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ENERGY RESEARCH

Negative Prices in the French Power Market

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Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

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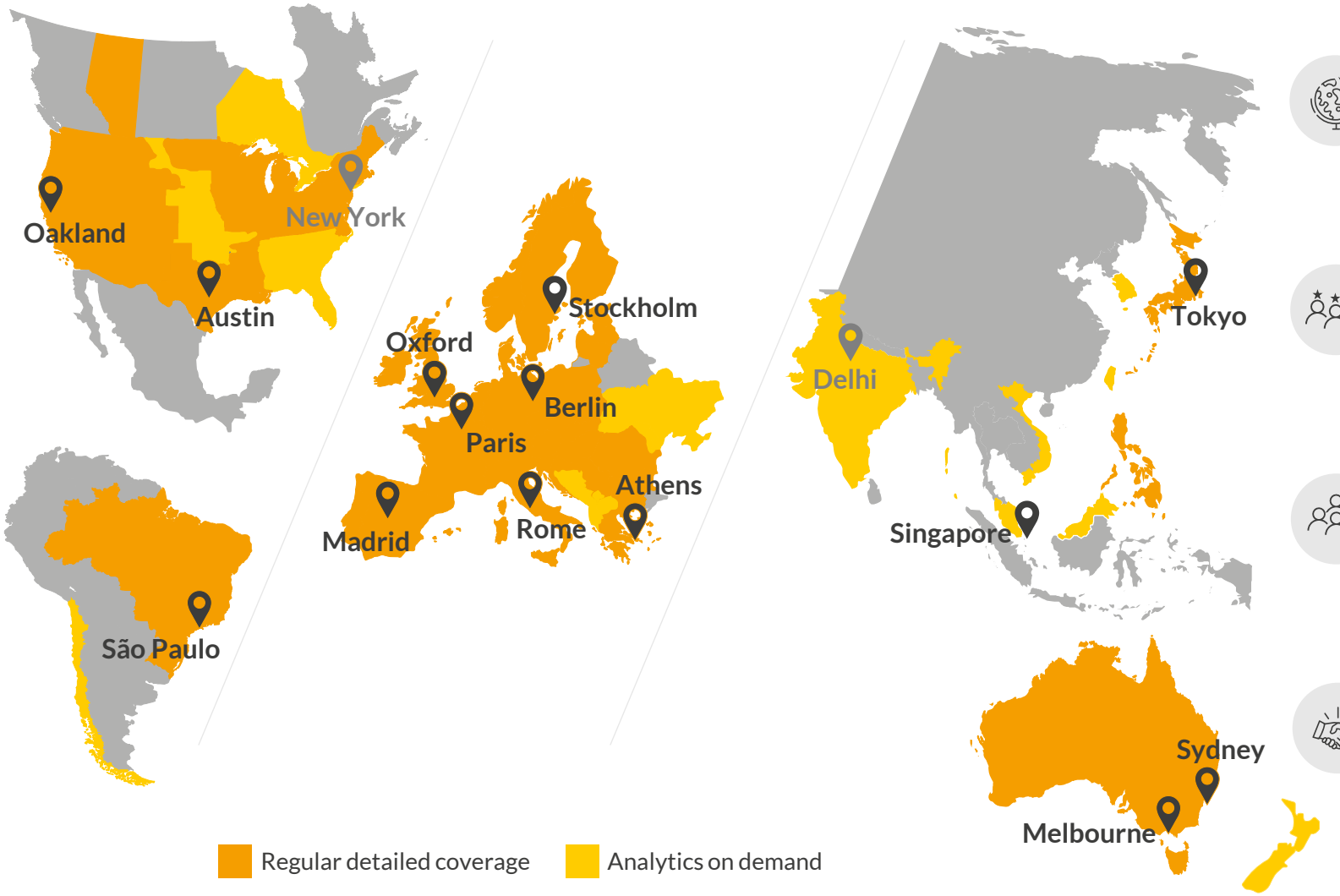

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In recent years, the trend of negative prices in the French system has been increasing, with already 125% more hours in 2024 compared to 2023

