

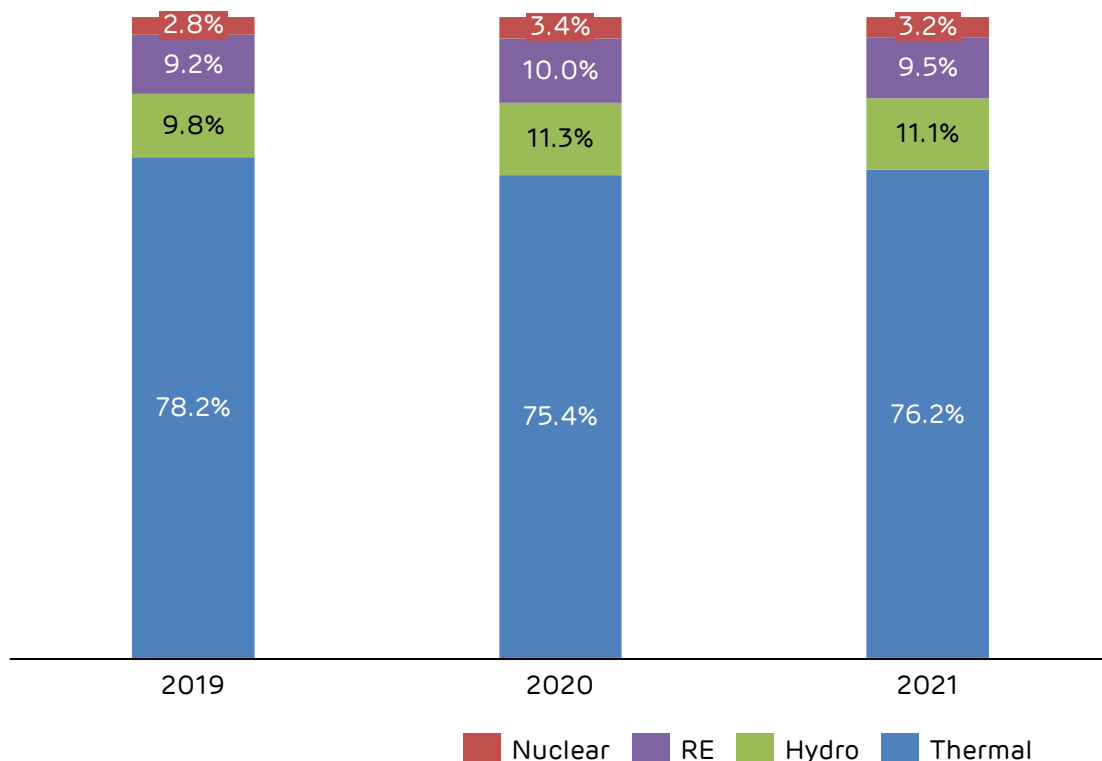
Coal: Sustainable energy for development

Indian Coal Forum

June 2021

>70% of India's electricity comes from coal but per capita coal consumption remains below developed economies

Although Coal is a dominant source of power generation in India...



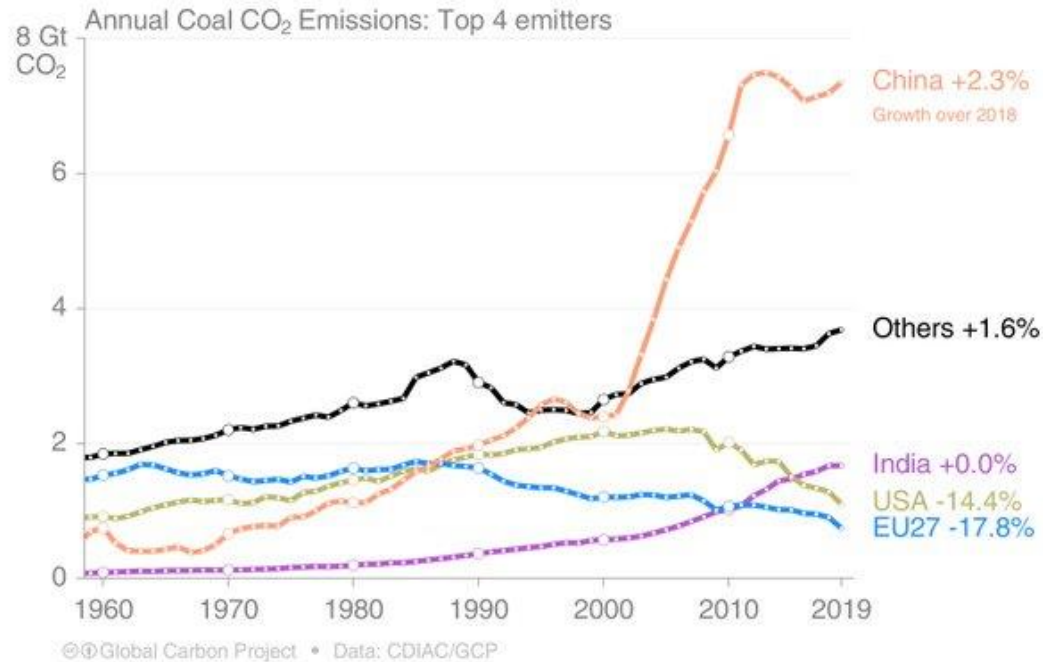
...per capita coal consumption is still below developed countries and world average

