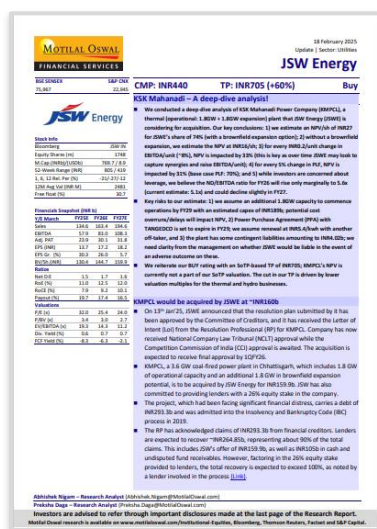


Our latest Utilities updates



India set to embrace nuclear energy

- **India aims to triple nuclear capacity by 2032:** In the Union Budget 2025-26, the finance minister announced a new INR200b mission for the research and development (R&D) of small modular reactors (SMR), with the aim of operationalizing at least five indigenous SMRs by 2033. India is significantly expanding its nuclear power capacity to 22GW by 2032 and 100GW by 2047 (vs. 8GW currently operational, 15GW under development).
- **Conventional reactors, SMRs to drive growth of nuclear energy globally:** As per the International Energy Agency (IEA), there is a global push to triple nuclear capacity by 2050 (~399GW operating and ~71GW under development as of Dec'24). The IEA projects global nuclear capacity to exceed 1,000GW by 2050 with a total investment of USD2.9t (under its Net Zero Emissions scenario), driven by both development in the existing large reactors and advanced technologies like SMRs. Investment in nuclear power by 2050 is projected to be distributed as follows: 61% in new large reactors (574GW of additional capacity), 33% in new SMRs (200GW), and 6% in extending the lifespan of existing reactors (117GW).
- **Nuclear energy could emerge as a long-term growth driver for Indian power utility companies:** We believe NTPC is the bellwether play for nuclear energy, which could emerge as a new growth driver. Given the sensitive nature of nuclear energy, we believe conventional nuclear investments may continue to be done in partnership with Nuclear Power Corporation of India Limited (NPCIL). About 10GW of nuclear energy projects are in the planning stage, which, at INR150m/MW, would require total capex of INR1.5t. We estimate the Maahi Banswara project, which was recently transferred from NPCIL to ASHVINI, could add ~5.8% to NTPC's regulated equity base (estimated capex of INR205b for NTPC's 49% stake and; 30% equity). Private players such as Tata Power and Jindal Nuclear are likely to take the SMR route to participate in nuclear energy. This route, we believe, entails a lower investment outlay with a shorter gestation period, though technology for SMRs continues to evolve.

SMR: Scalability, economies of scale are key advantages

- SMRs are advanced nuclear reactors with an installed capacity of around 30MW to +300MW typically and offer a flexible, scalable, and economically attractive alternative to traditional large-scale nuclear plants. Their modular design enables factory-based manufacturing, leading to shorter construction times and lower costs.
- Accordingly, SMRs are well-suited for diverse applications, from grid-connected power generation to off-grid deployment in remote and isolated regions. The production of SMRs, along with their components and systems, is carried out in a controlled factory setting. The modular manufacturing approach, coupled with on-site transportation and integration, helps leverage economies of scale.
- Overtime, benefits from advancements in learning-curve efficiencies lead to cost reductions and streamlined deployment. Primarily focused on generating emission-free electricity, SMRs are also being explored for producing other clean energy products like hydrogen.

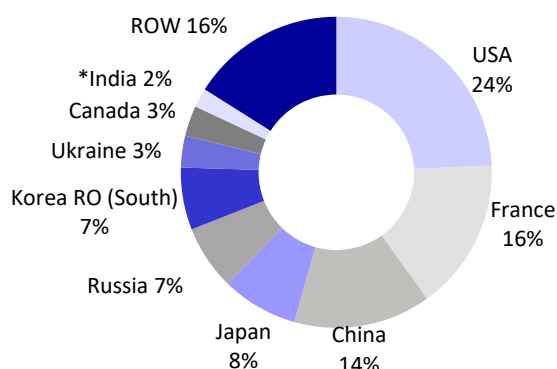
Exhibit 1: Comparison between large reactors and SMRs

