The Electrotech Revolution

The shape of things to come

Daan Walter

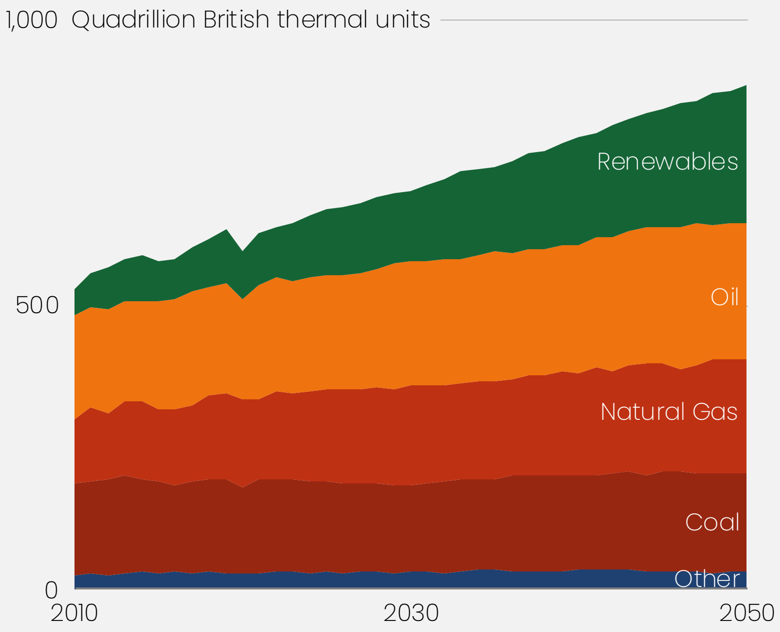
December, 2025

Two views on energy dominate the conversation.

The dominant energy views in the energy debate today

The incumbent energy view, centred on fossil fuels, slow change and business-as-usual

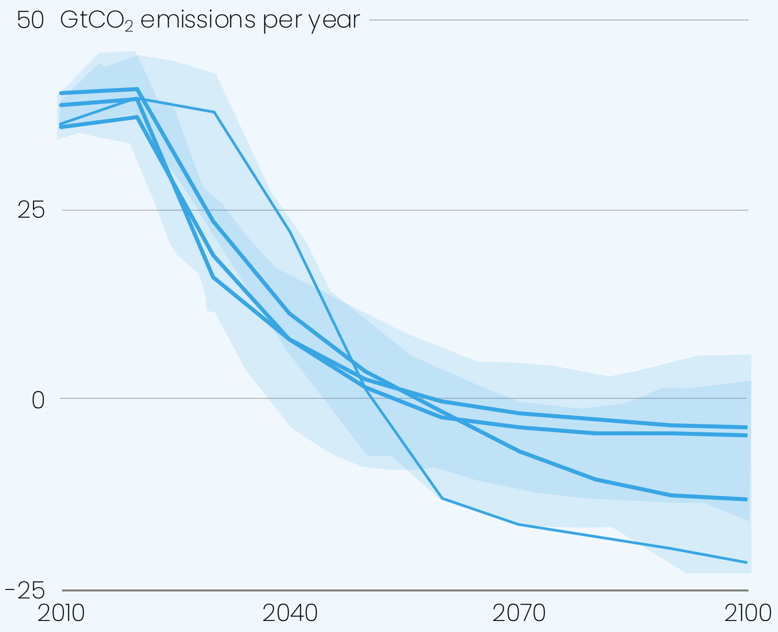
EIA – Primary energy supply



Source: Energy information Administration

The climate view, centred on emissions, policy targets and the moral obligation to fix climate change

IPCC – Pathways to net zero emissions



Source: Intergovernmental Panel on Climate Change (IPCC)

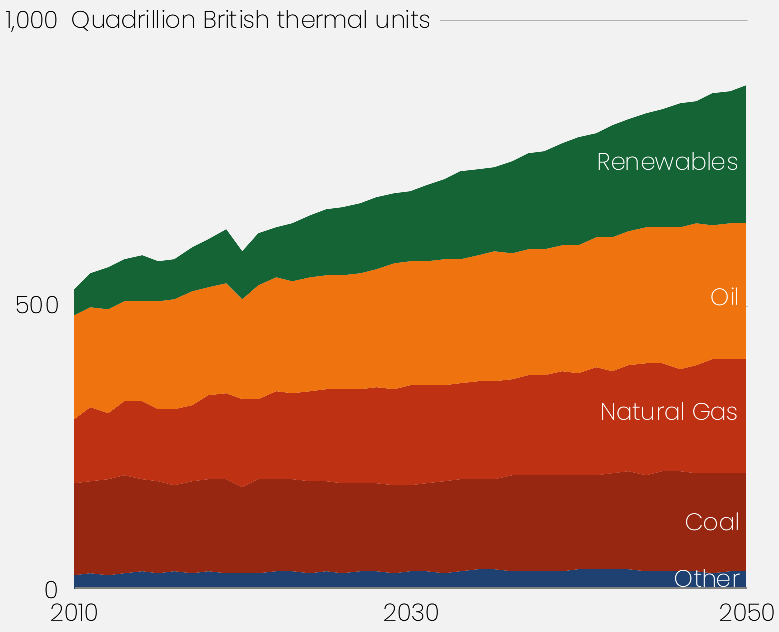
EMBER

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

The dominant energy views in the energy debate today

The incumbent energy view, centred on fossil fuels, slow change and business-as-usual

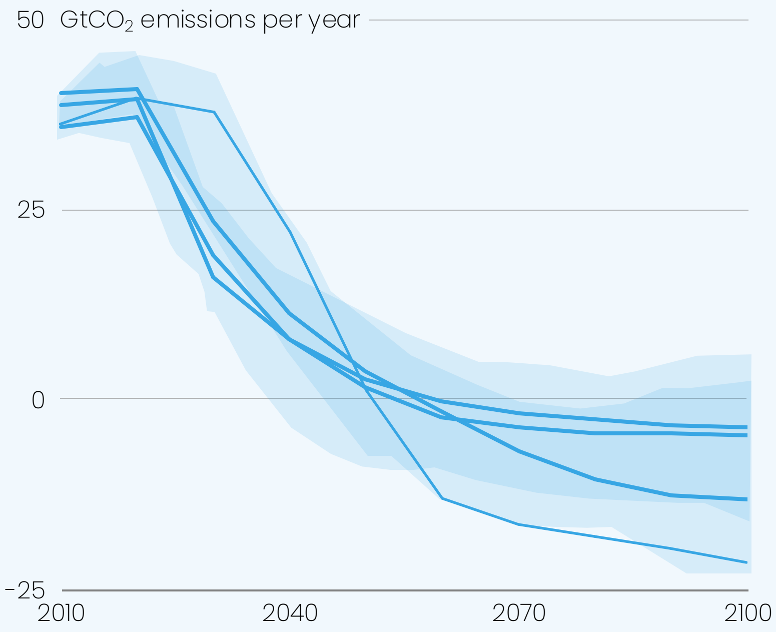
EIA – Primary energy supply



Source: Energy information Administration

The climate view, centred on emissions, policy targets and the moral obligation to fix climate change

IPCC – Pathways to net zero emissions

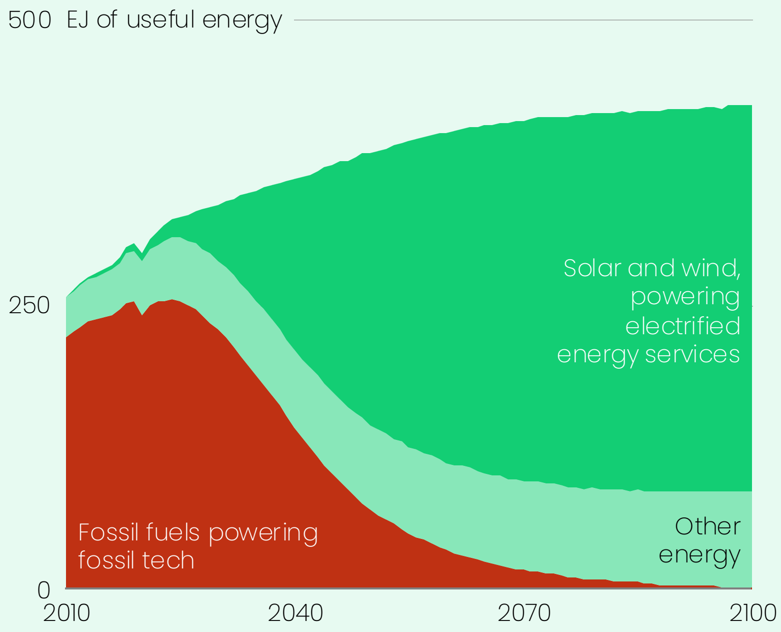


Source: Intergovernmental Panel on Climate Change (IPCC)

