

# European price sensitive curtailment report



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# About this report

European power markets have been seeing increasing numbers of negative prices in the day ahead market over the past years. After a glimpse into the future during Covid in 2020, where many markets saw negative prices for the first time, markets have started evolving to deal with extreme renewable generation and negative prices as capture rates for solar and wind have dropped and cannibalisation has become more prominent.

With renewables seeing lower revenues from power generation, we see renewable operators moving their business into multiple markets, stacking revenues and shielding themselves from both price and volume risk as well as cannibalisation.

As subsidy regimes are now beginning to exclude assets from receiving subsidies under increasingly strict rules (ranging from six consecutive hours of negative prices, to four, three or even a single hour) assets are now incentivised to bid into auctions at limit prices, if they can switch off. Non-dispatchable assets, or assets that have a must-run generation, will bid in at any price (-500 euro).

This report covers the volumes and values of curtailed renewable generation at the day-ahead stage of European markets. The analysis covers the volume of power being offered to the market in sell offers above -500 and up to 0 euro (exclusive). This report focuses on 3 key countries in Europe, Germany, France, Netherlands. Detailed analytics are also available for other markets, such as Austria, Belgium, Finland, Great Britain, Hungary, Poland and Switzerland. The next version of this report will be expanded to incorporate additional countries.

# Commercially curtailed renewables in 2025 (GWh)



# Executive summary

As renewable power generation keeps growing (and demand recovery after the energy crisis has been lagging) Europe is facing periods of excess power supply from renewables. This can also lead to negative power prices and the cannibalisation of revenues for renewable assets.

Renewable power producers are increasingly exposed to these negative prices, which reached new record levels in 2025. This results in producers deciding to no longer offer their potential renewable power generation at 'any price', instead only offering it at prices above zero. When prices go below zero, they then consider turning down or shutting down production altogether. We call this commercial (or market-based) curtailment, meaning that it is a business decision not to produce, rather than a decision by a grid operator.

Curtailment of renewable generation is controversial. Switching off zero-emission power generation that has a marginal cost of zero, is counterintuitive. When a coal plant or a gas-fired power plant does not run at full power, this is not perceived as an issue. Put simply, there is a cost vs revenue consideration that drives this and when an asset runs at lower output, some emissions are prevented. This cost vs revenue consideration also applies to renewables, just at different price levels. Nobody wants to have to pay to produce power. The core of the controversy lies in the assumption that if renewables are switched off while fossil fuel generation remains online, this happens to favor fossil fuels. In practice, the reasons are often more complex.

Fossil fuel assets are capable of providing reserves to the grid operator in different ways and quantities than renewables. The compensation for being available to balance the grid can cover the cost of producing at negative prices, whereas block orders and smart orders can be used to guarantee an average price over the day or a larger block of hours of consecutive generation. This all provides stability and security of supply around variable renewable production.

As we focus on commercial curtailment in this report, we are considering cost savings for renewable assets from not producing at negative prices. Thanks to the bidding behavior of renewable generation operators, the day-ahead price is less negative than when it would be if the assets would have sold at 'any price'. This positively influences capture prices of renewables and reduces cannibalisation.

This voluntary decision not to produce, does not cost TSOs (and by extension energy consumers) money, as assets are not paid to turn down. This saves consumers money and helps to mitigate both congestion and redispatch issues. They avoid paying for produced MWh at negative prices. This report analyses the bidding behavior of market participants in 10 countries, of which the three with the highest volume of renewable curtailment during negative prices (Germany, France and the Netherlands) have seen close to 4 TWh of power voluntarily not produced.

# European commercial curtailment statistics

Country	GWh Curtailed < 0
Germany	1,749.7
France	1,429.0
Netherlands	708.6
Finland	296.9
Switzerland	172.7
Great Britain	92.6
Poland	71.1
Belgium	58.2
Hungary	53.8
Austria	34.9

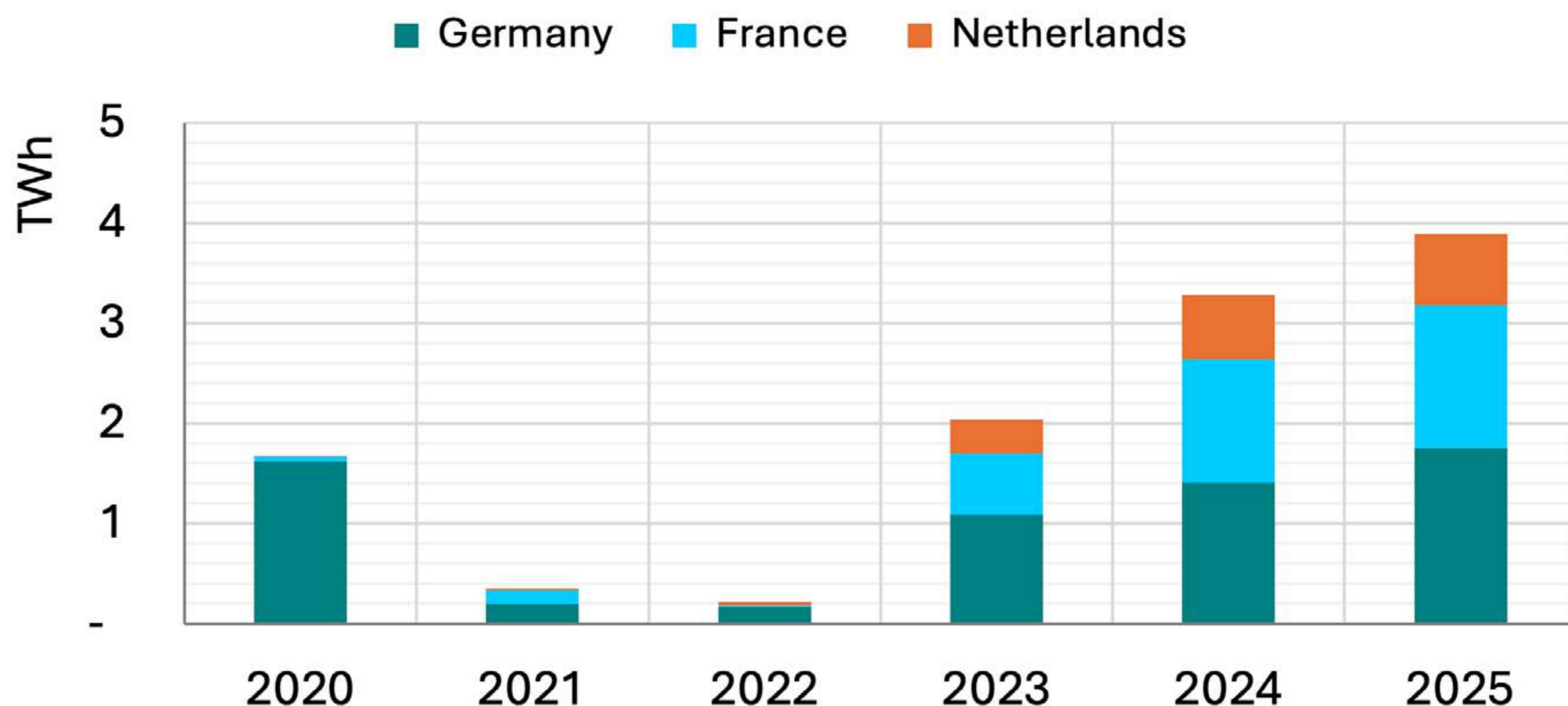
The three countries seeing the highest volumes of commercial curtailment, make up over 80% of the curtailed volumes across the 10 countries currently monitored in this report. They see a continuous increase in curtailment volumes, with continued growth of renewable generation. This report also covers the longer-term trend of these 3 countries, where we can see that with regulatory changes, the volume of market-based/commercial curtailment is increasing over time.

This implies that renewable flexibility is an important instrument, keeping markets functioning, while storage and other flexibility develops. Renewable flexibility is a cheap source of flexibility for grid operators as it is relatively fast and there is limited impact on efficiency and emissions of the assets themselves.

## Total commercial curtailment per year per country (GWh)

Year	Germany	France	Netherlands	Total
2020	1,621	47	12	1,680
2021	191	141	18	351
2022	165	14	40	218
2023	1,088	609	338	2,036
2024	1,404	1,236	642	3,282
2025	1,750	1,429	709	3,887

## Total commercial curtailment per year per country



We can see that Germany already saw significant commercial curtailment during the COVID pandemic, where clear skies and a massive installed capacity of solar, combined with low demand, provided a look into the future. After COVID, and the energy crisis of 2021 and 2022, demand has not fully recovered and Europe has seen massive development of additional renewable capacity. The drivers of negative prices and commercial curtailment are slightly different between Netherlands and France.

