ACHIEVING THE LOW-CARBON TRANSITION: WHAT ROLE FOR GREEN INNOVATION AND INDUSTRIAL POLICIES?

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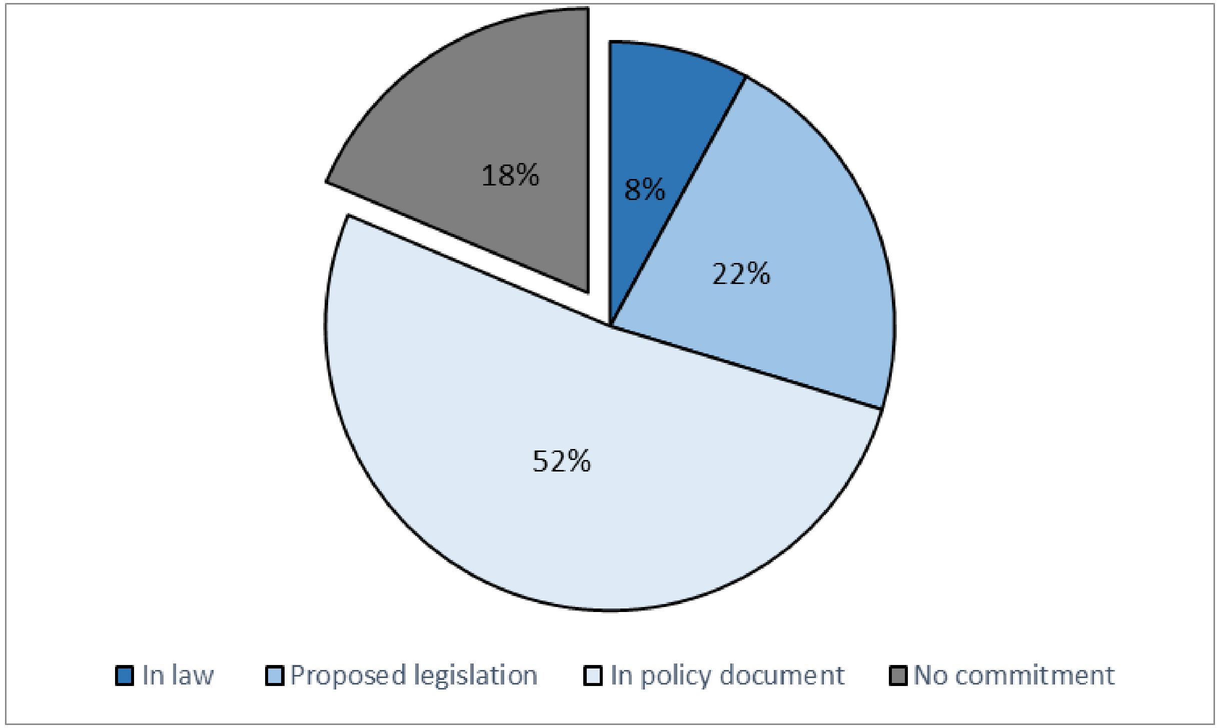
OECD
BETTER POLICIES FOR BETTER LIVES

BACKGROUND

An ambitious climate agenda across OECD and non-OECD countries

- Over 80% of the world's economy has adopted carbon neutrality goals by 2050
- 2030 targets:
  - EU: -55% wrt 1990
  - US: -50% wrt 2005

Share of global economy that announced net-zero CO_2 or GHG emissions by mid-century



Source: Own calculations based on the share of global GDP represented by the countries that commit according to the Net Zero Tracker (https://eciu.net/netzerotracker). Share of global GDP is calculated based on GDP in 2017 taken from World Bank national accounts data and OECD National Accounts data (2021).

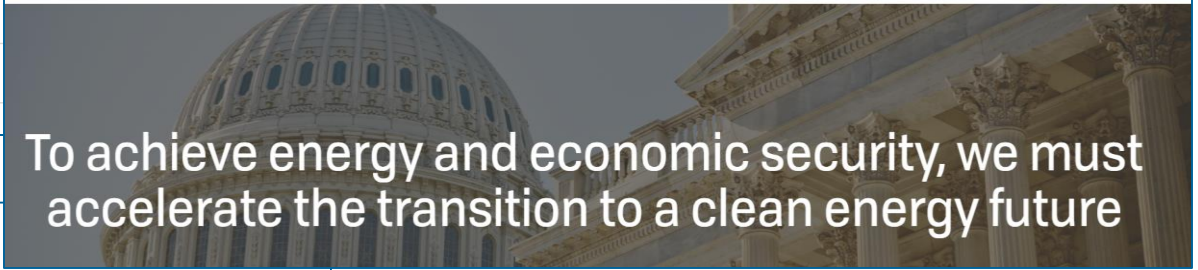
The need to reduce fossil fuel dependence makes decarbonization even more urgent

ENVIRONMENT

Will war fast-track the energy transition?

IN FOCUS: UKRAINE

Ceres



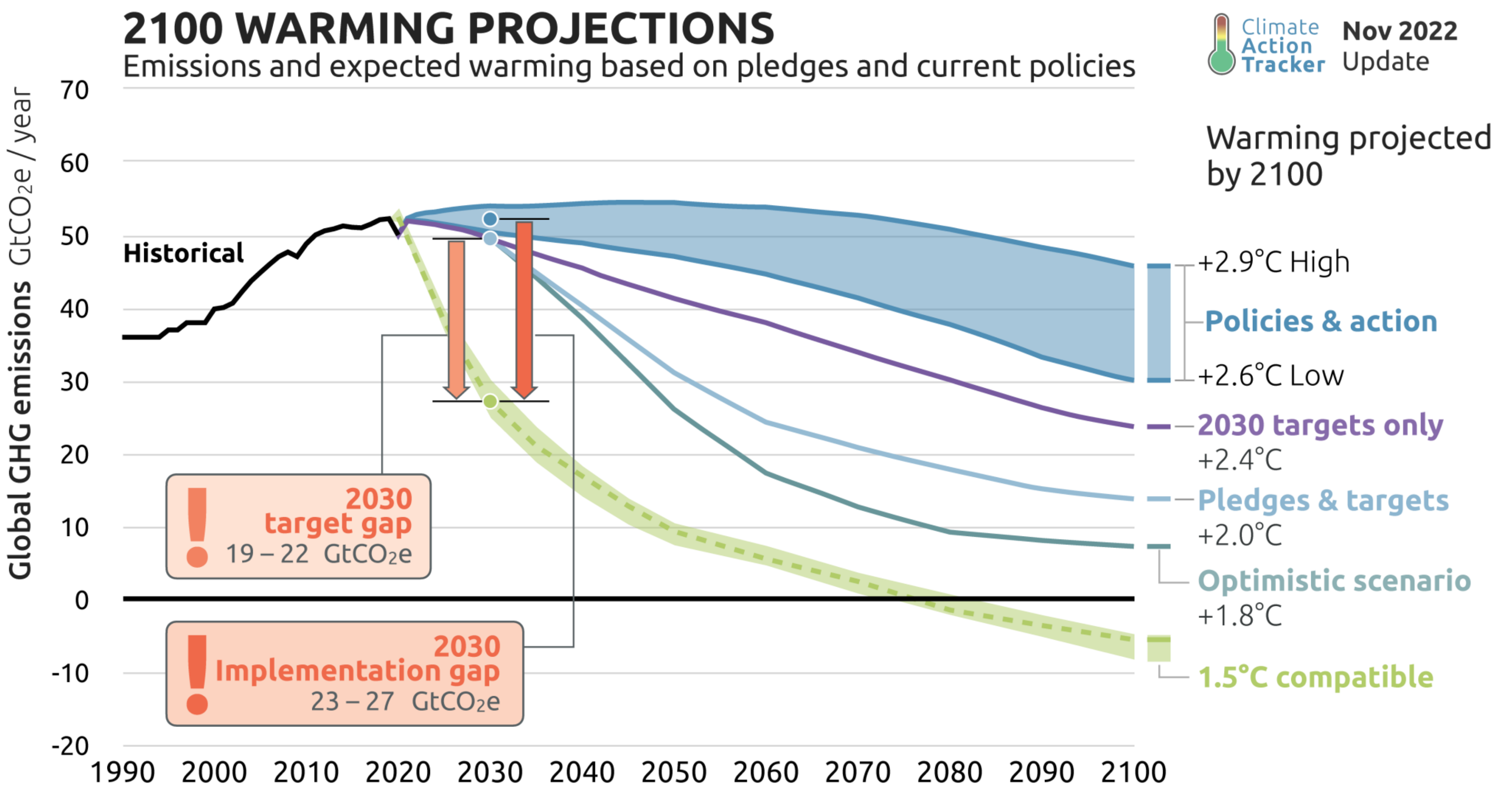
European Commission

Home > Strategy > Priorities 2019-2024 > A European Green Deal > REPowerEU: affordable, secure and sustainable energy for Europe

REPowerEU: affordable, secure and sustainable energy for Europe

How we reach zero-carbon energy independence

But emissions are not on track - climate policies need to become much more ambitious

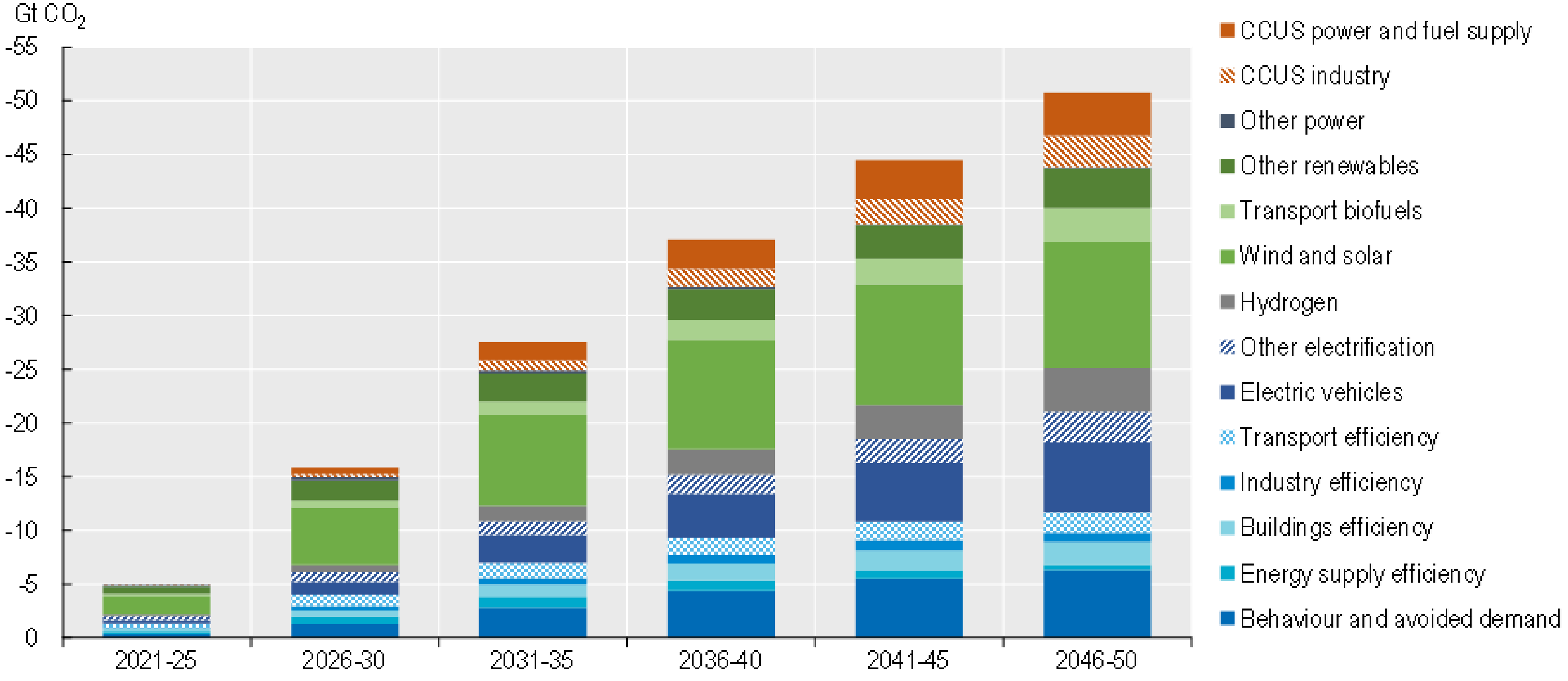


Source: Climate Action Tracker 2022

INNOVATION IS KEY FOR NET ZERO

Climate neutrality requires a system-wide technological shift

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



Source: IEA 2021

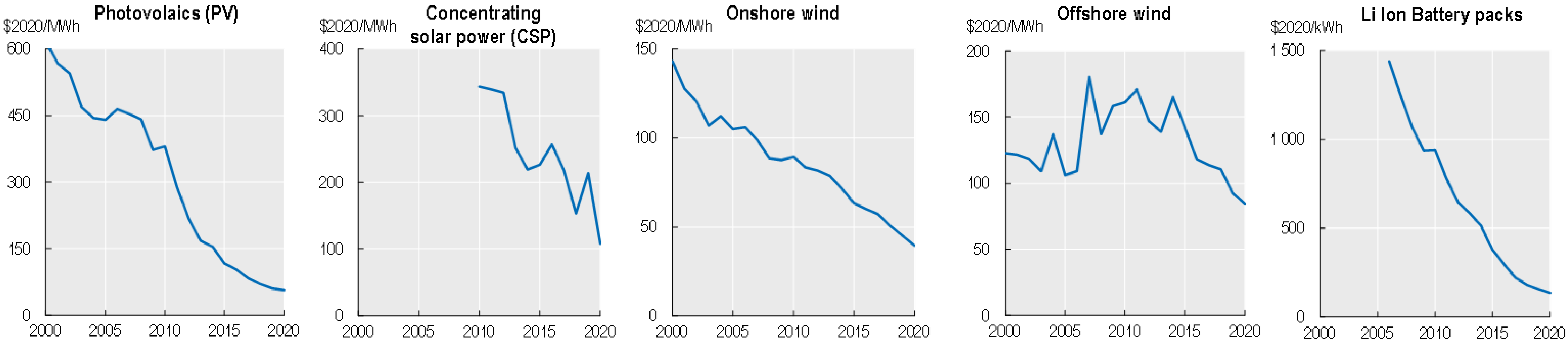
Innovation is needed

1. Reduce the cost of existing technologies
2. Develop early-stage technologies further and discover potential breakthroughs

✓ Both in low-carbon technologies and enabling technologies (eg digital)

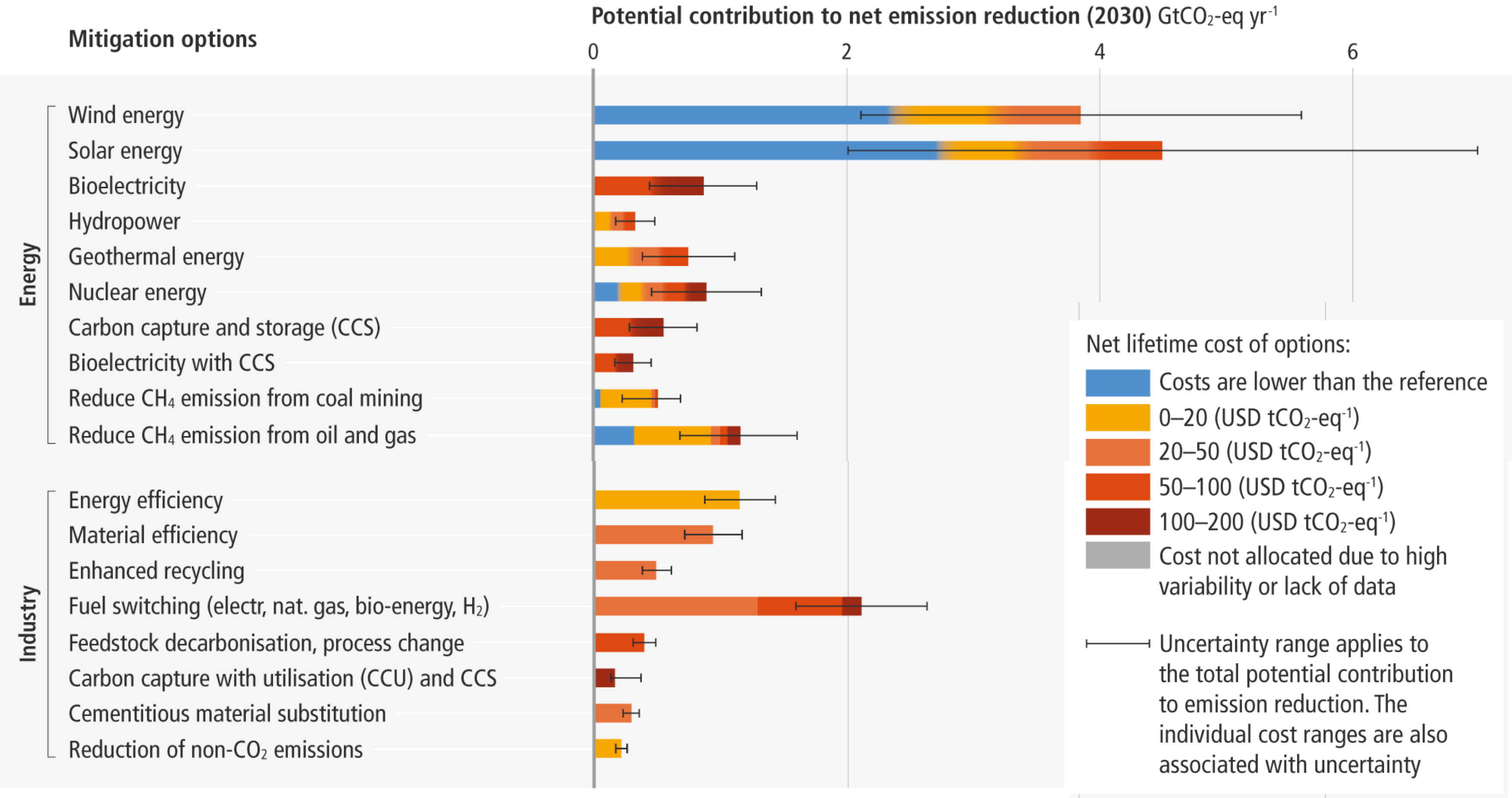
Continuous innovation is key to reducing the costs of low-carbon technologies

Declining renewable energy and battery costs since 2010



Source: IRENA 2021, IPCC 2022.

