

EU fossil generation hits record low as demand falls

A fall in demand drives collapse in coal and gas in the first half of 2023, as solar pushes forward clean power growth.

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About

This report analyses changes in Europe's power sector from January to June 2023 to measure the progress of its clean energy transition.

Highlights

-5%

EU power demand fell by 5% year on year in the first half of 2023

-17%

EU fossil fuel generation fell by nearly a fifth in the first half of 2023

17

Seventeen EU countries had record renewable generation from January to June

Drop in demand drives EU fossil fuels to collapse

Solar leads the EU's clean energy transition as coal and gas slump

The first half of 2023 saw a collapse in EU fossil generation, leading to the lowest output on record. Wind and solar continued their growth, with solar generation increasing by 13% and wind by 5%. Hydro and nuclear are recovering from their historic lows in 2022, though their long term outlook is uncertain.

The fossil fall was predominantly driven by a significant drop in electricity demand, amid persistently high gas and power prices, a reduction in industrial output and emergency measures over winter. To accommodate demand recovery at the same time as ensuring the energy transition remains on track, the EU must accelerate the deployment of clean power, with particular focus on addressing the barriers to renewables integration.

01 Fossil fuel generation collapsed by 17% to lowest on record

Between January and June, fossil fuels generated 410 TWh in the EU, making up the lowest ever 33% of demand. This collapse was led by coal, which fell by a staggering 23% in the EU in the first half of the year, while gas decreased by 13% year-on-year. In May, coal set a record by generating less than 10% of the EU's electricity generation for the first time ever.

02 Electricity demand fell by 5% in the first half of 2023

Amid high energy prices and emergency measures, electricity demand fell

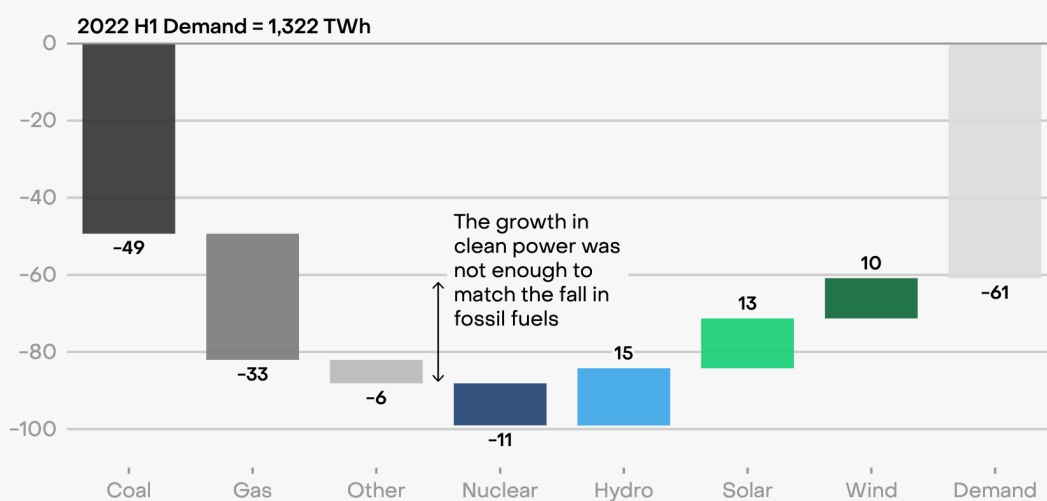
substantially to a record low of 1261 TWh, below even 2020’s pandemic low of 1271 TWh and the lowest since at least 2008 for current Member States. This drop was responsible for the majority of the decrease in fossil generation in the EU.

03 Solar continues growth, as clean power recovered and grew moderately

Growth in solar power continued in the first half of the year, with generation up 13% compared to the same period in 2022. Wind generation rose by 5%, while hydro recovered towards average levels (+11%). Nuclear fell (-4%) but is set to improve as the year continues. From January to June, 17 countries generated record shares of power from renewables, with Greece and Romania passing 50% for the first time and Denmark and Portugal both breaking 75%.

