Office of the Principal Scientific Adviser
to the Government of India

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ACTIVITIES : 3.0



2025

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to the Government of India



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Principal Scientific Adviser (PSA)
to the Government of India

Foreword

As the primary architect of the country's science advice infrastructure, the Office of the Principal Scientific Adviser (OPSA) to the Government of India ensures that our scientific progress is built upon a robust foundation of governance. As we stand at the threshold of an era defined by rapid technological disruption, it is imperative to align our scientific endeavors with national priorities as well as the technical advancements. Our mission is rooted in the conviction that India's growth must be driven by a unified, visionary, and evidence-led strategy. Thus, OPSA's influence begins with the strategic alignment of India's Science, Technology, and Innovation (STI) ecosystem, fostering mission-oriented research and long-term planning to ensure that emerging technologies serve both the people and the planet.

Acting as a vital "system integrator" OPSA steers high-level platforms such as the PM-STIAC and ETG. This architecture facilitates the cross-ministerial coordination and strategic foresight necessary to navigate an increasingly complex global landscape. Our commitment to transforming "Evidence into Action" is best exemplified by landmark initiatives such as the National One Health Mission, the One Nation One Subscription initiative, and many others that have stayed active through the year.

Prioritising the governance of the ongoing technological revolution, OPSA is releasing critical white papers on Artificial Intelligence (AI) that address data sovereignty, techno-legal frameworks and other key infrastructural parameters of AI. Furthermore, our focus remains on building a resilient ecosystem through initiatives at the grassroot level as well as strengthened international diplomacy. Key milestones this year on the global front included the G20 Chief Science Advisers' Roundtable (CSAR) 2025, the India-EU Trade and Technology Council, the International Technology Engagement Strategy (ITES) for Quantum, the Emerging Science, Technology, and Innovation Conclave (ESTIC), and the inaugural International S&T Clusters Conference. These engagements ensure that India remains at the vanguard of deep-tech and open science.

At the core, our work is intrinsically aligned with the vision of Viksit Bharat @2047. By developing long-term blueprints like the MegaScience Vision 2035, National Technological Readiness & Assessment Framework, Roadmaps on e-mobility, and defining India's drone research priorities etc., we are securing India's technological sovereignty and strategic autonomy. "Knowledge-Led Strategic Integration" has been at the centre of our activities in 2025. Reflecting upon this, OPSA's Anthology 3.0 serves as a repository of our continued efforts. Organised thematically, the report reflects the diverse functions of this Office across the science-policy interface.

Together, these chapters offer a glimpse into our ongoing efforts to foster a collaborative and forward-thinking ecosystem where knowledge informs decisions, innovation meets societal needs, and India advances toward a secure, sustainable, and scientifically empowered future. Through critical S&T infrastructure and institutional innovation, OPSA will continue to serve as a key pillar in nurturing national capabilities and supporting the nation's advancement towards strategic autonomy.



Dr Parvinder Maini

Scientific Secretary,
Office of the Principal Scientific Adviser
to the Government of India

Science and technology continue to underpin India's development trajectory, significantly influencing economic growth, public welfare, and national preparedness. Within this landscape, the Office of the Principal Scientific Adviser (OPSA) to the Government of India serves as a critical intermediary between research and governance, convening multidisciplinary expertise to translate evidence into actionable policy pathways. The Anthology of Science & Technology Activities: 3.0 (2025) documents some of OPSA's key roles as a dynamic "system integrator," harmonising the efforts of academia, industry, and government to address the complexities of a rapidly evolving technological era. This foundational role is exercised through high-level platforms such as the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC) and the Empowered Technology Group (ETG), which align scientific investments with national strategic goals. During the current year, PM-STIAC deliberations focused on the National Plant Health Initiative and Cell and Gene Therapy, while the ETG evaluated 17 draft cabinet notes across 12 meetings, resulting in approved projects spanning defense procurement, tax analytics, agricultural research, and the domestic semiconductor and component ecosystem.

Executive Summary

A primary function of the OPSA is ensuring that strategic insights are implemented through robust national missions. This year, the Office directed the deployment of frameworks for ethical Artificial Intelligence and achieved significant progress in the National One Health Mission through structured stakeholder engagements. The continued strengthening of the One Nation One Subscription initiative democratises research access. Society for Electronic Transactions and Security (SETS) protects digital infrastructure. These reflect a sustained commitment to technology-led societal impact. Beyond large-scale missions, the OPSA enables the broader STI ecosystem by bridging the gap between state-of-the-art research infrastructure and the industry through platforms like I-STEM, Manthan, Rural Technology Action Group (RuTAG), RuTAGe Smart Village Centres (RSVC) and Science and Technology Clusters, which adapt sophisticated scientific concepts into sustainable solutions for the society and ensures that innovation remains decentralized and inclusive. This year in 2025 the Office has further contributed to national progress through rigorous knowledge synthesis and policy analysis. Notable research outputs include seminal AI whitepapers, drone research priorities, and strategic roadmaps such as the MegaScience Vision 2035, the e-Mobility R&D Roadmap, and the National Technical Research Advisory Framework (NTRAF). Marking an institutional milestone, a special edition of Vigyan Dhara was released to commemorate 25 years of the OPSA's legacy, transitioning the publication into a comprehensive magazine, documenting the diverse themes of the STI ecosystem. On the international stage, the OPSA has bolstered India's leadership by steering initiatives such as the G20 CSAR 2025, the International Technology Engagement Strategy (ITES), and the India-EU Trade and Technology Council. By hosting the inaugural International Science and Technology Clusters Conference and the "Technology Dialogue 2025" summit, OPSA has transitioned national capacity-building efforts into a globally connected innovation platform. Moving forward, OPSA will continue to provide analytical scaffolding for India's technological ambitions, and refining foresight mechanisms to meet the 2047 vision while ensuring that scientific advice remains strategic, inclusive, and anchored in the spirit of national development.

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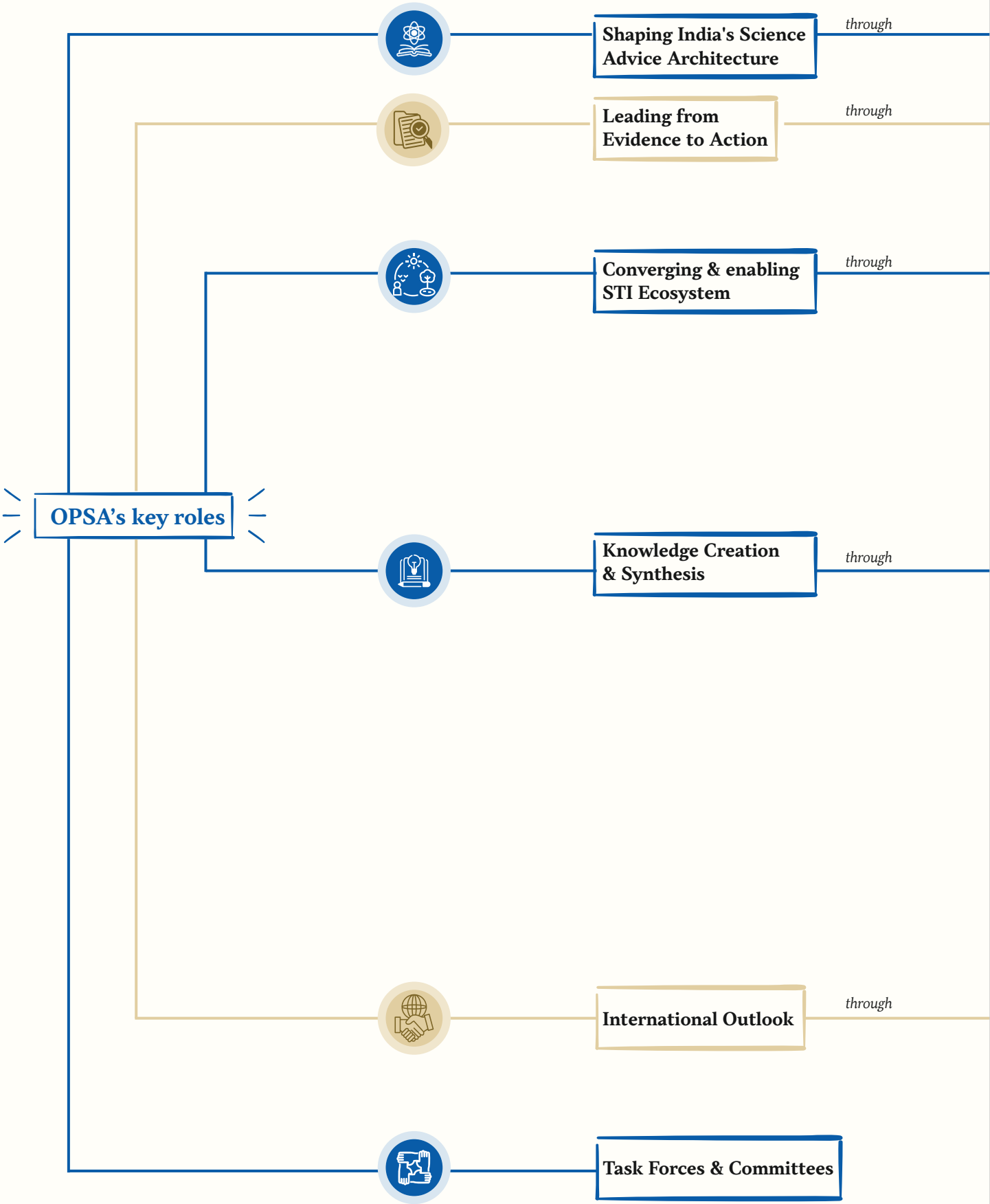
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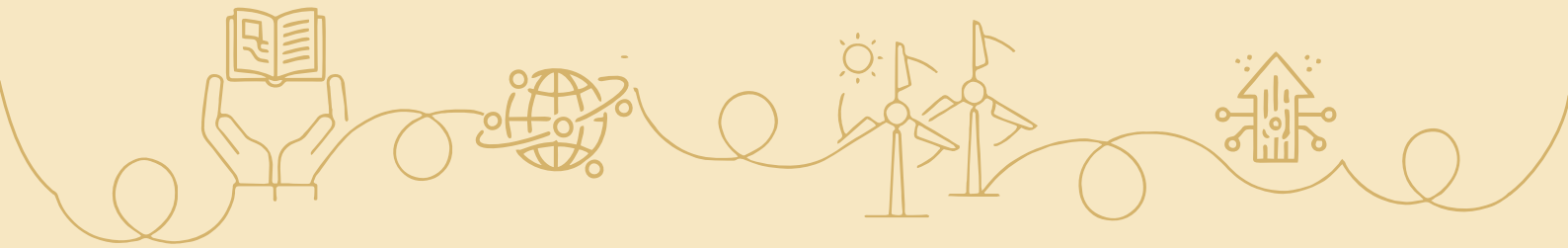
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- Task Forces & Committees
- International Conference on Science and Technology Cluster
- Technology Dialogue 2025
- International Technology Engagement Strategy (ITES)



Shaping India's Science Advice Architecture

01

The journey of scientific progress begins with a robust foundation of governance, where the OPSA serves as the primary architect of India's science advice infrastructure. By steering high-level platforms such as the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC) and the Empowered Technology Group (ETG), we create a strategic blueprint that aligns our scientific efforts with national priorities. This architecture is designed to identify emerging challenges and opportunities, ensuring that the government is equipped with the foresight needed to navigate a rapidly evolving global technological landscape. By harmonising the goals of various ministries and scientific stakeholders, this foundational role ensures that India's growth is not accidental, but is driven by a unified and visionary evidence-led strategy.



1.1 Prime Minister's Science Technology Innovation Advisory Council

Constituted in August 2018, the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC) serves as an overarching council to assess the status of various science and technology-related matters, comprehend challenges, formulate interventions, develop a futuristic roadmap, and advise the Prime Minister accordingly. The council also oversees the implementation of these interventions by concerned S&T departments, agencies, and other government ministries. PM-STIAC also mandates formulation, convergence, collaboration, coordination, and implementation of multi-stakeholder policy initiatives, mechanisms, reforms, and programmes. These initiatives are aimed at synergising collaborative science and technology; enabling future preparedness; formulating and coordinating S&T missions; providing an enabling ecosystem for technoentrepreneurship; driving innovation, and technology, developing innovation clusters, and fostering effective public-private linkages among other responsibilities. Several missions, aligned with the national interest, have been approved by the PM-STIAC to date. Among them, the Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission, and National One Health Mission have been approved for implementation.

So far, 28 PM-STIAC Meetings have been conducted and various ideas discussed in these meetings have become successful missions, being implemented by various Departments/Ministries like One Health Mission, Quantum Mission, Anusandhan National Research Foundation etc. In addition, several initiatives like the One Nation One Subscription (ONOS), are discussed for improving the R&D ecosystem in the country. During last year, two meetings of PM-STIAC were convened wherein the "Cell and Gene Therapy in India," and "National Plant Health Initiative (NPHI)" were discussed with subject experts.

Recent Initiatives

Cell and Gene Therapy in India

The 27th meeting of PM-STIAC was held on 21 January 2025 at Vigyan Bhawan, New Delhi, under the chairmanship of PSA. The meeting reviewed the current status and future direction of cell and gene therapy in India, taking note of India's disease burden, including rare and genetic disorders and cancers, and highlighting the relevance of cell and gene therapy in addressing these challenges. Ongoing national initiatives, including the Genome India Project, and recent indigenous developments such as Chimeric Antigen Receptor T-cell (CAR-T) cell therapy and gene therapy for haemophilia were noted.



Figure 1.1.1: 27th PM-STIAC meeting, chaired by PSA on Jan 21, 2025 at Vigyan Bhawan, New Delhi.

Presentations were made by the Department of Biotechnology (DBT), Council of Scientific and Industrial Research (CSIR), and the Department of Health Research (DHR)/Indian Council of Medical Resarch (ICMR) on ongoing research, clinical translation efforts, and the existing regulatory framework. Inputs from academia and industry covered research progress, manufacturing, regulatory processes, and cost-related issues.

The meeting discussed challenges related to affordability, access, infrastructure, skills, and regulation, and noted the need for a coordinated, mission-mode approach covering research, manufacturing, regulation, and clinical deployment.

It was noted that ICMR, in consultation with DBT and other agencies, would work towards preparing a consolidated roadmap for cell and gene therapy, including mechanisms for coordination and monitoring.

The PSA, in his concluding remarks, reiterated that cell and gene therapy represents not just a technological opportunity but a test of India's ability to translate scientific strength into societal benefit. In bringing together policy makers, scientists, industry leaders, and regulators around a single theme, the 27th PM-STIAC meeting signalled a decisive step towards positioning cell and gene therapy as a national priority rather than a niche scientific pursuit.

Scan QR Code to read the **Press Release**



Figure 1.1.2: 27th PM-STIAC meeting reviewed cell & gene therapy's status, challenges, and future in India.

National Plant Health Initiative (NPHI)

The 28th meeting of PM-STIAC was held on 21 August 2025 at the National Agricultural Science Complex, New Delhi, under the chairmanship of PSA. The meeting focused on the proposal for a National Plant Health Initiative.

The meeting examined plant health in the context of food security, agricultural productivity, farmer incomes, environmental sustainability, and the One Health framework; observing emerging challenges like climate change, crop losses, and evolving pest and disease patterns.



Figure 1.1.3: The 28th meeting of PM-STIAC was held on 21 August 2025 at the National Agricultural Science Complex, New Delhi.

Presentations from government departments, research institutions, and NITI Aayog highlighted existing plant health programmes, surveillance systems, and the use of digital tools and artificial intelligence, including the National Pest Surveillance System. Gaps related to early warning, coordination, and data integration were also deliberated.

The meeting emphasised prevention through quality planting material, seed systems, and surveillance, and noted the need for region-specific approaches supported by national coordination. Integration of existing institutional,

laboratory, and digital platforms through an open and federated architecture was discussed.

Industry inputs covered advances in integrated crop solutions, biologicals, precision agriculture, and digital systems, and highlighted the need for regulatory clarity and predictable approval processes.

The meeting noted the requirement for a mission-mode national initiative, anchored by Indian Council of Agricultural Research (ICAR) in coordination with central ministries, state governments, and other stakeholders. Preparation of a comprehensive mission roadmap with defined outcomes and coordination mechanisms was agreed upon.

In his concluding remarks, PSA wove together the key strands of the discussion, stressing that a mission-mode approach is essential to prevent duplication and fragmentation while bringing states and stakeholders together in a manner similar to the National One Health Mission.

Progress in Previous Initiatives

Streamlining of regulatory approval process for medical and biotechnology related products

Two review meetings on the Progress on Recommendations of the 24th PM-STIAC Meeting for Regulatory Reforms were convened between 18 December 2024 and 19 August 2025 under the chairmanship of the PSA. Achievements and milestones were presented by Dr Raghuvanshi, CDSCO during the fourth Review Meeting. These meetings reviewed the ongoing regulatory reform efforts at the Central Drugs Standard Control Organisation (CDSCO) under the Ministry of Health & Family Welfare. Supported under the National One Health Mission, the initiative focuses on strengthening India's drug regulatory ecosystem through scientific, digital, and operational capacity building.

Milestones

The Digital Drug Regulatory System (DDRS), a flagship digital public infrastructure project, advanced significantly toward approval following completion of the Request for Proposal (RFP) and cost structure vetting by the relevant technical authorities. The DDRS aims to integrate end-to-end processes for submissions, reviews, and approvals across categories of regulated products, ensuring efficiency, transparency, and coordination between central, state, and institutional stakeholders.

Analytics-enabled dashboards were developed for real-time monitoring of application pendency, division-wise workload, and evidence-based decision-making, marking a key step in the organisation's digital transformation.

The State Drug Regulatory Index was launched on 12 August 2025, providing an objective benchmarking mechanism for evaluating the performance of State Drug Regulatory Authorities across India.

These achievements and reform milestones were presented during the Fourth Review Meeting of CDSCO, chaired by PSA.

Initiatives

A process-improvement programme was implemented across CDSCO's central and regional offices, associated laboratories, and port units. This included the introduction of daily review boards, performance indicators, and a tiered governance mechanism, promoting accountability and continuous improvement.

A comprehensive Guidance Framework for Subject Expert Committees (SECs) was released, standardising norms for expert selection, review conduct, and committee recommendations to improve regulatory transparency and scientific rigour.

Regulatory-processing efficiency improved markedly through the reduction of average application pendency time and automation of multiple certificate-issuance processes.



Figure 1.1.4: Regulatory review meeting, held on 19th August 2025

1.2 Empowered Technology Group

The Empowered Technology Group (ETG) continues to serve as a central governance structure, instituted by the Cabinet to proactively lay down, coordinate, and oversee national-level policies around procurement, technology induction, and R&D for advanced domains that demand significant financial and human capital investments. Through timely and expert advice, ETG shapes the trajectory of the Government's R&D and technology development programmes.

Governance and Structure

- The Chair of ETG is the Principal Scientific Adviser to the Government of India.
- Key members of the ETG are the Chairpersons of the Atomic Energy Commission, Space Commission, Defence Research and Development Organisation (DRDO) and the Secretaries of Ministry of Electronics and Information Technology (MeitY), Department of Telecom (DoT), and Department of Science & Technology (DST).
- A Technology Advisory Group (TAG) comprising of experts (9 from academia and 10 from industry/other sectors) has been created to provide knowledge support to ETG.
- The OPSA serves the ETG and has an ETG Secreteriat for overall management of the entire ETG process.

Objective

ETG's functioning is steered by three core pillars:

- **Policy Guidance:** Crafting roadmaps, advising on indigenisation priorities, benchmarking obsolescence, and embedding technology officers in ministries to monitor and strategise emerging technology adaptation.
- **Procurement Support**: Facilitating the adoption of newer technologies by helping ministries/ departments with frameworks, procurement routings (especially for innovative products with limited market competition), and interfacing with solution provid-

R&D Support: Encouraging strategic technology development, promoting public-private synergy, and guiding R&D investments to align with national priorities in the emerging tech landscape.

Milestones

Recent Evaluations and Outcomes

The ETG meets regularly for the evaluation of cabinet/EFC (Expenditure Finance Committee) notes and policy documents which are submitted by various ministries and departments. The ETG Secretariat does significant groundwork for the evaluation of these notes through expert consultations, and discussions on these proposals with stakeholders, prior to the ETG meetings. Evaluations are done as per a well-defined Standard Operating Procedure (SOP), formulated by the OPSA in consultation with Cabinet Secretariat.

During the calendar year 2025, 17 draft cabinet notes were evaluated and 12 ETG meetings were convened. Table 1 provides a list of the proposals discussed and recommended by the ETG and these have been subsequently approved by the cabinet.

Table 1: Proposals discussed in ETG meeting during the reported calendar year and subsequently approved.

S. No.	Name of the Proposal	Department/ Ministry	Status	Description
1.	Procurement of ADM for PINAKA Multiple Launch Rocket System	Department of Defence (DoD)	Approved by cabinet	The project proposes procurement of 9,360 ADM Type-1 DPICM rockets for the 214 mm PINAKA Multiple Launch Rocket System by the Ministry of Defence with an aim to enhance the Indian Army's area-denial and anti-armour operational capabilities through indigenous suppliers.
2.	Project Insight 2.0	Department of Revenue	Approved by cabinet	The project proposes the implementation of Project Insight 2.0 by the Income Tax Department, with a total outlay of ₹3,999.24 crore over seven years, to upgrade to a secure, cloud-ready, microservices-based data analytics platform for advanced tax data integration, risk assessment, and taxpayer services.

3.	Development of Component Ecosystem	Ministry of Electronics and Information Technology (MeitY)	Approved by cabinet	The project proposes the implementation of the Scheme for Development of Component Ecosystem by MeitY with a total outlay of ₹22,919 crore over 72 months, to build domestic capabilities in electronic and semiconductor component manufacturing through incentives, technology transfer, and R&D support.
4.	VSIPL - ATMP & OSAT (ISM)	Ministry of Electronics and Information Technology (MeitY)	Approved by cabinet	The project proposes the establishment of a greenfield OSAT facility by VSIPL in India, with a total investment of ₹3,064.38 crore, including ₹1,532 crore central government support, to enable advanced wafer-level packaging technologies for high-end semiconductor applications, supported by Foxconn's global manufacturing expertise.
5.	SiCSem (ISM)	Ministry of Electronics and Information Technology (MeitY)	Approved by cabinet	The project proposes the establishment of a greenfield integrated compound semiconductor fabrication and ATMP facility by SiCSem at Info Valley, Bhubaneswar, with a total investment of ₹2,066.70 crore, including ₹745.7 crore central government support, to manufacture silicon carbide power devices and modules for high-voltage and high-current applications in India.
	CDIL - OSAT (ISM)		Approved by cabinet	The project proposes the establishment of an OSAT facility by Continental Device India Private Limited in SAS Nagar, Mohali, with a total investment of ₹117.73 crore, including ₹49.96 crore central government support, to undertake advanced wire-bond and clip-bond semiconductor assembly, testing, and packaging for power and discrete devices in India.
6.	ASIP - OSAT (ISM) (revised from the meeting held on 6th June 2025)	Ministry of Electronics and Information Technology (MeitY)	Approved by cabinet	The project proposes the establishment of a greenfield Outsourced Semiconductor Assembly and Test (OSAT) facility by ASIP at Electronics Manufacturing Cluster (EMC), Maheshwaram, Ranga Reddy District, Telangana, with a total

				investment of ₹468.70 crore, including ₹208.12 crore central government support, to manufacture Flip Chip Ball Grid Array (FCBGA) and Quad Flat No-leads (QFN) packaged Integrated Circuits (ICs).
	3DGS - Fab, OSAT & ATMP (ISM)	Ministry of Electronics and Information Technology (MeitY)	Approved by cabinet	The project proposes the establishment of an ATMP manufacturing facility with a total investment of ₹1,943.53 crore by Heterogeneous Integration Packaging Solutions Pvt. Ltd. with ₹799.16 crore support from the Central Government, to enable high-end semiconductor packaging and 3D heterogeneous integration technologies in India.
7.	Establishment of International Potato Center (CIP), Lima, Peru's South Asia Regional Centres	Ministry of Agriculture and Farmers Welfare	Approved by cabinet	The project proposes the establishment of the International Potato Centre (CIP), South Asia Regional Centre at Agra, Uttar Pradesh, with an estimated five-year toatal outlay of USD 20 million, of which USD 13 million will be supported by the Department of Agriculture & Farmers Welfare (DA&FW) and USD 7 million will be provided by CIP as in-kind support. This is to create a world-class research and capacity-building facility for root and tuber crops in India and South Asia.
8.	Scheme to Promote Manufacturing of Sintered Rare Earth Permanent Magnet (REPM)	Ministry of Heavy Industries (MHI)	Approved by cabinet	The Ministry of Heavy Industries has proposed a ₹7,280 crore scheme for seven years to develop an integrated domestic NdFeB permanent magnet manufacturing ecosystem through sales-linked incentives and capital subsidies, aimed at meeting domestic REPM demand, reducing import dependence, and supporting strategic sectors such as EVs, wind energy, defence, and aerospace.

Second Meeting of the Technology Advisory Group (TAG) of the ETG

The TAG of the ETG was reconstituted on 28 January 2025. The TAG consists of 9 experts representing academia and 10 experts from industry. The second meeting of the TAG of the ETG was held on 18 February 2025 under the chairmanship of PSA Prof. Sood. The meeting focused on reviewing opportunities and identifying interventions to strengthen Advanced Manufacturing (AM) in India.

The meeting was attended by members of the TAG from academia and industry, members of the ETG, senior government officials, and subject experts. Discussions covered the present state of AM in India, international developments, and the need for a coordinated national approach towards developing AM capabilities in India. In the meeting, the importance of strengthening collaboration among stakeholders, developing sensor hubs, and ensuring alignment of regulatory and policy frameworks to support the growth of AM in the country was stressed upon.

In addition to the TAG members, technical experts from AM related fields also participated in discussions. Technical presentations were made by experts on key aspects of AM, that included :

01 **Smart capital goods and automation**
Dr Nagahanumaiah, Director, Central Manufacturing Technology Institute (CMTI), Bengaluru

02 **Digital and hybrid manufacturing**
Dr Gurumurthy, Director, Foundation for Science Innovation and Development (FSID), IISc Bengaluru

03 **Additive manufacturing applications**
Dr Sankhadip Das, Ministry of Electronics and Information Technology

04 **3D concrete printing using construction waste**
Mr. Atul Choudhari, Chief Technology Officer, Tata Consulting Engineers Limited

05 **4D printing for healthcare**
Prof. Kaushik Chatterjee, Department of Bioengineering, IISc Bengaluru

06 **Cybersecurity in manufacturing systems**
Dr N. Subramanian, Executive Director, Society for Electronic Transactions and Security (SETS)

The group discussed the need for shared infrastructure, development of standards, workforce training, and closer coordination among government, academia, and industry. The importance of capacity building and the creation of technology and capability centres near manufacturing hubs was also recognised. The meeting concluded with agreement on the need for a structured and collaborative approach to enhance national capabilities in AM in line with the objectives of the National Manufacturing Mission.



Figure 1.2.1: PSA Prof. Sood opening the session and delivering his initial remarks during the second meeting of the TAG in Vigyan Bhawan Annexe, New Delhi



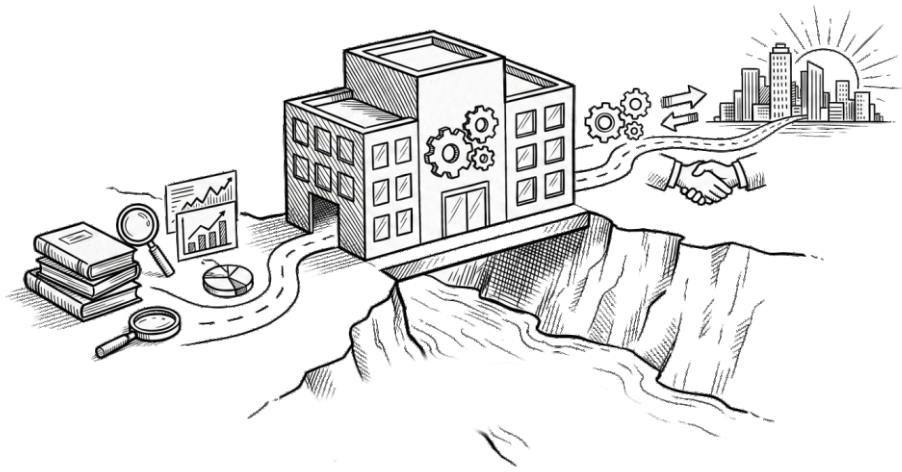
Figure 1.2.2. Second meeting of the TAG held on 18th February 2025 in Vigyan Bhawan Annexe, New Delhi



Leading from Evidence to Action

02

With the strategic architecture established, the narrative shifts from planning to performance, with the Office acting as a vital bridge in the journey from evidence to action. It is at this stage that theoretical insights and gathered data are distilled into high-impact national missions designed to solve the country's most pressing problems. By leading large-scale interventions such as the National One Health Mission, Artificial Intelligence frameworks, and the democratisation of research via One Nation One Subscription, we ensure that scientific evidence is operationalised into tangible public outcomes. This transition from "knowing" to "doing" ensures that the nation's scientific investments yield life-changing benefits, moving towards impacting the health, livelihoods, and digital empowerment of every citizen.



2.1. Artificial Intelligence

Artificial Intelligence (AI) is transforming industries, societies, and governance by enabling machines to mimic human cognitive functions such as learning, reasoning, and perception. Its vast potential is being realised across critical sectors like healthcare, education, finance, agriculture, and manufacturing, where AI-driven innovations ranging from natural language processing and computer vision to intelligent decision-making and speech recognition are creating advanced solutions that enhance efficiency and impact.

Acknowledging this potential, India has emerged as a significant force in AI research and development, actively fostering an ecosystem that ensures access to computing power, innovation, and research across diverse sectors and regions. Through flagship initiatives such as the IndiaAI Mission, the establishment of Centres of Excellences, and the development of Digital Public Infrastructure, the country is laying a strong foundation for a future-ready digital economy. Reflecting this progress, the Technology and Innovation Report by the United Nations Conference on Trade and Development (UNCTAD) ranked India 36th in 2024 on the 'Readiness for Frontier Technologies' index, an improvement from 48th in 2022. The report also recognised India's global standing with highest Revealed Technology Advantage score in AI patents. Furthermore, India boasts a robust AI talent pool with a 24% share of AI projects on GitHub, positioning itself as a potential global "Skills Capital" in AI.

Despite these promising advancements, India, like other nations, needs to overcome significant challenges in harnessing AI's full potential. Issues related to data privacy, misinformation, algorithmic bias, and cybersecurity vulnerabilities underscore the requirement for government intervention for ensuring responsible, ethical, and secure deployment of AI technologies. This ongoing global dialogue underscores the delicate balance required between technological advancement and the protection of societal values.

Milestones

Recognising the immense opportunities as well as the complex challenges presented by AI, India has strategically charted its path forward through a series of key initiatives and policy frameworks that have laid the groundwork for its leadership in AI innovation and governance.

I. Initiating the Path to AI Governance

The Ministry of Electronics and Information Technology (MeitY) established an Advisory Group on AI Governance in November 2023, chaired by PSA. This body was tasked with crafting a regulatory roadmap tailored to India's unique needs. A subcommittee under the group conducted a detailed gap analysis of existing frameworks and identified areas requiring urgent attention, including the spread of deepfakes, AI-enabled intellectual property violations, cybersecurity risks, and issues of algorithmic discrimination.



These principles align with international norms, including those of the Organisation for Economic Co-operation and Development (OECD), while emphasising India's socio-cultural context.

The draft subcommittee report was open for public consultation till early 2025, ensuring wider stakeholder engagement in shaping the governance framework. The committee recommended a hybrid techno-legal and lifecycle-based regulatory approach, engaging all actors across the AI value chain from data providers and developers to end users and regulators. This governance model advocates for industry-led transparency measures, well-defined regulatory responsibilities, mandatory incident reporting, and technology-driven compliance mechanisms. These efforts also align with India's vision for Sovereign AI, ensuring protection of domestic data and intellectual property while fostering innovation tailored to national priorities.

After detailed consultations, the guidelines to AI governance was launched on 5 November 2025. The guidelines present a balanced and innovation-focused framework built on 7 Sutras (principles) like Trust, People First, Fairness, and Accountability, Aiming for Safe, Inclusive AI Development by leveraging existing laws (DPDP Act, IT Act) rather than new AI-specific laws. They focus on enabling responsible innovation through public-private partnerships, sandboxes, and national data infrastructure, guided by an AI Governance Group (AIGG) for areas like deepfakes, balancing economic growth with risk mitigation.



Figure 2.1.1:
PSA Prof. Sood in the presence of Scientific Secretary; Secretary, MeitY; Additional Secretary, MeitY; CEO IndiaAI Mission; DG released the India AI Governance Guidelines

II. Driving Responsible AI Adoption for Socio-Economic Growth

In support of responsible AI adoption, OPSA, in partnership with the World Economic Forum (WEF), has developed an AI Sandbox framework to enable startups and researchers to safely test and validate AI applications. Complementing this effort, WEF, in consultation with OPSA, has developed sector-specific AI Playbooks that offer practical guidance, readiness assessments, and real-world use cases, with a focus on agriculture and MSMEs. The AI Playbooks for MSMEs and Agriculture, along with the AI Sandbox White Paper, were launched on 22 October 2025. Together, these initiatives mark a significant milestone in advancing AI adoption across India's key development sectors. Developed through extensive multi-stakeholder engagement, expert consultations, on-ground visits, and pilot projects under the AI for India 2030 programme of the Centre for the Fourth Industrial Revolution (C4IR) India, the playbooks serve as a strategic roadmap for leveraging AI to enhance productivity, efficiency, and resilience in the agriculture and SME sectors, while also providing a scalable model for adoption across other priority sectors in India.



Figure 2.1.2: AI Playbooks for MSMEs and agriculture, along with the AI Sandbox White Paper, were launched in Kartavya Bhawan, New Delhi.

III. AI Policy Roundtables

On the global front, OPSA has taken a leadership role in shaping India's AI ethics and governance agenda. In partnership with MeitY and IISc Bengaluru, OPSA hosted high-level AI policy roundtables as a precursor to the AI Action Summit in Paris. These roundtables brought together leading researchers, industry experts, and policymakers. OPSA also played an active role in the AI Action Summit, held in Paris in February 2025, which was co-chaired by Hon'ble Prime Minister Modi.

A. India-France AI Policy Roundtables

OPSA has conducted a series of high-level AI policy roundtables focused on India's national AI policy priority areas. In partnership with the IISc Bengaluru, and IndiaAI Mission (MeitY), OPSA organised two official side events prior to the AI Action Summit 2025 held in Paris during 10-11 February 2025. The first roundtable was held at IISc Bengaluru on 25 January 2025, where India and France discussed inclusive AI frameworks, diverse datasets, infrastructure and skills, and foundational models, while also addressing AI governance, innovation, and public-private partnerships. The second roundtable was held on 10 February 2025 at Sciences Po University, Paris (in partnership with Sciences Po University).

Building on these engagements, OPSA convened a Track 1.5 dialogue as a pre-summit event to the forthcoming AI Impact Summit 2026 on 7 November 2025 at IISc Bengaluru, in collaboration with IISc and the French Consulate in Bengaluru.



Figure 2.1.3: 1st India-France AI Policy Roundtable



Figure 2.1.4: 2nd India-France AI Policy Roundtable



Figure 2.1.5: 3rd India-France AI Policy Roundtable

B. High-level Roundtable on Techno-Legal Regulation

Continuing its efforts on India's national AI policy priorities, OPSA, together with the iSPIRT Foundation and the Centre for Responsible AI (CeRAI), further convened a high-level roundtable on Techno-Legal Regulation for Responsible, Innovation-Aligned AI Governance on 22 December 2025, as an official pre-summit event to the India AI Impact Summit 2026.



Figure 2.1.6: Techno-Legal Regulation Roundtable

Looking ahead, India is set to host the AI Impact Summit in February 2026, the first AI summit in the Global South. This summit will provide India with an unprecedented opportunity to lead discussions on critical issues like data privacy, security, AI safety, and ethical governance, further establishing the country as a key player in global AI dialogue. OPSA is contributing towards creating a long lasting impact emerging from the AI impact summit. In addition, OPSA is intending to release a series of white papers primarily on AI regulatory, data governance, and AI use cases. These papers will support national AI mission initiatives and state-level efforts, reinforcing India's leadership role in shaping the future of AI globally. The first of these White Papers was released in December 2025, details of which are mentioned in Section 4 of this Anthology.

2.2. National One Health Mission

The National One Health Mission (NOHM), approved by PM-STIAC in 2022, represents India's commitment to a holistic approach to health, linking human, animal, and environmental systems. It drives integrated surveillance, pandemic preparedness, and multi-sectoral collaboration, while fostering evidence-based policy, capacity building, and innovative interventions to address emerging health challenges nationwide.

The Mission is guided by a multi-tiered governance structure, with an Executive Committee chaired by the Union Health Minister providing policy oversight, a Scientific Steering Committee chaired by PSA ensuring scientific and technical guidance and four Advisory and Review committees to provide subject-specific technical guidance, oversight, and strategic recommendations to support the implementation of the Mission.

On 3 July 2025, the Executive Committee of NOHM welcomed new members from the Ministry of Home Affairs (MHA), strengthening its governance framework. In addition, the Ministry of Earth Sciences (MoES), Indian Space Research Organisation (ISRO), and the Department of Fisheries were incorporated as key stakeholders in the Scientific Steering Committee, further reinforcing the Mission's multi-sectoral and integrative approach.

Milestones

Mission Approval:

Approved under the 21st PM-STIAC Meeting, with OPSA designated as the coordinating body for implementation across human, animal, plant, and environmental health sectors.

Governance Framework:

Establishment of a multi-tiered governance structure, including an Executive Committee chaired by the union Health minister, a Scientific Steering Committee chaired by the PSA, and four Advisory and Review Committees on Bio-Safety Level (BSL) network, R&D countermeasures, integrated surveillance, and data integration.

Bio-Safety Level (BSL)-3/4 Network Strengthening:

Formation of national working groups and inclusion of a Defence Research & Development Establishment (DRDE) laboratory in the network; harmonisation of BSL certification processes and creation of Minimum Standard Requirements for laboratories.

R&D Portfolio Initiation:

Launch of cross-sectoral research projects across key stakeholders and other institutions, addressing surveillance, diagnostics, AMR, and zoonotic disease monitoring.

State and UT Engagement:

Nomination of 27 Nodal Officers across States/UTs and completion of one-on-one consultations with 24 states to strengthen sub-national One Health governance and coordination.

Governance Model for States:

Development of a suggestive Model One Health Governance Framework by OPSA, integrating NCDC guidelines, Kerala's One Health model, and state-level consultations to enable coordinated action across human, animal, and environmental health sectors.

Preparedness and Mock Drills:

Successful conduct of the two National Mock Drill "Vishanu Yudh Abhyas" (August 27 to August 31, 2024) in Ajmer, Rajasthan and "Vishanu Sankraman Pratirodh Abhyas" (November 02 to November 05 2025) in Khandwa, Madhya Pradesh to test laboratory coordination, biosafety protocols, and emergency response mechanisms.

Capacity Building and Training:

Regular laboratory biosafety and pathogen diagnostics training at institutions like Institute of Microbial Technology (IMTECH), Post Graduate Institute of Medical Education and Research (PGIMER), Indian Veterinary Research Institute (IVRI), and National Institute of Immunology (NII) to strengthen technical expertise nationwide.

Digital Enablement:

Launch of the One Health Mission Dashboard and development of a unified e-learning module to support real-time monitoring and standardised capacity building across States/UTs.

Scan QR Code
to access the
One Health Mission Dashboard

Public Outreach and Engagement:

Initiation of national outreach activities including publications, digital media, youth engagement programmes, and national-level events to strengthen awareness and participation.

Inter-State Collaboration:

Facilitation of structured inter-state consultations on Japanese Encephalitis (Assam-Uttar Pradesh) and Kyasanur Forest Disease (Goa-Karnataka) to promote cross-learning and best practice adoption.

International Engagement:

Participation in the 50th anniversary commemoration of the Biological Weapons Convention, highlighting the National One Health Mission as a framework for strengthening preparedness, biosafety, and biosecurity, particularly for the Global South.

Initiatives

Executive Steering Committee on One Health

The Union Minister of Health and Family Welfare, Shri J. P. Nadda chaired the Second Meeting of the Executive Committee of NOHM on 26 September 2025. The chair reviewed the progress made under the Mission and discussed the roadmap for future activities. He emphasised the interconnectedness of human, animal, plant, and environmental health, underscoring that collective efforts are essential to anticipate, prevent, and respond to emerging threats. He appreciated the progress made in developing Standard Operating Procedures (SOPs), roadmaps, and implementation pathways under the Mission and urged further strengthening of institutional structures and inter-departmental collaboration. The chair also highlighted the need for a futuristic and anticipatory approach to ensure the Mission's sustained success.



Figure 2.2.1: The second Executive Steering Committee on One Health meeting chaired by Union Minister for Health and Family Welfare.

Scientific Steering Committee on One Health

Three meetings of the Scientific Steering Committee on One Health were convened during the reporting period.

The Second Meeting of the Scientific Steering Committee of the National One Health Mission was held on 15 April 2025 at Vigyan Bhawan, under the chairmanship of PSA Prof. Sood. The discussions focused on the funding mechanism for Mission projects, plans for conducting an animal disease mock drill, and strategies for enhancing state-level engagement through the creation of a cross-learning platform. The Committee also reviewed progress in surveillance methodologies and the development of R&D countermeasures, including vaccines, diagnostics, and monoclonal antibodies for diseases of One Health relevance. Emphasising the Mission's broad scope, the Chair highlighted the need for continued collaboration, innovation, and adaptability among all stakeholders. The meeting concluded with the launch of a special edition of Vigyan Dhara dedicated to NOHM and the release of a video showcasing the Mission's vision, stakeholder diversity, and overarching goals. The video can be accessed on the given QR.

Scan QR Code
to access the
NOHM Video

The Third Meeting of the Scientific Steering Committee of NOHM was convened on 26 August 2025 at Vigyan Bhawan. The meeting deliberated on the proposed tiered governance model spanning state, district, and panchayat levels, and reviewed initiatives for inter-state linkages to promote cross-learning. Discussions also covered the development of a unified e-learning module on One Health for State and UT officials, along side youth engagement initiatives such as hackathons and ideathons to identify regional-level solutions to One Health challenges. It was noted that the Mission has made significant progress, with upcoming efforts focused on developing suggestive governance frameworks, establishing a National Outbreak Data Repository, scaling up wastewater surveillance, strengthening laboratory and surveillance systems, and enhancing capacity building. The meeting reaffirmed the Mission's commitment to advancing a coordinated, technology-enabled, and participatory approach to One Health implementation across India.



