AURORA ENERGY RESEARCH

Enabling the Transition: the Investment Case for Batteries in Italy

Aurora Italian Power & Renewables Market Webinar

1 February 2022

Introducing Aurora's speakers

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Sources: Aurora Energy Research

RES penetration in the next decades will create a strong need for system flexibility, leading to massive expected battery capacity growth as a result

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Battery capacity
MW

Installed[1]

~50 MW

In the pipeline

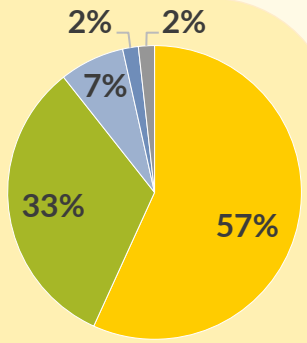
~500 MW committed by 2024

- ~200 MW awarded in the Capacity Market 2023 auctions
- ~250 MW awarded in the Fast Reserve 2024 auctions
- ~30 MW from the UPI[2] project by end 2021

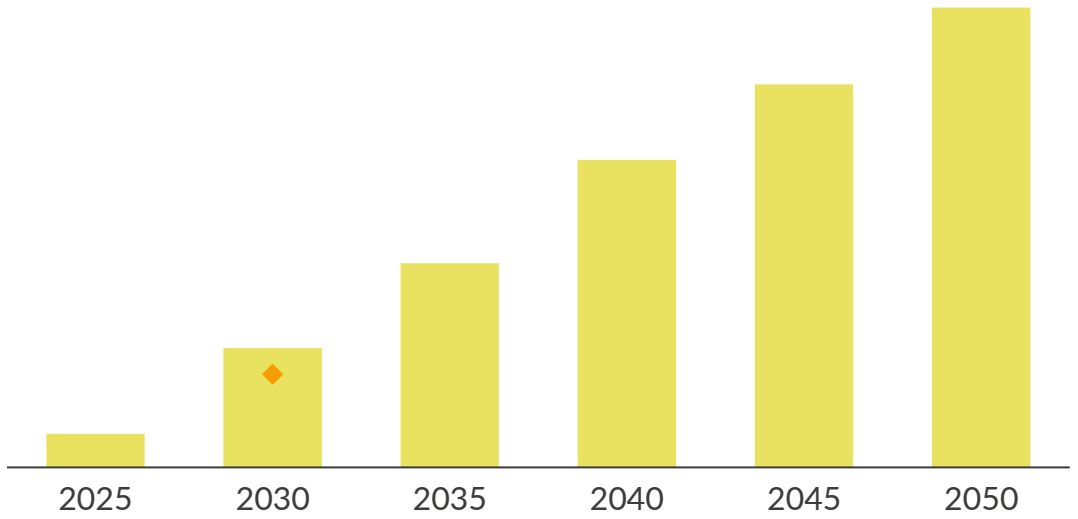
Grid connection requests

> 5 GW requests received until end 2020

- Stand-alone
- Co-located Solar PV
- Co-located Onshore
- Co-located Offshore
- Co-located Thermoelectric



Battery capacity – Aurora Central Scenario (Oct 2021)
GW



- In the first years, battery deployment will be supported through schemes in the like of the Fast Reserves projects and Capacity Market contracts
- As RES penetration increases, the focus will shift toward load shifting and energy arbitrage will play an increasingly large role in battery profitability
- Aurora outlook on battery capacity is in line with current policy targets:
  - Additional battery capacity can be built by our model whenever economics are favourable, i.e. NPV>0