Falling demand drives a collapse in fossil fuels in the EU

Year-on-year change in EU electricity generation from January to June

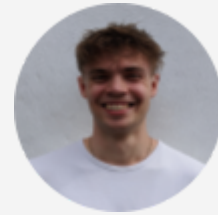


Source: Ember monthly data
 'Other' includes bioenergy, other renewables, other fossil fuels and net imports

“The decline in fossil fuels is a sign of the times. Coal and gas are too expensive, too risky, and the EU is cutting them out. But we need to see clean power replacing fossil fuels faster. A massive push, especially on solar and wind, is urgently needed to underpin a resilient economy across Europe.”

Matt Ewen

Europe data analyst, Ember



The fossil fall

EU fossil generation hits a record low in the first half of 2023

Drop in demand drives EU fossil fuels to collapse. Wind and solar continue growing while hydro and nuclear recover from historic lows.

Fossil fuels collapsed, with coal tumbling the furthest

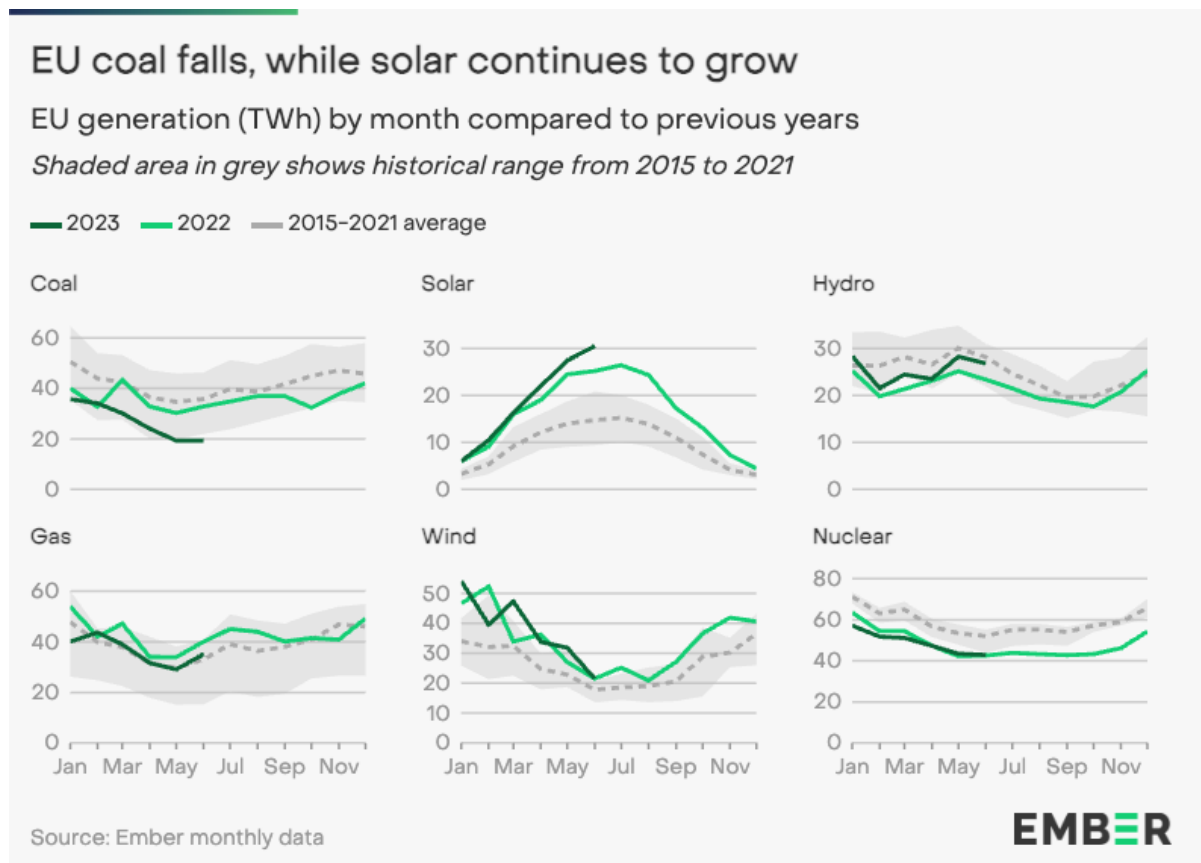
EU fossil generation collapsed in the first half of 2023, falling by 17% (-86 TWh) compared to the same period in 2022. Fossil generation from January to June was the lowest since at least 2000 at 410 TWh. The drop was Europe-wide, with a fall of at least 20% in eleven countries, and more than 30% in five (Portugal, Austria, Bulgaria, Estonia, Finland).

