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Energy Security in an Insecure World

The New Electrotech Strategy

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The electrotech strategy to energy security (1/2)

Rising fossil import dependence. Since 1960, fossil fuel imports have grown twelvefold, now supplying over one-third of all primary energy as of 2022. Today, three-quarters of the global population live in net fossil-importing nations. This includes all of Greater China, South Asia, and Northeast Asia; 99% of Europeans; two-thirds of Africans; and nearly half the populations of Southeast Asia and Latin America.

Some nations are especially exposed. In 52 countries, fossil fuel imports account for more than half of primary energy use. In economies representing 20% of global GDP—including Germany, Japan, and Italy—imports supply over two-thirds of total energy demand.

Global trade is under threat. The decline of the Pax Americana, rising regional conflicts, increasingly contested maritime routes, and intensifying tariff wars have placed global trade under greater threat than at any time since World War II.

From dependency to vulnerability. What was once seen as efficient interdependence has become a national security liability. If energy imports were cut off, three-quarters of the world's economies would grind to a halt—trucks would stop, factories would shut down, and lights would go dark.

The new security strategy: electrotech. Prudent nations are pursuing a two-pronged strategy: shifting energy supply to local renewables and directing energy use toward domestically generated electricity. With renewable potential 120 times greater than fossil fuels—and available everywhere—energy independence is within reach for every nation.

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The electrotech strategy to energy security (2/2)

Electrotech can slash imports and minimise security risks. Three key levers—electric vehicles, heat pumps, and renewables—can cut net fossil fuel imports by 70%, saving importers $1.3 trillion per annum globally. The largest gain comes from EVs replacing oil in road transport (one-third). Scaling solar and wind to displace fossil fuels in power generation can save another 23%, while heat pumps replacing imported fossil fuels for buildings adds a further 14%.

Electrification is the largest driver of energy independence. Over three-quarters of global fossil fuel imports are for end use sectors, such as oil for transport and gas for heating. Electrification can eliminate the need for such imports.

China has a strategic lead. China is rapidly deploying electrotech, curbing its fuel imports, while gaining industrial and military advantages over the West. As the US restricts Chinese electrotech imports, China is extending its influence by deploying these technologies throughout the Global South.

New dependencies are not comparable to old. Unlike fossil *fuels*—which must be imported and burnt continuously—electro *technologies* require a single import to achieve secure energy for 30 years. Even diversified fossil imports will always be less dependable than the sun rising.

Act before the lights go out. Countries must act swiftly to localise electricity generation, electrify end uses, and enhance efficiency. That requires doubling down especially on electrification, and avoiding increased reliance on fossil fuel imports in growing economies.

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Energy Security in an Insecure World *in six numbers*

37%

Total primary energy demand that comes from imported fossil fuels

52

Countries importing over 50% of their primary energy from fossil fuels

25%

Share of global population spending over 5% of GDP on fossil fuel imports

$1.8 trillion

Global import spending on fossil fuel by net importers

92%

Countries that have over 10x as much renewables potential as energy demand, and can therefore easily be energy independent

70%

Potential fossil import reduction of importers through just three levers: electric vehicles, heat pumps and renewables

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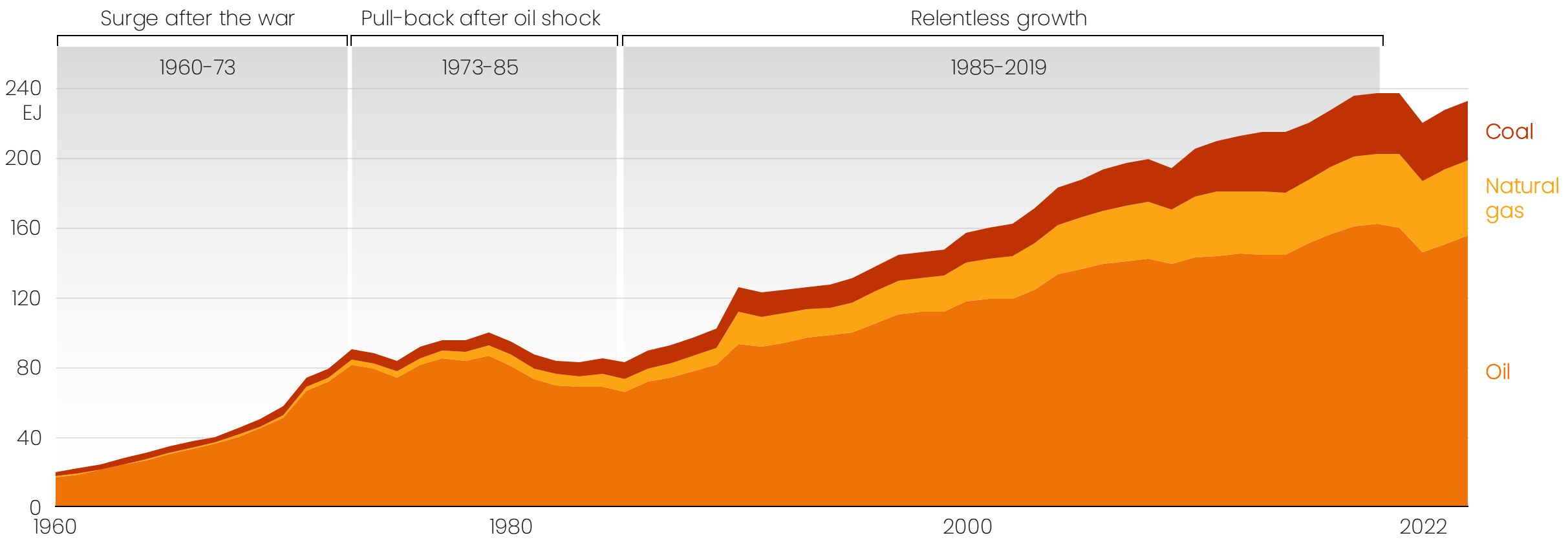
Fossil fuel imports have increased 12-fold since 1960

Imports of fossil fuels are over a third of primary energy demand

Fossil fuel imports, global



Sources: IEA WEB, Ember

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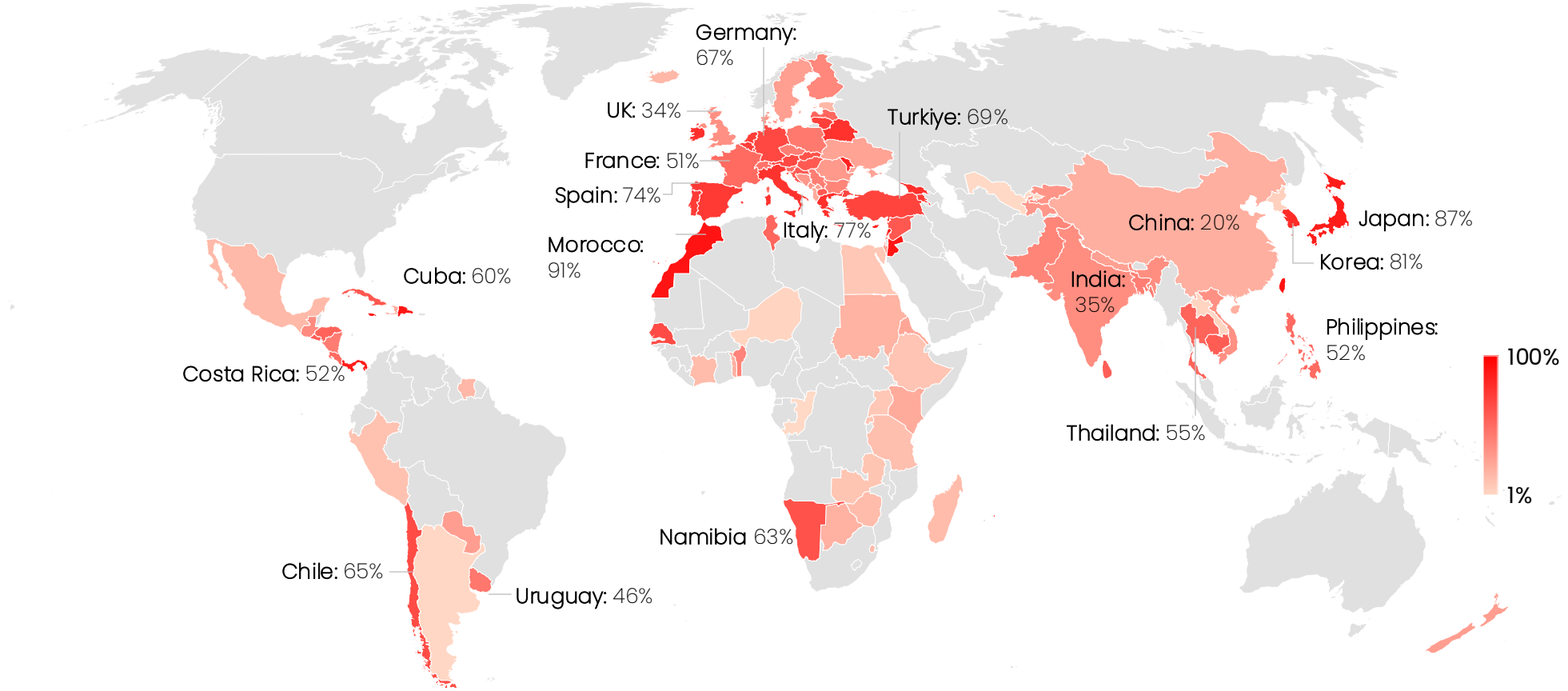
Fossil import dependency is widespread

52 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 illustrative and do not imply any judgment on legal status or sovereignty.

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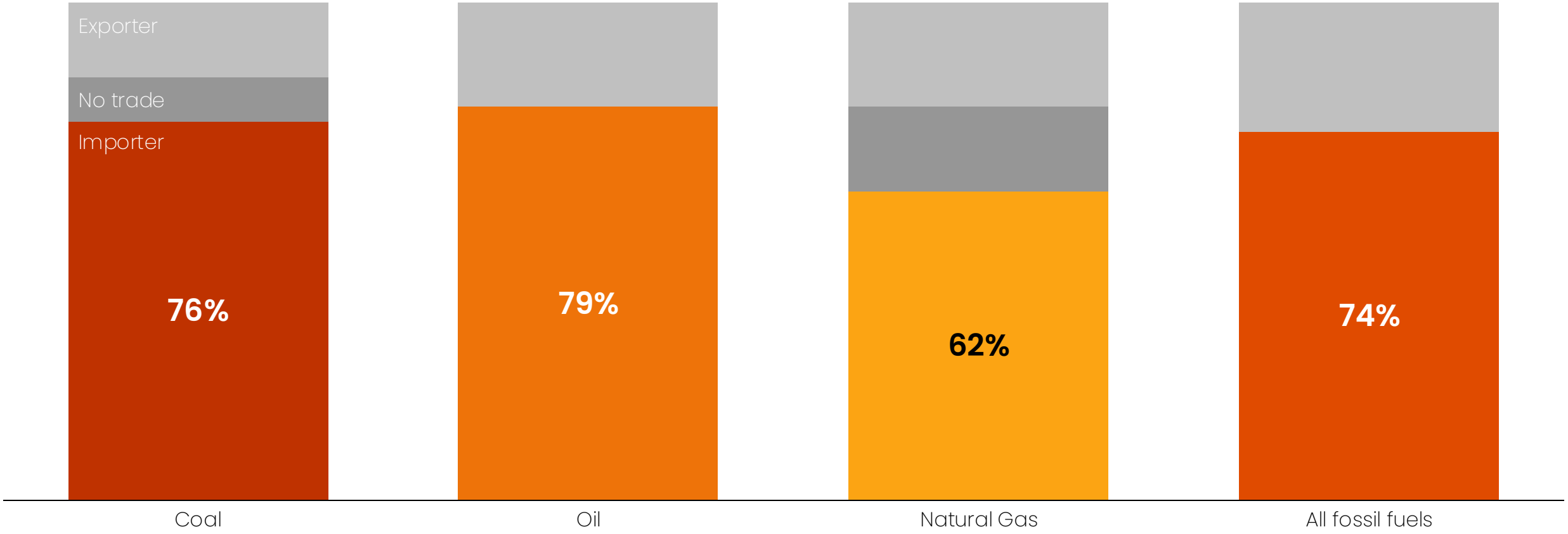
Three quarters of people live in net energy importers

The lottery of geography leaves most nations dependent on foreign supplies of fossil fuels

Share of population living in net importers by fuel type, 2022



Note: net importers are countries with a negative energy trade balances.
Sources: IEA WEB, Ember

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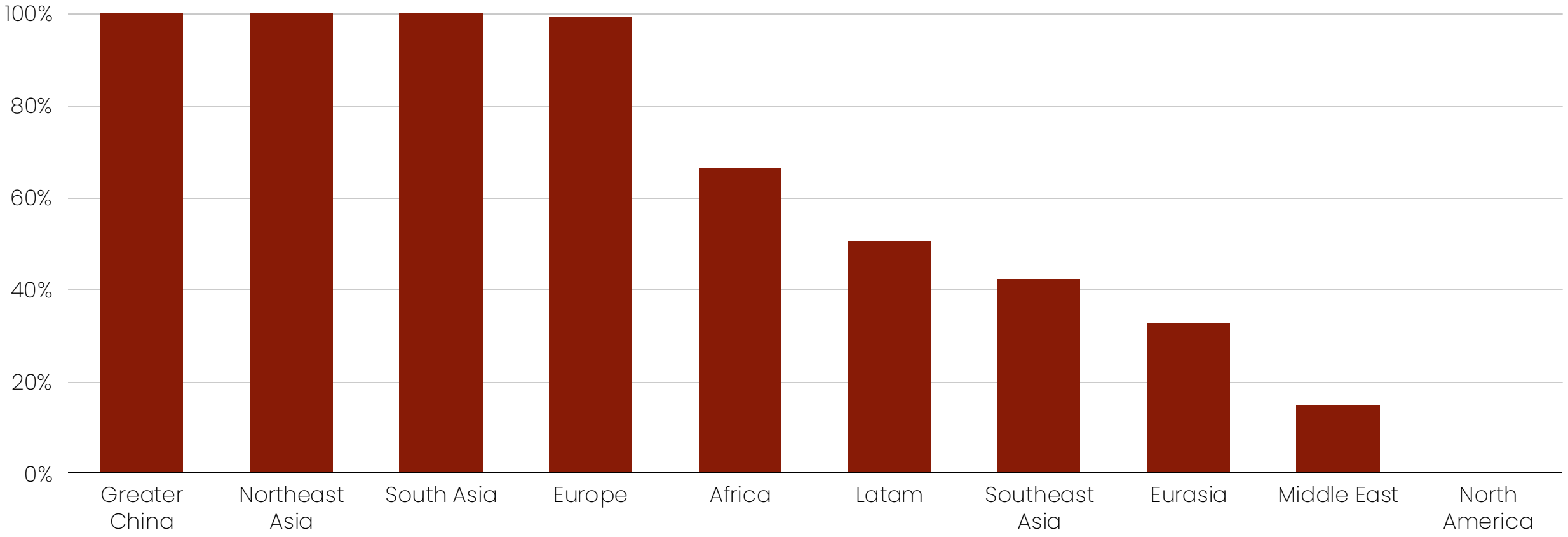
Asia is the most exposed to fossil import risk

