India's Nuclear Development Programme

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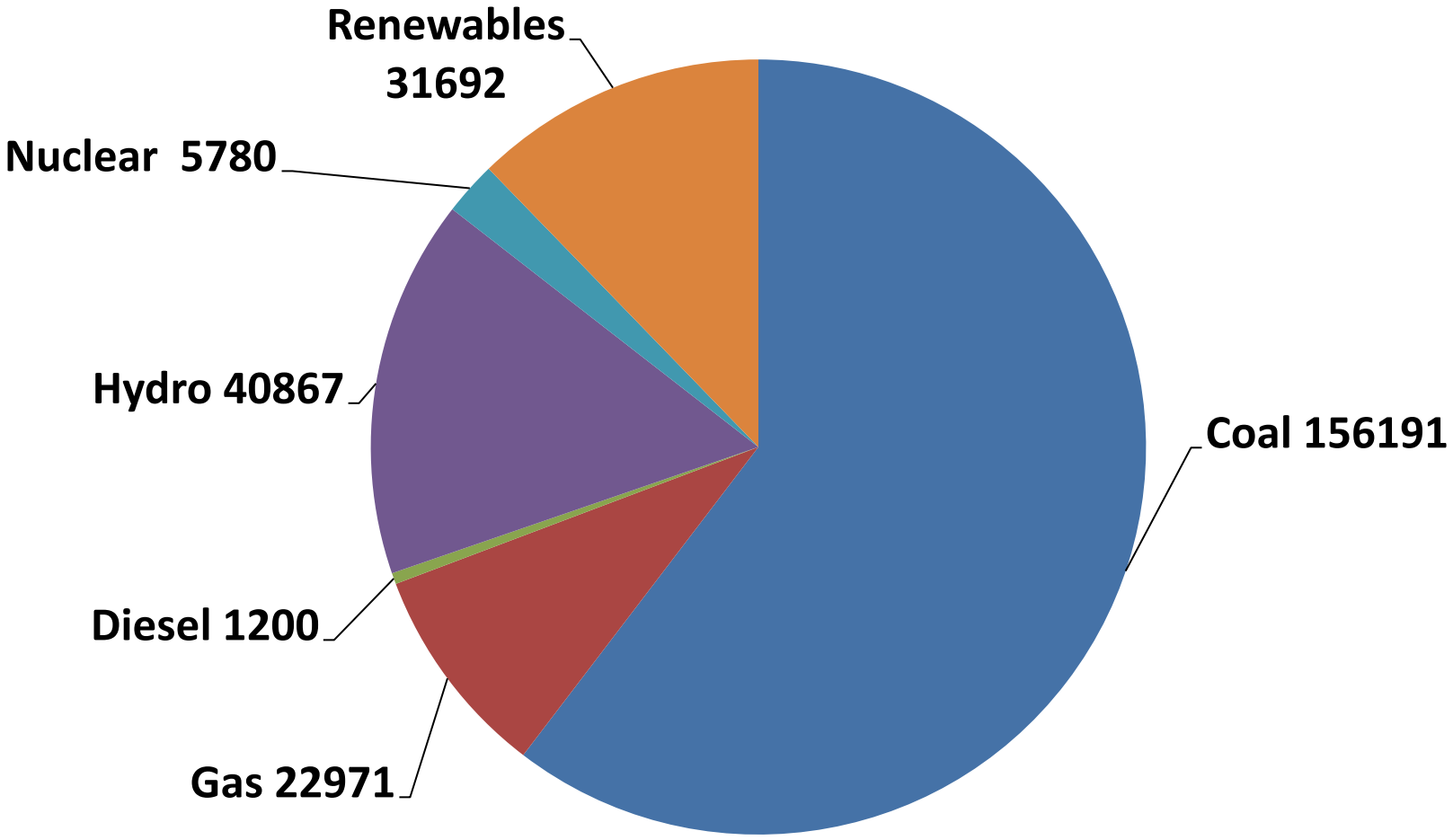
Installed Capacity (MW)



as on January 31, 2015, 258701 MW

India's immediate target: Nuclear power capacity addition in next two decades

- To increase share of nuclear energy to about 10% of total electricity in next two decades (closer to the current world average)

- To create a fissile inventory base from where rapid growth is achievable through implementation of the Three stage programme
  – ultimately attaining long term energy security.