Figure 2.2.2: Third Scientific Steering Committee on One Health

The Fourth Meeting of the Scientific Steering Committee on One Health, held on 18 December 2025, reviewed progress across the core pillars of the Mission, including governance, integrated surveillance, research and development of medical countermeasures, laboratory preparedness, data integration, and engagement with States and Union Territories. The meeting noted significant advances guided by the four Advisory and Review Committees. Key achievements included the consolidation of the national BSL-3/4 laboratory network with harmonised SOPs and priority pathogen lists, piloting of technology-enabled, community-linked surveillance models in select States, initiation of a comprehensive national landscape of medical countermeasures across priority pathogens, and formulation of a federated data-sharing architecture supported by the design of a One Health dashboard. Collectively, these efforts strengthened coordination, preparedness, and evidence-based decision-making across the human–animal–environment interface.

A key outcome of the meeting was the release of the Model Governance Framework for Strengthening One Health Governance in States and Union Territories, the details of which are included in Section 4 (Knowledge Creation and Synthesis) of this Anthology. Emphasising the importance of robust and institu-

tionalised governance mechanisms at the State and district levels, the Chair encouraged stakeholder Ministries and Departments to actively support dissemination of the framework and advise their respective field formations to facilitate its adoption and contextualisation by States and Union Territories. The Committee also reviewed progress on capacity building under the Mission, including completion of structured training programmes for State/UT nodal officers and the ongoing development of One Health e-learning modules, including hosting on the iGOT Karmayogi platform, to enable standardised, scalable upskilling of officials and professionals across Ministries, States, and Union Territories.



Figure 2.2.3: Fourth Scientific Steering Committee Meeting

Advisory and Review Committees

On 8 November 2024, four Advisory and Review Committees were constituted to guide subject-specific working groups in supporting the implementation of the National One Health Mission. The committees continue to review ongoing initiatives, identify gaps, propose standards and protocols, and facilitate coordination across sectors for areas such as high-containment laboratories, research and development of medical countermeasures, technology-enabled surveillance, outbreak investigation, and data integration.

I. **Advisory and Review Committee for BSL-3/4 Laboratory Network:** Chaired by Lt. Gen. Madhuri Kanit-

kar (Retd.), the Committee convened three meetings since October 2024 to strengthen India's high-containment laboratory network under NOHM. Dedicated subgroups were constituted on SOP review (supported by ICMR), data-sharing platforms (supported by NCDC), and Minimum Standard Requirements (supported by OPSA). These subgroups supported harmonisation of BSL-3/4 laboratory certification, reviewed learnings from the First National Mock Drill (Vishanu Yudh Abhyas), examined training outcomes, and advanced proposals for a centralised reporting platform.

A syndrome-based list of 39 priority human pathogens and 15 priority animal pathogens was finalised, along with identification of gold-standard diagnostic kits. Efforts are underway to ensure uniform procurement of these kits across all network laboratories. The network was further strengthened through the inclusion of a DRDE laboratory, and regular bi-weekly coordination meetings between ICMR and OPSA were instituted to address operational issues.

Capacity-building remained a key focus, with specialised trainings conducted on biorepository management at CSIR-IMTECH, Chandigarh, and bacteriology at PGIMER, Chandigarh (31 July–2 August 2025), and additional trainings on animal pathogen testing and immunological assays scheduled. A Biosafety and Biosecurity Assessment Tool and a comprehensive Laboratory Biosafety Manual for BSL-3 facilities are under development to standardise safety and operational practices. Preparedness exercises, including Ebola diagnostics, demonstrated full concordance across participating laboratories. The Committee is advancing work on the hub-and-spoke laboratory model, strengthened integration with national surveillance systems, and recommended linkage with genomic sequencing platforms to further enhance outbreak preparedness and response.

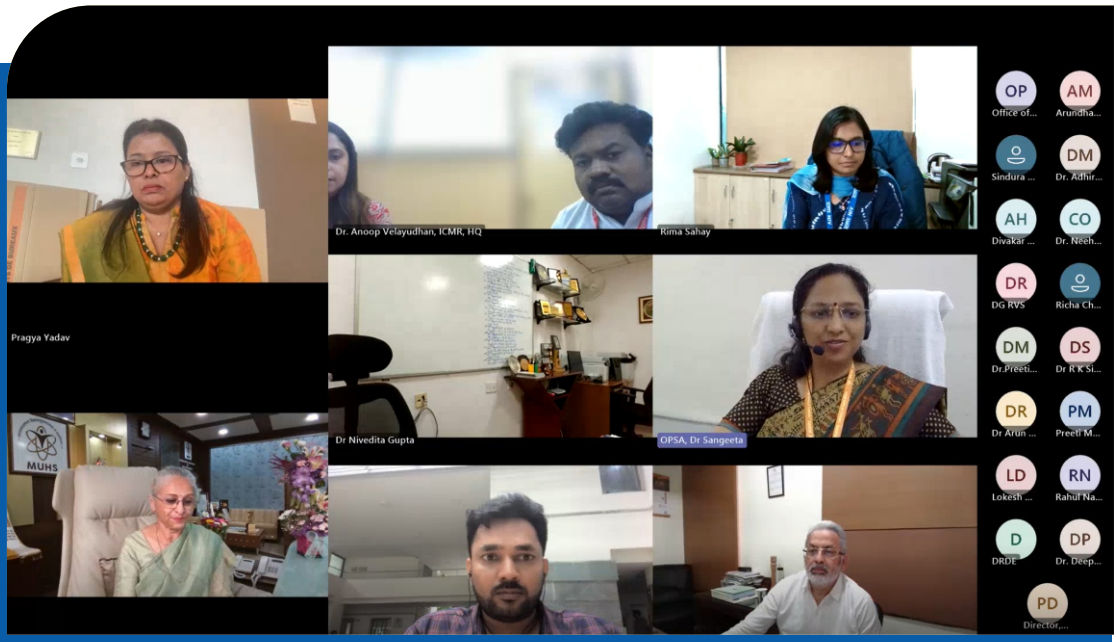


Figure 2.2.4: Seventh Meeting of the A&R committee for BSL 3/4 laboratory network held on 13th August 2025

II. **Advisory and Review Committee on Research and Development of Medical Countermeasures:** Chaired by Dr Renu Swarup, the Committee held three meetings during the reporting period to review ongoing One Health research and provide strategic oversight for strengthening national preparedness through research and innovation. A key achievement was the initiation and advancement of a comprehensive Medical Countermeasures (MCM) landscaping exercise, which combined structured data collection from Ministries and institutions with systematic literature review to map diagnostics, vaccines, therapeutics, and other countermeasures across priority pathogens and stages of development.

The Committee reviewed initial synthesis outputs, including pathogen-wise and product-wise mapping and institutional analysis, and supported the development of a dynamic digital tracker to visualise and update the MCM landscape. Key recommendations focused on refining priority pathogen lists, incorporating Technology Readiness Levels, aligning Mission-funded projects with identified gaps, strengthening engagement with the private sector, and organising focused

planning workshops to improve coordination and accelerate translation from research to deployment.

III. **Advisory and Review Committee on Technology-Enhanced Integrated Surveillance and Outbreak Investigation**: Under the chairmanship of Dr N. K. Arora two meetings were held to review surveillance activities and identify gaps in the application of technology for outbreak investigation. The Committee emphasised the integration of digital technologies with community engagement to strengthen early detection and response mechanisms. Pilot exercises conducted in selected States demonstrated the feasibility of collaborative surveillance models that combine digital tools with trained community volunteer networks.

The Committee also undertook baseline assessments to identify strengths and gaps in zoonotic disease surveillance, laboratory integration, intersectoral coordination, and data sharing. Based on these findings, recommendations were made to develop standard operating procedures for intersectoral coordination, institutionalise community surveillance mechanisms, and strengthen feedback loops between field systems and laboratories. The Committee highlighted the importance of youth engagement, multi-district surveillance models, and structured review mechanisms to support scalable and sustainable implementation.

IV. **Advisory and Review Committee on Integration of Databases and Data Sharing:** Chaired by Dr Vijay Chandru, the Committee convened two meetings to map the existing data landscape across Ministries and Departments and to develop a scheme for dataset integration under the One Health framework. The Committee discussed the development of a federated data-sharing architecture that enables integration across human, animal, and environmental health systems while respecting sectoral mandates. The Committee also addressed governance and sustainability aspects of data integration.

Key recommendations included defining common data standards, ensuring data confidentiality and clear custodianship, and developing mechanisms for interoperability of existing databases. To operationalise the framework, the Committee proposed constituting smaller working groups, conducting co-creation workshops with Ministries and States, and adopting a phased approach, including piloting through a flagship disease-focused initiative.

State and Union Territory Engagement

Engagement of States and Union Territories is central to the success of NOHM, as surveillance, prevention, and response efforts are most effective when anchored at the local level. Active state/UT participation enables coordinated, multisectoral action across human, animal, and environmental health systems. Strengthening state-level ownership ensures that national strategies are effectively translated into region-specific actions, fostering timely and sustainable One Health outcomes.

I. **Bilateral Consultations:** To strengthen the institutional framework for One Health implementation across India's States and UTs, extensive outreach has been undertaken through a series of one-to-one meetings with the nominated Nodal Officers. These discussions focused on the governance structures guiding interdepartmental coordination, funding avenues for R&D, capacity-building requirements, and approaches to bridge knowledge gaps in implementing the One Health framework. The meetings also served to familiarise state representatives with national policies, guidelines, and capacity-building initiatives, facilitating alignment between national objectives and state-level implementation.

At present, 27 States and Union Territories have officially nominated Nodal Officers. One-on-one interactions have been conducted with 24 States/UTs, providing detailed insights into local challenges, institutional arrangements, and the specific requirements for effective intersectoral collaboration. These engagements have been instrumental

in building a foundation for effective governance, coordination, and technical dialogue essential to advancing the One Health approach at the State and UT levels.

II. **First State and UT Workshop:** The First State/UT Engagement Workshop under NOHM was held on 9 June 2025 under the chairmanship of PSA Prof. Sood bringing together representatives from 27 states and UTs, central ministries, and partner institutions. The workshop emphasised the pivotal role of states/UTs in advancing the Mission's objectives and strengthening intersectoral coordination for disease surveillance and preparedness. Key discussions focused on governance, surveillance, outbreak response, and capacity building. Two flagship initiatives were launched during the workshop - the One Health Youth Engagement Programme and the One Health Dashboard (details of the Dashboard are included in Section 4 of this Anthology), serving as a central repository of ongoing initiatives. Participants also undertook a simulation exercise on outbreak response, coordinated by national agencies, to assess preparedness and coordination mechanisms. The workshop concluded with a poster session showcasing One Health initiatives from states and partners, reaffirming the Mission's commitment to collabo-

Scan QR Code to access the **Press Release**



Figure 2.2.5: Group picture with State and UT officials during the workshop

Scan QR Code
to access the
NOHM
(Youth Engagement Program) Video

rative, data-driven action across sectors. The workshop report is shared in Section 4 (Knowledge Creation and Synthesis) of this Anthology.

The Youth engagement was launched as a flagship initiative during the first State and Union Territory Engagement Workshop under the National One Health Mission. The video can be accessed on the given QR.

Following its launch, a range of structured activities were undertaken involving students and young professionals through academic and institutional networks, including hackathons, ideathons, creative competitions, and community outreach initiatives. These activities were subsequently showcased during the National One Health Assembly, reinforcing the Mission's emphasis on inclusive participation, innovation, and long-term capacity building in advancing the One Health approach. These initiatives are intended to build a pipeline of informed and engaged young professionals while embedding One Health principles within educational and community settings.



Figure 2.2.6: Youth Engagement Flyer

III. Centre – State Linkage: A Centre-State level consultation was held on 1 August 2025 at Assam, to address the state's high burden of Japanese Encephalitis (JE). This disease accounted for nearly half of India's reported cases, with transmission sustained across 33 districts. The meeting facilitated by OPSA brought together the Assam Health Department and key central government agencies working in human and animal health to devise a One Health strategy for JE

prevention and control.

This consultation was followed by an inter-state knowledge-sharing session with Uttar Pradesh on 14 August 2025, facilitating the exchange of lessons and best practices. The insights generated from these sessions were compiled and shared with relevant authorities. A formal communication was sent to the Senior Administrative Officer of Assam on 8 September 2025, recommending that the state consider integrating the insights from these consultations into its JE management strategy, where appropriate. The discussions emphasised that a coordinated and sustained One Health approach is essential for achieving long-term reductions in JE incidence and mortality in the state.

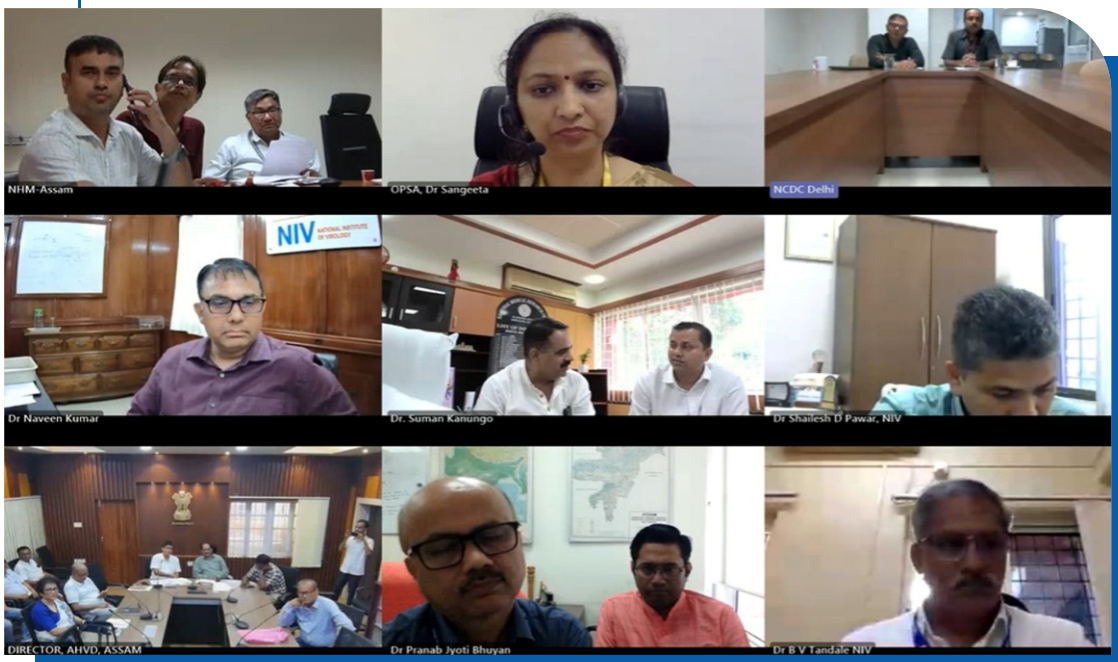


Figure 2.2.7: Discussion with Assam and Central Stakeholder Representatives

IV. **Inter-State Linkage**: As part of knowledge-sharing under the One Health Mission, officials from Uttar Pradesh, a state recognised for its success in reducing JE and Acute Encephalitis Syndrome (AES), were invited to share their experiences with Assam on 14 August 2025. The session facilitated by OPSA identified state-specific challenges and critical gaps, leading to expert recommendations for a com-

prehensive, multi-sectoral strategy. Assam also benefitted from UP's DASTAK programme; a door-to-door campaign conducted in collaboration with UNICEF, demonstrating the value of cross-state learning for disease control.

Similarly, a knowledge exchange session between Goa and Karnataka was held from 21–22 August 2025 under the One Health and Agro-Ecology Project of the Ministry of Environment, Forest and Climate Change (MoEF&CC). Goa officials visited Karnataka to learn about management strategies for Kyasanur Forest Disease (KFD), a highly localised disease. Such exchanges are critical not only for synchronised awareness campaigns but also for promoting sharing of best practices and region-specific strategies across states, and reinforcing the value of inter-state collaboration in the One Health framework.

V. **Governance Structure:** A model framework on One Health Governance Structure for States and Union Territories drawing on existing frameworks such as the NCDC guidelines and Kerala's One Health model, as well as insights from virtual consultations with states has been developed by OPSA. The structure emphasises a whole-of-state approach, with committees established from the lowest administrative units to the state/UT level.

This ensures effective implementation of the One Health approach, strengthens capacity at district and block levels, and facilitates coordinated, multi-sectoral action across human, animal, plant, and environmental health systems. The preliminary draft was circulated to all relevant stakeholders for review and feedback, aligning it with national policies and collaborative inputs. Following consolidation of comments, the finalised document will be disseminated to States and UTs, providing a structured model to institutionalise One Health governance nationwide while enabling States/UTs to operationalise the approach effectively at local levels. The document can be accessed on the given QR.

Scan QR Code to access the **document**

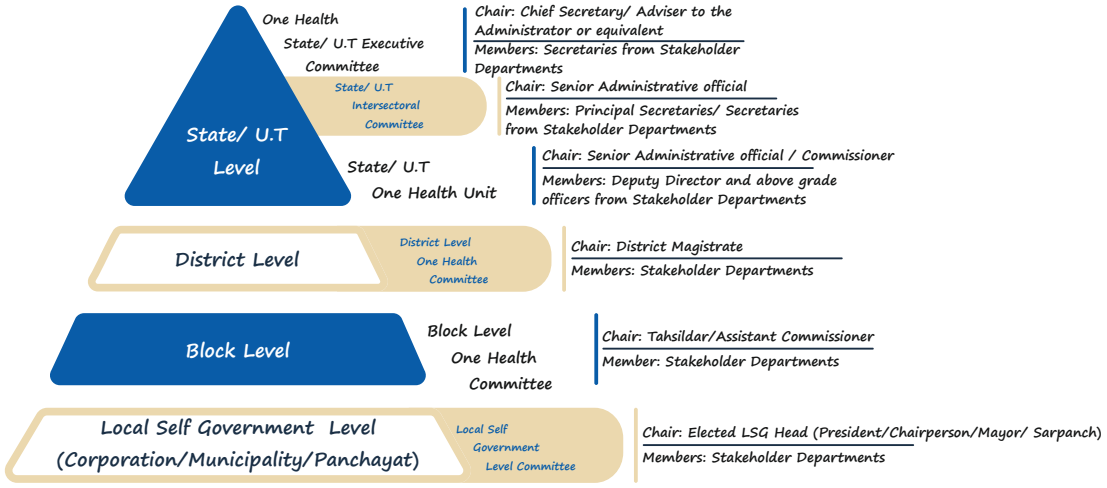


Figure 2.2.8: Model framework on One Health governance for State/UTs

Research and Development (R&D)

The mission has launched an R&D strategy in 2024–25. Partnering with leading institutions, the first cycle of projects that were funded by NOHM focussed on surveillance at the animal–human interface, wastewater monitoring for Antimicrobial Resistance (AMR), and syndromic surveillance for infectious diseases, respiratory viruses, and Acute Encephalitis Syndrome (AES). This initiative strengthens India's integrated disease monitoring and prevention framework, fostering evidence-based policymaking and national preparedness.

Other Stakeholder Engagements

I. **National One Health Mission Assembly-2025:** The National One Health Assembly held on 20-21 November 2025 served as a key national platform for stakeholder engagement under the Mission, bringing together policymakers, scientific experts, representatives from States and Union Territories, academia, and youth. The Assembly facilitated cross-sectoral dialogue on Mission priorities, implementation pathways, and emerging challenges, while strengthening awareness and ownership of the One Health approach.



Figure 2.2.9 : Representative pictures of the National One Health Mission Assembly-2025

II. **International Engagement - Biological Weapons Convention (BWC):** At the international level, the Mission's relevance was highlighted during India's engagement at the 50th anniversary commemoration of the Biological Weapons Convention. NOHM was presented as an integrated framework for strengthening preparedness, biosafety, and coordinated response at the human – animal - environment interface, underscoring India's commitment to global health security and multilateral cooperation.

2.3. One Nation One Subscription

The One Nation One Subscription (ONOS) initiative of OPSA was approved by the Union Cabinet as a Central Sector Scheme on 25 November 2024. ONOS is aimed at providing access to scholarly research e-journals from prominent publishers covering the disciplines of Science, Technology, Engineering, and Mathematics (STEM), medical, management, social sciences, and humanities, to all individuals in the country. The INFLIBNET Centre, an Inter-University Centre under the University Grants Commission (UGC), Ministry of Education (MoE), serves as the implementing agency for ONOS.

Nearly 6,400 institutions across the country including Higher Educational Institutions i.e. central and state universities, colleges (including all medical colleges) and central government R&D institutions will benefit from ONOS. This translates to nearly `1.8 crore students, faculty, and researchers across the country getting access to more than 13,000 journals from 30 publishers including the top 4 global publishers i.e. Elsevier, Springer-Nature, Taylor & Francis and Wiley.

As part of the recent Anusandhan National Research Foundation (ANRF) Act, the Government plans to seed and promote a vibrant research culture in the tier-2 and tier-3 higher educational institutions. Through ONOS, many such institutions will begin to get access to journals, which is a necessity for doing research. Under ONOS, the government has negotiated for national licences for e-journal subscriptions with 30 publishers, thus consolidating various consortia/institutional subscriptions. In addition to the above, it is also planned to have a consolidated central funding to support Indian authors to pay for article processing charges Article Processing Charges (APCs) for good quality

Core Committee for the Implementation of the "One Nation One Subscription (ONOS)

A core committee of Secretaries chaired by PSA was constituted in June 2022 for overseeing the implementation of the ONOS initiative. Dr Parvinder Maini, Scientific Secretary, OPSA, Sri Vineet Joshi, Secretary, Department of Higher Education (DHE); Prof. Abhay Karandikar, Secretary, Department of Science

and Technology (DST) serve as members of the Committee. The Committee also invites representatives from DHE, Chair of the Cost Negotiation Committee, and members from INFLIBNET Center and OPSA as invited members for its meetings.

The 16th Meeting of the Core Committee for the implementation of ONOS

The 16th Meeting of the Core Committee was held on 17 July 2025. To review the progress of ONOS implementation, assess registration and usage statistics, finalise mechanisms for funding article publishing charges (APCs), and deliberate on the inclusion of additional publishers and journals in the ONOS framework. During the meeting, the Joint Secretary, DHE presented the progress update, highlighting that the ONOS portal has been operational since January 2025, with over 4500 higher education institutions registered. The Committee discussed the need for enhanced outreach to increase participation, especially from state universities and affiliated colleges. A significant discussion also centred on usage mapping and reconciliation of download statistics between INFLIBNET and publishers, where discrepancies were observed.

The outcome of the meeting included key recommendations such as conducting focused webinars to accelerate institutional onboarding, reconciling usage data with publishers, following up with concerned ministries for pending fund contributions, formulating transparent APC guidelines, and considering the inclusion of six additional publishers in the ONOS scheme.

The 17th Meeting of the Core Committee for the implementation of ONOS

The 17th Meeting of the Core Committee was held on 7 November 2025. The meeting was convened to review the status of ONOS implementation, examine institutional registration and usage trends, assess the status of funding, deliberate on the onboarding of additional publishers, and review progress on the APC framework. A detailed presentation on the implementation status was made by the Joint Secretary, DHE, highlighting that the ONOS platform has been operational since January 2025 and has recorded 8.69 crore article

downloads by September 2025, with monthly downloads consistently exceeding one crore since April 2025. The Committee discussed challenges related to institutional onboarding, usage mapping, reconciliation of publisher data, and the need to enhance IP-based access.

The Committee noted that while over 5,400 higher education institutions have registered, a significant number of affiliated colleges remain unregistered. It emphasised the need for focused outreach and monitoring. Discussions were also held on publisher-wise usage patterns, per-article download costs, and the importance of continued data-driven monitoring to inform future subscription strategies. The status of funds earmarked for ONOS was reviewed, and follow-up with concerned departments for pending contributions was advised. Based on recommendations from the last Core Committee meeting and the status presented by DHE, the Committee approved the inclusion of two (RSC and World Scientific) out of six publishers .

The outcome of the meeting included recommendations on conducting focused outreach to boost registrations; examining usage data for new users, including state public universities; obtaining per-article download cost comparisons using ESS data; on-boarding the two accepted publishers with Department of Expenditure approval; conducting outreach for APC rollout; and reviewing data for the top 5% and top 10% criteria to potentially revise APC guidelines.

2.4. Science and Technology (S&T) Interventions for Sustainable Livelihood System

The Mission for Science and Technology-based Sustainable Livelihood System (Mission सह SANKALP- Science and Advanced Networks for Knowledge-driven Action for Livelihood Promotion) aims to leverage Science, Technology, and Innovation (STI) to address challenges like climate change, pandemics, and resource depletion that threaten key livelihood sectors like agriculture, fisheries, and forestry - vital for reducing poverty and hunger. By promoting STI-led solutions, the Mission seeks to strengthen natural resource management, enhance value chains, and build community resilience in alignment with the Sustainable Development Goals (SDGs).

Serving as a convergence platform for multiple ministries including the Department of Science and Technology (DST), Ministry of Rural Development (MoRD), and Ministry of Panchayati Raj (MoPR), the Mission focuses on local-level technology deployment, capacity building, and market creation for indigenous products. It emphasises strengthening the five livelihood capitals, addressing multi-dimensional poverty, and integrating traditional knowledge, skill development, and inter-ministerial collaboration for sustainable rural transformation.

Milestones

The Mission was presented to the PM-STIAC in January 2023, where it received approval for phased implementation and piloting in selected villages. OPSA was designated to coordinate inter-ministerial efforts for its effective rollout.

The first inter-ministerial meeting was convened on 9 November 2023, under the chairmanship of PSA Prof. Sood

OPSA, in collaboration with DST as the nodal ministry, is overseeing mission coordination, planning, and budgeting to ensure alignment with the priorities identified by participating ministries.

Nodal officers from 15 ministries and departments have been nominated, and their first meeting, held on 22 October 2024, had focused on mapping existing livelihood-related programmes. Insights from this exercise informed site selection and the development of an actionable timeline for mission initiation.

Initiatives

After rigorous follow-ups with various stakeholder ministries and departments on developing a working mechanism and during the mission's planning phase, several high-level meetings were chaired by PSA, which included:

25 March 2025: Exploring various existing schemes of stakeholder ministries/departments on the livelihood sector, and scope of leveraging and converging them in the mission with DST as an implementing agency.

29 April 2025: Discussions brought together Secretaries and Joint Secretaries from key ministries such as DST, MoRD, and the Ministry of Social Justice and Empowerment (MoSJE). These discussions focused on strengthening ongoing livelihood initiatives and integrating S&T innovations into existing government programme, paving the way for an inter-ministerial convergence mechanism under Mission सह SANKALP.

To ensure effective coordination and implementation, a three-tiered governance mechanism has been established:

- At OPSA level, a Steering Committee serves as the apex body providing policy direction, strategic oversight, and inter-ministerial coordination for resource mobilisation and technology transfer.
- A Strategic Planning Committee guides progress, ensuring convergence of efforts, and integration of S&T innovations with national and regional livelihood priorities.

At the DST level, a Technical Advisory Group (TAG) will be constituted comprising domain experts for providing technical guidance, reviewing proposals, and recommending projects for funding to ensure scientific relevance and impact.

A schematic representation of stakeholder ministries along with 3-tiered Governance structure is depicted through Figure 2.4.1

- As part of groundwork activities, a comprehensive needs assessment was undertaken to identify requirements of implementing agencies across livelihood schemes. The assessment revealed that while many ministries have developed scalable S&T innovations, deployment remains limited due to dissemination gaps. To address this, a web-based information template was developed to collect data on S&T interventions from all stakeholder ministries, resulting in the creation of a unified database of rural livelihood technologies.

- Building on this effort, a Compendium of 357 Ready-to-Use Technologies has been curated serving as an actionable inventory mapped to field requirements. Each entry includes deployment details, cost, location, manufacturer information, post-sale support, and training opportunities. QR-coded links have also been embedded for easy access to extend digital information and direct interaction with technology developers.

- Leveraging the governance framework and compendium, DST is now preparing to launch a Call for Proposals (CFP) inviting eligible institutions to pilot STI-based livelihood interventions in selected Aspirational Blocks. The initiative aims to develop scalable, community-driven models that enhance socio-economic resilience, build capacity, and align with India's SDG commitments. Support will encompass technology deployment, pilot implementation, creation of decentralised STI hubs, S&T-based training, integration of indigenous knowledge, scale-up planning, and impact assessment.

The Mission is now being advanced for implementation by DST, with coordinated inter-ministerial efforts ensuring the convergence of science, technology, and innovation toward building sustainable livelihood systems across India.

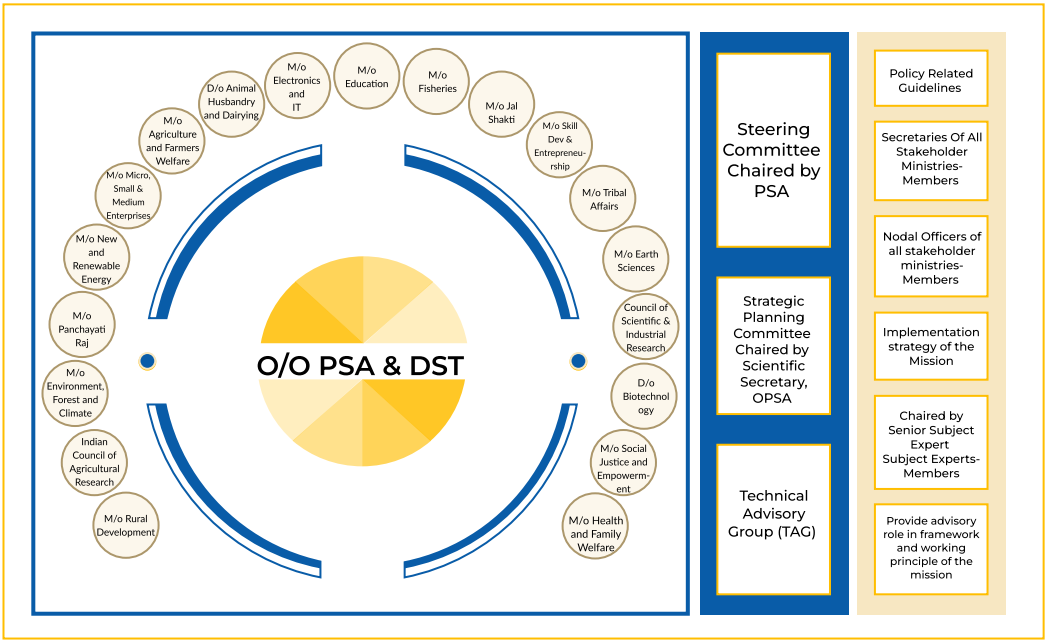


Figure: 2.4.1 Schematic representation of stakeholder ministries and the three-tier governance framework under Mission सह SANKALP

2.5. Society for Electronic Transactions and Security (SETS)

Society for Electronic Transactions and Security (SETS), an initiative under OPSA of India, has been working in the frontier of Cyber Security areas such as Hardware Security, Cryptology, Network Security, and Quantum Security. During the year 2025, SETS has undertaken a few extramural projects, the details of which are given below:

New Cyber Security R&D Initiatives

I. **Malware Defence and Detection in OT environment**

This project was initiated from July 2025 for a period of two years supported by Power Grid Centre of Excellence (PGCoE) in Cyber Security, and IISc, Bengaluru. SETS shall develop Malware Detection and Defending Tool integrated with advanced threat detection techniques that can be used for existing Power Grid transmission grid operations which includes, SCADA (Supervisory Control and Data Acquisition) and distributed control systems (DCS).

The power grid is considered a vital infrastructure that requires robust cybersecurity measures for its operations. Vulnerabilities within the grid pose significant risks, as malware can exploit these weaknesses to cause malfunctions or disrupt services. SETS will create a smart tool to detect and block malware in the transmission grid's Operation Technology (OT) security systems. It will also build and update a threat database to spot, analyse, and stop potential malware early, strengthening protection against growing cyber risks. Currently, literature survey, study of various attacks, and preparation of case study report is ongoing.

II. **Enabling Secure Boot in RISC – V Processors using Post Quantum Secure Schemes**

This project was initiated in January 2025 for a period of three years supported by MeitY and being carried out jointly by SETS and Centre for Development of Advanced Computing (C-DAC),

Thiruvanthapuram. The primary objective of the project is to demonstrate secure boot functionality in a reduced instruction set computer (RISC-V) environment, employing both classical and post-quantum secure cryptographic schemes. Firstly, SETS shall implement and demonstrate the entire secure booting process on Field-Programmable Gate Array (FPGA). Secondly, the FPGA device containing the required cryptographic implementations would be interfaced with a RISC-V kit and the secure boot would be demonstrated. Finally, a software implementation of the requisite cryptographic schemes would be run in the processor kit itself and the secure booting would be demonstrated. Currently SETS has implemented EdDSA on FPGA and demonstration of secure boot for VEGA processor is ongoing.

III. Programmable photonic quantum computing using qubits encoded in different degrees of freedom of a photon (under NQM)

This project was initiated in February 2025 for a period of sixty-one months under the National Quantum Mission (NQM), Department of Science & Technology (DST), led by IISc Bengaluru along with SETS Chennai, Jaypee Institute of Information Technology (JIIT) and C-DAC Bangaluru. Main objectives of the project include the development of gate-based programmable photonic quantum computing system & cloud enablement and development of crypto specific applications.

SETS will develop a system-specific quantum error model for photonic quantum processors, implement quantum error detection and correction techniques optimised for photonic architectures and design, and develop algorithms for a small-scale photonic quantum processor, with a focus on cryptographic applications. Implementation of classical decoding algorithms for quantum error correction (QEC) and review of quantum tokenised signature scheme suitability for QEC is under progress.

IV. Quantum Internet with Local Access (QuILA) - NQM

This activity was initiated in January 2025 for seventy-five months under NQM, DST, led by IIT Madras along with SETS Chennai, IISc

Bengaluru, C-DAC Bengaluru, IIT Hyderabad, IIT Indore and C-DAC Thiruvananthapuram. The main objective of this initiative is to set up long-distance quantum key distribution links with intermediate secure nodes and metro area quantum access networks at end points of the long-distance links.

The deliverables include developing new modalities for quantum communications, beyond Quantum Key Distribution (QKD), create testbeds for quantum secure encrypted applications, develop interoperability standards for quantum communication equipment and to develop QKD Network/Testbed as a Service, and to develop autonomic QKD Network management with Self-X capabilities.

The role of SETS includes:

(a) Setting up a backbone QKD network between Chennai and Bengaluru along with C-DAC and IIT Madras;

(b) Development of classical subsystems for QKD, incorporating standardised algorithms for secure key distillation and trusted-node key relay; and

(c) Integrating post-quantum algorithm-based solutions to ensure end-to-end security in quantum key delivery to users and applications. Setting up of QKD notes with already existing infrastructure is in progress, development of key distillation engine (KDE) hardware accelerator for COW-QKD (Coherent-One-Way Quantum Key Distribution) protocol, and analysis of existing frameworks for security evaluation is ongoing.

V. Automation and Setting up of a reference plan for validating cryptographic algorithms and modules

This project was initiated in January 2025 for a period of three years, supported by MeitY, led by C-DAC Bengaluru and jointly being carried by SETS Chennai, IIT Madras, IIT Kharagpur and Standardisation, Testing and Quality Certification (STQC). The overall objective of this project includes enhancing and automating test procedures and to establish a reference lab for validating cryptographic algorithms/modules as per ISO/IEC standards. The role of SETS is to establish a reference laboratory for the mitigation of non-

invasive attack classes against cryptographic modules in accordance with ISO/IEC 17825 by creating the infrastructure for evaluation of cryptographic module against non-invasive Side Channel Analysis (SCA) attack as per the ISO/IEC 17825. Establishment of the reference laboratory as per ISO/IEC 17825 for asymmetric key algorithms is currently underway.

VI. Privacy Preserving Techniques using Homomorphic Encryption of Genomics Data

This project, initiated in December 2025 for two years, is supported by MeitY and jointly implemented by SETS Chennai and C-DAC Pune. The overall objective is to develop a framework for privacy preservation based on homomorphic encryption for genomics data encryption and analysis. The role of SETS is to contribute towards comparison of various homomorphic encryption schemes, development of architecture for genomics data and prototype implementation. The Bio-Informatics team from C-DAC Pune will conduct the literature survey on genomics data, data collection, pre-processing, and testing and validation. Currently, related survey, study, and analysis are being carried out.

Cyber Security Product Development

SETS as part of internal R&D and product development initiatives has initiated the development of the following solutions:

Indigenous Side Channel Evaluation Board – ANVAYAM

Design, Development, Fabrication and Assembly of indigenous FPGA based Side-channel evaluation board along with the automated software for capture and analysis.

Design and development of Indigenous FIDO2 device for Passwordless Authentication

To design and develop an Indigenous Fast Identity Online2 (FIDO2) device for password-less authentication using third-party certified crypto-chip.

Design and development of Post Quantum Based PKI for Enterprise Security

Design and development of a comprehensive software suite for Public Key Infrastructure (PKI) with a focus on leveraging Post Quantum Cryptography (PQC) alongside classical cryptographic algorithms.

International and National Events

SETS as part of internal R&D and product development initiatives has initiated the development of the following solutions:

i. HACK@CHES 2025

SETS team was selected in the top 10 teams of HackTheSilicon (HACK@CHES 2025) global competition on hardware bug hunting and participated in Phase 2 on-site competition in Malaysia during 13 – 15 September 2025 .



Figure. 2.5.1 SETS team participating in HACK@CHES 2025 Phase 2 on-site competition at Kuala Lumpur Convention Centre, Malaysia.

ii. Bit-by-Bit Hardware Hackathon by IIT Kharagpur:

SETS team bagged First Runner Up award in Side-channel Hackathon conducted by IIT-Kharagpur held on 21 – 23 September 2025.



Figure. 2.5.2 SETS team receiving the First Runner-Up award at the Bit-by-Bit Hardware Hackathon, IIT Kharagpur (21 – 23 September 2025)

iii. TN Police Hackathon 2025 by Cyber Crime Wing, Chennai

SETS team won First prize in TN Police Cyber Crime Hackathon problem statement "TOR – Unveil: Peel the Onion", held on 23rd December 2025.



Figure. 2.5.3 SETS team winning the first prize in TN Police Cyber Crime Hackathon

Contributions to National Roadmap

I. National Roadmap on Hardware Security

Amid rising cyber threats, hardware security is essential for designing and deploying digital infrastructure, from consumer electronics to advanced industrial control systems. Hardware security encompasses the protection of IP cores, integrated chips, and supply chain of each hardware component from manufacturing to deployment. Ensuring the security of hardware components is crucial in safeguarding against compromise of confidentiality, integrity, and system availability.

SETS has been focussing on hardware security and has established facilities for SCA and hardware testing. SETS is also working with industries and R&D labs towards securing the crypto modules deployed in the communication devices. With this background, OPSA had directed SETS to formulate this National Roadmap on Hardware Security in consultation with various industry stakeholders and strategic sectors.

SETS prepared the roadmap for hardware security involving 35 Indian Industries [Fabless design, IDMs (Integrated Design and Manufacturing), Startups], R&D organisation, Academia & Strategic agencies. The roadmap outlines the current strategic areas of focus, global initiatives, current

national scenario, emerging threats, and important goals to strengthen the security of hardware components in our country. Discussion on the implementation of the roadmap is being done with the leading ministries.

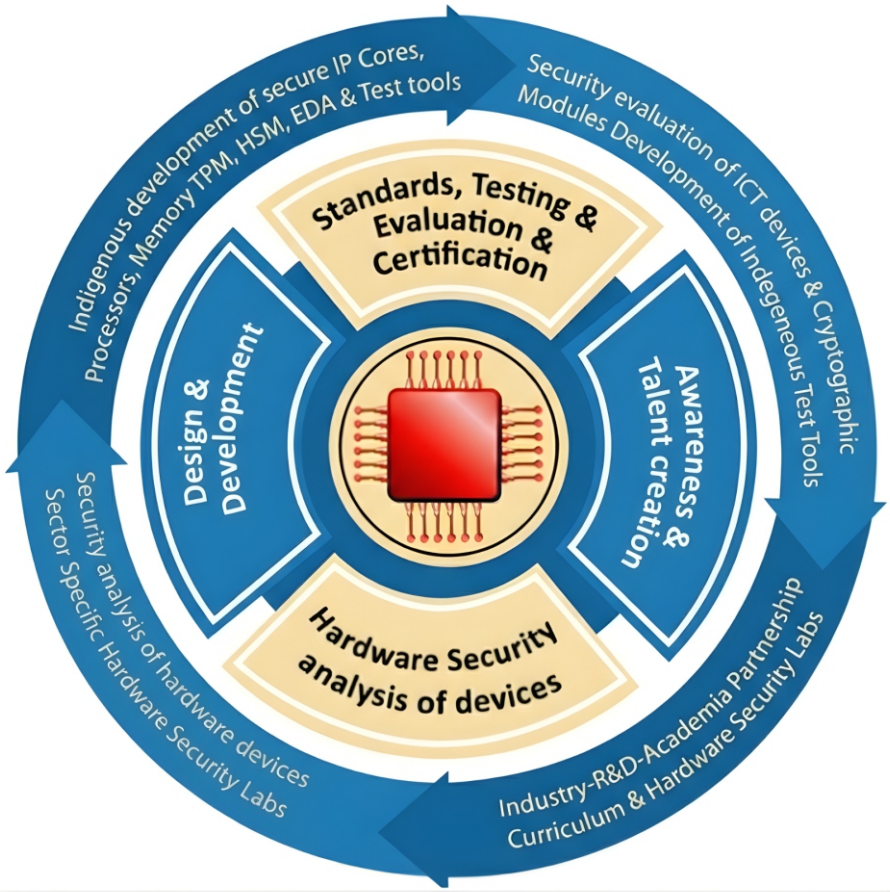


Figure. 2.5.4 Framework of India's National Hardware Security Ecosystem

II. National Roadmap on Transition to Post Quantum Cryptography

In the evolving context of advances in the development of Quantum Computing, it is important to ensure that traditional cryptosystems are resilient to adversaries from such an environment. In order to enable the classical systems to be resilient against quantum adversaries National Institute for Standards and Technology (NIST), USA is in the process of standardising the Post Quantum Cryptographic (PQC) algorithms that are likely to be secure against the threat of quantum computers.

It is in this context, that a roadmap was prepared by SETS and CCA/MeitY

towards transition to PQC from classical computing environment to quantum resilient environment. This was done through brainstorming discussions and in consultation with 40+ Industries, R&D organisations, Academia & Strategic agencies. The report is submitted to NQM, DST. A committee and taskforce has been constituted by DST for the Implementation of Quantum Safe Ecosystem in India.