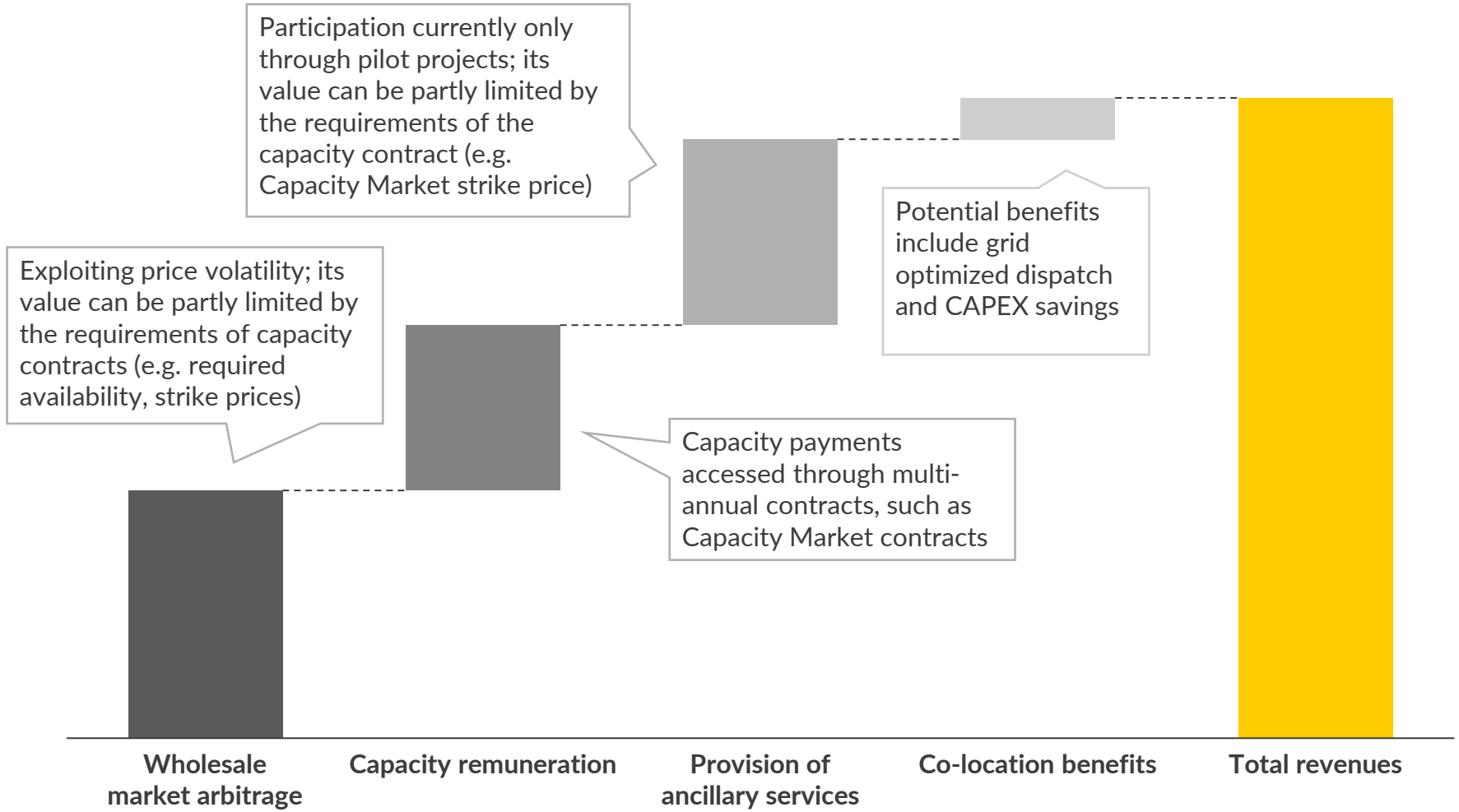
Battery ◆ NECP target

1) 51 MW by Terna and 6 MW from the UPI[2] project; 2) "Unita' di Produzione Integrata", Integrated Unit of Production: co-location of a storage asset with a dispatchable unit to provide Primary Frequency Control.

Sources: Aurora Energy Research, Terna, ANIE Fondazione

The investment case for batteries will depend on the revenue stacking opportunities in the different markets they will access

Revenue stacking opportunities for batteries (illustrative)
kEUR/MW



Sources: Aurora Energy Research

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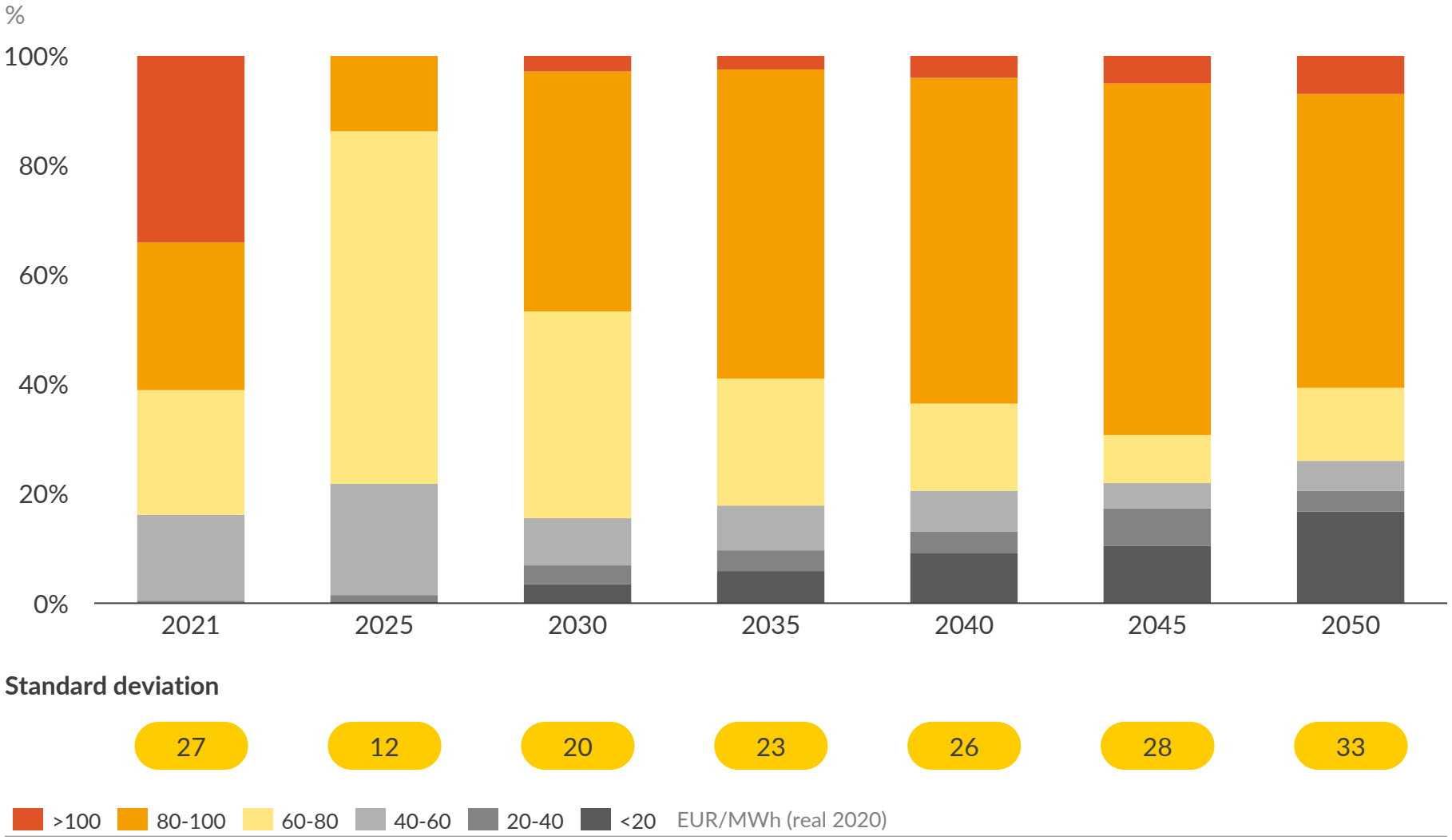
Potential for revenue stacking

- Batteries can participate to different extents to the energy markets
- Several capacity mechanism are accessible to batteries in the Italian power market with different requirements and remuneration scheme
- Co-location with RES plants unlocks further revenues and cost savings
- Revenue stacking can lead to sound business cases for batteries in the Italian power market

The increase of intermittent generation and the retirement of baseload capacity result in growing price volatility

Frequency distribution of the Italian national wholesale power price (PUN)



