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Why renewables and electrification hold the keys to EU energy security

Using the low-carbon transition to improve resilience, mitigate geopolitical risks and lower costs

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Summary

- Low-carbon technology is generally associated with tackling climate change. That remains an urgent task. But in addition to their implications for emissions, EU policies promoting the deployment of solar panels, wind turbines, electric vehicles (EVs) and heat pumps – when combined with investment in a more flexible and resilient electricity system – can be justified on the grounds of energy security alone. This paper makes the case for accelerating the EU's low-carbon transition, and seeks to dispel the myth that decarbonization is somehow at odds with achieving European energy security when, in reality, renewables and electrification hold the keys to a more energy-secure future.
- Indeed, the most important source of energy *insecurity* in the EU is that member states are highly dependent on imported fossil fuels. Fifty-eight per cent of the EU's energy comes from oil and gas, of which nearly all is imported. Until this changes, the EU will be exposed to shocks arising from supply disruptions and from price volatility in international energy markets; these challenges impose clear constraints on the EU's strategic autonomy.
- Simply shoring up domestic fossil fuel supplies or building more nuclear power plants is not the answer to these challenges. There is little chance of a significant uptick in oil and gas production within the EU, as supply from well-exploited fields continues to decline, and as extraction within the EU becomes increasingly uneconomic. A net increase in nuclear power capacity is also unlikely in the medium term, due to the long timelines and high costs involved in new builds, and to the impending retirement of much of the EU's existing reactor fleet.
- Renewables offer protection against supply shocks. Once installed, technologies such as solar panels and wind turbines convert domestic renewable energy sources – sunshine and wind – into a variable but predictable supply of electricity. Unlike imported fuels, this supply cannot easily be cut off. The decentralized nature of renewable energy generation makes a country or bloc's total generating capacity more difficult and expensive to deplete through physical attack, a feature not lost on Ukrainian energy companies, which have been rapidly building out wind and solar generation and battery storage as Russia has relentlessly targeted the country's conventional power plants. (Like any infrastructure a system based on renewables and electricity is not immune to sabotage or attack, although cybersecurity is typically a more important factor than the risk of equipment being destroyed.)

- Renewables can also mitigate the effects of high and volatile energy prices, such as those Europe experienced following the Russian invasion of Ukraine in 2022 (and from which EU markets have yet to fully recover). Following steep declines in technology costs – a trend that may yet continue as renewable energy deployment increases globally – wind and solar have emerged as the cheapest ways to generate electricity in most countries, even factoring in the cost of battery storage. Predictable power generation, insulated from international markets, can have a stabilizing effect on electricity prices paid by businesses and consumers.
- Electrification also brings down energy demand. Electricity is more efficient: an EV requires half the energy input of an equivalent petrol or diesel vehicle. Demand-response technologies can be integrated into digitized electricity grids to make better use of energy resources. Reducing demand is an important part of boosting energy security as the EU transitions away from the use of imported fossil fuels.

Recommendations

In light of these arguments, this paper recommends that the European Commission – in conjunction with EU member states, businesses, citizens and other relevant stakeholders – take the following actions to increase energy security:

- Accelerate deployment of renewable energy generation and grid-scale battery storage to reduce the EU's structural reliance on gas imports, and as a hedge against the uncertain timelines of new nuclear builds.
- Significantly scale up investment in Europe's electricity delivery network as the critical enabler of EU-wide energy security. In addition to existing sources of finance, funds should come from, at the EU level, joint borrowing and, at the member state level, from the NATO commitment to spend 1.5 per cent of GDP on 'critical infrastructure'.
- End Russian gas imports by the end of 2026 for liquefied natural gas (LNG) and by the autumn of 2027 for pipeline gas, as planned. The widely predicted oversupply in the global LNG market in the coming years should enable EU buyers to access alternatives to Russian supply at reasonable prices.
- Develop LNG market-monitoring capabilities, and deepen partnerships with other importers – particularly in Asia – in recognition of the critical role that LNG will play in the EU's energy mix in the short to medium term.
- Avoid overdependence on any one supplier. Spending $750 billion on US energy products over three years, as envisaged in the 2025 US–EU trade deal, would reduce the diversity of suppliers and jeopardize the EU's energy security; this commitment should be revisited.
- Mitigate exposure to future oil price volatility by reducing the EU's oil consumption. Central to this is the electrification of road transport. The European Commission's proposal to weaken the planned 2035 ban on sales of new petrol

and diesel vehicles, under apparent pressure from some European auto manufacturers and member states, risks prolonging the EU's chronic and costly dependence on imported fuel.

- Increase support for measures that can reduce how much energy the EU consumes. Such measures should ensure that less energy is required to provide the same energy services, and should include insulating homes, promoting demand-response technologies and increasing the efficiency of industrial processes.
- Boost cybersecurity, given the cyber risks arising from the expansion of digitized grids as electricity over time accounts for a higher share of both production and consumption of energy. Important measures will include promoting best practice in grid design, ensuring relevant legislation is sufficiently tailored to the specificities of low-carbon infrastructure, and restricting operational access for connected devices and components such as solar inverters and wind turbine controllers.
- Promote the continued EU-wide growth of community-owned renewable energy projects. These foster public support for the energy transition by increasing citizen ownership and control, and by demonstrating tangible economic and social benefits at a local level.
- Provide smart, selective industrial support across the low-carbon sector. For wind power, support should ensure reliable access to rare earth magnets; for solar power, support should focus on product-related innovation and local manufacturing of inverters. Most important: more skills development programmes are needed to ensure a lack of installers and technicians does not slow deployment.

01 Introduction

As the fourth largest emitter of greenhouse gases, the EU is a critical player in global efforts to tackle climate change. Yet in addition to simply reducing the EU's emissions, decarbonization promises to improve overall energy security by alleviating the bloc's heavy reliance on imported fossil fuels.

The EU needs to increase the share of renewables in its electricity generation, and the share of electricity in its overall energy consumption, to achieve genuine energy security. Historically, decarbonization has been driven by recognition of the risks from climate change. The catastrophic flooding and devastating wildfires that Europe contends with on an increasingly regular basis, and the ballooning economic losses associated with such events, make clear the urgency of this imperative.[1] Moreover, the EU's position as one of the world's largest emitters of greenhouse gases, and a pioneer in decarbonization technology and policy, means it is an indispensable actor in the fight against climate change.[2]

But reducing emissions, though as vital as ever, is only part of the picture: the energy transition can also insulate the EU against fossil fuel supply shocks (whether resulting from weather or geopolitical factors); protect against the price shocks imposed on governments, businesses and citizens by inherently volatile international energy markets; and bring down energy bills over time, through greater efficiency and electricity generation at zero marginal cost.

These arguments matter because the public debate over renewables has long featured a counter-narrative, sometimes abused for political and commercial ends, that security of energy supply is somehow incompatible with the low-carbon transition. The typical articulation of such a viewpoint asserts that the EU cannot reduce fossil fuel usage in line with what climate science shows is necessary without risking electricity blackouts, queues at petrol stations, and economic calamity. This paper seeks to dispel that myth insofar as it relates to EU policy options. Rather, we contend that wider dimensions of the EU's energy security (such as the bloc's

1 European Environment Agency (2025), *Europe's Environment 2025*, 28 September 2025, https://doi.org/10.2800/1121467.
2 Crippa, M. et al. (2025), *GHG Emissions of all World Countries – 2025 Report*, Luxembourg: Publications Office of the European Union, https://data.europa.eu/doi/10.2760/9816914.

ability to manage electricity demand efficiently, source low-carbon technology and manage cybersecurity risks) will be as important in the era of renewables as the evident continued need to contain risks to fuel supply.

Our thesis has two central strands. The first is that the low-carbon transition can be justified on the basis of the benefits for energy security alone. Not only does reducing greenhouse gas emissions *not* need to be at odds with improving the EU's energy security, but wider adoption of renewable energy in tandem with comprehensive and secure 'electrification' – including maximizing the use of electricity in households, transport and industry, and building out and connecting next-generation grids – is actually central to achievement of that goal. This is because such measures can reduce the need for gas and oil, which in turn would lessen the EU's reliance on potentially unreliable suppliers. This reliance – a long-standing problem – has become more acute in the short term as a result of both Russia's war on Ukraine and, more recently, the Trump administration's aggressive push to commit trade partners to buying US fossil fuels.

While the energy transition brings its own import dependency concerns, given China's dominance of low-carbon technology manufacturing, this paper will argue that the risks around a system based on renewables and electricity are qualitatively different to those in a system reliant on largely imported fossil fuels. That is another reason why it is increasingly important to define 'energy security' expansively, as about more than simply ensuring sufficient gas and oil supplies (see 'Beyond security of supply', below).

The second and related part of our argument is that the EU's challenge is to transition successfully from an energy model and policy mindset focused primarily on the acquisition of *fuels* to one designed around developing *infrastructure* and mobilizing *technologies*. The nature of renewable energy generation, the growing electrification of energy end uses, and the digitization of electricity grids (notwithstanding the technical integration challenges this brings) provide opportunities to manage energy supply and demand more efficiently. This will involve making use of an ever-growing range of grid-connected assets and technical tools. In short, how successfully EU member states – and neighbouring states – integrate their electricity markets, upgrade and expand their electricity grids, and use technology to securely and efficiently manage their energy systems will be a prime determinant of the bloc's future resilience to energy security risks.

About this paper

This paper offers ideas for how the EU can manage its energy transition in a way that ensures and promotes energy security: both in the short term, taking into account member states' existing high levels of dependence on imported oil and gas; and in the longer term, by strengthening the structural shift towards renewables and electrification.

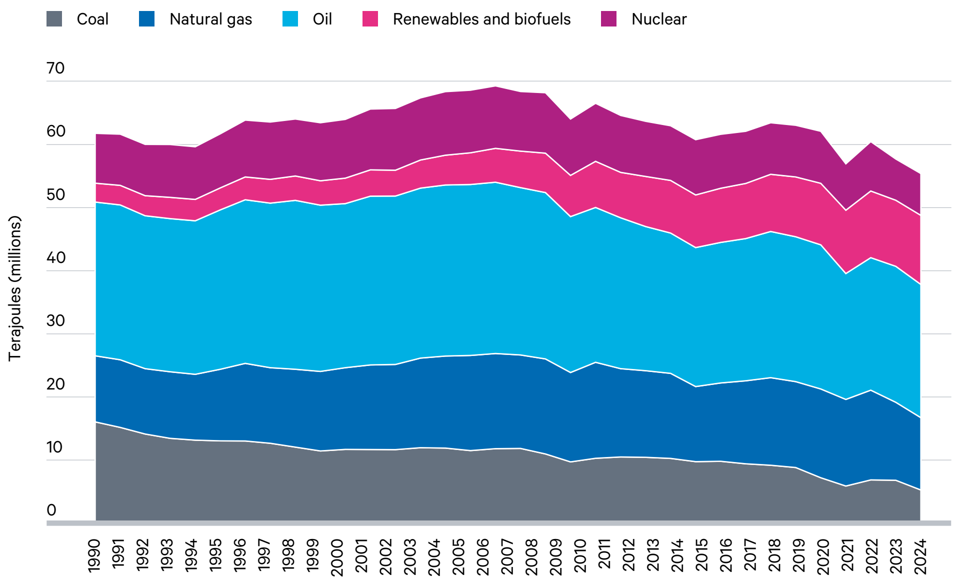
The paper covers three principal areas. First, it outlines the EU's current energy dependencies – anticipating geopolitical and market dynamics relevant to future energy security and considering the implications of these dynamics for fossil fuels, nuclear and renewables. Second, it presents the case for a more ambitious transition, arguing that the benefits of systems based on renewables and electricity extend beyond their potential to reduce EU emissions of planet-warming gases. Third, the paper identifies practical options to improve European energy security, recognizing the need for action across multiple fronts. In essence, this involves doubling down on the deployment of low-carbon technologies for both energy supply and demand, and building out the necessary supporting infrastructure, both hard and soft, while managing and seeking to reduce the EU's reliance on fossil fuel imports in the interim.

Our analysis deliberately focuses on the policy options available to the European Commission, on the basis that the commission is the main driver of policy on the energy transition within the EU and has a *de facto* popular mandate to take action in this area: according to Eurobarometer, 77 per cent of EU citizens want to see the EU play a stronger coordinating role on energy.[3]

Each EU member state has its own specific energy security challenges, and different fuels and technologies also have their own market dynamics. This paper does not seek to provide answers to each EU27 member's individual challenges, but rather to identify a set of priority actions which, when taken together, will accelerate the transformation of the bloc's energy system and put genuine European energy security within reach.

An energy system under increasing pressure

Figure 1. EU energy consumption, 1990–2024



Source: Authors' compilation based on Eurostat (2025), 'Simplified energy balances', https://ec.europa.eu/eurostat/databrowser/view/nrg_bal_s__custom_16541692/default/table (accessed 16 Dec. 2025).

Central to the EU's energy security challenge is a continued heavy reliance on fossil fuels, despite the bloc's rising use of renewables and declining overall energy consumption. In 1990, oil (primarily for transportation) was the largest single energy

3 European Commission (2024), 'European's [sic] attitudes towards energy policies', September 2024, https://europa.eu/eurobarometer/surveys/detail/3229.

source across the 27 countries that would make up the post-2020 EU, accounting for 39 per cent of energy consumption across all activities and sectors. This was followed by coal (26 per cent), gas (17 per cent), nuclear (13 per cent), and renewables and biofuels (5 per cent).[4]

By 2024, the picture was substantially different. Oil remained the largest source of energy used in the EU, accounting for a similar share (38 per cent) of total consumption, but with usage down by 13 per cent in absolute terms. Behind oil were renewables and biofuels, which accounted for 21 per cent of consumption (up 292 per cent in absolute terms); gas (20 per cent of consumption, up 10 per cent); nuclear (12 per cent of consumption, down by 18 per cent); and coal (8 per cent, down 71 per cent).

As these data make clear, oil and gas will remain present in Europe's energy mix for many years. But renewables and electrification represent an opportunity in the long term for the continent to escape – and in the interim, reduce – strategic constraints arising from dependence on major hydrocarbon exporters such as the US, the Gulf states and Russia. At various times, each of these suppliers has unilaterally cut energy flows to Europe (in 1956, 1973 and 2022 respectively), inflicting costs and damage on the region's economies.[5]

The EU energy system's vulnerability to geopolitical pressures has been all the more evident since the US presidential election in 2024. Even before taking office, while still president-elect, Donald Trump had explicitly threatened to impose tariffs on the EU if it did not import more US fossil fuels.[6] A full year into Trump's second term, his administration remains keen to extend what it champions as US 'energy dominance' by pressing the EU and other importers of oil and gas to increase purchases from US suppliers. In July 2025, as part of an agreement with the US to avoid large tariff hikes, the European Commission pledged that the EU would buy $250 billion worth of US energy products each year for three years (see Box 1).[7] However, EU purchases of oil and gas from the US reached only just over a quarter of this amount ($66 billion) in 2024. Even if the $26 billion worth of Russian oil and gas imported by the EU in 2024 were replaced with purchases of US supplies in the coming years, the total would still fall far short.[8] Delivering on the EU's commitment to the Trump administration cannot therefore be achieved without a massive scaling up of purchases from the US; this would risk displacing many, if not most, of the EU's other import partners, and significantly concentrating the EU's energy supplier base, to the profound detriment of the EU's energy security. It should also be said, given the unpredictability of US foreign policy at the moment, that acquiescing to US conditions on energy trade would seem, in any case, to be an unreliable means of avoiding tariffs.

4 A range of minor sources including peat and non-renewable waste accounted for 1.1 per cent of consumption in 1990 and 1.2 per cent in 2024.
5 Judah, B., Vallée, S. and Sahay, T. (2024), *Escaping the Permanent Suez: Navigating the Geopolitics of European Decarbonization*, Washington, DC: Atlantic Council, https://www.atlanticcouncil.org/wp-content/uploads/2024/01/Escaping-the-Permanent-Suez.pdf.
6 Reuters (2024), 'Trump threatens EU with tariffs over oil and gas imports', 20 December 2024, www.reuters.com/world/us/trump-says-eu-should-make-up-tremendous-deficit-with-us-by-purchasing-its-oil-2024-12-20.
7 European Commission (2025), 'EU-US trade deal explained', press release, 29 July 2025, https://ec.europa.eu/commission/presscorner/detail/en/qanda_25_1930.
8 Authors' calculations based on Eurostat (2025), 'EU imports of energy products - latest developments', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_imports_of_energy_products_-_latest_developments (accessed 7 Jul. 2025). Exchange rate: 1.0818 (average EUR–USD exchange rate for 2024) from https://www.investing.com/currencies/eur-usd-historical-data (accessed 12 Dec. 2025).

Box 1. The 2025 US–EU Framework Agreement on Reciprocal, Fair, and Balanced Trade

On 21 August 2025, the EU and the US published a joint statement confirming the terms of a deal on tariffs and trade that had initially been announced by the US president, Donald Trump, and the president of the European Commission, Ursula von der Leyen, at a meeting in Scotland the previous month.[9]

The deal is a 'framework agreement', meaning that it is not legally binding and that the parties anticipate further negotiation.[10] It includes the following provisions:

— **Tariffs.** The EU will eliminate tariffs on imports of all US industrial goods. The US will apply a maximum tariff of 15 per cent to most EU exports to the US, including cars, but excluding steel, aluminium and copper, for which a 50 per cent tariff will remain in force. (Obviously, the agreement excludes the possibility, increasingly in evidence as this paper neared publication, that the Trump administration could still find numerous other reasons to raise tariffs on EU member states at any time.)

— **Non-tariff barriers.** The EU and the US 'commit to work together' to reduce or remove non-tariff barriers, including on energy.

— **Climate and sustainability regulations.** The EU will work to provide 'additional flexibilities' in implementing its Carbon Border Adjustment Mechanism (CBAM) and ensuring that the EU's flagship sustainability directives, the Corporate Sustainability Due Diligence Directive (CSDDD) and the Corporate Sustainability Reporting Directive (CSRD), 'do not pose undue restrictions' on US–EU trade.

— **Energy purchases.** The EU 'intends to procure' liquefied natural gas (LNG), oil and nuclear energy products worth $750 billion from the US by the end of 2028.

— **Investment.** European companies 'are expected to invest an additional $600 billion across strategic sectors' in the US by the end of 2028.

A European Commission document explaining the $750 billion energy purchasing commitment emphasizes that, while the commission can connect energy buyers and sellers through the EU Energy Platform, 'commercial decisions naturally belong to companies'. The document states that the distribution of the committed sum across purchases of LNG, oil, nuclear fuels and services, as well as investments in new nuclear projects, would depend on factors including commodity prices, exchange rates and the decisions of project developers.[11]

On 21 January 2026, in response to US demands to purchase the autonomous Danish territory of Greenland, and accompanying threats to impose tariffs on eight European countries, including six EU member states, the European Parliament suspended its procedural work on the US–EU trade deal and postponed a ratification vote.[12]

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9 European Commission (2025), 'Joint Statement on a United States-European Union framework on an agreement on reciprocal, fair and balanced trade', 21 August 2025, https://policy.trade.ec.europa.eu/news/joint-statement-united-states-european-union-framework-agreement-reciprocal-fair-and-balanced-trade-2025-08-21_en.
10 Herbert Smith Freehills Kramer (2025), 'The US-EU Trade Deal. What does it mean and will it last?', https://www.hsfkramer.com/notes/crt/2025-09/deal.
11 European Commission (2025), 'EU-US trade deal explained - energy aspects', 31 July 2025, https://ec.europa.eu/commission/presscorner/api/files/document/print/en/qanda_25_1935/QANDA_25_1935_EN.pdf.
12 Corlin, P. and Genovese, V. (2026), 'Exclusive: EU lawmakers freeze EU-US trade deal after Trump tariff threat', Euronews, 21 January 2026, https://www.euronews.com/my-europe/2026/01/21/exclusive-eu-lawmakers-freeze-eu-us-trade-deal-after-trump-tariff-threat.

Notwithstanding this newly crystallizing risk from US policy, energy security has long been a priority for EU policymakers and was thrust to the very top of the agenda during Ursula von der Leyen's opening term as president of the European Commission (2019–24). The first half of that period was marked by extreme energy price volatility resulting from COVID-19-induced lockdowns and the subsequent economic recovery. The second half of von der Leyen's term was characterized by a gas supply shock in the aftermath of Russia's full-scale invasion of Ukraine in 2022, as Russia cut exports of pipeline gas to Europe in an attempt to drive up European energy costs and weaken European support for Ukraine. This made the EU's dependency on Russian energy painfully clear. The EU responded by working to reduce energy demand among member states, diversify its sources of fossil fuel supply and accelerate renewable energy deployment. The REPowerEU Plan, launched in May 2022, introduced policies intended to achieve these aims.[13]

The first half of von der Leyen's opening term as president of the European Commission was marked by extreme energy price volatility resulting from COVID-19-induced lockdowns and the subsequent economic recovery. The second half was characterized by a gas supply shock in the aftermath of Russia's full-scale invasion of Ukraine.

On several metrics, the results of this response were impressive. The EU's consumption of Russian gas fell precipitously, from 45 per cent of the bloc's imports in 2021 to 15 per cent in 2023, as new sources of supply were rapidly secured.[14] Gas demand across the EU fell by 19 per cent, from 15.8 million terajoules in 2021 to 12.8 million terajoules in 2023, as households and industry reduced their usage.[15] (This was not entirely due to increased energy efficiency – some of the fall was due to 'demand destruction' as factories reduced production or were shuttered, some permanently.[16]) Renewable energy deployment accelerated, with the share of EU electricity generated by wind and solar growing from 19 per cent in 2021 to 27 per cent in 2023.[17]

13 European Commission (2025), 'REPowerEU: Affordable, secure and sustainable energy for Europe', last updated 17 June 2025, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en.
14 European Commission (2024), 'Two years of REPowerEU: Strengthening Europe's energy resilience', press release, 17 May 2024, https://commission.europa.eu/news-and-media/news/two-years-repowereu-strengthening-europes-energy-resilience-2024-05-17_en.
15 Eurostat (2025), 'Supply, transformation and consumption of gas', https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_gas__custom_11515431/bookmark/table?lang=en&bookmarkId=765fa36b-c5a2-4bdc-8a79-86bcccc6d3ac (accessed 4 Jul. 2025).
16 Losz, A. and Corbeau, A. S. (2024), 'Anatomy of the European industrial gas demand drop', Center on Global Energy Policy at Columbia School of International Public Affairs, 18 March 2024, https://www.energypolicy.columbia.edu/publications/anatomy-of-the-european-industrial-gas-demand-drop.
17 Ember (undated), 'Yearly Electricity Data', https://ember-climate.org/data-catalogue/yearly-electricity-data (accessed 4 Jul. 2025).

