Energy Transitions Commission

Economics of the transition: shaping future analysis

ETC Representatives meeting

18 September 2025

Two key themes relating to the economics of the transition

The costs of NZ are unaffordable and are leading to us losing out economically

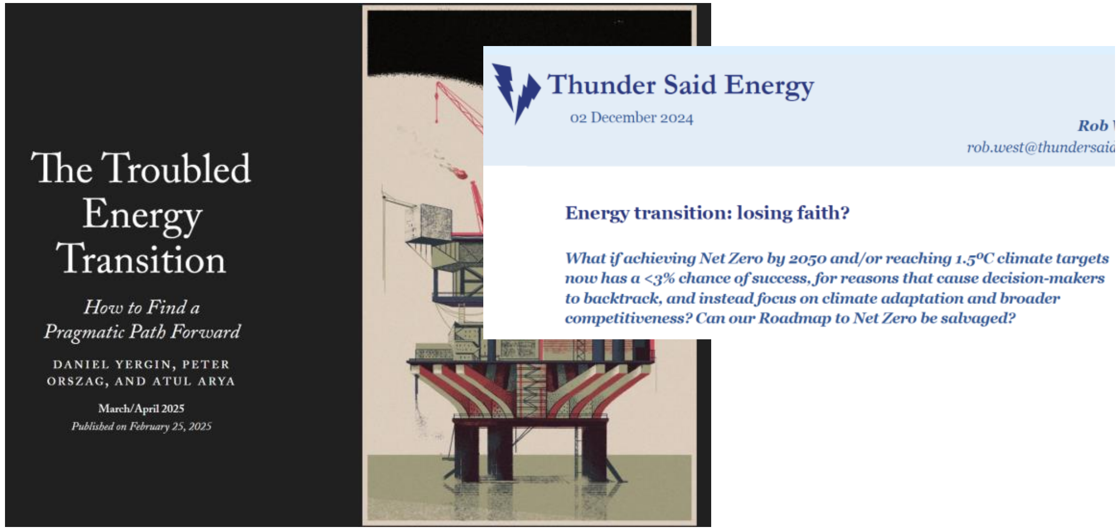
1.5°C is not happening, 2°C+ more likely

The real reason why heat pumps are eye-wateringly expensive

Net zero heat pump drive 'will cost 6,000 jobs'

A New Year Resolution Worth Toasting: End Net Zero

It isn't inevitable and it won't be easy, but voters are finally having to face the enormous costs of eliminating carbon emissions.



But the fundamentals of the transition haven't changed dramatically: how can we restate these?

Agenda

- **Mitigation costs – aggregate and distributional implications**
- Adaptation costs & intersection with mitigation
- Jobs

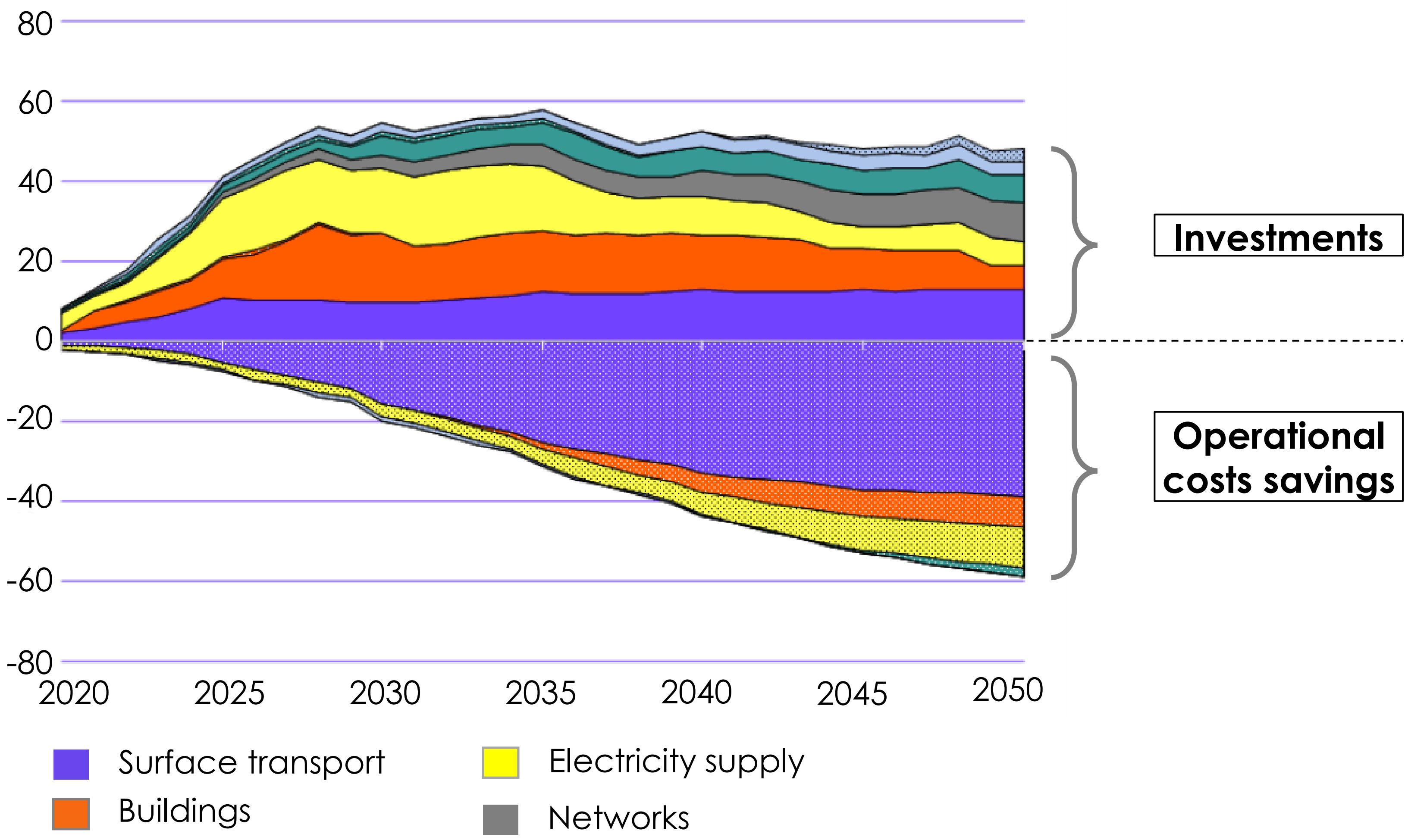
The cost / economic impact of the energy transition has several levels

Aggregate level	**Initially, overall higher costs** due to higher upfront costs of clean technologies/investment needs; **over time, lower costs** as operational savings kick in
Sector level	While overall costs will go down in aggregate, **there will still be sectors where the cost is higher in the long-term**, as decarbonisation technologies are more expensive
Consumer level	The cost and distributional impact will depend on: 1) Consumption mix 2) Individual access to finance and cost of capital 3) Income level
Country level	The overall effect on countries will depend on: 1) Access to finance and cost of capital 2) Natural resource endowment 3) Extent of lost rents from fossil fuels

Despite higher upfront costs, transition to clean energy will lead to savings over time due to lower operating costs – partly driven by efficiency gains

Capital investment costs and savings in a net-zero pathway - UK

£ billion a year



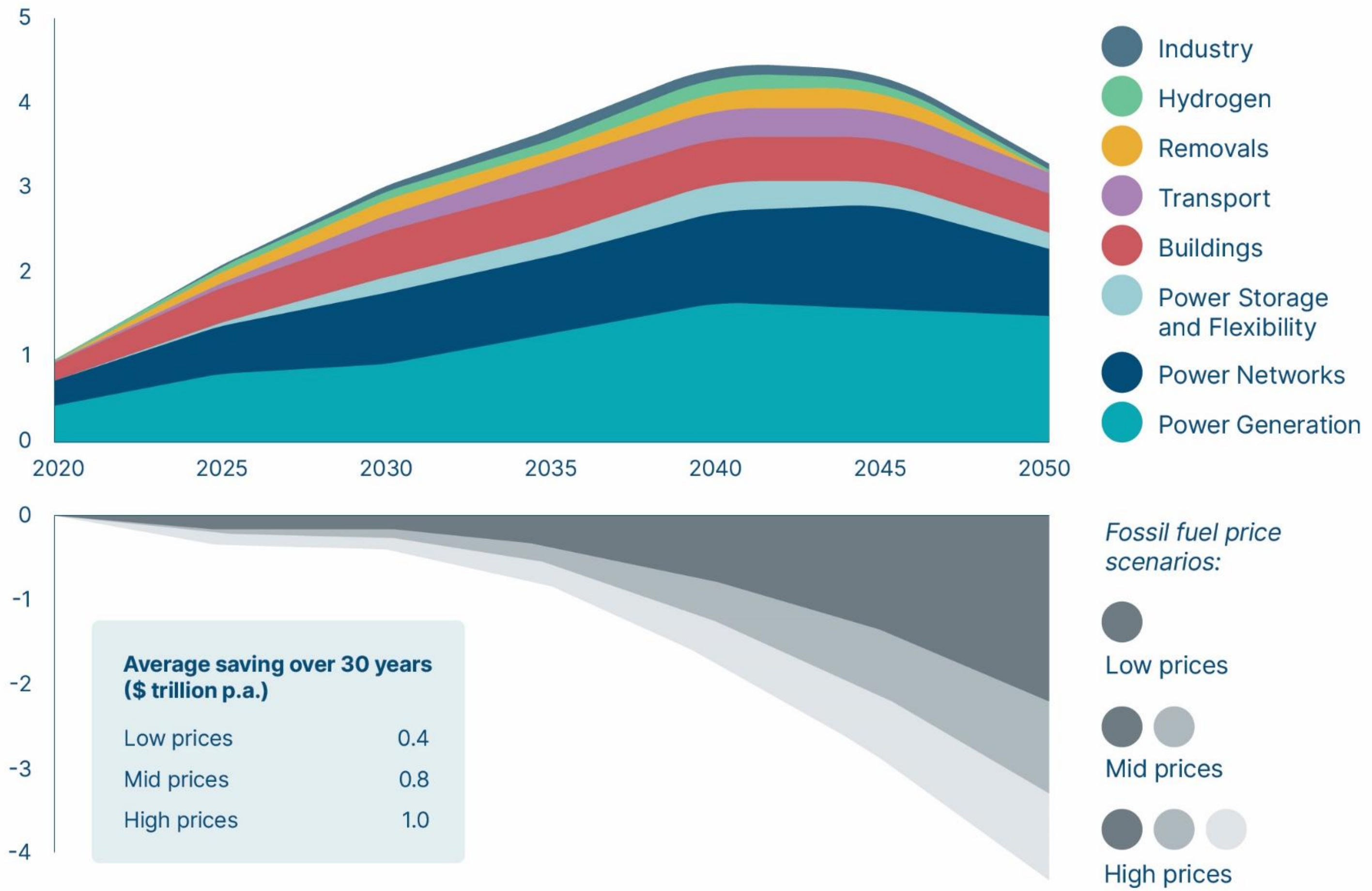
Source: CCC (2025), *The Seventh Carbon Budget*.

- The cost of the transition at the aggregate level is often modelled in terms of GDP
- Given the **capex-heavy** nature of the energy transition, GDP will be driven by investment
- However, it is possible for GDP to therefore rise, while consumption decreases
- Given the inherent feature of the transition is high upfront investments to deliver subsequently lower operating costs, the best way to think about it is terms of the **combination of changes in capex and opex**

At an aggregate level, some of the one-off transition investment ramp-up will also be offset by falling spend on fossil fuels

Annual capital expenditure in the energy system and annual savings from reduced spending on O&G, under different price scenarios

Trillion $



This implies:

- **2050 and beyond:** A likely trivial or possibly positive impact on living standards once the energy transition is largely complete – around 0.2-0.5% of global GDP: equivalent to a 5 month delay in global living standard attainment.

