Wind and solar overtake EU fossil fuels in the first half of 2024

Fossil generation continues to fall in the EU, even as demand rebounds. Wind and solar rise to new highs, reaching a share of 30% of EU electricity generation and overtaking fossil fuels for the first time.

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About

This report analyses developments in the EU's power sector in the first six months of 2024 (H1-2024), to measure the progress of its clean energy transition.

Highlights

30%
Wind and solar share of EU electricity generation in H1-2024

27%
Fossil share of EU electricity generation in H1-2024

-17%
Fall in fossil generation in H1-2024

Executive Summary

Wind and solar overtake fossil fuels in the first half of 2024

The EU electricity transition is in full swing even as demand rebounds following crisis years.

The EU's electricity system has continued its rapid shift towards renewables, led by wind and solar. Reliance on fossil fuel generation reached an all-time low in the first half of this year, even though electricity demand increased and power prices returned to pre-crisis levels. The momentum behind the clean energy transition is spreading: almost half of Member States generated more electricity from wind and solar than from fossil fuels in the first six months of 2024.

01 EU fossil generation fell by 17%

Fossil generation continued to fall to new lows, even as demand rebounded. Fossil fuels generated 17% less (-71 TWh) in the first half of 2024 compared to the same period in 2023, falling to 27% of generation (343 TWh). Coal fell by a quarter (-24%, -39 TWh) and gas by 14% (-29 TWh). This happened even as demand rebounded by 0.7%, picking up after two years of decline. As a result, emissions in the first half of the year are now nearly a third (-31%) lower than in the first half of 2022 — an unprecedented decline over such a short period.

02 Wind and solar outpaced a rebound in demand

Wind and solar growth was the single largest driver of the fossil fuel fall, more than exceeding a recovery in electricity demand. Electricity demand rose by 0.7% in the first half of 2024. This marked a reversal from the last

two years where demand had fallen amid the gas price crisis, but a mild winter limited the increase. As wind and solar were boosted by structural growth through capacity additions as well as favourable conditions, they more than met the increase in demand to replace fossil fuel generation.

03 Wind and solar overtook EU fossil generation for the first time

Wind and solar generated more electricity than fossil fuels during the first six months of 2024. Wind and solar generated 30% of the EU's electricity in the first half of the year, compared to 27% from fossil fuels. Together, wind and solar surpassed fossil generation in thirteen Member States, with four of these hitting the milestone for the first time in 2024 over a January-June period: Germany, Belgium, Hungary and the Netherlands.

The first half of 2024 shows the EU's electricity transition in full swing, as wind and solar grew fast enough to outpace demand growth and push fossil fuels out of the mix. The EU's swift action to reduce dependency on fossil fuels was evident as new wind and solar capacity came online, marking a permanent structural change.

However, sustaining the EU's electricity transition at this pace will require dedicated policy focus to ease barriers to wind and solar integration. Adequate support on grid connections and other enablers of swift development will be needed to ensure that economic, security and climate benefits are delivered across Europe.

“The first half of the year shows fossil generation’s narrowing role in the power sector, and gains for renewables that are beyond temporary variations in conditions. We are witnessing a historic shift and it is happening rapidly. If Member States can keep up momentum on wind and solar deployment then freedom from fossil power reliance will truly start to come into view.”

Chris Rosslowe
Senior Energy & Climate Data Analyst,
Ember

First six months of 2024 in review

EU fossil generation continues structural decline as wind and solar outpace increasing demand

Even as electricity demand began to rebound in the first half of 2024, strong wind and solar growth pushed fossil generation into continued decline.

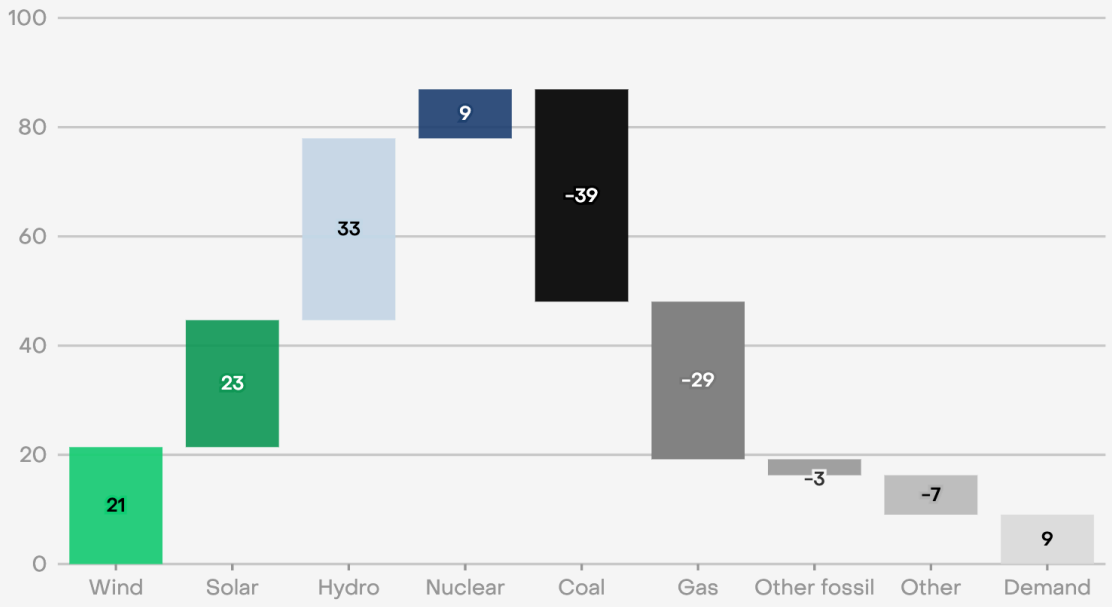
The first six months of the year revealed a now-familiar pattern as the EU's energy transition continued at pace: wind and solar generation grew, and fossil power fell. What was new this year was that the fossil fuel decline happened even as electricity demand recovered from the impacts of the gas price crisis.

