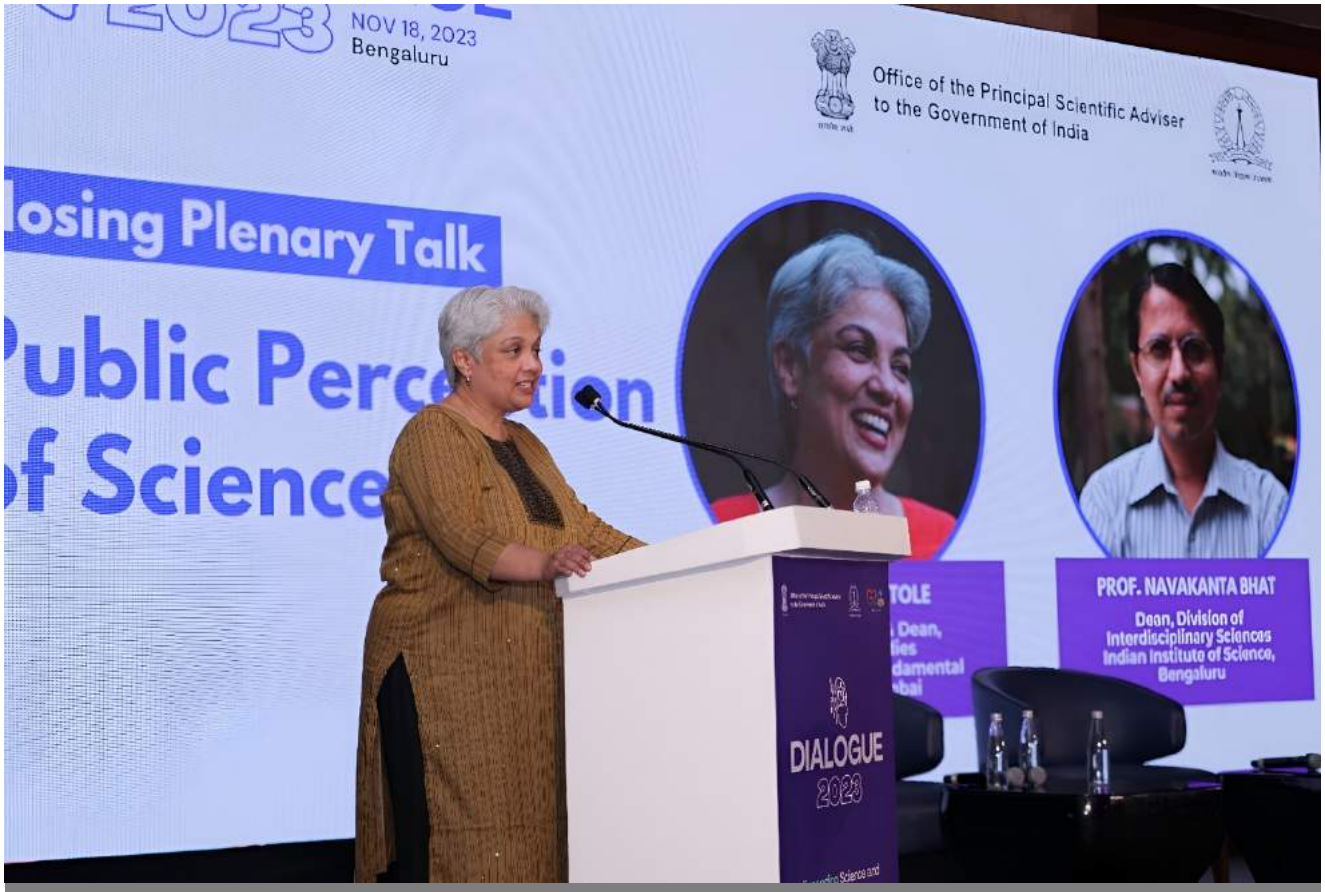


Figure 35: Prof. Shubha Tole delivers closing plenary session talk

'Dialogue 2023' provided a platform for in-depth discussions on some of the contemporary science and technology policy issues with an extended stakeholder base. The sessions throughout the summit featured experts from various fields and highlighted the importance of themes ranging from ethical considerations to global competitiveness and the diversity of knowledge in shaping the future of science and technology. The summit culminated in an engaging open discussion, providing participants with the opportunity to share their thoughts and insights.

11.2 QUANTUM

11.2.1 The Indo-US Quantum Coordination Mechanism under US-India Initiative on Critical and Emerging Technologies (iCET)

In 2022, the US and India initiated the US-India Initiative on Critical and Emerging Technologies (iCET) and established a joint Indo-US Quantum Coordination Mechanism led by PSA Prof. Ajay Kumar Sood and Dr. Charles Tahan. Subsequently, the first US-India Dialogue on Quantum Information Science and Technology (QIST) was held in May 2023, discussing potential areas of collaboration and cooperation, with plans for future workshops. President Biden and Prime Minister Modi welcomed the initiative in a joint statement, highlighting as important follow-up steps India's participation in the Quantum Economic Development Consortium (QED-C) and the Quantum Entanglement Exchange, as well as the development of an Indo-US Quantum Cooperation Agreement.

Milestones

Notable progress has been made on the above items in recent months as mentioned below:

In September 2023, the SN Bose National Centre for Basic Sciences, Kolkata, an autonomous R&D institution under DST, became a member of QED-C. In September 2023, India also joined the Quantum Entanglement Exchange. DST also readied an advanced version of the Indo-US Quantum Science and Technology Agreement in close consultation with the Office of PSA for further discussion.

11.2.2 Quad Centre of Excellence on Quantum Information Sciences (Quad CoE-QIS)

During the third Quad Summit at Hiroshima on 20th May 2023, the Quad Centre of Excellence on Quantum Information Sciences (Quad CoE-QIS) was established. The Quad CoE-QIS, or Quantum CoE in short, was launched with its Inaugural Meeting at Melbourne on July 9, 2023. In this inaugural meeting, it was decided that the CoE should have four co-chairs, one from each of the four Quad nations. It was also decided that four Task Forces on Computing, Communications, Sensors, and Ecosystem and Workforce Development, one led by each Quad nation, would be formed as technical think-tanks to assist the CoE in its work.

