The Renewable Revolution

It's exponential, global, and this decade

Kingsmill Bond, CFA
Sam Butler-Sloss

June 2023

Summary

- **Overall:** This is the pivotal decade in the energy transition because change is driven by prices and flows.
- **The technology revolution is the key driver**. Renewable technologies enjoy learning curves and exponential growth, which has already led to peak fossil fuel demand.
- **China is the leader**. That both makes change easier and has sparked a global race to the top.
- **This is the decade of change**. Solar and EVs will rise to dominate sector sales by 2030. Renewables will hit price tipping points in every major area of energy demand. Energy efficiency will double as it follows technology up the S-curve.
- **The barriers to change are many but they are solvable** with continued (and likely) support from technology, policy, finance, and civil society.
- **The debate will be very different by 2030** when change will be priced into markets.
- **For investors, companies, and banks** there will be a shift from tactics to strategy; from ESG to energy system transition thinking.
- **Most policymakers** will embrace the competition to lead the "Age of Renewables" and enjoy energy security.
- **For the Global South,** there is a new development opportunity. And for petrostates a necessity to reform.
- **For climate, health, justice, and nature** there is hope from the application of superior technology.
- **For energy modelers,** it is time to up your game or become stranded experts.

Contents

1. The energy technology revolution 4
2. Led by China and going global 13
3. Plays out this decade 23
4. With significant implications 39

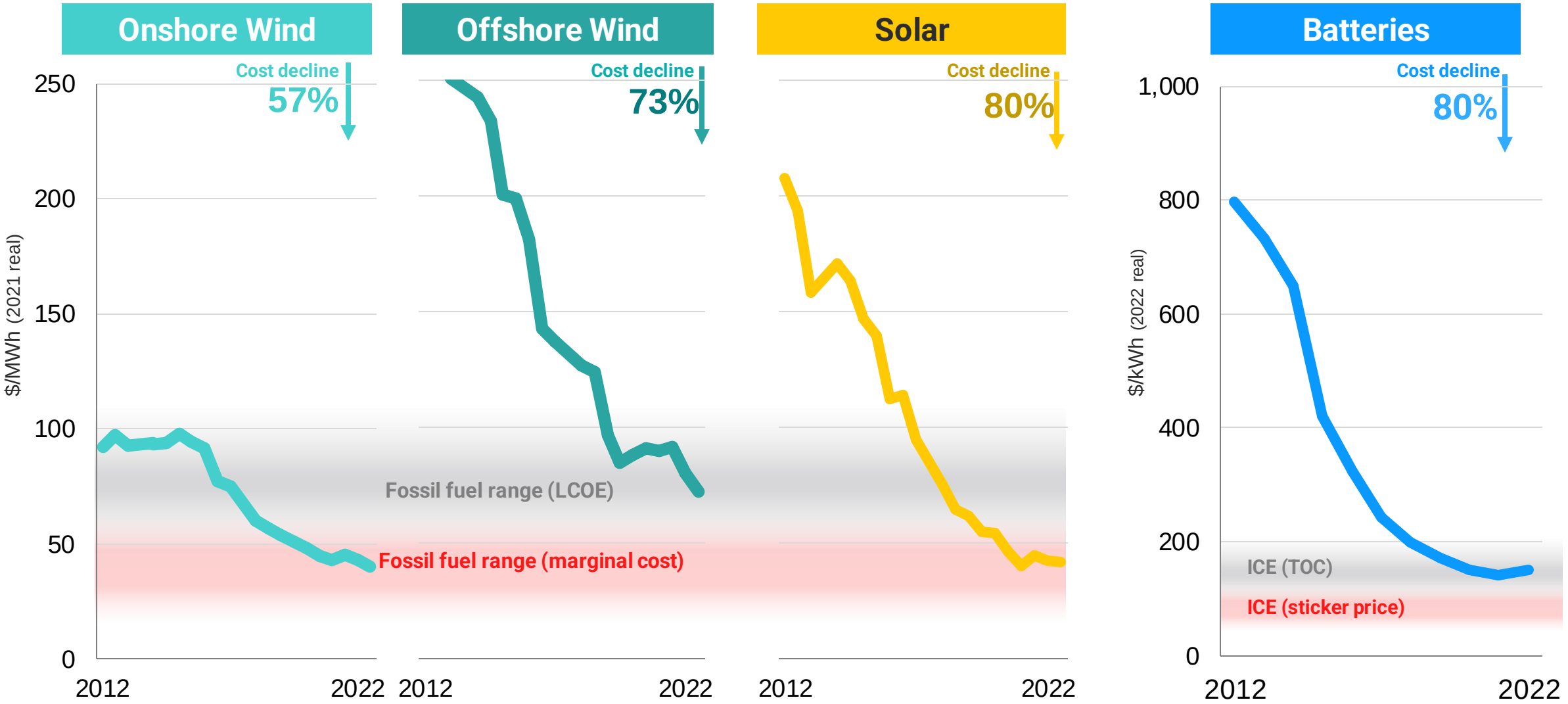
1

The energy technology revolution

- Renewable costs are falling on learning curves
- Renewable sales are growing exponentially
- Capital is shifting to renewables
- Fossil fuel demand has already peaked
- Most incumbent modelers have missed the transition so far

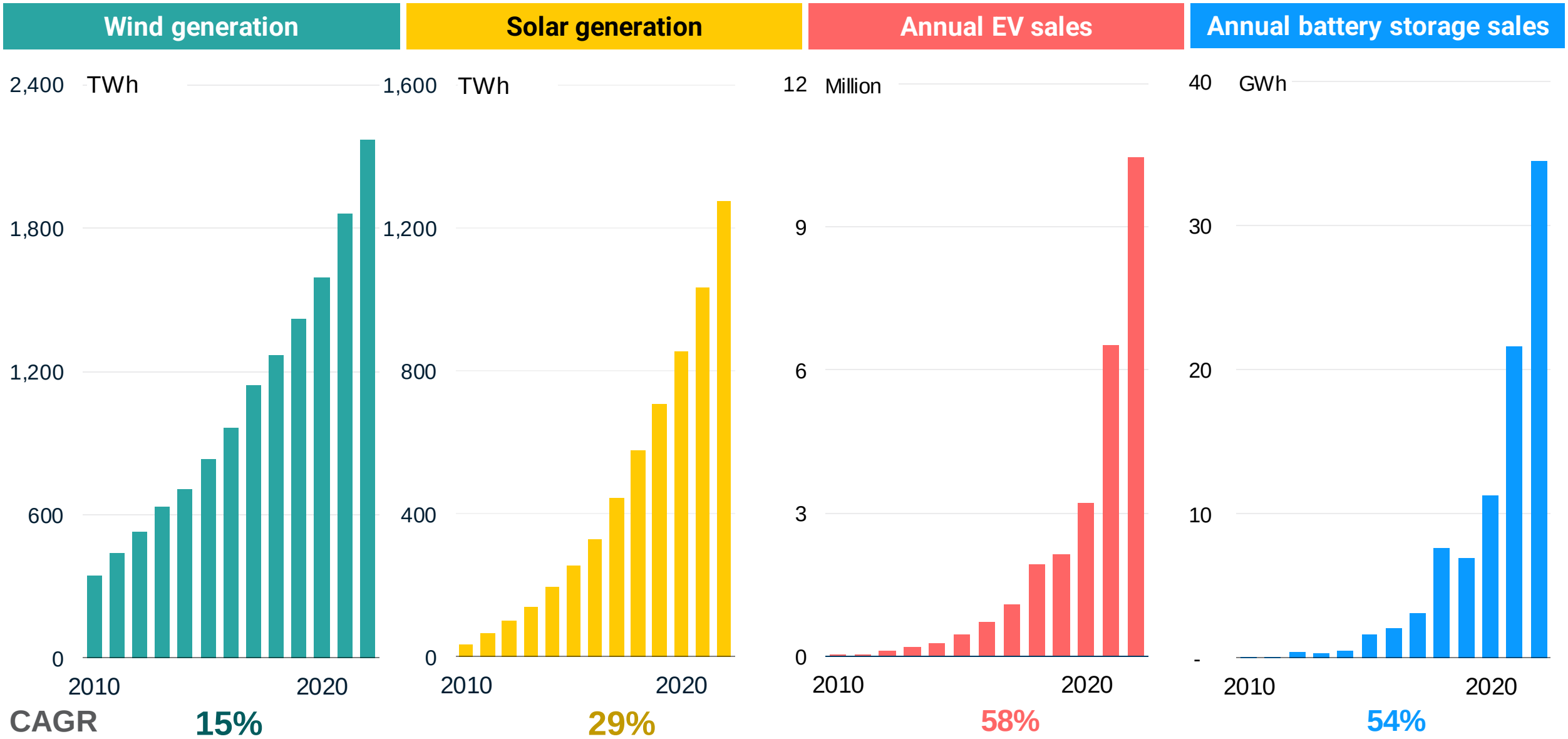
We are in the middle of an energy technology cost revolution

The cost of new energy technologies has fallen by 60%–80% in the past 10 years



Source: BNEF

Exponential energy change is all around us

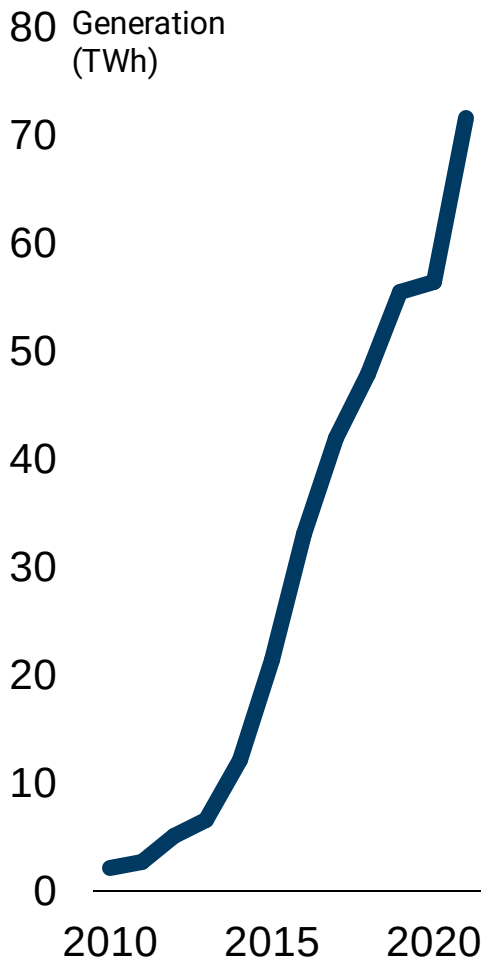


Source: BNEF, BP, Ember; Note: CAGR is the compound annual growth rate between 2012 and 2022. All data is global

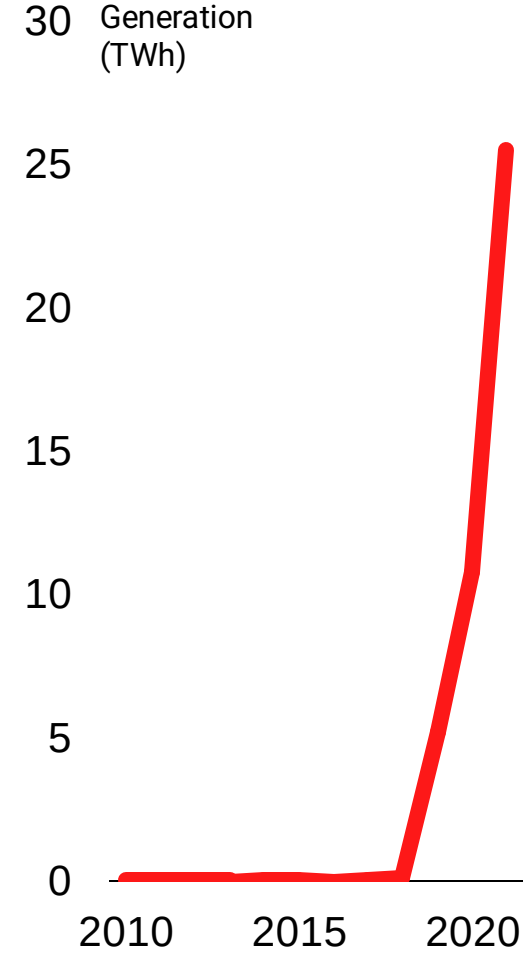
Change is happening across the world

Adoption of superior technology is not confined to the Global North

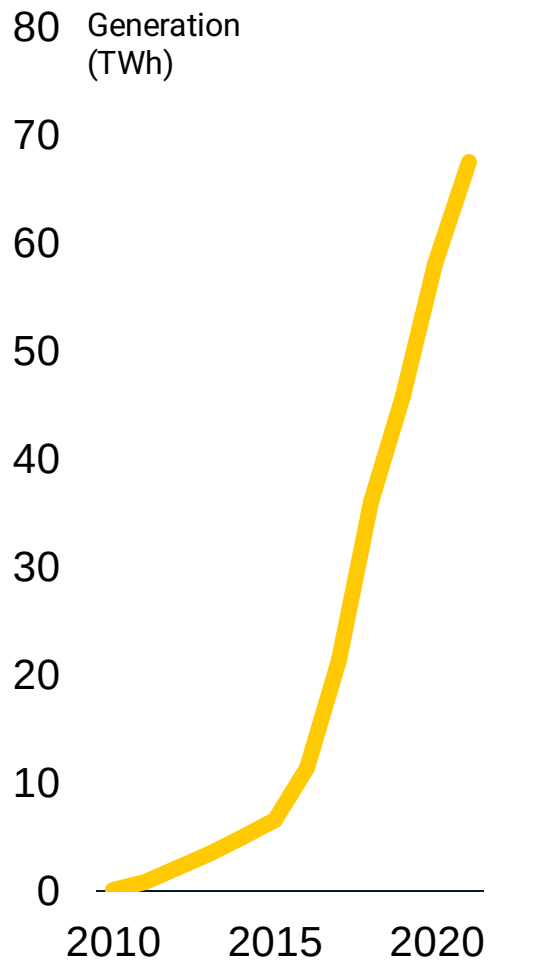
Brazil wind



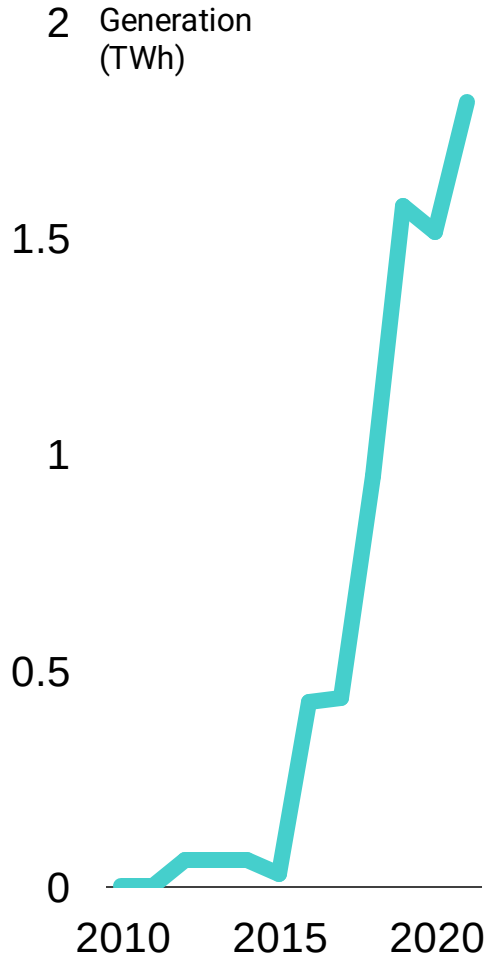
Vietnam solar



India solar



Morocco Solar



Source: BP, Ember

Price falls have unlocked superior renewable solutions

Renewables are local, cheap, and clean. They provide more local jobs and enable a circular economy.

The Age of Carbon

- Commodity-based system
- No learning curve (or decreasing returns)
- Geographically concentrated
- Finite
- Continuous material flow required
- EROI falling
- Heavy
- Fiery molecules
- Low efficiency
- Pervasive negative externalities
- Trillions of dollars of rent for oligarchs
- Concentrates power

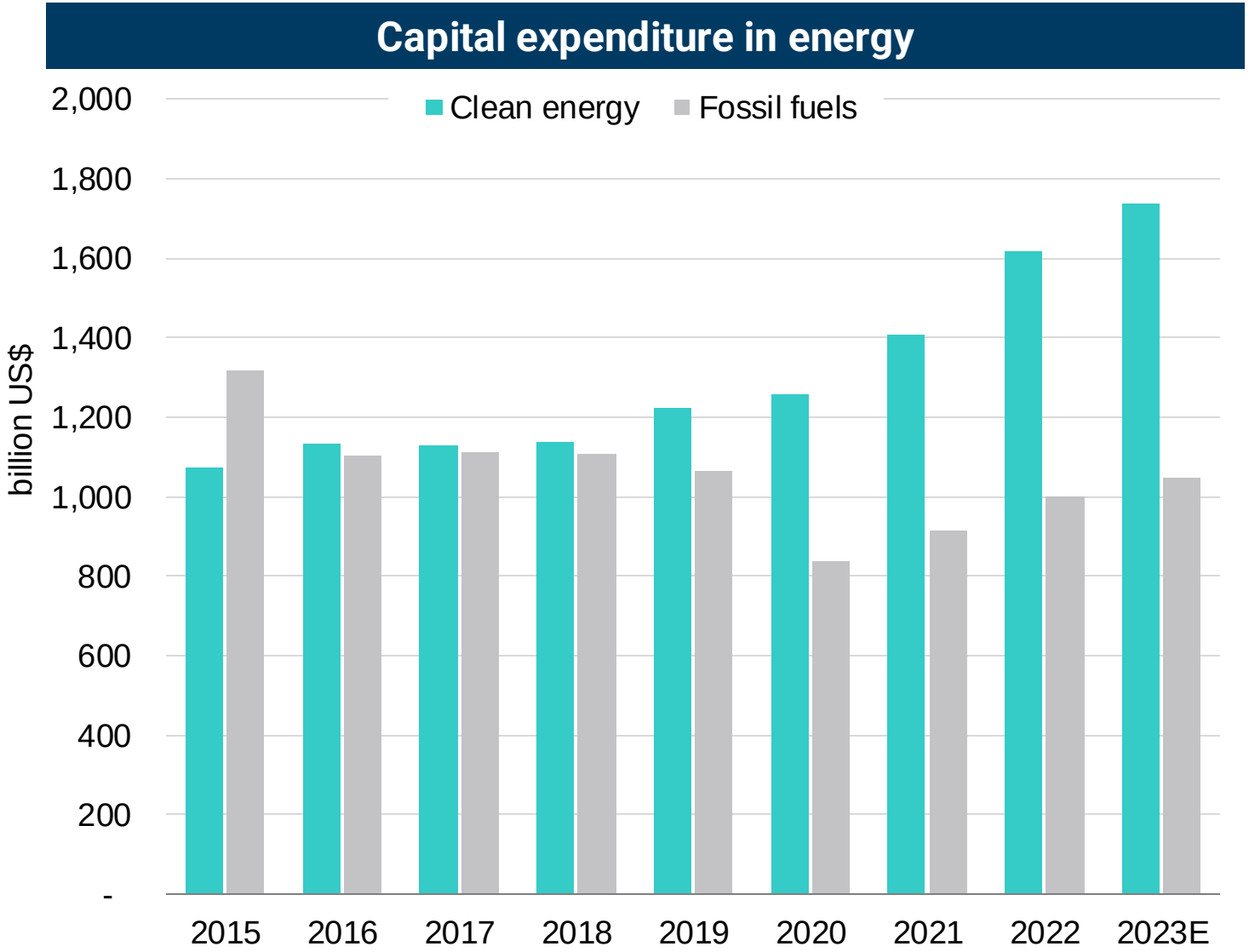
The Age of Renewables

- Technology-based system
- Learning curve (increasing returns)
- Everywhere
- Abundant
- Circular economy
- EROI rising
- Light
- Obedient electrons
- High efficiency
- Much lower impact on nature
- No superprofits
- Distributes power

Source: RMI

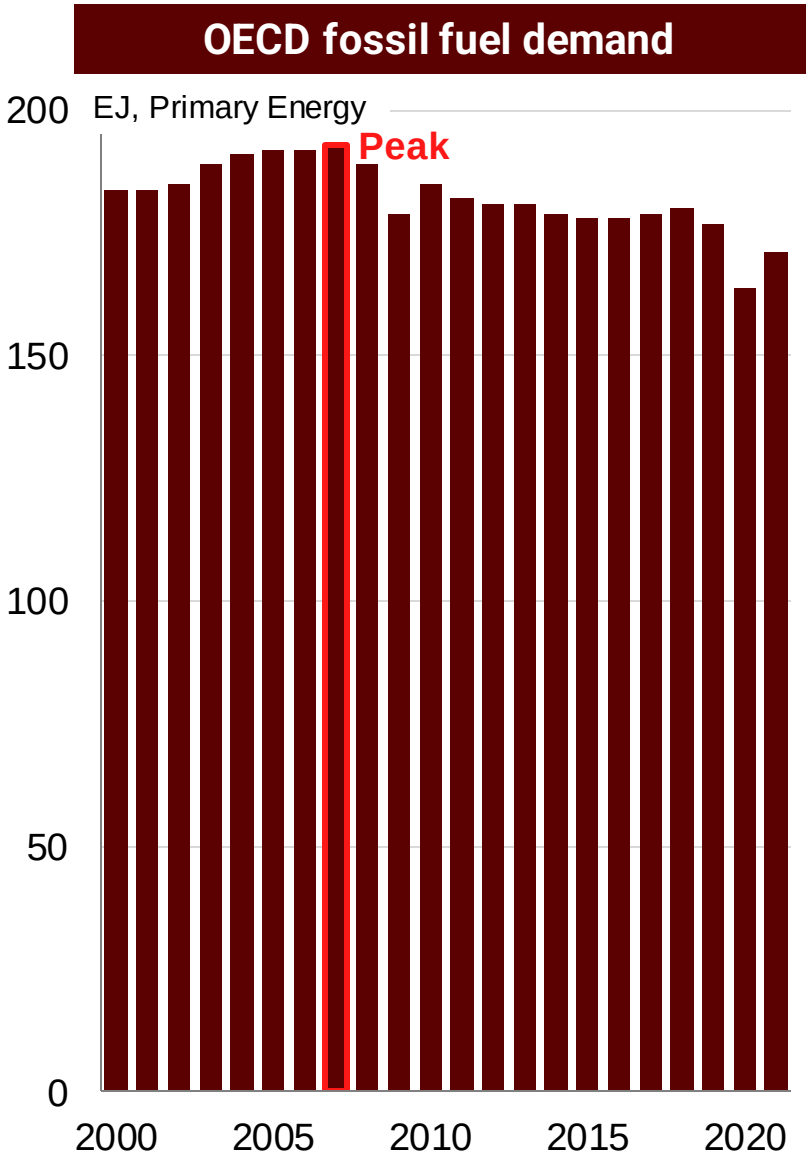
Capital is shifting into renewables

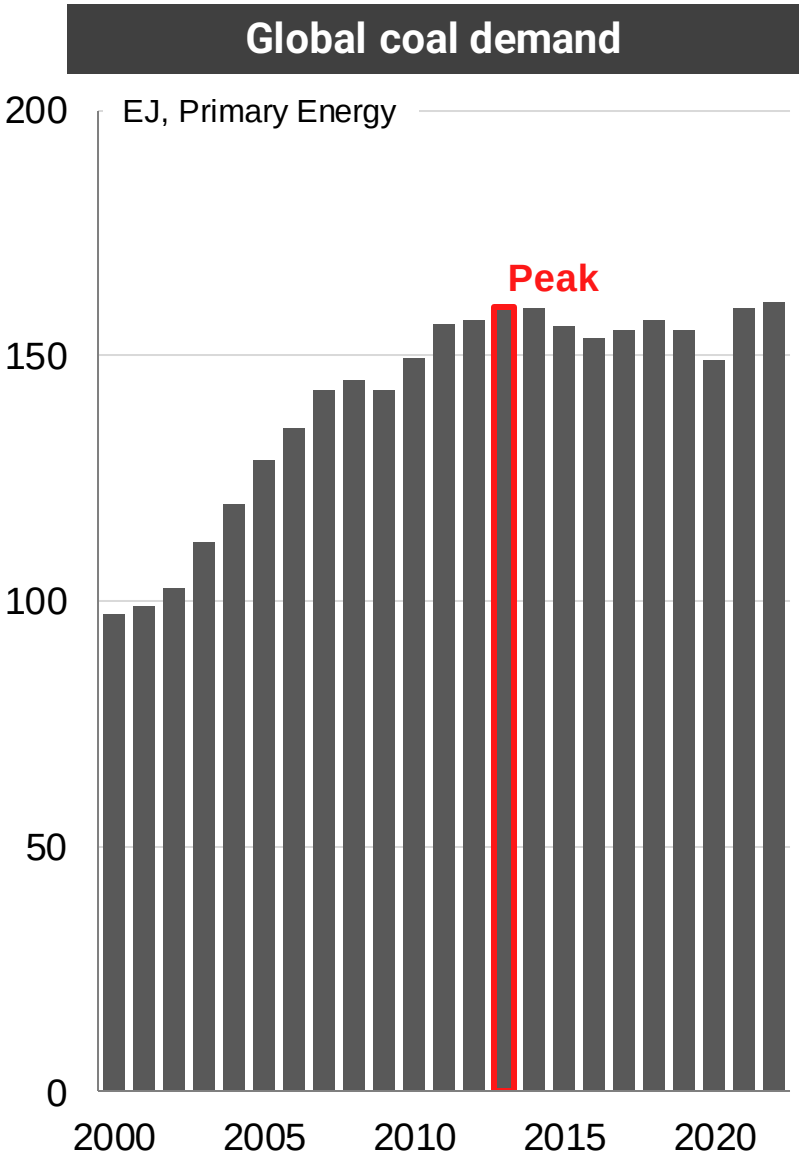
- Capital flows are therefore flooding into clean energy solutions. In 2023 they will be over 60% of the total.
- While capital flows into the fossil fuel system are stagnant, and mainly directed at maintenance.
- Half of fossil fuel cash flows are now being repaid, suggesting the sector is approaching rundown.
- Nearly 90% of capital flows in the electricity sector in 2023 will be into renewables.
- The solar industry is investing over $1B a day and has overtaken oil capex.

