

Global Energy Scenarios 2026

Insights summary

Pathways to resilience

Energy Macro Analytics
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From shock to resilience

Welcome to the fifth edition of our annual flagship report, Global Energy Scenarios 2026. In just five years, the global energy system has faced two of its most severe stress tests since the 1970s oil crises – and neither is over: Russia's war in Ukraine is still disrupting energy flows, and the US-Israeli war with Iran has severely impacted flows through the Strait of Hormuz. The first has already left a structural mark on the energy system, the second is likely to leave a deeper one the longer it lasts. Resilience is fast becoming a fundamental priority, both for the countries hit directly and for those watching from afar.

What resilience means has changed since the 1970s, because the toolbox has expanded so much. The hybrid energy system we described last year relies on technologies that are faster to deploy and easier to scale up than anything earlier generations had – from LNG cargoes to solar panels and batteries.

The system has absorbed the current crisis remarkably well so far, much of it through capacity built after the previous shock. In 2021, Russia supplied around 36% of Europe's gas imports and the US around 6%. By 2025, Russia was down to around 7.5% while US LNG supplied around 21%. The terminals, contracts and shipping built for that shift now help buffer

the system as flows through the Strait of Hormuz are disrupted – though at a price, as Europe and Asia compete for the same LNG cargoes, which risks leaving Europe short of winter stocks and Asia short of supply. For oil, much of the work has been done by pipelines, crude on water, storage and demand response, most visibly in China.

Decades of investment, innovation and diversification created this optionality and, with ample buffers at the onset of the crisis, this has bought the system valuable time. How much remains depends on how long the Strait of Hormuz stays constricted and how fast options can materialize. The longer the conflict lasts, the harder it will affect interlinked systems like food, logistics and manufacturing.

From history, we have seen that energy crises can change the system's direction as well as test it. The 1970s oil shocks brought more efficient cars, pushed oil out of power generation, expanded nuclear power, opened new offshore regions for oil and gas production, created strategic reserves and made energy security a permanent policy priority.

The shocks of the 2020s are already leaving their own legacy, and they differ from the 1970s by hitting oil and gas at once, with Europe and

Asia, the largest importers, bearing the brunt. Importers have little short-term recourse beyond paying up, drawing down stocks and cutting demand. The two conflicts also compound each other when it comes to diesel supply, as Ukrainian strikes on Russian refineries have pushed Moscow to ban diesel exports just as Hormuz has cut Middle East supply. With diesel stocks around 14% below their five-year average, US diesel cracks have climbed above a record \$100 per barrel, raising costs for trucking, shipping and freight. Europe's push for energy sovereignty since 2022 shows the second response, which has meant looking to domestic renewable resources above all, alongside electric vehicles (EVs) and heat pumps – a path many other regions now also look set to follow.

That second response is already visible: Chinese exports of solar panels and EVs have surged, and renewables are growing the fastest in emerging economies. Battery storage is set to jump by around 51% this year, well ahead of solar at 18%. Electric trucks are set to reach around 45% of heavy-truck sales in China, four years ahead of its 2030 target, while passenger EV sales have spiked as diesel prices hit records across Europe, South America and Southeast Asia.

Net importers now buy around three-quarters of their oil and gas abroad, up from 56% in 1985, as imports have grown nearly twice as fast as consumption since 2010. For them, the long-term route to lower dependence runs through electrification, whether from renewables, nuclear or domestic fossil fuels. Producers such as the US face a different calculation. Asia is moving the fastest, and nuclear is back on the security agenda, helped by data centers contracting it directly.

Artificial intelligence is a different kind of shock. This is felt the most in local power markets and grids, where data centers outbid existing customers, strain supply of gas-fired generation equipment, fill gas turbine and fuel cell order books and, in the US, lean largely on gas for the firm power they need first.

Yet, there are good reasons for optimism. Established technologies keep getting cheaper, while new ones, from long-duration heat storage to new battery chemistries, approach commercialization. New winners are emerging, too – and just as Japanese automakers rose from the 1970s efficiency drive, Chinese manufacturers are expanding rapidly into the global markets for batteries and solar equipment, as well as electric trucks and cars.

That said, for most countries, an expanded toolbox gradually shifts exposure instead of eliminating it entirely. China holds most of the global solar and battery manufacturing capacity, and commands significant proportions of the trade in key minerals.

Yet a country importing a barrel of oil needs another one tomorrow, whereas an imported solar panel or battery can produce for decades. As such, energy security shifts from fuels to factories, from a flow of molecules to a stock of assets. Crucially, as factories can be replicated and installed assets keep operating through a disruption, this dependency is potentially easing, becoming much more manageable. How quickly it eases, however, depends on how fast the supply chain diversifies as other countries build their own capacity.

This all sets the preface for how our scenarios work. They start out from this world of greater uncertainty and greater optionality, beginning with the energy services economies need, such as mobility, heat, cooling and industrial output, and testing how policy, technology and costs change the way they are delivered. Each scenario is designed to be realistic and plausible – and while every pathway delivers broadly the same services, the outcomes diverge sharply: by 2050, import dependence among today's importers falls from around 40% to between 14% and 33%, and annual emissions differ by more than 27 Gt.

Our House view, the 15-year central forecast, builds the current crisis in as a starting condition. The new Pragmatism scenario, our reference pathway to 2050, advances that trajectory using technologies and policies already in motion.

Resilience improves in every pathway, and global emissions are set to plateau within the next year or two. No pathway scores best on security, affordability and sustainability at once. In the near term, the Fossil first scenario is cheapest, as it avoids the upfront cost of electrification. The Climate first scenario cuts imports and emissions fastest. Beyond 2040, the cost gap narrows as fuel bills fall and clean technologies scaleup, while Climate first keeps its lead on security and emissions.

Today's crises are also likely to make oil and gas supply more resilient, through more storage, new export routes and a deeper LNG market, which matters because exposure fades only slowly. Under Pragmatism, oil and gas trade grows into the mid-2030s and stays above today's level until 2043, Middle East exports hold near current levels through 2050, and Europe and Asia still import around 76% and 49% of their gas. Greater resilience leaves the underlying risk in place and more visible, so import-dependent countries are likely to cut their exposure in their own way, through renewables, nuclear, domestic coal or, most often, a mix.

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Whichever mix countries choose, the common denominator is electricity. Most alternatives to imported oil and gas produce power, and power is what displaces them in transport, heating and industry. The same holds for the data centers driving AI, so the many transitions unfolding around the world increasingly run on the same current.

Jarand Rystad
Executive Chairman

Source: Rystad Energy research and analysis; Rystad EnergyDemandCube

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State of Play

Energy security is driving the energy transition

The crises of the 2020s is set to leave a lasting mark on the energy system for decades to come

Over the past five years, global energy markets have weathered two severe energy crises. Both represented scenarios that had long been considered major risks to the global energy system – but so far, they have played out quite differently than anticipated.

First, Rystad Energy’s latest Global Energy Scenarios flagship report examines why. The toolbox for responding to energy shocks has expanded, giving the energy system greater flexibility and more options for adapting to disruptions. Second, the report investigates the long-term effects of energy shocks on the speed and trajectory of the energy transition.

Not all energy crises have had a lasting impact on the energy system. Their effects often depend on the scale of supply losses and the duration of the disruption. Some crises have been severe but short-lived, such as the 2019 attacks on Abqaiq and Khurais, which temporarily removed almost 6 million barrels per day (bpd) of Saudi Arabian production. That disruption was brief and production was restored relatively quickly, limiting its longer-term impact on the energy system.

Other shocks have had lasting effects. The energy crises of the 1970s, for example, reshaped the thinking around energy security

and contributed to changes in technology, policy and energy consumption. The energy crises of the 2020s fall into this latter category and are notable because several major shocks occurred within a relatively short period.

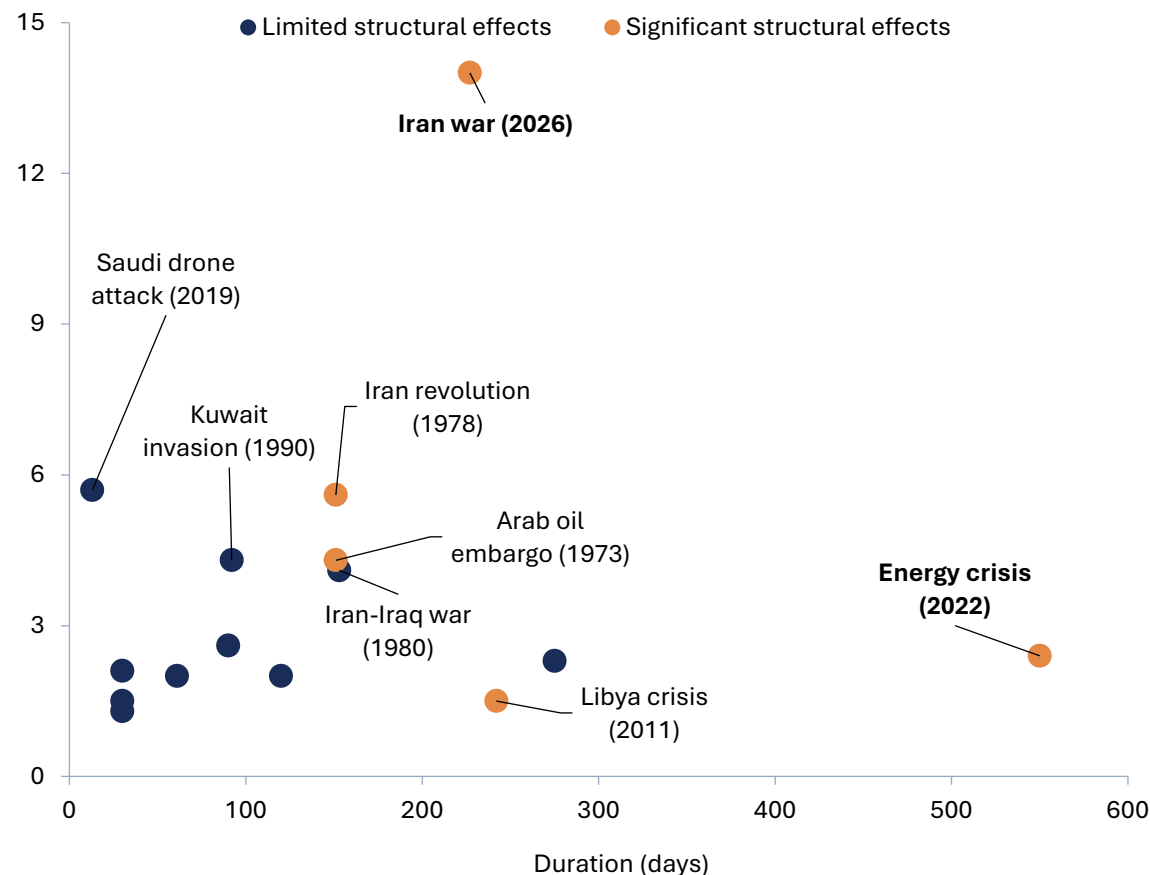
In directly affected regions, high fossil-fuel prices and growing energy-security concerns have reinforced diversification through electrification technologies such as renewable energy and electric vehicles (EVs). The report investigates whether these responses will translate into lasting changes in the trajectory of the global energy system.

Finally, policymakers have responded with new measures to strengthen energy security, improve affordability and advance sustainability. How each region balances this energy trilemma in the short and long term will determine the direction and pace of the energy transition.

Near-term trade-offs remain, but all our scenarios improve resilience through more diverse and increasingly domestic energy supply. Over time, lower import dependence, falling clean-technology costs and declining emissions can strengthen all three dimensions of the energy trilemma.