North America is the only region where nobody lives in a fossil fuel importing country

Share of population living in fossil fuel importing countries, 2022



Sources: IEA WEB, Ember

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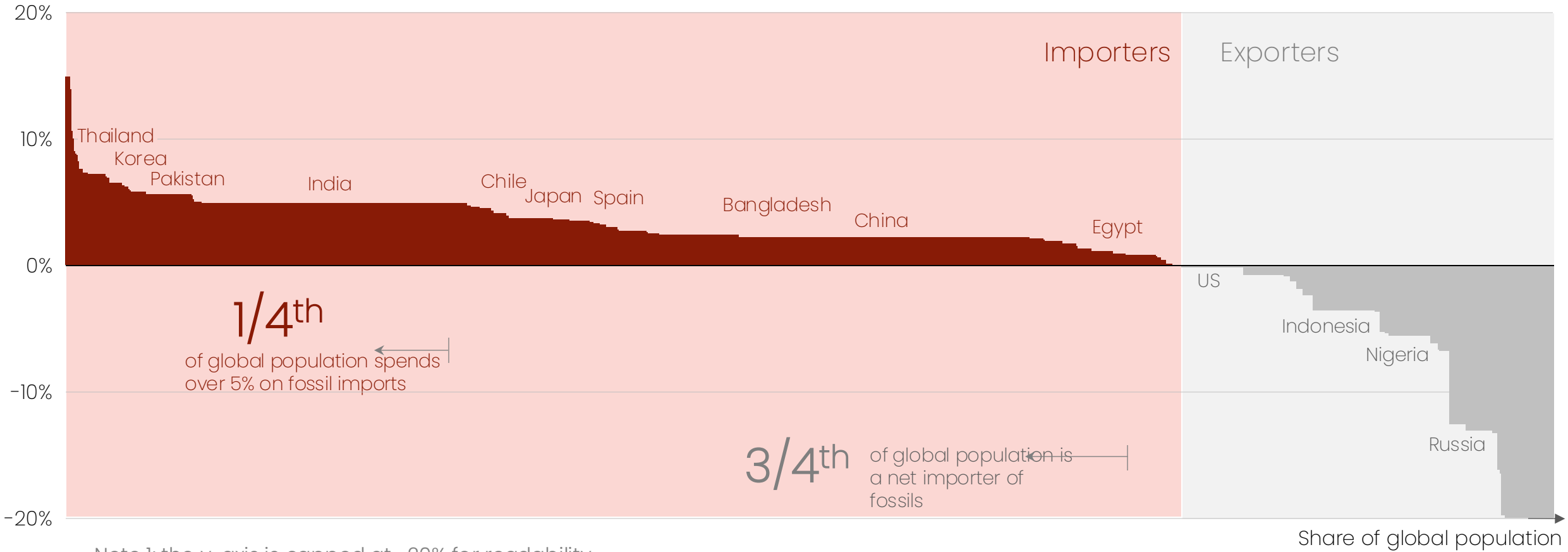
Fossil import dependency is expensive

A quarter of the world spends over 5% of GDP on annual fossil fuel imports

Fossil fuel net imports (-) and exports (+) value as share of GDP, 2022



Note 1: the y-axis is capped at -20% for readability.
Note 2: GDP balance based on energy trade balances in EJ from 2022, multiplied by typical commodity prices from IEA.
Sources: IEA WEB, Ember analysis

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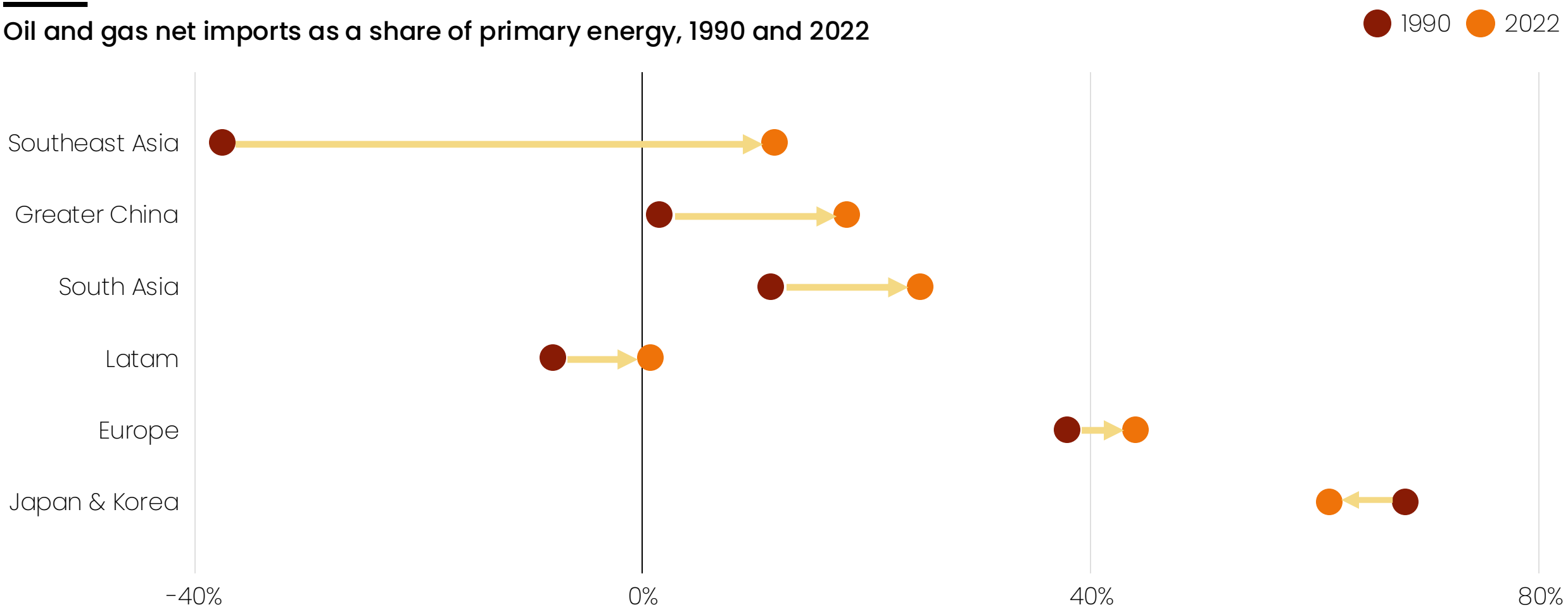
Fossil import dependency is deepening among importers

Asian exposure in particular is high and set to rise further

Oil and gas net imports as a share of primary energy, 1990 and 2022



Note: Latam excludes Venezuela.
Sources: IEA, Ember

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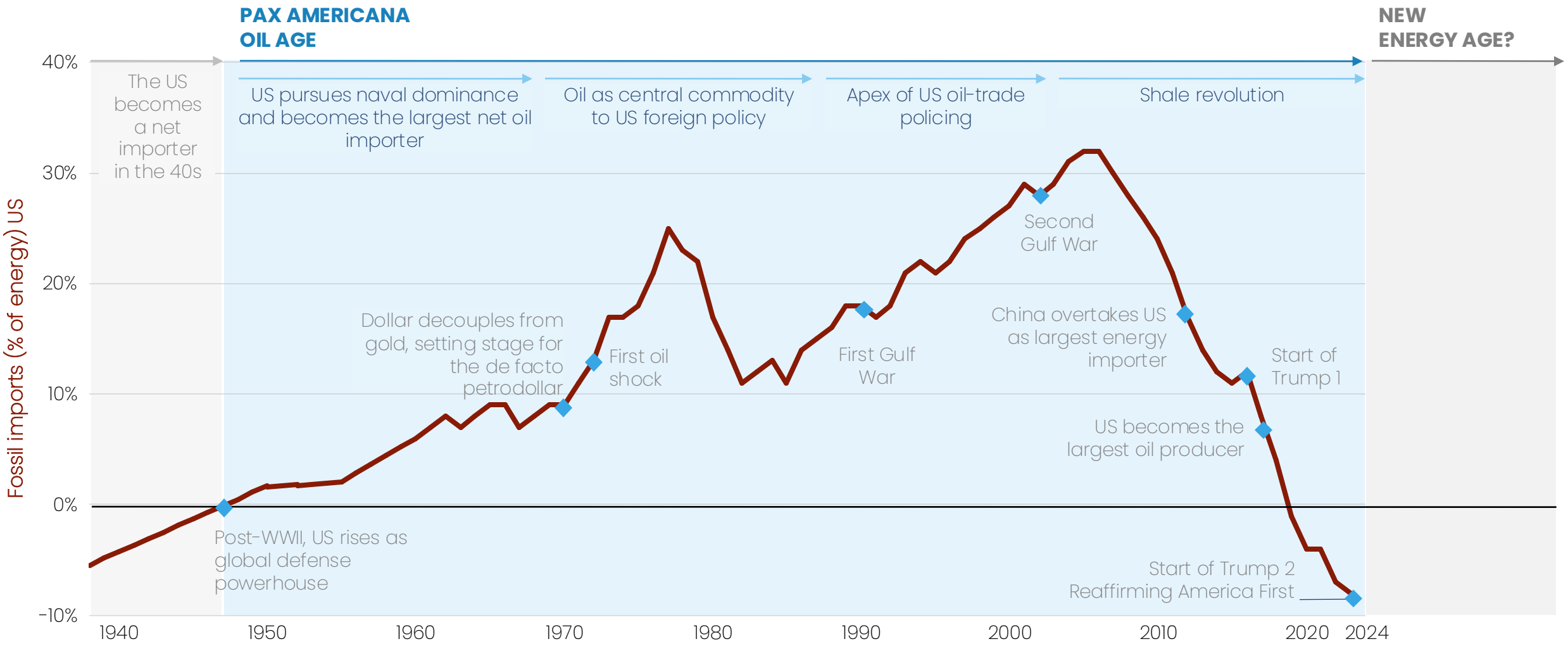
The United States has built its own fossil fortress

For the first time since 1945, the U.S. is energy independent



Sources: IEA WEB, Darmstadter, Carlyle The New Joule Order, Ember

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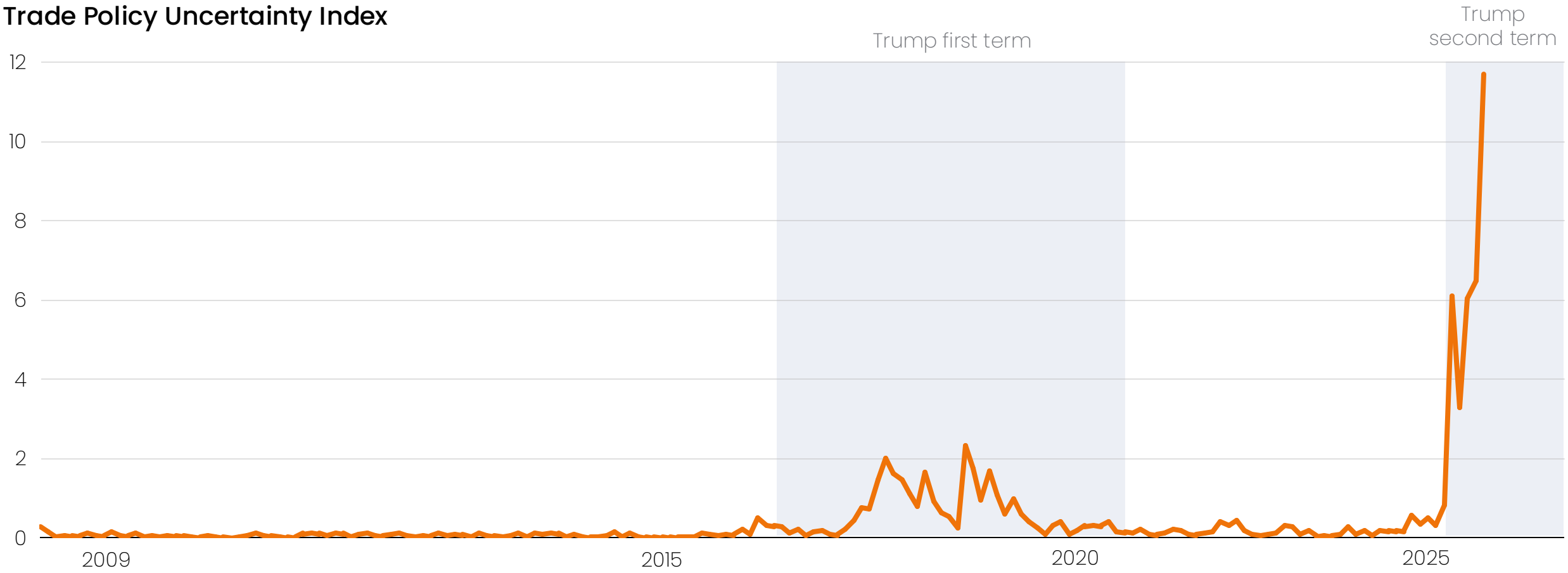
Trade is under threat

As trade is getting more uncertain in general, so do fossil imports

Trade Policy Uncertainty Index



Note: The Bloomberg Economics Global Trade policy uncertainty index counts the monthly frequency of articles discussing trade policy uncertainty
Sources: Bloomberg Economics

