



Is the French battery market set for exponential growth?

31/10/2019

Agenda

Section

1 About Aurora

2 The role of batteries in the French power market

- a. Space for batteries
- b. Battery arbitrage economics

Aurora brings a sophisticated approach to the provision of analysis and insight to the energy industry

Research & Publications



- Industry-standard reports and price forecasts for power and gas markets
- Read and constantly challenged by over 200 subscribers from all industry sectors

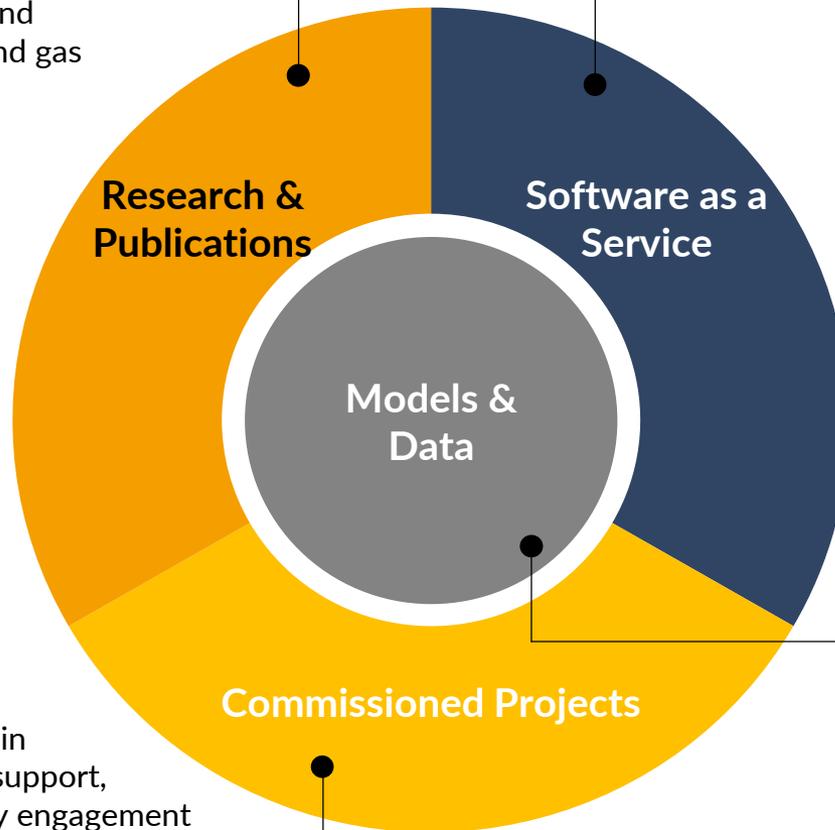


Software as a Service

- Cloud-based tools for quick, accurate, asset- and site-specific valuations using Aurora's trusted forecasts
- Wind tool – Amun – released earlier this year and already widely adopted in GB
- Tools for other technologies coming soon

- Bespoke analysis, drawing upon our models and data
- Trusted advice for all major market participants proven in 400+ projects: transaction support, valuations, strategy & policy engagement

Commissioned Projects



Models & Data

- Market-leading long-term models for power, gas, carbon, oil and coal markets
- Continuous model improvements through client feedback

The model has succeeded – we are working with the industry’s biggest players...

Power & utilities



Financial sector & investors



Oil & gas



Policy & regulation



“Aurora Energy Research is, I think, one of the smartest energy modelling companies around, and helped us on this Energy Outlook and continue to help us”

Spencer Dale, Chief Economist, BP



“Aurora’s ability to forecast all the revenue streams relevant to UKPR’s business model in a joined-up way sets them apart from their peers and has been very helpful to us in investment and business planning”

