INDUSTRIAL STRATEGIES FOR THE GREEN TRANSITION

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Designing Climate Policy: From Innovation to Diffusion
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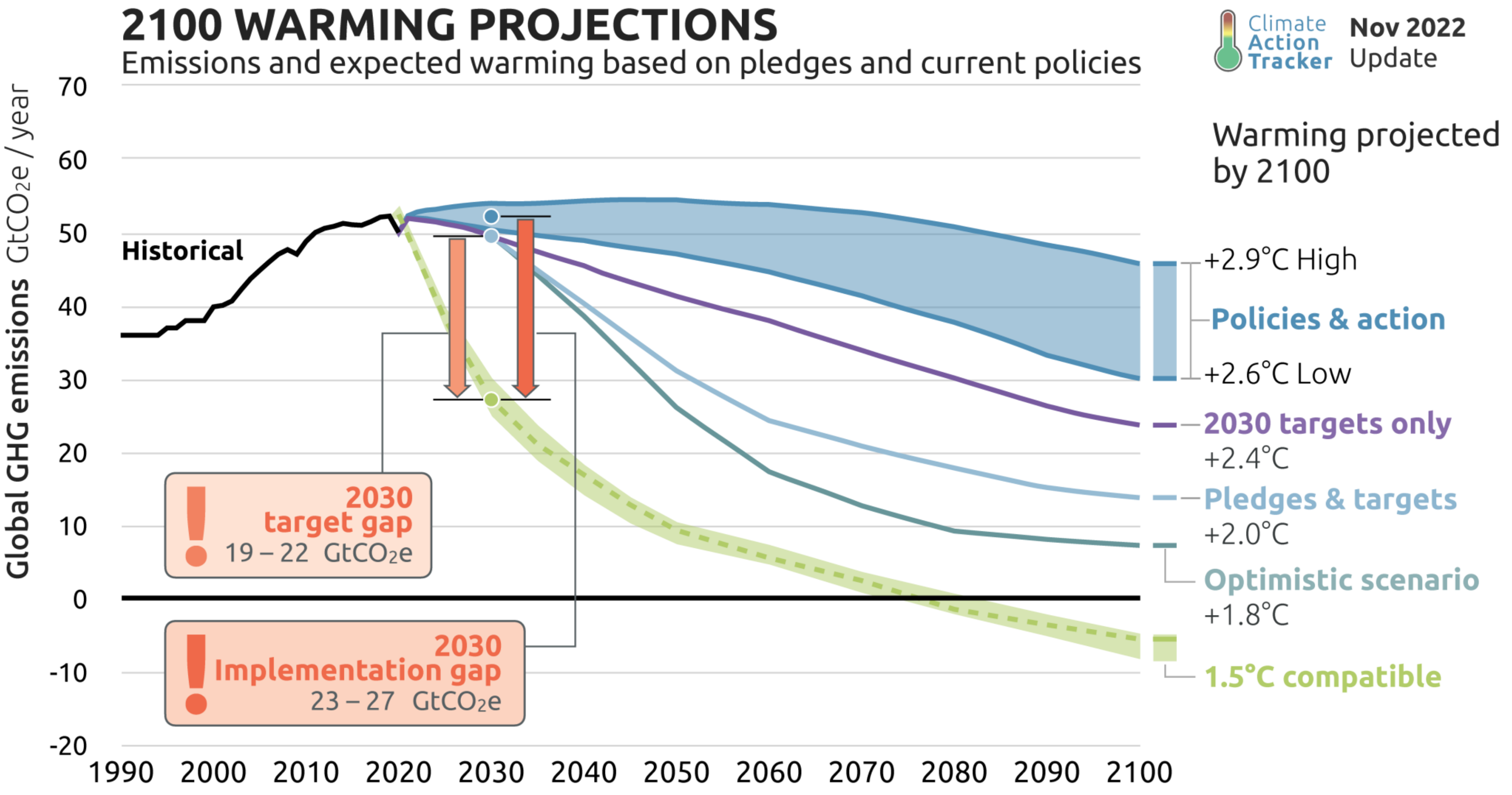
BETTER POLICIES FOR BETTER LIVES

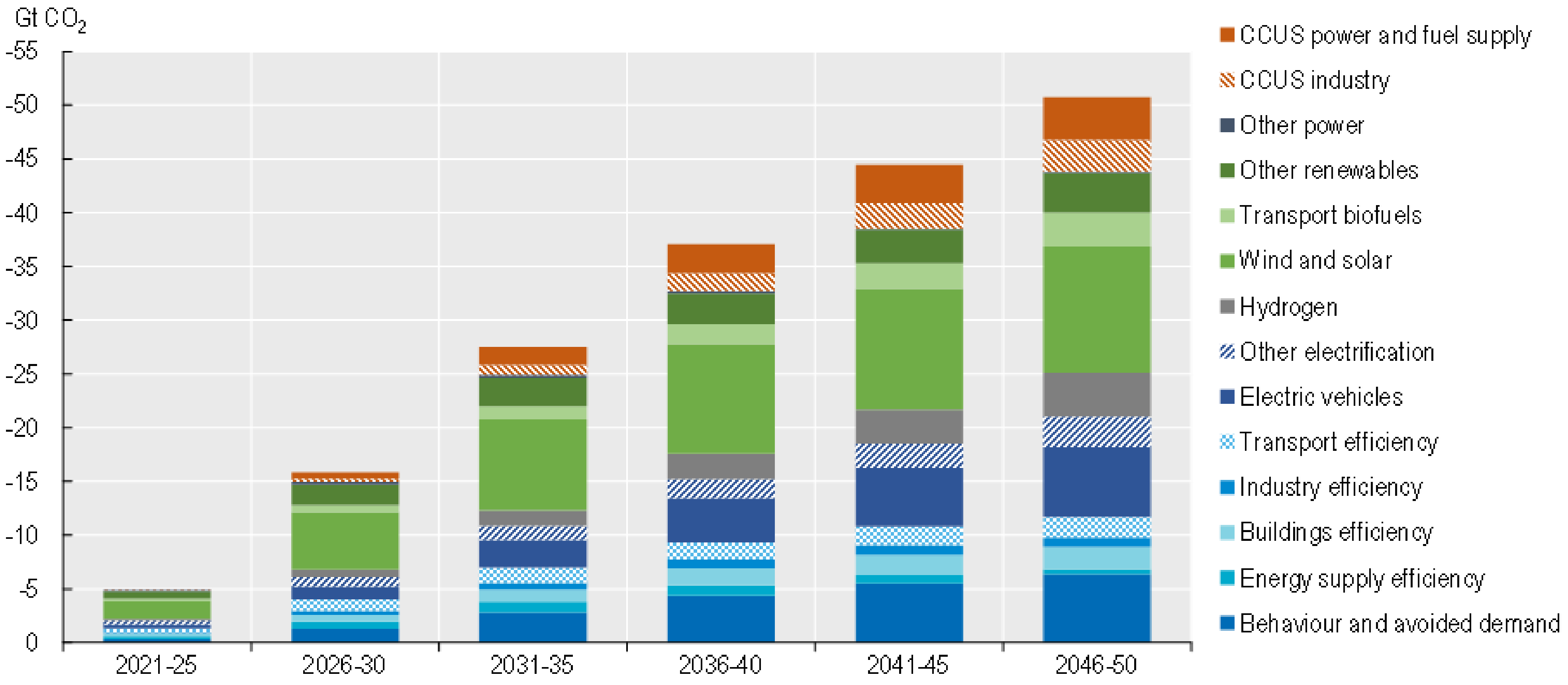
Emissions are not on track - climate policies need to become more ambitious



Source: Climate Action Tracker 2022

The green transition requires a system-wide technological shift

Sources of CO_2 emission reductions in IEA's net-zero scenario

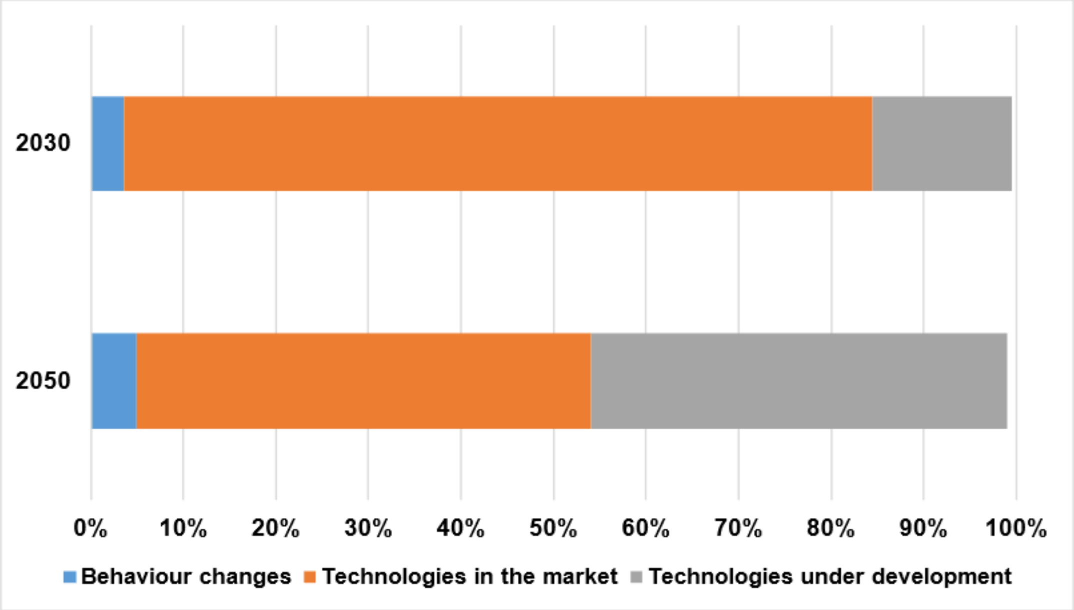


Source: IEA 2021

2030 objectives can be reached with existing technologies, but not 2050 targets

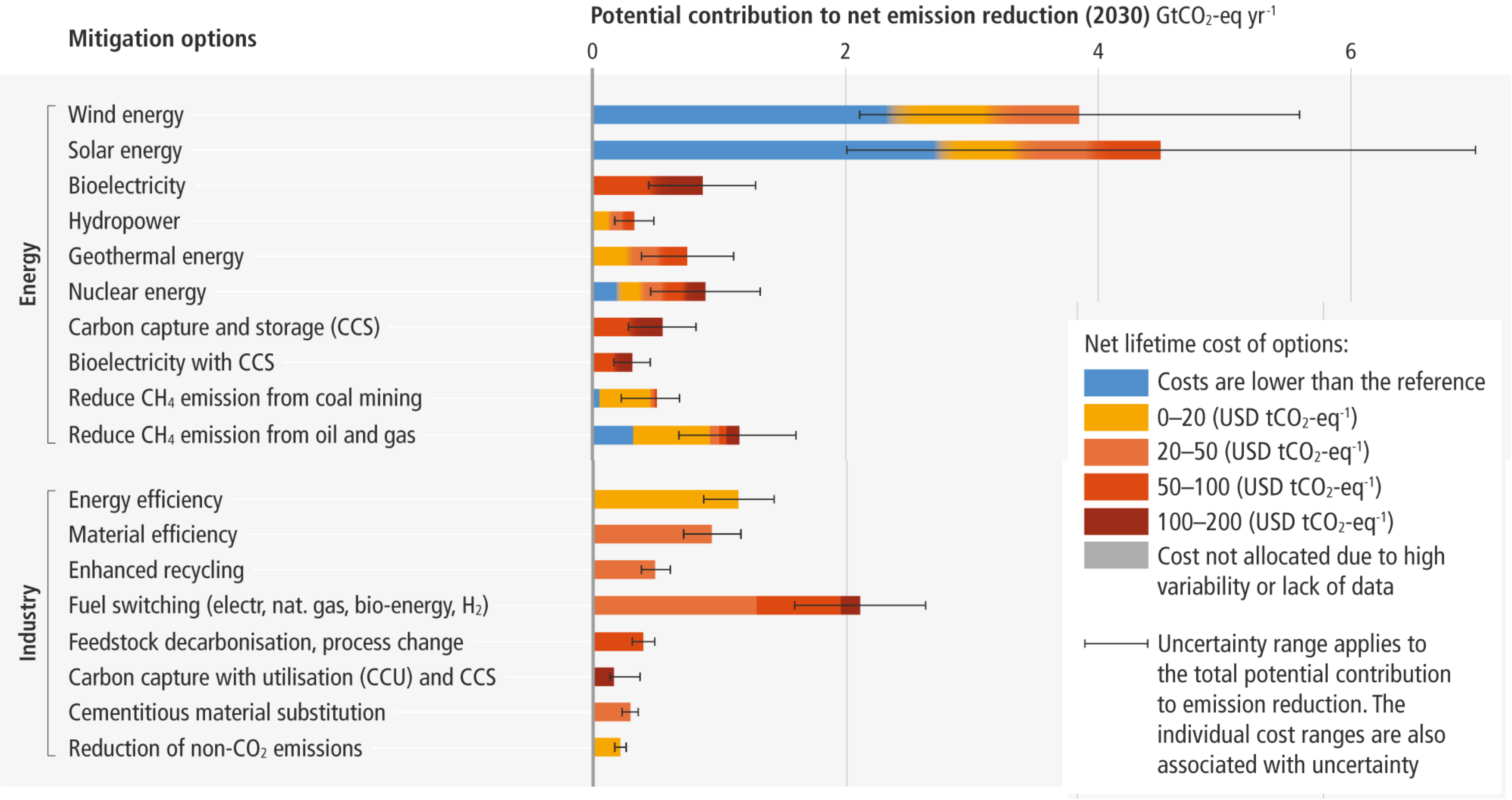
- In the IEA's net-zero scenario, most of the global reductions in CO_2 emissions through **2030** come from technologies readily available today
- But almost **half the reductions in 2050** will have to come from technologies that are currently at the **demonstration or prototype phase**

Share of CO2 emissions savings from mature and early-stage technologies in the IEA Net Zero scenario



Source: IEA 2021

Mitigation costs are still too high in many technologies & sectors

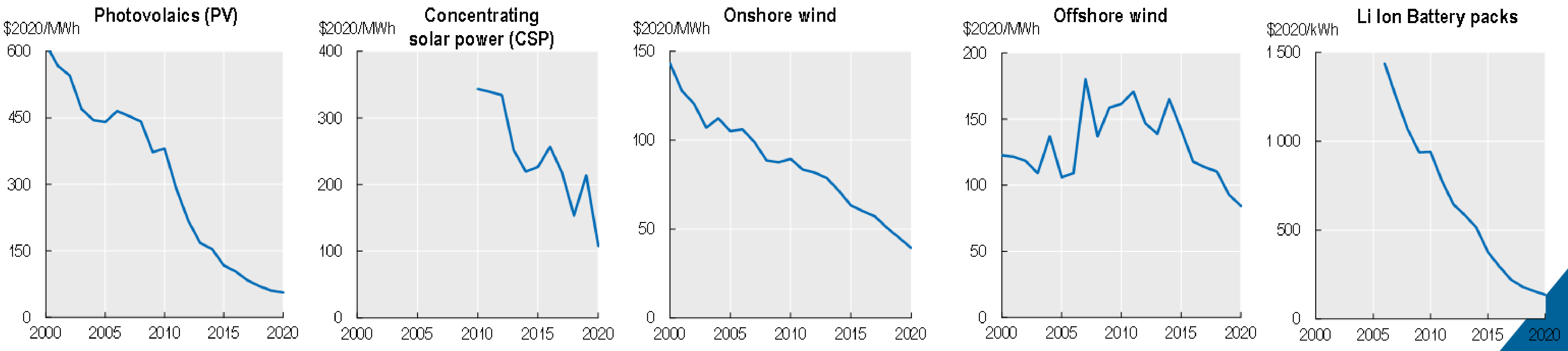


Source: IPCC 2022, Sixth Assessment Report, Working Group III – Mitigation of climate change

