



NUCLEAR POWER IN INDIA

K. Koshy

Head NRRF

Nuclear Power Corporation of India Limited (NPCIL)

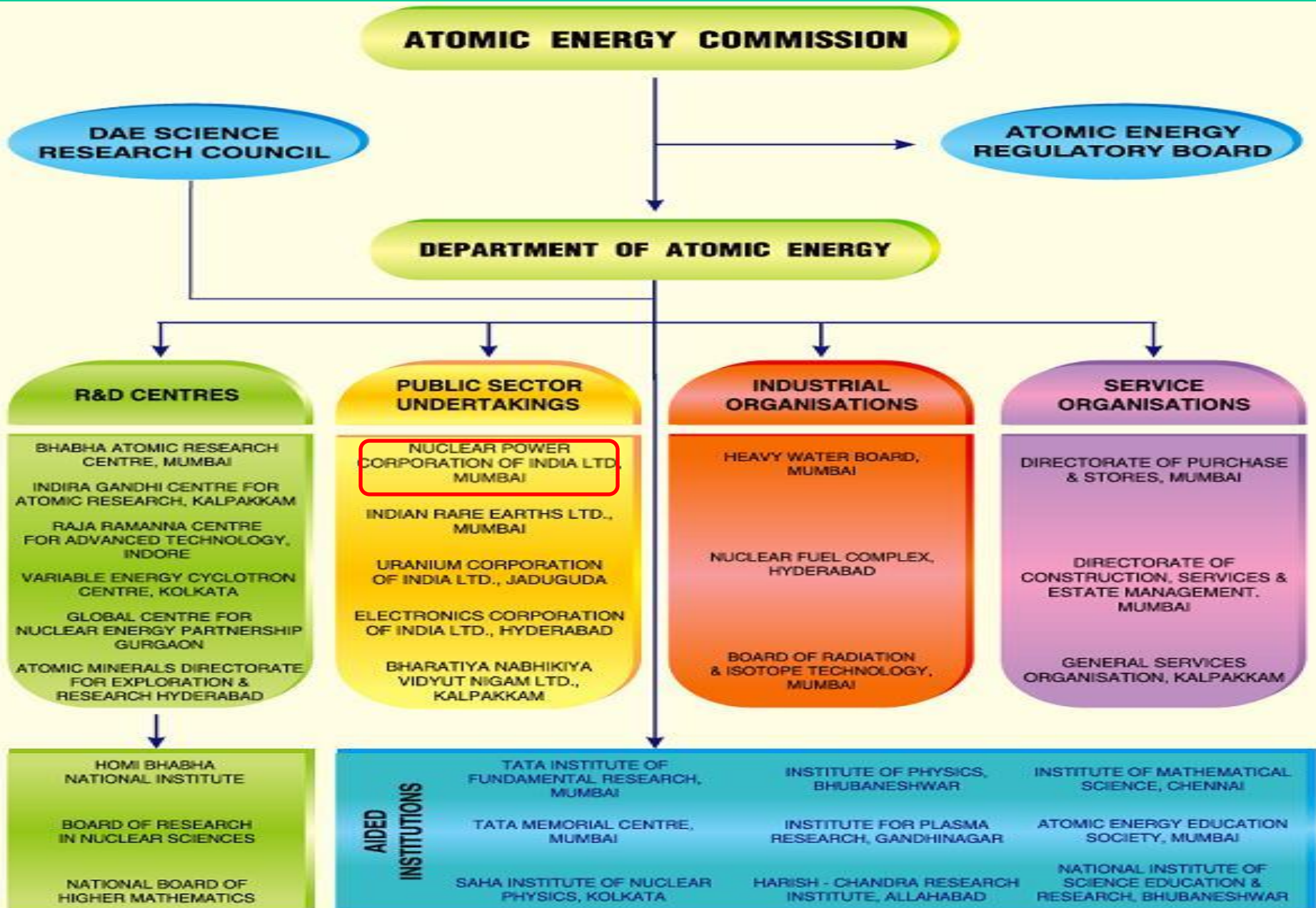
INDIA



NUCLEAR POWER CORPORATION OF INDIA LTD. (NPCIL)

