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Net zero emissions pathways, related feasibility challenges and enabling conditions

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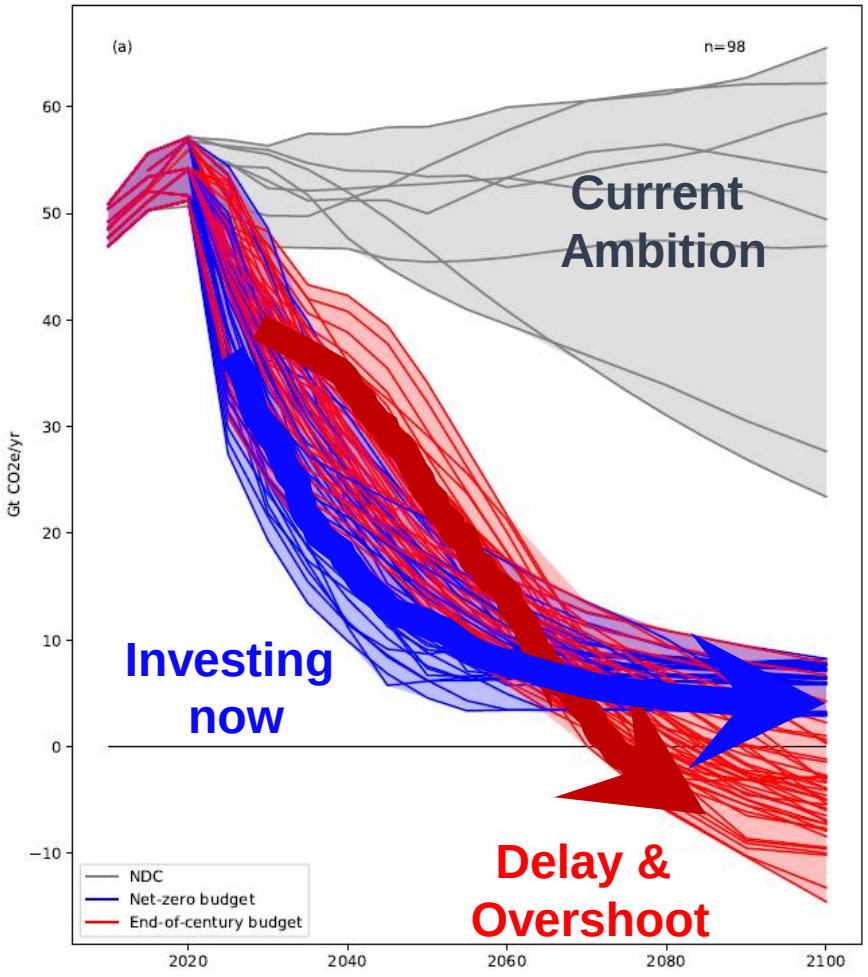
ENGAGE
FEASIBILITY OF CLIMATE PATHWAYS

ALPS Symposium 2022,

8 March 2022

Rapid and unprecedented effort required to stay "well below 2C"

World GHG Emissions



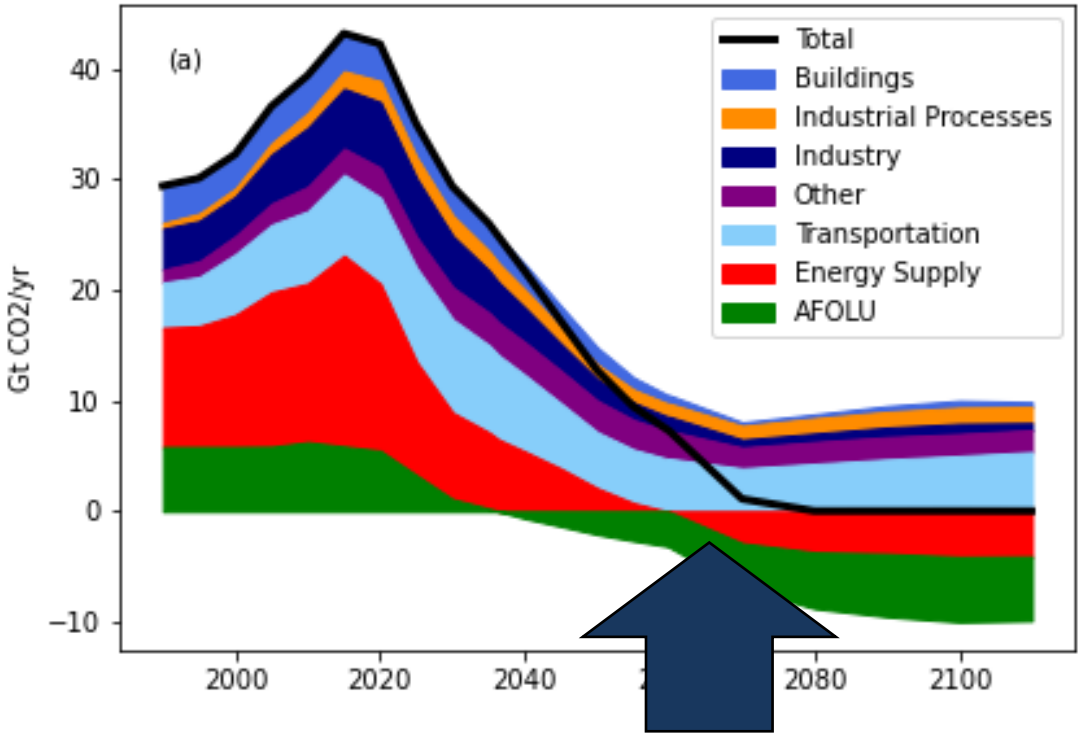
- CO2 emissions need to reach net zero in parallel to rapid reductions of non-CO2 GHG emissions
- Reductions across all sectors needed
- A portfolio of technologies are available
- Behavioral and lifestyle change important to manage the challenge
- Carbon dioxide removal required to compensate for residual emissions
- Investments need to be scaled up

Riahi et al, Nature Climate Charge, 2021

What does carbon neutrality mean?