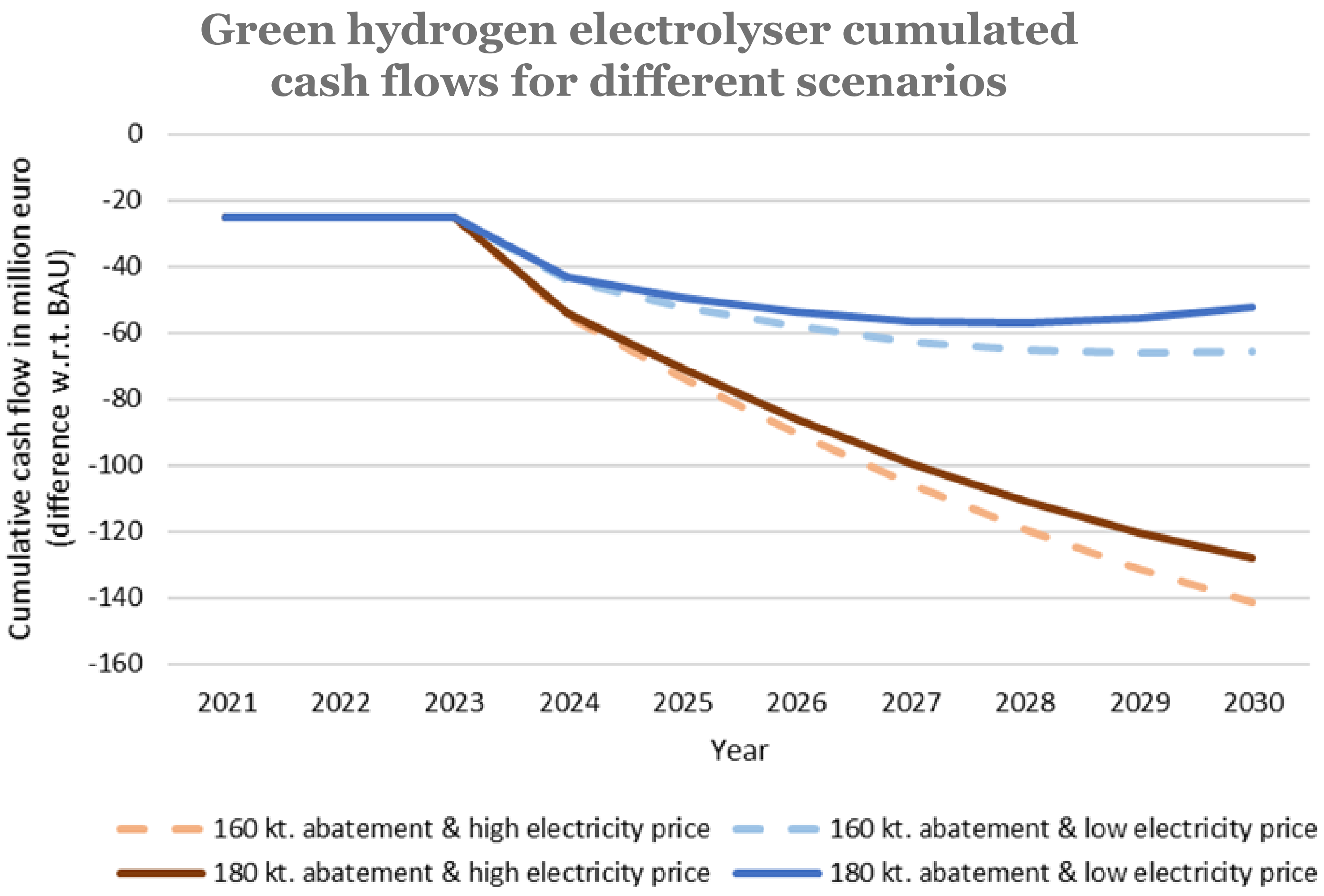
Mitigation costs are still too high in many technologies & sectors



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

For example, green hydrogen is not competitive with fossil-based alternatives (even with high carbon prices)

- Producing hydrogen from electrolysis with renewable electricity is still 3 times more expensive than from natural gas
  - Even with carbon price savings and adoption subsidies in NLD
- Cost reductions are needed

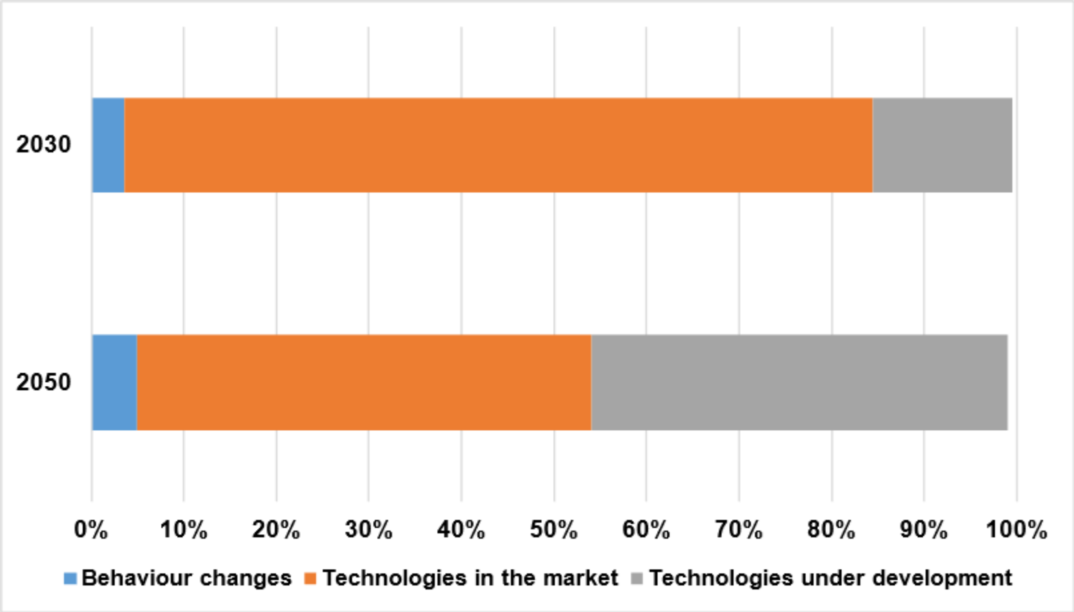


Source: Cammeraat, E., A. Dechezleprêtre and G. Lalanne (2022), "Innovation and industrial policies for green hydrogen", OECD Science, Technology and Industry Policy Papers, No. 125, OECD Publishing, Paris

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**

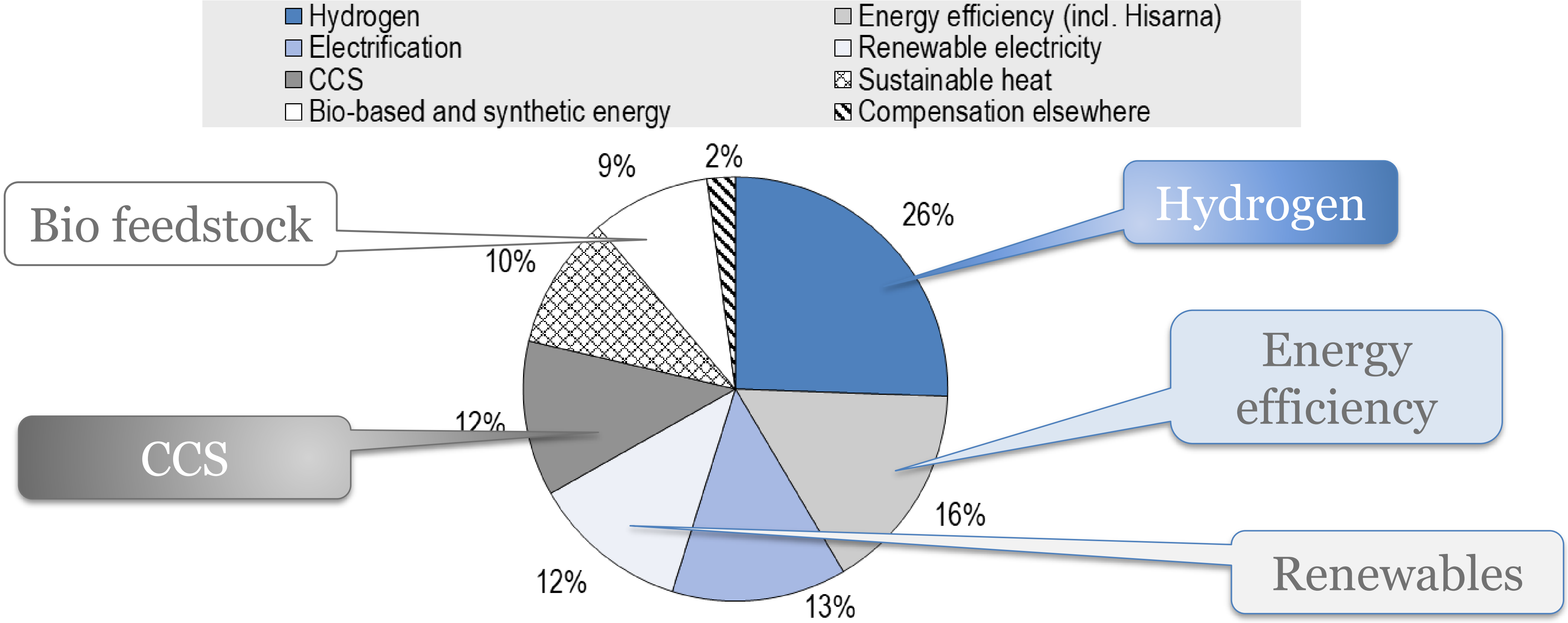
Share of CO2 emissions savings from mature and early-stage technologies in the IEA Net Zero scenario



Source: IEA 2021

Decarbonisation requires emerging technologies and breakthroughs: e.g. in Dutch industry

Role of various technologies in emission reductions in the Dutch manufacturing sector, 2015-50

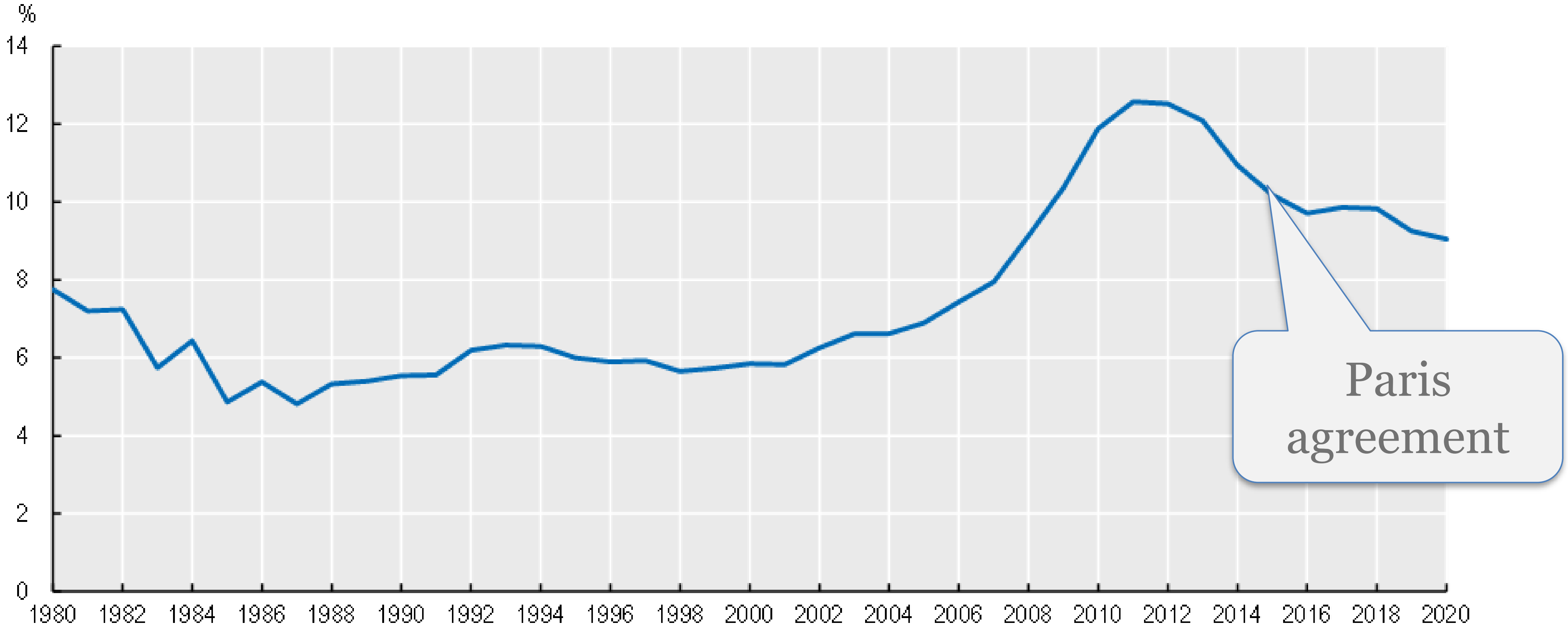


Source: OECD, Policies for a climate-neutral industry – lessons from the Netherlands, https://www.oecd.org/netherlands/policies-for-a-climate-neutral-industry-a3a1f953-en.htm

ARE WE MOVING FAST ENOUGH?

The pace of low-carbon innovation has slowed down

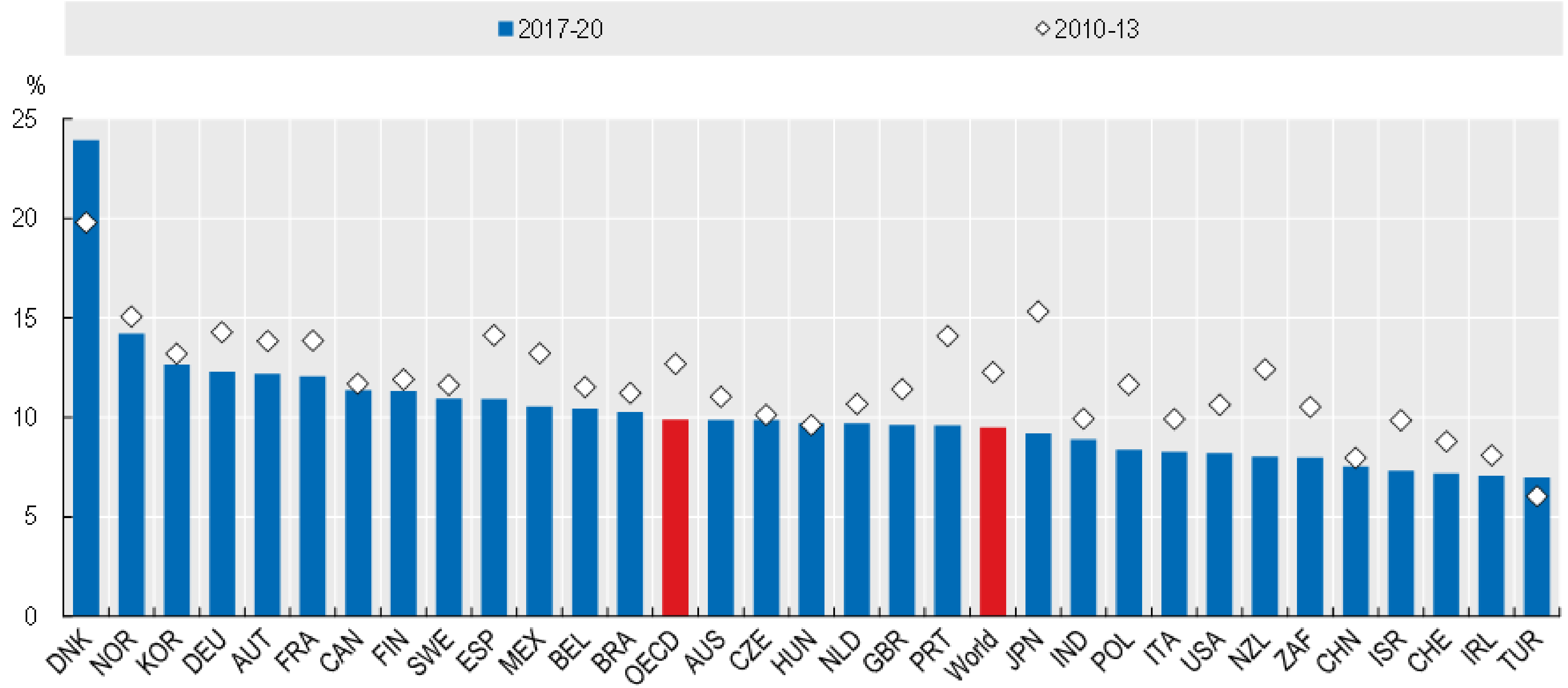
Share of climate mitigation patents in total patents, 1980-2020