**A PUBLIC SECTOR ENTERPRISE
UNDER THE ADMINISTRATIVE CONTROL
OF
DEPARTMENT OF ATOMIC ENERGY**

Organisation



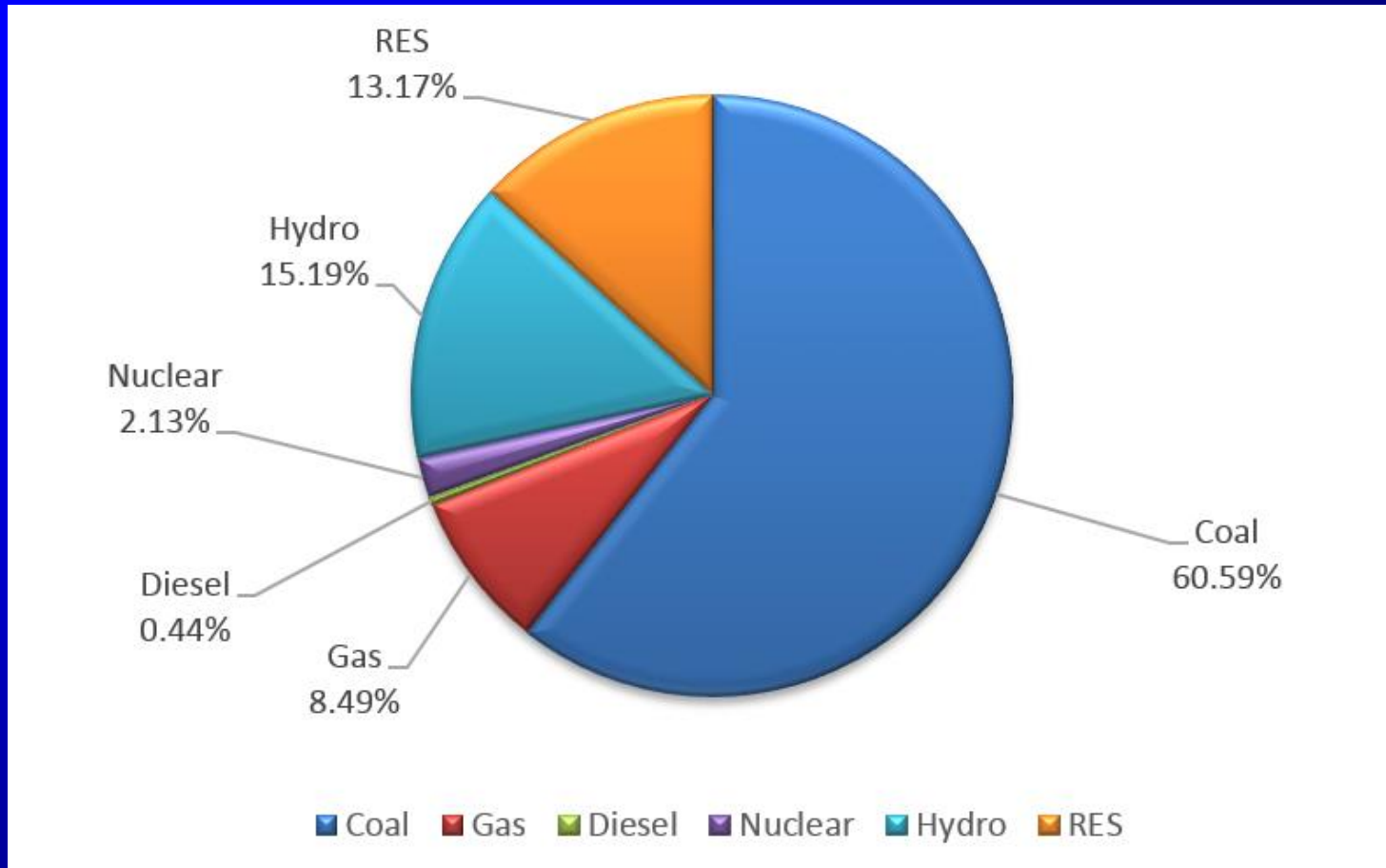
NPCIL - MANY COMPANIES IN ONE

- Siting
- Design
- Construction
- Commissioning
- Operation & Maintenance
- R&M & Upgrades
- Life Extension
- Waste Management



INDIAN ENERGY SCENARIO

Fuel Shares in Electricity Generation



INSTALLED CAPACITY 271722.17 MW
(As on 31.03.2015)

Demand Projections

(based on 8% GDP Growth)

Year	Energy Requirement (BUs)	Peak demand (GW)	Required Installed Capacity (GW)
2017	1524	226	306
2022	2118	323	425
2027	2866	437	575
2032	3880	532	778

Source: Integrated Energy Policy, Planning Commission, Gol

By 2050, the required Installed Capacity is estimated to be 1300 GW

India's Energy Resource Base

	Amount	Electricity Potential [□] GWe-yr
Coal	38-BT	7614
Hydrocarbon	12 –BT [#]	5,833
Uranium-Metal	61,000 -T	
- In PHWR		328
- In Fast Breeders		42,231
Thorium-Metal (In Breeders)	2,25,000 –T	155,502
Hydro	150 -GWe	69 GWe-yr / yr
Non-conv. Ren.	100 -GWe	33 GWe-yr / yr

□ Assuming entire resource is used for generating electricity.

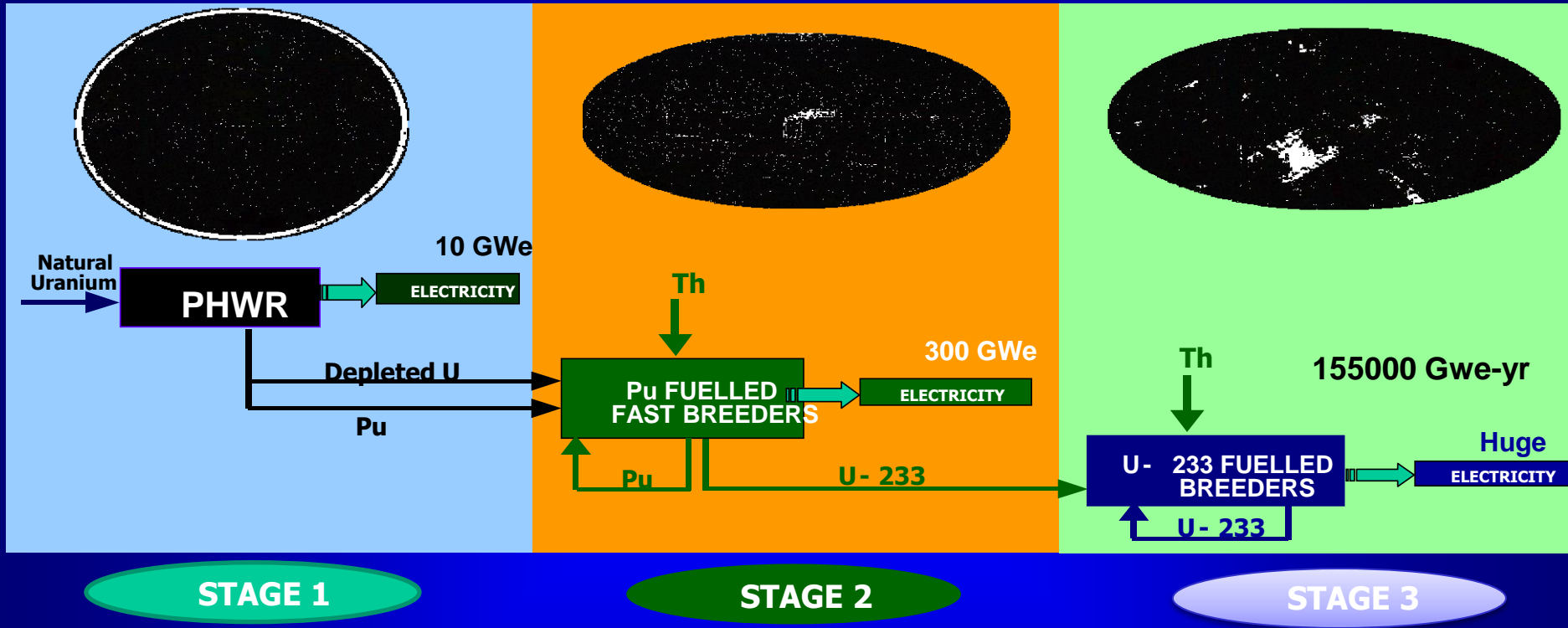
Currently known resources (including coal bed methane) are 3 BT.

