

# Navigating Battery Financing in Iberia

Public Report

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June 2024



## Our team

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For more information on the Iberian  
power market, please contact

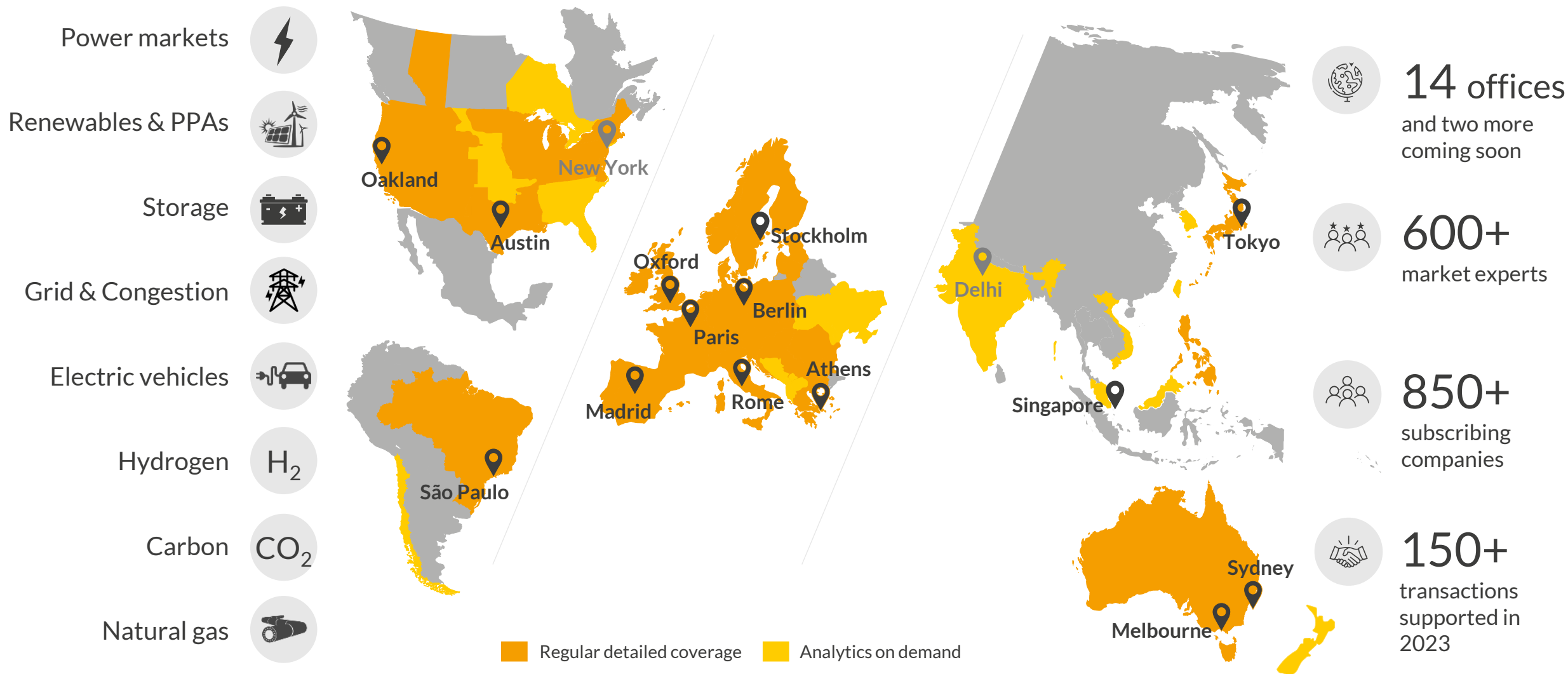
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# Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

A U R  R A







# Aurora has successfully supported +60 companies in Iberia with the analysis of battery and other storage projects



## KEY FIGURES



## PROJECT TYPE

-  Project development
-  Transaction support
-  PERTE subsidies applications
-  Financing<sup>1</sup>

1) Ongoing.

# Aurora has a strong track record of acting as a market lending advisor


Aurora's price forecasts have been relied upon by lenders in transactions across all technologies, including storage:




**£1.9Bn debt refinancing for EfW Enfinium plants**



**€35m green loan refinancing wind and solar portfolio of Pacifico Renewables Yield**



**€380m non-recourse financing 487MW merchant onshore wind farm of CIP**




**\$650MM debt financing of a 215MW Solar + Storage facility in CAISO**



**AUS \$440m debt financing 209MW onshore wind farm for GIG**



**£100m debt financing Gas peaking plant development portfolio of Green Frog Power**



**AUS \$160m battery debt financing Neoen's 300 MW/450 MWh Victorian Big battery**



**100 MW portfolio of battery projects of Zenobe First battery project financing in UK**



**€28m debt financing First subsidy-free wind financing in Poland**




**58 MW solar portfolio for Neoen and BNRG Renewables**



**€370m debt financing 220MW onshore wind portfolio of NTR in Ireland and GB**




**€48m debt financing 220MW Potegowo onshore wind farm of Israel Infrastructure Fund**



**408 MW onshore wind portfolio Lending advisor for Fomento**



**£380m debt financing battery storage portfolio of Gresham House**



**€133m debt financing 93.5MW portfolio of solar assets for Technique Solaire**

- I. Introduction to battery financing
- II. Price risk
- III. Regulatory risk
- IV. Volume risk
- V. Key takeaways

# The Spanish market has not yet seen large scale battery financing, however reaching government targets will require over 10 bn € in funding

Regulatory uncertainty and a small pipeline has led to low installed battery capacity, although the deployment rate is expected to increase.

