

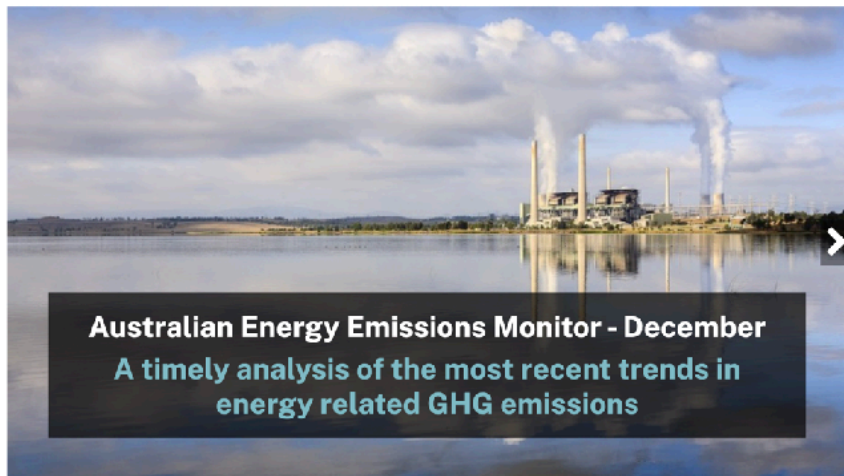
Global/regional Market and Economic Trends & the International Security of Supply Chains



Llewelyn Hughes
@ Energy Studies Institute, National University of Singapore
12-13 January 2023

We acknowledge the support of Strategic Policy Grants Program, Department of Defence, Australian Government (Grant Agreement 202021-0243) in supporting this research.













Zero Carbon Energy for the Asia-Pacific Initiative (ZCEAP)



Australia supporting the energy transition in the Asia-Pacific region.

For more information, contact: zceap@anu.edu.au

Journal Articles

- Jorrit Gosens, Alex B.H. Turnbull, [A protocol to determine the least cost supply of coal to China with an installation-level optimization model](#), STAR Protocols, Volume 3(4) (November 2022) [Journal article]
- Christian Downie, [Geopolitical leverage in the energy transition: A framework for analysis and the case of Australian electricity exports](#), *Energy Research & Social Science*, Volume 93 (November 2022) [Journal article]
 10
- Yuan Peng and Xuemei Bai, [Cities leading hydrogen energy development: the pledges and strategies of 39 Chinese cities](#), *npj Urban Sustainability*, Volume 2 (September 2022) [Journal article]
 6
- Cheng Cheng, Natalia Pereira Gutierrez, Andrew Blakers and Matthew Stocks, [GIS-based solar and wind resource assessment and least-cost 100% renewable electricity modelling for Bolivia](#), *Energy for Sustainable Development*, Volume 69 (August 2022) [Journal article]
- Alison Reeve, Emma Aisbett, [National accounting systems as a foundation for embedded emissions accounting in trade-related climate policies](#), *Journal of Cleaner Production*, Volume 371 (August 2022) [Journal Article]
 8
- Thang Nam Do, Paul J. Burke, Llewelyn Hughes, Ta Dinh Thi, [Policy options for offshore wind power in Vietnam](#), *Marine Policy*, Volume 141 (July 2022) [Journal Article]
- Reza Fazeli, Fiona Beck, Matthew Stocks, [Recognizing the role of uncertainties in the transition to renewable hydrogen](#), *International Journal of Hydrogen Energy*, Volume 47, (July 2022) [Journal article]
- Cheng, Wenting, [Intellectual Property and International Clean Technology Diffusion: Pathways and Prospects](#), *Asian Journal of International Law*, Volume 12, Issue 2, pp. 370 – 402 (July 2022) [Journal Article]
- Emma Aisbett, Wyatt Raynal, Bruce Jones, [International Green Economy Collaborations](#), *Energy Proceedings*, Volume 25: Accelerated Energy Innovations and Emerging Technologies (July 2022) [Journal article]
- Thang Nam Do, Paul J. Burke, Llewelyn Hughes, Ta Dinh Thi, [Policy Options for Offshore Wind Power in Vietnam](#), *Marine Policy*, Volume 141 (July 2022) [Journal Article]
 7
- Keigan Demaria, Bjorn C. P. Sturmberg, Brad Riley, Francis Markham, [Exploring the feasibility of electric vehicle travel for remote communities in Australia](#), *Australian Geographer*, Volume 53 – Issue 2 (July 2022) [Journal Article]
 344
- Lee White, Andre L. Carrel, Wei Shi, Nicole D Sintov, [Why are charging stations associated with electric vehicle adoption? Untangling effects in three United States metropolitan areas](#), *Energy Research and Social Science*, Volume 89 (July 2022) [Journal Article]
 11
- Paul Burke, Fiona Beck, Emma Aisbett, Kenneth Baldwin, Matthew Stocks, John Pye, Mahesh Venkataraman, Janet Hunt, Xuemei Bai, [Contributing to regional decarbonization: Australia's potential to supply zero-carbon commodities to the Asia-Pacific](#), *Energy*, Volume 248. 123563 (June 2022) [Journal Article]
 165
- David F. Silalahi, Andrew Blekers, Bin Lu, Cheng Cheng, [Indonesia's Vest Off-River Pumped Hydrc Energy Storage Potential](#), *Energies*, 15, 3457 (May 2022) [Journal Article]
 62

