The role of state-owned enterprises in the low-carbon energy transition

Moving towards cleaner power generation

…NTPC playing a pivotal role

Presentation by:
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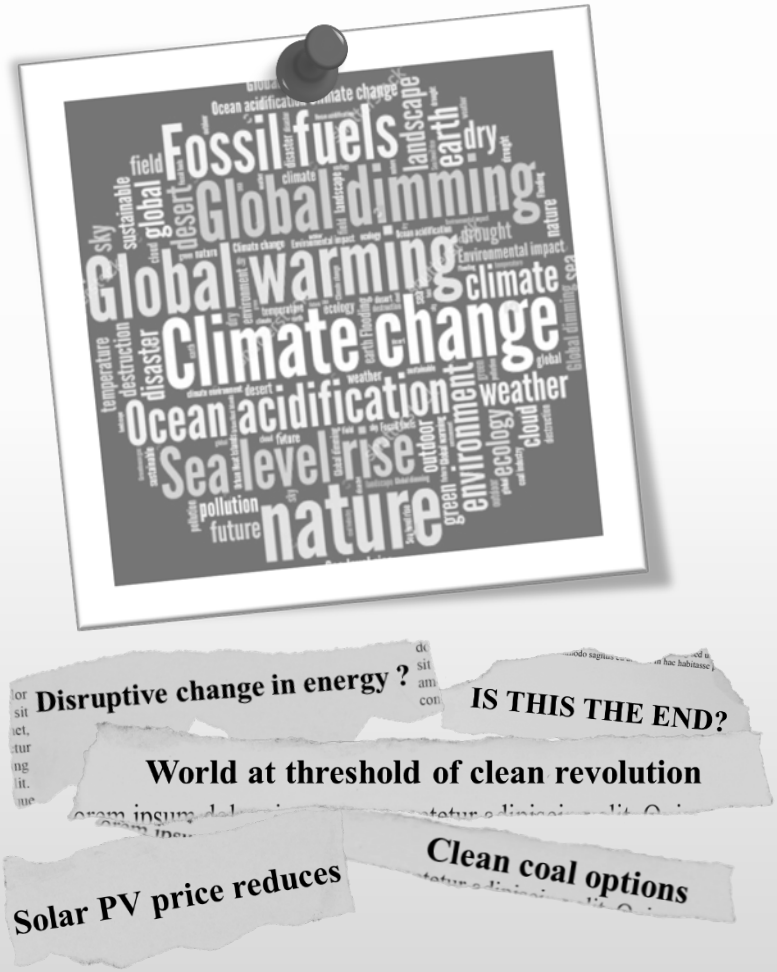
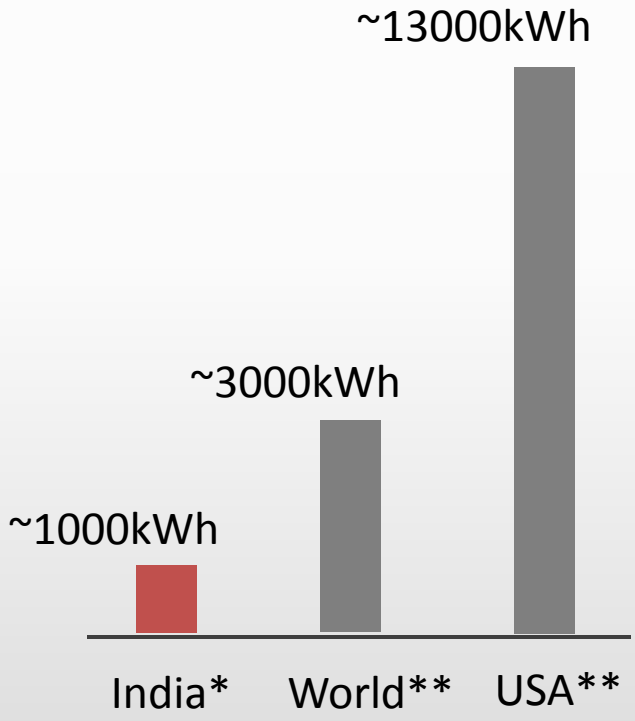
Climate change debate has brought carbon to the centre stage



- COP-21 Paris agreement sets quantifiable target for reduction of global temperature by 1.5° – 2°C
- Advent of INDC(Intended Nationally Determined Contributions) concept with periodic ratcheting up of emission reduction.
- COP-21 Paris agreement establishes requirement of global collaborative R&D