	Production (MT)	Consumption (MT)	Per capita coal consumption (Kg)
India	756	966	714
China	3,846	3,936	2,826
Unite States	640	507	1,553
Germany	134	244	2,941
Russia	440	174	1,202
World	8,129	7,658	1,009

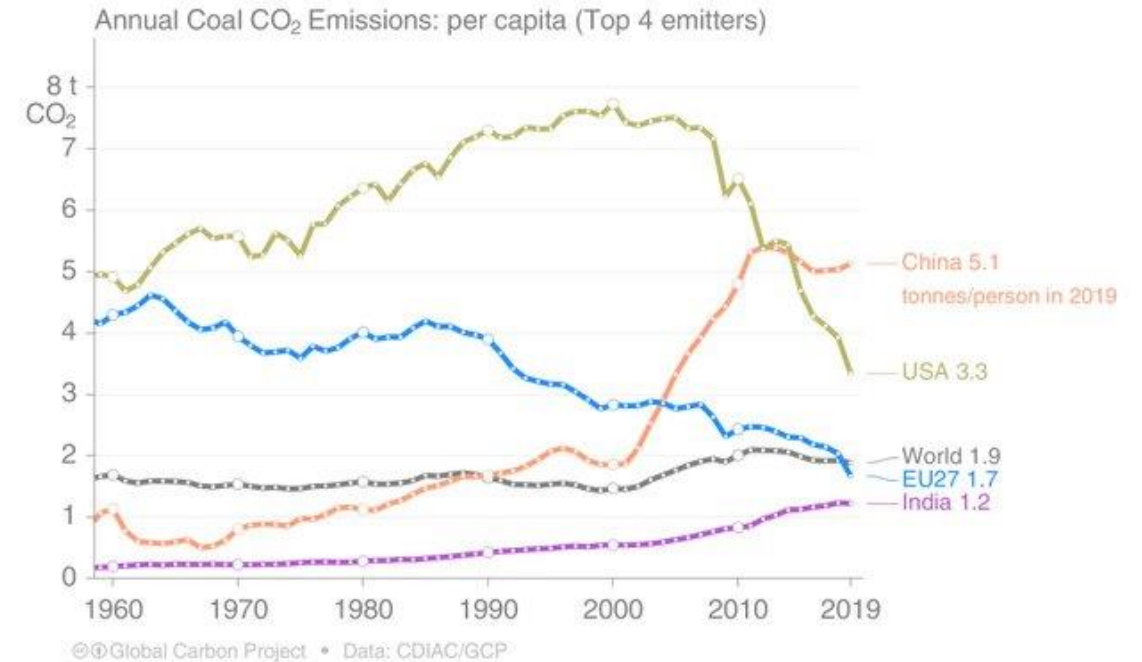
Source: CEA, BP statistical review 2020
 Note: Thermal includes Coal, Gas and Lignite generation

Both absolute and per capita CO2 emissions of India are well below the developed nations

Absolute CO2 emissions



Per capita CO2 emissions



India's per capita CO2 emissions are lower than most of the developed nations and world average too

Coal has a huge influence on the economy beyond the power/steel sectors and contributes significantly to creation of social infrastructure in the less developed regions of the country- taking life & livelihood to hinterland