<https://iced.s.anu.edu.au/research/research-initiatives/zero-carbon-energy-asia-pacific-initiative/publications>

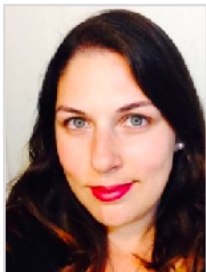


Disruptive Technologies: Model-based Scenario Analysis of Decarbonisation and National Security Risks in the Indo-Pacific

- In a fossil fuel dominated energy system, issues such as control over reserves have been identified as key risks for security of supply.
- Policies implemented by governments in response to climate change have important implications for energy security of supply:
 - Changes in the ratio of different fuels.
 - Changes in volumes of fuels trade.
 - Emergence of potentially disruptive technologies, such as CCS, hydrogen, and storage options.
- There are important uncertainties about levels of climate ambition, and decarbonisation pathways.
- Response:
 - Model decarbonisation pathways, accounting for different:
 - * Level of ambition of decarbonisation;
 - * Technology options;
 - * Underlying factors such as population and GDP growth.
- Focus:
 - CCS vs. firming renewables within decarbonisation trajectories.
 - (Australian) major trading partners' imports of coal and gas.



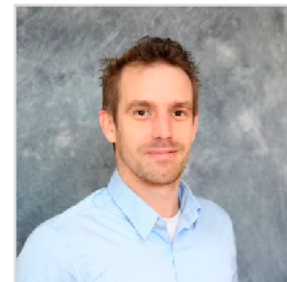
The Team



Dr. Yeliz Simsek
Research Fellow
Modelling of Decarbonisation
Trajectories and System Interactions



Dr. Thomas Longden
Research Fellow
Crawford School of Public Policy



Dr. Jorrit Gosens
Research Fellow
Crawford School of Public Policy



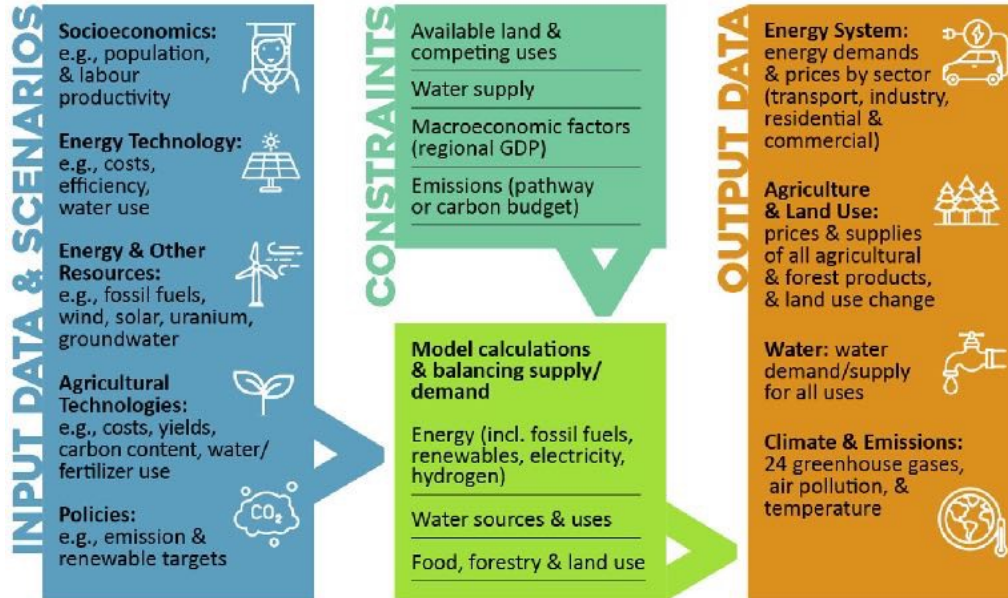
Prof Frank Jotzo
Professor
Crawford School of Public Policy