Milestones

Considerable progress has been made in the CoE-related work in recent months as mentioned below:

Japan and the US have now completed the process of nominating their co-chairs. Accordingly, Dr. Hiroaki Aihara, Executive Vice President, University of Tokyo, and Dr. Celia Merzbacher, Executive Director, QED-C, have now joined the two originally appointed co-chairs — Dr. Cathy Foley, Chief Scientist-Australia and PSA Prof. Ajay Kumar Sood —as CoE co-chairs.

The four nations also made their choices about the TFs that they would lead. They decided as follows – Ecosystem and Workforce Development (Australia), Communications (India), Computing (Japan), and Sensors (US). They also nominated their leads for the Task Forces — Ecosystem and Workforce Development (Dr. Cathy Foley, Chief Scientist, Australia), Communications (Prof. Anil Prabhakar, IIT Madras, India), Computing (Dr. Hiroaki Aihara, EVP-University of Tokyo-Japan) and Sensors (Dr. Celia Merzbacher, ED-QED-C-USA). The members of Task Forces from various nations were also nominated.

Next, the Task Forces were launched in a meeting with co-Chairs on November 7, 2023 (IST). The goals and a first list of Key Performance Indicators for the CoE and TFs were discussed. As a near-term goal, each Task Force will prepare a short White Paper identifying the opportunities for Quad nations to achieve a global leadership position in Quantum Science and Technology, and ways and means of achieving that position. Some important aspects of the contents of the White Papers were also discussed.

11.4 INDIA-EUROPEAN UNION TRADE AND TECHNOLOGY COUNCIL

11.4.1 International Workshop on Green and Clean Energy Technologies

Under the India-European Union (EU) Trade and Technology Council (TTC), a two-day International Workshop on Green and Clean Energy Technologies was organized on October 10-11, 2023, with an objective to exchange the key insights on policy and regulatory frameworks, identify partners for leapfrogging, identifying cutting-edge green technologies and convergence on collaboration opportunities (Figure 36).

Figure 36: PSA Prof. Ajay Kumar Sood, Scientific Secretary Dr. Parvinder Maini at India-EU TTC WG2 workshop

The international workshop comprised four sessions with the following key takeaways:

Session 1: Waste to Green Hydrogen

The session emphasised the possible avenues of collaboration between India and EU on Hydrogen Storage, transportation, Safety Standards, and regulatory framework. Technologies and solutions including the development of new tools and methodologies for hydrogen leakage detection sensors, and solutions furthering the opportunities to convert Waste into Green Hydrogen were also the focused areas of this session.

Session 2: Marine Plastic litter and Wastewater

As part of an ongoing dialogue, gap analysis to address and to tackle litter/pollution, monitoring of micro and nano-plastics, was presented. The session also underlined the strategies to mitigate marine plastic pollution and wastewater treatment and urban water challenge.

Session 3: E-mobility, Circulatory Aspects of Batteries and Interoperability of charging infrastructures

In this session, the knowledge on circularity and interoperability aspects of batteries was shared. The session also focussed upon the strategies for recovery of important raw materials. The possibility of co-developing charging infrastructure technologies and EV battery recycling sector were also discussed.

Session 4: Standards

Intense discussions were observed during the session regarding the importance of harnessing data and scientific insights for interoperable standards and cost-effective solutions for facilitation of global trade in technology.

These collaborative efforts between India and the European Union, involving the exchange of policy insights, identification of cutting-edge green technologies, fostering technology co-development, and creating institutional collaborations, will accelerate the growth of green and clean energy technologies. This partnership will enable both regions to access advanced solutions, bridge collaboration gaps, and work towards a shared vision of a sustainable future by leading the way in addressing environmental challenges and reducing carbon emissions.

In early 2024, the co-chairs will meet again in India to review the progress achieved and determine the next steps.

Collaborating Agencies:

- Ministry of External Affairs
- Ministry of New and Renewable Energy
- Bureau of Indian Standards
- Ministry of Power
- Ministry of Heavy Industries
- Ministry of Earth Sciences
- Ministry of Environment, Forest and Climate Change
- Ministry of Housing and Urban Affairs
- Department of Science & Technology

11.4.2 Second Ministerial Meeting of the India-EU Trade & Technology Council

The second Ministerial Meeting of the India-EU Trade & Technology Council (TTC) Working Group-2 on Green and Clean Energy Technologies organized by the Ministry of External Affairs was convened on November 24, 2023 at GS Bajpai Committee, South Block in hybrid mode. During the virtual meeting, both the Indian and EU delegations presented future roadmaps for Working Group 2 on Green and Clean Energy Technologies (Figure 37). They expressed mutual appreciation for each other's efforts in identifying technological gaps within clean energy technologies, leading to the formulation of substantial work plans for collaborative scientific and technological endeavours in the future.

PSA Prof. Ajay Kumar Sood, Chair of Working Group 2, delivered remarks on the group's presentation, underscoring the imperative of achieving tangible deliverables ahead of the India-EU TTC Summit. PSA Prof. Sood highlighted the significance of translating interactions into cooperation on concrete activities and deliverables that go beyond discussions focused solely on research and development. This commitment was exemplified through the initiation of specific projects, including the development of green hydrogen pilot initiatives and the establishment of related standards.

Dr. Parvinder Maini, Scientific Secretary, Office of PSA provided insights on the presentation and endorsed the collaborative endeavours undertaken by both parties in agreeing on future roadmaps and identifying potential areas for collaboration. Dr. Maini reiterated that the EU-TTC collaboration will significantly enhance research and development in clean technologies, creating economic opportunities that facilitate trade and technology through the establishment of a competitive market.

The meeting facilitated discussions focused on expediting the development of solutions to critical issues associated with clean energy technologies like waste-to-green hydrogen, battery recycling, marine plastic litter, and wastewater management. Furthermore, the meeting explored the possibility of organizing a matchmaking event between Indian and European start-ups. This initiative aims to unleash the potential of start-ups in the areas of battery recycling, covering the entire spectrum from waste collection to valuable material extraction. There was a focus on establishing targeted collaborations, particularly in the areas of decentralized waste-to-energy facilities as this approach offers a sustainable and community-oriented approach to waste management, environmental protection, resource recovery, and generation of clean energy at the local level.

