

The Electrotech Revolution

The shape of things to come



BUILDING
DECARBONIZATION
COALITION

Daan Walter

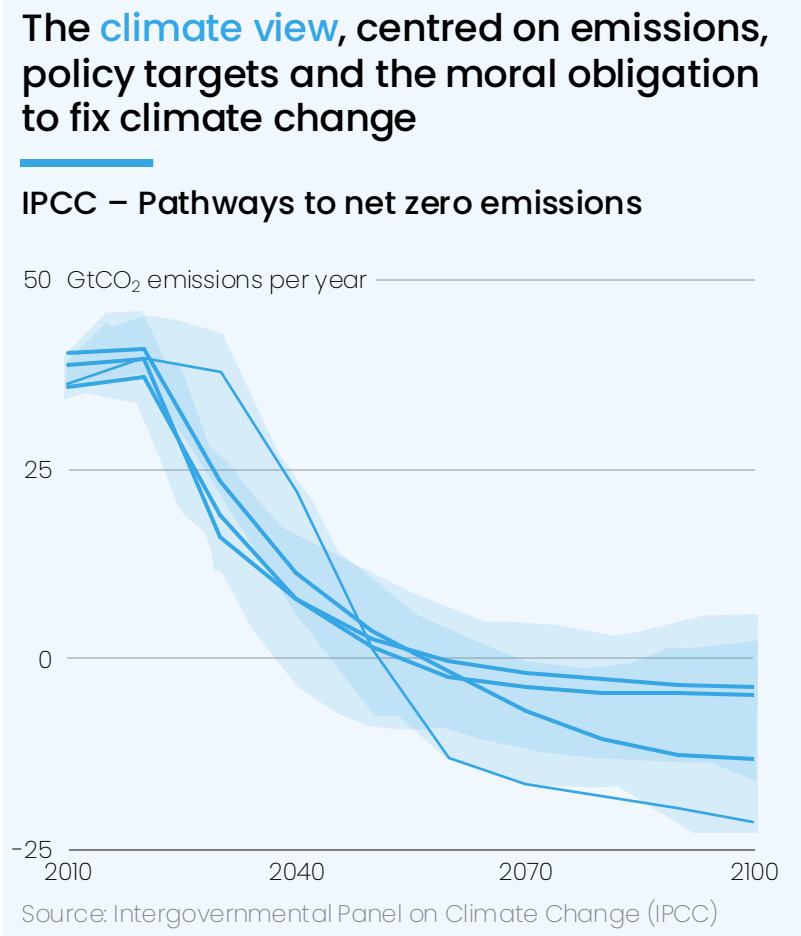
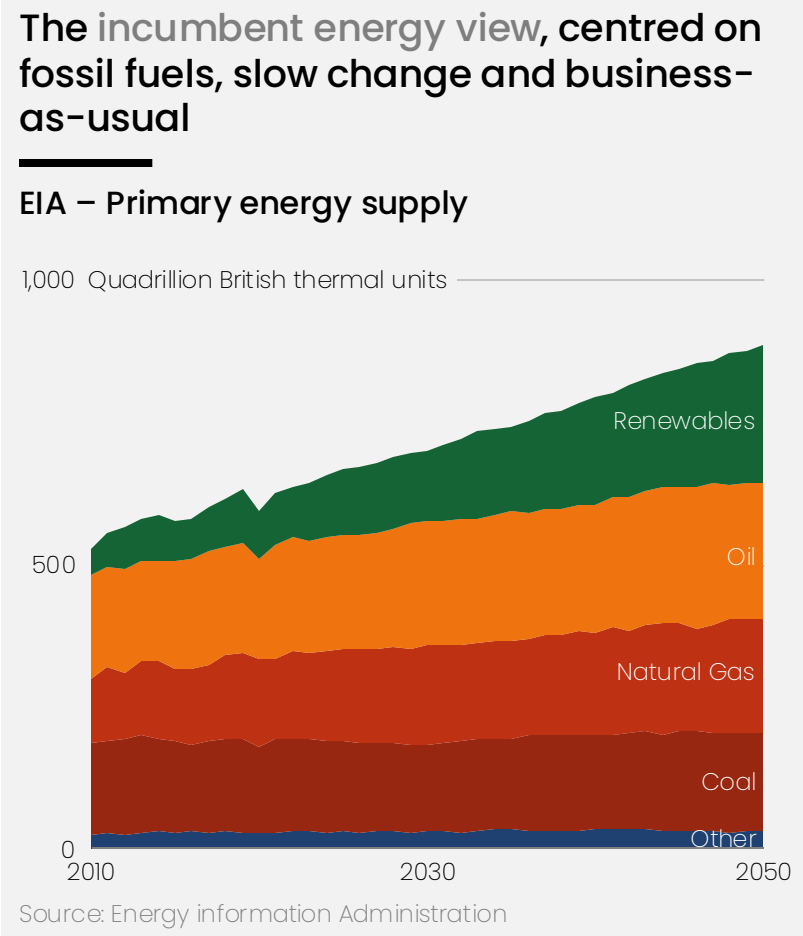
November, 2025





Two views on energy dominate the conversation.

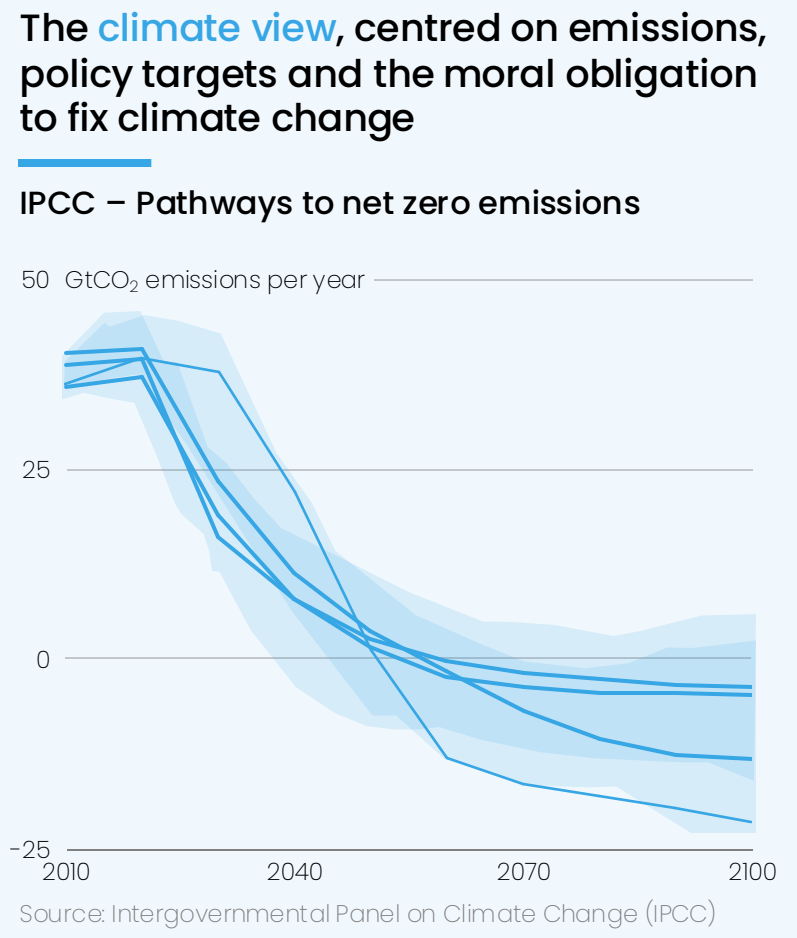
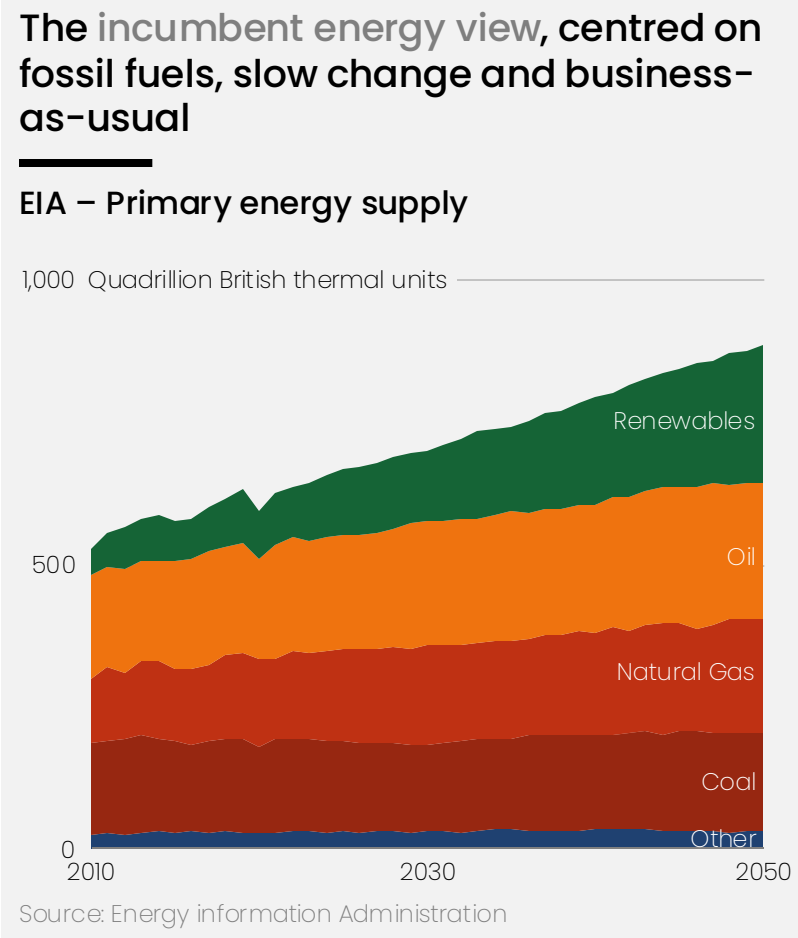
The dominant energy views in the energy debate today



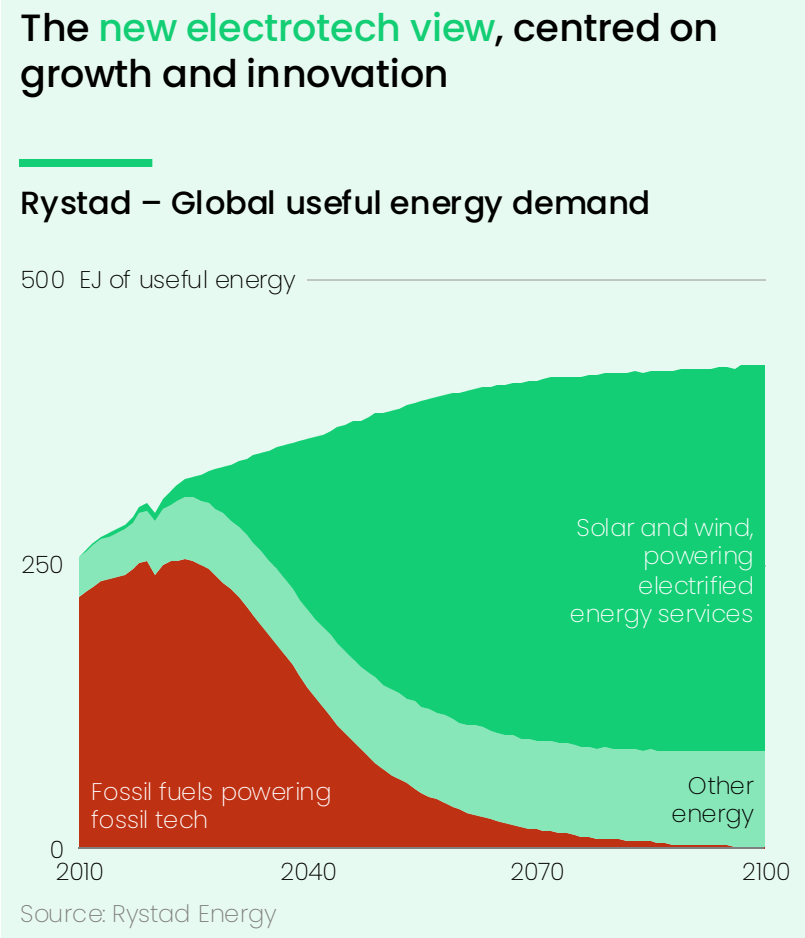


Two views on energy dominate the conversation. We propose a third

The dominant energy views in the energy debate today



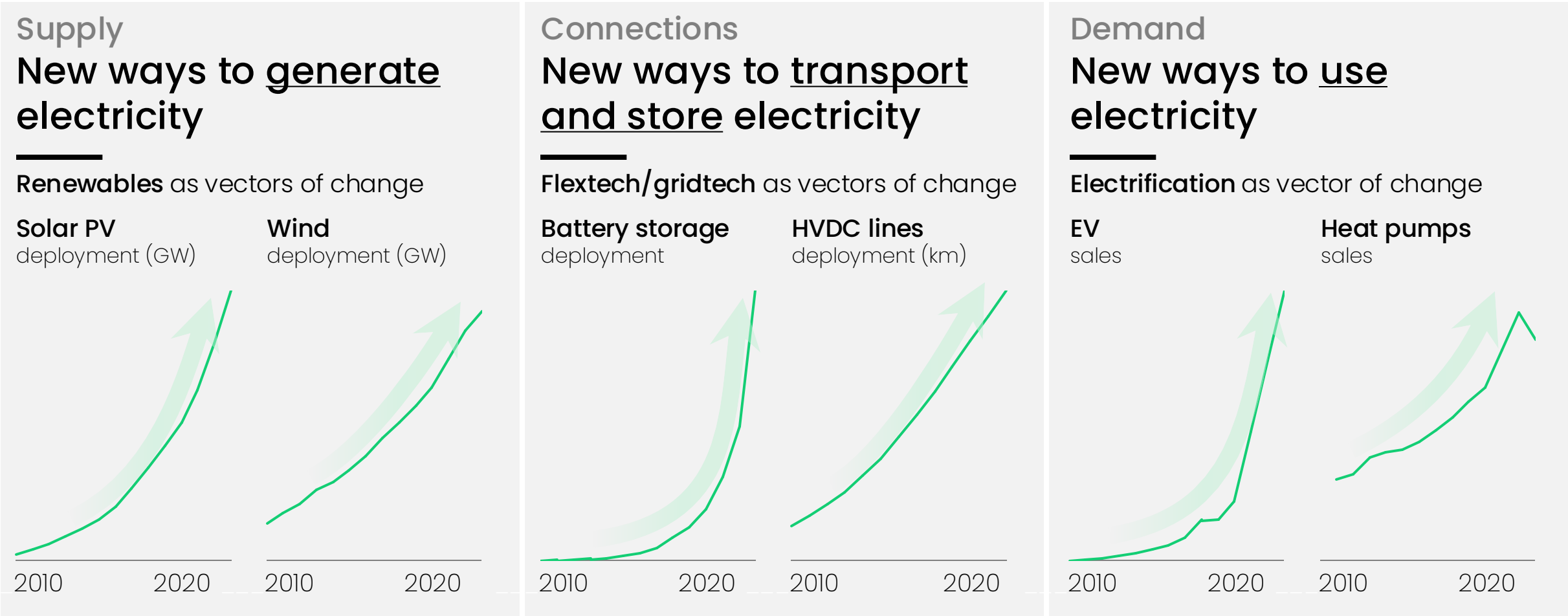
A third way: the electrotech view





This is a technology revolution in energy

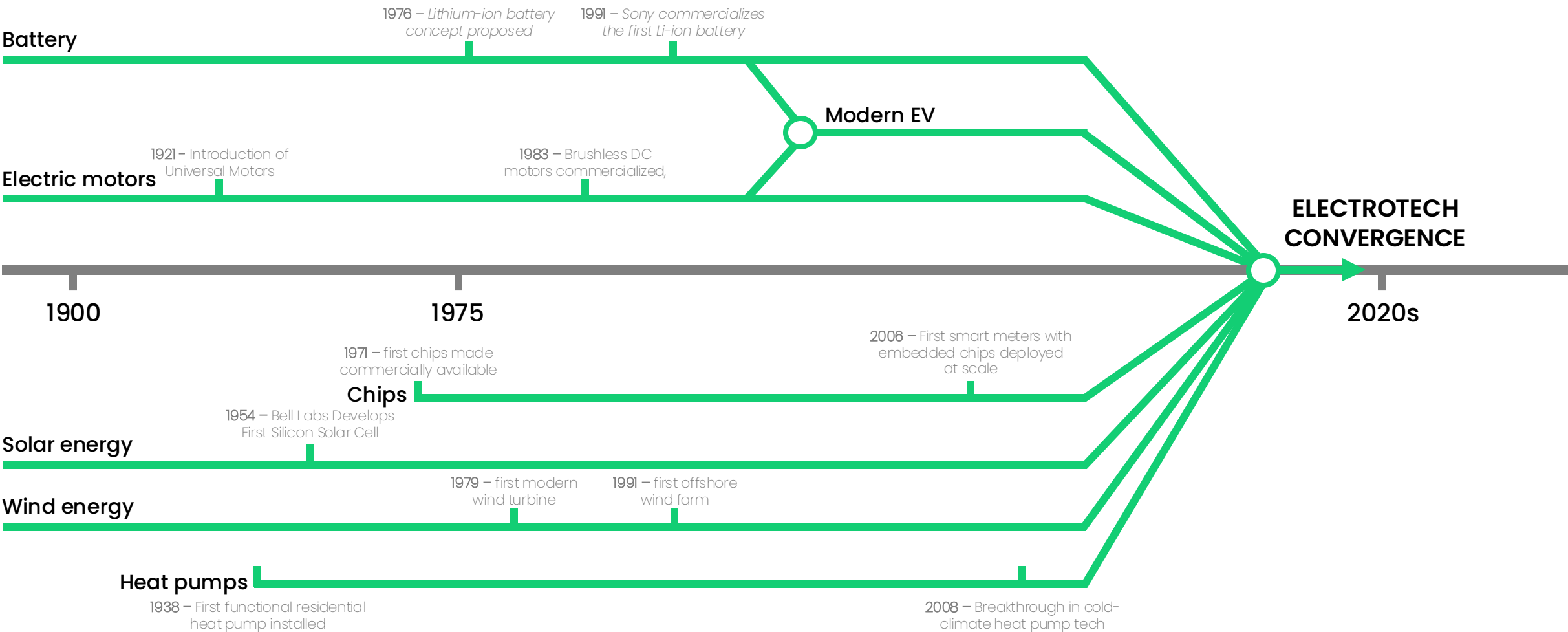
Electrotech is technology that revolutionises the supply, connection and demand of electricity