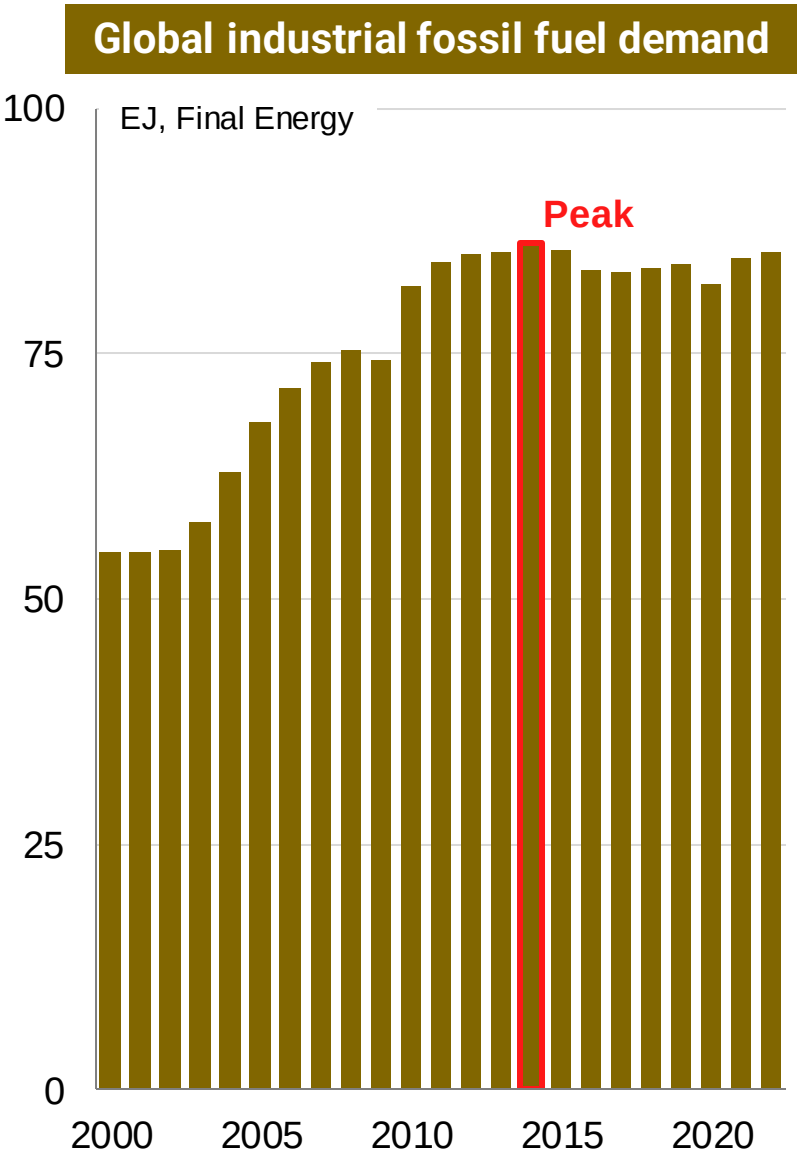


Source: IEA World Energy Investment 2023

Many fossil fuel demand peaks are clearly behind us





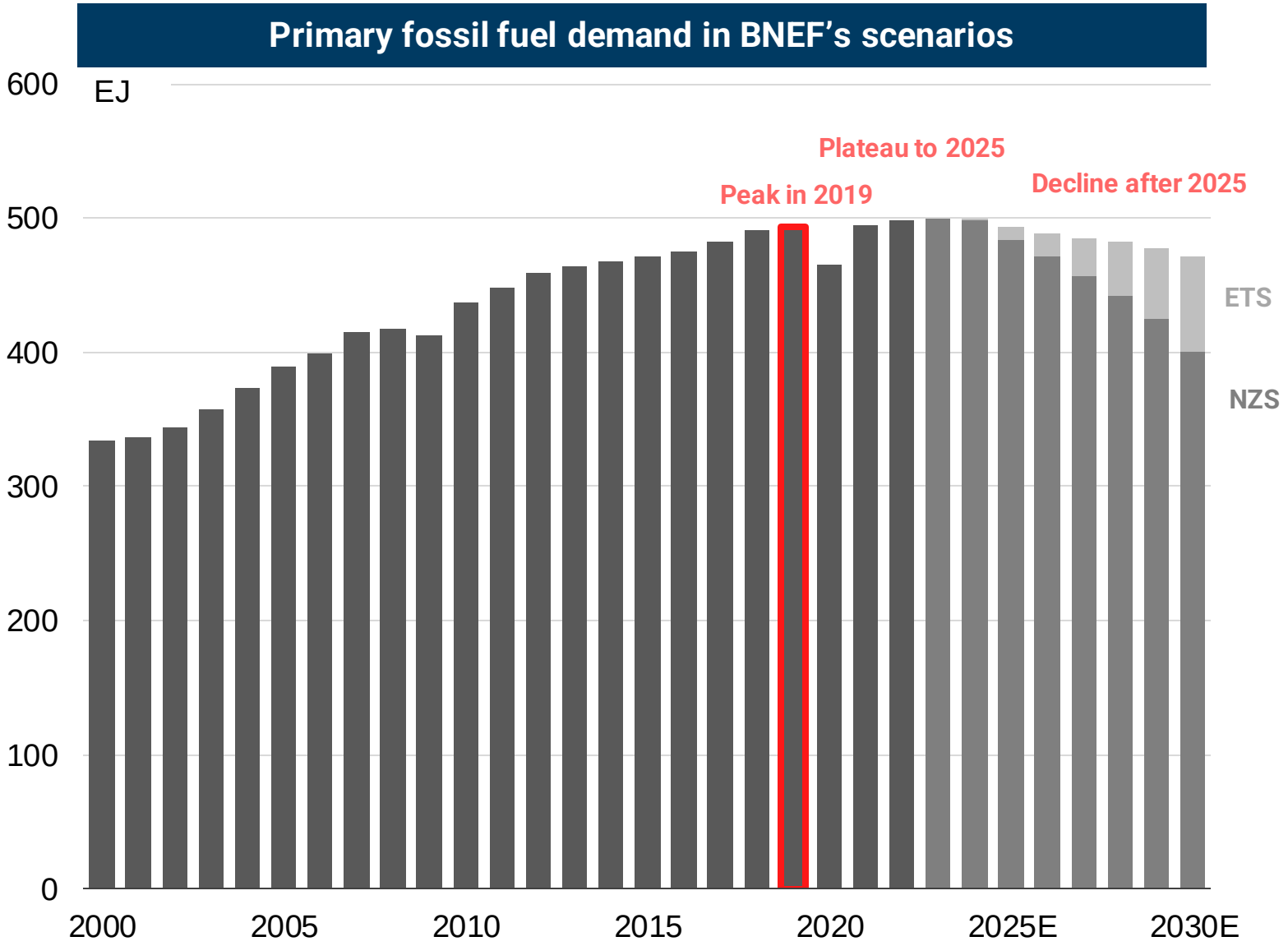


Source: IEA, Rystad, BNEF

Global fossil fuel demand has peaked around 500 EJ

Primary fossil fuel demand peaks in both BNEF's scenarios for example

- The growth of these new energy technologies has been fast enough to mean that we already hit a peak in fossil fuel demand in 2019.
- Fossil fuel demand is now bouncing along a plateau; with a couple of small bumps.
- The chart illustrates fossil fuel demand forecasts from BNEF in their two core scenarios — in neither case does fossil fuel demand break out of the plateau.
- We see a similar framing by the IEA, Rystad, BP, Shell, and McKinsey. At heart this is simple math: Any fast-growing new technology will drive peak incumbent demand early in a transition.
- The plateau will end around 2025. And then fossil fuel demand will go into terminal decline.

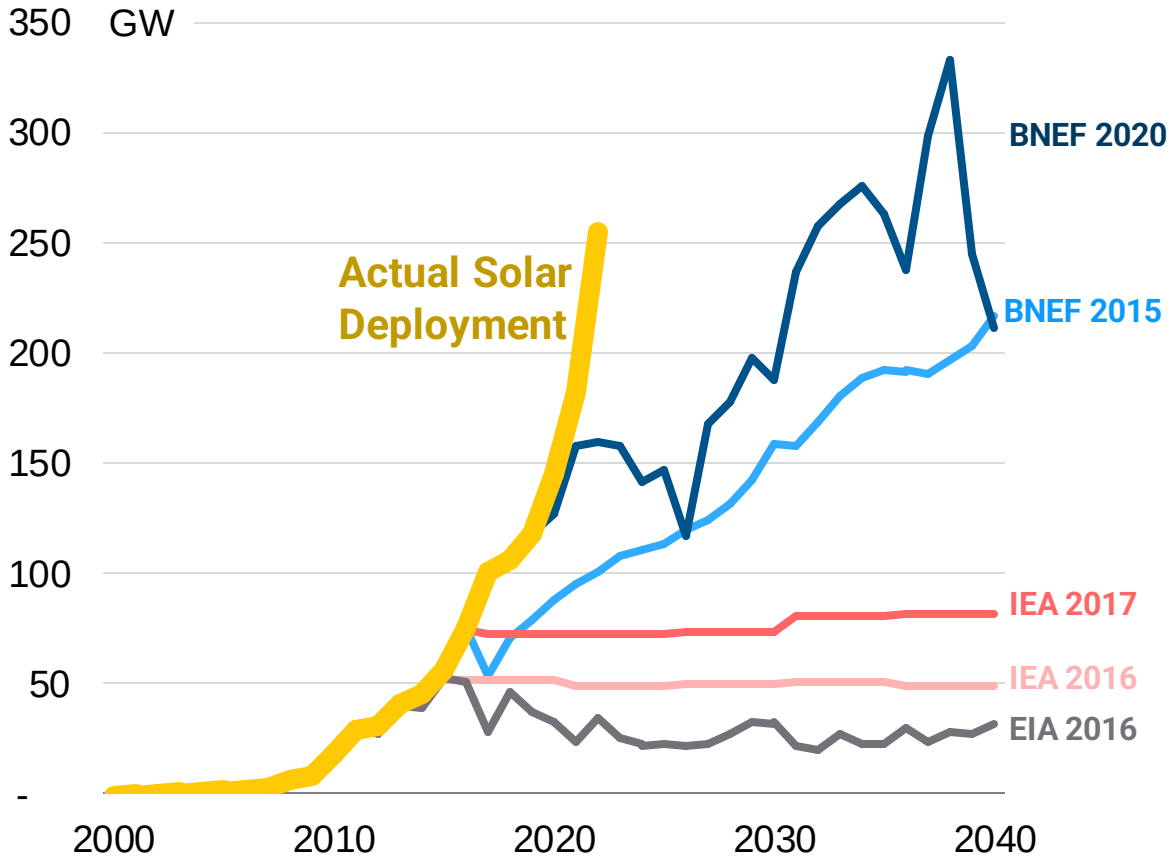


Source: BNEF NEO, Economic Transition Scenario (ETS) & Net zero scenario (NZS)

But most incumbent modelers have missed the transition

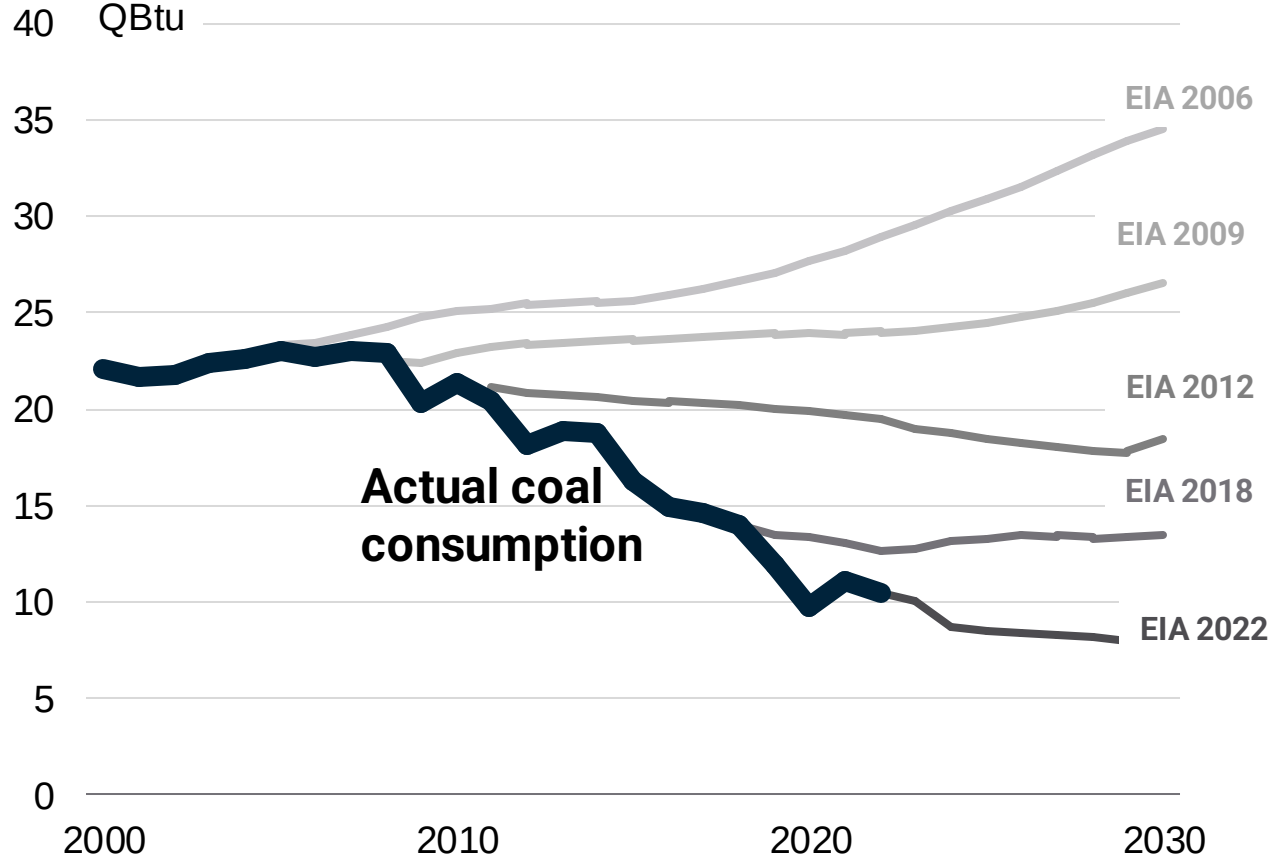
They have modeled linear change not exponential

Projected global solar deployment



For 20 years the IEA forecast linear growth of solar deployment. For 20 years solar has been growing exponentially.

EIA projected US coal consumption



The EIA has been forecasting flat or rising US coal demand since 2009. But demand has been falling rapidly.

Source: IEA, BNEF, EIA, RethinkX, Auke Hoekstra

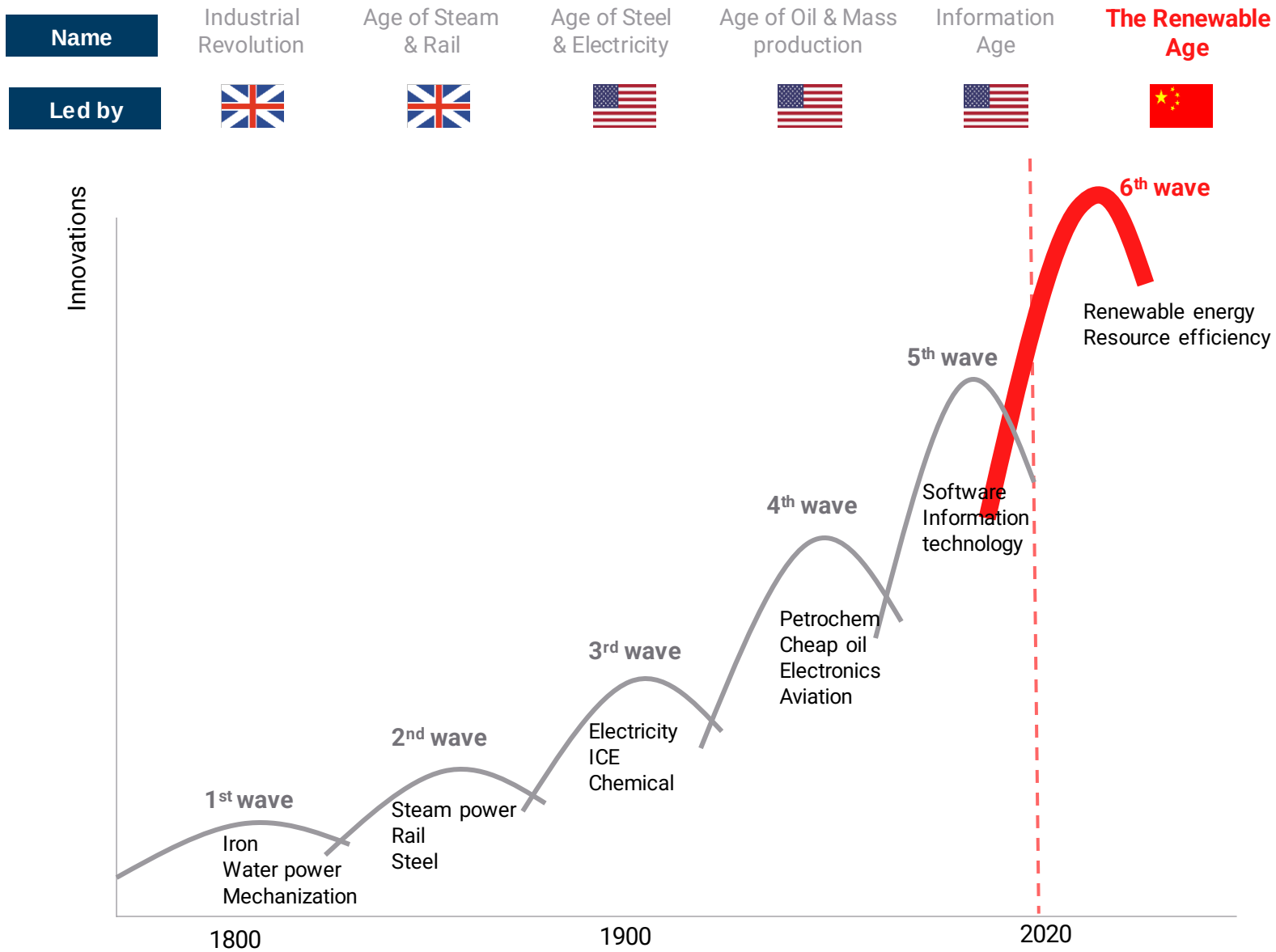
2

Led by China

- The energy technology revolution in context
- Why China leads
- The Global South can leapfrog
- The West is waking up
- The rest of the world will follow the leader, as with the internet

Another technology revolution — this time led by China

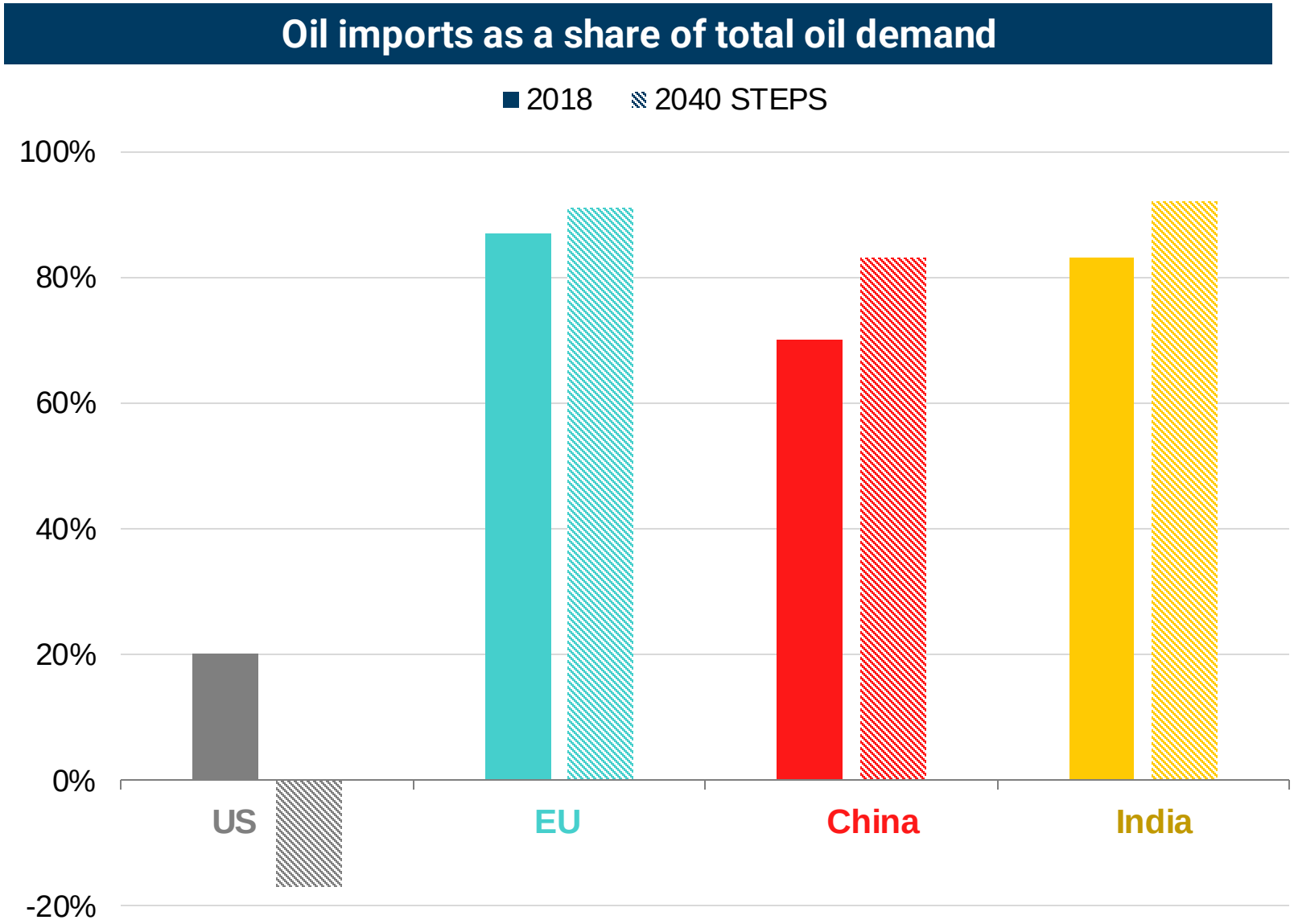
- Carlota Perez sets out five technology revolutions, taking place once every 40 years or so.
- The first two technology revolutions were led by the UK.
- The next three by the United States.
- The renewable revolution is led by China. That matters to the speed of change because China does not have the constraints faced by others.
- And as China surges ahead, so others race to catch up.