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

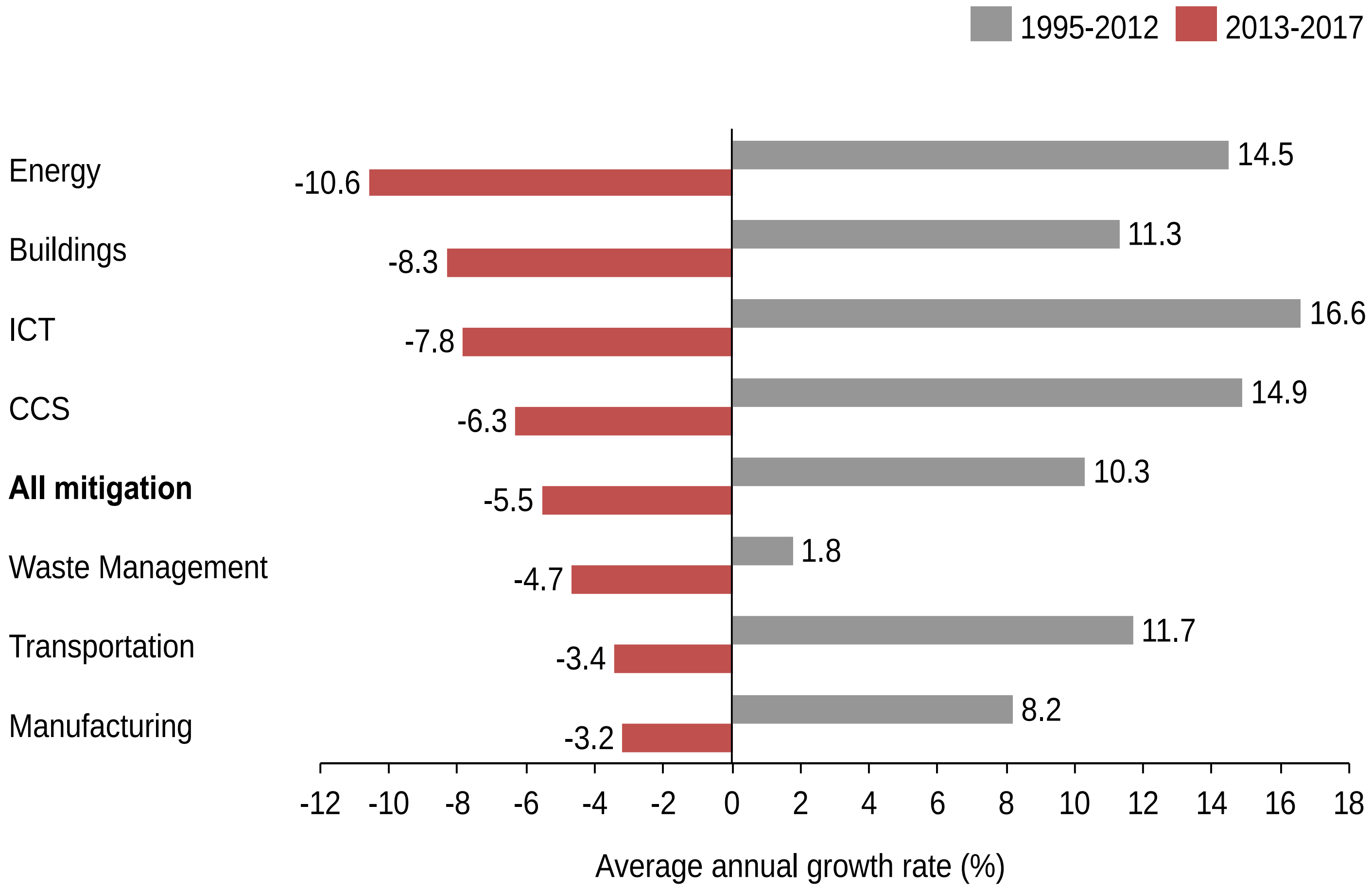
With a decrease across all major inventor countries

Climate-related technologies in the patent portfolio of countries, 2010-13 and 2017-20



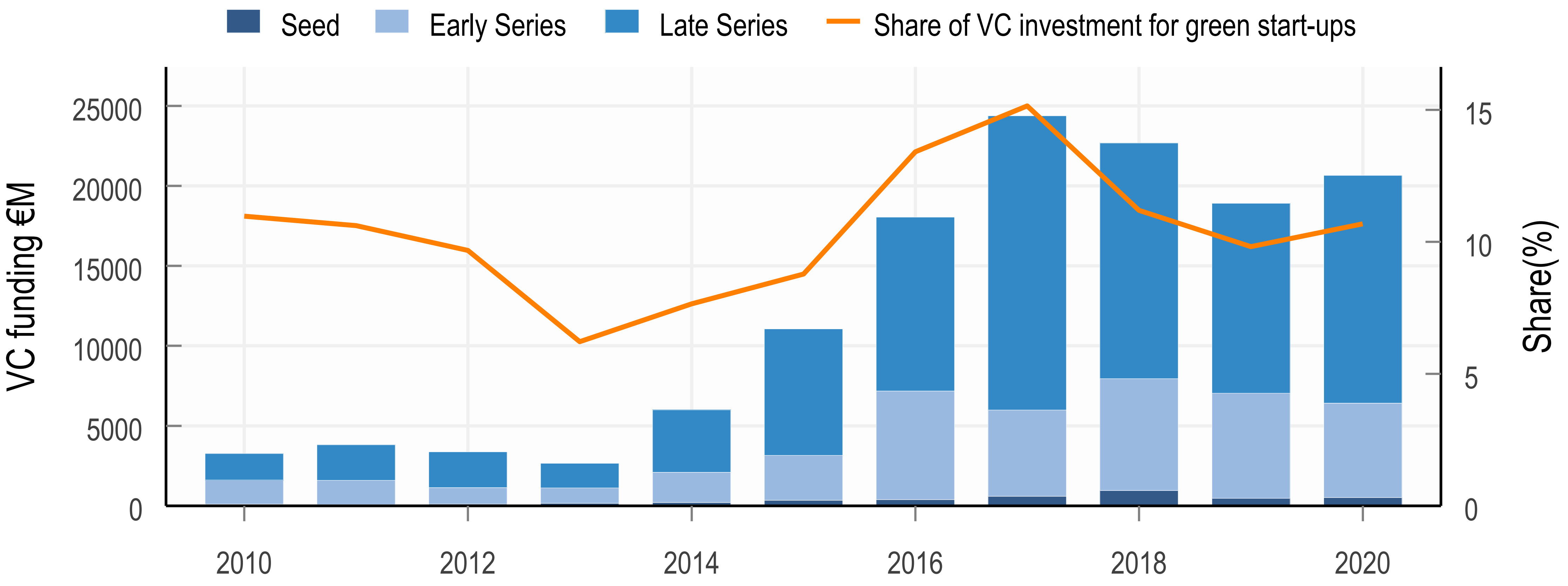
Source: OECD STI MicroData Lab, Worldwide Patent Statistical Database (PATSTAT), November 2022

And across all technology areas



Source: Probst, Touboul, Glachant, Dechezleprêtre, 2021. "Global trends in the invention and diffusion of climate change mitigation technologies," Nature Energy, Nature, vol. 6(11)

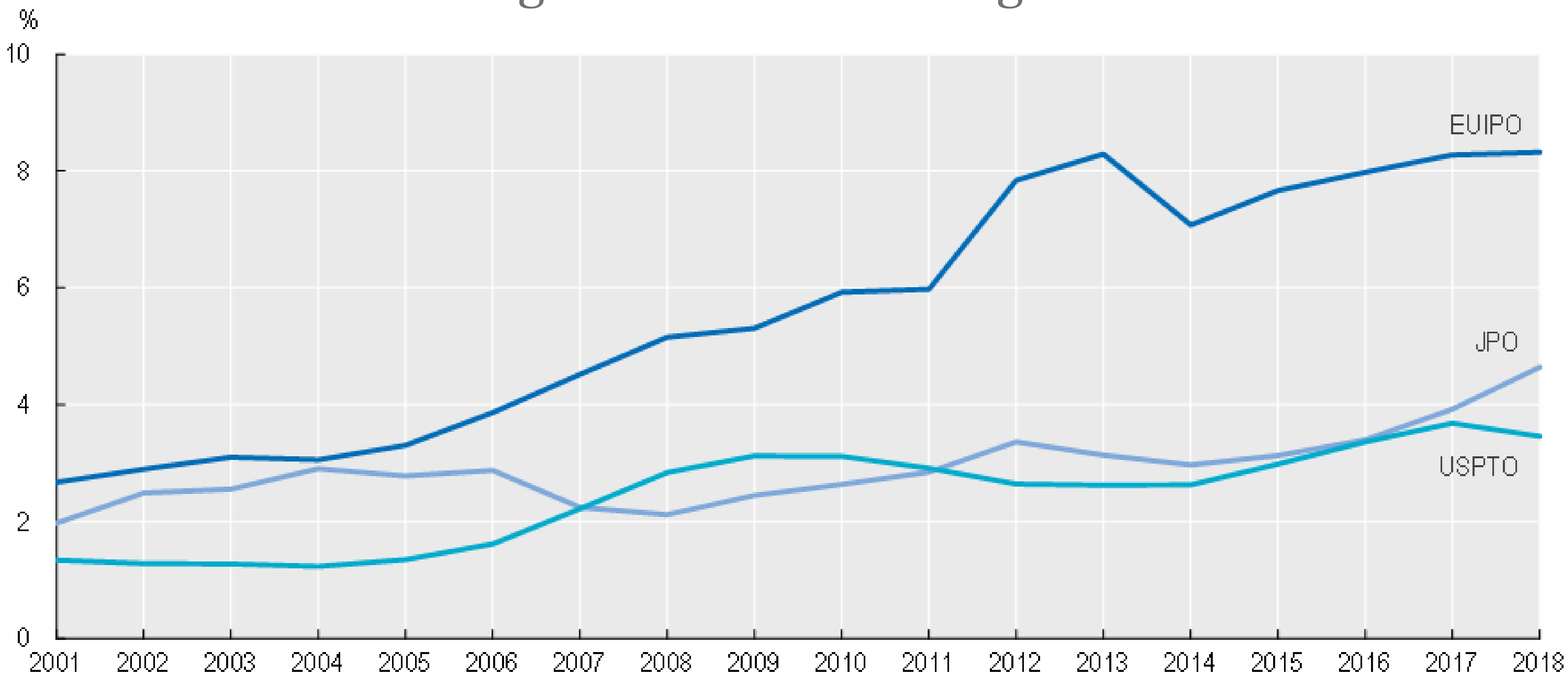
The volume and share of green Venture Capital has decreased recently



Source: OECD, based on Crunchbase and Dealroom data.

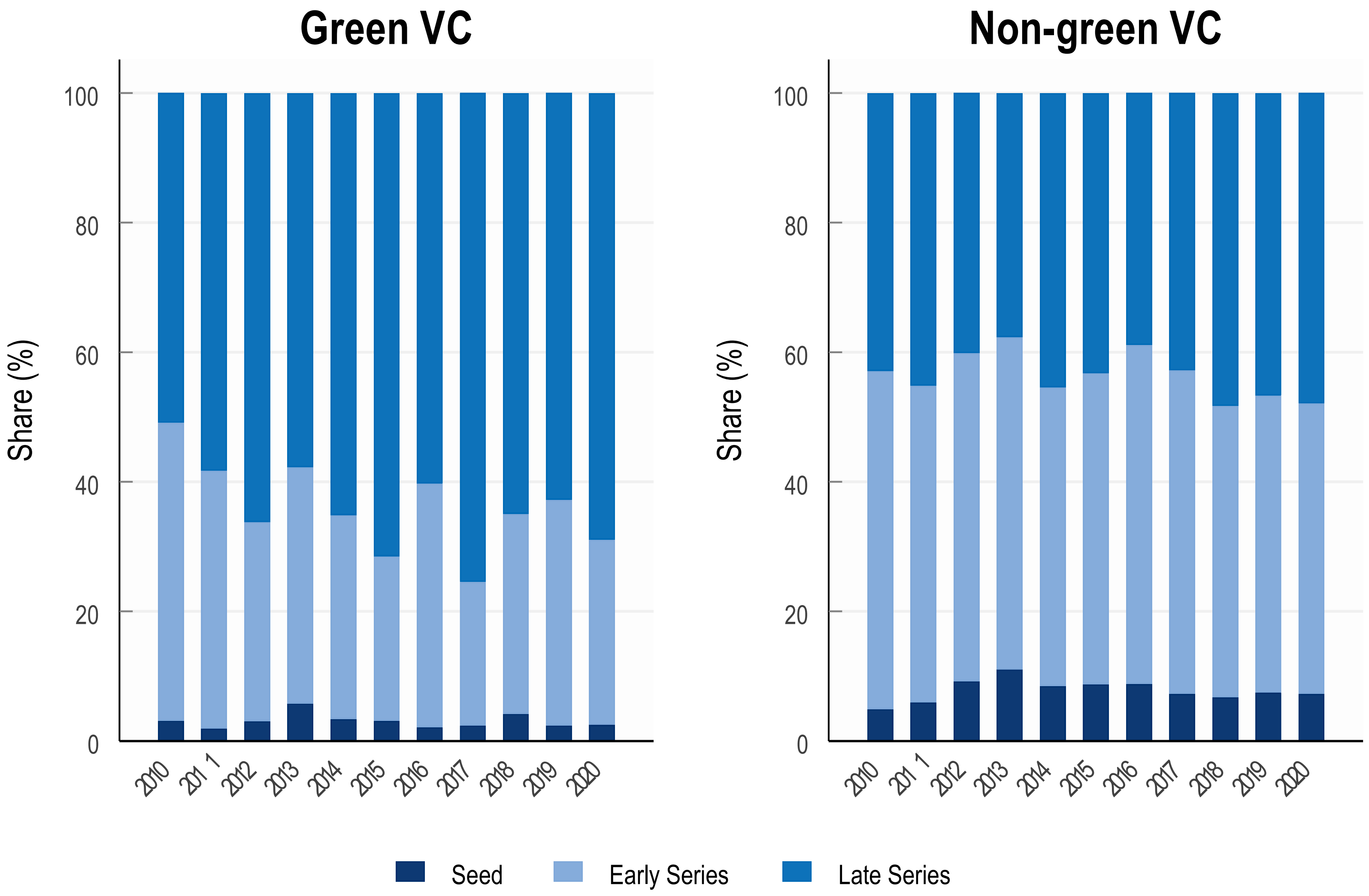
The filing of climate-related trademarks is growing, suggesting focus on diffusion of existing technologies

Trademark filings in climate-related goods and services



Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, October 2021

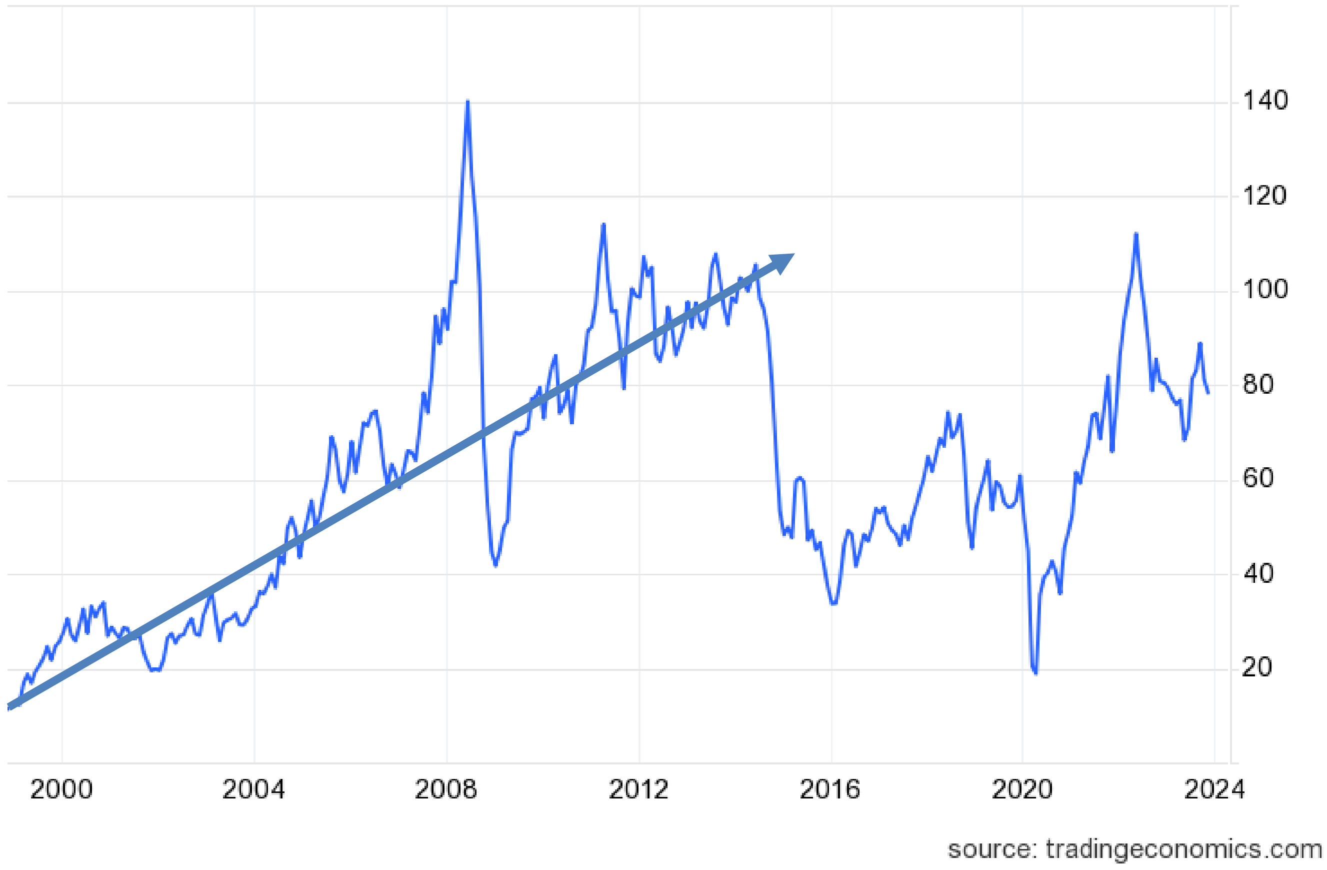
The share of seed funding is lower in green VC compared to non-green VC



WHY IS LOW-CARBON INNOVATION SLOWING DOWN?

