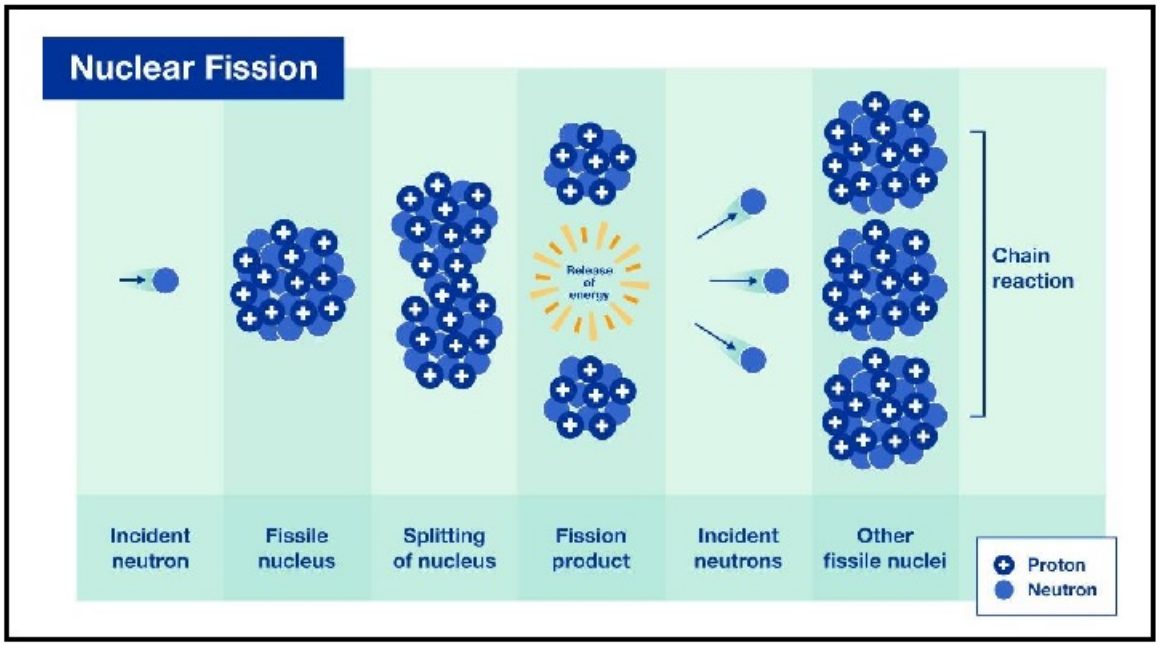
The Need for Nuclear Energy

Why in news?

The rapid economic growth of India and the status of the primary energy consumption stands which stands at 3rd highest globally triggers the demand for energy.

What is nuclear energy?

- Nuclear energy is a form of energy released from the nucleus, the core of atoms, made up of protons and neutrons.
    - **Nuclear fission**- It is a reaction where the nucleus of an atom splits into two or more smaller nuclei, while releasing energy.
    - **Nuclear fusion** -It is produced when nuclei fuse together.
- **Nuclear fission**- In 1939, German Scientist Otto Hahn and F.Strassman discovered that when a uranium nucleus is bombarded with a neutron, it breaks up into 2 smaller nuclei of comparable mass along with the emission of a few neutrons and energy.



- Nuclear reactor is the important part of the nuclear power plant which controls the nuclear chain reaction
- Each time the reaction occurs, there is a release of energy in the form of heat and radiation.
- The heat can be converted into electricity in a nuclear power plant, similar to how heat from fossil fuels such as coal, gas and oil is used to generate electricity.

What are the different types of nuclear reactors utilised?

About	Pressurized Heavy Water Reactor (PHWR)	Light Water Reactor (LWR)	Protype Fast Breeder Reactor
Type	Thermal Neutron Reactors	Thermal Neutron Reactors	Fast Neutron Reactors
Fuel	Natural Uranium	Low Enriched Uranium	Use uranium-238 to breed plutonium in a sodium-cooled fast reactor design.
Coolant	Heavy Water (deuterium oxide D2O)	Normal water	Liquid sodium is used in the Kalpakkam nuclear reactor.
Moderator	Neutron	Neutron	No moderator is used.
India	IPHWR 700 is designed by Nuclear Power Corporation of India Limited (NPCIL)	900 MWe LWR design is prepared by Department of Atomic Energy	It is designed by Indira Gandhi Centre for Atomic Research

- **European Pressurized Water Reactor**- It is a 3rd generation PWR design, compared to the most modern reactors.
- EPRs are more powerful, with 14% higher power output capacity.
- 3rd generation reactors are much safer than their predecessors.

