

# Heat and power: Impacts of the 2025 heatwave in Europe

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A June–July heatwave has caused stress for European power systems, driving electricity demand and doubling daily power prices. Yet grids remained stable, fueled by record volumes of solar.

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## About

This report analyses the impact of the June–July 2025 heatwaves on European power systems. As shown in the study, the rise in temperatures resulted in an increase in power demand, the increased risk of power plant outages, and elevated electricity prices. The analysis discusses solutions that can help in maintaining grid stability – ranging from battery storage, interconnection and demand flexibility, to blackout prevention and renewables-based black start techniques.

# Record EU solar generation helps keep power supply stable amid demand spike and nuclear plant outages

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**Heatwaves are becoming more frequent in Europe, putting electricity grids under severe stress. Complementing the vast volumes of solar, solutions like clean flexibility and interconnection can help maintain grid stability.**

In June and July 2025 Europe experienced a heatwave, with local temperatures exceeding [40°C](#). This triggered an increase in electricity demand as the use of air conditioners soared. This, coupled with outages in thermal power plants, posed a challenge for power systems. Such events will become more frequent and require proactive planning from grid operators.

- **The 2025 heatwave increased the daily power demand by up to 14%.** Combined with thermal power plant outages, this led to a 2–3 times increase in average daily power prices.
- **June 2025 saw the highest EU solar generation on record – 45 TWh**, which kept the grid well-supplied during daytime hours.
- **During the hottest days, electricity price spreads exceeded 400 €/MWh.** Heatwaves make power demand peaks more severe due to cooling needs. This makes the business case for storage and flexibility.

Heatwaves will not go away – they will only get more severe in the future. Solutions that can help mitigate their impacts, such as battery storage, interconnection, demand flexibility and dynamic tariffs, should become a key part of grid planning and power market design. Luckily, there is no lack of sunshine during heatwaves. The biggest opportunity is to store solar electricity, to help power air conditioning well into the evening.

**Pawel Czyzak**

Europe Programme Director, Ember

# Heatwaves have a major impact on European power systems

From economic to energy security challenges, heatwaves bring major disruptions to electricity grids.

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## 1.1 Heatwaves can increase daily power demand by up to 14% and double average prices

During the 2025 heatwave, culminating between June 28 and July 2, peak daily temperatures averaged over the whole country reached 35°C in Germany and Spain (with local maximums exceeding 40°C), 34°C in France and 30°C in Poland.

In the most striking case of Germany, this meant a 9°C increase in peak daily temperature compared to just a week before.

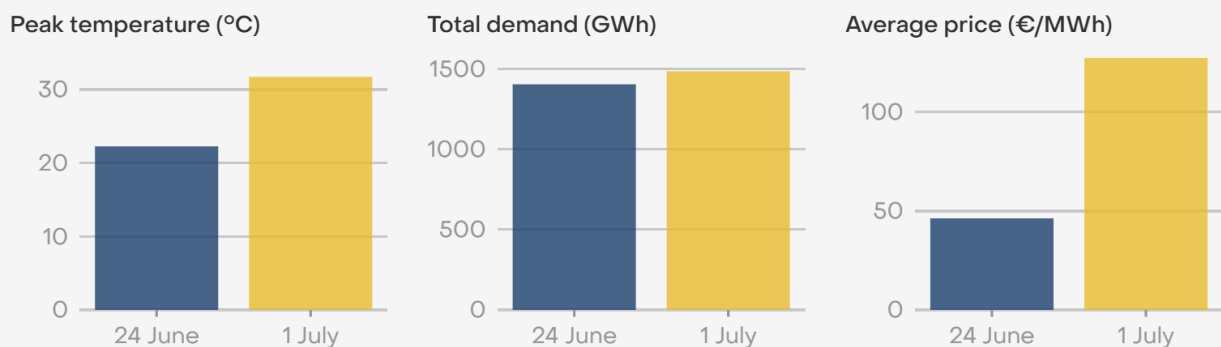
This temperature increase had a major impact on electricity demand – which grew by up to 6% in Germany, 9% in France and 14% in Spain, when comparing a Tuesday before (June 24) and during the heatwave (July 1). Peak demand grew as well, by 12% in France and 15% in Spain, and 5% in Germany and Poland.