Figure 37: The 2nd Ministerial Meeting of the India-EU Trade & Technology Council Working Group-2 on Green and Clean Energy Technologies

Theme 12

Synergy Projects

12.1 WELL-TO-WHEELS ANALYSIS OF VEHICLE PROPULSION TECHNOLOGIES FOR INDIA

This project titled 'Life-cycle Assessment (LCA) of Vehicle Propulsion Technologies for India, Phase-1: Well-to-Wheels Analysis' was sanctioned in August 2020 to the IISc Bengaluru.

Milestones

The study was completed and a project report was submitted by IISc Bengaluru in September 2021. The project was formally closed in May 2022.

The report was recently shared with four stakeholder ministries/departments i.e., Ministry of Power, MoRTH, MNRE, and Department of Heavy Industries for their comments and for taking appropriate actions in the implementation of their programmes/schemes in light of the findings and recommendations of the study.

Salient Features of the Study

- The aim of the study was to assess potential future fuel and propulsion systems by analyzing the complete cycle of the fuel from production to use in the propulsion system, also termed as a Well-to-Wheels (WTW) analysis.
- This study essentially consisted of three parts, the Well-to-Tank (WTT) analysis, Tank-to-Wheel (TTW) analysis and the combined WTW analysis.
    - The WTT part computes the energy use and emissions generated during the fuel production stage,
    - The TTW stage concerns the energy use and CO2 emissions associated with vehicle operation over a typical Indian drive cycle.
    - Both the WTT and TTW results are integrated to provide the final WTW estimates of energy use and CO2 emissions.
- The WTW energy use, efficiency & CO2 emissions were evaluated for 12 vehicle/fuel configurations for a passenger sedan in the Indian context.
- The WTW analysis covered gasoline, diesel and CNG powered conventional vehicles, series hybrids and plug-in series hybrids. In addition, hydrogen fuel cell-powered series hybrid and its plug-in version, along with a battery electric vehicle are also studied.
- In addition to the above-mentioned variants of a passenger sedan, in the two-wheeler category, a conventional gasoline-powered vehicle and a battery electric version are simulated.

- The four wheelers are simulated over the Modified Indian Drive Cycle (MIDC), whereas the two-wheelers are simulated over the World Motorcycle Test Cycle (WMTC).
- Finally, the WTW analysis is repeated for a couple of scenarios for the year 2030 to forecast future trends.

Key Findings

- For two-wheelers:
  - A battery electric vehicle (BEV) offers higher WTW efficiency than the conventional gasoline-powered vehicle, even with the current electricity mix.
  - This is because the advantage of high TTW efficiency of the battery outweighs the disadvantage of low WTT efficiency associated with electricity generation.
  - For two-wheelers, the BEV is also associated with lower WTW CO2 emissions as compared to the conventional vehicle.
- For four-wheelers:
  - Simulations of the aggressive shift to renewables scenario for the year 2030 show that the plug-in series hybrids show the highest WTW efficiencies, with the diesel-powered plug-in hybrid showing the highest efficiency.
  - This scenario assumes that India betters the NDC targets of 40% of cumulative power installed capacity from non-fossil fuel-based energy resources by 2030.

Collaborating Agencies

- Indian Institute of Science, Bengaluru

12.2 HUB FOR LIVESTOCK DISEASE SURVEILLANCE AND MODELLING IN INDIA

This project titled 'Hub for livestock disease surveillance and modelling in India' was sanctioned in September 2023, jointly to IISc Bengaluru, International Centre for Theoretical Sciences (ICTS), Bengaluru and ARTPARK, Bengaluru.

Milestones

The project was sanctioned jointly to three PIs, in IISc, ICTS and ARTPARK in September 2023.

The PRMC for the project will be constituted soon with subject matter experts.

Major Objectives

- Informing the effective utilisation of modelling across different susceptible species.
- Training of field and disease control staff on methods of surveillance, data collection, validation, sample collection, transport etc.
- Guiding the FMD (Foot and Mouth Disease) elimination strategy over the so that the FMD control programs are driven in a scientific and data-informed manner.
- Define environmental sampling protocols for FMD and incorporate them into the National Surveillance program.
- Build capacity in India for disease modelling and using tools such as environmental surveillance for various national programs (Across human, animal and wildlife health).

Project Deliverables

Workstream 1: Establish Livestock Disease Modelling Capacity

- To establish local expertise through capacity building in collaboration with Indian and international disease modelling groups.
- Enable relevant Govt. agencies to implement science and data-informed disease surveillance and control strategies under the guidance of the Empowered Committee for Animal Health.
- Work with the relevant Government agencies to develop capacity and inform effective utilisation of modelling across different susceptible species.
- Development of data models to evaluate and inform FMD control strategies.

- The Models will be extended to other priority diseases and will inform the design and implementation of the disease control programs and strategies.

Workstream 2: Establish and Pilot Environmental Sampling Strategies to Augment the Current Surveillance Programs for Animal Diseases

- Establish methodologies for environmental surveillance.
- Facilitate data collection, management, and visualisation tools to optimise ongoing disease surveillance efforts. Data from environmental surveillance will be channelled into the data modelling efforts.
- Work with the relevant Government agencies for capacity building and leverage environmental surveillance for disease control programs (across animal, wildlife, and human health).

Collaborating Agencies

- IISc Bengaluru
- International Centre for Theoretical Sciences (ICTS), Bengaluru
- ARTPARK, Bengaluru

12.3 INDIGENOUS DEVELOPMENT AND MANUFACTURING OF SEAMLESS TUBES OF ASTM B983 FOR HIGH TEMPERATURE/PRESSURE APPLICATIONS

The project was sanctioned in October 2020 and is being implemented by Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam (Lead agency), Nuclear Fuel Complex (NFC), Hyderabad and Mishra Dhatu Nigam Limited (MIDHANI), Hyderabad.

