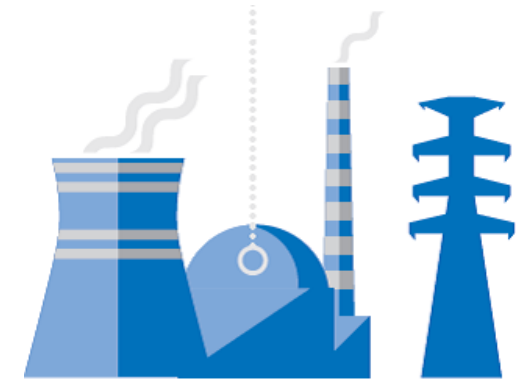


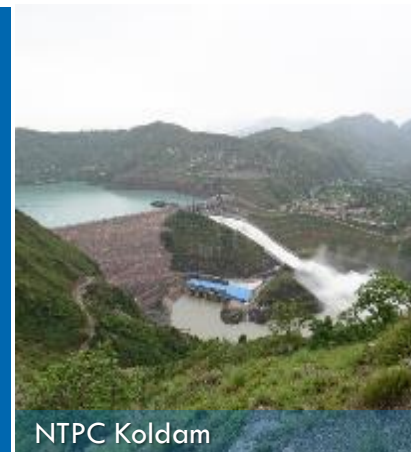


BIMSTEC, Bengaluru

16.09.2026

Emerging Nuclear Technologies

A P Samal, CEO (NPUNL) & ED (Nuclear), NTPC Ltd



NTPC Koldam



NTPC Kayamkulam



NTPC Rojmal

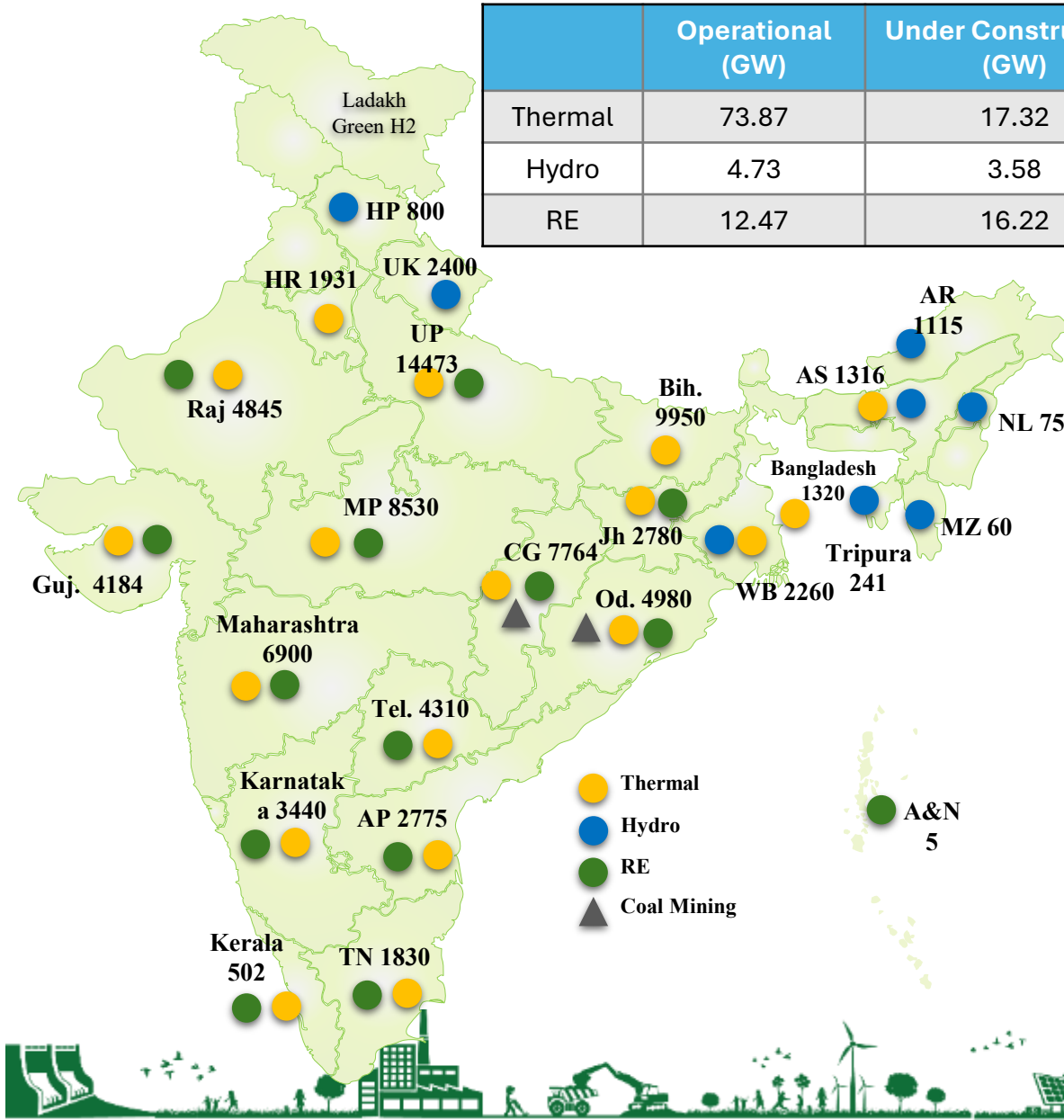
Follow us on:



- 1 Overview of NTPC
- 2 Indian Nuclear Sector
- 3 Energy Transition
- 4 Basics of Nuclear Energy
- 5 Types of Reactor Technology
- 6 Evolution of Nuclear Reactors
- 7 PHWR
- 8 PWR & BWR
- 9 SMR & Gen IV Reactors
- 10 Conclusion



NTPC Group Profile



	Operational (GW)	Under Construction (GW)
Thermal	73.87	17.32
Hydro	4.73	3.58
RE	12.47	16.22

123.5GW

Portfolio of Thermal , Hydro & Renewable Assets

91.08 GW

Capacity under Operation

37.12 GW

Capacity under Construction

12.47 GW

Renewable Capacity under Operation

~48 MMTPA

Coal Mining Capacity
[6 Mines Operational + 3 Under Development]

28
Companies

11 Subsidiaries
17 Joint Ventures

Pan India
Customers

Supplying Power to beneficiaries in all States & UTs

17,000+

Employees

NTPC International presence



Sri Lanka

- NTPC Registered a Branch Office in Sri Lanka
- TPCL: Phase I & II : 50 & 70 MW Solar

Mauritius

- NTPC to develop 15 MW Floating Solar PV Project in Mauritius

Bangladesh

- 2 x 660 MW Commercial capacity

ASEAN

- NTPC Entered into MoU with ACE (ASEAN Centre of Energy) for collaboration in various RE initiatives.

ISA Assignments

- 6620 MW Solar PMC in 13 countries
Latin America: 3750 MW, Africa: 2870 MW

Belize, Jamaica & SVG

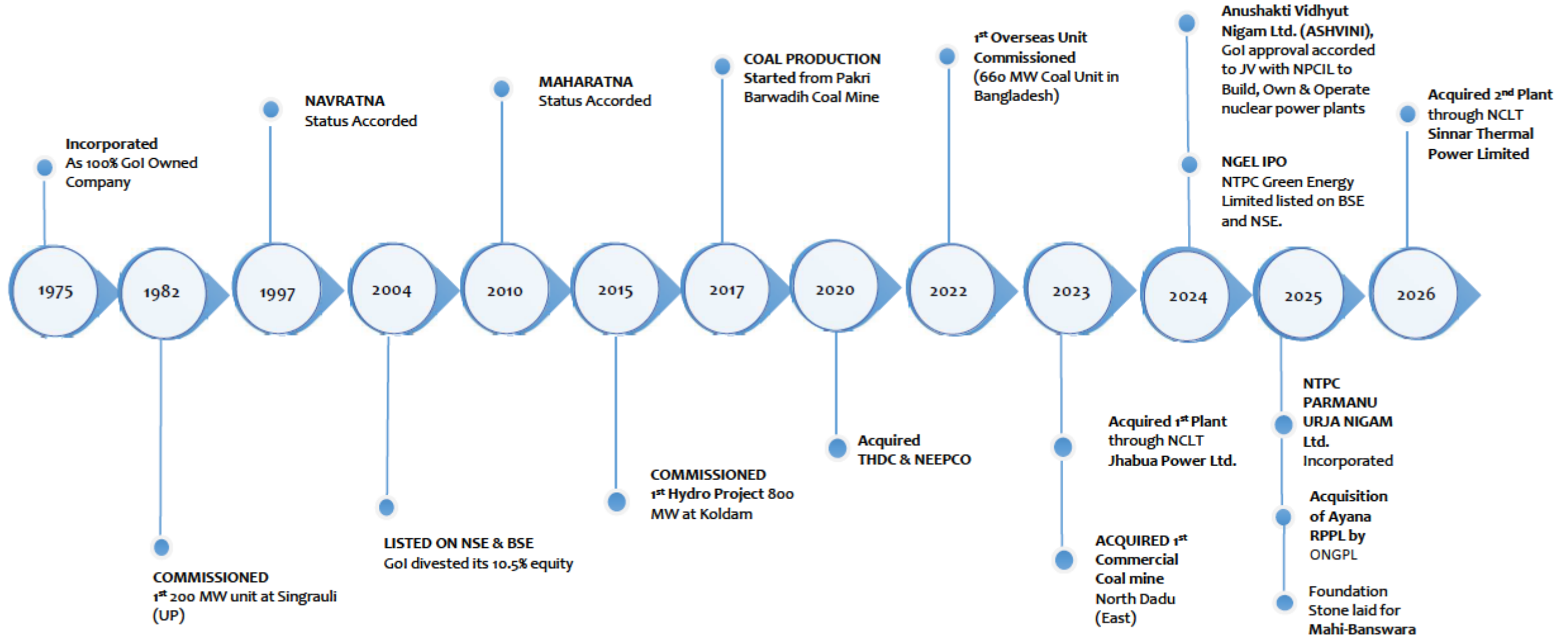
- Solarization of Iconic Building in Belize, Jamaica & Sainr Vincent & the Grenadines and Trinidad & Tobago
Solarization projects of 180KW under MEA



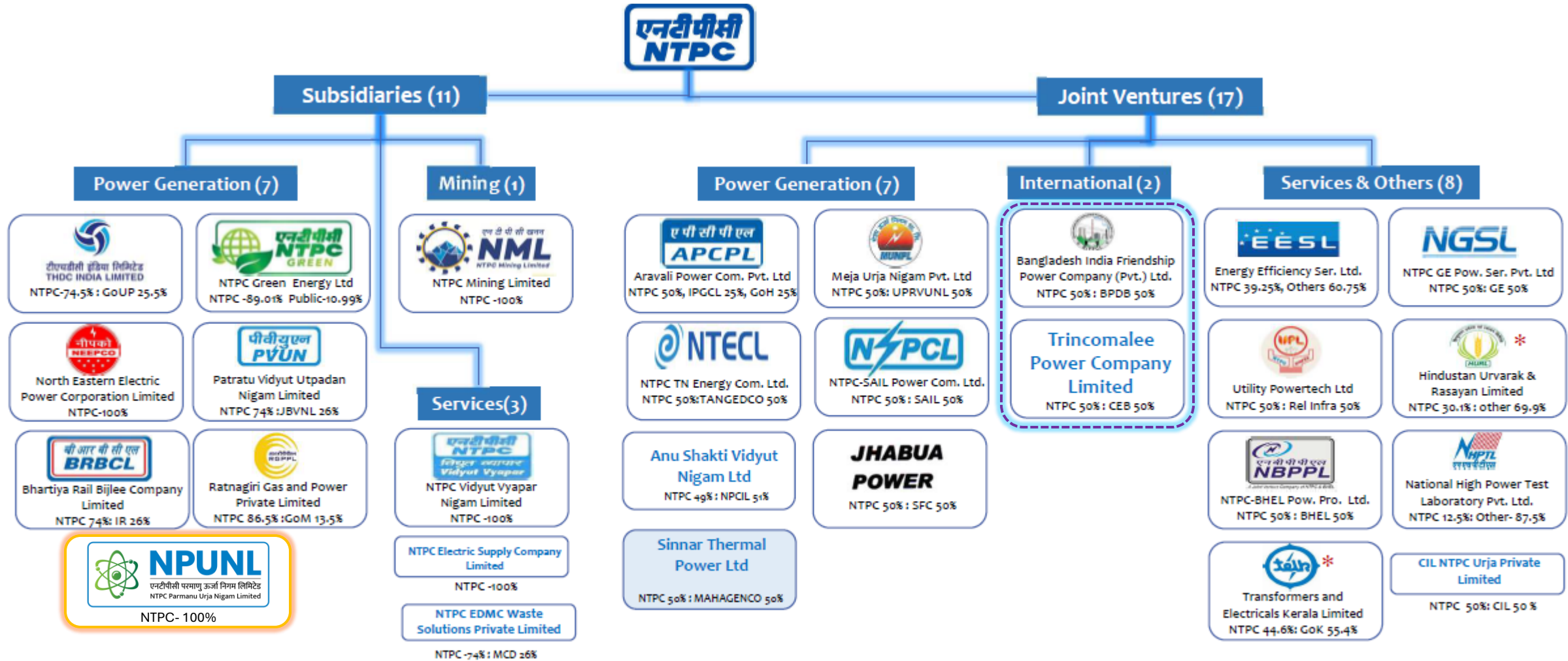
NTPC is pursuing power sector assignments for O&M services, Capacity Building, Engineering & PMC services for Thermal (Coal/Gas), Renewables (Solar/ Wind) and Energy Storage Solutions in [Africa](#), [Middle East](#), [SAARC](#), [ASIAN](#), [CIS](#), etc., in collaboration with other partners.



NTPC Journey- Major Milestones



Subsidiaries and Joint Ventures



* Under exit/ winding up

NTPC Group Highlights FY26



Generation
~ 432 BUs



Coal Production
48.65 Million MT



Capacity Addition
9,619 MW



Group Capex
₹ 46,947 Crs.



Energy Traded
46.52 BU



Foundation Stone Laying of
4 x 700 MW Mahi Banswara Project

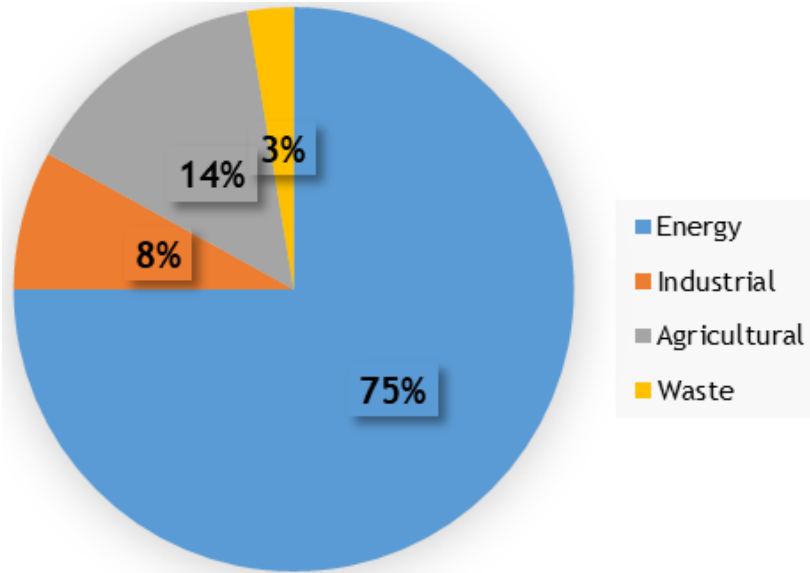


Foundation Stone Laying of
Sampur Solar Power Project, Sri Lanka



Need for Energy Transition & Nuclear Energy

Sector Wise share of GHG Emissions

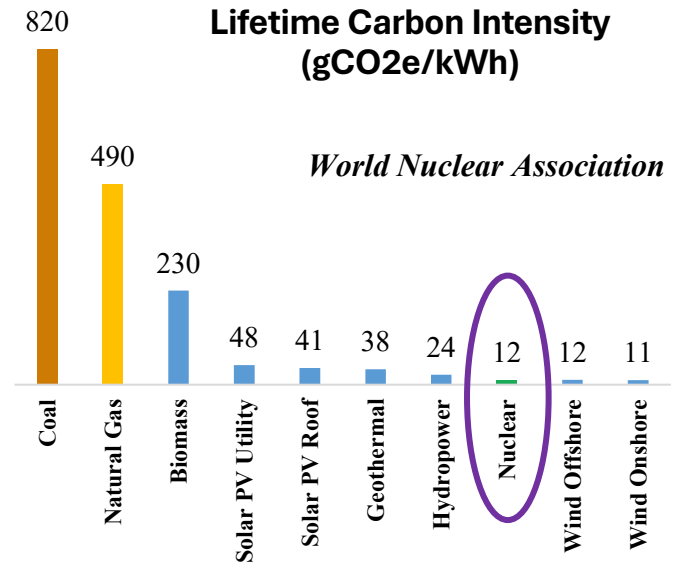


United Nations Framework Convention on Climate Change (UNFCCC)

Energy Storage systems have limitations. Hence, requirement for dispatchable power to supplement renewable sources.

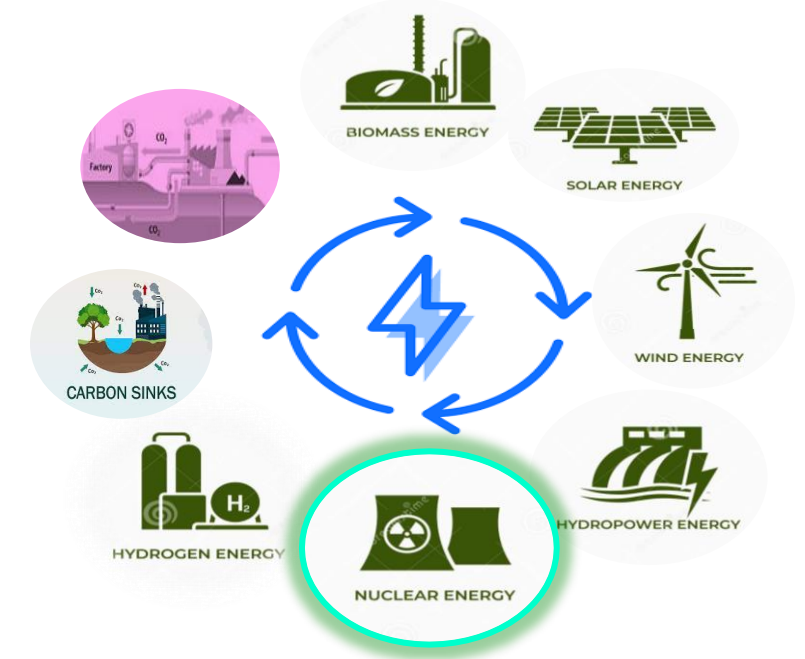
Globally, IEA & IAEA have expressed this.

