Delhi Policy Group

Advancing India's Rise as a Leading Power

POLICY BRIEF

A New Vigour around India's Nuclear Power Programme

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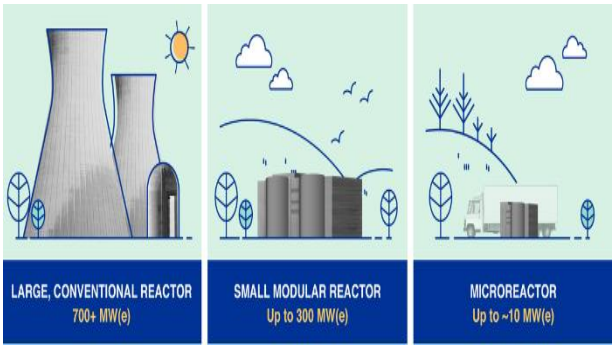

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Cover Photographs:

The Unit-7 of the Rajasthan Atomic Power Project (RAPP-7) in Rawatbhata, Rajasthan, achieved criticality on March 17, 2025. Source: X/@NpcilOfficial
Artistic depiction of Small Modular Rectors (SMRs). Source: iLearnCANA

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Introduction

Ever since the government of India announced the Nuclear Energy Mission for Viksit Bharat during the presentation of the Union Budget of 2025-26, a new vibrancy has seized the national nuclear power sector. This was reinforced by a meeting of the Consultative Committee of the members of Parliament convened by the Ministry of Power to outline the roadmap for nuclear power generation.[1] Nuclear energy has been placed at the heart of the Indian commitment to achieve net zero emissions by 2070. Since this cutback in greenhouse gas emissions must happen without hampering an ascendant economy, nuclear energy is seen as a logical choice for ensuring energy security through a stable and an environmentally sustainable non-fossil fuel source.

Given that the power sector spews nearly 75% of the greenhouse gas emissions in India[2], the government is keen to move away from polluting thermal power to environmentally friendly electricity sources such as renewables and nuclear. For the latter, an ambitious target of 100 GWe electricity by 2047 has been set. The Ministry of Power has committed to collaborating with the Department of Atomic Energy, state governments, industries, and other stakeholders to accelerate the deployment of nuclear power projects for ensuring a clean, secure, and sustainable energy future for India.

To get to 100 GWe from the current just about 9 GWe in two decades from now is going to be challenging. It will require many pieces of the jigsaw puzzle from within and outside the country to come together quickly, safely and sustainably. The government has indicated a readiness to move on all fronts -- amend the Atomic Energy Act, 1962 and Civil Liability for Nuclear Damage Act, 2010 to enable participation by foreign and domestic private sectors; incentivise public-private partnership with tax concessions and long term financing; invite foreign direct investment; ensure stringent regulatory processes for nuclear safety and security; facilitate faster land acquisition through brownfield expansions and repurposing of decommissioned thermal

[1] "Consultative Committee of the Members of Parliament for the Ministry of Power held on the subject- 'Roadmap for Development of Nuclear Power Generation'", https://pib.gov.in/PressReleasePage.aspx?PRID=2124961, Apr 28, 2025
[2] Niti Aayog, India Climate and Energy Dashboard: Economy wide Emissions, https://iced.niti.gov.in/climate-and-environment/ghg-emissions/economy-wide

sites; build skilled manpower capacity; and most importantly change public perception on nuclear energy. Indeed, for the potential of nuclear energy mission to be realised, all actions will need to be simultaneously taken in mission mode.

This policy brief makes an assessment of India's nuclear programme on three aspects – one, the pace and state of construction and operationalisation of indigenous and imported large capacity conventional nuclear reactors; secondly, the pathways towards small modular reactors and their role in India's energy mix; and thirdly, the adoption of necessary legislative and regulatory changes to facilitate private participation in both the above programmes.

Progress on indigenous and imported larger capacity reactors

On March 17, 2025, India's 25th nuclear reactor, Rajasthan Atomic Power Plant (RAPP-7) was connected to the grid taking India's share of electricity from nuclear generation to 8.88 GWe.[3] A 700 MWe indigenously designed and constructed reactor, this is the third one, in as many years, to start commercial operation. RAPP-8 is in advanced stage of construction and is likely to be commissioned in 2026. Meanwhile, two more 700 MWe reactors are under construction at Gorakhpur, Haryana. 10 more such PHWRs have already received government approval and will come up at Kaiga, Karnataka (Kaiga-5&6), Gorakhpur, Haryana (GHAVP-3&4), Chutka, Madhya Pradesh (CMAPP-1&2) and Mahi Banswara, Rajasthan (Mahi Banswara-1 to 4)[4]. This plan to build the reactors in fleet mode signals policy predictability and offers a much-needed assurance to the nuclear industry.