What is the need for nuclear energy?

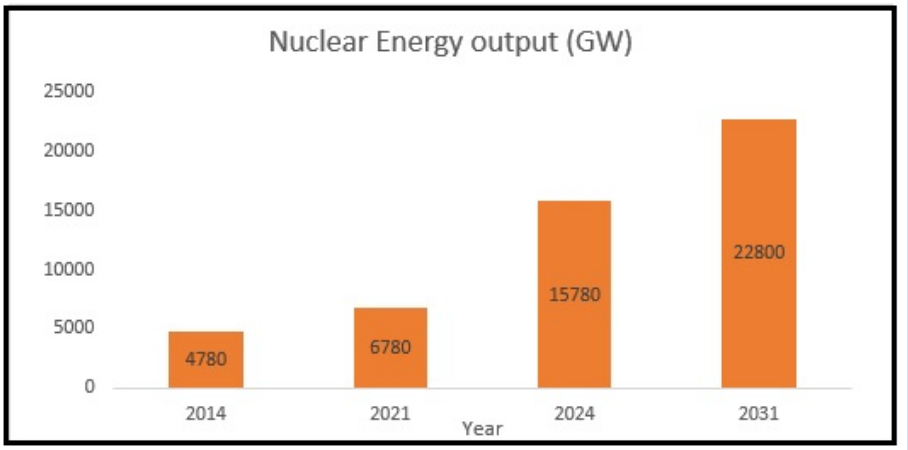
- **Issues with fossil fuel-** It is the major contributor of global warming, hence focusing on nuclear energy would reduce the dependency on fossil fuel.
- **Net zero target**- There is a global consensus to reach net zero goal before a 2045–2070 time frame.
    - *India* has promised to become *carbon neutral by 2070.*
- Transition to net zero involves massive transformation of energy systems which also includes nuclear energy, involving new technologies, restructuring of energy systems etc.,
    - A study done by Vivekananda International Foundation and IIT-Bombay reveals that nuclear energy would need to be scaled up to a couple of thousand GWe for an optimum solution to reach net-zero in a developed India.
- **Improve HDI-** India requires a minimum of 2400 kilogram oil equivalent energy consumption (kgoe) per capita per year. If the energy is used efficiently the energy consumption could be improved to around 1400 kgoe.
    - With the improvement in deployment of other renewable energy like hydro we need to make rapid strides in nuclear energy as well.
- **Eco-friendly-** Nuclear power is a clean and environment friendly base load source of electricity generation, which is available 24 x 7.
- **Combat climate change**- It is a low-carbon source of energy, because unlike coal, oil or gas power plants, nuclear power plants practically do not produce CO2 during their operation.

- **Energy security**- It also has a huge potential and can provide the country long term energy security in a sustainable manner.
- **Sustainable development**-It will help the country to achieve *SDG 7* “Ensure access to affordable, reliable, sustainable and modern energy for all”.