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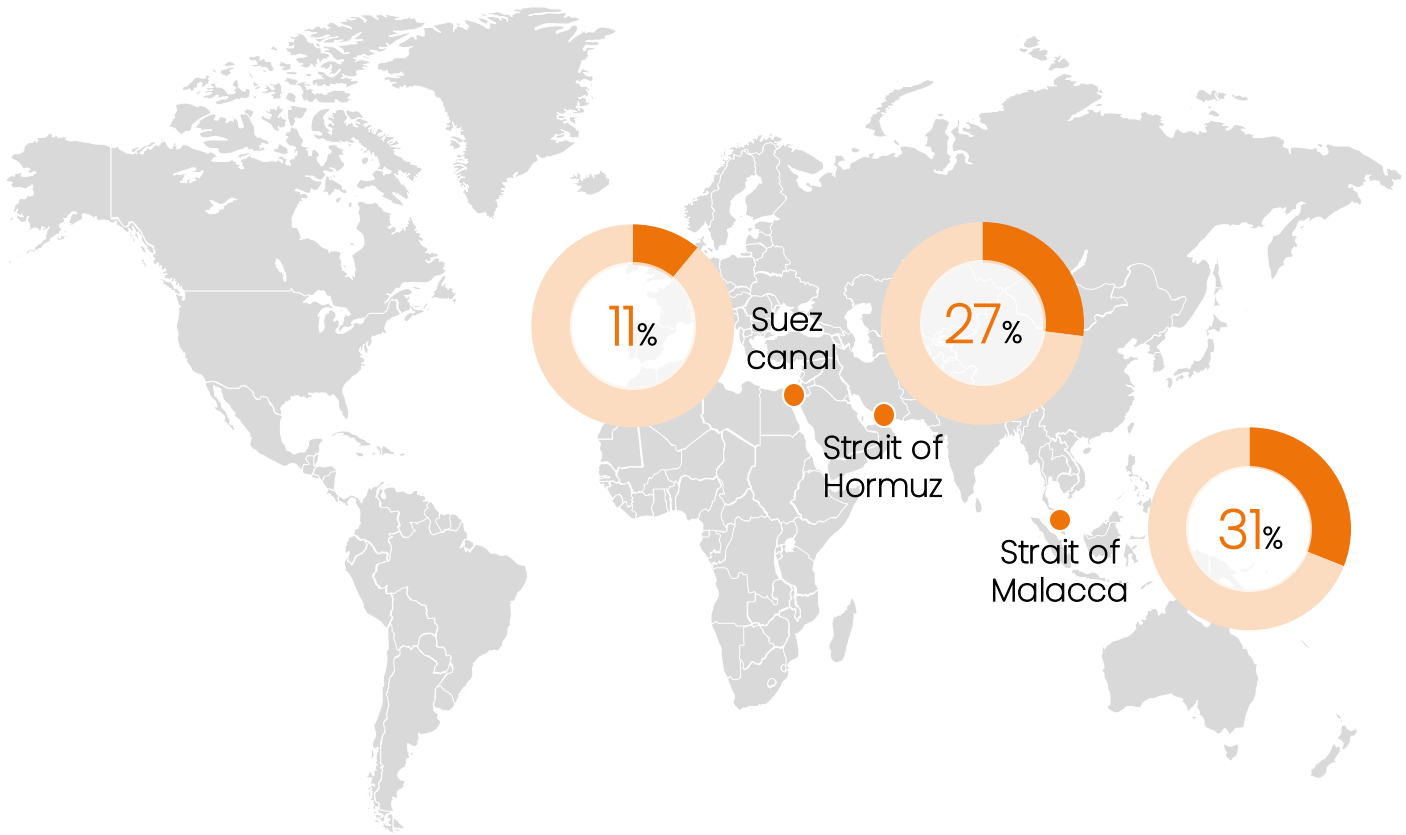
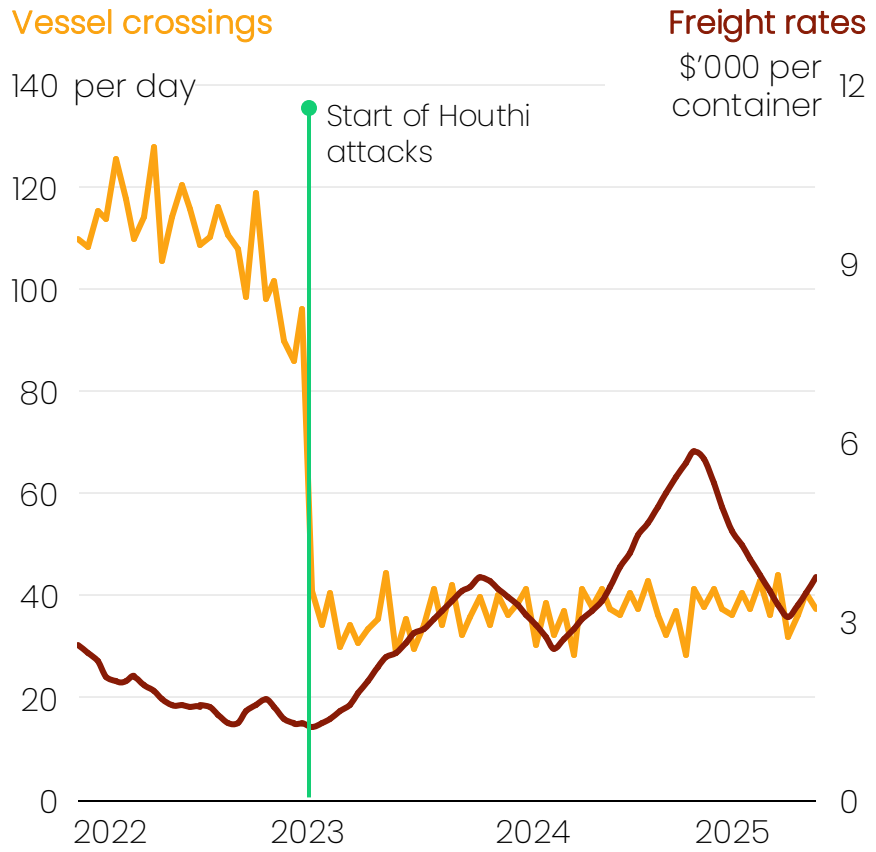
Fossil fuels pass through vulnerable chokepoints

The majority of fossil trade goes past just a few vulnerable chokepoints

Share of maritime oil trade by location



Example of chokepoint disruption: Suez



Sources: EIA, Ember, Bloomberg, The Economist

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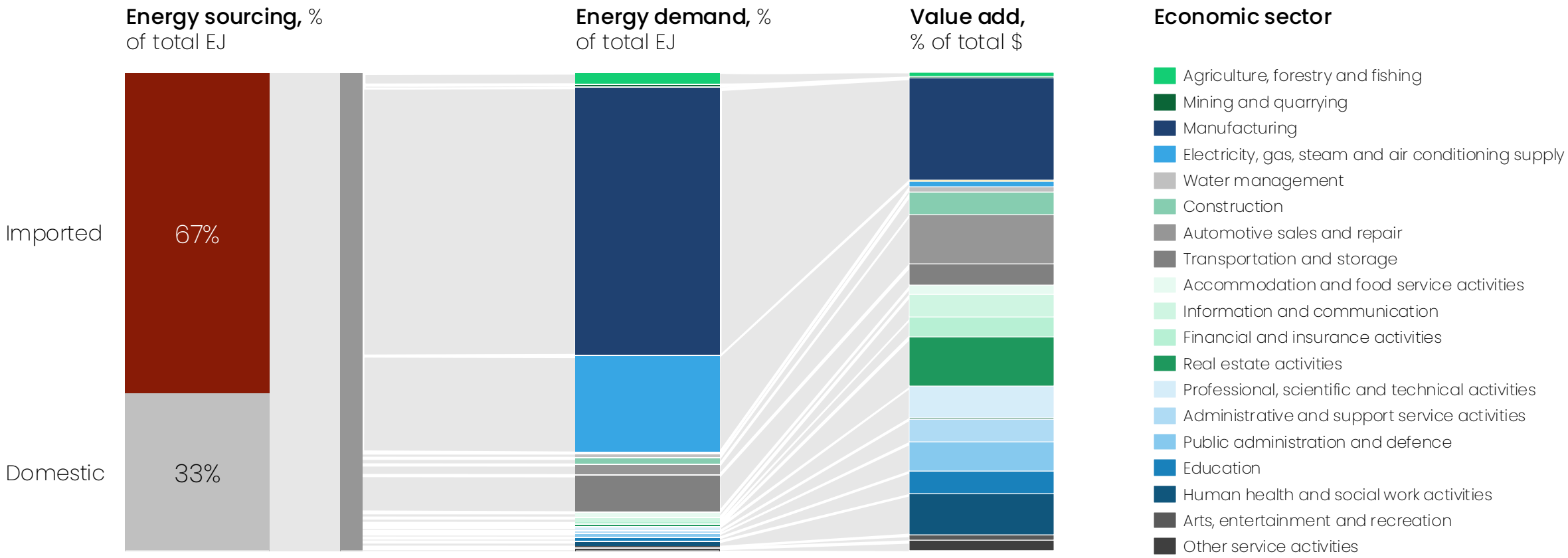
When energy imports stop, the economy stops

Given new risks, there is a powerful urgency to reduce fossil import dependence

Example: Energy imports and use, Germany, 2019



Note: Value added is each sector's net contribution to GDP, measured as output minus intermediate inputs.
Sources: Eurostat, Ember analysis

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Conventional energy security is all about import diversification…

	OLD ENERGY SECURITY STRATEGY
Boundary conditions	Continuous inflows. Fuels are single-use and so the economy needs continuous inflows to keep going.
	No way but to import. Most nations don't have the domestic resources to supply their own energy needs.
Matching energy security strategy	Diversification of imports to many suppliers and sources. If one fails to deliver, there is always another source that can jump in.
	Hope the US navy keeps the sea lanes open and exporters are prepared to sell to you at a price you can afford.

… but there is a new energy security solution: deploy electrotech

NEW ENERGY SECURITY STRATEGY
One-off tech imports. Electrotech needs one-off tech imports, then delivers local energy for decades. As with all manufactured goods, they can be made in a wide variety of locations.
Enough domestic supply for all. Every country in the world has enough renewables to supply all its energy demand.
Accelerate the deployment of electrotech to cut reliance on imports altogether.

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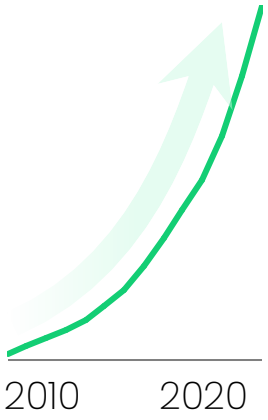
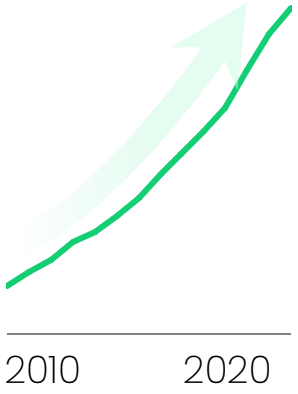
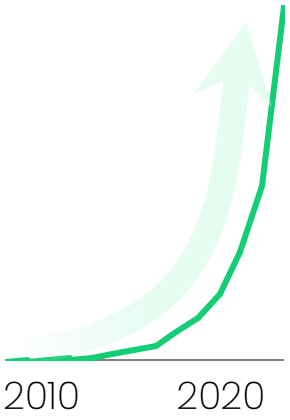
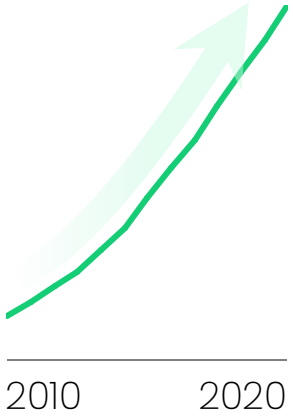
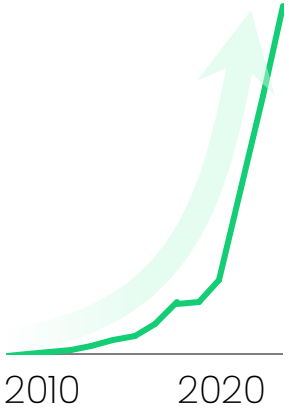
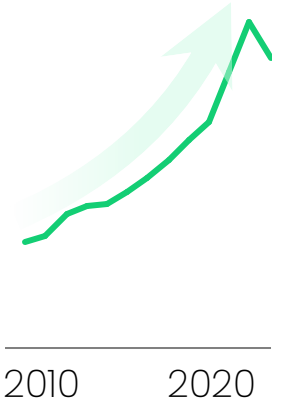
What is electrotech?

The revolution in how we generate, connect and use electrons

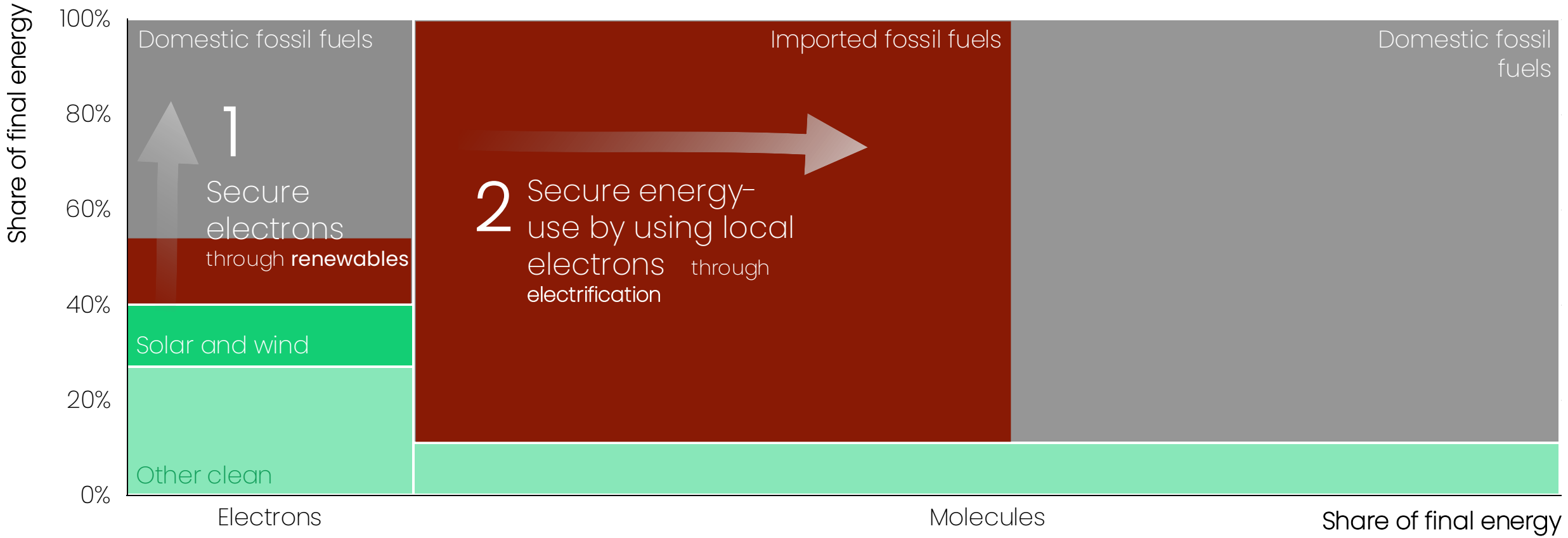
	Supply	Connections	Demand
Vector of change	Renewables	Flextech & gridtech	Electrification
Examples of rapidly growing technologies	Solar PV GW deployment  2010 2020 Wind GW deployment  2010 2020	Battery storage deployment  2010 2020 HVDC lines km deployment  2010 2020	EVs sales  2010 2020 Heat pumps sales  2010 2020
Revolutionary change	New ways to *generate* electricity	New ways to *transport and store* electricity	New ways to *use* electricity

Sources: IEA, RMI, Thunder Said, Ember

A two-pronged security strategy

Renewables replace fossil electricity, electrification replaces fossil molecules. Both drive efficiency

Global energy demand in 2023



Notes: In gross terms and in final EJ. Other clean electrons are mainly hydro and nuclear. Other clean molecules are mainly biomass. Sources: IEA WEO 2024, IEA WEB, Ember.