Where the Netherlands saw a 'solar boom', with massive development of solar both behind the meter and in large scale installations, far exceeding peak demand, France's conventional assets prove to be relatively inflexible when prices go negative. Nuclear can flex downward to follow demand, but with growth of wind and solar, this is often insufficient to cope with temporary excesses.

# By country statistics

This section focuses on the evolution of commercial curtailment over the years. Following the trend in market-based curtailment shows where curtailment occurs most frequently and what the underlying drivers are.

Analysis for each country covers the cumulative commercial curtailment volume over the year and the unsold volume on the day-ahead auction in certain price classes.

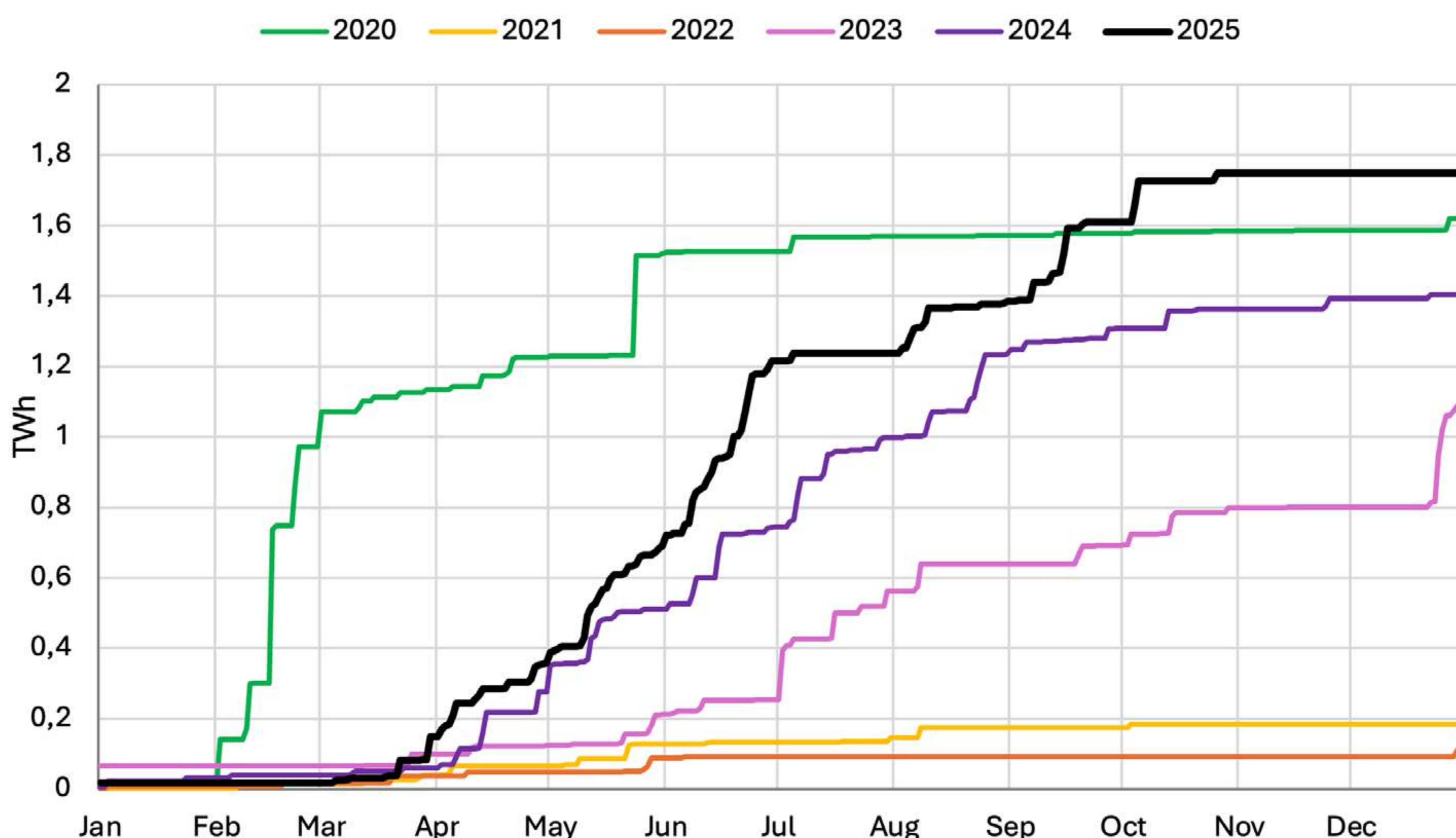
As the curtailment estimate only focuses on the volume that was not cleared below a price of zero, this additional metric provides insight into additional volume that was not cleared in the auction, which was priced above zero, but could potentially still fall under market-based renewable curtailment, considering market-access costs and risk premiums, as described in the previous paragraph.

## Germany

Germany sees negative prices occur earlier and earlier in the year as the total installed capacity of solar increases. Solar peaks now start occurring in April, continuing to the end of September, where peaks in previous years would only reach

significant levels during the summer months. The total for 2025 ended at just below 1.75 TWh, roughly 125 GWh higher than during the Covid pandemic and close to 25% higher than in 2024.

DE - Cumulative price sensitive curtailment per year

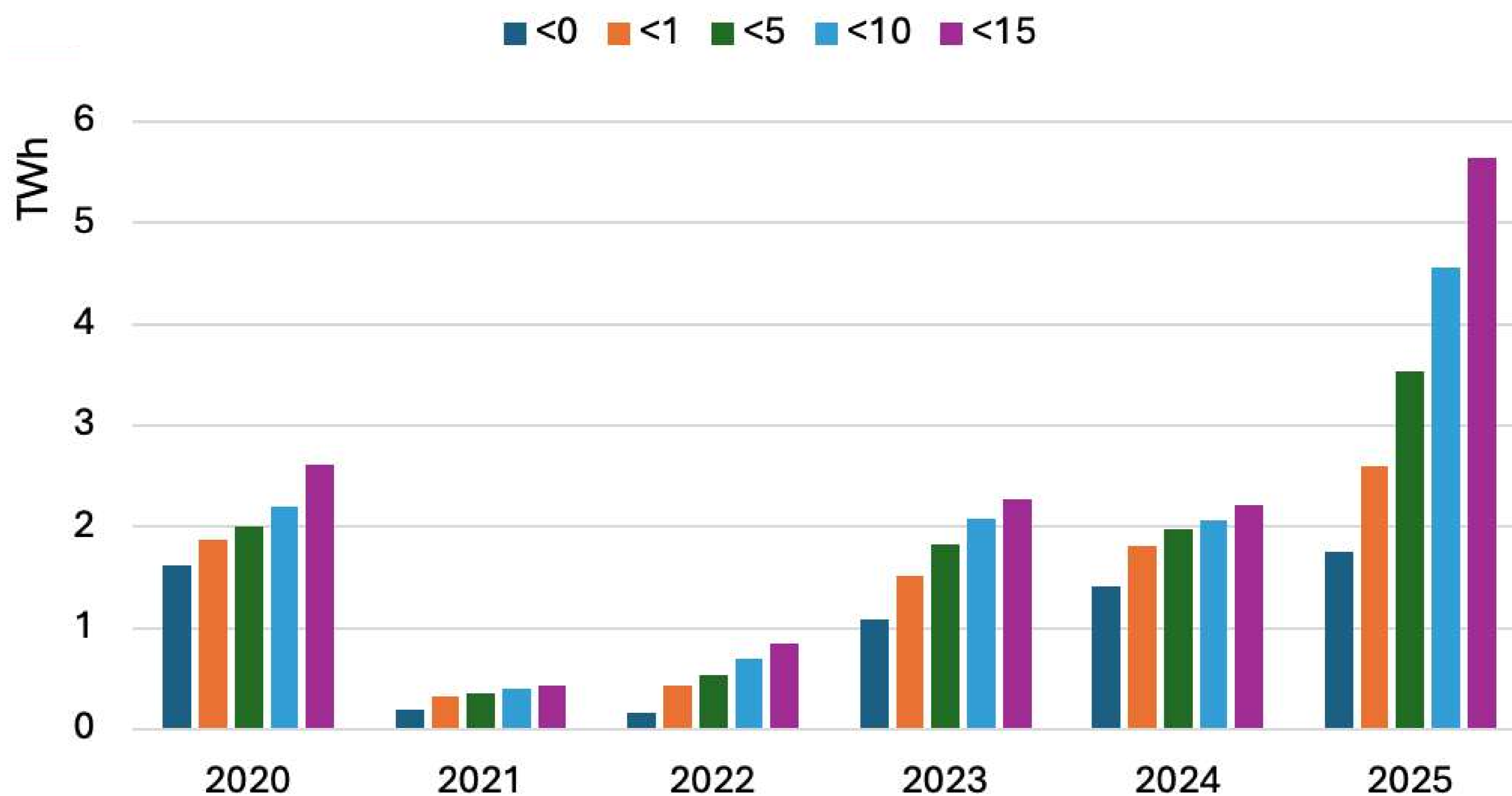


An interesting trend from the unmatched volume statistics is that the volume that was not matched at prices between zero and 15 EUR/MWh has exploded in the last year. The uncleared volume below 5 EUR/MWh is over twice the volume below zero. The volume that did not clear in the auction at prices below zero is also increasing.

