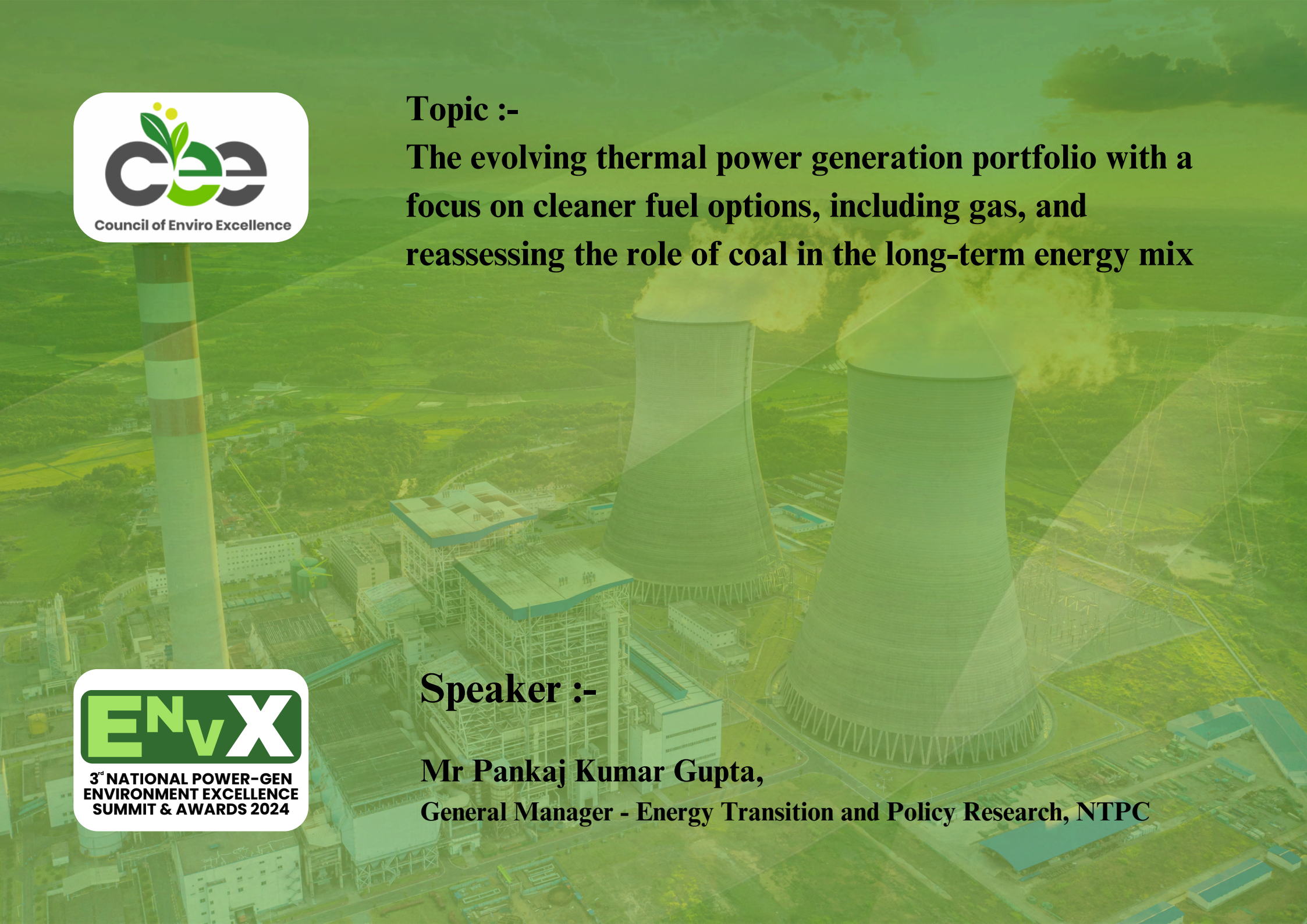


Council of Enviro Excellence

Topic :-

The evolving thermal power generation portfolio with a focus on cleaner fuel options, including gas, and reassessing the role of coal in the long-term energy mix

ENvX

3rd NATIONAL POWER-GEN ENVIRONMENT EXCELLENCE SUMMIT & AWARDS 2024

Speaker :-

Mr Pankaj Kumar Gupta,
General Manager - Energy Transition and Policy Research, NTPC


NTPC R&R Colony, Darlipali


NTPC Bhadla


NTPC Kudgi


NTPC Koldam

Thermal Power Plants in The Age of Innovation


NTPC Simhadri


NTPC Rojmal

1 About NTPC

2 Significance of Coal

3 India Power Situation

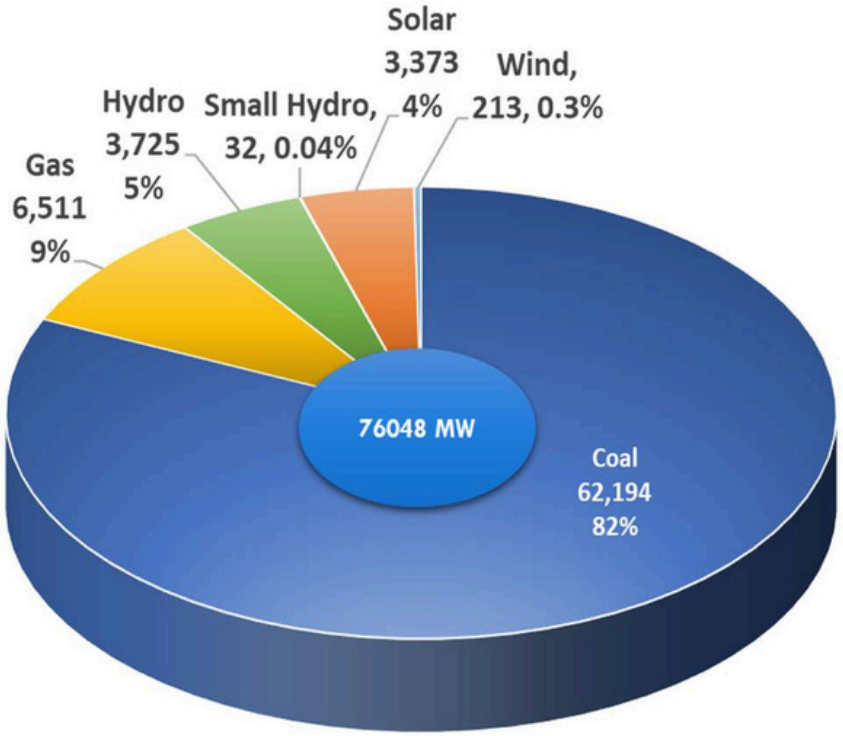
4 World Energy Mix

5 Innovations in Thermal PP

6 Cleaner Power

7 Greener Power

8 Way Forward

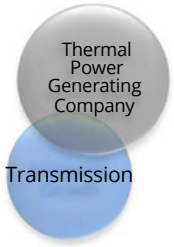


- The Largest Power Company In South Asia
- 2ndLargest IPP in the World

76,048 MW	~25%	353 Cr.	17,794
Installed Capacity	Share in All India Generation	of Community Investment	Employees

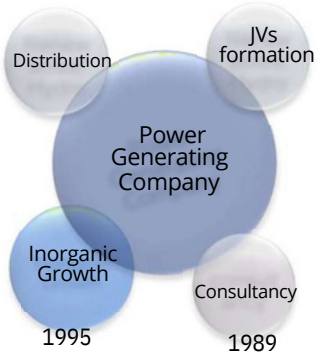
NTPC's TransformationalJourney

1975



GoI:100%

2002



2020

2023-24

GoI:51.1%

Leading Indian PowerCompany –Supplier of Clean, Green and Affordable Power in India andAbroad

NTPC Journey

Installed Capacity

200 MW

130 ksc/530°C/530°C

200 MW
(1982)

3100 MW

170 ksc/537°C/537°C

First 500 MW
(1986)

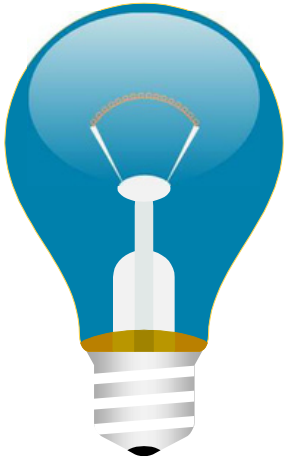
31005 MW

170 ksc/537°C/565°C

500 MW
(2010)

36315 MW

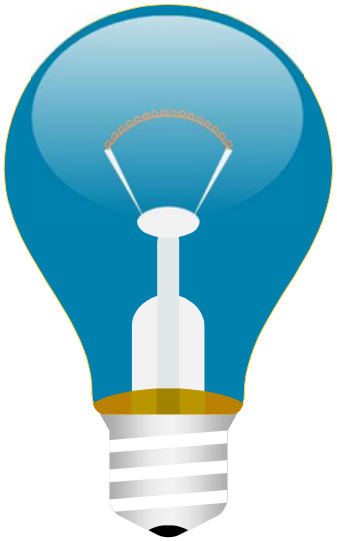
247 ksc/537°C/565°C



660 MW
(2011)

43610 MW

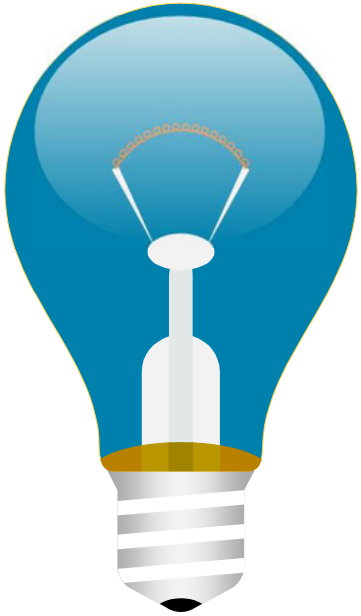
247 ksc/565°C/593°C



660/800 MW
(2014)

76048 MW

270 ksc/600°C/600°C

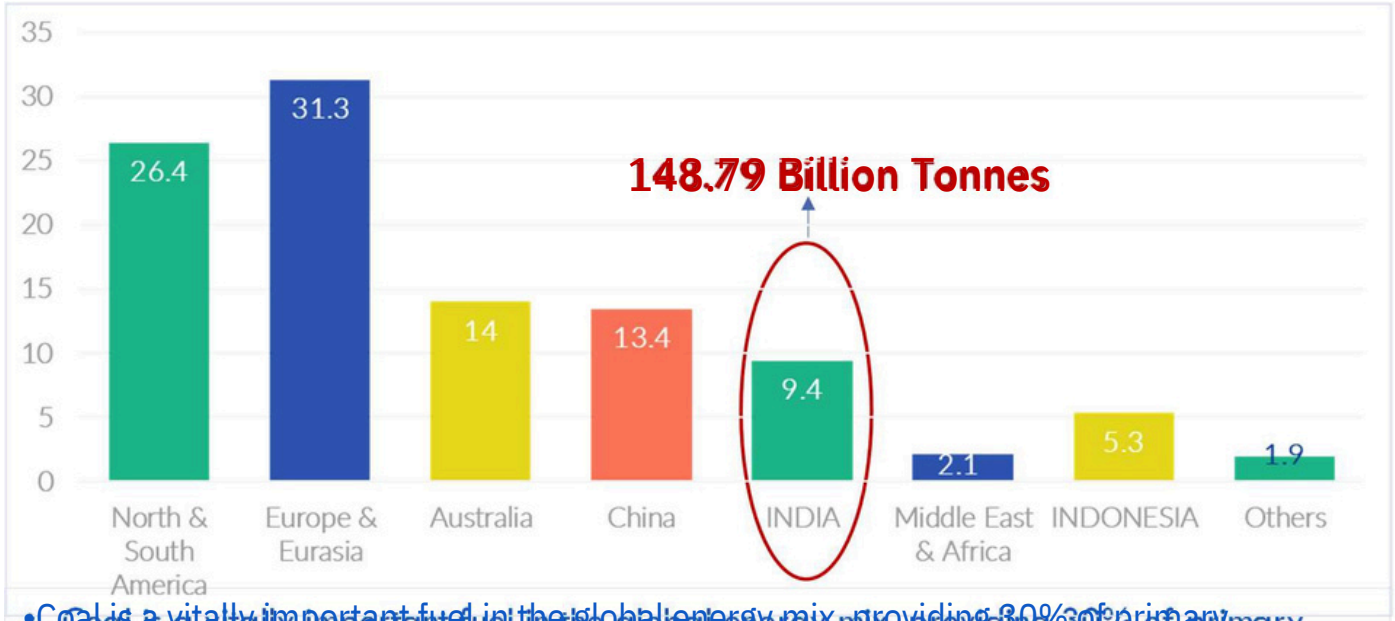


660/800 MW
(2023-24)