Prof Llewelyn Hughes
Professor
Crawford School of Public Policy



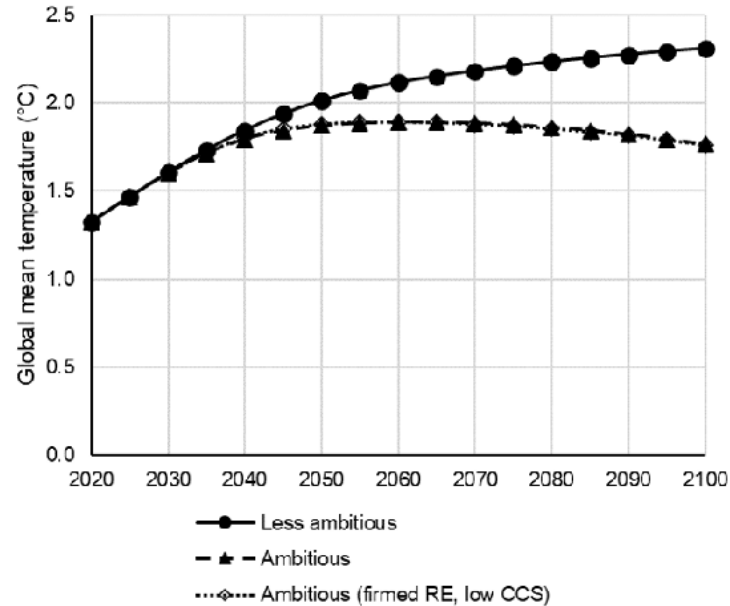
Global Change Analysis Model



- Open source model developed Pacific Northwest National Laboratory.
- Market equilibrium model for 1990 to 2100 with five-year increments.
- Approach:
 - Select a CO₂ trajectory consistent with a given temperature increase.
 - Impose a carbon price to achieve given trajectory.
 - Allow for differences in technology availability, cost, or other factors, along with GDP/population etc. to determining optimal decarbonisation pathway globally.



Global Mean Temperature by Level of Climate Ambition



- Concentration pathways are consistent with global radiative forcing of 2.7°C and 1.8°C in 2100.
- GCAM model achieves these pathways by imposing a carbon price to increase the costs of emissions intensive fuels.
 - ◉ The use of carbon price is shorthand for a suite of policies governments are likely to use in order to achieve different levels of climate ambition.



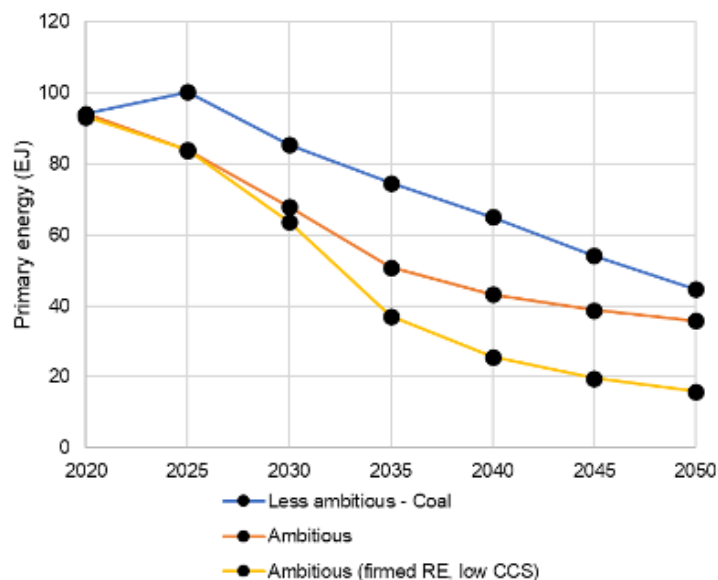
Scenario 1: Coal and Gas Use in the PRC, Japan, South Korea, and India

- We also examined the role of thermal coal and gas in transition pathways of the People's Republic of China, Japan, South Korea, and India under different levels of climate ambition, and with different technology options (CCS, firmed renewables).