- **During the transition:** A period of increased costs (i.e. reduced living standards relative to BAU) because of the large investments need → this is likely to be relatively small and easily affordable (i.e. 1-2% of GDP), but still needs to be carefully managed

Source: ETC (2023), *Financing the Transition.*

In the long-run, there will be a distinction between sectors where there will be a lower cost, and those where there will always be a green cost premium

Cost once the transition is complete

Buildings

Road Transport

Non-heavy industry

Electrification > greater energy efficiency
+
Power decarbonisation at low cost

Zero or negative cost impact on consumers (i.e., consumers gain)

Heavy industry
(steel, chemicals, cement)

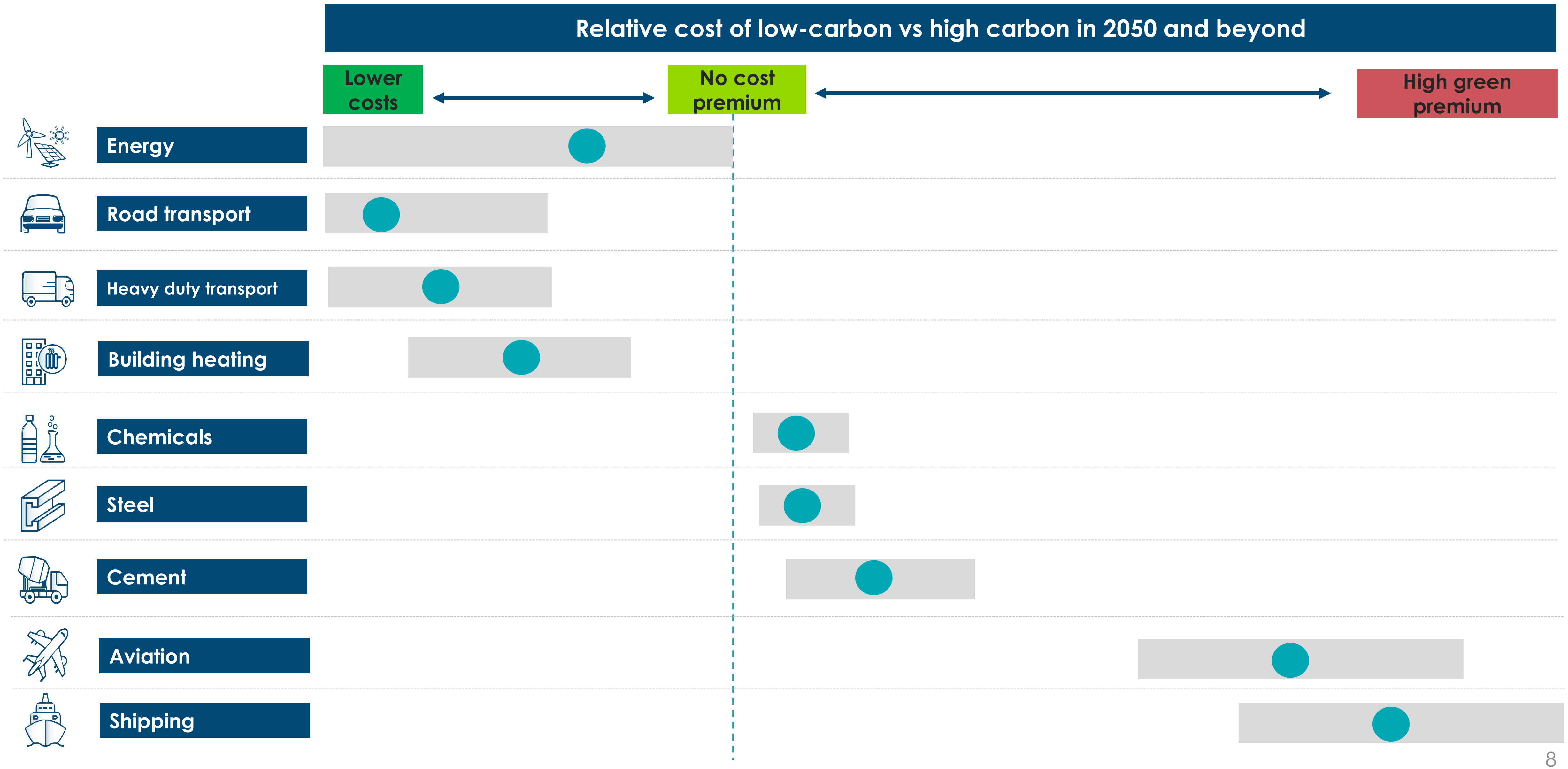
Aviation and shipping

Green cost premia – for long time or in perpetuity

But small at consumer level (except in aviation)

Small cost to consumers

Shipping and aviation are expected to have the biggest cost premia

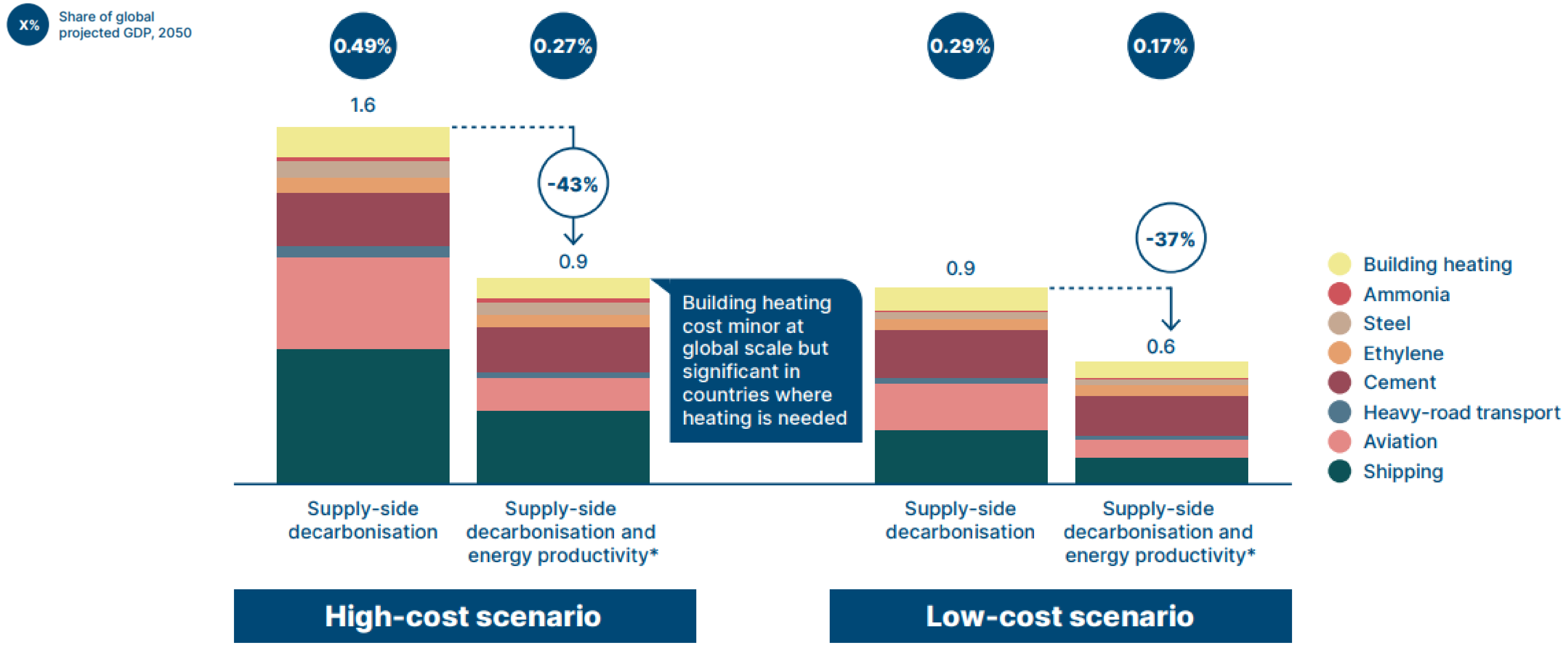


Sources: MPP sector transition strategies; BNEF for transport; ETC (2025), *Achieving Zero-Carbon Buildings*. Note: Buildings and transport represent total cost of ownership.

Our previous estimates suggested this long-term cost could be in the order of magnitude of 0.2-0.5$ trillion, depending on assumptions about cost and energy productivity improvement

Total cost of decarbonisation

Trillion $ per year, 2050

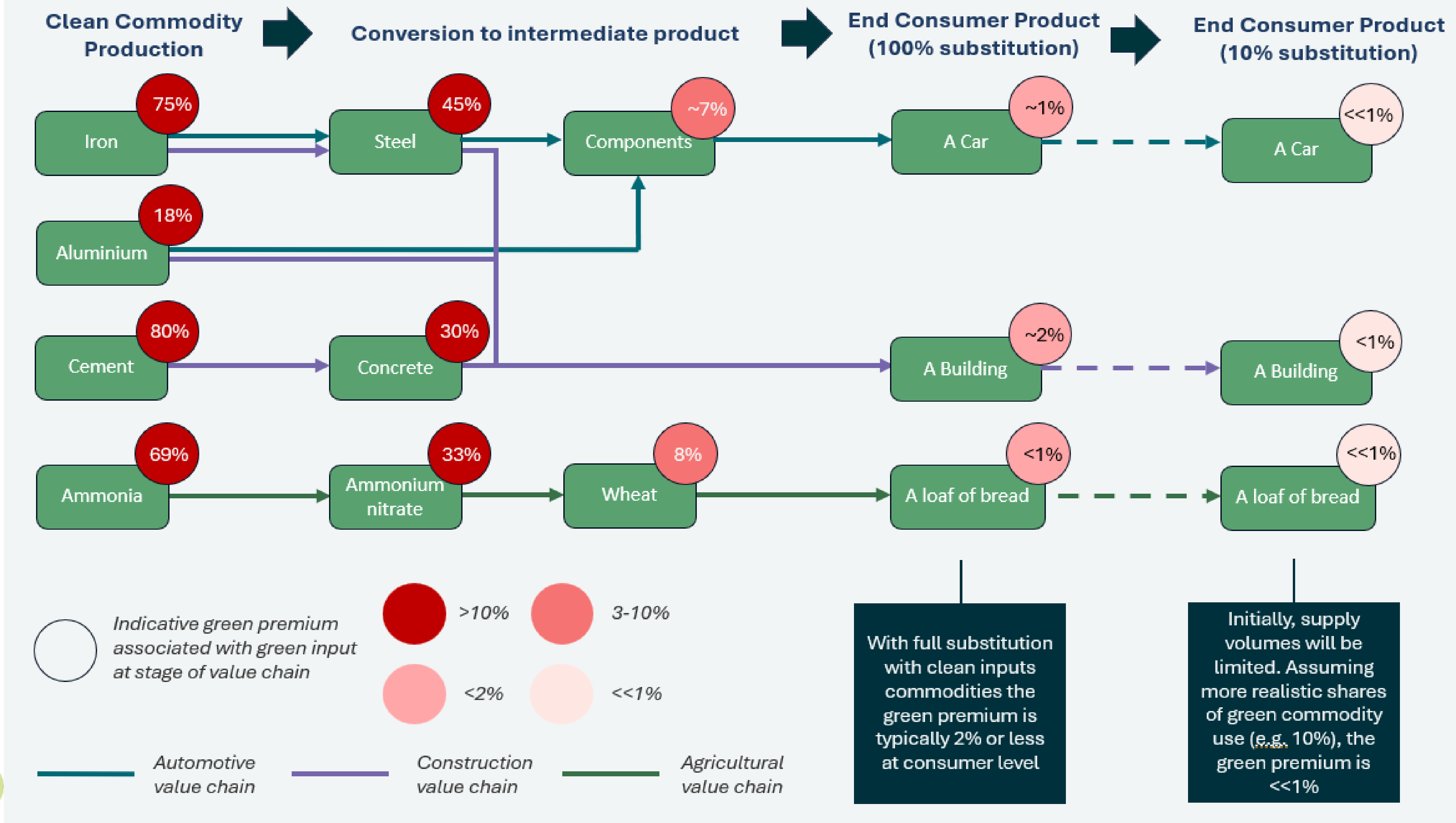


Source: ETC (2020), *Making Mission Possible.*

While there will only be a minimal impact on most end consumer prices, most sectors will see significant impact on intermediate product costs