Socio-economic contribution

Key stats

1
Revenue and employment generation in mineral rich states

>5Lac

Direct Jobs

3%-10%

Coal share in Economy*

2
Important source of revenue for Government

25K Cr+

Govt revenue through Coal cess, CIL dividends in addition to royalties

>30%

Indian Railways revenue comes from Coal Freight

3
Creating social infrastructure in mineral rich states

1500+

Isolation beds set up by CIL across 8 states for Covid-19

40+ Schools

Currently run by NTPC



Dedicated COVID hospital by MCL



Upskilling youth through education programs

*For mineral rich states
<https://www.livemint.com/companies/news/govt-to-get-rs-3-056-crore-dividend-from-coal-india-11605112770102.html>
<https://www.statista.com/statistics/741257/india-railways-revenue-distribution-by-segment/>

Not all coal plants are the same – substantial emission reductions can be achieved by simply shifting generation to super critical and ultra-super critical plants

Every **800 MW USC** unit is equivalent to **600 MW Solar** capacity in terms of avoided emissions

	Value	Unit
Ultra super critical unit size	800	MW
Units generated @ 85% PLF	5960	MUs
National Emission intensity ¹	0.97	T/Mwh
Ultra super-critical emission intensity	0.8	T/Mwh
Avoided CO2 emissions per 800 MW unit	1.0	MT
RE MUs reqd to displace equivalent CO2	1044	MUs
Equivalent RE capacity @ 20% CUF	600	MW

The GHG intensity of the Indian coal-power sector may be reduced by **13%** by retiring plants with the lowest efficiencies and replacing them with higher efficiency supercritical plants³

– Mallapragada, Ganesan, Naik, Banerjee, Laurenzi

Total amount of flue gas emitted from the ultra-supercritical plant is about 14 per cent smaller than similar capacity sub-critical power generation unit²

– Lauri Myllyvirta (climate expert)

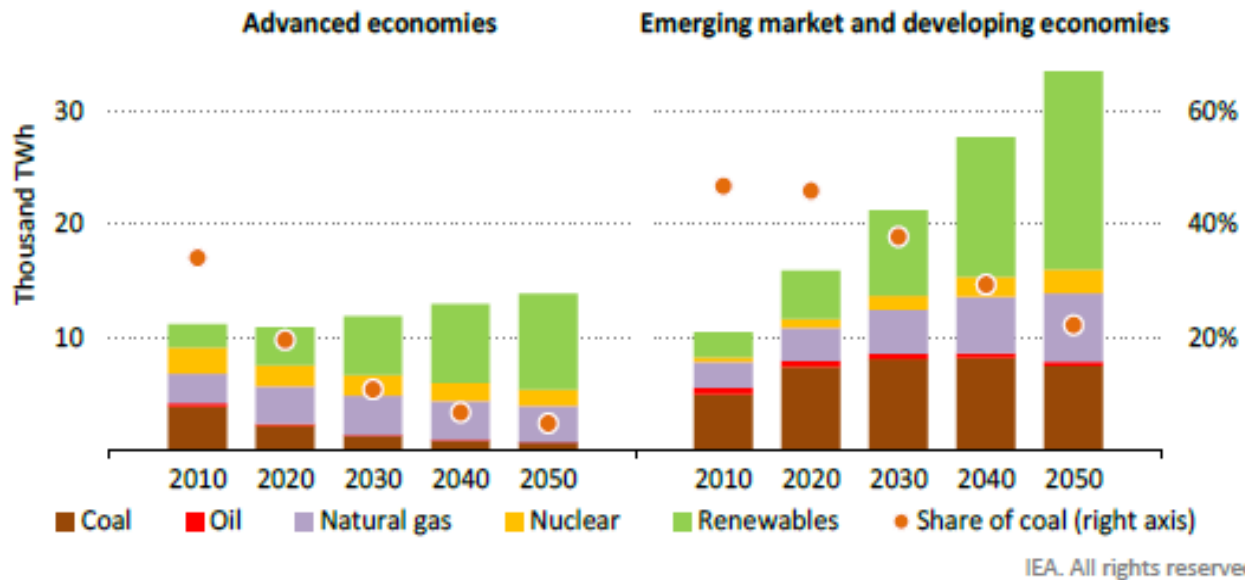
Specific coal consumption should be factored into MOD to enable more benign generation