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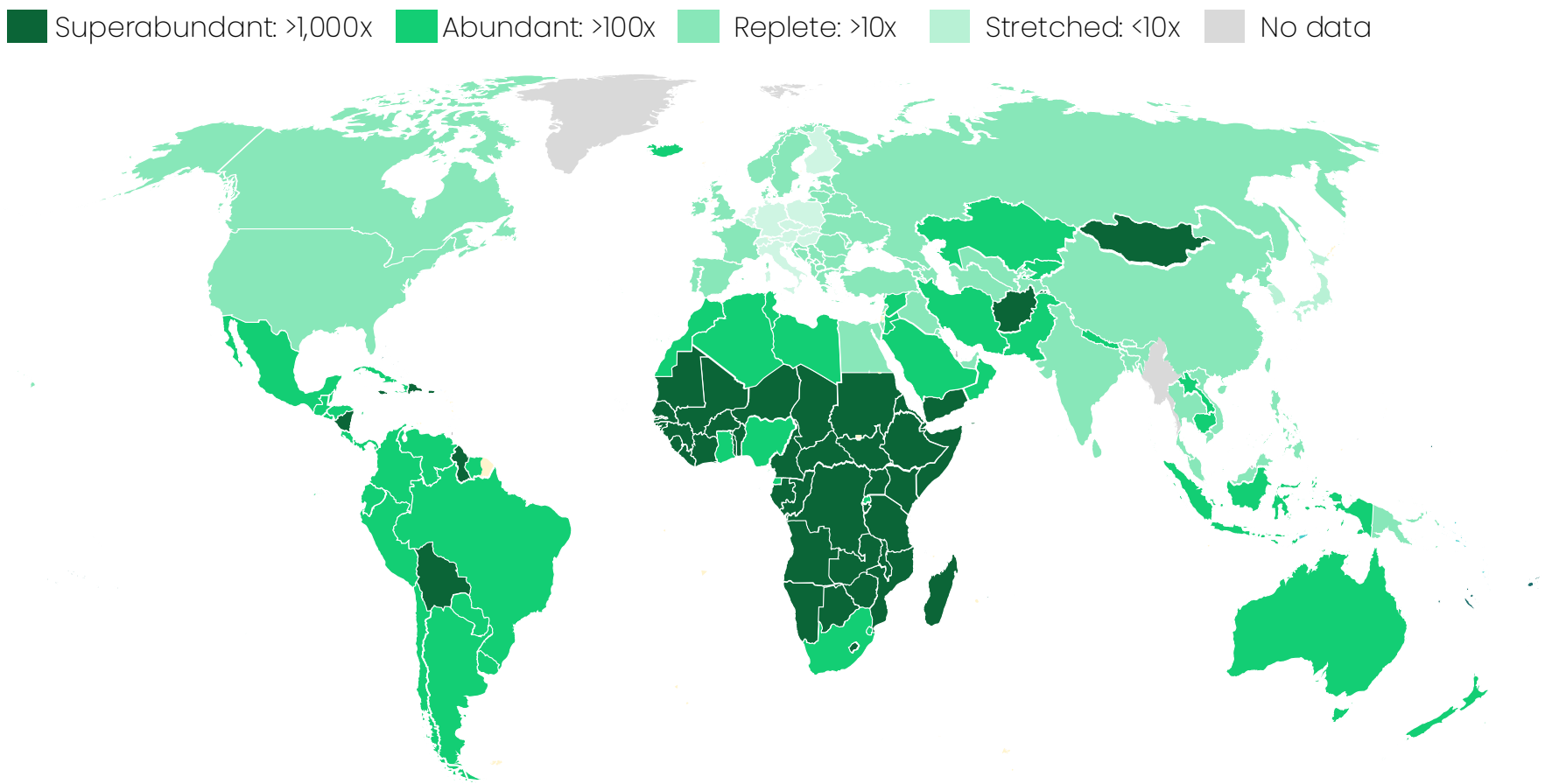
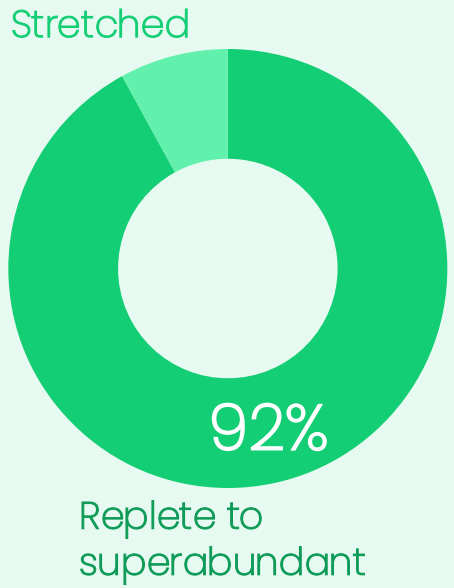
Renewables are available to all

They are 100x bigger than fossil fuels, and every country has them

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

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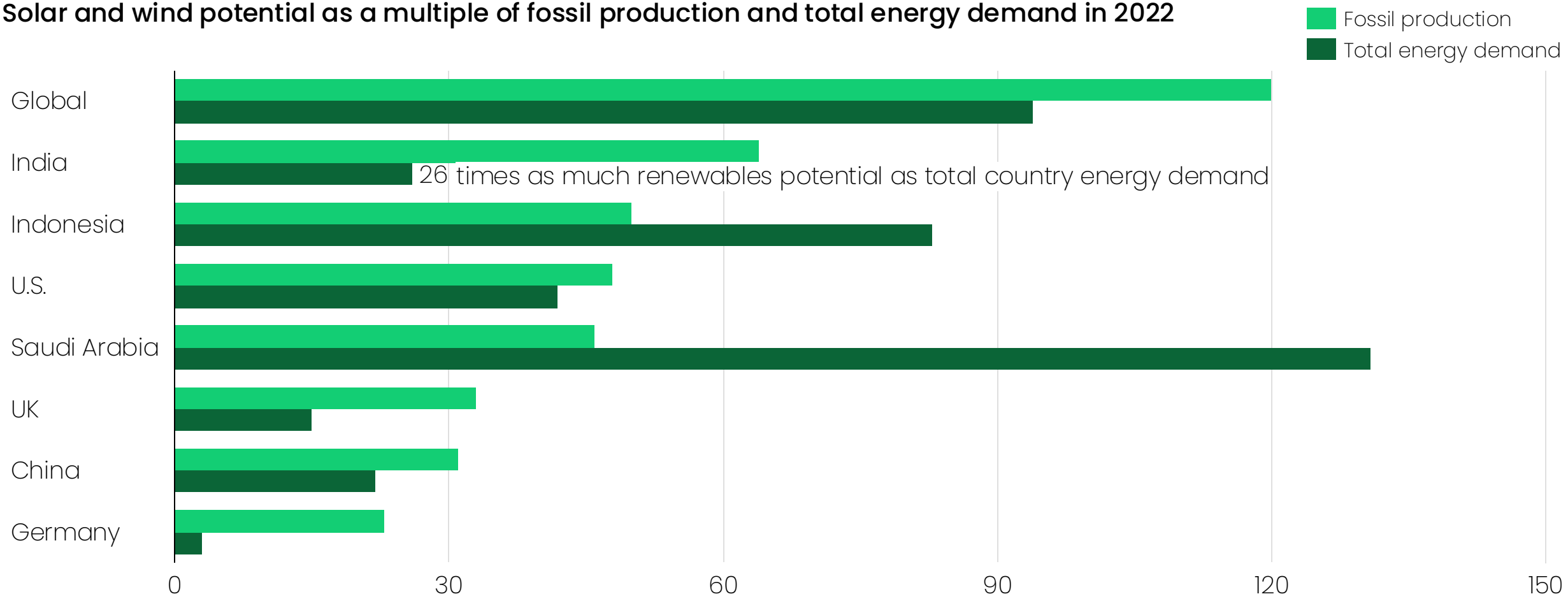
Renewables potential is far larger than fossil production

Solar and wind potential is nearly 100x energy demand, and 120x fossil fuel production

Solar and wind potential as a multiple of fossil production and total energy demand in 2022



Sources: NREL (wind), Solargis (utility solar), Jacobson (rooftop solar), IEA WEB (fossils and total).

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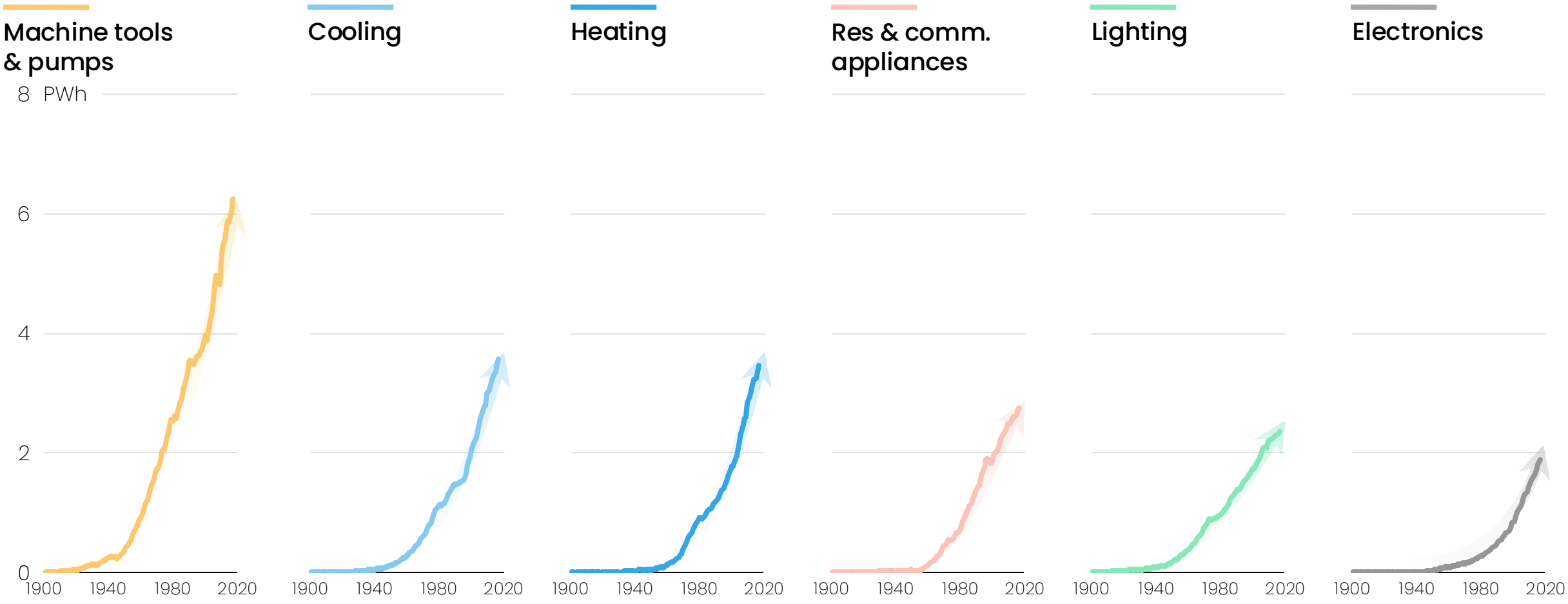
Electrification is growing in one area after the next

The attractiveness of electrons has brought them into more and more applications



Sources: Pinto et al, Ember

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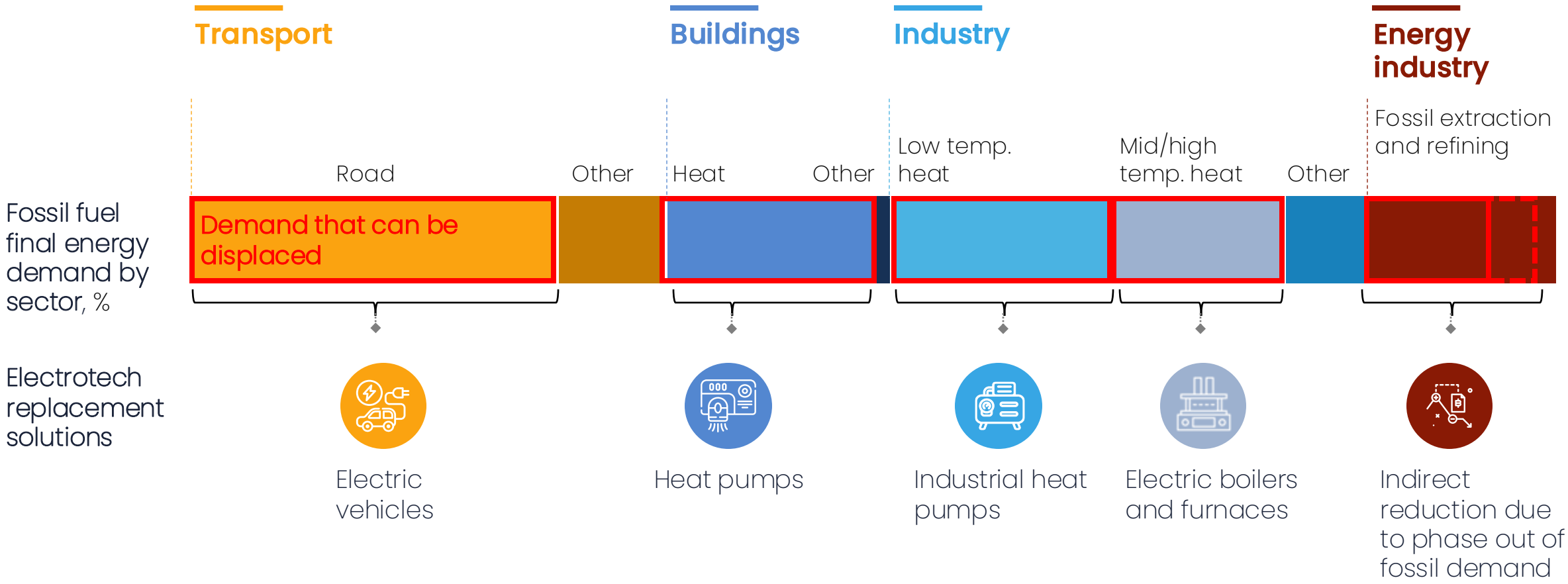
Electricity can now displace most fossil fuel demand

A new generation of electrotech can replace the vast majority of final demand for fossil fuels



Sources: IEA, IIASA, RMI, Ember Analysis.