This implies that the actual commercial curtailment may in fact be much higher than the estimate shown. Since bids on the power exchange are anonymous, it is difficult to provide a firm number, but the trend is clear. Renewable assets are choosing not to produce at very low prices.

This supply gets removed from the auction and therefore ensures the day-ahead price does not go as far below zero than when all assets would accept 'any price'. However, these assets are not then out of the market completely. An increasing volume of renewables are now accessing additional revenue streams, and activity in multiple other markets next to the day-ahead market. For example, renewables are now prequalifying for ancillary services, providing balancing power and reserves. Renewables are also becoming more active in the intraday market and co-located assets with storage are becoming more mainstream.

### DE - Unmatched sell volume below price



A key fundamental driver in Germany is the rapid expansion of solar capacity over recent years. Germany has added large volumes of photovoltaic capacity, with annual installations accelerating sharply as policy support, falling technology costs and permitting reforms boosted deployment. This has created a pronounced midday generation peak, particularly in spring and summer. During sunny conditions, solar output can rise very quickly while electricity demand remains relatively subdued, especially on weekends, holidays and during shoulder seasons. The resulting surplus pushes wholesale prices down, often into negative territory, directly incentivising solar generators to curtail commercially.

The structure of Germany's generation mix reinforces this effect. While coal-fired generation has declined, parts of the thermal fleet, including lignite and some gas units, can still be relatively inflexible in the short term for technical or economic reasons. When these units remain online during periods of high renewable output, they reduce the available market space for wind and solar. Combined with strong solar and wind generation, this can accelerate price collapses and deepen negative price episodes, increasing the likelihood that renewables curtail voluntarily to avoid losses.

Correlated renewable production across Germany and neighbouring countries further amplifies commercial curtailment. Sunny or windy weather systems tend to affect large geographic areas simultaneously, meaning surplus conditions are often shared across borders. In such situations, exports cannot always relieve the excess supply, as neighbouring markets may also be long. With limited opportunities for price arbitrage through exports, the surplus instead manifests through lower prices in the domestic market, strengthening the economic incentive for generators to curtail.

Market design and remuneration rules also shape commercial behaviour. Support schemes increasingly expose renewable producers to wholesale price signals, particularly during negative-price periods. When prices remain below zero for sustained intervals, producers may lose financial support or face direct losses from continued generation. This encourages market-oriented behaviour and reinforces voluntary curtailment as a response to oversupply, rather than generation continuing regardless of market conditions.

Underlying all of this is a broader imbalance between the pace of supply growth and the evolution of demand and flexibility. Electrification of transport, heating and industry has not yet expanded fast enough to absorb the growing volumes of renewable generation during peak production hours. At the same time, storage capacity and demand-side flexibility, while growing, remain insufficient to consistently soak up large midday solar surpluses. As a result, excess renewable energy increasingly expresses itself through negative prices, which translate directly into commercial curtailment decisions.

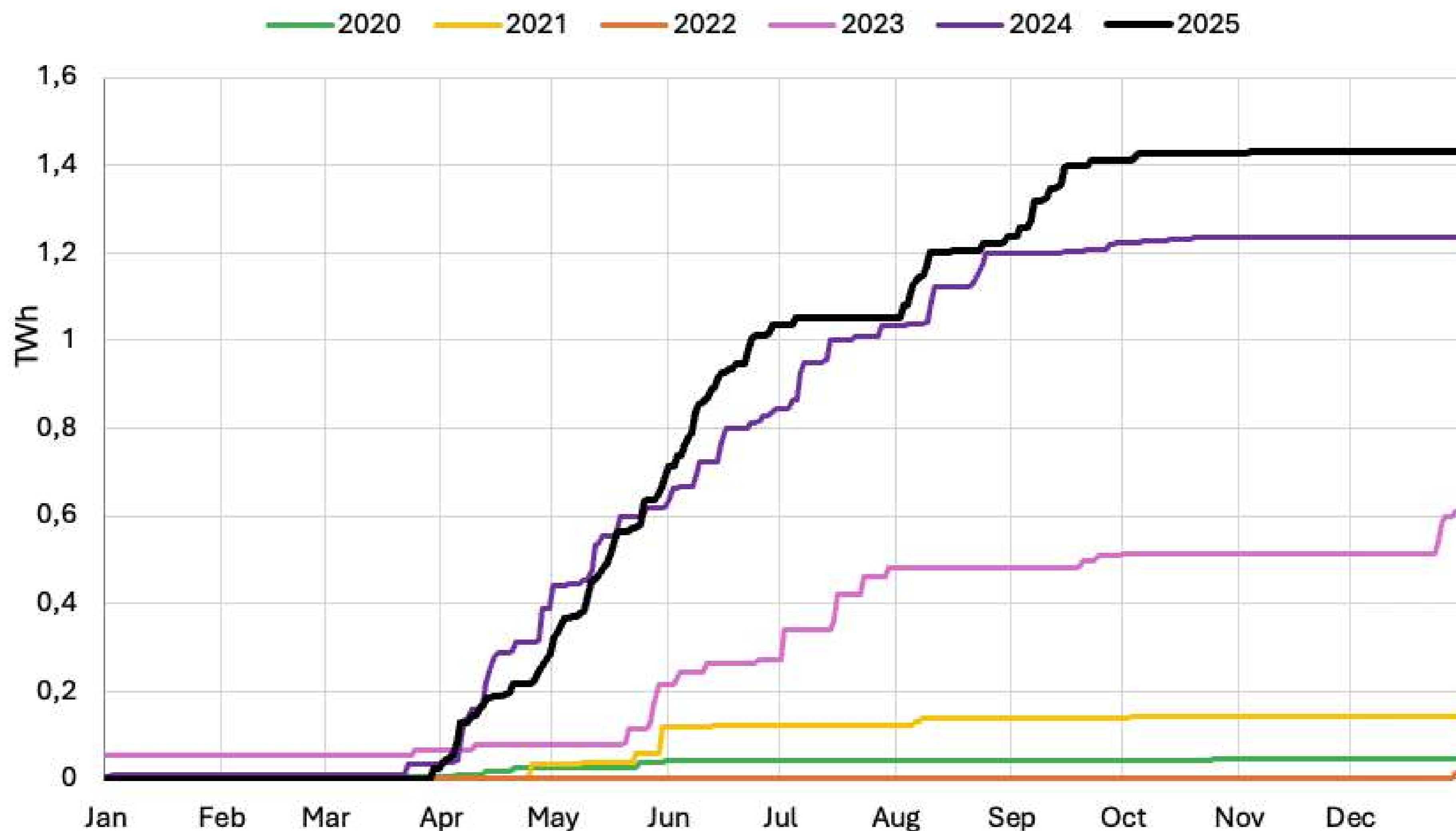
In combination, Germany's recent solar deployment boom, the timing of renewable generation relative to demand, residual inflexibility in the fuel mix, and limited short-term flexibility create recurring periods of market oversupply. Commercial curtailment is therefore best understood as a structural outcome of the current phase of the energy transition, where renewable capacity has expanded faster than the system's ability to absorb and shift that energy through demand growth, storage and flexibility.