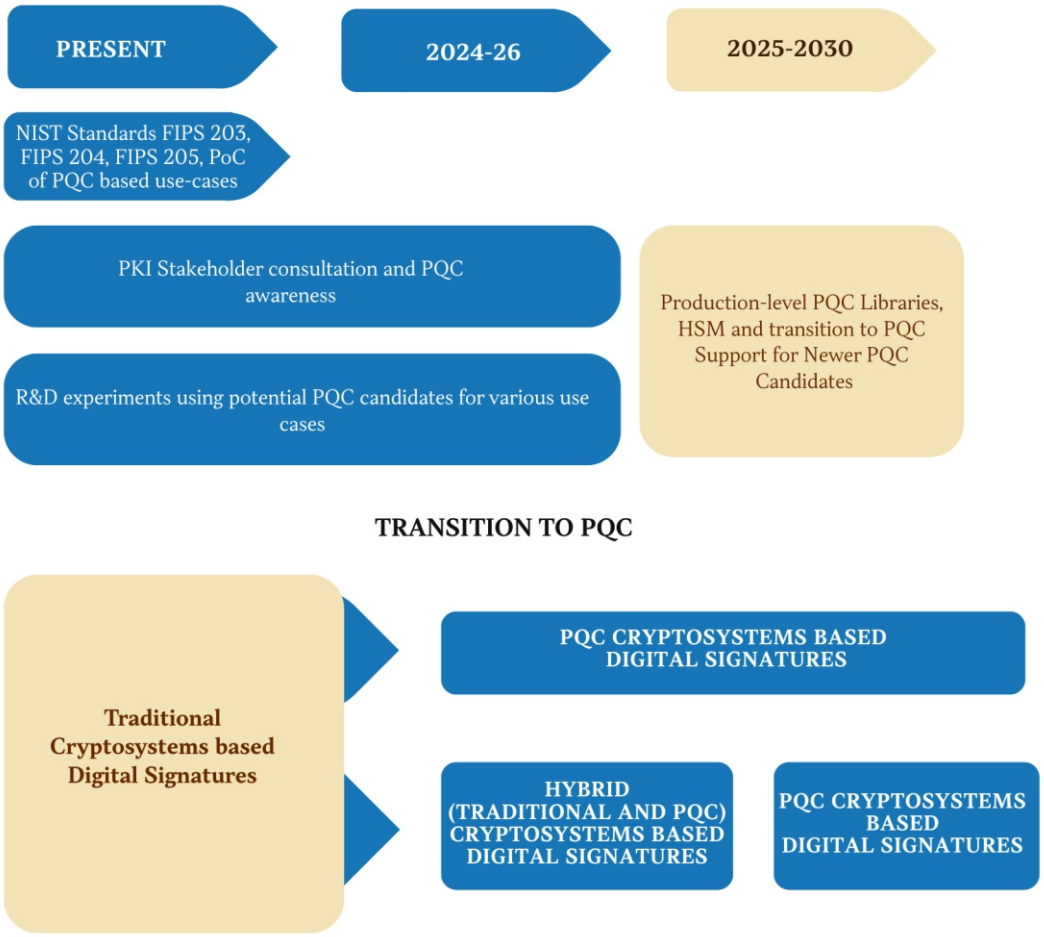


Figure. 2.5.5 Transition Roadmap for Post-Quantum Cryptography (PQC) in India

24th Foundation Day of SETS

SETS celebrated its 24th Foundation Day at its headquarters in Chennai on 25 June 2025. The event was chaired by PSA Prof. Sood and President SETS, who delivered the presidential address. Lt. Gen M.U Nair, Former National Cyber Security Coordinator, Government of India, delivered the foundation day address, where he emphasised the key role of SETS and opportunities to develop innovative cyber security solutions.

In his presidential address, Prof. Sood highlighted SETS's pivotal role in advancing cutting edge research and development in cybersecurity and translating this research into the deployment of indigenous solutions. Prof. Sood also directed to develop a national roadmap on hardware security and a transition plan for PQC. He commended SETS for accomplishing these tasks successfully, taking inputs from experts, government and industry.

While congratulating SETS on its Foundation Day, Prof. Sood outlined SETS's priorities for the next year of developing solutions for password-less authentication, establishing a SCA evaluation platform and collaborating with key agencies on drone security. Prof. Sood inaugurated "Workshop on Technology Trends in Cyber Security," (WORTICS) 2025. In addition, on the occasion, two panel discussions were held:

- **"WORTICS,"** which featured expert talks and panel discussions on emerging areas of cybersecurity. Dr Rakesh Kaur, Adviser & Scientist-G, OPSA, moderated a panel discussion on SETS's R&D and Technology Roadmap.
- **"Drone Security: Current Trends and Challenges",** a panel discussion was chaired by Dr S. N. Omkar, Chief Research Scientist, Dept. of Aerospace Eng., IISc Bengaluru; Dr K. Senthil Kumar, Professor & Director, Dr Kalam Advanced UAV Research Centre, Chennai; Mr. Venkatesh Sai, Co-Founder & Technical Director, Zuppa Geo Navigation Technologies Pvt. Ltd, Chennai and Capt. Nikunj Parashar, Founder and CMD of Sagar Defence Engineering Pvt Ltd., Pune, shared their inputs as panel member and the session was moderated by Mr. Hari Prasad R, Scientist-D from SETS. The panel discussed the current status, the drone policies in India, and the research, and development opportunities in the field of drones. PSA proposed that researchers and industries from this domain formulate R&D problem statements for indigenous technology development.



Figure. 2.5.6 Dignitaries during the 24th Foundation Day of SETS, Chennai (25th June 2025)

SETS organised an Open House, showcasing its R&D activities to researchers and industries, and hosted selected research scholars from across the country pursuing research in cybersecurity.

Commercialisation of SETS Products

SETS is uniquely positioned as a lab established for cyber security research to meet the specific needs to develop indigenous technology in the area of cyber security. Considering its key focus in emerging areas of cyber security, there is a huge opportunity to translate SETS research outcome as products and services. Also, SETS areas of research and activities can be scaled up by leveraging the Startup/Industry eco-system towards innovation, co-development, and wide scale proliferation of cybersecurity solutions and services.

Accordingly, as per the directions of the Society (Apex body), SETS formed a committee and evolved the following collaborative innovation models for research translation:

1. **Transfer of Technology (ToT)**
   To offer the SETS Technology outcome to industry and interested agencies.
2. **Co-Development (CoDe)**
   This enables SETS to jointly develop technologies and to leverage technology outcomes for customisation.

3 Industry Collaboration and Innovation (ICON)

To offer SETS products and solutions through industry to user agencies and participation in EoI/RFP.

Subsequently based on the discussions in its Governing Council and Society (Apex body) meetings, Memorandum of Understanding between SETS and Industrial Consultancy and Sponsored Research (IC&SR), IIT Madras was signed on 19 November 2025 in the presence of PSA Prof. Sood and Prof. V Kamakoti, Director IITM to enable the commercialisation of cybersecurity solutions and products developed by SETS through the Technology Transfer Office (TTO IIT Madras), ICSR. The services from IC&SR-IITM will aim to identify potential users of SETS's IP among entrepreneurs, SMEs, start-ups, and MNCs in India and abroad.

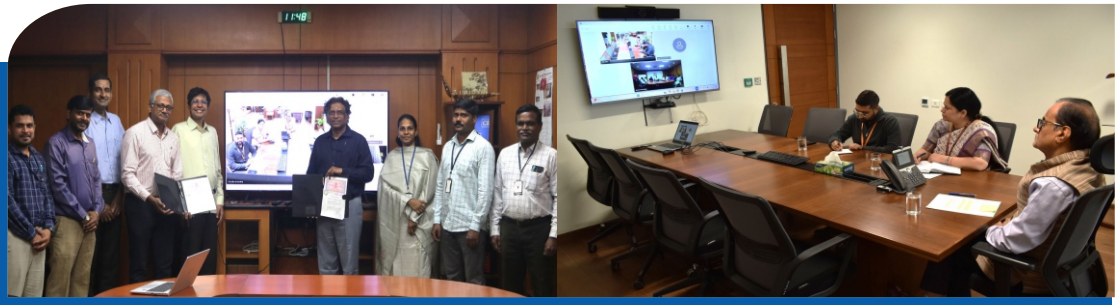


Figure. 2.5.7 MoU signed between IC&SR, IITM and SETS

SETS Outreach Activities

During the year, SETS coordinated and conducted various training programmes in the areas of cyber security. Scientists of SETS have actively contributed towards training and related events and activities. SETS team conducted specific hands-on training during the year as given below:

01 Two-day training programme on the "SETS VPN solution" to the officials from 21 Signal Corps, Indian Army at New Delhi from 25 February 2025 to 26 February 2025.

02 Three-day hands-on training to strategic sectors on "Hardware Testing" at SETS Chennai from 20 August 2025 to 22 August 2025.

03 Five-day hands-on training programme "PractoCrypt 2025 - Cryptography in Practice" on Cryptographic Algorithms & Implementation at SETS, Chennai from 13 October 2025 to 17 October 2025.

04 Five-day hands-on training programme "Foundation of Network Security, Threats, Defences, and Practical Skills" for Tamil Nadu police department – Technical Services from 10 November 2025 to 14 November 2025.

05 Five-day hands-on training programme on "Blockchain-Based Secure Data Systems using Hyperledger Fabric" Tamil Nadu police department – Technical Services from 17 November 2025 to 21 November 2025.

06 Five-day hands-on training programme "QKD Practicum 2025" in collaboration with IITM CDOT Samgnya Technologies Foundation, C-DAC and CODE IITM on QKD and FPGA-based post-processing at SETS, Chennai.



Figure : 2.5.8 PractoCrypt 2025 - Cryptography in Practice training by SETS

Ongoing R&D Activities

SETS is executing the following projects supported by various funding agencies including MeitY, NSCS, DST, DRDO, etc:

I "Development of PKI-based certificates for IoT device security" is a MeitY supported collaborative project being carried out by SETS

along with C-DAC Bengaluru & Hyderabad. SETS is developing a compact PKI framework for generating digital certificate for IoT and to develop firmware to manage certificates over secure on-board storage. Currently, the development of PKI application for IoT device life cycle management is completed and proof of concept of PKI for device authentication is implemented.

II "Internet of Things (IoT) Sandbox development and nationwide establishment" is a MeitY supported consortia project jointly being carried out by SETS, C-DAC, IIIT Bengaluru, IIT Madras, ERNET and Amirta University. The role of SETS is established a comprehensive IoT security ecosystem and sandbox for (a) formal verification for trusted execution environment, (b) privacy and identity theft analysis and (c) prepare tools and techniques for IPV6 security testing.

III "Establishment of hardware testing facility" is a project supported by National Security Council Secretariat (NSCS) to establish infrastructure to evaluate hardware vulnerabilities and to evolve a comprehensive testing procedure to evaluate hardware devices. The project is being implemented in two phases for the strategic sector.

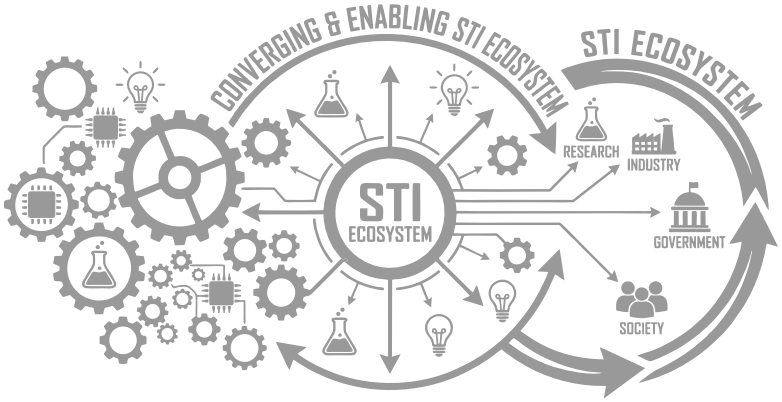
IV "Development of secure post quantum public key infrastructure" is a MeitY supported consortia project jointly being carried out by SETS, Chennai, IIT (Madras), IIIT (Kurnool), C-DAC (Noida). The role of SETS is to device mechanisms for validation and verification of crypto modules as per the standard compliance and side channel evaluation of post quantum crypto algorithms. SETS has developed a framework to validate the ML-KEM and ML-DSA PQC algorithms and develop the side channel evaluation procedures.

V Artificial Intelligence (AI) for Cyber Security (CS) is a consortia project along with SETS, Chennai, C-DAC Bengaluru, IIT Madras, IIT Jodhpur and IIT Delhi, under National Supercomputing Mission (NSM), supported by MeitY. SETS is contributing to four out of the five sub-projects, including (a) Multimodal misinformation detection and network analysis in collaboration with IIT Jodhpur (b) Techniques for secure and private machine learning, with applications to ransomware forensics (c) DARFA – Dynamic Adversarial Robustness Analysis Framework for AI Applications in collaboration with C-DAC Bengaluru (d) Physical attack on AI systems and AI for physical attack analysis with IIT Madras.

Converging & enabling STI Ecosystem

03

Sustaining effective action, however, requires a thriving, connected environment that supports continuous innovation. To this end, the Office serves as a system integrator that converges and enables the broader Science, Technology, and Innovation (STI) ecosystem. Recognising that breakthroughs happen at the intersection of disciplines, we work to dismantle institutional silos by bringing together academia, industry, and government. Through digital platforms like Manthan and I-STEM, which facilitate the sharing of resources and infrastructure, and the creation of regional S&T Clusters,and other such platforms, we are building a national network that is greater than the sum of its parts. By fostering this collaborative spirit, from deep-tech accelerators to rural technology groups, we ensure that the momentum generated by our national missions is sustained by a resilient and inclusive ecosystem.



3.1. I-STEM

The Indian Science, Technology, and Engineering Facilities Map (I-STEM) project is a national digital initiative of OPSA, conceived to enable systematic sharing and optimal utilisation of publicly funded scientific infrastructure across the country. Launched in January 2020 by the Hon'ble Prime Minister, Shri Narendra Modi, the I-STEM National Portal provides a unified platform for discovery and access to advanced research equipment, facilities, and software housed within academic and R&D institutions.

The portal has been designed to democratise access to high-value scientific resources by enabling researchers, start-ups, and innovators, particularly from Tier-2 and Tier-3 institutions, to utilise costly R&D infrastructure that would otherwise remain underused. By promoting shared access, I-STEM aims to enhance research efficiency, reduce duplication of capital expenditure, and strengthen India's innovation and startup ecosystem. The initiative is being implemented in a phased manner and, to date, has onboarded 35,284 registered users, with over 27,271 instruments listed by 3,345 institutions across the country.

To strengthen and institutionalise the use of the platform, the Department of Expenditure, through its Office Memorandum dated 3 July 2025, has advised all funding agencies to make it mandatory for publicly funded equipment costing more than ₹20 lakh to be registered on the I-STEM portal. This policy intervention reinforces I-STEM's role as a central instrument for governance, transparency, and accountability in the management of national research infrastructure.

Major Achievements during 2024-25

During 2025, the I-STEM transitioned from a shared-infrastructure repository to an intelligence-driven digital governance platform for national research infrastructure. Under the strategic guidance of OPSA, and with implementation support from IISc Bengaluru, the platform has matured into a dynamic and adaptive digital ecosystem. By integrating data-driven analytics, standardised workflows, and policy frameworks, I-STEM has strengthened transparency and improved the utilisation of publicly funded research infrastructure.

This has enabled more inclusive access across the R&D ecosystem, positioning I-STEM as a key enabler of India's research- and innovation-led economy.

The major achievements of I-STEM during 2025 are outlined below:

Scale, Coverage, and Utilisation:

During the year, I-STEM expanded its institutional footprint with the onboarding of 1,033 new institutions, representing a 31% increase and extending the national network to over 3,300 institutions. A total of 5,104 high-end scientific instruments were added to the portal, marking a 23% growth in available assets. Platform usage also showed significant improvement, with 26,128 booking requests processed and 12,105 experiments successfully executed raising the fulfilment rate to approximately 46%, compared to about 38% in FY 2023–24. User engagement continued to grow strongly, with 14,487 new researchers onboarded, taking the total registered user base beyond 35,000.

Outreach and Capacity Building:

Targeted outreach and training programmes strengthened user adoption and technical capacity, particularly in underserved regions. Flagship initiatives such as SAMAVESHA 2024 engaged over 1,500 participants across multiple zones, facilitating access for researchers from Tier-3 and Tier-4 institutions to advanced facilities in Tier-1 and Tier-2 laboratories. Regional Strategic Program for Accelerated Research and Knowledge Startup (SPARK) events demonstrated effective conversion from awareness to active platform use, resulting in new instrument listings and user registrations. Operator-focused training programmes under India in Research Innovation and STEM Education (I-RISE) and Industry Operated Training Programme (I-OTP) further enhanced technical competencies across participating institutions, with measurable improvements in operational skills.

Platform Enhancement and Operations:

Significant upgrades were undertaken to improve platform performance and reliability. A comprehensive UI/UX redesign reduced user task-completion time by approximately 30%, while the deployment of a centralised helpdesk enabled real-time support, service-level monitor

ing, and data-driven operational oversight. The adoption of a cloud-based business continuity framework ensured uninterrupted service delivery and strengthened data security protocols.

Institutional and Inter-Ministerial Integration:

I-STEM further deepened its institutional integration through alignment with 14 Central Ministries, enabling the onboarding of more than 200 additional institutions and reinforcing inter-ministerial collaboration in research infrastructure sharing. Integration with the AICTE's AURA Scheme extended the platform's reach to over 1,200 higher-education institutions, embedding I-STEM within academic quality and accreditation processes.

Collectively, these developments underscore I-STEM's transition towards a mature, data-driven national platform that supports efficient utilisation of public R&D infrastructure and advances India's research and innovation capabilities.

Evaluation by QCI-NABET

OPSA had commissioned an independent third-party evaluation in January 2025 through the Quality Council of India (QCI) – National Accreditation Board for Education and Training (NABET) to systematically assess the impact and performance of the I-STEM National Portal since its launch four years ago. This evaluation has been undertaken to measure effectiveness against stated objectives, and to analyse key parameters such as utilisation of shared research infrastructure, stakeholder adoption, governance processes, and contribution to capacity building across academia, industry, and start-ups. The assessment helped identify gaps, brought out best practices, and evidence-based recommendations that will help to strengthen the I-STEM programme and guide its future scaling and policy decisions.

Based on the evaluation report released on 29 October 2025, following recommendations were made:

I. There is a strong need to strengthen awareness and capacity building through regular workshops and hands-on training focused on portal navigation, equipment booking, status tracking, and reporting. National-level and regional outreach programmes should be institu-

tionalised to improve adoption among students, researchers, facility managers, nodal officers, and Alternate Point of Contacts (POCs).

II. Institutional reporting must be reinforced by mandating quarterly updates of equipment status, timely addition and removal of instruments, clear disclosure of user charges, and availability timelines to improve planning and utilisation.

III. To ensure sustained usage, integration of I-STEM with government funding mechanisms is essential. Registration of all project-funded equipment on the portal should be made mandatory and linked to the release of subsequent funding installments, in line with the Department of Expenditure OM (July 2025).

IV. Alternate POC mechanism should be strengthened by nominating technically competent young faculty members as alternative points of contact to improve responsiveness and coordination.

V. Technical upgrades to the portal are required, including improved search and filtering, real-time slot monitoring, a mobile application, standardised user charges, and integration of publication and patent tracking, along with exploring international facility-sharing collaborations.

VI. Given the highly concentrated usage pattern and large number of inactive institutes, targeted interventions are needed to improve execution rates and broaden institutional participation, by converting inactive institutes to active.

VII. Finally, to enhance efficiency and avoid duplication, an apex-level decision should be taken to merge or integrate other similar research facility portals with I-STEM, enabling a unified and streamlined

Overall, the evaluation highlights the need for targeted capacity building, stronger institutional compliance, tighter linkage with funding mechanisms, and key technical upgrades to enhance I-STEM's effectiveness. The recommendations provide an evidence-based pathway to broaden participation, improve utilisation, and strengthen I-STEM as a unified national framework for research infrastructure sharing.

Future Outlook

In the upcoming year, I-STEM will prioritise advancing equitable access to research infrastructure while strengthening regional innovation ecosystems. A key focus will be the implementation of "One District, One Equipment" initiative, aimed at improving the availability and discoverability of high-value scientific equipment across district-level clusters and addressing regional disparities in research access.

The programmes will also support the establishment of Catalyst Centres and Advanced Common Measurement and Certification (ACMC) facilities as regional R&D hubs to enable collaborative research, Testing-as-a-Service (TaaS), and standardised measurement and certification services. Outreach and capacity-building efforts will be scaled up through the expansion of Ambassador and Knowledge Hub programmes to enhance training, awareness, and scientific literacy among diverse stakeholder groups. In parallel, the Lab Access and LabLink initiatives will be strengthened to improve laboratory visibility, interoperability across institutions, and structured pathways for early-stage technology validation and commercialisation.

In view of increasing registrations, growing platform usage, and the recommendations emerging from the independent evaluation, a comprehensive revamp of the I-STEM portal has been initiated. Accordingly, a Technical Evaluation Committee has been constituted to assess and define the technical requirements for the next phase of portal development.

Collectively, these measures are expected to further reinforce I-STEM's role as a national enabler of inclusive, efficient, and impact-oriented research and innovation.

3.2. Manthan

Manthan, derived from the Sanskrit word which means "churning of ideas," encapsulates the platform's core philosophy. Launched by PSA Prof. Sood on 15 August, 2022, it is a digital platform that aims to promote collaboration between various stakeholders and the scientific research and development ecosystem to help meet India's national targets and United Nations' 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.

It has won the Best Transformative Digital Solution by the Government for Industries/Public sector units at Bharat Public Sector Unit Excellence Award 2025.

Scan QR Code
to access the
Web Page of Manthan

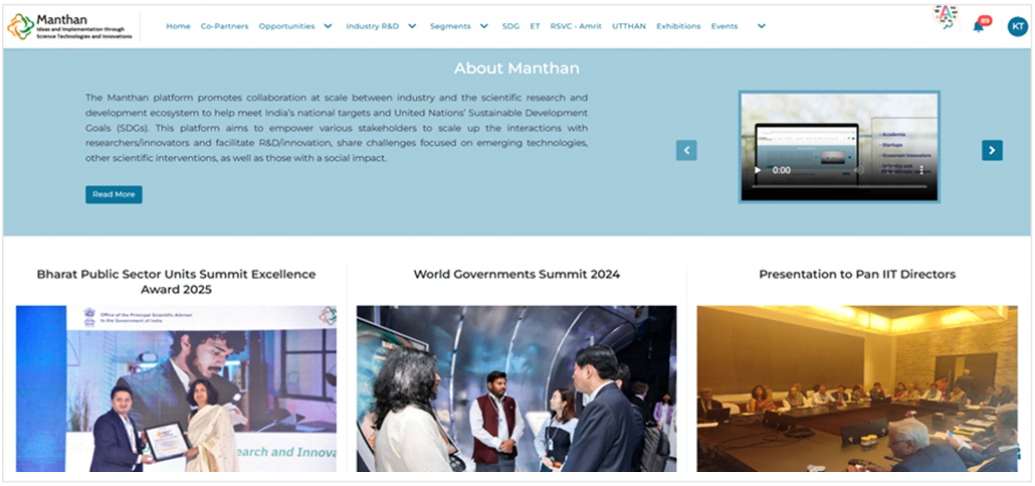


Figure 3.2.1: Manthan Landing Page



Figure 3.2.2: Bharat Public Sector Unit Excellence Award 2025

Manthan Dashboard



Figure 3.2.3: Overview of Manthan's activities

Milestones

To date, a total of 923 opportunities have been created, with 127 of these emerging in 2025. The cumulative value of budgeted opportunities stands at INR 8,768.15 crores (approx. One Billion USD). Since January 2025, opportunities worth over INR 482 crores have been posted on the platform, engaging more than 90+ demand-side stakeholders and supporting over 115 startups and academic institutions across India. On the international front, 208 opportunities have been created overall, including 11 in 2025, with budgeted international opportunities valued at INR 5,248.38 crores, of which INR 111.28 crores were accounted for in 2025.

The platform has also facilitated 5 centres of excellence, 31 R&D/early-stage innovations, 27 market-ready innovations, 11 in-kind/social impact projects, and 20 implementation projects, thereby creating a significant societal impact.

The top opportunity providers during 2025 are –

Reliance Foundation (`106 crore)	SBI Foundation (`90 crore)	Massive Earth Foundation (`50 crore)
XPRIZE- Quantum Applications (`42 crore)	Security Printing & Minting Corporation of India Limited (`40 crore)	King's College London & Hinduja (`36.31 crore)

HCLTech Grant Edition XI (`24 crore)	Temasek Foundation (`12 crore)	FITT-SIDBI Accelerator (`10 crore)
BHP (`10 crore)	Kotak Education Foundation (`7.5 crore)	Novo Nordisk Foundation (`6 crore)
The Nudge Institute (`5.25 crore)	National Cancer Grid (`5 crore)	AssisTech Foundation (`5 crore)
GEAPP ENTICE (`4.27 crore)	Delhi Pollution Control Committee (`4 crore)	World Economic Forum (`3.75 crore)
Samsung (`1.5 crore)	L'Oréal India (`85 Lakh)	Mercedes-Benz (`21.24 crore)

Centres of Excellence

OPSA envisions Centres of Excellence (CoEs) as innovation and research hubs focused on sustainable technologies. These CoEs aim to translate academic research into market-ready solutions, bridging theory and practical implementation. By fostering new business models and scalable technologies, the initiative promotes sustainability, technological advancement, and inclusive economic growth, aligning with global environmental and societal goals. The key pillars of the CoE are: -

Pillar-1:
Technology screening from the National and Global Ecosystem

Pillar-2:
Evaluation & Incubation of a cohort of start-ups to work jointly with Researchers on shortlisted ideas

Pillar-3:
Real-life scale testing and demo/expo

Pillar-4:
Support to scale-up promising technologies, business and skill development, and developing micro-entrepreneurs

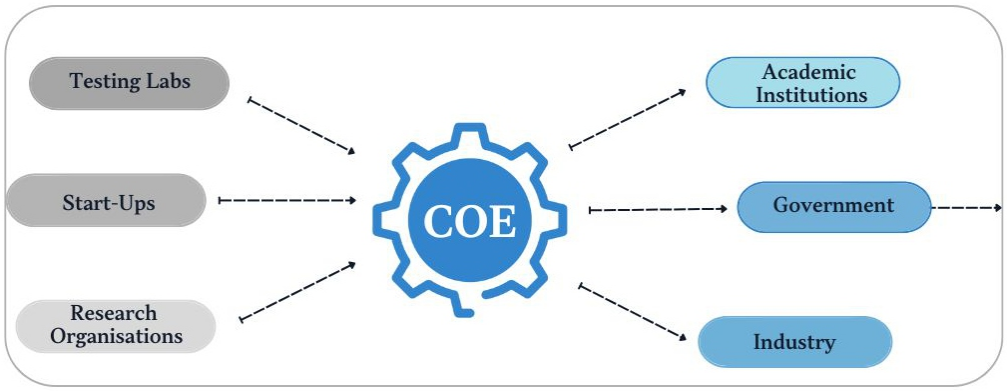




Figure 3.2.4: Verticals of the Centre of Excellence

In the year 2025, two CoEs have been supported. These include:

a) Centre of Excellence – Coal Mine Closure & Repurposing

Partnership:
GIZ – TEXMiN & IIT (ISM) Dhanbad

Timeline:
October 2025 – March 2028

Focus:
Inclusive, gender-responsive coal mine closure and repurposing across three pilot districts

Objectives:

- Strengthen institutional capacity at national, state, and district levels
- Promote socio-economic development, clean energy, and alternative livelihoods for impacted communities
- Repurpose mine land for renewable energy and employment opportunities

Alignment & Funding:
UN SDGs 4 & 5; financed under €10M EU–BMZ Just Transition initiative (2025–2028)

Impact:
Supports India's low-carbon transition through workforce reskilling, gender-equitable development, and sustainable post-mining land use

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b) Global Centre of Excellence – Steel Decarbonisation

Supported by:
BHP

Timeline:
October 2025 – March 2028

Focus:
Accelerate decarbonisation in steel through operational efficiency and low-carbon technologies (hydrogen-rich gases, biomass, top-gas recycling)

Activities:
Applied R&D, technical studies, talent development with emphasis on women in STEM

Budget & Timeline:
INR 10 crores; launched 5 October 2025, selections 26 February 2026

Impact:
Enhances industry expertise, facilitates knowledge sharing, and enables deployment of abatement solutions for a low-carbon steel sector aligned with UN SDGs 7 & 9

Government

A. Ministry of Mines

- R&D Challenge (May 2024 – January 2025): Focused on sustainable mining, recycling, rare/critical metals, advanced materials, new processes, and energy efficiency.
- 24 projects approved from 40 proposals across premier IITs (Dhanbad, Hyderabad, Bhubaneswar, etc.)
- Funding: ₹17.18 crore total; ₹11.97 crore by the Ministry
- Impact: Drives greener mining, circular economy, energy-efficient technologies, and industry-academia collaboration for real-world adoption.

B. Ministry of Power

National R&D Innovation Challenge (July 2024 – January 2025): Targets energy storage, solar energy, EV chargers, advanced materials, recycling, and efficiency.

- 6 projects approved from 51 proposals; institutions include IIT Delhi, IIT BHU, CSIR-IMMT, Pondicherry University
- Funding: ₹6.23 crore
- Impact: Strengthens power-sector innovation, clean energy technologies, scalable solutions for energy security, and net-zero transition.

C. Security Printing & Minting Corporation of India Ltd.

- Passport Security Upgrade Opportunity (October 2025 – December 2025) : Replacing 125-micron HAUV laminate with <10-micron advanced thin-film laminate.
- Impact: Enhanced anti-counterfeiting, improved authenticity, aesthetics, and reduced import dependence; strengthens indigenous security printing.

D. Pahle India Foundation Initiative

To address government-sector challenges via innovation since August 2025.

- 3 target states: Assam, Madhya Pradesh, Uttar Pradesh
- Assam pilot: 5 departments engaged (Industries, MSME, Health, WCD, Statistics)
- Impact: End-to-end innovation pipeline from R&D to market-ready solutions; scalable, replicable governance models via Manthan platform.

School Innovation

School Innovation Programmes: Nurturing Future-Ready Minds

School innovation initiatives foster creativity, problem-solving, and critical thinking, giving students hands-on exposure to real-world challenges, modern technologies, and entrepreneurial skills. By building a culture of innovation, these programmes empower students, boost confidence, and strengthen India's knowledge-driven economy.

A. Samsung – Solve for Tomorrow 2025

- **Focus:** AI for Inclusive Bharat, Health, Sustainability, Social Change
- **Timeline & Budget:** 29 April – 30 June 2025, ₹1.5 crore, 10-month engagement
- **Impact:** Four winning teams developed tech solutions in inclusivity, healthcare, sports accessibility, and environment; awarded ₹1 crore in incubation grants and mentorship at IIT Delhi's FITT Labs

B. Setuwelt – Apprenticeships in Germany

- **Focus:** Paid, hands-on work experience combined with classroom training
- **Timeline:** Launched 16 June 2025; selections 15 September 2025; 2.5–3 year programmes
- **Impact:** Participants earn globally recognised certifications, gain practical skills, and strengthen India's global workforce presence.

C. SBI Platinum Jubilee Asha Scholarship

- **Focus:** Financial support for Classes 9–12 students from low-income backgrounds
- **Timeline:** Launched 19 September 2025; selections 02 February 2026
- **Impact:** Supports 23,230 students, enabling continued education, and nurturing a skilled, future-ready workforce.

D. Bose Beam Line Challenge (BBLC) 2025

- **Focus:** Innovative experiment proposals using advanced beamline technologies
- **Timeline:** Launched 21 May 2025; selections 30 September 2025
- **Impact:** Winning teams receive fully funded visits to CERN, Geneva, gaining exposure to world-class research and global scientific collaboration.

Women in STEM

Women remain underrepresented in STEM, limiting diversity and innovation in technology, engineering, and research. Programmes that provide financial support, mentorship, and advanced training help women overcome systemic barriers, socio-economic constraints, and skill gaps. By empowering women in STEM, these initiatives enhance workforce participation, drive inclusive growth, and promote solutions shaped by diverse perspectives.

A. SAFFAL (South Asia Finance Facility for Acceleration and Leverage)

- **Focus:** Empower women-led SMEs to scale clean energy and low-carbon technologies.
- **Timeline & Funding:** Launch 15 September 2025; selections 30 March 2026; USD 6M blended finance facility.
- **Impact:** Supports 100 women-led SMEs with mentorship, workshops, and scaling support to strengthen business models and investment readiness.

B. Kotak Kanya Scholarship 2025

- **Focus:** Supports girls post-Class 12 pursuing professional degrees (Engineering, MBBS, Law, Design, IISER/IISc, etc.)
- **Funding:** INR 1.5 lakh/year until graduation
- **Timeline:** 01 September – 31 December 2025
- **Impact:** Eases financial barriers, enabling young women to pursue professional higher education confidently.

C. L'Oréal India Scholarship

- **Focus:** Girls from economically disadvantaged backgrounds in UG, PG, and PhD programmes in science, engineering, and medicine.
- **Funding & Awards:** UG – ₹62,500/year; PG – up to ₹1,00,000/year; 100 scholarships annually
- **Timeline:** 26 September – 21 November 2025
- **Impact:** Reduces financial barriers, empowering women to excel in research and STEM careers.

D. EmpowerHER – Tredence Initiative (Women in Data & AI)

- **Focus:** Promotes skills and innovation for women in Data & AI.
- **Impact:** Builds expertise in emerging technologies, enhancing career opportunities, and representation in STEM.

E. Duolingo Determined Scholarship

- **Focus:** Supports Indian women pursuing advanced STEM studies in the U.S.
- **Funding:** USD 30,000 (~₹25 lakh) for 2026–27 academic year
- **Timeline:** Launched 1 June 2025; selections 12 September 2025
- **Impact:** Strengthens India's STEM talent pipeline, fosters gender diversity, and encourages scholars to bring global knowledge back to India.

Science Communication

Science communication connects cutting-edge research with the global Indian diaspora, inspiring innovators, startups, and students to contribute to national development. By bridging academia, industry, and communities, it strengthens innovation ecosystems both within India and globally.

A. Netflix – Inspiring Innovators Docuseries

- **Launch:** 13 Jan 2026, 8-part series in collaboration with Graphiti Multimedia
- **Focus:** Social innovators and startups (Neofly & NeoBot, CultYvate, Blind Vision Foundation, Innogle, WeVOIS, Greengine, LCB Fertilizers) addressing healthcare, sustainability, assistive tech, oceanography, climate action, and waste management
- **Impact:** Showcases grassroots innovation, inspires future changemakers, and positions Indian ingenuity on the global stage.

B. Capacity Building Commission (CBC)

- **Launch:** September 2025, structured case study & training on Manthan and RSVCs
- **Reach:** 1.5 crore government officials nationwide
- **Impact:** Equips officials with tools to implement RSVCs effectively, promoting innovation-driven governance and UN SDG alignment

C. Elsevier – Documenting RSVC Framework

- **Timeline:** September 2025 – March 2026
- **Scope:** Book documenting RSVC evolution, field research, stakeholder interviews (>30), and national development alignment
- **Impact:** Positions RSVCs within global research discourse, highlighting adaptability, scalability, and rigour

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D. International Film Festival of India (IFFI) – RSVC Showcase

- **Focus:** Showcasing Manthan and RSVC stories through cultural and creative platforms
- **Impact:** Makes innovation stories accessible to wider audiences, bridges science and arts, and encourages cross-sector dialogue

3.3. UTTHAN

Upscaling Tier 2 And 3 Colleges For The Holistic Advancement Of Its Network

UTTHAN is a structured national initiative that systematically strengthens Tier-2 and Tier-3 education institutions through capacity building, ecosystem creation, and measurable institutional transformation. Using a scientifically developing Learning Enabling Program (LEAP) Framework and supported through over 20 collaborative partnerships, UTTHAN enhances research productivity, faculty capability, student readiness, innovation ecosystems, and institutional integration with industry and national missions.

The LEAP Readiness & Maturity Framework

The LEAP Framework functions as an institutional compass, it identifies baseline strengths and gaps, prescribes targeted interventions, measures progress over time, and aligns institutions with national performance objectives.

Seven Capability Dimensions

Measures governance, partnerships, infrastructure, faculty capability, student innovation, ethics, and societal impact (14% each, with Research Outputs & Deployment Impact at 16%).

Five Maturity Levels

Institutions assessed from Nascent, Emerging, Developing, Advanced and Exemplary, enabling clear identification of current readiness and realistic progression pathways.

360-Degree Profile

Comprehensive institutional assessment spanning all critical dimensions of research and innovation capability.

Three-Phase National Assessment Architecture

Rapid Assessment

Mandatory 10-minute baseline maturity signal enabling nationwide participation without administrative burden.

Deep Validation

Voluntary 45390 minute evidence- based verification across 100+ structured indicators, resulting in digitally verifiable Trust Card.

Targeted Interventions

Research support, infrastructure recommendations, industry match-making, and policy-aligned funding pathways.

UTTHAN-LEAP functions as a strategic intelligence engine supporting national missions, data-driven funding prioritisation, regional cluster formation, and deployment-oriented research investments for transforming assessment into actionable institutional growth.

The UTTHAN-LEAP Readiness Questionnaire

The UTTHAN-LEAP Readiness Questionnaire serves as the foundational diagnostic instrument of the framework, explicitly designed to support scale, equity, and actionability rather than ranking or exclusion. This innovative tool enables institutions to assess and enhance their research and innovation capabilities systematically.

Comprehensive Assessment Coverage

Institutional Readiness

Primary and secondary research domains	TRL positioning and governance maturity
Partnership depth and infrastructure utilisation	Ethical and societal alignment

Strategic Outcomes

Customised intervention roadmaps	Reduced due-diligence for funders
National visibility mechanism	Policy intelligence input

The questionnaire functions simultaneously as a national visibility mechanism, a policy intelligence input, and an institutional growth guide, aligning academic capability development with India's innovation, inclusion, and mission-driven development objectives.

Key members and subject-matter experts who contributed to the development of this framework.

S. No.	Name	Organisation/ Expert field	Role
1.	Prakash	Scanzer	Core Team Member
2.	Dr Shivakiran Makam	Section Infin8	Core Team Member
3.	Krishnan Narayanan	Alumnus, IIT Madras	Core Team Member
4.	Nagabhushan Raju	Academia & industry	Expert Member
5.	Udaya Bhat	Research/Innovation	Expert Member
6.	Uday Wankawala	Innovation/Industry	Expert Member
7.	Dr Mukund Raj PK	Academia/R&D	Expert Member
8.	Chitra (Japan)	Academia & industry	Expert Member
9.	Tomo Kawane (Japan)	Academia	Expert Member
10.	Preethi Rao	Academia & industry	Expert Member

UTTHAN pillars:

Pillar 1 — Capacity Building

Research Capacity Building	Informative Courses	Society-Centric & Technology Courses
Capacity Building in IPR Management	Workshops on Literature Review	Knowledge Exchange & Outreach
Foreign institutes & Think Tanks	Publications	Patents

1. Internet Operations Research Internship

Partner: India Internet Foundation
Timeline: Submission – 31 May 2025 | **Selection** – 10 June 2025

This initiative enabled advanced research exposure in Internet infrastructure through two focused areas: Internet Measurement Networks and Anycast DNS systems. Students conducted data analysis and examined protocol behaviour to recommend process improvements.

Outcome: Established the first structured Internet infrastructure research pathway within participating institutions.

2. Surfactant & Detergent Research Internship

Partner: Technithon Technologies
Timeline: Submission – 15 May 2025 | Selection – 1 June 2025
Stipend: ₹20,000 (Paid Internship)

Focused on applied formulation science and surfactant solubility optimisation, addressing industry-relevant research challenges.

Outputs: Research reports, literature reviews, and experimental findings.

3. Rural Enterprise & SHG Support Programme

Partners: University of South Wales, Tumkur University,
Section: Infin-8 Foundation
Launch Date: 15 April 2024 | **Funding:** £10,000

Supported rural entrepreneurship and SHG strengthening through digital literacy and agri-enterprise capacity building.

Outcome: International funding deployed for grassroots enterprise development.

4. Health Education Courses

Partners: YouTube Health × NCBS

Developed three structured course series on microbiology, antimicrobial resistance, and health worker training with multilingual accessibility.

Deliverables: 18 educational videos in English, Hindi, and Kannada.

5. Data Analytics Training Programme

Partner: Crossroad Elf DSS Pvt. Ltd. | **Launch Date:** 20 February 2025
Submission Deadline: 31 March 2025

Delivered foundational training in data analytics, data warehousing, and database systems aligned with industry requirements.

6. AI Literacy Course

Partner: Knowledge E
Launch Date: 3 February 2025 | **Submission Deadline:** 31 May 2025

Introduced foundational AI concepts, generative AI awareness, and responsible usage frameworks for academic contexts.

7. Academic Conference Preparation Series

Partner: Knowledge E
Launch Date: 19 February 2025 | **Submission Deadline:** 31 May 2025

Strengthened academic dissemination skills through training on conference selection, proposal development, and scholarly presentation.

8. Intellectual Property Rights (IPR) Awareness Campaign

Partner: Yuvamanthan | **Launch Date:** February 2025

Conducted expert-led sessions to build a foundational understanding of intellectual property and innovation protection.

9. Publishing Capacity Building Programme (Train-the-Trainer Model)

Partner: Taylor & Francis | **Launch Date:** July 2025

Trained five senior faculty members per institution in advanced scholarly publishing practices and research ethics.



Figure 3.3.1 : Launch of Capacity Building Programme

10. RISE-UTTHAN Programme

Partner: Springer Nature | **Launch Date:** July 2025

Focused on research integrity, open access awareness, and book publishing pathways.



Figure 3.3.2 : RISE-UTTHAN Programme with Springer Nature

International Manthan & Uthaan Expansion:

Webinar conducted in coordination with the Africa Smart Cities & Townships Alliance ASCA Secretariat, which has further coordinated and supported the onboarding of African Universities (Uganda & Kenya) onto the Manthan platform.

Under Project Uthaan, the onboarding of Kisumu universities is being facilitated by the ASCA Secretariat, Prof Derek, to enable their participation in Taylor & Francis capacity-building programmes for professional development.

Pillar 2 — MiTTi Innovation Hubs

- MiTTi (Manthan (M) International Federation Inventors Association Industries (I) Tier 2 & 3 colleges (T) Technologies (T) Innovation (I) Hub)
- Building a strong entrepreneurial ecosystem in academic institutions
- Developing a dynamic incubation ecosystem
- Promoting Startup innovations within industry and academia
- Centres of Excellence

MiTTi Case Studies:

1. MiTTi Innovation Hub – SMVITM

Interventions: Acharya FDP conducted; 30 faculty trained in entrepreneurial mindset.

Student Reach: 600+ students sensitised to entrepreneurship.

Outcome: 1 Intellectual Property (IP) created in collaboration with SI8.

Status: Structured entrepreneurship programme for launch.

2. MiTTi Innovation Hub – Canara Institutions

Student Engagement: 210 students in innovation immersion; 64 students enrolled in E^2 – Exploring Entrepreneurship.

Status: 11 teams are being coached closely for prototype development.