Sources: Aurora Energy Research

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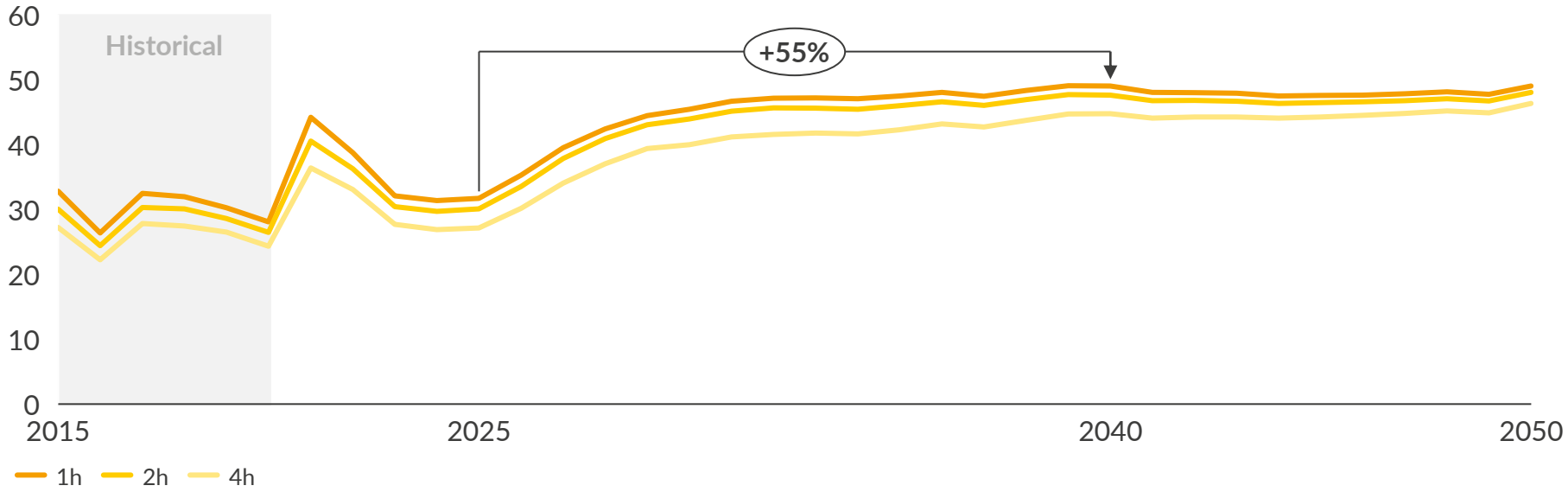
Outlook for price distribution

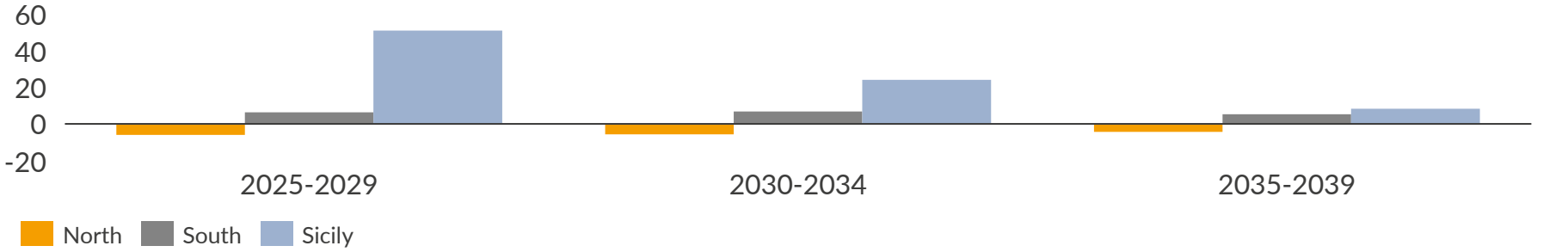
- The distribution of power prices in 2021 is skewed by the current extraordinary gas market conditions
- In the medium-term, power prices level and volatility return to their historical averages
- In the long-term, following the buildout of intermittent RES and the retirement of baseload capacities, wholesale prices become increasingly volatile
- The frequency of low prices (<20 EUR/MWh), from almost 0 in 2025, inches toward 20% by 2025
- The frequency of high prices (>80 EUR) is over 60% in 2050, reflecting the marginal costs of flexible plants in periods of low renewable generation

The growing price volatility also impacts the daily price spreads, increasing the opportunities for arbitrage in the wholesale market

Average daily spreads[1] (PUN)
EUR/MWh (real 2020)



Delta average daily 2h spreads, zonal vs PUN
EUR/MWh (real 2020)



1) Defined as the average difference between the most expensive 1, 2, 4 hours and the cheapest 1, 2, 4 hours in a day.

Sources: Aurora Energy Research

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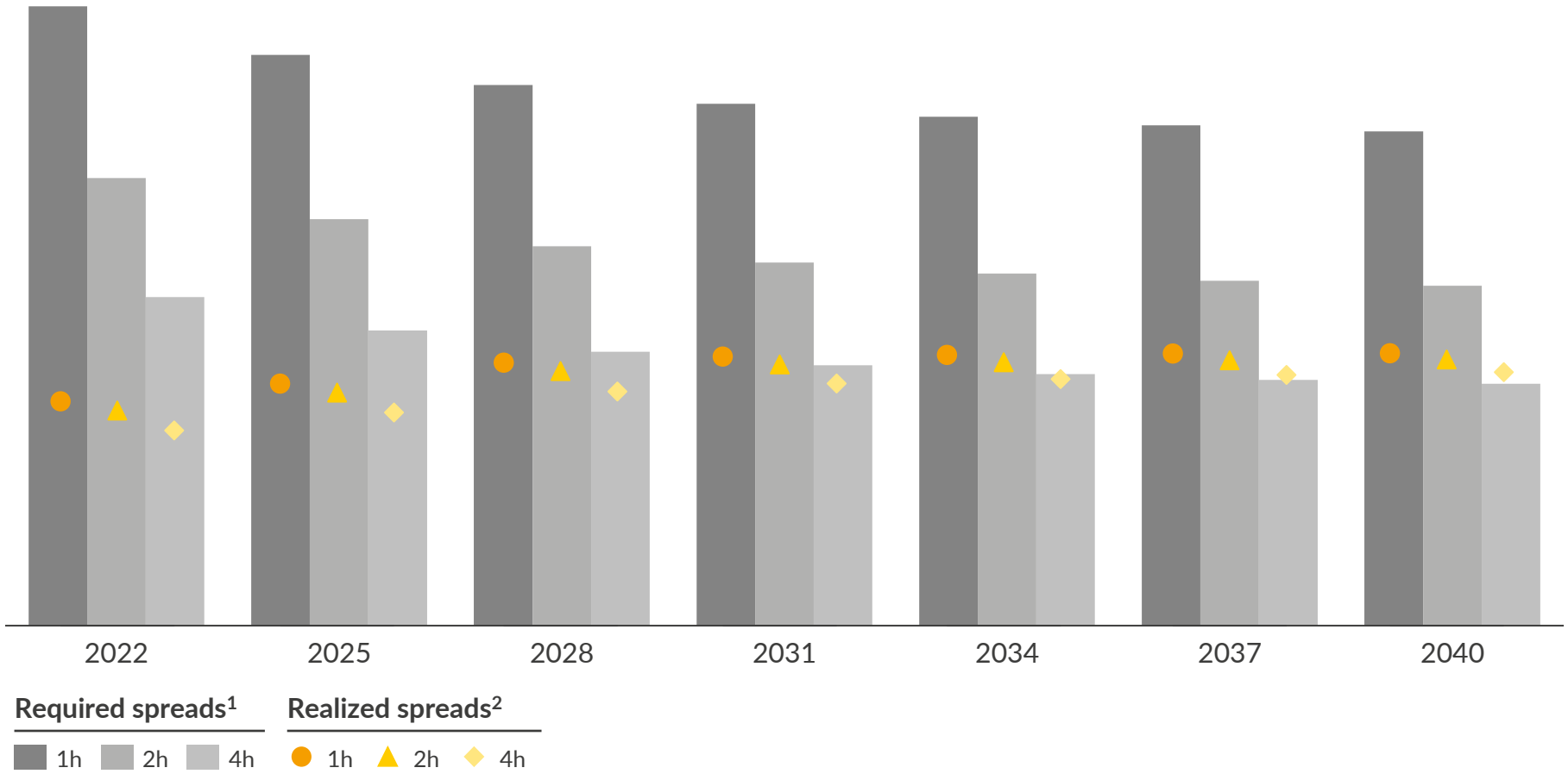
Outlook for daily spreads