Sector	Impact on final product cost US$ / % price increase		Impact on intermediate product cost US$ / % price increase	
Cement	+$15,000 on a $500,000 house	+3%	+$100 per tonne of cement (+$30 per tonne of concrete)	+100% (+30%)
Steel	+$180 on the price of a car	+1%	+$120 per tonne of steel	+20%
Plastics	+$0.01 on a bottle of soda	<1%	+$500 per tonne of ethylene	+50%*
Heavy-road transport	No price impact	None	No price impact	None
Shipping	+$0.03 per kg of imported sugar	<1%	+$4 million per annum on typical bulk carrier voyage	+110%
Aviation	+$40-80 on a 6,500-km economy flight	+10-20%	+$0.3-0.6 per liter of jet fuel equivalent	+50-100%

MISSION POSSIBLE PARTNERSHIP has updated this analysis for 4 key sectors, pointing to minimal impacts on end consumer products at both high and low substitution levels



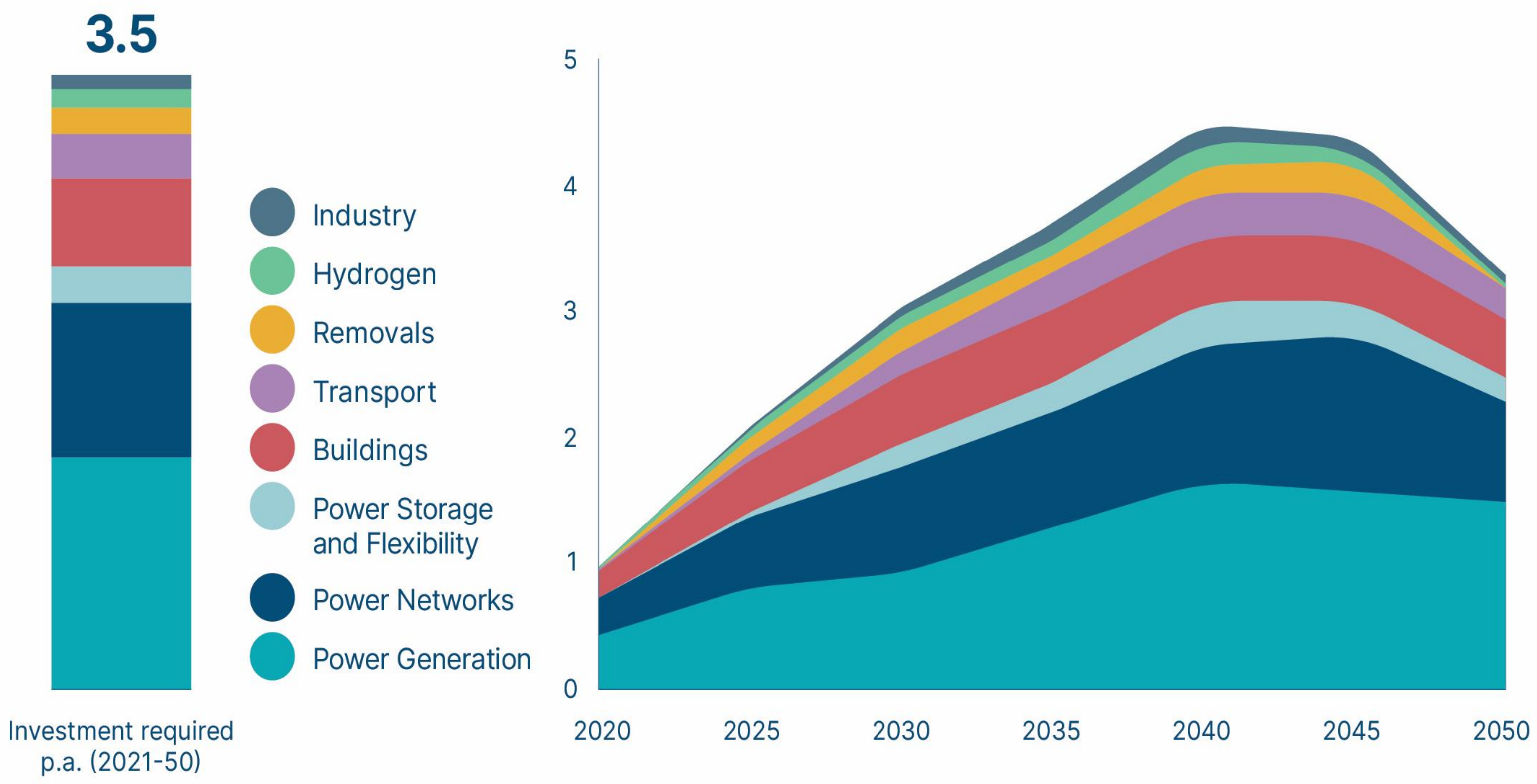
With full substitution with clean inputs commodities the green premium is typically 2% or less at consumer level

Initially, supply volumes will be limited. Assuming more realistic shares of green commodity use (e.g. 10%), the green premium is <<1%

In the transitional period, the cost to consumers arises primarily from investment – the two biggest categories of which are power and buildings

Annual capital expenditure in the energy system

Trillion $



There is an important distinction in how individuals face this investment cost:

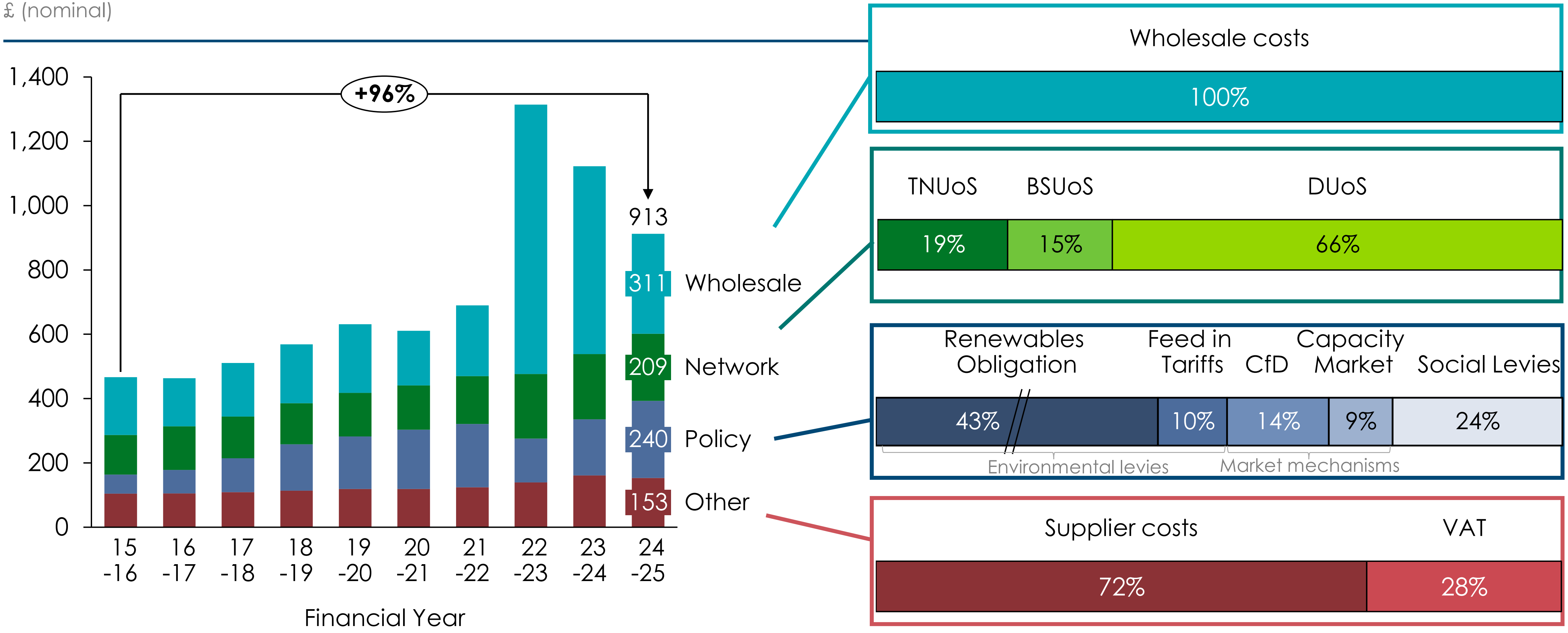
- **Buildings**: consumers may face this cost directly (e.g., need to invest in heat pumps and improved insulation)
- **Power system**: investments get reflected in electricity prices, and the cost of the transition therefore come through to consumers in grid charges, CFD contract costs, etc (see next slide).

Source: ETC (2023), *Financing the Transition.*

In the power system, the falling costs of renewable technologies are not reflected in electricity prices, especially in developed economies

UK consumer bill component trends, FY15–16 to FY24–25 (left) and FY24–25 breakdown (right)

£ (nominal)



Note: **Includes subsidies during the energy crisis. Incorporating inflation would reduce the total price per annum.** Electricity bills are made of a usage charge (£ per kWh) and standing charge (daily rate). Taxes and levies are split across both. Based on price cap for 3100 kWh/year Single-Rate Metering Arrangement household. Social levies include Energy Company Obligation (ECO), Assistance for Areas with High Electricity Distribution Costs (AAHEDC) Warm Home Discount, Smart metre costs. TNUoS = Transmission Network Use of System, BSUoS = Balancing Services Use of System, DUoS = Distribution Use of System, VAT = Value-added Tax. **Source:** Ben James (2025), *Electricity Bills*; Ofgem (2024), *Wholesale cost allowance methodology Annex 2*; Ofgem (2024), *Network cost allowance methodology for electricity Annex 3*; Ofgem (2024), *Policy cost allowance methodology Annex 4*; Ofgem (2024), *Smart metering net cost change methodology Annex 5*; AAHEDC (2024), *Charging statements from NESO*.

Several measures could have an impact to reduce consumer bills

1. **Reducing the number of hours in which gas sets the wholesale electricity price requires a combination of structural and operational reforms.**
2. **Rebalancing policy costs across gas, oil and/or government fees, levies or taxation.**
3. **Price signals: time-of-use tariffs/real-time pricing and dynamic network tariffs**
4. **Reforming grid cost recovery frameworks, including extending amortisation periods for grid investments**
5. **Incentivise self-reliance across residential and industrial properties**

To be analysed further in 2026 with an ETC focus on 'Consumer Market Design'

Note: PPAs = Purchasing Power Agreements. CFDs = Contracts for Difference. Source: Systemiq analysis for the ETC (2025)

The distributional effects on consumers depend on three factors

The cost and distributional impact will depend on:

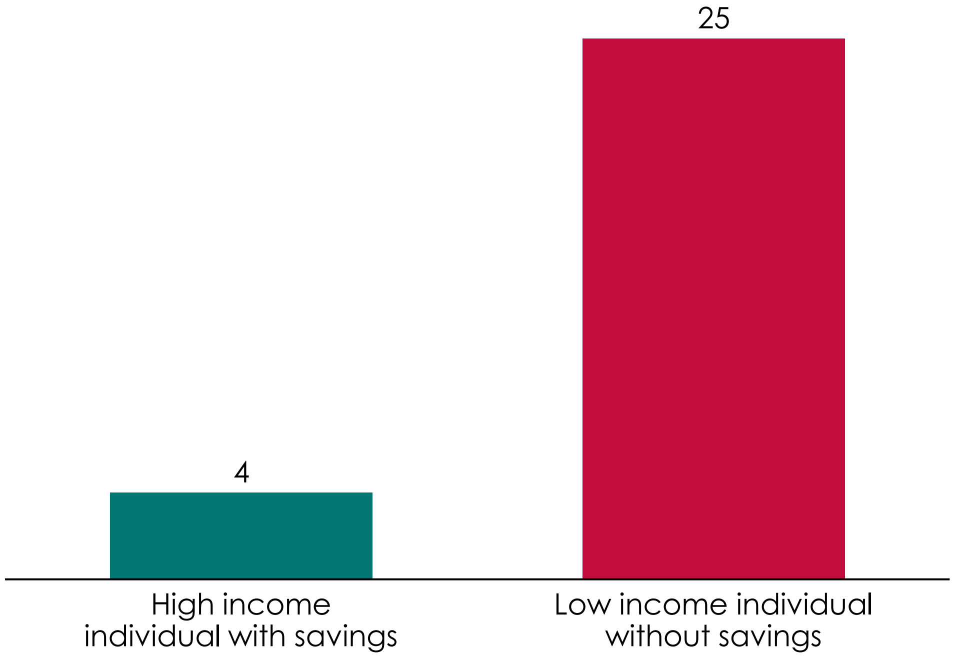
1. Consumption mix
2. Cost of capital
3. Income level

Cost of capital across different income groups, UK
%

The cost of capital of purchasing a heat pump is…

… The opportunity cost of savings interest that could have been earned

… The interest rate from borrowing on a credit card



Sources: Systemiq analysis for the ETC (2025).