Sources:

1. CEA CO2 baseline database
2. <https://energypost.eu/how-much-do-ultra-supercritical-coal-plants-really-reduce-air-pollution/> (Authors: Lauri Myllyvirta published in June'17)
3. <https://www.researchgate.net/publication/329298806>, (Authors: Dharik Mallapragada, Karthik Ganesan, Indraneel Naik, Rangan Banerjee, Ian J. Laurenzi Published in Nov'18)

Coal will have a major role to play as emerging markets develop with a greater share of electricity in their energy mix

Electricity generation by fuel type in IEA Stated Policies Scenario¹



Emerging markets develop with a higher share of electricity in energy mix (e.g., EVs, Industrial processes based on electricity, electric heating). Various reports predict 2.5-5X expansion in sector by 2050

Benefits:

- Shifting pollution from population centers,
- Greater efficiencies
- Lower carbon footprint

Enabling trends:

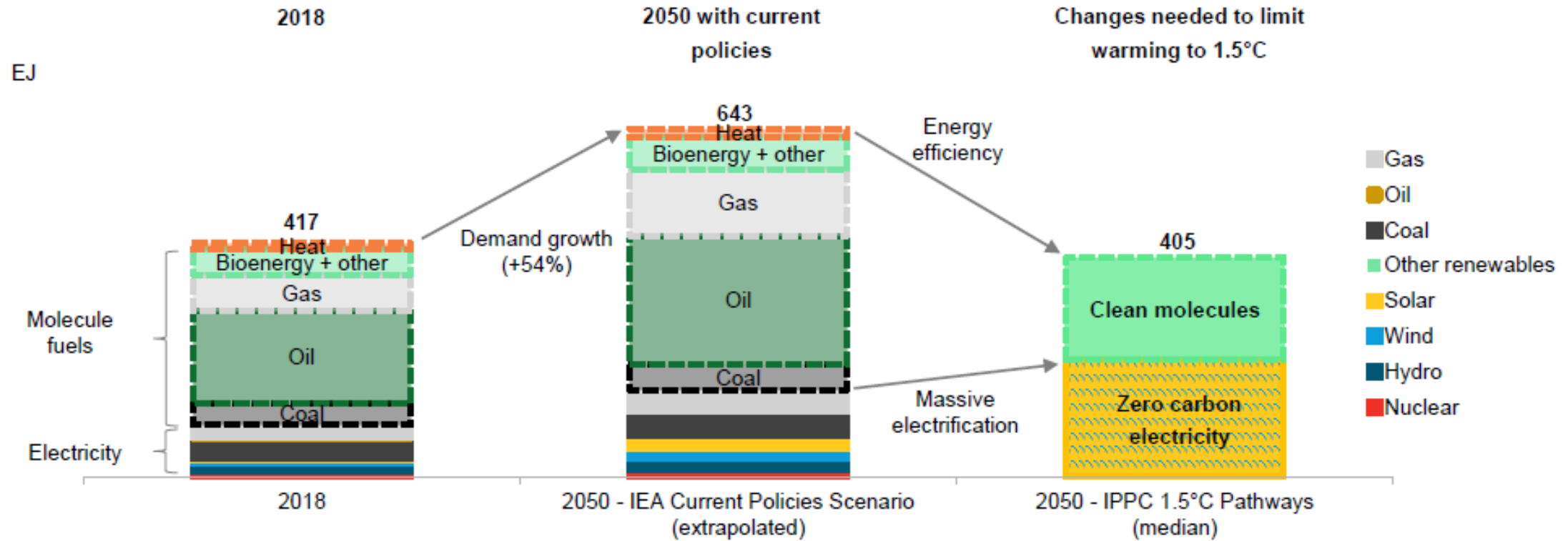
- Electric vehicles
- Electric arc furnaces substituting Blast furnaces
- Fuels produced from electricity (e.g., hydrogen)

Implication:

- For the next few decades, large scale coal plants will have to support this effort