Source: Carlota Perez (first five), RMI (renewable age)

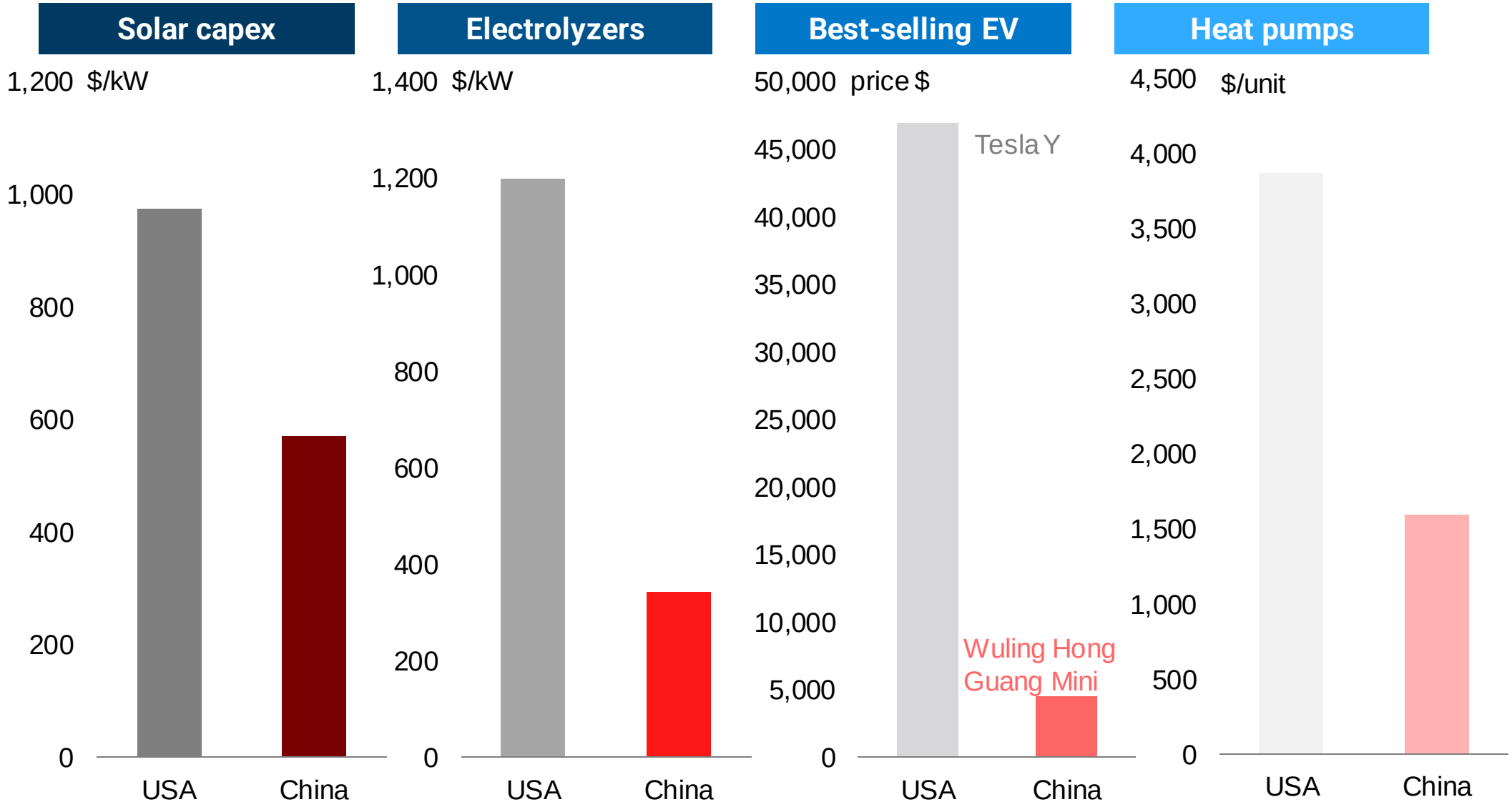
China is a major fossil fuel importer

- China, India, and Europe are large fossil fuel importers, and under business as usual their imports will increase.
- For these regions, energy independence is a key motivation.
- In contrast, the United States is a net fossil fuel exporter and does not suffer the same pressure.
- China and India also have severe issues of local pollution.



Source: IEA WEO 2019

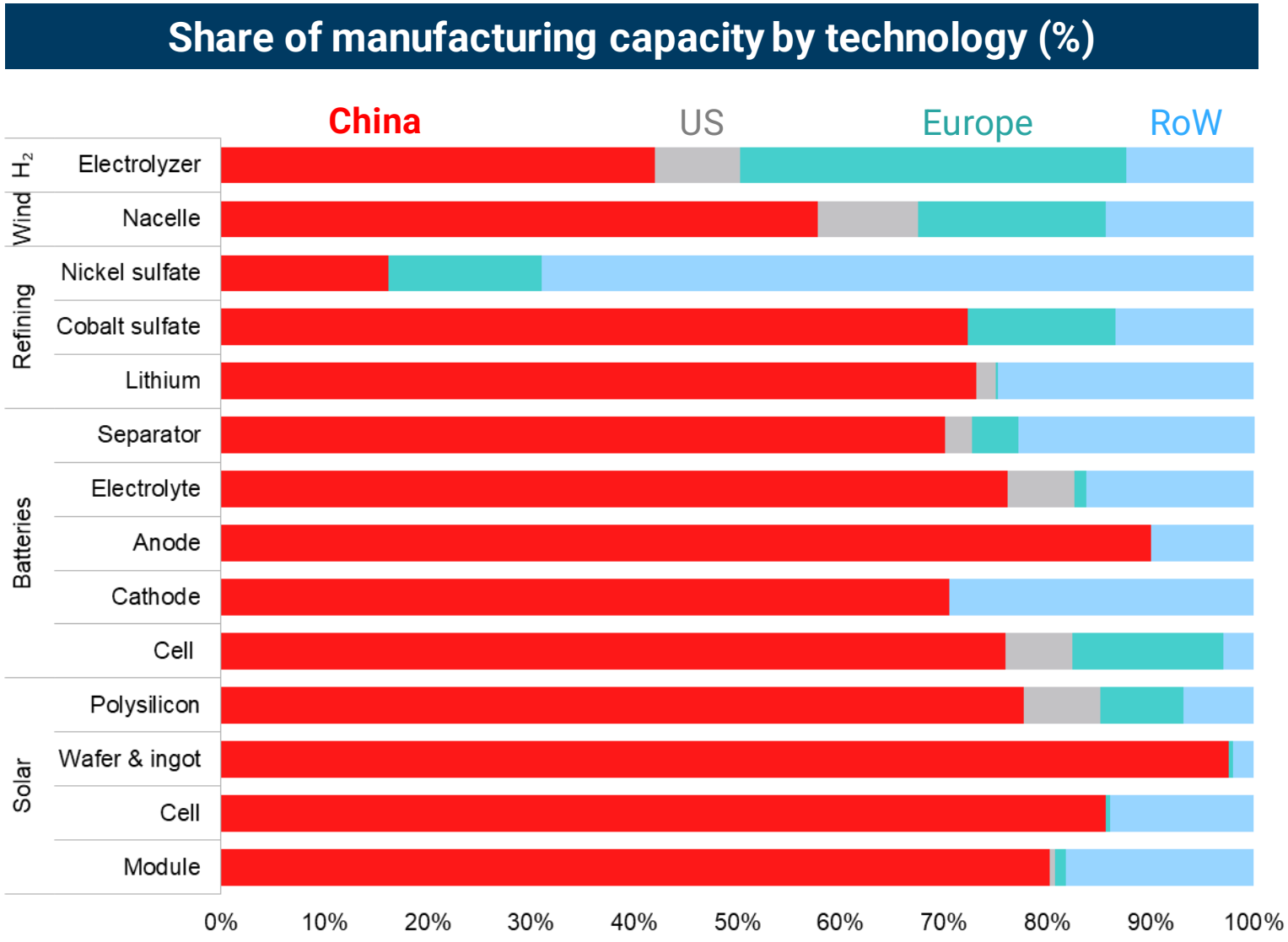
China has the lowest renewable costs



Source: BNEF, NYT, IEA. Notes: Ex-subsidies. Alkaline electrolyzer, Air-to-air heat pump equipment & installation costs of cheapest model.

China dominates production of renewables

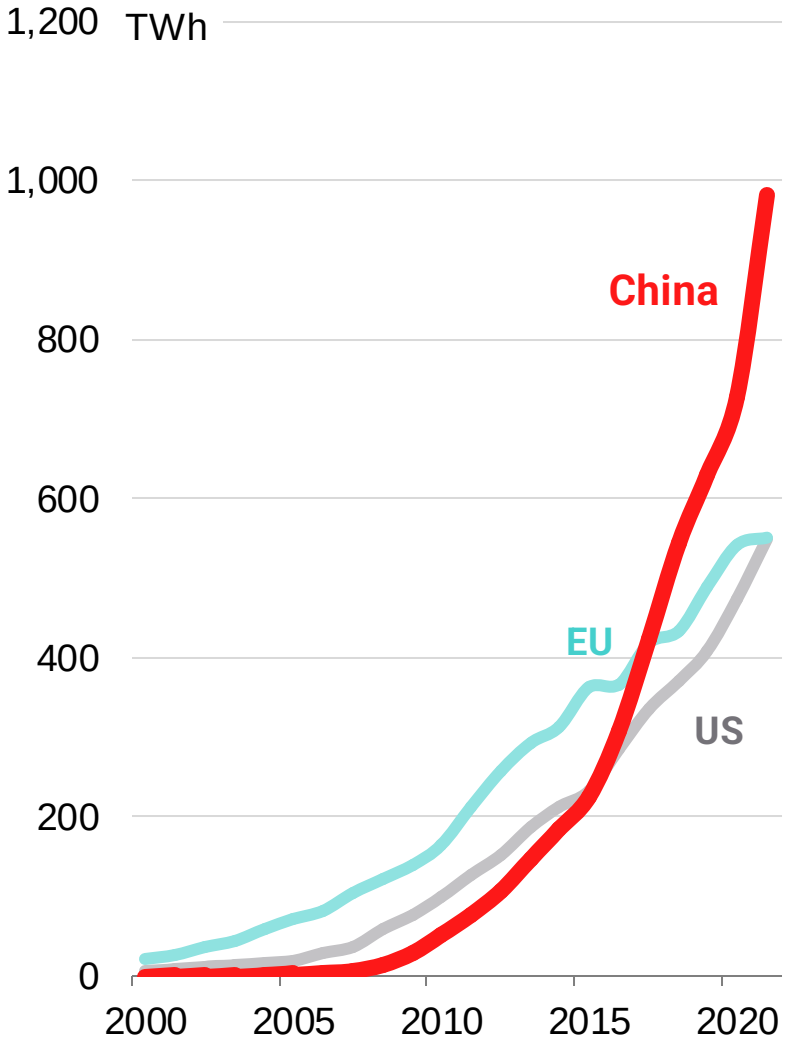
- China dominates production of all the key renewable energy technologies for many reasons:
  - It is the workshop of the world.
  - Manufacturing costs are considerably lower in China than elsewhere.
  - It is a major fossil fuel importer.
  - The government has had a strategic focus on renewables for a long time.
  - The West was not sufficiently focused on leadership.



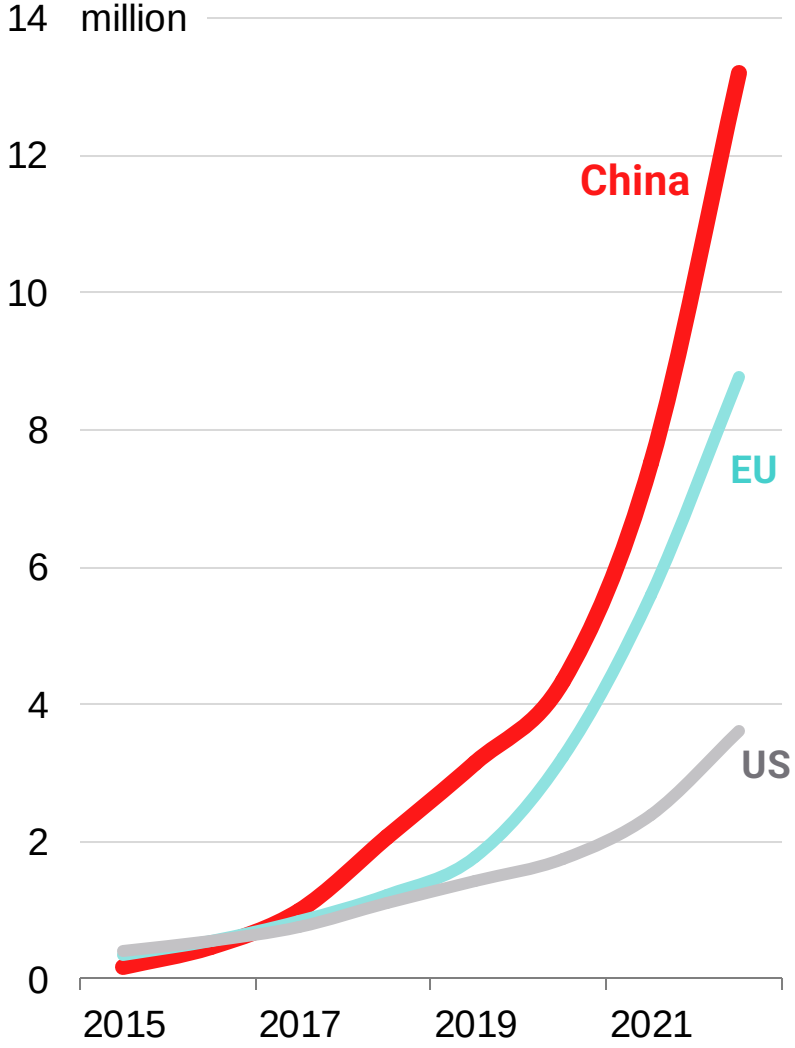
Source: BNEF, *The Cost of Localizing Clean Energy Supply Chains, 2022*

China leads the deployment of renewables

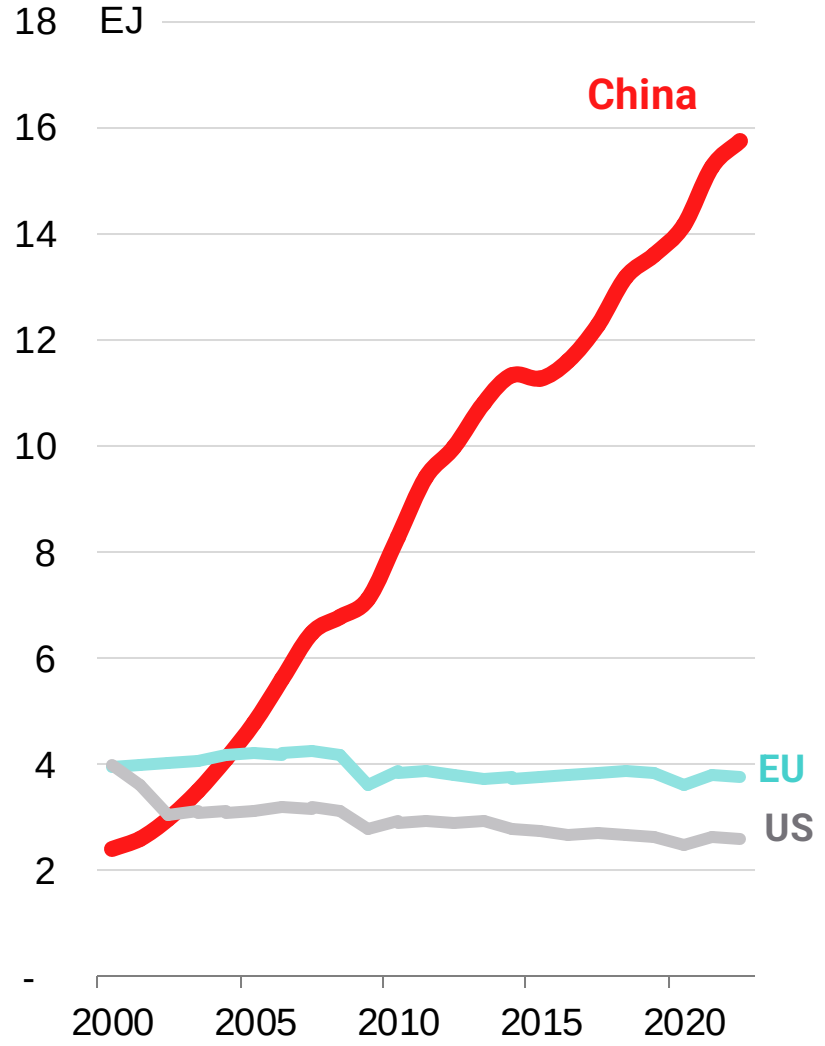
Solar and wind generation



Electric vehicle car fleet



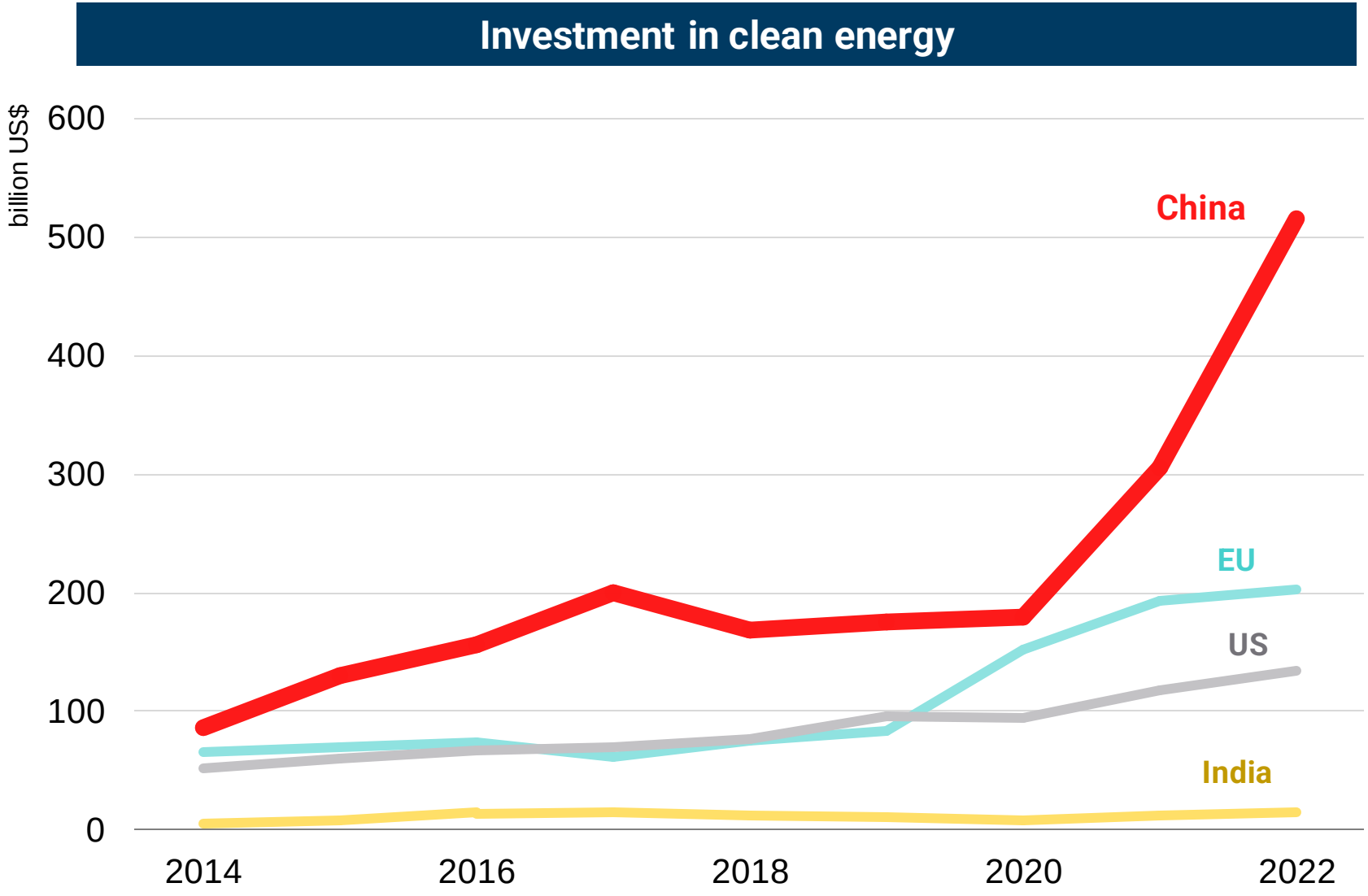
Electricity demand in industry



Source: BP, BNEF

China has the largest capital expenditure on renewables

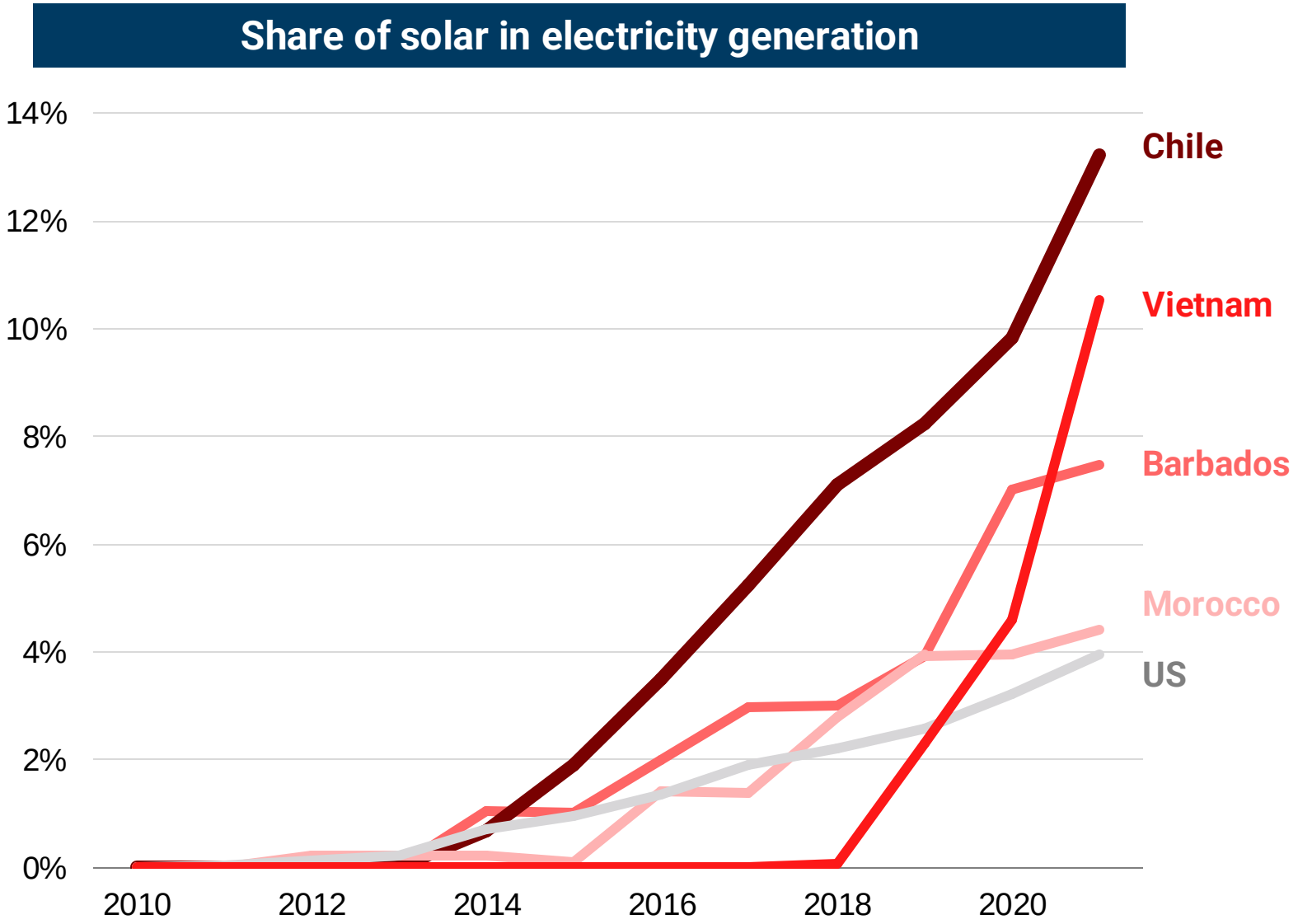
- Capital expenditure on renewable technologies in China is higher than in the United States and Europe combined.
- Given lower costs in China, the volume advantage is even greater.
- Although China also dominates capex on coal capacity, this is one tenth the spending on renewable capex and is likely to be used for backup to a larger renewable system not baseload.



Source: BNEF

The Global South can leapfrog

- Many countries in the Global South are taking advantage of the new technology in order to leapfrog to superior solutions.
- In just three years, and from a standing start, Vietnam overtook the United States for the share of solar in electricity.
- Morocco is deploying renewables to replace fossil fuel imports and build an energy export industry.
- India has made renewables central to its drive for development.
- Chile has driven a peak in fossil fuel demand and is building a hydrogen export industry.
- Barbados is planning for 100% renewables.



