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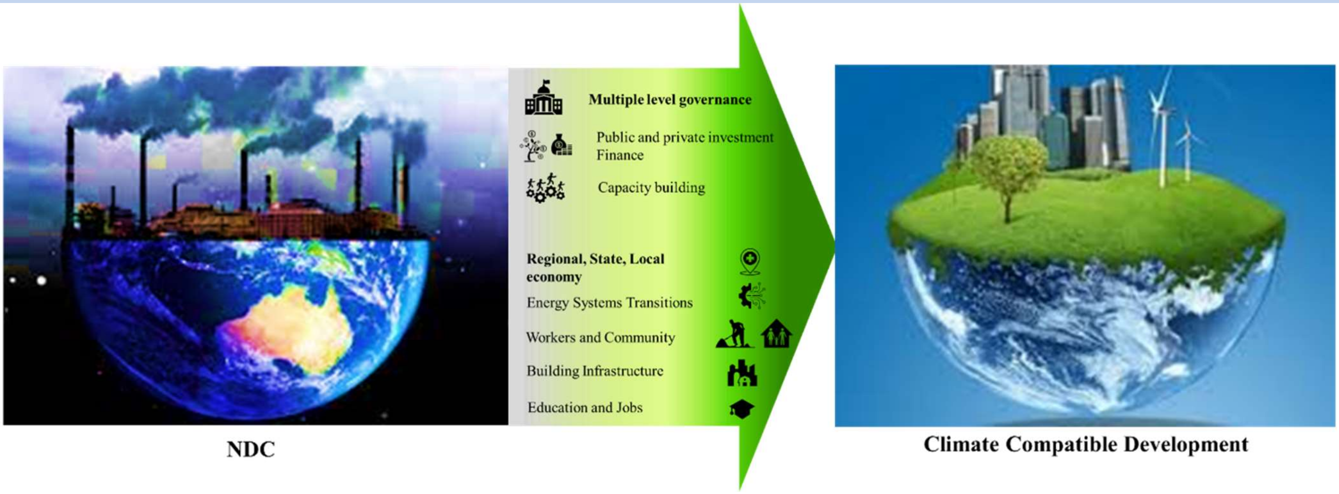
Assessing NDC and climate compatible development pathways for India

Saritha Sudharmma Vishwanathan[1*], Panagiotis Fragkos[2], and Amit Garg[3]

Key Messages

- India will exceed its main NDC targets before 2030; however, it will not be able to reach net zero in 2050 under a climate compatible development (CCD) scenario.
- Emissions will not peak before 2050 in NDC scenario, but may peak around 2040 in CCD scenario.
- Uncertainties will be observed at supply level depending on the type of fuels (coal domestic production, natural gas imports, nuclear fuel production/import, bioenergy, and supply chains) and the future development of renewable energy sources including storage, availability of critical minerals in addition to social acceptability and geological uncertainties of Carbon Capture Use and Storage.
- About 227 billion tonnes of coal will be stranded between 2020 and 2050 with a total cost of around 6.5 trillion USD but renewable energy offers significant opportunities through modernization of the grid and creation of new jobs.



Transitions towards decarbonized India

India's Nationally Determined Contribution (NDC) includes: (a) a reduction of emission intensity of its GDP by 33–35% during 2005–2030 (unconditional target); (b) an increase in the share of non-fossil-based energy resources to 40% of installed electric generation capacity (conditional target); and (c) the creation of a cumulative carbon sink of 2.5–3 Gt-CO2e through additional forest and tree cover by 2030 [1, 2].

India has reduced its emission intensity of gross domestic product (GDP) by 24% between 2005 and 2016 [3]. According to our current estimates in 2019, India is the only large developing country that has achieved its 2020 Copenhagen Pledge (~27.7% reduction by 2019, excluding landuse, landuse change, and forestry (LULUCF)) and is diligently following its NDC targets. Indian actions will contribute to the transition towards 2°C and subsequently 1.5°C world [5, 6, 7]. The current share of non-fossil fuels in installed electrical capacity is around 38%, showing clear progress by India towards this NDC target [4].