3. MiTTi Innovation Hub – St. Joseph Institutions

Interventions: Two MiTTi programme conducted; 30 faculty trained.

Student Reach: 600+ students sensitised to entrepreneurship.

Outcome: 1 Intellectual Property (IP) created in collaboration with Si8.

4. MiTTi Industry Innovation Hub – CREDAI Mangalore

Planned Activities: Hackathon and formal hub launch scheduled, Industry engagement programmes on Carbon Credits and ESG conducted in collaboration with KCCI

Impact: Enabled sector-specific innovation engagement with academia.

Overall MiTTi Impact

04 Academic MiTTi Innovation Hubs + 1 industry hub	60+ Faculty trained	1,400+ Students sensitised
210 Students in innovation immersion	64 Students in structured entrepreneurship programmes	02 Intellectual Properties created

UTTHAN-NCG

Cancer Care Initiatives:

Cipla Foundation

Under the UTTHAN initiative, Cipla Foundation is collaborating with the HCG Cancer Group to strengthen and scale the Andaman Palliative Care Model. The partnership emphasises strategic knowledge and resource sharing, including mapping Cipla-supported partner organisations and their clinical expertise, aligning UTTHAN's technology-enabled palliative care framework. The collaboration further explores integration of UTTHAN's AI-driven helpline with Cipla Foundation's "Sath Sath" referral service, expert-led mentoring and capacity-building initiatives, and the feasibility of providing dedicated palliative care manpower support in Andaman.

Renaissance eServices Ltd.

Renaissance eServices Ltd. has been engaged with Malabar Cancer Centre, Kerala, to explore potential collaboration aimed at strengthening state cancer care initiatives. The collaboration focuses on curating online vernacular medical courses to support state cancer control activities, aligned with the objectives of the Malabar Cancer Centre.

3.4. Rural Technology Action Group (RuTAG)

The Rural Technology Action Group (RuTAG) was conceptualised in 2003-04 by OPSA and was formally established in 2004. RuTAG functions as a demand-driven mechanism focusing on identifying grassroots needs through field-level engagement and on developing and disseminating appropriate technologies that are locally relevant, affordable, and sustainable. OPSA provides overall guidance, coordination, and financial support to RuTAG centres. Its role is to act as a knowledge partner and catalyst, ensuring that technologies are developed in response to grassroots requirements and are supported through training and demonstrations.

Building on nearly two decades of experience, the initiative has now progressed to RuTAG 2.0, launched in 2023. This phase strengthens the focus on commercialisation and scaling up of proven technologies, establishing linkages with government programmes, and promoting rural entrepreneurship to enhance adoption and sustainability. RuTAG 2.0 also places greater emphasis on stakeholder partnerships, especially with private enterprises, to enable technology manufacturing, distribution, and maintenance, thereby supporting the long-term use and adoption of developed technologies. RuTAG 2.0 is implemented by the following seven Project Implementing Agencies (PIAs):

01	Indian Institute of Technology, Bombay
02	ICAR-National Academy of Agricultural Research Management, Hyderabad
03	Sher-e-Kashmir University of Agricultural Sciences & Technology, Kashmir
04	Indian Institute of Technology, Roorkee
05	Indian Institute of Technology, Delhi
06	Indian Institute of Technology, Madras
07	Indian Institute of Technology, Guwahati

A Brief Overview of the Activities Undertaken by the RuTAG Centres

During the calendar year 2025, the RuTAG Centres continued to implement activities under RuTAG 2.0 across different sectors such as agriculture, textile, animal husbandry, rural livelihoods, food processing, and crafts, among others. Each Centre worked towards identifying local challenges, developing appropriate technological solutions, and ensuring their suitability for rural users. The focus was on reducing drudgery, improving efficiency and productivity, and enabling income generation for rural communities. Many technologies were being refined based on user feedback collected during demonstrations and pilot testing.

RuTAG Centres followed a participatory approach involving rural communities, Self-Help Groups (SHGs), Farmer Producer Organisations (FPOs), and local entrepreneurs. This ensured that the technologies were practical, affordable, and aligned with local needs. Several Centres also initiated collaborations with industries, government departments, and NGOs for joint development, manufacturing, and wider dissemination of technologies. To date, most Centres have been progressing with prototype fabrication, field trials, and design modifications. A few technologies had reached the commercialisation stage, while others were under advanced testing. Training, awareness, and skill development activities were also carried out to support adoption and entrepreneurship in rural areas.

Second Project Review and Monitoring Committee (PRMC) Meeting held at IIT Guwahati on 25 April 2025

The Second PRMC Meeting of RuTAG 2.0 was held on 25 April 2025 at IIT Guwahati. The meeting was chaired by Prof. Prabuddha Ganguli, CEO, Vision-IPR, and Honorary Professor, Homi Bhabha National Institute, and co-chaired by Dr. Praveen Malik, CEO, AgriInnovate India Limited.

Members of the PRMC, representatives from all seven RuTAG 2.0 Centres, and officials from OPSA, including Dr Rakesh Kaur, Adviser/Scientist 'G' (RuTAG Coordinator); and Dr Hafsa Ahmad, Scientist 'D' participated in the meeting.

Each Centre presented progress on ongoing projects, covering technology development, field demonstrations, and user engagement. Discussions focused on improving the effectiveness of technology interventions, strengthening field validation, addressing implementation challenges, and enhancing collaboration with industry, FPOs, and SHGs to improve adoption and long-term impact.



Figure. 3.4.1: Second PRMC Meeting of RuTAG 2.0 held at IIT Guwahati on 25th April 2025

Second Annual Review Meeting held at IIT Guwahati on 13-14 November 2025

Review of The Seven RuTAG Centres

The Second Annual Review Meeting of RuTAG 2.0 chaired by PSA Prof. Sood and joined by Scientific Secretary, OPSA, Dr Parvinder Maini, was held on 13-14 November 2025. The meeting reviewed the progress of all seven RuTAG 2.0 Centres- IIT Bombay, ICAR-NAARM Hyderabad, IIT Roorkee, IIT Delhi, IIT Madras, IIT Guwahati, and SKUAST-Kashmir.

Each Centre presented its annual progress, covering technology development, field validation, user engagement, and early deployment experiences. The review discussions focused on scaling-up proven technologies, strengthening inter-centre collaboration, and aligning innovations with clearly identified rural problem statements.

The Chair emphasised quality, standardisation, and partnerships with government departments,

industry, FPOs, SHGs, and community organisations to ensure wider adoption and sustained impact.





Figure. 3.4.2: Second Annual Review Meeting of RuTAG 2.0 held at IIT Guwahati on 13-14 November 2025

A Few Technologies from RuTAG 2.0

(I) Power-Operated Grader for Whole Walnuts - RuTAG SKUAST-Kashmir

The Power-Operated Grader for Whole Walnuts was developed to address the problem of ungraded and mixed walnut lots that reduce market value. Manual grading as shown in figure 3.4.3 was slow and inconsistent, taking nearly an hour to grade only 15 kg. The power-operated grader designed by RuTAG SKUAST-K, as shown in figure 3.4.4, has a throughput capacity of 350 kg per hour with an efficiency of more than 97 percent. It grades walnuts into four uniform sizes, improving quality and market acceptance. The technology has been commercialised and deployed at the Model Walnut Processing Unit in Shangus Block, Anantnag, benefitting growers from nearby villages. The system reduces drudgery, enhances earnings, and is affordable for walnut producers, costing about ₹30 per 100 kg of produce.



Figure: 3.4.3 Manual method of grading whole walnuts



Figure: 3.4.4 Power Operated Grader for Whole Walnuts developed by SKUAST-K

(II) The Rhizome Planter - RuTAG IIT Guwahati

The Rhizome Planter as depicted in Figure: 3.4.5 is being developed by RuTAG IIT Guwahati, to mechanise the planting of ginger and turmeric. Traditional planting in the northeastern region is labour-intensive and inconsistent due to uneven spacing and depth. The compact planter, operable by a power tiller or power weeder, will ensure uniform placement of rhizomes and will reduce manual effort. Prototype fabrication and initial

laboratory trials have been completed. The planter is intended for small and marginal farmers in Assam, Arunachal Pradesh, and Meghalaya, with an estimated cost of about ₹58,000. Partnerships have been established with local NGOs and FPOs for testing and feedback. The design will be refined further before field deployment.



Figure: 3.4.5 Computer-aided design model of the Rhizome Planter.

(III) Manual Press for Earthen Tawa Making - RuTAG IIT Delhi

RuTAG IIT Delhi is developing a Manual Press for Earthen Tawa Making as shown in Figure: 3.4.6 to support artisans in Poonchhari village, Rajasthan, who traditionally shape clay tawas by hand. The manual process limited output and caused variations in quality. The new screw-based manual press simplifies shaping, improves uniformity, and allows faster production. Laboratory trials and field feedback helped refine the moulding mechanism to prevent cracking and sticking. The estimated prototype cost about ₹30,000 and can be locally fabricated for ₹15,000-₹20,000. Once finalised, the design will be shared with artisan clusters and local fabricators for wider use.



Figure: 3.4.6. Demonstration of the prototype with rural community in lab

(IV) Modernisation and Upgradation of Handlooms in Kerala- RuTAG IIT Madras

The Modernisation and Upgradation of Handlooms in Kerala project was undertaken by RuTAG IIT Madras to improve the traditional loom design and enhance the working conditions of handloom weavers. The existing looms often caused arm and shoulder strain due to high friction and poor ergonomics. The upgraded design as depicted in Figure. 3.4.7 aims to provide frictionless motion, better seating comfort, and support for wider-width fabric production. The redesign focuses on mechanical modernisation through improved take-up and let-off mechanisms and optimised frame layouts to increase efficiency and productivity. The design phase has been completed, and fabrication work is in progress. The estimated cost of the upgraded loom is ₹75,000, which is targeted to remain less than three times the cost of a conventional handloom, making it affordable for cooperatives and small weavers.



Figure: 3.4.7. Prototype Development of the modernised and upgraded handloom.

(V) Multi-Millet De-husking Machine - RuTAG IIT Roorkee

RuTAG IIT Roorkee developed a Multi-Millet De-husking Machine for small and marginal farmers as shown in Fig 3.4.8. Manual dehusking of millets using traditional tools is labour-intensive and inefficient. The compact electric machine processes different millet varieties using adjustable sieves and a spiral blade mechanism. It separates husk and broken grains efficiently, reducing drudgery and increasing productivity. The machine costs about ₹35,000 and can be shared by local NGOs and SHGs through common-facility centres. The technology is ready for field deployment and training activities are planned to promote community-level use.



Figure: 3.4.8. Multi-Millet De-husking Machine developed by RuTAG IIT Roorkee

(VI) Multi-Purpose Processor - RuTAG IIT Bombay

In rural areas, Chironji seed decortication and Dal/grain processing are labor intensive, time-consuming, and often require distant facilities, causing drudgery for women and limiting local value addition as shown in Figure. 3.4.9. The Multi-Purpose Processor (MPP) as shown in Figure. 3.4.10, was developed by RuTAG IIT Bombay to meet rural needs for small-scale processing of chironji, pulses, and cereals. The MPP runs on a single-phase 5 HP motor and performs chironji decortication (40 kg/h), pulse milling (40 kg/h), and flour milling (100 kg/h). It reduces manual labour and supports village-level value addition. The technology has been deployed in 11 districts across 5 states, benefiting several SHGs and FPOs. The cost ranges between ₹1.5 and 2 lakh per unit and the machine has been adopted under group-ownership models to promote livelihood generation and rural entrepreneurship.



Figure: 3.4.9: Chironji harvesting and traditional method of decortication



Figure: 3.4.10: Multi-Purpose Processor (MPP) developed by RuTAG IIT Bombay

(VII) Banana Pseudostem Injector - RuTAG ICAR-NAARM

The Banana Pseudostem Injector as shown in Figure. 3.4.11, was jointly developed by the ICAR-Central Institute of Agricultural Engineering, Regional Station, Coimbatore, Tamil Nadu, and the ICAR-National Research Centre for Banana (NRCB), Tiruchirappalli, Tamil Nadu to mechanise the manual process of injecting chemicals into banana pseudostems. The device includes a 16-litre chemical tank, a diaphragm pump, and an electronic control unit to regulate the injection depth and quantity. Field testing was conducted at the ICAR-NRCB, Tiruchirappalli. The technology simplifies field operations, reduces labour requirements, and ensures precise chemical application for improved crop management.

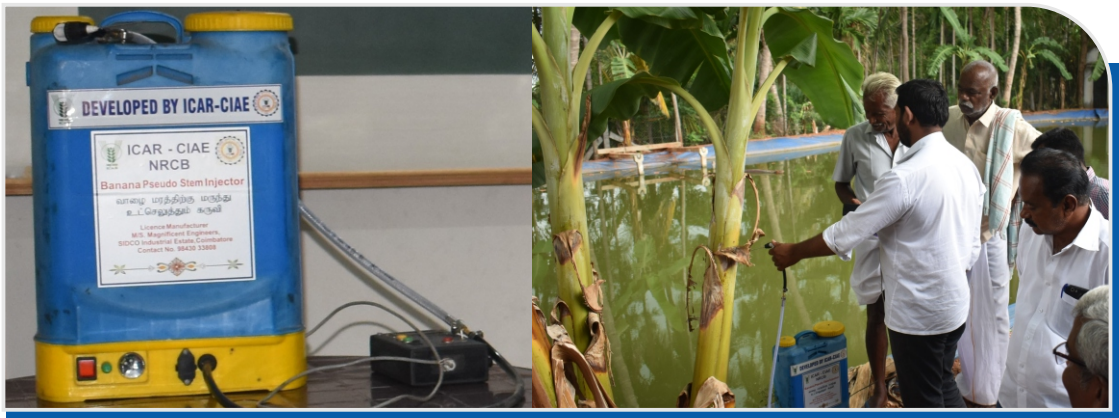


Figure: 3.4.11. The Banana Pseudostem Injector supported by RuTAG ICAR-NAARM

Release of RuTAG 2.0 Annual Progress Report

The RuTAG 2.0 Annual Progress Report 2024-25 was also released, details of which are included under Section 4 (Knowledge Creation and Synthesis) of this Anthology.

Grassroots Innovation and Exhibition Stalls

A Grassroots Innovation and Startup Exhibition was organised alongside the annual review meeting, featuring technologies and prototypes developed by RuTAG Centres and partner organisations under the RuTAG 2.0 programme. The exhibition enabled direct interaction between innovators, reviewers, and stakeholders, and showcased solutions across agriculture, livelihoods, post-harvest processing, renewable energy, and allied sectors.



Figure: 3.4.12: Grassroots Innovation and Exhibition held during the 2nd Annual Review Meeting of RuTAG 2.0

Inauguration of Facilities at IIT Guwahati

PSA Prof. Sood inaugurated the Centre for Innovation in Agri & Aqua Voltaics (CIAAV) and the Integrated Facility for Wellness-Product Innovation (IFWPI) at School of Agro & Rural Technology, IIT Guwahati, in the presence of Dr Parvinder Maini, Scientific Secretary, OPSA, Dr Rakesh Kaur, Adviser/Scientist 'G'; OPSA and senior faculty and officials from IIT Guwahati (Figure 3.4.13).

These facilities are aimed at promoting interdisciplinary research and innovation in agrivoltaics, aquavoltaics, and wellness-product development, with a focus on strengthening rural entrepreneurship, livelihood generation, and technology deployment in the North Eastern region.



Figure: 3.4.13: Inauguration of the Centre for Innovation in Agri & Aqua Voltaics (CIAAV) and the Integrated Facility for Wellness-Product Innovation (IFWPI) at School of Agro & Rural Technology, IIT Guwahati

RuTAG Stakeholders Meeting

During this period, a RuTAG Stakeholder Meeting was also organised at IIT Guwahati, chaired by PSA Prof. Sood and joined by Dr Parvinder Maini, Scientific Secretary, OPSA. The meeting was attended by representatives from key stakeholder organisations, including the Ministry of Development of the North Eastern Region (MDoNER), North Eastern Council (NEC), Ministry of Micro, Small and Medium Enterprises (MSME), Government of Uttar Pradesh, North East Centre for Technology Application and Reach (NECTAR), Assam Science, Technology and Environment Council (ASTEC), National Bank for Agriculture and Rural Development (NABARD), Assam State Rural Livelihoods Mission (ASRLM), and all seven RuTAG 2.0 Centres.

Discussions focused on identifying concrete problem statements, aligning RuTAG technologies with existing schemes, and exploring funding

and deployment pathways to enable scaling and sustained field adoption of validated rural technologies.



Figure: 3.4.14: RuTAG Stakeholder meeting held on 14th November 2025 at IIT Guwahati

3.5. RuTAGe Smart Village Centre (RSVC)

Villagers often struggle to communicate their needs or select appropriate technologies. Innovators also lack adequate spaces to plug in and demonstrate their technologies in rural settings, making them feel lost in the milieu. Hence, a new framework was recently envisioned by the OPSA. It entails baseline technology needs assessment from the ground; testing, verifying, and institutionalising deployment of these technologies; creating livelihoods; increasing farm output; building capacity of SHGs and FPOs; and developing rural entrepreneurship using technology as a catalyst.

The name RuTAGe draws from the legacy of the RuTAG programme, which has supported rural technologies for over two decades, and PURA (Providing Urban Amenities to Rural Areas), originally launched by Dr A.P.J. Abdul Kalam. RuTAG was used to pilot the framework, and following the pilot, all innovators listed on Manthan (RSVC Section) can utilise it. Implementation partners may invite suitable innovators based on results from baseline surveys. Further, the 'e' in RuTAGe stands for entrepreneurship and employment.

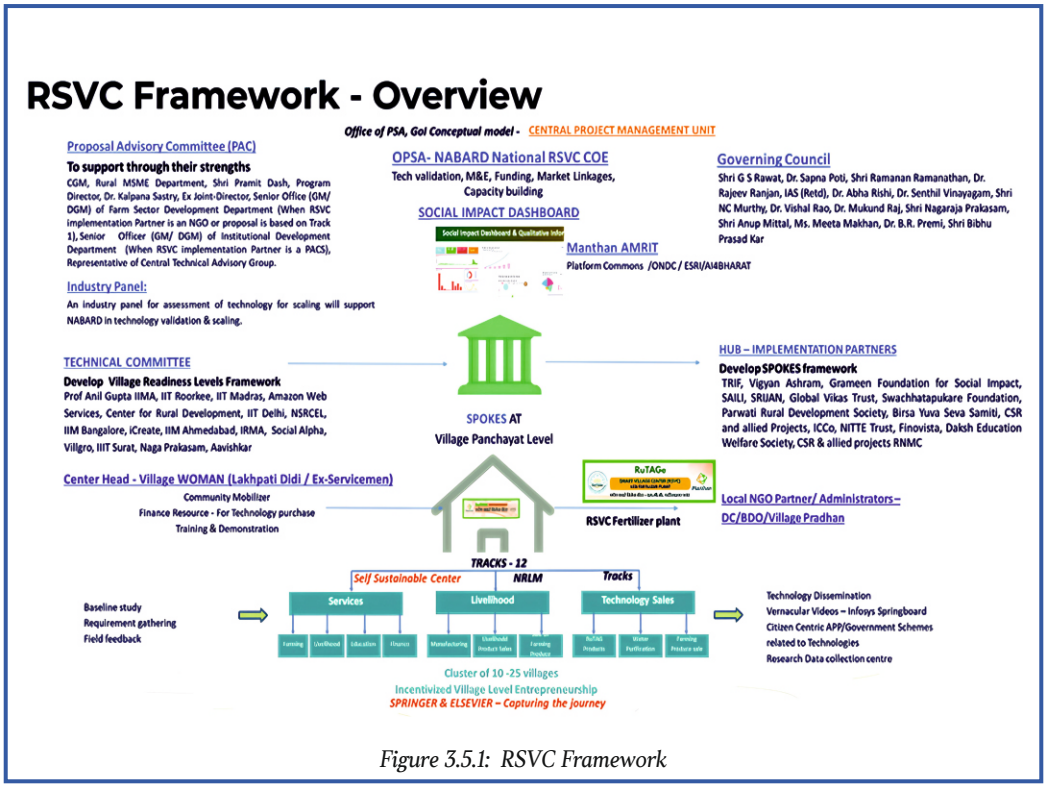
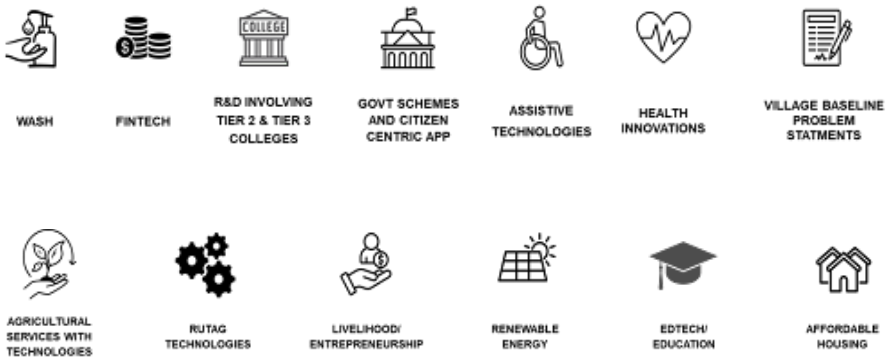


Figure 3.5.1: RSVC Framework

Types of RSVCs:

TYPE 1:

RSVCs type 1 are platforms for the deployment of 13 technology tracks- Agriculture, RuTAG Technologies, Livelihood, Renewable Energy, EdTech, Affordable Housing, WASH, FinTech, R&D Interventions, Government Schemes, Assistive Technologies, Health Innovations and Village Baseline Problem statements. The RSVC type 1 facilitates the adoption of relevant solutions by rural communities through awareness generation, field demonstrations, capacity building, and skilling on technology use, along with credit and financial linkages to enable access and affordability. Technology adoption will be enabled through multiple delivery models, including direct sales, rental models, and user–fee–based services, aligned with the needs and paying capacity of the villagers. Each RSVC may choose to operationalise one or multiple technology tracks, based on local needs assessment, implementation partner capacities, budgetary considerations, and contextual conditions.



TYPE 2:

RSVCs that develop Entrepreneurs/Small Enterprises through technology transfers – these RSVCs are fabricating units or enterprises supported by implementation partners to undertake market research, to take a technology transfer from the IITs, and to manufacture the same and sell the technologies. This type of RSVC focuses on democratisation of rural technologies.

TYPE 3: Engaging students in structured rural immersions to foster empathy and innovation by identifying the rural problem statements to drive innovation, incubate and prototype tech-enabled solutions tailored for rural realities.

As of now, 52 RSVCs have been established across 14 states, with 44 more in the pipeline by March 2026.

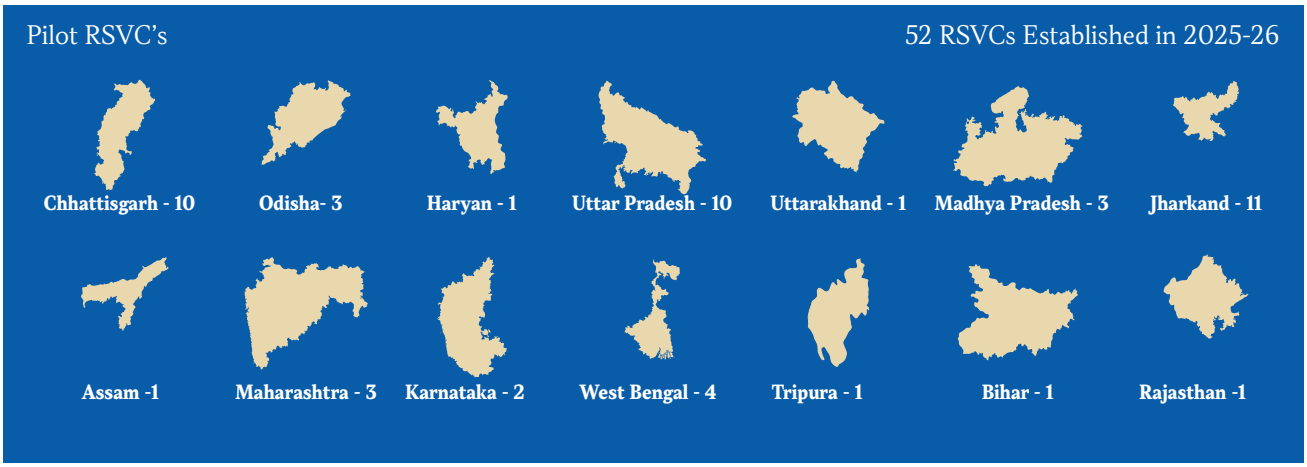


Figure 3.5.2: Existing RSVCs across states

The 52 RSVCs have been established across 14 states with the support of our implementation partners, including:

01 Agri Matrix India Pvt Ltd

02 Swachhatapukare Foundation

03 SAILI – Sustainable Agriculture Integrated Livelihood Institute

04 Self-Reliant Initiatives through Joint Action (SRIJAN), funded by Rotary

05 TRIF – Transform Rural India Foundation

06 CSR & Allied Projects Resourcing Networking Management Consulting with Parwati Rural Development Society

07 Grameen Foundation for Social Impact

08 NITTE Trust

09 IIT Roorkee (local implementation agency working through IITR)

10 Vigyan Ashram

11 Innovate Change Collaborate (ICCo)

12 Finovista with JEEViKA through J-WiRES

13 Daksh Education Welfare Society

14 Arangaar Foundation

RSVC Dashboard

No of RSVCs setup 52	No of Technologies deployed at RSVCs 22	No of States covered 14	No of potential technologies for RSVCs identified 580
IPs engaged/ sensitised on RSVC 73	Nos engaged in Hyacinth recycling- 2500	Nos engaged in Tulsi Mala Beed Making 100	LCB Fertilizer sold (50 KG bags) 1235
No of Mobile Subjee cooler sold 90	No of Soil testing samples collected 555	Satellite crop monitoring (in acres) 1715	Farmers Registered With RSVCs 4422
Youth Registered at RSVC 1902	Women Registered at RSVC 3125	Villagers Skilled on technology 5700	Entrepreneurs developed 122

Figure 3.5.3: RSVC Dashboard

OPSA- NABARD National RSVC Centre of Excellence (CoE) – A Strategic Collaboration between NABARD, NABFOUNDATION, and OPSA

The National RSVC CoE has been established as a flagship initiative to institutionalise and scale the RuTAGe Smart Village Centres (RSVCs) across India. This CoE serves as a national-level platform for rural transformation through science and technology. It is jointly anchored by NABARD, NABFOUNDATION, and the OPSA.

The National RSVC CoE is poised to become a national anchor for scaling rural innovation, standardising RSVC implementation, and fostering multi-stakeholder collaboration for inclusive development. This strengthens governance, accelerates technology deployment, and expands the RSVC ecosystem through multi-stakeholder collaboration and state-level engagement.

RSVC Key Verticals

Technology Sandbox:

Identify, validate, pilot, and scale technologies across RSVCs using VRL scoring, certification, and partnerships. Includes technology acceleration and AI-driven RSVC-AMRIT platform for end-to-end RSVC setup, monitoring, evaluation, and capacity building.

Monitoring, Evaluation & Impact:

Establish KPIs, dashboards, and real-time data systems to track RSVC performance, technology adoption, and generate impact reports for stakeholders.

Market Linkages:

Enhance rural market access, livelihoods, and enterprise outcomes via aggregation under the AMRIT brand, partnerships with buyers, SHGs, FPOs, and digital platforms. Integrates e-commerce, ONDC, and blended finance for sustainable rural enterprises.

Financial Linkages & Fundraising:

Centralise funding via NAB Foundation from CSR, donors, HNIs, and government schemes. Standardise costing, proposals, SOPs, and introduce instruments like social impact bonds and SSE listing.

NGO Implementation Partners:

Identify and train credible NGOs to implement RSVCs, deploy technologies, and manage data, finance, and markets. Develop SOPs and curriculum for RSVC Types 1–3, leveraging AI and vernacular tools for scalable local capacity building.

Capacity Building & Training:

Provide structured training for IPs, RSVC staff, SHGs, and FPOs on technology adoption and operations, aligned with Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Deendayal Antyodaya Yojana - National Rural Livelihoods Mission (DAY-NRLM) , and Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME) national skilling programmes.

Key Functional Verticals of the CoE:

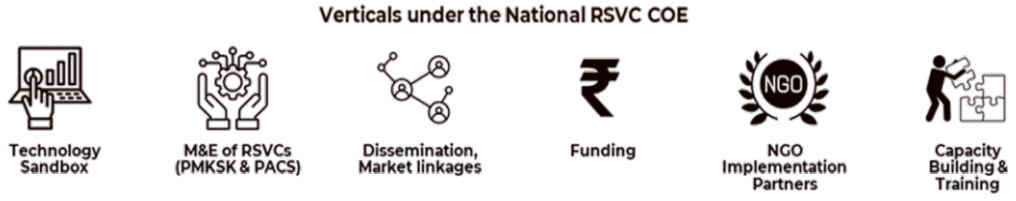


Figure 3.5.4: Verticals under National RSVC CoE

Progress achieved:

A. Institutional Framework:

1. A tri-partite MoU was signed on 12 August 2025 between NABARD, OPSA, and NABFOUNDATION, formalizing the collaboration.
2. The Governing Council was reconstituted on 13 August 2025 to provide strategic oversight.
3. A Project Advisory Committee (PAC) has been constituted to evaluate and recommend RSVC projects.
4. The National RSVC CoE PMU team currently comprises 9 members.

B. Standard Operating Procedures (SOPs) Developed:

1. **Technology Baseline Survey Templates** – To assess the local needs and technology requirements of each village. Based on the findings, suitable technologies are identified from the Manthan Platform for deployment. In cases where relevant technologies are unavailable, the identified needs can be listed on the Manthan Platform to invite innovators to develop appropriate tech-based solutions.
2. **Village Readiness Level (VRL) Scoring** - VRL helps determine the technology readiness for the village.
3. **Set-up and Impact Templates** – To ensure uniform documentation of RSVC establishment and its outcomes, including details on technology adoption, number of farmers and community members trained, livelihoods created, entrepreneurs supported, and revenue generated.
4. **Concept Note and DPR Formats** – Standardised formats for proposing and evaluating RSVC projects.
5. **Workflow Process** – A structured pipeline from concept development to DPR approval.

For the effective implementation of the CoE, a Governing Council and Proposal Advisory Committee (PAC) has been put in place.

C. Proposal Advisory Committee Meeting Outcomes (22 September 2025):

The first PAC meeting resulted in the approval of the following RSVC proposals:

2 RSVCs - BAIF

(BAIF Development Research Foundation)– located in Ujjain and Ahmednagar.

1 RSVC - PACS

PACS (Primary Agricultural Credit Societies) – Nandanam PACS, Hanumakonda, Telangana.

1 RSVC

WeCare Society, funded by ONGC.



Figure 3.5.5: First PAC meeting

D. Social Stock Exchange Registration:

NABFOUNDATION Registration & Technology Initiatives

NABFOUNDATION completed registration with the Social Stock Exchange on 4th Dec 2025, enhancing transparency, impact reporting, and access to sustainable funding for RSVC establishment.

1. RSVC AMRIT Platform (AI-driven)

An end-to-end AI platform for RSVC management, capacity building, monitoring, evaluation, and technology sandboxing. Developed with Platform Commons and PWC under OPSA guidance.

Key milestones:

Preliminary framework finalised with OPSA, Platform Commons, and National RSVC CoE.

AI-driven platform requirement specification developed and under finalization

2. Technology Sandboxing & Deployment

National RSVC CoE identifies, validates, pilots, and deploys rural technologies in collaboration with IITs.

Current status:

21 technologies assessed for validation and acceleration.

67 technologies across Agriculture, Livelihood, and Entrepreneurship assessed and identified for scaling.

Collaborations initiated with IITs and other premier institutions.

3. RSVC Technology Track Collaborations

Strategic partnerships established for sector-specific innovations:

Ed-Tech: Physics Wallah

Renewable Energy: AVAADA

Health: ICMR

Agri-Tech: WRI

AI & Data: Open AI

4. Technology Acceleration Initiatives

The Technology Vertical, anchored by OPSA and NABARD, drives identification, validation, acceleration, and deployment of high-impact rural technologies

Intervention areas:

Scouting & selection from platforms like Manthan and RuTAG.

Mentorship, business modeling, testing, IP support for early-stage technologies.

Commercialisation via revenue models, go-to-market strategies, and RSVC linkages.

Scale-up support including manufacturing, training, and after-sales.

Institutional collaborations:

NSRCEL (IIM Bengaluru T-Hub, IIT Delhi (FITT), Ajay Kumar Garg Engg. College, Tumkur University, Amrita University, NAB-Ventures, Atal Incubation Centres.

Webinar series on technologies for RSVCs:

Launched by OPSA on 24 September 2025, featuring validated technologies for RSVCs.

9 sessions completed, enabling knowledge sharing and collaboration opportunities.

NABARD took over from 17 December 2025.

Impact:

Validated, scalable, and contextually relevant innovations are reaching rural communities through RSVCs, accelerating inclusive development and technological empowerment.

E. RSVC Pilot with PACS

The RSVC Pilot initiative for PACS (Primary Agricultural Credit Societies) by OPSA-NABARD National RSVC Centre of Excellence, aims to strengthen rural service delivery. As part of the pilot phase, the selected locations across India are being targeted for implementation from January 2026.

To expand the RSVC network, sensitisation meetings and proposal scouting were conducted across multiple states:

1. **Assessment of PACS capabilities and mobilisation of new proposals:** Uttar Pradesh, Gujarat, Maharashtra, Telangana, Rajasthan, Gujarat & Andhra Pradesh.
2. **Karnataka (Chikkaballapur):** Proposal received for Mutturu Gram Panchayat on Wastewater Management in collaboration with Aquamaps, IIT Madras.

Proposals Received from PACS for integrating RSVCs

A total of 9 proposals have been received which include two each from Gujarat, Uttar Pradesh, Telangana, and Andhra Pradesh; and one proposal received from Rajasthan.

Progress Achieved

Assessed and identified 9 PACS centres for integrating RSVCs.

Concept notes have been received from 8 PACS towards setting up RSVCs.

3 DPRs are being developed, and 1 DPR has been submitted for approval.

F. RSVC Type 2 - Gaushala Model

Integration of Livestock Technologies in Gaushalas

Under the RSVC initiative, efforts are underway to integrate advanced livestock technologies into Gaushalas, enhancing rural livelihoods and animal welfare. Supported by BAIF and in collaboration with IIT Bombay, IIT Kanpur, ICAR, and Indian Institute of Pulses Research (IIPR), the initiative aims to deploy selected technologies across RSVCs and PACS to boost productivity, sustainability, and service delivery.

Key Technologies for Deployment:

1. **Bio CNG** – Processed biogas yielding 95% pure methane, equivalent to natural gas.
2. **LCB Plant** – High-yield organic crops recommended by ICAR/IIPR, developed at IIT Kanpur.
3. **Biofloc Technology** – Microbial aquaculture system improving feed efficiency and fish productivity.
4. **Cow Lift** – Portable cattle lift by RuTAG, IIT Bombay, aiding "downer cows."
5. **Breeding Technologies** – Genetic tools to enhance livestock productivity and profitability.

Progress:

Proposal for RSVC Type 2 – Gaushala Model, Nandurbar, Maharashtra has been Approved for funding by NABARD on 11 December 2025.

Impact:

Deployment of these technologies is expected to improve animal health, increase rural incomes, and promote sustainable practices, making RSVCs more holistic and impactful.

G. CASE STUDIES: Unique RSVCs

1. RSVC Dhamari

The RSVC at Dhamari has established a comprehensive farmer-centric ecosystem by deploying LCB fertilizer, satellite-based crop monitoring and advisory services, and solar dryers, complemented by the distribution of fruit saplings. Together, these interventions promote crop diversification, improve productivity, and enable sustainable income enhancement for farmers.

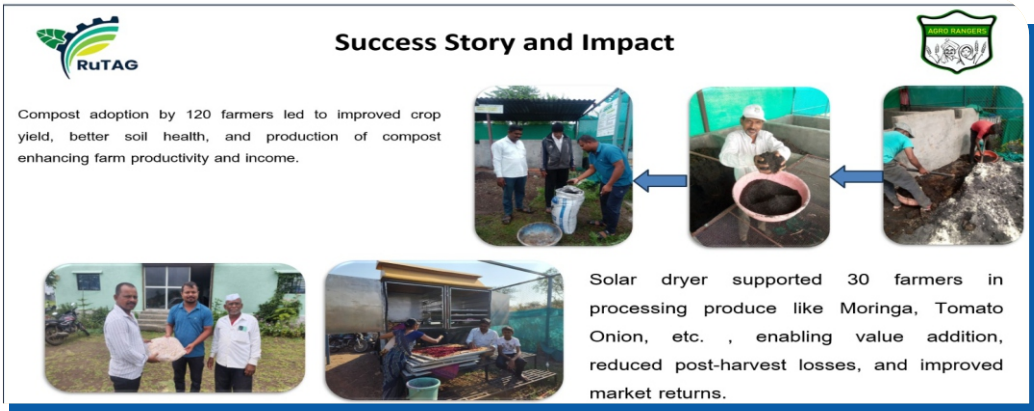


Figure 3.5.6: Case study from RSVC Dhamari

The video can be accessed on the given QR.

Scan QR Code to access the **RSVC Video**

2. Swatchatapukare Foundation

"Weed to Wealth"

The program supports more than 2,500 families, enhancing their economic resilience and livelihoods through recycling Hyacinth weeds. The SHG members are earning in the range of ₹2,000 to ₹8,500 per month, depending on the quality of the finished products.

The range of products includes notebooks, files, and folders; pen stands and utility boxes; as well as sarees and leatherite items such as laptop bags and ladies' bags.



Figure : 3.5.7 Products out of Hyacinth processing

Scan QR Code to access the **Swatchatapukare Foundation** Video

3. Finovista

Finovista in collaboration with JEEViKA Women Initiative Renewable Energy and Solutions Pvt. Ltd., conducts a Training Programme on Induction Repairing and Maintenance at the RuTAG Centre, J-WiRES Office, Dobhi (Gaya). The training is aimed to enhance the technical skills of Clean Cooking Champions (CCCs) and Solar Mart women entrepreneurs under J-WiRES, thereby enabling them to independently manage repair and maintenance of induction cooktops distributed across the Gaya district. A total of 15 CCC Didis are actively engaged in the training programme. The participants learnt about induction technology, fault identification, troubleshooting, and safe handling practices. These trained women are now capable of maintaining and repairing devices on their own, ensuring timely after-sales service and creating a robust last-mile support model.



Figure 3.5.8: Training of women on maintaining and repairing induction cookers

MANTHAN RSVC Global CoE

The Manthan RSVC Global CoE aims to internationalise the RSVC model through technology-driven collaborations, deploying scalable solutions in agriculture, health, sanitation, and waste management. It drives innovation via problem identification, technology scouting, co-development, and deployment across geographies.

Geographical Presence:

India: Active deployments and pilots

Seoul, South Korea: Official launch in the first week of December

Kisumu, Kenya: RSVC Type 1 set up under exploration with ISEF support

Deployment Process:

Problem Identification – Challenges mapped via the Manthan platform

Technology Scouting – Sourcing relevant innovations

Joint Collaboration – Co-development with partners

Proof of Concept (PoC) – Testing viability

Deployment – Implementation across India and Africa

Current Status:

Karnataka: Wet waste management project completed; transitioning to a state-wide solid waste initiative

Impact:

The Global CoE is catalysing cross-border innovation, enabling rural technology deployment, and creating replicable models for sustainable development in India and Africa.

Manthan RSVC Global CoE: South Korea – Feasibility Study for A Model Smart City

The Manthan RSVC Global Centre of Excellence has initiated a feasibility study in South Korea to develop a Model Smart City focused on sustainable urban waste management. The study targets Municipal Solid Waste (MSW) and Construction & Demolition (C&D) waste, proposing a technology-driven, community-centric framework aligned with RSVC's mission of replicable, integrated service delivery.

Core Challenges:

MSW: 250–300 TPD, largely unscientific disposal.

C&D Waste: 5 TPD, increasing illegal dumping.

Drivers: Rapid population growth, industrialisation, and rising waste volumes.

Proposed Solution – Smart Distinct Framework:

Technology: IoT-enabled monitoring with centralized dashboard.

Strategy: Source segregation, composting, biogas generation, Material Recovery Facilities (MRFs).

Resource Recovery: Recycling and reuse of C&D waste.

Governance: Dedicated waste management cell and public-private partnerships.

Expected Outcomes (5 Years):

Environmental: Reduced pollution; improved water quality.

Economic: Job creation and revenue from recyclables & energy.

Social/Policy: Lower public health risks, community engagement, and a scalable model for replication in Karnataka and beyond.

Impact:

The initiative aims to establish a benchmark for urban sustainability, integrating technology, governance, and community participation to tackle pressing urban waste challenges.

3.6. Science and Technology Clusters

The Science & Technology (S&T) Clusters, a flagship initiative of OPSA, operate as demand-driven, collaborative ecosystems to solve regional problems through S&T intervention. Operating on a consortium-based framework, these clusters integrate academia, research institutions, industry, local government entities, and civil society to leverage S&T-driven solutions. The structure of the Clusters is organised into a three-tiered model: the foundational level establishes a collaborative ecosystem, the intermediate tier focuses on addressing regional-specific issues, and the apex tier seeks to enhance global competitiveness. By fostering synergies among universities, R&D centres, startups, MSMEs, and government agencies, the Clusters effectively bridge the gap between scientific research and practical, real-world applications, thereby advancing the goals of India's "Atmanirbhar Bharat" initiative.

The initiative operates under a legal framework that supports autonomy while fostering structured collaboration. By enhancing cross-sector collaborations, the S&T Clusters are poised to make significant economic and societal contributions, both locally and globally. As of now, eight Clusters are active, namely:

RICH Research and Innovation Circle of Hyderabad — *Established in 2020*

Jodhpur City Knowledge and Innovation Foundation JCKIF — *Established in 2020*

Pune Knowledge Cluster PKC — *Established in 2020*

CKIC-DRIIV — *Established in 2020*

BCKIC Bhubaneswar City Knowledge Innovation Cluster Foundation — *Established in 2021*

BeST Cluster Bengaluru Science and Technology Cluster — *Established in 2022*

PI - RAHI — *Established in 2023*

Vizag Science & Technology Cluster — *Established in 2024*

Currently, five of these Clusters (RICH, JCKIF, PKCF, DRIIV, BCKIC) are in Phase 2.0, each focused on specific research agendas and strategic partnerships. Phase 2.0 of the initiative, currently underway, intensifies industry involvement and, positioning industries as key drivers in translating scientific research into practical, market-ready solutions. This phase emphasises the interplay between science and industry, with sectors acting as solution-seekers, implementers, and funders.