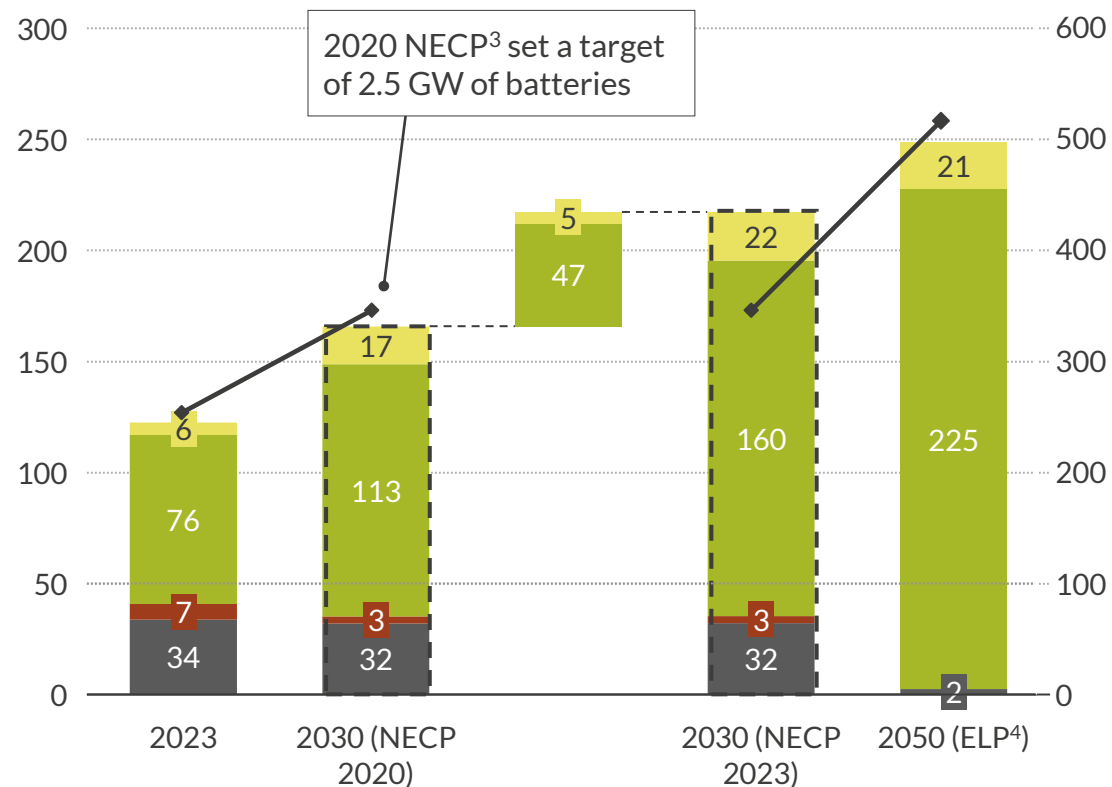
Installed capacity<sup>1</sup>



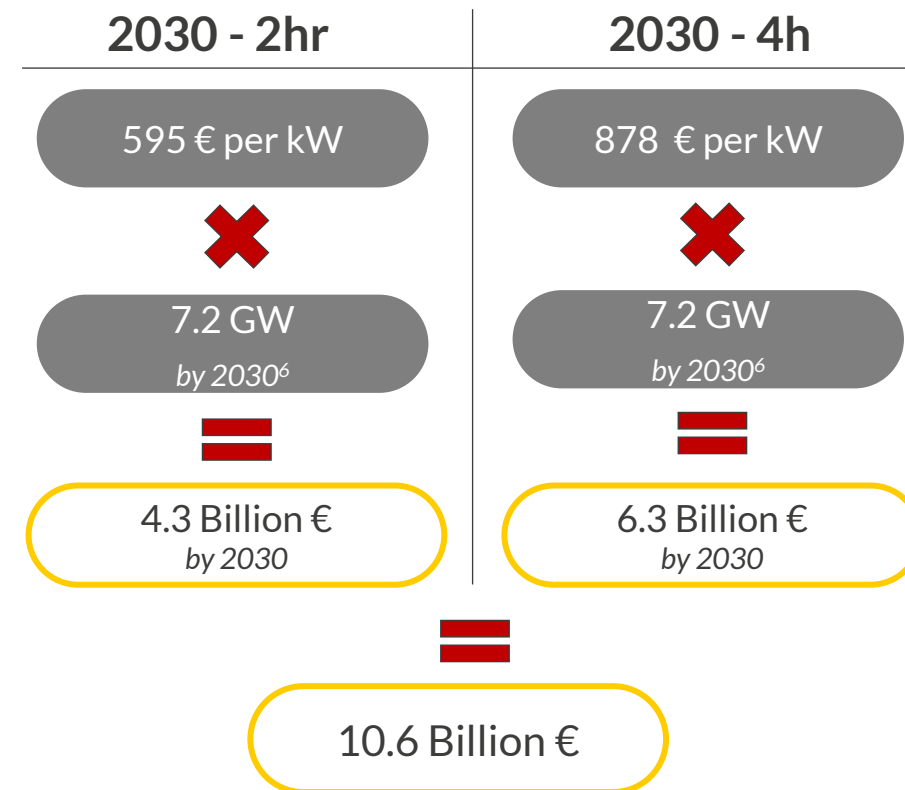
GW, bar chart

Total generation<sup>1,2</sup>

TWh, line chart



Assuming government targets are met, this could open up to 6 bn € of financing opportunity in debt funding



Accounting for 620 mn € of PERTE<sup>7</sup> funding leaves 9.98 bn € of capital required. Considering a conservative 60% leverage leads to a debt requirement of approximately 6 bn €.

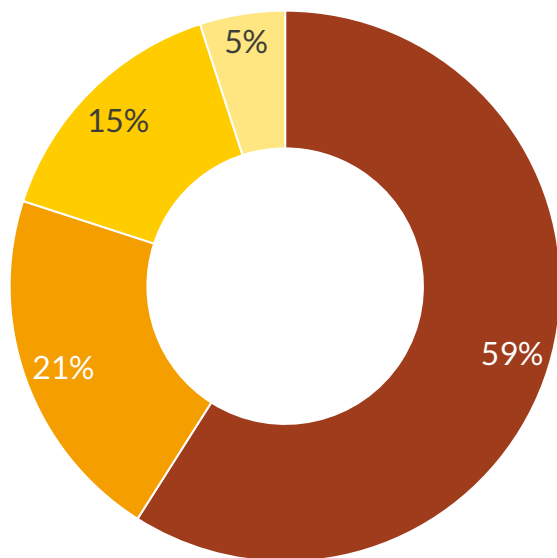
Storage<sup>5</sup> Renewables<sup>6</sup> Nuclear Fossil Fuels NECP Targets Generation

1) Peninsular data. 2) Target generation included in National roadmaps. 3) National energy and climate plan. 4) Estrategia de Descarbonización a Largo Plazo. 5) It includes batteries, pumped storage and thermal storage. 6) It includes solar CSP, solar BtM, hydro, biomass, waste and other renewables. 7) Aid from the Recovery, Transformation and Resilience Plan allocated to innovative energy storage projects, flexible technologies and new business models. An additional 90 mn € post an EU addendum approval is yet to be confirmed.



# 30 MW is installed in Spain, and there is no public information on the pipeline, but we expect 1.9 GW to come online in the next years<sup>1</sup>