Why Nuclear

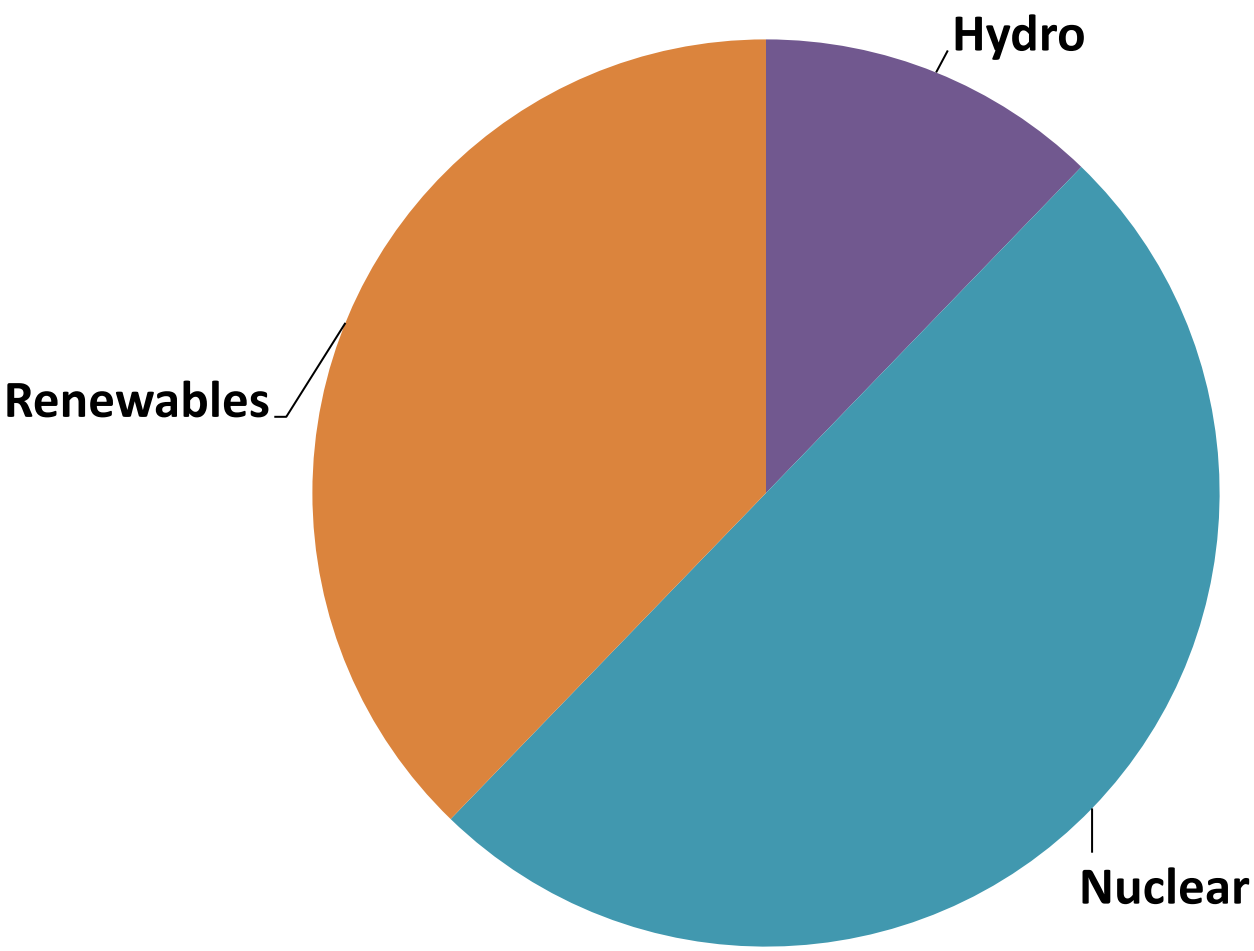
Nuclear Power

- *offers* a potential system for energy security lasting a few hundred years, without generating green house gases.

- is a proven and dependable base-load option.

