Vaibhav Chaturvedi
Poonam Nagar Koti
Anjali Ramakrishnan Chordia

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Renewables

Power Sector

Industrial Sustainability & Competitiveness

Low-Carbon Pathways

Risks & Adaptation

Technology, Finance, & Trade

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The Larger Context

- **Nationally Determined Contribution and Mid-Century Strategy**
  - Together these intend to achieve the goals of the Paris Agreement
  - A lot has changed since October 2015, Could there be scenarios under which NDC targets would not be achieved?

- **Uncertainties**
  - Lack of literature on key uncertainties for India's energy and climate policy

- **Sustainable Development and National Priorities**
  - Could a stringent climate policy impact sustainable development and national priorities?

Research Objectives

Electricity generation

- Evolution of electricity generation mix under an uncertain future and implication for progress towards the NDC target of 40% share of non-fossil sources in electricity generation capacity

Emissions and Emissions Intensity

- Evolution of long-term carbon dioxide emissions under an uncertain future and implication for progress towards the NDC target of 33-35% reduction in emissions intensity of India's GDP between 2005 and 2030

Mid-Century Strategy and Sustainable Development

- Insights for India's 'Mid-Century Strategy'
- Aligning India's climate policy with sustainable development and priorities

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Methodological approach: Characterising uncertainties

Defining uncertainty: "*any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system*" (Walker, 2003)

- Large bunch of scenarios spanning key uncertainties
- Technology cost pathways
  - 2 cost pathways each for coal, gas and nuclear
  - 3 cost pathways each for solar and wind
  - 72 unique pathways (combination of technology costs) under each economic growth pathways
- Economic growth pathways
  - 3 economic growth pathways
- 216 unique pathways
- 6 additional scenarios for testing uncertainties related to energy efficiency and energy demand behaviour in end use sectors

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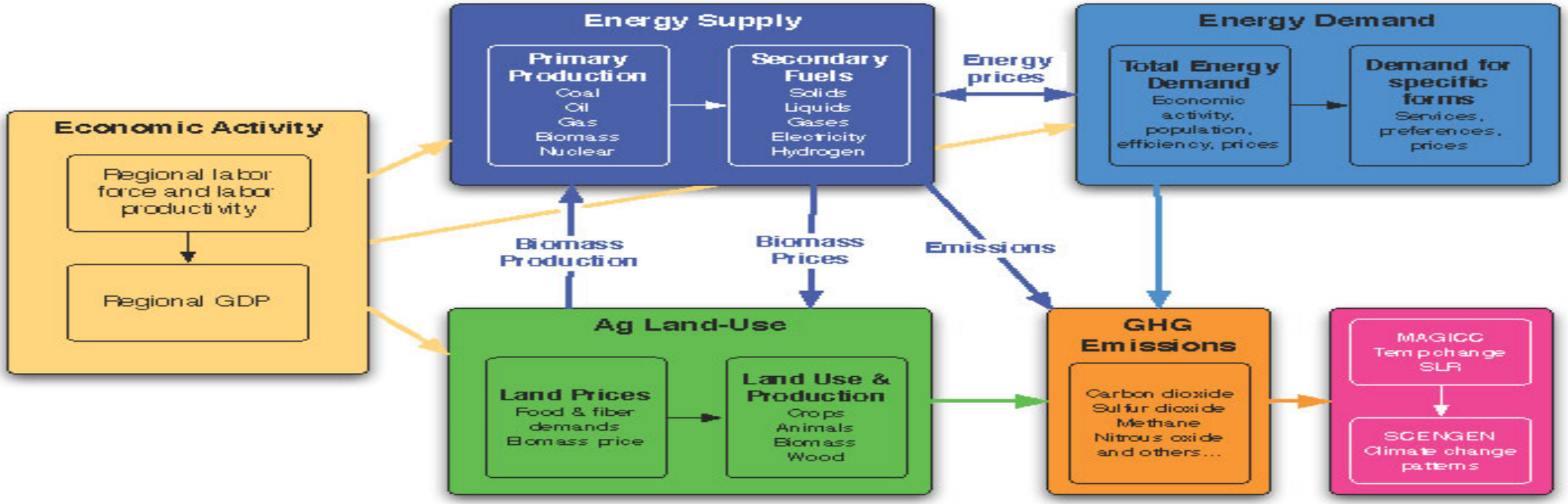
Global Change Assessment Model- IIM Ahmedabad version



- Assumptions based on inputs by experts from MNRE, CEA, and NTPC
- Cost of integration included (though there is no India specific detailed study on this topic)
- Transparency of key assumptions