It's been a long time coming

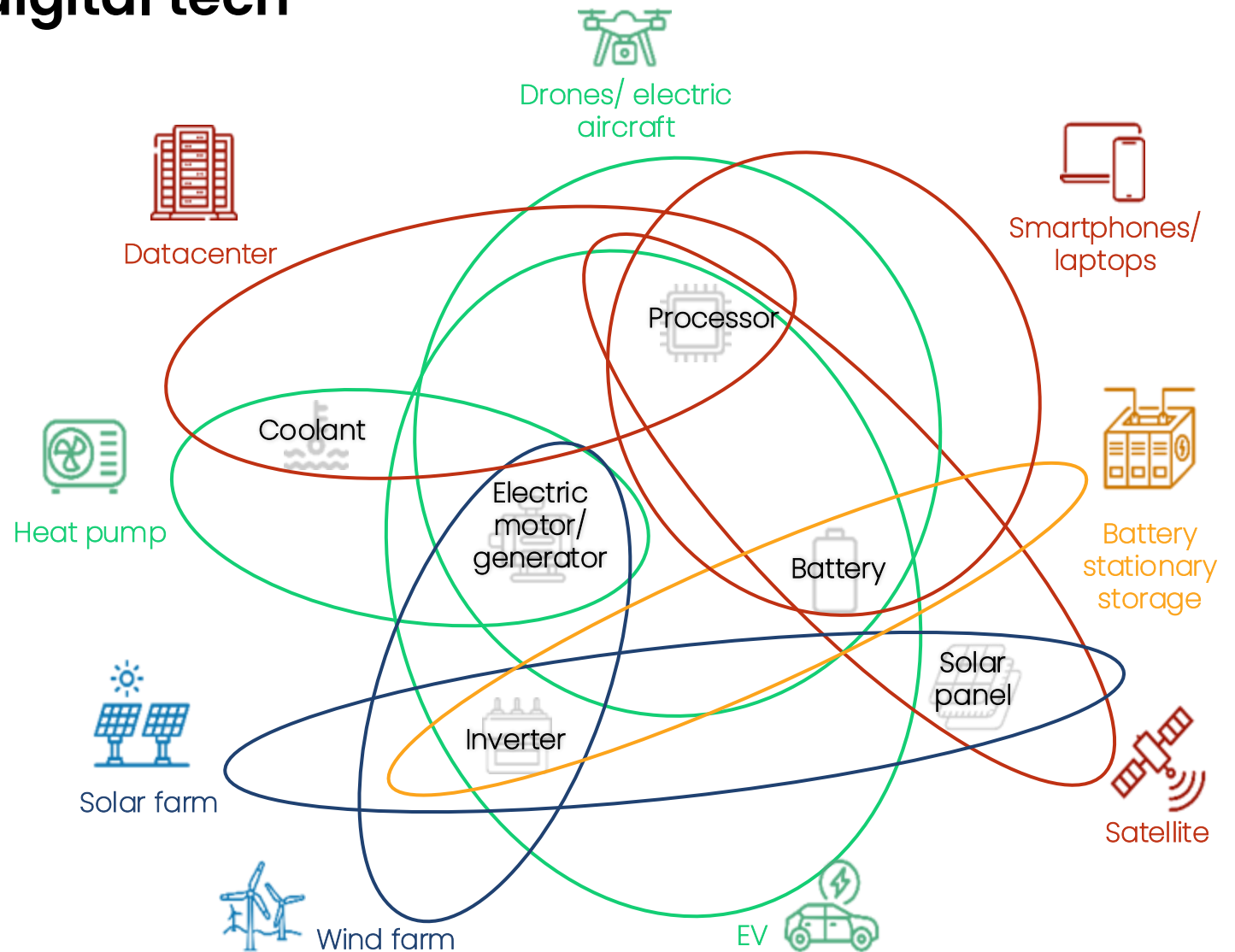
A century of evolution is converging into a decade of revolution

ILLUSTRATIVE



Electrotech is the child of digital tech

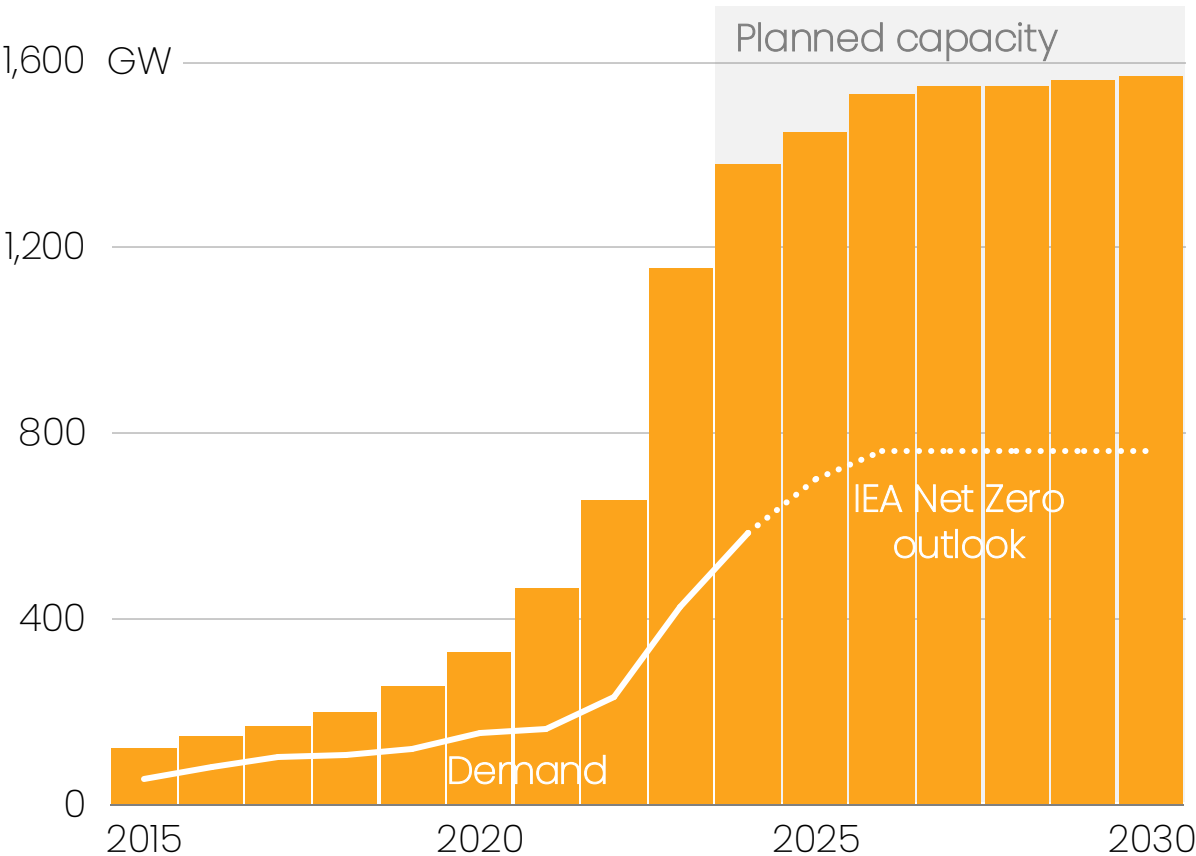
Electrotech is made of the same components as digital tech, and inherits its momentum



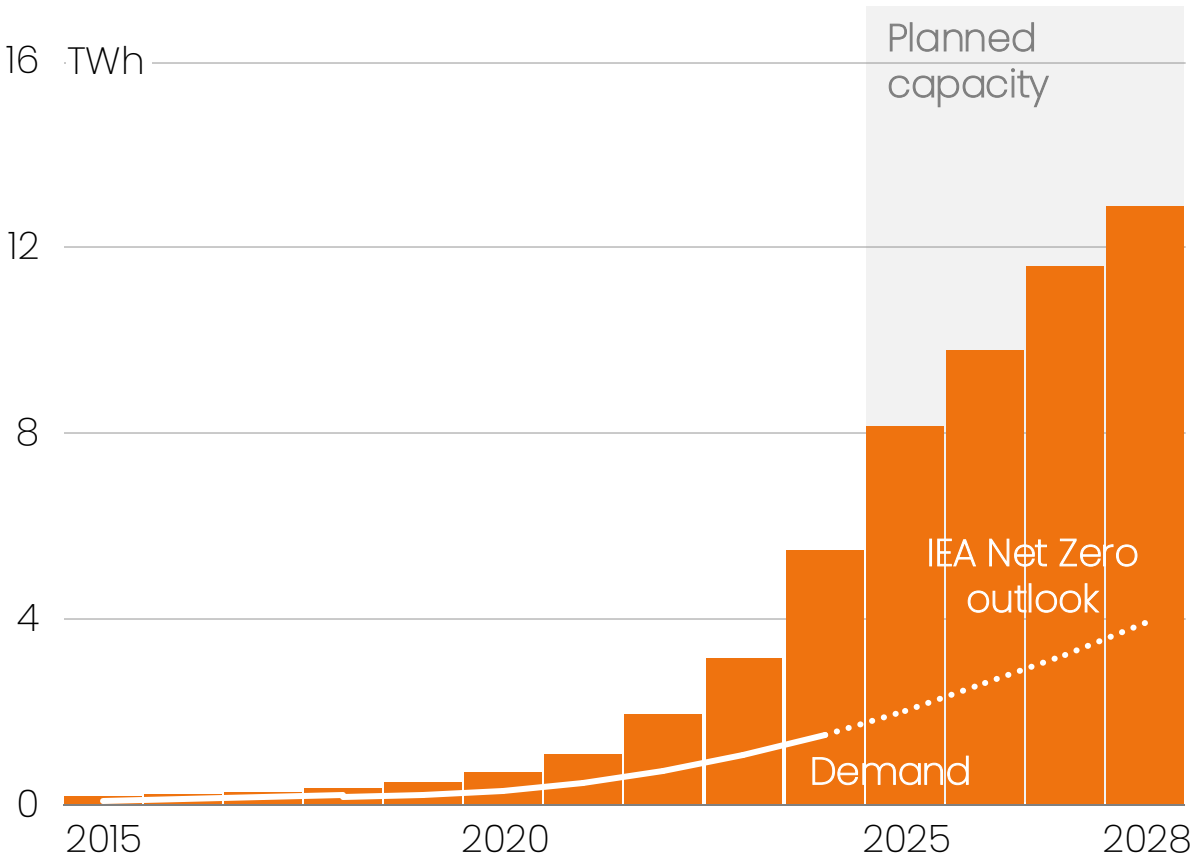
The manufacturing capacity is in place

Outpacing projected demand of even net zero scenarios

Solar PV manufacturing capacity



Battery manufacturing capacity

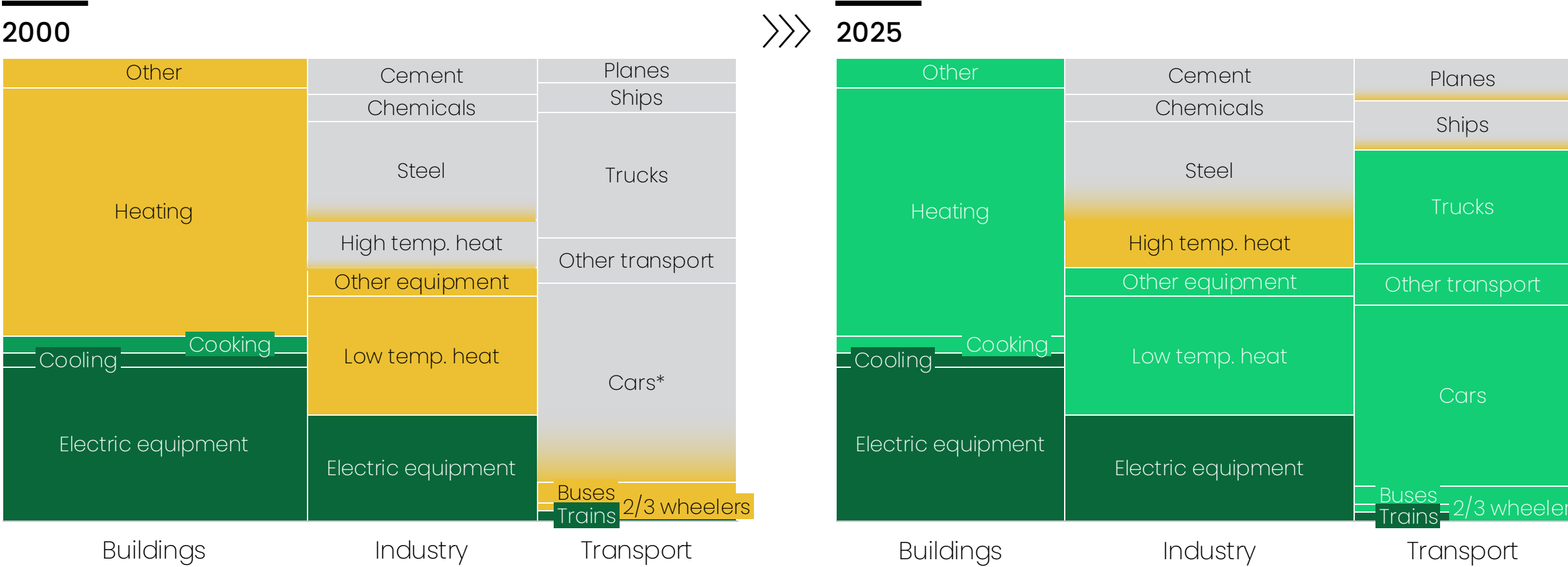


The ceiling is high and rising

Over 75% of the global energy system can now be electrified

- Already (largely) electrified
- Can be electrified economically
- Can be electrified technically
- Still under development

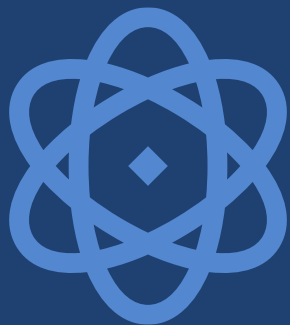
Share of final energy demand by subsector and electrification potential (%)