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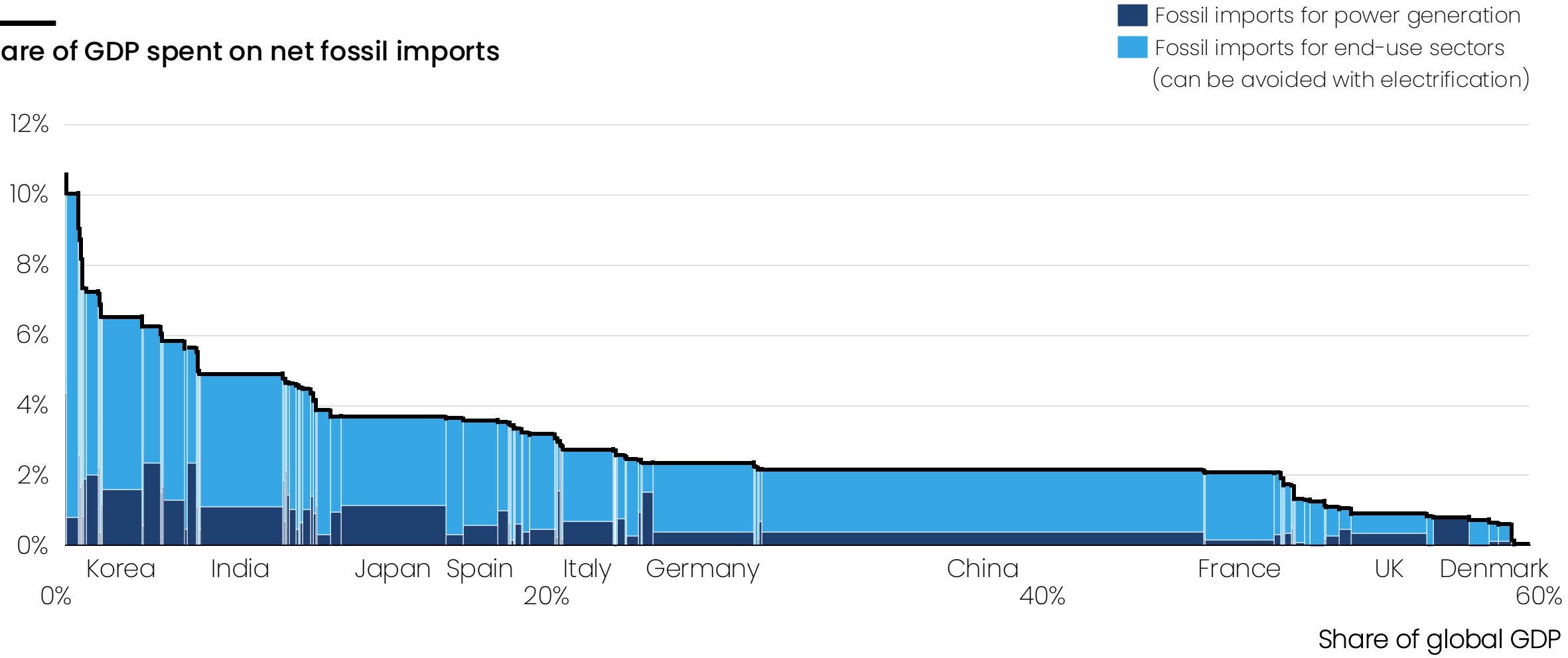
Electrification is the most powerful security lever

Three quarters of energy imports are for end-use sectors, which can be electrified

Share of GDP spent on net fossil imports



Sources: IEA, WB, Ember. All numbers in terms of dollars and assume fossil imports are first allocated to electricity

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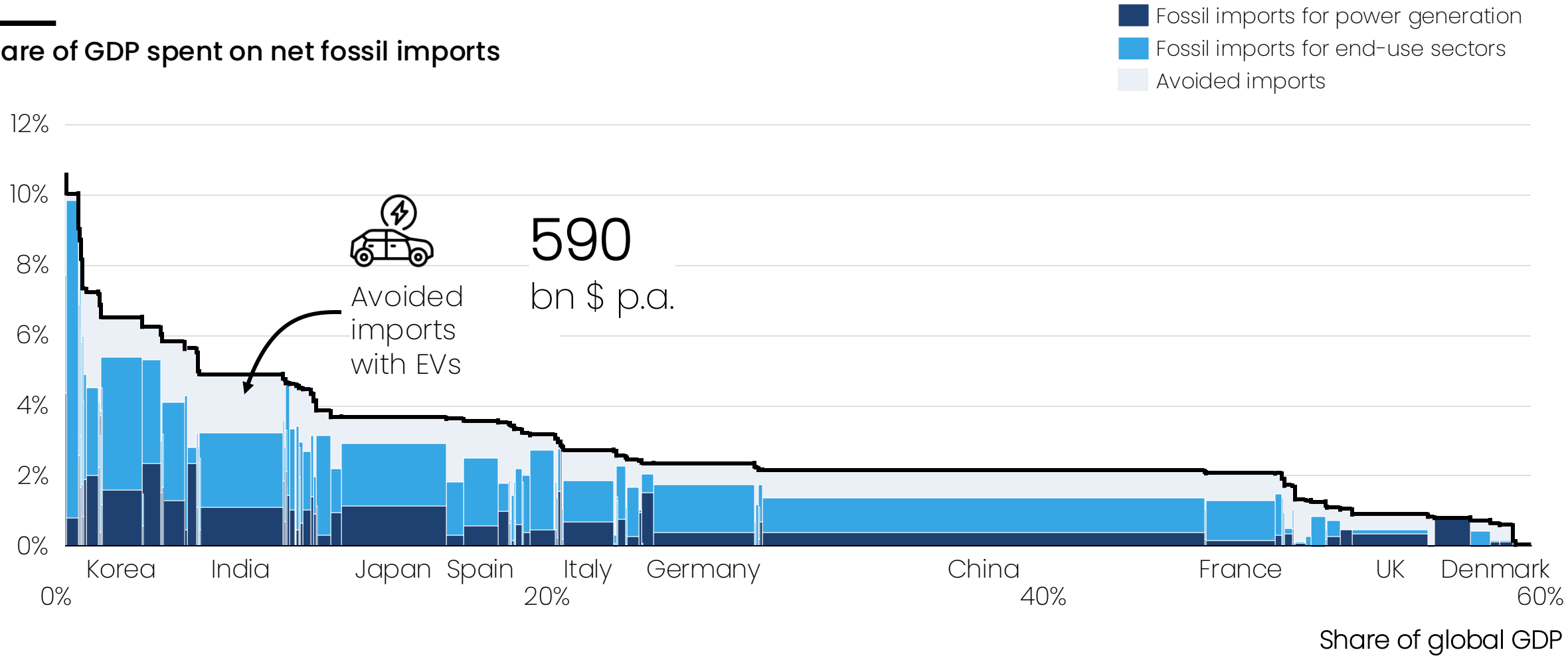
EVs can reduce total import dependency by a third

Replacing imported oil for diesel and gasoline cars with domestic energy slashes oil imports

Share of GDP spent on net fossil imports



Sources: IEA, WB, Ember

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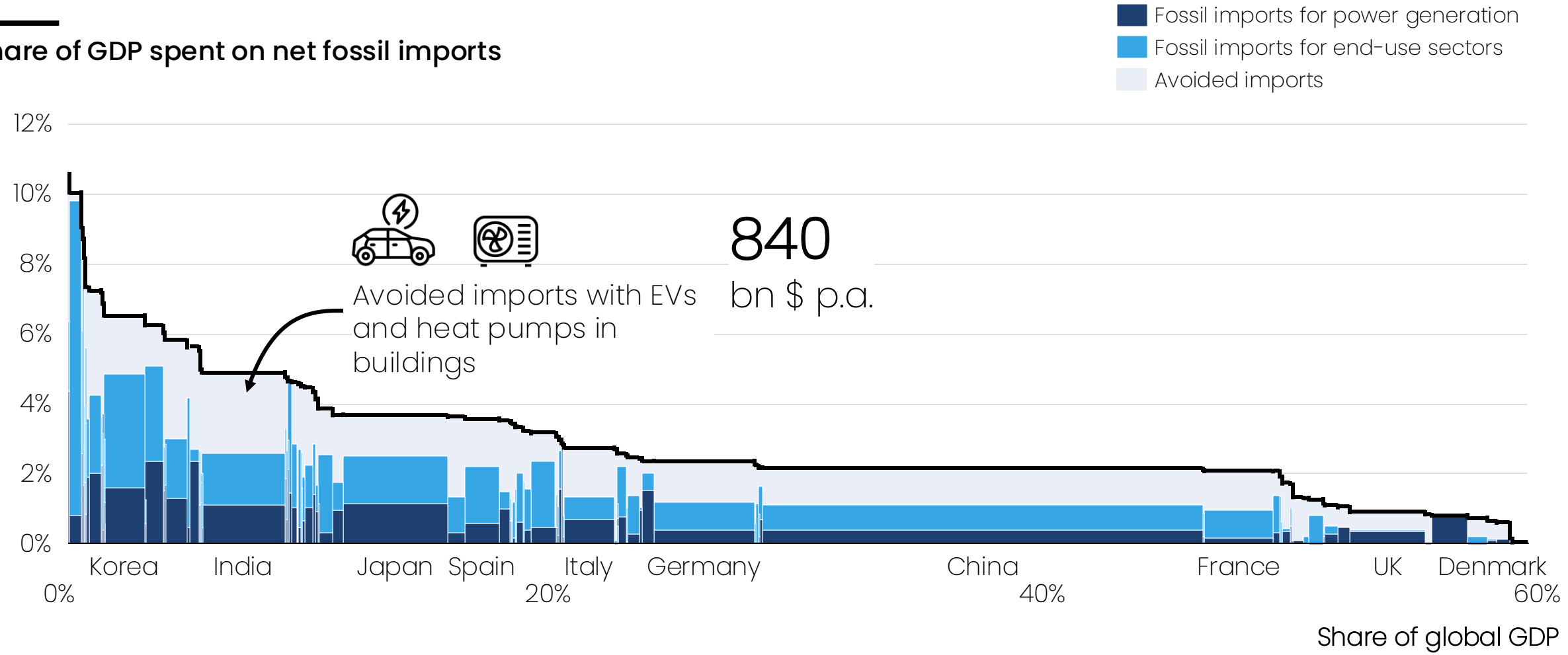
Heat pumps in buildings can reduce it by another 14%

Local electricity used in heat pumps can displace gas imports for residential heat



Sources: IEA, WB, Ember

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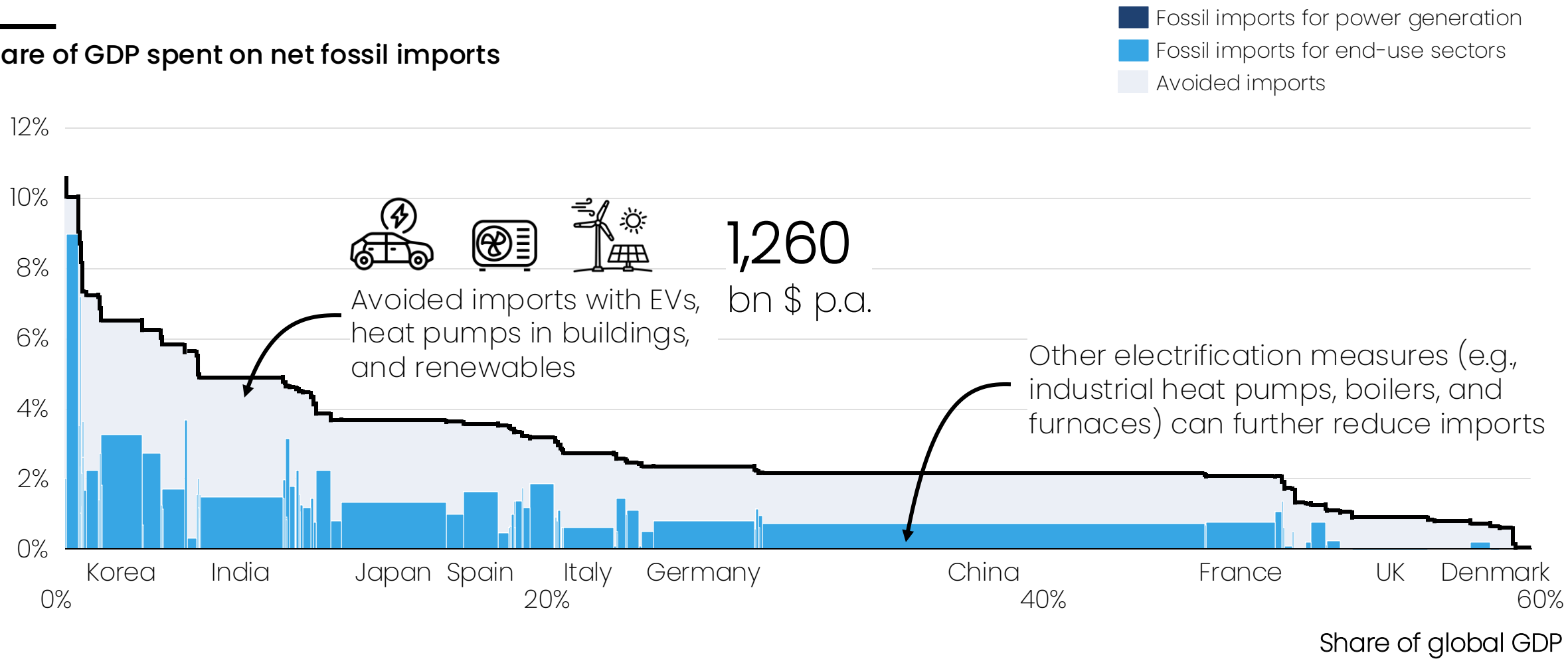
Renewables help avoid another quarter of fossil imports

