Delhi Policy Group

Advancing India's Rise as a Leading Power

POLICY BRIEF

India's Evolving Nuclear Energy Landscape

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Cover Photographs:

US President George W. Bush shakes hands with Indian Prime Minister Manmohan Singh following a meeting at the G-8 Summit, in Hokkaido, Japan on, July 9, 2008. Source: White House Archives
Prime Minister of India, Narendra Modi and the President of the French Republic, Emmanuel Macron meeting in Marseilles on February 11, 2025. Source: X/@narendramodi
Indian Prime Minister Narendra Modi with US President Donald Trump at their Joint Press Conference at the White House in Washington DC, on February 13, 2025. Source: Narendra Modi

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Contents

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Introduction

On March 12, 2025, the Union Minister of State for Science and Technology, Jitendra Singh, informed the Lok Sabha that the "concept design" stage of India's proposed Bharat Small Modular Reactor (BSMR) has been completed and is in the process of being approved. Once the project is sanctioned, the reactor will be constructed in 60-72 months.[1]

BSMRs are modified versions of India's existing 200 MWe Pressurised Heavy Water Reactor (PWHR). BSMRs will be fuelled with "slightly enriched uranium" and are being jointly designed and developed by the Bhabha Atomic Research Centre and Nuclear Power Corporation of India Limited (NPCIL).

In the Union Budget of 2025-26, the government launched the 'Nuclear Energy Mission', which is focused on research and development of Small Modular Reactors (SMRs). The government has allocated Rs.20,000 crore (US$ 2.33 billion) for this initiative, aiming to develop at least five indigenously designed and operational SMRs by 2033. The government has also set an ambitious target of 100 GW of nuclear power capacity by 2047.[2]

This brief explores India's renewed quest for nuclear power, its future goals, and the challenges faced by India's nuclear sector.

India's Nuclear Power Journey

India's growth of nuclear power has been marked by international cooperation in the years after its independence, followed by decades of isolation, and then a gradual reintegration into global nuclear supply chains.

In 1948, India established the Atomic Energy Commission, led by Dr. Homi Bhabha. With British assistance, India's first nuclear research reactor, Apsara, was commissioned in 1956. The United States helped India construct two 160

[1] Writer, Staff. "India Completes Design of Bharat SMR." Nuclear Engineering International (blog), March 13, 2025. https://www.neimagazine.com/news/india-completes-design-of-bharat-smr/.
[2] "Nuclear Power in Union Budget 2025-26." Accessed March 18, 2025. https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=2099244.

Mwe boiling water reactors (BWRs) at Tarapur, while Canada helped construct a Pressurised Heavy Water Reactor (PHWR) at Rajasthan.

India's 'Peaceful Nuclear Explosion' of 1974 triggered a set of international sanctions, with Canada and the US halting all nuclear cooperation and curtailing access to technologies and equipment. The sanctions proved a setback to India's nuclear power generation. The installed nuclear capacity in 1979-80 was about 600 MWe, and it could climb to no more than 950 MWe by 1987.[3]

The sanctions forced India to slowly attain self-sufficiency in fuel fabrication, heavy water production, reactor design and construction, reprocessing and waste management.[4] When India carried out its second nuclear test in 1998, it had ten operational reactors, with an additional six reactors under construction.

Even though additional sanctions were imposed on India after the nuclear test, by this time, India had developed sufficient indigenous capability to continue expanding its nuclear power programme. The only shortfall lay in the availability of Uranium to fuel its growing demand.

By the early 2000s, changing geopolitical dynamics led to India and the US drawing closer. On July 18, 2005, U.S. President George W. Bush and Indian Prime Minister Manmohan Singh issued a landmark joint statement announcing that the US would "work with friends and allies to adjust international regimes to enable full civil nuclear energy cooperation and trade with India."[5]

In 2008, the two countries signed the 123 Agreement permitting civil nuclear trade. India also negotiated a safeguards agreement with the International Atomic Energy Agency (IAEA) and obtained a waiver from the Nuclear Suppliers Group (NSG) permitting member countries to engage in civil nuclear trade with India. India now had access to foreign nuclear technology and fuel, which were crucial to meeting the country's future energy requirements.

[3] capsnetdroff. "India's Nuclear Power Journey: Why Has It Grown in Fits and Starts?" CAPS India (blog), February 29, 2024. https://capsindia.org/indias-nuclear-power-journey-why-has-it-grown-in-fits-and-starts/.
[4] "Nuclear Power in India - World Nuclear Association." Accessed March 18, 2025. https://world-nuclear.org/information-library/country-profiles/countries-g-n/india.
[5] Ministry of External Affairs, Government of India. "Joint Statement, India-U.S." Accessed March 19, 2025. https://mea.gov.in/bilateral-documents.htm?dtl/6772/Joint_Statement_IndiaUS.