Fourteen countries saw their lowest total fossil generation on record for the period, with Austria, Czechia, Denmark, Finland, Italy, Poland and Slovenia at the lowest fossil output since at least 2000. Over summer, some countries went for significant periods without using the fossil fuels that have traditionally been bedrocks of their power systems. In June the Netherlands used coal for only five days, and saw a record seventeen consecutive days with no coal use, while Greece achieved more than 80 hours without lignite in July.

[Russian gas pipeline imports also fell dramatically](#), slashed by 75% to 13 bcm in the first half of 2023, down from 50 bcm in the first half of 2022. As alternatives to Russian gas supply were sourced and EU storage replenished, gas prices fell below the spikes in 2022. This contributed to the fall in coal power over the first half of this year.

Coal generation decreased by a staggering 23% (-49 TWh) year-on-year, compared to 13% (-33 TWh) for gas. Coal continues to be in [structural decline](#) in Europe, and despite the

volatility of the power sector since Russia’s invasion of Ukraine, [a coal ‘comeback’ did not materialise](#) over winter. Coal accounted for less than 10% of the EU’s electricity generation for the first time ever in May, with May and June the two lowest coal months on record.



Wind and solar are leading the renewables charge

The first half of 2023 shows evidence of the significant effort the EU has made to accelerate the deployment of renewables, with solar capacity additions booming in particular. After record-breaking additions of 33 GW in 2022, the pace has continued in 2023. In the first six months of the year [Germany added 6.5 GW](#) (+10%) of new solar capacity, while [Poland added over 2 GW](#) (+17%) and [Belgium added at least 1.2 GW](#) (+19%). [Italy installed 2.5 GW of solar](#) in the first six months of 2023 compared to a total of 3 GW for the whole of 2022, while

[France added](#) at least 600 MW in the first quarter of 2023, slightly above its deployment in the same period last year. [Spain is expected](#) to accelerate its deployment from 4.5 GW in 2022 to 7 GW this year.

This increases confidence in further robust growth in solar generation, since the additional capacity that has come online since last summer has already led to an impressive rise in measured solar generation of 13% (13 TWh) in the first half of 2023. Even this is an underestimate of the true scale of solar generation, since in many countries behind the meter distributed solar is not reported as generation but instead appears as [“missing” demand](#).

Wind generation rose by 4.8% (+10 TWh) compared to the first six months of 2022, a modest increase. Installation rates are a mixed picture in the face of various barriers, [despite countries’ increased ambitions](#). While [France had record additions](#) of over 850 MW in the first quarter of the year, elsewhere signs of challenges are evident. In Germany, total wind capacity only grew by 1.5 GW in the first half of 2023, and [less than 2 GW](#) of offshore wind was added across the entire EU in the same period. [Rising costs](#) have had a [detrimental effect](#) on [investment](#) in wind projects, and [policies in some Member States](#) have hindered deployment.

