Direct Air Carbon Capture and Storage (DACCS) for India's Net Zero Target

Anuj PATHAK[1], Ken OSHIRO[2], Saritha SUDHARMMA VISHWANATHAN[1,3], Shinichiro FUJIMORI[1,4,5]

*Email: pathak.anuj.84h@st.kyoto-u.ac.jp

[1]Department of Environmental Engineering, Kyoto University, [2]Faculty of Environmental Earth Science, Hokkaido University, [3]Indian Institute of Management, Ahmedabad (IIMA), [4]Social Systems Division, National Institute for Environmental Studies (NIES), [5]International Institute for Applied Systems Analysis (IIASA)

1. Introduction

- While many national strategies prioritize land-based carbon dioxide removal (CDR) options, their scalability is limited. Direct air carbon capture and storage (DACCS) offers higher removal potential but remains costly and technologically immature.
- India, targeting NZ by 2070, has yet to evaluate DACCS despite a significant share of emissions from hard-to-abate sector.
- Existing Indian studies primarily focus on CCS and hydrogen pathways, lacking analysis of CDR options such as DACCS.
- Technologically, DAC remains expensive, with projected costs ranging between \$100–600/tCO2 by mid-century.
- This study investigates how DAC deployment cost (non-energy) affects India's net-zero transition using the AIM-Technology model, highlighting implications for energy system transformation, sectoral decarbonization and its economic implications.

2. Methods

Model and Scenario

Emission Scenario
- **NPi**
- **Net Zero**

Techno-economic Scenario
- **DAC_Def** = Net Zero + DAC Cost Default
- **DAC_Early** = Net Zero + DAC Cost Low
- **DAC_Delay** = Net Zero + DAC Cost High
- **NO_DAC** = Net Zero + No DAC

