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Geopolitics and Europe's Natural Gas Supply

Aspects and Consequences from a Gas and Electricity Markets Perspective

The Russian invasion of Ukraine led to extreme disruptions on the international energy markets. Europe, the world's largest importing region for oil, natural gas and hard coal, was particularly affected. The loss of major supply routes for Russian natural gas created a bottleneck situation and restricted short-term diversification potential. Three years after the supply shocks of 2022, although the European Union was able to overcome the situation together, the quest to diversify European natural gas supplies remains in many cases a balancing act between existing and new dependencies, still distant from the objective of crisis-resilient energy sovereignty.

The upheavals in the wake of Russia's war of aggression against Ukraine represented a turning point for energy markets far beyond the European Union. Structures and supply relationships that were believed to be secure abruptly revealed dependencies that had developed over a long period of time. With dependence on Russian energy imports out of the question, the diversification of European natural gas supplies became a central joint task for the EU27, which had agreed on a series of sanctions packages against Russia. The electricity markets were also significantly affected. This was reflected in extreme price swings on the wholesale electricity market, which were the result of the tense situation in the natural gas market.

Current natural gas supply flows to Europe

In 2021, the last year before Russia's invasion of Ukraine, natural gas consumption in the EU amounted to 421 bil-

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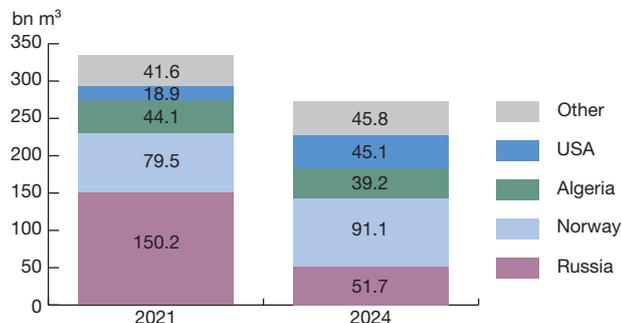
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lion m³, equivalent to 24% of total European energy consumption. In 2021, a total of 334.3 billion m³ of natural gas was imported into the EU27, of which around 45% came from Russian natural gas supplies, as shown in Figure 1 (European Commission, 2025a). At 332 billion m³, EU natural gas consumption in 2024 was 21% lower than in 2021. Natural gas imports have fallen by 18% since 2021 to 272.9 billion m³ in 2024. Supplies from Russia still accounted for 18.9% of total EU gas imports in 2024 (European Commission, 2025a). The decline compared to 2021 was mainly due to a sharp increase in liquefied natural gas (LNG) imports from the US. Almost 45% of total LNG supplies to the EU came from the US in 2024 (Strategic Insights, 2025).

Figure 2 shows the most important LNG import routes in the EU, as well as the locations of the relevant terminal infrastructure; a distinction is made between LNG terminals in regular operation, under construction and planned or proposed. The central part of the LNG infrastructure consists of 33 large LNG terminals in regular operation, each with an annual regasification capacity of over 0.7 billion m³ (N) (Gas Infrastructure Europe [GIE], 2025; Global Energy Monitor [GEM], 2025).

The total annual regasification capacity of all large-scale terminal facilities in the EU27 in regular operation is 215 billion m³; of this, 153 billion m³ or 71% is accounted for by stationary onshore facilities and 62 billion m³ or 29% by floating storage and regasification units (FRSUs) (GIE, 2024). A further 22 billion m³/a is under construction and 78 billion m³/a is in the planning stage. Across Europe, a further 100 billion m³/a of active regasification capacity

Figure 1
Natural gas imports into the EU27 in 2021 and 2024



Sources: European Commission, ENTSO-G, LSEG.

