EMBER

The Electric Fast Track

Presentation to CVF

Daan Walter

March 13th, 2026

Contents

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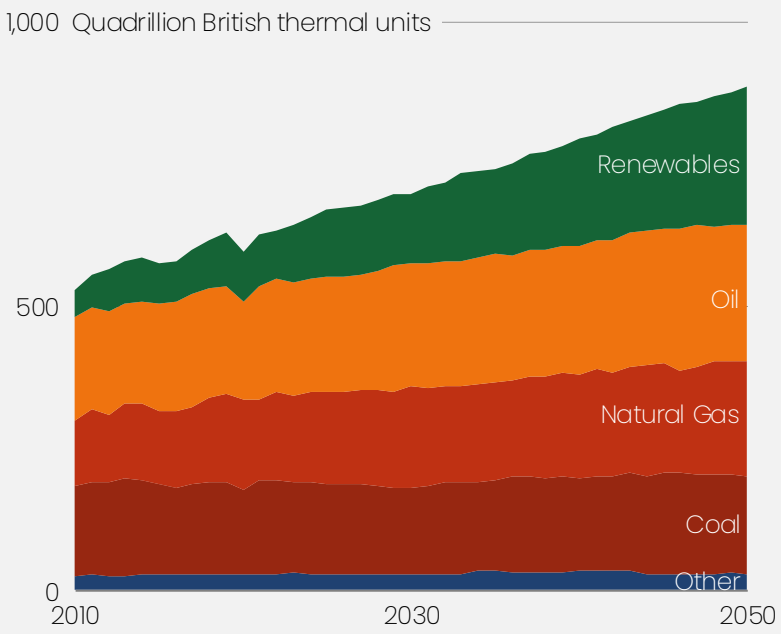
Two views on energy dominate the conversation.

The dominant energy views in the energy debate today

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

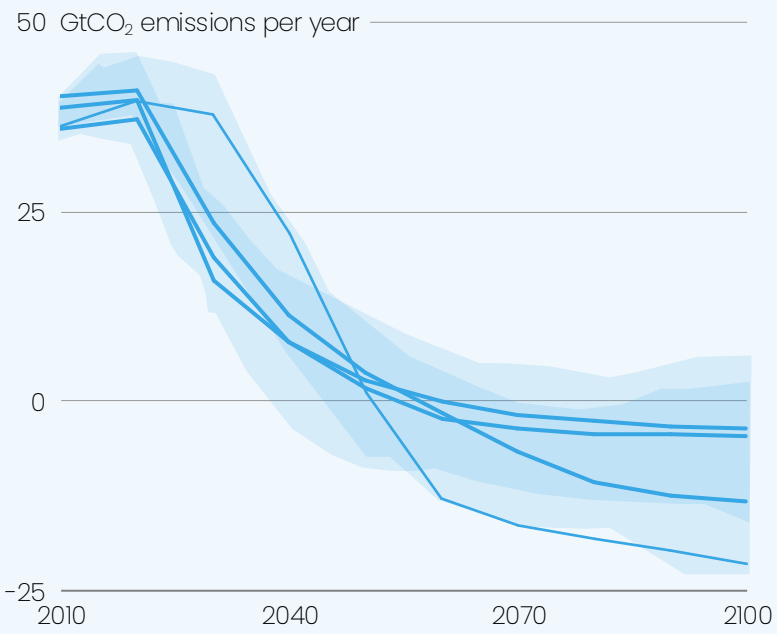
EIA – Primary energy supply



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)

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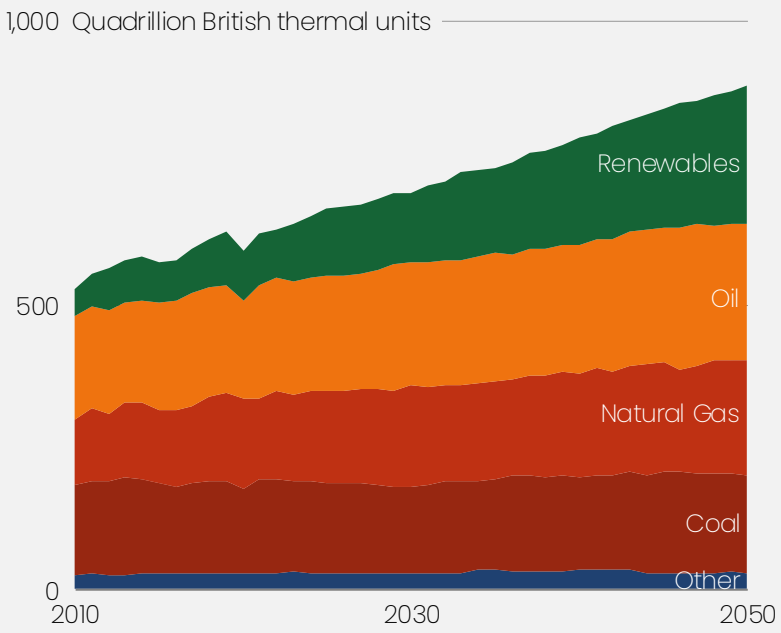
Two views on energy dominate the conversation. We propose a third

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



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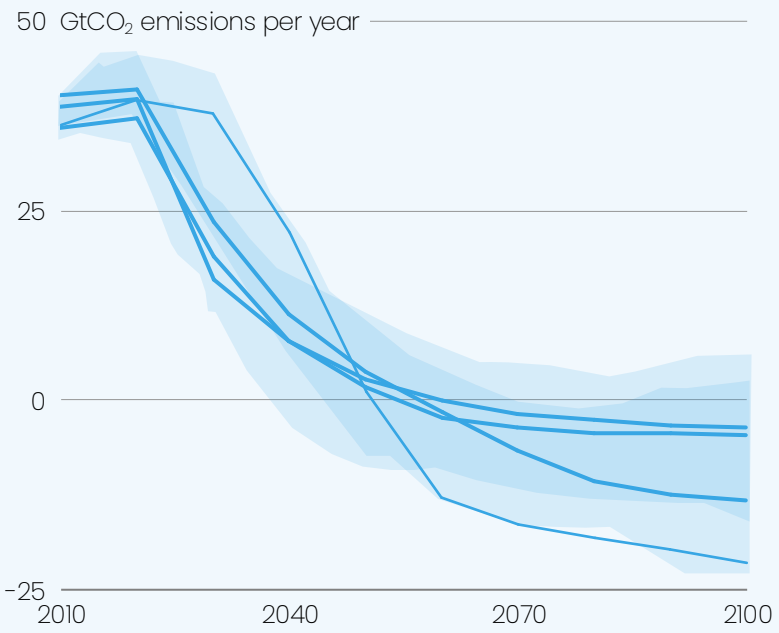
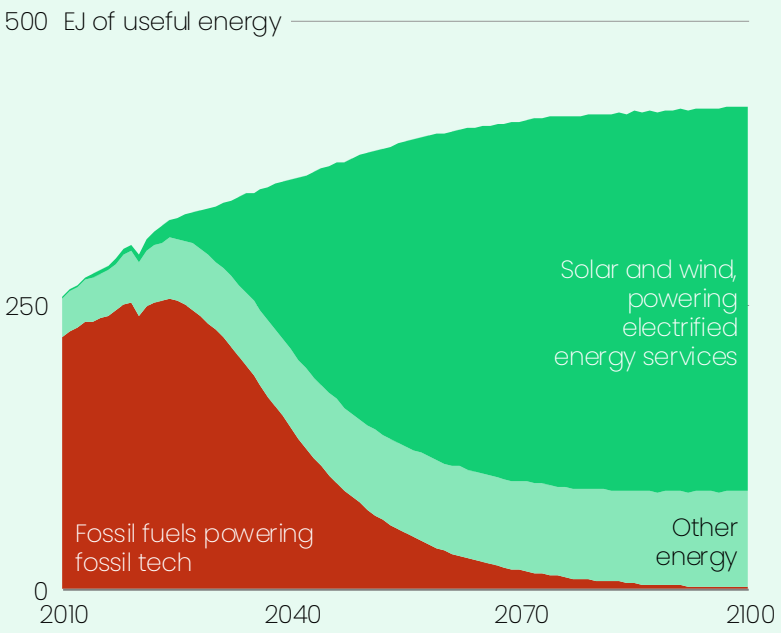


Source: Intergovernmental Panel on Climate Change (IPCC)

A third way: the electrotech view

The new electrotech view, centred on growth and innovation

Rystad – Global useful energy demand



Source: Rystad Energy

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This is a technology revolution in energy

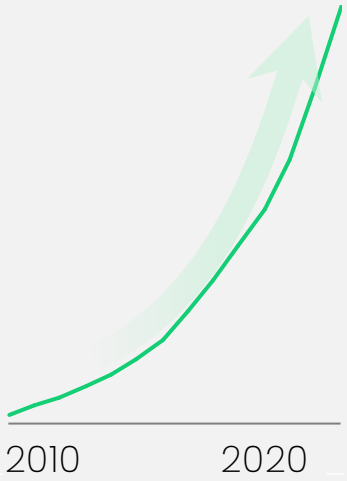
Electrotech is technology that revolutionises the supply, connection and demand of electricity

Supply

New ways to generate electricity

Renewables as vectors of change

Solar PV
deployment (GW)



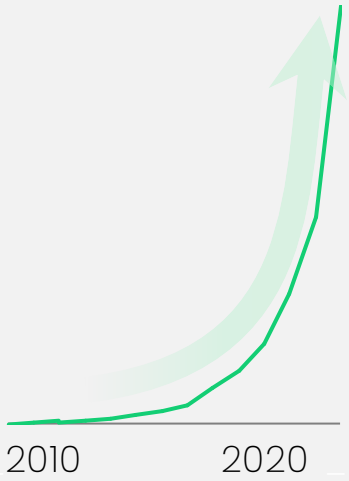
Wind
deployment (GW)

Connections

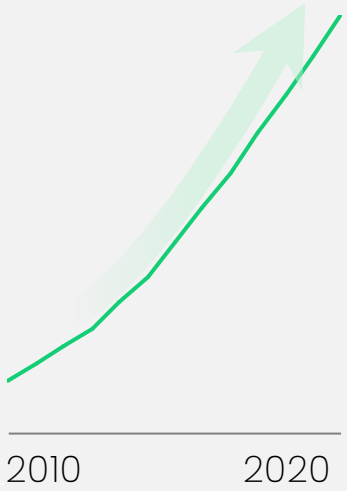
New ways to transport and store electricity

Flextech/gridtech as vectors of change

Battery storage
deployment



HVDC lines
deployment (km)

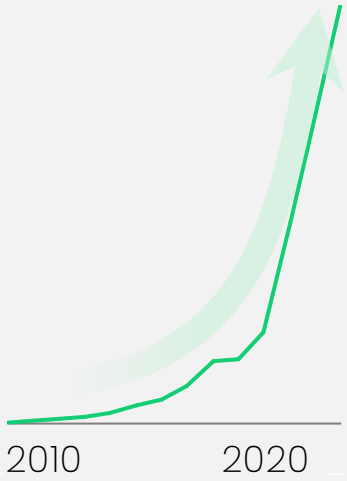


Demand

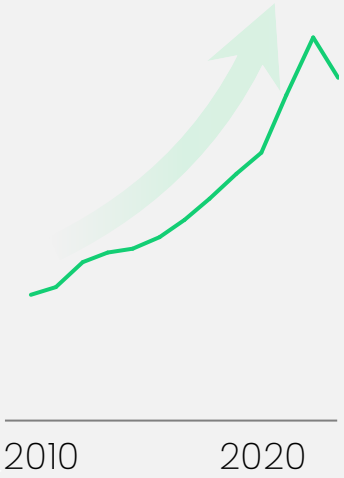
New ways to use electricity

Electrification as vector of change

EV
sales



Heat pumps
sales



Sources: Ember, IEA, RMI, Thunder Said

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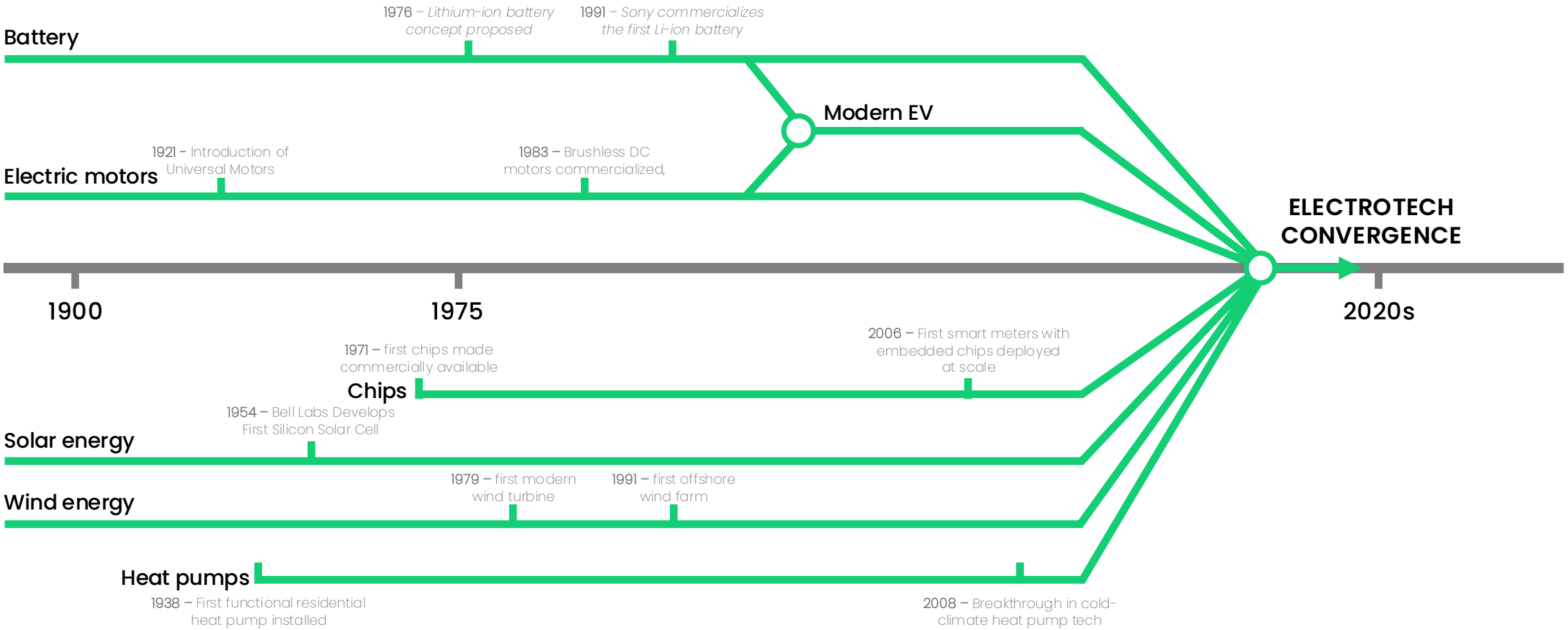
It’s been a long time coming

A century of evolution is converging into a decade of revolution

ILLUSTRATIVE



Source: Ember

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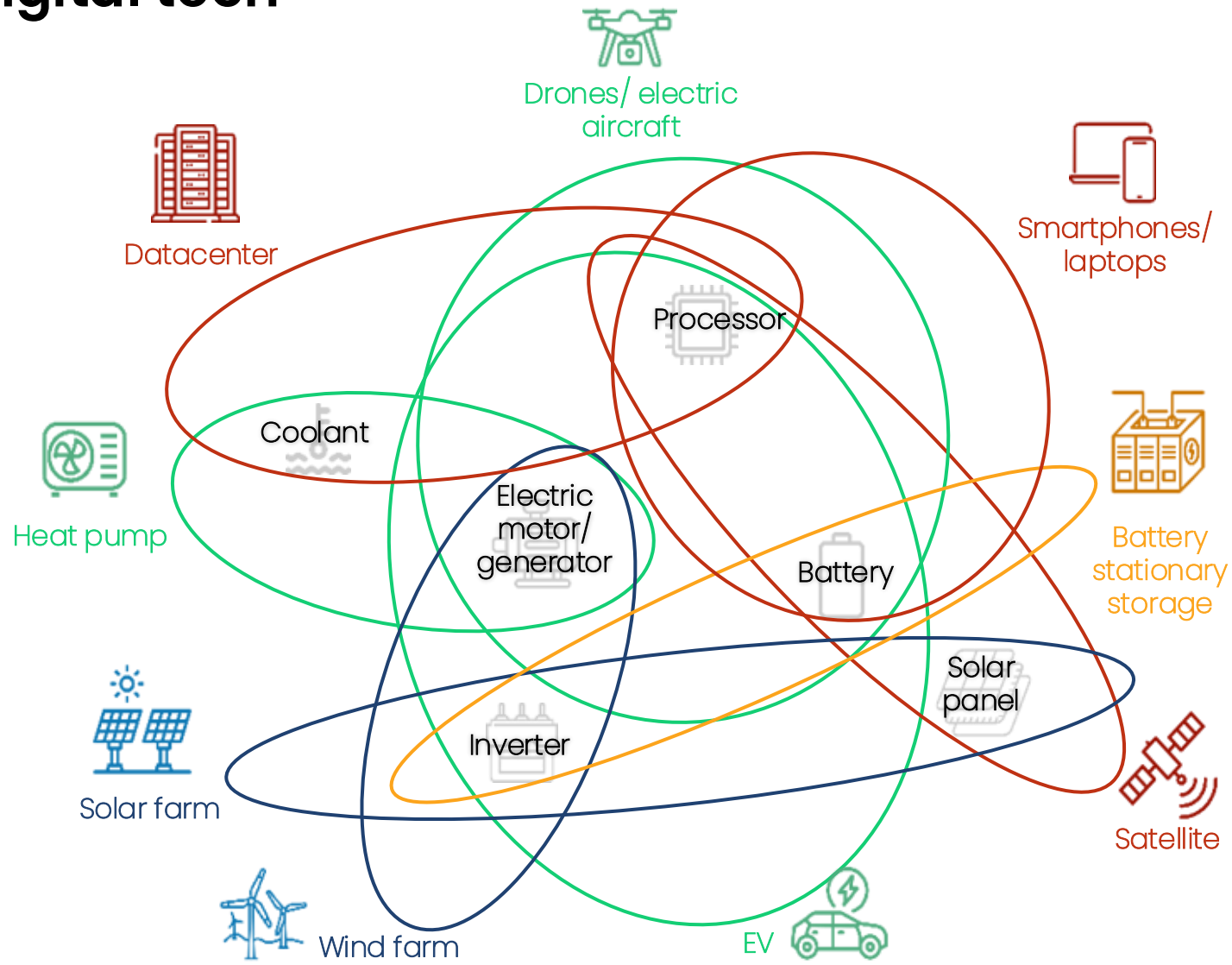
Electrotech is the child of digital tech

