Shift of Tech Giants Towards Nuclear Energy

For Prelims: Small Modular Reactors (SMRs), Startup Oklo, Wind and Solar Energy, Carbon Footprints, Greenhouse Gas Emissions, Nuclear Power, Rural Electrification Corporation, Nuclear Power Corporation of India, Nuclear Fission, Bharat Small Modular Reactor, Uranium, Chernobyl Disaster (1986), Fukushima Accident (2011), Nuclear Waste.

For Mains: Growing significance of nuclear energy for meeting energy needs and climate goals.

Source: TH

Why in News?

Recently, some **big tech companies** including **Google** signed agreements to **purchase nuclear energy** to meet rising electricity demands for **Artificial Intelligence** **data centres**.

Which Big Tech Companies Investing in Nuclear Energy?

- **Google**: Google has entered into a corporate agreement to purchase nuclear energy from multiple **Small Modular Reactors (SMRs)** being developed by **Kairos Power**.
    - It will provide **500 MW** of carbon-free power for development of **AI technologies**.
- **Microsoft**: Microsoft signed a 20-year power purchase agreement with **Constellation Energy** to restart the **Three Mile Island nuclear power plant** **in the US.**
    - It will provide approximately **835 MW of carbon-free energy**, supporting Microsoft's goal of becoming carbon negative.
- **Amazon**: Amazon has formed **three agreements** to support nuclear energy. It includes, partnership with **Energy Northwest** for **SMRs in Washington**, investing in **SMR** development with **X-energy**, and collaborating with **Dominion Energy in Virginia.**
- **OpenAI**: OpenAI CEO **Sam Altman** has backed the nuclear **startup Oklo**, aiming for operational status by 2027.
    - Altman also invested in **Helion,** a **nuclear fusion company**, in 2021.

Why Are Big Tech Companies Shifting to Nuclear Energy?

- **Increasing Energy Demands from AI**: The **Electric Power Research Institute (EPRI)**, a non-profit organisation, highlighted that **data centres' electricity consumption could more than double by 2030.**
    - Data centres, which are critical for AI operations, are projected to **consume up to 9% of the United States' electricity by 2030**, more than double their current usage.
- **Limitations of Renewable Energy**: Nuclear energy provides **continuous and carbon-free power** around the clock as AI companies scale their operations.
    - Renewable energy sources such as **wind** **and** **solar** **are intermittent** in nature.
- **Sustainability**: Major tech companies are increasingly focused on reducing their **carbon footprints** and achieving **sustainability goals.**
    - E.g., Google reported a **13% rise in global** **greenhouse gas emissions** **in 2023**,

highlighting the challenges of balancing growth with sustainability.

- **Strategic Partnerships and Investments:** Tech giants are forging strategic partnerships with energy companies to invest in **nuclear power projects**.
    - E.g., Microsoft partnered with **Constellation Energy** to revitalise the Three Mile Island nuclear plant in the US for securing long-term carbon-free energy.
- **Potential for Economic Advantage**: Investing in nuclear power now enables tech firms to secure a **reliable energy source**, which will be increasingly **valuable** as energy **competition intensifies**.
- **Climate Change Concern**: Concerns about **climate change** and energy reliability make nuclear power **more appealing**, prompting tech companies to justify their investments in this sector.

What is the Nuclear Energy Scenario in India?

- India aims to **triple its nuclear power capacity to 22,480 MW by 2032**, with a goal of deriving **25%** of its electricity from **nuclear sources by 2050.**
- **REC (Rural Electrification Corporation)** plans to allocate **Rs 6 trillion** to renewable and nuclear projects by **2030**.
- **NTPC** is partnering with **NPCIL (Nuclear Power Corporation of India)** to form **Anushakti Vidhyut Nigam**, focusing on building and operating **nuclear power plants**.
- India plans to establish **10 new reactors** and collaborate with private players to explore SMRs and innovate in nuclear technologies.

What are Key Points about Small Modular Reactors (SMRs)?