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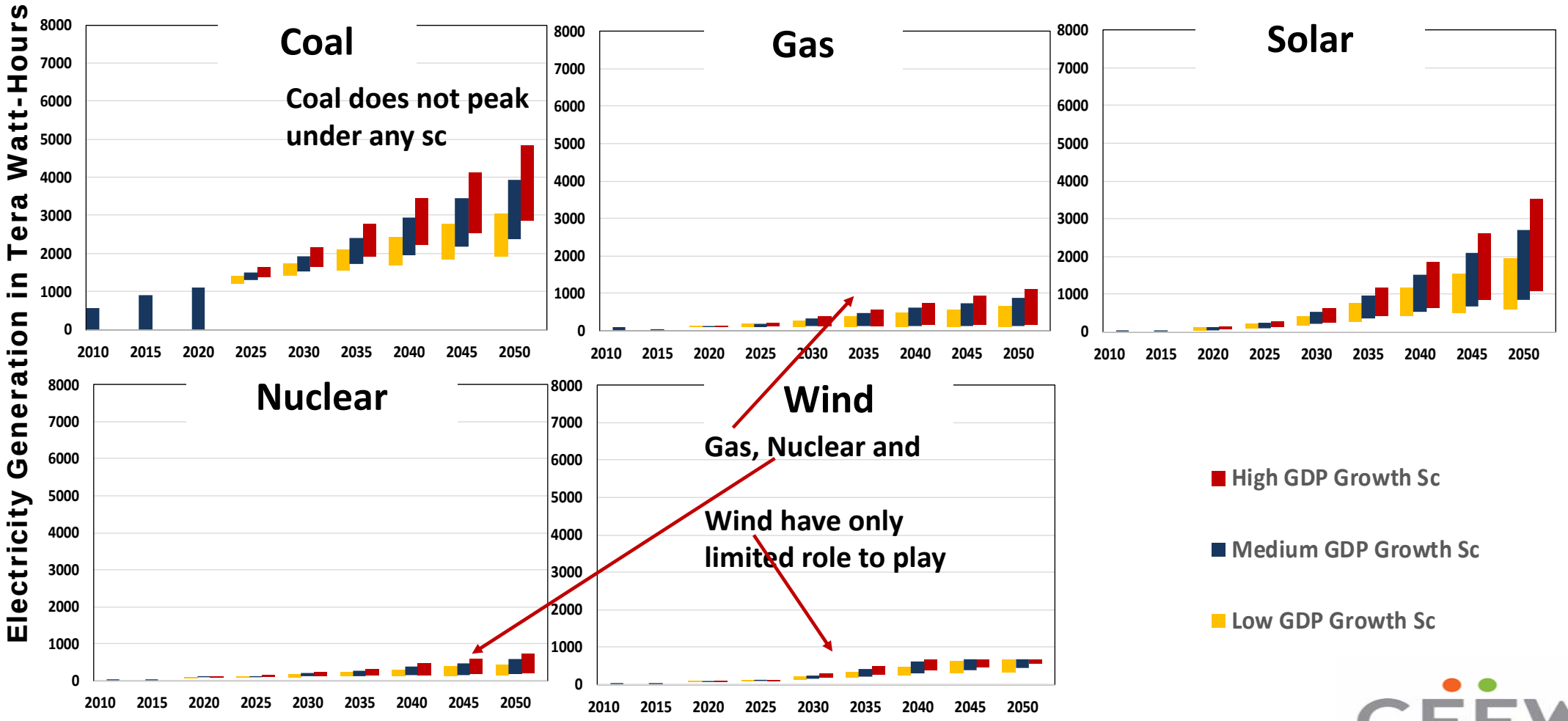
RESULTS