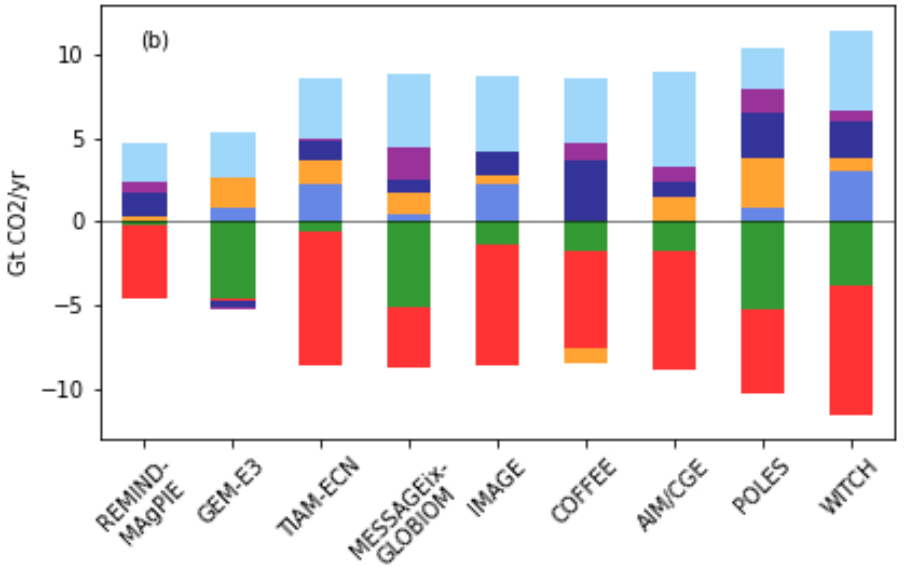
SECTORAL emissions sources and sinks

Illustrative zero emissions pathway



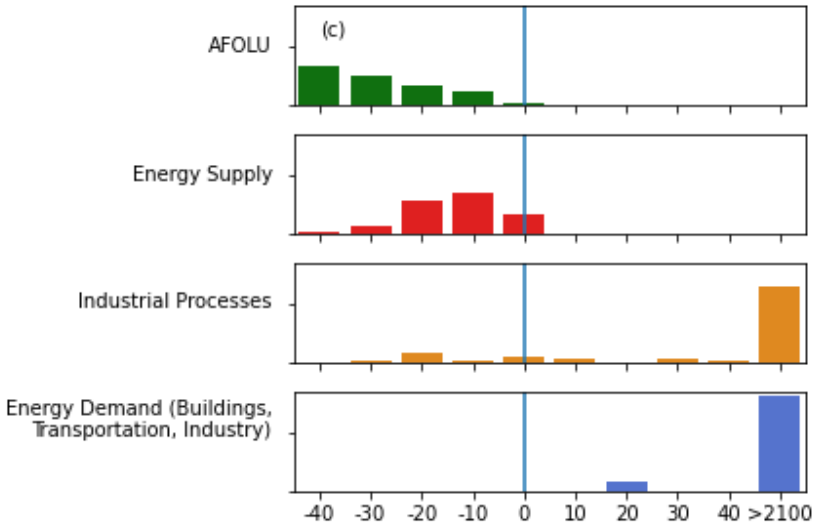
Net zero CO2 emissions 2050-2070

Different strategies across models



Timing of sectors for zero emissions

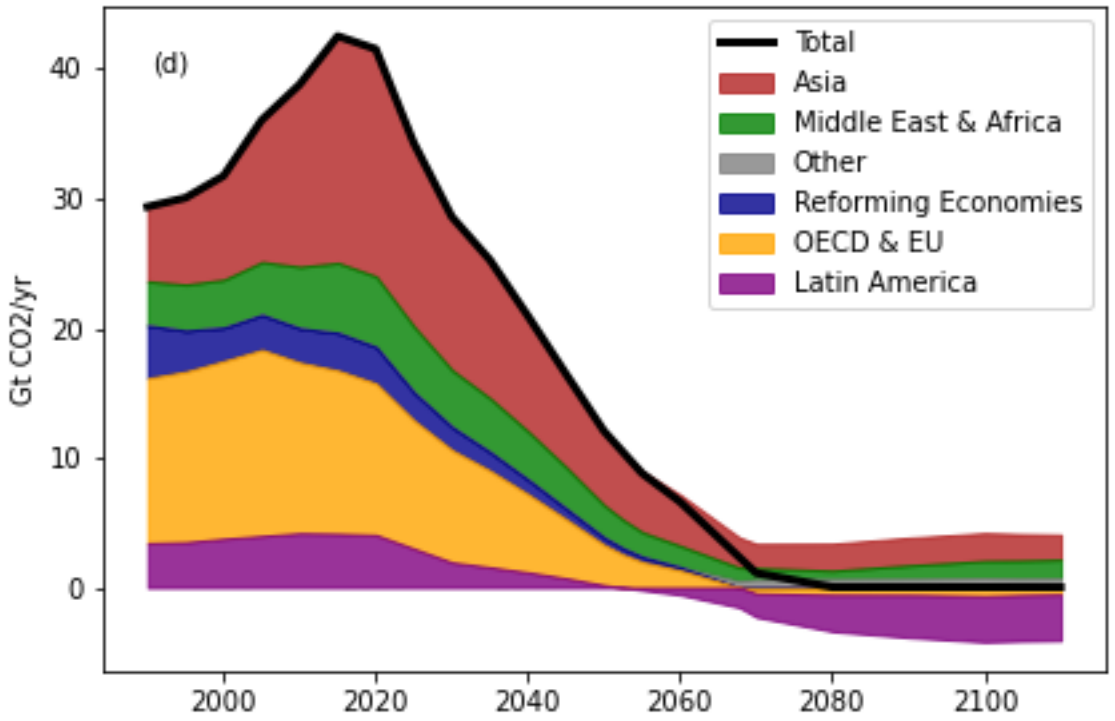
(compared to the timing of the overall system)



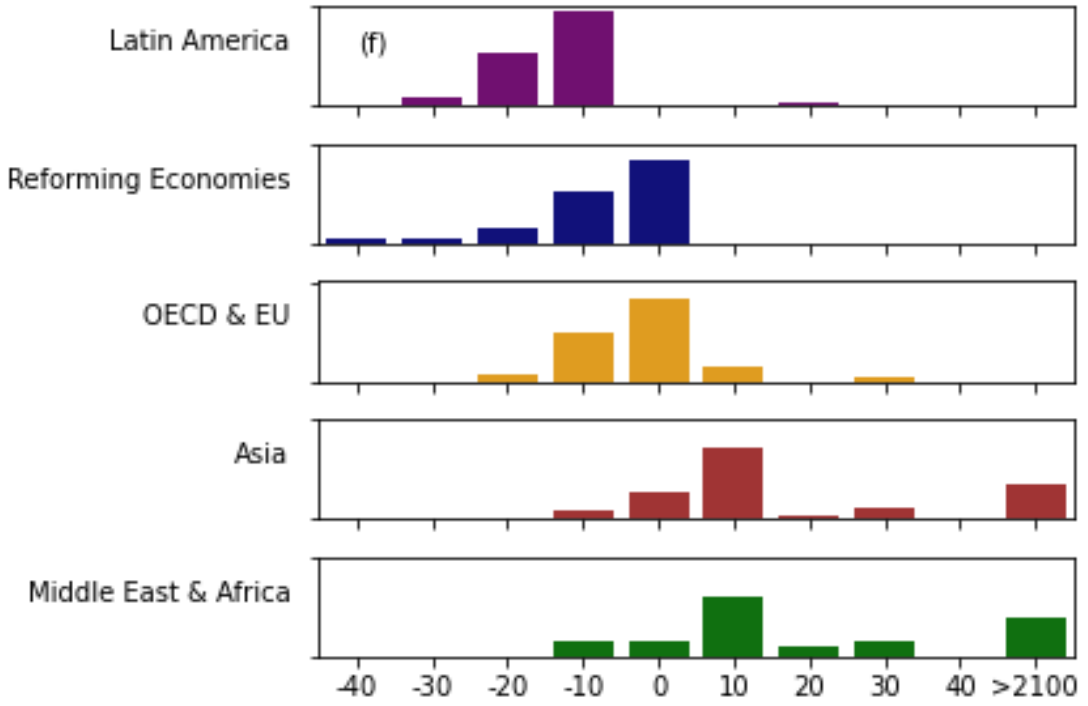
Riahi et al, 2021

What does carbon neutrality mean?
REGIONAL emissions sources and sinks

Illustrative zero emissions pathway



Timing of regions for zero emissions
(compared to the timing of the overall system)



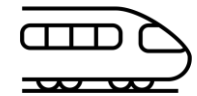
Riahi et al, 2021

Innovation & Decarbonization in service sectors needed

CO_2 emissions in Industry in 2050:

- 75-90% reductions compared to 2010 (1.5°C)

  ↳ 50-80% for 2°C

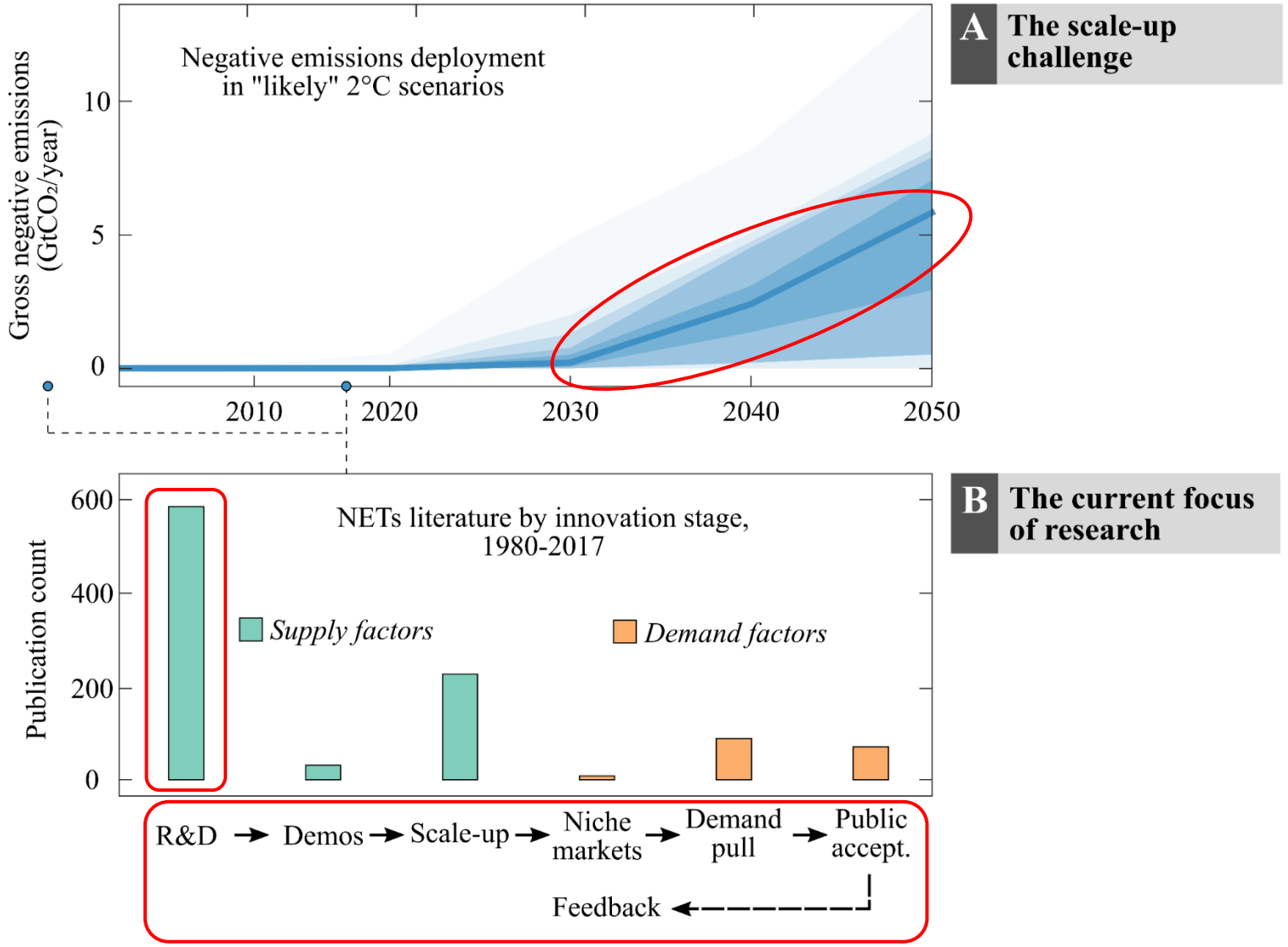


Share of low-carbon transport:

- 35-65% in 2050 (1.5°C)

  ↳ 25-45% for 2°C

We are still early stage in developing many CDR options



Nemet et al. (2018), Negative Emissions – Part 3: Innovation and upscaling, *Environ Res Lett.*

Policies to accelerate technology diffusion needed

Minx and Nemet (2018), The inconvenient truth about carbon capture, *Washington Post;* Figure by William Lamb (MCC)

Conceptual Framework

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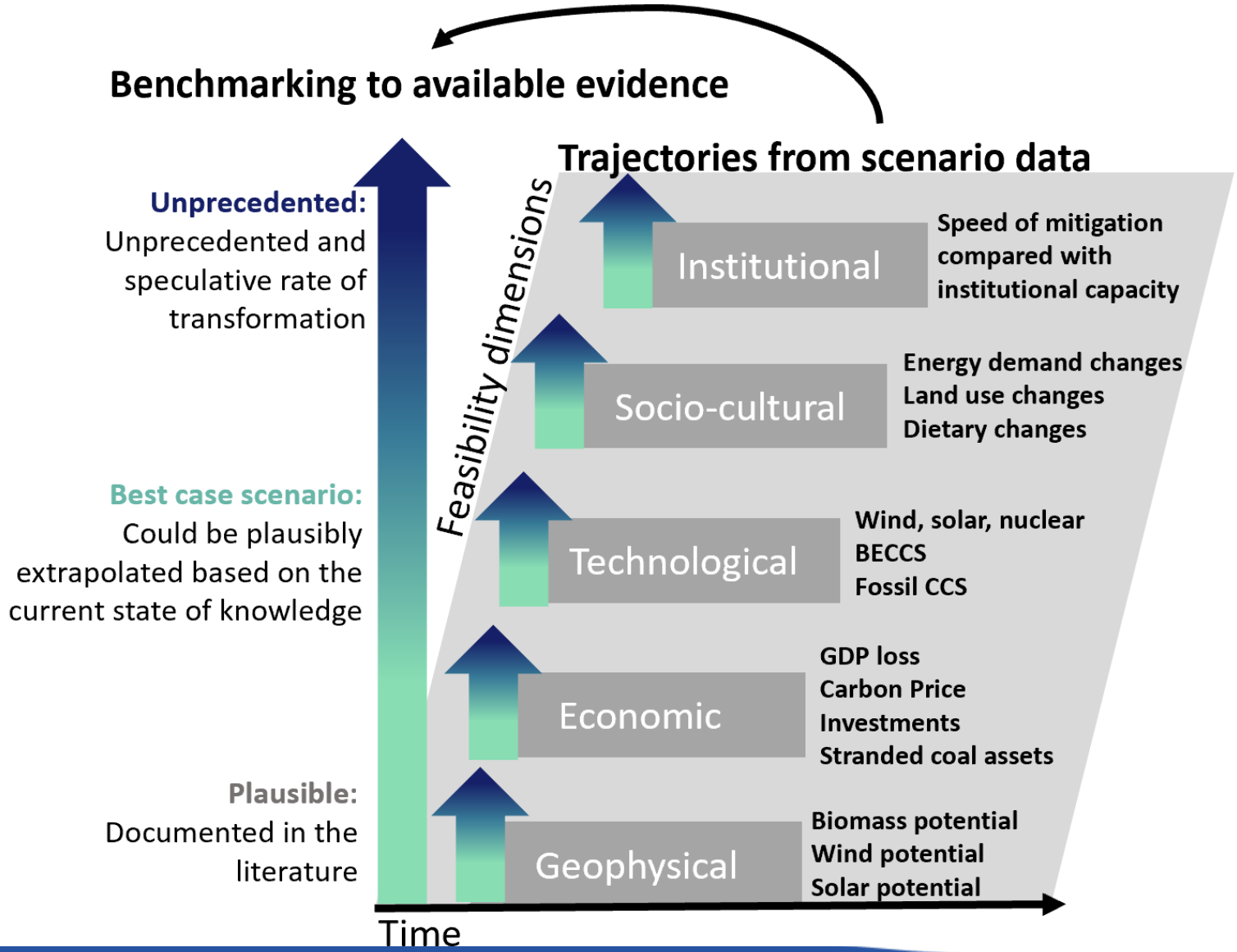
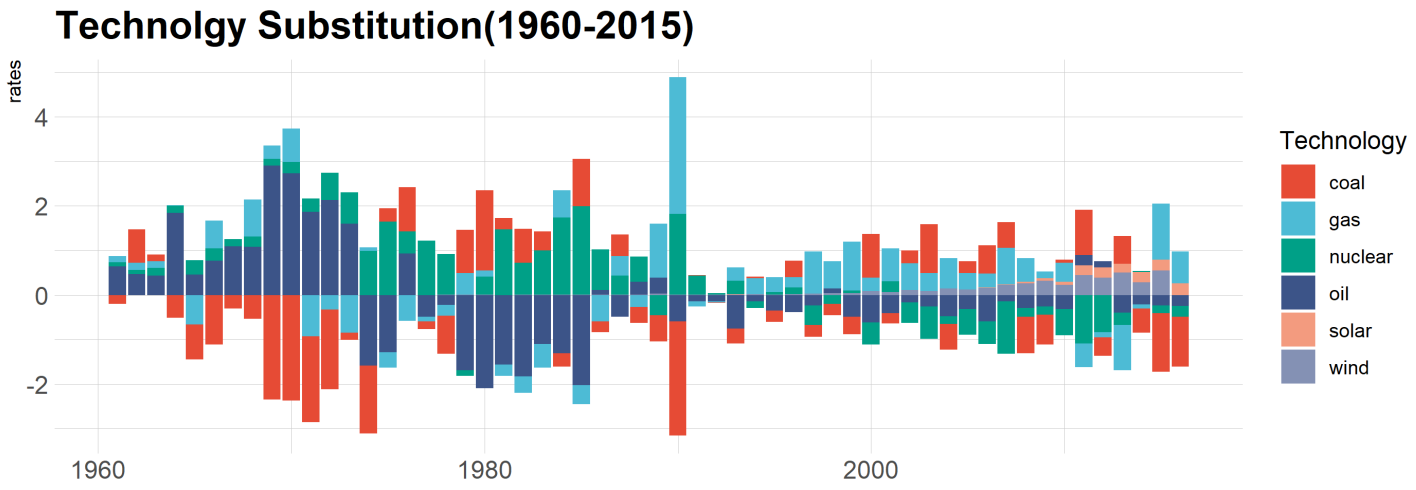


Are the global pathways feasible?

Based on: Brutschin, E., Pianta, S., Tavoni, M., Riahi, K., Bosetti, V., Marangoni, G., & Ruijven, B. J. van. (2021). A multidimensional feasibility evaluation of low-carbon scenarios. *Environmental Research Letters*, *16*(6), 064069. https://doi.org/10.1088/1748-9326/abf0ce