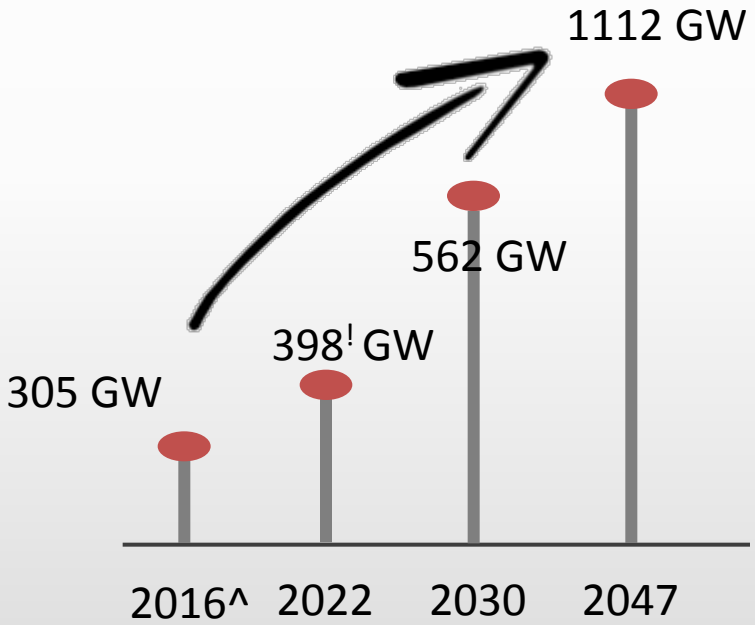
India posed for rapid electricity capacity ramp up

India's per capita power consumption among the lowest in the world…



Source:
* CEA: GROWTH OF ELECTRICITY SECTOR IN INDIA FROM 1947-2015, 2015 value
** IEA: Key World Energy STATISTICS 2014 Data corresponds to year 2012

With High GDP Growth Projections & electrification program the capacity is set to rise rapidly



Source: A Report on Energy Efficiency and Energy Mix in the Indian Energy System (2030) *Using India Energy Security Scenarios, 2047 ,* NITI Aayog | April 2015

! The report in its analyses has not assumed the energy policy announcements of the Government regarding 175 GW target of renewable energy in 2022 which might rise further in the years to come.

^Source CEA installed capacity as on 31.08.2016

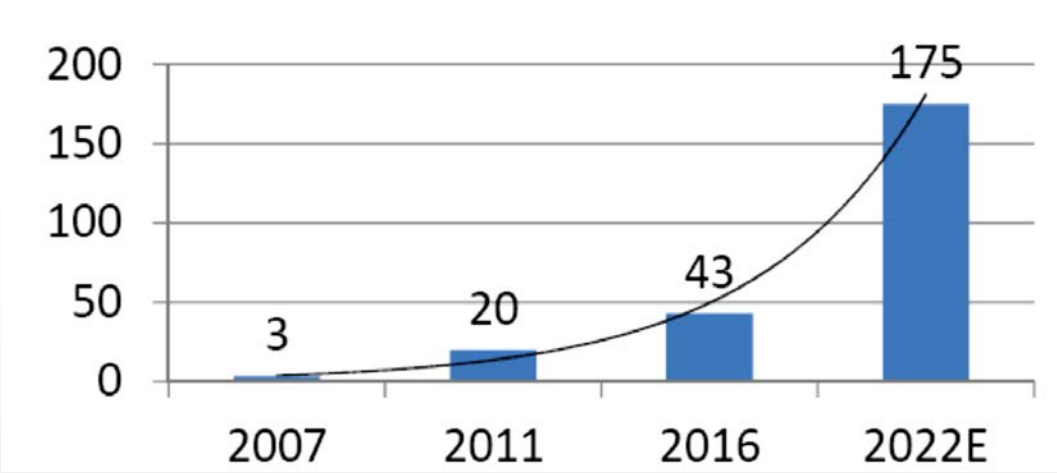
India's INDC

- To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
- To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.

Achieving the INDC targets along with the capacity addition targets call for improvement across the energy spectrum from source to end use. Power generation is on key target area for achieving the intended reductions.