→ AIM Technology (India) → Results

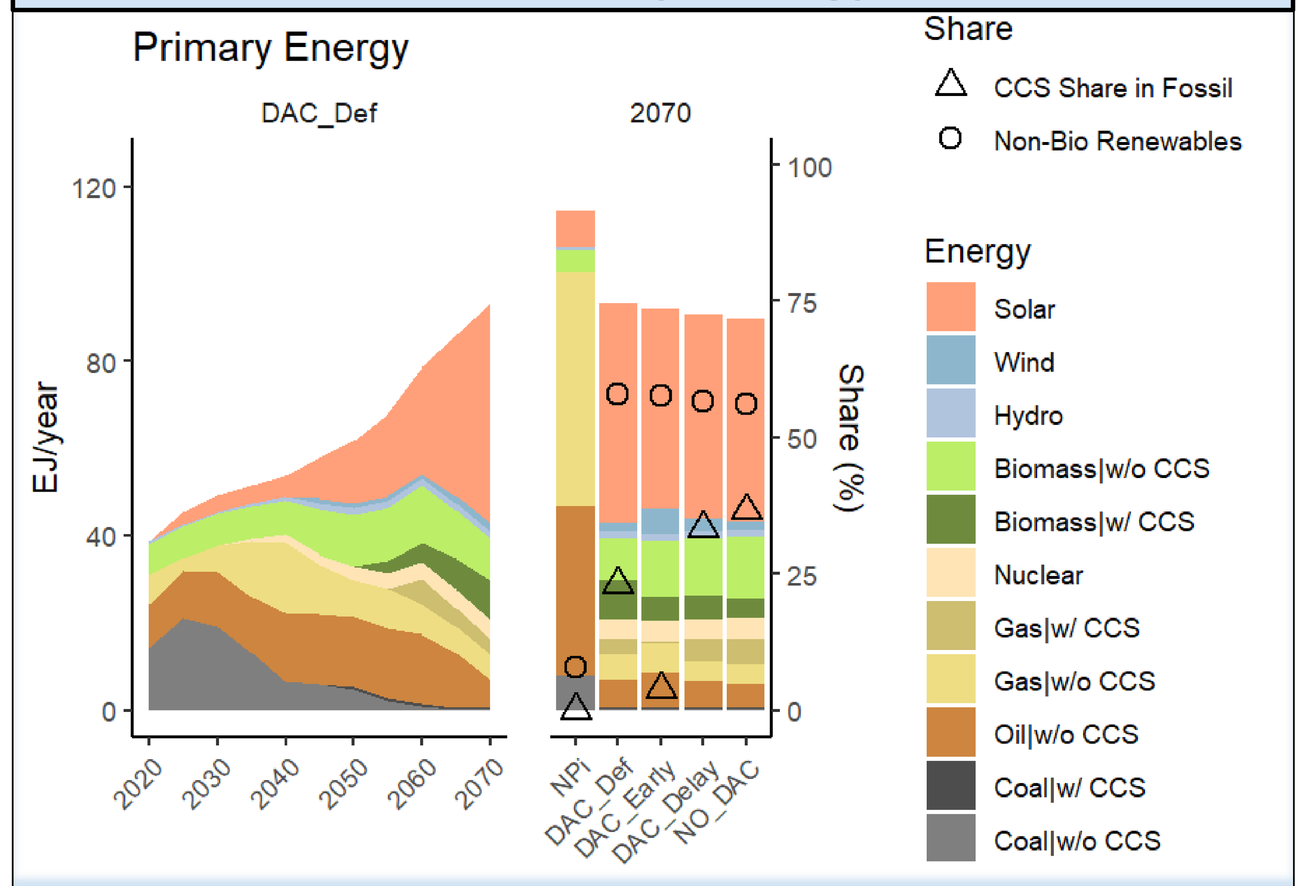
DAC Technology Assumptions

Scenario	Capital cost in 2050 (for 1Mt plant) (M\$)	O/M cost (US\$/tCO2)	Energy requirement (GJ/tCO2)	
			Electricity	Heat
DAC_Def	1146	42	1.3	5.3