India is one of the key players in the international climate policy debate – along with Europe, the United States of America, and China – aiming to achieve the Paris Agreement goals, while ensuring that citizens have access to affordable, sustainable electricity and clean cooking to improve their socio-economic conditions. India's climate plan includes a halt in the construction of new coal-based power plants, in addition to the introduction of ambitious renewable energy targets by 2030.

After Paris, India has raised its renewable ambition from 100 GW by 2020 to 175 GW by 2022 and 450 GW by 2030. This has been complemented by sectoral policies and market instruments to support and enhance the transformation. However domestic coal is projected to remain as an essential fuel to fulfil Indian energy requirements by 2030 under ongoing policies.

Methodology

Our study provides a quantitative model-based assessment to address the socio-technical, politico-economic, and financial implications of India shifting away from coal. We have coupled the bottom-up technology-rich energy system model, AIM/Enduse India [6,7,8] with a macroeconomic computable general equilibrium (CGE) model, GEM-E3 [8, 9, 10], that provides details on the complex interactions of energy transition with the economy and labour market. Two main scenarios have been explored, namely: current NDC and climate compatible development (CCD) scenarios. The NDC scenario captures the ongoing policies while the CCD scenario ratchets up these policies, especially pertaining to renewables and energy efficiency policies (**Table 1**).

The study provides insights on the challenges in achieving decarbonization in India related to energy security, accessibility, grid stability, and affordability goals, and on the new opportunities from energy sector restructuring, including reduction of local pollution and creation of new green jobs [11].

Key results

In the *NDC scenario*, the coal consumption increases to about 1.07 billion tonnes (bt) between 2020 and 2050 with a compounded annual growth rate (CAGR) of 0.49% over 30 years. The coking coal demand increases to 90–120 Mt between 2030 and 2050. This is because coal will be used as the base load under ongoing policies, combined with a rapid increase in share of renewables. The stabilization is due to a combination of energy efficiency and shifting to renewables in all sectors (power, industry, transport, residential, and commercial sectors).

In the *CCD scenario*, the total coal demand decreases to around 0.69 bt in 2050 with a CAGR of -0.94% over 30 years. This is driven by a rapid increase in the share of renewable energy (mostly wind and PV) with nuclear, large hydro, and a small share of gas serving as the base load after 2030.

The cumulative emissions between 2020 and 2050 are 111 btCO_2, and 98 btCO_2 for NDC and CCD scenarios respectively. When compared to NDC, total CO_2 emissions in the CCD scenario are reduced by 9% in 2030 and 28% in 2050 (**Figure 1**).

Figure 1: Coal demand and Carbon dioxide emissions in India

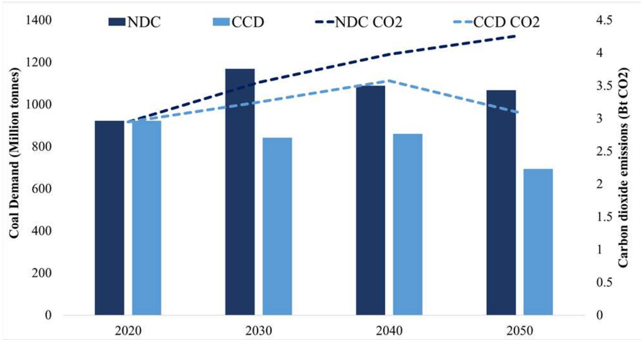


Table 1: NDC and CCD scenario description

Sector	NDC	CCD
Power	175 GW renewables; Transmission and Distribution (T&D) losses reduces by 6–7%; Phase our old, inefficient plants by 2040.	250 GW renewables; T&D losses reduces by 8–10%; Phase our old, inefficient plants by 2030.
Industry	Improve Energy Efficiency (EE) through Perform, Achieve, and Trade (PAT) Cycles.	Ratcheting EE through widening and deepening of PAT Cycles in medium and small enterprises (MSMEs) in addition to large point sources (LPS).
Transport	Ethanol blending: 2%; EV penetration: 30 per cent of private cars, 50 per cent of commercial cars, 30 per cent of buses and 60 per cent of two and three-wheelers by 2030.	Ethanol blending: 5%; EV penetration: 30 per cent of private cars, 70 per cent of commercial cars, 40 per cent of buses and 80 per cent of two and three-wheelers by 2030.
Building	EE AC penetration: (i) reduce cooling demand across sectors by 10% to 15% by 2040, (ii) reduce refrigerant demand by 10% to 15% by 2040, (iii) Reduce cooling energy requirements by 5% to 10% by 2040.	EE AC penetration: (i) reduce cooling demand across sectors by 20% to 25% by 2040, (ii) reduce refrigerant demand by 25% to 30% by 2040, (iii) Reduce cooling energy requirements by 25% to 40% by 2040.