India’s big renewables push

India’s Renewables (installed Capacity over the years in GW Actual and Projected)

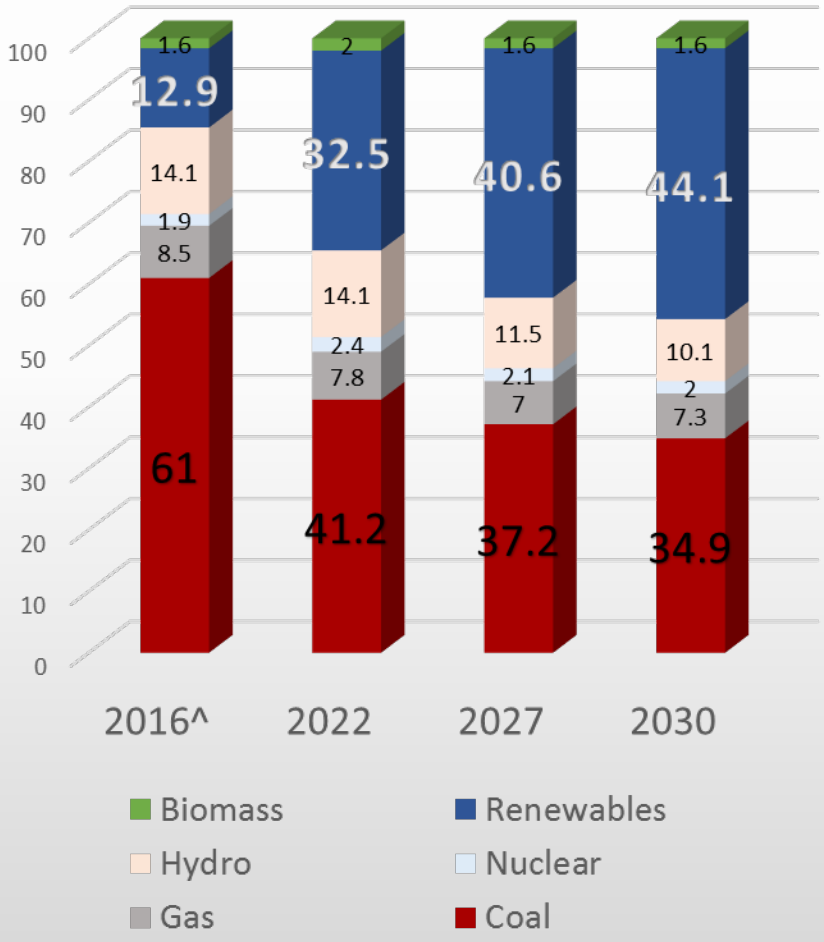


175,000 MW RE by 2022

Wind	60,000 MW
Solar	100,000 MW
Biomass	10,000 MW
Small Hydro	5,000 MW

Coal to remain integral to India's energy security

India's Electricity Mix Projection*



Growth Drivers for Coal Based TPS

- Abundant coal reserves, vital for energy security of the country.
- Low availability & high cost of gas
- India has great push for renewable energy (RE). However "cyclic behaviour" of RE, again calls for baseline capacity of coal based generation for stability.

The predicted energy use and targeted emissions reduction calls for dramatically improving efficiency of coal fired power plants in addition to RE capacity addition.

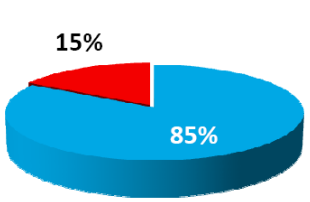
*Source: IESS, 2047, NITI Aayog ^Installed capacity as on 31.08.16 source CEA

NTPC's role has been pivotal in Indian power growth story

NTPC, a SOE with 69.74% holding of GoI, was established in 1975 to accelerate power development in India.
Today it has …….

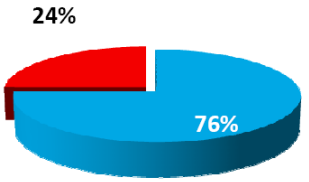
- **47,228 MW capacity under Operation**
- **Another 24,009 MW under Construction**
- **10 coal mine blocks awarded by GOI**
- **22,000 plus committed workforce**
- **23 JVs and 5 Subsidiaries in Generation, Services & other Business**

Share of Installed Capacity (*as on June 30,2016)



*Rest of India 255940 MW
*NTPC (Group) 47178 MW

Share of Electricity Generated (during Q1 FY17)

