

“The fragility of the fossil fuel system: possible pathways and initiatives to a just and equity transition”

Mark Campanale, Founder & CEO, Carbon Tracker

11th December 2025



Carbon Tracker: Financial Think Tank

Covering key research themes...

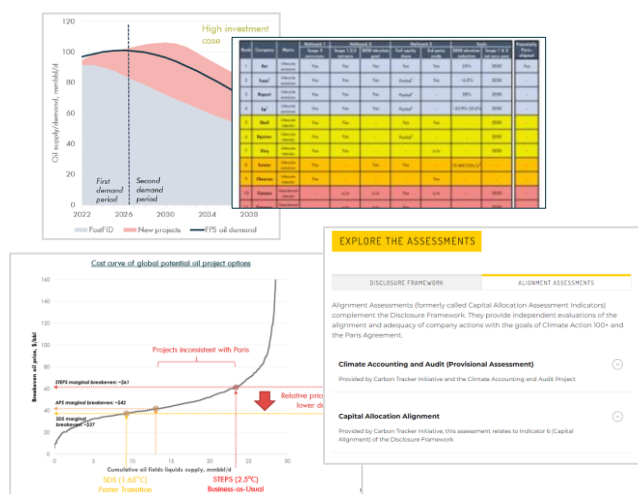
- Financial and strategic implications of the energy transition
- Assessment of corporate climate-alignment
- Key considerations for financial regulators and policymakers

...within a range of tailored research products

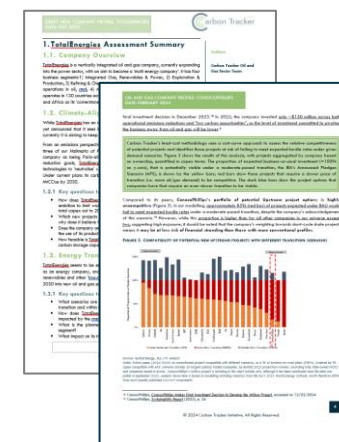
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The window of time to achieve the goals of the Paris Agreement is rapidly shrinking, and yet oil and gas companies are still failing to take the requisite actions to align their activities with Paris.

Meanwhile, investor demand for assessments of climate alignment is growing: more and more investors with a 'universal owner' investment perspective are recognising the risks that climate change poses to their wider portfolios, while others are seeking for their investments to be managed 'sustainably'.

Investors can also use climate alignment assessments as a proxy for transition risk exposure to low carbon future scenarios.

This report provides investors with climate alignment and transition risk exposures for 25 of the world's largest listed oil & gas companies.

The note is aimed at portfolio managers, analysts, sustainability & stewardship teams. It provides:

- Our first **Combined Alignment Assessment**, which identifies the leaders and laggards on Paris alignment, assessed according to Carbon Tracker's key metrics:
 - Investment Options
 - Production plans

SUMMARY VIDEO

Watch Here!

20 March | Online As the energy transition continues to accelerate, demand for each of the fossil fuels is...

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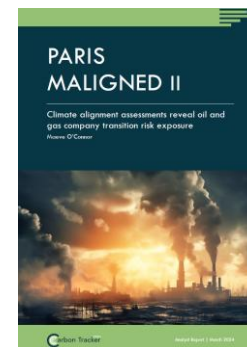
SUPPORTING EXCEL FILE WITH CHARTS

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FIGURE 2: COMPATIBILITY OF POTENTIAL NEW UPSTREAM PROJECTS WITH MODERATE AND SLOW TRANSITION SCENARIOS - EXTENDED COMPANY UNIVERSE

APS Quartile	Company	Unsanctioned Capex inside of a Moderate Transition (APS/7 C)	Unsanctioned Capex outside of a Moderate Transition (APS/7 C) / Inside of a Slow Transition	Unsanctioned Capex outside of a Slow Transition (STEP/2 4 C)
1	Baytex Energy	0-10%	30-100%	10-20%
1	Chord Energy	0-10%	30-100%	10-20%
1	Civitas Resources	0-10%	30-100%	10-20%
1	ConocoPhillips	10-20%	30-100%	10-20%
1	Ecopetrol	20-40%	30-100%	10-20%
1	Enerplus Corporation	10-20%	30-100%	10-20%
1	Marathon Oil	20-30%	30-100%	10-20%
1	Marathon Petroleum	30-40%	30-100%	10-20%
1	Murphy Oil	30-40%	30-100%	10-20%
1	Northern Oil & Gas	0-10%	30-100%	10-20%
1	Quintiv	10-20%	30-100%	10-20%
1	Parex Resources	0-10%	30-100%	10-20%
1	Permian Resources	0-10%	30-100%	10-20%
1	Petrobras	30-40%	30-100%	10-20%
1	Pioneer	10-20%	30-100%	10-20%
1	Suncor	0-10%	30-100%	10-20%
2	APA Corporation	30-40%	30-100%	10-20%
2	Antero Resources	40-50%	30-100%	10-20%
2	bp	50-60%	30-100%	10-20%
2	Cenovus Energy	40-50%	30-100%	10-20%
2	Chevron	50-60%	30-100%	10-20%
2	Crescent Point Energy	40-50%	30-100%	10-20%
2	Devon	40-50%	30-100%	10-20%
2	ExxonMobil	40-50%	30-100%	10-20%
2	Hess	30-40%	30-100%	10-20%
2	Magnolia Oil & Gas	50-60%	30-100%	10-20%
2	Occidental	30-40%	30-100%	10-20%
2	Range Resources	50-60%	30-100%	10-20%
2	Repsol	50-60%	30-100%	10-20%
2	Santos	40-50%	30-100%	10-20%
2	SM Energy	40-50%	30-100%	10-20%
2	Vermilion Energy	30-40%	30-100%	10-20%
3	Aker BP	60-70%	30-100%	10-20%
3	Beach Energy Limited	50-60%	30-100%	10-20%
3	CNOOC	60-70%	30-100%	10-20%
3	Chesapeake	60-70%	30-100%	10-20%
3	Comstock Resources	60-70%	30-100%	10-20%
3	EOG	50-60%	30-100%	10-20%
3	EDT	60-70%	30-100%	10-20%
3	Equinor	60-70%	30-100%	10-20%
3	Paramount Resources	60-70%	30-100%	10-20%
3	PetroChina	60-70%	30-100%	10-20%
3	Saudi Aramco	60-70%	30-100%	10-20%
3	Shell	60-70%	30-100%	10-20%
3	Southwestern	60-70%	30-100%	10-20%
3	TotalEnergies	50-60%	30-100%	10-20%
3	Toullane Oil	50-60%	30-100%	10-20%
3	Whitecap Resources	50-60%	30-100%	10-20%
4	Arc Resources	70-80%	30-100%	10-20%
4	CNOOC	70-80%	30-100%	10-20%
4	NX Resources Corporation	70-80%	30-100%	10-20%
4	Coterra Energy	70-80%	30-100%	10-20%
4	Diamondback Energy	70-80%	30-100%	10-20%
4	Eni	70-80%	30-100%	10-20%
4	Galp	70-80%	30-100%	10-20%
4	Harbour Energy plc	70-80%	30-100%	10-20%
4	Imperial Oil	70-80%	30-100%	10-20%
4	Inpeti	70-80%	30-100%	10-20%
4	Kosmos Energy	70-80%	30-100%	10-20%
4	MEG Energy	70-80%	30-100%	10-20%
4	OMV	70-80%	30-100%	10-20%
4	Sinpec	70-80%	30-100%	10-20%
4	Via Energy	70-80%	30-100%	10-20%
4	Woodside	70-80%	30-100%	10-20%



61 companies in downloadable Excel



Clean technology revolution displaces fossil
fuel use for heat, power and transport

Inevitable Energy Transition: Key Messages



The fossil fuel industry is facing an irreversible decline in demand driven by technology revolution & accelerated by policy action.



Lower demand & price for fossil fuels impacts government revenues, regardless of production costs – all O&G exporting countries will be affected.



Most petrostates would see over 50% of expected O&G revenue lost under a moderate-paced energy transition.



Fragile O&G dependent states need international support to diversify their economies away from fossil fuels, and support green economic growth.



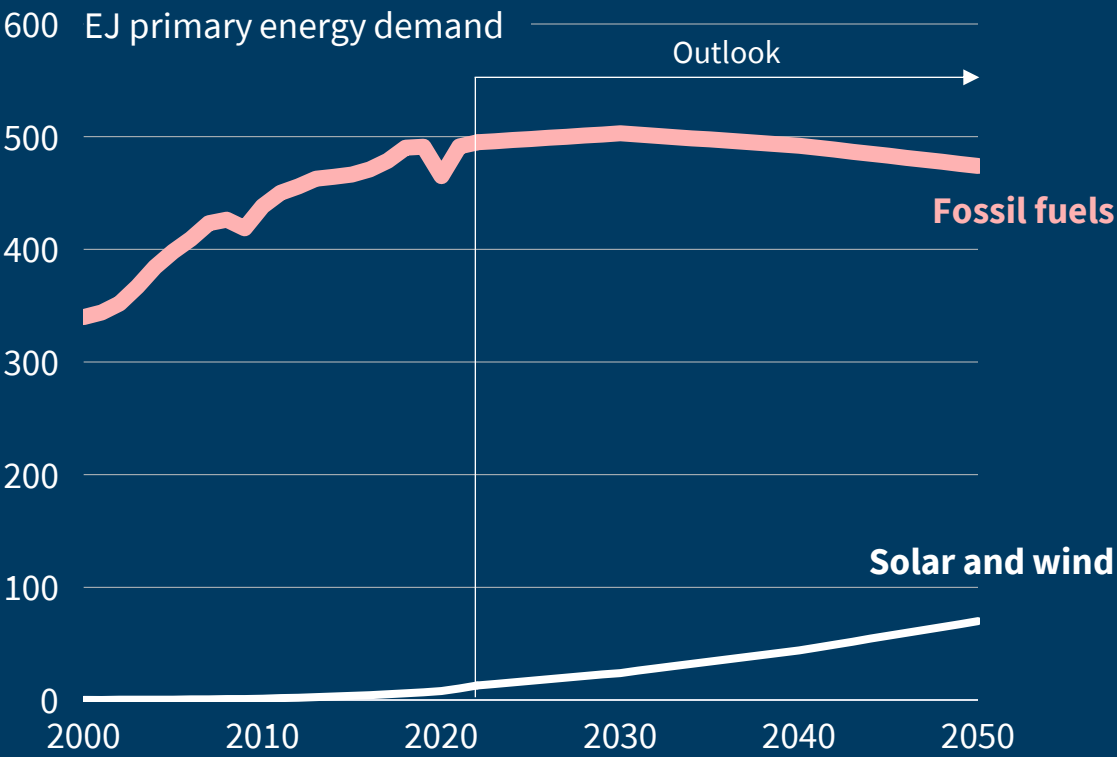
Reduction in future revenues increases debt and impacts creditworthiness of countries, with implications for sovereign markets.



The two visions of the energy future

The **old commodities** narrative of business-as-usual: reducing fossil fuel demand will be slow, expensive, and painful

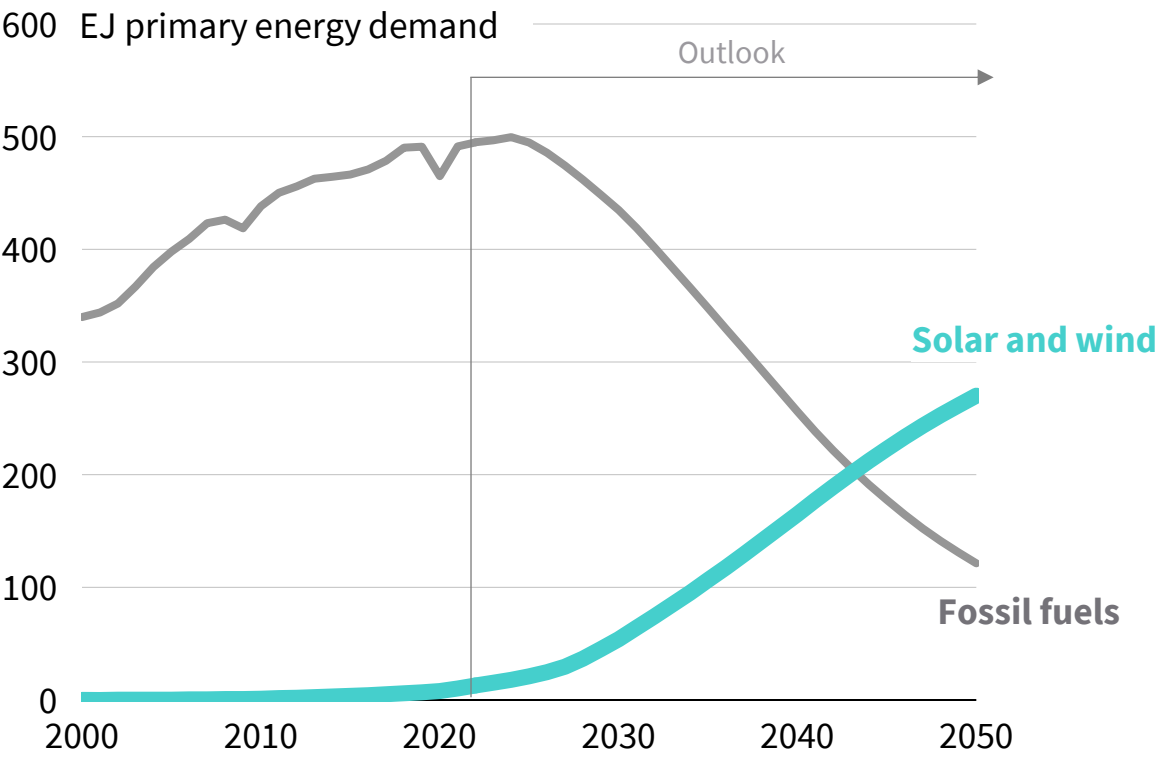
The old guard's energy outlook



Source: Exxon Mobil Global Outlook 2023.

The **new technology** narrative of exponential and beneficial change: a shift to a cheaper, faster, and distributed energy system

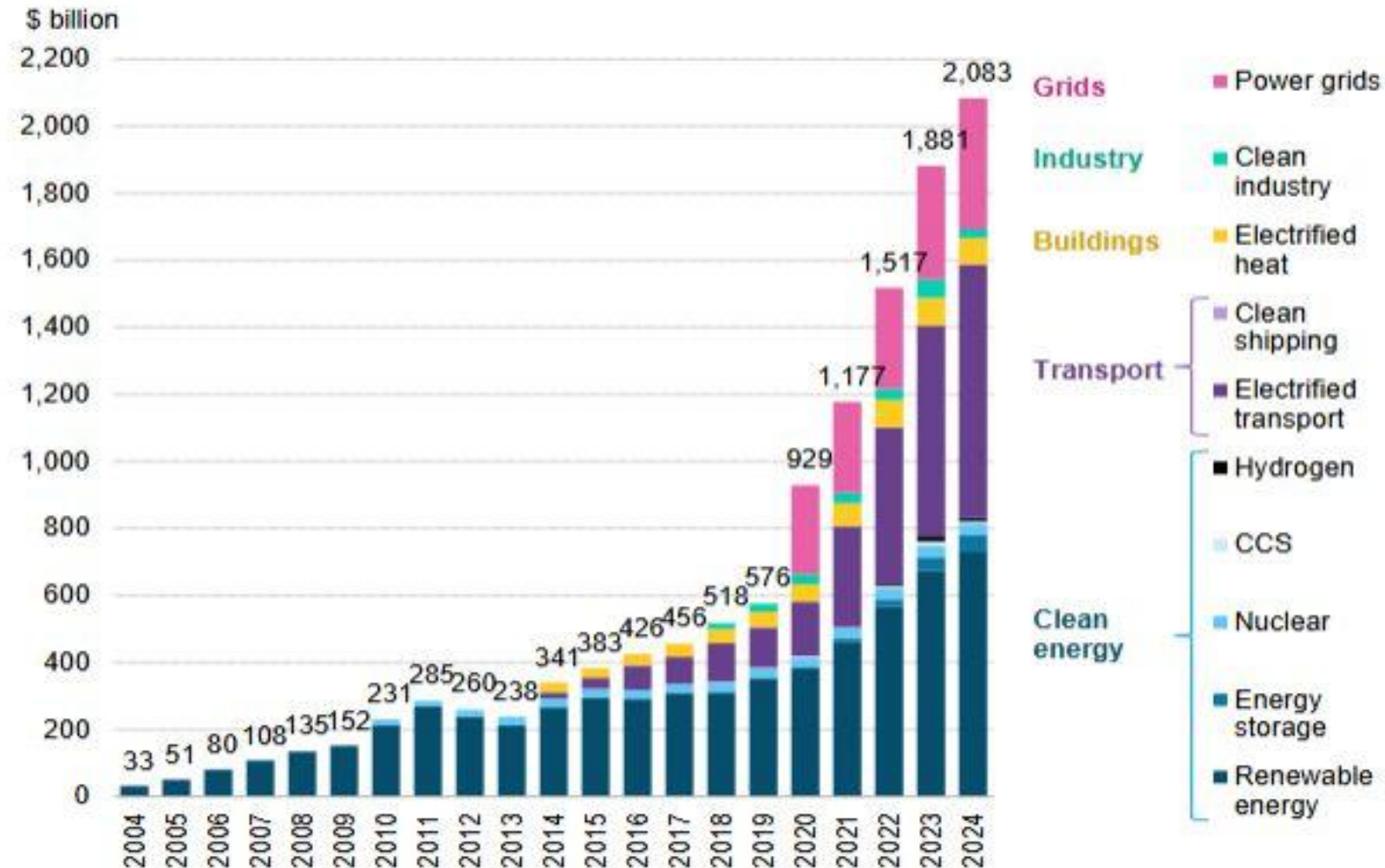
The new technology insurgent's energy outlook



Source: Rystad Energy 1.6°C Scenario.