It was widely anticipated that India's nuclear energy sector would experience rapid growth following the removal of international sanctions. However, this expectation was largely unmet, due in part to India's domestic legal framework governing nuclear energy.

The Civil Liability for Nuclear Damage Act, passed in 2010, imposed very strict liability clauses for suppliers.[6] Clause 17(b) of the Act permits the operator to seek recourse against suppliers in cases where nuclear incidents result from defective equipment or services. This deviates from international norms, which typically channel liability exclusively to the operator, thereby limiting the liability of suppliers. This clause has made international companies cautious, delaying the finalisation of contracts. Resolving liability concerns remains critical to unlocking foreign technology and investments.

The Atomic Energy Act, 1962 contains several provisions that effectively restrict or prohibit private sector participation in India's nuclear energy sector. The Act specifies that the Central Government has exclusive rights to produce, develop, use, and dispose of atomic energy. It also limits the sharing of nuclear-related technological information and research to private parties without explicit government approval.[7]

Current and Future Plans

India currently operates 24 nuclear power plants, mostly based on the PWHR design, with an installed capacity of 8180 MWe. These reactors are managed by the state-owned Nuclear Power Corporation of India Limited (NPCIL), except for one under the fast breeder program.[8]

The government has initiated steps to increase nuclear power capacity to 22,480 MWe by 2031-32. This expansion includes the construction and commissioning of ten reactors, totalling 8,000 MWe, across Gujarat, Rajasthan, Tamil Nadu, Haryana, Karnataka, and Madhya Pradesh. Additionally, pre-project activities for ten more reactors have commenced, with plans for progressive completion by 2031-32.[9]

[6] "FAQs Version 2.0 on CLND Act 2010 | Department Of Atomic Energy | India." Accessed March 23, 2025. https://dae.gov.in/faqs-version-2-0-on-clnd-act-2010/.
[7] Rai, Diva. "Atomic Energy Act, 1962." iPleaders (blog), November 15, 2020. https://blog.ipleaders.in/atomic-energy-act-1962/.
[8] "Home: Nuclear Power Corporation of India Limited." Accessed March 18, 2025. https://www.npcil.nic.in/content/328_1_AboutNPCIL.aspx.
[9] Nuclear Power in Union Budget 2025-26. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/feb/doc2025234954 01.pdf

India is actively exploring SMRs as a crucial part of its energy transition strategy. SMRs are advanced nuclear reactors with a power generation capacity ranging from 30 MWe to 300 MWe, providing a flexible, scalable, and cost-effective alternative to conventional large nuclear reactors. In February 2025, India and France signed a letter of intent to develop Small Modular Reactors and Advanced Modular Reactors.[10]

Even if all the reactors under construction become operational as planned and meet the target of 22 GW by 2032, India would still need to add about 78 GW of nuclear power in the next 15 years to reach 100 GW by 2047. India's highest capacity indigenous PWHRs are 700 Mwe and more than 100 will be required to reach this ambitious targe. Therefore, there is a need to complement India's indigenous efforts with higher-output foreign reactors.

Currently, four Russian VVER 1000 MWe reactors are under construction at the Kudankulam Nuclear Power Plant (KKNPP) in Tamil Nadu. Talks are ongoing for the construction of an additional six VVER 1200 MWe reactors.[11] However, apart from Russia, India has not yet been able to conclude deals for nuclear reactors with other countries.

In 2009, a Memorandum of Understanding (MoU) was signed between NPCIL and France's Areva for the construction of six European Pressurised Reactors (EPRs), each with a capacity of 1,650 MWe, totalling 9,900 MWe. Following Areva's financial challenges, a revised MoU was signed between NPCIL and Électricité de France (EDF) in 2016. In 2020, EDF submitted its techno-commercial offer for the project. As of today, discussions are still ongoing.[12]

In June 2016, NPCIL and Westinghouse agreed to finalise contractual arrangements for six AP1000 reactors by June 2017. During U.S. President Donald Trump's visit to India in February 2020, there were expectations that the agreement could be signed, but differences over liability and project layout prevented the finalisation of the deal.[13] In December 2024, the Lok Sabha was

[10] World Nuclear News. "India and France Sign SMR and AMR Partnership Letter of Intent." Accessed March 19, 2025. https://world-nuclear-news.org/articles/india-and-france-aim-to-establish-smr-and-amr-partnership.
[11] Tracey. "India and Russia Strengthen Nuclear Cooperation by Exploring New Projects and Advanced Technologies." Nuclear Engineering International (blog), July 12, 2024. https://www.neimagazine.com/news/india-and-russia-strengthen-nuclear-co-operation-by-exploring-new-projects-and-advanced-technologies/.
[12] "India, France in Talks for Financing Mechanism, Localisation for Jaitapur n-Project." The Economic Times, January 26, 2024. https://economictimes.indiatimes.com/news/india/india-france-in-talks-for-financing-mechanism-localisation-for-jaitapur-n-project/articleshow/107174054.cms?from=mdr.
[13] Chaudhury, Dipanjan Roy. "NPCIL-Westinghouse Deal: Still Many Differences to Resolve." The Economic Times, February 27, 2020.