Tim Emrich, CEO, UKPR

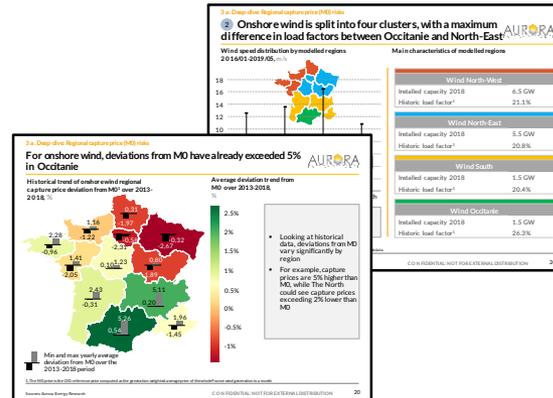


Aurora's France Power Market Service

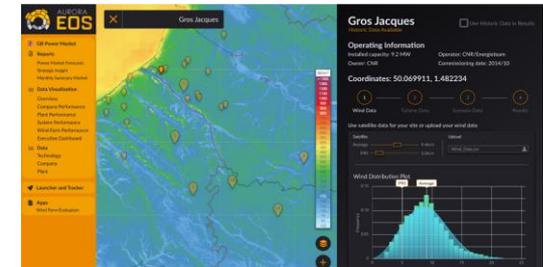
France Core Power Market Service



France Renewables Add-On



Amun wind valuation tool



Aurora works across the board in the French energy market to provide reliable, bankable forecast intelligence

For more information, please contact
 Joshua Margulies, Commercial Associate France Service

✉ joshua.margulies@auroraer.com
 ☎ +44 (0) 741 909078 | +33 (0) 6 07 93 62 67

2 France Renewables Add-On

Renewable-specific analysis that complements Aurora's France Core Service

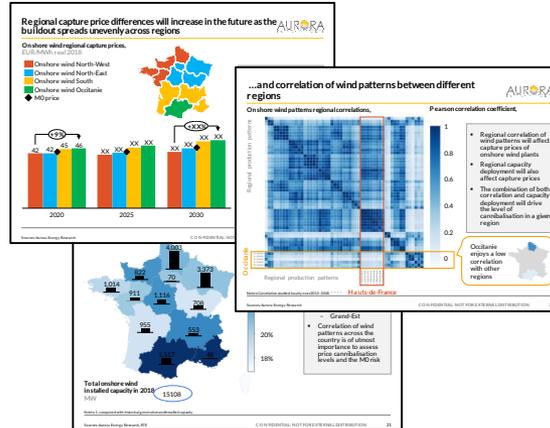
Biannual data to assess RES projects and manage risks

- P10/P90 capture price forecast, based on whole system modelling
- Regional capture prices by technology
 - 4 regions for onshore wind
 - 3 regions for offshore wind
 - 2 regions for solar PV
- The M0 price and regional deviations from M0
- Number of negative prices per year
- Regional subsidy-free build-out of wind and solar
- Imbalance costs (available 2020)

In yearly granularity till 2040

Biannual reports to get on top of RES market developments

- Detailed reports focusing on the economics of renewables, including both subsidised and unsubsidised business models, corporate PPAs and in-depth intelligence to quantify and manage merchant risks



Interactions and deep-dives into key topics for renewables

- Seats to our additional **Renewables Group Meeting** with senior representatives from RES industry (developers, utilities, banks, government)
- Regular interaction with **Aurora team** via bilateral workshops and ongoing analyst support to discuss your specific questions



All intelligence for a successful business, based on bankable price forecasts

For more information, please contact
Joshua Margulies, Commercial Associate France Service