Capital has poured into cleantech

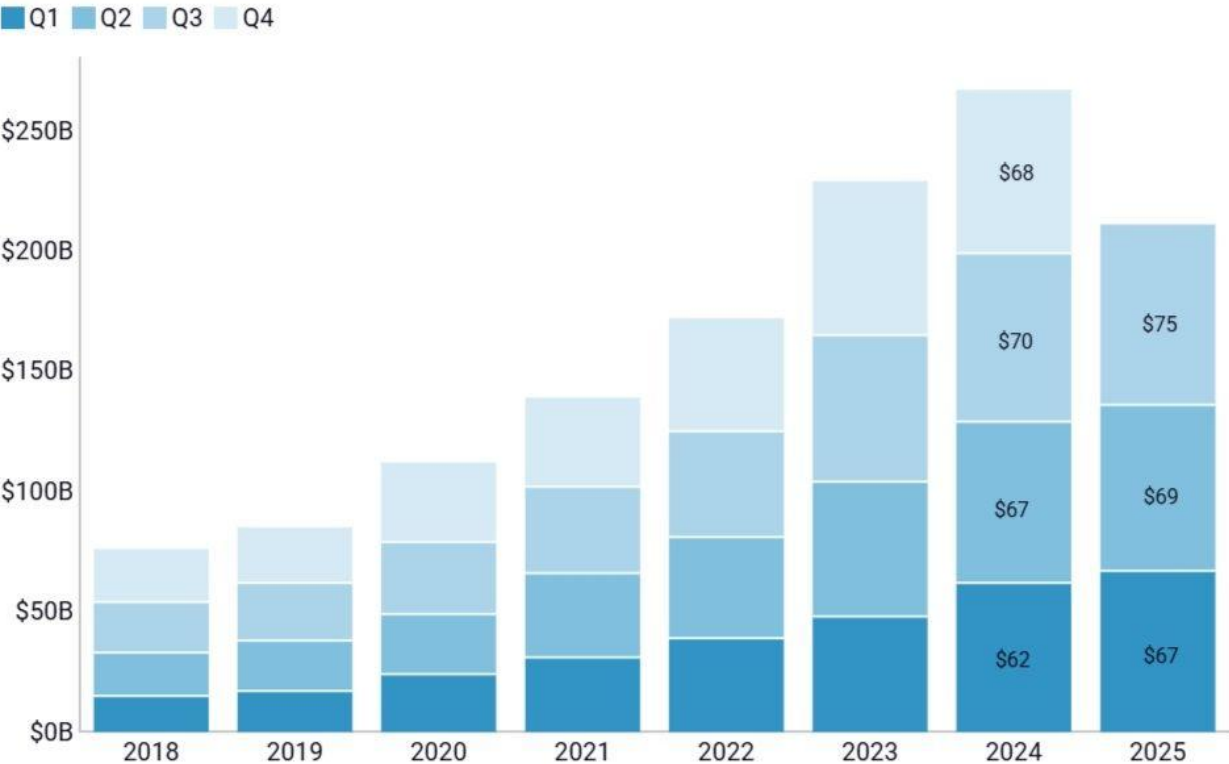
Global investment in energy transition, by sector



Source: BloombergNEF. Note: Start years differ by sector but all sectors are present from 2020 onwards; see [Methodology](#) for more detail. Most notably, nuclear figures start in 2015 and power grids in 2020. CCS refers to carbon capture and storage.

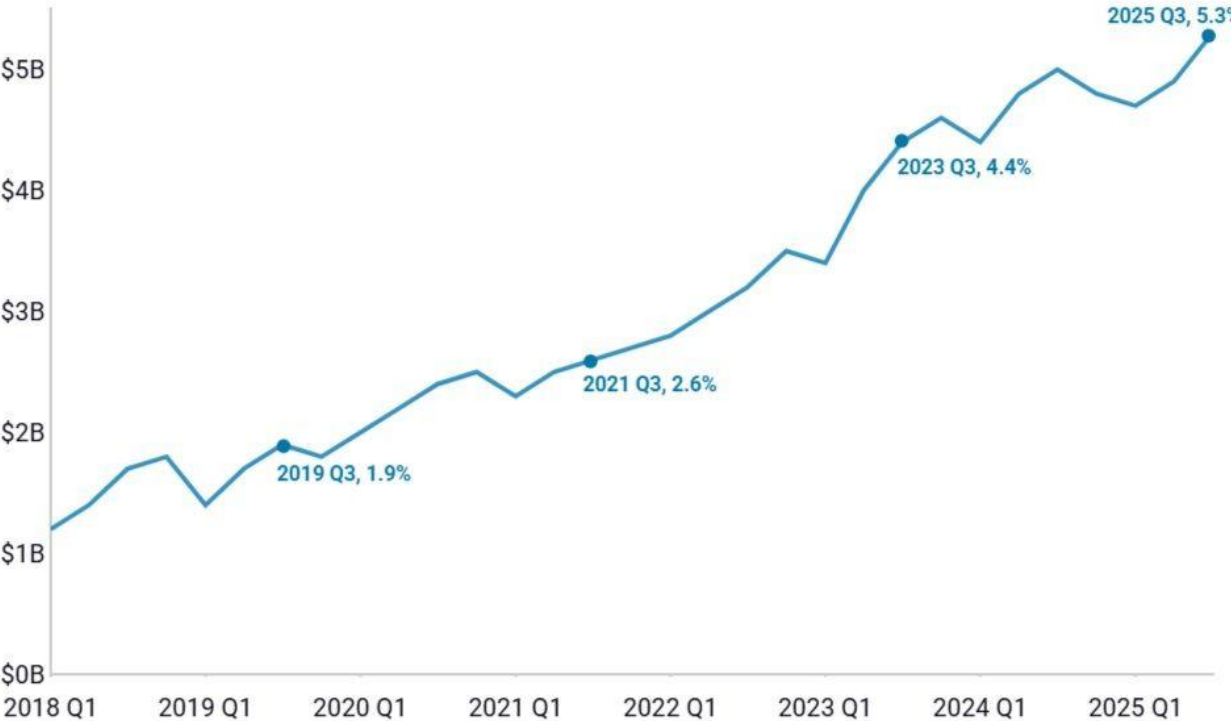
Cleantech Spending May Hit Record Despite Trump

FIGURE 1
Clean investment by quarter
Billion 2024 USD



Source: Rhodium Group/MIT/CEEPR Clean Investment Monitor

FIGURE 2
Actual clean investment as a share of total US private investment
Annualized basis, total investment in all private structures, equipment, and durable consumer goods



Source: Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor and Bureau of Economic Analysis



Technology transformation ends the fossil fuel system



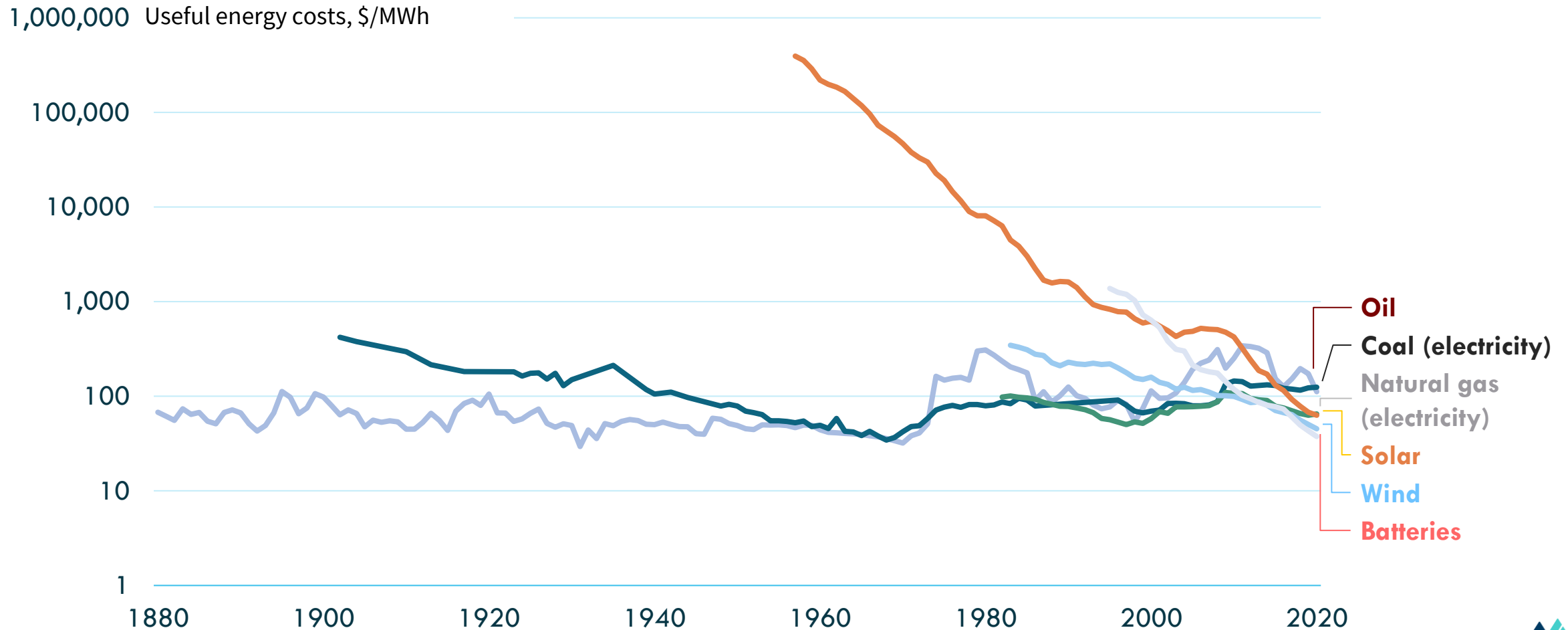
"Investors are waking up to the biggest investment opportunity in the history of the world...In economics, things take longer to happen than you think they will... and then they happen faster than you thought they could."

Al Gore

Technologies beat commodities on costs

Manufactured technologies (e.g., solar and wind) enjoy cost learning curves; (fossil) commodities don't

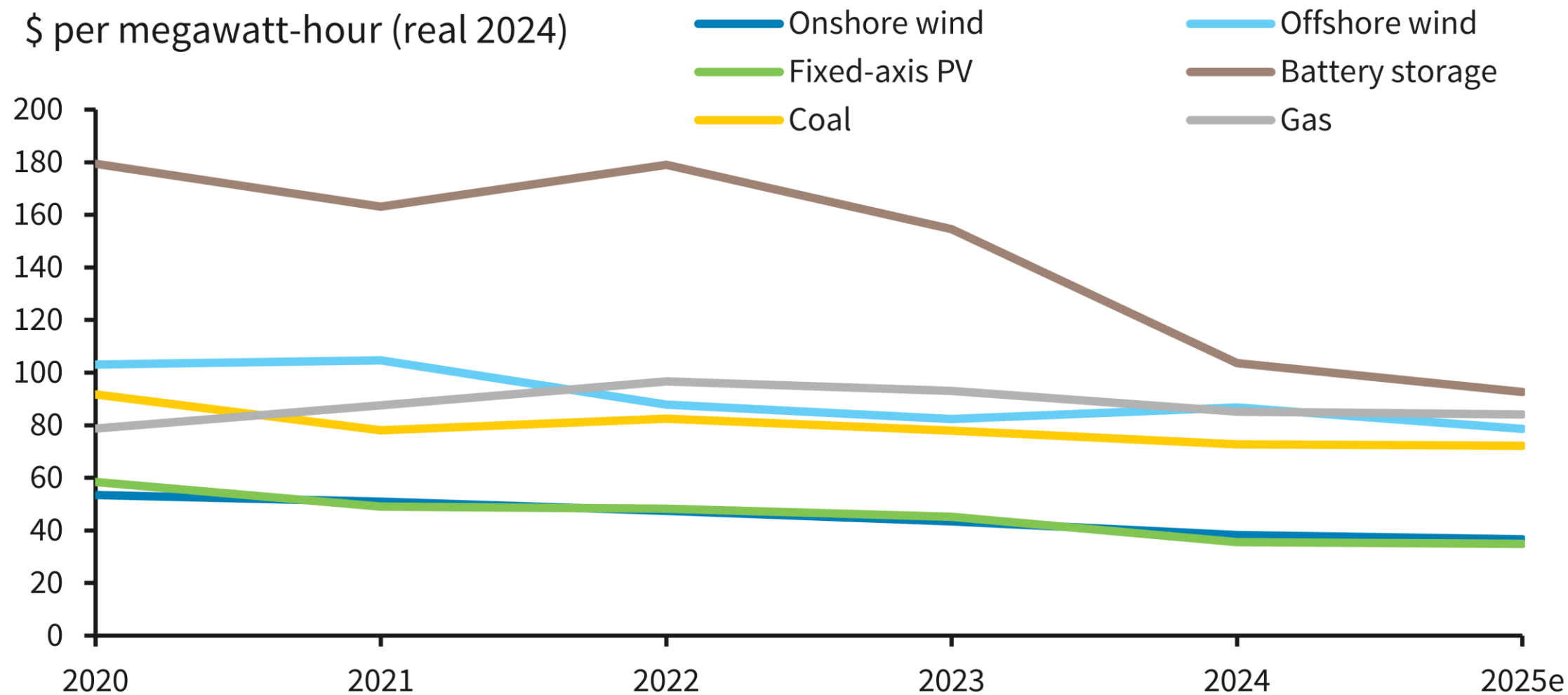
Historical costs of energy sources



• Source: Way et al. 2022. Individual fossil fuel technologies of course do have learning curves; but because of depletion and cartels, fossil fuel prices have not shown structural decline over time.

Clean energy technology costs has declined significantly

many below cost of hydrocarbon-powered generation, even on an LCOE-basis

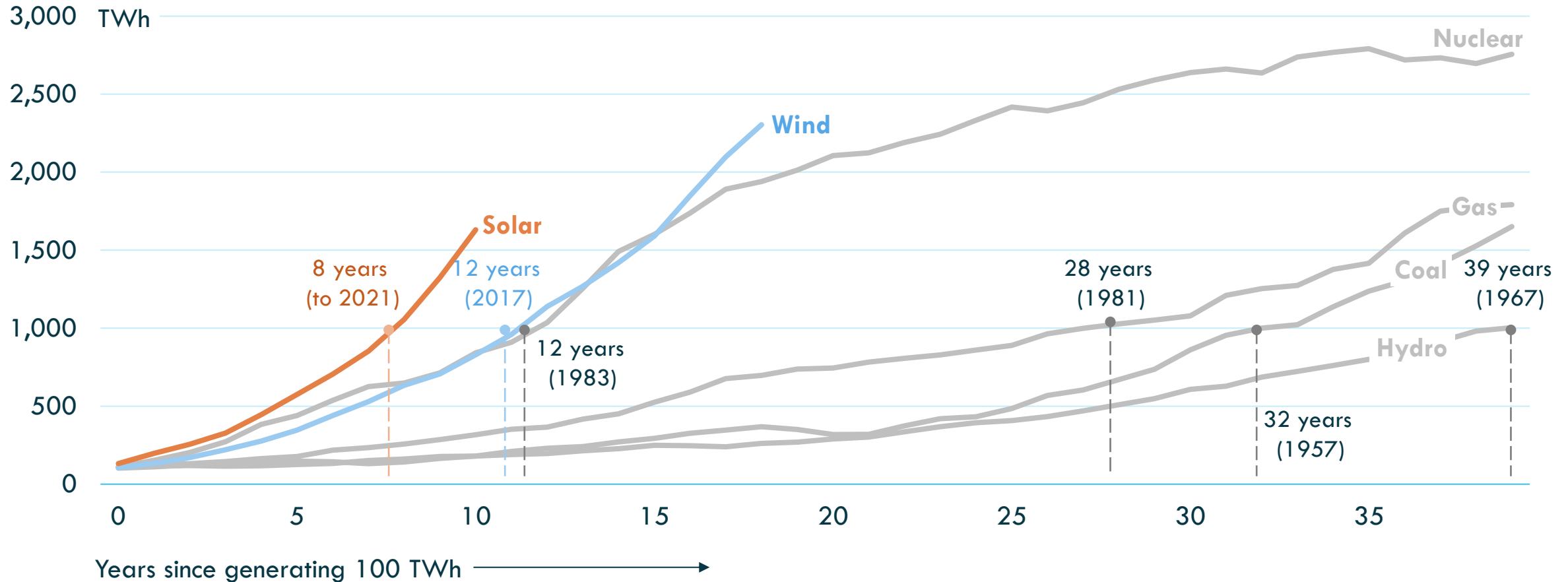


• Source: Barclays Bank, 10th Feb 2025.

Technologies beat commodities on speed

- Manufactured technologies grow fast; commodities grow slowly

Electricity generation after reaching 100 TWh

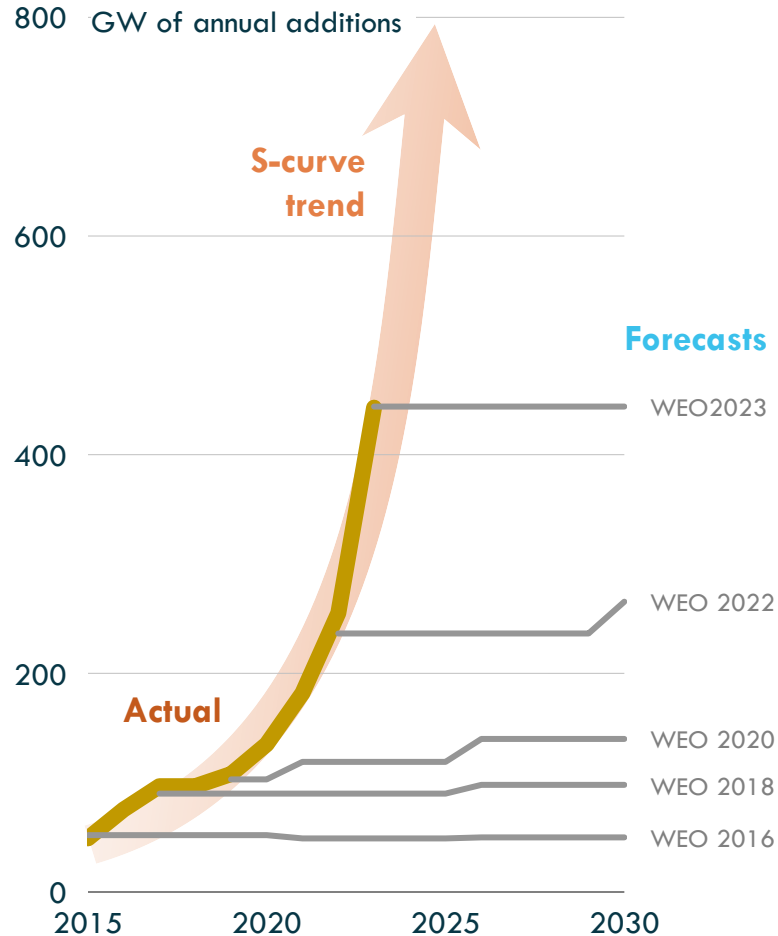


• Source: Ember 2023 Global electricity review; Wind and solar generation data from Ember annual electricity data, nuclear, gas, coal and hydro generation data from Pinto et al. (2023). This graphic is based on a chart by Nat Bullard. Nuclear technologies in 2024 have a 10–15 year lead time.

