EMBER

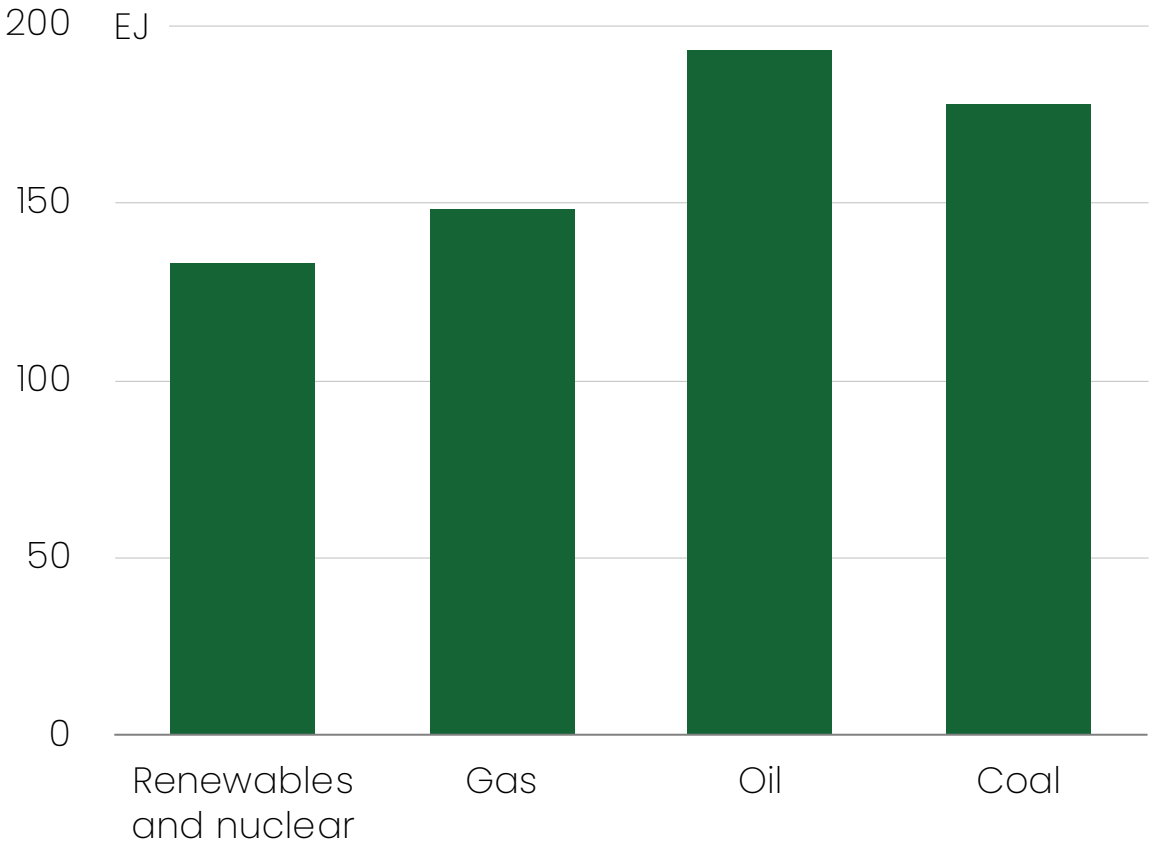
The economic and climate cost of dependence on fossil fuels

Kingsmill Bond, CFA

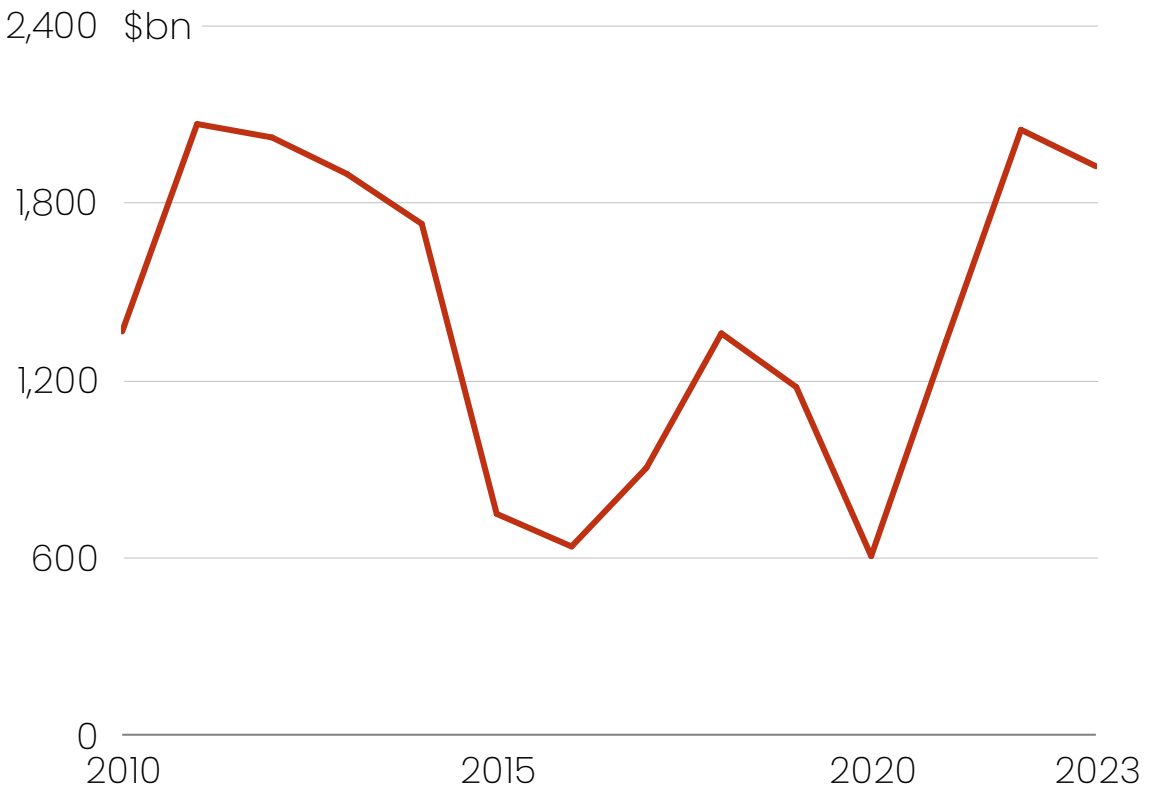
January, 2026

We live in an energy system apparently dominated by fossil fuels

Global primary energy supply in 2024



Oil rents



Sources: IEA WEO 2025, World Bank

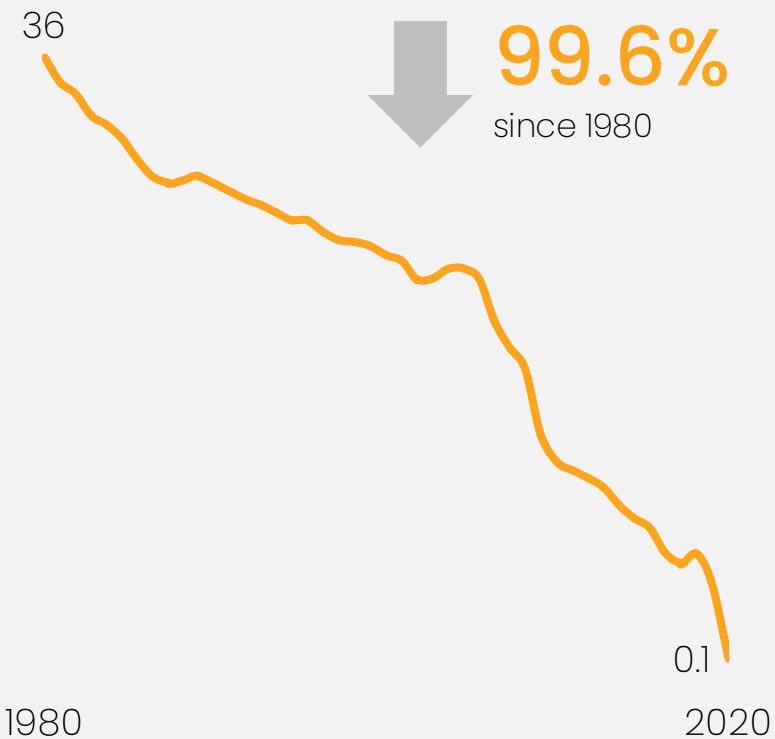
But there is a technology revolution going on in energy

Decades of steady cost innovation improved electrotech economics

Solar PV module price

$/W, global price

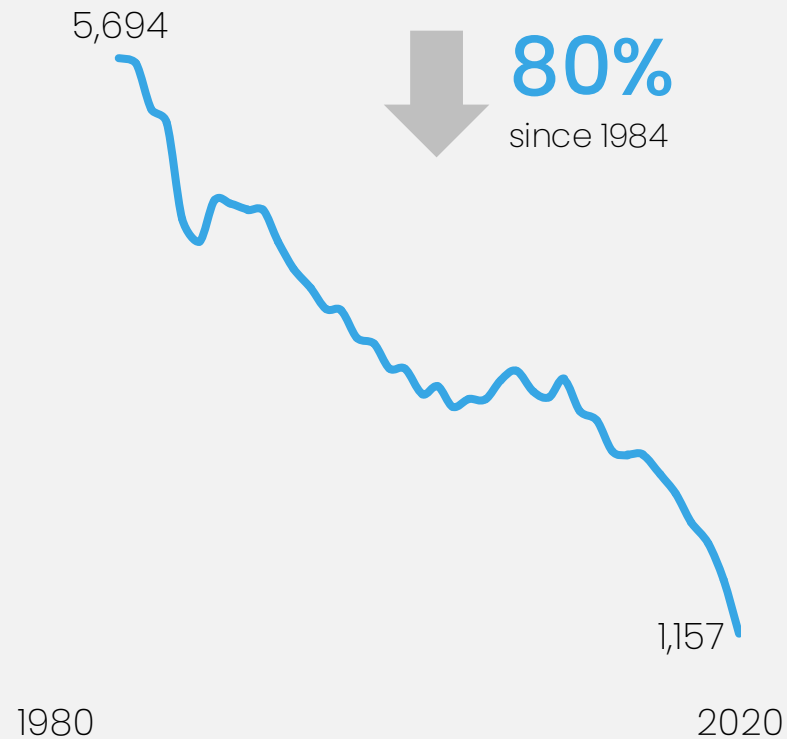
Logarithmic scale



Wind installation cost

$/kW, global price

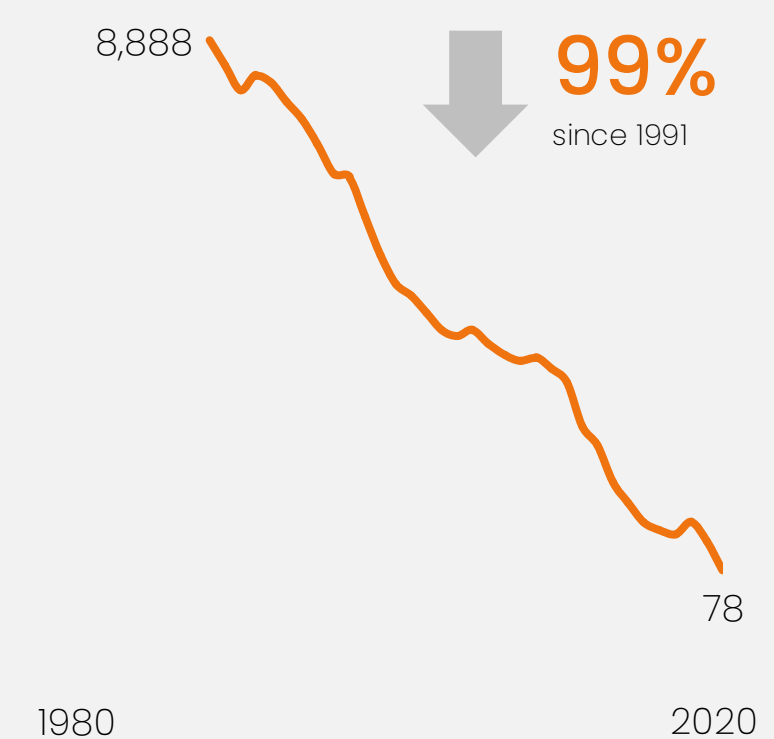
Logarithmic scale



Battery cell price

$/kW, global price

Logarithmic scale



Sources: OWID; IRENA; BNEF/Avicenne

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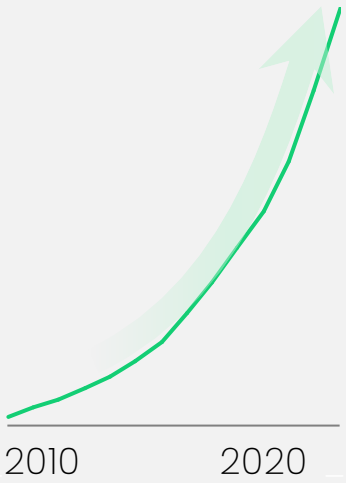
Leading to spectacular growth of electrotech