Source: Ember

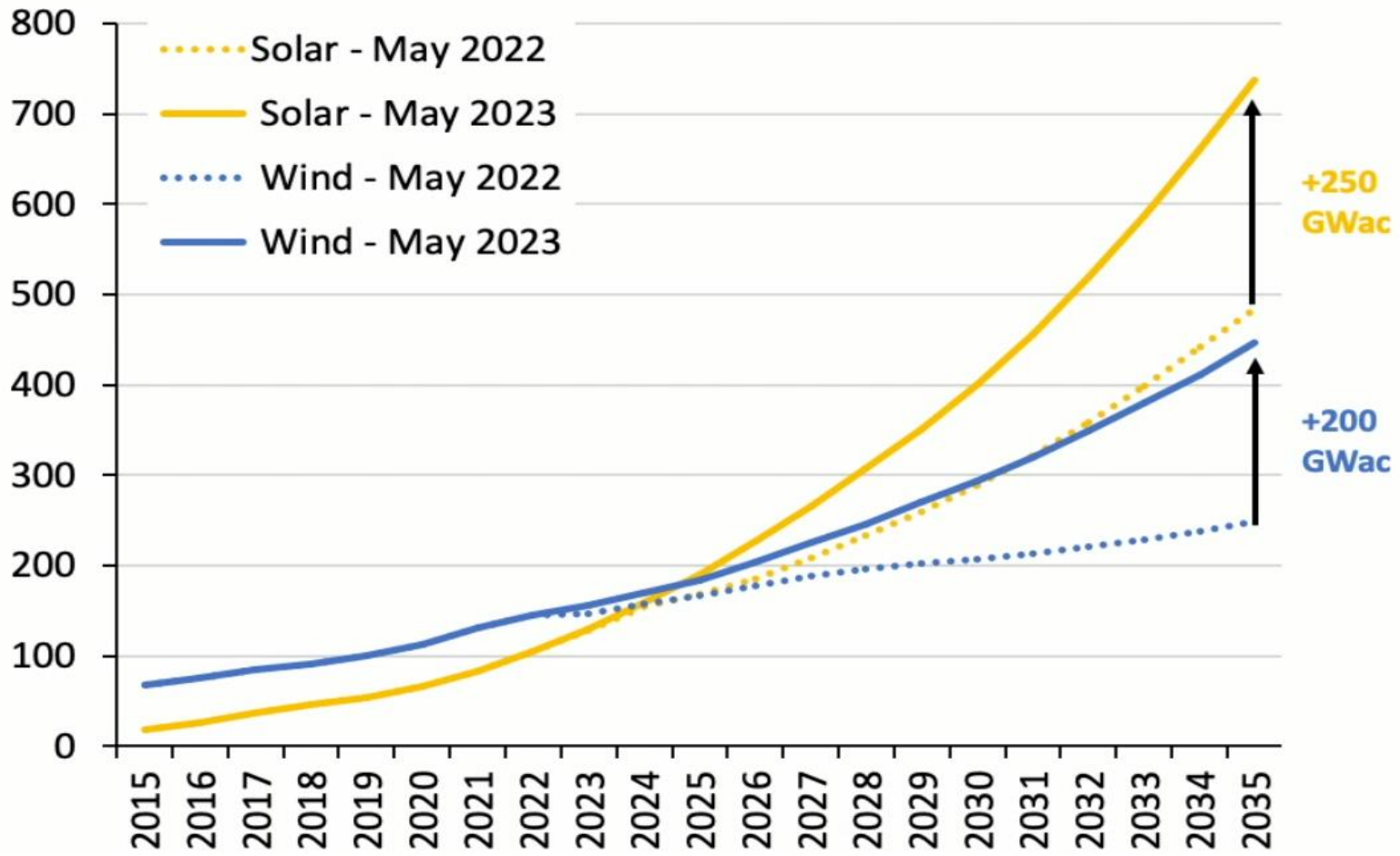
The West is waking up

Putin sparked a global race to deploy clean energy technologies

- Putin's invasion of Ukraine alerted the West to its dependency on China for renewable energy. Arguably this was the "Sputnik moment" that galvanized action.
- The Inflation Reduction Act (IRA) gets the US back in the game, with $370B of public finance catalyzing private capital, bringing down costs, and leading to a tsunami of innovation and deployment.
- Europe has massively increased its ambitions with RePowerEU and the Green Industrial Plan.
- That has been enough to get the West back on an exponential growth path.

The IRA keeps the US on an exponential path

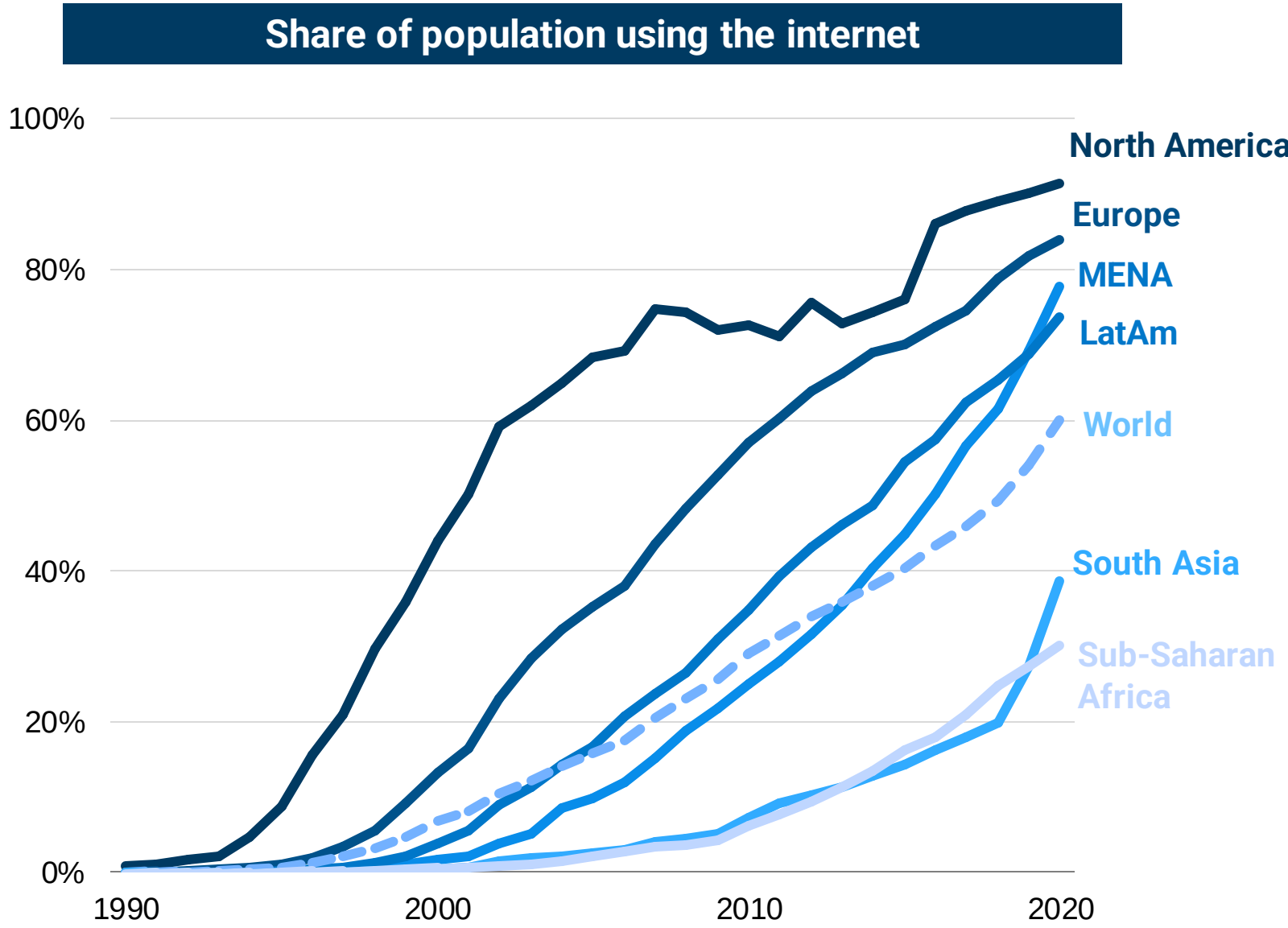
Projected solar and wind capacity in the United States, GW



Source: Rystad

Expect a race to the top

- Technologies spread out from a central core to the rest of the world.
- For example, the United States led the deployment of the internet, and this has since spread around the world.
- The later deployment of the internet in sub-Saharan Africa and South Asia did not hold back the spread of the internet.
- Global internet use only reached 50% in 2018. The impact had long been felt.
- China is the leader of the renewable revolution — and faces fewer constraints.
- Petrostates and those influenced by fossil fuel incumbents will be the last to change — and will suffer for it.



Source: OWID

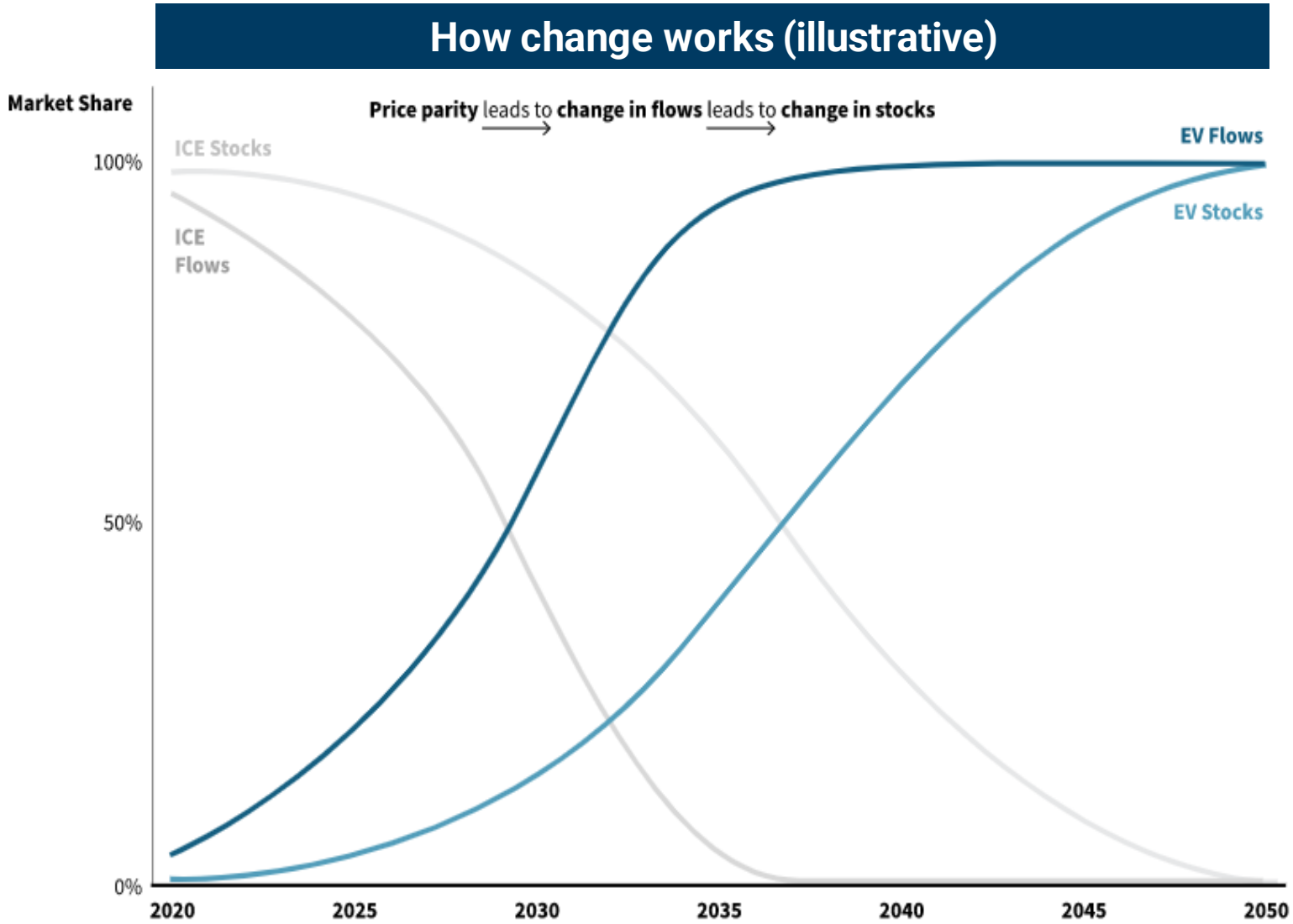
3

The revolution will play out this decade

- Technology revolutions move from price to sales to stocks
- But change is never easy
- Technology and policy help solve the barriers to change
- 70% of fossil fuel demand is at risk today and by 2030, all of it will be
- The picture will be very different by 2030

Revolutions move from price to sales to stocks

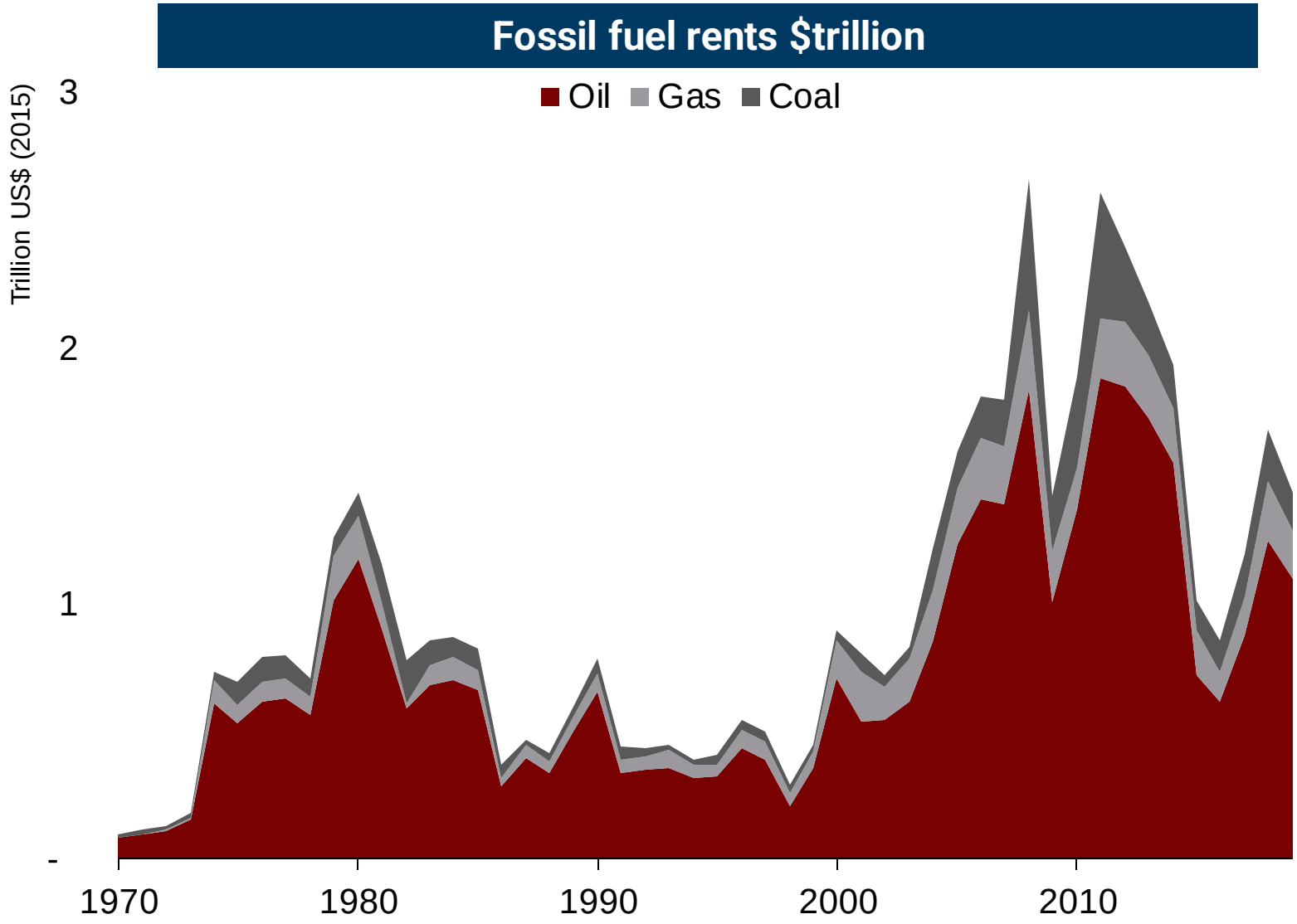
- Successful technologies spend decades in development before a price tipping point is reached.
- At that point, sales take off. Typically, sales will grow up S-curves from about 10% to 80% market share in a decade or so.
- As soon as sales are dominated by the new technology, the stock of assets will change — slowly, but inexorably, with depreciation.
- The key analytical issue: When is the price tipping point reached and sales begin to race up the S-curve.
- Stocks are a lagging indicator.



Source: BNEF NZS, RMI

But change is hard

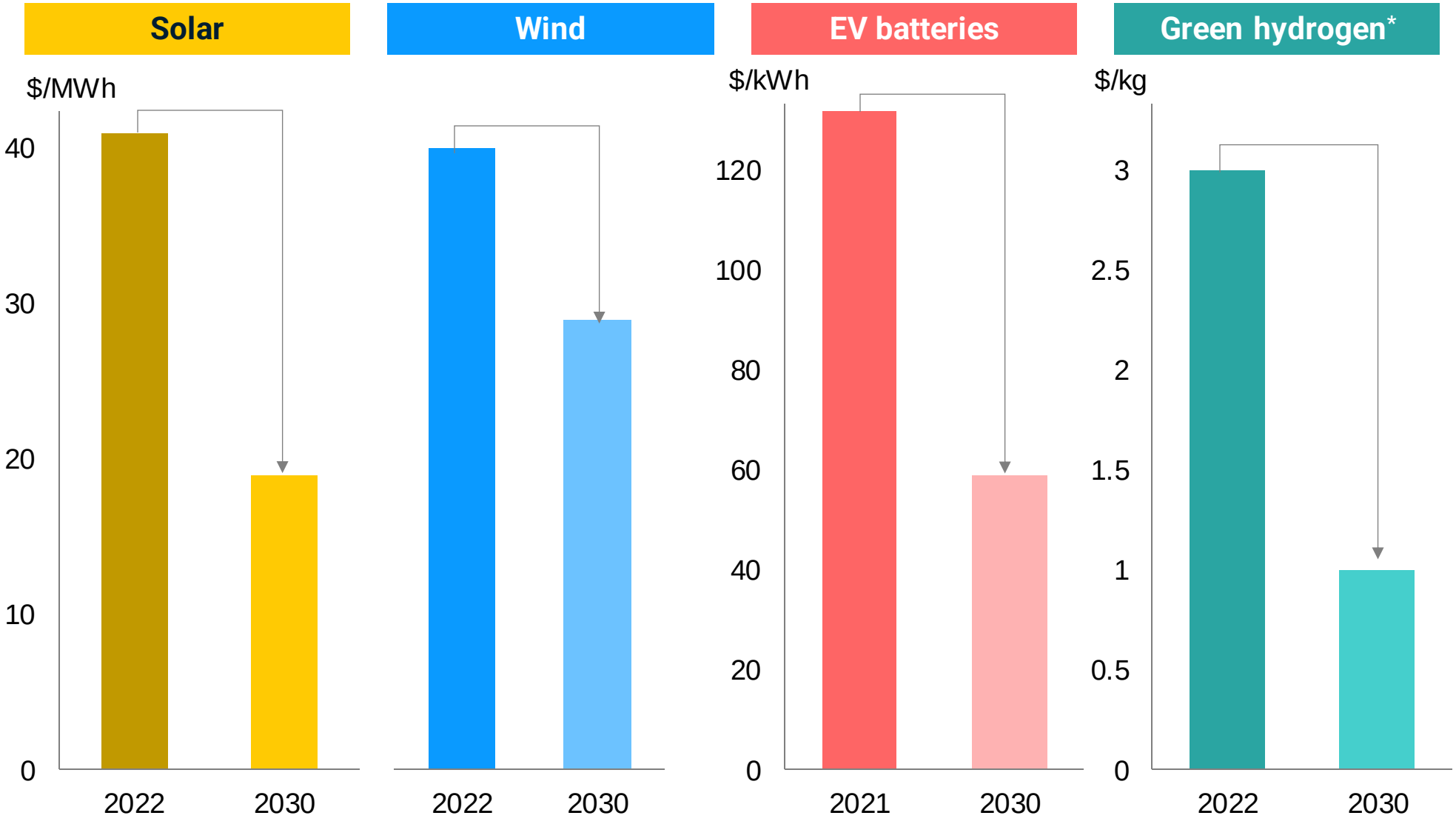
- Inertia and vested interests inevitably hold back change.
- Fossil fuels generate up to $2 trillion every year in “rent” for incumbents.
- 10% of the world live in petrostates whose current political economy is largely dependent on the continuity of the fossil era.
- Large parts of the financial system are deeply linked to the fossil fuel incumbents.
- Many energy actors cannot conceive of a world of change, and work actively to maintain the status quo.



Source: World Bank

Cheap renewables open up a new paradigm

- If we continue on existing learning and growth rates, then by 2030 the world will enjoy: sub $20/MWh solar, $30/MWh wind; $60/kWh Li-ion batteries and $1/kg green hydrogen (in optimal locations).
- Which means renewable technologies much cheaper than any fossil fuel alternative.
- Low prices and the desire for technology leadership drive a new race to the top — for business, for finance, and for government.

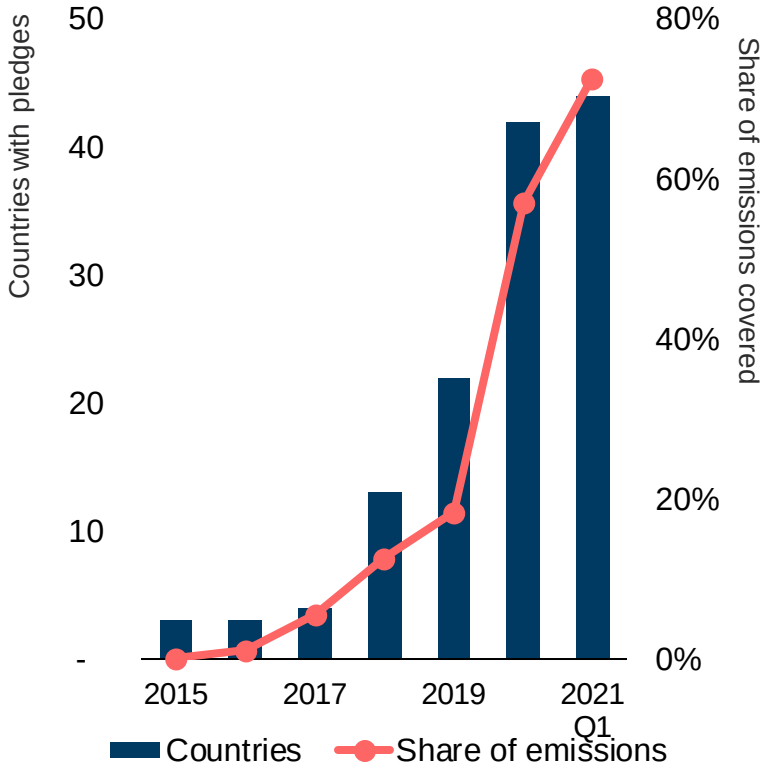


Source: BNEF, RMI, Oxford INET. *competitive locations. $ real 2021.

Rising temperatures and falling costs galvanize policy action

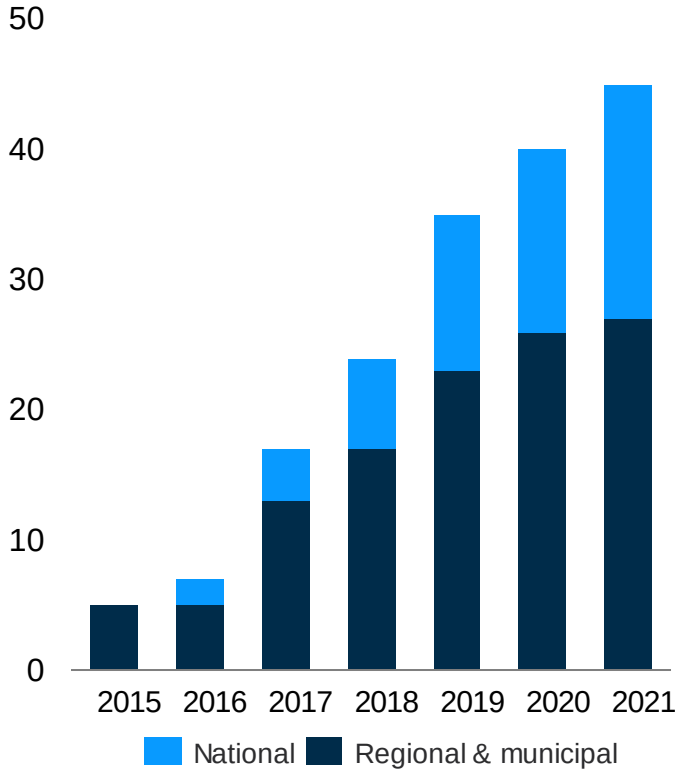
Change in one country encourages change in the next

Net-zero targets



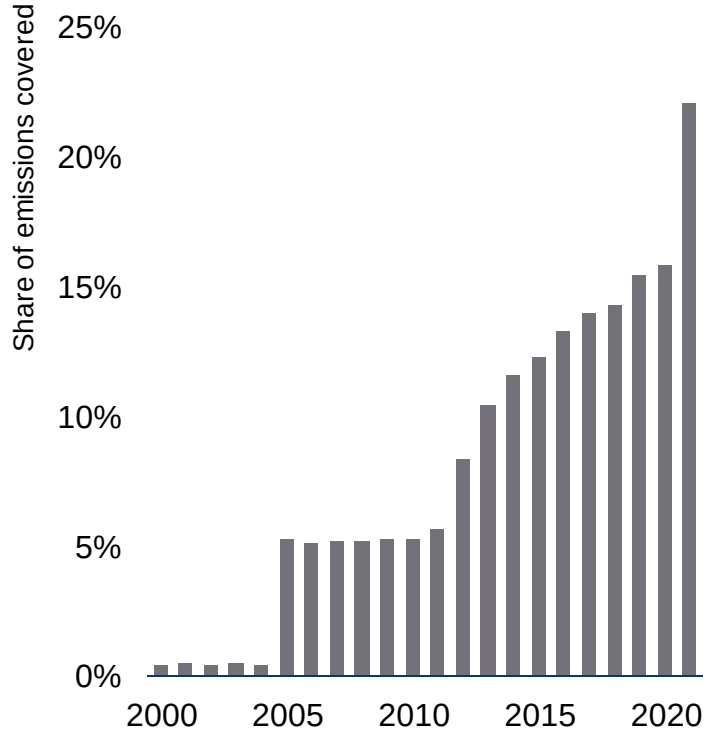
In 2022, over 90% of the world by GDP had set net-zero targets, up from 6% in 2017.