Meeting the Demand

- **Optimal Deployment of all sources**
- **Emphasis on Nuclear Power for long term energy security & sustainability**
- **Setting up Nuclear Power Reactors based on**
 - **Indigenous Nuclear Power Programme**
 - **International cooperation**

Indian Nuclear Power Programme

Indigenous Three-stage Programme

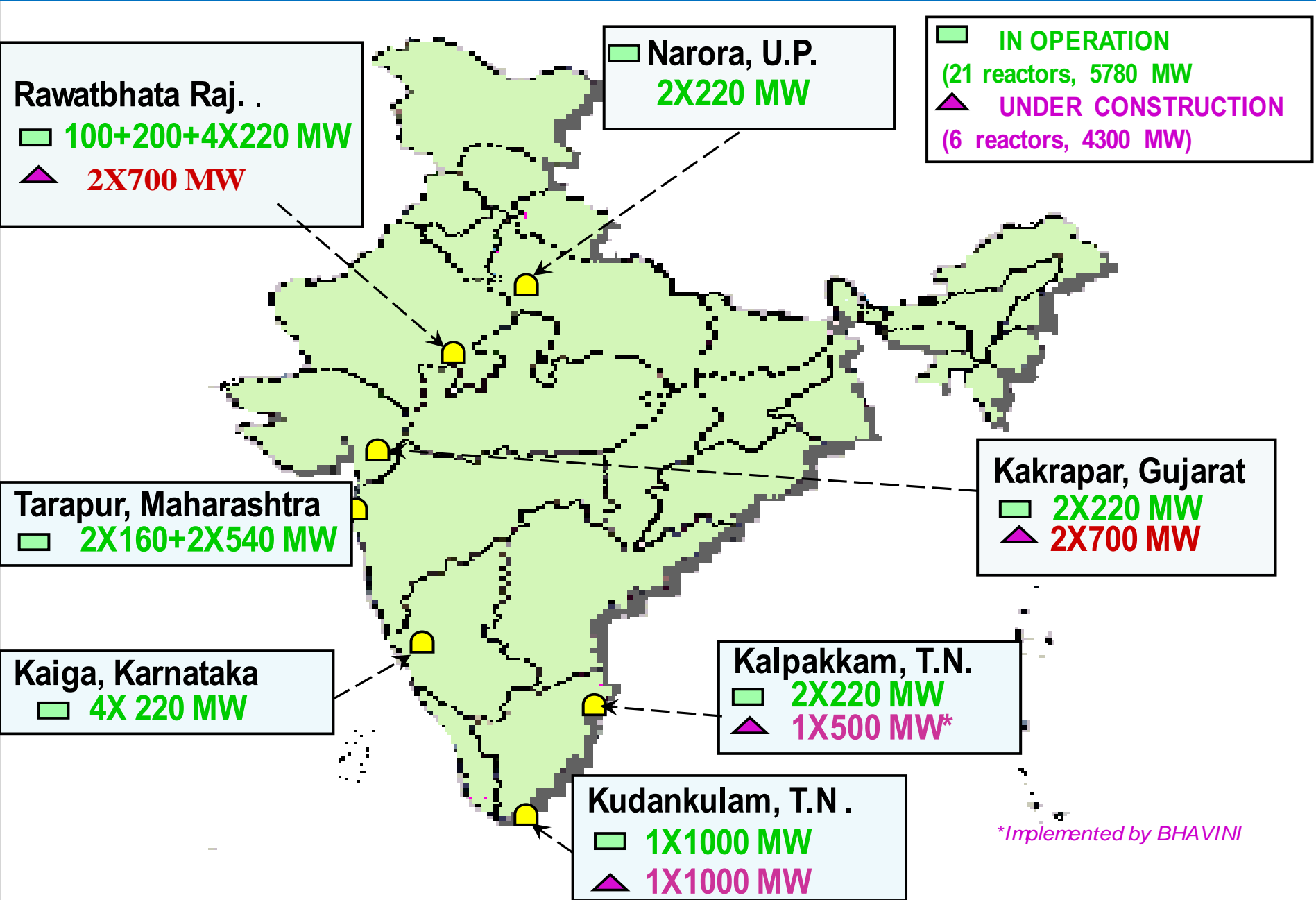


Additionalities

(LWRs with International cooperation)



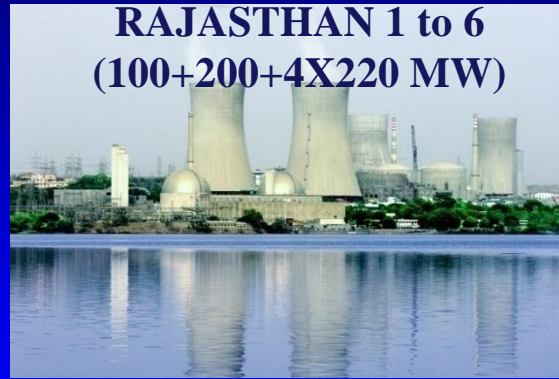
Nuclear power plants in Operation & under Construction



Operating Nuclear Power Plants in India



TARAPUR 1&2
(2X160MW)



RAJASTHAN 1 to 6
(100+200+4X220 MW)



