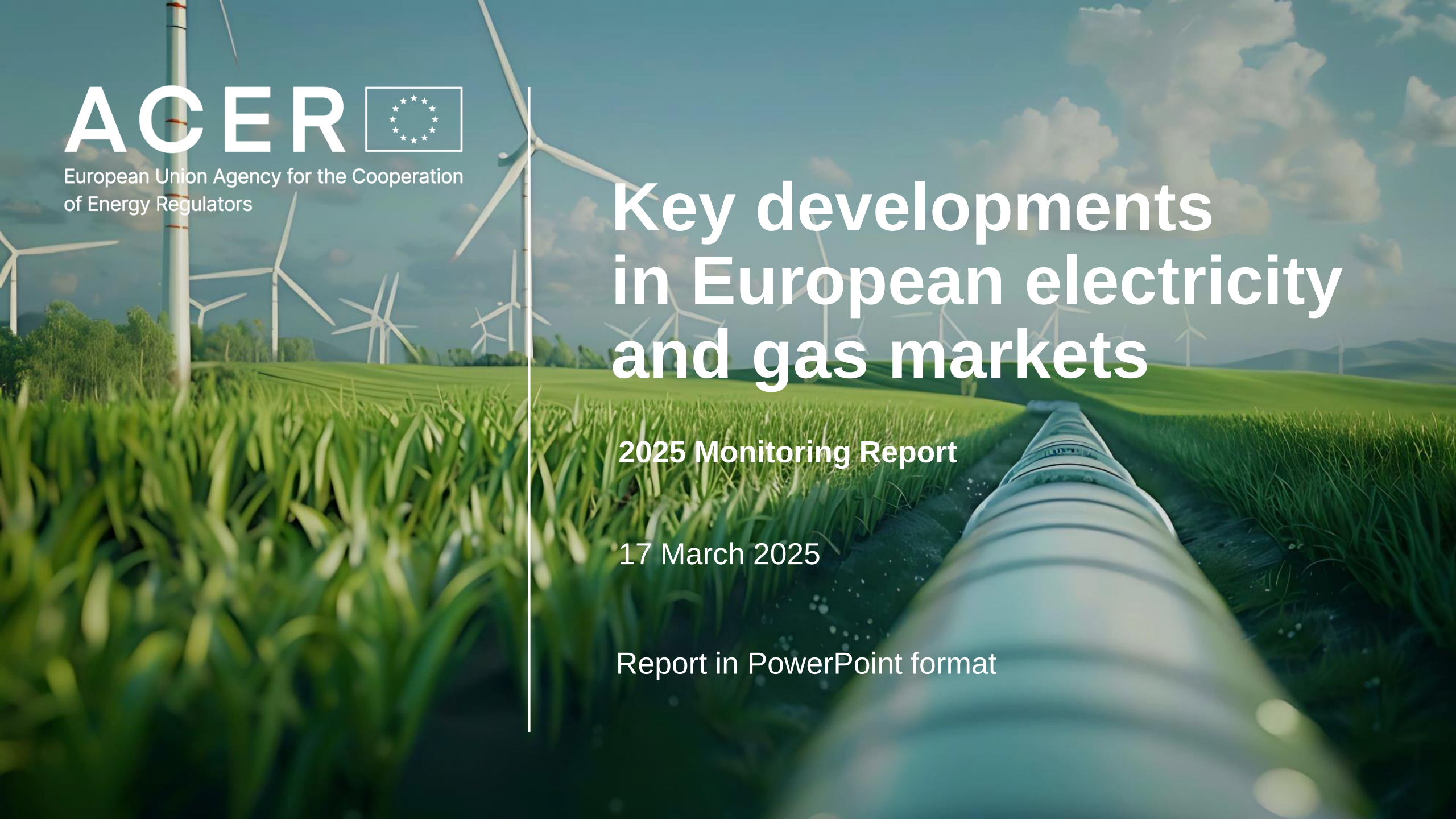

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Key developments in European electricity and gas markets

2025 Monitoring Report

17 March 2025

Report in PowerPoint format

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Executive Summary

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Key figures

+41 TWh rise

in solar generation, leading the overall rise in European renewable generation.

-16% annual drop

in European electricity prices, bringing them to their lowest levels since 2021, with notable regional disparities.

-3% base load +10% peak load

electricity produced from gas, revealing a shift in the role of gas in power generation.

Challenges arise at the mid-stage of the energy transition

Europe's energy landscape is at a crossroads. Can it fully harness renewables and reduce its reliance on fossil fuels while managing price volatility?

Renewable energy saw significant growth, accounting for 34% of power generation in 2024. Early 2024 marked some of the lowest energy prices since 2021, thanks to a strong renewable supply and nuclear recovery in France.

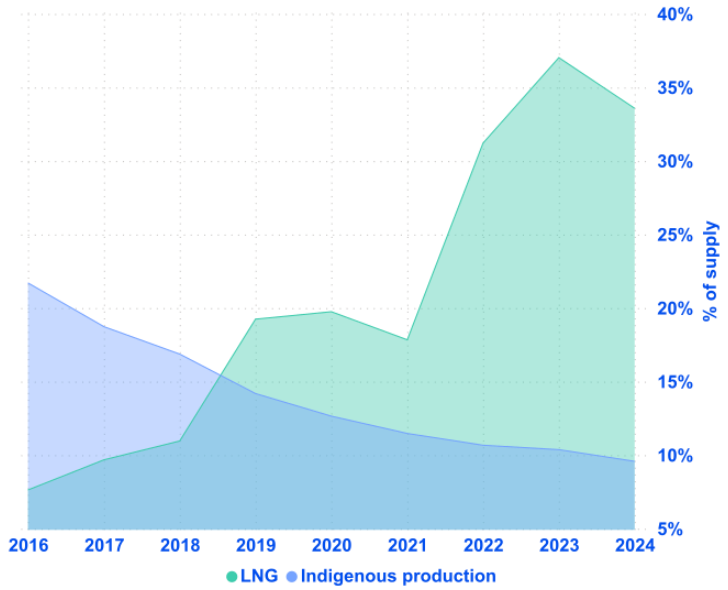
Inflexible generation kept EU summer electricity prices low, causing more negative price events, increasing by 50% in 2024.

Europe's energy transition faces persistent vulnerabilities.

Europe continues to rely heavily on imported gas, exposing it to global market conditions e.g. rising gas prices in 2024.

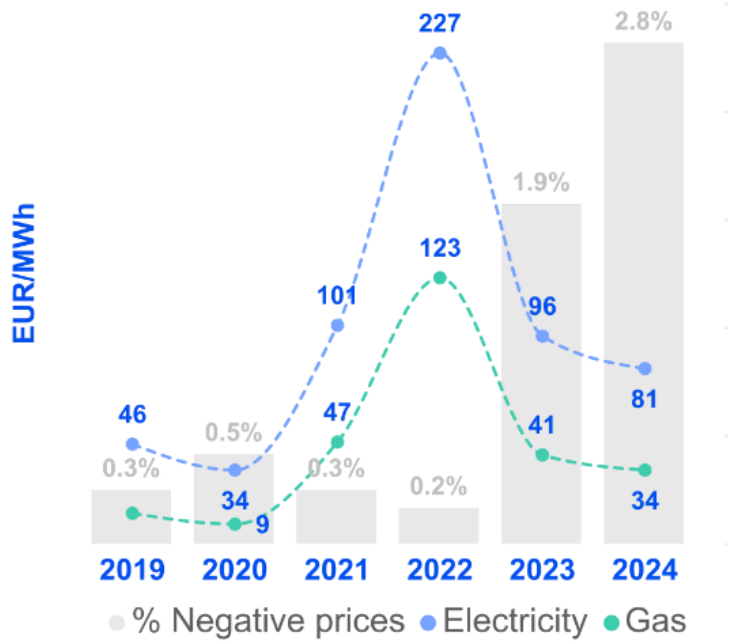
Exposure to global dynamics is the new reality for EU gas markets.

Share of LNG and indigenous production in total supply, EU-27, 2016-2024 (%)



Energy prices fell to their lowest since 2021, with negative prices rising, although unevenly across regions and throughout the year.

Electricity and natural gas price evolution, and annual percentage of the time when prices were negative, EU-27/EEA(Norway) and at the TTF, 2019-2024 (EUR/MWh and %)



Source: ICIS.
Note: LNG stands for liquified natural gas. TTF stands for Title Transfer Facility, the virtual gas trading point in the Netherlands used as benchmark for EU natural gas prices.
EEA stands for European Economic Area.

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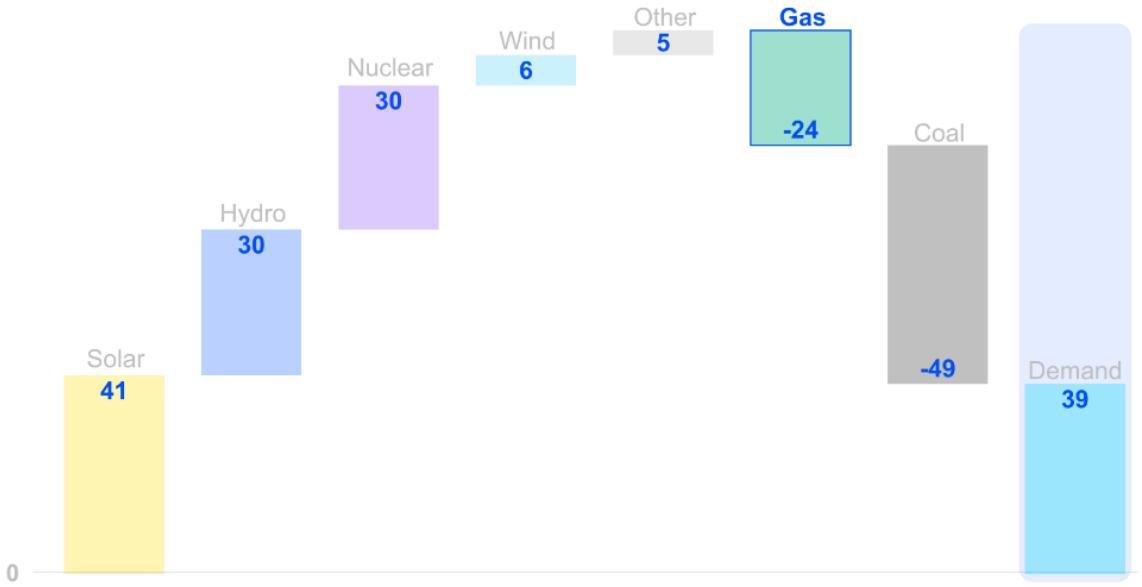
Relationship between gas and electricity is evolving

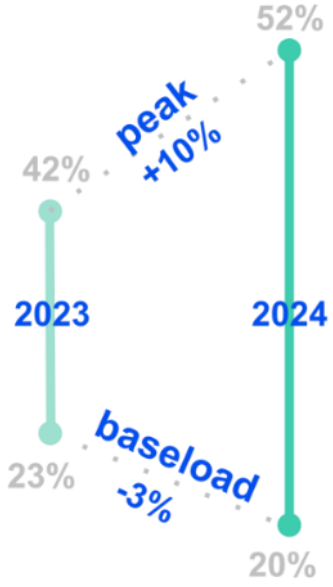
Growth in renewables crowded out coal and gas generation ...

Year-on-year changes for the main generation technologies, EU-27/EEA(Norway), 2024 (TWh)



… but demand for flexible gas supply increased.

Capacity factors of gas-fired power plants, EU-27/EEA(Norway), 2023-2024 (%)



Energy market transformation challenge: As renewables expand and coal plants retire, electricity markets reduce gas reliance but remain exposed to price volatility when fossil fuels are needed.

Source: European Network of Transmission System Operators of Electricity (ENTSO-E) Transparency Platform.

Gas-electricity interplay is also reflected in price dynamics

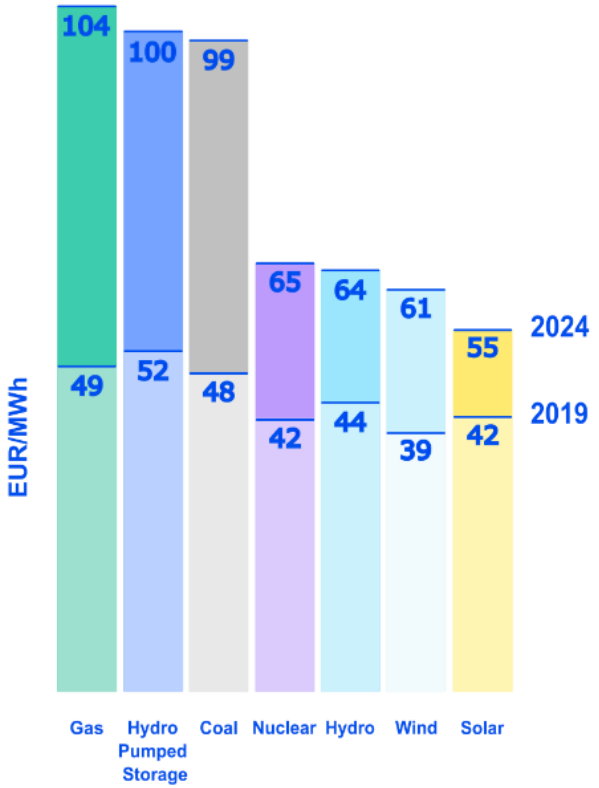
Europe's energy transition faces significant challenges in managing price volatility and energy system costs.

Fossil fuels, particularly gas and coal, remain essential for peak demand flexibility. Market prices are volatile, driven by gas price fluctuations and renewables' variability. The need for electricity market integration is growing faster than the actual progress being made, thus failing to bridge a gap that undermines market efficiency and stability. Rising grid modernisation costs add pressure, demanding efficient and coordinated investments to maintain security of supply without increasing energy bills.

Current market conditions, with frequent and significant price swings, support the deployment of flexibility solutions, provided that barriers to their deployment are removed.*

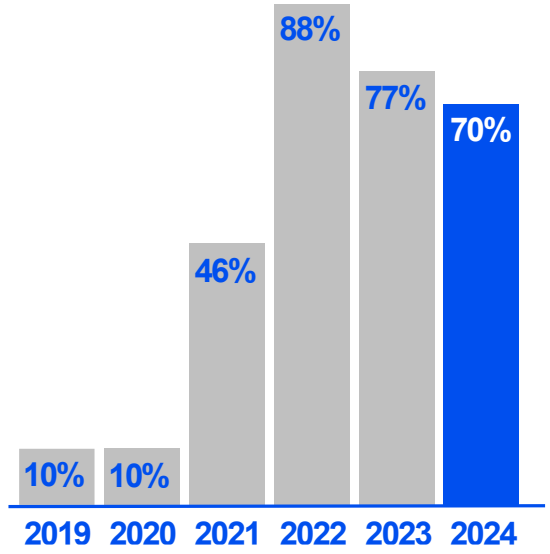
Fossil fuel technologies mainly run during high-price hours.

Average value of electricity by production type, EU-27/EEA(Norway), 2024 (EUR/MWh)



Electricity price swings remain frequent.

Annual percentage of days when price variation per day was greater than 50 EUR/MWh, EU-27/EEA (Norway), 2019-2024 (EUR/MWh)



Source: European Network of Transmission System Operators of Electricity (ENTSO-E) Transparency Platform.
Note: *See the 2023 ACER report on demand response and other distributed energy resources and the upcoming ACER report on no-regret measures to remove barriers to demand response (April 2025).

EU gas system remains a relevant backstop for energy markets

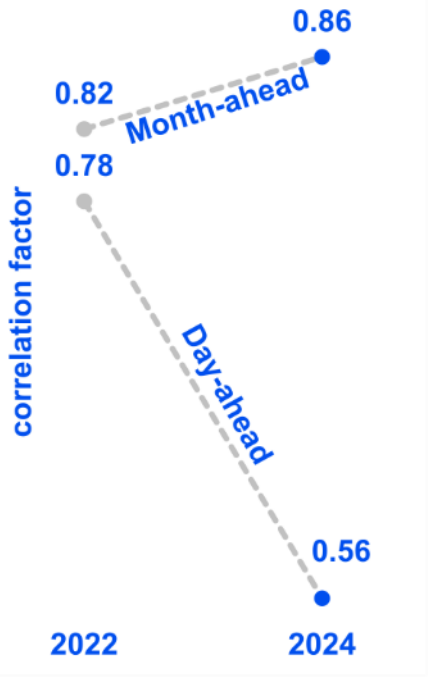
Gas has maintained a key role in the wider European energy system, despite being affected by the energy crisis.

Large EU gas storages help manage seasonal energy demand swings and provide a buffer against supply risks.

Electricity and gas prices diverge in short term markets but move together in longer term markets. This influence of gas generation costs over electricity prices remains in the absence of alternatives to seasonal gas storages, backed with liquid gas futures markets.

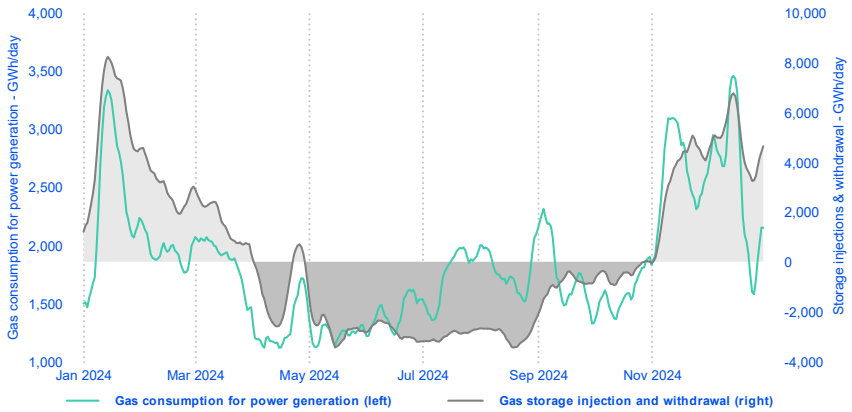
Interplay between gas and power prices shifted.

Correlation between gas and electricity month-ahead and day-ahead prices for selected Member States*, 2022 and 2024



Gas storage is vital for Europe's supply security and stability.

