



Chintan
Research
Foundation

WORKSHOP REPORT

May 28, 2025



Workshop on

PRIVATE SECTOR PARTICIPATION IN THE NUCLEAR POWER SECTOR IN INDIA

Opportunities, Challenges and Path Ahead



ABOUT CRF

Chintan Research Foundation is an independent think tank committed to shaping policy through rigorous research and thought leadership. With a strong focus on fostering collaboration between policymakers and industry, CRF aims to incorporate practical insights into its research and advocacy efforts. It conducts comprehensive research to support informed decision-making and engages with stakeholders through discussions, events, and workshops. By publishing research papers, articles, and op-eds, CRF seeks to address key challenges in India and the Global South, fostering diverse perspectives and contributing to impactful policy advocacy.

Workshop on

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FOREWORD

The global nuclear energy landscape is witnessing a significant resurgence. As nations intensify their decarbonization efforts in the face of climate imperatives and clean energy transition, nuclear energy is being rediscovered as a crucial low-carbon, high-capacity baseload option. The COP28 inclusion of nuclear power in the Global Stocktake and the International Atomic Energy Agency's upward revision of global nuclear capacity projections signal this shift clearly. Emerging technologies such as Small Modular Reactors (SMRs), enhanced international collaboration, and revising regulatory regimes are driving this global momentum. The Government of India, as well, has announced the Nuclear Energy Mission, with a target of 100 GW of nuclear energy by 2047. However, achieving the transformation of this scale will necessitate equal participation of both the public and private sector.

It is against this backdrop that Chintan Research Foundation (CRF), under its Centre for Climate Change & Energy Transition, convened the workshop on 'Private Sector Participation in the Nuclear Power Sector in India: Opportunities, Challenges and Path Ahead' on May 28, 2025.

In India, this energy transition is particularly timely and consequential. As we pursue our vision of becoming a developed nation (*Viksit Bharat*) by 2047, we face a dual challenge: meeting a rapidly growing energy demand while simultaneously honouring our climate commitments. With intermittent renewables alone insufficient for long-term energy security, nuclear energy is emerging as an indispensable component of India's energy portfolio.

Today, the role of private sector in the nuclear power value chain of India is limited to the provision of equipment, components, and engineering services on behalf of NPCIL. However, given the magnitude of the 100 GW roadmap and the scale of capital, project execution, and technology integration required, greater private sector involvement across the nuclear lifecycle – from Engineering, Procurement, and Construction (EPC) and supply chain management to operation and financing – is increasingly seen as critical. For this, calibrated reforms in regulatory frameworks, liability laws, safety protocols, and financial models are essential. India's own experience, as well as global best practices, highlight the potential of public-private collaboration to deliver secure, sustainable, and scalable nuclear power.

The workshop brought together leading voices from government, industry, academia, and civil society, to explore policy, regulatory, financial, and diplomatic pathways to accelerate private sector engagement in India's nuclear energy journey. This is part of CRF's commitment to shaping India's energy future through informed, evidence-based policy dialogue. We hope the deliberations and this summary report contribute meaningfully to India's ongoing energy transition and support actionable steps towards a secure and sustainable nuclear future.

Warm regards,

Mr. Shishir Priyadarshi

President, Chintan Research Foundation

CONTENTS

01	Executive Summary	2
02	Background	3
03	Welcome Address	4
04	Keynote Address.	6
05	Panel 1: Policy and Regulatory Reforms to Support Private Sector Participation	10
06	Panel 2: Enabling Frameworks for Investments by the Private Sector ...	13
07	Panel 3: Nuclear Technology in Diplomacy – International Collaborations, Technology Transfer & Fuel Security	17
08	Recommendations and Way Forward	21
09	Annexure	23

01 EXECUTIVE SUMMARY

The discussions and deliberations in the workshop culminated in a four-pillar reform agenda for the private sector participation in nuclear power sector in India:

1. **Policy and Regulatory Reforms:** Amendments to the Atomic Energy Act, 1962 to allow private firms into non-strategic areas like EPC, operations, ancillary services, and non-critical R&D. The Civil Liability for Nuclear Damage Act (CLND) Act, 2010 must be realigned with global norms – limiting supplier liability to proven misconduct and removing overlapping legal risks under Section 46. A statutory Nuclear Regulatory Authority with autonomy, and transparency, is necessary to anchor investor trust.
2. **Technology Collaboration and Supply Chain Localization:** India must accelerate the deployment of Small Modular Reactors (SMRs) via fast-track licensing and joint pilot projects. Long-term fuel contracts and thorium utilization must secure energy sovereignty. A phased localization roadmap, standard Quality Assurance protocols, and a competitive domestic vendor ecosystem must be developed.
3. **Financing and Capacity Building:** To address long gestation periods and capital intensity, sovereign green bonds (25-30 years), PPP models with viability gap funding, and tariff-blending with renewables are recommended. The need for long-term revenue assurance mechanisms – such as a Nuclear Power Purchase Obligation (NPPO) or central pooling of tariffs – are highlighted as essential to enhance bankability. Nuclear should be recognized under green finance taxonomies to access climate capital. Simultaneously, human capital gaps must be bridged through technical training and EPC-O&M role separation. Community trust must be earned via local engagement and transparent project communication.
4. **Siting and Safety Modernization:** Guidelines aligned with International Atomic Energy Agency (IAEA) standards – covering seismic risk, hydrology, and climate resilience – and a single-window clearance mechanism integrating Ministry of Environment, Forest and Climate Change (MoEFCC), Atomic Energy Regulatory Board (AERB), and state regulators are critical to de-risking private participation.