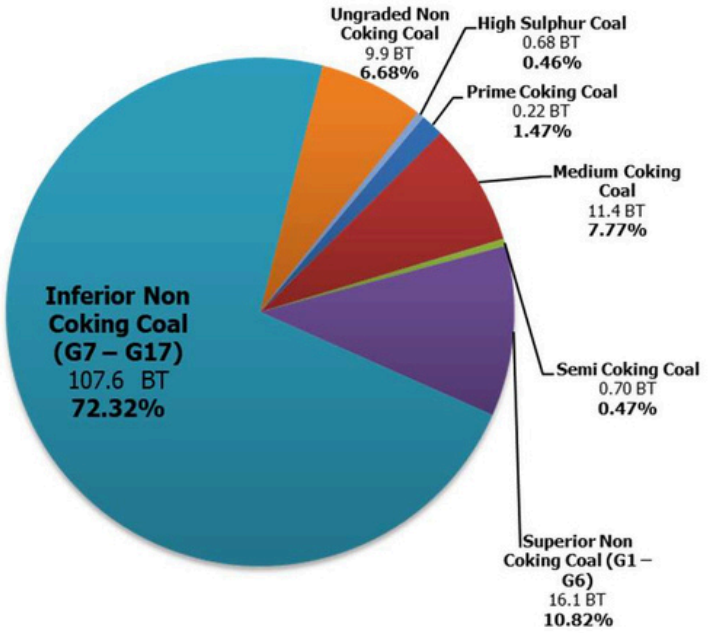
The evolving thermal power generation portfolio with a focus on cleaner fuel options, including gas, and reassessing the role of coal in the long-term energy mix

Significance of Coal in India

COAL RESERVES –GLOBAL & INDIA



Coal Resources in India

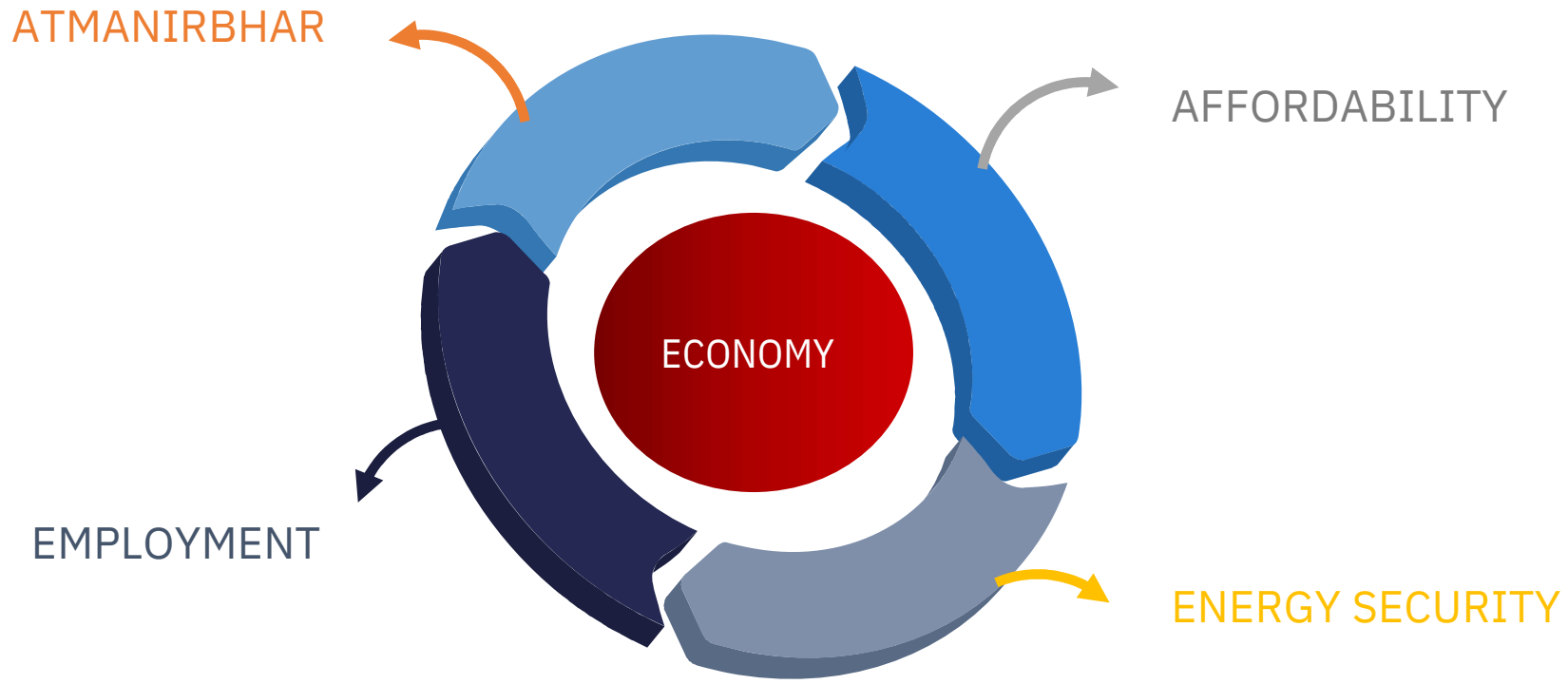


- Coal is a vitally important fuel in the global energy mix, providing 30% of primary energy.
- ~ 1055 billion Tonnesof proven coal reserves worldwide : sufficient for ~ 132 years @ current rates of production
- India has ~ 9.4% of world's proven coal reserves & stands 5th in the world.

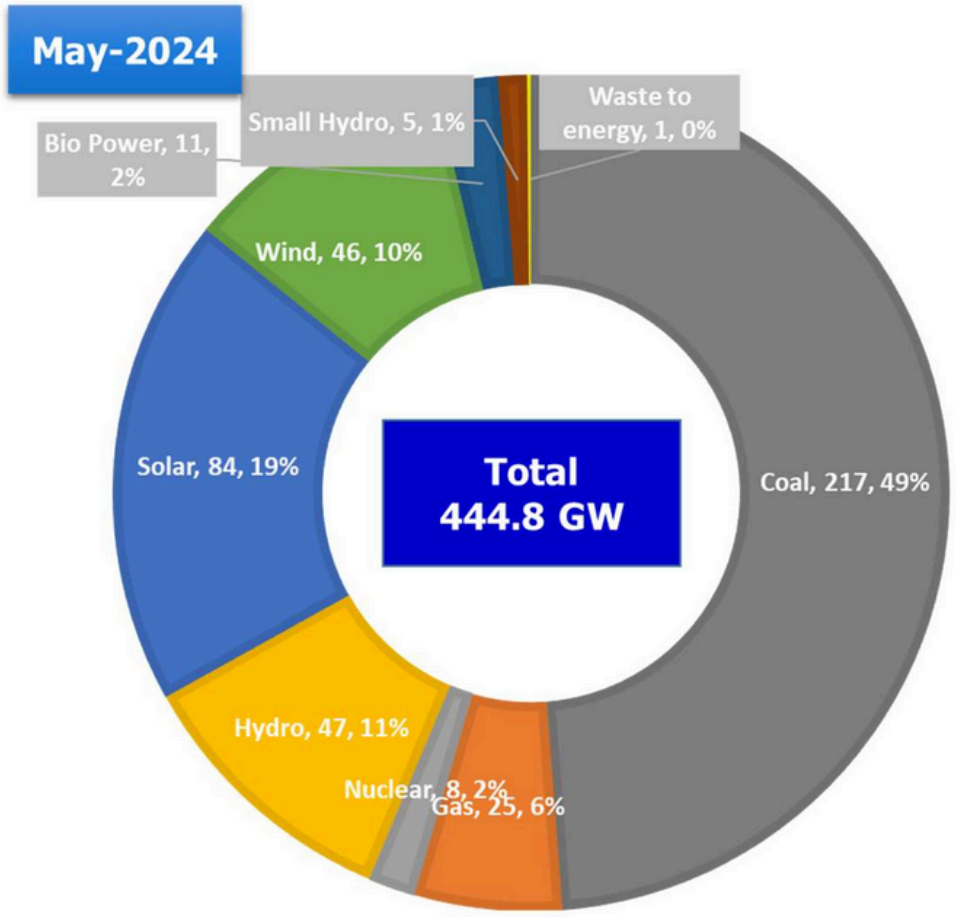
Coal is the only source of base load power generation in India due to the limited potential of hydro and India being a non-member of the Nuclear Suppliers Group.

Source –BP Statistical Review 2019/MoC

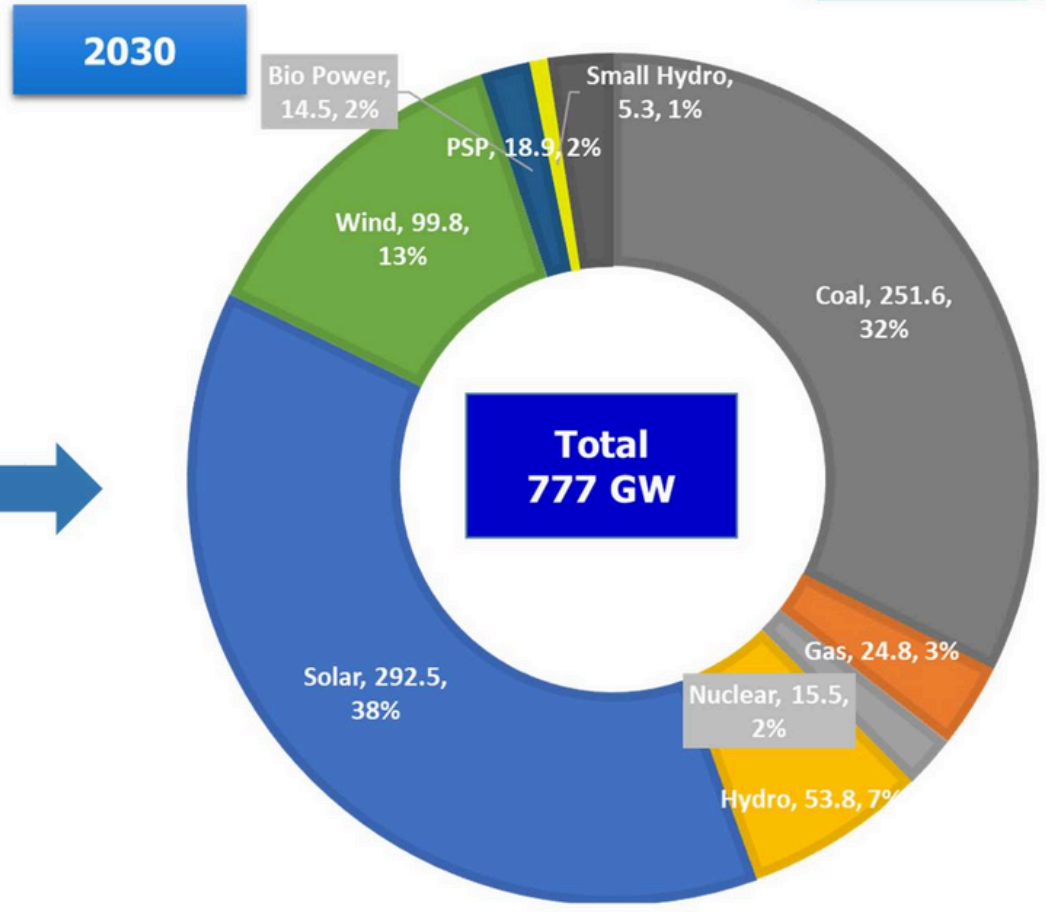
Importance of Thermal Power Plant in Indian Context



