India's Energy Transition under a Net-Zero Future

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CEEW's research and perspective on the net-zero debate

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Peaking and Net-Zero

ACCELERATING FINANCE, CAPACITY DEVELOPMENT AND INNOVATION IN BRICS FOR A Net-Zero Future

BRICS INDIA 2021

PALLAVI DAS AND VAIBHAV CHATURVEDI

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Research Article

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RESEARCH ARTICLE

Implications of a net-zero target for India's sectoral energy transitions and climate policy

VAIBHAV CH
ARUNABHA

INTRODUCING EQUITY IN THE NET-ZERO DEBATE—A VIEW FROM INDIA AHEAD OF COP 26

Arunabha Ghosh and Vaibhav Chaturvedi

The 26th Conference of Parties (COP 26) is being held in interesting times. Three big forces are shaping the larger backdrop of this COP. The first is the COVID-19 pandemic, which has ravaged humanity, not just taking lives but also pushing millions into

Various perspectives in the Indian civil society

- Why are long-term targets important?
  - The power of policy signals cannot be underestimated
  - Credibility and Certainty are two important principles
  - Short term targets should guide us towards the long-term objective

- Comparing short term actions and long term actions is a false binary

- Peaking and net-zero have to go together for a growing economy

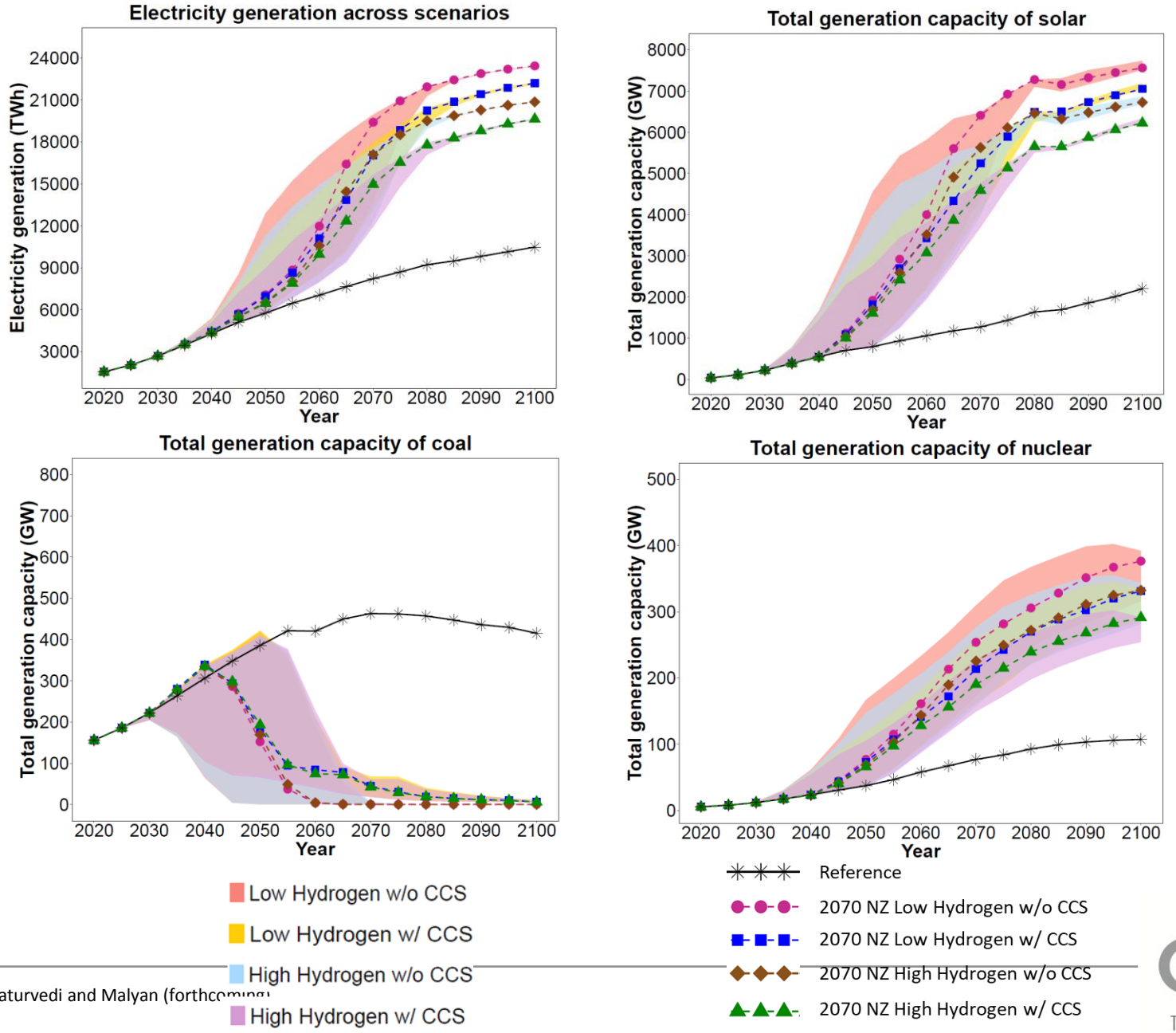
- Understanding alternative scenarios is important

