Major Types of Nuclear Reactors

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Why in News?

Recently, India's nuclear programme and global debates on advanced reactor technologies are frequently in focus for energy security and climate goals.

- **Nuclear Reactor –** It is the core component of a nuclear power plant that initiates and controls a sustained nuclear chain reaction.
- In a nuclear power reactor, the energy released is used as heat to make steam to generate electricity.

Pressurised Heavy Water Reactors (PHWRs)

- **Fuel –** Natural uranium.
- **Moderator and Coolant –** Heavy water (D_2O).
- **Capacity –** 220–700 MW.
- **Mechanism –** Heavy water slows neutrons to thermal speeds, allowing natural uranium to sustain chain reaction.
- **India –** Backbone of Stage I programme.

Fast Breeder Reactors (FBRs)

- **Fuel –** U-238 to Pu-239, Th-232 to U-233.
- **Neutrons –** Fast neutrons (no moderator).
- **Capacity –** 500+ MW.
- **Mechanism –** Uses fast neutrons to convert fertile isotopes into fissile ones, breeding more fuel.
- **India –** Crucial for Stage II.

Small Modular Reactors (SMRs)

- **Fuel –** Low-enriched uranium (3–4% U-235).
- **Capacity –** 30–300 Mwe (Megawatt electrical).

- **Mechanism –** Factory-built modules with passive cooling; flexible deployment.
- **Global –** Emerging technology.

Conventional Nuclear Reactors

- **Fuel –** Enriched uranium (3–4% U-235).
- **Capacity –** 500–1000+ MW.
- **Mechanism –** Thermal neutrons moderated by water in large centralized plants.
- **Global –** Proven backbone of nuclear power.

Boiling Water Reactors (BWRs)

- **Fuel –** Enriched uranium (3–4% U-235).
- **Capacity –** 600–1000 MW.
- **Mechanism –** Water boils inside reactor core; steam directly drives turbine.
- **Deployment –** Common in U.S. and Japan.

Pressurised Water Reactors (PWRs)

- **Fuel –** Enriched uranium (3–4% U-235).
- **Capacity –** 900–1300 MW.
- **Mechanism –** Water kept under high pressure; heat transferred to secondary loop for steam.
- **Deployment –** Most widely used globally.

Advanced Heavy Water Reactors (AHWRs)

- **Fuel –** Thorium + small U-233/U-235.
- **Capacity –** 300–700 MW.
- **Mechanism –** Heavy water moderates the neutrons to convert fertile Thorium into fissile U-233, while boiling light water (normal water) is used as the coolant to drive the turbine directly.
- **India –** Stage III of nuclear programme (thorium focus).

References

1. Visual Capitalist | Uranium
2. World Nuclear | Nuclear Reactors

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