Current market shares BESS  
% of total installed capacity



Total installed capacity  
MW

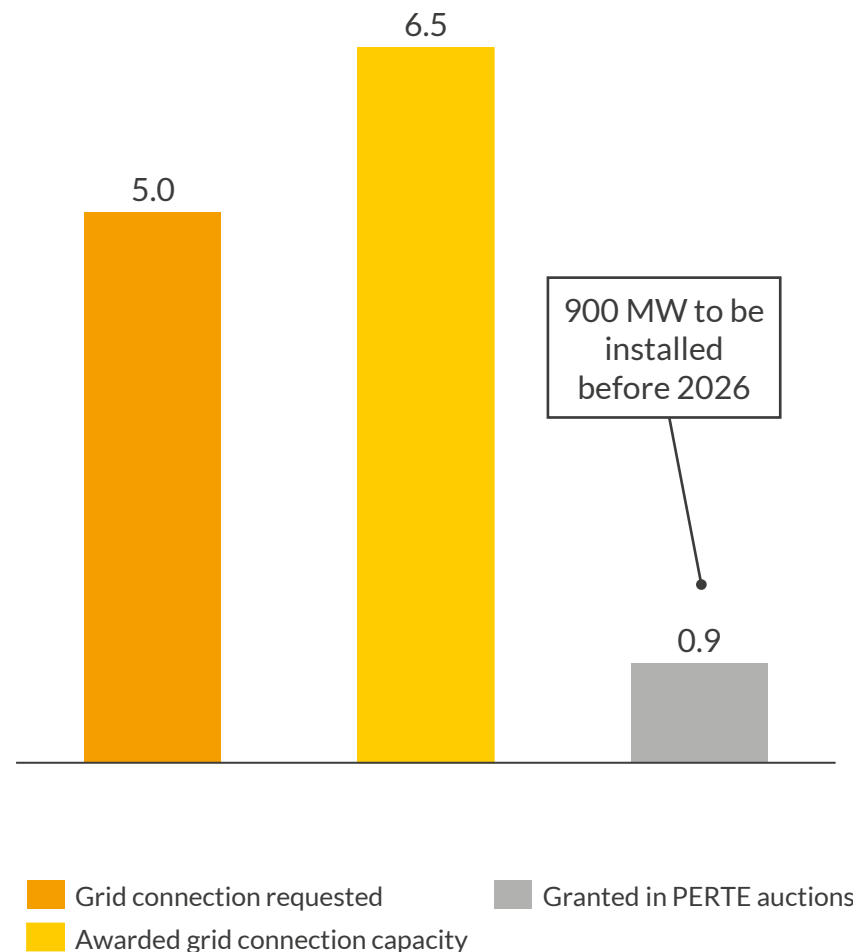
30 MW

■ Engie ■ Other ■ Iberdrola ■ Acciona

1) Data from January 2024

Sources: Aurora Energy Research

BESS awarded grid connection and expected buildout  
GW



## Commentary

- Currently, there is just 30 MW of batteries installed in Spain, mainly consisting of pilot projects.
- There is no public information available about battery projects in the pipeline in Spain, and the market participants driving these.
- However, the TSO has communicated that 6.5 GW of battery projects have applied for a grid connection and have been approved.
- According to the TSO there are also 5 GW of battery projects in the pipeline that have requested grid connection permits.
- 900MW of hybrid storage were awarded through PERTE Hybrid auctions and are to be installed before 2026.



# Understanding how the project finance risk assessment applies to batteries will be key for banks to start deploying capital

## Price risk

- Unlike the majority of renewable assets, batteries operate across several markets.
- Therefore, understanding the price risk related to each market will be key for battery financing.

## Regulatory Risk

- Incorporating storage assets into the existing legislation and regulatory framework can take time.
- As a less mature technology the regulatory framework around storage is expected to continue evolving.

## Volume Risk

- Unlike renewable assets, total battery volumes do not depend exclusively on external resources, but on other factors such as cycling and duration.
- All technologies are at risk of being curtailed.

Detailed analysis included in the scope of Aurora's market Due Diligence reports

## Sponsor risk

- As with the financing of renewables, a strong balance sheet and experience in developing storage assets is desirable.

## Macroeconomic risk

- As with the financing of other technologies, the impact of inflation and interest rates should be considered in the financing.

## Technology Risk

- Battery storage is a proven technology; however, it will be important to consider technology-specific risks in the Due Diligence process.

# Agenda

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I. Introduction to battery financing

II. Price risk

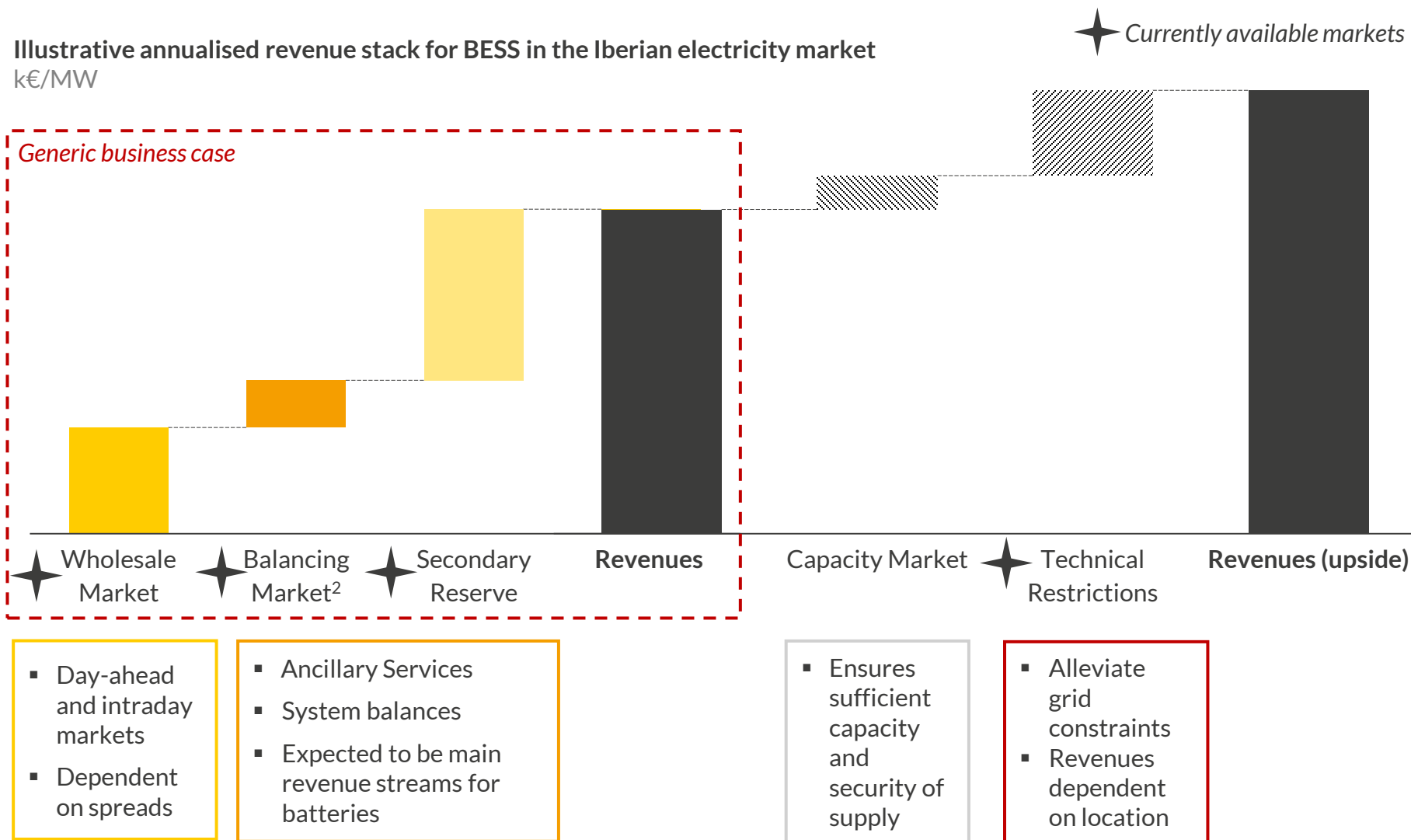
III. Regulatory risk

IV. Volume risk

V. Key takeaways

# Wholesale and Ancillary markets will be the key sources of revenues for batteries, although other revenue streams could become available