How much can we accelerate technology diffusion – empirical research

A



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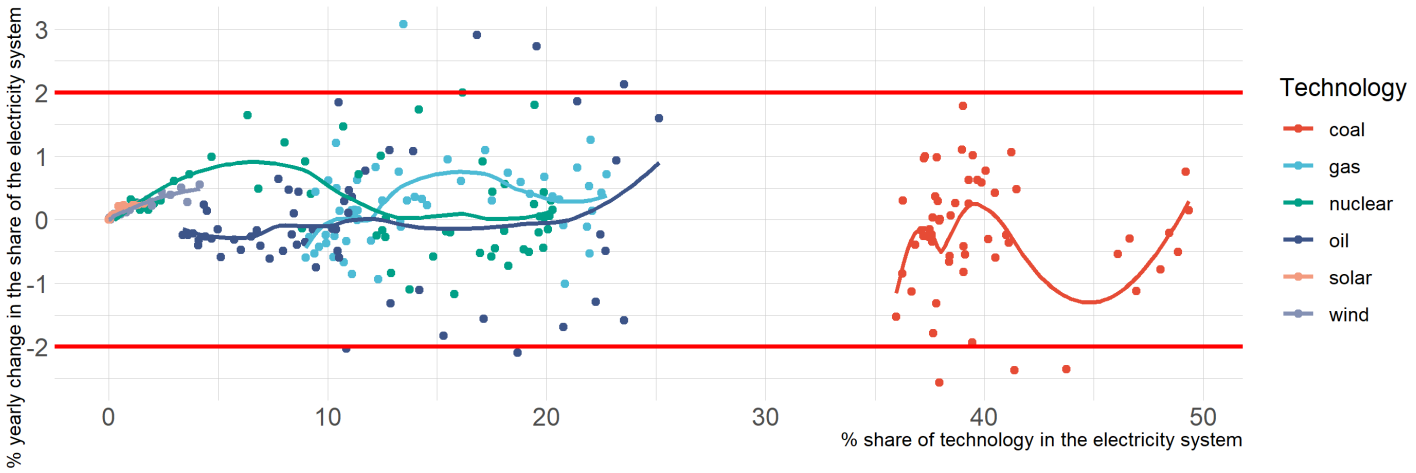
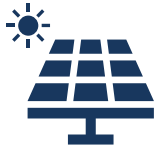
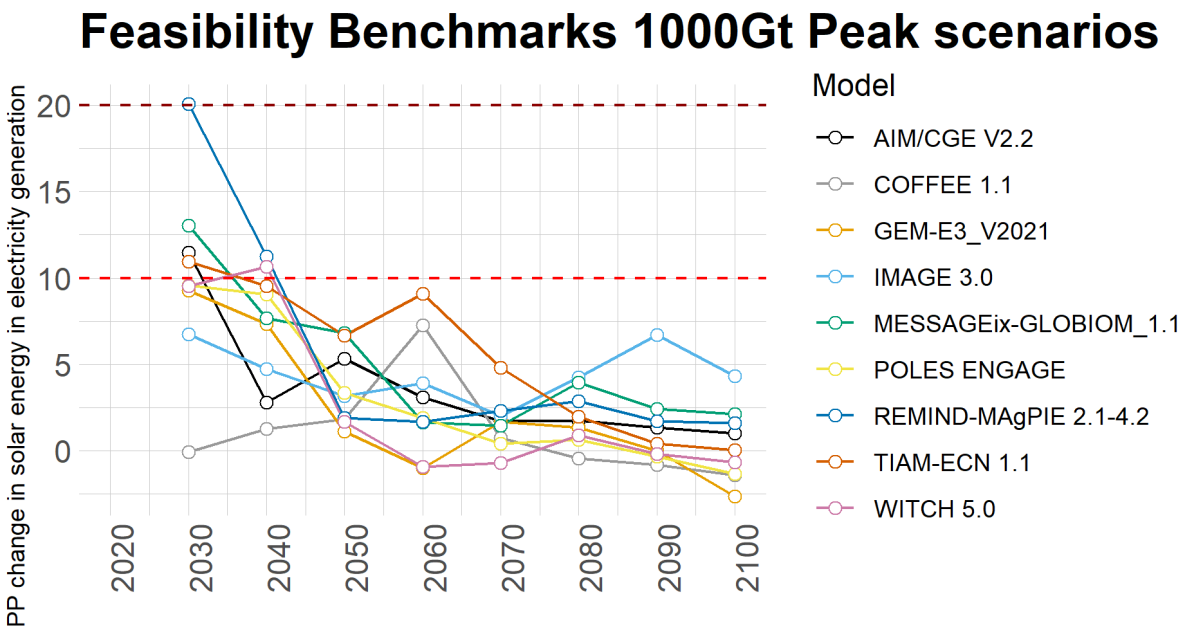


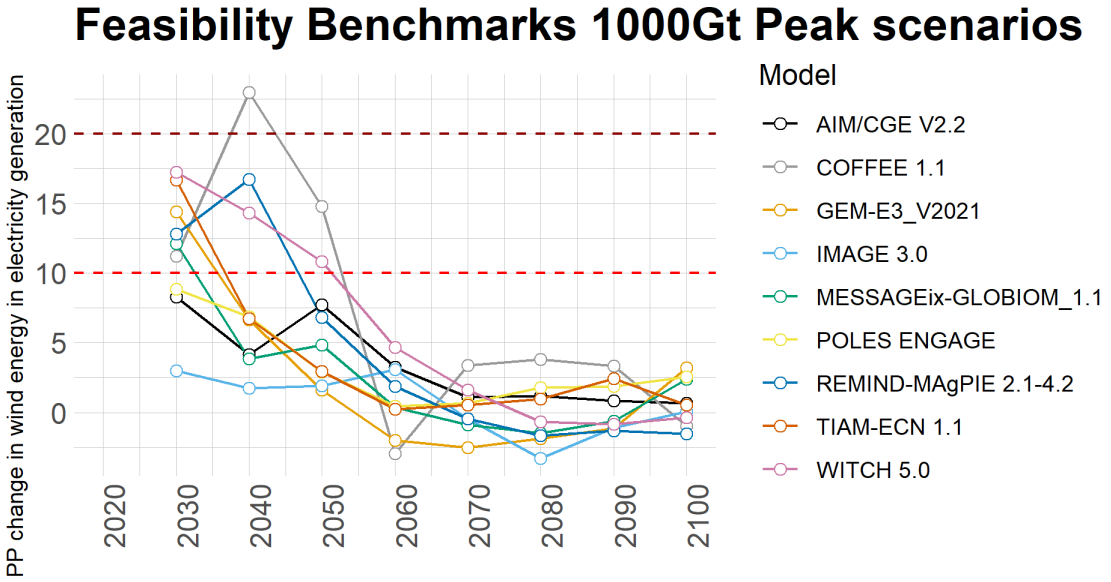
Technological constraints *Indicators assuming ideal conditions for technological growth*			
Electricity sector			
Established technologies			
2.1 Wind scale-up	Decadal percentage point increase in the wind share in electricity generation	10 pp	20 pp
2.2 Solar scale-up	Decadal percentage point increase in the solar share in electricity generation	10 pp	20 pp
2.3 Nuclear scale-up	Decadal percentage point increase in the nuclear share in electricity generation	5 pp	10 pp
Emerging technologies			
2.4 Biomass scale-up	Decadal percentage point increase in the biomass share in electricity generation	2 pp	5 pp
2.5 **CCS with coal** scale-up	Decadal percentage point increase in the share of coal with CCS in electricity generation	2 pp	5 pp
2.6 **BECCS** scale-up	Decadal percentage point increase in the share of BECCS in electricity generation	2 pp	5 pp

Brutschin et al, 2021

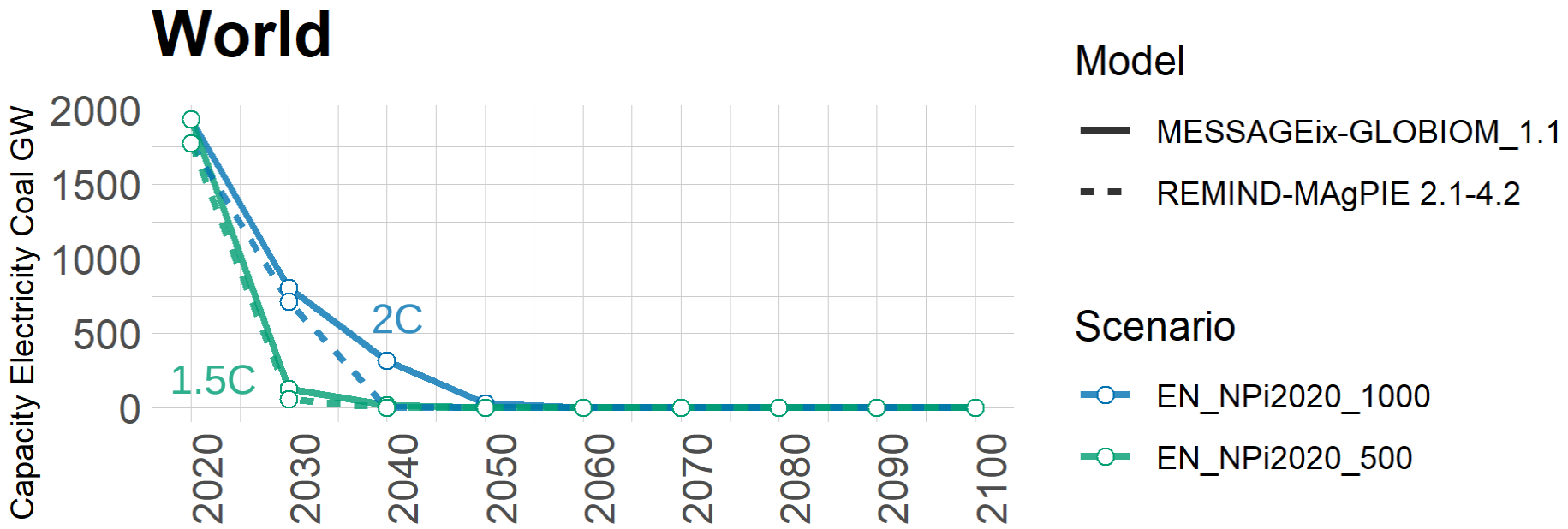
Solar and wind upscaling in scenarios







Global Coal Phase Out for ambitious mitigation goals



In preparation: Brutschin, Schenuit, et al.