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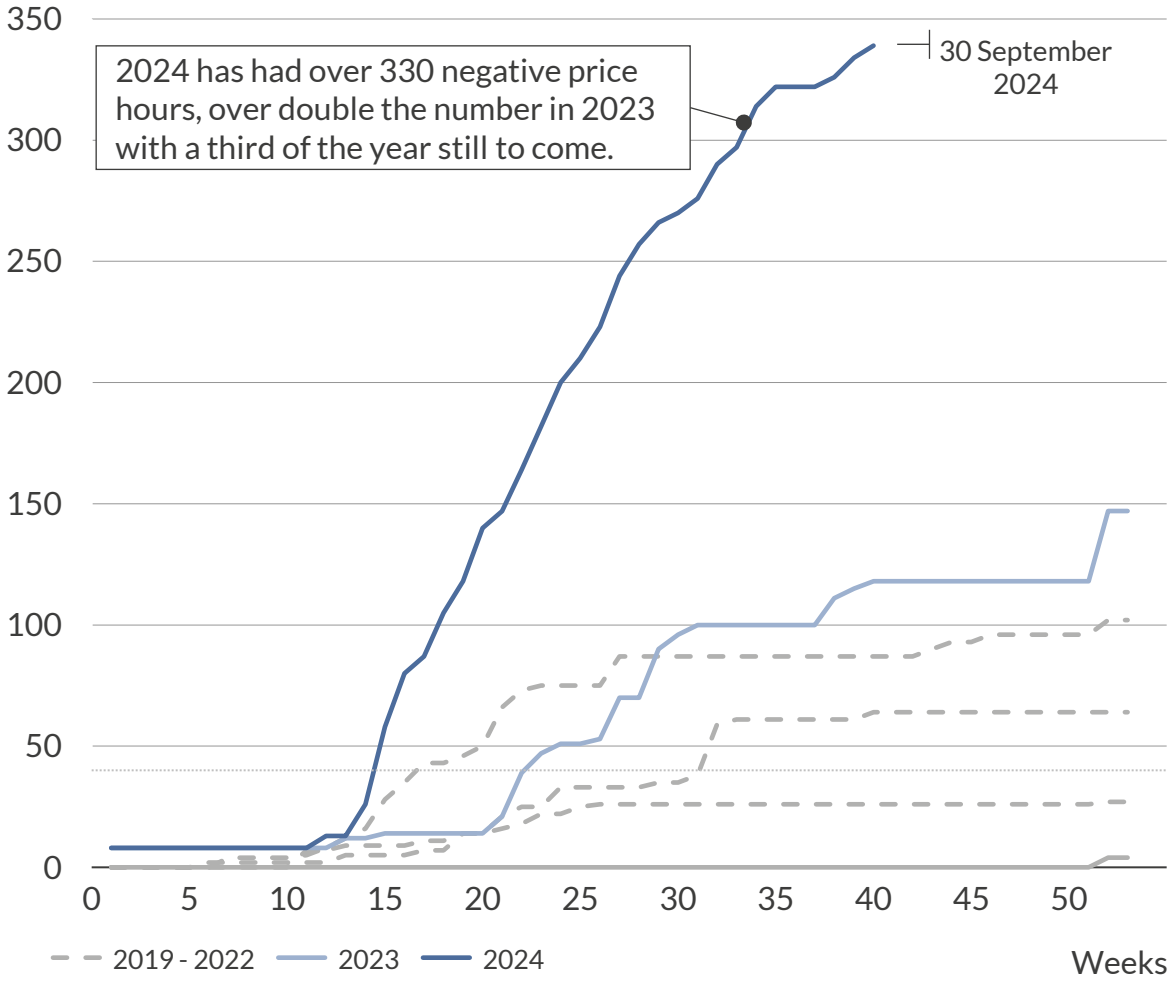
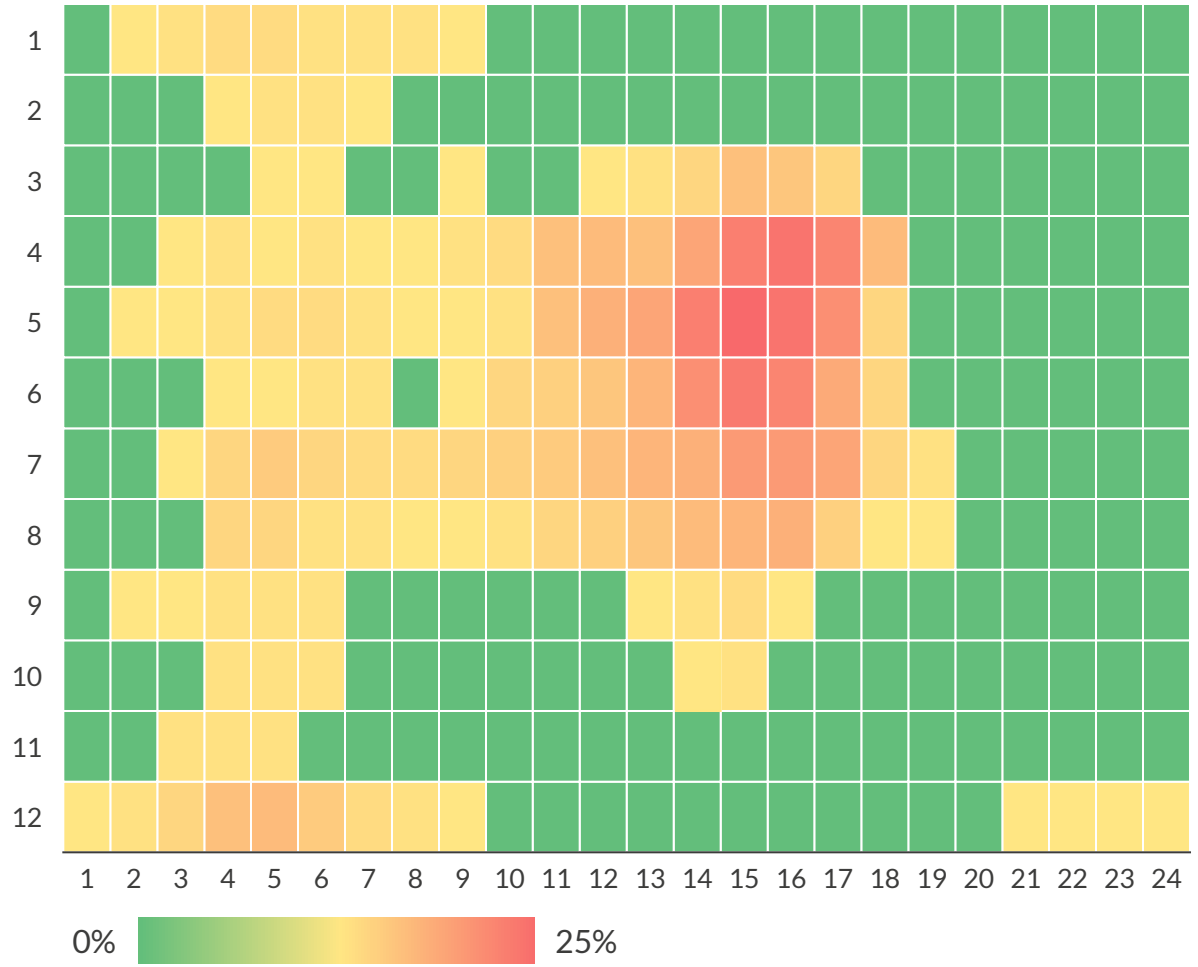
Number of negative price hours [1]

Distribution of negative prices historically throughout the year



Heatmap of negative prices in France by hour of day and month

Total % of hours 2019-2024 [1]



1) Day-ahead, up to 30 September for 2024.