Combustion car bans



Fifty countries and regions are planning to ban ICE cars.

Carbon taxes



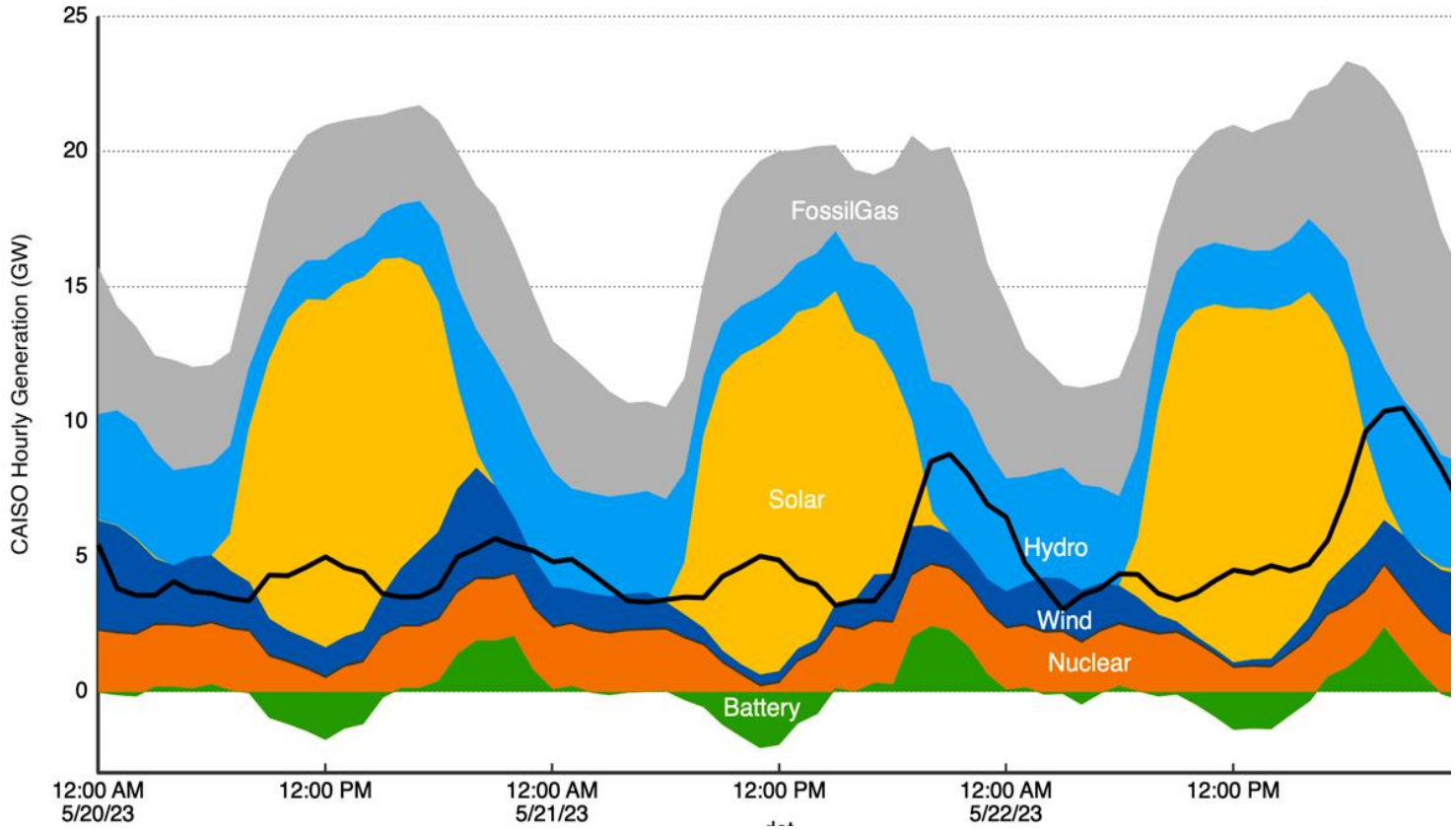
The share of emissions covered by taxes has increased fourfold in a decade.

Source: IEA, BNEF, World Bank

There are many barriers, but none are insoluble

- As with any technology shift, there are many barriers to change, but none of them is insoluble, universal, and permanent.
- Civil society, policy, business, finance, and technology will all need to play their part.
- Flexibility is provided by better demand-side management, supply-side management, and new storage technologies. The *Dunkelflaute* is an endgame problem, not a barrier in 2023.
- The world has enough minerals for the entire energy transition, and is rapidly building out the mines to extract them.
- For now, key issues include building out grids, speeding up permitting, and changing market design for a renewable world.

Electricity generation May 2023 California

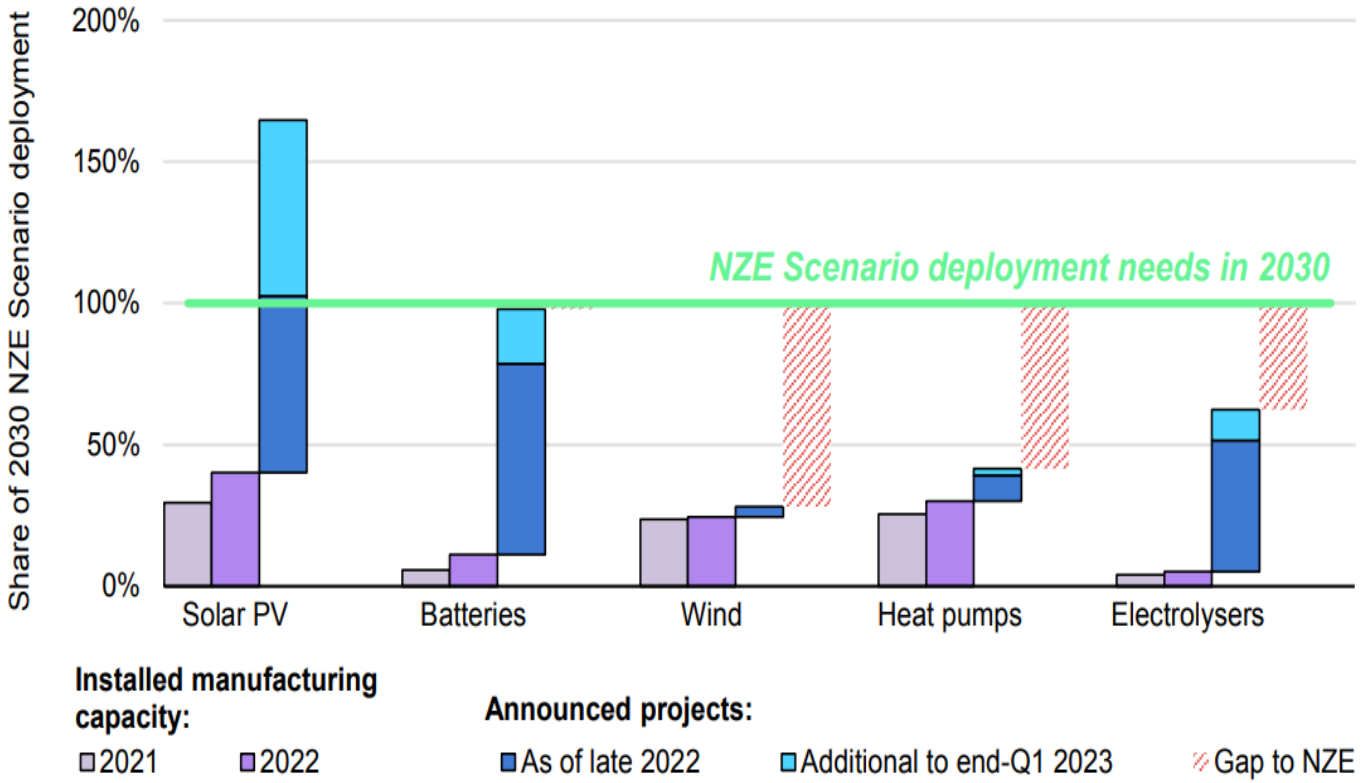


Source: CAISO for May 2023.

Manufacturing capacity is being built at remarkable speed

- There has been a surge in new manufacturing capacity for key renewable technologies in the past two years.
- At the end of 2022 announced projects already were sufficient to build all the solar required under the IEA NZE for 2030. In the first three months of 2023, project announcements increased by a further 50% to 1,100 GW of expected throughput in 2030.
- There are enough battery factories (6,800 GWh by 2030) coming onstream to ensure the IEA NZE is on track.
- Electrolyser announced capacity is already 140 GW in 2030, is increasing by the day, and is likely soon to exceed the IEA NZE target.

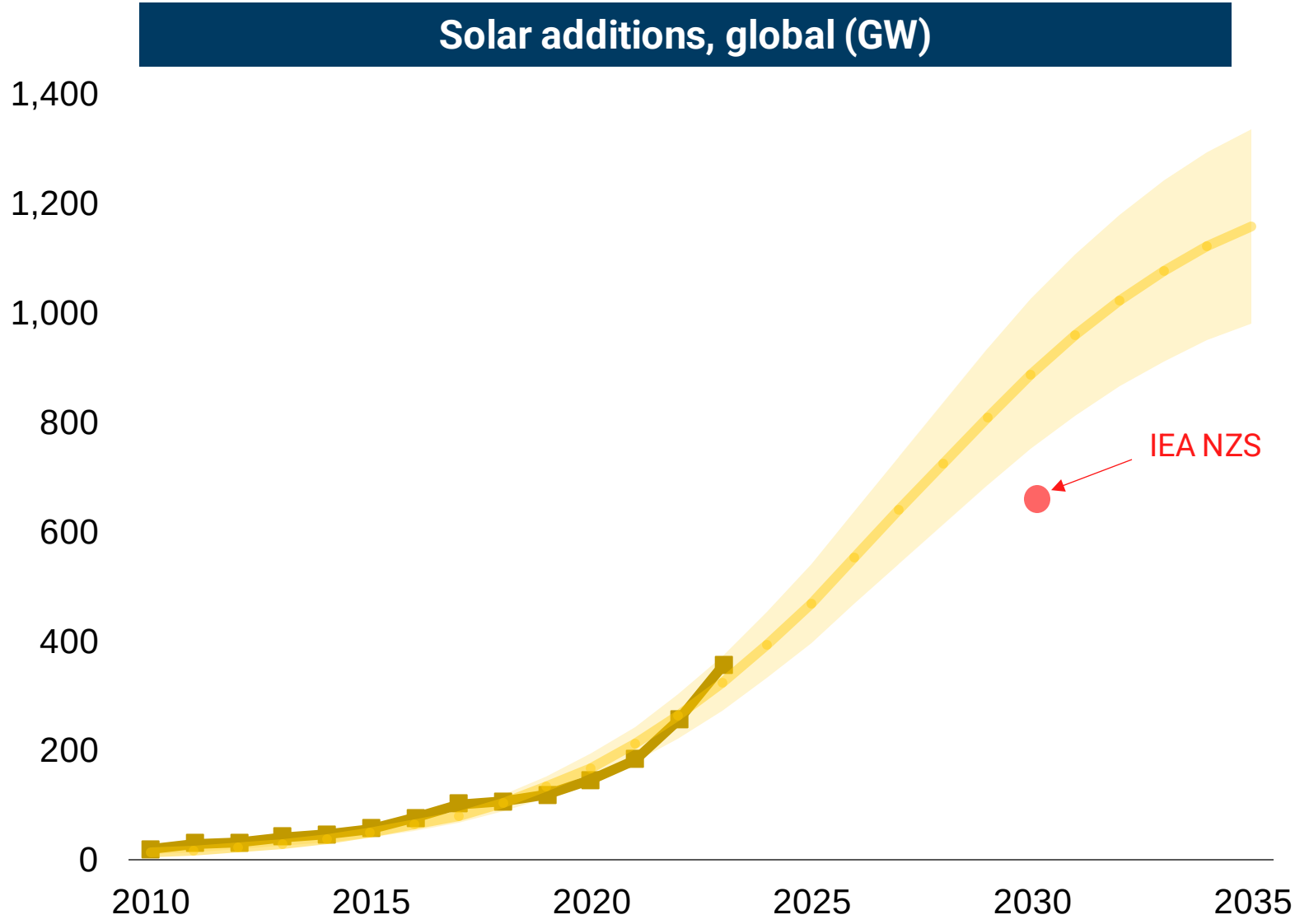
Manufacturing capacity for key renewable technologies



Source: IEA, *The State of Clean Technology Manufacturing*, 2023

This is the decade that solar sales race up the S-curve

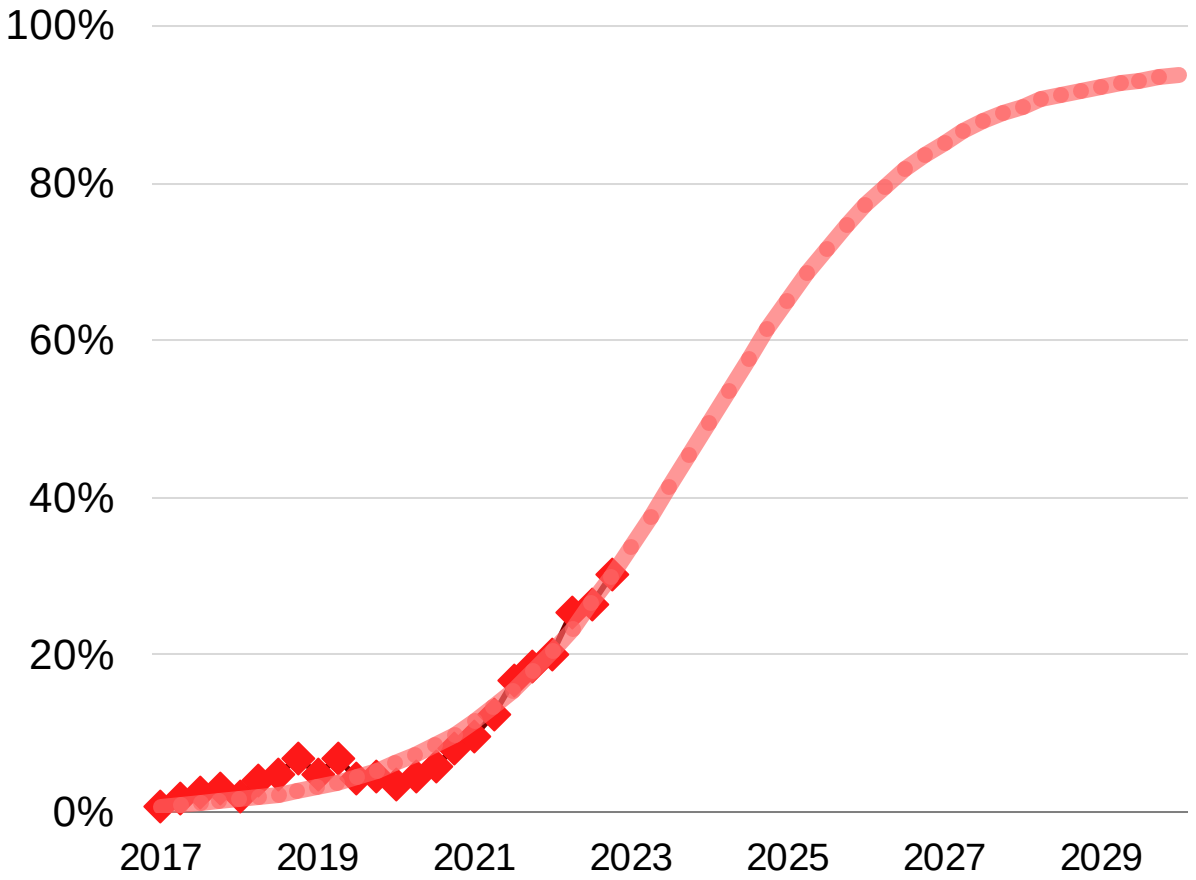
- S-curve modeling of key renewable technologies has been the best way to model sales growth so far.
- Simple extrapolation implies that they will move up the steep part of the S-curve during the course of this decade.
- The solar industry is preparing for over 1,000 GW of sales by 2030.
- If we maintain our current path, we will be installing more solar in 2030 than the IEA's stretch target for net zero.



Source: BNEF (past), RMI (exponential extrapolation)

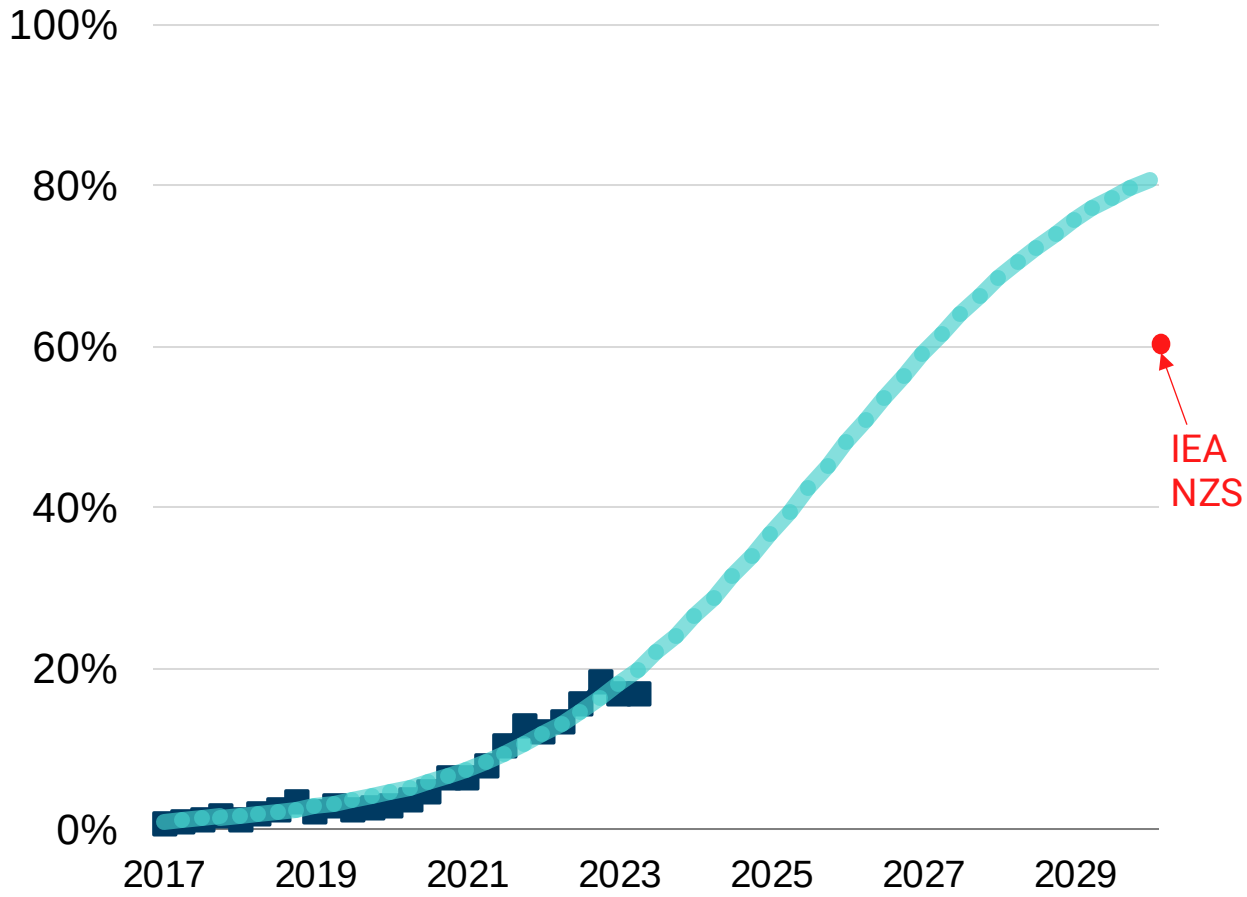
This is the decade EVs rise to dominance

EV sales share in China (%)



- By 2030, S-curve modeling of vehicle sales implies that 90% of China sales will be electric. Globally, over 70% will be EVs.

EV sales share global (%)

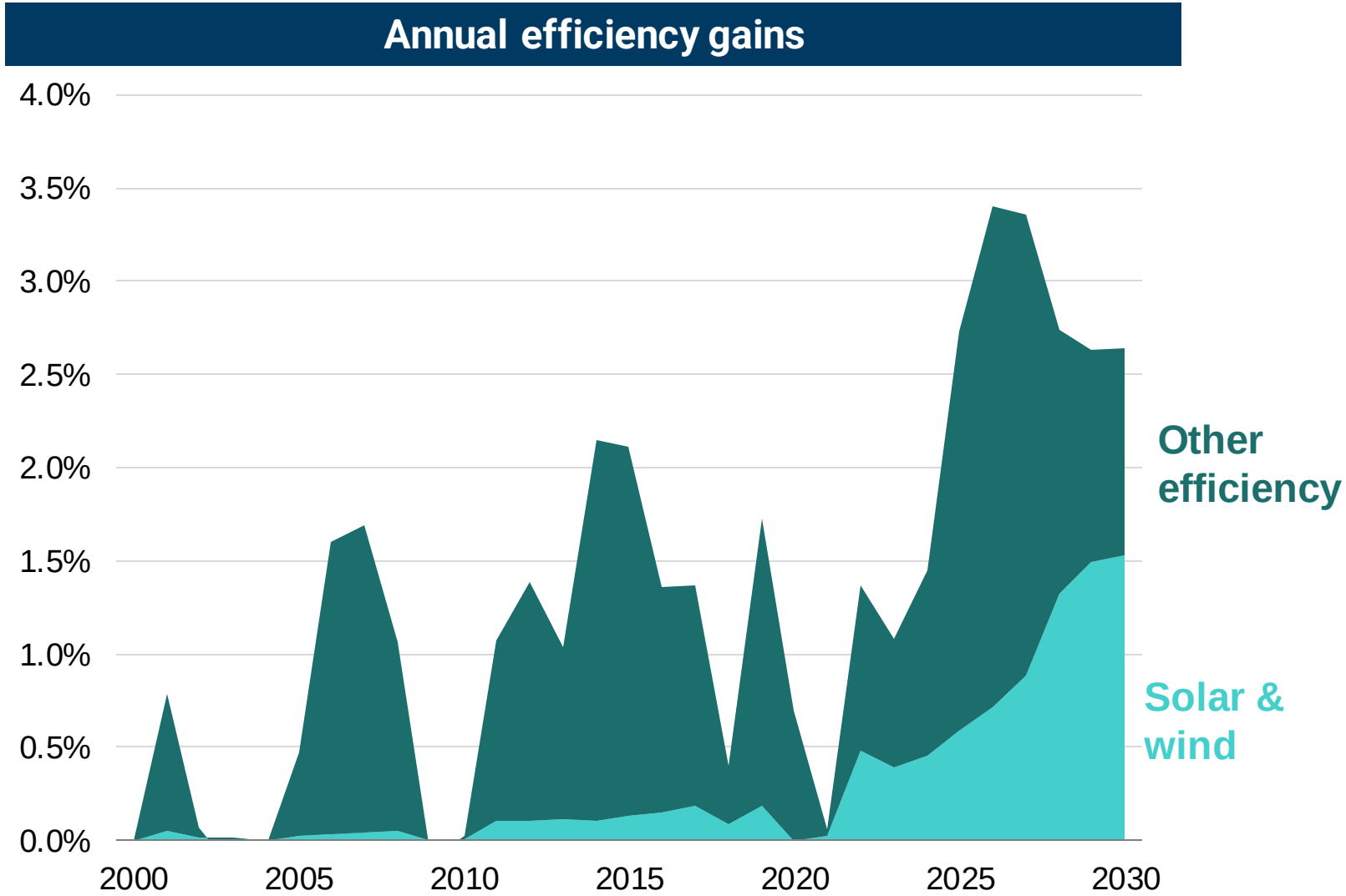


- Continuity would be far above the level required in the IEA net-zero scenario.
- Car industry planning for EV sales to be up to 100% by 2030.

Source: BNEF (historic), RMI (exponential extrapolation)

Renewables and electrification drive efficiency up an S-curve

- For the past 20 years, annual efficiency gains have been incremental — at 1% to 2%.
- Now there are two systemic drivers of efficiency gains along S curves: solar and wind electricity, and electrification. They benefit from digitization and artificial intelligence (AI).
- Solar and wind reduce primary energy demand by around 60%; electrification by up to 80%.
- Efficiency gains are thus likely to nearly double, to over 3% per year.
- Efficiency gains could thus overtake GDP growth, meaning peak primary energy demand.