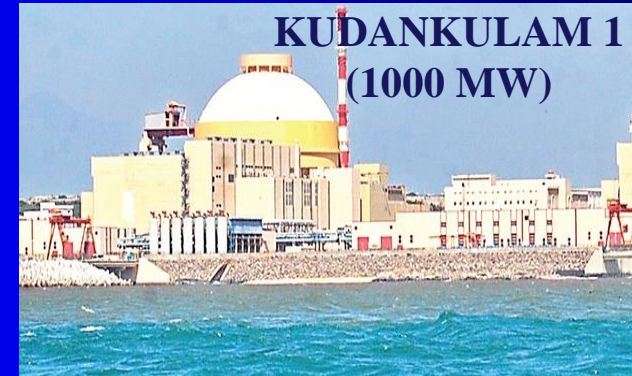
MADRAS 1&2
(2X220 MW)



TARAPUR 3&4
(2X540 MW)

5780 MW

3380 MW under IAEA Safeguards



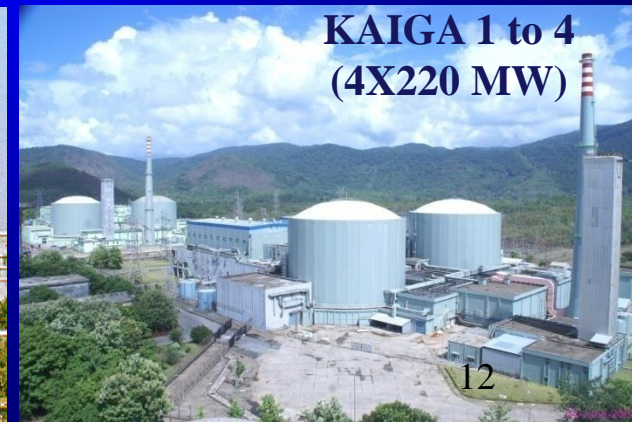
KUDANKULAM 1
(1000 MW)



NARORA 1&2
(2X220 MW)



KAKRAPAR 1&2
(2X220 MW)



KAIGA 1 to 4
(4X220 MW)

Experience in Construction of NPPs

Construction of Nuclear Power Plants in India remained alive over the last 45 years.

Simultaneous construction of 6 Reactors.

Vendors specializing in manufacture and supply of exacting standards equipment and supplies are developed .

Reactors under Commissioning

KKNPP - 2 (1000 MW)

Expected completion - 2015-16



Reactors under Construction



KAPP 3&4 (2X700MW)

*Physical Progress – 64.6%
(KAPP 3 – 71.0%, KAPP 4 – 57.26%)*

Expected Completion 2017 / 18

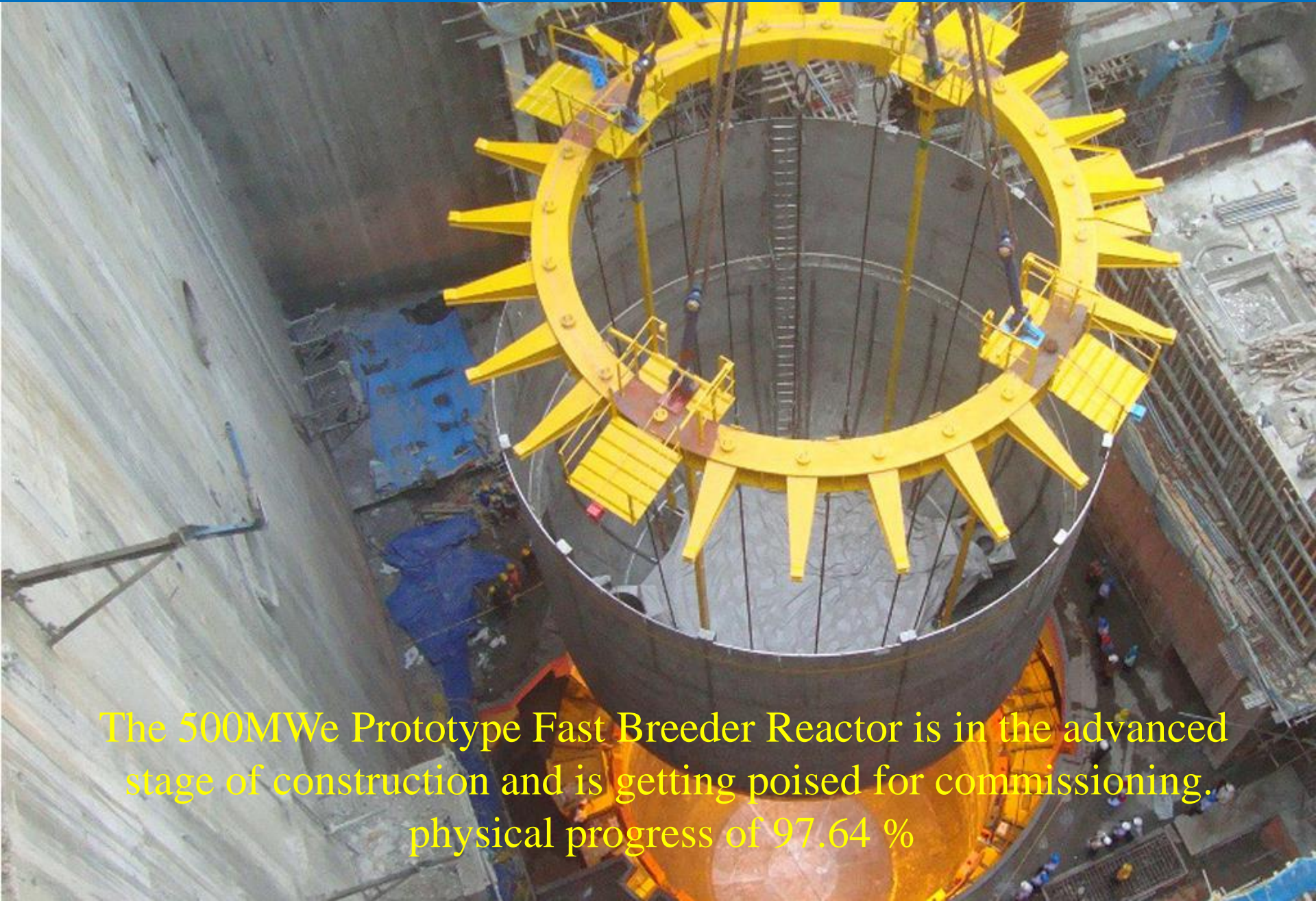
RAPP 7&8 (2X700MW)