Sources: Aurora Energy Research, RTE

There are two clear types of negative prices in 2024 – those caused by internal bidding and those caused by neighbouring countries

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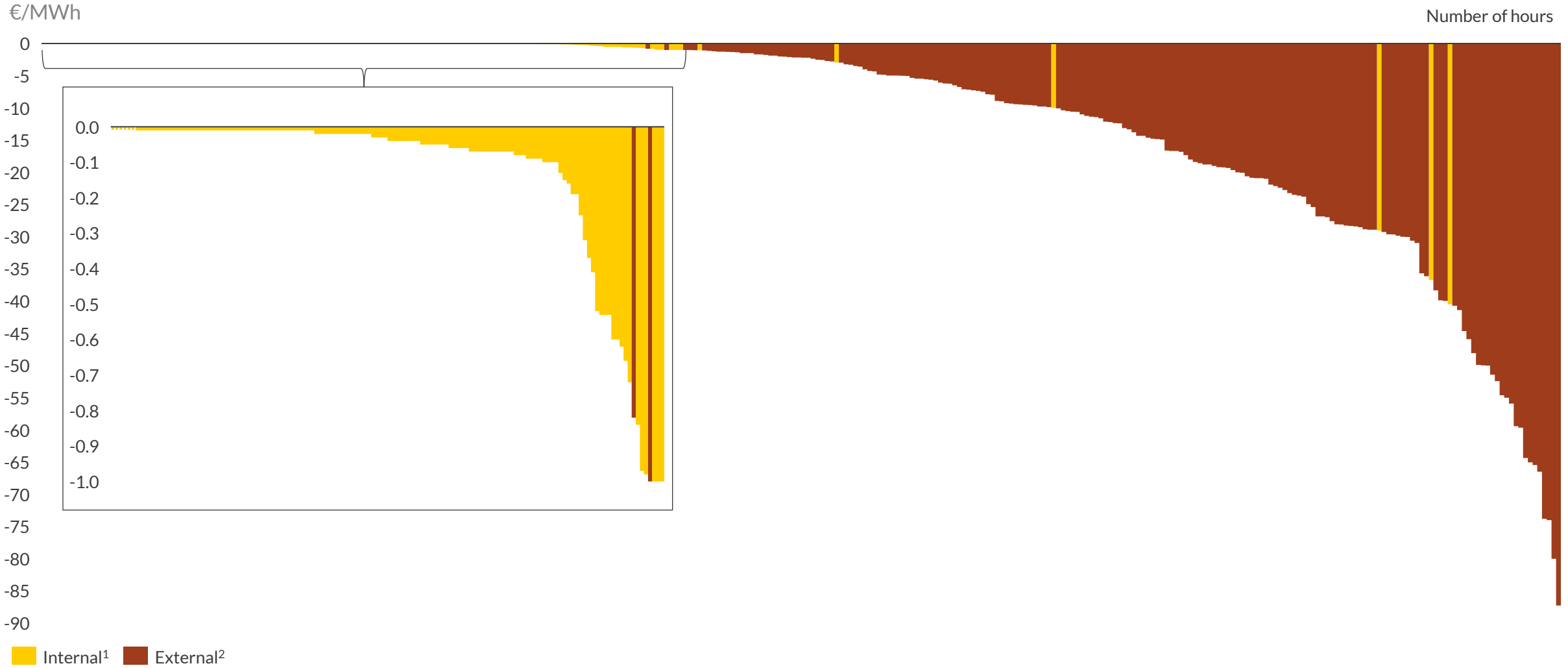
Price curve of negative price hours by source (as at end August 2024)



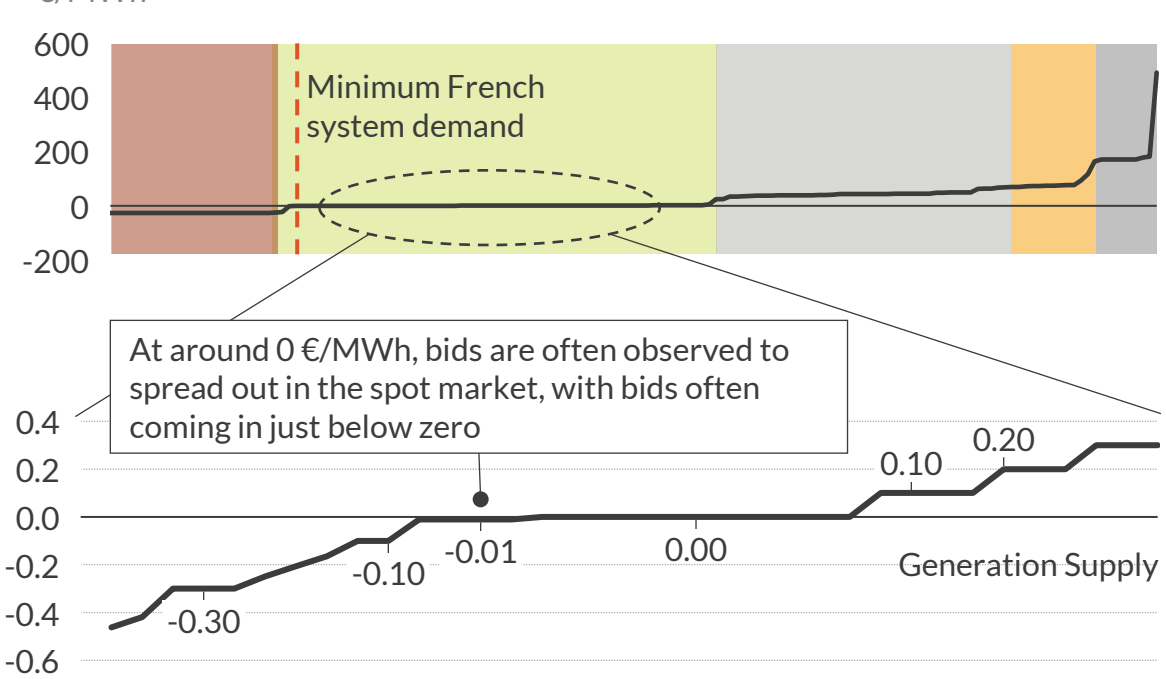
1) Referring to hours with prices below -1 €/MWh, or where the French power price is more negative than its neighbours, and France is exporting power; 2) Referring to hours where the French power price is less negative than its neighbours and France is importing.