Local electricity can displace imported fossil fuels for electricity — and power EVs and heat pumps

Share of GDP spent on net fossil imports



Sources: IEA, WB, Ember

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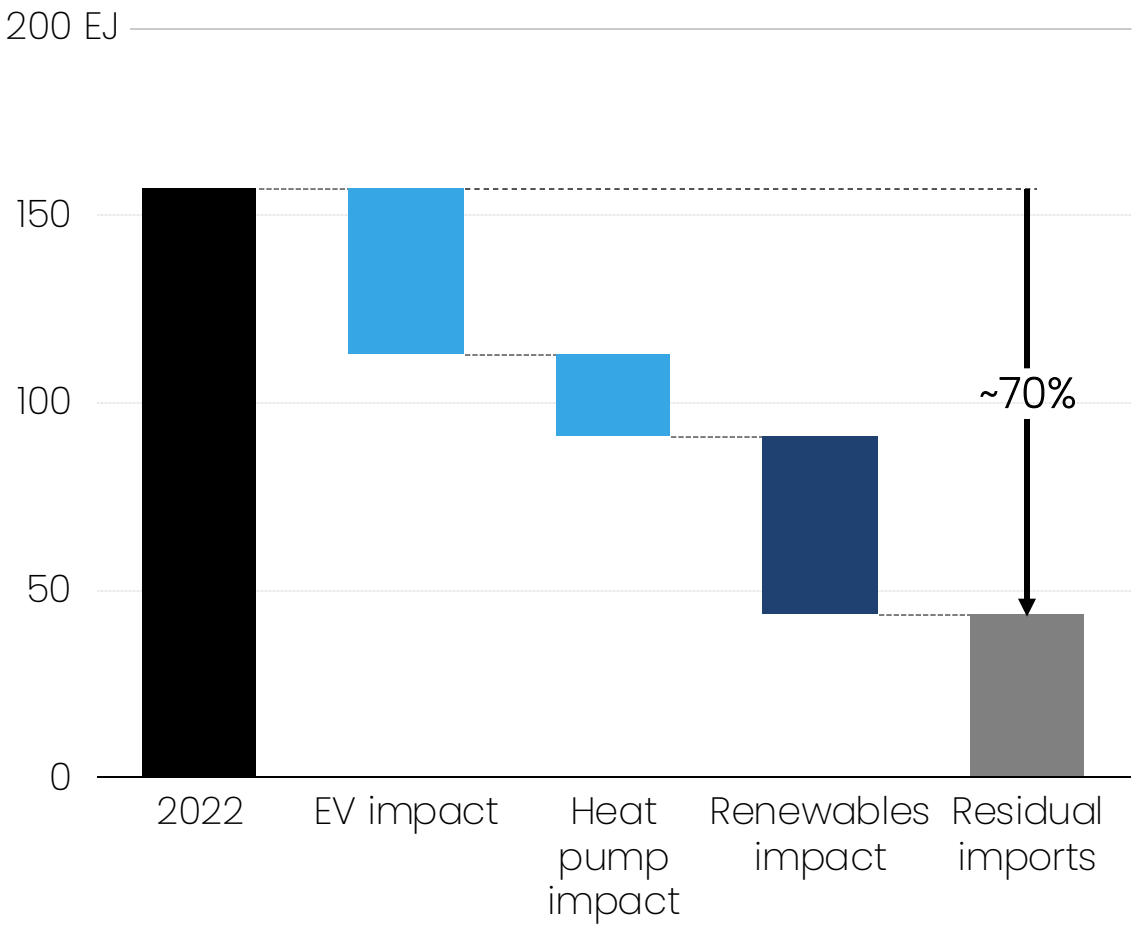
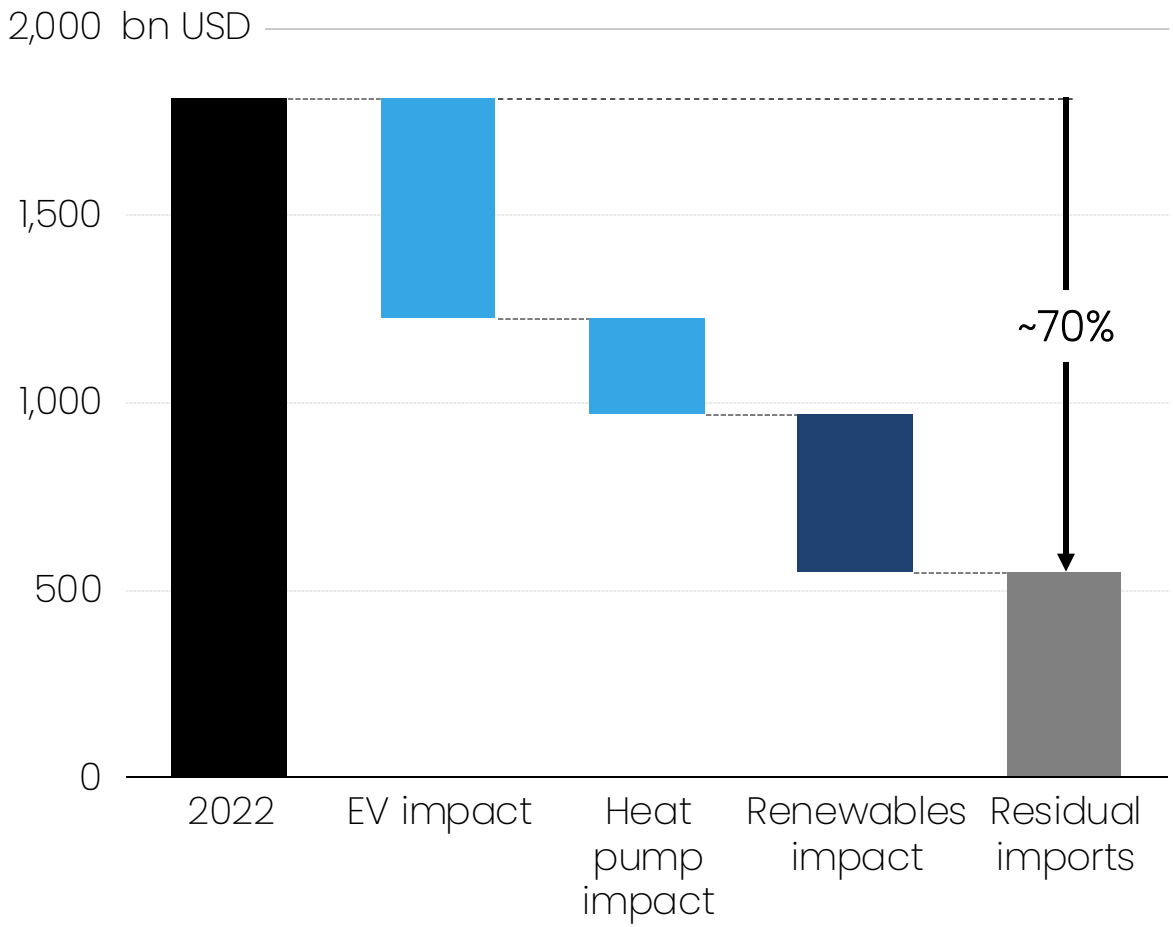
These three levers can reduce net imports by 70%

And save the importers nearly $1,300bn in fossil imports every year

Global fossil energy net imports by importers



Global net spending on fossil fuels by importers



Sources: IEA WEB, WB, Ember

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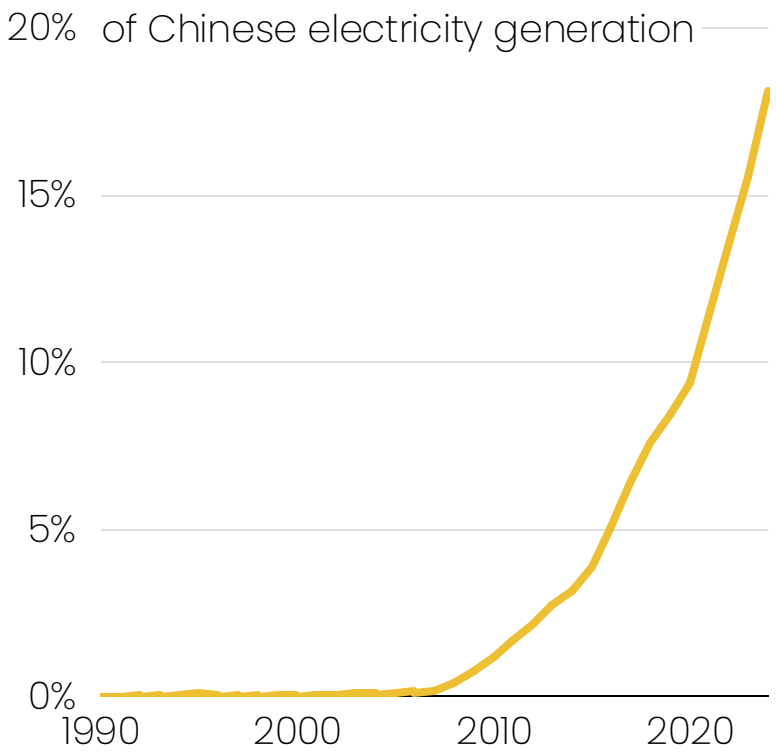
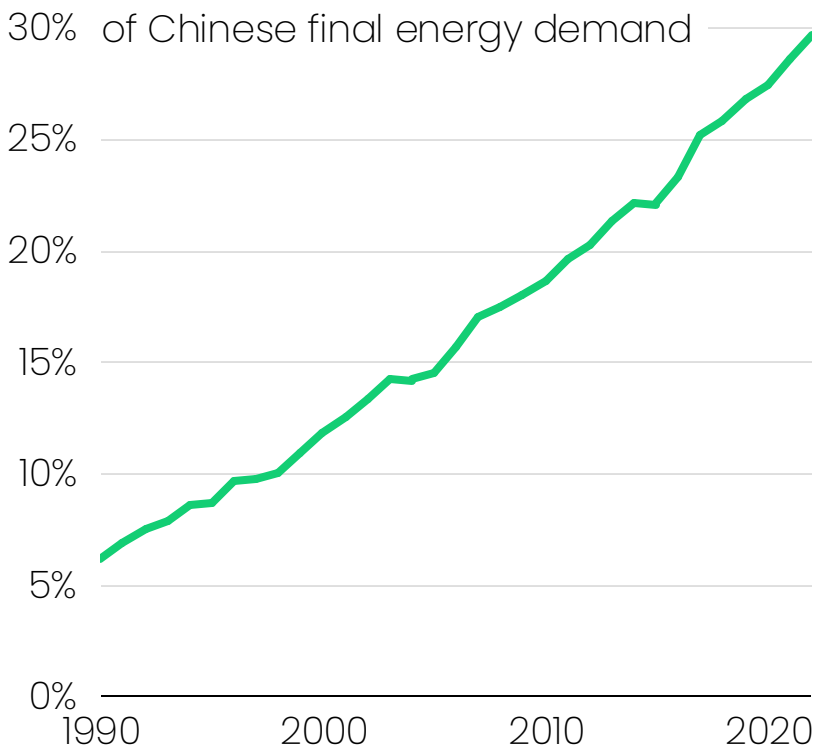
China pursues an electrotech strategy

The twofold strategy helps reduce dependency on volatile and vulnerable foreign sources

1. Localise energy production via solar and wind



2. Convert end uses to electricity



Curb growing import dependency

$440b

per year spent on fossil fuel imports by China

Note: China's reduced imports have also been achieved through increase in domestic coal production, but their long-term strategy lies in solar and wind. Sources: IEA, Ember