CRF aims to publish a White Paper encompassing legal analysis, cost-risk modelling, international benchmarks, policy simulations, and stakeholder-specific roadmaps. CRF also wish to form a taskforce to conduct targeted policy engagement through high-level policy briefings and industry roundtables, translating deliberations into actionable reform pathways.

02 BACKGROUND

India is approaching a pivotal crossroads in its clean energy transition. With two goals – achieving net-zero emissions by 2070 and becoming a developed nation by 2047 – India must rapidly scale up stable and clean base-load power. In this scenario, nuclear power emerges not just as an alternative, but as a critical enabler. It holds the potential of dispatchable, low-carbon power sources capable of supporting the grid while aligning with climate goals.

A projected six-fold increase in energy demand, coupled with the need to avoid reliance on imported fossil fuels, has placed nuclear firmly back on the national agenda. India's path forward will depend on creating an institutional and financial ecosystem conducive to deploying over 100 GW of nuclear capacity by 2047.

The current legislative framework - anchored in the Atomic Energy Act, 1962 and the amendment made in 2015 and the CLND Act, 2010 – has allowed participation of only the central public sector enterprises in the nuclear power sector in India with role of private sector limited to engineering, procurement and construction (EPC) on behalf of the Nuclear Power Corporation of India Ltd. (NPCIL). This framework now requires significant reform to permit meaningful private participation across the value chain - in areas such as EPC, Operations and Maintenance (O&M), Research and Development (R&D), and advanced nuclear technology.

CRF, with Grant Thornton Bharat LLP as the Knowledge Partner, convened a high-level policy workshop titled “*Private Sector Participation in the Nuclear Power Sector in India: Opportunities, Challenges and Path Ahead*” to deliberate the role of private sector in nuclear power value chain in India and necessary policy and regulatory changes that may be required. The workshop was spread across three technical sessions and an inaugural session and attended by over 90 participants consisting of policymakers, government officials, public sector companies, private industries, legal experts, energy regulators, consultants, academicians, and think tanks researchers

The detailed background note and agenda of the workshop is provided as Annexure.

03 WELCOME ADDRESS

Mr. Shishir Priyadarshi, President, CRF, opened the workshop by warmly welcoming the keynote speaker, Dr. Montek Singh Ahluwalia, Former Deputy Chairman of the Planning Commission of India and the distinguished panelists, and other participants. Mr. Priyadarshi described the workshop as part of CRF's early initiatives in its mission to provide a platform for open, evidence-based dialogue on critical policy matters.



He spoke about India's dual challenge: on one hand, the national commitment to achieving net zero emissions, and on the other, the developmental imperative to raise per capita incomes and meet rapidly growing energy demand. With India's per capita energy consumption still well below global average, Mr. Priyadarshi emphasized that achieving developed country status by 2047 will require a four- to five-fold increase in energy production not all of which can be met through renewables alone. In this context, nuclear energy becomes vital not only as a clean energy source but potentially as one that is "as close to green as it can get."

Turning to the focus of the workshop, Mr. Priyadarshi emphasized that the government's recent Budget 2025 announcement targeting 100 GW of nuclear capacity was an important signal. However, given the long gestation periods of nuclear projects, he stated unequivocally that this ambition cannot be fulfilled by the public sector alone. He pointed to the limitations of treating private sector engagement as an auxiliary service provider and made the case for their full integration into nuclear power

generation role. This, he acknowledged, raises complex issues of civil liability, safety regulation, and institutional trust, which the day's sessions would aim to address.

In a compelling framing device, Mr. Priyadarshi introduced the '*PQRS framework*' for evaluating private sector participation in nuclear energy.

- **P – Priority:** The private sector's involvement must not be an afterthought. Policy windows must open before momentum is lost and not after the opportunity has passed.
- **Q – Quality and Quick Decision-Making:** The private sector must exceed standards in quality assurance. The government too must demonstrate efficiency and decisiveness in clearing pathways for investment.
- **R – Regulatory Reforms:** Without serious reforms to India's regulatory and liability frameworks, private sector engagement will stall after preliminary steps. Streamlined, investor-friendly reforms are essential.
- **S – Safety:** Nuclear safety remains the bedrock of public confidence. Any move toward privatization must allay concerns about safety and security through robust regulatory systems and technical standards.

“PQRS - Priority, Quality, Reforms and Safety Approach very crucial for private sector participation in nuclear energy sector in India”.

Mr. Priyadarshi further emphasized that the workshop is not just a policy conversation, rather it is an opportunity to explore pathways to structural reform. He previewed that these issues will be explored in detail through the sessions of the day, especially during the panel on investment frameworks and privatization models. He closed his remarks by welcoming and expressing deep respect for Dr. Montek Singh Ahluwalia, describing him as a rare voice of frankness and clarity in public policy.

04 KEYNOTE ADDRESS

Dr. Montek Singh Ahluwalia, Former Deputy Chairman of the Planning Commission of India, delivered the keynote address, providing a comprehensive analysis of the strategic imperatives for integrating private sector participation into India's nuclear energy landscape.

Delivering his address, Dr. Ahluwalia offered a deeply reflective, experience-based overview of India's nuclear policy journey, blending historical insight with strategic guidance for the path ahead. Drawing from his personal involvement in the negotiations of the Indo – U.S. civil nuclear agreement, Dr. Ahluwalia shared valuable lessons on the complexity of international diplomacy, the weight of internal resistance within India's nuclear establishment, and the immense value of precision in language and trust in negotiation.

