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EDITORIAL ANALYSIS

The Nuclear Clock — PFBR's First Criticality and What India Must Do Next to Make Stage 2 Count

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THE EDITORIAL ARGUMENT

When Prime Minister Narendra Modi used his Mann Ki Baat 133rd episode on April 26 to call the Prototype Fast Breeder Reactor's first criticality a "historic milestone," he was not exaggerating. The PFBR at Kalpakkam, Tamil Nadu, achieved self-sustaining nuclear fission for the first time on April 6, 2026 — 15+ years behind its original commissioning schedule. The delay makes the milestone more significant in one sense (the project survived despite every incentive to abandon it) and more sobering in another (this is the pace at which India builds nuclear infrastructure). The question is what comes next — and the answer reveals how far India is from the 100 GW nuclear ambition by 2047.

WHAT FIRST CRITICALITY ACTUALLY MEANS

First criticality — the moment a nuclear reactor achieves a self-sustaining chain reaction — is a commissioning milestone, not a commercial milestone. The PFBR is now a functioning reactor. It is not yet a power-generating reactor.

After first criticality, the PFBR will undergo:

- ❶ **Power ascension testing** — gradually increasing power output while monitoring all safety systems
- ❷ **100-day continuous operation trial** — demonstrating reliability at operational power levels
- ❸ **AERB clearance** — the Atomic Energy Regulatory Board issues commercial operation approval only after all safety reviews are complete
- ❹ **Grid connection** — only then does the 500 MWe reactor begin contributing electricity

This process typically takes 12–24 months. The PFBR is not expected to supply electricity to the grid before late 2027 at the earliest.

THE SCALE CHALLENGE: FROM ONE REACTOR TO 100 GW

The Union Budget 2025–26 announced the **Nuclear Energy Mission** with a declared goal of **100 GW of nuclear power by 2047**. India's current installed nuclear capacity is approximately 7.5 GW (from 22 operating reactors, all pressurised heavy water reactors in Stage 1). The gap between 7.5 GW and 100 GW is not a matter of linear **extrapolation** — it requires a qualitative transformation in how India plans, finances, builds, and operates nuclear infrastructure.

Stage 2 of India's three-stage programme requires commercial FBRs — not just one prototype. Each commercial FBR of the planned 600 MWe design requires approximately 5–7 years to build under optimal conditions. Even assuming 10 commercial FBRs are under simultaneous construction by the late 2020s, reaching 100 GW by 2047 would require an industrial capacity that India does not currently possess.

Two specific bottlenecks deserve attention:

MOX fuel supply. Fast breeder reactors use Mixed Oxide fuel — a blend of plutonium dioxide and uranium dioxide. India's plutonium production capacity is limited by the **throughput** of its reprocessing plants. Expanding MOX fuel supply is not primarily an engineering challenge; it is a political economy challenge, because reprocessing raises proliferation concerns that affect India's nuclear cooperation agreements.

Sodium handling infrastructure. The PFBR is a **liquid sodium-cooled** reactor. Sodium burns violently on contact with water and air — managing it requires specialised engineering, trained personnel, and industrial infrastructure that has been built for one reactor at Kalpakkam. Scaling this to 10 or 20 reactors simultaneously requires a new industrial ecosystem.

THE PRIVATE SECTOR QUESTION

The **SHANTI Act** (Small and Medium Nuclear Reactors: Harnessing Atoms for New Technology and Industry) proposes to open nuclear energy to private sector participation for the first time since the Atomic Energy Act, 1962 established a state monopoly. If enacted and implemented, it could catalyse the investment and project management capacity needed for 100 GW.

But private sector participation in nuclear energy requires regulatory certainty, liability frameworks that make investment risk calculable, and insurance mechanisms that private capital can price. The current nuclear liability framework — amended in 2010 after Fukushima concerns — places unlimited liability on the operator and creates supplier liability provisions that have deterred foreign technology transfers. Resolving these requires careful legislative drafting that balances investor protection with public safety.

The PFBR milestone creates momentum. The government should use the next 12 months — as the PFBR undergoes power ascension testing — to finalise the SHANTI Act framework and table the nuclear liability amendment. These are the foundational decisions that will determine whether 2047's 100 GW ambition is a goal or a slogan.

UPSC RELEVANCE

PAPER	ANGLE
GS3 — Science & Tech	Three-stage nuclear programme; fast breeder reactors; nuclear fuel cycle
GS3 — Economy	Nuclear energy mission; energy security; 100 GW nuclear target
GS2 — Polity	AERB; Atomic Energy Act; nuclear liability; SHANTI Act

Mains Keywords: PFBR, first criticality, three-stage nuclear programme, Stage 2, BHAVINI, IGCAR, MOX fuel, liquid sodium, AERB, Nuclear Energy Mission, 100 GW nuclear, SHANTI Act, Mann Ki Baat 133

Prelims Facts Corner

ITEM	FACT
PFBR location	Kalpakkam, Tamil Nadu
First criticality date	April 6, 2026
PFBR capacity	500 MWe (prototype); 600 MWe planned for commercial FBRs
Coolant	Liquid sodium (pool-type)
Designed by	IGCAR (Indira Gandhi Centre for Atomic Research)
Built/operated by	BHAVINI (Bharatiya Nabhikiya Vidyut Nigam Limited)
Stage 2 fuel	MOX (Mixed Oxide — plutonium + uranium)
Stage 3 fuel	Thorium-232 → U-233
India nuclear capacity (current)	~7.5 GW (Stage 1, PHWRs)
Nuclear target 2047	100 GW
Mann Ki Baat episode	133rd (April 26, 2026)

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