Illustrative annualised revenue stack for BESS in the Iberian electricity market  
k€/MW



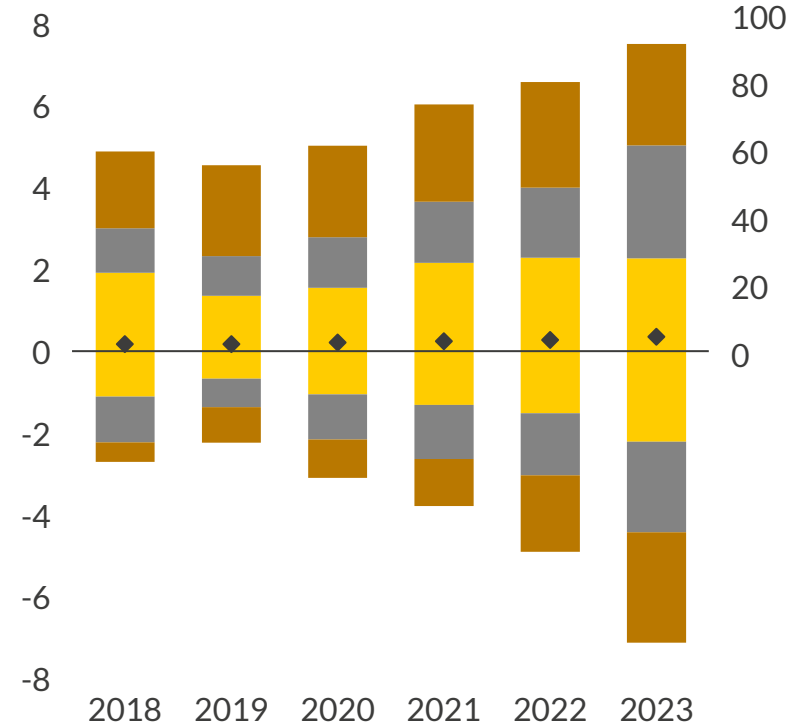
- Currently, batteries can participate in the wholesale market and ancillary services.
- Key ancillary markets in Iberia:
  - Primary Reserve (non-remunerated)
  - Secondary Reserve (regulation band and energy)
  - Tertiary Reserve
  - Replacement Reserves
- To be competitive in a capacity market auction, storage assets will have to carefully consider the revenue opportunities across other markets.
- The potential upside for a battery that participates in the Technical Restrictions services is highly dependent on the specific location of the asset.

1) Secondary reserve volumes refer to the energy component only; not the capacity component (Regulation Band). 2) Defined as Replacement Reserve and Tertiary Reserve.

# As with the day-ahead market, the main drivers of price formation in Ancillary services markets are supply and demand

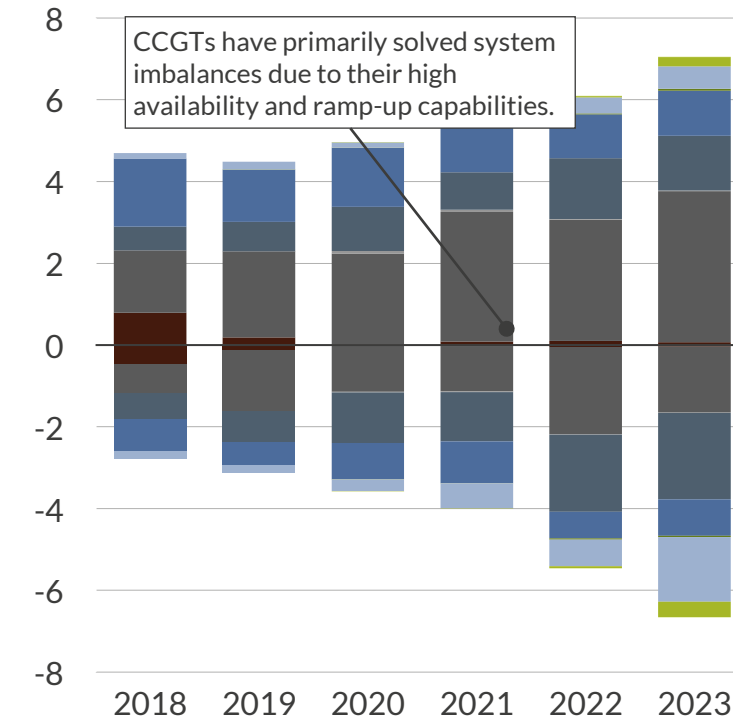
Total AS<sup>1</sup> volumes increased since 2018, however they represent a small percentage of total volumes

Ancillary Services volumes TWh Ancillary Services share<sup>2</sup> %



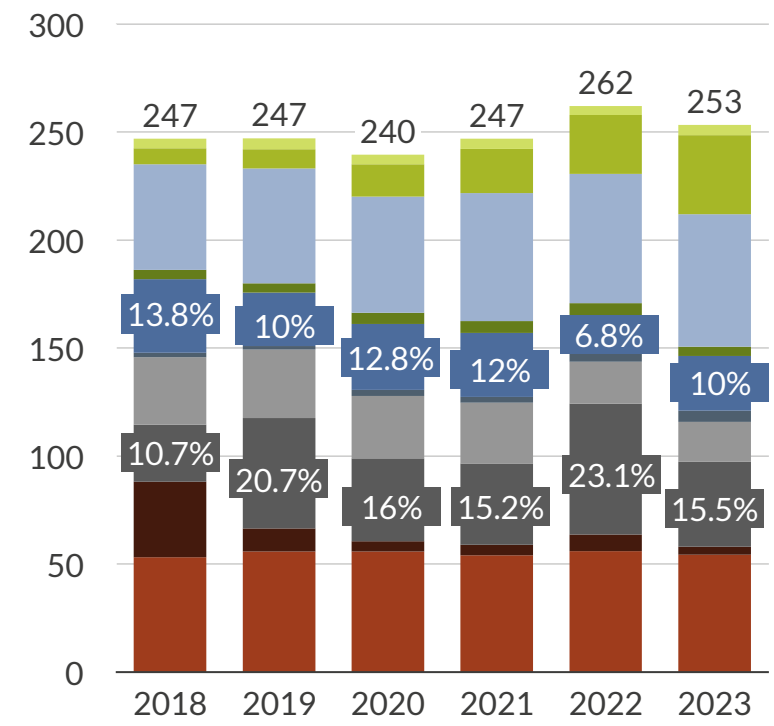
In 2023, 53% of AS<sup>1</sup> volumes were provided by CCGT and hydroelectric plants...