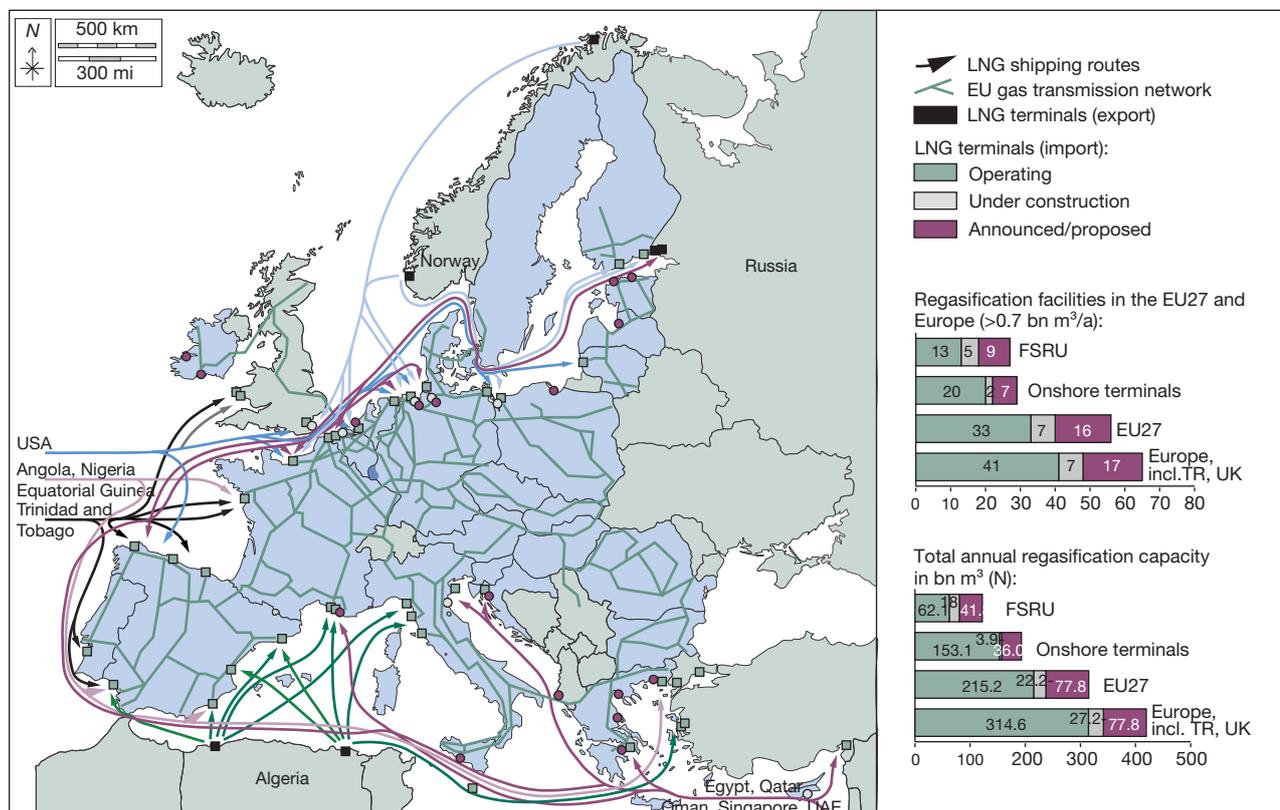
and 5 billion m³/a under construction will be added (GIE, 2024). The EU member states with the largest active regasification capacities include Spain (67 billion m³/a), France (40 billion m³/a), Italy (21 billion m³/a), the Netherlands (20 billion m³/a), Belgium (15 billion m³/a) and Germa-

ny (14 billion m³/a) (GIE, 2024). However, with an additional 11 billion m³/a under construction and a further 19 billion m³/a in planning, Germany leads the ranking of projected regasification capacities in Europe (GIE, 2024).

The main tanker routes for supplying LNG to Europe are the shipping routes through the North Sea and Baltic Sea from Norway and Russia, across the Atlantic from the US and Trinidad and Tobago, along the African coast from Angola, Equatorial Guinea and Nigeria, and through the Mediterranean from Algeria, Egypt, Qatar, Oman, Singapore and the United Arab Emirates. LNG deliveries from Qatar, Oman, Singapore and the United Arab Emirates must continue to pass through the Suez Canal and the Strait of Hormuz and are therefore subject to geopolitical tensions.

A basic distinction can be made on the global natural gas market between net export regions and net import regions. Net export regions include Africa, Australia, the Middle East, North America and Russia (Rystad Energy, 2023, p. 134). On the consumer side, the net