Despite these challenges, however, [industry enthusiasm](#) for wind remains. And with both industry and policymakers ringing alarm bells on the barriers to wind, there are some signs that the slowdown is being taken seriously, including [policy changes in Poland](#) and a concerted effort by the European Commission to [address permitting delays](#). Existing wind capacity continues to deliver for Europe’s power system, with unusually windy conditions in July resulting in output 22% (5.5 TWh) higher than July 2022.

Renewables break records as increased ambition pays off

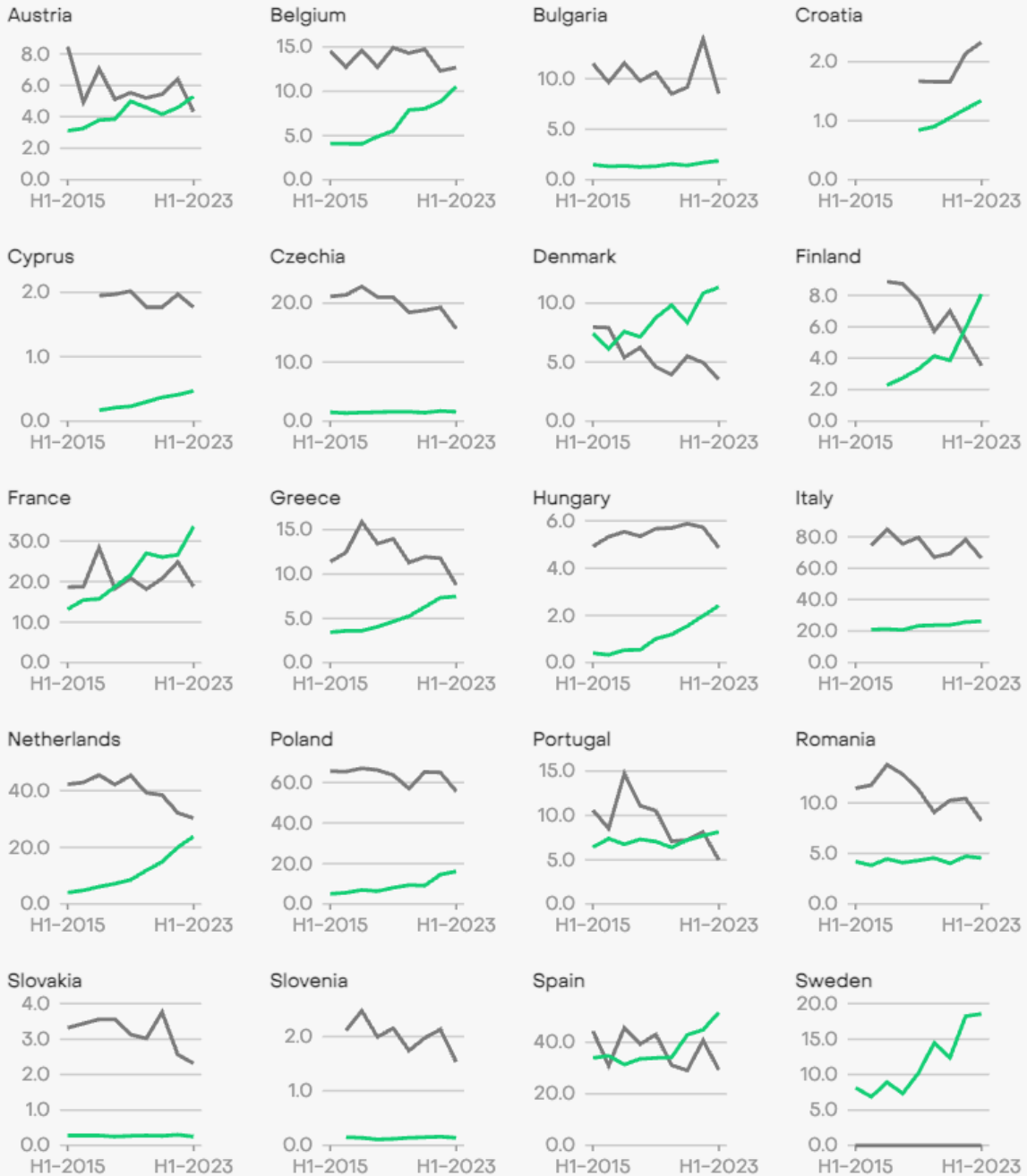
Following the [rapid expansion of renewables ambition](#) in recent years, both the EU and individual countries continue to break records. Wind and solar accounted for more than [30% of electricity production in the EU for the first time](#) in both May and July, and surpassed total fossil generation in May. Over the first six months of the year seventeen countries generated record shares of power from renewables, with Greece and Romania passing 50% for the first time and Denmark and Portugal both breaking 75%. In Portugal, this was primarily from wind and solar, which accounted for more than half of total generation in both April and May. After seeing 140 hours in June in which wind and solar produced more than the entire country’s