Gas consumption for power generation and storage net withdrawals (GWh/day)



Source: ACER based on Gas Infrastructure Europe and ENTSOE data.
Note: *Correlation of prices in EU Member States with significant data for day-ahead and month-ahead markets (AT, BE, CZ, DE, ES, FR, HU, IT, NL, PL).

Unlocking a clean, secure, and competitive energy future

To deliver a clean, secure, and cost-competitive energy future, Europe must harness its market strength, digitalize its systems, and foster trust among Member States.

Achieving the EU's energy goals requires a targeted approach:

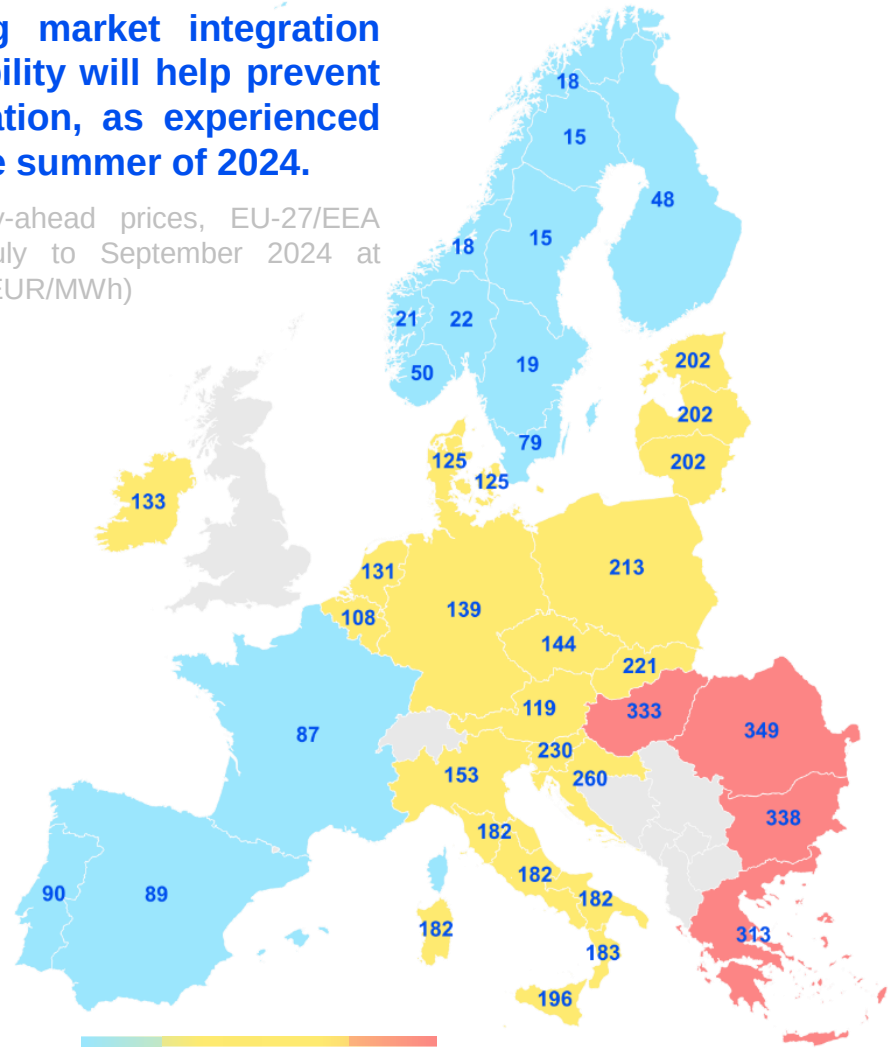
Target new transition cost drivers: Control grid investment growth through better network tariffs and 'efficiency first' capacity incentives, ensuring infrastructure upgrades are cost-effective and avoid stranded assets. Design support schemes for capacity, flexibility, and renewables to remain affordable while sustaining long-term energy security.

Harness energy efficiency and flexibility: Leverage both centralised and local flexibility solutions, including demand-side response, electric vehicles, and battery storage, to optimise system use. These technologies help stabilise supply and demand, reduce price volatility, and strengthen overall grid resilience, particularly during peak periods.

Expand energy market integration: Enhance cross-border resource use, particularly renewable generation, to improve flexibility and security of supply. Strengthen interconnectivity to maintain available cross-zonal capacity, reduce fossil fuel reliance, and build trust in well-functioning European energy markets.

Furthering market integration and flexibility will help prevent fragmentation, as experienced during the summer of 2024.

Average day-ahead prices, EU-27/EEA (Norway), July to September 2024 at 17:00 UTC (EUR/MWh)



Source: ENTSO-E Transparency Platform.

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In 2025, keep an eye on ACER's work …

Focus now shifts to helping pave and navigate the way towards a clean, secure, and competitive energy system, tackling trade-offs as these emerge.

Going forward, strengthened cross-border cooperation is key to building political trust and aligning regional energy markets.

- *In 2025, ACER will monitor no-regret measures to remove barriers to demand response (April) and the evolution of cross-zonal capacity available for trade (July). ACER has issued its recommendation on demand response rules in March. In July it will publish a recommendation on intertemporal cost allocation for hydrogen financing (don't miss the public consultation, open until 31 March!).*

Smarter deployment and greater utilisation of renewable capacity, going hand-in-hand with flexibility, is necessary to meet growing demand and reduce dependence on fossil fuels. Accelerating the deployment of wind, solar, and battery storage will drive this transition.

- *In 2025, a variety of reports will monitor how gas and electricity markets tackle the energy transition, from global liquefied natural gas dynamics in May, gas network capacity and electricity cross-zonal capacity in June, to hydrogen markets and electricity market integration in October.*

Efficient grid investment will require comprehensive planning to enhance efficiency and security, integrate renewables, as well as ensuring a cost-effective modernisation of the grid.

- *In March, ACER will publish a report on best practices regarding network tariffs. In July ACER will publish a guidance on distribution network development plans.*

Incentive mechanisms are crucial to promoting flexibility resources and encouraging innovation. These schemes will help optimise the energy system and support the transition to cleaner energy.

- *Network flexibility and security will be tackled in the context of the adoption of a flexibility needs methodology (July) and a report on security of supply (November).*

Find out more about ACER's contribution in 2025.

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Introduction

Overview

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Report overview: EU gas and power in 2024

The worldwide uncertain context drove energy markets price volatility in 2024, with gas and global LNG dynamics. EU import/export patterns highlighted reliance on external sources for gas and electricity, at a premium to prices in North America.

In European gas and electricity markets, prices declined significantly early in 2024, but gas prices, in particular, trended upwards from spring. Evolutions in behind-the-meter consumption and renewable production added volatility. During the first quarter of 2024, episodes of low demand, high supply, facilitated by the recovery of the French nuclear fleet, strong liquefied natural gas supply and high gas storage levels, contributed to a high occurrence of negative electricity prices. During the last quarter of 2024, episodes of low renewable input and cold weather driving higher demand led to energy price increases.

Challenges ahead: Fossil fuels still provide high-value flexibility during peaks. To reduce reliance, the system must optimise gas storage and increase other sources of flexibility, such as electricity storage and network interconnection capacity. Addressing these will minimize fossil impacts and prepare for evolving energy demand and supply.

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Global context

- EU energy challenges and opportunities
- Current renewable growth and fossil fuel reliance in Europe
- How gas imports and renewables shape EU energy trade

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EU energy challenges and opportunities

Energy market context

- Historically, **EU electricity and gas prices were moderately higher than those in the US** and often lower than in Northeast Asia.
- The 2022 energy crisis, though global, had the most significant structural impact on European markets, causing the price gap to widen sharply at its peak.

Key factors driving disparities

- **As an importer of gas, the EU is unlikely to reach price parity with exporting nations like the US.** EU gas wholesale prices will primarily reflect LNG supply costs (local commodity prices, export infrastructure, and shipping cost) and, to a lesser extent, global competition for cargoes, especially with Asia, as seen in recent years.
  - ➢ *By 2024, the price disadvantage narrowed but remained significant. Challenges such as further reduced Russian supply and competition for LNG cargoes could limit further reduction of the gap in 2025.*
- **EU wholesale electricity and gas prices also factor in environmental costs more than in other regions, reflecting its leadership in decarbonization.** While this drives climate action, it contributes to higher prices.

Current and future benefits of EU energy policy

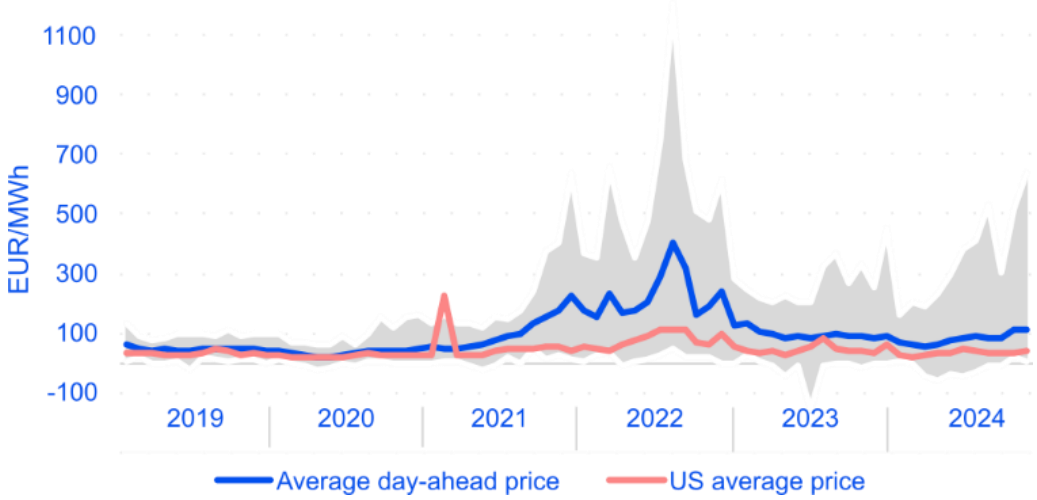
- **The EU energy policy reflects the needs of an importing region.** Despite a larger population, the EU consumes less energy than the US. Further, carbon reduction targets have contributed to reducing costly fossil fuel imports and lessening exposure to political risks in exporting countries.
- In the space of the next two years, possibly as early as late in 2025, new global LNG supply, growth in renewables' capacity and potentially new forms of electricity demand and supply flexibility are expected to lower EU gas and electricity prices and help close the gap further.

Reducing EU's need for energy imports will cut costs

Energy in the EU remained more expensive than that of US.

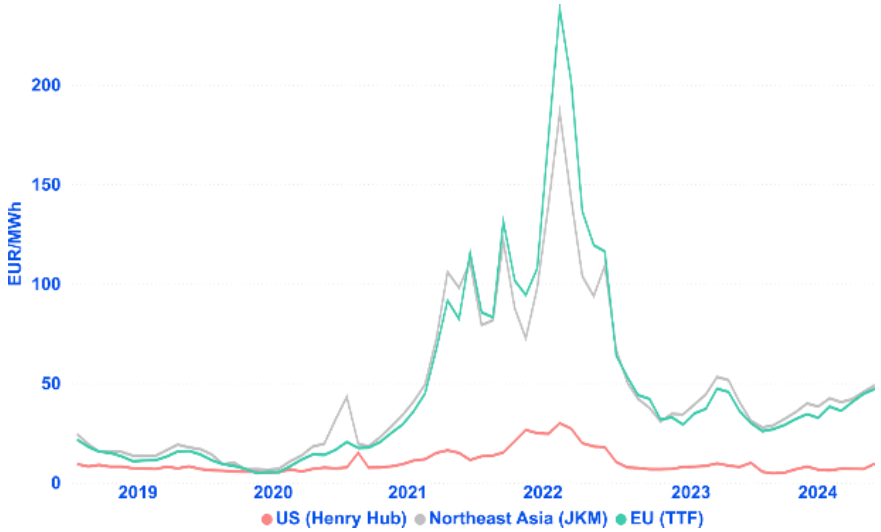
In 2024, average wholesale electricity price was twice that of the U.S. (46 EUR/MWh) …

Average of the minimum, average and maximum day-ahead electricity prices per month and Member State, 2019-2024 (EUR/MWh)



… while average wholesale gas price was five times higher (27 EUR/MWh).

Average prices of key international gas benchmarks, 2019-2024 (EUR/MWh)



In the long term, the best way to tackle high gas prices is to reduce gas use by switching to electricity. For high electricity prices, the solution lies in reducing peak demand and maximising the benefits of renewables in the mix. This requires expanding cheap renewable generation and managing load and price spikes through flexibility, market integration, and resource sharing.

Source: ENTSO-E Transparency Platform, EIA, Eurostat.

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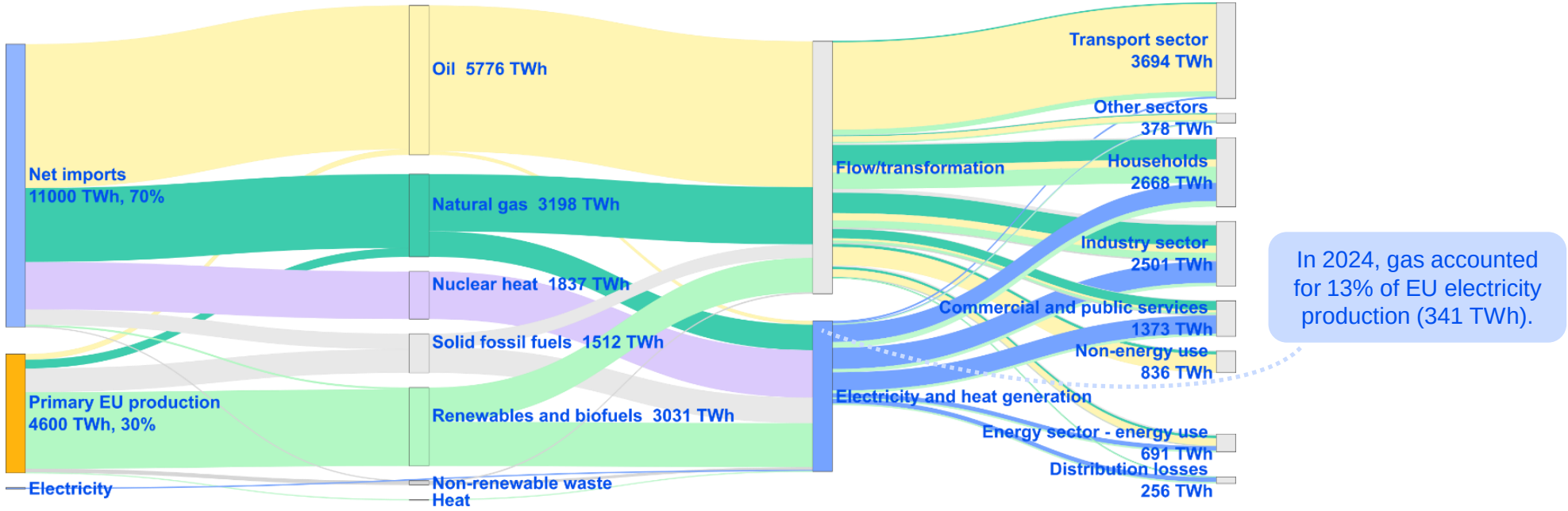
Renewable growth and fossil fuel reliance in Europe

European energy policies are critical for competitiveness, security, and decarbonisation towards climate neutrality by 2050.

Final energy consumption reflects Europe's progress toward energy security, efficiency and sustainability goals.

Flow of energy products in the economy, EU-27, 2023



In 2024, gas accounted for 13% of EU electricity production (341 TWh).

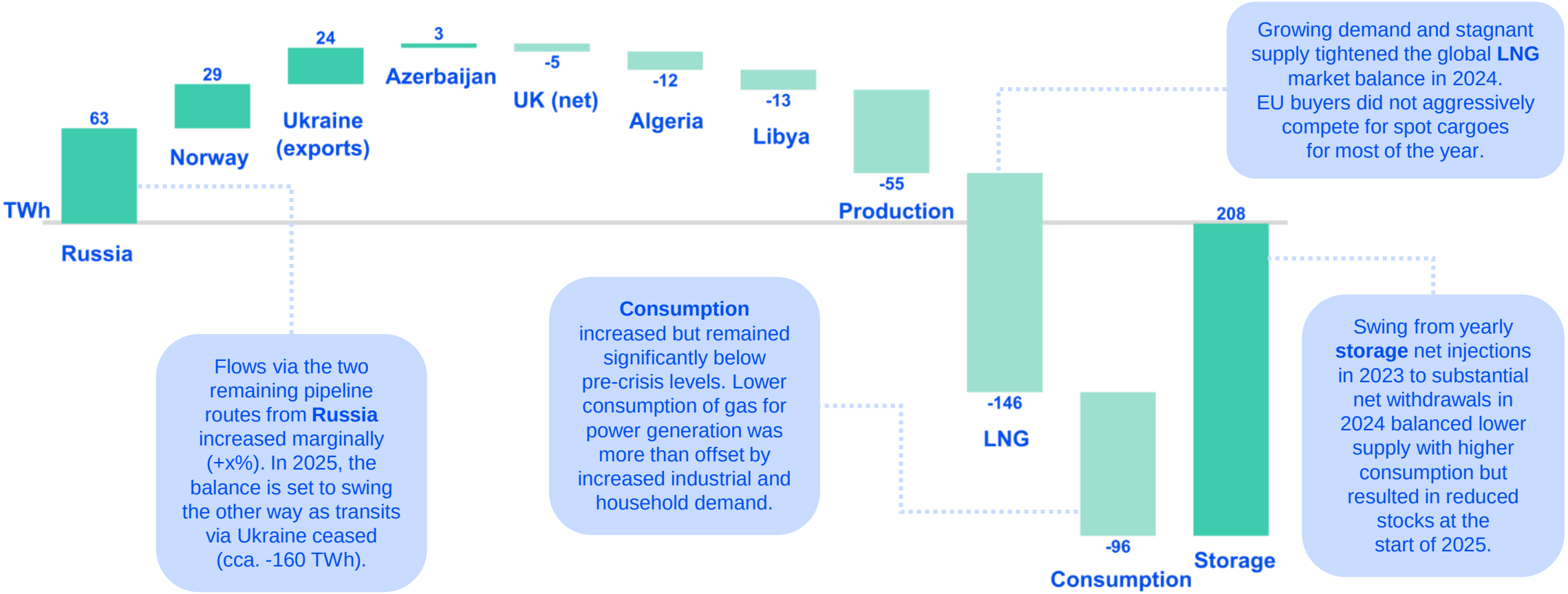
Additional efforts are needed to meet the 2030 target to cut EU greenhouse gas emissions by at least 55% compared to 1990, and become climate neutral by 2050. Europe remains significantly reliant on imported fossil fuels (oil and gas).