The climate policy mission: reducing the costs of low-carbon technologies

- Reducing costs to make carbon-free technologies competitive with their high-carbon alternatives should be a primary objective of climate policy

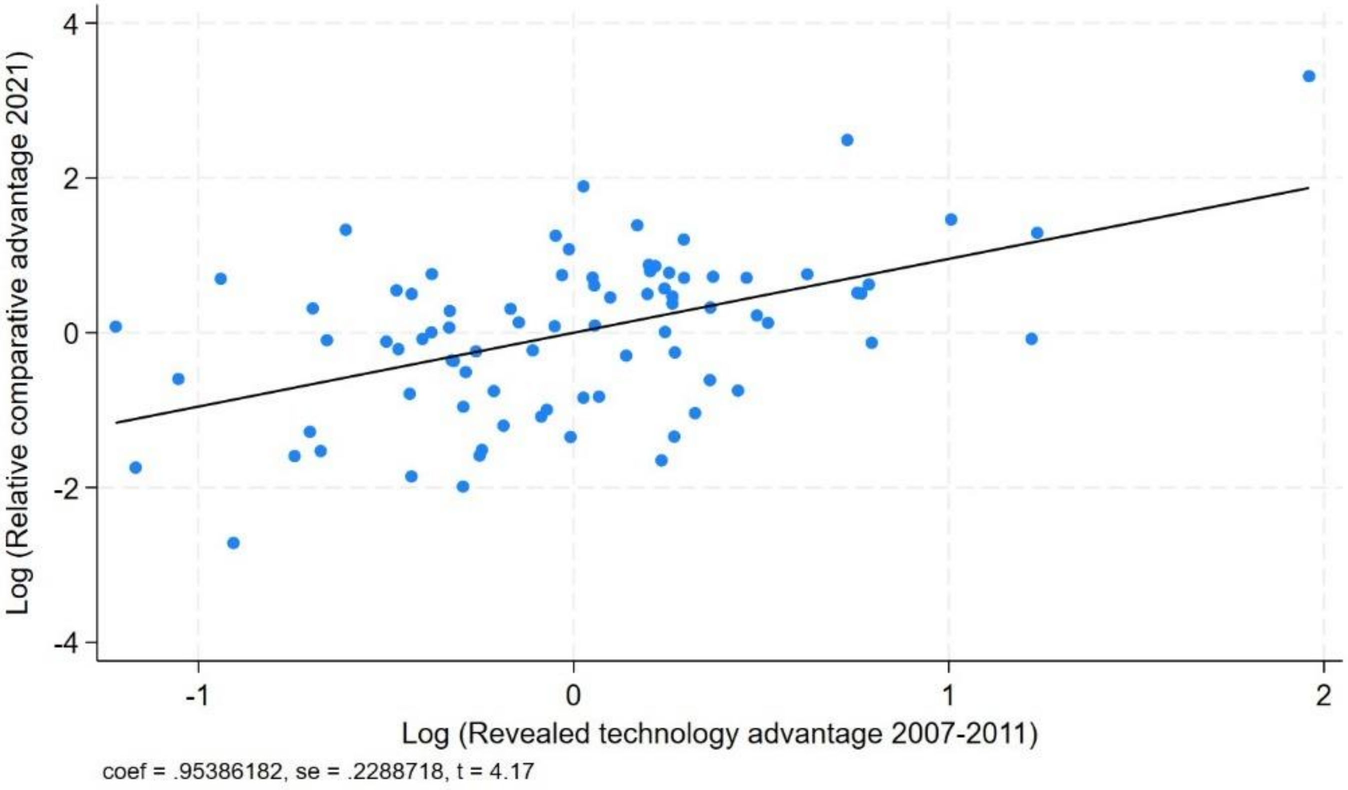
Declining renewable energy and battery costs since 2010



Source: IRENA 2021, IPCC 2022.

Technological leadership and export performance are linked: example from renewables

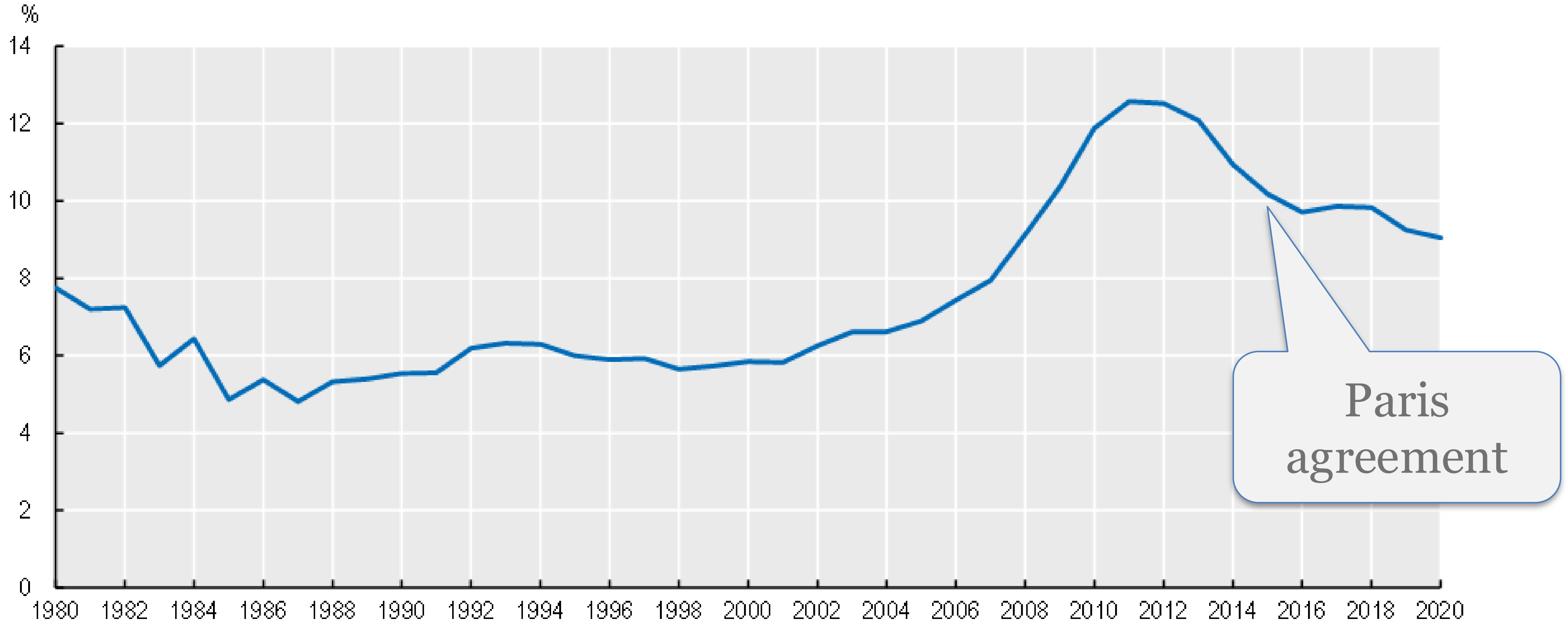
Cross-country regression of the logged relative comparative advantage in trade of capital goods used for solar, wind and hydro technologies in 2021 on the logged revealed technology advantage in those technologies in 2007-2011, controlling for the initial level of export performance



Source: Own elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats and UN Comtrade database.

The pace of low-carbon innovation has slowed down

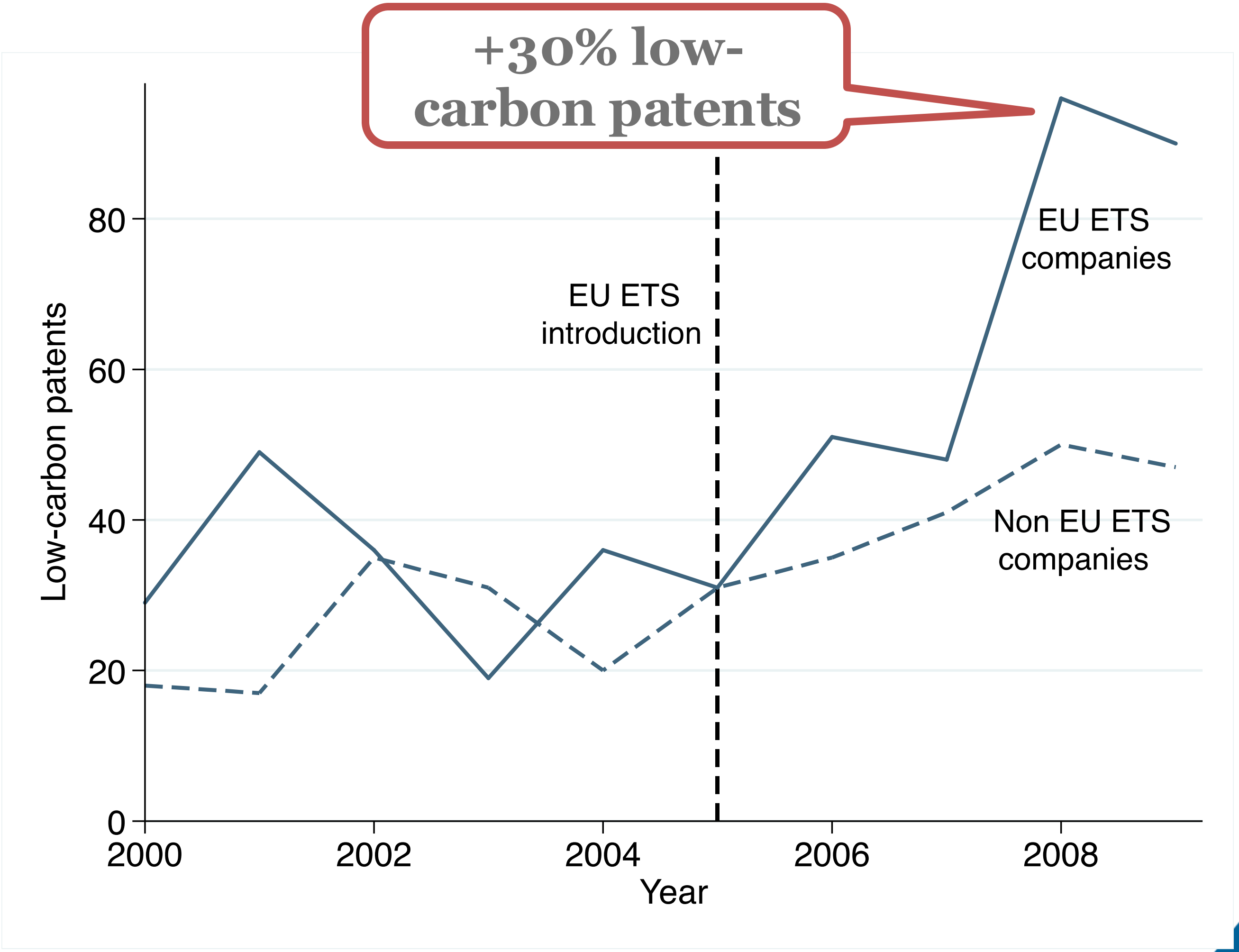
Share of climate mitigation patents in total patents, 1980-2020



Source: OECD STI MicroData Lab, Worldwide Patent Statistical Database (PATSTAT)

What needs to be done?

- Carbon pricing

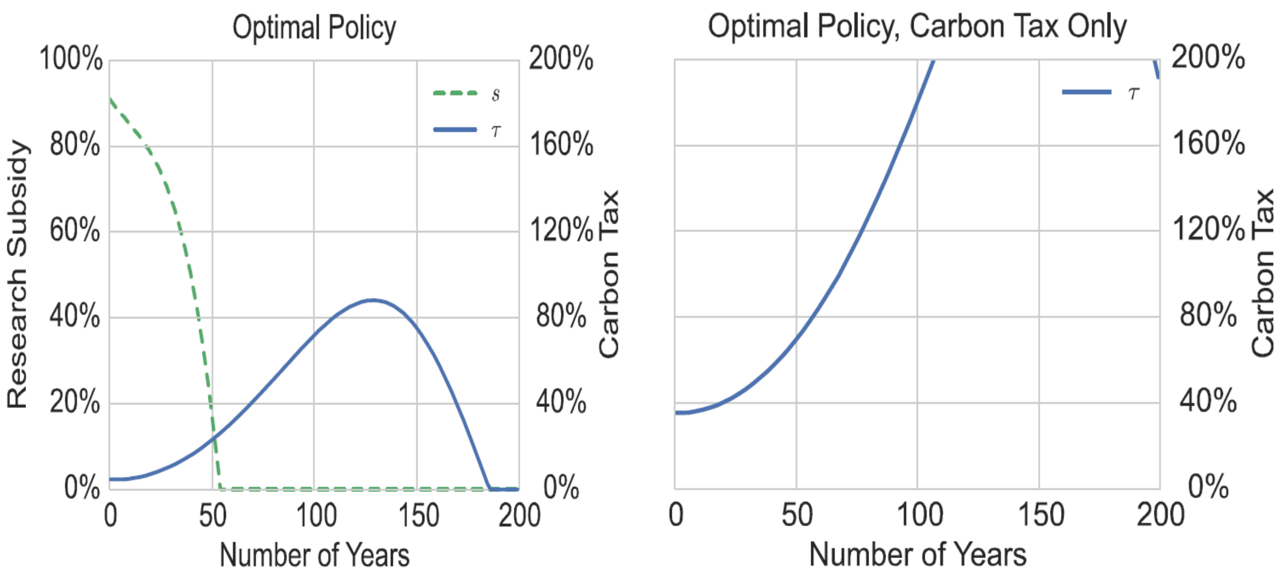


Source: Calel & Dechezleprêtre, 2016. "Environmental Policy and Directed Technological Change: Evidence from the European carbon market". *Review of Economics and Statistics*

What needs to be done?

- Carbon pricing
- Support to innovation

Subsidies to clean research allow for much smaller carbon taxes



Source: Acemoglu et al., 2016. Transition to clean technology. Journal of Political Economy

What needs to be done?

- Carbon pricing
- Support to innovation
- Infrastructure
- Standards & regulations
- Public procurement

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- Carbon pricing
- Support to innovation
- Infrastructure
- Standards & regulations
- Public procurement

➢ **Industrial strategy** ("articulated group of policy instruments designed to reach specific policy objectives" - Criscuolo et al. 2022, "An industrial policy framework for OECD countries")

WHAT ARE GOVERNMENTS DOING?