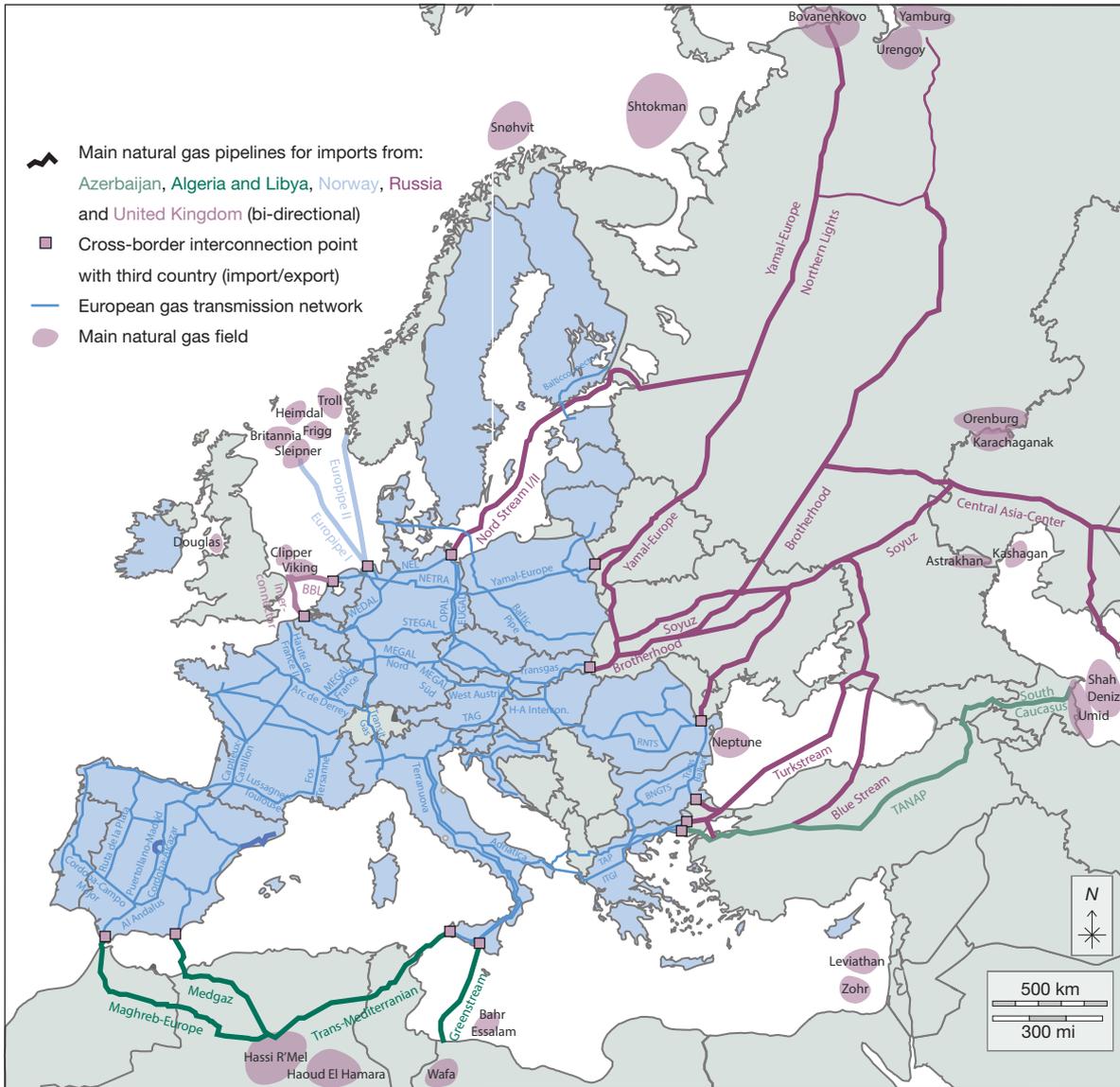
Figure 2
European liquefied natural gas infrastructure and import routes, 2025



Note: FSRU: Floating storage and regasification units.

Sources: BDEW, ECFR, Eurogas, GEM Project, Rystad Energy, Base map: d-maps.

Figure 3
Pipeline infrastructure and main sources of pipeline gas imports to the EU27



Sources: BDEW, GEM Project, GIE, IFRI, Base map: Mapchart.

import regions of Asia and Europe dominate as highly import-dependent regions (Rystad Energy, 2023, p. 134). Figure 3 provides a regional overview of Europe’s pipeline-based natural gas supply, the border crossing points into the European interconnected network and significant natural gas reserves in the main supplier countries. A distinction is made between five key supply regions: Russia, North Sea I (Norway), North Sea II (United Kingdom), North Africa (Algeria and Libya) and the Caspian Corridor (Azerbaijan) (European Commission, 2024).

Natural gas from the large Norwegian gas fields Frigg, Heimdal, Sleipner and Troll is transported to the EU via Europipe I (13 billion m³/a) and Europipe II (21 billion m³/a) through the Dornum border crossing point in Germany. With regard to natural gas flows from the United Kingdom, it should be noted that the two pipelines Balgzand Bacton Line (BBL) (19 billion m³/a) and Interconnector (25.5 billion m³/a), which connect the British Isles to the Netherlands, can be used bi-directionally, meaning that gas flows to and from the European mainland are possible. Supplies from North Africa are divided into natural gas flows from Algeria

and Libya. Algerian natural gas from the Hassi R'Mel and Haoud El Hamara gas fields reaches the border crossing points to Spain via the Maghreb-Europe (12 billion m³/a) and Medgaz pipelines (10.7 billion m³/a), while Libyan natural gas from the Bahr Essalam and Wafa gas fields reaches Italy via the Greenstream Pipeline (11 billion m³/a) (GIE, 2024).