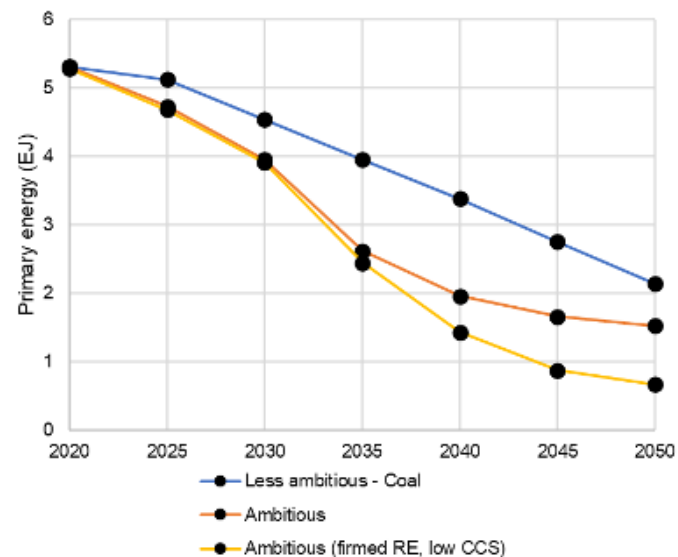


Coal Use in Selected Indo-Pacific Countries

China



Japan

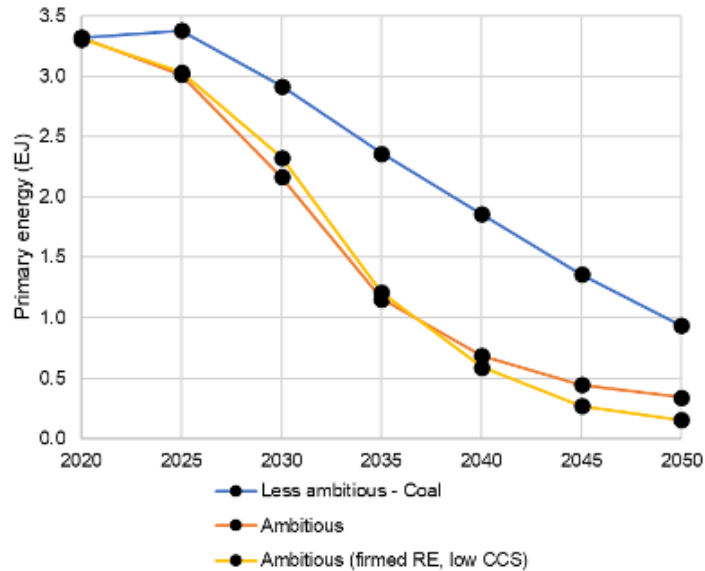


- Coal exits in the near term across all scenarios.
- More (global) climate ambition means more rapid near-term exist.
- Capping CCS options and/or allowing for more firmed RE, reduces coal further in medium-term.

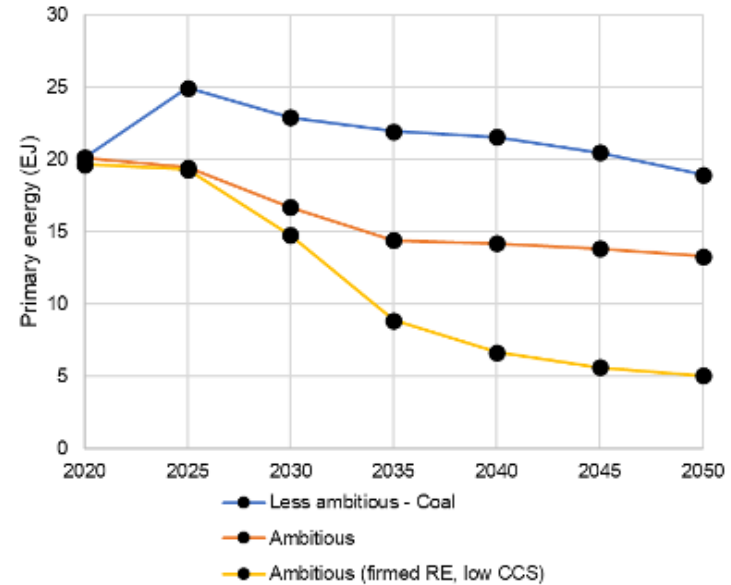


Coal Use in Selected Indo-Pacific Countries

South Korea



India

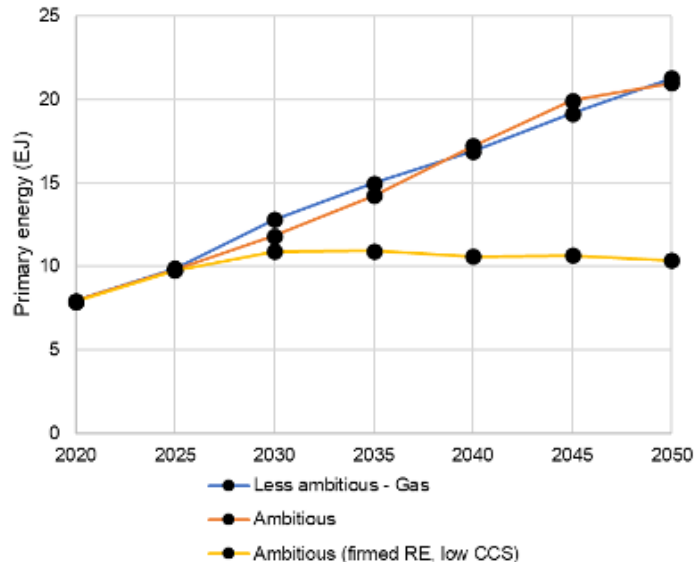


- Coal exits in the near term across all scenarios.
- Large difference in coal use in India under ambitious scenario in which CCS is capped, and RE available at scale.