4.1. The Role of Nuclear Power in India's Energy Transition

Dr. Ahluwalia unequivocally stated that nuclear power must play a central role in India's energy transition, especially considering the intermittency of renewables and the imperative to reduce coal dependence. He emphasized that achieving a net-zero pathway will require more than just declarations – it demands substantial institutional reforms, private sector participation, and detailed legislative clarity. He expressed strong support for the government's intent to amend the Atomic Energy Act, 1962 and CLND Act, 2010 but warned that the nature of those amendments will determine success. Mere legal access is insufficient if private sector firms still find the risk landscape or regulatory frameworks unworkable.



4.2. Ambitious Growth Targets for India's Nuclear Sector

A central data point highlighted by Dr. Ahluwalia was the central government's ambition to grow India's nuclear capacity from 8 GW today to 100 GW by 2047 – a 12-fold expansion in approximately 22 years. He noted that this is more aggressive than any other sectoral growth target under the “Viksit Bharat” vision. Putting things into context, *Viksit Bharat* projects a five-fold expansion in GDP, yet no other economic sector, he pointed out, is expected to grow twelve times over the same period. He said that achieving this nuclear target will require not just ambition but serious, immediate policy and institutional preparation.

“This 12-fold expansion in nuclear energy - from 8 to 100 GW by 2047 - is larger than anything else envisioned under Viksit Bharat. If that's the scale we want, we better be ambitious and serious about getting there.”

– Dr. Montek Singh Ahluwalia

4.3. Exploring the Potential of Small Modular Reactors

Dr. Ahluwalia spoke at length about the role of Small Modular Reactors (SMRs) as the “new kid on the block” in nuclear innovation. He highlighted their potential to lower costs through factory-based, standardized manufacturing, and to enable modular deployment in industrial sectors such as data centres, which are projected to grow significantly with the rise of AI and digital infrastructure. However, he raised three key questions:

- Should India restrict SMR capacity to 250-300 MW?
- What about smaller SMRs for niche industrial needs – say, 50 MW or less?
- Would India be open to multiple technology choices, or would policy mandate a single technology model?

He strongly advised that such decisions be left to an independent nuclear regulator, not the Atomic Energy Commission or policy bodies, to preserve transparency, objectivity, and investor trust.

4.4. Engaging the Private Sector in Policy Reform

Dr. Ahluwalia stressed that policy reforms must be shaped through genuine engagement with the private sector, not merely through consultation but via co-authored policy design. Government decision-makers, he noted, often lack practical exposure to how policies affect business models, technologies, and investment strategies. To that end, he recommended the active involvement of key industrial players such as Adani, L&T, Reliance, Tata – as well as foreign Original Equipment Manufacturers (OEMs) in drafting workable rules and commitments. A strong suggestion he offered was for CRF to coordinate a statement or endorsement document co-signed by major private sector actors, ensuring that future regulations do not provoke retroactive dissent or disengagement.

“Policy reforms must be shaped through genuine engagement with the private sector, not merely through consultation but via co-authored policy design.” – Dr. Montek Singh Ahluwalia

4.5. Strengthening Nuclear Governance and Safety

On the subject of safety and governance, Dr. Ahluwalia made a firm case for a statutory independent Nuclear Regulatory Authority. Citing past concerns – including the dome collapse at the Kaiga plant, he pointed out that India's current regulatory structure, which places the safety authority under the Atomic Energy Commission (which also formulates policies and manages nuclear power plants), presents a conflict of interest. Whether or not the private sector is introduced, this governance gap needs to be fixed.

“It is not acceptable to create rules that nobody finds workable. Two companies opting out is fine – but if everyone opts out, the policy has failed.” – Dr. Montek Singh Ahluwalia

4.6. Lessons from the Civil Liability Law Implementation

Mr. Ahluwalia also reflected on the flawed implementation of the civil liability law post the India – U.S. nuclear deal. The CLND Act, 2010 he argued, was introduced in a way that undermined the very objective of the agreement – by overburdening suppliers with ambiguous liabilities, thus chilling interest from both Indian and international partners. He recommended that India now fully align its liability regime with established international frameworks such as the Convention on Supplementary Compensation (CSC) to enable insurability, unlock technology transfer, and attract financing.

“You can’t ask to join a club and then reject the club’s rules. We should have simply mirrored international norms on civil liability instead of making entry harder for ourselves.” – Dr. Montek Singh Ahluwalia

4.7. Proactive Stakeholder Engagement

Dr. Ahluwalia underscored the importance of involving private sector stakeholders in the policymaking process, particularly concerning proposed amendments to the Atomic Energy Act, 1962 and the CLND Act, 2010. Such engagement is crucial to ensure that reforms are pragmatic and address the operational realities of private enterprises. He gave the food for thought for the policymakers and civil society that “With the anticipated amendments under India’s Nuclear Energy Mission, particularly to the Atomic Energy Act, 1962, and the CLND Act, 2010, will the opening up of the nuclear sector be limited to Indian private companies only? Or will it also permit participation by foreign private companies either directly, through joint ventures with Indian entities, or via other permissible structures? I would like to understand whether the envisioned regulatory reforms will accommodate international private sector involvement, and if so, under what conditions or safeguards.”



4.8. Conclusion and Call to Action

He concluded by commending CRF for taking the lead in convening an open, substantive dialogue on this critical issue. He urged CRF to prepare a white paper that reflects true multi-stakeholder consensus, including voices from industry, international experts, and regional think tanks. While cautioning against directly drafting legislation (as this falls under the Law Ministry's mandate), he encouraged CRF to provide a clear evaluative framework that can be used to assess whether any proposed legal amendments are meaningful in enabling private participation.