Lifetime Carbon Intensity (gCO₂e/kWh)



World Nuclear Association

Energy Transition Routes



INDIA's PANCHAMRIT

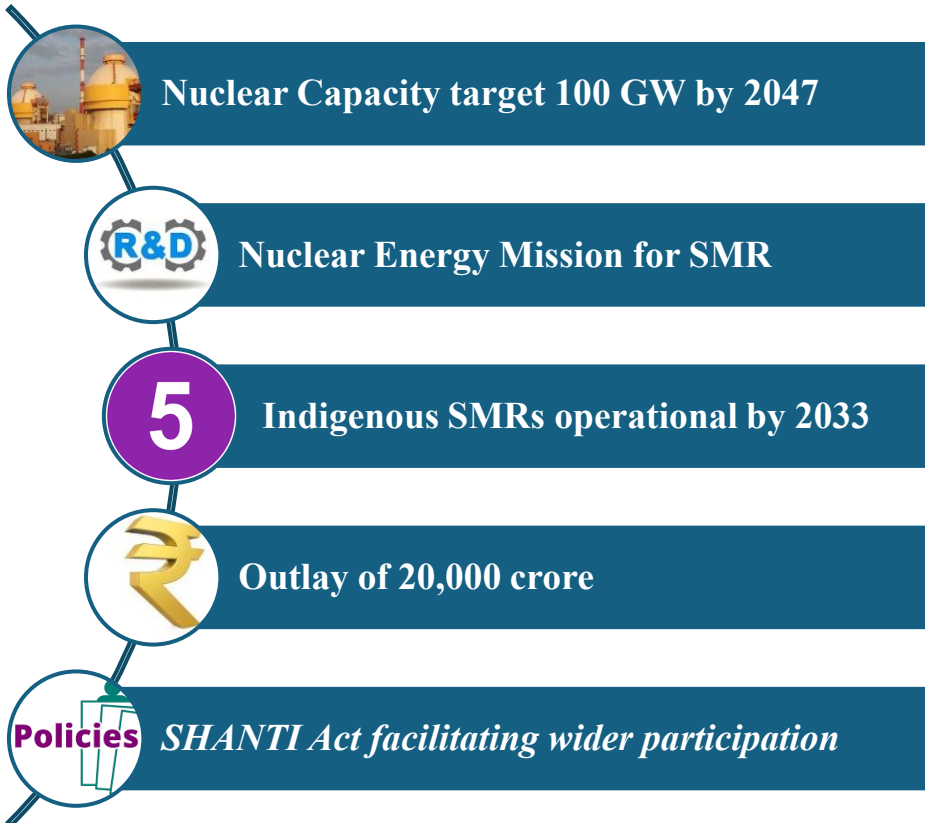
- ❑ To increase non-fossil fuel energy capacity to 500 GW by 2030.
- ❑ Increase the share of renewables in the energy mix to 50% by 2030.
- ❑ Reduce emissions by 1 billion Tonnes of CO₂.
- ❑ Reduce the emissions intensity of its economy by 45%.
- ❑ Carbon Net-zero by 2070

Nuclear fits into 4 out of above 5 Amrits!

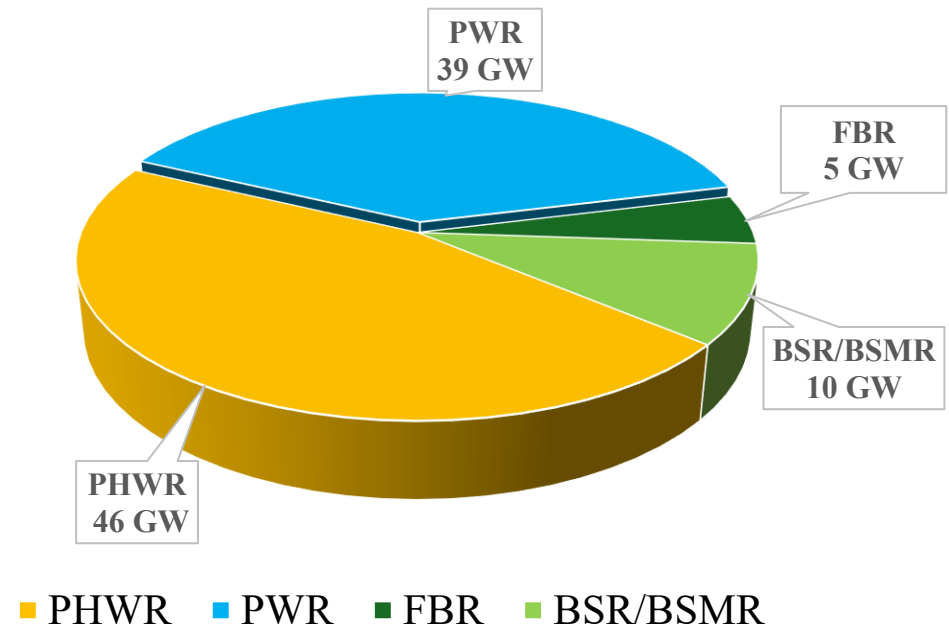
National inclination towards Nuclear Energy

BUDGET 2025-26

Promotion of Nuclear



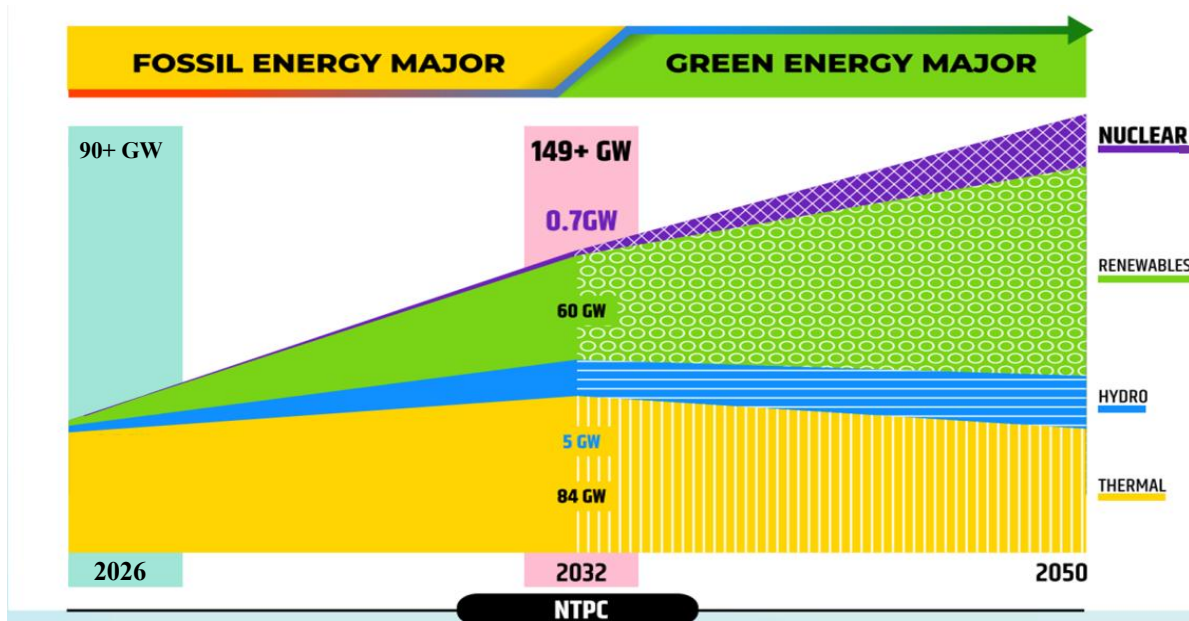
✓ Committee by GoI released report on “**100 GW Nuclear Roadmap**” in Oct’2025



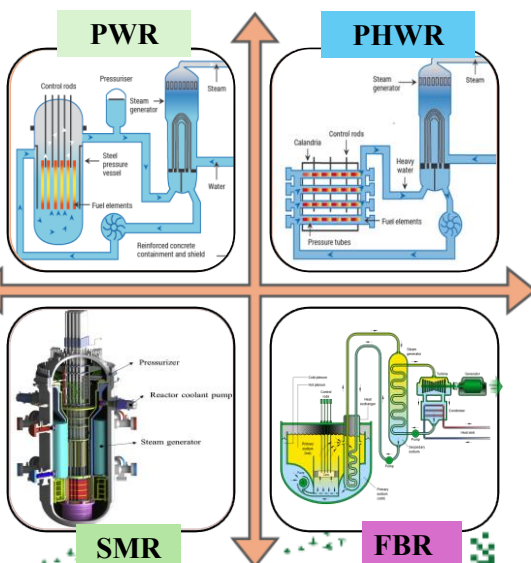
SHANTI Act transforms nuclear power from a closed, state-only program into a scalable, regulated, globally integrated infrastructure sector, while keeping strategic control with the Government of India.



NTPC Pursuing Energy Transition



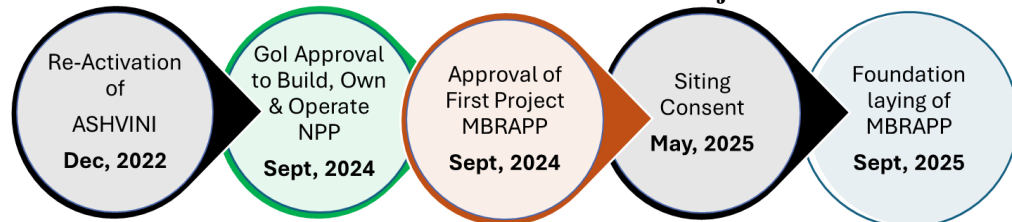
**Aiming
30 GW
Nuclear Capacity By 2047
Inline with GoI's
100 GW
Nuclear Roadmap**



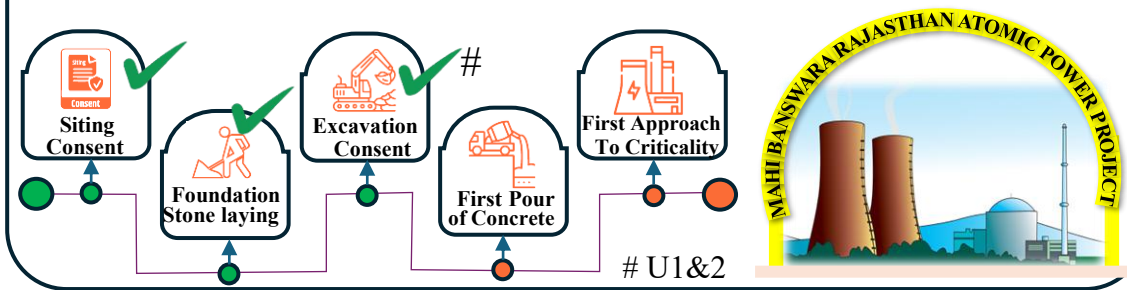
ANUSHAKTI VIDHYUT NIGAM LIMITED (ASHVINI)



A joint venture



MAHI BANSWARA RAJASTHAN ATOMIC POWER PROJECT (4 X 700 MW)



NTPC PARMANU URJA NIGAM LIMITED (NPUNL)

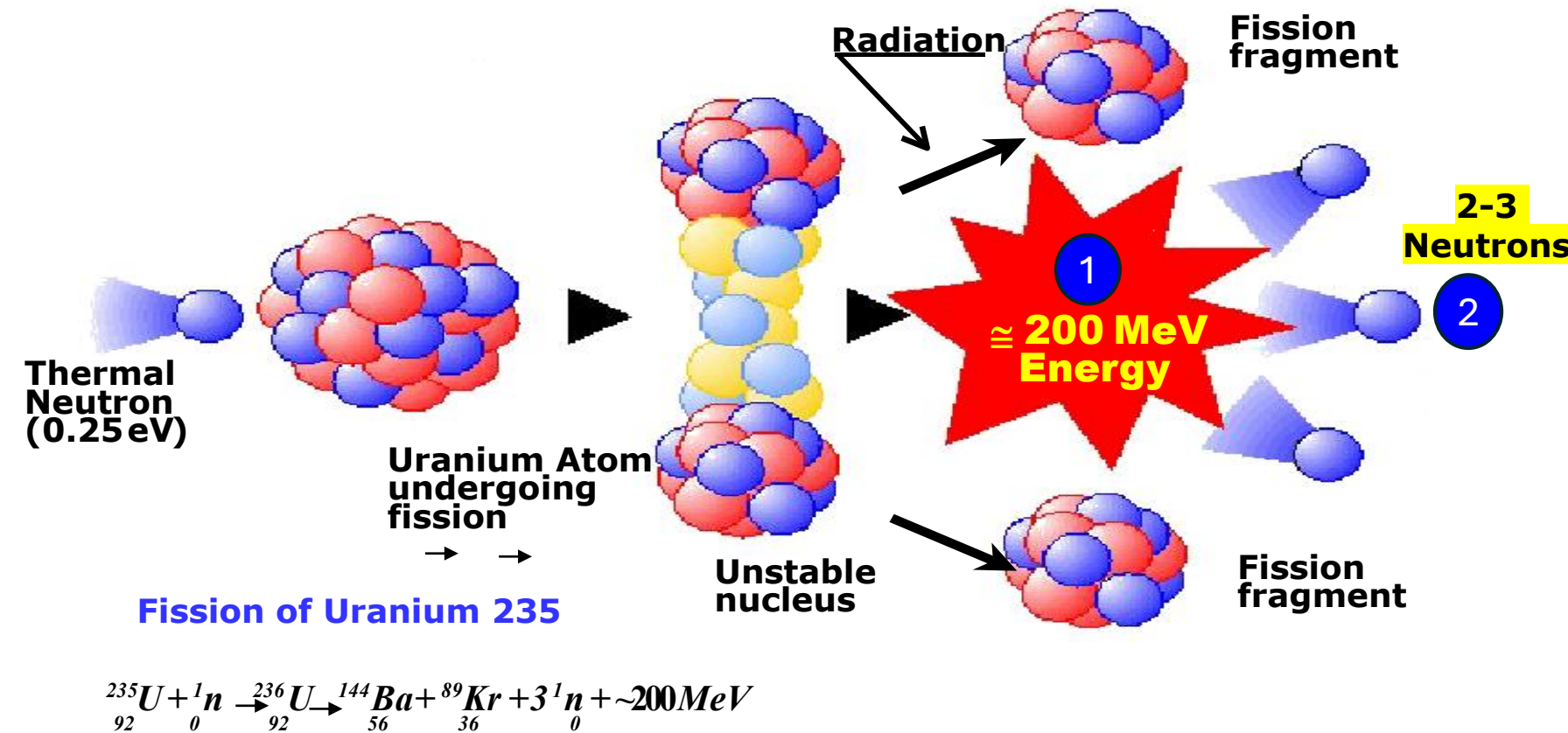


A Wholly Owned Subsidiary



Application submitted to DAE to authorize Build, Own & Operate NPP

Nuclear Fission



Fissile materials (Fuel) :

1. Pu 239 (Manmade)
2. U 233 (Manmade)
3. U 235 (Natural)

Fuel Breeder:

1. Th 232 (Natural) $\rightarrow$ U 233 (Manmade)
2. U 238 (Natural) $\rightarrow$ Pu 239 (Manmade)

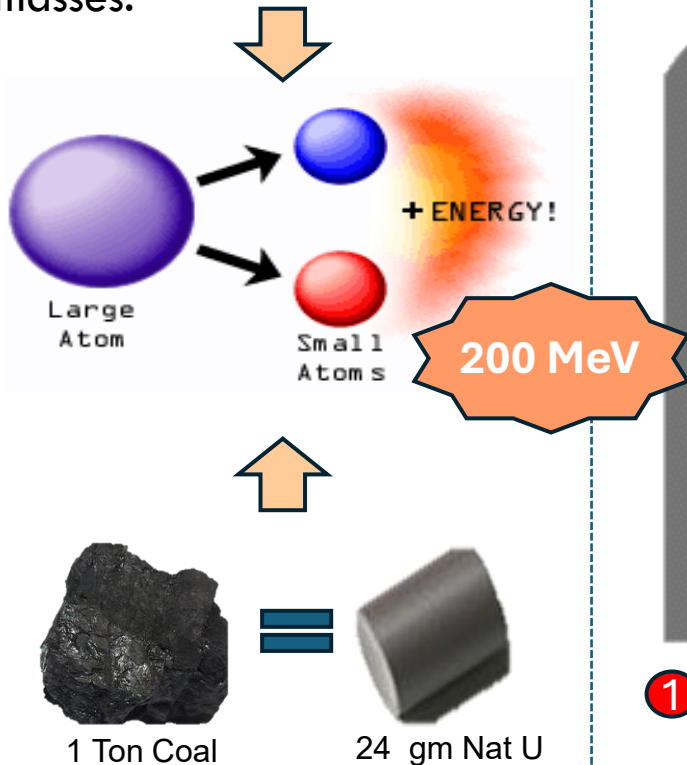
Neutrons are of interest to nuclear engineers

primarily for the following reasons;

- Neutrons being electrically neutral, directly interact with nucleus
- Sustained Chain reactions are possible as they are both in the reactant as well as the product side.

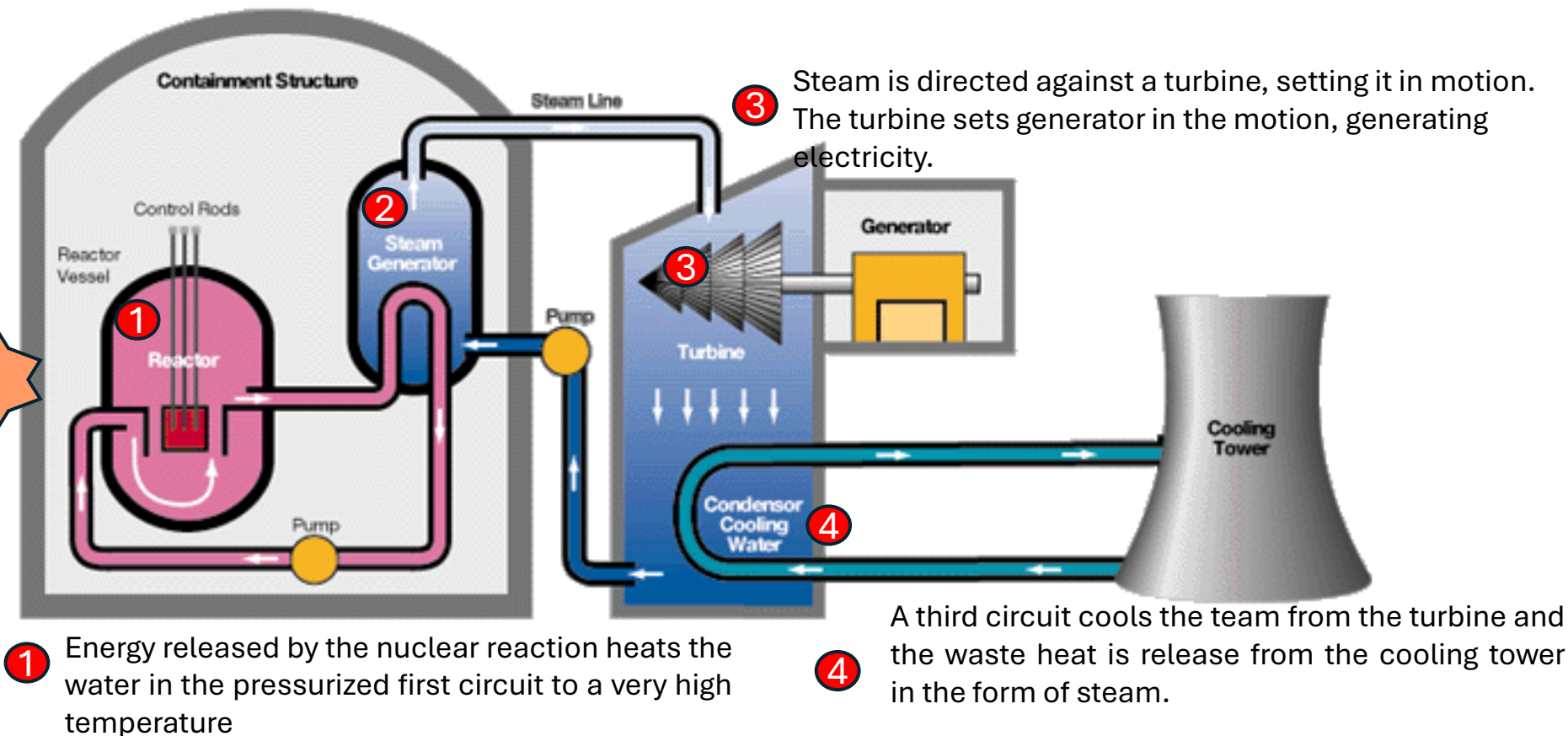
What is Nuclear Energy?