Renewables bidding strategy pushes prices only slightly below zero to ensure participation in the merit order

Roughly half of negative price hours in 2024 have been close to zero as RES plants bid between 0 and -1 €/MWh.

Near-zero negative prices in France are caused by bidding behaviour of certain renewable in the merit order.

Illustrative day-ahead merit order – Price vs Generation Supply bids



Negative bids that are close to zero are due to bidding strategies to ensure participation.

RES plants can bid slightly under zero to ensure their place in the merit order, due to three main reasons:

Inflexible generation

- To avoid paying imbalance costs when the asset is not equipped to modulate its production, an asset will bid slightly negative to ensure it is accepted into the merit order

Contracts incentivising production

- Contracts such as PPAs might require a certain level of production, leading to slightly negative bids to ensure accepted generation

Guarantees of Origin certificate issuance

- Merchant RES or RES plants under PPAs might bid slightly under zero to ensure production for the issuance of GoOs[3].

1) Must-run nuclear capacity is often contracted outside of the day-ahead market, with flexible nuclear then bidding at a higher price based on SRMC. However this must-run nuclear generation is below the French minimum system demand so does not impact negative prices; 2) Contains flexible nuclear capacity; 3) Guarantees of Origin.

There are two clear types of negative prices in 2024 – those caused by internal bidding and those caused by neighbouring countries

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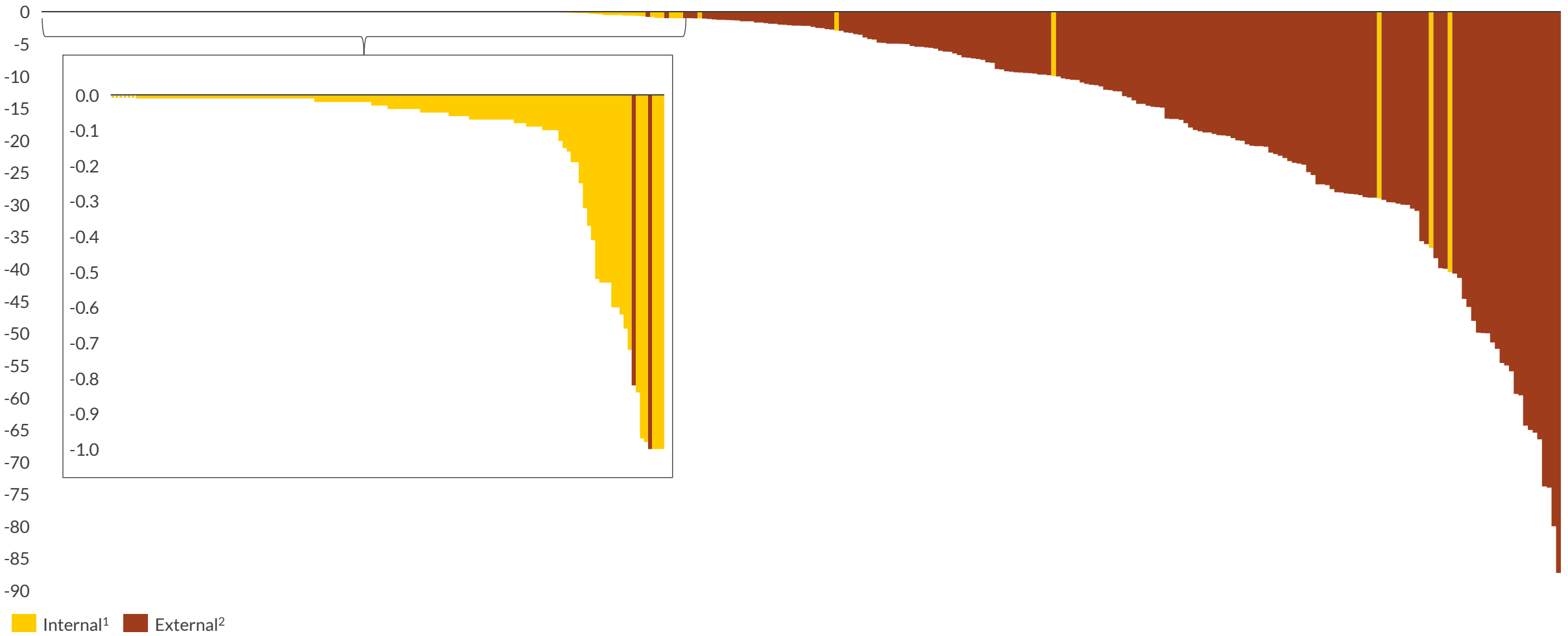
Price curve of negative price hours by source (as at end August 2024)

€/MWh



1) Referring to hours with prices below -1 €/MWh, or where the French power price is more negative than its neighbours, and France is exporting power; 2) Referring to hours where the French power price is less negative than its neighbours and France is importing.