The role of fossil fuels narrows

The first six months of 2024 saw fossil fuels continue to decline, even as EU electricity demand began to recover from the impacts of the gas price crisis. Fossil fuels generated 17% less than in the same period in 2023 (-71 TWh), while demand grew by 0.7% (+9 TWh). The drop in fossil generation meant fossil fuels accounted for just 27% of total EU electricity generation in the first half of 2024, compared to 33% over the same period in 2023.

Renewables drove a strong fall in EU fossil generation in the first six months of 2024

Change in generation H1-2024 vs. H1-2023 (TWh)



Source: Monthly electricity data, Ember
*Other includes bioenergy, other renewables and net imports

An increase in renewables drove this trend. Strong wind and solar growth was the main contributor to the fall in fossil power in the first half of the year. Solar generation grew by 20% (+23 TWh) and wind generation rose by 9.5% (+21 TWh) compared to the first six months of 2023. Combined, wind and solar grew 13% (+45 TWh). This meant that their share of EU electricity generation increased from 27% in the first half of 2023 to 30% in 2024, an all-time high. Hydro rebounded by 21% (+33 TWh), following droughts that had resulted in very low output for the previous two years. The growth from solar and wind combined with the recovery in hydro generation meant that at 50%, renewables generated half of the EU's electricity in the first half of 2024. This significantly surpasses the previous record set last year of 44%.

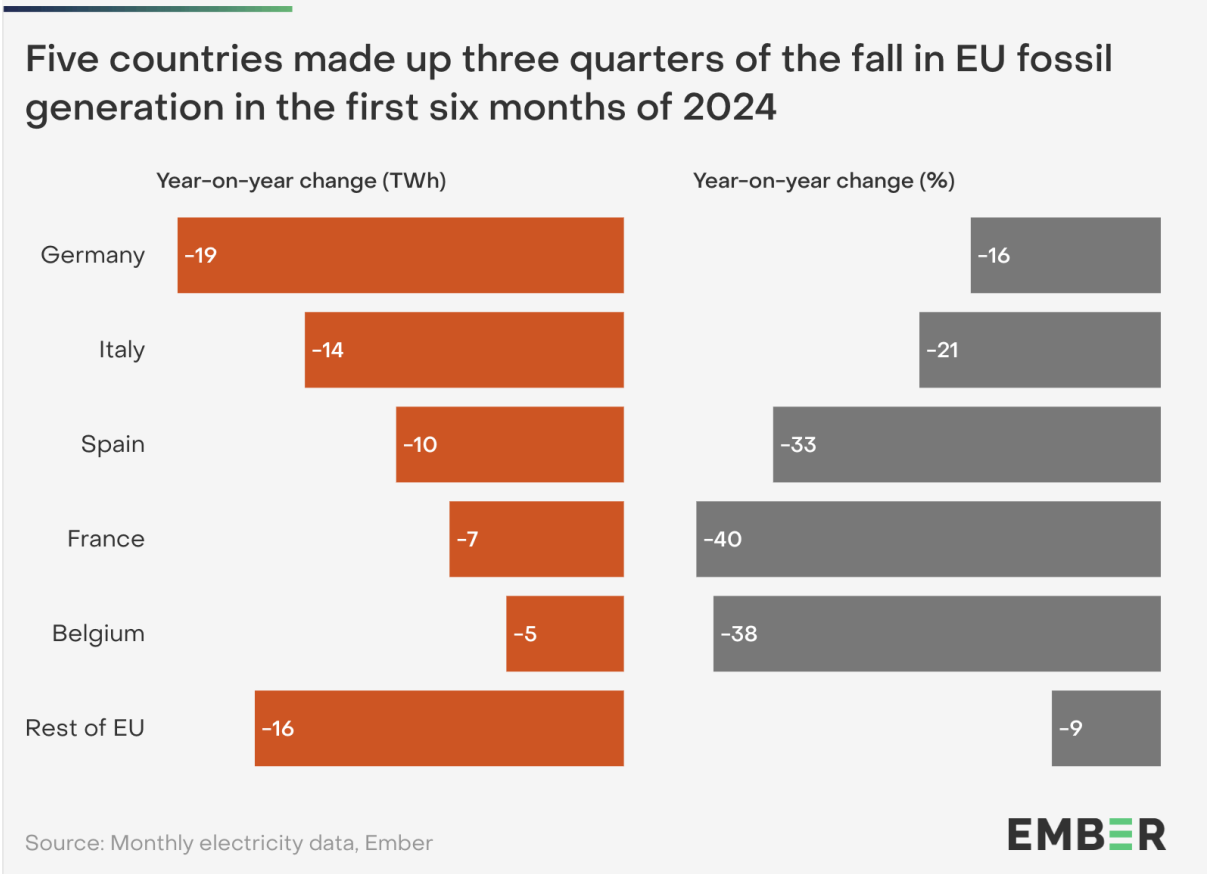
Low carbon sources combined to make up nearly three quarters (73%) of EU electricity generation in the first half of 2024. Alongside renewables growth, nuclear generation also increased by 3.1% (+9 TWh) across the EU, compared to the same period in 2023. This

masked two opposing trends: French nuclear generation came back online following maintenance and outages, rebounding by 19 TWh. However, closures to the last German nuclear fleet in the spring of 2023 meant a 7 TWh fall that will not be reversed.