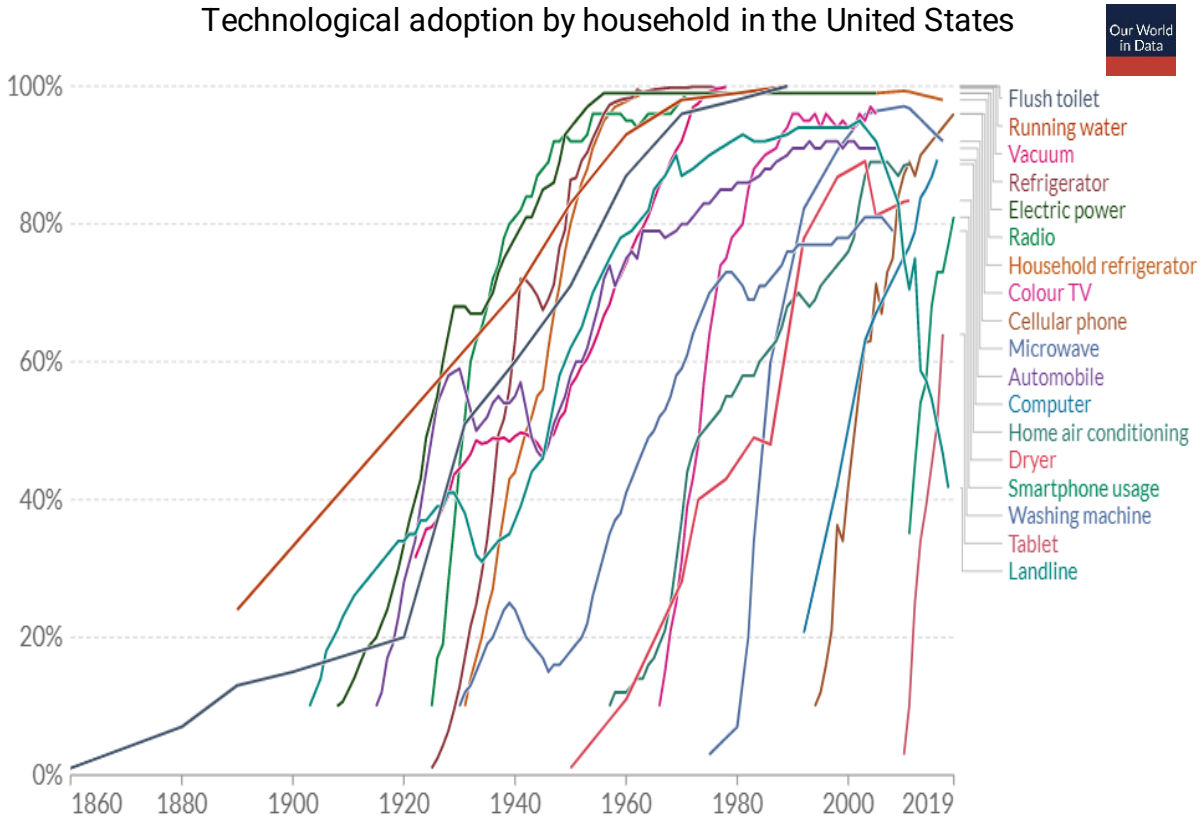


Source: Rystad 1.6DG, RMI estimates for solar & wind impact. Note that Rystad measures efficiency against GDP not GDP in PPP terms. So its annual gains are a little lower than those of the IEA.

Technologies move up S-curves all the time

Individual products

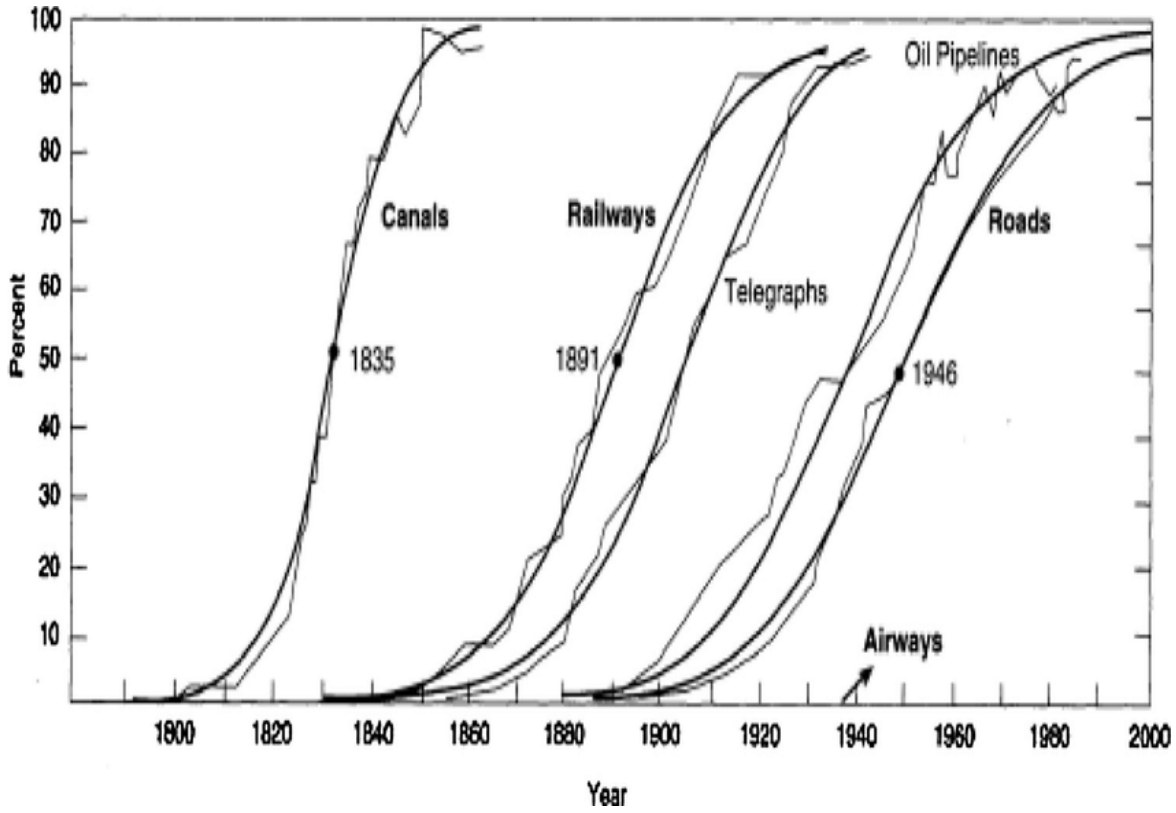
Technological adoption by household in the United States



Rapid exponential growth along S-curves is a standard characteristic of successful new technologies.

Infrastructure systems

Share of maximum size in the United States



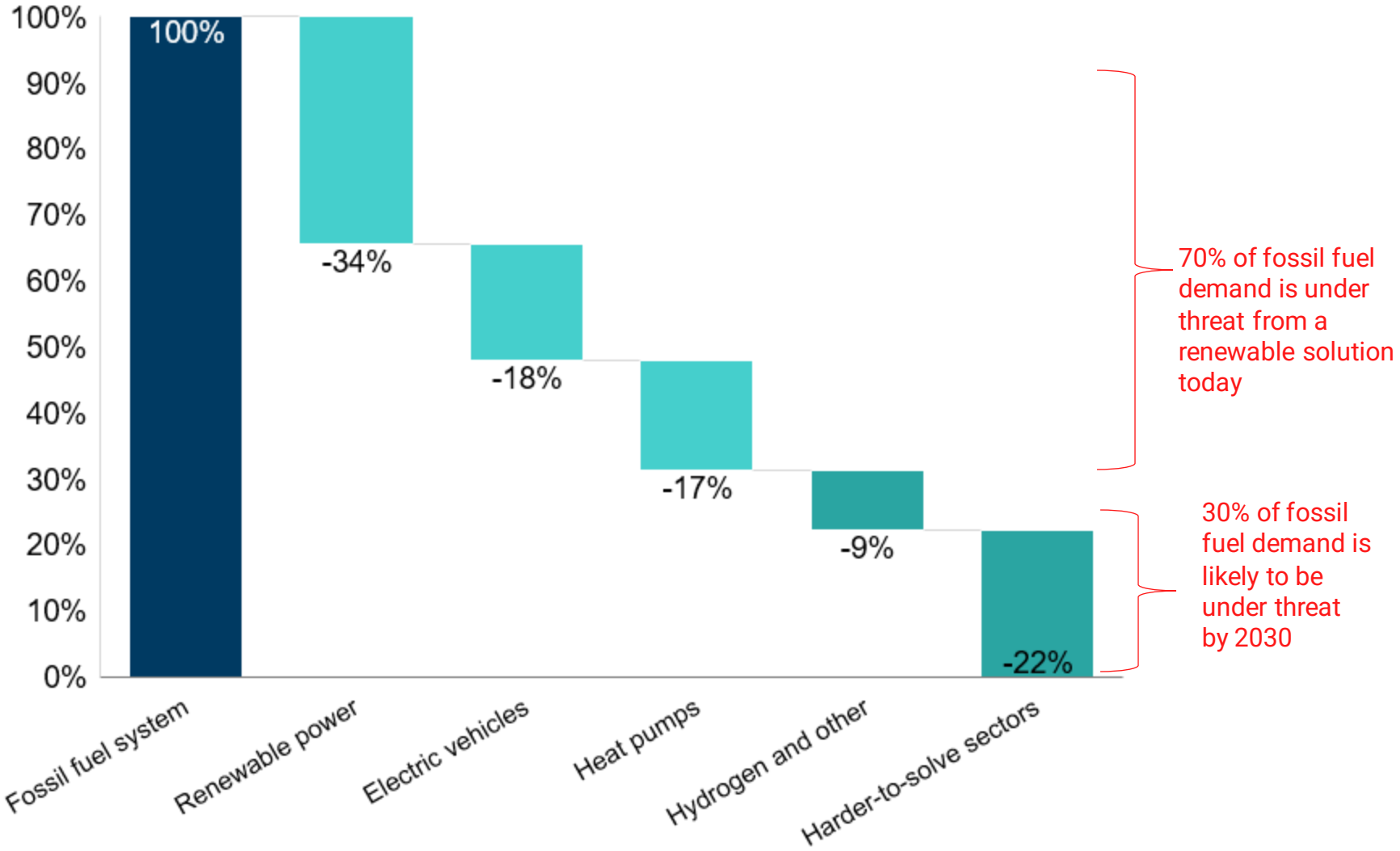
S-curve-type growth even applies to infrastructure.

Source: Comin & Hobijn via OWID (L); Grubler (R)

Key technologies are enough to reshape the energy system

- Solar and wind decarbonize electricity, which is over a third of fossil fuel demand.
- EVs decarbonize road transport — first light then heavy.
- Heat pumps decarbonize home heat and light industry.
- Electrification and hydrogen solve most of the rest.
- Most attention focuses on the hard-to-solve areas which are the last 22% of fossil fuel demand, and solutions are already coming.
- But we already have today economically viable technology solutions eating into the first 70% of fossil fuel demand.

Ways to substitute fossil fuel demand



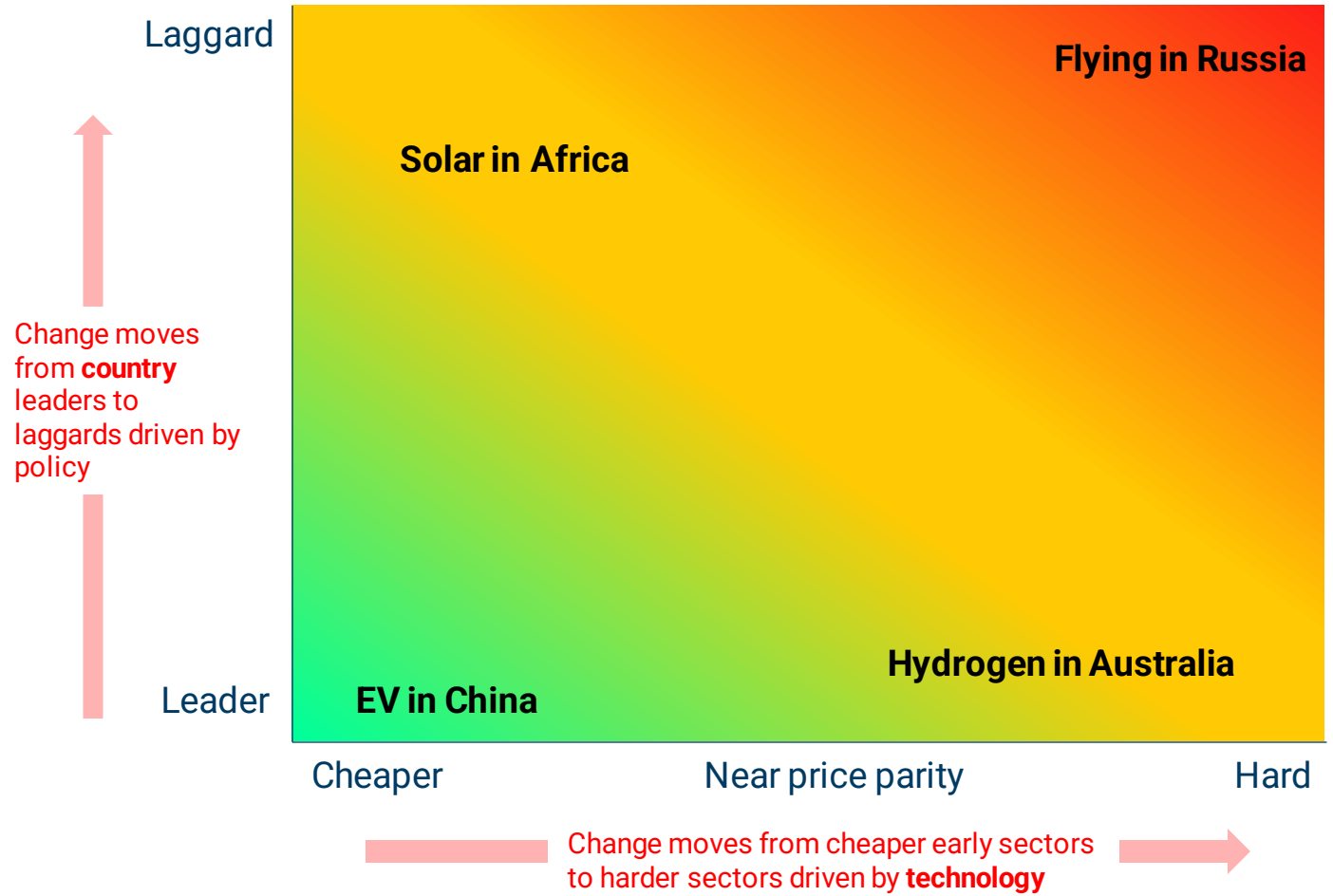
Source: RMI based on 2022 data from BNEF, Tesla framing

Technology revolution means complex change across three vectors

It takes a lot of work to drive change from the central core

- As with all technology transitions, change requires a lot of work across three main vectors:
  - **Deepen**. Successful technologies in leading countries (e.g., EVs in China) must continue growing up the S-curve, which requires greater flexibility, more grids, and more minerals.
  - **Widen technology**. Technology price points (e.g., green ammonia) need to be found in harder-to-solve sectors.
  - **Widen geography**. Successful technologies need to be rolled out at scale in laggard countries (e.g., solar in Africa).
- We also need to work to maintain ongoing efficiency gains by designing cities better, improving building codes and product standards, and more.

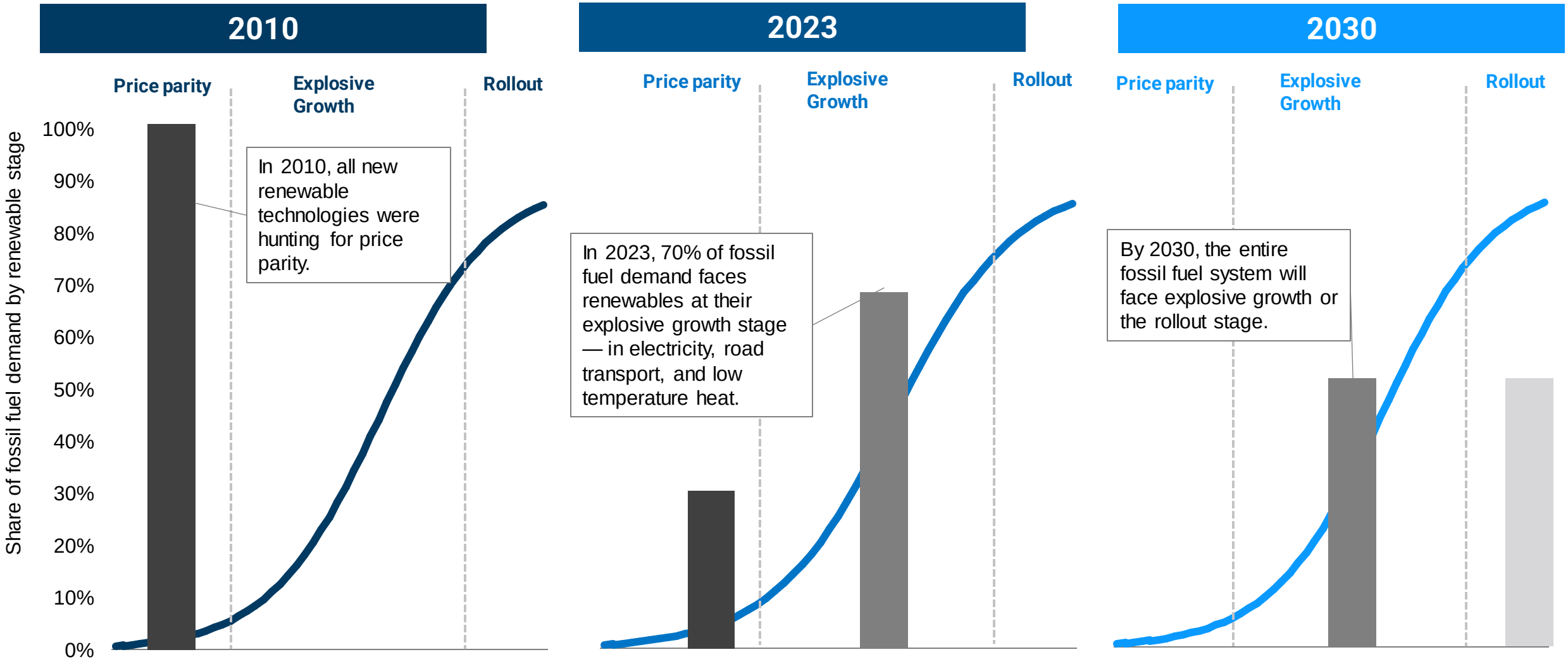
The country and technology spread of change



Source: RMI concept chart. Green signifies areas where rapid change is taking place already. Yellow where the cutting edge of change lies. And orange and red are the harder areas. Four examples have been added for illustration

By 2030 the entire fossil system will face disruptive challengers

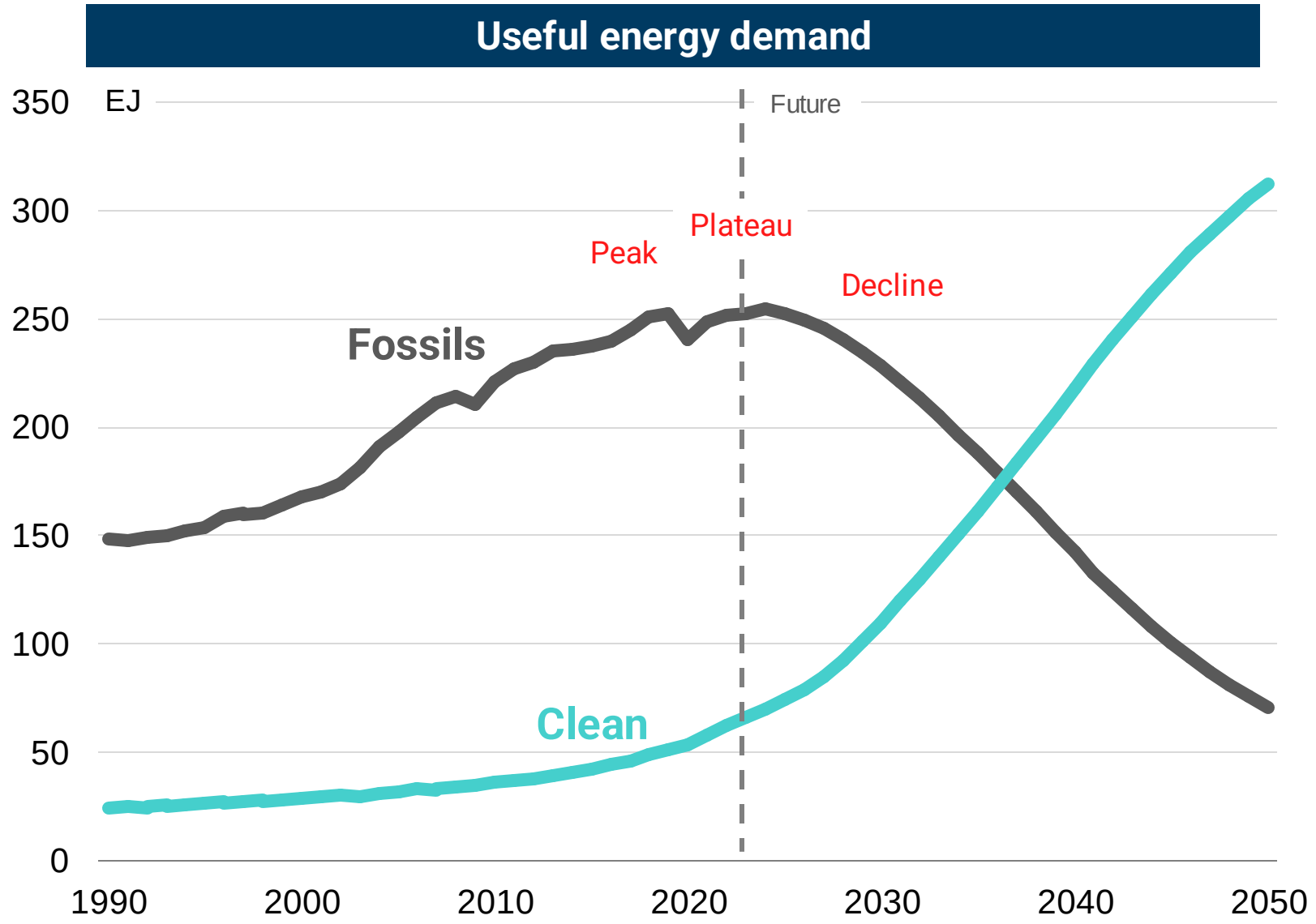
New technologies move from the hunt for price parity to explosive growth to rollout



Source: RMI

The renewable future is taking shape

- As renewables move up the S-curve, so fossil fuel demand follows a peak, plateau, decline shape.
- As soon as decline becomes clear, it is priced in by markets and geopolitics.
- That sets off a series of positive and negative feedback loops
- For renewables, this signifies a race to the top.
- For fossil fuels, it signifies a race to get out while you still can.



Source: Rystad 1.6°C Scenario

The debate will be very different in 2030

- If we ensure that renewable growth stays on track, both reality and perception will be very different in 2030.
- Renewable costs will be clearly lower than fossil costs in at least one part of every major system.
- Societal pressure for change will be higher.
- Renewables will be supplying all the growth in energy demand, and fossil fuel demand will be in clear decline.
- Many barriers to change will be solved, and new solutions will be visible.
- Geopolitics and financial markets will have embraced the new technology.