India’s Installed Power Capacity



Installed Capacity, GW



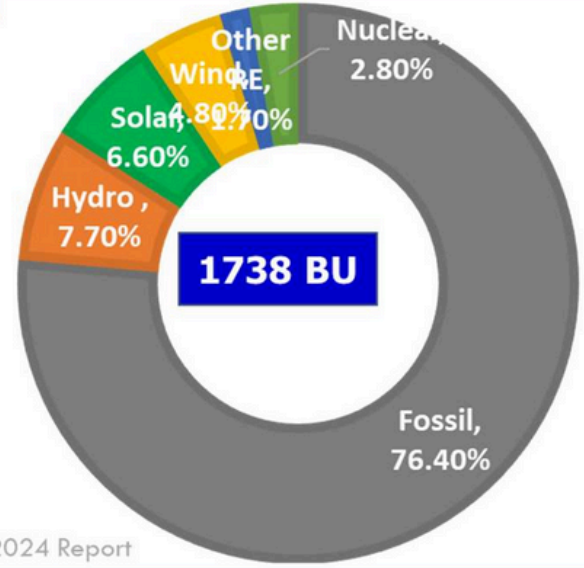
Installed Capacity GW

Source: https://powermin.gov.in/en/content/power-sector-glance-all-india

Source: Report on Optimal Generation Capacity Mix for 2029-30 Ver 2.0 April 2023

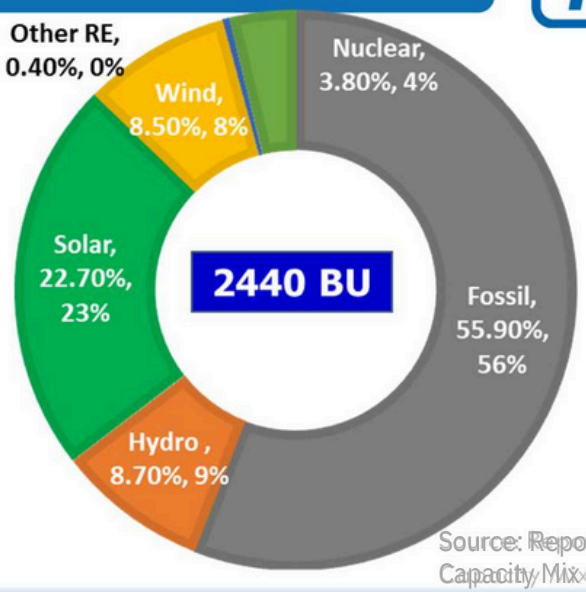
India's Electricity Generation

2024



Source: CEA 2024 Report

2030

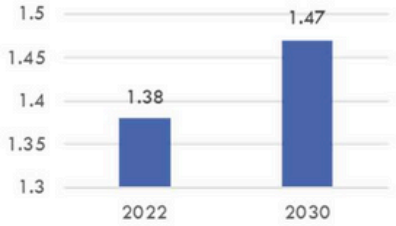


Source: Report on Optimal Generation Capacity Mix for 2029-30 Ver-2.0 April 2023

% Share in Generation from Various Energy Sources

Population (Billion)

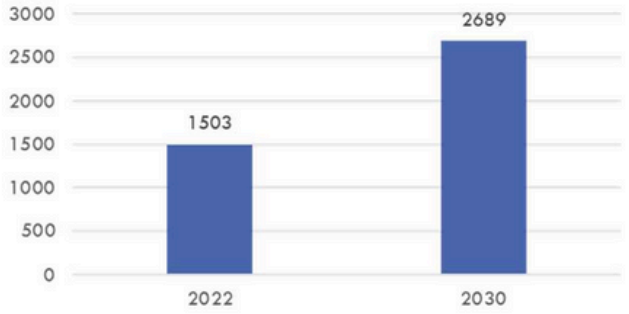
Ministry of Health & Family Welfare
United Nations Population Projection



Electricity (BU) Consumption

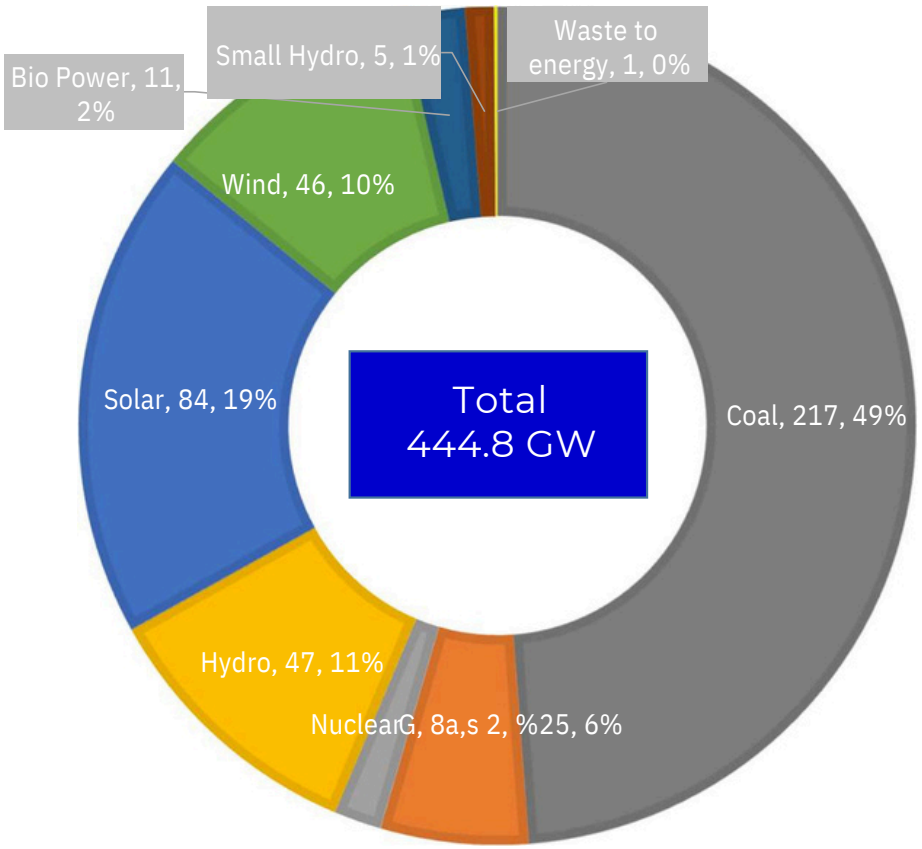
Per capita Average electricity consumption
World ~ 3800 kWh
India ~ 1255 kWh

World Energy Outlook 2022



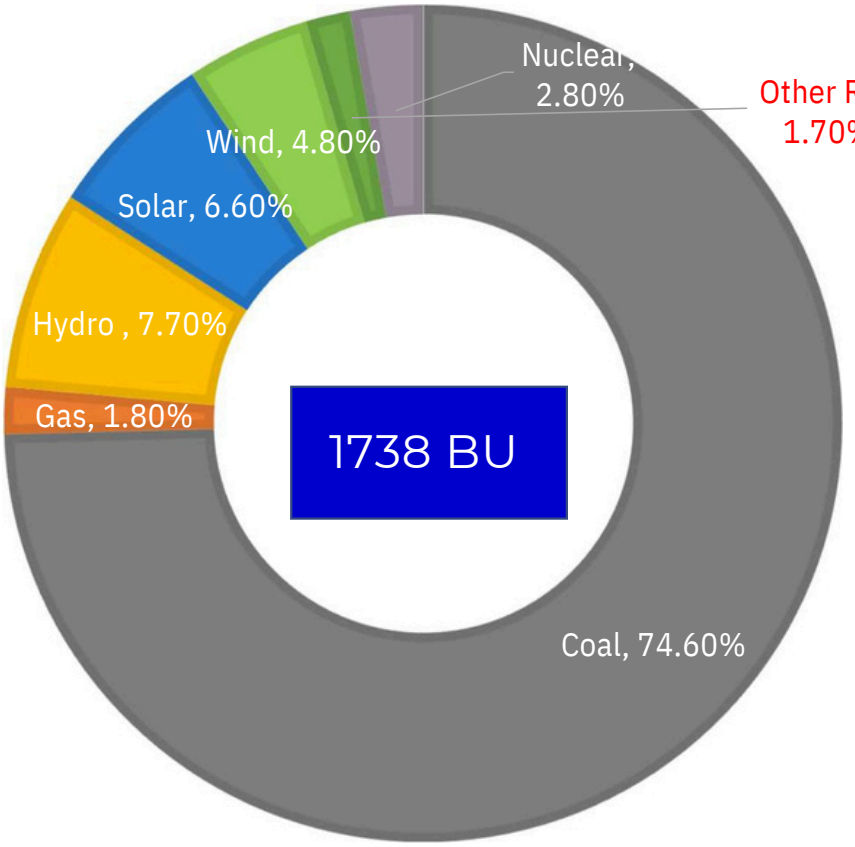
India’s Installed Power Capacity & Generation -Present

May-2024



Installed Capacity, GW

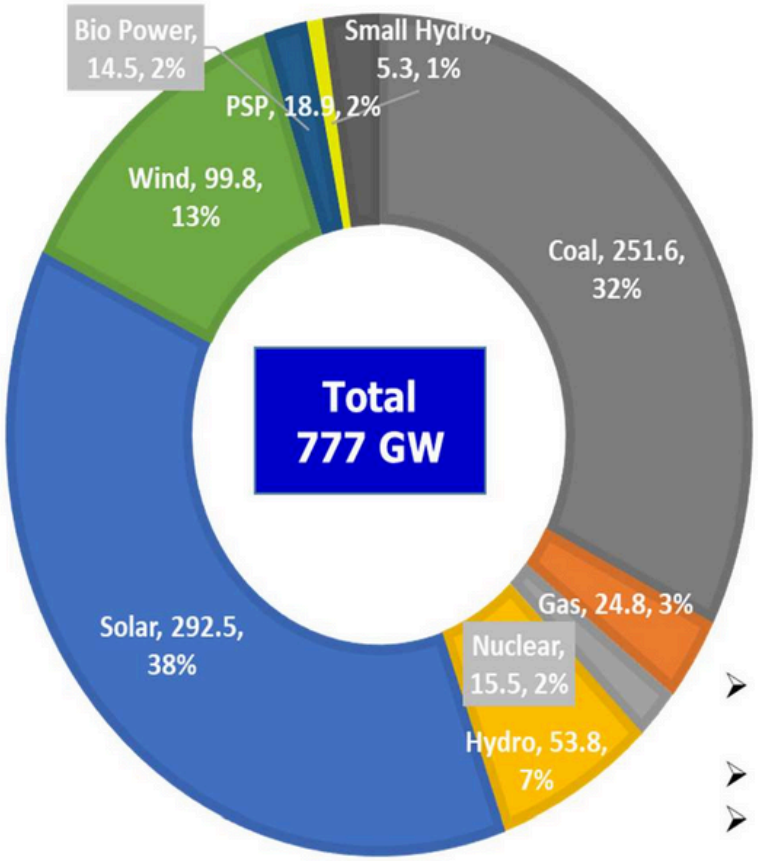
Source: https://cea.nic.in/installed-capacity-report/?lang=en



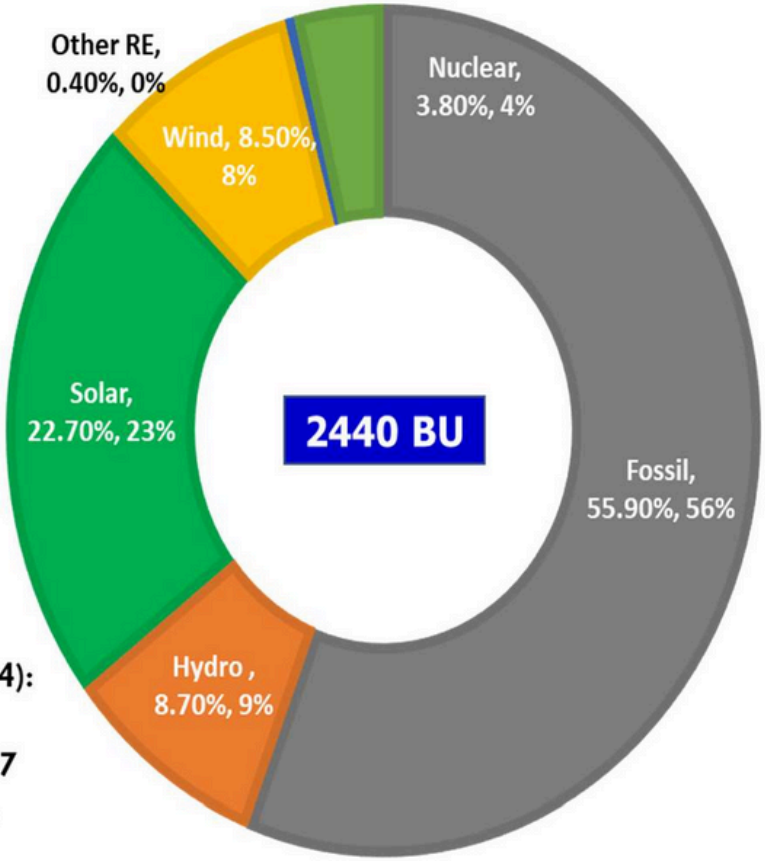
Generation, BU

Source: Report on Optimal Generation Capacity Mix for 2029-30 Ver 2.0 April 2023

India’s Installed Power Capacity & Generation -Future



2030

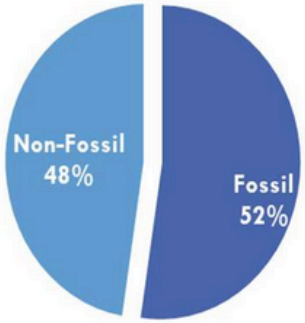


- India’s GDP Growth (2023-24): 7.3% (Source-ISO)
- Target: Developed Country by 2047
- To sustain high Economic Growth, Power sector must grow commensurately

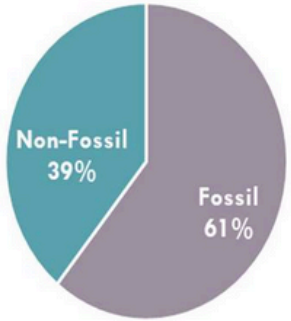
Source: https://cea.nic.in/installed-capacity-report/?lang=en

