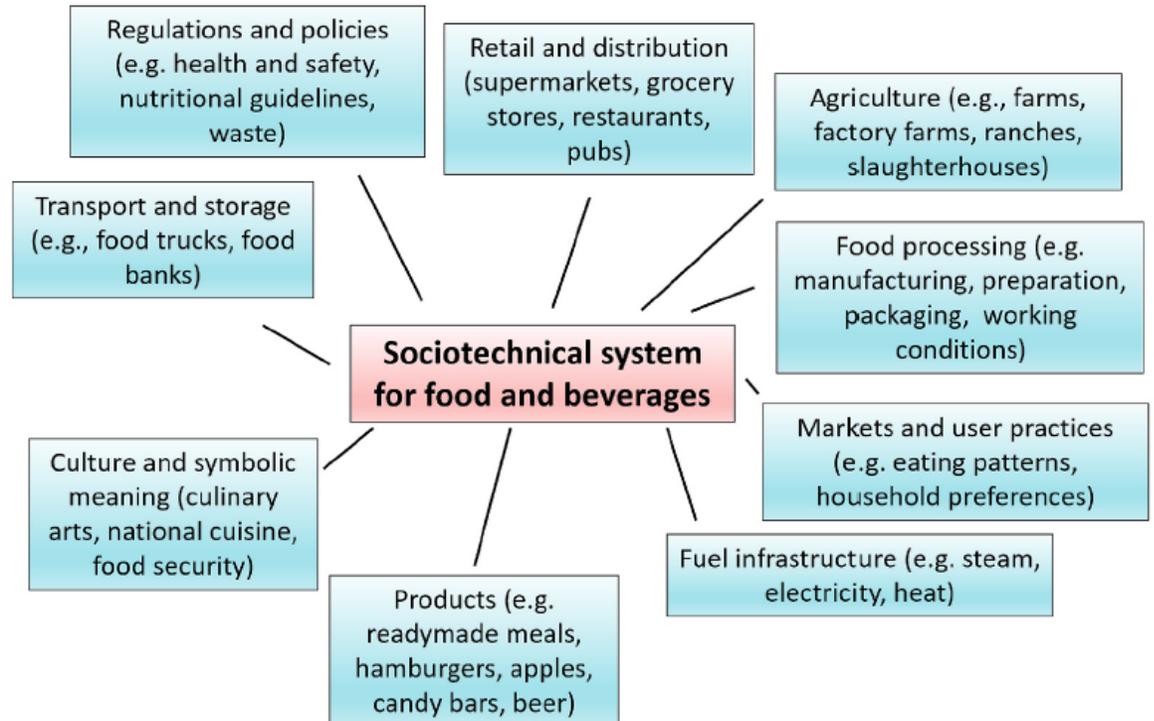
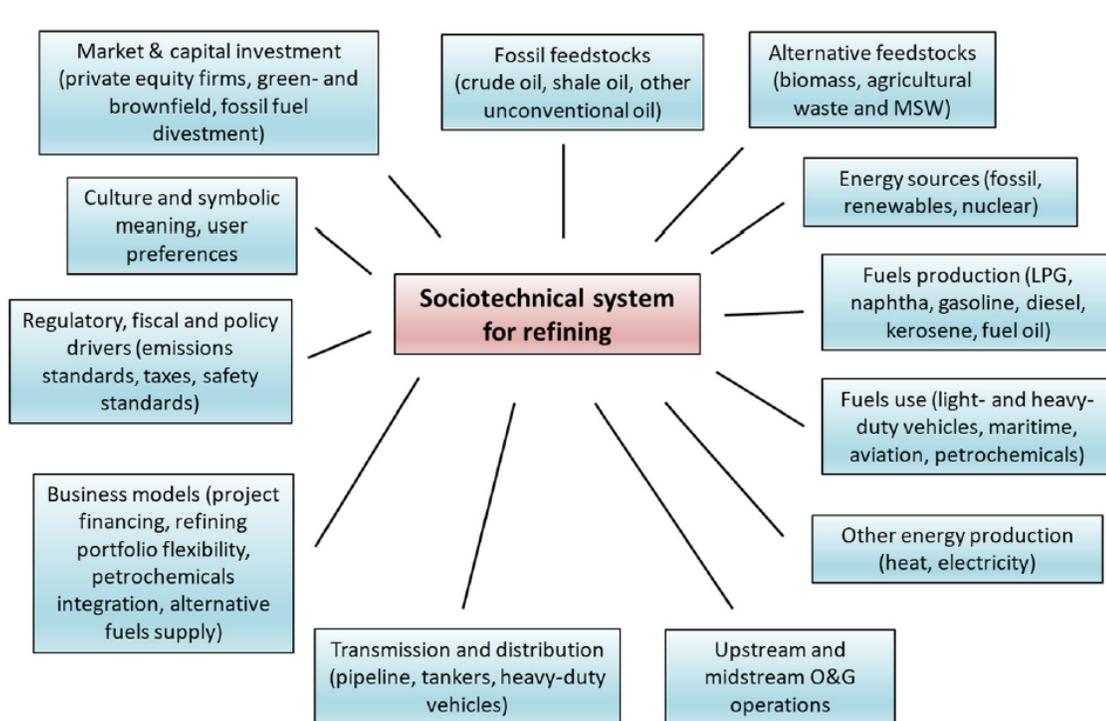


GLOBAL INTERACTIONS AND INTERNATIONAL LESSONS ON DECARBONIZATION

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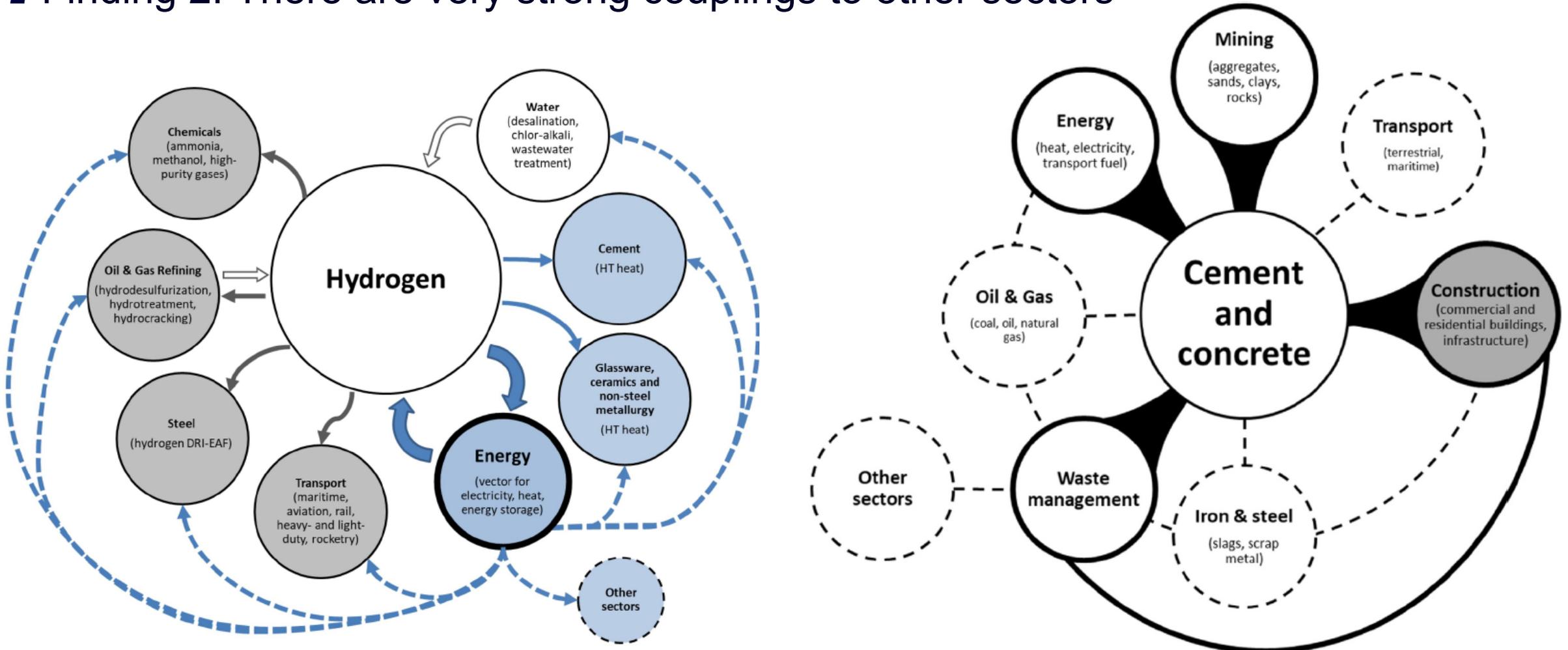
Viewing industrial decarbonization as a ST system