1.5C (500Gt): global phase-out by **2030**

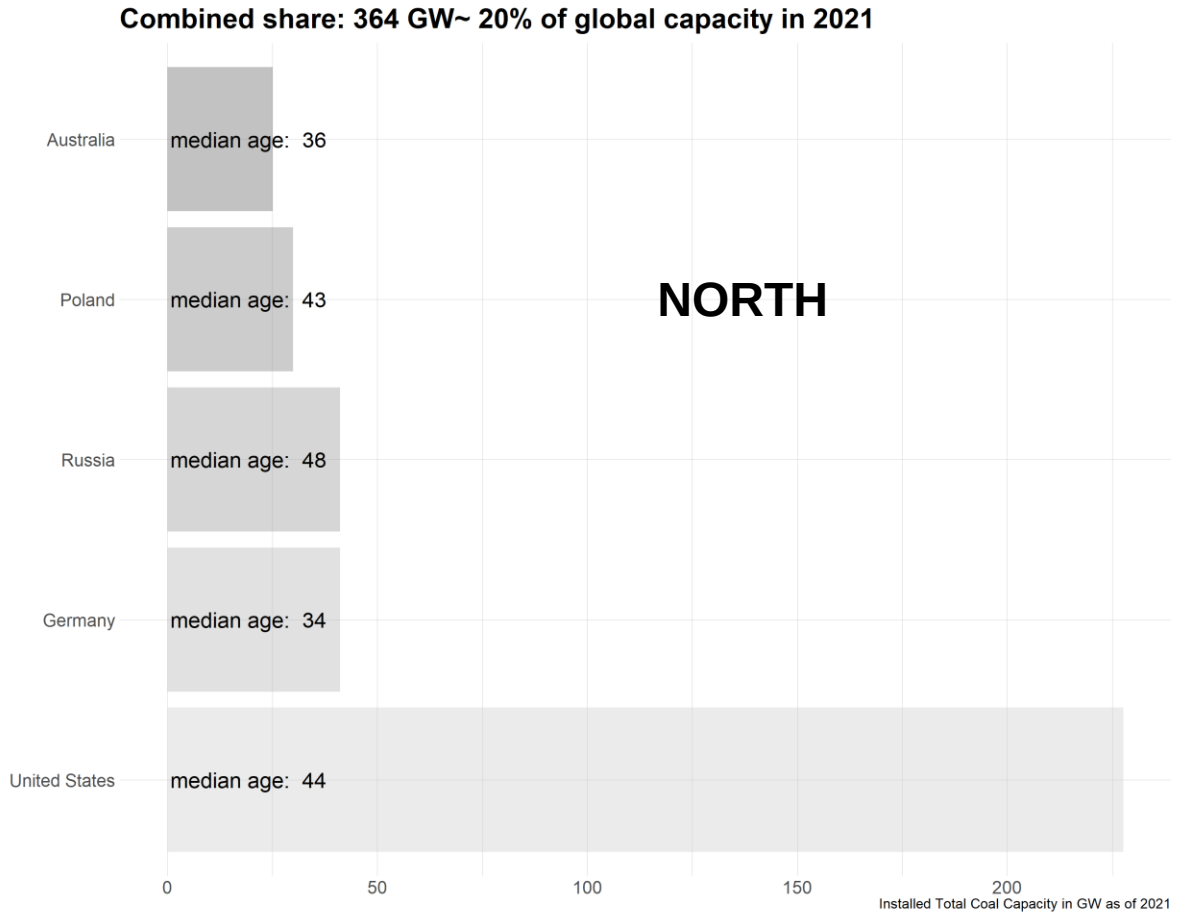
2C (1000Gt): decline in global capacity by **more than 50% by 2030**

Ca. 70 % of global coal capacity in countries with rapidly growing energy demand

In preparation: Brutschin, Schenuit, et al.

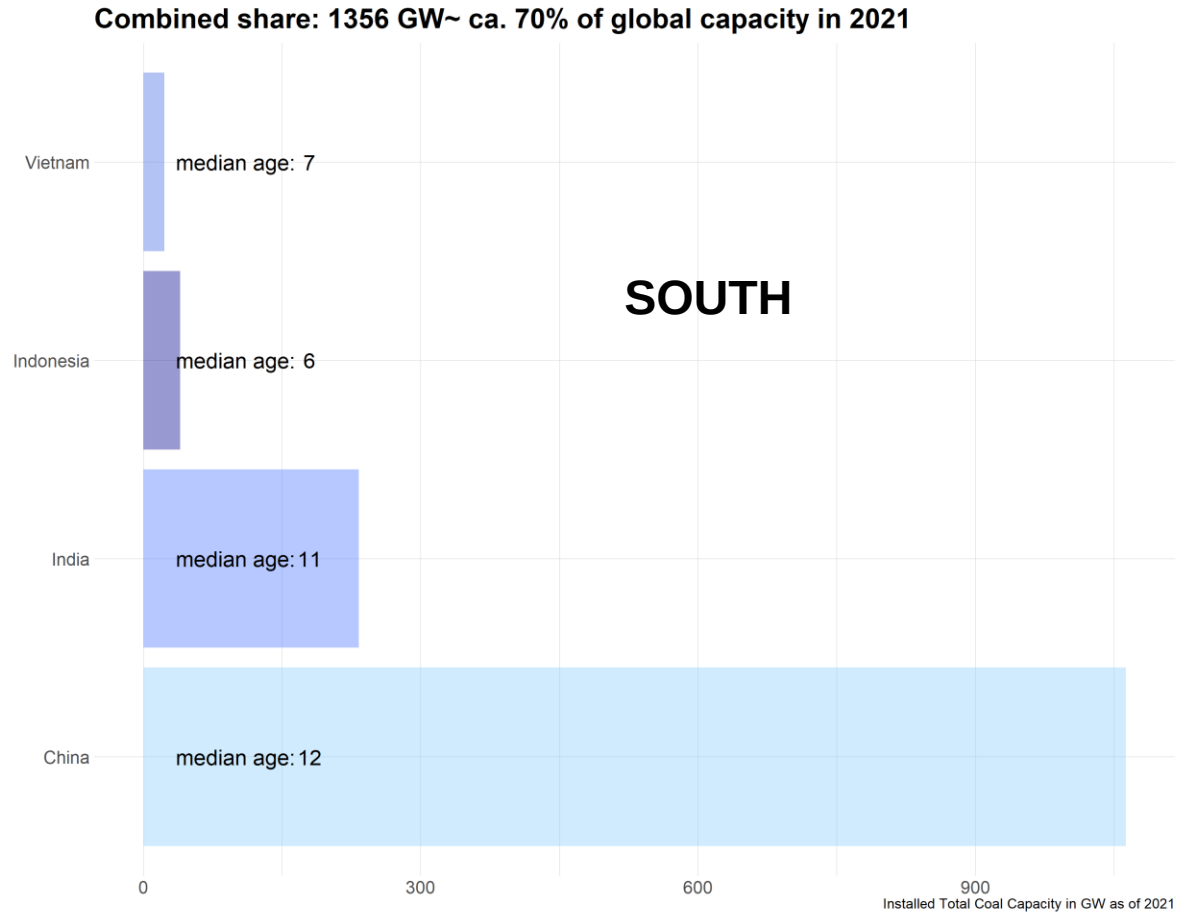
Aging coal fleet and signs of coal substitution or decline

A



Young coal fleet and cases of premature (<30 years) retirement only in China

B



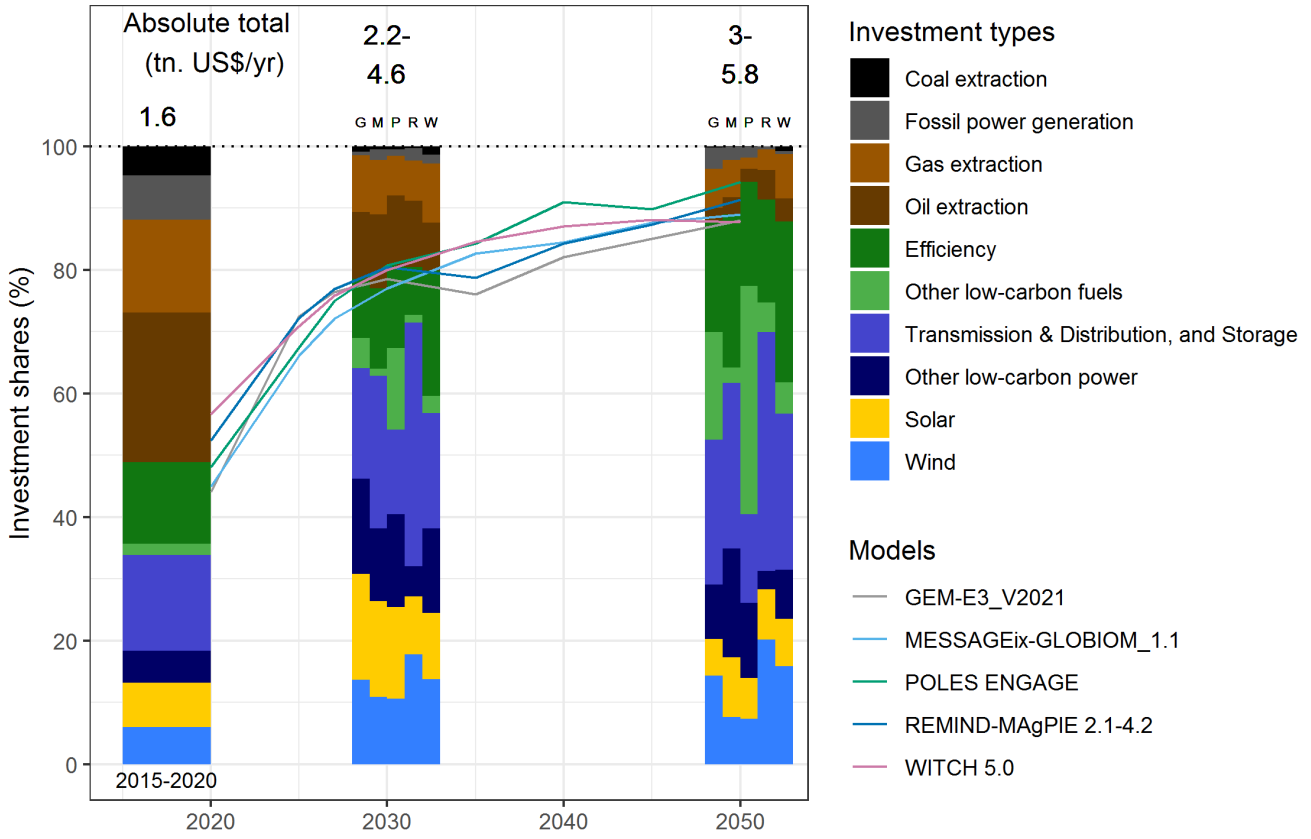
Energy investment requirements

- 1.5°C require rapid shift and scale-up of energy investments:

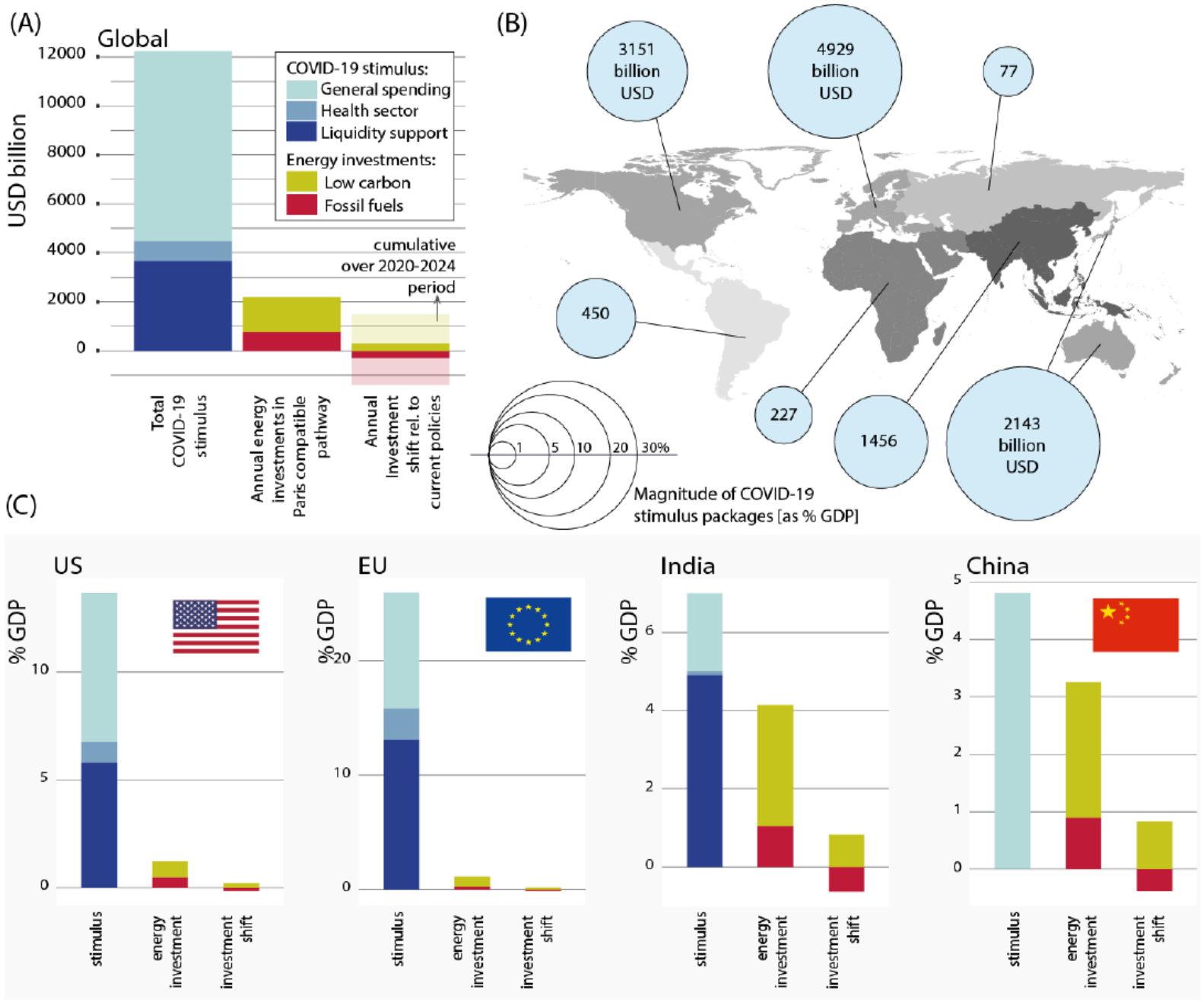
- In the next decade, investments into decarbonizing power are dominating, especially solar and wind, plus "system" investments into **transmission & distribution** and storage

- **Coal, and fossil power generation investments are eliminated nearly immediately**, and gas and oil investments strongly reduced

Share of investments 1.5°C scenarios



Bertram et al, 2021

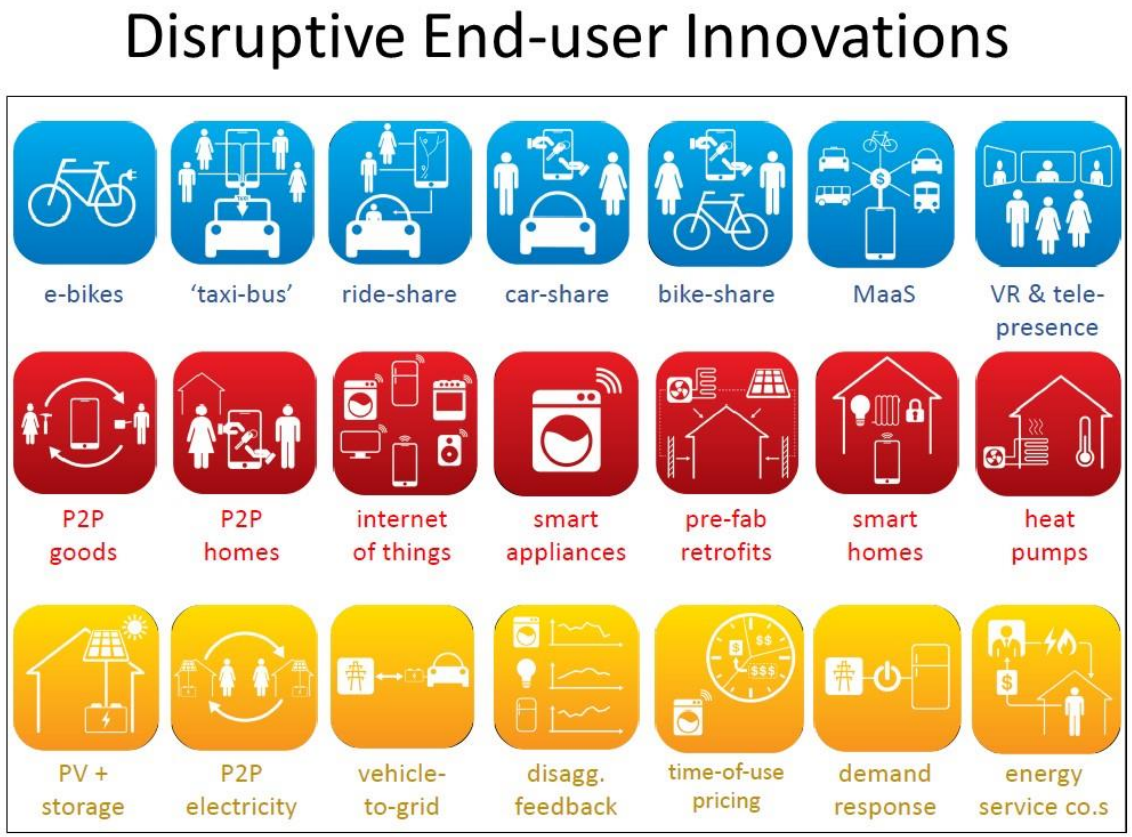


Investment needs small compared to COVID-19 recovery packages

Andrijevic et al. (2020)

Limiting Demand critical for feasibility, however, an own challenge

- Change in consumer preferences (e.g. diets)
- Genrational change in materilism (service orientation rather than owenership)
- New business models (sharing & circular economy)
- Digitalization and ICT convergence
- Rapide innovation in granularer technologies und integrated digital services