Global v/s India -2023

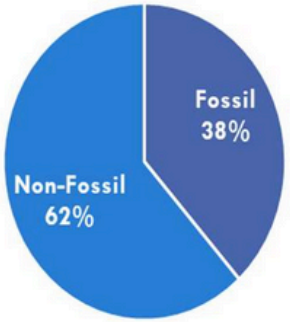
Global Capacity (GW)



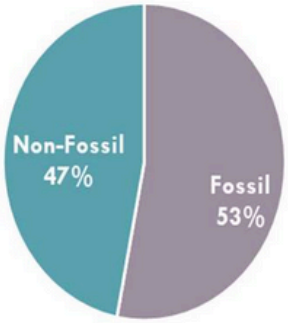
USA Capacity (GW)



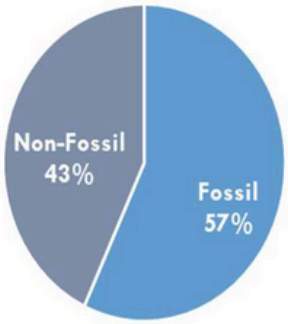
EU Capacity (GW)



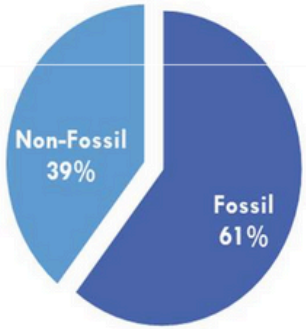
China Capacity (GW)



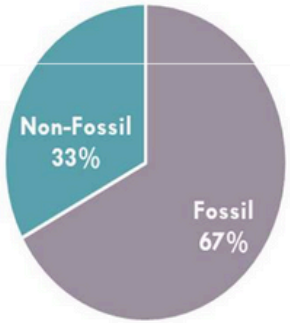
India Capacity (GW)



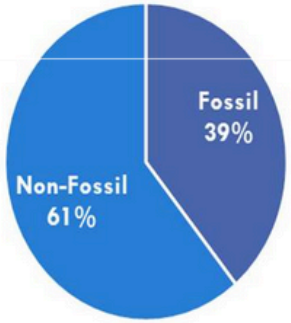
Global Generation (TWh)



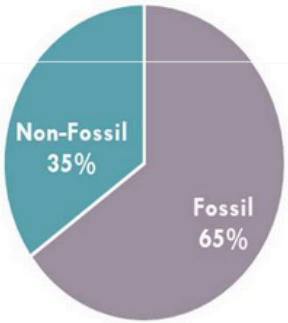
USA Generation (TWh)



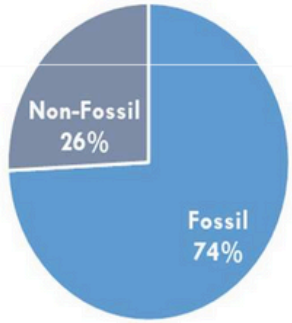
EU Generation (TWh)



China Generation (TWh)

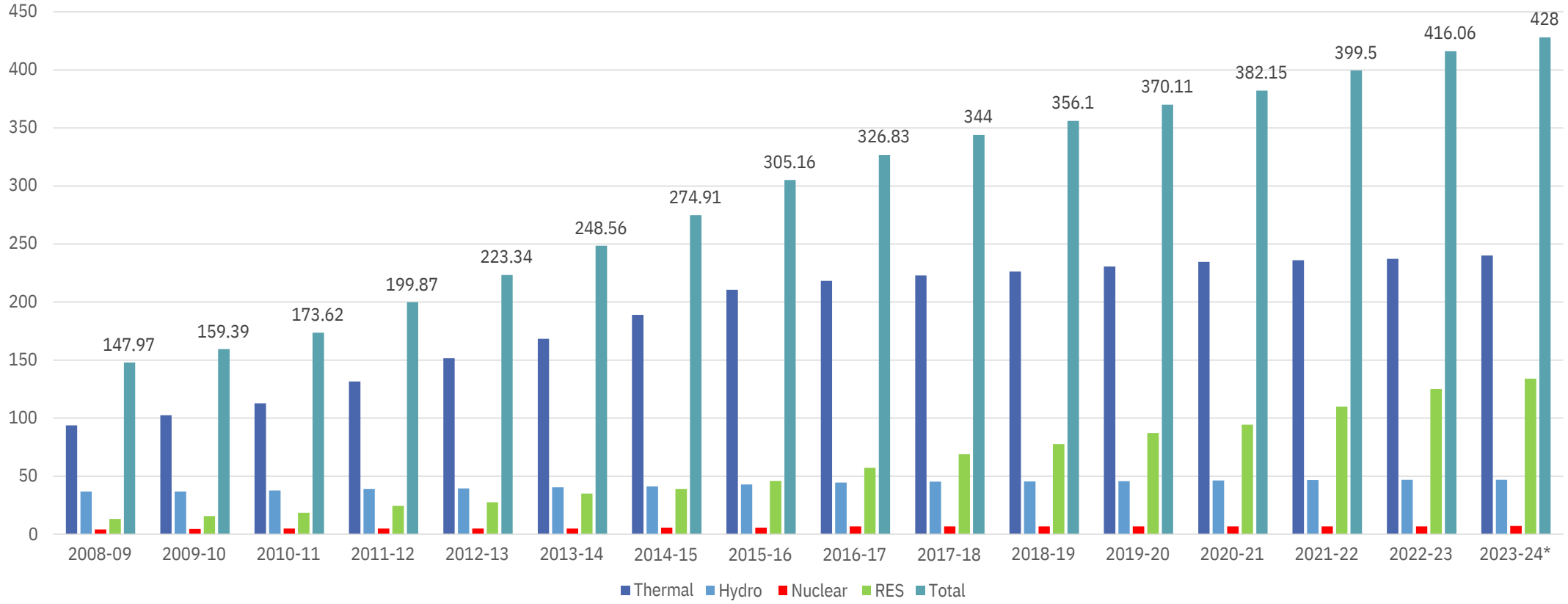


India Generation (TWh)



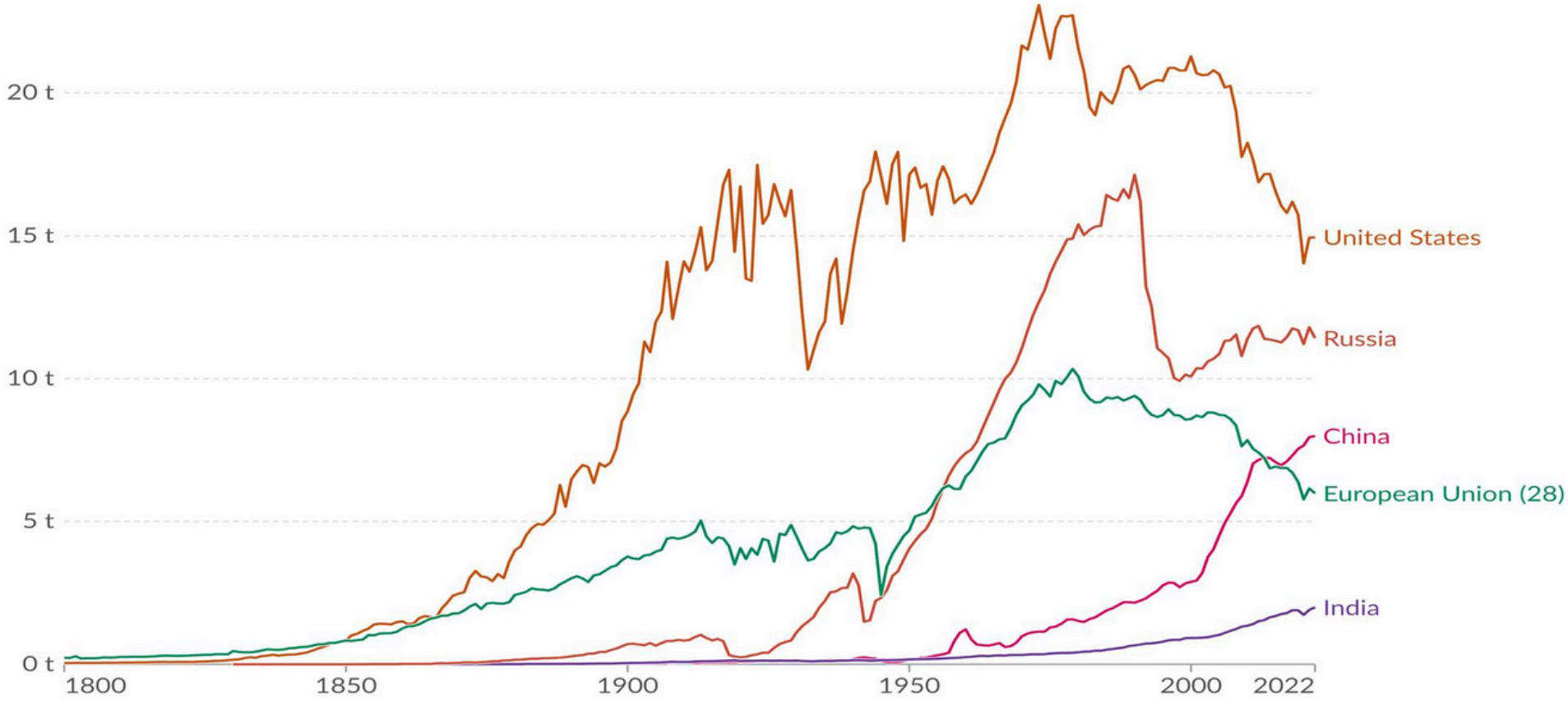
Source: IEA World Energy Outlook 2023

Installed Electricity Generation Capacity in India (GW)



Source: CEA, Growth of Electricity Sector in India, various issues.
* till Dec 2023 ** RES includes Sma ll Hydro Project (< 25 M W)

Per capita CO_2 emissions (India vs Other Countries)



Data source: Global Carbon Budget (2023); Population based on various sources (2023)
OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

NTPC future Plan for Thermal Capacity addition

Govt. of India has planned to add 80GW Thermal Plant by 2031-32

Under Construction

Project Name	Capacity (MW)
~~BARH-I (3x660 MW)~~	660
~~Singrauli-III (2X800~~	1600
~~NORTH KARANPURA (3x660)~~	660
~~Talcher-III (2x660 MW)~~	1320
~~Lara-II (2x800 MW)~~	1600
~~Patratu(3x800 MW)~~	2400
Khurja(2X660MW)	1320
Total	9560

Under Tendering

Project Name	Capacity (MW)
Telangana-II (3X800 MW)	2400
Gadarwara-II (2x800)	1600
Nabinagar-II (3x800 MW)	2400
Sipat-III (1X800 MW)	800
Darlipali-II (1X800 MW)	800
Meja-II (3X800 MW)	2400
Total	10400

To be Tendered

Project Name	Capacity (MW)
Patratu-II (2X800 MW)	1600
Obra-D (2x800 MW)	1600
Anpara-E (2x800 MW)	1600
Total	4800

The identified plants shall be designed considering following:

- Meet stringent environment norms
- Provision of 20% torrefied biomass cofiring
- Provision for installation of Carbon Capture and Utilisation Plant