- Net-Zero is about an Economic Transformation

Understanding the net-zero future through scenario analysis

Sc No.	Scenario Name	Peaking year	Net-Zero Year	Availability of breakthrough technologies
1	Reference sc	As determined endogenously by the model		CCS availability - No Hydrogen availability - Low
2	2030_2050_NoCCS_LowH2	2030	2050	
3	2030_2060_NoCCS_LowH2	2030	2060	
4	2040_2070_NoCCS_LowH2	2040	2070	
5	2050_2080_NoCCS_LowH2	2050	2080	
6	2030_2050_WithCCS_LowH2	2030	2050	CCS availability - Yes Hydrogen availability - Low
7	2030_2060_WithCCS_LowH2	2030	2060	
8	2040_2070_WithCCS_LowH2	2040	2070	
9	2050_2080_WithCCS_LowH2	2050	2080	
10	2030_2050_NoCCS_HighH2	2030	2050	CCS availability - No Hydrogen availability - High
11	2030_2060_NoCCS_HighH2	2030	2060	
12	2040_2070_NoCCS_HighH2	2040	2070	
13	2050_2080_NoCCS_HighH2	2050	2080	
14	2030_2050_WithCCS_HighH2	2030	2050	CCS availability - Yes Hydrogen availability - High
15	2030_2060_WithCCS_HighH2	2030	2060	
16	2040_2070_WithCCS_HighH2	2040	2070	
17	2050_2080_WithCCS_HighH2	2050	2080	

Transitions in the electricity sector are going to be massive



Source: Chaturvedi and Malyan (forthcoming)