Coal generation dropped steeply, with a 24% fall compared to the same period last year (-39 TWh). This was more than half of the 71 TWh fall in fossil generation. Gas generation fell by 14% (-29 TWh). This follows sizeable falls in the previous year: in the first six months of 2023, coal fell by 21% (-45 TWh) and gas by 16% (-39 TWh).

Fossils fall in big EU power sectors

Over 75% of the fall in fossil generation came from just five Member States, driven by the EU's largest power sectors. The largest fall was in Germany, where fossil generation fell by 19 TWh (-16%). This was due to coal generation dropping by over a quarter (-28%, -19 TWh), as gas also fell but other fossil generation slightly increased. Coal supplied 20% of Germany's electricity in the first half of 2024, down from 26% in the same period in 2023.



In Italy, fossil generation fell by 14 TWh (-21%), split evenly between coal and gas. Large falls in gas generation were responsible for fossil generation decreases in Spain, France and Belgium. This was particularly notable in Spain, where coal generation has almost been phased out and rising wind and solar generation is increasingly pushing out gas generation. Gas generation in Spain had already fallen by 25% in the first half of 2023, and fell a further 34% in the same period this year.

The trend of falling fossil generation was also evident even in Member States that are traditionally heavily reliant on fossil fuels for electricity generation. For example, the share of coal in the Polish electricity mix reached an all-time low for a single month in May 2024, supplying 57% of the country's electricity. Just five years ago, in May 2019, coal supplied 80% of Polish electricity.

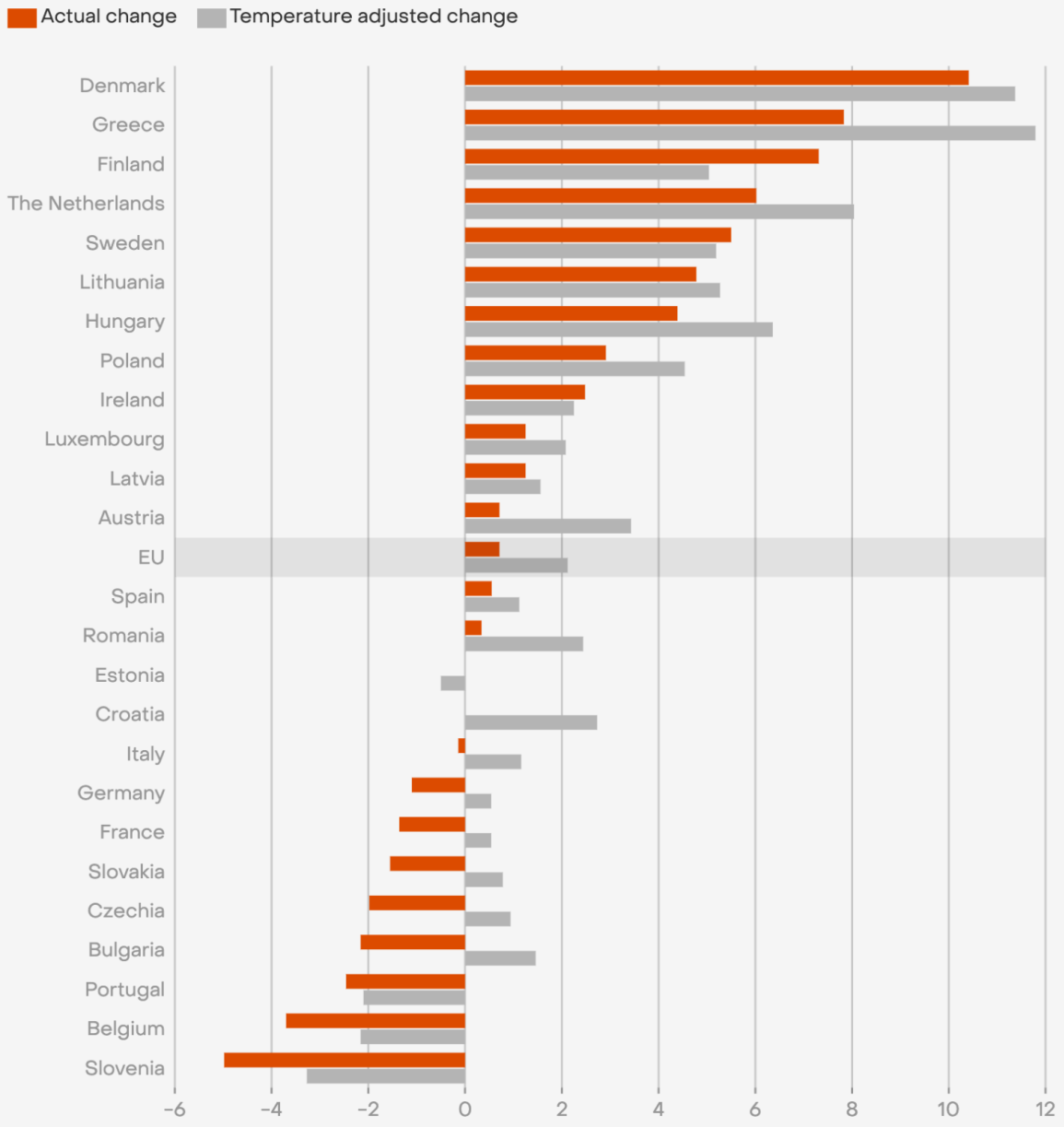
Demand rebounds, but mild temperatures suppressed bigger increase

Unlike the last two years, the fall in fossil generation happened without significant reductions in EU electricity demand. Instead, demand grew by 0.7% (+9 TWh) in the first half of the year. The largest absolute increases in demand were in Sweden (+3.5 TWh), the Netherlands (+3.3 TWh) and Finland (+2.9 TWh). In Denmark and Greece, demand rose by 10.4% (+1.9 TWh) and 7.8% (+1.7 TWh) respectively.