17

Energy Transition and Innovation of Thermal Power Plant

Country Specific Issues for making Greener power

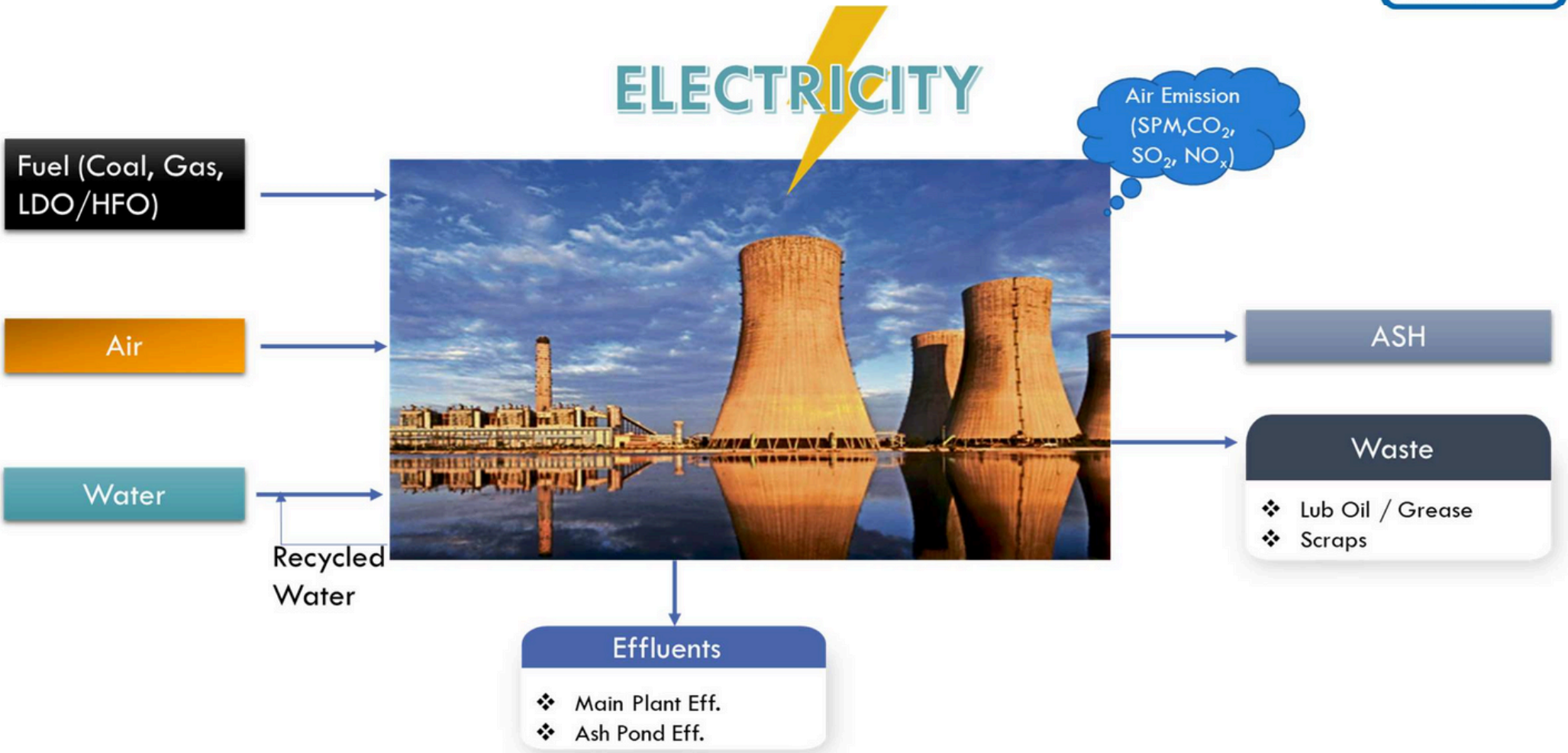
- Growing Demand: Developing Country and Huge GDP growth target
- Cleaner Power Supply : First priority to clean power before doing Green Power
- Base Power/ Back Up Power- Except Coal no other alternative energy Source as of now
- Huge Employment of Country in Coal & Thermal Power Sector

Role of Coal based Plant During Transition

- **Integral Part of future Energy Mix:** Major Generation share for at least for a few decades
- **Cleaner and Greener Power Supply :** Decarbonization of Thermal Plant is Inevitable
- **Continue to Supply Reliable and affordable power**
- **Continue to Support Economical Growth and Employment of Country**
- **Need to Operate in Flexible Mode to Accommodate Variability of RE**

Environmental Challenge and Mitigation

Coal Plant & Environment



New Environment Norm from Thermal power Plants

Change in Environment Norms issued on 07/12/2015

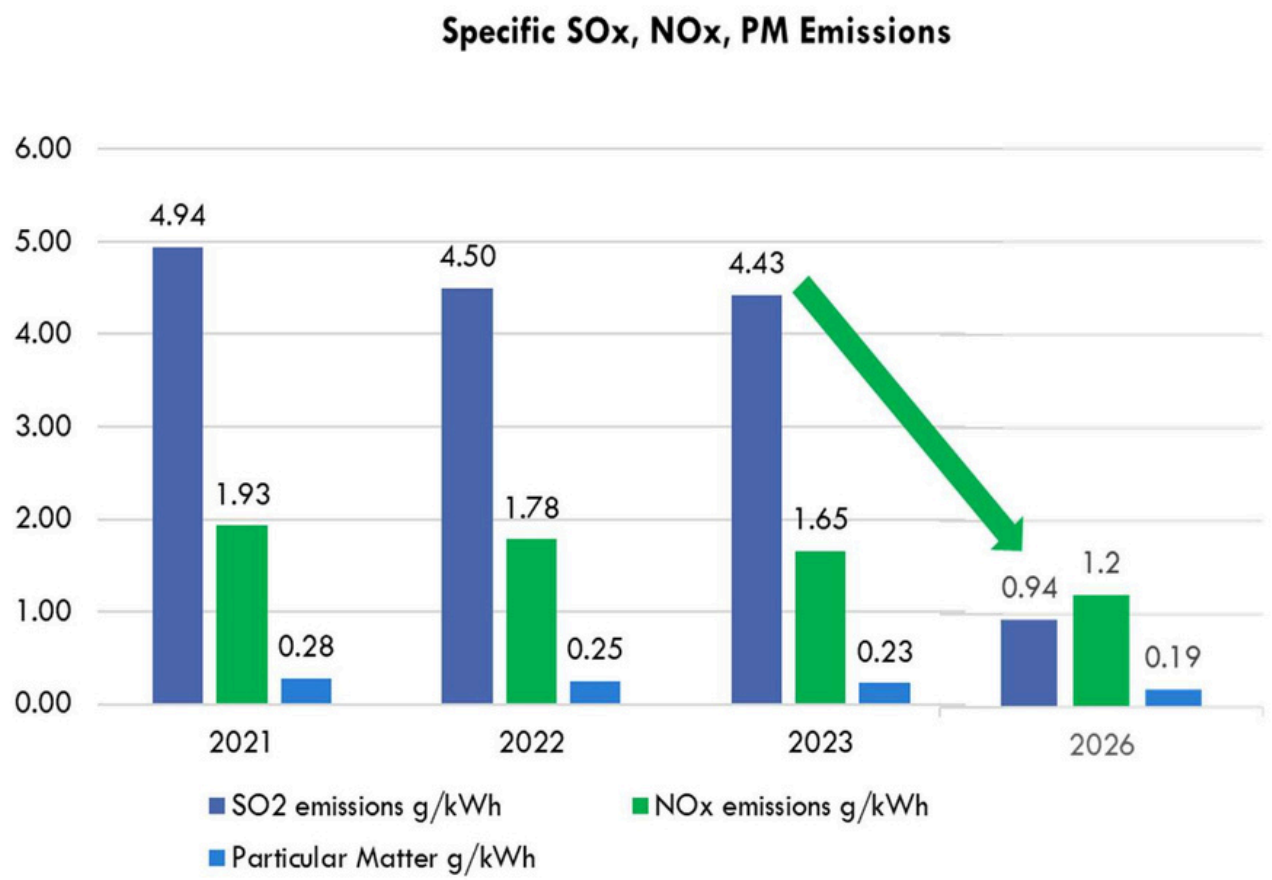
Previous Norms		New Norms				
All emission are in mg/ Nm^3		Installed before 31.12.2003		Installed after 01.01.2004 & up to 31.12.2016		Installed on or after 01.01.2017
Unit Size	All	< 500 MW	≥500 MW	< 500 MW	≥500 MW	All
SO2	Dispersion through Chimney	600	200	600	200	100
NOx	No Norms	600		450		100*
SPM	150/100/50	100		50		30
Mercury	No Norms	--	0.03	0.03		0.03

- All plants with once through cooling shall install Cooling Tower and achieve spec water consumption max 3.5M3/MWhr
- New plantsinstalled after 01.01.2017 shall meets max specific water consumption limit 3.0M3/MWhrand achieve ZLD

MOEF & CC has issued new timeline for new norms compliance, vide notification dated 05-09-2022

Sl. No.	Category	Location/area	Timelines for compliance (Non retiring units)		Last date for retirement of units for exemption from compliance	
			parameters other than SO2 emissions	SO2 emissions	parameters other than SO2 emissions	SO2 emissions
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Category A	Within 10 km radius of National Capital Region or cities having million plus population[1].	Upto 31st December 2022	Upto 31st December 2024	Upto 31st December 2022	Up to 31st December 2027
2	Category B	Within 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Upto 31st December 2023	Upto 31st December 2025	Upto 31st December 2025	
3	Category C	Other than those included in category A and B	Upto 31st December 2024	Upto 31st December 2026	Upto 31st December 2025	

Result of Adopting Air Pollution Control Technology



SPM Reduction :

- ESP R&M completed in 14/15GW
- Additional reduction being achieved through FGD installations

SO2 Reduction :

- FGD including DSI Commissioned in around 12000 MW
- Gas in achieved in 3280 MW
- FGD under various stages of Erection and Commissioning in57+ GW capacity.

NOX Reduction :

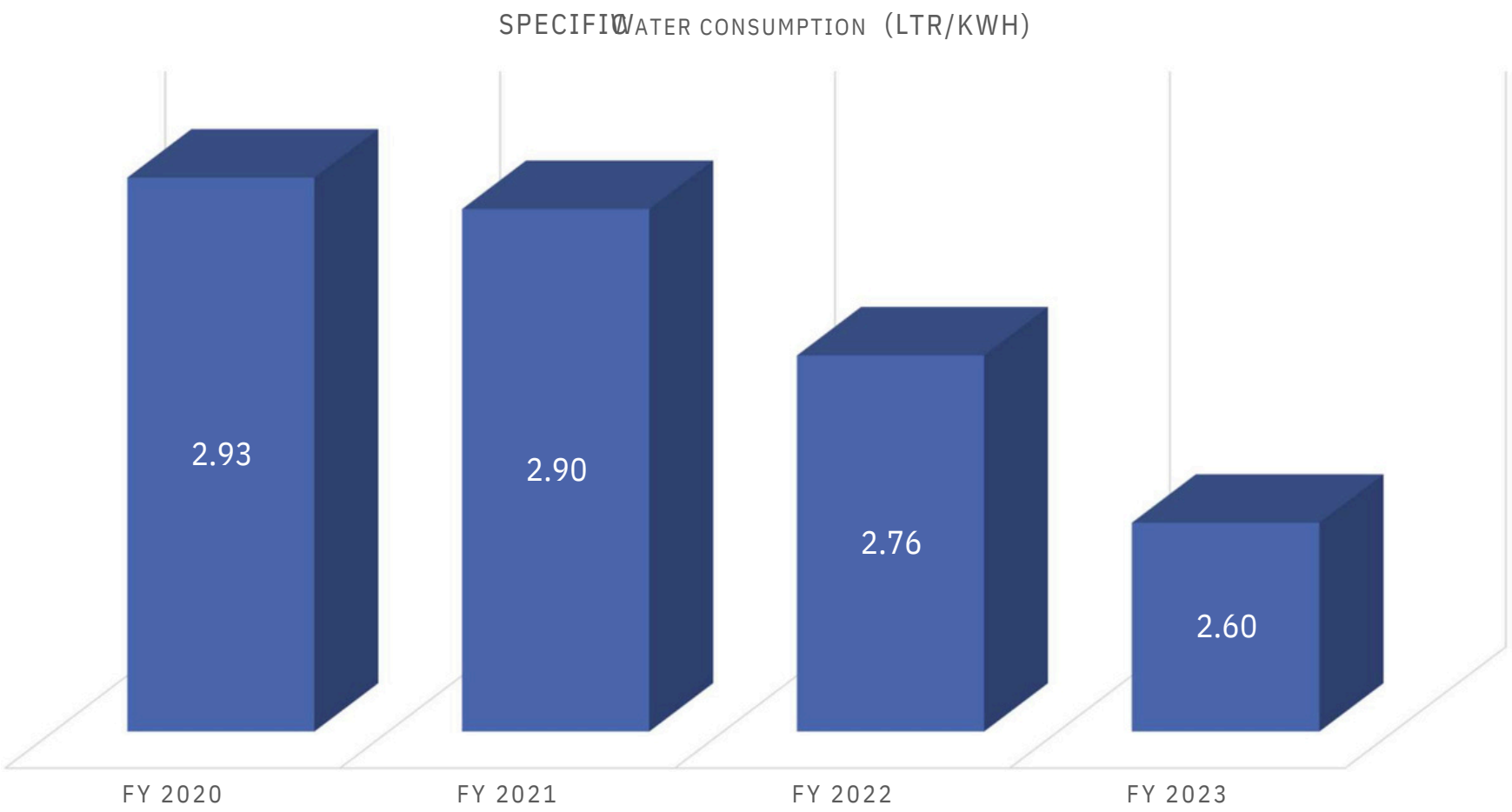
Modification completed in –21560MW.

As per the Notification Dated 05.09.2022of the Ministry of Forest & Climate Change, the timeline for implementation is up to 31.12.2024/26.

