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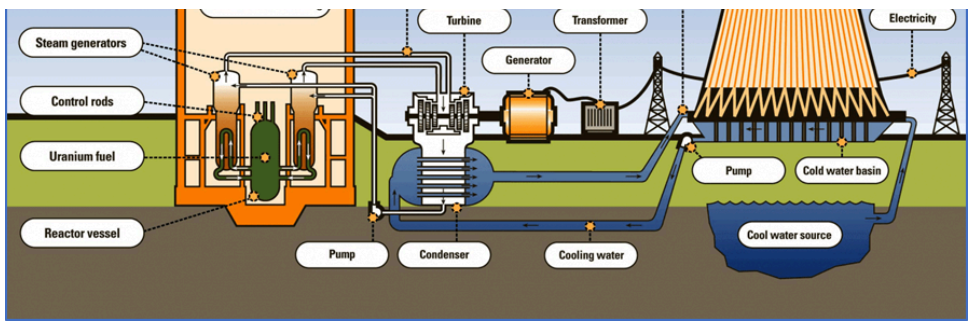
INDIA’S EXPANDING NUCLEAR AMBITIONS AND THE EMERGING MARKET FOR SMALL REACTORS

Articles Dec 04,25

As India’s Vision 2047 sets a target of 100 GW of nuclear capacity, the government is shifting to distributed nuclear generation by deploying smaller reactors across multiple locations, writes R Jayaraman & Tarjani Shah.

In the last four years, the growth rate of power generation has varied between 5.21 and 8.89 per cent. Per capita electricity consumption rose by 45.8 per cent to 1,395 kWh in 2023-24 from 957 kWh in 2013-14. Energy shortages reduced from 4.2 per cent (2013-14) to 0.1 per cent (2024-25).

There are two broad divisions in power generation plants: one, coal-based and nuclear, and two, all others. This division is based on generation capacity. The first group consists of plants with large capacities (for example, coal-based thermal units have been upped to 810 MW, and the average capacity of the seven nuclear plants in operation is about 1,300 MW), whereas all other units are of much smaller capacities. According to the current plans, nuclear capacity in India is set to hit 100 GW by 2047.



This means we need to install about 4,000 MW of nuclear per annum between now and 2047. In the same period, coal-based thermal capacity is set to reach 600,000 MW by 2047, an addition of 12,000 MW per annum. While M/s EDF, BHEL and L&T are the three main companies capable of manufacturing nuclear turbines in the required MW range, there are at least 10 companies that can supply high-MW steam turbines for thermal coal-fired plants. Hence, to cater to the projected demand in these two sectors, BHEL and L&T will probably have to do the heavy lifting. Others, including Toshiba, will also be competitors ready to cater to the expected market growth.

Current installed power generation capacity in India

Source	Installed Capacity, MW	Percentage to total
Fossil based	244,800	48.9
Non fossil based, except nuclear	247,310	49.4
Nuclear	8,780	1.8
Total	500,890	100.0

Source: Union Ministry of Power

The companies that cater to both segments need to make challenging decisions in the near future to decide the product mix. To get an idea of the developing scenario, let us look at the emerging picture, which at the moment is far from clear. Yet, this is the only one available and, in line with the uncertainties associated with long-term planning, has to be adopted as the baseline for the planning and decision-making exercise.

Current and planned nuclear capacity: India's nuclear energy programme is progressing rapidly, with 8,780 MW of operational capacity already in place and an additional 12,200 MW under construction. Further, the government has outlined planned additions of 19,680 MW by 2032, reflecting a steady and ambitious build-out of nuclear infrastructure. Looking ahead, the country's Vision 2047 sets a target of 100 GW of nuclear capacity, representing a nearly thirteen-fold increase over current levels. This trajectory underscores India's long-term strategy to make nuclear power a cornerstone of its decarbonised, reliable and sustainable energy mix.

A key change in the government's policy towards the installation of nuclear plants is distributed generation. In this scenario, it is proposed to have smaller-sized reactors spread over more locations. The idea could be twofold: induce many more manufacturers to get into the supply side and avoid the large-scale risks in large-capacity plants in a few locations. The Three Mile Island disaster, the Chernobyl disaster and others (the Fukuyama accident during the tsunami) have made some governments think about smaller reactor size and distributed generation.

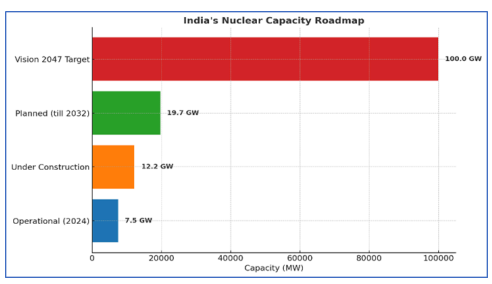
Vision 2047 target: 100 GW of nuclear capacity, a 13X increase over current levels.