Due to European price coupling and French interconnections, the power price in France is strongly linked to its neighbours

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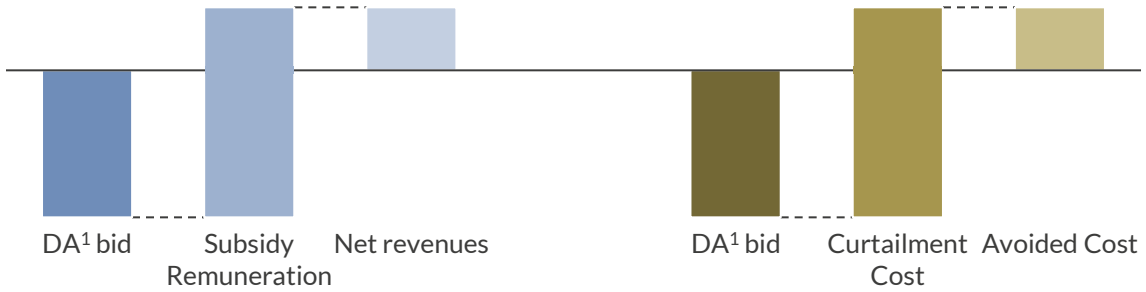
External

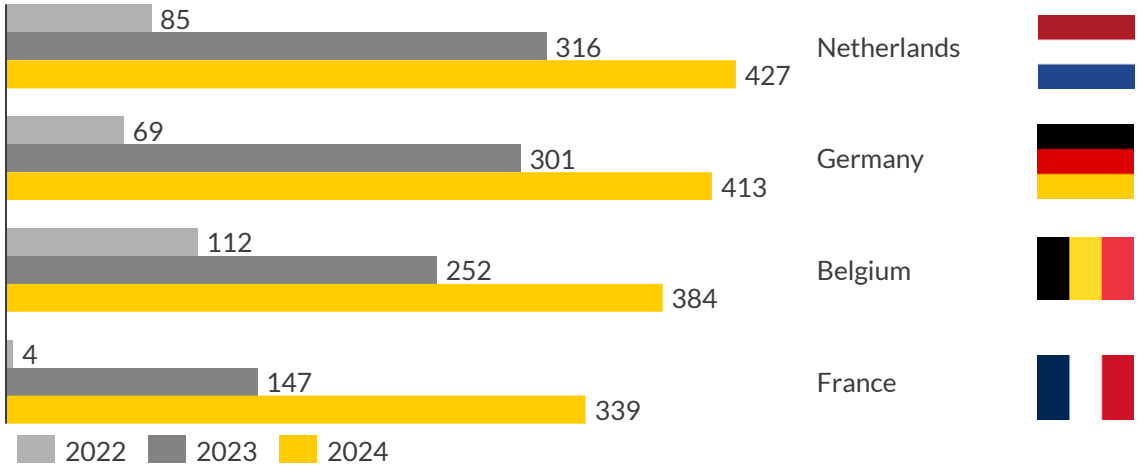
Negative prices below -1 €/MWh are the result of plants' willingness to accept negative remuneration, with two main drivers:

Subsidised assets with remuneration during negative price hours

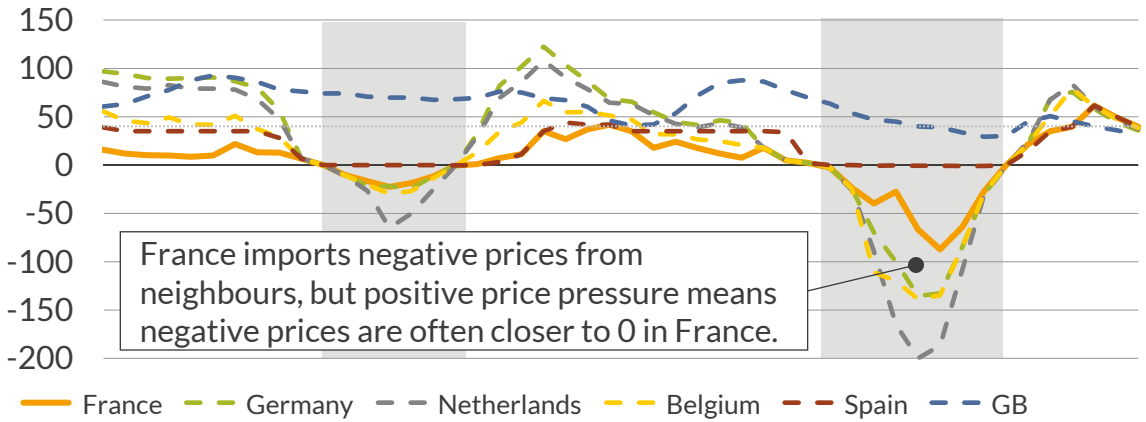


Inflexible plants with a high cost of curtailment

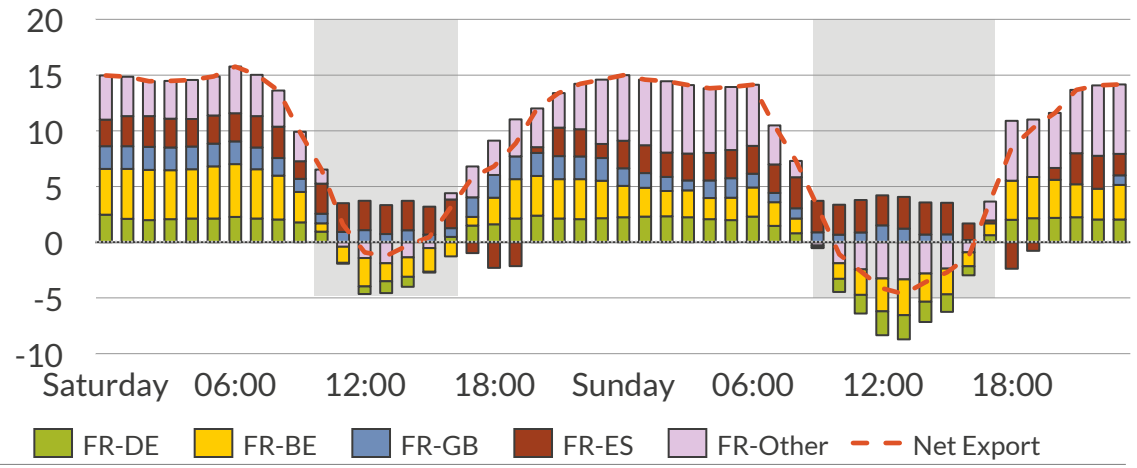
Number of negative price hours per country