Major Achievements During 2024-25

Bengaluru Science and Technology Cluster (BeST)

The BeST Cluster is driving significant initiatives to integrate human, animal, and environmental health in the city through One Health, Precision Agriculture, Digital Health, and Urban Mobility initiatives. In 2024-25, the One Health Bengaluru Initiative developed a ward-level dengue prediction model leveraging multi-sectoral data to generate a "vulnerability index" for outbreak prediction, supported by the establishment of BBMP's One Health Cell and targeted training programmes for frontline health workers. In digital health, the Digital Podiatry Clinic (D-PoC) screened over 10,000 patients for diabetic foot complications, expanded into rural Primary Health Centres (PHCs) via Trinity Care Foundation, and was piloted in 17 district hospitals under the National Centre for Disease Control (NCDC) Mission. In agriculture, BeST advanced climate-resilient farming through collaborations deploying drone spraying, climate-controlled polyhouses, and pheromone-based pest control across Karnataka's cotton belt. Additionally, BeST launched a metro health impact study to assess how Bengaluru's upcoming Yellow Line influences physical activity, pollution exposure, and public well-being, informing data-driven policies for sustainable urban mobility.

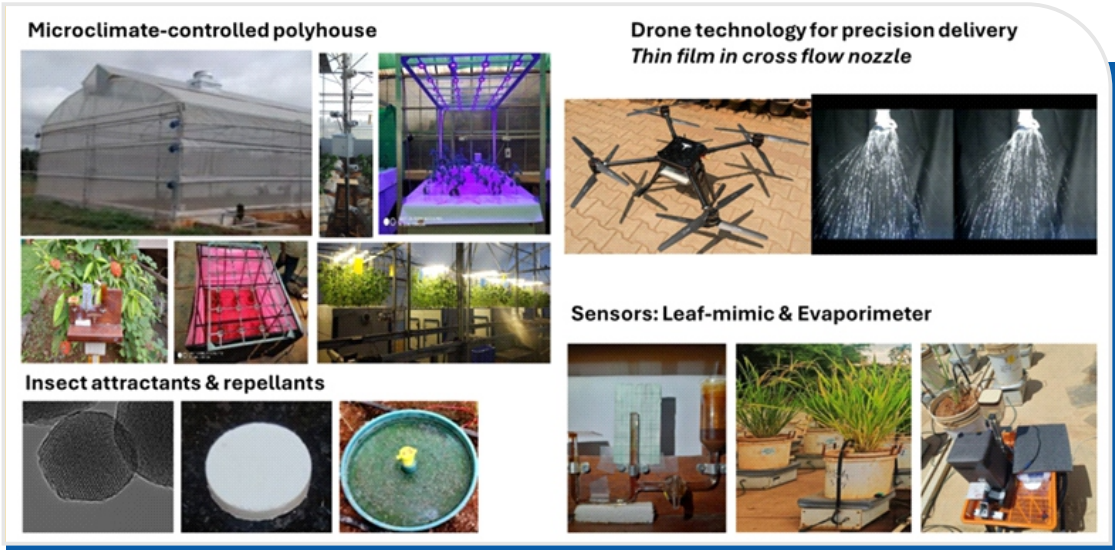


Figure: 3.6.1: Technological Innovations in Precision Agriculture developed by experts from IISc, UAS Bangalore, ICAR-NBAIR and JNCASR

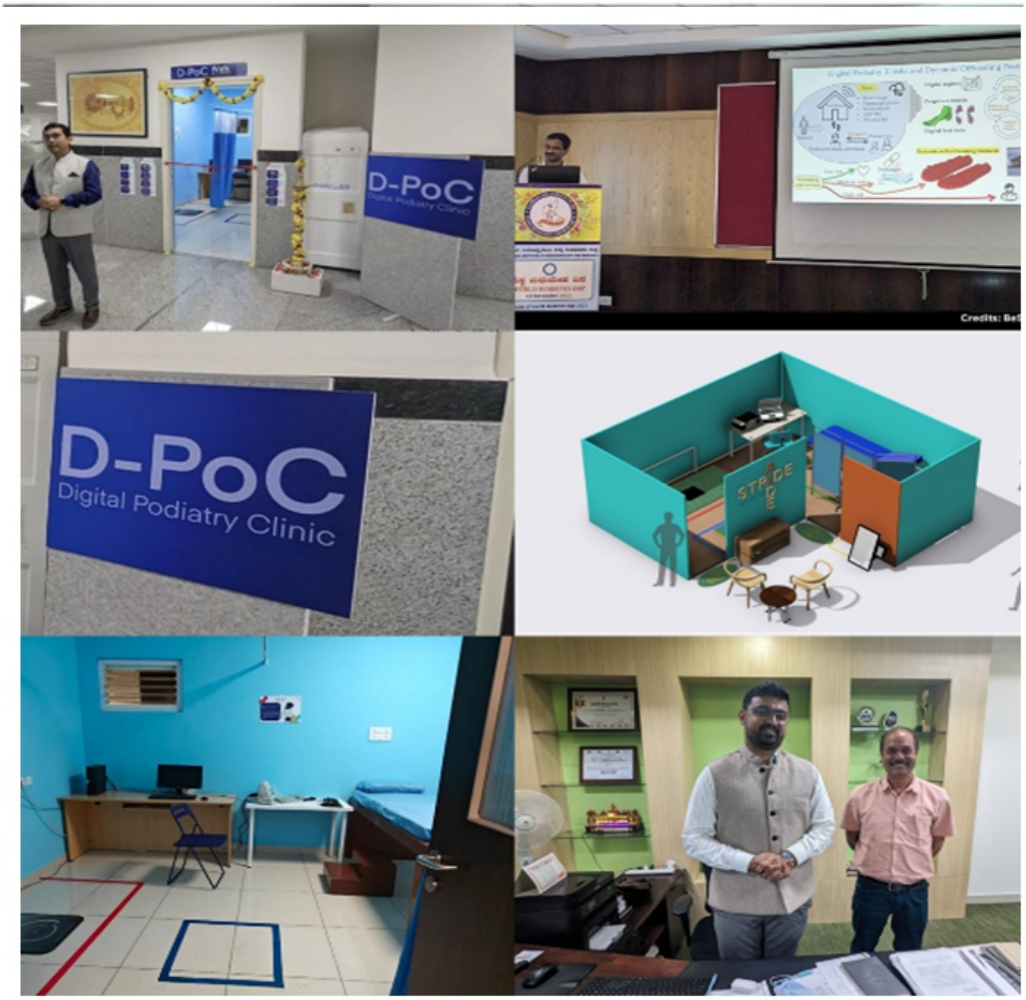


Figure: 3.6.2: Demonstration of Digital Podiatry Clinic at the Directorate of Health and Family WelfareServices, Government of Karnataka, in collaboration with IISc, KIER and StrideAIde - BeST Cluster

Bhubaneshwar City Knowledge Innovation Cluster (BCKIC)

The BCKIC Cluster is catalysing high-impact, inclusive innovation across health-tech, clean energy, marine ecosystems, wetland management, rural enterprise, and grassroots innovation. In 2024-25, the UK-India Health-Tech Bootcamp connected 6 Indian health-tech startups with National Health Service (NHS) mentors and UK ecosystem stakeholders, enabling transnational product validation and co-development. Under Project ROSHNI, supported by the Jindal Stainless Foundation, a Women Technology Park was established in Kendujhar, Odisha, to promote clean energy-driven microenterprise development among rural women.

The initiative has provided hands-on training to over 80 women and engaged more than 130 Self-Help Groups (SHGs) in enterprise incubation. As part of the project, a LED Bulb Manufacturing Unit was set up in the Bileipada and Deojhar blocks to facilitate sustainable livelihoods and foster local economic empowerment, contributing to the overall socio-economic development of the region. In marine innovation, the Blue Economy Mission 50 Accelerator, launched at the International Conference on Blue Economy, provided capital and mentorship to 50 startups across ocean energy, marine biotechnology, and digital maritime trade, accelerating product-market fit and commercialisation. At the school innovation level, the "Catch Them Young" programme, in partnership with NITI Aayog's Atal Innovation Mission, activated over 130 Atal Tinkering Labs (ATLs) across 21 districts in Odisha, resulting in 300+ student idea pitches and over 60 prototype-ready projects, bolstering early-stage tech innovation pipelines.



Figure: 3.6.3: International Conference on Blue Economy - BCKIC

Northern Region S&T Cluster, Chandigarh (PI-RAHI):

The PI-RAHI Cluster, North India's first regional innovation cluster, is advancing inclusive, high-impact innovation across agriculture, indigenous technology, healthcare, and green energy. In FY 2024–25, the Cluster accelerated deep-tech commercialisation and startup growth across five northern states through focused R&D translation, startup funding, and capacity-building initiatives. In waste-to-value innovation, a microbial consortium enabling rapid composting within 30 days was co-developed with the Chandigarh administration, targeting urban organic waste management. Under startup acceleration programmes, IGNITE and SPARKS, early-stage ventures received grant support of up to ₹10 lakh, catalysing prototype development and scale readiness. In biopharma, a cost-effective, non-pathogenic Bacillus-based Hyaluronic Acid production method was commercialised via tech transfer to Invigorate Biotechnologies LLP. In manufacturing, an AI vision-enabled welding platform was field-validated with over 20 MSMEs across Punjab, enhancing automation and precision; and scale-up partnerships were initiated with CICU Ludhiana. The Syn-Pharma initiative, launched in June 2025, established a regional pharma innovation platform to integrate R&D institutions and industry, strengthen self-reliance, and bridge translational gaps in northern pharma clusters. Capacity-building efforts included thematic workshops on AI for sustainable development and ecosystem resilience, while She Cohort 3.0 supported over 200 women entrepreneurs in tech-led enterprise development. The year culminated in the 2025 Investors Summit, where 15 startups pitched to over 20 investors, reinforcing PI-RAHI's role as a regional engine for innovation-driven growth and technology commercialisation.





Figure: 3.6.4: Startup Accelerated at PI-RAHI developed an AI-vision-enabled welding platform for MSME's - Northern Region S&T Cluster (PI-RAHI)

Delhi Research, Implementation & Innovation Cluster (DRIIV):

The DRIIV Cluster is accelerating translational science by integrating academia, industry, government, and civil society to address national priorities across Critical and Emerging Technologies, Green Energy Transition, and Water Security. In FY 2024–25, DRIIV established a dedicated vertical for Critical and Emerging Technologies, advancing deep-tech applications in spacetech and civil aviation through strategic collaborations with IN-SPACe and the Airports Authority of India. Key deployments included AI and Large Language Model (LLM) integration for satellite mission planning, satellite-based CNS systems, and rollout of ATFM and satellite-based VHF communication solutions in partnership with Air India, GMR, and DGCA. In environmental sustainability, DRIIV piloted solar-powered EV charging stations using second-life batteries in collaboration with IIT Delhi and BATX Energies, demonstrating CO_2 emission reduction and grid independence. Air quality monitoring under Project AirView+ was scaled across urban NCR, with recorded improvements in PM2.5 levels. The Cluster also strengthened international cooperation through the Indo-Danish Plastic Innovation Network, co-developing sustainable waste management strategies. To bolster India's semiconductor and electronics ecosystem, high-end skilling programs in Analog and IC Design were launched, aligned with national capacity-building goals. DRIIV further amplified global engagement through cross-sector dialogues at SemiConIndia, and enabled multi-cluster collaboration on circular economy initiatives. The launch of an integrated web portal for real-time tracking of tech validation, pilot deployment, and CSR-policy alignment has reinforced DRIIV's role as a national platform for innovation-led systemic transformation.



Figure: 3.6.5: it should be: DRIIV's major chievements across sectors

Research and Innovation Circle of Hyderabad (RICH):

The RICH Cluster is driving innovation-led growth by supporting deep-tech startups, enabling digital transformation in agriculture, and promoting sustainable practices in MSMEs. In FY 2024–25, RICH advanced its Phase 2 verticals, namely Precision Health, Digital Agriculture, and Decarbonisation of MSMEs, through targeted pilots, ecosystem partnerships, and capacity-building programmes. In healthtech, the AID program supported 28 startups in diagnostics, medical devices, and digital health, facilitating IP generation, regulatory navigation, and commercialisation. The cohort created over 300 jobs, executed 5 paid pilots, and initiated Cohort 7 with a focus on musculoskeletal health technologies. In digital agriculture, RICH curated a repository of more than 600 AgriTech startups and executed 35 field pilots, co-developing AI and GIS-based solutions under Telangana's Ne-GPA Phase 2 for crop health monitoring, soil moisture prediction, and carbon credit tracking. To support clean energy transitions in industry, RICH implemented decarbonisation pilots under the RAMP (Raising and Accelerating MSME Performance) Scheme, conducting energy audits and clean tech interventions across over 100 MSMEs in six industrial zones. The Cluster was designated as a nodal partner under Telangana's new MSME policy for green innovation. In inclusive innovation, the Women in STEM initiative facilitated over 50 internships at premier life sciences institutions with Biocon Foundation's support and amplified visibility for women scientists through the "League of Her Own" media campaign.



Figure: 3.6.6: Technology demonstration of an Agri-Tech Startup-RICH Cluster

Jodhpur City Knowledge and Innovation Cluster Foundation (JCKIF)

The JCKIF Cluster is advancing innovation at the intersection of cultural preservation for handicrafts and handlooms artisans, facilitation of medical technologies, and water and environmental sustainability through technology integration and ecosystem partnerships. In FY 2024–25, JCKIF transformed artisan engagement via the "Dharohar" Phygital Museum and immersive e-commerce platform "Kalaanubhav.in," leveraging AR/VR, QR-linked storytelling, and 3D visualisation to showcase over 800 handcrafted products from 23 artisan families. A 3D Experience Centre further enhanced public interaction with India's intangible cultural heritage. To protect traditional knowledge, the Cluster facilitated 19 design registrations across five indigenous craft forms and initiated GI tagging for the Sindhi Sarangi of the Langa community, aligning with national IP and heritage conservation priorities. In water and environment, JCKIF deployed a smart AIoT-enabled graded water supply system (~1 MLD capacity) featuring digital twin simulations, sensor-based optimisation, and real-time monitoring, developed through Indo-German collaboration with Fraunhofer IGB.

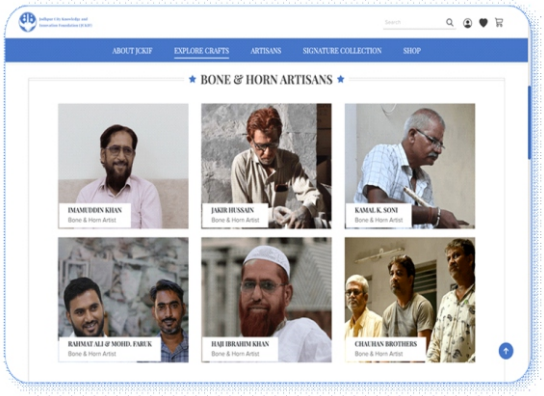


Figure: 3.6.7: Kalaanubhav.in E-Commerce platform



Figure: 3.6.8: International Conference on Blue Economy - BCKIC

Pune Knowledge Cluster (PKC)

The PKC Cluster is advancing science-driven, community-anchored innovation through interventions in Water Management, Plastic Waste Management, and Industry Connect. In FY 2024–25, PKC delivered cross-sectoral impact through flagship programs in public health, climate resilience, education, and international collaboration. In disease surveillance, PKC led a multi-institutional program integrating genomic and environmental monitoring, sequencing over 1,000 samples and launching two open-access dashboards. Notably, its wastewater-based COVID-19 surveillance platform was recognised by WHO as India's only live system with global user engagement. In health systems strengthening, the Saksham initiative trained 792 frontline workers across Maharashtra, while the WEnyan programmes supported 37 women from 19 districts through scholarships and structured mentorship. In sustainability, PKC enabled the Detailed Project Report (DPR) for the Pune Green Hydrogen Valley Innovation Cluster and facilitated Harit Bharat Fund disbursements to 15 NGOs for land restoration projects across three states. In education, the ChemAmaze initiative deployed 42 gamified STEM learning tools across 16 schools, reaching over 1,100 students and teachers. Global engagement was strengthened through Indo-Danish water-tech collaborations under the Global Innovation Network. PKC further supported 57 capacity-building events, impacting over 3,400 stakeholders, reinforcing its role in catalysing science-led, climate-resilient, and inclusive development.



Figure: 3.6.9: WEnyan Industry Visit - PKC



Figure: 3.6.10: Edu-Conclave 2025 - PKC

Vizag S&T Cluster (AMTZ)

The Vizag S&T Cluster is advancing innovation across MedTech, High-Tech Materials, Industry 4.0, and E-Waste Management to address critical technology gaps while promoting environmental sustainability and self-reliance. In FY 2024–25, the Cluster operationalised "EYANTRAM," a sustainable e-waste management facility developed in collaboration with CSIR-National Metallurgical Laboratory (NML), integrating collection, processing, and material recovery. It demonstrates a scalable circular economy model launched at the All Clusters Meet 2025. In MedTech, the Cluster enabled indigenous manufacturing of pacemaker leads through a technology transfer MoU with Microport, supported by strategic collaborations with Purple Microport and public-sector institutions to strengthen domestic cardiac device production. Industry-academia collaboration was deepend through the Vizag S&T Cluster Industry Meet, fostering technology partnerships and knowledge exchange. Public engagement and science outreach were strengthened through the "Breakfast with Science" series and the World Health Innovation Forum (WHIF) 2024, which convened over 1,500 participants across sectors.

These initiatives reinforce the Cluster's role in translating science and technology into scalable solutions with measurable environmental, healthcare, and economic impact.



Figure: 3.6.11: E-Waste Management Centre (EYANTRAM)- Vizag S&T Cluster (AMTZ)



Figure: 3.6.12: Demonstration of the hPod Health Kiosk which can measure over 50 vital health parameters, including blood pressure, weight, SpO2, BMI, body mass composition, pulse, temperature, and ECG - Vizag S&T Cluster (AMTZ)

Annual Report Launch

The "Science and Technology (S&T) Clusters Annual Report 2024-2025", highlighting key advancements and innovations was launched on 26 June 2025. The details of the report are included under Section 4 (Knowledge Creation and Synthesis) of this Anthology.

All Clusters Meet 2025

The third "All Science & Technology (S&T) Clusters Meet" was convened on 9–10 September 2025 in Visakhapatnam under the chairmanship of PSA Prof. Sood with the participation of Dr (Mrs.) Parvinder Maini, Scientific Secretary, and Dr Rakesh Kaur, Adviser/Scientist-G, from OPSA. The meet served as a strategic forum to review the annual progress of all eight S&T Clusters, explore synergies with the RuTAG and RSVC programmes, and define inter-cluster collaboration pathways. A key highlight was the official unveiling of the S&T Clusters logo, symbolising the Clusters' role as the connective matrix linking academia, industry, startups, and government. The PSA also launched the official webpage and flyer for the International Conference on S&T Clusters, setting the stage for global engagement and showcasing India's innovation ecosystem on an international platform.

A major milestone was the inauguration of "EYANTRAM", a state-of-the-art e-waste management facility developed by the Vizag S&T Cluster at the AMTZ campus with OPSA's support which aligns with national sustainability goals. The PSA also released the "One Health" compendium curated by the BeST Cluster, which consolidates cross-sectoral innovations addressing health, agriculture, and environmental resilience. The newly developed S&T Clusters Dashboard was presented, providing a real-time interface to track high-impact technologies nearing deployment, enabling stakeholders to assess and adopt validated innovations across sectors.

Throughout the two-day meet, clusters showcased key achievements, ongoing initiatives, and future roadmaps, emphasising technology transfer, regional deployment, and solution-centric models. The PSA advised clusters to prepare thematic compendiums on water rejuvenation, e-waste management, and smart agriculture, to amplify visibility of cluster-supported technologies. He further recommended inter-cluster transfer of validated solutions that have demonstrated adoption by user agencies, promoting scalability across geographies. Reiterating the vision of "Atmanirbhar Bharat", PSA emphasised the need for clusters to evolve into self-sustaining, industry-integrated ecosystems that enable collaborative research and localised innovation to address both national and global challenges.



Figure: 3.6.13: Third All Clusters meet in Vishakhapatnam, hosted by the Vizag Science and Technology Cluster (AMTZ)

Inter-Cluster Collaborations

Since December 2024, a total of six inter-cluster meetings have been successfully conducted across key thematic areas including Plastic Waste Management, Smart Agriculture, Healthcare, Technologies Empowering Livelihood, Environmental Sustainability, and Industry 4.0 Automation. These meetings aim to foster deeper cooperation and collaboration among S&T Clusters, with a strong emphasis on scaling matured solutions developed within individual clusters. Each cluster is encouraged to identify at least two thematic areas with proven potential for cross-cluster implementation, enabling wider on-ground impact. Moving forward, clusters will continue to actively explore areas for joint initiatives to enhance national capacity through shared innovation.

First International S&T Cluster Conference 2025

OPSA organised the 1st International Science & Technology (S&T) Clusters Conference – 'Making Lives Easier Through S&T', on 4-5 December 2025 at the Dr. Ambedkar International Centre, New Delhi. This flagship 2-day event brought together government officials, diplomats, policymakers, academics, industry leaders, and

innovators from India and around the globe to strengthen international collaboration in S&T. The Conference is further reported in detail under section 5 (International Engagements) of this Anthology.



Figure: 3.6.14: The first International S&T Clusters Conference that brought together officials, diplomats, policymakers, academics, industry, and innovators concluded on December 5, 2025.

Inauguration of Kalaanubhav at the Kunj Mall New Delhi

The Ministry of Textiles had set up the "The Kunj", a flagship retail and cultural destination dedicated to celebrating and promoting the diverse heritage of Indian handicrafts and handlooms located at Plot No. 8, Nelson Mandela Marg, Vasant Kunj, New Delhi. Conceived and developed by the Office of the Development Commissioner (Handicrafts), the Kunj was a first-of-its-kind initiative aimed at empowering artisans, enhancing market access, and reimagining the craft sector through a design-led, experiential lens.

The Jodhpur Cluster's Kalaanubhav is an innovative platform dedicated to the convergence of art & craft. An exhibition of Kalaanubhav was inaugurated by the PSA at The Kunj, New Delhi, to align the initiative with ongoing sectoral efforts of the Ministry of Textiles. By inaugurating the exhibition in the Kunj, which is a nationally significant platform dedicated to Indian crafts, the initiative highlighted the importance of aligning scientific innovation with existing cultural and market ecosystems to maximise impact. This enabled Kalaanubhav to be presented not only as an exhibition but as a practical demonstration of how science based solutions can be taken forward for wider adoption through inter-ministerial collaboration.



Figure: 3.6.15: PSA inaugurating Kalaanubhav exhibition at the Kunj

The inauguration underscored the evolving role of the S&T Clusters programme in addressing region-specific socio-economic challenges through locally grounded innovation. Kalanubhaav brought together outcomes of sustained engagement with artisan communities in Rajasthan, demonstrating how material science, process optimisation, digital technologies, and intellectual property tools can be integrated into traditional craft practices.

In his inaugural address, PSA emphasised that science and technology must ultimately translate into improved livelihoods and economic resilience at the grassroots level. The inauguration reinforced the principle that artisans and local communities are central stakeholders in the innovation process, and that their experiential knowledge is essential to developing solutions that are both effective and adoptable.



Figure: 3.6.16: Exhibitions by the local artisans during Kalanubhav

3.7. Synergy Projects

3.7.1. ASTM Project

The project titled indigenous development and manufacture of seamless tubes of nickel-based superalloy conforming to ASTM B983 (ASME Code Case: 2702) for high-temperature and high-pressure applications, commonly referred to as the ASTM project, was sanctioned to the Indira Gandhi Centre for Atomic Research on 5 October 2022. The project was conceived primarily to meet the demanding material requirements of Indian Advanced Ultra Super Critical (AUSC) power plants, with the longer-term objective of extending its application to other high-temperature and high-pressure power generation systems. The initiative represents a strategic effort to establish indigenous capability in a class of advanced materials that are critical for next-generation thermal power technologies and are currently dependent on global supply chains.

The major objectives of the project were clearly defined at inception. These included the development of India-specific material specifications for a nickel-based superalloy conforming to ASTM B983 and ASME Code Case 2702, the indigenous development and manufacture of seamless tubes of specified dimensions suitable for AUSC applications, and the establishment of an optimised and reproducible process sheet covering all stages of tube manufacture. The emphasis throughout has been on developing not only a product but also a validated and scalable manufacturing pathway that can be demonstrated through repeated production cycles.

A substantial body of foundational work was undertaken through an extensive survey of both scientific and commercial literature. This exercise was essential to understand the role of chemical composition in governing the high-temperature performance and manufacturability of these alloys. Given that multiple alloy compositions fall within the ASTM B983 specification, common trends were identified and critical compositional ranges were established. In parallel, manufacturing-related concerns specific to these alloys were identified, drawing upon reported experimental results as well as insights derived from computational thermodynamics. This body of knowledge formed the basis for subsequent experimental and specification development activities. Building on this foundation, experi-

mental studies were conducted on existing superalloys conforming to ASTM B983 to evaluate their behaviour under conditions relevant to tube manufacturing.

Sixth PRMC of the ASTM Project Held on 9 July 2025

The PRMC examined the work carried out on alloy design, billet specification, and tube manufacturing in the context of the intended application AUSC power plants. The PRMC noted that the project has progressed from the developmental and experimental stages into the manufacturing phase, with all major thermo-mechanical processing steps required for seamless tube production having been completed.

The Committee reviewed the manufacturing status in detail and took note that extrusion, pilgering, solution annealing, straightening, and aging of the seamless tubes have been successfully completed at the identified industrial facility. The PRMC recorded that these steps were carried out using the India-specific chemical composition and process route developed under the project, thereby demonstrating the feasibility of indigenous manufacturing of seamless nickel-based superalloy tubes conforming to ASTM B983. The role of coordinated execution between IGCAR, MIDHANI Hyderabad, and NFC (Nuclear Fuel Complex) Hyderabad through the joint task force mechanism was noted as critical to achieving this stage of completion.

The PRMC further reviewed the certification and inspection status of the manufactured tubes.

3.7.2. India Antimicrobial Resistance Innovation Hub (IAIH)

The India AMR Innovation Hub (IAIH) is housed at C-CAMP, and supported by OPSA. IAIH is envisioned to be the innovation arm of National Action Plan on AMR 2.0 (NAP-AMR 2.0). It is a first-of-its-kind international convergent platform for stakeholders and partners across the AMR ecosystem to come and build a novel technology pipeline. It is a timely step toward addressing one of the most pressing issues of AMR that has emerged as a shared global problem and one of the major public health concerns. Major focus areas under IAIH are innovations for human health, animal health, agriculture and environment.

India AMR Innovation Workshop Under IAIH at C-CAMP, Bengaluru

The India AMR Innovation Workshop (IAIH Workshop) under the aegis of India Antimicrobial Resistance Innovation Hub (IAIH) initiative supported by OPSA, was held on 3 July 2025 at the C-CAMP, Bengaluru. The workshop brought together a wide range of national and international stakeholders from the domains of health, agriculture, environment, and biotechnology to deliberate on strengthening India's innovation ecosystem in combating Antimicrobial Resistance (AMR) through a One Health approach.

A keynote address was delivered by PSA Prof. Sood who shared his insightful perspective on fostering scientific collaboration, innovation, and policy alignment to tackle AMR challenges. Dr Hafsa Ahmad, Scientist 'D', OPSA, participated as a panelist in a discussion on "Innovating Across One Health: IAIH's Strategic Initiatives in Environment, Human, and Animal AMR, contributing insights on the strategic initiatives of IAIH and the role of inter-sectoral collaboration in advancing AMR research and innovation. The workshop also featured key panel discussions on- "Tackling AMR in India: A One Health Approach Across National and State Levels", exploring synergies between global ecosystems to fast-track contextual innovations in AMR for India; and Global best practices from innovation-focused programs for India's AMR needs.

The workshop concluded with a strong consensus on the need for coordinated multi-sectoral efforts to address AMR through innovation and policy integration.



Figure: 3.7.2.1: Glimpses from the IAIH AMR Workshop

3.7.3. Transforming Deep-Science Discoveries into Impactful Innovations for India Discovery to Innovation Accelerator (DIA) Program, Under C-CAMP

The project titled "Transforming Deep-Science Discoveries into impactful Innovations for India Discovery to Innovation Accelerator (DIA) Program" sanctioned to the C-CAMP, Bengaluru aims to foster growth of deep-science-based Indian innovations that are both socially and commercially impactful, translating academic discoveries into industry-ready, de-risked technologies by employing an active translation intervention. Currently three key technologies namely air disinfection using cold plasma technology, a topical formulation for skin cancer, and a wound-healing therapeutic are being developed under the project with an aim to achieve TRL 5-6, while two other bioactive agricultural solutions viz Xantho Control and AphidControl have been transferred for commercialisation to industry.

Technology Transfer event of Two Next-Generation Agricultural Bio-Solutions technologies under DIA programme

Two novel bioactive, non-chemical agricultural solutions — Aphid Control and XanthoControl — developed under the DIA programme of C-CAMP with support from OPSA, were successfully transferred for commercialisation to PI Industries Ltd. This announcement was made during an event held at the OPSA, New Delhi, on 21 February 2025 in the presence of PSA Prof. Sood, and Dr Kris Gopalakrishnan, Managing Trustee, Pratiksha Trust.

Prof. Sood, emphasised the role of the C-CAMP DIA programme in fostering industry-driven innovation and bridging the gap between research and commercialisation. Dr Gopalakrishnan, underscored the importance of translating scientific discoveries into real-world impact and positioning India as a global bio-innovation hub. Dr Mohanty (Former Adviser, OPSA) highlighted this achievement as a step to India's commitment to advancing sustainable agricultural solutions through deep-science innovation.

Dr Taslimarif Saiyed, CEO & Director, C-CAMP, highlighted the role of DIA in facilitating this transition, stating that the programme has successfully lever-

aged knowledge generated by research institutions across the country, advancing their technology-readiness level in line with industry standards.

The event was also attended by Dr Alka Sharma, Scientist H, DBT, Mr. Mayank Singhal, Vice Chairman & Managing Director, IP Industries, Mr. Prashant Hegde, CEO, AgChem Brands, Mr. Eswara Reddy, CIMAP, Dr Sarangthem Indira Devi, IBSD, Dr Sudesh K. Yadav, Director, IHBT, Dr Ajit Kumar Shasany, Director, NBRI, Dr Prabhod Kumar Trivedi, Director, CIMAP, Dr Sangeetha Agarwal, Scientist F, OPSA, and Dr Hafsa Ahmad, Scientist D, OPSA. The discussion also stressed the importance of industry-academia collaboration, large-scale validation, and regulatory alignment to accelerate the adoption of these bio-solutions.



Figure: 3.7.3.1: Technology Transfer event-DIA program

The PRMC meeting for the project titled "Transforming Deep-Science Discoveries into Impactful Innovations for India Discovery to Innovation Accelerator (DIA) Programme" (C-CAMP)

The PRMC meeting for the project titled "Transforming Deep-Science Discoveries into Impactful Innovations for India" under the DIA Programme (C-CAMP) was held on 11 July 2025, in hybrid mode. The meeting was chaired by Dr Gagandeep Kang, Director, Enterics, Diagnostics, Genomics and Epidemiology, Global Health, Bill & Melinda Gates Foundation.

The PRMC, comprising Dr Gagandeep Kang, PRMC Chair Dr Praveen Malik (CEO, Agrinnovate India Ltd.), and Dr Mohd Aslam Former Advisor, DBT reviewed the progress made under the project. The Principal Investigator (PI) of the programme, Dr Taslimarif Saiyed, presented the overall progress of the DIA programme. The Plasma Clean Project successfully developed a compact plasma-based air sanitisation prototype, which efficiently eliminates pathogens from ambient air. Industry engagements have been initiated with Appidi Technologies Pvt. Ltd. and Losma India Pvt. Ltd., with licensing discussions underway. The Skin Cancer Project demonstrated encouraging results in developing a novel peptide with dual intracellular and extracellular activity for targeting tumour microenvironments. A PCT patent was filed in June 2025, and discussions are ongoing with Biocon and Shilpa Biologics Pvt. Ltd. for potential partnerships. The Wound Healing Project showed accelerated and scarless wound healing in diabetic rat models, with PCT filing completed in May 2025. Industry negotiations are progressing with Gowriz Skincare, Shilpa Biologics, and MIM Components.

3.7.4. Interaction meeting with citizens selected under the "Waste to Wealth" category for the At Home Reception at Rashtrapati Bhavan on the occasion of the 76th Republic Day

The citizens selected under the "Waste to Wealth" category for the At Home Reception at Rashtrapati Bhavan visited OPSA for an interaction meeting with PSA Prof. Sood on 27 January 2025. The meeting was also attended by Dr Parvinder Maini, Scientific Secretary, Dr Monoranjan Mohanty, Adviser, and Dr Hafsa Ahmad, Scientist, from OPSA. This gathering provided a platform for innovative start-ups to present their impactful initiatives, fostering collaboration and discussions about sustainable solutions.

Ten innovative start-ups, including BatX Energies, Craste Pvt Ltd, Strawcture Eco, Zerocircle, Paving+, Liqsure Systems, Sea6, Recyclekaro, PadCare, and Bioprime participated during the meeting, showcasing their impactful contributions across diverse areas such as lithium-ion battery recycling, upcycling crop residue into sustainable products, developing ocean-safe materials, repurposing plastic waste into eco-friendly building materials, and advancing sustainable water treatment technologies. Other initiatives included pioneering solutions for e-waste recycling, promoting sustainable menstrual hygiene management, supporting marine agriculture, and creating biological products to enhance climate-smart farming.



Figure: 3.7.4.1: Startup's representatives nominated as 'eminent citizens' under Waste to Wealth category for the 76th Republic Day At-Home Reception with the PSA & Scientific Secretary, OPSA



Figure: 3.7.4.2: At Home Reception at Rashtrapati Bhavan

3.7.5. The first Project Review and Monitoring Committee (PRMC) meeting for the project titled "Developing a Life Cycle Assessment (LCA) Framework for Waste Management Technologies in India" under the Waste to Wealth Mission

The PRMC meeting for the project titled "Developing a Life Cycle Assessment (LCA) Framework for Waste Management Technologies in India" under the Waste to Wealth Mission was held on 11th April 2025 at the Indian Institute of Science (IISc) Bengaluru in hybrid mode. The meeting was chaired by Prof. (Retd.) M. S. Mohan Kumar, Department of Civil Engineering, IISc Bengaluru, and aimed to review the progress made by the Project Implementing Agencies (PIAs) — IISc Bengaluru, Indian Institutes of Technology (IIT) Madras, and IIT BHU.

The PRMC comprised of Prof. (Dr) M. S. Mohan Kumar (Chair), Dr Monoranjan Mohanty (ICAR-IISS, Bhopal), Prof. Ajay Kalamdhad (IIT Guwahati), and Dr Anurag Garg (IIT Bombay), among others. from IIT Madras (Dr. Indumathi Nambi & Dr R. Vinu), IISc Bengaluru (Dr G. L. Sivakumar Babu & Dr H. Chanakya), and IIT BHU (Dr R. S. Singh & Dr Ravi Jaiswal), along with their teams participated in the meeting.

The key outcomes of the meeting included a collective agreement to align all PIA activities with the LCA framework recommendations, organise interactive workshops with Urban Local Bodies and informal waste sector representatives, and develop a comprehensive national policy report based on the project's conclusion. The PRMC also recommended integrating real-time municipal data into IIT Madras's application, refining methodologies for waste characterisation, and expanding scenario studies by IISc Bengaluru to compare Bio-CNG and conventional fuel systems.

The Second PRMC Meeting of Developing LCA Framework for Waste Management Technologies in India under Waste to Wealth Mission

The second PRMC meeting of the project titled "Developing a Life Cycle Assessment (LCA) Framework for Waste Management Technologies in India" was held on 29 September 2025 in virtual mode. The meeting, chaired by Prof. (Retd.) M. S. Mohan Kumar, Department of Civil Engineering, IISc Bengaluru, was convened to review the progress made by the three PIAs — IIT Madras, IISc Bengaluru, and IIT BHU — and to discuss the standardisation of methodologies, data-sharing mechanisms, and next steps towards developing a robust national LCA framework.

IIT Madras demonstrated the Greenhouse Gas (GHG) Calculator App tailored for Indian conditions and nearing completion; IISc Bengaluru presented detailed LCA results identifying biomethane production as the most environmentally and economically viable option; and IIT BHU showcased studies on legacy waste management and torrefaction technologies. The PRMC recommended integration of India-specific emission factors, dataset sharing across institutes, and standardised data templates to ensure uniformity.

Review Meeting of "Developing LCA Framework for Waste Management Technologies in India"

A review meeting of the project "Developing LCA Framework for Waste Management Technologies in India" was held on 18 November 2025 under the chairpersonship of PSA Prof. Sood. The meeting reviewed progress made by the three PIAs, (IISc Bengaluru, IIT Madras, and IIT BHU), covering technology wise LCA findings, city-level data collection, and development of a web-based GHG calculator. Key issues discussed, included the need for India-specific emission factors, standardised data reporting formats, improved waste segregation, and user-friendly digital tools to support decision-making by urban local bodies. The Chair emphasised timely comple-

tion of remaining activities, harmonisation of methodologies across teams, and formulation of clear, data-backed short- and medium-term recommendations for nation-wide adoption.

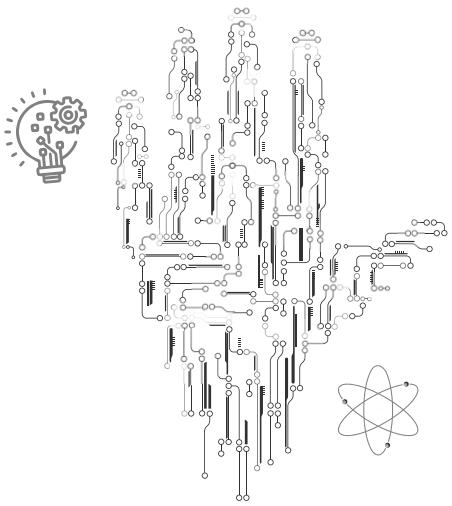


Figure 1.1.5: Review Meeting on "Developing a Life Cycle Assessment (LCA) Framework for Waste Management Technologies in India"

Knowledge Creation & Synthesis

04

As this interconnected ecosystem matures, it generates a wealth of data and experience that the Office captures to fuel future foresight. This role involves the deep synthesis of research and policy analytics to understand where the world is heading next. By producing documents on strategic autonomy and long-term roadmaps like the MegaScience Vision 2035, the Office transforms raw information into a repository of national intellect. This cycle of knowledge creation ensures that our previous actions inform our future plans, ensuring continuous learning. Through publications like Vigyan Dhara, we document this intellectual capital, providing the analytical scaffolding required for the nation to stay ahead of the curve and maintain its technological sovereignty.



4.1 Research & Tech Policy Analysis

4.1.1. AI White Papers

Technology Policy (AI Policy)

AI Policy Priorities for India - White Paper Series: As part of the broader efforts to advance India's AI Policy and governance landscape, the Office has identified nine emerging AI policy priority areas for the country. Detailed information about AI and its policy roundtables are mentioned in Chapter 2 of this Anthology. To build on these themes, the office has developed a white paper series - a set of explanatory briefs on India's AI policy and governance priorities. Each paper serves as a platform to foster informed, nuanced, and inclusive discussions within India and with international partners. The first White Paper in the series, focussing on "Democratising Access to AI Infrastructure" was released in December 2025. It highlights the need to treat AI infrastructure as a shared national resource and identifies key enablers such as access to high-quality datasets, affordable computing resources, and leveraging Digital Public Infrastructure (DPI). The Second White Paper titled "Strengthening AI Governance through a Techno-Legal Framework" was published in January 2026 before the AI Impact summit in February 2026. These White Papers have helped stimulate wider and more substantiative discussions at the AI Impact summit. Further, the office is planning White Papers on other identified areas including: "Advancing Indigenous Foundation Models" and "Balancing Data Sovereignty with International Data Interoperability."



Scan QR Code to access the **AI White Papers Report book**

4.1.2. Defining India's Drone Research Priorities

OPSA played a key role in shaping India's national approach to drone technologies by identifying critical research and capability gaps across the drone ecosystem. The Office made a detailed presentation to the Prime Minister's Office outlining priority drone research areas, with a specific focus on component and sub-assembly level dependencies, strategic vulnerabilities, and long-term technology sovereignty. Building on this direction, the Office worked closely with the ANRF to translate these broad deep-technology themes into well-defined and actionable problem statements for the ANRF Drones program. This effort ensured that public research funding was aligned with national priorities, global benchmarks, and future defence and civilian needs, shifting the focus from platform assembly to the indigenous development of foundational drone technologies.

Future Actions and Stakeholder Roles:

Moving forward, the focus will shift toward the rigorous execution of these identified priorities. A key aspect of the future roadmap involves the Ministry of Civil Aviation (MoCA), which will play a critical role in establishing the necessary regulatory corridors and compliance frameworks required to test and deploy these indigenous technologies safely. While OPSA drives the research agenda, MoCA's involvement ensures that scientific breakthroughs are met with an enabling regulatory environment. The envisaged future actions include the launch of targeted "Grand Challenges" for component indigenisation and the establishment of test-beds where developers can validate their systems against global standards.

4.1.3. Inclusivity in STEMM

The Inclusivity in Science, Technology, Engineering, Mathematics and Medicine (STEMM) initiative originated as a knowledge-building exercise informed by extensive deliberations. It was shaped by reflections on the diversity of identities, the plurality of languages and knowledge systems, and the critical role of disaggregated data in understanding inclusivity indicators.

Inclusivity-STEMM-SARF:

To make this knowledge exercise actionable, the Inclusivity in STEMM Self-Assessment and Reporting Framework (SARF) was developed by the Office. This framework aims to identify and evaluate institutional efforts in critical areas such as gender equity, support for historically underserved groups, plurality in knowledge, languages, and perspectives, and the promotion of just and open science. Recognising the unique characteristics of India's STEMM ecosystem, the framework moves beyond a 'one-size-fits-all' approach. It draws from global best practices while tailoring them to India's specific needs through both conceptual and contextual understanding. Ultimately, this framework envisions serving as a toolkit for institutions and decision-makers, offering insights into key enablers and challenges in STEMM inclusivity. By doing so, it can foster evidence-based decision-making, helping to create a more inclusive scientific landscape.

Expert consultation:

The Inclusivity-STEMM-SARF was evolved through multiple written and in-person consultations.

A roundtable was conducted on 8 January 2025 under the chairship of the Scientific Secretary, Dr Parvinder Maini, for thematic brainstorming involving experts from government, academia, think tanks, civil society, and industry. Based on the discussion in the expert consultation, the inclusivity in STEMM self-assessment and Reporting Framework was further refined.

Inclusivity-STEMM-SARF:

To make this knowledge exercise actionable, the Inclusivity in STEMM SARF was developed by the office. This framework aims to identify and evaluate institutional efforts in critical areas such as gender equity, support for historically underserved groups, plurality in knowledge, languages, and perspectives, and the promotion of

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just and open science. Recognising the unique characteristics of India's STEMM ecosystem, the framework moves beyond a 'one-size-fits-all' approach. It draws from global best practices while tailoring them to India's specific needs through both conceptual and contextual understanding. Ultimately, this framework envisions serving as a toolkit for institutions and decision-makers, offering insights into key enablers and challenges in STEMM inclusivity. By doing so, it can foster evidence-based decision-making, helping to create a more inclusive scientific landscape.