A third way: the electrotech view

The new electrotech view, centred on growth and innovation

Rystad – Global useful energy demand



Source: Rystad Energy

EMBER

This is a technology revolution in energy

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

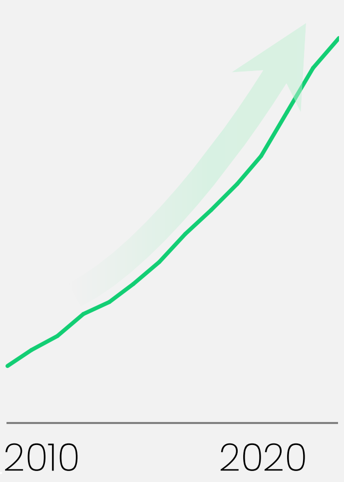
Supply

New ways to generate electricity

Renewables as vectors of change

Solar PV
deployment (GW)

Wind
deployment (GW)

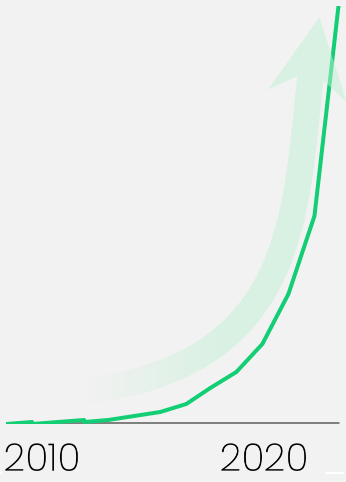


Connections

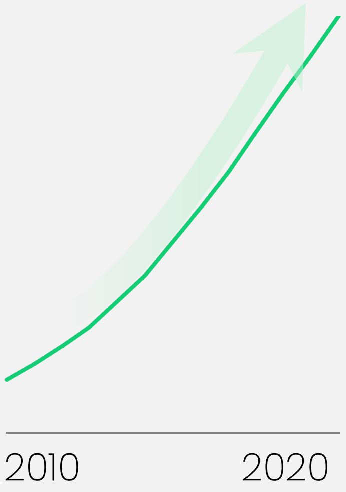
New ways to transport and store electricity

Flextech/gridtech as vectors of change

Battery storage
deployment



HVDC lines
deployment (km)

