



Criticality of Prototype Fast Breeder Reactor

[Source: PIB](#)

Why in News?

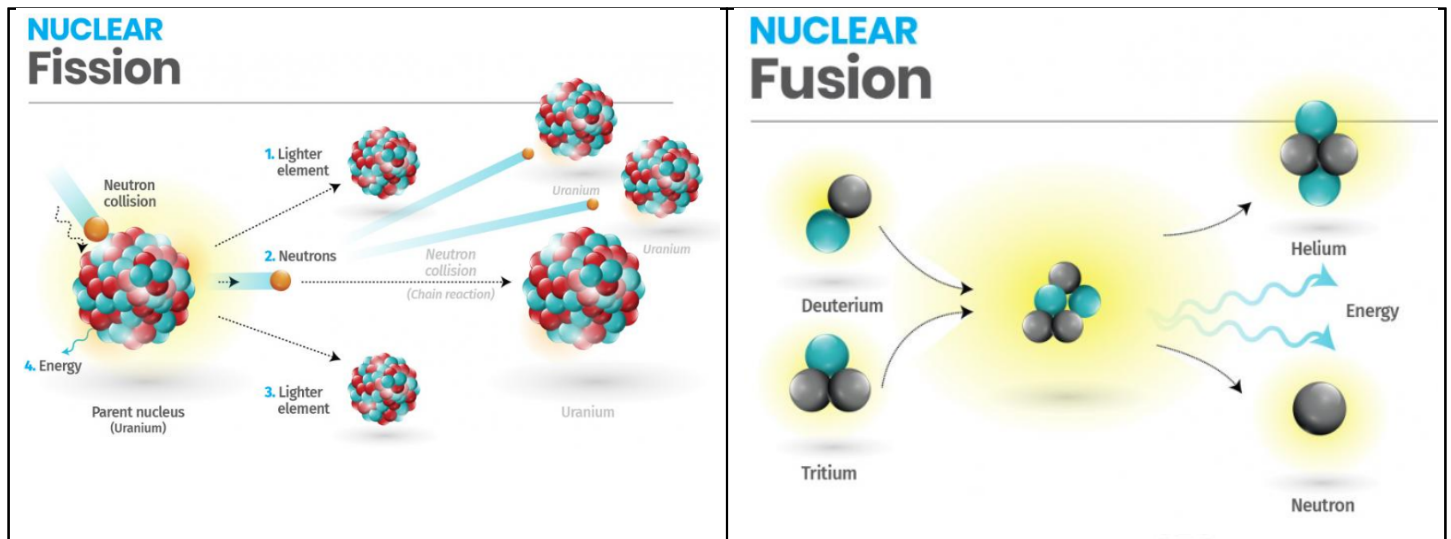
Recently, the [Atomic Energy Regulatory Board \(AERB\)](#) has officially granted permission for the "**First Approach to Criticality**" of the 500 MWe [Prototype Fast Breeder Reactor \(PFBR\)](#) at Kalpakkam, Tamil Nadu, **India's first indigenous PFBR.**

Note

- **Criticality:** Criticality in a nuclear reactor is when **enough neutrons are produced by fission to replace those lost** through leakage or absorption, ensuring the number of neutrons remains constant.
- **Fission Vs Fusion:**

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Parameters	Nuclear Fission	Nuclear Fusion
Natural occurrence	This is not observed in nature.	This is observed in stars such as the sun.
By-products formed	A lot many high particles are generated.	Very few radioactive particles are produced.
Critical conditions	A critical mass of the substance with high-speed neutrons.	A higher density and high temperature are necessary.
Energy requirement	It takes a small amount of energy to split an atom.	Very high energy is required.
The release of energy	This process is exothermic.	This process is endothermic.
The production of energy	In nuclear power plants.	Experiments that are used for the generation of energy.



What is India's FBR Programme?