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



Source: Ember analysis

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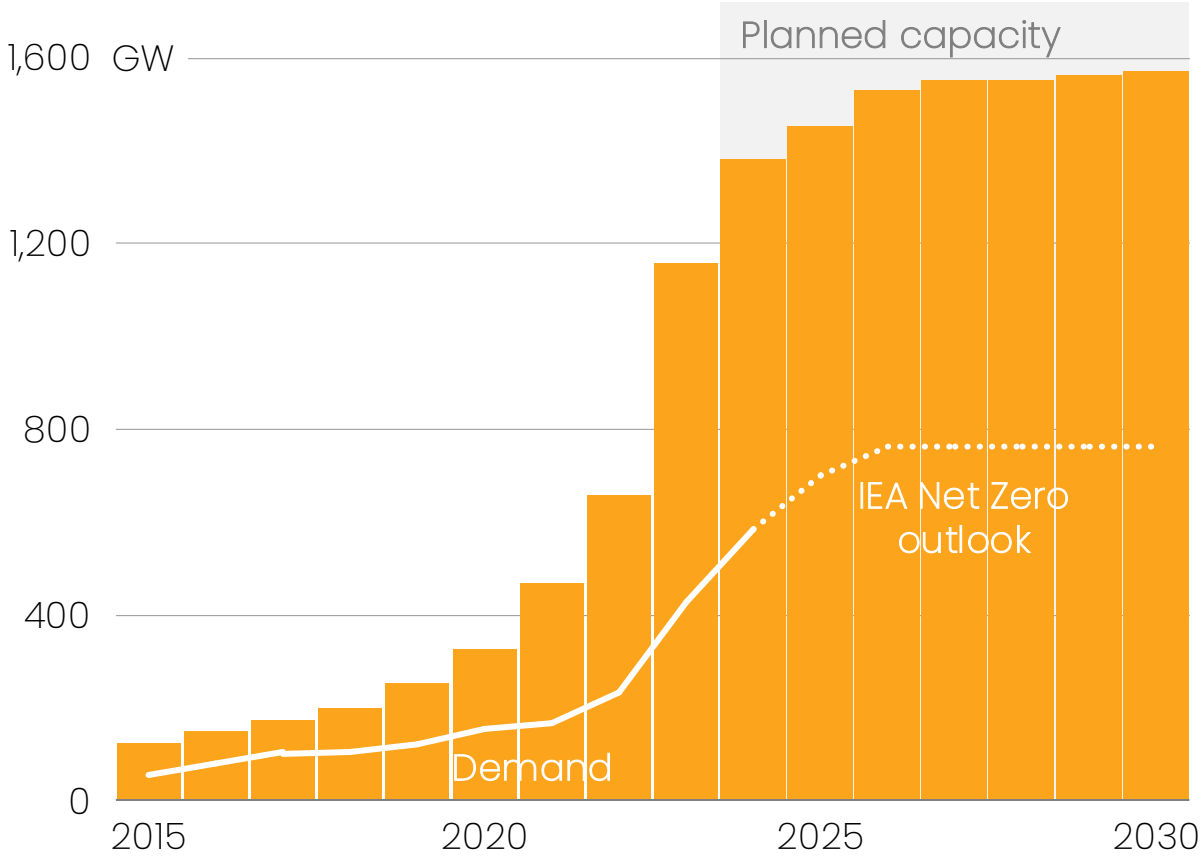
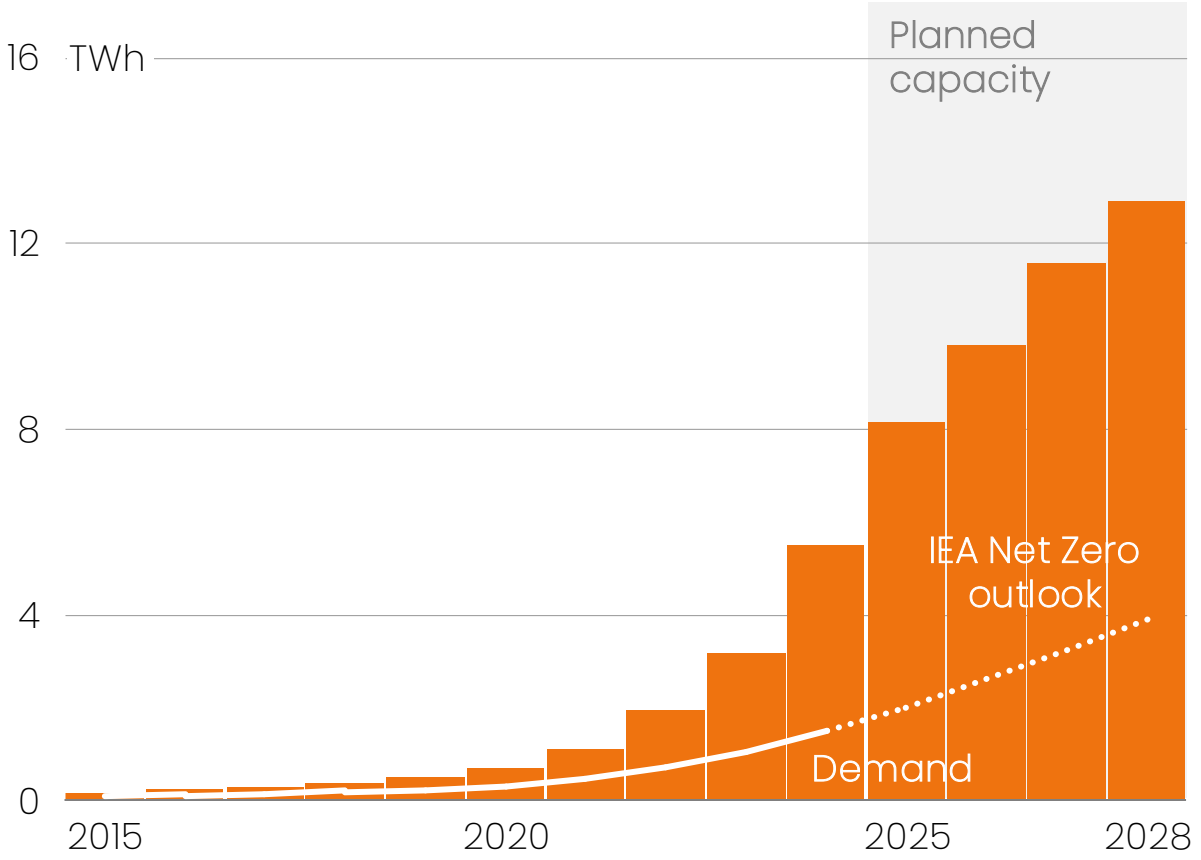
The manufacturing capacity is in place

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.

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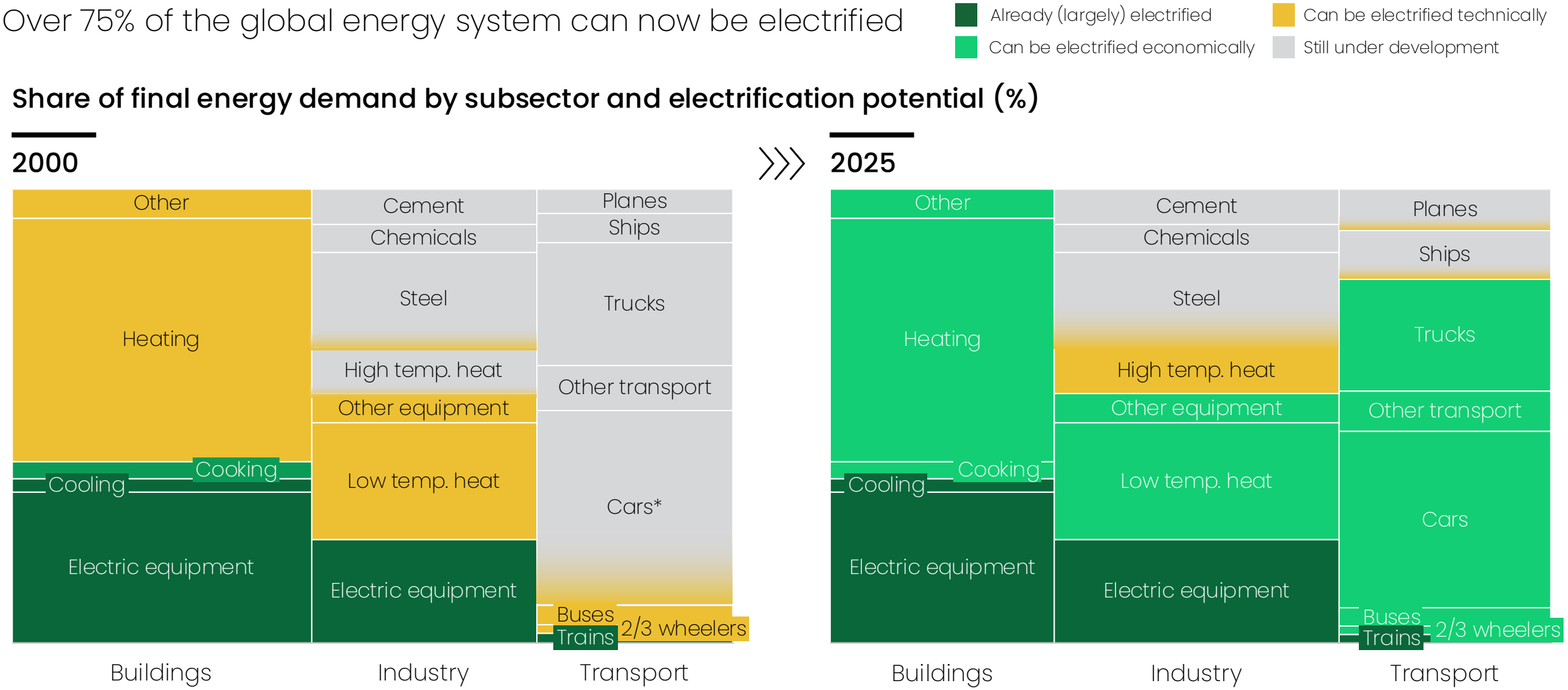
The ceiling is high and rising

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



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

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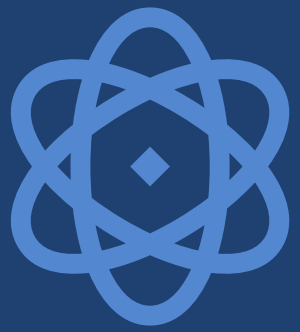
Three fundamental drivers of change

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

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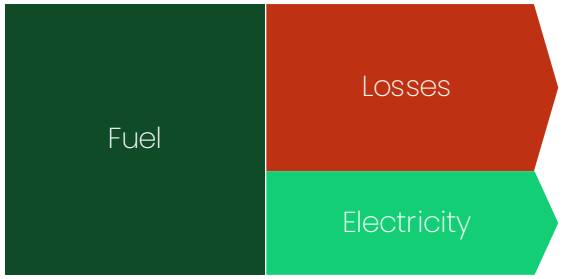
Electrotech is 3x more efficient

It offers a leap in energy efficiency across the economy

Supply

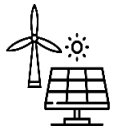
Electricity generation

Fossil thermal



30-40% efficiency

Wind & solar

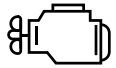


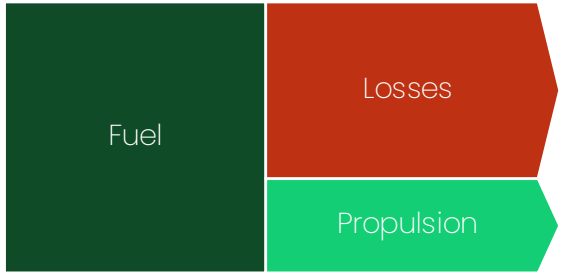
100% efficiency

Demand

Transport

Internal combustion engine





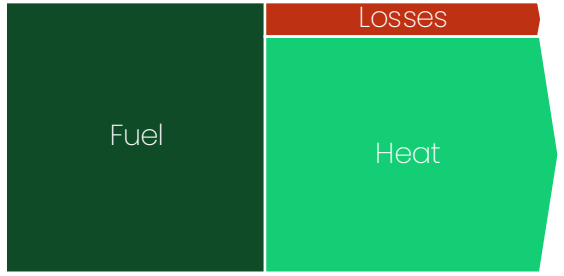
25-40% efficiency

Electric vehicles

80-90% efficiency

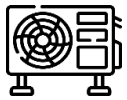
Heating

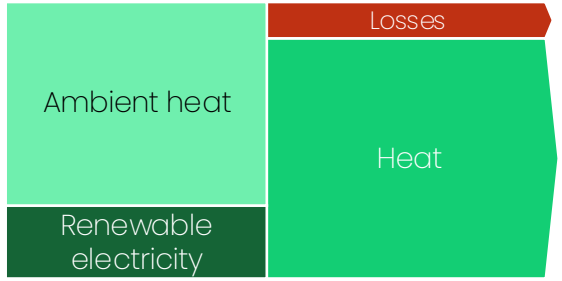
Gas boiler



85% efficiency

Heat pumps





300-400% efficiency

2-3x
as efficient

2-4x
as efficient

3-4x
as efficient

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

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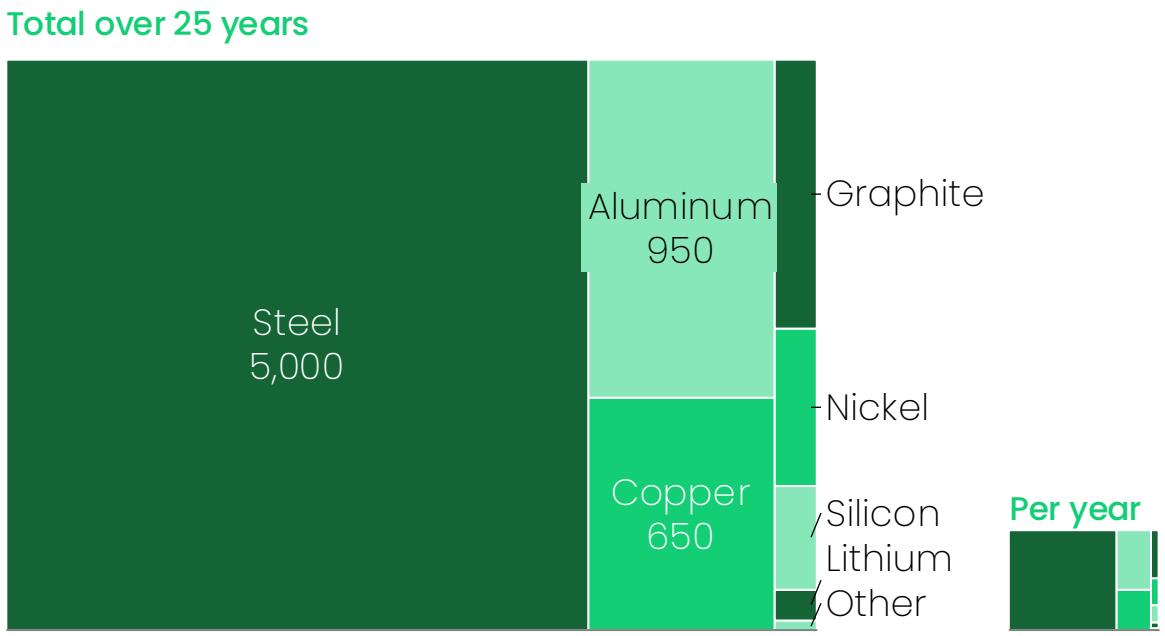
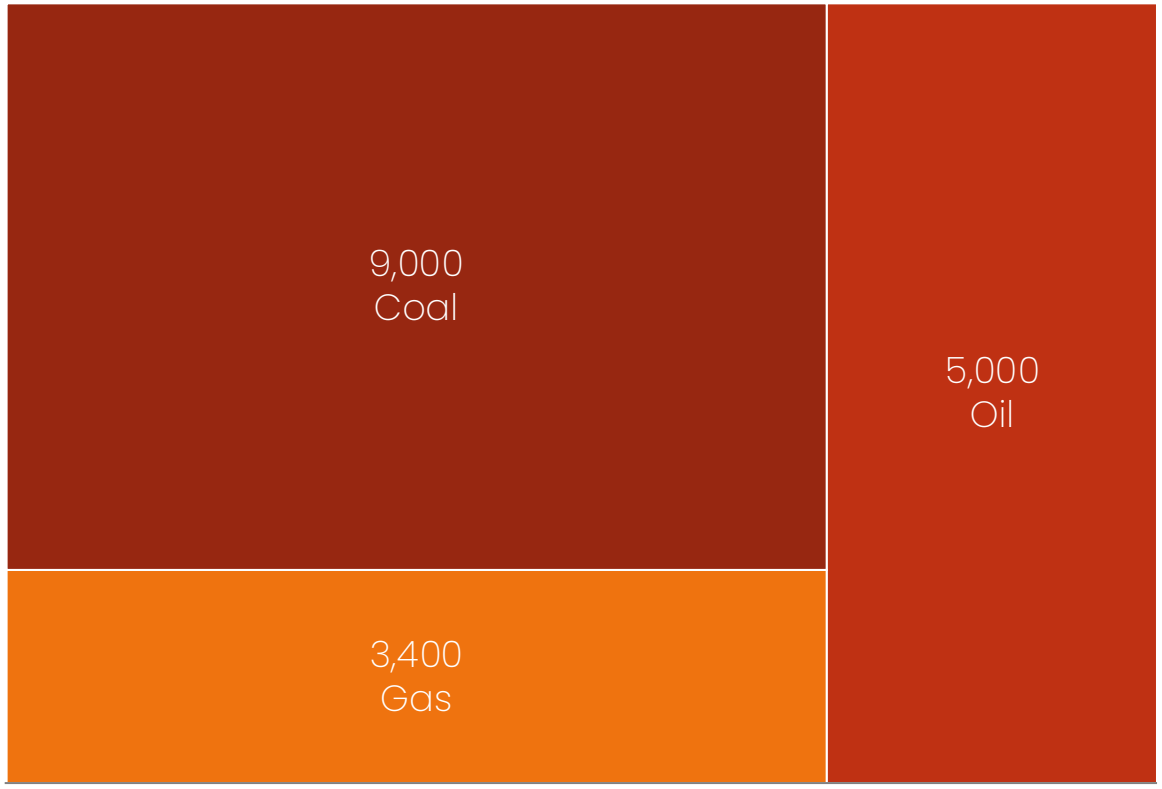
The unbearable heaviness of the fossil fuel system

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



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



Sources: ETC; EI; Ember analysis

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Three fundamental drivers of change