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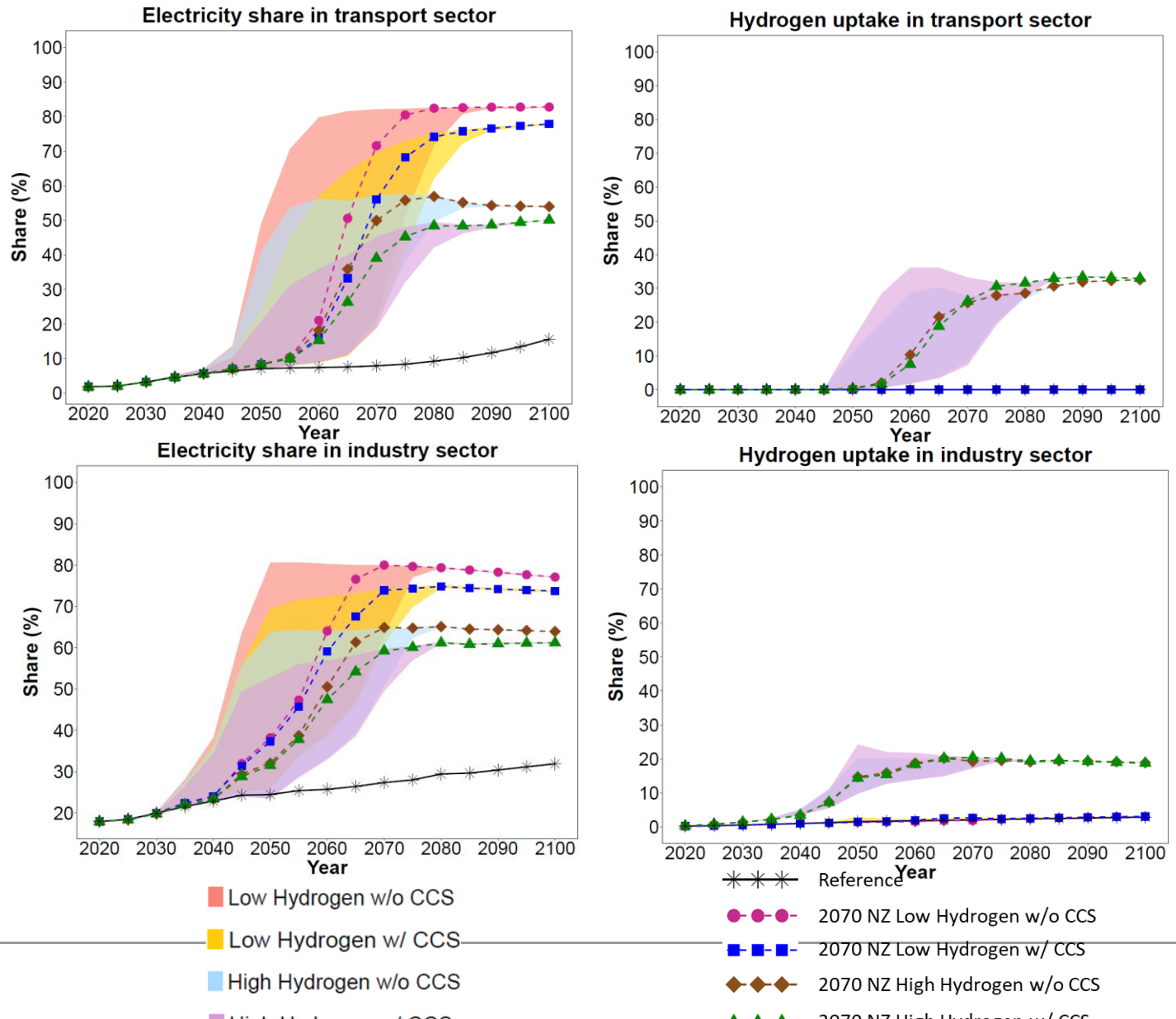
Transport and industrial sector will also need to redefine their energy architectures



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12 Key Steps for 2040 peak -2070 net-zero sc, with hydrogen without CCS

Power sector

1. Coal-based power generation must peak by 2040 and reduce by 99 per cent between 2040 and 2060
2. Solar-based electricity generation capacity must increase to 1689 GW by 2050 and to 5,630 GW by 2070, while
3. Wind-based electricity generation capacity much increase to 557 GW by 2050 and 1792 GW by 2070
4. Nuclear-based electricity generation capacity must increase to 68 GW by 2050 and to 225 GW by 2070

Transport sector

5. The share of electric cars in car sales must reach 84 per cent by 2070
6. The share of electric trucks in freight trucks must total 79 per cent by 2070, the rest being run mainly on hydrogen
7. The share of biofuel blend in oil for cars, trucks, and airlines must touch 84 per cent by 2070

Source: Chaturvedi and Malyan (forthcoming)

12 Key Steps for 2040 peak -2070 net-zero sc, with hydrogen without CCS

Industrial sector

8. Coal use in the industrial sector must peak by 2040 and reduce by 97 per cent between 2040 and 2065
9. Hydrogen share in total industrial energy use (heat and feedstock) must increase to 15 per cent by 2050 and 19 per cent by 2070
10. The industrial energy intensity of total GDP must decline by 54 per cent between 2015 and 2050, and by a further 32 per cent between 2050 and 2070

Building sector

11. The intensity of electricity use in the building sector with respect to total GDP must decline by 45 per cent between 2015 and 2050, and by another 2.5 per cent between 2050 and 2070