# France

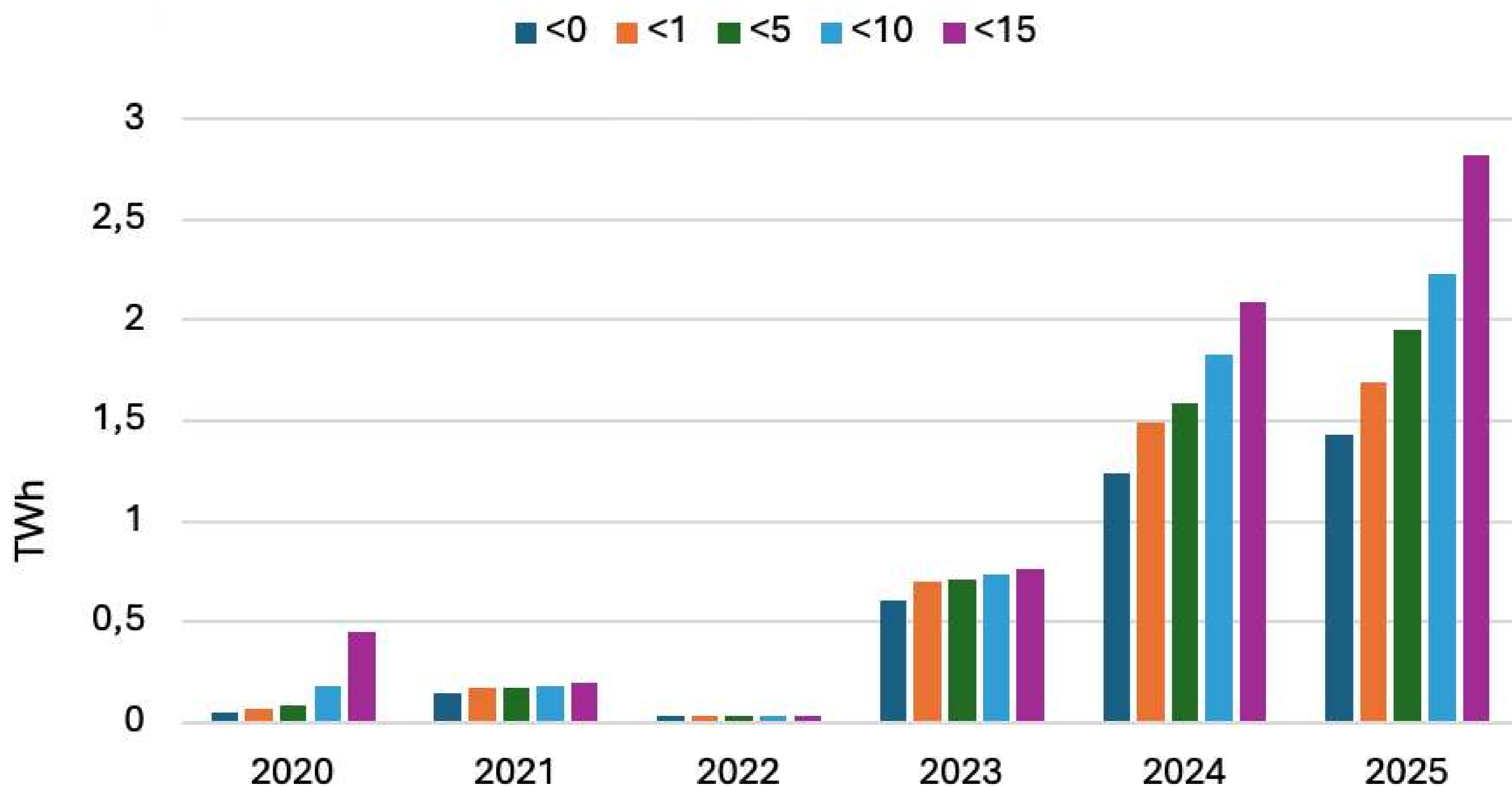
In France we see a similar trend, with the 2025 total commercial curtailment at around 1.5 TWh. This is just under a 20% increase versus the previous year, if we count only the volume curtailed below zero.

In terms of other unmatched volume in the power exchange, France still sees significant volumes not matched in day ahead auctions at very low prices, but it is not quite at the scale of Germany yet.

## FR - Cumulative price sensitive curtailment per year



## FR - Unmatched sell volume below price



Commercial curtailment in France is fundamentally a market-driven response to persistent oversupply, rather than a consequence of grid security actions. It occurs when renewable producers voluntarily reduce output because wholesale power prices fall to zero or turn negative, making continued generation economically irrational. The rise in commercial curtailment therefore reflects deeper structural imbalances between supply, demand and system flexibility in the French power market.

A central driver is the growing frequency of negative and near-zero prices in the day-ahead market. Negative prices have shifted from being an occasional anomaly to a regular feature of the French market, particularly in spring and summer. When prices fall below zero, renewable generators that are exposed to market prices, either directly or through feed-in premium schemes, have a clear financial incentive to curtail rather than sell electricity at a loss. This dynamic has intensified as the number of negative-price hours has increased year on year, directly translating into higher volumes of commercially curtailed wind and solar generation.

At a more fundamental level, solar oversupply during sunny conditions collides with France's structurally inflexible generation mix. Solar output peaks sharply around midday, precisely when French demand is often weakest, especially on weekends and public holidays. At the same time, nuclear generation, which still accounts for the bulk of French electricity supply, operates largely as a baseload technology with limited short-term flexibility. High nuclear availability combined with surging solar output leaves little room for additional generation in the merit order, compressing residual demand and driving prices down rapidly during solar hours. In such conditions, solar generation effectively competes with itself, accelerating price cannibalisation and triggering commercial curtailment. This effect is compounded by correlated renewable production across Europe.

Sunny or windy conditions tend to occur simultaneously across neighbouring markets, meaning France cannot always rely on exports as an outlet for surplus power. Even when interconnection capacity is available, neighbouring countries may be experiencing the same oversupply, limiting cross-border price arbitrage. This synchronisation reduces the market's ability to absorb excess French renewable output, further deepening negative price episodes and reinforcing curtailment incentives.

Market design also plays a role. Under France's feed-in premium regime, many renewable assets receive a top-up above the market price but are still exposed to negative prices beyond certain thresholds. This preserves the economic signal to curtail during extreme oversupply, rather than producing regardless of market conditions. This is not a flaw but an intended feature of market-based support schemes, ensuring that renewables respond to price signals. Even if, in the short term, it leads to rising commercial curtailment volumes.

Finally, demand growth and flexibility have lagged behind supply growth, amplifying these price effects. Electrification of transport, heating and industry has not yet progressed fast enough to absorb rapidly increasing solar and wind output during peak generation hours. Similarly, storage and demand-side response remain insufficient at scale to soak up surplus power. The result is that excess renewable generation expresses itself through prices rather than physical congestion, once again feeding directly into commercial curtailment decisions.

Taken together, commercial curtailment in France is best understood as a rational market outcome of high solar penetration, inflexible nuclear baseload, slow demand growth and limited flexibility, all interacting through the price mechanism. Without faster electrification, more flexible demand and greater storage deployment, commercial curtailment is likely to remain a structural feature of the French power market.

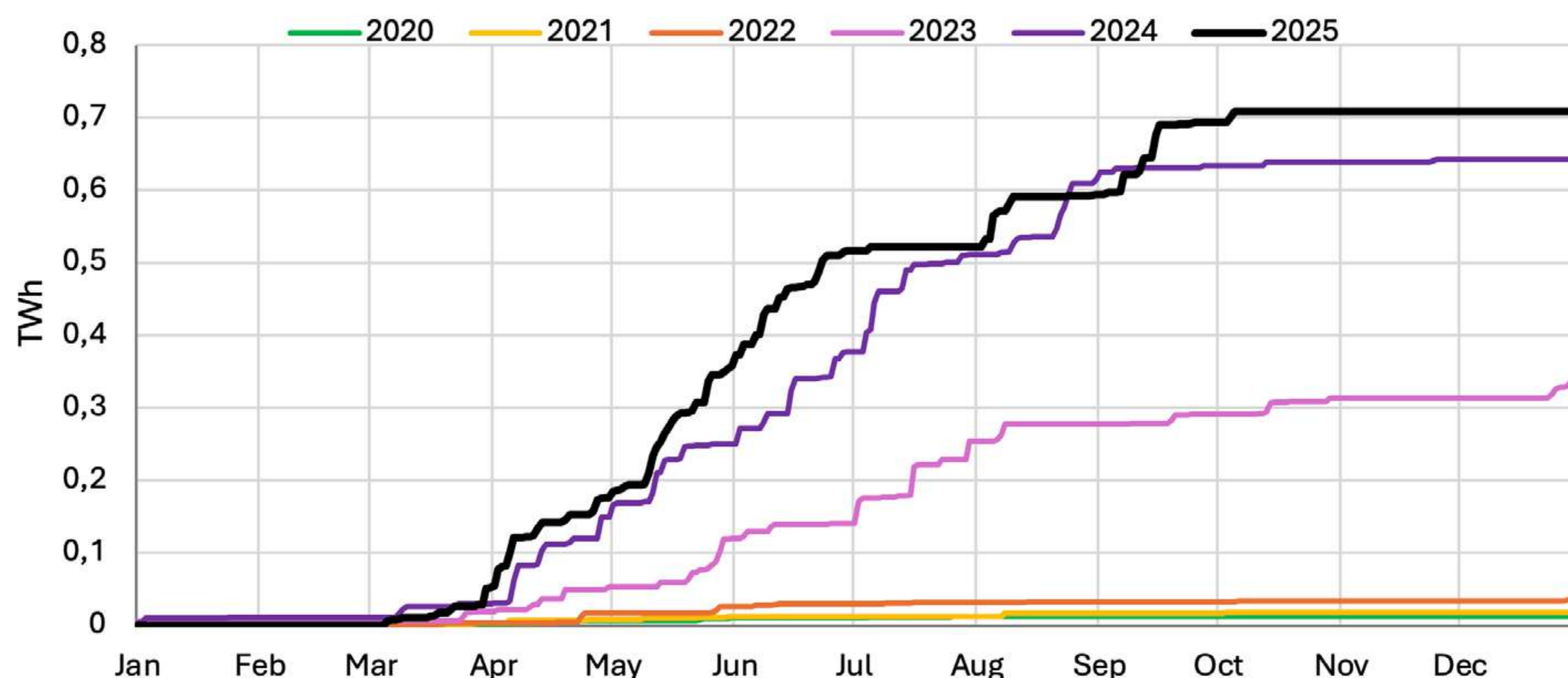
# Netherlands

The Netherlands is a much smaller market, but sees massive commercial curtailment due to periods of enormous oversupply. A generous subsidy regime has resulted in a massive build out of solar, much of it behind the meter and therefore with limited dispatchability. The grid has become so congested over the last years, that connection capacity has run out in most regions of the country, causing long queues for getting new grid connections for both consumption and generation.

