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India's Nuclear Energy Mission: Ambitions, Challenges, and the Road Ahead

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India's Union Budget 2025 has announced a new Nuclear Energy Mission, setting the stage for a major shift in the country's energy landscape. This ambitious initiative, backed by an allocation of INR 20,000 crore (approximately USD 2.4 billion), aims to operationalise five Small Modular Reactors (SMRs) by 2033 and achieve 100 GW of nuclear power capacity by 2047¹. In addition to positioning nuclear power as a key pillar of India's energy mix, this move will also strengthen energy security, reduce dependence on fossil fuels, and support India's ability to meet its international climate commitments under the 2015 Paris Agreement, which India ratified in October 2016².

Currently, India's installed nuclear power capacity stands at 8,180 MW, spread across 24 nuclear reactors³. Achieving the new target is a bold challenge, requiring the addition of 91.82 GW of nuclear capacity over the next 22 years.

Push for SMRs

At the heart of this mission is a focus on the research, development and deployment of SMRs. SMRs are advanced nuclear reactors characterised by their compact size and modular design, typically generating up to 300 MW per unit, about a third of the generating capacity of conventional nuclear power plants. Their small and modular design allows for scalability, making them ideal for regions where large plants may not be feasible, as well as faster installation and lower construction costs⁴.

The government's plan to commission at least five indigenously designed SMRs by 2033 reflects a strategic focus on indigenous technology development, with the Bharat Small Reactors (BSRs) expected to play a central role. India's nuclear operator, Nuclear Power Cooperation of India Ltd (NPCIL), defines BSRs as compact 220 MW pressurised heavy water reactors designed specifically for 'captive use'. In January 2025, NPCIL invited proposals from the private sector to finance a fleet of 220 MW BSRs to expand the country's use of green energy and replace existing coal-fired thermal power plants⁵.

With 20 pressurised heavy water reactors operating, India has the necessary expertise in this technology. This could provide a basis for the development and possible export of SMRs. In addition, SMRs could also incorporate the technology used to develop advanced thorium-based reactors, which are already being pursued, given the country's vast thorium deposits⁶.

Opening the Nuclear Sector

Perhaps the most ground-breaking aspect of the Nuclear Energy Mission is the proposed amendment to the Atomic Energy Act and the Civil Liability for Nuclear Damage Act. These legislative reforms aim to remove barriers that have restricted private and foreign investment in India's nuclear sector.

The Atomic Energy Act of 1962 currently prohibits private investment in nuclear power plants ⁷. Under this Act, India's nuclear sector operates as a state monopoly, restricting all nuclear-related activities to the central government and its designated companies or corporations. This monopoly creates significant barriers for India to realise its ambitious nuclear energy expansion plans. An amendment to the Act could pave the way for private sector players to operate nuclear reactors, reducing NPCIL's position as the sole operator of nuclear reactors in the industry.

The strict liability provisions of the Civil Liability for Nuclear Damage Act of 2010 have deterred foreign suppliers due to concerns that nuclear suppliers could be held liable alongside operators in the event of an accident ⁸. Global norms require that all liability for a nuclear accident be assigned to the plant operator to ensure prompt compensation to victims. However, India's strict liability law gives the operator the right to seek legal redress from equipment and component suppliers in the event of an accident. C. Raja Mohan argues that without changes to the civil liability law, it will remain difficult to expand nuclear power in India and achieve a smooth green transition ⁹. The nuclear liability law has also hampered the implementation of the 2005 Indo-US nuclear deal by preventing foreign partnerships with US suppliers such as GE Hitachi Nuclear Energy and Westinghouse.

The proposed amendments are expected to open new avenues for private sector participation, allowing companies to invest in, develop and potentially operate nuclear facilities. It will also be possible to align with the 1997 Convention on Supplementary Compensation for Nuclear Damage ¹⁰, a multilateral treaty that establishes an international liability regime and increases the amount of compensation available in the event of an accident. This shift could be a game changer, reassuring and attracting both domestic and international investors.