*Physical Progress – 48.2%
(RAPP 7 – 53.42, RAPP 8 – 42.18%)*

Expected Completion 2018 / 2019

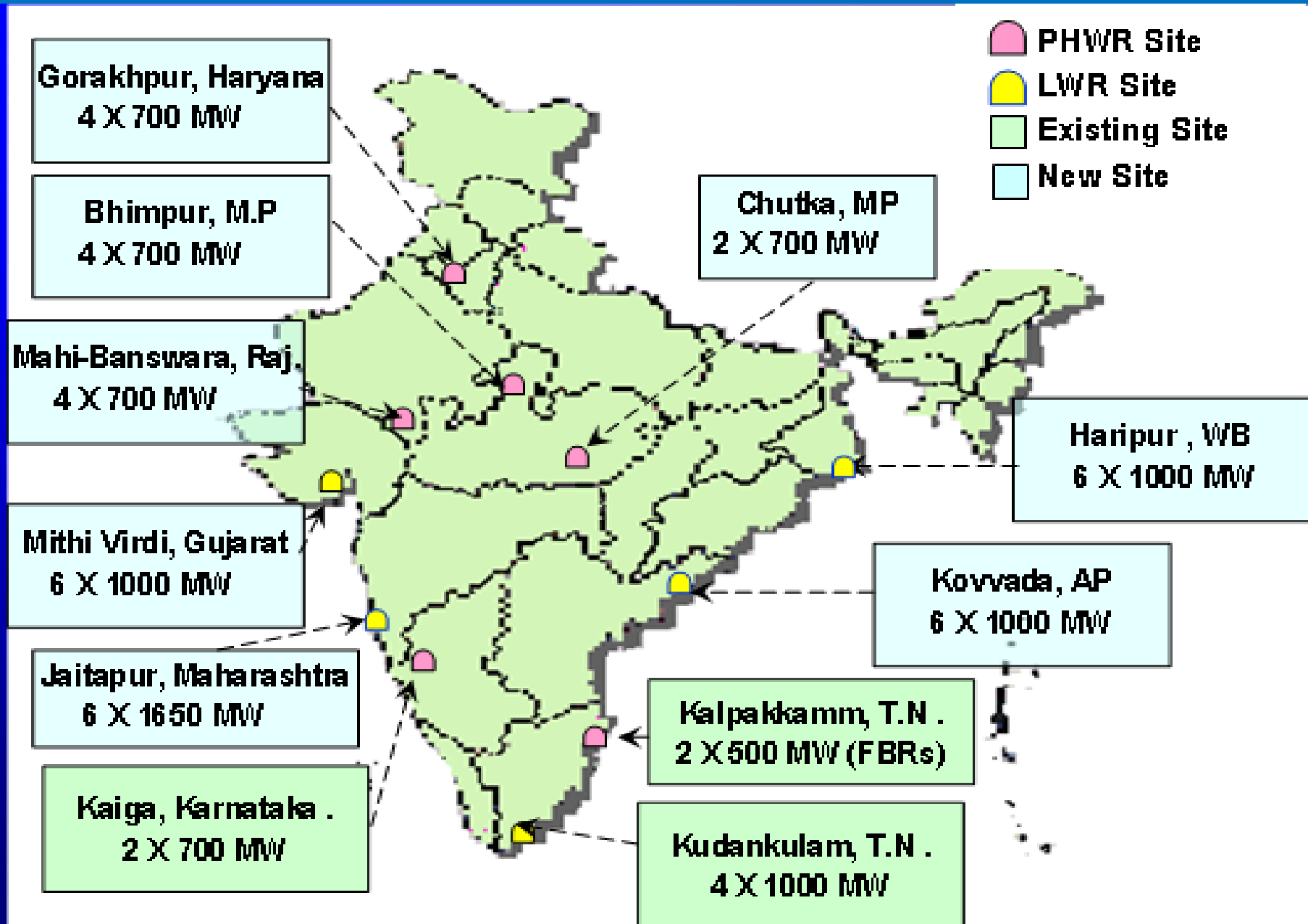


Bharatiya Nabhikiya Vidyut Nigam Limited



The 500MWe Prototype Fast Breeder Reactor is in the advanced stage of construction and is getting poised for commissioning.
physical progress of 97.64 %

Sites for Future Projects



Projects to be implemented on twin unit basis, in phases at a site

Planned New Starts by 2017

Project	Location	Capacity (MW)
Indigenous Reactors		
GHAVP 1&2	Gorakhpur, Haryana	2 x 700
CMAPP 1&2	Chutka, Madhya Pradesh	2 x 700
Mahi Banswara, 1&2	Mahi Banswara, Rajasthan	2 x 700
Kaiga 5&6	Kaiga, Karnataka	2 x 700
Reactors with Foreign Cooperation		
KKNPP 3&4 (Russian Federation)	Kudankulam, Tamilnadu	2 x 1000
JNPP 1&2 (France)	Jaitapur, Maharashtra	2 x 1650
Kovvada 1&2 (USA)	Kovvada, Andhra Pradesh	2 x 1500
Chhaya Mithi Viridi 1&2 (USA)	Chhaya Mithi Viridi, Gujarat	2 x 1100

GHAVP 1&2 and KKNPP 3&4 accorded financial sanction by the government and are being readied for launch in this year. Pre-project activities are in progress at remaining sites.