Supply

New ways to generate electricity

Renewables as vectors of change

Solar PV
deployment (GW)



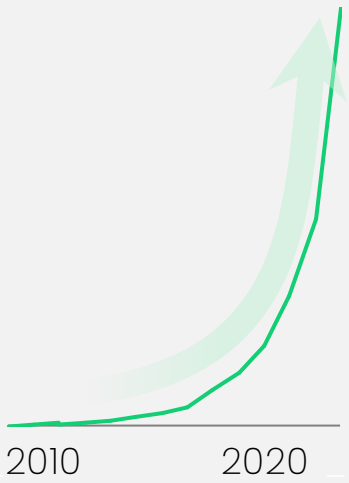
Wind
deployment (GW)

Connections

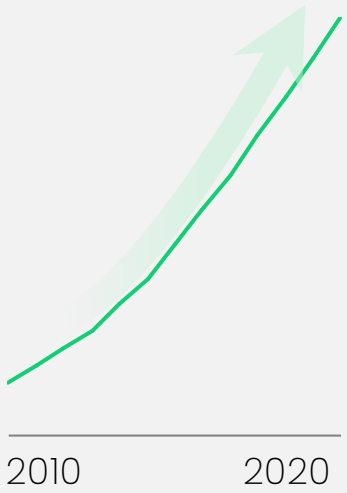
New ways to transport and store electricity

Flextech/gridtech as vectors of change

Battery storage
deployment



HVDC lines
deployment (km)

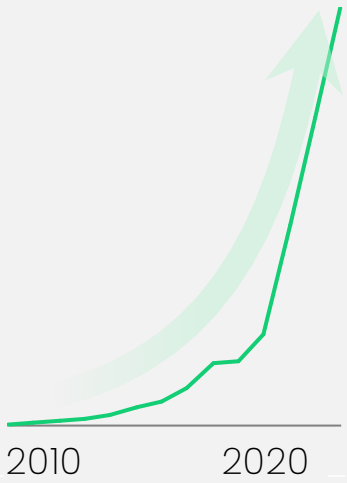


Demand

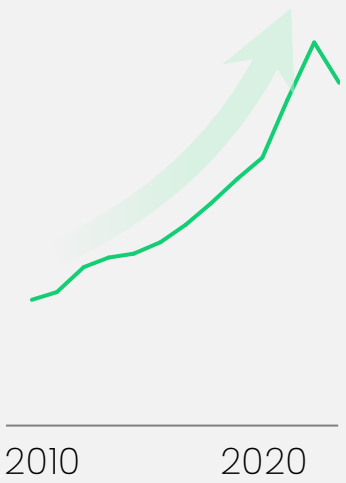
New ways to use electricity

Electrification as vector of change

EV
sales



Heat pumps
sales



Sources: Ember, IEA, RMI, Thunder Said

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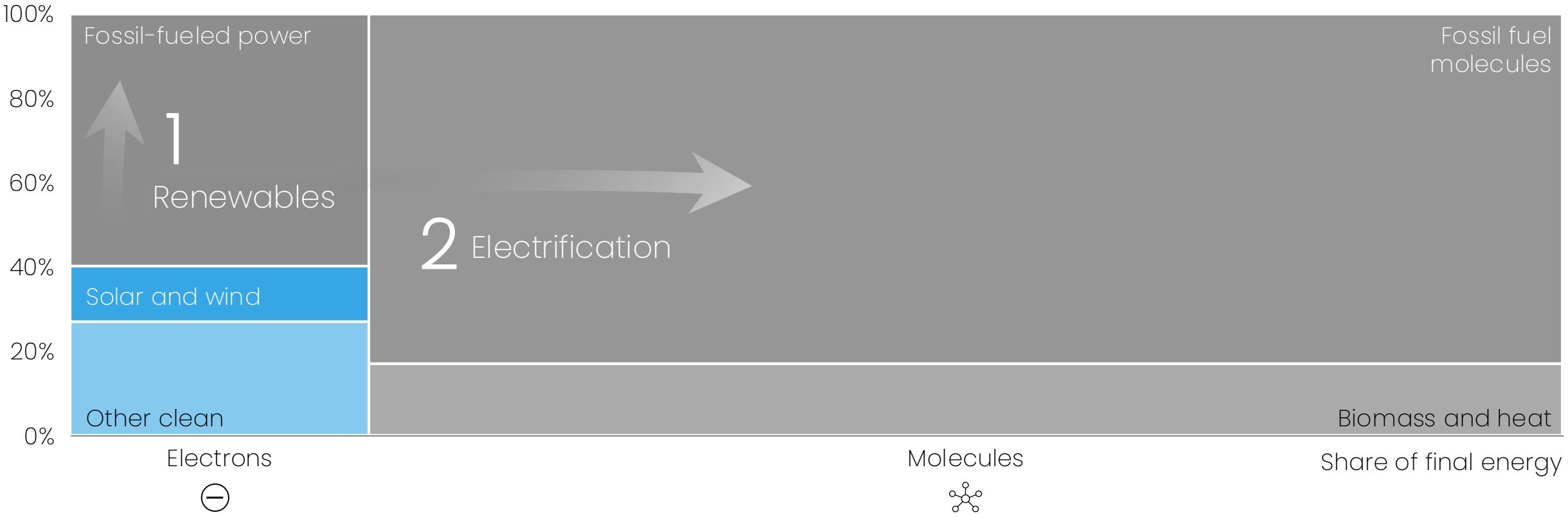
Across two vectors of change

Renewables replace fossil electricity; electrification replaces fossil molecules

Global final energy demand in 2023

Share of final energy



Sources: IEA WEO 2024; Ember analysis. Other clean electrons are mainly nuclear and hydro.

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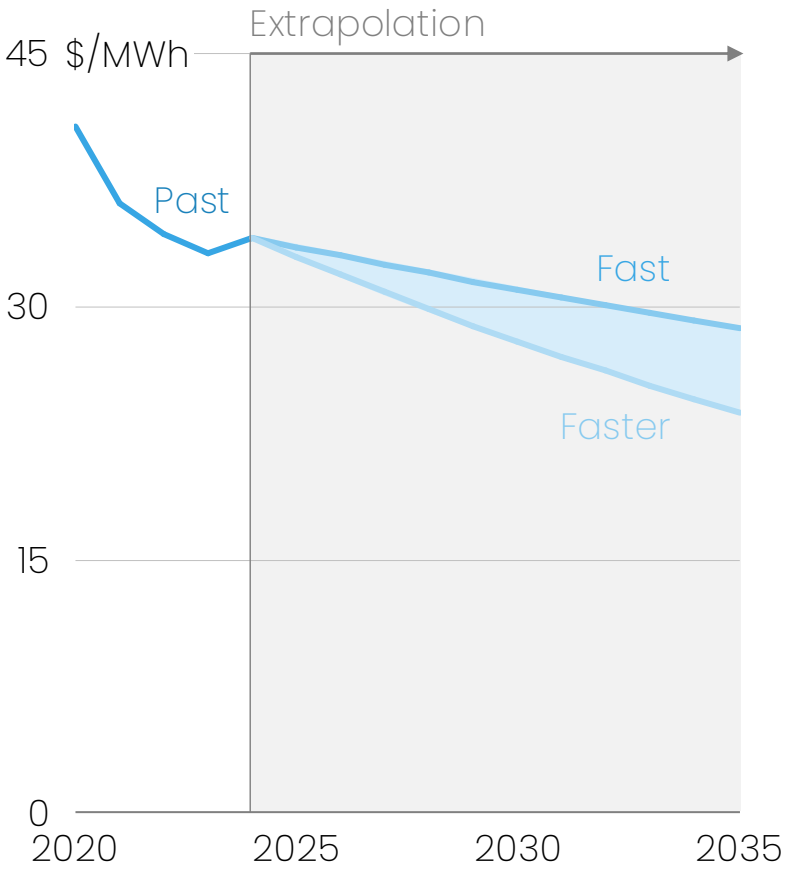
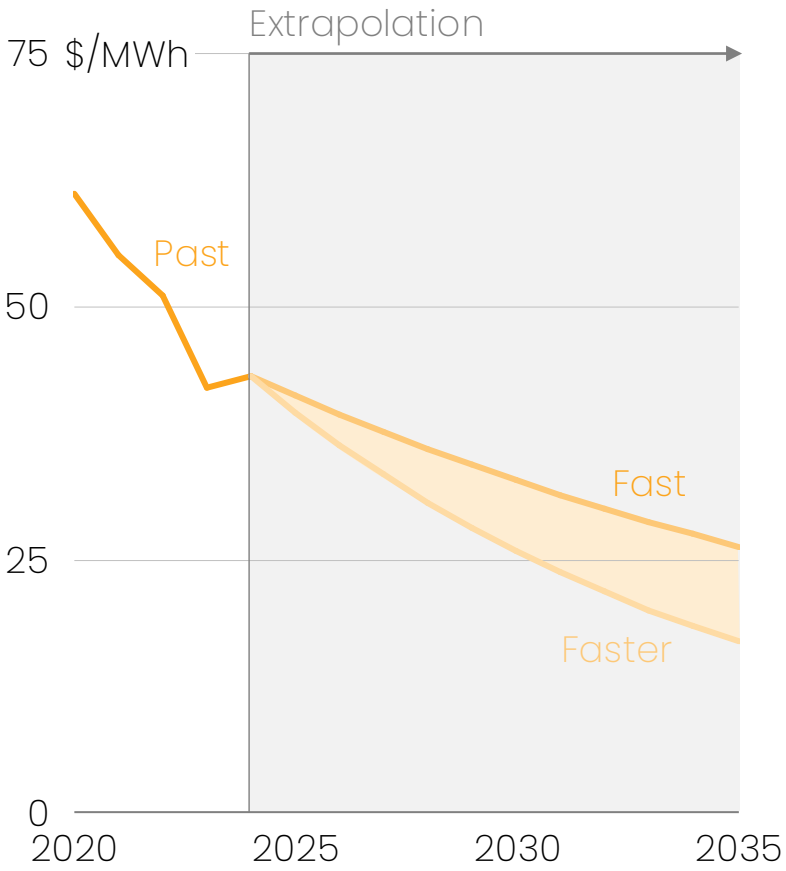
Electrotech will get cheaper driven by learning curves