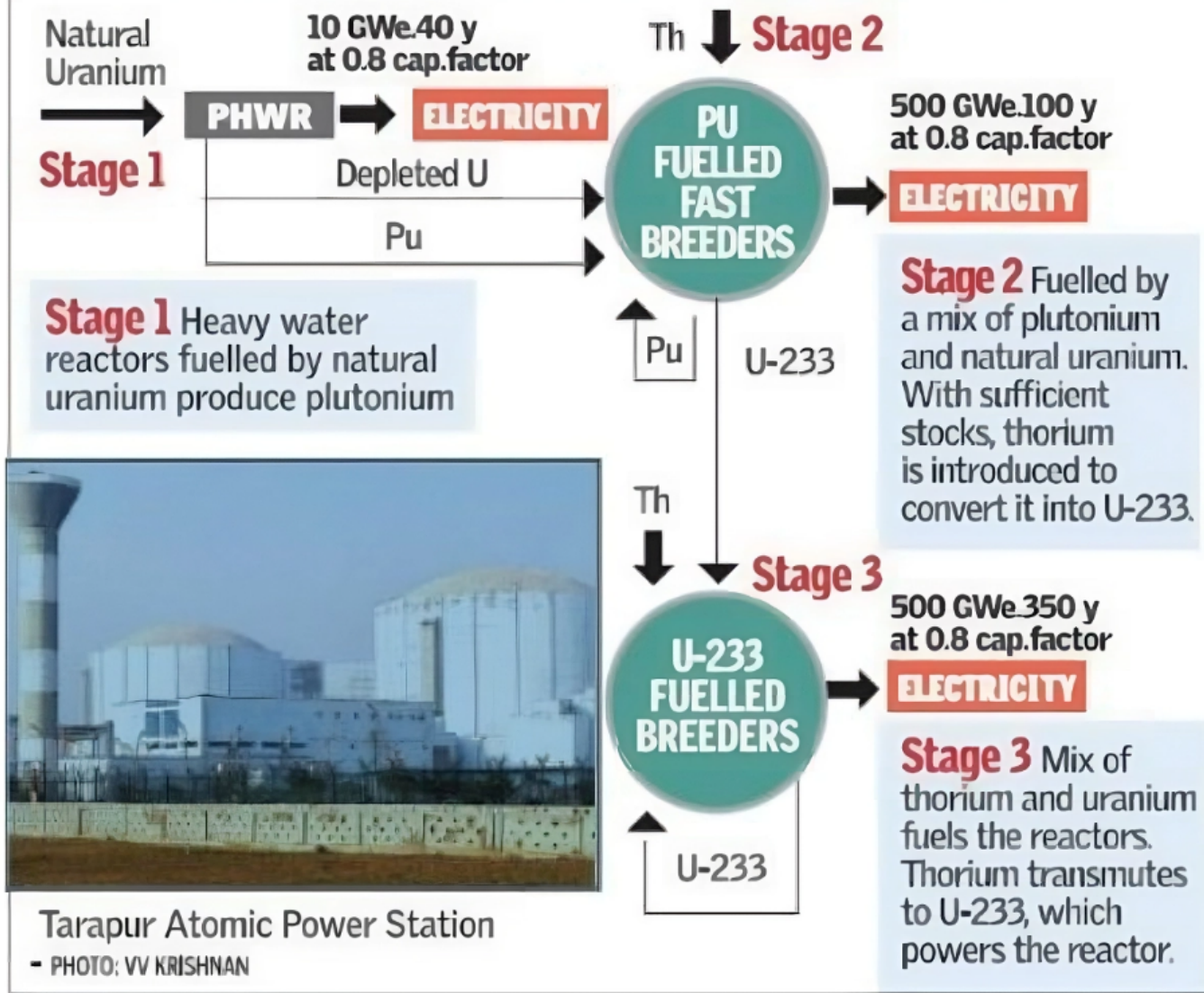
- Efforts to build an FBR were initiated two decades ago.
 - It is a step towards India developing comprehensive capabilities that span the entire **nuclear fuel cycle**, by which electricity is produced from uranium in nuclear power reactors.
- The **Department of Atomic Energy (DAE)** aims to **increase the share of nuclear power** in the energy mix by 2032 by producing 22,400 MWe from its nuclear power plants.
 - It has **approved the construction of 10 new PHWRs** in 'fleet mode', in which a plant is expected to be built in five years from the first pouring of concrete.
 - FBRs reactors **generate more nuclear fuel** than they consume due to the gainful conversion of fertile isotopes into fissile material.
- In 2003, the **Bharatiya Nabhikiya Vidyut Nigam Ltd or BHAVINI** was incorporated to **build and operate India's most advanced nuclear reactor, the Prototype Fast Breeder Reactor (PFBR)**.
 - Once commissioned, India will be the second country after Russia to have a commercial operating FBR.