The demand trends, combined with outages of thermal power plants (described in the following section), led to a dramatic rise of electricity prices. Compared to the same baseline day of June 24, during the heatwave average daily prices grew by 15% in Spain, 106% in Poland, 108% in France and 175% in Germany – in the latter case almost tripling. During peak evening hours on July 1, prices reached over 400 €/MWh in Germany and over 470 €/MWh in Poland.

## Heatwaves drive up electricity demand and trigger price spikes

Peak temperatures, daily electricity demand and average daily prices on June 24, 2025 (before heatwave) and July 1, 2025 (during heatwave)

Germany ▾



Source: ENTSO-E Transparency, Open-Meteo

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## 1.2 Heatwaves elevate the risk of thermal plant outages



Heatwaves impact electricity systems in several ways. The overheating of cables is the likely cause of [power outages](#) in Italy on July 1. With rising air and water temperatures, the cooling of thermal power plants becomes more challenging as well. This led to forced reductions in electricity generation from nuclear power plants in [France](#) and [Switzerland](#). In Poland, longtime concerns around the [cooling of coal power plants](#) led to several remedial actions in the past few years. To further strengthen grid resilience, at the peak of the heatwave on July 2, the government together with the grid operator PSE proposed an [anti-blackout package](#).

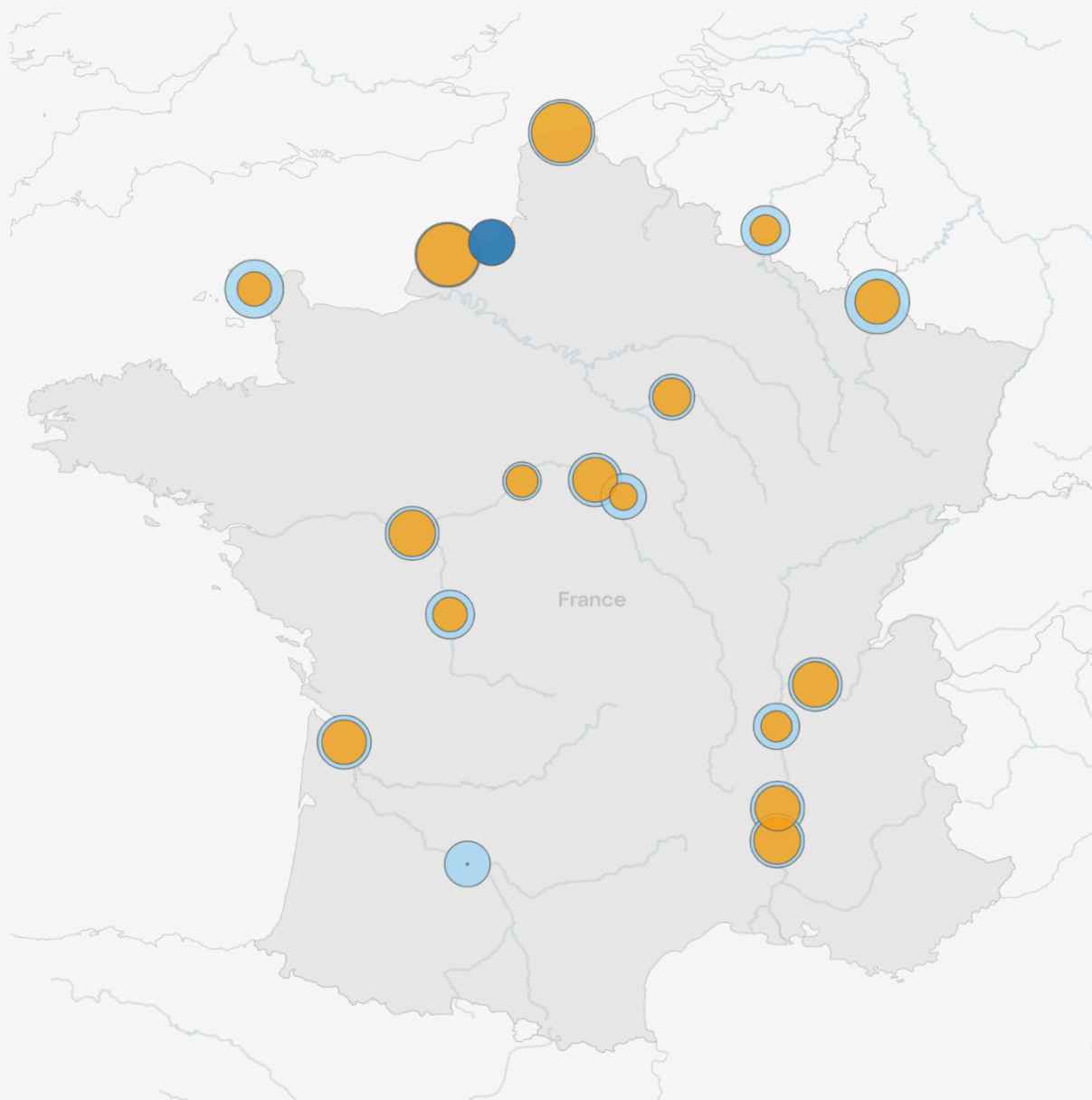
The French nuclear fleet has been impacted the most, with all but one of the 18 facilities experiencing some type of capacity reduction. Power plants along the Garonne, Loire and Rhône rivers were [impacted the most](#), with e.g. the [Golfech](#) plant having to shut down completely. While multiple reductions were related to scheduled maintenance, at least 7 GW of offline capacity on July 1–2 was marked as “Forced” by the transmission system operator (TSO). Reductions in Bugey 2 and Golfech 1 were marked as “Planned”, but specifically spanned the heatwave period. This means that the heatwave might have impacted up to 15% of France’s nuclear capacity.