05 PANEL 1 - POLICY AND REGULATORY REFORMS TO SUPPORT PRIVATE SECTOR PARTICIPATION

MODERATOR



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The first panel of the workshop focused on the policy and regulatory reforms needed to unlock private sector participation in India's civil nuclear energy sector. With India's ambitious target to achieve 100 GW of nuclear capacity by 2047, aligning with its net-zero commitments and growing energy demand, panellists argued that the existing legal framework is inadequate to enable private investment and technological innovation. Central to the discussion was the need to amend the Atomic Energy Act, 1962 and the CLND Act, 2010, which were identified as major deterrents for suppliers, insurers, and financiers due to ambiguous and excessive liability provisions. The current legal setup, especially Sections 17 and 46 of the 2010 Act, imposes disproportionate and unpredictable risk on suppliers, diverging from international conventions like the Convention on Supplementary Compensation for Nuclear Damage, thereby discouraging both domestic and international stakeholders.

“The current legal structure especially Sections 17 and 46 makes projects unbankable. No private capital will come in until liability is predictable and aligned with global norms.” – Mr. Suhaan Mukerji

The panel emphasized that institutional reforms must accompany legal changes. A key proposal was the establishment of a fully independent and financially autonomous nuclear regulatory authority to instil investors' confidence and ensure transparent oversight. The integration of SMRs into India's nuclear roadmap was another major theme. While SMRs were recognized as promising for industrial, remote, and captive applications – especially in reducing transmission loads and enhancing 24x7 clean energy access – experts stressed that they cannot substitute for large-scale reactors required to meet India's national goals.

“Nuclear will help relieve the pressure on transmission systems, especially when sited closer to consumption centers. Small Modular Reactors are ideal for such use cases.” – Mr. Manoj Kumar Agrawal



“On all metrics like cost, land, and scalability it is nuclear that offers the most viable pathway. But to meet this challenge, we must address regulation, capital, and uranium supply together.” – Amb. D. P. Srivastava

From a systems perspective, speakers pointed to the strategic advantage of nuclear power in ensuring grid stability in a renewables-heavy landscape, especially as India transitions to a carbon market regime. Unlike intermittent solar and wind, nuclear offers consistent and emission-free firm power, making it an attractive option for industries with clean energy mandates. A modelling study by IIT Bombay and Vivekananda International Foundation, presented in the panel further strengthened this case, showing that a nuclear-intensive energy mix would be more cost-effective and land-efficient than a renewables-only path, especially given India’s high future electricity demand projections.

Overall, the panel concluded that strategic clarity, regulatory independence, and targeted investment will be critical to unlock the full potential of nuclear energy. In particular, leveraging India’s three-stage nuclear programme and its thorium reserves was seen as a strategic long-term imperative to ensure fuel security and reduce dependence on imports.

“Safety and security are not destinations, they are journeys. Private players must internalize this ethos, not view it as a cost center.”
– Dr. Manpreet Sethi

Key Takeaways:

1. **Legislative Overhaul:** India must amend its nuclear laws to provide a predictable, internationally aligned legal framework that enables private sector participation.
2. **Predictable Liability Norms:** Liability must be channelled to the operator on a no-fault basis, capping exposure and removing overlaps with unrelated statutes.
3. **Independent Nuclear Regulator:** An autonomous regulatory body is essential to assure investors and ensure transparent governance.
4. **SMRs as Enablers, Not Substitutes:** Small Modular Reactors can address specific use cases but cannot replace large-scale reactors for national energy targets.
5. **Nuclear as Strategic Asset:** For cost-effective decarbonization and land use efficiency, nuclear must be prioritized alongside efforts to secure domestic fuel supply through thorium-based technologies.

06 PANEL 2 - ENABLING FRAMEWORKS FOR INVESTMENTS BY THE PRIVATE SECTOR

MODERATOR



MR. AMIT KUMAR

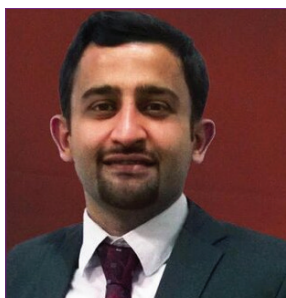
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The second panel critically evaluated the institutional, financial, regulatory, and technological frameworks necessary to enable meaningful private sector participation in India's civil nuclear energy program. Against the backdrop of India's ambitious 100 GW nuclear capacity target, the discussion underscored the strategic imperative of mobilizing private capital and capacity to complement public sector efforts. However, the panellists highlighted that despite early interest – particularly from energy-intensive industries seeking decarbonization pathways – private sector involvement remains largely aspirational due to foundational policy and regulatory inadequacies.

“A comprehensive policy roadmap is essential to facilitate meaningful private investment in nuclear power, warning that Request for Proposal (RFPs) alone are not sufficient to secure long-term sectoral transformation.” – Prof. A.V. Krishnan

A key theme across interventions was the need for comprehensive legislative and regulatory reform. The current frameworks – governed by legacy codes, restrictive siting norms, and ambiguous technology eligibility – were deemed misaligned with the scale and pace of investment required. Similar to Panel 1, the panellists of this session too stressed the importance of updating the Atomic Energy Act, 1962 and CLND Act, 2010 to permit broader private engagement across the project lifecycle. Similarly, outdated siting regulations, particularly seismic zone restrictions, were identified as key bottlenecks that constrain land availability and delay project timelines. Several speakers pointed to international examples – such as Japan and France – as benchmarks for more adaptive regulatory models.