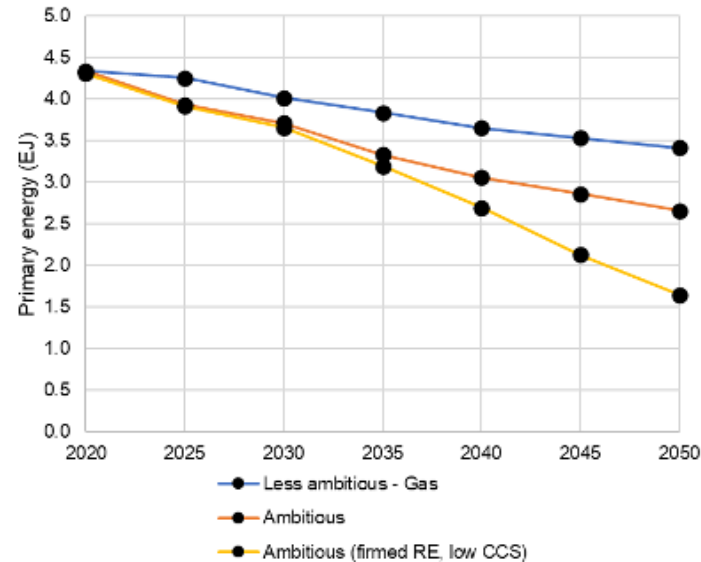


Gas Use in Selected Indo-Pacific Countries

China



Japan

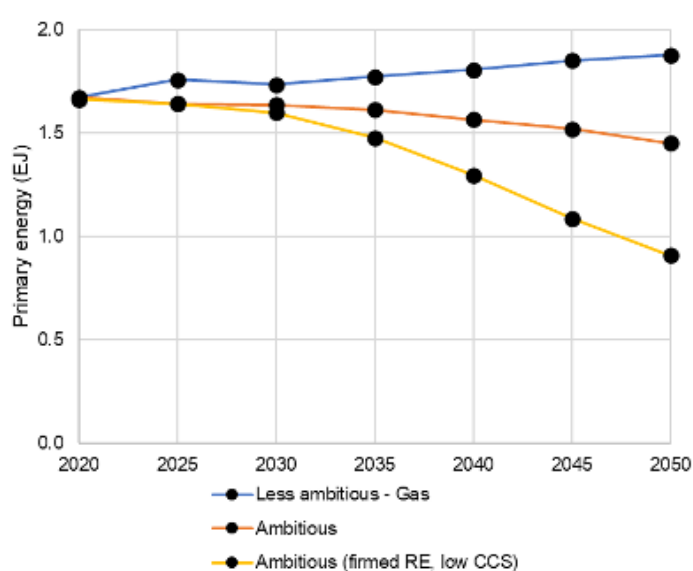


- More differences in gas use.
- For China, much less gas will be used if CCS is limited and RE storage options are available.
- For Japan, gas use falls across scenarios. But much less gas will be used if CCS is not available and/or storage options are available.

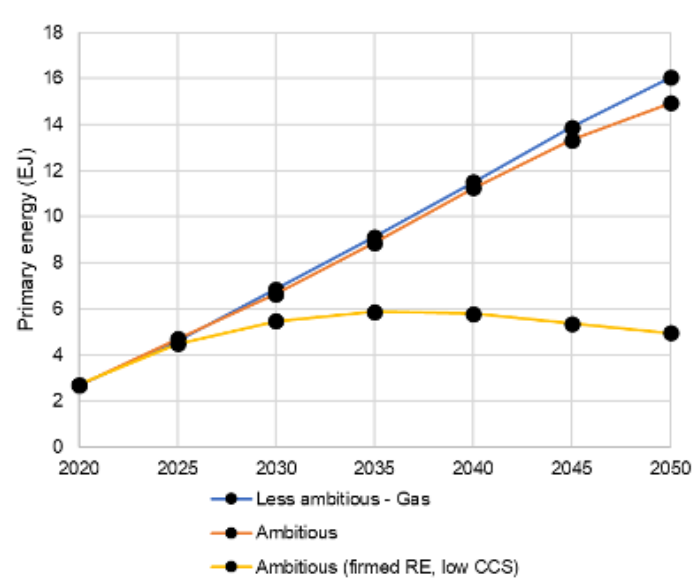


Gas Use in Selected Indo-Pacific Countries

South Korea



India



- More differences in gas use.
- South Korea is similar to Japan. Much less gas is used if CCS is limited and RE storage options are available.
- For India, gas remains a near-term option, but much less gas will be used if CCS is limited and RE storage options are available.