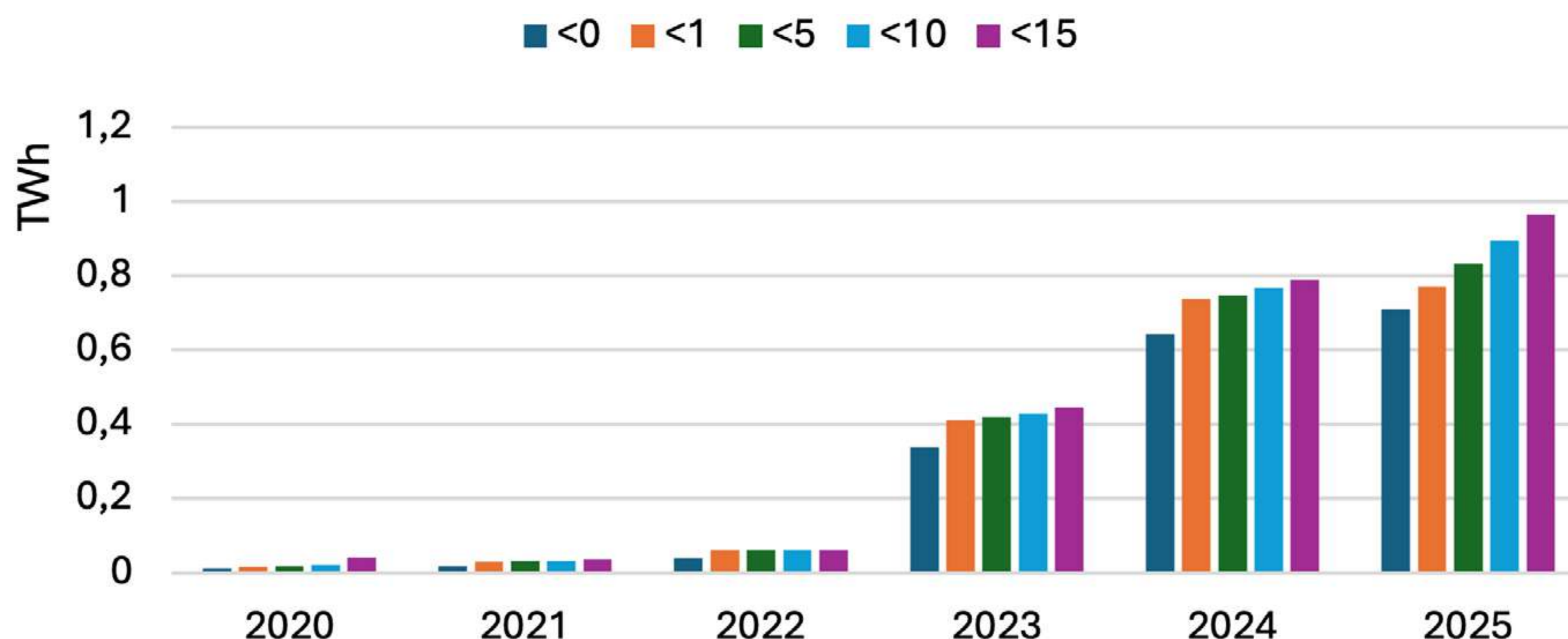
With nearly 3 TWh of commercial curtailment, Dutch market participants mitigate the excess on the local grid. Growth in solar is expected to slow, while storage increases, due to a change in subsidy regimes and changes in grid costs.

The auction curve analysis shows a similar picture to France. There is significant volume that is not matched in the auction at low prices, but not quite as observed in the German market.

NL - Cumulative price sensitive curtailment per year



NL - Unmatched sell volume below price



Commercial curtailment in the Netherlands is fundamentally a market response to persistent oversupply, where renewable generators voluntarily curtail output because wholesale electricity prices fall to zero or into negative territory, making continued production economically disadvantageous. In these periods, producers that are exposed to market prices face direct financial incentives to shut in rather than sell power at a loss; this behaviour reflects the interaction of supply, demand and price signals in the Dutch electricity market.

A defining feature of the Dutch system is the rapid expansion of solar capacity over recent years. Cumulative solar photovoltaic capacity has grown substantially, with installed capacity rising sharply through the early 2020s as homeowners and commercial developers adopted PV at scale. This has created a pronounced midday solar generation peak on clear days, particularly in spring and summer, when electricity demand tends to be modest. Because rooftop solar and distributed PV continue feeding into the grid regardless of price signals, the midday residual demand (after accounting for this distributed output) can shrink dramatically. When this occurs alongside strong utility-scale renewables, the aggregate supply can exceed system demand by enough that markets clear at zero or negative prices. In 2025, the Netherlands recorded a record number of negative day-ahead price hours, with figures through the first eight months well above prior years (several hundred hours) illustrating the strong correlation between solar output and price collapses.

The structure of the Dutch fuel mix and generation portfolio also shapes this dynamic. While gas-fired plants remain key flexible resources, and conventional thermal generation has declined over time, there remain hours when the system is long even after thermal output has reduced as far as feasible. In those hours, renewable oversupply tends to dominate the price formation process.

When abundant solar (and wind) output coincides with calm demand periods and limited export opportunities, such as when neighbouring markets are also long, price signals adjust accordingly. Negative prices are the clearest expression of this imbalance, and market-exposed generators respond by curtailing voluntarily to avoid selling at negative rates or triggering adverse remuneration adjustments tied to prolonged negative price episodes.

A notable example of this phenomenon occurred during 2025, when the Netherlands logged an exceptionally high number of hours with negative wholesale electricity prices. In the first eight months alone, the total negative-price hours surpassed those recorded in all of 2024, with particularly strong concentration around periods of high solar output. June 2025 alone saw a large cluster of negative price events closely tied to midday solar peaks and modest demand. These episodes send clear market signals: with supply outstripping demand, prices fall, and producers rationally choose to curtail rather than generate at unfavourable prices, especially where commercial arrangements or support mechanisms penalise continued production during extended negative pricing.

Cross-border conditions amplify these effects. The Netherlands is highly interconnected with Belgium, Germany and the Nordic markets, but simultaneous renewable surpluses across these regions, a common weather-driven pattern, can weaken export demand just when Dutch PV output is strongest. This limits the extent to which excess power can be absorbed regionally and increases reliance on price formation at the local market level to balance supply and demand. The result is more frequent and deeper negative prices, which in turn translate into voluntary commercial curtailment by generators that are exposed to market pricing.

Underlying all of this is an imbalance between the pace of renewable capacity growth and the evolution of demand and flexibility options. While electrification of heating, transport and industry is progressing, it has not yet been sufficient to absorb the rapid growth of solar production during peak hours. At the same time, grid-scale storage and demand response mechanisms, though expanding, remain relatively limited. This means excess renewable energy increasingly expresses itself not through physical grid constraints in normal conditions, but through price signals. Those price dynamics are precisely what drive commercial curtailment: producers reduce output when prices indicate oversupply, preserving revenue and signalling a broader need for more demand-side flexibility and storage to better align supply and demand in real time.

# Maturity, balancing risk and optimiser penetration

As Germany has been dealing with negative prices and therefore with commercial curtailment for much longer than France and Netherlands, it is not unlikely that its bidding behavior on the day-ahead market is an indication of where other markets might evolve towards. We consider Germany to be the more mature market in dealing with negative prices and commercial curtailment.