- **About**: SMRs are advanced nuclear reactors that are about **one-third the size** of traditional nuclear reactors.
    - **Small Size (S)**: Power capacity of up to **300 MW(e).**
    - **Modular (M)**: Components are **prefabricated and transported** to the installation site.
    - **Nuclear Reactors (R)**: Use **nuclear fission** to generate low-carbon electricity.
- **Advantages**:
    - **Smaller Footprint**: SMRs can be installed in locations **unsuitable for larger reactors.**
    - **Cost and Construction Efficiency**: Prefabrication and modular design **reduce construction time and costs.**
    - **Off-Grid Potential**: SMRs, especially **microreactors (up to 10 MW),** can provide power in remote areas.
    - **Reduced Refuelling Frequency**: SMRs may only need refuelling every **3 to 7 years,** with some designs lasting up to **30 years** without refuelling.
- **Global Adoption:** Russia's floating SMR power plant, the **Akademik Lomonosov**, began commercial operation in **2020**.
    - India aims to deploy 40-50 SMRs named **Bharat Small Modular Reactor** to replace captive thermal power plants
    - Other countries like **Argentina, Canada, China, South Korea, and the U.S.** are also advancing SMR projects.
    - More than **80 commercial SMR** designs are being developed globally for various applications, including **electricity generation, heating, water desalination, and industrial steam.**
- **Challenges**: Although SMRs have a lower upfront capital cost per unit, their economic competitiveness **still needs to be proven in real-world deployments**.

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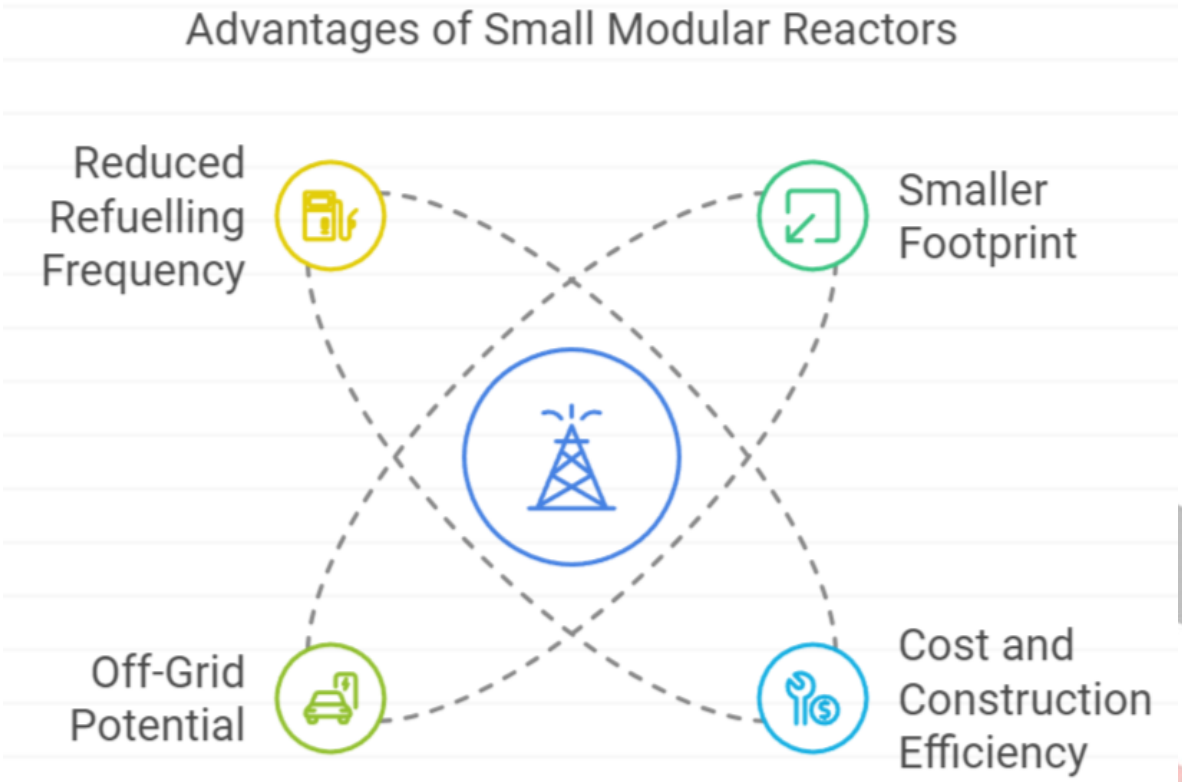