DAC_Early	700	27	1.3	5.3
DAC_Delay	2060	76	1.8	8.1

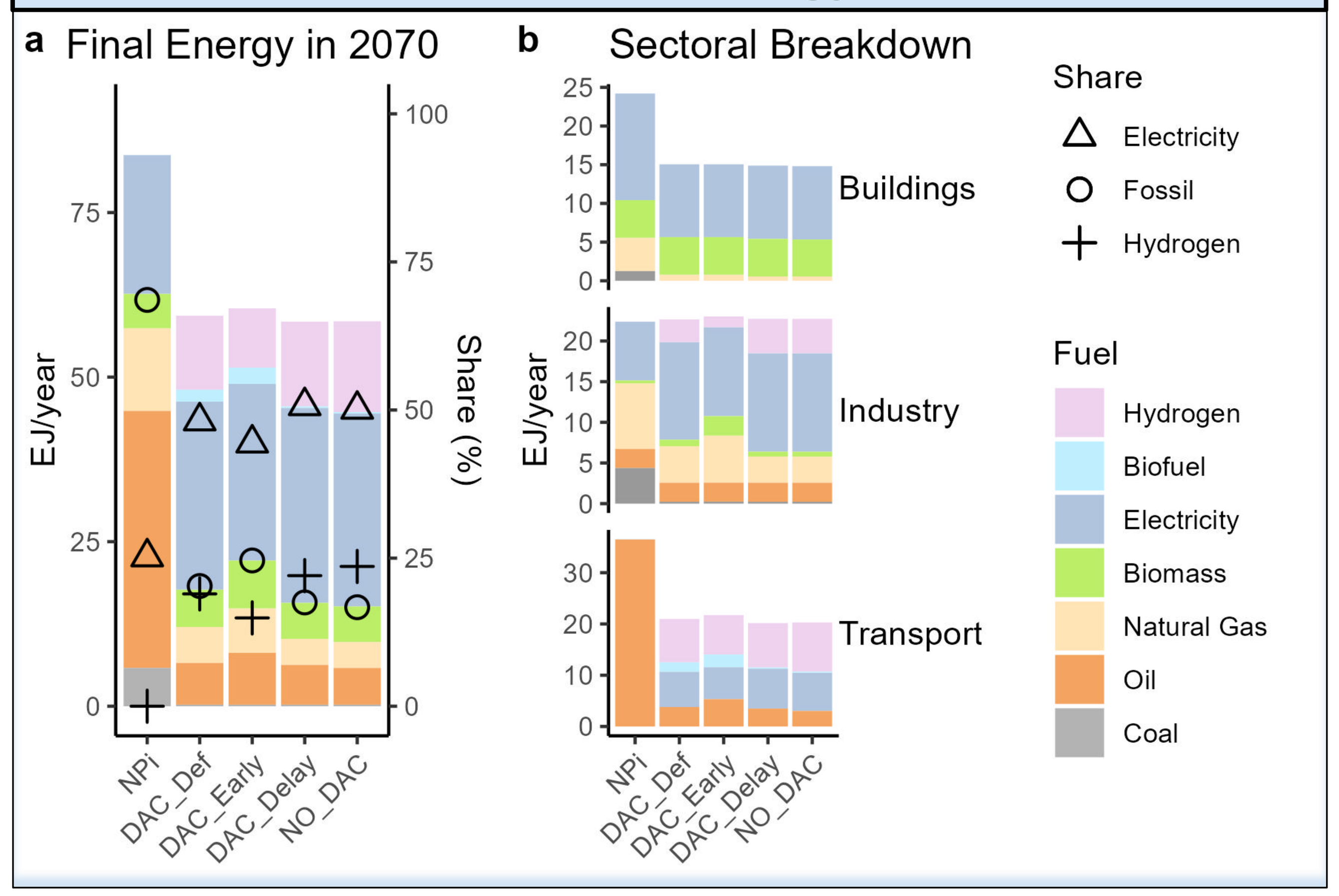
The non-energy cost of DAC after annualizing the capital cost (with 20 years life and 20% discount rate) ranges between \$170 and \$500/tCO2 in this study.