From competitive to irresistible

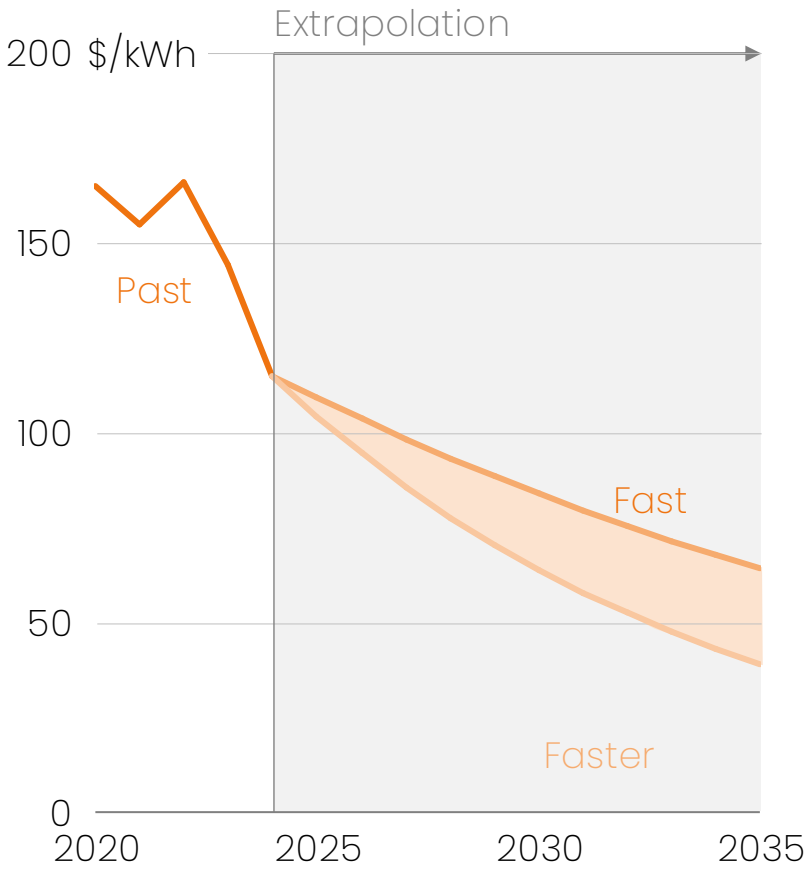
Wind costs



Solar costs



Battery costs



Sources: IRENA, BNEF, Ember Futures extrapolation based on learning rates; a method set out in detail by Oxford INET among others. Costs are derived by extrapolating historic growth rates and learning rates for each of the key technologies for the next decade. Solar assumes growth (g) of 15%-18% and learning rates (LR) of 20-30%. Wind 8-13%(g) growth 12-17% (LR). Batteries 19-22% g & 19-29% LR.

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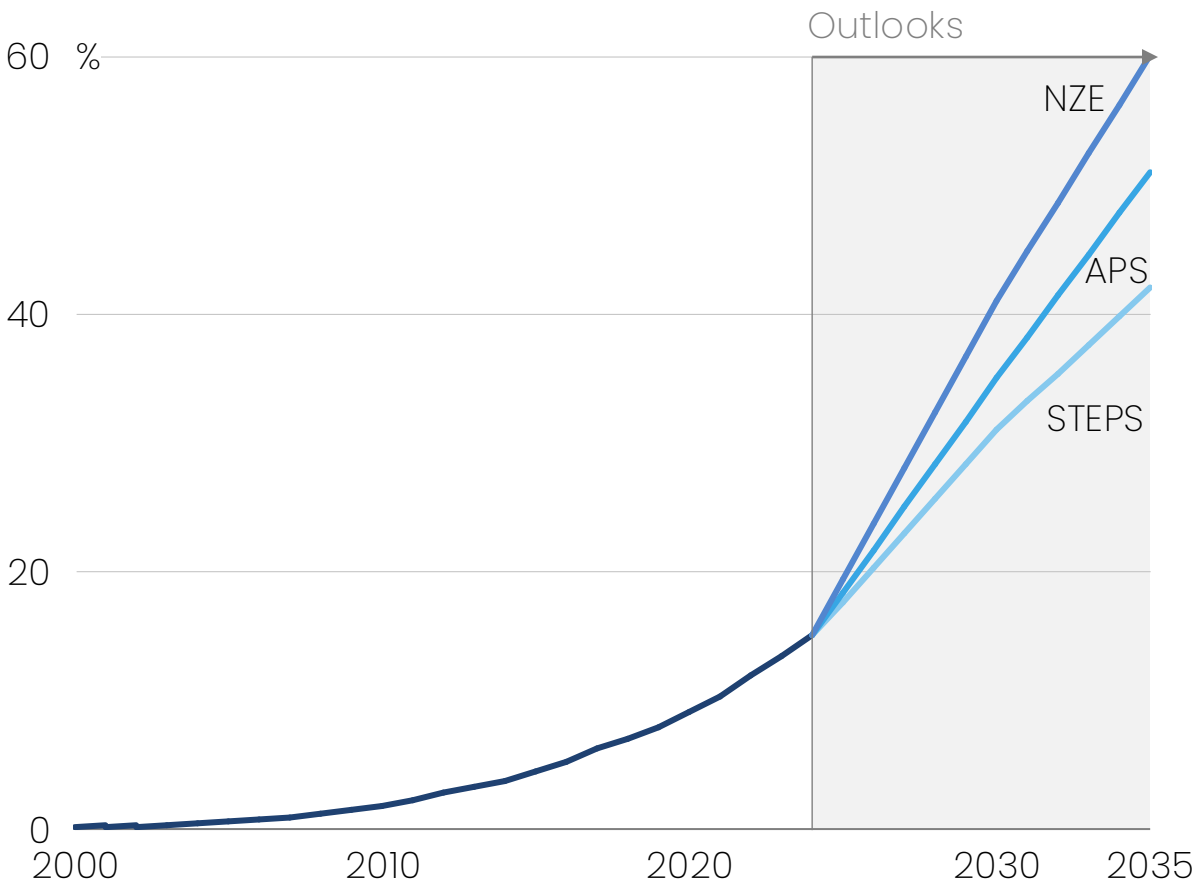
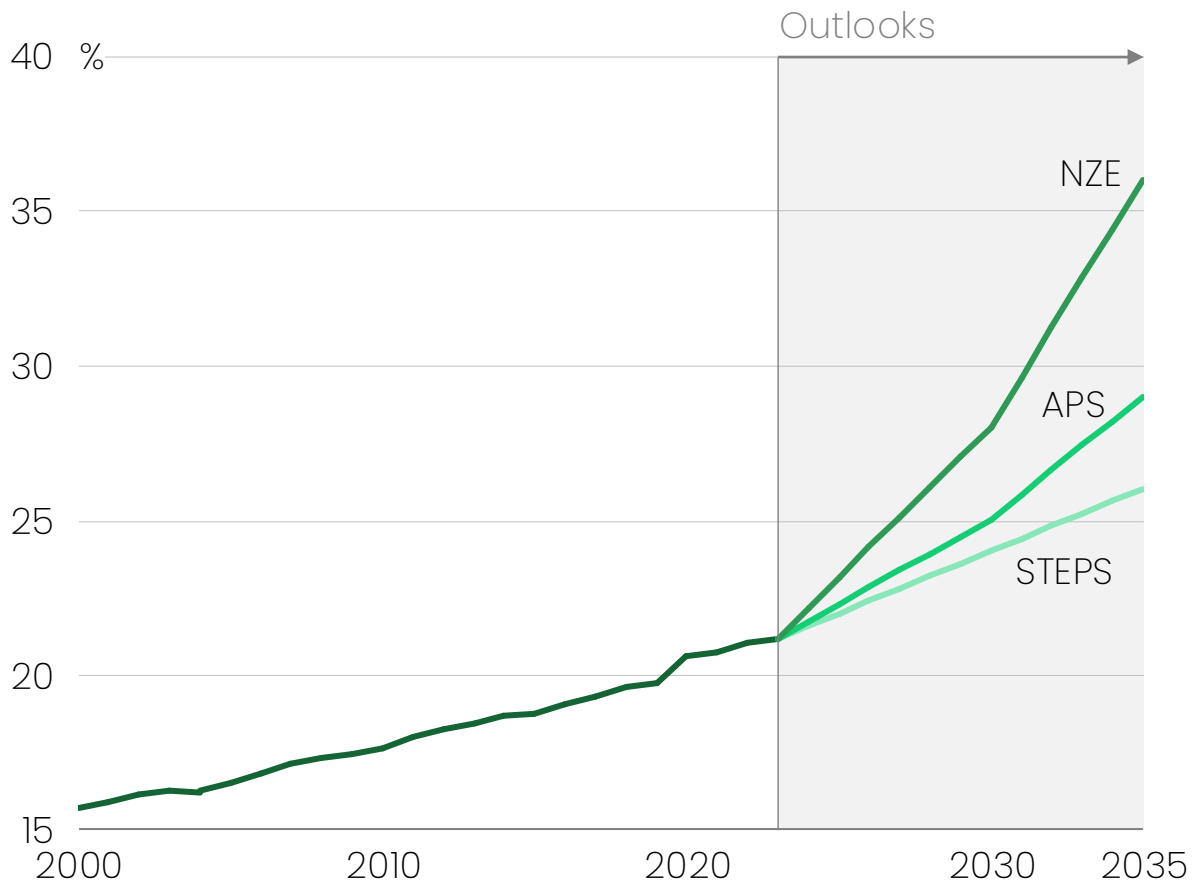
The future is renewables and electrification

The momentum will continue

Solar & wind share of global generation



Electricity share of final energy



Sources: Ember, IEA WEO scenarios. Note NZE stands for (Net Zero), Announced Policies (APS), Stated Policies (STEPS)

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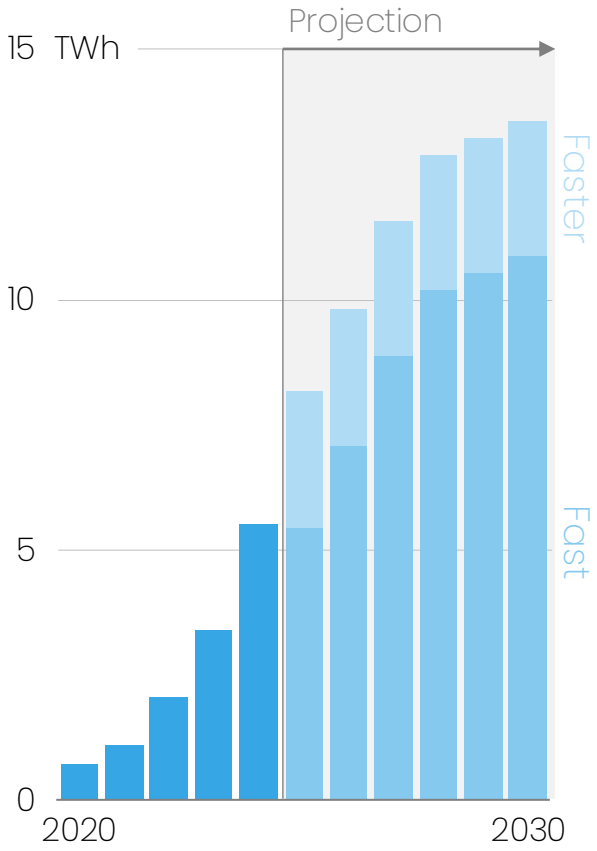
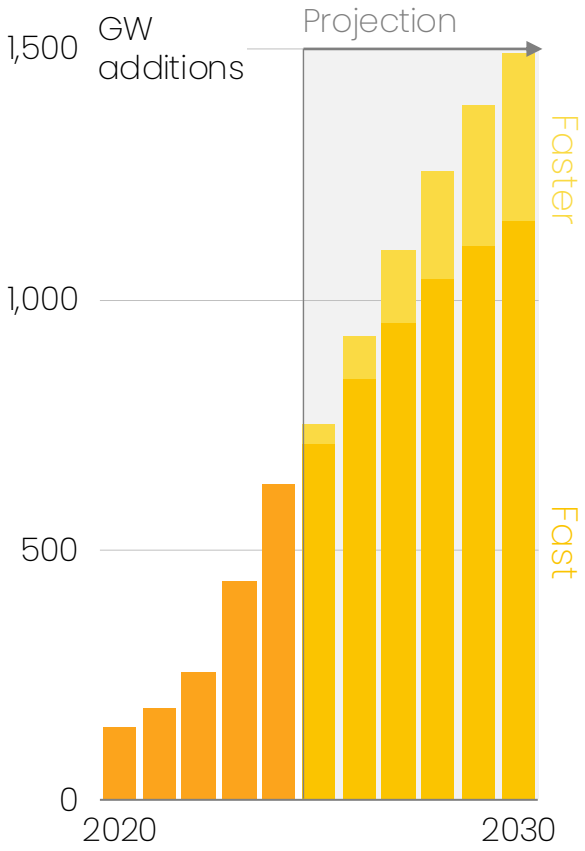
This is the decisive decade