Demand likely would have risen further if not for a warmer-than-average winter in many Member States, which lowered electricity demand for heating. Without the impact of mild winter weather, demand would have increased by an estimated 2.1%, aligning with the IEA's forecast rate of EU electricity demand increase of 2.3% growth per year between 2024-26.

Mild temperatures suppressed larger demand increases across the EU in the first half of 2024

Year-on-year change in demand (%)



Source: Monthly electricity data, Ember · Temperature data from tealtool.earth based on ERA5 dataset
Adjustment is based on relationship between heating degree days and daily load and scaled to fit monthly data; there is no data available for Malta

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Mild weather conditions had a significant impact on electricity demand in France, which relies heavily on electric domestic heating. Demand declined 1.4% (-3 TWh) in France in the first half of 2024 compared to 2023. Yet, adjusted for temperature, demand would have increased by 0.5% (+1.2 TWh).

In Germany, electricity demand continued to fall in the first half of 2024, making it the third consecutive fall for the January-June period. However, the 1.1% fall (-2.8 TWh) in 2024 was much lower than last year's historic demand drop of 6.6%. Adjusted for the mild temperatures in the first half of the year, Germany's electricity demand would have grown 0.5% (+1.3 TWh). German demand may also be more than it appears due to how data is collected and reported. In Germany there has been a rapid rise in residential solar PV installations, which can appear in data reporting as reduced electricity demand.

Wind and solar continue rapid growth

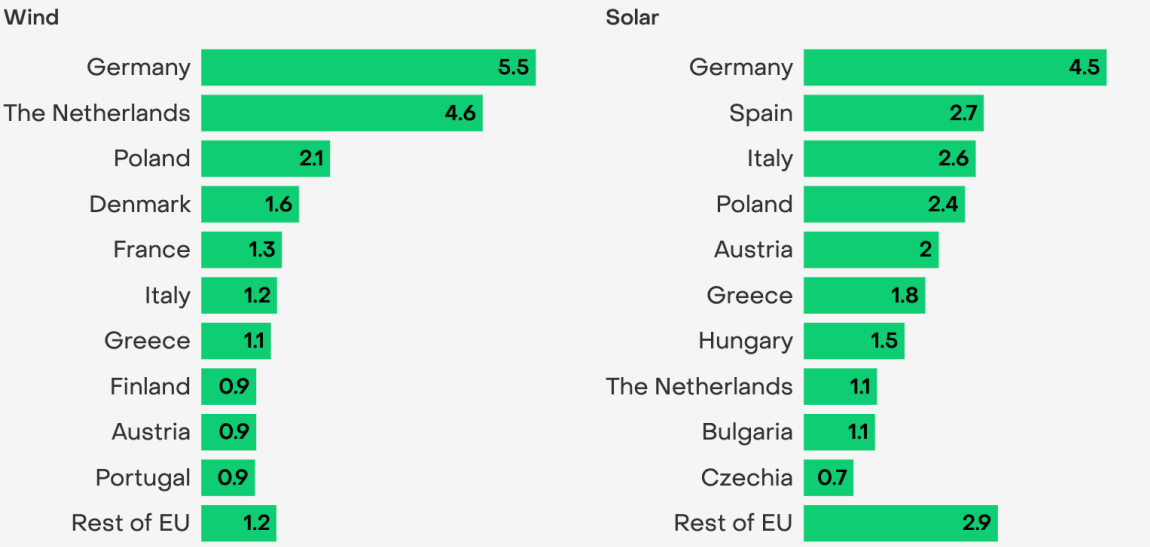
Across the EU, solar generation increased by 21% (+25 TWh) compared to the first six months of 2023, while wind generation rose by 9% (+20 TWh).

Almost half of the growth in wind generation came from just two countries: Germany (+5.5 TWh, +8.4%) and the Netherlands (+4.6 TWh, +35%).

The growth in solar is more widespread, with strong capacity additions leading to large generation increases across the EU, including in Germany (+4.5 TWh, +14%), Spain (+2.7 TWh, +13%), Italy (+2.6 TWh, +17%) and Poland (+2.4 TWh, +37%). Relative growth was even faster in other countries with Hungary's solar generation increasing 49% (+1.5 TWh) in the first half of 2024 compared to the same period in 2023.