Despite these successes, the political will to conclusively end energy dependence on Russia remains less than unanimous within the EU. Hungary and Slovakia still oppose any ban on imports of Russian energy, while the governments of Austria and Italy have indicated that they would like to keep open the option of renewing gas flows from Russia if a peace deal between Russia and Ukraine is reached.[18] Yet restarting this trade would restore Russia's ability to use the threat of withholding gas supplies as leverage over the EU, at a time when the prospect of a less dependable US security umbrella is increasing geopolitical risk for Europe. Such a move would also constitute a breach of the EU regulation adopted in January 2026 that will introduce a full, legally binding ban on Russian liquefied natural gas (LNG) imports by the end of 2026 and on Russian pipeline gas imports by the autumn of 2027.[19]

Meanwhile, new threats to supply are emerging (see Figure 12). Production in Norway, which in 2024 accounted for 33.4 per cent of the EU's gas imports, is forecast to start declining before the end of the decade, according to the Norwegian government regulator.[20] In Algeria – another important supplier, accounting for 14.3 per cent of the EU's gas imports – gross production has been flat for more than 10 years, while domestic consumption is increasing.[21] Qatar, set to become an important exporter of LNG to the EU, has indicated that new EU legislation on environmental and human rights impacts in supply chains could deter state-owned QatarEnergy LNG, the world's largest LNG company, from trading with the EU.[22]

The EU also remains acutely exposed to price volatility and supply shocks that may result from conflict in the Middle East. Israel's bombing of Iran in June 2025 raised the spectre of worsening conflict in an unstable region which produces 30 per cent of the world's oil and 17 per cent of the world's gas, and which retains an outsized influence on global energy prices.[23] Following Israel's bombing campaign, the Iranian parliament voted to block the narrow Strait of Hormuz, although ultimately no action was taken.[24] But the strait, through which transit all of Qatar's LNG exports, is a critically important artery for the global energy trade.[25]

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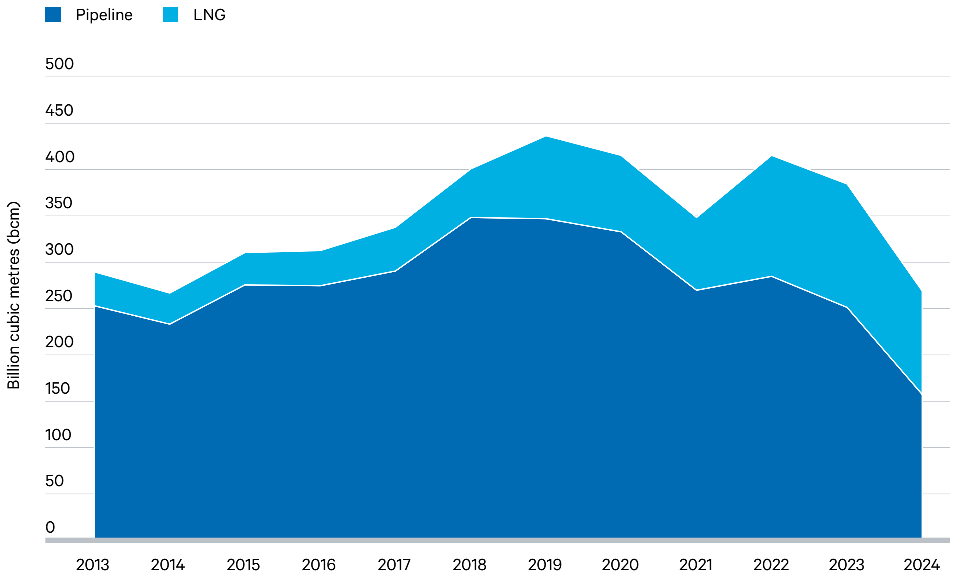
18 Jack, V. (2025), 'EU countries move to pull plug on Russian gas to Hungary and Slovakia ', POLITICO, 20 October 2025, https://www.politico.eu/article/eu-countries-move-pull-plug-on-russia-gas-hungary-slovakia; and Hancock, A., Ruehl, M. and Bounds, A. (2025), 'EU should be open to resuming Russian gas imports, says Austria', *Financial Times*, 17 June 2025, https://www.ft.com/content/f1272e5c-8d61-4ad1-bee7-a9f9c0b4ef82.
19 Council of the European Union (2026), 'Russian gas imports: Council gives final greenlight to a stepwise ban', press release, 26 January 2026, https://www.consilium.europa.eu/en/press/press-releases/2026/01/26/russian-gas-imports-council-gives-final-greenlight-to-a-stepwise-ban.
20 Norwegian Offshore Directorate (2024), *The Shelf in 2024*, https://www.sodir.no/en/whats-new/publications/reports/the-shelf/the-shelf-in-2024/oil-and-gas-on-the-shelf-moving-forward.
21 Escribano, G. (2025), *Another round of Algerian gas for Europe*, Madrid: Elcano Royal Institute, https://www.realinstitutoelcano.org/en/analyses/another-round-of-algerian-gas-for-europe.
22 Abnett, K. (2025), 'Qatar threatened to cut EU LNG supplies over sustainability law, letter shows', Reuters, 26 July 2025, https://www.reuters.com/sustainability/climate-energy/qatar-threatened-cut-eu-lng-supplies-over-sustainability-law-letter-shows-2025-07-26.
23 International Energy Agency (2025), *World Energy Investment 2025 – 10th Edition*, https://iea.blob.core.windows.net/assets/1c136349-1c31-4201-9ed7-1a7d532e4306/WorldEnergyInvestment2025.pdf.
24 Atlantic Council (2025), 'Four questions (and expert answers) about Iran's threats to close the Strait of Hormuz', 23 June 2025, https://www.atlanticcouncil.org/blogs/new-atlanticist/four-questions-and-expert-answers-about-irans-threats-to-close-the-strait-of-hormuz.
25 International Energy Agency (undated), 'Strait of Hormuz – Factsheet', https://iea.blob.core.windows.net/assets/203eb8eb-2147-4c99-af07-2d3804b8db3f/StraitofHormuzFactsheet.pdf.

New energy dependencies

While the EU's reliance on Russian energy is greatly reduced, today the bloc faces new dependencies. The first concerns the supply of LNG. Although the EU, excluding Hungary and Slovakia, has weaned itself off imported Russian pipeline gas, achieving this has required a sharp increase in imports of LNG. According to Eurostat, LNG accounted for 48 per cent of the EU's gas imports in the second quarter of 2025, up from 27 per cent in the second quarter of 2021.

Figure 2. Gas imports to EU27 by mode, 2013–24



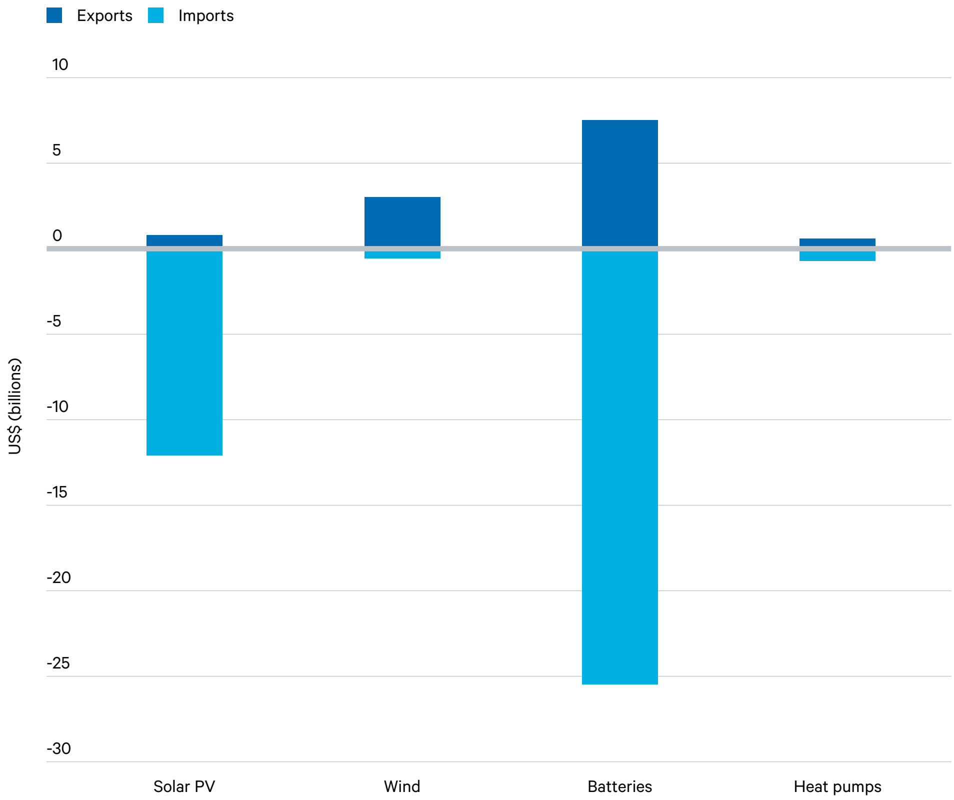
Source: Authors' compilation based on multiple annual editions of Energy Institute (2014 to 2025), *Statistical Review of World Energy,* https://www.energyinst.org/statistical-review (accessed 4 Jul. 2025).

The irony is that a large proportion of this LNG has come from Russia. Following the precipitous drop in total Russian gas supply from 2021 to 2023, as pipeline flows were curtailed, the share of EU gas imports from Russia subsequently increased in 2023–24 as LNG imports grew.[26] France, Belgium and Spain were the EU's biggest buyers of Russian LNG in November 2025, while in aggregate the EU has been by far the world's largest importer – buying 49 per cent of total Russian LNG exports since December 2022; this was well ahead of China (with 22 per cent) and Japan (18 per cent).[27] In the third year of Russia's war on Ukraine, the EU spent €21.9 billion on imports of Russian fossil fuels, €3 billion more than it sent to Ukraine in financial aid in 2024.[28]

26 Keliauskaitė, U., McWilliams, B., Sgaravatti, G. and Zachmann, G. (2025), 'European natural gas imports', Bruegel, https://www.bruegel.org/dataset/european-natural-gas-imports (accessed 9 Jan. 2026).
27 Raghunandan, V. and Katinas, P. (2025), 'November 2025 — Monthly analysis of Russian fossil fuel exports and sanctions', Centre for Research on Energy and Clean Air, 11 December 2025, https://energyandcleanair.org/november-2025-monthly-analysis-of-russian-fossil-fuel-exports-and-sanctions.
28 Raghunandan, V., Katinas, P., Levi, I. and Wickenden, L. (2025), 'EU imports of Russian fossil fuels in third year of invasion surpass financial aid sent to Ukraine', Centre for Research on Energy and Clean Air, 24 February 2025, corrected 10 April 2025, https://energyandcleanair.org/publication/eu-imports-of-russian-fossil-fuels-in-third-year-of-invasion-surpass-financial-aid-sent-to-ukraine.

The other emerging part of this picture is the US. As Russia began to cut pipeline supplies to Europe in May 2022, and gas prices spiked, US LNG traders massively increased their own exports to the EU. In 2024, US suppliers provided nearly half of the EU's LNG imports, a share that has almost tripled since 2021 and continues to grow.[29] But the antipathy of the Trump administration towards the EU, and the US's preparedness to use energy exports for geopolitical leverage – both clearly stated in the US National Security Strategy in late 2025[30] – have turned the EU's increased consumption of US LNG from an energy security solution into a potential liability.

Figure 3. EU trade balance of selected clean technologies, 2024



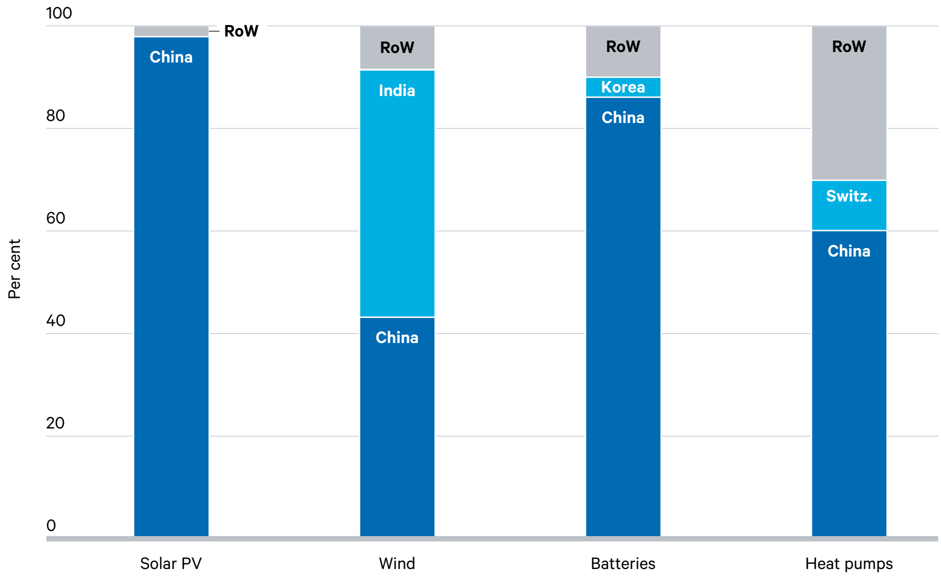
Note: 'Solar PV' includes both cells and panels.
Source: Authors' compilation based on United Nations (undated), 'UN Comtrade Database', https://comtradeplus.un.org.

Another rapidly growing external dependency is around the supply of low-carbon technologies. The EU was an early mover in adopting solar power, wind power, electric vehicles (EVs) and heat pumps, and to varying degrees member states maintain domestic manufacturing capacity for these products. However, this capacity has not increased in line with the EU's rising demand for low-carbon technology. In the face of fierce competition from China, EU-based manufacturing of solar photovoltaic (PV) equipment has largely ceased; in other sectors, such as EV

29 European Council (2025), 'Where does the EU's gas come from?', https://www.consilium.europa.eu/en/infographics/where-does-the-eu-s-gas-come-from.
30 The White House (2025), *National Security Strategy of the United States of America*, p. 14 and p. 25, https://www.whitehouse.gov/wp-content/uploads/2025/12/2025-National-Security-Strategy.pdf.

batteries, European entrants have struggled to establish themselves. As a result, the EU relies on imports to meet a large share of its demand for low-carbon technologies and equipment, although the extent of this dependency varies significantly from one product to another. Most such imports come from China (see Figure 4).

Figure 4. Share of EU imports of selected clean technologies by supplier, 2024



RoW: Rest of world, Korea: Republic of Korea, Switz.: Switzerland.
Note: 'Solar PV' includes both cells and panels.
Source: Authors' compilation based on United Nations (undated), 'UN Comtrade Database', https://comtradeplus.un.org.

China has firmly established itself as the world's leading manufacturer of low-carbon technologies. The country's dominance of these sectors is the result of many factors, including consistent government support, huge economies of scale and intense competition between domestic firms.[31] Today, Chinese low-carbon products are both competitively priced and technologically sophisticated.

During Ursula von der Leyen's first five-year term (2019–24) as president of the European Commission, the commission made a concerted effort to boost EU manufacturing of low-carbon technology. This drive has continued in von der Leyen's second term under the banner of a package called the Clean Industrial Deal. The initiative aims to fuse measures to improve economic competitiveness with those to promote decarbonization, and includes plans to support domestic low-carbon technology manufacturing by providing financial guarantees, speeding up the approval of state aid, investing in research and innovation, and boosting demand for EU-made products.[32]

31 You, X. (2023), 'The 'new three': How China came to lead solar cell, lithium battery and EV manufacturing', Dialogue Earth, 7 November 2023, https://dialogue.earth/en/business/new-three-china-solar-cell-lithium-battery-ev.
32 European Commission (2025), 'Clean Industrial Deal', https://commission.europa.eu/topics/eu-competitiveness/clean-industrial-deal_en.

The Clean Industrial Deal builds on progress that is already occurring in some manufacturing sectors. In early 2024, the European Commission judged that the EU was on track to meet 90 per cent of its battery demand through domestic production by 2030 – although the subsequent collapse in late 2024 of Northvolt, a major Swedish battery maker and a symbol of Europe's green industrial ambition, damaged confidence.[33] Some European companies are also seeking to benefit from Chinese expertise by entering into joint ventures with Chinese firms. For instance, Stellantis, a Dutch-based multinational automotive firm, and CATL, a Chinese battery maker, are collaborating on a lithium iron phosphate (LFP) battery factory in Spain.[34]

Overall, however, there is little chance of the EU becoming self-sufficient in low-carbon technology in the foreseeable future. This was tacitly acknowledged in the EU's Net Zero Industry Act (NZIA), adopted in 2024, which envisaged the EU producing only 40 per cent of its total demand for low-carbon technologies by 2030.[35]

As tacitly acknowledged in the Net Zero Industry Act, there is little chance of the EU becoming self-sufficient in low-carbon technology in the foreseeable future.

Moreover, even if this share were to reach 100 per cent, and substantial new capacity to produce intermediary components and process raw inputs were also built, it would not comprehensively reduce the EU's import dependency for raw materials. The region's geology condemns it to a heavy reliance on imports of critical minerals, such as lithium for batteries, rare earth elements for wind turbines, and manganese for solar panels. Underlining this limitation, the 2023 European Critical Raw Materials Act set a target for the EU of extracting a mere one-tenth of the bloc's required supply of critical raw materials from sources within EU borders by the end of the decade.[36]

Reserves of these materials are spread across several different countries. Australia, Brazil, Chile, China, the Democratic Republic of the Congo (DRC) and Indonesia all have substantial reserves of different minerals needed for low-carbon technology. China has the largest overall share of known rare earth reserves (40 per cent of the global total), but across the suite of minerals needed for low-carbon technologies

33 European Commission (2025), 'Report from the Commission to the European Parliament and the Council - Progress on competitiveness of clean energy technologies', https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=celex:52025DC0074.
34 Stellantis and Contemporary Amperex Technology Co., Limited (CATL) (2024), 'Stellantis and CATL to Invest Up to €4.1 Billion in Joint Venture for Large-Scale LFP Battery Plant in Spain', press release, 10 December 2024, https://www.stellantis.com/en/news/press-releases/2024/december/stellantis-and-calt-to-invest-up-to-4-1-billion-in-joint-venture-for-large-scale-lfp-battery-plant-in-spain.
35 European Council (2025), 'Net-zero industry act: a benchmark for the manufacturing capacity of strategic net-zero technology products', https://www.consilium.europa.eu/en/infographics/net-zero-industry-act.
36 European Commission (2023), 'European Critical Raw Materials Act', https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/european-critical-raw-materials-act_en.

it is in refining, rather than natural endowment, that the country is most dominant.[37] In 2024 the country accounted for 78 per cent of the world's cobalt refining capacity, 91 per cent of refining capacity for rare earth elements used in the production of high-performance magnets, 70 per cent of lithium refining capacity, and 96 per cent of battery-grade graphite refining capacity.[38] A notable exception is nickel refining, in which China, accounting for 31 per cent of global capacity, trails Indonesia (43 per cent).[39]

Beyond security of supply

Energy security is commonly associated with security of *supply*: that is, ensuring a country or region has uninterrupted access to all the energy it needs, at prices it can afford.[40] The importance of this simple imperative became clear in 2022 as pipeline gas flows ceased (or, in some cases, were sharply reduced), and as Europe suffered its worst energy crisis since the 1970s. Yet while the temptation for European policymakers to focus on supply is understandable given the recent trauma of Russia's weaponization of gas flows, a more expansive understanding of energy security would bring into play additional tools that could improve the EU's position in the future.

As grids expand and become highly digitized, and as a greater share of energy is consumed in the form of electricity, cybersecurity will become an increasingly vital element of EU energy security.

Rather than being framed principally in terms of supply, energy security should be considered as an equation requiring that supply meets demand.[41] Managing demand is thus as important as securing supply. Insulating homes, making industrial processes more efficient, introducing demand-response technologies into electricity systems – all can contribute to energy security by reducing the total quantity of energy that the EU requires. As EU citizens, businesses and member states demonstrated in the wake of Russia's full-scale invasion of Ukraine, demand for energy can be reduced if needed. Energy efficiency measures, which enable the same services (e.g. heating, cooking, lighting) to be provided using less energy, have the added benefit of reducing household energy bills. Potentially, this can also help with securing popular and/or political buy-in for the energy transition.

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37 Ritchie, H. and Rosado, P. (2024), 'Which countries have the critical minerals needed for the energy transition?', Our World In Data, 16 September 2024, https://ourworldindata.org/countries-critical-minerals-needed-energy-transition.
38 International Energy Agency (2025), 'Critical Minerals Data Explorer', https://www.iea.org/data-and-statistics/data-tools/critical-minerals-data-explorer (accessed 21 Aug. 2025).
39 Ibid.
40 International Energy Agency (undated), 'Glossary – Energy Security', https://www.iea.org/glossary#energy-security.
41 Kuzemko, C. et al. (2025), 'UK energy security: making the most of demand-side measures', UK Energy Research Centre, https://doi.org/10.5286/UKERC.EDC.000996.

Technology is central to managing the supply–demand equation. The transition to renewables and wider electrification of the economy will increasingly bring into operation systems that integrate sophisticated devices and digital tools. A modest but growing share of the EU's energy is provided not by the combustion of fossil fuels such as coal and gas, but by technology products that convert renewable, ambient energy into electricity (see Figure 1). These products, which include solar panels and wind turbines, are already contributing to EU energy security by displacing the use of imported fuels. Accelerated deployment of renewables, plus the further electrification of transport and heating, could have a transformative impact in this regard.