- A series of reviews looking at the sociotechnical policy aspects of industrial decarbonisation for iron and steel, cement, chemicals, oil refining, food and drinks, pulp and paper, glass, and ceramics
- Finding 1: challenges, barriers, and policies are all *sociotechnical*



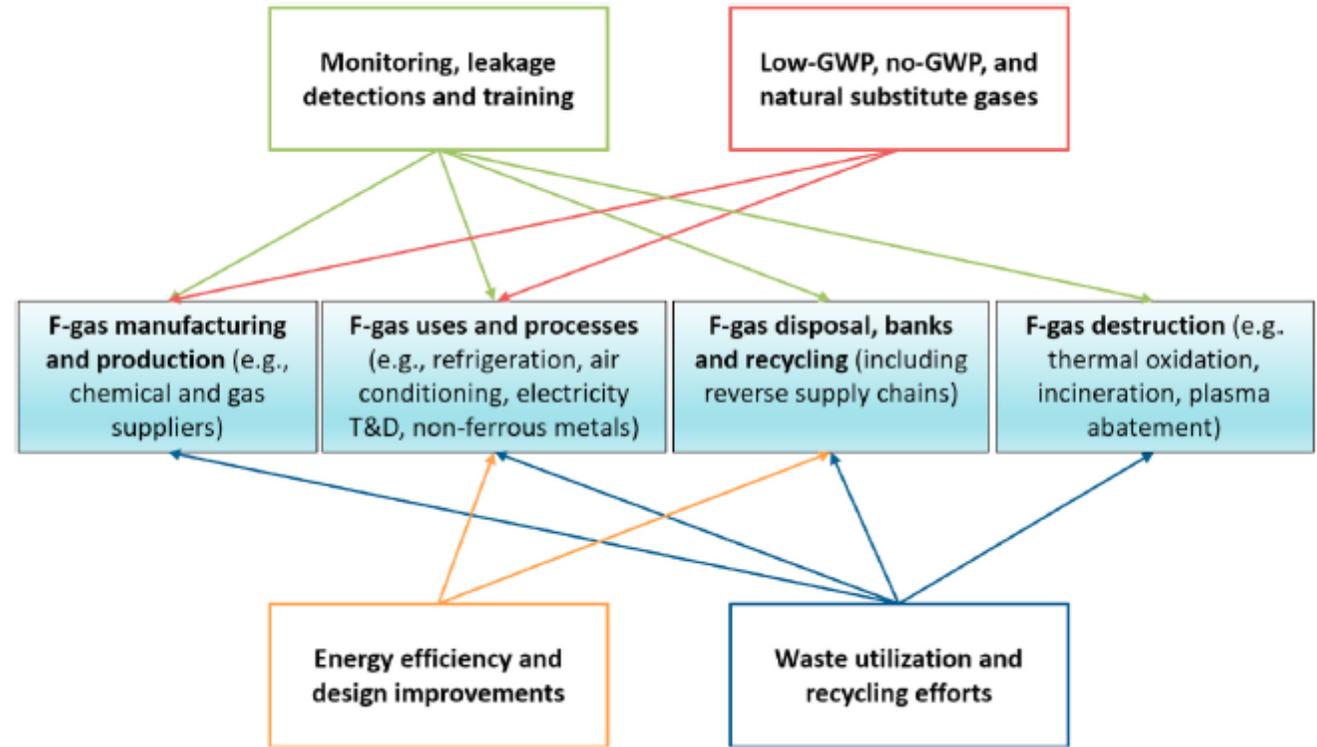
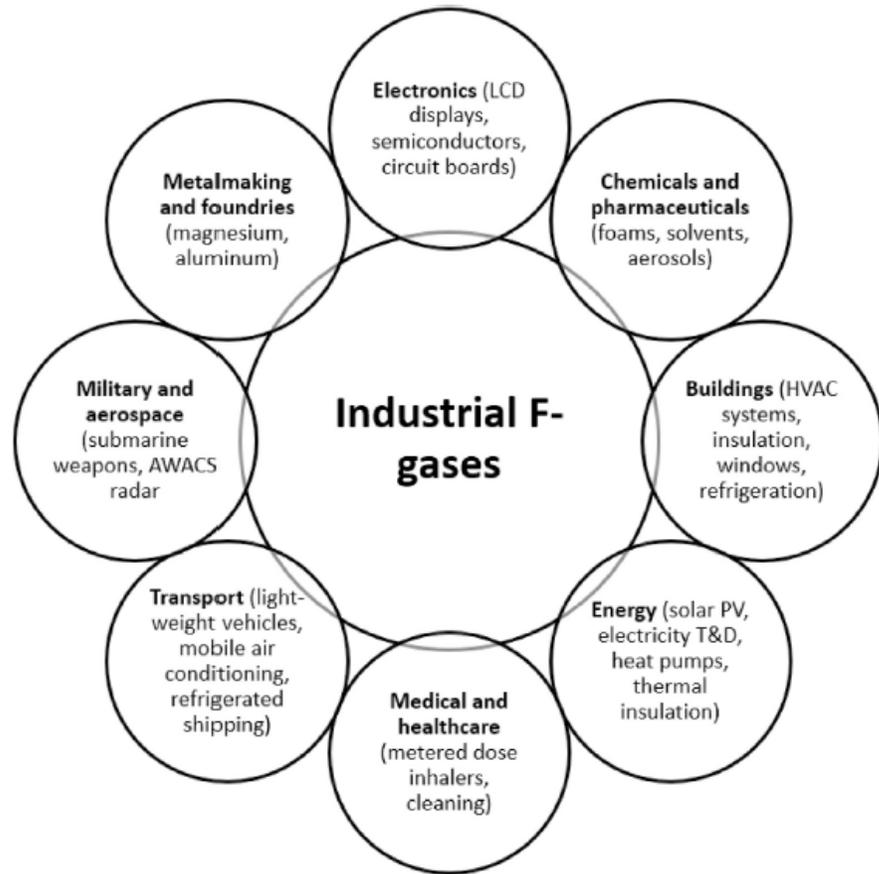
A sociotechnical system approach to ID