Electricity generation technology outlook



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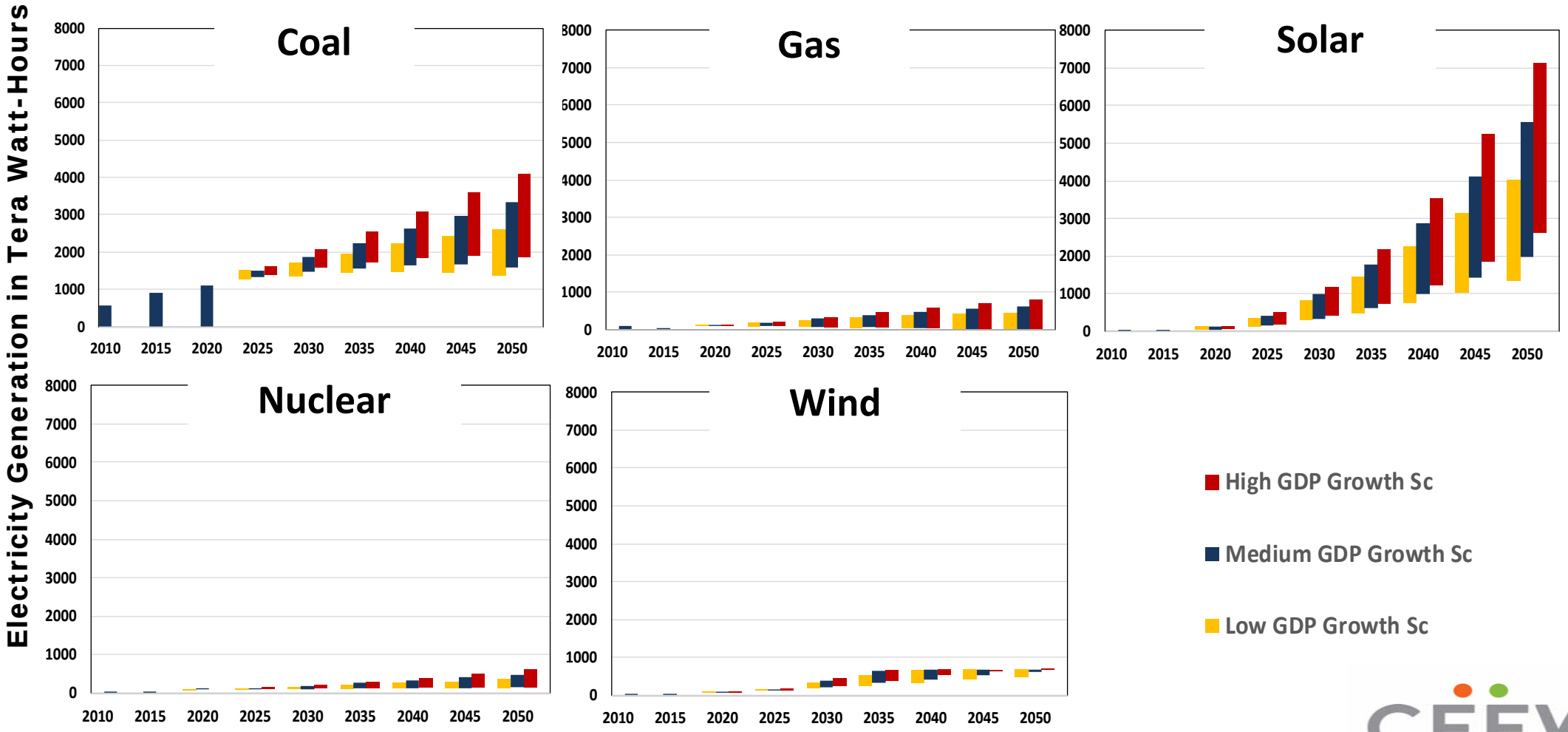
Electricity generation technology outlook- WITHOUT VRE Integration Cost