Figure: 4.1.3.1 Expert consultation on Inclusivity-STEMM-SARF at Vigyan Bhawan Annexe on 08 January 2025

In the expert consultation, the inclusivity in STEMM Self Assessment and Reporting Framework was further refined.

After the expert consultations, the draft framework was opened for public consultation until 15 April 2025, after which the framework was finalised for its uptake.

Public Consultation:



Figure. 4.1.3.2 Announcement for the public consultation on the draft Inclusivity-STEMM-SARF by OPSA

High-level meeting: OPSA convened a high-level meeting on 28 May, 2025, to discuss the operationalisation of the framework. Chaired by PSA Prof. Sood, the meeting was joined by Dr R. Balasubramaniam, Member (HR), Capacity Building Commission; Shri Vineet Joshi, Secretary, Department of Higher Education; Dr Parvinder Maini, Scientific Secretary, OPSA; and Dr Amit Dutta, Director, Policy & Academic Planning Bureau, All India Council for Technical Education. During this meeting, it was decided that the SARF exercise is to be taken up for implementation jointly by OPSA, the Capacity Building Commission (CBC), the Department of Higher Education (DHE), and the All India Council for Technical Education (AICTE).



Figure. 4.1.3.3 Discussion on Operationalisation of the Inclusivity in STEMM Self-Assessment and Reporting Framework in partnership with DHE, CBC, and AICTE.

Operationalisation of the framework:

Key decisions to operationalise the Inclusivity-STEMM-SARF initiative were taken during the leadership level meeting. It was decided that a Self-Assessment and Reporting Framework will be piloted with an appropriate pilot strategy jointly with DHE. A capacity-building module on inclusivity in STEMM will be co-developed with CBC. To oversee and coordinate these efforts, a joint working group comprising representatives from the OPSA, DHE, CBC, and AICTE is being constituted.

Survey Instrument for the Pilot:

A 35-question survey, divided into five thematic sections, has been designed on the 'Survey Monkey' platform for piloting with select Higher Education Institutions (HEIs). This tool aims to capture institutional practices and perceptions around inclusivity in STEMM.

Capacity-Building Course:

Under the Karmayogi Bharat platform, two training modules for civil servants are being developed for awareness and sensitisation at the leadership level. Module 1 of the course introduces the concept of inclusivity, its significance within the STEMM ecosystem, and its relevance in the Indian context. Module 2 provides an in-depth understanding of the Inclusivity-STEMM-SARF, its objectives, and

4.1.4. Release of Report on 'Evaluation of Innovation Excellence Indicators of Public Funded R&D Organisations'

OPSA launched a comprehensive report titled "Evaluation of Innovation Excellence Indicators of Public Funded R&D Organisations", aimed at benchmarking and enhancing innovation performance across India's publicly funded research ecosystem. The Confederation of Indian Industry (CII) and the Center for Technology, Innovation, and Economic Research (CTIER) served as knowledge partners for this study, contributing their expertise to strengthen the assessment framework.

The report was formally unveiled by PSA Prof. Sood, during the 15th CII Global Innovation and IP Summit 2025 held on 29 April 2025 in New Delhi. The launch also witnessed the presence of Dr Parvinder Maini, Scientific Secretary, OPSA, along with senior industry leaders, researchers, and representatives from academia and industry.

The study presents a pioneering framework to evaluate innovation capacity and impact, developed through extensive engagement with stakeholders and supported by rigorous data analysis. This exercise reflects the Government of India's continued commitment to fostering excellence, accountability, and innovation within publicly funded research and development institutions. The study saw participation from over 240 R&D organisations across 21 Ministries.

The evaluation framework focused on six key dimensions - research output and quality, technology transfer and commercialisation, collaborations and industry engagement, intellectual property generation, societal and policy impact, and human resource development and capacity building. These indicators were designed to provide a holistic view of innovation performance across institutions. The report is expected to serve as a reference for scientific ecosystem stakeholders and decision makers as they align with the vision of making India a knowledge and innovation powerhouse. The report may be accessed at the given QR Code.

Scan QR Code to access the **Report**





Figure. 4.1.3.4 Glimpses from the launch of report entitled 'Evaluation of Innovation Excellence Indicators of Public Funded R&D Organisations' at the 15th CII Global Innovation and IP Summit 2025

4.1.5. Research & Innovation Policy Analytics

Under this initiative, analytical and mapping exercises are undertaken to generate insights and provide advisory support to ministries, departments, and agencies on science, technology, research, and innovation policy issues. The work focuses on developing actionable inputs based on both global and national assessments of programmes, initiatives, policy incentives, and innovation ecosystems. Key activities include:

Small Business Deep Tech Innovation Grant:

The Office has contributed in conceptualising the proposed ANRF's Small Business Deep Tech Innovation Grant (SBDIG) in terms of mapping the life cycle and benchmarks of various Deep Tech Programmes. The exercise involved mapping various Deep Tech programmes and initiatives implemented by ministries, departments, and government agencies to identify the financial outlay, stakeholder group, targeted value chain component of the Deep Tech ecosystem, and the nature of the programme.

Based on this analysis, a visual representation was developed to illustrate the positioning of these programs across the Deep Tech startup life cycle, enabling a clearer understanding of ecosystem coverage and potential gaps.

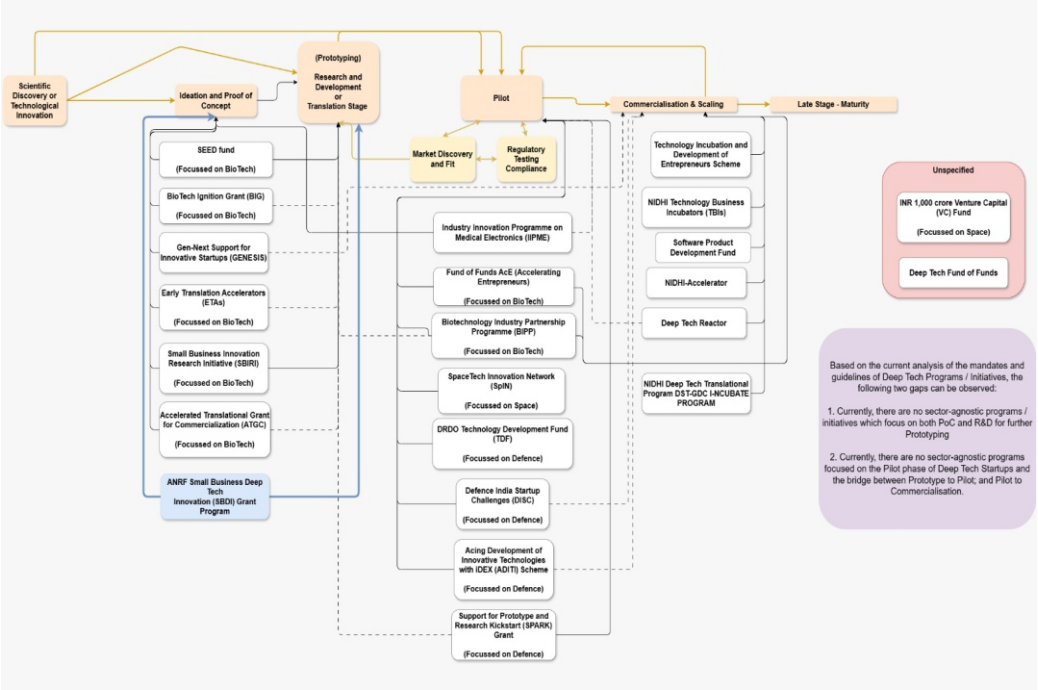


Figure: 4.1.5.1 Deep Tech Startup lifecycle mapping with government programs

National Deep Tech Startup Action Plan:

The Office has been advocating policy and programmes level interventions to strengthen Deep Tech Startup ecosystem in the country, in alignment with Hon'ble Prime Minister's clarion call of making India a Product Nation. In this regard, a set of interventions as part of the National Deep Tech Startup Action Plan was proposed and discussed with Hon'ble Minister of Commerce & Industry, Mr. Piyush Goyal and senior officials of Department for Promotion of Industry and Internal Trade (DPIIT) on 16th June, 2025. Accordingly, the proposed interventions on (a) Operationalising Deep Tech Fund of Funds, (b) Establishing Deep Tech Regulatory Sandboxes, (c) Synergising IP Regime and (d) "First Buyer" Procurement Policy are currently under consideration for its implementation. Especially with the proposed Startup India Fund of Funds 2.0 Scheme, the Office's insights have been shaping the operational aspects of Alternate Investment Funds (AIFs), including the aspects of (a) separate budget allocation for Deep Tech startups, (b) adopting a comprehensive definition of Deep Tech startups and its scope, (c) managing foreign investments in Deep Tech, (d) linking FFS 2.0 with the Deep Tech Fund of Funds, (e) establishing regulatory sandboxes and (f) developing common, shareable high-end technology and research facilities to support the ecosystem.

4.1.6. India's Science, Technology, and Innovation (STI) ecosystem analytics

This is an exercise by OPSA to capture India's international STI engagements with key partner countries. Under this initiative, the India-United Kingdom Science, Technology, and partnership (IUK-STP) dashboard is an effort by the Office towards demonstrating the partnership between India and the United Kingdom under the STI umbrella, by getting insights through joint projects undertaken by the two countries. A total of 148 projects that have been initiated from either side are added on the dashboard. The IUK-STP dashboard drives informed policy decisions by analysing project funding flows and technological areas of cooperation between the two countries, helping policymakers to identify strengths, gaps, and emerging areas to prioritise. The dashboard also strengthens collaboration and alignment as both the countries can coordinate more effectively, avoid duplication, and focus resources on shared strategic priorities or under-researched areas.

The pilot version of the IUK-STP Dashboard was unveiled on 4 November 2025 by PSA Prof. Sood and Dr David Warren Smith, National Technology Adviser to the UK, during a bilateral meeting held at Bharat Mandapam, New Delhi. The pilot dashboard maps projects by funding value, implementing partners, and funding agencies from both countries.

Project mapping is further aligned with the objectives of the India–UK Science and Innovation Council (SIC), the 17 Sustainable Development Goals (SDGs), and broad areas of technological cooperation, to assess strategic alignment and synergy with high-level bilateral priorities.

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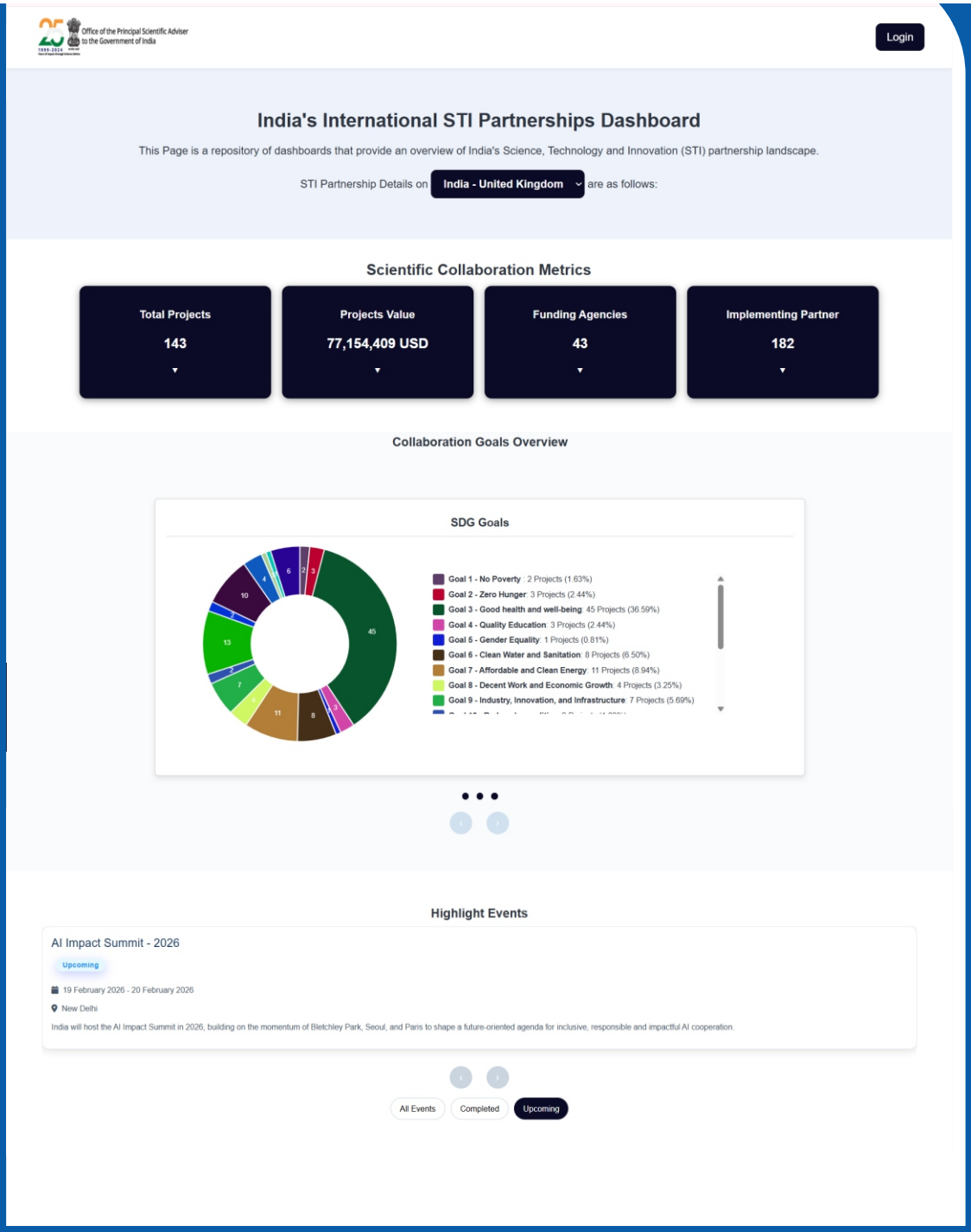


Figure 4.1.6.1 : Infographic showcasing India-UK Science, Technology, and Innovation (IUK-STI) Dashboard

4.1.7. Analysis of Industrial R&D Expenditure

The OPSA undertook an initiative to analyse industrial research and development (R&D) performance in the country. As part of this initiative, a study covering 1,000 listed companies was conducted in partnership with the Indian Institute of Corporate Affairs (IICA). As a follow-up, the Office carried out an extended analysis of industrial R&D expenditure, mapping R&D spending across 600 firms in India. This follow-up exercise complemented the IICA study and was undertaken to develop a more comprehensive understanding of industrial R&D activity. The analysis provides a systematic assessment of industrial R&D expenditure in India, including a detailed mapping of its distribution across firms and sectors.

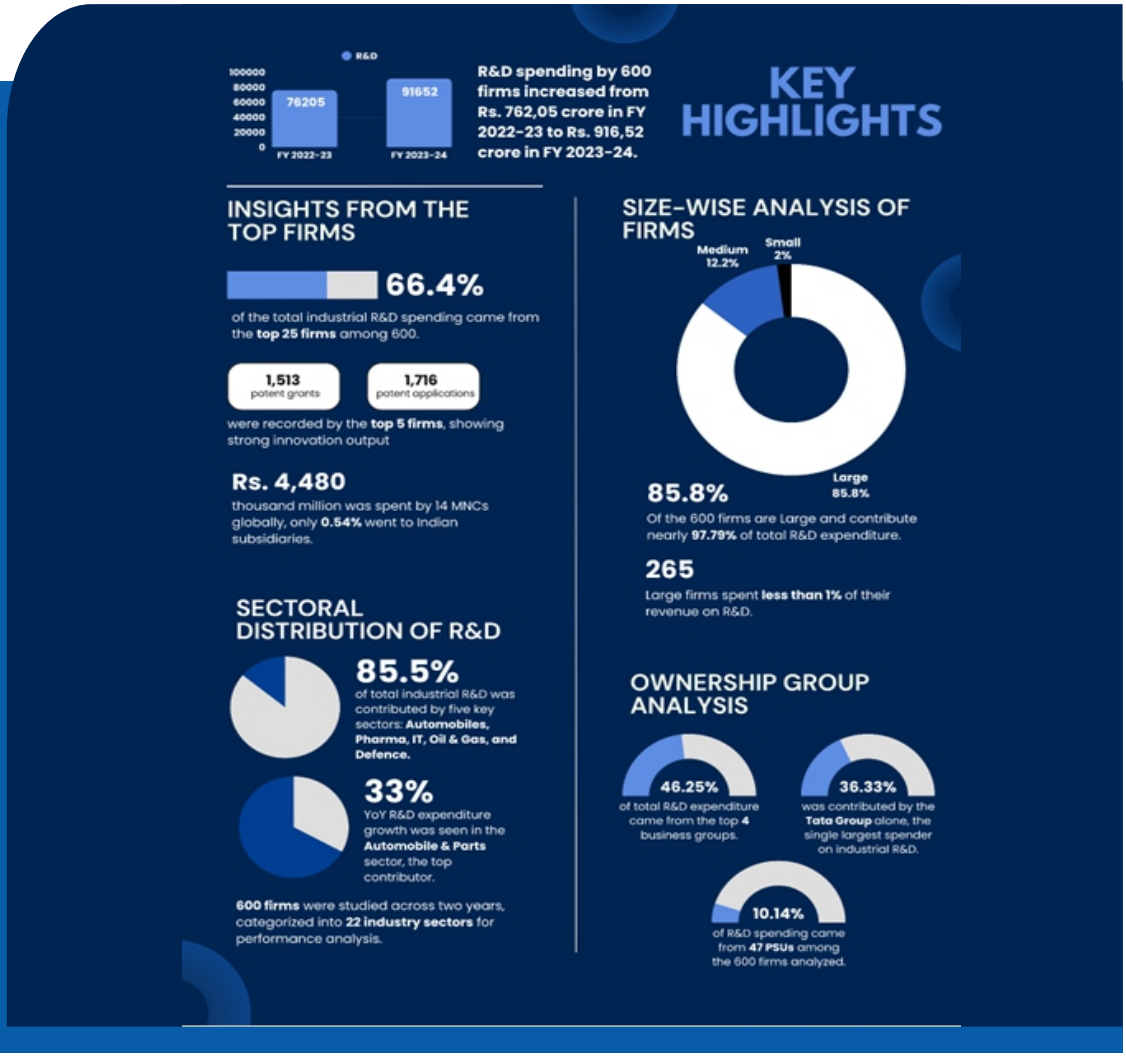


Figure 4.1.7.1 : Industrial R&D expenditure study

The findings of the study reveal a pronounced concentration of R&D investment among a limited number of large firms and within a few key sectors. This concentration points to an underutilisation of India's overall innovation capacity by many domestic companies, certain industrial sectors, and foreign multinational corporations (MNCs). For instance, the study found that the Indian subsidiaries of global MNCs report a negligible fraction of their parent companies' worldwide R&D activities in India. Notably, approximately 80% of industrial R&D spending is accounted for by the top 600 R&D spending firms.

Five key sectors, namely pharmaceuticals & biotechnology, automobiles & parts, information technology, aerospace & defence, and oil & gas, dominate India's industrial R&D landscape. The study concludes with key insights and policy recommendations aimed at enhancing data transparency, implementing strategic policy reforms, and introducing targeted incentives. These measures are essential for strengthening India's industrial R&D ecosystem, narrowing the innovation gap, and advancing the country's aspirations to emerge as a global leader in science and technology.

4.1.8. Gross Domestic Knowledge Product (GDKP)

India is among the pioneering countries advancing statistical frameworks to meaningfully measure economic activity emerging from knowledge products. In this pursuit, in addition to existing macro-level measures such as Gross Domestic Research and Development (GDR) and Gross Expenditure on Research and Development (GERD), etc., efforts are underway to develop a framework for measuring Gross Domestic Knowledge Product (GDKP). OPSA, in collaboration with the Ministry of Statistics and Programme Implementation (MoSPI) and other key stakeholders, is involved in conceptualising this framework.

On 10 February 2025, a National Brainstorming Session on "Conceptual Framework of Gross Domestic Knowledge Product (GDKP) Measurement" was organised by the National Accounts Division of the MoSPI. The session was chaired by PSA Prof. Sood and attended by representatives of Ministries, Industry associations, and NGOs. The session was aimed at discussing the existing framework of measuring knowledge products within the Gross Domestic Product (GDP) and to deliberate on the conceptualisation of a fresh approach to measure India's Knowledge Economy. Delivering the keynote address, Prof. Sood elaborated on the significance of transitioning from traditional economic indicators to a knowledge-centric measurement approach. He emphasised that a refined methodology for GDKP would better capture the contributions of knowledge-driven sectors, innovation, and intellectual assets to India's economic growth.

GDKP is a concept that measures the economic value of a country's knowledge production and use. It is an alternative or complementary metric to GDP, focusing on the contribution of knowledge-intensive sectors, innovation, research, education, and technology to the economy. Broadly, there are four aspects of knowledge in an economy: the knowledge items, the knowledge producers, the knowledge distributors, and the knowledge users (consumers and enhancers).



(PIB Press release can be accessed here https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=2101439)

Figure 4.1.8.1 : Brainstorming Session chaired by Prof. Ajay Kumar Sood on "Conceptual Framework of GDKP Measurement"

Current approaches of measuring knowledge production as part of Gross Fixed Capital Formation (GFCF) was discussed in this brainstorming. It was noted that all expenditures on Intellectual Property Products (IPP) are currently recorded under GFCF, which serves as a key indicator of knowledge production. The Office has further contributed to this GDKP exercise by providing input on the sectors to be considered while measuring the knowledge economy, and a list of possible knowledge indicators (including proxy measures). It is expected that in the long-run, these exercises would help frame a pragmatic measurement framework for estimating the country's knowledge economy.

The Press Release can be accessed on the given QR.

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4.1.9. Strategic Autonomy and Technology Sovereignty

The OPSA has launched an initiative on technology sovereignty for India to provide indicative pathways for strategic autonomy in critical technologies. Given the rapid pace of technological advancements and the competitive nature of technologies, building technology sovereignty in key critical technology areas is essential. To this effect, an exercise was carried out for the identification of critical and emerging technologies (CETs) for India and their analysis through a systems thinking approach was carried out. Through this initiative, the Office aims to map the existing gaps in the technology ecosystem and further derive the way forward to strengthen the technology sovereignty and strategic autonomy for India.

a. Technology Sovereignty in UAVs: As a demonstrative case example, technology sovereignty exercise for Unmanned Aerial Vehicles (UAVs), as one of the CETs, was undertaken:

I. A mapping of the Indian UAV technology value chain was prepared by undertaking a block-level analysis of the UAV technological system. The mapping elucidated key insights including (a) the presence of heavy dependency in raw materials, (b) the growing UAV market in India and (c) the need for technology indigenisation in the UAV ecosystem.

II. Based on the inputs on the value chain mapping, a study on technology sovereignty in UAVs through a systems thinking approach was carried out. This study analysed the UAV technology ecosystem in India and highlighted the gaps and vulnerabilities that are hindering India's progress towards a technologically sovereign UAV ecosystem. The study employed scientometric indicators as well as a technology-criticality level analysis to pinpoint areas of limited capacity in the UAV technology ecosystem in India. Through this study, the vulnerabilities in the supply chain, R&D, IP competencies, manufacturing ecosystem and policy levers were identified.

4.2. Roadmaps & Reports

4.2.1. S&T Clusters: Year in Review

On 26th June 2025, PSA Prof. Sood launched the "Science and Technology (S&T) Clusters Annual Report 2024-2025" in New Delhi, highlighting key advancements and innovations. The report showcased impactful initiatives, including the deployment of EV charging infrastructure in Delhi/NCR, the development of "Kalaanubhav.in," an AR/VR-driven artisan marketplace, and the "One Delhi" digital transit app, which has already gathered over 3 lakh users. Additionally, breakthroughs in health-tech, such as diabetic foot screening mats, e-waste management systems, and pacemaker lead development at AMTZ Vizag, were featured.

PSA emphasised the importance of inter-cluster collaborations to scale successful regional innovations nationally, while Dr Parvinder Maini, Scientific Secretary, OPSA, underscored the role of industry partnerships in Phase 2.0, critical for aligning scientific research with real-world applications and market demands. The Report can be accessed on the given QR.

Scan QR Code to access the **report book**



Figure 4.2.1. The launch of "S&T Clusters Annual Report 2024-2025 at Vigyan Bhavan Annexe, New Delhi.

4.2.2. Compendiums of S&T clusters

The following Compendiums were released by various S&T Clusters throughout 2025 include:

1. **Compendium on Health:** The Compendium highlights the wide-ranging health initiatives of India's S&T Clusters, spanning pandemic preparedness, One Health and AMR, digital health, deep-tech innovation, and ecosystem strengthening through data-driven surveillance, AI-enabled tools, and translational research. Collectively, these efforts demonstrate scalable, impact-oriented interventions, from public health prediction models and affordable diagnostics to startup support and workforce skilling, aimed at strengthening resilient and inclusive healthcare systems.

2. **Technology Compendium for Energy and Environment:** The Compendium showcases S&T Cluster–led innovations across sustainable waste management and renewables, wastewater treatment, air pollution mitigation, and sustainable mobility and energy transition. Collectively, it highlights impact-driven initiatives, from green hydrogen planning, metro health-impact studies, and AIoT-enabled resource efficiency to blue economy acceleration and sustainable e-waste management, demonstrating the role of cluster-based innovation in advancing environmental sustainability.

3. **STEM Education Compendium:** The Compendium highlights the collective efforts of PKC, BCKIC, RICH, and DRIIV in advancing STEM pedagogy, capacity building, and career pathways through teacher training, fellowships, mentorship programmes, innovation initiatives, and youth outreach. Recent cluster-led interventions, including STEM gamification, AI skilling, executive training, inclusive internships, and school-level innovation programmes, demonstrate a sustained commitment to fostering innovation, entrepreneurship, and interdisciplinary learning across diverse communities.

4. **Compendium on Livelihood Through S&T:** The Compendium showcases how JCKIC and BCKIC are leveraging science and technology to strengthen local and rural

livelihoods through market access, value addition, and capacity building. Key initiatives include JCKIC's Kalaanubhav D2C platform and IP protection for artisans, alongside BCKIC's water, agriculture, processing, and entrepreneurship programmes, such as the ROSHNI initiative, demonstrating scalable, community-centred livelihood models.

5. **Compendium for North-East & Industry 4.0:** The Compendium highlights cluster-led initiatives leveraging Industry 4.0 digital technologies to strengthen the North-East's innovation ecosystem through startup support, regional innovation hubs, and climate-, infrastructure-, and biodiversity-focused solutions. Complementing these efforts, programmes such as IGNITE and SPARKS have accelerated deep-tech innovation through early-stage funding and technology commercialisation, reinforcing cluster-driven, market-oriented growth.

6. **Compendium on Agri-Tech Startups:** The Compendium highlights how RICH, BCKIC, and BeST Clusters are leveraging science and technology to address region-specific agricultural challenges through research translation, biodiversity conservation, agri-waste valorisation, and precision farming solutions. Collectively, these initiatives, spanning startup databases, pilot deployments, policy support, and inter-cluster collaboration, aim to enhance productivity, farmer incomes, and food security through scalable agritech innovation.

7. **Agri-Tech in Action:** The Agritech Solutions Compendium highlights the rapid evolution of India's agritech ecosystem, showcasing science- and technology-driven innovations from climate-smart and bio-based solutions to precision farming and deep-tech tools that address resource constraints and climate challenges. Featuring market-ready and field-tested technologies, it underscores the role of innovation in enhancing productivity, optimising resource use, and empowering farmers towards a resilient, future-ready agriculture sector.

8. **Technologies Empowering Livelihood Compendium:** It highlights the role of digital interventions in transforming traditional artisan livelihoods by improving market access, visibility, and income opportunities. Showcasing the

Kalaanubhaav platform, it underscores how technology-driven, direct-to-consumer models are enabling inclusive economic growth and building resilient, future-ready artisan communities.

9. **Technology Compendium on Solid Waste Management:** The Compendium highlights the growing role of science and technology in addressing India's waste challenges through innovations in recycling, AI- and IoT-enabled systems, and advanced resource recovery. Featuring market-ready and field-tested solutions, it underscores the sector's progress towards efficient waste management and a resilient, future-ready circular economy.

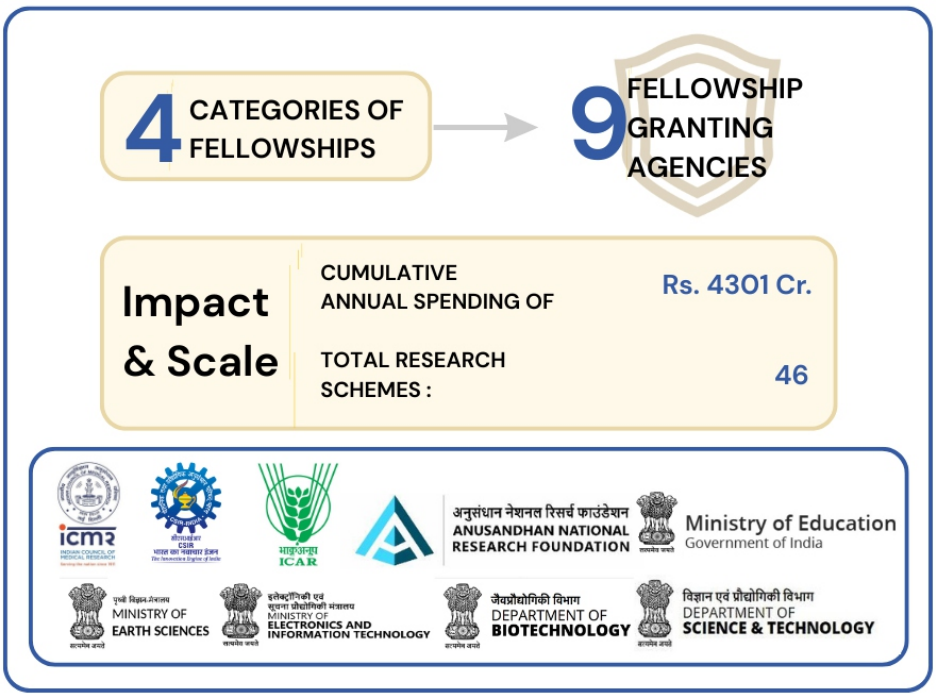
10. **Compendium of Water Technologies:** The Compendium highlights science- and technology-led innovations addressing India's water challenges, ranging from watershed restoration and nature-based solutions to IoT, remote sensing, and AI-driven analytics. Showcasing market-ready and field-tested technologies, it underscores efforts to enhance water security, optimise resource use, and build resilient, sustainable water systems.

Scan QR Code to access the **Science and Technology Clusters Website** and the published **Compendiums.**

4.2.3. Analysis of Fellowship

The Office undertook an exercise to map and analyse PhD and Postdoctoral fellowship schemes offered by nine Government of India Ministries and departments, namely the Anusandhan National Research Foundation (ANRF), Council of Scientific and Industrial Research (CSIR), Department of Biotechnology (DBT), Department of Higher Education, Ministry of Education (DHE), Department of Science and Technology (DST), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Ministry of Electronics and Information Technology (MeitY), and the Ministry of Earth Sciences (MoES). The analysis examined fellowship amounts, associated grants (where applicable), number of beneficiaries, and total annual expenditure for the financial years 2023–24 and 2024–25. An inter-ministerial meeting was convened on 18 November 2025 under the chairmanship of PSA Prof. Sood, bringing together representatives of the concerned ministries and departments to identify redundancies, explore standardisation of compensation, and consider the consolidation of overlapping schemes to improve coherence and efficiency.

Snapshot of Analysis



4.2.4. e-Mobility R&D Roadmap

Electric mobility or e-mobility plays a vital role in India's approach to sustainable transportation and clean energy. E-mobility adoption is focused on reducing dependence on fossil fuels, cutting emissions, and boosting domestic EV manufacturing. Initiatives such as the National Electric Mobility Mission Plan (NEMMP) 2020, FAME-II, the Production Linked Incentive (PLI) Scheme for Advanced Chemistry Cells, the Green Hydrogen Mission, and the PM-Electric Drive Vehicle Incentive and Ecosystem (PM-E-DRIVE) are driving this transformation. These programmes offer both demand- and supply-side incentives, along with support for manufacturing and indigenous technology development, creating a strong foundation for the growth of various segments within the EV ecosystem.

Adoption of e-Mobility is crucial for India to meet its 2070 Net Zero commitment and to achieve energy security by reducing dependence on imported fuels, which is a key aspect of the Viksit Bharat vision. The status of key enablers for e-Mobility in India presents a mixed picture. On the policy front, demand incentives, regulatory actions, Product Linked Incentives, and taxation concessions have significantly supported adoption in the 2W, 3W, and bus segments. Translational research is progressing well for 2W, 3W, cars, and bus segments. India will have all the capabilities in the coming 3 to 4 years, thanks to various government and Industry initiatives and market potential. However, adoption of zero emission trucks, both electric and fuel cell, is yet to gain requisite momentum. Notably, nearly 40% of fuel consumption and transport emissions in India come from long-distance trucks, special focus on Zero Emission Trucks will help India achieve faster and bigger achievements towards its Net Zero commitments. In this context, the electrification of freight transport, particularly through the adoption of Zero-Emission Trucks (ZETs), is recognised as a critical and transformative pathway to reducing greenhouse gas emissions, improving air quality, and strengthening the nation's energy security.

OPSA has undertaken several initiatives in 2025 to demonstrate a comprehensive, whole-of-government approach aimed at developing India's electric mobility ecosystem. There have been consistent efforts towards effective integration of

policy, research, and industry collaboration to overcome key challenges related to technology readiness, infrastructure expansion, supply chain robustness, and environmental sustainability. Through evidence-based insights OPSA has established a strong foundation for electrifying India's road freight sector and accelerating the adoption of ZETs.

Constitution of the Core Group on e-Mobility (CGeM)

In line with the vision of Viksit Bharat 2047 and the national target of Net Zero emissions by 2070, OPSA established the Core Group on e-Mobility (CGeM) on 12 August 2022, comprising experts from Government, academia, and industry. The CGeM developed various Technical Roadmaps and Documents to advance: (a) Zero-Emission Truck (ZET) deployment, (b) Indigenous technology development through an R&D Roadmap, (c) Technical roadmap for field research and (d) Policy advisory to create enabling policies and drafting regulatory frameworks. The CGeM was reconstituted in April 2025 with newer mandates and responsibilities. The composition of the CGeM is as follows:

Advisory Committee

The Advisory Committee, chaired by PSA Prof. Sood provides overall strategic direction and policy oversight to the CGeM. The Committee supports the formulation and execution of national initiatives in electric mobility, ensures inter-ministerial coordination, and aligns research activities.

Working Committee

The Working Committee, chaired by Dr Preeti Banzal, Advisor/Scientist 'G', OPSA, serves as the operational and technical arm of the CGeM. It comprises 10 experts from premier academic institutions, national research centres, and industry, and is responsible for implementing CGeM's strategic directives, reviewing ongoing projects, and guiding the preparation of key reports and studies. Prof. Karthick Athmanathan, PSA Fellow, OPSA and adjunct faculty IIT M co-chairs the committee.

Technical Research Project on ZET

The OPSA has not only released documents, roadmaps, and reports but is also consistently engaging with stakeholder ministries, acade-

mia and industry experts to create important pathways to onground actions. OPSA is collaborating with IIT Madras (IITM) as well as ARAI (Automotive Research Association of India), Pune, Nonferrous Materials Technology Development Centre (NFTDC), etc for implementation of action items as identified in our documents and Bharat Policy Advisory Plans.

Further, OPSA in supporting Technical Research Project on Zero Emission Trucking to Centre of Excellence for Zero Emission Trucking (CoEZET), IITM. The proposed project is built on intensive research works related with ZET Technical Road Map (TRM) to provide much needed technical research support to enable the transition to ZET in India.

The project outcome includes:

a. Developing a ZET safety roadmap leading to the identification and creation of safety manuals, materials and communication videos.

b. Standardisation of ZET Batteries for Interoperability.

c. Development of a Driver Rating Application to monitor and promote efficient and safe truck driving.

d. Evaluation of Rare-Earth Magnet-Free Motors for Electric Trucks.

e. Development of a low-cost virtual reality ZET driver trainer.

f. Development of an interactive map to identify potential locations for ZET charge parks.

g. Preparation of a ZET Penetration and Emission Report.

CGeM Workshop on Advancing e-Mobility and Zero-Emission Technologies

A workshop of the reconstituted CGeM was convened on 6 August 2025 to review ongoing initiatives and strengthen coordination for advancing India's zero-emission mobility ecosystem. Key outcomes included the finalisation of the "Landscape Study of e-Drives for Zero-Emission Trucks" report, and development of the Interactive Map for e-Truck Charge Parks. The meeting also reviewed alignment of the e-Mobility R&D Roadmap with national

programmes such as ANRF and Automotive Mission Plan (AMP) 2047, and discussed the advancement of the Battery Aadhaar System developed by CoEZET and ARAI.

The workshop reaffirmed OPSA's commitment to advancing innovation, technology localisation, and coordinated action for achieving Viksit Bharat 2047 and Net Zero 2070 goals.



Figure 4.2.4.1 A workshop of the reconstituted CGeM was convened for advancing India's zero-emission mobility ecosystem.

Milestones

OPSA is consistently working towards greening the trucking sector and has released a series of technical roadmaps, technical study, and technological assessment reports for accelerated adoption of ZET in India. These documents together provide actionable frameworks to address technological, infrastructural, and policy challenges, for early ZET induction as pilots and their respective blueprints for scaled deployment across the country.

Three reports highlighting key priority areas have been released in 2025.

01

Release of the Priority Corridors for Zero-Emission Trucking Report- In May 2025, the report **"India's Priority Corridors for Zero-Emission Trucking"** was released, which presents a detailed assessment for the deployment of Battery Electric Trucks (BETs) across the country. The report was prepared under the guidance of the CGeM in collaboration with Centre of Excellence for Zero Emission Trucking (CoEZET), IIT-Madras, and Rocky Mountain Institute (RMI). Over 100 freight corridors were identified and the

top 10 corridors suitable for early BET deployment were selected based on commercial viability, operational feasibility, and infrastructure readiness. The report also provides recommendations on charging infrastructure, grid preparedness, policy support, and fleet planning, offering a structured framework to guide targeted investments, informed policymaking, and large-scale ZET adoption.

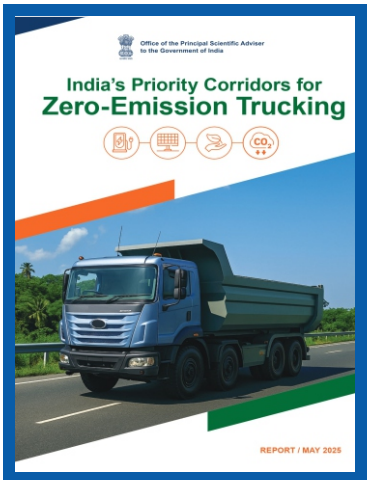


Figure 4.2.4.2 : Report on India's Priority Corridors for Zero-Emission Trucking

Scan QR Code to access the **Report Book**



Figure 4.2.4.3 "India's Priority Corridors for Zero-Emission Trucking" report released in May 2025.

02

ZET Adoption in India and its Impact on Emissions and Energy Report- In July 2025 the report **"ZET Adoption in India and its Impact on Emissions and Energy"** was released, which provides a detailed assessment of BET adoption in India's Medium and Heavy-Duty Truck (M&HDT) segment. The study examines market growth, technology readiness and potential impacts on emissions and energy and identifies BETs as the primary zero-emission technology in the context of current green hydrogen costs and limited infrastructure. The report was prepared by CoEZET IITM, under the guidance of OPSA, with contributions from experts across industry and

academia. The study emphasises the need for fiscal incentives, tailored product offerings and robust charging infrastructure and serves as a key reference for policymakers, industry stakeholders, and investors to support India's transition to sustainable freight transport.



Figure 4.2.4.4 : Report on ZET Adoption in India and Its Impact on Emission and Energy

Scan QR Code to access the **Report Book**

03

Landscape Study of e-Drives for Zero-Emission Trucks-In October 2025 the report **"Landscape Study of e-Drives for Zero-Emission Trucks"** was released which provides an in-depth assessment of traction motor technologies for heavy-duty electric vehicle applications, with a focus on rare-earth-free alternatives to strengthen supply chain resilience and sustainability. The report was prepared by the NFTDC in collaboration with CoEZET, IITM, under the guidance of OPSA. The report was reviewed by the CGeM and experts from industry and academia. The study evaluates Permanent Magnet Synchronous Motors (PMSM), Induction Motors (IM), and Synchronous Reluctance Motors (SynRM) alongside emerging magnet technologies such as AlNiCo, Iron Nitride, and Mn-Al-C. It further examines advancements in Axial Flux and Switched Reluctance Motors (SRM), supported by insights into power electronics, wide bandgap devices, and noise, vibration, and harshness (NVH) performance.

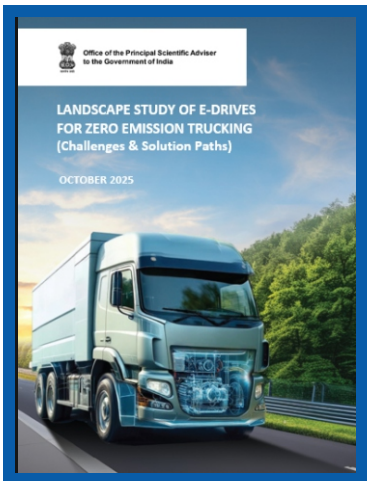


Figure 4.2.4.5 : Report on Landscape Study of E-Drives For Zero Emission Trucking

Scan QR Code to access the **Report Book**

> The report provides actionable recommendations for R&D prioritisation, indigenous manufacturing, and performance optimisation of e-drive systems and supports India's long-term objective of achieving self-reliant and sustainable ZET.

Development of Guidelines for Implementation of Battery Aadhaar System- As part of the e-Mobility R&D Roadmap launched on 16th July 2024, the Battery Aadhaar System was identified as a key priority for India. Accordingly, CoEZET, IIT Madras, and ARAI, developed a unique digital identity for each battery pack, capturing life-cycle data from manufacturing to disposal to ensure traceability, transparency, and accountability across the battery value chain. This unique identity is being termed as Battery Aadhaar.

The Battery Aadhaar as a unique identity number combines alphanumeric codes, QR codes, and a secure server-based database to record static information (manufacturer details, battery specifications, material composition, carbon footprint) and dynamic data (operational parameters and remaining life). This enables access for manufacturers, recyclers, and regulators, supporting real-time monitoring and offline operability.