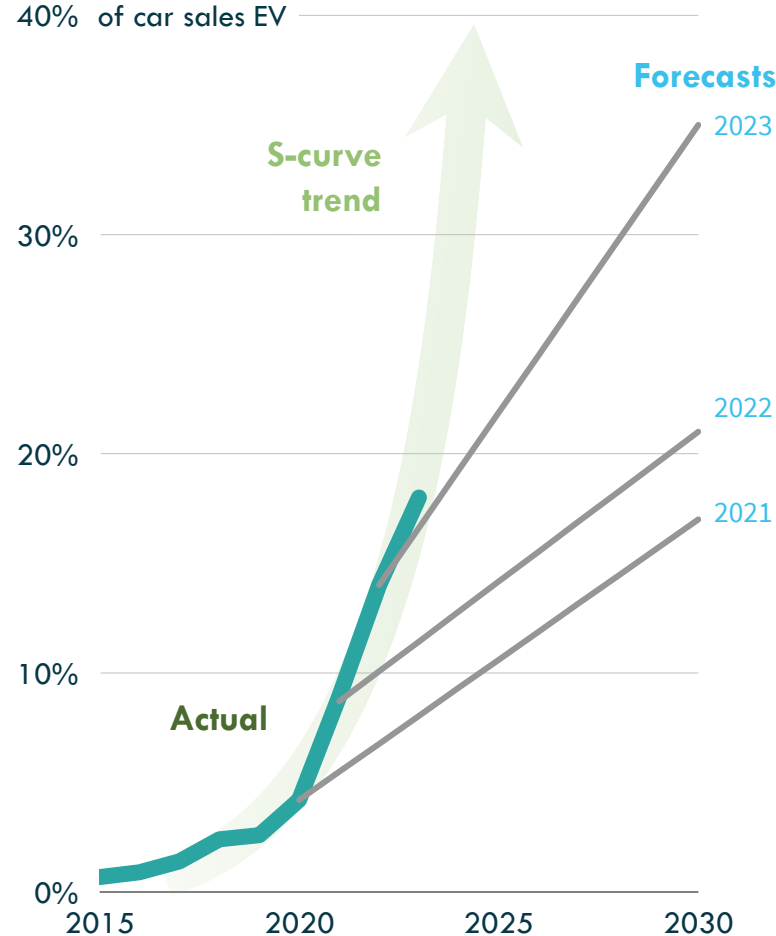
Incumbents have underestimated the speed of change

- Even neutral actors modeled in **linear** terms. But change has been exponential

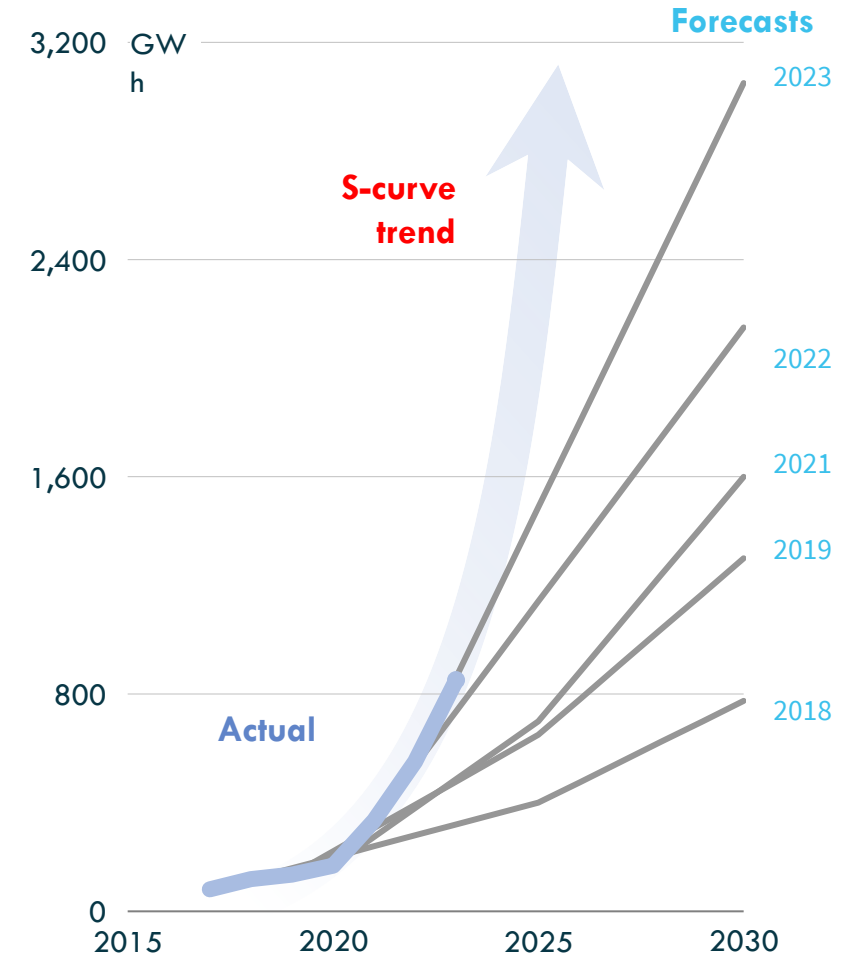
New solar additions



EV share of sales



Battery sales

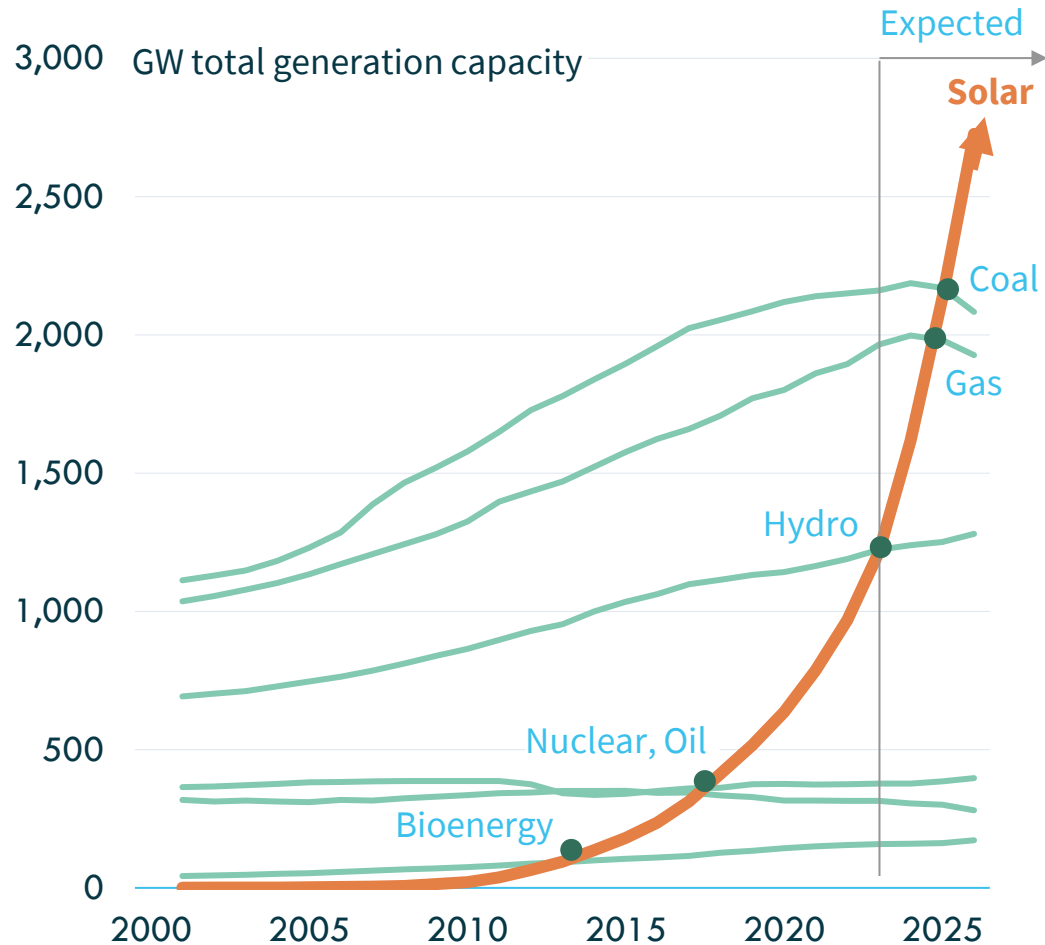


• Source: BNEF (solar and battery actuals), IEA STEPS for WEO forecasts, RMI annotation.

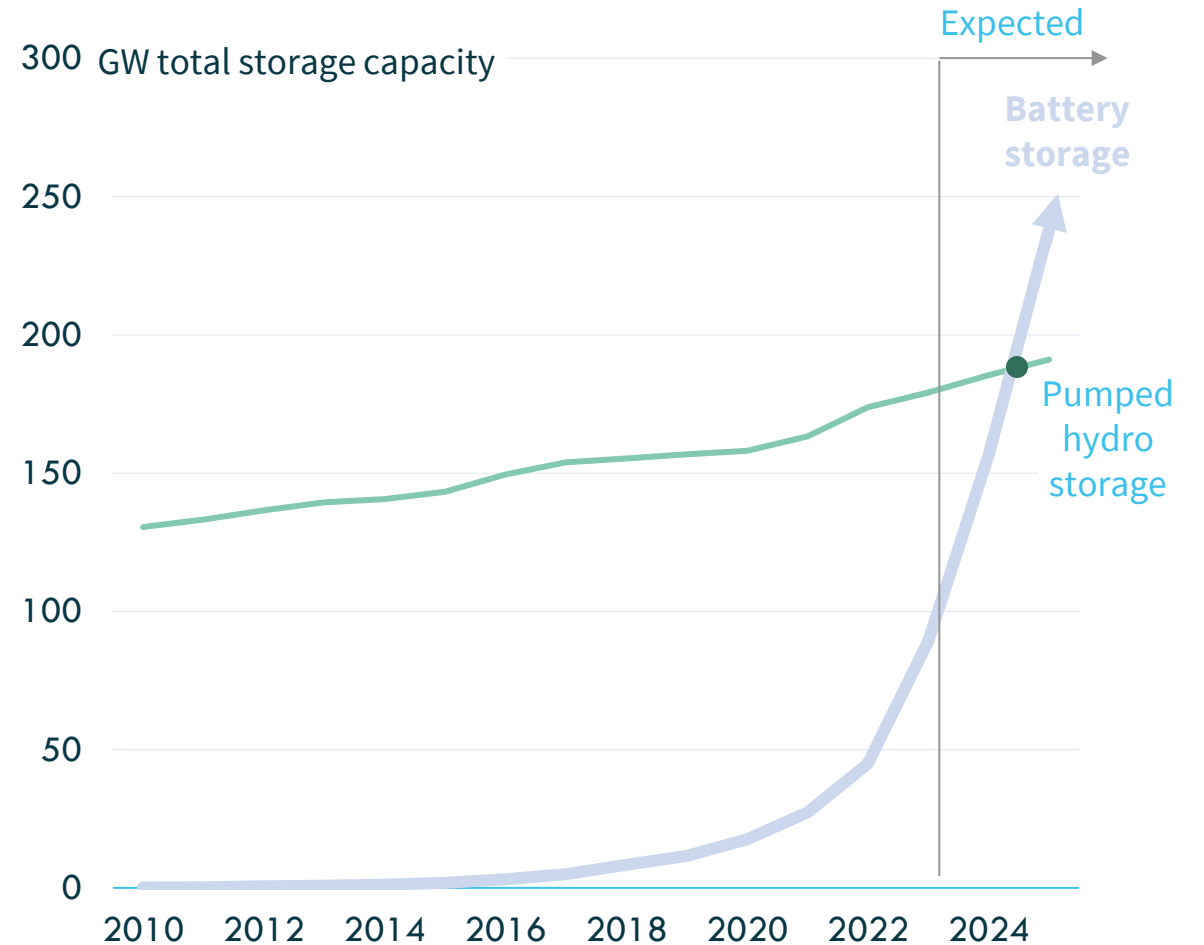
Solar and batteries are taking over

- Solar will shortly overtake every other type of capacity, and battery storage will leapfrog pumped hydro

Solar



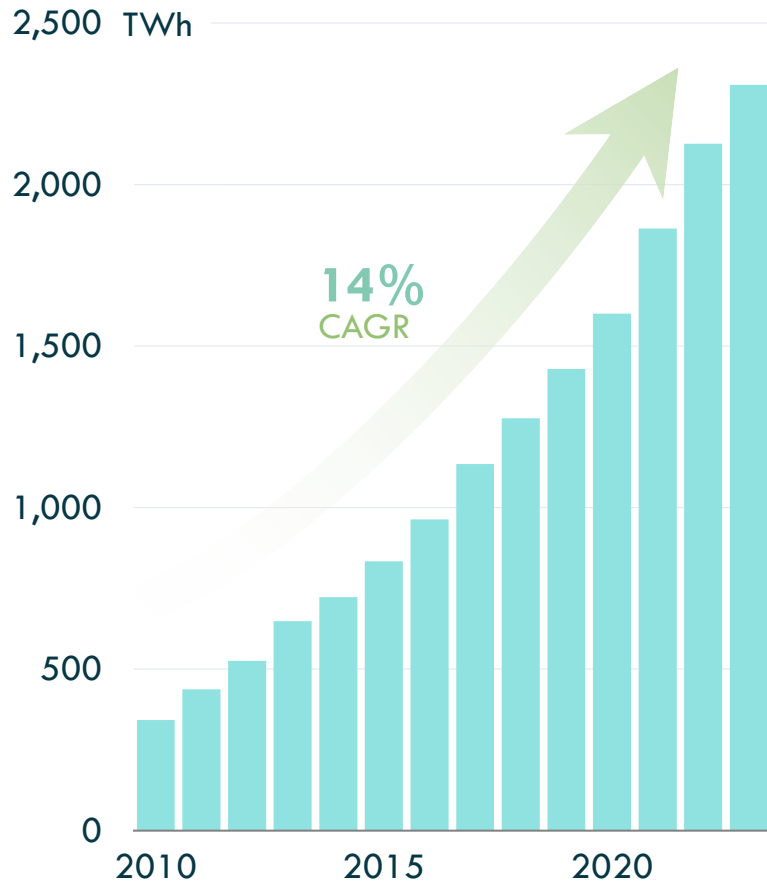
Batteries



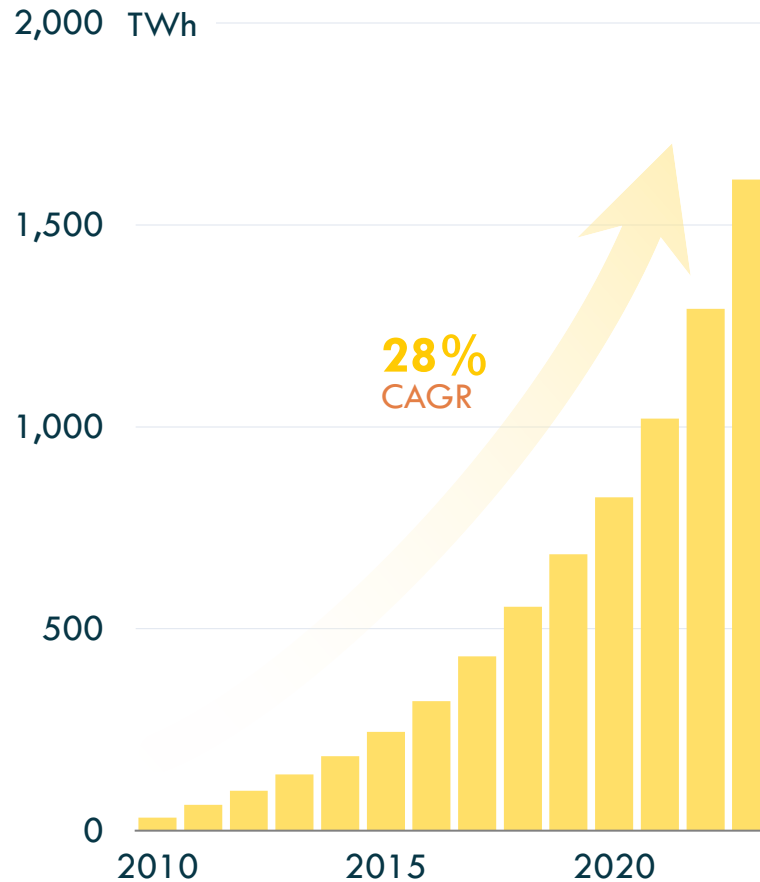
Leading to exponential growth in renewables

- Global solar generation has been doubling every 2–3 years, and battery storage capacity every year