➤ Finding 2: There are very strong couplings to other sectors



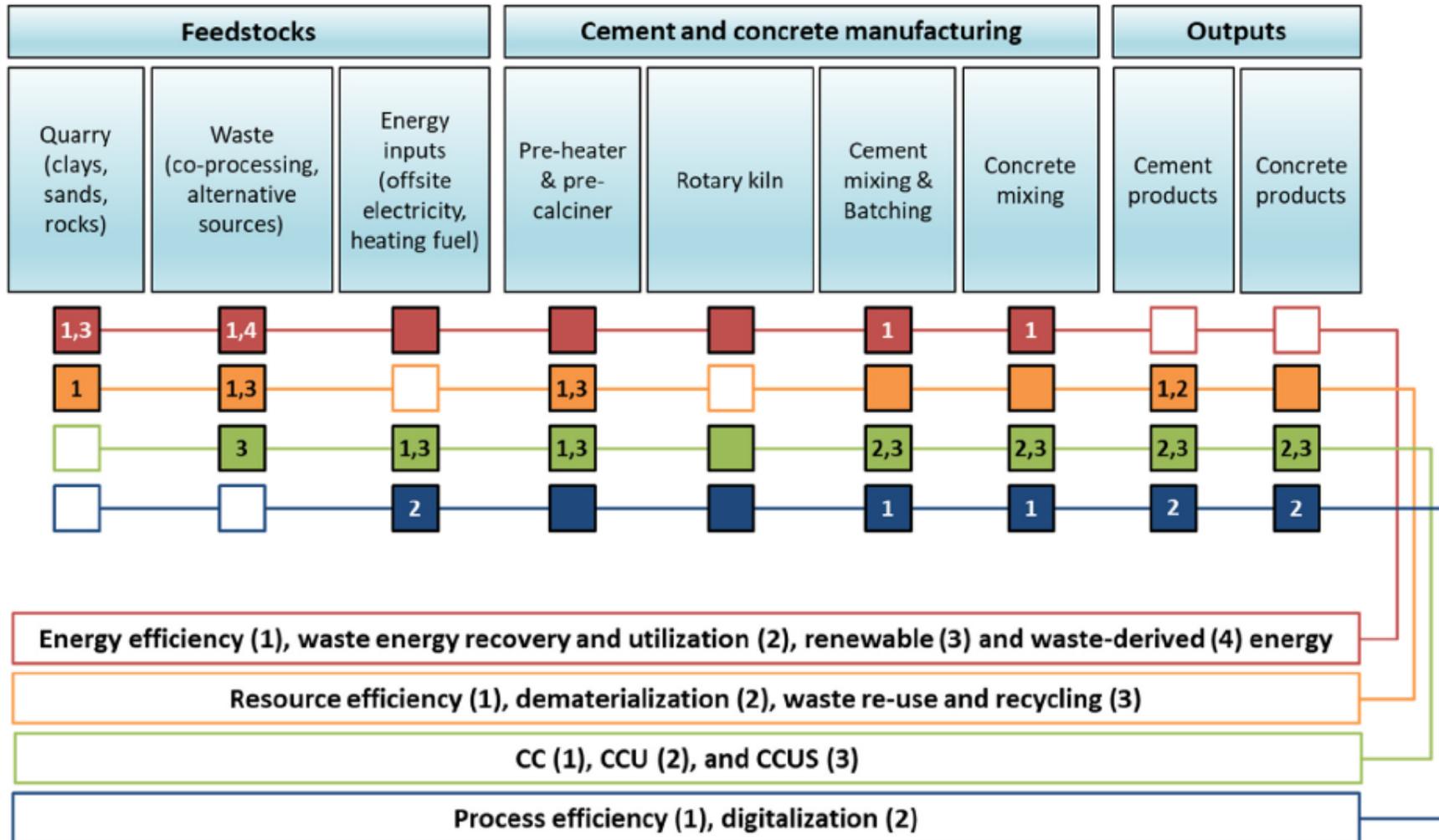
A sociotechnical systems approach

➤ This creates opportunities for cross-cutting interventions, where one type of intervention can decarbonize multiple parts of the lifecycle or supply chain, e.g. F-gases ...



A sociotechnical systems approach

➤ ... or cement and concrete



Learning from the UK

Industrial and Corporate Change, 2024, 00, 1–31
 DOI: <https://doi.org/10.1093/icc/dtae015>
 Original Article



Leading the post-industrial revolution? Policy windows, issue linkage and decarbonization dynamics in the UK's net-zero strategy (2010–2022)

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Table 2. Key industrial decarbonization policies in the UK by category

Policy category	Name	Description	Year implemented or revised
Climate change	Climate Change Act	Commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050	2008, updated in 2019
Carbon pricing	UK Emissions Trading Scheme	Came into force on January 1, 2021 to replace the UK's participation in the EU ETS, which was established in 2005.	2021
	Climate Change Levy	An environmental tax charged on the energy that businesses use, intended to encourage businesses to be more energy efficient in how they operate, as well as helping to reduce their overall emissions	2016, but updated annually
Competitiveness support	UK ETS Free Allowances	Provides £1.05 billion in allowances to targeted industrial clusters	2019
	Financial relief for energy-intensive industries	Gives £470 million per year in reduced electricity costs	2012–2021
	Climate Change Agreements	A voluntary scheme that encourages businesses in a wide range of industrial sectors with energy-intensive processes, such as chemicals, paper and ceramics to agricultural businesses such as intensive pig and poultry farming to invest in energy efficiency measures	2015–2021
	Demonstration Funding	Offers £505 million in support that aims to accelerate the commercialization of innovative clean energy technologies and processes	2016
Infrastructure	Net Zero Innovation Program	Provides £1 billion in support for low-carbon technology such as offshore wind, nuclear advanced modular reactors (supported through the aligned Advanced Nuclear Fund), energy storage and flexibility, bioenergy, hydrogen, direct air capture and greenhouse gas removal, industrial fuel switching, and CCUS	2021
	Transforming Foundation Industries	Disburses £66 million to the cement, metals, glass, paper, ceramics, and chemicals industries to make them more internationally competitive	2020
	Industrial Energy Transformation Fund	Budgets £315 million to help businesses with high energy use to cut their energy bills and carbon emissions through investing in energy efficiency and low carbon technologies	2019
	Industrial Decarbonization Challenge	Offers £170 million to the six largest industrial clusters in their mission to decarbonize at scale, laying the foundation for developing at least one low-carbon industrial cluster by 2030 and the world's first net-zero industrial cluster by 2040	2019

Table 2. (Continued)

