ujiyari

UPSC & STATE PCS CURRENT AFFAIRS · UJIYARI.COM

DAILY CURRENT AFFAIRS

India's 100 GW Nuclear Roadmap by 2047: Tenfold Expansion, PFBR Kalpakkam Criticality, and the Private-Sector Question

18 April 2026 · SCIENCE & TECH · ECONOMY · ENVIRONMENT · GS3

CURATED & WRITTEN BY

Bharat Choudhary

UPSC Educator & Content Creator

linkedin.com/in/epicbharat

India's 100 GW Nuclear Roadmap by 2047: Tenfold Expansion, PFBR Kalpakkam Criticality, and the Private-Sector Question

18 April 2026 · 6 min read · 3 tags

WHY IN NEWS:

Central Electricity Authority (CEA) Chairperson Ghanshyam Prasad announced on April 17, 2026, that India targets a **more than ten-fold expansion of nuclear capacity from the current 8.8 GW to 100 GW by 2047** — a centennial-of-Independence target. The announcement comes days after the **500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, Tamil Nadu**, achieved **first criticality on April 6, 2026** — a foundational milestone in India's Stage II nuclear programme conceptualised by **Dr. Homi Bhabha** in the 1950s.

INDIA'S NUCLEAR POSITION TODAY

INDICATOR	VALUE (APRIL 2026)
Installed nuclear capacity	8.8 GW
Reactors operational	24
Share in total installed capacity	~1.6%
Share in total electricity generated	~2.5%
New target by 2047	100 GW
Required tenfold expansion	Approx 91 GW additional

THE 100 GW ARCHITECTURE

NPCIL — The Lead Player

Nuclear Power Corporation of India Limited (NPCIL), a PSU under the Department of Atomic Energy, will provide approximately **54 GW** of the 100 GW target through:

- **Indigenous Pressurised Heavy Water Reactors (PHWRs)** — proven Indian design, the workhorse of the existing fleet.

- **Light Water Reactors (LWRs)** through international cooperation — including discussions with USA, France, Russia, and Japan.
- **Small Modular Reactors (SMRs)** — smaller (300 MW or below) reactors with factory fabrication and faster deployment.

Bharatiya Nabhikiya Vidyut Nigam (BHAVINI)

BHAVINI operates the PFBR Kalpakkam and is the lead for fast-breeder reactor commercialisation. Stage II expansion through BHAVINI could add another 30+ GW by 2047.

Private Sector Entry

The 100 GW target explicitly contemplates **opening the nuclear sector to private players** — a fundamental shift from the historical PSU-only model. This requires:

- **Atomic Energy Act 1962** amendment to permit private operation.
- **Civil Liability for Nuclear Damage Act (CLNDA), 2010** amendment to address operator liability concerns that have deterred international investors and Indian private players alike.
- New regulatory framework under the **Atomic Energy Regulatory Board (AERB)** for private operators.

THE THREE-STAGE NUCLEAR PROGRAMME — CONCEPTUALISED BY BHABHA

India's nuclear strategy was articulated by **Dr. Homi Bhabha** in the 1950s, reflecting India's unique resource constraint: limited natural uranium reserves but the world's largest **thorium reserves** (~30% of global thorium).

Stage I — Pressurised Heavy Water Reactors (PHWRs)

- Uses **natural uranium** as fuel.
- Produces **plutonium** as a by-product.
- Current operational stage; the 8.8 GW fleet is here.

Stage II — Fast Breeder Reactors (FBRs)

- Uses **plutonium-uranium mixed oxide (MOX) fuel**.
- "Breeds" more fissile material (Plutonium-239 from U-238) than it consumes.
- Sodium-cooled.
- **PFBR Kalpakkam (500 MWe) achieving first criticality on April 6, 2026** — entry point to Stage II.

Stage III — Thorium-Based Reactors

- Uses **thorium-uranium-233 fuel cycle**.
- Designed to leverage India's vast thorium reserves.
- Long-term goal — reactors include Advanced Heavy Water Reactor (AHWR).
- IAEA recognised Stage III as critical for India's long-term energy security.