| Criteria | Large Reactors | SMRs |
|---|--|--|
| Execution Mode | ❖ Project Mode (Combination of traditional on-site building techniques and some factory-made modules) | ❖ Product Mode (Factory-built, fully modular, and standardized design) |
| Upsides of the Learning Curve | ❖ Average unit takes 5-7 years | ❖ Modular design facilitates the deployment of more units. |
| Supply Chain Management | ❖ Individual project based | ❖ Sustained commercial partnerships supporting a network of SMR units |
| Engineering and Component Production | ❖ Heavy equipment | ❖ Readily available, high-TRL (technology readiness level) standard components |
| Investment | ❖ Substantial national infrastructure investment and a lengthy payback period, typically 5 to 10 years | ❖ Require less investment per unit and offer a shorter time for revenue generation (typically 5 years or less), with potential for further reductions through learning and standardization |

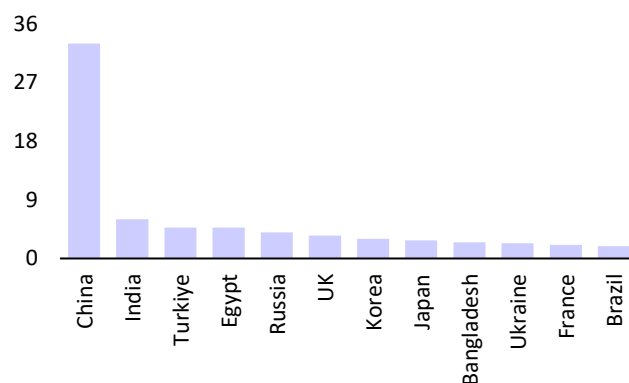
Source: Niti Ayog, MOFSL

Emerging economies now driving growth in nuclear energy

- As of 2024, over 440 nuclear reactors operate in more than 30 countries with total installed capacity of ~399GW, supplying 9% of the world's electricity. As of Dec'24 end, the US, France, and China together account for ~54% of the world's total installed nuclear capacity.
- Though historically dominant in advanced economies, nuclear power is getting increased attention and investment in emerging economies, with China leading the expansion. Since 2017, a majority of the nuclear reactors that commenced construction have been based on Chinese or Russian designs. As of 2024 end, a total of 63 reactors (combined capacity: 71GW) were under construction worldwide, with a significant 75% located in emerging economies and a half of those situated in China alone.
- Growing global electricity demand has fueled renewed interest in nuclear energy. As per IEA, global nuclear capacity is expected to triple by 2050 (Dec'23: ~372GW), with policy support from over 40 countries. This resurgence is reflected in a substantial increase in nuclear investment, reaching ~USD65b in 2023, nearly double the investment of 10 years ago.
- In 2023, nuclear energy remained the second-largest source of low-emission electricity, trailing only hydropower. It generated ~20% more electricity than wind, ~70% more than solar, and four times more than bioenergy. Since 1971, nuclear power has prevented an estimated 72GT of CO2 emissions by displacing fossil fuel-based electricity generation (Source: IEA).
- Additionally, while a bulk of investment continues to go into conventional nuclear reactors, interest and investments in advanced nuclear technologies, such as SMRs, are increasing, with over 80 designs currently in development. However, only two SMRs are currently operational globally: Russia's KLT-40S and China's HTR-PM.
- Even as the technology and commerciality for SMRs continue to evolve, IEA forecasts 39GW/118GW/200GW of SMR capacity by 2050 under STEPS (Stated Policies Scenario)/APS (Announced Pledges Scenario)/NZE (Net Zero Emissions by 2050).