Balancing risk in Europe should converge eventually to a common value under the influence of harmonisation and cross-border balancing mechanisms such as Picasso and MARI. The excesses will still be mostly local, but the average risk should converge across the continent in the long-term. It is not unthinkable that Germany will be the benchmark for balancing risk.

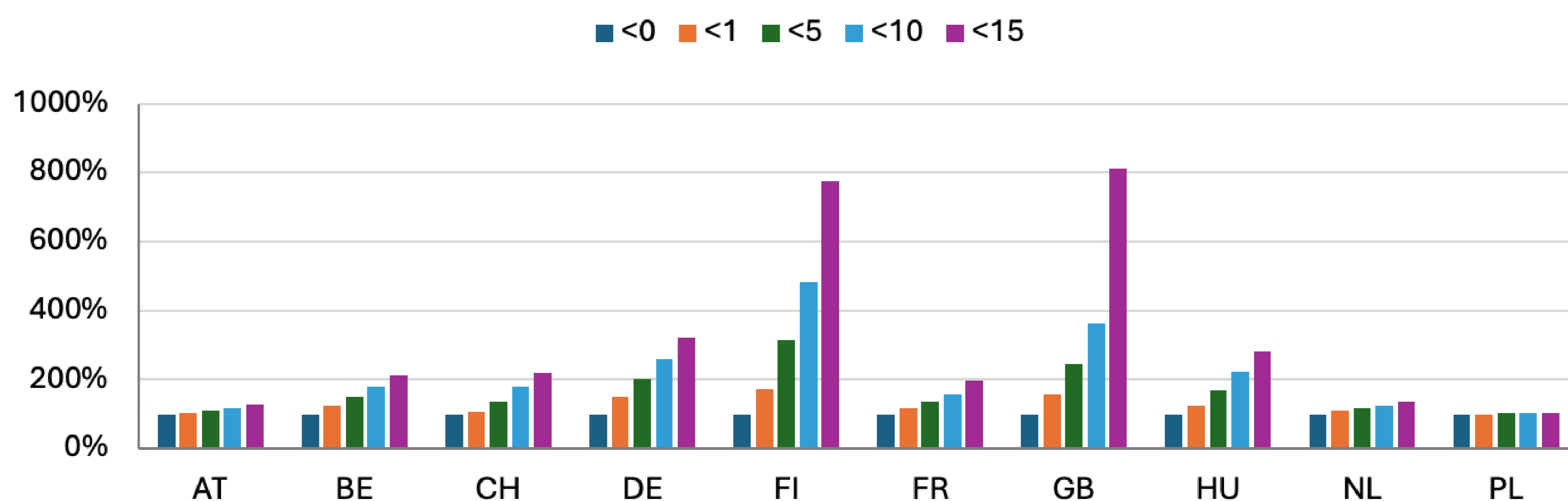
Finally, we see the German market is the most liquid intraday market on the continent, with many optimisers and direct marketers servicing renewable asset trading. This is another indication that other markets are more likely to trend towards German behavior, rather than the other way around.

Comparing the unmatched volume in different price classes, across European countries, shows us that Germany is not the most extreme case. Finland and GB see even more extreme (relative) volumes unmatched at 'low-but-not-negative' prices. Finland is part of Nordpool, the liquid day-ahead auction across the Nordics, whereas GB is also a mature power market, with a Contracts for Difference (CfD) based subsidy structure.

Hungary sees a similar distribution to Germany, which is likely driven by a higher cost of market access and balancing risk.

This analysis indicates which countries may see a faster evolution in commercial curtailment than others. Finland and GB are likely to see slower growth, whereas Poland, Austria and the Netherlands are more likely to see a faster growth of commercial curtailment as market participants discover the cost of doing business and the risk of imbalance.

## 2025 - Unmatched volume as % of unmatched volume < €0



# The curious case of commercial curtailment during positive prices

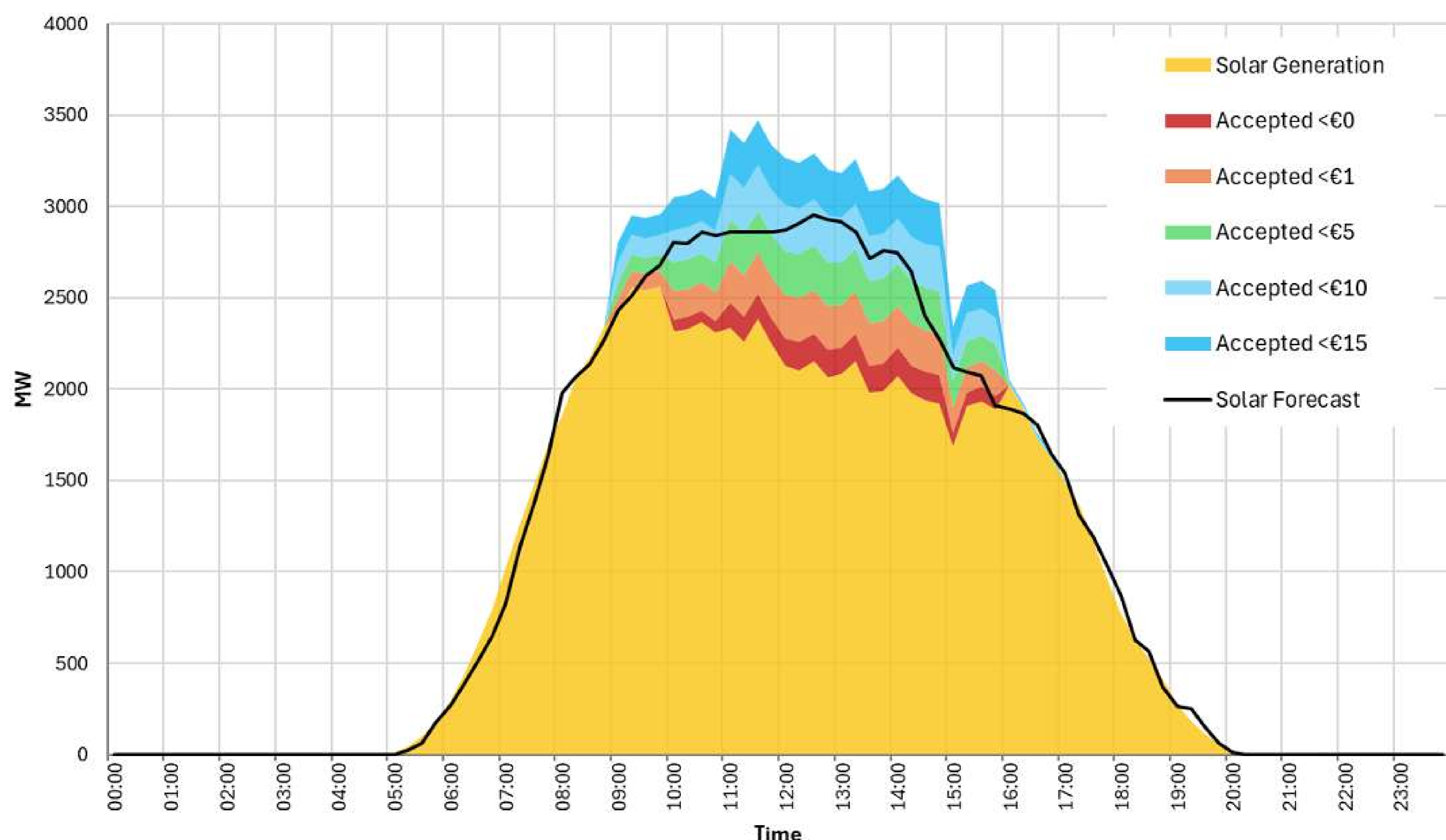
An interesting feature of renewable power generation is that the risk profile of a renewable asset is different from a conventional asset. As most renewables do not run on a 'flat line' setpoint per quarter hour, there is an inherent balancing risk involved. Furthermore, direct-marketers, optimisers and other service providers base their fees on matched volumes in the auction. Quantifying these risks and additional costs, ensures that renewable assets actually need a price slightly above zero to really generate a positive revenue.

This effect is best demonstrated by this example from the Hungarian market, where we have visualized the expected solar generation (forecast) versus the actual outturn.

If we assume commercial curtailment only occurs during negative prices, we see that the curtailed volume (in red) does not line up with the generation potential based on installed capacity and radiation levels.

In fact, it is very plausible that curtailment already happens when multiple hours in a row are below 10 Euros. In some countries, we see this effect very strongly, although the levels at which the curtailment becomes significant differ quite strongly from country to country. France, for example sees high volumes being offered between zero and 1 Euro, suggesting that the curtailment boundary is more likely at the 1 Euro level than at zero.