A century in the making, electrotech will define this decade

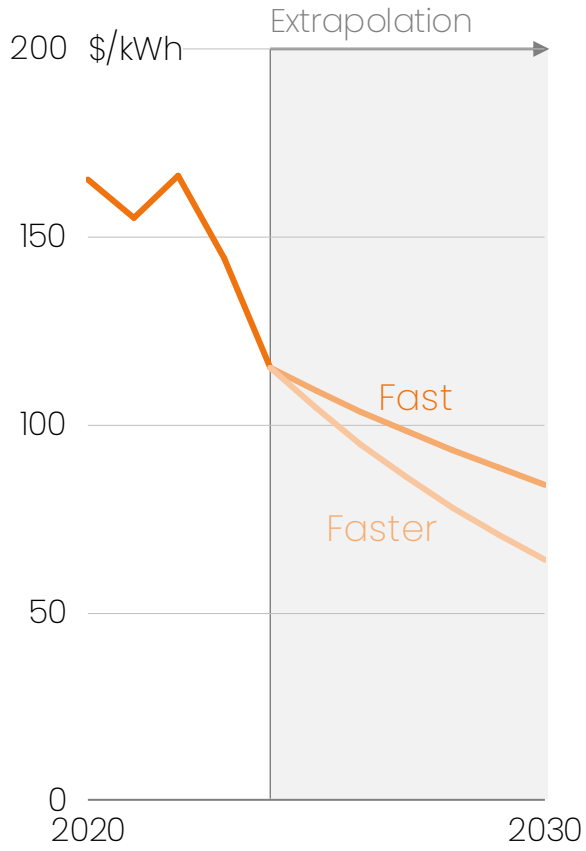
Manufacturing capacity is built: Batteries



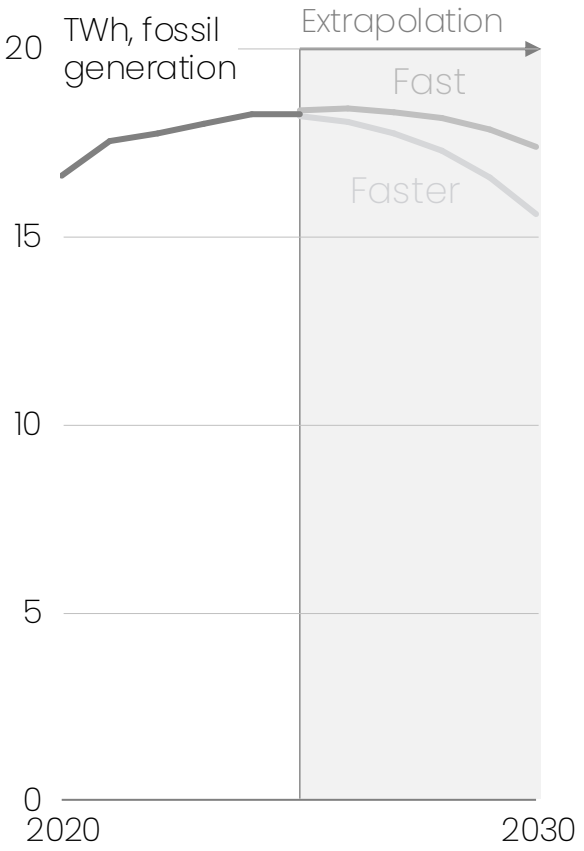
S-curves hit their steepest parts: Solar



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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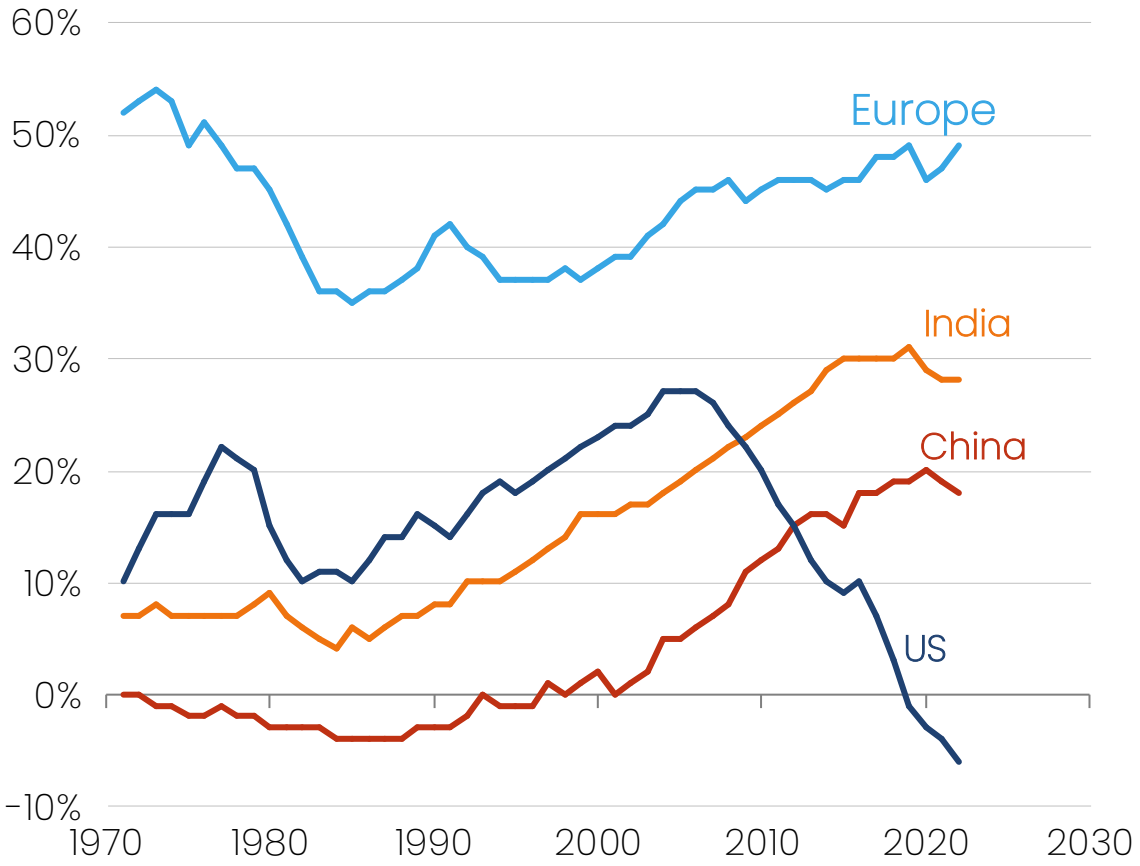
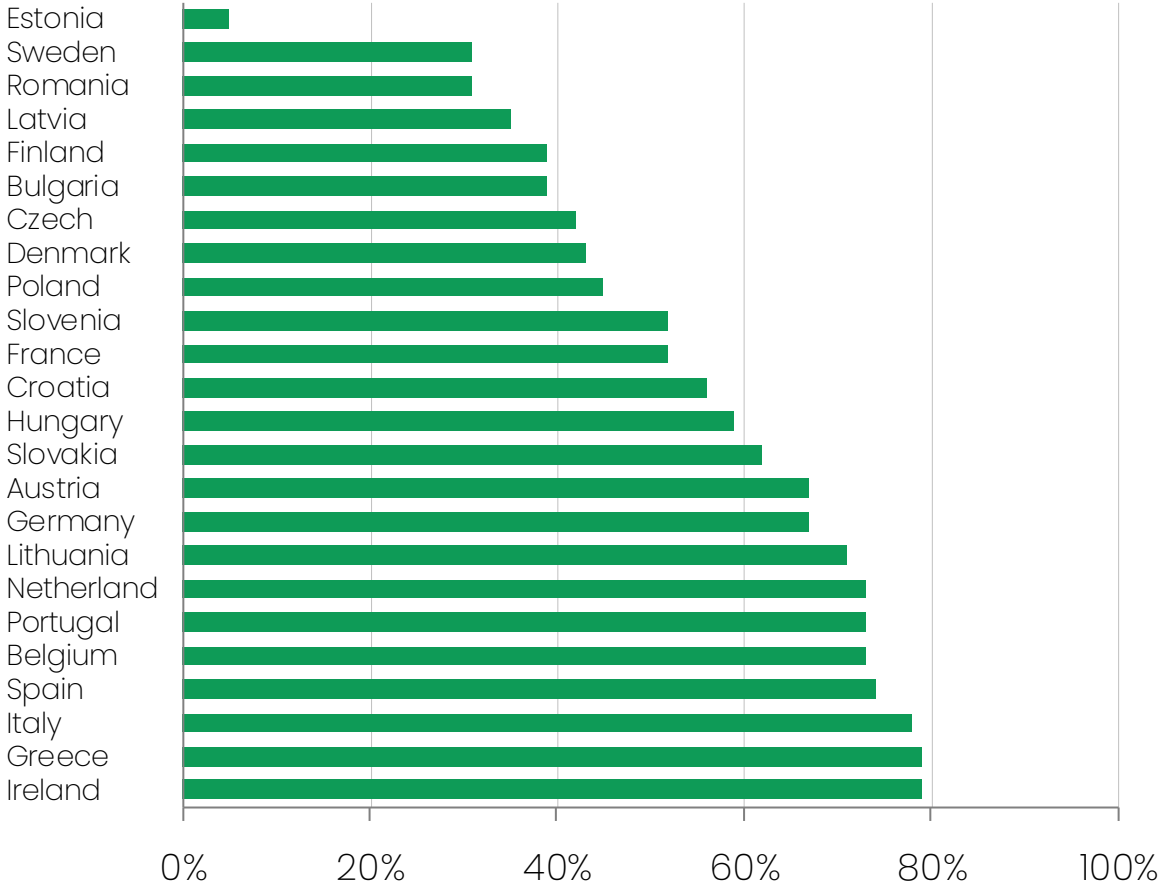
Europe is very poorly positioned for the fossil fuel system