Future Plans

Start of Work Pre-Project Activities on

- 8 more indigenous PHWRs of 700 MW each
- 8 LWRs of 1000 MW or larger size based on international cooperation
- 2 Fast Breeder Reactors(500MW)
- To reach 63000 MW by 2032 based on indigenous reactors & LWRs with international cooperation

Considerations for Setting up LWRs

- **Viable Tariff**
- **Progressive Indigenization to optimize Cost**
- **Cooperation between Indian Industries & Foreign Technology Partners**
- **Life time fuel supply guarantees**

Our Experience in setting up LWRs

2 VVERs at Kudankulam (KK 1&2 – 2 X 1000 MW)

1 Unit commissioned and 2nd at advanced stage of commissioning

Implementation Model

Role of Technology Partner

- Design
- Supply of Equipment
- Evaluation of Personnel

Role of NPCIL

Construction
Erection
Commissioning
Training

Training of Personnel

Phase-1 in India

Phase-2 in Russia

Phase-3 in India

: Carried out in Three Phases

: Induction in Nuclear Technology

: Simulator and Technology Specifics

: Commissioning and Systems operation

Evaluation by Technology Partners

Tour To KKNPP

KK 1 – 100%

- Commercial operation started in Dec 2014**
- Cumulative Generation so far - 6500 MUUs**

KK 2 – 98.01%

- Hot Run Completed**
- Criticality and synchronization to follow**

A few glimpses

KKNPP



THEN

NOW



Technological Partnership Endeavour Kudankulam Nuclear Power Project 1&2



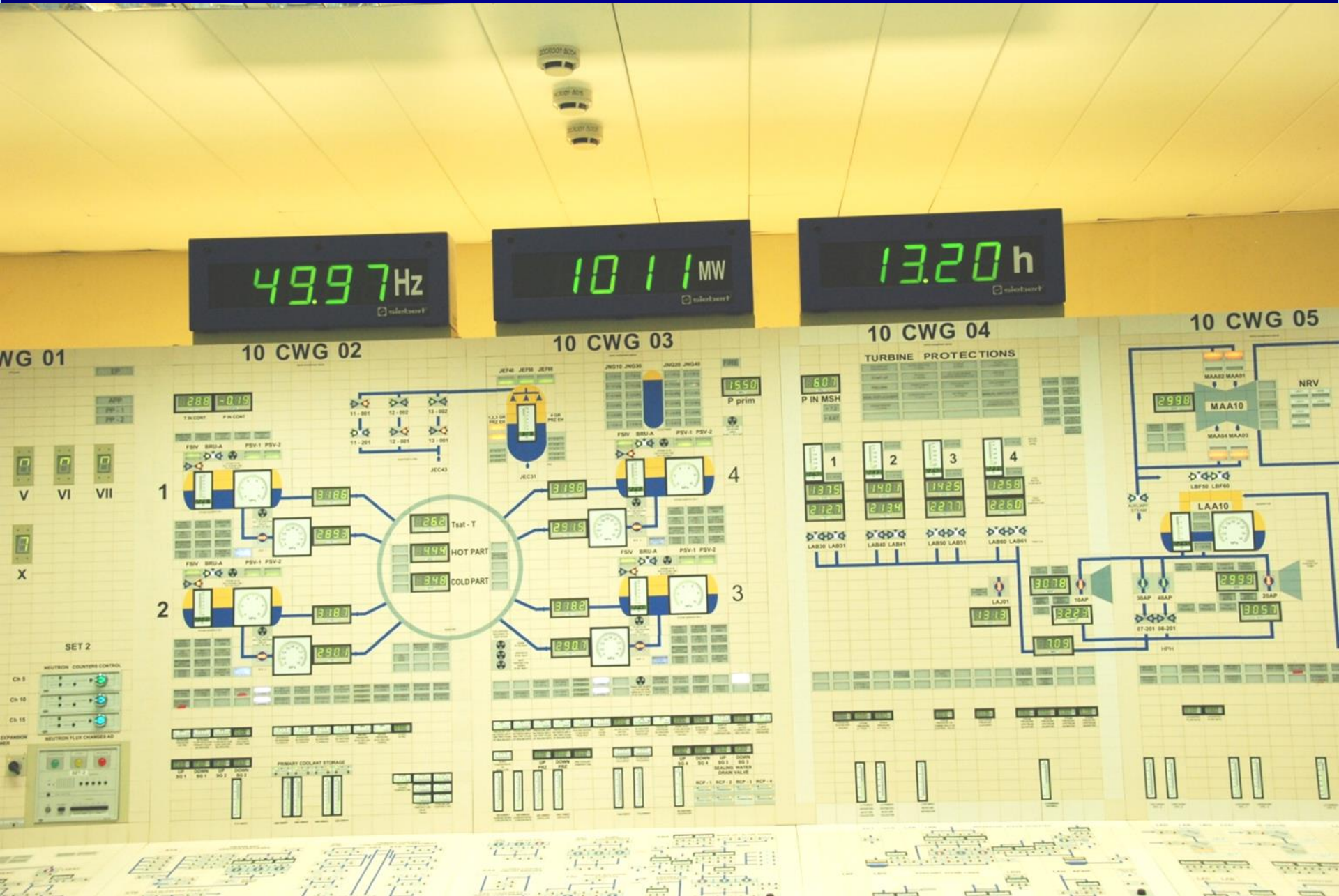
KK 1&2 Panoramic View



Unit-1: Criticality of Reactor on 13.7.2013



7 JUN 2014: KK-1 reached 1000MWe Power



Night view from the Sea



Intake & Break water Dyke Structure



View from sea



View from North



View of Turbine Generator



Control Room



Desalination Plant



View of KKNPP 3 to 4 area from KKNPP 1&2



KKNPP 3 to 4 AREA

Visit of Dignitaries



Visit of Dignitaries



Visit of Dignitaries



Preparedness for large Capacity Addition

- **Sites made available – Pre project activities in progress**
- **Augmentation of existing capacity & capability of Indian industry initiated**
 - Joint Ventures / Consortia between Indian and foreign companies
 - Companies setting up manufacturing facilities being facilitated
 - Joint Venture Company between NPCIL & Indian companies
- **Structured development of human resources**

The experience with the Training model adopted for KKNPP has been good. Same model is planned to be followed for each new technology.