Exhibit 2: Installed nuclear capacity- ~399GW (Dec'24 end)

Source: World Nuclear Association, *NPCIL, MOFSL

Exhibit 3: Under construction (nuclear) - 71GW (Dec'24 end)

Source: IEA, MOFSL

Exhibit 4: Share of nuclear energy in total electricity generation 2023 (%)

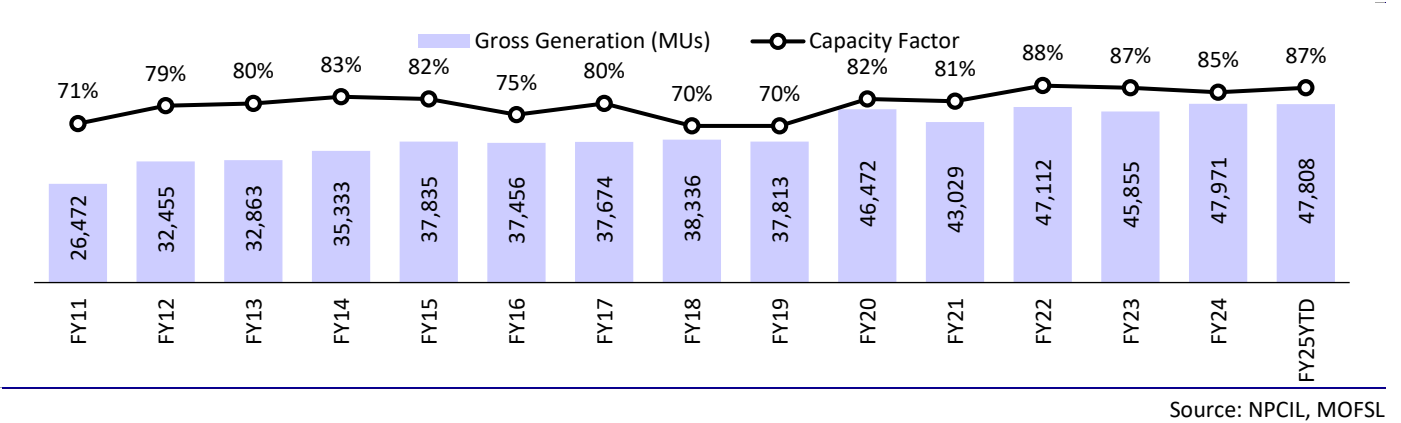
| Countries | Share (%) |
|---|-----------|
| France, Slovak Republic | Above 50 |
| Ukraine, Hungary, Finland, Belgium, Bulgaria | 40-50 |
| Czechia, Belarus, Slovenia, Switzerland, Armenia, Korea | 30-40 |
| Sweden, Spain | 20-30 |
| UAE, Romania, US, Russia, Pakistan, UK, Canada | 20-10 |
| Japan, Argentina, Chinese Taipei, China, South Africa, Mexico, Netherlands, India, Brazil, Iran | Below 10 |

Source: IEA, MOFSL

Despite aggressive plans, nuclear share at 3% of installed capacity by 2032

- India is making a major push to expand its nuclear power capacity. Currently, over 24 reactors operate in India with an installed capacity of more than 8GW. There are 21 new reactors under development: 9 (7GW) under construction and 12 (8GW) in planning. The government aims to triple installed capacity to 22GW by 2031-32, targeting 100GW by 2047 (as per [press release](#) dated 3rd Feb'25). Despite growing from 35BUs in 2013-14 to 48BUs in 2023-24, nuclear power generation forms only ~3% of total power generation.
- India is looking to follow a two-pronged approach to expanding nuclear power via conventional nuclear reactors and Bharat Small Reactors (BSRs). BSRs are upgraded 220 MW pressurized heavy water reactors (PHWR) designed to minimize land requirements and enable deployment near industries for captive power, supporting decarbonization in sectors like steel and aluminum ([link](#)). The key highlight of the Union Budget 2025-26 was the launch of the INR200b Nuclear Energy Mission focused on R&D for SMRs, with the goal of deploying at least five indigenously designed SMRs by 2033.

Exhibit 5: India’s nuclear power generation (2010-11 to 2024-25)



SMRs: Advantages and obstacles of an emerging technology

Advantages:

- SMRs are scalable and can supplement existing plants or repurpose old ones. They’re expected to require less frequent refueling (every 3-7 years, or even up to 30 years for some designs) compared to traditional plants (every 1-2 years).
- They also require less land than large reactors or even renewable projects, and thus, allow the repurposing of existing fossil plant sites. Lastly, with lower upfront costs and a smaller overall outlay, they are better suited for developing economies.