## During the 2025 heatwave, all but one of France's nuclear power plants experienced reductions, with 23 GW offline

Available capacity after forced and planned reductions in French nuclear power plants between 1-2 July 2025 (MW)

800 MW   4000 MW

 Nominal capacity  No reductions  Reduced capacity



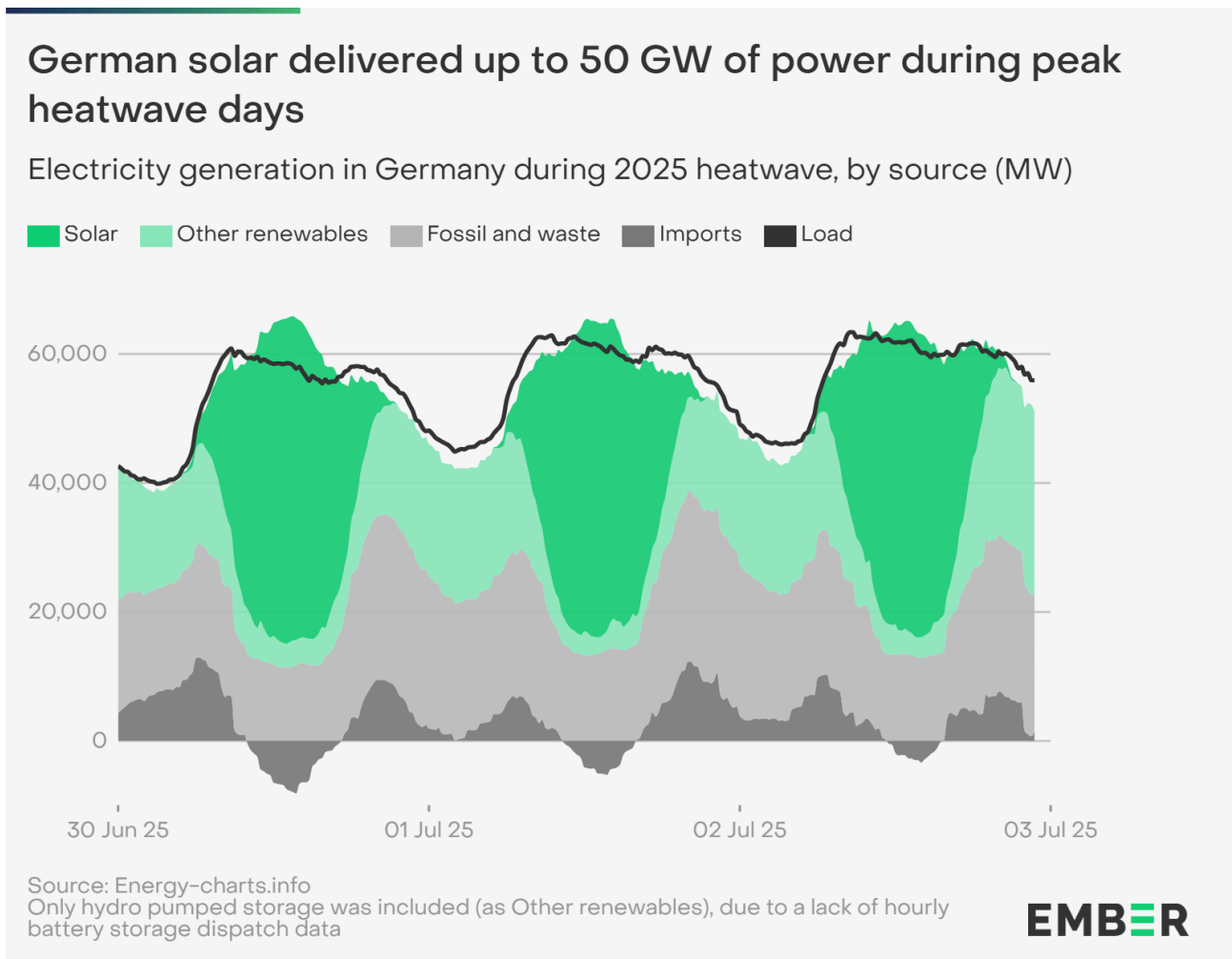
Source: ENTSO-E Transparency

While many reductions are related to scheduled maintenance, both planned and forced reductions are shown on the map. This is because of the inconsistent labelling of these events in the ENTSO-E data source. For example, reductions such as Bugey 2 and Golfech 1 are marked as "Planned", but are specifically related to the heatwave conditions, as acknowledged by EDF.

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### 1.3 The sun brings heat, but also power

While heatwaves bring major challenges, these are partially offset by the large volumes of solar energy available during daytime. In fact, June 2025 was the highest EU solar electricity production month on record – [45 TWh](#), a 22% increase from June 2024 (37 TWh).



In the peak days of the heatwave, solar delivered up to [50 GW](#) of power in Germany alone, generating 33–39% of Germany’s electricity. Germany has [14 GW](#) of battery storage and 10 GW of pumped storage, which helped to store some solar to use when the sun went down.

Solar power is one of the cheapest forms of electricity that Europe has. However, when the sun goes down, electricity will naturally be more expensive. Consumers using air conditioning to keep cool during a hot day should have access to cheap electricity. But when the sun goes down, they will need to pay more to use power-hungry AC units. Smart electrification and time of use tariffs can not only unlock consumer savings, but also ease grid balancing at times of stress, such as during a heatwave.

# Smart solutions can help with grid stability during extreme weather events

Heatwaves are expected to happen more and more often in Europe. Deploying measures such as clean flexibility and interconnection can help grid operators prepare, and avoid disruptions in the future.