Three fundamental drivers of change

Physics

Electrotech is more efficient than alternatives



Economics

Electrotech as a technology has learning curves and growth curves



Geopolitics

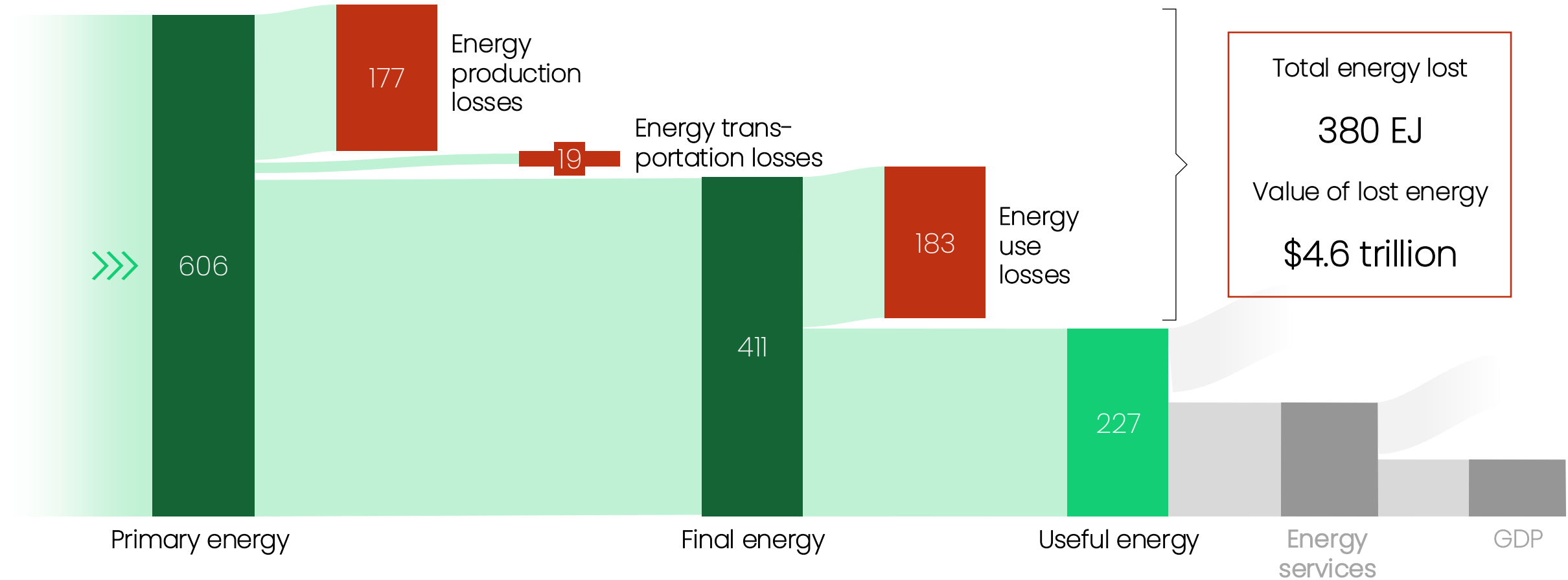
Electrotech is a key tool of energy security



The current fossil energy system is incredibly inefficient

We lose some two thirds of the energy we put into the system

Global energy flows and waste, EJ per year, 2019



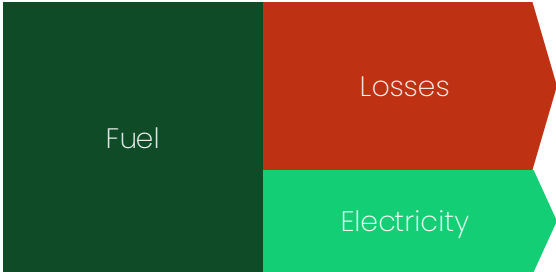
Electrotech is 3x more efficient

It offers a leap in energy efficiency across the economy

Supply

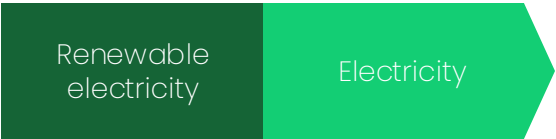
Electricity generation

Fossil thermal



30-40% efficiency

Wind & solar



100% efficiency

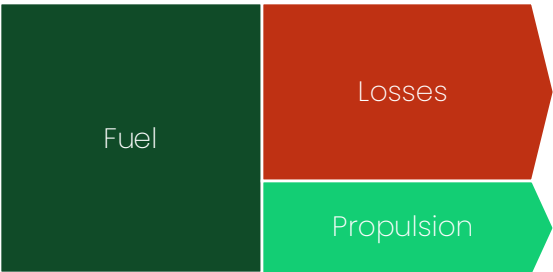
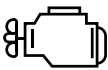
2-3x

as efficient

Demand

Transport

Internal combustion engine



25-40% efficiency

Electric vehicles



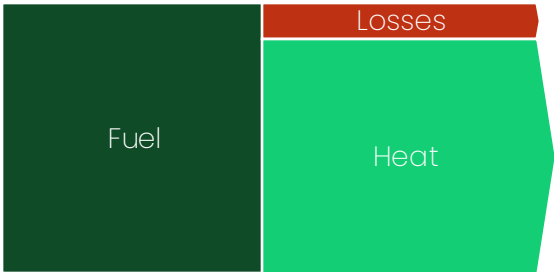
80-90% efficiency

2-4x

as efficient

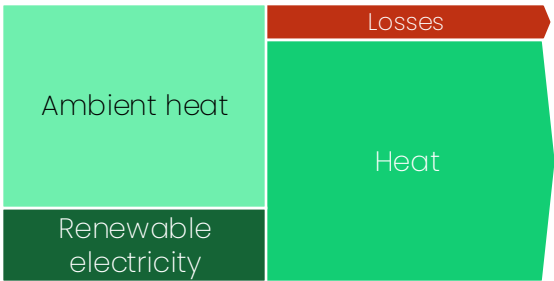
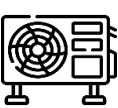
Heating

Gas boiler



85% efficiency

Heat pumps



300-400% efficiency

3-4x

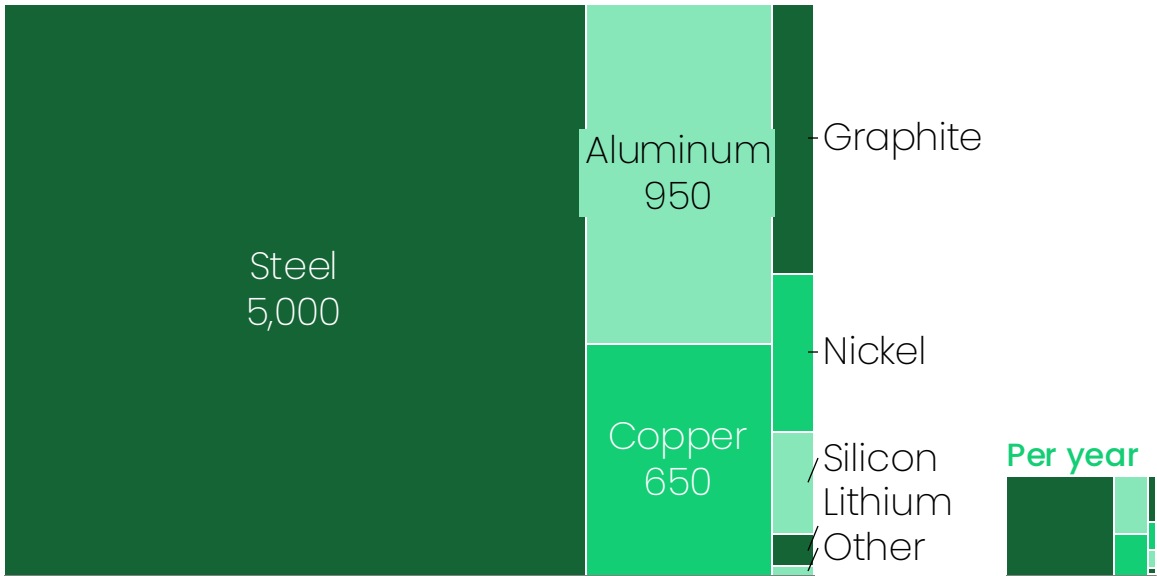
as efficient

The unbearable heaviness of the fossil fuel system

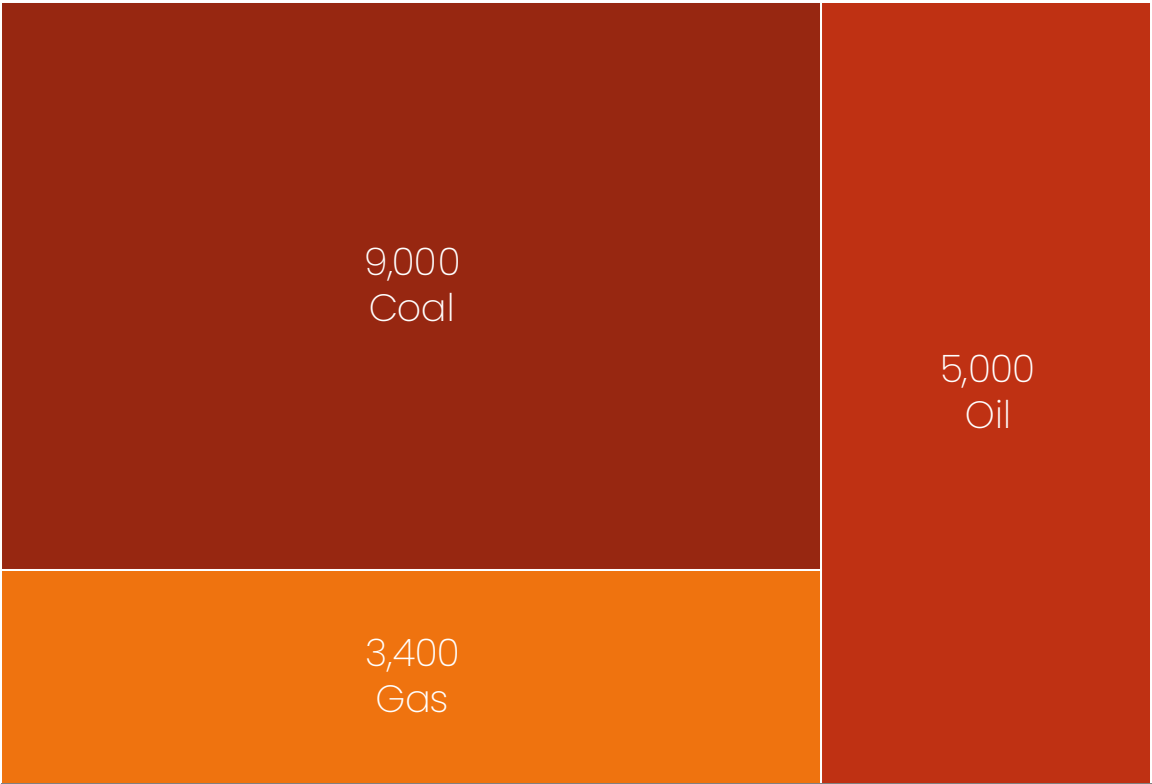
The fossil fuel system requires over 50x more materials than electrotech

Total material demand for the energy transition for 25 years (2024-2050), Million metric tons

Total over 25 years

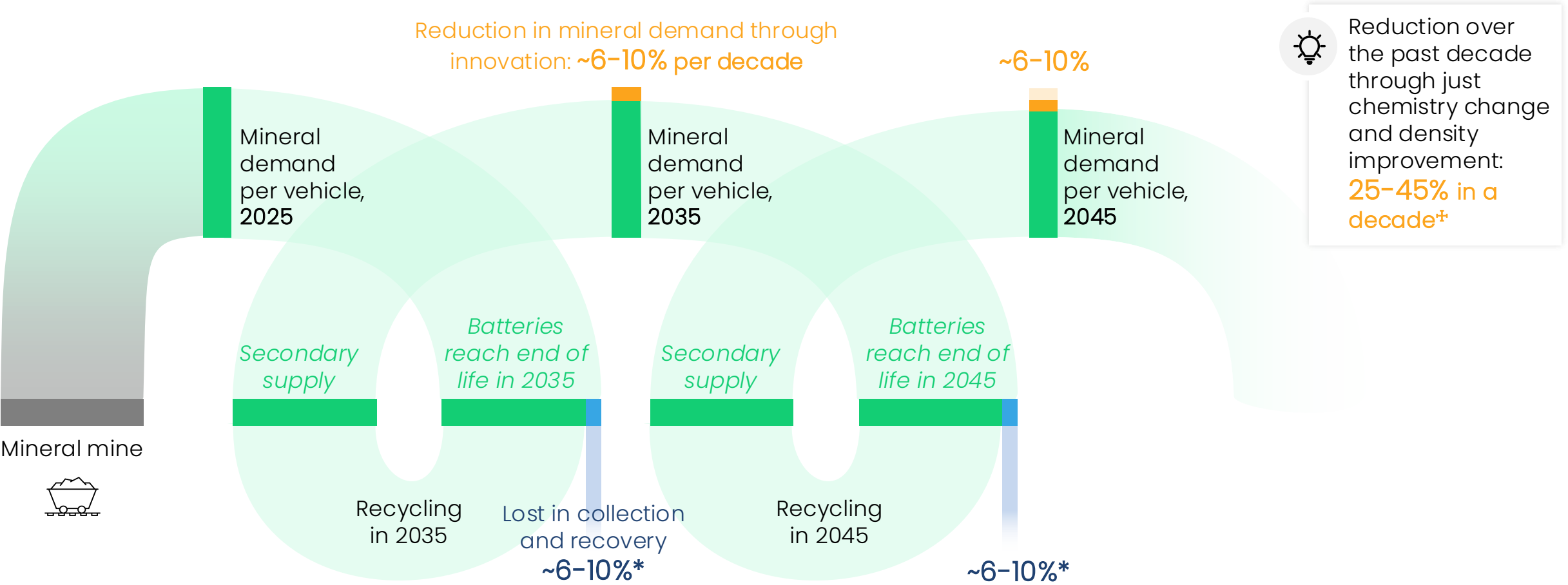


Fossil fuel extraction *per year today*, Million metric tons



Borrowing, not burning

If you recycle batteries and improve performance, you don't need to extract new minerals



Three fundamental drivers of change

Physics

Electrotech is more efficient than alternatives



Economics

Electrotech as a technology has learning curves and growth curves



Geopolitics

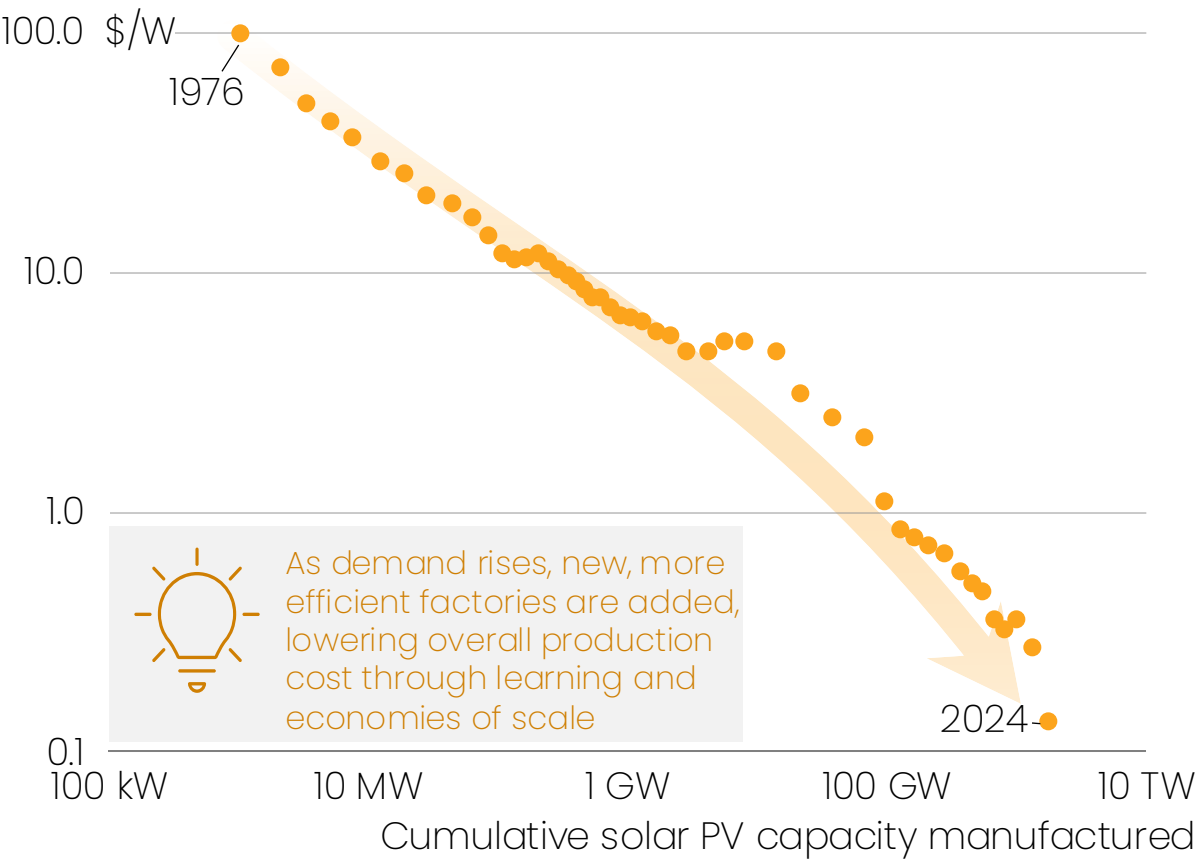
Electrotech is a key tool of energy security