Source: EUROSTAT.

Decrease in LNG imports and storage stocks stand-out in 2024

Gas balance in 2024: Stocks used to compensate for lower LNG supply and increase in consumption with import demand implications for the year ahead.

Year-on-year changes for gas supply and demand in the EU-27, 2024 (TWh)

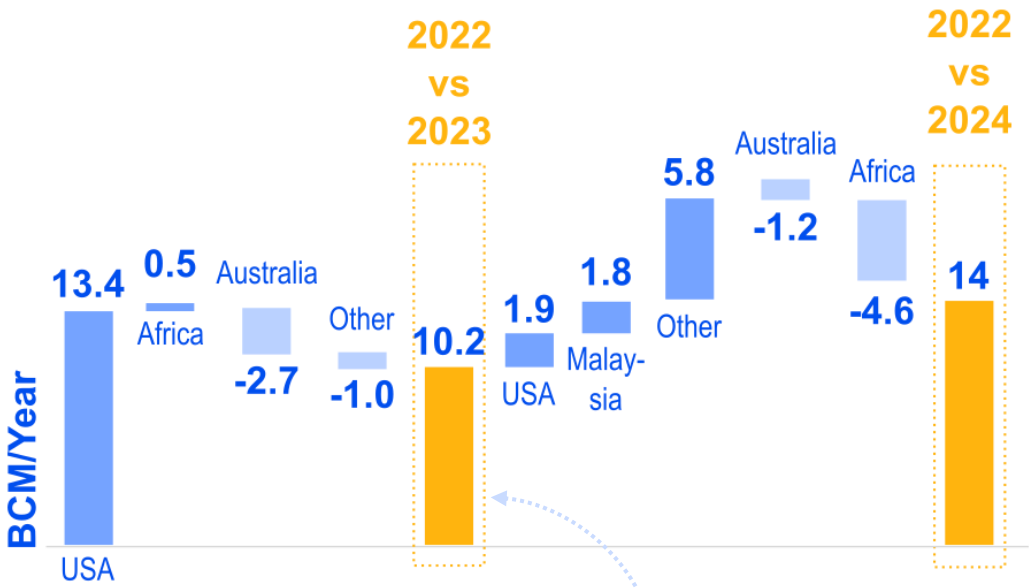


Source: ACER based Gas Infrastructure Europe, ENTSOG and Eurostat.
Note: Dark green shows eased supply constraints (e.g. year-on-year increased imports or higher storage withdrawals), while light green highlights factors that tightened the market (e.g. year-on-year decreased imports or rising demand).

Global LNG market set to move from tight to well-supplied

Global LNG production has only seen modest growth since 2022 …

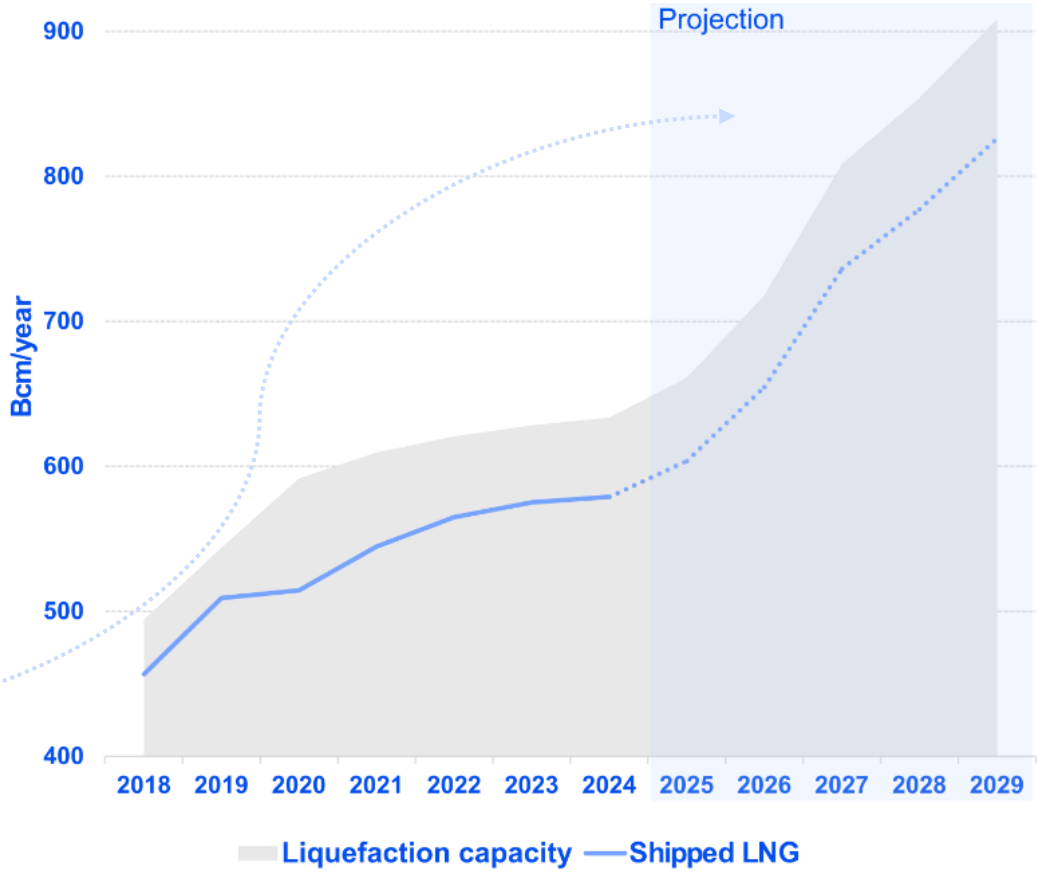
Changes in global liquefied natural gas supply, 2022-2024 (Bcm)



From 10 additional Bcm of LNG in 2023
to expected 50 Bcm per year between 2025 and 2030.

… but this is set to change in the coming years with several large projects close to starting production.

Global liquefaction capacity and LNG production, 2018-2029 (Bcm)

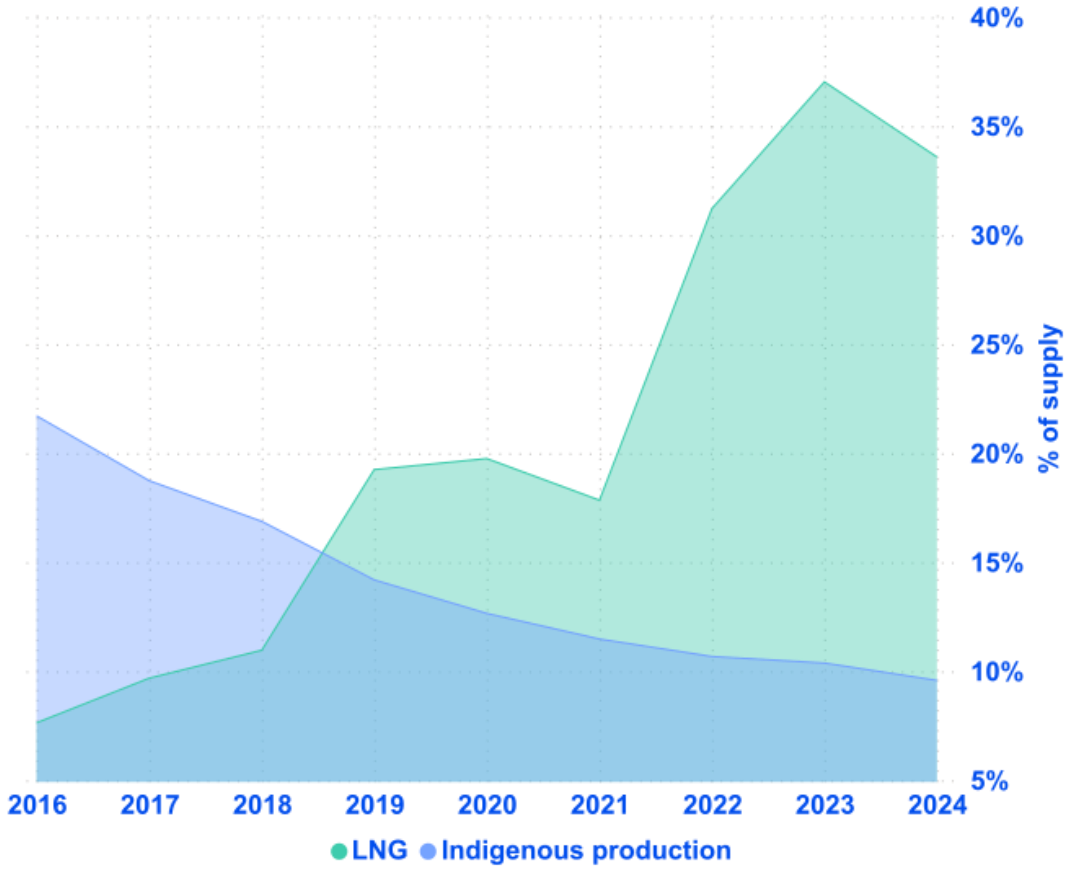


Source: ACER based on S&P Global.

Gas imports and renewables shape EU energy trade

Exposure to global dynamics is the new reality for EU gas markets.

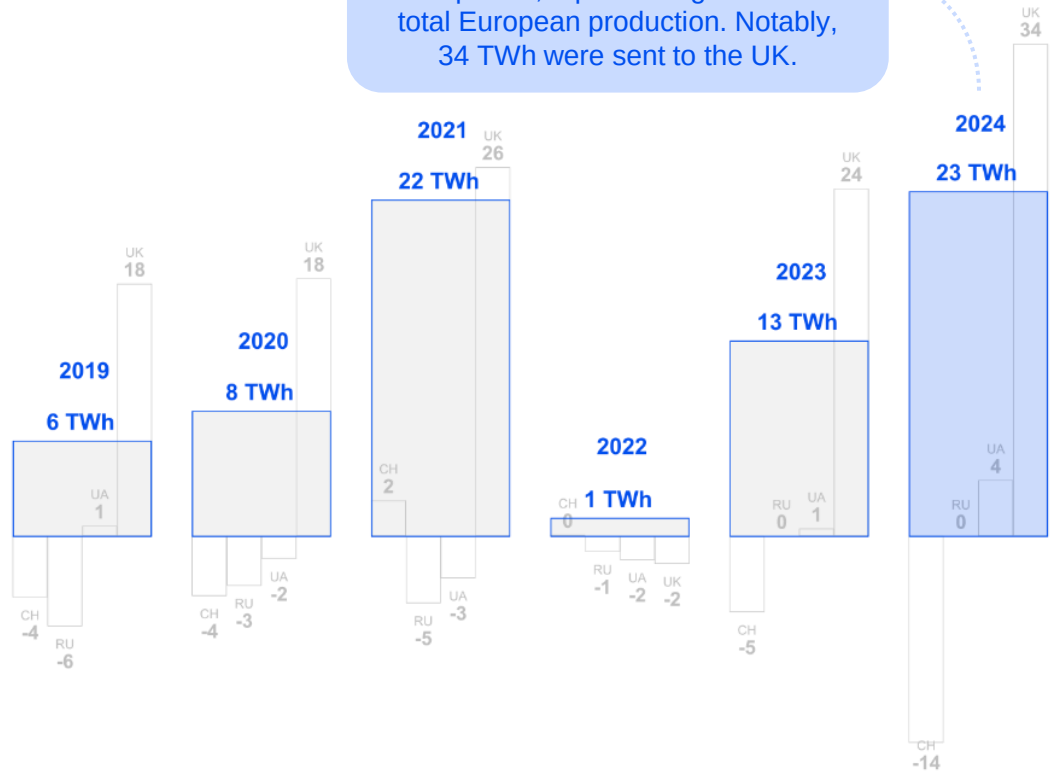
Share of LNG and indigenous production in total supply, EU-27, 2016-2024 (%)



Renewables support EU electricity production surplus.

EU electricity import (<0) and export (>0) from and to third countries, EU-27/EEA(Norway) and selected countries, 2019-2024 (TWh)

In 2024, the EU exported 23 TWh more electricity to third countries than it imported, representing 1% of the total European production. Notably, 34 TWh were sent to the UK.



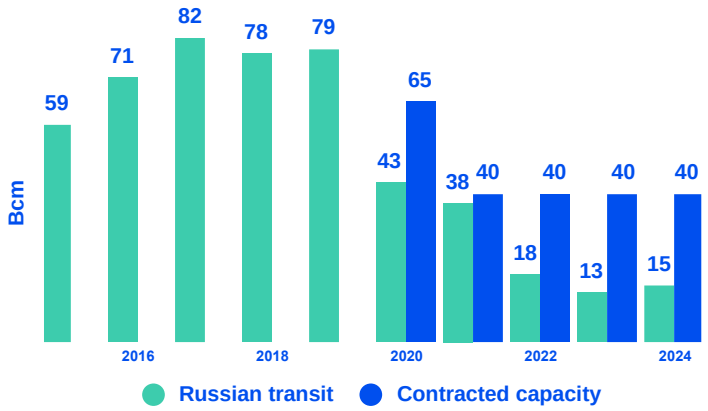
Sources: ACER based on S&P Global (left), ENTSO-E Transparency Platform (right).

Gas transits to EU via Ukraine ended after years of decline

Russian gas transit through Ukraine has declined sharply since 2022. However, the Ukraine-Russia gas transit agreement, active from 2020 to 2024, allowed some flows to continue despite the war. Expiring on 31 December 2024, it aligns with EU's 2027 phase-out plan but causes challenges for gas balances and transmission network obsolescence in CEE. The integrated European gas network and LNG import infrastructure ensures capacity is available to facilitate the substitution of terminated Russian supply. Replacing the circa 15 Bcm/year will mean importing more LNG cargoes into the EU while shippers of those volumes will incur higher cross-border transport costs to deliver gas to the affected markets such as Austria and Slovakia. Global LNG supply is set to expand in the coming years, but substantial additions may not be available in the course of 2025 leading to pressure on EU gas prices.

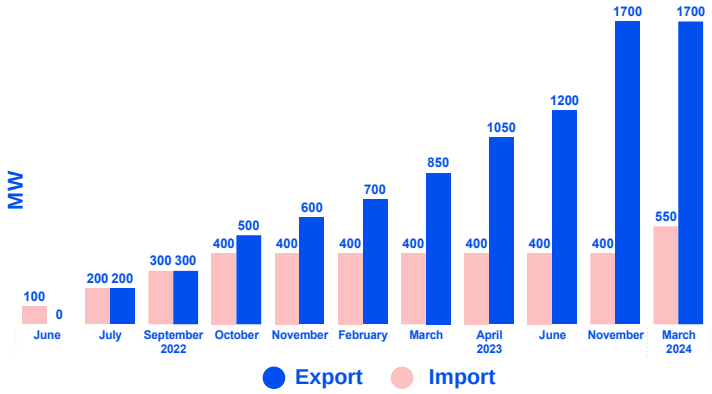
Ukraine transits of Russian gas cease after lapse of transport agreement.

Russian gas transits via Ukraine and contracted capacity, 2015-2024 (Bcm)



Russia's invasion increased exchanges between Ukrainian and European electricity networks.

Network Transfer Capacity development for Ukraine's export and import commercial exchanges with Europe, June 2022 to September 2024 (MW)



Source: ENTSO-G (left), ENTSO-E, Energy Community Regulatory Authorities (right).
Note: See End of transit via Ukraine – Information from the conclusions of the Commission's assessment, late 2024.

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Europe

- EU energy prices volatility
- How gas reliance influences electricity prices
- Renewables cut gas role in electricity generation but dependence remains

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In 2024, EU gas and electricity prices fell, remained volatile

Lower prices at the start of 2024

- In early 2024, EU energy markets saw falling gas and electricity prices, reaching their lowest levels since 2021. Plentiful supply outpaced moderately increasing demand across most of Europe. Nuclear generation in France rebounded after two years of maintenance constraints, hydropower output hit multi-year highs, and wind and solar capacity expanded.
- These factors reduced spot electricity prices and cut gas demand for power generation. Weak industrial and household demand, along with strong LNG supply, led to record gas storage levels by the end of winter.

Diverging trends from spring 2024

- From spring onwards, gas and electricity prices diverged. Electricity supply stayed strong, driven by non-price responsive sources like nuclear, wind, and solar. Gas and coal use remained low, but a fall in LNG imports due to tight global supply pushed EU gas prices higher. While gas storages reached mandated levels, high prices deterred industrial gas demand recovery.

Electricity prices and market volatility

- Strong output from non-price responsive sources kept average spot electricity prices low through summer across most of the EU. This also led to frequent periods of low or negative prices. Occurrences of negative prices had risen by 12 times in 2023; they increased further by half in 2024. However, electricity futures mirrored rising gas futures, reflecting market uncertainty. Some regions experienced spikes in electricity prices despite the overall trend.