“Land will be a critical constraint. Our siting regulations are based on legacy codes. France and Japan offer more contemporary templates that we can adapt.” – Mr. Vivek Sharma





On the technological and operational front, the panel noted that while Indian EPCs like L&T are technically prepared to execute nuclear projects, implementation is hampered by non-standardized reactor designs, fragmented procurement procedures, and an underdeveloped vendor ecosystem. These inefficiencies elevate project risk and prolong timelines, discouraging private capital. Therefore, standardization in design and quality assurance protocols, coupled with phased localization strategies and technology transfer from foreign OEMs, were proposed as essential reforms.

“A single non-performing vendor among 200 can jeopardize the entire project. The private sector cannot afford such inefficiencies.”

– Mr. Praveen Bhatt

Financing challenges were also central to the discussion. The high capital intensity, long gestation periods, and cost unpredictability of nuclear projects deter investments unless de-risked through appropriate fiscal instruments. Suggestions included Sovereign Green Bonds (SGB) with long tenors, Viability Gap Funding (VGF), Interest During Construction (IDC) exemptions, and production-linked incentives (PLI) for domestic manufacturing. Moreover, revenue predictability through nuclear-specific offtake mechanisms and payment security systems was deemed critical to build investor confidence. The need for long-term revenue assurance mechanisms – such as a Nuclear Power Purchase Obligation (NPPO) or central pooling of tariffs – was highlighted as essential to enhance bankability.

Institutional coordination emerged as another foundational need. The absence of a single point of coordination across ministries, regulators, and utilities, exacerbates delays and policy uncertainty. To address this siloed approach and ensure coordinated action to reduce the delays, the establishment of a National Power Mission was recommended to streamline approvals, align demand aggregation, and facilitate public-private partnerships. In parallel, human capital shortages – particularly in O&M and regulatory oversight – were identified as latent constraints requiring urgent investment in skills development.

“Private players must transition from co-developers to full project developers. That requires assurance on fuel, technology, demand, and risk-sharing.” – Mr. Arpan Gupta

“If we can predict the levelized cost of power, we can invest confidently. Without cost predictability, investment will be limited to captive interest only.” – Mr. Neeraj Agrawal

Finally, the panel argued for reimagining nuclear energy’s value proposition beyond electricity, proposing its integration into hydrogen production, process heat for industry, and hybrid renewable systems. Such a diversified deployment strategy, supported by demonstration projects and R&D partnerships, could unlock new markets and strengthen the business case for private investment

“India’s industry is focused on short-term costs, not long-term decarbonization. A 75-paise increase in tariffs can derail a project.”
– Mr. Karthik Ganesan

Key Takeaways:

1. **Comprehensive Legislative and Regulatory Reforms:** Amendments to the Atomic Energy and CLND Acts – are essential to allow private sector entry and mitigate legal ambiguities.
2. **Standardization and Localization of Technology:** It must be prioritized to reduce project delays, enable economies of scale, and develop a robust domestic supply chain.
3. **Financing Mechanisms:** Innovative financing mechanisms and risk mitigation tools, such as SGBs, VGF, and PLI schemes, are necessary to improve project viability.
4. **Institutional Coordination:** Institutional coordination through a National Nuclear Power Mission can streamline decision-making, align stakeholder efforts, and improve investor confidence.
5. **Human Capital Development:** Human capital development and hybrid applications of nuclear energy are critical to ensure operational readiness and diversify the sector’s economic relevance.

07 PANEL 3 - NUCLEAR TECHNOLOGY IN DIPLOMACY: INTERNATIONAL COLLABORATIONS, TECHNOLOGY TRANSFER & FUEL SECURITY

MODERATOR



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Westinghouse India

The final session of the workshop focused on the international dimensions of India's nuclear energy ambitions, delving into the critical interplay between diplomacy, technology partnerships, and long-term fuel security. The discussion underscored that while India has made considerable strides in civil nuclear energy – particularly since the India-U.S. nuclear deal – its legislative and regulatory environment still constrains full-scale global engagement and private sector participation. One of the recurring themes was the urgent need to modernize India's nuclear laws, especially the Atomic Energy Act, 1962 and the CLND Act, 2010, to reflect technological advancements and the shifting nature of global nuclear governance.

“To build 100 GW of nuclear, we need manufacturing scale, site readiness, global vendors, and fuel assurance. NTPC is preparing on all fronts.”

– Mr. Prasenjit Pal

The panel highlighted the transformative potential of emerging technologies like nuclear fusion and SMRs, which could redefine India's clean energy roadmap. Fusion, previously seen as a futuristic solution, is now nearing commercial feasibility. However, India's regulatory framework does not differentiate fusion from traditional fission, limiting innovation. Regulatory clarity – through legal reclassification and risk-differentiated licensing – was advocated as a precondition to unlocking domestic innovation and global collaboration in this space.

“We're living in 2025, not 1962. Fusion needs to be classified separately from fission. India has the chance to become a leader in the Global South on fusion development.” – Dr. Shaurya Kaushal





Fuel security emerged as another strategic concern. As India scales its nuclear capacity, reliance on imported uranium and fuel guarantees from global vendors will be unavoidable. Participants argued for embedding long-term fuel assurances within EPC contracts and accelerating thorium-based fuel research, particularly through collaborations with international entities. Concurrently, India must actively participate in international standard-setting efforts, especially around SMRs, to align its domestic licensing regimes with global best practices and to position itself as both a user and exporter of nuclear technologies.

“Fuel is not the problem. Policy alignment, legal clarity, and international financing models will determine India’s nuclear success.”