Azerbaijan's most important natural gas fields are Shah Deniz and Umid, which are connected to the EU via the South Caucasus Pipeline (24 billion m³/a) and the Trans-Anatolian Gas Pipeline (TANAP) (24 billion m³/a), with border crossing points into the European gas network located on the Turkish-Greek and Turkish-Bulgarian borders (GIE, 2024). Azerbaijan's potential supply volume is limited by the capacity of the pipeline connections to Europe, therefore an expansion of TANAP capacity to 31 billion m³ is planned by 2026 (GEM, 2025). The remaining Russian natural gas flows reach the EU27 via the Turkstream (31.5 billion m³/a) and Bluestream (16 billion m³/a) pipelines (Rystad Energy, 2023, p. 81). The most important Russian production areas for European natural gas supplies included the Bovanenkovo gas field, via Yamal-Europe and Northern Lights, the Urengoy and Yamburg gas fields via Brotherhood and Soyuz, and Orenburg via Soyuz.

New dependencies vs. diversification

The energy targets of the EU member states envisage achieving complete independence from Russian natural gas by 2027, while at the same time phasing out imports of oil and nuclear fuels. A key pillar for meeting this target is the massive expansion of LNG imports and, above all, the purchase of LNG from the US. However, this shift towards US gas harbours the potential for new dependencies. With Donald Trump's re-election, just a few months after his return to the White House, a new threat emerged to the EU's energy security, in which the new dependence on LNG imports became a bargaining chip to pressure the EU into making far-reaching trade concessions (Strategic Insights, 2025). At the same time, by re-establishing unilaterally dominant supply relationships, the EU is paving the way for the US to become an energy superpower.

The agreement reached on 27 July 2025 in Prestwick, Scotland, in the latest customs and trade conflict between the EU and the US includes commitments to purchase US energy worth US \$750 billion in the period up to 2028 (European Commission, 2025b). The White House fact sheet states that the agreement would strengthen the US dominance in the energy sector, reduce Europe's dependence on hostile sources and reduce the US trade

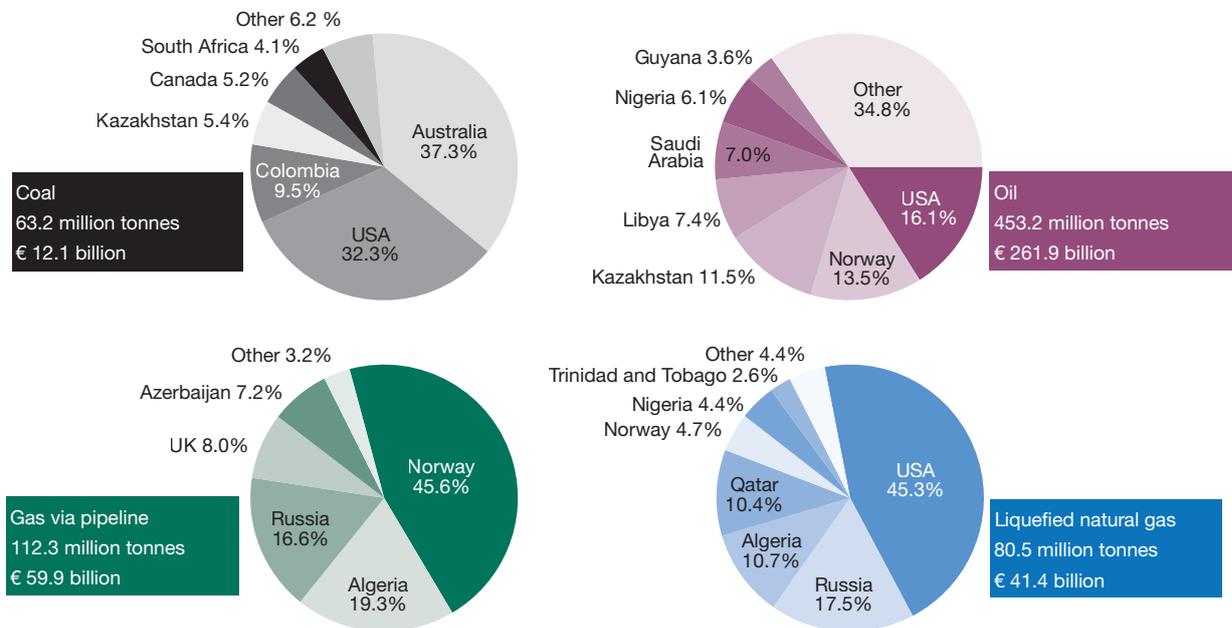
deficit with the EU (The White House, 2025). EU Commission President Ursula von der Leyen, on the other hand, emphasised the expansion of energy cooperation in a communiqué on the settlement of the dispute. By purchasing energy products from the US, the EU would diversify its sources of supply and thus contribute to the security of energy supply in Europe, with natural gas and oil from Russia being replaced by significant purchases of LNG, oil and nuclear fuels from the US (European Commission, 2025b).