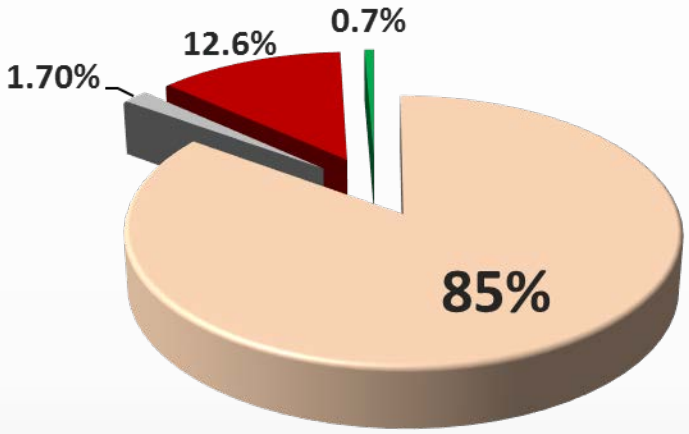


Rest of India 224.98 BUs
NTPC (Group) 71.50 BUs

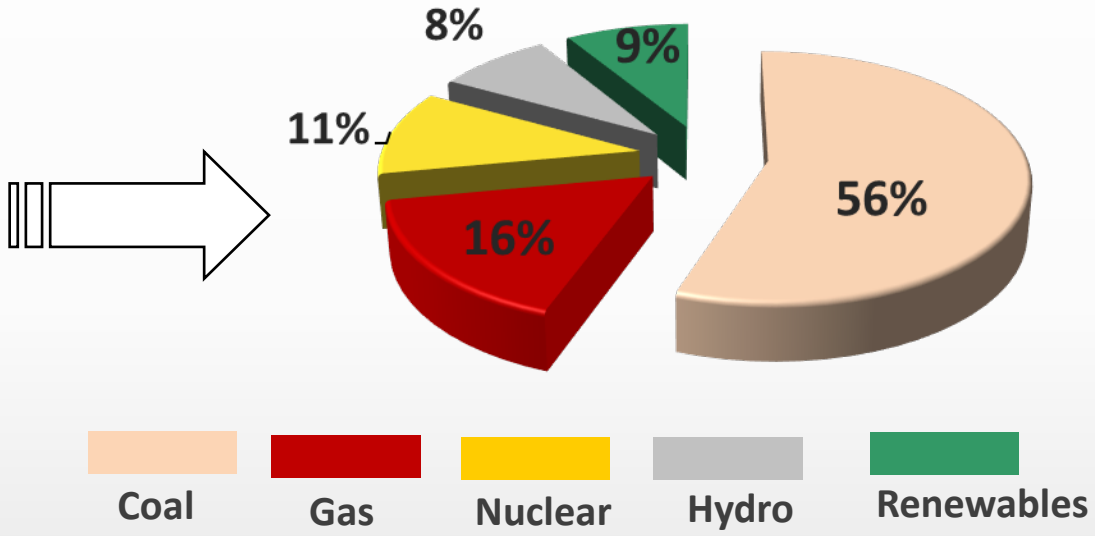
Fuel Mix	No. of Plants	Capacity (MW)	% Share
NTPC Owned			
Coal	18	35,085	74.29%
Gas/Liquid Fuel	7	4,017	8.51%
Hydro	1	800	1.69%
Solar	9	360	0.76%
Sub-total	**35**	**40,262**	**85.25%**
Owned by JVs and Subsidiaries			
Coal	8	4,999	10.58%
Gas	1	1,967	4.17%
Sub-total	**9**	**6,966**	**14.75%**
Total	**44**	**47,228**	**100.00%**