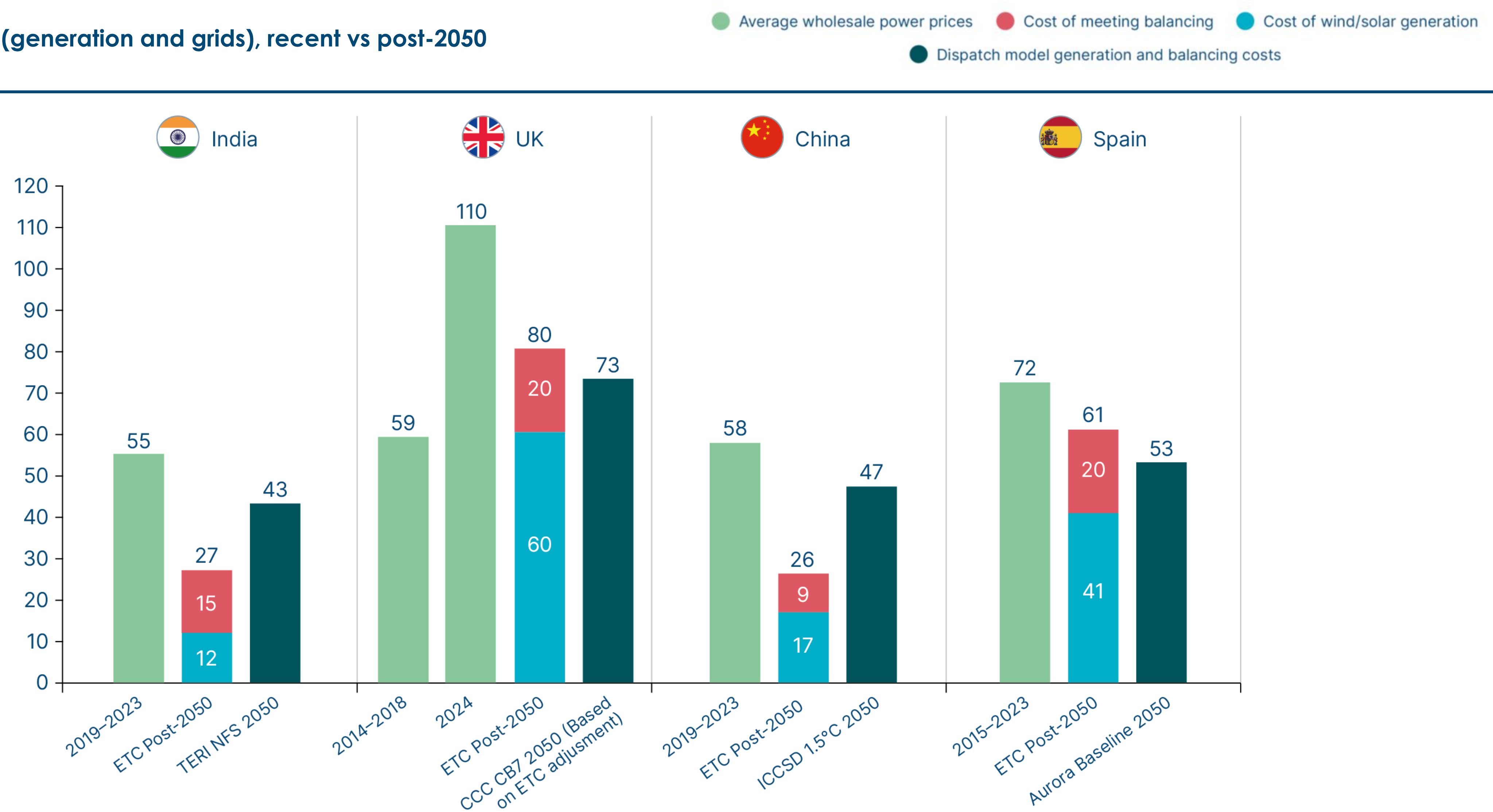
The key issues relating to consumers vary by sector, due to specific individual circumstance during the transition

Sector	Distributional / regressive impact?	
Aviation	No	Higher aviation prices will impact people who spend a higher % of income on air travel. But this tends to be higher income groups, so **the distributional consequences of this are not concerning.**
Energy	Yes	Potentially higher electricity prices during transition, will hit people whose electricity expenditure is a higher % of total expenditure – this tends to be lower income households
Road transport	Yes	There are major differences in operating cost by consumer group, depending on access to charging at residential electricity rates (e.g., private driveway), or at much higher public charging rates (e.g., 3x higher).
Building heating	Yes	Several issues: • Heating costs are a higher percentage of total expenditure for lower income groups. • Retrofit costs depend on the quality of the building (typically less energy efficient for lower income households). • Affording the high upfront cost of a heat pump depends significantly on individual cost of capital.

What other effects do we need to consider – both in high and lower income countries?

In general, the cost of electricity will be lowest in the global sun belt countries, which tend to be lower income

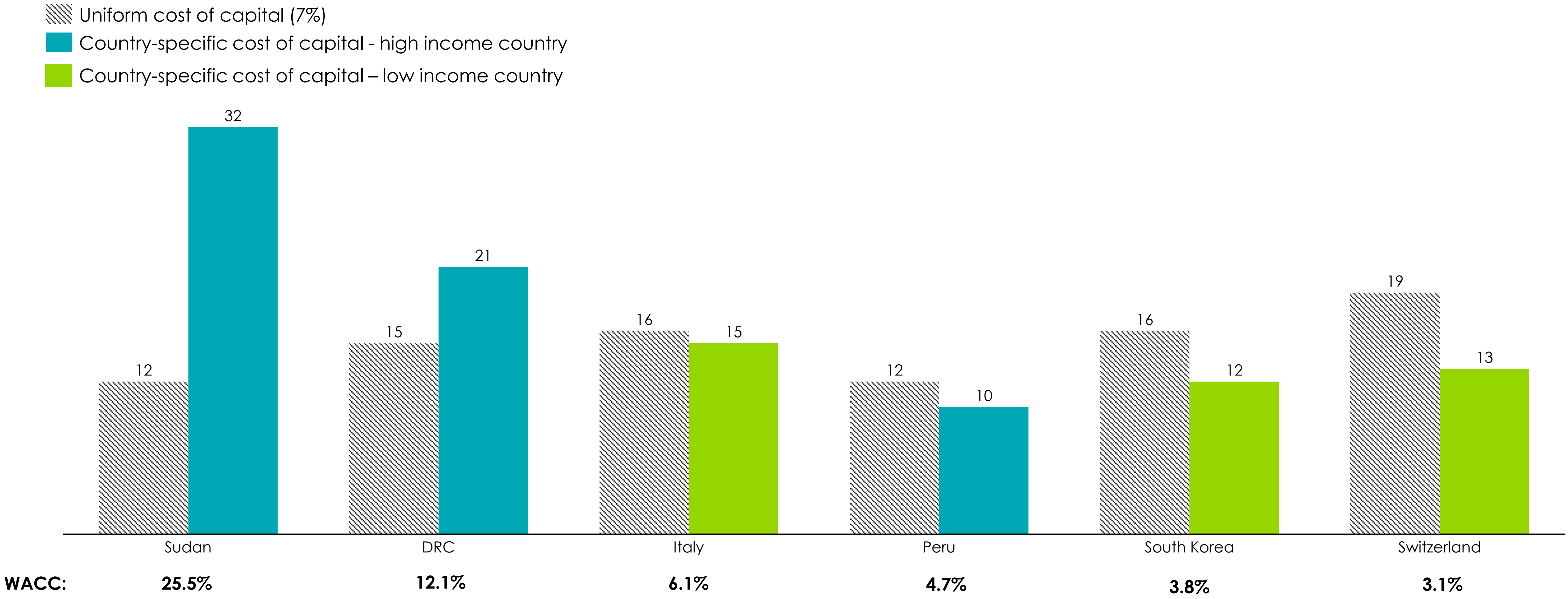
Total system costs (generation and grids), recent vs post-2050
$/MWh (real 2024$)



Notes: T&D = Transmission and distribution. T&D costs per MWh have been assumed based on ETC modelling outlined in Chapter 2 across all presented here for consistency.
Sources: Systemiq analysis for the ETC (2025); BNEF (2025), LCOE: Data Viewer; Ofgem (2025), *Wholesale market indicators – Electricity Prices: Forward Delivery Contracts – Weekly Average (GB)*; IEA (2023), *Electricity Market Report – Update 2023*; Statista (2024), *Average electricity prices for enterprises in China from September 2019 to September 2024;* Ember (2025), Wholesale electricity prices in Europe; CCC (2025), *The Seventh Carbon Budget*; TERI (2024), *India's Electricity Transition Pathways to 2050: Scenarios and Insights*; ICCSD (2022), *China's Long-Term Low-Carbon Development Strategies and Pathways;* Aurora (2023), *Long Duration Energy Storage in Spain*

But some of this is offset by the fact that they have a higher cost of capital – this makes international finance critical to seizing the opportunity

LCOE of solar PV based on country WACC
€/MWh

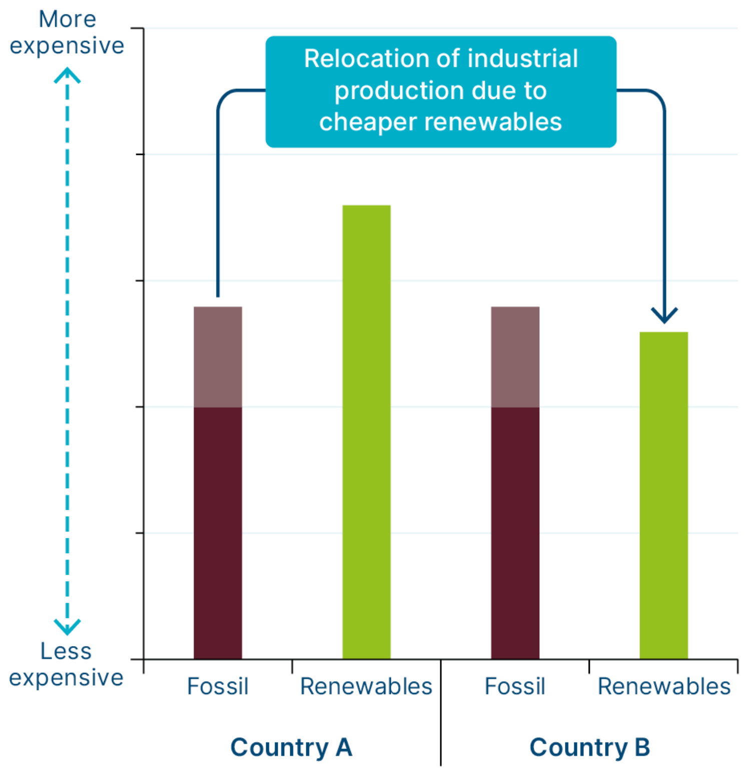


This means the global sunbelt countries have the potential to become least cost locations for electricity intensive heavy industry