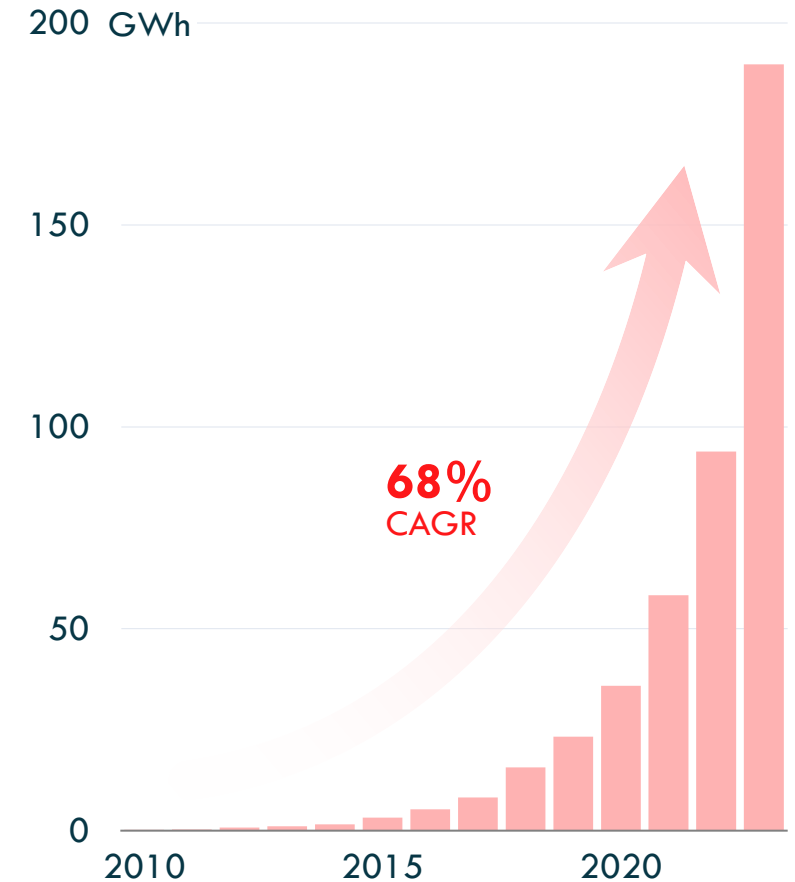
Wind generation



Solar generation



Battery storage

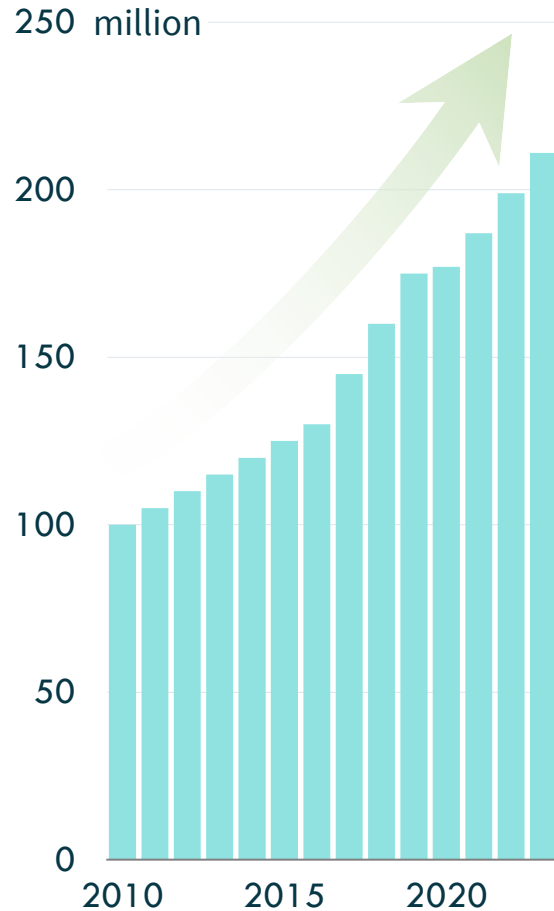


• Source: IEA, BNEF; Note: CAGR is the compound annual growth rate between 2013 and 2023.

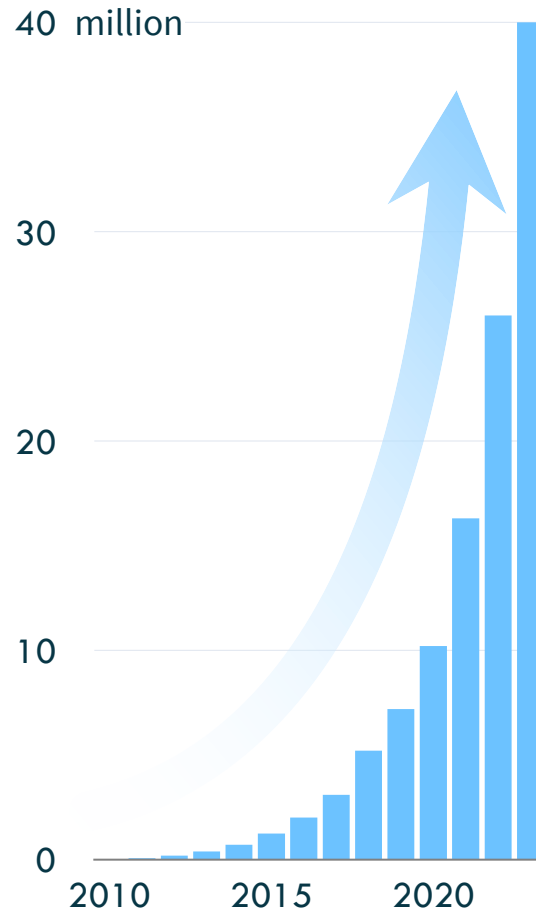
We are poised to electrify the rest of the system

•The global stock of EV cars and digital devices has been doubling every 2 years

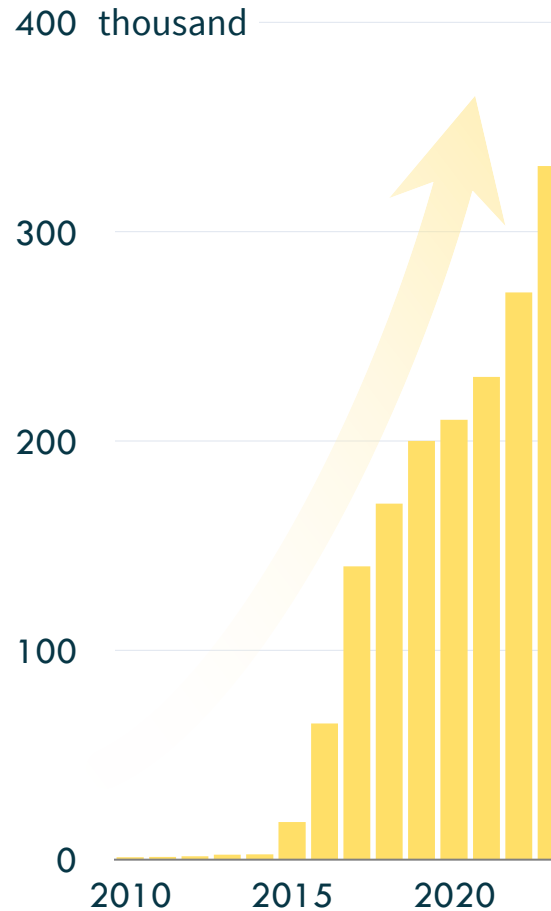
Heat pumps



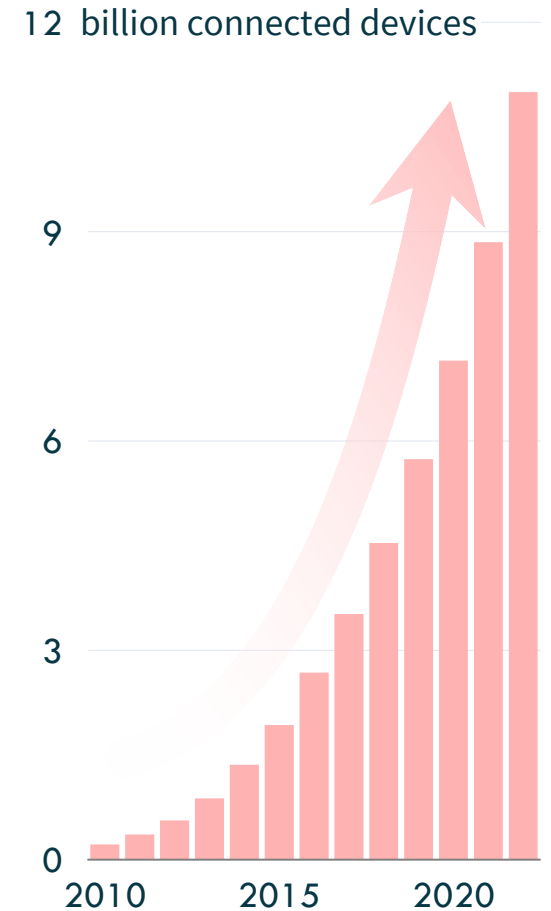
EV cars



EV trucks



Digitally enabled automated devices

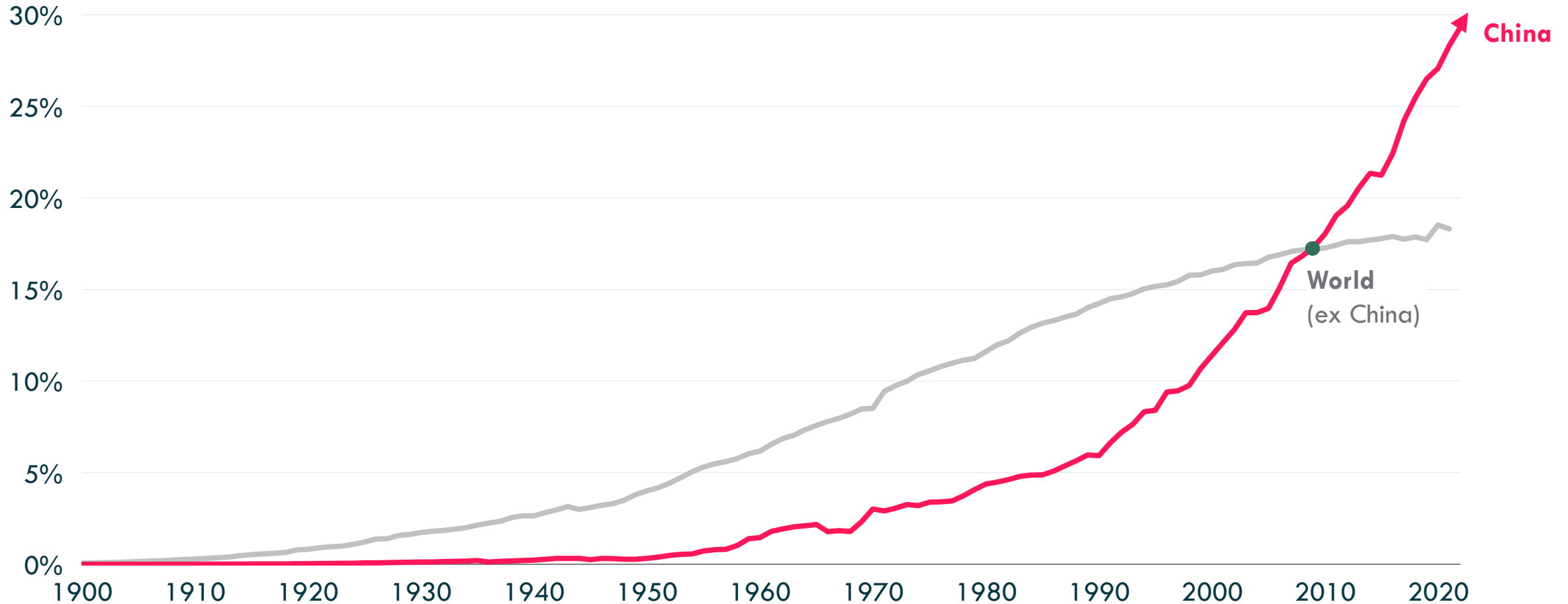


• Source: IEA, Carbon Brief for heat pumps.

China has become the first major electrostate

- China has been electrifying at 10 percentage points per decade, nine times faster than the rest of the world

Electricity share of final energy



Notes: IIASA data to 1971, IEA onward.

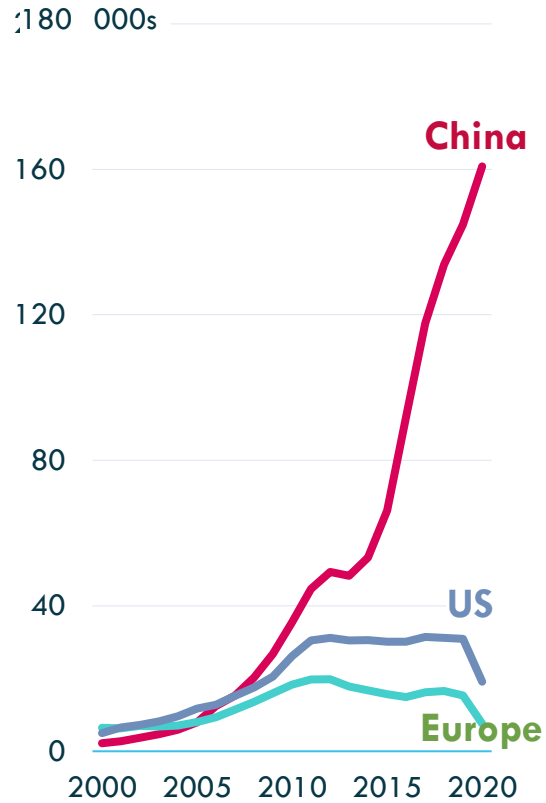
- Source: IIASA, IEA WEB. WEB defines final energy slightly differently than WEO.

The world's largest energy consumer is moving fast

- China is leading the way to patent, make, and deploy the energy technologies of the future