Supply Chain

- **Nuclear Island (NI)**
- **Balance of Nuclear Island (BNI)**
- **Conventional Island (CI)**
- **Balance of Conventional Island (BCI)**
- **Balance of Plant (BOP)**

India - Future Nuclear Industry Hub

- **Country having an alive small and Medium reactor technology with excellent safety and performance record**
- **Cost advantage with technology expertise of Indian industry**
- **Availability of Large pool of trained Human Resource**

Conclusion

- **India has a robust Nuclear Power Programme**
- **Stage is set for nuclear power capacity expansion to meet its huge electricity demand through indigenous technologies and with international cooperation**
- **India poised to be the future global nuclear industry hub**

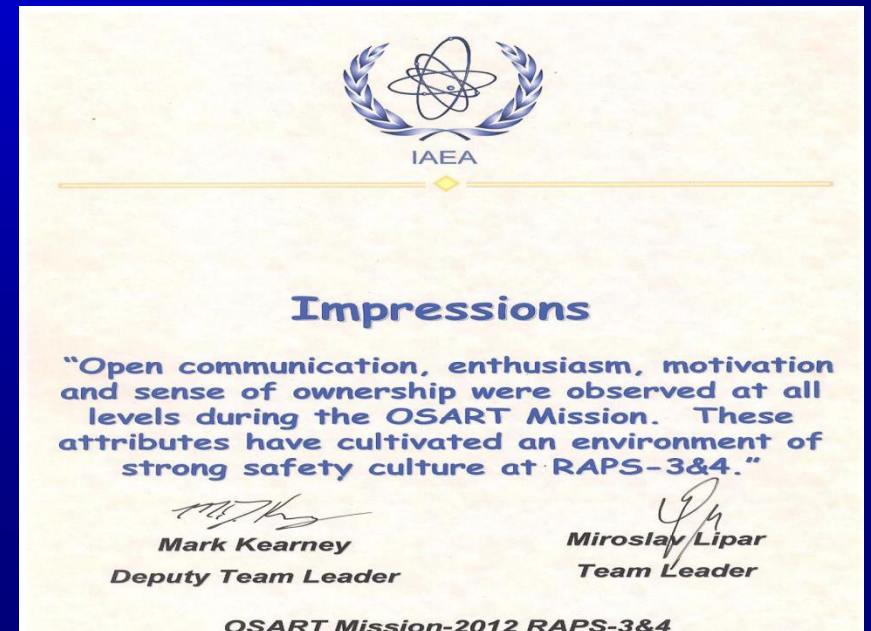
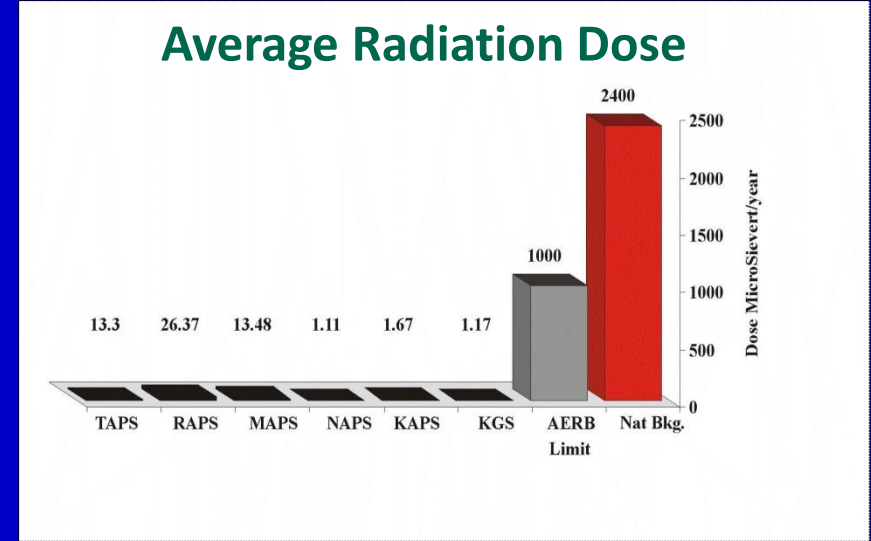
NPCIL Performance

Performance

- Excellent Safety Record
 - No accident or incident of release of radioactivity beyond stipulated limits in public domain
 - Radiation dose around nuclear power plants a negligible fraction of natural background
- Excellent Safety Culture
- High Plant Load Factors and Availability Factors, long continuous run
- Viable Tariffs
- Environment Protection
- Neighbourhood Inclusion