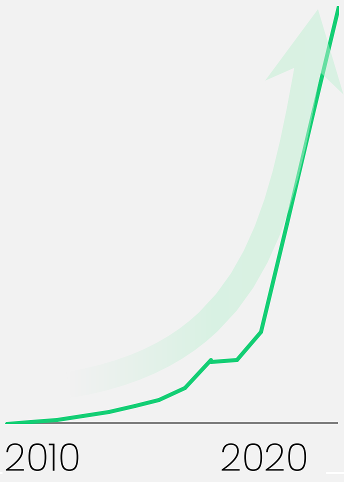


Demand

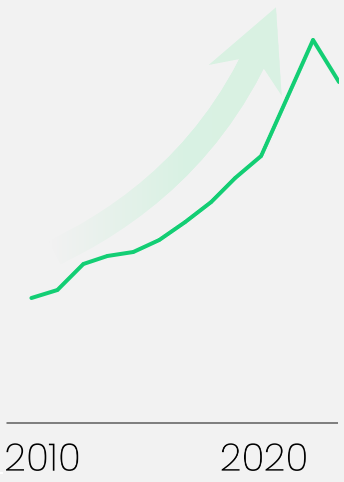
New ways to use electricity

Electrification as vector of change

EV
sales



Heat pumps
sales

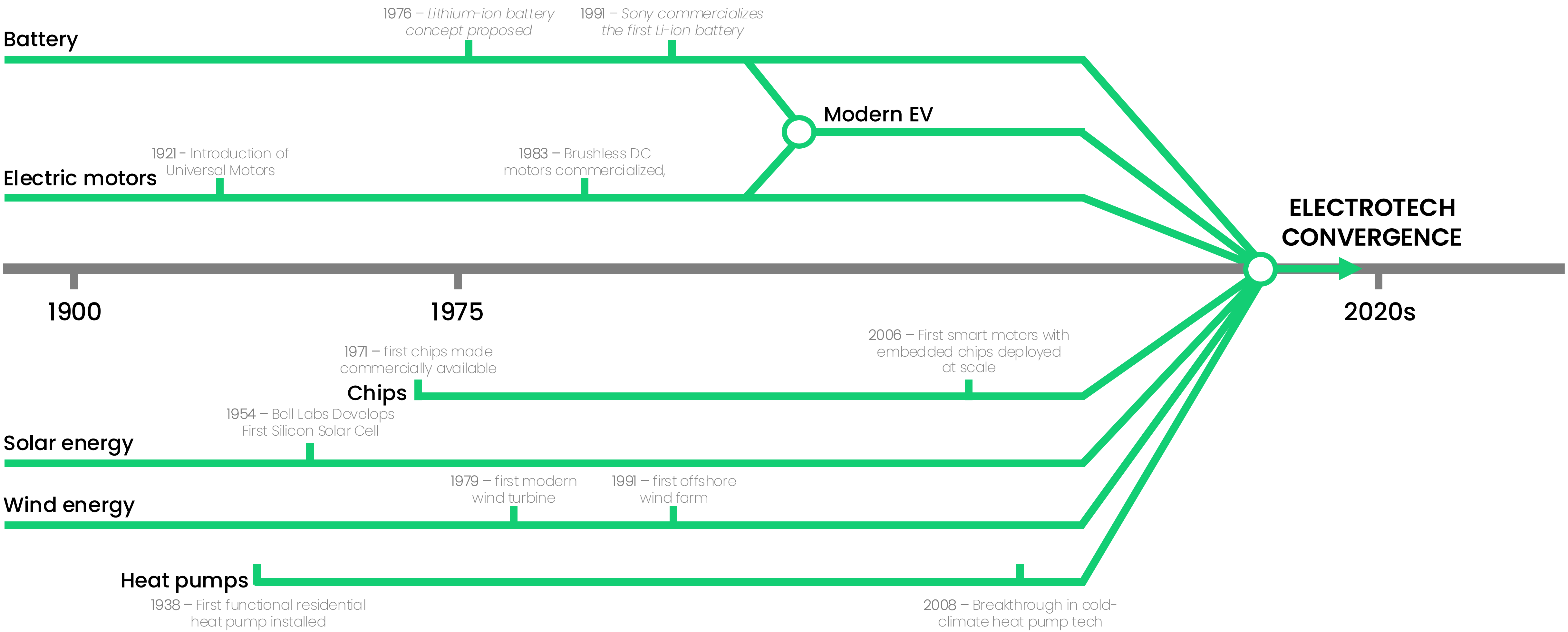


Sources: Ember, IEA, RMI, Thunder Said

It’s been a long time coming

A century of evolution is converging into a decade of revolution

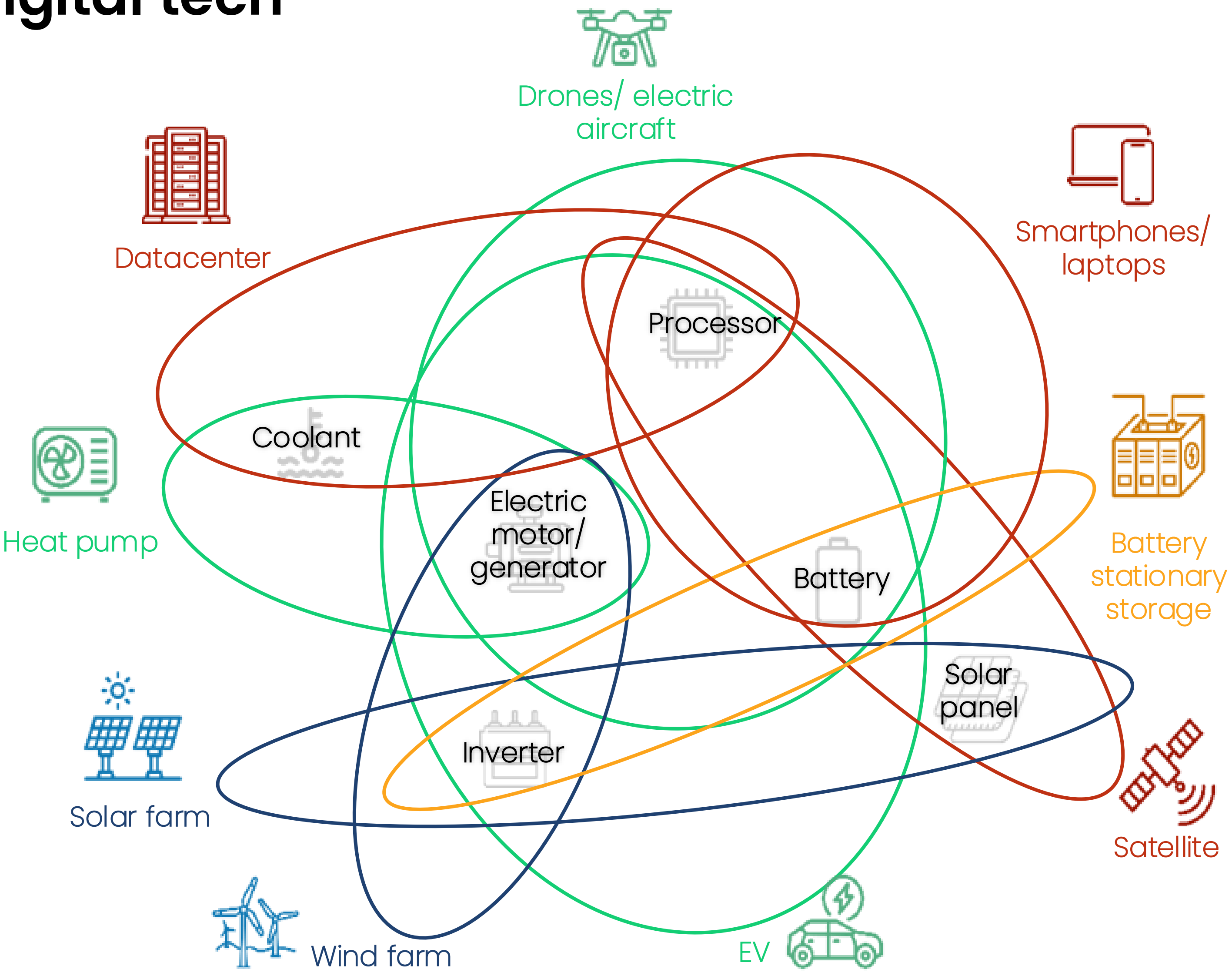
ILLUSTRATIVE



Source: Ember

Electrotech is the child of digital tech

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

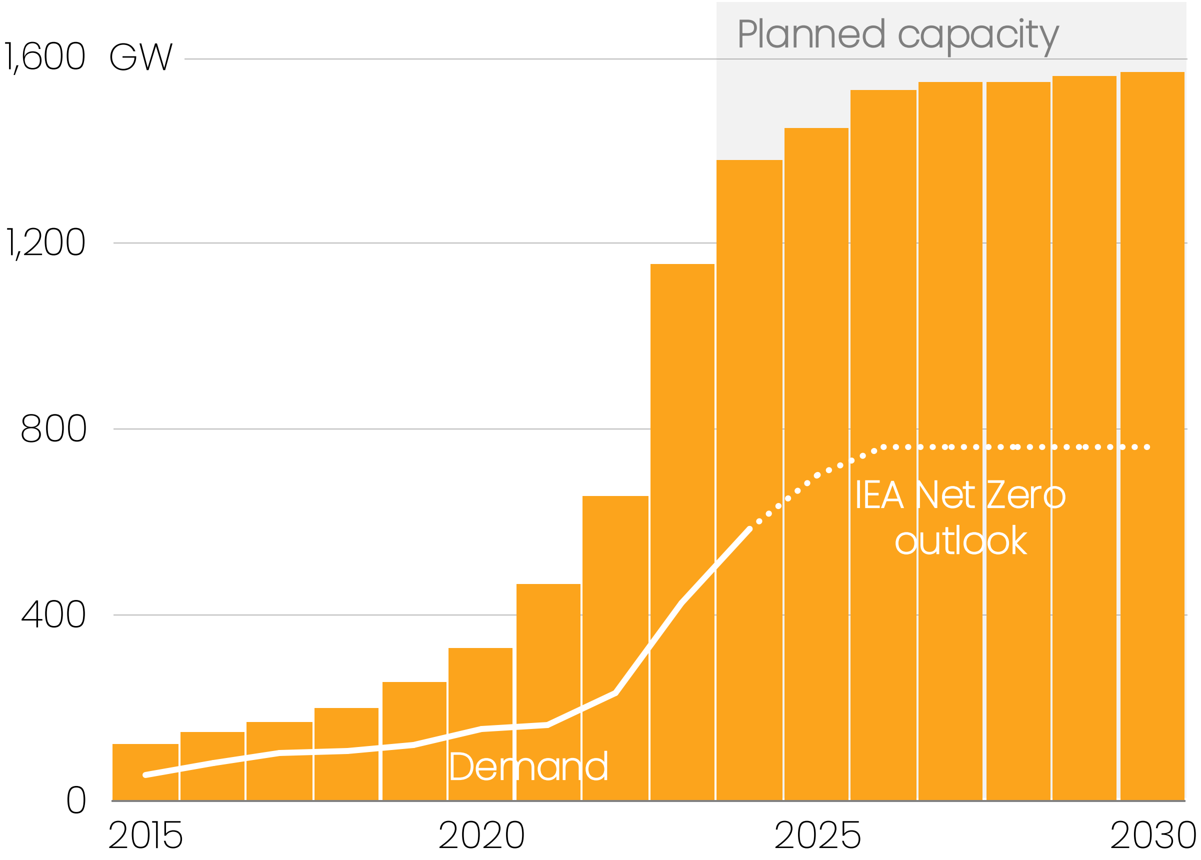


Source: Ember analysis

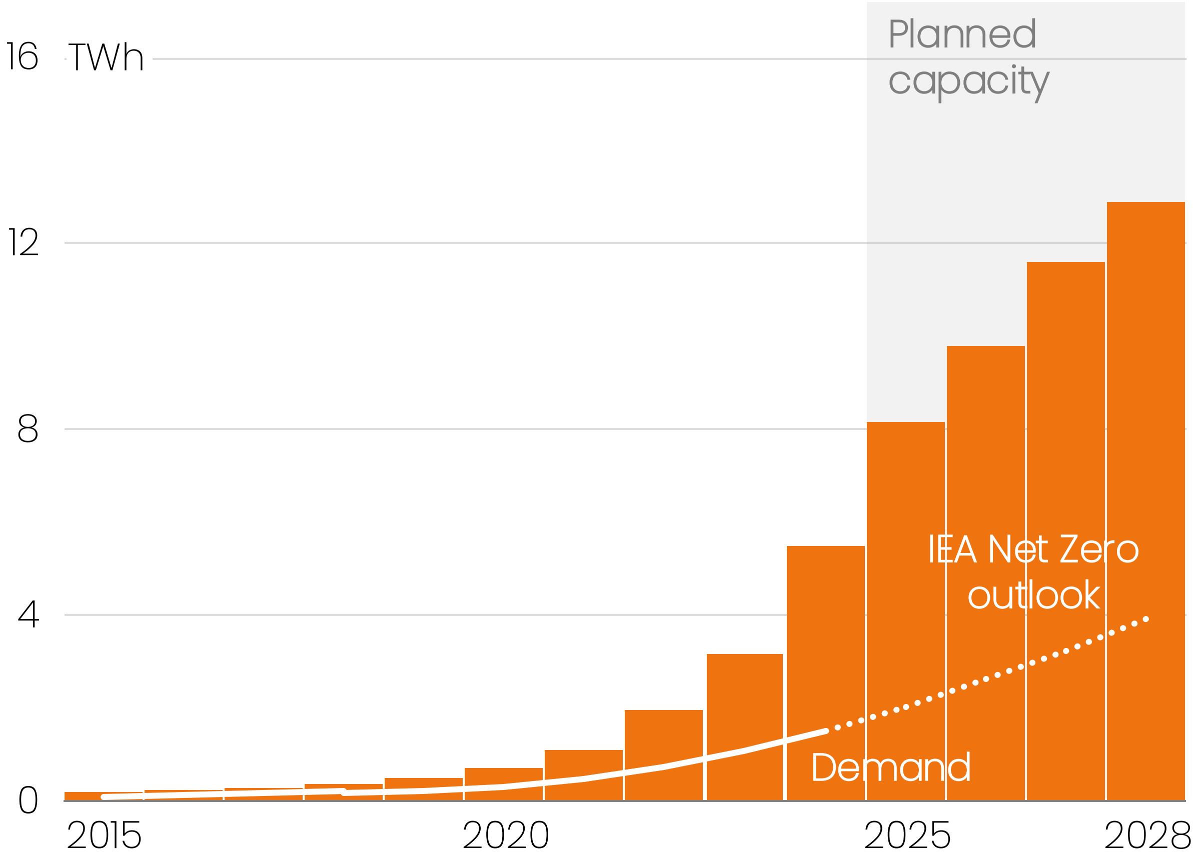
The manufacturing capacity is in place

Outpacing projected demand of even net zero scenarios

Solar PV manufacturing capacity



Battery manufacturing capacity



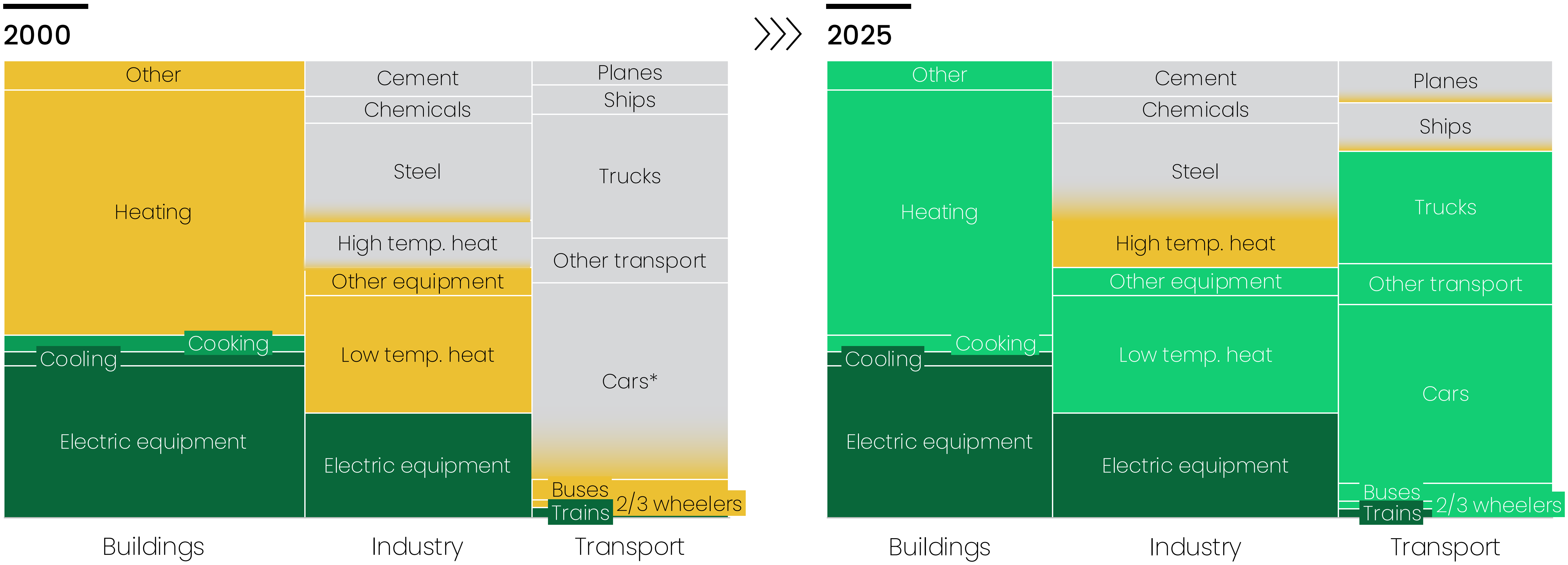
Sources: IEA; Ember analysis. The IEA net zero outlook is chosen as an illustration that capacity is above even this level.

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 (%)



