

# **Small Modular Reactors for Decarbonization**

For Prelims: Low-Carbon Electricity Resources, <u>Decarbonization</u>, <u>International Energy Agency (IEA)</u>, <u>Rare Earth Elements</u>, <u>International Atomic Energy Agency (IAEA)</u>, <u>Atomic Energy Act</u>, <u>1962</u>.

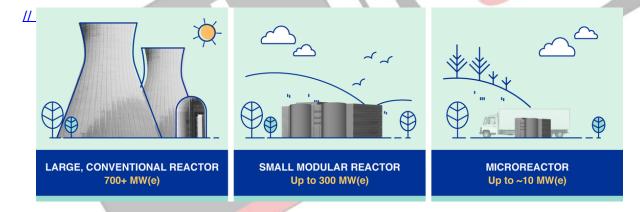
For Mains: Small Modular Reactors for Decarbonization.

#### **Source: TH**

### Why in News?

The rise in coal consumption despite increased solar and wind power underlines the need for Low-Carbon Electricity Resources such as **Small Modular Reactors (SMRs)** to ensure Deep <u>Decarbonization</u>.

Conventional <u>NPPs (Nuclear Power Plants)</u> have generally suffered from time and cost overruns. As an alternative, several countries are developing (SMRs) - nuclear reactors with a maximum capacity of 300 MW - to complement conventional NPPs.



#### What is Decarbonization?

#### About:

Decarbonization refers to the process of reducing the Carbon Dioxide (CO<sub>2</sub>) Emissions
produced by human activities, particularly those related to the burning of fossil fuels such
as <u>Coal</u>, Oil, and Natural gas.

#### Need:

- The global pursuit of decarbonization aligns with the <u>UN Sustainable Development Goal</u>
   7, which emphasizes affordable and sustainable energy access.
  - However, the world's heavy reliance on fossil fuels, **constituting 82% of energy supply**, necessitates the urgent decarbonization of the power sector.
- The rise in coal consumption in Europe despite increased solar and <u>Wind Power</u> underlines the need for reliable low-carbon electricity resources to ensure deep

decarbonization, grid stability, and energy security.

- Challenges of Decarbonization:
  - Clean Energy Transition Challenges: The shift from coal to clean energy is a
    complex challenge globally. Several nations concur that relying solely on solar and wind
    energy would not suffice reliable and affordable energy access for all.
    - In decarbonized power systems dominated by renewables, introducing at least one **stable power source enhances grid reliability and reduces expenses,** contributing to a balanced energy mix.
  - Critical Minerals Demand and Complexities: The <u>International Energy Agency</u> (<u>IEA</u>) predicts a potential 3.5x surge in demand for <u>critical minerals like lithium</u>, <u>nickel</u>, <u>cobalt</u>, and <u>Rare Earth Elements</u> by 2030, essential for clean energy technologies.
    - However, this demand escalation raises multiple global issues, including the large capital investments to develop new mines and processing facilities.
  - Challenges in the Mineral Supply Chain: Rapid development in countries like China, Indonesia, Africa, and South America, coupled with concentration of mineral extraction and processing capacities, presents environmental, social, geopolitical, and supply risks.
    - Addressing these challenges becomes critical for sustainable clean energy advancement.

# What are Small Modular Reactors (SRMs)?

- About:
  - SMRs are advanced nuclear reactors that have a power capacity of up to 300 MW(e)
    per unit, which is about one-third of the generating capacity of traditional nuclear power
    reactors.
  - SMRs, which can produce a large amount of low-carbon electricity, are,
    - **Small:** Physically a fraction of the size of a conventional nuclear power reactor.
    - **Modular**: Making it possible for systems and components to be factory-assembled and transported as a unit to a location for installation.
    - Reactors: Harnessing nuclear fission to generate heat to produce energy.
  - Their designs incorporate enhanced safety features, reducing the risk of uncontrolled radioactive material release.
    - SMRs are designed to operate for 40-60 years with capacity factors exceeding 90%.



# Advantages:

- Reliable Low-carbon Electricity Source:
  - As the demand for electricity is projected to surge by 80-150% by 2050, SMRs could provide a reliable 24/7 low-carbon electricity source that complements intermittent renewables.
  - This is crucial for achieving grid reliability and reducing costs in decarbonized electricity systems.
- Minimized Land Acquisition Challenges:
  - SMRs generate less spent nuclear fuel and can be safely operated in existing brownfield sites, minimizing land acquisition challenges.
  - SMRs are also simpler to design and manufacture, with potential for cost reduction through serial manufacturing.
- Alternatives to Critical Minerals:
  - The transition to clean energy requires <u>Critical Minerals</u> for technologies like lithium-ion batteries, leading to concerns about geopolitical risks and environmental impacts.
  - SMRs offer an alternative, as they require low-enriched uranium, which is more

widely distributed than critical minerals.

- Integration with India's Energy Strategy:
  - For India, which aims to achieve net-zero emissions by 2070, SMRs can play a
    pivotal role. As coal-based thermal power plants and variable renewable energy
    sources contribute significantly to the energy mix, SMRs can enhance energy
    security and grid stability.
    - India's **Central Electricity Authority** envisions SMRs as a crucial element in meeting electricity demands, while private sector investments, including public-private partnerships, are vital for expansion.

# How can Low-Carbon Electricity Resources be Promoted for Decarbonization?

- An efficient regulatory regime comparable to that in the civil aviation sector which has more stringent safety requirements – is important if SMRs are to play a meaningful role in decarbonising the power sector.
- This can be achieved if all countries that accept nuclear energy direct their respective regulators to cooperate amongst themselves and with the <u>International Atomic Energy</u> <u>Agency (IAEA)</u> to harmonize their regulatory requirements and expedite statutory approvals for SMRs based on standard, universal designs.
- To facilitate SMR deployment, India needs to amend the <u>Atomic Energy Act, 1962</u> to allow private sector involvement.
- While maintaining government control over nuclear fuel and waste, an independent regulatory board should oversee the entire nuclear power cycle.
- The India-US '123 agreement' provides opportunities for India to reprocess spent fuel from SMRs under IAEA safeguards, contributing to resource sustainability.
  - It also permits India to set up a facility to reprocess spent fuel from SMRs under safeguards of the IAEA.

# **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
- (d) 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)** 

PDF Reference URL: https://www.drishtiias.com/printpdf/small-modular-reactors-for-decarbonization