What are the Three stages of India's Nuclear Energy Program?

- **The First Stage:** The installation of Pressurised Heavy Water Reactors (PHWRs) is underway, with PHWRs using natural uranium as fuel and heavy water as coolant and moderator.
- **The Second Stage:** It involves the **setting up of FBRs backed by reprocessing plants** and plutonium fabrication plants, primarily to multiply the inventory of fissile material.
 - **Multiplication of fissile inventory** is also needed to establish a higher power base **for using thorium in the third stage of the programme.**
- **The Third Stage:** It will be **based on the Thorium and Uranium Cycle.** For producing Uranium-233 (U233), obtained by irradiation of thorium in PHWRs and FBRs, an **Advanced Heavy Water Reactor (AHWR) is proposed.**

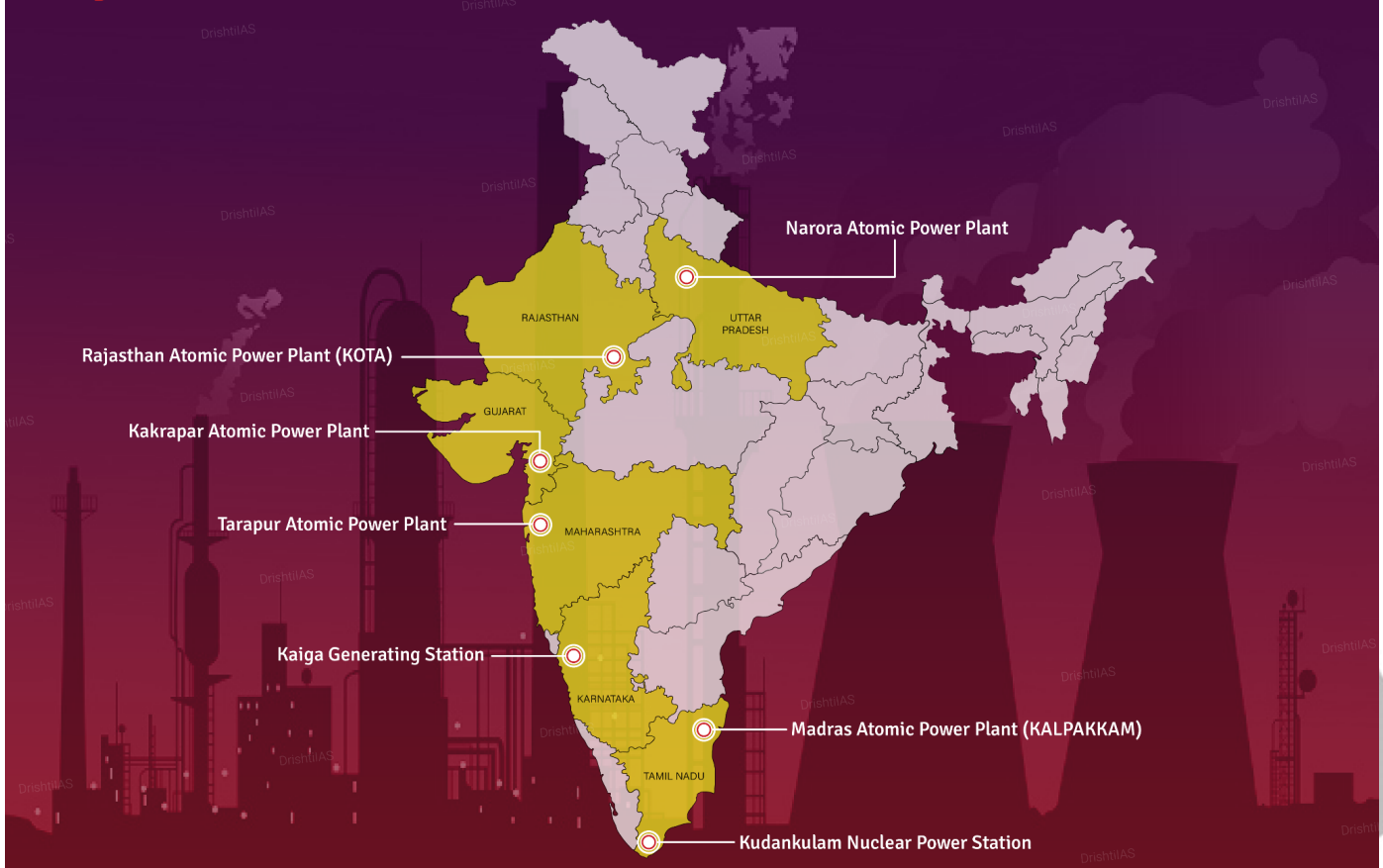
INDIA'S THREE-STAGE NUCLEAR PROGRAMME

Homi Bhabha envisioned India's nuclear power programme in three stages to suit the country's low uranium resource profile



- The combination of power reactors from all three stages is **expected to ensure long-term energy security** for the country.
 - But the commercial utilisation of thorium on a significant scale can begin **only when abundant supplies of either Uranium-233 (U233) or Plutonium-239 (Pu239)** are available.
 - The progress on the FBR has made the **passage to the third phase visible**.

Operational Nuclear Power Plants in India



FACTS

- Presently, India has 22 nuclear power reactors operating in 6 states, with an installed capacity of 6780 MegaWatt electric (MWe).