Major energy crises since World War II

Gross peak supply loss (million barrels of oil equivalent per day)



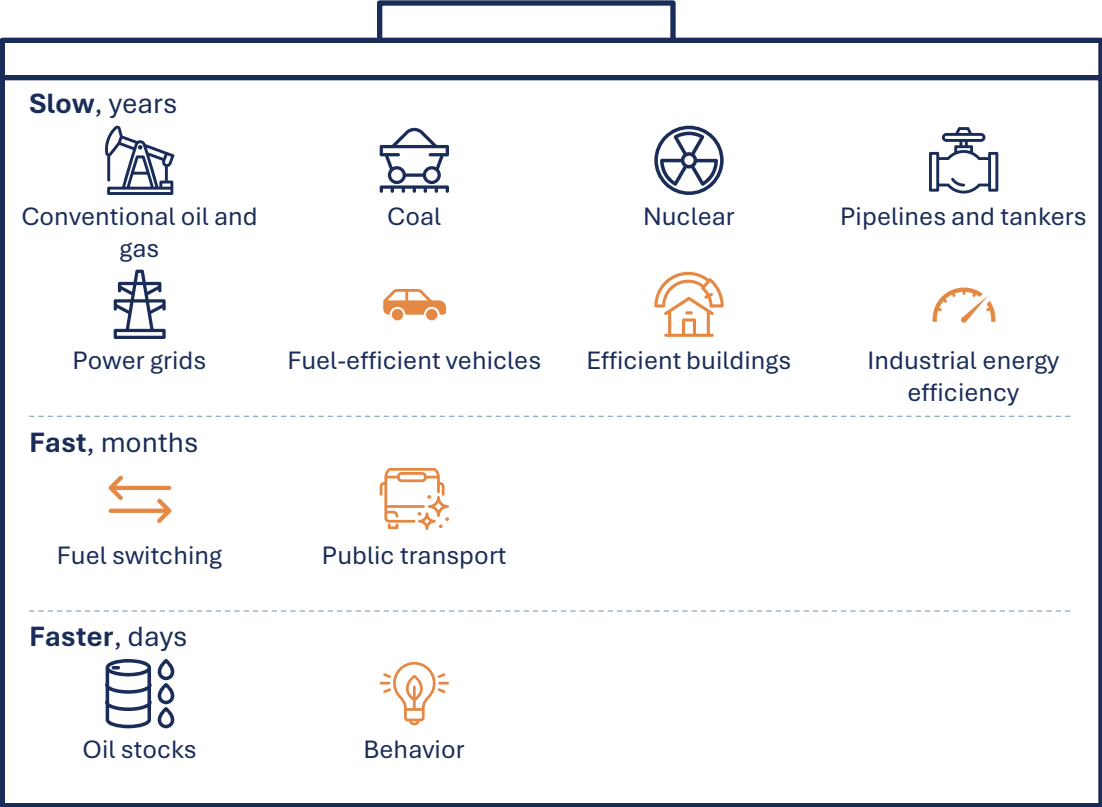
Source: Rystad Energy research and analysis; IEA

Five decades of innovation have expanded the energy resilience toolbox

Ongoing energy crises can draw on 25 technology options

1970s

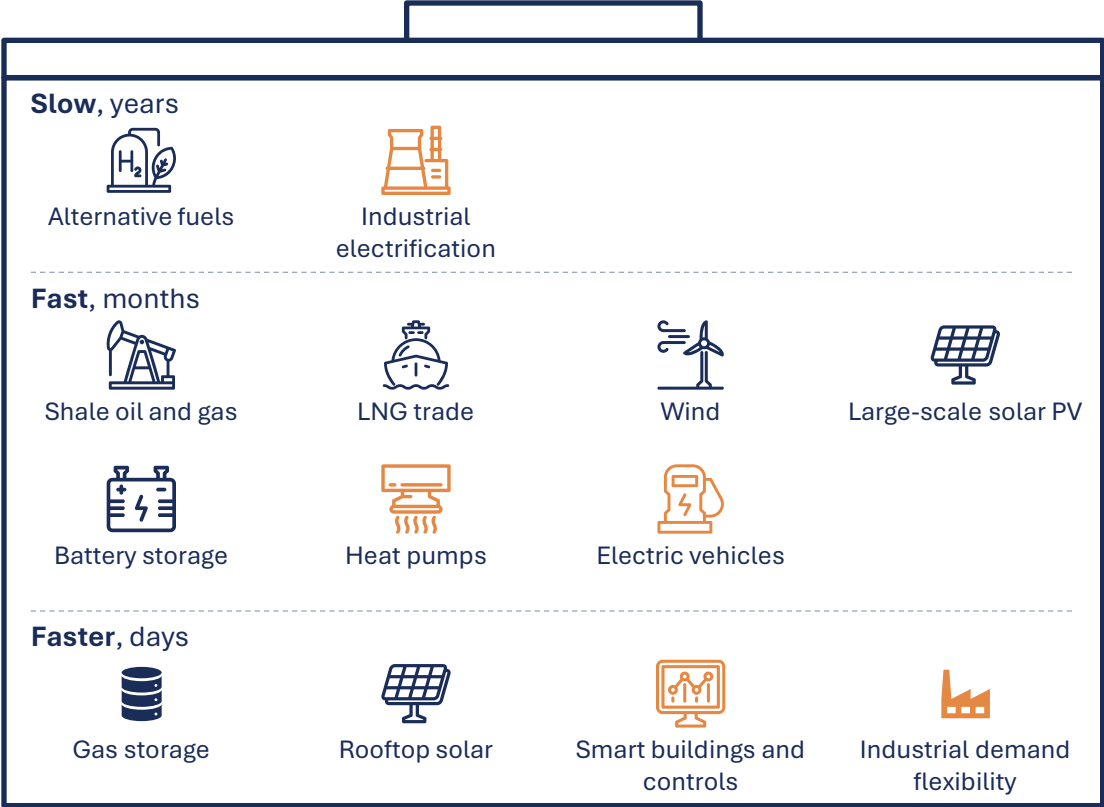
12 options, two-thirds take years to deploy



The 1970s response relied on supply, infrastructure and efficiency that took years to build. Only oil stocks, fuel switching, public transport and behavior acted faster.

2020s

13 options added, 11 can deploy in months or days



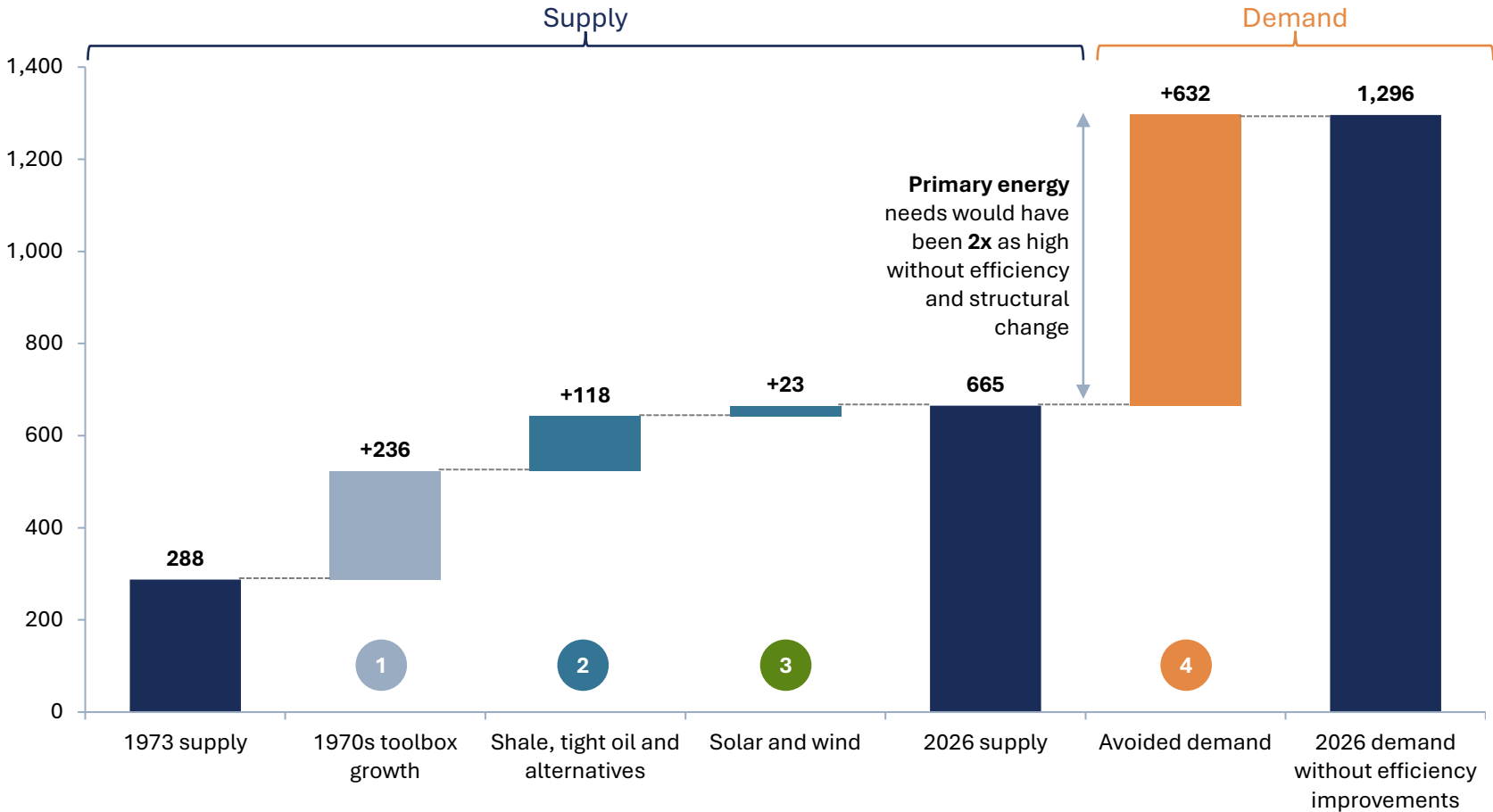
Modular technologies such as solar PV, batteries, heat pumps and EVs can be deployed in months. This gives policymakers faster options to respond to supply shocks.

Source: Rystad Energy research and analysis

Gradual efficiency improvements and fast new supply growth support resilience

Supply grew from 288 EJ to 665 EJ since 1973, while efficiency and structural change avoided another 632 EJ

Global primary energy supply and avoided demand, 1973 to 2026
Exajoules



- 1 Conventional** oil and gas, coal, hydro, nuclear and biomass have grown by 236 EJ since 1973.
- 2 Shale oil and gas** has added 94 EJ, while oil sands and heavy oils added 17 EJ. Alternative fuels include biofuels and biogas, which contributed to a growth of 14 EJ since 1973.
- 3 Solar and wind** have added 12 EJ and 11 EJ to primary energy supply, respectively. As solar and wind produce electricity directly, their contribution to useful energy is typically 2-3 times higher per unit of primary energy supply compared to fuels.
- 4 Avoided demand** comes from energy efficiency improvements and structural changes to the economy. Without these gains, primary energy demand today would have been twice as high.

Source: Rystad Energy EnergyDemandCube

Policy response moves from crisis management to structural reform

Europe and Asia are responding to the largest supply disruption in history; structural electrification is front and center

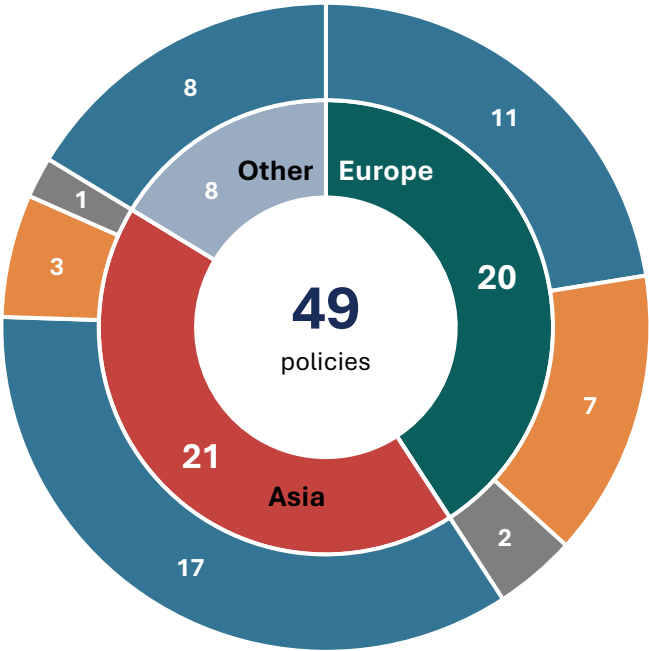
Ukraine taught Europe that pipeline gas is a security risk. Hormuz is now teaching Asia the same lesson about liquefied natural gas (LNG). Since February 2026, most governments first shielded consumers: 97 cut fuel taxes, paid subsidies or capped prices. Only 26 adopted electrification policy, 22 of them in Europe and Asia.