Net fossil fuel imports as share of primary energy demand



Net fossil fuel imports as share of demand 2022

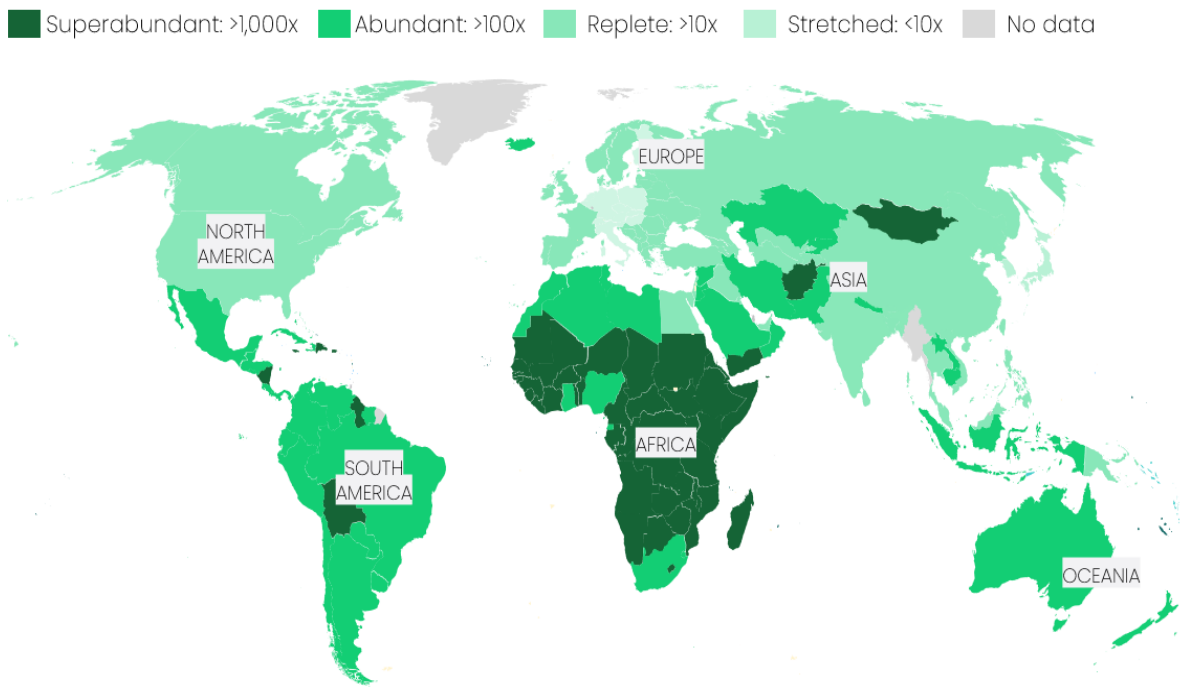


Sources: IEA WEB, Ember calculations for Greater Europe (I)