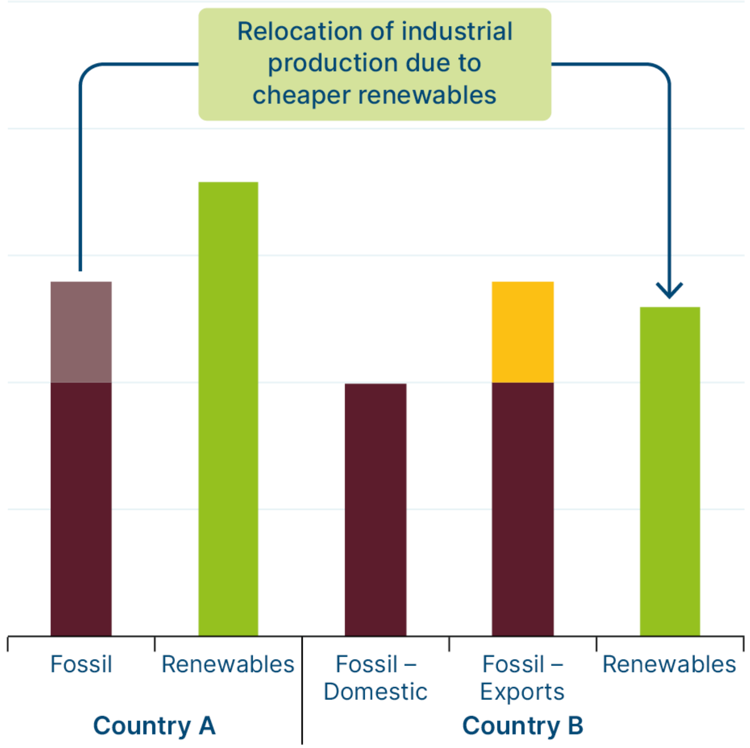
Cost of industrial production in two illustrative scenarios

Cost of production: With fossil fuels | With renewables | CO_2 Cost increase | Cost increase due to carbon border adjustment

Tighter climate policy in both countries



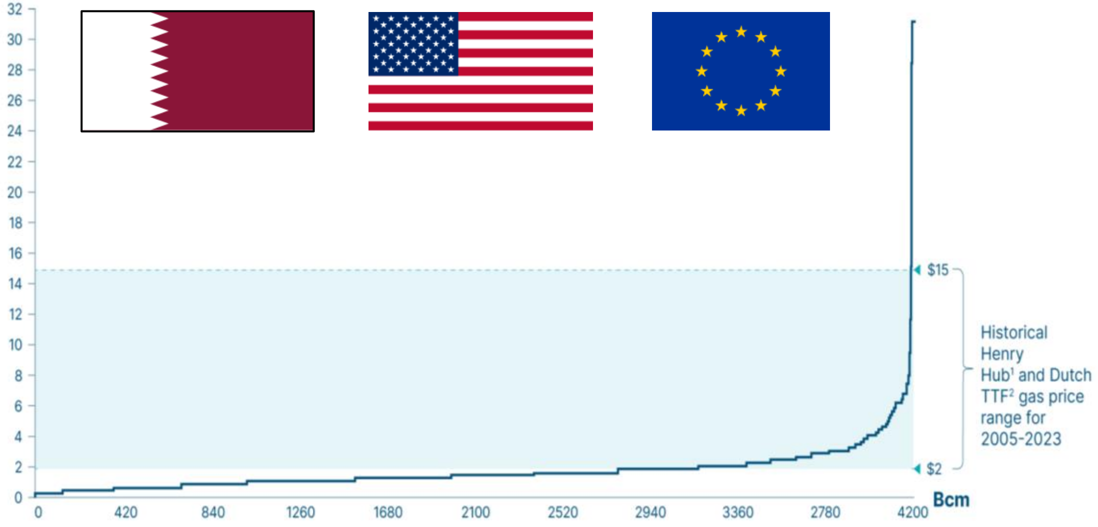
Unilateral tightening of climate policy in country A, in combination with the introduction of a CBAM



Source: Energy Research & Social Science (2023), *The renewables pull effect: How regional differences in renewable energy costs could influence where industrial production is located in the future.*

The decline of fossil fuel demand cuts the revenues of fossil fuel exporters, and is especially problematic for those which have high extraction costs

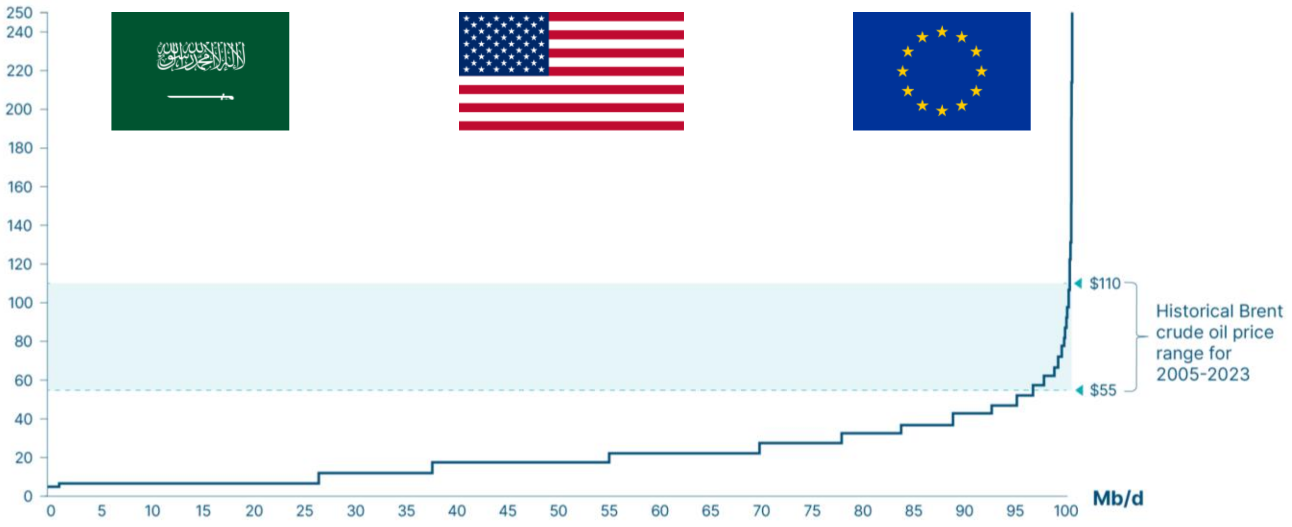
Supply cost curve for natural gas
$/MMBtu



NOTE: Supply cost curves are technical breakeven costs and not lifting costs (or marginal cost of production), exclude financing costs and implicit costs from balancing government and trade budgets, include CAPEX depreciation for the current year. MMBtu=1 million British Thermal Units (a measure of heat).
[1] Henry Hub is the main pricing point for natural gas in North America, [2] Dutch TTF (title transfer facility) serves as the price benchmark for natural gas in European Markets.

SOURCE: Systemiq analysis for the ETC; Rystad Energy (2022), *Rystad Energy Ucube database.*

Supply cost curve for oil
$/bbl



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SOURCE: Systemiq analysis for the ETC; Rystad Energy (2022), *Rystad Energy Ucube database.*

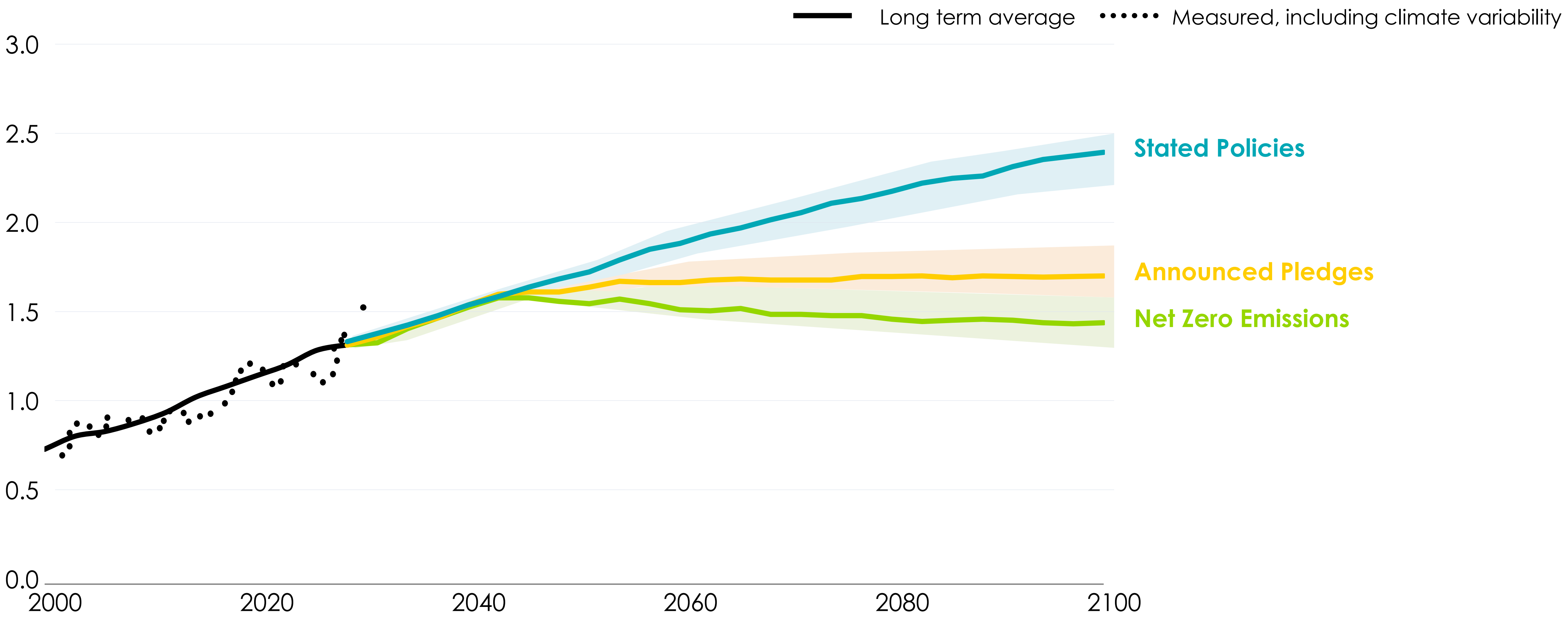
Agenda

- Mitigation costs – aggregate and distributional implications
- **Adaptation costs & intersection with mitigation**
- Jobs

The US slowdown and the ‘implementation gap’ suggest temperatures towards 2°C or above, creating a need to invest in adaptation

IEA scenarios for global temperature increase vs preindustrial level before impact of changed US policies

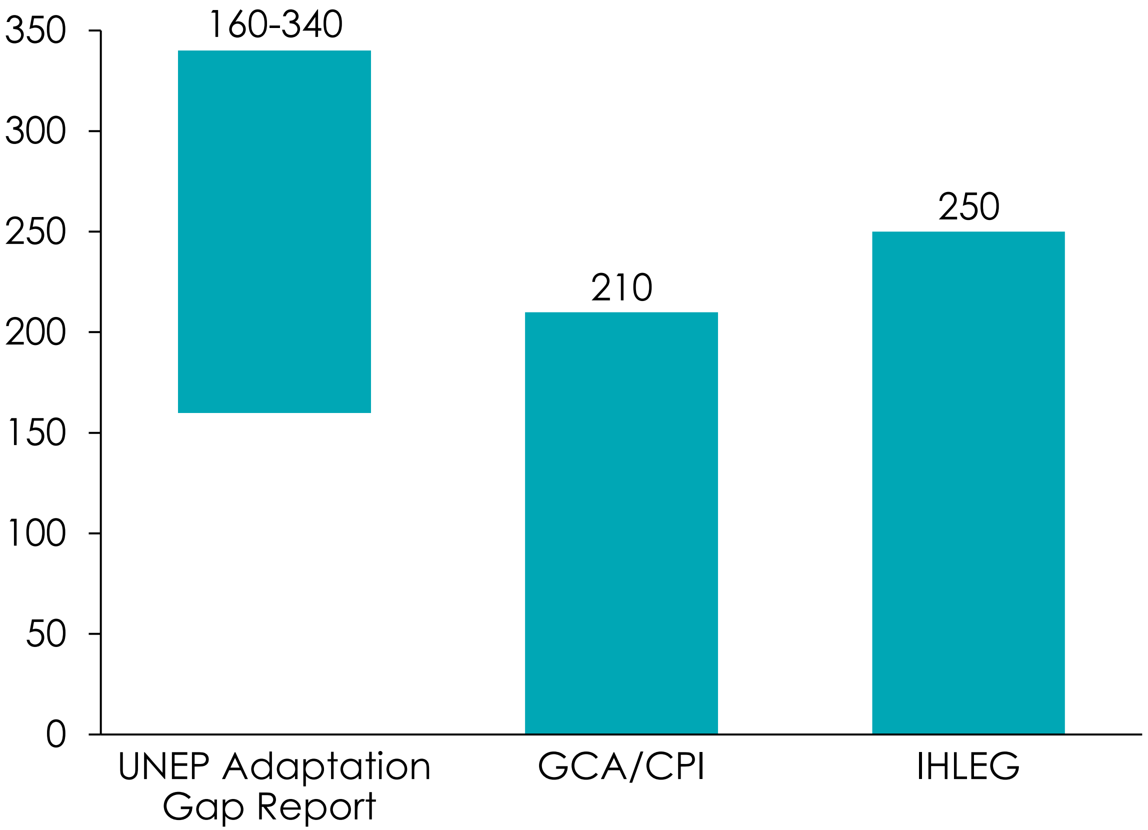
°C



Notes: IEA STEPS scenario projects what will happen under current stated policies and trends; APS projects what will happen under all announced policies and net-zero commitments; NZS describes what needs to happen to limit warming to levels consistent with 1.5°C of warming.
Sources: IEA (2024), World Energy Outlook