Energy security is making electrification more politically durable, even in countries such as Italy and Japan that had placed less emphasis on sustainability. But the rule is to electrify using domestic energy sources: renewables and nuclear where available, and coal where reserves exist. Little new coal capacity is being built, but plant life extensions, restarts and delayed phaseouts – including Italy to 2038 and Thailand’s Mae Moh – add years of emissions.

China is the structural winner. Importers are replacing oil and gas from the Persian Gulf with Chinese batteries, minerals and EVs, deepening dependence in Europe and India. Infrastructure also tends to outlast subsidies. Europe’s 2022 heat-pump boom faded, but REPowerEU’s grid build-out continued. Policies that embed structural changes in law, such as China’s truck targets, Spain’s electricity tax reform and France’s industrial heat decrees, are also more likely to remain.

Structural electrification policies by region
Number of policies, by region (inner) and end use (outer)

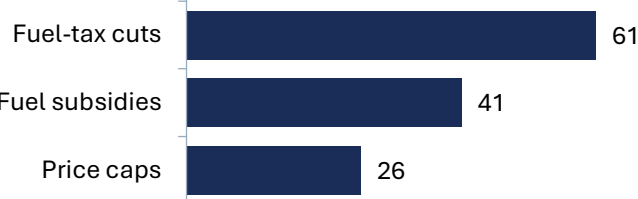
■ Transport ■ Heating & cooking ■ Multi-sector



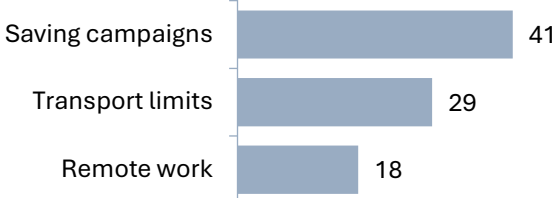
84% of policies are in Europe and Asia
The two major net-importing regions that are being most affected by the 2020s energy crises are also the ones with the most amount of structural electrification policies in place since February 2026.

Crisis policy responses by type
Number of countries

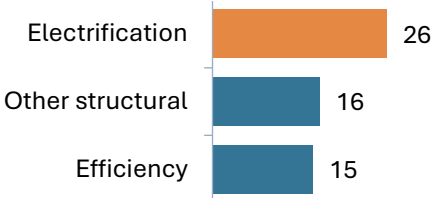
Shield consumers: 97 countries



Cut demand: 60 countries



Restructure: 34 countries

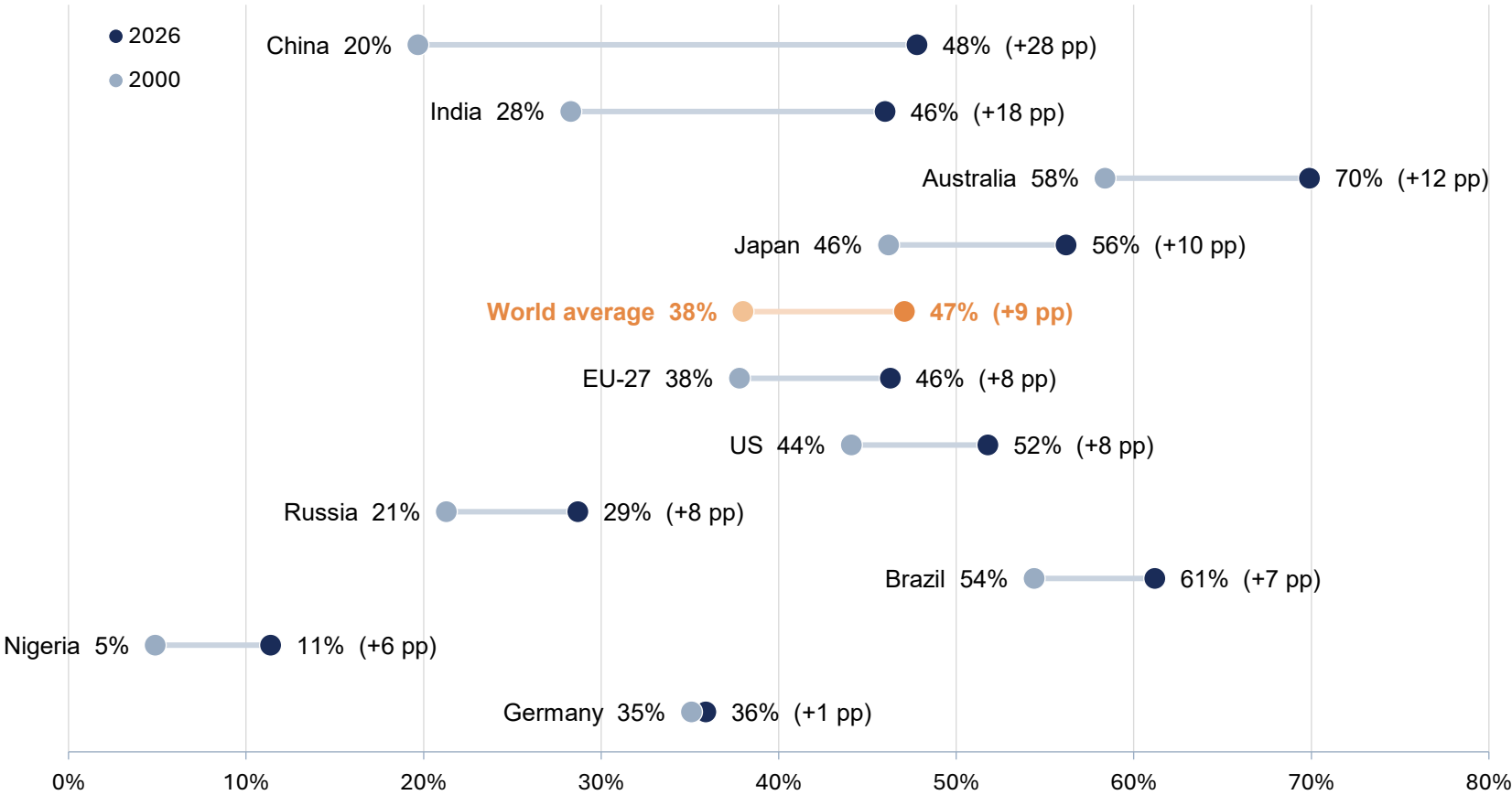


Note: Europe includes European Union level policies , France, Spain, UK, Netherlands, Ireland, Sweden, Denmark, Luxembourg, Croatia and Iceland. Asia includes China, India, Indonesia, South-Korea, Thailand, Viet Nam, Lao PDR, Cambodia, Myanmar, Bangladesh, Nepal
Multi-sector covers measures spanning several end uses: the EU Electrification Action Plan, France’s national electrification plan, and Cambodia’s import-tariff cuts on EVs, electric stoves and appliances
Source: Rystad Energy research and analysis; IEA

Electricity’s economic importance is rising faster than its energy share suggests

China’s electricity-linked share of GDP has risen 28 percentage points since 2000, versus 9 points globally

Electricity share of GDP, selected economies, 2000 and 2026
Percent



The 2022 energy crisis gave an early indication of how much economic value now depends on electricity. In Europe, much of the damage came through gas and power prices rather than oil. This reflects a longer-term shift, as electricity is now linked to about 47% of the world’s gross domestic product (GDP), up from 38% in 2000.

Two factors drive the share in each country: the sector mix of the economy and how electrified each sector is. China accounts for the most striking change, rising 28 percentage points to 48%. Services grew from 33% to 47% of value added, while electricity’s share of energy use in services rose from 25% to 68%. India added 18 percentage points, as electricity’s share of energy use more than doubled in services, to 46%.

By comparison, Germany barely moved, from 35% to 36%. Electricity still covers only 43% of energy use in services and 20% in manufacturing. This suggests that natural gas remains firmly embedded in the country’s heating and industry.

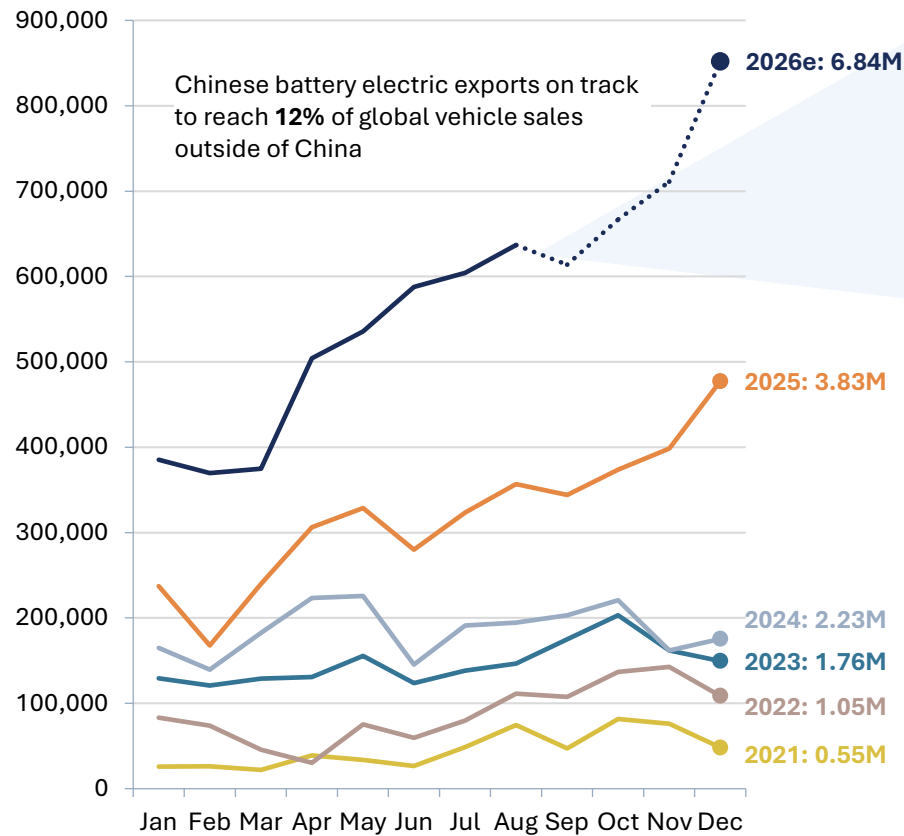
As electrification continues, the affordability and reliability of power systems are expected to become an ever more central part of energy security.