- Activities concerning the establishment and utilization of nuclear facilities and use of radioactive sources are carried out in India in accordance with the Atomic Energy Act, 1962.
- Atomic Energy Regulatory Board (AERB) regulates nuclear & radiation facilities and activities.
- **Newest & Largest Nuclear Power Plant:** Kudankulam Power Plant, Tamil Nadu.
- **First & Oldest Nuclear Power Plant:** Tarapur Power Plant, Maharashtra.



UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. Which one of the following statements best reflects the idea behind the “Fractional Orbital Bombardment System” often talked about in media?

- (a) A hypersonic missile is launched into space to counter the asteroid approaching the Earth and explode it in space.
- (b) A spacecraft lands on another planet after making several orbital motions.
- (c) A missile is put into a stable orbit around the Earth and deorbits over a target on the Earth.
- (d) A spacecraft moves along a comet with the same speed and places a probe on its surface.

Ans: (c)

Q. In the context of Indian news in recent times, what is MCX-SX? (2009)

- (a) A kind of supercomputer
- (b) Title of Moon Impact Probe
- (c) Stock exchange
- (d) Nuclear-powered submarine

Ans: (c)

Q. Which among the following has the world's largest reserves of Uranium? (2009)

- (a) Australia
- (b) Canada
- (c) Russian Federation
- (d) USA

Ans: (a)

PDF Reference URL: <https://www.drishtias.com/printpdf/criticality-of-prototype-fast-breeder-reactor>