Historic day-ahead power prices – 11/12 May 2024



Historic French interconnection flows – 11/12 May 2024



1) Day-ahead

Sources: Aurora Energy Research, RTE, European Commission

Subsidised renewable capacity exacerbates negative prices below -1 €/MWh, but such capacity is small in France compared to its neighbours

External

Subsidy schemes incentivise some well-below zero prices internally…

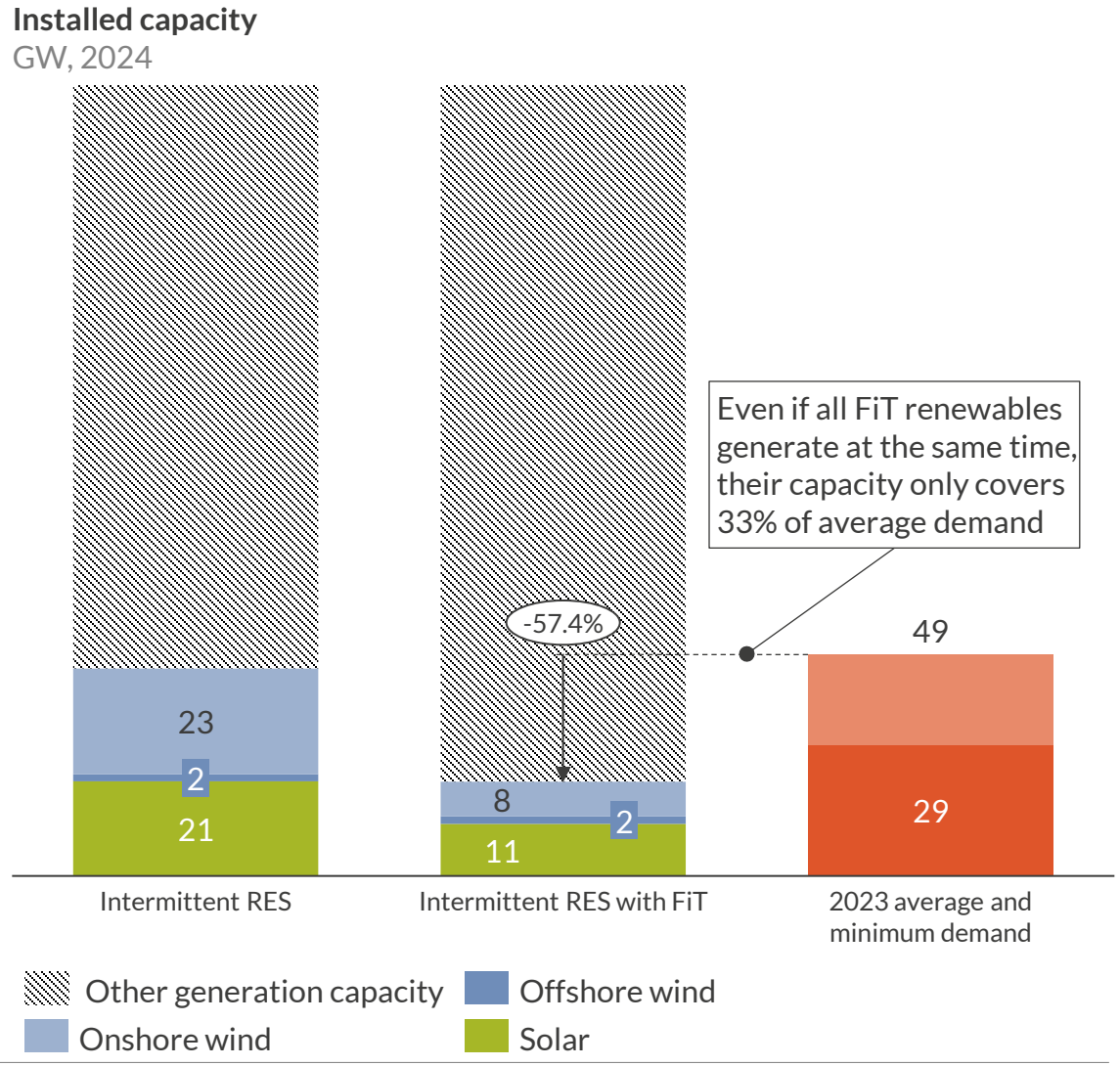
FIT schemes exacerbate negative price events by generating regardless of price

- From 2001 until 2017, FiTs[1] were the predominant subsidy in France for installing renewable capacity.
- These FiTs provide a regulated tariff independent of the spot market when an asset is generating, which exacerbates the demand supply balance.
- Currently ~11GW of solar and ~10GW of wind capacity is supported by this subsidy.
- Rooftop solar capacity < 500kWp can still apply for this subsidy.

… but such drivers are much stronger in neighbouring countries

French subsidised capacity rarely pushes power prices negative independently

- In 2024 French FiT capacity only makes up 15% of total capacity and **could only cover ~72% of minimum French demand in 2023** (at 100% load factor – which is highly unlikely across all subsidised renewables).
- Compared to Germany, where **subsidised solar capacity alone stands at 92 GW** (~260% of minimum German demand in 2023), the size of French subsidised capacity is nearly never sufficient to meet all of French demand.



1) Feed in Tariffs - Obligation d'Achat.

Sources: Aurora Energy Research, RTE, AEN (2011)

RES subsidies driving negative prices are set to fade out in the near future, while increased flexibility will help mitigate their impact on negative prices

FiTs and more generally subsidies during negative hours will fade out

- Only one support scheme for FiT[1] is still operational in **France**, for rooftop solar <500kWc - S21 Guichet Ouvert.
- It is expected that the maximum capacity for this Guichet Ouvert will gradually be reduced.
- Additional measures to limit negative prices are also under discussion, such as mandating curtailment during those hours.