However, while this transition stands to reduce EU dependence on foreign fuel suppliers, one consequence would be higher dependence on imported raw materials and technology. As discussed, China is the dominant global supplier of such materials and products, and has demonstrated a willingness to use this leverage, imposing export controls on critical minerals and associated technologies.[42] The transition also introduces a new dimension to managing energy security: because renewable generation relies on inherently variable energy sources such as wind and sunshine, efficient management of supply and demand in the electricity system becomes all the more important. In particular, ensuring sufficient flexibility in electricity networks is critical – for example, through assets such as cross-border interconnections and energy storage.[43] As grids expand and become highly digitized, and as a greater share of energy is consumed in the form of electricity, cybersecurity will also become an increasingly vital element of EU energy security (see also Chapter 3).

Box 2. Why 'electricity security' is set to emerge as a key concept for EU policymakers

As the EU's reliance on electricity grows, so too will the risks and challenges specific to the use of electricity as an energy carrier. If the path of greater electrification is taken, 'electricity security' must become central to the EU's energy security strategy.

The International Energy Agency (IEA) defines electricity security as the capability of the electricity system – which includes generation and storage assets, and transmission and distribution infrastructure – to ensure the continuous availability of electricity in the face of disruptions and shocks.[44]

Electricity security, as distinct from energy security, can be understood by reference to 'three I's': intermittency, integrity and interconnection.[45]

42 Reuters (2025), 'China expands rare earths restrictions, targets defense and chips users', 9 October 2025, https://www.reuters.com/world/china/china-tightens-rare-earth-export-controls-2025-10-09.
43 International Renewable Energy Agency (2024), *Geopolitics of the energy transition: Energy security*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Apr/IRENA_Geopolitics_transition_energy_security_2024.pdf.
44 International Energy Agency (2020), *Power systems in transition: challenges and opportunities ahead for electricity security*, https://iea.blob.core.windows.net/assets/cd69028a-da78-4b47-b1bf-7520cdb20d70/Power_systems_in_transition.pdf.
45 Bradshaw, M. J. (2026, forthcoming), *The geopolitics of energy system transformation: managing the messy mix*, Bristol: Bristol University Press.

— *Intermittency* is a characteristic of energy generated by renewable sources, such as wind and solar. It means that the quantity of energy produced is variable, unlike the constant supply generated by conventional power plants. Electricity itself cannot be stored: it must be converted into another form of energy, such as electrochemical, in the case of batteries, or gravitational, in the case of pumped hydroelectric storage. Efficiently managing the variability of renewable energy assets requires careful, system-level planning.

— *Integrity* refers to the ability of the delivery network to distribute electricity reliably. This can be threatened if the electricity grid does not develop and expand in line with the addition of new renewable generation, or if there is a shortage of dispatchable capacity such as gas power plants and battery storage. The integrity of the system can also be threatened by attacks to physical infrastructure, such as subsea cables, and to digital infrastructure, such as smart grid systems; by extreme weather events, such as storms and floods; and by extremes of temperature, both high and low.

— *Interconnection*, or the linking of neighbouring grids so that they can share electricity, gives grid managers access to a broader range of generation and storage assets. This boosts diversity of supply, enables better balancing of supply and demand, and contributes to grid stability. It can also increase the efficiency, flexibility and resilience of the energy system. Interconnection is especially useful in systems with a high share of renewable energy generation: while one grid may be producing more electricity than it can absorb, another may not be producing enough. However, interconnection can create new vulnerabilities, for example if there is a high level of dependence on a single electricity exporter, or if countries find themselves unable to exit the interconnected system due to a lack of alternatives.

02
The security case for renewables and electrification

The transition to renewables – paired with comprehensive electrification of energy end uses, such as heating and transport – can protect against supply shocks and price volatility, while offering ever-improving cost advantages over fossil fuels.

This chapter expands on the argument that improved energy security in the EU depends on scaling up the use of renewables as a means of energy production and increasing electricity's role as a vector of energy consumption. Our analysis first considers the extent of the EU's reliance on imports of oil, gas and coal. The essential challenge is that the EU consumes far more fossil fuels than it can produce, and is thus – depending on the fuel – partially or almost wholly dependent on imports. We then consider the potential for nuclear energy to play a greater role in the EU's energy system. High costs and long development times represent the main barriers to rapid expansion of the use of nuclear power; an additional concern is that some EU states are dependent on Russian fuel and technology for their existing nuclear generation.

The third part of the chapter considers the potential contribution of renewables and electrification to energy security. The benefits include: providing insulation against geopolitically driven supply shocks (given that a hostile state can't 'turn off' the sun or wind – although an adversary could theoretically seek to interfere remotely with renewable energy systems); contributing to lower and less volatile energy prices for users; and allowing more efficient conversion of energy into useful services relative to fossil fuels. The distributed nature of most renewable energy generation makes a system based on such generation harder to degrade through kinetic attack in the event of war – although this resilience is not absolute; for example, undersea cables transmitting electricity from offshore wind farms can be attacked or sabotaged. At the same time, increasing digitalization across the energy system means that cybersecurity will be an ever more critical consideration.

Near-total fossil fuel import dependency

After many decades of operation, offshore oil and gas fields in Europe have reached maturity. At the same time, countries like Saudi Arabia and Russia are able to produce oil and gas extremely cheaply. These two factors mean that domestic fossil fuel extraction has become increasingly uneconomic in the EU.

As a result, the bloc's own hydrocarbon production is declining. By 2024, annual production of gas in the EU had declined by 80 per cent from its 1996 peak.[46] Annual production of oil peaked in 2004, and has since fallen by 63 per cent.[47] Some EU member states – including Denmark, a major producer – have banned new licences for oil and gas exploration in recent years.[48]

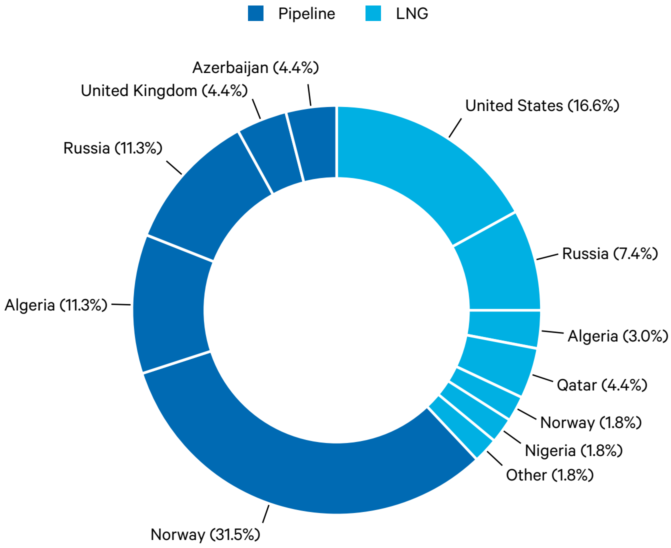
In the most recent authoritative global survey, in 2020, the EU's proven reserves[49] of oil and gas were estimated at 0.1 per cent and 0.2 per cent of the global total respectively. To put these amounts into perspective, such reserves would be sufficient to meet seven and a half months of the EU's oil demand and a year and a half of its gas demand, at 2024 consumption levels.[50]

The EU uses far more gas and oil than it can produce. In 2024, the 27 countries of the EU accounted for 7.8 per cent of global gas consumption but only 0.8 per cent of production, and 10.5 per cent of global oil consumption but only 0.3 per cent of production.[51] Nearly all the gas and oil consumed in the EU is imported. Recent discoveries, such as the Wolin East field off Poland's Baltic coast, will only change the EU's import dependency at the margins.

In 2024, Norway supplied the largest share of the EU's gas imports, accounting for 33.4 per cent of the total by volume (pipeline gas accounted for 31.5 per cent of the total, LNG for 1.8 per cent). Russia was the second largest supplier, accounting for 18.7 per cent of EU imports (pipeline 11.3 per cent, LNG 7.4 per cent). The US was third, with 16.6 per cent of the total, all of it LNG.

46 European Union (2025), 'EUROSTAT - Supply, transformation and consumption of gas', https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_gas__custom_19365272/default/line?lang=en (accessed 16 Dec. 2025).
47 European Union (2025), 'EUROSTAT - Supply, transformation and consumption of oil and petroleum products', https://ec.europa.eu/eurostat/databrowser/view/NRG_CB_OIL__custom_19365406/default/line?lang=en (accessed 16 Dec. 2025).
48 BBC News (2020), 'Denmark set to end all new oil and gas exploration', 4 December 2020, https://www.bbc.co.uk/news/business-55184580.
49 Defined as 'those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions'. Source: BP (2021), *Statistical Review of World Energy – 70th Edition*, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf.
50 Ibid. See also Energy Institute (2025), 'Statistical Review of World Energy', https://www.energyinst.org/statistical-review (accessed 4 Jul. 2025).
51 Ibid.

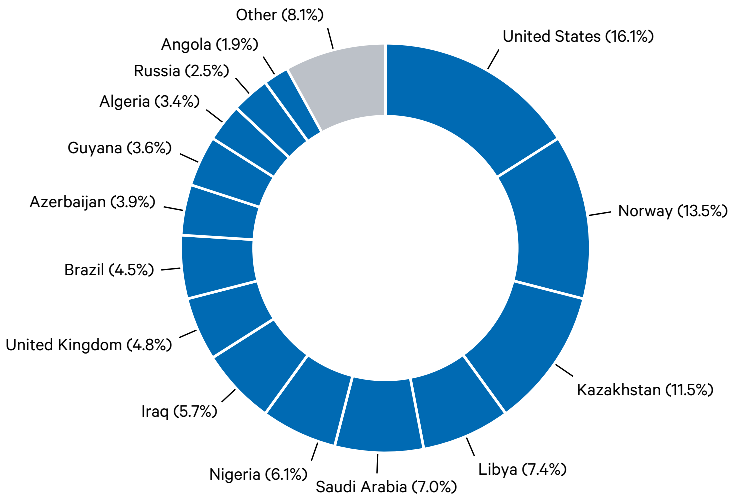
Figure 5. EU gas imports, share of total by volume, 2024



Source: Authors' compilation based on European Commission (2025), *Quarterly Report on European Gas Markets*, Report, 7 (4), Brussels: European Commission, https://energy.ec.europa.eu/document/download/4aebee79-01e9-4a06-927e-8dd42fc4f9a8_en?filename=New%20Quarterly%20Report%20on%20European%20gas%20markets%20Q4%202024.pdf.

In 2024, the largest share of EU oil imports by value came from the US, which accounted for 16.1 per cent of the total. Norway was the next largest supplier, providing 13.5 per cent of EU oil imports.

Figure 6. EU petroleum oil imports, share of total by value, 2024



Source: Authors' compilation based on European Commission (2025), 'EUROSTAT – Energy Update March 2025', https://ec.europa.eu/eurostat/documents/4187653/20614060/energy_update_MAR_2025.xlsx/6de4ca03-dcde-d8fc-49e7-f28c04a33390?t=1742373563758 (accessed 4 Jul. 2025).

The EU's fossil fuel import dependency also extends to coal. However, while the EU imports nearly half of what it consumes,[52] coal has been declining in the energy mix and now accounts for a minor share of total EU energy consumption as member states have increasingly switched to gas and renewables for electricity generation.[53] Although there was an uptick in the EU's use of coal during the 2022 energy crisis, this increase was sharply reversed again in 2023.[54]

The EU's high import dependency for fossil fuels can be very costly. In 2023, for example, high prices meant that the EU paid foreign fossil fuel suppliers, including Russia, €416 billion (a sum equivalent to 2.7 per cent of the EU's GDP in that year).[55]

Barriers to rapid scale-up of nuclear power

Nuclear power is a significant part of the EU's energy mix, accounting for 24 per cent of electricity produced and 12 per cent of all energy consumed in 2024.[56] The gas price shock following Russia's full-scale invasion of Ukraine in 2022 sparked renewed interest in nuclear power. However, the prospects for a major expansion of nuclear power in the EU are poor. Only one reactor is currently under construction in the EU (although 12 more are planned, mainly in Central and Eastern Europe). Out of the 100 reactors in operation in the EU, more than four-fifths are over 30 years old and reaching the end of their operational lifetimes. The planned level of new builds is insufficient to replace capacity that is set to be retired, so the share of nuclear power in the EU energy mix will almost inevitably fall in the near term.[57]

The primary obstacle to building new nuclear power stations in the EU is cost. A typical pair of reactors requires an investment of up to €50 billion. As this is far beyond what most utility companies are willing and able to provide, expansion of nuclear power necessitates significant, long-term support from taxpayers and/or electricity consumers for construction, financing, revenue stability and decommissioning.[58] Consequently, the levelized cost of electricity (LCOE) from nuclear generation in the EU is much higher than for other sources: in 2024, the LCOE for nuclear power was $165/MWh, compared with $60/MWh for onshore wind and $50/MWh for solar PV.[59] A 2025 article in the journal *Energy*, taking

52 Eurostat (2025), 'Energy statistics - an overview', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Imports_and_exports (accessed 7 Jul. 2025).
53 Ibid.
54 Ember (2025), *European Electricity Review 2025*, https://ember-energy.org/app/uploads/2025/01/EER_2025_22012025.pdf.
55 European Commission (2024), *The future of European competitiveness - Part B | In-depth analysis and recommendations*, https://commission.europa.eu/document/download/ec1409c1-d4b4-4882-8bdd-3519f86bbb92_en?filename=The%20future%20of%20European%20competitiveness_%20In-depth%20analysis%20and%20recommendations_0.pdf.
56 Ember (2025), *European Electricity Review 2025*; and Eurostat (2025), 'Simplified energy balances', https://ec.europa.eu/eurostat/databrowser/view/nrg_bal_s__custom_16541692/default/table (accessed 16 Dec. 2025).
57 World Nuclear Association (2025), 'Nuclear Power in the European Union', updated 10 July 2025, https://world-nuclear.org/information-library/country-profiles/others/european-union; and Guedes Ferreira, V. (2024), *Strategic autonomy and the future of nuclear energy in the EU*, Briefing Paper, Brussels: European Parliamentary Research Service, https://www.europarl.europa.eu/RegData/etudes/BRIE/2024/757796/EPRS_BRI(2024)757796_EN.pdf.
58 Mauduit-Le Clercq, C. and Dubois-Pelerin, E. (2024), 'Is Europe Ready for a Nuclear Renaissance?', S&P Global, 27 November 2024, https://www.spglobal.com/en/research-insights/special-reports/is-europe-ready-for-a-nuclear-renaissance.
59 International Energy Agency (2025), *World Energy Outlook 2025*, https://www.iea.org/reports/world-energy-outlook-2025.

Finland as a case study, found that an energy system based on nuclear power would cost 71–84 per cent more in 2050 than a system based on renewables.[60]

A related problem is the long timelines involved. Construction times for nuclear reactors have increased steadily since the first wave of projects in the post-Second World War period, when units were smaller and regulations were looser. Of the 69 reactors that began generation globally between 2015 and 2024, the average time between breaking ground on construction and the finished reactors being connected to the grid was 9.4 years.[61]

Major time and cost overruns are common, usually as a result of repeated technical setbacks. The Flamanville 3 reactor in France began generating electricity in 2024, 17 years after construction had begun; it had originally been scheduled to open in 2012.[62] Finland's Olkiluoto-3 reactor opened in 2023, 18 years after the start of construction; it had been scheduled to open in 2009.[63] Many nuclear power projects are cancelled: a 2025 study by Global Energy Monitor found that a quarter of all European nuclear power capacity ever planned ultimately never entered operation.[64]

The advent of small modular reactors (SMRs) as a design innovation holds the promise of reduced costs and construction times. Several SMRs are in operation in China and Russia, but SMR development in Europe is at an earlier stage, with both technical and (above all) commercial hurdles still to be overcome.[65] The European Commission hopes to deploy SMRs by the early 2030s, but acknowledges problems with 'limited market uptake and slow commercialisation' to date.[66]

In the short to medium term, the simplest and most cost-effective means of maintaining – or at least slowing the decline of – the share of nuclear energy in the EU's energy mix is likely to be through extending the lifetime of existing reactors, as Belgium is doing.[67] However, this can only be sustained for so long.

Nuclear fuel supply is also an area of continued vulnerability, particularly given Russia's importance to the markets for both natural and enriched uranium. The EU does not mine natural uranium but relies on imports. In 2024, the EU imported 34 per cent of its supply from Canada; the next largest source was Kazakhstan

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60 Satymov, R. et al. (2025), 'Who will foot the bill? The opportunity cost of prioritising nuclear power over renewable energy for the case of Finland', *Energy*, 337, https://doi.org/10.1016/j.energy.2025.138630.
61 Schneider, M. (2025), *The World Nuclear Industry - Status Report 2025*, Paris: Mycle Schneider Consulting Project, https://www.worldnuclearreport.org/IMG/pdf/wnisr2025-v1.pdf.
62 Ibid.; and France 24 (2024), 'France's most powerful nuclear reactor comes on stream after 12-year delay', 21 December 2024, https://www.france24.com/en/live-news/20241221-france-s-most-powerful-nuclear-reactor-finally-comes-on-stream.
63 Lehto, E. (2023), 'After 18 years, Europe's largest nuclear reactor starts regular output', Reuters, 15 April 2023, www.reuters.com/world/europe/after-18-years-europes-largest-nuclear-reactor-start-regular-output-sunday-2023-04-15.
64 Bernardi, J., Levy, V., Huang, Y. and Cato, J. (2025), 'Nuclear outpaced fourteen to one by wind and solar in Europe', Global Energy Monitor, September 2025, https://globalenergymonitor.org/report/nuclear-outpaced-fourteen-to-one-by-wind-and-solar-in-europe. Global Energy Monitor uses the United Nations Statistics Division's definition of Europe, which includes non-EU countries that use nuclear power including Russia, Switzerland, the UK and Ukraine.
65 Mauduit-Le Clercq and Dubois-Pelerin (2024), 'Is Europe Ready for a Nuclear Renaissance?'.
66 European Commission (2024), 'Small Modular Reactors explained', https://energy.ec.europa.eu/topics/nuclear-energy/small-modular-reactors/small-modular-reactors-explained_en; and European Commission (2025), 'Nuclear illustrative programme', https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14617-Nuclear-illustrative-programme_en.
67 European Union (2025), 'Commission approves Belgian State aid measure to support lifetime extension of two nuclear reactors', press release, 21 February 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_565.

(24 per cent), followed by Russia (16 per cent), Australia (11 per cent) and Niger (8 per cent). Once imported, natural uranium is enriched at facilities within the EU. The supply of EU-enriched uranium met 64 per cent of EU demand in 2024, with the rest sourced primarily from Russia (24 per cent).[68]

Five EU member states – Bulgaria, Czechia, Finland, Hungary and Slovakia – have Russian-designed reactors; the operators of these facilities rely on Rosatom, Russia's state-owned nuclear company, for spare parts and maintenance.

Reliance on Russian technology and components is a further source of risk. Five EU member states – Bulgaria, Czechia, Finland, Hungary and Slovakia – have Russian-designed reactors; the operators of these facilities rely on Rosatom, Russia's state-owned nuclear company, for spare parts and maintenance. The degree to which the use of Russian raw materials, equipment, technology and expertise is integral to the EU's civil nuclear sector, combined with the long waits for alternative fuel supplies suitable for Russian reactors, means that the bloc is still effectively locked into nuclear energy relationships with Russia. For this reason, the European Commission's plans to end Russian energy imports by the end of 2027 do not yet cover nuclear fuel and parts.[69]

How renewable energy and electrification can contribute to energy security

In light of the above challenges and constraints, shifting to an energy system based on renewables and electricity offers the clearest path towards improved energy security. The principal benefits are outlined in more detail below:

Protection against supply shocks

Energy systems based on fuels (whether fossil fuels or nuclear) require a continuous flow of inputs. Trade interruptions can have immediate and costly impacts. For example, as gas prices spiked in the summer of 2022, EU governments spent €379 billion (2.4 per cent of GDP) that year on energy subsidies, up from €213 billion (1.3 per cent of GDP) the previous year.[70] Energy systems based on renewables are not exposed to this risk. A sudden drop in imports of raw materials, components

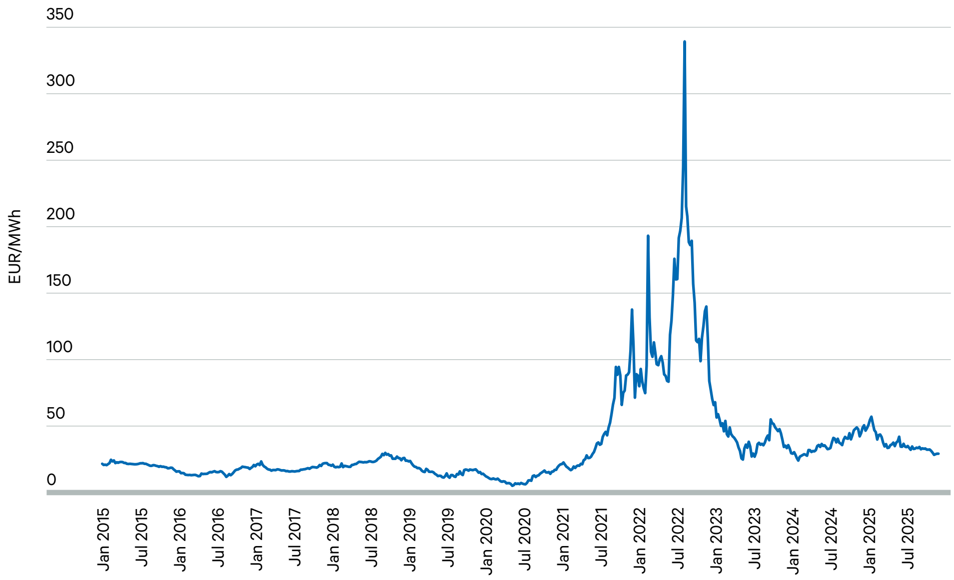
68 Euratom Supply Agency (undated), 'Market Observatory', https://euratom-supply.ec.europa.eu/activities/market-observatory_en.
69 Abnett, K. (2025), 'EU pushes back proposals to curb reliance on Russian nuclear fuel', Reuters, 16 June 2025, https://www.reuters.com/sustainability/climate-energy/eu-pushes-back-proposals-curb-reliance-russian-nuclear-fuel-2025-06-16.
70 European Commission (2025), *2024 Report on Energy subsidies in the EU*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2025:17:FIN.

or finished products may disrupt manufacturing or deployment of new sources of generation, but it will not cause existing generation to be cut off abruptly. However, as with all systems based on electricity, supply can be interrupted if generation, storage or grid infrastructure fails, is remotely disabled, or is damaged or destroyed.