Policy category	Name	Description	Year implemented or revised
Deployment Funding	CCUS/Hydrogen Business Models	Provides revenue support to hydrogen producers and CCUS facilities, making up the operating cost gap between low-carbon and higher-carbon fuels via 15 year contracts	2022
	Renewable Heat Incentive	A scheme that provides £684 million per year aiming to encourage uptake of renewable heat technologies amongst householders, communities and businesses through financial incentives, and increase heating coming from renewable sources	2014 (closing in 2022)
	Net Zero Hydrogen Fund	Provides up to £240 million to support the development and deployment of new low carbon hydrogen production to de-risk investment and reduce lifetime costs	2022
Infrastructure	Clean Steel Fund	Pledges £250 million to support the UK steel sector to transition to lower carbon iron and steel production	2019
	Industrial Heat Recovery Support	Offers £18 million to encourage and support investment in heat recovery technologies	2018 (closing in 2022)
	CCUS Infrastructure Fund	Allocates £1 billion for CCUS transport and storage networks, coupling to bioenergy via BECCS, and capital expenditure for CCUS-enabled “blue” hydrogen projects	2020
Demand-side and behavior	Heat Network Improvement Program	Provides £320 million to increase the number of heat networks being built, deliver carbon savings, and create the conditions necessary for a sustainable heat network market	2018
	First Demand-Side Policy Introduced	Supports demand-side measures such as the introduction of product standards, labelling schemes or procurement policies	2021

Source: Authors, modified from HM Government (2021a). CCUS=carbon capture utilization and storage. BECCS= bioenergy with carbon capture and storage. UK= United Kingdom. ETS= emissions trading scheme.

(continued)

Learning from the UK

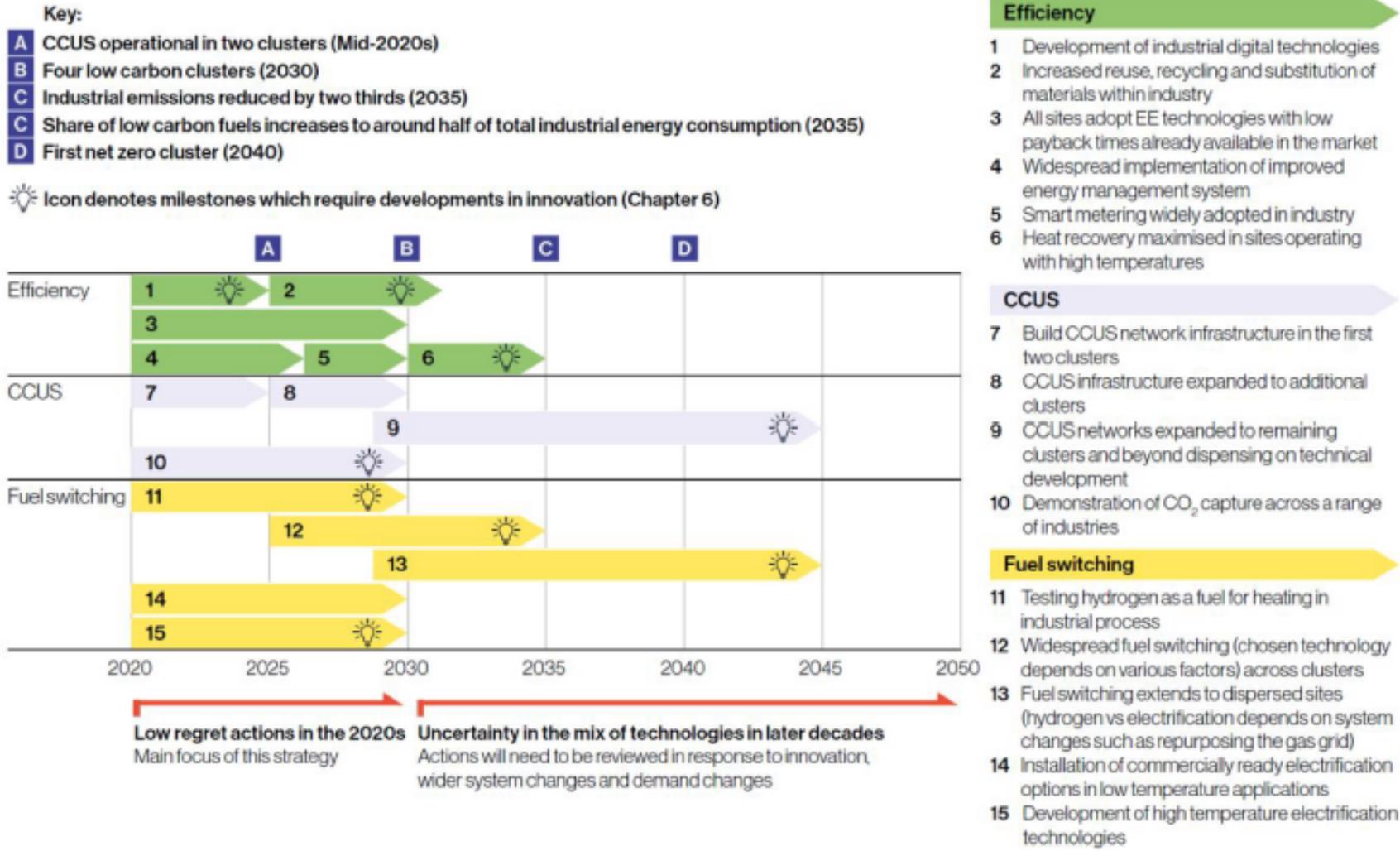
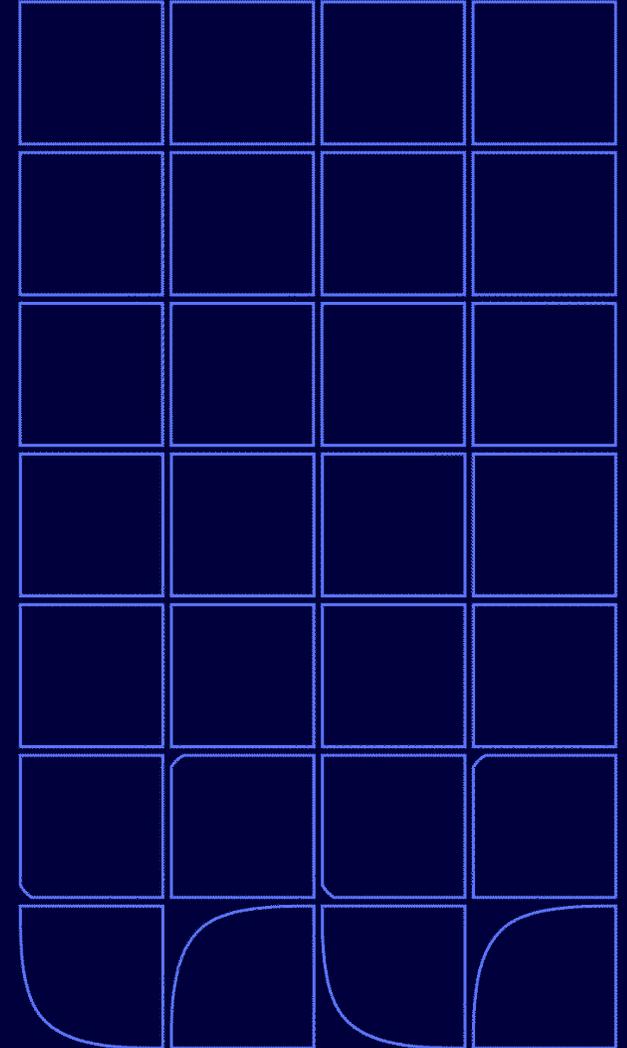


Figure 4. An overview of industrial decarbonization technology pathways in the UK, 2020–2050. *Source: HM Government (2021a).* Note CCUS = carbon capture utilization and storage. EE = energy efficiency.