- ***requires highest priority to be given to safety in all stages of its life cycle from design to decommissioning.***

Could be on January 31, 2051



Objective of Indian Nuclear Power Programme

- Utilisation of both fissile & fertile components of Uranium
- Thorium utilisation
- Sustainability

Fuel cycle & sustainability

Important considerations for sustainability:

Environment

- Clean energy

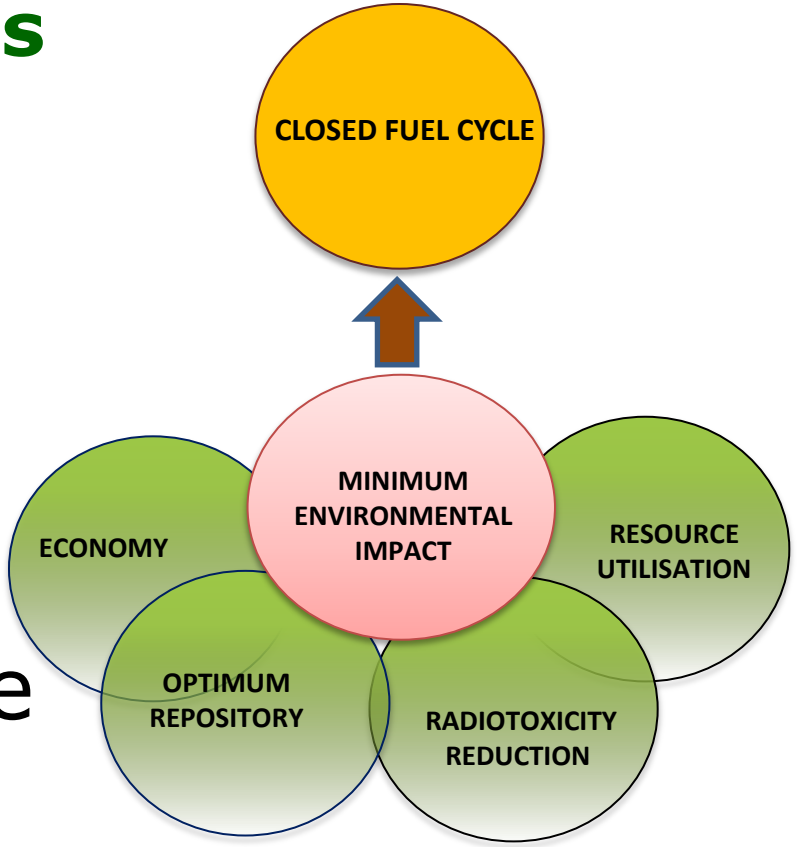
Resources

- Fissile material
- Fertile material

Long lived nuclear waste reduction

Safety and security

Economy



Homi Bhabha's vision

The three stage nuclear power programme of India

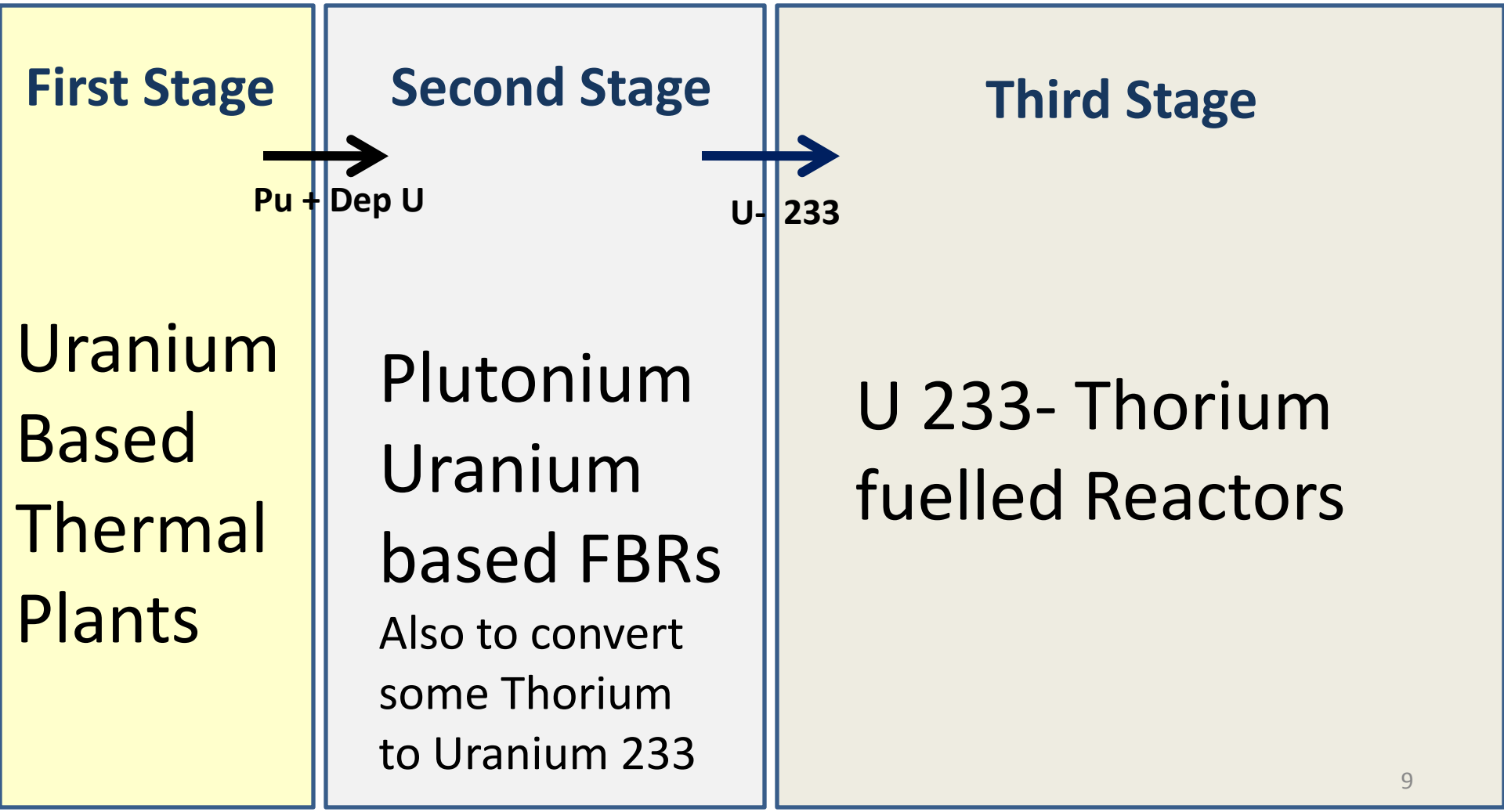
First stage : burning U^{235} and generating Pu^{239}