Challenges and Opportunities

While the Nuclear Energy Mission marks a significant policy shift, it also invites cautious optimism. India's historical track record of nuclear expansion has been mixed, with several announced reactors still not operational years after their original timelines ¹¹. Achieving the ambitious target of 100 GW by 2047 will require not just policy reforms but also efficient execution, adequate infrastructure and sustained political will.

There are also concerns about how the private sector will take up a technology that has yet to achieve commercial success¹². It will be necessary to communicate transparently with the private sector on the progress of proposed changes and the regulatory process so that they can better plan for implementation and potential obstacles.

Despite these challenges, the positive momentum is undeniable. The focus on SMRs is in line with overall international trends towards more flexible, efficient and safer nuclear technologies. The inclusion of private players could drive competition, innovation and cost efficiency, while international cooperation could bring in newer technologies and best practices. The expansion of India's nuclear programme is expected to create highly skilled jobs across the industry, boost employment, drive innovation and create a vibrant nuclear ecosystem with a healthy public-private partnership.

India's Nuclear Energy Mission is more than an energy policy – it demonstrates the nation's commitment to a sustainable and secure future. While the journey may not be without challenges, the potential rewards - in terms of energy security, economic growth and environmental sustainability - make it a journey well worth taking.

Notes:

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² Ibid.

³ Department of Atomic Energy, Government of India, "India's Installed Nuclear Power Capacity to Triple by 2031-32: Union Minister Dr Jitendra Singh," July 25, 2024, <https://pib.gov.in/PressReleasePage.aspx?PRID=2037046>. Accessed on February 06, 2025.

⁴ Joanne Liou, "What Are Small Modular Reactors (SMRs)?," International Atomic Energy Agency, September 13, 2023, <https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs>. Accessed on February 04, 2025.

⁵ "India's NPCIL Seeks Proposals for Privately Funded Small Reactor Projects," *World Nuclear News*, January 02, 2025, <https://world-nuclear-news.org/articles/npcil-seeks-proposals-for-privately-funded-small-reactor-projects>. Accessed on February 04, 2025.

⁶ PK Vijayan et al., "Role of Thorium in the Indian Nuclear Power Programme," *Progress in Nuclear Energy* 101, part A (2017): 43–52, November 2017, <https://doi.org/10.1016/j.pnucene.2017.02.005>. Accessed on February 04, 2025.

⁷ Sethuraman N R and Sarita Chaganti Singh, "India Proposes to Open Up Guarded Nuclear Sector to Private Firms," Reuters, February 01, 2025. <https://www.reuters.com/world/india/india-budget-india-proposes-open-up-guarded-nuclear-sector-private-firms-2025-02-01/>. Accessed on February 04, 2025.

⁸ "India's Nuclear Energy Budget 2025: A Bold Leap Forward," Nuclear Business Platform, February 03, 2025, <https://www.nuclearbusiness-platform.com/media/insights/india-nuclear-energy-budget-2025>. Accessed on

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⁹ C. Raja Mohan, “The Story of India’s Atomic Slide – and an Opportunity to Bounce Back,” *Indian Express*, February 05, 2025. <https://indianexpress.com/article/opinion/columns/c-raj-mohan-writes-the-story-of-indias-atomic-slide-and-an-opportunity-to-bounce-back-9817764/>. Accessed on February 06, 2025.

¹⁰ “Convention on Supplementary Compensation for Nuclear Damage,” International Atomic Energy Agency, <https://www.iaea.org/topics/nuclear-liability-conventions/convention-supplementary-compensation-nuclear-damage>. Accessed on February 06, 2025.

¹¹ Gopalika Arora, “Budget 2025: Powering India’s Green Energy Future,” Observer Research Foundation, February 03, 2025. <https://www.orfonline.org/expert-speak/budget-2025-powering-india-s-green-energy-future>. Accessed on February 05, 2025.

¹² Anushree Pratap, “Nuclear Energy Mission on a Long Road to Fruition: Experts,” *Deccan Herald*, February 03, 2025. <https://www.deccanherald.com/business/union-budget/nuclear-energy-mission-on-a-long-road-to-fruition-experts-3386345>. Accessed on February 06, 2025.