EU wind generation growth in the first half of 2024 was driven by Germany and the Netherlands, with solar generation growth more widespread

Year-on-year change in generation, Jan-Jun 2024 vs. Jan-Jun 2023 (TWh)



Source: Monthly electricity data, Ember

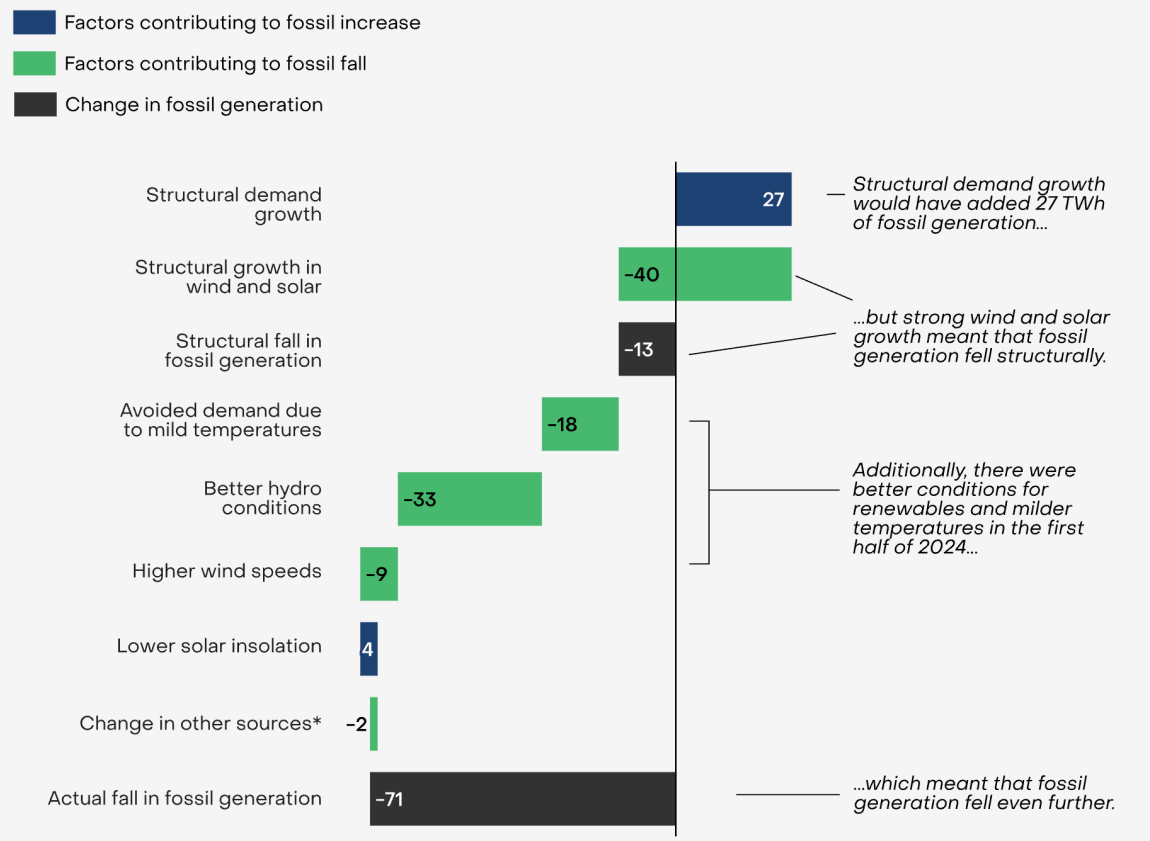
Wind and solar outpace demand growth in the first half of 2024

Structural growth in wind and solar was the single largest contributor to falls in fossil generation in the EU in the first half of 2024, outpacing growth in demand and pushing down emissions.

Wind and solar grew by 45 TWh, fast enough to meet and exceed new electricity demand, leading to a fall in fossil generation. Closer scrutiny hints at a more permanent shift: when adjusted for differences in conditions between the first six months of 2024 and the first six months of 2023, wind and solar still would have grown by 40 TWh. This outpaced the structural growth in demand (demand growth adjusted for temperatures), which was 27 TWh.

Wind and solar growth and good weather conditions led to a large fall in EU fossil generation in the first half of 2024

Contribution to change in fossil generation by factor, H1-2024 vs. H1-2023 (TWh)



Source: Monthly electricity data, Ember, ERA5 meteorological data
Temperature adjustment for demand based on country-wide heating degree days; effects of wind speed and solar insolation are estimated based on ERA5 data for capacity-weighted locations by country

*Other sources include nuclear, bioenergy, other renewables and net imports

The fall in fossil generation was made even larger by weather conditions in the first half of 2024. Mild winter temperatures reduced the actual increase in demand, with good hydro conditions and wind speeds further adding to the decline in fossil generation.

However, EU solar conditions were slightly worse in the first half of 2024 than in the previous year, preventing even faster generation growth. Adjusted for the amount of sun reaching the ground (the difference in insolation) in the first half of 2024 compared to the first half of

2023, solar generation would have grown by 27 TWh (+24%), instead of the recorded 23 TWh (+20%).

In contrast, higher wind speeds across the EU in the first half of 2024 helped boost output. If wind speeds in the first half of 2024 had been the same as in the previous year, wind output would have grown by 5.6% (+13 TWh) instead of the 9.5% (+21 TWh) observed. The Netherlands had one of the largest percentage increases in wind generation at 35%, with growth still at 27% after adjusting for wind conditions. This shows the impact of substantial wind capacity additions in the Netherlands in 2023, totalling 2.4 GW, a 27% increase in the country's wind capacity.