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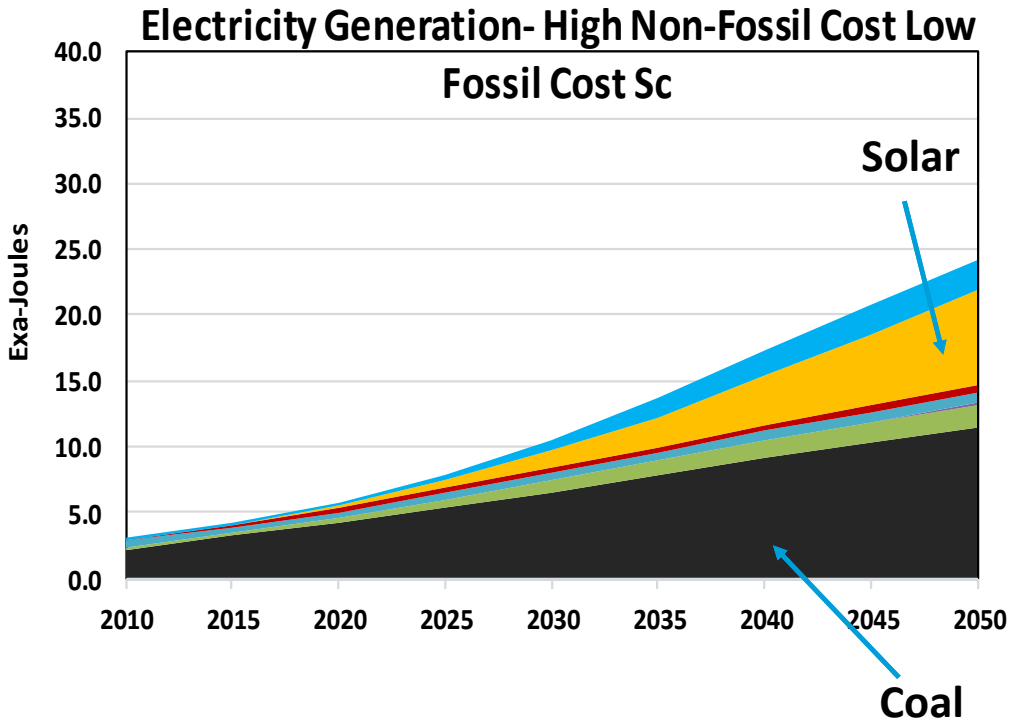
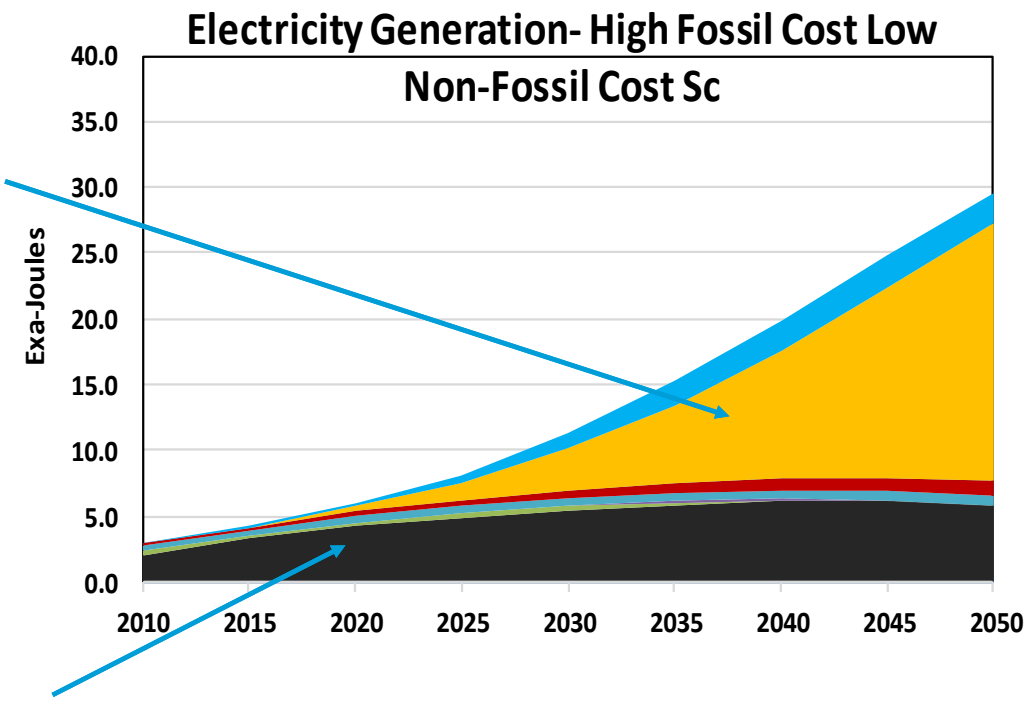
Storyline based scenarios VERSUS Uncertainty Assessment





- Different underlying technology cost assumptions will give us different perspectives of the future
- Uncertainty assessment is a key tool for getting robust insights