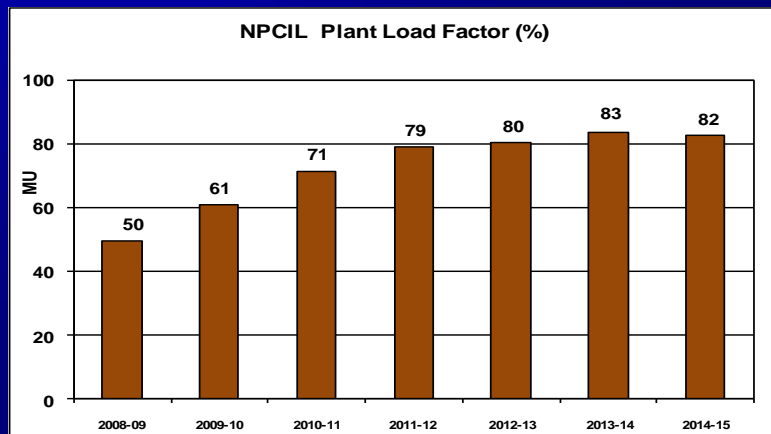
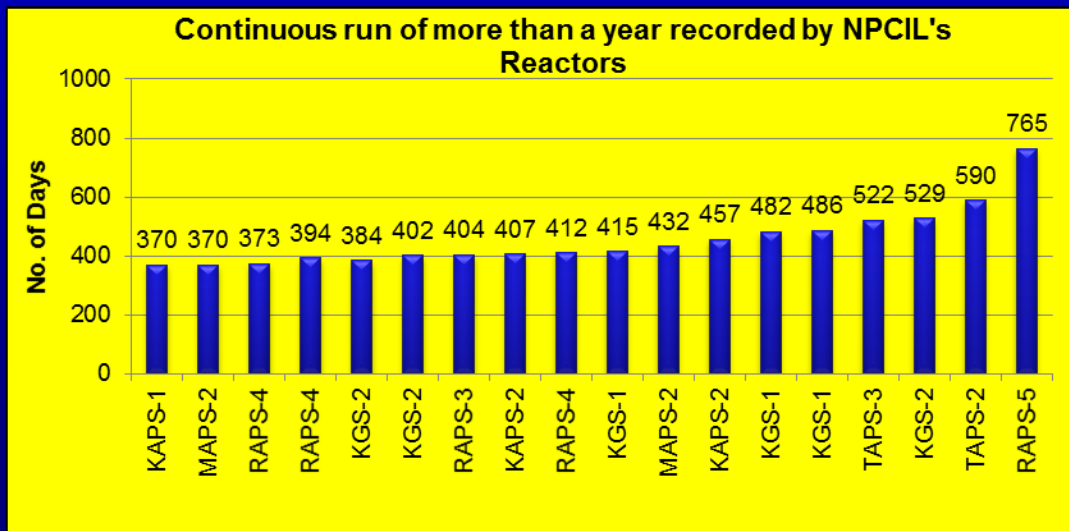
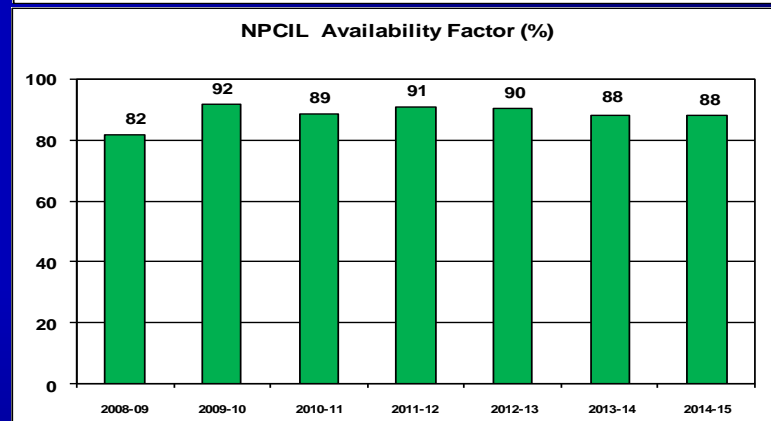
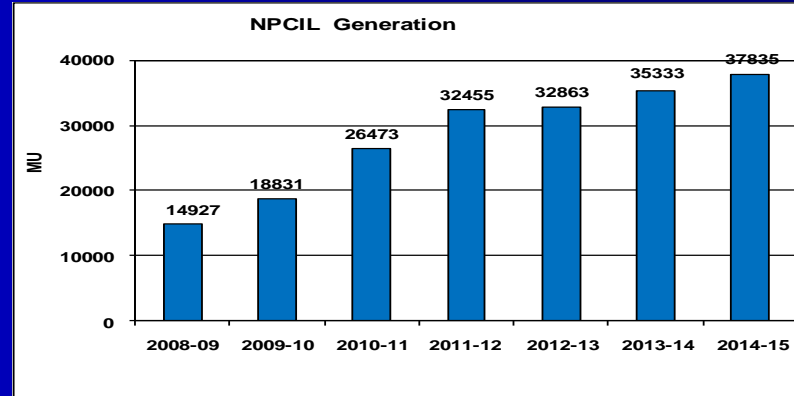
Safety

- **Excellent Safety Record**
 - No accident or incident of release of radioactivity beyond stipulated limits in public domain in over 45 years of operation
 - Radiation dose around nuclear power plants a negligible fraction of natural background
- **Excellent Safety Culture**



Performance - Operation

- **Growing Generation**
- **High Availability Factors**
- **Increasing Plant Load Factors**
- **Long continuous runs**
 - RAPS-5 second longest in the world of 765 days
 - Continuous runs longer a year (365 days) registered 18 times



Neighbourhood Inclusion



Healthcare



Education



Sanitation – Toilets
Swachh Bharat Abhiyaan



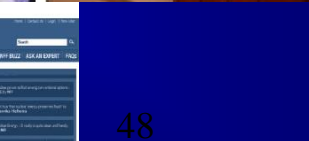
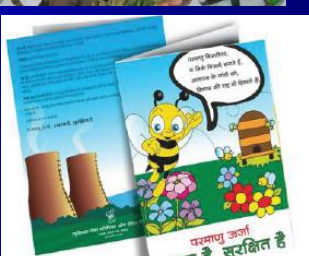
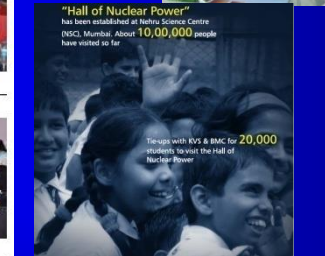
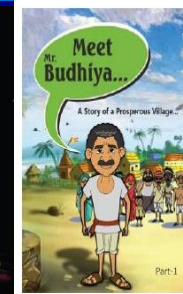
Infrastructure



Skill Development

Public Awareness

- Structured action plan with monitoring mechanism
- Focus on Capacity building, Media, state officials, peoples representatives, students and faculty .
- Partnership with 21 Professional Agencies and Government organizations
- Multipronged Approach
 - Permanent Exhibition Centres
 - Single sheet publications
 - Short films
 - Radio jingles
 - TV Commercials
 - Digital Media – Cinema & Cable TV
 - Comic Books
 - Animation Films
 - Web based Awareness
 - Press Meets
 - Visits to Plants
 - Briefing Opinion makers



Environment Stewardship - *Safety first Environment foremost*



Thank You