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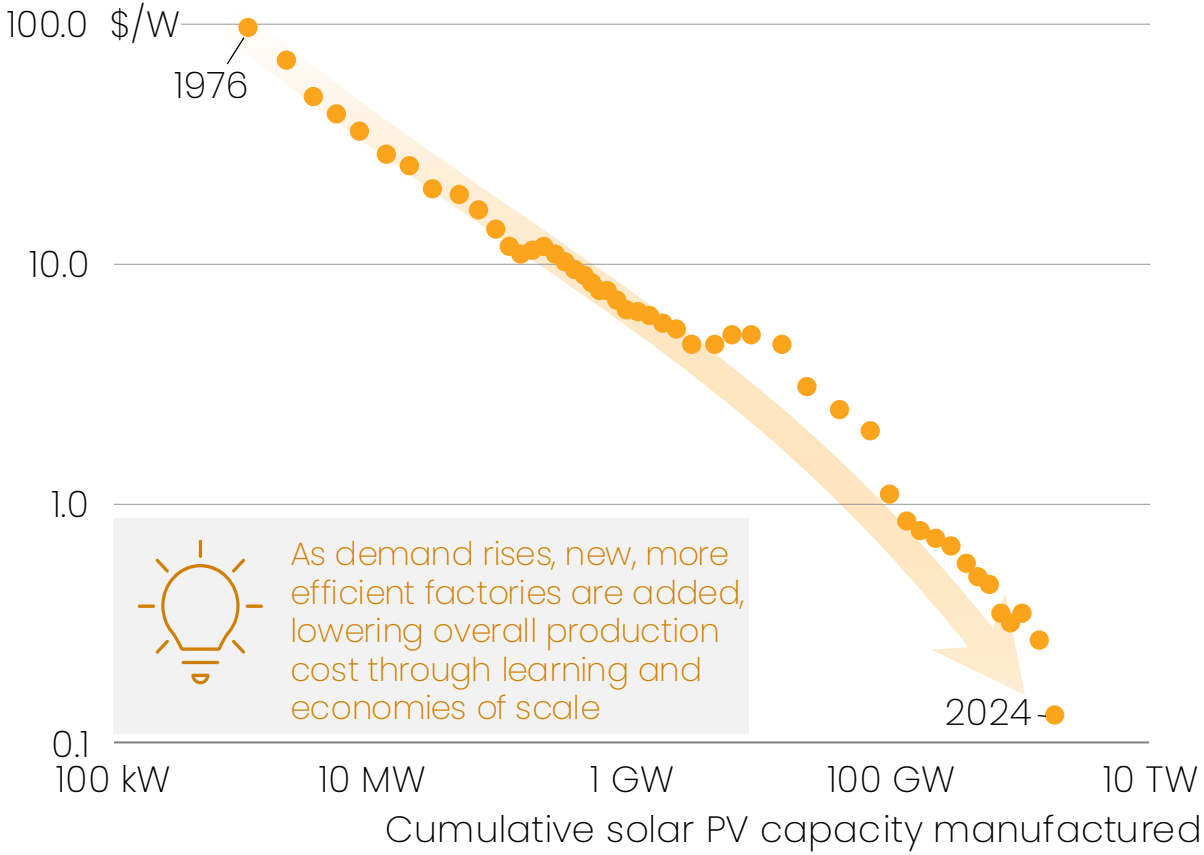
Learning beats digging

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

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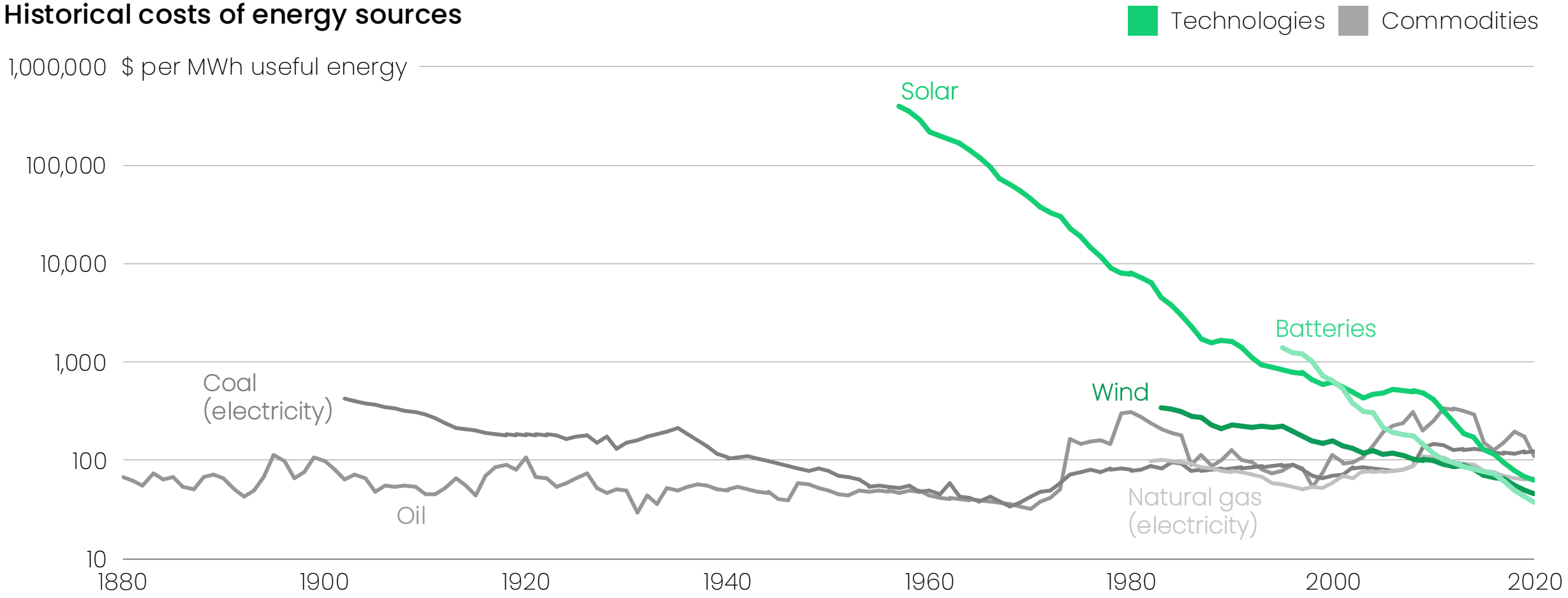
Technologies beat commodities on cost

Electrotech is the triumph of brain over brawn

Historical costs of energy sources



Sources: Way et al. 2022. Fossil fuel extraction has learning curves but empirically this has been matched by depletion.

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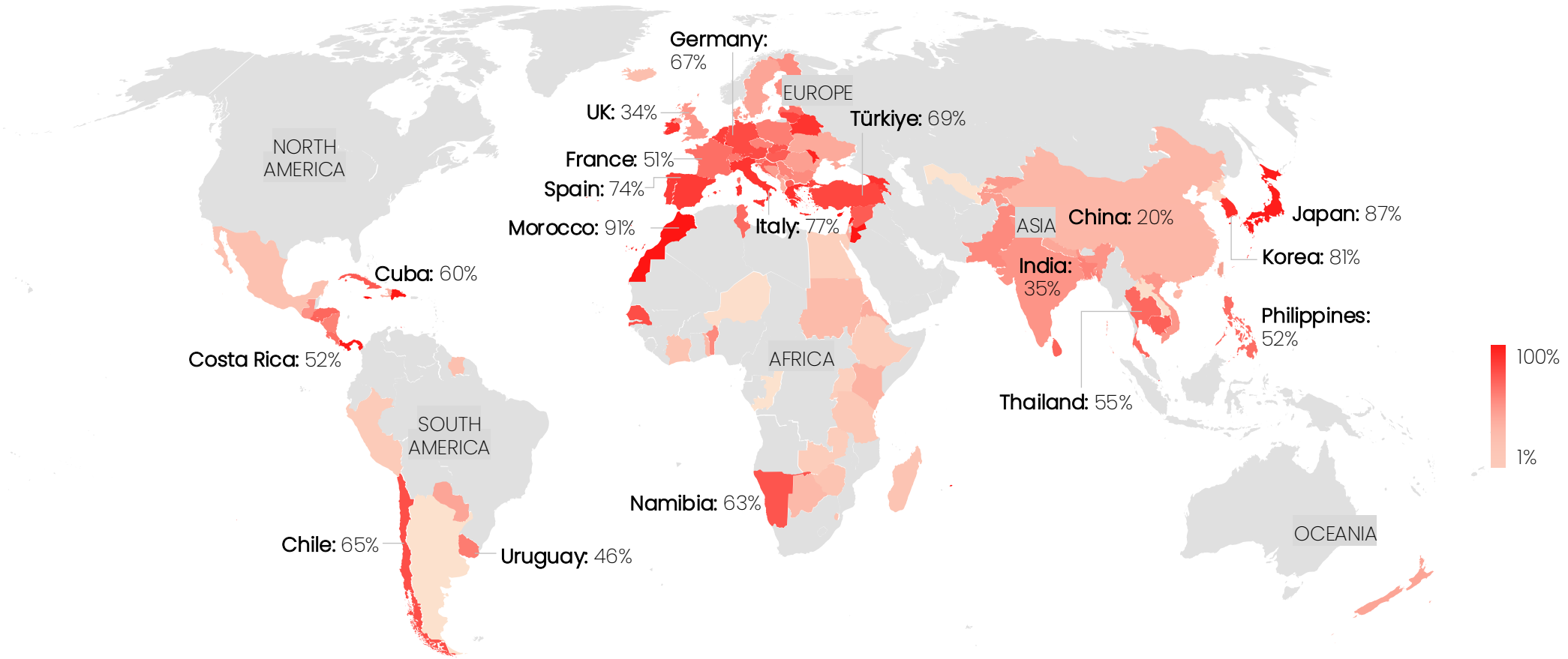
Fossil import dependency is widespread

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.

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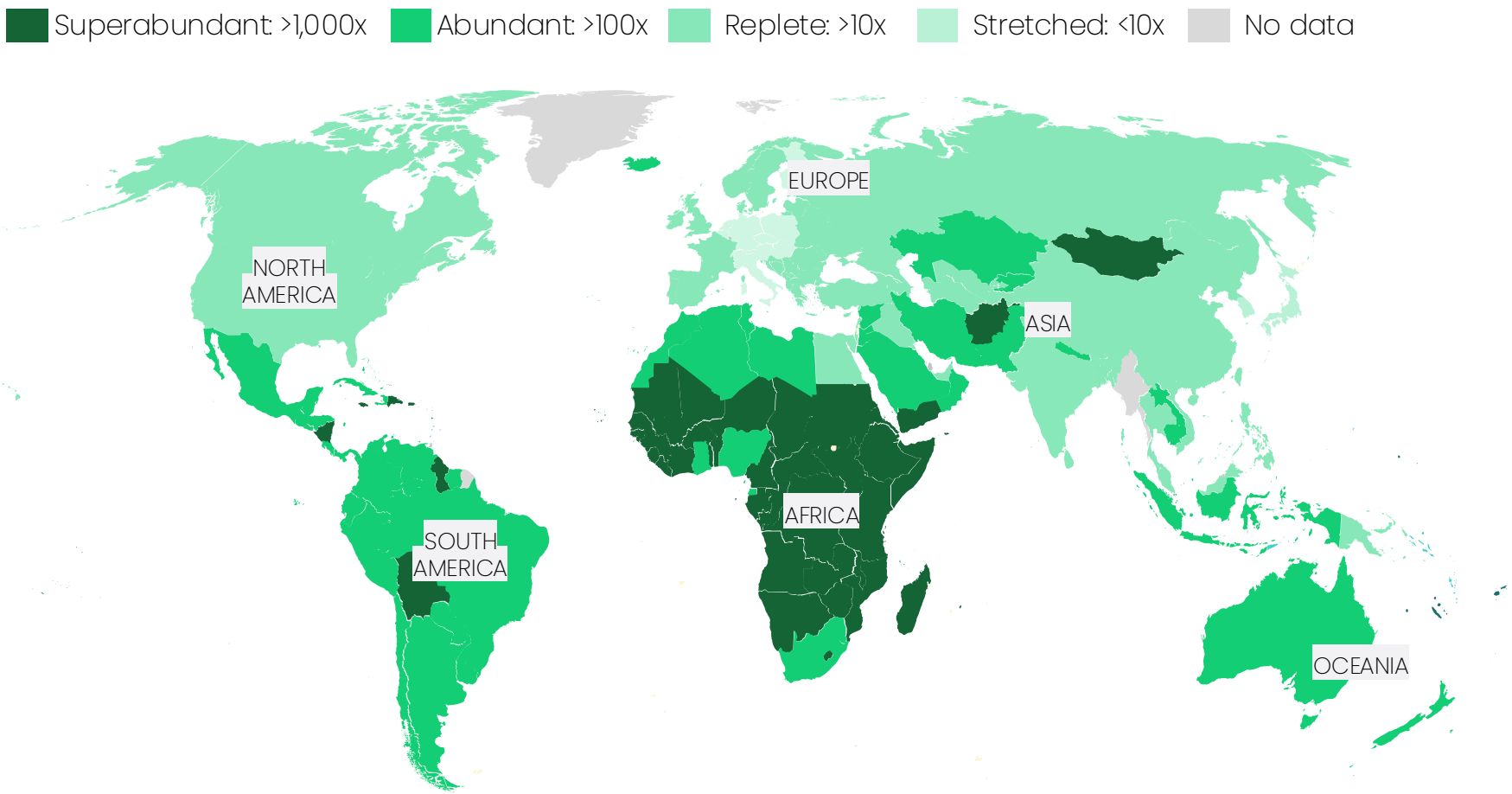
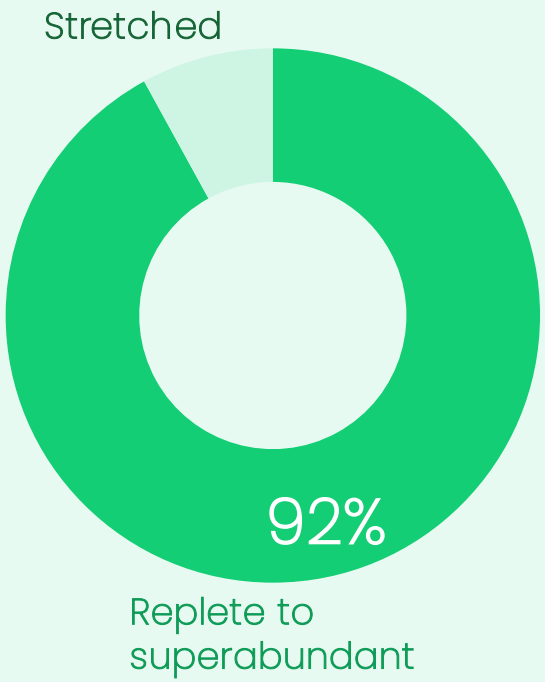
Renewables are available to all

They are 100x bigger than fossil fuels and every country has enough to be self-sufficient

Renewable potential as a multiple of energy demand in 2022



Share of population endowed with replete or better renewable resource



Sources: NREL, Solargis, Jacobson. For more detail see Carbon Tracker – The Sky's the Limit
Map boundaries are from Microsoft Bing and do not imply any judgment on legal status or sovereignty.

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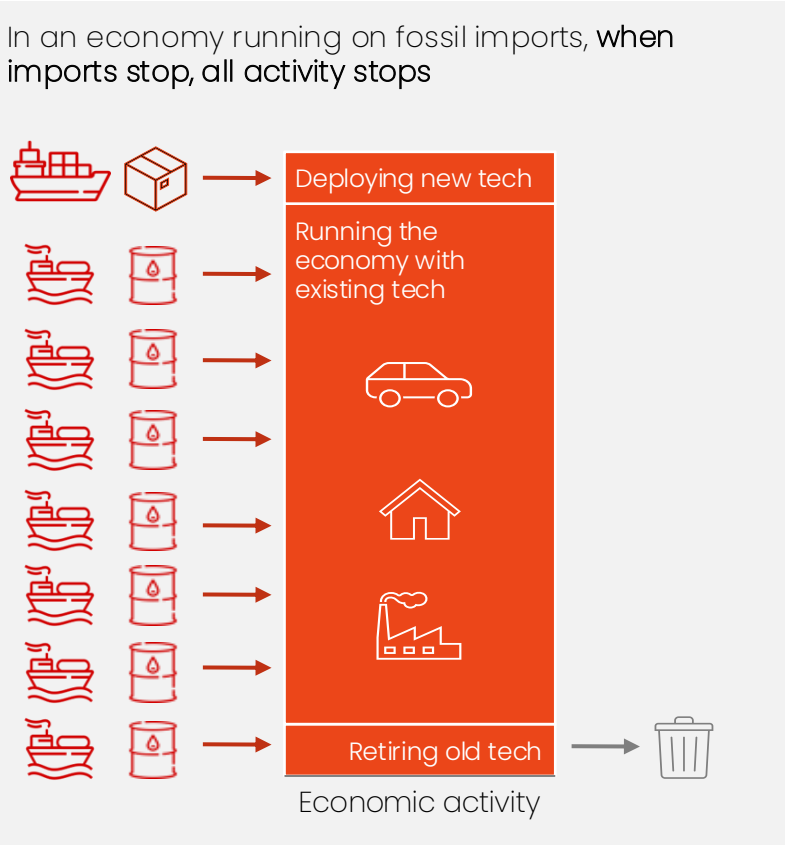
Electrotech offers a path to permanent energy security

When fossil flows stop, the economy stops.