6 years of low fossil fuel prices, after 15 years of price increases

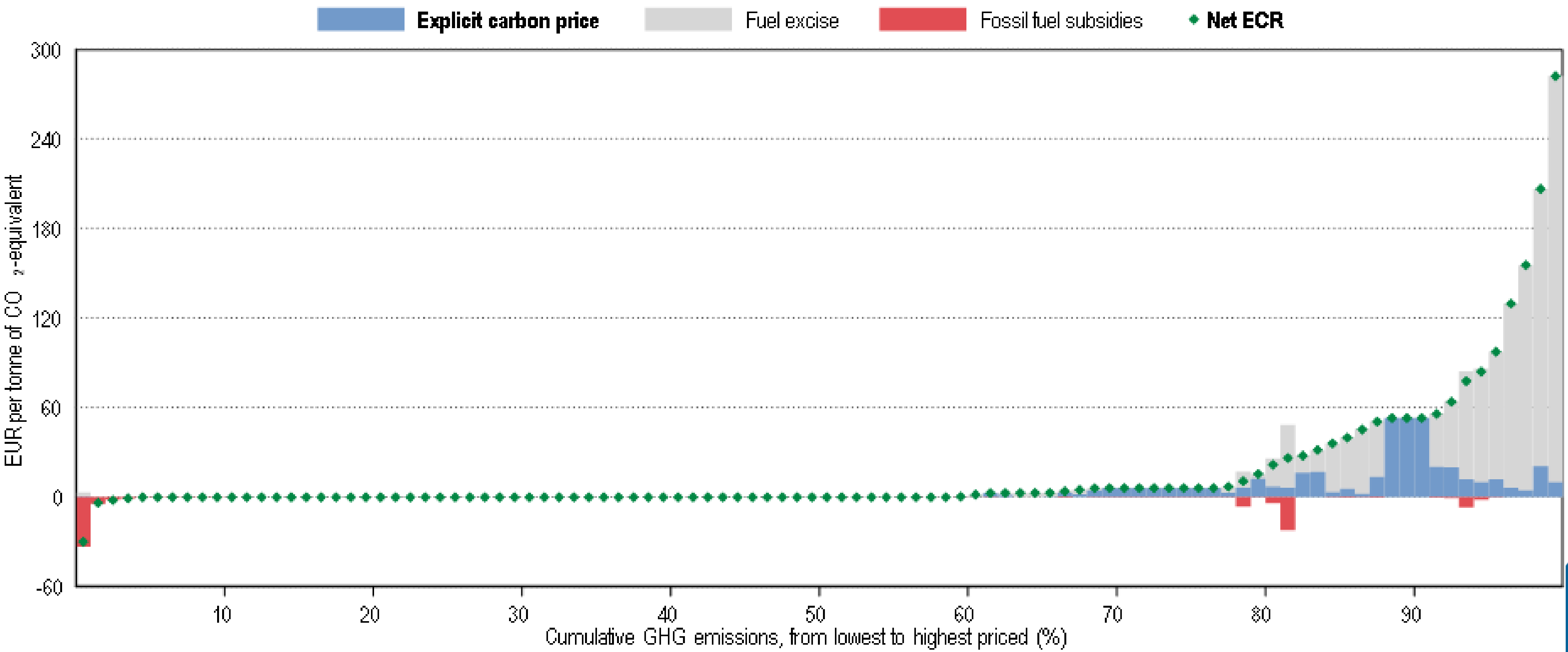
Crude Oil WTI (USD/Bbl), 1999-2023



Low carbon prices globally…

- 60% of carbon emissions not priced
- Only 10% priced at above 60 EUR/ton

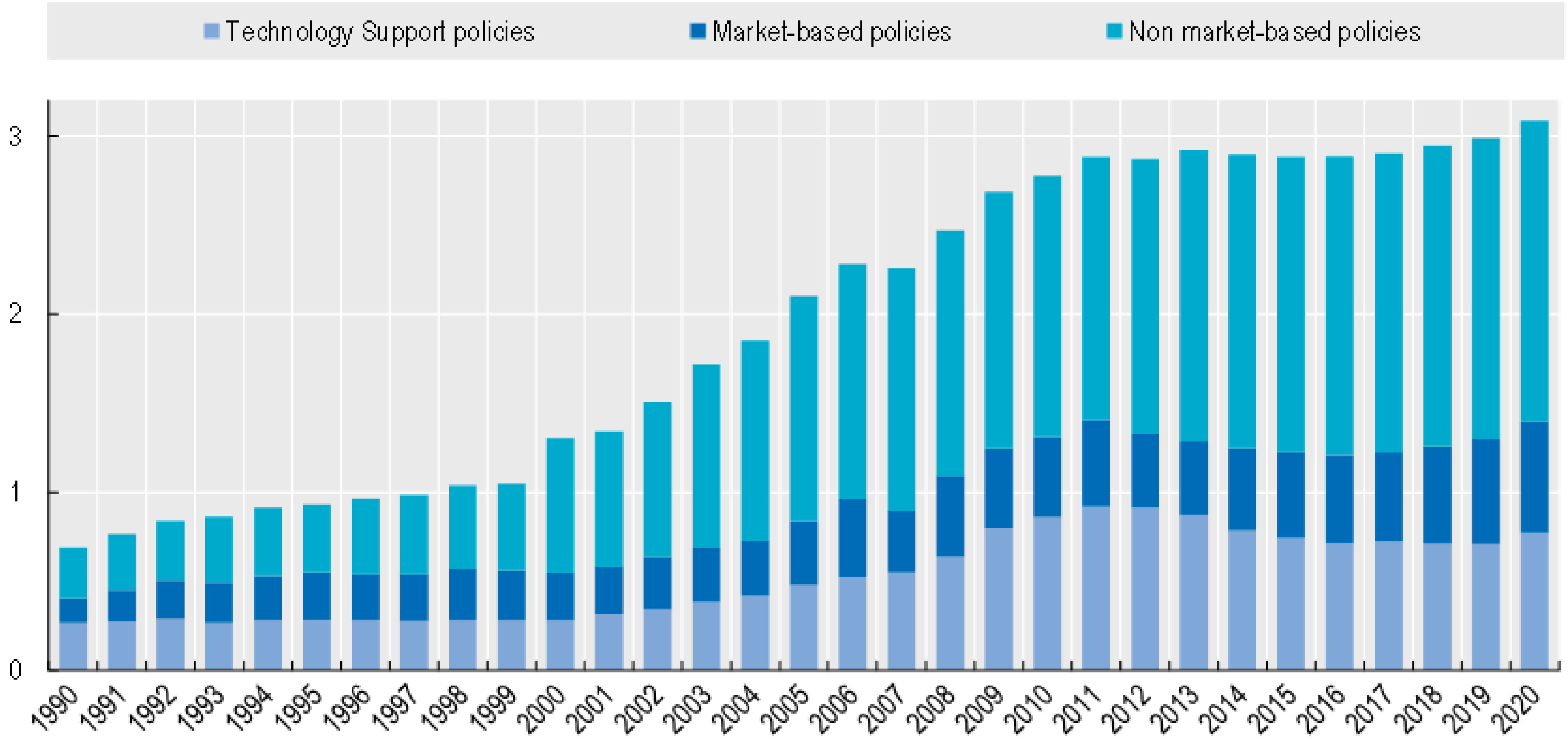
Carbon pricing in 44 OECD and G20 countries, 2021



Source: OECD Effective Carbon Rates (2021)

Slowdown in growth of climate policy stringency…

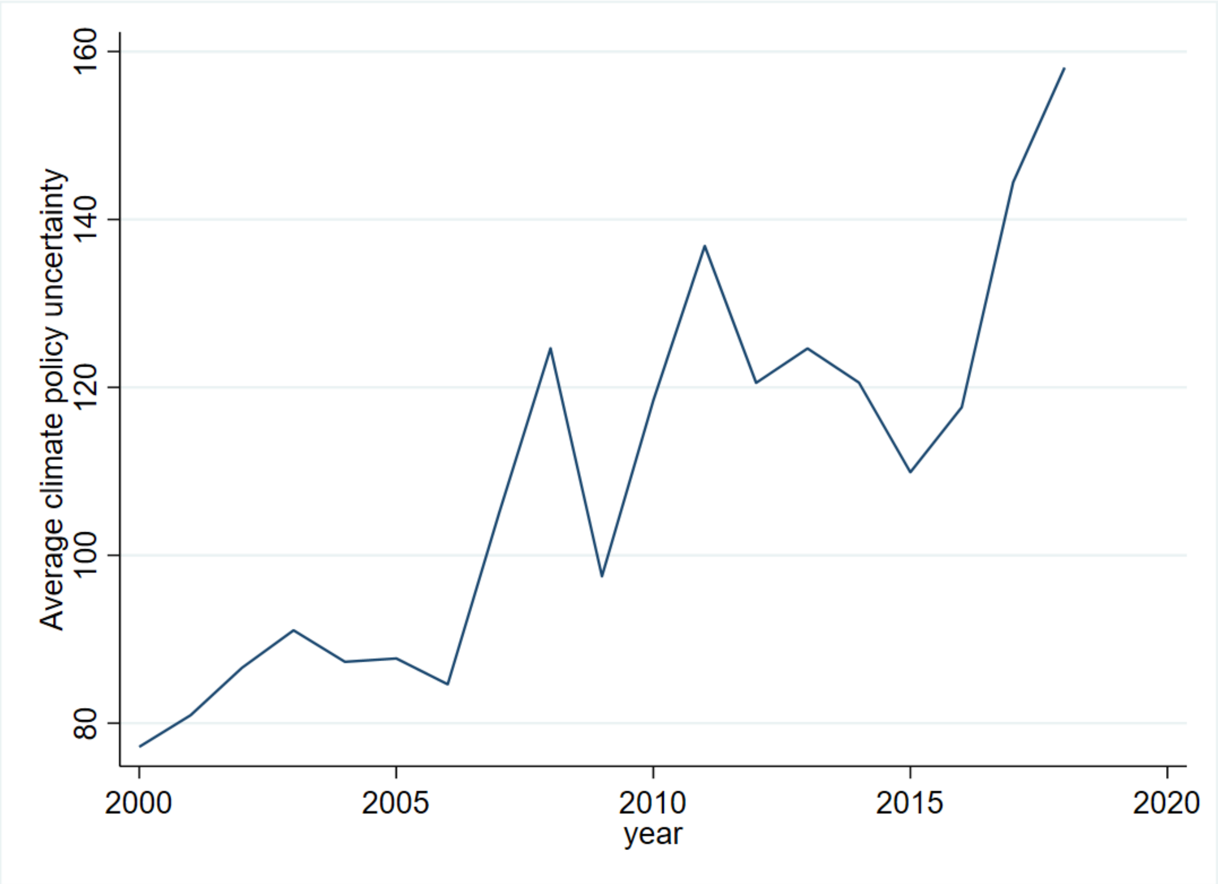
Climate policy stringency in OECD countries, 1990-2020

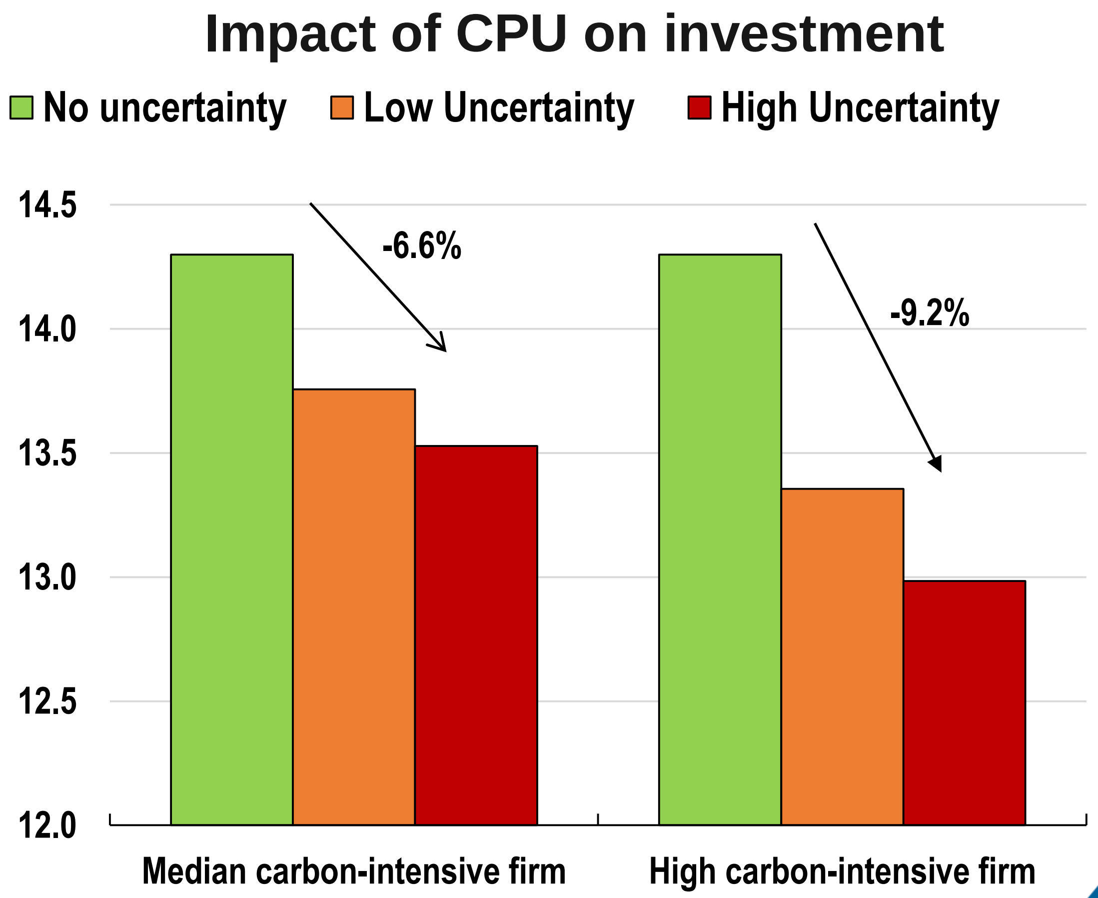


Source: OECD Environmental Policy Stringency indicator (2022)

Increasing climate policy uncertainty

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

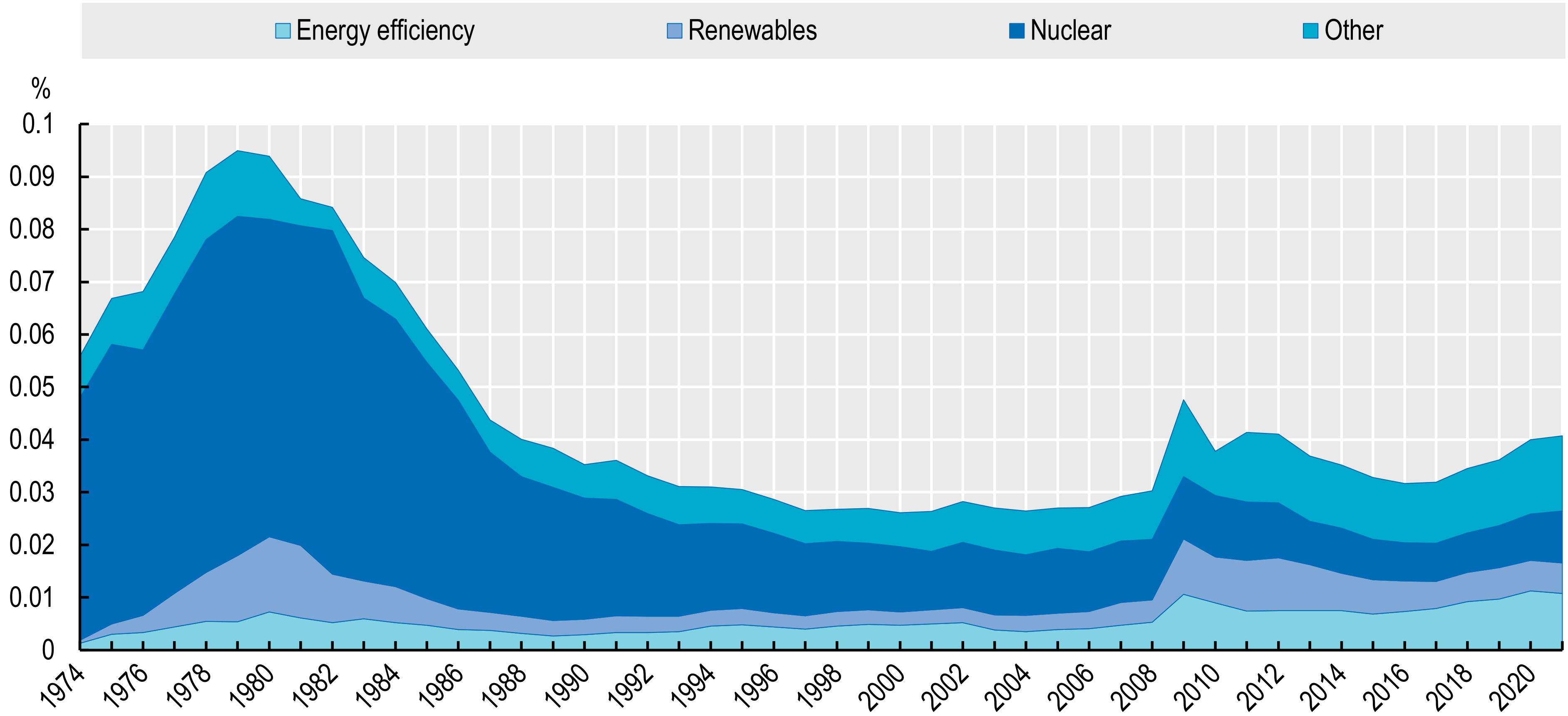




Source: Berestycki, C. et al. (2022), "Measuring and assessing the effects of climate policy uncertainty", OECD Economics Department Working Papers, No. 1724