## Hungary - Solar forecast vs generation vs accepted volume below price X



# Looking forward

Is more curtailment expected next year and will this result in even more frequent occurrences of negative prices? With significant market changes in many of the countries involved, this is always difficult to say. What is clear, is the European trend towards more 'market-based' subsidy regimes. The older lucrative subsidy schemes, using feed-in tariffs and netting rules, are fading out as regulation evolves and we see a trend towards CfD-like structures.

CfD-like support schemes are increasingly seen as better suited to Europe's power system because they provide long-term revenue certainty for low-carbon investment while preserving short-term market price signals. By settling financially rather than guaranteeing physical offtake, CfDs avoid "produce-and-forget" behaviour and keep generators exposed to dispatch and curtailment incentives.

Properly designed two-way CfDs can suspend support during negative prices, reducing distortions and limiting inefficient overproduction. They lower consumer costs by clawing back windfall profits during price spikes, improving political and social acceptability. Crucially, CfDs integrate clean capacity into the market without fragmenting it, supporting both security of supply and system stability.

## Germany

The German TSOs can now bid the renewables under the EEG-subsidy scheme dynamically into the market. However, the impact of this is expected to be limited. They will still offer the power at prices well below zero, but no longer at minimum price (-500 EUR/MWh). The effect will become visible when prices go below -100 EUR/MWh, which is not expected to happen a lot. However, new capacity will curtail much sooner as changes in the rules imply that these new assets will not receive a subsidy when prices go below zero.

Changes around supporting renewables during consecutive periods of negative prices have been evolving, (from six consecutive hours to one hour) and with the arrival of quarter-hourly day ahead markets, this already applies if the average of the quarter-hourly prices is negative. Effectively, Germany is ending support for renewables during negative price periods. That said, older assets are effectively insulated from these effects.

## France

The French Regulator CRE has made recommendations to mitigate negative prices. Support schemes were already very strict and did not support renewable generation during negative price hours.

In France, the debate around commercial curtailment is not limited to price formation. RTE has repeatedly warned that large-scale, synchronised curtailment of inverter-based renewables, particularly if driven by uniform negative-price or subsidy thresholds, can pose risks to frequency quality. As a result, France has traditionally favoured more coordinated, TSO-led curtailment approaches and remains cautious about market designs that could trigger abrupt generation drops during low-demand, high-renewables periods.

## Netherlands

The Netherlands is a good case where negative prices are increasingly a market reality, and support design is evolving toward CfD-like logic. With support dropping at negative prices, for new assets, we will see those assets increasingly curtail at negative prices. Will we see more negative prices? That depends not just on the local market, but also on what happens in Germany and how Belgium will evolve now that it has shut down more nuclear capacity.

## Other European Countries

As mentioned, European market rules are evolving towards market based (commercial) curtailment.

The GB market sees a more modest commercial curtailment volume, well below 0.5 TWh. This is mainly due to more 'forced curtailment' for grid issues as we highlight in our specific curtailment report about the GB market. As an island system, the grid operator needs to interfere more often than in the continental coupled markets, where more interconnection capacity and flexibility results in price-driven, rather than grid driven curtailment.

Curtailed volumes of electricity are rising on average and may continue to do so as more renewable capacity comes online. GB already largely conforms to CfD structures (mostly) and commercial curtailment is preferable to grid-based curtailment and redispatch, which are borne by the consumer in the end. As the GB market sees a relatively lower volume of commercial curtailment, all eyes will be on grid development. If GB solves its congestion issues, it may well need less forced curtailment for grid issues, resulting in more renewable generation and lower prices, which could then lead to more commercial curtailment.

**Austria and Switzerland** see negative prices and therefore commercial curtailment mainly as a result of imported renewables from Germany and other European markets. As long as they have sufficient local flexibility from hydro-assets (no massive oversupply, no massive drought), they should see a gradual growth in commercial curtailment.

**Hungary** has seen massive commercial curtailment and with its intraday and balancing market volatility, it is a textbook example of a country that sees commercial curtailment from renewables at relatively 'high' (i.e. positive) prices.

Producers see a high balancing risk and therefore choose not to produce when risks are too high. We are likely to see more curtailment following a similar trend as in the Alpine countries.

**Belgium** is a country that is closely linked to France, Germany and Netherlands, its own surpluses will be lower than in previous years, when a baseload level of inflexible nuclear generation was higher than it will be going forward. This will not insulate the market from a further increase in commercial curtailment.

Older and less flexible energy systems such as Poland, will be subject to record levels of curtailment in 2026. Poland saw no less than 305 days with non-market based curtailment in 2025, highlighting a significant lack of flexibility. With new flexible assets such as gas-fired power stations and battery storage coming online from 2027, it looks like 2026 will definitely see a further increase in curtailment, both market based and non-market based curtailment.

**Nordic** markets have seen negative prices. Sweden especially is still facing massive overproduction from renewables, especially during the 'spring melt'. A wet year will produce more negative prices, however it is difficult to determine the volume of commercial curtailment as the power exchanges do not publish by-region aggregated curves. In Finland the number of negative hours has decreased in 2025 and Norway has not seen very many negative prices. Denmark is also more difficult to assess, as regional supply curves are not published by the power exchanges.

**Spain and Italy** were not yet covered in this report, due to differences in regulations and data publication. We aim to add insights about these markets in the next edition of this report. Commercial curtailment is an inherent part of everyday operations in the Spanish market, which sees many negative prices.

# Negative prices: transmission limitations and lack of flexibility

As negative prices drive commercial curtailment, let's go through the reasons for producing power at negative prices.

**Non-dispatchability:** not all assets can be switched off when prices are low. Many of the early renewable installations or behind-the-meter solar installations cannot be operated remotely. Unless someone is on site to turn off the production, the assets will continue producing. With the massive growth of behind-the-meter solar, the volume in this category keeps growing.

**Must-run generation:** Some assets have little flexibility and will run at a minimum baseload level. They are either not fast enough to respond or the cost of stopping and restarting does not justify switching off during negative price periods. Assets in this category are Nuclear, Lignite, Coal and industrial CHP's needed for steam-production.

**Slow recovery of demand:** the energy crisis of 2021 led to demand destruction, due to a shake-out of some energy intensive industries and a strong drive to energy efficiency. Some of this demand has not returned, whereas the drive for energy efficiency has remained. Demand has not recovered fully after Covid and the energy crisis and we see slower than expected electrification in most countries.

**Alternative revenues:** Where day-ahead prices are low or negative, you would expect generation assets to switch off. However, next to the power exchanges, there are many other revenue streams that generation assets can tap into.

**Cross-Border capacity limitations:** Market Coupling mechanisms ensure power flows from low-price areas to high-price areas. Despite increasing efficiency, local differences are, at times, so high that the limits of cross-border capacity are reached, causing price divergence across markets. Obviously, when there is sufficient cross-border capacity and surplus energy is widespread, negative prices can also propagate across multiple areas.

**Lack of flexibility:** the above reasons for negative prices would be mitigated by flexibility in demand and generation if available. As renewable growth accelerated during and after the energy crisis of 2021, this growth outpaced the speed at which flexibility has been growing. This compounds into a need for flexibility from the production side. The cheapest flexibility comes from assets that are online and save fossil fuels, and from assets that can start and stop without additional costs. When most fossil fuels are pushed out of the merit order by renewables, curtailing renewables becomes the most viable option to provide additional flexibility.

## Negative prices statistics

Negative prices have been on the rise in most European countries over the past years. 2025 was a new record year for negative prices in Germany, France and the Netherlands.

## Making the case for storage and demand response

We are seeing renewables filling the flexibility gap that has occurred. A more natural solution would be to solve surpluses by using storage and demand response to fit consumption around the availability of zero-emission electricity. So, what does curtailment tell us about the business cases for storage and demand response?