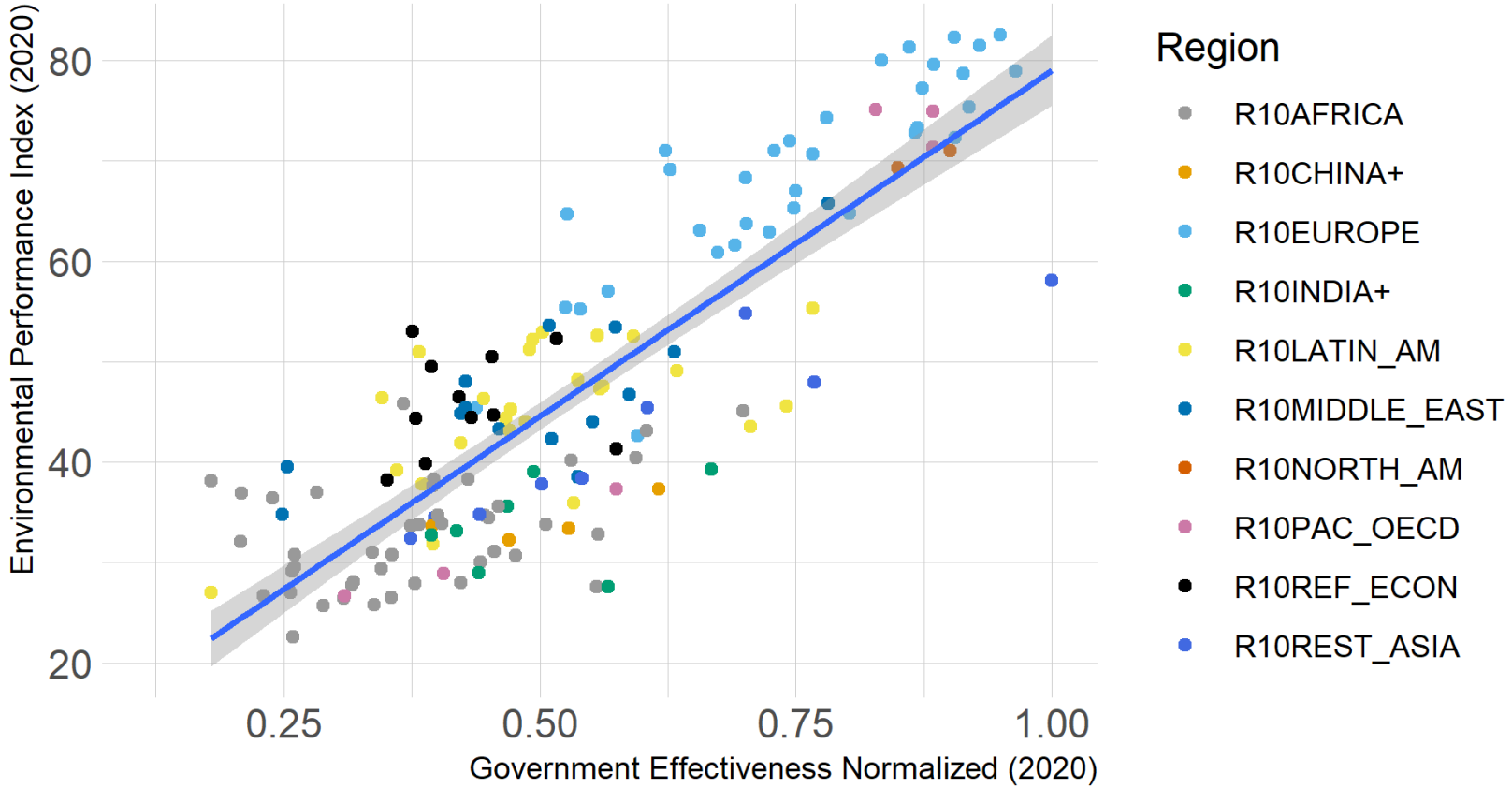


(1) From ownership to usership – (2) Sharing Economy – (3) From atomized to connected

Source: Charlie Wilson

Government effectiveness and mitigation capacity

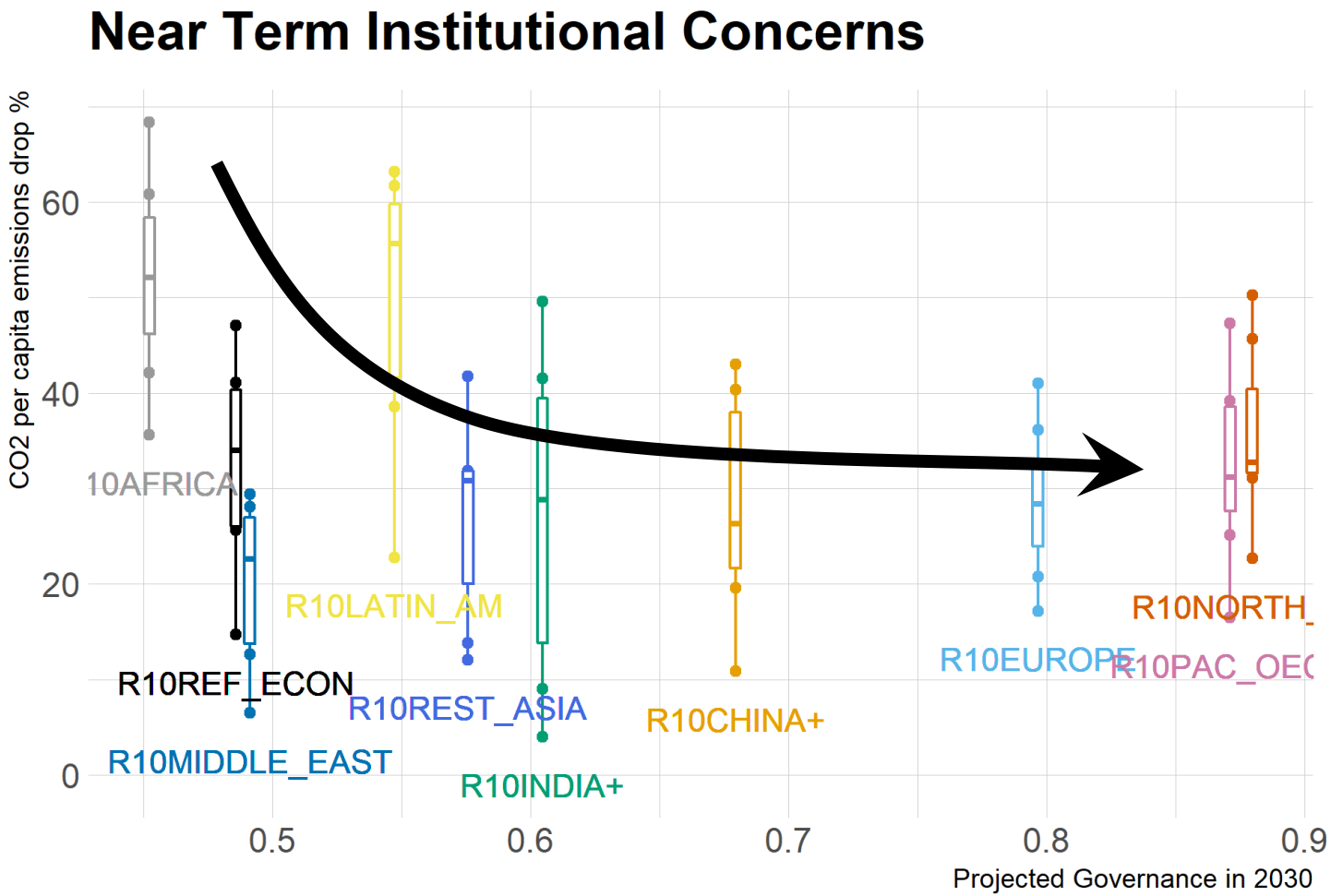
Overall **EPI** indicates which countries are best addressing the environmental challenges that every nation faces.
Source: https://epi.yale.edu/about-epi



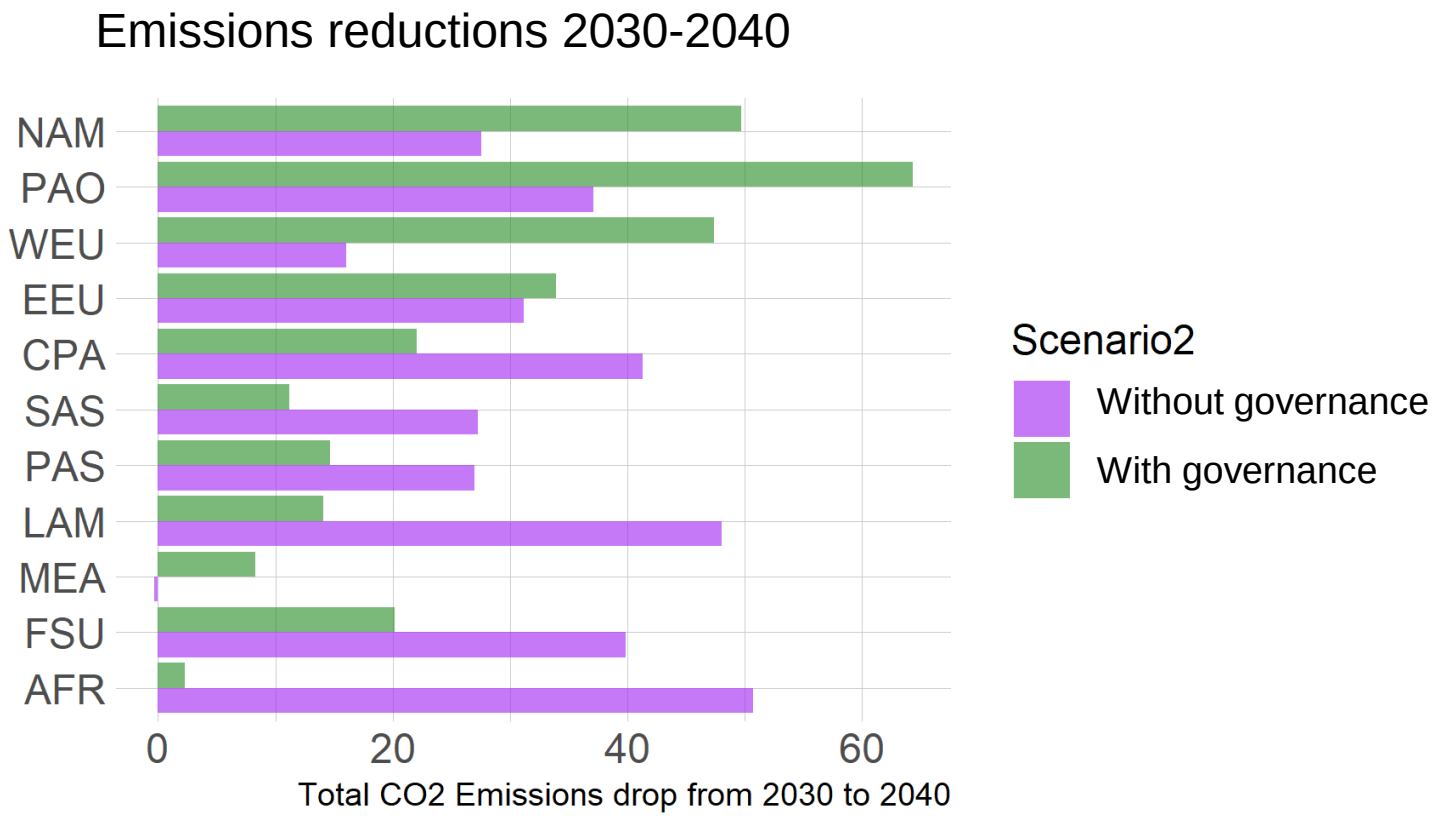
Government Effectiveness (from the WB governance indicators):

Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree
of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the
government's commitment to such policies.

Regional near-term institutional feasibility risks

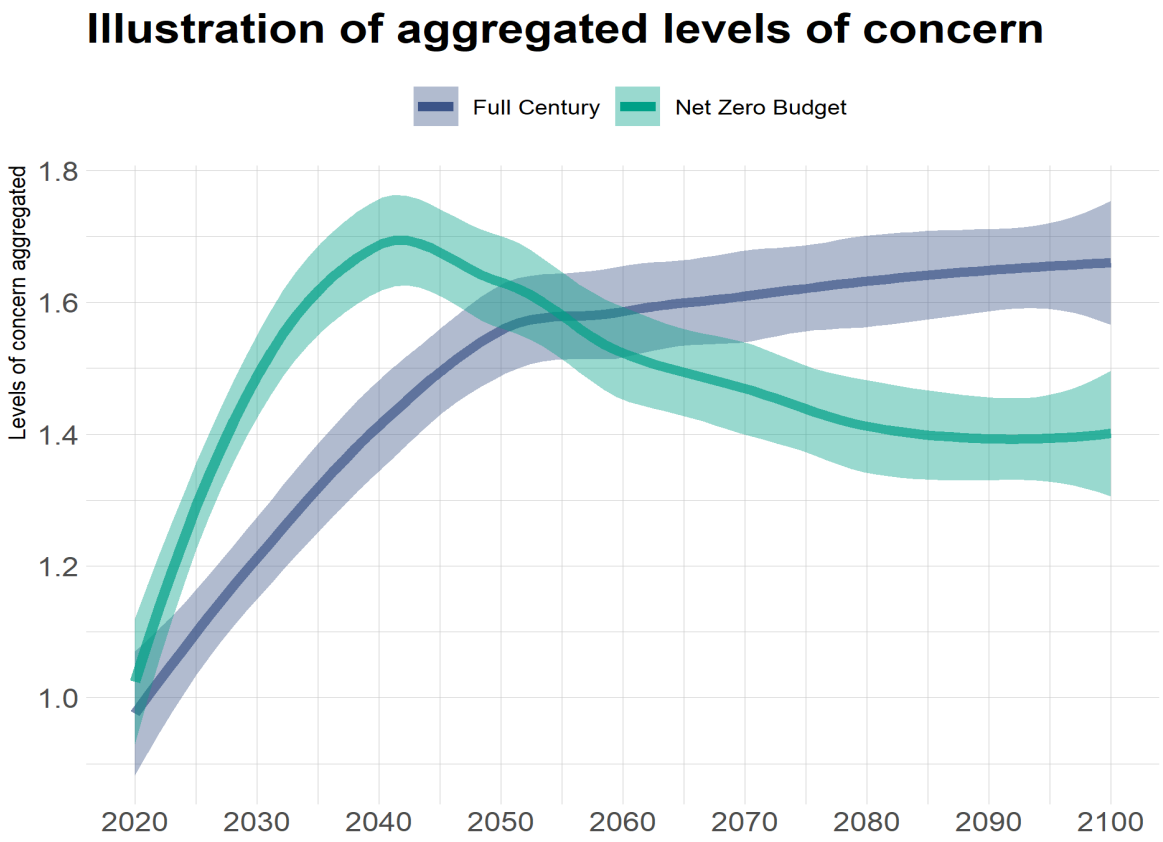


Preliminary scenarios with governance representation very different from cost-effective solution

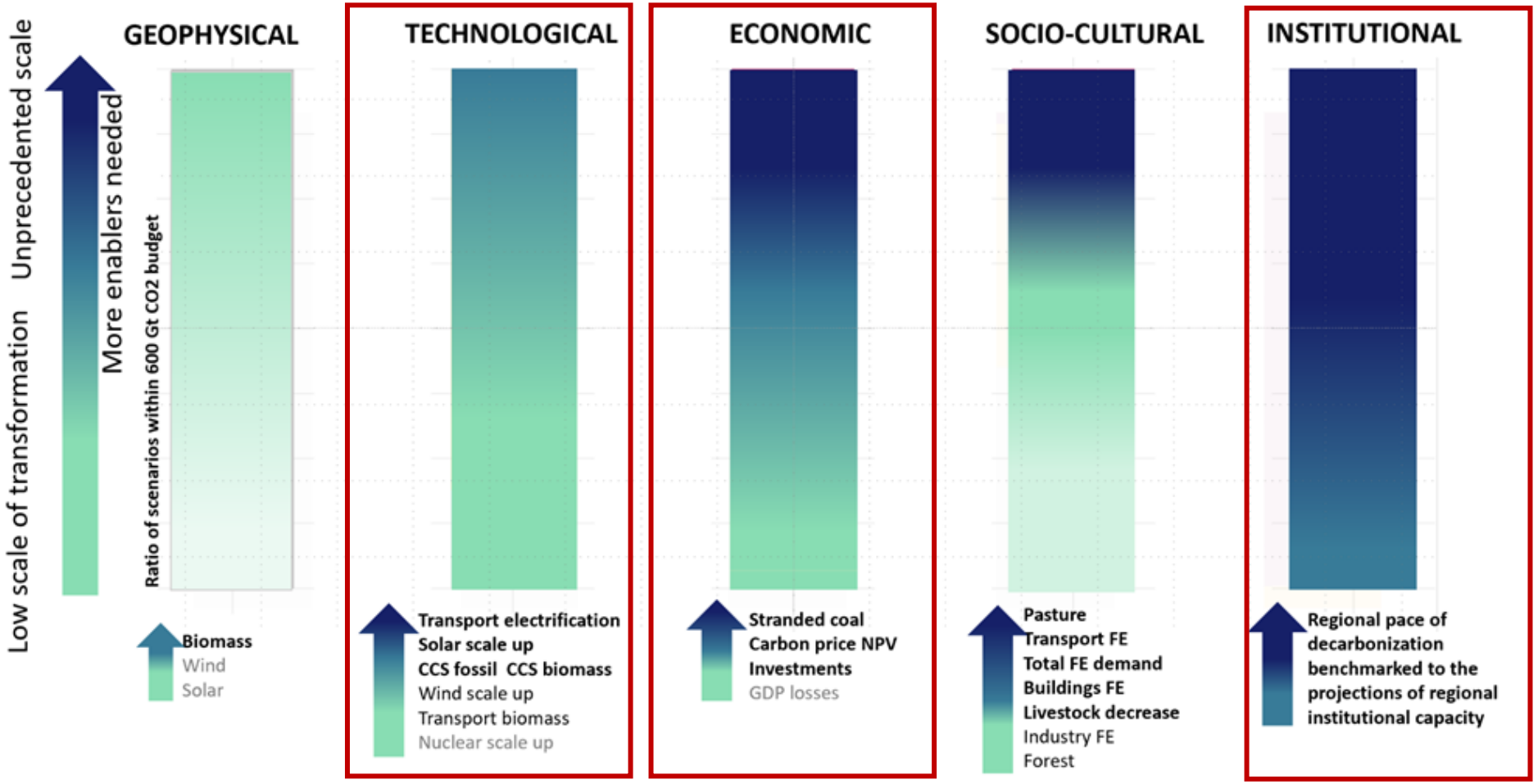


In preparation: Please do not cite or distribute – Brutschin et al

Delays in mitigation do not resolve governance issues – temporal trade-offs



High level insights from the ENGAGE project



Thank you.

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Note PRELIMINARY results of ENGAGE – UNDER EMBARGO, please do not circulate outside the meeting