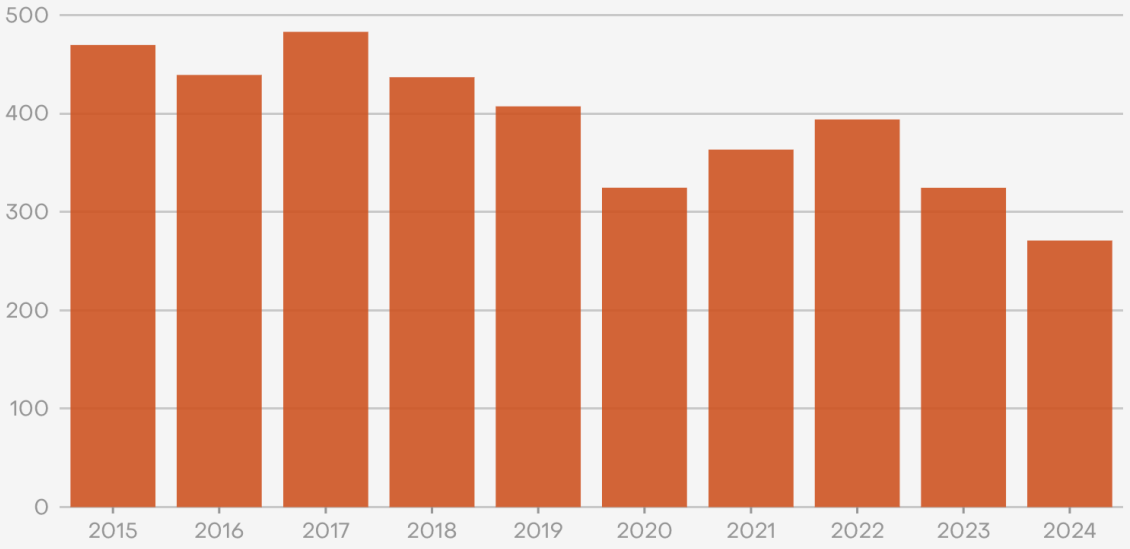
The uptick in hydro power was primarily weather-dependent, after several years of significant variation linked to conditions. After years impacted by droughts, Europe experienced higher-than-average rainfall in the first half of 2024. As a result, hydro generation rebounded by 21% (+33 TWh) to reach the highest output since 2018. Some Member States saw particularly large upticks in hydro output: Italy increased by 56% (+8.5 TWh), France by 35% (+9.3 TWh), Spain by 54% (+6.9 TWh) and Portugal by 69% (+3.5 TWh). Overall, hydro generation was 15% higher in the EU than the average generation in January-June over the last 5 years.

Steep fall in emissions for the second year running

As fossil fuels fell and wind and solar continued to grow, power sector emissions dropped by 17% in the first half of 2024 compared to the same period last year. This follows a similarly large fall of 18% in January-June 2023. Consequently, emissions in the first half of the year are now nearly a third (-31%) lower than in the first half of 2022, an unprecedented decline over such a short period. This decline is even larger than the fall seen over the same periods in 2020 and 2018, which reflected the impact on demand from the Covid-19 pandemic. Compared to the first half of 2017, emissions from the EU power sector are now down 44%.

EU power sector emissions in the first half of 2024 were 31% lower than in 2022

Power sector emissions in the first half of each year (MtCO2)



Source: Monthly electricity data, Ember
Emissions are measured in CO2 equivalent and include other greenhouse gases such as methane

Wind and solar overtake fossil fuels

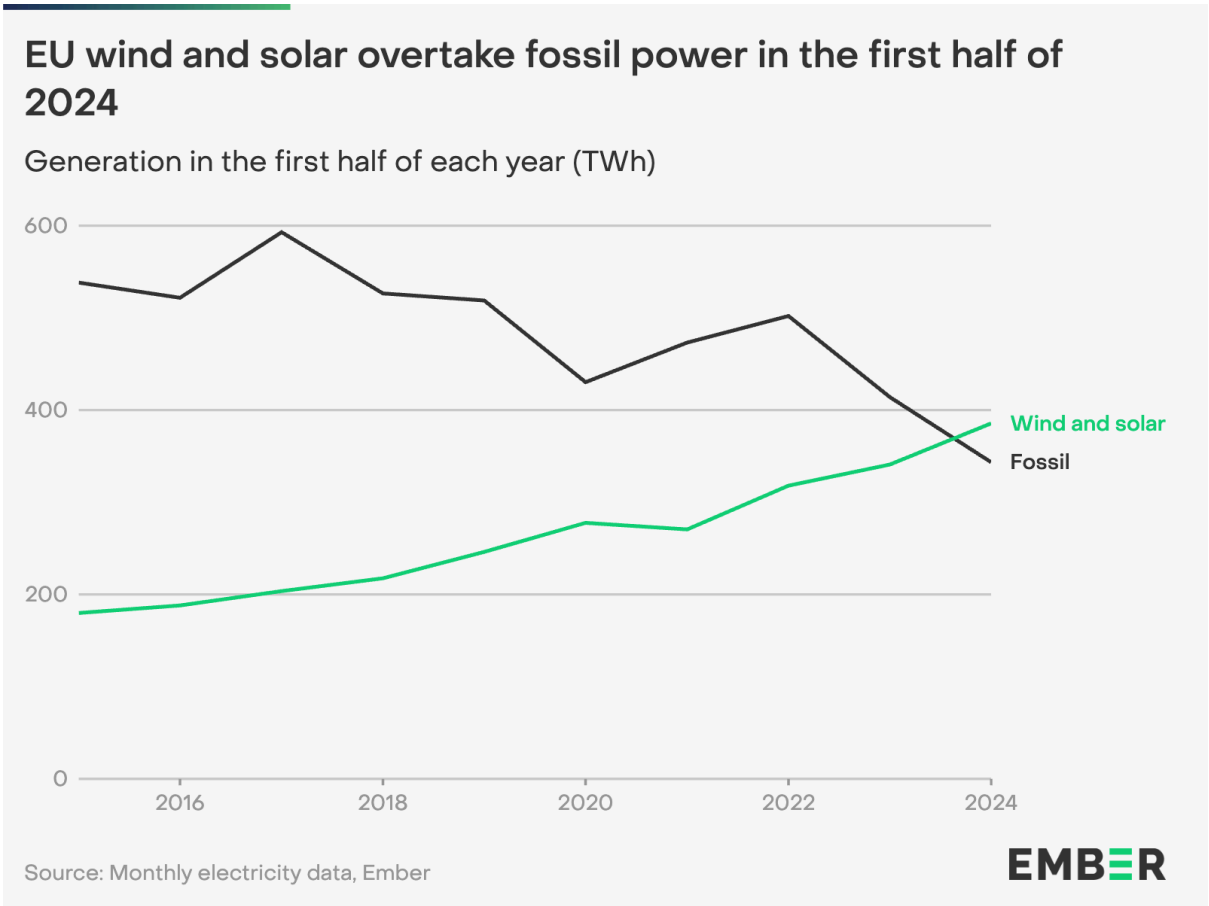
New era in sight as wind and solar bring structural shift