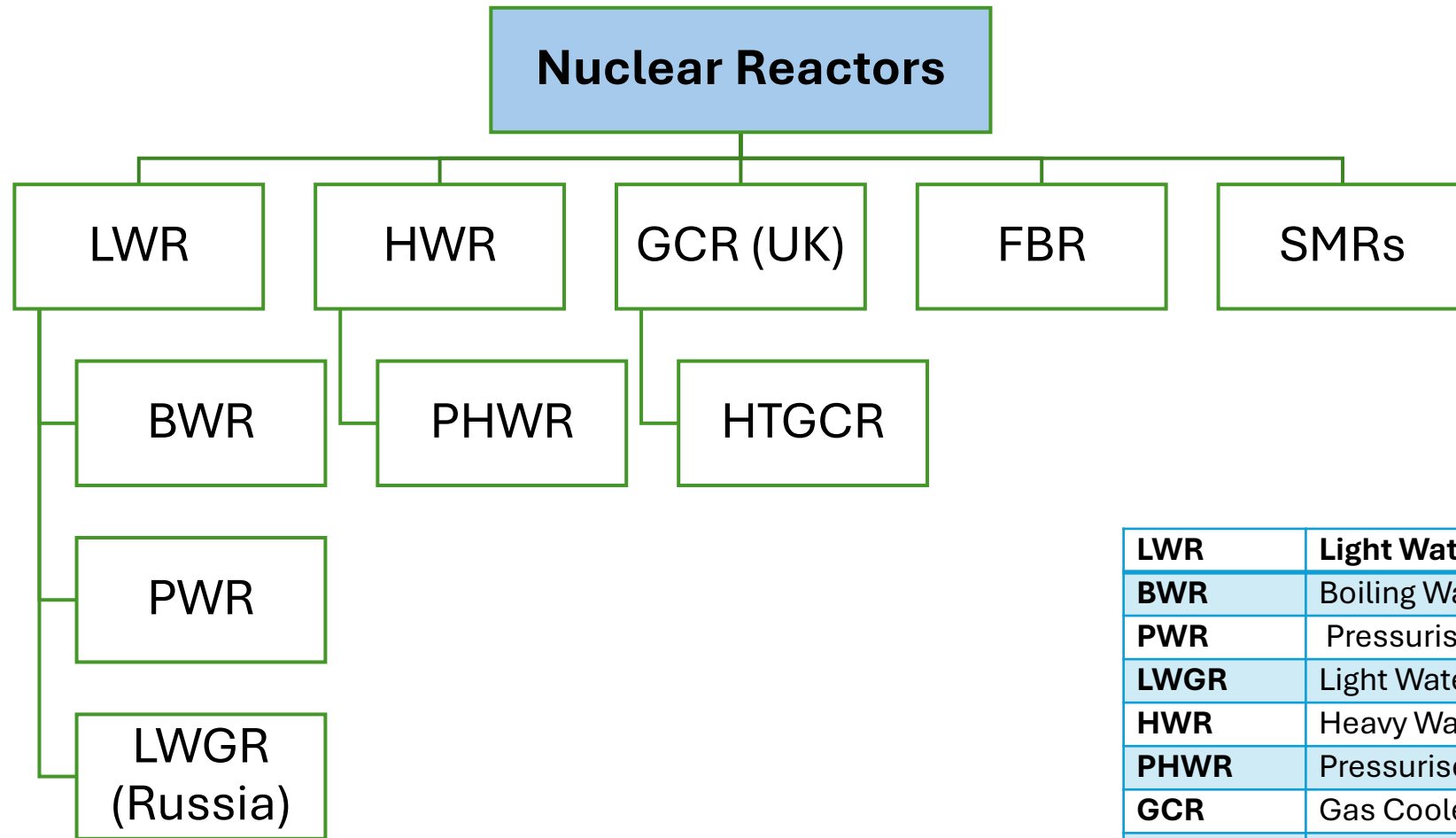
Nuclear fission is the process of splitting a nucleus into two nuclei with smaller masses.



Working of Nuclear Power Plant

2 The superheated water is pumped to a heat exchanger, which transfers the heat of the first circuit to the second circuit. Water in the second circuit flashes into the high-pressure steam





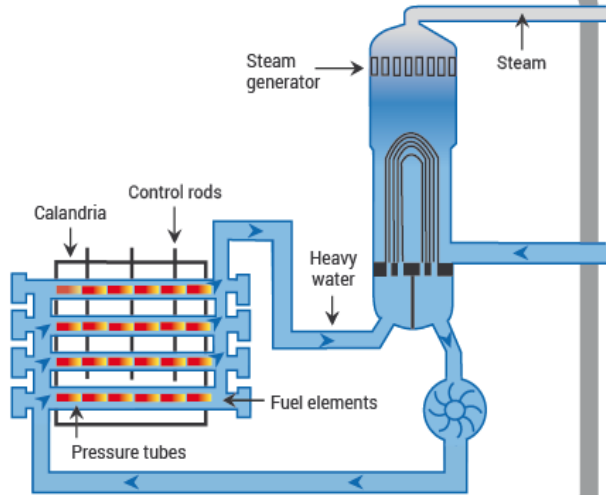
LWR	Light Water Reactor
BWR	Boiling Water Reactor
PWR	Pressurised Water Reactor
LWGR	Light Water Graphite Reactor
HWR	Heavy Water Reactor
PHWR	Pressurised Heavy Water Reactor
GCR	Gas Cooled Reactor
FBR	Fast Breeder Reactor
SMR	Small Modular Reactor



Major Reactor Technology

PROVEN TECHNOLOGY

PHWR



Fuel: Nat Uranium (0.7% U-235)

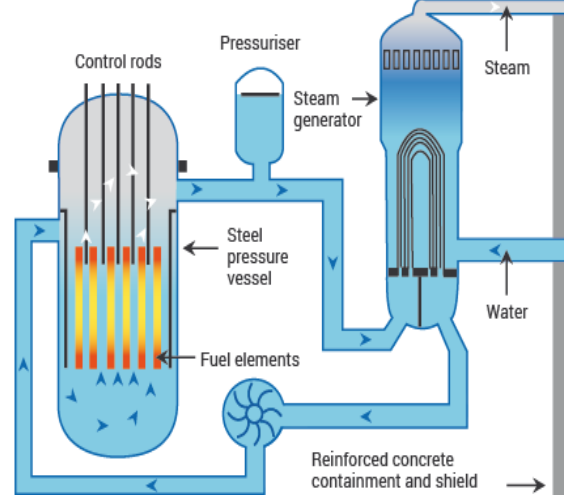
Moderator: Heavy water

Primary Coolant: Heavy Water

Refuelling: Online

***Major shutdown:** EMCCR (1.5 yrs
once in 15 to 20 yrs)

PWR



Fuel: LEU (2.5 - 5% U-235)

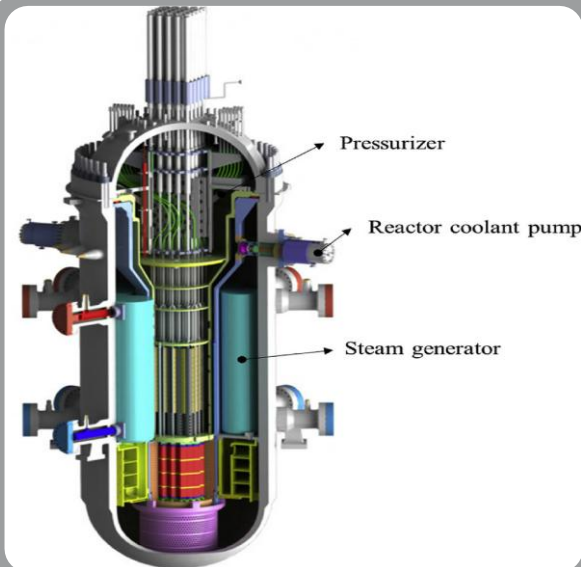
Moderator: Light water

Primary Coolant: Light Water

Refuelling: Offline (once in
18-24 months)

EMERGING TECHNOLOGY

SMR



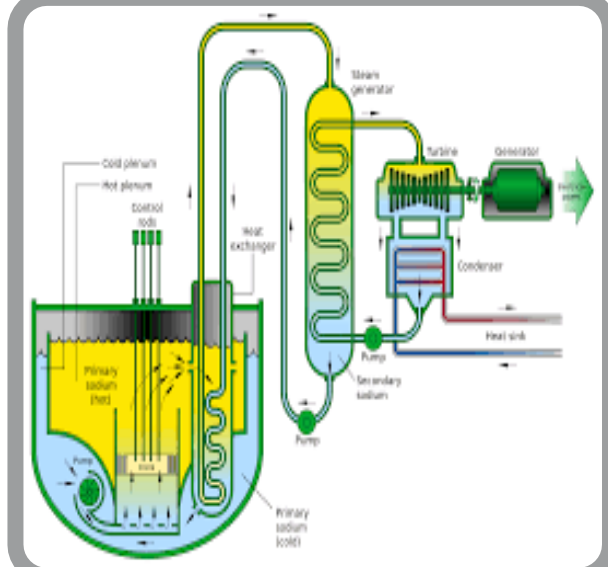
Fuel: LEU (4-15% U-235)

Moderator: Light water

Primary Coolant: Light Water

Refuelling: Offline (once in 2 -5
years)

FBR



Fuel: Plutonium / U-238

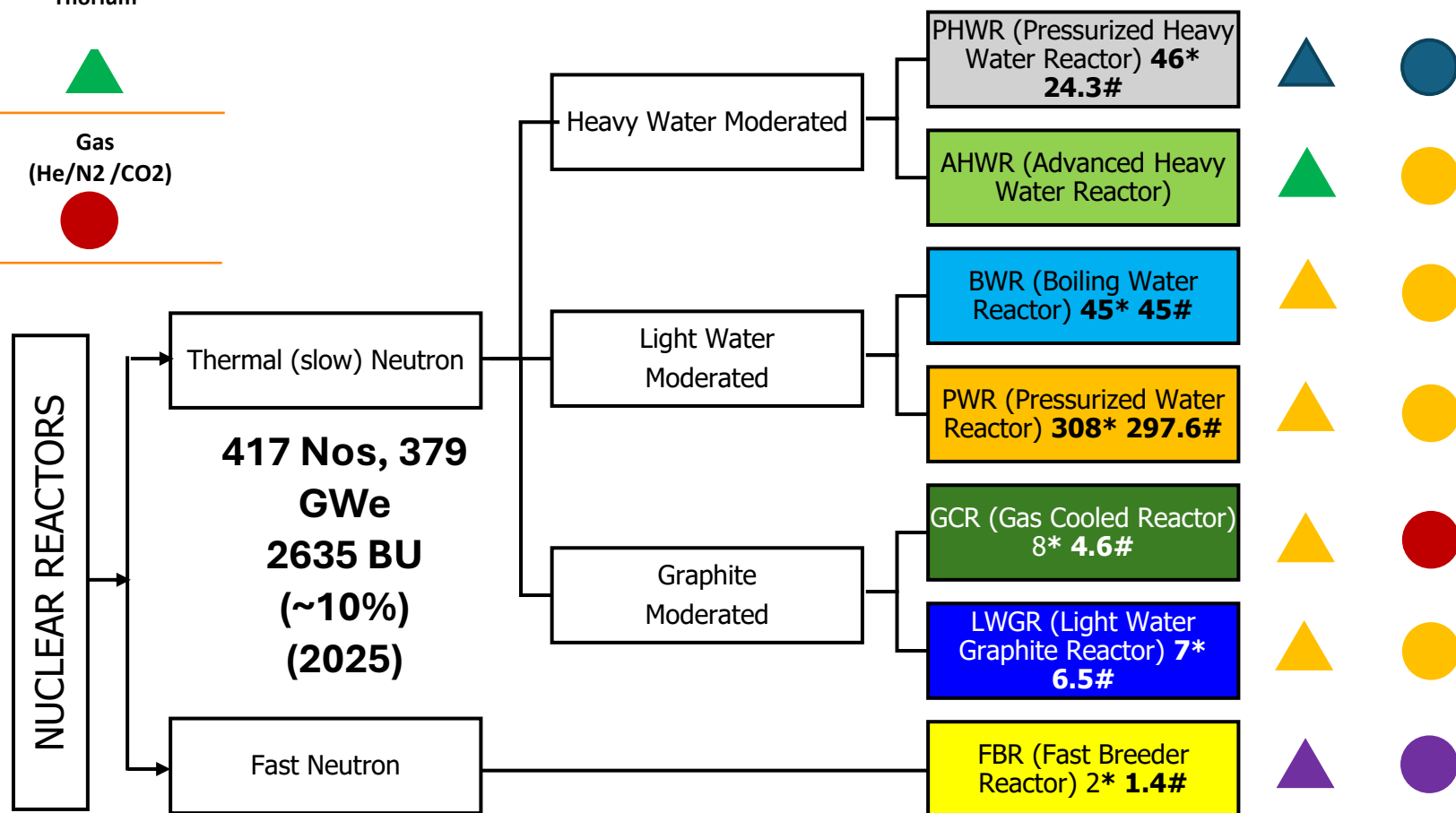
Moderator: NA

Primary Coolant: Sodium

Refuelling: Offline (basically a
breeder reactor)

Nuclear Power Technologies across the World

Fuel	Natural Uranium	Enriched Uranium	Plutonium	Thorium
	▲	▲	▲	▲
Coolant	Heavy Water	Light Water	Sodium	Gas (He/N ₂ /CO ₂)
	●	●	●	●



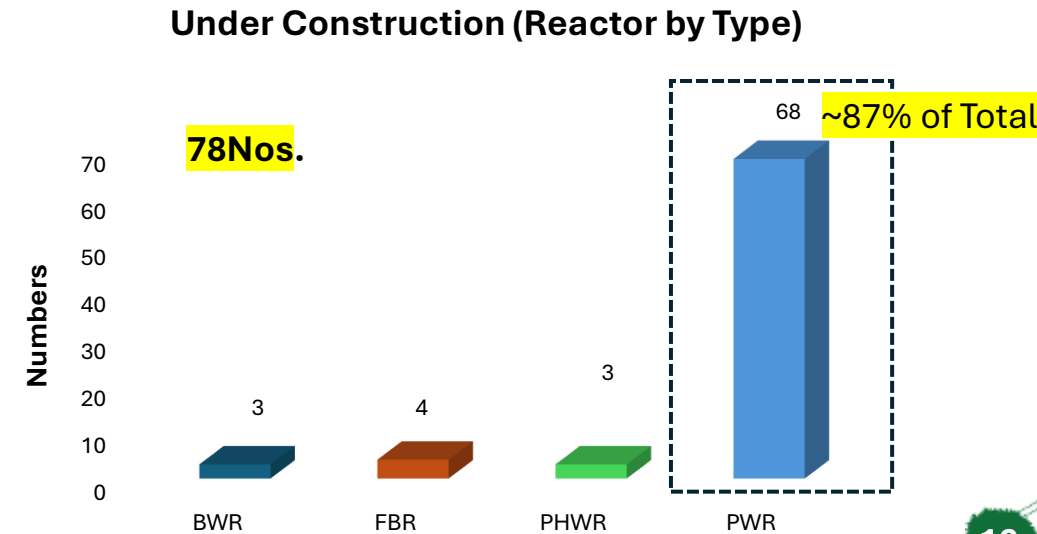
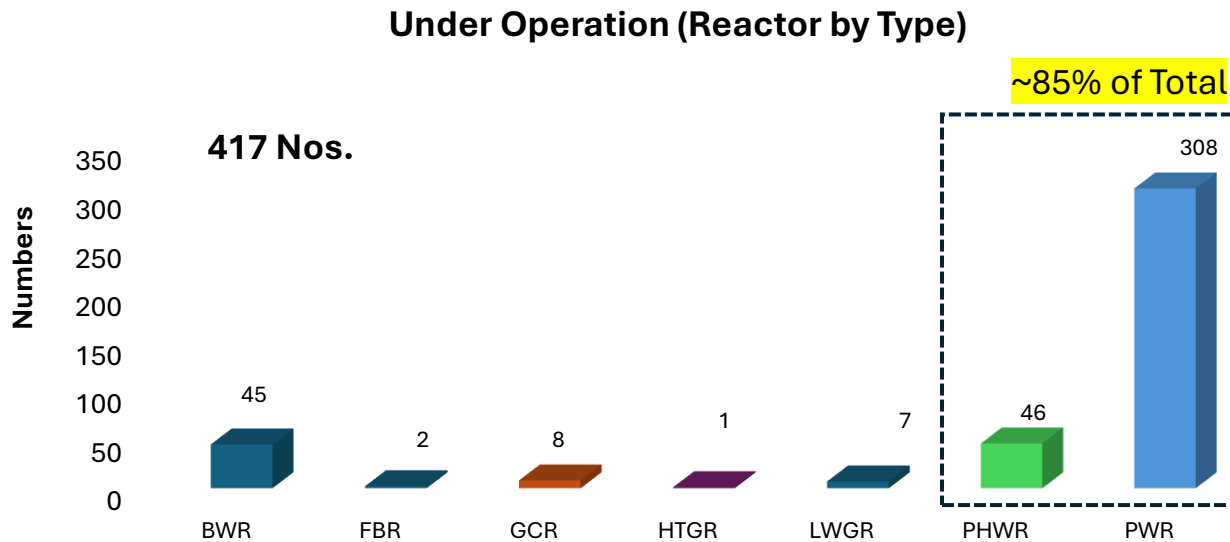
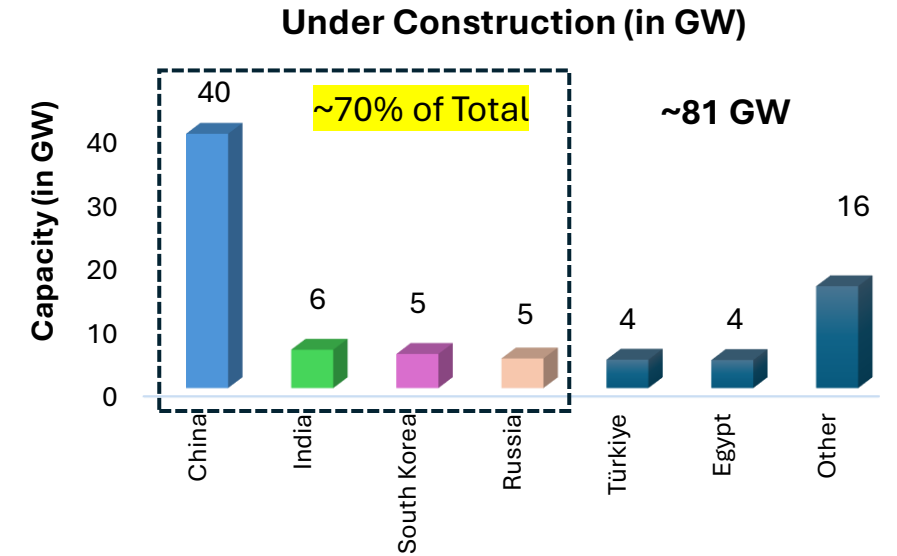
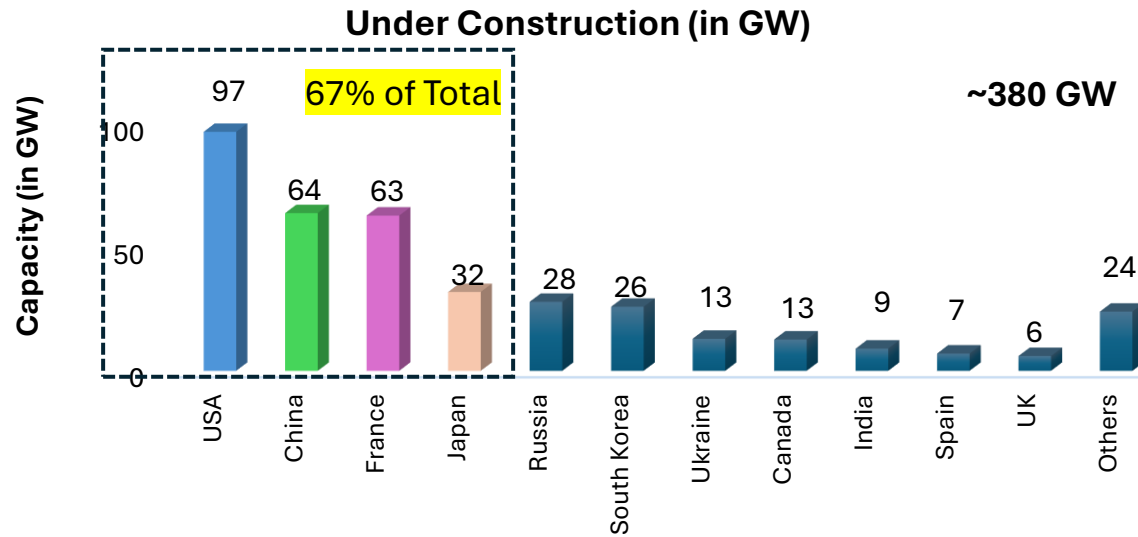
Under Construction: 81349 MW, 78 Reactors, 17 Countries