Sources: IIASA; IEA; BNEF; Ember analysis • Note: excluding feedstock *Technologies available for subset of total end-use with a clear path to expansion

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

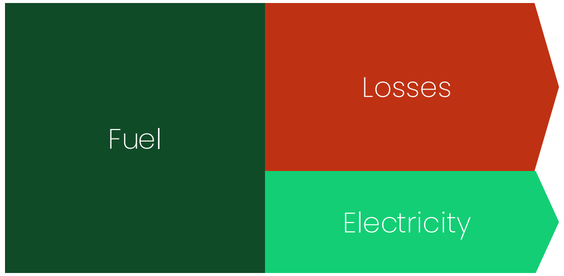
Electrotech is 3x more efficient

It offers a leap in energy efficiency across the economy

Supply

Electricity generation

Fossil thermal



30-40% efficiency

Wind & solar

100% efficiency

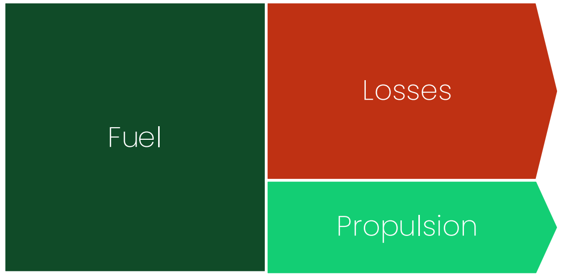
2–3x

as efficient

Demand

Transport

Internal combustion engine



25-40% efficiency

Electric vehicles

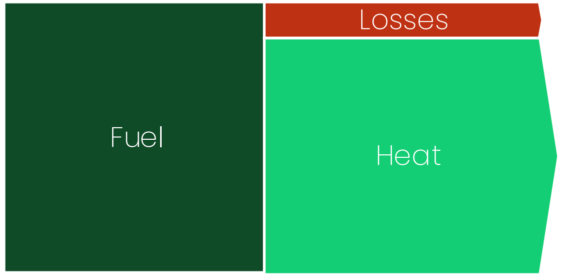
80-90% efficiency

2–4x

as efficient

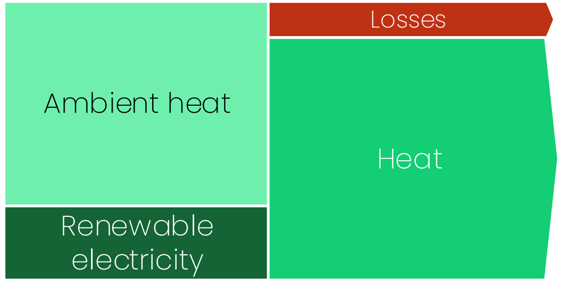
Heating

Gas boiler



85% efficiency

Heat pumps



300-400% efficiency

3–4x

as efficient

Sources: IEA, IIASA, Visual adapted from Prof. Tomas Kåberger and RMI • Note: heating refers only to low temperature heating

Three fundamental drivers of change

Physics
Electrotech is more efficient than alternatives

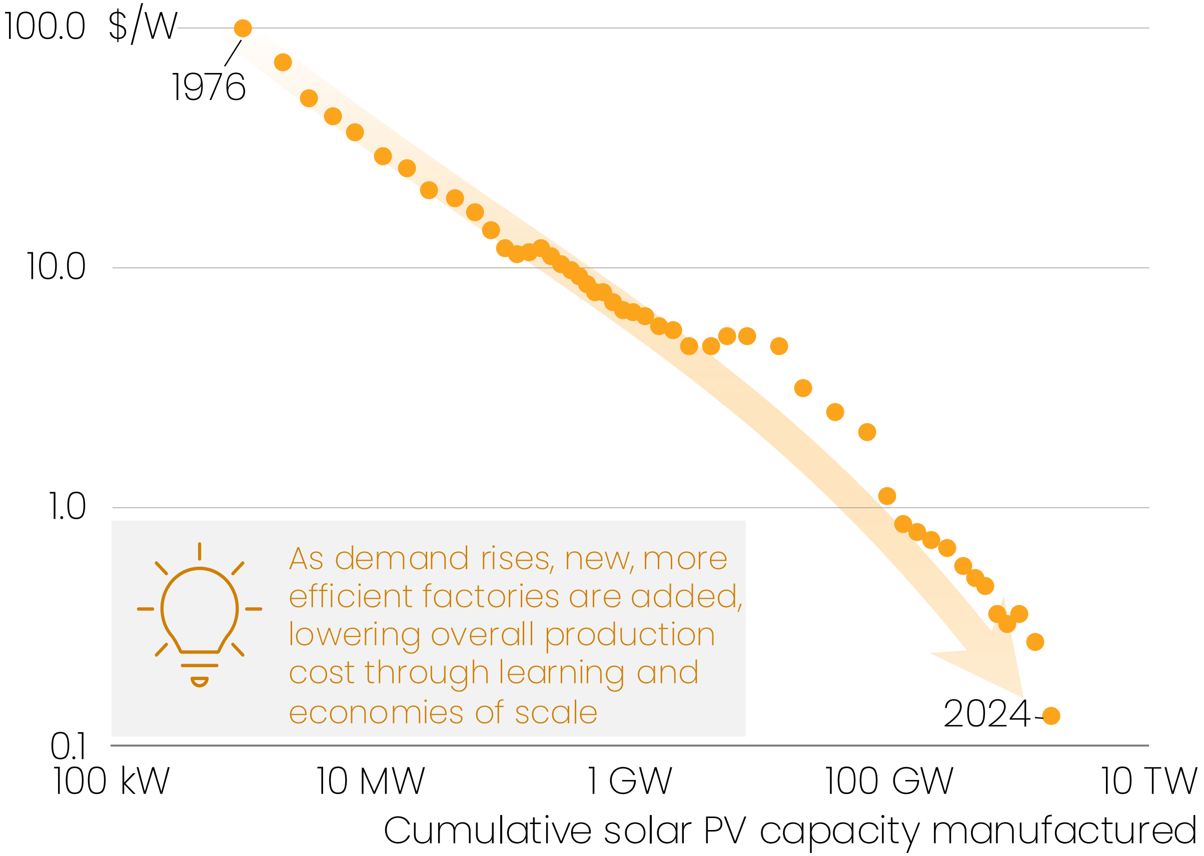
Economics
Electrotech as a technology has learning curves and growth curves