A change in both reality and perception

Area	2023	2030
Relative costs renewables vs. fossil fuels	Comparable	Renewables are much cheaper
Societal pressure for change	Moderate	Intense
Renewable share of energy demand growth	Most of the growth	All of the growth
Share of solar & wind in electricity generation	About 14%	About 40%
EV share of sales	About 20%	Over 70%
Global fossil fuel demand	Maybe peaking	Clearly in decline
China's fossil fuel demand	Maybe peaking	Clearly peaked
Harder-to-solve sectors	Some solutions	Lots of solutions
Barriers to change	Lots of concerns	Less concerns
Geopolitics	Renewables nice to have	Renewables a key tool of power
Financial markets	I should hedge my bets	Renewables are the future
Corporations	Green premium	Green prize

Source: RMI

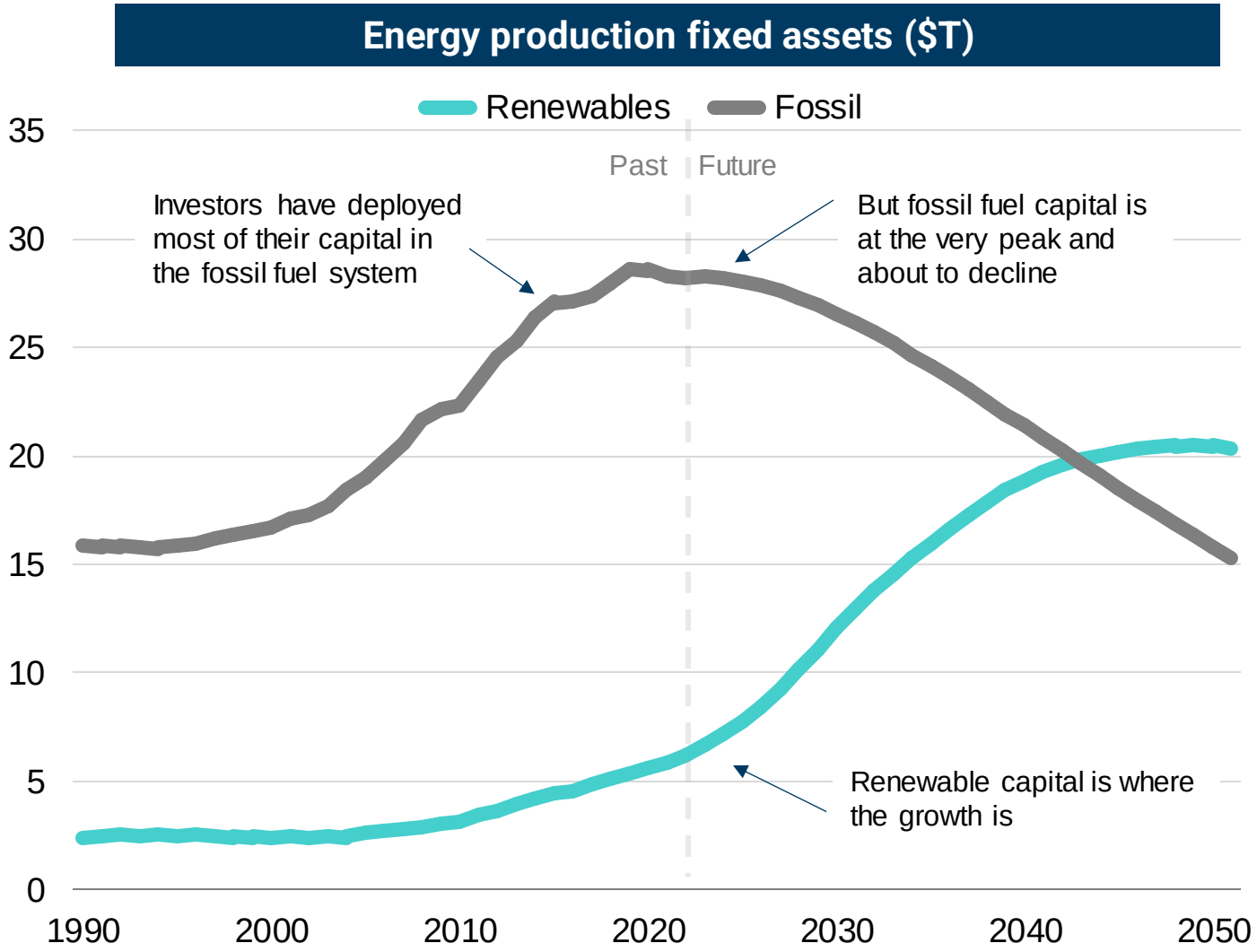
4

Implications of the revolution

- Investors, banks, and companies
- Policymakers, national security
- The Global South, petrostates
- Climate, health, justice, and nature
- Models

Investors: play the renewable supercycle

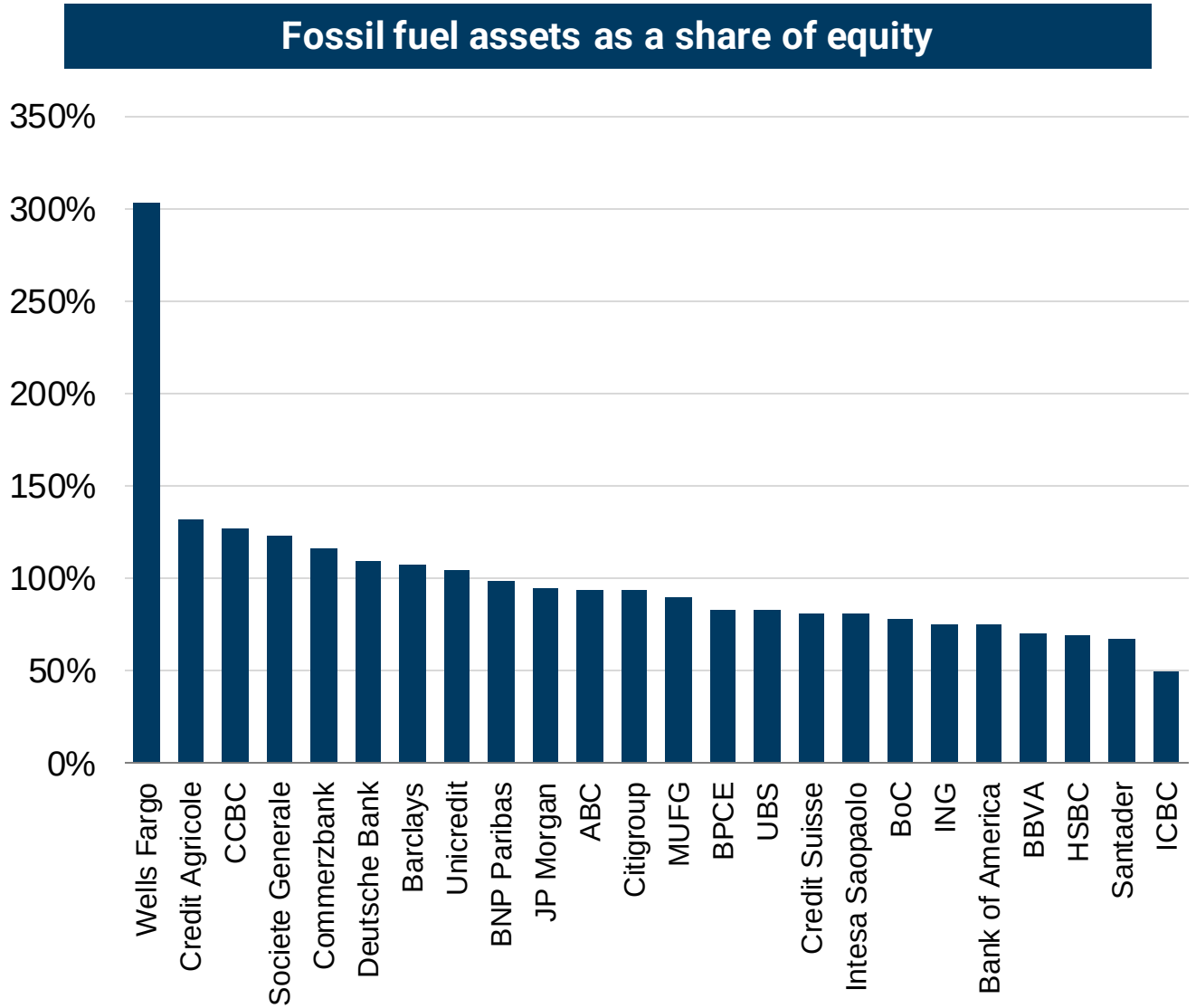
- This change is a renewable supercycle, similar to the China-driven commodities supercycle after 2001.
- The difference is that investors already have massive exposure to the current system.
- Invest in everything that is needed for the energy transition — from minerals to infrastructure. Not all will succeed, but this is the nexus of growth.
- Invest in disrupters building new industries in both energy supply and energy usage.
- Avoid sectors facing structural decline, which means both fossil fuel producers and heavy users who fail to transition.
- Avoid petrostates resisting change and invest in the *electrostates* driving it.



Source: Rystad 1.6 degrees, RMI

Banks: wake up to the risk

- The fossil fuel system has around $50T of fixed assets in production and consumption. The collapse of that system must lead to trillions of dollars of stranded assets.
- Banks are deeply exposed. Half of US syndicated loans are to fossil fuel sectors. For many banks, fossil fuel sector loans exceed equity capital.
- Banks still use old data, old models, and BAU framing (like IAMs, NGFS, or IPCC scenarios) in most of their stress testing.
- Banks like to argue that they can avoid disaster because their loan books have only a short tenure. But prices and stranding can move very fast.
- When banks realize the degree of risk they are carrying, they will all try to sell at the same time; this may be a classic Minsky moment like 2008.



Source: Reclaim Finance

Companies: time to move from tactics to strategy

- Companies face the prospect of a rapid transition to a new environment, which creates its own set of opportunities and risks.
- Stage 1 of the energy transition has largely been a tactical response to external pressure. This has meant ESG, box-ticking, CCS, carbon footprinting, and so on. But tactics will only take you so far in the face of real change.
- Stage 2 is more serious. A new world of energy is opening up and the driver of change is the need to survive and thrive. This requires a strategic response to the new world that is unfolding.
- Different types of companies will have to respond in different ways, but now is the time for proper leadership.

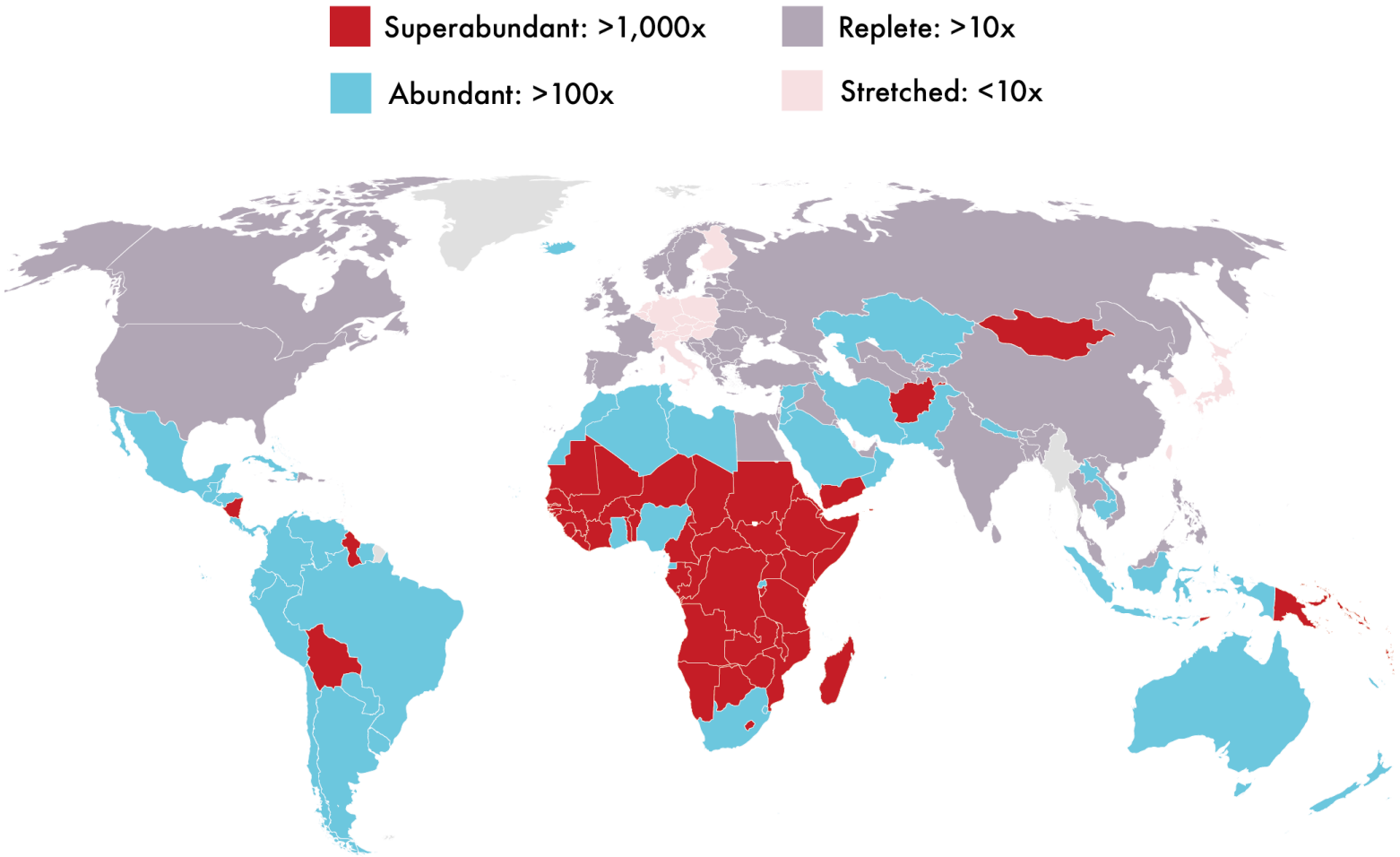
Company types and options		
Type	**Future**	**What to do**
Fossil fuel producers	Decline	Reinvention; rundown
Heavy fossil fuel users	New energy source	Retool for the new energy source
Renewable companies	Rapid growth, rapid innovation	Innovate and expand
Entrepreneurs	A brave new world	Solve barriers and get rich
Others	A new environment	Rethink areas of focus

Source: RMI

National security: renewables are the answer

- Everyone has renewables. They are 100 times bigger than fossil fuels.
- But only 20% of people live in countries with ample fossil fuel supply.
- Fossil fuels are often used as a tool of power. You cannot do the same thing with renewables. If you cut off supply, then countries still have the renewable technologies they bought over the past 20 years.
- At present China does have a dominance in manufacturing, but that is changing fast as the United States and Europe build up their own supply chains.
- Solar and wind by definition are local. Nobody can cut off the sun.

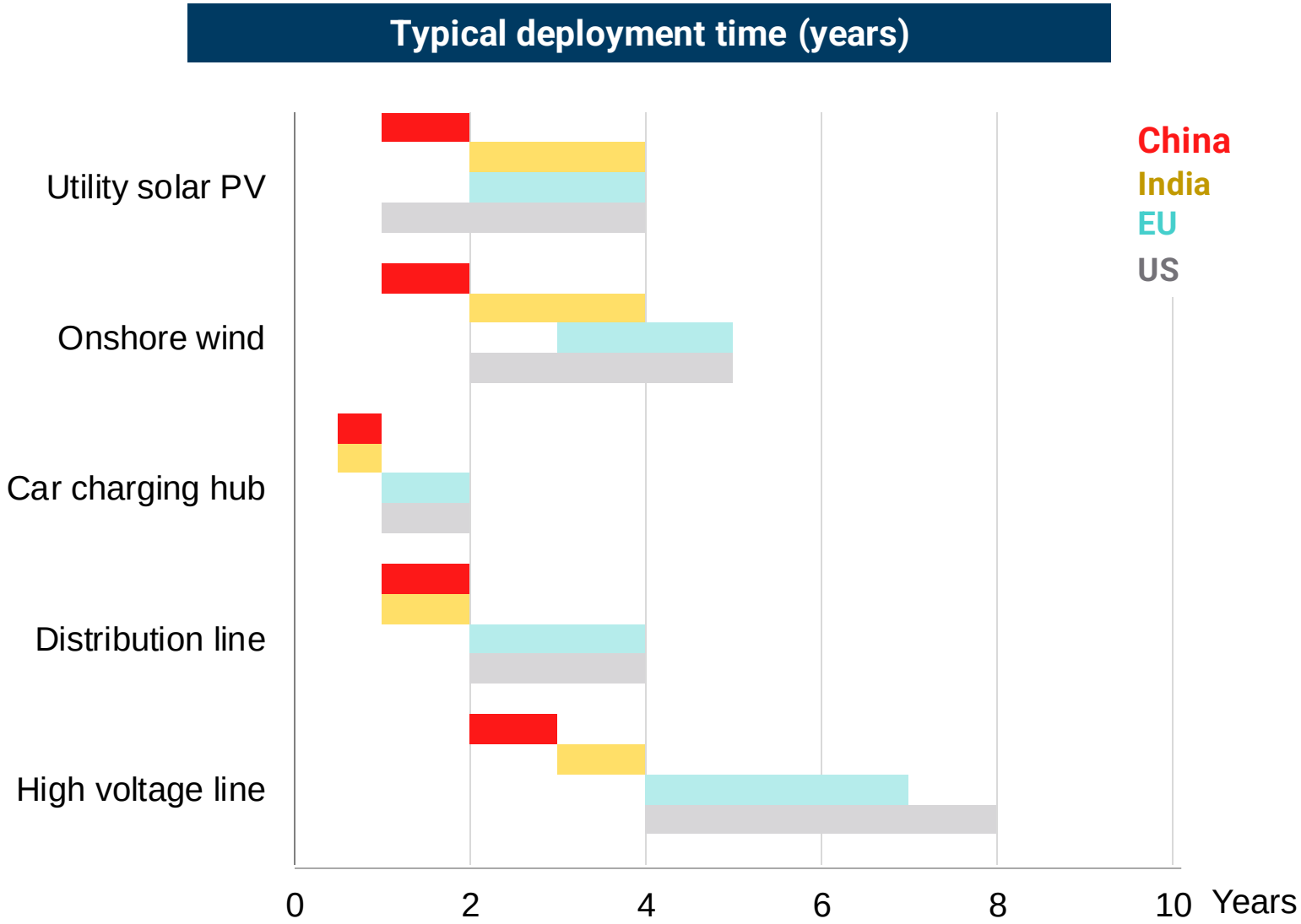
Solar and wind energy potential as a multiple of total energy demand



Source: Carbon Tracker

Policymakers: a race to the top

- A decade ago, policymakers led the transition. Now in many places they are holding it up, because technology and costs have run ahead of policy.
- We face a regulatory battle to make systems fit for purpose and unleash the renewables revolution.
- Putin fired the starting gun for a race to the top in the technologies of the renewables revolution.
- China currently leads. It is time for others to catch up.
- Key issues right now include building grids; solar and wind permitting; and market structures.

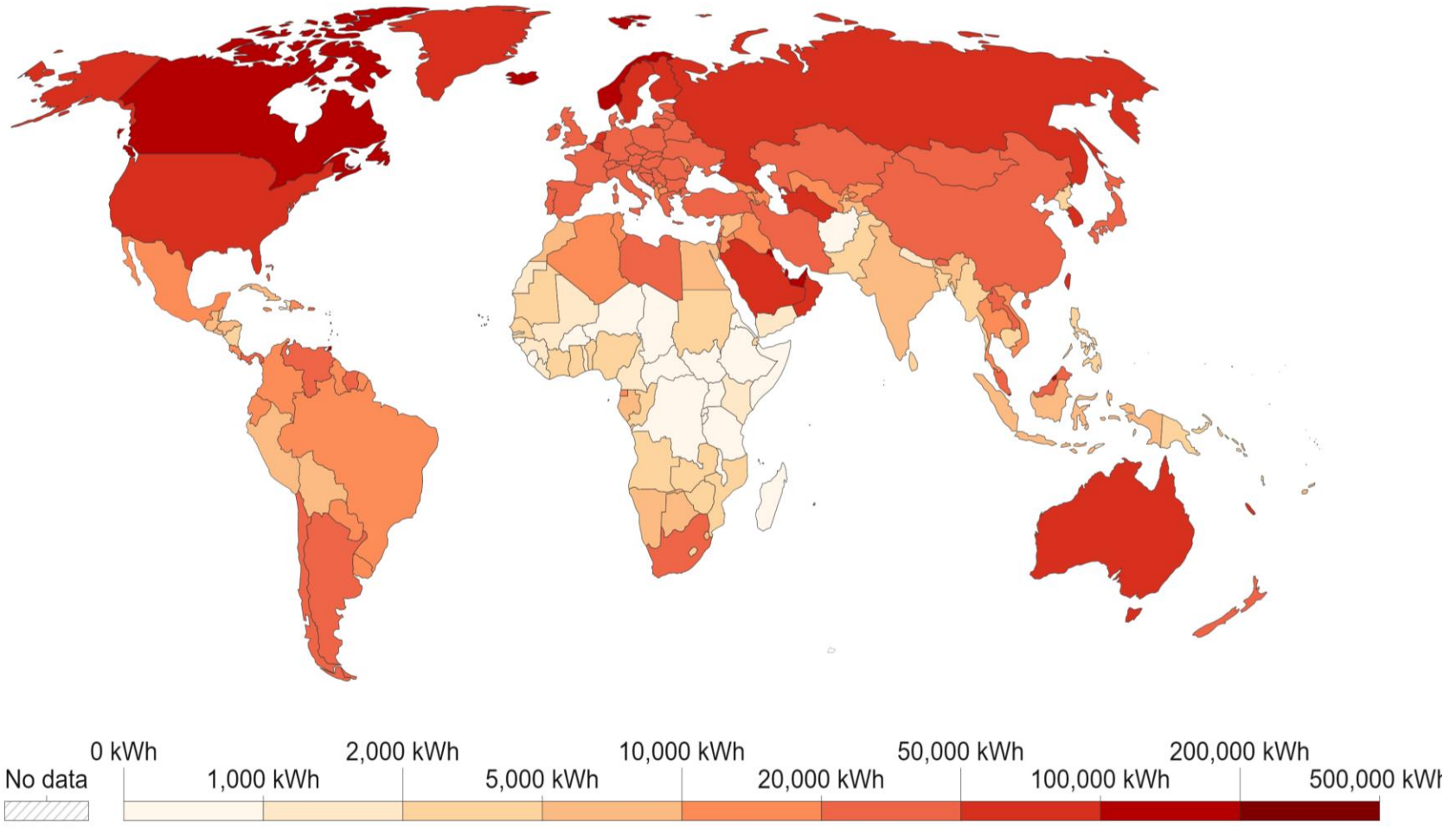


Source: IEA, World Energy Outlook 2022

The Global South: a huge development opportunity

- The Global South has huge renewable resources, 100 times bigger than fossil fuels.
- Falling costs unlock these resources and are a new tool for development.
- Most countries in the Global South are also fossil fuel importers.
- The opportunity is to deploy renewables, which are cheap, local, and distributed.
- The risk is being stuck with the old technologies of the past which are already being phased out in developed markets, but are now aggressively pushed by the fossil fuel industry.
- It is time to leapfrog and claim a place in the sun. And RMI is helping make that happen.

Energy use per person, kWh

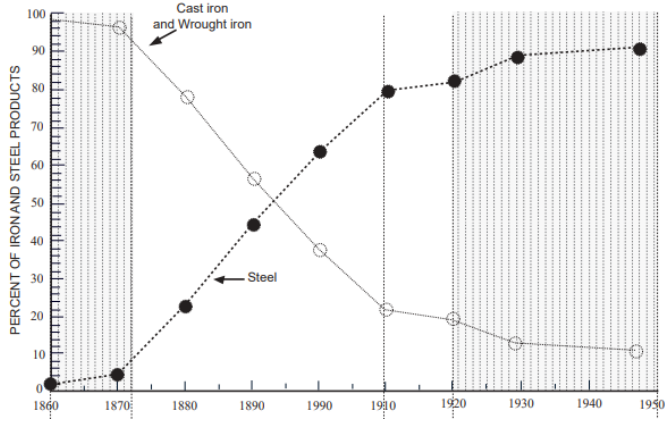


Source: OWID

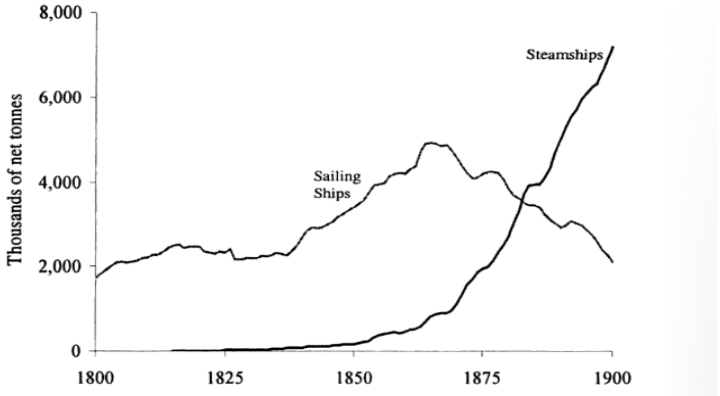
Petrostates and incumbents: change before it's too late

The risk is to be left high and dry with old technologies. Greenwashing and CCS are tactics not strategy