Summary of Results

- GCAM modelling suggests we should expect a near-term drop in thermal coal use by major APAC economies.
 - Introduction of new technology options (capped CCS/more firm RE) leads to deeper/more rapid falls.
- GCAM modelling suggests gas use by key trading partners is strongly affected by the availability of CCS and limited availability of firm RE, coupled with the overall level of global climate ambition.
- Extension: fuel mix is strongly determined and mix of security of supply risks depends strongly on secondary technology availability.
 - Less CCS and more RE storage options shift supply chain risks more rapidly from coal/gas to renewables.



Financial services group Orix, utility Kansai Electric construct 113MWh battery storage system in western Japan

By Andy Colthorpe
July 19, 2022

Asia & Oceania, Central & East Asia Grid Scale Business, Market Watch

LinkedIn Twitter Feed Facebook Email



Concept drawing of the BESS being built at Kinokawa Substation, Wakayama, Japan. Image: Orix

Japanese solar building up resiliency against curtailment

Mitsubishi and Japanese utility Kyushu Electric Power are teaming up to use more grid-scale storage, in order to reduce financial losses caused by curtailment.

JUNE 13, 2022 EMILIANO BELLINI

COMMERCIAL & INDUSTRIAL PV DISTRIBUTED STORAGE ENERGY STORAGE MARKETS RESIDENTIAL PV TECHNOLOGY AND R&D
UTILITY SCALE PV UTILITY SCALE STORAGE JAPAN



Mitsubishi built this rooftop solar plus storage system.



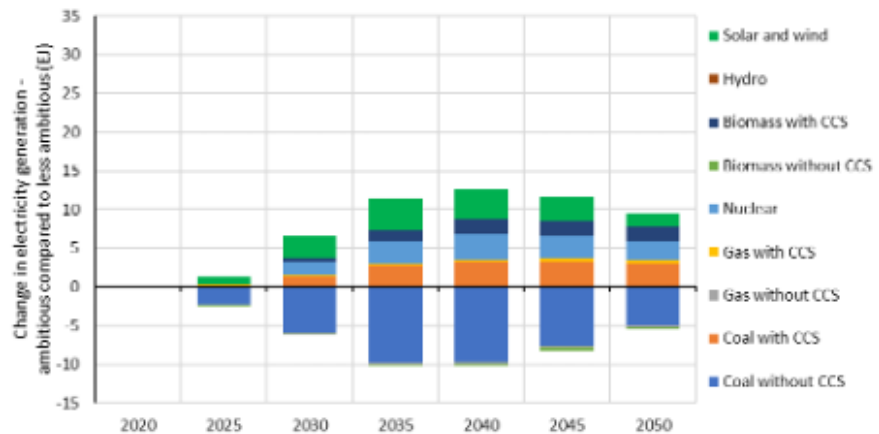
Scenario 2: Energy Mix in Electricity Generation in the PRC, Japan, South Korea, and India

- Decarbonisation scenarios suggest electrification is an important factor in the overall decarbonisation of energy systems.
- We considered the energy mix used for electricity generation in the PRC, Japan, South Korea, and India.
- The purpose of the analysis is to examine how the energy mix changes as global climate ambition increases, and how this is affected by technology availability.
- The analysis accomplishes this by comparing the electricity generated via different fuels and technologies in the ambitious scenario with that of the less ambitious scenario, under different technology assumptions.