Geopolitics
Electrotech is a key tool of energy security

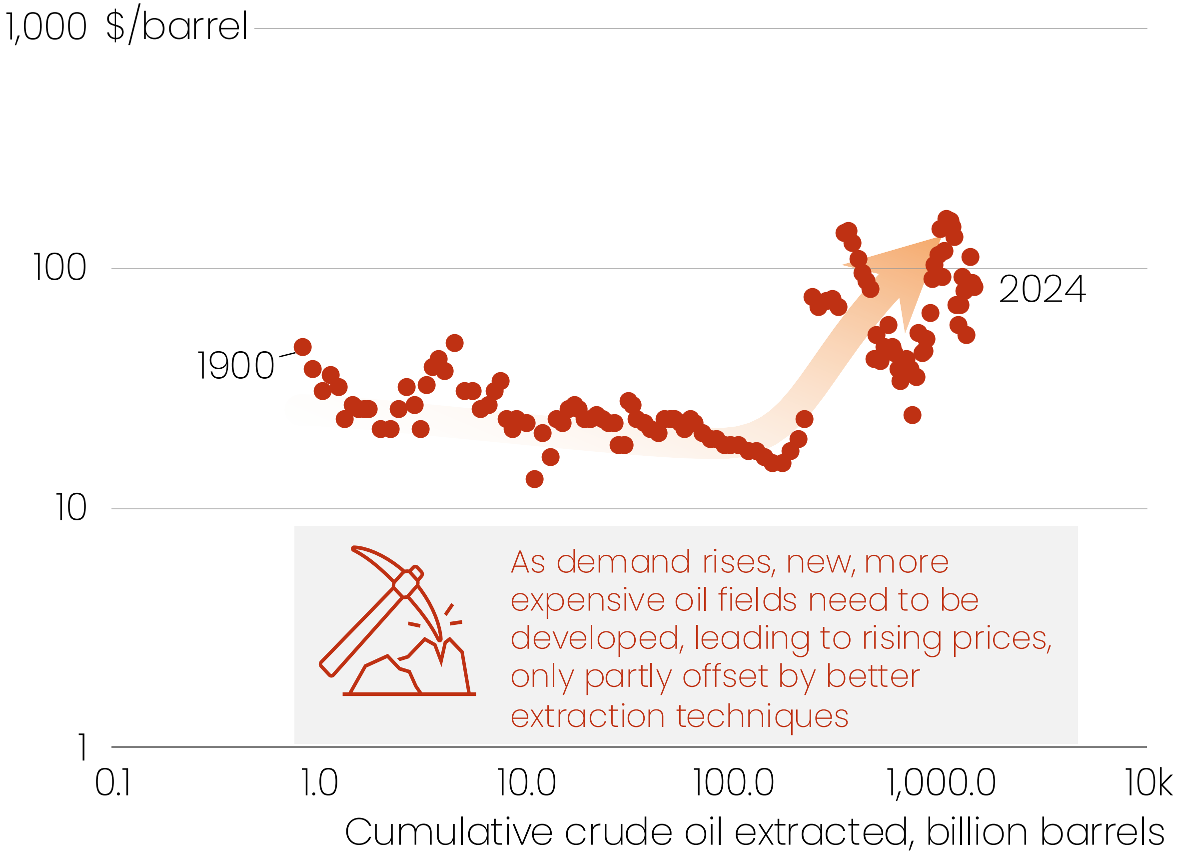
Learning beats digging

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

Solar panel price cost versus amount manufactured



Oil price versus amount extracted



Sources: Rystad; BNEF; Ember analysis

Three fundamental drivers of change

Physics
Electrotech is more efficient than alternatives

Economics
Electrotech as a technology has learning curves and growth curves

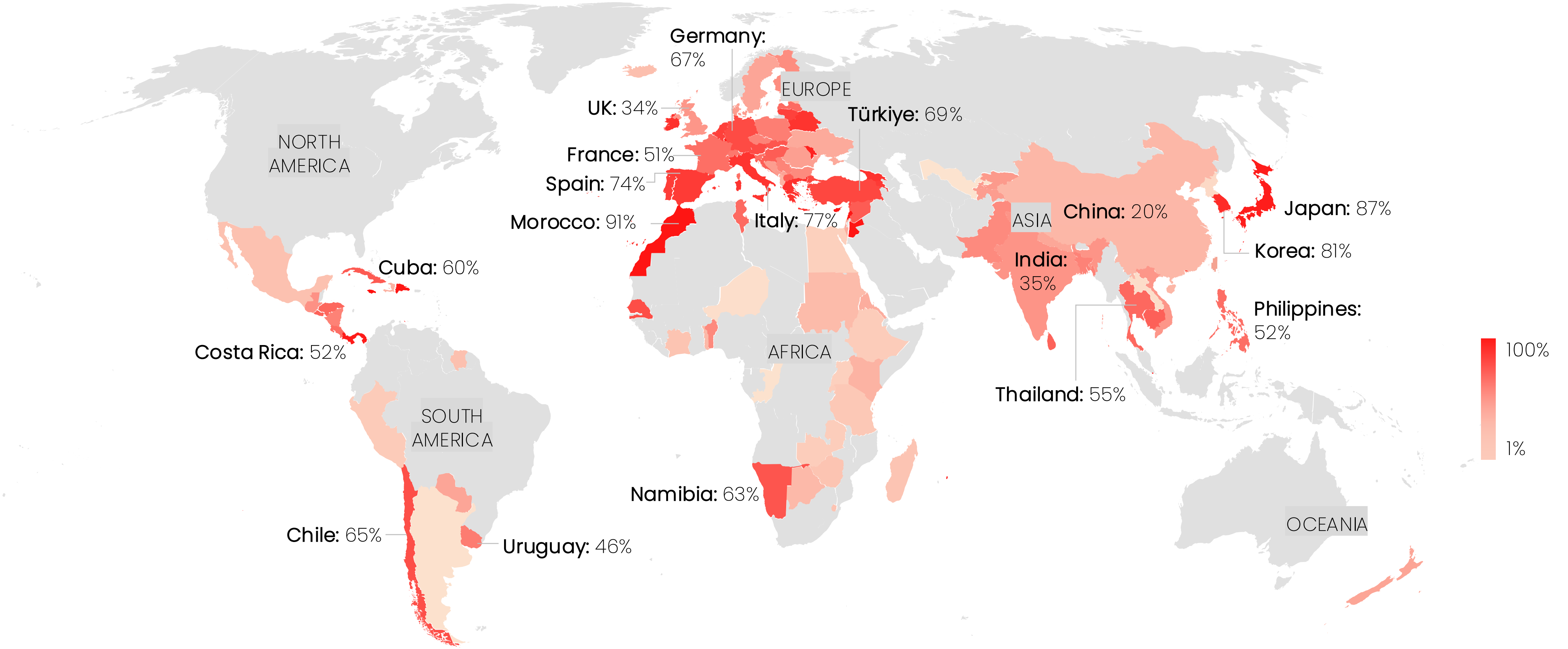
Geopolitics
Electrotech is a key tool of energy security

EMBER

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, %



Sources: IEA WEB, Ember analysis. Map boundaries are from Microsoft Bing and do not imply any judgment on legal status or sovereignty.

Electrotech offers a path to permanent energy security

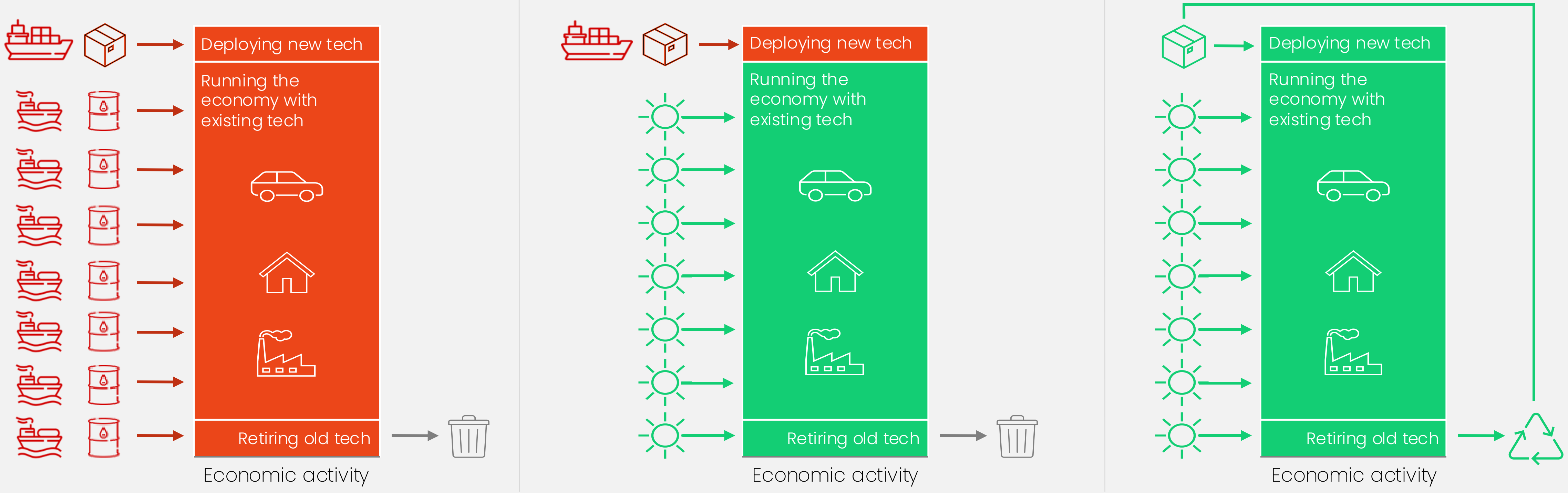
When fossil flows stop, the economy stops. When electrotech flows stop, only growth is at risk

