Mains Practice Question

Q. "Small Modular Reactors (SMRs) are emerging as a potential solution for clean energy transition."Examine the prospects and challenges of SMRs in India's nuclear energy strategy. **(150 words)**

26 Feb, 2025 GS Paper 3 Science & Technology

Approach

- Introduce Small Modular Reactors (SMRs) and their role in clean energy transition.
- Discuss prospects, challenges and solutions of SMRs in India, including energy security, decarbonization, and grid flexibility.
- Conclude suitably.

Introduction

Small Modular Reactors (SMRs) are **advanced nuclear reactors** with capacities ranging from **less than 30 MWe to over 300 MWe.** Their **modular design, enhanced safety features, and adaptability** make them a viable solution for India's **clean energy transition**. India's focus on SMRs aligns with its **net-zero targets and energy security goals.**

Body

Prospects of SMRs in India's Nuclear Energy Strategy:

- **Energy Security & Reliability**: SMRs provide a **stable, low-carbon alternative** to fossil fuels, reducing India's **dependence on coal and oil imports.**
- **Scalability & Grid Flexibility**: Due to their **smaller size and modular nature**, SMRs can be deployed **quickly** and **integrated into existing grids** or used in **off-grid locations.**
- **Decarbonization & Climate Commitments:** SMRs align with India's **COP26 commitment** to achieving **50% non-fossil fuel-based power by 2030** and its **net-zero target by 2070.**
- **Repurposing Coal Power Plants:** BARC is developing **indigenous SMRs** to repurpose **retiring coal-based power plants,** reducing **carbon emissions while utilizing existing infrastructure.**
- **Private Sector Participation & Investment**: The **Nuclear Energy Mission for Viksit Bharat** encourages **private investment** in SMRs, fostering **technological innovation and commercial viability.**
- **Efficient Land & Water Use**: SMRs require **less land** and **cooling water** than large reactors, making them suitable for **industrial clusters** like **steel and aluminum plants.**

Challenges for SMRs in India

- **Regulatory & Policy Hurdles:** The **Civil Liability for Nuclear Damage Act, 2010** imposes liability on suppliers, discouraging **private investment** in nuclear energy.
- **High Initial Costs & Funding Issues:** Developing **indigenous SMRs** requires significant **capital investment.**

    - Estimates suggest that CAPEX costs for these reactors can be up to $5,000/kW
- **Technological Challenges:** SMRs involve **complex designs and novel fuel cycles,** requiring **advanced research and expertise.**
- **Radioactive Waste:** SMRs generate spent fuel waste, needing storage, while some SMR designs increase waste due to neutron reflectors and specialized fuels.
- **Public Perception and Engagement:** Nuclear power faces opposition because of potential consequences of nuclear disasters. The scars iof Bhopal gas tragedy are green even today.

Solutions & Steps Taken by the Government:

- **Regulatory Reforms:** The **government plans to amend the Atomic Energy Act** to allow **private sector participation.**
- **Financial Support: ₹20,000 crore allocated in Budget 2025-26** for **SMR R&D and deployment.**
- **Technological Development: BARC is developing indigenous SMRs** to support **coal power plant repurposing.**
- **Public Awareness Initiatives:** NPCIL and DAE are conducting **awareness campaigns** to build **public trust in nuclear energy.**
- **Global Collaborations:** India is **exploring partnerships** with **Russia, France, and the USA** for **SMR technology transfer** and **fuel supply.**

Conclusion

SMRs offer a transformative opportunity for India's nuclear energy sector with **scalable and clean power.** Overcoming regulatory, financial, and technological challenges through policy support, private investment, and global collaboration is crucial for success.