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UNCERTAINTY-BASED SCENARIO ASSESSMENT FOR INDIA TO ACHIEVE ITS NDC TARGET AND INFORM MID-CENTURY STRATEGY

To inform pathways for India to achieve its NDC commitment, the Council on Energy, Environment and Water (CEEW) generated 200+ scenarios for an uncertainty-based assessment. The analysis projects the evolution of India's electricity generation-mix and energy mix in an uncertain future and analyses the impact of variable renewable energy (VRE) integration cost, energy efficiency improvement rate, and behaviour of energy demand in end-use sectors on these pathways.

It highlights the key uncertainties that India has to address to meet its NDC target of 40 per cent non-fossil share in electricity generation capacity mix, and of reducing the emission intensity (EI) of its GDP by 33-35 per cent from 2005 levels by 2030.

48%

estimated decline in CO_2 EI of GDP between 2005 and 2030 driven by significant energy-efficiency improvements and increasing share of electricity in end-use sector

but

37%

estimated decline in CO_2 EI of GDP between 2005 and 2030 if energy efficiency in end-use sectors improves at a lower rate, industrial and transportation energy demand grows at a faster pace, and electricity's share in industrial energy use doesn't increase

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48%

estimated share of non-fossil sources in India's electricity generation capacity mix in 2030; 59 per cent in 2050

10%

reduction in electricity consumption compared to reference growth scenario in 2030 with low economic growth rate, while a high growth leads to an increase by 12 per cent.

All data points CEEW analysis.

"Understanding key uncertainties that could impact India's climate policy is critical, yet there is almost no focus on this issue in India's energy and climate policy modelling literature. CEEW's attempt is an initial step in the direction to better characterise the uncertainties that impact India's energy system. We find that India's energy and climate policy is highly sensitive to uncertainties related to the solar and wind electricity grid integration cost and its distribution across investors, rate of industrial energy efficiency improvements, and the share of electricity in industrial energy use.

DR VAIBHAV CHATURVEDI
Research Fellow, CEEW
He leads the research on Low-Carbon Pathways at The Council

Image: Pexels

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Study methodology

Multi-Stakeholder Insights

- Indian private sector renewable energy experts- for insights on the future of India's renewable energy
- Government representatives from the Ministry of New and Renewable Energy, Ministry of Power, National Thermal Power Corporation, Central Electricity Authority - to inform scenario design
- International expert - Dr Robert Pietzcker, Energy Expert (PIK, Germany) - for VRE integration cost
- Researchers within India and across the world - for their inputs during various stages of the study

Integrated Assessment Modeling

- Global Change Assessment Model (GCAM)
- A detailed energy sector model used extensively for global and India-specific analysis.
- Modelling electricity generation growth and technology share
- Modelling end-use energy demand
- Modelling energy access

Scenarios

A combination of 72 unique technology cost combination pathways for each of the three economic growth rate leads to 216 pathways, thus spanning a range of uncertainties. The uncertainties include:

- Uncertainty in cost of power generating technologies
- Uncertainty in the growth rate of the Indian economy

Six additional scenarios test the uncertainty in the energy efficiency and behaviour of energy demand in the end-use sectors

Range for the different parameters across 216 scenarios

		2015	2030	2050			2015	2030	2050	
GDP (TRILLION 2015 USD)	MAX	2.1	6.9	26.3	TOTAL PRIMARY ENERGY CONSUMPTION (MTOE)	MAX	699	1387	3053	
	BAU		6.1	20.3		BAU		1261	2450	
	MIN		5.5	14.5		MIN		1119	1802	
ELECTRICITY GENERATION-UTILITY (BILLION KWH)	MAX	1107	3281	8306	PRIMARY ENERGY COAL (MTOE)	MAX	407	809	1598	
	BAU		2816	6460		BAU		710	1229	
	MIN		2276	4523		MIN		584	767	
ELECTRICITY GENERATION CAPACITY (GW)	MAX	302	900	2877	PRIMARY ENERGY OIL (MTOE)	MAX	195	395	867	*Data points shows the uncertainty in electricity generation cost and economic growth rate. No climate policy assumed. If energy efficiency across sectors improves at a lower rate, industrial and transport energy demand grows at a fast pace, and electricity's share in industrial energy use does not increase, the emission intensity of India's GDP will increase by 11 percentage points in 2030, relative to the reference scenario.
	BAU		677	1704		BAU		336	689	
	MIN		558	1097		MIN		302	524	
SOLAR CAPACITY (GW)	MAX	6.2	397	1961	TOTAL FINAL ENERGY CONSUMPTION (MTOE)	MAX	423	934	2031	
	BAU		186	738		BAU		848	1753	
	MIN		108	316		MIN		762	1472	
COAL CAPACITY (GW)	MAX	185	313	651	FINAL ENERGY TRANSPORT (MTOE)	MAX	83	198	548	
	BAU		277	495		BAU		179	442	
	MIN		220	278		MIN		163	333	
CO_2 EMISSIONS ($MTCO_2$)	MAX	2221	4777	9867	FINAL ENERGY BUILDING (MTOE)	MAX	114	150	371	
	BAU		4180	7697		BAU		154	315	
	MIN		3581	5277		MIN		139	251	
CO_2 EMISSIONS PER CAPITA (TCO_2/CAPITA)	MAX	1.76	3.2	5.9	FINAL ENERGY INDUSTRY (MTOE)	MAX	225	587	1232	
	BAU		2.8	4.2		BAU		515	996	
	MIN		2.4	3.2		MIN		460	768	

