

NEXT IAS

**DAILY EDITORIAL
ANALYSIS**

TOPIC

**NUCLEAR POWER EXPANSION IS AN
R&D CHALLENGE**

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NUCLEAR POWER EXPANSION IS AN R&D CHALLENGE

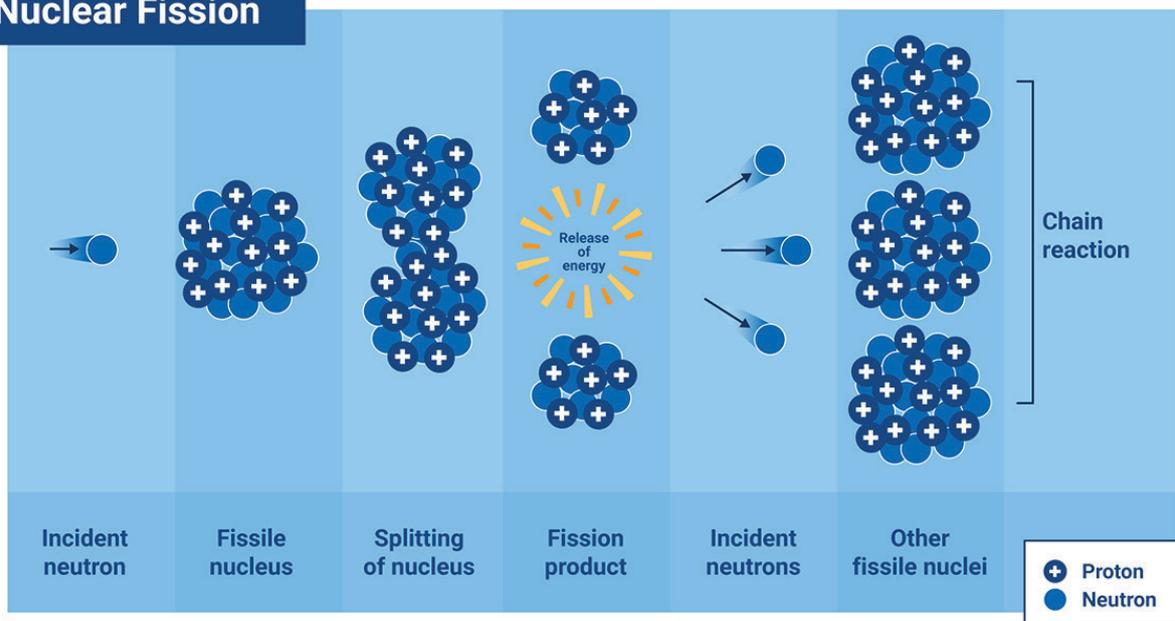
Context

- The **draft National Electricity Policy** aims to align the **power sector** with **India's long-term energy goals**.

About

- The Draft NEP 2026 is a proposed revision of **India's existing National Electricity Policy (initially notified in 2005)**.
- It supports **India's target of reducing emissions intensity of GDP by 45% by 2030 (compared to 2005)**.
 - The policy strongly promotes nuclear energy as a clean, stable, non-weather-dependent power source.
 - India plans a **10-fold increase** in nuclear power capacity by **2047**.
- It supports new technologies** like Small Modular Reactors (SMRs), which are safer, smaller, and can be set up near factories and cities.
- Thorium Based Energy:** India depends on **imported uranium**, so the policy stresses developing thorium-based nuclear energy, where India has large reserves.
 - The main challenge is boosting research and technology to make thorium energy practical.

Nuclear Fission



Need to Increase Nuclear Capacity

- Nuclear Capacity Goal:** India's plans to increase its nuclear power capacity from the current 8,180 MW to 22,480 MW by 2031-32 and eventually 100 GW by 2047.
- Energy Demand Growth:** India's electricity demand is expected to increase 4-5 times by 2047, and nuclear power will help meet base-load demand alongside renewables.
- India's Targets:** To reduce the emission intensity of its GDP by 44% by 2030 from the 2005 level.
 - To achieve 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.

Challenges

- Limited Indigenous Experience:** India's nuclear programme has historically focused on **Pressurized heavy-water reactor (PHWRs)** and fast breeder reactors, leading to limited domestic expertise in **Light Water Reactor (LWR)** design and operation.

Light Water Reactors

- **Light Water Reactors** form a mainstay of the **global nuclear program** currently account for over **85% of the civil nuclear reactor capacity in the world.**
 - ♦ They use **ordinary (light) water as both a coolant and a neutron moderator.**
- **LWRs** entail **simpler design and engineering** compared to heavy water reactors given that they use normal water as **both coolant and moderator.**
- **Low Cost:** It usually involves lower construction costs due to economies of scale and they are considered **more thermally efficient.**

Limited domestic uranium: India has low-grade and limited uranium reserves, forcing dependence on imports.

- ♦ Long-term nuclear expansion needs assured fuel supply agreements with foreign countries.
- **High capital cost:** Nuclear plants require huge upfront investment and long construction periods.
- **Technological constraints:** Advanced technologies like Small Modular Reactors (SMRs) are still at an early stage in India.
- **Safety and public concerns:** Fear of nuclear accidents leads to local opposition and delays in projects.
- **Thorium utilisation gap:** Though India has large thorium reserves, commercial technology is still under development.

Government Initiatives

- **Nuclear Energy Mission & Capacity Targets:** The Government has launched a Nuclear Energy Mission aimed at expanding nuclear power capacity to about 100 GW by 2047.
 - ♦ This mission emphasises enhancing domestic capabilities and adopting advanced technologies.
- **Indigenous Reactor Development:** Such as Bharat Small Reactors are under development to support scalable deployment.
 - ♦ While these are PHWR and SMR variants, they lay the groundwork for a broader nuclear innovation ecosystem.
- **Three-Stage Nuclear Power Programme:** India has a long-term strategy to utilise India's thorium reserves through PHWRs, Fast Breeder Reactors and thorium-based reactors.
- **SHANTI Act, 2025:** It enables capacity expansion, advanced reactor technologies and wider participation in nuclear power generation.
- **Research & Development Funding:** The Union Budget 2025-26 allocated significant funding (around 20,000 crores) for R&D in advanced nuclear technologies.
- **International Cooperation & Tech Access:** The government is working on international partnerships and technology transfer mechanisms that can help bridge experience gaps in technologies.

India's Thorium Reserves

- India has one of the largest reserves of thorium in the world.



- ◆ Together, **Kerala and Odisha account for over 70%** of India's thorium.
- India has been developing a **three-stage nuclear program**, with thorium-based reactors being a critical part of the third stage.
- **Challenges:** Extracting thorium from ores requires high amounts of energy and creates significant waste.
 - ◆ While India has large thorium reserves, extracting it for nuclear energy use has faced challenges, including the need for advanced reactor technology and economic viability.

Conclusion

- India is all set for **transformative and multi-dimensional growth** of clean and renewable energy sources; however, India should accelerate **R&D on thorium reactors** by strengthening industry collaboration with the stakeholders.
- India can **develop pilot and demonstration projects** to move thorium technology from lab to commercial scale.
- Nuclear energy can give India clean, secure and indigenous power, but only sustained R&D, policy support and institutional commitment can unlock its full potential.

Source: IE

Daily Mains Practice Question

- [Q] Examine the role of nuclear technology in ensuring India's long-term energy security and meeting its climate commitments.