Second stage : burning Pu^{239} and capacity enhancement, generating U^{233}

Third stage : operating U^{233} -Th cycle

Second United Nations Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958

The Three Stages of the Indian Nuclear Programme



The First Stage of the Indian Nuclear Programme- operation

First Stage

Uranium Based Thermal Plants

21 reactor units are in operation

Comprising of

of PHWRs	16	Units 220 MWe
	2	Units 540 Mwe
BWRs	2	Units 160 Mwe
VVER	1	1000MWe

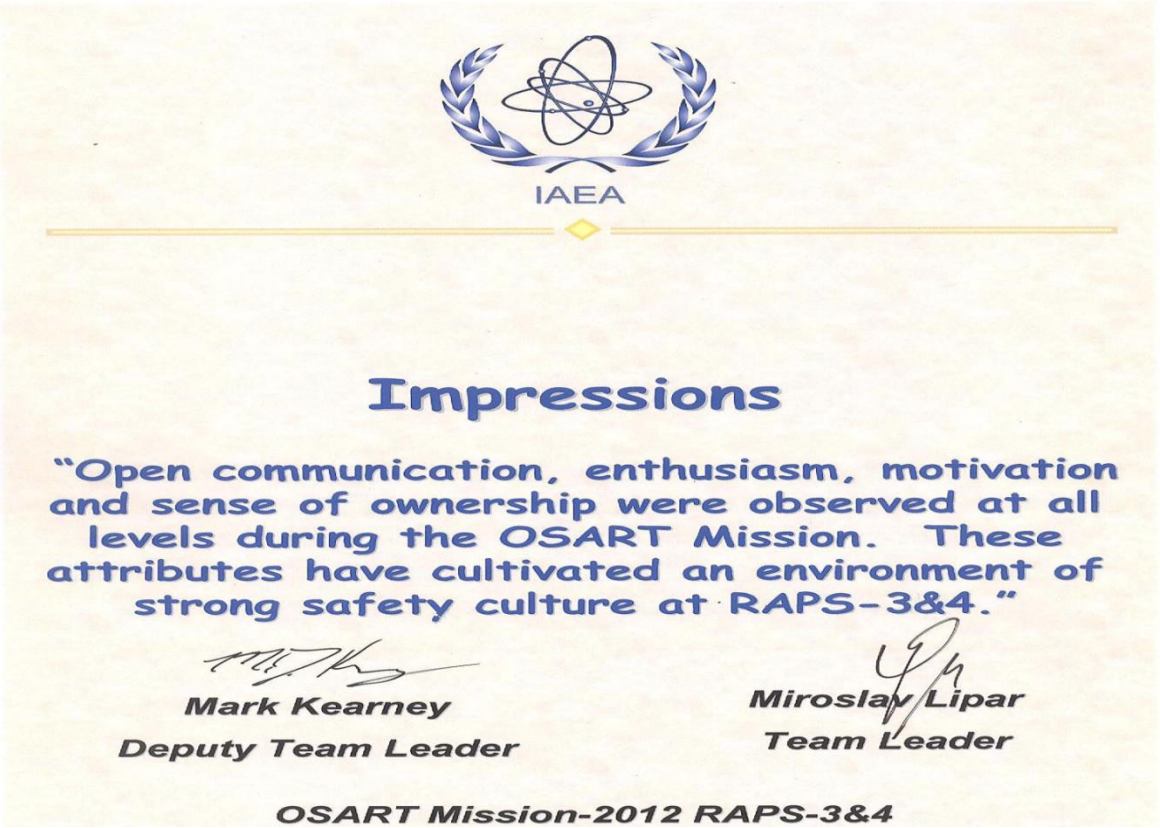
Post-Fukushima: Major actions taken in India

- Review of Safety of existing reactors by six task Forces for each technology by utility (NPCIL) and a committee constituted by regulator in India (AERB) - found sufficient margins & design provisions in Indian NPPs to withstand extreme natural events. Improvements suggested. Reports in public domain.
- Accord of statutory (*de jure* independence) status to the regulators - NSRA Bill introduced in Parliament
- Review of Regulatory Codes and Guides post Fukushima is ongoing. An important AERB Safety code revised recently is 'Site Evaluation Of Nuclear Facilities' . A Safety code 'Design of Light Water Reactor Based Nuclear Power Plants', has been issued.
- Further strengthening of Emergency Preparedness - underway.
- Instituted massive Public Outreach Programme

OSART Review of RAPS 3&4

Noted series of good safety practices at the station to be shared by IAEA with global nuclear industry. Examples:

- Safety culture that cultivates constructive work environment, sense of accountability and opportunities for skill enhancement
- Public Awareness Programme
- Management of Training and Authorisation
- Testing facilities and use of mock-ups to improve quality



The First Stage of the Indian Nuclear Programme- Projects

First Stage

Uranium Based Thermal Plants

4 reactor units of 700 MWe capacity each under construction.

1 unit of VVER under final steps to fuel loading

Construction of 2 units of 700 MWe PHWRs and
2 Units of 1000MWe VVERs to start this year.

Important priorities

- Continue PHWR programme
  - More installation sites

- Addition through deployment of LWRs
  - LWRs of 1000+ MW capacity based on foreign technical cooperation
  - Developing indigenous LWR