Ancillary Services volumes<sup>3</sup> by technology, TWh



...Which is far above their participation in the Wholesale market

Wholesale Market volumes by technology, TWh



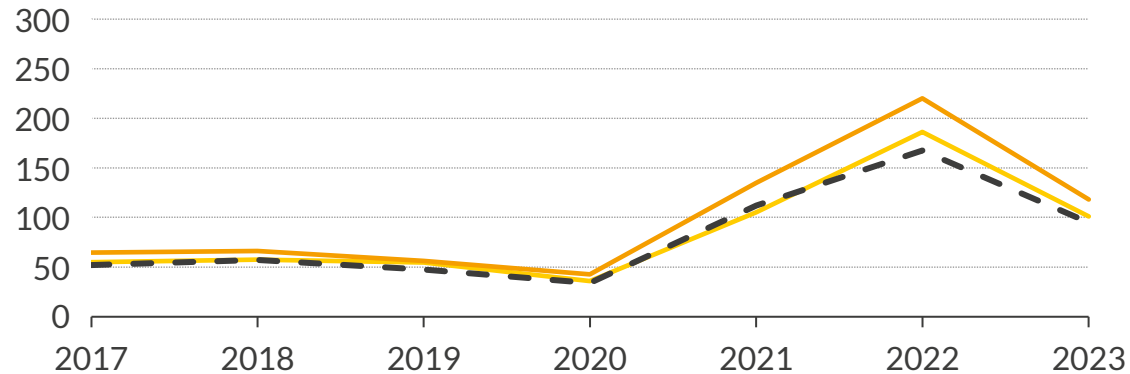
Tertiary Reserve  
Replacement Reserve  
Secondary Reserve energy  
Share of Ancillary Services

Solar CSP  
Onshore wind  
Hydro  
Other thermal<sup>6</sup>  
Solar PV<sup>4</sup>  
Other RES<sup>5</sup>  
Pumped storage  
CCGT  
Coal  
Nuclear

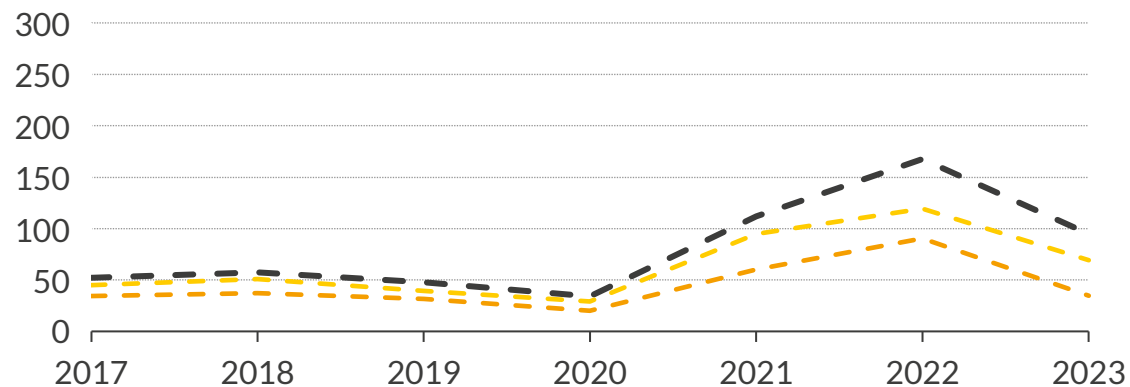
1) Ancillary Services. 2) Total gross volumes of Ancillary Services over total gross volumes in the system. 3) Slight variations in volumes by technology vs Ancillary Services volumes exist due to missing data. 4) Utility scale ground-mounted PV. 5) Other RES includes biomass and renewable cogeneration. 6) Other thermal includes fossil fuelled cogeneration

# Ancillary service prices historically trade at a spread to the day-ahead market and are influenced by opportunity costs of participating in additional markets

Ancillary services average annual prices (upwards)  
€/MWh, nominal



Ancillary services average annual prices (downwards)  
€/MWh, nominal






— Secondary Reserve (upward) — Day-Ahead market — Balancing Market (upward) — Secondary Reserve (downwards) — Balancing Market (downwards)

## Ancillary services price fundamentals

- Historically, prices in ancillary services such as Secondary Reserve and Balancing Markets show a spread in both upward and downward directions compared to the Day-Ahead market, representing an attractive opportunity for batteries to participate in energy arbitrage.
- There are fundamental market drivers for why these markets show a spread compared to the Day-Ahead market:
  - Upward balancing prices are higher than day-ahead prices, as flexible assets such as CCGTs reflect in their bids their opportunity cost from participating in the day-ahead market and start-up costs.
  - Downward reserve prices are lower than day-ahead prices as flexible assets are willing to reduce their scheduled generation and obtain a spread with respect to day-ahead actions, including CCGTs facing lower running costs when reducing their output.
- As a result, the price evolution of these markets will be driven by similar fundamentals to the Day-Ahead market, that can be modelled consistently and with hourly granularity.

# Route-to-Market providers offer third party optimisation and risk management services which can help mitigate merchant risk

Price clauses		Merchant risk exposure	
Commercial Clause	Description	Battery owner	Trader/offtaker
Variable fee	The revenues are split between the battery owner and the trader		
Price floor	The price floor guarantees fixed revenues while incentivising the trader to maximise the performance.		
Fixed fee	The battery owner receives a fixed payment; all risks and upsides lie with the trader.		

**Larger portfolios of assets** under management may enable RtM providers to **lower the service fees** they can offer, due to **economies of scale** benefits.

## Key considerations for a price floor structure

- Asset owners without internal trading and optimisation capabilities can contract optimisation and risk management services from route-to-market providers.
- Within these services, floor structures have been essential for obtaining non-recourse financing in more mature markets such as Great Britain.
- Although structures can vary, the standard contracts guarantee a revenue floor per MW of connected capacity.
- Tenors typically range between 7 and 10 years, although structures of up to 15 years are available.
- Whilst floor structures provide certainty around future revenue streams, fees charged by the RtM provider are typically higher than a merchant model.