What people want

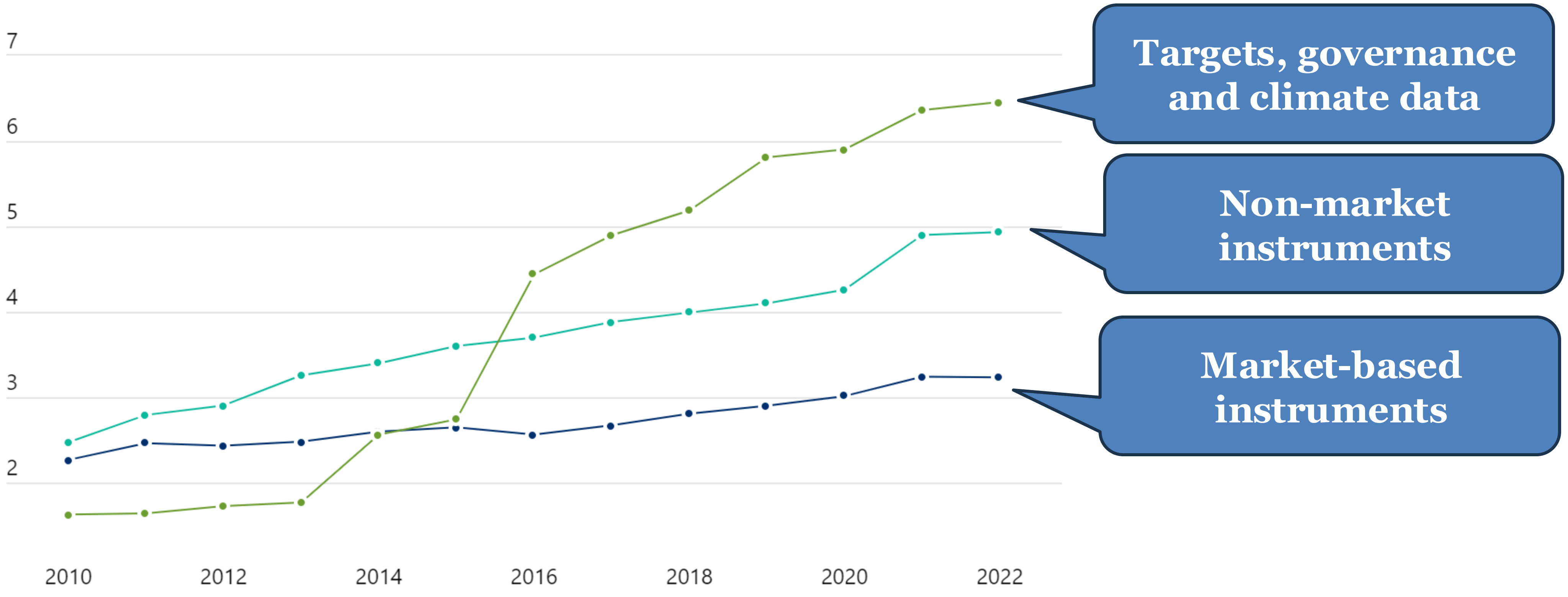
- Support to various climate policies:

(Global survey; 2000 respondents per country)

	High-income	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	Middle-income	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine
Support for Main Climate Policies																						
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Support for Other Climate Policies																						
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Ban on combustion-engine cars w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Support for Carbon Tax With:																						
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42
Support for Cattle-Related Policies																						
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24

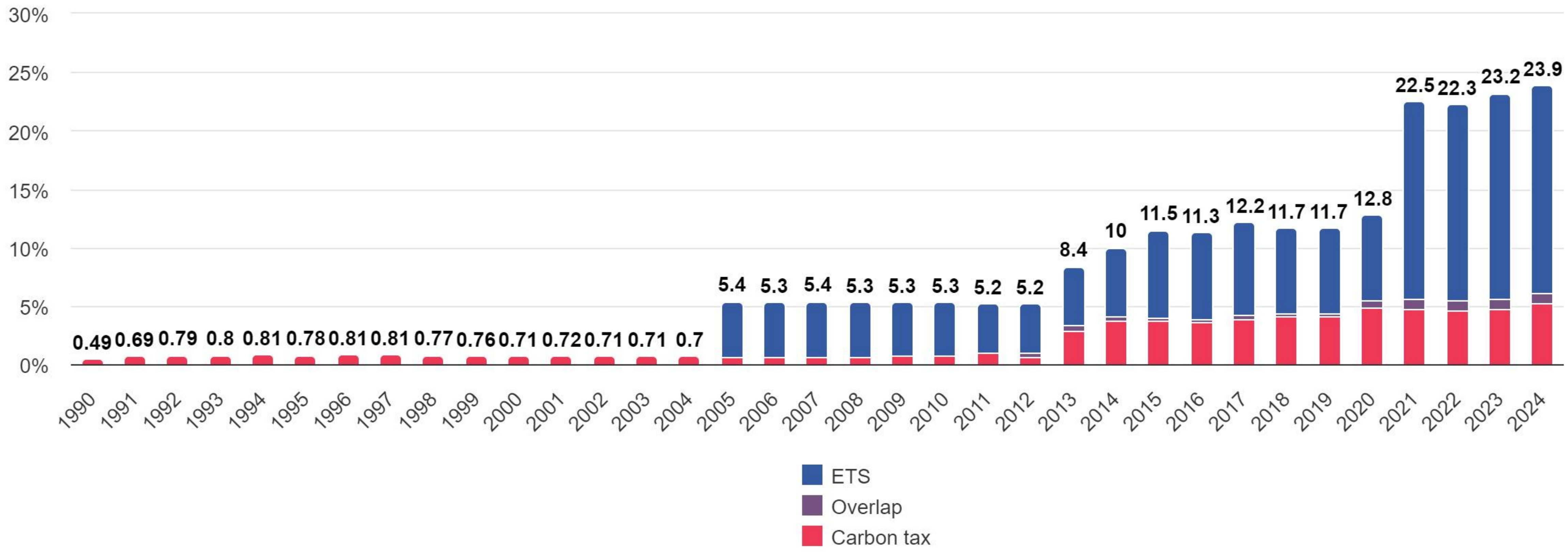
Source: Dechezleprêtre, A. et al. (2025), "Fighting climate change: International attitudes toward climate policies", American Economic Review 115 (4)

What governments have been doing



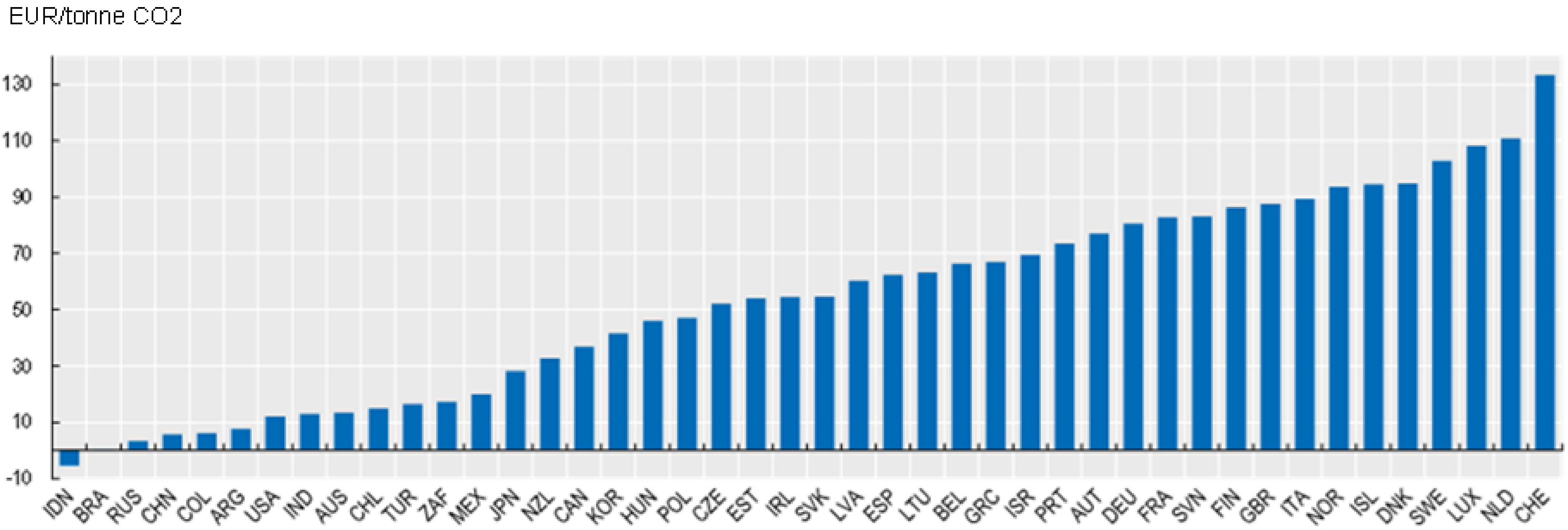
Source: OECD Climate Action Monitor 2023

Some carbon pricing



Source: Carbon Pricing Dashboard 2024

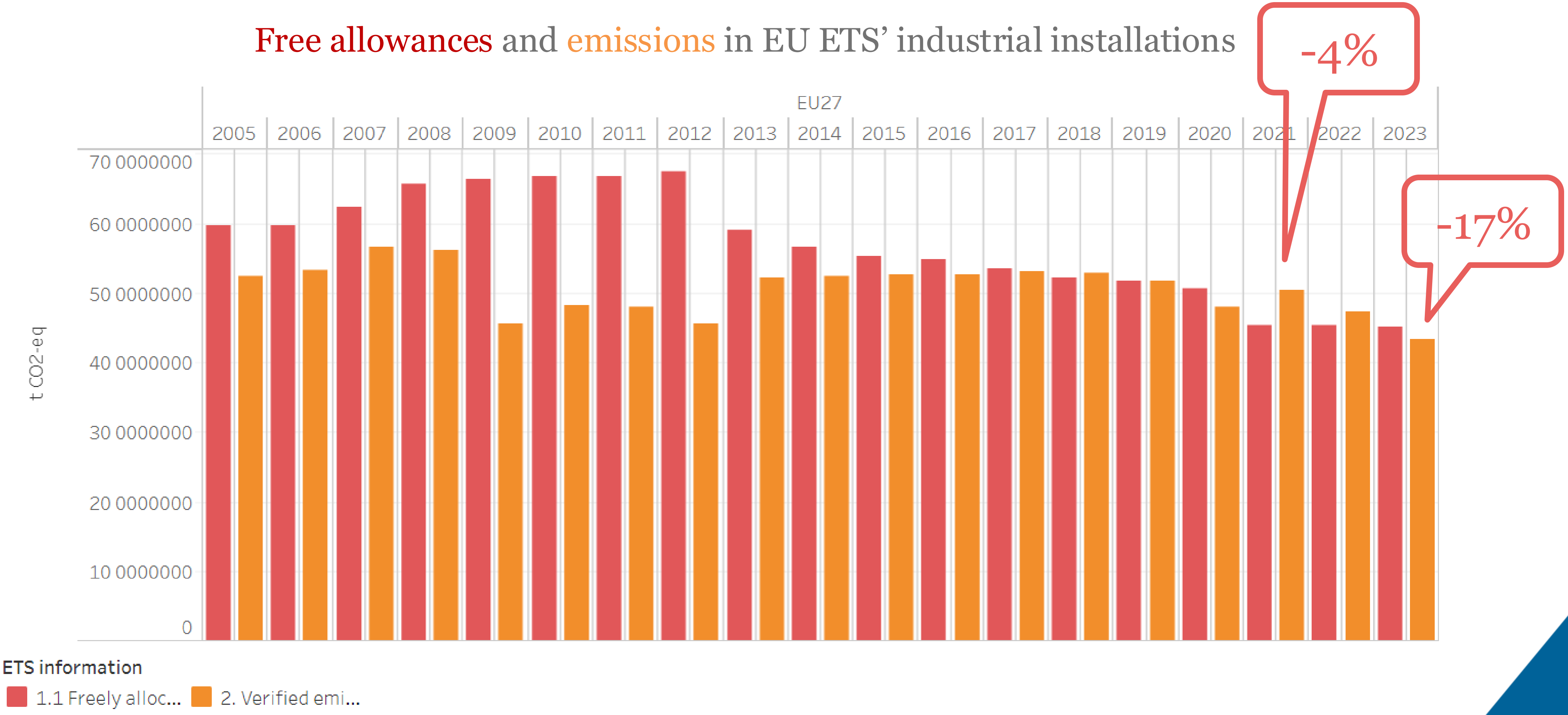
But with vast heterogeneity



Source: OECD Effective Carbon Rates (OECD, 2021).