Developing countries need to spend at least $200bn a year on climate adaptation between now and 2030

Estimates of adaptation spending needs to 2030 in developing countries
$ bn a year



Key categories of spending:

- **Coastal zones**: sea walls, dikes, beach nourishment, mangrove restoration, managed retreat.
- **Water supply & flood protection**: reservoirs, drainage, irrigation upgrades, flood defenses.
- **Infrastructure:** “climate-proofing” roads, bridges, power, housing, ports.
- **Agriculture, forestry & fisheries**: crop breeding, irrigation, sustainable land management, livestock adaptation, aquaculture changes.
- **Human health**: malaria control, heat health systems, vaccines, disease surveillance.
- **Extreme weather events**: early warning systems, emergency response capacity, disaster shelters.

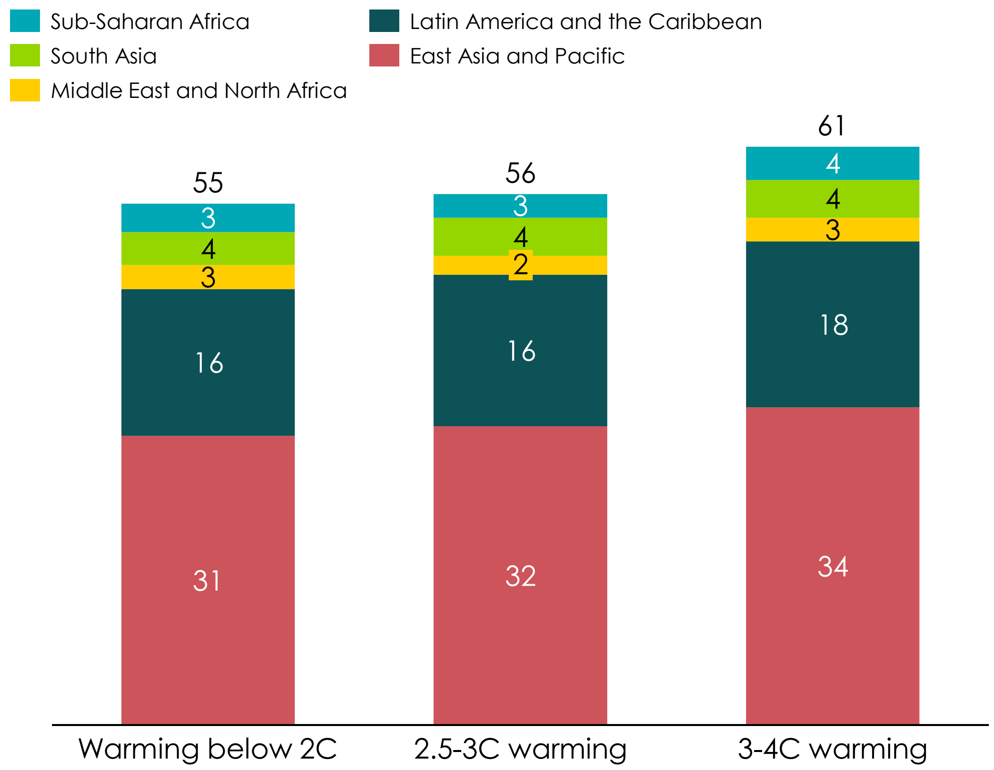
Sources: UNEP (2023), *Adaptation Gap Report 2023*; CPI (2024), *State and Trends in Climate Adaptation Finance*; IHLEG (2024), *Raising Ambition and Accelerating Delivery of Climate Finance*.

Adaptation spending varies significantly across countries and for implied temperature ranges

The more that the world warms, the more that adaptation spending will need to rise

Cost of coastal adaptation for lower income countries, 2020-30

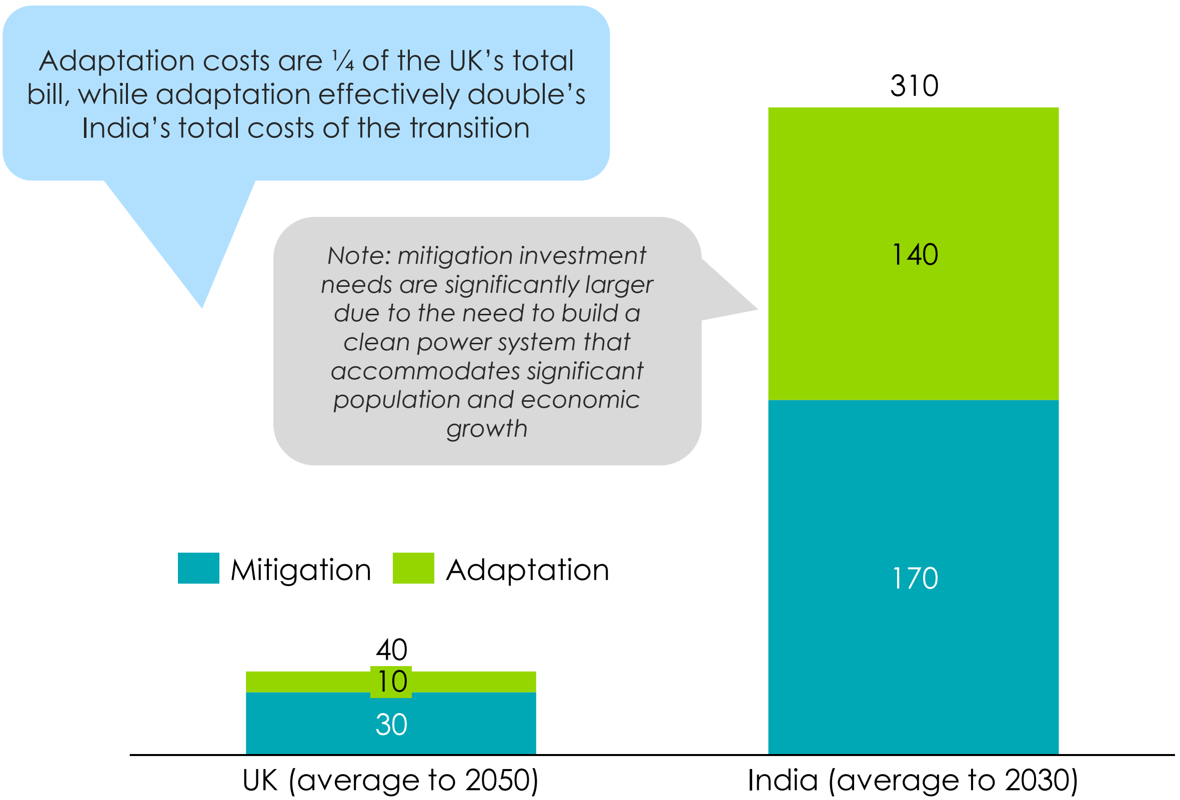
$ bn a year



Many lower-income countries will have to manage significant adaptation costs alongside mitigation investment

Mitigation and adaptation spending in the UK vs India

$ bn a year



Sources: UNFCCC (2023), *Adaptation Finance Gap Update 2023;* CCC (2025), *The Seventh Carbon Budget;* CPI (2024), *Landscape of Green Finance in India;* IFC (2023), *Blended Finance for Climate Investments in India.*

Key issues – what could the ETC explore?

What are the implications?

- In a logical world, spending money to adapt to a 1.7°C world doesn't mean that significant money on mitigation is also not needed
- But in the real world, mitigation + adaptation costs could be competing for domestic and international financial flows – **this is the key issue**

To discuss: how much should the ETC address this?

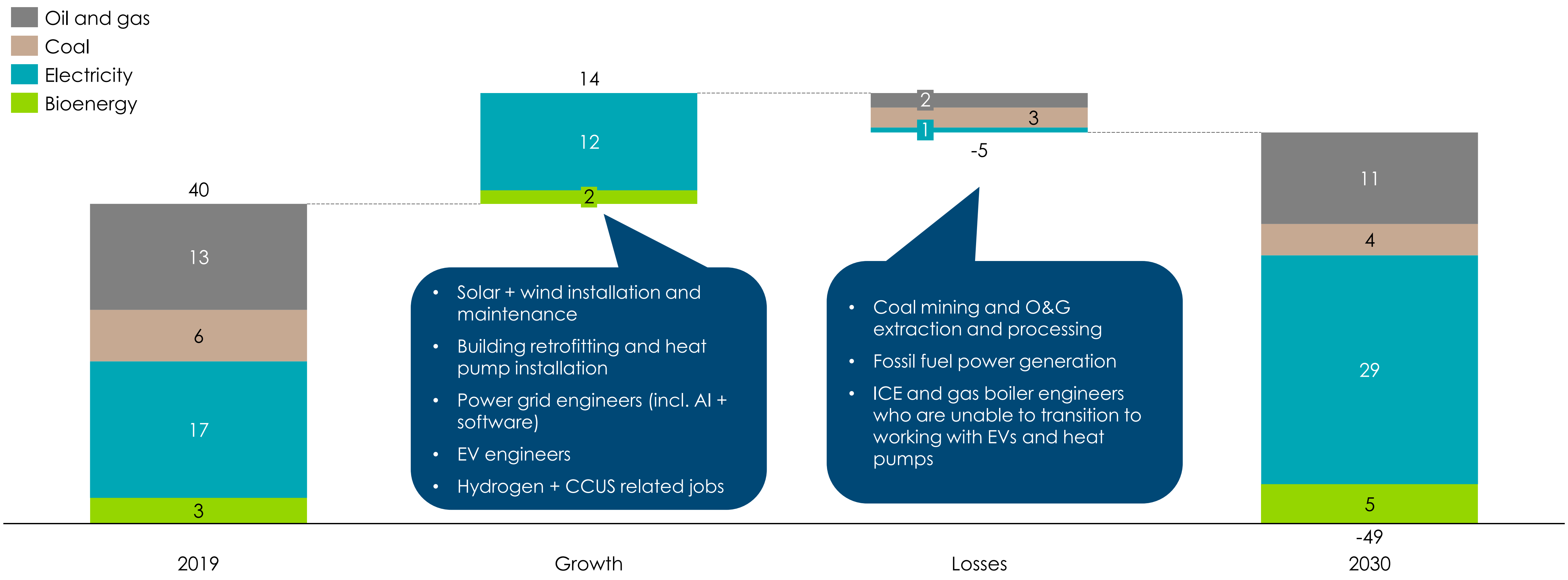
Agenda

- Mitigation costs – aggregate and distributional implications
- Adaptation costs & intersection with mitigation
- **Jobs**

The net-zero transition will have a significant net positive impact on jobs at a global level in the ramp-up period – in line with growing investment and GDP