Nuclear Capacity Buildup

- **Present Capacity : 5780 MW**

- **By 2017 on completion of reactors under construction : 10080 MW**

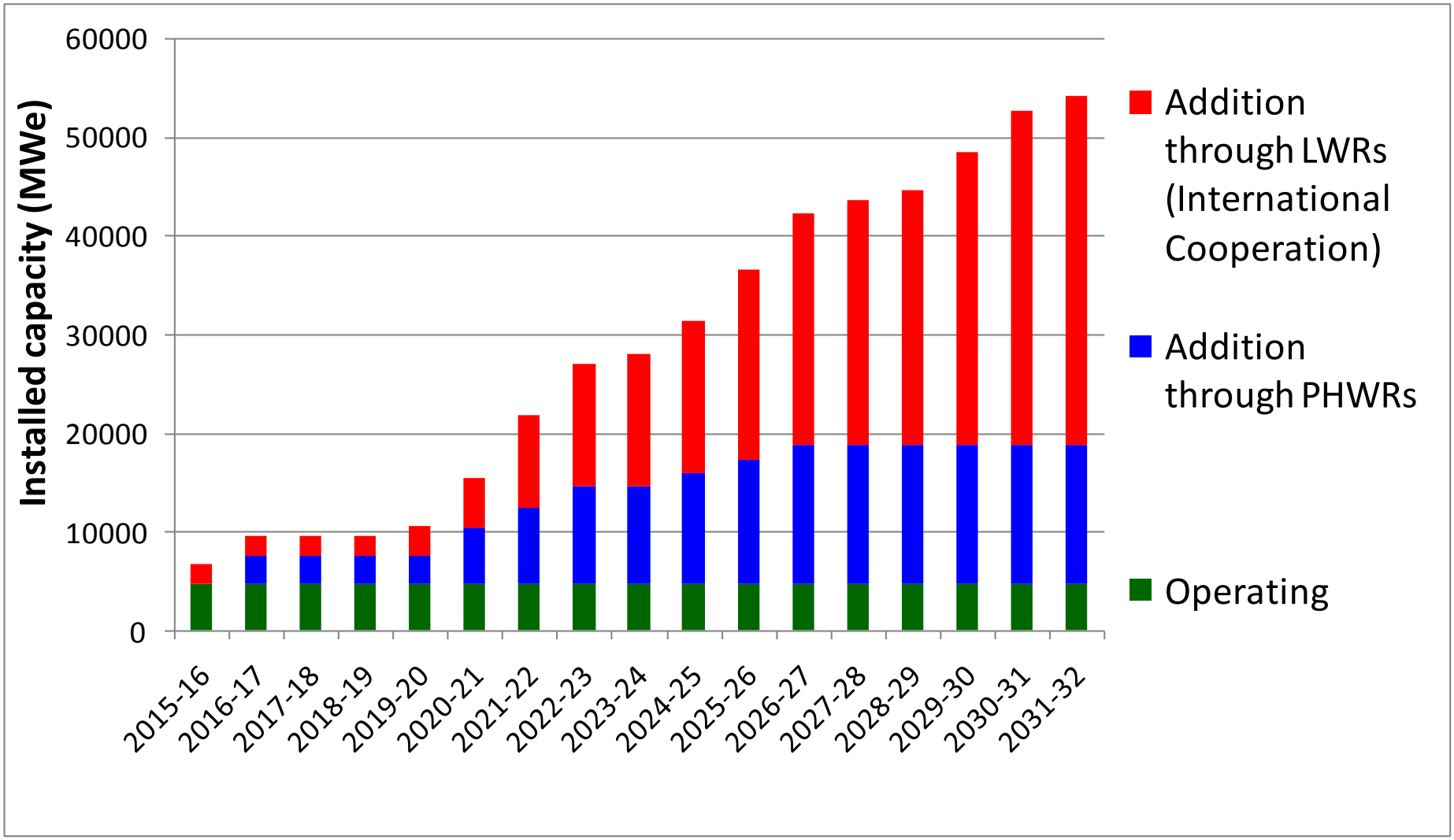
- **On completion of new launches planned by 2021-22 : 27080 MW**

- **By 2032 : 48000 MW - 63000 MW**

  (By a mix of indigenous PHWRs & FBRs and LWRs based on foreign technical cooperation)

- **Beyond 2032, capacity addition based on FBRs and thorium based reactors**

Capacity addition through PHWRs and LWRs: 2000-2500 MWe per year during period 2020-2032



Constraints Experienced in Recent Time

- Public perception following Fukushima.
- Process of acquiring land for new projects.
- Civil liability for nuclear damage act.