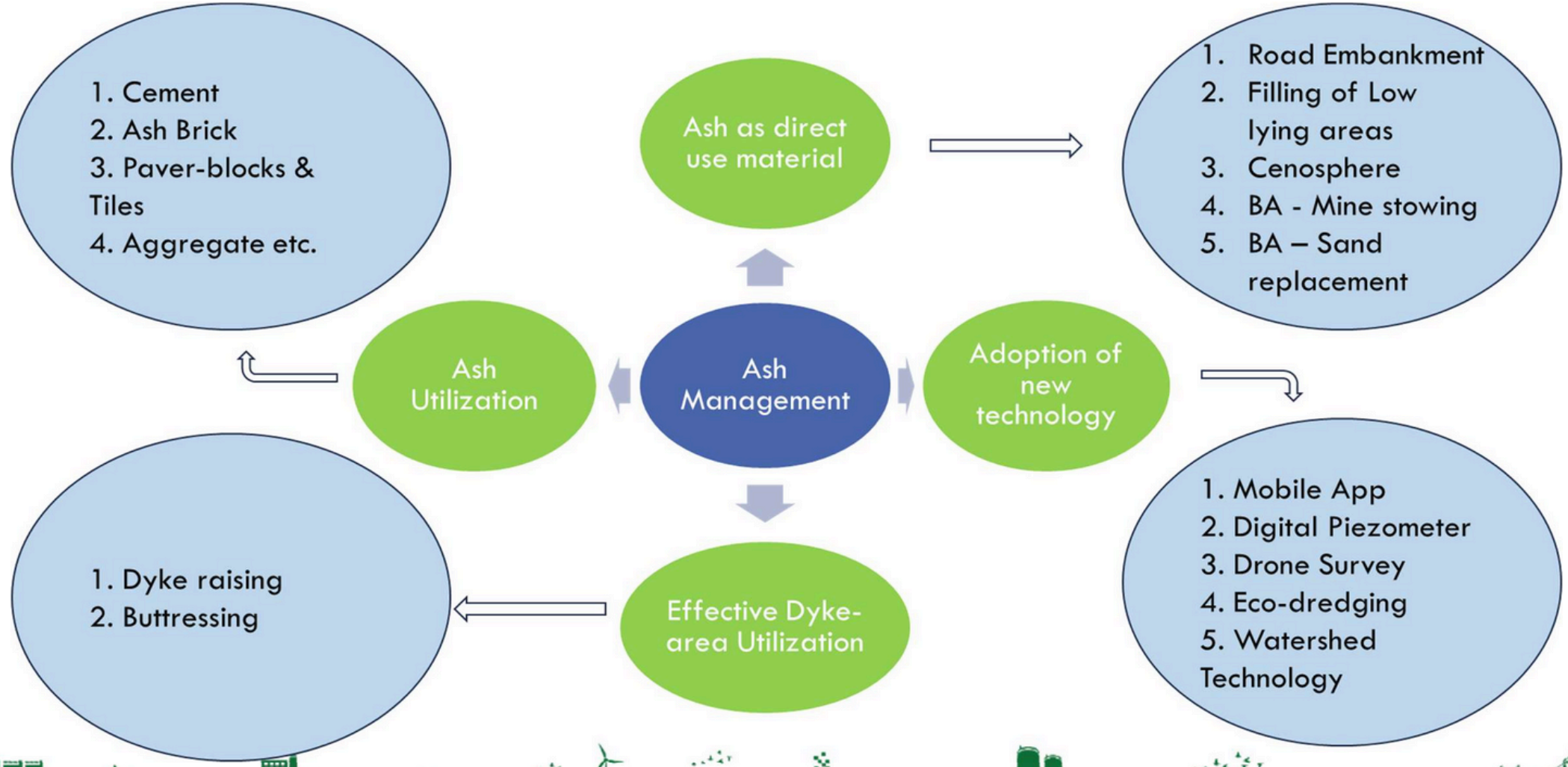
Water Conservation

Water Conservation Strategy

Reduction in Specific Water Consumption in NTPC

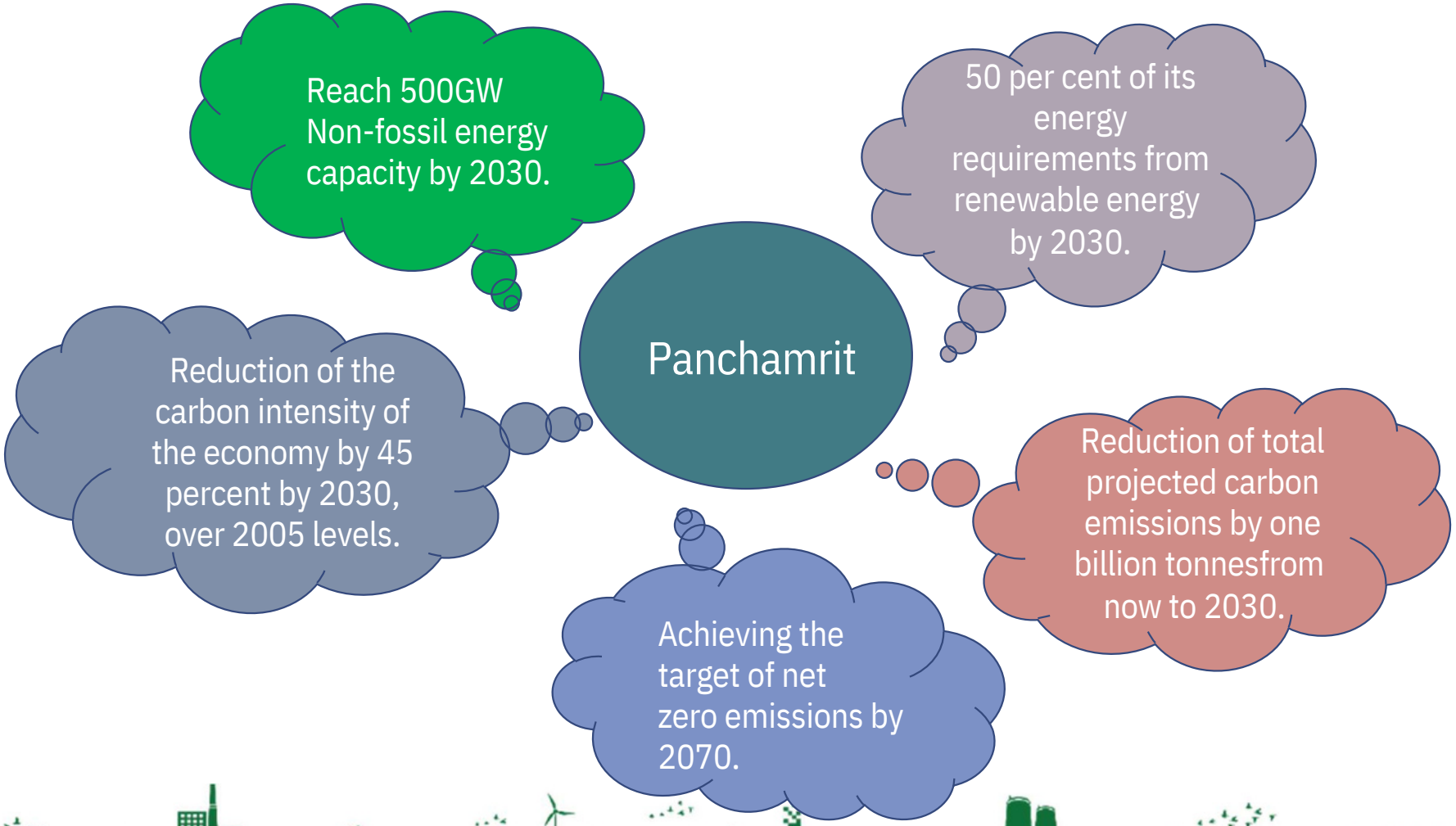


Ash Utilization

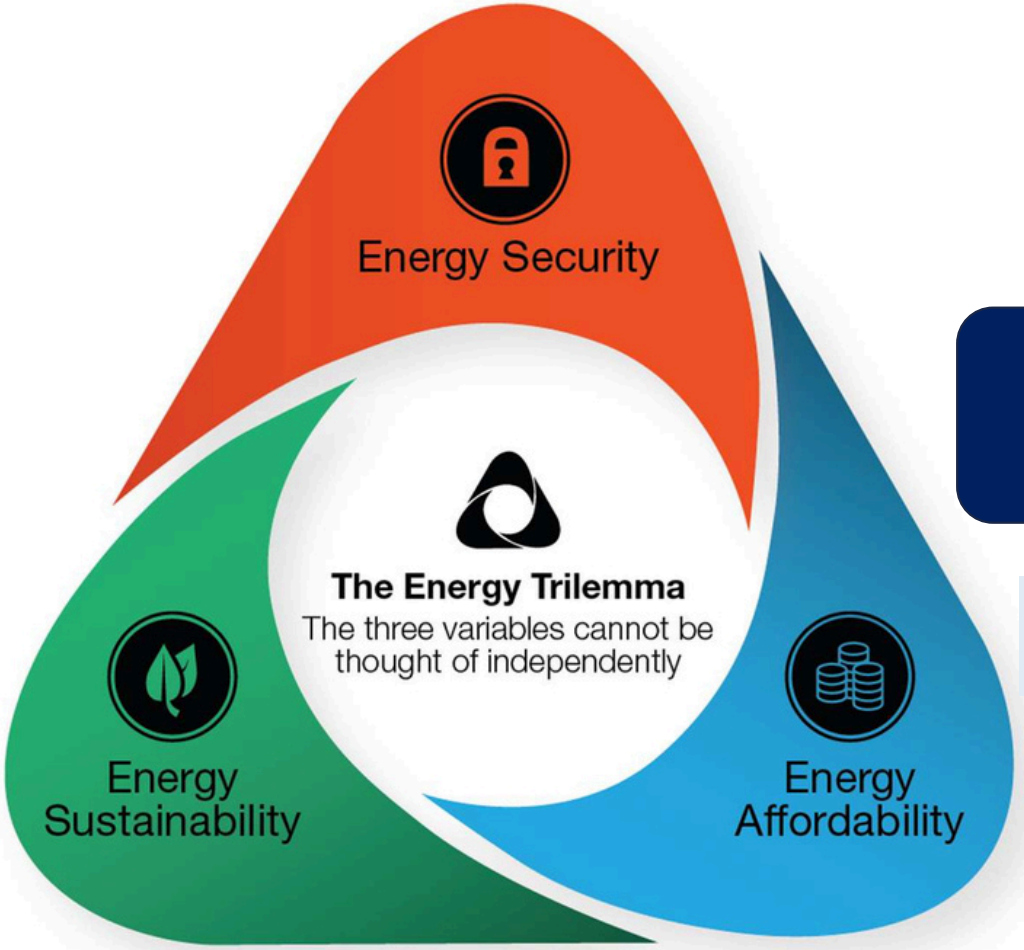


Handling the Transition Challenges by Innovat ion

Five Nectar Elements Of India's Climate Action



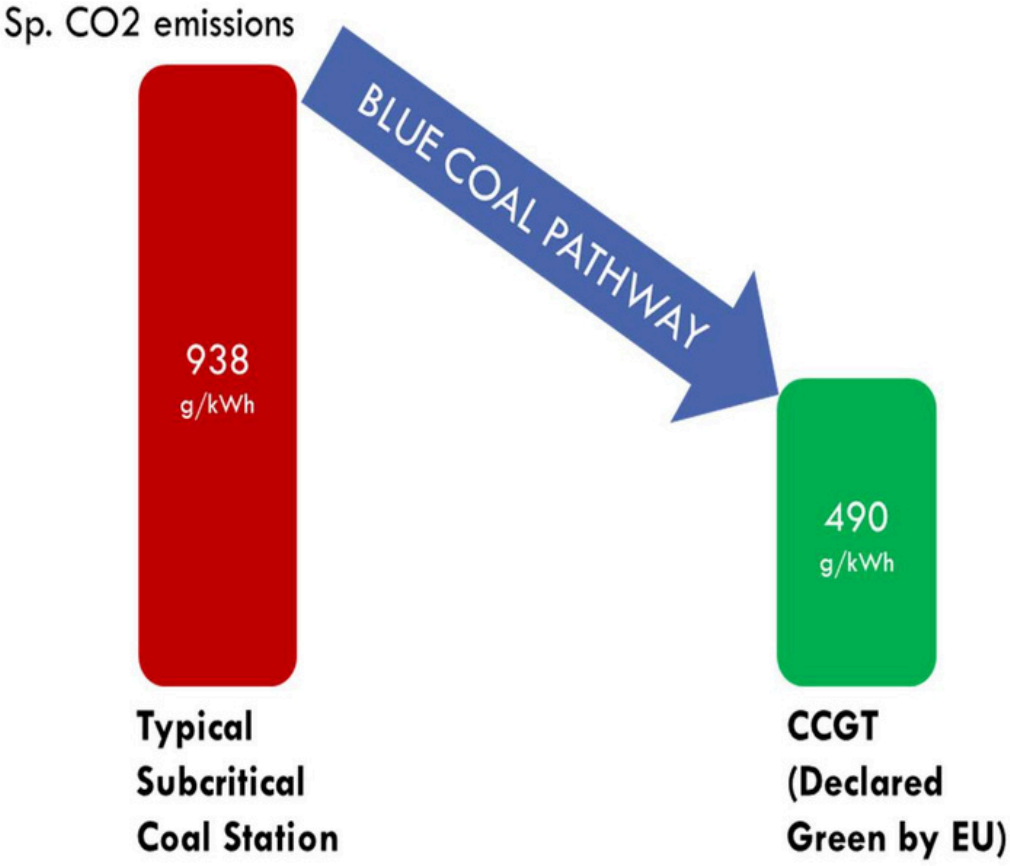
The Energy Trilemma



Solving the Energy Trilemma:Key to a Sustainable Future

Meeting the energy needs of the country is the first and foremost consideration

In Quest of Blue Coal Generation



Handling the Transition Challenges by Innovation

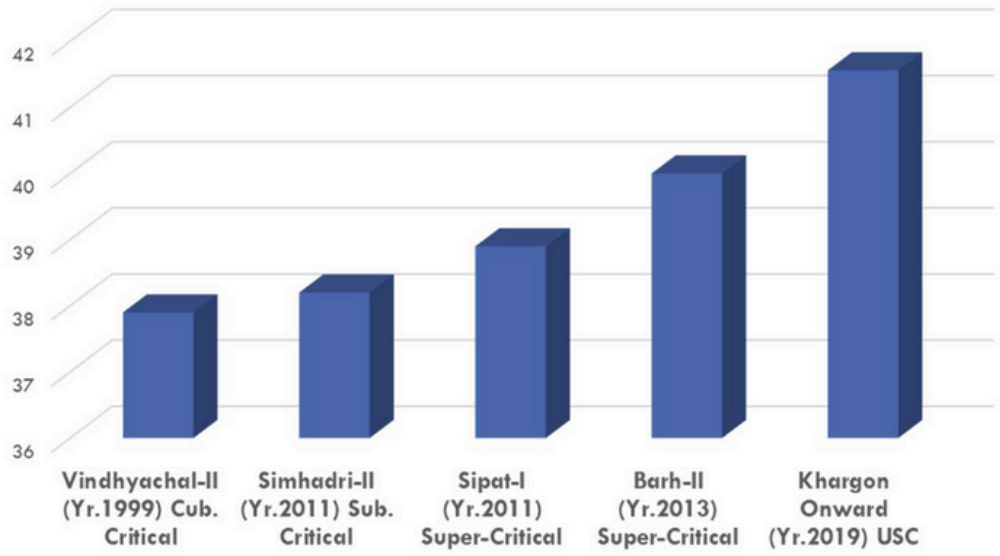
Decarbonisation of Thermal Plants

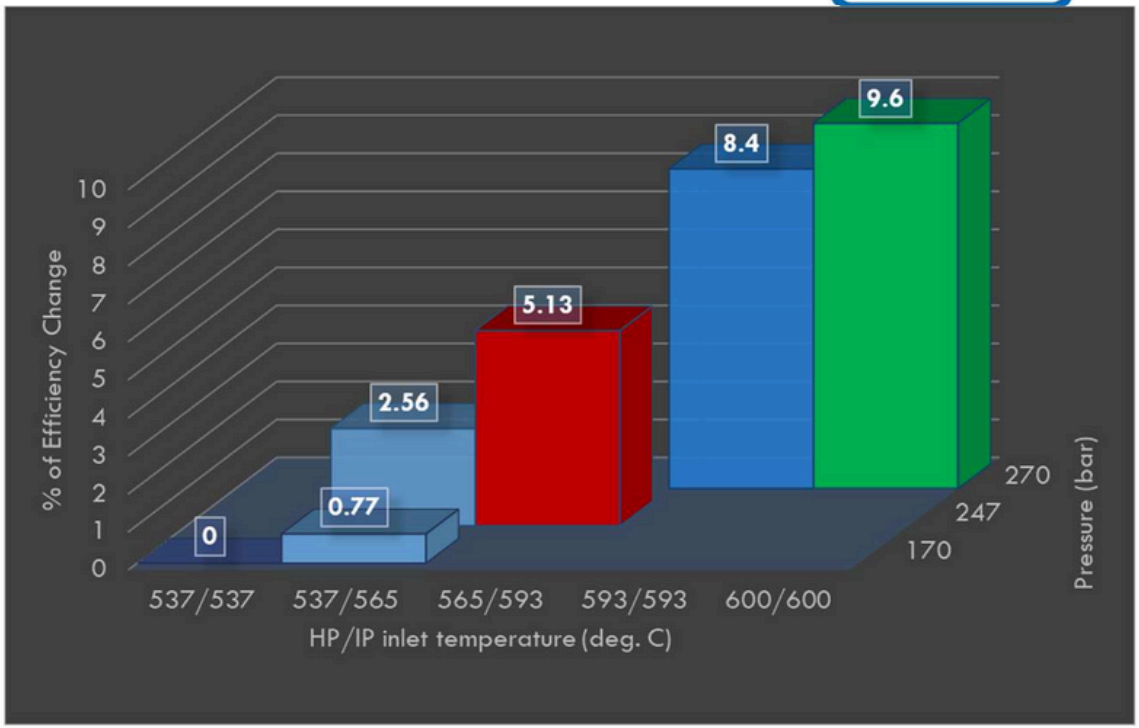
- Technology Upgradation & Efficiency Improvement
  - Fossil fuel is required for the Energy Security of our country
    - Moved from sub-critical to supercritical and onto ultra-supercritical technology
    - Efficiency Improvement of existing plant by R&M

- Upgradation to a Perpetual or Blue coal-based power plant
  - Migration to cleaner and greener coal power
    - Partial Carbon capture
    - Biomass cofiring
    - Ammonia and Methanol Co-firing

Enhancing Efficiency
Technology Upgradation

Improving Coal Technologies: Sub-critical→Supercritical →USC





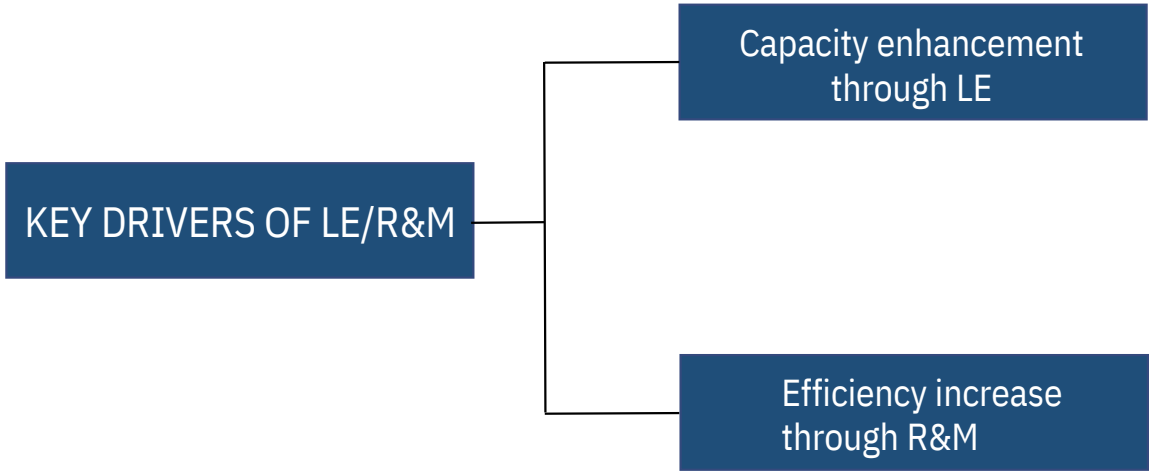
With increase in Efficiency from Sub critical to ultra Super critical. The following will reduce by 9.6%

- Reduction in Coal
- Reduction in CO_2
- SO_2 Decrease

Efficiency of the Rankine Cycle improves with increase in Temperature and Pressure. This is the basis of technology improvement from sub-critical (537°C/170kg) to Supercritical (565°C/247kg) to Ultra-Supercritical (600°C /270kg)

Enhancing Efficiency
By Renovation & Modernisation

Role of R&M in Decarbonization