informed that while discussions are in progress, Westinghouse was yet to submit a techno-commercial offer.[14]

In order to complement NPCIL's efforts, the government, in the 2024-25 budget, proposed partnerships with the private sector to research and develop Bharat Small Reactors, Bharat Small Modular Reactors, and other nuclear energy technologies. The NITI Aayog has estimated that nearly US$ 26 billion of private investment will be needed to develop the nuclear sector to meet India's energy goals. However, meaningful private sector involvement will require an amendment of the Atomic Energy Act (AEA), which stipulates that only government-owned or controlled entities can manage nuclear energy production.[15]

Overcoming Challenges

- The government has set up two task forces to examine amendments required in the Atomic Energy Act and the Civil Liability for Nuclear Damage Act. The Atomic Energy Act task force is reviewing key aspects such as the build-own-operate model of nuclear power plants by the private sector, nuclear safety, security, safeguards, fuel procurement, waste management, and spent fuel reprocessing. The second task force is looking at resolving liability concerns which remain critical to unlocking foreign technology and investments [16]

- As India's nuclear sector expands, greater attention must be paid to safety. The Atomic Energy Regulatory Board (AERB), which is responsible for the safety of India's nuclear program, has too many institutional affinities to the DAE, the body whose assets it is supposed to be supervising.[17] A proposal to establish a Nuclear Safety Regulatory Authority (NSRA) has been under consideration since 2011, but legislation has yet to be passed. The government needs to appoint an empowered regulator for nuclear safety.

https://economictimes.indiatimes.com/industry/energy/power/npcil-westinghouse-deal-still-many-differences-to-resolve/articleshow/74328698.cms.

[14] Standard, Business. "Discussions on with Westinghouse for Kovvada Nuclear Project: Govt," December 3, 2024. https://www.business-standard.com/india-news/discussions-on-with-westinghouse-for-kovvada-nuclear-project-govt-124120301264_1.html.

[15] Vajiram & Ravi. "Having Private Participation in India's Nuclear Energy." Accessed March 22, 2025. https://vajiramandravi.com/.

[16] "Centre Reviewing Nuclear Laws to Boost Energy Capacity: Jitendra Singh." Accessed March 22, 2025. https://ddnews.gov.in/en/centre-reviewing-nuclear-laws-to-boost-energy-capacity-jitendra-singh/.

[17] Carnegie Endowment for International Peace. "Reclaiming the Promise of Nuclear Power in India." Accessed March 22, 2025. https://carnegieendowment.org/research/2024/10/nuclear-power-india-promise?lang=en.

- Private sector participation is essential for the growth of India's nuclear sector. Financial support, risk mitigation mechanisms, and a guarantee of future revenue can make nuclear projects more attractive to private investors. Focusing on small modular reactors offers scalable and cost-effective opportunities for private investment. International collaborations should be encouraged to bring in advanced technologies and best practices, enhancing domestic capabilities.

- Nuclear power often faces public acceptance challenges in India. The commissioning of Kudankulam-1 was delayed by nearly a year due to intense protests in 2011–12 sparked by safety fears after Fukushima. Protests in Gujarat, Tamil Nadu, West Bengal and Maharashtra have forced relocation of some of the proposed projects to more receptive regions.[18] Building trust with local communities by strong safety assurances and economic rehabilitation packages is essential.

Conclusion

Currently, nuclear power contributes approximately 3 per cent to India's total electricity generation, a figure which will need to grow significantly if the country is to realise its ambition of bringing its net carbon emissions down to zero by 2070. India has shown impressive progress in achieving self-sufficiency in nuclear power generation, but achieving the goal of 100 GW nuclear capacity by 2047 will require some swift and decisive actions including legislative reforms, resolving liability issues, and empowering regulatory bodies to ensure stringent safety standards.

The introduction of BSMRs and active exploration of international partnerships reflects India's desire to scale up its capacity. Meaningful participation from the private sector will be crucial, but will require amendments to the Atomic Energy Act, financial incentives, and effective risk mitigation measures. Equally important is fostering public trust and acceptance through transparent communication, safety assurances, and responsible project management. India's path to nuclear expansion holds promise, but it will require a comprehensive vision and a razor-sharp focus on structural reforms to achieve its ambitious goals.

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[18] Nuclear Power in India - World Nuclear Association....

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