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Role of Nuclear Energy in India's Energy Security

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ABSTRACT

India's energy requirements are rapidly growing due to a various reasons such as economic activities, population growth, industrialization, climate change mitigation, increasing number of cities and migration etc. The projections for the peak electricity demand and electrical energy requirement is 277.2 GW and 1907.8 BU for the year 2026-27and 366.4 GW and 2773.8 BU for the year 2031-32 as per 20th Electric Power Survey Demand Projections. This research tries to expertise the use of nuclear energy as a low carbon energy source within the India's energy framework. Nuclear energy contributes 3% to total electricity generation. This research presents a evaluation of India's nuclear power infrastructure which comprises 22 operational reactors.

INTRODUCTION

Nuclear energy is a part of India's strategy to meet its increasing energy demands while reducing dependence on fossil fuels. India operates 22 nuclear reactors with a total installed capacity of 7480 MW, contributing around 3% to nation's electricity mix. India is the third largest emitter of Co_2 globally, discharging over 2.9 gigatones in the year 2022.

India has set a target to achieve net zero emissions by the year 2070 and to reduce GDP by 45 % by the year 2030. At present, coal continues to be the foundational pillar of India's energy sector. But this is obstacle to India's climate pledges and nuclear energy is seen as an alternative to fossil fuels energy sources and also a solution for attaining low carbon energy sources.

India Nuclear Power Program
India follows a unique three-stage nuclear power program established in 1950s with a goal of utilizing thorium to meet India's energy needs . The program is enhanced for the target of reaching 100 GW of nuclear power capacity by 2047. Three-Stage Program –

Stage 1: This stage makes the use of natural uranium and heavy water reactors (PHWRs) to produce electricity and plutonium.

Stage 2: Utilizes fast breeder reactors (FBRs) that can utilize plutonium from stage 1 to generate electricity and produce more plutonium for stage 3.

Stage 3: This stage makes use of thorium based reactors that can use thorium reserves for electricity generation.

ADVANTAGES OF NUCLEAR ENERGY

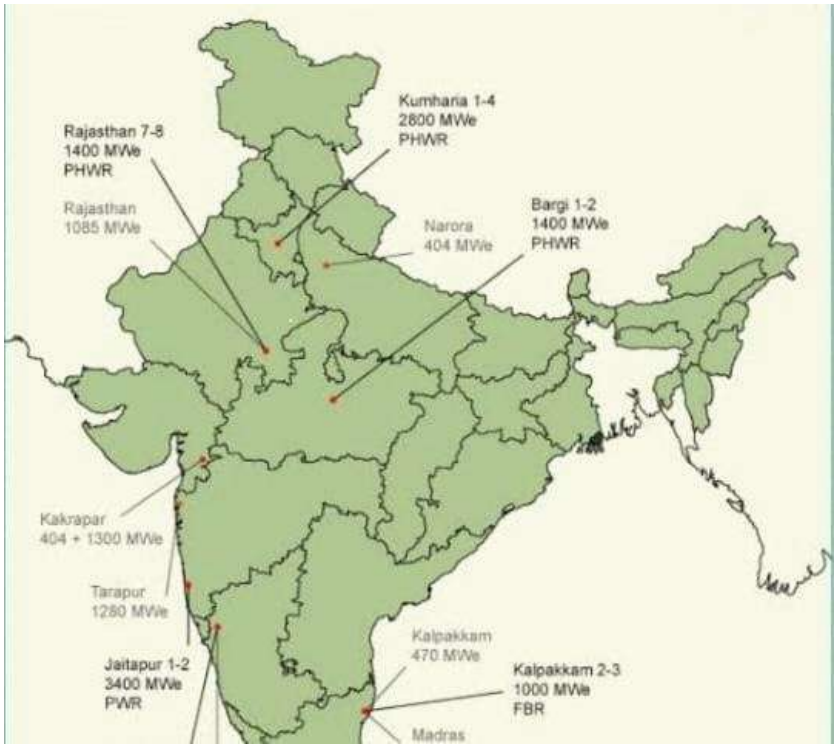
1. Low carbon emissions
2. High energy density
3. Reliable And Stable
4. Energy Security
5. Base Load Power
6. Long term Potential

Current Status of Nuclear Energy in India
India's nuclear energy system primarily driven by NPCIL plays an important role in the country's strategy to meet its energy requirements and become less dependent on fossil fuels. India had installed capacity of 6780 MW. We have nuclear reactors in states such as Rajasthan, Kakrapar, Tarapur, Kaiga, Chennai, Narora and Kudankulam.

Kudankulam Nuclear Plant =2000 MW
Tarapur Atomic Power Station=1400 MW
Kaiga Generating Station=880 MW

Nuclear Capacity Targets

In 2018, Indian govt. said that nuclear energy capacity would fall short of its target of 63 GW outlined in the 12th Five year plan for 2012-17 and nuclear capacity is likely to be about 22.5 GW by the year 2031. In February 2025, Finance Minister announced that 'Development of 100 GW of nuclear energy by 2047' is essential for our energy transition efforts.



Key Players

NPCIL - Nuclear Power Corporation of India ltd is responsible for design, construction commissioning and operation of thermal power plants.

NTPC - National Thermal Power Corporation is larger than NPCIL and sees itself as main power producer.

AEC - The Indian Atomic Energy Commission is the main policy making body.

BARC - Bhabha Atomic Research Centre operates two specific reactors -

The two Tarapur 150 MWe boiling water reactors (BWRs) built by GE on a turnkey contractors are using imported enriched uranium.

A. The two small Canadian (Candu) PHWRs at Rajasthan nuclear powerplant are also under safeguards.
B. The Madras reactors have their capacity restored to 220 MW gross.
C. Kakrapar unit 1 was upgraded in 2009-10.
D. The Tarapur 3C4 reactors of 540 MW gross were built by NPCIL.
E. The 500 MW Prototype Fast Breeder Reactor (PFBR) started construction in 2004 at Kalpakkam near Madras.
F. Kudankulum 1 C2 -The AES -92 units at Kudankulum,Tamil Nadu State have been built by NPCIL.

Technological Developments

India has made substantial progress in nuclear reactor developments across various locations. Civil Nuclear Cooperation Agreements have been signed with USA, Russia, France, UK and South Korea etc.

NPCIL intends to set up five 'Nuclear Energy Parks' each with capacity of 8 new -generation reactors of 1000 MW. India's nuclear strategy mainly talks about development of FBRs.

CONCLUSION

Challenges associated with Nuclear energy are following –

1. Safety Concerns.
2. High Capital Costs
3. Nuclear Waste Management.
4. Dependence on Imported Uranium.
5. Regulatory and Bureaucratic Delays
6. Technological Limitations.
7. Public Opposition.

Nuclear energy is essential for India's sustainable growth, providing a reliable and low-carbon energy source. With focus on thorium -based reactors and advancements in technology, India aims to enhance energy security and contribute to climate change mitigation.

Way Forward

The Future of nuclear energy in India lies in increasing number of reactors and enhancing safety measures and advancing thorium reactor development. Nuclear energy with capacity exceeding 85% provides a stable solution to changing outputs of solar and wind energy.

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