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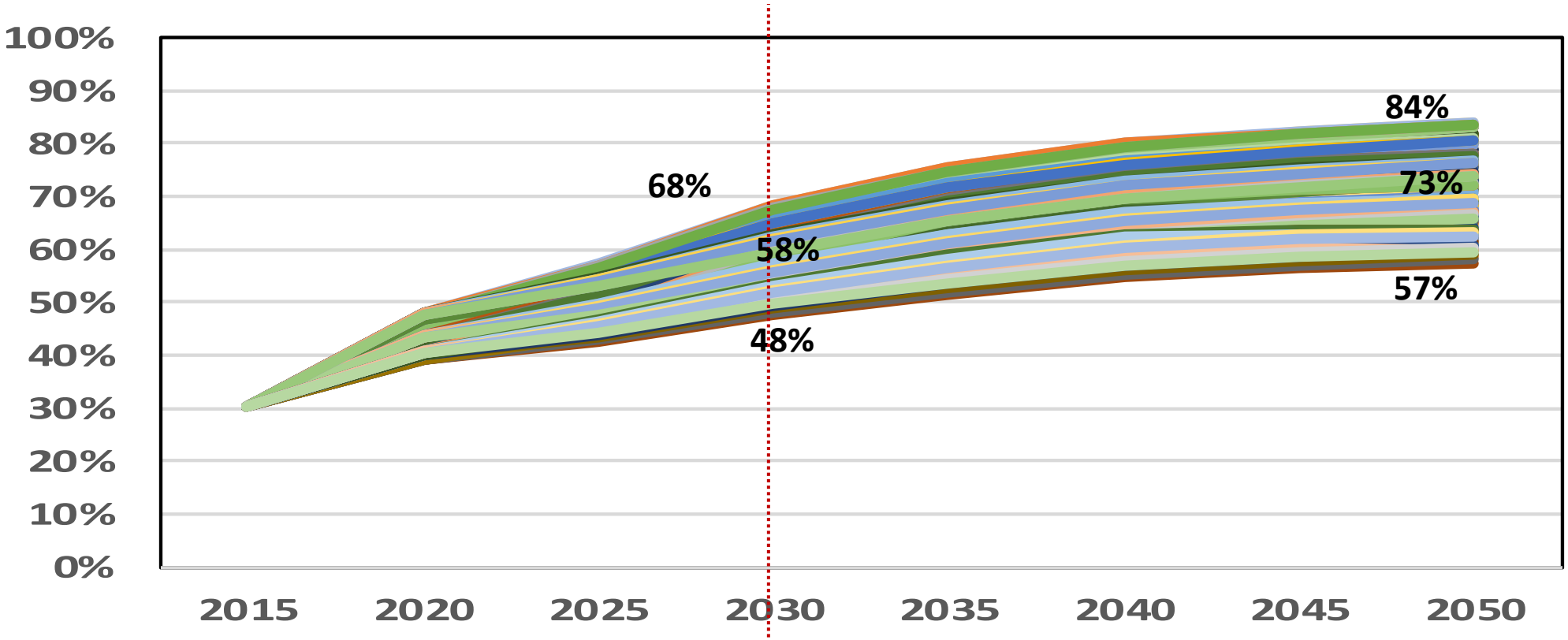