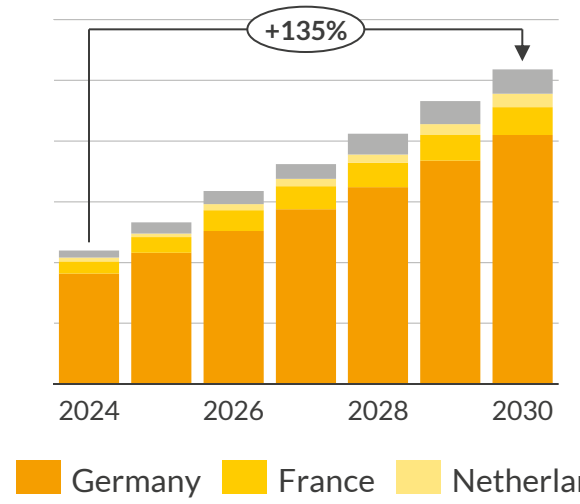
- Until 2027 additional subsidised capacity will cause more negative price hours in **Germany**, but in the medium term, as less subsidised capacity is installed and existing subsidy. contracts run out, instances of negative prices in Germany will decrease.
- After 2027 German assets ≥400kW[2] will no longer be subsidised for generation when the day-ahead price is negative:
  - Germany's RES subsidy law (EEG[3])is based on 'x-hour' rules.
  - They define subsidy payments up until day-ahead prices are negative for a consecutive period x hours, where x will reduce from 4 currently to 1 by 2027 (meaning no remuneration in for generation in negative price periods).

- In the **Netherlands**, SDE++[4] subsidy contracts after 2022 will not remunerate during negative price periods.

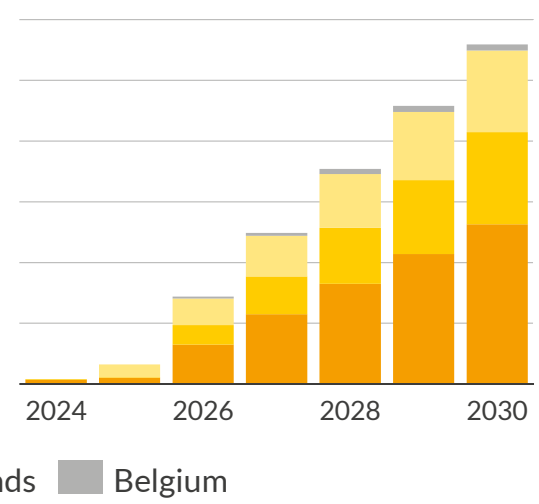
Increased flexible demand will mitigate negative price pressures

- Battery capacity in France and neighbouring countries is expected to increase by 135% by 2030, reducing numbers of negative price hours by increasing demand in periods of high renewables generation.
- Electrolysers are expected to be a growing part of European demand after 2025, acting as this flexible demand, but more heat pumps and electric vehicles that can respond flexibly to power prices are expected as well.
- This flexible demand will help increase demand in these low-price periods, reducing the number of negative price hours.

Forecasted BESS capacity



Forecasted H2 electrolyser demand



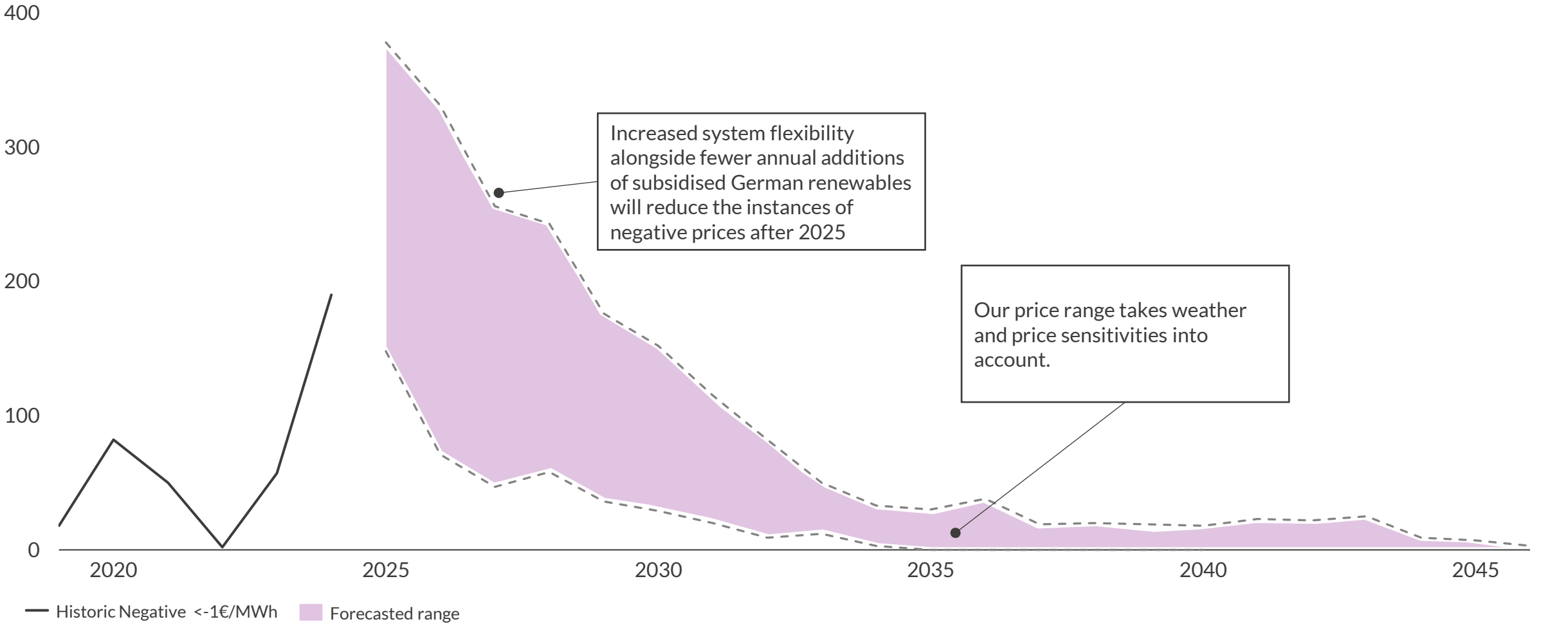
Germany France Netherlands Belgium

1) Feed in Tariffs; 2) For assets commissioned after 2022; 3) Erneuerbare-Energien-Gesetz; 4) Sti;ulering Duurzame Energieproductie en Klimaattransitie.