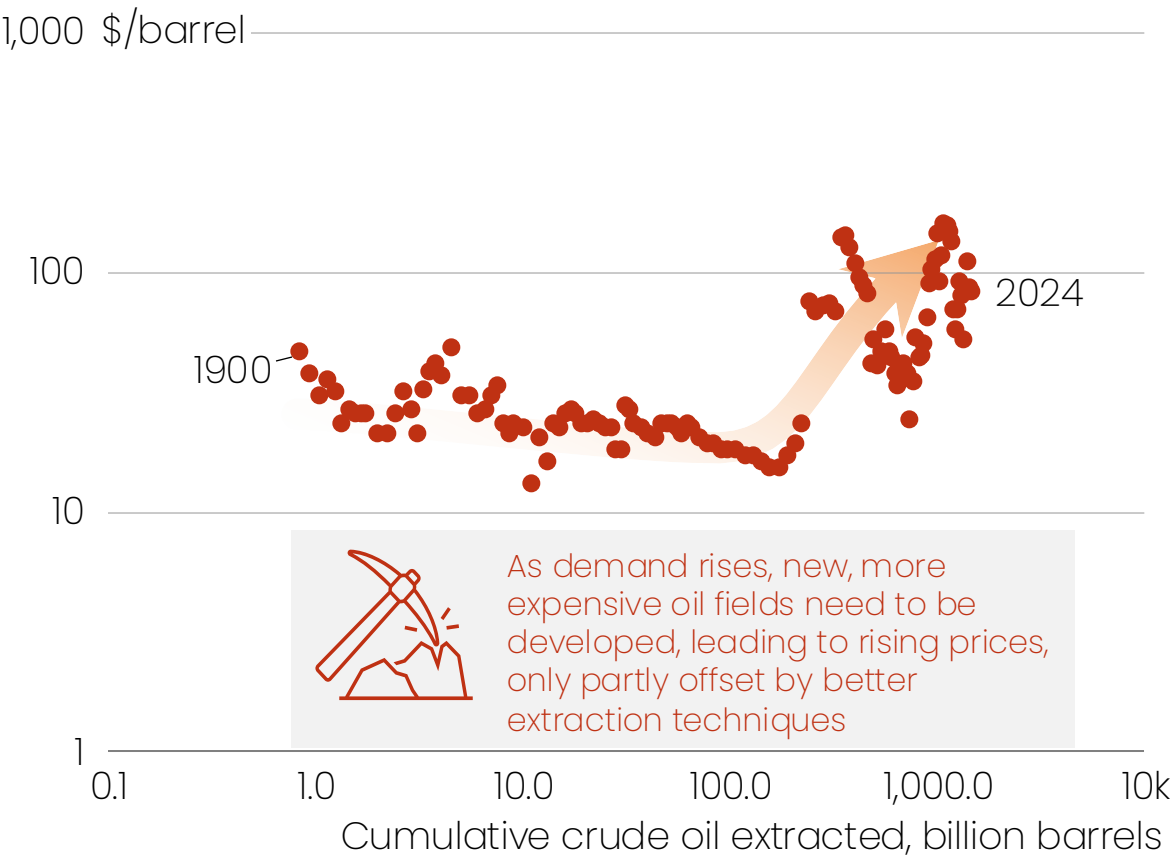
Learning beats digging

Electrotech gets cheaper with scale, whereas fossil fuels get more expensive

Solar panel price cost versus amount manufactured



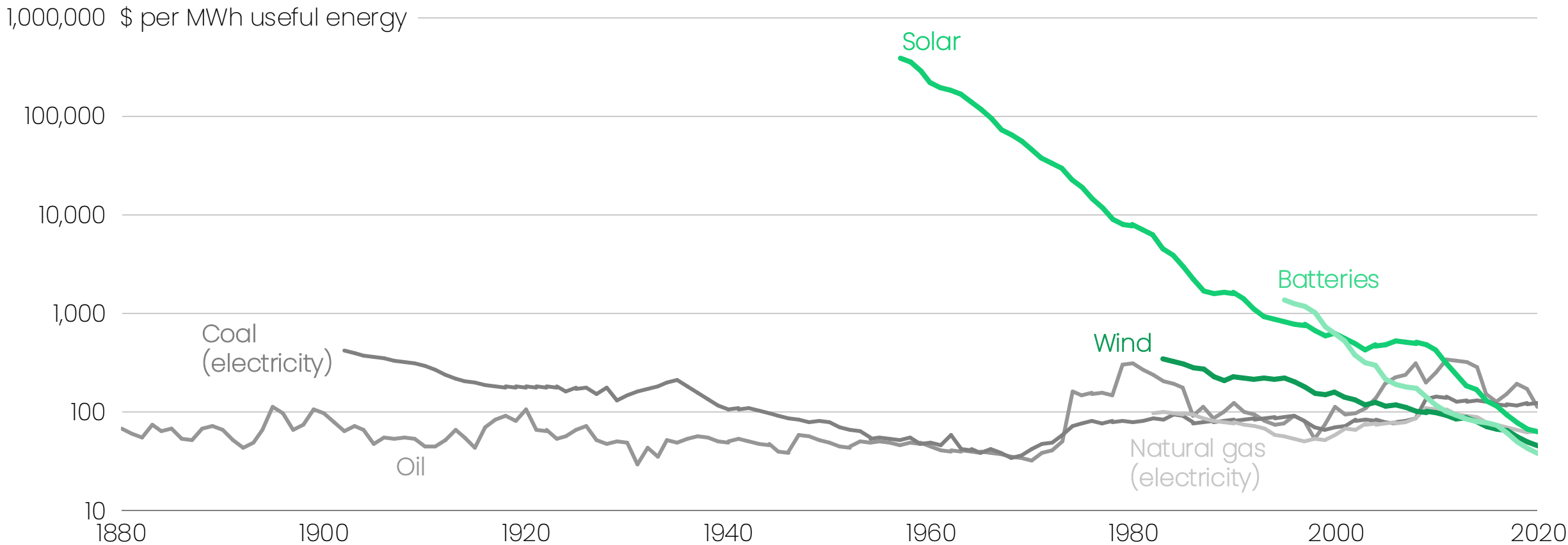
Oil price versus amount extracted



Technologies beat commodities on cost

Electrotech is the triumph of brain over brawn

Historical costs of energy sources



Three fundamental drivers of change

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Geopolitics

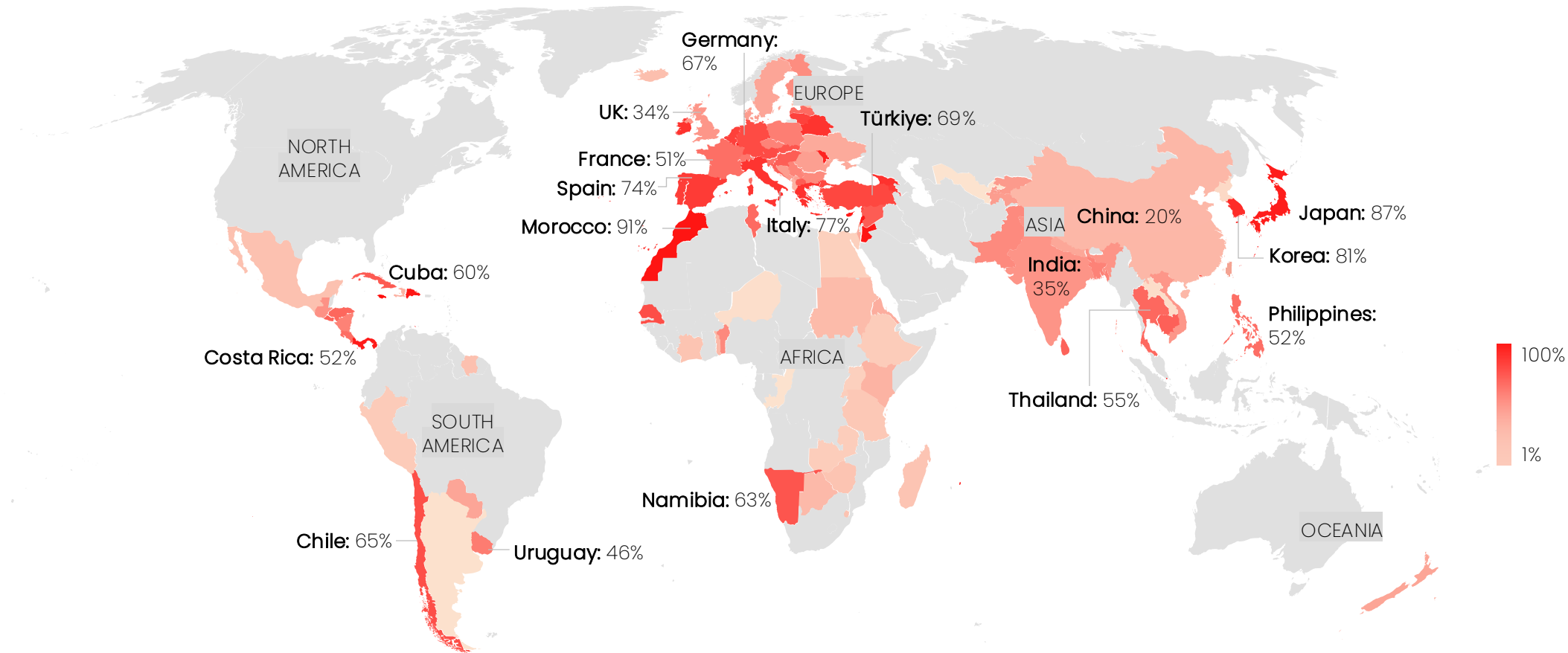
Electrotech is a key tool of energy security



Fossil import dependency is widespread

Over 50 countries import more than half their primary energy as fossil fuels

Fossil net imports as a share of primary energy demand 2022, %



Electrotech offers a path to permanent energy security

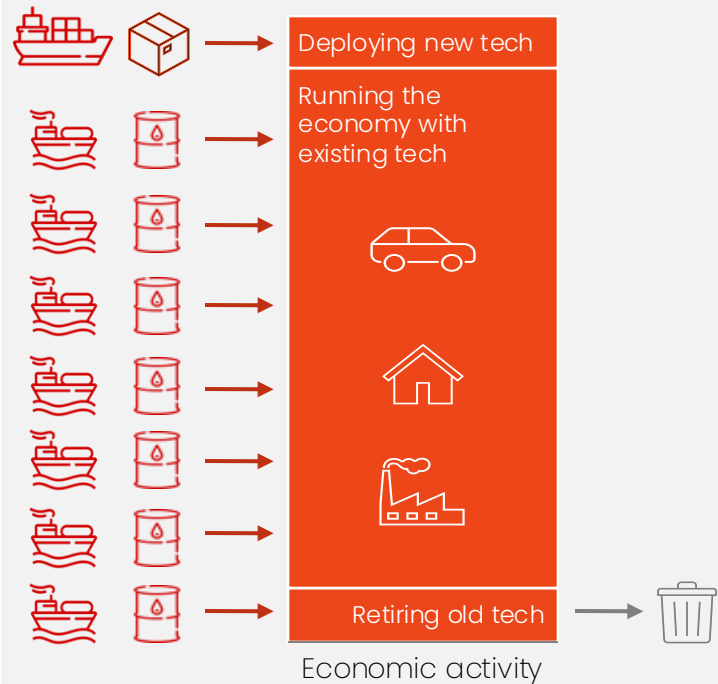
When fossil flows stop, the economy stops. When electrotech flows stop, only growth is at risk

From fossil import dependency...

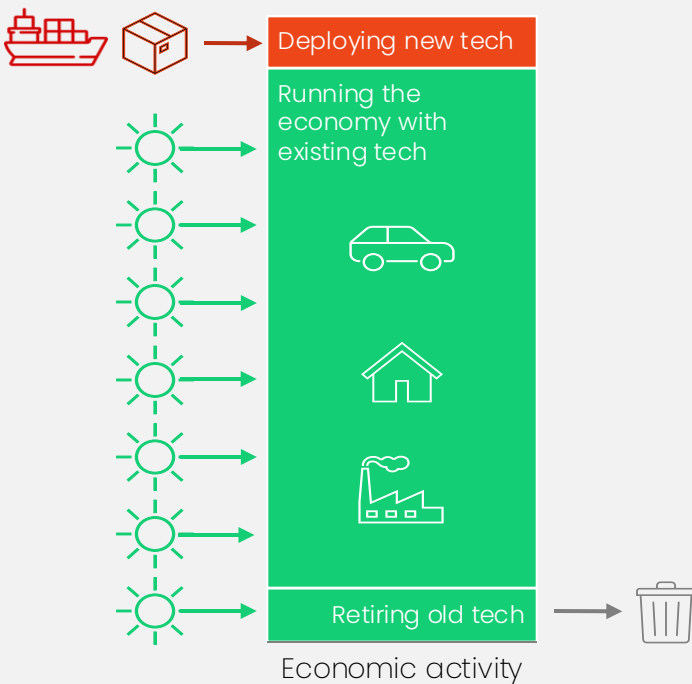
→ ...to electrotech import dependency...

→ ...to full circular energy independence.

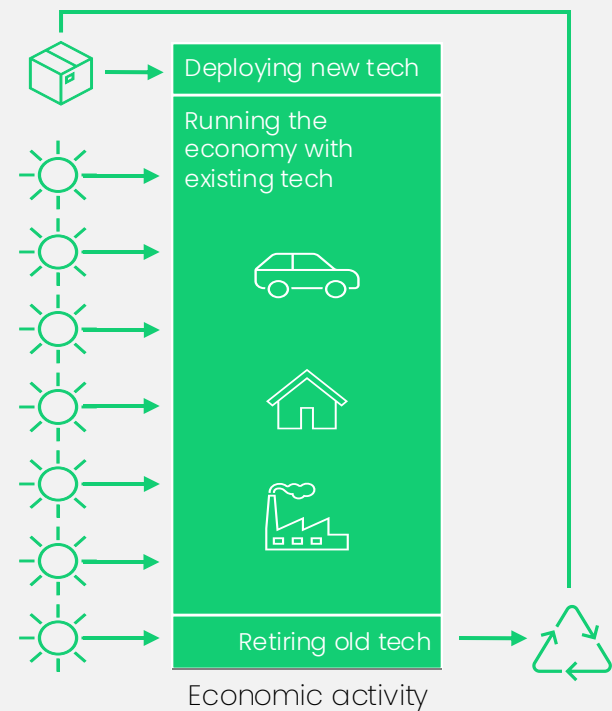
In an economy running on fossil imports, when imports stop, all activity stops



In an economy running on imported electrotech, when imports stop, only growth is inhibited.



In an economy running on local circular electrotech, trade shocks have little impact



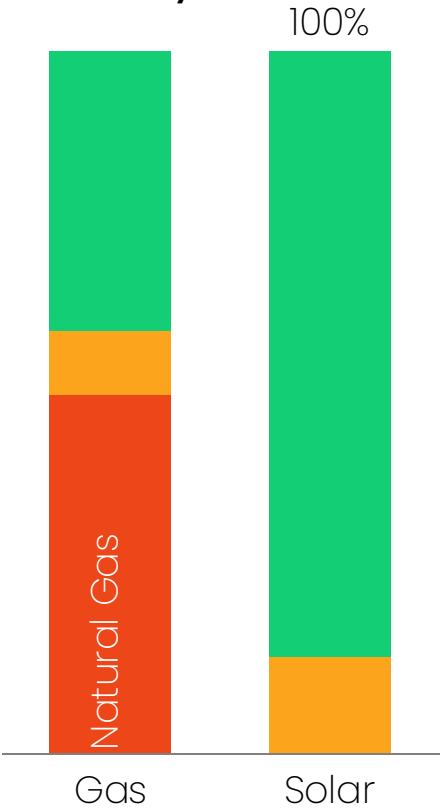
At immediate risks without imports Not at immediate risk

Electrotech saves you from fossil volatility

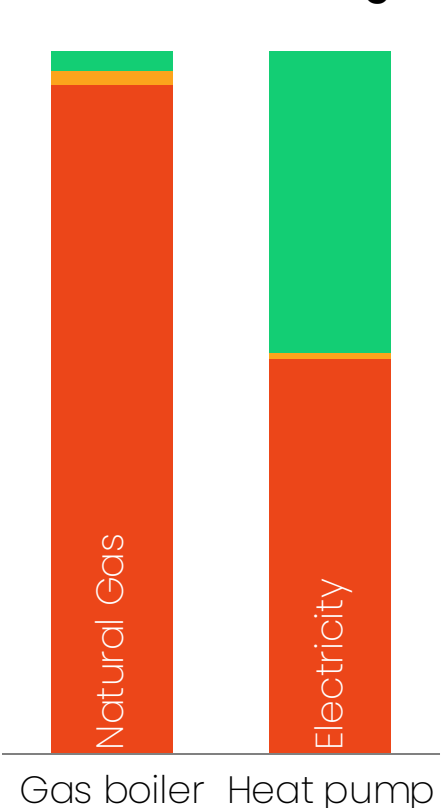
Once installed, electrotech costs remain stable — even if global supply chains falter or fuel costs rise

Total cost of ownership breakdown, %, US examples

Electricity



Residential heating



Passenger cars



Inflation risk after deployment

Low/
None

Cost already sunk
Cost don't change with inflation as technology is already deployed.

Mid

Labor & manufacturing inflation
Inflation in labor and replacement parts can raise maintenance cost.