Refinery sector

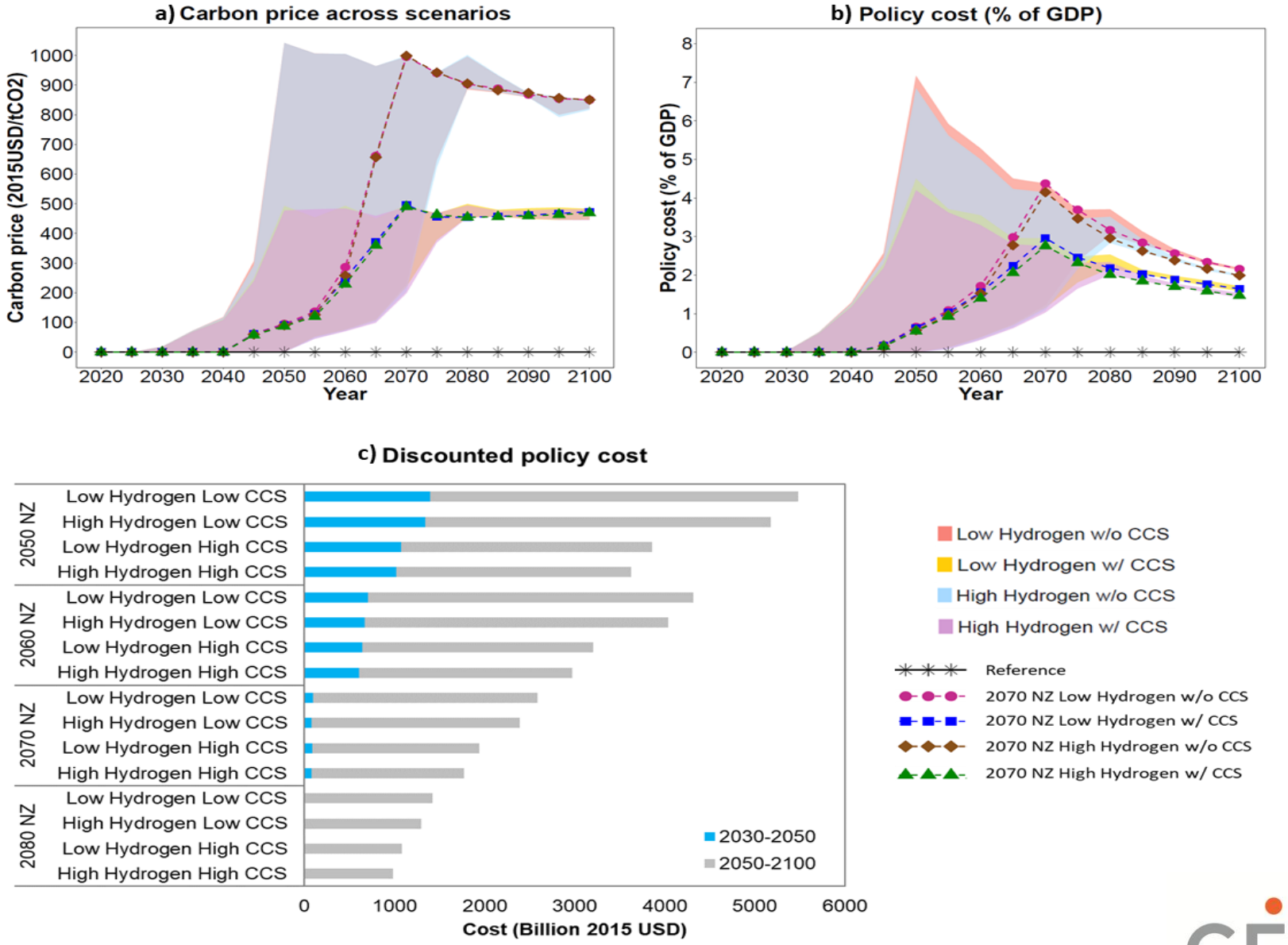
12. Crude oil production in the economy must peak by 2050 and decrease by 90 per cent between 2050 and 2070

Source: Chaturvedi and Malyan (forthcoming)

Economic trade offs, sooner or later

- Power pricing reforms
- New economic paradigm for coal dependent states
- Half a million coal workers: Compensation package?
- Coal India, ONGC, GAIL?
- Shifting geopolitics
- Stranded assets

Understanding policy costs for creating an economy of the future



Source: Ghosh and Chaturvedi (2021)