From fossil import dependency…



At immediate risks without imports Not at immediate risk

Sources: Ember• Note: bar sizes are illustrative

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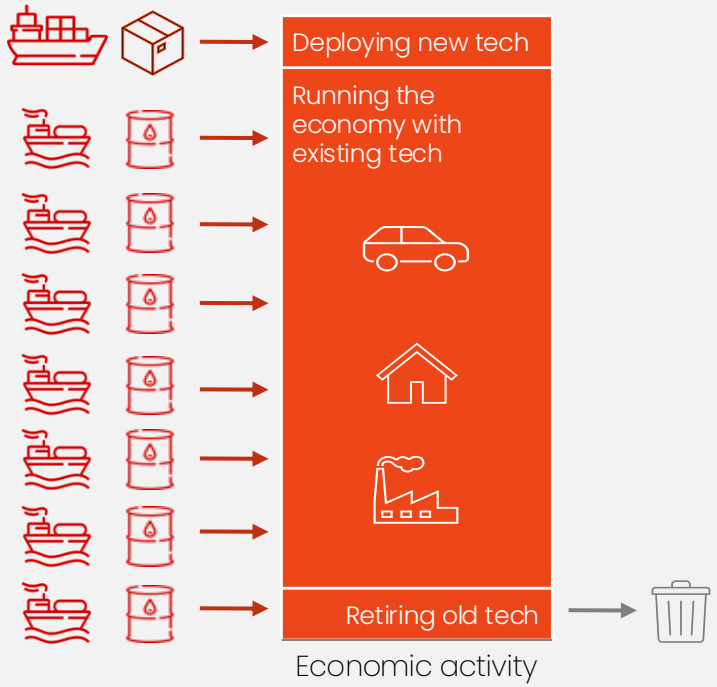
Electrotech offers a path to permanent energy security

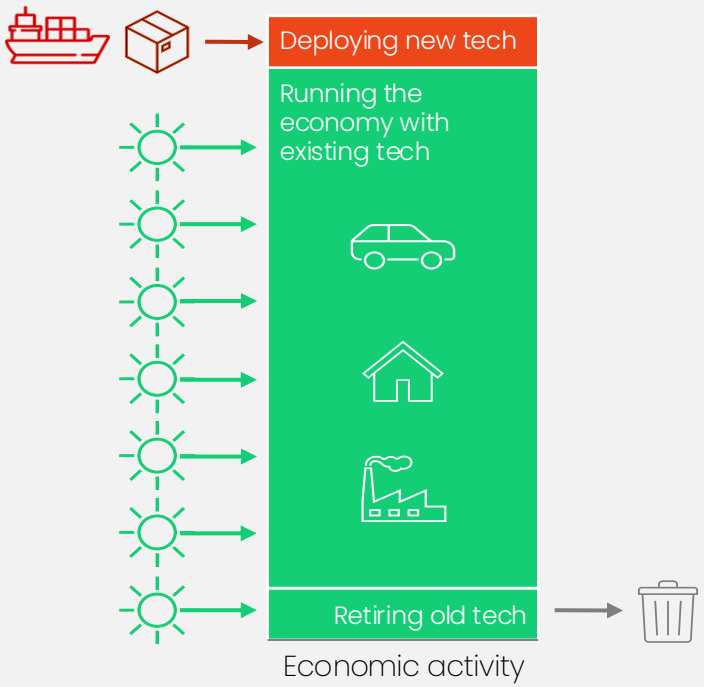
When fossil flows stop, the economy stops. When electrotech flows stop, only growth is at risk

From fossil import dependency… → **…to electrotech import dependency…**

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.**



At immediate risks without imports

Not at immediate risk

Sources: Ember• Note: bar sizes are illustrative

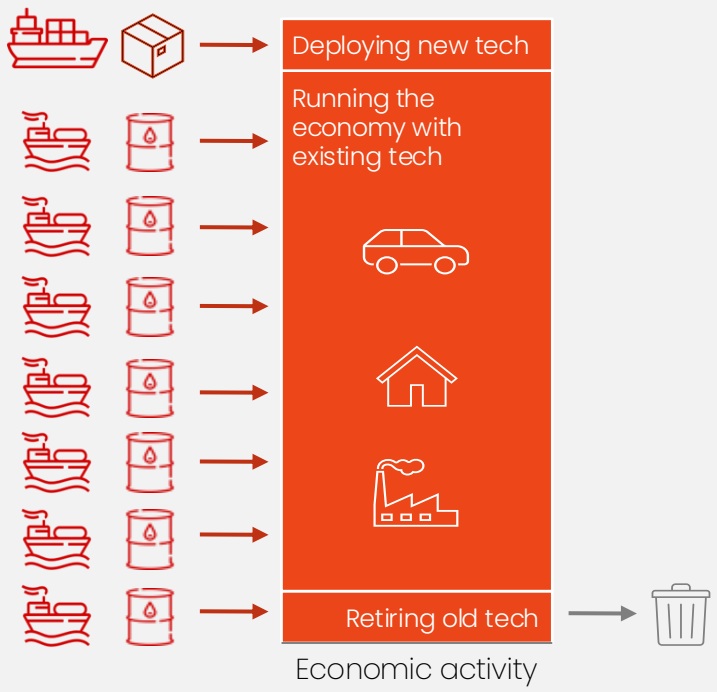
EMBER

Electrotech offers a path to permanent energy security

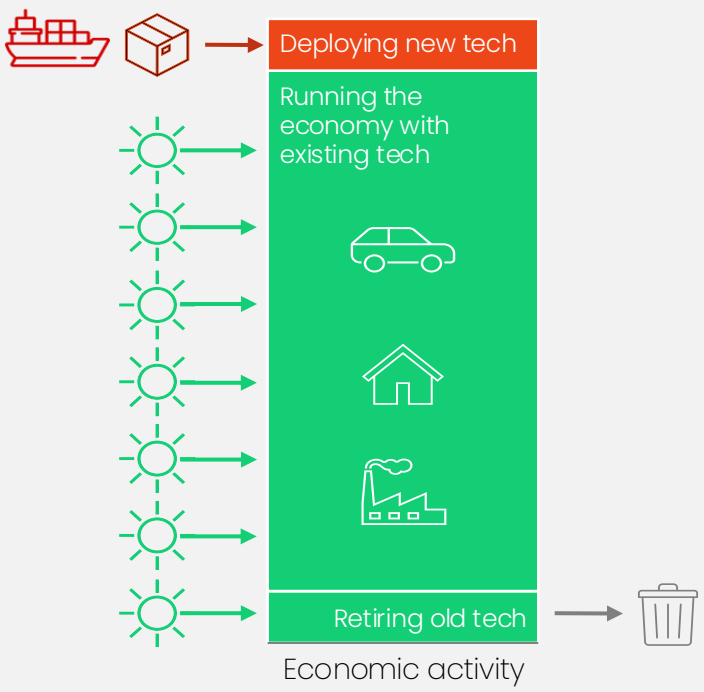
When fossil flows stop, the economy stops. When electrotech flows stop, only growth is at risk

From fossil import dependency… → **…to electrotech import dependency…** → **…to full circular energy independence.**

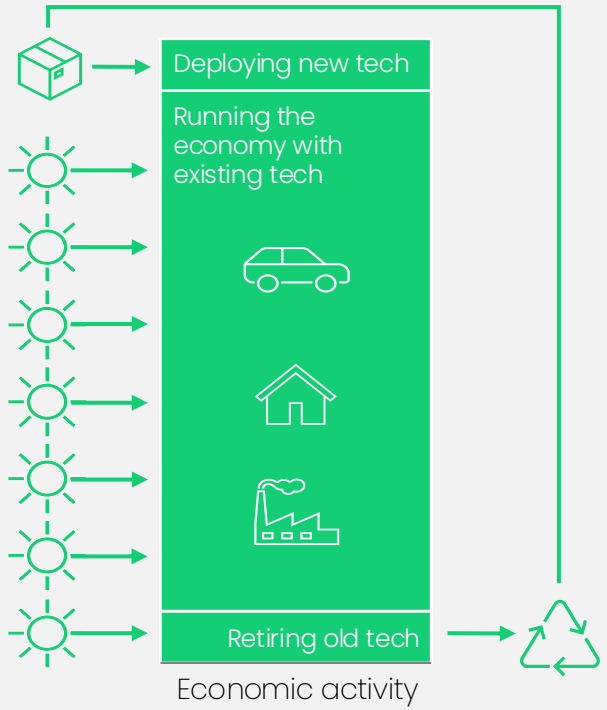
In an economy running on fossil imports, **when imports stop, all activity stops**



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

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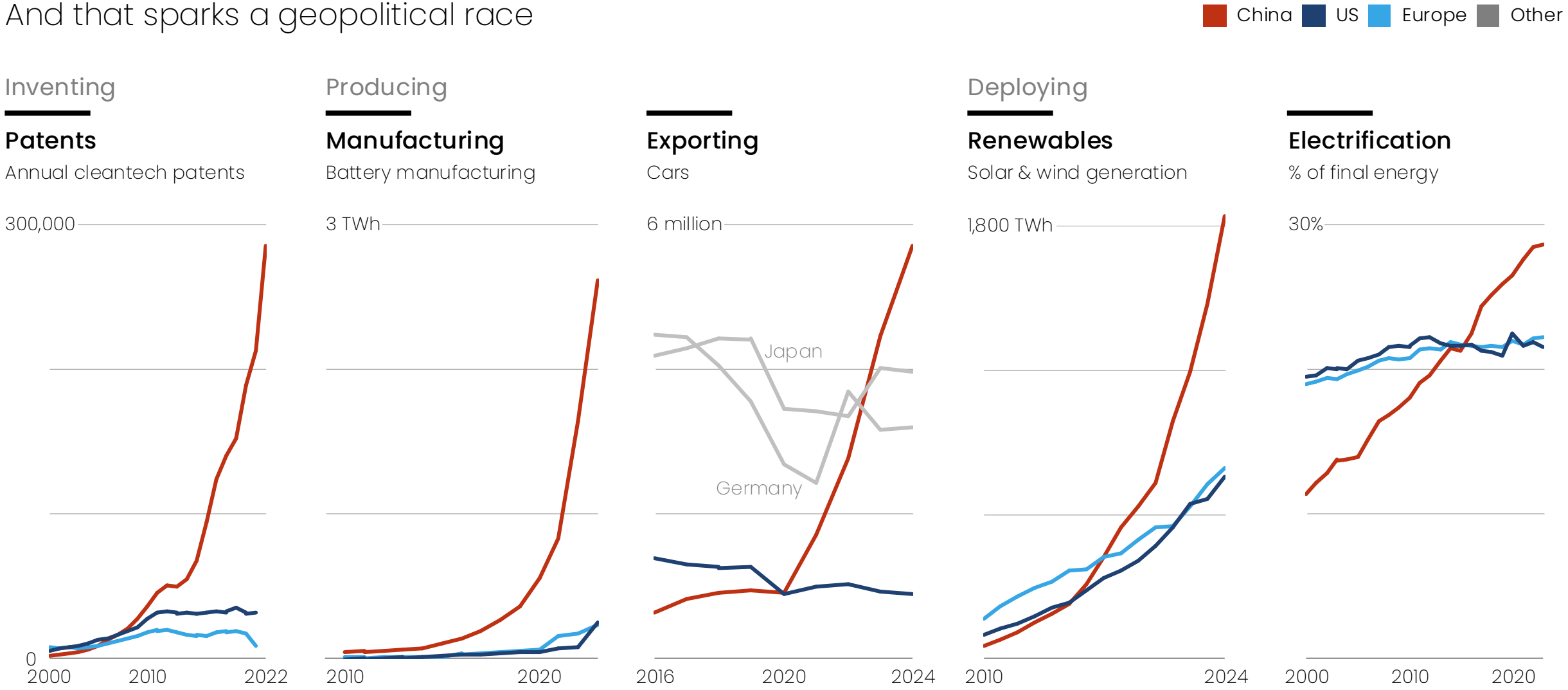
China is the first major electrostate

And that sparks a geopolitical race



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

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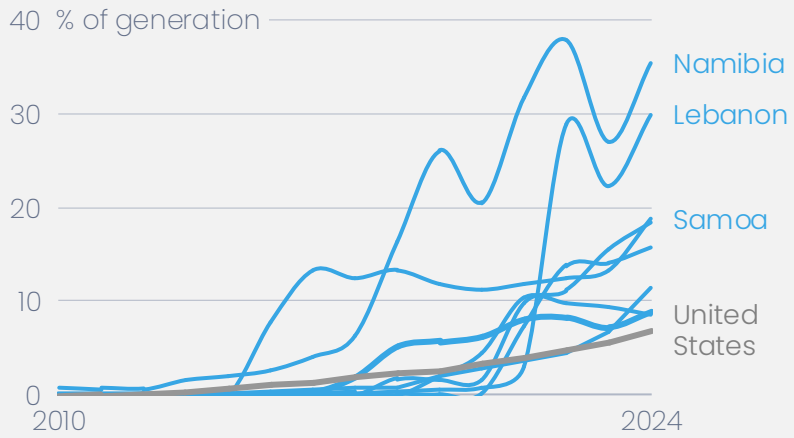
Electrotech is growing rapidly in CVF economies

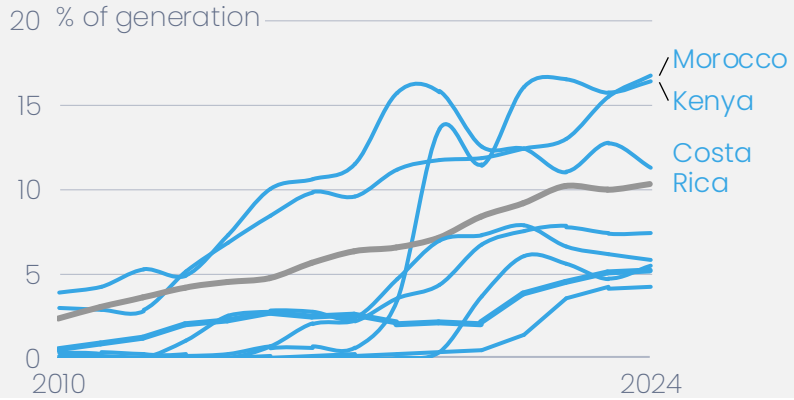
46% of CVF has leapfrogged the US on solar uptake, and 51% has surpassed it on electrification.

Supply

Solar generation

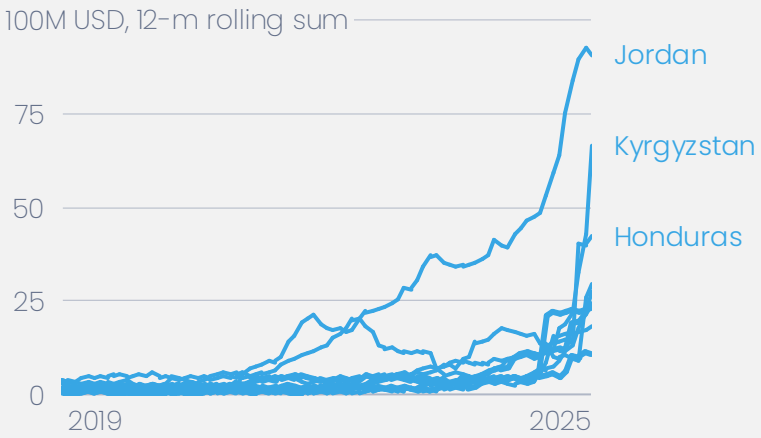


Wind generation



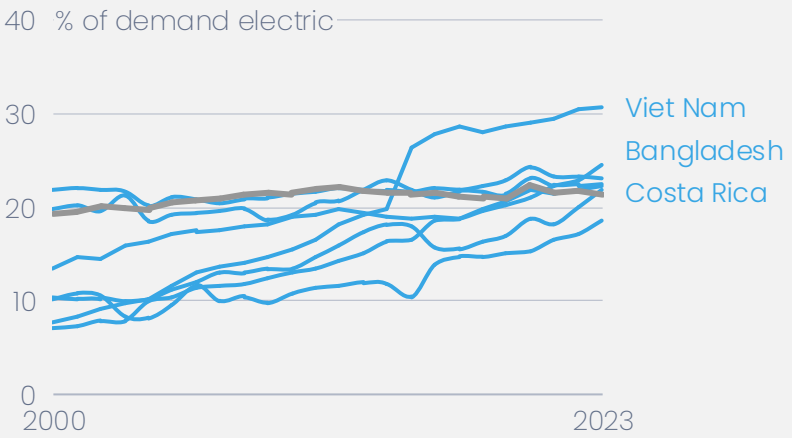
Connections

Battery sales

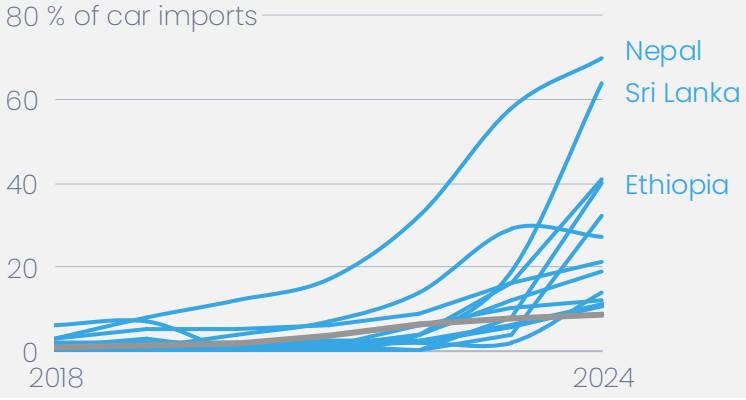


Demand

Electrification



EV car sales



Notes: EV car sales are measured by share of car imports that are electric.
Sources: IEA, UN Comtrade, Ember

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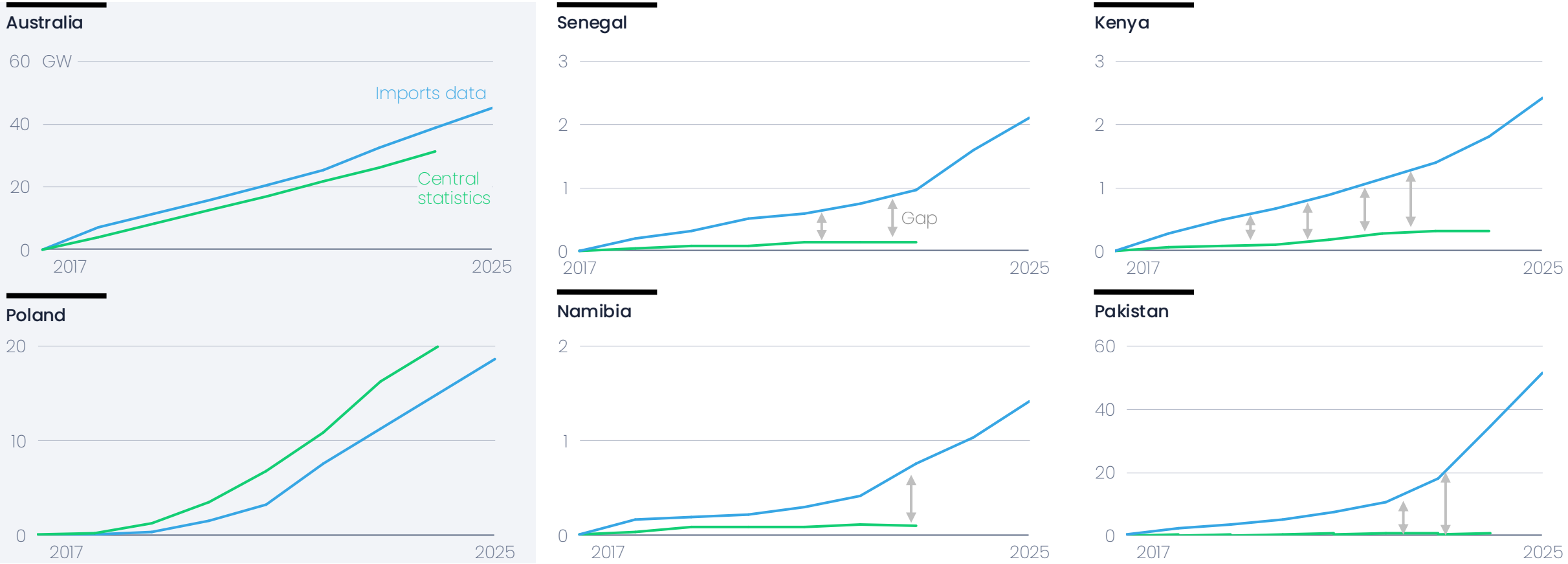
China exports data suggests much of the solar revolution is going unrecorded in emerging markets

As decentralised adoption outpaces centralised statistics

Solar capacity imported/installed



Sources: Ember. Imported statistics are in DC, while reported capacity is in AC. Lines show cumulative imports from China and official reported solar capacity change since 2017 (indexed to 2017 = 0).