IDRIC is the focal point of the green transformation in the UK's industrial heartlands. Powered by research and innovation and funded by UKRI, IDRIC develops innovative decarbonisation solutions at pace and scale in the places where it matters most.



Our partners: collaborating at scale and pace



Prof Mercedes Maroto-Valer
Champion and Director
Heriot-Watt University

Partners

142

With global reach

Funding

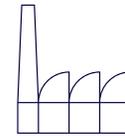
£30M

Until 2024



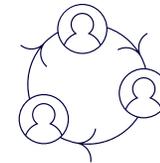
23

Research organisations



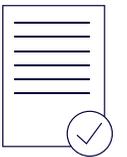
74

Industry partners



35

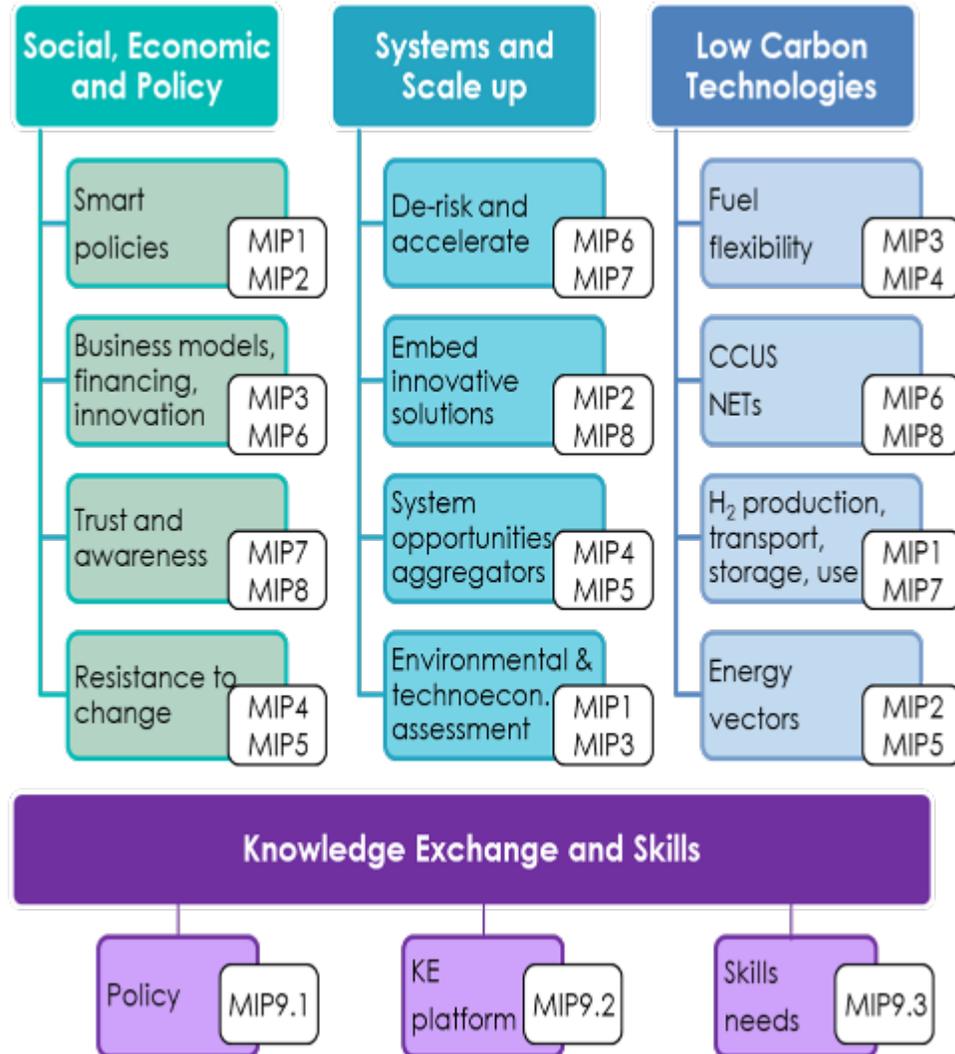
Associations,
NGOs & Trade
organisations



10

Policy makers
& government
bodies

Research and Innovation Themes (RITs) and MIPS



Multidisciplinary Integrated Programmes - MIPS

MIP1: System planning for net-zero industrial clusters

MIP2: Infrastructure for net-zero industrial clusters

MIP3: Operating net-zero industrial clusters

MIP4: Scale up opportunities at cluster and value chain level

MIP5: Energy vectors for industrial decarbonisation

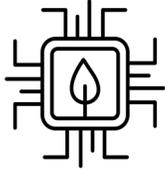
MIP6: Accelerating deployment of CCUS for industrial decarbonisation

MIP7: Large scale deployment of hydrogen systems for industrial decarbonisation

MIP8: Reducing costs and risks of NETs and their integration in industrial clusters

MIP9: Skills and knowledge exchange

Industrial decarbonization requires system-wide enablers



Technology & systems

How to **evolve or replace technologies and processes** so they do not emit GHGs and improve resilience to climate change and other threats?



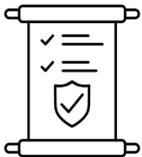
Community & labor force

How to **mitigate worker and community impacts – and even expand opportunity?** How to improve public understanding and acceptance?



Enabling infrastructures

How to **design, site, and incentivize** the siting of clean electric power, direct air capture, carbon capture and sequestration, and hydrogen to meet future needs across industrial supply chains?



Orgs, institutions, & policy

How can we **design organizations, institutions, and policy** to incentivize net-zero compatible investments with broad benefits? What **decisions** need to be made to **encourage action** to deploy decarbonization solutions?

International collaboration can inform decarbonization efforts

Example: **Industrial Decarbonization** Analysis, Benchmarking, and Action (INDABA) Partnership



Institute of Energy, Environment, and
Economy, Tsinghua University
Beijing, China

ie³, TU-Dortmund, **Dortmund, Germany**

Climate and Environmental Economics, ZEW
Mannheim
Mannheim, Germany

Energy Systems Research Group,
University of Cape Town
Cape Town, South Africa

Carnegie Mellon University
Pittsburgh, United States

~20 multi-sector, multi-stakeholder partners

Supported by the U.S. National Science Foundation

CMU Investigator Team:

Paulina Jaramillo and Valerie Karplus, Department of Engineering and Public Policy

Chris Pistorius, Department of Materials Science and Engineering

Edson Severnini, Heinz College of Public Policy and Information Systems



Insights for global efforts to decarbonize the industrial sector

- May be easier to build a shared understanding and to incentivize decarbonization globally by working **at the industry level**
- **Collaboration involving academia, industry, and other stakeholders** with relevant industry expertise can help to create this momentum
- **Trade policy can serve as an important climate policy lever** and should be used to accelerate – and not impede – ambition