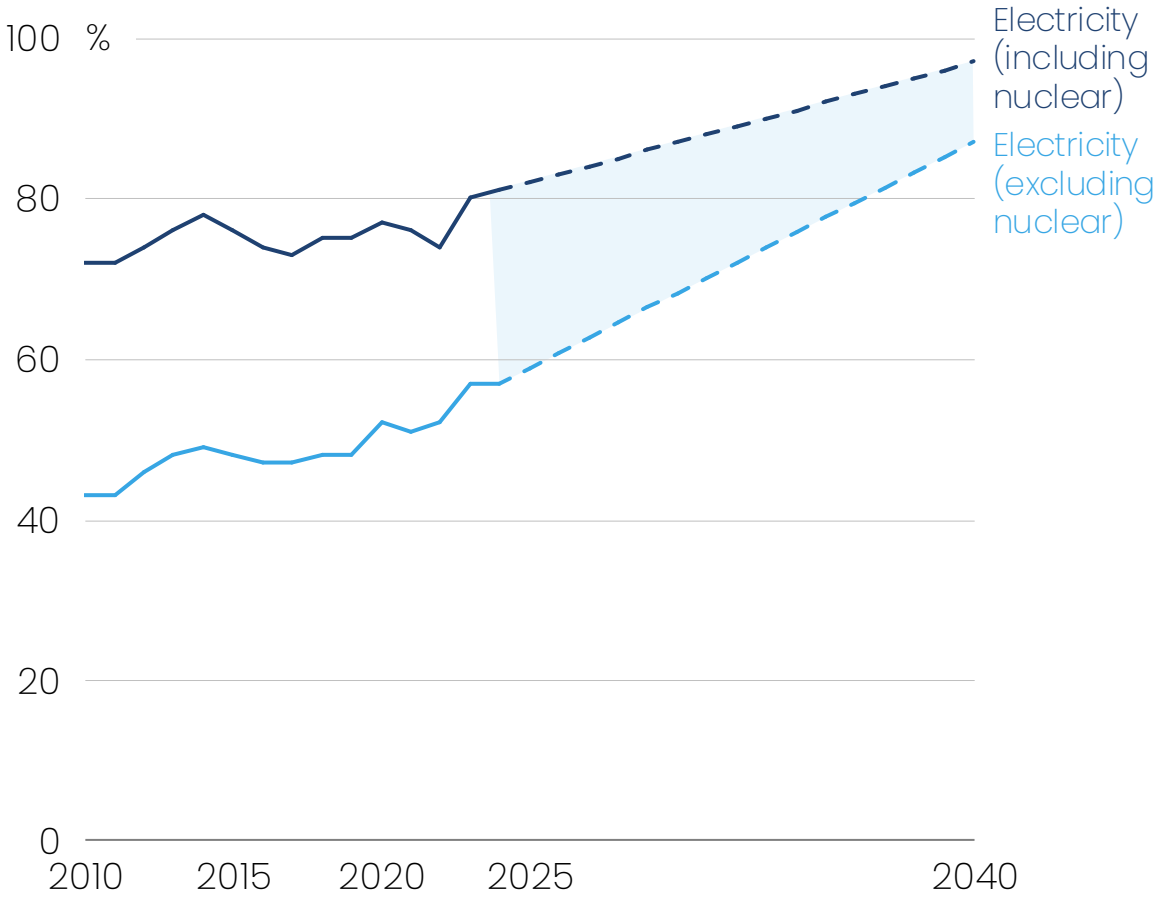
EMBER

Europe is well positioned to embrace electrotech

Renewable potential as a multiple of demand



Share of EU electricity from domestic sources



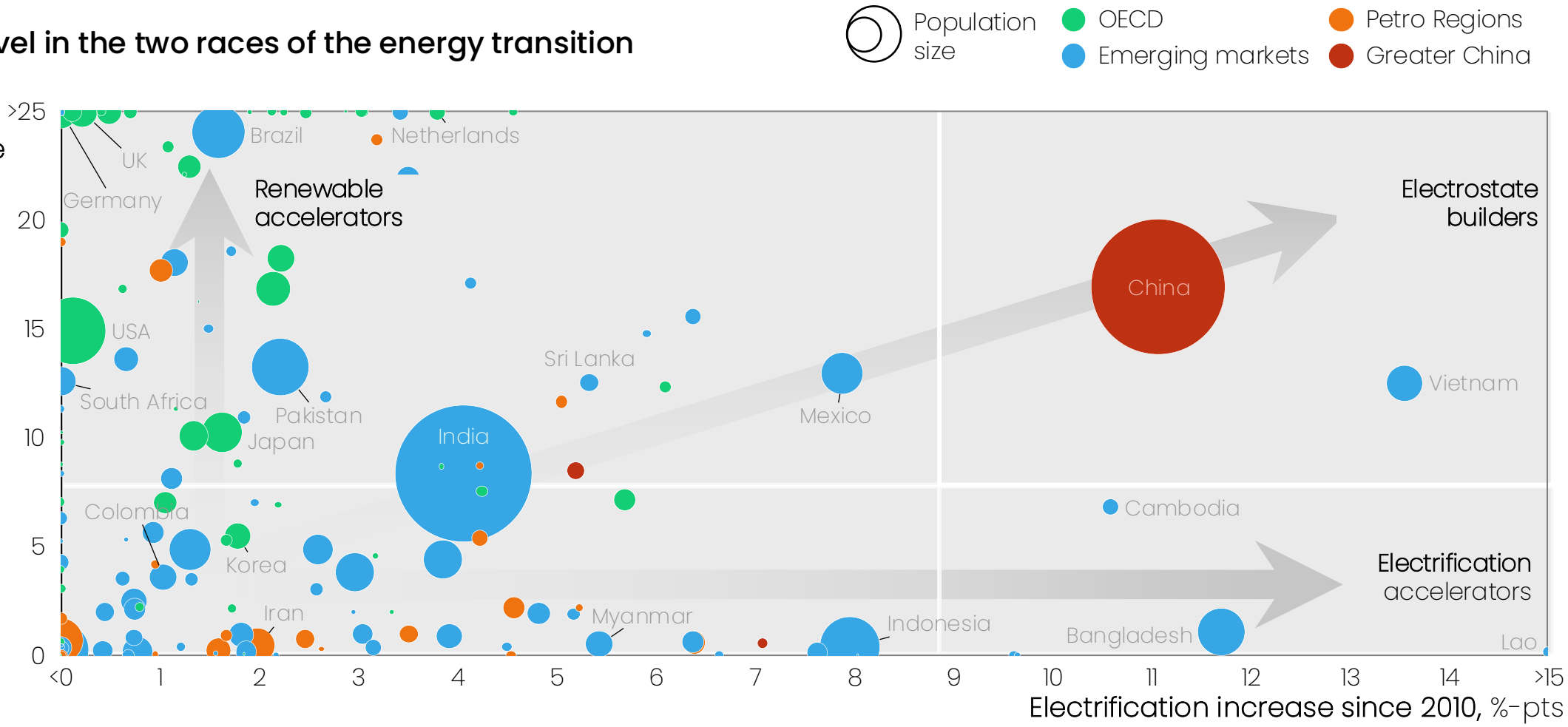
Sources: Carbon Tracker, Ember

EMBER

But Europe is falling behind in practice

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

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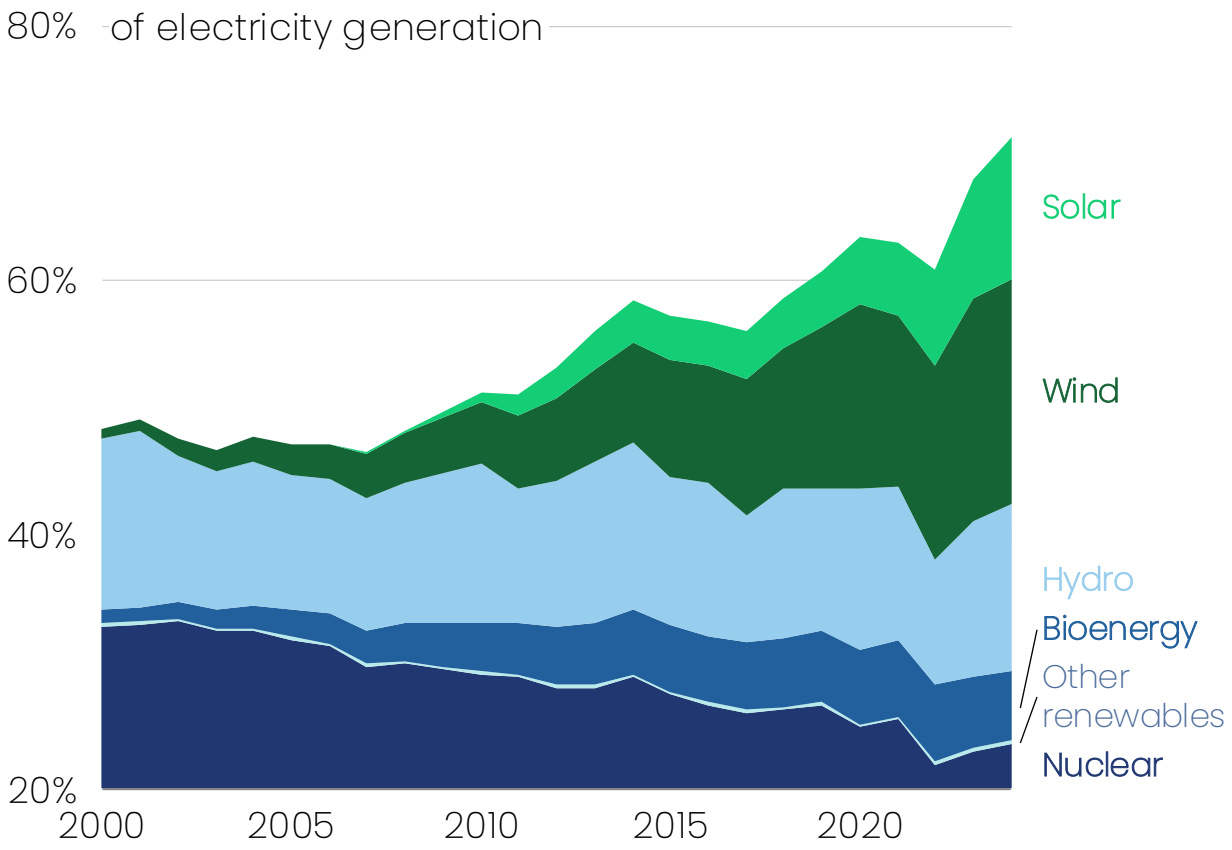
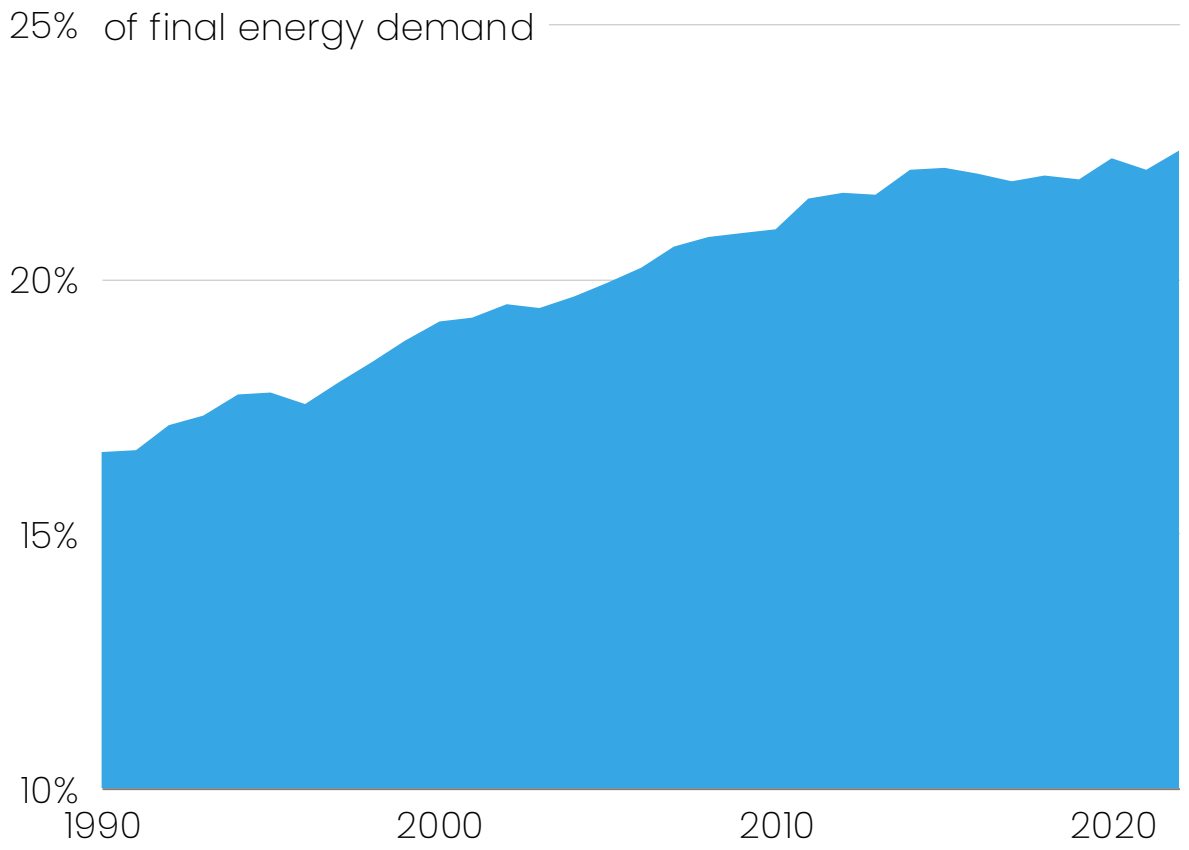
Europe needs to focus on electrification

Renewables was stage one and is on track; we need to focus on stage two which is electrification

1. EU Renewables



2. EU Electrification



Sources: Ember, IEA WEB

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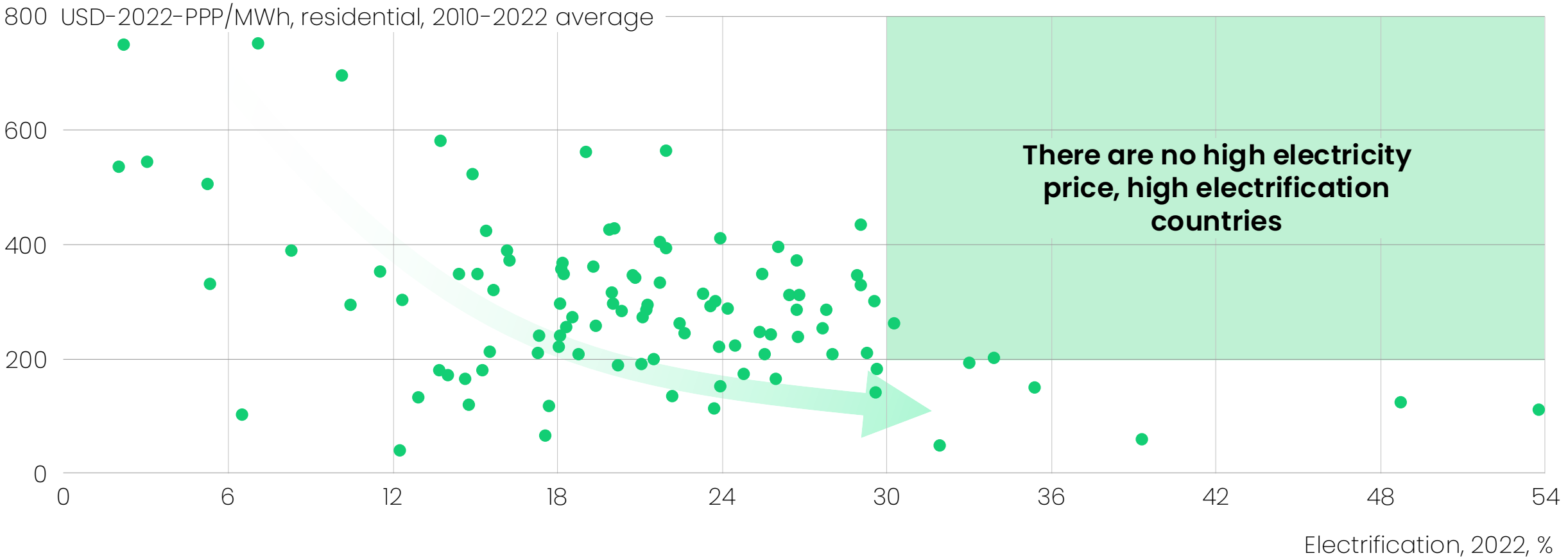
Reduce high electricity prices

Lower prices incentivise uptake

Electricity price



Sources: IEA; Ember analysis

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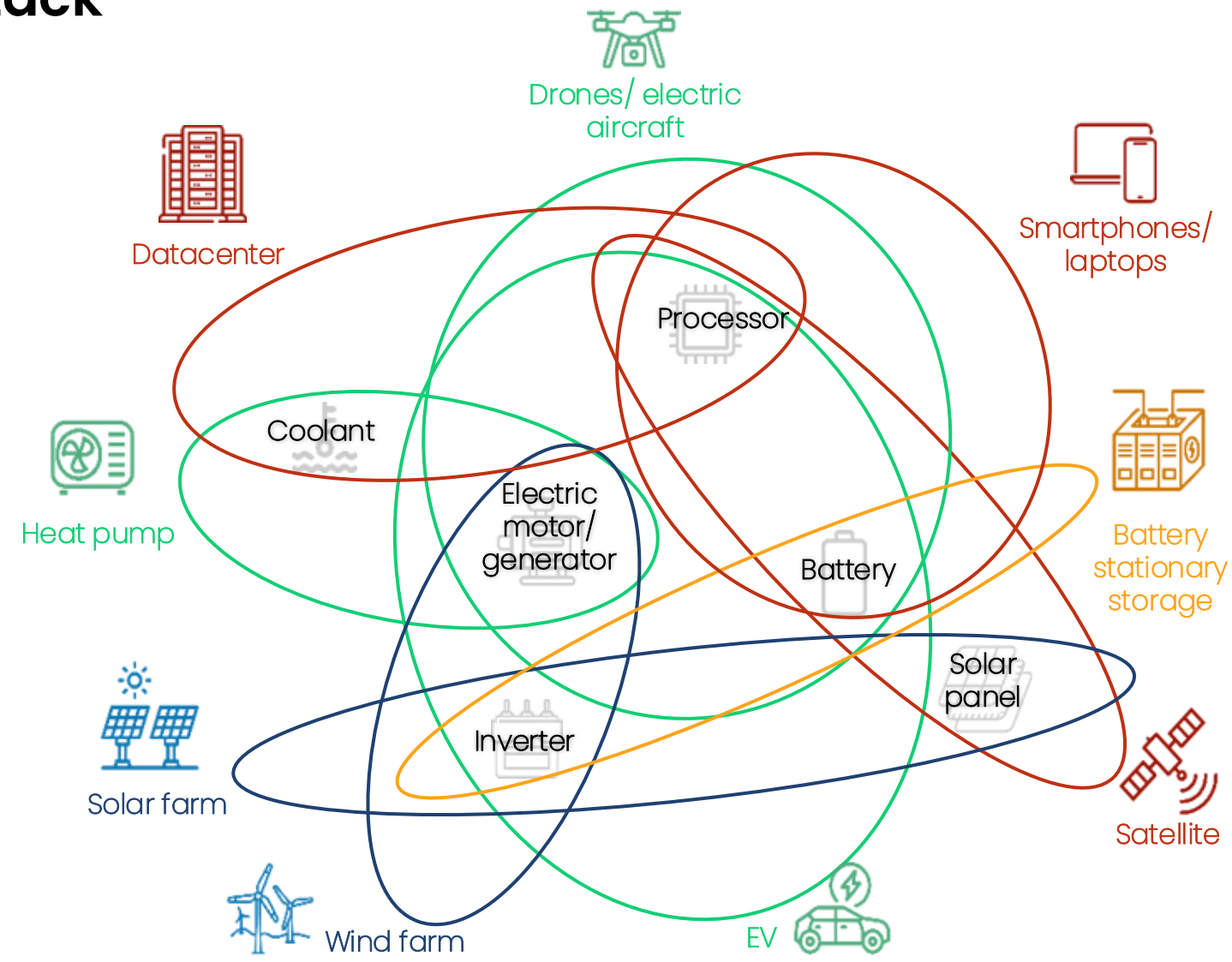
Build up the electrotech stack

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



Sources: Ember analysis

Focus on what works

We do not need to focus on endgame solutions in 2025

	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?
CCS	✗ **No**	✗ **No**	✗ **No**
Biofuels	✗ **No**	✗ **No**	✗ **No** **unless you are Brazil**
Green hydrogen	✗ **No**	✗ **Not really** **except for the electrolyser**	✓ **Yes** **unless imported**
Electrotech	✓ **Yes**	✓ **Yes**	✓ **Yes**