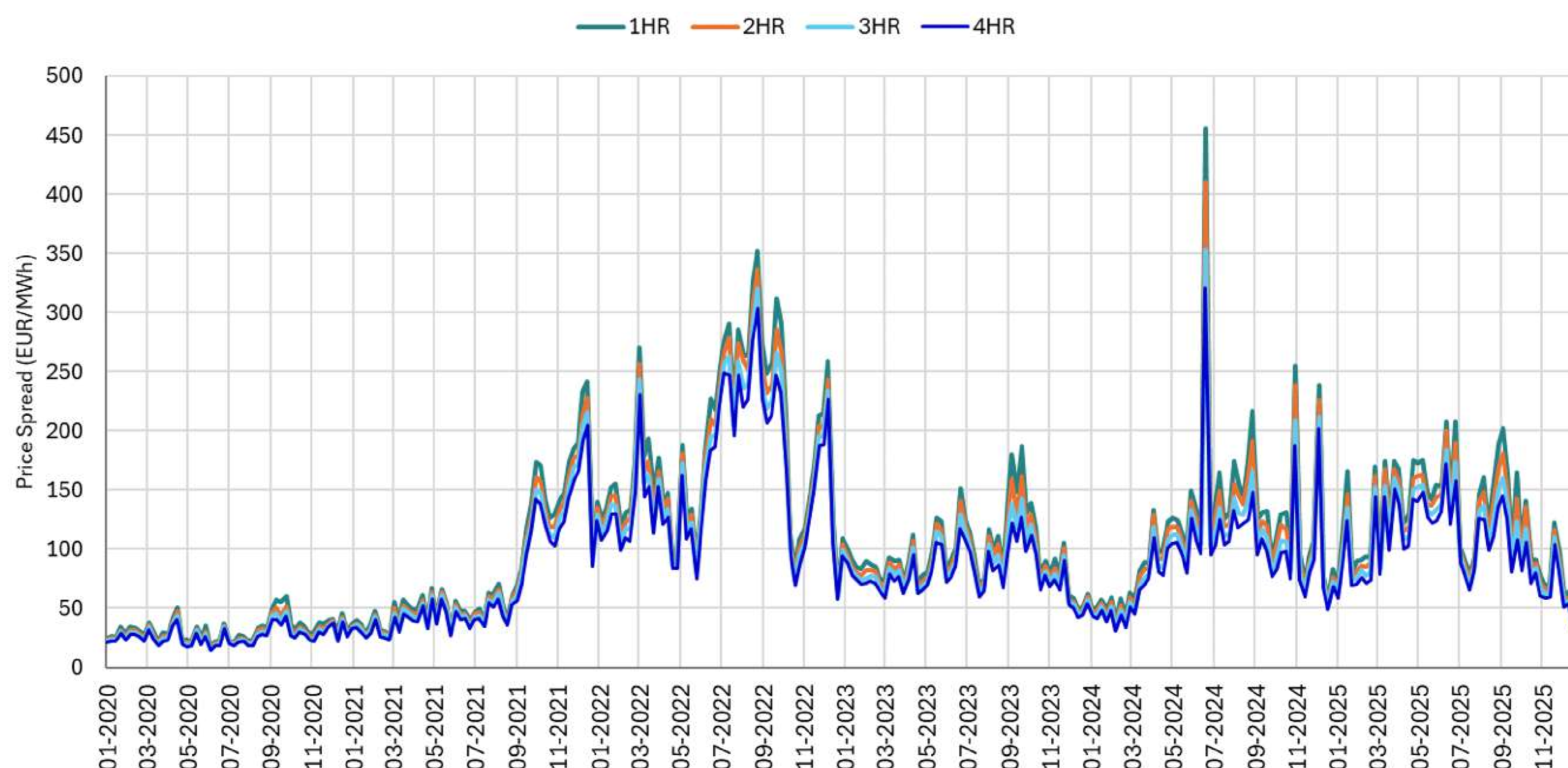
## The storage market is far from saturated

As we see continued growth in commercial curtailment, we can conclude that storage assets storing cheap energy are not cannibalising their own market, yet. The 'charging' part of the storage business case looks healthy and provided the 'discharging' revenue is high enough, storage should see a healthy business case going forward, even if congestion, voltage issues, transmission issues and redispatch are mitigated.

## Hours of negative day ahead prices

Country	2020	2021	2022	2023	2024	2025
Germany	298	139	69	301	450	539
France	102	64	4	147	350	509
Netherlands	97	70	85	315	457	584

## DE - Day ahead price high-low spread x-hour duration



The different types of storage display different strengths and weaknesses in their business cases. Alongside the massive interest in battery storage, e-boilers, power-to-heat, pumped storage and long-duration energy storage are also growing.

Demand Response, increasing demand during negative prices and decreasing it during high price periods is an interesting second option. In general, we see this in industrial consumers, with relatively limited volumes. Dynamic price contracts can be a step to involve retail users as well, although any type of demand response comes with an 'inconvenience cost'.

# Report methodology

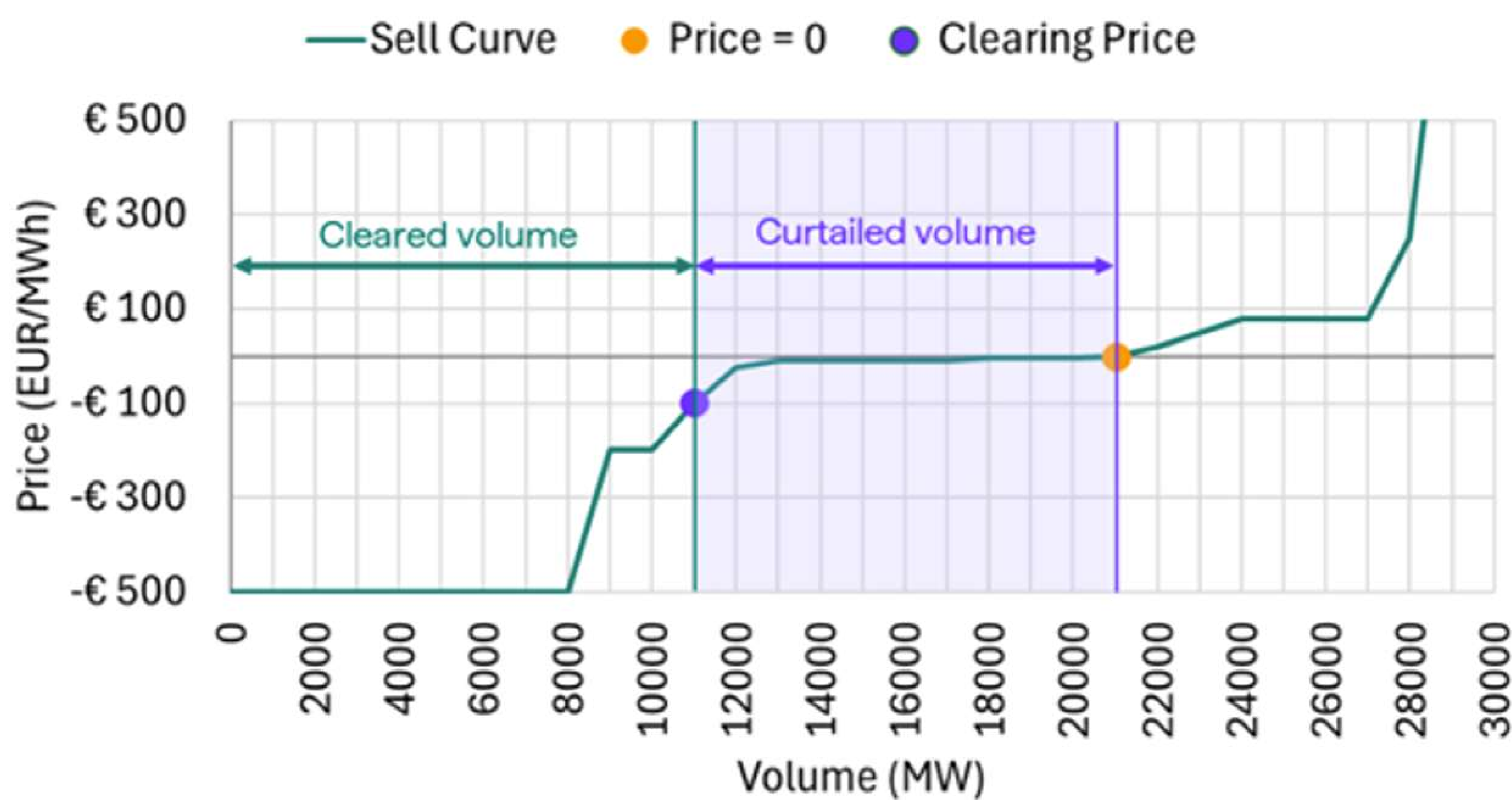
We calculate the estimated price-sensitive curtailment volumes, using the sell-curve of the day-ahead auction. For every hour (up until 1 October 2025) or quarter-hour (from 1 October 2025), we calculate the volume offered in the sell-curve between the market clearing price and zero.

This is a simplification, as depending on market rules, including the number of consecutive negative price periods, subsidy regimes applicable to the assets, and commercial considerations, market participants may curtail renewable assets at prices above zero, or may start curtailing at more negative prices than that. There will also be renewable capacity in the purchase curve and curtailment may also occur or disappear due to intraday price developments.

The model does not distinguish between curtailment for solar and wind power, as the bids into the day-ahead auction are anonymous. Curtailment as a result of redispatch or balancing actions is left out of scope for this report. As different countries handle transmission constraints and balancing markets differently, it is hard to create a homogenous comparison.

As a result, this report focuses on the commercial flexibility of renewable assets and the money they save by not producing during negative prices.

## Sell curve analysis



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