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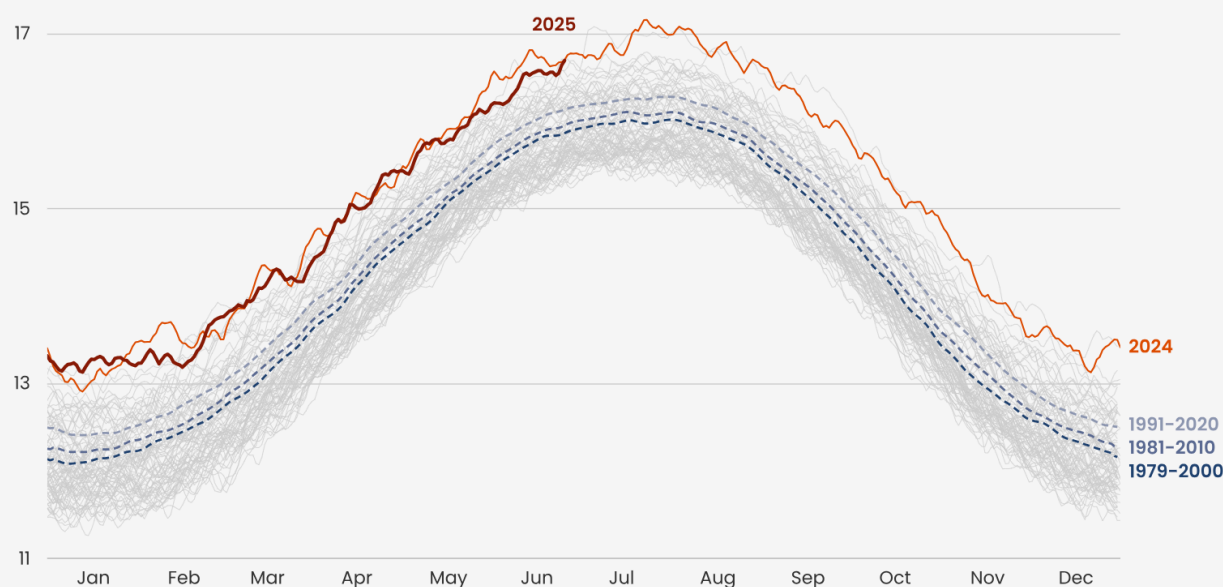
## 2.1 Heatwaves are set to become more frequent

With climate change accelerating, heatwaves are expected to increase in frequency and intensity. 2025 is likely to become the [second hottest year on record](#), only behind 2024. [Multiple records](#) were broken in the June–July heatwave, including mainland Portugal’s record of [46.6°C](#).

Impacts of extreme weather events on Europe’s power systems are estimated in [billions of euros](#) over the next decade, and [45 billion euros in 2023](#) alone for the wider European economy, according to the European Environment Agency (EEA).

## Rising global temperatures drive more frequent and severe heatwaves

Global daily surface air temperature (°C)



Source: Climate Reanalyzer, Climate Data Store (CDS), Copernicus Climate Change Service (C3S) (2023)  
World (90°S–90°N, 0–360°E)  
ERA5 hourly data on single levels from 1940 to present.

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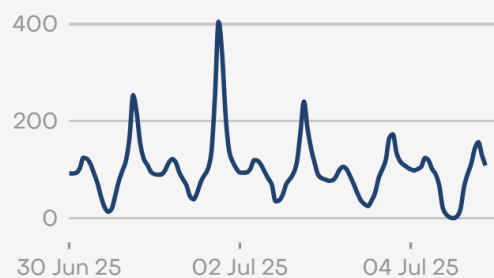
## 2.2 The widening price spreads during heatwaves show the need for battery storage, clean flexibility and interconnection

While heatwaves are a severe challenge for governments and grid operators, they also present an opportunity for [clean flexibility solutions](#). Due to a high supply of solar electricity during the day, and a cooling-related demand peak in the late afternoon hours, the daily electricity price spreads skyrocketed to over 400 €/MWh on July 1.

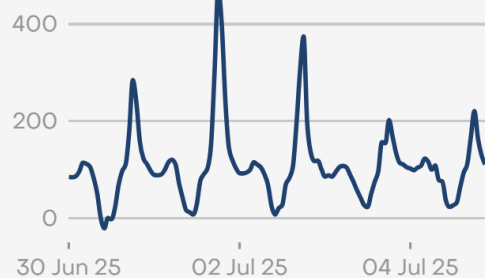
## Widening price spreads amid the European heatwave strengthen the case for storage and flexibility. Interconnection helps price peaks dissipate quickly

Hourly day ahead power price in four EU countries (€/MWh)

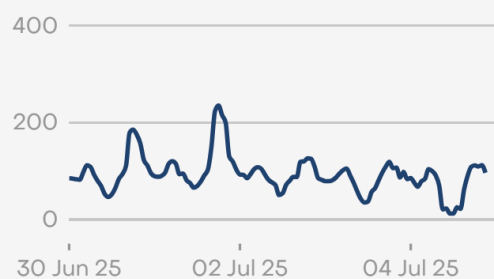
Germany



Poland



France



Spain



Source: ENTSO-E

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This means that matching electricity consumption with generation mattered more than ever. Storage assets benefitted from price spreads, charging at low prices and discharging during expensive peak time, reducing the need for costly imported fossil fuels in the evening, and supporting the balancing of the grid.