Objectives & Deliverables

1. To develop an India-specific composition for Ni-base super alloy conforming to ASTM B983 (ASME Code Case: 2702).
2. Indigenous development and manufacturing of seamless tubes of Ni-base super alloy conforming to ASTM 8983 (ASME Code Case: 2702).
3. Development of an optimal process sheet for the tube making process starting from melting stage through the final tube-making heat treatment stage, followed by demonstration of the process sheet by repeat manufacturing.
4. Deliverables
   - India-specific alloy specification, conforming to the chemical composition range provided in the ASME Code Case: 2702.
   - Indian Boiler Regulation (IBR)-certified seamless tubes with dimensions of 52mm OD x 9.6 mm wall thickness 7000mm (min.) length, amounting to a total of 100m.

Milestones

The experimental phase of the project has been completed which involved the development of process sheet for the seamless tube making process starting from melting stage through final tube making heat treatment stage.

This is a first-of-its-kind industrial effort to develop the India-specific specification, which involved the optimization of the melting, homogenization and billet forging processes. It was undertaken through collaboration between IGCAR and MIDHANI.

Through industrial scale-experiments, the alloy, hereafter 'Indian advanced High Temperature Alloy (IHTA)', was successfully produced at MIDHANI, Hyderabad, in the form of ten billets. The billets were subsequently converted into tubes (IBR certified) at NFC, Hyderabad.

The produced tubes were dispatched from NFC (to be sent to IGCAR) on 21st November 2023 in a flagging off ceremony which took place at NFC Hyderabad (Figure 38 and Figure 39).

The process sheet developed in the experimental phase will subsequently be demonstrated through repeat manufacturing.

The project is expected to be completed by August 2024 with the production of total 100m of tubes of Ni-base super alloy conforming to ASTM 8983 (ASME Code Case: 2702) tubes.

Implementing Agencies

- Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam (Lead agency)
- Nuclear Fuel Complex (NFC), Hyderabad
- Mishra Dhatu Nigam Limited (MIDHANI), Hyderabad

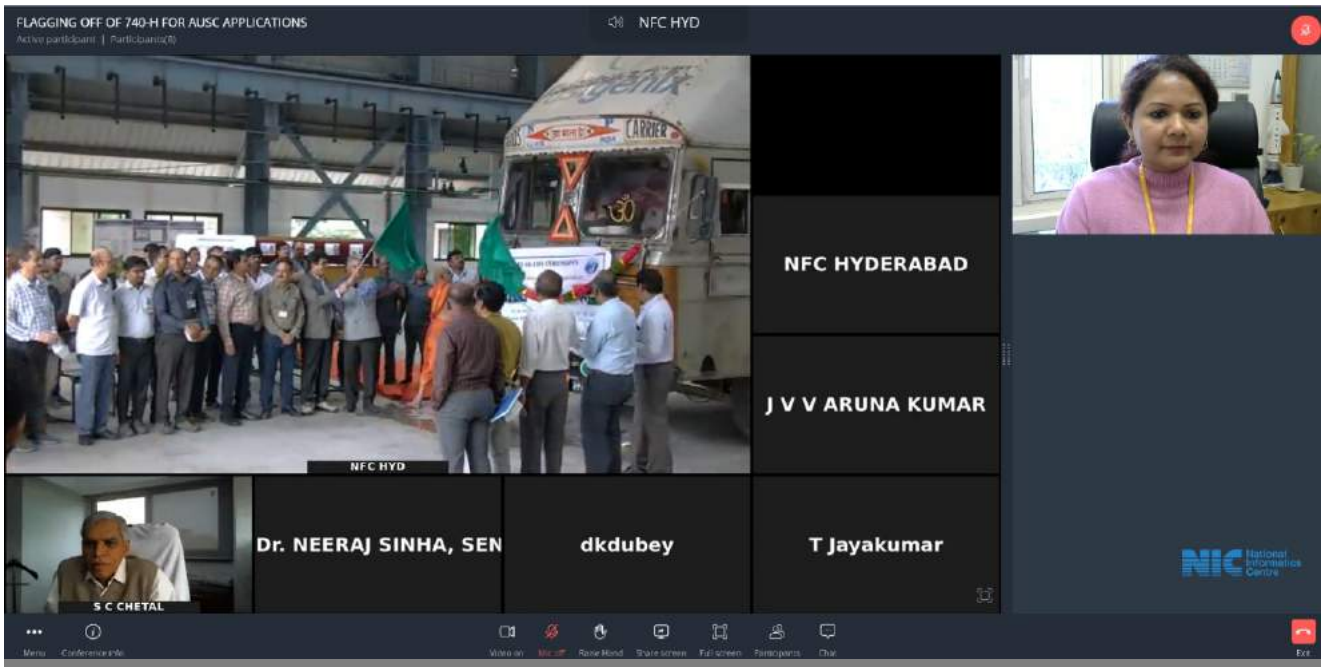


Figure 38: Flagging off ceremony held at NFC, Hyderabad on 21st November 2023 for the first batch of indigenously manufactured tubes of Ni-base super alloy conforming to ASTM 8983 (ASME Code Case: 2702) for High Temperature/Pressure applications. The ceremony was attended virtually by the members of the Project Review and Monitoring Committee chaired by Shri S. C. Chetal, Ex-Mission Director, AUSC (Advanced Ultra Super Critical) Mission.