NTPC plans aligned to meet the capacity & climate challenges

Today - 47.20+ GW



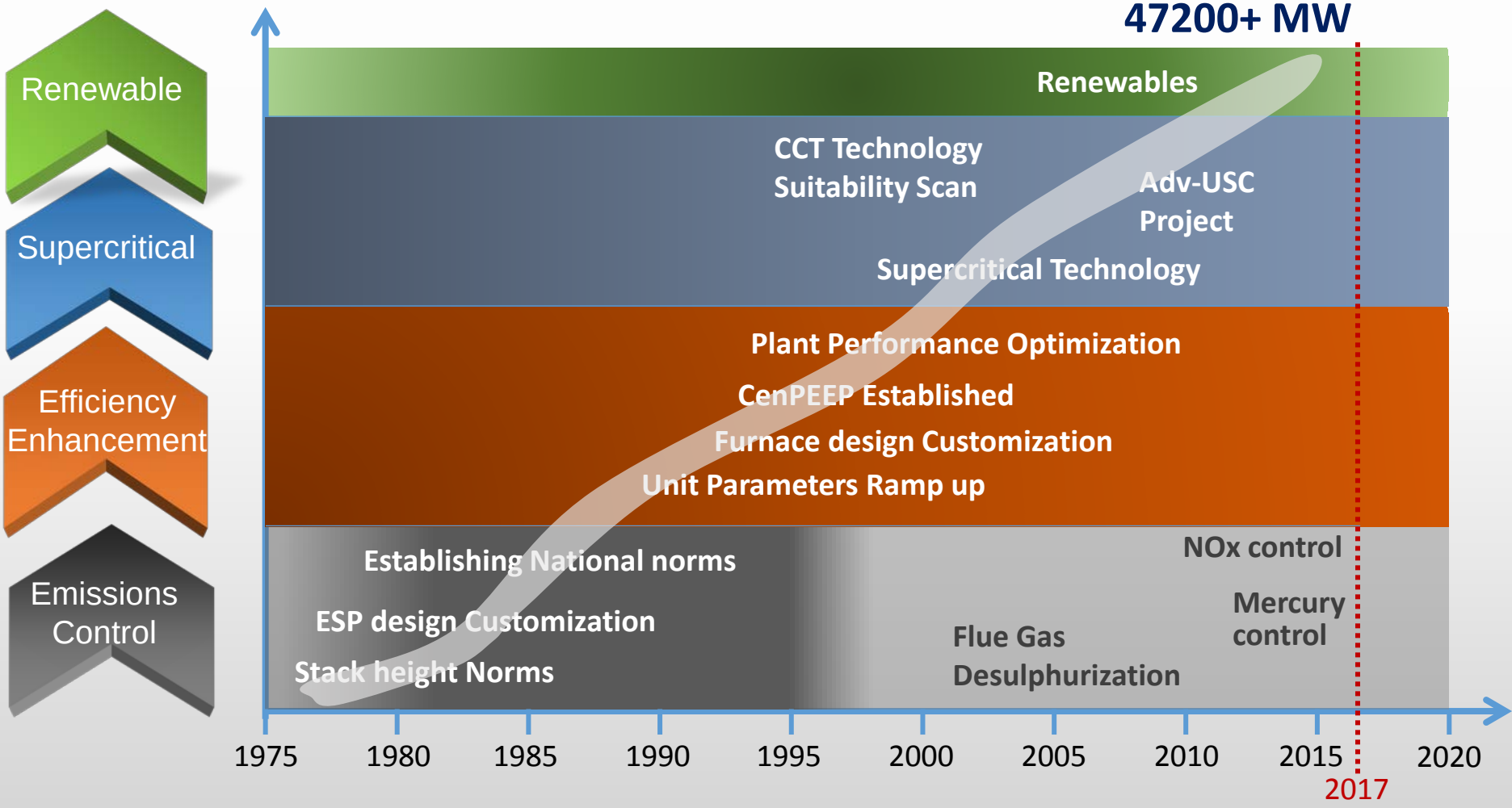
Year 2032 - 130 GW



- Corporate Plan under review due to thrust on renewable and non availability of gas.
- Have given Green Energy Commitment for 10 GW solar in 5 years. This generation would save around 10 MMT of CO_2 emissions annually.