– Mr. Shah Nawaz Ahmad

The panel also made a strong case for India to assume a leadership role in shaping the future of global nuclear diplomacy, not merely as a reactor market but as a trusted democratic partner capable of exporting both technology and governance models. Examples from France, the U.S., and multilateral institutions were used to highlight how India can balance public ownership and commercial orientation, build local stakeholder trust, and advance its strategic interests. Moreover, the growing influence of private companies, AI integration, and regional diplomacy in nuclear governance was discussed as an opportunity for India to shape a new multipolar nuclear order through bilateral and multilateral platforms.

“Nuclear is no longer only the domain of states. Private sector, AI, and regional diplomacy are reshaping the governance model.”

– Mr. David Santoro

“We are ready with reactors, supply chain, and fuel. The only thing needed now is regulatory certainty to proceed.” – Dr. Alok Mishra

In essence, the session argued that for India to fully realize its nuclear potential – commercial, diplomatic, and technological – it must modernize its legal frameworks, proactively shape global standards, deepen strategic partnerships, and invest in next-generation technologies.

“Nuclear energy isn’t just infrastructure; it’s a generational responsibility and a diplomatic tool for peace.” – Ms. Myrto Tripathi

Key Takeaways:

1. **Legislative Modernization:** India must urgently amend the Atomic Energy Act to separately classify nuclear fusion and introduce differentiated regulatory treatment for SMRs.
2. **Fuel Security Strategy:** Long-term uranium supply contracts and accelerated thorium R&D are essential for sustaining large-scale nuclear deployment.
3. **Global Partnerships:** India should institutionalize bilateral and trilateral technology partnerships with other countries, foreign private industries and IAEA-led platforms.
4. **Private Sector Enablement:** Clear liability norms and predictable regulatory pathways are prerequisites to attract private investment and international vendors.
5. **Innovation & Diplomacy:** Fusion, AI-nuclear integration, and exportable governance models can position India as a leader in the future nuclear order.

08 RECOMMENDATIONS AND WAY FORWARD

India's ambition to achieve net-zero emissions by 2070 and *Viksit Bharat* by 2047 requires urgent expansion of clean, reliable base-load power. Nuclear energy, with its low-carbon and firm generation profile, is central to this vision. However, unlocking its full potential – particularly through private sector participation – necessitates legislative, financial, technological, and institutional reforms. Based on deliberations at CRF's workshop on "Private Sector Participation in the Nuclear Power Sector," the following recommendations and strategic way forward are suggested:

7.1. Policy and Regulatory Reform

- Amendment of the Atomic Energy Act, 1962 to allow private participation in non-strategic areas like EPC, O&M under license, ancillary services, and non-critical R&D. Enable differentiated regulation for modern technologies like SMRs and fusion reactors.
- Reforming the CLND Act, 2010 to limit supplier liability under Section 17 to gross negligence or wilful misconduct; amendment of Section 46 to align with CSC for better insurability and FDI.
- Establishing a statutory Nuclear Regulatory Authority (NRA) with independent staffing, budget, and global-standard protocols.
- Enabling coordination of inter-ministerial efforts on project approvals, land acquisition, de-risking tools, and state-level coordination under the Nuclear Energy Mission.

7.2. Technology, International Collaboration, and Supply Chain Localization

- Accelerating Small Modular Reactors (SMRs) via fast-track regulatory approval and pilot co-development with global partners.
- Strengthening fuel security through long-term uranium contracts and enhance thorium R&D at BARC/IGCAR.
- Institutionalizing international R&D cooperation through active collaboration, focusing on latest technology, fusion, and safety aspects.
- Localization of the nuclear supply chain with phased indigenization, quality standards, and support for export-oriented manufacturing.

7.3. Finance, Market Architecture, and Capacity Building

- Designing of financial instruments such as long-tenor sovereign green bonds, PPP models with sovereign guarantees, and tariff blending mechanisms. Establish escrow-backed payment systems.
- Integrating nuclear into green finance taxonomies to access climate and multilateral finance.
- Building human capital through public-private training and phased EPC/O&M role transfer to trusted private operators.
- Fostering community engagement with structured outreach in siting regions and toolkits for district authorities.

7.4. Siting and Safety Standards Compliance

- Modernizing siting and land acquisition guidelines, institutionalizing public-sector-led pooling and aligning with IAEA standards on seismic, hydrological, and population factors.
- Establishing a single-window clearance mechanism for streamlined regulatory and environmental approvals with multi-agency coordination.

Way Forward:

As convenor of this dialogue, Chintan Research Foundation (CRF) proposes two strategic steps:

1. Comprehensive White Paper Development covering:

- Legal and regulatory gaps.
- Cost-risk analyses of nuclear projects under reformed frameworks.
- International benchmarks.
- Policy simulations for SMRs, restructured regulation, etc.
- Action roadmaps for key stakeholders (DAE, AERB, EPCs, Insurers among others).

2. Formation of a Task Force for targeted Policy Engagement

- Stakeholder Engagement with DAE, NITI Aayog, MoP, MEA among others.
- Industry roundtables with technology providers, EPCs, utilities, and financiers to co-develop reform-aligned models and investment pathways.