Insufficient public support for R&D …

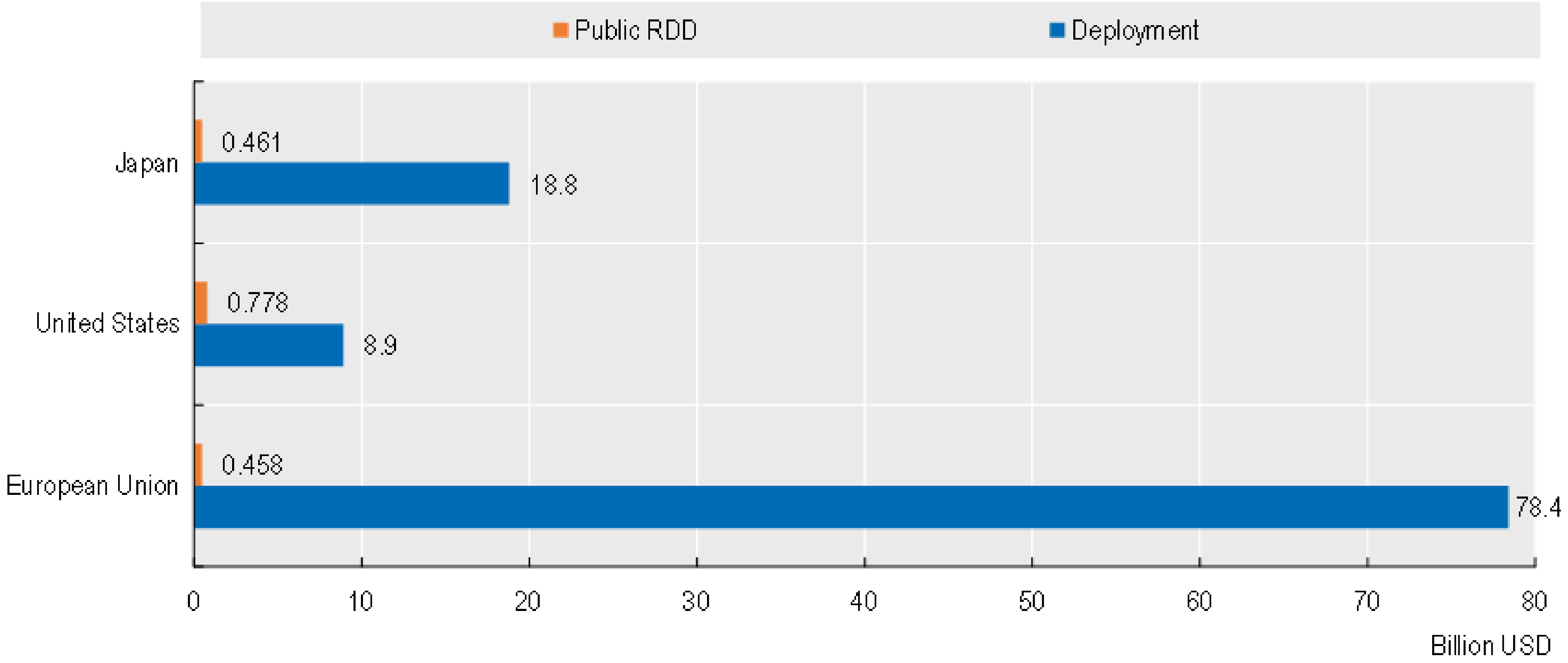
Low-carbon public R&D expenditures in GDP, 1974-2021



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

...compared to large support for deployment (e.g. renewables)

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



Source: IEA (RD&D); IRENA (deployment)

THE CASE FOR LOW-CARBON INNOVATION & INDUSTRIAL POLICIES

STI policies are widely socially accepted, making them politically attractive

- Support to various climate policies (results from global OECD survey, 2000 respondents per country):

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

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

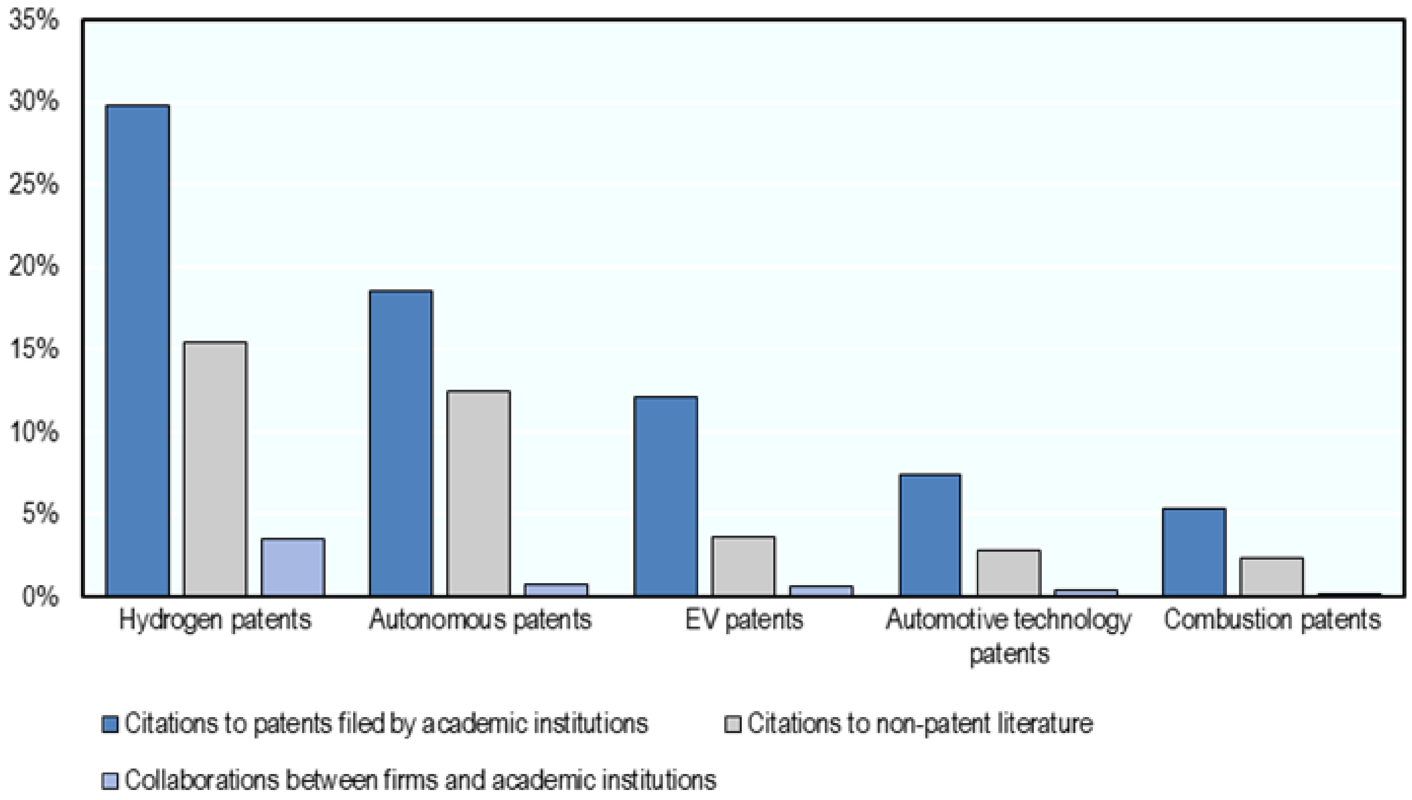
Source: Dechezleprêtre, A. et al. (2022), "Fighting climate change: International attitudes toward climate policies", OECD Economics Department Working Papers, No. 1714

Multiple barriers impede low-carbon innovation

- Market failures on top of environmental externality: knowledge spillovers, learning-by-doing, information asymmetries, financial constraints
- Inertia and systemic barriers, including path-dependence & limitations to competition
- Lack of capabilities
- Government failures eg policy uncertainty

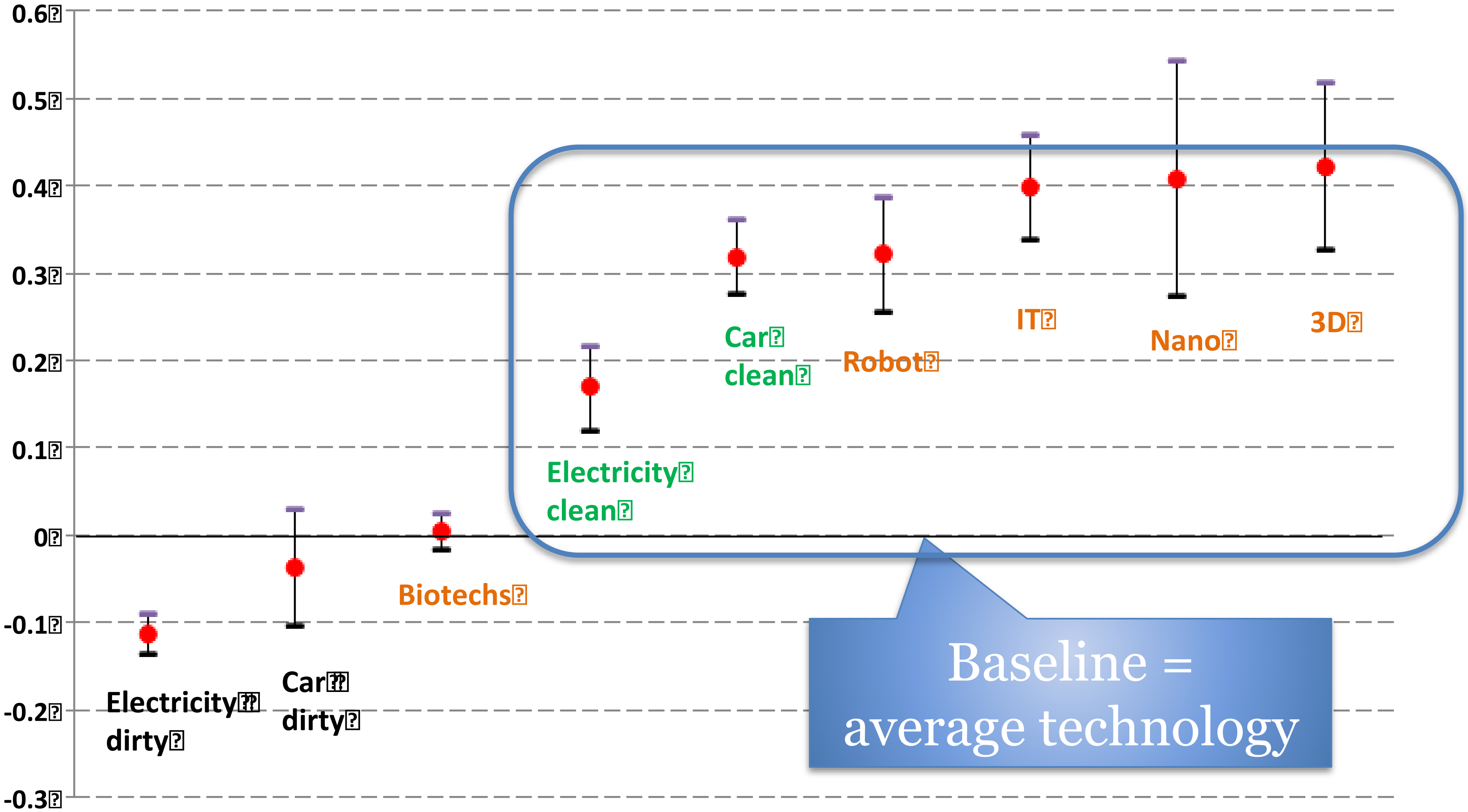
Low-carbon innovations rely on scientific research more than fossil-based innovations

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.

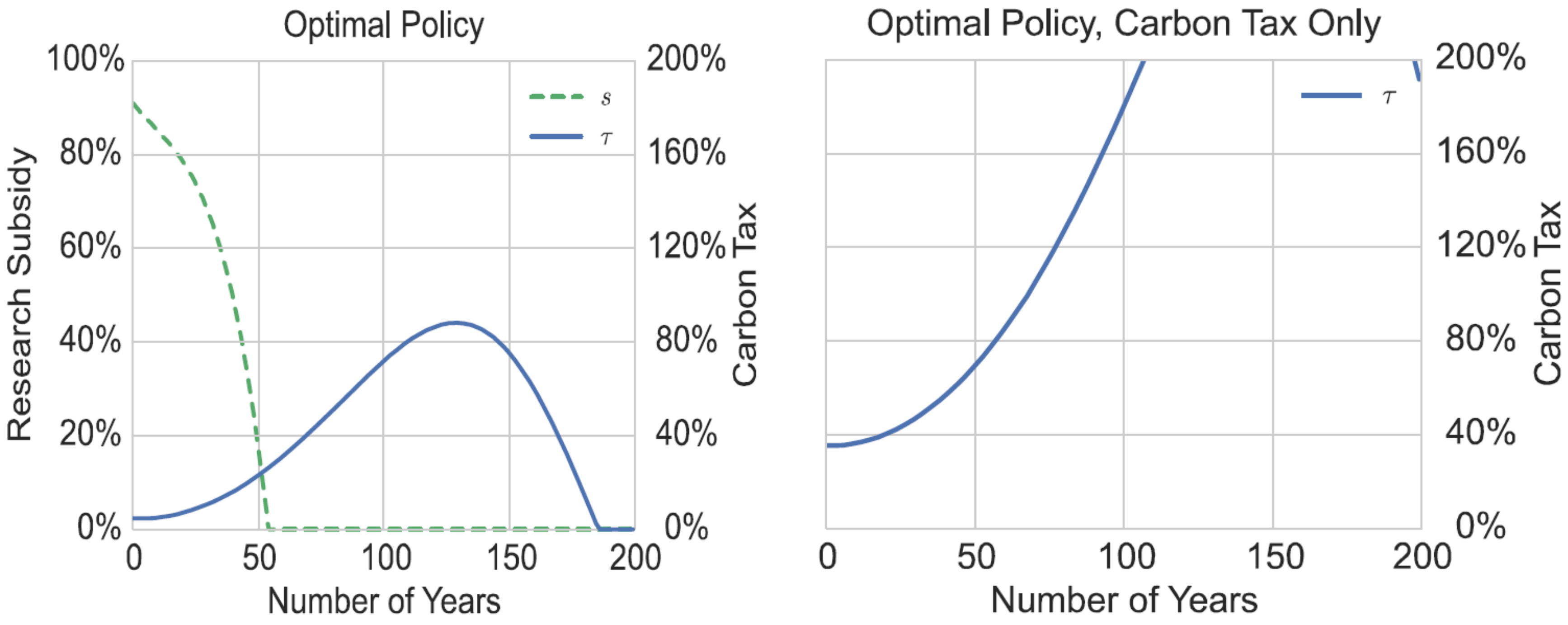
Large knowledge spillovers in clean tech (as in other emerging fields)



Source: Dechezleprêtre, A., R. Martin and M. Mohnen (2014), "Knowledge spillovers from clean and dirty technologies", CEP Discussion Papers, No. CEPDP1300, LSE, London, http://eprints.lse.ac.uk/60501/

Innovation policies reduce the cost of reaching climate objectives

Subsidies to clean research allow for much smaller carbon taxes



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

Making STI&I policies a cornerstone of climate policies

- Reducing costs to make carbon-free technologies competitive with their high-carbon alternatives should be a primary objective of climate policy
- Innovation and industrial policies should constitute a cornerstone of strategies to reach carbon neutrality
  - Theoretical justifications very strong
  - Can partially substitute for low carbon prices and support carbon pricing
  - Can facilitate the adoption of more ambitious climate policies
  - Can boost international technology diffusion to emerging economies

DID COVID-19 GREEN STIMULUS PACKAGES HELP?