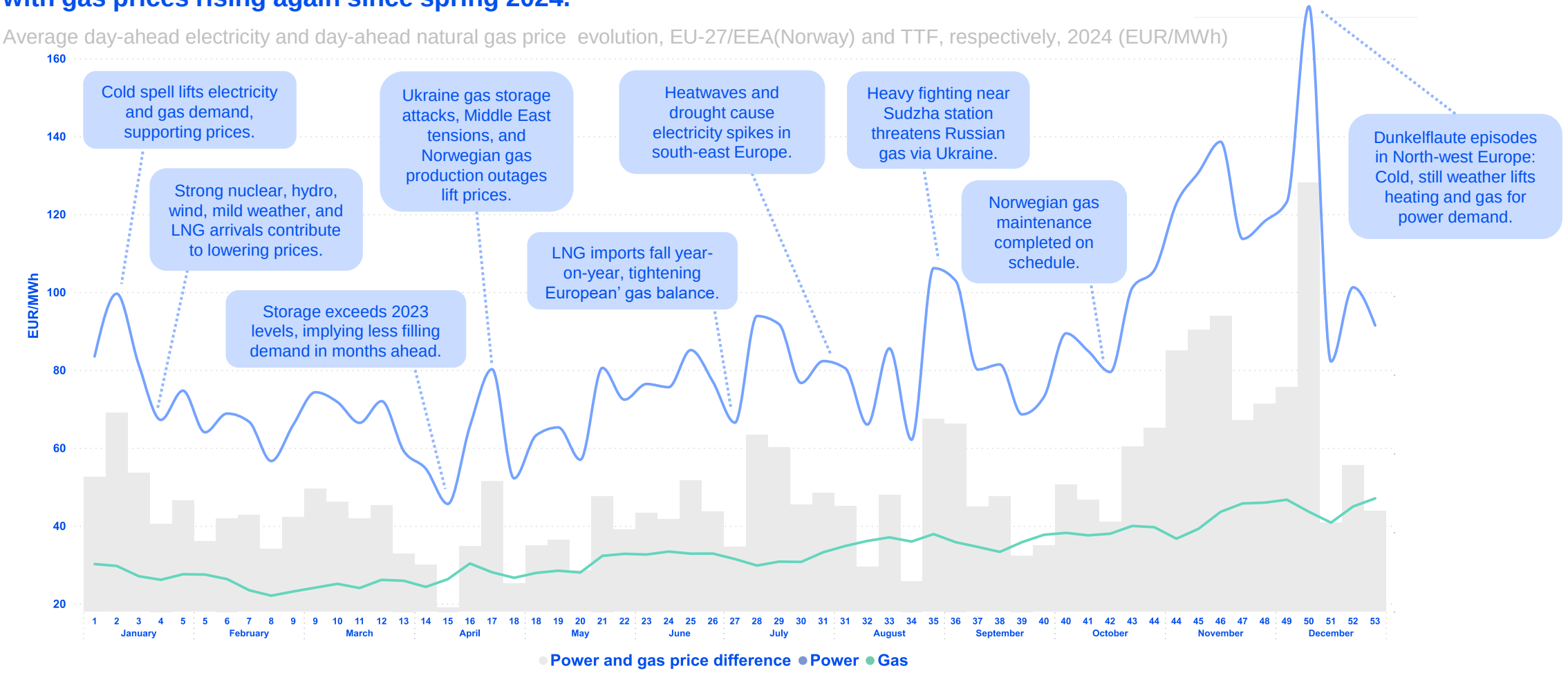
Markets tightened at year’s end

- Gas and electricity wholesale prices hit yearly highs in the last months of 2024. Gas storages were filled less and began emptying sooner than in the past two years, while the expected end of transit of Russian gas via Ukraine added further uncertainty. In electricity markets, episodes of low wind generation increased the call on gas generation, which was reflected in growing wholesale prices.

Energy markets faced both surplus and scarcity in 2024

EU wholesale electricity and gas prices fell to their lowest since 2021 but stayed higher and more volatile than pre-crisis levels, with gas prices rising again since spring 2024.

Average day-ahead electricity and day-ahead natural gas price evolution, EU-27/EEA(Norway) and TTF, respectively, 2024 (EUR/MWh)

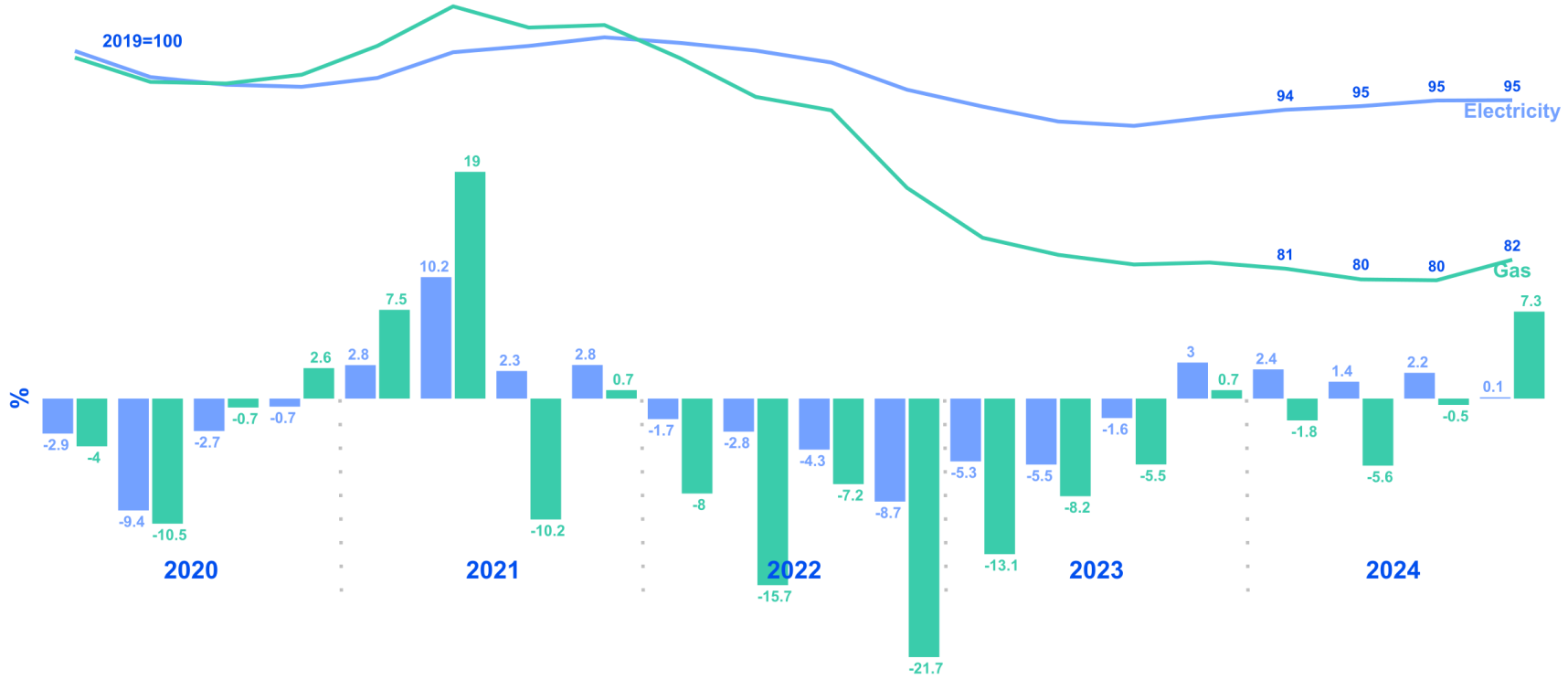


Source: ACER based on ICIS.
Note: The power and gas price difference is a weekly average value.

EU gas and electricity consumption slightly increased in 2024

Gas and electricity consumption rose for the first time since 2021 but remained below pre-crisis levels.

Changes in electricity and gas demand as year-on-year quarterly variations and variations compared to 2019, EU-27/EEA(Norway), 2020-2024 (%)



Since 2019, EU-27 gross domestic product grew, but energy demand lagged, possibly reflecting an industrial shift and improved energy efficiency.

Source: ENTSO-E Transparency Platform and EUROSTAT.
Note: electricity demand is electricity demand at wholesale level, not including behind-the-meter generation and consumption.

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In 2024, renewables reduced EU reliance on gas and coal

Electricity prices dropped across the EU

- **In 2024, EU electricity prices fell significantly, averaging 81 EUR/MWh compared to 227 EUR/MWh in 2022.** This marked the lowest prices since 2021, driven both by reduced reliance on fossil fuels and lower coal, gas and emission allowance prices.

Fossil fuels in decline, accelerated renewable expansion

- Coal and gas generation fell for the second straight year in 2024, continuing a sharp decline since 2022 as renewables expanded their share. Despite this shift, installed capacities of conventional generation remained stable, supporting the transition during peak demand.
- The energy crisis and geopolitical tensions spurred rapid renewable capacity growth across the EU. Solar increased by 21%, +41TWh in 2024 (+129% since 2019), with wind also rising, though impacted by slow permitting. Renewables' rapid expansion highlights the region's commitment to clean energy.

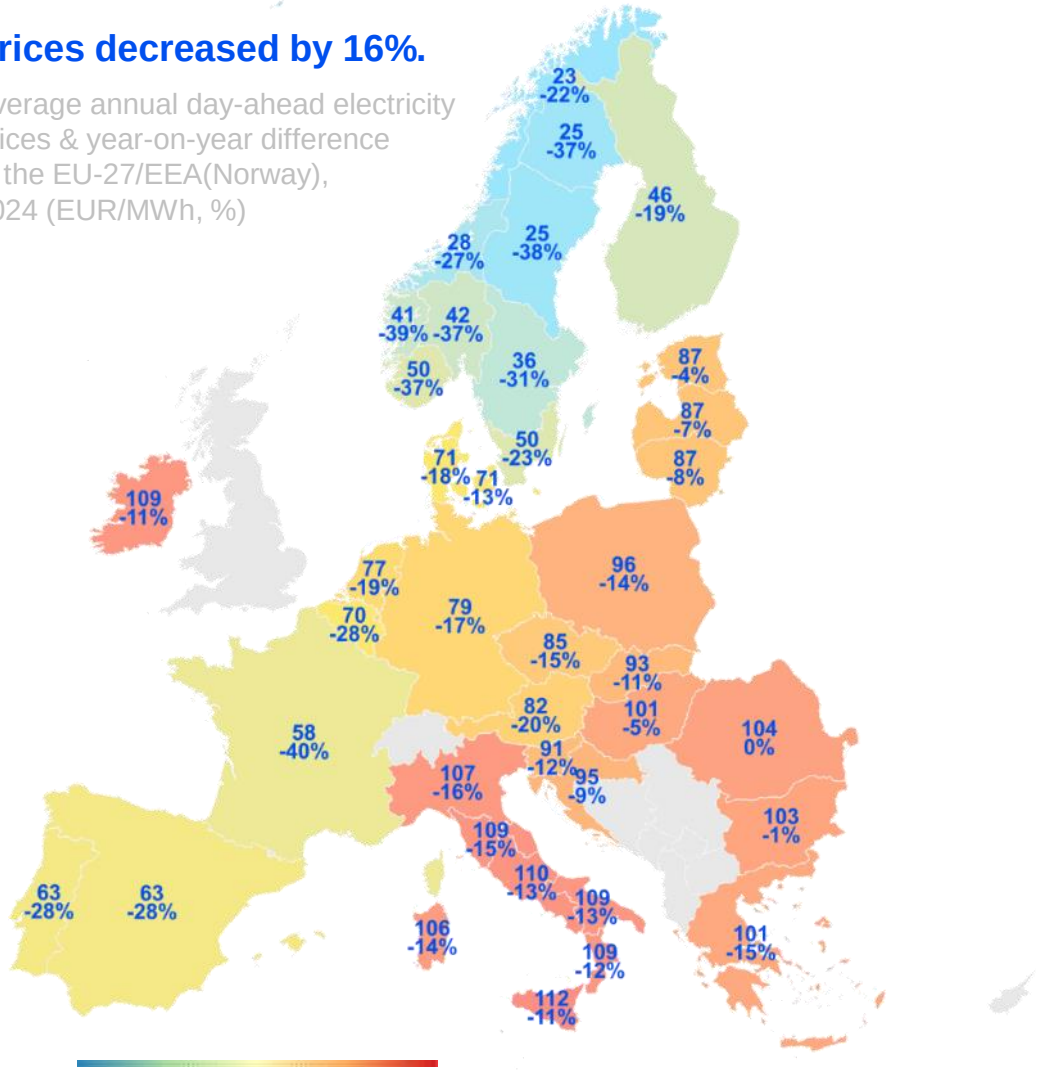
The evolving dynamics of gas and electricity markets

- The interplay between gas and electricity markets is driven by two main trends: growing renewable capacity and the retirement of coal power plants. As renewable generation outpaces electricity demand growth, the need for conventional generation has, on average, decreased.
- However, coal plant retirements have reduced competition among conventional power sources, limiting the ability to switch between coal and gas. While electricity markets are becoming less reliant on gas generation overall, they are increasingly exposed to gas market fluctuations during periods when fossil-fired generation is required.
- Near-real-time trades show weaker links between gas and electricity prices, reflecting renewable growth. However, longer-term trades highlight the ongoing importance of gas in electricity pricing.
- Countries with more low-carbon energy and less industrial activity show reduced correlations between gas and power prices, emphasizing the benefits of cleaner energy systems.

Gas reliance influences electricity prices

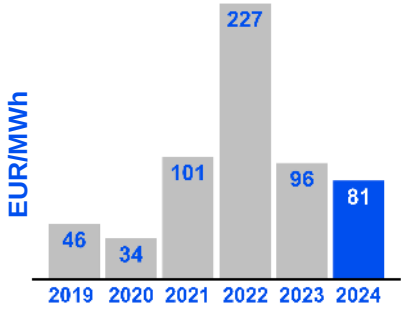
Prices decreased by 16%.

Average annual day-ahead electricity prices & year-on-year difference in the EU-27/EEA(Norway), 2024 (EUR/MWh, %)



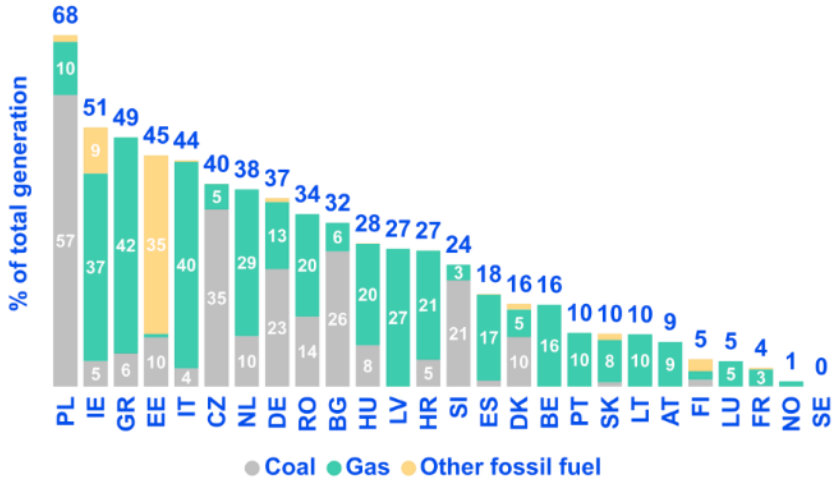
Day-ahead prices at their lowest since 2021.

Average annual day-ahead electricity prices, EU-27/EEA(Norway), 2019-2024 (EUR/MWh)



Fossil fuel reliance raises electricity prices.

Share of electricity generated from fossil fuels, EU-27/EEA(Norway), 2024 (EUR/MWh)

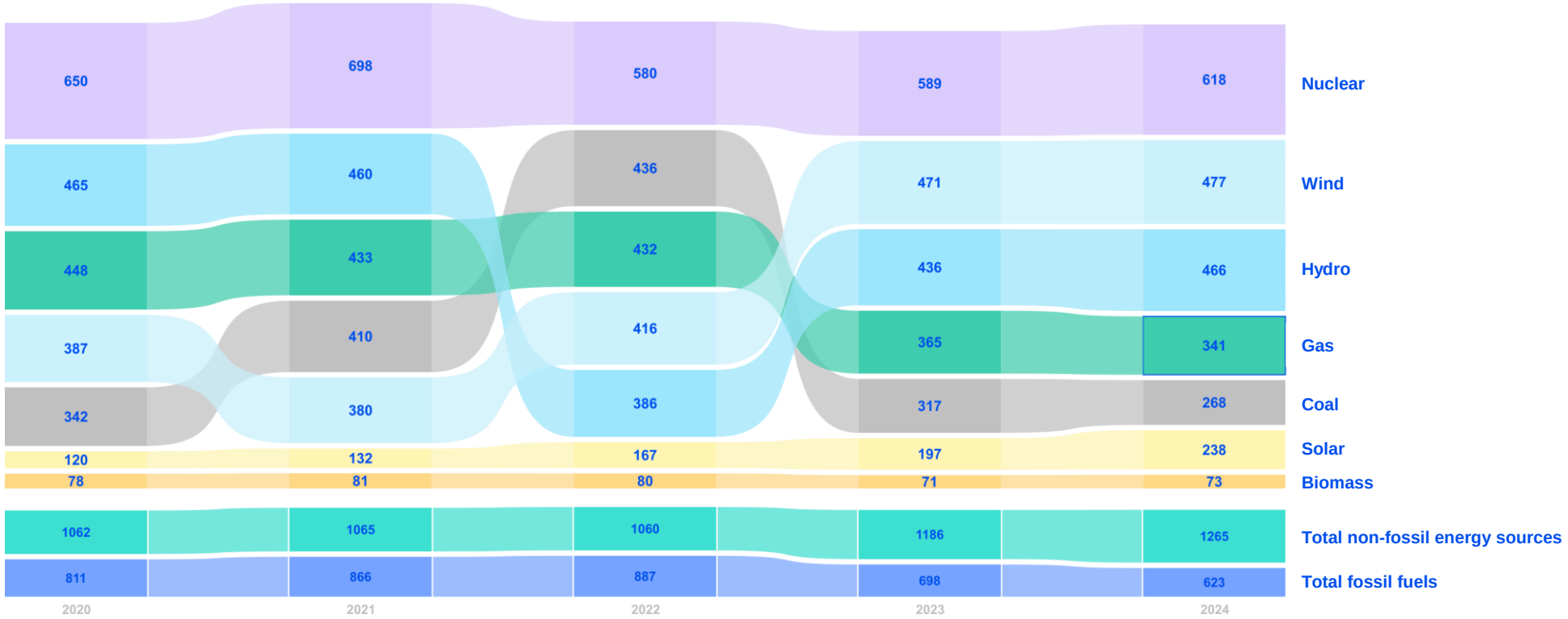


Source: ACER calculations based on ENTSO-E Transparency Platform.
Note: While not part of the EU, Norway provides data to the ENTSO-E Transparency Platform.