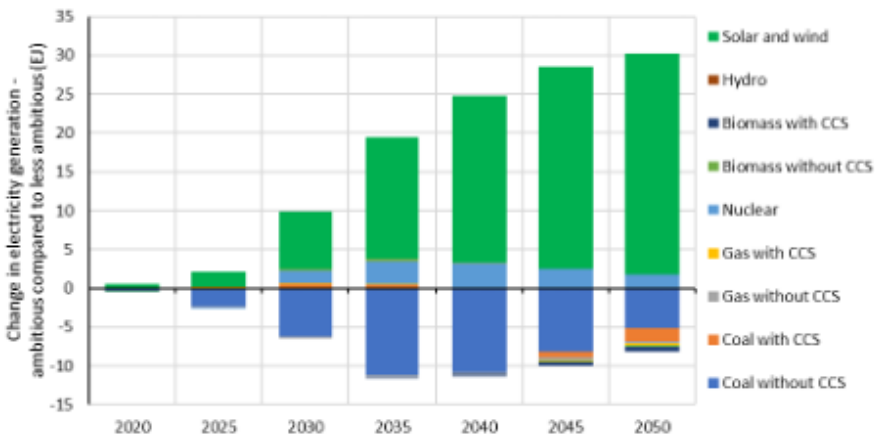


Change in Electricity Generation: China

China: Ambitious Climate Scenario Less Renewables, More CCS



China: Ambitious Climate Scenario Firmed Renewable Energy, Low CCS

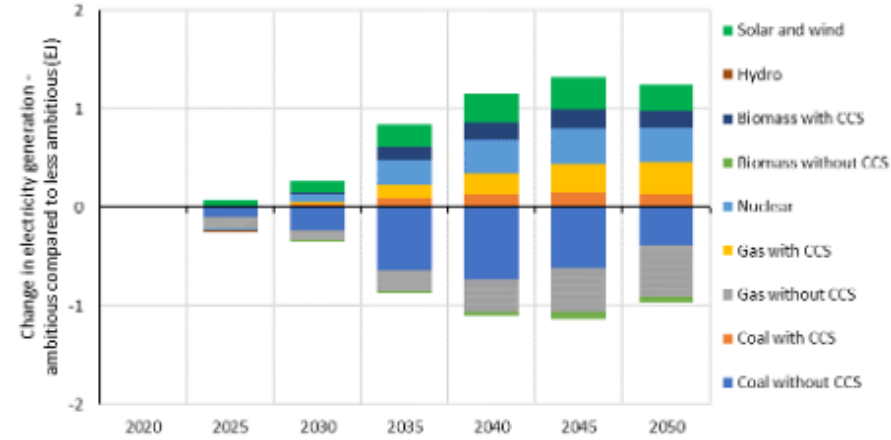


- Once again, as ambition grows coal exist as climate ambition increases.
 - ◉ Some new coal as CCS is available at scale.
- Large overbuilt in firmed renewables as CCS is capped and capacity factor of RE increases.
 - ◉ More electrification of heating/other energy services.
 - ◉ Overbuild with curtailment can be optimal from cost perspective in managing remaining intermittency problem.