Transition Strategies in China and other Asian Countries

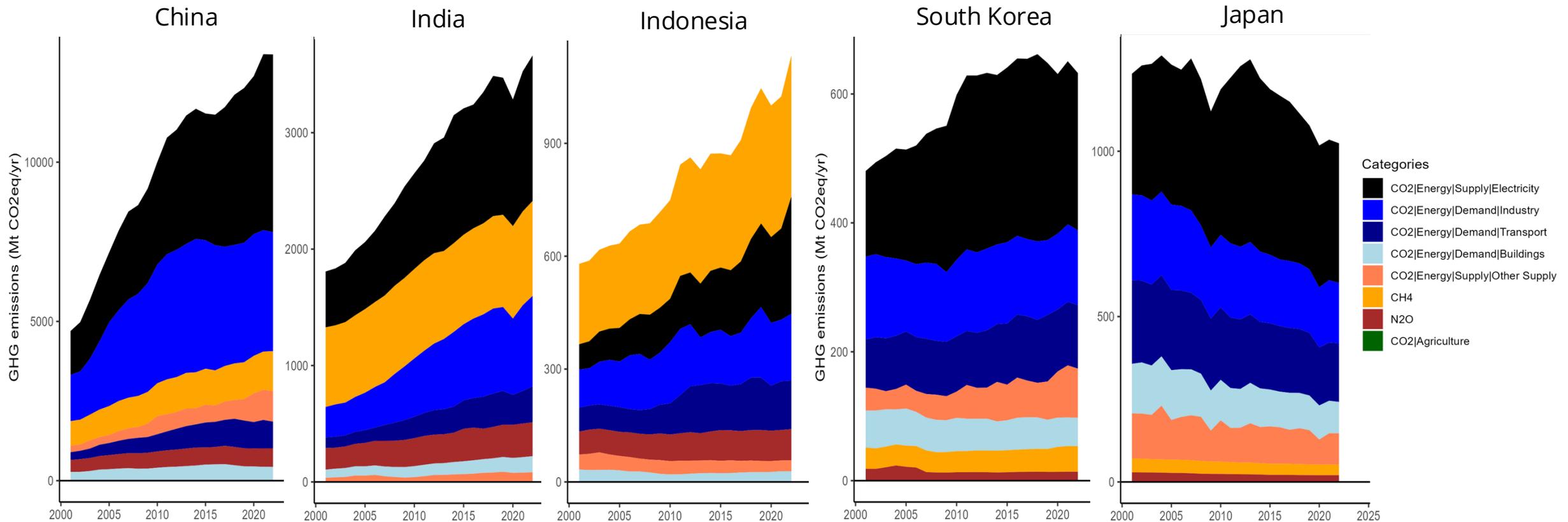
Macroeconomic Implications for Decarbonization Policies and Strategies

Session 4: Global Interactions

September 12–13, 2024, Washington D.C.

Emissions profiles and trends in key emitting Asian countries

- Emissions have been increasing rapidly in China, India, Indonesia, but started to decline in South Korea and Japan
- Electricity (and heat) generation and industrial sectors are main contributors of emissions



Historical GHG (excl. LUC CO₂) emissions by sector 2000-2022, sorted from largest to smallest in 2022 (CEDs)

Key transition strategies – China

- **China’s emissions may have already peaked in 2023 or will be soon (by 2025)**, driven by rapid green technology deployments and declining demand for energy-intensive products due to economic slowdown and restructuring.
- **How quickly it can reduce emissions during post-peaking for a meaningful 2035 target:**
 - Continue high-speed RE deployment and integration in electricity, with non-coal solutions for grid balancing
 - Move away from energy-intensive, infrastructure-driven growth through economic restructuring
 - Maximize low-cost abatement opportunities to reduce non-CO2 gases – i.e., methane, industrial N2O
- China is pursuing a **comprehensive social and economic transition** towards carbon neutrality, powered by new, green industries:
 - Tremendous success in green technology industries: the “new three” of solar, EV, and batteries, driving down costs for domestic and global deployment
 - Investments in green industries have started to drive China’s economic growth

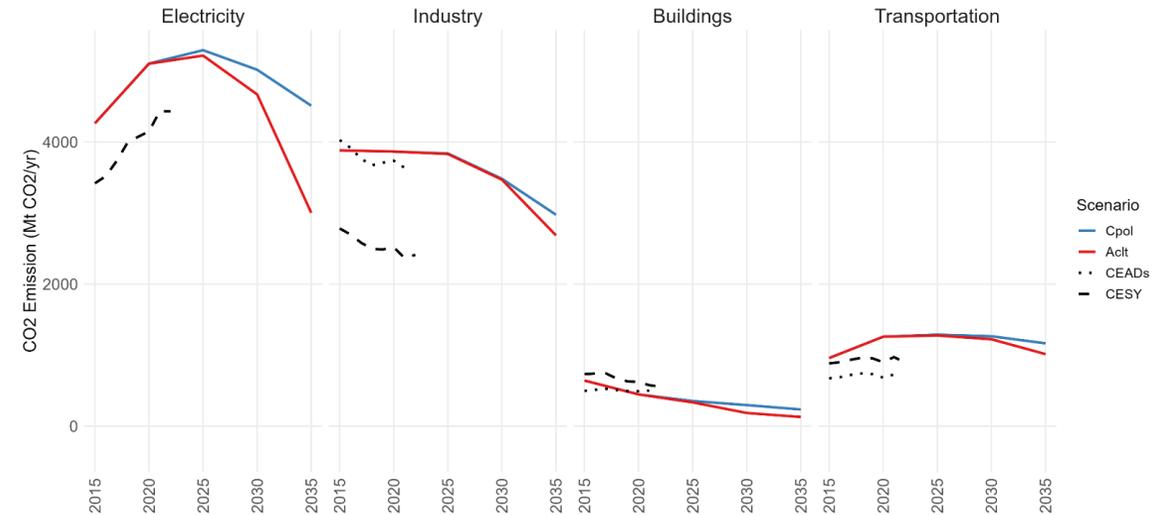


Figure 1: Sectoral emissions pathways under current policies and accelerated actions in China

Annual Solar & Wind Capacity Additions in China (GW)					
	2020	2021	2022	2023	2024 H1
Solar	48	55	87	217	102
% of global	38%	36%	46%	63%	n.a.
Wind	72	48	38	76	26
% of global	65%	51%	51%	66%	n.a.
Total Solar + Wind	120	103	125	293	128

Potential implications to trade and economy

- **Energy security** and **industry/economic development** are two main themes of key Asian countries' transition strategies:
 - Japan/Korea: hydrogen (+ammonia) industry and economy – economic viability & emissions outcomes are highly uncertain
 - Indonesia: nickel mining and processing – powered by carbon-intensive captive coal plants
- Most countries have insufficient progress but large potential in accelerating **RE (+storage) and EV adoptions**.
- China's "overcapacity" of solar and EV manufacturing creates concerns for other countries' own green industry development.
- With increasing challenges to enter the U.S. and E.U. markets, China has strong interests to **establish new markets in other developing countries**, creating opportunities for accelerated global transition.
- It is **not** a U.S. priority to compete with China on global renewable manufacturing but mostly to protect domestic industries and supply chain resilience; competitive advantages focus more on high-tech, high-value industries.