*No of operating reactors across the world, # Installed capacity (GWe),

** Under research

SMR- emerging technology mostly in similarity with PWR with smaller capacity & added safety features

Nuclear Power Technologies across the World



Evolution of Nuclear Power Reactor Technology

Generation I



*Dresden-1, BWR
General Electric*

Early prototypes

- **Calder Hall** GCR
- **Douglas Point** PHWR/CANDU
- **Dresden-1** BWR
- **Fermi-1** SFR
- **Kola 1-2** PWR/VVER
- **Peach Bottom 1** HTGR
- **Shippingport** PWR

MHS-NENP-NPTDS-May2015

Generation II



*Calvert Cliffs, PWR
Westinghouse*

Large-scale power stations

- **Bruce** (PHWR/CANDU)
- **Calvert Cliffs** (PWR)
- **Flamanville 1-2** PWR
- **Fukushima II 1-4** BWR
- **Grand Gulf** BWR
- **Kalinin** PWR/VVER
- **Kursk 1-4** LWGR/RBMK
- **Palo Verde** PWR

Generation III/III+



EPR, EDF PWR

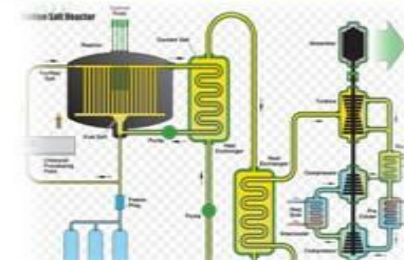


AP1000, Westinghouse PWR

Advanced Evolutionary and Advanced Passive designs

- **ABWR** GE-Hitachi BWR
- **AP1000** Westinghouse PWR
- **APR1400** KHNP PWR
- **CAP1000** SPIC PWR
- **EPR** EDF PWR
- **HPR1000** (Hualong One) CNNC and CGN, PWR
- **VVER1200** ROSATOM
- **ESBWR** GE-Hitachi, passive BWR
- **Small Modular Reactors**
 - CNNC ACP-100 PWR
 - Rosatom RITM-200 PWR
 - CNEA CAREM PWR
 - Holtec SMR-160 PWR
 - EDF NUWARD
 - KAERI SMART PWR
 - NuScale VOYGR PWR
 - GE Hitachi BWRX-300 BWR
 - Rolls-Royce RR-SMR PWR
 - KHNP i-SMR PWR

Generation IV



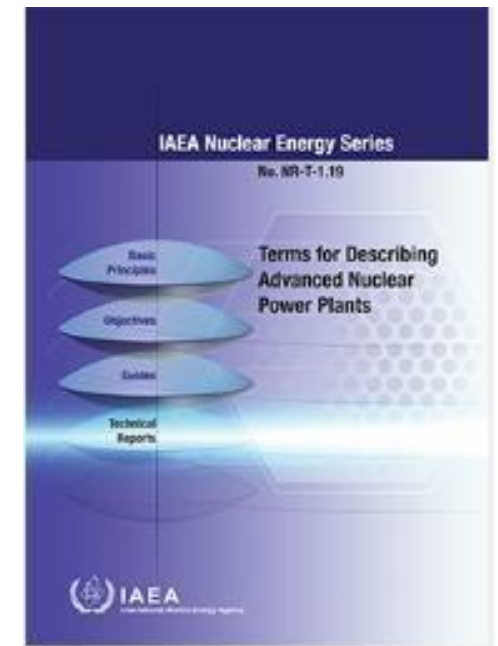
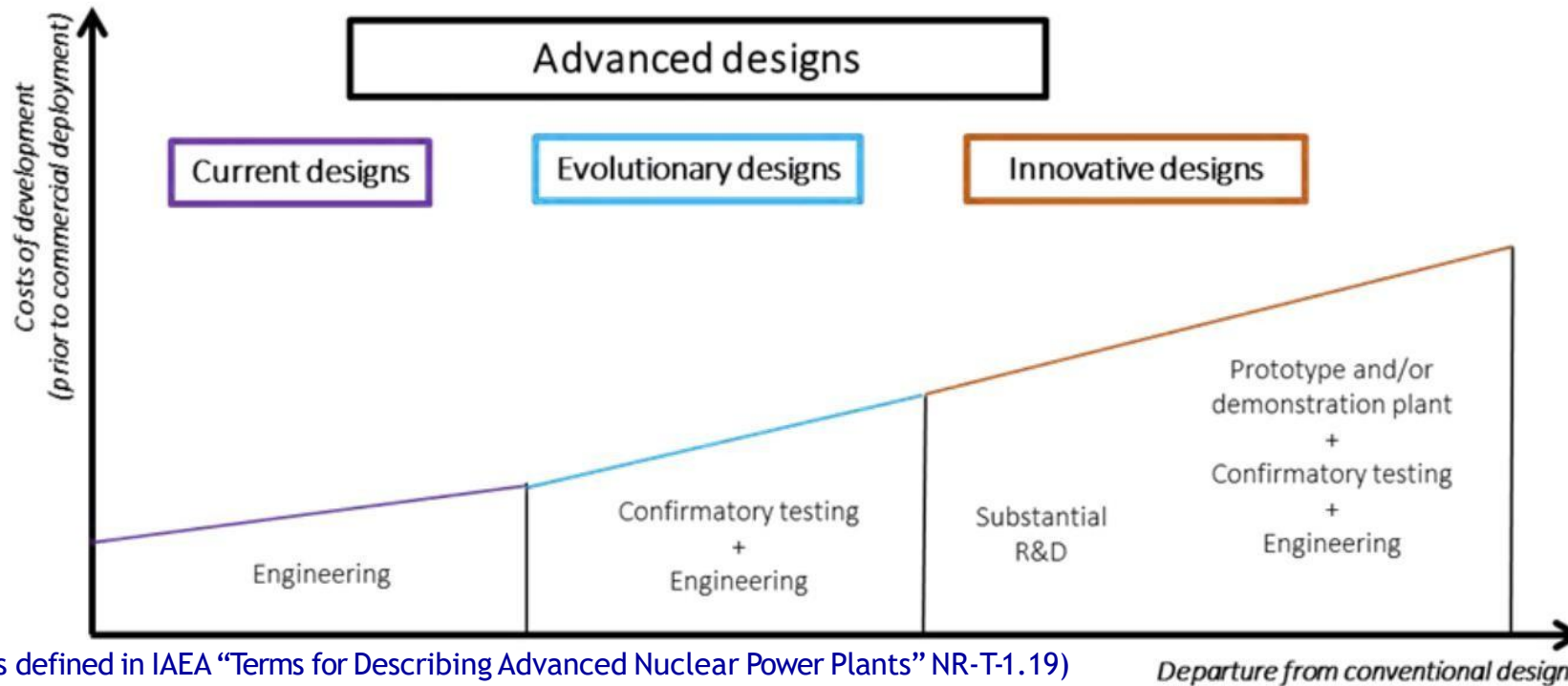
Molten Salt Reactor

Innovative designs

- **GFR** Gas-cooled Fast reactor
- **LFR** Lead-cooled fast reactor
- **MSR** Molten salt reactor
- **SFR** Sodium-cooled fast reactor
- **SCWR** Supercritical water cooled reactor
- **VHTR** Very high temperature reactor

Design Stages of Advanced Reactors: Evolutionary and Innovative

- **Evolutionary Designs** - an advanced design that achieves **improvements over current designs** through **small to moderate modifications**, with a **strong emphasis on maintaining proven design elements** to minimize technological risks.
- **Innovative Designs** - an advanced design **which incorporates conceptual changes in design approaches or system configuration** in comparison with existing practice



Early prototype reactors may or may not be full commercial scale and are intended to demonstrate:

- performance,
 - reliability,
 - safety systems,
 - economics.
- A demonstration plant will typically generate electrical power and/or process heat for industrial applications at some limited scale.
 - Early Prototype reactors provided the technical basis for the currently operating reactor fleet.

Generation I



*Dresden-1, BWR
General Electric*

Early prototypes

- **Calder Hall** GCR
- **Douglas Point**
PHWR/CANDU
- **Dresden-1** BWR
- **Fermi-1** SFR
- **Kola 1-2** PWR/VVER
- **Peach Bottom 1**
HTGR
- **Shippingport**
PWR



Commercial power reactors use highly reliable reactor power plant designs, are built to full scale and intended solely for commercial use in the generation of electricity and/or process heat for industrial applications.

- These commercial power reactors make up the majority portion of the currently operating reactor fleet.
- Experience in these commercial power reactors have motivated significant developments in safety.

Generation II



*Calvert Cliffs, PWR
Westinghouse*

Large-scale power stations

- **Bruce** (PHWR/CANDU)
- **Calvert Cliffs** (PWR)
- **Flamanville 1-2** PWR
- **Fukushima II 1-4**
BWR
- **Grand Gulf** BWR
- **Kalinin** PWR/VVER
- **Kursk 1-4** LWGR/RBMK
- **Palo Verde** PWR

*Indian 220 & 540 MW
PHWR*



Evolutionary reactors achieve improvements over previous designs through small to moderate modifications, and may, for example, include:

- Redundant systems
- Increased application of passive safety systems
- Significant improvements to containment

A few reactors are currently operating, with several more under construction.

Indian 700 MW
PHWR

Generation III/III+



AP1000, Westinghouse PWR



MHS-NE NP-NPTDS-May 2015

NuScale, iPWR-SMR

Evolutionary and Advanced Passive designs

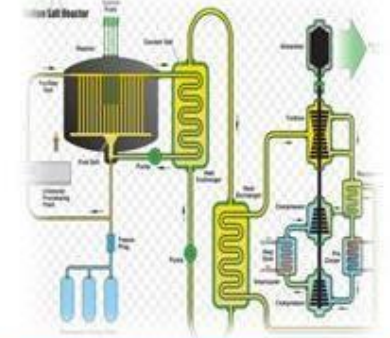
- | | |
|---|---|
| <ul style="list-style-type: none">▪ ABWR
GE-Hitachi, Toshiba▪ ACR1000
AECL CANDU PHWR▪ AP1000
Westinghouse PWR▪ APR1400
KHNP PWR▪ APWR
MHI PWR▪ ATMEA1
Areva, MHI, PWR | <ul style="list-style-type: none">▪ EPR AREVA PWR▪ ESBWR
GE-Hitachi Nuclear Energy▪ Small Modular Reactors<ul style="list-style-type: none">— B&W mPower PWR— Holtec SMR-160 PWR— India BARC AHWR— KAERI SMART PWR— NuScale PWR— Westinghouse SMR PWR• VVER-1200 (AES2006)
Gidropress PWR• ACC1000 (Hualong One)
CNNC & CGN |
|---|---|



Innovative reactors incorporate radical conceptual changes from the currently operating reactor fleet and may require a prototype or demonstration plant before commercialization.

Many innovative reactor concepts utilize new materials or different neutron energy ranges from current reactors (as in GFR, LFR, MSR), while others operate in greatly different parameter ranges (as in SCWR, VHTR).

Generation IV



Molten Salt Reactor

Revolutionary designs

- **GFR**
Gas-cooled Fast reactor
- **LFR**
Lead-cooled fast reactor
- **MSR**
Molten salt reactor
- **SFR**
Sodium-cooled fast reactor
- **SCWR** Supercritical water cooled reactor
- **VHTR** Very high temperature reactor



Evolutionary PWRs

- APR-1400 (KEPCO)
- APWR (MHI)
- ATMEA1 (Areva + MHI)
- AP-1000 (Westinghouse)
- CAP-1400 (SPIC)
- EPR (EDF)
- VVER-1200 (Rosatom)

Evolutionary BWRs

- ABWR (Japan)
- ESBWR (Japan)
- KERENA (German-French)

Evolutionary PHWRs

- EC6 and AFCR (Canada)
- IPHWR-700 (India)

Innovative Nuclear Energy Systems

- Water-Cooled Small Modular Reactors (SMR)
- High-Temperature Gas Reactors (HTGR)
- Generation IV Reactor Technology
 - Supercritical Water Reactors (SCWR)
 - Fast Reactors (FR)
 - (Very) High Temperature Gas Reactors (VHTGR)
 - Molten Salt Reactors (MSR)

- **SMRs can be either *evolutionary* or *innovative***



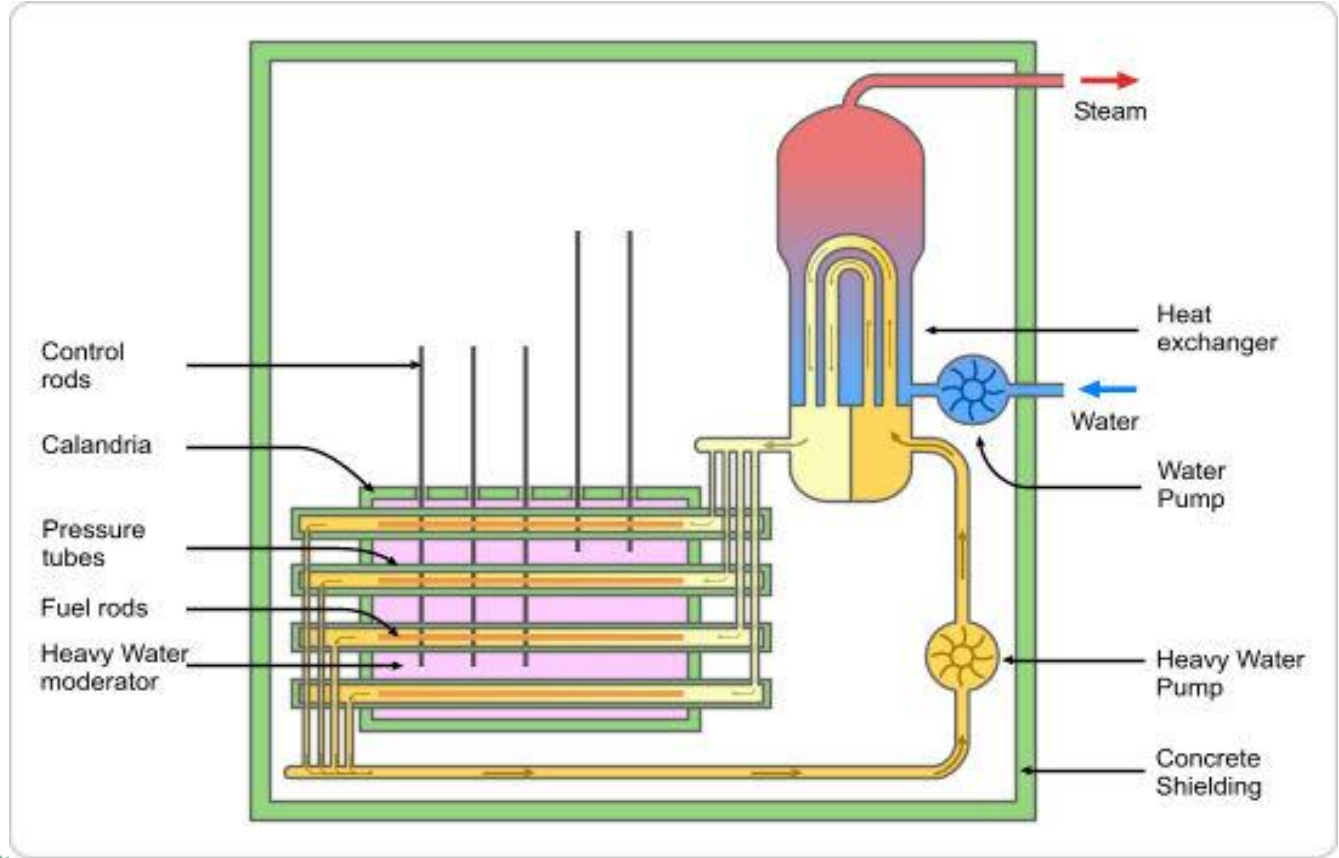
Evolutionary PHWR



Pressurised Heavy water Reactor



Fuel	Natural Uranium
Moderator	Heavy water (D ₂ O)
Coolant	Heavy water (D ₂ O)
Refueling	Online