1. IEA Stated policies scenario includes all policies in place or announced by Governments

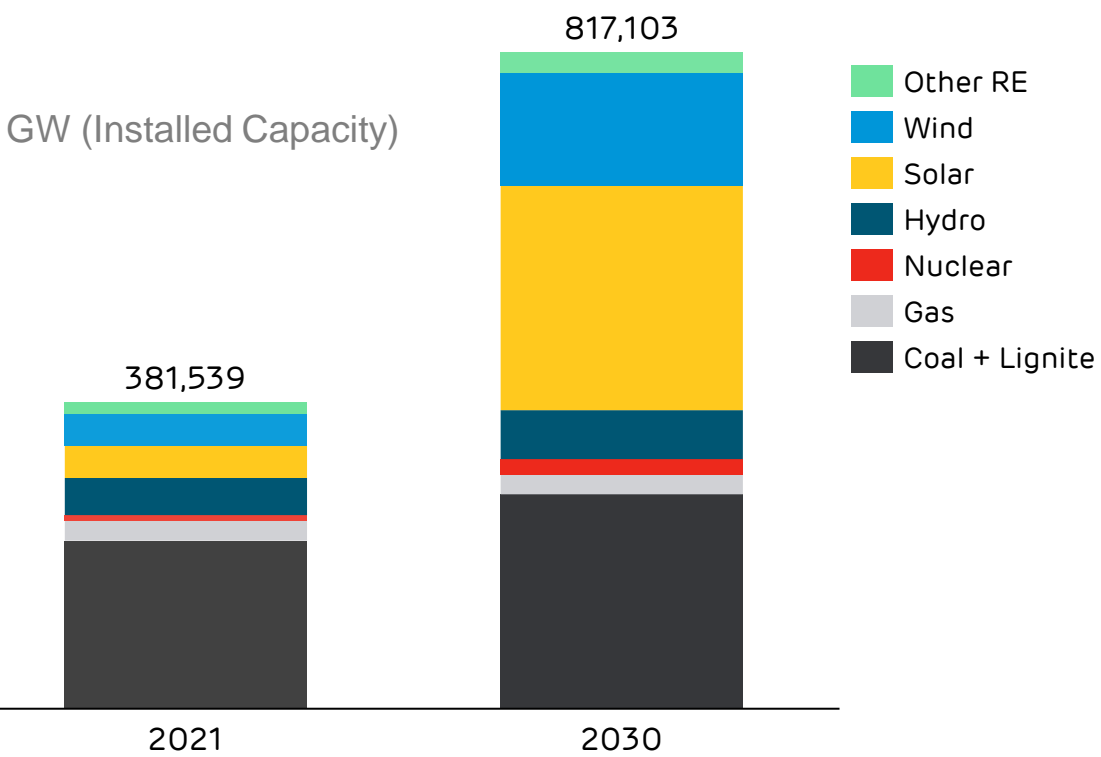
Electrification is likely to drive significant energy demand



Source: BloombergNEF, IEA, IPCC. Note: The IEA's Current Policies Scenario is extrapolated using data from 2030 and 2040 to approximate final energy consumption in 2050. The 1.5°C compatible pathway is the median value for the 53 pathways analysed by the IPCC limiting global warming below 1.5°C, or 1.5°C with limited overshoot.

Innovation will play a key role as the supply mix changes over the next few decades - Flexibility of coal plants

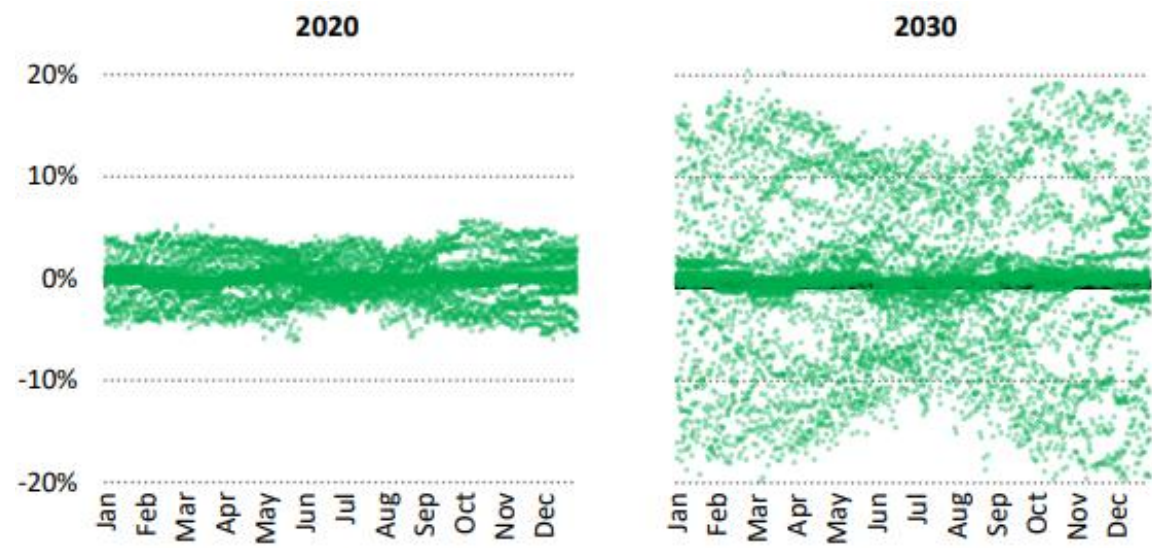
High RE is expected to be penetrated in the Indian grid by 2030....



