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Small Modular Reactors (SMRs): Key to India's Nuclear Energy Expansion

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Small Modular Reactors (SMRs) have emerged as a major focus area in India's nuclear energy strategy. According to recent reports, India's atomic energy regulator is likely to maintain the same rigorous safety and licensing standards for SMRs as those applicable to large nuclear reactors. The development comes amid India's ambitious plans to expand nuclear power generation and achieve clean energy goals.

The Government of India has identified SMRs as a crucial component of the Nuclear Energy Mission, announced in the Union Budget 2025-26, which aims to achieve 100 GW of nuclear power capacity by 2047. The mission includes a financial allocation of ?20,000 crore for the design, development, and deployment of indigenous SMRs.

What are Small Modular Reactors (SMRs)?

SMRs are advanced nuclear reactors with a power generation capacity of up to 300 MWe (Megawatt Electric) per module, roughly one-third the size of conventional nuclear power reactors. They are designed to be factory-manufactured and assembled at the project site, reducing construction time and costs.

Key Features of SMRs

Smaller size and modular design.

Enhanced passive safety systems.

Lower capital investment requirement.

Suitable for remote and difficult-to-access regions.

Can complement renewable energy sources.

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Reduced construction time through factory fabrication.

Longer refuelling intervals compared to conventional reactors.

India's SMR Programme

The Department of Atomic Energy (DAE) is developing three indigenous SMR models:

Bharat Small Modular Reactor (BSMR-200) – 200 MWe.

SMR-55 – 55 MWe modular reactor.

High Temperature Gas-Cooled Reactor (HTGR) – up to 5 MWth for hydrogen production.

India aims to have at least five indigenous SMRs operational by 2033.

SHANTI Act, 2025

A major reform supporting India's nuclear expansion is the SHANTI Act, 2025 (Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India).

Key Objectives:

Modernize India's nuclear legal framework.

Enable limited private sector participation under regulatory oversight.

Facilitate investment and innovation in the nuclear sector.

Support deployment of SMRs and advanced nuclear technologies.

Why are SMRs Important for India?

Help achieve Net Zero target by 2070.

Provide reliable baseload power alongside renewable energy.

Support decarbonisation of industries.

Reduce dependence on fossil fuels.

Can replace retiring coal-fired power plants.

Promote energy security and self-reliance.

Additional Key Facts

India's Three-Stage Nuclear Programme

Proposed by Homi Jehangir Bhabha in the 1950s.

Stage-I

Uses Pressurized Heavy Water Reactors (PHWRs).

Fuel: Natural Uranium.

Produces Plutonium-239.

Stage-II

Uses Fast Breeder Reactors (FBRs).

Fuel: Plutonium-based mixed fuel.

Generates Uranium-233 from Thorium.

Stage-III

Uses Thorium-based reactors.

Fuel: Uranium-233 derived from Thorium.

Objective: Utilize India's vast Thorium reserves.

Nuclear Energy Mission

Announced: Union Budget 2025-26.

Target: 100 GW nuclear capacity by 2047.

Allocation for SMRs: ?20,000 crore.

Goal: Five indigenous SMRs operational by 2033.

Department of Atomic Energy (DAE)

Established: 1954

Headquarters: Mumbai

Secretary of Atomic Energy and Chairman, Atomic Energy Commission: Ajit Kumar Mohanty,

Functions directly under the Prime Minister of India.

Responsible for nuclear power generation, research, and atomic energy development.

Nuclear Power Corporation of India Limited (NPCIL)

Established: 1987

Headquarters: Mumbai

Chairman & MD: B. C. Pathak

Public Sector Enterprise under DAE.

Responsible for design, construction, and operation of nuclear power plants in India.

Bhabha Atomic Research Centre (BARC)

Established: 1954

Headquarters: Trombay, Mumbai

Director: Vivek Bhasin

India's premier nuclear research institution.

Exam Focus Points (Quick Revision Notes)

Technology in News ? Small Modular Reactors (SMRs)

Maximum Capacity of SMRs ? Up to 300 MWe

Mission ? Nuclear Energy Mission

Target Nuclear Capacity by 2047 ? 100 GW

Allocation for SMRs ? ?20,000 crore

Operational Target ? Five indigenous SMRs by 2033

Key Legislation ? SHANTI Act, 2025

Developing Agency ? Department of Atomic Energy (DAE)

Major Indian SMR ? Bharat Small Modular Reactor (BSMR-200)

Related Concept ? Clean Energy Transition & Decarbonisation