High

Energy inflation
Note: This applies less to electricity, as purchased electricity can originate from renewables like solar power, which primarily involve fixed costs and therefore carry minimal inflation risk.



China is the first major electrostate

And that sparks a geopolitical race

China US Europe Other

Inventing

Patents

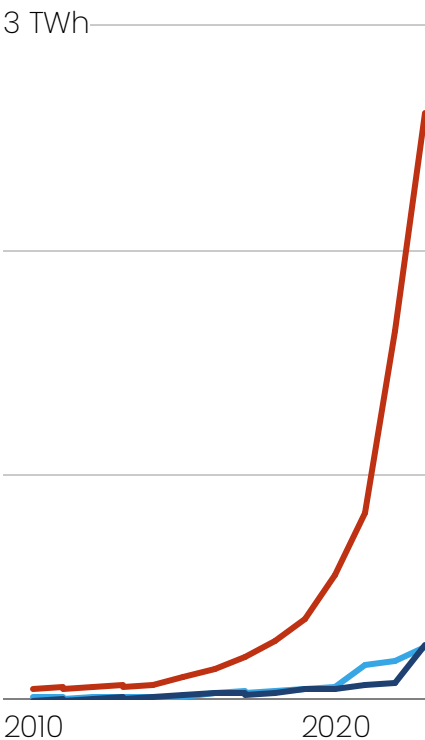
Annual cleantech patents



Producing

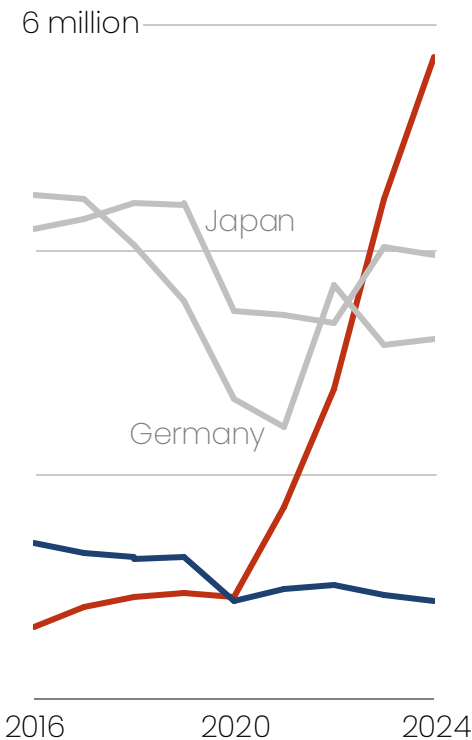
Manufacturing

Battery manufacturing



Exporting

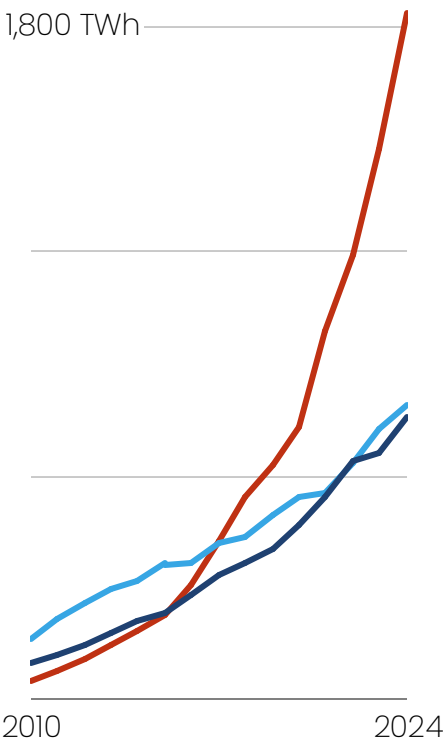
Cars



Deploying

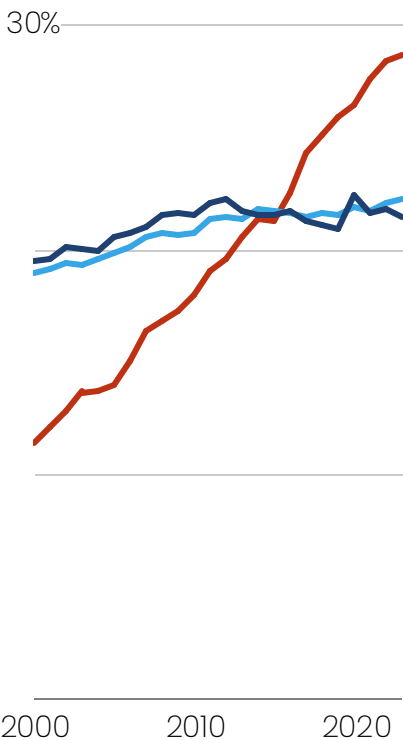
Renewables

Solar & wind generation



Electrification

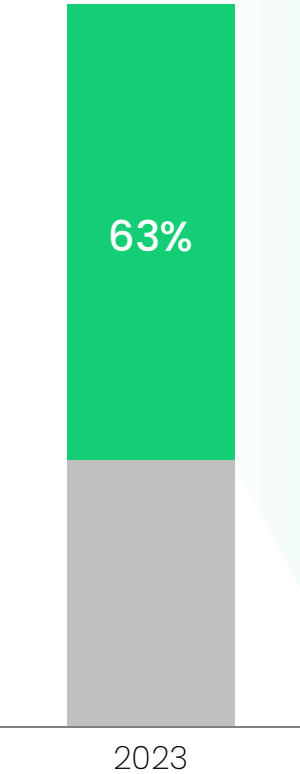
% of final energy



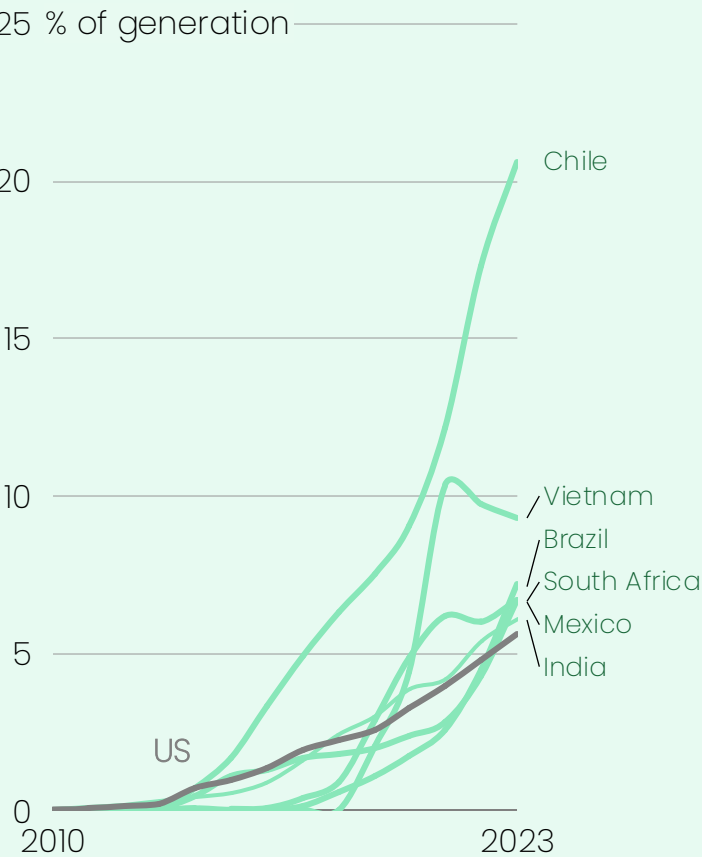
Emerging markets are leapfrogging

Two thirds are ahead of the US in solar deployment and a quarter in electrification

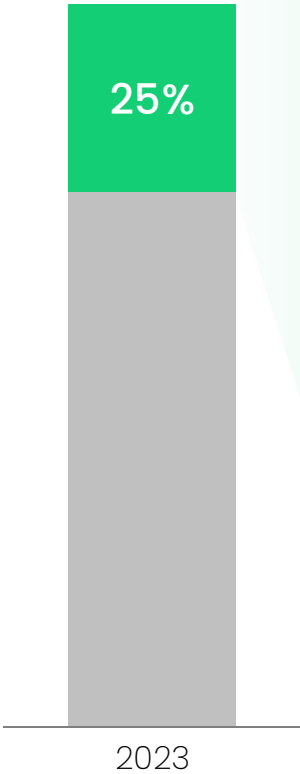
Share of EM ahead of US in solar uptake



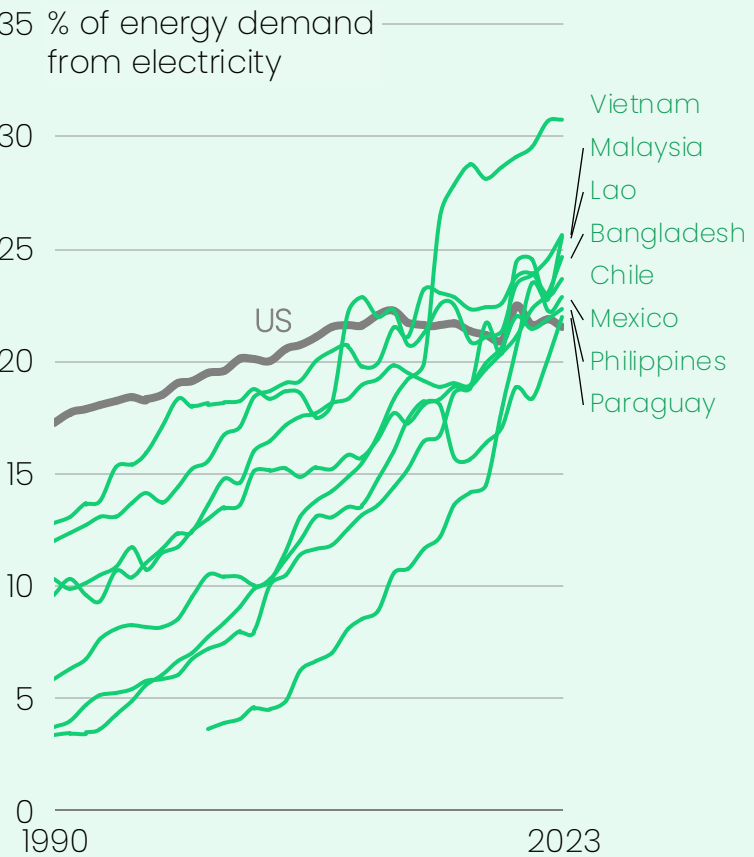
Example countries



Share of EM ahead of US electrification



Example countries



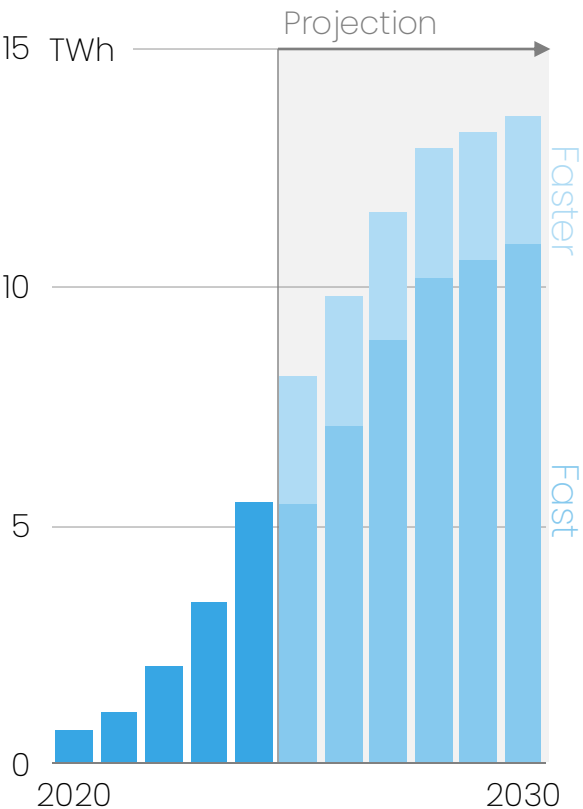


This is the decisive decade

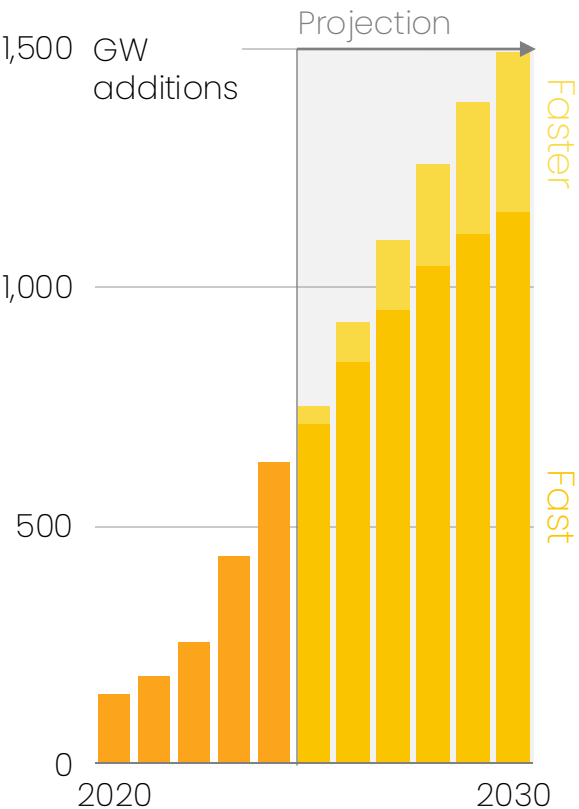
A century in the making, electrotech will define this decade



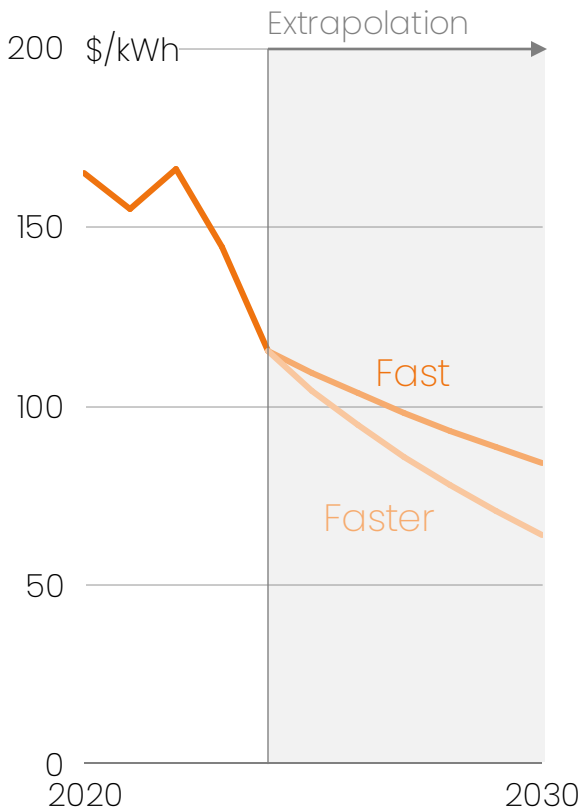
Manufacturing capacity is built: Batteries



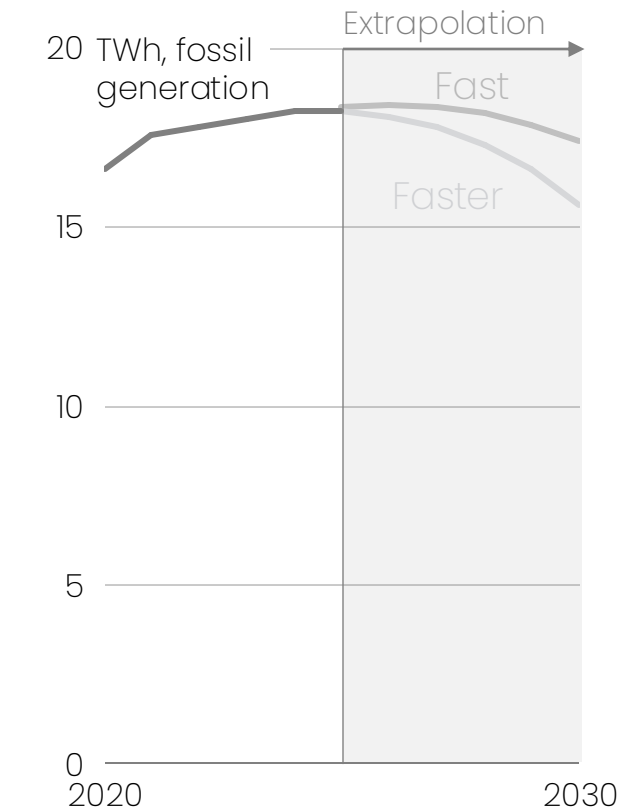
S-curves hit their steepest parts: Solar