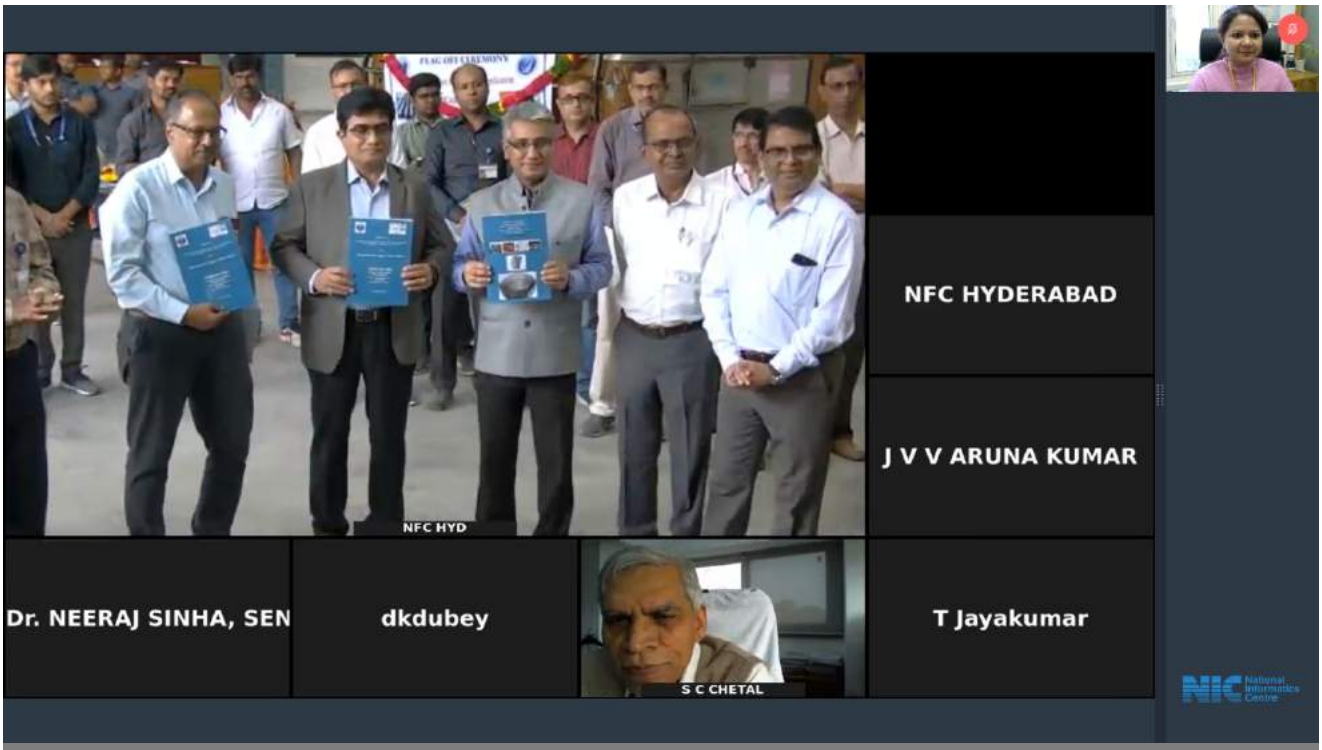


Figure 39 From left: Dr. Divakar R., Outstanding Scientist and Director, Metallurgy and Materials Group (MMG), IGCAR; Dr. Sanjay Kumar Jha, C&MD, MIDHANI and Dr. Komal Kapoor, Chairman and Chief Executive, NFC releasing the Quality Documents for the manufactured tubes during the flagging off ceremony.