consumption, the Netherlands also hit 50% wind and solar for the first time in July, while Germany came close with a record 49% share in the same month.

Wind and solar rise as fossil falls across the EU

Generation Jan-Jun of each year (TWh)

■ Fossil ■ Wind and solar



Source: Ember monthly data
Countries with no records, or with very low generation or poor data availability are excluded

Despite these successes, measures to integrate wind and solar are becoming more pressing. [Negative prices](#) are increasingly frequent and disruptive, causing market distortions that harm both wind and solar and other clean sources. [Grid congestion](#) is increasing, particularly at the distribution system level, with 19% of Spanish behind-the-meter solar [curtailed](#) in 2022. [Transmission](#) across regions and borders also needs to [increase](#) to support planned renewables growth. For Europe to unlock the full potential benefits of wind and solar to cost, security and climate, these limitations need to be addressed in systems planning and supportive infrastructure.

Nuclear and hydro show improvement but longer term outlook is uncertain

Hydro generation increased by 11% (+15 TWh) in the first half of 2023. This was driven by significantly higher output in Southern Europe and the Baltic States, while Nordic countries' performance has been similar to 2022 but lower than 2021. Reservoirs are overall at higher levels, with [French reserves almost 400 GWh higher](#) and [Nordic reserves almost identical](#) to their levels at this point last year. These conditions point to better performance than the shortfalls of last year, though generation is so far still below recent average levels. However, European hydro has seen increasingly poor and volatile output since 2000, exacerbated in recent years by [severe droughts](#). Given escalating climate impacts, consistent output cannot be relied upon.

Meanwhile, nuclear generation fell by 3.6% (-11 TWh) in the first half of 2023. This drop was largely as a result of the German nuclear phase out, the closure of Belgian Tihange 2, outages in Sweden and the poor performance of the French fleet. In the first three months of the year French output fell 6.2% (-6.8 TWh), though the near-term future looks a bit brighter with the French reactors outperforming 2022 by 18% since April through June (+11 TWh). Furthermore, French nuclear capacity is [forecast to be 93% available](#) by the end of the year, and [EDF has confirmed its prediction of 300-330 TWh for 2023](#). The opening of Finnish Olkiluoto 3 is also now partially offsetting closures elsewhere.

As with hydro generation, however, the outlook for nuclear over the next few years has some uncertainties. Belgium has [delayed its nuclear exit](#), originally planned for 2025. However,

France anticipates only gradual improvements to nuclear output with full recovery some time away. Even EDF's upper bound forecast for 2025 (365 TWh) is still well below the average from 2011-21 of 410 TWh, though [longer term prospects are encouraging](#).

Demand has collapsed amid continued high energy prices

EU fossil gas prices have now dropped from crisis highs, but remain elevated compared to before the gas crisis began. With an average of €44/MWh from January to June 2023, gas prices have fallen by more than 50% compared with the levels seen in the same period last year (€97/MWh). However, they are still double the prices in the first half of 2021 (€22/MWh).

Gas is currently expected to remain at least this high for the rest of the year based on forward prices. The recent rise in European prices due to the threat of curtailed LNG supplies from Australia is also a reminder that the risks of gas price surges remain, increasing as winter and the heating season approach.