Besides these indigenous reactors, four 1000 MWe capacity reactors imported from Russia are also being constructed at Kudankulam. The ongoing Russia-Ukraine conflict has affected the schedule of deployment, but at least two of them are in an advanced stage of construction. Meanwhile, the finalisation of price negotiations with the French for the deployment of six 1600 MWe European Pressurised reactors at Jaitapur has long been pending, also interrupted by the reorganisation of the French nuclear establishment and businesses over the last decade. The possibility of importing American nuclear reactors is also expected to resurface once India amends its liability law, more of which is discussed in the third section of this paper.

[3] "Rajasthan's RAPP-7 Unit Joins Northern Grid, Marking Key Milestone", PIB Release, Apr 17, 2025, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2111887#:~:text=Mumbai%2C%2017th%20March%202025,Energy%20Regulatory%20Board%20(AERB)

[4] Chairman's Statement, 37th Annual General Meeting, NPCIL, Sep 20, 2024, https://www.npcil.nic.in/WriteReadData/CMS/CMD_Statement_2024.pdf

Overall, India is keen to have rapid addition of nuclear power to the country's electricity production which is possible through the induction of larger capacity reactors.

The Buzz around Small Modular Reactors

In addition to the above stream of the nuclear programme which has been steadily chugging along, the government has recently outlined a roadmap for deployment of small modular reactors (SMRs). These are reactors with a power generation capacity of up to 300 MWe or less. They are also meant to have the attribute of modularity. This means that they are designed in such a way as to be able to be manufactured as modules at factories which can then be transported to a site for assembly/installation as a product, rather than being constructed bottom up as a project. It is estimated that such construction and assembly would significantly reduce construction time, offer economies of serial production, and flexibility of deployment on land, ship, or even in an underground or submerged environment with the freedom to sequentially add modules to enhance capacity of power generation.

Globally, over 70 SMR designs are at different stages on the drawing board at present. New concepts are being developed, some with newer technologies that can offer enhanced safety and security features, including reducing the need for emergency planning zones since the risk of radiation exposure in case of an accident is expected to be lower.

Amongst the frontrunners on SMRs are Russia, China, and USA. India too has indicated its desire to join this group with the allocation in this year's budget of a sum of $2.3 billion (Rs 20,000 crores) for the development of "at least five indigenously designed and operational SMRs by 2033". India's plan is to utilise its long experience of designing and operating 220 MWe pressurised heavy water reactors, with which it started its programme. A number of such reactors have been in operation since the 1960s with a proven safety and performance record. Of course, these reactors were not modularly built. But, the plan now is to designate these as Bharat Small Modular Reactors (BSMRs) and redesign them so that they can be produced modularly. According to latest media reports, the design changes have been completed and submitted for regulatory approvals.[5]

[5] Jacob Koshy, "Design stage of small modular nuclear reactor completed: Jitendra Singh", The Hindu, Mar 13, 2025, Design stage of small modular nuclear reactor completed: Jitendra Singh - The Hindu.

Once these have been granted, India would be ready to build and operate the BSMRs relatively quickly making use of its past experience. In this effort, the country's main nuclear operator, the Nuclear Power Corporation of India Ltd. (NPCIL), has sought the assistance of the private sector to provide capital, land, and cooling water while it focusses on the design, safety and security of operations and maintenance. This arrangement can be achieved without the need for any legislative changes since NPCIL will remain in charge of nuclear material, technology and operations. Such reactors are being envisaged as captive power plants for energy-intensive industries such as steel, aluminium and cement. Since these are energy guzzlers and currently dependent on thermal sources, the idea is to provide them with baseload nuclear power and thereby help India's energy transition.

Apart from BSMRs, the Department of Atomic Energy is also designing other SMRs with newer technologies, including with foreign collaborations. Recent joint statements signed with countries that have advanced nuclear programmes, such as USA[6], Russia and France[7] all mention collaborative development of SMRs. This will help India gain from technological developments elsewhere, whilst exploiting its own capability as a component and equipment manufacturing hub in nuclear supply chain once designs achieve standardisation.