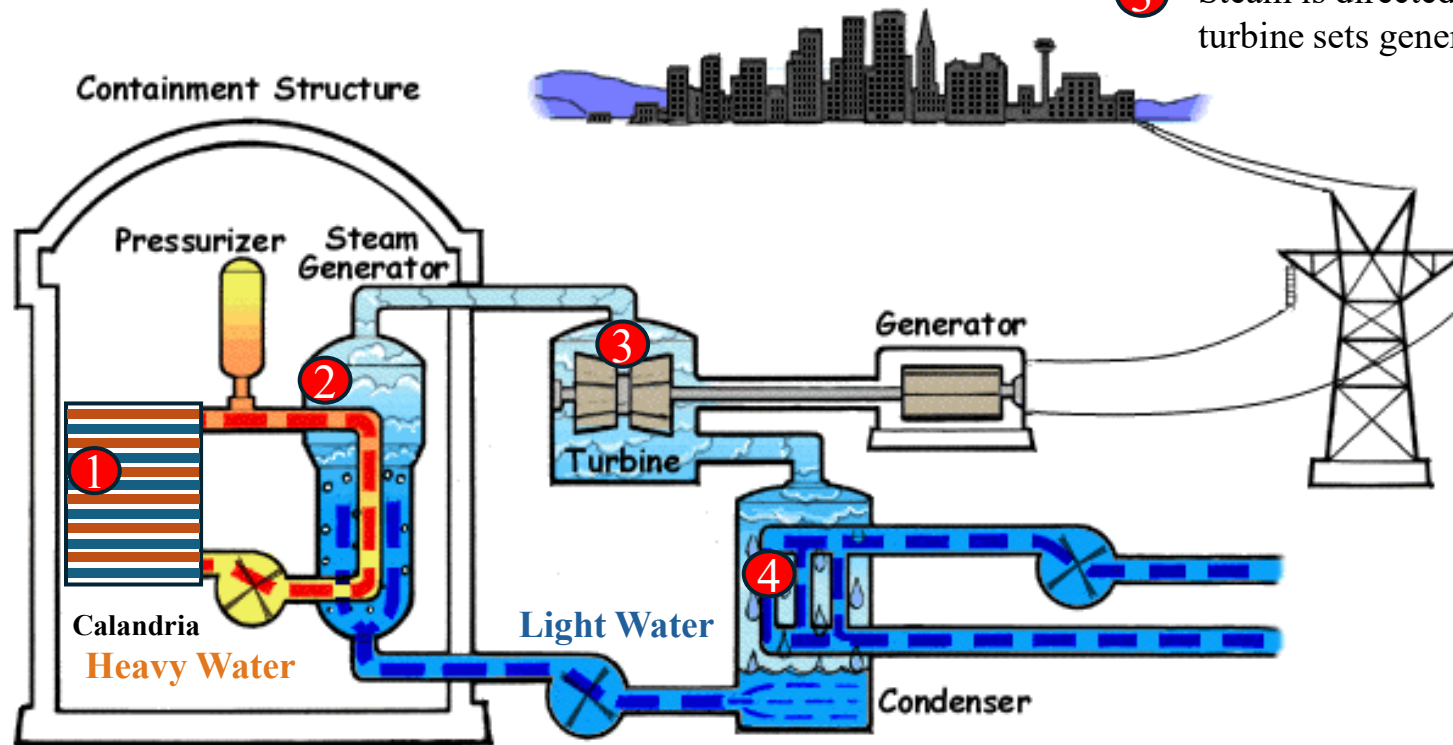


Parameter	Typical value
Coolant pressure	~8–10 MPa
Coolant temperature	~260–310°C
Moderator temperature	~60–80°C
Core configuration	Horizontal pressure tubes
Steam conditions	Typically ~250–300°C, ~4–5 MPa
Electrical output	~220–700+ MWe, depending on design
Primary heat transport	Pressurized heavy-water coolant
Secondary system	Light-water/ordinary-water steam cycle
Typical thermal efficiency	~30–35%

CANDU reactor schematic.png

② The heated water is pumped to a Steam Generator, which transfers the heat of the first circuit to the second circuit. Water in the second circuit flashes into the high-pressure steam

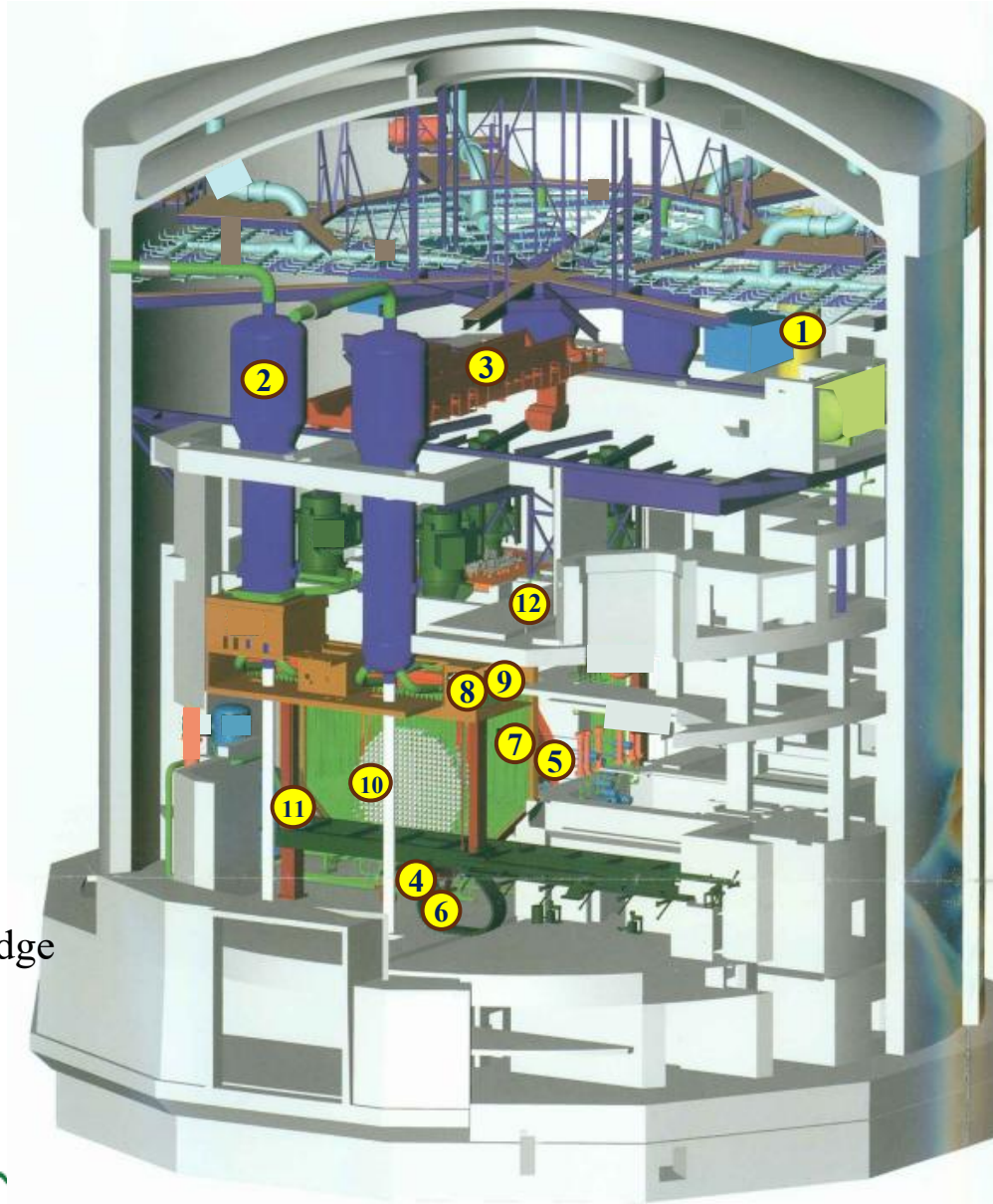
③ Steam is directed against a turbine, setting it in motion. The turbine sets generator in the motion, generating electricity.



① Energy released by the nuclear reaction heats the water in the pressurized first circuit to a very high temperature

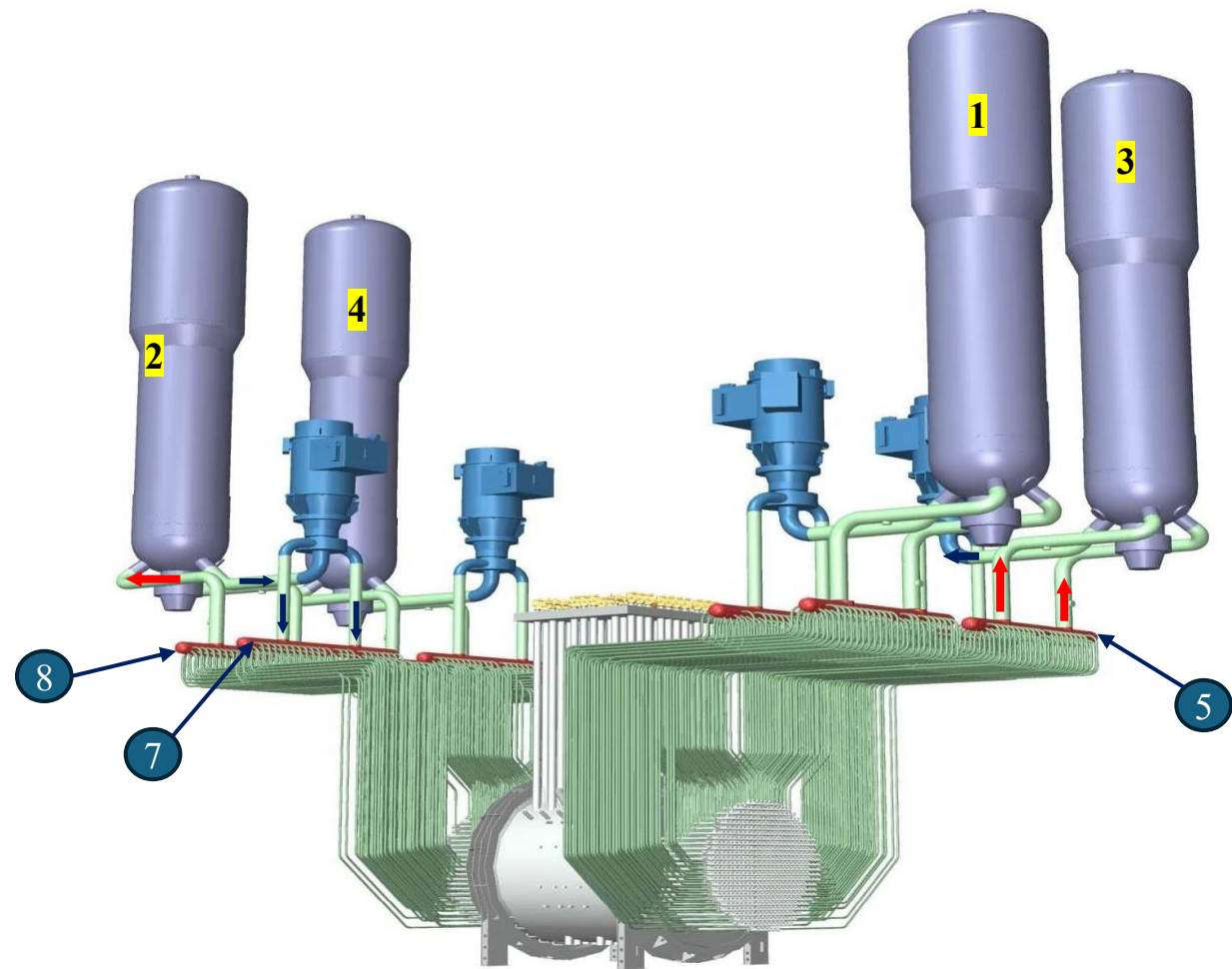
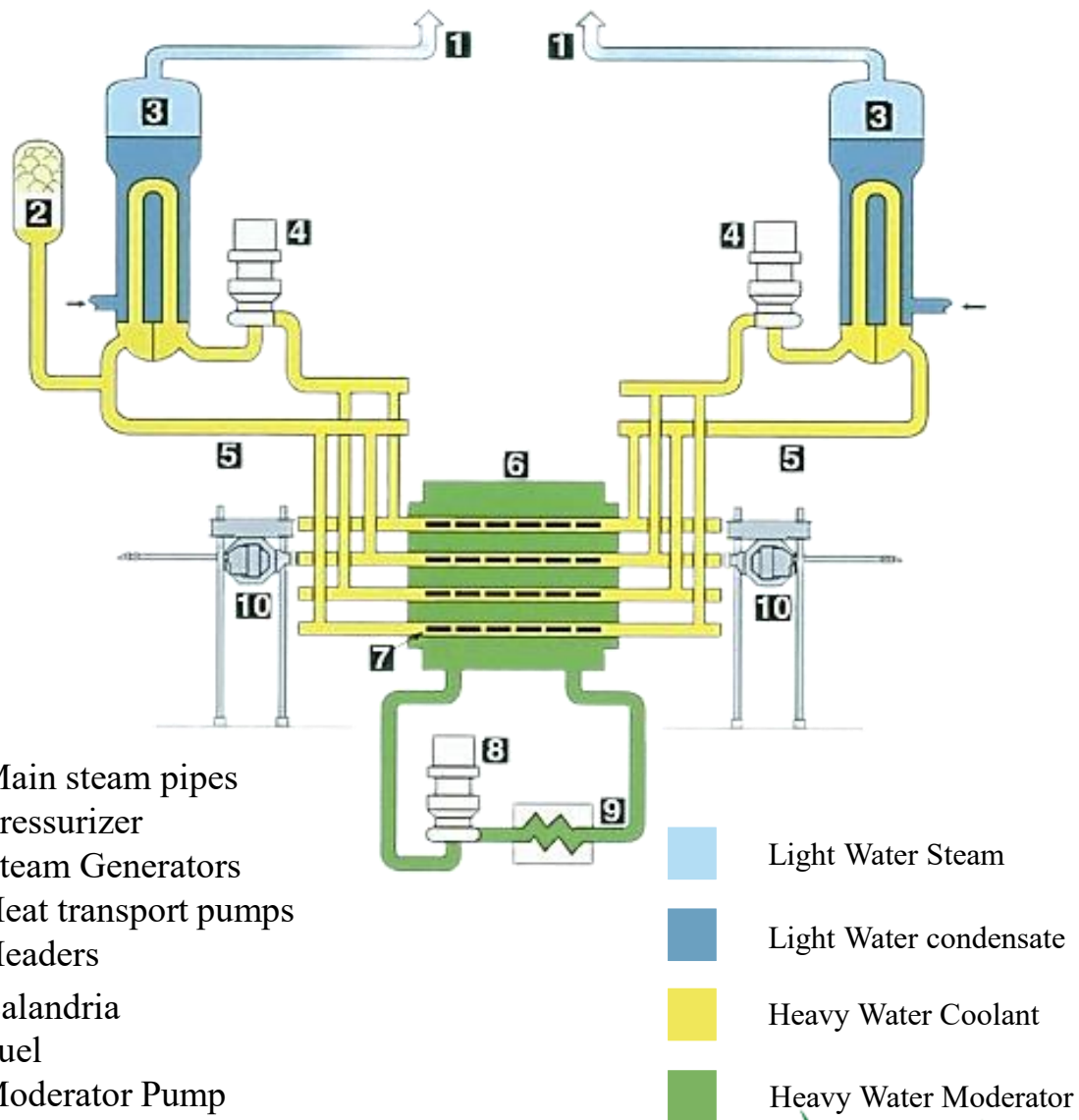
④ A third circuit cools the steam from the turbine and the waste heat is released from the cooling tower in the form of steam.

- ② Steam Generator
- ③ Crane
- ⑦ Feeder Pipes
- ⑩ End Shield
- ⑥ Fuelling machine catenary
- ⑪ FM Machine carriage and bridge



- ① Pressurizer
- ⑫ Reactivity device mechanism
- ⑨ Headers
- ⑤ Calandria
- ④ Fuelling machine
- ⑧ Feeder Header insulation Cabinet

Heat Transport Cycle



1. Main steam pipes
2. Pressurizer
3. Steam Generators
4. Heat transport pumps
5. Headers
6. Calandria
7. Fuel
8. Moderator Pump
9. Moderator Heat Exchanger
10. Fuelling Machine

MERITS

- Indigenous & proven technology
- Natural uranium fuel – no enrichment requirement
- Online refuelling – high fuel-management flexibility
- Low-pressure calandria with distributed pressure-tube design
- Established Indian supply chain & operating experience
- Standardised 700 MWe fleet deployment potential

CHALLENGES

- Large number of pressure tubes/feeders – EMCCR (En Mass Coolant channel replacement)
- Lower power density compared with PWRs
- Heavy-water inventory & management



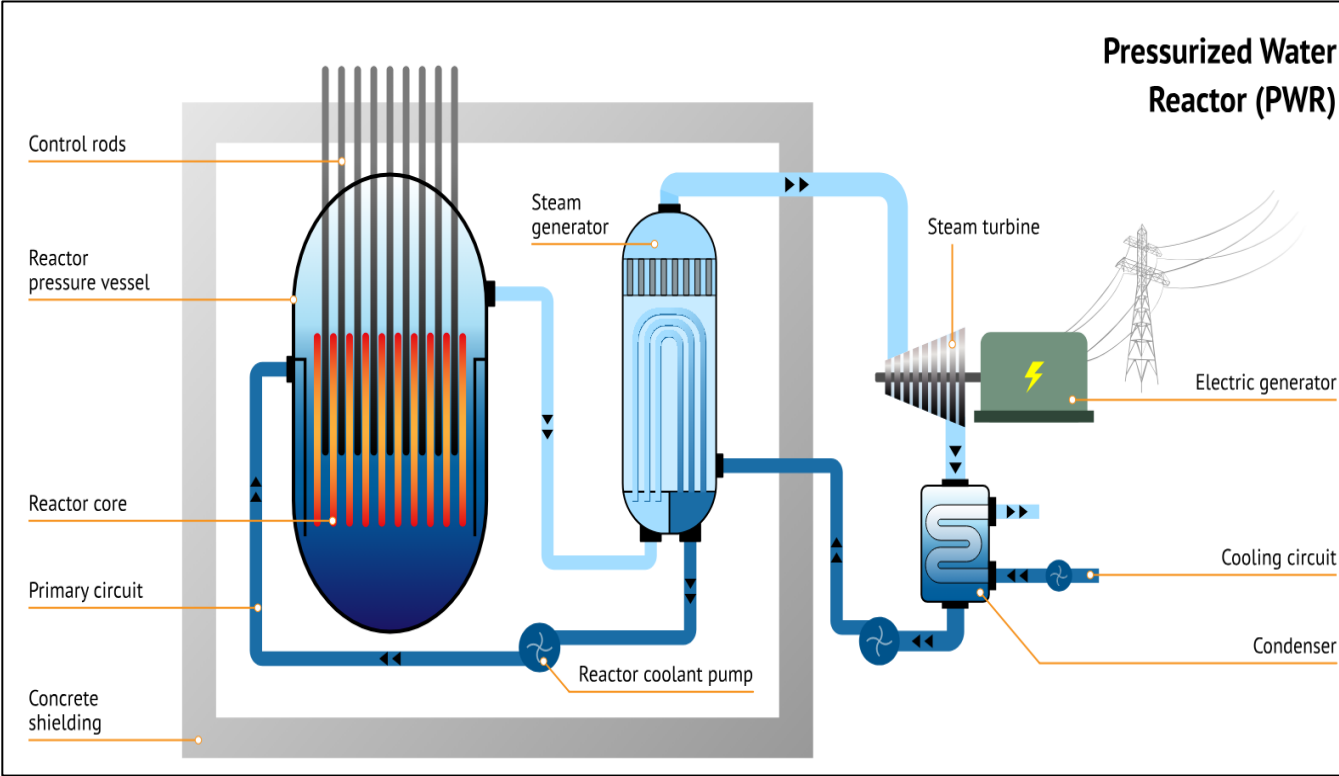
Evolutionary PWR



Pressurized water Reactor



Fuel	Enriched UO_2
Moderator	Light water (H_2O)
Coolant	Light water (H_2O)
Refueling	During scheduled shutdown