Coal prices show a similar story for the first six months of this year. Rotterdam prices have averaged \$134/tonne, compared to \$275/tonne in the first half of 2022. However, as with gas, coal is still much more expensive than before the start of the gas crisis, with prices of \$78/tonne in the same period in 2021.

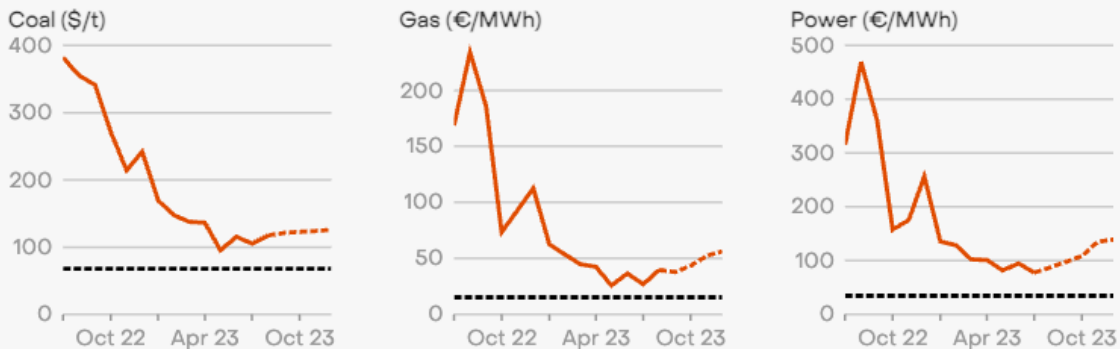
Due to the price-setting role of fossil fuels in Europe's power system, electricity prices also remain high at an [average of €107/MWh for January to June 2023](#). This is a drop of more than 40% compared to the same period in 2022 (€185/MWh) but twice the price in the first half of 2021 (€55/MWh).

Prices have fallen from their peak, but remain elevated

2023 prices compared to averages from 2018–2020

Dashed red lines represent futures prices

Price 2018–2020 average



Sources: Montel, ENTSO-E
 Coal data is API2 from by ICE, using front month then future monthly prices as of 2023-08-22. Gas data is TTF, using day ahead prices from PEGAS then future monthly prices from ICE. Power uses German prices as a proxy for the wider EU, using day ahead prices from ENTSO-E then future monthly prices from EEX. ICE, PEGAS and EEX data provided by Montel



High energy prices, emergency measures and mild weather push down demand

One of the impacts of the sustained high energy prices has been a substantial reduction in electricity demand of 4.6% (-61 TWh) in the first six months of the year. Demand for the period was 1261 TWh, lower even than 2020’s pandemic low of 1271 TWh and the [lowest since at least 2008](#) for current Member States. The European Commission introduced emergency measures to [cut EU electricity](#) demand from November 2022 to March 2023 in response to soaring energy prices, and nearly all Member States succeeded in [reducing their consumption](#) over that period. The [IEA](#) attributes two thirds of the demand decline in 2022 to non-weather related factors, with a large contribution from reduction in output of energy-intensive industries.

Industrial demand fall has been particularly acute in Germany, where output from energy-intensive industries has [fallen](#) 15-20% from its 2021 average. Falls have also occurred in the EU’s other major industrial centres, with declines in [Italy](#), [France](#), [Spain](#), [Poland](#) and the [Netherlands](#). While some of the fall in demand can be attributed to energy efficiency, demand side response and unmeasured solar generation, it is clear that demand destruction is also playing a role, adding to concerns about the competitiveness of European industry.

If this rate of year-on-year decline in electricity demand was to continue to the end of 2023 it would equate to the largest annual fall since 2009. However, demand had already begun to fall in the fourth quarter of 2022 with a staggering 8% decline from the same period in 2021, in part due to mild weather conditions. Even with mild weather, a large fall in this period is unlikely, and the EU must be prepared to meet demand if conditions are not as favourable this year.