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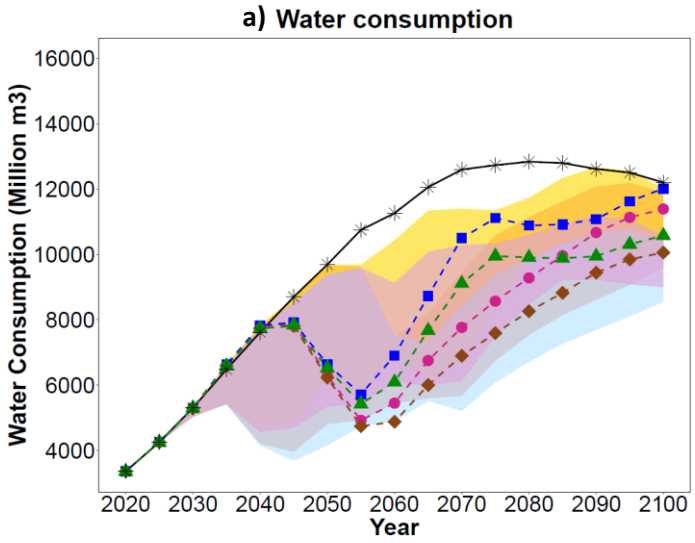
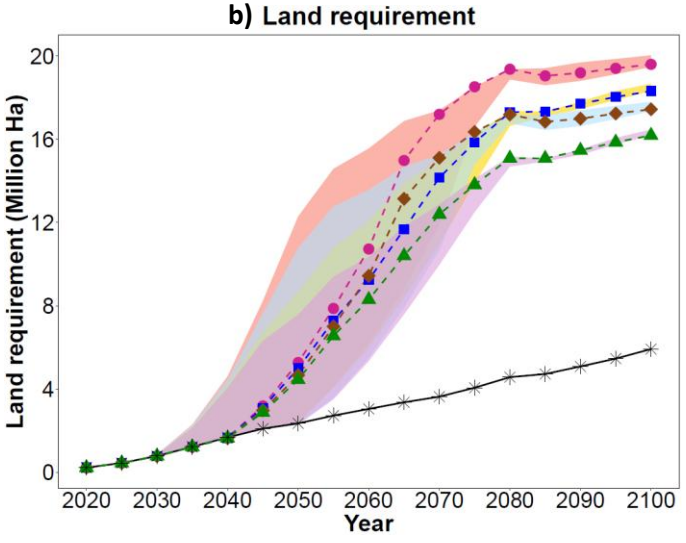
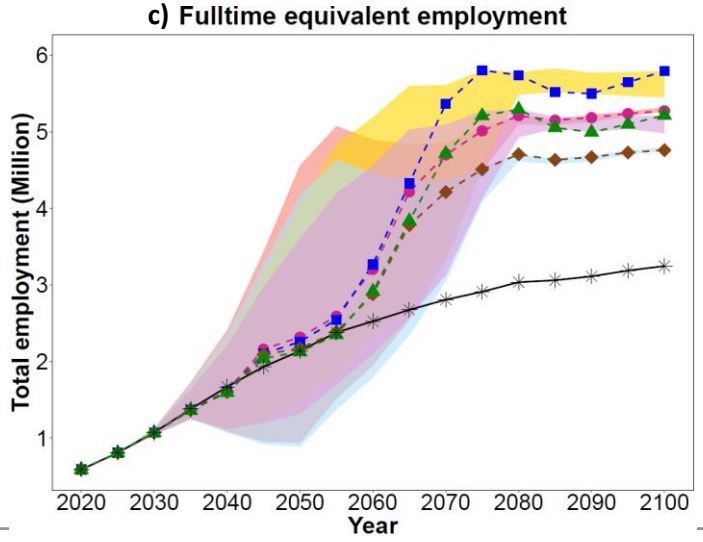
Land requirement could be a big impediment



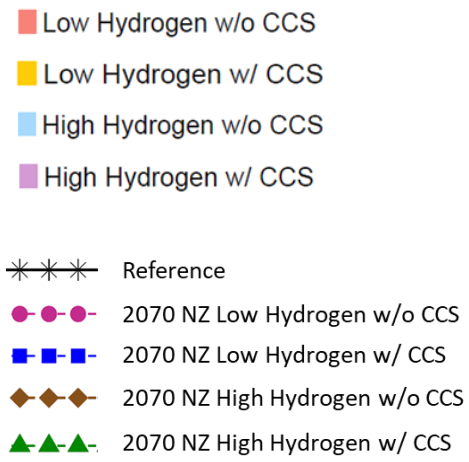
Note: Water consumption here is a representation of consumption only in power sector



Note: Land requirement here is a representation of consumption only in power sector