India has the potential to emerge as a supplier of nuclear components and equipment. Global nuclear power capacity is projected to surge by 25% by 2035.[8] In fact, over 30 countries, many in the developing world, are considering nuclear energy. The World Bank has indicated that it would lift its long-standing prohibition on financing nuclear energy projects to support the initiatives towards decarbonization of economy[9]. Such a policy decision by World Bank would help overcome the biggest hurdle of financing for nuclear power projects. As the world sees an uptick in nuclear reactor construction, driven largely by climate change considerations and geopolitical shifts, Indian nuclear industry could become an important part of the global nuclear supply chain. Its long experience with nuclear technology, engineering skills and

[6] India - U.S. Joint Statement (February 13, 2025)
[7] India – France Joint Statement on the visit of Shri Narendra Modi, Hon'ble Prime Minister of India to France (10-12 February 2025), India – France Joint Statement on the visit of Shri Narendra Modi, Hon'ble Prime Minister of India to France (10-12 February 2025)
[8] Kaleigh Harrison, "Nuclear Power Set for 25% Growth by 2035", E + E Leader for a Sustainable Tomorrow, https://www.environmentenergyleader.com/stories/nuclear-power-set-for-25-growth-by-2035,74380#:~:text=The%20nuclear%20power%20sector%20is,%2C%20environmental%2C%20and%20economic%20factors.
[9] "World Bank may drop ban on funding nuclear power: Ajay Banga", The Economic Times, March 21, 2025

availability of well-educated human resource is an asset that can be well exploited.

In the case of India, SMRs could be most usefully deployed for providing back-up for renewable energy plants; repurposing existing infrastructure of decommissioned coal plants; or, meeting electricity requirements of remote areas such as high mountains or islands subject to their meeting the safety and security pre-requisites.

However, for the idea of SMRs to truly live up to its potential, it would be necessary that a few of the reactor designs are finalised and receive regulatory approval. The advantage of economy of production can be enjoyed only when a design is standardised and set for modular manufacture. The timeline for such a maturity is not clear at the moment.

Realising the potential of public-private participation

A rapid expansion of India's larger capacity and small modular reactors requires involvement of the private sector. To facilitate this, the government has announced several steps. For one, it is considering amending the Atomic Energy Act 1962 to be able to offer a stake of up to 49% to foreign investments in nuclear projects[10]. Secondly, it intends to make the necessary legislative amendments to the Civil Liability for Nuclear Damage Act (CLNDA) that had been passed in 2010. This, coincidentally was the time when the Bhopal gas verdict was being pronounced amidst a sense of public anger and despondency on how long it had taken for justice to be delivered to the victims of the 1984 Union Carbide factory gas leak tragedy. So, the mood was in favour of a stringent nuclear liability law that would ensure quick remedy in case of a nuclear accident.

Accordingly, the law placed liability on the operator to simplify the process for victims to seek compensation. But in a departure from global norms, it allowed the operator to take recourse against the supplier in case of a nuclear accident resulting from a design defect or substandard equipment. This clause dampened private industry enthusiasm. While the government did announce

[10] Sarita Chaganti Singh, "India Considers Allowing 49% Ownership in Nuclear Power Plants", Reuters, April 25, 2025. Available at https://www.reuters.com/sustainability/boards-policy-regulation/india-considers-allowing-49-foreign-stakes-nuclear-power-plants-2025-04-25/#:~:text=NEW%20DELHI%2C%20April%2025%20(Reuters,goals%20to%20cut%20carbon%20emissions

a Rs 1,500 crore Indian nuclear insurance pool (INIP) in 2015 to mitigate supplier risks, domestic and foreign private companies remained sceptical.

This can change once the amendment, as is being speculated, would cap the right of the operator to seek compensation from the supplier in case of an accident at the value of the contract. It will also be subject to a period to be specified in the contract, instead of being for the lifetime of the plant as per the current CLNDA.[11] The possibility of customised insurance is also being considered by experts who are engaged on this with insurance companies and the Atomic Energy Regulatory Board[12].

The legislative amendments are expected to be passed in the monsoon session of the Indian Parliament this year. If all goes as per plan, it will offer a fresh opportunity to unlock the potential of domestic and foreign private investment in the nuclear sector to accelerate India's clean energy transition. Also being offered is the promise of faster clearances, tax breaks and long-term financing for nuclear projects.