NTPC – Focus on clean power since inception

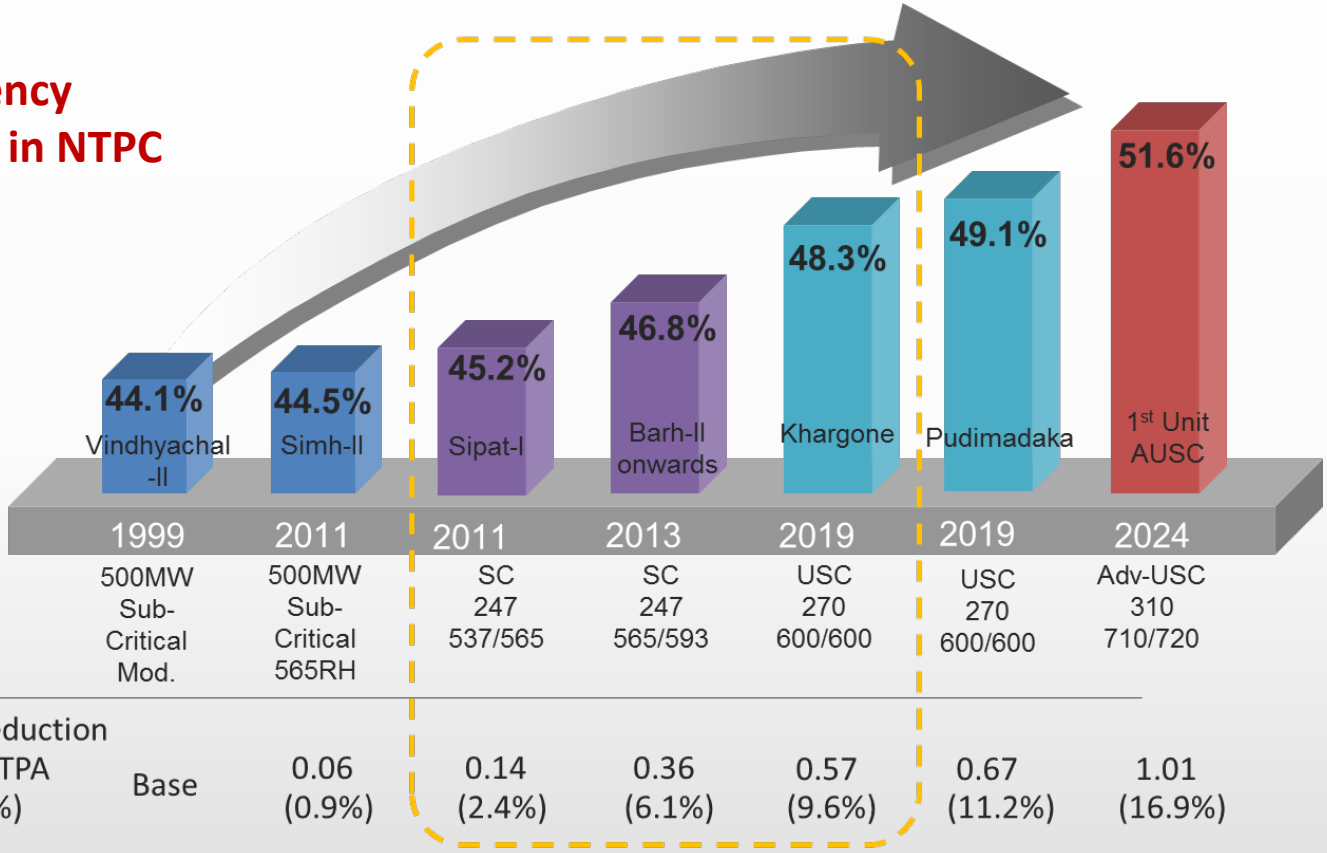
NTPCs environment initiatives which started much before the advent of climate concerns have metamorphosed to de-carbonization



Clean Use of Coal - High Efficiency Trajectory

(Turbine cycle efficiency)

Thermal Efficiency improvements in NTPC

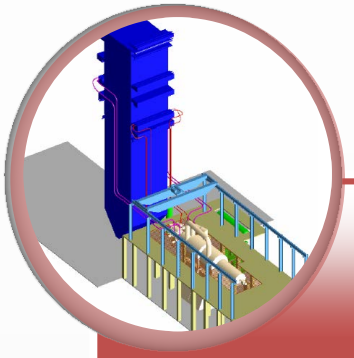


* 1000 MW plant size taken for reference

Ultra supercritical technology with steam temperatures upto 600°C is being specified for new 600/800/1000 MW units. 20680 MW of generation capacity currently under construction is based on SC/USC technology

Indian Adv-USC Program

NTPC is expanding the endeavour through development of AUSC technology



Indian A-USC

- **Collaboration between NTPC, BHEL and IGCAR**
- **Objective: 800 MWe Adv-USC Plant having 310 ksc press / 710°C MS / 720°C RH Temp**
- **Target efficiency 46%(GCV Basis) against 38% in sub-critical plants resulting in 18% reduction in carbon emissions**
- **Time schedule 7 years (3 yrs R&D & 4½ yrs plant Const.)**

Status Update

- R&D phase of the project with ~ Rs.1500 crores (USD 225 million) estimated expenditure recently approved by GOI
- Test loops utilizing indigenously developed advanced materials for high temperature applications shall be installed at NTPC Dadri for hot corrosion tests
- Plant Design Memorandum (PDM) finalized
- Nine Pre-project R&D activities have been initiated.