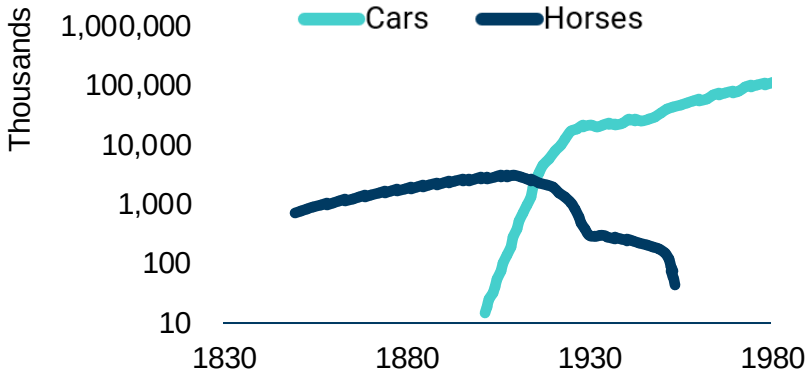
Cast iron to steel



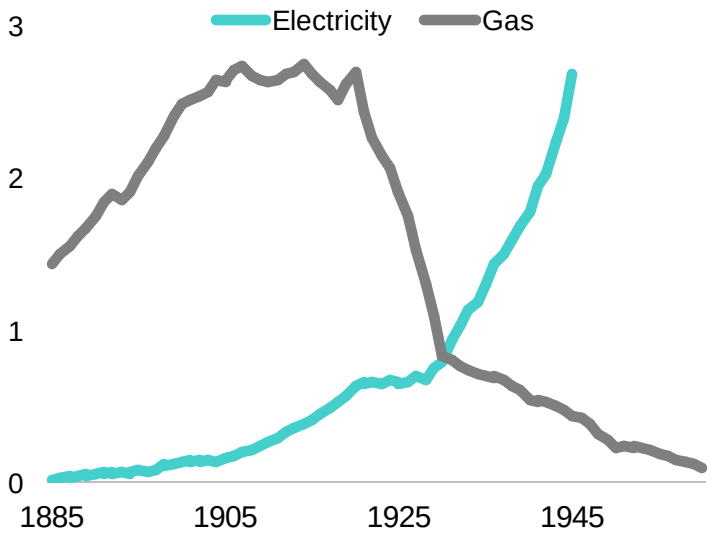
Transport: Sailing ships to steamships



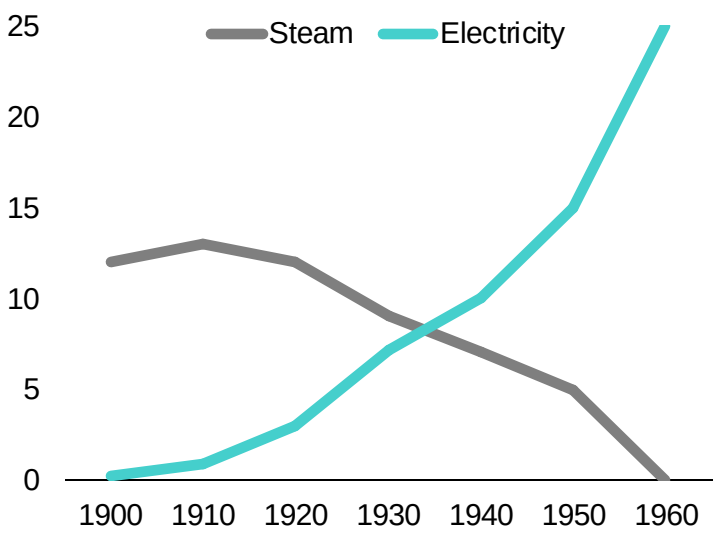
Transport: Horses to cars



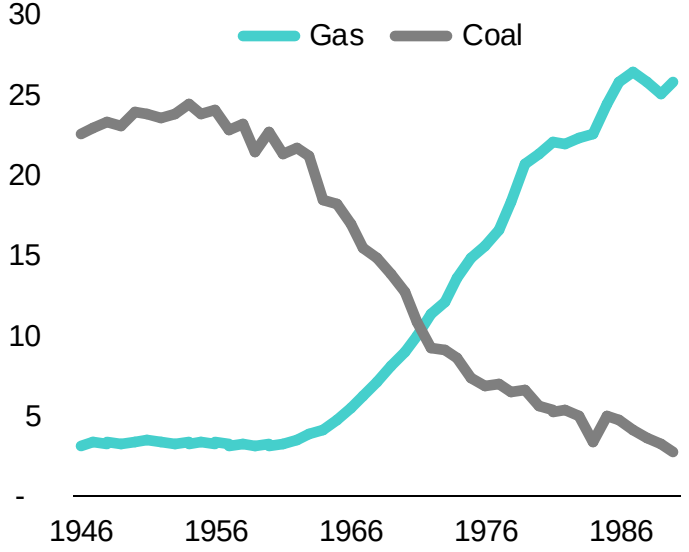
Lighting: Gas to electricity



Power: Steam to electricity



Heat: Coal to gas

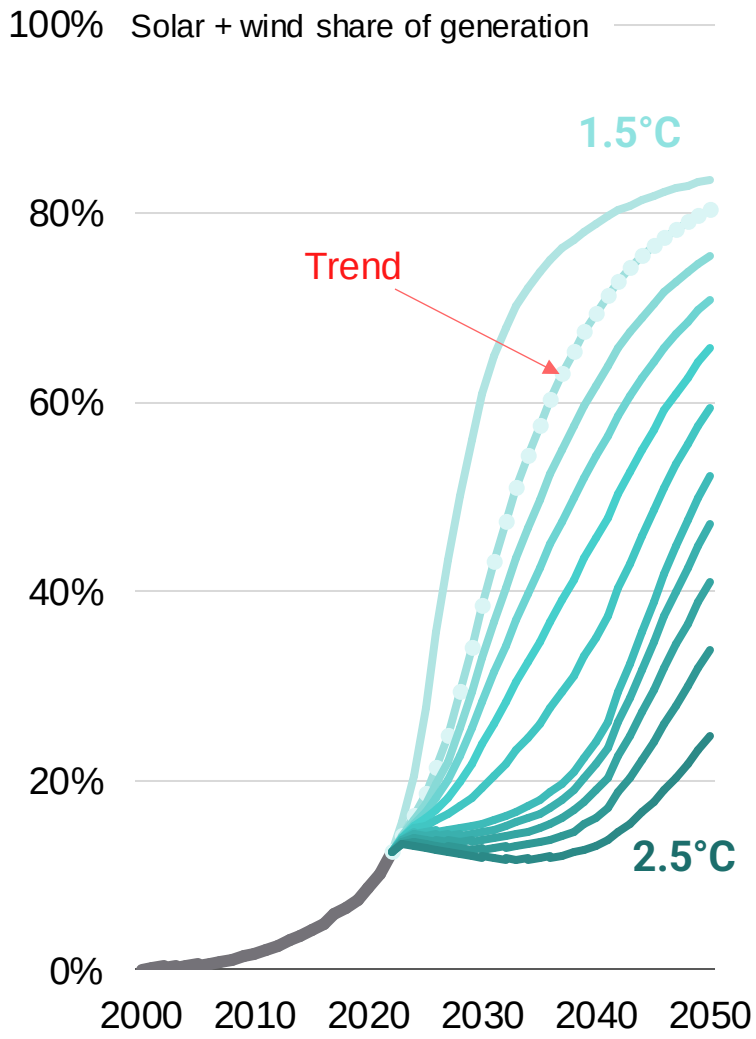


Source: Perez, Fouquet, Nakicenovic, Mitchell; Note: all UK charts except horses to cars (US)

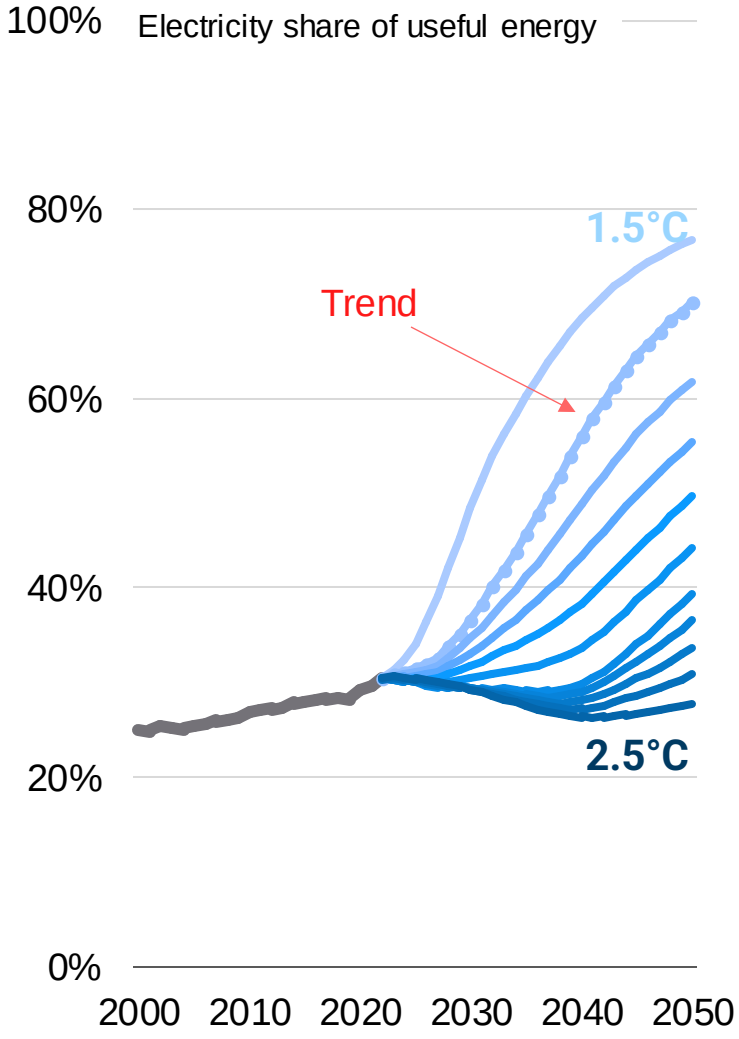
Climate: The Paris Agreement goals are within our reach

There is no room for despair or complacency

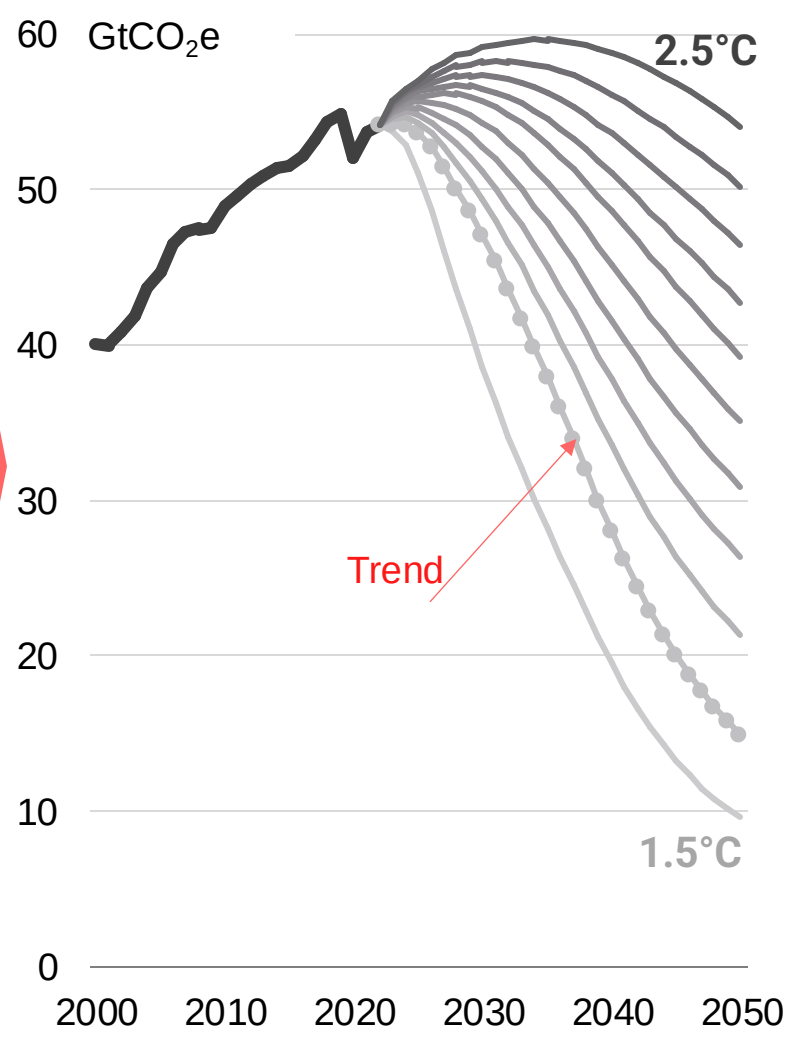
Grow solar and wind



Electrify the economy



Emissions will collapse



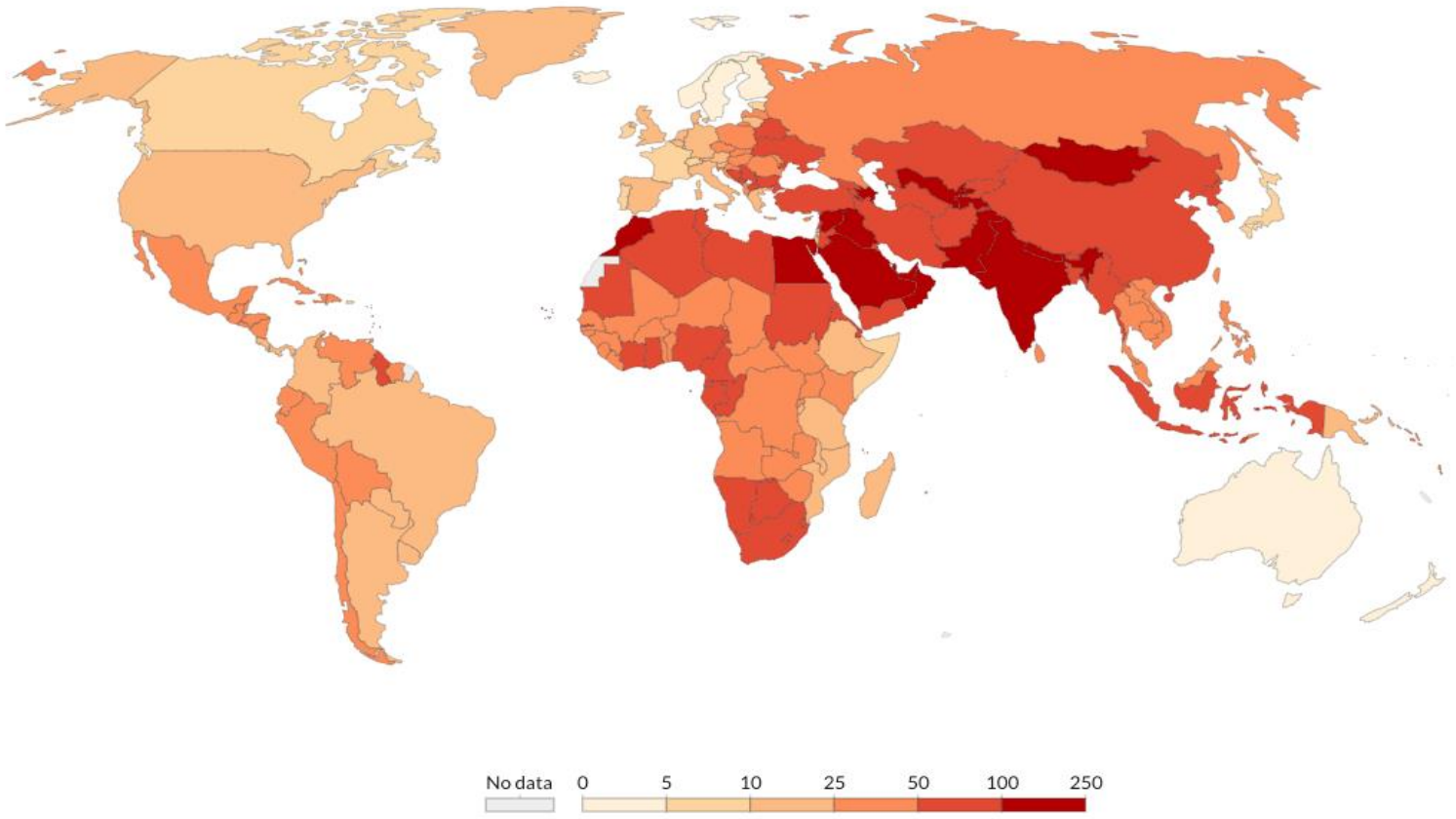
Source: Rystad Energy. The RMI view is that to get to net zero by 2050 we need to halve emissions every decade

Health: we can save 8 million lives a year

- The fossil fuel system kills 8 million people a year through air pollution leading to asthma, heart disease, and lung damage.
- That is the third largest killer in the world, responsible for 20% of all deaths.
- The problem is especially intense in the Global South.

Outdoor pollution death rate per year, 2019

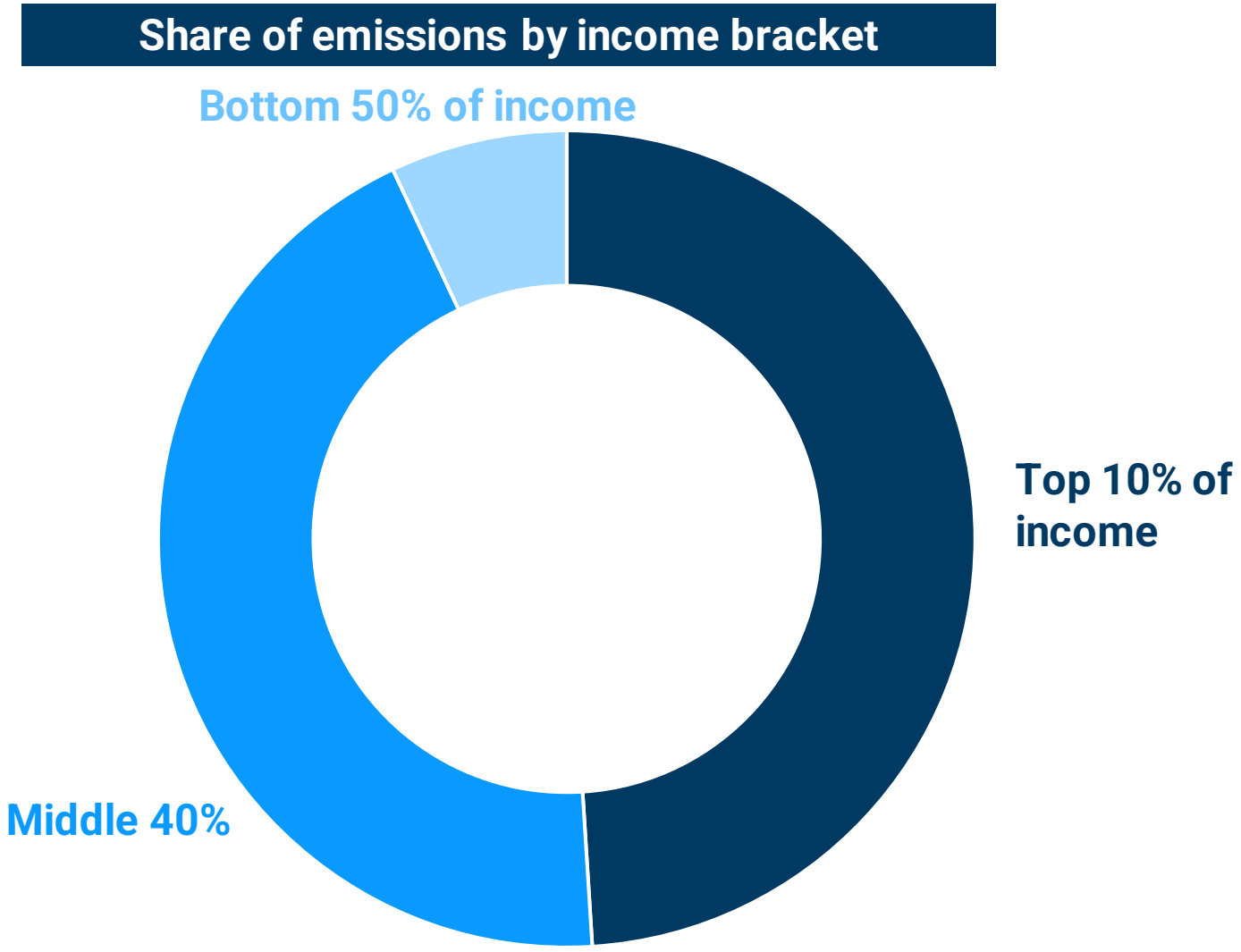
The number of deaths attributed to outdoor ozone and particulate matter pollution per 100,000



Source: IHME via OWID

Justice: renewables make possible a fairer system

- Fossil fuels are used mainly by the rich, but damage the poor disproportionately.
- The richest 10% of people account for half all emissions, and the poorest 50% account for only 10% of emissions.
- Renewables are local, clean, efficient, universal, and cheap.
- They provide local jobs and distributed energy.
- The shift to renewables will free up massive resources, and gives us the opportunity to do things better.



Source: Stockholm Environment Institute. Note: emissions share in 2015

Nature: Renewables can massively reduce the pressure

- Renewable solutions have an impact on Nature which is around two orders of magnitude less than fossil fuels.
- Renewables make use of eternal flows of light electrons. While fossil fuels require the continuous burning of heavy stocks and molecules.
- Mineral extraction for a renewable system (43 mt/y) is 360 times less than for fossil fuels (over 15,000 mt/y).
- From a given piece of land, solar panels capture 360 times as much useful energy for driving as biofuels.
- We need to do it right this time. With better mining practices and circularity built in from the start.

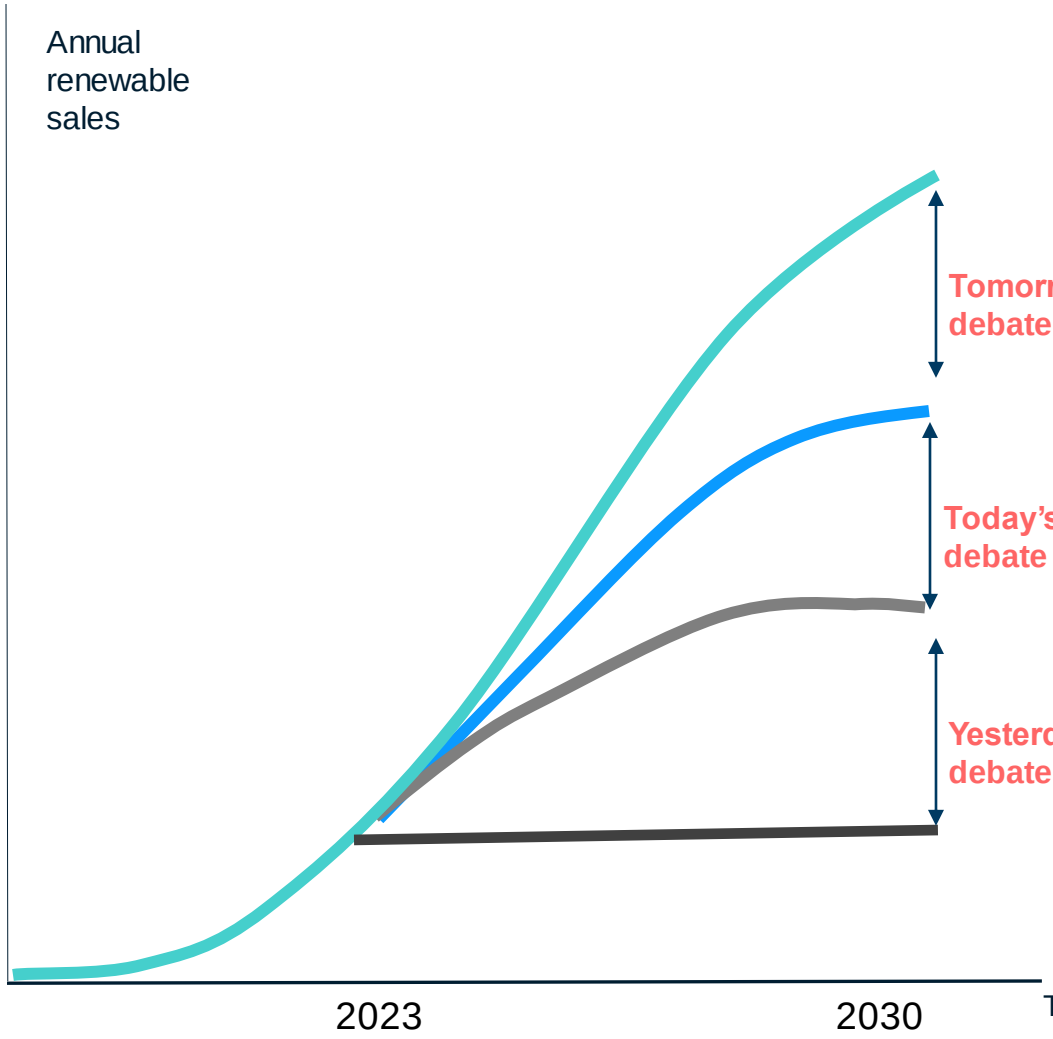
Comparing the impact of renewable and fossil fuel solutions

Area	Unit	Renewable	Fossil fuels	Renewable to fossil superiority
Transport	m^2 of land per km driven	Solar	Biofuels	360
Land	% capture of sunshine	Solar	Biofuels	120
Water	t of water per MWh	Solar	Coal	2,000
Minerals	Annual extraction mt	Key minerals	Fossil fuels	360
Materials	Annual usage	Total materials	Fossil fuels	35
Carbon	Gt 2020–2050	Total emissions	Total emissions	38
Transport	t of materials per car over its life	Minerals and electricity	Minerals and oil	75
Electricity	t of materials per MWh	Minerals and sunshine	Minerals and coal	2,188
Electricity	kWh per kg	Polysilicon	Coal	3,600

Source: WRI, EIA, IEA, Tesla, World Bank, RMI

Energy modelers: up your game or become a stranded expert

- Complex incumbent models have thus far failed to capture the speed of change.
- Models have been held back by excess complexity, old data, artificial barriers, incumbent influence, and business-as-usual thinking.
- Yet exponential growth keeps happening, and barriers keep being crossed.
- Many models are still wedded to the status quo and deeply influenced by fossil fuel incumbents.
- The new normal is exponential growth. Those who fail to see it are becoming stranded experts.



Who is where? (illustrative)	The group
RethinkX RMI Oxford INET	"A new energy paradigm"
Tomorrow's debate	
BNEF Rystad New IEA	"Renewables are the future"
Today's debate	
Princeton Net Zero America S&P McKinsey	"Change is difficult but we should try and do this"
Yesterday's debate	
OPEC EIA/ Old IEA Exxon JP Morgan	"Green idealists are naïve; the world needs our fossils"

Source: RMI

About RMI

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and Beijing.

Authors

Kingsmill Bond, Energy Strategist, kbond@rmi.org
Sam Butler-Sloss, Senior Associate, sbutlersloss@rmi.org

With special thanks to: Rushad Nanavatty, Laurens Speelman, and Laurie Stone

Related

The Energy Transition Narrative

Peaking: Why Fossil Fuel Demand Peaked in 2019

Peaking: Why Peaks Matter