joshua.margulies@auroraer.com

+44 (0) 741 909078 | +33 (0) 6 07 93 62 67

Agenda

Section

1 About Aurora

2 The role of batteries in the French power market

- a. Space for batteries
- b. Battery arbitrage economics

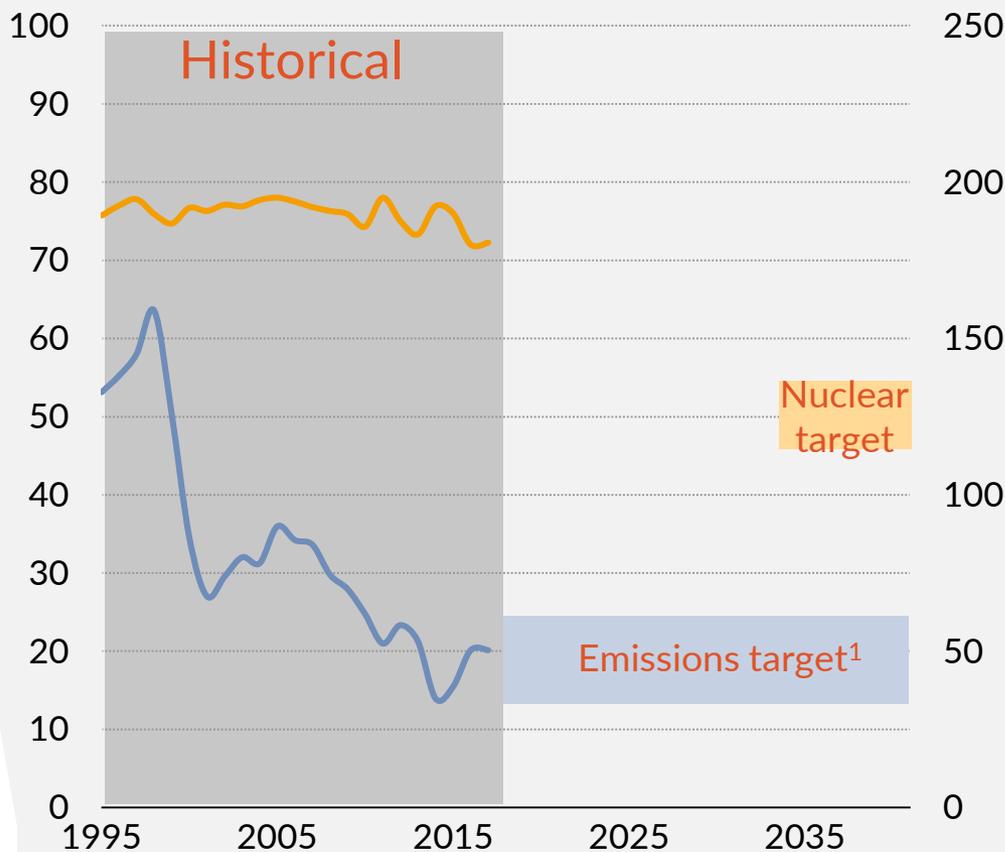
2019 PPE consultation confirms France's ambition of diversifying energy mix while keeping emissions in check

Key objectives of the transformation

- 1 Reduce the share of nuclear generation to 50% by mid 2030s
- 2 Reach carbon neutrality by 2050
- 3 Keep cost down for consumers
- 4 Ensure security of supply
- 5 Phase out coal by 2022
- 6 Avoid building new thermal plant

Nuclear production, Share of total generation

CO₂ emissions, gCO₂/kWh



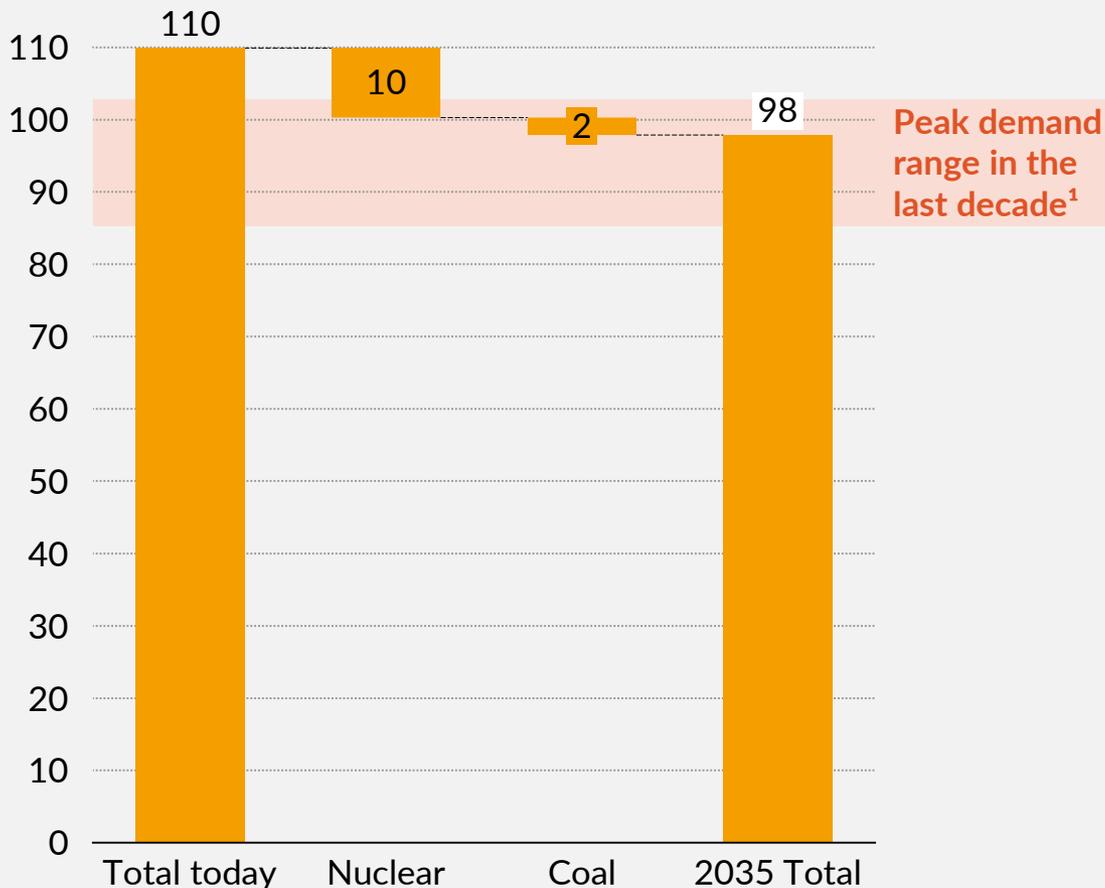
1. France Government has stated that decarbonisation efforts should not be compromised despite nuclear diversification.