Discussion and Conclusion

It is evident that the future of coal hinges on how the power, as well as industry, sector transforms in the coming decades. The decrease of coal use in the CCD scenario in the electricity sector is due to the combined impact of 1) increased uptake of renewable energy, 2) a decrease in transmission and distribution losses, 3) an increase in fuel and technical efficiency in thermal based power plants and 4) a shift of base load to nuclear and large hydro, with storage providing flexibility to the power grid. Industrial emissions also decline due to electrification combined with a decarbonized power grid in addition to the implementation of the energy efficient programme (PAT) under the National Mission for Enhanced Energy Efficiency (NMEEE) and installation of Carbon Capture Use and Storage (CCUS), especially in energy intensive industries like steel and cement.

Overall, the increased deployment of low-carbon technologies in the CCD scenario requires high investment to be redirected to clean energy options. The feasibility of the scenario is dependent on various factors ranging from the provision of low-cost financial investment, relevant technology transfers, capacity building, and increased social acceptance of the transition away from fossil fuels, especially coal.

Stranded assets in the form of coal reserves and coal-based power plants will increase as a consequence of ambitious climate policies. About 227 billion tonnes of coal (reserves and unused coal from CCD scenario) will remain unutilized between 2020 and 2050 with a total cost of roughly around 6.5 trillion USD. Stranded assets in power plants will also increase massively, especially related to coal-fired plants. **Therefore, both coal and power sectors need to develop a coherent strategy for future energy systems to manage transition risks and avoid stranded assets.**

Uncertainties will be observed at supply level depending on the type of fuels (coal domestic production, natural gas imports, nuclear fuel production/import, bioenergy, and supply chains) and the future development of renewable energy sources. This development includes the storage and availability of critical minerals. The social acceptability and geological uncertainties of CCUS are additional factors.

The energy sector transformation resulting from the accelerated uptake of renewable energy, electrification of end services, and energy efficiency will also bring substantial co-benefits for Indian development. These include reduced local air pollution and thus improved human health (especially in large cities), as well as reduced energy imports thus improving India's trade balance. Our socio-economic analysis also shows that this transition will not have large impacts on GDP and employment, but it will cause sectoral shifts: coal-related jobs will decline, posing significant challenges for regions heavily dependent on coal activities. On the other hand, employment opportunities massively increase in clean energy industries and construction and electricity sectors, suggesting that **there is a need for policies to ensure soft-landing, especially for fossil-energy based workers.**

India will exceed its main NDC targets before 2030, but it will not reach net-zero in 2050 under the CCD scenario. Indian emissions have not yet peaked and are likely to peak after 2050 under the NDC scenario, while around 2040 under the CCD scenario, indicating a net-zero target by 2070–80, similar to the trajectory of industrialized countries with carbon neutrality targets set 30–40 years after emissions peaking. Hence, under the CCD scenario, India will **need to not only restructure its coal-based electricity and industry sector but also will need to implement the process in an equitable manner, ensuring that no state, region, or household is left behind.**

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Notes

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The academic work does not in any way represent our considered opinion for climate negotiations and also does not reflect the official policy or position of the Government of India.

Author Information

Affiliations

[1] Social Systems Division, National Institute for Environmental Studies, Tsukuba, Japan.

[2] E3Modelling S.A., Panormou 70-72, Athens, Greece.

[3] Public Systems Group, Indian Institute of Management Ahmedabad, Gujarat, India.

**Corresponding author*

sarithasv@iima.ac.in