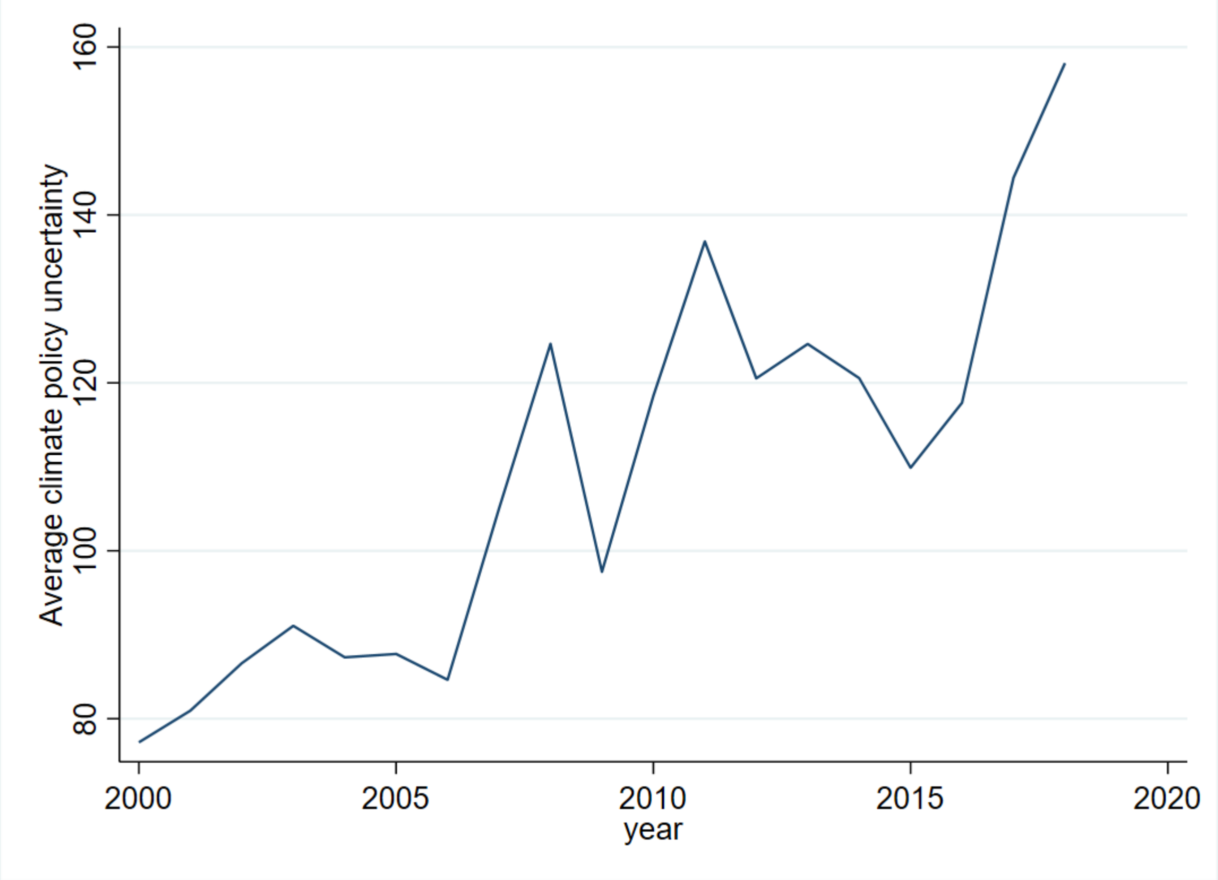
“Competitiveness” provisions

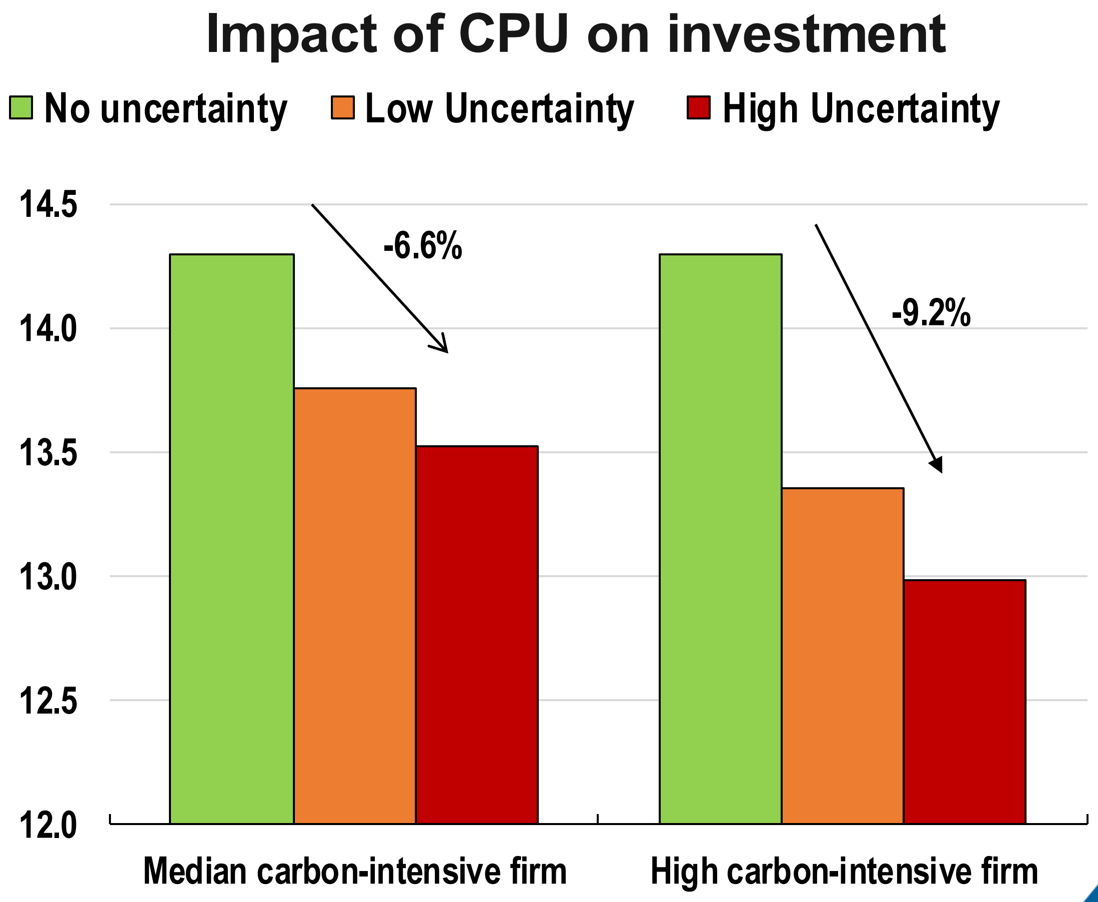
Free allowances and emissions in EU ETS’ industrial installations



Increasing climate policy uncertainty

Climate policy uncertainty average (12 countries), 1990-2020



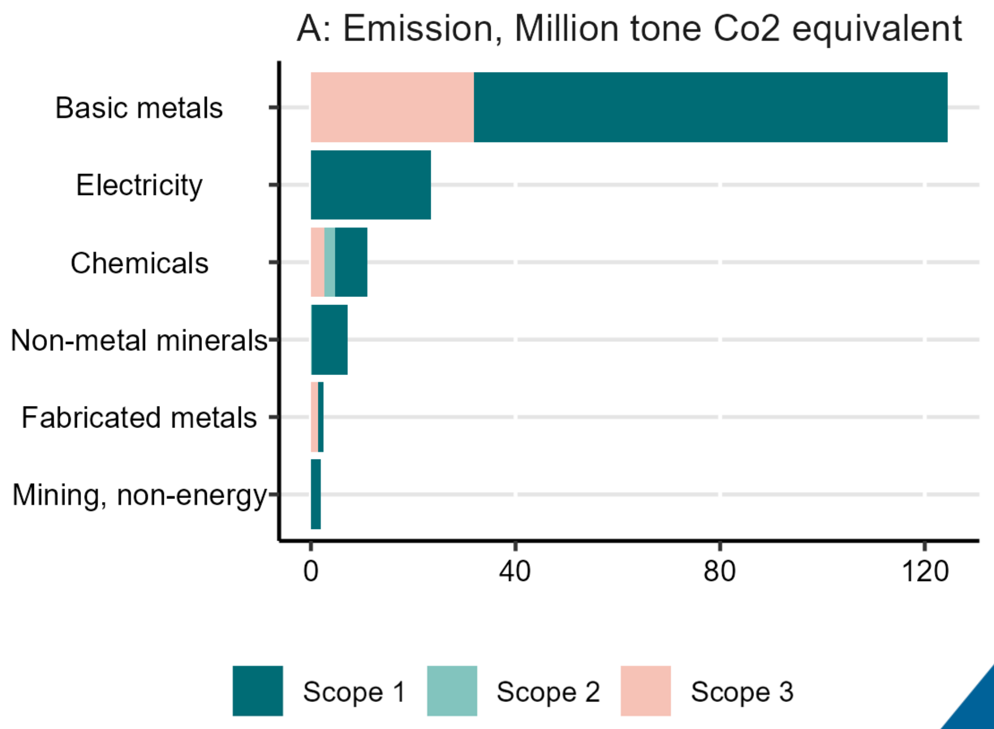


Source: Berestycki, C. et al. (2022), "Measuring and assessing the effects of climate policy uncertainty", OECD Economics Department Working Papers, No. 1724

An upcoming tiny bit of CBAM

- 303 energy-intensive goods (Iron and steel, Cement, Fertilizers, Aluminium, Electricity, Hydrogen) + partly scope 2 emissions and scope 3 upstream
  - 132 billion USD of traded goods with EU (0.4% of global trade flows, 3% of EU imports)
  - 171 Mt of embedded emissions: **0.31% of global energy and process-related emissions** (6.6% of EU's)

Covered emissions by CBAM (Scope 1 + 2 + 3)

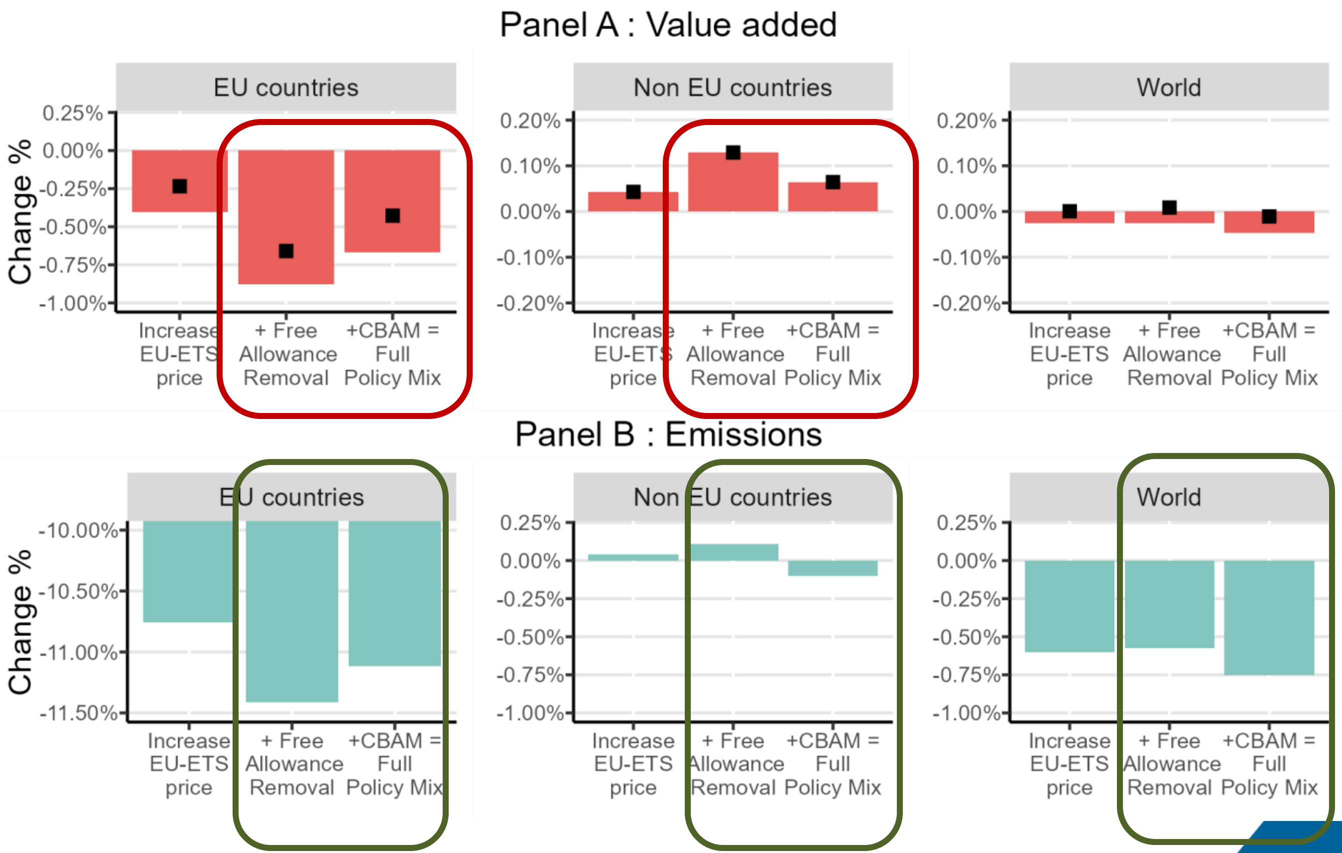


Source: Dechezleprêtre et al. (2025), "Carbon Border Adjustments: The potential effects of the EU CBAM along the supply chain". OECD STI Working Paper

CBAM effectively tackles carbon leakage but does not fully address competitiveness issues

- **Value-Added**
  - CBAM will only partly mitigate the negative impact of higher ETS prices and free allowances removal (EUR 35bn/year at current price)
  - Revenue recycling can only partially attenuate these effects (EUR 12bn at today's price)
- **Emissions**
  - Effective anti-leakage instrument: negative leakage due to shift in demand towards countries with low emission intensity and carbon prices
- Ex-post impact will depend on dynamic response

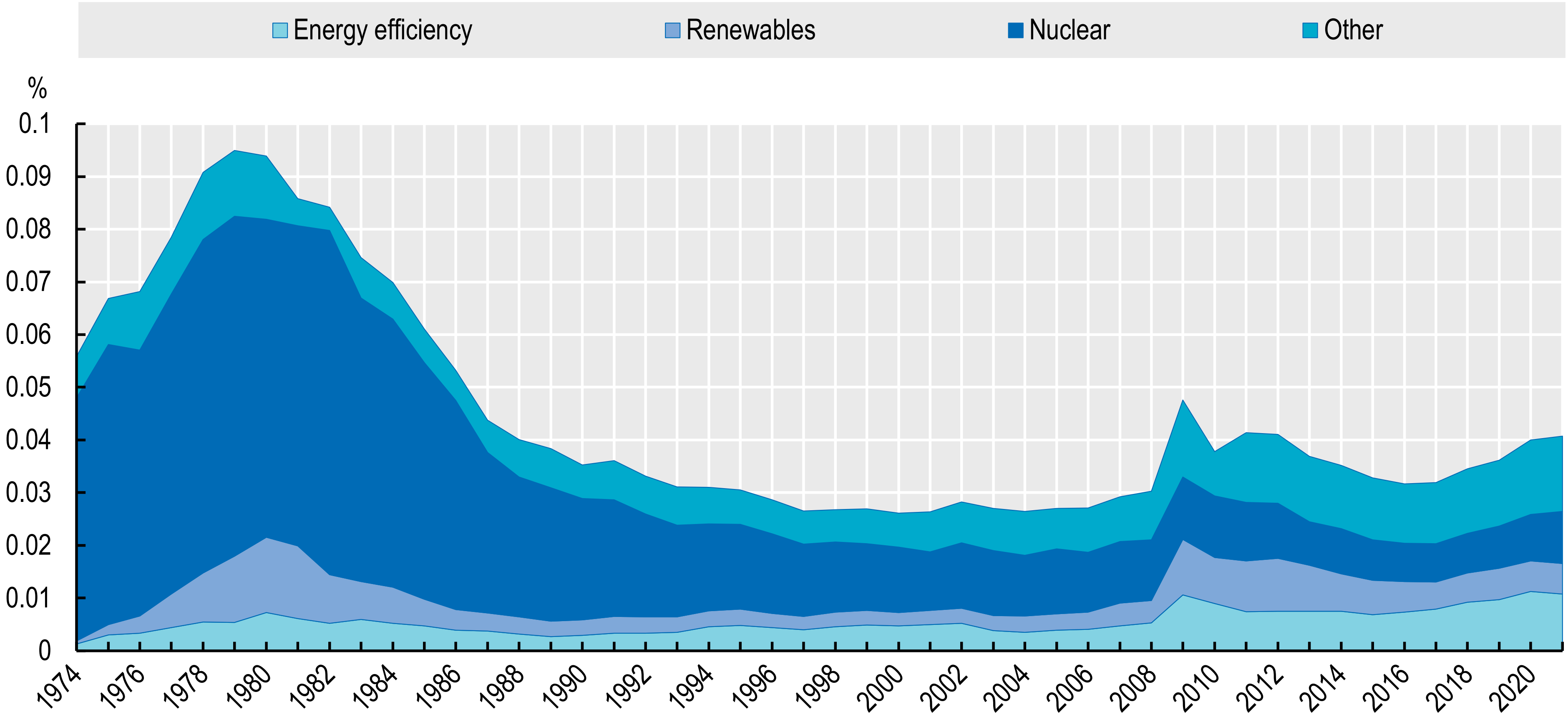
Macro-level effect across CBAM industries



Source: Dechezleprêtre et al. (2025), "Carbon Border Adjustments: The potential effects of the EU CBAM along the supply chain"