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

Sources: Ember• Note: bar sizes are illustrative

EMBER

China is the first major electrostate

And that sparks a geopolitical race

China US Europe Other

Inventing

Patents

Annual cleantech patents

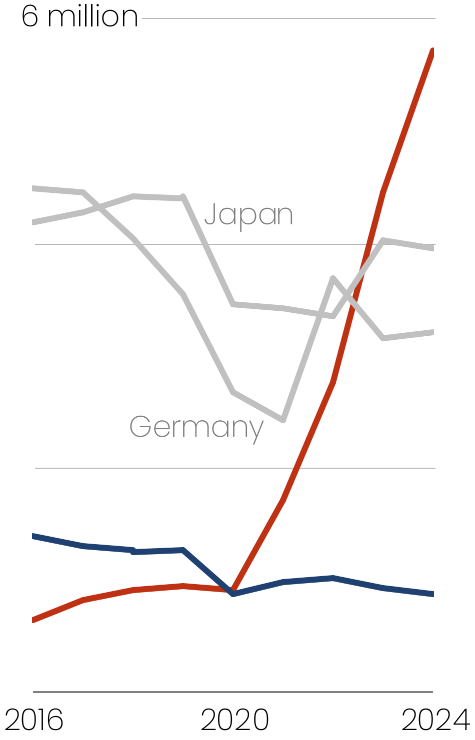
Producing

Manufacturing

Battery manufacturing

Exporting

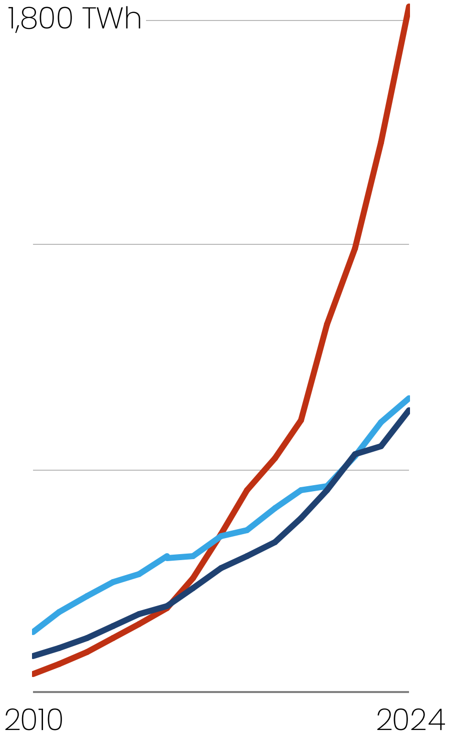
Cars



Deploying

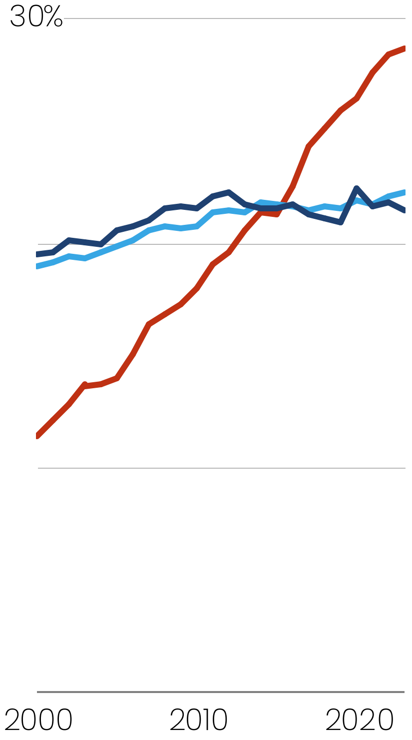
Renewables

Solar & wind generation



Electrification

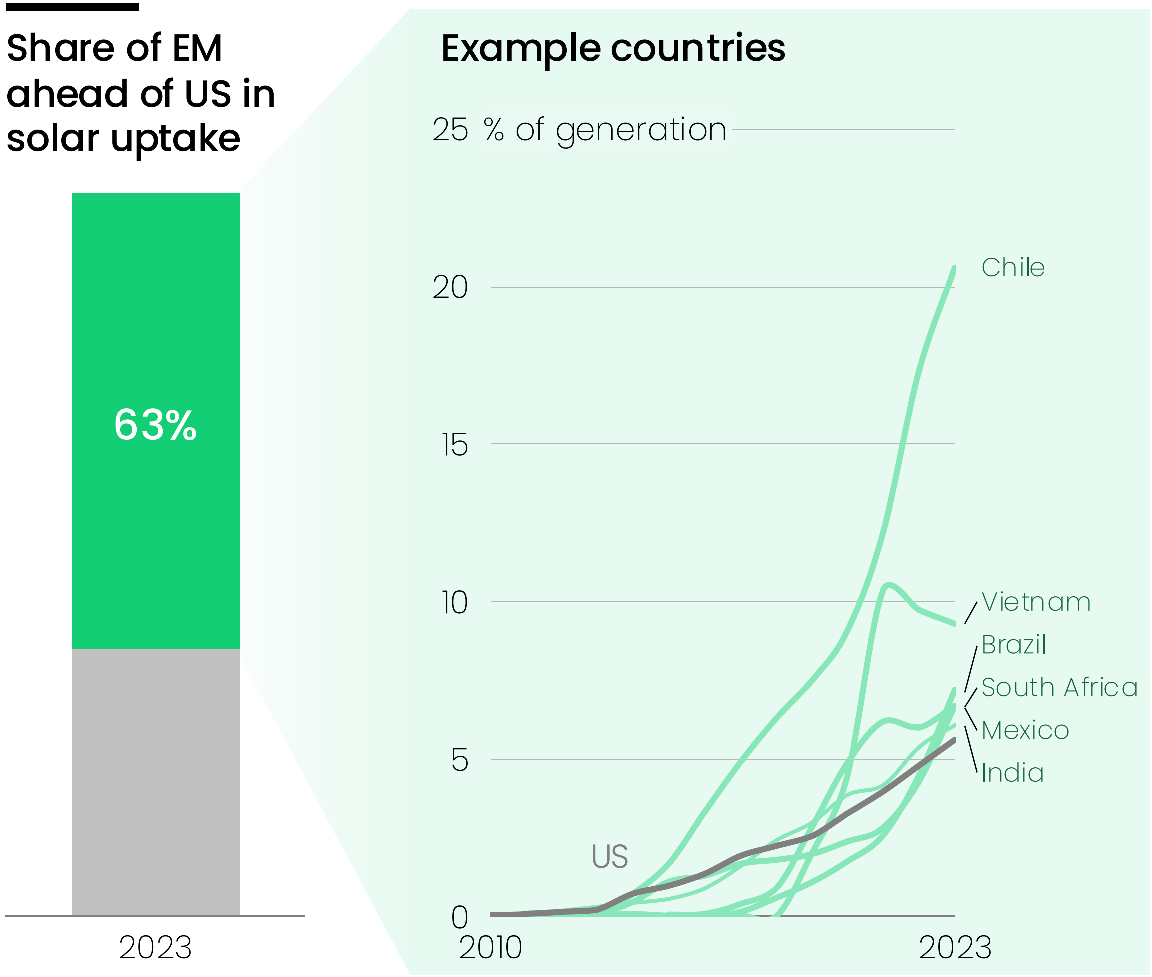
% of final energy

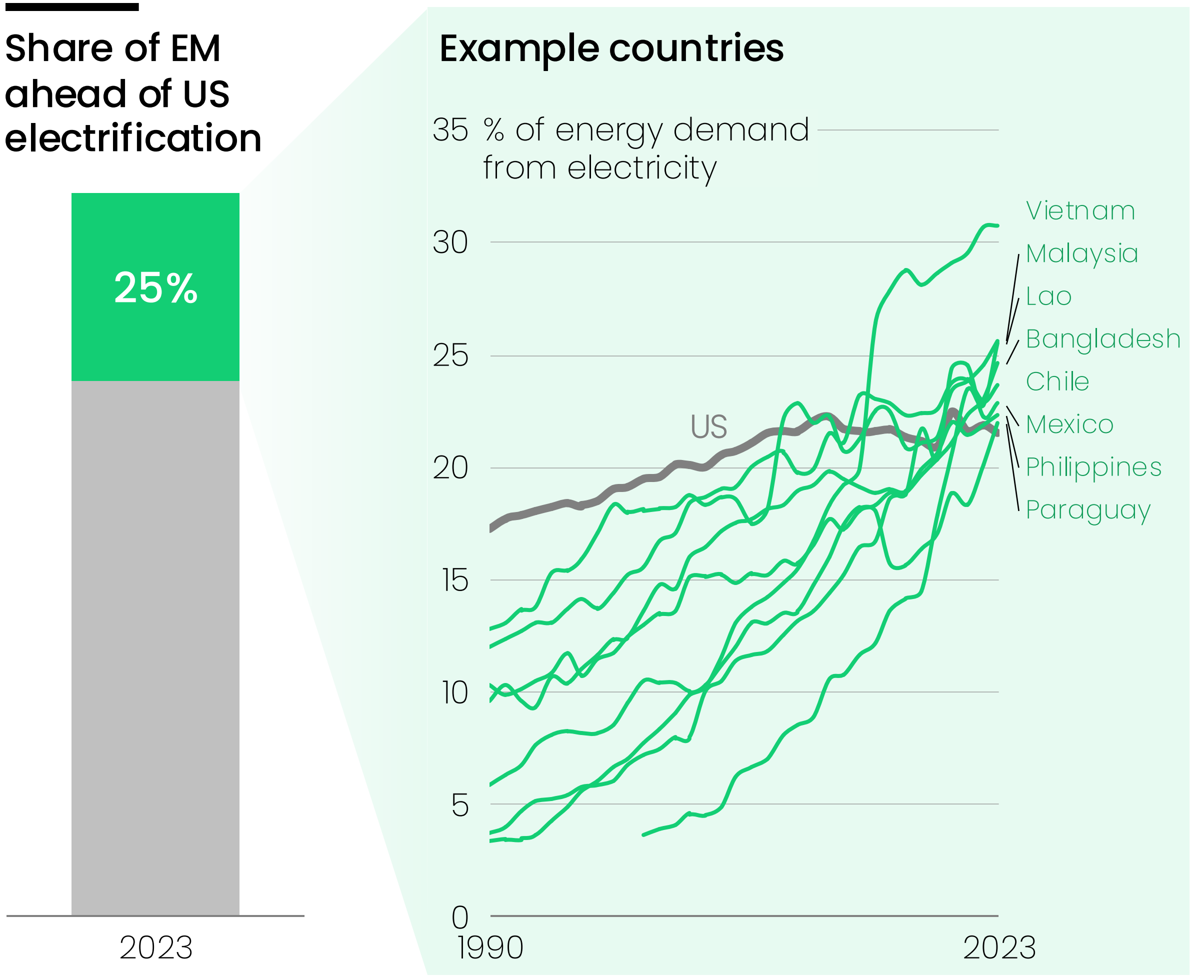


Sources: Ember, IEA WEB, IRENA, BNEF, NYT.

