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Breeding Ambition: Why India's Nuclear Leap Should Ride Proven Indigenous Technology

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GS3

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THE LIFT LINE

A nation that has waited two decades for its **fast breeder reactor** (<https://ujjyari.com/terms/fast-breeder-reactor-fbr/>) to go critical has learned patience the hard way, and that patience is precisely the asset it must protect as it decides whether to build its nuclear future on technology it owns or technology it must buy.

WHY THIS EDITORIAL MATTERS FOR YOUR EXAM

On 6 April 2026, the 500 MWe Prototype Fast Breeder Reactor at Kalpakkam in Tamil Nadu attained first criticality, opening the long-delayed second stage of India's three-stage nuclear programme. The milestone matters because it revives a strategic question India has ducked for years. To reach the stated goal of 100 GW of nuclear capacity by 2047, should India lean on its proven indigenous Pressurised Heavy Water Reactors and the three-stage roadmap, or spend scarce capital on imported light-water reactors and unproven Small Modular (<https://ujjyari.com/vocab/modular/>) Reactors? The Kalpakkam breeder, using a plutonium-uranium mixed oxide core to convert fertile Uranium-238 into fresh fuel, is a working demonstration that the indigenous path, though slow, delivers energy independence that no import can match.

GS Paper 3: Science and technology, **indigenisation** (<https://ujjyari.com/vocab/indigenisation/>) of technology, energy security, and infrastructure.

For **Prelims**, hold the specifics: the three-stage programme conceived by Homi Bhabha, with Stage I Pressurised Heavy Water Reactors on natural uranium, Stage II fast breeder reactors on plutonium that breed more fuel than they consume, and Stage III reactors on India's vast thorium reserves; the Prototype Fast Breeder Reactor at Kalpakkam operated through Bhavini; the **Nuclear Energy Mission** (<https://ujjyari.com/scheme/s/nuclear-energy-mission/>) and the Bharat Small Reactors initiative announced in the Union Budget; India's status outside the Non-Proliferation Treaty and its Nuclear Suppliers Group waiver of 2008; and the Civil Liability

for Nuclear Damage Act, 2010. For **Mains**, argue that **energy security** (<https://ujiyari.com/terms/energy-security/>) in nuclear power is inseparable from **fuel-cycle sovereignty** and that a reactor which breeds its own fuel from domestic thorium is worth more strategically than a larger reactor dependent on imported enriched uranium.

BACKGROUND AND CONTEXT

India holds roughly a third of the world's thorium but very little uranium, and that geological accident shaped its entire nuclear strategy. Bhabha's three-stage design was an answer to scarcity. Stage I heavy water reactors burn natural uranium and produce plutonium. Stage II breeder reactors burn that plutonium and, crucially, breed more **fissile** (<https://ujiyari.com/vocab/fissile/>) material while wrapping the core in a thorium blanket. Stage III reactors then run on the Uranium-233 bred from that thorium, unlocking a fuel source that could power India for centuries.

The catch has always been time. The Kalpakkam breeder was sanctioned in the early 2000s and expected to operate by 2010, yet criticality came only in 2026, more than fifteen years late. That delay is the argument both for and against the indigenous path. Critics say it proves the three-stage dream is too slow for a country adding capacity urgently. Defenders reply that the technology now works, is fully owned, and frees India from the fuel-supply **leverage** (<https://ujiyari.com/vocab/leverage/>) that foreign vendors hold.

THE CORE ARGUMENT / ISSUE

Owned technology versus bought capacity

The choice is not merely technical but strategic. Imported light-water reactors need imported enriched uranium, tying India's baseload power to the goodwill of the Nuclear Suppliers Group and the reliability of foreign fuel contracts. The heavy water and breeder route runs on natural uranium and domestically bred plutonium, and points ultimately at thorium.

ROUTE	FUEL DEPENDENCE	STRATEGIC CHARACTER
Indigenous PHWR and breeders	Natural uranium, bred plutonium, then thorium	Fuel-cycle sovereignty (https://ujiyari.com/vocab/sovereignty/), slow to build
Imported light-water reactors	Imported enriched uranium	Faster capacity, external fuel leverage
Small Modular Reactors	Design-dependent, largely unproven at scale	Attractive on paper, no commercial track record in India

The Small Modular Reactor temptation

SMRs are marketed as fast, factory-built and flexible, and the Bharat Small Reactors push reflects genuine promise. But no SMR design has yet delivered cheap, reliable power at commercial scale anywhere. Betting the 2047 target on a technology still being proven abroad would repeat the very import dependence the three-stage programme was built to avoid.

The liability question

The Civil Liability for Nuclear Damage Act, 2010, which routes supplier liability in a way foreign vendors dislike, has slowed imported reactor deals for over a decade. That friction is itself an argument for scaling what India can build and fuel on its own terms.

HOW TO THINK ABOUT THIS (ANALYTICAL FRAME)

Distinguish speed from sovereignty. Imports can add gigawatts faster, but every imported reactor deepens a dependence that a supplier state can one day exploit. The indigenous route is slower but compounding, because each breeder reactor produces fuel for the next and moves India closer to thorium self-reliance. The transferable rule for GS3 is that in strategic sectors, the right metric is not capacity added this decade but control retained over the fuel cycle for the century. The examiner rewards the candidate who sees that a slower technology which India owns can beat a faster one it must keep buying.

THE DIAGRAM IN WORDS

Thorium-rich, uranium-poor geology -> Bhabha's three-stage design -> Stage I PHWR on natural uranium produces plutonium -> Stage II Kalpakkam breeder (criticality April 2026) burns plutonium, breeds more fuel, wraps thorium blanket -> Stage III reactors on bred Uranium-233 from thorium -> centuries of domestic fuel -> compared with imported LWRs (need enriched uranium, external leverage) and unproven SMRs -> strategic verdict: scale proven indigenous route for fuel-cycle sovereignty toward 100 GW by 2047

WAY FORWARD

- ❶ **Anchor the 2047 target on proven reactors.** Government should scale the fleet of indigenous heavy water reactors and commission more breeders on the Kalpakkam template, treating imports as a supplement rather than the spine of the programme.
- ❷ **Prove SMRs before betting on them.** Fund the Bharat Small Reactors demonstration rigorously, but do not fold unproven modular capacity into headline targets until at least one design delivers reliable commercial power.

- ③ **Resolve the liability logjam.** Revisit the operation of the Civil Liability for Nuclear Damage Act so that genuine partnerships proceed, without surrendering the supplier-accountability principle that protects citizens.
- ④ **Invest in the thorium bridge.** Accelerate research and fuel-fabrication capacity for Stage III, since thorium utilisation is the ultimate payoff that justifies the patience the programme has demanded.

PYQ LINKAGE AND PRACTICE

UPSC has repeatedly asked about India's three-stage nuclear programme, thorium utilisation and energy security. This editorial converts the Kalpakkam milestone into a live strategic choice, which is exactly the applied analysis the examiner rewards over a textbook recital of the three stages.

Practice question: "India's nuclear future is better secured by scaling proven indigenous technology than by importing reactors or betting on unproven modular designs." Critically examine in the light of the three-stage nuclear programme and the goal of 100 GW by 2047. (250 words, 15 marks)

Sources: The Hindu (<https://www.thehindu.com/>), *Department of Atomic Energy* (<https://dae.gov.in/>), *Press Information Bureau* (<https://www.pib.gov.in/>)

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