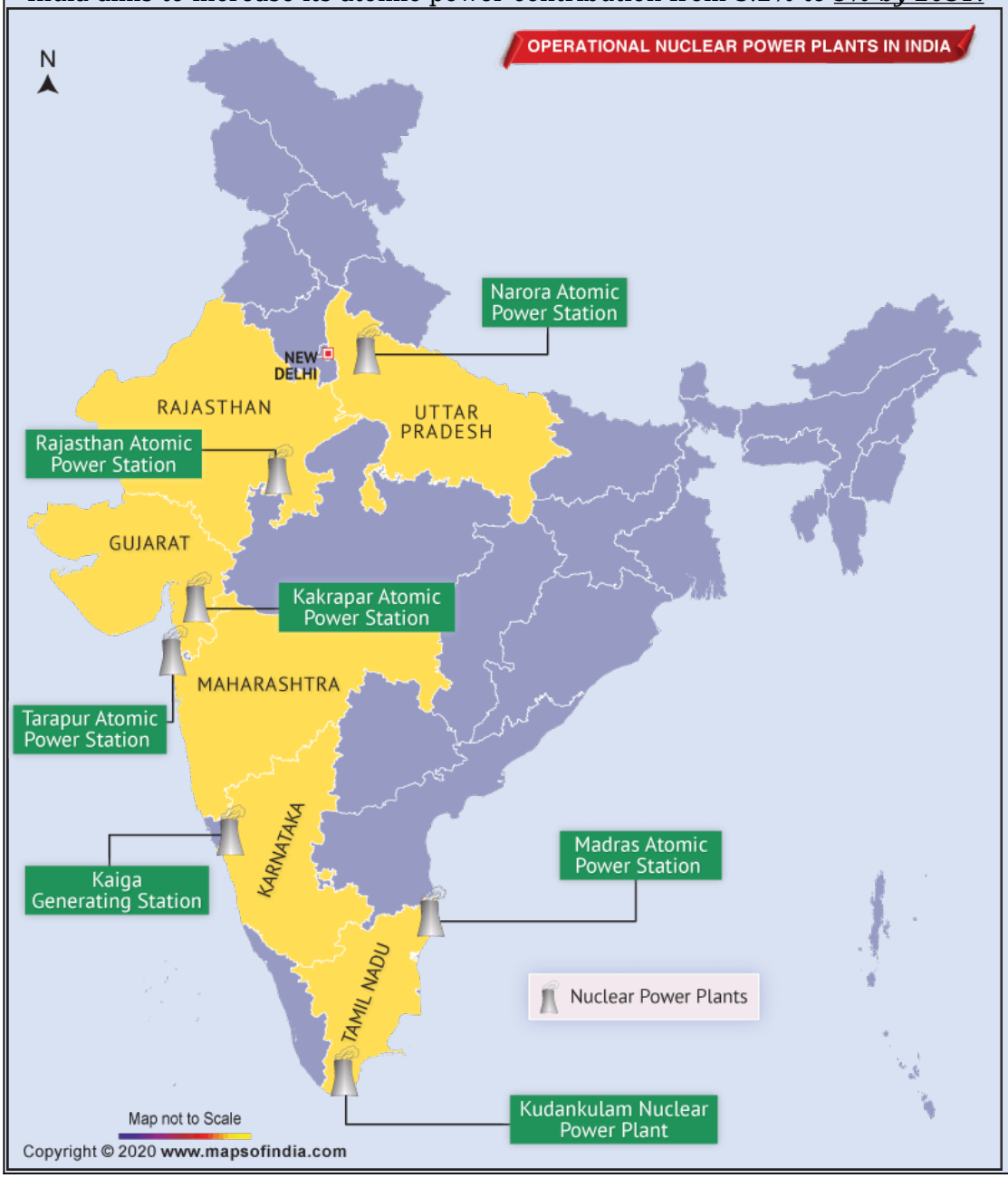
To know about the history of India’s nuclear program click here

Status of Nuclear Energy in India

• Among all the developing nations, India is the *only one to have* generated electricity using indigenously developed, demonstrated, and deployed nuclear reactors.
• Nuclear energy is the *5th largest source of electricity* for India. It ranks 3rd in terms of electricity production worldwide by producing 1207 TWh of electricity.



• India stands at *7th position* in terms of the number of nuclear reactors, with over 23 nuclear reactors in 7 power plants across the country which produces 6780 MW of nuclear power.
• India aims to increase its atomic power contribution from 3.2% to *5% by 2031.*



What are the challenges regarding nuclear energy in India?

- **Lack of safety-** If nuclear energy is not generated adhering to the highest standards of safety, there is possibility of catastrophic accidents such as *Chernobyl, Three Mile Island, improper disposal of Cobalt 60 in New Delhi and Fukushima nuclear accident.*
- **Poor skill base-** India lacks the necessary skill set to deploy the technology.
- **Waste disposal-** India lacks policy framework on waste disposal and its management.
    - Recently, Japan began releasing wastewater from the crippled Fukushima nuclear plant into the Pacific Ocean, as tanks containing the radioactive water neared capacity.

How India can scale up the nuclear energy?

- **Indigenous PHWR**- 700 MWe PHWR, the first unit of which is already in commercial operation, should be the prime workhorse for base load electrical capacity addition.
- **Build indigenous SMRs**- Small Modular Reactor is proposed class of nuclear fission reactors, smaller than conventional nuclear reactors.
- They can be used to replace the retiring cola plants that would be vacated in coming decades.
- **Captive units**- A well-proven 220 MWe PHWR units can be offered as partially owned captive units for electricity and hydrogen for energy-intensive industries such as metals, chemicals, and fertilisers.
- **Cheap green hydrogen production-** Develop a high temperature reactor for direct hydrogen production without resorting to electrolysis to reduce pressure on excessive electrification of the energy system in the country.
- **Utilise resources**- Bhabha Atomic Research Centre has the requisite capability to speed up 2nd and 3rd stage nuclear-power programme development to unleash thorium energy potential in accordance with the pre-existing plans for long-term sustainable energy supply.

What lies ahead?

- India’s PHWRs are globally competitive both in terms of performance and capital cost and are a good fit for meeting these requirements.
- Thorium-HALEU fuel in PHWR can make these reactors even more attractive in terms of economics, safety, waste management and proliferation resistance.
- India should encash this opportunity through piloting a major international co-operation for global efforts to address climate change challenges.

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