WHY NUCLEAR NOW?

1. Net Zero by 2070

India committed at **COP26 (Glasgow, November 2021)** to achieving **net-zero emissions by 2070**. This requires:

- Phasing out coal (currently ~70% of electricity).
- Massive renewable scale-up (500 GW non-fossil by 2030 already committed).
- Nuclear as **base-load low-carbon power** — complementing intermittent renewables (solar, wind).

2. Energy Security

India imports approximately:

- 87-90% of its **crude oil** (Strait of Hormuz vulnerability).
- 50%+ of its **natural gas**.
- Increasingly significant **uranium imports** as well — but uranium can be stockpiled (unlike crude).

Nuclear provides relatively secure base-load with strategic stockpile potential.

3. The Renewable Storage Gap

Solar and wind are intermittent. Battery storage at grid scale remains expensive (~₹4-6 crore per MW for 4-hour storage). Nuclear provides 24/7 base load that complements renewables in the grid mix.

THE CHALLENGES

1. Liability and the CLNDA 2010

The **Civil Liability for Nuclear Damage Act, 2010** caps operator liability at **₹1,500 crore** but allows **suppliers to be sued by the operator** for "right of recourse" in case of latent defects. This **deviates from international norms** (Vienna Convention, CSC) that channel liability exclusively to operators. The CLNDA structure has deterred:

- US nuclear suppliers (Westinghouse, GE-Hitachi).

- French (EDF Areva for Jaitapur).
- Japanese (Hitachi-GE).

2. Time and Cost

Nuclear plants take **8-12 years from approval to commissioning** typically. Cost overruns at Kudankulam (Russian VVER) and delays at Jaitapur (French EPR) demonstrate the challenge.

3. Land Acquisition and Local Opposition

Sites like **Jaitapur (Maharashtra)**, **Kudankulam (Tamil Nadu)**, and **Kovvada (Andhra Pradesh)** have faced sustained local opposition citing seismic, ecological, and livelihood concerns.

4. Skills and Supply Chain

Scaling from 8.8 GW to 100 GW in 21 years requires:

- Trained workforce expansion (currently ~30,000 nuclear workers; need 2-3x).
- Indigenous supply chain for forging, instrumentation, controls.
- Vendor development beyond the existing handful of approved suppliers.

5. Waste Management

Spent fuel from PHWRs is currently stored at reactor sites or sent to interim storage. Long-term **deep geological repository** for high-level waste remains undecided. The 2024 amendments to the **Atomic Energy (Safe Disposal of Radioactive Wastes) Rules** are a step but not a solution.

COMPARATIVE POSITION

COUNTRY	OPERATIONAL CAPACITY (GW, 2025)	LONG-TERM PLAN
USA	~95 GW	Stable; some new construction
France	~62 GW	EPR2 fleet expansion
China	~57 GW	Doubling by 2035
Russia	~28 GW	Export-led growth
South Korea	~25 GW	APR1400 fleet
India	**8.8 GW**	**100 GW by 2047**

India's target is **ambitious but achievable** if regulatory, liability, and skill-supply challenges are addressed simultaneously.

WAY FORWARD

Legislative Reform

1. **Amend Atomic Energy Act 1962** to permit private operation under AERB licensing.
2. **Amend CLNDA 2010** to align supplier-liability provisions with international norms (Vienna Convention/CSC).
3. **Empower AERB statutorily** — currently it operates under executive authority; statutory backing recommended by the Nuclear Safety Regulatory Authority Bill (lapsed).

Institutional Strengthening

1. **NPCIL capacity-building** — expand procurement, project execution, vendor management.
2. **AERB independence** — to ensure regulatory credibility for private-sector entry.
3. **National Nuclear Skills Mission** — workforce development pipeline.