2019 PPE consultation confirms France's ambition of diversifying energy mix while keeping emissions in check

Key objectives of the transformation

- 1 Reduce the share of nuclear generation to 50% by mid 2030s
- 2 Reach carbon neutrality by 2050
- 3 Keep cost down for consumers
- 4 Ensure security of supply
- 5 Phase out coal by 2022
- 6 Avoid building new thermal plant

Total de-rated capacity, GW

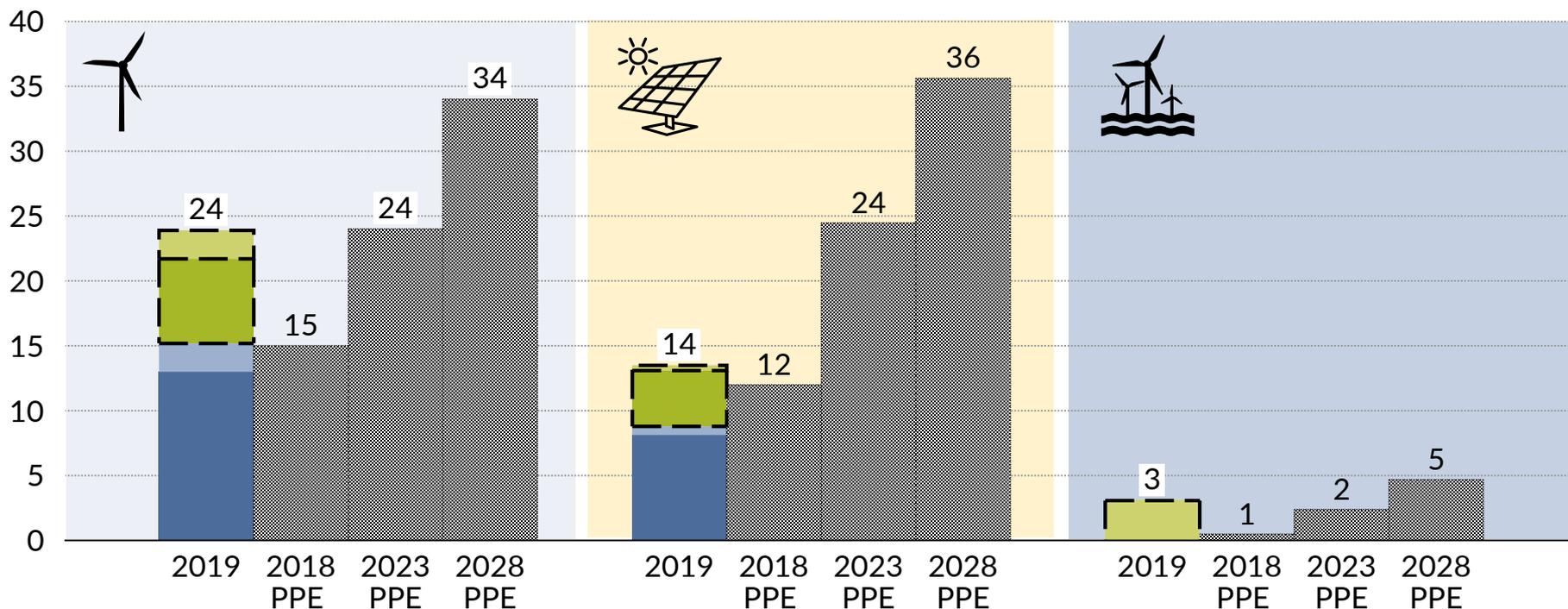


1. Peak demand range taken from historical data from 2008 to 2018