More clean power is needed to meet future demand

The first half of 2023 showed some encouraging signs for the energy transition. Fossil fuel generation fell substantially, wind and solar power continued to rise, and other clean sources recovered from underperformance last year. However, much of the fossil decline can be attributed to a significant fall in electricity demand, much of which is not sustainable or desirable. While trends of falling coal and gas generation must continue in order to achieve EU and country level targets on decarbonisation, Europe cannot rely on undesirable demand reduction to achieve this.

The need to address this dynamic is even more pressing with the [push to electrify across sectors](#). With wider electrification, electricity demand will ultimately rise. European policy makers must ensure that the conditions are right for this increase to be met by clean sources rather than fossil fuels. Not only does this require the acceleration of wind and solar deployment, but also the urgent development of key enablers to support renewables such as streamlined permitting, grid expansion and adequate storage deployment. It is essential that a coordinated whole system approach is placed at the top of the political agenda across Europe, to unlock the [security and cost benefits](#) of clean power.

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: 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: [Agora](#)

- Greece: ENTSO-E
- Hungary: Solar data from 2020 from Eurostat; other fuels from ENTSO-E
- Ireland: [Sustainable Energy Authority of Ireland](#)
- Italy: Biomass and behind-the-meter solar from [Terna](#); other fuels from ENTSO-E. Flow data from Terna
- Latvia: ENTSO-E
- Lithuania: ENTSO-E
- Luxembourg: Eurostat
- Malta: Eurostat
- Netherlands: [Statistics Netherlands](#), with recent months estimated using data from ENTSO-E and [NetAnders](#). We are grateful to NetAnders for the use of their data
- Poland: Historical solar data 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

Hourly coal generation

Hourly generation data for the Netherlands and Greece is taken from ENTSO-E. In the case of the Netherlands coal was very slightly above 0 MW on several occasions due to occasional very small injections from the outed Maasvlakte 3. We have taken this to be functionally no generation.

Distributed solar

In recent years the EU has deployed a large amount of solar generation not metered on the transmission network, in large part on rooftops. Because this generation is rarely measured directly it must be estimated. In several countries, such as Italy, Belgium, Poland and France, the national TSOs report such estimates, while in the Netherlands estimates are made after the fact by [Statistics Netherlands](#) and in real time by [NetAnders](#). Elsewhere however, in at least eleven countries including Spain, Hungary, Bulgaria, Romania, Portugal and Austria, estimates are not reported. Instead, unmeasured solar is visible to some extent as “missing” demand: reported demand being lower than expected during peak solar hours, as a result of

the grid needing to serve less load due to households consuming their own solar power. At high levels this results in a visible [duck curve](#).

Reservoir levels

Reservoir levels are from [RTE](#) and [Nordpool](#), with [Montel](#) providing figures for Switzerland and Austria. [ENTSO-E water reservoir filling rates](#) were also checked to confirm conditions.

French nuclear availability

French nuclear availability is reported by [Montel](#), and can be calculated from [outage reports](#) published on ENTSO-E.

Prices

Power prices are day ahead prices reported to [ENTSO-E](#), with Irish prices from [SEMOpX](#). German future prices are from EEX. Coal and gas prices are both accessed via [Montel](#); coal is API2 prices from ICE, while gas is TTF prices from PEGAS and ICE.

Historical demand

Demand before 2015 is calculated from Eurostat [historical monthly generation data](#), counting all current EU-27 Member States (so including Croatia and excluding the UK for all periods). Data was checked against Ember monthly data to ensure comparability.

Gas imports

Gas import data is provided by [Bruegel](#).

Acknowledgements

Thanks

We are grateful to [NetAnders](#) for the use of their data in the Netherlands. Thanks to Ali Candlin, Sarah Brown, Reynaldo Dizon, Uni Lee and Chris Rosslowe for their contributions and review.

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