Note: Share of GDP = $\sum (\text{sector value added} \times \text{electricity share of sector final energy}) \div \text{total value added}$. Covers 207 countries and territories.
Source: Rystad Energy research and analysis; Rystad Energy EnergyDemandCube; OECD; UN

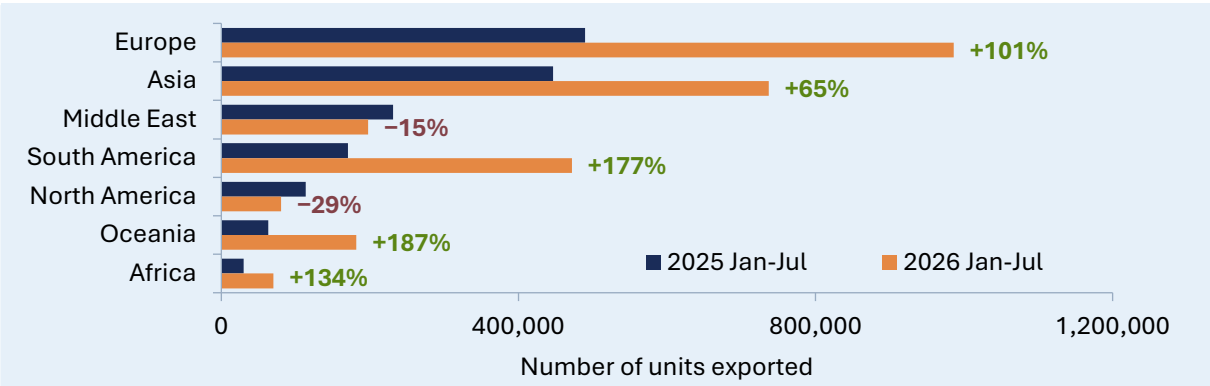
The Hormuz energy crisis is the first with a real electric alternative

Chinese EV exports set to reach 12% of global total car sales outside of China in 2026

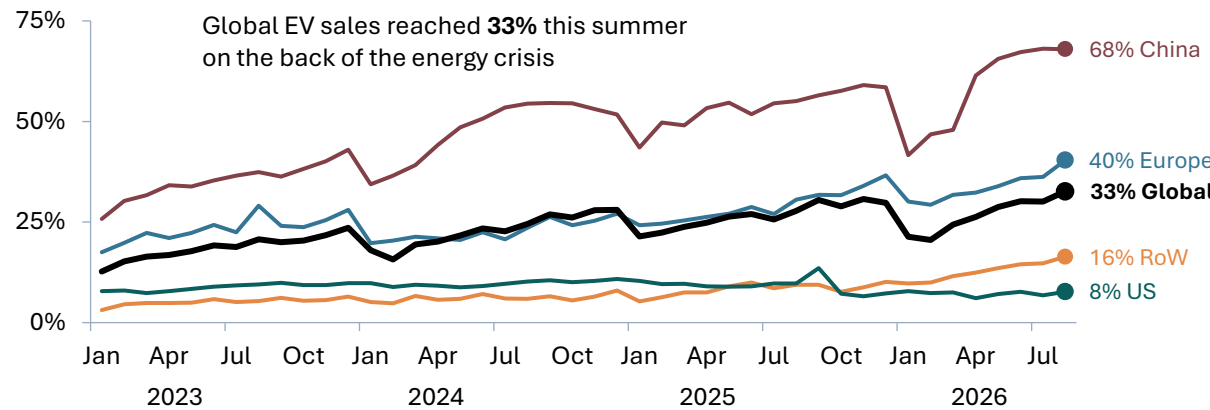
China monthly battery electric vehicle exports by year
Number of units exported by month



Chinese monthly export of battery-electric vehicles, by region
Units exported, January - July



Monthly EV share of light-duty vehicle sales by region
Percent



Note: September–December 2026 are estimates (dotted line). Labels show the annual total.
Source: Rystad Energy research and analysis; Rystad Energy Battery Market Dashboard



Pathways

Four scenarios, testing the range of outcomes



Fossil first

Slower technology, weaker policy, higher import dependence



Pragmatism

Market-led, policy-supported transition



Climate first

Rapid, coordinated global effort



NDC

Meets short-term climate targets as pledged

One forecast, what we expect



House View

The path we commit to in price decks and investment cases

Insights summary: Pathways

Scenarios map credible energy pathways

Rystad Energy's scenarios start with a realistic forecast of energy service demand, not a target energy mix. The model first estimates the services economies need – mobility, heat, cooling, industrial output and feedstock demand – using granular drivers such as passenger-kilometers, freight movement, building stock, industrial production and macroeconomic growth.

This demand view is then balanced across 217 countries, more than 80 sectors and more than 90 energy carriers. The model draws on Rystad Energy's asset-level research and proprietary databases, keeping supply, demand, costs, prices and efficiencies consistent across sectors and geographies.

The House View is Rystad Energy's central forecast for the global energy system over the next 15 years. It is the pathway used in price decks, market outlooks and investment cases, reflecting the company's current view of supply, demand, technology, policy and macroeconomic drivers. As those drivers change, the House View is updated.

The scenarios test how the same energy system could evolve under different assumptions. The *Climate first* scenario assumes rapid policy support, faster clean-technology deployment

and coordinated global action, putting the system on a fast transition trajectory.

The *Pragmatism* scenario assumes a gradual strengthening of current policies, with affordability, energy security and technology costs setting the pace toward a moderately paced transition pathway.

Fossil first assumes weaker policy support, slower clean-technology progress and a stronger focus on energy security and affordability, keeping oil, gas and coal central for longer and placing the system on a slow transition course.

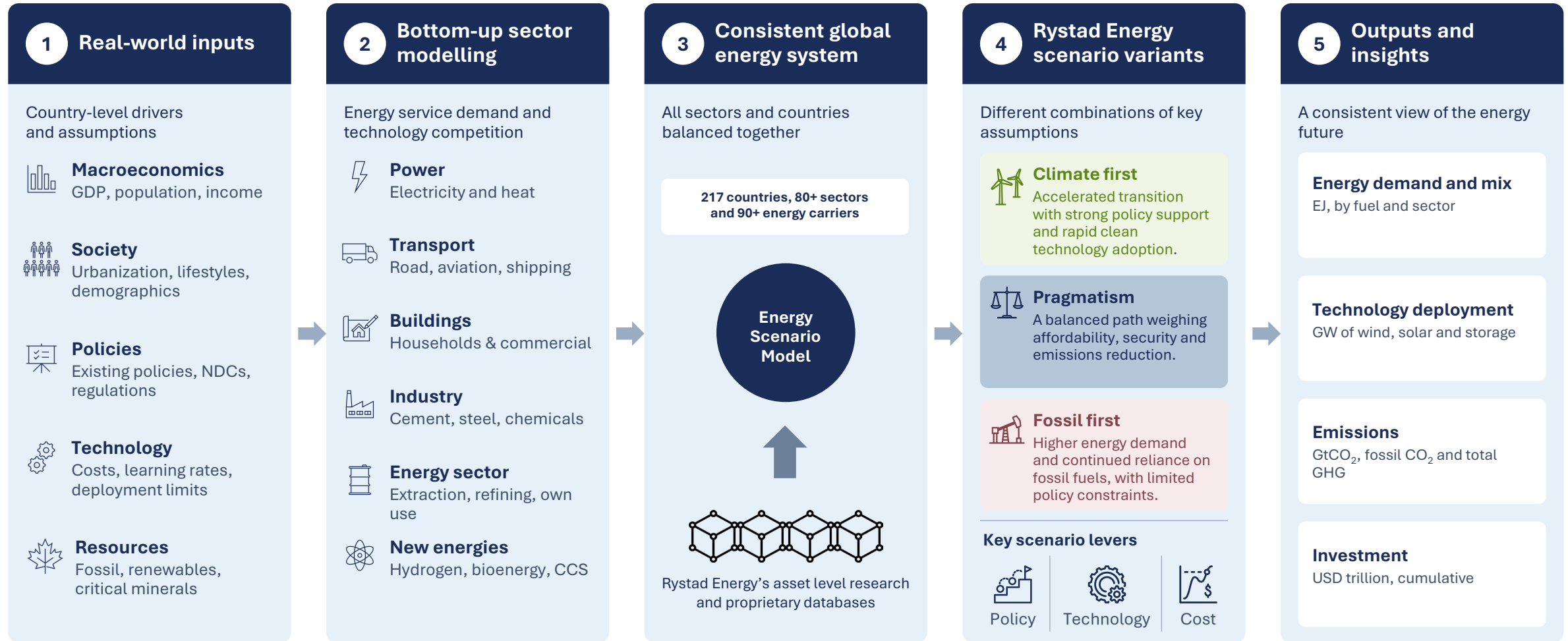
The *Nationally Determined Contributions (NDC)* scenario reflect countries' filed climate pledges under the Paris Agreement and their future revisions.

The scenarios are directly comparable because they are produced with the same model structure and energy service demand foundation. Useful energy delivered to consumers remains broadly similar, but the fuel mix, pace of electrification, emissions trajectory and investment requirement diverge. The House View shows what Rystad Energy plans for; the scenarios show what could change.

Source: Rystad Energy research and analysis; Rystad Energy EnergyDemandCube

Rystad Energy Scenario modeling framework

From real-world drivers to credible, differentiated energy futures



Source: Rystad Energy scenario model

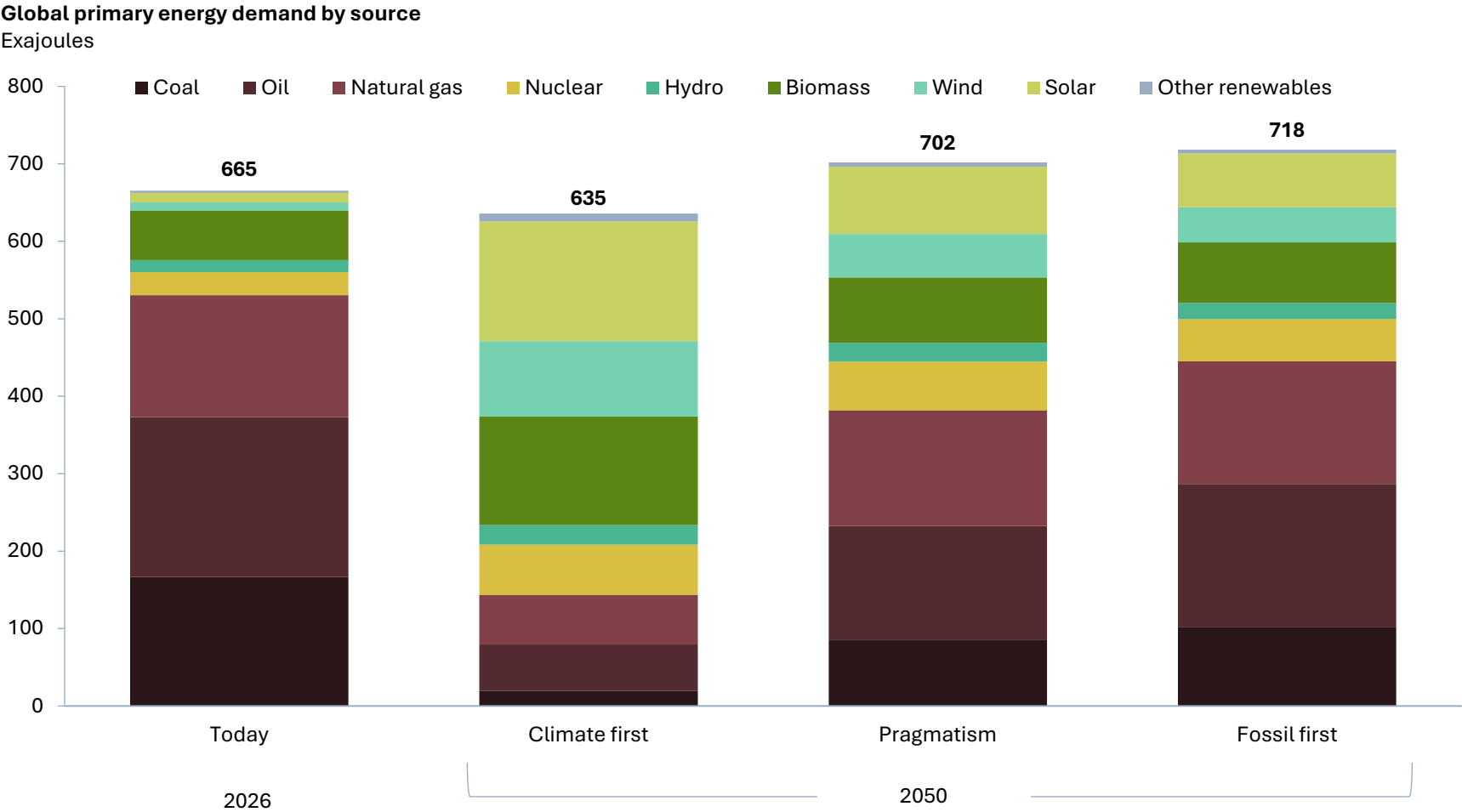
Multiple pathways remain plausible – three scenarios to 2050

All scenarios deliver broadly the same energy services to end users, but the energy supply mix differs substantially

The closure of the Strait of Hormuz and the 2022 energy crisis have contributed to a shift away from a transition driven primarily by stringent climate policies towards a more pragmatic approach that balances reliable, affordable and clean energy. How regions balance this energy trilemma in the short and long term will shape both the pace and direction of the transition.