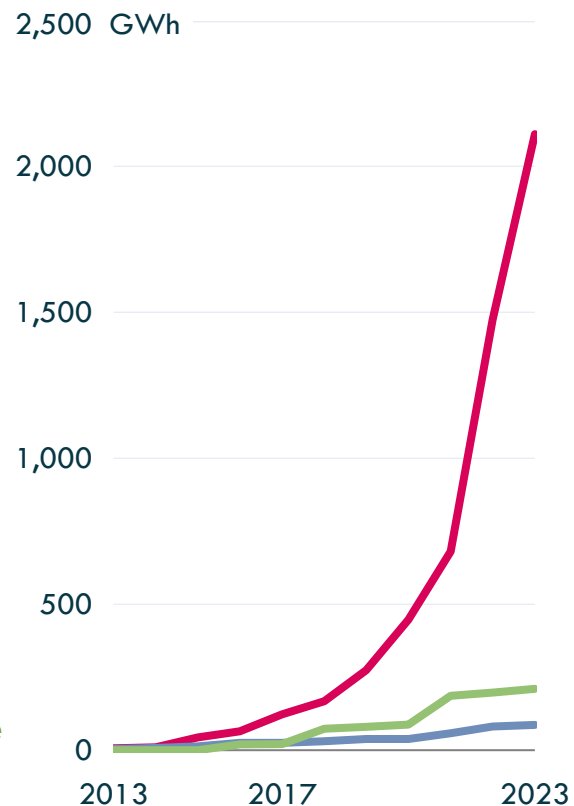
Patent

Clean energy patents



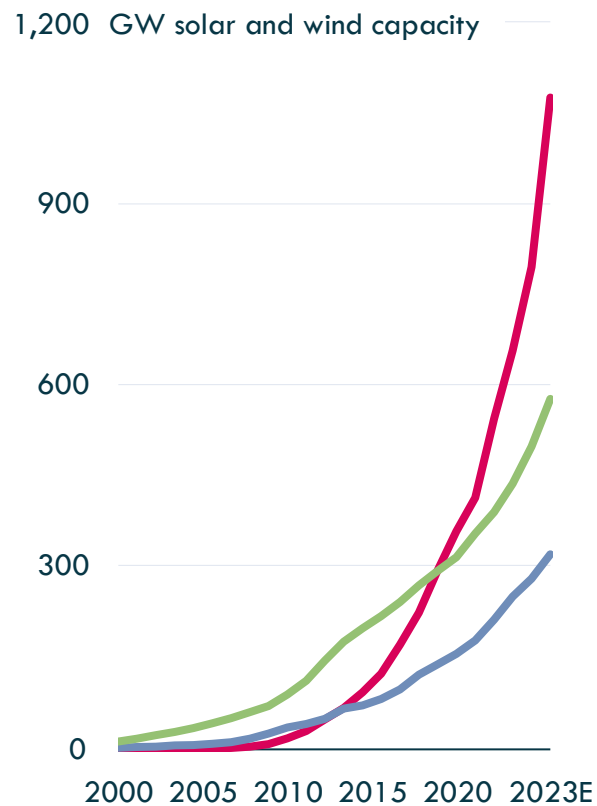
Make

Battery manufacturing capacity

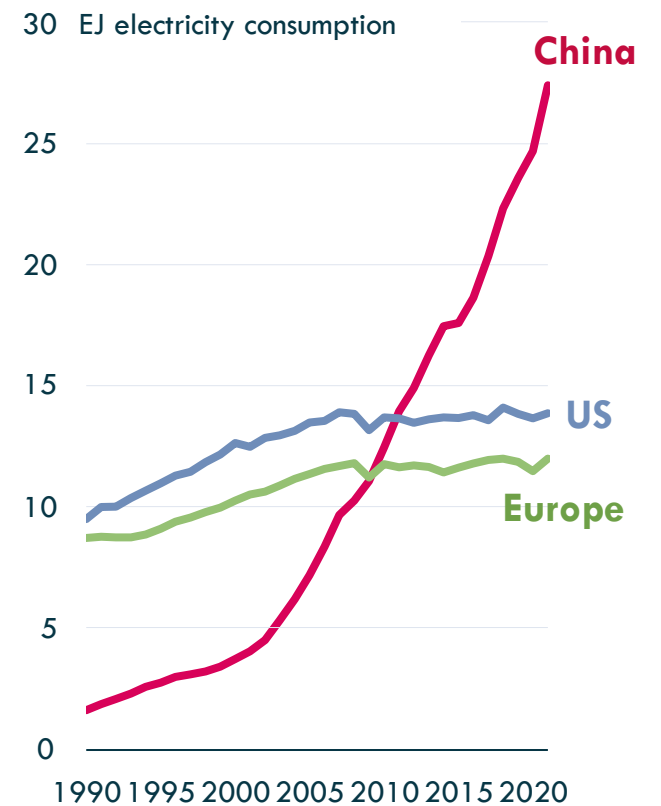


Deploy

Renewables



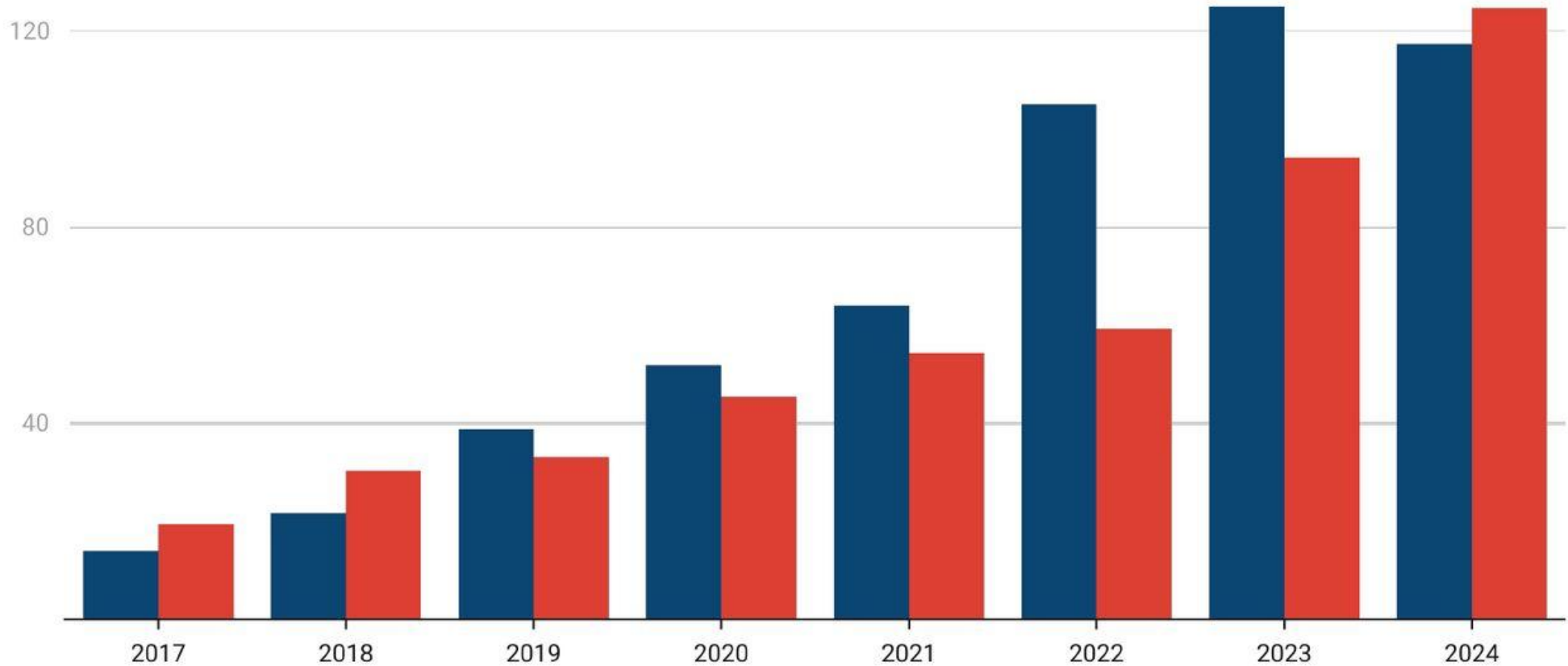
Electrification



China's solar panel exports to global south have overtaken global north after more than doubling in two years

Annual exports, gigawatts

Global north Global south

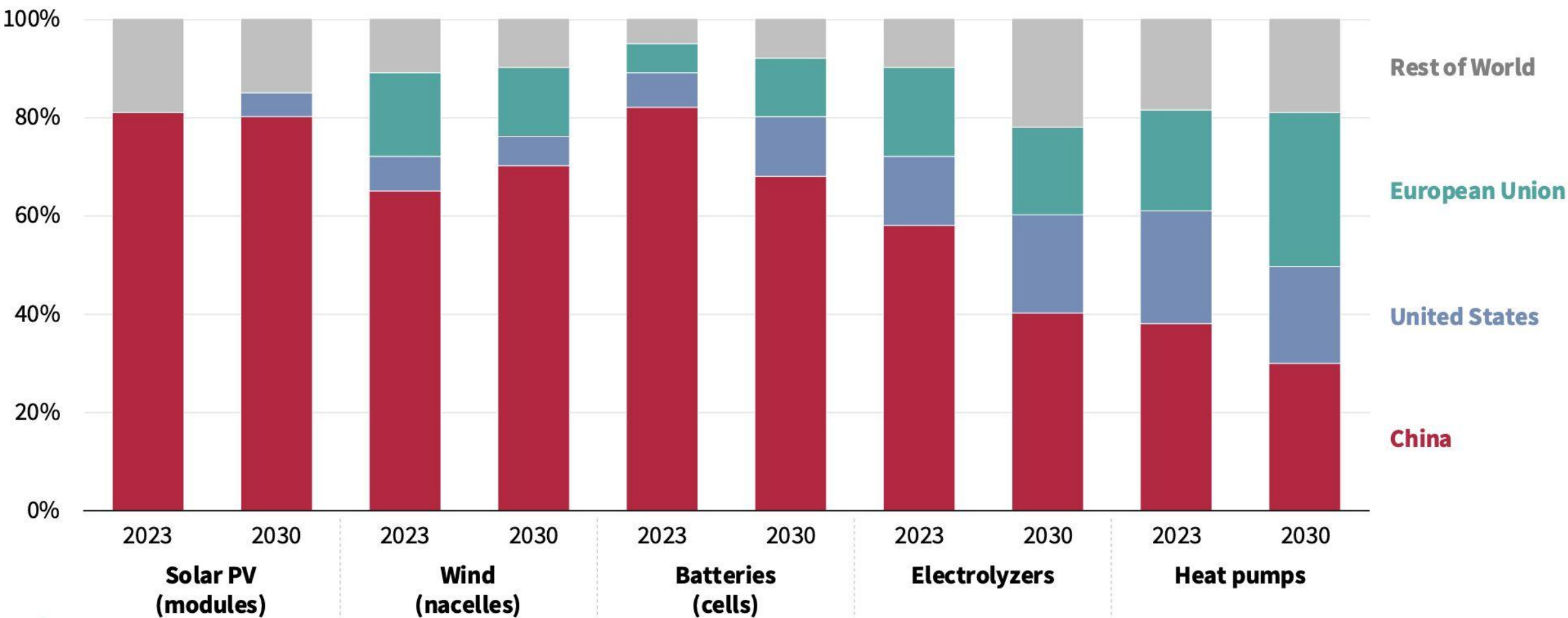


Source: Ember

China is the manufacturing hub of the transition

China dominates manufacturing of the key energy technologies of the future

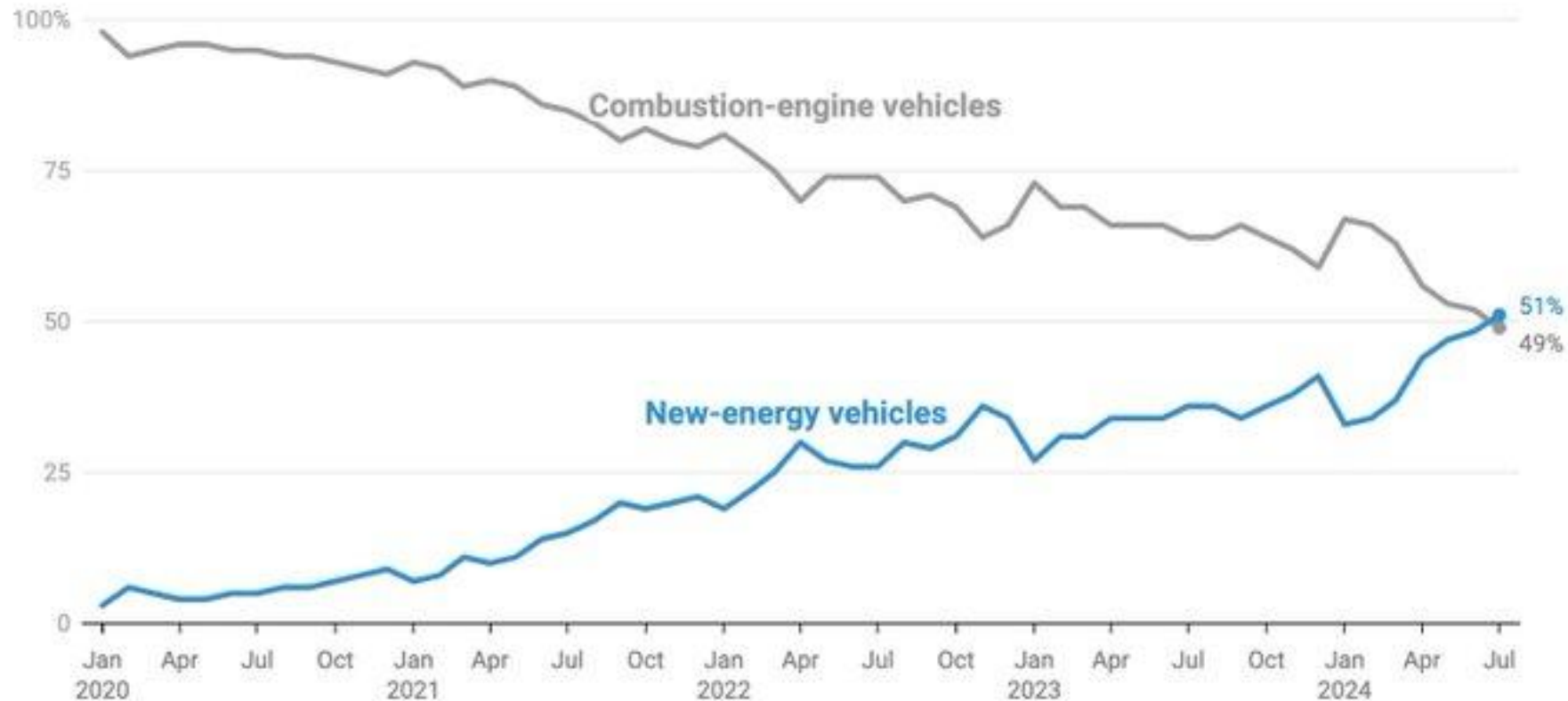
Geographical concentration of current and announced manufacturing capacity, 2023–2030



Electric Vehicle Sales: Chinese EV's outsell ICE

New-energy vehicles just topped 50% of the Chinese car market for the first time

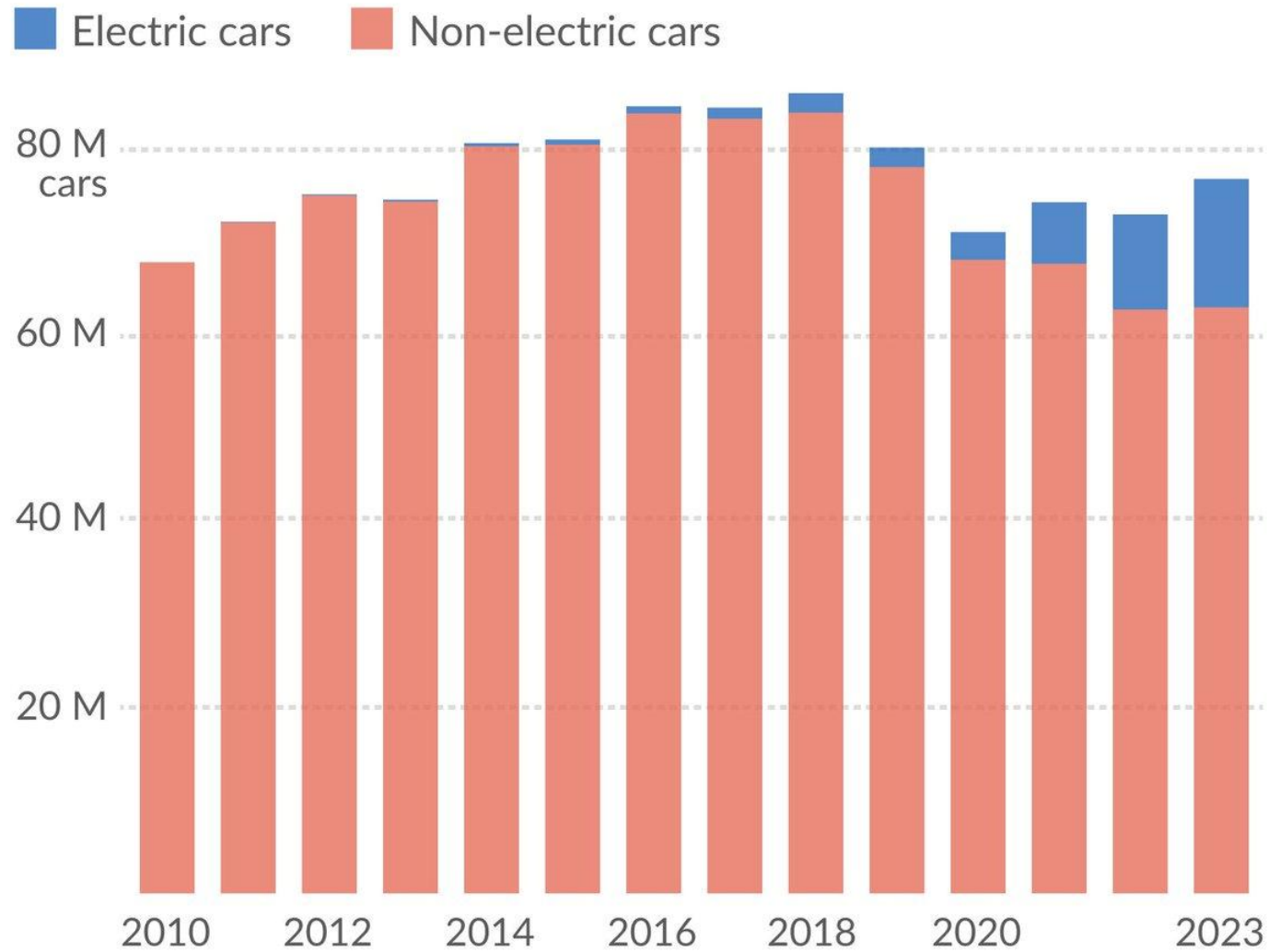
Share of passenger car retail sales in China, %



Source: China Passenger Car Association

Global sales of combustion engine cars peaked in 2018

Our World
in Data



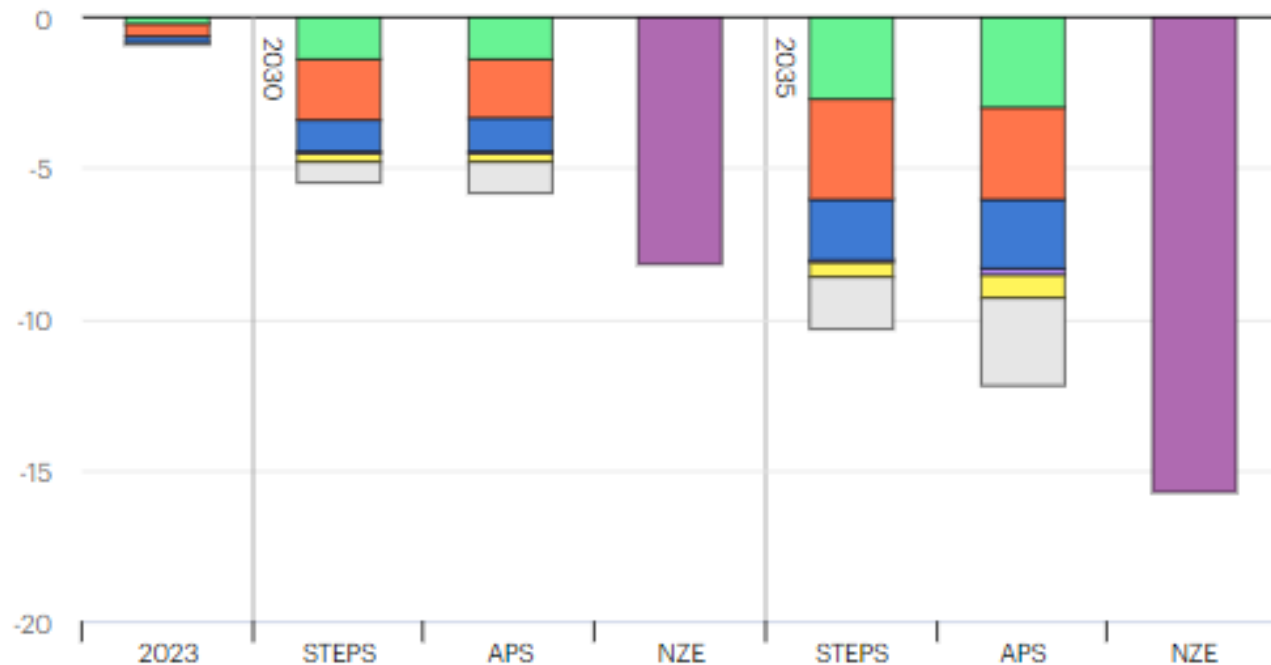
Data source: International Energy Agency. Global EV Outlook 2024.