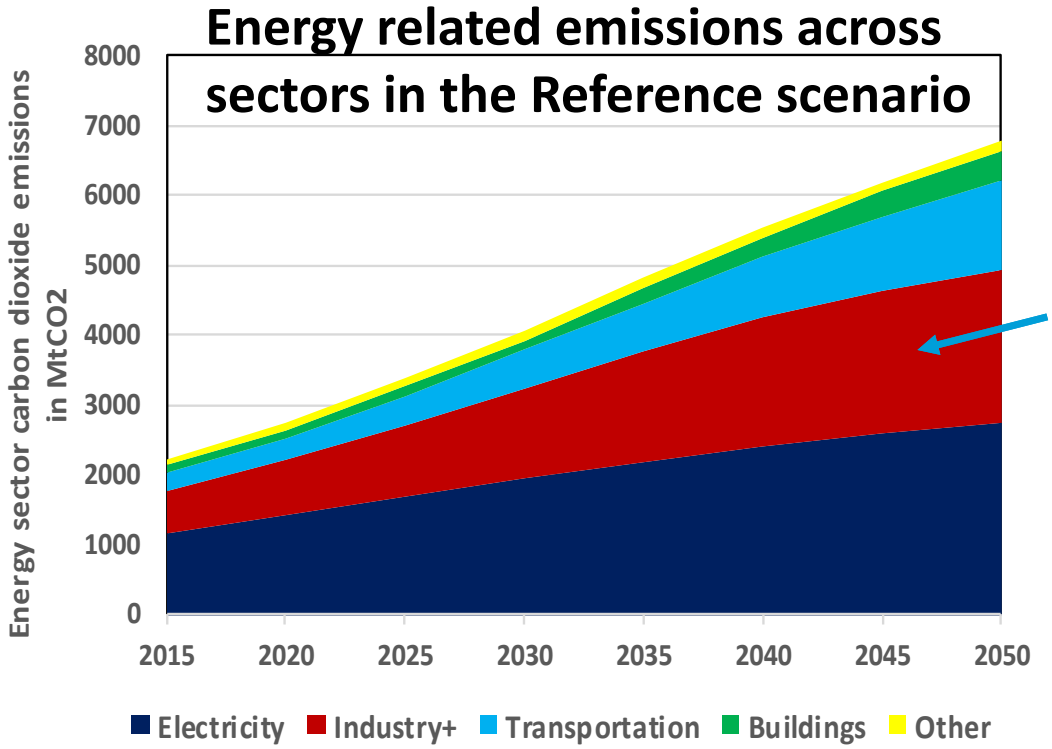
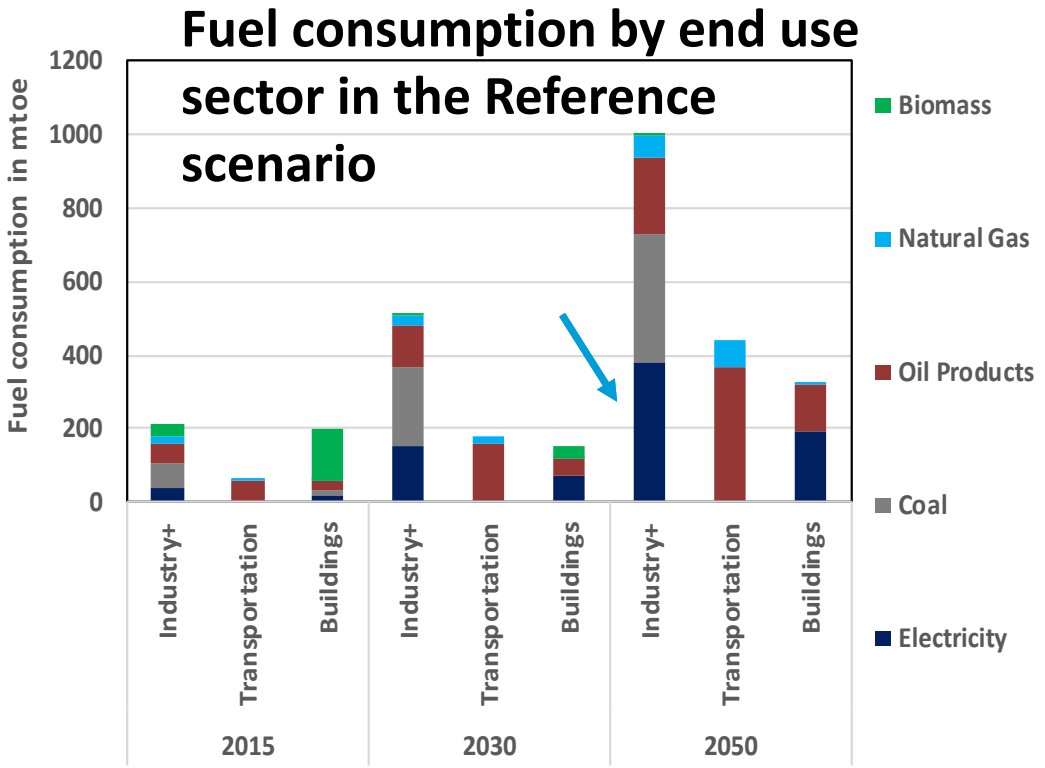
Is there room for enhancing India's NDC?