Interconnection played a role as well. The heatwave swept across Europe, peaking in Madrid on Sunday, Paris on Tuesday, Berlin and Warsaw on Wednesday – and with that, interconnectors moved electricity to where it was needed most, dissipating the price peaks in the process. In fact after the major blackout earlier in 2025, Spain and Portugal have been calling for [more](#)

[interconnection](#), to help in stabilizing the grid after potential disruptions – such as ones related to heatwaves.

## 2.3 Additional solutions can boost grid resilience during extreme weather events

Aside from the deployment of clean flexibility, storage and interconnection, several actions are being taken by European grid operators to plan for times of grid stress, or even blackouts. Some of them are still pilot or R&D projects, but heatwaves like the recent one make a strong case for their wide adoption.

The [Distributed ReStart](#) project by the UK National Energy System Operator (NESO) explored how distributed energy sources, including wind and solar, could be used to restart the grid after a blackout. One of the recommendations was to increase the adoption of [grid-forming inverters](#) that can start without external voltage supply, building renewables-powered energy islands that are later joined to synchronize the whole grid. Modelling of grid forming assets is tested by the [Belgian TSO – Elia](#), as well.

[Several grid-forming solutions](#) are already available. However, it is key to ensure they can access ancillary services markets to reach broad adoption – as proven in [NESO's Quick Reserve auction](#). System services markets, like inertia or voltage control markets, are being rolled out in multiple countries, including the [UK](#), [Germany](#), [the Netherlands](#).

Coinciding with the heatwaves, the Polish Transmission System Operator – PSE, has proposed an [anti-blackout recommendations package](#) on July 2. The package proposes several measures, such as: access to real-time data from distributed energy sources and storage units, and an ability to control their operations in emergency situations; wider adoption of dynamic tariffs; or increased participation of generation units in the balancing market. All of these measures should provide the TSO with more control over the grid, and eliminate the risk of blackouts ahead of time.

# Supporting information

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## About Ember

Ember is an independent, not-for-profit energy think tank that aims to shift the world to clean electricity using data. It gathers, curates and analyses data on the global power sector and its impact on the climate, using cutting edge technologies and making data and research as open as possible. It uses data-driven insights to shift the conversation towards high impact policies and empower other advocates to do the same. Founded in 2008 as Sandbag, it formerly focused on analysing, monitoring and reforming the EU carbon market, before rebranding as Ember in 2020. Its team of electricity analysts and other support staff are based around the world in the EU, UK, Türkiye, India, China and Indonesia.

## Methodology

### Weather

Weather data is sourced from the Open-Meteo API; Country temperatures are calculated by extracting data for grid points within a country on a 0.25 degree resolution and averaging across all grid points for every hour. The peak temperature is the value in the hour with the highest average temperature.

## Demand

Demand is calculated based on hourly data from ENTSO-E, Agora, Energy-Charts and REE. In Spain, reported solar generation is scaled to account for unreported behind-the-meter solar installations.

## French nuclear outages

Data on nuclear plant reductions was sourced from the [ENTSO-E Transparency platform](#). Typically, outages or capacity reductions are grouped into “Forced” and “Planned” – the latter being e.g. scheduled maintenance, the former being unexpected faults, or environmental issues like heatwaves. However, this grouping isn’t always consistent. Reductions such as Bugey 2 and Golfech 1 were marked as “Planned”, but were directly linked to the temperature conditions, as [reported by EDF](#). In some cases, plants ramped up or down during the heatwave period – in such cases the average reduction capacity was used in the analysis. The analysis included all capacity reductions that were active during July 1–2. From the 23 GW of reductions, 7 GW were marked as “Forced”, with at least 2–3 GW additional capacity marked as “Planned” in ENTSO-E data, but spanning specifically the period of mid-June to mid-July.

## Acknowledgements

### Contributors

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