Successful Cases	
Sta tion	Impact
Ramagundam	Turbine HR-10% improvement

Non-negotiable aspects

- Efficiency: Improvement in heat rate & reduction of aux. power consumption
- Flexibilization: Equipment prone to fatigue/creep phenomenon due to cycling, advanced process control, combustion optimization, mill scheduler etc.
- Reliability: Replacement with equipment of latest technology

CO2 Emission Reduction
Carbon Neutral and Low Carbon Fuel Cofiring

Bio-Mass Co-firing

Why Biomass Co-firing?

- Biomass is carbon-neutral fuel.
- Seasonal Stubble burning problem.
- Agro-Residue Potential : 18,728 MWe.

Benefits:

- Each % of biomass co-firing- Potential to reduce CO2 by same %
- Alternate fuel for Thermal Power Plant.
- Economic value to farmers for agro-residue.
- Reduced burning of farm-waste.
- Pollution reduction.

- Total Biomass fired by NTPC– ~300,000 MT
- (till date).

Capability Developed by NTPC in Co-firing:

- Non-torrefied: 10%.
- Torrefied :20%

Co-firing of Low-Carbon Fuel

Working for Methanol Co-firing

- Exploring Methanol Co-firing along with BHEL at Vindhyachal
- Exploring Methanol Co-firingpossibilities at Gas Plant
- MoU with GE for cofiring of Methanol

Benefit

- CO_2 Emission Reduction
- Replace HFO/LDO being used in power plants and can significantly reduce the imports.
- Circular Economy

Carbon Capture

Circular Economy from Fossil Fuel

CO_2 to Methanol
10 TPD Plant at NTPC Vindhyachal

20 TPD CO_2 Capture Plant
- Technology: Modified Tertiary Amine
- Commissioned on 15th Aug'22

2 TPD Hydrogen Plant
- Technology: Proton Exchange Membrane Electrolyzer

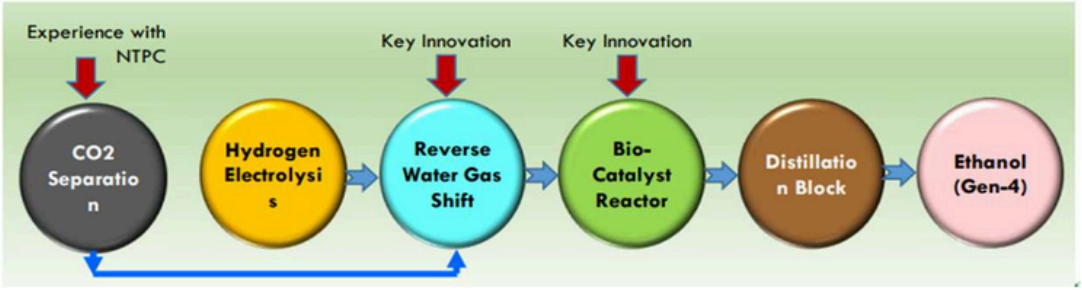
10 TPD Methanol Plant
- Technology: Heterogenous Catalytic Hydrogenation of CO_2

CO_2 to Generation-4 Ethanol
10 TPD Plant at NTPC Lara

Positioning: First 'CO_2 to Green Ethanol' Plant, globally.