Protection against price volatility

Gas and oil are internationally traded commodities, and their prices are highly sensitive to geopolitical turbulence. Both fuels have exhibited significant price volatility in recent years. As can be seen in Figure 7 below, gas price volatility – as well as the gas price itself – remains markedly higher for the EU than before the 2021–22 price shock.[71] This is in large part a consequence of the EU's forced move away from importing gas via pipeline from Russia, a move that has resulted in EU buyers competing with Asian buyers for shipments on the global LNG market.[72]

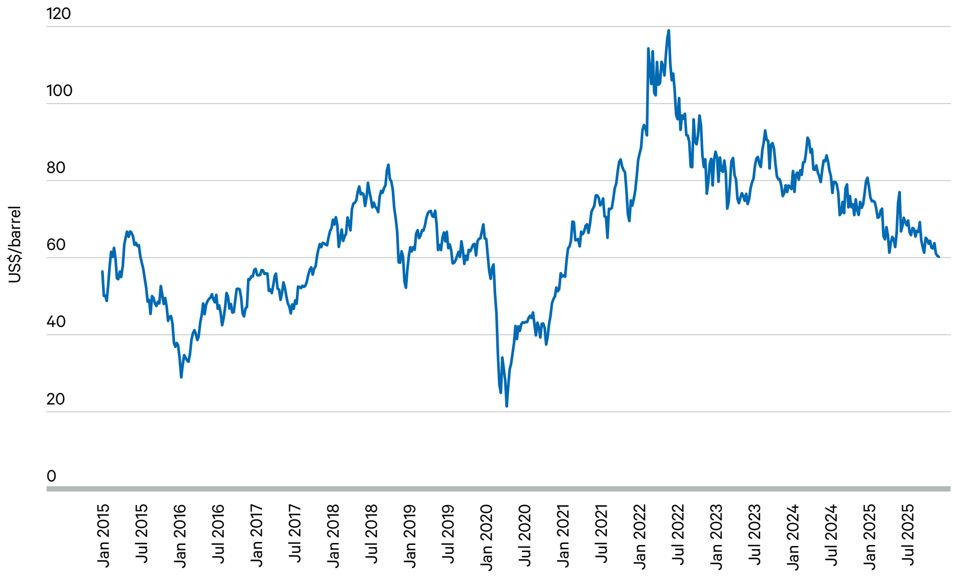
Figure 7. Natural gas price per MWh, EU Dutch TTF, 2015–25



Source: Based on Trading Economics (undated), 'EU Natural Gas TTF', https://tradingeconomics.com/commodity/eu-natural-gas (accessed 5 Jan. 2026).

71 European Gas Hub (2025), 'Gas price volatility remains well-above their [sic] historical levels', 10 June 2025, https://europeangashub.com/gas-price-volatility-remains-well-above-their-historical-levels.html.
72 Smith, A. and Tani, S. (2024), 'Europe's winter gas supplies at risk from market disruptions', *Financial Times*, 7 November 2024, www.ft.com/content/1bf29f6e-fcdf-462a-b257-d1690ff53825.

Figure 8. Brent crude oil price, $/barrel, 2015–25



Source: Authors' compilation based on Trading Economics (undated), 'Brent Crude Oil', https://tradingeconomics.com/commodity/brent-crude-oil (accessed 5 Jan. 2026).

While renewable energy generation is variable, it follows known patterns and can be increasingly accurately predicted. Moreover, so-called 'flexibility assets' such as energy storage and demand-response systems allow grid operators to manage supply fluctuations efficiently (see 'Strengthening the electricity grid' section in Chapter 3, below).

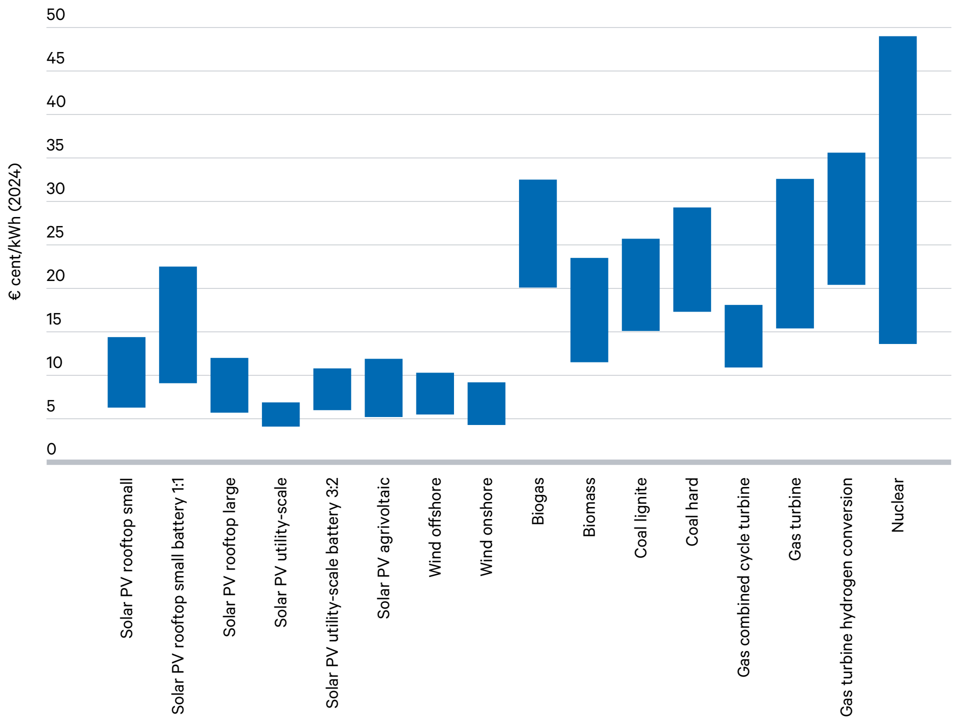
Consequently, increasing the EU's share of electricity generated by renewables can be expected to stabilize electricity prices. A 2025 study by researchers at the University of Cambridge simulated the impact on power markets of European countries[73] deploying new renewable capacity in line with each country's 2030 climate and energy targets, and found that such action would reduce the sensitivity of electricity prices to gas prices by 40 per cent relative to 2024. The researchers argued that the protection against price volatility offered by renewables confers a distinct and quantifiable benefit to society – an 'insurance value' – not currently accounted for in energy policy decision-making.[74]

Low and falling costs

The Cambridge study also found that average European electricity prices could be 26 per cent lower in 2030 than in 2024 if European countries meet the renewables deployment targets in their 2030 national energy and climate plans.[75]

73 EU27 plus Switzerland and the United Kingdom.
74 Simon, N. and Diaz Anadon, L. (2025), 'Power price stability and the insurance value of renewable technologies', *Nature Energy*, 10, pp. 329–41, https://doi.org/10.1038/s41560-025-01704-0.
75 Ibid.

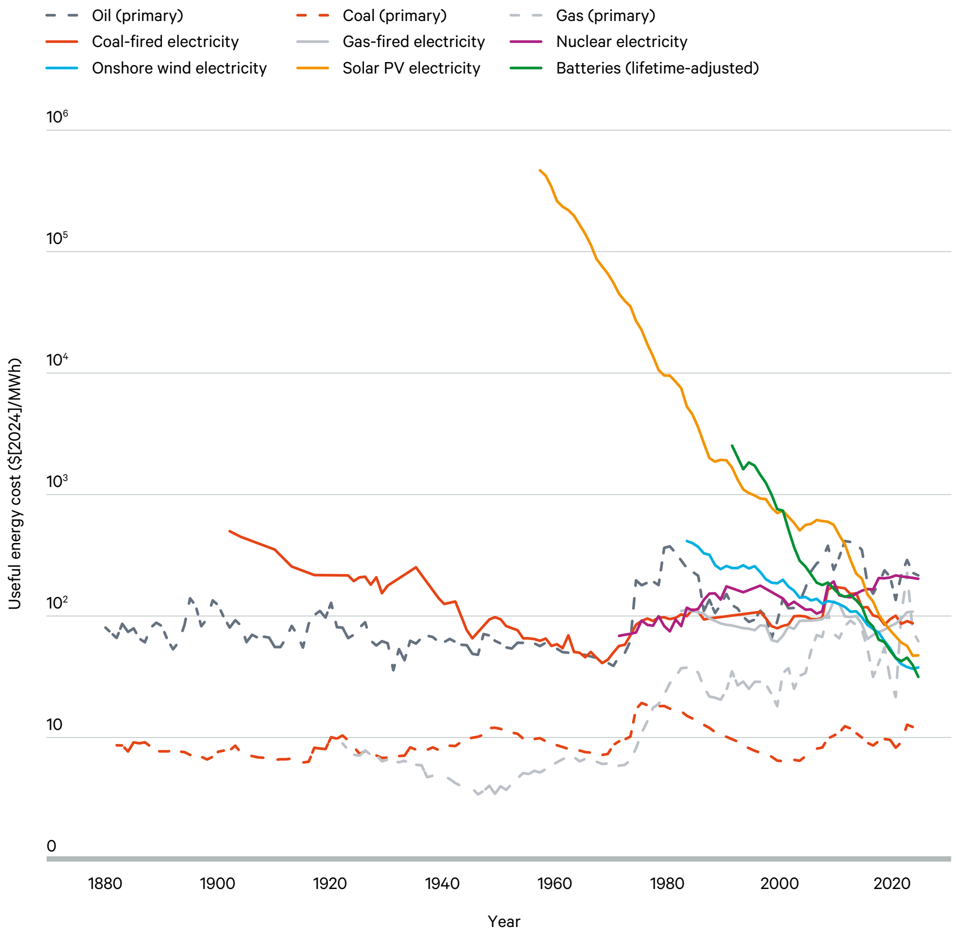
Figure 9. Levelized cost of electricity by technology/type of power plant, Germany, 2024



Source: Kost, C. (2024), *Levelized Cost of Electricity- Renewable Energy Technologies*, Research Paper, Freiburg: Fraunhofer ISE, https://www.ise.fraunhofer.de/en/publications/studies/cost-of-electricity.html.

Indeed, renewables are today the least-cost option for new electricity generation in most countries around the world. In Germany, new-build solar and wind projects offer significantly lower prices per kilowatt hour (kWh) relative to new coal, gas or nuclear power plants (see Figure 9). This advantage holds even when calculations of the cost of solar include battery storage as well as generation.

Figure 10. Historical costs of key energy supply technologies

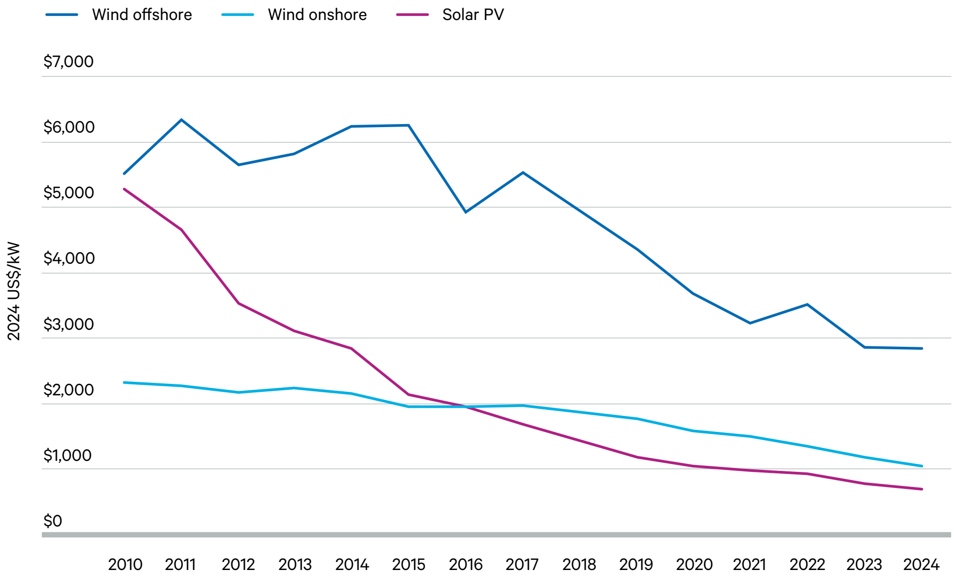


Source: Way, R., Ives, M., Mealy, P. and Doyne Farmer, J. (2022), 'Empirically grounded technology forecasts and the energy transition', *Joule*, 6 (9), pp. 2057–82, https://doi.org/10.1016/j.joule.2022.08.009. Data for 2021–24 supplied by Rupert Way.

The cost advantage of renewables is expected to widen as their roll-out continues. A 2022 study by researchers at the University of Oxford compiled the long-run historical cost trajectories of over 50 technologies to empirically assess the impact of learning and innovation on costs. It sorted the technologies into two groups: those whose costs remain roughly constant over time – the majority – and a far smaller group whose costs decline exponentially as deployment increases. Energy from coal, oil and gas falls into the first category: inflation-adjusted prices today are similar to those at the end of the 19th century. Solar power, wind power and batteries fall into the second category: costs have declined at a rate of close to 10 per cent a year for several decades (see Figure 10). The study assigned a high statistical probability to continued cost declines in these technologies.[76]

76 Way, R., Ives, M., Mealy, P. and Doyne Farmer, J. (2022), 'Empirically grounded technology forecasts and the energy transition', *Joule*, 6 (9), pp. 2057–82, https://doi.org/10.1016/j.joule.2022.08.009.

Figure 11. Total per-kW installed cost of wind and solar power systems, 2010–24 (global)



Source: Authors' compilation, based on International Renewable Energy Agency (2025), *Renewable Power Generation Costs in 2024*, https://www.irena.org/Publications/2025/Jun/Renewable-Power-Generation-Costs-in-2024.

Improved efficiency

Electric technologies are generally able to provide the same services to users as fossil fuel equivalents while using much less energy. Heat pumps, for example, can provide as much heat as gas boilers but require three to five times less energy input to do so.[77] Only 11 per cent of the energy supplied to an electric vehicle (EV) is wasted, while around 80 per cent of the energy consumed by a conventional vehicle is lost, mainly in the form of heat.[78] The more electrified an energy system is, the lower the total amount of energy it needs in order to deliver its services – and thus potentially the more energy-secure it is.

Lower aggregate vulnerability to physical attack

An energy system based on a few large power plants is inherently less physically resilient than one based on a network of widely distributed smaller sources. For instance, in the case of an armed conflict, an adversary would likely need only a limited number of high-tech drones and missiles to destroy an energy facility costing many millions or billions of euros and supplying, say, 5 per cent of the target country's electricity. In contrast, destroying distributed wind and solar generation

77 Energy Institute (2025), 'What is the primary energy fallacy?', 29 January 2025, https://knowledge.energyinst.org/new-energy-world/article?id=139309.
78 Kirk, K. (2024), 'Electric vehicles use half the energy of gas-powered vehicles', Yale Climate Connections, 29 January 2024, https://yaleclimateconnections.org/2024/01/electric-vehicles-use-half-the-energy-of-gas-powered-vehicles.

infrastructure of equivalent value and capacity would be much more complicated and expensive, and thus harder for the adversary to justify in strategic and economic terms.

Ukraine is a case in point. Every one of the country's coal and gas power plants has been the target of Russian attacks, while Ukraine's wind and solar assets have been much less intensively targeted.[79] Where Ukrainian solar parks have been attacked, it has still been possible to get such facilities back online in a matter of days, with damaged panels simply swapped out for new ones.[80] For this reason, major private energy companies in Ukraine are opting to replace damaged coal-fired power stations with renewable-energy installations and batteries.[81] In effect, Ukraine is rapidly replacing a centralized fossil fuel-based system with a decentralized network that uses renewables.

That said, the need to roll out new sources of distributed generation while continuing to rely on existing generation sources means that the full physical resilience benefits of the transition for Europe's energy system will take time to be felt, and that risks will persist in the interim. Furthermore, certain infrastructure required for the energy transition – including interconnector cables and expanded electricity grids – will retain inherent vulnerability to physical attack or sabotage. Put another way, while distributed renewable energy generation is generally less exposed in aggregate, on a MW to MW basis, to physical damage or destruction than is the case for generation by large conventional power plants, that does not make the infrastructure needed for the transition wholly invulnerable to such threats.

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79 Hobhouse, C. (2025), 'Keeping the lights on: How Ukraine can build a resilient energy system (and why this matters to the EU)', European Union Institute for Security Studies, Expert Comment, 28 March 2025, https://www.iss.europa.eu/publications/commentary/keeping-lights-how-ukraine-can-build-resilient-energy-system-and-why; and International Energy Agency (2025), *Empowering Ukraine Through a Decentralised Electricity System*, https://iea.blob.core.windows.net/assets/1cb1324f-e145-41c3-b0c2-d78561b4f1fd/EmpoweringUkraineThroughaDecentralisedElectricitySystem.pdf.
80 Prengaman, P. (2024), 'Ukraine has seen success in building clean energy, which is harder for Russia to destroy', Associated Press, 20 November 2024, https://apnews.com/article/ukraine-clean-renewable-energy-russian-bombing-distributed-1f226213742cc057f9f65208167e6f38.
81 Roundtable on Ukraine energy security held under the Chatham House Rule.

03 Practical steps for improving EU energy security

This chapter sets out options for addressing the financial, technical and political challenges of deploying renewables and electrifying the energy system, and for reducing risks from foreign gas and oil dependency in the short to medium term.

Achieving the transition proposed in this paper without jeopardizing European energy security in the interim, and without risking public and business confidence in the direction of travel, will require the EU to develop effective approaches across a broad range of areas. We have divided these challenges into four categories: (1) the conditions, both in terms of financing and public support, needed to enable the low-carbon transition; (2) ensuring the security of fossil fuel supplies in a complex geopolitical landscape, in recognition of the fact that the EU will remain dependent on imported gas and oil to a substantial degree for years to come; (3) navigating the trade-offs and security concerns around acquiring and rolling out the low-carbon technology equipment needed to reduce the need for fossil fuel imports; and (4) strengthening the underlying system critical to the EU's transition – the electricity grid.

Enabling conditions for the low-carbon transition

Finance

The problem: high upfront transition costs, national budget constraints

The European Commission's 2024 report on competitiveness, the so-called 'Draghi report', calculated that building the infrastructure needed for the EU's energy transition across all sectors of the economy will require public and private investment totalling an additional €450 billion a year until 2030; this represents an annual sum equivalent to 2.6 per cent of the EU's GDP in 2023.[82] With the bloc's major economies struggling with sluggish growth, some member states constrained by large budget deficits, and increased defence spending placing new demands on fiscal resources, this represents a formidable challenge.

There is limited scope for redirecting financial flows destined for high-carbon assets into low-carbon ones. Investment in fossil fuel infrastructure in the EU has fallen significantly in recent years, and investment in renewables is already 35 times higher than investment in unabated fossil fuel power on an annual basis.[83]

While greater investment in renewables and electrification has clear potential in principle, as the Draghi report argues, to improve productivity, increase economic growth and raise tax revenues, such effects will take time to materialize.

There is no single straightforward solution to financing the transition – but there are existing sources that could be better used and, with political will, new sources that could be exploited.

Policy options

Use public funds better. There is scope to do more with what public funds are available. A first step to achieving this would be to ensure such funds are used for their intended purpose: the European Court of Auditors found that only 13 per cent of the EU's 2014–20 budget had been spent on 'climate action' – a definition that includes supporting the energy transition – rather than the pledged 20 per cent.[84] According to European Commission data, less than 5 per cent of the €7 billion awarded to companies under the EU's Innovation Fund for low-carbon technologies since it was set up in 2021 has actually been disbursed, due to lengthy and complex administrative processes.[85]

Better coordination of public funds across different EU financing instruments and within member state budgets could reduce regulatory complexity, improve transparency and speed up disbursement.[86] Reforming state aid so that there is less

82 European Commission (2024), *The future of European competitiveness - Part B | In-depth analysis and recommendations*.
83 International Energy Agency (2025), *World Energy Investment 2025 – 10th Edition*, https://iea.blob.core.windows.net/assets/1c136349-1c31-4201-9ed7-1a7d532e4306/WorldEnergyInvestment2025.pdf.
84 European Court of Auditors (2022), *Climate spending in the 2014-2020 EU budget*, https://www.eca.europa.eu/Lists/ECADocuments/SR22_09/SR_Climate-mainstreaming_EN.pdf.
85 Hancock, A. (2025), 'Companies swamped by 3,000 hours of paperwork to tap EU climate funds', *Financial Times*, 30 November 2025, https://www.ft.com/content/07970763-ad7a-452a-b3f5-82d6d3939ada.
86 Energy Transitions Commission (2024), *Financing the energy transition in the EU*, EU Policy Factsheet, May 2024, https://www.energy-transitions.org/wp-content/uploads/2020/07/Financing-the-energy-transition-in-the-EU_vf.pdf.

emphasis on funding projects and more emphasis on rewarding results – in the form of, for example, per-unit aid for each qualifying EV battery produced – could also make public money go further, faster, as was seen in the US under the production tax credits of the Inflation Reduction Act.[87]

There is no single straightforward solution to financing the transition – but there are existing sources that could be better used and, with political will, new sources that could be exploited.