Global employment in energy supply in the Net Zero Scenario, 2019-2030

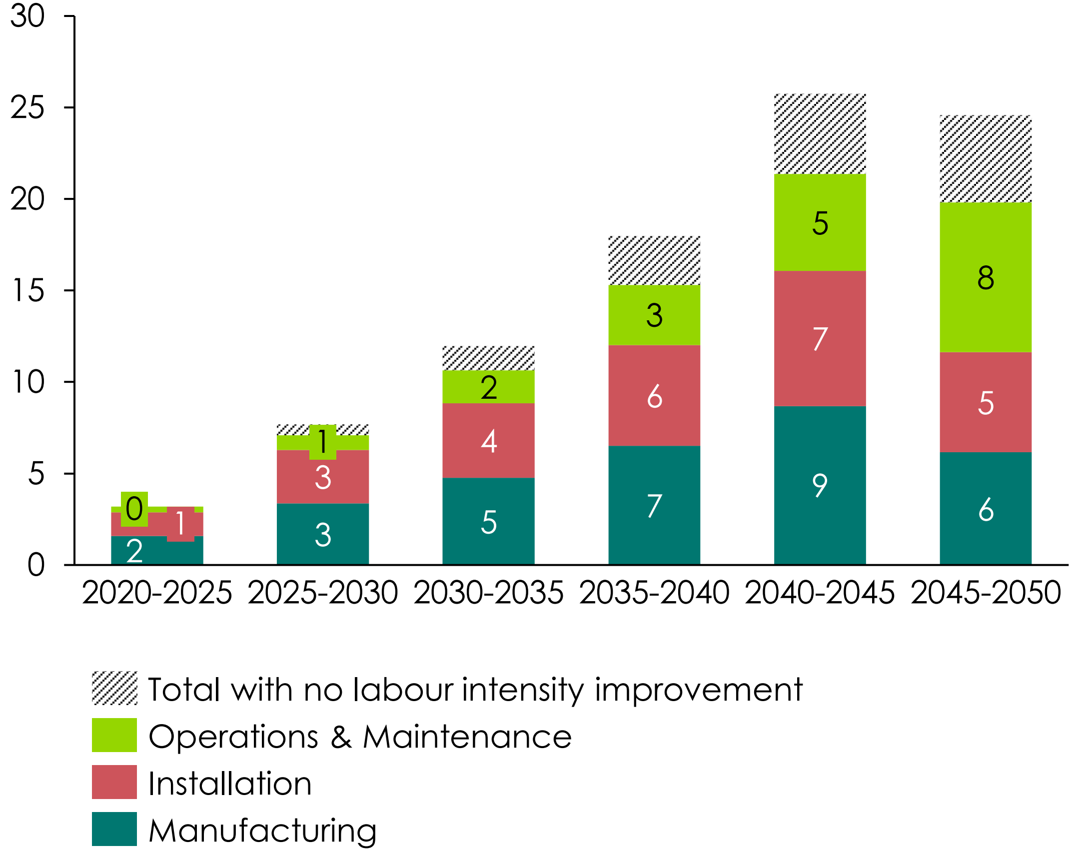
Millions



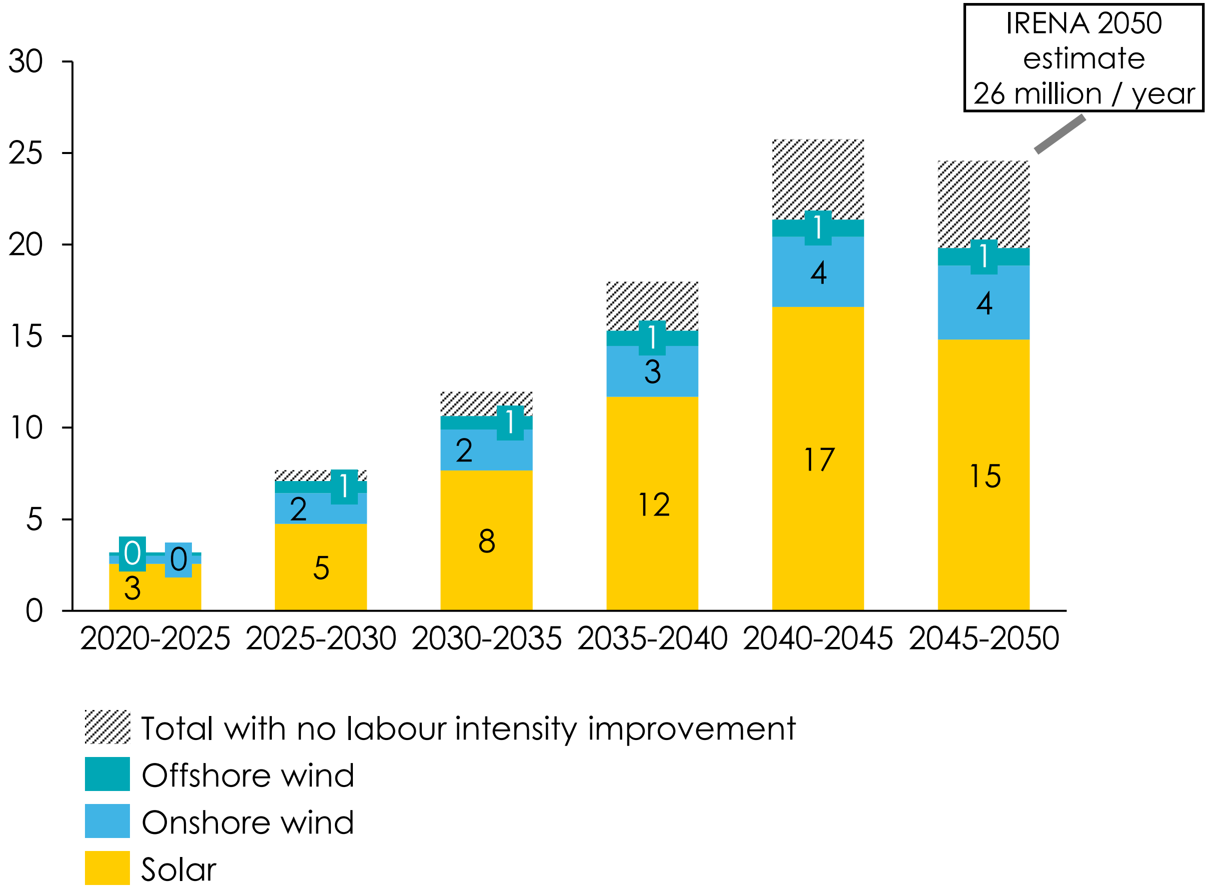
Sources: IEA (2021), *The importance of focusing on jobs and fairness in clean energy transitions.*

However, just as investment falls in the end period, jobs are also expected to do so

Jobs by type Millions



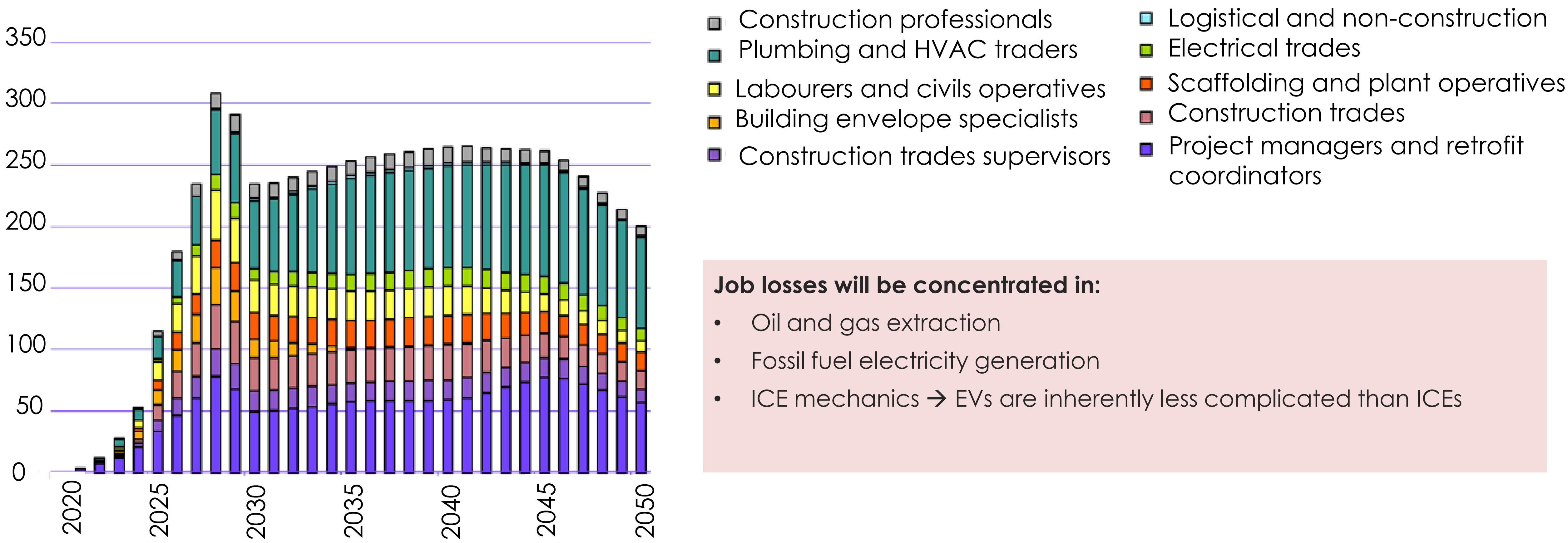
Jobs by technology Millions



Source: ETC (2021), *Making Clean Electrification Possible.*

A key area of job creation for the UK will be in the buildings sector

UK employment in low-carbon heating and energy efficiency
Additional full-time equivalent jobs above 2019 levels



Job losses will be concentrated in:

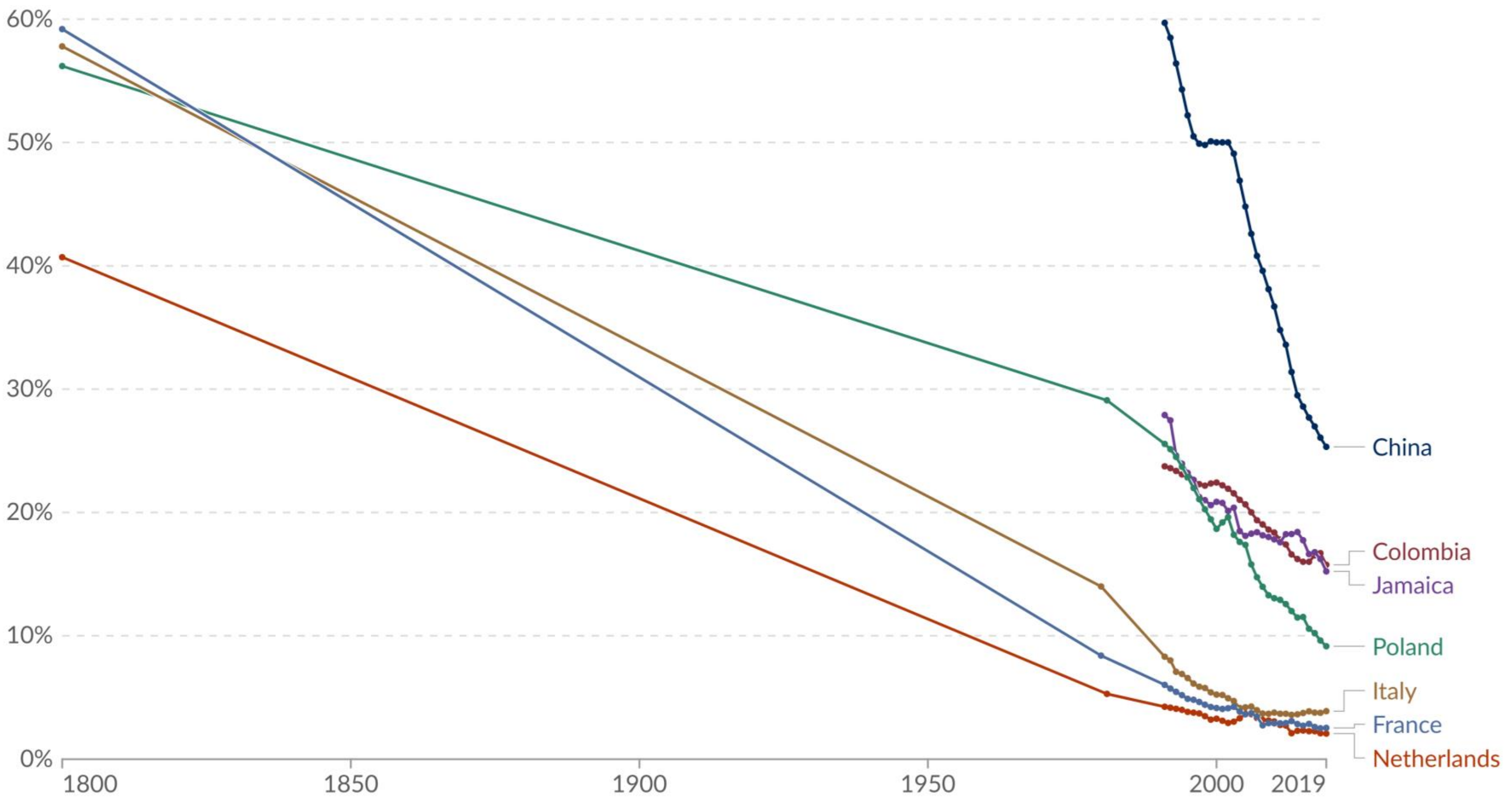
- Oil and gas extraction
- Fossil fuel electricity generation
- ICE mechanics → EVs are inherently less complicated than ICEs