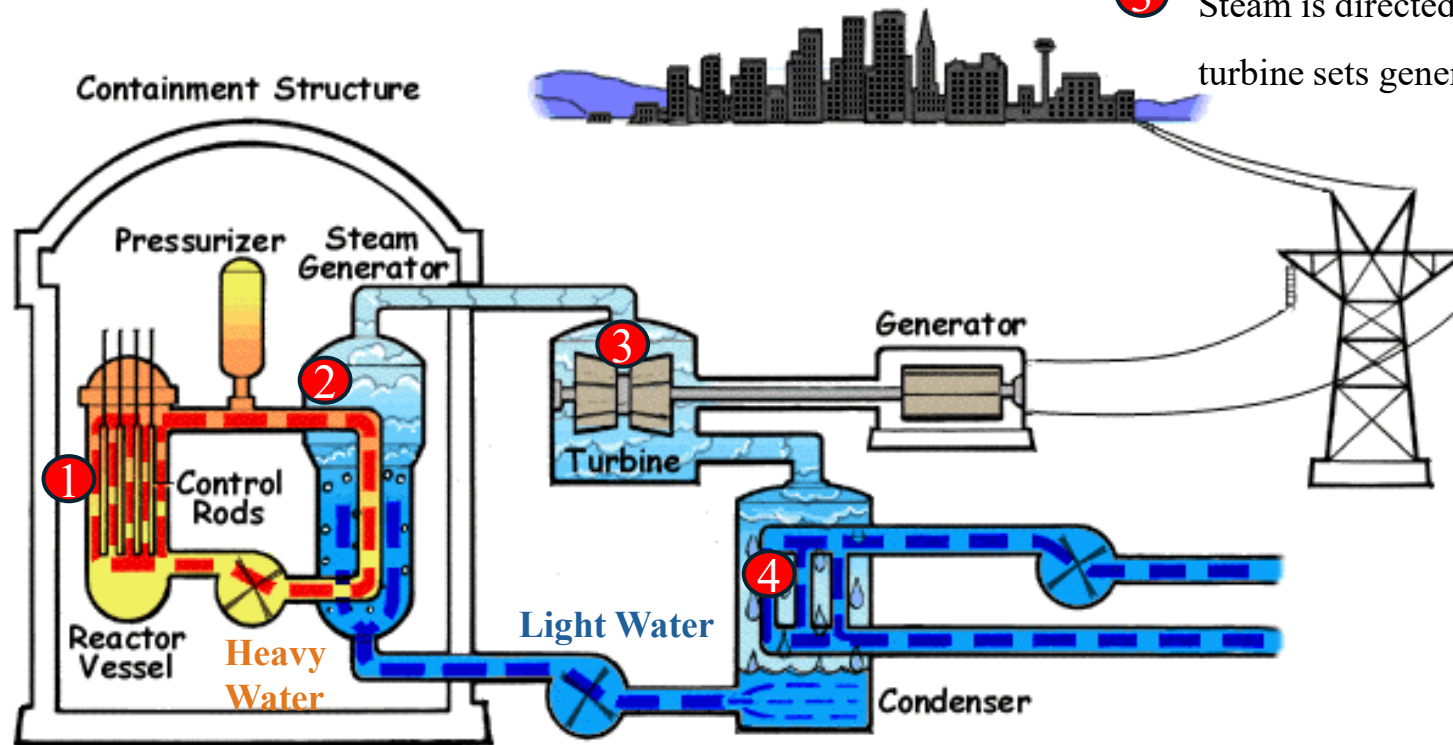


Parameter	Typical value
Fuel Enrichment	3-5%
Coolant pressure	~15–16 MPa
Coolant temperature	~290–330°C
Core configuration	Fuel assemblies in reactor vessel
Steam conditions	Typically ~5–8 MPa
Electrical output	~300–1650+ MWe, depending on design
Primary heat transport	Pressurized light-water coolant
Secondary system	Light-water/ordinary-water steam cycle
Typical thermal efficiency	~32–37%



- ② The heated water is pumped to a Steam Generator, which transfers the heat of the first circuit to the second circuit. Water in the second circuit flashes into the high-pressure steam

- ③ Steam is directed against a turbine, setting it in motion. The turbine sets generator in the motion, generating electricity.

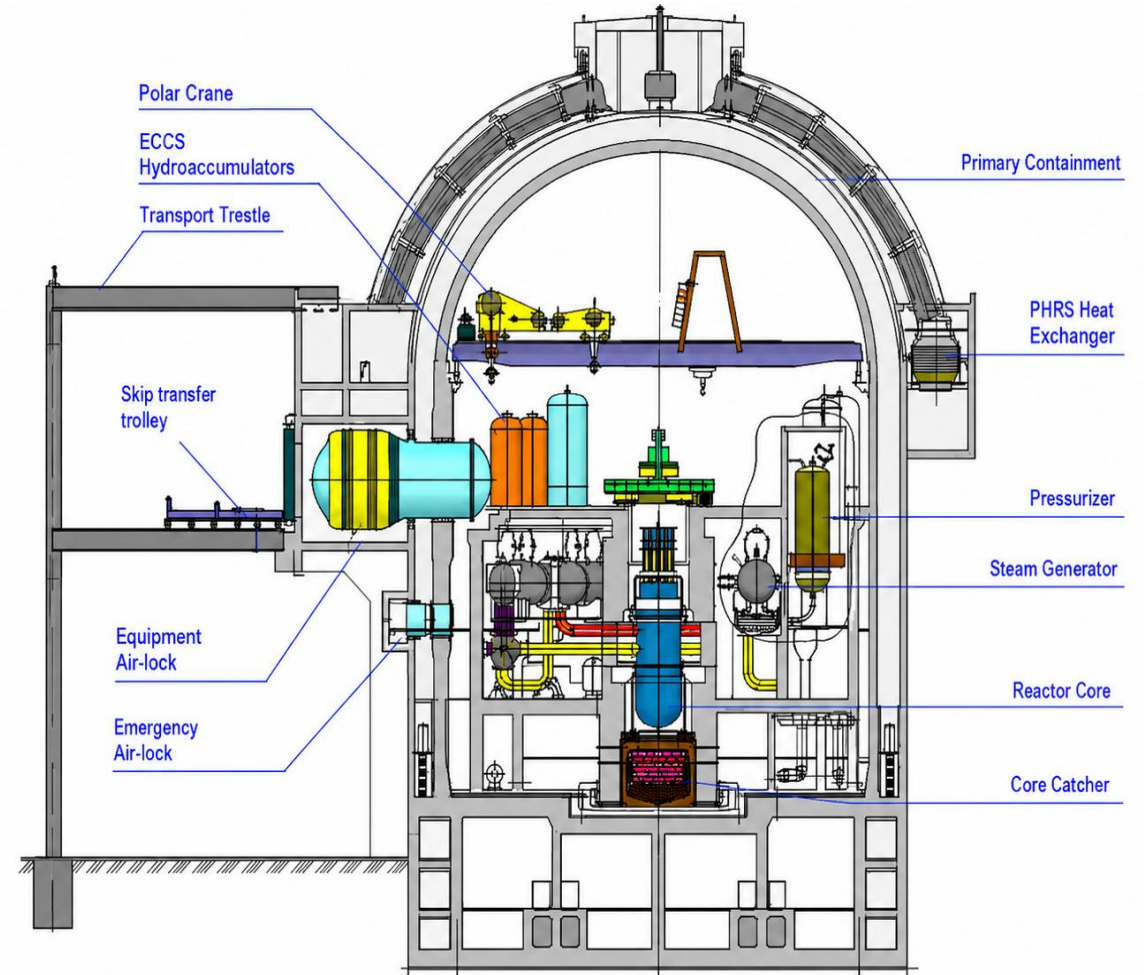
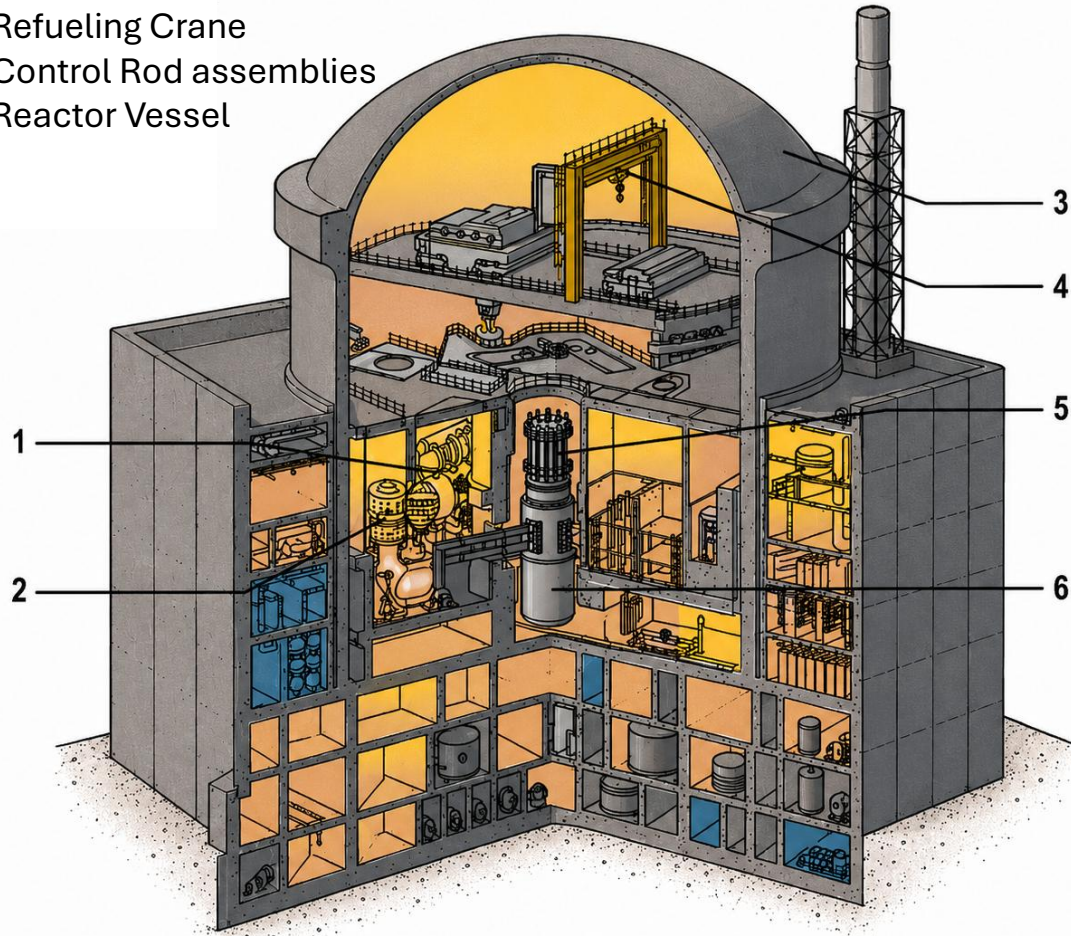


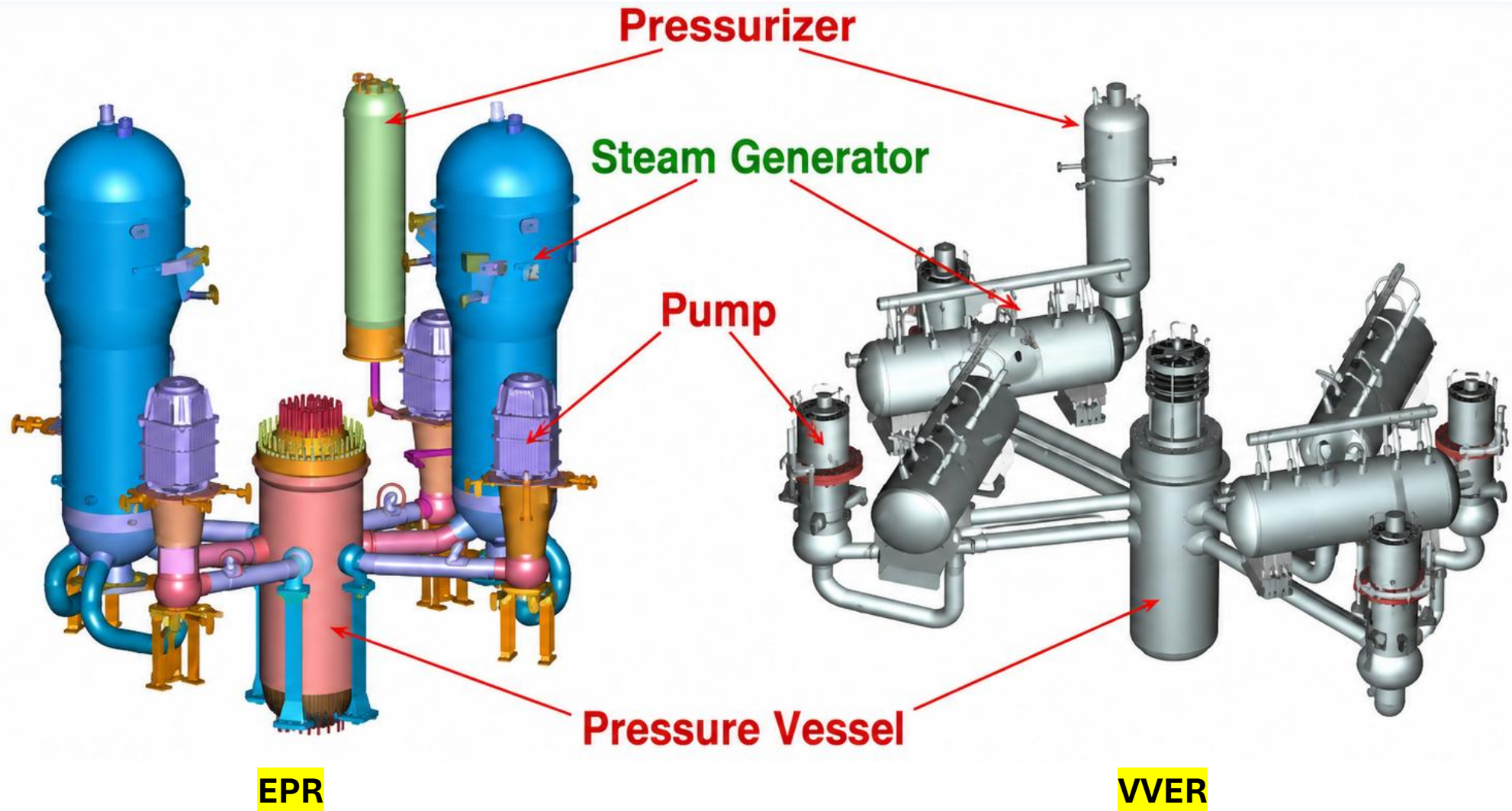
- ① Energy released by the nuclear reaction heats the water in the pressurized first circuit to a very high temperature

- ④ A third circuit cools the steam from the turbine and the waste heat is released from the cooling tower in the form of steam.