Mobilize private capital. Public financing needs to be accompanied by measures to attract more private investment, as outlined in the EU's 2025 'Competitiveness Compass' roadmap.[88] The initiative aims to improve the business environment for manufacturing and deploying clean technologies, including through 'enablers' such as skills development. The need for more productive use of the EU's private capital stock was emphasized in a 2024 report by Enrico Letta, a former Italian prime minister, on reforming Europe's single market; the report proposed the creation of a Savings and Investment Union, the aim of which would be to direct a larger share of European private savings towards strategic priorities such as the energy transition.[89]

Exploit increased emissions trading revenue. The EU's Emissions Trading System (ETS) has a critical role to play in generating funds for the energy transition and maintaining decarbonization incentives. The ETS has become a significant source of revenue since its establishment in 2005, having generated €112 billion in 2021–23 alone. This figure is set to increase as the ETS undergoes major changes over the next few years.

The scheme requires companies in energy-intensive sectors to buy allowances equivalent to the quantity of carbon they emit, at the prevailing price under the ETS. Currently, companies receive a quantity of emissions allowances for free, intended to shelter companies against foreign competition as they decarbonize. However, free allowances are being phased out between 2026 and 2034, while charges to importers under the EU's Carbon Border Adjustment Mechanism (CBAM) are being phased in, meaning that importing companies will be required to pay for a growing share of the embedded emissions in goods produced outside the EU. In parallel, the price of an allowance under the ETS is expected to rise as the supply of allowances in the market structurally decreases in line with the EU's climate targets; no new allowances will be issued after 2039. A new revenue stream will also be introduced

87 Sol, X. (2025), 'Europe needs a cleantech State Aid overhaul - starting with production incentives', T&E, 30 May 2025, https://www.transportenvironment.org/articles/europe-needs-a-cleantech-state-aid-overhaul-starting-with-production-incentives.
88 European Commission (2025), *A Competitiveness Compass for the EU*, https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en?filename=Communication_1.pdf.
89 Letta, E. (2024), *Much more than a market*, Brussels: European Commission, https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.

in the form of a second ETS, covering road transport and buildings, although its launch was recently delayed from 2027 to 2028 amid member state concerns about costs to consumers.[90]

Redirect fossil fuel subsidies. Public funds currently used or foregone by member states to subsidize fossil fuel production and consumption represent another potential source of finance for the energy transition. Fossil fuel subsidies in the EU averaged around €60 billion a year before Russia's full-scale invasion of Ukraine, but they hit €136 billion in 2022 as oil and gas prices spiked. Although spending on such subsidies eased to €111 billion in 2023, this was still well above the pre-crisis average and was nearly twice the amount spent on subsidizing renewable energy (€61 billion) in the same year.[91] The fossil fuel subsidies included $14 billion (approximately €13 billion)[92] in tax breaks, investment incentives and other support for oil, gas and coal production across the 23 EU member states in the OECD.[93]

Reforming or removing energy subsidies is politically challenging, however. Where proposed measures would result in higher energy prices for consumers, change must be introduced in a phased and transparent manner, with well-designed, well-communicated compensation mechanisms targeting the people most affected.[94]

Phasing out measures that encourage fossil fuel consumption is a stated aim of the proposed revision to the Energy Taxation Directive. The directive has not been updated since 2003. Its revision, proposed by the European Commission in 2021 and currently being examined in the European Parliament and the Council of the European Union, would also establish a high minimum tax rate for environmentally damaging fuels.[95] The revised directive, if passed, has the potential to free up public funds to invest in the energy transition.

Introduce joint EU borrowing. While the measures presented above should be vigorously pursued, in aggregate they are unlikely to meet the scale of investment needed for the transition. A more dramatic increase in investment will require EU institutions and member states to reassess their fiscal rules and assumptions. Such reassessments are under way in many parts of the bloc, prompted in part by the need to ramp up defence spending in today's uncertain world.

Nowhere is this better demonstrated than in Germany, traditionally one of the most fiscally conservative member states. In March 2025 the Bundestag eased the country's strict debt rules to facilitate investment in defence. Legislators

90 Marcu, A. et al. (2025), *2025 State of the EU ETS Report*, Brussels: European Roundtable on Climate Change and Sustainable Transition, https://ercst.org/2025-state-of-the-eu-ets-report; and Anwer, A. (2025), 'EU postpones new carbon levy on transport and heating fuels by one year', TVP World, 11 November 2025, https://tvpworld.com/89860506/eu-delays-carbon-levy-on-transport-and-heating-fuels-to-2028.
91 European Commission (2025), *2024 Report on Energy subsidies in the EU*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2025:17:FIN&pk_campaign=todays_OJ&pk_source=EUR-Lex&pk_medium=X&pk_content=Report&pk_keyword=Energy&pk_cid=EURLEX_todaysOJ.
92 Exchange rate: 0.9248 (average USD–EUR exchange rate for 2023) from https://www.investing.com/currencies/usd-eur-historical-data (accessed 2 Dec. 2025).
93 OECD (2024), 'OECD Data Explorer', https://data-explorer.oecd.org/vis?fs[0]=Topic%2C1%7CTrade%23TRD%23%7CTrade%20policy%23TRD_POL%23&pg=0&fc=Topic&bp=true&snb=53&df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_FFS%40DF_FFS_IND_DETAIL&df[ag]=OECD.TAD.ADM&df[vs]=2.0&dq=A.EU23OECD.._T.PROD.....USD%2BPT_B1GQ&pd=%2C2023&to[TIME_PERIOD]=false&vw=tb (accessed 4 Jul. 2025).
94 McCulloch, N. (2023), *Ending Fossil Fuel Subsidies: The Politics of Saving the Planet*, Rugby: Practical Action Publishing, p. 55.
95 European Commission (2023), 'Revision of the Energy Taxation Directive', https://taxation-customs.ec.europa.eu/taxation/excise-taxes/revision-energy-taxation-directive_en.

also approved the creation of a €500 billion infrastructure fund, financed by borrowing, which will include €100 billion for the energy transition and other climate-related investment.

In June 2025, NATO members agreed to a massive increase in defence spending and investment, to 5 per cent of GDP by 2035. Of this 5 per cent, almost one-third (1.5 per cent of GDP) would be allocated to investments which 'protect our critical infrastructure, defend our networks, ensure our civil preparedness and resilience, unleash innovation, and strengthen our defence industrial base'.[96] As this broad category of activity might easily be interpreted as including investment in the security and resilience of energy infrastructure, such as electricity grids, the NATO decision is potentially positive for the prospects of increased financing of the transition to renewables and electrification.

The energy transitions of individual member states will contribute to the EU's overall security and strategic autonomy. However, most member states cannot borrow at the same scale or on the same terms as Germany. This makes the transition a strong candidate for joint EU borrowing, as proposed by the European Central Bank (ECB)'s former president, Mario Draghi.[97] Joint borrowing is controversial within the EU, and resistance remains fierce from Germany, the Netherlands and others. Nevertheless, as the European Commission negotiates the next long-term EU budget, known as the 2028–34 Multiannual Financial Framework, EU policymakers should make a case for joint borrowing as essential for achieving bloc-wide energy security.

Public support

The problem: maintaining citizen buy-in as political consensus fragments

In 2019, with public concern surging about the threat posed by climate change, a record number of pro-climate and pro-renewable-energy candidates were elected to the European Parliament, in what was dubbed a 'green wave'. The European Commission's incoming president, Ursula von der Leyen, from the centre-right European People's Party (EPP), made the European Green Deal the centrepiece of her first term (2019–24). In this period, the number of EU member states in which more electricity is produced by renewables than by fossil fuels grew from 12 to 20.[98]

However, the green wave did not last. By 2024 – against a backdrop of high inflation, which exacerbated concerns about the costs of the energy transition, and pan-Europe protests by farmers, driven in part by anger at new environmental rules in the Green Deal – the European Parliament elections returned a set of legislators less supportive of the energy transition. The Greens/European Free Alliance grouping fell back to the number of seats it had held before 2019, while the European Conservatives and Reformists (ECR) and Identity and Democracy (ID) groups, both consisting of far-right parties that are hostile to renewable energy, made gains. Together

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96 NATO (2025), 'The Hague Summit Declaration', press release, 25 June 2025, https://www.nato.int/cps/en/natohq/official_texts_236705.htm.
97 European Commission (2024), *The Draghi report on EU competitiveness*, https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en.
98 Ember (2025), *European Electricity Review 2025*.

with a newly formed far-right group, Europe of Sovereign Nations, politicians seeking to roll back the Green Deal now occupy over a quarter of the parliament's seats. The long delay in agreeing the EU's 2040 climate target, and the November 2025 vote to weaken corporate sustainability reporting rules, demonstrated the power of this bloc.[99]

The inflationary shocks from the COVID-19 pandemic, and from Russia's full-scale invasion of Ukraine in 2022, contributed to the political challenges the energy transition faces. Amid rising living costs, right-wing politicians sought – and continue to seek – to stoke popular fears of 'green' policies imposing an unfair economic burden on financially struggling citizens. Where such tactics have been effective, they have prompted what is sometimes described as a 'greenlash' against the energy transition and other aspects of the Green Deal.

However, the strength of popular opposition towards the transition should not be overstated. An April–May 2024 Eurobarometer survey found continued support for the EU's decarbonization goals, with 70–80 per cent of respondents believing the transition will not only provide climate and environmental benefits, but will also create jobs, enable greater participation by communities and businesses in energy production, improve energy security and make energy more affordable.[100] Of course, such surveys also increase the pressure on governments and policymakers to ensure the transition delivers tangible results for people's daily lives.

Policy options

Support at-risk communities. The energy transition is already creating jobs in technology manufacturing, infrastructure deployment, renewable energy operations and maintenance. However, it is eliminating jobs in other sectors, such as coal mining. The new jobs are not always a good fit, whether due to location or job type, for people employed or previously employed in fossil fuel sectors.[101] Promises of 'green jobs' are likely to be treated with suspicion by the many EU citizens – up to six in 10, according to Eurobarometer – who do not trust their national governments.[102]

To address such concerns, the EU and member state governments should work closely with affected communities to produce credible transition plans tailored to local circumstances and informed by international best practice. There are plenty of precedents to draw on, whether inside or outside the EU. For example, the Spanish government navigated the closure of 28 coal mines in 2019 through a 'social dialogue' with businesses, labour unions and provincial administrations, agreeing a comprehensive support package for affected workers and communities –

99 Csaky, Z. (2025), 'The far right's impact on the EU's climate agenda', Centre for European Reform Insight, 14 November 2025, https://www.cer.eu/insights/far-right-impact-eu-climate-agenda.
100 European Union (2024), *European's [sic] attitudes towards energy policies*, Brussels: European Commission, https://europa.eu/eurobarometer/surveys/detail/3229.
101 International Energy Agency (2022), *World Energy Employment*, https://iea.blob.core.windows.net/assets/a0432c97-14af-4fc7-b3bf-c409fb7e4ab8/WorldEnergyEmployment.pdf.
102 European Union (2025), *Standard Eurobarometer 104: Public Opinion in the European Union, Data Annex, October-November 2025*, QA6.7, https://europa.eu/eurobarometer/surveys/detail/3378.

and was subsequently rewarded at the polls.[103] Scotland's Just Transition Commission has formulated context-specific plans and policy recommendations, based on extensive local engagement, for regions negatively affected by declining fossil fuel production.[104] Chile's Just Energy Transition Strategy and action plan for the coal-dependent Tocopilla region demonstrate the value of broad stakeholder participation and are also worthy of study.[105]

Proactive planning for affected communities should be based on a broad view of the jobs that the transition will generate. There has been a great deal of focus on the job creation potential of low-carbon technology manufacturing. However, more attention needs to be paid to the larger number of skilled roles that will need to be filled as the EU seeks to make its housing stock more energy-efficient, to take one example, including technical roles such as installers of heat pumps and insulation.

Increase local agency and citizens' sense of ownership. If the main beneficiaries of a new energy system are seen as being private companies rather than citizens, this will breed cynicism and resistance to the transition. Backlashes are likely where communities host new infrastructure – whether a lithium mine, a cobalt processing plant, a set of electricity pylons or a wind farm – but do not see the economic benefits from it themselves. It is imperative in this context for governments and policymakers to confront the sense that communities are being 'sacrificed' to the advancement of the energy transition. Changing perceptions will require proactive engagement with affected communities, efforts to foster a genuine sense of local agency, and the provision of clear material benefits.

One potentially useful strategy would be for the European Commission to make good on its 2015 commitment to citizen ownership of the energy transition[106] by building on the growing momentum behind so-called 'energy communities',[107] as called for in the EU's Action Plan for Affordable Energy.[108] Thousands of new energy communities were established in the EU during the commission's 2019–24 term; as of November 2025, there are more than 8,000, reaching every corner of the bloc.[109] This concept envisions local stakeholders participating and investing in community-level power projects; typically, an energy community could take the

103 Bolet, D., Green, F. and González-Eguino, M. (2024), 'How to get coal country to vote for climate policy: the effect of a "Just Transition Agreement" on Spanish election results', *American Political Science Review*, 118(3), pp. 1344–59, https://doi.org/10.1017/S0003055423001235.
104 Just Transition Commission (undated), 'Publications', https://www.justtransition.scot/publications (accessed 4 Jul. 2025).
105 Moreno, J., Frohlich, V. and Gómes, C. (2024), *Progress achieved in the retirement of coal facilities in Chile and the definition of a Just Energy Transition Strategy*, case study, Bonn and Geneva: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Just Energy Transition in Coal Regions Knowledge Hub, https://www.jetknowledge.org/wp-content/uploads/2024/04/Chile-case-study-giz.pdf.
106 European Commission (2015), *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, https://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF.
107 European Commission (2025), 'Energy communities', https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities_en.
108 European Commission (2025), *Unlocking the true value of our Energy Union to secure affordable, efficient and clean energy for all Europeans*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0079&qid=1741780110418.
109 Hockenos, P. (2025), 'Community-owned renewables now span all of Europe', Energy Transition, 21 May 2025, https://energytransition.org/2025/05/community-owned-renewables-now-span-all-of-europe.

form of a cooperative or partnership in which local people, companies, non-profit groups or some other combination of actors not only produce renewable electricity for their own consumption but also, where possible, sell it back to the grid. Initiatives that enable local communities to invest in their own energy enjoy public support, as such schemes make citizens active participants in energy production, rather than passive consumers of energy, and can lower electricity bills, protect against price spikes and boost local investment.[110]

More broadly, member states need to consider increasing public and community ownership in the energy sector. Publicly owned utilities have been found to deliver lower bills[111] and invest more in renewables[112] than their private counterparts.

Distribute the gains and prioritize affordability. Large upfront costs have meant that the benefits of low-carbon products such as EVs and rooftop solar systems have been felt primarily by people who are already well-off. This feeds the perception of the energy transition itself as an unaffordable luxury. Without active and sustained policy intervention, the gains of the energy transition will continue to skew towards consumers at the high end of the socioeconomic spectrum. Many different policy levers will need to be pulled to redress this imbalance. One of the most critical will be to increase the availability of grants and concessional loans, as this would help to overcome prohibitive upfront product costs for consumers.

Although such support implies increased costs to EU member states, it is important to factor in the wider benefits when making calculations of fiscal affordability and return on investment. For example, a comprehensive programme that replaced gas boilers with heat pumps in low-income households would reduce energy poverty, improve the health of occupants and create installation jobs, generating tax revenue and potentially easing pressures on the public purse.

Security of fossil fuel supplies

Gas

The problem: supply concentration and concerns over the reliability of major suppliers

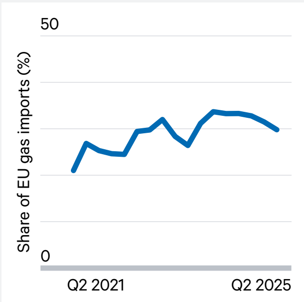
The EU's gas imports are highly concentrated among a small number of supplier countries. The three largest suppliers, Norway, Russia and the US, account for nearly 70 per cent of the bloc's gas imports (see Figure 5). Each major supplier of gas to the EU brings its own risks, summarized in Figure 12 below.

110 European Commission (2025), 'Energy communities'.
111 Fiorio, C. V. and Florio, M. (2013), 'Electricity prices and public ownership: Evidence from the EU15 over thirty years', *Energy Economics*, 39, pp. 222–32, https://doi.org/10.1016/j.eneco.2013.05.005.
112 Steffen, B., Karplus, V. and Schmidt, T. (2022), 'State ownership and technology adoption: The case of electric utilities and renewable energy', *Research Policy*, 51 (6), 104534, https://doi.org/10.1016/j.respol.2022.104534.

Figure 12. The EU's gas supply risks, by supplier country[113]

Norway

Share of EU gas imports, Q2 2025: 30%



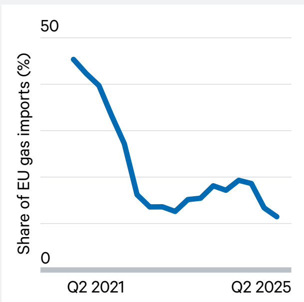
In 2024, gas production on the Norwegian continental shelf reached its highest level since 2009. However, the Norwegian Offshore Directorate (SODIR) forecasts that output will begin to decline at the end of the 2020s.* Under SODIR's baseline scenario, Norway's total oil and gas production is projected to fall by two-thirds by 2050.** This suggests a gradual decline in the ability of the most important supplier to the EU to meet demand in the coming decades.

Unscheduled infrastructure maintenance or overrunning of planned works could reduce production and raise prices. In May 2025, a compressor failure in Norway's Troll field – Europe's largest gas reserve – forced cuts of 34.6 million cubic metres per day and increased European gas futures prices by 2.2 per cent.***

* Norwegian Offshore Directorate (2024), *The Shelf in 2024*.
** Norwegian Offshore Directorate (2024), *Resource Report 2024*, https://www.sodir.no/en/whats-new/publications/reports/resource-report/resource-report-2024/three-potential-scenarios-for-the-ncs-leading-up-to-2050/#base-scenario.
*** Market Screener (2025), 'Equinor extends partial shutdown at the Troll field', 26 May 2025, https://uk.marketscreener.com/quote/stock/EQUINOR-ASA-1413290/news/Equinor-extends-partial-shutdown-at-the-Troll-field-50062896; and Kern, M. (2025), 'Europe's natural gas prices rise on supply outage in Norway', Oil Price, 26 May 2025, https://oilprice.com/Energy/Natural-Gas/Europes-Natural-Gas-Prices-Rise-on-Supply-Outage-in-Norway.html.

Russia

Share of EU gas imports, Q2 2025: 11%



Even before its 2022 full-scale invasion of Ukraine, Russia had a track record of unilaterally cutting energy supplies to European customers.* Russia may seek once again to weaponize EU gas dependency, as it did in 2022 when it halted major pipeline flows, triggering a supply shock that caused prices to increase fivefold.**

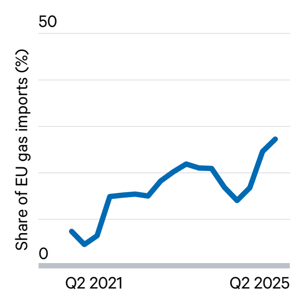
For as long as Russia remains an exporter to the EU, it will continue to have the means to employ a selective supply strategy that could allow Moscow to foment discord and political fragmentation across member states.*** Although the EU formally adopted a regulation in January 2026 to permanently end all Russian gas imports by the autumn of 2027, it is by no means guaranteed that this will hold in practice. Among EU states, Hungary and Slovakia are firmly opposed, while Austria and Italy remain open to resuming imports of Russian pipeline gas in the event of some form of settlement to the Ukraine conflict.†

* European Union (2025), *Roadmap towards ending Russian energy imports*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0440R%2801%29&qid=1747125158211.
** Alessandri, P. and Gazzani, A. (2023), 'The impact of gas supply shocks in Europe', Centre for Economic Policy Research, 25 July 2023, https://cepr.org/voxeu/columns/impact-gas-supply-shocks-europe.
*** Keliauskaitė, U., Tagliapietra, S. and Zachmann, G. (2025), 'Europe urgently needs a common strategy on Russian gas', Bruegel, 2 April 2025, https://www.bruegel.org/analysis/europe-urgently-needs-common-strategy-russian-gas.
† Reuters (2025), 'Slovakia and Hungary reject EU plan to phase out Russian gas by end-2027', 7 May 2025, https://www.reuters.com/business/energy/slovakia-rejects-eu-plan-phase-out-russian-gas-by-end-2027-2025-05-07.

113 Quarterly EU gas import data from Jugé, M., McWilliams, B. and Zachmann, G. (2025), 'European natural gas demand tracker', Bruegel, https://www.bruegel.org/dataset/european-natural-gas-demand-tracker (accessed 17 Dec. 2025); and Institute for Energy Economics & Financial Analysis (2025), 'European LNG Tracker', https://ieefa.org/european-lng-tracker (accessed 17 Dec. 2025).

United States

Share of EU gas imports, Q2 2025: 27%



The actions of the current US administration to date, its 'energy dominance' agenda and serious trade – and even territorial – tensions with the EU all raise the possibility of the EU's dependency on American gas being coercively leveraged to extract concessions in other aspects of the transatlantic relationship. A stated desire to intervene in the domestic politics of European countries* raises the possibility of the US administration exploiting the gas import reliance of an EU member state to pursue political change within that member state.

In a joint letter with his Qatari counterpart, sent to EU leaders in October 2025, the US secretary of energy suggested that American energy companies may no longer export LNG to the EU if it goes ahead with proposed supplier requirements relating to net zero transition plans, environmental performance and human rights under the Corporate Sustainability Due Diligence Directive (CSDDD).**

The reliability of US supply to the EU is vulnerable to geological and economic factors that may impose production constraints in the coming years. The decline rates of US shale wells have been accelerating, and upstream investment has been falling.***

US companies are also scaling back drilling due to low oil prices.† Over a third of US gas – 37 per cent in 2023 and 2024 – is extracted as a byproduct of oil drilling.‡ A reduction in oil production would also reduce gas production and could, in a context of growing US electricity demand resulting from the mass deployment of data centres associated with artificial intelligence (AI), and a slowdown in deployment of renewable energy generation, drive up gas prices.