The OECD Low-Carbon Technology Support Database

1.166 measures

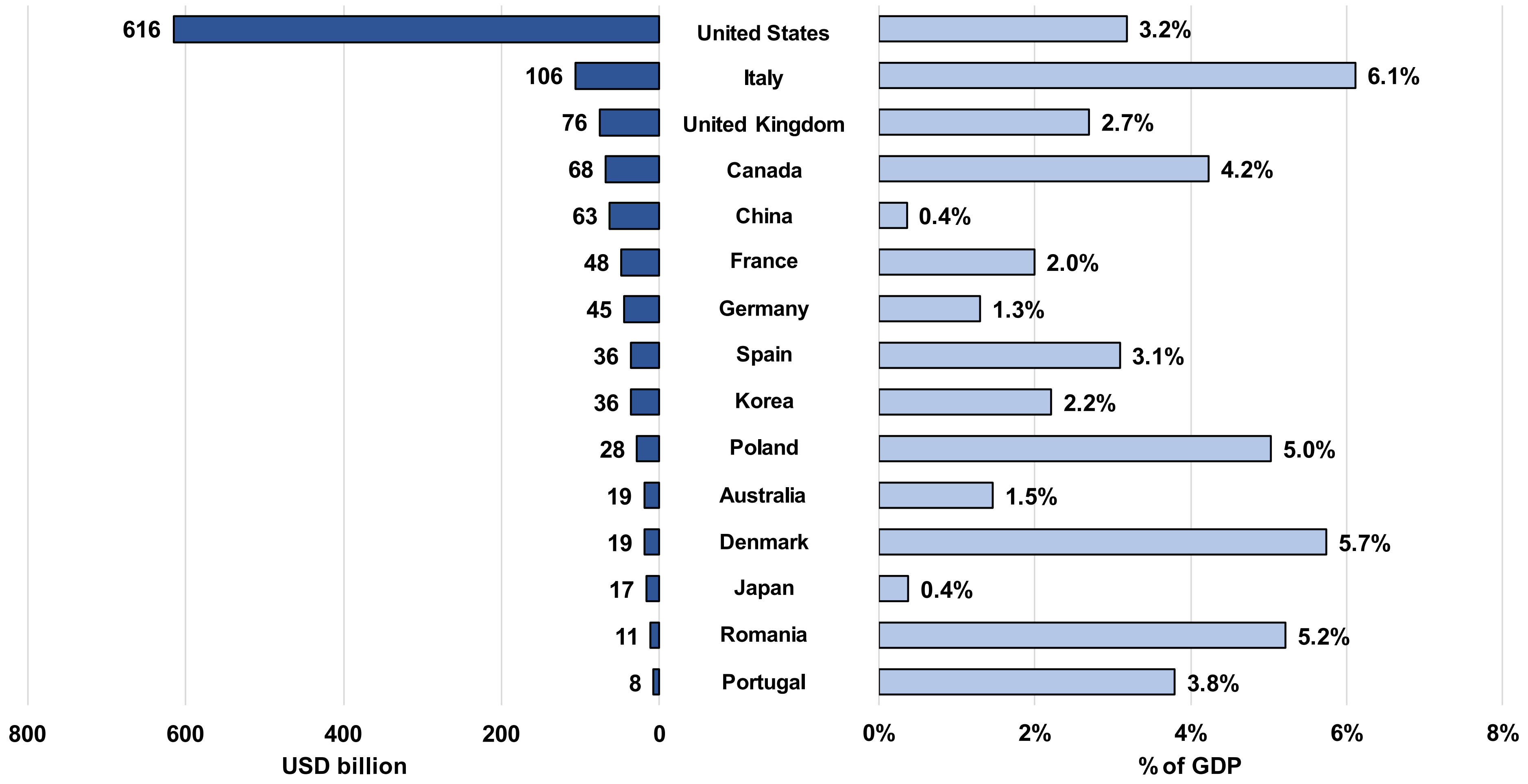
1.29 trillion USD announced spending on low-carbon technologies (2% of one year of GDP on average)

51 countries + EU (89% of global GDP, 79% of global emissions)

Announced in 2020-2021 + updates (eg US Inflation Reduction Act, EU's Recovery and Resilience Plans)

Extensive verification + validation by delegates to the OECD Committee on Industry, Innovation, and Entrepreneurship (CIIE) and to the Committee on Science and Technology Policy (CSTP)

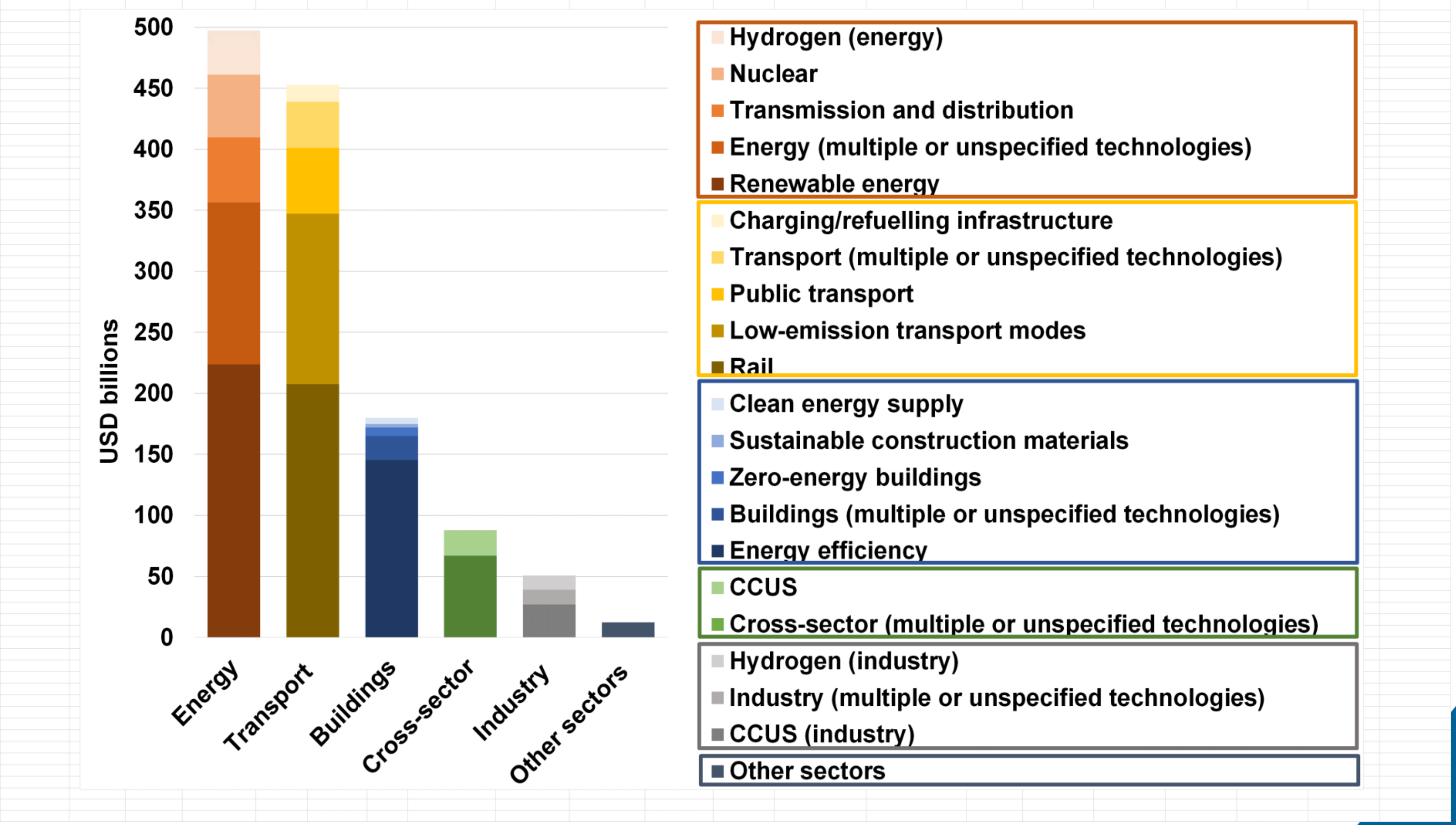
Spending by country



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.

Energy and transportation received most of the funding

- Most spending in energy (39%) and transport (35%):
  - renewable energy
  - railway expansion
  - Electric vehicles
- 14% to the buildings sector (energy efficiency: subsidies to renovation, heat pumps)
- 7% to cross-sector techs (eg CCUS)
- Industry 4%



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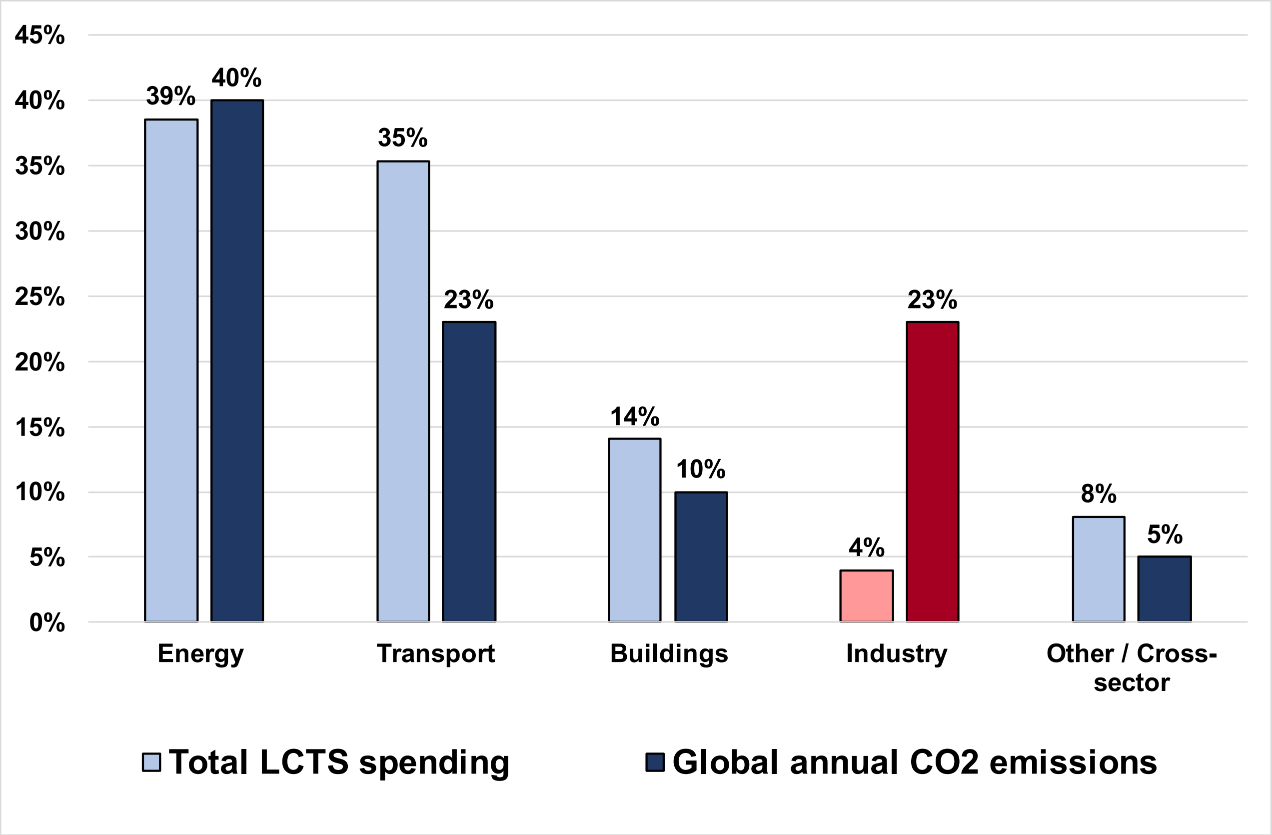
Compared to current GHG emissions, industry appears underfunded

- Energy, transportation, buildings broadly in line with emissions share
- **Industry**: 23% of global annual GHG emissions, 4% of funding



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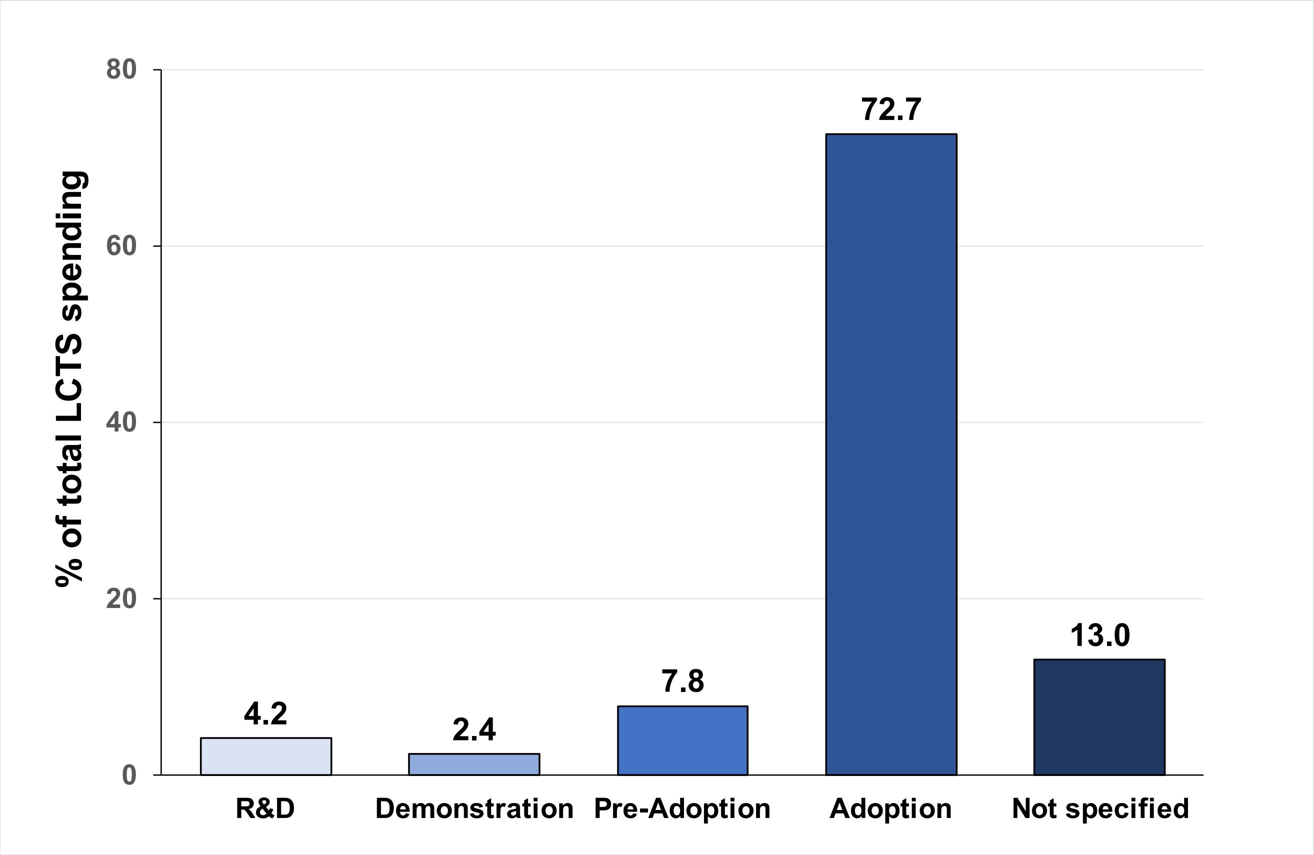
Adoption of mature technologies receives much greater support than RD&D

- **Most funding is channeled towards adoption and deployment of mature technologies**
- R&D receives 4.2% of total funding, demonstration 2.4%, other emerging techs (pre-adoption) 7.8%
- Ratio of RD&D against adoption is 1:5; literature suggests 1:1 or 1:2 optimal



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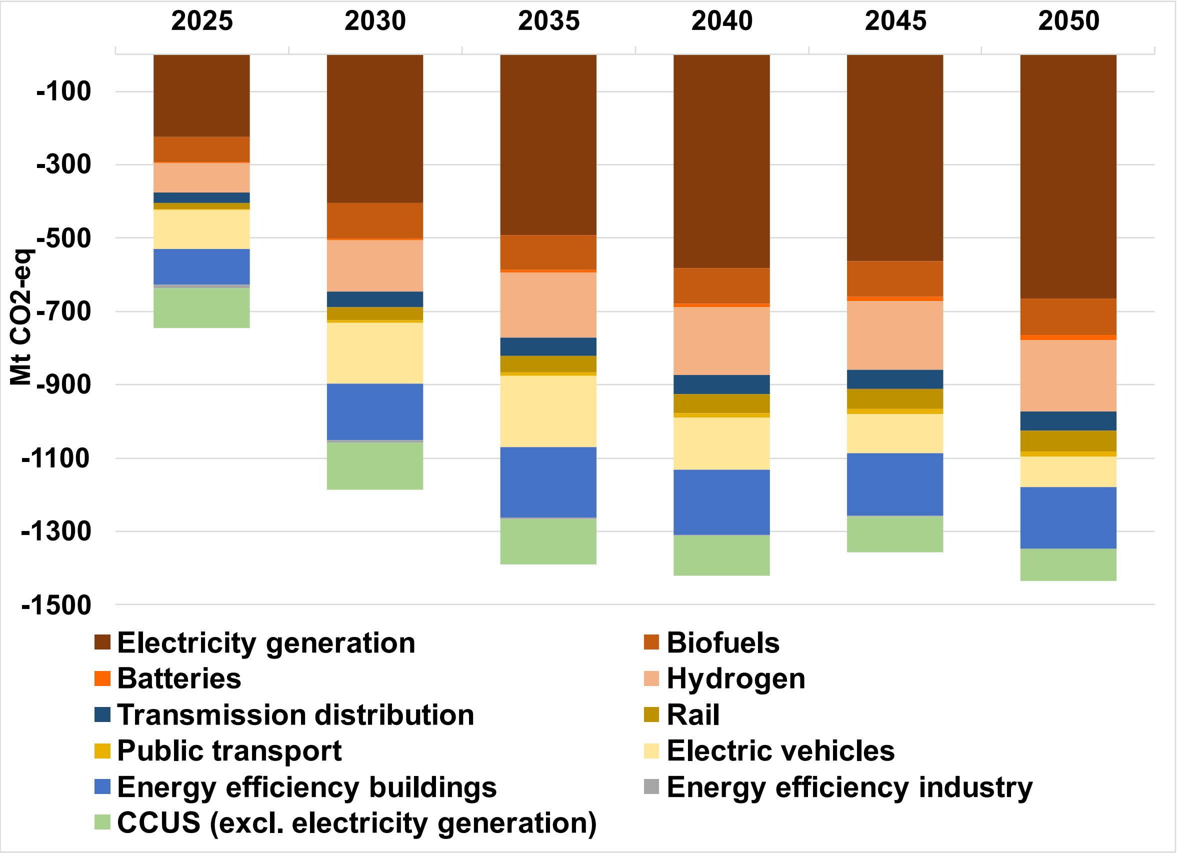
Emissions go down by 10% in OECD + EU