(Very) Little support for R&D

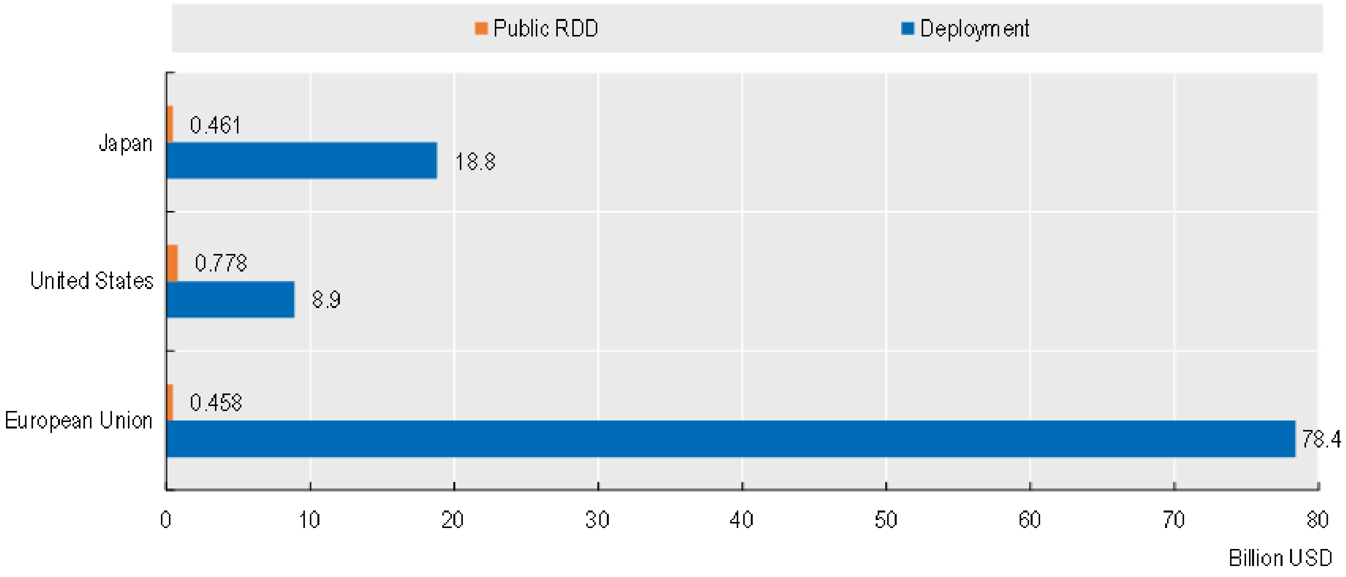
Low-carbon public R&D expenditures in GDP, 1974-2021



Source: IEA Energy RD&D public expenditures (2023)

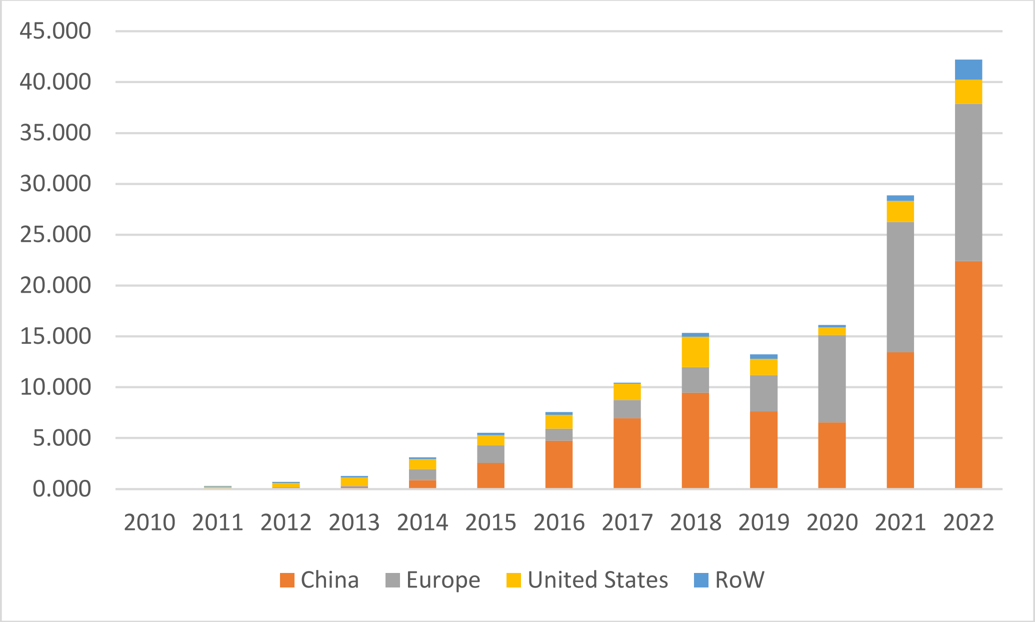
Compared to large subsidies for deployment

Public RD&D vs deployment support in renewable energy 2018 (bn USD)



Source: IEA Energy Technology RD&D Budgets database, December 2022; Taylor, Michael (2020), Energy subsidies: Evolution in the global energy transformation to 2050, International Renewable Energy Agency.

Subsidies for EV purchase (million USD)



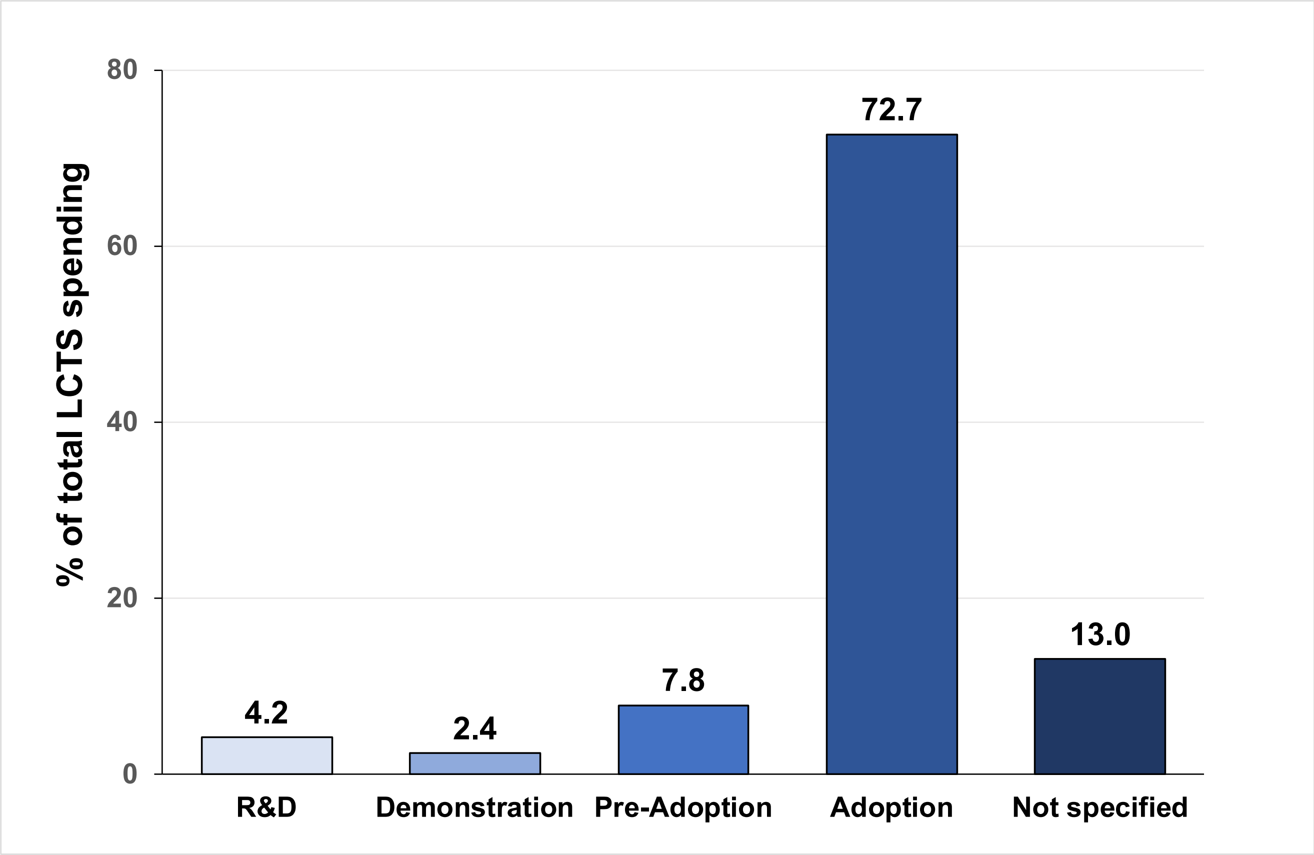
Source: IEA.

R&D vs deployment and cost reductions

- Fischer et al. (2017): public spending ratio between R&D support and deployment = 1 for wind energy (extreme assumption 6.5) and solar (extreme assumption 10)
- Kavlak et al. (2018):
  - Over 1980–2000, public R&D and spillovers accounted for 50% of cost reductions in renewable energy technologies, economies of scale and learning-by-doing 25%
  - From 2001 to 2012, public R&D and spillovers accounted for 25% of the observed cost reductions, scale economies and learning-by-doing 50%

Post-covid packages (IRA, NextGenEU) similar

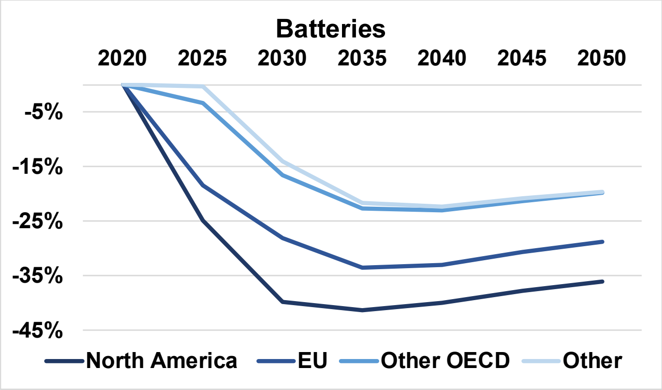
- Covid recovery: **1.29 trillion USD** announced spending on low-carbon technologies (2% of one year of GDP on average)
- Most funding channeled towards adoption and deployment of mature technologies

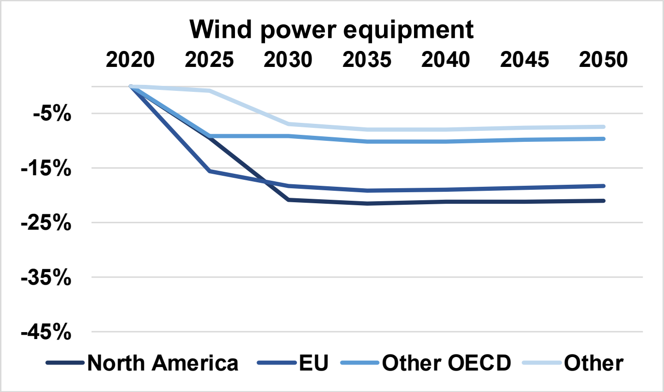


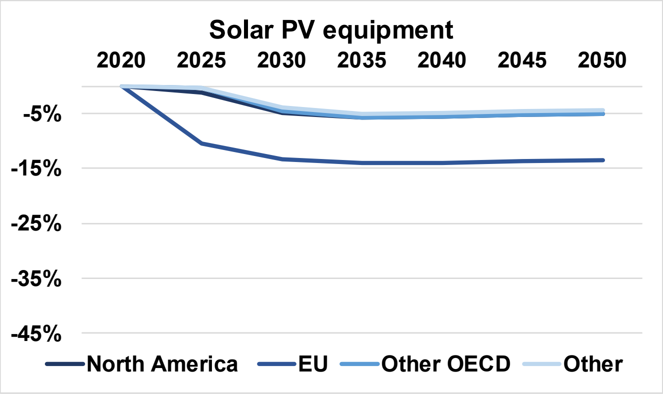
Source: Aulie, F., et al. (2023), "Did COVID-19 accelerate the green transition?: An international assessment of fiscal spending measures to support low-carbon technologies", OECD STI Policy Paper No. 151, https://doi.org/10.1787/5b486c18-en.

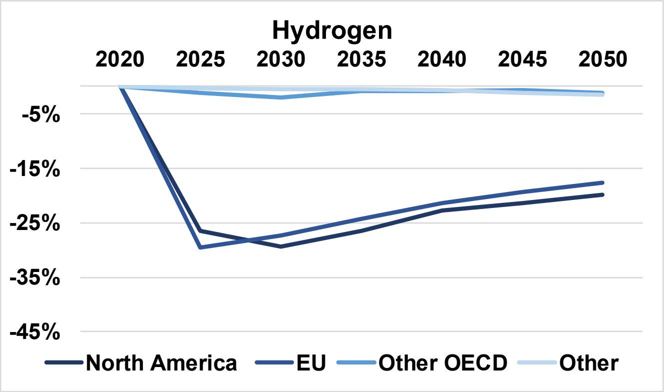
Clean tech support leads to significant cost decreases

- R&D investments, knowledge spillovers and learning by doing trigger large cost reductions:
  - Batteries -40% in US, -30% in EU
  - Hydrogen -30%
  - Wind -20%
- These cost reductions trigger 400Mt of emissions reductions outside OECD and EU by 2050









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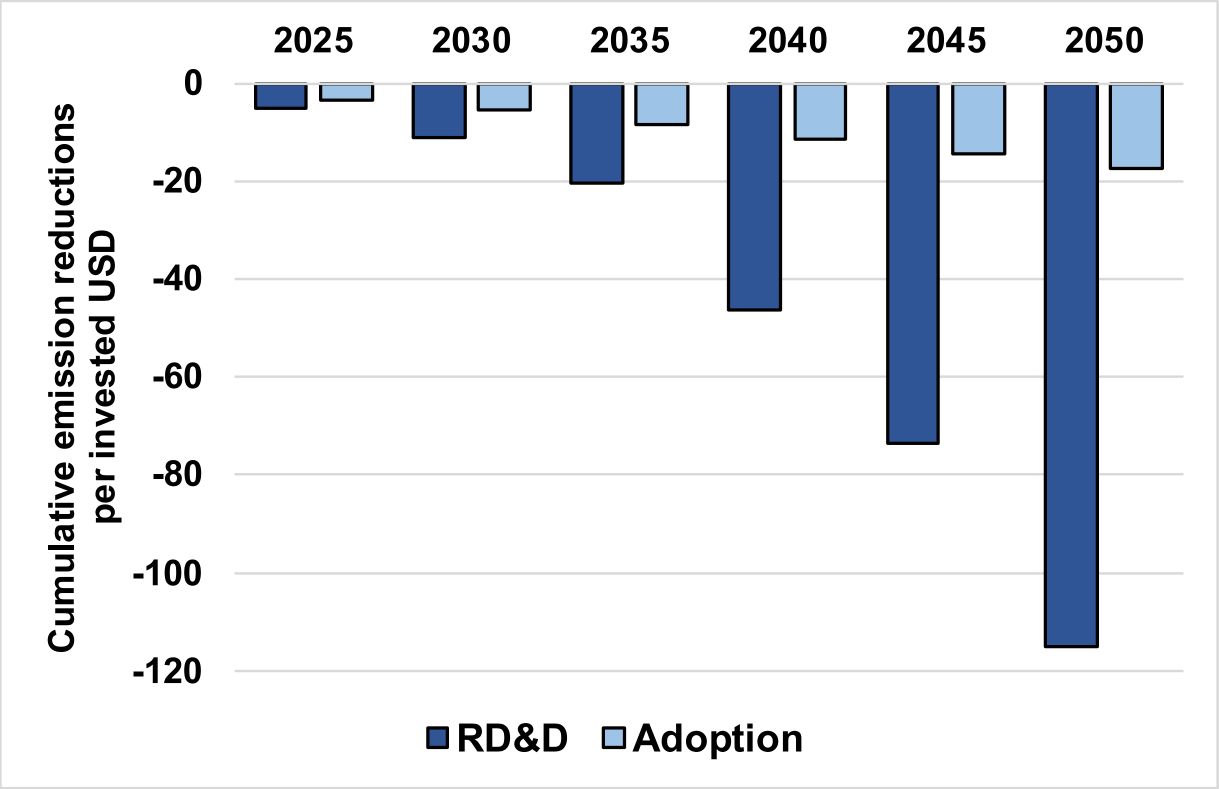
RD&D support has major & growing impact on emissions reductions over time