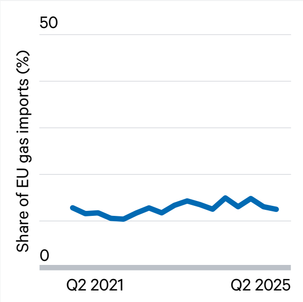
Analysis by the US Department of Energy has found that unrestricted LNG exports could increase wholesale domestic gas prices by over 30 per cent, which would in turn increase electricity prices.‡‡ Electricity prices have become increasingly politically salient in the US, having risen at over twice the rate of inflation from 2024 to 2025.§ Should US gas exports become associated in the popular imagination with higher prices for US consumers, there may be political pressure and/or economic incentives to prioritize domestic demand.

As climate change increases the frequency and severity of extreme weather events such as hurricanes, there will also be a growing risk of storms disrupting LNG exports from the US's Gulf Coast.§§

* The White House (2025), *National Security Strategy of the United States of America*, p. 27.
** U.S. Department of Energy (2025), 'U.S. Energy Secretary and Qatari Energy Minister Send Letter to EU Regarding Proposed Corporate Climate Regulations', press release, 22 October 2025, https://www.energy.gov/articles/us-energy-secretary-and-qatari-energy-minister-send-letter-eu-regarding-proposed-corporate.
*** International Energy Agency (2025), *The Implications of Oil and Gas Field Decline Rates*, 16 September 2025, https://www.iea.org/reports/the-implications-of-oil-and-gas-field-decline-rates.
† Elliott, R. F. (2025), 'U.S. Oil Companies Are 'Battening Down the Hatches'', *New York Times*, 30 May 2025, www.nytimes.com/2025/05/30/business/energy-environment/oil-companies-production-prices-opec.html.
‡ Ameen, N. (2025), 'U.S. associated natural gas production increased 6% in 2024', U.S. Energy Information Administration, 21 November 2025, https://www.eia.gov/todayinenergy/detail.php?id=66684.
‡‡ U.S. Department of Energy (2024), '2024 LNG Export Study: Energy, Economic, and Environmental Assessment of U.S. LNG Exports', https://fossil.energy.gov/app/docketindex/docket/index/30.
§ Eckhouse, B. and Malik, N. S. (2025), 'Spiraling power costs are now a major political issue in the US', Bloomberg, 23 September 2025, https://www.bloomberg.com/news/newsletters/2025-09-23/us-power-costs-rising-faster-than-inflation-are-a-major-political-issue.
§§ Webster, J., l'Anson, R. and Herzberg, A. (2024), 'Hurricanes could upend US oil and gas exports and global energy markets. Here's what to know', Atlantic Council, 26 August 2024, https://www.atlanticcouncil.org/blogs/new-atlanticist/hurricanes-could-upend-us-oil-and-gas-exports-and-global-energy-markets-heres-what-to-know.

Algeria

Share of EU gas imports, Q2 2025: 13%



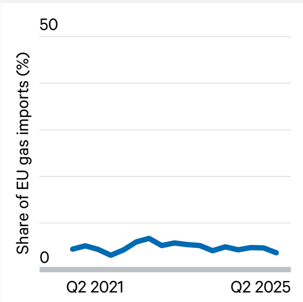
Algeria's conventional gas reserves are declining. Gross production has been flat for over a decade. Meanwhile, domestic consumption has been growing at an average annual rate of 4 per cent, reducing the amount available for export.

There is widespread industry consensus that only by developing non-conventional gas, of which Algeria has very large reserves, can the country maintain its current export levels. However, this type of extraction presents significant technical, financial and political challenges. As such, the viability of the country's non-conventional reserves remains highly uncertain.*

* Escribano, G. (2025), *Another round of Algerian gas for Europe*.

Qatar

Share of EU gas imports, Q2 2025: 4%



Qatar's share of EU gas imports, though modest, is expected to increase in the coming years in line with the country's expanding share of the global market. As major new liquefaction infrastructure comes online, Qatar's LNG exports are set to increase by 55 per cent relative to 2024 by the end of the decade, cementing the country's position as the world's number two LNG exporter, behind the US and ahead of Australia.*

However, Qatar has repeatedly insisted that the CSDDD could be a barrier to continued exporting of LNG to the EU.** In a letter to the Belgian government in May 2025, Qatar's energy minister, Saad al-Kaabi, said that in the absence of changes to the CSDDD, his government, and state-owned oil and gas monopoly QatarEnergy, would have 'no choice but to seriously consider alternative markets outside of the EU'.*** Kaabi's concerns regarding the CSDDD were reiterated in the October 2025 US/Qatar letter to EU leaders.†

There are also physical risks to supply. Qatar is located in a volatile region, and its LNG shipments must pass through multiple 'chokepoints' en route to Europe.‡ Supply-chain vulnerabilities were highlighted during the '12-day' war between Israel and Iran in June 2025, when the latter threatened to close the Strait of Hormuz, although Asia is more exposed than Europe to such interruptions of supply.‡‡

* International Energy Agency (2025), *Gas 2025: Analysis and Forecasts to 2030*, https://iea.blob.core.windows.net/assets/db3d568d-b985-4cc2-bb1a-119517f118ac/Gas2025.pdf.
** England, A. and Hancock, A. (2024), 'Qatar will 'stop' EU gas sales if fined under due diligence law', *Financial Times*, 22 December 2024, https://www.ft.com/content/2260c21b-f5f4-4ea9-b176-ba1b38c8471c.
*** Abnett, K. (2025), 'Qatar threatened to cut EU LNG supplies over sustainability law, letter shows', Reuters, 26 July 2025, https://www.reuters.com/sustainability/climate-energy/qatar-threatened-cut-eu-lng-supplies-over-sustainability-law-letter-shows-2025-07-26.
† U.S. Department of Energy (2025), 'U.S. Energy Secretary and Qatari Energy Minister Send Letter to EU Regarding Proposed Corporate Climate Regulations'.
‡ The two chokepoints at either end of the Red Sea – the Suez Canal and the Bab-el-Mandeb Strait – can be avoided by going around the Cape of Good Hope, as was seen throughout much of 2024, as Houthi militants threatened vessels traversing the strait. However, this route takes nearly twice as long (29 days instead of 17). See also: Sharples, J. (2024), *LNG Shipping Chokepoints: The Impact of Red Sea and Panama Canal Disruption*, Oxford: The Oxford Institute for Energy Studies, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2024/02/NG-188-LNG-Shipping-Chokepoints.pdf.
‡‡ Dunn, C. and Barden, J. (2025), 'Amid regional conflict, the Strait of Hormuz remains critical oil chokepoint', U.S. Energy Information Administration, 16 June 2025, https://www.eia.gov/todayinenergy/detail.php?id=65504.

Policy options

End Russian gas imports. Prospective changes in international market dynamics present the EU with an opportunity to definitively end its historic reliance on imported Russian gas. A wave of new LNG supply is on the horizon, set to be the largest in the history of LNG markets. By 2030, based exclusively on projections for projects that have reached a final investment decision or are under construction, nearly 300 billion cubic metres (bcm) a year of new liquefaction capacity will come online globally, an increase of 43 per cent on global capacity in June 2025.[114]

Over half of this new capacity will be in the US, with just under 20 per cent coming from Qatar; a dozen other countries will account for the remaining 30 per cent.[115] This should mean that, within the next two years, the global LNG market will be sufficiently well supplied to enable the EU to find alternatives to Russian gas without having to pay a substantially higher price. This is a very different situation to the one in which the EU found itself following Russia's invasion of Ukraine in 2022.

Challenges to making a decisive and permanent break with Russian gas will remain, however. Hungary and Slovakia firmly oppose halting their gas imports via TurkStream, the pipeline through which the remaining flows from Russia are routed, and plan to mount a legal challenge to the full ban set to take effect in the autumn of 2027.[116] There is also the question of contractual purchase commitments: it is unclear whether all EU member states will be willing and able to compel companies operating in their jurisdictions to break long-term LNG contracts with Russian suppliers.

Prioritize a well-functioning LNG market. The EU does not need to intervene in the market by signing bilateral agreements, such as the $750 billion commitment to buy American energy products, or place undue obligations on member states. For the most part, its focus simply needs to be on supporting a well-supplied and fully functional LNG market. As the global gas market rebalances, the European Commission needs to phase out storage obligations, which distort the market in favour of sellers (by sending a signal that buyers will be required to source significant supplies on the spot market during the summer months, before the high-demand winter season).

Increase market-monitoring capabilities. One consequence of the 2022 gas crisis was that the role of Europe in global LNG markets changed significantly. In 2014, the EU27 had imported 33.8 bcm of LNG, which accounted for 10.1 per cent of total global LNG imports. In 2024, the same countries imported 111.7 bcm of LNG and their share of the total had risen to 20.5 per cent. China, by comparison, imported 105.2 bcm (19.3 per cent of the total) in the same year.[117]

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114 International Energy Agency (2025), 'New data resource tracks global LNG liquefaction capacity additions as markets gear up for record wave of new projects', 6 June 2025, https://www.iea.org/news/new-data-resource-tracks-global-lng-liquefaction-capacity-additions-as-markets-gear-up-for-record-wave-of-new-projects.
115 International Energy Agency (2025), 'Global LNG Capacity Tracker', https://www.iea.org/data-and-statistics/data-tools/global-lng-capacity-tracker (accessed 16 Dec. 2025).
116 Szijjártó, P. (@FM_Szijjarto) via X (2025), 'As soon as the RePowerEU plan is adopted next week, together with Slovakia we will submit an annulment request to the European Court of Justice […], 7 December 2025, https://x.com/FM_Szijjarto/status/1997695682019278932.
117 Energy Institute (2025), 'Statistical Review of World Energy', https://www.energyinst.org/statistical-review (accessed 8 Jul. 2025).

As they have become much bigger importers of LNG, European buyers have gone from being passive players in the global LNG market to active competitors (largely competing against Asian importers). This changed role requires more proactive market monitoring and a deeper understanding of market dynamics on the part of EU member states and the European Commission.

Already, progress has been made on this front. The European Union Agency for the Cooperation of Energy Regulators (ACER) now produces an LNG monitoring report, and the European Court of Auditors has produced a study articulating the lessons from the 2022 gas crisis.[118] The International Energy Agency (IEA) produces quarterly gas market reports and an annual gas security assessment. Europe is also well served by a strong corporate presence in the global LNG market, and by a number of independent think-tanks that monitor gas market developments.

Broadly speaking, these developments bode well for management of the risks associated with a greater reliance on LNG imports to meet EU gas demand. Nevertheless, the EU requires a change of mindset to acknowledge the centrality that LNG will have for the continent's energy security for some years to come; this also means recognizing that LNG market dynamics are very different to those for pipeline gas.

Coordinate with other LNG importers. Above all, Europe's changed role presents opportunities to coordinate responses with other importers. An existing, Japan-led international arrangement provides one potential mechanism to achieve this. In 2012, in the aftermath of the 2011 tsunami and Fukushima Daiichi nuclear disaster, Japan turned to the global LNG market to compensate for the loss of nuclear power generation. To minimize market disruption and ensure supply, the Japanese government convened the first meeting of the LNG Producer Consumer Conference (LNG PCC). The aim of this common platform was to deepen cooperation between LNG producers and consumers.

Europe's changed role in the global LNG market presents opportunities to coordinate responses with other importers. An existing, Japan-led international arrangement provides one potential mechanism to achieve this.

As the LNG PCC has become more established, its reach has widened, and for the last three years the event has been co-hosted with the IEA.[119] The European Commission and LNG-importing EU member states are already involved in the conference; they should use this forum to pursue greater coordination with other importers, in support of European supply needs. Other forums such as the G7 and

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118 European Union Agency for the Cooperation of Energy Regulators (2024), *Analysis of the European LNG market developments – 2025 Monitoring Report*, https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER-LNG-Monitoring-Report-2025.pdf; European Court of Auditors (2024), *Security of the supply of gas in the EU – EU's framework helped member states respond to the crisis but impact of some crisis-response measures cannot be demonstrated*, https://www.eca.europa.eu/en/publications/sr-2024-09.
119 LNG PCC 2025 (2025), 'Navigating Global Uncertainty and Economic Growth', https://lngpcc.go.jp/en.html.

G20 also provide fertile ground for energy diplomacy, and the EU should pursue cooperation through these avenues too. This push for cooperation should be informed by a full, European Commission-led review of the EU's energy diplomacy towards other LNG importers, especially Asian buyers most affected by its LNG strategy.[120]

Remain vigilant to global gas market dynamics as demand falls. The very high gas prices in the summer of 2022, following Russia's invasion of Ukraine, led to dramatically reduced gas demand in the EU. Even today, EU gas demand has not returned to pre-war levels and is unlikely to do so.

A number of factors not directly related to the 2022 price shock are also behind the reduction in demand. They include: replacement of gas-fired electricity generation with renewable generation and, to a far lesser extent, coal-fired generation; efficiency improvements; mild winters and rising energy poverty; and permanent demand destruction from the closure of factories and industrial facilities that previously consumed gas. This latter trend has raised concerns about deindustrialization in energy-intensive sectors.

There is considerable uncertainty about the future trajectory of European gas demand. Demand will almost certainly continue to fall, which, this paper argues, is necessary to improve Europe's energy security – but how quickly it will fall is unclear. One recent study suggests that it could fall a further 7 per cent by 2030.[121] However, as gas becomes less significant as a primary mode of power generation, its importance will grow as a source of intra-seasonal energy storage and as a back-up for variable wind and solar generation, at least in the medium term, until there is sufficient storage in the energy system. In some electricity markets in the EU, the price of gas may continue to set the price of electricity at least some of the time.

Thus, even though gas demand will likely continue to fall, and the EU may largely wean itself off Russian imports by the end of 2027, the bloc will still be exposed to global gas market volatility – and to the effects of geopolitics on supply, demand and prices – for some time yet. Consequently, as noted above, the EU and its member states will need to remain vigilant to factors that might impact the global supply of LNG and the price of LNG on spot markets; until the shock of 2022, these were not issues the EU had had to worry about.

Oil

The problem: high risk of price volatility in coming years

The EU's oil supply is better diversified than its gas supply. Whereas the EU's top three import partners for gas accounted for 69 per cent of the bloc's gas imports in 2024, the EU's top three oil import partners (the US, Norway and Kazakhstan)

120 Sassi, F. (2025), 'The (Un)Intended consequences of power: The global implications of EU LNG strategy to reach independence from Russian gas', *Energy Policy*, 198, March 2025, 114494, https://www.sciencedirect.com/science/article/abs/pii/S0301421525000011.
121 Harrison, T. (2025), *EU national targets show gas in decline*, London: Ember Energy, https://ember-energy.org/app/uploads/2025/06/Report-EU-national-targets-show-gas-in-decline.pdf.

accounted for 41 per cent, with nine other countries, including Saudia Arabia, Nigeria and Brazil, supplying between 3 and 8 per cent (see Figures 5 and 6). However, this healthy diversity of supply would inevitably decrease if purchases of oil from the US were ramped up in line with the pledges of the US–EU trade deal of July 2025 (see Box 1).

Globally, oil supply has been growing, with Brazil, Canada, Guyana and the US among the countries increasing output. Meanwhile, demand growth has been slowing, due to stagnating demand in advanced economies and the rapid adoption of EVs in China. This has led to expectations of an oversupplied oil market in the coming years, which would be advantageous for the EU's security of oil supply.[122] The EU is also relatively well prepared for sudden oil shocks: as of September 2025, the 20 EU member states that are also members of the IEA were all meeting the central IEA oil security requirement to hold in reserve an amount of oil equivalent to at least 90 days of demand.[123]

For the EU, oil supply security would thus seem to be less of a concern than price volatility, which has been acute in recent decades, is exacerbated by geopolitical tensions, and imposes unpredictable and often crippling costs on governments and citizens.

Conflict in Europe and the Middle East, combined with a global economic outlook characterized by 'exceptionally high uncertainty' according to the IMF,[124] suggests that volatility in oil markets will continue. Moreover, when global oil demand eventually reaches a structural peak and starts to decline – a moment some forecasters see happening in the next few years, although the timing is highly contested – a cooperative and orderly market adjustment is unlikely. Partly, this is because each producer will naturally be keen to maximize the monetization of its oil resources by 'pumping the last barrel', as industry jargon puts it.

This competition between oil producers to remain in the market for as long as possible is not conducive to market stability. It increases the risk of supply–demand imbalances and sudden price shocks. Furthermore, the lower prices currently forecast in the short term could squeeze out higher-cost producers in the medium term, which in turn could lead to a concentration of global oil supply among a smaller number of the lowest-cost producers in the longer term.[125] In this scenario, an EU still dependent on oil would be potentially exposed to the weaponization of oil supplies, much as it was to Russia's weaponization of gas supplies in 2022.

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122 World Bank Group (2025), *Commodity Markets Outlook: October 2025*, Washington, DC, https://openknowledge.worldbank.org/server/api/core/bitstreams/c579e19c-83a7-4d94-abda-77e4810b4ea4/content.
123 Bulgaria, Croatia, Cyprus, Latvia, Malta, Romania and Slovenia are not members of the IEA; International Energy Agency (2025), 'Oil Stocks of IEA Countries', https://www.iea.org/data-and-statistics/data-tools/oil-stocks-of-iea-countries (accessed 16 Dec. 2025).
124 International Monetary Fund (2025), 'Opportunity in a Time of Change: Speech, Kristalina Georgieva, Managing Director, Annual Meetings 2025, Washington, D.C.', 8 October 2025, https://www.imf.org/en/News/Articles/2025/10/08/sp100825-annual-meetings-2025-curtain-raiser.
125 Graham, R. and Atigui, I. (2024), 'A strong focus on oil security will be critical throughout the clean energy transition', Commentary, International Energy Agency, 11 March 2024, https://www.iea.org/commentaries/a-strong-focus-on-oil-security-will-be-critical-throughout-the-clean-energy-transition.

Policy options

Reduce unnecessary oil demand. The single most effective way for the EU to address the energy security risks from continued crude oil price volatility would be to reduce the amount of oil products member states consume, and therefore states' exposure to market fluctuations. This should begin with reducing use of oil in the transport sector, which accounts for two-thirds of all oil consumed in the EU.[126]

Progress on reducing oil demand has been slow, however. The sharp fall in gas demand following Russia's invasion of Ukraine was not replicated for oil: while gas demand fell by 15 per cent between February 2022 and February 2023, relative to the same period one year earlier, oil demand actually increased by 2 per cent within the same timeframe, returning to levels seen before the COVID-19 pandemic.[127]

No single policy can achieve the change required, but the key measures to reduce oil use are well known.[128] The EU is seeking to push through 'modal shifts' in transport and travel patterns through its Sustainable and Smart Mobility Strategy; this strategy includes a target to double rail freight traffic by 2050.[129] The IEA advocates reducing vehicle speed limits, promoting more efficient use of trucks, discouraging unnecessary business travel, and cutting the cost of public transport relative to private vehicle usage.[130]

A good example of policy innovation in this area is Germany's *Deutschland-Ticket*, introduced in 2023, which entitles holders to unlimited travel across the country's public transport network for a low flat fee. The scheme has proven enormously popular with both the public and politicians: in September 2025, it had 14 million active subscriptions, and was extended to 2030 with unanimous approval from Germany's federal states.[131] Initiatives like *Deutschland-Ticket* have the potential to reduce oil demand, by incentivizing people to switch from driving cars to taking buses, trams and trains. However, such initiatives must be accompanied by robust investment in public transport infrastructure, especially rail networks, to ensure that services offered to travellers can be reliably provided.

Ensure driving an EV is both affordable and practical. Electrifying road transport will also be essential if the European Commission wishes to put oil consumption on a sustainable downwards trend. The prohibitive upfront cost of EVs has slowed the switch from petrol and diesel vehicles, and tariffs on EV imports from China will

126 Eurostat (2025), 'Oil and petroleum products - a statistical overview', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Oil_and_petroleum_products_-_a_statistical_overview#Consumption_in_sectors (accessed 7 Jul. 2025).
127 Suzan, S. and Bounfour, A. (2023), *New oil map: Impact of Russia's war on Ukraine on supply and demand,* Brussels: Transport & Environment, https://www.transportenvironment.org/uploads/files/202307_oil_imports_report_compressed.pdf.
128 Transport & Environment (2022), *How Europe can cut a third of its oil demand by 2030*, https://www.transportenvironment.org/uploads/files/2022August-oil-transport-demand-TE.pdf.
129 European Commission (2021), 'Mobility Strategy', https://transport.ec.europa.eu/transport-themes/mobility-strategy_en.
130 International Energy Agency (2022), *A 10-Point Plan to Cut Oil Use*, 18 March 2022, https://www.iea.org/reports/a-10-point-plan-to-cut-oil-use.
131 Levy, M. (2025), 'Germany ticket: long-term financing secured until 2030', *Urban Transport Magazine*, 18 September 2025, https://www.urban-transport-magazine.com/en/germany-ticket-long-term-financing-secured-until-2030.

exacerbate this.[132] But change is perhaps on the way.[133] European automakers have largely focused on selling high-end EVs to date,[134] but a number of firms launched cheaper models in 2025 as new EU targets have taken effect. These car firms are seeking to keep pace with Chinese manufacturers, which are competitive even with tariffs applied.[135] The trend towards European production of cheaper EVs should continue to push down the prices of EVs and make such vehicles accessible to a wider range of consumers.