- After the normalization of power prices in the short-term, average daily spreads increase until 2040: 1-hour, 2-hour and 4-hour daily spreads grow around 55% between 2025 and 2040
- The increase of daily spreads leads to greater opportunities for energy arbitrage in the wholesale market
- After 2040, the average spreads stabilize between 45 EUR/MWh and 50 EUR/MWh due to the increased penetration of flexible technologies and demand (batteries, electrolysers, smart-charging EVs, etc.)

Even assuming perfect foresight, a 4h battery achieves the required rate of return with wholesale market arbitrage only in the late '30s

Day-ahead energy arbitrage required and captured daily spreads (PUN) by commission date
EUR/MWh (real 2020)



1) Fixed spread necessary to reach an IRR of 9% over the lifetime of the battery; 2) Fixed spread that provide the same NPV of the realized yearly spreads, assuming a discount rate of 9%.

Sources: Aurora Energy Research

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Outlook for wholesale market arbitrage

- The required daily spreads provide an indication of the necessary volatility in the day-ahead market for the battery to recover its CAPEX and OPEX
- Assuming 4-hour batteries can capture the maximum possible spreads, the realized spreads (based on PUN) will be higher than the required ones only in the late 2030s
- For 1-hour and 2-hour batteries, wholesale market arbitrage alone will not be enough to sustain the business case, that will have to rely on other revenue streams as well

Terna has published the details for the Capacity Market auction for delivery in 2024 that will take place on February 21st, 2022

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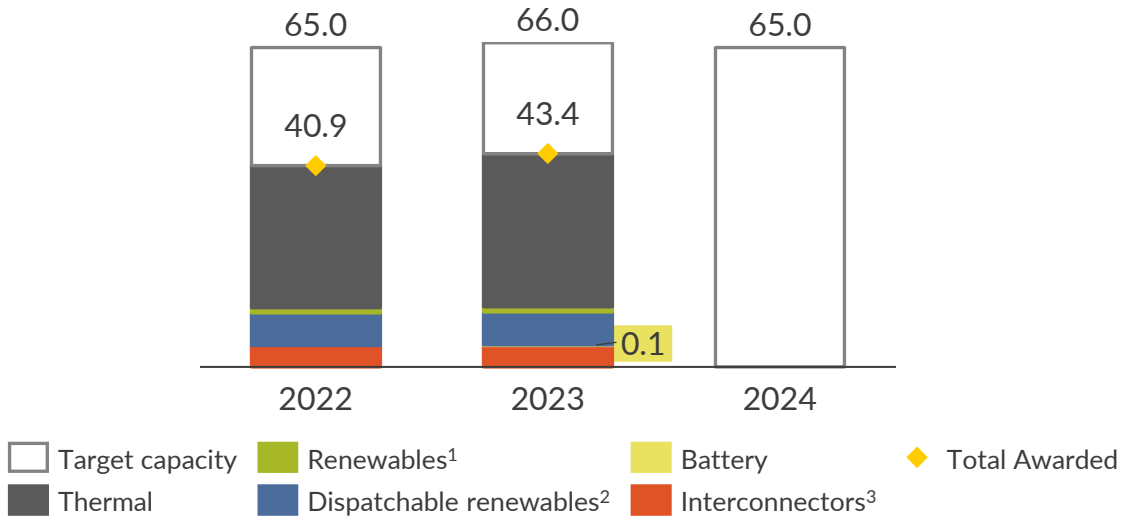
Auctioned and awarded de-rated capacity (3h LOLE)

GW



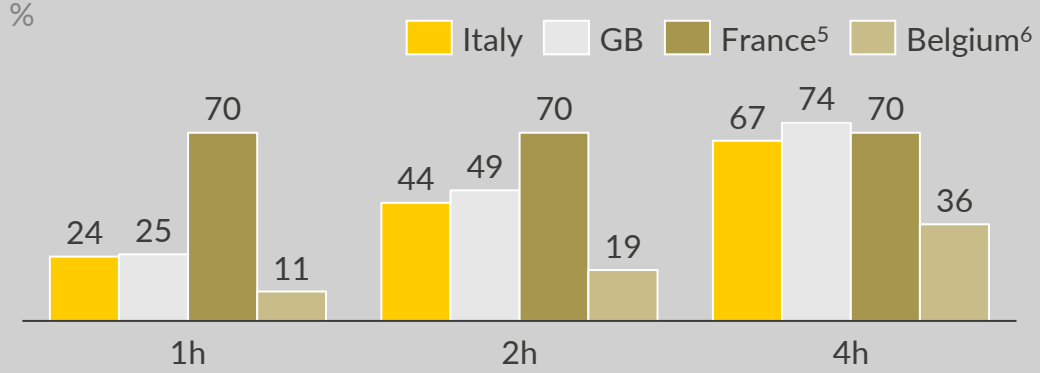
- In the first two T-4 CM auctions for delivery years 2022 and 2023 capacity targets were not met, thus auctions cleared at maximum premiums
- **Auction remuneration caps:**

33 kEUR/MW/year	**for existing plants**
75 kEUR/MW/year	**for new plants and delivery years 2022/23**
70 kEUR/MW/year	**for new plants and delivery years 2024/25**