OurWorldinData.org/energy | CC BY

Oil displacement by region, 2023-2035

Open ↗

mb/d



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United States China Europe Japan India Other World

Oil Displacement by Region, 2023-35

EV's could displace between 5-8 mb/d by 2030 (2024 demand forecasted at 83.4 mb/d)

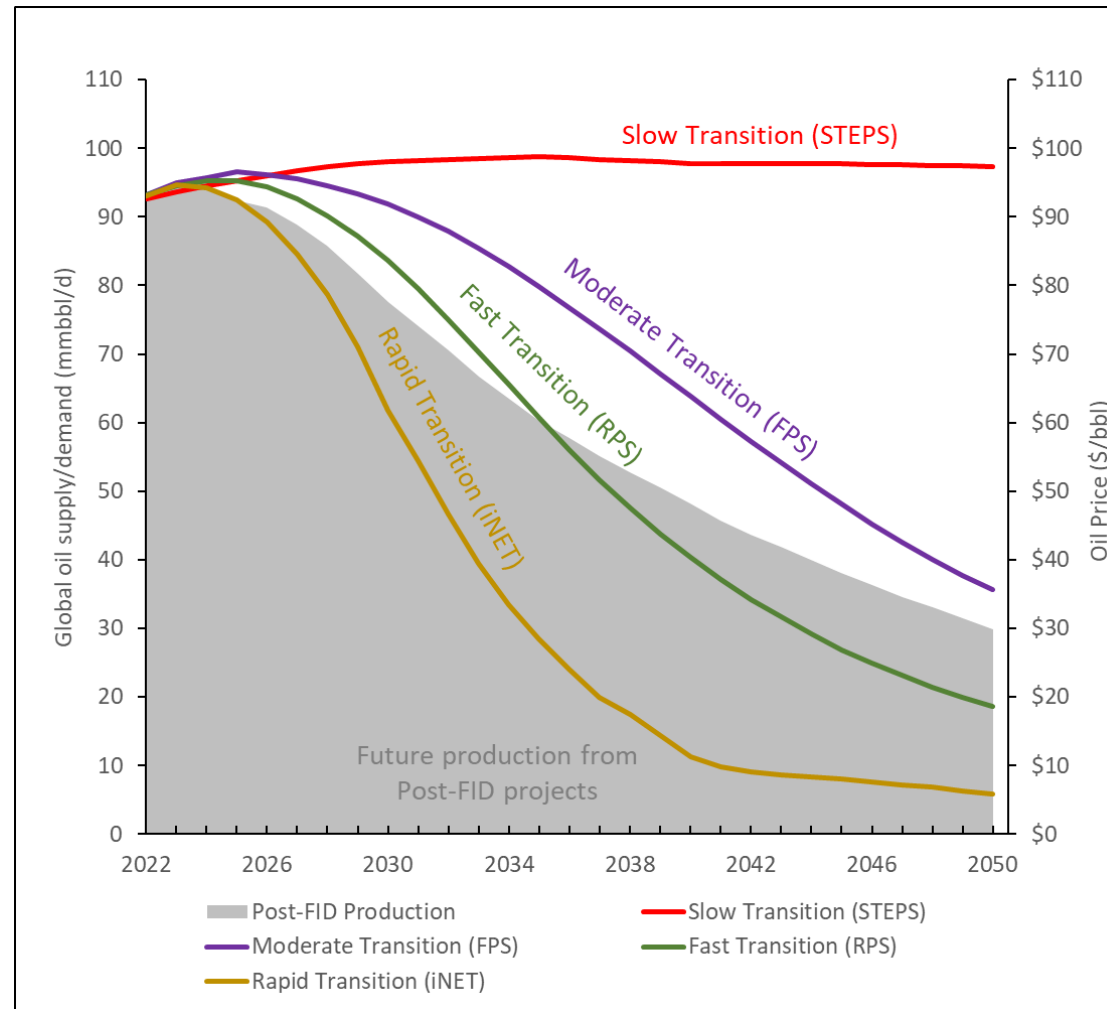
<https://www.iea.org/reports/global-ev-outlook-2024/outlook-for-battery-and-energy-demand>



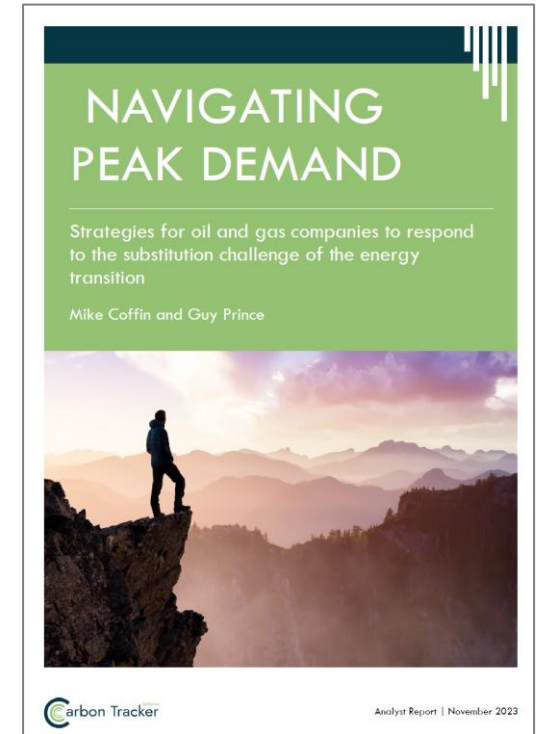


What does this mean for O&G?

The risk of overinvestment is very real



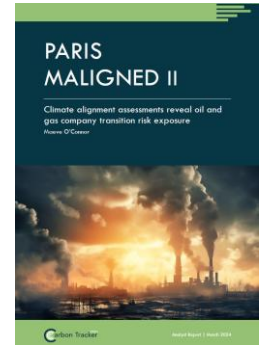
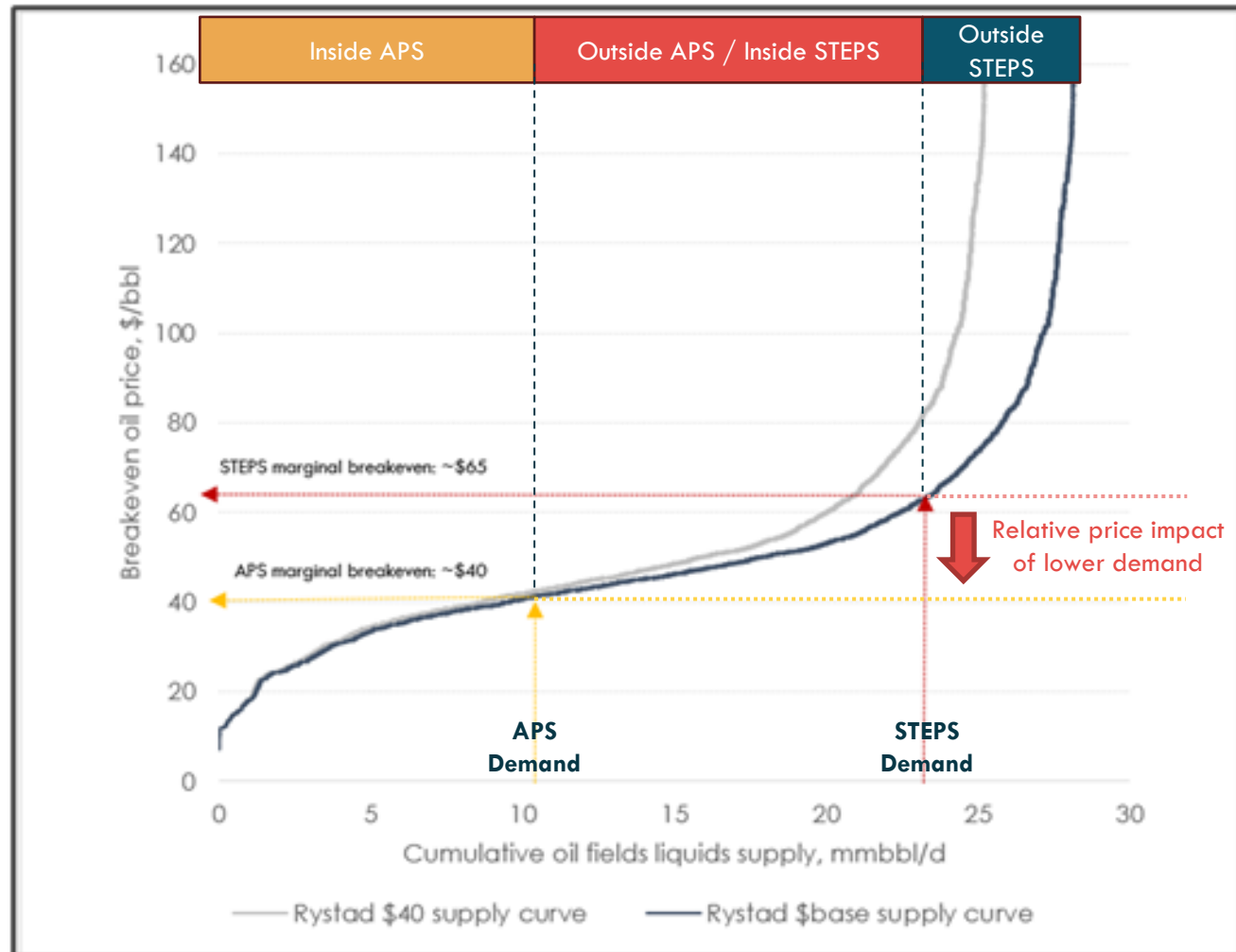
Source: IEA, IPR, Oxford iNET, Rystad Energy, Carbon Tracker analysis.



Cost Curve of Potential Supply



Cost Curve of Potential Supply

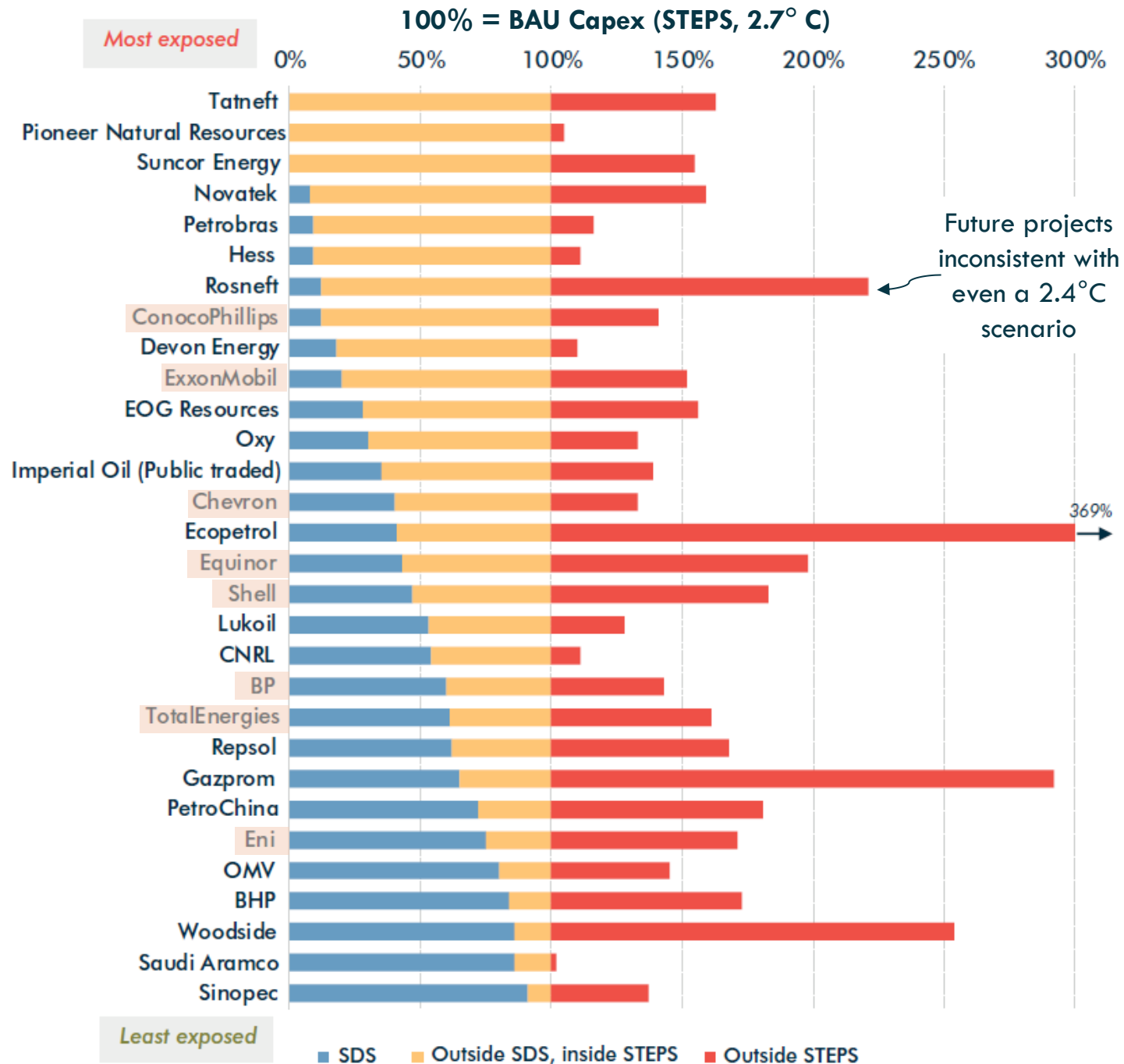


Company risk exposure varies significantly

- Listed companies could spend \$1tn on new, un-needed, assets => risk of financial stranding
- Cost curve approach; expressed as capex-at-risk
- Portfolio of project options impacts risk exposure

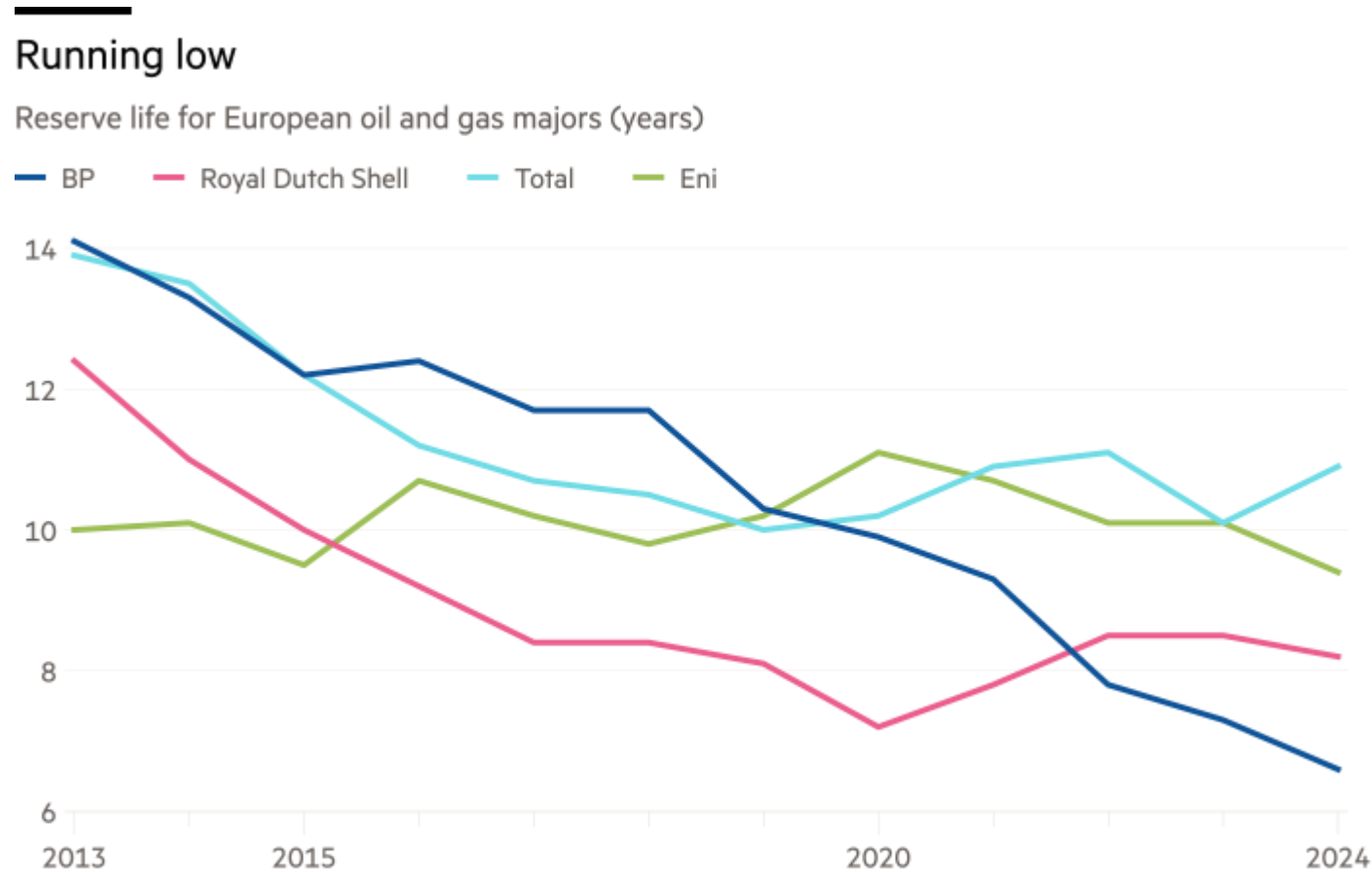


Source: IEA, Rystad Energy, Carbon Tracker analysis



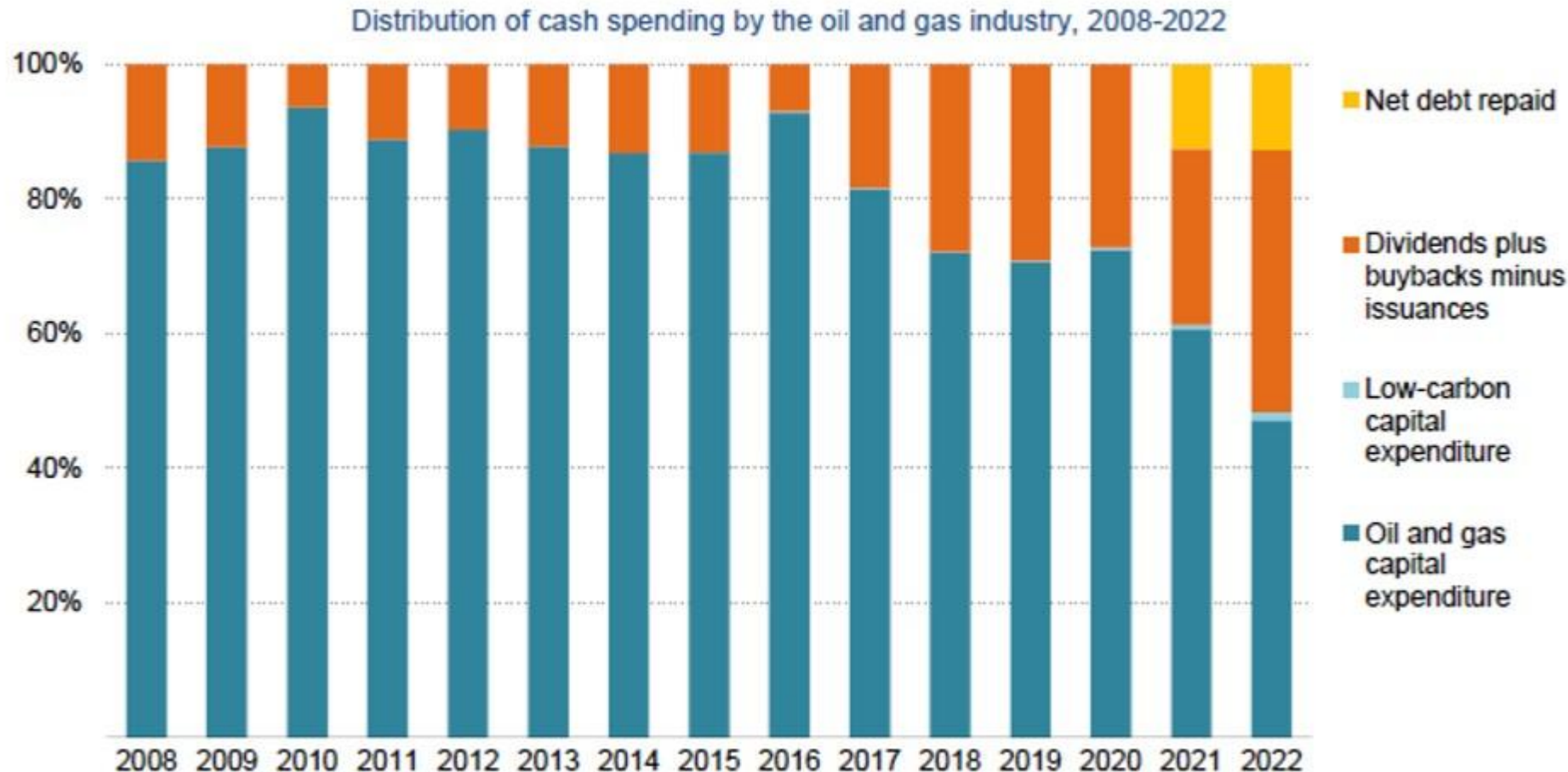
Reserve Life for European O&G Majors (years)