The French PPE plans to increase total installed renewables to 75 GW by the end of the next decade

Renewables projects pipeline¹, GW

■ Installed - Distribution ■ Pipeline - Distribution ■ Targets
■ Installed - Transmission ■ Pipeline - Transmission

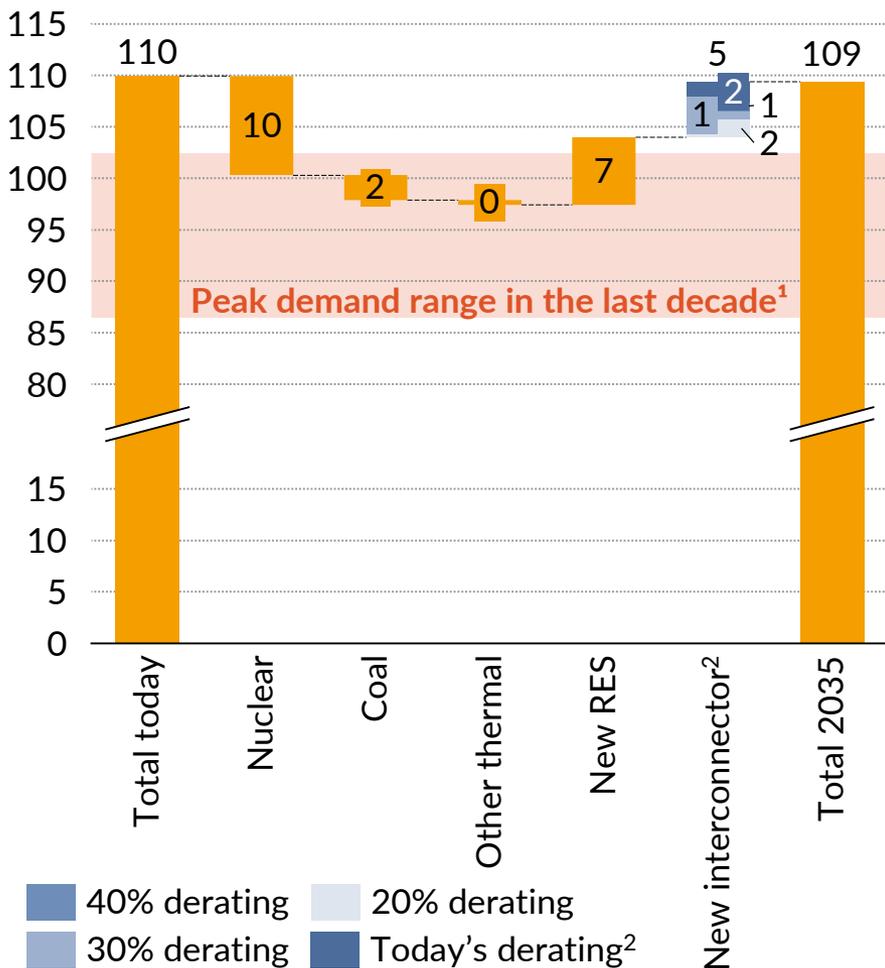


- Meeting the French PPE targets would mean a three-fold increase in total renewables capacity, reaching 75 GW by 2028
- Interest amongst developers is evident, with c. 13.4 GW of onshore wind and solar assets in the pipeline awaiting construction