- RD&D support accounts for 5% of emissions reductions in 2030, but 26% in 2050.
- 1 euro spent on RD&D support induces **six times** more cumulative emissions reductions by 2050 than the same euro invested to support adoption



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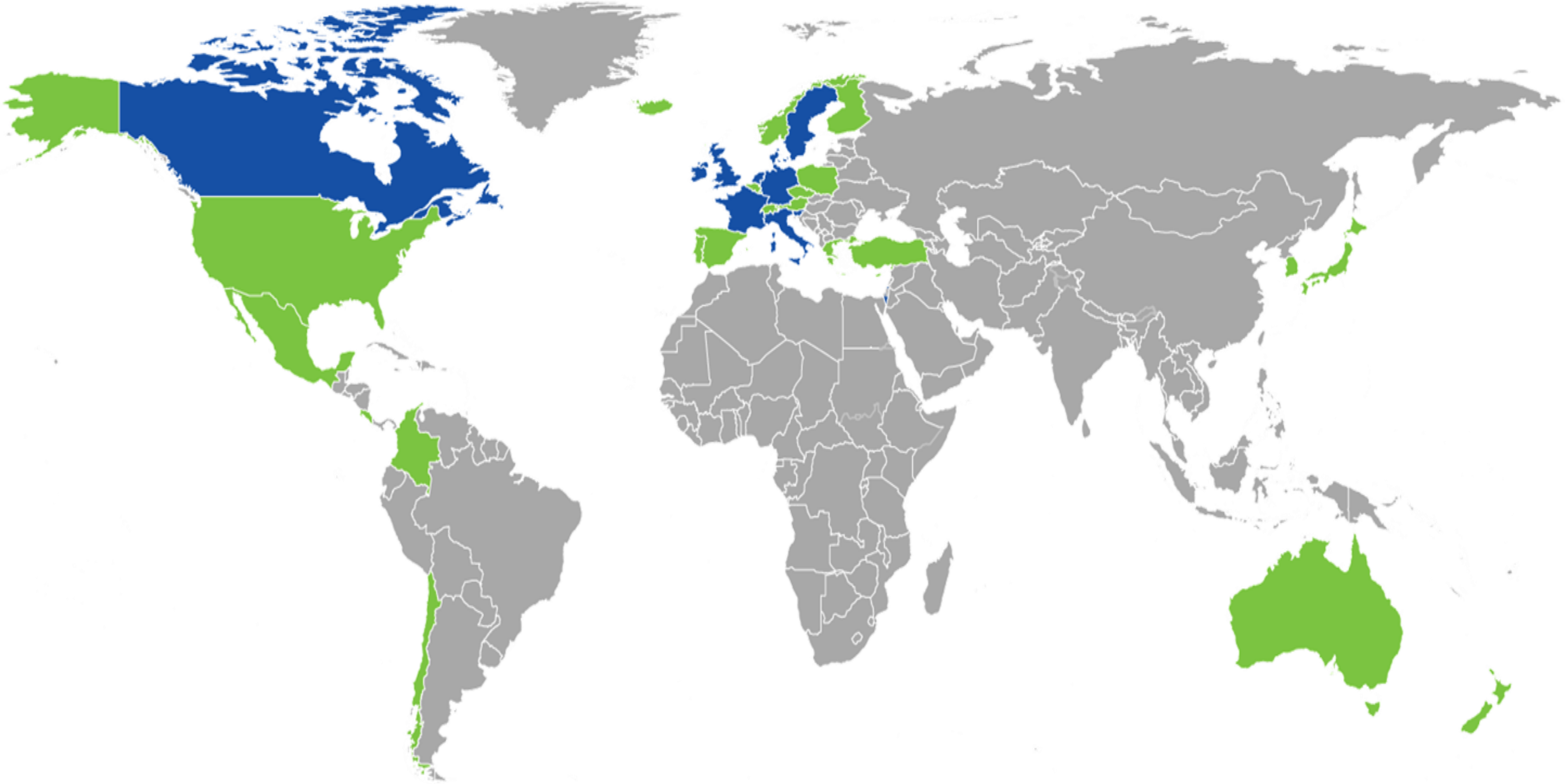
A ZOOM ON GREEN INDUSTRIAL POLICIES

The “Quantifying Industrial Strategies” project



QuIS

11
participant countries

5
G7 countries

QuIS participant countries

OECD member states

The database

- **1 536 policy instruments**
- 2019-2022
- Instruments collected from publicly available sources (threshold 0.002% of GDP):
  - Budgetary documents
  - Reports of government agencies
  - Governmental websites
- Quality checks with complementary sources (e.g. OECD Stip Compass, GTED database, ...)

Instrument Types	Target
Grants and Tax Expenditures	**Digital**
Grants	**Green**
Tax expenditures	**Jobs / skills**
	R&D
Financial Instruments	**Sectoral**
Loans	**SMEs and young firms**
Loan guarantees	**Technology**
Venture capital	**Energy cost**
	Regional
	Investment

A focus on supply-side instruments

SUPPLY

WITHIN
Instruments affecting firm performance

Investment incentives
- Tax expenditures, grants, subsidies
- Financial instruments (public VCs, loans, guarantees)

Access to inputs
- Skills policy (education, training)
- Public R&D and transfer of publicly provided knowledge
- Infrastructure, energy, …

BETWEEN
Framework instruments affecting industry dynamics

Framework instruments
- Well-functioning capital markets
- Labour mobility
- Tax system
- Entrepreneurship policies
- IP and technical standardisation policies

Complementary policy areas
- Competition
- Trade and investment

DEMAND
Instruments affecting the demand of products/services

Product regulation
- Product standards
- Pigouvian taxes and subsidies

Public Procurement

Awareness-raising campaigns and behavioural nudges

GOVERNANCE
Instruments coordinating stakeholders

International cooperation

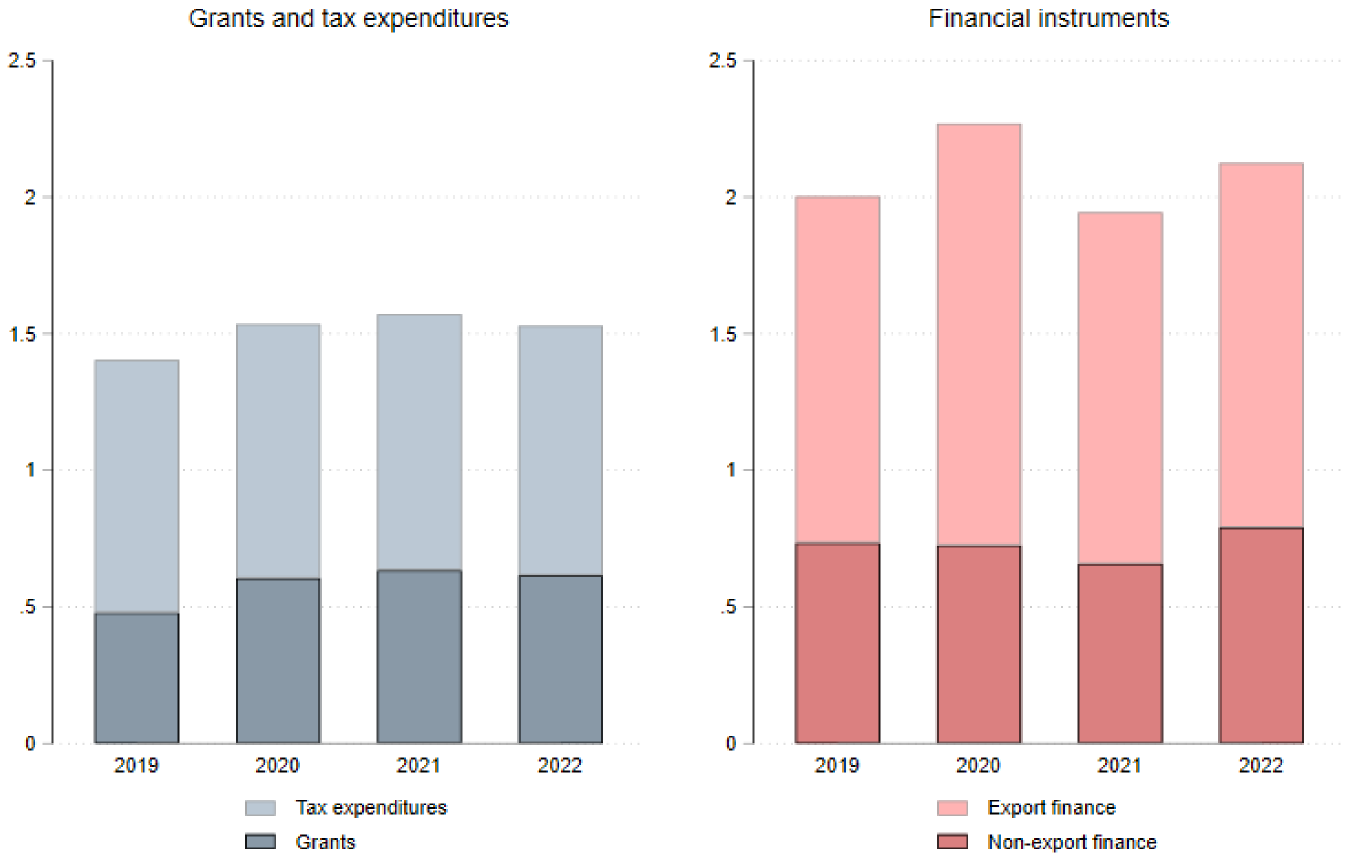
Public-private fora

Industry boards

Source: Criscuolo et al. (2022), "An industrial policy framework for OECD countries", https://doi.org/10.1787/0002217c-en

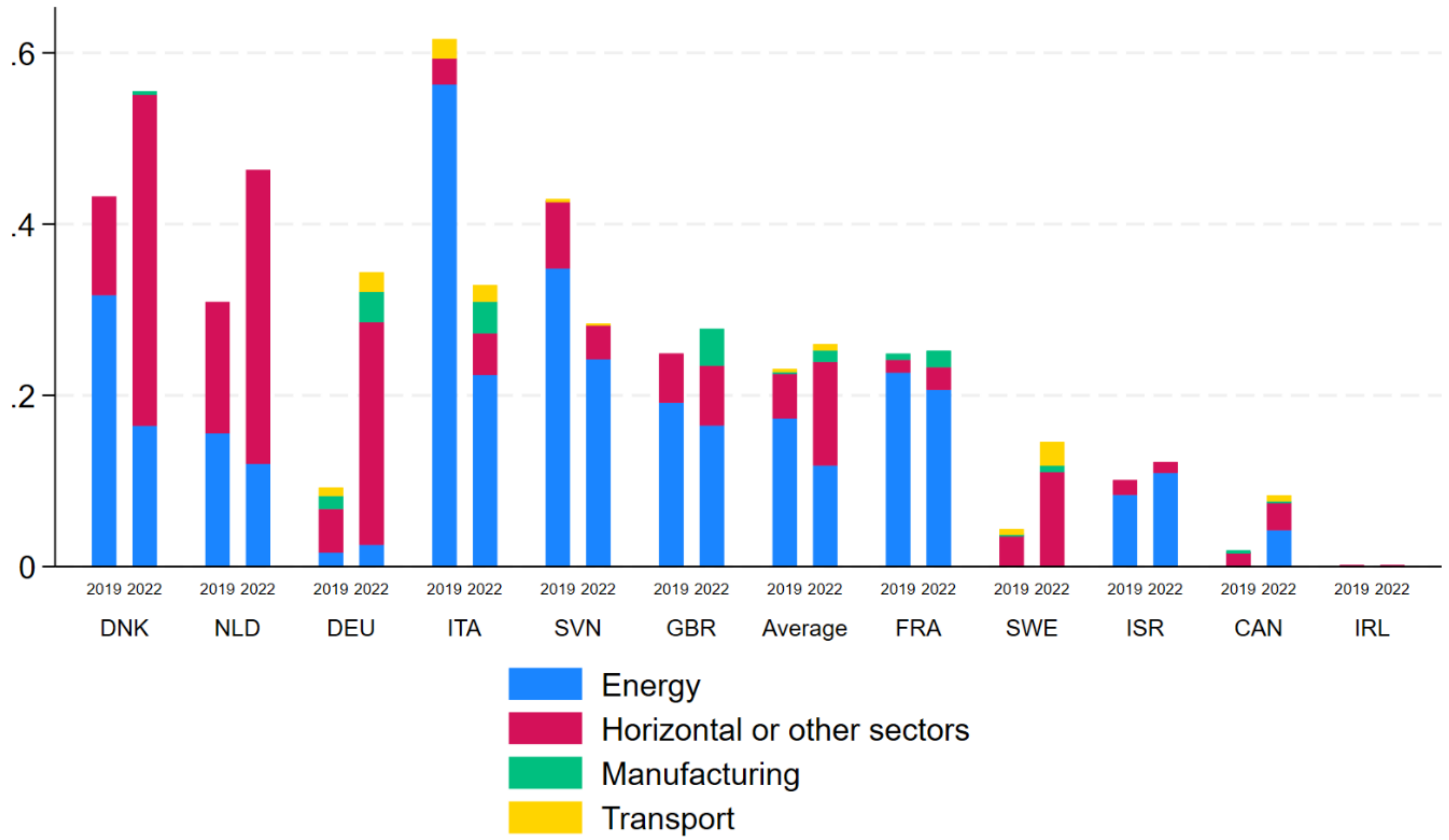
Industrial policies are on the rise

Evolution of structural industrial policy support (excluding COVID emergency support), % of GDP, yearly averages across countries, 2019-2022