09 ANNEXURE

Background Note

Globally, as countries accelerate their transition towards low-carbon electricity generation, nuclear power has witnessed a renewed focus due to its significant potential in enabling deep decarbonization. Amongst all the sources of energy generation, nuclear energy has a very low lifecycle greenhouse gas (GHG) emissions intensity (29 tonnes CO₂e/GWh). In contrast, the same for coal and natural gas are 888 tonnes CO₂e/GWh and 499 tonnes CO₂e/GWh, respectively. Experts have increasingly acknowledged that achieving the Paris Agreement goal of limiting the average rise in global temperatures to below 1.5°C would be significantly more difficult without expanding the role of nuclear energy. Nuclear power also offers high-capacity factors, energy security, and dispatchable baseload electricity – making it an indispensable component of future power systems, particularly when paired with variable renewables. Its deployment can supplement the energy transition away from fossil-fuel-based power generation, thereby avoiding emissions on a substantial scale.

Reflecting this global shift, the United Nations Climate Change Conference (COP28) held in Dubai in 2023 included nuclear power for the first time in the Global Stocktake, that emphasized the need to accelerate the deployment of low-emission technologies, including nuclear, to support rapid and deep decarbonization. In line with this momentum, the International Atomic Energy Agency (IAEA) has revised its projections for nuclear power growth upwards for the fourth consecutive year. In its high-case scenario, global nuclear capacity is projected to increase 2.5 times – from 371.5 GW to 950 GW – by 2050, with significant contributions expected from Small Modular Reactors (SMRs), which offer enhanced siting flexibility, modular construction, and potential for cost reductions.

In the Indian context, the country's aspiration to become a *Viksit Bharat* by 2047 will necessitate sustained economic growth of 8 to 9% per annum. This growth trajectory will, in turn, drive a substantial increase in energy demand. As of 2023, India's per capita electricity consumption was 1,331 kWh – about one-third of the global average – but it is expected to rise to 3,675 kWh by 2047. Over the next 25 years, total energy demand is expected to double, with the share of electricity in the energy mix increasing from 18.3% in 2022 to 40.3% in 2047. To meet this growing demand sustainably and achieve its target of 50% electricity generation from non-fossil fuel sources by 2030 and net-zero emissions by 2070, India is diversifying its energy portfolio. As of December 2024, India's total installed power capacity stood at 462 GW, with 209.45 GW coming from renewable energy sources. However, renewable energy sources, like solar and wind, are limited by their intermittency, lower energy density, and the inability to provide baseload power on a standalone basis. This underscores the importance of clean, firm generation sources like nuclear power, which can stabilize the grid, provide long-duration output, and reduce reliance on fossil backup.

Nuclear power is thus emerging as an important pillar in India's clean energy transition. With this background, the Government of India has launched the Nuclear Energy Mission, aiming to develop

at least 100 GW of nuclear power capacity by 2047. Currently, India's installed nuclear power capacity is 8.18 GW, contributing less than 3% to the national electricity mix. All the reactors are operated by Nuclear Power Corporation of India Ltd (NPCIL), a public sector enterprise. Two new reactors are being implemented by Anushakti Vidhyut Nigam Ltd. (ASHVINI), which is a joint venture of NPCIL and NTPC. The role of private sector in the nuclear power value chain is limited to the provision of equipment, components, and engineering services on behalf of NPCIL. However, given the magnitude of the 100 GW roadmap and the scale of capital, project execution, and technology integration required, greater private sector involvement across the nuclear lifecycle – from Engineering, Procurement, and Construction (EPC) and supply chain management to operation and financing – is increasingly seen as critical.

To enable a deeper participation by the private sector, as part of the Nuclear Energy Mission, amendments to the Atomic Energy Act, 1962, and the Civil Liability for Nuclear Damage Act, 2010, are being considered by the Govt. of India. The Finance Minister's 2025 budget speech recognized the need to enable private sector engagement in nuclear power generation through a calibrated reform of the legislative framework. These reforms are aimed at creating a regulated space for private investment while maintaining sovereign control over strategic assets, fuel cycles, and safety protocols.

Globally, countries with high share of nuclear energy – such as France, Hungary, Japan and South Korea – are predominantly state-led, with varying degrees of private participation. Even in countries with hybrid models such as Belgium, Switzerland, and Finland, where private or semi-private companies operate nuclear plants, the state often retains significant ownership or strategic control. On the other hand, in the United States, nearly all commercial nuclear reactors are owned by private utilities, and the regulatory and liability frameworks have evolved to support private ownership under strict oversight. Canada, meanwhile, uses long-term leases between public owners and private operators, while Finland's cooperative "Mankala" model enables industries to co-invest in nuclear capacity for self-use at cost. These structures offer valuable lessons for India in designing context-specific public-private models. In addition to legal and institutional reforms, the modernization of India's nuclear licensing framework is being discussed, with an emphasis on international best practices such as risk-informed approaches to exclusion zones, concurrent licensing mechanisms for imported technology, and design standardization to enable faster deployment. The refreshing of codes and regulatory processes will also be crucial to enhance investor confidence and reduce lead times for new builds.

As India expands its nuclear ambitions, international collaboration will become vital for accessing advanced technologies – particularly SMRs – and securing long-term fuel supply chains. India's recent bilateral engagement with countries like France and the United States has emphasized technology cooperation, reinsurance protocols, and co-development of safety and quality assurance standards. Fuel supply arrangements, such as uranium procurement, enrichment services, and long-term fuel leasing, will also require coordinated strategies involving both state and industry actors. These collaborations will support the creation of a resilient supply chain for India's 100 GW nuclear roadmap.