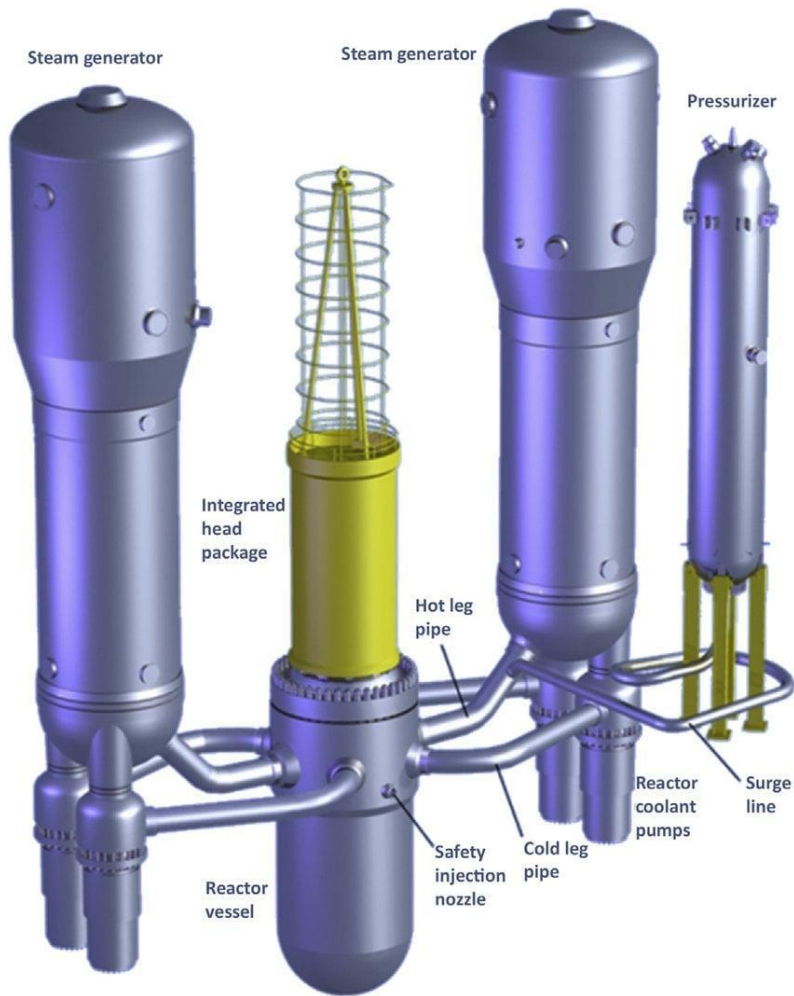
Schematic Representation

1. Horizontal Steam Generator
2. Reactor coolant pump
3. Containment Building
4. Refueling Crane
5. Control Rod assemblies
6. Reactor Vessel

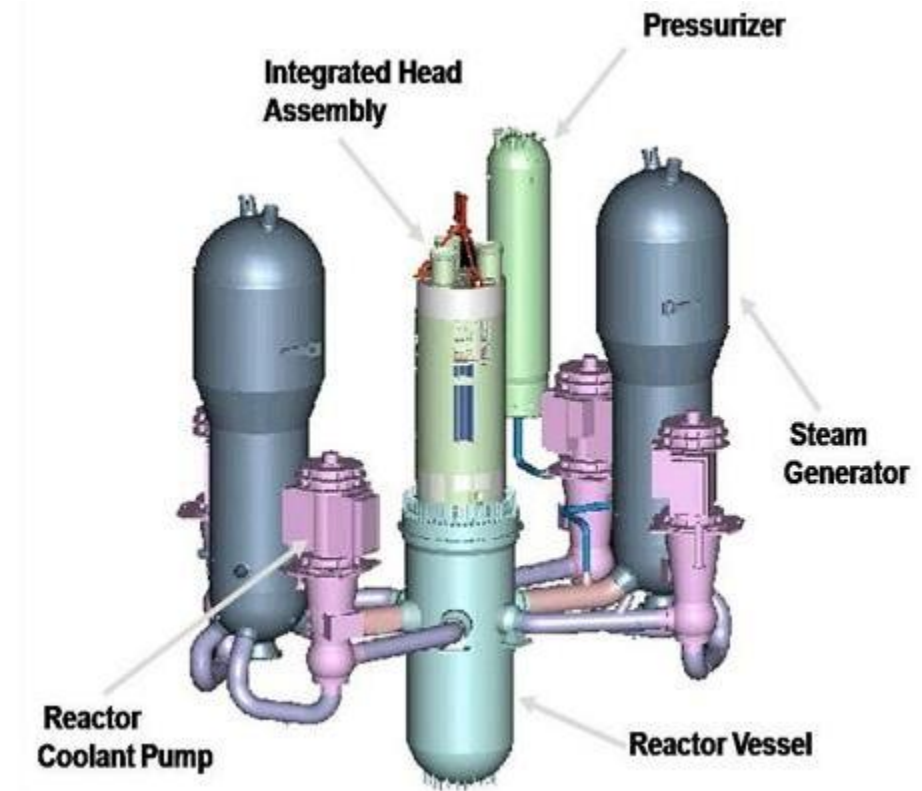




Schematic Representation - PWR

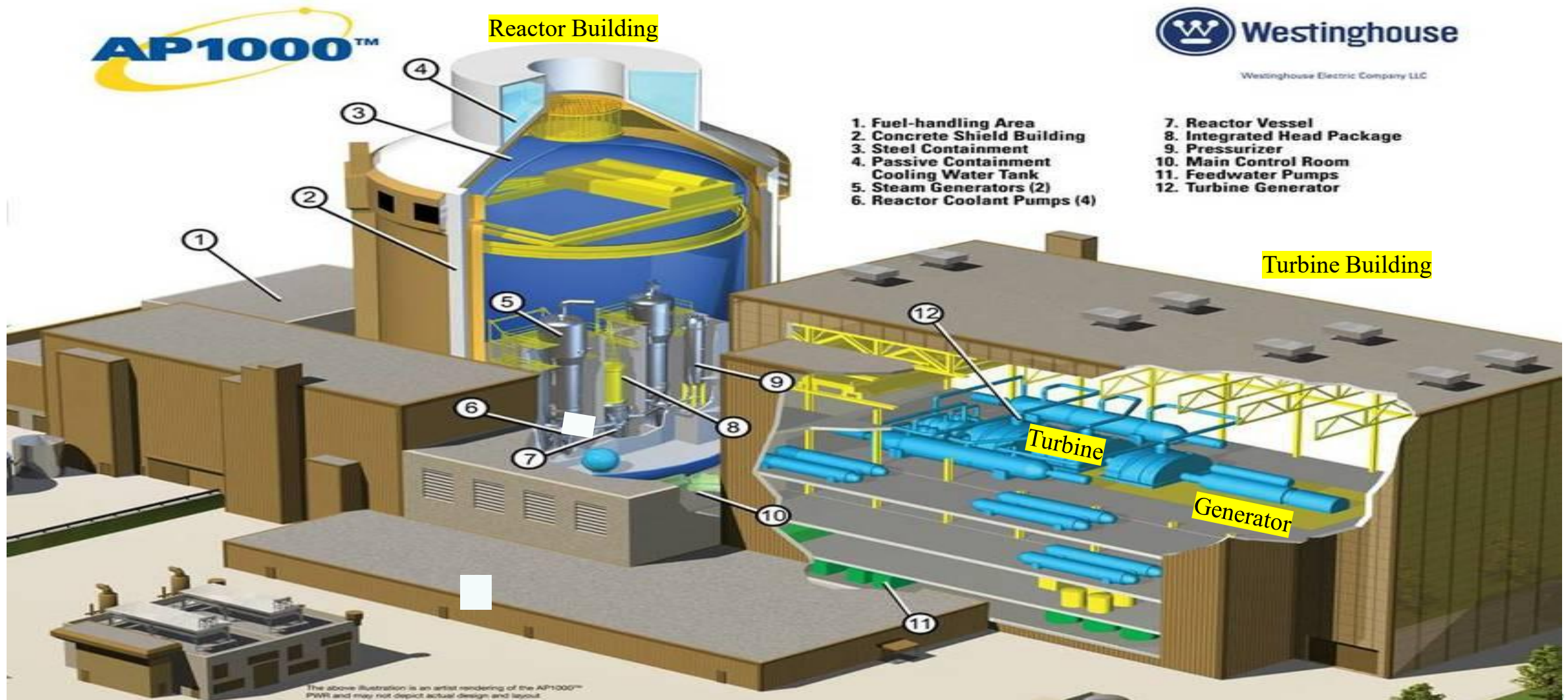


AP-1000



APR-1400

Layout of Nuclear Power plant



MERITS

- Mature & globally proven technology
- High power density → compact reactor island
- Large unit capacity → suitable for baseload & fleet deployment
- Extensive global operating experience & safety database
- Multiple established technology options – VVER, EPR, AP1000, APR1400, etc.
- Established global supply chain
- Simple operation & possibility of load following
- No heavy-water requirement
- Low spent fuel

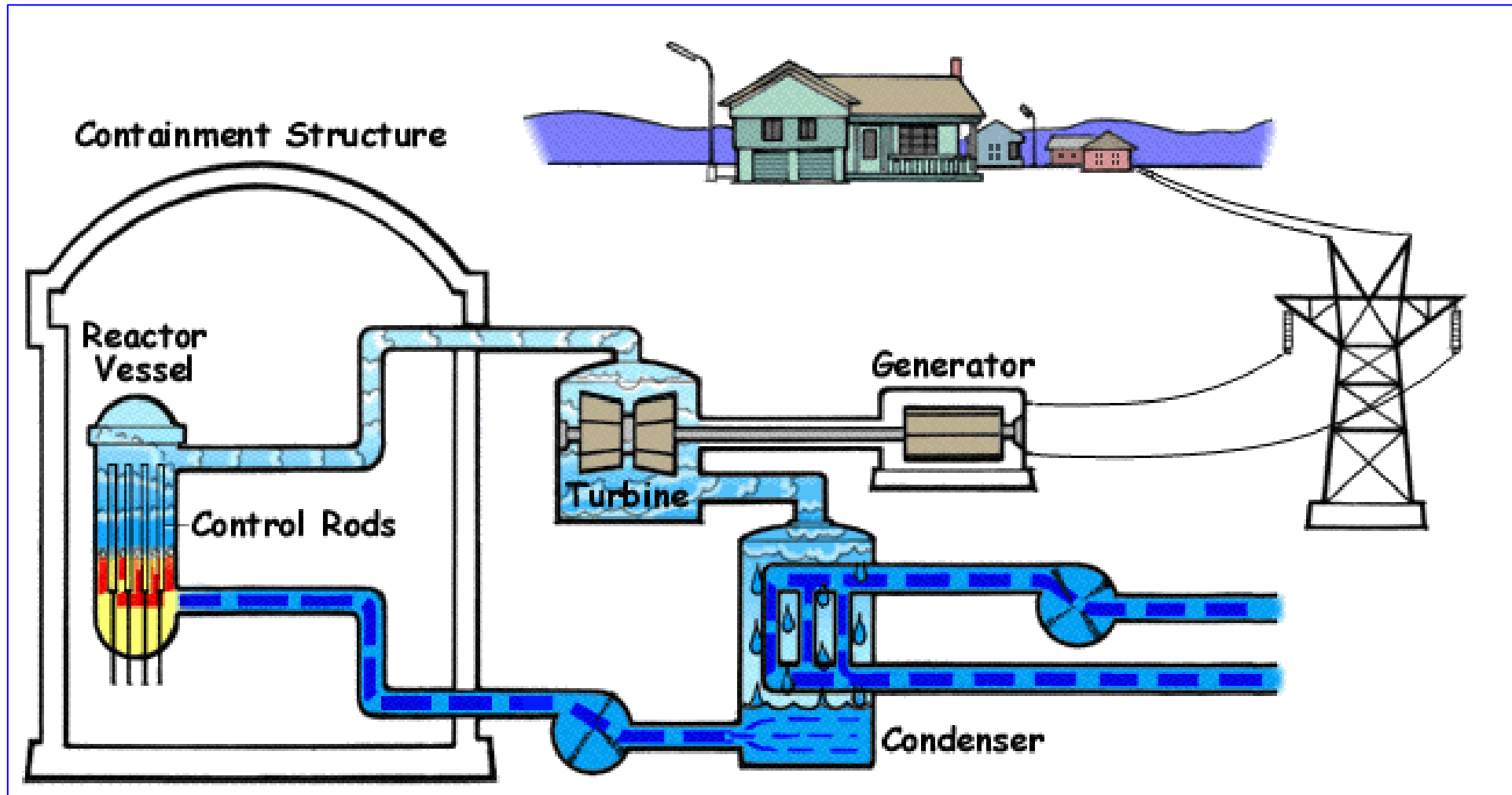
CHALLENGES

- Requires enriched uranium fuel
- Dependence on enrichment & international fuel supply chain
- High capital cost & financing requirement – Needs deep localization for viability
- Refuelling requires planned shutdown



Evolutionary BWR





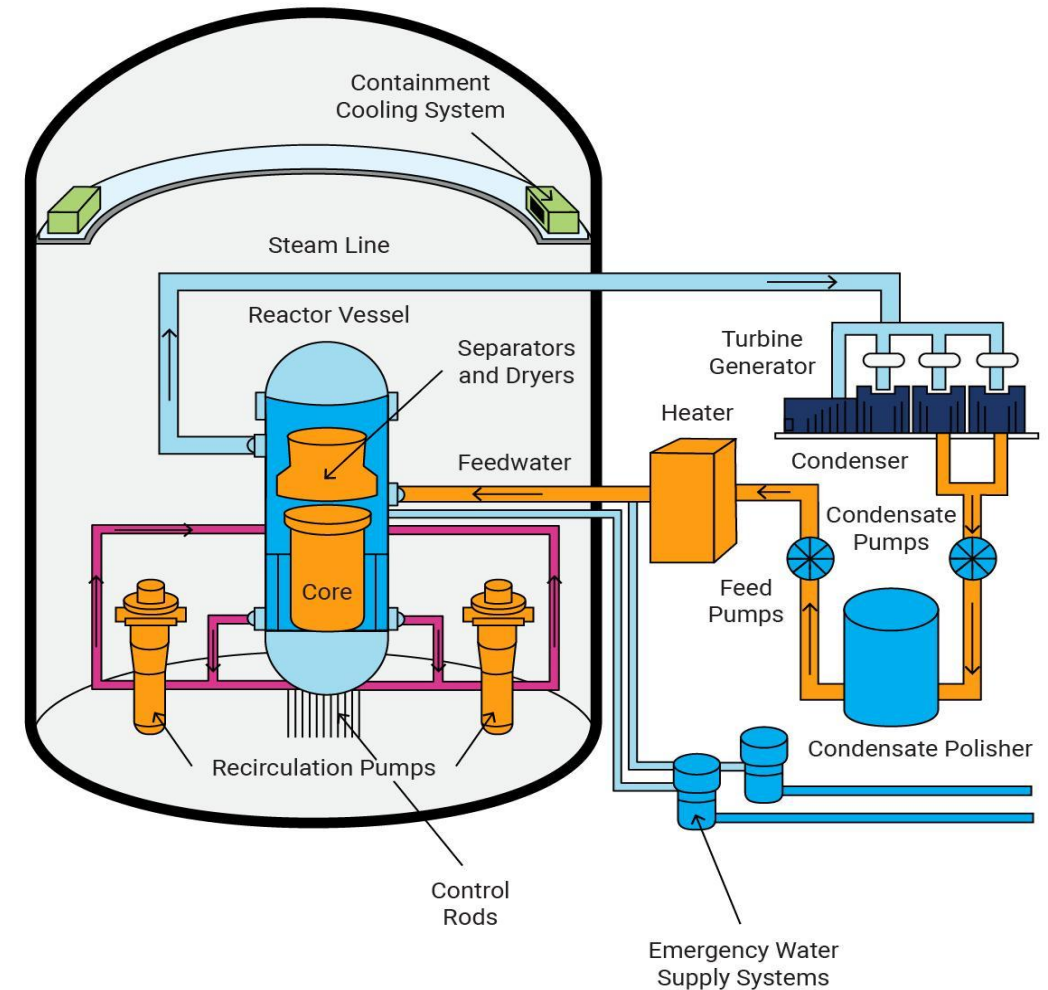
Reactor vessel: Contains the core, where water is boiled directly to produce steam.

Separators and dryers: Remove water droplets from the steam before it leaves the reactor vessel.

Steam line: Carries generated steam directly to the turbine-generator.

Containment cooling system: Helps remove heat from the containment atmosphere and control containment conditions.

Control rods: Regulate the nuclear reaction by controlling neutron absorption in the core.



MERITS

- Mature & globally proven technology
- Direct steam generation → eliminates separate steam generator
- Simplified steam cycle and potentially fewer major components
- High power density
- Lower primary-system pressure than PWR
- Good operational/load-following capability

CHALLENGES

- Requires enriched uranium fuel
- Radioactive steam reaches turbine/steam-cycle systems
- More demanding radiation protection & maintenance arrangements
- Refuelling requires planned shutdown
- High capital cost and long project execution cycle

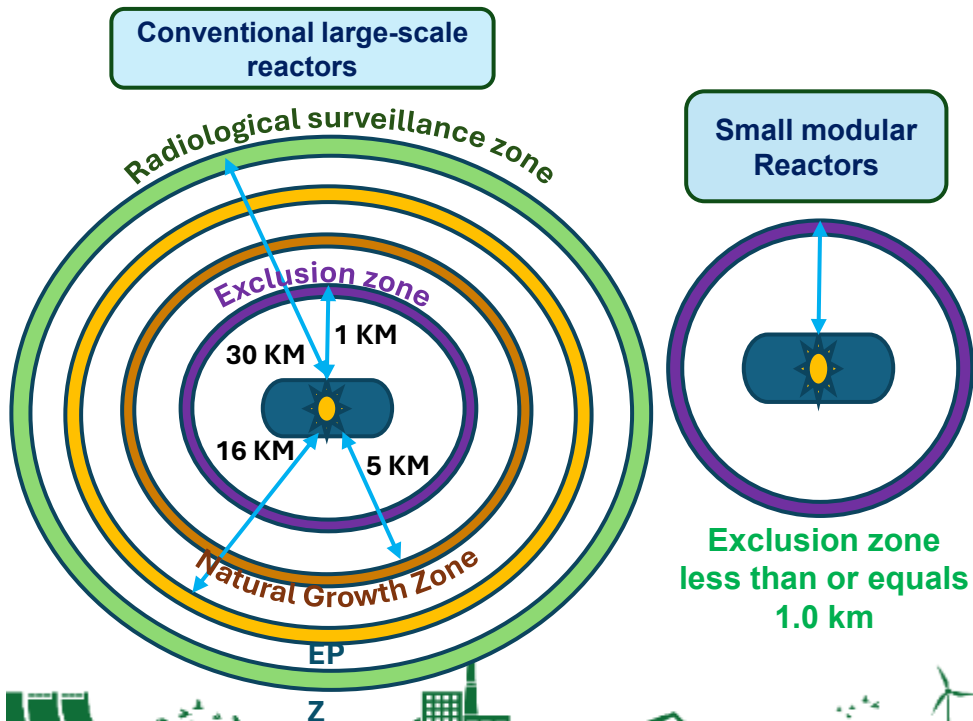
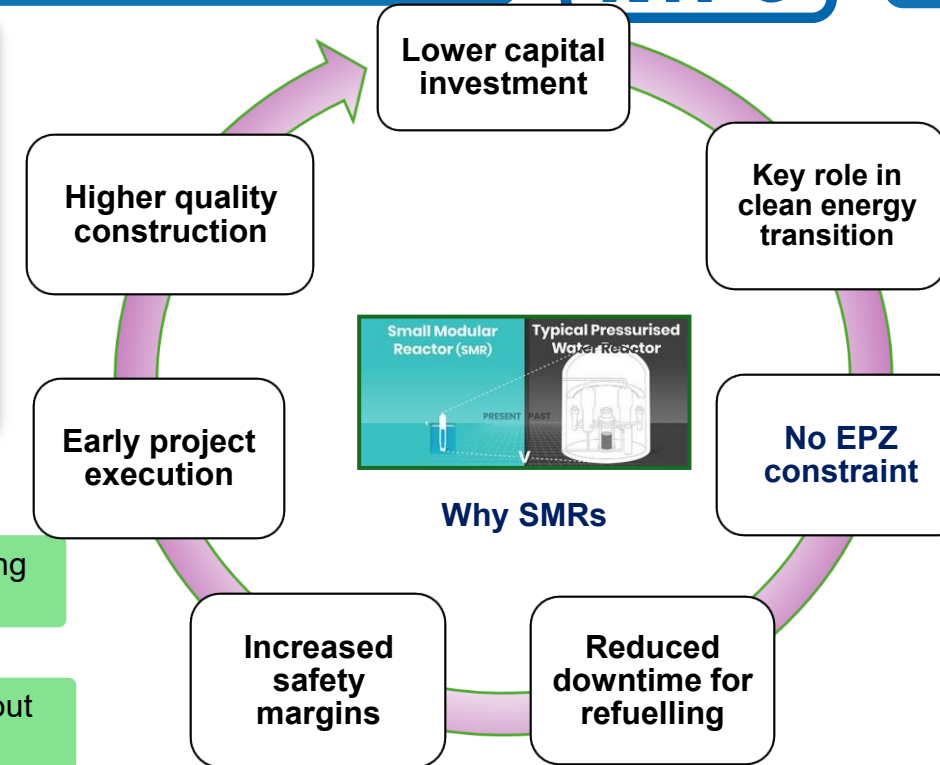


Small Modular Reactor



Small Modular Reactor

- Nuclear Reactors with a power output between 10 MWe and 300 MWe
- Module factory fabrication, factory-based construction in order to maximise economies of series
- The different modules can then be transported and assembled onsite
- Predictability and savings in construction times
- Level of construction quality and efficiency improvement



Passive cooling system & infinite cooling through design

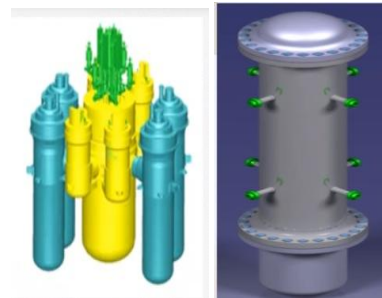
Ensures core cooling for > 7 days without operator intervention

Rules out core meltdown & reduces core damage frequency drastically

Types:

Block: Each of the major components of the reactor, i.e. SG, pressuriser & pumps are welded directly to RPV

Integral: The reactor and associated components like SG, Pumps & Pressurizer are all positioned within a single pressure vessel



Operational	Under construction	Basic/detailed design stage	Conceptual design stage
4	3	67	28
KLT-40S (2), HTR PM (2)	CAREM (2028), ACP100 (2026), BRESTOD (2026), Hermes (*)		

*USA – Low Power demonstration reactor (Fluoride salt based) – Heat energy (not power production)

Fuel Cycle

Most SMR designs – HALEU (5% to 20% U-235)
HALEU commercial stage production in Russia & USA

Type	Fuel used	Refuelling cycle
Land based Water Cooled Reactors	LEU (< 5%)	18–24 months
Marine based Water Cooled Reactors	HALEU	Up to 120 months
Gas Cooled Reactors	LEU / HALEU (TRISO coated)	25-60 months
Molten Salt Reactors	LEU / HALEU (TRISO coated)	Up to 150 months
Liquid Metal M Fast Neutron Reactors	HALEU (14-20%)	Up to 30 years



1

BSMR-220

Financial sanction approved, pre-project activities are under progress (Tarapur)

2

SMR-55

In-principle approval received (Tarapur)

3

5MWth HTGR

H2 generation: in-principle approval for engineering & construction received (Vizag)



Department of Atomic Energy

PARLIAMENT QUESTION: NUCLEAR ENERGY MISSION & BHARAT SMALL MODULAR REACTORS

Posted On: 05 AUG 2026 3:33PM by PIB Delhi

Under the Nuclear Energy Mission announced in the Union Budget 2025–26, a total budgetary provision of Rs.20,000 crore has been allocated for the design, development and deployment of Small Modular Reactors (SMRs). This allocation is aimed at supporting India's objective of developing and operationalising at least five indigenous SMRs by 2033.