Exhibit 6: Greenhouse gas emissions & resource use for different generation technologies

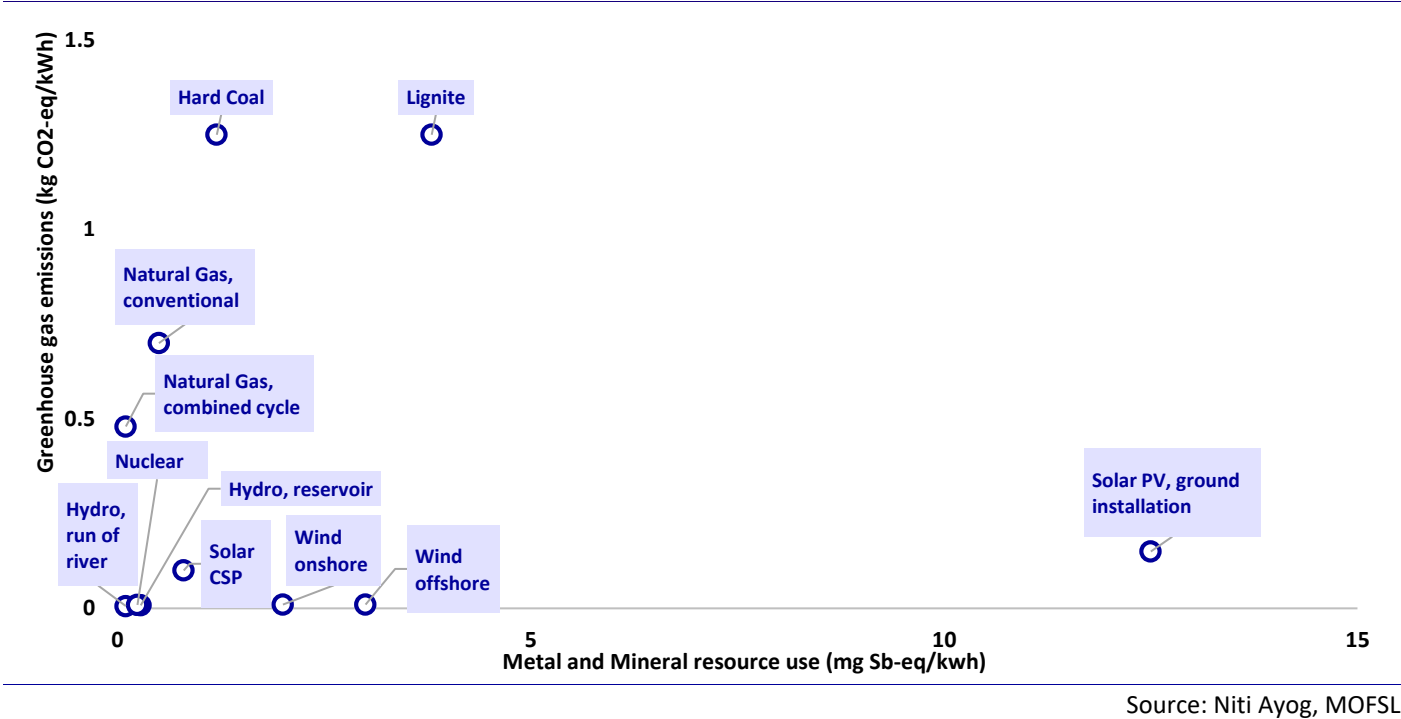
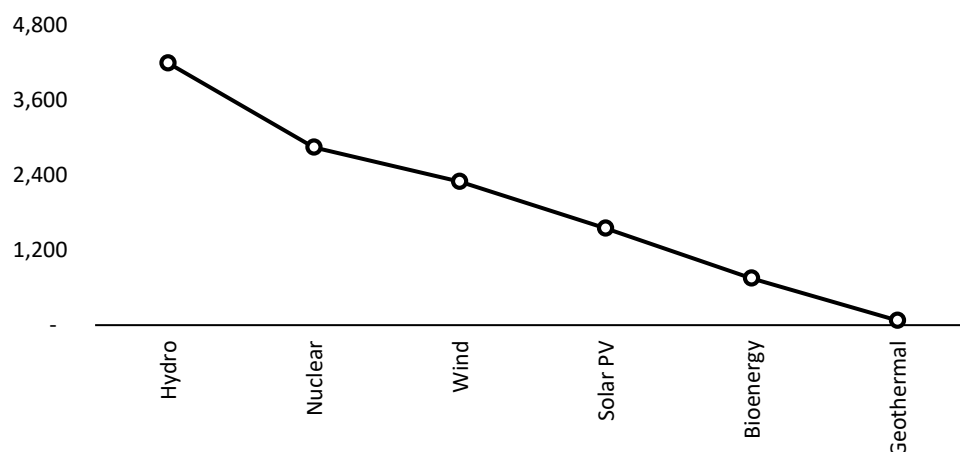