Source: CEEW analysis

Comparison between business-as-usual (BAU) and 2°C scenarios for India in 2050

GDP (TRILLION 2015 USD)	BAU	20.3	TOTAL PRIMARY ENERGY CONSUMPTION (MTOE)	BAU	2450
	2°C	20.3		2°C	1969
ELECTRICITY GENERATION-UTILITY (BILLION KWH)	BAU	6460	PRIMARY ENERGY COAL (MTOE)	BAU	1229
	2°C	9963		2°C	136
ELECTRICITY GENERATION CAPACITY (GW)	BAU	1704	PRIMARY ENERGY OIL (MTOE)	BAU	689
	2°C	5267		2°C	437
SOLAR CAPACITY (GW)	BAU	738	TOTAL FINAL ENERGY CONSUMPTION (MTOE)	BAU	1753
	2°C	4425		2°C	1454
COAL CAPACITY (GW)	BAU	495	FINAL ENERGY TRANSPORT (MTOE)	BAU	442
	2°C	37.6		2°C	389
CO_2 EMISSIONS ($MTCO_2$)	BAU	7697	FINAL ENERGY BUILDING (MTOE)	BAU	315
	2°C	1663		2°C	205
CO_2 EMISSIONS PER CAPITA (TCO_2/CAPITA)	BAU	4.2	FINAL ENERGY INDUSTRY (MTOE)	BAU	996
	2°C	1.0		2°C	860

Source: CEEW analysis

Progress towards India's NDC commitment and Mid-Century Strategy

Parameter	2030	2050
Share of non-fossil sources in India's electricity generation capacity	48% to 68%	57% to 84%
Reduction in EI of GDP as compared to 2005 levels	48% to 54%	70% to 81%

Source: CEEW analysis

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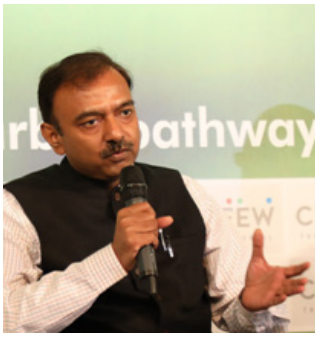

Dr Anil Kakodkar, Dr Navroz Dubash, and **Mr Amit Kulshreshtha** at the CEEW Dialogue - 'India's Energy and Climate Policy: Pathways towards NDC and Mid-Century Strategy' April 2018.

"India's future energy mix must focus on universal energy access, social development, and economic growth. We must consider nuclear energy, as it is the only reliable non-fossil fuel source of electricity. All other energy sources are unpredictable and variable. We need to set up 20 nuclear plants with a 32 GW capacity, with international collaborations. In addition, we must focus on other technologies, including coal-bed methane, coal gasification, splitting water for hydrogen, solar thermal, etc.

DR ANIL KAKODKAR
Research Fellow, CEEW

Trustee, CEEW, and Former Chairman, Atomic Energy Commission

"The perception whether the Paris gamble has paid off will be determined by modelling studies like this. Though this study is 2050 based, it is important in shifting the politics.

DR NAVROZ K. DUBASH

Professor and Coordinator- Initiative on Climate, Energy, and Environment, Centre for Policy Research (CPR)

"While there has been international research on the cost of the integration of renewables in the power generation mix CEEW's research is the first credible study in the Indian scenario.

AMIT KULSHRESHTHA

Additional General Manager, National Thermal Power Corporation (NTPC)

CEEW Research

Sustainable Development, Uncertainties, and India's Climate Policy: Pathways towards Nationally Determined Contribution and Mid-Century Strategy.

CEEW Report | April 2018

https://bit.ly/2or2FW6

Images: CEEW

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The Council on Energy, Environment and Water is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain-and change-the use, reuse, and misuse of resources.

Ranked the best in South Asia with an annual operating budget of less than USD 5 million, five years in a row. Among top 100 out of 6,846 think tanks in eight categories.

Global Go To Think Tank Index, 2018

Ranked 2nd in the 'International Energy' category for its pioneering study on solar-powered healthcare.

Prospect Think Tank Awards, 2018

Ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks.

ICCG Climate Think Tank's standardised rankings, 2016

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