In 2024, the total trade value of petroleum, natural gas and coal imported into the EU amounted to €375.3 billion. If this amount is broken down by energy source, the import value was distributed as shown in Figure 4 (Eurostat, 2025). The US accounted for approximately €65 billion of this, equivalent to US \$75.9 billion at current exchange rates, representing a share of 17.3%. The US accounted for oil imports worth €42 billion, or 16.1%, while the US was by far the largest supplier of LNG to the EU, with a share of 45.3%. The import value of US LNG was just under €19 billion. Imports from the US also accounted for around one third of the EU's total coal imports, representing a trade value of €4 billion for 2024.

Even assuming that the EU completely replaces its remaining natural gas supplies from Russia with purchases from the US, the gap between aspiration and reality remains enormous. In 2024, Russian supplies of pipeline gas and LNG accounted for 17% of the total trade value of natural gas imports into the EU, corresponding to an import value of €17.1 billion, or US \$20 billion. However, as neither a sustained increase in EU energy imports nor a significant rise in energy prices on international markets is foreseeable, the US contribution to total EU energy imports would have to increase from 17% in 2024 to more than 50% on average between 2026 and 2028 in order to meet the level of ambition set out in the agreement. This also applies if nuclear fuels, which are not included in the figures mentioned, are taken into account.

Such a profound shift in supply sources within such a short period of time is not plausible, especially since it can be assumed that the companies responsible for supplying the markets have already contractually regulated their supply relationships for the period in question, at least in part. There is another factor to consider. It is not consistent with a market economy to impose requirements on market players as to how they should structure their supply relationships. It is also questionable whether the US would be able to provide additional energy volumes for export in the quantities necessary to increase the value of EU energy imports from the US to the aforementioned US \$750 billion by 2028.

Figure 4
EU27 energy imports by country of origin in 2024, share (%) of trade in value



Source: Eurostat.

Overview of the competitive situation in the European market

Natural gas prices have stabilised since 2024, though they remain above the long-term pre-war level, indicating that market conditions remain tense. The elevated price level is accompanied by high volatility. The main causes are geopolitical uncertainties and the associated risks regarding the availability of the required LNG volumes. These include, for example, the ongoing war in Ukraine, conflicts in the Middle East and the associated potential temporary bottlenecks in LNG logistics, as well as the US government’s customs policy. In addition, European storage filling requirements at the end of 2024 also led to unusual price formations for the 2025 calendar year.

In the electricity sector, the higher gas price level in the first two quarters of 2025 often led to the preferred use of lignite and hard coal-fired power plants over gas-fired power plants, as the clean spark spreads (CSS) for both base and peak products were often below the clean dark spreads (CDS). On the futures market, the forward curve for TTF (Title Transfer Facility) annual contracts remains in backwardation (Figure 5).

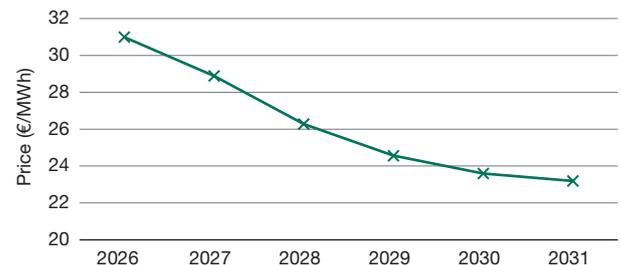
LNG competition

Since large parts of pipeline imports from Russia have been lost, LNG imports from non-European countries

have become the main source of supply for Europe, alongside deliveries from Norway (European Commission, 2025a). Europe, and Germany in particular, are in direct competition with Asian buyers, especially in Japan, South Korea and China (JKC region).

The price relationship between the Northwestern European market and the Asian spot market (JKC) determines which market acts as the “premium market” and thus attracts LNG deliveries (cargos) preferentially. In periods of high Asian demand (e.g. cold winters or hot summers), this can lead to supply shortages in Europe.

Figure 5
Forward price curve for TTF annual contracts on the European Energy Exchange on 15 October 2025



Source: European Energy Exchange.

The largest supplier of LNG to Europe is currently the US (Eurostat, 2025). The technical condition and utilisation of central export terminals such as Sabine Pass, Corpus Christi, Freeport and Cameron have a direct impact on short-term price volatility. Disruptions in important shipping routes such as the Panama Canal or the Suez Canal also have a noticeable impact on supply flows. The current security situation in the Middle East, including the conflict between Israel and Iran, as well as attacks by Houthi rebels on merchant ships in the Red Sea, increase the risk of supply disruptions and transport cost increases.