Focus on batteries

De-rating factors[4] for 2024 auction

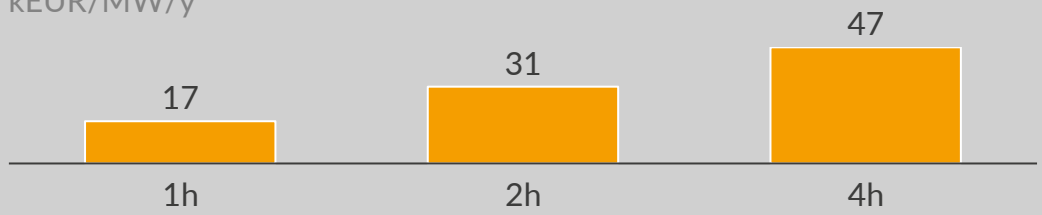
%



- With the exception of France, de-rating factors depend on battery duration: longer duration batteries are less derated than shorter durations batteries
- Derating factors for batteries in Italy are in line with the levels set in GB and higher than in Belgium

Maximum capacity payment 2024 auction[7]

kEUR/MW/y



1) Includes run-of-river, geothermal, onshore wind and solar PV; 2) Includes storage and pumped hydro, biofuels; 3) Interconnectors capacity includes plants in virtual foreign areas; 4) Calculated as *1 - derating factor*; 5) Availability constraints; 6) De-rating factors for first capacity auction (T-4) for delivery in the 2025/2026 winter period; 7) Calculated as auction cap (kEUR/MW/year) times available capacity (%).

Sources: ARERA, Terna, Aurora Energy Research

Terna procures the dispatching resources necessary to manage the power system in the Ancillary Services Market (MSD)

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- The participation to the Ancillary Services Market (MSD) is currently possible and mandatory for dispatchable production units with installed power over 10 MVA[1]
- A complete reform of dispatch extending the participation to MSD to new technologies is expected over the coming years

Service	Description	Procurement
Resolution of congestions	Used to clear network congestions (mainly at the intra-zonal level) and guarantee the operational limits of the grid components.	MSD
Primary reserve	Automatic correction of instantaneous imbalances between total production and total demand of the entire interconnected European electricity system.	Compulsory[1]
Secondary reserve	Automatic correction of the differences between the national system's requirements and production while keeping the power exchanges at the borders at the programmed values.	MSD
Tertiary reserve	Procurement of appropriate reserve margins. Divided in 3 sub-categories (“pronta”, “rotante”, “di sostituzione”) based on technical requirements.	MSD
Balancing service	Terna uses real-time balancing resources offered on the MSD to (1) maintain balance between inflow and outflow of electricity, (2) resolve grid congestion, (3) restore the correct secondary power reserve margins. In this context, Terna activates also the tertiary power reserve.	MSD

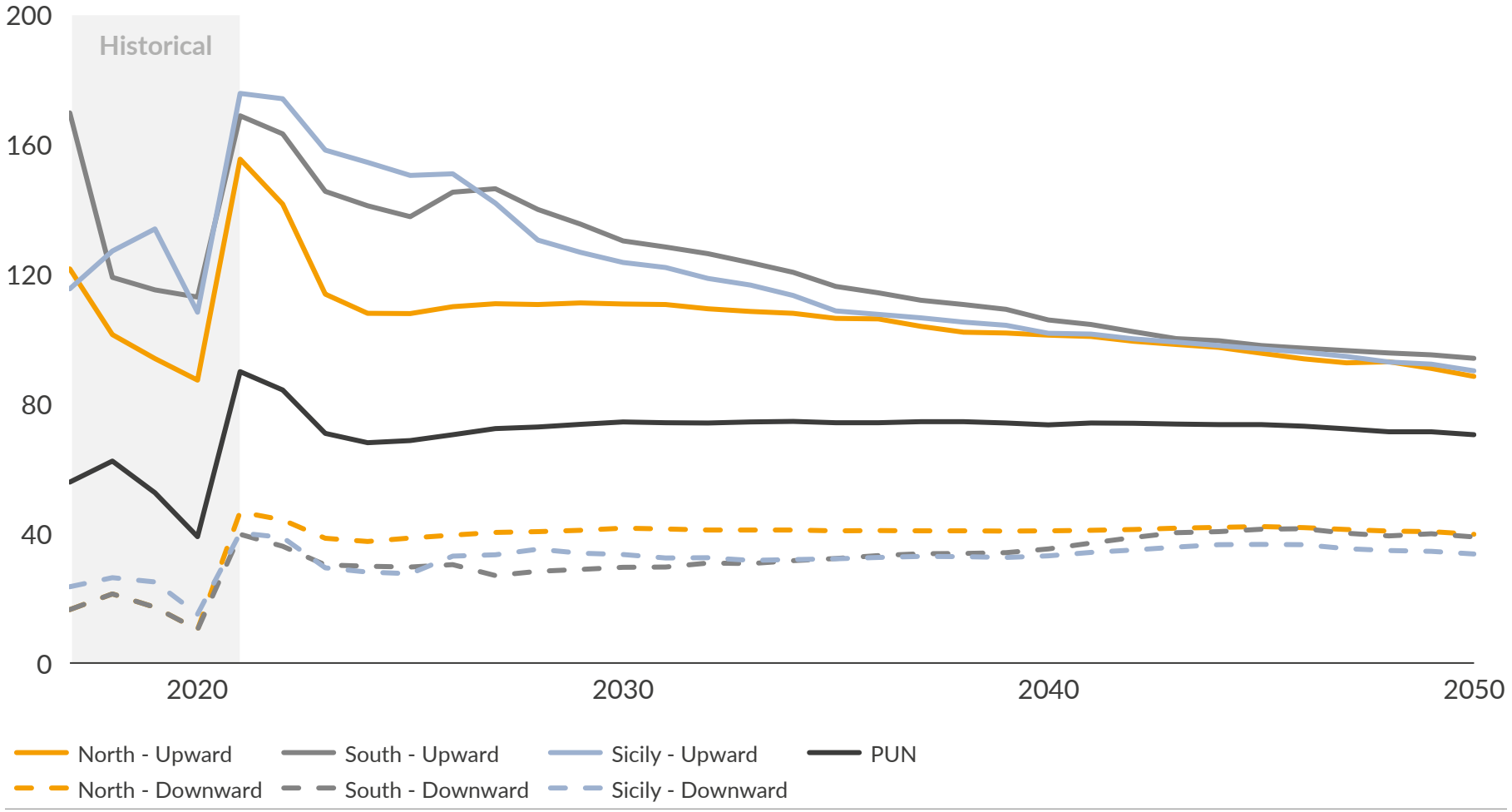
- Other Ancillary Services are currently not marketed nor remunerated and made compulsory for all the eligible generation units: voltage regulation (primary and secondary), load rejection and black-start[2]. A further liberalization of these services (and in particular voltage regulation) could increase the revenue stacking potential for batteries

1) Mega Volt-Ampere, that measure the plant’s apparent power; 2) A separate service for interruptibility of load is procured through auctions.