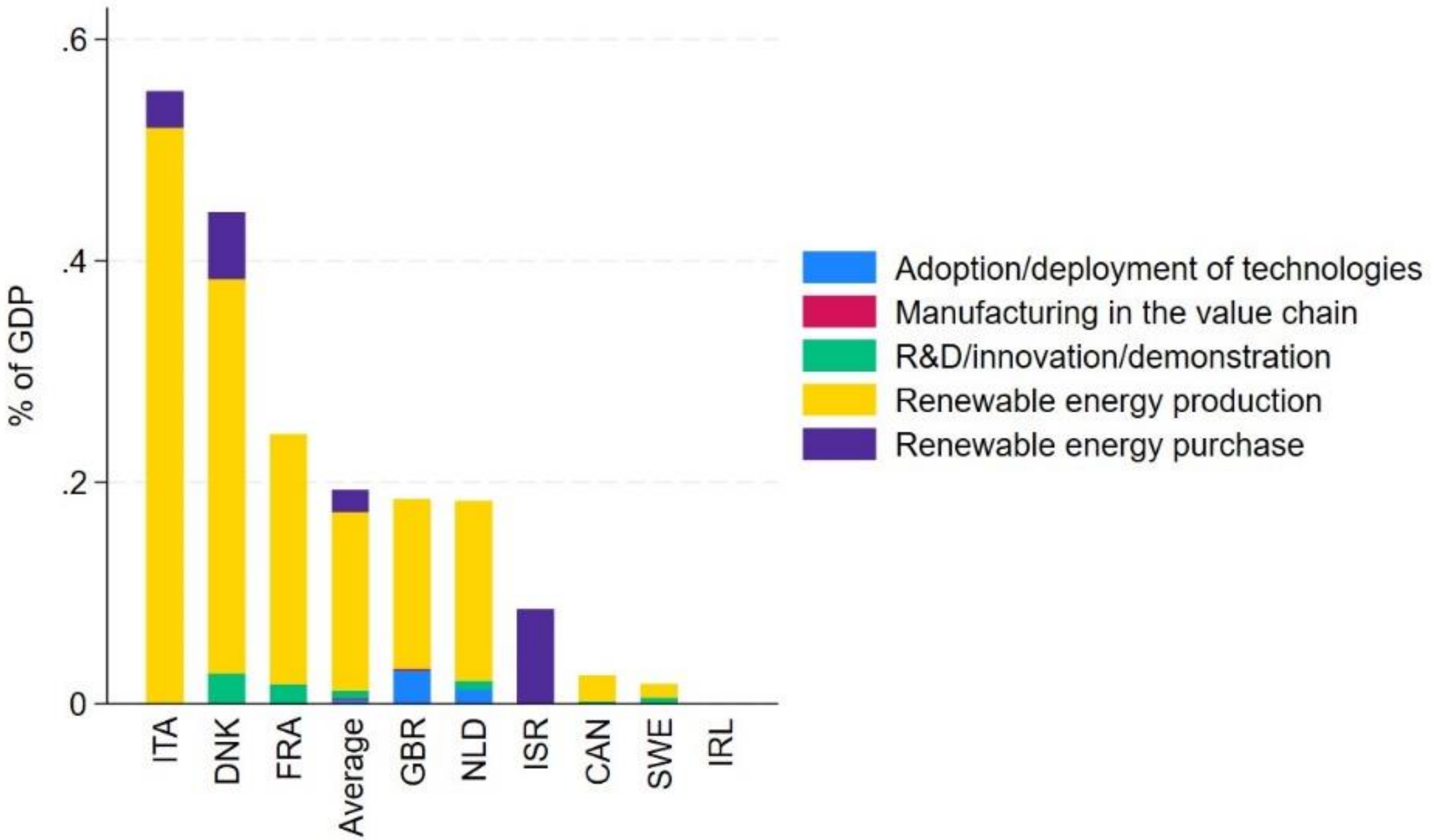
Green industrial policies are expanding and start focusing less on the energy sector

Green grants and tax expenditures by sector, 2019 and 2022, % of GDP



Public support for renewables strongly focuses on electricity production, not R&D or manufacturing

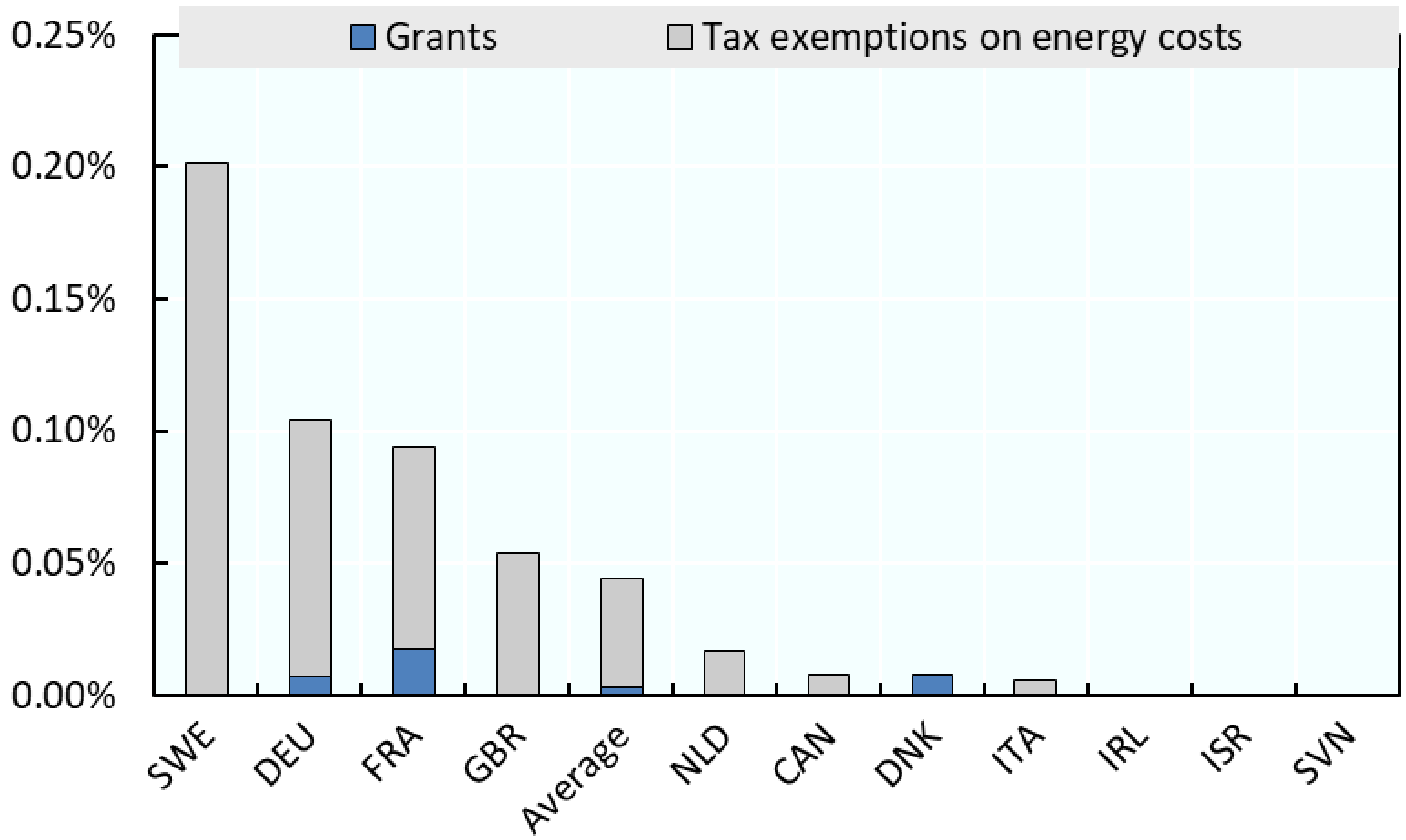
Business support to the renewable energy ecosystem by objective
(average 2019-2021), % of GDP



Source: Own elaboration based on the QuIS database, http://oe.cd/quis.

Green instruments coexist with brown instruments to lower energy costs for energy-intensive industries

Direct business support explicitly targeted to energy-intensive sectors by instrument type, as a % of GDP, average for 2019-2021



Source: OECD QuIS database.

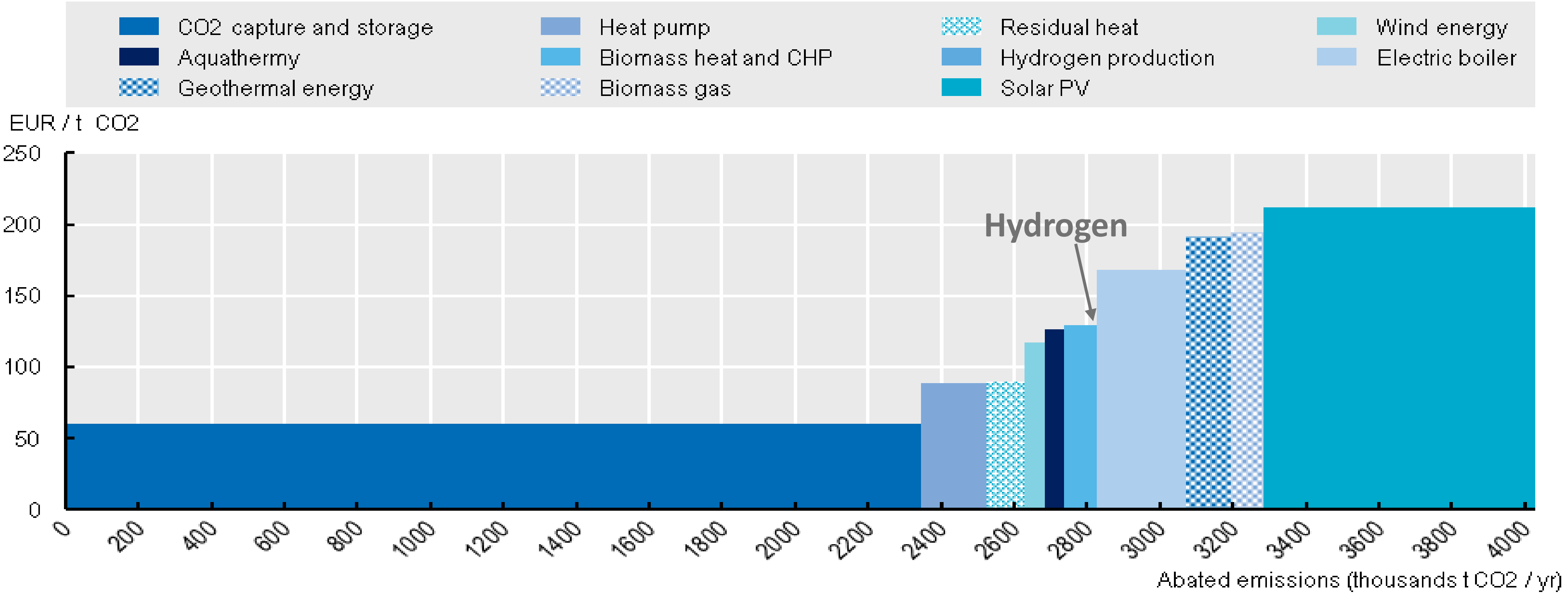
WHAT CAN GOVERNMENTS DO?

Encouraging innovation directly

- Re-balancing STI policies: greater **support for breakthrough technologies**, and better balance with **diffusion of existing technologies**
  - Target early-stage low-carbon technologies (e.g. H2), enabling technologies (e.g. digital) and focus deployment on infrastructure (e.g. charging stations)
  - Increase support for **demonstration projects** – currently too small compared to typical project needs
  - Growing and predictable **budgets**
- More **direct** support instruments, not just R&D tax credits – technology neutrality is not neutral, but tends to favours incumbents
  - Direct support works (eg Howell 2017) but more research needed

Technology-neutral policies favour mature technologies

SDE++ subsidy demand curve in first tender (Netherlands)



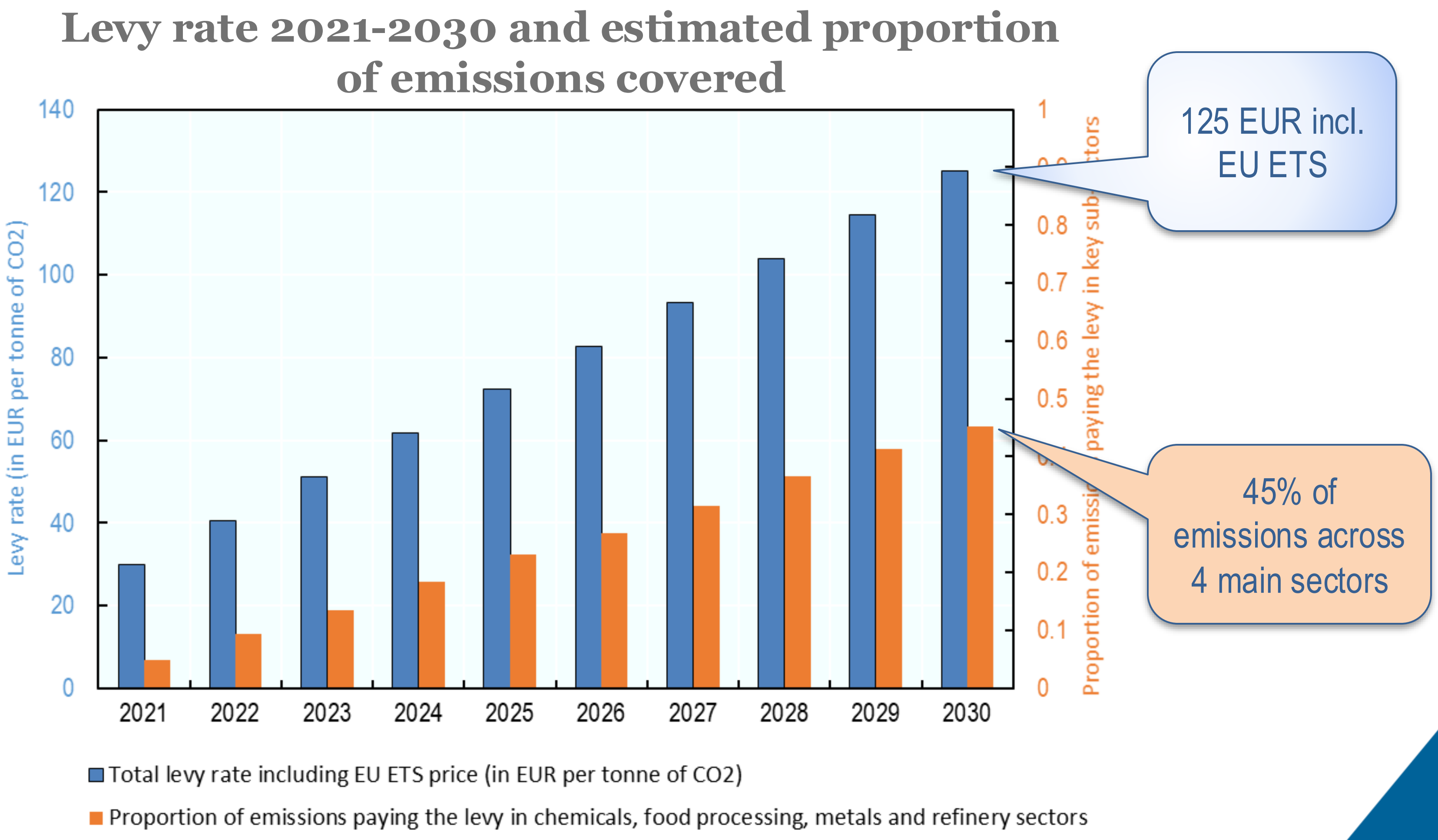
Source: Anderson, B. et al. (2021), "Policies for a climate-neutral industry: Lessons from the Netherlands", OECD Science, Technology and Industry Policy Papers, No. 108, OECD Publishing, Paris, https://doi.org/10.1787/a3a1f953-en.