Storage levels and summer-winter spreads

The EU's storage policy is a key factor for security of supply and price formation. For storage to be economically viable, the summer-winter spread (the difference between prices for summer and winter deliveries) must exceed the costs of injection and withdrawal. If the summer-winter spread is below the costs of injection and withdrawal, or even becomes negative, storage operators would incur losses when withdrawing gas in winter. The European requirement to fill storage facilities to at least 90% by 1 November 2024 led to negative summer-winter spreads from around October 2024 onwards, i.e. higher prices for deliveries in summer than in winter, as there was a threat of compulsory feed-in if the requirement was not met. With the minimum filling requirement relaxed to 75% within a variable filling window, a positive summer-winter spread could return for 2025 (e.g. Q2 2025 vs. Q1 2026) (European Energy Exchange, 2025).

Short-term restrictions on gas transport routes, such as those caused by maintenance work or geopolitical events, can also have a negative impact on the spread. For winter 2026/2027, spreads in the TTF market are currently just in positive territory (around €1/MWh), while they are significantly more positive at the long end of the forward curve (European Energy Exchange, 2025).

Outlook for winter 2025/2026

Despite the geopolitical and market risks mentioned above, current storage levels, LNG import capacity and stable supplies from Norway indicate that Europe will be sufficiently well supplied in winter 2025/2026. However, the course of geopolitical conflicts, weather conditions and Asian demand remain decisive factors. In the long term, the planned introduction of a complete EU embargo on Russian natural gas imports is likely to lead to further structural adjustments in supply chains. The extent to which Russia can divert the lost export volumes to the EU to other markets entirely will have a significant impact on global pricing.

Outlook for natural gas demand in the EU and in Germany as its largest natural gas market

According to estimates by the International Energy Agency (IEA), natural gas consumption in the EU will fall by 22% between 2024 and 2035 as a result of the announced policy measures coming into force, based on the modeled Stated Policy Scenario (IEA, 2025, p. 214). This would be accompanied by a reduction in gas imports into the EU. Taking this assumption into account, EU imports of LNG will increase by 32% compared to 2024 levels, reaching 145 billion m³ in 2035. This will compensate for the continued decline in natural gas production in the EU and the expected reduction in imports of pipeline natural gas. Nevertheless, total EU imports of natural gas (pipeline gas and LNG) will decline by 65 billion m³ between 2024 and 2035, which is attributed to the decline in demand (IEA, 2025, p. 217).

In Germany, consumption of natural gas, which was the second most important energy source in 2024 with a share of 25.9% of the primary energy consumption after mineral oil, will decline in the future, as it will across the EU. The expected decline in demand can be explained by growing electrification in all sectors (i.e. transport, buildings and industry), the continued increase in the share of renewable energies in electricity generation and improvements in energy efficiency. This assessment is based on the fundamental assumption that gross domestic product will grow at an average annual rate of around 1% and that the population will remain largely stable at around 85 million (DNV, 2025, p. 11).

Electricity consumption and generation in Germany, on the other hand, are likely to increase in the future due to increasing electrification in the transport and buildings sectors as well as in industry. By 2035, growth of around a quarter is expected, and by 2050, an increase of around three quarters compared to the 2024 level. In the future, most of Germany's electricity demand will be met by generation based on renewable energies. The target of 80% renewable energy share of gross domestic consumption is to be achieved as early as 2030. However, the fluctuating generation from wind and solar plants – in addition to an increase in storage capacities – will require a significant expansion of controllable capacity, primarily based on natural gas, which will be partially replaced by hydrogen in the future.

The Norwegian consulting and certification company DNV (2025, p. 76), for example, expects peak load in Germany to rise from 75-80 GW in recent years to around 100 GW in 2035 and around 135 GW in 2050. The residual load that cannot be covered by renewable energy plants will

require the provision of sufficient secured capacity based on natural gas in the future. As the long-term goal is to replace natural gas with hydrogen, it can be assumed that natural gas consumption for electricity generation will decrease despite rising natural gas capacity.

Construction of natural gas power plants to secure future electricity supply

The security of the electricity supply depends on the extent to which electricity generation capacity can be assumed to be reliably available at peak load times. The total installed electricity generation capacity in Germany amounted to 265,427 MW at the beginning of 2025. Of this, 177,801 MW came from renewable energies and 87,626 MW from non-renewable energies, in particular fossil fuels.