BP's O&G Reserves down to below 8 years, Shell at 9 years



Source: Goldman Sachs

Less than half of O&G Industry's unprecedented cash flow is going back into traditional supply



Only a small fraction of cash flow is invested in clean technologies

Distribution of cash spending by the Oil and Gas Industry, 2008-2022

Conclusions

No one-size-fits-all strategy to navigate the transition

Managed Decline

- Return capital to shareholders
- Dividends
- Share buy-backs

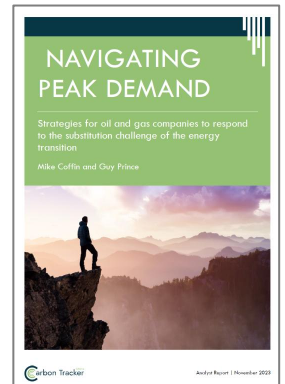
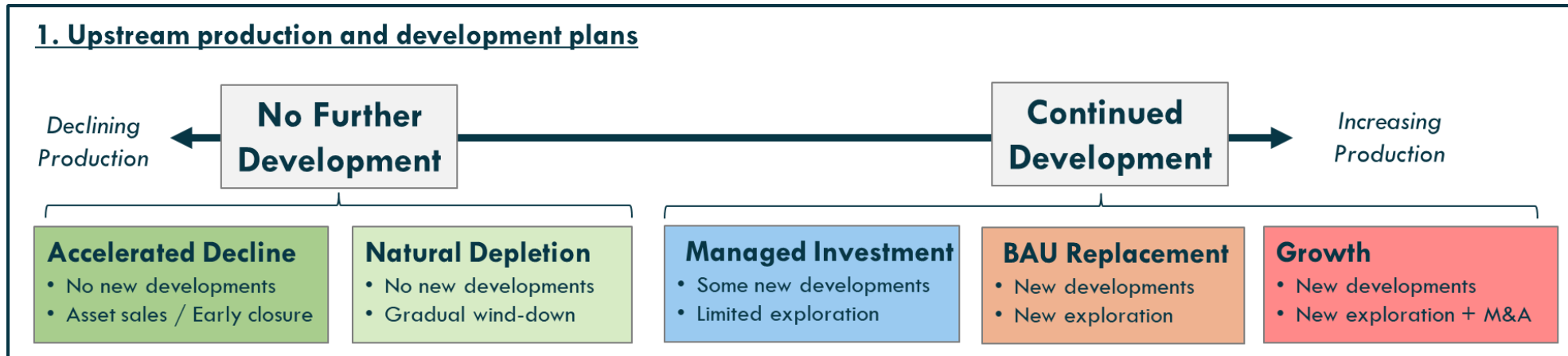


Diversification

- Renewable electricity generation
- Electricity distribution
- Decarbonisation services (CCUS)
- Chemicals
- Biofuels



Companies need to plan for falling demand...



Orsted



aramco



talEnergies



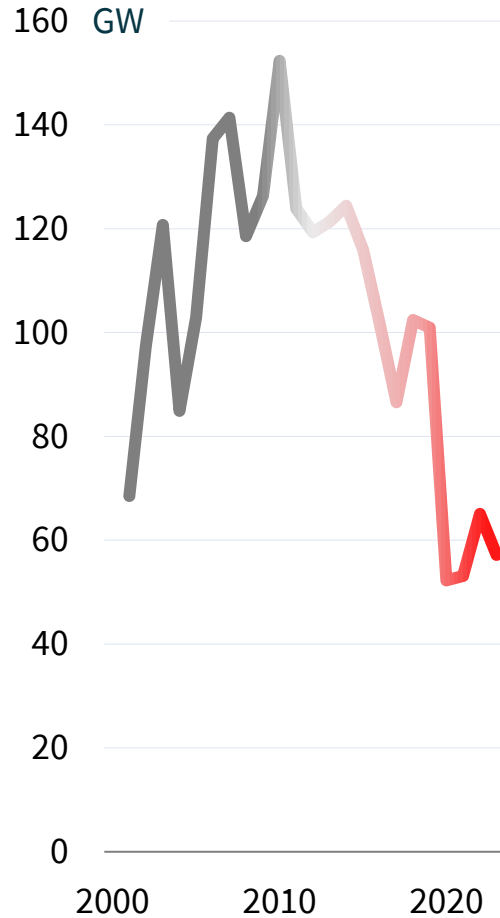
ExxonMobil



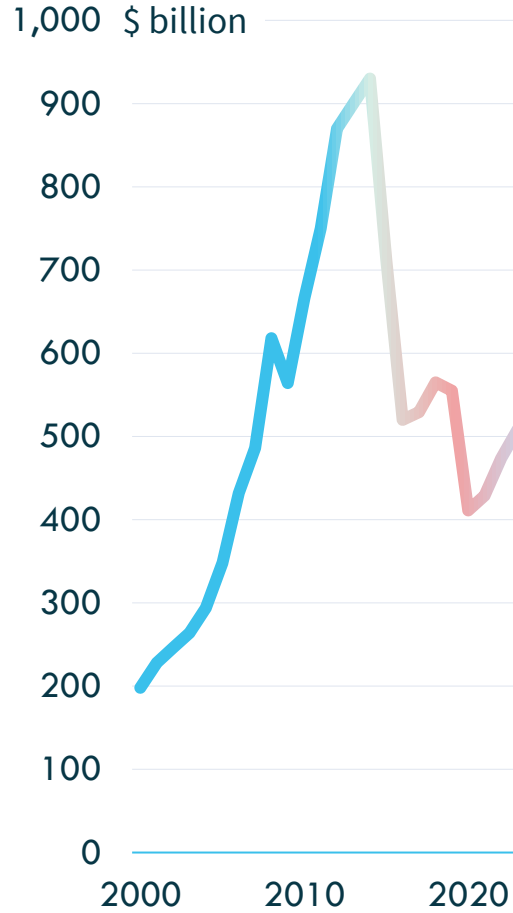
Flashing **red** lights all over the fossil fuel system

- As **growth** turns to **decline**

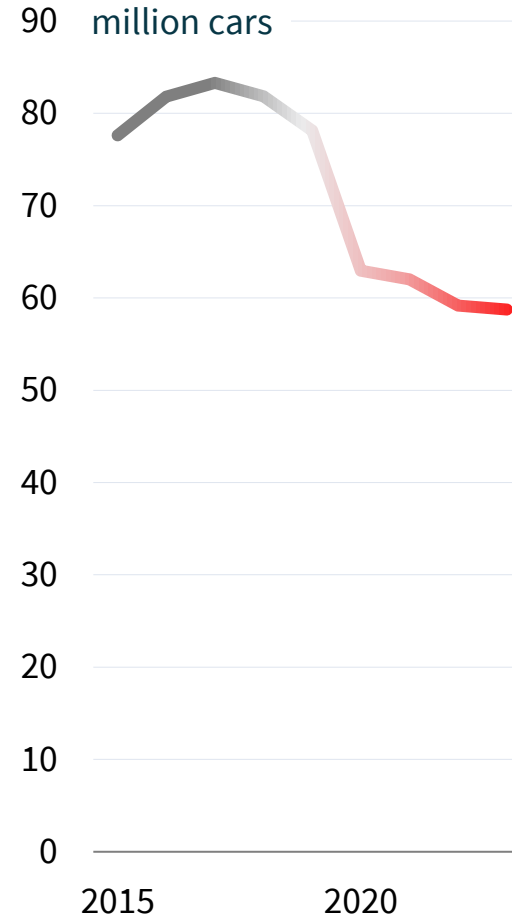
Fossil fuel capacity additions



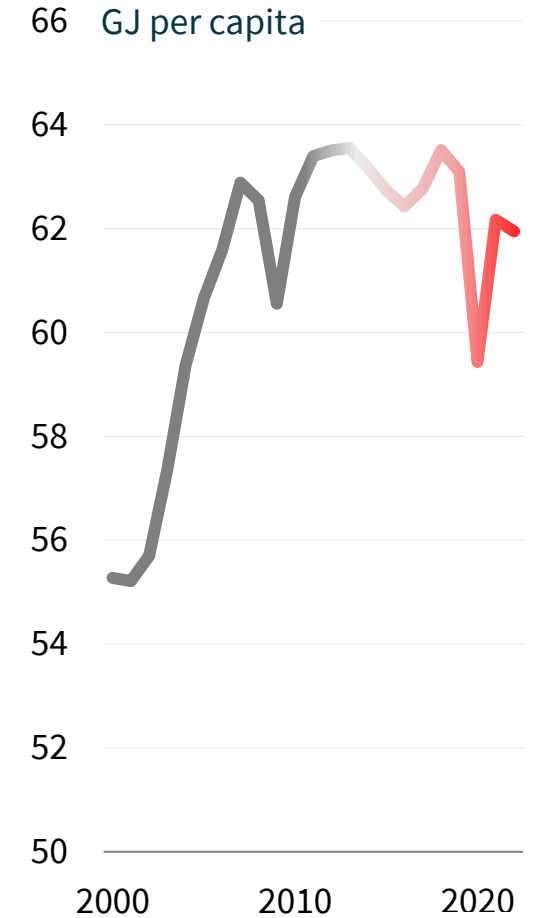
Oil and gas capex



ICE sales



Fossil fuel demand

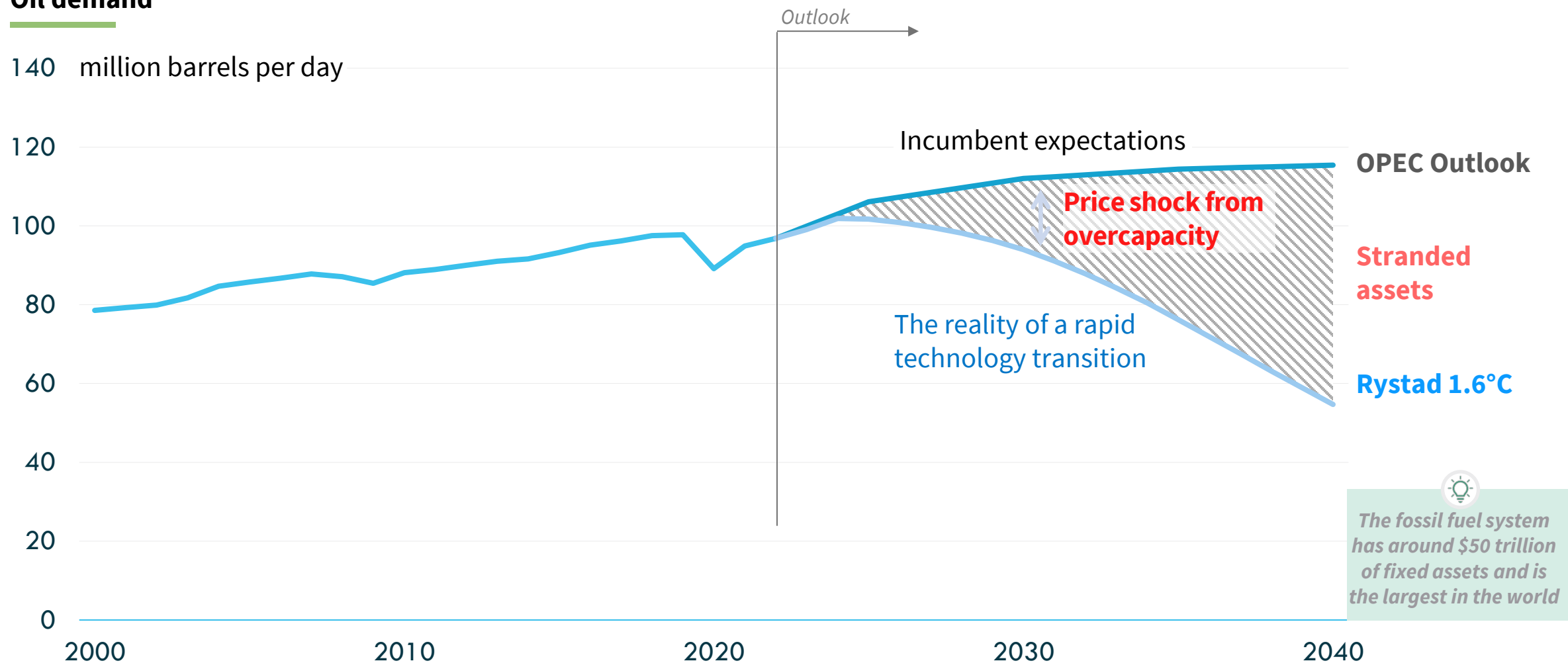


- Source: Ember (new fossil fuel electricity generation capacity), IEA WEI (oil and gas upstream capex), BNEF (ICE sales), Energy Institute (global fossil fuel demand pp).
- Note fossil fuel capacity additions are a net figure.

The fossil fuel system faces trillions in stranded assets

- Assets get stranded at the top of the market, and disruption is driven by price changes

Oil demand

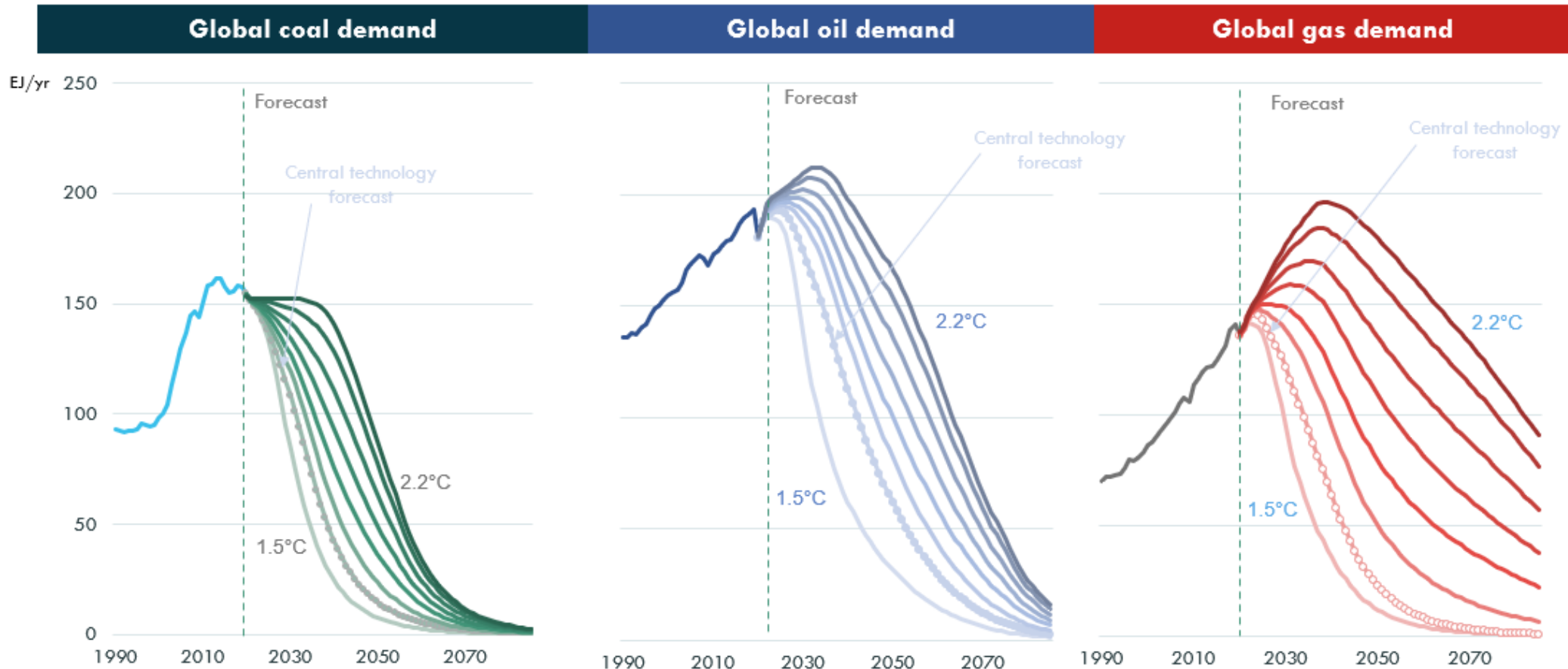


• Source: Rystad Energy, OPEC, RMI.


The fossil fuel system
has around \$50 trillion
of fixed assets and is
the largest in the world

Fossil Fuel Demand Will Decline

Fossil fuel demand faces a cliff edge. The key variable is the length of the plateau — short or very short



Coal demand is reaching the end of its plateau and is about to decline steeply.

Oil demand reached its peak in 2019 and is bouncing along the plateau.

Gas demand is still rising, but the peak is near.