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The Electrotech Moment for CVF nations

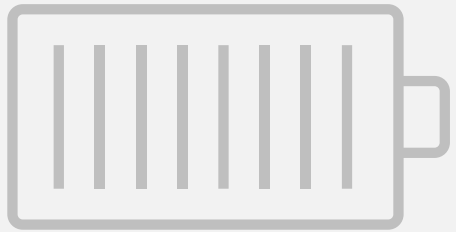
Three key moments change the story for CVF nations

Supply

Capex parity is here

Connections

The last mile can now be solved with batteries



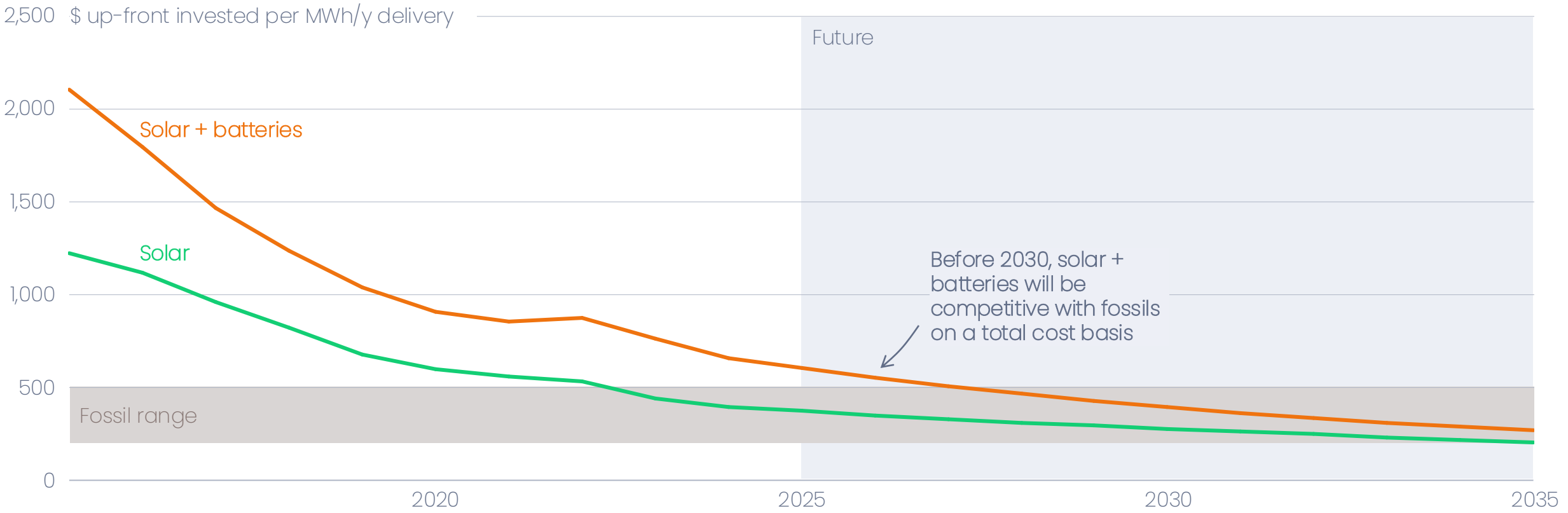
Demand

Electrification was never so cheap

Solar is no longer more capital intensive than fossil power

Purely on an upfront basis, solar & storage are now competitive with fossils – and that is before considering fossil sources need fuels, and solar does not

Capital intensity



Notes: Capital intensity looks only at the upfront costs, adjusting for utilization for a like-for-like comparison between sources; given it is a capex-only comparison, numbers exclude fuel, O&M, financing costs etc. Solar-plus-storage share with 4h battery pack.
Sources: IRENA, BNEF, Ember

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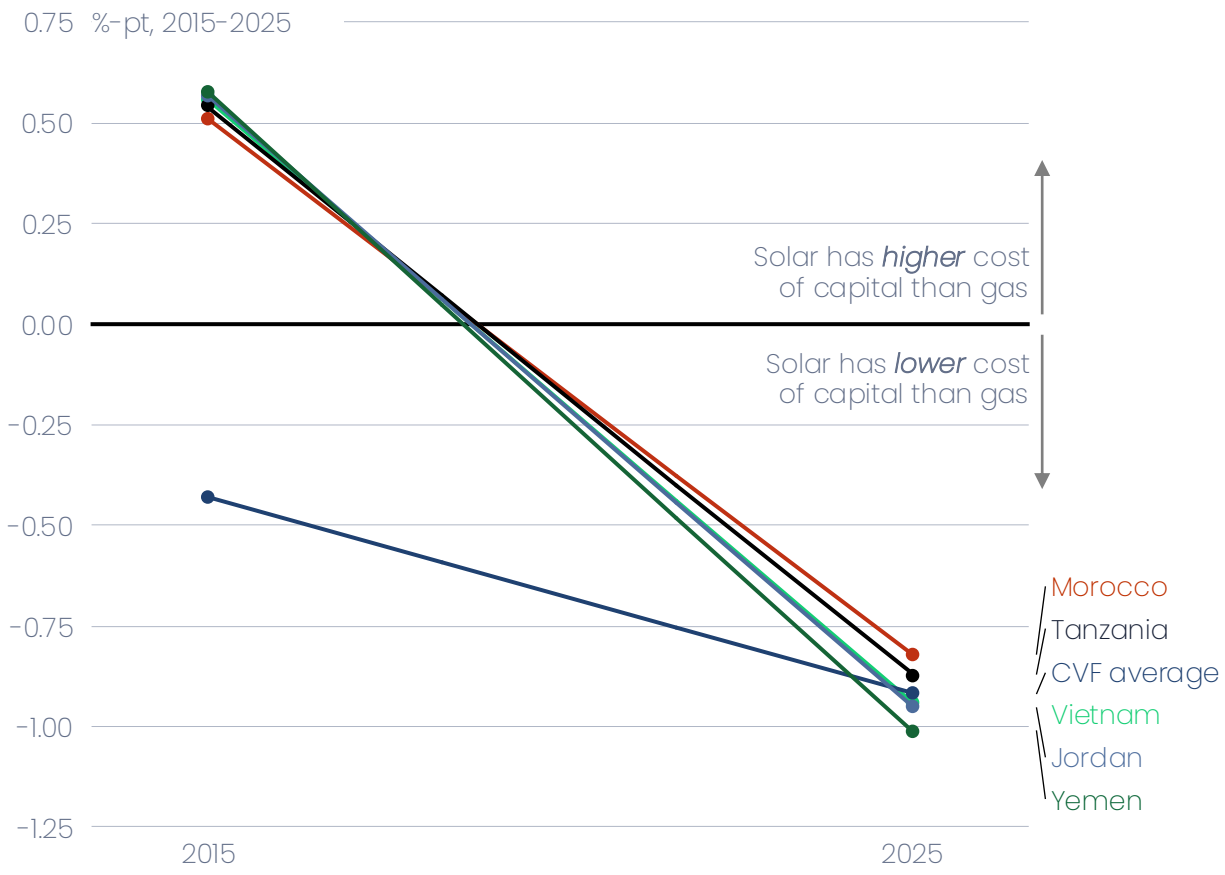
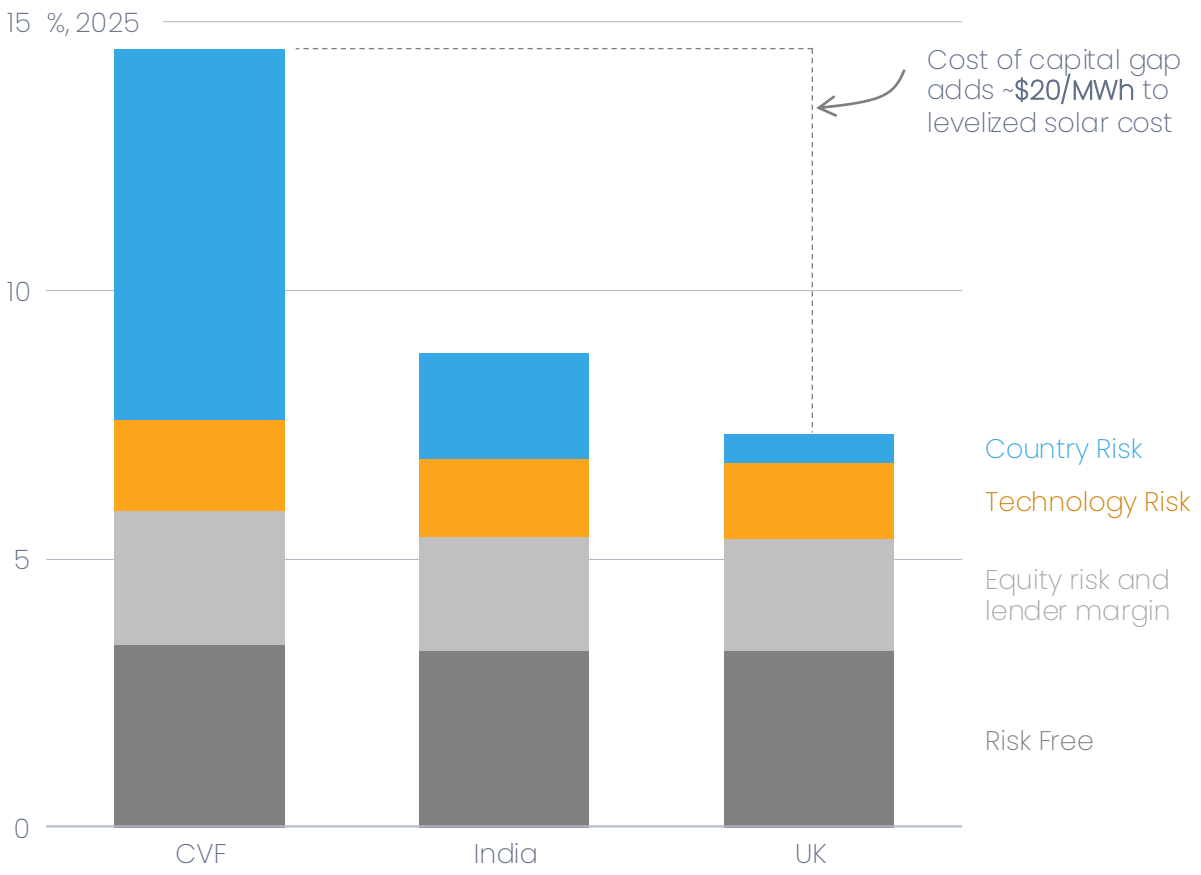
Capital markets now price in lower electrotech risk

Solar's cost of capital is lower than gas in most CVF economies, but still above developed-market levels; driven more by perceived country risk than solar technology risk

Delta cost of capital, solar versus gas



Cost of capital solar, CVF average versus India and UK



Sources: Hatton et al. (2025); Ember analysis

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The Electrotech Moment for CVF nations

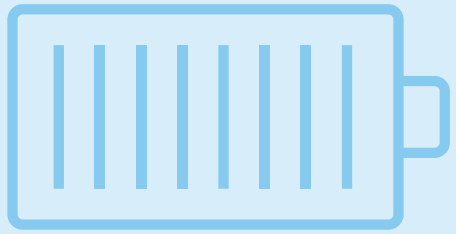
Three key moments change the story for CVF nations

Supply

Capex parity is here

Connections

The last mile can now be solved with batteries



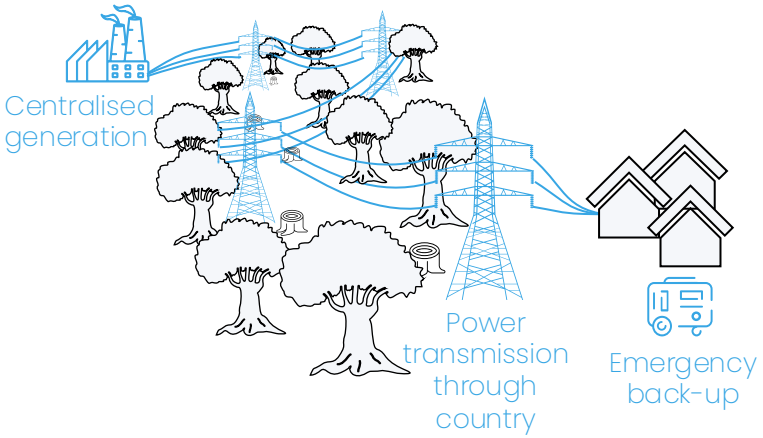
Demand

Electrification was never so cheap

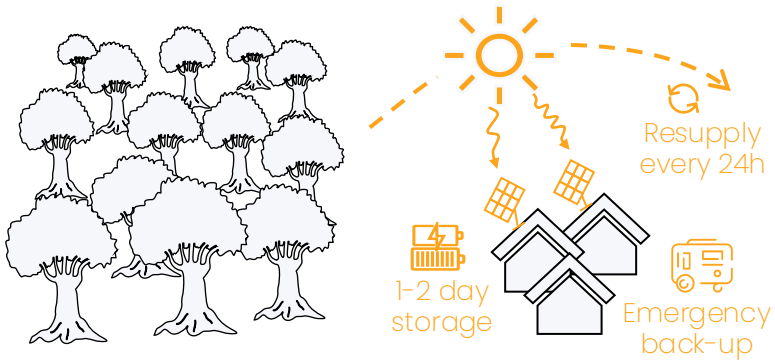
Solar + battery offers an alternative way to solve the last mile

As solar and battery costs fall, decentralised generation can become economically viable in regions that are too expensive to connect to centralised grids

Centralised



Decentral solar + battery



Note: Assuming ~20MW load, connected with 132 kV lines through rough terrain at $15k/MW/km. Decentral system optimized to meet 100% uptime between solar, battery and diesel gen back-up.
Sources: UNdata; IEA; BNEF; press search data; Ember analysis

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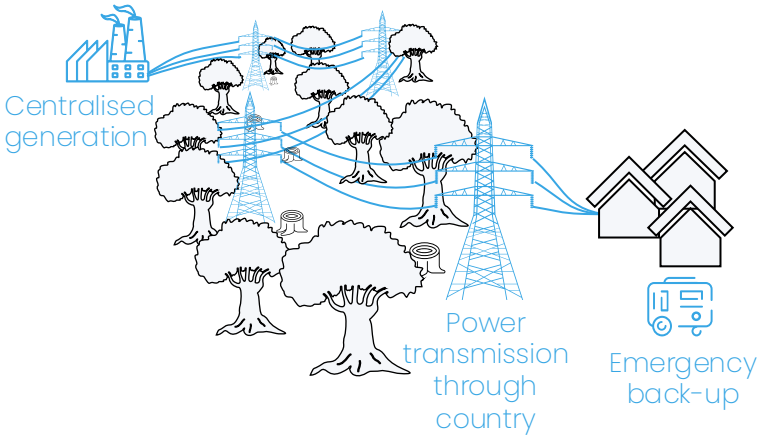

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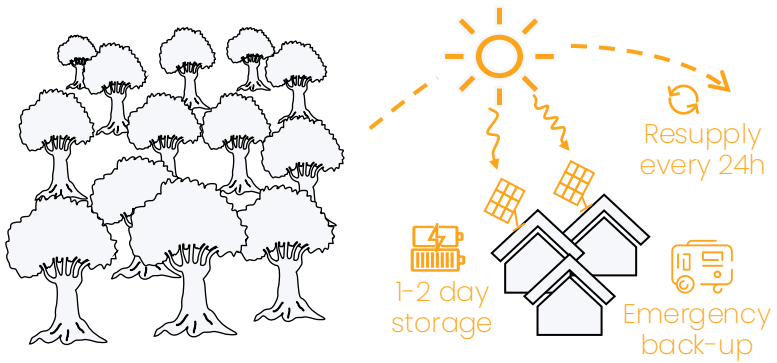
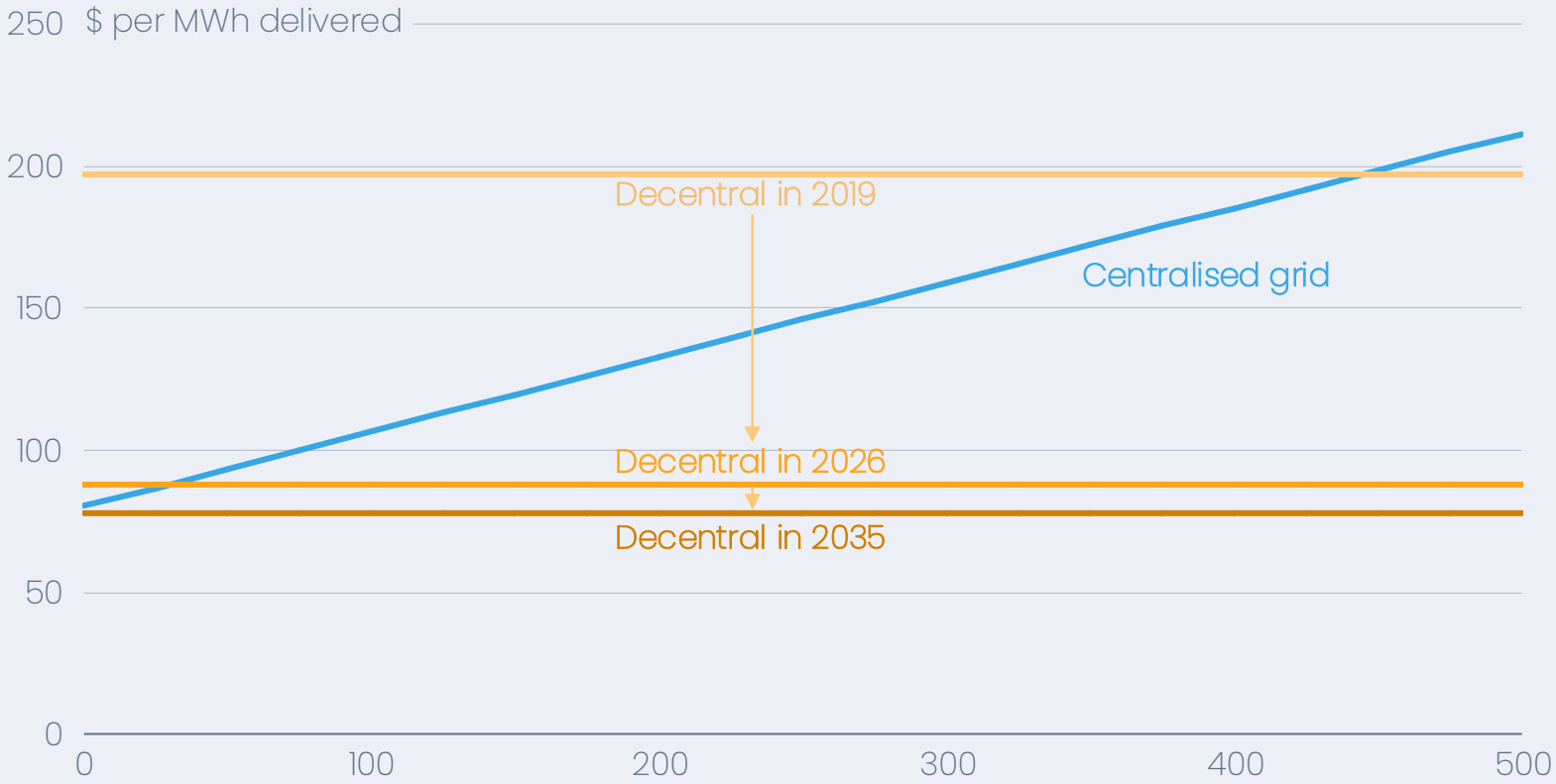