Exhibit 7: Global low-emissions electricity generation by source, 2023 (TWh)

Source: IEA, MOFSL

Obstacles:

- Numerous SMR technologies exist, each with unique supply chain, regulatory, and operational needs. Thus, prioritizing and narrowing down technology choices is crucial for large-scale deployment and improving technology readiness levels (TRLs) of SMRs. This is critical for attracting utilities, investors, and government support.
- Given that SMRs are an evolving concept, existing licensing processes may struggle to accommodate new SMR technologies. Regulatory bodies' lack of experience with innovative designs poses a challenge for safety reviews and approvals, and this can be a major hurdle impeding investment.
- Lastly, SMRs, like traditional reactors, generate radioactive waste requiring storage and disposal, thus potentially facing socio-political resistance.

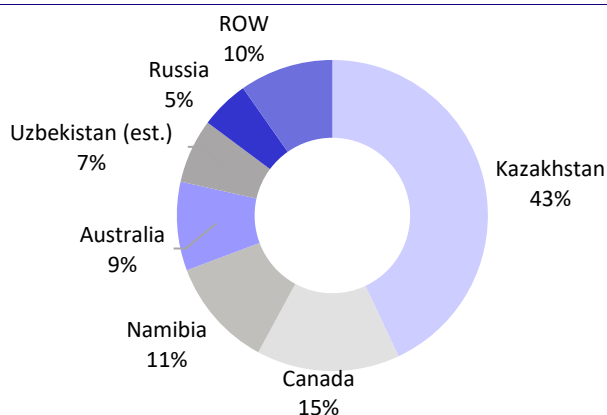
Revisions to liability and regulatory structures key hurdle to be crossed

- Despite strict safety standards, nuclear accidents remain possible, with potentially transboundary impacts. Therefore, robust nuclear liability frameworks are crucial. International conventions, like the Vienna and Paris Conventions, along with supplementary agreements, aim to ensure adequate compensation for victims, placing ultimate liability on the operator.
- As per the Union Budget, to support the nuclear energy mission, Parliament will consider amendments to the Atomic Energy Act and the Civil Liability for Nuclear Damage Act. These changes are aimed at stimulating private investment in nuclear power and fostering a more favorable environment for investment and innovation in the nuclear sector. This development is expected to enable India to leverage advanced nuclear technologies, particularly SMRs, which are gaining traction in developed economies. This is also expected to enthruse American and French nuclear power companies, whose projects have remained stalled for over 15 years due to legal uncertainties ([link](#)).

Challenges with mass-scale deployment of nuclear energy

- A mass-scale deployment of nuclear energy faces multiple challenges. The concentration of uranium production (43% in Kazakhstan) and enrichment capacity (among four suppliers) creates a significant supply chain risk for nuclear energy. Expanding and diversifying these supply chains, along with investing in a skilled workforce, is crucial for ensuring the security and affordability of nuclear power.
- Government support is essential to enable bank financing for nuclear projects by guaranteeing predictable cash flow and mitigating construction risks. Political instability, however, can cause delays. New nuclear builds face greater financing challenges than lifetime extensions of existing plants due to higher construction risks, making banks less willing to fund early stages. Thus, the development of specialized institutions, which can fund nuclear projects, will go a long way in popularizing the deployment of nuclear technology.
- The future of nuclear power hinges on the timely and cost-effective construction of both large and small reactors. Any construction overruns or delays can severely impact its competitiveness. Increased construction cost risks diminish the attractiveness of nuclear investment.
- Lastly, the lack of a favorable liability regime and unsuitable regulatory structures may prevent emerging economies from being able to access the latest technology for nuclear projects.