Renewables generation surged, fossil fuels declined further

Electricity generation: in 2024, wind confirmed its position, solar drove transition, coal, gas declined.

Evolution of generation per type in EU-27/EEA(Norway), 2020-2024 (TWh)



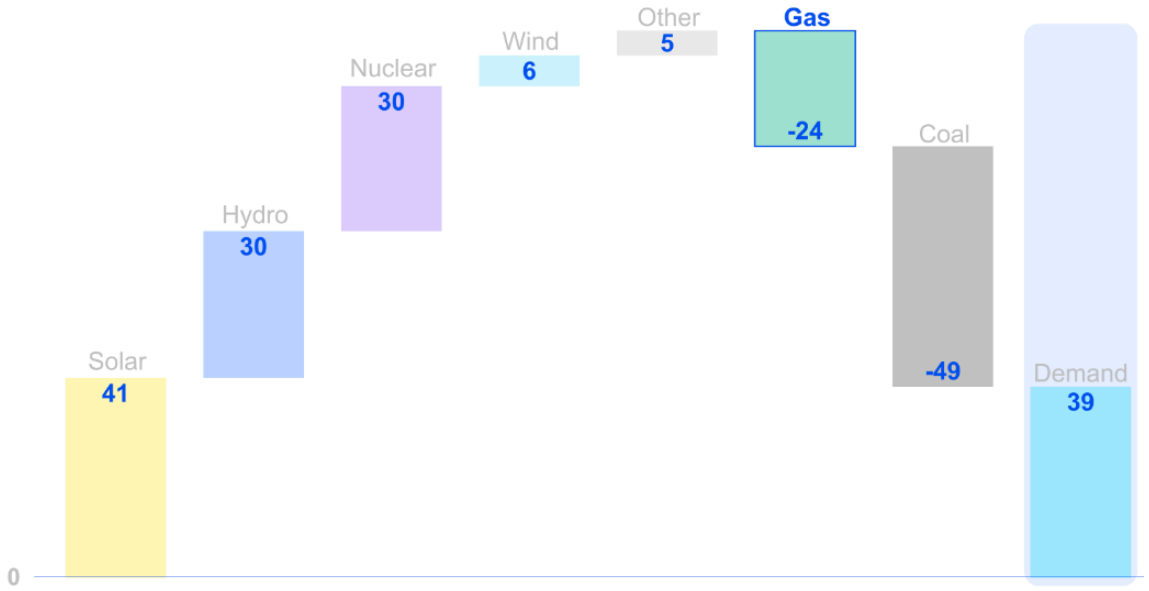
By 2024, fossil fuel use fell to a record low, contributing just 33% of EU power generation, about a third of EU power for the second consecutive year.

Source: ENTSO-E Transparency Platform.

Solar drove energy transition, offsetting gas demand

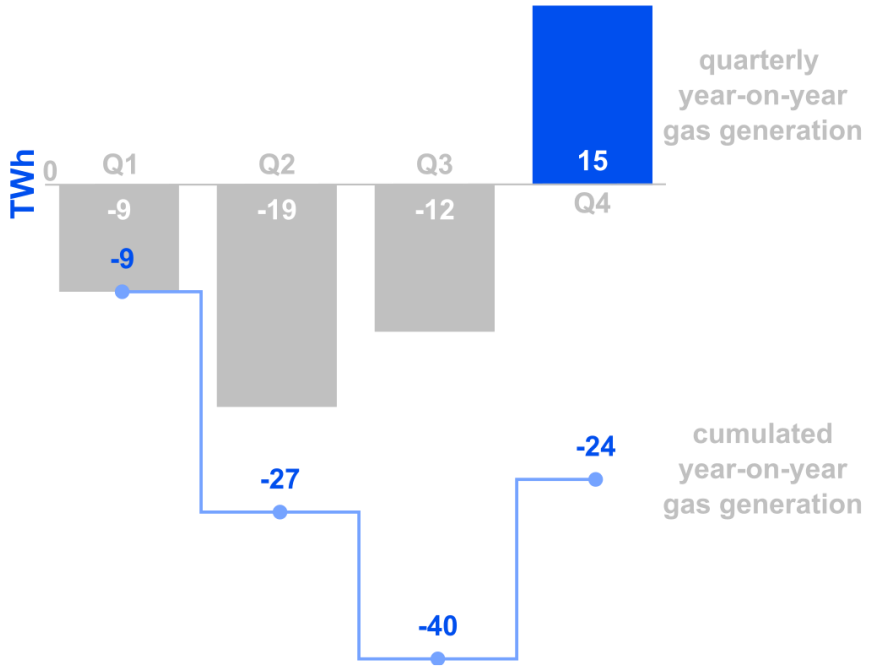
Electricity generation in 2024: Solar confirmed its leading role in the transition, nuclear, hydro back.

Year-on-year changes for the main generation technologies, EU-27/EEA(Norway), 2024 (TWh)



Adverse weather in last months of 2024 limited the decline in gas-generated electricity.

Year-on-year changes for gas generation, EU-27/EEA(Norway), 2024 (TWh)

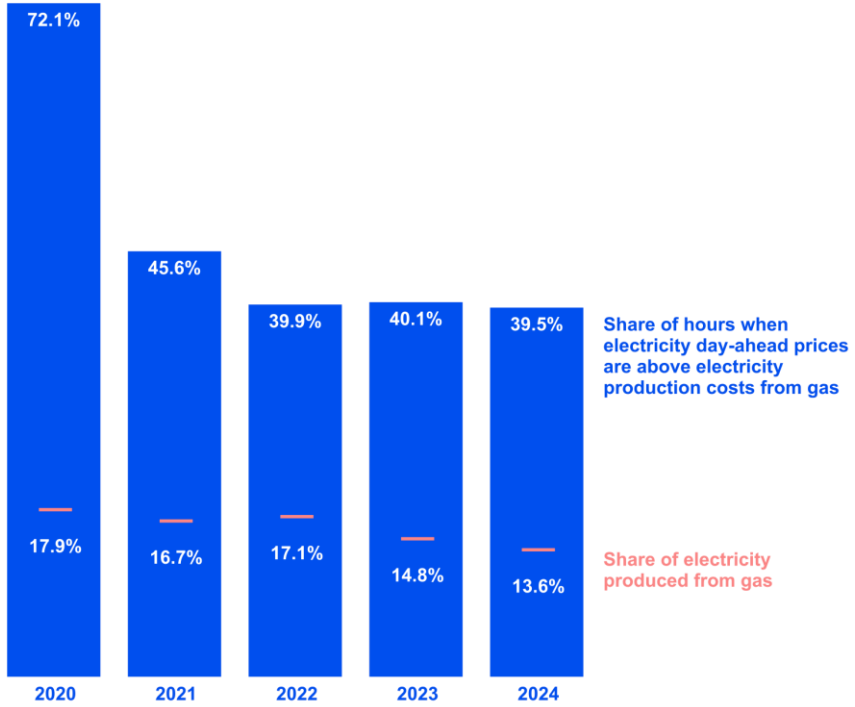


Source: ACER calculations based on ENTSO-E data. Note: Hydro does not include hydro-pumped storage. Hydro-pumped storage, biomass, and other generation sources were accounted for separately, with other generation sources, for which the aggregated variation in generation for 2023 was zero.

Renewables cut gas role, dependence remains

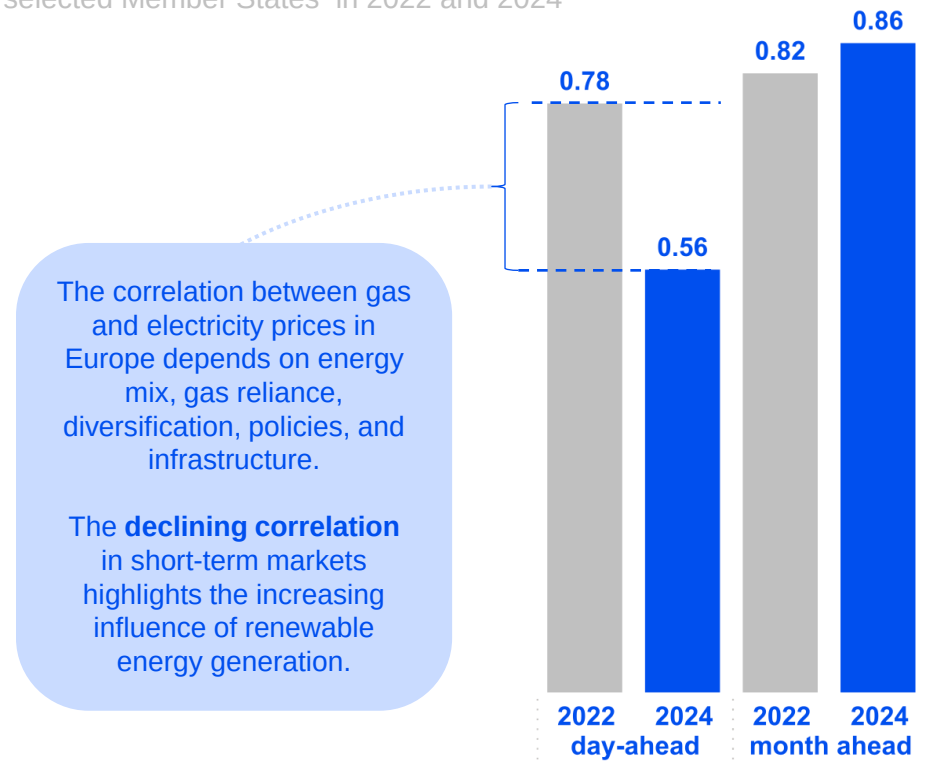
Declining role of gas in setting marginal electricity prices.

Percentage of hours when electricity day-ahead prices were equal or above costs of producing electricity from gas and gas-produced electricity as a share of the total electricity production (%) on average, EU-27, 2020-2024[1]



Interplay between gas and power prices shifted.

Correlation between gas and electricity month-ahead and day-ahead prices for selected Member States[2] in 2022 and 2024



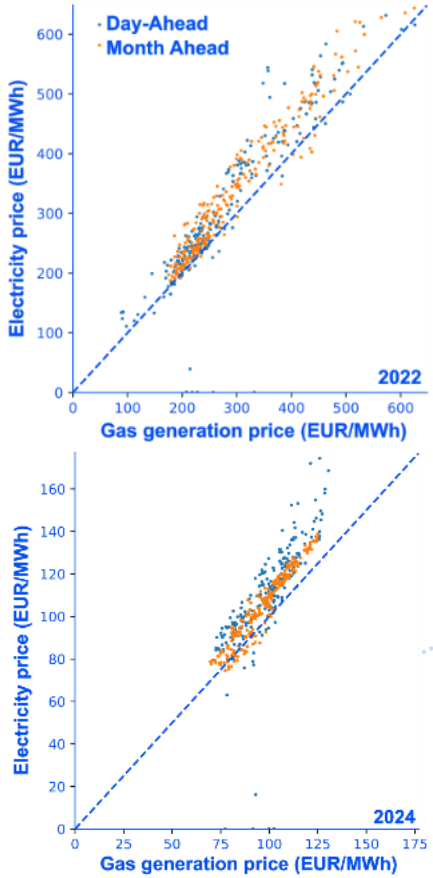
The correlation between gas and electricity prices in Europe depends on energy mix, gas reliance, diversification, policies, and infrastructure.

The **declining correlation** in short-term markets highlights the increasing influence of renewable energy generation.

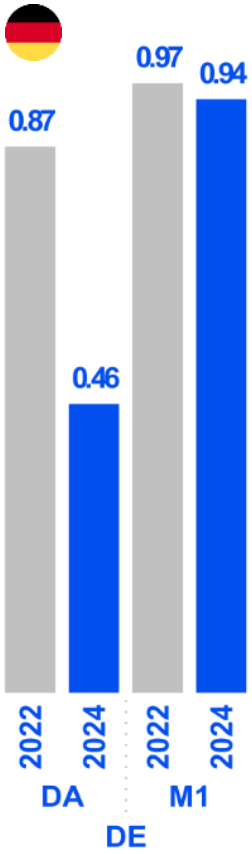
Further reducing gas reliance requires addressing its role in peak electricity supply and seasonal balancing of energy systems.

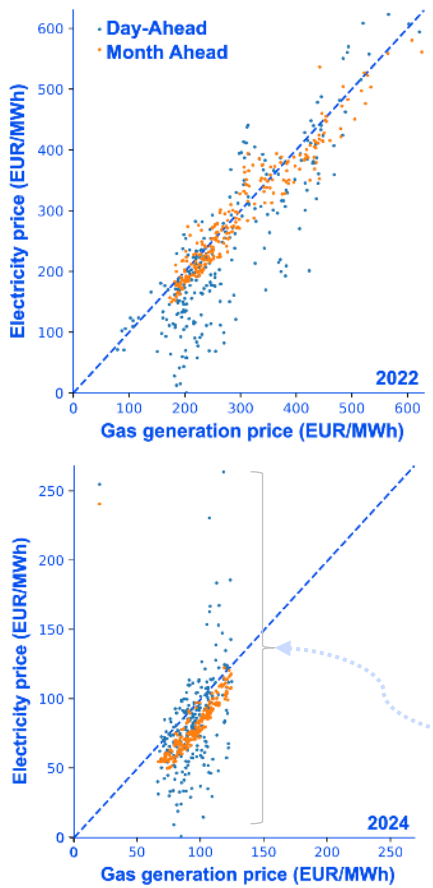
Source: ACER calculations based on ENTSO-E Transparency Platform.
Note 1: The cost of producing electricity from gas is obtained by applying an efficiency factor of 0.5 to gas prices and adding carbon emission allowance prices.
Note 2: Correlation of prices in EU Member States with significant data for day-ahead and month-ahead markets (AT, BE, CZ, DE, ES, FR, HU, IT, NL, PL).

Impact on Member States differ per varying electricity mix



Italy: Day-ahead and Month-ahead plots remain concentrated, showing strong correlation both in 2022 and 2024.



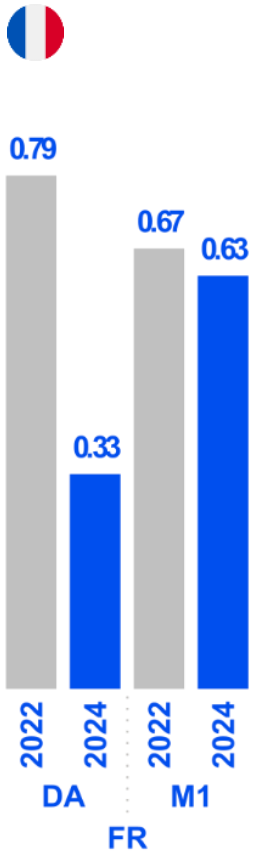


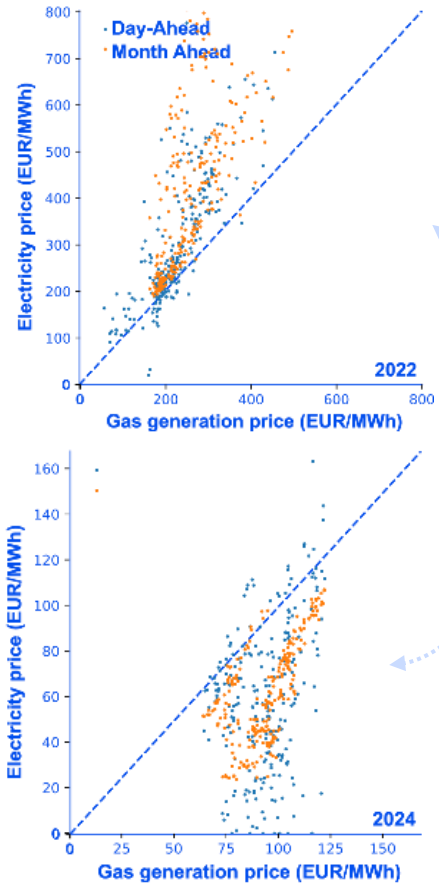
Germany: Day-ahead scattered plot in 2024 shows the impact of renewable energy sources.

In 2024, the link between gas and electricity prices in Italy remained similar to 2022. In Germany, long-term electricity and gas prices remained closely linked, but renewable deployment has reduced gas influence on short-term electricity prices.

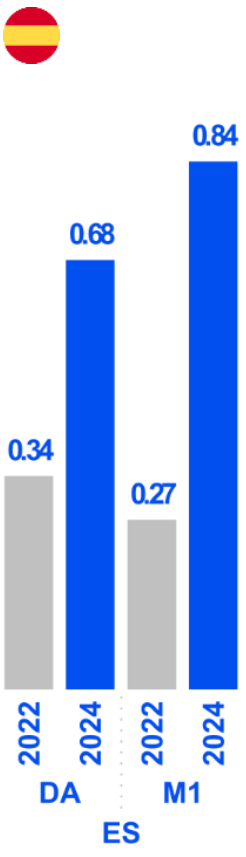
Source: ACER calculations based on ENTSO-E Transparency Platform.

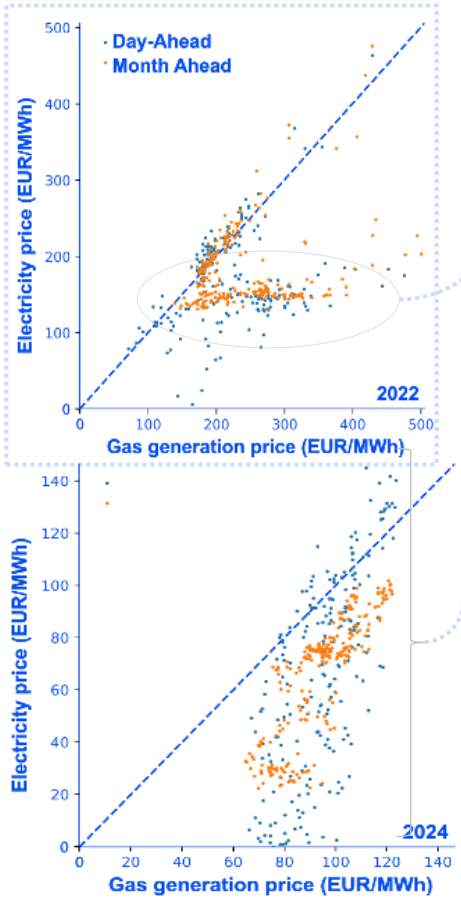
Impact on Member States differ per varying electricity mix





France: Day-ahead and Month-ahead plots show moderate correlation both in 2022 and 2024, revealing the importance of low carbon sources in the energy mix.