Sources: Aurora Energy Research, Terna

Batteries will lead to increased convergence of MSD prices, with upward ~90 EUR/MWh and downward ~40 EUR/MWh by 2050

MSD prices[1]
EUR/MWh (real 2020)



1) Volume-weighted average MSD prices.

Sources: Aurora Energy Research

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Outlook for MSD prices

- In the short-term, MSD prices are affected by the spike in commodity prices, remaining above historical averages
- In South and Sicily, the higher upward prices in the short-term are exacerbated by the retirement of essential units that cover a relevant share of the total zonal volumes
- In the medium-term, even though volumes are expected to increase due to higher RES imbalance, the increasing participation of batteries leads to decreasing and converging upward prices across zones
- Towards 2050, MSD premiums versus the PUN stabilize at ~30% for upward and ~-50% for downward regulation, versus ~85% and ~-55% in 2021 respectively

The Capacity Market offers an attractive business case for batteries, mainly for longer durations and in the zones South and Sicily

COD: 2025

Revenues

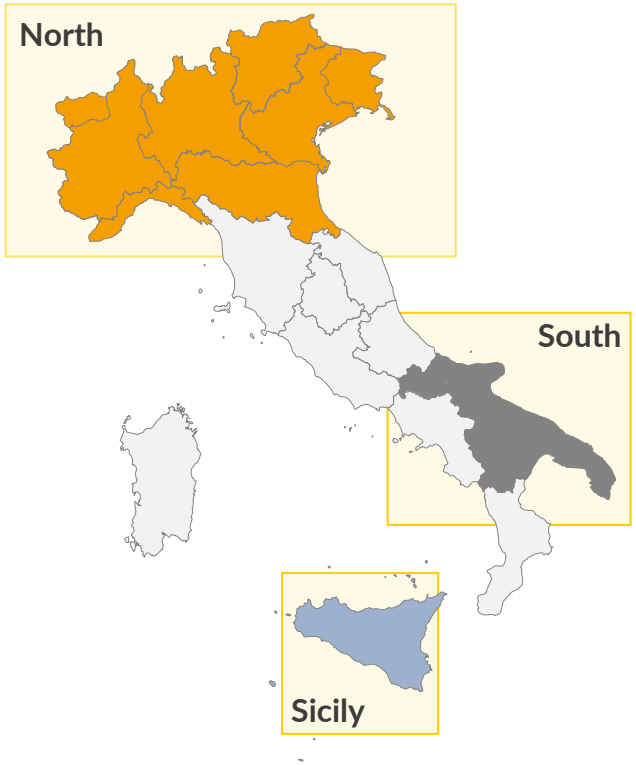
Capacity payment

- Capacity Market contract for new capacity during 2025-2039: 70 kEUR/MW/y, derating factor dependent on duration

Energy arbitrage

- Energy arbitrage between day-ahead market and MSD
- Revenues during 2025-2039 capped at the CM strike price (calculated monthly based on marginal costs of an OCGT)