Note: Include direct and indirect jobs associated with the power sector



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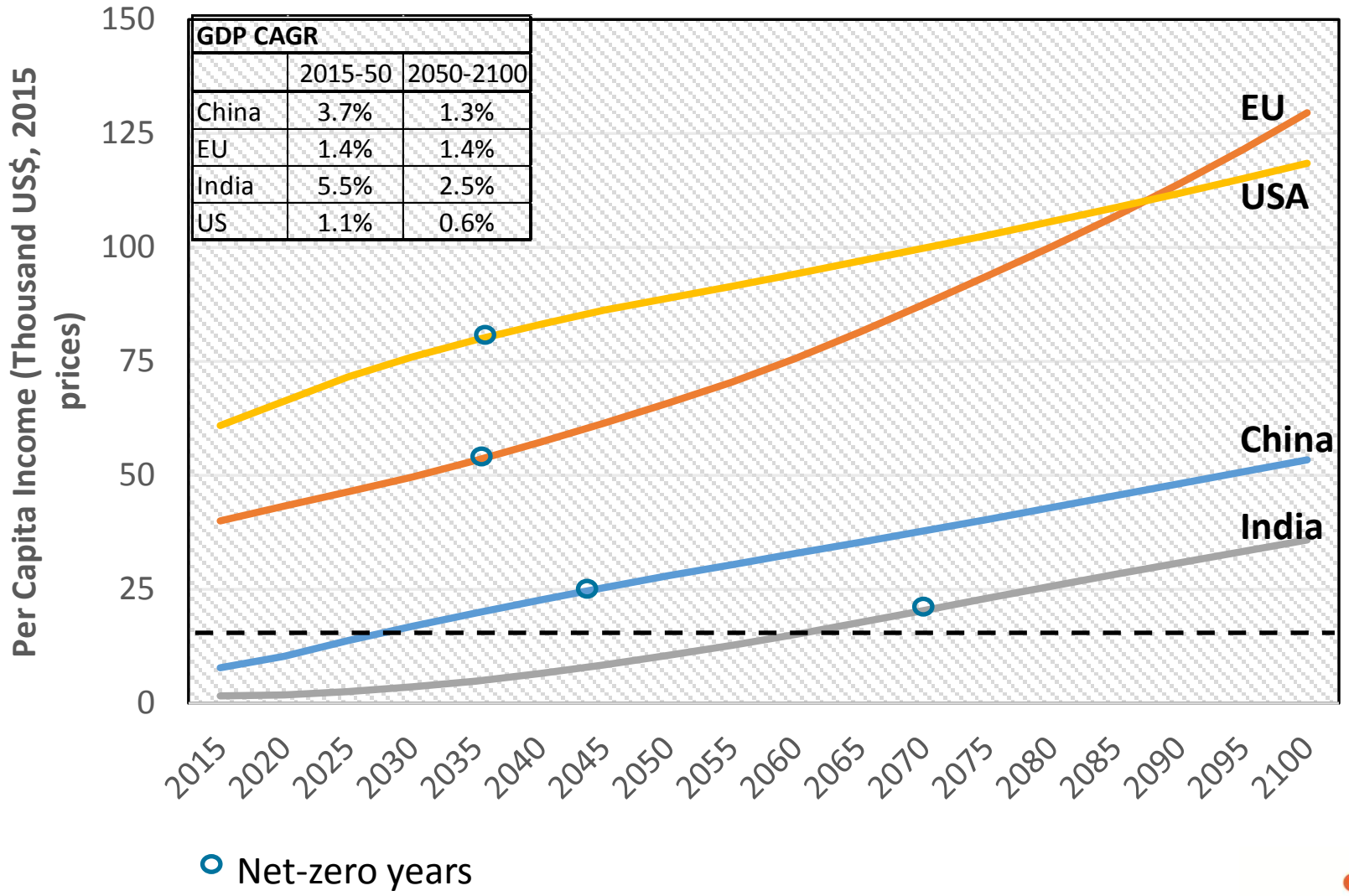
Information for framing net-zero scenarios