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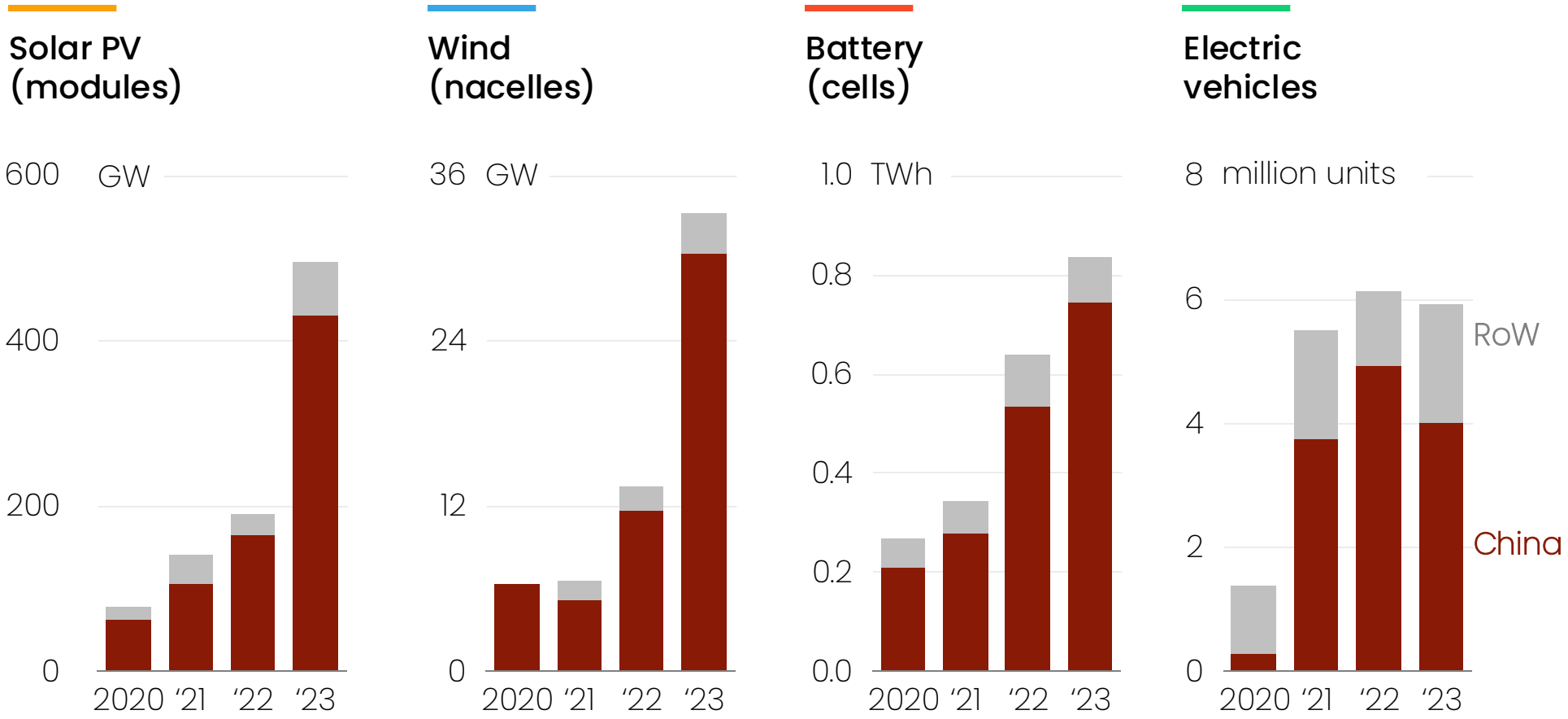
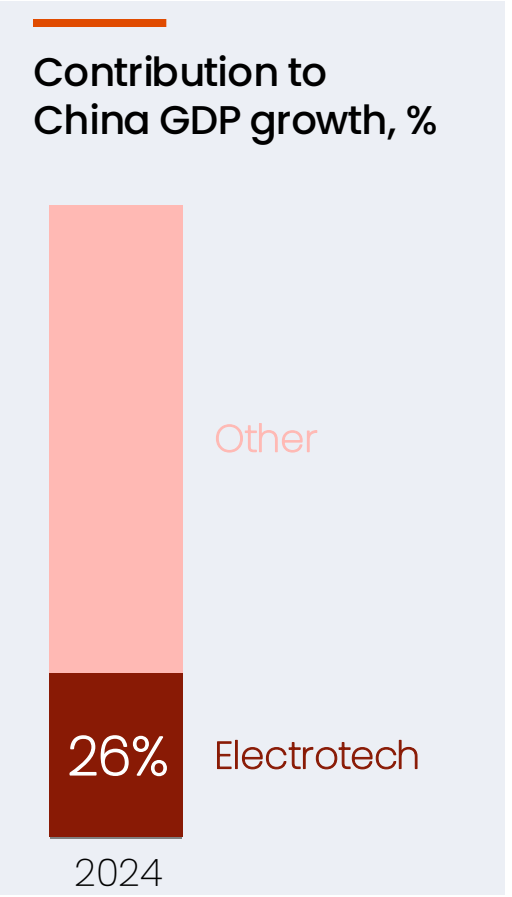
China is manufacturing electrotech at home

Its industry is now laser-focused on developing electrotech at lightning speed

Manufacturing capacity additions for select electrotech





Sources: IEA ETP, Carbon Brief

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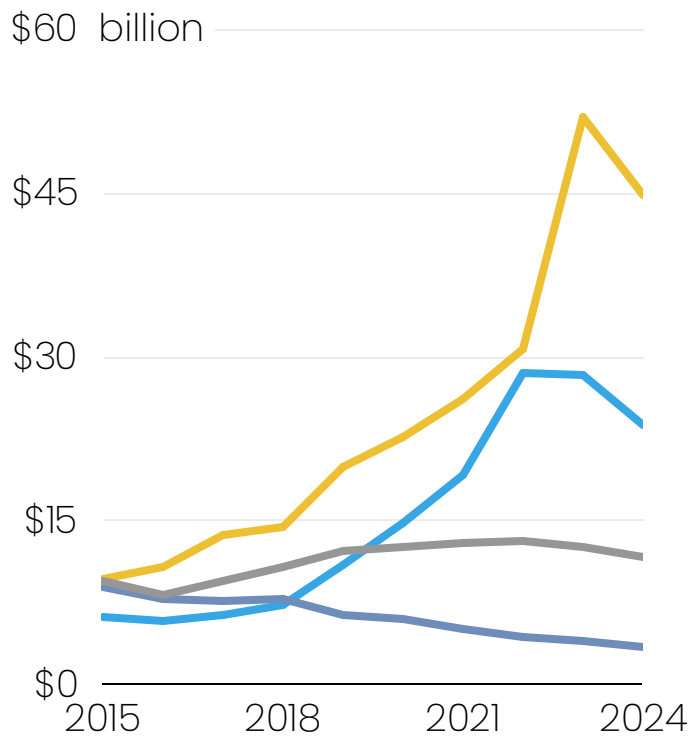
China is exporting electrotech to the world

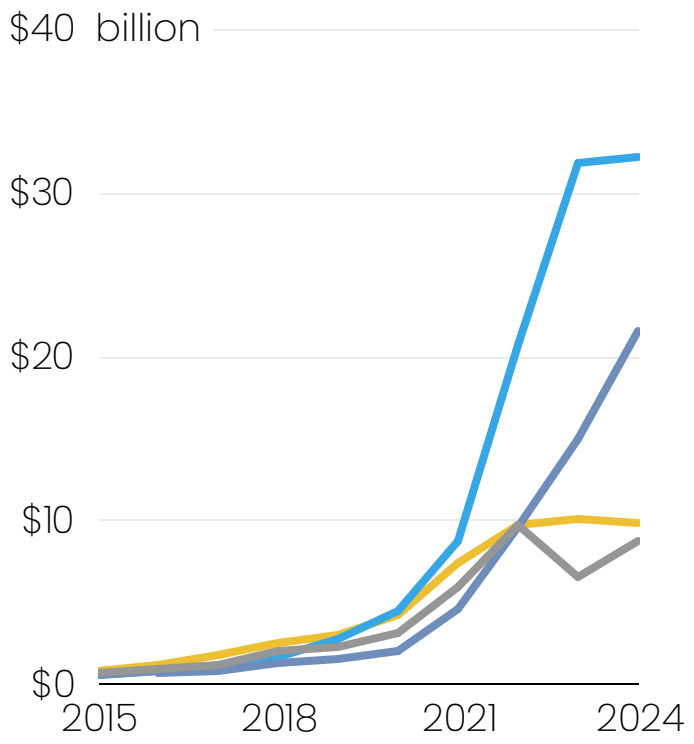
Gaining allies along the way — especially in the Global South

Chinese exports

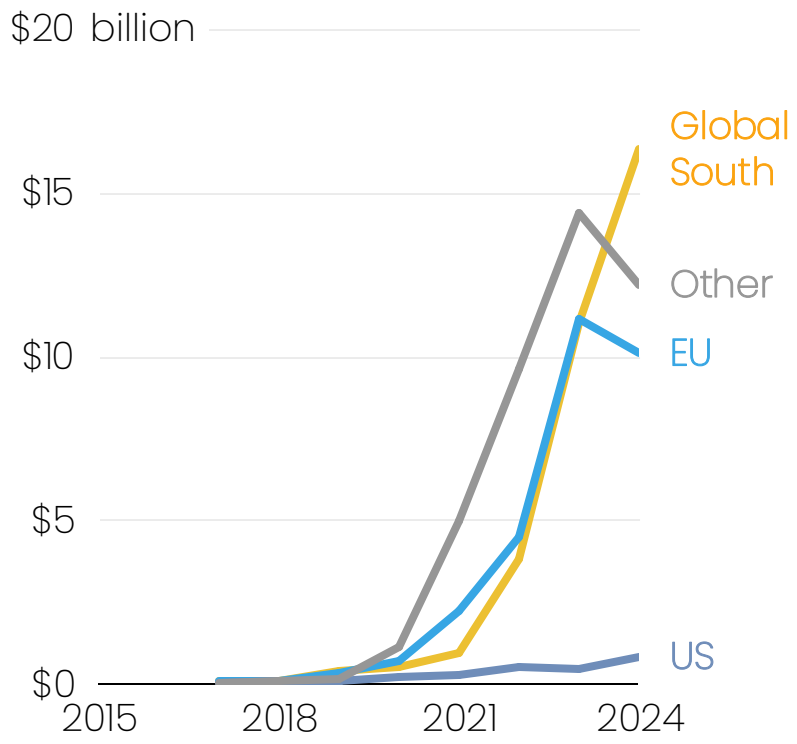
Solar PV



Batteries



Electric vehicles



Sources: Comtrade; Dialogue Earth; Nat Bullard

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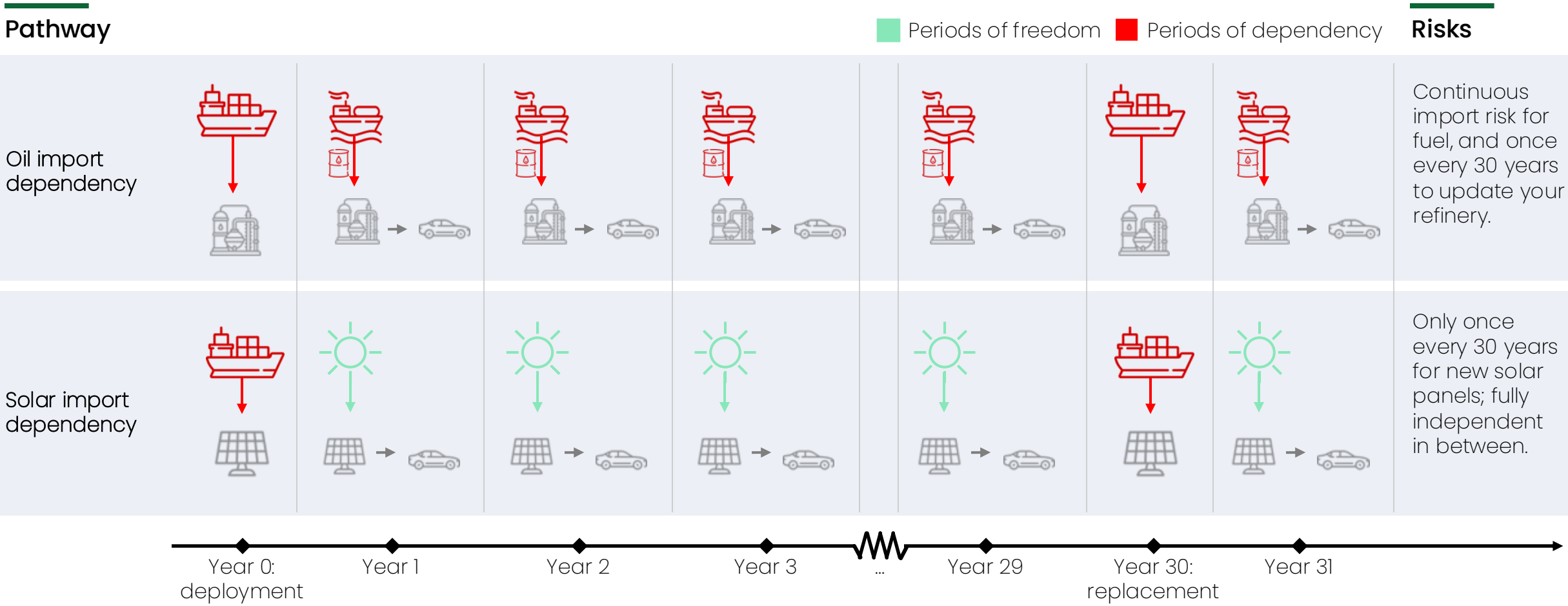
Electrotech import dependency is different to fossil fuels

Fossil import reliance is permanent; electrotech imports are only periodic



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Electrotech avoids the dependencies of fossil fuels

When fossil flows stop, the economy stops. When electrotech flows stop, only the 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…**

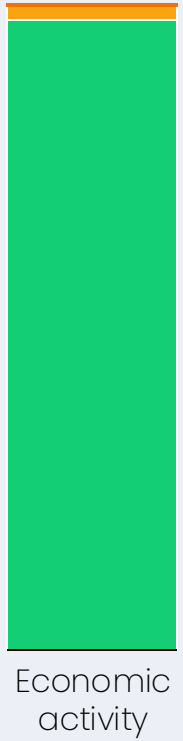
…the **entire economy comes to a halt** as engines run out of oil, gas, and coal to power them

In an economy running on imported electrotech, **when imports stop…**

…**only economic growth is inhibited** in the immediate term as no new technologies can get deployed

…while the **rest of the economy can keep running** on its current technology stock — only facing a long-term challenge as aging technologies need to get replaced eventually

In an economy running on circular electrotech, **when imports stop…**



…**most growth can continue** being powered with materials gained from old technologies at their end of life

…while the **rest of the economy can continue to run on its circular material loop**, even in the long term