Exhibit 8: Country-wise uranium production from mines, 2022 (49,355 tonnes)

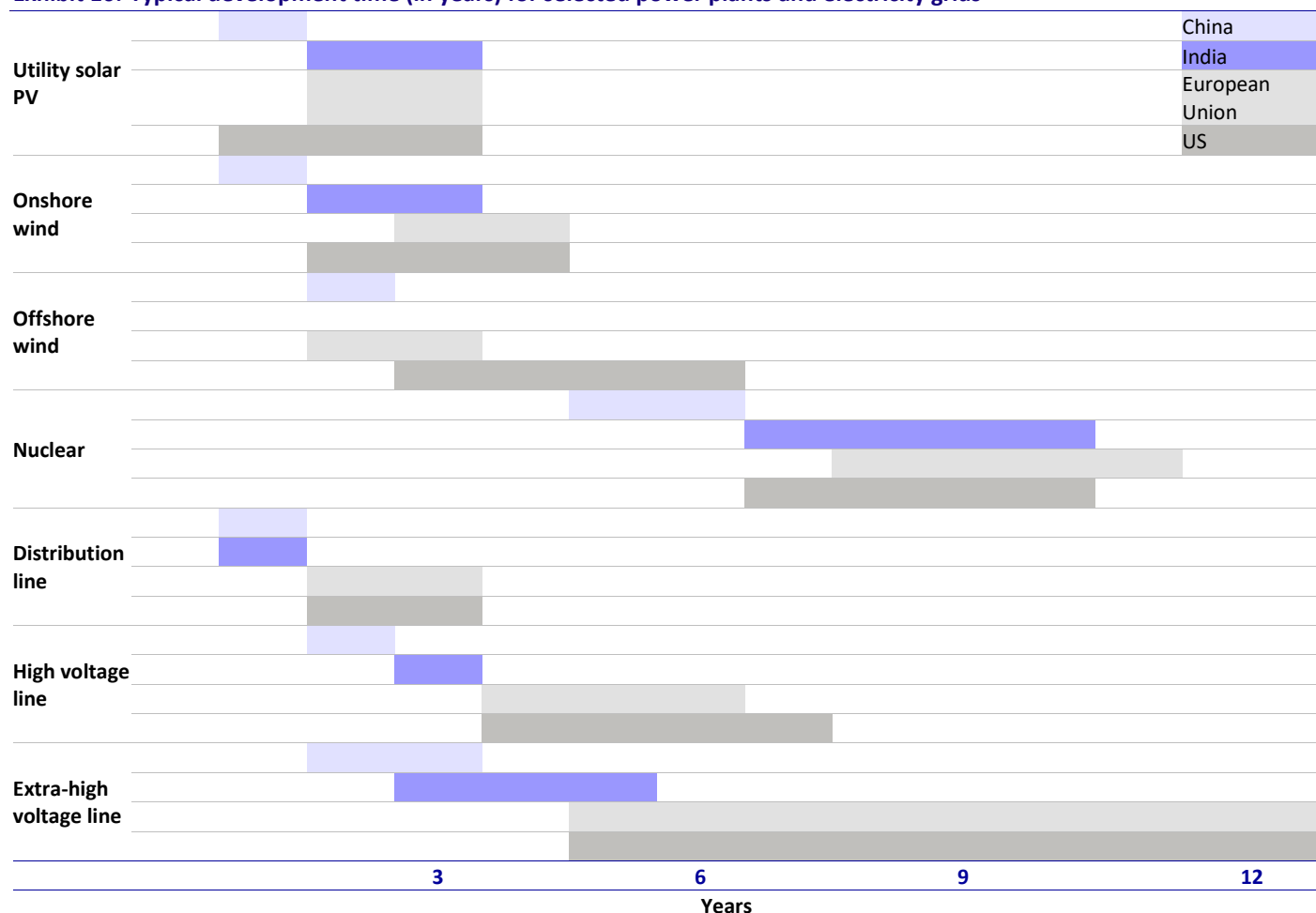


Source: World Nuclear Association, MOFSL

Exhibit 9: Uranium production by company, 2022

| Company | Tons | % of world total |
|------------------------|--------|------------------|
| Kazatomprom | 11,373 | 23 |
| Cameco | 5,675 | 12 |
| Orano | 5,519 | 11 |
| CGN | 4,627 | 10 |
| Uranium One | 4,454 | 9 |
| Navoi Mining | 3,300 | 7 |
| CNNC | 3,247 | 7 |
| BHP | 2,813 | 6 |
| ARMZ | 2,508 | 5 |
| General Atomics/Quasar | 1,740 | 4 |
| Other | 4,098 | 6 |

Source: World Nuclear Association, MOFSL

Exhibit 10: Typical development time (in years) for selected power plants and electricity grids

Source: IEA, MOFSL

NTPC's growing role in India's nuclear energy sector

- As per a [media article](#), NTPC is embarking on a major nuclear expansion, planning to add 10GW of capacity in the next 10 years. This INR1.5t investment underscores the company's commitment to nuclear energy as a key driver of its long-term sustainable growth.
- In Sep'24, the government approved Anushakti Vidhyut Nigam Ltd. (ASHVINI), a joint venture between NPCIL (51%) and NTPC (49%), to build, own, and operate nuclear power plants in India, in compliance with the Atomic Energy Act.
- Planned projects under ASHVINI include the Chutka (Madhya Pradesh, 2x700 MW) and two new PHWR facilities to boost India's fleet-mode nuclear capacity ([Link](#)). The Indian government has also approved the transfer of the Mahi Banswara Rajasthan Atomic Power Project (MBRAPP), a 4*700MW project using indigenous PHWR technology, from NPCIL to ASHVINI, thus further boosting NTPC's nuclear project pipeline.
- While NTPC may continue to partner with NPCIL for conventional nuclear projects, the company in Jan'25 incorporated a wholly owned subsidiary, NTPC Parmanu Urja Nigam Limited (NPUNL), with the objective of commercially developing nuclear energy for electricity generation and other uses, including building, owning, operating, and managing nuclear facilities, promoting R&D, and selecting suitable sites for power stations and related infrastructure.