With this background, this workshop aims to deliberate on some of the issues mentioned below:

- Importance of nuclear energy to meet India's rising demand in a decarbonized way
- Understand the current institutional, regulatory, and legal framework governing the nuclear power sector in India

- Examine liability-sharing frameworks, including risk pooling, reinsurance ecosystems, and international conventions to reduce legal uncertainty
- Explore the refresh of licensing procedures, safety codes, and planning zones in alignment with global standards
- Assess the existing role of the private sector – both domestic and foreign – in India’s nuclear industry
- Identify challenges & opportunities to enable greater private sector participation across nuclear value and fuel supply chains, and explore the required regulatory, institutional, and legal, insurance reforms.
- Discuss global models for investment risk mitigation such as the Regulated Asset Base (RAB) model, long-term power purchase contracts, and sovereign guarantees
- Assess project structuring models – from EPC contracting to full-scale operations – and their viability under Indian electricity and pricing regulations
- Evaluate India’s readiness in terms of skilled workforce, local manufacturing capabilities, and supply chain localization
- Examine global best practices and potential models for India to adopt; and
- Explore opportunities for public-private partnerships in the development, deployment, and operation of nuclear energy technologies, particularly BSRs and SMRs.
- Examine the role of technology diplomacy and strategic partnerships in transferring technology and ensuring long-term fuel procurement.

The workshop seeks to foster a multi-stakeholder dialogue involving policymakers, regulatory bodies, industry leaders, and independent domain experts. The objective is to deliberate and co-create actionable policy and institutional recommendations that can support effective private sector engagement in India’s nuclear energy sector, while ensuring safety, sustainability, and strategic autonomy.

Workshop Agenda

Time	Agenda
10:00 – 10:30 hours	Registration and Tea/Coffee
10:30 – 10:45 hours	Welcome Address: Mr. Shishir Priyadarshi, President, Chintan Research Foundation
10:45 – 11:15 hours	Keynote Address: Dr. Montek Singh Ahluwalia, Former Deputy Chairman, Planning Commission, Govt. of India
11:15 – 11:30 hours	Presentation: Setting the Context
11:30 – 13:00 hours	<p>Panel 1: Policy & Regulatory Reforms to Support Private Sector Participation in the Nuclear Power Sector in India</p> <p><i>(This panel will explore proposed legal and regulatory changes, including amendments to the Atomic Energy Act and CLND Act, liability frameworks, licensing reforms, and zoning norms to enable greater private participation while ensuring safety and oversight.)</i></p> <p>Panelists:</p> <ul style="list-style-type: none"> • Dr. Manpreet Sethi, Distinguished Fellow, Centre for Air Power Studies • Amb. D.P. Srivastava, Distinguished Fellow, Vivekananda International Foundation • Mr. Manoj Kumar Agrawal, Executive Director, Grid Controller of India Limited • Mr. Suhaan Mukerji, Managing Partner, PLR Chambers <p>Moderator: Mr. Shishir Priyadarshi, President, Chintan Research Foundation</p>
13:00 – 13:45 hours	Lunch and Networking
13:45 – 15:15 hours	<p>Panel 2: Enabling Frameworks for Investments by the Private Sector in the Nuclear Power Sector</p> <p><i>(This panel will focus on investment models, including PPPs and RAB frameworks, financing structures, cost recovery mechanisms, and localization of supply chains to support India's 100 GW nuclear roadmap.)</i></p> <p>Panelists:</p> <ul style="list-style-type: none"> • Prof. A.V. Krishnan, Raja Ramanna Chair, National Institute of Advanced Studies • Mr. Vivek Sharma, Business Head, Nuclear Energy and Head Energy Strategy, Adani Group

- Mr. Neeraj Agrawal, President, Nuclear Power, JSW Energy Limited
- Mr. Praveen Bhatt, Vice President- Nuclear Business, L&T Heavy Engineering
- Mr. Arpan Gupta, Director and Head, Nuclear Energy, FICCI
- Mr. Karthik Ganesan, Fellow and Director, Strategic Partnerships, CEEW

Moderator:

Mr. Amit Kumar, Partner, Grant Thornton Bharat LLP

15:15 – 16:30 hours

Panel 3: Nuclear Technology in Diplomacy: International Collaborations, Technology Transfer, and Fuel Security

(This session will highlight global partnerships for SMRs and advanced reactors, technology transfer models, fuel security strategies, and the role of diplomacy in strengthening India's nuclear ecosystem.)

Panelists:

- Mr. Shah Nawaz Ahmad Senior Advisor, World Nuclear Association
- Dr. Shaurya Kaushal, Co-Founder, Pranos Fusion Energy
- Dr. David Santoro, President, Pacific Forum
- Ms. Myrto Tripathi, President and Founder, The Voices of Nuclear & RePlanet
- Mr. Prasenjit Pal, Executive Director (Nuclear), NTPC Ltd.
- Dr. Alok Mishra, Country Director, Westinghouse India

Moderator:

Dr. Debajit Palit, Centre Head, Chintan Research Foundation

16:30 – 16:45 hours

Concluding remarks

16:45 hours onwards

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CRF workshop emphasises nuclear energy's pivotal role in India's secure energy future

By IANS | Updated: May 28, 2025 22:28 IST

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CRF workshop emphasises nuclear energy's pivotal role in India's secure energy future

The workshop was held in the context of India's expanding energy demand and long-term clean energy goals, including the ambition to achieve 100 GW of nuclear power capacity by 2047 under the Nuclear Energy Mission.

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New Delhi, May 28 (IANS) Independent think tank Chintan Research Foundation (CRF), in collaboration with Grant Thornton Bharat, on Wednesday said it successfully conducted a high-level national workshop titled

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The workshop opened with a welcome address from CRF President Shishir Priyadarshi, who underlined the importance of nuclear power in balancing energy security with climate goals

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Nuclear energy is crucial to India's stable energy future, according to the CRF workshop