Cap on gas prices.

Spain: Day-ahead scattered plot in 2024 shows the impact of renewable energy sources.

In 2024, gas had significantly less impact on electricity prices in France than in 2022, with the return of nuclear capacity.
In Spain, rising solar power likely reduced the correlation, but the 2022 gas price cap also kept it low, making the impact unclear.

Source: ACER calculations based on ENTSO-E Transparency Platform.

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EU electricity prices dropped as renewables rose

Surge in low and negative electricity prices

- **Negative electricity prices rose across the EU and Norway in frequency and magnitude.**
  - ➢ *Finland and Sweden experienced negative prices 8% of the time, mainly due to Finland's nuclear recovery. Bulgaria, Greece and Spain faced their first-ever negative prices*.*
- Low demand and high supply, combined with subsidized renewables with guaranteed revenue, push prices below zero. These renewables outcompete non-responsive conventional plants, exacerbating negative price episodes. Improved subsidy designs could align renewable output with system needs, reducing such occurrences.

Cross-zonal trade improves, but volatility persists

- **Enhanced capacity calculation and allocation methods, like flow-based market coupling in the Nordic capacity calculation region, and the on-going implementation of a minimum 70% requirement have improved cross-zonal trade.** However, increased renewable integration puts pressure on the grid, relying heavily on cross-zonal trade, network development and congestion management. ACER continues to monitor these developments, with a new report on congestion management due in July.

Gas market price convergence

- Unlike electricity, gas cross-zonal trade is generally not limited by capacity. After record-high gas hub price spreads in 2022, prices began converging in 2023. New LNG terminals and expanded transport capacity eased congestion from disrupted Russian flows. **By 2024, price convergence returned to levels comparable to or higher than those in 2021.**

Note: Negative prices are enabled by shifts in contract structures that redefine risk allocation between lenders and producers.

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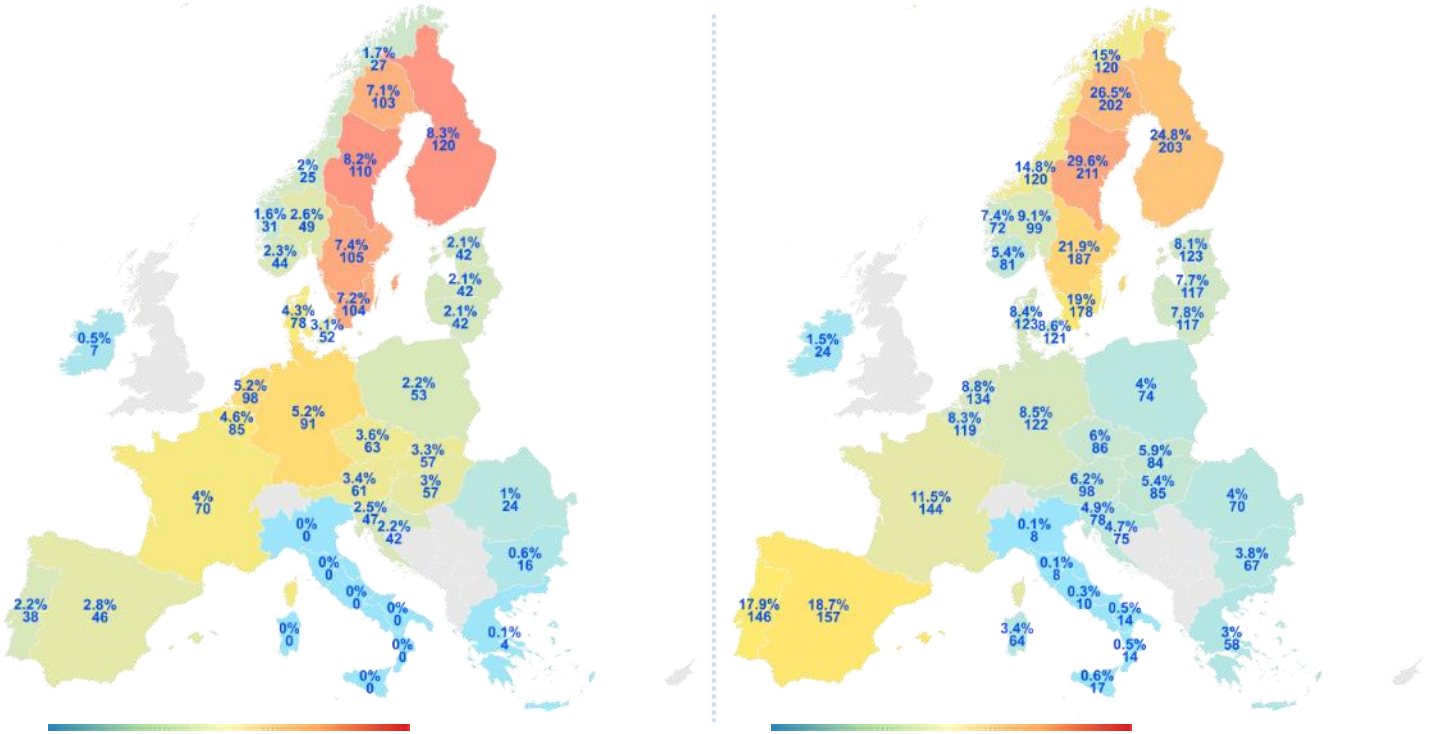
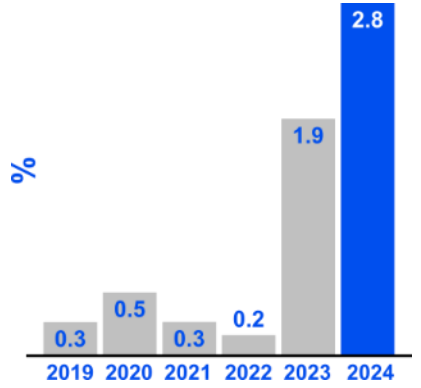
Negative and low electricity prices increased

Surge in negative electricity prices across the EU in 2023 intensifies further in 2024.

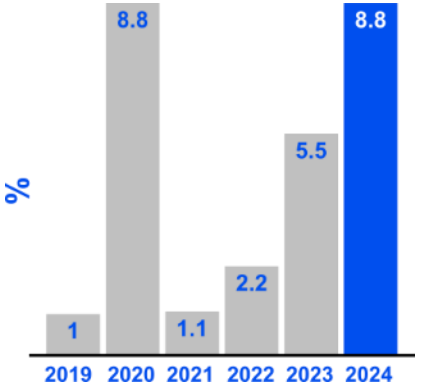
Percentage of the time and number of days when prices were negative (left) and below 5€/MWh (right), EU-27/EEA(Norway), 2024



Annual percentage of the time when prices were negative, EU-27/EEA (Norway), 2019-2024 (%)



Annual percentage of the time when prices were <5EUR/MWh, EU-27/EEA (Norway), 2019-2024 (%)



Occurrences of negative prices had risen by 12 times in 2023; they increased further by half in 2024.
Better subsidy designs and overall tariffs reflecting local constraints could encourage renewable producers to align output with system needs, reducing negative price episodes.

Source: ACER calculations based on ENTSO-E Transparency Platform.

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Case study
Summer electricity price spikes in Southeastern Europe

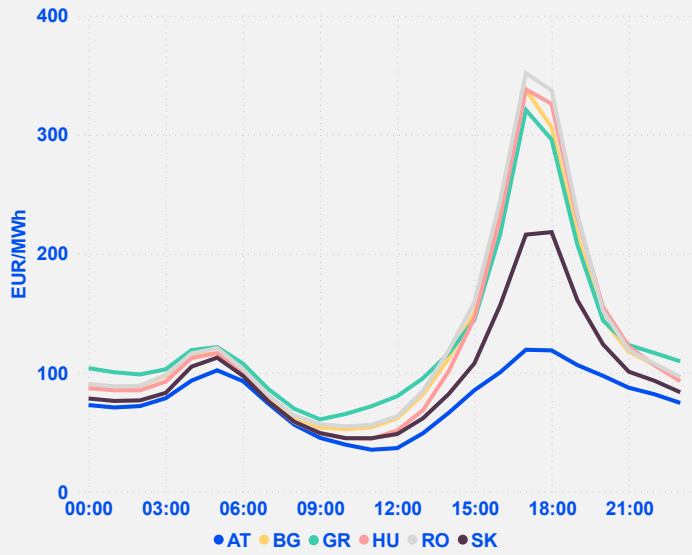
From mid-July to mid-September, southern and central eastern Europe experienced sustained high evening day-ahead prices, with price decorrelation from western-European bidding zones.

Between July and September, hourly electricity prices exceeded EUR 300/MWh on average over 104 hours in Romania, Hungary, Bulgaria, Greece, and Croatia.

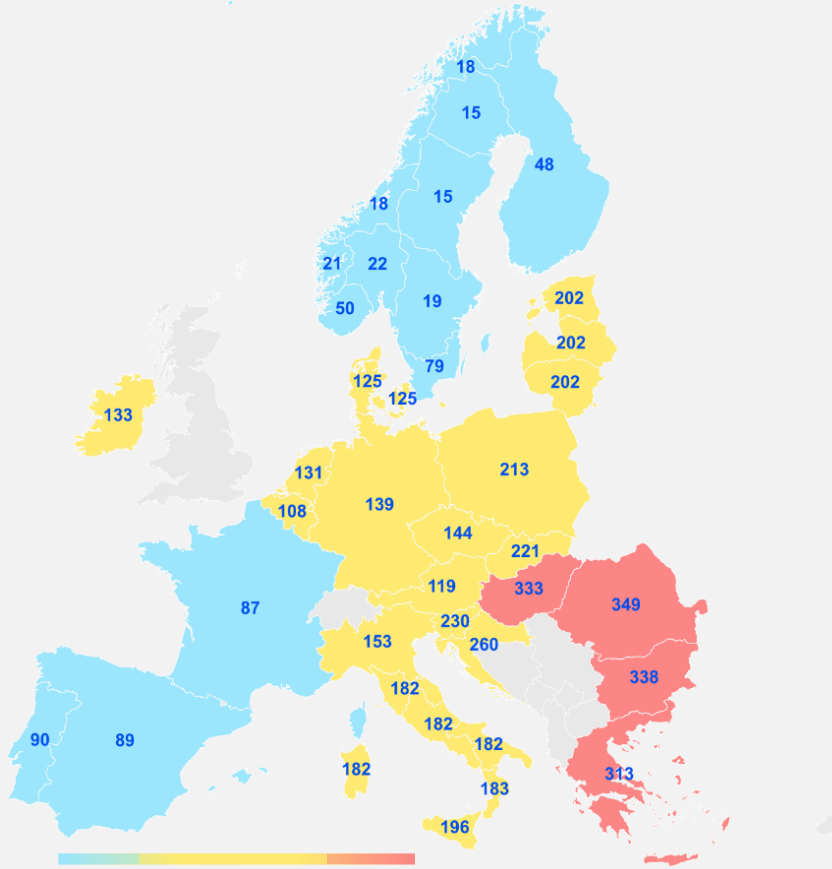
Heatwaves and drought reduced domestic hydro and nuclear generation and drove high peak demand. Limited flexible assets (gas powerplant outages) and low cross-zonal capacity for imports exacerbated the situation. Exports to Ukraine also played a role.

The main bottlenecks in the grid were in Austria and Slovakia. The root causes of the spikes are a lack of local flexibility, issue further developed in this report, and a lack of cross-zonal capacity, detailed in a dedicated ACER report, with the next edition set for publication in July.

Evolution of average day-ahead prices in select EU bidding zones, July to September 2024 (EUR/MWh)



Average day-ahead prices, EU-27/EEA(Norway), July to September 2024 at 17:00 UTC (EUR/MWh)



Source: ACER calculations based on ENTSO-E Transparency Platform.

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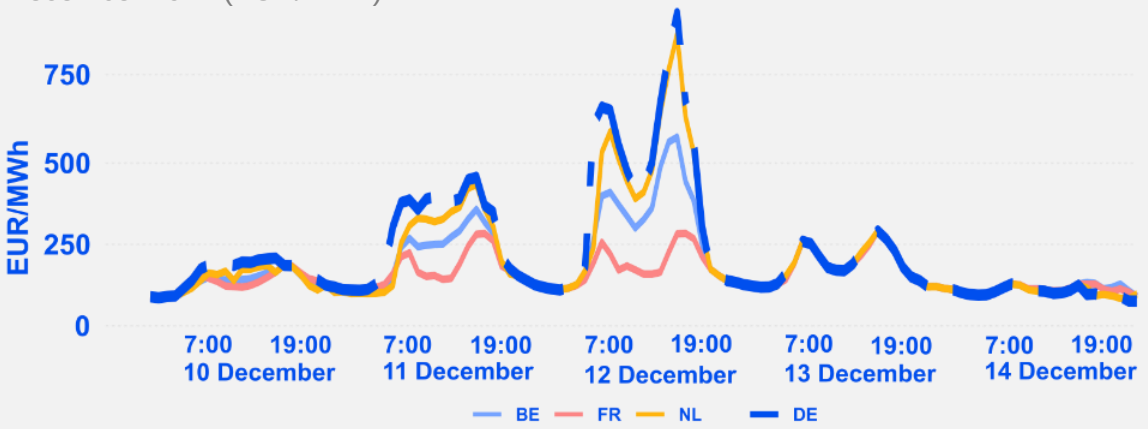
Case study
Electricity price spikes in Germany, 11 December

Germany faced a Dunkelflaute in December 2024, with wind generation falling significantly below the seasonal norm.

- 'Dunkelflaute' refers to periods of low solar and wind power generation, lasting hours or days, which challenge renewable-based energy systems.
- On 12 December day-ahead and intraday power prices neared 1,000 EUR/MWh, far exceeding the annual average of 81 EUR/MWh.
- Cold weather drove demand up, while fossil fuel plants and imports had to compensate for 11 GW of fossil capacity outages.
  - ➢ *As fossil fuel plants remain key at peak times, better EU-wide coordination of plant planned outages is increasingly vital.*
- Energy-intensive industries reduced production to avoid costs, but long-term contracts shielded most consumers.

Day-ahead prices in Belgium, France, Germany and the Netherlands, 10 to 12 December 2024 (EUR/MWh)



- These events highlight the need for EU-wide grid interconnection and other flexibility sources, possibly in the form of backup generation capacity (such as thermal generation, storage or demand-response).
  - ➢ *Local flexibility will help manage short Dunkelflaute episodes, while longer ones may require energy imports.*
- Strengthening overall system flexibility will help ensure supply security during severe conditions and prevent more extreme situations (one example outside the EU being the 2021 Texas gas and power crisis).

Source: ACER calculations based on ENTSO-E Transparency Platform.

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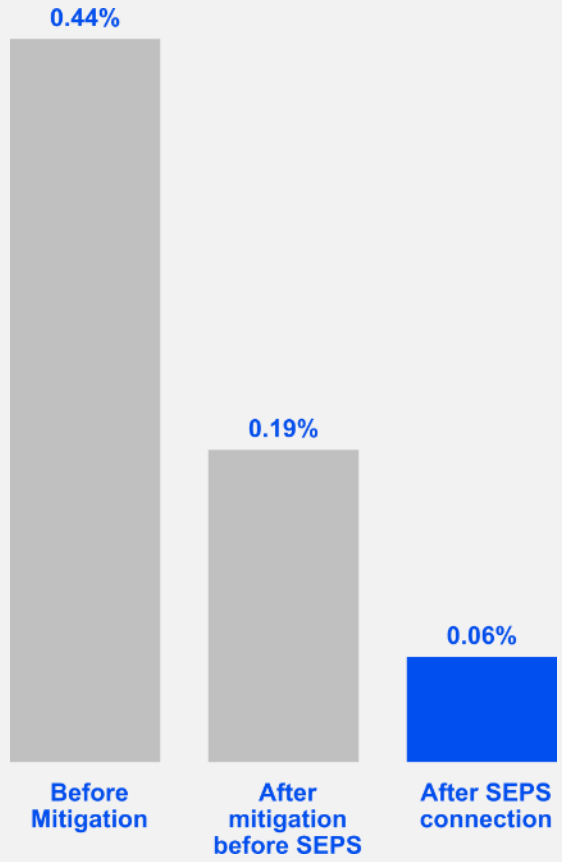
Case study

More balancing participation means fewer price incidents

Mitigating measures and the participation of more transmission system operators contributed to lowering the number of instances of electricity balancing price spikes.

- Balancing the electricity system is crucial for system security, ensuring supply-demand balance and frequency stability in real time. Integrating balancing markets across borders lower costs and improve efficiency by allowing TSOs to activate cheaper balancing energy bids.
- The new method for calculating cross-border marginal prices on the PICASSO platform[1] has greatly improved performance.
- Since adopting this alternative method, price incidents have dropped across all Load Frequency Control areas, with an average of 65%[2] decrease compared to earlier in 2024. Compared to the same time last year, incidents also fell by 60% on average, showing the improvement is not just seasonal.
- Further, additional participation of transmission system operators in balancing platforms has further improved their efficiency, e.g. in the Czech market with the participation of the Slovak transmission system operator, and a further reduction by 30% in price incidents.

Slovak transmission system operator (SEPS) connection to the PICASSO platform on Czech market reduces price incidents, 2024[2] (%)



Source: Transnet BW.
Note 1: As approved by ACER Decision 2024/08. See also the 2024 ACER report on market integration (page 33).
Note 2: These values represent the percentage of time with price incidents; the time unit considered here is an optimisation cycle.