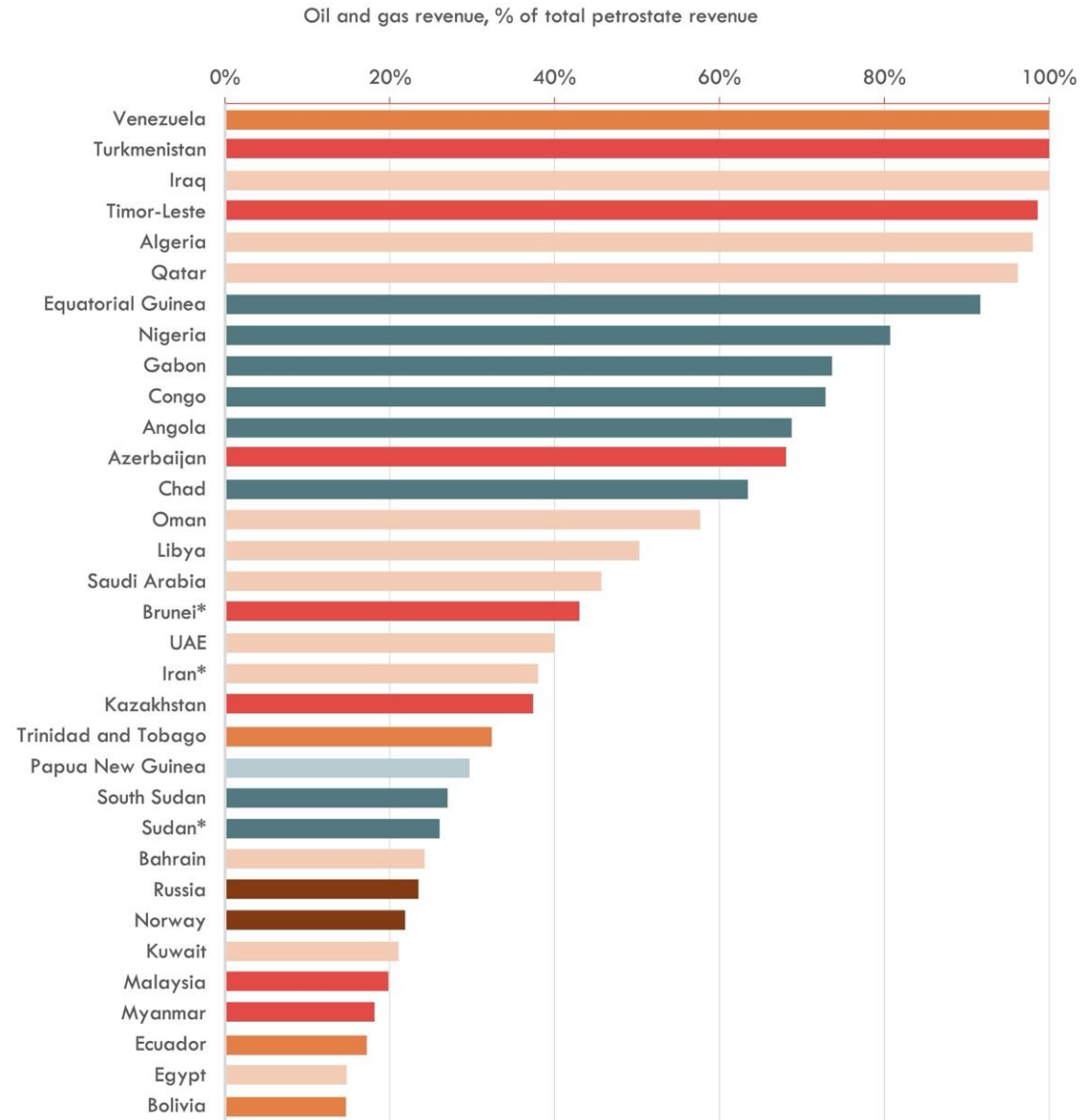
Source: Rystad; Note: Light to dark: 1.5°C to 2.2°C



Carbon Tracker has identified 40 petrostates which rely on oil and gas revenue to balance fiscal budgets

Nearly half derive over 40% of total government revenue from oil and gas

Several highly populated and LDCs feature highly dependent in our ranking, including Angola and Nigeria



“PetroStates of Decline” Dependence of oil and gas revenues by country, as a % of total government revenue

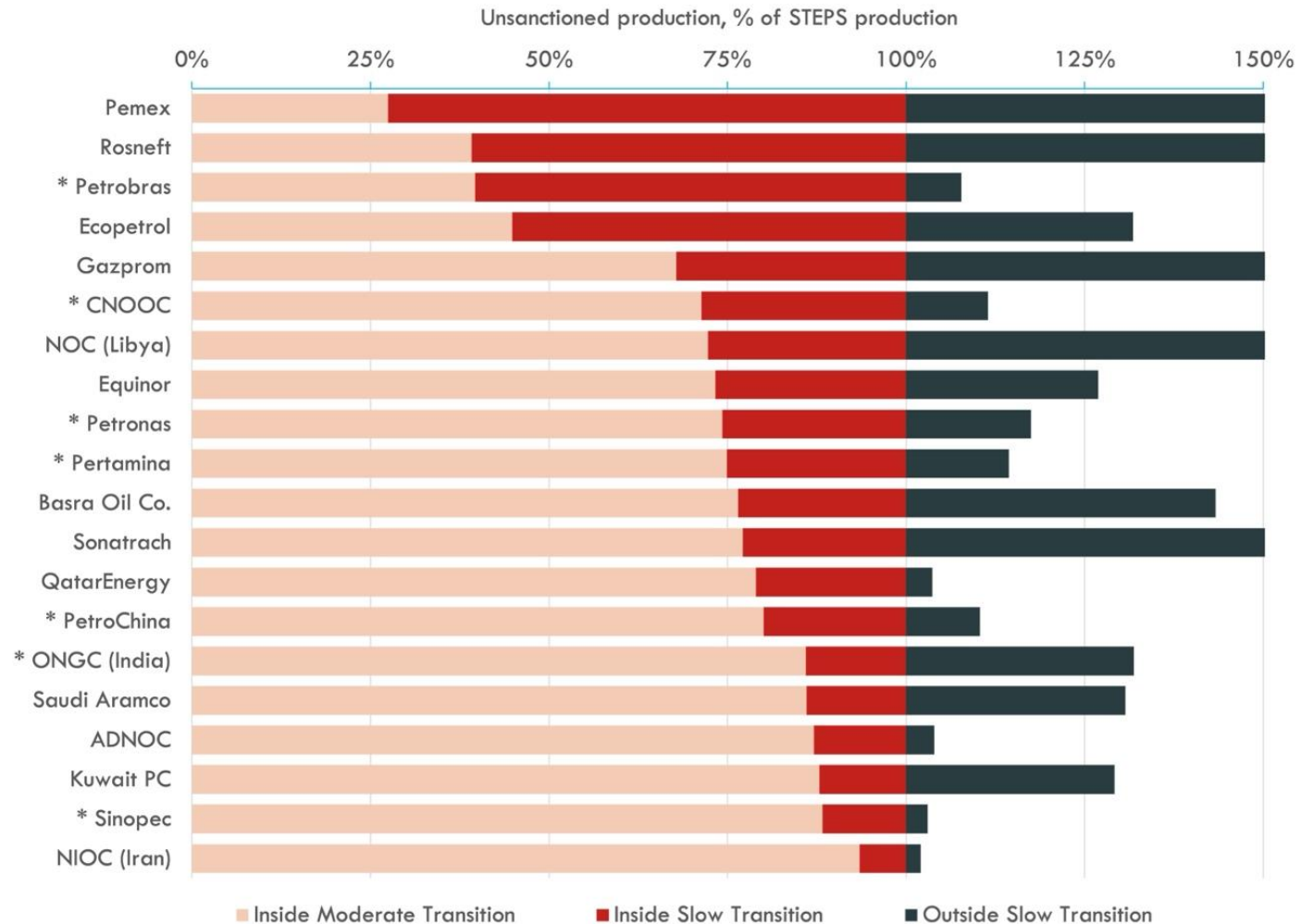


National oil companies should really question the viability of future investments

Whilst lower cost producers may appear less exposed to a moderate transition...

... associated lower prices will negatively affect revenues for all producers.

And more destructive to long term cash flows.



Executive Summary

- **The energy system is being transformed by the exponential forces of renewables, electrification, and efficiency.**
- **The orthodox view of slow change is wrong.** New clean technologies beat old fossil commodities because clean technologies' costs fall over time on learning curves, they are universal, and they grow quickly.
- **Exponential change has been remarkable in the past decade.** Cleantech costs have fallen by up to 80 percent, while investment is up nearly tenfold and solar generation has risen twelvefold. Electricity has become the largest source of useful energy, and the deep force of efficiency has reduced energy demand by a fifth.
- **Change is led by China.** Half the growth in cleantech is from China, but exponential growth is also happening in the OECD and across the Global South as Asia electrifies.
- **Red flags across the fossil fuel system.** New fossil electricity capacity peaked in 2010, oil and gas capex in 2014, and internal combustion engine (ICE) car sales in 2017. Fossil demand peaked for industry in 2014, for buildings in 2018, most likely for electricity in 2023, and will shortly peak in transport.
- **The drivers of growth are more powerful than the barriers.** Falling cleantech costs, the energy security of eternal renewables, Chinese leadership, and a race to the top will continue to overwhelm a fragile fossil fuel system which wastes two-thirds of its primary energy and fails to pay for its externality costs.
- **So exponential growth of cleantech will continue.** By 2030, we will be installing 1,000 GW of solar a year and selling 6,000 GWh of batteries a year, making possible the COP goal of tripling renewable capacity. Electrification rates will double to 0.5% a year, and efficiency gains will increase to over 3% a year.
- **The fossil fuel system faces inexorable decline.** Renewables will drive fossil fuels out of electricity generation, electrification will push fossils out of final energy, and efficiency will reduce fossil waste. Some 75% of fossil fuel demand is exposed to rapidly growing cleantech alternatives, so stranded assets are inevitable.
- **Wider implications of change.** The goals of the Paris Agreement are feasible, and the Global South will continue to leapfrog to cleantech.
- **This is the pivot decade.** When cleantech costs become irresistible, the renewable capacity is built, fossil fuel demand reaches the end of its plateau, and the transition is priced into markets.
- **Now is the time to act.** We need to build out renewables and electrify energy use, make good bets on small modular technologies, and harvest the enormous efficiency opportunity. The direction of change is inevitable, but the speed is up to us.

Disclaimer

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Gas and nuclear are the most expensive forms of energy

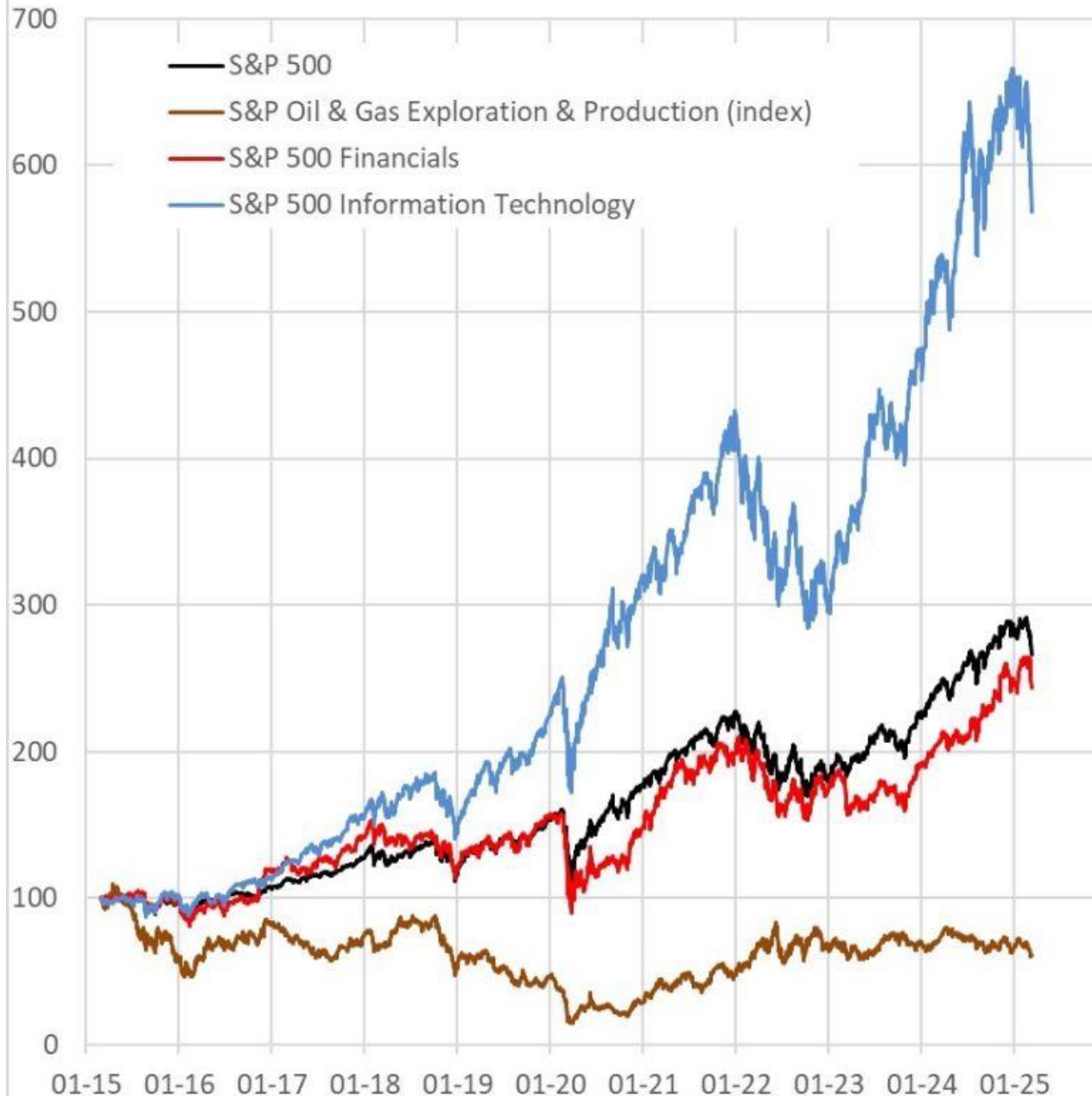
Levelised cost of energy (\$/MWh)



Source: CSIRO GenCost 2024-25 - Table B.10 • Created with Datawrapper



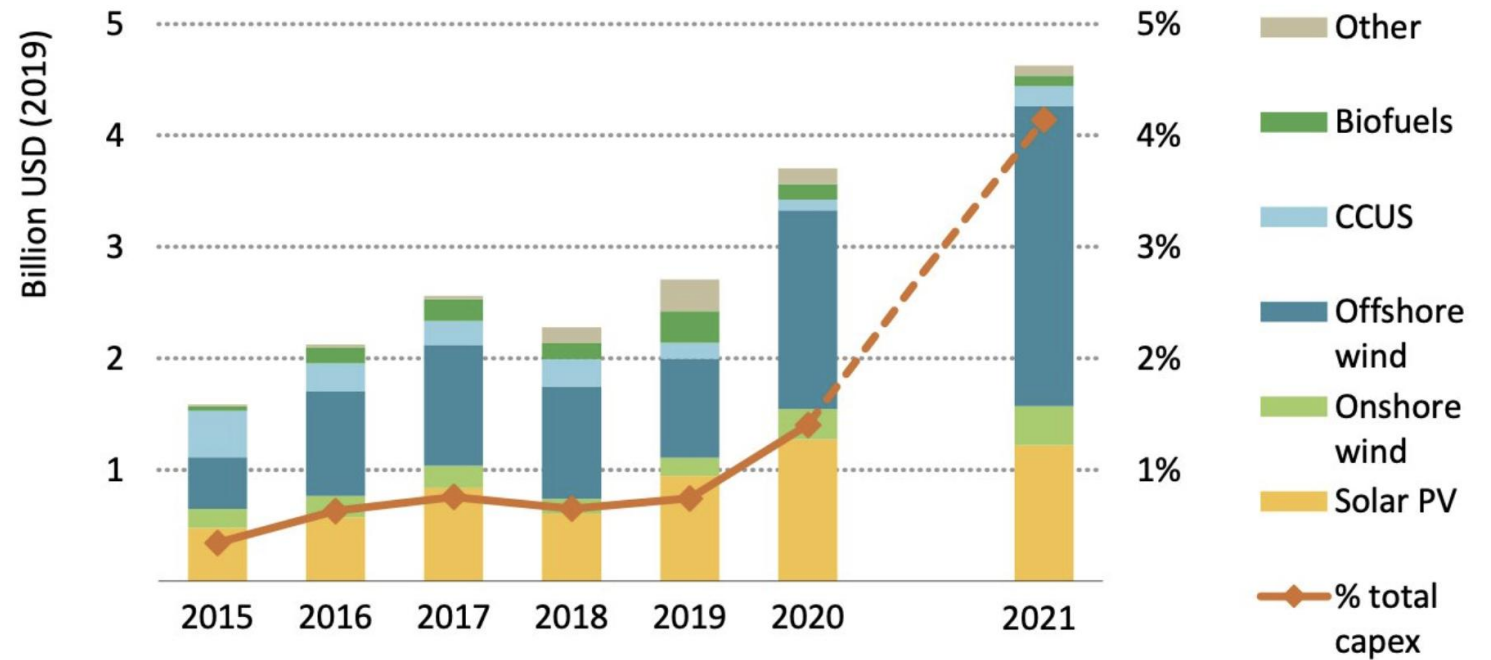
S&P 500 & sector performance
(100 = Feb. 2015)



Over ten years to Jan 2025, upstream O&G Assets has consistently underperformed the rest of the market



“In the last seven years, the oil majors invested just USD 113 billion in low-carbon technology, compared with a total energy transition investment of USD 4.8 trillion over the same period.”
GSCC – June 2023



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Notes: Companies included in this tracking are the Majors and selected others: ADNOC, CNPC (China National Petroleum Corporation), CNOOC, Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec and Sonatrach. The estimated share of total capex in 2021 is based on projects announced through 9 May 2021 and assumes that this pace of investment is maintained through the year.

Sources: IEA calculations based on Bloomberg (2021); BNEF (2021), Clean Energy Pipeline (2021); company reports.

Source: IEA July 2021 dataset that also includes the NOC's <https://www.iea.org/reports/world-energy-investment-2021>