However, progress on this front will slow if, as proposed by the commission, the EU weakens its planned 2035 ban on sales of new petrol and diesel vehicles.[136] Allowing the continued sale of internal combustion engine and plug-in hybrid vehicles, even in small quantities, introduces uncertainty for investors in the emerging EV ecosystem, while enabling new investments to be made into manufacturing vehicles that rely on oil rather than electricity.[137]

One way to accelerate the transition would be for EU member states to further shrink the 'electric premium' by offering consumers means-tested purchase subsidies.[138] These subsidies could be combined with other incentives, such as exemptions from road taxes and parking charges; Norway's success in promoting EV adoption illustrates the potential of this approach.[139]

EV sales in the EU are strongly correlated with the availability of charging infrastructure.[140] Consumer incentives should therefore be accompanied by measures to encourage the rapid build-out of public, high-speed EV chargers. The European Commission is supporting this with co-funding of €1 billion for development and installation of charging infrastructure under the Alternative Fuels Infrastructure Facility.[141] The commission should encourage member states to offer their own support measures to ensure even progress across the EU towards the central

132 Aylett, C. (2024), 'Imposing tariffs on Chinese electric vehicles will make the EU's transition slower and more expensive', Chatham House Expert Comment, 13 June 2024, https://www.chathamhouse.org/2024/06/imposing-tariffs-chinese-electric-vehicles-will-make-eus-transition-slower-and-more.
133 European Commission (2025), 'Commission takes action for clean and competitive automotive sector', press release, 16 December 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_3051.
134 Carey, N. and Steitz, C. (2025), 'Automakers debut new EVs, affordable models at Munich car show', Reuters, 8 September 2025, https://www.reuters.com/business/autos-transportation/automakers-debut-new-evs-affordable-models-munich-car-show-2025-09-08.
135 Mathieu, L. (2024), 'What's wrong with electric car prices?', Opinion, Transport & Environment, 23 October 2024, https://www.transportenvironment.org/articles/whats-wrong-with-electric-car-prices.
136 European Commission (2025), 'Commission takes action for clean and competitive automotive sector', press release, 16 December 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_3051.
137 Transport & Environment (2025), 'EU 2035 reversal: playing for time won't make European carmakers great again', press release, 16 December 2025, https://www.transportenvironment.org/articles/t-es-reaction-to-automotive-package.
138 Muehlegger, E. and Rapson, D. S. (2022), 'Subsidizing low- and middle-income adoption of electric vehicles: Quasi-experimental evidence from California', *Journal of Public Economics*, 216, 104752, https://www.sciencedirect.com/science/article/pii/S0047272722001542.
139 OECD (2022), *Norway's evolving incentives for zero-emission vehicles*, https://www.oecd.org/en/publications/ipac-policies-in-practice_22632907-en/norway-s-evolving-incentives-for-zero-emission-vehicles_22d2485b-en.html.
140 European Automobile Manufacturers' Association (ACEA) (2024), 'Interactive map – Correlation between electric car sales and charging point availability (2023 data)', 7 May 2024, https://www.acea.auto/figure/interactive-map-correlation-between-electric-car-sales-and-charging-point-availability-2023-data.
141 European Climate, Infrastructure and Environment Executive Agency (2024), 'CEF Transport Alternative Fuels Infrastructure Facility (AFIF) call for proposal', 29 February 2024, updated 7 March 2025, https://cinea.ec.europa.eu/funding-opportunities/calls-proposals/cef-transport-alternative-fuels-infrastructure-facility-afif-call-proposal_en.

target of the Alternative Fuels Infrastructure Regulation: the presence of a public EV charger with an output of at least 150 kW every 60 kilometres along Europe's major road transport arteries.[142]

An accelerated rollout of public EV charging facilities must be accompanied by robust enforcement of standards introduced by the EU's updated Network and Information Security Directive (NIS 2). NIS 2, which came into force in October 2024, requires operators to adopt cybersecurity risk management measures, report incidents to national authorities, safeguard customer data, and ensure their vendors and service providers comply with the same security standards.[143]

Rollout of low-carbon technology

The problem: high dependence on China

Moving from fuels such as oil and gas to technologies such as solar panels and EVs – though critical to the EU's prospects for achieving future energy security – presents a new set of challenges. The thorniest of these relate to the commanding technological lead and dominance of global markets held by one country – China – for most of the products that the EU needs for its energy transition. The EU sees China as an 'economic competitor' and a 'systemic rival', but also as a 'partner for cooperation'.[144]

There are fears that China might exploit its dominant position as a supplier of energy technology to threaten European energy security in the way Russia did with gas exports in 2022. Amid disputes with trading partners, and citing national security concerns, China imposed (though subsequently loosened) export controls on intermediary products on several occasions in 2025, including on rare earth elements, and on chips needed for automotive manufacturing. The specific risk to the EU's energy security arising from this should not be overstated, however. For one thing, as discussed, the risk profile of renewable energy technology is qualitatively different to that of fuels, as supply interruptions are much less immediately consequential for the former than for the latter. A deliberate curtailment of exports of finished solar panels or batteries from China also seems unlikely, given the country's high production capacity and the importance of such exports for the Chinese economy.[145] Cyber risks seem more pertinent (see 'Strengthening the electricity grid', below).

Nevertheless, it would be prudent for the EU to diversify – to the extent possible – its supplies of finished products such as solar modules, components such as silicon wafers (as envisaged in the Net Zero Industry Act), and raw materials like lithium, in both processed and unprocessed states (as envisaged in the Critical Raw Materials

142 European Union (2023), *Regulation (EU) 2023/1804 of the European Parliament and of the Council*, 13 September 2023, https://eur-lex.europa.eu/eli/reg/2023/1804/oj/eng.
143 European Union (2022), *Directive (EU) 2022/2555 of the European Parliament and of the Council*, 14 December 2022, https://eur-lex.europa.eu/eli/dir/2022/2555.
144 European External Action Service (2023), 'EU-China Relations factsheet', 7 December 2023, https://www.eeas.europa.eu/eeas/eu-china-relations-factsheet_en.
145 Shijia, O. (2024), "New three' paves way for high-quality growth', *China Daily*, 21 February 2024, https://www.chinadaily.com.cn/a/202402/21/WS65d55174a31082fc043b83d7.html.

Act).[146] The Critical Raw Materials Act stipulates that no more than 65 per cent of the EU's annual consumption of a given raw material at any stage of processing should be sourced from a single third country.[147] This is especially important in the context of the current highly uncertain global trade environment.

A more significant risk is simply that Chinese imports will continue to outcompete European-made products, potentially resulting in further factory closures in the EU and damaging the EU's ability to manufacture the products needed for its own transition. Such an outcome could jeopardize the wider energy transition by shrinking the political coalition needed to support it, as businesses would see fewer opportunities in the transition and citizens could associate it with job losses and deindustrialization.

On the other hand, restricting Chinese imports would increase costs for project developers and consumers, potentially constraining the development of sectors like renewable energy installation and maintenance, and ultimately slowing progress towards a more secure energy system. In practice, measures that protect or prioritize domestic production will be more justifiable in some sectors and instances than in others. Combining necessary protections with sufficient market openness to maintain the impetus of the energy transition will be a matter of getting the policy balance right.

Policy options

Provide selective industrial support. The EU's capacity and competitiveness relative to international rivals vary significantly by product in the renewable energy and low-carbon manufacturing sectors. EU-level and member state support for manufacturing needs to be calibrated to the dynamics and needs of each sector. Support for a given product should depend on its strategic importance, economic contribution and industrial viability; decisions will also need to factor in the ways in which local production, relative to importing, contributes to energy security.

In the case of solar panels, industrial support could usefully be geared towards developing the next generation of photovoltaic (PV) modules, which might be based on perovskites or other thin-film technologies to reduce weight and increase efficiency.[148] Although it would also be prudent for the EU to maintain some manufacturing capacity for today's silicon-based panels, mass production of these should not be a policy priority. Rather, policy support should favour innovation.

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146 European Union (2023), *Regulation of The European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act)*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023PC0161; and European Union (2024), *Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1252&qid=1720020986785.
147 European Union (2024), *Regulation (EU) 2024/1252*.
148 Schröder, P. and Aylett, C. (2024), 'How Europe's Solar Industry Can Be Saved', *Foreign Policy*, 22 March 2024, https://foreignpolicy.com/2024/03/22/europes-solar-industry-panels-energy-strategy.

On the other hand, there is good reason to support solar inverter manufacturing in the EU. Inverters are the 'smart', internet-connected parts of solar power systems that receive software updates and transmit data (in contrast to the 'dumb', static panels). Local production of inverters, then, can play a role in mitigating cybersecurity risk in a way that local production of panels cannot. Unlike with panels, the EU has substantial inverter manufacturing capacity: 96.4 GW in 2025, more than enough to supply the 68.7 GW of installations needed annually between 2026 and 2030 to meet the EU's target of 750 GW of solar capacity deployed by the end of the decade.[149] However, local inverter manufacturers have been losing share of the EU market to Chinese competitors in recent years.[150] Cognizant of this, the European Commission has proposed possible measures to 'price in' the advantages of locally produced inverters, including through non-price criteria in renewable energy auctions and public procurement under the NZIA.[151]

Policy support is also needed for the training of solar panel installers and technicians. Work in this area accounts for a far larger share of solar sector jobs (824,000 in 2024, or 95 per cent of the total) than manufacturing does (41,000 jobs, 5 per cent).[152] Where solar power is concerned, it is a lack of qualified people, rather than a lack of panels, that is likely to slow the EU's transition.[153] The European Commission should increase support for skills development programmes in the solar and wind sectors in particular, to avoid the 'green skills gap' becoming a major bottleneck to the EU's transition.[154]

The EU has a significant wind power manufacturing sector, which supplies nearly all of the bloc's equipment needs while also exporting equipment to other markets. The European Commission estimates that the sector could provide up to 936,000 jobs by 2030, more than three times today's total.[155] However, manufacturers in this sector face fierce competition from Chinese companies, and continue to struggle with high capital and supply-chain costs. Policy support should be geared towards ensuring fair competition, predictable long-term returns for developers, and resilient supplies of key inputs such as rare earth magnets.[156] The commission's proposal,

149 SolarPower Europe (2025), *EU Solar Market Outlook 2025-2030*, https://www.solarpowereurope.org/insights/outlooks/eu-solar-market-outlook-2025-2030.
150 Norman, W. (2025), 'Solar inverter market to shrink in 2025-26 amid uncertainty in China, US, EU', PV Tech, 16 December 2025, https://www.pv-tech.org/global-solar-inverter-market-to-shrink-in-2025-26-amid-uncertainty-china-us-eu.
151 European Commission (2025), *Joint Communication to the European Parliament and the Council: Strengthening EU economic security*, 3 December 2025, https://data.consilium.europa.eu/doc/document/ST-16389-2025-INIT/en/pdf.
152 SolarPower Europe (2025), *EU Solar Jobs Report 2025*, https://www.solarpowereurope.org/insights/outlooks/eu-solar-jobs-report-2025.
153 PV Europe (2025), 'Hybrid skills – the key to Europe's solar boom', 20 May 2025, https://www.pveurope.eu/markets/hybrid-skills-key-europes-solar-boom.
154 Emmerling, J., et al. (2025), 'Green jobs and just transition: Employment implications of Europe's Net Zero pathway', Energy Research & Social Science, 127, 104292, https://doi.org/10.1016/j.erss.2025.104292.
155 European Commission (2025), 'In focus: Wind energy powering the clean transition', news article, 17 March 2025, https://energy.ec.europa.eu/news/focus-wind-energy-powering-clean-transition-2025-03-17_en.
156 Patey, L. and Tsang, B. (2025), *Last gasp: Securing Europe's wind industry from dependence on China*, Berlin: European Council on Foreign Relations, https://ecfr.eu/publication/last-gasp-securing-europes-wind-industry-from-dependence-on-china.

under the RESourceEU Action Plan, to restrict exports of rare earth magnet scrap and waste, with the goal of encouraging recycling capacity of this key input within the EU, would be a sensible and practical move.[157]

The EU has seen significant investment in battery manufacturing capacity, and should build on this base as EV usage continues to grow. The automotive sector is a major EU employer, with vehicle manufacturing – internal combustion engine and electric – accounting for 2.6 million direct jobs.[158] Only around one in five cars produced in the EU in 2024 was electric,[159] but this share will grow – albeit at a slower pace than previously forecast if the strong policy signal of the EU's ban on sales of new petrol and diesel vehicles from 2035 is weakened as per the commission's proposal. The EU target, as stipulated in the NZIA, of manufacturing 40 per cent of strategic net zero technologies domestically by 2030 also constitutes a potentially powerful driver of demand.

To be clear, building 'gigafactories' for the assembly of batteries is not enough: the EU will need to strengthen the entire battery supply chain by supporting market development at each stage. This includes cathode and anode production, critical mineral refining and processing, and critical mineral extraction. The need for the EU to diversify its critical mineral supply chain has become clearer in the past year, as China has expanded its export control regime, including by introducing licence requirements for exports of battery components and precursors, rare earth magnets and associated production technologies.[160]

Support global mineral supply-chain governance. As discussed above (see 'New energy dependencies', Chapter 1), the EU's limited geological endowment obliges it to look beyond its borders for raw material inputs. Stockpiling critical minerals, an option being pursued by the European Commission under RESourceEU, offers only a short-term solution and risks increasing price volatility; the commission should also back the development of international governance mechanisms for minerals. Such mechanisms could coordinate supply and demand in a transparent and equitable manner, enabling consumers such as the EU to manage supply-chain risks while protecting resource-rich countries from coercion and ensuring exporting countries access real benefits.[161] Another critical area of focus should be on developing domestic European capabilities and capacity in enhanced recycling techniques, as this will reduce the need for raw material imports (of copper in particular – see 'Strengthening the electricity grid', below) in the long term.

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157 European Commission (2025), 'Commission adopts RESourceEU to secure raw materials, reduce dependencies and boost competitiveness', press release, 3 December 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_2891.
158 European Commission (undated), 'Automotive industry', https://single-market-economy.ec.europa.eu/sectors/automotive-industry_en.
159 Authors' calculation based on International Energy Agency (2025), *Global EV Outlook 2025 – Expanding sales in diverse markets*, https://www.iea.org/reports/global-ev-outlook-2025; and European Automobile Manufacturers Association (2025), *Economic and Market Report - Global and EU auto industry: Full year 2024*, https://www.acea.auto/publication/economic-and-market-report-global-and-eu-auto-industry-full-year-2024.
160 McMorrow, R. and Sevastopulo, D. (2025), 'China unveils sweeping rare-earth export controls to protect 'national security'', *Financial Times*, 9 October 2025, https://www.ft.com/content/c4b2c5d9-c82f-401e-b763-bc9581019cb7.
161 Schröder, P. (2025), 'Rich Countries Stockpiling Critical Minerals Is Not a Plan', *Foreign Policy*, 15 July 2025, https://foreignpolicy.com/2025/07/15/critical-minerals-governance-body-treaty.

Collaborate with non-EU firms. Perhaps the greatest challenge will be ensuring that the EU's low-carbon technology manufacturing sectors keep up with the blistering pace of technological development. Battery chemistries are rapidly evolving, for example.[162] Public and private investment must account for the risk of capital misallocation and stranded assets if investment is directed towards technologies or manufacturing processes that quickly become obsolete. One strategy to mitigate this risk would be to enter more partnerships with leading companies from outside the EU – including Chinese firms. Such an approach would have the potential both to create local jobs and to bring industry in the EU closer to the fast-moving frontiers of technological innovation.

However, the EU should not settle for being an assembly hub: joint ventures with leading non-EU firms must be carefully structured to ensure the exchange of expertise and technology, and to facilitate joint innovation. Joint ventures, where established, should require that operational control remains in the EU; they should also limit foreign data access, as per the General Data Protection Regulation (GDPR) and the NIS 2 Directive on cybersecurity.[163]

Strengthening the electricity grid

The problem: slow grid development constraining potential of renewables and electrification

Europe's energy system was designed largely with combustible fuels in mind. The idea was that homes would be heated by burning gas, that vehicles would be propelled by burning oil, and that electricity would be generated by burning coal (and later by burning gas, as well as by nuclear fission) in large power plants. The electricity produced by these plants was then sent to consumers via national grids and local distribution networks.

Given the EU's need, as this paper has argued, to transition from a fuel-based energy model to a technology-based one, the assumptions on which the energy system has been built need to be updated. Policymakers must plan for a future in which electricity becomes the dominant energy carrier, for example as heat pumps replace gas boilers and as EVs replace vehicles powered by internal combustion engines. A very large share of this electricity will need to be generated from variable renewable sources.

The underlying system required to achieve this vision is not being developed fast enough. Electricity's share of final energy consumption in the EU has stalled in recent years, at around 22 per cent.[164] New renewable energy projects are facing long waits to connect to the electricity grid: as of 2024–25, projects accounting

162 United Nations Conference on Trade and Development (2025), *Changing battery chemistries and implications for critical minerals supply chains*, 14 April 2025, https://unctad.org/publication/changing-battery-chemistries-and-implications-critical-minerals-supply-chains.
163 Tagliapietra, S., Trasi, C. and Sebastian, G. (2025), *A smart European strategy for electric vehicle investment from China*, Bruegel, Policy Brief, Issue No. 21/25, 16 July 2025, https://www.bruegel.org/policy-brief/smart-european-strategy-electric-vehicle-investment-china.
164 Tauschinski, J. and Stylianou, N. (2025), 'How we made it: will China be the first electrostate?', *Financial Times*, 20 May 2025, https://www.ft.com/content/e1a232c7-52a0-44dd-a13b-c4af54e74282.

for 1,700 GW of generation capacity were stuck in connection queues across 16 member states.[165] With European grids unable to absorb all the electricity produced by renewables in member states, this creates opportunity costs while imposing direct financial costs on transmission system operators (TSOs) due to the forced 'curtailment' (i.e. deliberate reduction) of electricity generation. In 2024, management of grid congestion added more than €4 billion to the cost of running the EU's electricity grid.[166]

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One example of the potential consequences of outdated grid infrastructure was the power outage, Europe's largest in two decades, on the Iberian Peninsula on 28 April 2025. A report published by an expert committee set up by the Spanish government found that the blackout had a 'multifactorial origin', with the proximate cause identified as a series of large variations in voltage, inadequately cushioned by voltage-control mechanisms, which triggered a cascade of generator disconnections and cut off Spain's interconnection with France.[167] The blackout brought into sharp focus the importance of a well-planned, well-managed and resilient electricity grid. It is likely no coincidence that Spain invests less in the grid relative to its spending on renewable generation – investing 30 cents in the former for every €1 it spends on the latter – than any other country in Europe.[168]

As Mario Draghi, a former prime minister of Italy and former president of the ECB, emphasized in his report on the future of European competitiveness in 2024, grids are critical enabling infrastructure and their importance to energy security can hardly be overstated.[169] The commission's European Grids Package and accompanying Energy Highways initiative, both proposed in December 2025, represent an important step forward. Significantly, the package introduces a centralized, cross-European dimension to grid planning, an activity which to date has taken place almost entirely at the national level.[170] Modelling by a consortium of European think-tanks found that investment coordination and independent

165 Beyond Fossil Fuels (2025), *How Europe's grid operators are preparing for the energy transition*, May 2025, https://beyondfossilfuels.org/wp-content/uploads/2025/05/REPORT_FINAL.pdf.
166 Includes costs incurred in Norway as well as the EU27. European Union Agency for the Cooperation of Energy Regulators (2025), *Transmission capacities for cross-zonal trade of electricity and congestion management in the EU*, 5 September 2025, https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER-Monitoring-Report-2025-crosszonal-electricity-trade-capacities.pdf.
167 Council of Ministers of Spain, La Moncloa (2025), 'The Government of Spain presents the report on the causes of the blackout, which was due to a "multifactorial" surge', press release, 17 June 2025, https://www.lamoncloa.gob.es/lang/en/gobierno/councilministers/paginas/2025/20250617-council-press-conference.aspx.
168 Millan, L. and Mathis, W. (2025), 'Before Blackout, Spain's Power Grid Investment Lagged Solar Boom', Bloomberg, 3 May 2025, https://www.bloomberg.com/news/articles/2025-05-03/spain-s-power-grid-spending-has-fallen-behind-as-solar-boomed.
169 European Commission (2024), *The Draghi report on EU competitiveness*.
170 European Commission (2025), 'Commission proposes upgrade of the EU's energy infrastructure to lower bills and boost independence', press release, 10 December 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_2945.

top-down planning would significantly reduce the amount of infrastructure needed to transform the EU's energy system in line with decarbonization goals, and could bring down total costs to 2050 by as much as €750 billion.[171]

Policy options

Promote best practice in connection processes. As the European Commission recognizes, the most pressing priority is to speed up permitting processes for new grid infrastructure – a highly complex challenge involving myriad stakeholders and trade-offs, notably around local environmental impacts. The European Grids Package includes legislative proposals to address this, including by streamlining environmental assessments and introducing time limits for permitting processes. However, getting the infrastructure built is only part of the challenge. Europe's TSOs, with the support of member state governments, need to update the processes for connecting generation sources to the grid, and expand the use of scenario planning to ensure these operations facilitate, rather than constrain, rapid development of the energy system. Reforming legacy connection processes would reduce the time taken for genuine projects to connect to the grid, by preventing speculative projects with little chance of being built – so-called 'zombie projects' – from taking up space in the queue. Revising outdated national energy plans to account for increased use of renewables – and integrating market and technological trends in such plans – would permit anticipatory investment in the grid. With many examples of good practice already on display across the EU, the European Commission needs to coordinate such efforts and ensure the lessons from them are understood and widely communicated.[172]

Support copper recycling. Policymakers must pay close attention to the evolving demand for materials that the grid's expansion will necessitate. According to Eurelectric, the distribution grid that serves the EU27 plus Norway will need to grow from 10 million kilometres of cables today to nearly 17 million kilometres by 2050, and the number of transformers will need to double, just to meet the EU's existing energy transition goals;[173] this will require large quantities of copper. With resistance to new mines, including copper mines, growing around the world, and with global copper supply increasingly falling short of demand,[174] the EU needs to boost its already impressive rates of copper recycling.[175] Options might include incentivizing increased end-of-life collection and designating new recycling facilities as favoured 'strategic projects' under the Critical Raw Materials Act, as has been done with Atlantic Copper's 'CirCular' project in southwest Spain.[176] Such efforts

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171 Agora Energiewende et al. (2025), *Designing energy infrastructure for a climate-neutral Europe. Solutions for cost-effective system development*, https://www.agora-energiewende.org/publications/designing-energy-infrastructure-for-a-climate-neutral-europe.
172 Beyond Fossil Fuels (2025), *How Europe's grid operators are preparing for the energy transition*, May 2025, https://beyondfossilfuels.org/wp-content/uploads/2025/05/REPORT_FINAL.pdf.
173 Eurelectic (2024), 'Why the distribution grid must be a critical enabler of Europe's energy transition', 24 May 2024, https://www.eurelectric.org/in-detail/distributiongridsforspeed.
174 International Energy Agency (2025), *Global Critical Minerals Outlook 2025*, 21 May 2025, https://www.iea.org/reports/global-critical-minerals-outlook-2025.
175 International Copper Association (2020), 'Circularity and Recycling in the EU', 9 November 2020, https://internationalcopper.org/resource/circularity-and-recycling-in-the-eu.
176 European Union (2024), *Regulation (Eu) 2024/1252 of the European Parliament And Of The Council*, 11 April 2024, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1252; and Atlantic Copper (2025), 'The European Commission declares Atlantic Copper's CirCular project strategic', 27 March 2025, https://atlantic-copper.es/en/the-european-commission-declares-atlantic-coppers-circular-project-strategic.

should be accompanied by full implementation of the EU Circular Economy Action Plan, including legislating for product lifetime extensions, remanufacturing and refurbishment, to reduce the need for primary copper extraction.[177]

Boost cybersecurity. Cybersecurity will need to be a priority for EU policymakers as the electricity grid becomes larger and more digitalized, as more generation assets connect to it, and as the number of connected devices grows. A coordinated, 'resilient by design' approach should guide the energy system's development. Modernization and expansion of the ageing European grid will provide an opportunity to make the energy system more secure from the ground up, for example by integrating state-of-the-art network architecture principles so that unstable, damaged or compromised zones of the grid can be temporarily isolated.[178]

Regulatory gaps will also need to be filled. Recent cybersecurity regulation, such as the EU's Cyber Resilience Act, is insufficiently tailored to the specificities of renewable energy. Nor does such regulation address the cybersecurity risks associated with the use of distributed networks of small-scale generation assets such as rooftop solar panels.[179]

Remote operational access to devices (such as solar inverters and wind turbine controllers), software hosting and access to operational data should be restricted by default to entities in the EU or other jurisdictions that can, at a minimum, guarantee equally strong security protocols and enforcement. Access to equipment, systems and data by non-EU entities should be permitted on a highly selective basis, for tasks essential to a product's safe operation, such as critical system updates. These conditions could be enforced by the European Commission under the auspices of the EU's Network Code on Cybersecurity, which aims to establish 'a European standard for the cybersecurity of cross-border electricity flows'.[180] Access conditions could also be included in pre-qualification criteria for renewable energy auctions under the NZIA.[181]

Invest in flexibility. A flexible electricity grid will be better equipped to smooth out imbalances in supply and demand. This should help to reduce the likelihood and severity of price spikes, and contribute to lower and more predictable electricity bills for households and businesses.