This expansion includes mega nuclear parks such as:

- Jaitapur: 9,900 MW (Maharashtra)

- Mithi Virdi: 6,000 MW (Gujarat)

- Haripur: 4,000 MW (West Bengal)



Emerging opportunity: In 2024, the finance minister of India announced the government's thinking on the nuclear power scenario. She said that the government was promoting three concepts – Bharat Small Reactor (the BSRs will be based on India's tried and tested 220-megawatt Pressurised Heavy Water Reactor (PHWR) technology), Small Modular Reactors (SMR) and Bharat Small Modular Reactors (BSMR). All three are along the lines of producing smaller reactors to be located in a distributed manner. An advantage could be lower transmission losses due to the possibility of connecting to the main

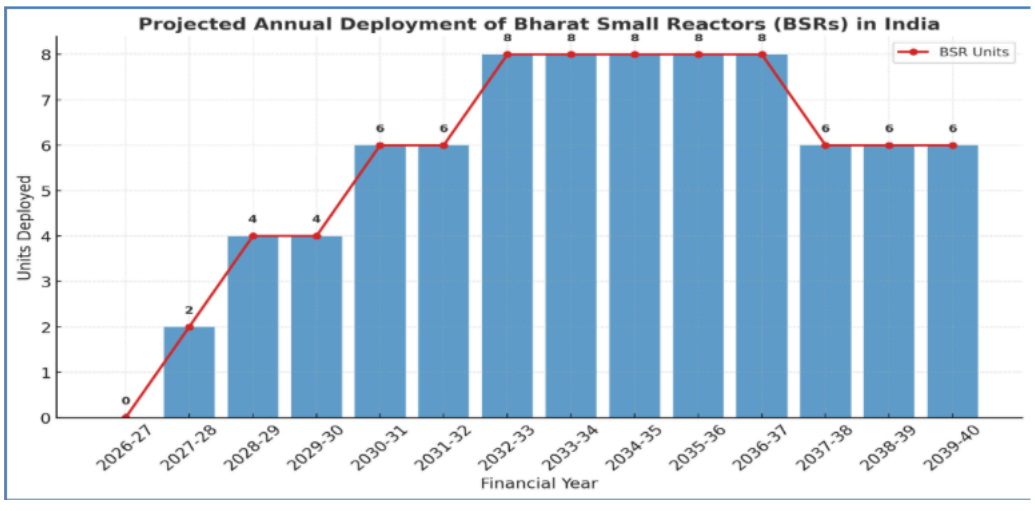
- Simplified and safer operations
- Suitability for remote locations or industrial clusters

In view of this new opportunity, companies like EDF, L&T and BHEL may have to decide to add to their capacities or allocate some of their capacities to the BSR type of reactors. There is possible synergy for sharing capacities in preference to putting up separate plants to manufacture thermal and nuclear turbines. Several factors may make the 'sharing capacity' option an attractive one:

Design and manufacturing capabilities in turbine-generator (TG) islands.

Access to PHWR-compatible steam turbine technologies.
Proven experience in EPC of thermal and?nuclear?power plants.
Participate in joint OEM agreements and technology licensing (TLA)
Collaborate on standardisation of TG modules for faster rollout
Enable "Make in India" manufacturing of nuclear-grade equipment

Clearly, this is a possible line of strategy that needs careful examination. The market size and demand forecast for BSRs appears tempting.



Nuclear reactor for BSR roadmap till 2040

- From 2026 onwards, tenders will be floated for SMRs.
- 2–4 reactors per year expected in the first phase of deployment.
- A total market of ~80 units by 2040, translating to Rs 300–400 billion for TG-related EPC, if captured early.

To succeed in the BSR market, the companies need to be ready to do the following:

- TLA (Technology Licensing Agreement) for Steam Turbines.
- Agreement under CLND (Civil Liability for Nuclear Damage) framework.
- In-house design standardization, quality assurance for nuclear components.
- Development of BSR-specific supply chains and vendor ecosystems.

Indian companies may have to consider some sort of collaborations, albeit in a small way, could be, with experienced foreign companies. To get into the manufacture of BSR's, these companies need to consider the following roadmap:

Strategic Area	**Action Plan**
Technology	Formalise TLA for 220–300MW saturated steam turbines
Manufacturing	Upgrade QA/QC protocols to meet nuclear standards
Partnership	Collaborate with NPCIL, Westinghouse, Rosatom
Market Entry	Form a dedicated nuclear business development cell for BSR
Certification	Ensure readiness for CLND compliance and AERB approvals

Those companies currently involved only in the manufacture of thermal equipment like turbines should examine the possibilities of modifying their manufacturing facilities.

Area	**Thermal Manufacturing (Current)**	**Nuclear Readiness (Repurposed)**
Documentation	Project-specific	Regulator-auditable, continuous traceability, digital QA records
Equipment	VTLs, slotters, thermal-specific jigs	Dedicated nuclear beds, precision welding bays, upgraded cranes, calibrated PWHT furnaces

Design Standards	ASME Section IX	ASME Section IX for welding

Clearly, making the changes needed to get into the BSR manufacturing field is not going to be easy, as it will include crucial manpower training in new skills. In addition, the working processes will need to be upgraded to align with manufacturing nuclear-grade equipment.

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