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Challenges ahead

- Electricity prices reveal a need for short-term flexibility
- Short-term flexibility solutions exist; uptake must grow
- Seasonal flexibility remains ensured by gas

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Flexible systems key to efficient energy transition

Peak and baseload price gap

- Since 2019, the average daily gap between the lowest and highest day-ahead electricity prices has almost doubled. Gas and coal continue to provide critical short-term and seasonal flexibility during peak demand but come with high marginal costs and environmental impacts, raising questions about their long-term sustainability.
- Solar, wind, hydro, and nuclear energy are key to lowering electricity prices but require flexible energy systems for stability.

Emerging flexibility solutions

- Interconnectivity, storage, and demand-side flexibility are becoming essential for stabilizing markets and preventing excessively low capture prices[1] for wind and solar, in addition to facilitating grid operation. Expanding and diversifying flexibility resources, including large-scale batteries, will reduce reliance on fossil fuels.
- Battery Energy Storage Systems (BESS) are emerging to address within-day flexibility gaps, but progress remains slow. Regulatory support is needed to accelerate deployment and scale.

Renewables and regional integration

- Wind and solar variability require combining technologies and aligning regional patterns to balance output and lower costs. EU-wide coordination can increase capacity factors, reduce risks, and accelerate the energy transition.

The role of gas storage

- While decarbonization progresses, alternatives to gas storage for seasonal flexibility remain underdeveloped. Gas storages play a critical role in ensuring security of supply and market stability. The energy crisis underscored the need for coordinated, efficient storage policies to avoid costly missteps, and backup capacity (such as thermal generation, storage or demand-response) ensuring security of supply during extreme conditions.

Note: The capture price is the weighted average price that a power generation technology receives for its electricity in the market.

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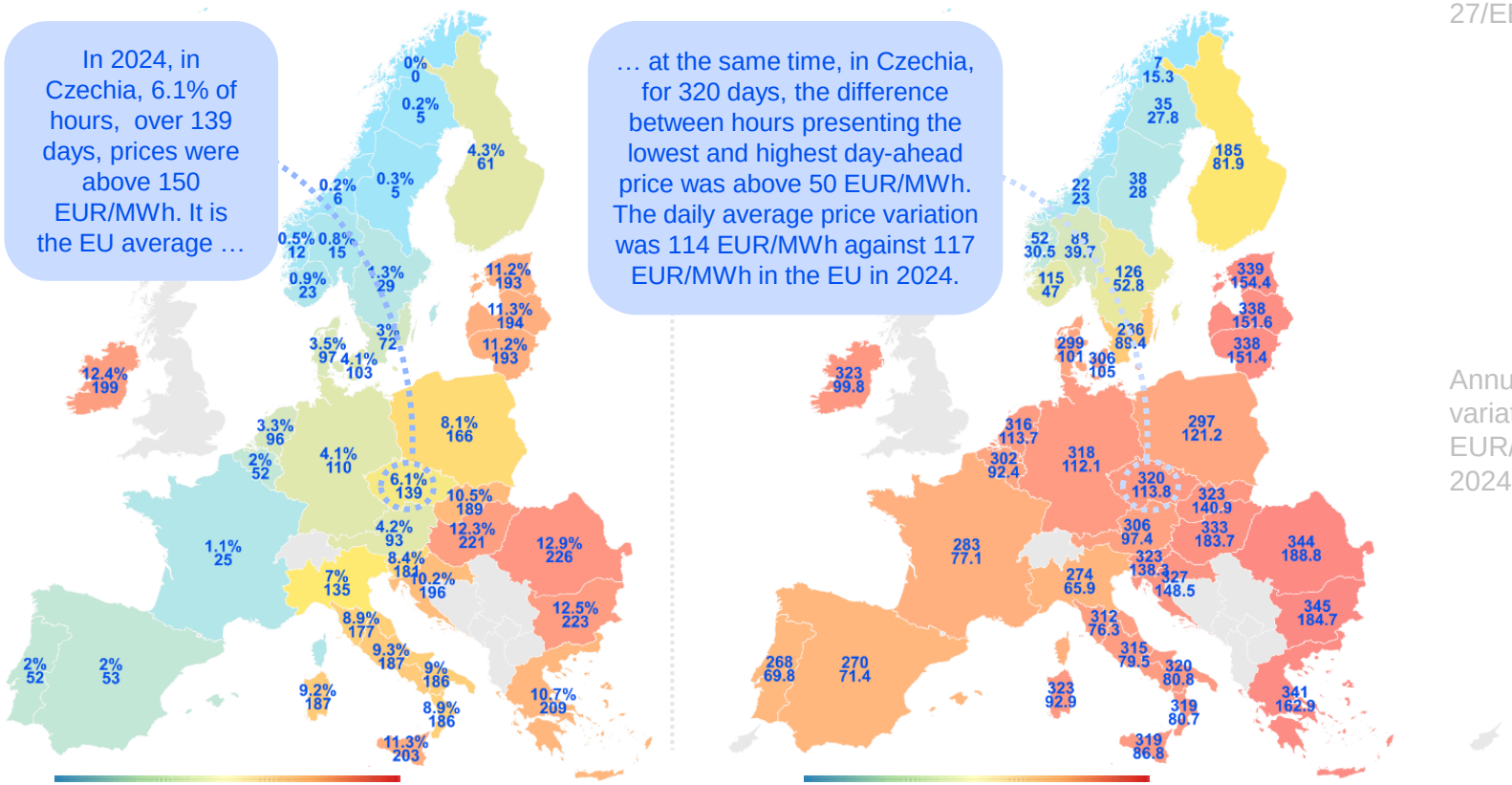
Electricity prices reveal a need for short-term flexibility

Fewer extreme price spikes after the crisis, but strong price swings persist.

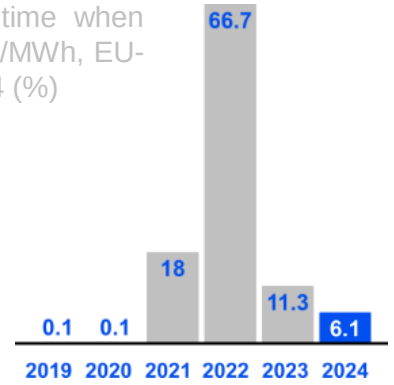
Share of hours and number of days with electricity prices above 150 EUR/MWh (left), number of days with price swings above 50€ and average within-day price difference (right), EU-27/EEA(Norway), 2024

In 2024, in Czechia, 6.1% of hours, over 139 days, prices were above 150 EUR/MWh. It is the EU average …

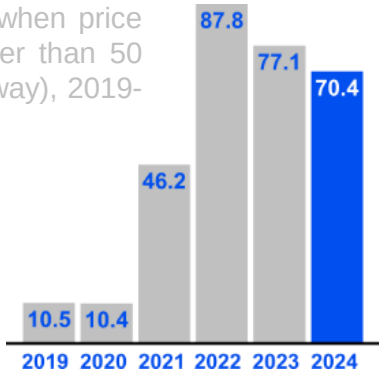
… at the same time, in Czechia, for 320 days, the difference between hours presenting the lowest and highest day-ahead price was above 50 EUR/MWh. The daily average price variation was 114 EUR/MWh against 117 EUR/MWh in the EU in 2024.



Annual percentage of the time when prices were above 150 EUR/MWh, EU-27/EEA(Norway), 2019-2024 (%)



Annual percentage of days when price variation per day was greater than 50 EUR/MWh, EU-27/EEA(Norway), 2019-2024 (%)



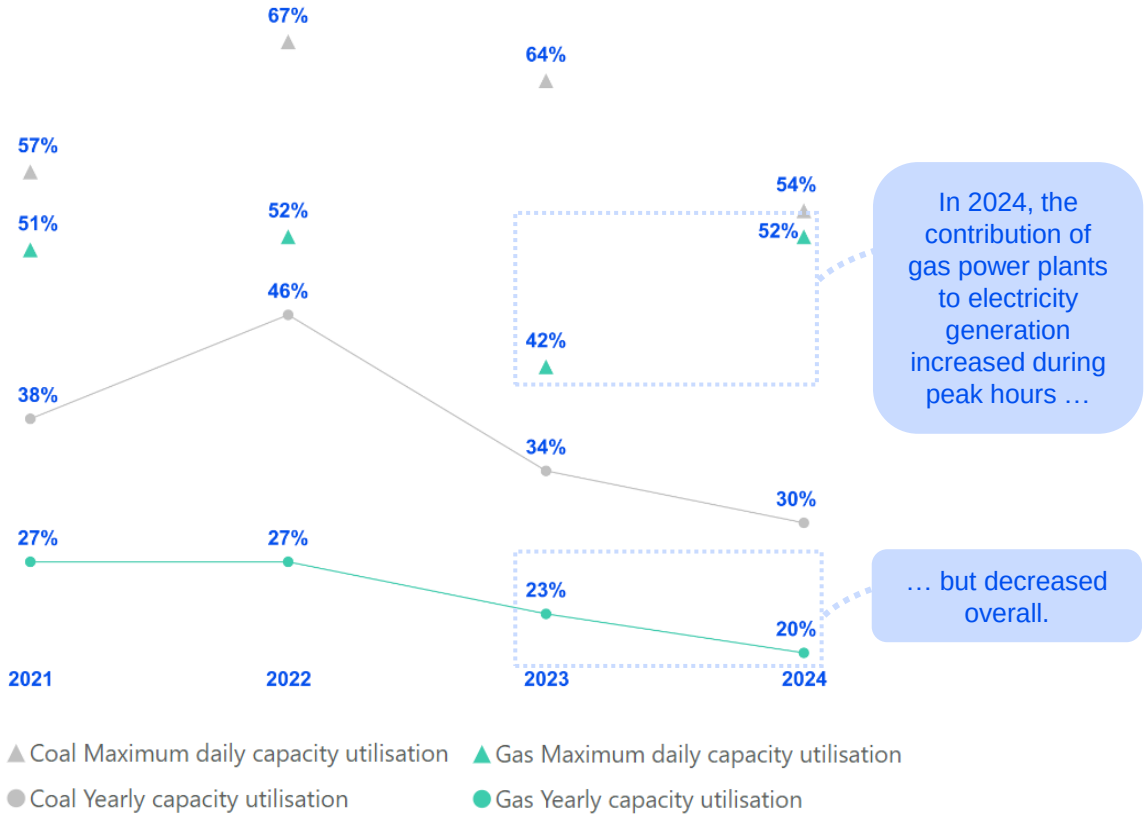
Electricity prices are now less extreme, but frequent swings within a day remain.
This signals shifting supply-demand patterns that call for more short-term flexibility.

Source: ACER calculations based on ENTSO-E Transparency Platform.

Peak gas use drove costly short-term electricity flexibility

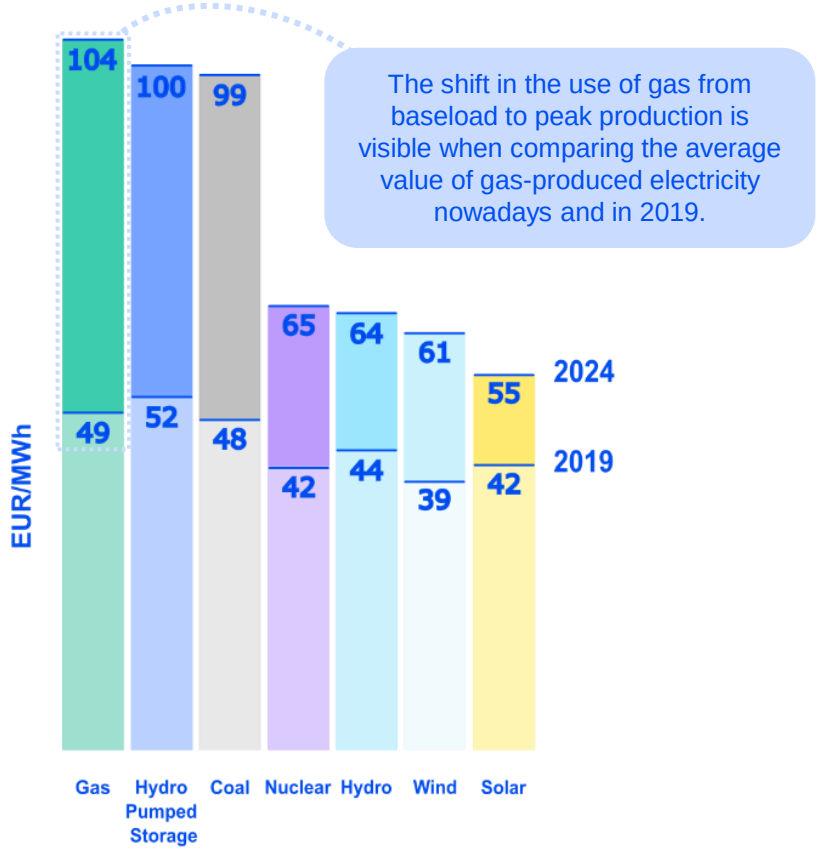
Baseline utilisation of coal, gas fired power plants decrease, peak-time contribution of gas increase.

Capacity factors of coal and gas-fired power plants, EU-27/EEA(Norway), 2021-2024 (%)



Fossil fuel technologies mainly run during high-price hours.

Average value of electricity by production type* in the EU-27/EEA(Norway), 2024 (EUR/MWh)



Source: ACER calculations based on ENTSO-E Transparency Platform.
Note: This value, for each technology, is calculated as the sum of the hourly generation multiplied by the hourly day-ahead prices, divided by the total annual generation.

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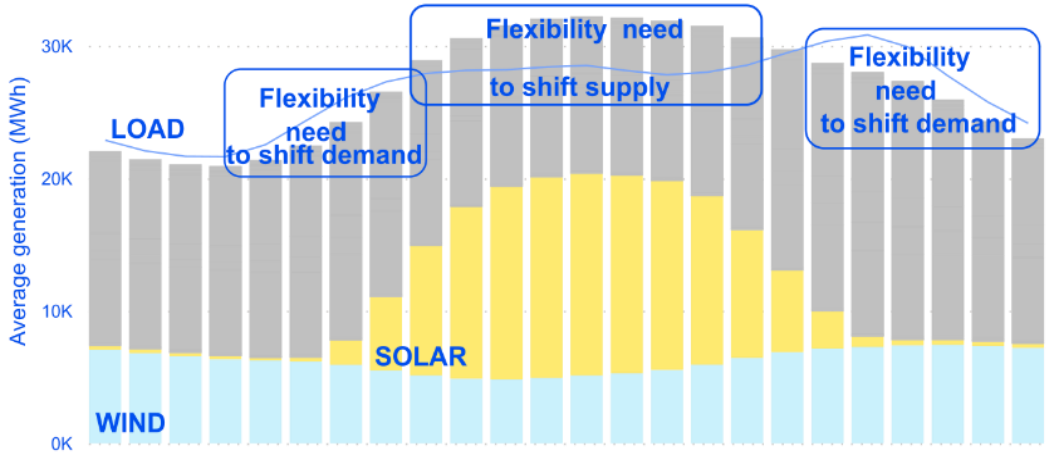
Short-term flexibility solutions exist; uptake must grow

The gap between midday solar oversupply and evening demand is growing.

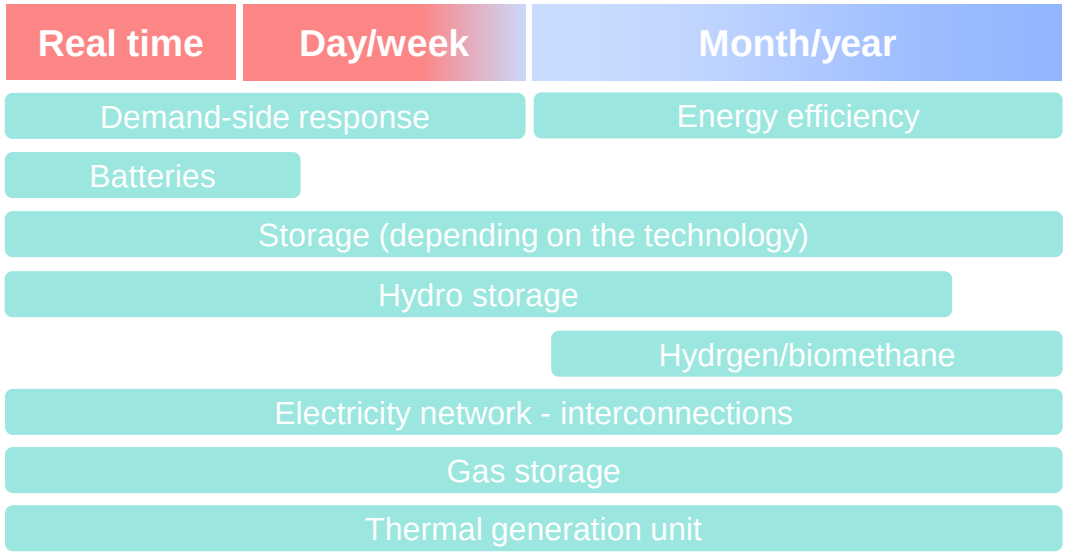
Renewables induce short-term flexibility needs.

Hourly averages of energy generation in Spain, 2024 (MWh)



Demand-response, interconnections, and batteries are key.

Flexibility services provided by various technologies, sorted according to their duration[1]



In real time, the gap between midday solar oversupply and evening demand is growing. Solutions exist and must be implemented. Managing this gap requires access to demand-side response[2], battery deployment, and cross-border trade through interconnections[3]. For longer-term flexibility, the role of gas storage remains central.

Note 1: The list of technologies is non-exhaustive (with e.g. the storage category covering several different technologies). As mentioned, coupling electricity with other energy sectors (sector integration) may provide significant flexibility services. Note 2: See the 2023 ACER report on demand response and other distributed energy resources and the upcoming ACER report on no-regret measures to remove barriers to demand response (April 2025). Note 3: See the 2024 ACER report on capacities for cross-zonal electricity trade and congestion management.