The EU's power sector continued to show signs of fundamental change as wind and solar generated more electricity than fossil fuels.

Wind and solar have demonstrated that they can grow quickly enough to meet demand increases and push fossil fuels out of the mix. EU policies aimed at accelerating the energy transition in the wake of the gas price crisis have resulted in record capacity additions for wind and solar, laying the groundwork for a sustained shift away from fossil fuels.

Wind and solar overtake fossil generation throughout the EU

The increase in wind and solar generation displaced fossil fuels, leading to a key milestone. In the first six months of 2024, the EU generated more electricity from wind and solar than from fossil fuels. Combined, they generated 30% (386 TWh) of the EU's electricity in the first half of 2024, with fossil generation only supplying 27% (343 TWh). Four Member States also hit this milestone for the first time between January and June in 2024: Germany, Belgium, Hungary and the Netherlands.

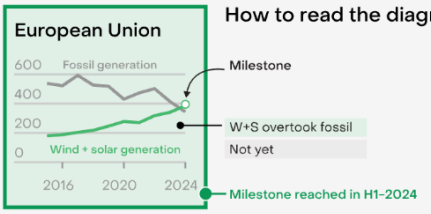


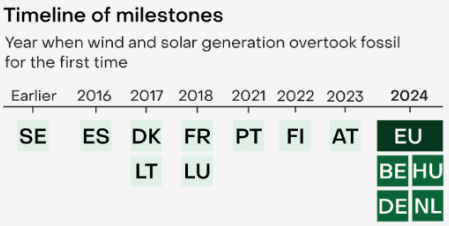
Wind and solar overtake fossil generation in 13 Member States

This EU milestone is not being driven by only a few countries: nine Member States already generated more electricity from wind and solar than fossil fuels over the first six months in previous years, with wind and solar continuing to widen their lead. Combined, wind and solar have now surpassed fossil fuels in close to half of EU Member States. These countries make up 70% of the EU's total electricity demand. Just five years ago, this figure stood at 5 out of 27 — France, Sweden, Denmark, Lithuania and Luxembourg — responsible for only 25% of EU electricity demand.

13 EU countries generated more electricity from wind and solar than from fossil fuels in the first half of 2024

Generation in the first half of each year (TWh)





Source: Monthly electricity data, Ember

A new era for wind and solar as milestones pile up

Wind and solar generation growth has led to additional milestone moments across the EU. In May, over 50% of Spain's electricity generation came from wind and solar, the first time this has ever happened. In the same month, Poland hit a third of generation coming from wind and solar, also for the first time. Poland's solar generation in the first half of 2024 increased by 37% compared to the same period in 2023. Strong solar growth in Hungary meant that the country set three consecutive all-time highs for solar output in a single month in April, May and June 2024, beating the previous record set in July 2023.

Capacity boom driven by policies and prices

Supportive policies and high energy prices have driven a wind and solar capacity boom

Recent years have fundamentally changed the EU's approach to the energy transition, particularly as Russia's invasion of Ukraine sent gas prices and the cost of electricity skyrocketing. This has resulted in a significant acceleration of wind and solar deployment across Member States. New policies on both the EU and national level have recognised and solidified the role of clean power technologies to minimise reliance on expensive fossil fuel imports and consumer exposure to volatile prices. Falling solar panel costs have helped to sustain deployment, even as energy prices begin to return to pre-crisis levels.

The EU broke records for both wind and solar capacity additions in 2023, reflected in this year's gains in generation. In Germany, reforms to reduce bureaucracy and boost incentives for rooftop solar installations have seen significant solar capacity additions continue into 2024: 5 GW of solar capacity was added in the first four months of the year alone, already meeting the country's capacity target for the year. In the Netherlands, the opening of the new 0.76 GW Hollandse Kust Noord offshore wind farm in December 2023 has resulted in an uptick in wind generation throughout 2024. Austria has also supercharged its solar growth in recent years through the introduction of new subsidies for solar generation and policies to facilitate the set-up of community energy initiatives.

A structural shift as new capacity comes online

While the scale of future falls in fossil generation is uncertain, significant wind and solar capacity additions throughout 2024 mean that this tipping point is likely to be permanent. Wind Europe expects 15.8 GW of wind capacity to be installed in the EU in 2024, while SolarPower Europe forecasts 62 GW of solar capacity additions over the same period.

Under these scenarios, wind and solar generation would still exceed fossil generation in the first half of 2025, even if hydro generation returned to its worst output for the period in the last five years and EU electricity demand grew at the fastest rate seen in the last five years. The first half of 2021 saw a 5.8% increase in demand following the Covid-19 lockdown in 2020. That rate of demand growth is unlikely to materialise in the near-term in the near-term, with the IEA expecting EU electricity demand to grow more slowly, at 2.3% per year on average between 2024-26.