Emerging markets are leapfrogging

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



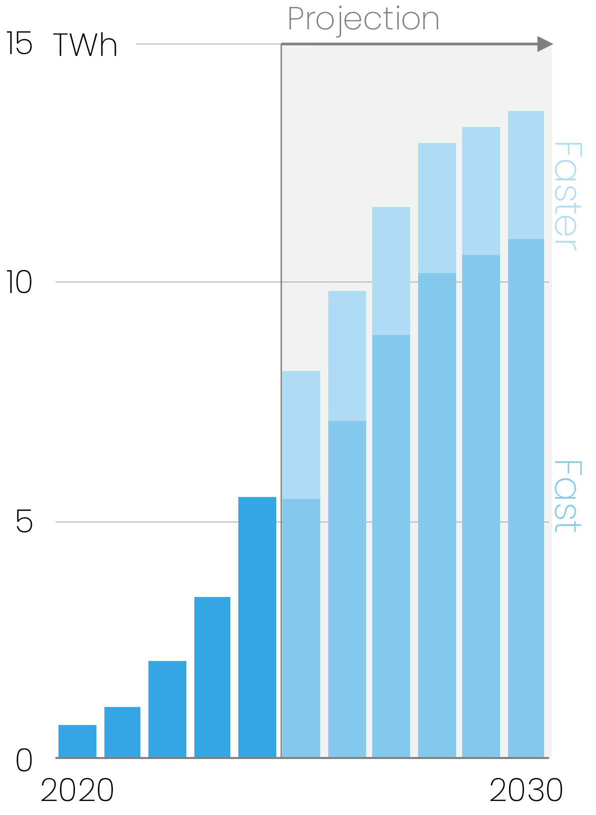


Sources: IEA; Ember analysis – Emerging markets (EM) defined as Latin America, Africa, South Asia and Southeast Asia and do not include the petroregions. Share of emerging markets is a share of electricity demand (l) and energy demand (r).

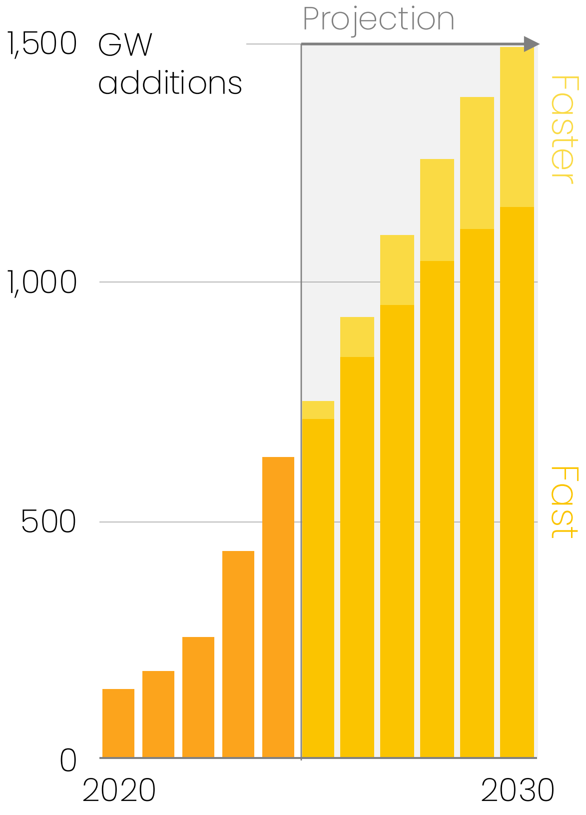
This is the decisive decade

A century in the making, electrotech will define this decade

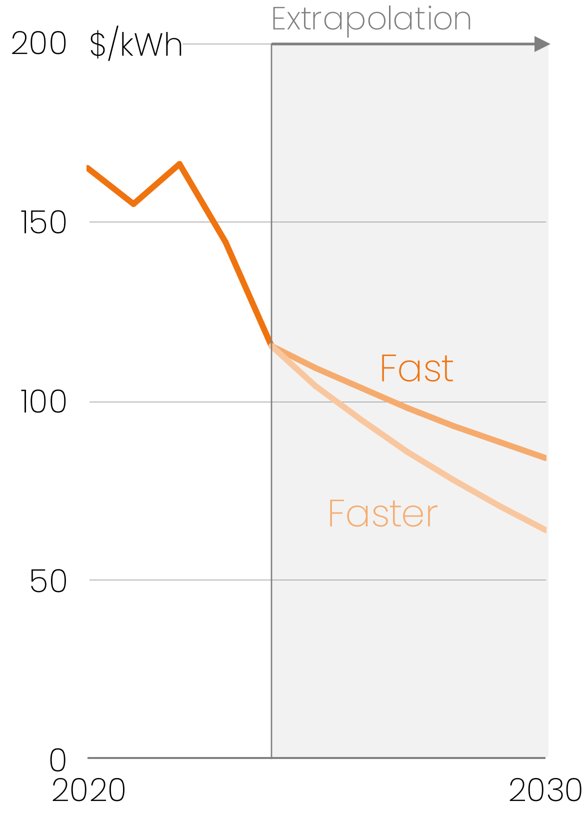
Manufacturing capacity is built: Batteries



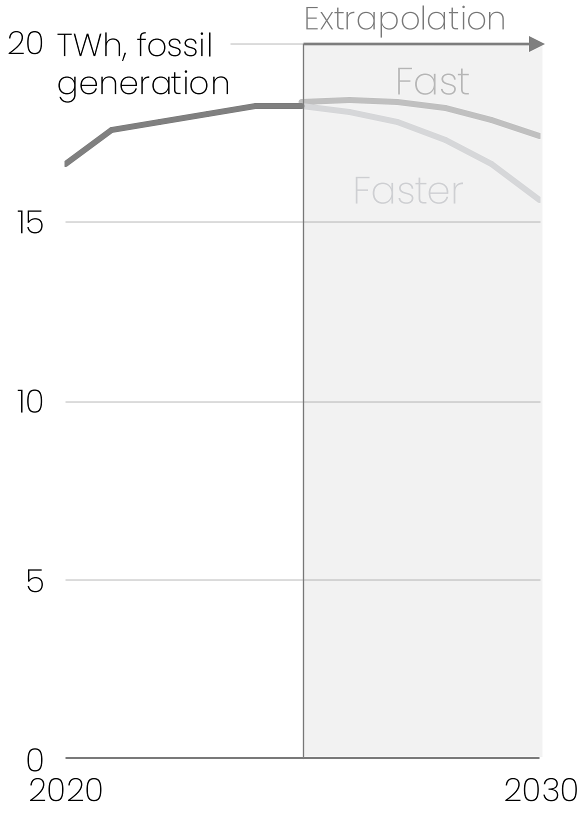
S-curves hit their steepest parts: Solar