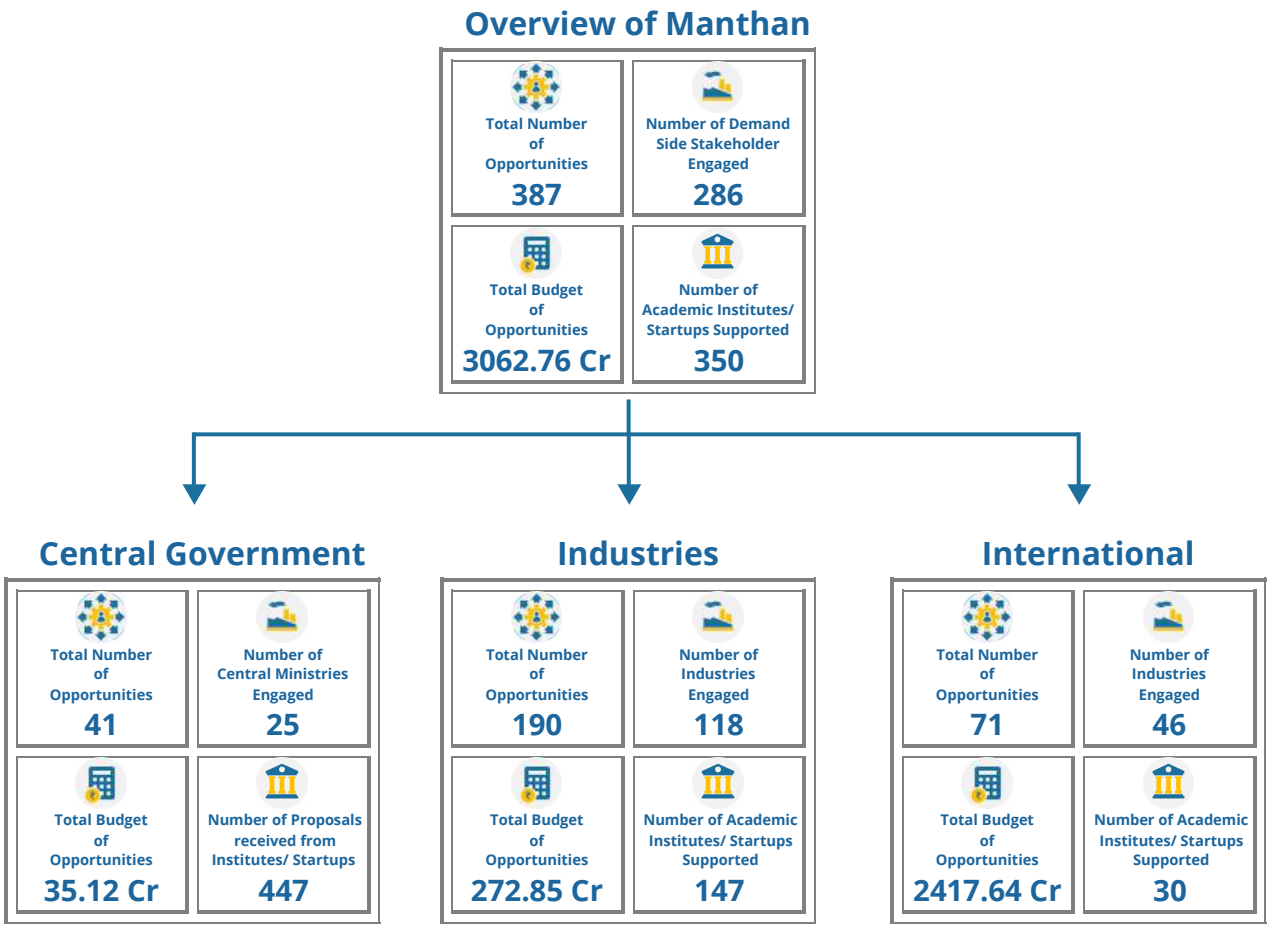
Theme 14

Outreach

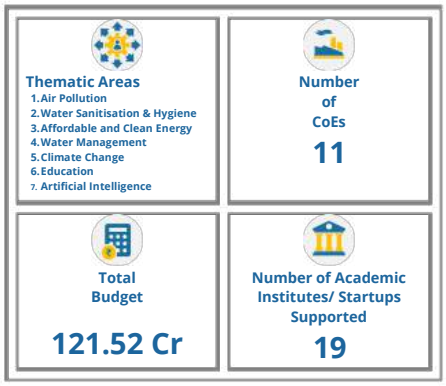
14. MANTHAN

14.1 OVERVIEW OF MANTHAN

Manthan is a digital platform for promoting collaboration between various stakeholders and the scientific research and development ecosystem to help meet India's national targets and Sustainable Development Goals (SDGs) through sharing Industry or philanthropic challenges or opportunities for partnerships on emerging technologies, other scientific interventions, as well as those with a social impact. Manthan benefits a wide-range of stakeholders, including industry, embassies/ other governments, coalitions/consortiums, philanthropists, multilaterals, public sector units and co-operatives, MSME Sector, Government—State and central line ministries, entrepreneurial support organisations, research institutes, incubators and their startups, Startups and SMEs S&T clusters, and Centres of Excellence (CoEs). A snapshot of the overview of Manthan has been shared below (Figure 40):



Centre of Excellence



Science Communication

The platform also supported **1000+** scholarships, **224** R&D/early-Stage Innovations, **49** Market Ready Innovations, **36** In-kind/Social Impact Projects and **31** Implementation projects creating a societal impact. It has supported research problem statements shared by various stakeholders on issues of national importance aligning to SDGs and Emerging Technologies.

Top Partner Organisations	Budget (Cr)
LEGO Foundation	1017.00
XPRIZE Foundation	840.20
USAID	407.27
Reliance Foundation	128.00
Department of Science and Technology	90.00
Global Energy Alliance for People and Planet	82.45
U.P. Electronics Corporation Limited (UPLC)	50.00
Caspian Debt	50.00
Gujarat State Biotechnology Mission	40.00
Rockefeller Foundation	30.00

Top SDGs Supported	No. of Challenges
Industry, Innovation and Infrastructure	68
Good Health and Well Being	40
Affordable and Clean Energy	38
Climate Action	33
Zero Hunger	27
Clean Water and Sanitation	23
Decent Work and Economic Growth	22
Quality Education	22
Responsible Consumption and Production	16
Gender Equality	14

Top Emerging Technology Supported	No. of Challenges
AI, ML, NLP	12
Future Telecommunication (5G and beyond)	13
Quantum Technology, Addictive and Subtractive Manufacturing	11
Big Data, Cyber Physical Systems, Cyber Security, IoT	8
Future Mobility, Electronics and Semiconductor	7
Green Hydrogen and Fuel Cells, Space Technology	10
Life Sciences, Medical Devices	4
Product Design, AR, VR	4

Top Thematic Areas Supported	No. of Challenges
Industry innovations	54
Health	26
Agricultural Technologies	22
Energy Efficiency & Decarbonisation	21
STEM Education	17
WASH	16
Livelihood	11
Disease Management	10
Diversity & Inclusion	10
Green Cities Projects	10
Renewable Energy	9

Figure 40: Overview of Manthan

Since April 2023, over Rs 360 crores worth of opportunities were posted on the platform engaging more than 80 demand side stakeholders, supporting more than 160 startups and academic institutes across India as shown in Figure 41. The platform also supported over 600 scholarships, 44 R&D/early-Stage Innovations, 26 Market Ready Innovations, 16 In-kind/Social Impact Projects and 8 Implementation projects creating a societal impact.

Segments	Total Opportunities	Funded Opportunities provided on Manthan (in Crores)	Total Startups & Academic Institutes Supported
International	25	216.90	29
Industries	60	134.05	109
Government	25	10.12	24
Total	**110**	**361.07**	**162**
Total Users – 34024; **Demand Side** - 2642; **Supply Side** – 31382			

Figure 41: Opportunities in Manthan (Since April 2023 – September 2023)

The top opportunity providers are - Reliance Foundation, XPRIZE Foundation, Global Energy Alliance for People and Planet, WRI India, HCL Foundation, European Union, Israel Innovation Authority, Sequoia Climate Foundation, SIDBI Swavalamban Challenge Fund 3, iHub AWaDH TIF IIT Ropar and Centre for Development of Advanced Computing, Bangalore (Figure 42).

Figure 42: Opportunity Providers on Manthan Platform

14.2 CENTRES OF EXCELLENCE

The Office of PSA envisions the creation of Centres of Excellence (CoEs) as innovation and research hubs for sustainable technologies. These CoEs will focus on transforming sustainable technological theories into market-ready products and practical implementations, thus cultivating new business models and promoting economic growth that meets global environmental and societal goals.

The key pillars of a Centre of Excellence are (Figure 43): -

1. Technology screening from National and Global Ecosystem
2. Evaluation & Incubation of cohort of start-ups to work jointly with Researchers on shortlisted ideas.
3. Real-life scaling testing and validation of prototype
4. Support to scale-up promising technologies, business and skill development, developing microentrepreneurs.