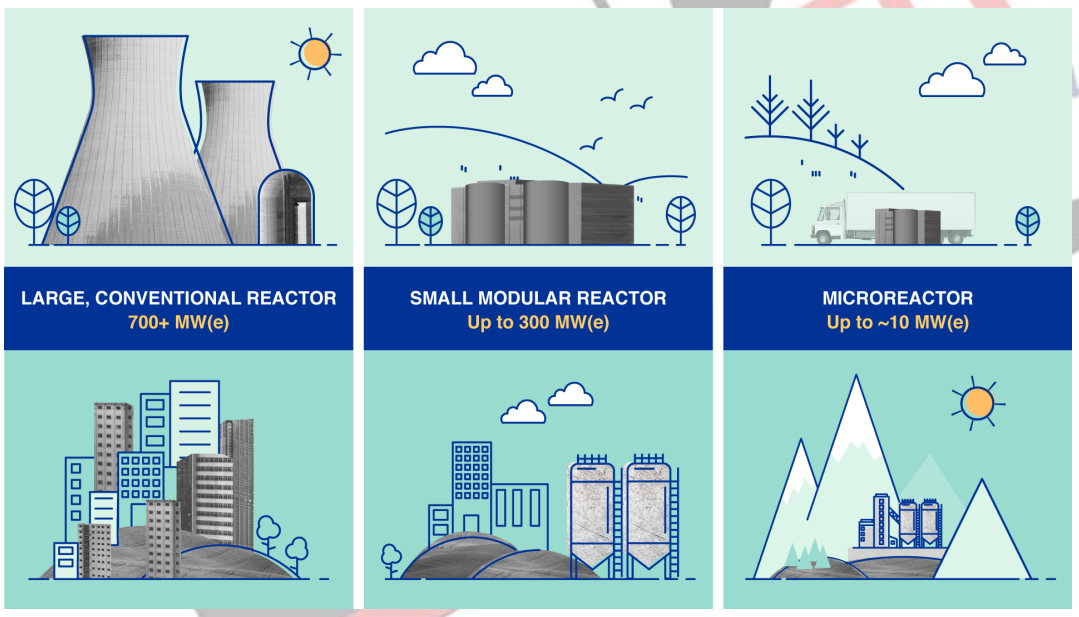

What are Advantages of Nuclear Energy?

- **Low-Carbon Solution**: Nuclear energy is a **reliable and consistent source** of power that is not affected by weather conditions, making it suitable for meeting energy demands continuously.
- **Small Land Footprint**: Nuclear facilities occupy **significantly less land** compared to other renewable energy sources.
    - A typical **1,000 MW nuclear plant requires only about one square mile**, whereas wind farms and solar plants need **360 and 75 times more land**, respectively.
- **High Power Output:** Nuclear power plants have a **high capacity factor**, producing maximum output approximately **93%** of the time.
- **Minimal Waste Production**: Nuclear energy produces **relatively small amounts of waste** compared to other energy sources.

- Advanced reactor designs are being developed that can utilise used fuel, potentially reducing waste even further.

What Concerns are Associated with Nuclear Energy?

- **Carbon Dioxide Emissions:** Nuclear power reactors themselves do not produce direct carbon dioxide emissions during operation but the processes of **mining and refining** **uranium ore**, as well as constructing nuclear power plants, require significant energy sourced from fossil fuels.
- **Reputation Issues**: Nuclear energy is often linked to **nuclear weapons**, which contributes to public fears about **proliferation and security risks**.
- **Safety Concerns:** High-profile accidents, such as **Three Mile Island Incident (1979)**, **Chernobyl Disaster (1986) and Fukushima Accident (2011)** have instilled fear about the safety of nuclear power plants, leading to widespread scepticism about their safety.
  - Environmental groups, such as **'Friends of the Earth,'** have criticised nuclear energy highlighting issues like **accidents, radioactive leaks,** and the challenges of **nuclear waste management.**
- **Cost and Financial Viability**: Nuclear power is often associated with **high initial construction and operational costs**, making it less appealing compared to alternative energy sources.

Way Forward

- **Enhancing Safety Protocols**: Adopt advanced reactor designs, such as **Generation IV reactors and Small Modular Reactors (SMRs)**, which prioritise **safety and efficiency.**
- **Innovative Waste Management**: Invest in advanced **nuclear waste management** solutions, such as **deep geological storage**, which has been successfully implemented in countries like **Finland**.
- **Integration with Renewables**: Promote nuclear energy as a **complementary resource** to intermittent renewable sources, enhancing overall **grid stability and energy security.**
- **Regulatory Improvements**: Implement stringent regulatory frameworks and **international safety standards** to restore public confidence in nuclear facilities.

Drishti Mains Question:

Small Modular Reactors (SMRs) are being hailed as the future of nuclear energy for their adaptability and efficiency." Critically examine.

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)**