The Second Stage of the Indian Nuclear Programme

First Stage

Uranium Based Thermal Plants

→ **Pu + Dep U**

Second Stage

Plutonium Uranium based FBRs

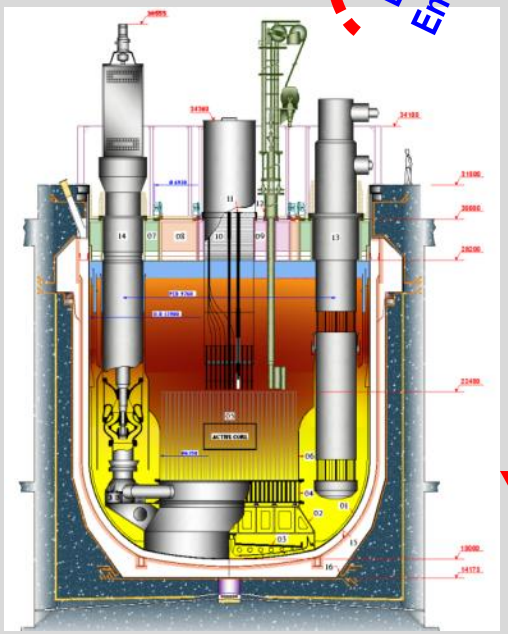
Also to convert some Thorium to Uranium 233

- *FBRs permit Effective Utilization of Uranium Resources*
- *High thermodynamic efficiency (high steam temperature).*
- *A fast reactor is 'flexible" in the sense that, it can be used as breeder or burner or sustainable reactor.*
- *It is possible to transmute MA in to short lived isotopes in a FBR, For a reduced burden on a deep geological storage*

Development Plan for FBRs

- Proven Prototype Concepts
- Design, Mfg. and Safety review Experience

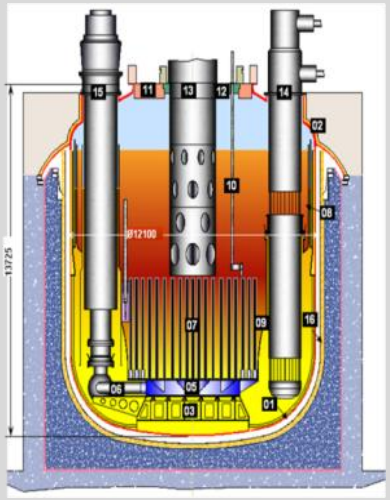
Improved Economics and Enhanced Safety



FBR - 500 MWe
MOX , Pool type, Indigenous
First 500 MWe unit final stages of Commissioning
Expected criticality End 2015

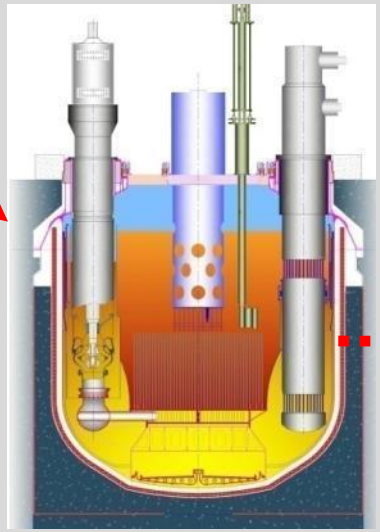
Operational Experience

FBTR,40MWt, 13.5MWe,
Loop type(Pu-U)Cfuel, in operation since 1985



FBR-600 MWe
MOX, Pool, Twin units, Indigenous

Adopting Innovative Features



Metal fuel Demonstration Fast Reactor – 500 MWe
Same reactor concepts, Indigenous

MFBR
1000 MWe

The Third Stage of the Indian Nuclear Programme

First Stage

Uranium Based Thermal Plants

Pu + Dep U

Second Stage

Plutonium Uranium based FBRs

Also to convert some Thorium to Uranium 233

U- 233

Third Stage

U 233-Thorium fuelled Reactors

Nuclear Reactor Systems for thorium utilisation

- AHWR & its Variants
- Utilisation of Thorium in Fast Reactors
- High temperature reactors and their utilisation for hydrogen production
- Molten salt reactors