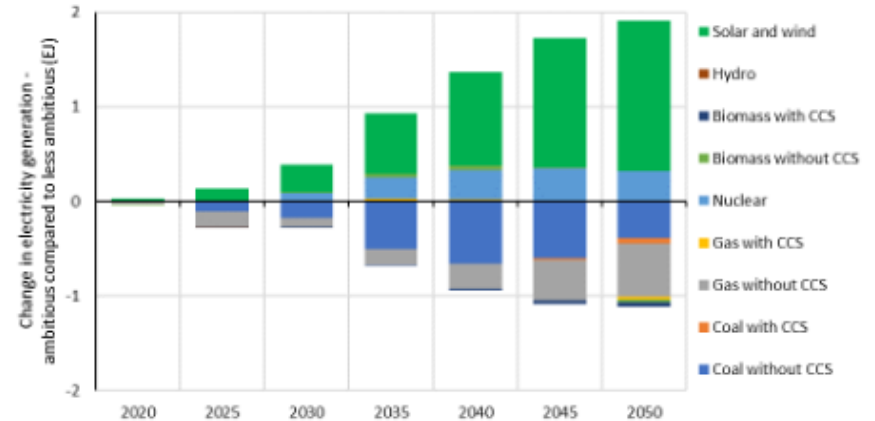


Change in Electricity Generation: Japan

Japan: Ambitious Climate Scenario Less Renewables, More CCS

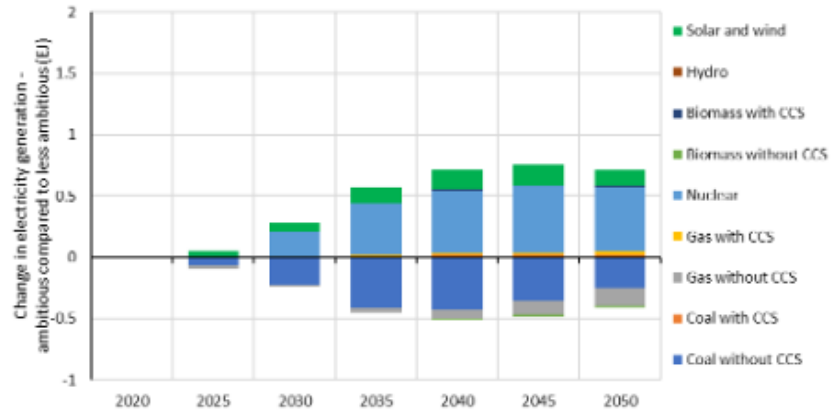


Japan: Ambitious Climate Scenario Firmed Renewable Energy, Low CCS

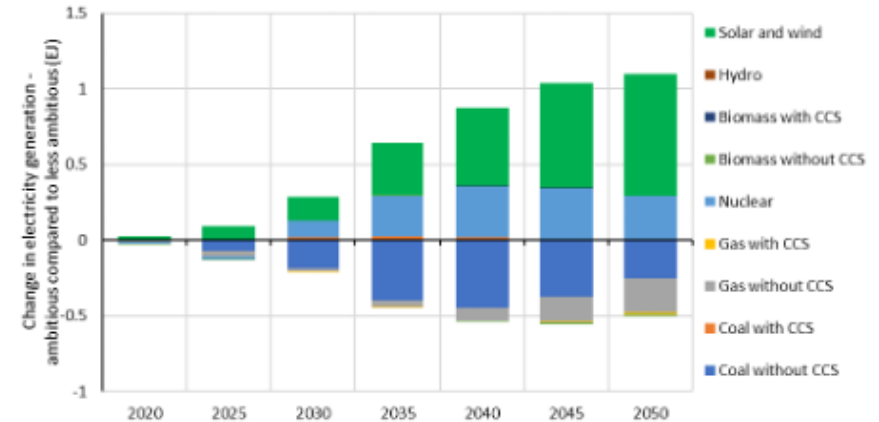


Change in Electricity Generation: India

South Korea: Ambitious Climate Scenario Less Renewables, More CCS

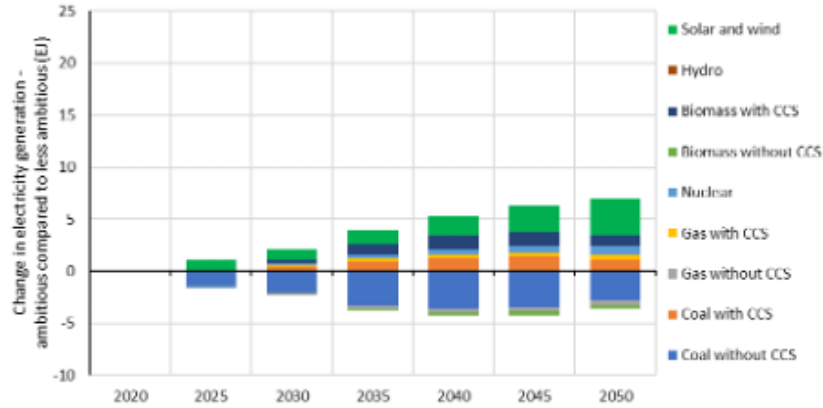


South Korea: Ambitious Climate Scenario Firmed Renewable Energy, Low CCS

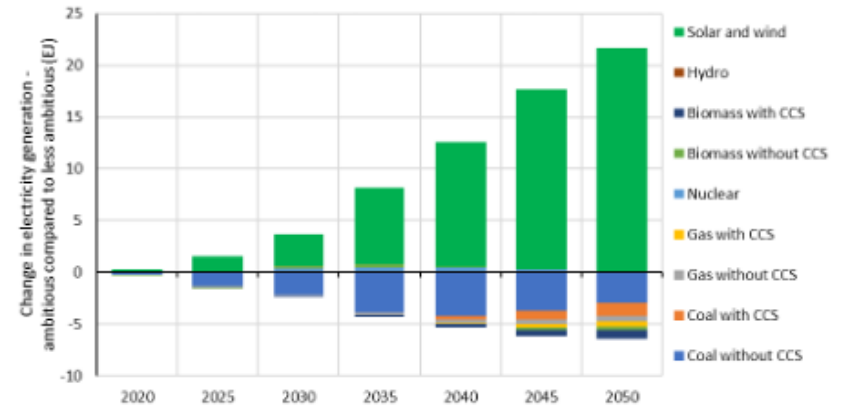


Change in Electricity Generation: India

India: Ambitious Climate Scenario Less Renewables, More CCS



India: Ambitious Climate Scenario Firmed Renewable Energy, Low CCS



Summary of Results

- The results highlight a direct trade-off between CCS and renewable energy with storage.
- As global climate ambition increases in China, coal with CCS grows, along with nuclear power, solar photovoltaics, and wind power.
- Low deployment of CCS, on the other hand, see a much larger deployment of solar PV and wind power.
- Similar amounts of nuclear power build between the two scenarios.
- Similar results can be seen in the other countries.



Overall

- GCAM results suggest changes in coal and gas use in major energy importers in the Indo-Pacific – China, Japan, India, and South Korea - are strongly dependent on three factors:
 - The global level of climate policy ambition;
 - The available technology options supporting decarbonisation, such as carbon capture and storage, and options for firming renewables such as batteries and pumped hydro;
 - Available resources in each country, including land, solar irradiance, wind, and carbon storage sites.
- The countries we examined all increased the use of solar and wind in the electricity mix.
 - Countries will increase their exposure to supply chain risks associated with solar, wind, and firming technologies as they decarbonise.
- There are large uncertainties in the technology pathways as they decarbonise.
 - Information and markers on regional decarbonisation pathways are crucial for understanding risks and opportunities as the region decarbonises.