Modelled price zones



IRR by zone and duration

%

	1 hour	2 hour	4 hour
North			
South			
Sicily			

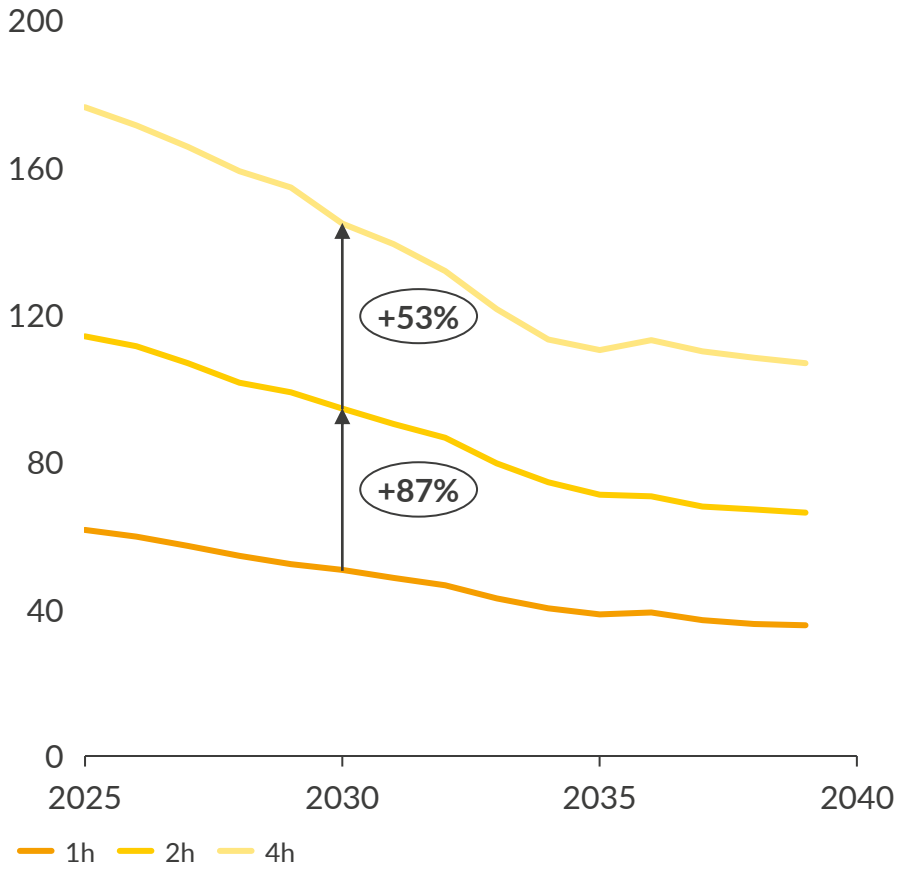
IRR < 6%
6 <= IRR < 9%
IRR >= 9%

Sources: Aurora Energy Research

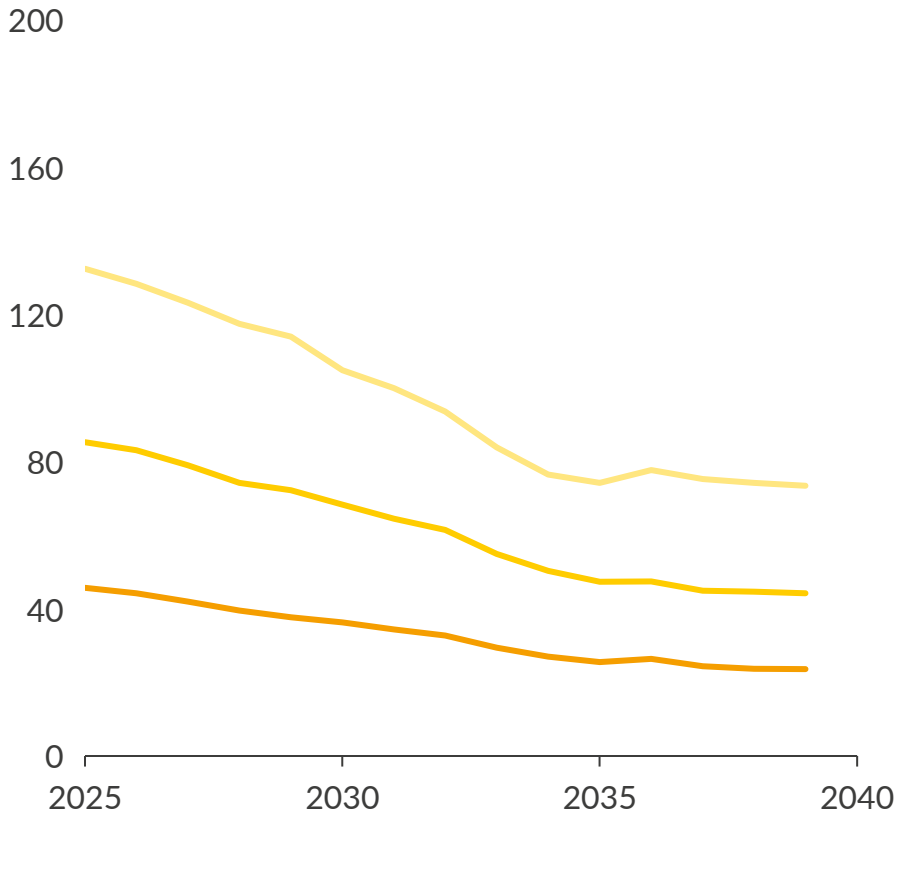
2-hour batteries realize approximately 87% higher gross margins than 1-hour batteries in early years

COD: 2025

Total gross margins[1] in Sicily
kEUR/MW (real 2020)



Energy arbitrage gross margins in Sicily
kEUR/MW (real 2020)



1) Includes margins from Capacity Market and energy arbitrage.

Sources: Aurora Energy Research

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Outlook for battery gross margins

- Total gross margins for a 2-hour battery in Sicily in 2030 are 87% higher than a 1-hour battery, driven by both higher capacity payment and energy arbitrage margins
- In the same year, 4-hour battery margins and 53% higher than 2-hour battery margins
- Gross margins decline until 2035 across durations driven by lower energy arbitrage opportunities
- Energy arbitrage drives most of the value of the battery, especially in early years

Battery developers in Sicily and the South could achieve positive returns even submitting Capacity Market bids well below the remuneration cap

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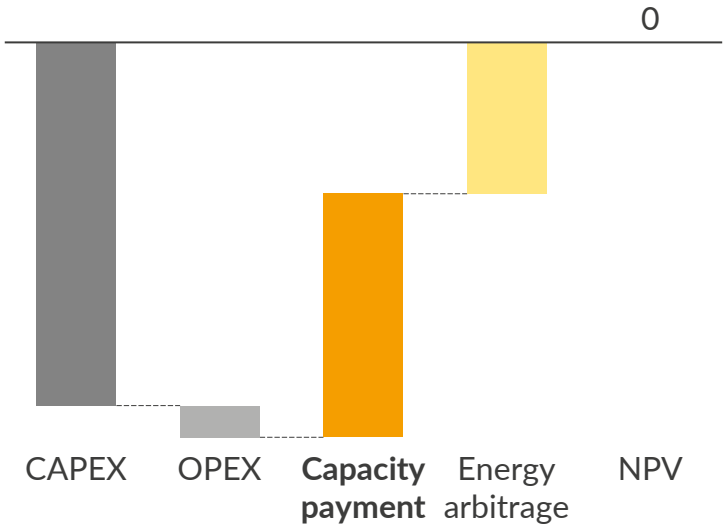
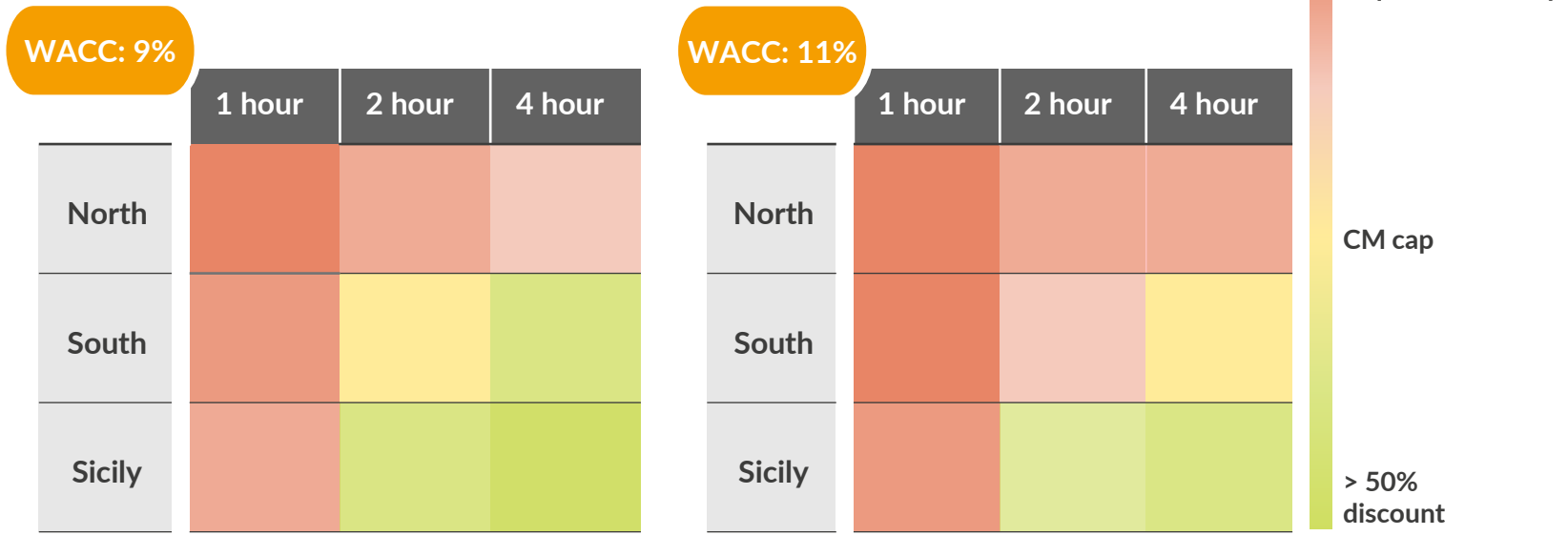
COD: 2025