Source: CEA optimal energy mix report

....resulting in higher variable generation and making it necessary to have a flexibility option

Hour to hour change in generation from variable RE (wind & solar) as % of average annual demand



Source: IEA India Energy Outlook 2021 (Stated policies scenario)

India needs to build flexibility in the existing coal plants to address the variable RE challenge and to provide grid stability

Intensifying competition in the sector will require greater emphasis on creating value for end user

Customer mindset & value will be increasingly important

Coal facing **increasing competition** from other sectors, such as **Renewables**, as well as within with **Commercial mining**

Evacuation infrastructure

- **Share of rail mode:** Accelerated increase in share of rail mode dispatch from current 50% & benign transportation
- **Tripartite agreements:** Enforceable tripartite fuel agreements between consumers, Railways and producers

Coal Quality

- **Grade slippage:** Reducing grade slippages, true-up based on actual grades supplied, full compensation for slippage (including taxes) and efficient processing of claims
- **Uncrushed coal:** Minimizing uncrushed 250 MM coal & providing sized coal; Coal processing to be a MUST!

Pricing for volumes

- **Reducing escalation:** Coal price escalation greater than WPI/CPI. Critical for future volumes - thermal sector needs to be able to compete for offtake - retaining Indian differentiation
- **Reducing e-auction premiums &** making commercially available

Streamlining process for better experience

- **ERP system:** To smoothen transactions in a seamless manner
- **Better tracking:** Use of ICT and analytics to reduce inefficiencies
- **Agility:** Relaxation of ACQ, waiving of performance incentive in situation of excess coal stocks and host of other charges

It is an opportune time for coal plants to push for adoption of benign technology to reduce coal consumption

	Technology area	Description	Global example
1	Blending with alternative fuels	Using hydrogen, ammonia as firing fuel in boilers to reduce the carbon emissions and increase the cost competitiveness	JERA is planning to pilot 20% ammonia blending and aims to convert 100% of coal fleet to ammonia by 2050
2	Use of digital and analytics	Use of AI algorithms to tune the combustion through data from flue gas, steam temp, boiler efficiency, combustion balance	Taiwan Power Company using AI system of Mitsubishi Hitachi, Adani undertaking similar initiative at Kawai & Tiroda
3	Carbon capture technologies	Capturing the carbon emitted from power generation and transporting it via ship or pipeline to store it underground in geological formations	Viridor plans to be net negative by 2045 through carbon capture and storage

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Converting hydrogen into continuous heat and using it to replace coal in boilers is going to be the catalyst for a zero-emission future

-Star Scientific Co.

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Government should frame a comprehensive roadmap on coal fired power and its role in transition



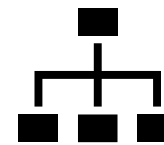
Pace of new additions and retirements

Modulating the pace of retirements and new additions depending on RE penetration and demand growth



Investment in new technologies

Creating policy mechanisms to support development and adoption of new technologies like flexibility, efficiency and decarbonization



Clarity on the 20-30 year vision for the coal sector

Direction for investors and stakeholders on the long term 20-30 year roadmap for the sector, roadmap on getting the insurance



Development of local capabilities

A policy mechanism to build local ecosystem (R&M, insurance and financing, digital and analytics) through skill building for continued support to the thermal sector

..... the journey continues!

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