- Cost of integration appears to be a key uncertainty
- Lack of reform in India's power sector is going to be a big bottleneck

Industrial sector emissions are going to be critical





- Share of electricity sector and industrial sector in India's CO_2 emissions would be 40% and 32% respectively in 2050, transport only 19%

- Electricity's share in the industrial sector's fuel mix is going to be critical, currently it is less than 17%

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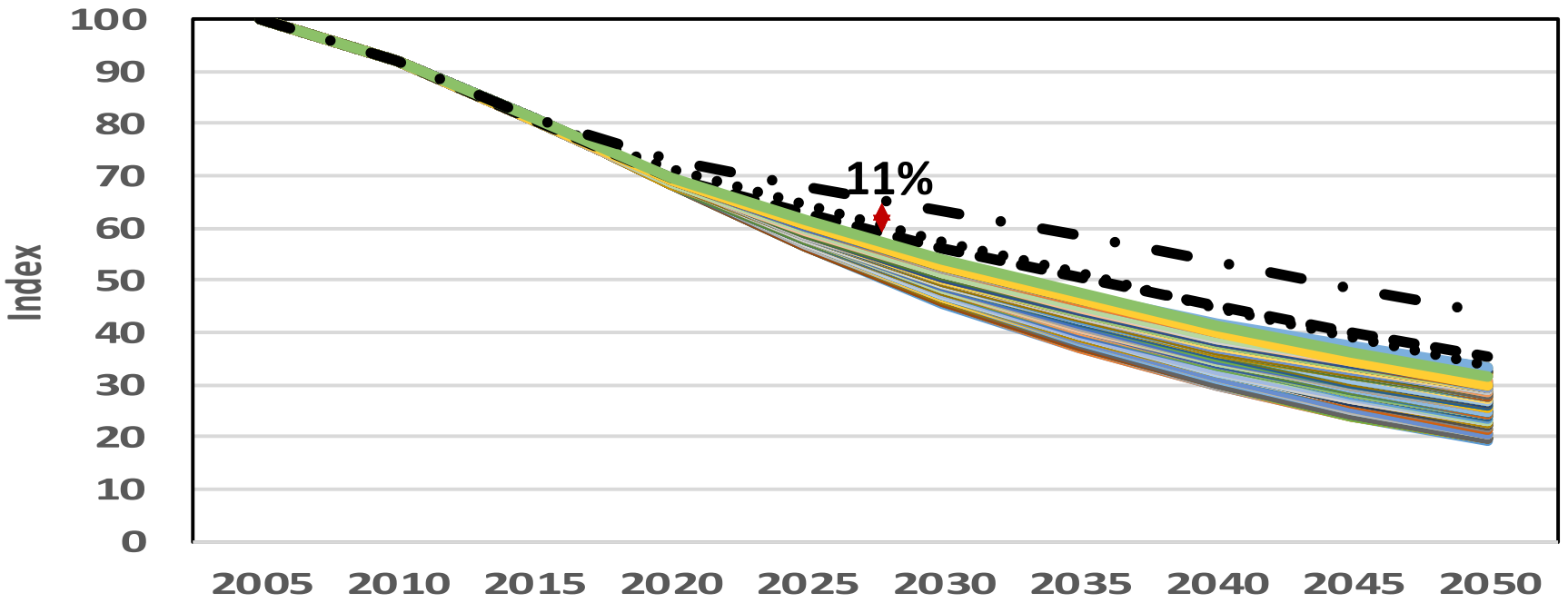
Will 33-35% EI reduction be achieved under all scenarios?



- EI of GDP relative to 2005 declines by 48-54% across all 216 scenarios by 2030, and by 70-81% by 2050

- Highly sensitive to developments in the industrial sector- high energy demand growth (Make In India), lower rate of energy efficiency improvements, and small increase in the share of electricity increases EI of GDP

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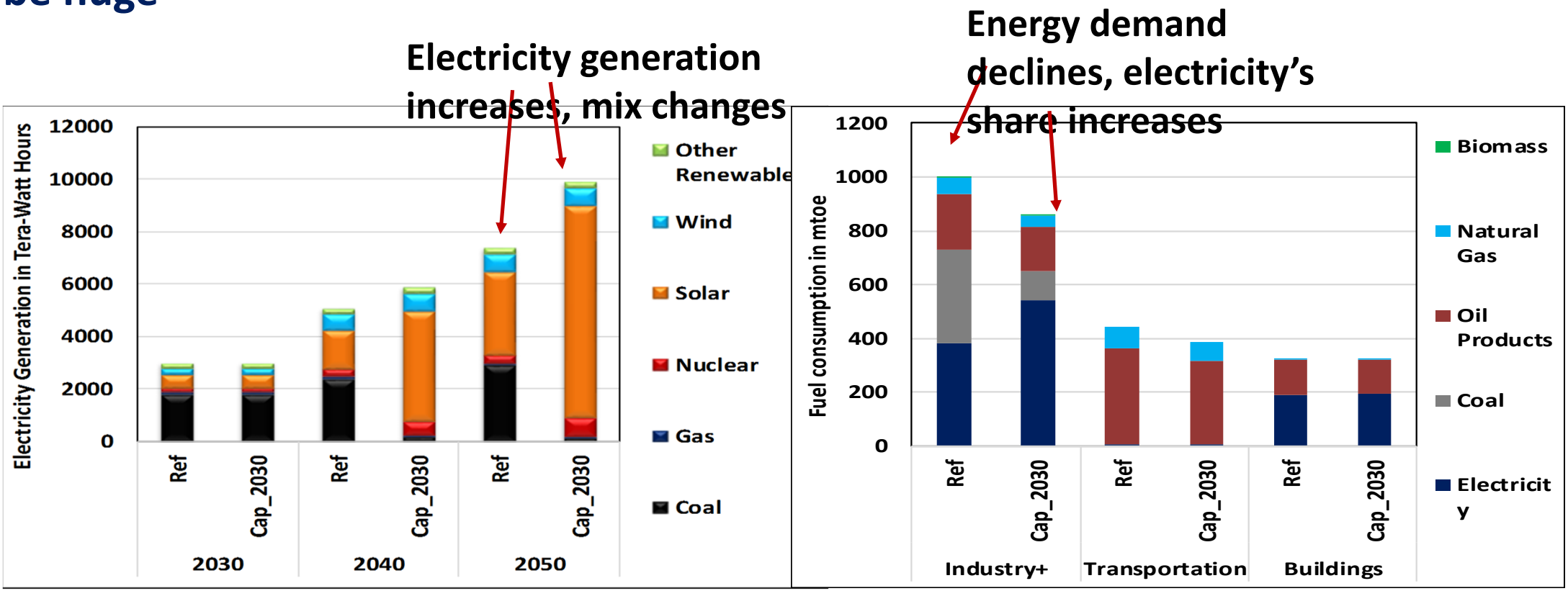
The pace of transformation required for a 2 DegC consistent pathway is going to be huge