Under Pragmatism, this balance still results in substantial change to the global energy system. Primary energy demand reaches 702 EJ by 2050, equivalent to adding another India to global energy demand in less than 25 years. Solar, wind and batteries continue their strong growth, enabling higher rates of electrification as the historical link between natural gas and power prices weakens. At the same time, greater reliance on domestic energy resources reduces import dependence among importing countries from around 40% today to near 25% by 2050.

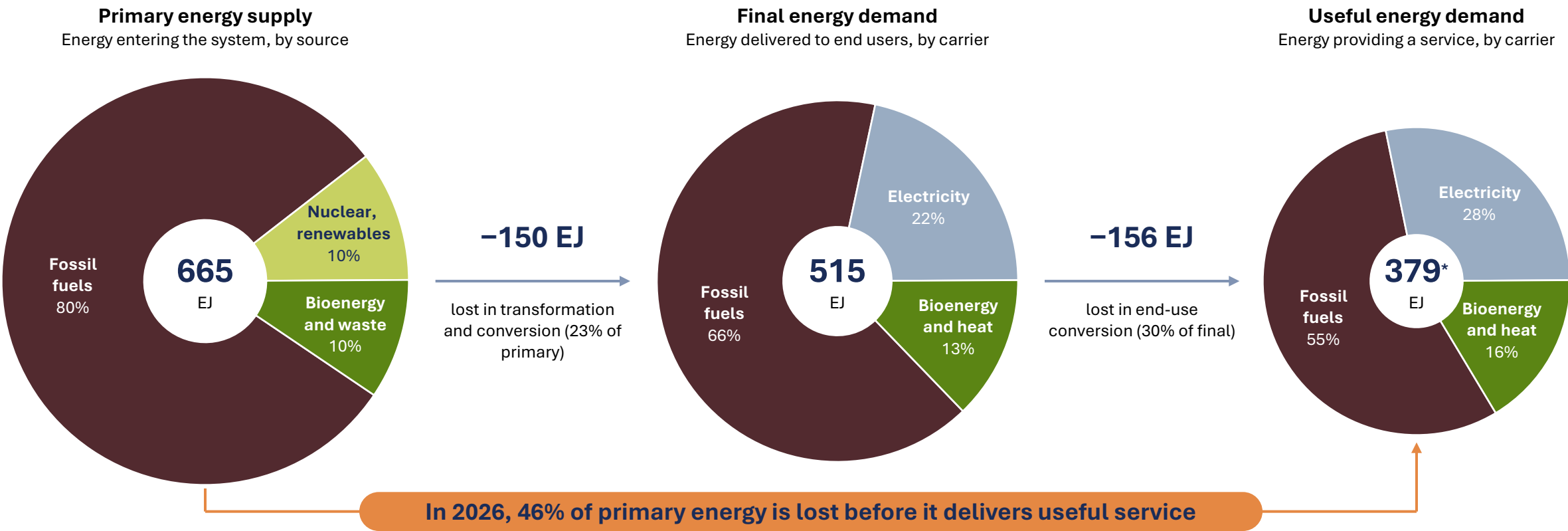
Under Climate first, primary energy demand remains around current levels, yet broadly the same energy services are delivered to end consumers, reflecting higher efficiency and greater electrification. The shift towards more efficient and domestic energy sources also reduces import dependence to less than 15% by 2050.



Source: Rystad Energy EnergyDemandCube

Nearly half of primary energy is lost before it delivers a useful service

In 2026, electricity delivers 96% of its energy as useful work, compared with 62% for fossil fuels



End-use efficiency, 2026 Useful energy ÷ Final energy	62% Fossil fuels	64% Bioenergy and heat	70% All carriers	96% electricity
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Note: Renewables include hydro, wind, solar, geothermal and ocean. Bioenergy includes waste and biogas; 'heat' covers generated heat, ambient heat, geothermal and hydrogen. Shares are rounded and may not add to 100%.
*Includes 20 EJ of ambient heat from heat pumps, counted in useful energy only (not in final or primary energy) and excluded from losses and end-use efficiency.
Source: Rystad Energy EnergyDemandCube

Importers' primary energy peaks in the late 2030s, but useful energy keeps growing

Electrification turns efficiency into energy security as importers get more from less fuel

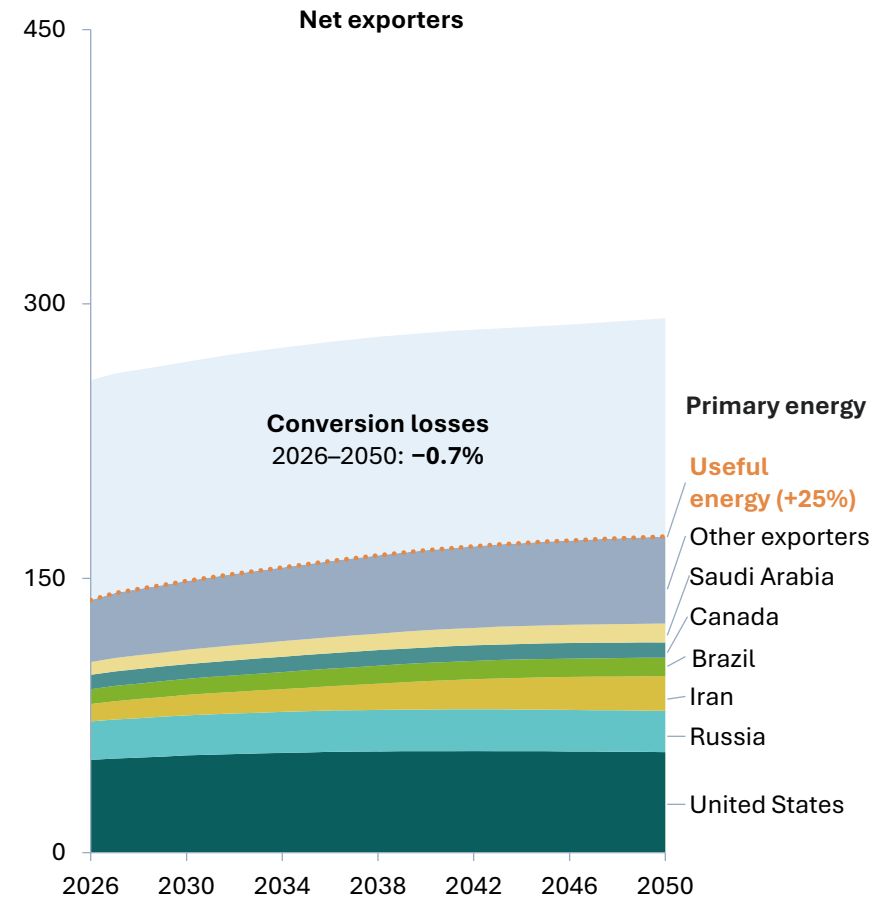
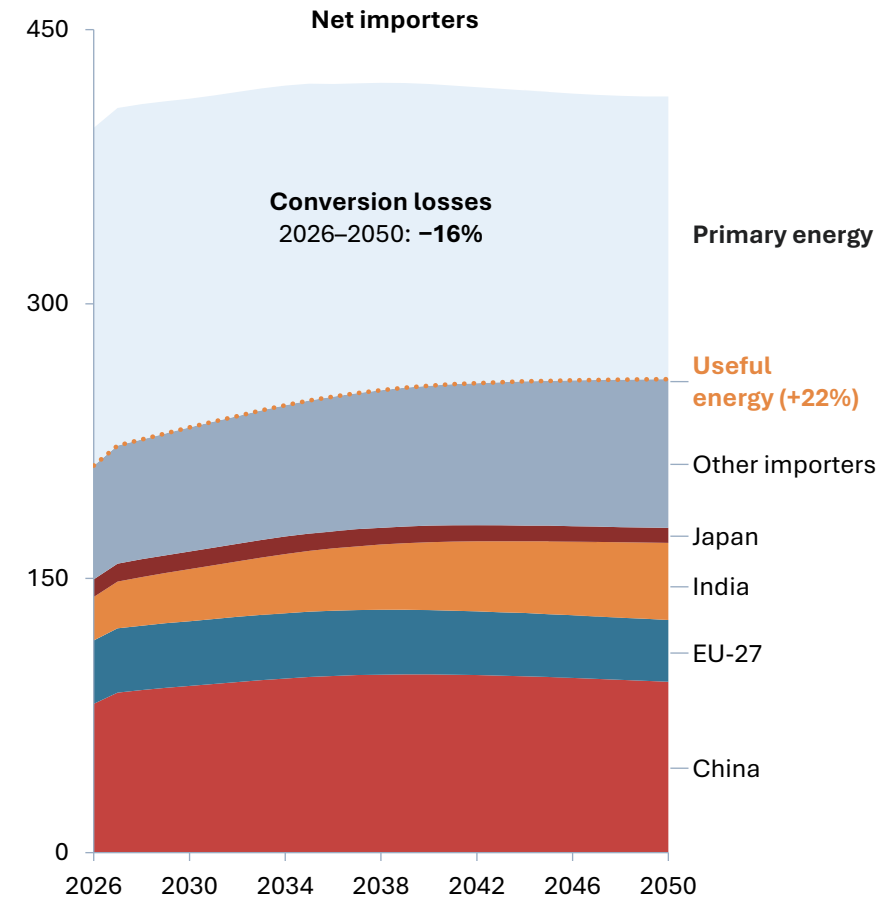
Global primary energy consumption has historically grown by an average of 1% to 2% per year, but that growth may now start to slow down. However, a slowdown in primary energy demand does not mean that access to energy stops growing. On the contrary, useful energy, the energy that delivers work and heat to end users, keeps rising as the system becomes more efficient at delivering services.

For importers, that means primary energy peaks in 2038 at 421 EJ and then eases, yet the energy they put to work grows 22% through 2050. The difference comes from wasting less energy between the fuel and the end use: conversion losses fall by 30 EJ.

Electricity drives the shift. Its share of useful energy rises from about 32% to 48% for importers and from 26% to 42% for exporters, supplying all of the growth while other carriers edge down. Electric end uses lose far less energy than combustion, so each step toward electrification cuts conversion losses.

For importers, this turns efficiency into energy security: they get more out of every unit of fuel, with India making the largest gains (+78%). Exporters grow useful energy slightly faster (+25%), but their losses barely fall, so their primary energy still rises 13%.