Electrotech get too cheap to resist: Batteries



Fossil fuel demand enters terminal decline

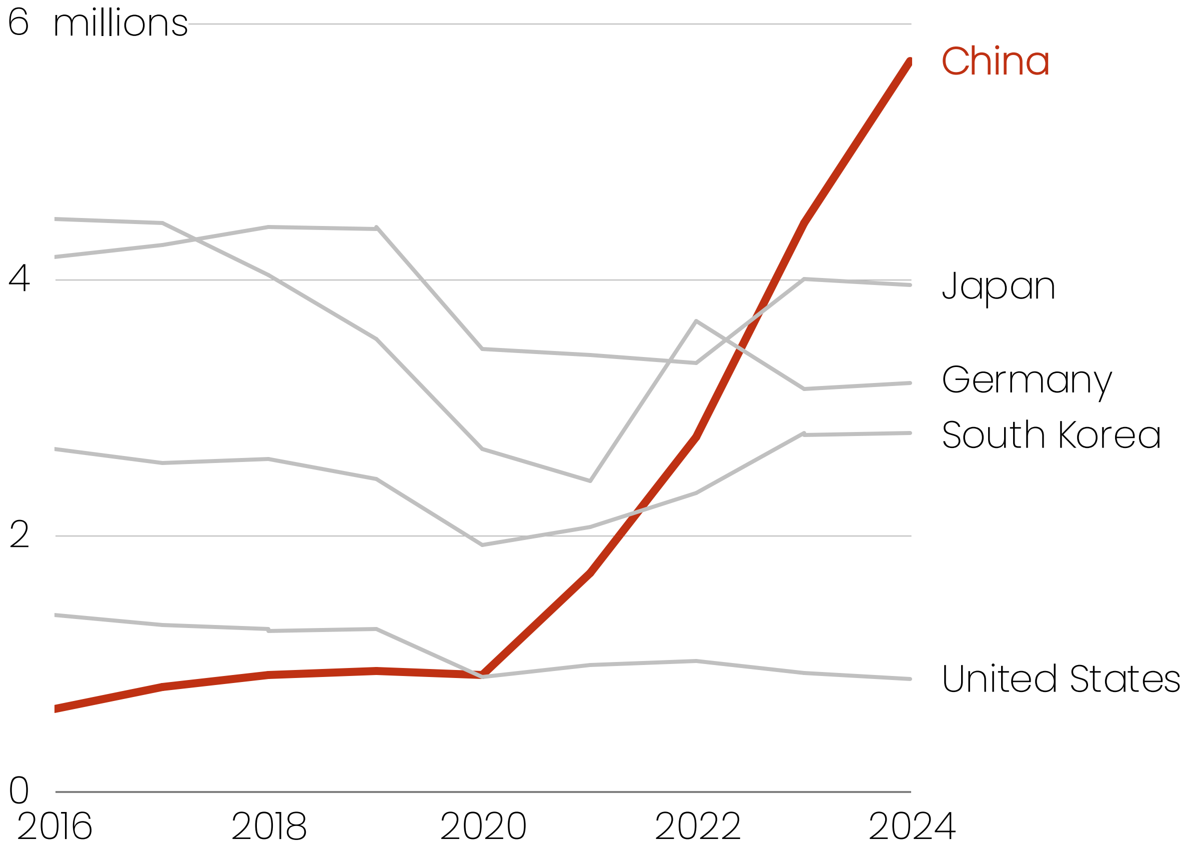


Sources: BNEF, RMI, Ember Futures extrapolation for fossil fuel demand, assuming 3% growth in electricity demand and 15-20% growth in solar and wind supply

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

Sources: Alix Partners, NYT, OICA, Wikipedia • Note: 2024 values are estimated.

EMBER

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**?

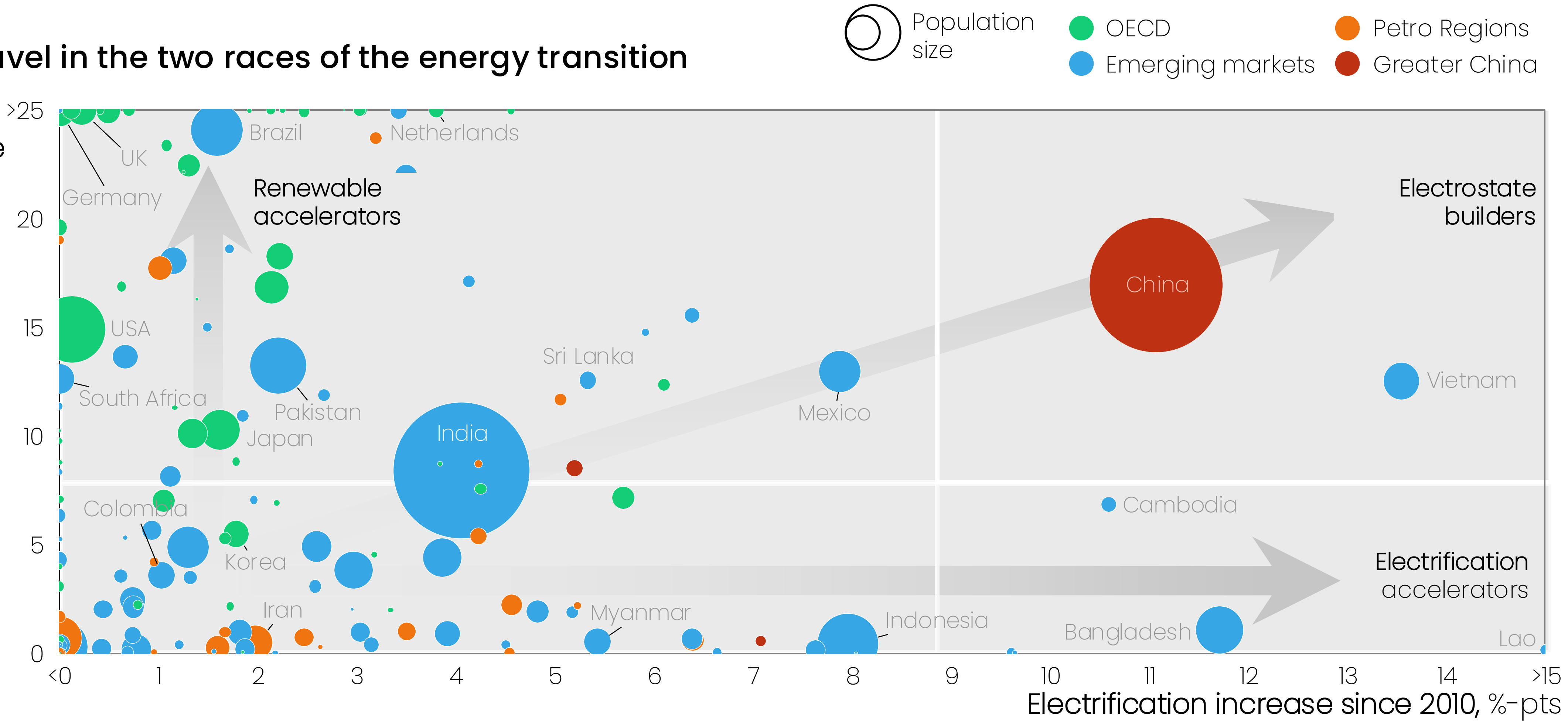
Geopolitics

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

The electrification imperative

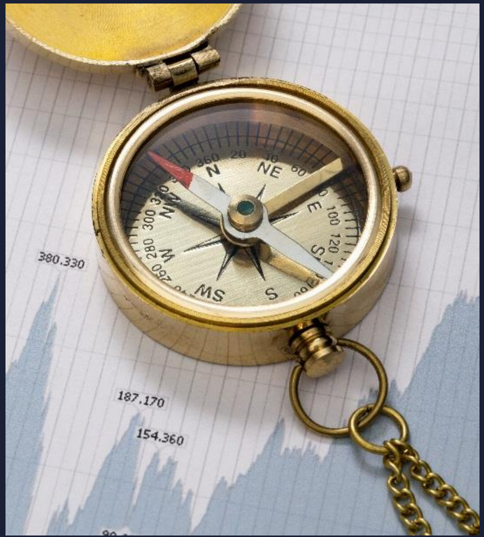
Many countries are building renewables; few an electrostate

Direction of travel in the two races of the energy transition



Sources: IEA WEB; Ember; Ember analysis • Note: Shown values cut off at 0-25% for wind & solar and 0-15% for electrification rates

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 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.

Acknowledgements

Data visualisation: Chelsea Bruce-Lockhart, Reynaldo Dizon.
Data: Sam Hawkins, Euan Graham, Nicolas Fulghum.
Strategy: Phil MacDonald, Harry Benham, Bryony Worthington, Dave Jones, Kostantsa Rangelova, Richard Black.
Communications: Hannah Broadbent, Ardhi Arsala Rahmani, Rashmi Mishra, Rini Sucahyo.
Asia team: Aditya Lolla, Muyi Yang, Dinita Setyawati, Ruchita Shah.

With thanks to: Arthur Downing, Assaad Razzouk, Amory Lovins, Bill McKibben, Bruce Douglas, Chris Goodall, Freya Newman, Greg De Temmerman, Hannah Ritchie, Hauke Engel, Jon Hansen, Jules Kortenhorst, Kate Bassett, Leonardo Buizza, Liza Rubinstein, Mark Campanale, Maria Pastukhova, Michael Collins, Michael Seckler, Mike Hemsley, Nigel Topping, Paul Dickinson, Tom Steyer.

Cover image: NanoStockk, Getty images

Authors

Daan Walter
Sam Butler-Sloss
Kingsmill Bond, CFA

EMBER