Illustrative Discounted Cash Flow
kEUR/MW



We show the capacity payment that would make the battery investment break even given a level of WACC[1]. This value, divided by the respective derating factor, is equivalent to the minimum bid that the operator would submit in the CM. We then calculate the discount versus the CM cap of 70 k€/MW/y

Capacity Market payment required to achieve WACC (*discount to the CM remuneration cap*)
kEUR/MW/y (%)



- Given the higher profitability achievable in Sicily, batteries could bid heavy discounts compared to the CM remuneration cap: up to 65% with a WACC of 9%, up to 38% with a WACC of 11%
- Due to the low derating factors for 1h batteries, the required CM payment to recover the WACC would be above the CM remuneration cap
- Discounts in the South could be up to 34% for a 4h battery with a 9% WACC, while the North remains unattractive

1) Weighted Average Cost of Capital.

Sources: Aurora Energy Research

Q&A

Key takeaways and next steps

Key Takeaways

1. As RES penetration in Italy increases the need for system flexibility, **it is crucial to construct a sound investment case for batteries built around revenue stacking opportunities**: 1) arbitrage in the wholesale market; 2) capacity market; 3) provision of ancillary services
2. **Wholesale price volatility is expected to increase, though this growth alone is not sufficient to ensure adequate returns to batteries**: a 4-hour battery trading with perfect foresight achieves a 9% IRR with wholesale market arbitrage only in 2037
3. **New revenue stacking opportunities will be available for batteries in the coming years**: the ancillary services market (MSD), whose prices retain a substantial spread to the day-ahead prices, is expected to be opened up, while new Capacity Market auctions can award a 15-year contract to new 4-hour batteries up to 47 kEUR/MW/year
4. **Aurora's modelling shows that longer duration batteries have a better investment case thanks to higher Capacity Market contracts**: those can achieve returns that can exceed 10% in Sicily and South, giving these investments also the option to submit bids below the Capacity Market cap in the upcoming auctions

Next Steps

- **Italian Market Power and Renewables Forecast Report – January 2022**
  - *Aurora just published its latest forecast update, covering key developments of the Italian power market including commodity prices, baseload prices, capture prices for renewables, generation mix*
  - *Forecasts cover the period up to 2050 in 3 scenarios (Central, Low and High) and are produced at the national level and for each of the 7 price zones*

- **Italian Market Flexibility Report - February 2022**
  - *Aurora's first report on the Italian Flexible Energy Market, focused on battery investment opportunities across a range of scenarios*

Thanks to all the participants for attending today's webinar!

For all questions or comments, please reach out to Deborah Scaggion (Deborah.Scaggion@auroraer.com)

Aurora's Italian Power & Renewables Market service offers everything you need to understand the market, as well as upsides and risks for your assets

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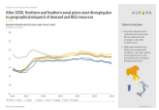
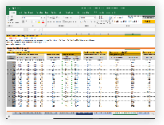
Italian Power & Renewables Market Service



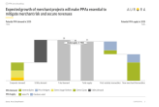
Bi-Annual Market Forecast reports with quarterly data updates

- **Yearly forecasts of wholesale market prices along three scenarios** (High, Low, Central) until 2050, both at **national and zonal** level
- **All the latest trends and forecasts,** recent market and policy developments
- **Price distributions**, capture spark spreads, peak prices
- **Capacity development**, generation mix, interconnector capacity, capacity buildout, exports
- **Capture prices** of key technologies (onshore, solar), load factors
- **PPA valuation**, example of fair price valuation
- **MSD Market**
- **EU ETS carbon price & gas price** forecasts



Underlying dataset

- **An Excel spreadsheet** containing all key input assumptions, baseload price, and fleet-wide onshore wind and solar capture prices on an annual basis through 2050. This will be provided for Aurora's Central, High and Low Scenarios and will include RES capture prices at a national level



Workshops and analyst support

- **Bilateral workshops** to discuss Aurora's analysis and specific implications
- **Ongoing analyst support** to answer questions about our research

Group Meetings

- Invitation to our **Italian Power Market and Renewables Group Meetings** in Milan/Rome (no less than three meetings per year) on topical issues, such the Impact of weather on renewables
- **In-depth thematic reports** on these topical issues

Access anytime via Aurora's EOS online platform

For more information, please contact
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Agenda

Contents Overview for the Italian Market Forecast Report (October 2021)

Aurora's Flexibility Add-On to the Italian Power & RES Market service allows to access all the essential tools to evaluate battery investments

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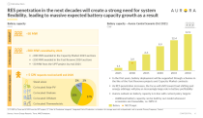
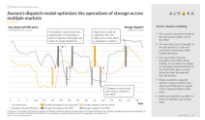
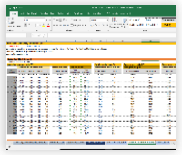
Italian Power & Renewables Market Service – Flexibility Market Add-On





Bi-Annual Italian Market Flexibility reports

- Updates on batteries pipeline development
- Overview of regulatory framework for batteries
- Description of revenue stacking opportunities, with main indicators of the economics for batteries in
    1. Wholesale market arbitrage
    2. Capacity remuneration scheme
    3. Ancillary Services Market (MSD)
- Analysis of investment case for batteries across multiple scenarios in terms of COD, duration and including all Italian price zones, featuring all relevant metrics for investment evaluation (CAPEX, OPEX, revenues by stream, IRR)
- Analysis of co-location benefits



Underlying datasets

- Two Excel spreadsheet
    1. Hourly forecasts of dispatch-relevant prices for batteries through 2050
    2. Detailed data and calculation backup of all the battery investment scenarios modelled

Access anytime via Aurora's EOS online platform

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Agenda

Contents Overview for the Italian Market Flexibility report (February 2022)

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