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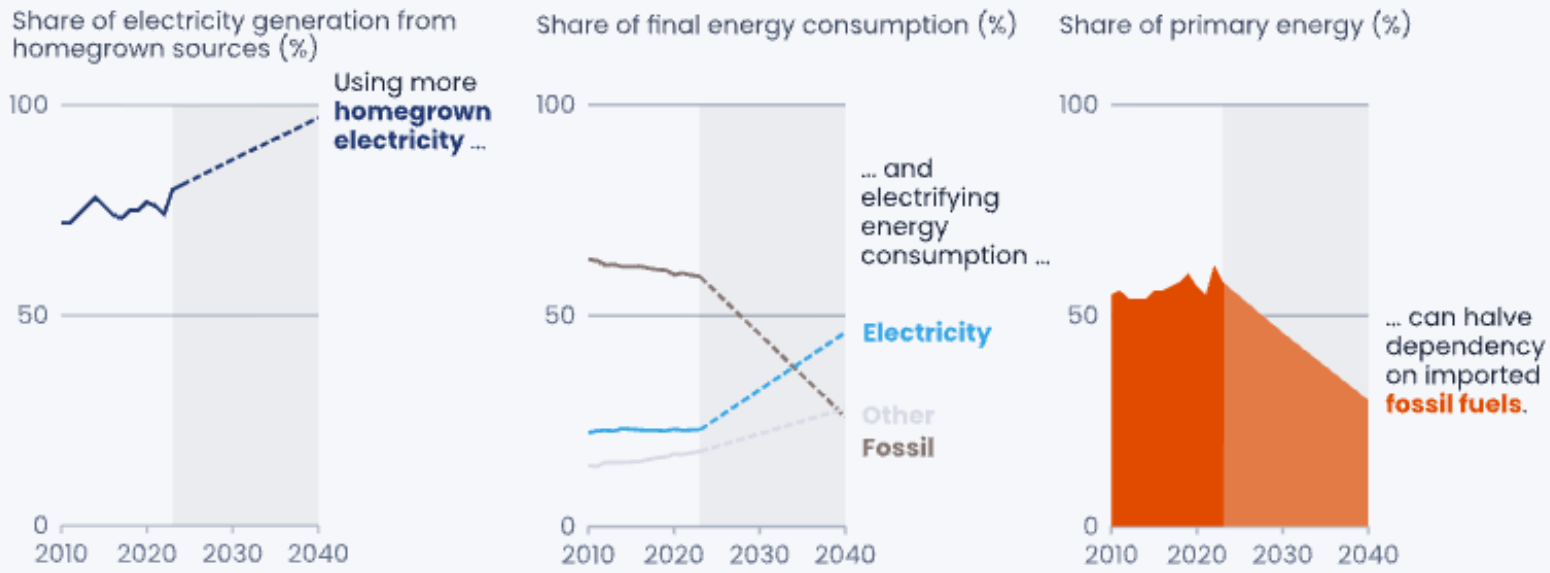
Electrotech will dramatically reduce our energy dependency

Homegrown clean power and electrification can halve EU fossil import dependency by 2040



Source: Ember, Eurostat, European Commission
Homegrown electricity generation includes renewables, fossil fuels sourced in the EU, and nuclear. Fossil import dependency represents the share of imported fossil fuels in primary energy.

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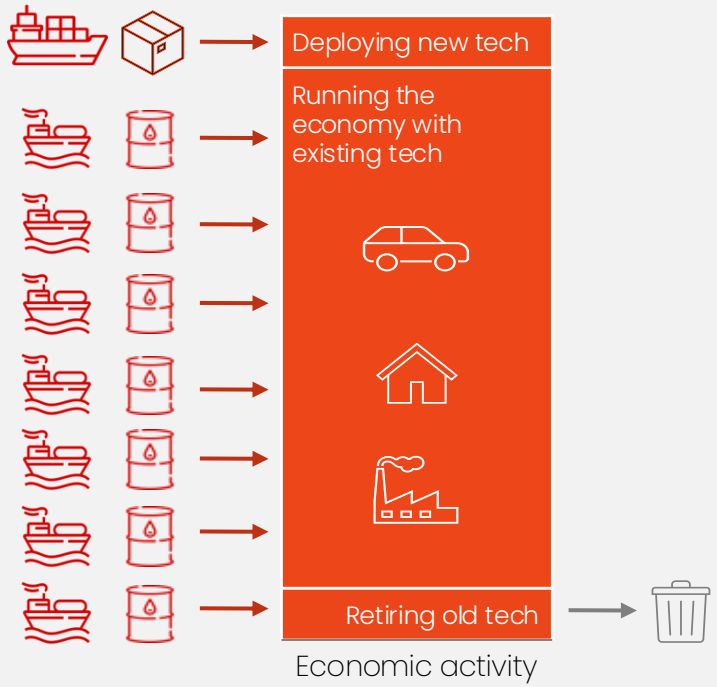
Electrotech offers a path to permanent energy security

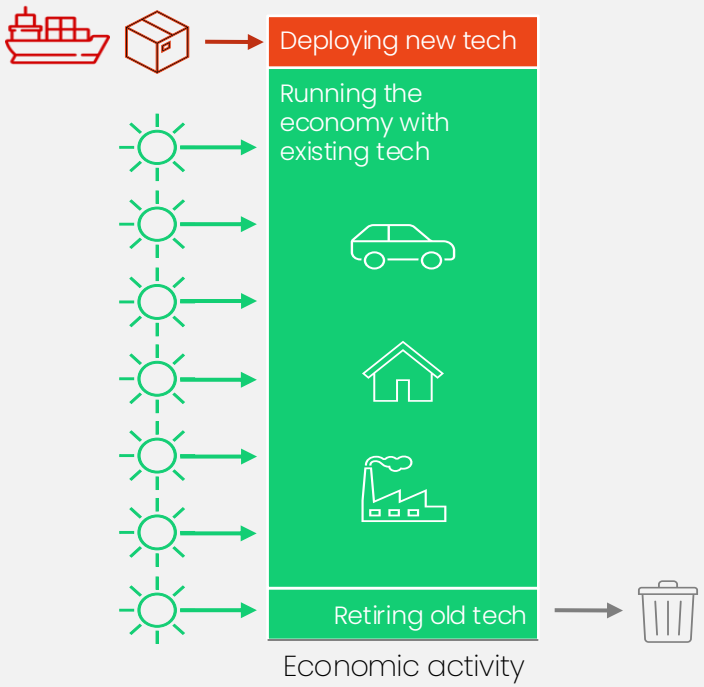
When fossil flows stop, the economy stops. When electrotech flows stop, only growth is at risk

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

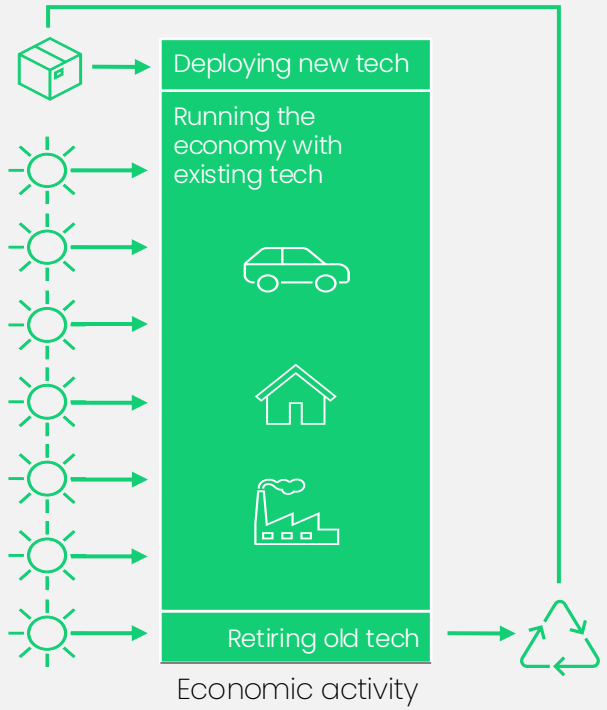
In an economy running on fossil imports, **when imports stop, all activity stops**



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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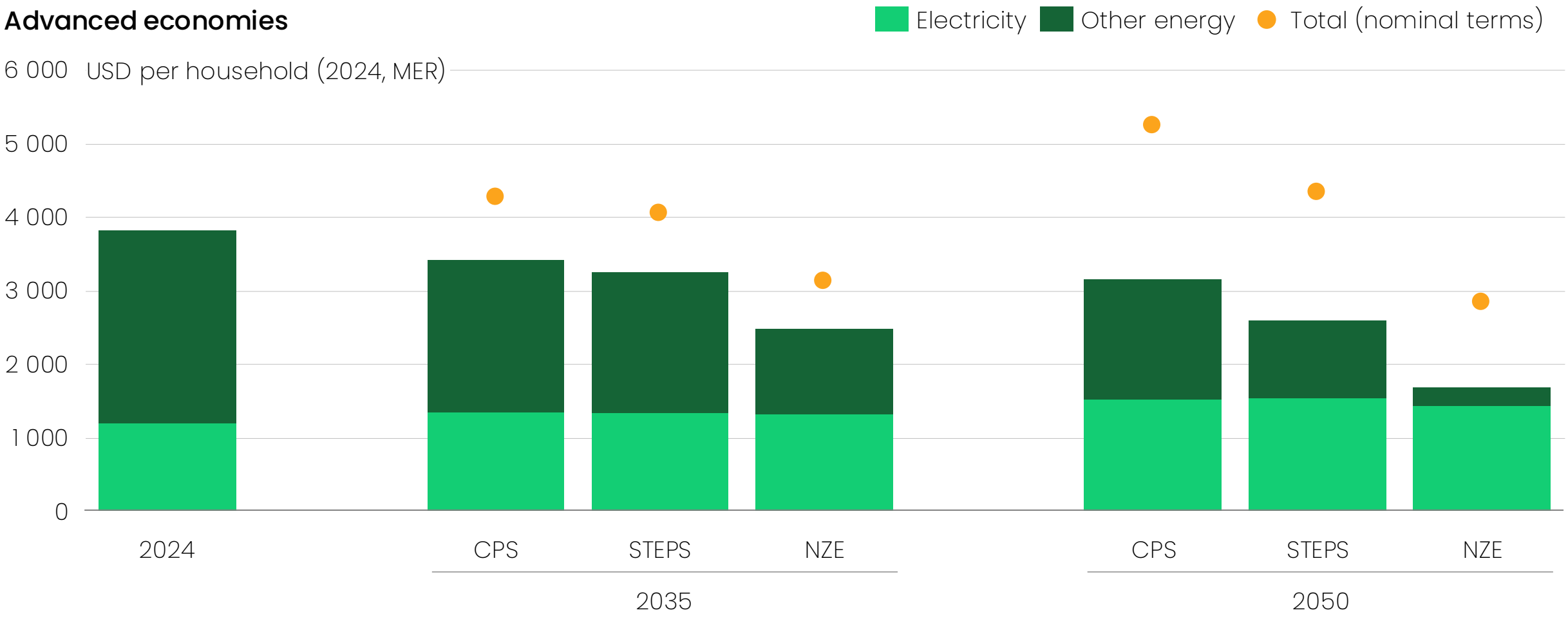
Electrotech will enable us to halve energy prices for European consumers

Electricity and total household energy bills by region and scenario, 2024, 2035 and 2050