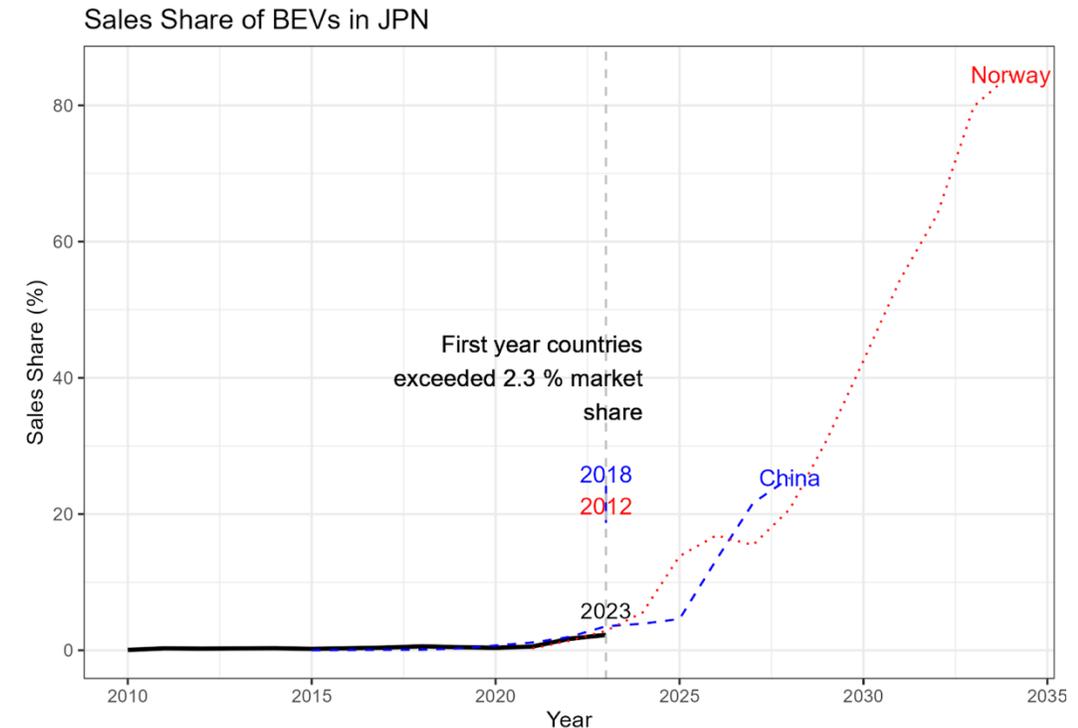


Figure 2: Sales share of BEVs in Japan compared to reference trajectories from Norway (red) and China (blue), shifted such that they coincide in the year that first surpassed 2% (which is 2023 for Japan, 2018 for China, and 2012 for Norway)



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SUSTAINABILITY

Thank you!

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Acting Director, China Program Co-Director, Associate Research Professor, Center for Global Sustainability, University of Maryland
Research Scientist, Joint Global Change Research Institute, Pacific Northwest National Laboratory
ycui10@umd.edu

Christoph Bertram, Jenna Behrendt, Maria Borrero, Audrey Rader, Mel George and others



Carbon border adjustments

National Academy of Sciences

Milan Elkerbout

Fellow, director international climate policy initiative

September 2024



CBAMs (or border measures): what & why?

- A fee on imported goods based on carbon (GHG) embedded in goods
- EU CBAM will be a world's first – from 2026
- UK to follow, but also interest elsewhere, including in the US – bipartisan!
- Why?
 - Prevent or mitigate carbon leakage risk
 - Protect industrial competitiveness
 - Level-playing field
 - Incentivize others to adopt certain policies
 - Reduce GHG emissions linked to consumption
- The How: technicalities matter
 - Which products or sectors (mostly basic industrial goods and electricity)
 - How to determine the fee (easy if there is a domestic carbon price – otherwise...?)
 - How to measure embedded carbon
 - Any exemptions?
 - Incidence: like a tariff, consumers ultimately pay – not the foreign country/producer



CBAMs & political economy challenges

- Policy spillovers! EU will credit for carbon prices already paid; hence more countries are considering carbon pricing
 - China considering adding sectors to its ETS
 - Turkey considering a new ETS
 - Many carbon taxes / ETSs under discussion
 - Key question: is it real policy or an attempt to avoid impact of EU CBAM?
- Retaliation – tariffs, or asymmetrically
- Reshuffling: what if a country simply exports its lowest-carbon goods, or shifts trade to a good that is not covered by the policy?
- Revenues: potentially attractive, but can also create resentment
- Administrative complexity is very high – international coordination difficult (so-called interoperability)



Some key messages about CBAMs in 2024

- Some evidence of renewed global impetus for carbon pricing
- Implementation is challenging – many things still to be sorted out even for the EU
- US has an interest too, but not necessarily in domestic carbon pricing, only imports
- Always compare a border measure with the domestic policy in place
- Including final, or complex goods (a car, a couch, a computer) is easy to envision in theory, but might be very hard to implement in practice





Thank you.

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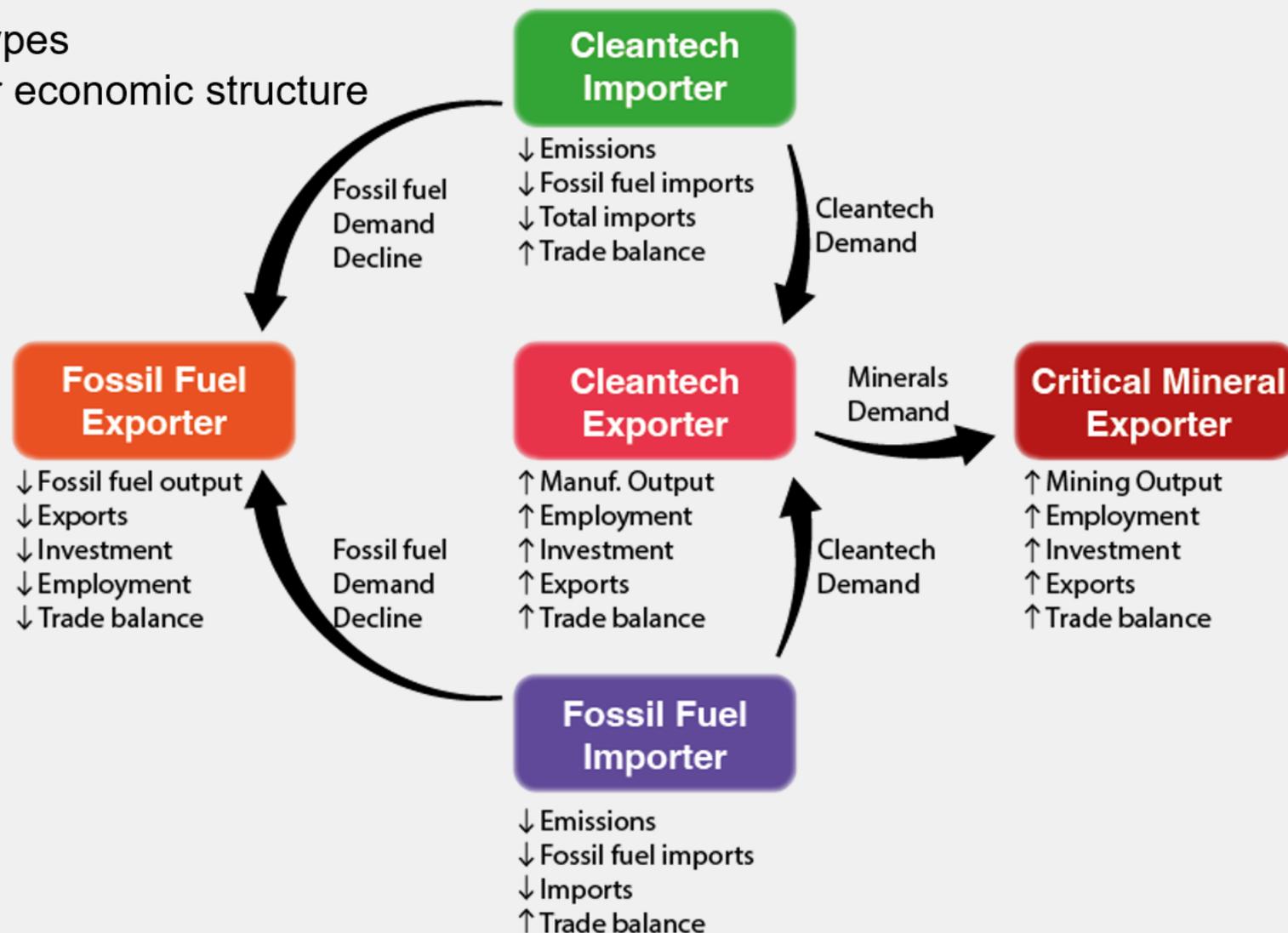
Cross-border risks in a low-carbon transition