Energy storage, such as grid-scale battery storage, is central to ensuring flexibility in systems based on variable sources of renewable energy. An electricity system must balance supply and demand in real time, which means ensuring that energy storage, alongside transmission and interconnector capacity (see below), keeps pace with new solar and wind generating capacity. Otherwise, when supply is high and demand is low, renewable generation is curtailed, or electricity consumers are

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177 European Commission (2020), *A new Circular Economy Action Plan*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0098.
178 Kresja, H. (2025), *Sun shield: how clean tech and America's energy expansion can stop Chinese cyber threats*, Pittsburgh: Carnegie Mellon Institute for Strategy and Technology, January 2025, https://www.cmu.edu/cmist/tech-and-policy/sun-shield/white-paper-krejsa-jan25.pdf.
179 SolarPower Europe (2025), *Solutions for PV Cyber Risks to Grid Stability*, April 2025, https://www.solarpowereurope.org/insights/thematic-reports/solutions-for-pv-cyber-risks-to-grid-stability.
180 ENTSO-E (undated), 'Network Code on Cybersecurity', https://www.entsoe.eu/network_codes/nccs.
181 Patey, L. and Tsang, B. (2025), *Last gasp: Securing Europe's wind industry from dependence on China*, Berlin: European Council on Foreign Relations, https://ecfr.eu/publication/last-gasp-securing-europes-wind-industry-from-dependence-on-china; SolarPower Europe (2025), *Solutions for PV Cyber Risks to Grid Stability*.

offered extremely low, or even negative, prices to take the surplus and maintain grid stability. Lags in storage additions and in the expansion of grid capacity led to electricity prices falling below zero for a record number of hours in 2025.[182] Negative prices can benefit some consumers – such as those with home battery systems or on variable tariffs – and professional electricity traders, but this reduces the appeal of future private investment in renewables.[183]

As the share of electricity generated from renewables in the EU grows, grid managers will need to be able to store energy for longer periods – days, weeks, months and even seasons.

As the share of electricity generated from renewables in the EU grows, grid managers will need to be able to store energy for longer periods – days, weeks, months and even seasons. Yet the average storage duration of battery projects in Europe was 2.5 hours in 2024.[184] The EU should focus its industrial support on the development and deployment of viable long-duration energy storage solutions, such as flow batteries. National regulatory frameworks must also enable operators of energy storage assets to participate in ancillary services and capacity markets; this is not currently the case in all EU member states.[185]

The supply-side flexibility provided by storage will need to be coupled with demand-side flexibility. This will involve the use of measures to shift consumption towards periods when electricity is abundant, thereby providing consumers with the same energy services while placing less pressure on capacity. This would contribute to the stability of the energy system and reduce costs.

One way to improve demand-side flexibility would be to expand the use of 'smart metering'. Smart meters provide real-time price signals that incentivize households and industrial consumers to use electricity when it is cheapest (e.g. when renewable generation is highest) and to avoid using it when it is expensive (when there is little renewable generation). Smart meter adoption rates vary greatly across the EU. In Denmark and Italy, practically all households have smart meters, whereas in Germany and Czechia the rate of adoption is less than 5 per cent.[186] A consequence of this is higher running costs for electric alternatives to fossil fuels, reducing the incentive for consumers to switch. One study found that German drivers switching from petrol vehicles to EVs can expect to save on average £970 (€1,106) a year, but that in Britain, where smart meter penetration is 70 per cent, drivers can expect

182 Farhat, E. (2026), 'Europe saw record surge in negative power prices in 2025', Bloomberg, 5 January 2026, https://www.bloomberg.com/news/articles/2026-01-05/europe-saw-record-surge-in-negative-power-prices-in-2025.
183 Tani, S. and Millard, R. (2024), 'Negative European energy prices hit record level', *Financial Times*, 14 September 2024, https://www.ft.com/content/1f94d0b4-c839-40a2-9c8d-782c00384154.
184 Tosoni, J. (2025), *European Market Monitor on Energy Storage (EMMES) 9.0*, Brussels: European Association for Storage of Energy, March 2025, https://ease-storage.eu/publication/emmes-9-0-march-2025.
185 Martins, E. (2025), 'Mapping Europe's battery storage potential for 2025', Synertics, 23 May 2025, https://synertics.io/blog/190/mapping-europe-battery-storage-potential-for-2025.
186 European Union Agency for the Cooperation of Energy Regulators (2024), *Energy retail – Active consumer participation is key to driving the energy transition: how can it happen?*, 30 September 2024, https://www.ceer.eu/wp-content/uploads/2024/09/ACER-CEER_2024_MMR_Retail-1.pdf.

to save over £1,500 (€1,710).[187] The European Commission, in its Action Plan for Affordable Energy, has emphasized the need for member states to accelerate deployment of smart metering.[188] Member states will also need to ensure that consumers are aware of the economic benefits of flexible energy consumption and have access to a range of dynamic pricing contracts.[189]

Increase interconnection capacity. High-voltage cross-border cables, known as interconnectors, have a crucial role to play in the energy transition. By enabling surplus electricity to be traded between national grids, interconnectors facilitate grid balancing and flexibility, temper price volatility and reduce costs. They also allow countries to import electricity and avoid blackouts in times of crisis. Britain's grid supplied France with 10 TWh of electricity in 2022 when half of France's nuclear reactors were taken offline for scheduled maintenance and unscheduled repairs.[190] Interconnectors helped Poland avoid major blackouts in 2020 and 2021.[191] Interconnectors have also been an important part of European support for Ukraine amid the ongoing destruction of the latter's energy infrastructure by Russia.

The European electricity system had interconnection capacity of 116 GW in 2024. Based on planned projects, this is expected to reach 167 GW by 2030. However, interconnection capacity will then need to almost double between 2030 and 2040, to 318 GW, to fully meet the anticipated needs of Europe's growing electricity system.[192] Electricity interconnectors are increasingly a target for sabotage, particularly in the Baltic Sea; security for this critical infrastructure should be prioritized. The European Commission's Action Plan on Cable Security, published in February 2025, proposes a number of measures, including: an integrated surveillance mechanism to coordinate the efforts of affected member states and private operators; an air, surface and underwater drone surveillance programme; and enhanced operational cooperation with NATO in response to attacks.[193]

The EU should also seek to maximize the energy security benefits of its interconnections with the UK. This must involve finalizing post-Brexit bilateral electricity trading arrangements, and resolving looming issues between the respective EU and UK carbon border adjustment mechanisms (CBAMs). Divergent

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187 Walker, C. (2025), '"Smart' British EV drivers saving more than German counterparts – analysis', Energy & Climate Intelligence Unit, 4 December 2025, https://eciu.net/media/press-releases/2025/smart-british-ev-drivers-saving-more-that-german-counterparts-analysis; and Department for Energy Security and Net Zero (2025), *Smart meters in Great Britain, quarterly update September 2025*, 27 November 2025, https://www.gov.uk/government/statistics/smart-meters-in-great-britain-quarterly-update-september-2025. Exchange rate: 1.1401 from https://www.investing.com/currencies/gbp-eur (accessed 12 Dec. 2025).
188 European Commission (2025), *Action Plan for Affordable Energy*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0079&qid=1741780110418.
189 European Union Agency for the Cooperation of Energy Regulators (2024), *Energy retail – Active consumer participation*.
190 Messad, P. (2023), 'Electricity exporter for 42 years, France became a net importer in 2022', Euractiv, 16 February 2023, https://www.euractiv.com/section/electricity/news/electricity-exporter-for-42-years-france-became-a-net-importer-in-2022; and Day, J., Phillips, G. and Wilson, G. (2023), 'Britain is a net electricity exporter for first time in 44 years', UK Energy Research Centre, 18 January 2023, https://ukerc.ac.uk/news/britain-net-electricity-exporter.
191 Czyzak, P. (2025), *New lines of defence: how interconnectors keep the lights on*, London: Ember Energy, 24 September 2025, https://ember-energy.org/latest-insights/new-lines-of-defence-how-interconnectors-keep-the-lights-on.
192 Geneletti, G. and Cremona, E. (2025), *Money on the line: scaling electricity interconnection for Europe's energy future*, London: Ember Energy, 1 December 2025, https://ember-energy.org/latest-insights/money-on-the-line-scaling-electricity-interconnection-for-europes-energy-future.
193 European Commission (2025), *Joint Communication to the European Parliament and the Council: EU Action Plan on Cable Security*, 21 February 2025, https://digital-strategy.ec.europa.eu/en/library/joint-communication-strengthen-security-and-resilience-submarine-cables.

treatment of electricity under the two schemes risks impeding growth in low-carbon energy flows and limiting the benefits for grid management and efficient energy trade.[194] At the EU–UK summit in May 2025, the two sides agreed to pursue efforts to link their emissions trading systems (ETS's), which would exempt each party from the other's CBAM, as well as to explore possible UK participation in the EU's internal electricity market.[195] EU–UK negotiations on linking their ETS's formally opened in the autumn of 2025, providing a tangible opportunity to make progress on this front.

Interconnectors can make a greater contribution to energy security if they are integrated with wind generation capacity to form 'offshore hybrid assets' (OHAs). OHAs enable clusters of offshore wind farms to be connected to the electricity grids of multiple countries, reducing the need for new infrastructure, facilitating more efficient electricity trading, and potentially enabling the creation of 'energy islands', where surplus electricity can be converted into green hydrogen.[196] This approach is particularly promising in the North Sea, offering an opportunity for the EU and the UK to capitalize on the increased political will for cooperation on the energy transition.

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194 Aylett, C., Froggatt, A. and Xie, C. (2024), *The United Kingdom's Strategy for Carbon Border Adjustment in a Changing Global Landscape*, Manitoba: International Institute for Sustainable Development, https://www.iisd.org/system/files/2024-07/border-carbon-adjustments-united-kingdom.pdf.
195 Cabinet Office (2025), 'UK-EU Summit - Common Understanding', Policy Paper, updated 19 May 2025, https://www.gov.uk/government/publications/ukeu-summit-key-documentation/uk-eu-summit-common-understanding-html.
196 National Grid (undated), 'Offshore Hybrid Assets', https://www.nationalgrid.com/national-grid-ventures/interconnectors-connecting-cleaner-future/offshore-hybrid-assets.

04 Conclusion

Smooth progress on the EU's energy transition is not guaranteed, and political and market-related risks abound. But for each potential objection to the transition, our analysis still leads to the inescapable conclusion that renewables and electrification offer the most logical and effective solution to the EU's energy security challenge.

The EU made substantial headway with its energy transition during the first term (2019–24) of European Commission President Ursula von der Leyen, with positive results for the bloc's energy security. During the first year of her second term, there has been an impressive array of plans and packages designed to embed and advance that transition; these have included the Clean Industrial Deal, the Action Plan for Affordable Energy, the REPowerEU roadmap and the European Grids Package.

The EU is on track to reduce gas demand to 1,615 TWh a year by 2030, in line with the ambitious target of the 2022 REPowerEU plan – this level of aggregate demand could, in theory, be satisfied by existing domestic production and pipeline imports, with no LNG imports required.[197]

Growth in wind and solar generation on the supply side, and in the market penetration of heat pumps on the demand side, has been steadily pushing up the share of renewable sources in total EU energy consumption – albeit at a slower pace than is needed to meet the revised Renewable Energy Directive target of at least 42.5 per cent by 2030.[198]

Continued progress is far from guaranteed, however. The European Commission's ambition is not shared by all member states: there is growing resistance in some capitals to various aspects of the Green Deal policy programme, amid fears that such policies risk hurting industry and pushing up energy prices. Indeed, with energy

197 Jugé, M., McWilliams, B. and Zachmann, G. (2025), 'European natural gas demand tracker', Bruegel, https://www.bruegel.org/dataset/european-natural-gas-demand-tracker (accessed 17 Nov. 2025).
198 European Environment Agency (2025), 'Share of energy consumption from renewable sources in Europe', 6 November 2025, https://www.eea.europa.eu/en/analysis/indicators/share-of-energy-consumption-from.

prices stubbornly high, and industrial competitiveness a widespread concern, the possibility of lower prices provides a seductive rationale for reopening Russian gas pipelines in the event of a negotiated settlement to the conflict in Ukraine. European auto giants, and member states such as Germany and Italy, successfully lobbied the commission to water down the EU's planned 2035 ban on sales of internal combustion engine vehicles, a development that – if agreed by the European Parliament and national governments – could slow the electrification of road transport and prolong the EU's exposure to volatile international oil prices. Efforts to dilute planned reforms to the EU's compliance carbon market, including by some actors within German industry,[199] risk depriving member states of crucial revenue to invest in renewable energy and electrification.

Until 2029 at the earliest, the European Commission and member states can expect to come under pressure from the US administration in Washington, and from US energy companies, to buy more American energy exports. It will be challenging, to say the least, to meet the commitment to massively ramp up spending on fuels from across the Atlantic in a way that is not inherently detrimental to the EU's energy security. Such a commitment risks sharply increasing reliance on one country and absorbing fiscal resources that might otherwise be directed at the technologies and infrastructure needed for a more secure energy system. Much depends on how strictly the $750 billion spending pledge is enforced by the US, and on the coercive tools the US administration is prepared to apply. As the distinctly one-sided US–EU trade deal made painfully clear, the US retains considerable leverage over the EU, with the power to hike tariffs and reduce security commitments.

The extent to which low-carbon technology supply chains are implicated in trade turbulence, or become collateral damage, represents another critical uncertainty in the EU's transition. European industry is experiencing ever stronger competition from China across a growing range of sectors, which suggests that tensions between the two trading powers are unlikely to subside in the near future.[200] Trade defence investigations, in both directions, have proliferated in recent years.[201] Measures by the EU to protect domestic industry from Chinese imports could constrain the supply of lowest-cost low-carbon technologies, slowing the transformation of the energy system and making that transformation more expensive. Chinese export controls on raw materials, components or production technologies could hurt the EU's ability to manufacture its own equipment.

Structural shifts in global energy markets, in combination with adverse macroeconomic conditions, could dampen the economic rationale for the shift to renewables. In the case of gas and oil, if global demand begins to fall while supply remains robust, all else being equal, there may be extended periods of lower prices,

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199 Kurmayer, N. J. (2025), 'Is Europe's biggest economy turning against carbon pricing?', Euractiv, 13 October 2025, https://www.euractiv.com/news/is-europes-biggest-economy-turning-against-carbon-pricing.
200 Colijn, B. and Brzeski, C. (2025), 'Rising trade tensions unveil Europe's China shock 2.0', ING, 5 November 2025, https://think.ing.com/articles/europes-china-shock-20.
201 Yu, J. (2025), 'China–EU summit is unlikely to improve relations amid key differences on trade and Ukraine war', Chatham House Expert Comment, 24 July 2025, https://www.chathamhouse.org/2025/07/china-eu-summit-unlikely-improve-relations-amid-key-differences-trade-and-ukraine-war.

encouraging greater usage by consumers, and complacency among policymakers.[202] In the case of renewable energy deployment, if supply chains tighten and interest rates increase, the total cost of projects will be driven up, reducing their appeal for developers and increasing costs for consumers.

None of the above, however, alters the underlying energy security case for the EU making an accelerated shift to a system based on renewables and electricity. Proven reserves of oil and gas across the 27 member states fall far short of current aggregate demand, and prospects for new extraction are limited by both geology and economics. This translates into a heavy structural reliance on imports, exposing the EU to supply shocks and price risks associated with international energy markets. This dependence on fuels, especially gas, from countries which may not share the EU's goals and may be actively hostile to them constrains the EU's ability to exercise its prized 'strategic autonomy'. Such dependence also threatens the EU's status as a regulatory superpower, as evidenced by the suggestion from the US and Qatari energy ministers that their energy companies may no longer export LNG to the EU if corporate sustainability rules are not rolled back.[203]

Dependence on fuels, especially gas, from countries which may not share the EU's goals and may be actively hostile to them constrains the EU's ability to exercise its prized 'strategic autonomy'.

Reducing the dependence on imported fossil fuels, gas in particular, requires scaling up the use of energy from other sources. Nuclear power is a crucial part of the EU's energy mix, accounting for nearly a quarter of electricity generation in 2024, and some consider increasing this share to be the most promising path to greater energy security. This ambition is, however, constrained by the extremely high costs and long, uncertain timeframes characteristic of new nuclear builds, and by the fact that most of the EU's existing nuclear power plants are reaching the end of their operational life. In the coming decades, simply maintaining the current level of generation capacity will prove challenging.

This leaves renewable energy, which in recent years has seen strong growth in the EU. Renewables are primarily associated with mitigating climate change, but there is increasing recognition of their role in energy security. It is harder for an adversary to disrupt a large, distributed network of machines converting wind and sun into electricity than it is to close a pipeline or cause LNG or oil shipments to be redirected. It is also more difficult and less cost-effective to destroy thousands of wind turbines and solar panels than it is to use a missile to knock out a single power plant. As renewable energy technology costs have fallen, so too has the cost of the electricity they produce, and renewables – which unlike fossil fuels, produce

202 Kennedy, S. (2025), 'Scarcity, abundance and urgency: How natural gas prices dictate the pace of energy transition', Energy Flux, 23 December 2025, https://www.energyflux.news/scarcity-abundance-and-urgency-how-natural-gas-lng-prices-dictate-pace-of-transition.
203 U.S. Department of Energy (2025), 'U.S. Energy Secretary and Qatari Energy Minister Send Letter to EU Regarding Proposed Corporate Climate Regulations'.

at zero marginal cost – are generally the most economic option. Wind and solar, with variable but predictable output, also offer an opportunity to escape the price volatility of internationally traded fossil fuels.

But as this paper has argued throughout, growth in renewable energy production must be accompanied by growth in electrification, whereby energy services conventionally provided by fossil fuels are provided by electric alternatives, and grids are expanded and upgraded, making the electricity system the basis of the energy system to a much greater degree. Electrification can enhance energy security through more efficient use of energy resources: EVs use half the energy of their internal combustion engine counterparts,[204] and digitized electricity grids permit the deployment of demand-response technologies that enable smarter management of supply. Crucially for energy security, electrification means that energy needs, such as transport and heating, currently met largely by imported fossil fuels can be fulfilled by domestic renewables instead.

A larger role for electricity comes with its own set of challenges for the EU. Ensuring 'electricity security' (see Box 2) as the system grows will require coordinated system-level planning to manage the variability of renewable energy generation, with increased deployment and use of flexibility assets such as battery storage. It will also require increasing the capacity of interconnectors that allow national grids to trade electricity – among EU member states, as well as with neighbours such as Norway and the UK – without creating new dependencies. The central challenge will be ensuring the integrity of the electricity delivery network: essentially, ensuring that there are no blackouts. Grids will need to expand in line with additions of renewable generation, with sufficient dispatchable capacity (battery storage and, in the short and medium term, gas-fired power) available when needed. Physical infrastructure must be made resilient to sabotage and the worsening impacts of climate change; digital infrastructure will need to be resilient to cyberattacks.

Moving towards greater energy security through renewables and electrification will require decisive action across several fronts. This paper has identified a non-exhaustive set of priority actions, across four categories (see Chapter 3), that will help to make pursuit of energy security – in the fullest sense – a strategic guiding principle for the EU as it navigates an uncertain future. The challenges, especially fiscal challenges, will be substantial: the costs of a transition from fuels to infrastructure and technologies are inevitably frontloaded. But the EU must find a way to make the investments needed today to build the lower-cost energy system of tomorrow – one that is more efficient, resilient and secure.

204 Kirk (2024), 'Electric vehicles use half the energy of gas-powered vehicles'.

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Cover image: Technicians arrive at the power substation in Rezekne, Latvia to disconnect the major power line between Latvia and Russia on 8 February 2025.
Photo credit: Copyright © Gints Ivuskans/AFP/Getty Images

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