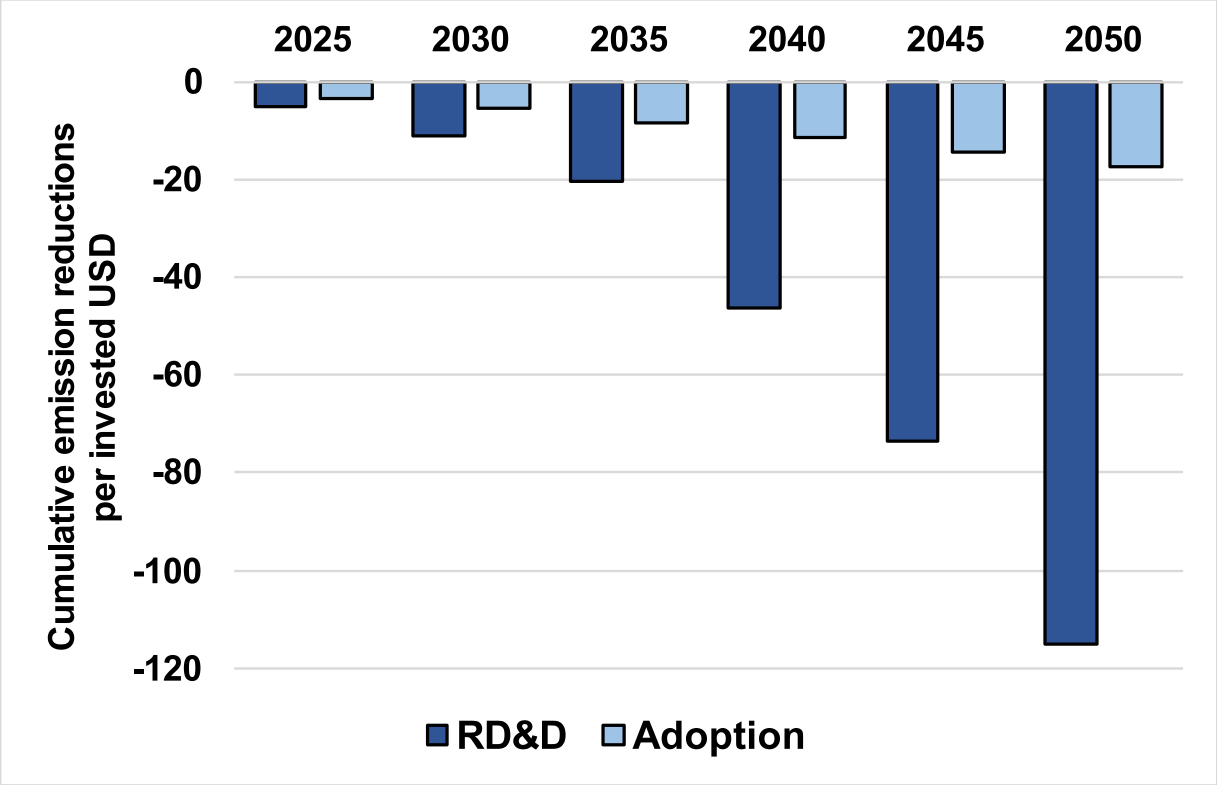
- GHG emissions are reduced by 1150 Mt CO2-eq in 2030 (-9%) and 1400 Mt CO2-eq in 2050 (-11%) in OECD and EU countries, compared to the Reference Scenario
- Half of the GHG emissions reductions comes from investments in electricity generation (esp. renewable energy)
- Investments in hydrogen and energy efficiency in buildings also make important contributions



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.

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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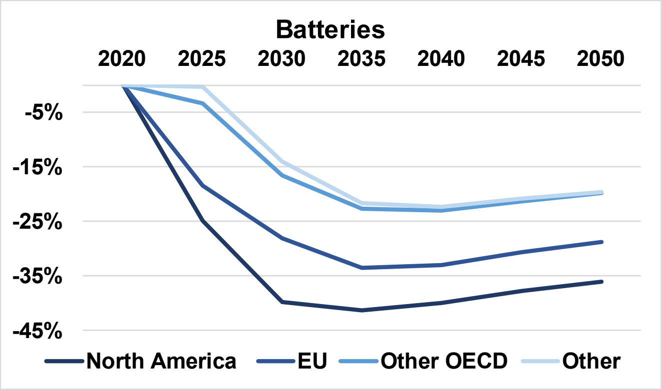
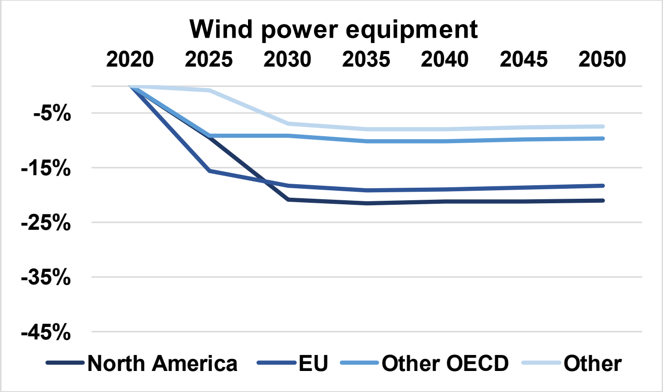
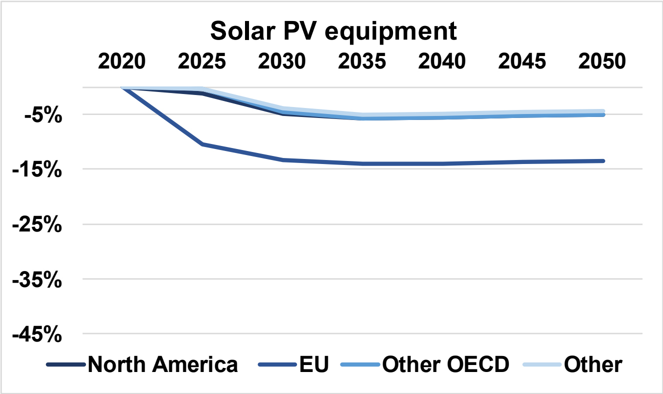
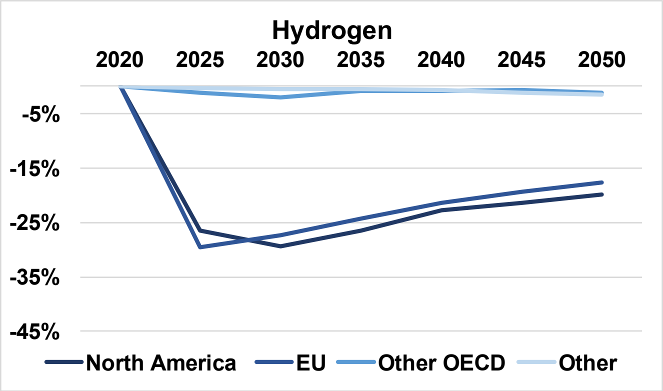
Clean tech support leads to significant cost decreases

- 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





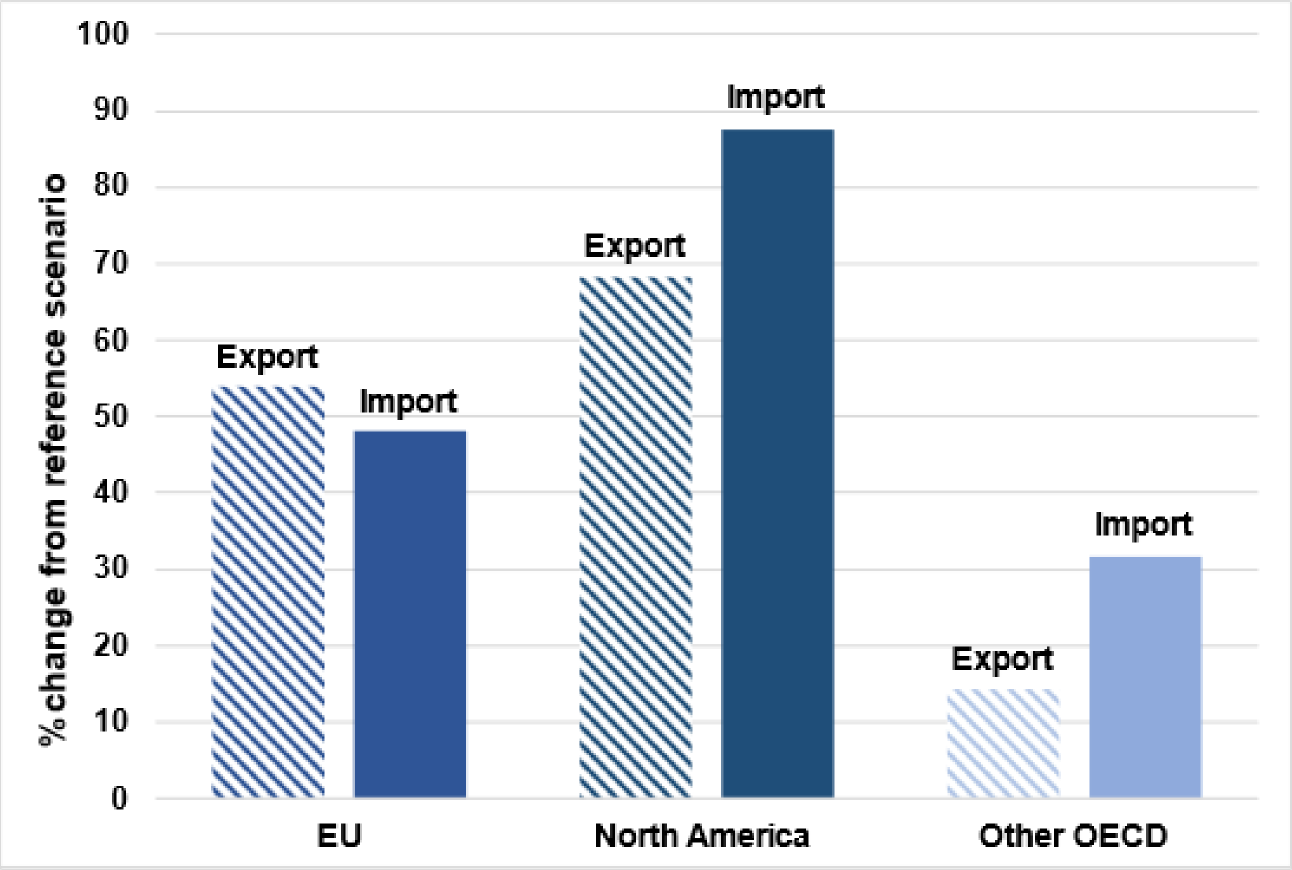




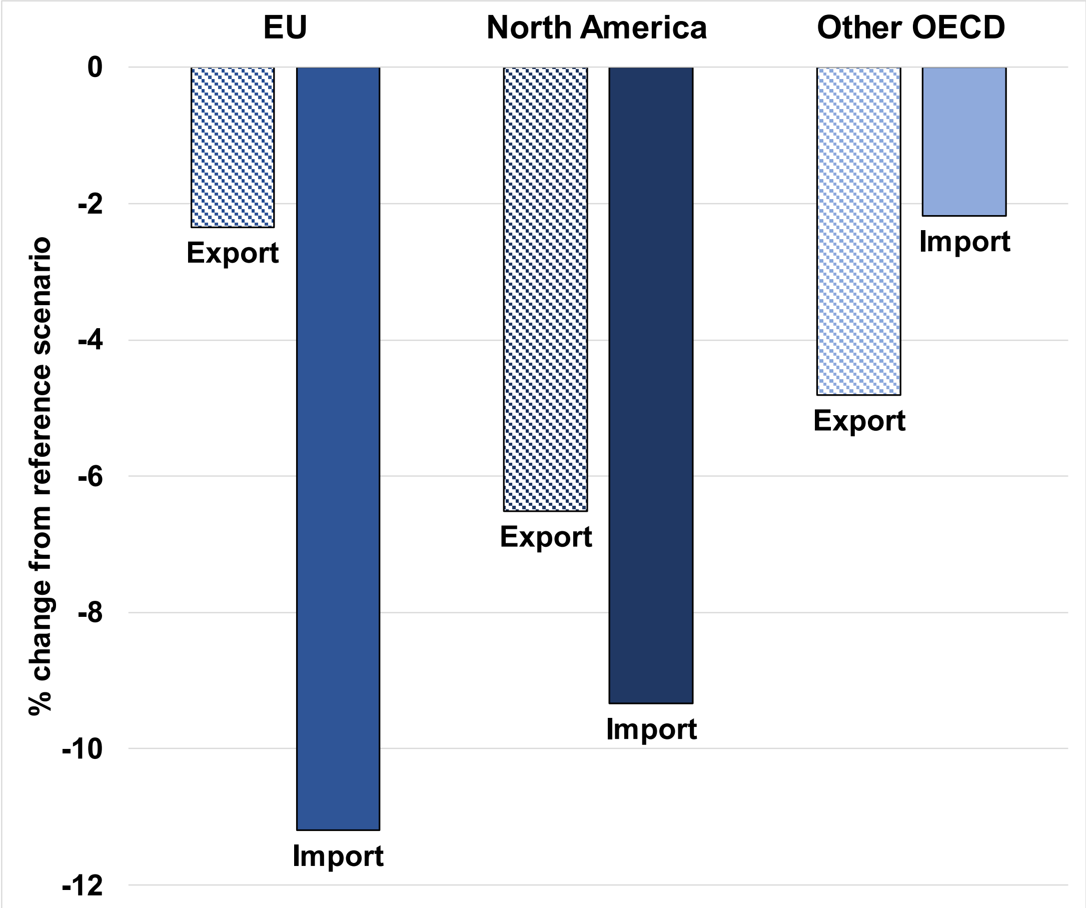
Source: Aulie, F., et al. (2023), "Did COVID-19 accelerate the green transition?: An international assessment of fiscal spending measures to support low-carbon technologies", OECD STI Policy Paper No. 151, https://doi.org/10.1787/5b486c18-en.

Green fiscal spending boosts clean sectors and reduces fossil fuel imports

Change in exports and imports of climate technology equipment 2021-2030



Changes in exports and imports of fossil fuel 2021-2030



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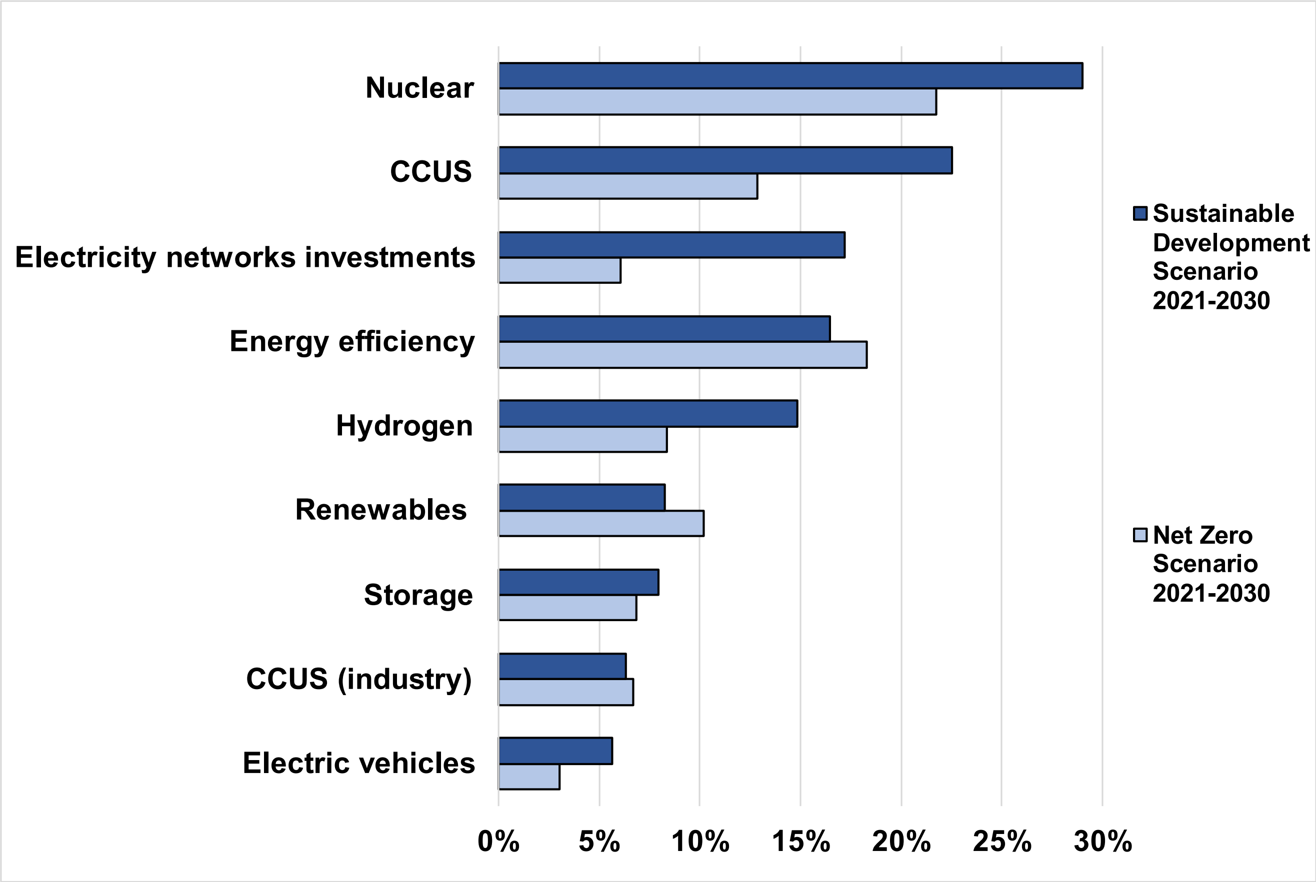
But the climate investment gap remains large