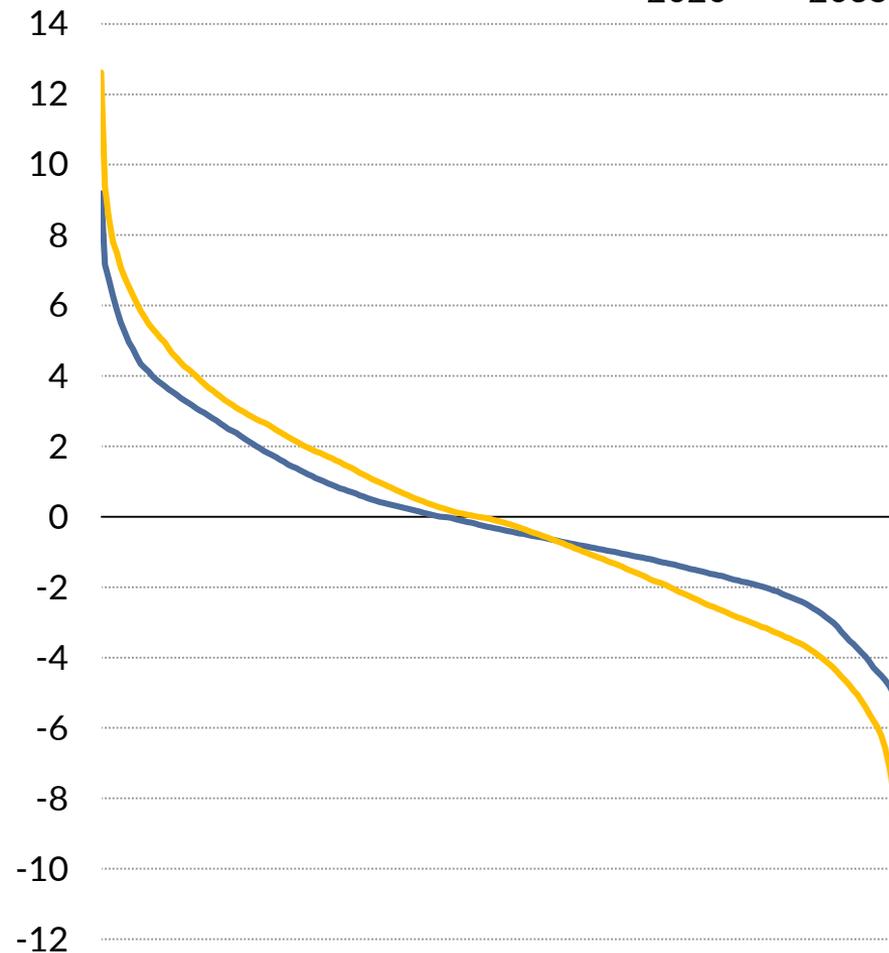
1. As of the 31st of March 2019

A space for batteries appears as firm capacity leaves the system and renewable penetration increases the need for flexibility

Total de-rated capacity, GW



System flexibility need evolution in an average year², GW



1. Peak demand range taken from historical data from 2008 to 2018. 2. Interconnectors capacity derated at 56.2%, de-rating at a lower level would increase security of supply concerns. 3. Cumulative Distribution Function of the hourly residual demand difference from one hour to the next. Residual demand is calculated as total demand minus RES Intermittent generation