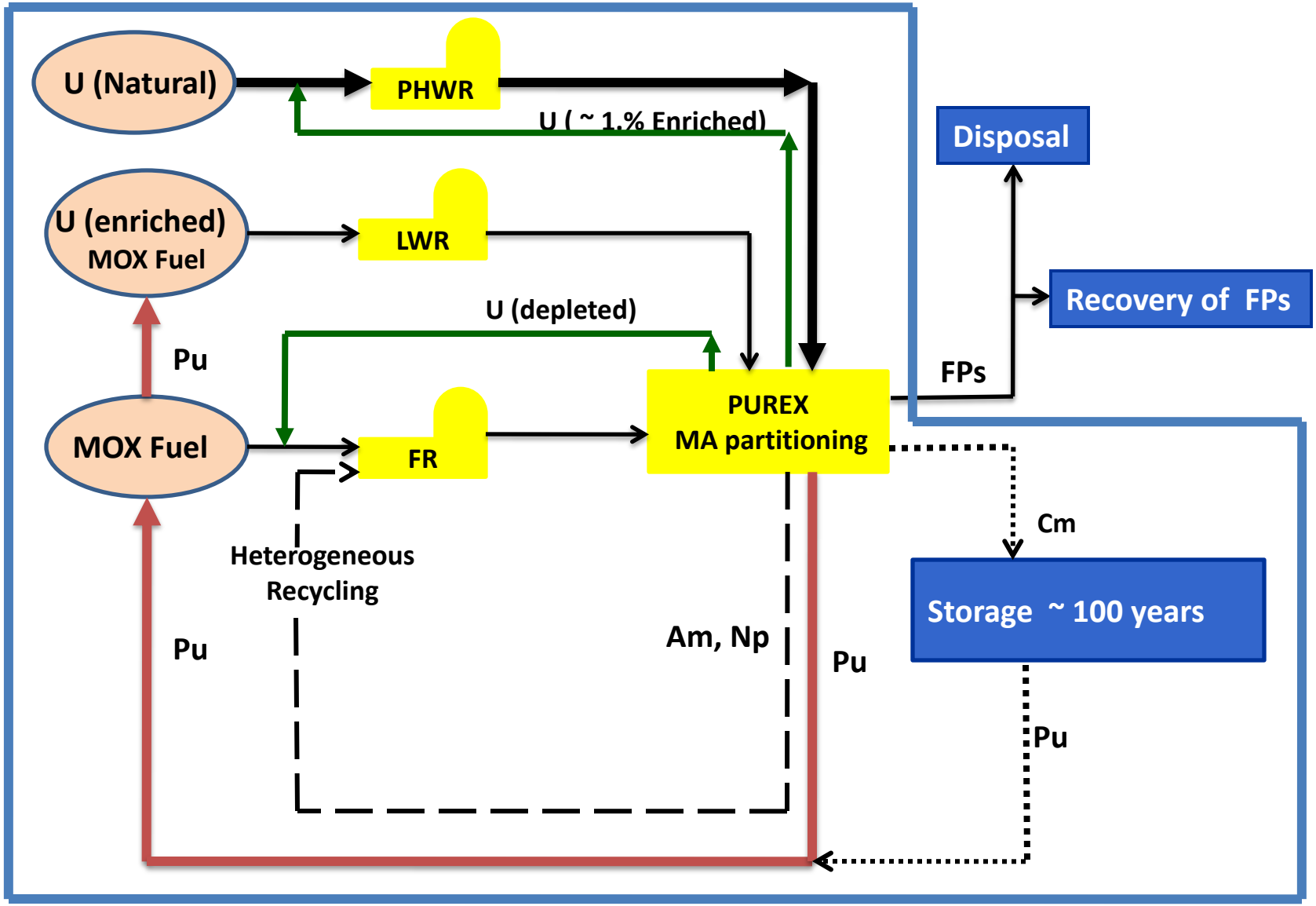
Accelerator Driven Systems

Fuel cycle technologies and requirements of remotisation

Partitioning and transmutation of waste

Evolving Fuel Cycle

(Partitioning and transmutation of waste)



Why Nuclear

- *The climate issue is global.*
- *it calls urgently for united action.*

Nuclear, a proven base-load power source, is part of solution to mitigate global warming concerns.

A united action by all to provide safe and secure nuclear technologies is necessary.

Thank you for your kind attention