Electrotech get too cheap to resist: Batteries

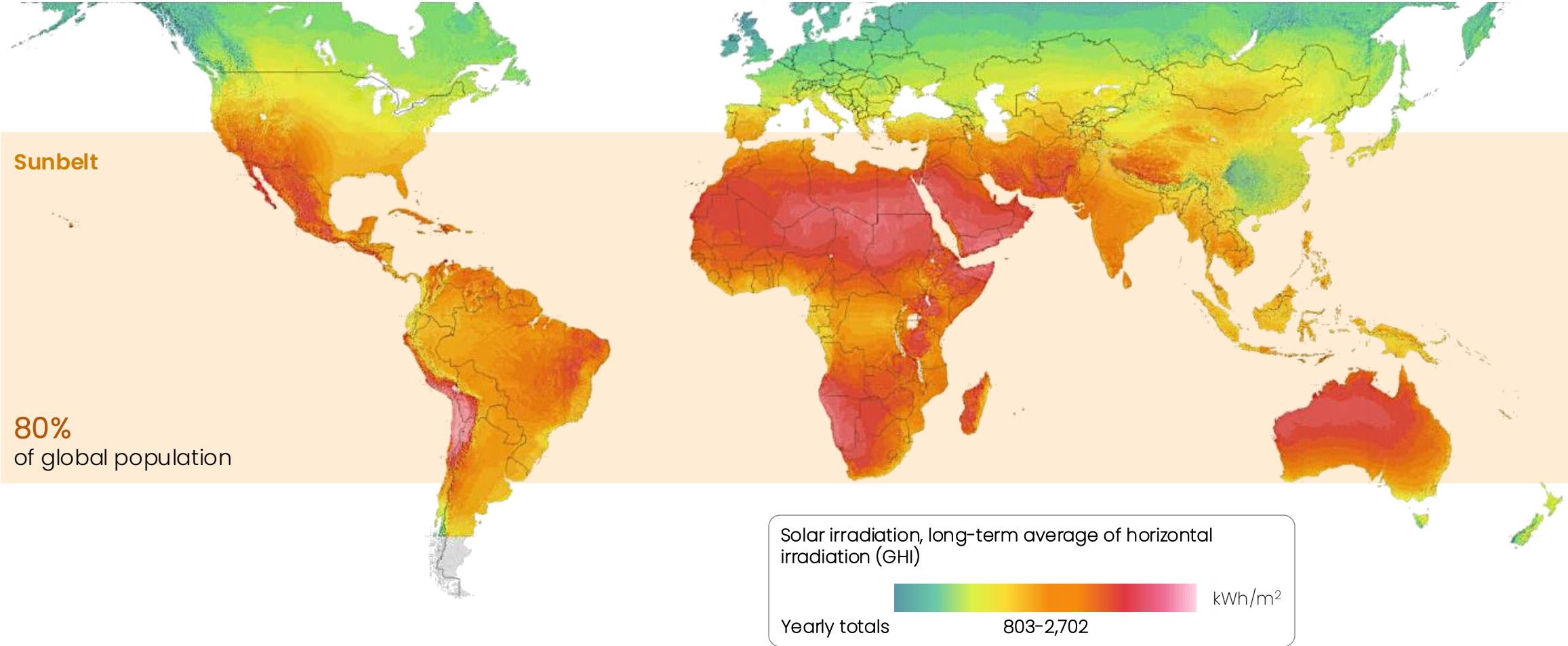


Fossil fuel demand enters terminal decline



Electrotech liberates the power of the Sunbelt

The emerging markets will have the lowest electricity cost

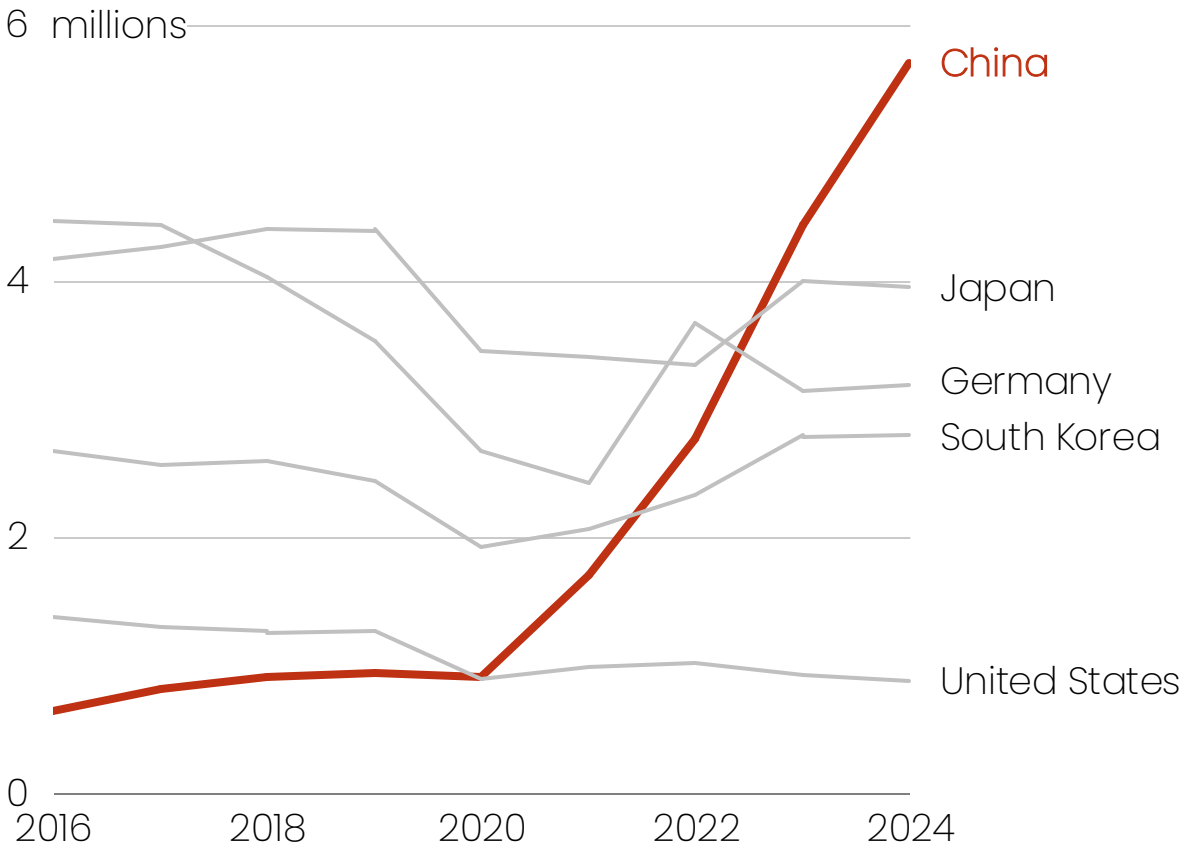




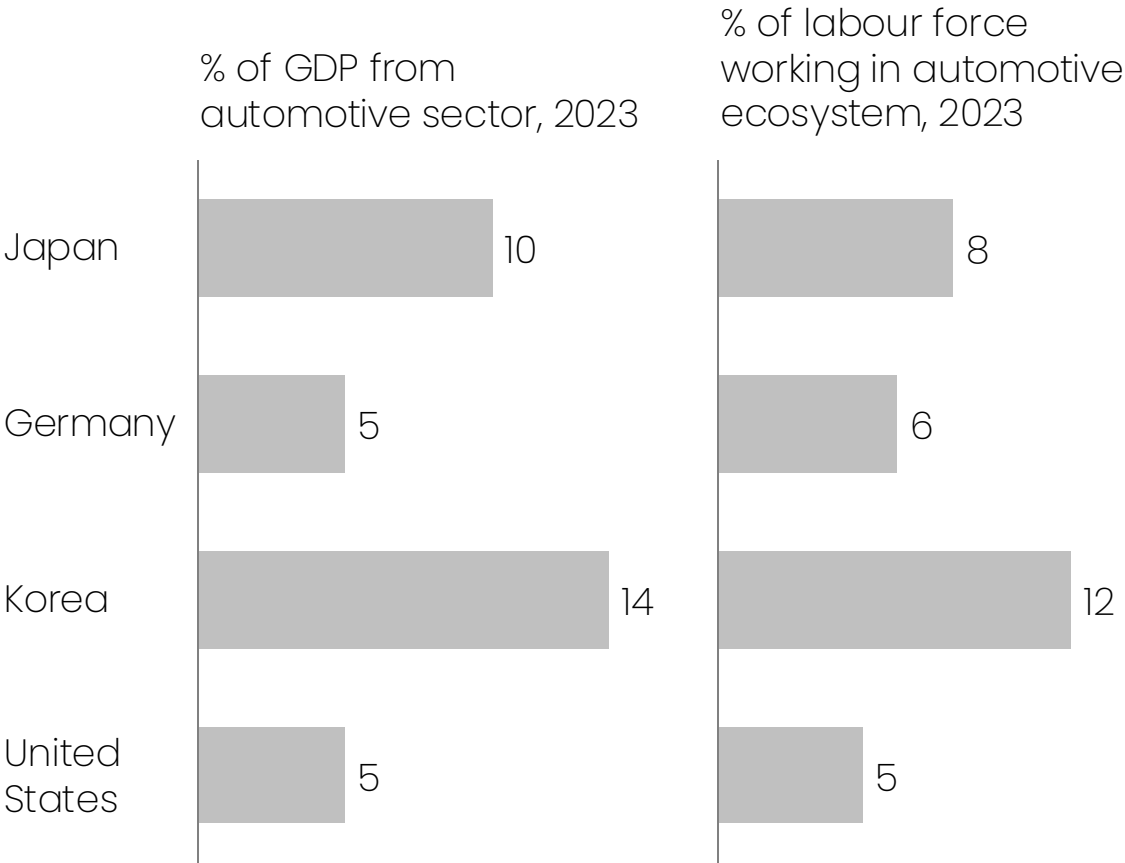
The automotive sector is a warning sign for other industries

In four years, China went from small to dominant

Car exports: China is taking over, enabled by EVs



Role of automotive in selected economies



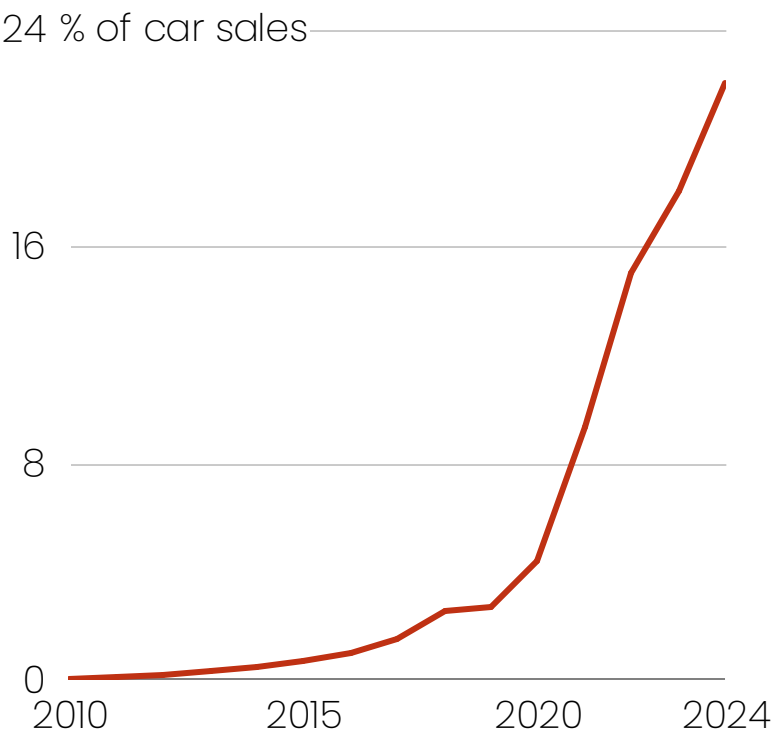


Don't expect the road to be smooth

Global curves are smooth; but locally it is a bumpy ride of lagging and leading

Smooth global curve

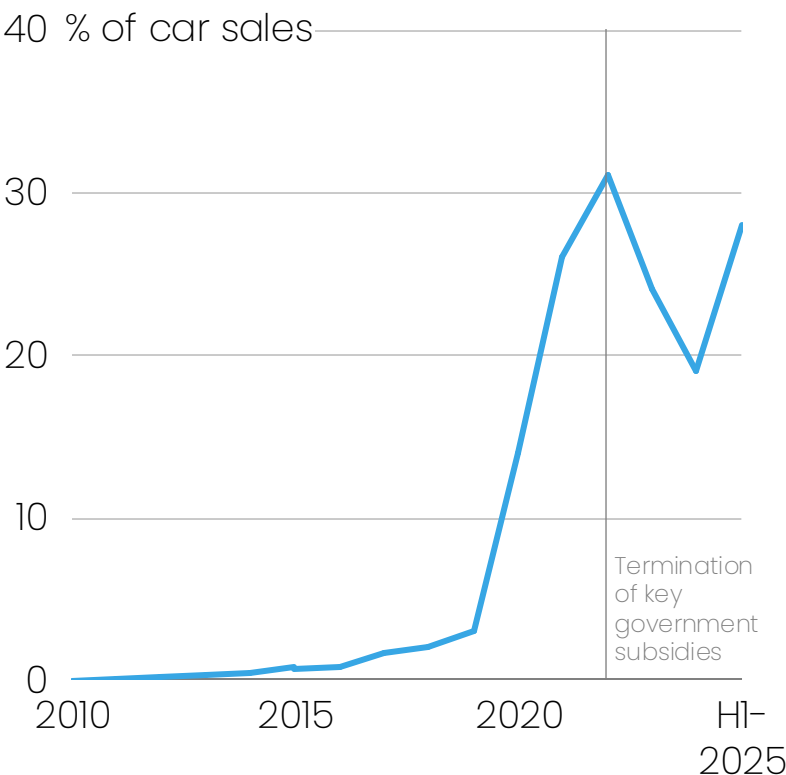
Global EV car sales



Bumpy local curves

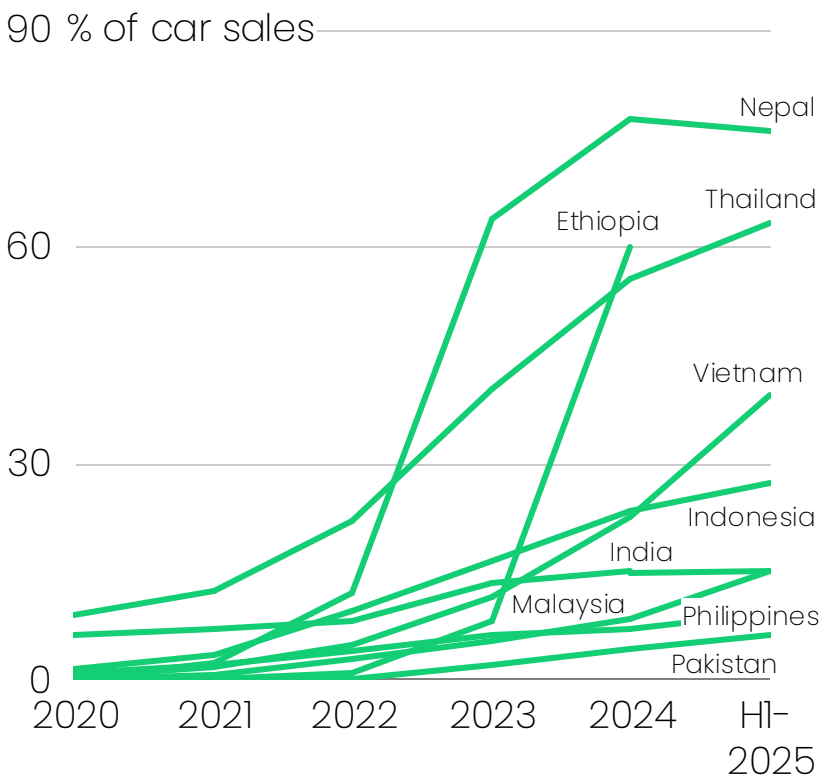
Larger-than-expected slowdown

Germany EV sales



Faster-than-expected acceleration

Emerging market EV sales



Focus on the fundamentals

Three key questions to gauge new energy technology in times of peak confusion

Physics

Does it make the energy system **more efficient**?



Economics

Is it **small and modular**, so it can be manufactured at scale and **benefit from learning curves**?



Geopolitics

Does it **enhance the independence and security** of its user?