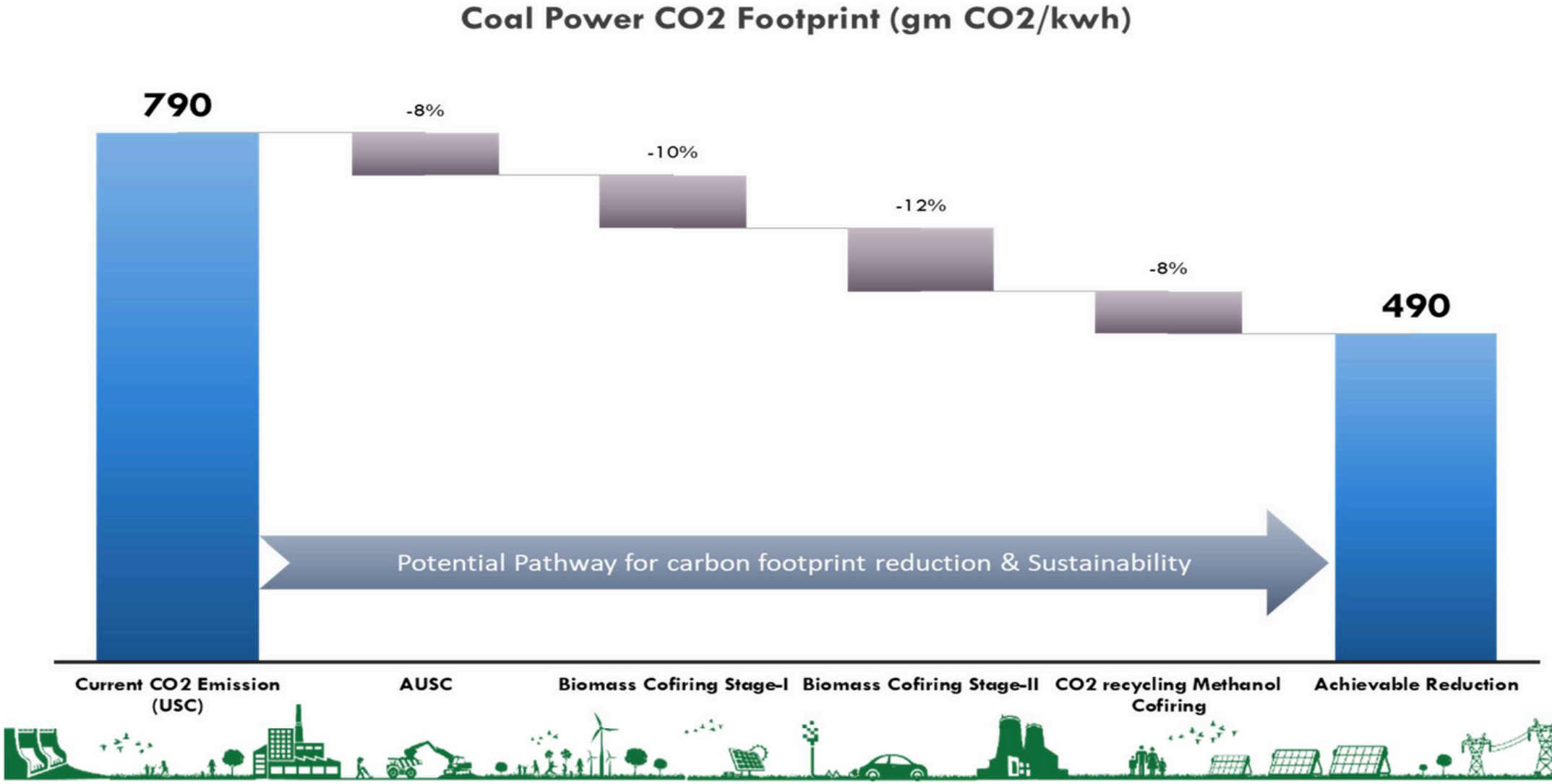
Rationale:
- **Connecting CCUS with 'Energy Security':**
  - ✓ Bigger market size – E20 petrol (20% ethanol blending) is already permitted
  - ✓ Market size likely to increase – E25 is minimum in Brazil
  - ✓ E100 vehicles already developed
  - ✓ Transition from G1-G2-G3-G4 Ethanol is already happening – required for sustainability

- **Higher price break even point:** G1 Ethanol Price is 47-67 Rs/Lit
- **Aviation Fuel:** Ethanol is the 'Starting Point' – Both Market Size & Price Point is attractive.
- **NTPCs Strength:** Processes both CO_2 resource & CO_2 capture experience

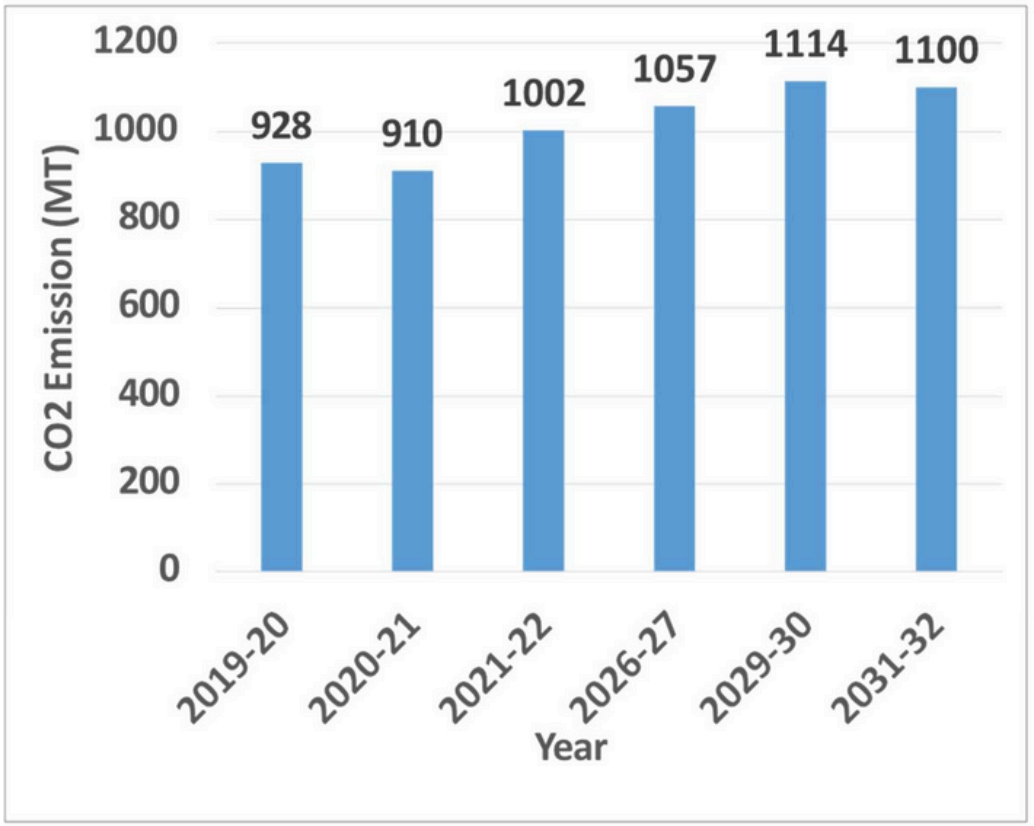


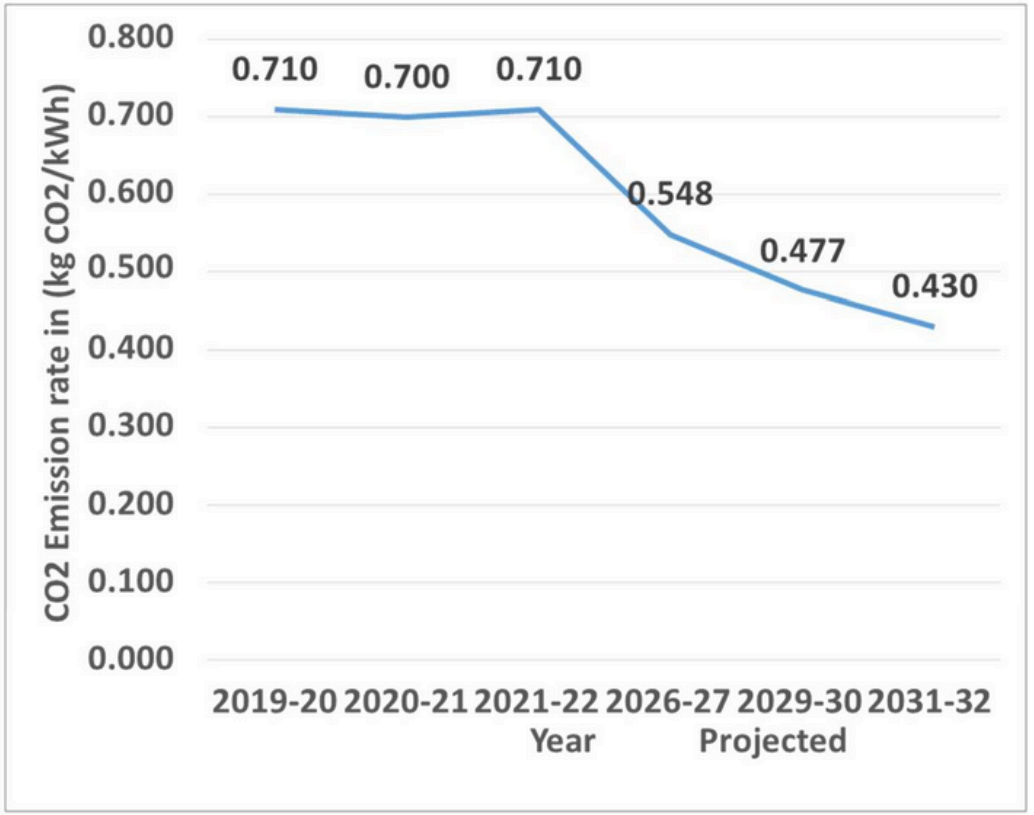
- Development of CO_2 Sequestered Aggregates 'Carbonated Aggregates'
  - By reacting CO_2 captured from flue gas with the fly-ash & other industrial waste with divalent Ca^{2+} or Mg^{2+}

NTPC: Decarbonization Roadmap for Coal-based Power



LikelyReductioninCO2Emissionsby2031-32from Power Sector

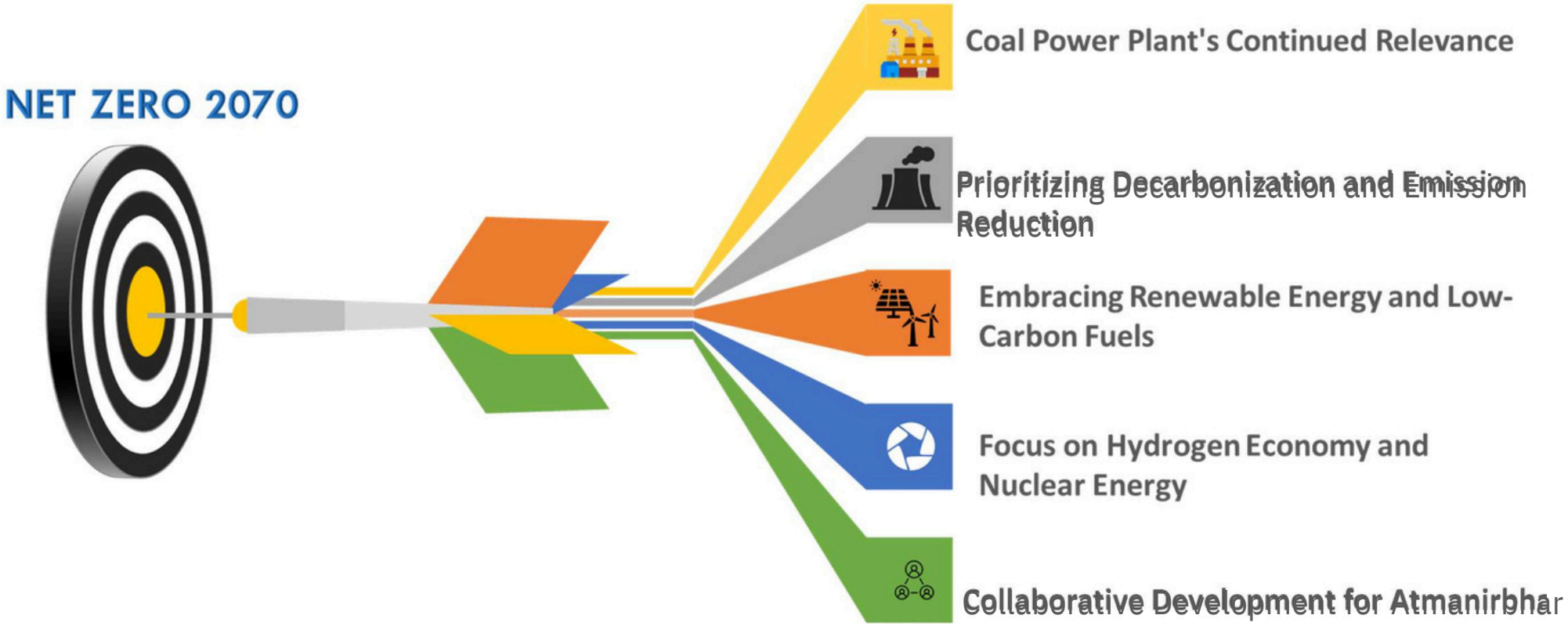




NTPC's Plan for Energy Mix

1. Plans to be a 130GW company by 2032 and annual generation of 600 BU
2. RE portfolio from 3.3 GW at present to 60 GW by 2032
3. Coal would continue as predominant fuel with 65% share of coal-based capacity till 2032 in the portfolio
4. 2032: Non-fossil fuel-based capacity would achieve a share of 30% and Thermal based generating capacity share would be 70%.
5. 2032: Share of RE (including hydro) would be 28%
6. 2032: NTPC aims to achieve 10% of the estimated market share for supply of electricity in E-mobility business

Way Ahead


NET ZERO 2070
Coal Power Plant's Continued Relevance
Prioritizing Decarbonization and Emission Reduction
Embracing Renewable Energy and Low-Carbon Fuels
Focus on Hydrogen Economy and Nuclear Energy
Collaborative Development for Atmanirbhar

Migratory Birds at NTPC Dadri

Thank You

NTPC Ramagundam

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Thanking You
on Behalf of !