The share of secured capacity in the installed capacity varies for the different technologies. For plants based on nuclear energy, hard coal, lignite and natural gas, more than 90% of the installed capacity can be classified as secured. At the other end of the spectrum is photovoltaics (PV). The PV capacity available at the time of the expected peak load is zero, as the peak load in Germany can occur at a time when it is dark. The situation is more favourable for wind energy, especially for offshore plants. However, it cannot be ruled out that there will be a lull in the wind at the time of peak load, as was the case in the first half of December 2022, for example. Of the 72,781 MW of wind power installed in Germany, a maximum feed-in value of 51,988 MW was achieved in 2024. The average value was 15,736 MW and the minimum value was 42 MW. The 42 MW corresponds to only 0.1% of the installed capacity (Schiffer, 2025, p. 215). According to the German transmission system operators, “it can be seen that the feed-in capacity (for wind turbines) is below 1% of the installed capacity for 1% of the time” (50Hertz et al., 2025, p. 11). The ratios are significantly more favourable for hydropower, bioenergy and geothermal energy. The latter technologies have the major disadvantage that, for various reasons, they are not freely scalable.

Taking the ratios outlined above into account, it can be assumed that Germany will have a guaranteed capacity of 89.5 GW from power generation plants on the electricity market at any given time in 2025. Of this, 77.3 GW will come from conventional power plants (including pumped storage) and 12.2 GW from renewable energy plants, as shown in Figure 6 (Schiffer, 2025, p. 219).

The secured capacity available in Germany is therefore sufficient to guarantee the electricity supply at all times, both now and in the short term. Germany is also integrat-

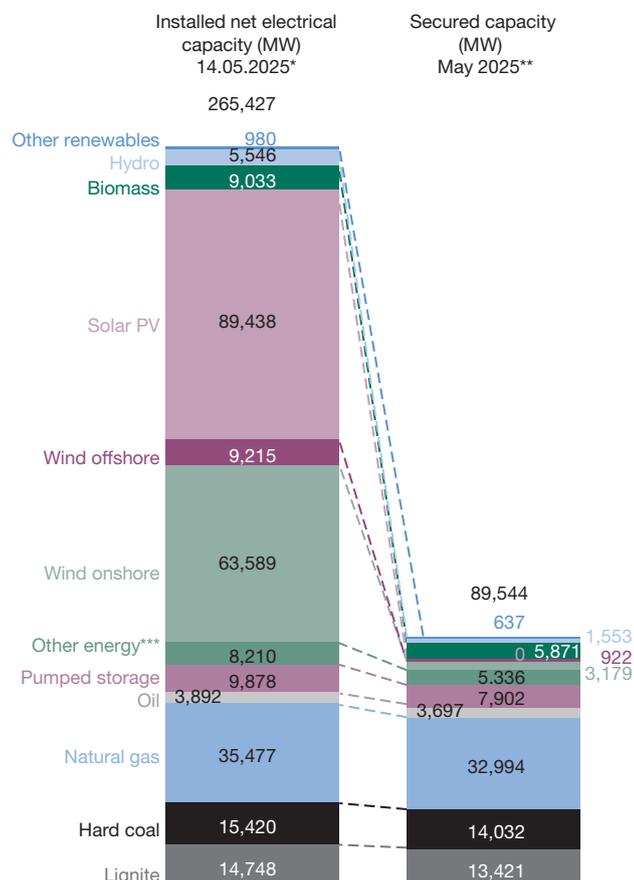
ed into the European electricity market. If bottlenecks occur, capacity abroad can be drawn on, provided that the capacities available there allow this and the cross-border transmission grids do not represent a limiting factor. However, in winter – which is the relevant period for assessing security of supply – a shortage of generation capacity is to be expected in all European countries. Moreover, peak load in Germany will increase. This means that a gap between the development of electricity demand and secured capacity will open up in the near future.

Market-active, controllable electricity generation capacity will decrease to 67 GW by 2030. This figure takes into account the provisions of the Coal-Fired Power Generation Termination Act (KVBG), the Act on Accelerating the Phase-out of Lignite in the Rhenish Mining Area, and the assumption of a constant gas capacity of 32 GW made in model calculations by the Institute of Energy Economics at the University of Cologne (Energiewirtschaftliches Institut an der Universität zu Köln [EWI], 2022, p. 13.) The agreement between RWE AG, the state government of North Rhine-Westphalia and the Federal Ministry for Economic Affairs of 4 October 2022 on the early phase-out of lignite in the Rhenish mining area by 2030 has been taken into account. This figure includes the combined output of 5.6 GW from lignite-fired power plants in Lusatia and central Germany, which are due to be decommissioned between the end of 2034 and the end of 2038 in accordance with the KVBG. With the complete phase-out of hard coal and lignite by the end of this decade, controllable capacity would be reduced to 53 GW by 2030 (EWI, 2022, p. 13).