- Significant contribution to investment needs for nuclear energy, CCUS and energy efficiency
- Low contribution for renewable energy, CCUS in industry and electric vehicles
- **A substantial investment gap remains**: private sector investment is critical



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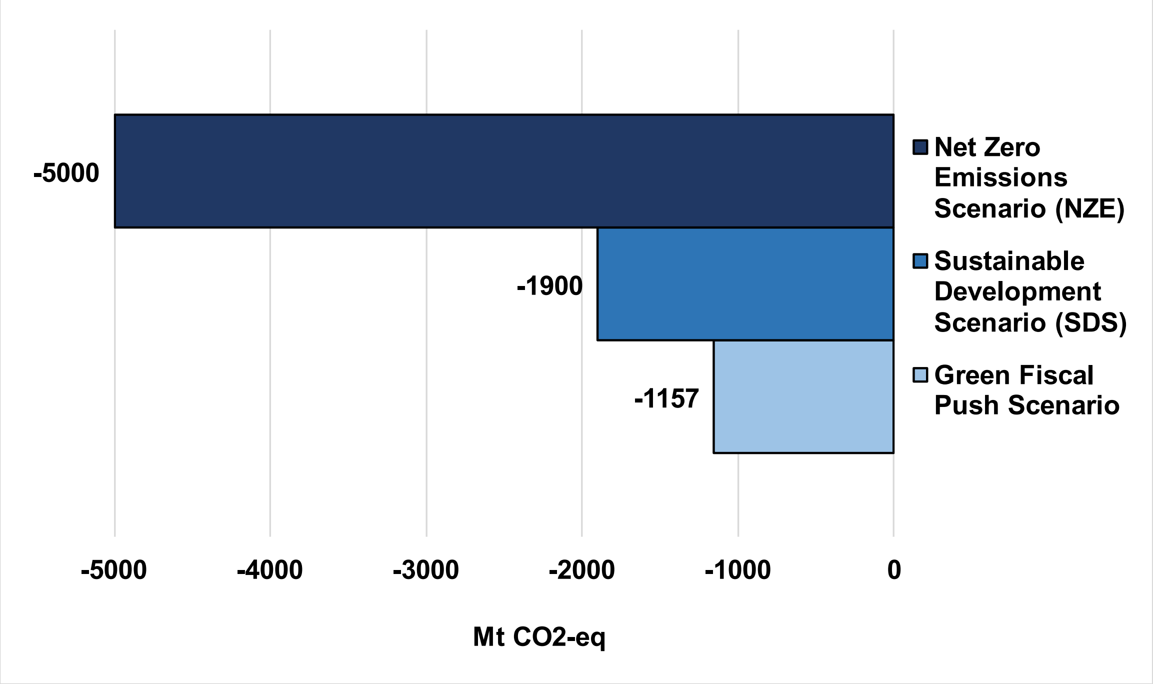
And more is needed to meet Net Zero targets

- Projected GHG emissions reductions account for 23% of the reductions required by 2030 to reach net-zero emissions by 2050
- But over 2 thirds of less ambitious targets (SDS scenario)



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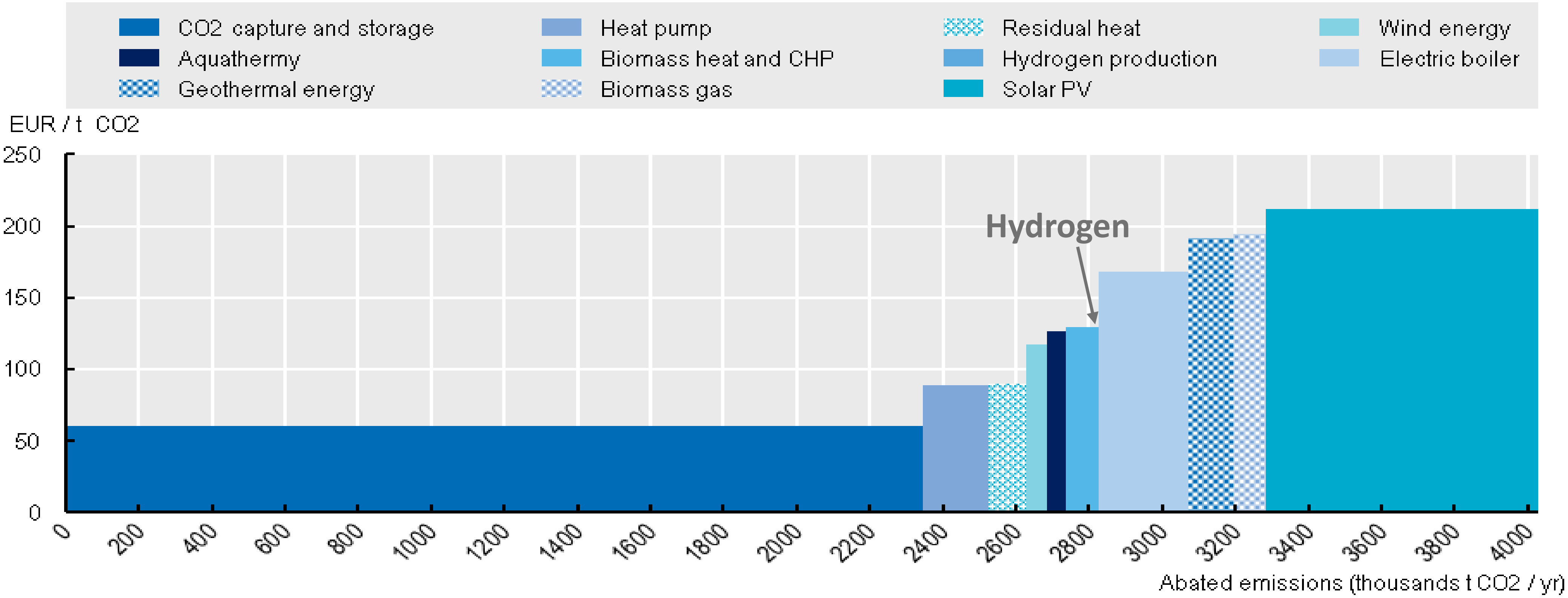
WHAT CAN GOVERNMENTS DO?

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.

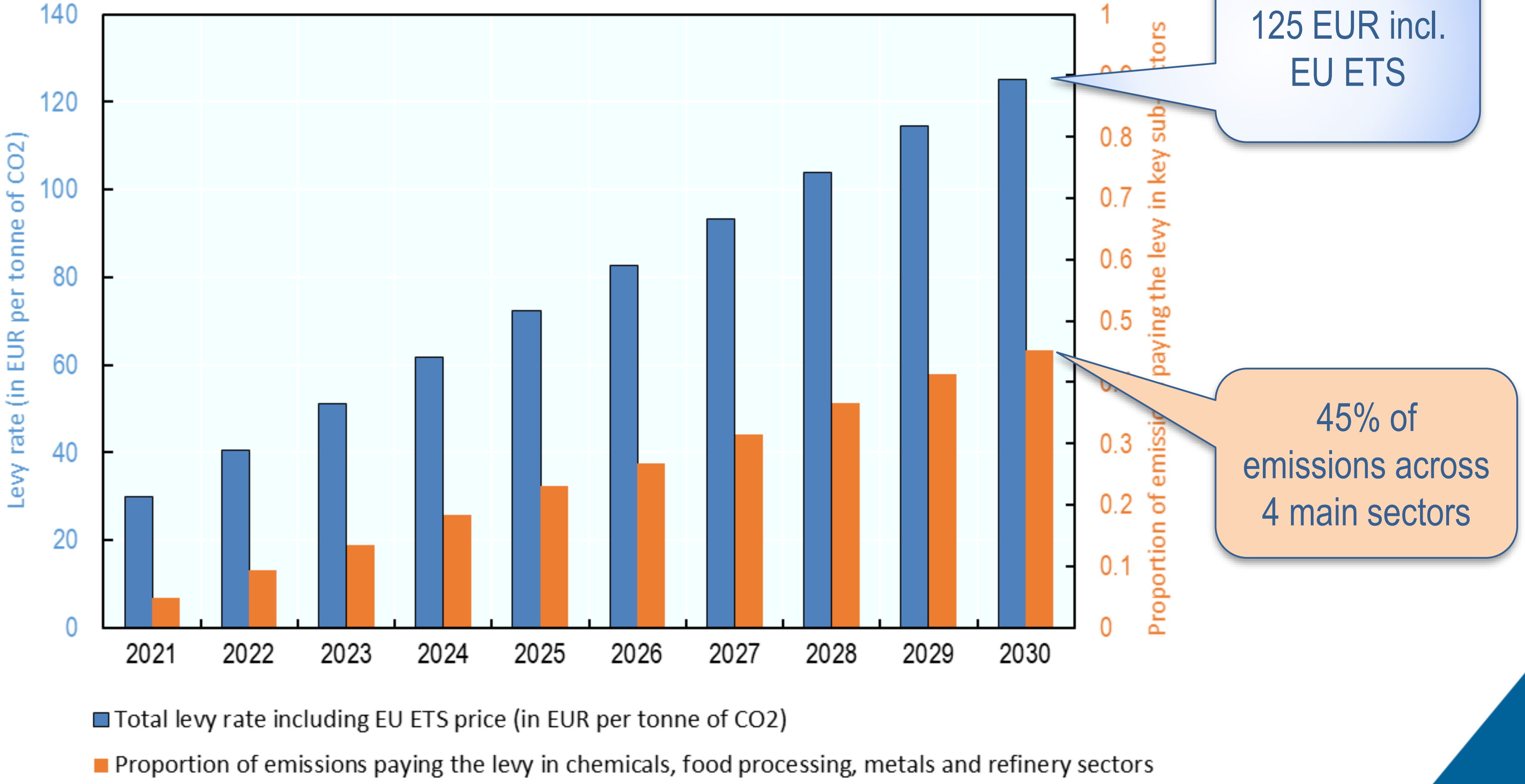
Provide clear indication on direction of change

- Carbon pricing (to ensure fossil prices won’t go back down) and removal of fossil fuel subsidies
- Reduce policy uncertainty
- Stir **demand** for low-carbon technologies
  - Product **standardisation** (e.g. green hydrogen, sockets for EVs, etc.)
  - **Regulation** (e.g. heating, buildings, emissions standards, recycled content, bio-based products)
  - Public procurement

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

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

Levy rate 2021-2030 and estimated proportion of emissions covered



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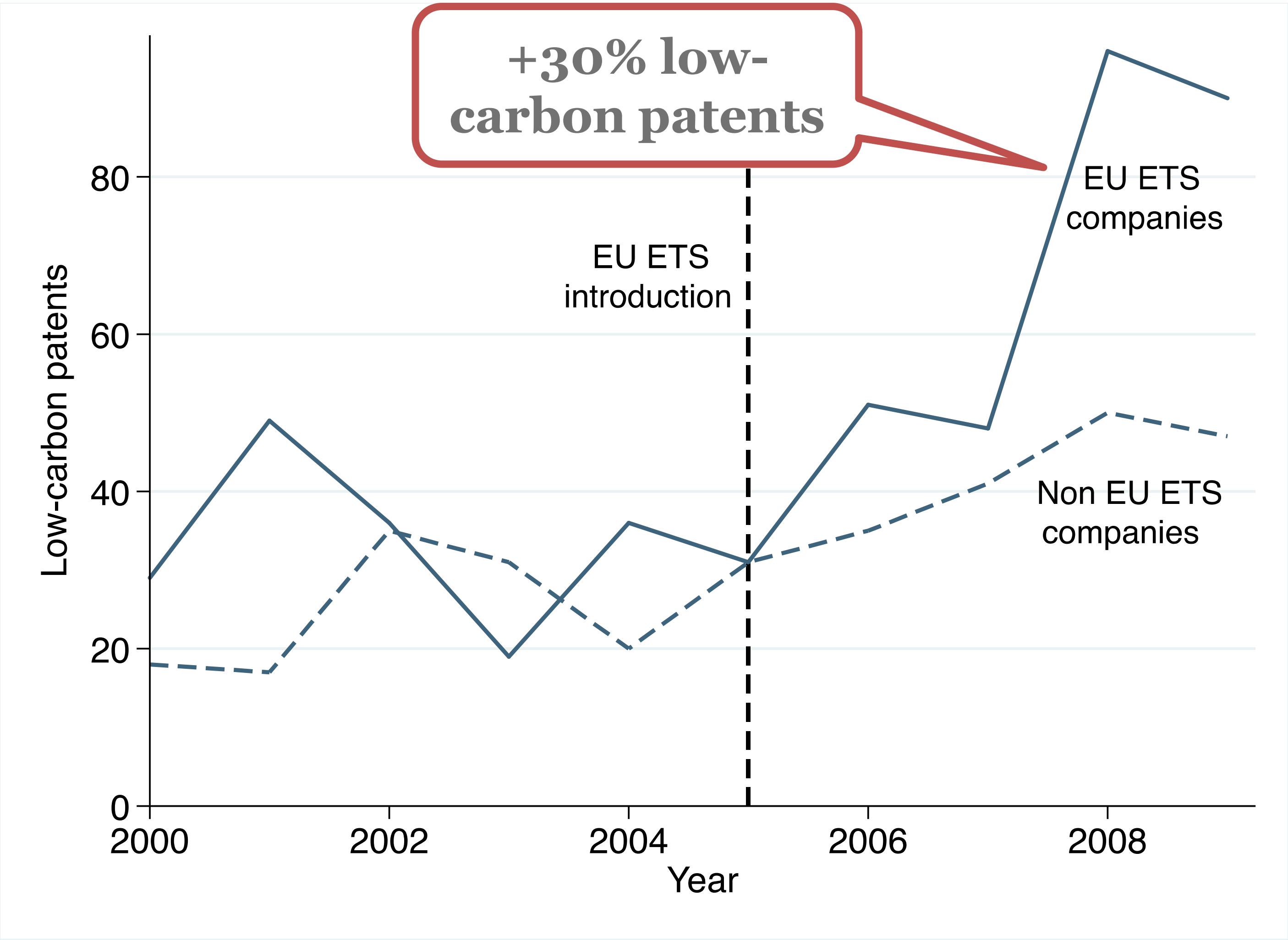
Pricing carbon encourages low-carbon innovation



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

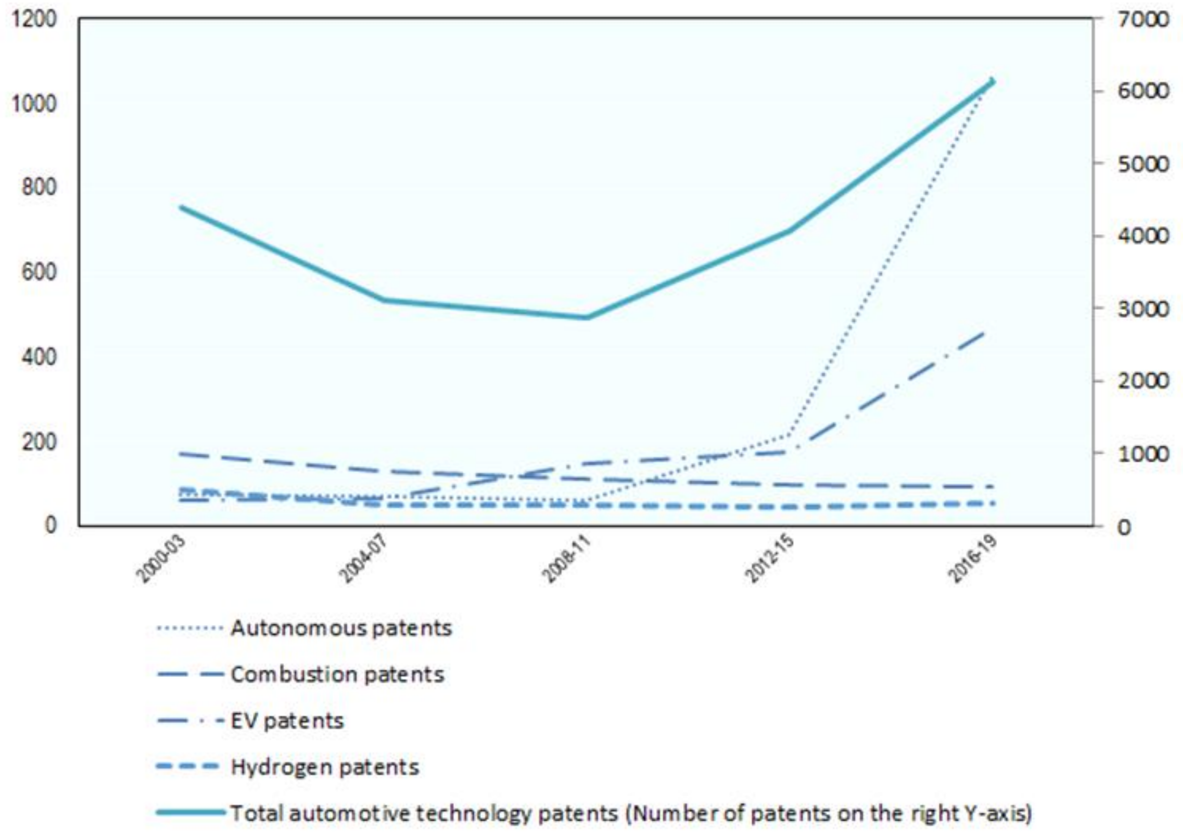
Providing the right framework conditions

- Fund **public infrastructure,** e.g. EV charging stations, 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

Young firms are increasingly innovating in automotive technologies (EVs, autonomous vehicles)

- Young firms (less than 5 years old) have significantly contributed to the growth of innovation in autonomous and EV technologies
- This could induce future changes in the composition of the automotive industry

Number of total automotive technology patents and patents filed by young firms, by technology



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.

Source: IEA, 2021

Thank you

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