Levelized cost of baseload electricity



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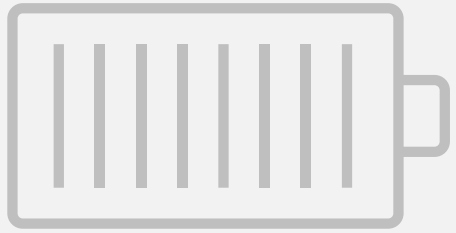

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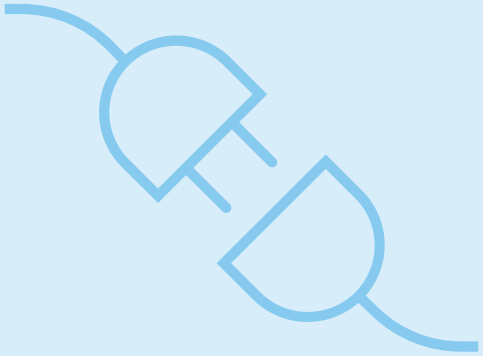

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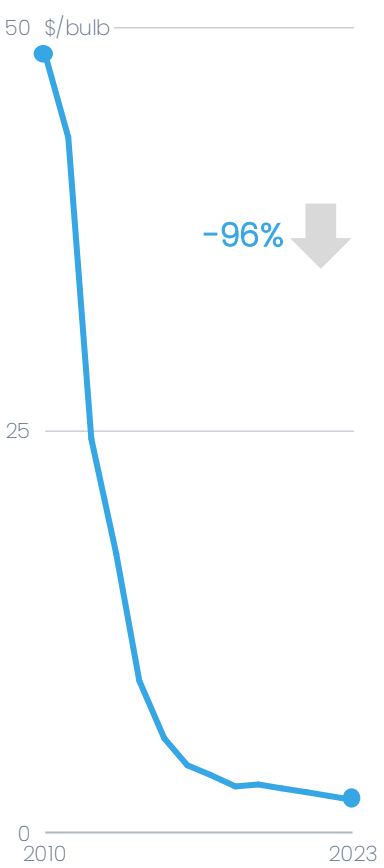
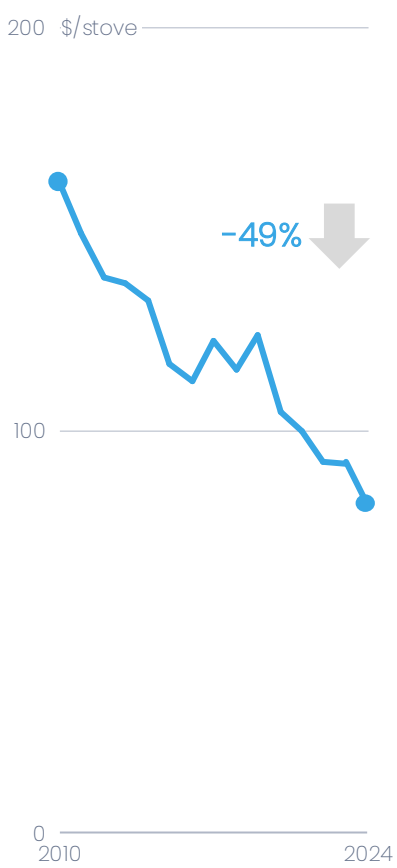
Electric end-use technologies are rapidly falling in price

Prices have fallen by 30-95+% in emerging economies over the past 15 years

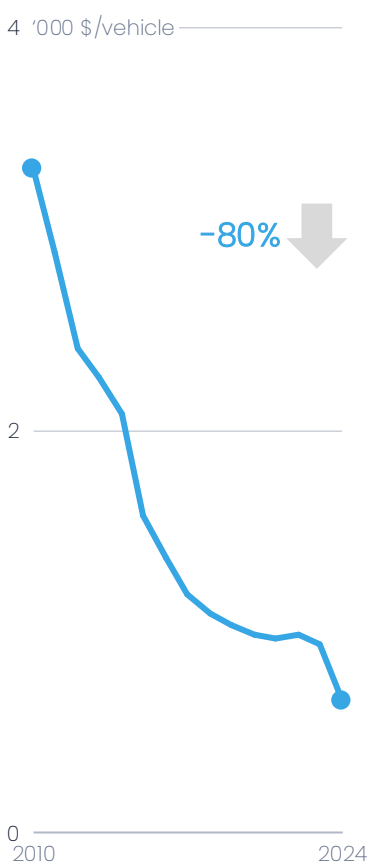
Lighting
LED light



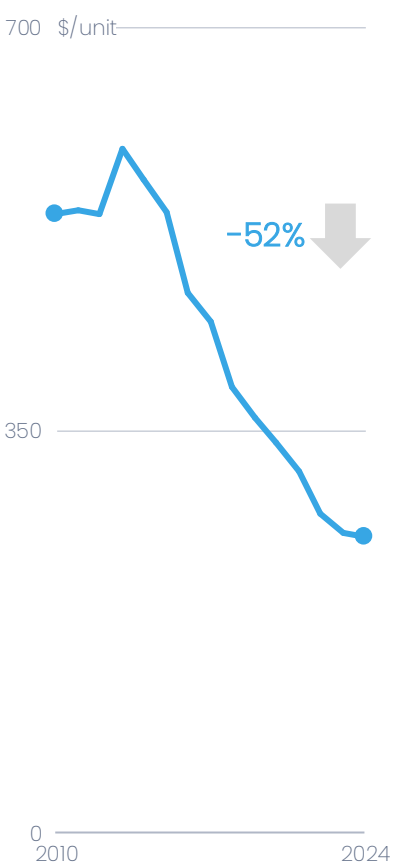
Cooking
Electric cookstove



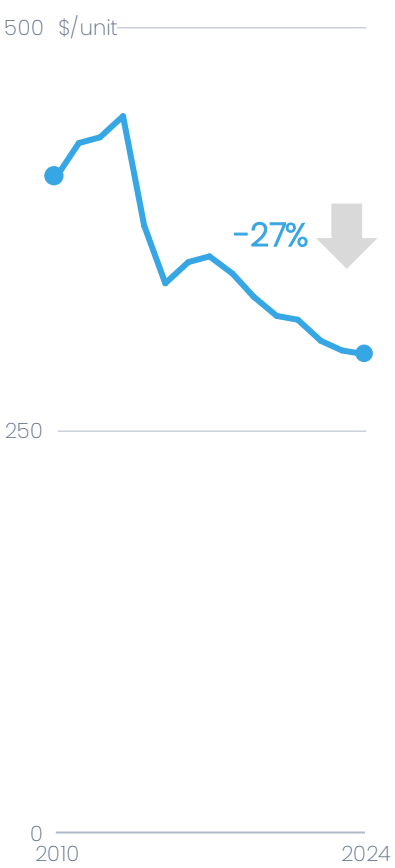
Transport
Electric 2-wheeler



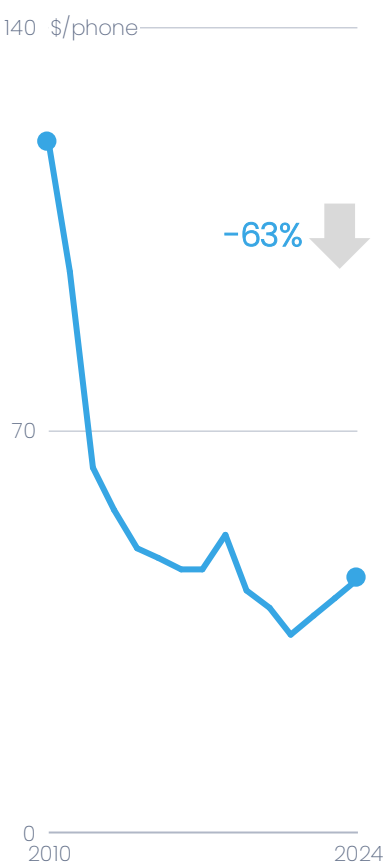
Space cooling
Air conditioner



Refrigeration
Refrigerator



Electronics
Internet-connected phone, entry level



Note: Assuming ~20MW load, connected with 132 kV lines through rough terrain at $15k/MW/km. Decentral system optimized to meet 100% uptime between solar, battery and diesel gen back-up.
Sources: UNdata; IEA; BNEF; press search data; Ember analysis

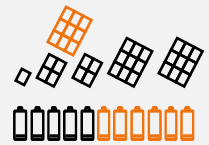
EMBER

Solar plus batteries let households climb the energy ladder one step at a time

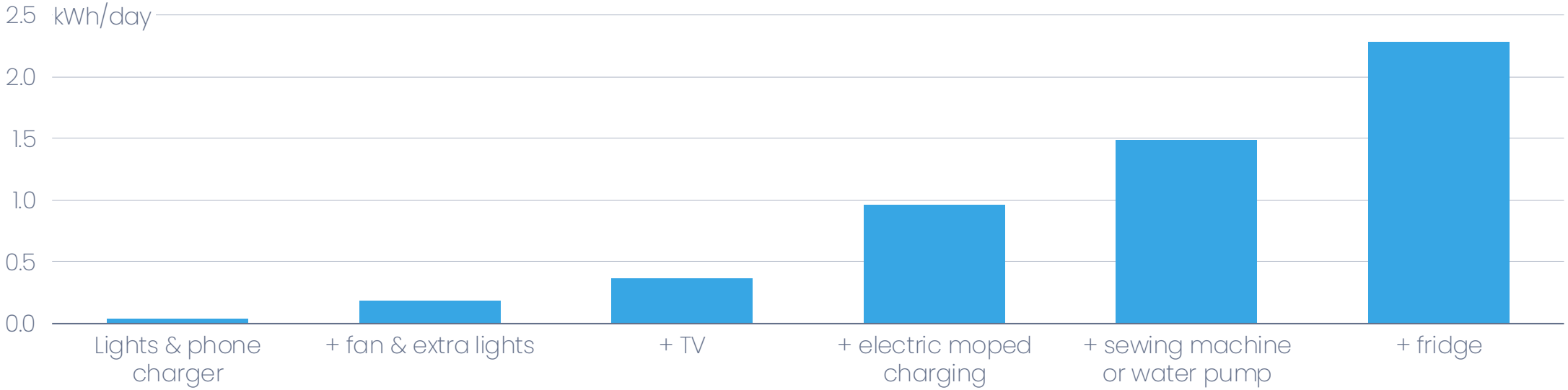
Most steps cost $50-100, within reach through savings or pay-as-you-go

INDICATIVE

Electricity demand and solar + battery requirements at each stage

Solar + battery system						
Incremental cost for supply	+$20	+$50	+$50	+$80	+$70	+$180

Household electricity demand ladder



Sources: Ember, various desktop sources. 3x3 panel icon ≈ 150 W; each battery icon ≈ 200 Wh storage. Indicative system sizes reflect households at the lower end of emerging markets income distribution.

EMBER

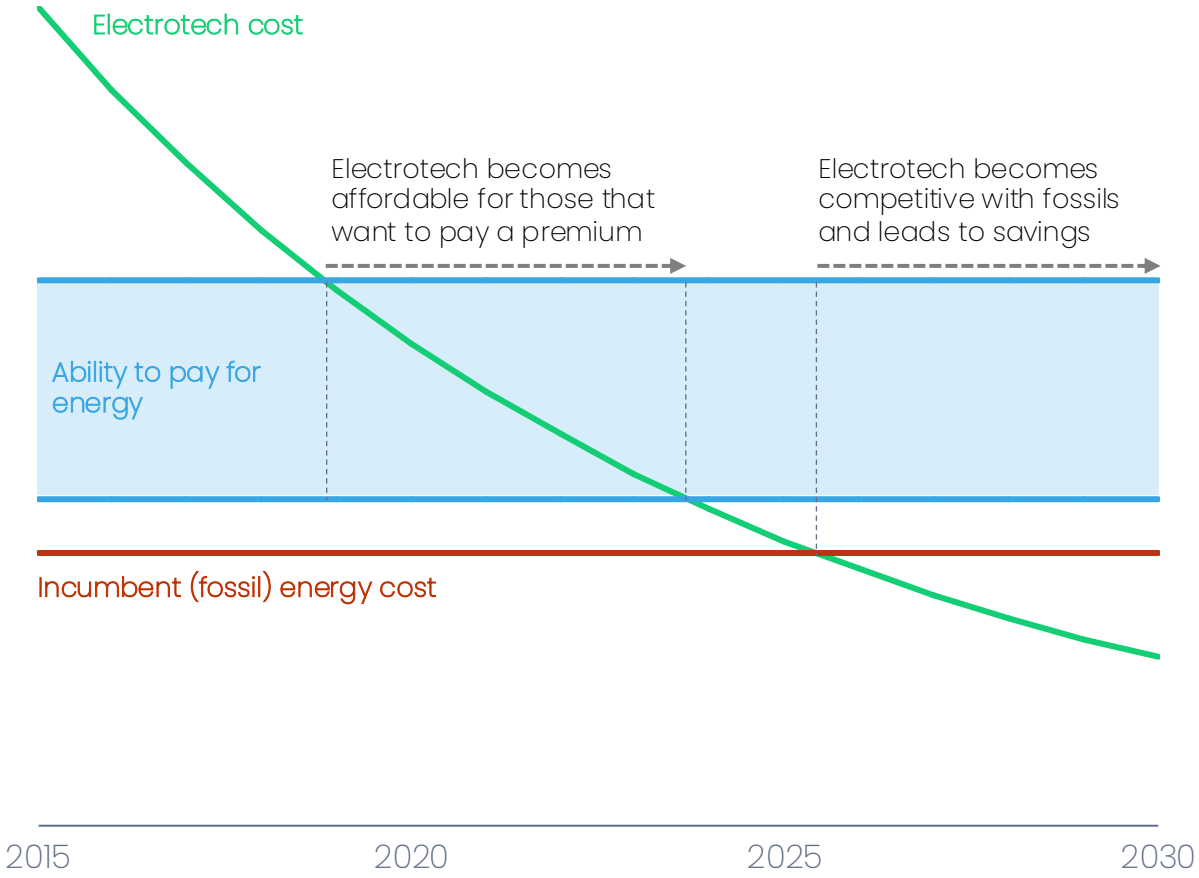
Electrotech is pricing in long-forgotten energy demand

Fossil fuels priced out billions; cheap electrotech is enfranchising them in the energy market

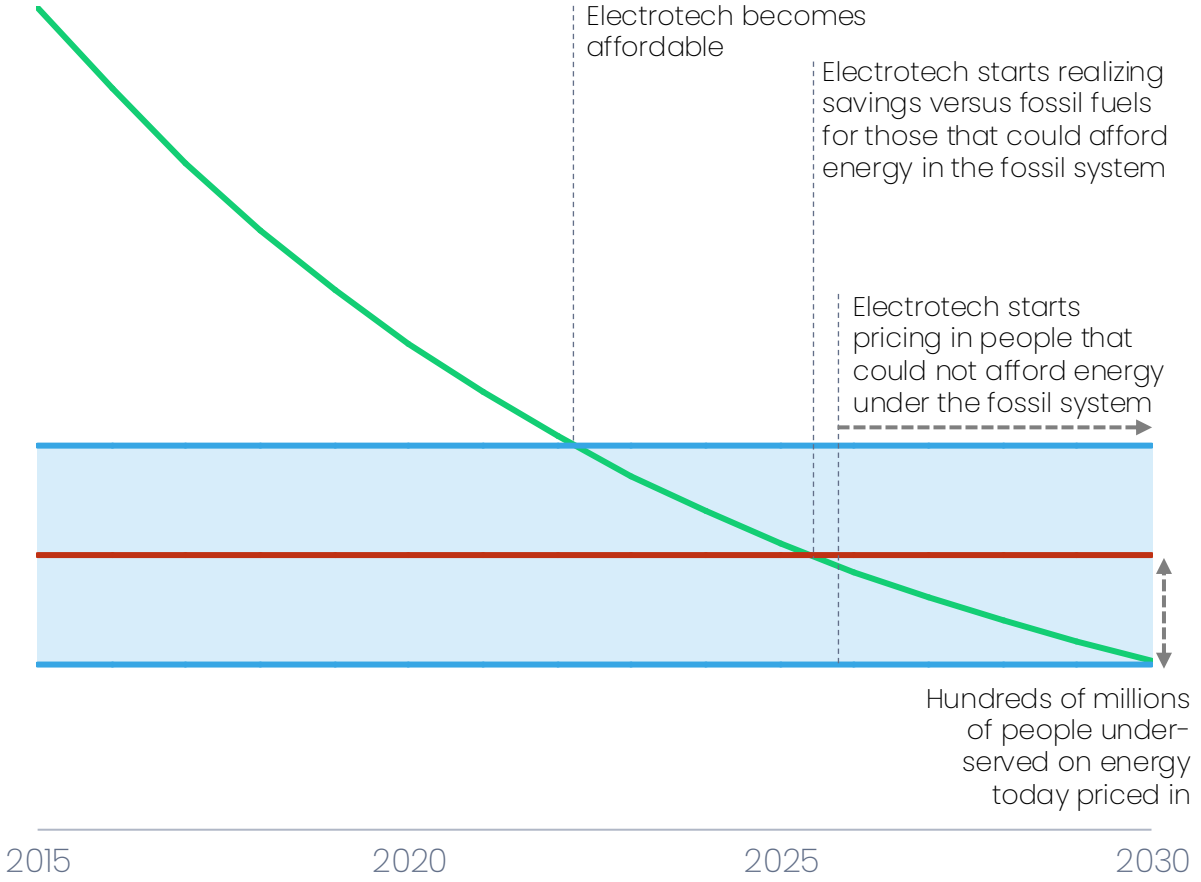
CONCEPT CHART

Energy cost versus household ability to pay

Developed economies



Emerging economies



Sources: Ember conceptual chart

EMBER

Contents

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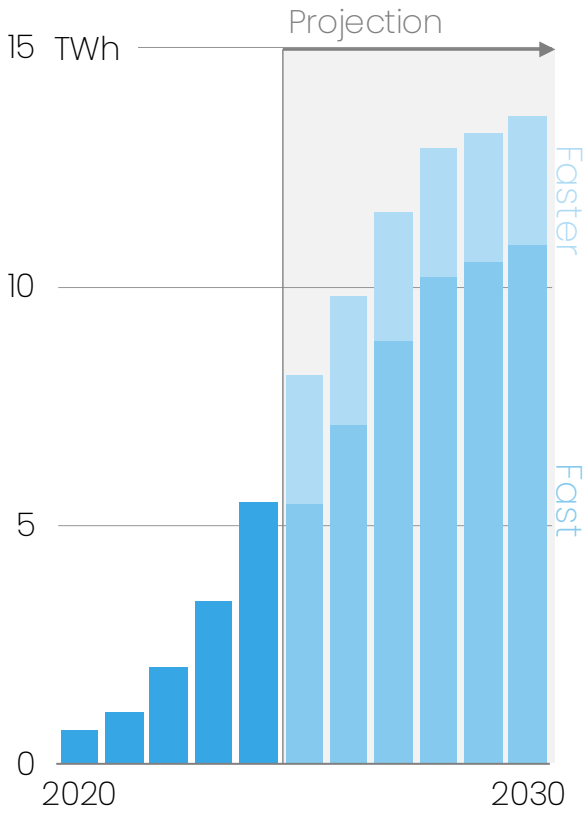
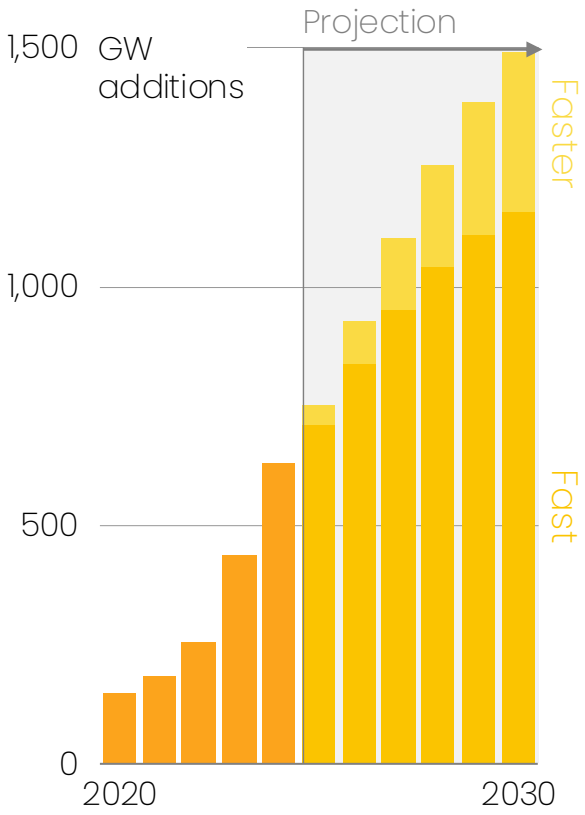
This is the decisive decade