3. Results

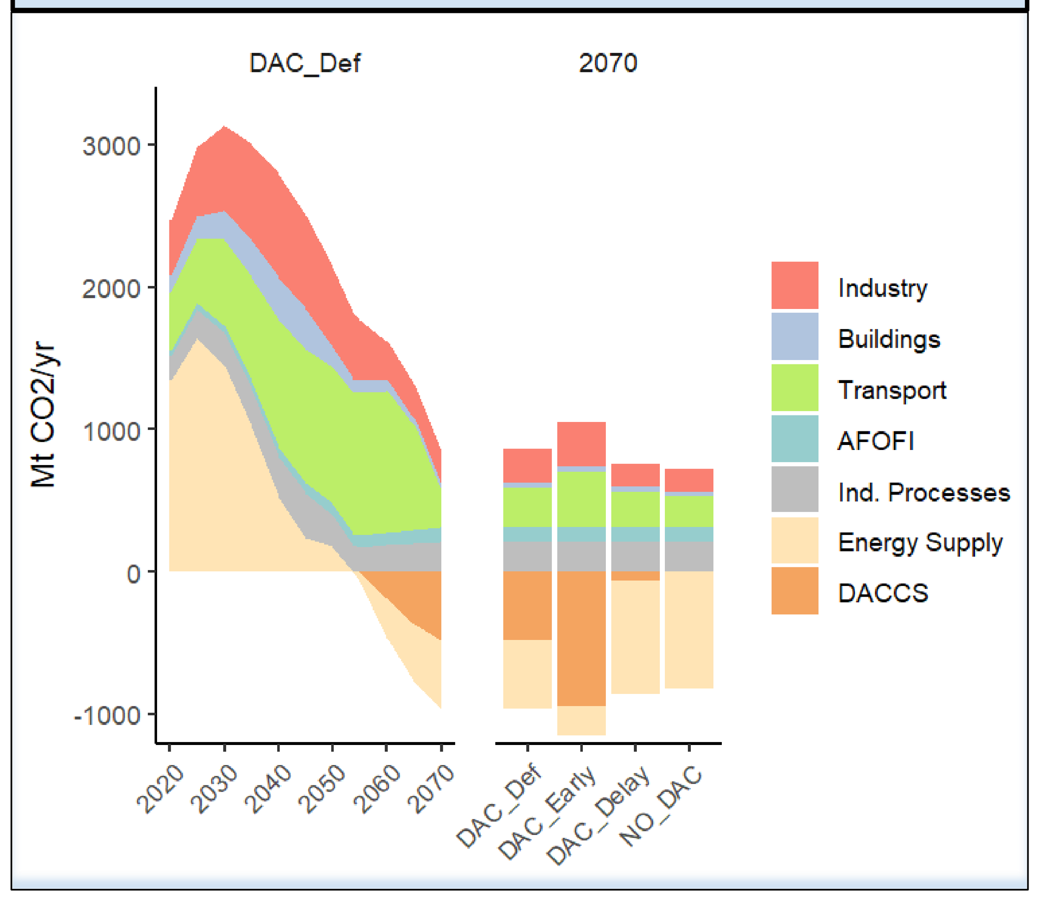
Primary Energy



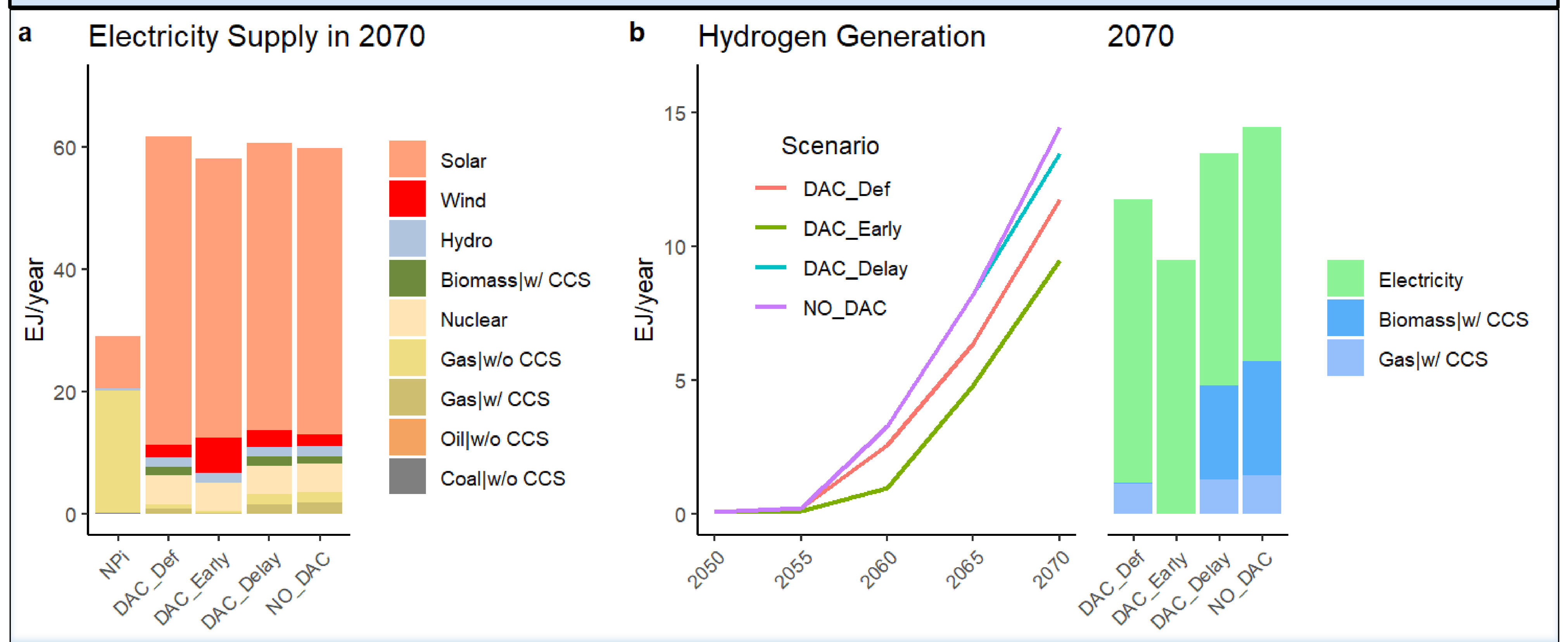
Final Energy



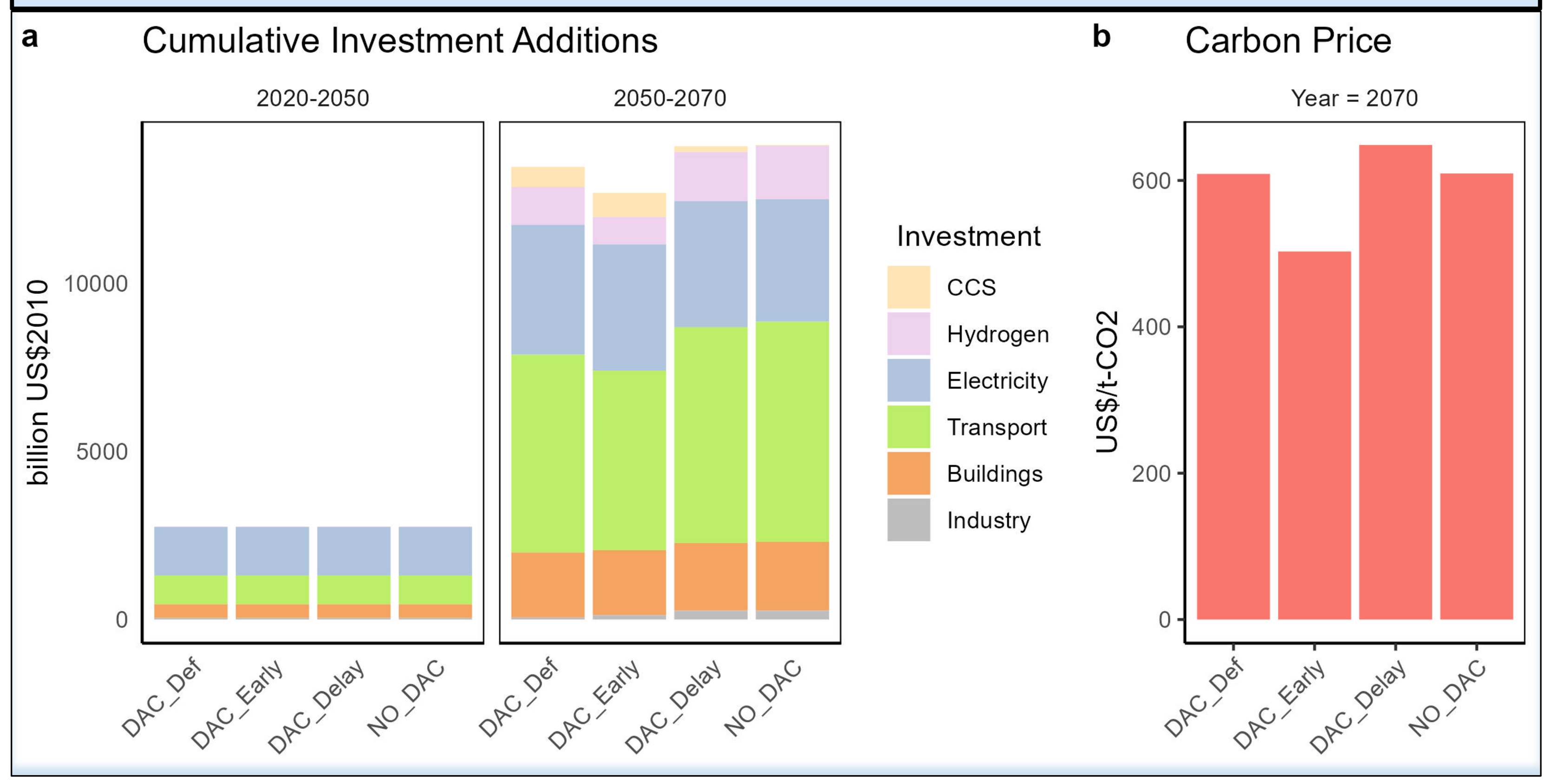
CO2 Emissions



Secondary Energy



Economic Implications



4. Conclusion

- Cheaper DAC leads to its earlier deployment which requires scaling up of high-capacity renewable electricity such as wind to run the DAC systems.
- Earlier deployment of DACCS delays and lowers the reliance on hydrogen and related transport sector transformations. This yields cumulative investment savings of over \$1400 billion (10% of total) between 2050-2070 for the India's net zero target.
- DAC deployment is suggested for India's net zero target which reduces mitigation costs and alleviates pressure on hydrogen infrastructure lowering the rapid transformations needed in transport sector. Further, proper policy initiatives for DAC and CCS infrastructure development are crucial to realize the benefits.

Acknowledgement

This research is financially supported by Japan Science and Technology Agency (JST) as part of Adopting Sustainable Partnerships for Innovative Research Ecosystem (ASPIRE), Grant Number JPMJAP2331.