In this regard, Bhabha Atomic Research Centre (BARC) a constituent Unit of Department of Atomic Energy (DAE) has undertaken the design & development of demonstration units of SMRs, namely 220 MWe Bharat Small Modular Reactor (BSMR-200), 55 MWe Small Modular Reactor (SMR-55) for power generation, and a High Temperature Gas Cooled Reactor (HTGCR) having capacity up to 5 MWth, for generation of process heat, which can be coupled with suitable thermochemical cycle for hydrogen production. These SMRs require 60 to 72 months for establishment after receipt of administrative & financial sanction.

BARC has undertaken the design and development of SMRs, namely 220 MWe Bharat Small Modular Reactor (BSMR-200), 55 MWe Small Modular Reactor (SMR-55), and High Temperature Gas Cooled Reactor (HTGCR) having capacity up to 5 MWth for hydrogen production.

- I. The BSMR-200 is an indigenous Pressurized Water Reactor (PWR) based power reactor. The current status of the BSMR-200 is mentioned below;
 - a. In-principle approval for engineering and construction of BSMR-200 has been received.
 - b. Proposal for Administrative & Financial sanction is cleared by Atomic Energy Commission (AEC) and the approval of Empowered Technology Group (ETG) has been obtained.
 - c. Atomic Energy Commission has approved Tarapur, Maharashtra as site for BSMR-200.
- II. The SMR-55 is based on Pressurised Water Reactor design. The current status of the SMR-55 is mentioned below;
 - a. In-principle approval for engineering and construction of SMR-55 has been received.
 - b. Atomic Energy Commission has approved Tarapur, Maharashtra as site for SMR-55
- III. HTGCR having power up to 5 MWth is being designed and developed by BARC as nuclear heat source and to be coupled with a suitable thermochemical cycle, such as copper-chlorine cycle, for hydrogen production. The current status of the HTGCR is mentioned below;
 - a. In-principle approval for engineering and construction of HTGCR has been received.
 - b. The proposed site for the reactor is BARC, Vizag. Siting consent has been received.
 - c. Terms of Reference (ToR) for obtaining environmental clearances has been received from the Ministry of Environment, Forest and Climate Change (MoEF&CC).



1 ₹20,000 cr
For SMR R&D + deployment

2 60–72 months
estimated establishment time

3 5 SMR
By 2033

BSMR-200

200 MWe • PWR-based power reactor

- In-principle approval for engineering & construction received.
- Administrative & financial proposal cleared by AEC; ETG approval obtained.
- Tarapur, Maharashtra approved as site.

SMR-55

55 MWe • Pressurised Water Reactor

- In-principle approval for engineering & construction received.
- Tarapur, Maharashtra approved as site by the Atomic Energy Commission.
- Designed as a demonstration unit under the Nuclear Energy Mission.

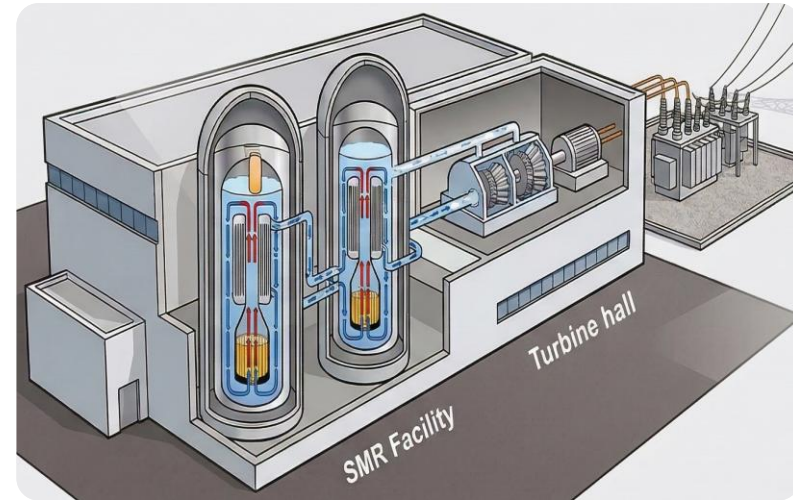
HTGCR

Up to 5 MWth • high-temperature process heat

- High Temperature Gas Cooled Reactor for nuclear process heat.
- In-principle approval received; proposed site: BARC, Vizag.
- Siting consent and environmental-clearance ToR received.

Application of SMR

Power Generation

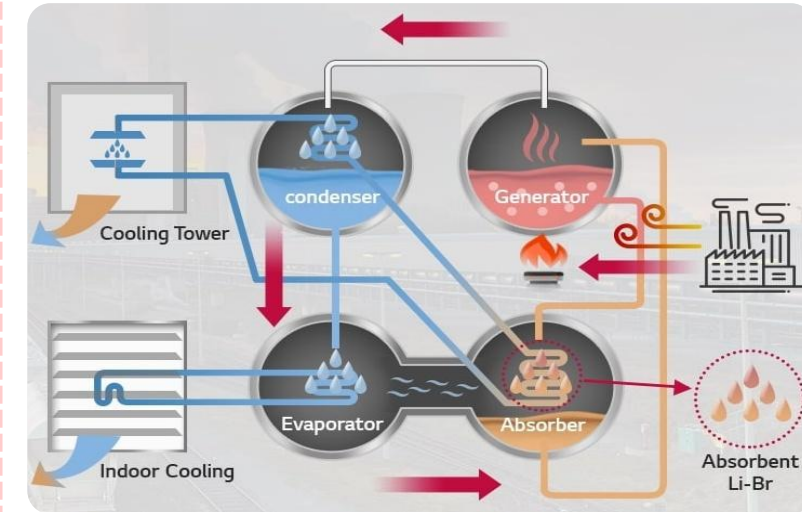


Industrial Heating



Textile Refinery Chemicals Food Process Fertilizers Paper

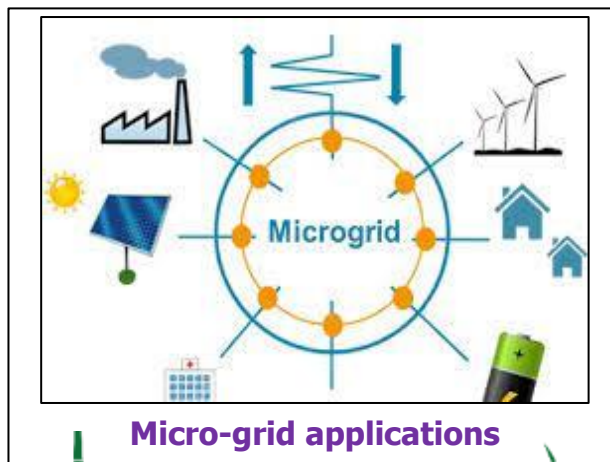
Cooling & Refrigeration



Desalination & Water Grid

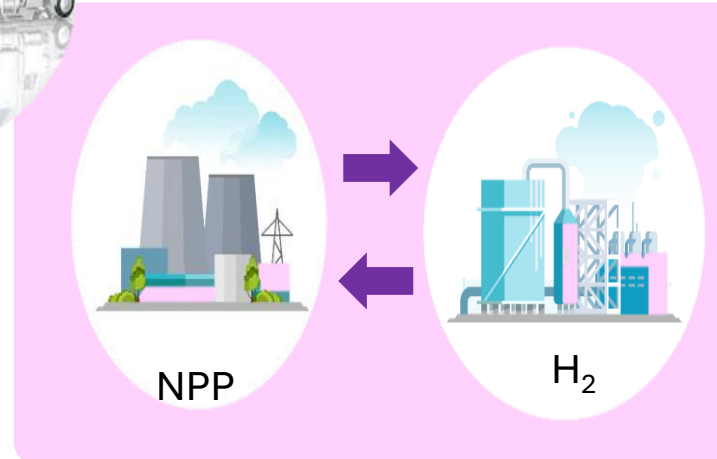


Distributed generation



SMR in remote locations

Nuclear Hydrogen



- ❖ Low Temp (LTE) (50-60 kWh/m³)
- ❖ High Temp (HTSE) (42-44 kWh/m³)
- ❖ Thermochemical (S-I₂, Cu-Cl₂ Cycles T > 600°C)

MERITS

- Smaller unit size → suitable for smaller grids and distributed deployment
- Modular & factory-based construction → potential for shorter construction time
- Lower upfront investment per module → potentially easier financing
- Enhanced passive safety in many advanced designs
- Flexible capacity addition through sequential module deployment
- Potential brownfield deployment at existing sites
- Multiple applications – electricity, process heat, desalination, hydrogen

CHALLENGES

- FOAK technology & cost risk for many advanced designs
- Licensing/regulatory framework for novel technologies
- Limited operating experience for most new-generation SMRs
- Manufacturing/supply-chain scale-up required
- Economic viability highly dependent on fleet deployment



Innovative Nuclear Energy Systems

Gen IV

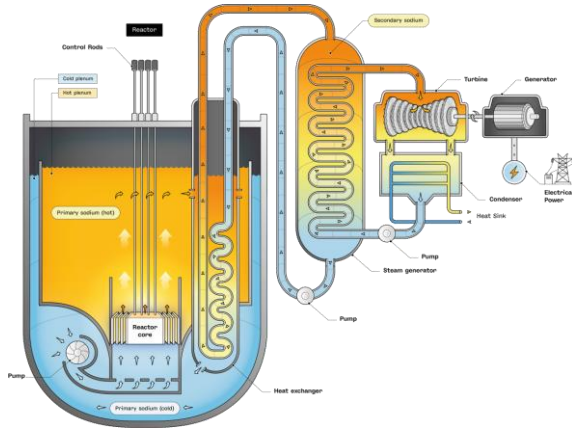


Overview of Generation IV Systems

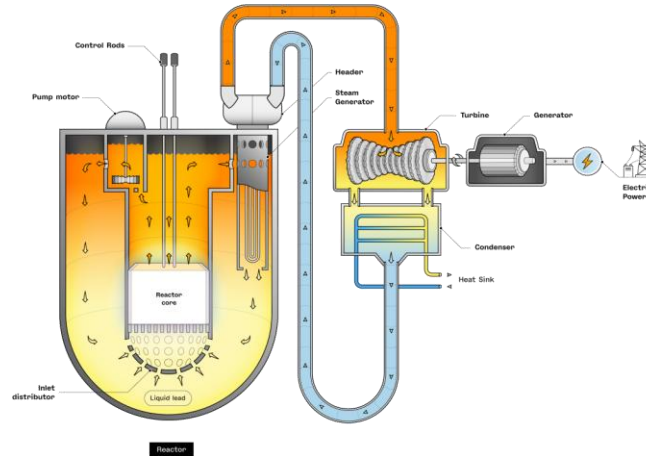
System	Neutron Spectrum	Fuel Cycle	Size (MWe)	Applications	R&D Needed
Very-High-Temperature Reactor (VHTR)	Thermal	Open	250	Electricity, Hydrogen, Process Heat	Fuels, Materials, H ₂ production
Supercritical-Water Reactor (SCWR)	Thermal, Fast	Open, Closed	1500	Electricity	Materials, Thermal-hydraulics
Gas-Cooled Fast Reactor (GFR)	Fast	Closed	200–1200	Electricity, Hydrogen, Actinide Management	Fuels, Materials, Thermal-hydraulics
Lead-Cooled Fast Reactor (LFR)	Fast	Closed	50–150 300–600 1200	Electricity, Hydrogen Production	Fuels, Materials
Sodium Cooled Fast Reactor (SFR)	Fast	Closed	300–1500	Electricity, Actinide Management	Advanced recycle options, Fuels
Molten Salt Reactor (MSR)	Epithermal	Closed	1000	Electricity, Hydrogen Production, Actinide Management	Fuel treatment, Materials, Reliability



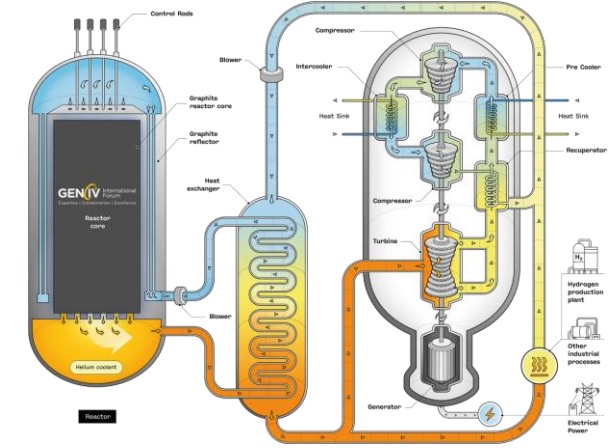
Sodium-cooled Fast Reactor (SFR)



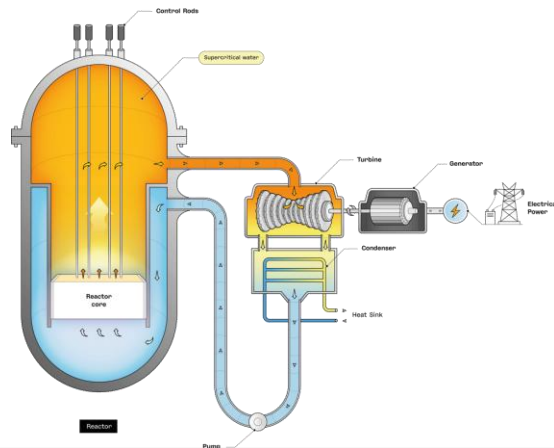
Lead cooled Fast Reactor (LFR)



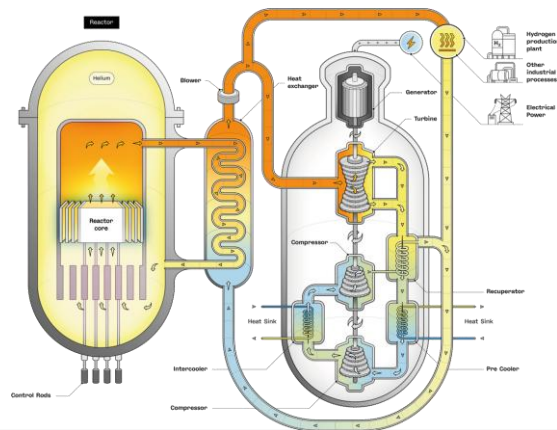
Very-High-Temperature Reactor (VHTR)



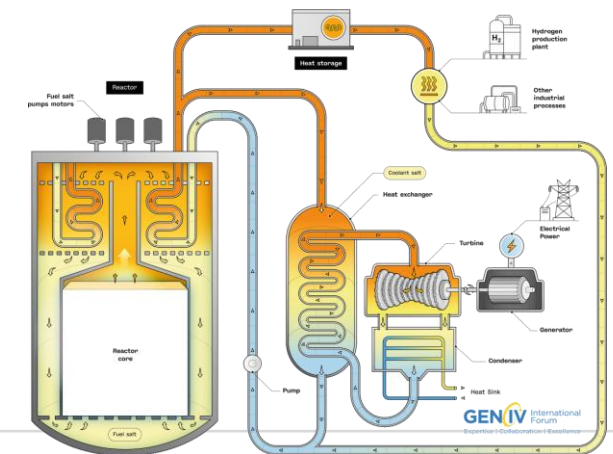
Supercritical Water cooled Reactor (SCWR)



Gas cooled Fast Reactor (GFR)



Molten Salt Reactor (MSR)



MERITS

- Enhanced inherent & passive safety
- High-temperature operation → higher efficiency & process heat
- Better fuel/resource utilisation
- Closed fuel-cycle potential → recycling & actinide management
- Potential reduction in long-lived waste
- Multiple non-electric applications – hydrogen, process heat, desalination
- Long-term sustainability & energy-security potential

CHALLENGES

- Limited commercial operating experience
- FOAK technology, cost & schedule risk
- Advanced fuel qualification & availability
- Demanding materials requirements
- Specialised manufacturing & supply-chain requirements



Nuclear power can play a key role in **decarbonizing electricity, industry and hydrogen production while providing reliable 24/7 energy**

Emerging nuclear technologies (SMRs, advanced PWRs, BWRs, fast reactors, etc) offer **improved safety, flexibility and potentially lower construction costs**

Advanced fuels and passive safety systems can enhance reactor performance, accident tolerance and operational reliability

Going forward, priority should be given to **indigenous R&D, demonstration projects, strong regulatory frameworks, skilled manpower and robust nuclear safety culture**

A balanced roadmap should combine **proven large reactors with emerging advanced technologies**, while strengthening the fuel cycle, waste management and public confidence





Thank You