Sources: IEA WEO 2025

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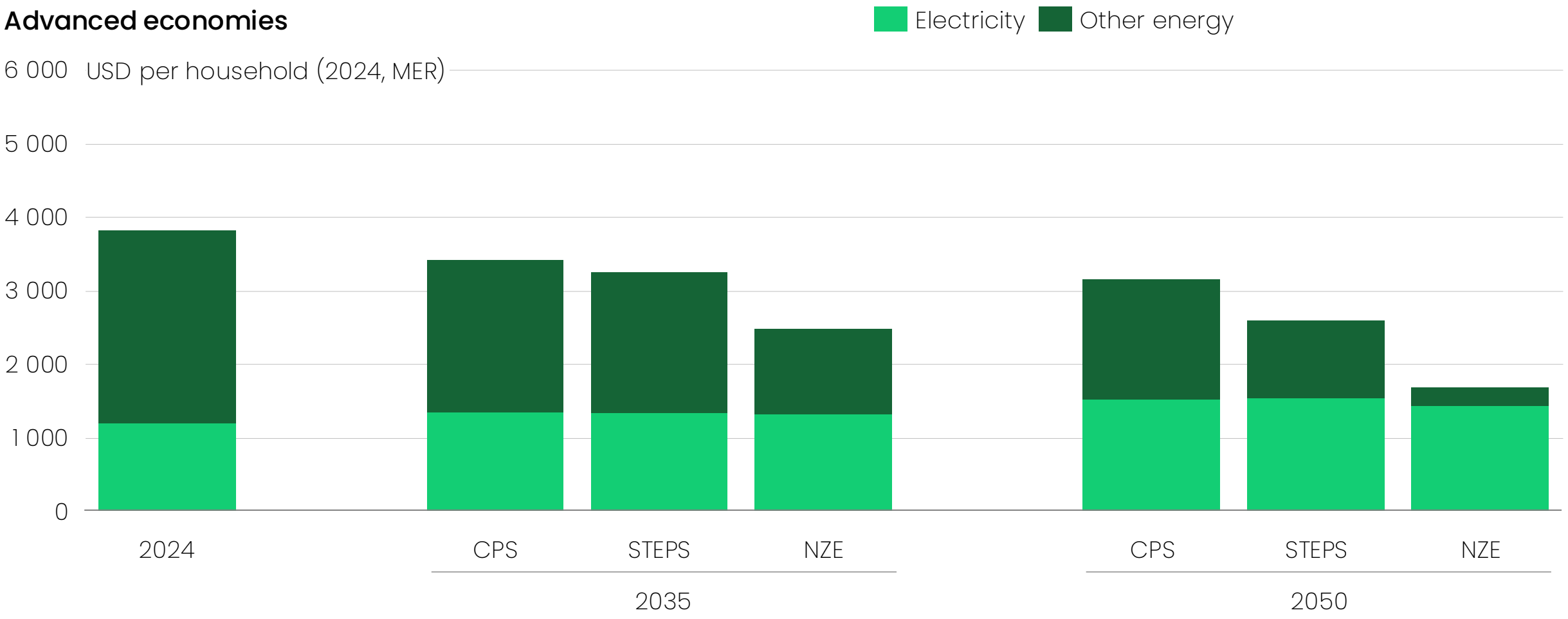
Electricity and total household energy bills by region and scenario, 2024, 2035 and 2050



Sources: IEA WEO 2025

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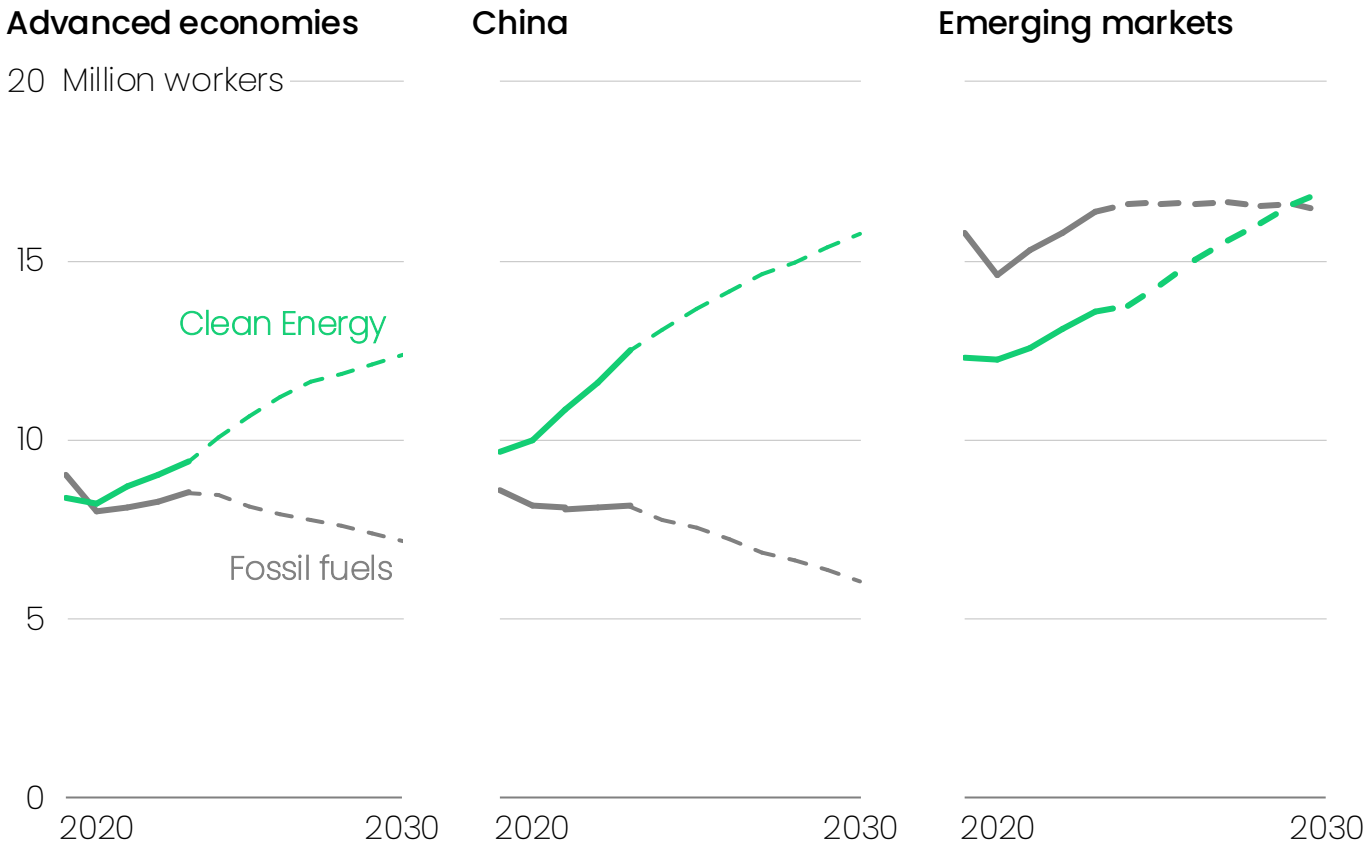
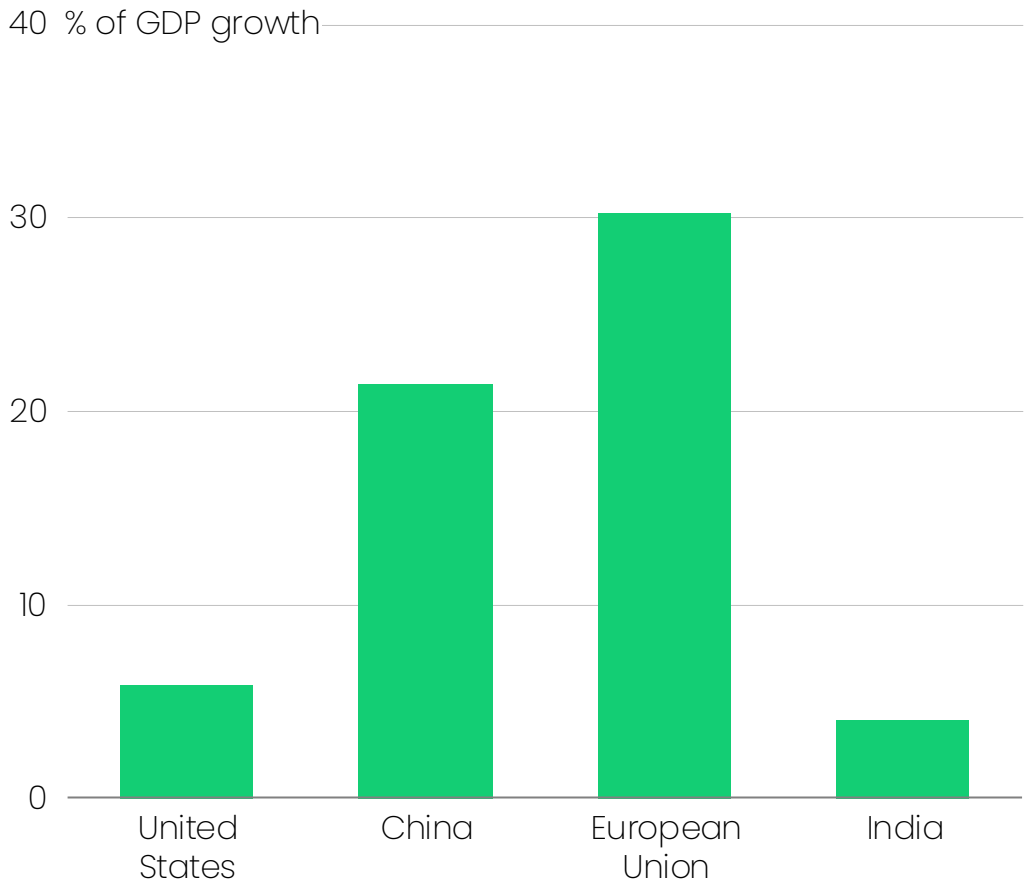
Open up the industries of the future to European companies and workers

Winning at electrotech means gaining cheap energy, jobs, growth, and future industries

Change in energy employment, 2019-2030



Contribution of cleantech to GDP growth, 2023



Sources: IEA World Energy Employment 2024 for STEPS scenario (I), IEA ETP

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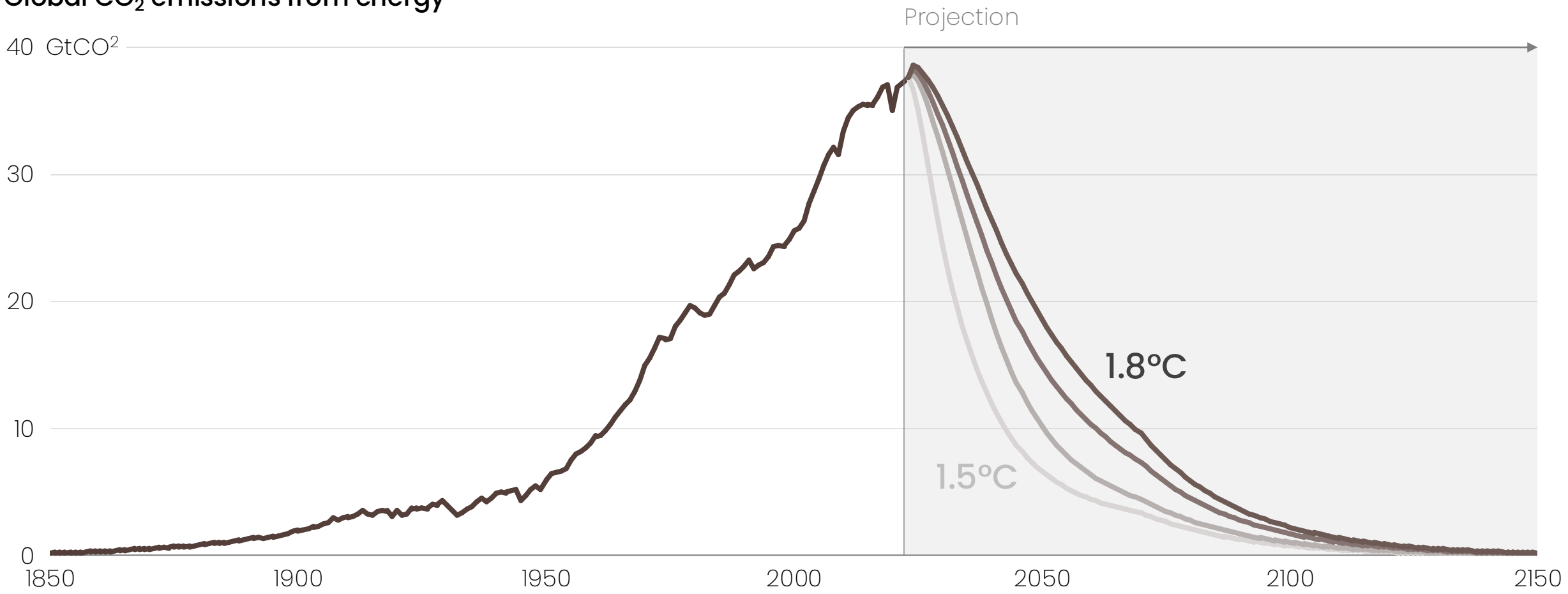
And cut emissions

The faster electrotech grows, the faster emissions will fall

Global CO_2 emissions from energy



Sources: Global Carbon Project, OWID (1850-2023), Rystad Energy to 2023-2070; RMI illustrative onwards.

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