Agenda

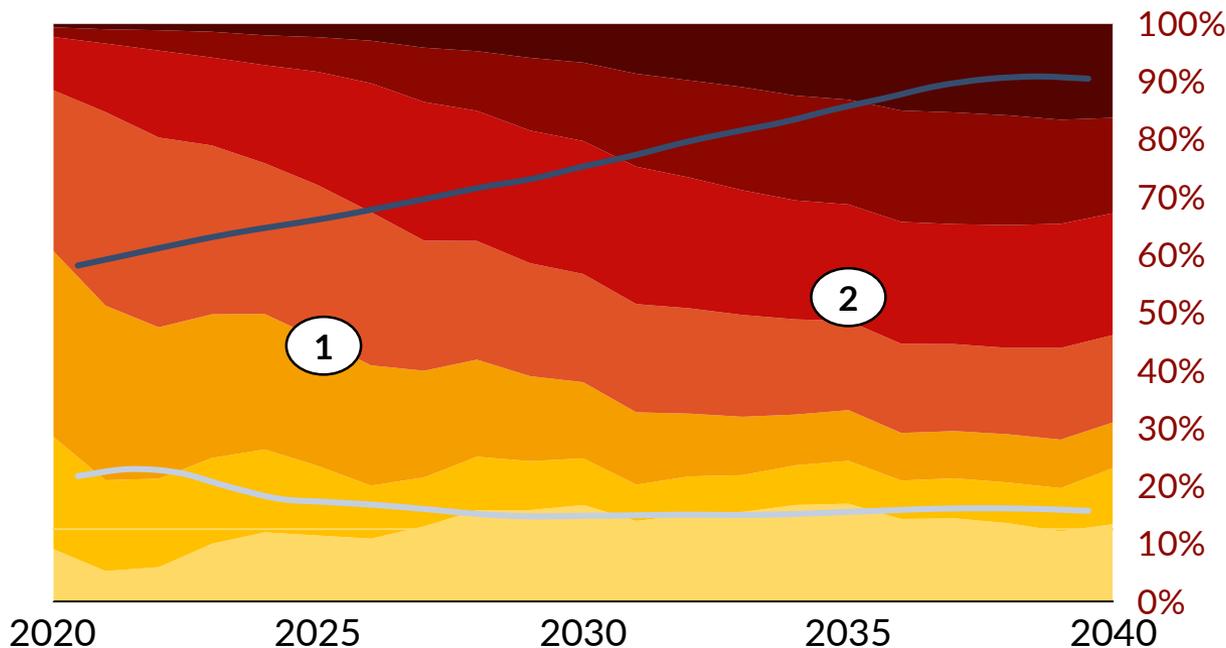
Section

- 1 About Aurora
- 2 The role of batteries in the French power market
 - a. Space for batteries
 - b. Battery arbitrage economics

Increased renewable output and commodity prices result in significantly greater wholesale price volatility...

Central scenario baseload price, EUR/MWh real 2018

Yearly wholesale price binned, % of time



Key drivers of the wholesale price

- 1 French export strategy and RES uptake depress prices
- 2 Nuclear reactors are decommissioned, gas and CO2 price increase substantially

Standard deviation



Chart left axis

— P95 — P5

Chart right axis

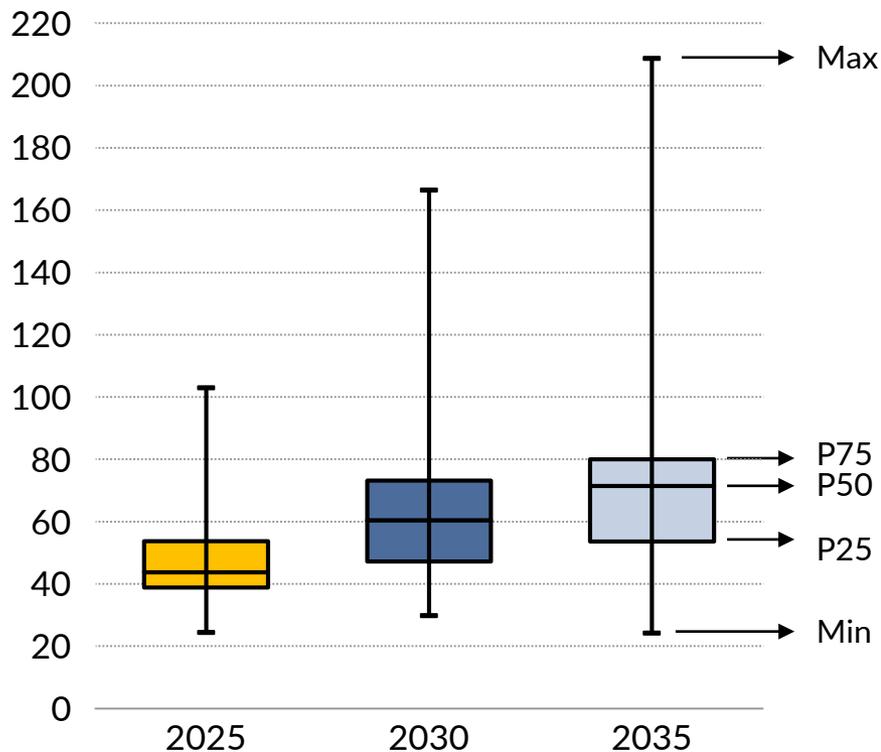


Implications for batteries

Price volatility increases throughout the forecast horizon, as well as occurrences of negative prices, improving the business case for batteries