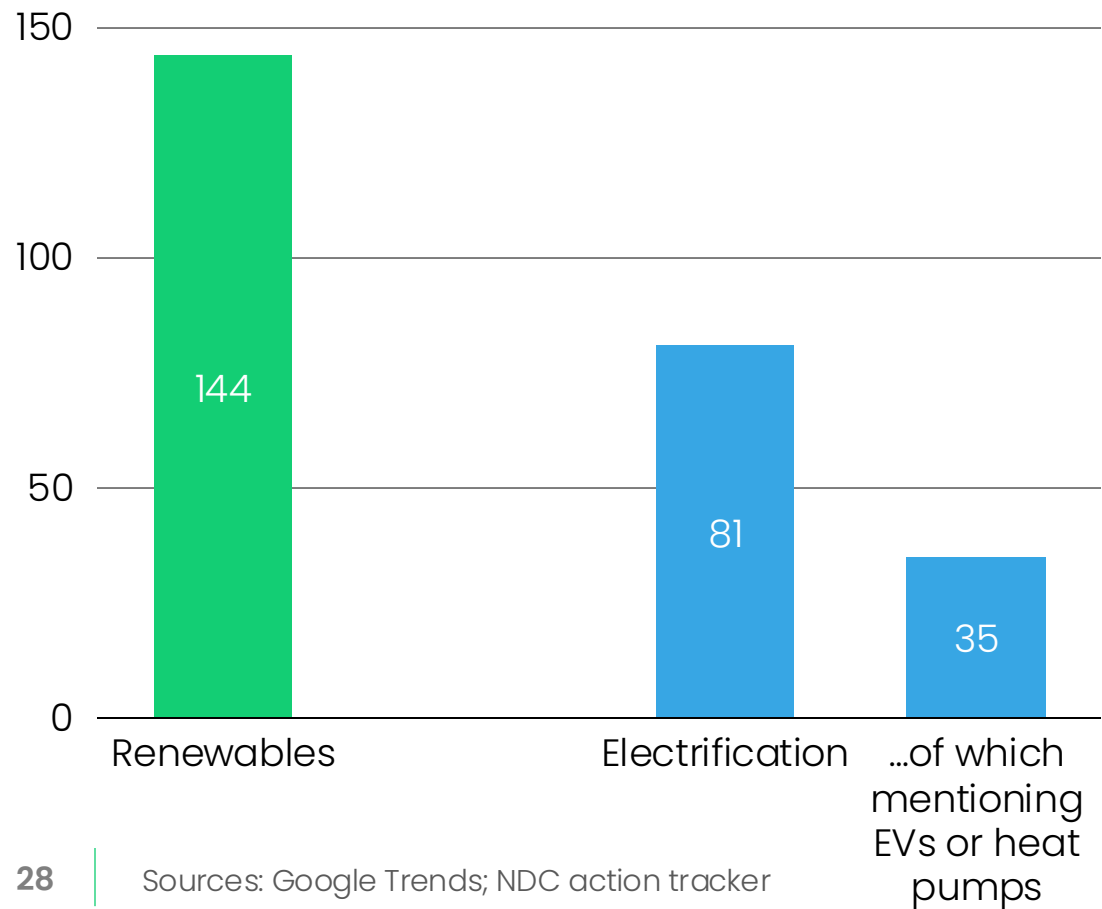


Electrification is underappreciated

Governments, companies and the general public seem to pay less attention to electrification

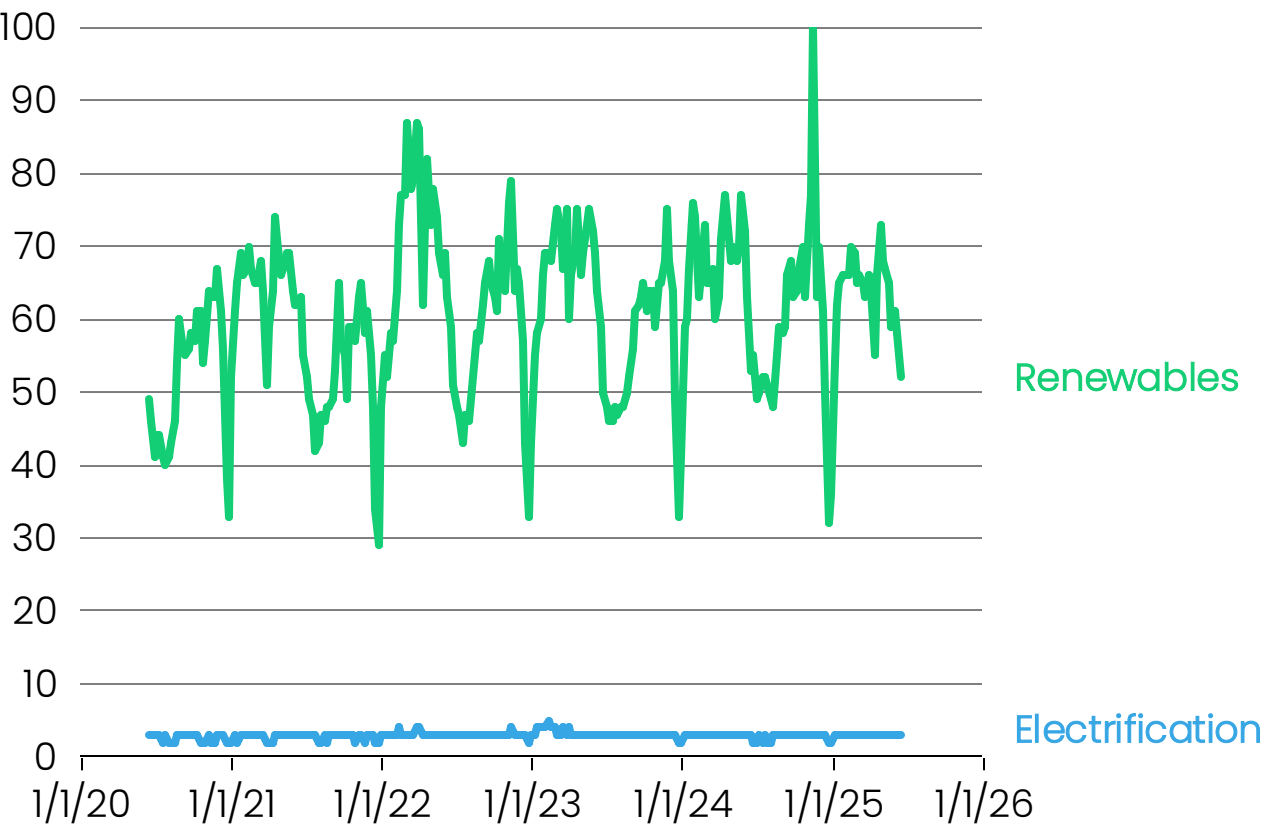
Government policy

Number of country NDCs that mention indicated topic



General public

Google searches by theme; max = 100



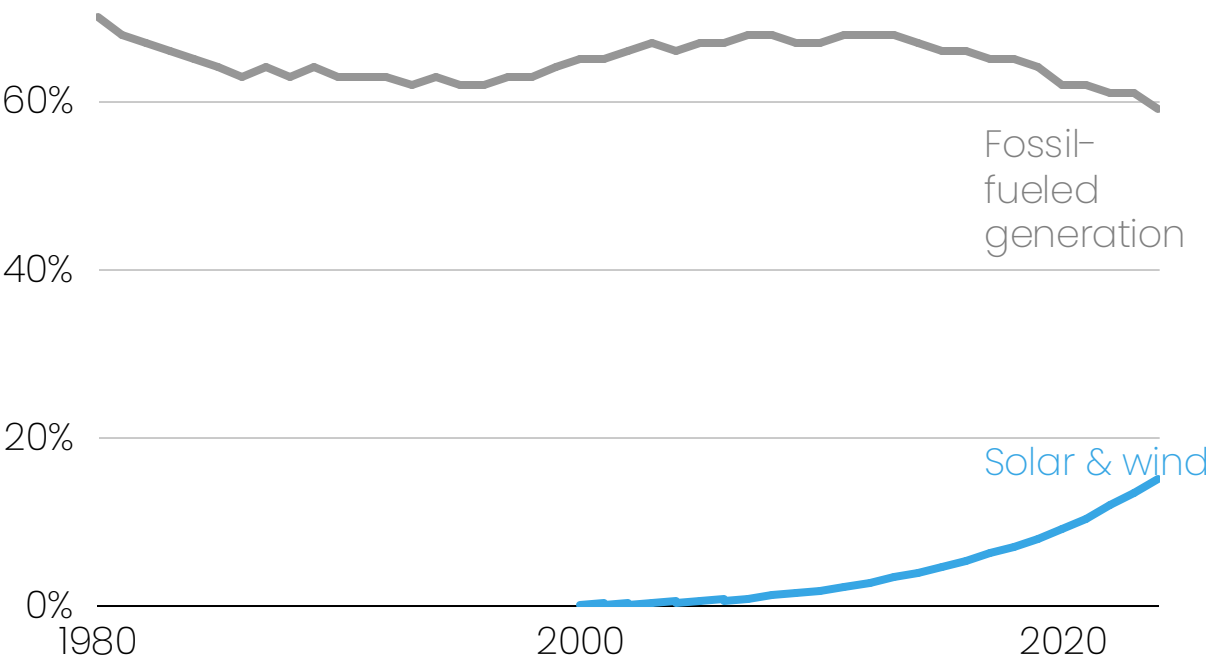
The races are moving at a different pace

Electrification is more advanced yet growing more slowly than renewables

Renewables

Solar & wind rise, fossil generation falls

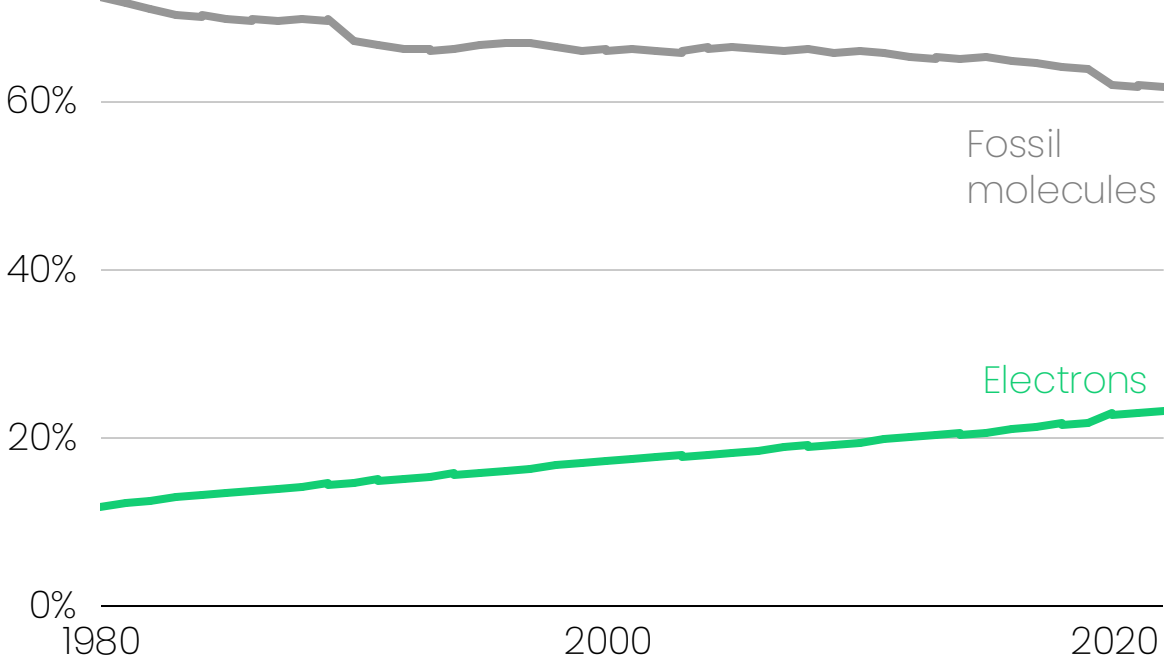
80% of electricity generation



Electrification

Electrons rise, fossil molecules fall

80% of final energy consumption



Note: Electrification refers to the share of final energy consumption supplied by electricity (electrons), replacing the direct use of fossil fuels (molecules) like oil, gas, and coal.

Electrification is the more consequential race today

Electrification...

...targets a **larger** part of the energy system



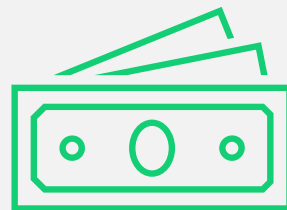
Bringing all of final energy consumption in scope by replacing molecules with electrons

...brings **more** energy security



Targeting the majority of energy imports of coal, oil, and gas

...makes **more** money



Larger revenue markets, higher margins, and larger export opportunities

...delivers **more** value to final consumers



Saving consumers money and offering superior products use in daily life

...is the global **differentiator** in energy leadership

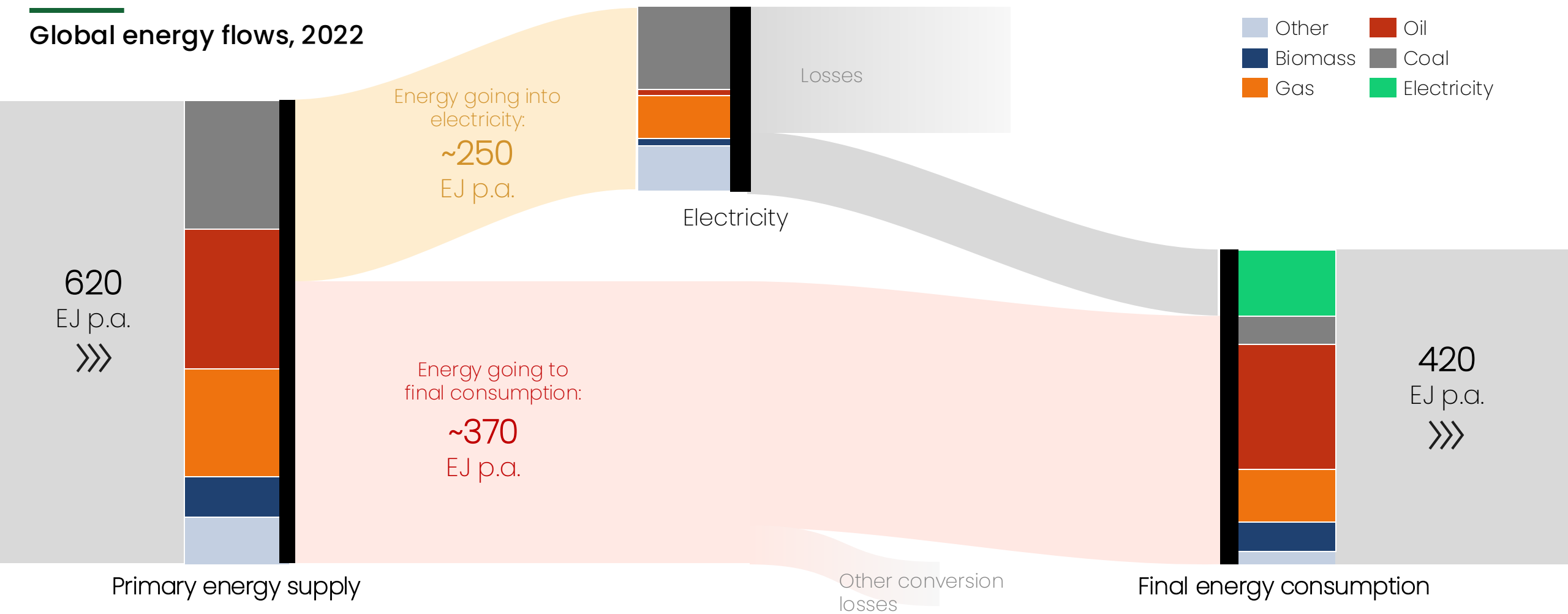


Electrification is what differentiates the West from the success of China and Asia

Most energy bypasses the electricity sector

Over 60% of primary energy does not pass through the electricity sector before use

Global energy flows, 2022



The majority of fossil fuel imports is for final demand

Only a quarter of net energy imports are used for electricity generation

 /  /  = 1 EJ

Coal net imports, global

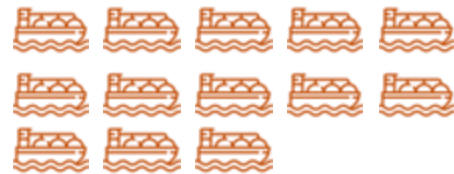


For electricity generation

Oil net imports, global



Gas net imports, global



For final demand (non electricity)