Renewables - going big on Solar

Renewable Bouquet

- Solar
- Solar thermal
- Solar ACs
- Wind
- Wind-offshore
- Small Hydro
- Geo-Thermal

Solar PV Capacity

Installed – 360 MW

Solar Planning	10000 MW by 2022 (own capacity)
	15000 MW by 2019 (Under NSM)

Project Being Developed

Geo-Thermal	MoU with Chhattisgarh
Wind-offshore	100 MW in Planning 1000 MW by 2022 (NTPC revising Plan)

Lack of capacity & capability in CSi PV cell manufacturing chain

Solar Capacity Approach

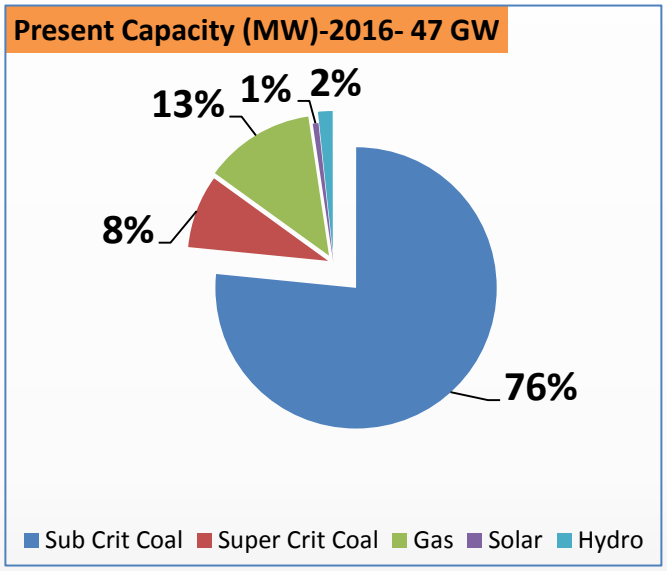
Two Pronged Approach

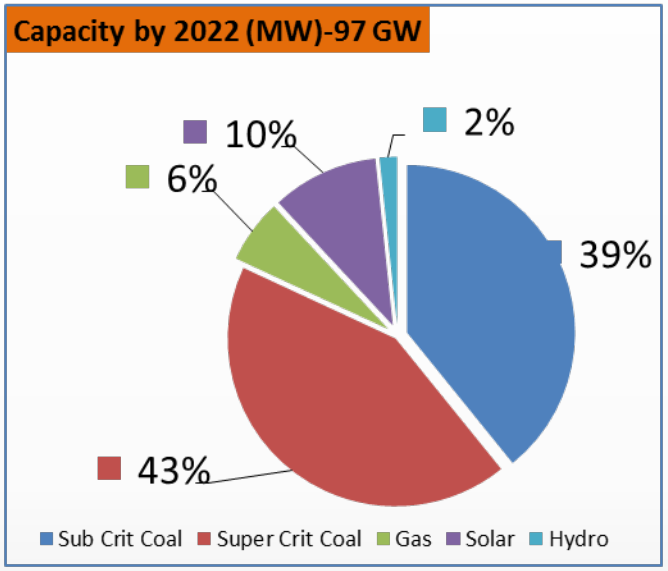
1. Add MW
2. Building Institutional capacity