Global energy demand, Pragmatism scenario
Exajoules



Note: colored bands are useful energy by country, largest at the bottom, EU-27 aggregated; the light blue band on top is conversion losses, so the top of each stack is primary energy.
Source: Rystad Energy research and analysis; net trade status per Rystad GEO classification (2025)

Electricity is now the single largest energy carrier measured in useful energy

Useful energy demand grows by over 22% to 2050 despite peak in primary energy supply

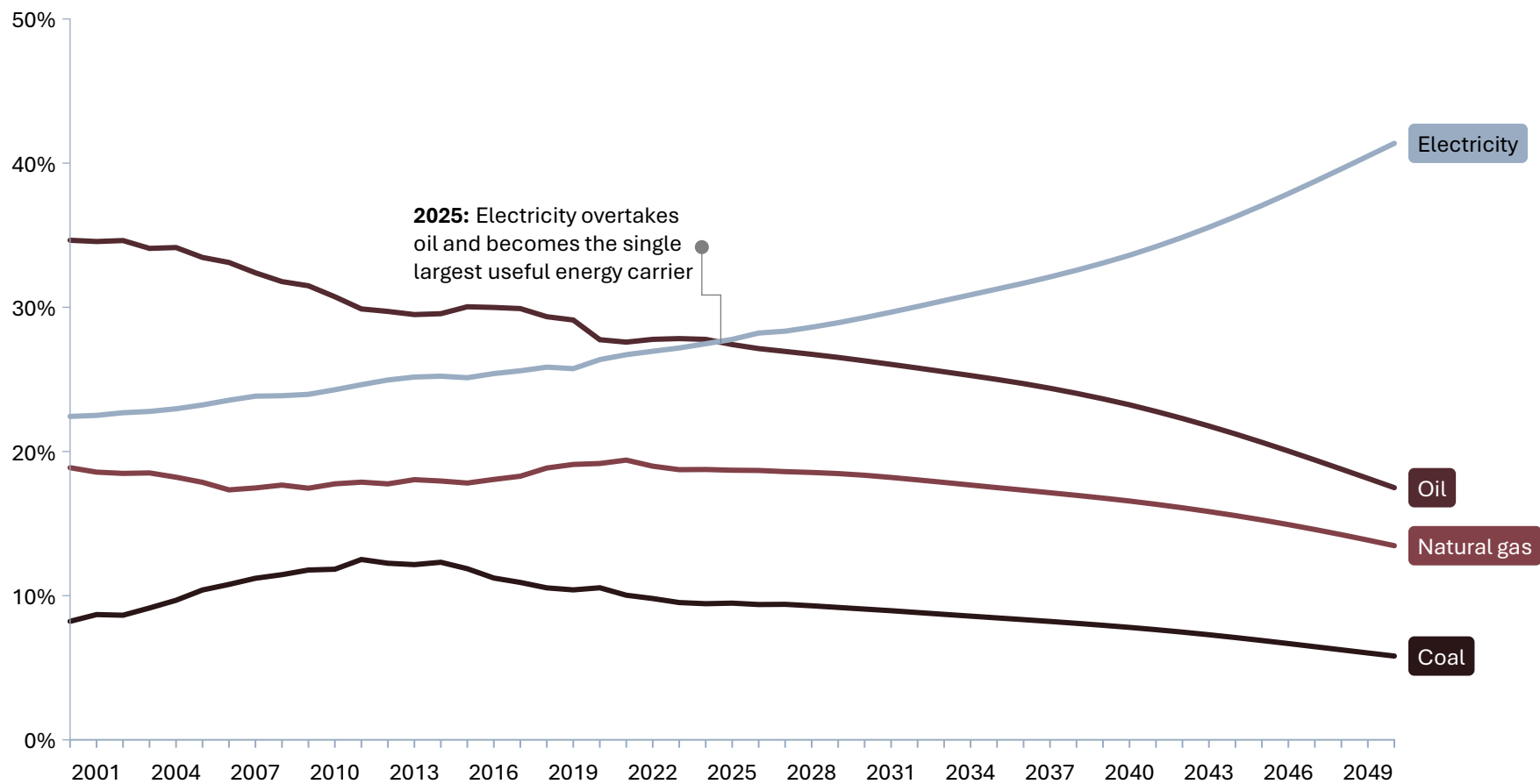
Electricity is set to become the dominant useful energy carrier, overtaking oil in 2025 and increasing its share of global useful energy demand from around 28% today to 41% by 2050. Electrification speeds up: electricity's share grew by five percentage points between 2000 and 2024 but gains a further 14 points by 2050. The main drivers are electrified transport, buildings and industry.

Together, oil, gas and coal's share of useful energy falls from 56% today to 37% in 2050. Separately, fossil fuels lose share at different paces. Oil's share halves from 35% in 2000 to 17.5% in 2050. Natural gas holds at around 19% until its peak in 2021, then slowly declines to 13.5%. Coal's share peaked at 12.5% in 2011. By 2048, electricity supplies more useful energy than coal, oil and gas combined, and twice as much as oil alone.

The gap between oil and gas narrows from 16 percentage points in 2000 to just 4 in 2050. Oil loses share much faster than gas as EVs replace oil in transport.

Despite primary energy supply reaching a peak, global useful energy demand is projected to grow by 22%, from approximately 379 EJ today to 460 EJ in 2050, because electrification converts more primary energy to useful energy.

Useful energy demand by energy carrier, Pragmatism scenario, 2000-2050
Percent



Source: Rystad Energy research and analysis; net trade status per Rystad GEO classification (2025)

What each scenario requires: Growth to 2050 against recent history

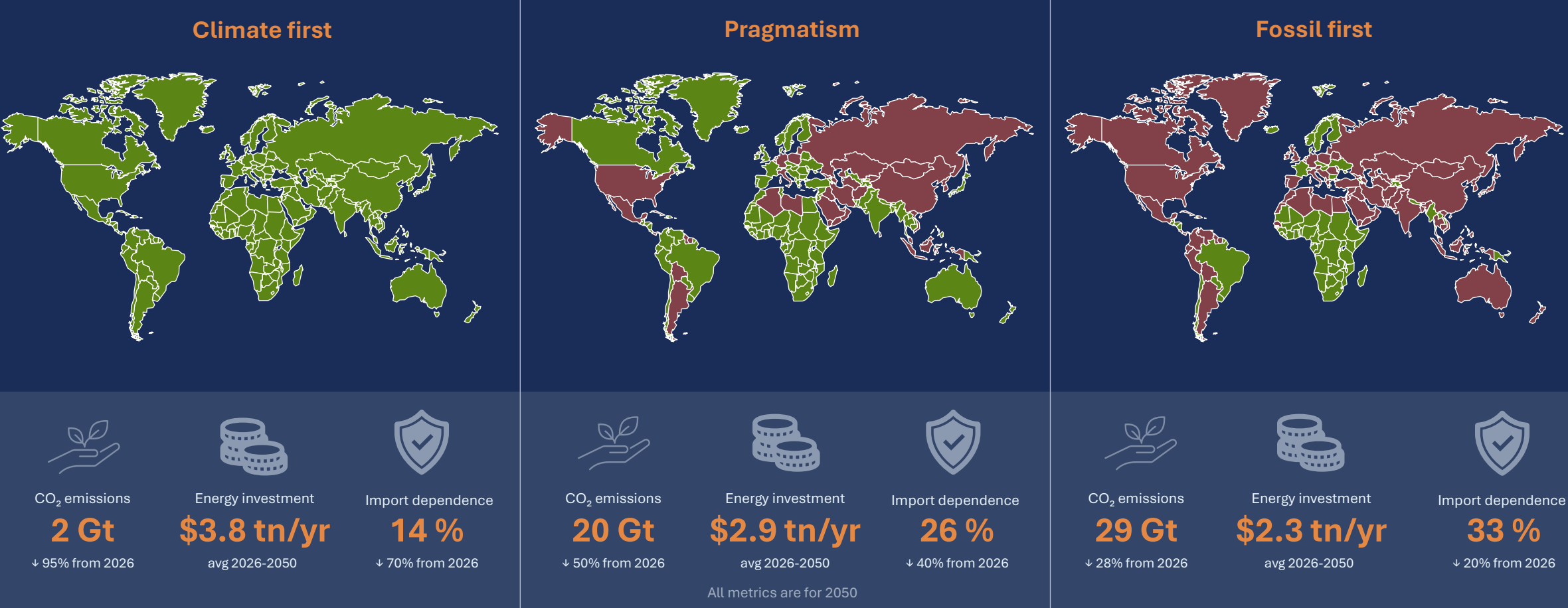
Compound annual growth rate, 2026-2050 against 2020-2026

Indicator	2026e	Historical CAGR 2020–2026	CAGR, 2026–2050		
			Pragmatism	Fossil first	Climate first
 Oil demand	102.0 million bpd	1.9%	-1.4%	-0.3%	-4.9%
 Gas demand	4,150 Bcm	1.1%	-0.6%	0.0%	-3.7%
 Final electricity demand	30,400 TWh	3.5%	2.6%	2.1%	3.7%
 Coal power generation	10,700 TWh	1.9%	-5.8%	-3.5%	-14%
 Solar power generation	3,330 TWh	26%	9.1%	7.6%	11%
 Wind power generation	3,060 TWh	12%	7.5%	6.1%	9.5%
 Battery storage installed	399 GW	79%	13%	11%	14%
 Electric car sales	25 million	42%	7.5%	6.6%	7.6%

Note: 2020–2026 oil growth is measured from a Covid-depressed 2020 base.
Source: Rystad Energy research and analysis; Rystad Energy EnergyDemandCube

Three scenarios for the future energy system – How does it look in 2050?

■ Non-fossil dominated (2050) ■ Fossil dominated (2050)



Fossil dominated is defined as primary energy from fossil fuels higher than non-fossil fuels
Net imports as a share of consumption for countries that were net energy importers in 2025. Covers oil, natural gas and coal only. Calculated as aggregate net import divided by aggregate consumption.
* CO₂ emissions include emissions from fossil fuel, and land use, land-use change and forestry (LULUCF)
Source: Rystad Energy EnergyDemandCube



Trilemma

Scenario performance depends on time horizon and priorities

Fossil-led pathways cost less upfront, but faster transitions strengthen across the trilemma over time

● Short term (2025–2040)

○ Long term (beyond 2040)



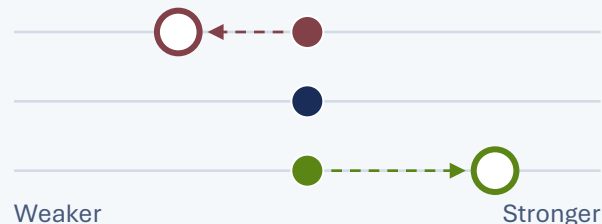
RELIABILITY

Ability to meet demand securely and reduce import dependence.

Fossil first

Pragmatism

Climate first



Long-term reliability divergence

All scenarios improve resilience in the transition period through diversification, higher domestic energy supply and lower exposure to traded fossil fuels. Over the long term, reliability diverges as import dependence falls fastest in *Climate first*, while *Fossil first* remains more exposed to fuel supply disruption. Net fossil fuel importers tend to have more scope to improve energy reliability than net exporters.



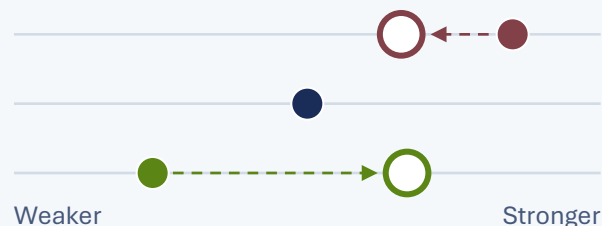
AFFORDABILITY

Total system costs for consumers and countries.

Fossil first

Pragmatism

Climate first



Cost convergence

Fossil first faces the least near-term cost pressure because it avoids some of the upfront investment needed for rapid electrification and clean energy buildout. Over time, affordability improves in *Climate first* as fuel costs fall and clean technologies scale, narrowing the gap with fossil-led pathways. Affordability will vary between countries, depending on their natural resources, current energy mix and trade position.



SUSTAINABILITY

Lower emissions and environmental impact.

Fossil first

Pragmatism

Climate first



Persistent gap

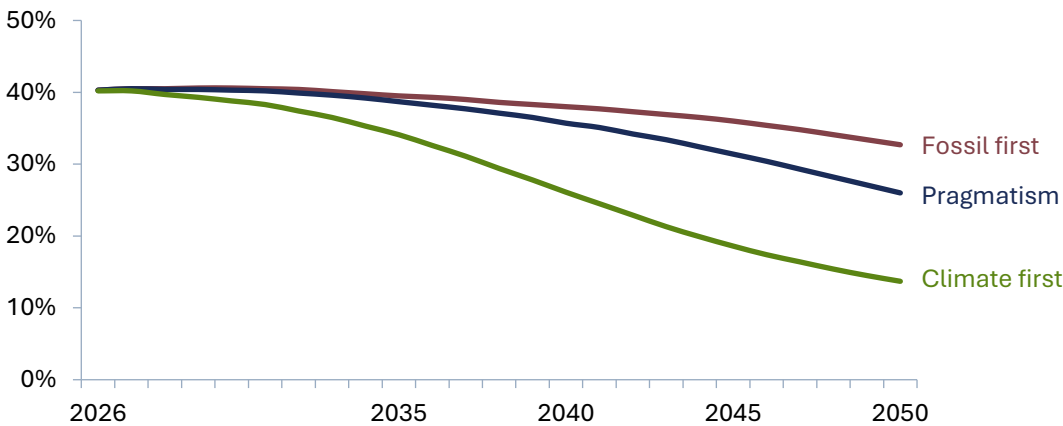
Sustainability improves fastest in *Climate first* and slowest in *Fossil first*. The direction is consistent over time: deeper electrification, faster renewable deployment and lower fossil fuel use reduce emissions and environmental impact more quickly.