Sources: Aurora Energy Research, RTE

Aurora forecasts negative prices will stay high France next year but will start to fall after 2025 driven by increased flexibility and changing subsidies

Yearly occurrence[1]
number of negative hours per year



1) Day-ahead up to 19 September 2024. 2) Acting as a proxy for negative prices hours not caused by bidding strategy behaviour.

Sources: Aurora Energy Research, RTE

Key takeaways

1. France and other European countries are seeing an unprecedented **surge in incidence of negative price hours**, with 330 in France in 2024 to date.

2. These negative price hours can be broadly split into **two categories** each making up roughly half of hours:
   1. Bidding strategies at around 0 €/MWh, largely caused by **internal plants** in France, pushing the price slightly below zero.
   2. More negative prices caused by subsidy schemes or plant flexibility, mostly caused by plants in France's **neighbours** that then export into France.

3. French renewables might bid at very small negative prices to **ensure that their generation is in the merit order** for several reasons, such as to gain Guarantees of Origin, due to inflexibility, or to ensure generation is counted for subsidy scheme purposes**.**

4. Nearly all other hours that were negative in France were caused by negative prices in neighbouring countries, and then the price was **'imported' into France through interconnectors**. Inflexible thermal plants such as **German lignite** or **subsidised renewables** are willing to bid very negatively to generate to avoid ramping costs or receive subsidies, and their excess generation is exported into France during low demand hours, pushing the French power price as low as -87 €/MWh.

5. In the future, two factors will work together to **decrease the number of negative prices starting in 2026**:
   1. **Increased battery capacity and flexible demand** in France and neighbouring countries will shift demand to hours of high renewable generation.
   2. Subsidies that encourage renewables to generate regardless of the wholesale price such as French FiT and German Market Premium Scheme phase out and **stop adding new capacity**.

Source: Aurora Energy Research

Stay tuned! In the second episode of this series, we will deep dive into the implications for asset owners and potential mitigation options

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1. **Impact of curtailment from negative prices**: We will quantify the expected losses from economic curtailment for specific solar and wind assets under different scenarios and revenue schemes (CfD, merchant and PPA)

2. **Compensation for negative prices**: The French CfD includes a compensation mechanism for solar and wind assets when they curtail during negative price hours. Looking at specific assets, we will look to understand whether that compensation is likely to partially, fully or overcompensate the loss from curtailment.

3. **Participation in balancing markets**: Negative prices cause disruption on the day ahead market, but also impact system frequency control due to the rapid ramp up and down of renewable generators at the same time. We will deep dive on this issue and explore the potential upside for renewable assets to reserve capacity in the balancing markets during hours of expected negative prices.

If you would like to attend the second part of this series please reach out to **Maricuz Álvarez** at maricruz.alvarez@auroraer.com

French Power and Renewables Markets Service:

Dive into key market analysis and forecasts for the French power market

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Power and Renewables Service

Forecast Reports & Data

Quarterly market reports with forecast data

- **Detailed report** on regulatory and market developments (bi-annual)
- **Forecast data of** wholesale, capacity and capture prices to **2060** with annual, monthly and quarterly granularity
- **Data under 4 scenarios (Central, Low, High, and Net Zero)**
- National prices
  - 11 weather years
  - Curtailed and uncurtailed capture prices for RES assets
- **Capacity development**, generation mix, interconnector capacity, capacity buildout, exports
- **Number of negative prices**
- **Input assumptions:** demand, gas and CO2 prices, CAPEX and OPEX
- **Capacity market prices to 2050**
- **Guarantee of origins to 2060**

Strategic Insights

3 Strategic Insight Reports

Three in-depth thematic reports on topical issues

Policy Updates

Timely research notes on recent changes to policy and regulation, demonstrating the impacts and opportunities for market participants

3 Group Meetings

3 Group Meeting roundtable events **in Paris** with key market participants such as developers, investors, financiers, utilities, grid operators, and government officials

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Biannual workshops and support from our bank of analysts, including native speakers and on-the-ground experts

For additional information, please contact
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Access detailed power market analysis and investment case data for batteries with our French Flexible Energy Add-On

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Flexible Energy Add-On

Forecast Reports & Data

Technology and Market Development Reports

- Overview of regulatory framework for batteries
- Revenue stacking models for batteries
- Projections for battery CAPEX and OPEX by delivery year
- Reports and datasets follow the same format with content tailored to specific markets

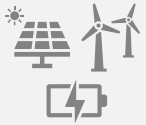
Forecast Data

- Central case forecast prices until 2050:
  - Hourly wholesale power prices
  - Yearly capacity market prices
  - 4-hourly FCR market prices
  - Hourly aFRR (energy and capacity, upward, and downward) prices
  - Hourly Intraday Continuous Index Prices

Investment Cases

Standalone battery

- Multiple investment cases per country or zone including:
  - Arbitrage of wholesale market, FCR, and aFRR market
- Annual project margins to 2050; IRR and NPV for two entry years



Co-location

- At least 4 investment cases for batteries co-located with solar PV in three different battery durations (1-hour, 2-hour, 4-hour)
- Central hourly wholesale, hourly intraday continuous index, 4-hourly FCR and hourly aFRR (capacity and energy) prices

Workshops and Assistance

- 1h Workshop with our Market Experts
- Ongoing analyst support

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