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# The regulatory framework for storage has been amended in recent years, but there are still policy and regulation barriers to be addressed

## Regulatory barriers and clarifications to be addressed

- |  |   |
|--|---|
| <p><b>1 Requirements allowing storage to charge from the grid</b></p> <ul style="list-style-type: none"> <li>Subject to interpretation if a DC co-located asset can charge from the grid, as the current Operating Procedure that regulates this is under review.</li> <li>The initial updated drafts of the Operating Procedure do not explicitly state that a DC co-located asset can charge from the grid.</li> </ul> | <p><b>2 Unclear licensing and permitting process</b></p> <ul style="list-style-type: none"> <li>Ambiguous environmental impact assessment requirements</li> <li>For hybridisations i) if adding storage is considered a substantial change, some administrative processes must be restarted; ii) if &gt;50 MW, project must be processed at central level, requiring additional permits.</li> </ul> |
| <p><b>3 Participation in additional markets suitable for batteries</b></p> <ul style="list-style-type: none"> <li>Primary reserve<sup>9</sup> is currently mandatory and not remunerated. No process has been started to change this.</li> </ul>   | <p><b>4 Possibility to operate hybrid installations separately</b></p> <ul style="list-style-type: none"> <li>Unclear if in the case of a RES imbalance i) the battery could participate separately in ancillary services or ii) assume the imbalance cost at the expense of more lucrative opportunities<sup>4</sup>.</li> </ul>   |

## Key upcoming developments in the Spanish market

### Capacity market

- 1 Auction rules and OPs<sup>8</sup>**
- ✓ MITECO requests a study by REE on national coverage.
  - ✓ MITECO must determine parameters and launch a public consultation.
  - MITECO defines de-rating factors.
- 2 EC opinion**
- ✓ EU Commission opens a consultation on the mechanism.
  - Discussions between TSO and CNMC.
- 3 EC decides on state aid investigation**
- Decision to initiate the procedure is published in the *Official EU Journal*.
  - Within two months, Govt. must comment on “the Opening Decision”

### EU Harmonisation projects

- 1 TERRE implementation**
- Applies to the Tertiary Reserve market.
  - Go-live: Q3 2024 (Spain) and Q1 2024 (Portugal)
- 2 PICASSO implementation**
- Applies to the Secondary Reserve market.
  - Go live for Iberia is planned for Q4 2024

✓ Milestone Achieved ■ Pending

2024

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# Aurora's dispatch model optimises the operations of storage on an hourly basis across multiple markets to maximise profits

1

## Aurora has an integrated energy system framework

We model at an **hourly granularity** the markets in which the battery participates:

Wholesale market

### Day-ahead market

- Iterative modelling with dispatch and capacity investment decisions
- Dynamic dispatch of plants
- Endogenous interconnector flows

### Intraday market

- ID<sup>2</sup> prices are modelled with historically calibrated variation to DA<sup>3</sup> prices

Ancillary services

### Balancing market

- Integrates balancing energy requirements from Tertiary Reserve and Replacement Reserve
- Stochastic estimate of imbalances
- Opportunity cost based on the Wholesale Market operations
- Prices and energy in upward and downward reserve

### Secondary regulation band

- Price forecast upwards and downwards based on TSO determined reserve requirements and fundamental merit-order design
- Calibration based on historical data including volatility, technology participation and hourly patterns
- Accounts for the increasing competition from the participation of flexible technologies i.e. batteries, pumped hydro, etc.

2

## Battery dispatch optimisation

- Aurora's dispatch model optimises the operations of storage across multiple markets in order to maximise profits.
- The battery has limited foresight into the Day-Ahead Market and Secondary regulation band prices. Based on these prices, Day-Ahead and Secondary Reserve Market participation is decided simultaneously.
- Optimisation is constrained by no foresight in the Balancing Market. The storage system can act in this market if prices are more attractive than planned Day-Ahead or Secondary Reserve actions. However:
  - The battery will be subject to penalties if it does not have enough capacity to comply with Secondary Reserve actions.
  - The battery will also be subject to penalties if it does not have enough energy to comply with Day-Ahead Market commitments.
  - The battery can also operate in the Intraday Market in real time to reduce the penalties in these markets.
- The asset is assumed to be available for energy trading 98% of the time. The modelled storage system can differ in terms of duration, cycling rates and degradation.
- Co-location with renewables can further condition battery operation (e.g. a battery can charge using spilled energy<sup>1</sup>, but might not be able to discharge if the grid connection is fully utilised).
- Battery dispatch decisions consider both revenue optimisation and state of charge management.

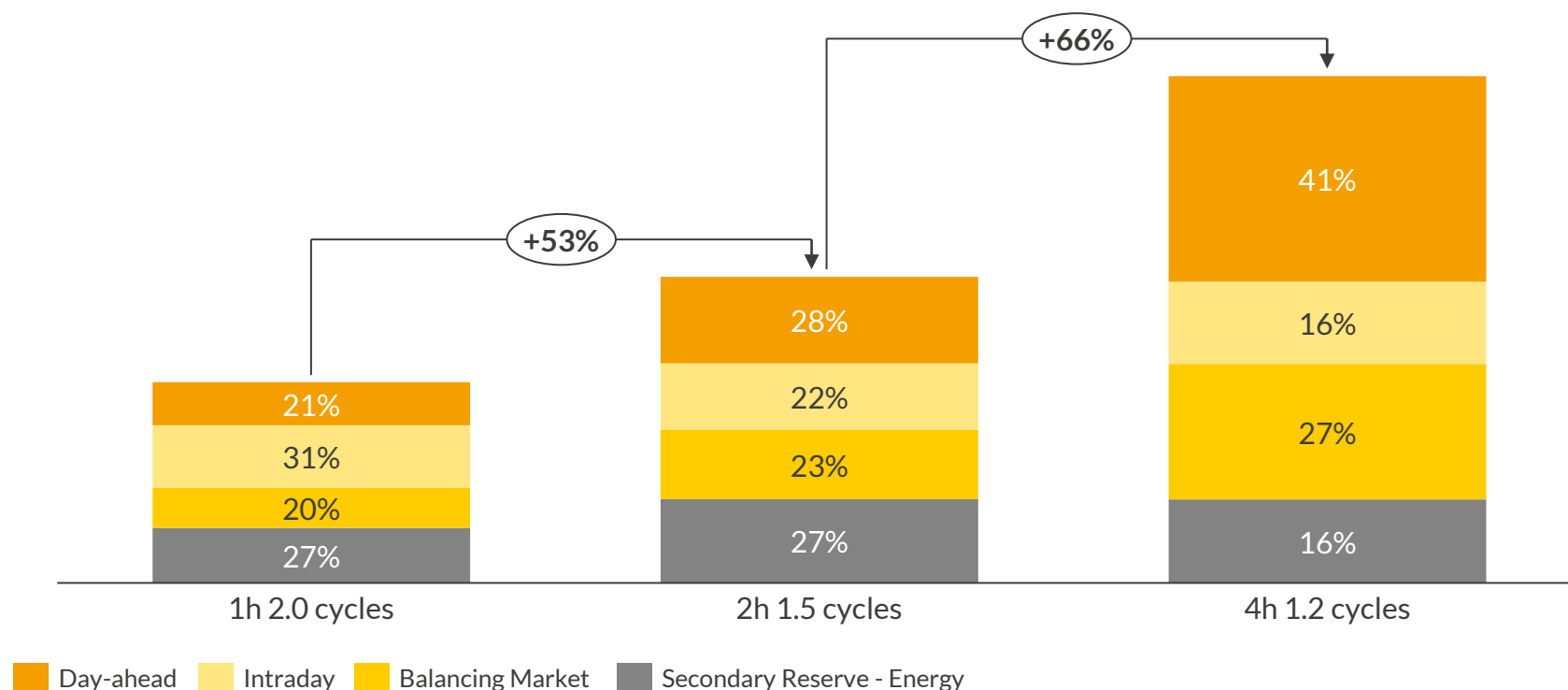
1) We consider spilled energy in our optimisation. 2) Intraday. 3) Day-ahead.

