



Kakrapar Atomic Power Project

For Prelims: [Kakrapar Atomic Power Project](#), Regulated Fission Reaction, Atomic Energy Regulatory Board (AERB).

For Mains: Kakrapar Atomic Power Project, Ways to Enhance India's Nuclear Power Capacity.

[Source: TH](#)

Why in News?

Recently, the fourth unit of [Kakrapar Atomic Power Station \(KAPS\)](#), Gujarat has achieved its **first Criticality** — the beginning of the regulated fission reaction — paving the way for its eventual transition to generating power for commercial use.

What is Criticality?

- Criticality is the **first step towards power production**. A nuclear reactor is said to be critical when the nuclear fuel inside a reactor sustains a fission chain reaction.
- Each fission reaction releases a sufficient number of neutrons **to sustain a series of reactions**. Heat is produced in the event, which is used to generate steam that spins a turbine to create electricity.
 - **Fission is a process** in which the nucleus of an atom splits into two or more smaller nuclei, and some byproducts.
 - When the nucleus splits, the **kinetic energy of the fission fragments (primary nuclei) is transferred** to other atoms in the fuel as heat energy, which is eventually used to produce steam to drive the turbines.

What is the Significance of Achieving First Criticality?

- **Milestone for Power Generation:**
 - This stage demonstrates that the **reactor can produce a controlled and continuous chain reaction**, essential for sustained power generation. It's a precursor to full operation and power generation for commercial use.
- **Technology Advancements:**
 - The Kakrapar reactors, particularly Units 3 and 4, boast advanced safety features inspired by lessons from past nuclear incidents like the [Fukushima Daiichi disaster](#).
 - These include steel-lined containment systems and passive decay heat removal systems, enhancing safety and reliability.
- **Energy Sustainability and Climate Goals:**
 - Nuclear energy, as a **low-carbon source**, aligns with India's climate goals to increase its renewable energy share.
 - India aims to generate 50% of its electricity from non-fossil fuel sources by 2030, as pledged at international forums like the [United Nations Convention of Parties \(COP26\)](#).

What are the Key Points about the Kakrapar Reactor?

- Existing KAPS reactors Unit-1 and Unit-2 have a capacity of 220 MW each. But the new 700MW projects, Unit-3 and Unit-4, are **among the safest reactors** in the world.
- The **Unit-3 and 4 reactors have steel-lined inner containment systems** that prevent any radioactive material from escaping in case of an accident.
- They also have passive decay heat removal systems, which **safely cool down the reactor even when it is shut down.**

How has India's Nuclear Journey Been?

- **Early Development:**
 - India's nuclear program started in the 1940s and gained momentum with the establishment of the **Atomic Energy Commission (AEC) in 1948.**
 - Homi Bhabha, known as the **father of India's nuclear program**, played a pivotal role in its early stages.
- **Peaceful Nuclear Explosions:**
 - India conducted its **first peaceful nuclear explosion as operation Smiling Buddha** 1974, in Pokhran, marking its entry into nuclear technology.
 - In May 1998 Pokhran-II was conducted as a series of five nuclear tests including one thermonuclear test aimed **at demonstrating nuclear weapon capability**
- **Civil Nuclear Cooperation:**
 - Despite being outside the [Nuclear Non-Proliferation Treaty \(NPT\)](#), India negotiated civil nuclear agreements with various countries, including the [Indo-US Civil Nuclear Agreement in 2008](#), allowing for technology cooperation and nuclear fuel supply.
- **Indigenous Nuclear Capabilities:**
 - India developed indigenous nuclear technology, including [Pressurised Heavy Water Reactors \(PHWRs\)](#) and **Fast Breeder Reactors (FBRs)**, showcasing self-reliance and scientific prowess.
 - India's nuclear power generation capacity grew steadily, with the Nuclear Power Corporation of India Limited (NPCIL) leading the construction and operation of nuclear reactors across the country.
- **Safety and Regulations:**
 - India focused on stringent safety standards and regulatory measures overseen **by the Atomic Energy Regulatory Board (AERB)** to ensure the safe operation of nuclear facilities.
 - Nuclear energy played a role in diversifying India's energy mix, contributing to energy security and reducing dependence on fossil fuels.
- **Current Status and Future Plans:**
 - Currently, India has **23 nuclear power reactors** in operation under NPCIL (Nuclear Power Corporation of India), with a total capacity of **7,480 MW.**
 - NPCIL is constructing nine more reactors, including KAPS Unit-4, with a total capacity of 7,500 MW.
 - As of 2023, India has a **total generation capacity of 417 GW**, out of which **43 percent is from renewable sources.** However, nuclear energy still has a small role in India's total energy generation, despite its rapid growth.
 - In 2022-23, nuclear energy formed around 2.8 percent of India's total energy production, according to government data.
 - India has set ambitious targets to significantly increase its nuclear energy production, **aiming to triple its capacity by 2031.**
 - However, challenges such as **public concerns over safety, land acquisition, and regulatory hurdles remain.**

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. The function of heavy water in a nuclear reactor is to (2011)

- (a) Slow down the speed of neutrons
- (b) Increase the speed of neutrons
- (c) Cool down the reactor
- b Stop the nuclear reaction

Ans: (a)

Mains

Q. With growing energy needs should India keep on expanding its nuclear energy programme? Discuss the facts and fears associated with nuclear energy. (2018)

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