At risk in the immediate term | At risk in the long term | Not at risk

Note: bar sizes are illustrative
Sources: Adapted from RMI

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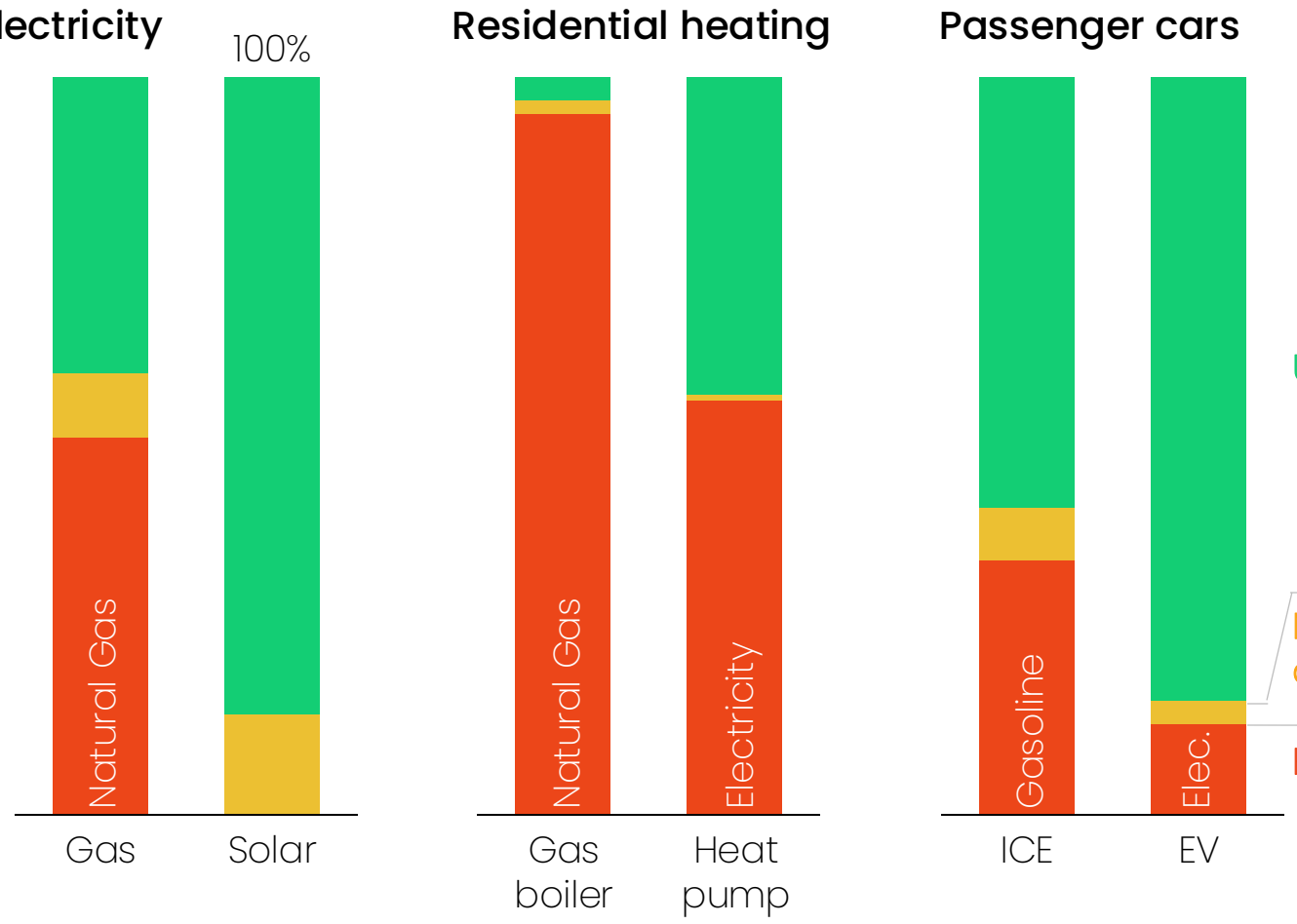
Electrotech reduces exposure to inflation

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

Total cost of ownership breakdown, %, US examples



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.

Sources: Lazard 2024; NREL; IEA EV TCO tool; RMI

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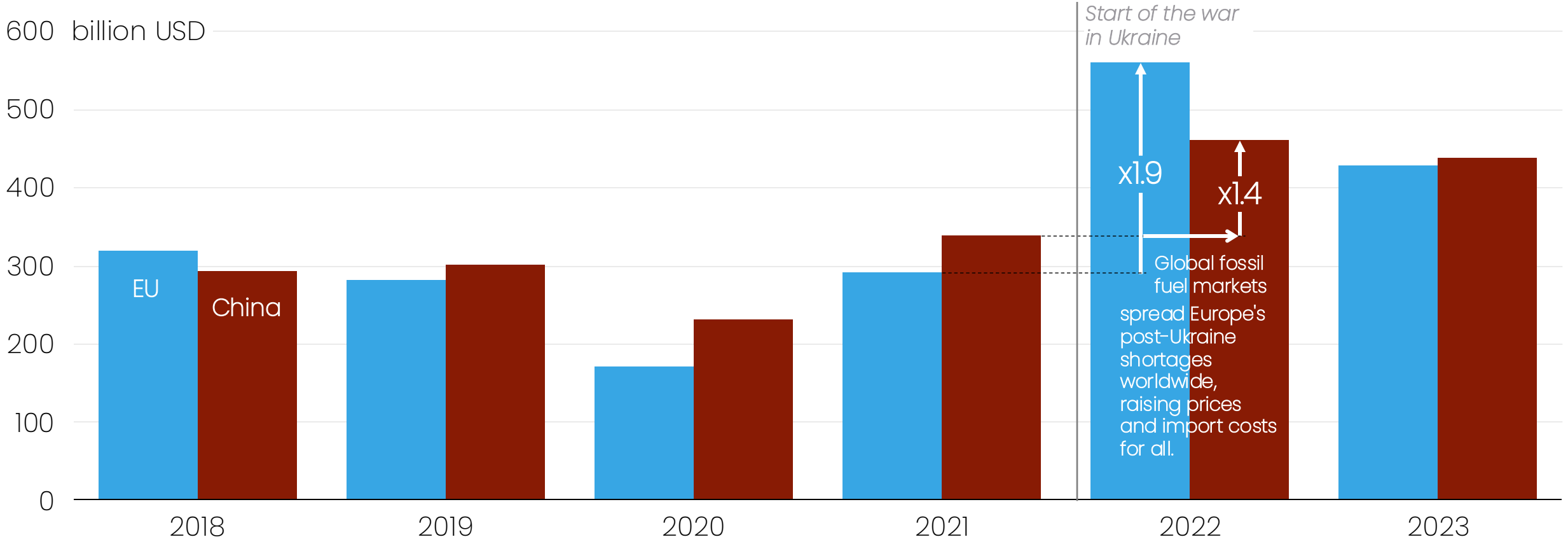
Electrotech insulates markets from global volatility

Fossil prices are set globally, exposing countries to risks even from halfway around the world

Europe and China net spending on fossil fuel imports



Sources: UN Comtrade; adapted from RMI visual

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Electrotech delivers faster than fossil fuels

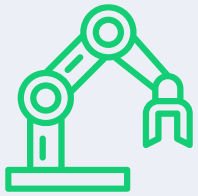
Electrotech is the cheapest and fastest way to grow developing economies

	Natural gas import case	Solar + battery power case
Steps to deploy new energy	Secure LNG offtake agreement and open new shipping route → Build new LNG terminal in harbour → Build new gas pipelines → Build a new gas power plant → Build out centralised network to deliver power	Import solar panels and battery packs through existing harbour → Deploy solar + battery locally → Build a localised grid to deliver power
Construction time	5-10 years	<1 year
Minimum size of investment	1-5 GW; ~$3-10 billion	1-10 kW; ~$2-3 thousand
Dependency after deployment	Dependent on gas supplier and exposed to volatile gas market	Fully independent until solar panel and battery are at end of life in 20-25 years

Sources: Adapted from RMI

There are reasons to pursue electrotech beyond energy

Electrotech is about more than providing energy, it is about winning in...



Robotics

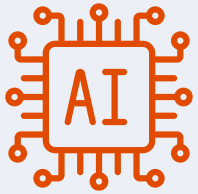
Requires top-tier batteries, electric motors, and cheap electricity

Hardware for the digital age

Requires top-tier batteries, and cheap electricity

New defence tech

Drones and other equipment require top-tier batteries, electric motors, etc.



AI

Requires cheap and rapidly scalable electricity generation sources

...which are all areas of national security as well

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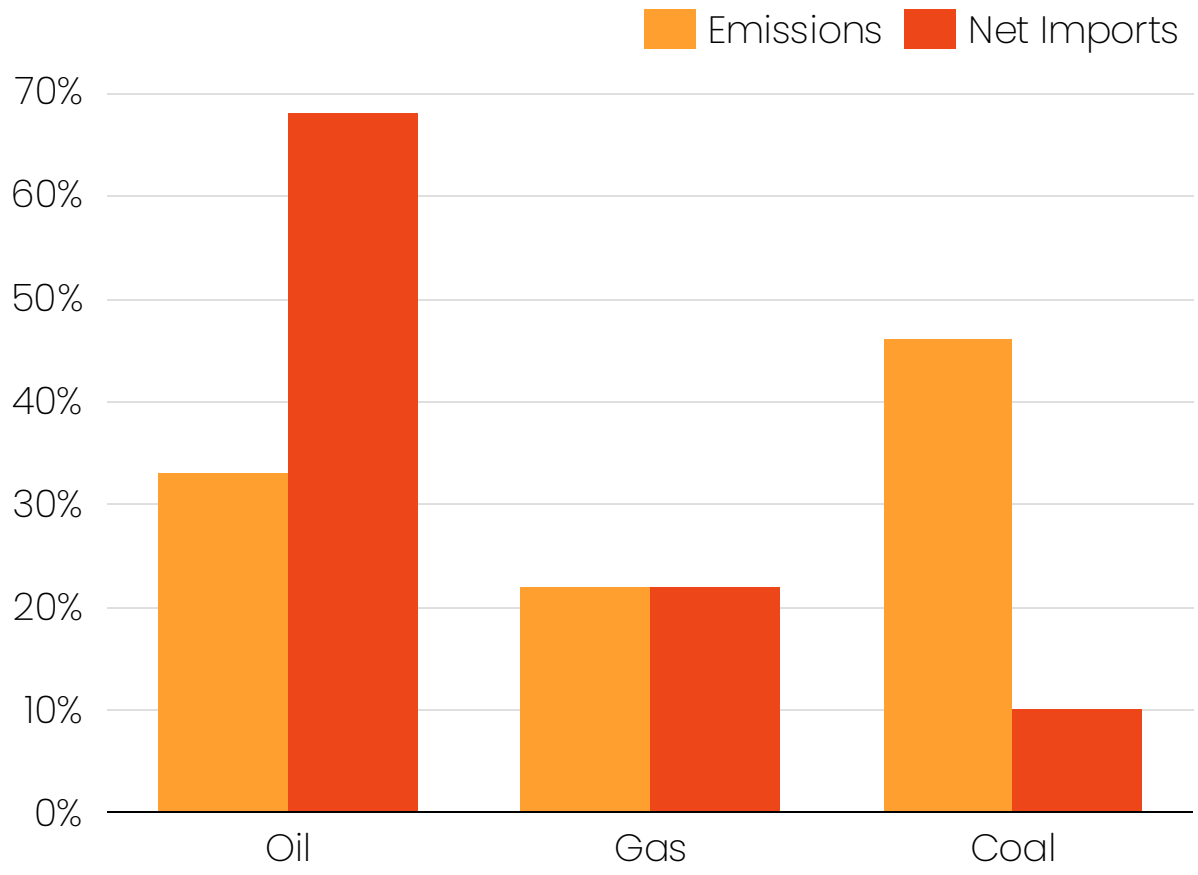
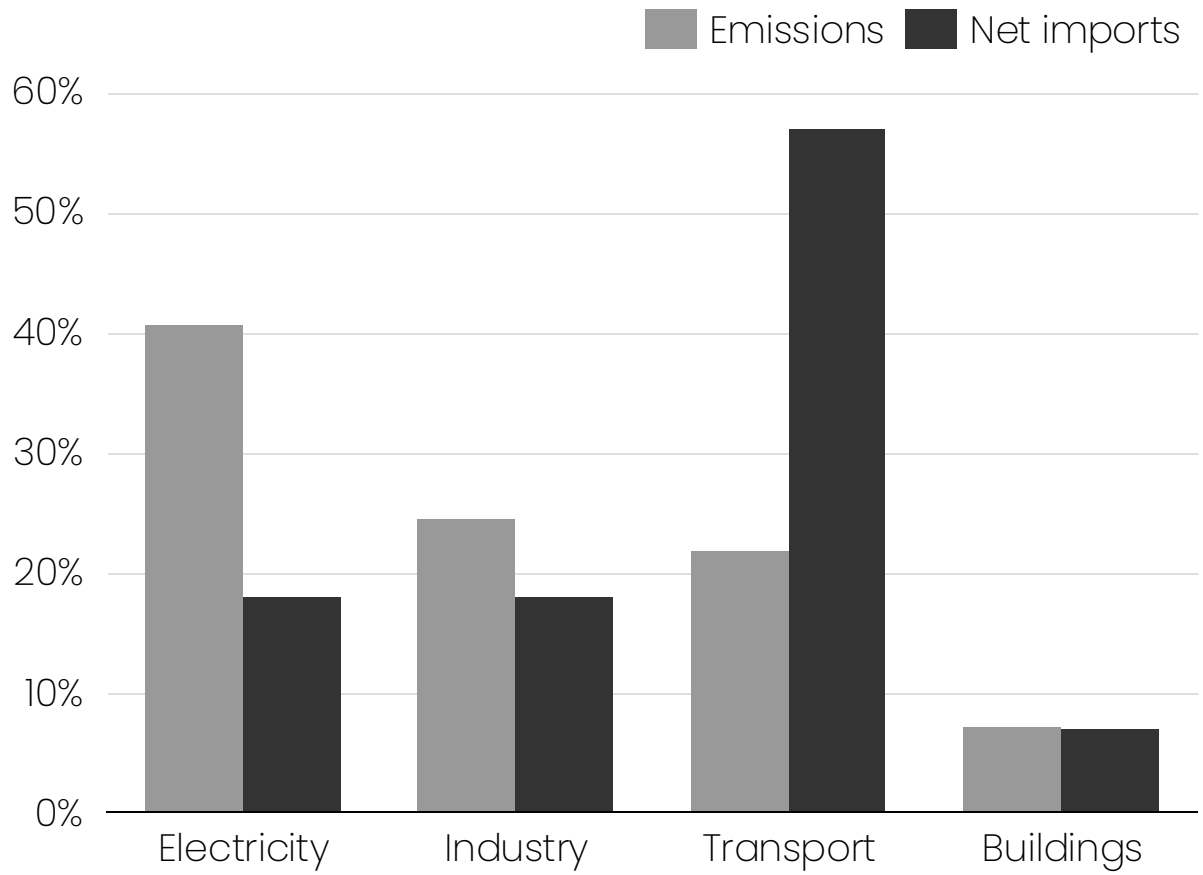
Security provides a different lens to the energy transition

Security implies you need to double down on electrifying transport

Share of emissions and net imports by fuel



Share of emissions and net imports by end-use sector



Sources: IEA WEO for emissions, IEA WEB for imports 2022. Taken as net imports in $ terms with proportional allocation at a global level

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The urgency of now

Clouds are gathering; weather the coming storm...

Strategy 1: Fossil import diversification

- Bow to cartel kings and collaborate with oil producers
- Diversify your suppliers and secure long-term contracts
- Stockpile fossil fuels whenever possible and from whomever has spare reserves
- Spend more on defence to protect critical chokepoints, or pursue territorial expansion
- Hope for the best

...or sail away from it

Strategy 2: Electrotech acceleration

- Ramp up domestic capabilities to manufacture, install, and operate electrotech
- Streamline regulation to accelerate domestic construction
- Organise more up-front investment in electrotech to lock in long term prices and security
- Accelerate domestic recycling and manufacturing to limit long term technology import dependence
- Reposition your country to benefit from the energy technology revolution in the coming decades

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 clean, electrified energy system for all.

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