## Results of the model optimisation include a breakdown of the battery's participation in each available market

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Entry year: 2025

Average annual energy export volumes (2025 – 2054)  
hours

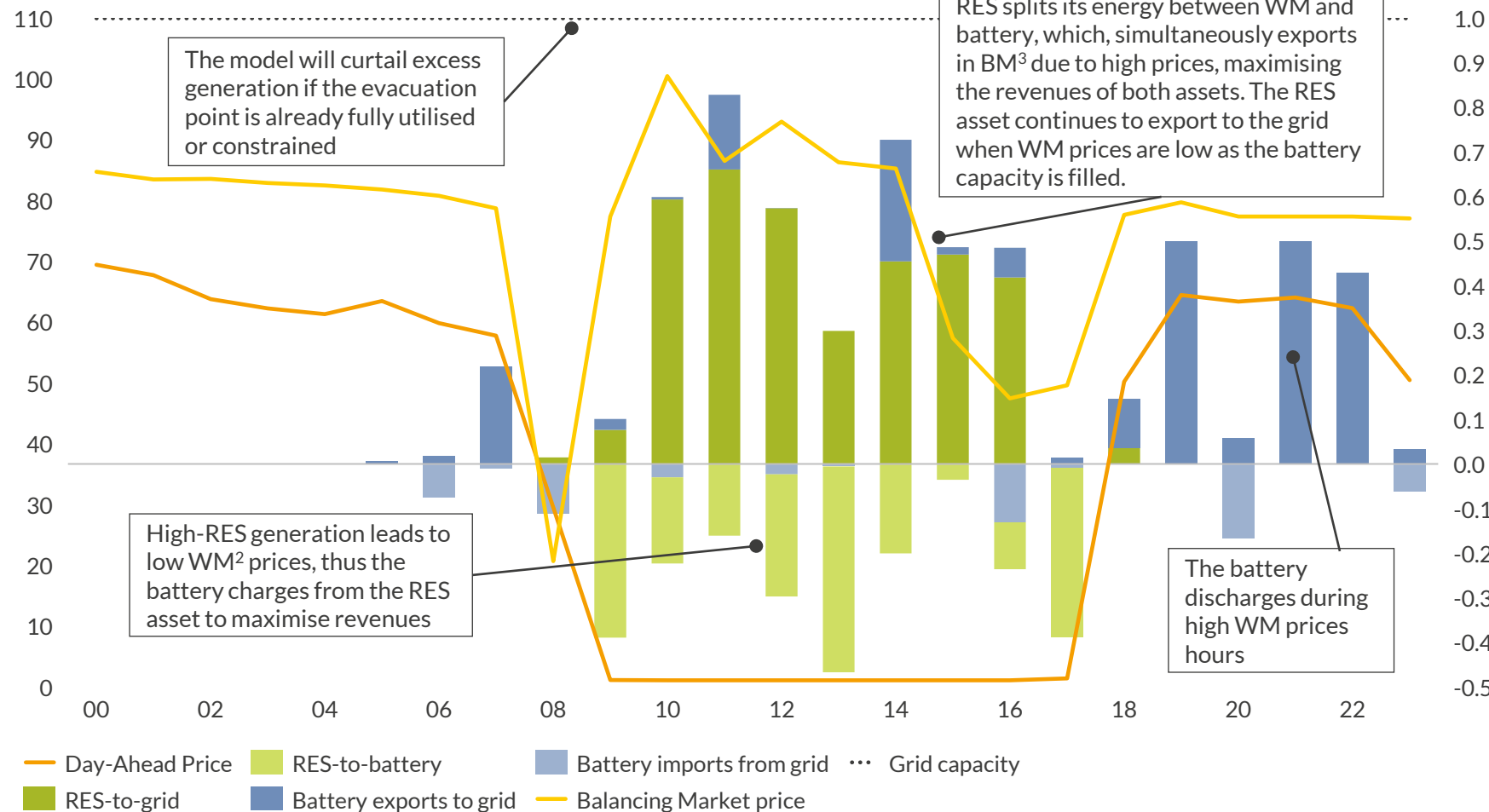


- As the battery duration increases, the battery has higher capacity to trade in the Day-ahead market and the Balancing market. This is because the batteries are able to take advantage of longer duration spreads.
- Similarly, the share of Secondary Reserve volumes decreases for 4hr batteries as lower duration batteries favour Secondary Reserve capacity reservations.
- While capacity is committed in the secondary reserve regulation band and receives a corresponding capacity payment, it does not always get dispatched.

# Aurora's co-optimisation approach allows for the simultaneous optimisation of co-located assets to maximise project revenues

Illustrative 4h DC co-located battery and solar co-optimised operation

Power price  
€/MWh



1) Discharging/export actions are shown as positive, while charging/import actions are shown as negative. 2) Wholesale market. 3) Balancing Market.

- The approach co-optimises the RES and battery assets based on:
  - Prices in each applicable market
  - Battery state of charge
  - Grid connection capacity
- Profits are optimised for the entire project meaning the grid connection does not always reach maximum capacity if RES-to-battery charging is more optimal than RES-to-grid export.
- In this instance, the opportunity cost of the solar asset selling energy to the grid is considered in the optimisation.
- The RES asset may therefore dispatch to the grid and charge the battery at the same time e.g. when prices are low.
- It also results in the battery charging more from the RES asset than the grid.