The CDU, CSU and SPD coalition agreement aims to establish reliable investment conditions through technology-neutral tenders, targeting up to 20 GW of new gas-fired power plant capacity by 2030 at existing sites across Germany. The agreement envisions a technology-neutral, market-based capacity mechanism that integrates various generation sources, storage facilities and flexible options to ensure supply security (Federal Government of Germany, 2025a, p. 33).

On 3 September 2025, the German government approved the report on electricity supply security prepared by the Federal Network Agency (2025, p. 7). The report forecasts an additional requirement for controllable electricity generation capacity of between 22.4 and 35.5 GW by 2035. Large battery storage systems remain important for short-term applications such as frequency maintenance and peak shaving, but cannot cover longer phases of high winter residual load. Even with a hypothetical expansion of 100 GW of installed capacity, this would only correspond to an energy volume of 200 GWh for two hour systems, which is far below the magnitude of demand during

Figure 6
Guaranteed vs. net installed capacity of power generation plants in Germany



Notes: * Installed net capacity of electricity generation plants according to the Federal Network Agency's power plant list as of 14.05.2025 (renewable energy installations as of 31.12.2024). The installed net capacity of power generation plants is 265,427 MW; 13,331 MW were recorded by the Federal Grid Agency as plants outside the electricity market (including grid reserve power plants). ** Calculation based on the average failure rates for conventional power plants or on unavailability rates for renewable energy installations. According to the transmission system operators and ENTSO-E, these are 5% for nuclear, 9% for lignite and hard coal, 7% for natural gas (and oil), 72% for run-of-river, 35% for biomass and 20% for pumped storage; 95% was set for wind onshore, 90% for wind offshore and 100% for photovoltaics. For other renewable energies – as with biomass – an unavailability of 35% is assumed. *** Including 2,634 MW battery storage and 4 MW other storage capacity.

Source: Schiffer (2025).

a dark doldrum period lasting several days in Germany. In fact, the storage capacity installed in Germany most recently amounted to around 2.5 GW.

This underlines the importance of the power plant strategy planned by the German government. According to the Federal Network Agency, the additional capacity required should be provided via a capacity mechanism. It can be

assumed that without a capacity mechanism, investment in additional power plants will be too low. The corresponding tenders for hydrogen-compatible gas-fired power plants must be issued by the beginning of 2026 at the latest so that the plants are available in time. This is also necessary because the construction of a new gas-fired power plant takes at least five years.

Conclusions

The EU's natural gas supply, which is heavily dependent on imports, is undergoing significant change. This applies to the structure of the countries of origin and the supply routes. Russia's war of aggression in Ukraine, which has been ongoing since February 2022, has led to a significant realignment. Norway and the US have replaced Russia as the most important suppliers of natural gas. The supply of LNG has become much more important, at the expense of the previously dominant pipeline supplies. Despite existing geopolitical and market risks, supply bottlenecks are not foreseeable in the winter of 2025/2026. In the first half of 2025, the EU still sourced a considerable amount of natural gas from Russia. According to Eurostat (2025), pipeline gas deliveries in this period had a trade value of €2.9 billion. In addition, LNG worth €4.5 billion was imported from Russia into the EU. The 19th package of sanctions against Russia, which the EU adopted on 23 October 2025, includes a ban on imports of LNG from Russia – for long-term contracts from January 2027 and for short-term contracts within six months (Federal Government of Germany, 2025b).

Given the foreseeable decline in gas consumption and the growing global export capacity for LNG, the complete cessation of natural gas supplies from Russia to the EU is unlikely to lead to shortages, especially as a number of supply contracts between European companies and foreign natural gas suppliers will come into effect from 2026. Natural gas-fired power plants play an important role in securing the electricity supply, particularly in covering residual load, given the emerging trend in other EU countries away from the use of coal for electricity generation and the foreseeable increase in electricity demand as a result of growing electrification. Due to the limited full-load hours that natural gas power plants have left to cover the load, the additional natural gas volumes required for electricity generation do not appear to be a bottleneck factor. The expansion of natural gas power plants, which is particularly urgent in Germany, is crucial to closing the gap between the expected increase in peak load and the decline in controllable electricity generation capacity.

Central policy challenges for the EU include reconciling the need for secure and affordable natural gas supplies

with the objective of higher energy sovereignty and the fulfilment of European climate targets. Strengthening internal market integration and storage coordination, diversifying import structures, and accelerating the development of hydrogen-ready gas infrastructure comprise key elements of a coherent policy strategy. In the German electricity sector, the implementation of a central capacity market will help ensure sufficient gas-fired, hydrogen-compatible power plants are constructed to safeguard security of supply during periods of high residual load.

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