While NPCIL collaborations with foreign entities will happen only after the necessary amendments, it can do so with Indian PSUs. So, it has already formed a Joint Venture (JV) with NTPC Ltd. On September 11, 2024, the government accorded approval for the creation of the Anushakti Vidhyut Nigam Ltd. (ASHVINI), with NPCIL having a 51% stake along with NTPC's 49%. Based on the model of Build, Own & Operate, the JV with take the construction of the Mahi Banswara Rajasthan Atomic Power Project (MBRAPP) with 4 units of 700 MWe reactors each as its first project, likely to start in mid-2025. NPCIL will transfer the indigenous PHWR technology to ASHVINI for the purpose. Such pooling of finances, technology & project expertise from both NTPC & NPCIL is expected to enable rapid expansion of nuclear power in the country. In addition to MBRAPP, ASHVINI shall also pursue other nuclear power projects, including with PWR technology. It has floated a tender inviting global partners to build such reactors with a combined capacity of around 15 GWe.[13]

Other Indian PSUs such as Indian Oil and Indian Railways too have indicated a desire to partner with NPCIL to co-develop the next generation of nuclear

[11] India Plans Liability Cap To Woo U.S. Nuclear Suppliers: Reports, Apr 18, 2025
[12] Yogima Seth Sharma & Deepshikha Sikarwar, "Customised Insurance in Work for Nuclear Power Plants", The Economic Times, April 25, 2025, https://economictimes.indiatimes.com/industry/banking/finance/insure/customised-insurance-in-works-for-nuclear-plants/articleshow/120594893.cms?from=mdr
[13] Upstox News desk, NTPC invites global bidders for 15 GW nuclear project; Holtec cleared for India partnership", NTPC invites global bidders for 15 GW nuclear project; Holtec cleared for India partnership, Apr 2, 2025

power plants.[14] Some states are also reported to have expressed interest in investing minor stakes in nuclear power plants in their area. More recently, Megha Engineering and Infrastructure Ltd (MEIL) has secured a purchase order worth Rs 12,800 crore from NPCIL to construct two reactors, Kaiga 5 and 6. On March 26, 2025, the US Department of Energy allowed Holtec International to transfer its unclassified SMR technology of 300 MWe to three companies in India — L&T, Tata Consulting Engineers and Holtec's regional subsidiary, Holtec Asia. This will enable India to participate in the manufacturing value chain of small reactors.

While nuclear collaborations are a heartening development, NPCIL must choose its partners wisely. Their experience and capacity to handle projects of this scale and stringent compliance with safety and security should be carefully considered. The country needs rapid addition of nuclear energy, but it must be built on a robust regulatory framework that harmonises growth with accountability. Any safety lapse will prove to be harmful for the entire nuclear programme.

India cannot afford any such eventuality since the benefit of nuclear energy as a low carbon and environmentally friendly source is critical for meeting its increasing electricity requirement as manufacturing grows alongside the service industry, both of which require a stable electricity grid. Investments in the larger capacity reactors will support the country's massive energy requirement, while SMRs can offer necessary additions at specific points, so that the country can sustainably meet its electricity targets in line with its demographic and aspirational requirements.

These plans, however, will also require outreach to the public to ensure greater acceptance of nuclear energy. People will need to be explained its nature and role, the problems with dependence on other sources of electricity generation, as well as the high focus that the nuclear industry places on safety of nuclear operations and processes.

Conclusion

The Indian nuclear sector is looking ripe for action once again. A similar enthusiasm had been felt in 2008 after the conclusion of the India-US nuclear deal and the grant of the exceptionalisation by the Nuclear Suppliers Group. However, the accident at Fukushima in 2011 had heightened public concerns on nuclear safety.

[14] Shilpa Samant, 'PSUs Keen on N-Plants", Economic Times, Apr 14, 2025

Nearly 14 years after Fukushima, the opportunity has again risen for the potential of nuclear energy to be fully utilised. In the meantime, India's nuclear programme has grown in confidence with its designing and operation of 700 MWe reactors. Government approval for their serial construction has added to the sense of policy certainty. Now, by putting its weight behind SMRs, taking the necessary steps to remove the legislative hurdles and providing a level playing field in financing nuclear power projects, a renewed commitment to nuclear energy is evident. This is obviously driven by the realisation that living up to the national climate change pledges is not possible without the large-scale inclusion of nuclear energy.

Given India's nearly six-decade long experience in the nuclear energy field, it is imperative that this national resource be suitably supported to reach its true potential. The key, however, for the nuclear establishment will be to remain steady, transparent and cautious. Safety and security will have to be uppermost at all time, particularly as any lapse could prove to be extremely costly, especially in terms of public support.

It needs to be recognised that the nuclear sector has a historic opportunity to seize the moment – given its long experience of safe operations, trained manpower and knowledge bank, government support, private industry enthusiasm and an informed public opinion – to enhance the share of nuclear electricity to the national energy mix and support the country's energy transition.

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