The MoRTH constituted a committee on 17 September 2025 to formalise its implementation, with representatives from CoEZET and ARAI as technical members. The Battery Aadhaar framework is designed to be scalable, future-ready, and a foundational component of India's digital sustainability infrastructure for e-mobility.

4.2.5. MegaScience Vision 2035

The Government of India (GOI) has been supporting the setting up of national, as well as participation in international, Mega Science Projects for some time now. These projects appeal to the scientific curiosity of researchers in search of answers to some of the important questions facing the world of science and are of interest to a large scientific community from within the country and outside. The Mega Science Projects are very large in terms of outlays and/or the complexity involved, making it necessary for a user group, institution or even individual countries to join hands with other similarly interested partners. Implementation of such projects involves multi-institutional teams, including possible international collaboration.



MSV-2035-High-Energy Physics Report

Scan QR Code to access the **MSV 2035 Report Book**

OPSA India initiated the Mega Science Vision 2035 Exercise to chart the country's mega science roadmap over the 2020-35 time period, covering six broad areas of science and technology: High Energy, Nuclear Physics, Astronomy & Astrophysics, Accelerator Science & Technology and Applications, Climate Research, and Ecology & Environmental Science. Together, these areas represent domains where sustained national and/or international R&D engagements involving large-scale collaborations and investments are essential for scientific progress. The exercise has focused on assessing India's current strengths, identifying emerging scientific opportunities, and outlining pathways for future participation in both national and global Mega Science Projects in these six disciplines.

The year 2035 was chosen to align with the typical planning cycles of comparable international exercises and with the expected timelines for the commissioning, operation, and utilisation of major national and international mega science projects either currently running or under consideration. The MSV-2035

Exercise has been structured to result in a set of detailed roadmap documents, each developed through extensive consultations with the relevant scientific communities and other stakeholders across the country and also with international experts.

As part of this process, several roadmap documents under the MSV-2035 framework have been released following stakeholder consultations. These include reports on Nuclear Physics, Astronomy & Astrophysics, and Accelerator Science & Technology and Applications. In July 2025, a significant milestone was achieved with the release of the Mega Science Vision-2035- "High Energy Physics" report. This Report presents a comprehensive national roadmap for India's engagement in particle physics-related Mega Science Projects in the 2020-35 period. Developed through extensive consultations with the Indian high energy physics community and also with leading international experts, the Report identifies priority scientific questions such as physics Beyond the Standard Model, neutrino properties, the nature of dark matter, etc., and maps these to potential national and international projects where India can play a meaningful and visible role after assessing India's current strengths in theory, experiments, instrumentation, computing, and accelerator science and technology. The Report also highlights the importance of sustained participation in national as well as international mega science projects, together with development of a necessary eco-system in the country for such R&D activities including development of indigenous detector and accelerator technologies, and strengthening of human resource pipelines. Mega Science Projects in High Energy Physics would thus become both a driver of fundamental discoveries and an enabler of development of advanced technologies and skilled manpower in the country.

Read the MSV 2035 High-Energy Physics Report at the given QR code.

4.2.6. NTRAF

To accelerate India's deeptech ecosystem, OPSA has spearheaded the development of the National Technology Readiness Assessment Framework (NTRAF) in collaboration with the Confederation of Indian Industry (CII). This initiative addresses the critical need for a standardised language to articulate technological maturity. Moving beyond subjective assessments, the framework provides a rigorous, evidence-based methodology to measure Technology Readiness Levels (TRL) across diverse sectors. By establishing a clear, objective yardstick for the journey from laboratory proof-of-concept to operational deployment, the NTRAF empowers funding bodies and stakeholders to effectively evaluate risk and catalyse the transition of indigenous innovations into market-ready solutions.

OPSA has further refined this initiative into a comprehensive document and a generic assessment tool that strips away specific agency biases, making it applicable across the entire R&D spectrum. This tool is now positioned as a prerequisite for major funding calls, ensuring that proposals are evaluated on a level playing field. It serves not just as a metric, but as a strategic enabler for the Lab to Market journey, ensuring that public funding is directed toward technologies with genuine deployment potential.

PSA Prof. Sood unveiled NTRAF on 29 December 2025. The launch event was attended by Dr Parvinder Maini, Scientific Secretary, OPSA; and Dr Shivkumar Kalyanaraman, CEO, Anusandhan National Research Foundation (ANRF), Dr Preeti Banzal, Adviser/Scientist 'G', OPSA; Shri Praveen Roy, Head TT, Department of Science and Technology (DST); Dr. Jyoti Sharma, Head RDI, DST, Shri Rohit Gupta, Chief Technology Officer (CTO), OPSA, and other officials from OPSA and Confederation of Indian Industry (CII). The framework was open for public consultation until 31 January 2026.

The NTRAF report can be accessed on the given QR.

Scan QR Code to access the **NTRAF document**



Figure: 4.2.6.1 The National Technology Readiness Assessment Framework was released by PSA Prof. Sood on 29 December 2025.

4.2.7. Strengthening the One Health approach

The first State and Union Territory Engagement Workshop under NOHM that concluded successfully on 9 June 2025, charted a collaborative path forward for strengthening India's integrated One Health approach. The insights and recommendations that emerged from the discussions offered a clear, actionable understanding of the strengths, challenges, and immediate opportunities at the state level. The workshop report featuring the highlights can be accessed at the given QR code.

Scan QR Code
to access the
workshop report

Additionally, a key outcome of the Fourth Meeting of the Scientific Steering Committee on One Health, held on 18 December 2025, was the release of the Model Governance Framework for Strengthening One Health Governance in States and Union Territories. The report can be accessed on the given QR.

To strengthen digital enablement, the One Health Dashboard was launched on 9 June 2025, which provides an integrated, single-window view of initiatives undertaken across central ministries, States/UTs, and partner institutions. Designed to support transparency, coordination, and data-driven decision-making, the dashboard enhances visibility of ongoing activities and outcomes across the human–animal–environment interface. In parallel, the Mission is facilitating the development of One Health e-learning modules, including hosting on the iGOT Karmayogi platform, to enable standardised, scalable capacity building and upskilling of officials and professionals across Ministries, States, and Union Territories.



Figure: 4.2.7.1 Release of the Model Governance Framework for Strengthening One Health Governance in States/UTs during the fourth meeting of the Scientific Steering Commitee

4.2.8. Progress 2025: RuTAG

The RuTAG 2.0 Annual Progress Report 2024-25 was released by PSA Prof. Sood in the presence of Dr Parvinder Maini, Scientific Secretary, OPSA; Dr Rakesh Kaur, Adviser/Scientist 'G'; and senior faculty and officials from IIT Guwahati. The report documents more than 56 ongoing projects addressing rural challenges in agriculture, animal husbandry, post-harvest management, renewable energy, textiles, and rural crafts, among others. It highlights technologies that have progressed to prototype development and field deployment, providing an overview of outcomes achieved under RuTAG 2.0 during 2024-25.

Scan QR Code to read the **Press Release**



Figure: 4.2.8.1: Release of the RuTAG 2.0 Annual Progress Report 2024-25

4.3. Vigyan Dhara

Vigyan Dhara is a thematic magazine series produced by OPSA The magazine brings together insights and developments across diverse themes in science, technology, and innovation (STI), while highlighting significant national initiatives, policy perspectives, and achievements within India's STI ecosystem.

Originally conceived as a newsletter, Vigyan Dhara transitioned into a magazine in OPSA 25th year, with the release of a special commemorative issue in June 2025 marking this milestone. This transition reflects the Office's evolving approach to science communication and its commitment to presenting deeper, thematic, and more accessible narratives on STI. The magazine focuses on key subjects shaping the STI landscape and aims to inform and engage a broad readership, including the general public, the scientific community, policymakers, and government functionaries. Through expert perspectives, interviews, and thematic explorations, it seeks to build awareness of science-led development pathways. In 2025, four editions of the magazine were released:

This edition was dedicated to the National One Health Mission (NOHM), encapsulating India's growth in the global One Health movement. The issue highlighted the mission's holistic approach to integrating human, animal, and environmental health. It featured a rich array of perspectives from experts on the role of NOHM in transforming integrated health outcomes, covering the mission's inception, governance framework, and advisory committees. Highlights included feature stories on Gujarat's innovations, Kerala's governance model, and the role of the Gujarat Biotechnology Research Centre, alongside a case article on using the One Health approach to decipher the Nipah Virus in Kerala.



Figure 4.3.1
March 2025 | Theme: "A Vision for a Healthier, Sustainable Future"

Scan QR Code to access the **Magazine**

This special commemorative edition celebrated the 25th anniversary of the Office of the PSA. It opened with a Foreword by PSA Prof. Ajay Kumar Sood, emphasising the strategic and systemic approach to science advice, followed by reflections from Scientific Secretary Dr Parvinder Maini on the future outlook of the field. The edition traced the evolution of science advice mechanisms in India and provided a comparative international perspective on global advisory frameworks. Key articles showcased the Office's role in driving major initiatives, including the National Knowledge Network (NKN), the EV Mission, and National Missions for Quantum, AI, and Deep Ocean research. The issue also explored stakeholder-driven solutions through RuTAG and underscored the Office's role in shaping the research landscape through I-STEM, One Nation One Subscription (ONOS), and the Anusandhan National Research Foundation (ANRF).



Figure 4.3.2
June 2025 | Theme: "Celebrating 25 Years of Impact through Science Advice"

Scan QR Code to access the **Magazine**

Dedicated to the journey and strategic significance of AI, this edition featured a Foreword by PSA Prof. Ajay Kumar Sood on positioning India competitively in the global AI landscape. The issue explored the evolution of AI and provided insights into India's AI ecosystem through an interview with the CEO of the IndiaAI Mission. Articles covered national policy priorities, the impact of AI across sectors, including healthcare, education, and climate resilience, and the potential of Digital Public Infrastructure (DPI) for AI. The edition also examined AI's role in arts and heritage and concluded with a preview of the upcoming AI Impact Summit scheduled for February 2026.

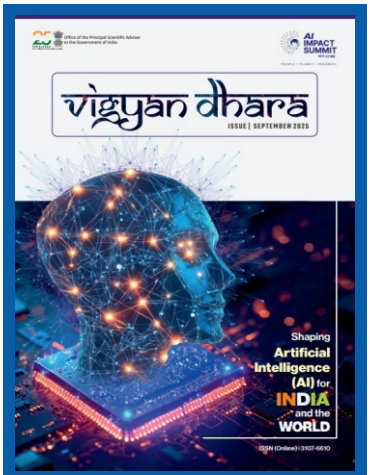


Figure 4.3.3
September 2025 | Theme: "Shaping Artificial Intelligence (AI) for India and for the World"

Scan QR Code to access the **Magazine**

Released during the International Science & Technology (S&T) Clusters Conference in New Delhi, this edition provided a comprehensive view of India's rapidly developing drone ecosystem. It opened with a Foreword by PSA Prof. Ajay Kumar Sood highlighting the industry's evolution and policy direction. The issue mapped India's "drone decade" through key milestones and analysed the economic dimensions of the sector, including market forecasts and employment opportunities. It examined regulatory progress and the expanding R&D ecosystem while showcasing deep-tech innovations. The volume also featured an interview with the DRDO Chairman and expert insights on national security, swarm capabilities, and essential considerations regarding safety, cybersecurity, and ethics in UAV systems.

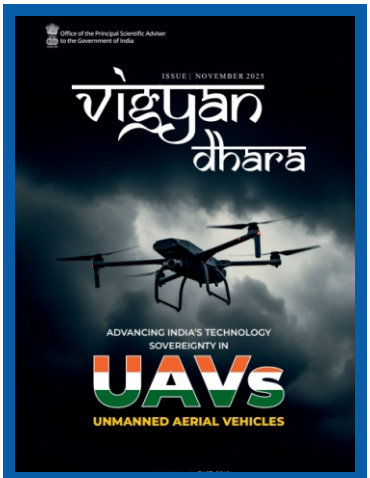


Figure 4.3.4
November 2025 | Theme: "Advancing India's Technology Sovereignty in Unmanned Aerial Vehicles (UAVs)"

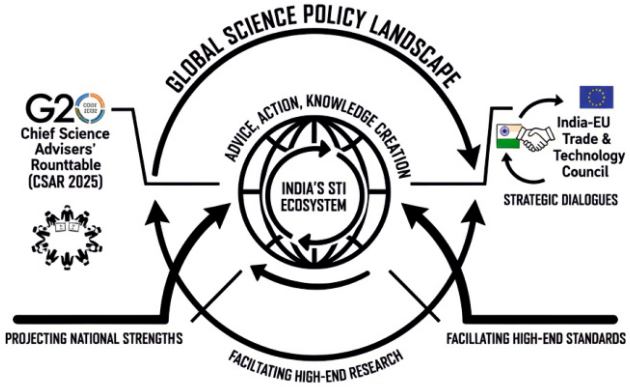
Scan QR Code to access the **Magazine**

International Outlook

05

This internal cycle of advice, action, and knowledge creation extends outward to position India as a proactive leader on the world stage. In an era of global challenges, our "International Outlook" ensures that India is not just a participant but a central architect of the global science policy landscape. By spearheading the G20 Chief Science Advisers' Roundtable (CSAR) 2025 and engaging in strategic dialogues like the India-EU Trade and Technology Council, the Office projects our national strengths to an international audience. Through these global partnerships, we facilitate the exchange of high-end research and help set the standards for emerging technologies, ensuring that the global scientific order is equitable, collaborative, and aligned with India's vision for a shared and sustainable future.

International Outlook



5.1. Emerging Science, Technology, and Innovation Conclave

Inaugurated by the Hon'ble Prime Minister, the Emerging Science, Technology, and Innovation Conclave (ESTIC) was envisioned as a maiden flagship annual event, uniquely designed to celebrate and propel India's advancements in science, technology, and innovation. The conclave was organised from 03–05 November 2025 at Bharat Mandapam, New Delhi.

Conceptualised and organised under the guidance of OPSA ESTIC represented a landmark collaboration of 13 Ministries and Departments of the Government of India. It was convened by the Department of Science & Technology (DST) in collaboration with the Department of Biotechnology (DBT), Council of Scientific and Industrial Research (CSIR), Ministry of Earth Sciences (MoES), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Ministry of Electronics and Information Technology (MeitY), Department of Telecommunications (DoT), Ministry of Ayush, Department of Space (DoS), Department of Atomic Energy (DAE), Defence Research and Development Organisation (DRDO), and the Ministry of Education (MoE).



Figure 5.1.1: Inauguration of ESTIC by Hon'ble Prime Minister, joined by Principal Scientific Adviser, plenary speakers, and panelists.

The theme for the year, "Inspire, Imagine, and Innovate," aimed to foster synergy among diverse stakeholders and to drive collaboration towards realising the ambitious vision of "Viksit Bharat 2047."

Objectives

Advancements in Emerging S&T

To brainstorm critical and emerging areas in science, technology, and innovation, with a well-defined roadmap.

Future Science & Technology Leaders:

To engage India's future S&T leaders and ignite a sense of commitment to science and innovation through sustainable, inclusive, and transformative technological pathways.

Foster Collaborations:

To provide a forum for young researchers, deep-tech start-ups, industries, funding agencies, and policymakers to promote engagement in high-tech innovations and solutions, positioning India prominently in the global S&T domain.

Celebrate Stakeholder Contributions

To showcase significant contributions by academia, research institutions, industries, and deep-tech start-ups in India's journey towards Viksit Bharat 2047.

Lab to Market:

To create a platform for demonstrating technologies with potential for commercialisation in India and globally.

The conclave brought together approximately 3500 participants from academia, government, industry and featured thought-provoking discussions led by globally eminent personalities, including Nobel Laureates, industry pioneers, and policymakers. Particular emphasis was placed on CEOs of deep-tech start-ups, women entrepreneurs, and emerging leaders in science and technology the primary target audience of the event.

In his address, Hon'ble Prime Minister highlighted India's recent achievements in science and technology, including the launch of its heaviest communication satellite and the establishment of major initiatives like the Anusandhan National Research Foundation and a ₹1 lakh crore Research, Development and Innovation (RDI) Fund. He noted India's rapid rise as a global innovation hub, with doubled R&D spending, exponential growth in patents, and a thriving startup ecosystem. He highlighted the several reforms in financial rules and procurement policies that the government has undertaken for improving ease of doing research. Emphasising inclusive innovation, he celebrated women's growing role in STEM and the expansion of Atal Tinkering Labs to nurture young talent. Looking ahead, he underscored India's leadership in emerging domains such as Artificial Intelligence, clean energy, and biotechnology, and called for a collective roadmap to advance Viksit Bharat 2047.



Figure 5.1.2: Hon'ble Prime Minister inspires the gathering with vision for India's innovation future.

The three-day programme of ESTIC 2025 featured seven plenary lectures delivered by a Nobel Laureate, a Fields Medallist, and other globally recognised thought leaders, offering profound insights into emerging domains. Complementing these were eleven thematic technical sessions (Table 1), each structured to advance discourse on priority areas of national and international relevance. The programme also included PitchX @ ESTIC 2025, a platform that convened some of India's most promising deep-tech startups with leading investors to catalysing entrepreneurial growth.

In addition, over 100 poster presentations by young scientists, faculty members, and engineers, together with interactive sessions involving VAIBHAV fellows, underscored the collaborative spirit of the conclave and its commitment to nurturing the next generation of innovators.

Each thematic session was structured for invited talk, delivered by a distinguished thought leader, setting the intellectual foundation for the session. This was followed by a sequence of three focused presentations, featuring a CEO of a deep-tech start-up, a woman entrepreneur, and a science and technology leader. Together, these talks provided complementary perspectives from industry, inclusive leadership, and academic or policy expertise, thereby enriching the discourse. The session culminated in a panel discussion, structured to encourage multi- stakeholder engagement. The panel comprised one moderator to guide the deliberations, two technical experts to provide depth of analysis, one industry expert to highlight practical applications, and one representative from a policy or funding agency to contextualise systemic support. This balanced composition ensured that the plenary session not only disseminates knowledge but also integrates diverse voices, thereby advancing the collective vision of innovation for national and global progress.

Table 1: Overview of Eleven Thematic Domains and Their Corresponding Lead Ministries/Departments

S. No.	Thematic Areas	Lead Ministry/Department	Session's Chair
1.	Advanced Materials & Manufacturing	CSIR	Dr (Mrs) N. Kalaiselvi (DG, CSIR & Secretary, DSIR)
2.	Artificial Intelligence	MeitY	Shri S Krishnan (Secretary, MeitY)
3.	Bio-Manufacturing	DBT	Dr Rajesh Sudhir Gokhale (Secretary, DBT)
4.	Blue Economy	MoES	Dr M. Ravichandran (Secretary, MoES)
5.	Digital Communications	DoT & MoE	Dr Neeraj Mittal (Secretary, DoT)
6.	Electronics & Semiconductor Manufacturing	DRDO	Dr Samir V Kamat (Secretary, DDR&D and Chairman, DRDO)
7.	Energy, Environment & Climate	DAE	Dr Ajit Kumar Mohanty (Secretary, DAE)
8.	Health and Medical	M/o AYUSH & ICMR	Dr Vaidya Rajesh Kotecha (Secretary, M/o Ayush) Co-Chair: Dr Rajiv Bahl (Secretary, DHR & DG, ICMR)
9.	Quantum Science & Technologies	DST	Prof Govindan Rangarajan (Director, IISc Bengaluru)
10.	Space Technologies	DAE	Dr A S Kiran Kumar (Former Secretary, DoS)
11.	Emerging Agriculture Technologies	ICAR	Dr Mangi Lal Jat (Secretary, DARE & DG, ICAR)



Figure: 5.1.3 Hon'ble Union Minister for Science and Technology Dr. Jitendra Singh with PSA and Secretaries of organising ministries and departments at ESTIC.

Plenary Perspectives: Nobel Laureates and Global Innovators

The conclave also featured seven distinguished plenary talks delivered by globally eminent personalities across science, mathematics, space, photonics, engineering, and biotechnology.

Table 2: Overview of Plenary speakers and Chairperson

S. No.	Plenary Speaker Name	Talk title	Plenary Session's Chair
1.	Prof. Andre Geim, Nobel Laureate in Physics (2010), University of Manchester	Random Walk to Graphene	Prof. V. Ramgopal Rao, Vice Chancellor, Birla Institute of Technology and Science, Pilani
2.	Prof. Manjul Bhargava, Fields Medalist (2014), Princeton University	Empowering India's Future: The Crucial Role of Mathematics and Science Education in Achieving India's Vision for 2047	Dr Parvinder Maini, Scientific Secretory, OPSA

S. No.	Plenary Speaker Name	Talk title	Plenary Session's Chair
3.	Dr Jean-Yves Le Gall, Former President of French Space Agency	Exploiting lunar resources, The next chapter in space exploration	Shri. A Rajarajan, Director, VSSC, ISRO
4.	Prof. Hidetoshi Katori, The University of Tokyo Team Director, RIKEN Center for Advanced Photonics	From Precision Time Measurement to Spacetime Engineering	Dr Shankar Kumar Selvaraja, IISc, Bengaluru
5.	Prof. Ganesh Ramakrishnan, IIT Bombay	Artificial General Intelligence and Sovereign Capability	Dr Shivkumar Kalyanaraman, CEO, ANRF
6.	Prof. Masaru Tomita, Distinguished Professor, Keio University, President & CEO, Tsuruoka Science Park	Synthetic Protein Materials: Industrializing Circular Biomanufact-uring for Apparel and Beyond	Prof. Ashwani Pareek, Executive Director, NABI, Mohali
7.	Group Captain Shubhanshu Shukla, Indian Air Force and ISRO	India in Orbit: Human Spaceflight as a Catalyst for Viksit Bharat 2047	Prof. Abhay Karandikar, Secretary, DST

The plenary sessions at ESTIC 2025 brought together some of the world's most distinguished voices in science and innovation. Nobel Laureate Prof. Andre Geim from the University of Manchester delivered his talk "Random Walk to Graphene", chaired by Prof. V. Ramgopal Rao, Vice Chancellor of BITS Pilani. Prof. Manjul Bhargava, Fields Medallist from Princeton University, spoke on "Empowering India's Future: The Crucial Role of Mathematics and Science Education in Achieving India's Vision for 2047", with Dr Parvinder Maini, Scientific Secretary OPSA, chairing the session. Former President of the French Space Agency, Dr Jean-Yves Le Gall, addressed "Exploiting Lunar Resources: The Next Chapter in Space Exploration", chaired by Shri A. Rajarajan, Director of VSSC, ISRO. From Japan, Prof. Hidetoshi Katori, University of Tokyo and Team Director at RIKEN Centre for Advanced Photonics, presented "From Precision Time Measurement to Spacetime Engineering", with Dr Shankar Kumar Selvaraja of IISc Bengaluru as chair.

The sessions also featured leading Indian scientists. Prof. Ganesh Ramakrishnan of IIT Bombay spoke on "Artificial General Intelligence and Sovereign Capability", chaired by Dr Shivkumar Kalyanaraman, CEO of ANRF. Prof. Masaru Tomita, Distinguished Professor at Keio University and President & CEO of Tsuruoka Science Park, presented "Synthetic Protein Materials: Industrialising Circular Biomanufacturing for Apparel and Beyond", with Prof. Ashwani Pareek, Executive Director of NABI Mohali, chairing. Finally, Group Captain Shubhanshu Shukla, Indian Air Force (IAF) and gaganyatri (astronaut) with ISRO delivered "India in Orbit: Human Spaceflight as a Catalyst for Viksit Bharat 2047", chaired by Prof. Abhay Karandikar, Secretary of DST.



Figure: 5.1.4 Seven plenary talks at ESTIC showcased distinguished speakers - (A) Sir Andre Geim with session chaired by Prof. V. Ramgopal Rao; (B) Prof. Manjul Bhargava with Dr Parvinder Maini; (C) Dr Jean-Yves Le Gall with Shri A. Rajarajan; (D) Prof. Hidetoshi Katori with Dr Shankar Kumar Selvaraja; (E) Prof. Masaru Tomita with Prof. Ashwani Pareek; (F) Prof. Ganesh Ramakrishnan with Dr Shivkumar Kalyanaraman; and (G) Group Captain Shubhanshu Shukla with Prof. Abhay Karandikar.

Round Table discussion with VAIBHAV Fellows:

A high-level Round Table was convened on " VAIBHAV " [VAIBHAV's Perspective for a Viksit Bharat]. The session was led by Union Minister for Science and Technology Dr Jitendra Singh, PSA Prof. Sood, and Secretary, DST Prof. Abhay Karandikar.

The roundtable brought together VAIBHAV (Vaishvik Bharatiya Vaigyanik) Fellows from leading universities and R&D centres across the globe, alongside eminent NRI scientists and scholars. Discussions focused on the progress and impact of the VAIBHAV Fellowship Programme, with fellows offering constructive suggestions to strengthen India's science and technology ecosystem. Key recommendations included structured student mobility programmes, simplified travel and conference clearance procedures, extension of fellowship tenure, and stronger industry linkages to sustain innovation. Participants also highlighted the importance of developing indigenous "systems for India" tailored to national scale and affordability, while exploring opportunities for public–private and cross-border collaborations.

Music for a Sustainable Future: Ricky Kej's Performance

Cultural Night at ESTIC featured a mesmerising performance by three time Grammy Award-winning composer Ricky Kej, whose music blended global harmony with Indian ethos. Ricky Kej and his ensemble created an immersive experience that combined soulful melodies with themes of sustainability and unity, perfectly complementing the spirit of ESTIC 2025. The performance not only

showcased India's rich cultural heritage but also highlighted how art and science can converge to inspire collective action for a better future.



Figure: 5.1.5 Grammy Award-winning composer Ricky Kej performing at ESTIC

Plenary Panel on Nurturing R&D and Innovation Ecosystem for Viksit Bharat 2047:

Under the chairmanship of the PSA, ESTIC also featured a high-level plenary panel discussion on the theme "Nurturing R&D and Innovation Ecosystem for Viksit Bharat 2047." The panel brought together eminent leaders from academia (Prof. Ashok Jhunjhunwala, IIT Madras; Prof. Govindan Rangarajan, IISc Bengaluru; Lt. Gen. Madhuri Kanitkar, Maharashtra University of Health Sciences), industry (Shri Baba Kalyani, Bharat Forge; Dr Pawan Kumar Goenka, IN-SPACe), foundations (Dr Soumya Swaminathan, Principal Adviser to the National Tuberculosis Elimination Programme, Ministry of Health and Family Welfare, Government of India), and the national academy (Shri J. D. Patil, Indian National Academy of Engineering).



Figure: 5.1.6 Plenary panel discussion on "Nurturing R&D and Innovation Ecosystem for Viksit Bharat 2047," chaired by the Principal Scientific Adviser, with distinguished speakers and panelists

The deliberations underscored the importance of aligning India's research and innovation ecosystem with national priorities. The theme emphasised:

Building sovereign capabilities in frontier domains such as AI quantum technologies, synthetic biology, and advanced materials.

Strengthening indigenous design-to-deployment pipelines to enhance India's share in the global value chain.

Operationalising mission-mode programs through structural enablers such as the (ANRF) and the ₹1 lakh crore RDI Scheme.

Fostering collaboration across academia, industry, and government to create a seamless continuum from foundational research to real-world application.

Positioning India as a co-architect of international standards through strategic partnerships and science diplomacy, thereby shaping global norms in science and technology.

5.2. G20 CSAR 2025

The Chief Science Advisers' Roundtable (CSAR) was originally conceptualised and launched as a Sherpa-track initiative during India's G20 Presidency in 2023, aimed at fostering global collaboration in science advice. While the OPSA spearheaded the 2023 edition, the 2024 edition was jointly organised by the Office and the Natural Sciences Sector of UNESCO on 6 September 2024 at the UNESCO Headquarters in Paris, France. OPSA has played a key role in ensuring the sustained continuation of this initiative with partner countries and organisations since its inception. The 2025 edition of CSAR was presided over by the South African G20 Presidency and was conducted in Pretoria, South Africa, on 21st September 2025. The theme for 2025 CSAR was "Equity-based science, technology, and innovation for inclusive human development and global sustainability." To prepare for the roundtable and draft the outcome statement, a Technical Session was held in Pretoria on 24 and 25 April 2025, followed by a number of intersessional meetings.

CSAR 2025 Technical Session:

The Technical Meeting of experts representing the G20 Chief Science Advisers and their equivalents was convened as a preparatory deliberation towards the September roundtable. The purpose of this gathering was to discuss the objectives and exchange perspectives on the proposed thematic issues elaborated on in the issue note and related documents shared by South Africa in preparation for the main CSAR in September 2025. The meeting took place at the CSIR International Convention Centre, Pretoria, South Africa, on 24 and 25 April 2025. The Indian delegation shared its input on the priority areas below:

Priority 1 Facilitating the development and promotion of a global science, technology and innovation (STI) agenda in support of the implementation of the sustainable development goals, and enabling a just, equitable and inclusive global energy transition

Priority 2 Promoting the establishment of a global knowledge system that is equitable and open to all.

Priority 3 Promoting the alignment of G20 STI initiatives with the STI and capacity building priorities of the African continent, the Global South and the developing world at large.



Figure: 5.2.1 G20 Chief Science Advisers' Roundtable (CSAR): Technical Meeting (24-25 April 2025, Pretoria, South Africa)

Sideline events during the technical session comprised closed-door discussions with South Africa and UNESCO on the progress, outcomes, and sustained continuation of CSAR in the absence of a strong Troika; engagement with the EU on Priority 1 of the G20 CSAR 2025 (STI for SDGs capacity building and foresight); and meeting with representatives from NRF, South Africa and University of Cape Town on India's proposal to host the 3rd Global Summit on Diamond Open Access.

G20-CSAR 2025- Pretoria Roundtable:

OPSA participated in the G20 Chief Science Advisers' Roundtable (CSAR) 2025 in Pretoria. In the lead-up, three intersessional negotiations were convened to shape the draft Outcome Statement, to which OPSA shared multiple comments and feedback. On 21 September, representatives from 19 countries participated in the G20-CSAR closed session and collectively adopted the "Outcome Statement". During India's intervention, Prof. Ajay Kumar Sood emphasised the need to democratise access to AI and bridge

digital divides, citing India's ONOS, I-STEM, RuTAG and Smart Village initiatives. Dr Parvinder Maini underscored that the Outcome Statement must live beyond individual presidencies and drive real impact.

G20-CSAR 2025 took place in two sessions: a closed session with the participation of G20 members and guest countries, and the open session with a wider participation beyond G20.



Figure: 5.2.2 G20-CSAR 2025 Group Photo of all the delegations (21 Sept 2025)

Closed Session

During the closed session, Prof. Sood highlighted the need to address global divides in AI, emphasising equitable access to computational power, data, and knowledge. He referred to India's One Nation One Subscription initiative and AI Impact Summit 2026 as steps towards democratising access and bridging capability gaps. In the adoption session, Dr Parvinder Maini underlined the importance of sustaining CSAR beyond individual presidencies and urged members to make the Outcome Statement a "living document" for inclusive and collaborative science.



Figure: 5.2.3 PSA Prof Ajay Sood delivering country intervention in the opening of CSAR 2025 session (21 Sept 2025)

Open Session:

At the Open Session on "Towards an STI Advice Platform and Capacity Building Programmes for Africa and Developing Countries," Prof. Ajay Kumar Sood shared India's experience of institutionalising science advice through OPSA Adviser and mechanisms such as the PM-STIAC and ETG. The interventions highlighted India's focus on inclusivity through ONOS and Inclusivity-STEMM-SARF, and on last-mile technology delivery through RuTAG and Smart Village Centres. Prof. Sood also emphasised the role of collaborative capacity-building initiatives like the Indian Technical and Economic Cooperation (ITEC) Programme and proposed CSAR as a platform to align various G20 STI efforts under a coherent global framework.



Figure: 5.2.4 Panel of experts discussing STI Advisory Platforms in the open knowledge-sharing session of G20-CSAR 2025 (21 Sept 2025)

UNESCO MOST Forum: AI for Social Impact and Policy:

PSA, Prof. Sood participated in the UNESCO MOST Ministerial Forum on "AI for Social Impact and Policy." He outlined India's approach to using AI as a tool for inclusion and social transformation. Citing examples such as the Digital Public Infrastructure stack, Bhashini for multilingual access, and open AI initiatives like AI Kosh, he emphasised that technology must serve humanity. He also spoke about India's plan to host the AI Impact Summit 2026 to advance equitable and human-centric AI governance.



Figure: 5.2.5 PSA speaking at UNESCO-MOST Ministerial Panel on AI for Social Impact and Public Policy (22 Sept 2025)

Sideline Engagements:

On the margins of G20-CSAR 2025, bilateral meetings were held where PSA Prof. Sood and Scientific Secretary Dr Maini engaged in bilateral meetings with key partner countries. Their discussion with Prof. Dame Angela McLean and Prof. Sir John Edmunds from the UK focused on strengthening cooperation through the India-UK Technology Security Initiative and the Comprehensive Economic and Trade Agreement (CETA). They also discussed the International S&T Clusters Meet being organised by OPSA, aimed at fostering global collaboration across eight S&T Clusters. With the Italian delegation led by Prof. Antonio Zoccoli, the emphasis was on advancing cooperation in supercomputing, big data, and quantum technologies, including joint research, AI collaboration, capacity building, and industrial partnerships. Additionally, meetings with Dr Sabine Henzler and Dr Liliana from the European Union's Joint Research Centre (JRC) focused on the India-EU Technology and Trade Council (TTC) and strengthening the India-EU STI partnership.

5.3. India EU TTC

The India-European Union (EU) Trade and Technology Council (TTC) is a strategic coordination mechanism created to strengthen cooperation between India and the European Union in trade, technology, and security. Announced by the European Commission President, Ursula von der Leyen, and India's Prime Minister, Narendra Modi, in April 2022, the TTC was formally established on 6th February 2023. It serves as a platform to address shared challenges and promote sustainable, inclusive growth through research, innovation, and technology collaboration.

The Working Group 2 (WG2) on Green and Clean Energy Technologies is co-chaired by OPSA and the Directorate-General for Research and Innovation (DG Retd.) of the European Commission. The WG2 focuses on advancing cooperation in research, innovation, and technology development to accelerate clean and green transitions. The group's focus areas include collaboration in research, innovation, investment, and standardisation related to green and clean energy technologies. It also encourages the active participation of incubators, SMEs, and start-ups in technology development; promotes academic and training programmes for human resource development; and supports capacity building through the establishment of infrastructure, testing, and simulation facilities.

During this calendar year, the President von der Leyen was on her landmark official visit as she led the European Union College of Commissioners to India on 27-28 February 2025. This is the first visit of the College of Commissioners outside the European continent since the start of their new mandate and also the first such visit in the history of India-EU bilateral ties. Prime Minister Shri Narendra Modi and President of the European Commission Ms. Ursula von der Leyen affirmed that the EU-India Strategic Partnership has delivered strong benefits for their people and for the larger global good.



Figure: 5.3.1. Prime Minister Shri Narendra Modi met H.E. Ms. Ursula von der Leyen, President of the European Commission at Hyderabad House, New Delhi, India (27-28 February 2025)

Coordinated Research Calls

Under the India-EU TTC, two major coordinated research and innovation calls were launched jointly by the Government of India and the EU, with a combined investment of approximately ₹412 crore (around €39.05 million). These calls were co-funded by Indian line Ministries (Ministry of Earth Sciences (MoES) for Marine Plastic Litter (MPL) and Ministry of New and Renewable Energy (MNRE) for the Waste to Hydrogen (W2H) theme) and the Horizon Europe Programme of the European Commission. Both calls focus on addressing global sustainability challenges through collaborative research and innovation.

Call on Hydrogen from Biogenic Wastes (Waste to Renewable Hydrogen)

This coordinated call was launched to promote joint research and development for producing renewable hydrogen from biogenic wastes. It aims to support technological advancements in catalysts, process intensification, feedstock pre- and post-treatment, and side-stream utilisation to improve hydrogen yield, reduce greenhouse gas emissions, and lower costs.

The initiative includes a funding contribution of ₹90 crore from the Ministry of New and Renewable Energy (MNRE) and €10 million from Horizon Europe. The call opened on 15th May 2025 and closed on 15th September 2025. It encouraged collaboration between research institutions, industries, and technology developers from India and the EU. Project evaluation is underway, with results expected in early 2026, and grant agreements anticipated by April 2026.

Call on Cumulative Impacts of Marine Pollution (Marine Plastic Litter)

The coordinated call on Marine Plastic Litter (MPL) was launched jointly by the Ministry of Earth Sciences (MoES), Government of India, and the Directorate-General for Research and Innovation (DG Retd.), European Commission. It focuses on understanding and mitigating the cumulative impacts of marine pollution, particularly plastic litter, on ecosystems and human health.

The initiative provides funding support of ₹90 crore from MoES and €12 million from Horizon Europe. The call opened on 6th May 2025 and closed on 23rd September 2025. It seeks to develop advanced tools for detecting micro- and nanoplastics, assess ecological and health risks, and design innovative waste management and pollution reduction strategies. The activity contributes to India's National Marine Litter Policy and the EU's Zero Pollution Action Plan, as well as the UN Decade of Ocean Science. Proposals are currently under review, with selected projects expected to be announced in early 2026, followed by the signing of grant agreements in May 2026.

India–EU Ideathon on Marine Plastic Litter

The India-EU Ideathon on "Combatting Marine Plastic Litter" was launched to promote collaboration between innovators, researchers, start-ups, and institutions from India and the European Union to develop practical and scalable solutions for addressing marine plastic pollution. The initiative was organised by OPSA and the Delegation of the European Union to India under the India-EU Trade and TTC Working Group 2 on Green and Clean Energy Technologies.

The Ideathon was soft-launched on 3rd July 2025 through an introductory webinar, following which applications were invited until 2nd October 2025. To support participants, a series of matchmaking sessions, technical workshops, and interactive Q&A sessions with Indian and European experts were organised during September and October 2025.



Figure: 5.3.2: The Soft Launch of the India-EU Ideathon on Combatting Marine Plastic Litter

Formal Launch Event of the India-EU Ideathon

The formal launch of the India-EU Ideathon on "Combatting Marine Plastic Litter" took place on 25th September 2025 as part of the collaborative activities under the India-EU TTC Working Group 2. The launch event was chaired by Dr Parvinder Maini, Scientific Secretary, OPSA, and Ms Signe Ratso, Deputy Director-General, DG Retd., European Commission. The event was also attended by Dr Rakesh Kaur, Adviser, OPSA; Ms. Nienke Buisman, Head of Unit, International Cooperation, DG Retd.; other senior officials, experts, and representatives from Indian and European research institutions, start ups, and civil-society organisations. The launch provided a structured framework for advancing India-EU cooperation in marine pollution research through early-stage innovation and technology development.

The event introduced three thematic challenge areas: Challenge 1: identification and tracking of marine plastics, Challenge 2: development of technologies for removal and

recycling, and Challenge 3: prevention and awareness through behavioural and community engagement. Experts from India and the EU presented overviews of the current landscape of marine litter research, highlighting ongoing projects and opportunities for joint action. The event presented the Ideathon framework outlining its structure, evaluation process, and mentoring mechanisms designed to support selected teams in developing and scaling up their innovations.

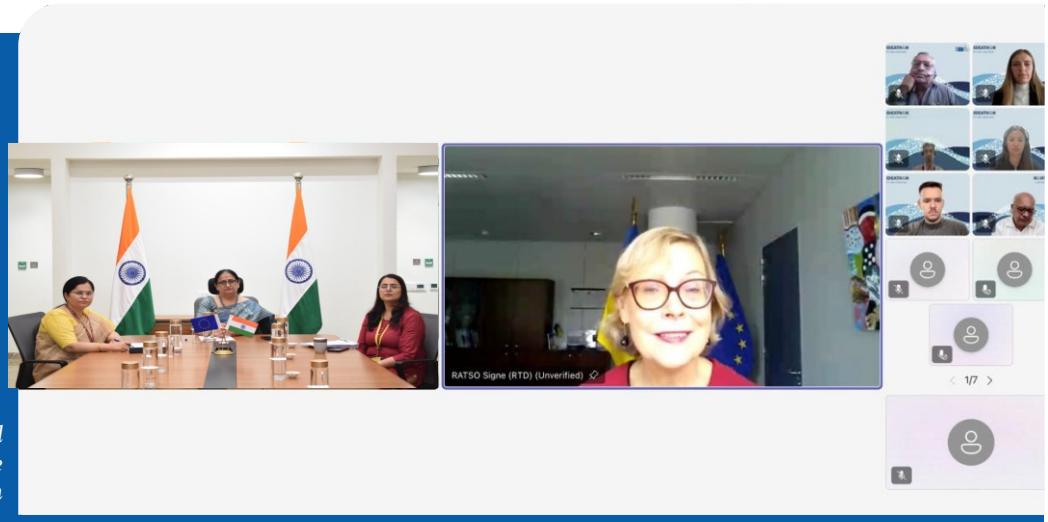


Figure: 5.3.3. Formal Launch Event of the India-EU Ideathon

Final Pitch and Award Ceremony of the India–EU Ideathon, Bhubaneswar

The India-EU Ideathon on Marine Plastic Litter concluded on 10th December 2025 with its final pitch and award ceremony held at the Bhubaneswar City Knowledge Innovation Cluster (BCKIC) Foundation, KIIT-DU, Bhubaneswar. The event marked the culmination of a collaborative initiative jointly organised by OPSA and the Delegation of the European Union to India.

Dr Parvinder Maini, Scientific Secretary, OPSA, delivered the keynote address, emphasising the role of coordinated scientific cooperation between India and the EU in generating scalable solutions to marine plastic pollution. Ms. Signe Ratso, Deputy Director-General, DG Retd., European Commission, reaffirmed the EU's commitment to strengthening collaborative research under the TTC framework.



Figure: 5.3.4. Final Event of the India-EU Ideathon on Combatting Marine Plastic Litter

Nine Shortlisted teams presented their final pitches across the three challenge tracks before joint Indian and European jury panels. Three winning teams: Ocean Resilience India (Challenge 1), Nautilus Nexus (Challenge 2), and TrashTrek App (Challenge 3) were announced. Each winning team received a cash award of ₹5 lakh, supported by the Mphasis F1 Foundation, along with incubation and mentoring support for further development. The event witnessed participation from over fifty innovators and experts from India and several EU countries,

reaffirming the shared India-EU commitment to innovation-led solutions for marine environmental protection.



Figure: 5.3.5. Winners of the India-EU Ideathon on Combatting Marine Plastic Litter

Cooperation between ARAI and JRC on Electric Vehicle Standards

To enhance collaboration in electric mobility and promote standardisation, the Automotive Research Association of India (ARAI) and the Joint Research Centre (JRC) of the European Commission initiated a partnership under the India-EU TTC Working Group 2. The cooperation aims to develop harmonised approaches for electric-vehicle (EV) standards, interoperability, and testing. It also provides a platform for joint research, technical exchange, and pilot testing of charging technologies.