Indicative relative performance within each trilemma dimension
Source: Rystad Energy research and analysis

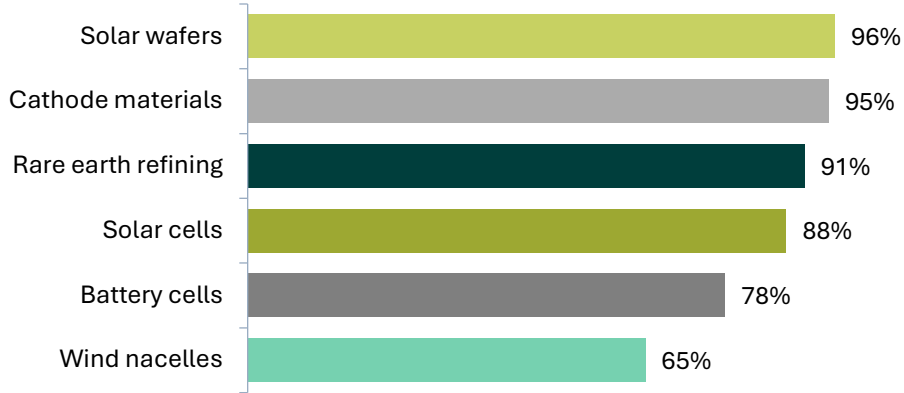
Energy security improves, but dependencies shift rather than disappear

Faster transitions cut fossil import exposure most, but concentrate clean-tech supply risks

Net fossil fuel import dependence by scenario, 2026-2050*
Percent



China's global share across selected energy supply-chain segments, 2026
Percent



Net fossil energy imports have grown 2% per year since 2000, nearly twice the rate of consumption growth, as domestic production in net-importing countries weakened. Recent disruptions have exposed the economic and physical risks of this dependence.

The energy system is better equipped to absorb short-term shocks than in the past. Rising LNG supply, more flexible trade routes and larger storage capacity give buyers more options when a supplier or transport corridor is disrupted. These measures improve responsiveness but leave the underlying exposure to internationally traded fuels in place.

Import dependence falls from about 40% today in all three scenarios, reaching 33% in Fossil first, 26% in Pragmatism and 14% in Climate first by 2050. Electrification, efficiency gains and more domestic energy supply cut the volume of oil, gas and coal traded across borders.

The pathways diverge most in the long term. Climate first delivers the largest resilience gains, as lower fossil fuel demand and faster build-out of domestic power supply cut import needs. Pragmatism improves resilience to a lesser degree, while Fossil first leaves importers

more exposed to international fuel supply disruptions.

Lower trade volumes affect importers and exporters differently. Importing countries gain from lower exposure to price volatility and supply interruptions. Producing countries face lower export volumes and revenue, which raises the importance of economic diversification as the transition advances.

Risk shifts toward clean-technology supply chains rather than disappearing. China holds 96% of solar wafer capacity, 95% of cathode materials, 91% of rare earth refining and 88% of solar cells, and even its smallest share shown, wind nacelles, is about two-thirds. Several emerging supply chains are more concentrated than the current fossil energy system.

The top three countries hold 96% of battery-material capacity and 89% of cell capacity. A more electrified system can be more secure overall, but its resilience is expected to depend increasingly on diverse mineral sources, manufacturing capacity, technology providers and trade partners. Energy security policy needs to broaden from protecting fuel flows to diversifying supply chains across the full energy system.

*Net fossil import dependence: net imports of oil, gas and coal as a share of total primary energy consumption, for the 172 countries and territories that were net fossil fuel importers in 2025
Source: Rystad Energy EnergyDemandCube; Rystad Energy PowerCube; Rystad Energy BatteryCube

Under Pragmatism, net imports peak in 2034 as Asian imports ease

Global net imports range from 42 EJ in Climate first to 108 EJ in Fossil first by 2050

Global net imports rose from 84 EJ in 2000 to 113 EJ in 2026. Asia drove most of the increase, from 33 EJ to 77 EJ, while Europe stayed within 33 to 40 EJ.

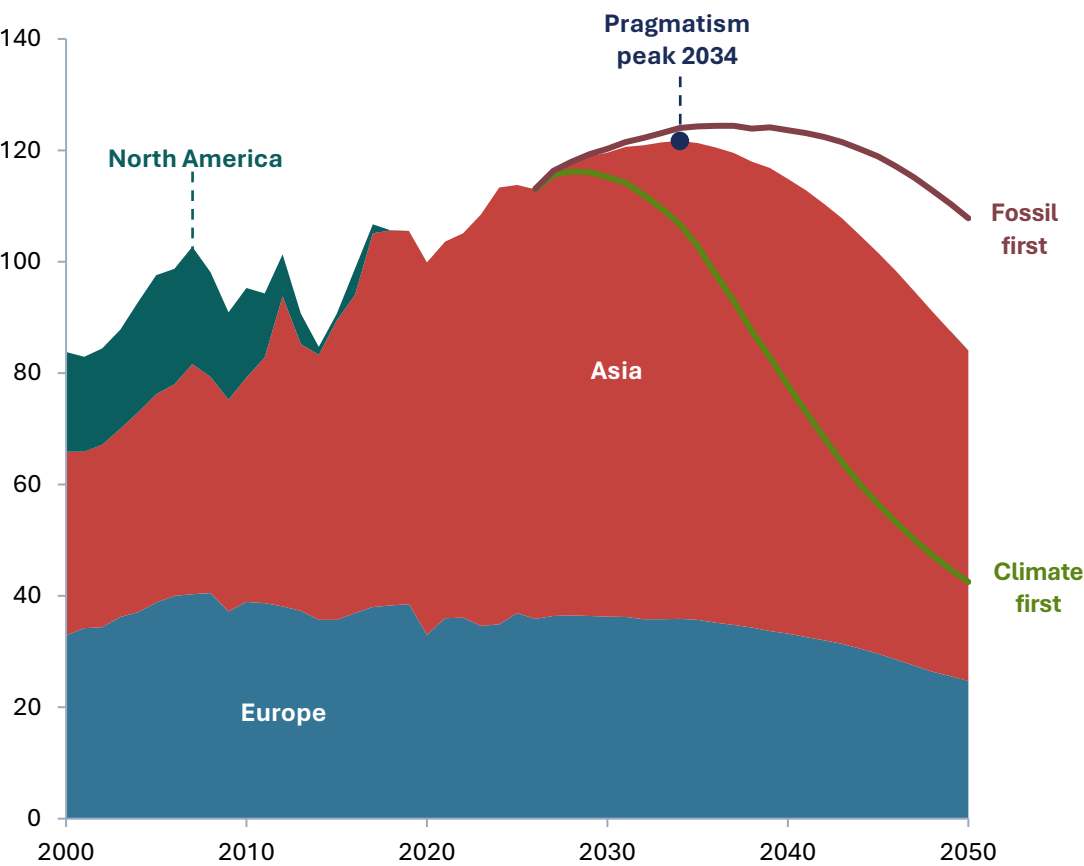
North America moved from a net importer to a net exporter as domestic production expanded. Its net imports fell from a peak of 21 EJ in 2005 to zero by 2018.

Africa, the Middle East, Russia, South America and Oceania do not appear because each region exports more fossil energy than it imports. Their importing countries, such as Morocco and Chile, are netted out within each region.

Under Pragmatism, global net imports rise to about 122 EJ in 2034 before declining. Asian imports plateau at about 85 EJ from 2032 to 2036, then fall to 59 EJ by 2050, while Europe declines from 36 EJ to 25 EJ.

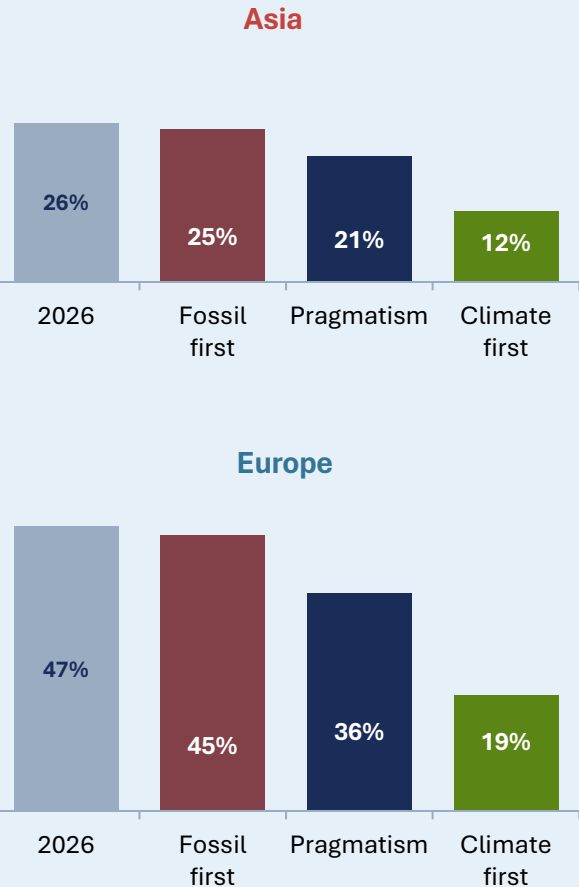
The scenarios diverge after 2030: Climate first falls to 42 EJ by 2050, while Fossil first stays at 120 to 124 EJ through the 2030s and ends at 108 EJ. Dependency stays concentrated. Asia still accounts for about 70% of net imports in 2050, and imports still supply more than one-third of Europe's primary energy under Pragmatism.

Global net imports by region under Pragmatism and total by scenario, 2000-2050
Exajoules



Note: Regional net imports – imports minus exports of oil, gas and coal, netted within each region; net exporting regions are not shown. Europe includes the UK, Norway and Ukraine; Asia excludes the Middle East.
Source: Rystad Energy EnergyDemandCube

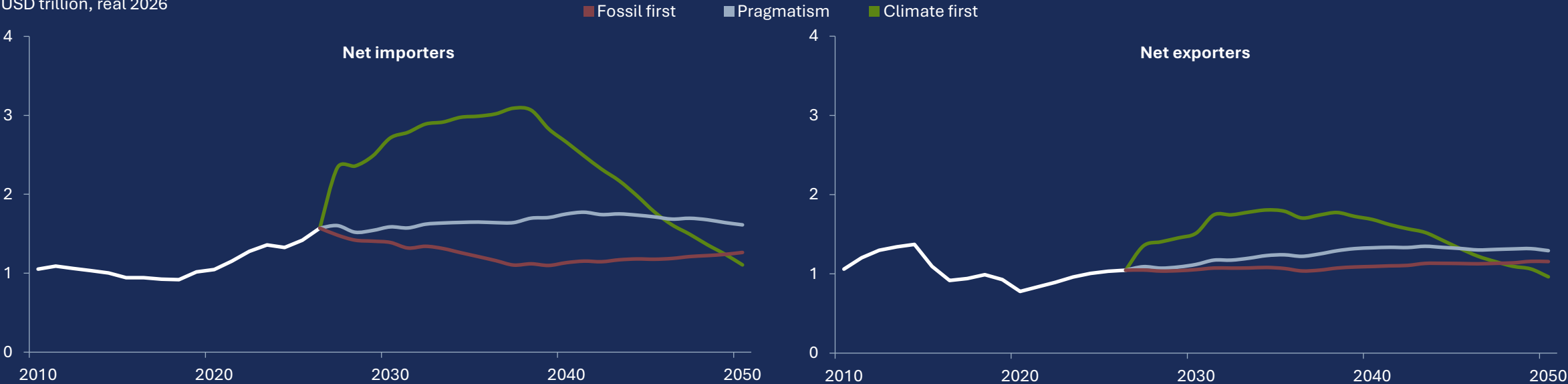
Fossil-fuel import dependence, 2026 and 2050
Percent of primary energy consumption



Pathways differ sharply in the timing of energy investment

Fossil-led pathways need less upfront capital but higher fuel spending over time

Energy capex by net trade position and scenario
USD trillion, real 2026



In our scenarios, Climate first front-loads investment as it builds up the low-carbon asset base as fast as possible. From 2037 to 2050, its capex falls by more than half as the asset demand saturates, while Fossil first capex rises 13% over the same time, leaving Climate first as the lowest of all pathways by 2050. For net importers, Pragmatism means a very modest capex growth at \$1.5–1.8 trillion a year, close to today’s \$1.6 trillion.