- As NTPC gains experience in managing nuclear projects, NPUNL may emerge as a key vehicle for undertaking nuclear energy projects in the future.

Private sector participation and growth prospects

- Private sector participation in conventional nuclear projects remains constrained due to pending amendments to the Atomic Energy Act and the Civil Liability for Nuclear Damage Act. While the Union Budget has proposed amendments to facilitate private players' involvement, their engagement may remain limited due to the substantial capital investment required and the long gestation period associated with such projects.
- NPCIL, both independently and through its subsidiaries, is projected to contribute ~50% of the government's target of building 100GW of nuclear energy by 2047. The state-owned entity will primarily leverage its indigenous technologies while remaining open to foreign collaborations, provided such partnerships offer large capacities at competitive costs.
- Private players such as Tata Power and Jindal Nuclear have shown interest in the nuclear space. Tata Power is exploring diversification into the SMR segment while considering the divestment of USD1b in non-core international assets. The company is actively evaluating opportunities in the nuclear sector, contingent on forthcoming policy directions and amendments to the Atomic Energy Act, which will determine the regulatory framework for private players' participation in SMRs and nuclear reactors. Jindal Nuclear has also announced an ambitious plan to contribute 18GW to India's nuclear power capacity by 2047.

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|----------------------------------|--|
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| BUY | >=15% |
| SELL | < - 10% |
| NEUTRAL | < - 10 % to 15% |
| UNDER REVIEW | Rating may undergo a change |
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