A century in the making, electrotech will define this decade

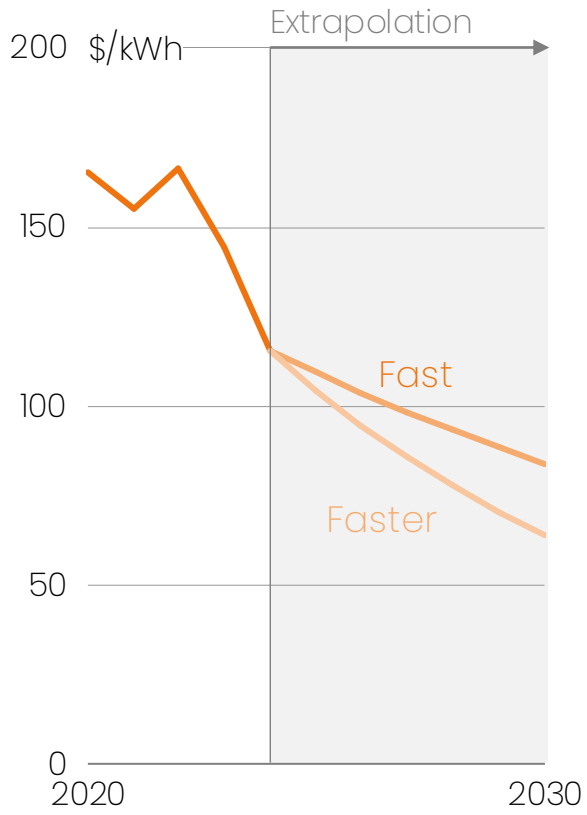
Manufacturing capacity is built: Batteries



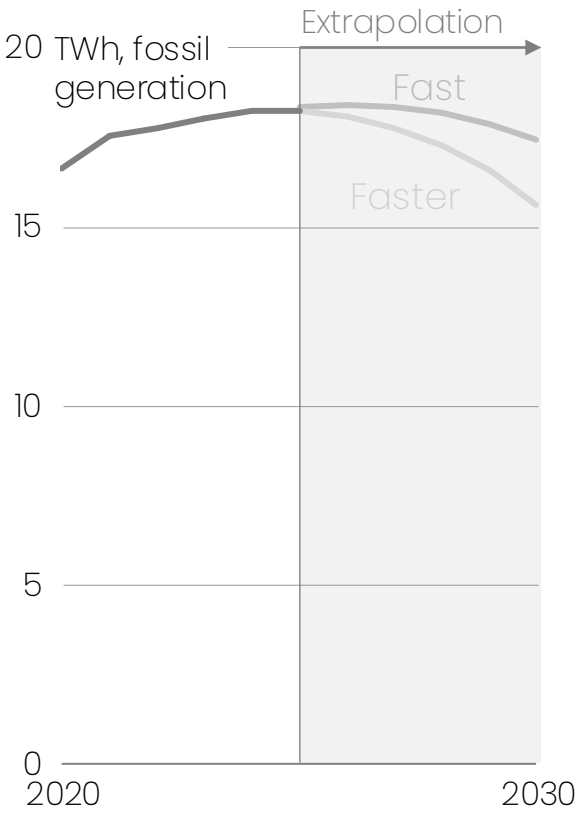
S-curves hit their steepest parts: Solar



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

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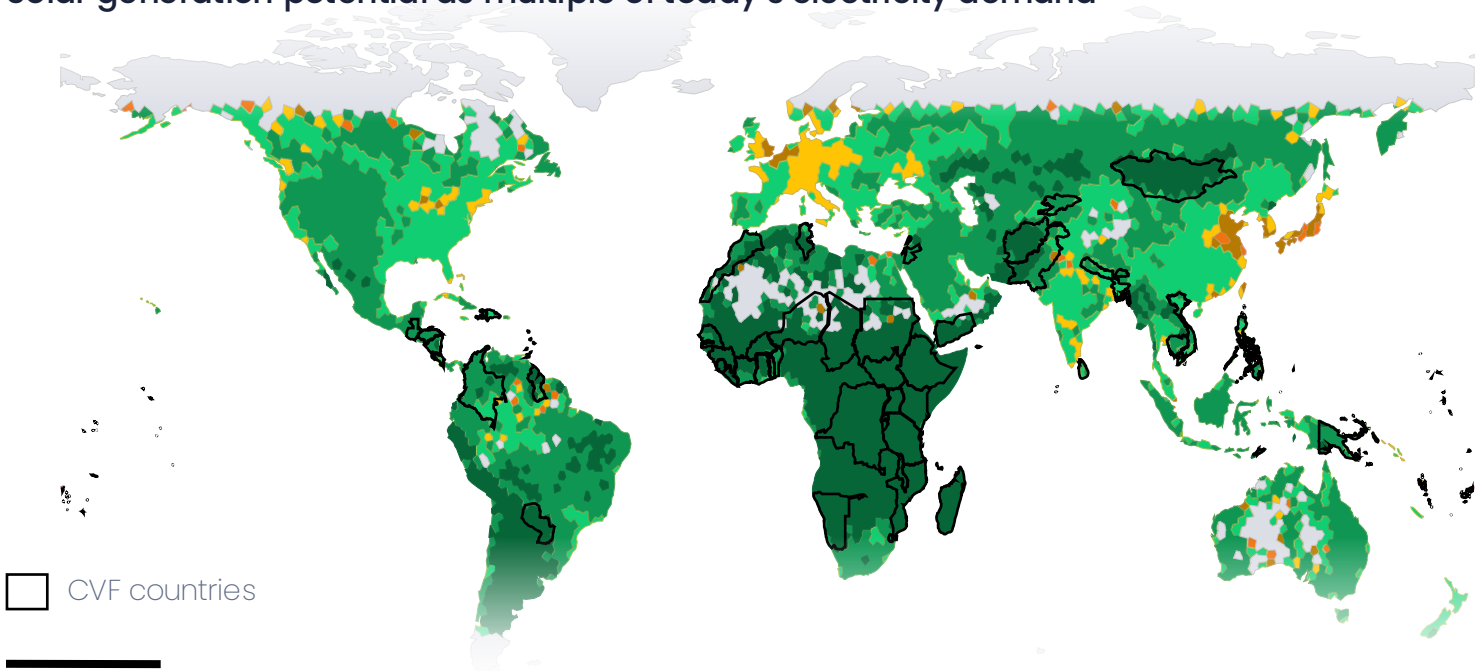
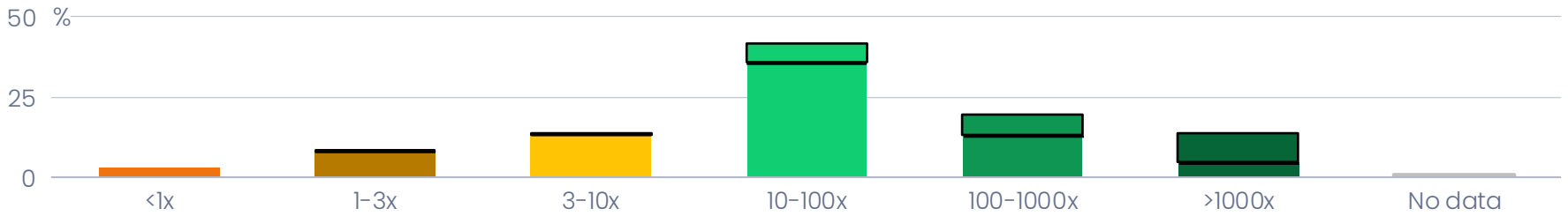
Everyone can be energy independent with renewables

Every CVF country and province has enough solar potential for energy independence

Solar generation potential as multiple of today's electricity demand



Share of global population by multiple



Share of global solar potential in CVF countries

27%

Range of multiples in CVF countries

90–11,000x

Solar potential per capita in CVF

320 MWh p.p

Note: US electricity demand today is 12 MWh p.p

Note: This analysis uses World Bank "Level 2" solar land availability, defined as solar PV potential on land that is physicaly suitable and not restricted by major environmental or land-use constraints.
Sources: Chen, J. et al. (2022); World Bank; NASA Socioeconomic Data and Applications Center (SEDAC); Gridded Population of the World (GPW); Ember analysis - The boundaries shown on this map are approximate and do not reflect an official endorsement or acceptance.

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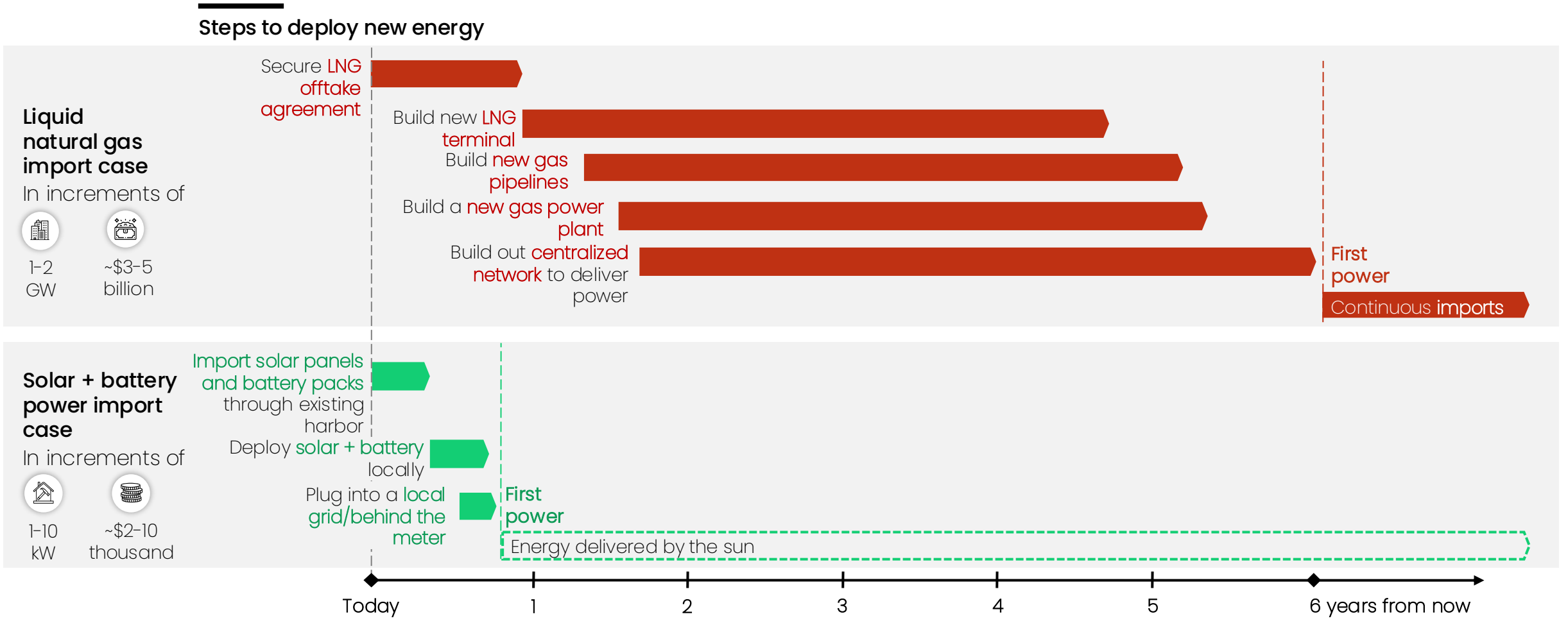
Solar will win the battle for the energy future

Because solar offers a better deal: more efficient, faster, cheaper, and local



Sources: Rystad, Ember analysis • Note: timelines are averages and indicative

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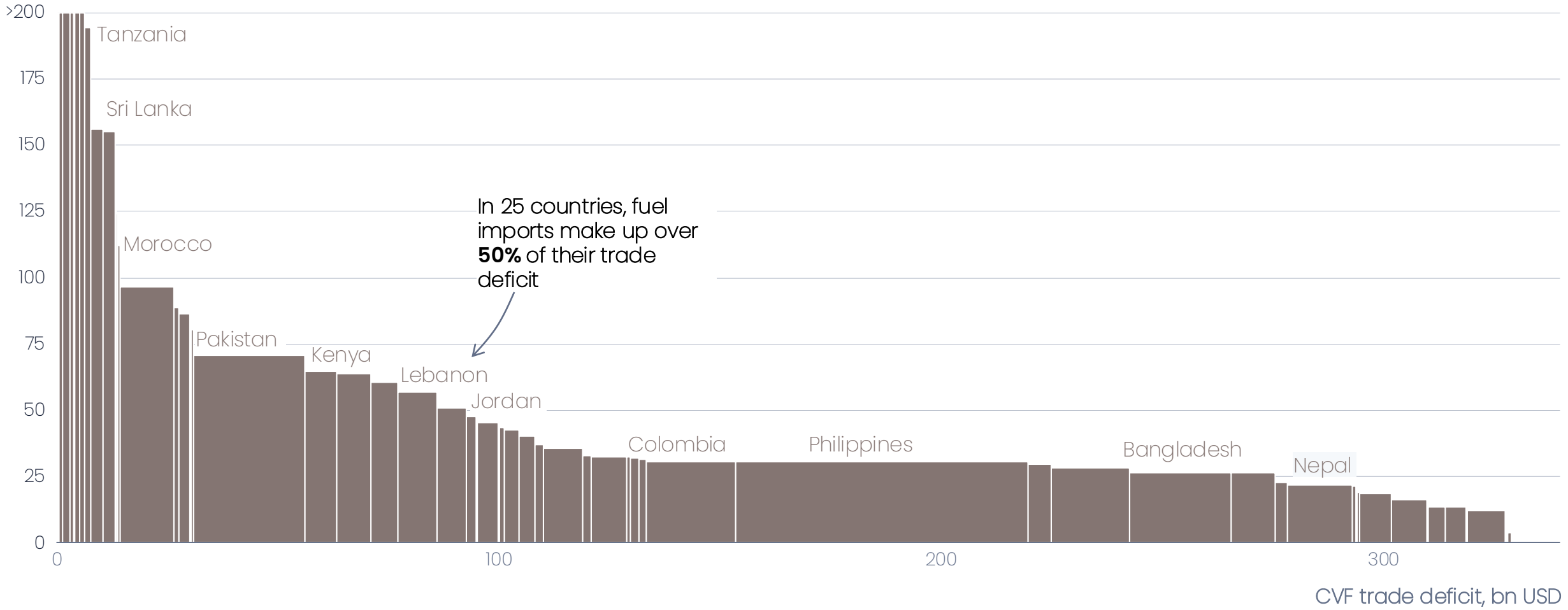
Fossil import dependency is a major economic burden

CVF nations spend $197 billion annually on fuel imports

Fuel imports as share of trade deficit, %



Note: the chart only shows CVF countries with a trade deficit (i.e. all but ten). The y-axis is capped at 200% for readability. Data as of 2024. Where unavailable, the most recent available year has been used.
Sources: World Bank, Ember analysis

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Fossil prices are likely to stay elevated for a long time

Finding a cheaper, more reliable alternative to power growth is essential for Asia

Oil price, Brent

Sources: Brent Spot Price (EIA daily). JPM scenario table — Kaneva, J.P. Morgan Global Commodities, May 2026.