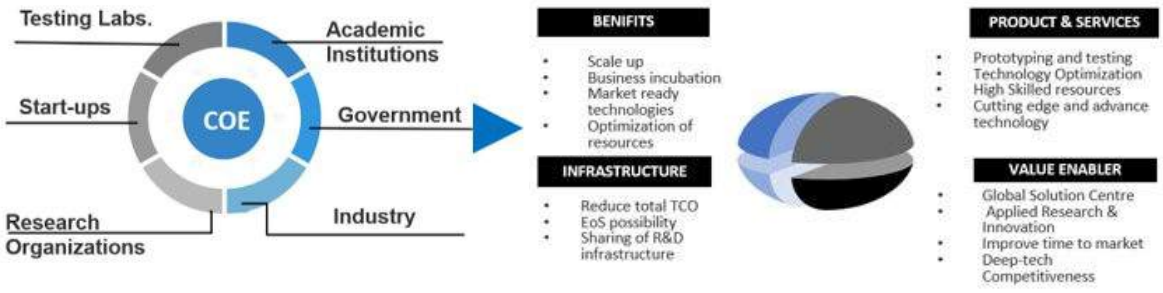


Figure 43: CoE Model and its Benefits

Key Highlights

Total no. of Centres of Excellence established	10
Thematic Areas	Air Pollution, Water Sanitation & Hygiene, Affordable & Clean Energy, Waste Management, Climate Change, Education, Artificial Intelligence
Total Budget	121.52 crore
No. Of Industry Donors	22
No. Of Technologies supported:	28
Academia & Startups Supported	24

14.2.1 Global Sanitation Centre of Excellence - IIT Palakkad

GSCoE accelerates water and sanitation innovations, incubating 50 startups with 5 reaching INR 50 Cr p.a. sales, generating 10k jobs. Focus: sanitation, water efficiency, cost reduction, and user-friendly tech.

Industry Partners: Bill & Melinda Gates Foundation, HDFC Bank, Eram Scientific, IAPMO, Toilet Board Coalition, Keystone Foundation
Budget: ₹68.20 Cr
National Mission: Swachh Bharat Mission
Theme: Sustainability

Milestones

Seven WASH tech startups onboarded, four in process. Achievements include innovative products like Nirgandh, EcoEnso, Munnarivan, IND Classic, SRMT, Kakoos, Cresa, Suzhiyam, Hygienity Solutions, Biofilm Engineers, and Cosmovend Automations.

Notable outcomes: 10,000L/day water saved, BOD reduced to 10 mg/L, coliforms decreased from 300 to 7 MPN/L.

14.2.2 Global Centre of Excellence in Affordable and Clean Energy-IIT Dhadwad

GCoE-ACE develops affordable, renewable energy solutions for underprivileged communities. It promotes sustainable livelihoods, mentors local and global innovations, and enhances on-grid appliance efficiency with a holistic approach.

Industry Partners: Honeywell, Infineon, Selco Foundation, Lowe's
Budget: ₹12.05 Cr
National Mission: National Action Plan on Climate Change
Theme: Sustainability

Milestones

Three key GCoE-ACE initiatives:

- Modernizing Garag village with clean energy (Supported by Honeywell).
- Upskilling and Outreach Programs (Supported Lowe's India Pvt. Ltd).
- Tech Innovation Challenges (Supported Honeywell, SELCO).

Achievements

- Solar power assistance to 12 families and key village locations.
- 17 funded innovations.
- 10 Upskilling programs and 20 TREES talk series sessions to build skills and awareness, reaching 800 students (44% girls) from diverse backgrounds, including SDGs and leadership topics.
- Project: Upskilling and Awareness Programs (Industry Partner: Lowe's)

14.2.3 Centre of Excellence on Advanced Pollution Monitoring Technologies - IIT Kanpur

The ATMAN team has identified three key innovation and development verticals to provide non-incremental scientific breakthroughs, cost effectiveness and direct integration with state and central government policies and action plans. These three research verticals (RV) in the CoE are - i) Next Gen Atma-Nirbhar PM sensors; ii) Use of Air Quality sensors for Real-Time Source Attribution and iii) AI/ML for nation-wide AQ monitoring networks.

Industry Partners: Bloomberg Philanthropy, Clean Air Fund, Open Philanthropy
Overall Budget: ₹29.60 Cr
National Mission: National Clean Air Programme
Theme: Sustainability

Project: Dynamic Hyper-local source apportionment for real-time policy action

Milestones

The project introduced a cost-effective Dynamic Hyper-local Source Apportionment (DHSA) method for real-time source tracking using data from various air quality sensors and machine learning. This scalable approach has enabled cities like Lucknow and Kanpur to take data-driven actions towards air quality management. By the project's conclusion, UP authorities were using DHSA data for informed air quality planning.

Project: Ambient Air Quality Monitoring of Rural areas using Indigenous Technology

Milestones

A network of portable sensors has been deployed with 540 units across various rural areas in Bihar and 826 in Uttar Pradesh to monitor environmental parameters. Additionally, a real-time dashboard has been developed to enable data visualization, facilitating immediate access to the insights gathered from these sensors.

14.2.4 Centre of Excellence on Water, Sanitation & Hygiene (Wash) - IIT Madras

NBCC (India) Limited, a Navaratna CPSE, funded the establishment of a 1018 sq. meter laboratory at IIT Madras's Discovery campus, enhancing the institute's research capabilities. This development is set to address the expanding infrastructural needs and foster research with wide-reaching national and global impacts.

Industry Partners: NBCC
Budget: ₹2.50 Cr
National Mission: Swachh Bharat Mission
Theme: Sustainability

Project: Construction of Pre-Engineered Structure for lab space for Centre of Excellence on Water, Sanitation & Hygiene at IIT Madras Thaiyyur campus.

Milestones

The final phase of Electrical/water /sewer connections, Commissioning is ongoing. The centre got inaugurated at IIT Madras discovery Campus on November 17, 2023.