Provide clear indication on direction of change

- Stir **demand** for low-carbon technologies
  - Carbon pricing, CCfDs and removal of fossil fuel subsidies
  - Product **standardisation** (e.g. green hydrogen, sockets for EVs, etc.)
  - **Regulation** (e.g. heating, buildings, emissions standards, recycled content, bio-based products)
  - Public procurement
- Reduce policy uncertainty

The Dutch climate levy: a gradual yet strong signal to incentivize decarbonisation

- A strong medium-term signal
- Provides certainty
- Kicks-in gradually



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Providing the right framework conditions

- Fund **public infrastructure,** e.g. carbon and hydrogen pipelines, 5G.
- **Support entrepreneurship,** (access to finance, clusters, academic spin-offs)
- Preserve **competition**, contestability of markets and openness (merger control)
- **Make trade work for the twin transition** – e.g. facilitating trade in environmental goods and services, IPR frameworks that balance protection and diffusion, etc. …
- **Support workers**, whose skills need to be updated

Take-away messages

- Low-carbon innovation critical
- Policy broadly focuses on adoption support for mature technologies
  - And carbon pricing in EU, but vast free allowances
- Policy needs to encourage low-carbon innovation directly
  - Greater support for early-stage technologies, and better balance with support to diffusion, using direct support instruments
  - More focus on the supply side (including infrastructure) and on the manufacturing sector
- On the demand side: provide clear direction
  - Reduce policy uncertainty
  - Carbon pricing, but also standards, regulation (e.g. buildings, recycled content, bio-based products) and public procurement

Thank you

For more information:

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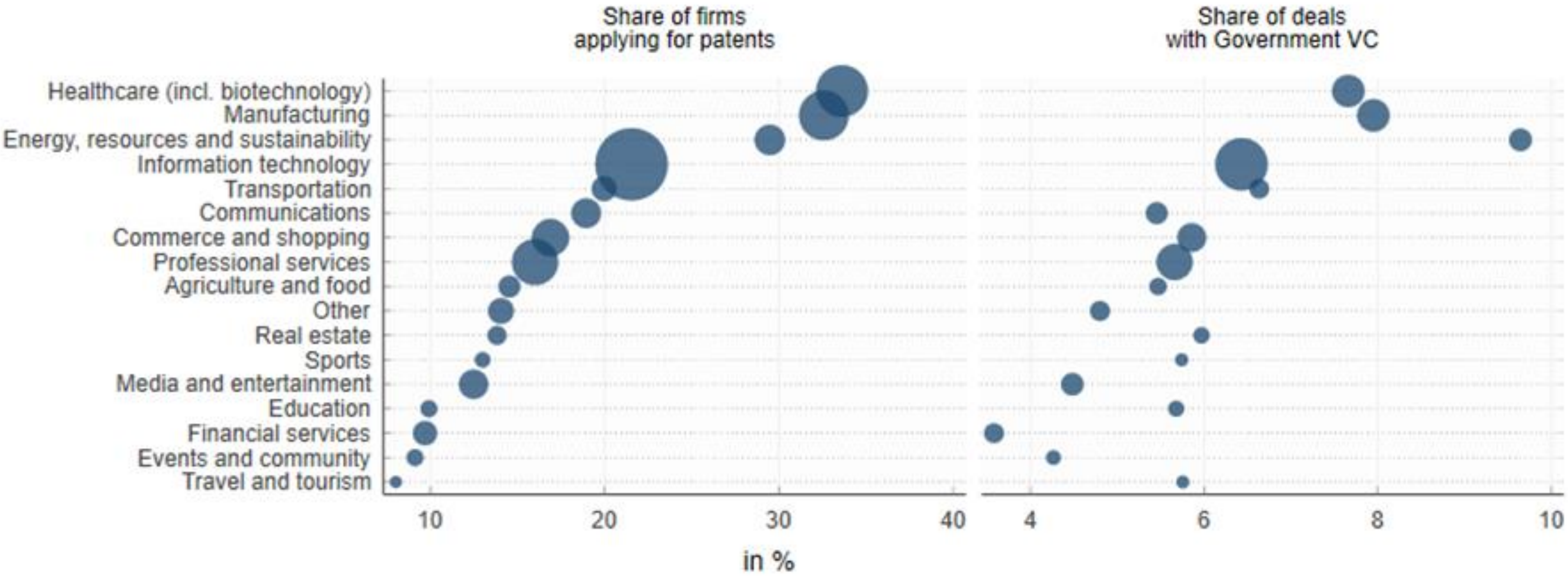
BETTER POLICIES FOR BETTER LIVES

APPENDIX

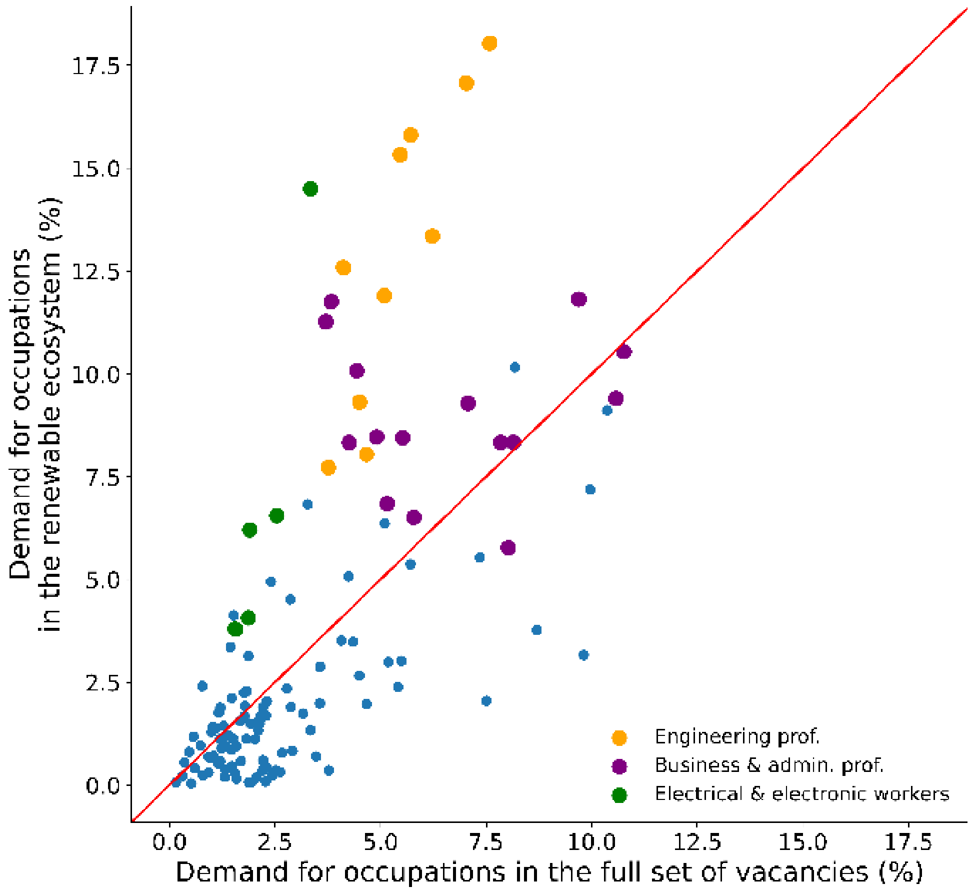
Government Venture Capital may have a role to play



Source: Berger, M., A. Dechezleprêtre and M. Fadic (2024), "What is the role of Government Venture Capital for innovation-driven entrepreneurship?", OECD Science, Technology and Industry Working Papers, No. 2024/10, https://doi.org/10.1787/6430069e-en.

Engineering professions are highly sought-after in the renewable energy ecosystem

Top five over-demanded occupations in the renewable energy ecosystem

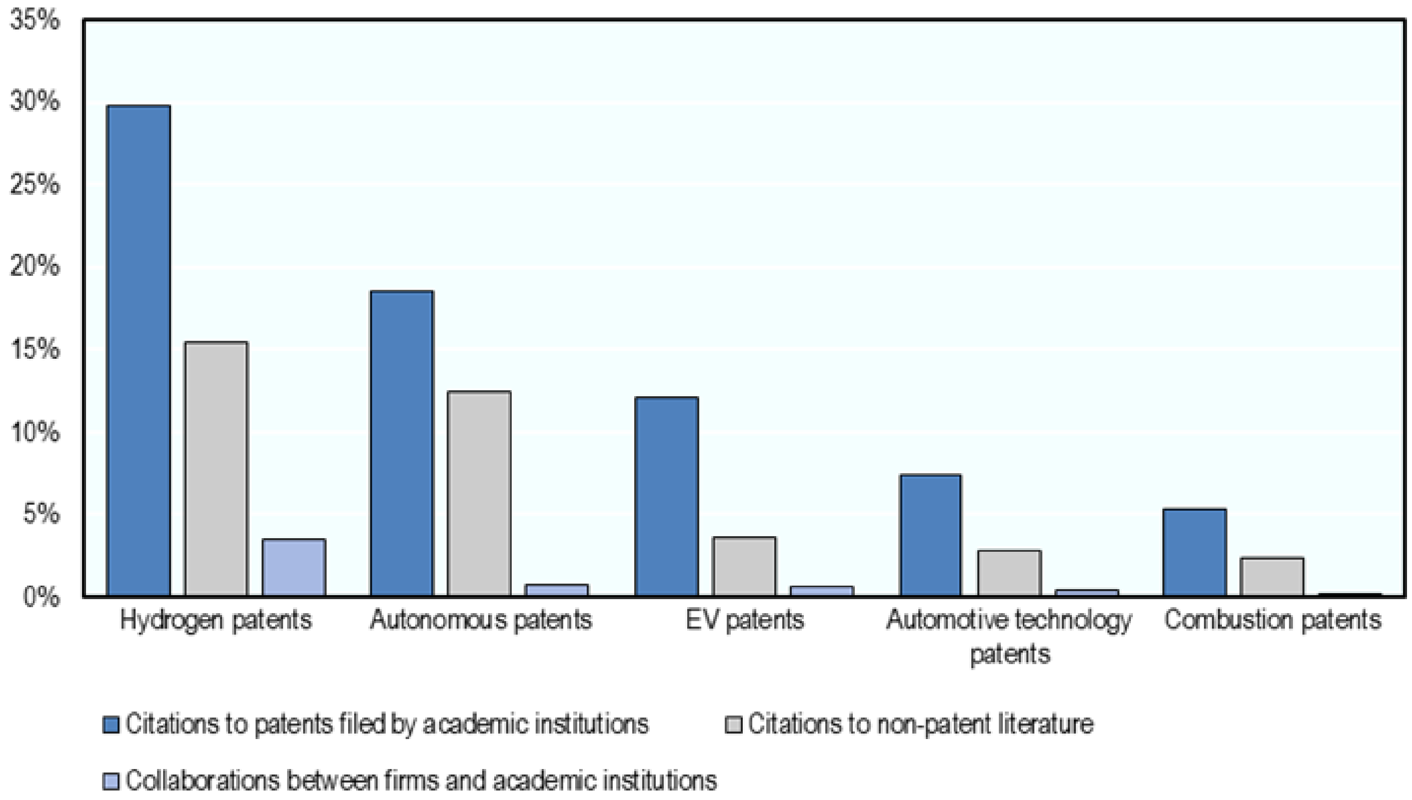


Source: Own elaboration based on Lightcast data.

Source: Dechezleprêtre, A. et al. (2024), "A comprehensive overview of the renewable energy industrial ecosystem", *OECD Science, Technology and Industry Working Papers*, No. 2024/11

Low-carbon innovations rely on scientific research more than fossil-based innovations

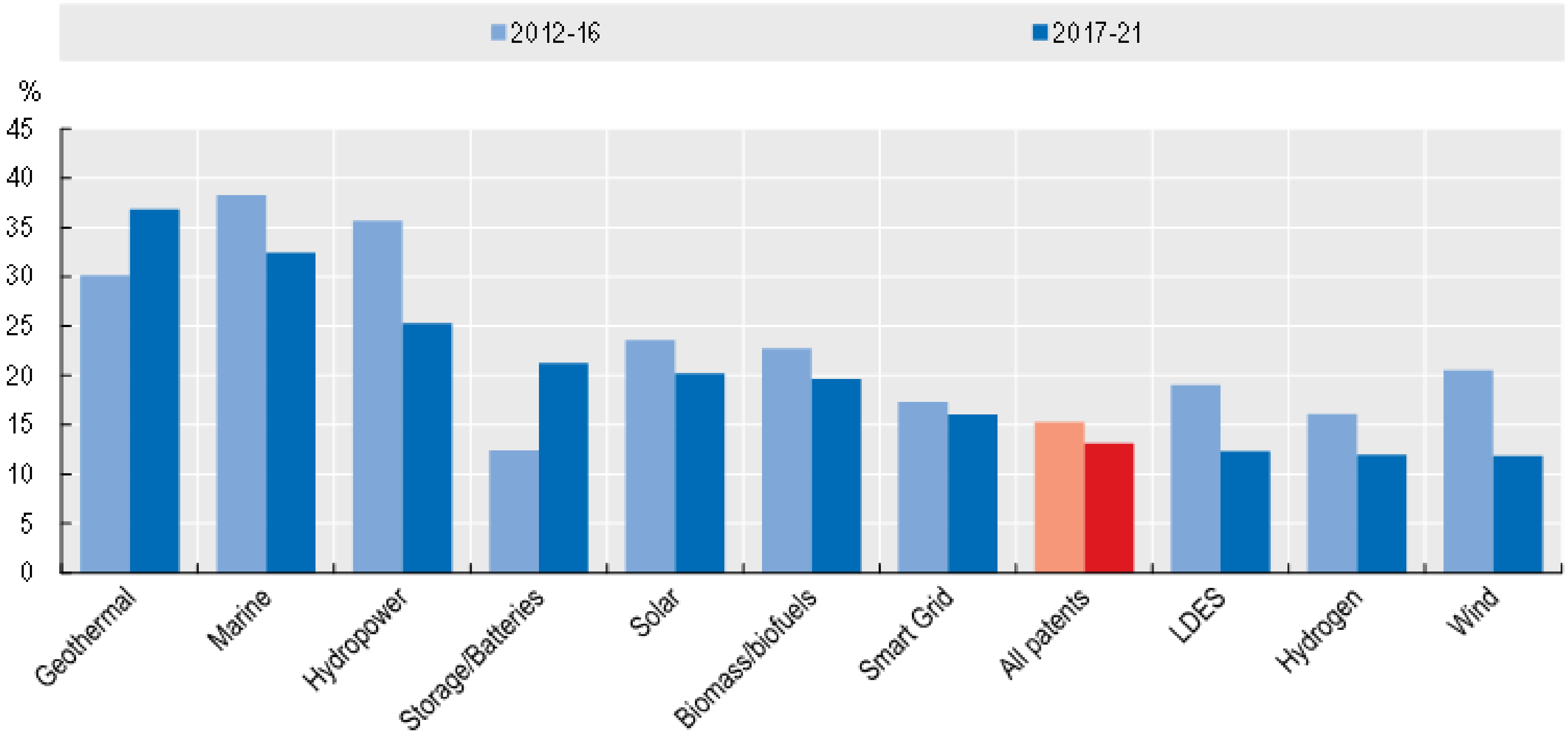
Emerging technologies are strongly linked with universities and scientific research



Source: Dechezleprêtre, A., et al. (2023), "How the green and digital transitions are reshaping the automotive ecosystem", OECD STI Policy Paper No. 144, https://doi.org/10.1787/f1874cab-en.

The contribution of young firms to innovation is slowing down, including in low TRL techs

Patents owned by young firms, as a % of total patents in each technology



Source: Dechezleprêtre, A. et al. (2024), "A comprehensive overview of the renewable energy industrial ecosystem", *OECD Science, Technology and Industry Working Papers*, No. 2024/11