...improving materially daily spreads for batteries

Daily spreads distribution¹ between 2025-35 for a 2h battery, EUR/MWh real 2018



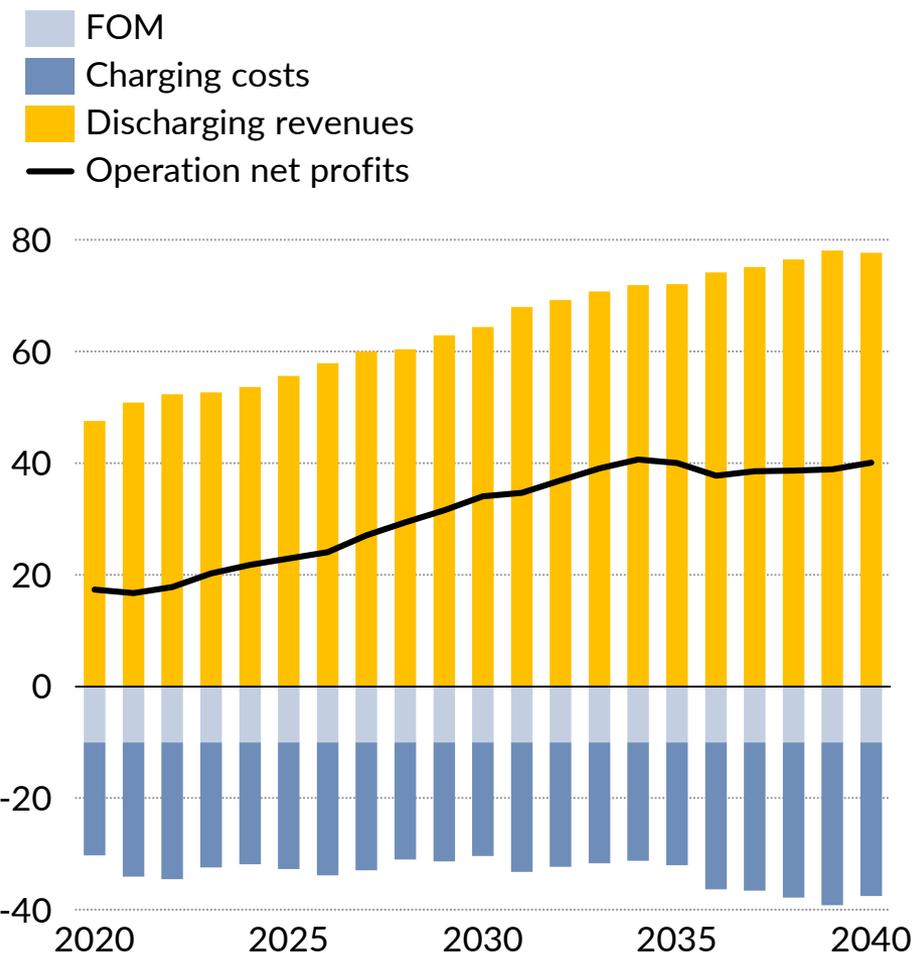
Standard deviation

11.6

16.7

20.3

Battery operation revenues and costs for a 2h battery², EUR/kWh real 2018



Notes: 1. Computed as the difference between the mean of the top two prices and the mean of the bottom two prices every day 2. 88% efficiency and 365 cycles per year

Key takeaways

The French power market currently provides low cost and low carbon power due to the dominance of nuclear within the generation mix; maintaining this will be the key challenges of the diversification

New flexible capacities will be required to ensure security of supply as nuclear reactors retire – batteries and interconnectors can provide for this, but their contribution diminishes as buildout increase

As renewable capacity grows in the power mix, price volatility increases, improving the battery arbitrage business case – a direct result of higher daily price spreads

The new long-term CM auction favours batteries over thermal, preventing newbuild competition emitting more than 200 gCO₂/kWh from entering the market (CCGT, gas peaking plants)