Source: CEEW Analysis

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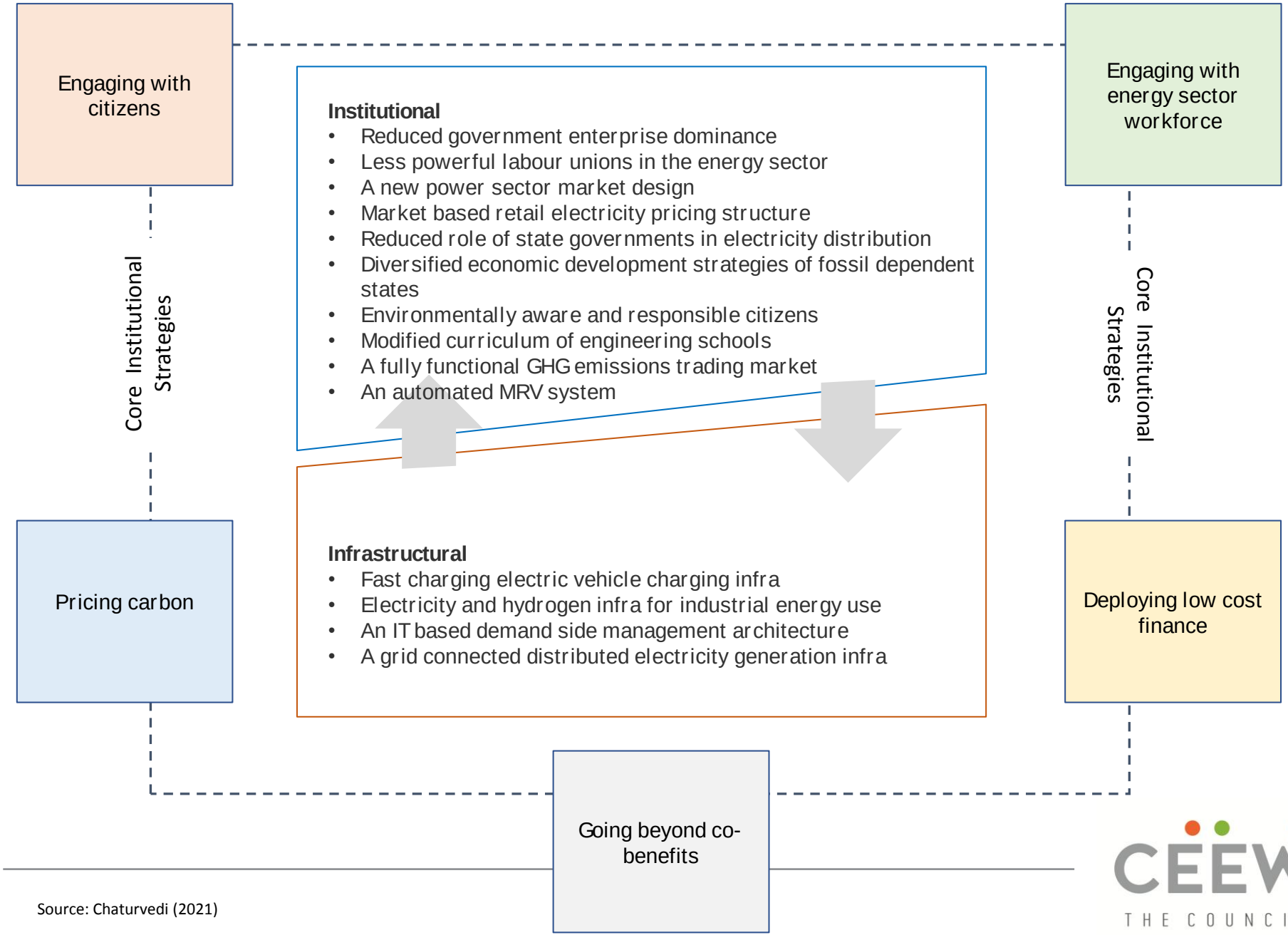
Net-Zero Future Would be Disruptive



Source: Chaturvedi (2021)