The EU has more to do

Further acceleration is needed to sustain this transformation

The transformation of the EU's electricity system has been swift over recent years. The first half of 2024 in particular has seen almost unprecedented falls in fossil generation despite demand growing. Renewables have played a vital role in alleviating high power prices in the bloc, but sustaining the pace of this transition will not be an easy feat. It will require dedicated policy action and implementation to ease barriers to future wind and solar deployment.

Annual additions of EU solar capacity increased by at least 40% or more in the three years up to and including 2023. While annual additions are expected to continue to increase, the growth rate of additions is forecast to slow to under 20% per year. Such growth would still be sufficient to reach the EU's target of 750 GWdc installed capacity by 2030 under the REPowerEU plan. However, the latest Member State plans aim to collectively deliver only 650 GWdc by 2030, exposing a gap between EU energy goals and national ambitions.

The EU's wind capacity additions are expected to ramp up only from 2025 onwards, as longer project lead times mean that the increased auction volumes and investment decisions in 2023 will take longer to deliver larger deployment. However, under current policy conditions, the EU is still forecast to fall 30 GW short of the minimum 425 GW required to meet its 2030 target, and further short of the 500 GW stipulated in the REPowerEU plan.

As power prices return to pre-crisis levels, Europe cannot rely on the market alone to drive the necessary acceleration of renewables deployment. Well-designed and implemented incentive schemes will remain important to sustaining momentum, as demonstrated by the impressive solar expansion continuing in Germany in 2024. Non-market barriers, such as grid capacity constraints, must also be overcome. This is evident in the Netherlands, where the network has struggled to keep pace with the country's solar boom.

Progress has already been made in developing policies to tackle these challenges, but rapid action is needed to unlock faster growth in renewables. Ursula von der Leyen's reappointment as President of the European Commission confirms a continued mandate to deliver on the Green Deal's ambitious targets, as she remains firmly committed to the EU's leadership on climate action. Thoughtful and rapid intervention to deliver on these goals is the only way to further reduce Europe's costly reliance on fossil fuelled generation and align the EU's energy goals with its climate obligations.

Supporting Materials

Methodology

The data in this piece is curated by Ember. The full dataset is available to download. Please address any data queries to data@ember-climate.org.

Monthly generation, imports and demand
Monthly data is gathered from a number of sources, including both centrally reported ENTSO-E data and directly reported national transmission system operators. In some cases data is published on a monthly lag; here we have estimated recent months based on relative changes in previous years. These cases are flagged in the dataset. Monthly published data is often reported provisionally, and is far from perfect. Every effort has been made to ensure accuracy, and where possible we compare multiple sources to confirm their agreement. Below is a list of countries included, and sources for recent monthly data. A complete country-by-country methodology for all countries, including those outside of Europe, is available for download here.

- Austria: Hydro from Eurostat; other fuels from ENTSO-E
- Belgium: ENTSO-E
- Bulgaria: ENTSO-E
- Croatia: ENTSO-E
- Cyprus: Eurostat, with demand estimates from the Cyprus Transmission System Operator
- Czechia: ENTSO-E
- Denmark: ENTSO-E
- Estonia: ENTSO-E
- Finland: Biomass, gas, hydro, solar and wind from Eurostat; other fuels from ENTSO-E
- France: ENTSO-E
- Germany: Gas and solar from Energy Charts; all other fuels from Agora
- Greece: ENTSO-E
- Hungary: Solar data from Eurostat; other fuels from ENTSO-E
- Ireland: Sustainable Energy Authority of Ireland
- Italy: Biomass and solar from Terna; other fuels from ENTSO-E. Flow data from Terna
- Latvia: ENTSO-E

- Lithuania: ENTSO-E
- Luxembourg: ENTSO-E
- Malta: Eurostat
- Netherlands, the: Statistics Netherlands, with recent months estimated using data from NetAnders. We are grateful to NetAnders for the use of their data
- Poland: Historical solar data until June 2020 from ARE via Instrat; other fuels from ENTSO-E
- Portugal: ENTSO-E
- Romania: ENTSO-E
- Slovakia: ENTSO-E
- Slovenia: ENTSO-E
- Spain: ENTSO-E. Flow data from REE
- Sweden: ENTSO-E

Weather conditions analysis

This report includes analysis on weather conditions and their impact on electricity demand as well as generation from renewable sources.

- The analysis of weather impacts on electricity demand is based on country-level temperature data from the ERA5 dataset. We conducted a regression analysis of the relationship between heating degree days and daily load data by country. The regression also included time-fixed effects on a yearly level to account for structural differences, such as COVID-19 restrictions. We estimated the temperature-adjusted electricity demand using the coefficients from the regression analysis and the differences in heating degree days between the first six months of 2024 and the first six months of 2023.
- For hydro generation, we attributed the entire difference in output between the first half of 2024 and the first half of 2023 to varying conditions, as the installed capacity has remained nearly constant
- For wind and solar generation, we utilised wind speed and solar insolation data from the ERA5 dataset, sampling up to 50 locations per country. These locations were derived from the largest wind and solar projects in each country, based on Global Energy Monitor's wind and solar tracker datasets and then clustered into a maximum of 50 locations. We calculated a simulated capacity factor for each location and subsequently derived a country-level wind and solar capacity factor by weighting the results of individual locations by their capacity. Using the percentage difference in the simulated capacity factor between the first six months of 2024 and the first six

months of 2023, we compared the expected output in 2024 with the actual output to derive values for structural and condition-based changes.

Acknowledgements

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