Sept - 13

J-F Mercure
Associate Professor in Climate Policy
Global Systems Institute, University of Exeter

Cross-border risks in the transition

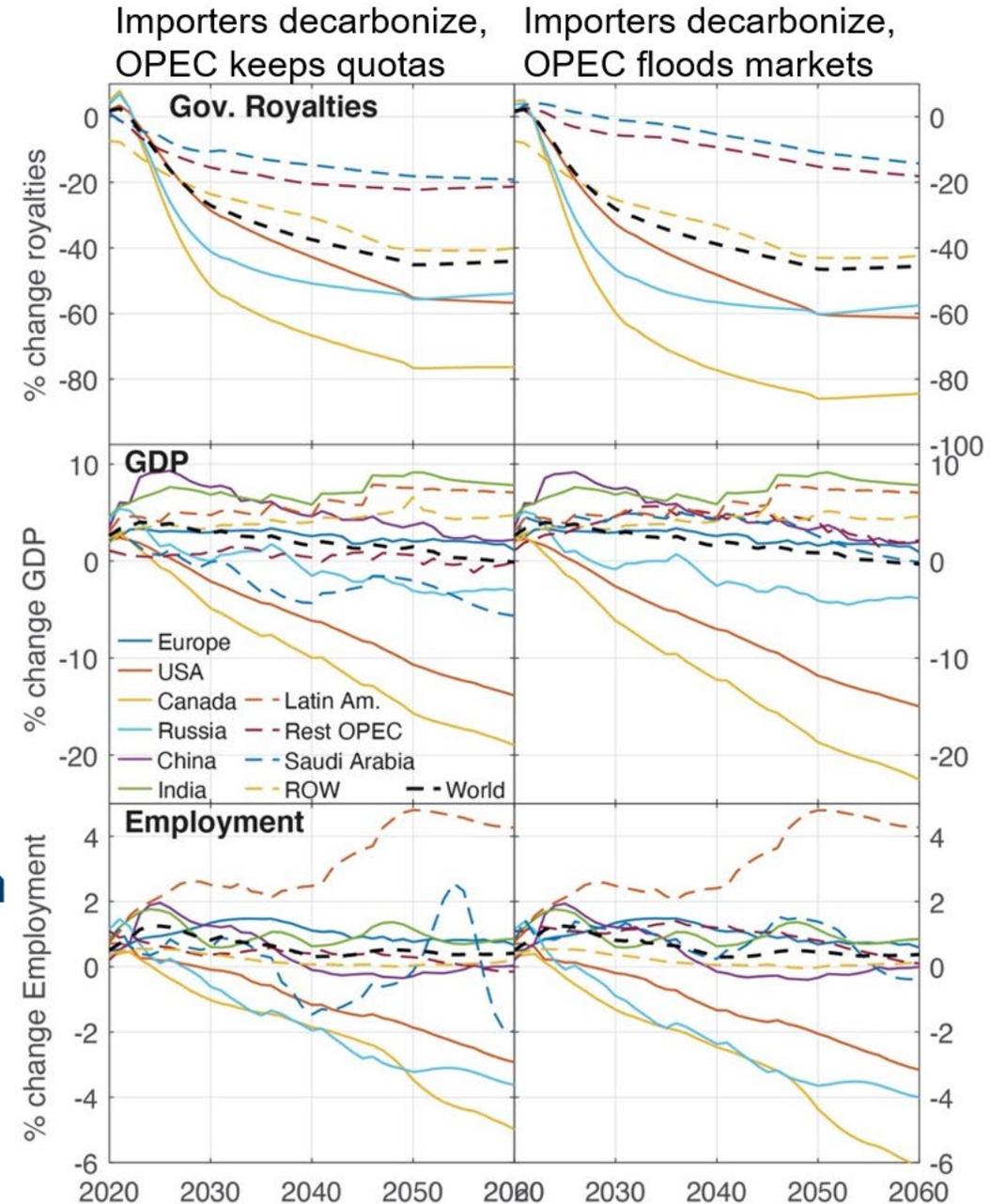
5 country archetypes
according to their economic structure



Demand-driven macro impacts of the end of oil:

Using E3ME-FTT energy-economy-climate model

1. Low-carbon investment boosts economic activity
 - Building activity ↗, GDP ↗, jobs ↗
 - Implies large investment and possible debt burdens
2. Decline in demand for fossil fuels
 - Excess supply, FF prices ↘, production ↘, GDP ↘, jobs ↘
 - Declines in investment across supply chains
3. Trade balance:
 - Importers:
Reduces energy imports and redresses trade balance, income ↗, competitiveness ↗, GDP ↗ (e.g. Europe, China, Japan, India)
 - Exporters
Decline of the fossil fuel industry, jobs ↘, GDP ↘ (e.g. USA, OPEC, Canada, Russia)



The cross-border climate-policy game

GDP payoff matrices (2020\$bn), E3ME-FTT macro-model

Large Fossil Importers vs OPEC

OPEC Response

		Quotas		Sell-off	
		Importers	OPEC	Importers	OPEC
Large Fossil Importers	Net-zero	26889	243	26521	1182
Strategy	Baseline	8367	-40	8171	410

OPEC vs High-Cost fossil exporters

High-cost fossil exporters Response

		Baseline		Net-Zero	
		HCE	OPEC	HCE	OPEC
OPEC	Quotas	-2590	243	-4595	1551
Strategy	Sell-off	-4042	1182	-6350	2748

Large fossil Importers: EU, China, Japan, Korea...

OPEC: Saudi Arabia mainly, rest of OPEC

High-cost fossil exporters: US, Canada, Russia...

- **Large fossil Importers** have incentive to decarbonise but cause economic damage to all fossil producers
- **OPEC** have incentive to capture oil/gas production and exclude other producers from global fossil markets
- **High-cost fossil exporters** lose out in all cases but can mitigate damage by maintaining domestic fossil markets

Thank You!