Strategic and Diplomatic

1. **NSG (Nuclear Suppliers Group) membership pursuit** — for unrestricted civil nuclear cooperation.
2. **Bilateral nuclear agreements** — operationalise India-USA Civil Nuclear Agreement (2008), India-Russia (Kudankulam additional units), India-France (Jaitapur), India-Japan (2017 agreement).
3. **SMR commercialisation partnership** — particularly with USA and Canada.

Sustainability Integration

1. **Nuclear in NDC** — explicitly integrate nuclear into India's Nationally Determined Contribution under Paris Agreement.
2. **Co-located renewables** — solar + nuclear hybrid plants for transmission infrastructure efficiency.
3. **Green hydrogen production** — high-temperature reactor heat for hydrogen electrolysis.

UPSC RELEVANCE

PAPER	ANGLE
GS-3 Science & Technology	Three-stage nuclear programme, PFBR, MOX, SMR, AERB, NPCIL, BHAVINI
GS-3 Economy	Energy security, Net Zero 2070, base-load vs intermittent renewables, infrastructure financing
GS-3 Environment	Climate commitments, COP26, Net Zero 2070, decarbonisation pathways
GS-2 Polity	Atomic Energy Act 1962, CLNDA 2010, AERB statutory status, nuclear regulation
GS-2 IR	India-USA Civil Nuclear Agreement 2008, NSG membership, Vienna Convention, CSC
Mains Keywords	NPCIL, BHAVINI, PFBR Kalpakkam, three-stage nuclear programme, Homi Bhabha, PHWR, MOX fuel, thorium reserves, AERB, CLNDA 2010, Atomic Energy Act 1962, India-USA Civil Nuclear Agreement 2008, NSG, Net Zero 2070, COP26 Glasgow, AHWR

FACTS CORNER

ITEM	DETAIL
Current installed capacity	8.8 GW
2047 target	100 GW
NPCIL share of target	54 GW
PFBR Kalpakkam capacity	500 MWe
PFBR first criticality	April 6, 2026
Three stages	PHWR (uranium) → FBR (MOX) → Thorium
Conceptual architect	Dr. Homi Bhabha (1950s)
Operator (existing fleet)	NPCIL (Department of Atomic Energy)
Fast-breeder operator	BHAVINI (Bharatiya Nabhikiya Vidyut Nigam)
Regulatory body	AERB (Atomic Energy Regulatory Board)
Liability regime	CLNDA 2010 — operator liability cap ₹1,500 crore
India's thorium reserves	~30% of global total
Nuclear share in India's electricity	~2.5% (currently)
Net Zero target	2070 (COP26 Glasgow commitment)

← NEWER ARTICLE
131st Amendment Defeated in Lok Sabha: A First in 12 Years...

OLDER ARTICLE →
India Withdraws COP33 Hosting Bid: Climate Leadership at the...

RELATED EDITORIALS

INDIAN EXPRESS

Noida Labour Unrest: Wage Stagnation, the OSH Code Gap, and the Subsistence Crisis

18 Apr

BUSINESS STANDARD

India's 100 GW Nuclear Push: Strategic Necessity, Liability Gridlock, and the Private-Sector Question

18 Apr

BUSINESS STANDARD

COP33 Withdrawal: India's Climate Leadership at the Crossroads

18 Apr

THE HINDU

Creeping Risk: India's Industrial Safety Failure and the Vedanta Chhattisgarh Tragedy

17 Apr

RELATED KEY TERMS

KEY TERM

ACNAS

Advisory Committee on National Accounts Statistics — the expert body...

KEY TERM

Act East Policy

India's strategic foreign policy framework prioritising active...

KEY TERM

Active Case Finding (TB)

A proactive public health strategy where health workers systematically...

KEY TERM

Advanced Technology Vessel (ATV) Programme

India's classified, decades-long programme to indigenously design and...

CURATED & WRITTEN BY

Bharat Choudhary

UPSC Educator & Content Creator

linkedin.com/in/epicbharat

Read Full Article on Ujiyari →

https://ujiyari.com/daily/2026/04/18/india-100-gw-nuclear-roadmap-2047-pfbr-kalpakkam/