- Non-fossil energy capacity increases to 98% in 2050, for a 2 DegC compatible pathway
- The share of electricity in the industrial sector increases to 55% in 2050

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A matrix for understanding 'Sustainable Development' synergies and trade-offs?

CEEW Synergies and Trade-Off Matrix		Reference Sc	Cap_2030 Sc	
Emissions	Total Emissions	6785	1663	$MtCO_2$
	Per capita emissions	4.09	1.00	tCO_2/capita
Electricity Access →	Per capita urban residential electricity consumption	1.38	1.41	MWh/capita
	Per capita rural residential electricity consumption	0.46	0.46	MWh/capita
Electricity Cost	Average generation cost for new investments	2.63	2.31	INR/kWh (2015 prices)
Jobs →	Total jobs related to energy generation sector	13.10	27.51	Million FTE
	Wind related jobs	0.35	0.36	Million FTE
	Ground mounted solar jobs	5.77	15.20	Million FTE
	Solar PV module manufacturing jobs	4.35	11.45	Million FTE
	Coal	2.43	0.15	Million FTE
	Gas	0.02	0.00	Million FTE
	Nuclear	0.17	0.34	Million FTE
Water →	Water withdrawal-Electricity	8.28	2.13	Billion Cubic Metres
Land →	Land Requirement	17398	31235	Thousand Acres
	PV	8366	22024	Thousand Acres
	CSP	63	173	Thousand Acres
	Wind	8350	8574	Thousand Acres
	Coal, oil and gas	619	464	Thousand Acres
Coal	Coal consumption (2021-50)	37.80	18.15	Billion tonnes

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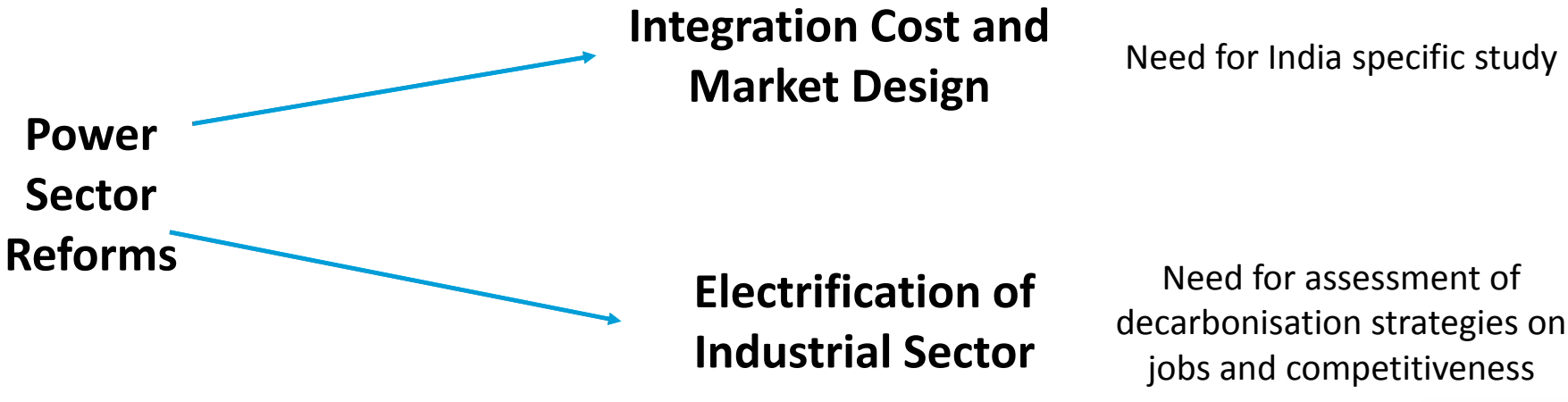
To summarise

- **Uncertainty based assessment** helps in deriving a robust understanding of the future

- Our assessment shows that solar is going to grow hugely, but this is very sensitive to the **cost of integration** and who bears this cost

- Industrial sector is where some important uncertainties are present



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Thank you

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