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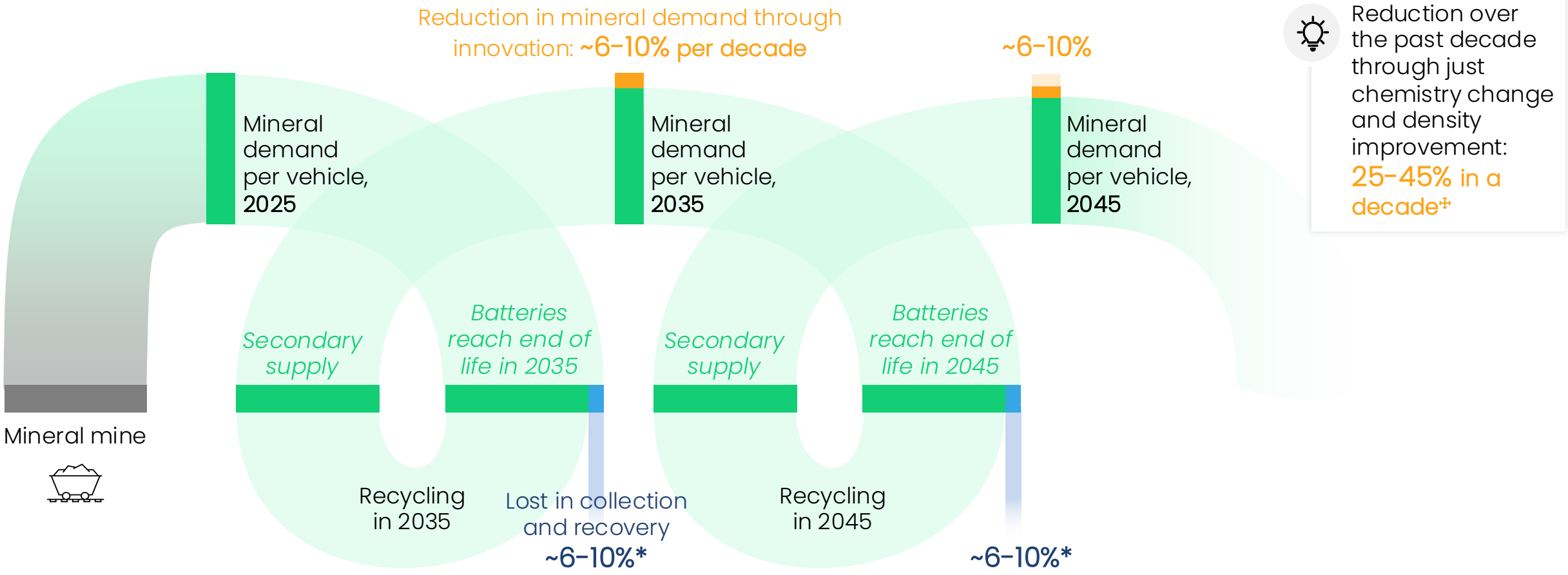
Minerals are NOT the new oil

Unlike fossil fuels, minerals can be recycled and innovation can change mineral requirement



Reduction over the past decade through just chemistry change and density improvement: 25-45% in a decade‡

Sources: RMI • Notes: Useful battery lifetime of a decade is indicative; lifetimes are likely longer. * Accelerated case ‡ About 25% for lithium, about 50% or more for nickel and cobalt

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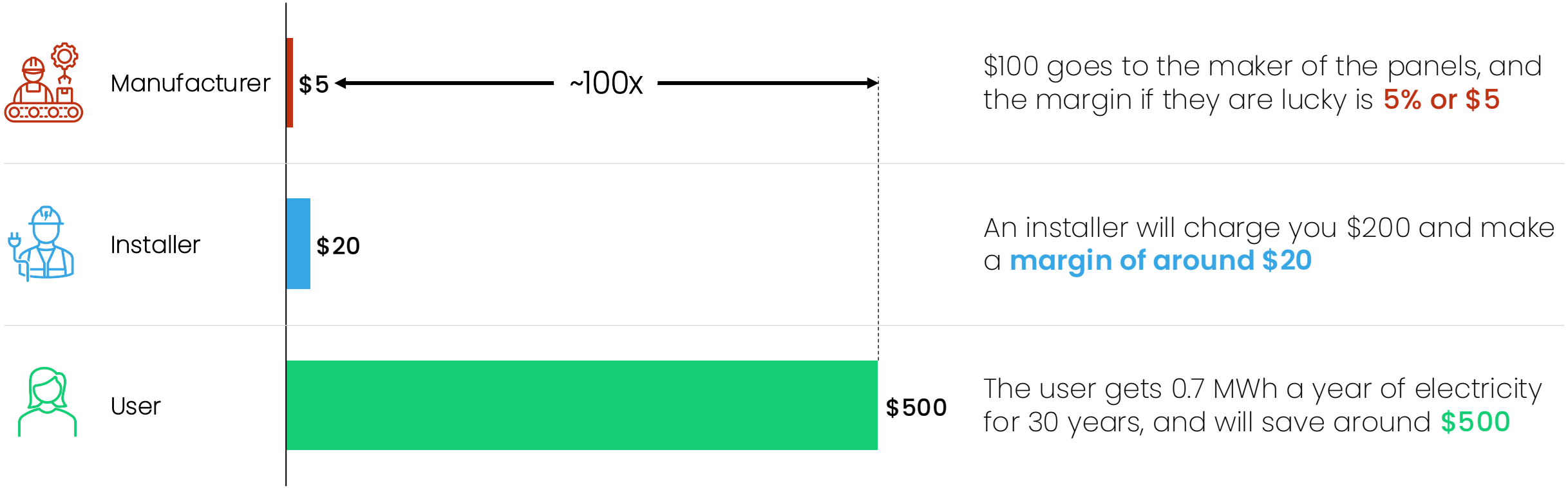
It’s not all about manufacturing

The user benefits are 100x greater than the manufacturer profits

The economics of putting up a couple of solar panels with 1kWp of capacity, UK example

Profits



$100 goes to the maker of the panels, and the margin if they are lucky is **5% or $5**

An installer will charge you $200 and make a **margin of around $20**

The user gets 0.7 MWh a year of electricity for 30 years, and will save around **$500**

Sources: Alibaba for solar panel costs, Greenmatch for installation costs, NPV calculation for the net savings made by a retail consumer based on data from the Renewable Energy Hub and at a 7% cost of capital.

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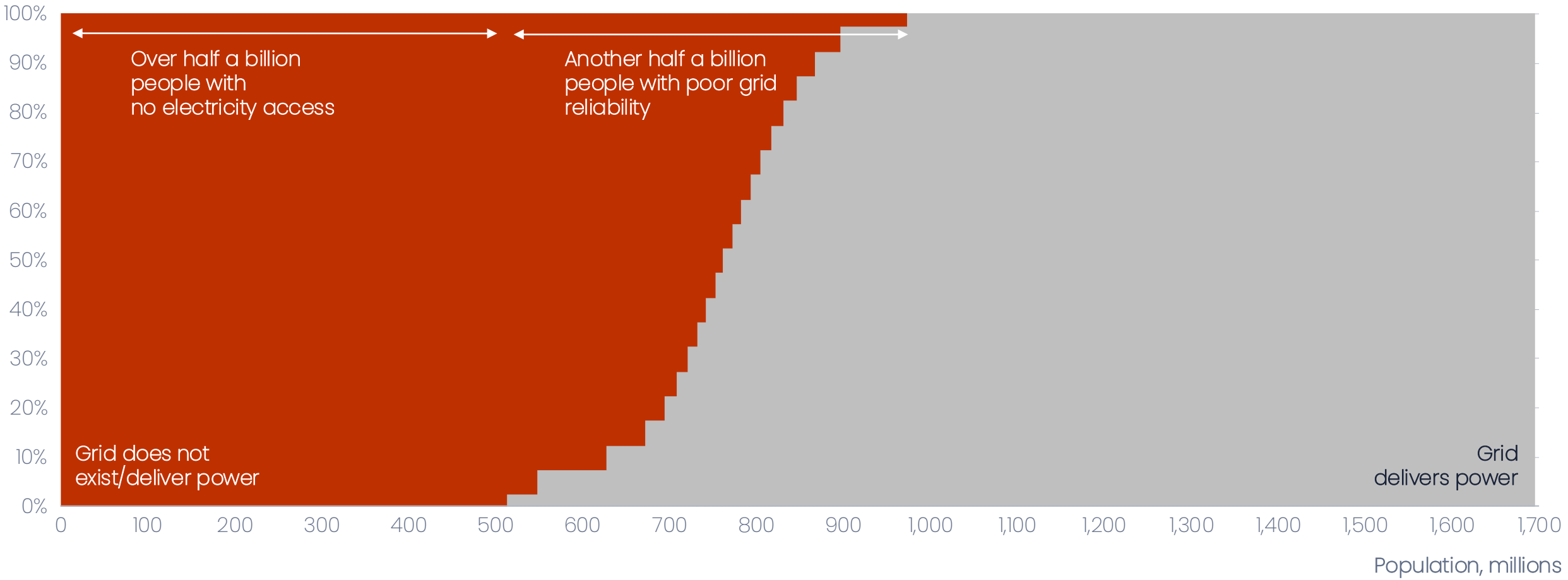
A billion people are waiting for reliable power

Cheap and local solar power can unlock electricity access across CVF countries

Hours per year with or without electricity in CVF countries, % uptime



Sources: HREA, World Bank, NASA GPW, Ember analysis

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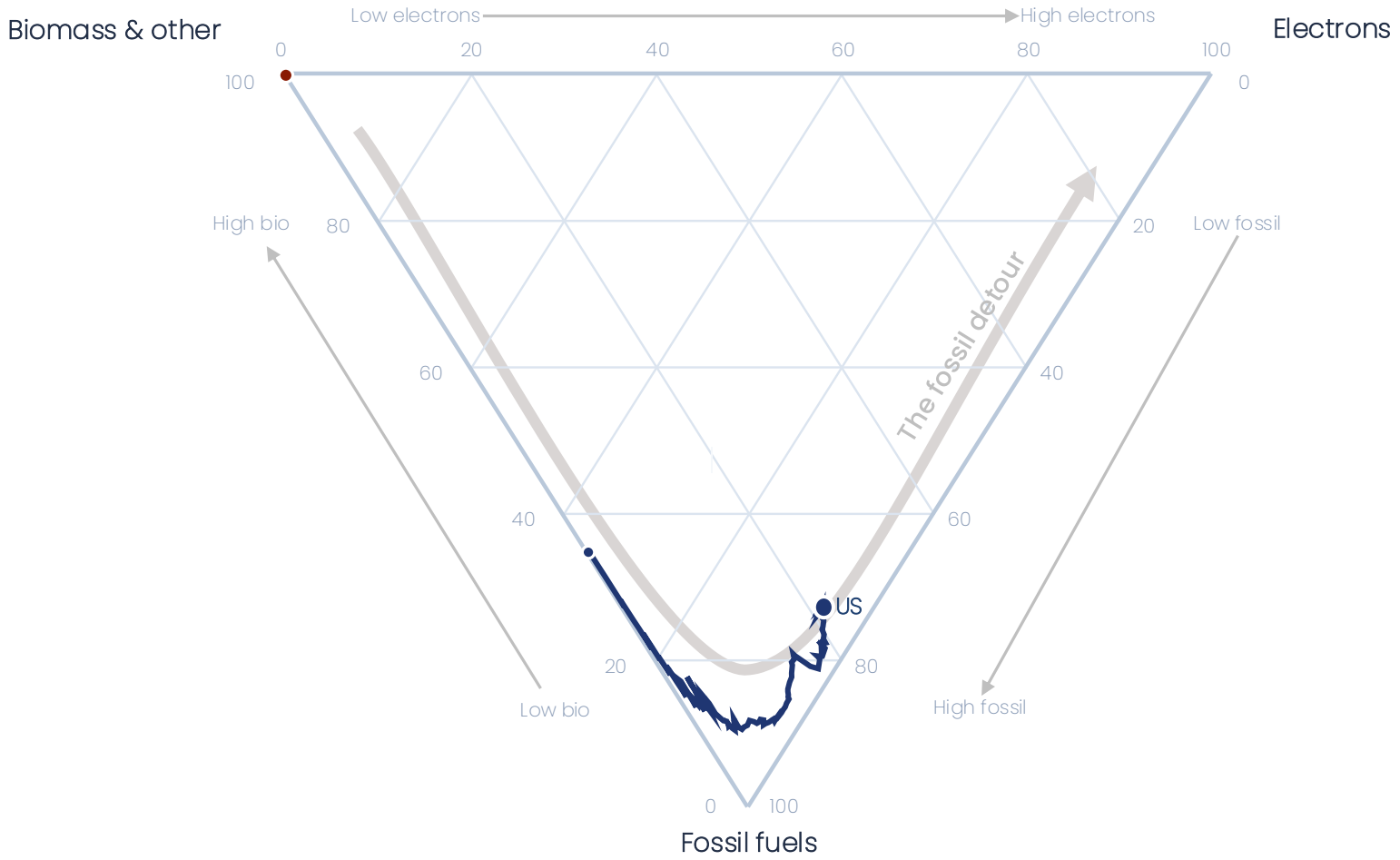
The Electric Fast Track

CVF nations face the choice to follow the fossil long way round or directly move to electricity

Final energy demand, % of total



Note: lowest third ranges 301-$1.5k p.p , avg $924 p.p.; middle third $1.6k-$4.3kp.p., avg $2.9k p.p.; top third $4.3k-$31k p.p., avg $9.7k p.p.
Sources: IEA; IIASA; Ember analysis

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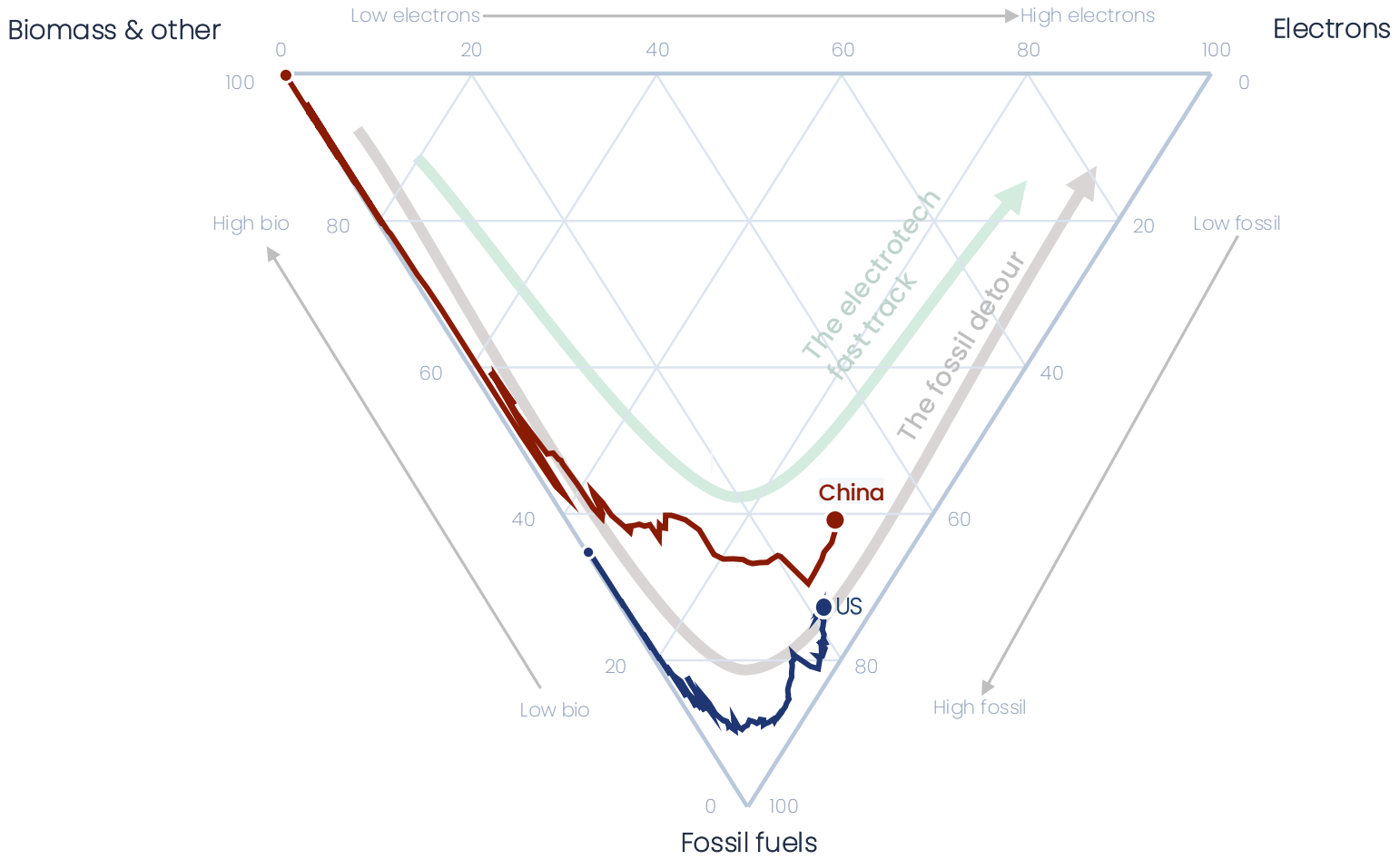

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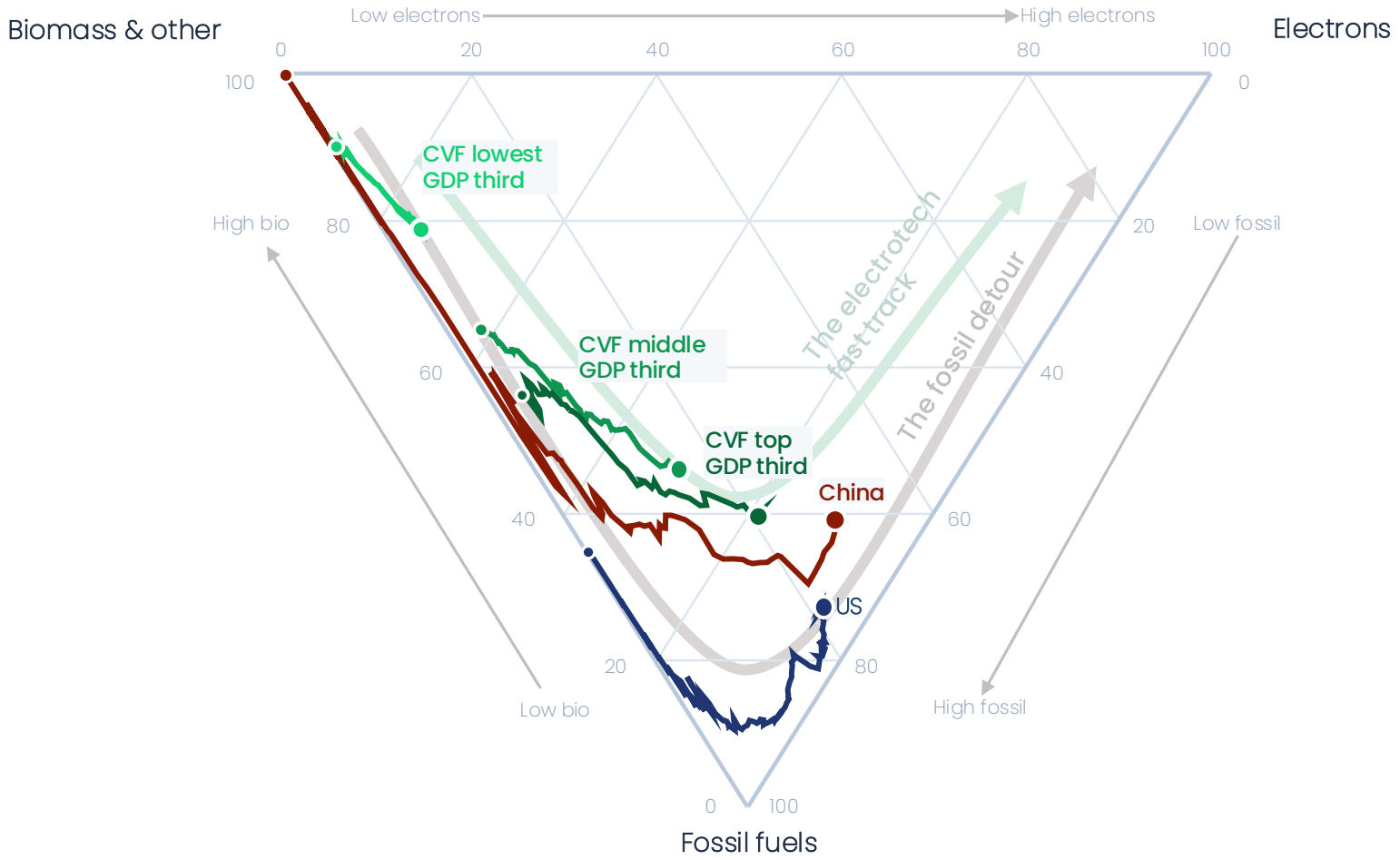

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About Ember

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

Ember Futures is a new research initiative established to help leaders navigate the rise of electrotech and what it means for energy, financial markets, and geopolitics.

The Team

Kingsmill Bond
Director

Daan Walter
Principal

Sam Butler Sloss
Manager

Antoine Issac
Analyst

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