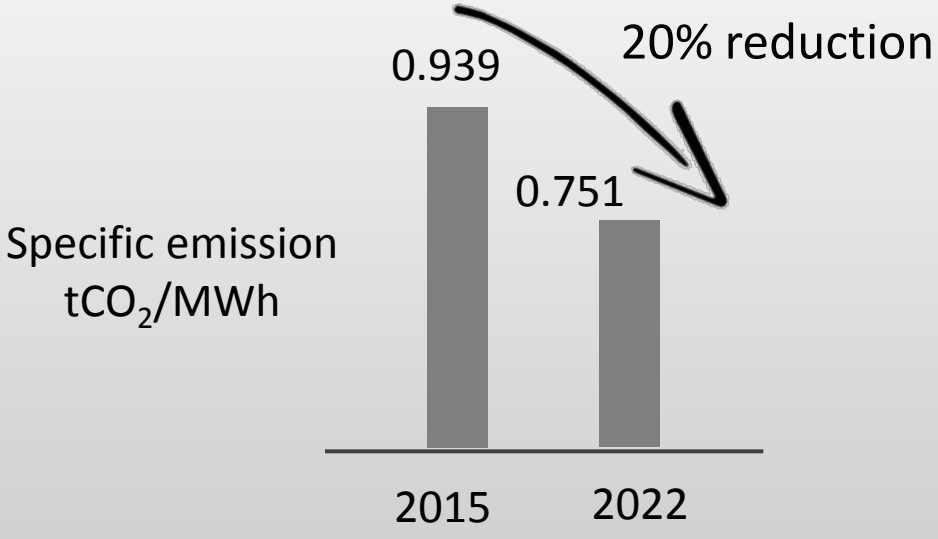
R&D in Solar

- 50 TR Solar AC Operational
- Solar Thermal Lab
- Development of indigenous floater for floating PV System
- Solar Thermal based cooking at Dadri
- Solar thermal hybrid with existing thermal plant
- Robotic Cleaning system for Solar Plant at Dadri
- Tie-up of NTPC - NETRA with
  - ✓ DLR, Germany
  - ✓ ISE, Fraunhofer Institute Germany

NTPC specific CO2 emission reduction

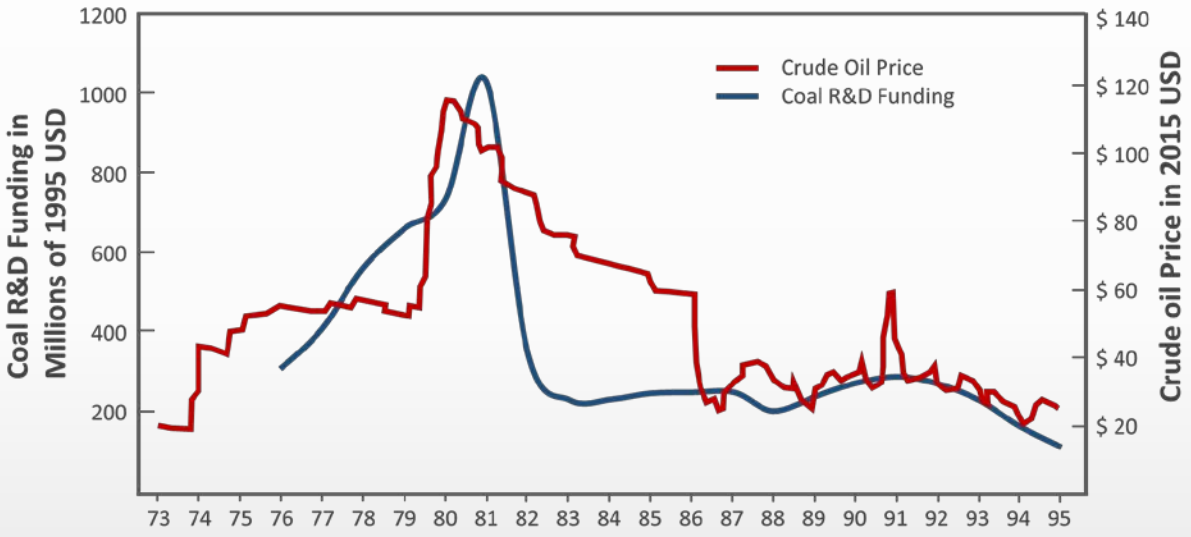






Going forward power technology development is essential

R&D funding focus for CCT has varied with perceived economic opportunity



History of funding for coal R&D under DOE's office of Fossil Energy R&D budget*

* Ref: J.P. Longwell, E.S. Rubin, J. Wilson, Coal: Energy for the future, Progress in Energy and Combustion Science, Volume 21, Issue 4, 1995

- **Coal to liquid fuels program**
- **Coal Gasification**
- **Electric Power Generation**
  - **Advanced Pulverized coal**
  - **IGCC (integrated gasification combined cycle)**
  - **IGFC (Integrated Gasification Fuel Cell Cycle)**
  - **PFBC (Pressurized Fluidized-bed Combustion)**

Climate change focus provides an renewed opportunity to develop the advanced energy conversion technologies. The short development cycle urgency and optimized resource intensity call for a collaborative effort.

Enabling low-carbon energy transition

Establishing advanced energy conversion technologies for coal and RE is a different ball game when simple compared with adoption of a mature technology import.

Imperatives……

- Collaborative CCT & RE R&D for technology development time reduction.
- CCT customization for Indian operating conditions- Fuel, MRO etc.
- Capacity building (both exogenous and endogenous) for technology absorption.
- Developing freeware for IPR as the problem is common to many countries.

…….drivers

- Increasing acceptance of the problem and global convergence
- Technology development is capital and R&D intensive

Looking at the huge capacity addition outlook in India, selection and establishment of advanced carbon conversion technology in addition to RE power generation will have a huge impact on the carbon emission values.

THANK YOU

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