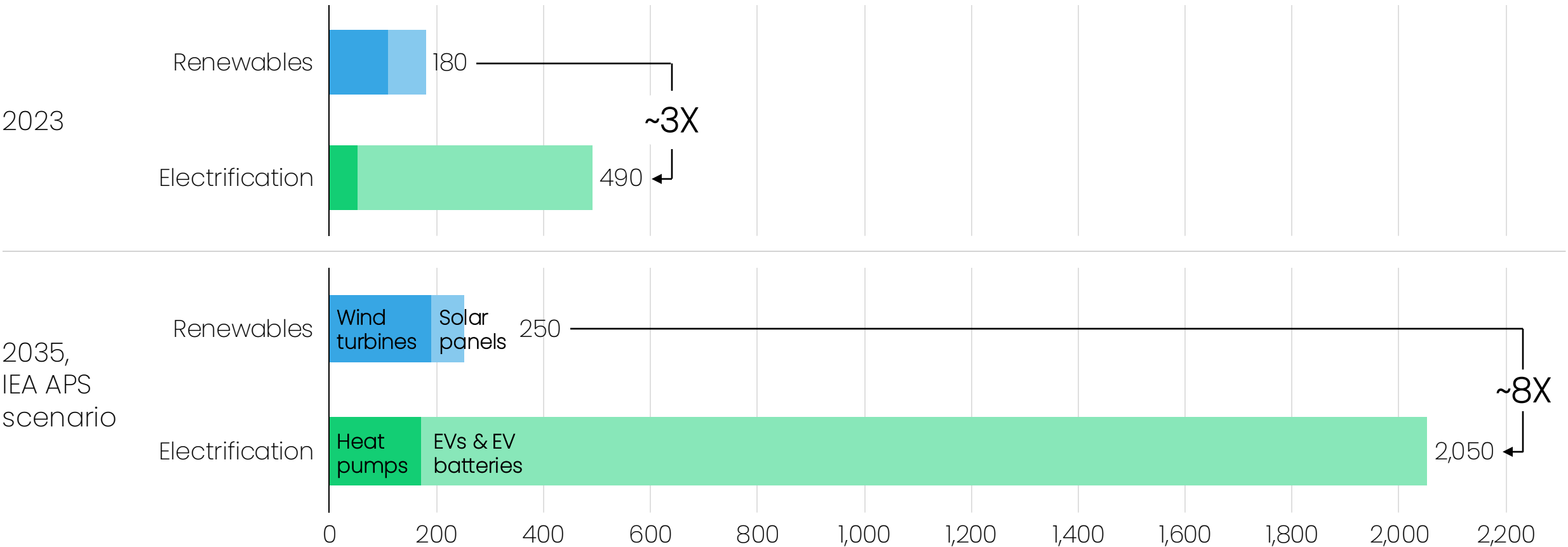


Key electrification technologies are already a bigger market

This gap is only set to widen into the future

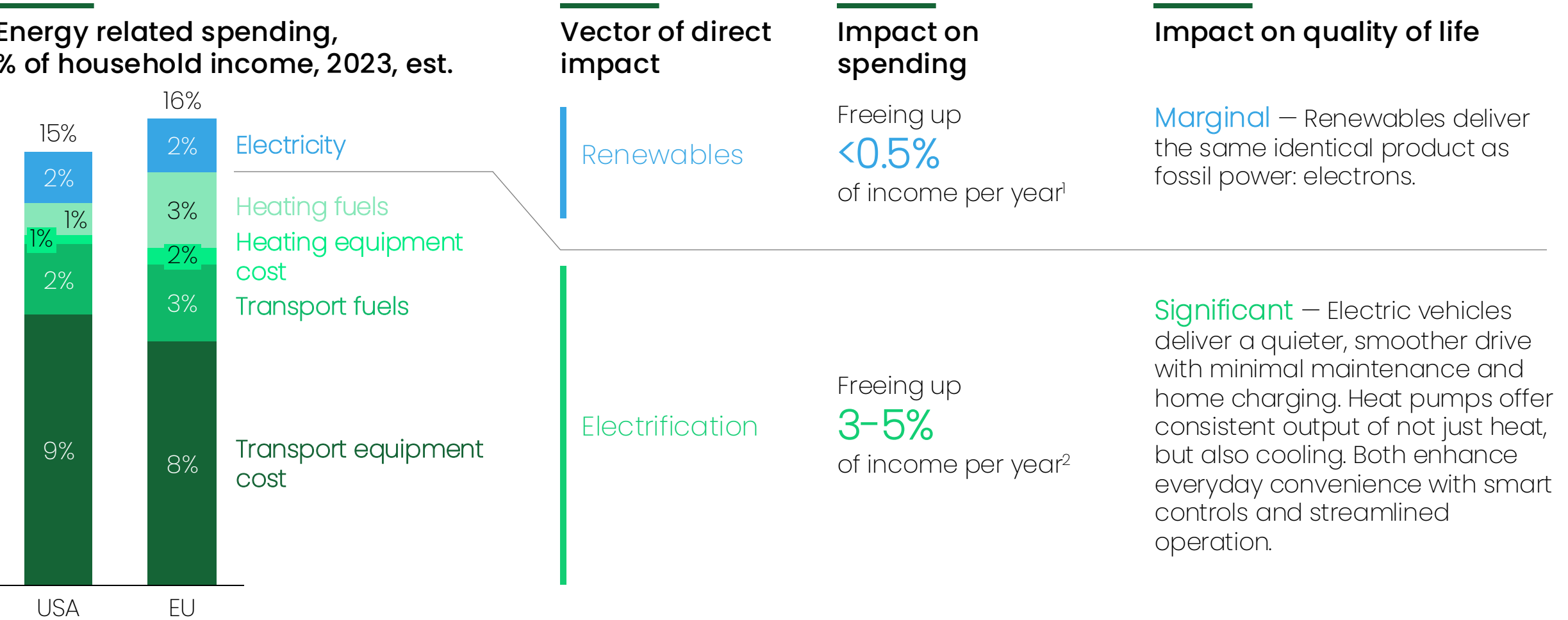


Market size of key renewables & electrification technologies, billion \$ revenue



Electrification hits home

Renewables help cut bills; electrification goes further and enhances everyday life



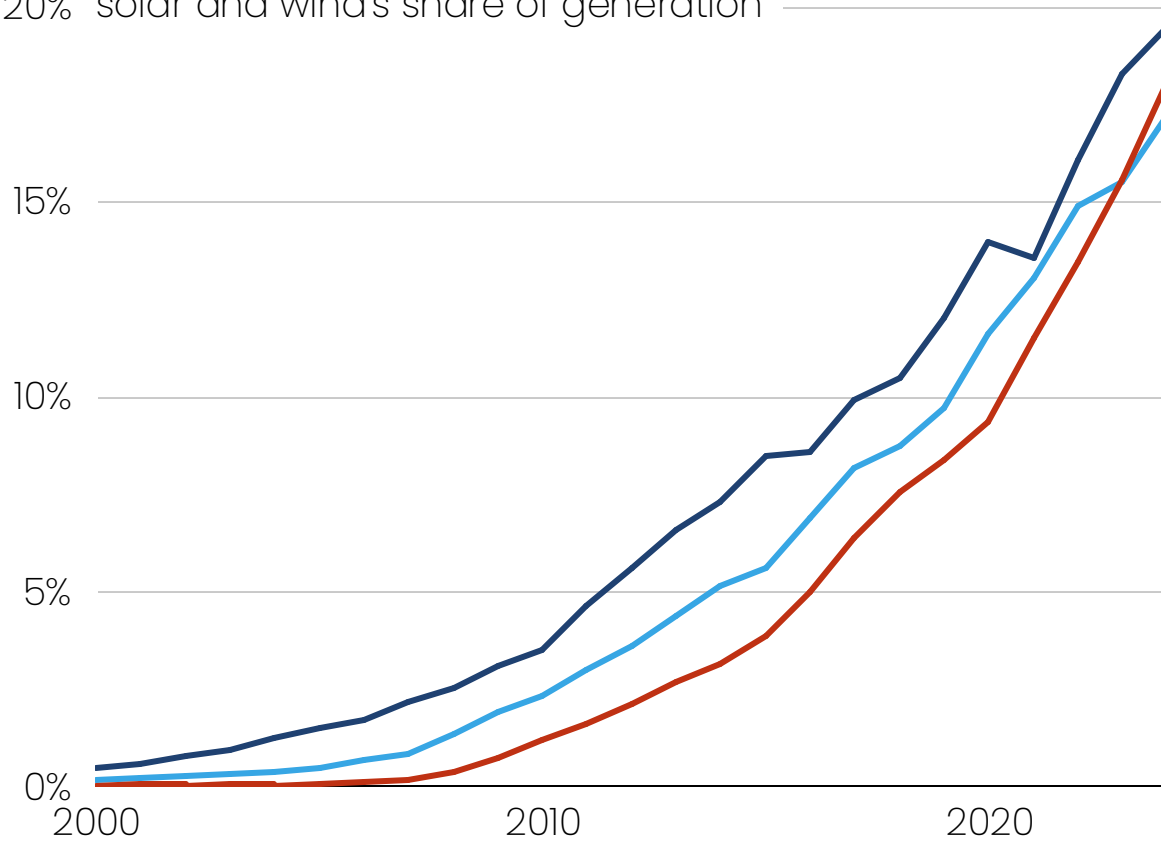
1. Even if renewables lower wholesale prices by 20–30%, impact on final residential prices, and hence household expenditure is smaller and in the order of hundreds of dollars per year
2. Electrifying heating and transport lowers fuel expenditures. Electrifying transport can also lower equipment expenditures due to lower maintenance cost as well as lower sticker prices.

One race is even, the other is not

In renewables, the race between Europe, US and China is even; in electrification it is not

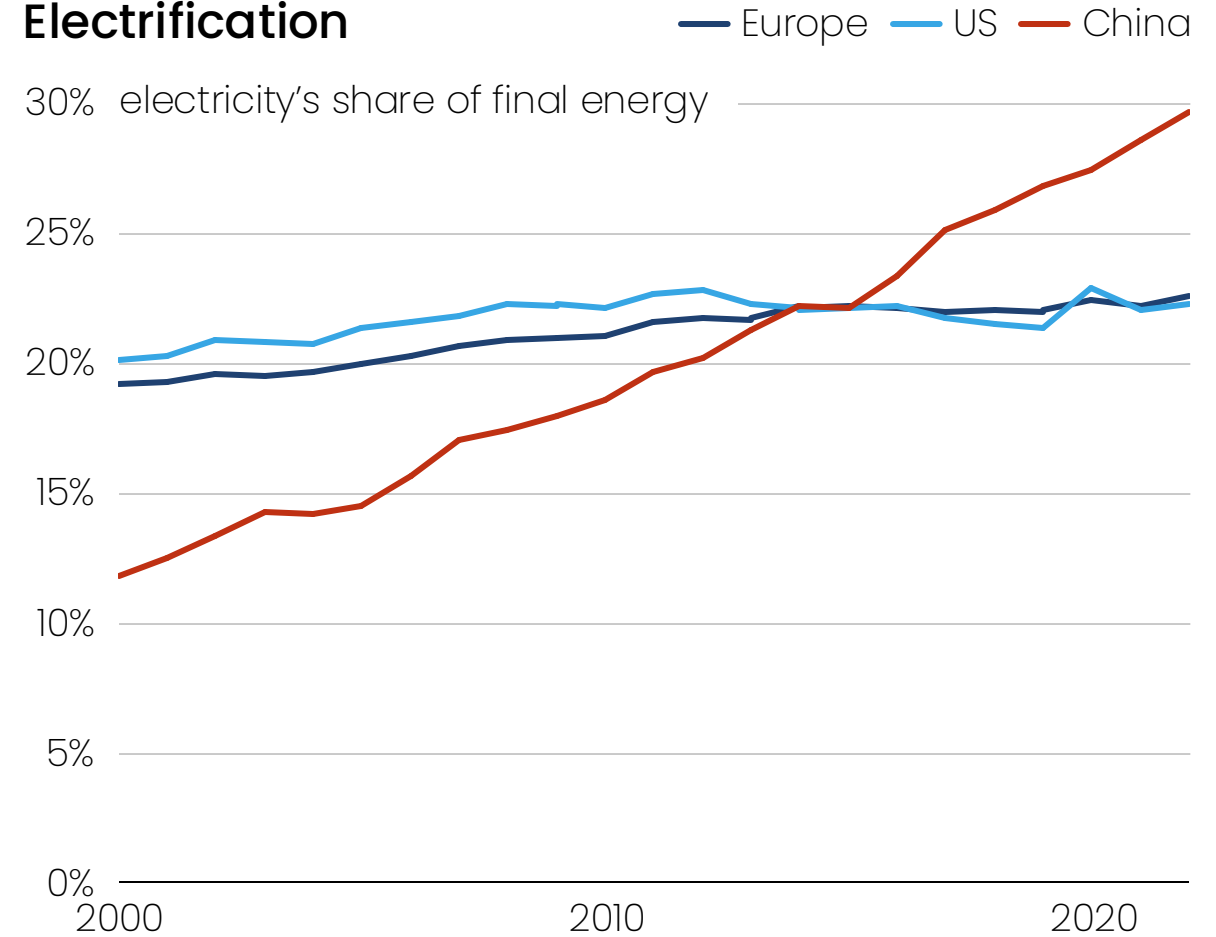
Renewables

20% solar and wind's share of generation



Electrification

30% electricity's share of final energy

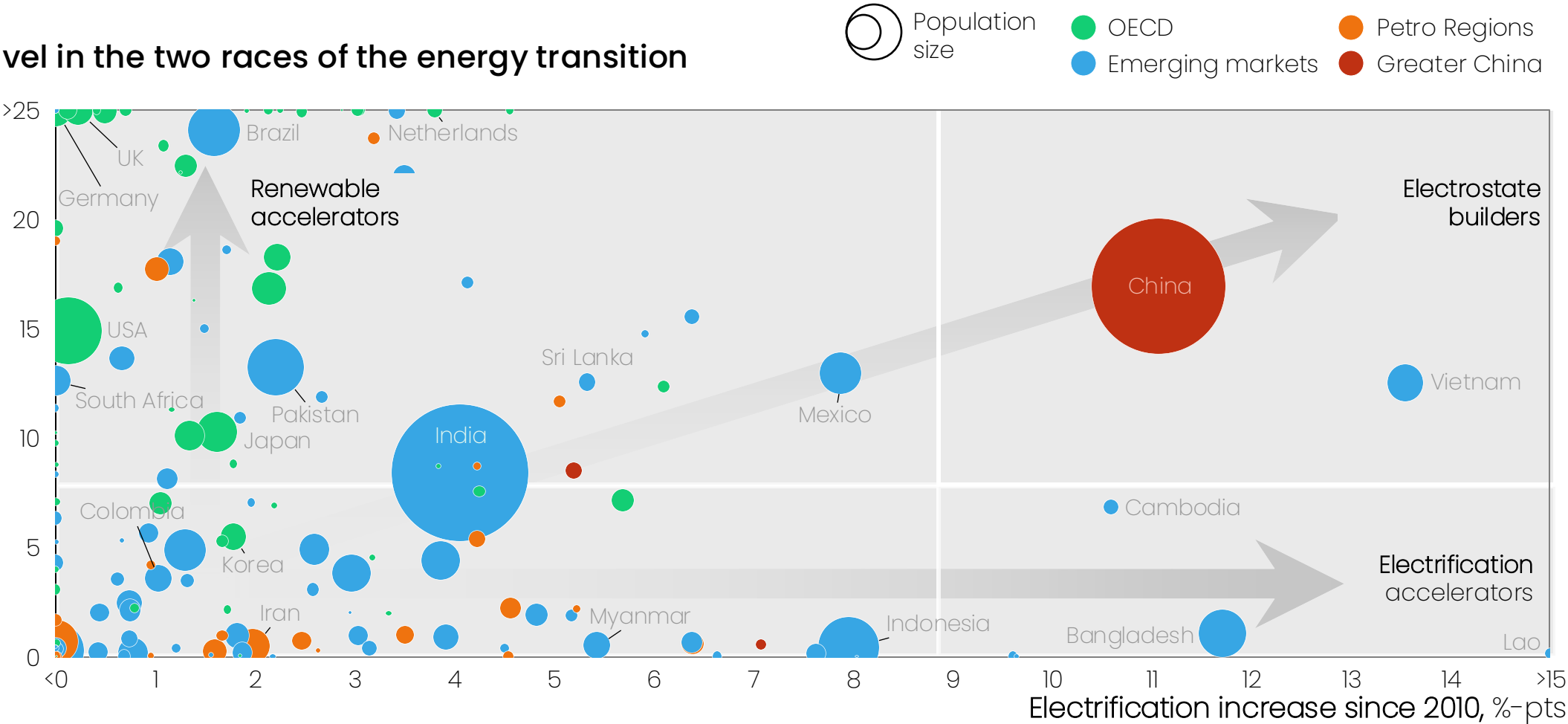


The electrification imperative

Many countries are building renewables; few an electrostate

Direction of travel in the two races of the energy transition

Wind & solar generation share increase since 2010, %-pt



The time is now



01

For the first time in history, we can harness the exceptional power of the sun through electrotech



02

After a century of evolution, electrotech is now coming together in a decade of revolution; surging globally, replacing fossil fuels, and powering emerging economies



03

Change is driven by the fundamental forces of physics, economics and geopolitics, not just climate action



04

This revolution will come faster and go further than most think, stranding more than just energy assets, and reshaping global leadership



05

This is the decisive decade. Surf the electrotech wave or be dragged under

About Ember

Ember is an independent energy think tank that aims to accelerate the clean energy transition with data and policy. Its vision is a world with a safe climate, powered by a clean, electrified energy system for all.

About Ember Futures

This report is the first annual pitch deck from Ember Futures, a new research initiative established to help leaders navigate the rapid rise of electrotech and the decline of fossil fuels, and what this transition means for energy, financial markets, and geopolitics.

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