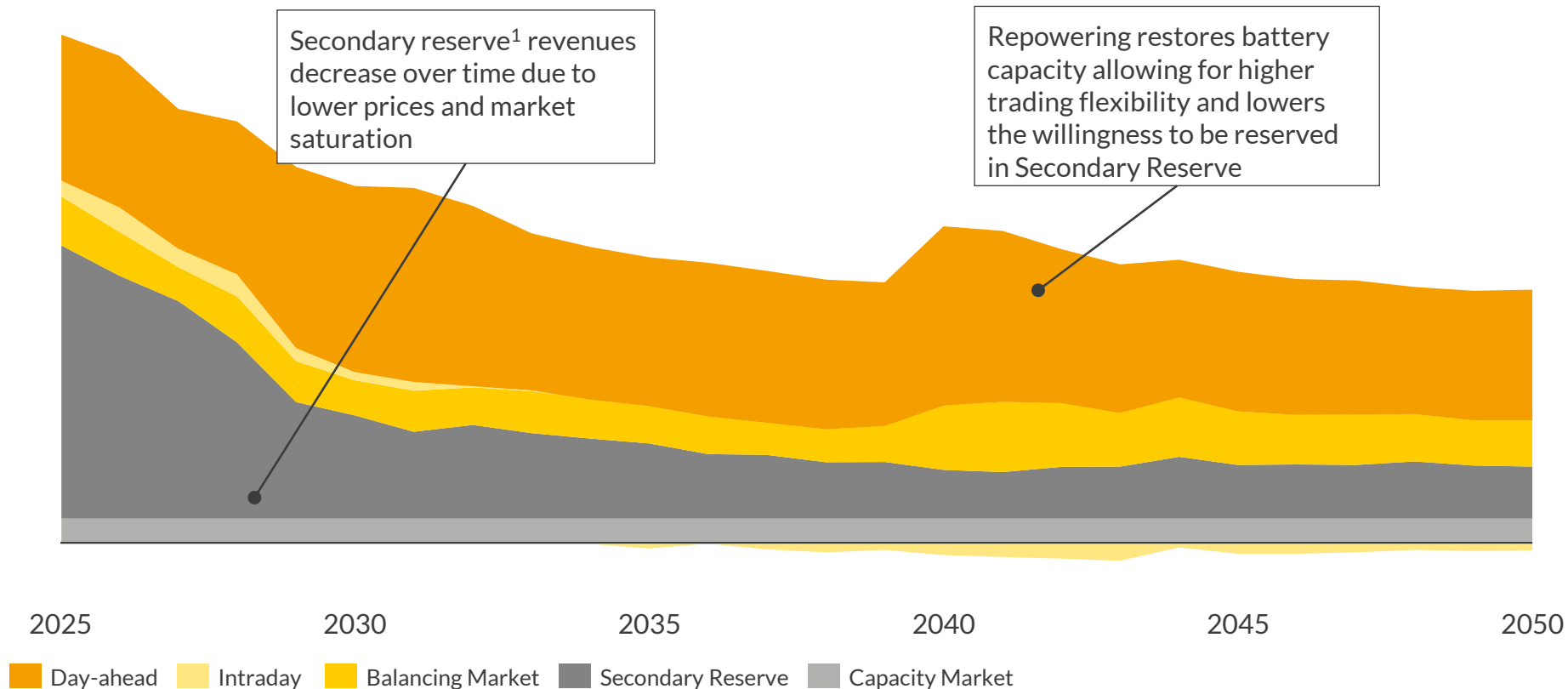
# Aurora provides the revenues breakdown considering market prices, battery duration and the repowering strategy

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Example of a stand-alone battery in Spain (4h, 1.2 cycles per day)

## Gross margins by market

€/kW/year (real 2023)



1) Includes both capacity and energy revenues. 2) State of charge.

Source: Aurora Energy Research

## Comments

- As secondary reserve prices remain relatively high during the 2020s in both the upwards and downwards directions, batteries prefer to capture those revenues rather than doing energy arbitrage.
- The Intraday Market is mostly used for SoC2 management. Therefore, the battery mainly operates in this market to avoid penalties for missed actions in Ancillary Services. This can lead to small losses in this market.
- Following a decrease in Day-ahead spreads due to increasing system flexibility in the 2030s, the Balancing Market becomes more profitable as volatility remains high in this market.
- Additionally, Secondary Reserve prices drop during this period. Therefore the battery favours energy arbitrage, mainly in the BM, in the 2030s.

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# Key takeaways

1

Up to 10.6 bn € of capital will be required to reach government targets of 22 GW of storage by 2030. Considering a conservative 60% leverage and accounting for 620 mn € of PERTE<sup>7</sup> funding leads to a debt requirement of approximately 6 bn €.

2

Understanding the fundamental drivers of price risk related to each market will be key for battery financing. Prices in Ancillary Markets closely follow the Wholesale Market trends, which Aurora captures in our fundamental modelling.

3

Route-to-Market providers offer third party optimisation and risk management services which can help mitigate merchant risk. Within these services, floor structures have been essential for obtaining non-recourse financing in more mature markets such as Great Britain.

4

The regulatory framework for storage has been amended in recent years, but there are still policy and regulation barriers to be addressed as storage is incorporated in the existing regulatory framework. Additional revenues streams such as a future Capacity Market would provide visibility on future revenues.

5

Aurora's modelling methodology and tools can be used to stress-test a storage asset's participation in different markets and corresponding revenues, allowing lenders to define a case suitable for financing. Our analysis can also be tailored to estimate the risk of grid constraints and the benefits of co-location.

# Access detailed power market analysis and investment case data for batteries with our Iberian **Flexible Energy Add-On**



## 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 provided at hourly granularity until 2050:
  - Wholesale power prices
  - Balancing market prices
  - Secondary reserve prices
  - Capacity Market
- Financial Model in excel format

### Investment Cases



#### Standalone battery

- At least three investment cases per country or zone including:
  - Arbitrage of wholesale market and balancing market
  - Secondary reserve participation
- Annual project margins to 2050. IRR and NPV for entry year 2025



#### Co-location

- At least 6 investment cases for batteries co-located with solar PV and/or onshore wind with both AC and DC configurations
- Annual project margins to 2050; IRR and NPV



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# CHRONOS

The leading battery analytics software, now in Iberia

**Chronos** allows you to evaluate any storage asset or project using Aurora's cutting-edge proprietary battery dispatch engine

**Thorough:** Accounts for all site-specific value drivers

**Reliable:** Backed by Aurora's trusted forecasts and team of experts

**Bankable:** Methodology recognised by banks and investors, with reliance available

**Comprehensive UX:** Intuitive interface that empowers user driven analyses

**Efficient:** Evaluate as many opportunities or scenarios as you require, without any consultancy lead times, for just one yearly fee

Intuitive 4-step process:

Input your  
site settings

Input your  
technology  
settings

Select your  
market  
scenario

Analyse  
your result



Transactions



Project Design  
Optimisation

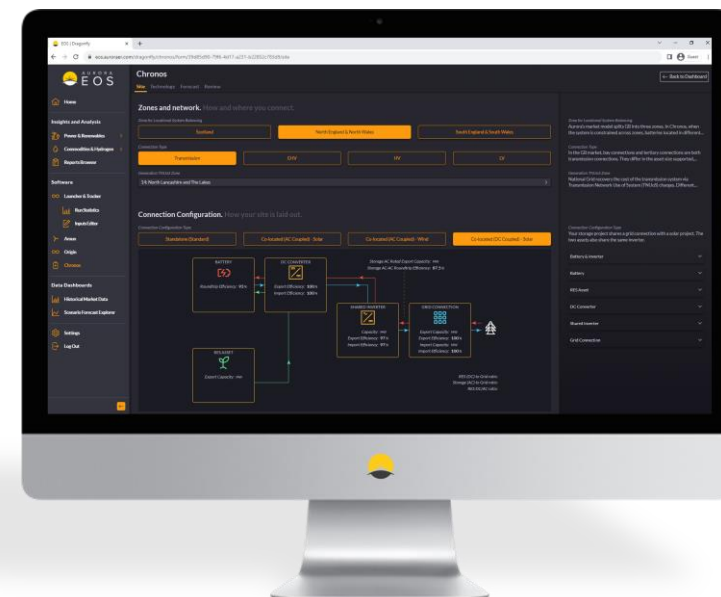


Portfolio  
Valuation



Optimisation  
Benchmarking

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Reach out to Amy Crisp, Commercial Associate—Chronos,  
for your personal demo: [amy.crisp@auroraer.com](mailto:amy.crisp@auroraer.com)

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