Source: UK's Climate Change Committee – *The Sixth Carbon Budget,* December 2020

However, these job transitions are tiny compared to long-term shifts that have occurred globally

Share of labour force employed in agriculture

% of total

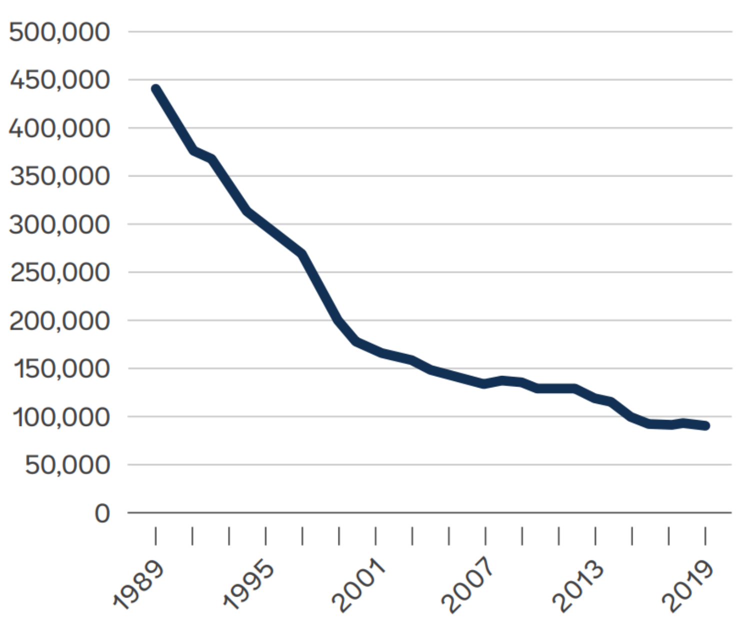


Source: Our World In Data.

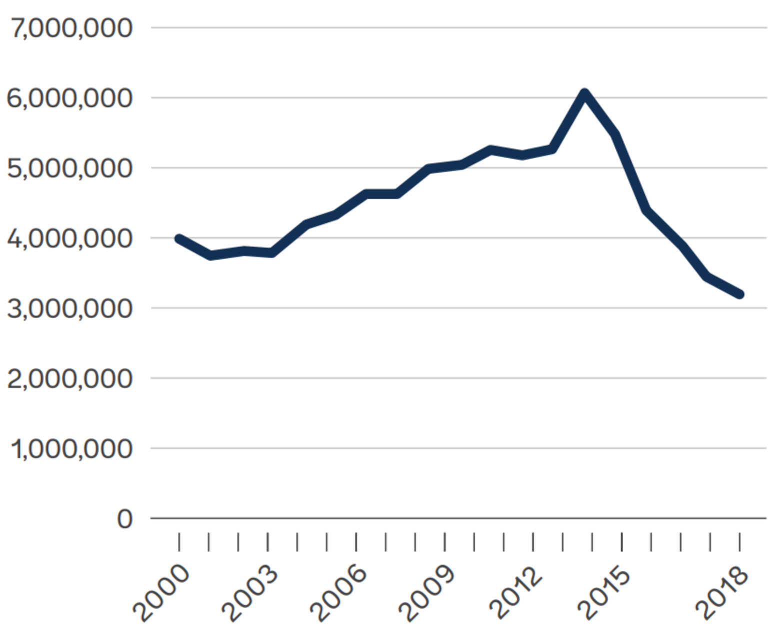
Globally, coal employment is already in decline even in key coal producing countries

Employment (formal and informal) in the coal and lignite mining sectors
Number of workers

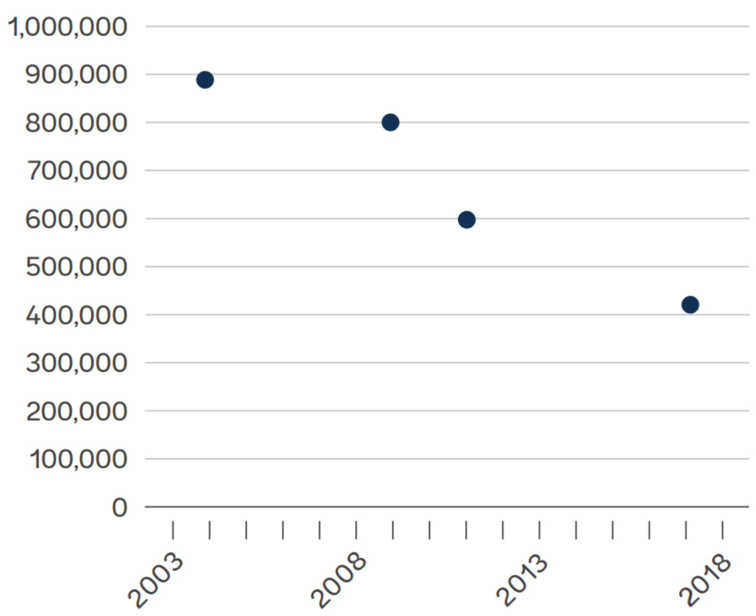
Poland



China



India



Source: World Bank, *Global Perspective on Coal Jobs 2021*

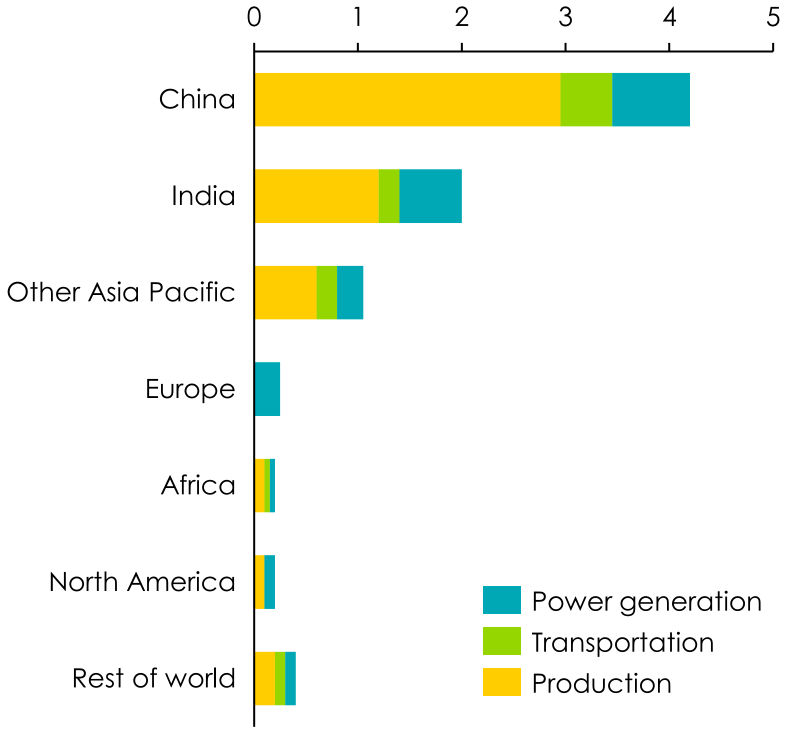
Despite declining employment, the transition will create important local transition challenges

Despite accounting for less than 1% of employment in China and India, the coal sector still employs millions of people

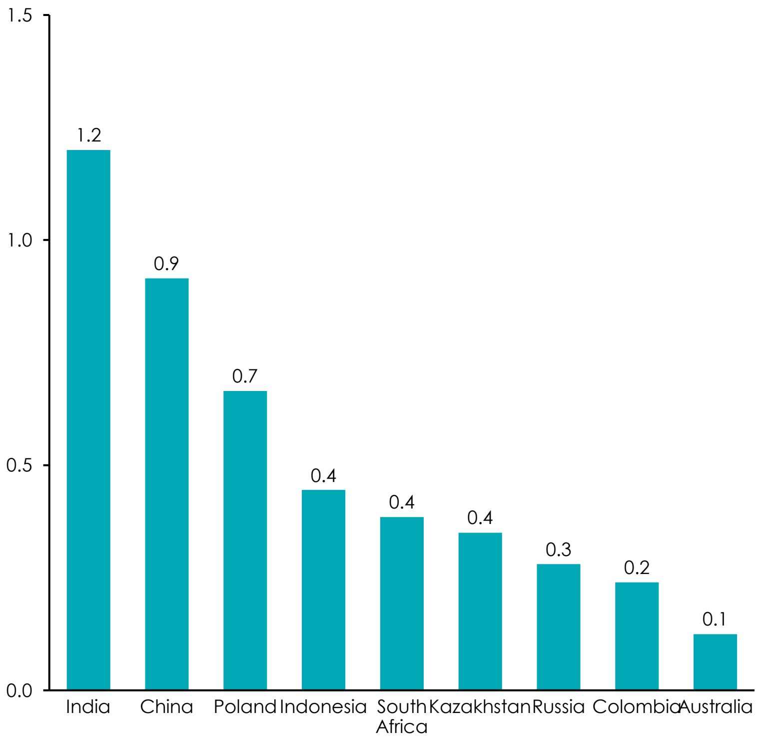
China and India's coal mining sector are also relatively inefficient compared to others

While policy frameworks are developing, there are critical gaps in key countries

Coal employment by region, 2019
Million employees



Labour intensity of coal mining, 2019
Thousand employees per Mtce



Just transition policies in selected countries

	Canada	Germany	Korea	Poland	South Africa
Net zero emissions or carbon neutrality target	2050	2045	2050	2050*	2050
National coal phase-out target	2030	2035	2050	2049**	
Support for workers					
Direct payments and compensation	● (enacted)	● (enacted)	● (announced)	● (announced)	● (announced)
Training, education, career services	● (enacted)	● (announced)	● (announced)	● (announced)	● (announced)
Support for industry development and economic diversification in coal communities					
Coal decommissioning or retrofits	● (enacted)	● (enacted)		● (announced)	● (announced)
Clean energy industries	● (enacted)	● (enacted)	● (announced)		● (announced)
Non-energy industries	● (enacted)	● (enacted)	● (announced)	● (announced)	● (announced)
Holistic support for coal communities					
Environmental rehabilitation		● (enacted)			● (announced)
Community identity and cohesion					● (announced)

● Policy enacted with funding ● Policy announced or recommended by a just transition commission

Source: IEA

Ensuring a just transition – some preliminary thoughts

- The energy transition will have a net-positive impact on employment opportunities, creating new, safer and healthier jobs outside of the fossil fuel sector
- There will be specific, localised impacts on certain communities and groups of workers that need to be carefully managed, with the appropriate support to transition into new jobs
- Key priorities will be to:
  - Respond to specific, highly concentrated effects even if total numbers small
  - Develop the new energy system fast to maximise job creation where possible
  - Implement policies to support supply chain and skills development

Summary and next steps

Our plan is to produce 2-3 publications to cover key topics

Insights Briefing

1

Cost of transition & distributional impacts

- Aggregate & sector level impacts
- Consumer impacts
- Country impacts

Link to Power systems workstream

Consumer prices & market design

Briefing note

2

The impact on jobs