As part of this cooperation, the Second EV Charging Technology Workshop on "Standardisation Strategies, Smart and bidirectional, megawatt, and wireless charging has been tentatively scheduled to be held on 5 -6 February 2026 at the JRC campus, Ispra (VA), Italy. Both sides have agreed to pursue pilot-scale validation of EV charging technologies in India and to continue structured knowledge exchange under the India-EU TTC WG2 framework.

The India-EU Workshop on Electric Vehicle Charging Technology

The first India-EU Workshop on Electric Vehicle Charging Technology was held on 24th February 2025 in Pune, India, under the India-EU TTC Working Group 2. The workshop was organised jointly by ARAI and the European Commission's JRC with the support of OPSA.

The event brought together policymakers, industry representatives, standardisation bodies, and research organisations from both sides to discuss harmonisation of EV charging standards and the future of sustainable mobility. Participants included officials from OPSA, Bureau of Indian Standards (BIS), ARAI, and experts from DG Retd. and JRC, alongside industry participants from the Indian and European electro-mobility sectors.

The workshop addressed policy and technical aspects related to EV charging systems, including interoperability, infrastructure requirements, communication protocols, and pre-normative research. It also showcased the EV testing facilities at ARAI and discussed opportunities for collaborative research and development. The deliberations emphasised the need for harmonised standards, joint testing and validation, and sharing of best practices to ensure safety, efficiency, and scalability of EV charging systems in both India and the EU.



Figure: 5.3.6. The first India-EU Workshop on Electric Vehicle Charging Technology held on 24th February 2025 in ARAI, Pune, India

Stocktaking Meeting of India-EU Trade and Technology Council Working Group 2

A Stocktaking Meeting of the India-EU TTC Working Group 2 on Green and Clean Energy Technologies was held virtually on 11th February 2025 to review progress made under ongoing collaborative activities and to align future priorities.

The meeting was co-chaired by PSA Prof. Sood and, Mr. Marc Lemaître,

Director-General, Directorate-General for Research and Innovation (DG Retd.), European Commission. The discussions reviewed the implementation of the WG2 roadmap, highlighting completed milestones, upcoming calls in clean energy technologies, and measures to strengthen research-industry linkages.

Both sides acknowledged each other's active contributions and reaffirmed their commitment to advancing India-EU cooperation through continued coordination and structured follow-up. The meeting provided a basis for refining future activities under the TTC framework to ensure sustained progress towards shared research and innovation goals.

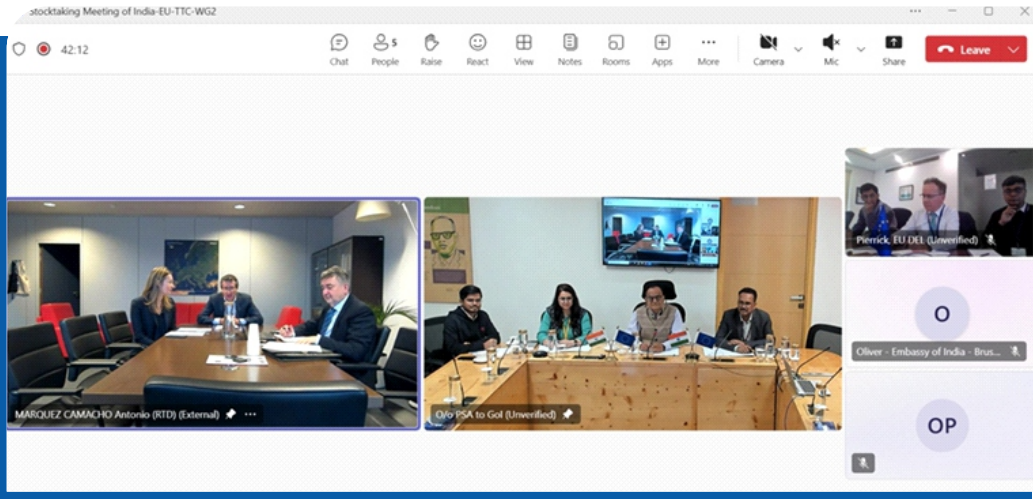


Figure: 5.3.7. A Stocktaking Meeting of the India-EU TTC Working Group 2 on Green and Clean Energy Technologies held on 11th February 2025

India-EU High-Level Meeting on Science and Technology Cooperation

An India-European Union (EU) Meeting on Science & Technology Cooperation was held on 27 Februray 2025 at the Office of the PSA, Vigyan Bhawan Annexe, New Delhi. The meeting was part of the various sectoral meetings being held in wake of the two-day visit of H.E. Ms. Ursula von der Leyen, President of the European Commission, to India along with the College of Commissioners. The meeting was co-chaired by PSA Prof. Sood and Ms. Ekaterina Zaharieva, EU Commissioner for Startups, Research and Innovation. Senior representatives from OPSA, the Secretaries of the Department of Science and Technology (DST), Department of Biotechnology (DBT), and the Ministry of Earth Sciences (MoES), participated from

the Indian side, while the EU delegation included senior officials from the Directorate-General for Research and Innovation (DG Retd.) and the EU Delegation to India.

Discussions focused on strengthening collaborative research and innovation in areas such as clean energy, water management, artificial intelligence, biotechnology, and climate change. The meeting reviewed progress made under the India-EU Science and Technology Agreement, originally signed in 2001 and renewed in 2015 and 2020, and agreed to extend it for the period 2025-2030. The cooperation has led to significant joint achievements in water purification technologies, smart grids, clean energy systems, vaccine research, and polar and marine studies. Participants noted that India's expanding innovation ecosystem, ranking among the world's top three in start-up creation, provides a strong base for collaborative projects. The EU acknowledged India's growing expertise in renewable energy, biopharmaceuticals, artificial intelligence, and advanced materials, and expressed interest in deeper engagement across these sectors.

Future collaboration areas identified during the meeting include quantum computing, bioeconomy, green hydrogen, blue economy, electric mobility and battery technologies, high-performance computing, and responsible AI. Both sides emphasised the importance of joint funding mechanisms, exchange programmes, and enhanced industry-academia partnerships to accelerate innovation and technology adoption.



Figure: 5.3.8 India-EU Meeting on Science & Technology Cooperation held on 27th Feb 2025 at the OPSA, Vigyan Bhawan Annexe, New Delhi.

Second Ministerial Meeting of the India-EU Trade and Technology Counc

The Second Ministerial Meeting of the India-EU TTC was held in New Delhi on 28th February 2025, marking a significant milestone in

advancing bilateral cooperation in trade, technology, and innovation. It was co-chaired on the Indian side by India's External Affairs Minister Dr S. Jaishankar; Commerce and Industry Minister Shri Piyush Goyal; and Minister for Electronics and Information Technology Shri Ashwini Vaishnaw. Executive Vice-President for Tech Sovereignty, Security and Democracy Ms. Henna Virkkunen, Commissioner for Trade and Economic Security, Inter-Institutional Relations and Transparency Mr. Maros Šefčovič and Commissioner for Startups, Research and Innovation Ms. Ekaterina Zaharieva co-chaired on the EU side. The meeting reviewed progress under all three Working Groups of the India-EU TTC.

The Working Group 2 (WG2) session, focusing on Green and Clean Energy Technologies, included progress updates and discussions on future collaborative priorities. Interventions were made by PSA Prof. Sood and Ms. Ekaterina Zaharieva, EU Commissioner for Startups, Research, and Innovation, both highlighting the growing scope of cooperation in research and innovation between India and the EU.

Both sides endorsed continued joint research cooperation through coordinated calls in battery recycling, marine plastic litter, and waste-to-hydrogen technologies, supported by a joint investment of approximately €30 million from the Horizon Europe Programme and matching Indian contributions. Cooperation on EV charging infrastructure, hydrogen safety standards, and wastewater treatment technologies was also agreed. The meeting highlighted the role of the TTC as a platform to align standards, strengthen value chains, and promote innovation-led investments in clean energy and sustainable technologies. Both sides reiterated their commitment to advancing collaborative R&I initiatives under WG2.



Figure: 5.3.9. Second Ministerial Meeting of the India-EU Trade and Technology Council at Hyderabad House, New Delhi, India on 28th February 2025

5.4. International Science & Technology Clusters Conference

The year marked a significant inflection point for India's Science and Technology Clusters programme with the organisation of the first International Science and Technology Clusters Conference under the theme "Making Lives Easier Through Science and Technology". Conceived and hosted by the Office of the PSA, the conference represented the transition of the S&T Clusters initiative from a primarily national capacity-building effort to a globally connected innovation platform. By bringing together policymakers, diplomats, scientific leaders, industry representatives, and innovators from across the globe, the conference demonstrated the maturity of India's cluster-based innovation model and its readiness for sustained international engagement.



Figure : 5.4.1 First International Conference on S&T Clusters - DAIC New Delhi

Total 35 countries participated in the Conference. The list of the participating countries included the United Kingdom, Slovenia, South Africa, Australia, Switzerland, Kenya, Italy, Japan, Denmark, Norway, Germany, UAE, New Zealand, Sweden, Indonesia, Spain, South Korea, United States of America, Israel, Brazil, African Union, European Union, Netherlands, Singapore, France, Angola, Malaysia, Thailand, Hungary, Greece, Vietnam, Sri Lanka, Finland, Zimbabwe, and Seychelles.

The panel discussions over two days deliberated on the following six thematic areas:

1. Smart Agriculture
2. Healthcare
3. Environment Sustainability
4. Industry Automation and Startups
5. Plastic and E-Waste Management
6. Technologies Empowering Livelihoods

A total of 40 speakers from 18 countries participated as panelists in these sessions. The details are given below:

S. No.	Country Name	Participant Name	Identified Thematic Session
1.	Slovenia	Dr Dragica Marinič	Plastics & E-waste Management
		Dr Alenka Mauko Pranjić	Industry Automation and Startups
		Dr Gasan Osojnik	Environment Sustainability
2.	Denmark	Dr Søren Tranberg Hansen	Plastics & E-waste Management
		Dr Alenka Mauko Pranjić	Environment Sustainability
		Dr Gasan Osojnik	Technologies Empowering Livelihood
3.	United Kingdom	Prof. Sir John Edmunds	Healthcare
		Mr. Brendan O'Neill	Industry Automation and Startups
4.	South Africa	Sedula Mashudubele Mamabolo	Technologies Empowering Livelihood
5.	Kenya	Prof. Jackson Kwanza	Smart Agriculture
6.	Australia	Ms. Caitlin Searle	Healthcare
		Prof. Mathew Morrell	Smart Agriculture
		Dr Julianne Biddle	Industry Automation and Startups

7.	Switzerland	Prof. Manfred Max Bergman	Environmental Sustainability
		Prof. Mary-Anne Hartley	Healthcare
		Prof. Amritbir Riar	Smart Agriculture
		Dr Angela Honnegger	Industry Automation and Startups
8.	Italy	Mr. Marco Pacini	Smart Agriculture
		Prof. Anna Barbara	Technologies Empowering Livelihood
		Prof. Francesco Corvaro	Environment Sustainability
9.	Germany	Dr Fabian Hecklau	Healthcare
		Ms. Anandi Iyyer	Smart Agriculture
		Dr Johannes Barth	Technologies Empowering Livelihood
10.	Spain	Ms. Ana L. Cudero	Plastics & E-waste Management
		Dr Luis Guash	Smart Agriculture
		H.E. Juan Antonio March	Smart Agriculture
11.	African Union	Mr. Brando Okolo	Technologies Empowering Livelihood
12.	Netherlands	Mr. Jan Pieter van Tilburg	Plastics & E-waste Management
		Mr. Jan Reint Smit	Environmental Sustainability
13.	Israel	Ms. Noa Amsalem	Environmental Sustainability
		Ms. Sharon Madel-Artzy	Technologies Empowering Livelihood
14.	Sweden	Ms. Geeny George	Healthcare
		Ms. Cecilia Tall	Plastics & E-waste Management
		Mr. Ola Svedin	Industry Automation and Startups
15.	USA	Prof. Pratim Biswas	Industry Automation and Startups
16.	European Union	MSc. D.Ing. Pierrick Fillon-Ashida	Plastics & E-waste Management
17.	Norway	Ms. Eirin Fossberg	Industry Automation and Startups
		Mr. Sonal Kumar	Environmental Sustainability
		H.E. May-Elin Stener	Environmental Sustainability
18.	Japan	Mr. Masafumi Senda	Technologies Empowering Livelihood

The inauguration was graced by the PSA, the Scientific Secretary, and the Chief Guest Prof. Sir John Edmunds.



Figure : 5.4.2 Inaugural Session

A Total of 40 exhibition stalls were displayed during the event which showcased technologies and solutions developed within the framework of the cluster concept, which have benefitted the society. Spanning agriculture, healthcare, sustainability, industrial technologies, waste management, and livelihood applications, the exhibition reflected a deliberate emphasis on deployability and scale. The presence of both domestic and international innovations underscored the clusters' role as platforms for co-creation, adaptation, and technology diffusion. A total of six exhibition stalls were displayed by the international partners, with UK and Japan showcasing 2 stalls each, and Norway and Sweden showcasing 1 stall each.





Figure: 5.4.3 Inauguration of the Exhibition by the PSA

The thematic discussions provided focused lenses through which the clusters' approach to problem-solving was examined. The Smart Agriculture deliberations highlighted how digital and precision technologies are reshaping agricultural systems, with particular emphasis on data-driven decision-making, resource optimisation, and climate resilience. The discussions underscored the role of artificial intelligence, sensor-based monitoring, and integrated agri-value chains in enabling sustainable food systems, while emphasising the importance of international research partnerships in accelerating adoption at scale.



Figure : 5.4.4 Session 1 on Smart Agriculture

Healthcare Innovations emerged as another critical domain where cluster-led approaches were shown to have strong potential for impact. The discussions focused on how digital health platforms, artificial intelligence, and data analytics are transforming healthcare delivery by improving access, efficiency, and affordability. Emphasis was placed on remote diagnostics, telemedicine, and predictive health systems, with global perspectives reinforcing the need for cross-border collaboration to scale solutions that address healthcare disparities, particularly in underserved regions.



Figure: 5.4.5 Session 2 on Healthcare

Environmental Sustainability discussions foregrounded the role of science and technology in addressing long-term systemic risks related to water security, energy transitions, and ecological resilience. The exchanges highlighted data-driven approaches to water governance, integration of renewable energy systems, and circular economy frameworks as essential components of sustainable development. The cluster model was positioned as a means to integrate technological innovation with policy objectives, enabling solutions that are both environmentally sound and operationally viable.



Figure : 5.4.6 Session 3 on Environment Sustainability

The Industry Automation and Startups theme reflected India's growing engagement with advanced manufacturing and deep-tech entrepreneurship. The discussions examined how intelligent automation, sensor-driven systems, and smart manufacturing architectures are reshaping industrial productivity and supply chains. A key insight was the role of clusters in creating enabling ecosystems for startups, linking advanced technologies with policy support and global networks to accelerate India's transition towards Industry 4.0.



Figure : 5.4.7 Session 4 on Industry Automation and Startups

The Plastic and E-Waste Management deliberations addressed the intersection of sustainability, technology, and behavioural change. The discussions emphasised advanced material recovery processes, smart segregation systems, and digital traceability as critical enablers of effective waste management. International perspectives reinforced the importance of circular material flows and science-led regulatory frameworks, positioning cluster-based innovation as a practical pathway for developing scalable and environmentally responsible waste solutions.



Figure : 5.4.8 Session 5 on Plastic and E-Waste Management

Technologies empowering livelihoods brought the focus back to inclusive development and grassroots impact. The discussions highlighted how science-driven interventions can strengthen local economies, generate skilled employment, and support entrepreneurship. Emphasis was placed on technology-enabled capacity building, waste-to-wealth models, and community-centred innovation approaches that align technological advancement with social inclusion and resilience.



Figure: 5.4.9 Session 6 on Technologies Empowering Livelihoods

The conference also marked an important step towards operationalising collaboration. The announcement of multiple Memoranda of Understanding across key sectors reflected a shift from dialogue to structured partnerships aimed at joint development and deployment. Educational and capacity-building initiatives unveiled alongside technology partnerships further reinforced the clusters' integrated approach to innovation.



Figure : 5.4.10 MoU Ceremony and unveiling of 'ChemAmaze', a gamified chemistry learning platform by PKC – IIT Madras & BASF, in the presence of PSA

The closing deliberations framed the conference as a point of departure for the next phase of the S&T Clusters programme. The emphasis on follow-through, prioritisation of affordability and scalability, and alignment with national and state-level needs underscored a clear expectation that clusters evolve into national technology accelerators. By consolidating global engagement, showcasing deployable solutions, and reinforcing a shared commitment to societal impact, the first International Science and Technology Clusters Conference established a strong foundation for deepening India's cluster-led innovation ecosystem.

A defining feature of the conference was its emphasis on international learning and collaboration. Rather than positioning the Indian clusters as isolated success stories, the discussions consistently situated them within a global landscape of innovation ecosystems. Contributions from international scientific advisers, diplomats, and domain experts reinforced the value of cross-border collaboration in addressing complex challenges that transcend national boundaries. This global engagement enriched the discourse around governance models, technology deployment pathways, and the role of public innovation institutions in translating research into societal benefit.



Figure : 5.4.11 Closing Ceremony of the first International S & T Clusters Conference

5.5. Technology Dialogue 2025

OPSA, Indian Institute of Science (IISc) and the Ministry of External Affairs (MEA) jointly organised an international technology policy summit titled "Technology Dialogue 2025: Exploring New Frontiers in Technology Diplomacy" on 24 and 25 January 2025 at IISc, Bengaluru as a continuation of Dialogue held in November 2023. Technology Dialogue is an international technology policy summit designed to explore the strategic dimensions of science and technology in driving India's global partnerships. The technology dialogue serves as a unique forum to enable discussions on critical and emerging technologies, creating synergies that advance global progress and socio-technological development.

Recognising the importance of technology in driving India's global partnerships, the 2025 summit focused on India's international technology engagement framework and the need for leveraging strategic partnerships on critical and emerging technologies such as quantum, AI, semiconductors, space tech, and bioeconomy. The platform enhances scientific and technological collaborations with key global partners, promotes inclusive and comprehensive discussions among all relevant stakeholders, and establishes synergy in the policy and governance of disruptive technologies.

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Figure: 5.5.1 : Key note address delivered by Hon'ble Minister Dr Jitendra Singh at the inauguration of the International Technology Policy Summit 2025 at IISc Bangalore

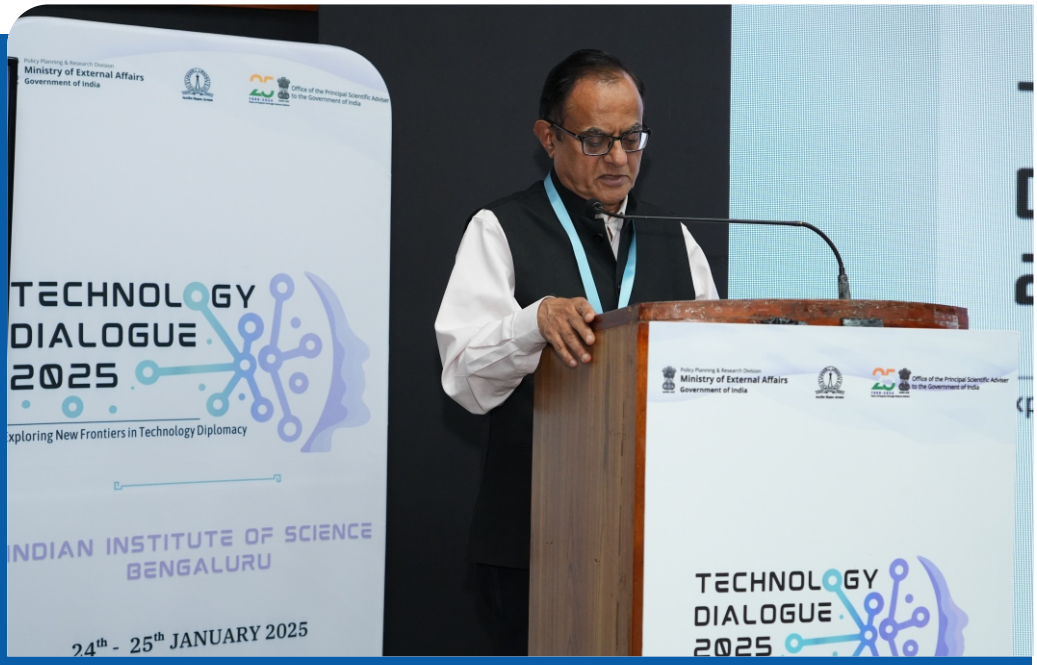


Figure: 5.5.2: Address by PSA Prof. Sood at the International Technology Policy Summit 2025 at IISc Bangalore

The summit was inaugurated with a keynote address on the International Technology Engagement Framework (ITEF) by the Hon'ble Minister of State (Independent Charge) for Science and Technology, Dr Jitendra Singh, who highlighted national initiatives and missions aimed at advancing India's technological objectives and underscored the importance of structured global technology partnerships. The inaugural session included addresses by PSA Prof. Ajay Sood, on the conceptualisation and building blocks of ITEF, and Dr Kiran Mazumdar-Shaw on the industrial perspective shaping India's international technology engagements. The session was attended by senior government officials, including H.E. Pavan Kapoor, Deputy National Security Adviser; Shri S. Raghuram, Joint Secretary, MEA; and Prof. G. Rangarajan, Director, IISc, and was chaired by Prof. G.K. Ananthasuresh, IISc.

The programme featured keynotes and thematic panels on leveraging strategic partnerships in critical and emerging technologies, expanding international technology engagements, and fostering collaboration in quantum technologies, space technologies, artificial intelligence, and the bio-economy. These sessions included participation from senior government officials, representatives of foreign missions, industry leaders, academic experts, and international technology practitioners.

The second day commenced with a keynote on India's technology and development partnerships by Shri Periasamy Kumaran, Special Secretary, MEA, followed by sector-specific panels deliberating on policy imperatives, governance frameworks, innovation ecosystems, and international collaboration.



Figure 5.5.3: Speech delivered by Dr Parvinder Maini at the International Technology Policy Summit 2025 at IISc Bangalore



Figure 5.5.4 : Speech delivered by H.E. Pavan Kapoor, Deputy National Security Adviser at Technology Dialogue 2025

Technology Dialogue 2025 also hosted the India-France AI Policy Roundtable: Roadmap for the AI Action Summit 2025, co-chaired by Shri Abhishek Singh, Additional Secretary, MeitY and CEO, IndiaAI Mission, and H.E. Mr Marc Lamy, Consul General of France in Bengaluru.

The roundtable focused on global AI governance, open and common AI infrastructure, digital inclusion, cultural and linguistic diversity, and sustaining AI innovation, and served as a preparatory platform for discussions leading up to the AI Action Summit 2025, co-chaired by the Hon'ble Prime Minister of India.

The two-day summit witnessed participation from foreign missions in India, global experts in critical and emerging technologies, representatives from industry, academia, start-ups, industry bodies, and public policy scholars, facilitating dialogue on technology policy and diplomacy with key international partners.



Figure 5.5.5 : Speech roundtable discussion at the Technology Dialogue 2025

5.6. International Technology Engagement Strategy (ITES)

As the global community increasingly acknowledges the critical importance of technology in socio-economic development, it is imperative for India to enhance its technological competitiveness - both domestically and through international collaborations. To this end, the International Technology Engagement Strategy (ITES) is an effort by the Office to develop effective international technology engagement strategies for India. This initiative is aimed at informing India's engagement in science and technology with key international partners. Under the ITES initiative, the office is undertaking several areas of work:

- Technology-specific strategies for international engagement.
- Country-level strategies for international engagement.

Technology-Specific Strategies

Under the ITES initiative, technology-specific strategies were prepared by the office with an aim to augment India's existing national technology initiatives. These strategy documents (consisting of dossiers and fact sheets) utilise various scientometric indicators to map a particular technology's domestic and global ecosystem and provide a comprehensive analysis for prospective international engagement. Based on these documents, actionable insights have been derived for augmenting India's outward-facing technology engagements with an aim to increase India's S&T competencies in a select set of critical and emerging technologies. The initial set of technologies identified for technology strategies include Quantum technology, Semiconductors, Artificial Intelligence (AI), Green Hydrogen, Advanced Biotechnology, and Space Technology.

The office released the ITES for Quantum on 14 April 2025. This strategy dossier analyses the quantum ecosystem on the global and national levels through scientometric indicators, while also analysing gaps in the Indian quantum ecosystem. Further to this landscape mapping, a set of indica tive efforts were advised for partner countries like the US, the UK, Australia, Germany, China and South Korea.

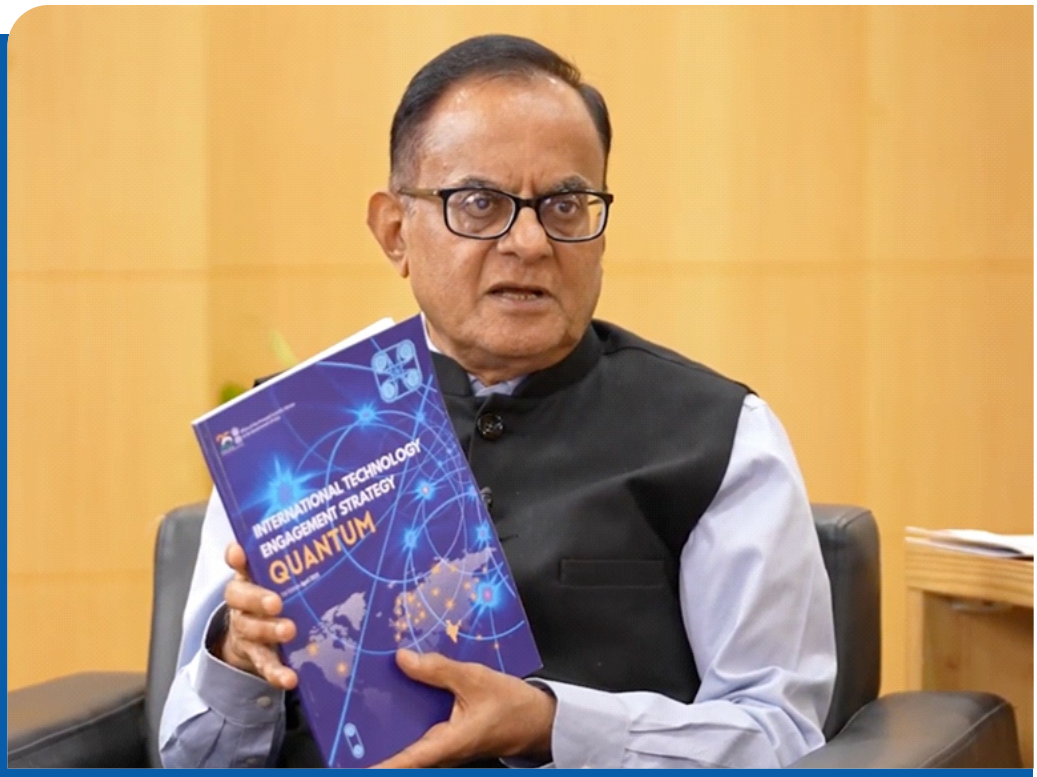


Figure 5.6.1 : Prof. Ajay Kumar Sood officially unveiled the first edition of the International Technology Engagement Strategy for Quantum

Country Dossiers: STI Strategies and Interventions

Under the ITES initiative, the Office undertook research and analysis to provide a comprehensive mapping of the Science, Technology, and Innovation (STI) ecosystems of partner countries. The analysis is based on a partner country's STI landscape, including socio-economic and scientometric indicators, STI priorities and strategies, and ongoing S&T collaborations with India. These dossier documents add value by providing directionality to S&T conversations with these partner countries and elucidating some key insights for potential engagements. Various country-specific dossiers and factsheets have been prepared for key partner countries, including France, Switzerland, EU, the UK, Germany, Slovenia, Japan, Guyana, Poland, Australia, Lithuania, the US and Denmark. In the year of 2025, dossiers and factsheets were prepared for Mexico and Italy. These countries are chosen based on India's partnership interest with key partner countries and to provide alignment with high-level bilateral engagements. The inputs from these dossiers/factsheets were utilised in high-level policy dialogues, discussions, and meetings to inform decision-making and shape discussion agendas.

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Task Forces & Committees

06

This chapter details the high-level governance and consultative mechanisms led or supported by the Principal Scientific Adviser. It chronicles the Office's leadership across a diverse array of Task Forces, Mission Steering Groups, and Advisory Committees that intersect critical sectors such as health, semiconductor manufacturing, deep-tech, and sustainable energy. By chairing or contributing to these 41 distinct bodies, ranging from the PM-STIAC and ETG to the Bharat 6G Mission and National Green Hydrogen Mission, the PSA ensures a cohesive, technology-led approach to national security, public welfare, and strategic autonomy.

S. No.	Subject	In capacity as	Date of Issue	Issued by
1.	Prime Minister's Science, Technology & Innovation Advisory Council (PM-STIAC)	Chairman	28/08/2018	Cabinet Secretariat
2.	Technical Committee for examination and use of innovations and technologies in drinking water and sanitation sector	Chairman	24/10/2019	Drinking Water and Sanitation
3.	Research and Technology Advisory Committee for examining the need and advising science and innovations in the field of Animal Husbandry and Dairying	Chairman	17/02/2020	D/o Animal Husbandry
4.	National Technical Textile Mission- Mission Steering Group	Member	17/03/2020	M/o Textile
5.	Committee on Technical Textiles on Research, Development & Innovation	Co-Chair	14/03/2020	M/o Textile

6.	Task Force for focused research on Corona Vaccine and other S&T issues	Co-Chair	14/04/2020	PMO
7.	ACT Acceleration Facilitation Council of World Health Organisation	Co-Chair	09/10/2020	M/o H&FW
8.	Mission Steering Group – National Digital Health Mission	Member	15/10/2020	M/o H&FW
9.	Geospatial Data Promotion and Development Committee	Chairman	04/03/2021	DST
10.	National Committee for examining the techno-commercial feasibility of installing small scale nuclear power plants	Member	13/05/2021	NITI Aayog
11.	Empowered Committee for Animal Health (ECAH) for policy inputs on veterinary vaccines/biological/drugs	Chairman	25/05/2021	D/o Animal Husbandry
12.	Mission Steering Committee under Deep Ocean Mission	Member	25/08/2021	MoES
13.	Deep Ocean Council under Deep Ocean Mission	Chairman	25/08/2021	MoES
14.	Task Force on Nutra Sector-Tenure completed	Chairman	09/11/2021	CSIR
15.	Gati Shakti	Chairman	22/11/2021	MoS(S&T)
16.	Advisory Committee for India Semiconductor Mission	Member	24/04/2022	MeitY
17.	Space Commission	Member	24/02/2022	Space
18.	Review Committee for Space reforms and Gaganyan Space Mission-2022	Member	07/03/2022	PMO

19.	Advisory Committee for S&T Capacity Building	Chairman	23/06/2022	O/o PSA
20.	Committee to deliberate on difficulties in accessing virus/clinical material for research from ICMR-National Institute of Virology, Pune	Chairman	04/10/2022	DBT
21.	Apex Committee for VAIBHAV Research Programme	Co-Chair	10/05/2023	DST
22.	National Technology Led & Deep Tech Start up Policy Consortium	Chairperson	13/09/2022	O/o PSA
23.	Mission Steering Group for Ayushman Bharat Digital Mission	Member	22/08/2022	H&FW
24.	Apex Council- Bharat 6G Mission	Member	22/03/2023	DoT
25.	Advisory Committee for the development of a policy framework for the effective implementation of the Carbon Capture, Utilisation and Storage (CCUS) initiatives in India	Member	28/07/2022	NITI Aayog
26.	Mission Governing Board (MGB) for National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)	Member	31/10/2022	DST
27.	Constitution of Committee for devising format for Indian Science Congress – 2024	Chairperson	07/03/2023	DST

28.	National Advisory Committee (NAC) for the National Initiative on Science, Technology and Innovation (STI) Statistics	Chairperson	08/06/2022	DST
29.	Empowered Group of Technology	Chairman	28.02/2020	O/o PSA
30.	Planning Committee of Space Applications Management System (SAMS) and the ten standing Committees to address the requirements of satellites & associated ground segment and its optimal utilization	Chairman	23/03/2021	O/o PSA
31.	Scientific Advisory Board (SAB) for the establishment of COSMOS-1 [Mysore Planetarium]	Co-Chair	06/10/2021	O/o PSA
32.	Oversight and Policy Guidance Committee to facilitate life sciences-based research	Chairman	12/03/2022	O/o PSA
33.	CORE Committee of Secretaries on ONOS	Chairman	13/06/2022	O/o PSA
34.	National Green Hydrogen Mission - Advisory Group	Chairperson	22/02/2023	MNRE
35.	National Green Hydrogen Mission - Empowered Group	Member	22/02/2023	MNRE
36.	The inter-ministerial Committee for India Genome Initiative (IGENI)	Co-Chair	01.04.2025	DBT

37.	Approval Committee for the recommendation of funding for proposals received for building India's foundational AI Models	Chairman	21.02.2025	MeitY
38.	Committee to synergize Artificial Intelligence across the Government of India	Chairman	02/06/2025	MeitY
39.	Prime Minister's Research Chair Scheme-Empowerment Committee	Chairman	29.12.2025	D/o Higher Education
40.	Governing Council of C-MET(Centre for Materials for Electronics Technology	Member	03-10-2025	C-MET, MeitY
41.	Steering Committee of C-MET	Chairperson	13.11.2025	C-MET, MeitY

Looking Ahead: The Future of Science Advice in India

07

As India advances toward becoming a knowledge-driven and technology-enabled nation, the role of science advice will be increasingly central to public policy and governance. Over the past two and a half decades, OPSA has established itself at the critical intersection of science, policy, and society, strengthening evidence-based decision-making, supporting national technology missions, and fostering systems-level thinking across sectors. This foundation positions OPSA to play an even more consequential role in the years ahead. The challenges shaping India's future be it climate change, health security, energy transitions, food systems, or emerging technologies, are complex, interlinked, and fast-evolving. They cannot be addressed through siloed approaches or disciplinary boundaries.

OPSA's continued relevance will lie in its ability to deepen sectoral integration, strengthen inter-ministerial coordination, and embed scientific inputs across the full policy lifecycle, from agenda-setting and design to implementation and evaluation. Going forward, science advice must also inform how national research and development priorities are set and funded. Aligning public investment in science and technology with long-term national goals will require structured, data-driven engagement between the science advisory system and governance mechanisms. In parallel, governance through foresight, horizon scanning, and scenario planning, will be essential to ensure that India remains proactive in navigating emerging technologies. Equally important is the translation of research into timely and usable policy insights.

By strengthening mechanisms for knowledge synthesis and outreach, OPSA can help bridge the gap between scientific research and societal impact. An inclusive approach to science advice—drawing on social sciences, grassroots innovation, industry, and civil society will further ensure that policy is grounded in real-world contexts. As India looks ahead, the future of science advice will depend on strong institutions, sustained collaboration, and mutual fluency between scientists and policymakers. Building on its legacy, OPSA is well placed to help shape a science advisory ecosystem that is agile, strategic, and firmly oriented toward the public good.

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List of Abbreviations

1. **ADM** – Area Denial Munition
2. **AES** – Acute Encephalitis Syndrome
3. **AI** – Artificial Intelligence
4. **AIGG** – AI Governance Group
5. **AM** – Advanced Manufacturing
6. **AMR** – Antimicrobial Resistance
7. **ANRF** – Anusandhan National Research Foundation
8. **ANVAYAM** – Indigenous Side Channel Evaluation Board
9. **APC** – Article Processing Charge
10. **ASIP** – Applied Semiconductor Infrastructure Private Limited
11. **ATMP** – Assembly, Testing, Marking and Packaging
12. **BSL** – Bio-Safety Level
13. **BWC** – Biological Weapons Convention
14. **C4IR** – Centre for the Fourth Industrial Revolution
15. **CAR** – Chimeric Antigen Receptor
16. **CCA** – Controller of Certifying Authorities
17. **C-DAC** – Centre for Development of Advanced Computing
18. **CDIL** – Continental Device India Limited
19. **CDSCO** – Central Drugs Standard Control Organisation
20. **CeRAI** – Centre for Responsible Artificial Intelligence
21. **CFP** – Call for Proposals
22. **CIP** – International Potato Center
23. **CMTI** – Central Manufacturing Technology Institute
24. **CoDe** – Co-Development
25. **CODE IITM** – Centre of Excellence in Wireless Technology, IIT Madras
26. **COW-QKD** – Coherent One-Way Quantum Key Distribution
27. **CS** – Cyber Security
28. **CSAR** – Chief Science Advisers' Roundtable
29. **CSIR** – Council of Scientific and Industrial Research
30. **D DA&FW** – Department of Agriculture and Farmers Welfare
31. **DAE** – Department of Atomic Energy
32. **DASTAK** – Disease Awareness and Surveillance through Knowledge and Action to
33. **DBT** – Department of Biotechnology
34. **DCS** – Distributed Control Systems
35. **DDRS** – Digital Drug Regulatory System
36. **DHE** – Department of Higher Education
37. **DoD** – Department of Defence
38. **DoT** – Department of Telecommunications
39. **DPDP Act** – Digital Personal Data Protection Act
40. **DPI** – Digital Public Infrastructur
41. **DPICM** – Dual Purpose Improved Conventional Munition
42. **DRDE** – Defence Research & Development Establishment
43. **DRDO** – Defence Research and Development Organisation
44. **DST** – Department of Science and Technology
45. **EFC** – Expenditure Finance Committee
46. **EMC** – Electronics Manufacturing Cluster
47. **EoI** – Expression of Interest

48. **ERNET** – Education and Research Network
49. **ESS** – Elsevier ScienceDirect Statistics
50. **ETG** – Empowered Technology Group
51. **EV** – Electric Vehicle
52. **FCBGA** – Flip Chip Ball Grid Array
53. **FIDO2** – Fast Identity Online 2
54. **FPGA** – Field-Programmable Gate Array
55. **FSID** – Foundation for Science Innovation and Development
56. **G G20** – Group of Twenty
57. **GoI** – Government of India
58. **I ICAR** – Indian Council of Agricultural Research
59. **ICMR** – Indian Council of Medical Research
60. **ICs** – Integrated Circuits
61. **ICSR** – Industrial Consultancy and Sponsored Research
62. **IEC** – International Electrotechnical Commission
63. **IGENI** – India Genome Initiative
64. **iGOT Karmayogi** – Integrated Government Online Training (Karmayogi Platform)
65. **IIIT** – International Institute of Information Technology
66. **IISc** – Indian Institute of Science
67. **IIT** – Indian Institute of Technology
68. **IITM** – Indian Institute of Technology Madras
69. **IMTECH** – Institute of Microbial Technology
70. **INFLIBNET** – Information and Library Network Centre
71. **IoT** – Internet of Things72. IP – Intellectual Property
73. **ISM** – India Semiconductor Mission
74. **ISO** – International Organization for Standardization
75. **iSPIRT** – Indian Software Product Industry Round Table
76. **ISRO** – Indian Space Research Organisation
77. **IT Act** – Information Technology Act
78. **ITEC** – Indian Technical and Economic Cooperation
79. **IVRI** – Indian Veterinary Research Institute
80. **JE** – Japanese Encephalitis
81. **KDE** – Key Distillation Engine
82. **KFD** – Kyasanur Forest Disease
83. **MCM** – Medical Countermeasures
84. **MEA** – Ministry of External Affairs
85. **MeitY** – Ministry of Electronics and Information Technology
86. **MHA** – Ministry of Home Affairs
87. **MHI** – Ministry of Heavy Industries
88. **ML-DSA** – Module Lattice Digital Signature Algorithm
89. **ML-KEM** – Module Lattice Key Encapsulation Mechanism
90. **MNCs** – Multinational Corporations
91. **MoE** – Ministry of Education
92. **MoES** – Ministry of Earth Sciences
93. **MoHFW** – Ministry of Health and Family Welfare
94. **MoPR** – Ministry of Panchayati Raj
95. **MoRD** – Ministry of Rural Development
96. **MoSJE** – Ministry of Social Justice and Empowerment
97. **MSME** – Micro, Small and Medium Enterprise
98. **NAC** – National Advisory Committee
99. **NCDC** – National Centre for Disease Control

100. **NdFeB** – Neodymium-Iron-Boron
101. **NII** – National Institute of Immunology
102. **NIST** – National Institute of Standards and Technology
103. **NOHM** – National One Health Mission
104. **NQM** – National Quantum Mission
105. **NSCS** – National Cyber Security Coordinator Secretariat
106. **NSM** – National Supercomputing Mission
107. **OA** – Open Access
108. **OECD** – Organisation for Economic Co-operation and Development
109. **ONOS** – One Nation One Subscription
110. **OPSA** – Office of the Principal Scientific Adviser
111. **OSAT** – Outsourced Semiconductor Assembly and Test
112. **OT** – Operational Technology
113. **PGCoE** – Power Grid Centre of Excellence
114. **PGIMER** – Post Graduate Institute of Medical Education and Research
115. **PINAKA** – Pinaka Multiple Launch Rocket System
116. **PKI** – Public Key Infrastructure
117. **PM-STIAC** – Prime Minister's Science, Technology and Innovation Advisory Council
118. **PQC** – Post-Quantum Cryptography
119. **PSA** – Principal Scientific Adviser (to the Government of India)
120. **QEC** – Quantum Error Correction
121. **QFN** – Quad Flat No-leads
122. **QKD** – Quantum Key Distribution
123. **QR** – Quick Response
124. **QuILA** – Quantum Internet with Local Access
125. **R&D** – Research and Development
126. **REPM** – Rare Earth Permanent Magnet
127. **RFP** – Request for Proposal
128. **RISC-V** – Reduced Instruction Set Computer – V
129. **RSC** – Royal Society of Chemistry
130. **SCA** – Side Channel Analysis
131. **SCADA** – Supervisory Control and Data Acquisition
132. **SDGs** – Sustainable Development Goals
133. **SEC** – Subject Expert Committee
134. **SETS** – Society for Electronic Transactions and Security
135. **SiCSem** – Silicon Carbide Semiconductor
136. SME – Small and Medium Enterprise
137. **SOP** – Standard Operating Procedure
138. **STEM** – Science, Technology, Engineering and Mathematics
139. **STI** – Science, Technology and Innovation
140. **STQC** – Standardisation Testing and Quality Certification
141. **TAG** – Technology Advisory Group
142. **TTC** – Trade and Technology Council
143. **TTO** – Technology Transfer Office
144. **UGC** – University Grants Commission
145. **UN** – United Nations
146. **UNCTAD** – United Nations Conference on Trade and Development
147. **UNICEF** – United Nations Children's Fund
148. **USD** – United States Dollar
149. **UT** – Union Territory
150. **VAIBHAV** – Vaishvik Bharatiya Vaigyanik
151. **VEGA** – RISC-V Processor Platform
152. **VPN** – Virtual Private Network
153. **VSIPL** – Vama Sundari Investments Private Limited
154. **WEF** – World Economic Forum
155. **ZET** – Zero-Emission Truck

सत्यमेव जयते

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