14.2.5 Centre of Excellence on Air Pollution - IIT Delhi (Arun Duggal Centre of Excellence for Research in Climate Change and Air Pollution)

CERCA, hosted at IIT Delhi, will serve as a think-tank and Action Centre, leveraging the institute's research expertise and collaborating with government, academia, and industry to devise sustainable clean air solutions for Delhi and beyond. It has established a system to fund research proposals from IIT Delhi's faculty aimed at societal benefits and informed policymaking.

Industry Partners: Clean Air Fund, World Bank, Aerogram
Budget: ₹3.75 Cr
National Mission: National Clean Air Programme
Theme: Sustainability

Milestones

The Air Quality Action Forum successfully held its Annual Conference for 2023 in a hybrid format over two days, on February 27-28, 2023. During this event, experts conducted various on-ground studies which have contributed to research-based recommendations that are crucial for the formulation of air quality policies.

14.2.6 Centre of Excellence on Managing Organic Waste and Sludge: Scaling up 'Waste to Value' Technologies – TERI

The Udaipur Municipal Corporation partnered with TERI to manage a two TPD biogas plant, aiming for sustainable waste management and reduced landfill use. This initiative supports the SDGs and NDCs by cutting GHG emissions and demands active participation from ULBs and waste producers.

Industry Partners: ICICI Securities
Budget: ₹0.84 CR
National Mission: Waste-to-Wealth Mission
Theme: Circular Economy

Milestones

In Udaipur, Rajasthan, an innovative project converts approximately 600 kg of daily organic waste and STP sludge from over 1,000 households into 40 m3 of biogas, yielding about 100 units of electricity each day. This sustainable initiative partially powers the local fire station. Following an impact assessment survey around 1,200 households, the necessary arrangements for waste and sludge supply have been established. The existing biogas plant, initially re-commissioned using cattle dung, now co-digests this waste with STP sludge, with ongoing optimizations of its operational parameters. The electricity generated is supplied to the Madri Fire Station, showcasing a model for waste-to-energy conversion.

14.2.7 Centre of Excellence on Wastewater Management, AquaMap - IIT Madras

The Aqua MAP Centre for Water Management and Policy at IIT Madras, initiated by the Office of PSA, aims to improve water management nationwide, with a focus on arid and rural regions. It is overseen by a board with IIT Madras's director and water sector experts, collaborating with institutes like Sutram, ICCW, and PCoE on Water and Sustainability. The centre is also setting up a hydro-informatics lab and fostering a model for alumni and community engagement.

Industry Partners: IBM
Budget: ₹0.70 CR
National Mission: Waste-to-Wealth Mission
Theme: Sustainability

Milestones

AquaMap spearheaded the technical solutions and project coordination, while CUBE executed the tasks efficiently in tandem. Gram Antara engaged with key stakeholders on the ground, ensuring smooth implementation. The local government scrutinized parts of the project report on water management, contributing to the Mallur Gram Panchayat's funding under the Jal Jeevan Mission. Additionally, AquaMap orchestrated the Deshpande Foundation's donation of Earth Moving Equipment to the Panchayat for lake desilting efforts.

14.2.8 Centre of Excellence on STEM Education - Pune Cluster

The Centre of Excellence on STEM Education, prompted by climate concerns and digital literacy needs highlighted by the Covid-19 pandemic, aims to align add-on STEM curricula with India's NEP 2020. It plans to establish Cluster STEM labs, sustainability clubs, and provide advanced pedagogical training for teachers, fostering hands-on learning and industry collaboration to invigorate education with an entrepreneurial edge.

Industry Partners: BASF, Infosys, IITMAA
Budget: ₹2.55 CR
Theme: Education

Milestones

Two teacher training workshops were conducted, benefiting 97 educators, while the Gamification in Chemistry project saw the development of 32 educational games, with a validation workshop engaging 240 students in schools. Additionally, awareness sessions for the WEnyan scholarship were held across 14 colleges in Maharashtra, resulting in 459 applications for the program's second round.

14.2.9 Centre of Excellence on Artificial Intelligence - NIT Patna

The Centre of Excellence at NIT Patna, a CSR initiative by the Telecom Sector Skill Council and an IT firm, provides new-age tech training in AI/ML, IoT, 5G, and related skills to boost employment. It aims to enhance practical skills and employability in advanced technologies. Smt. Kavita Bhatia, Scientist 'G', is a nominated member of the CoE Governing Body from the Ministry of Electronics and Information Technology, Government of India.

Industry Partners: IT Firm
Budget: ₹1.00 Cr
National Mission: Artificial Intelligence (AI) mission
Theme: Education

Milestones

400 trainees were trained, 252 passed their assessments, and 138 secured jobs in various roles such as Telecom Customer Care Executives, Handset Repair Engineers, IoT specialists, Optical Fiber Technicians, and CCTV Installation Technicians. These placements span across call Centres, relationship Centres, and technical fields within the telecom industry.

14.3 Science Communication

Showcasing Innovation and Research/Technology in Parliament through Sansad TV

The objective is to highlight and promote the innovations and technological advancements emerging from India. Sansad TV collaborated with Office of PSA for showcasing the winners of challenges posted on Manthan where they recorded snippets of these groundbreaking achievements to broadcast them during parliament session breaks. These informative clips are also prominently displayed on LED screens in the corridors of the Parliament and streamed live on their YouTube channel, ensuring that the nation's leaders are consistently in the loop about India's progress in the fields of research and technology.

The intent behind this initiative is to keep the Members of Parliament and Members of Legislative Assemblies informed and updated about the latest Indian research, development, and innovations, thereby incorporating these innovations in different states and constituencies for wider societal impact.

In the first phase, one start-up funded by Tata Consultancy Services (TCS), Trestle Labs which manufactures a device “Kibo XS” that enables people to listen, translate, and digitize hard copies of printed and handwritten documents, in real time, was selected to be showcased. Kibo XS uses Artificial Intelligence (AI) and Machine Learning (ML) to scan printed content and make it available in various formats for the visually impaired, in about 60 global languages. Launched in July 2019, the device is available across seven countries; the mobile application empowers over 45,000 visually impaired individuals, across 15 countries. Readers can access over 22 million pages of content; 40 million minutes of reading time have been collectively spent on the app.

Office of the Principal Scientific Adviser to the Government of India

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