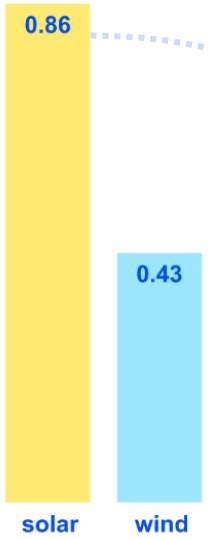
Regional coordination of renewables cuts costs, variability

The availability of wind and solar generation varies across countries. In comparison, solar generation shows less complementarity across regions than wind.

Correlation of solar generation across European capacity calculation regions, 2024

	SEE	SWE	IT. North	Nordic	GRIT	Baltic	Hansa	Core
SEE	1.0	0.7	0.8	0.8	0.7	0.8	0.8	0.8
SWE	0.7	1.0	0.8	0.8	0.8	0.8	0.8	0.9
IT. North	0.8	0.8	1.0	0.8	0.8	0.9	0.9	0.9
Nordic	0.8	0.8	0.8	1.0	1.0	0.8	1.0	0.9
GRIT	0.7	0.8	0.8	1.0	1.0	0.9	1.0	0.9
Baltic	0.8	0.8	0.9	0.8	0.9	1.0	0.9	1.0
Hansa	0.8	0.8	0.9	1.0	1.0	0.9	1.0	1.0
Core	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0

Generation correlation across European capacity calculation regions, 2024



While wind generation offers some extent of complementarity across regions, solar generation is highly correlated – when solar generation is low in one region, it is low in the neighbouring region and cannot be imported.

The Nordic and Core region show moderate correlation. Surplus wind generation can be exported from one region to the other.

Correlation of on-shore wind generation across European capacity calculation regions, 2024

	SEE	SWE	IT. North	Nordic	GRIT	Baltic	Hansa	Core
SEE	1.0	0.2	0.2	0.1	0.4	0.2	0.1	0.4
SWE	0.2	1.0	0.4	0.2	0.4	0.2	0.3	0.5
IT. North	0.2	0.4	1.0	0.2	0.5	0.2	0.2	0.7
Nordic	0.1	0.2	0.2	1.0	0.2	0.7	0.7	0.4
GRIT	0.4	0.4	0.5	0.2	1.0	0.2	0.3	0.6
Baltic	0.2	0.2	0.2	0.7	0.2	1.0	0.6	0.4
Hansa	0.1	0.3	0.2	0.7	0.3	0.6	1.0	0.6
Core	0.4	0.5	0.7	0.4	0.6	0.4	0.6	1.0

Better coordination of wind and solar across Europe can increase renewable capacity factors and reduce variability.
Solar generation is less complementary across regions than wind. In areas with high solar saturation, further solar capacity growth will likely depend more on storage uptake than on regional integration with other solar-heavy areas, unlike wind capacity additions.
Diversifying renewable assets by region helps lower risks.[1]

Source: ENTSO-E Transparency Platform
Note 1: See Unity in power, power in unity: why the EU needs more integrated electricity markets, Bruegel Policy Brief Issue n˚03/24, February 2024.

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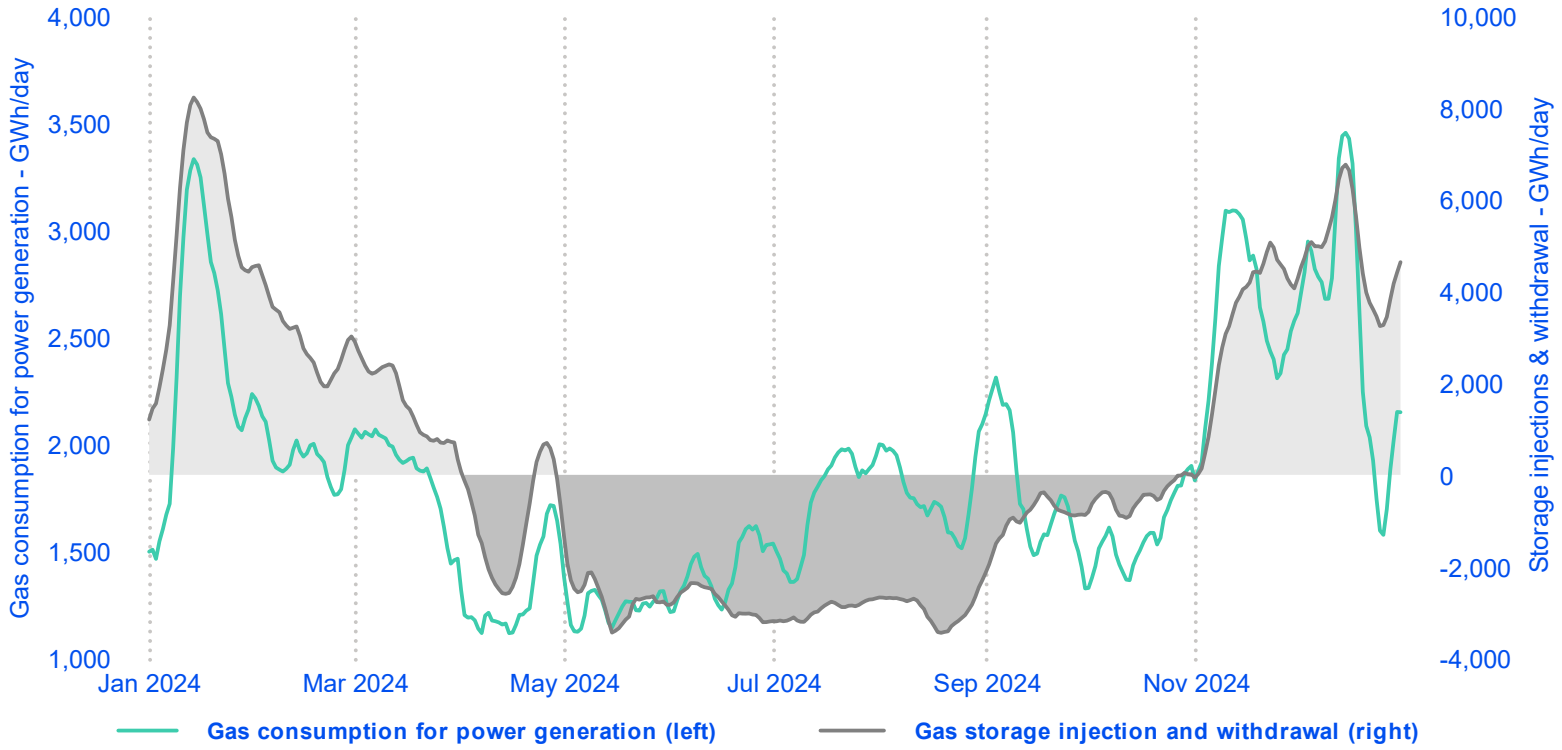
Seasonal flexibility is ensured by gas

Gas storage is vital for Europe's supply security and stability.

Gas consumption for power generation and storage net withdrawals (GWh/day)



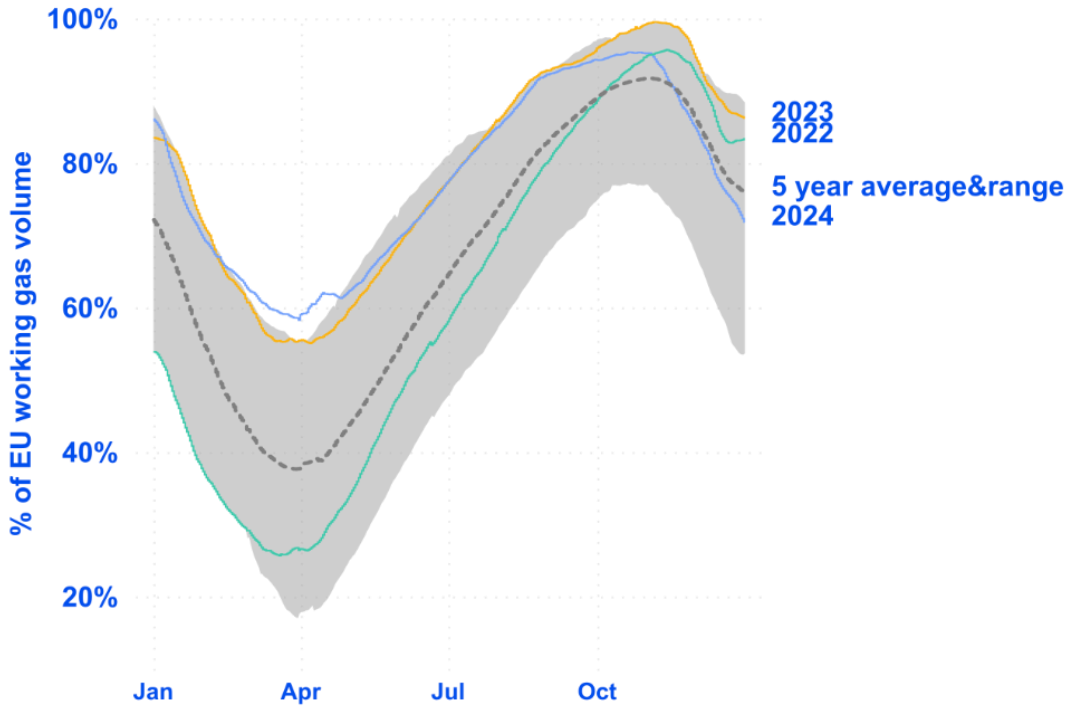
Even as the decarbonisation and the electrification of the energy system progress,
alternatives to gas storage for the provision of seasonal flexibility have yet to mature and scale.

Source: ACER based on Gas Infrastructure Europe and ENTSO-E data.
Note: Gas consumption for power generation is calculated from electricity generation data assuming 50% efficiency of gas power plants. Both time series displayed are seven day rolling averages.

Greater use of storages has implications for summer prices

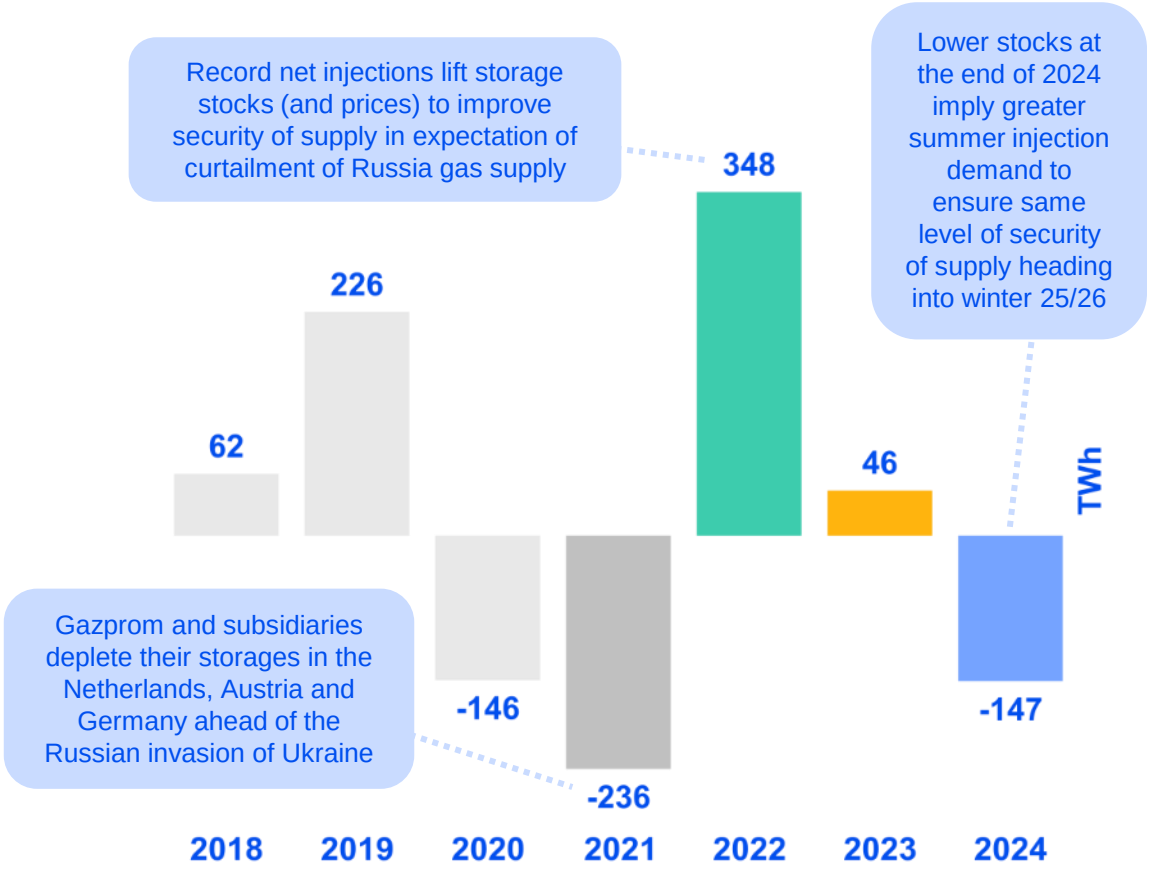
Record stocks at start of 2024 were followed by reduced injections over summer and increased withdrawals at start of winter …

Gas storage levels, 2018-2024 (% of EU working gas volume)



… implying greater injection demand in 2025 that could keep prices high thought-out summer.

Yearly EU storage net injections, 2018-2024 (TWh)



Source: ACER based on Gas Infrastructure Europe.

Managing energy infrastructure costs as demand shifts

Europe's energy transition requires significant investment in energy networks, but each sector faces distinct challenges that effective regulation must address to prevent over-investment and stranded assets[1].

Electricity: Can infrastructure capacity expand without cost escalation?

- Without timely power grid investment, Europe risks missing out on market integration benefits like price stability and security of supply. At the same time, network investment needs are set to significantly increase, potentially raising grid costs by up to 100% by 2050. Ensuring cost-reflective expansion serves EU competitiveness and affordability, particularly given gaps in data availability for grid planning and investment.

Gas: falling demand and the risk of stranded assets

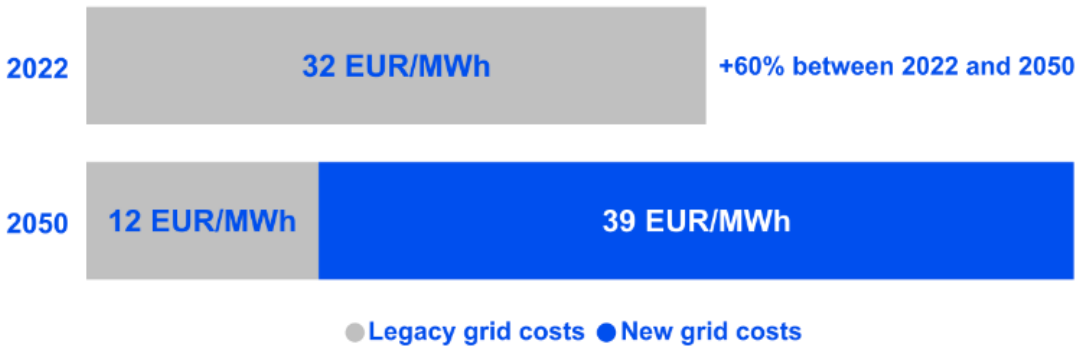
- With gas demand declining, existing networks face the risk of becoming stranded assets. Infrastructure planning must consider how to adapt the network efficiently to avoid over-investment in assets that may no longer be needed, while also recognising the central role of gas for energy (including electricity) security.

Hydrogen and intertemporal cost allocation

- Hydrogen infrastructure development adds another layer of complexity, requiring coordination with electricity and gas systems. Proper intertemporal cost allocation[2]—spreading costs fairly over time—is crucial to avoid burdening consumers with excessive expenses while ensuring long-term viability.

Average electricity grid costs for consumers could nearly double by 2050[3]

Evolution of total grid costs (EUR/MWh)



Source: EMBER.
Note 1: See the 2024 ACER report on electricity infrastructure. Note 2: ACER consultation on inter-temporal cost allocation mechanisms for financing hydrogen infrastructure (March 2025).
Note 3: Legacy grid costs cover historic investment and decrease by further depreciating assets while new grid costs represent investment between 2022-2050. Estimates give the order of magnitude. They are sensitive to many assumptions and based on partial data.

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How will ACER contribute in 2025?

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Stay tuned for more …

	Informing policy considerations	Monitoring
ELECTRICITY	• Recommendations: Demand response rules; improving the monitoring, investigation and enforcement framework (December) • Implementation of 15 min market time unit trading in EU-wide day-ahead and intraday markets (June) • Assessment of peak shaving products in normal conditions (June) • Opinion on the bidding zone review study (July) • Policy Paper on infrastructure cost benefit sharing (December)	• No-regret measures to remove barriers to demand response (April) • Network codes implementation delays (ad-hoc updates) • Market integration and cross-zonal capacity report (July) • Regional coordination centres report (March) • Balkan black-out investigation
GAS, HYDROGEN AND RETAIL	• Recommendation on intertemporal cost allocation (July) • Network codes 2.0 (CAM and CMP guidelines amendments) • LNG methodology update	• Gas monitoring quarterly • LNG (May) • Capacity/congestion (June) • Hydrogen market (October) • Retail gas country sheets (July)
ENERGY SYSTEM NEEDS	• Adoption of the flexibility needs methodology (July) • Guidance on Distribution Network development plans (July)	• Implementation of the ITC mechanism (March) • Best practices network tariffs report (March) • PCI monitoring (April) • Security of supply report (November)


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ACER role and governance

- **Supporting the integration of energy markets in the EU** (by common rules at EU level). Primarily directed towards transmission system operators and power exchanges.
- **Contributing to efficient trans-European energy infrastructure**, ensuring alignment with EU priorities.
- Monitoring energy markets to ensure that they function well, **deterring market manipulation and abusive behaviour**.
- Where necessary, **coordinating cross-national regulatory action**.
- Governance: **Regulatory oversight is shared** with national regulators. **Decision-making** within ACER is collaborative and joint (formal decisions requiring 2/3 majority of national regulators). **Decentralised enforcement** at national level.
- Headquartered in Ljubljana, Slovenia. **Engaged across the EU**.