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Thank you

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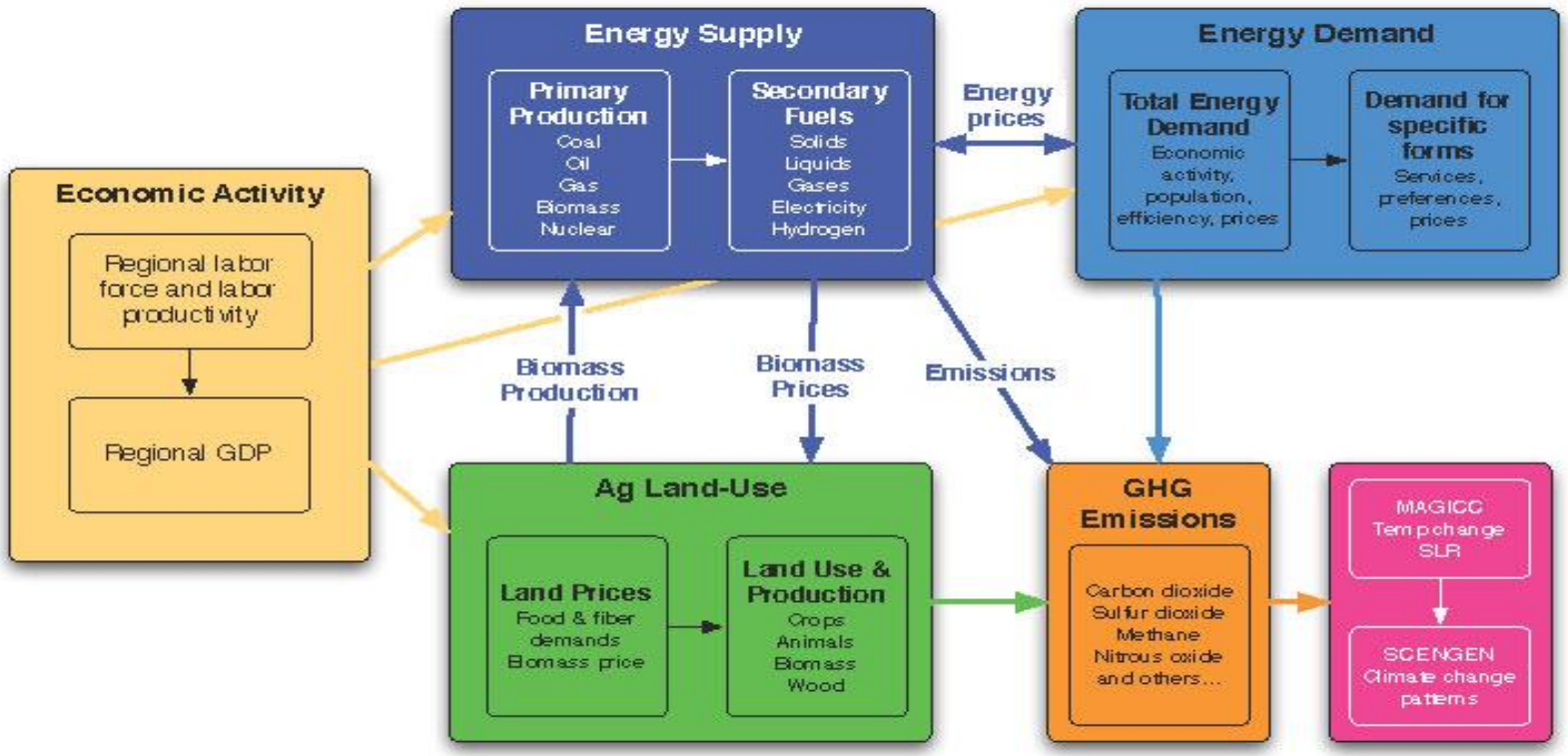
Global Change Assessment Model



- Global model (32 regions) with India as a separate region
- GCAM-IIMA version, set up at IIM Ahmedabad during 2007-09, under Prof P R Shukla
- Model used extensively for national and international exercises
- Extensively published in high impact international journals
- An important part of IPCC assessments on modelling related literature
- One of CEEW's in-house models

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Key inputs and outputs

- Inputs
  - Economic growth and population trajectory
  - Urbanisation rate and rural urban inequity
  - Costs and efficiencies of technologies: solar electricity cost, EV cost, hydrogen cost, AC cost, etc
  - Resource potentials
  - Carbon constraints or tax, carbon market configurations

- Outputs
  - Final Energy consumption by sector and technology, primary energy consumption
  - Electricity generation mix
  - **Global** energy price trajectories (long term trajectories)
  - Emissions and Carbon price, global temperature, sea level rise

- Other relevant information
  - Not used for informing operational planning of the grid
  - Not an inter-temporal optimization model
  - Models investor and consumer behaviour