Between exporters and importers, the latter carry the largest build-out because they replace imported fuel with domestic generation, grids and storage.

Their Climate first capex peaks at \$3.1 trillion in 2037, twice today’s level. Once that system is in place, spending falls to \$1.1 trillion by 2050, 30% below today and 12% below Fossil first, which keeps climbing to sustain a fuel-based

system. Exporters face a smaller swing because oil and gas investment continues in every pathway.

In Pragmatism, their capex grows gradually from \$1.0 trillion to \$1.3 trillion, but never above the \$1.37 trillion they invested in 2014, and adds only \$0.16 trillion a year over Fossil first. The transition can be paced without stretching their investment capacity.

Climate first moves exporters earlier, with capex peaking at \$1.8 trillion in 2034. Once the new asset base is built, spending falls 47% to \$1.0 trillion in 2050 and drops below Fossil first from 2048. Fossil first instead rises 11% from 2036 as exporters keep reinvesting in supply, so the cost advantage of the fossil pathway narrows each year.

Source: Rystad Energy research and analysis; Rystad Energy EnergyDemandCube

Clean power leads progress, but electrification becomes increasingly important

Further gains in the Decarbonization Index depend on progress across all three tasks of the energy transition

Rystad Energy's Decarbonization Index tracks progress across the Three Tasks of the Energy Transition from a decarbonization perspective: 1) cleaning and expanding the power system, 2) increasing electrification, and 3) addressing residual emissions.

The first two tasks are closely interrelated since a cleaner power system forms the basis for electrification, while Task 3 covers the remaining emissions that require solutions like clean alternative fuel and carbon capture.

Progress so far has been led by Task 1. In the mid-2020s, the Task 1 index stands at around 40%, compared with around 30% for Task 2 and 15% for Task 3. In Rystad Energy's Pragmatism scenario, Task 1 speeds up and reaches approximately 85% by 2050 since cleaner power generation continues to expand.

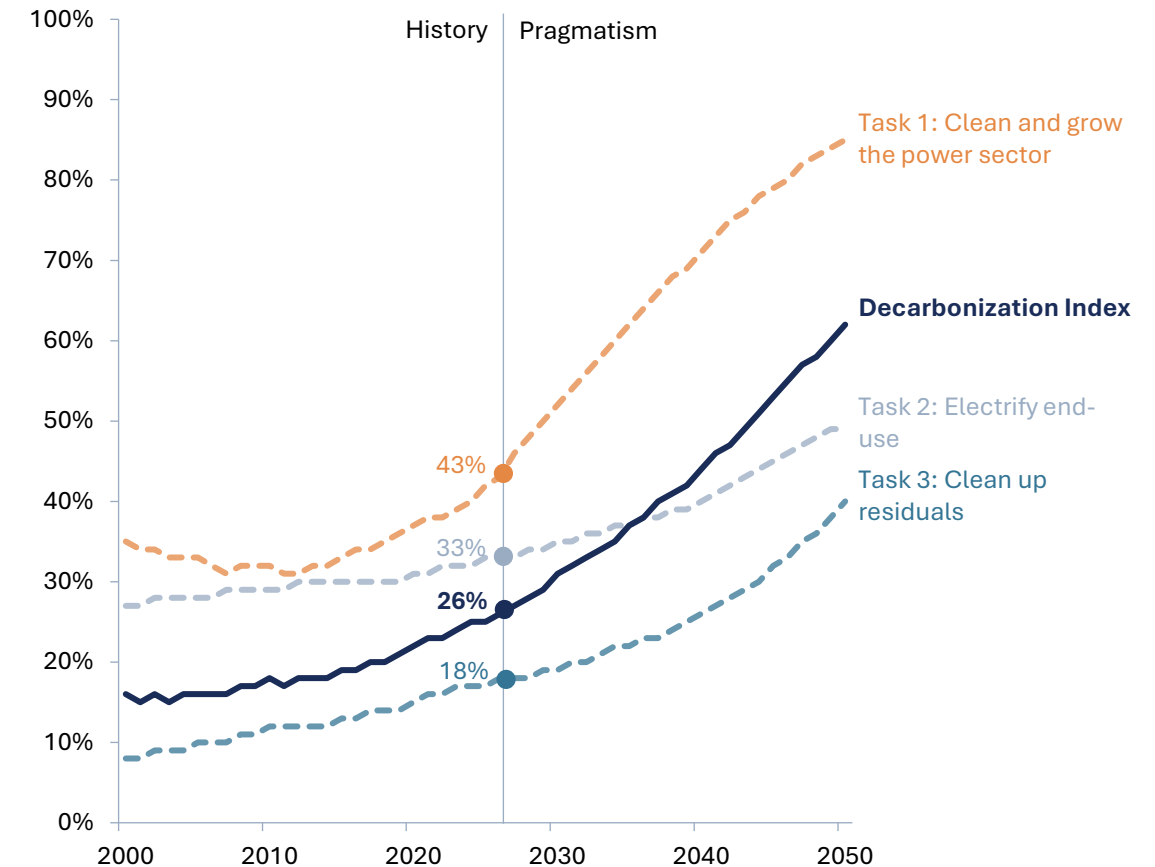
As the power system becomes cleaner, greater progress increasingly depends on putting those electrons to use across the wider energy system. The amount of progress achieved in Task 2 rises as demand for energy in transport, buildings, industry and other sectors becomes more electrified, thus increasing the proportion of useful energy that is delivered by electrons. In the Pragmatism scenario, Task 2 rises from

about 30% in the mid-2020s to about 50% by 2050.

The interaction between the tasks is important for the overall Decarbonization Index. Progress in cleaning the power system has a greater effect on economy-wide decarbonization as more end uses become electrified, allowing cleaner electricity to displace direct fossil fuel consumption. Task 3 complements this progress by addressing residual energy use that cannot be directly electrified. Together, progress across the three tasks could lift the overall Decarbonization Index from the low-20% range in the mid-2020s to above 60% by 2050 under Rystad Energy's Pragmatism scenario.

This progression is increasingly reflected in policy targets. For example, the EU has moved beyond renewable energy targets to explicitly track and placed an indicative electrification target of 46% by 2040. Similarly, COP follows a similar progression. COP28 focused on tripling renewable energy capacity target, while the COP31 presidency has proposed raising electricity's share of global final energy demand to 35% by 2035. This progression broadly mirrors the logic of three tasks: as Task 1 and Task 2 progress, the eventual scale from Task 3 should become clearer.

Global energy decarbonization trends, 1965-2050, Pragmatism scenario
Percent



Source: Rystad Energy research and analysis; Rystad Energy EnergyDemandCube

Emissions are plateauing, but the pace after decides the outcome

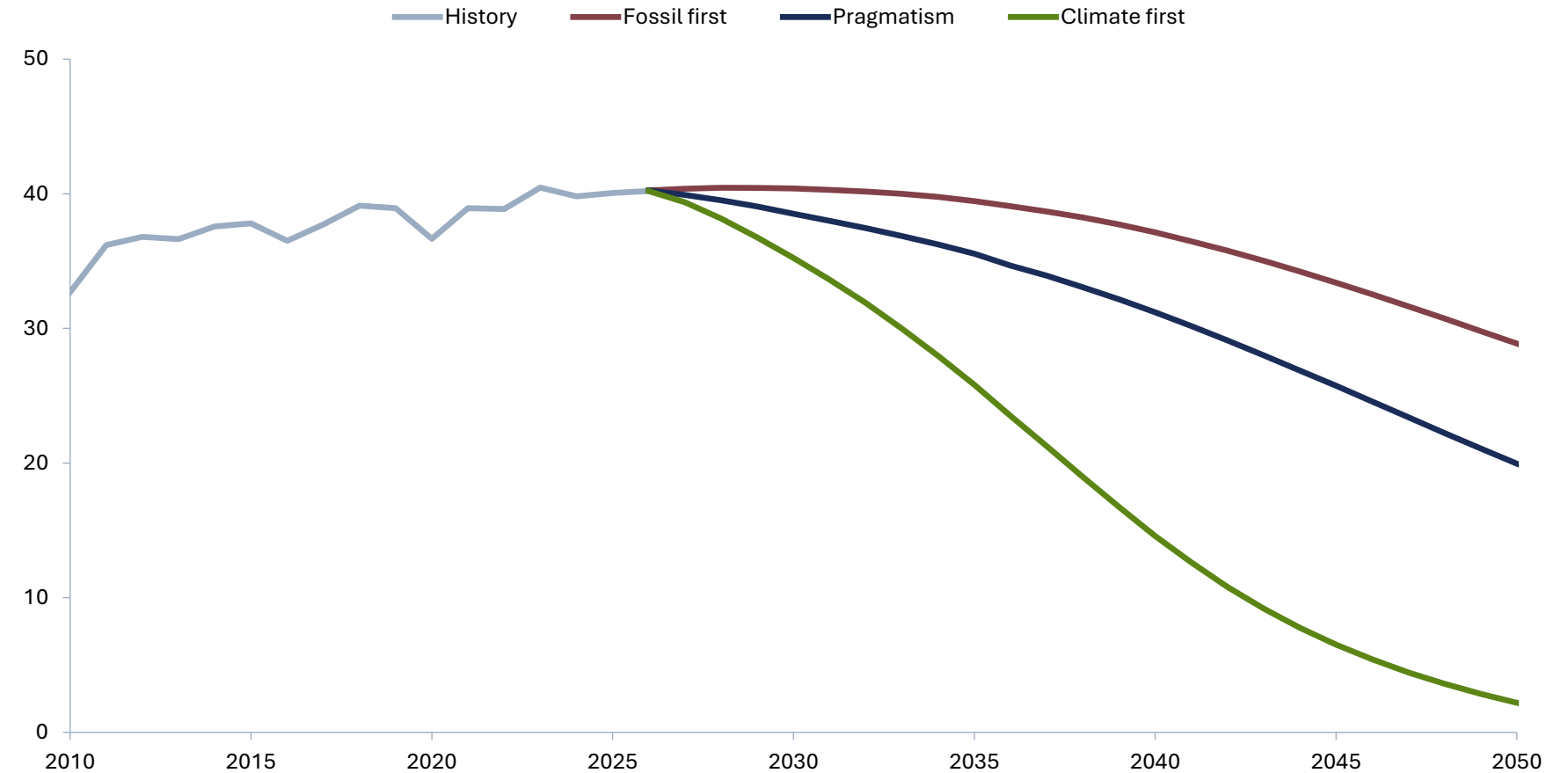
Pragmatism falls to roughly 20 Gt by 2050, implying around 0.35°C of warming

Global fossil CO₂ emissions have plateaued at around 40 Gt. Under Pragmatism, they decline to 20 Gt by 2050. Yet, cumulative emissions of 800 Gt between 2026 and 2050 correspond to roughly 0.35°C of additional warming, based on the IPCC estimate of about 0.1°C per 220 Gt of CO₂. That is well above the Paris Agreement goal, but far below the trajectories once seen as business as usual. Pathways consistent with limiting warming to 1.5°C typically reach global net-zero CO₂ around 2050; Pragmatism still emits half of today's level.

Climate first shows what delivering nearer to Paris means: emissions fall to about 2 Gt by 2050, and cumulative emissions of 500 Gt add about 0.25°C. Pragmatism emits around 300 Gt more over the period, so the gap between ambition and delivery remains. Fossil first stays near today's level for longer and adds 0.45°C.

So far, cleaner power has delivered most of the progress. As the power system decarbonizes, further cuts increasingly depend on electrifying transport, buildings and industry, and on cleaning up residual emissions. Policy targets are moving in the same order: renewables first, now electrification.

Global fossil CO₂ emissions, 2010–2050
Gigatonnes



* Includes land use, land-use change, and forestry (LULUCF)
Source: Rystad Energy EnergyDemandCube

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