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The BESS is Yet to Come: Storage Strategies for the Italian Market

Public Webinar

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Sources: Aurora Energy Research

Utility-scale BESS capacity reached 1GW in 2024, with 825MW alone installed in 2024 thanks to Capacity Market auctions

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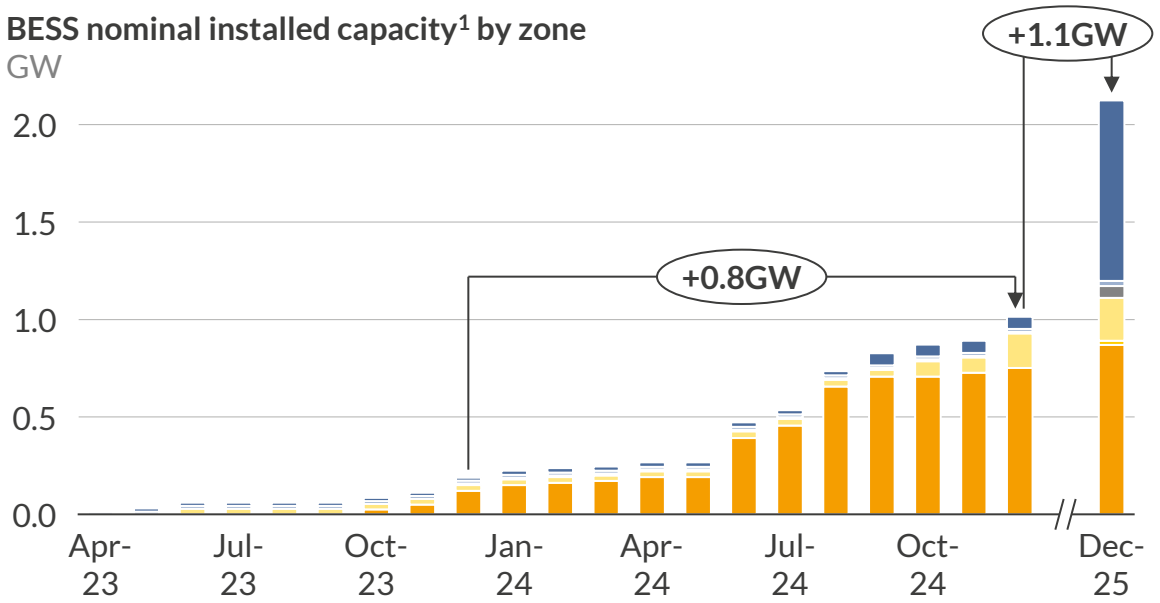
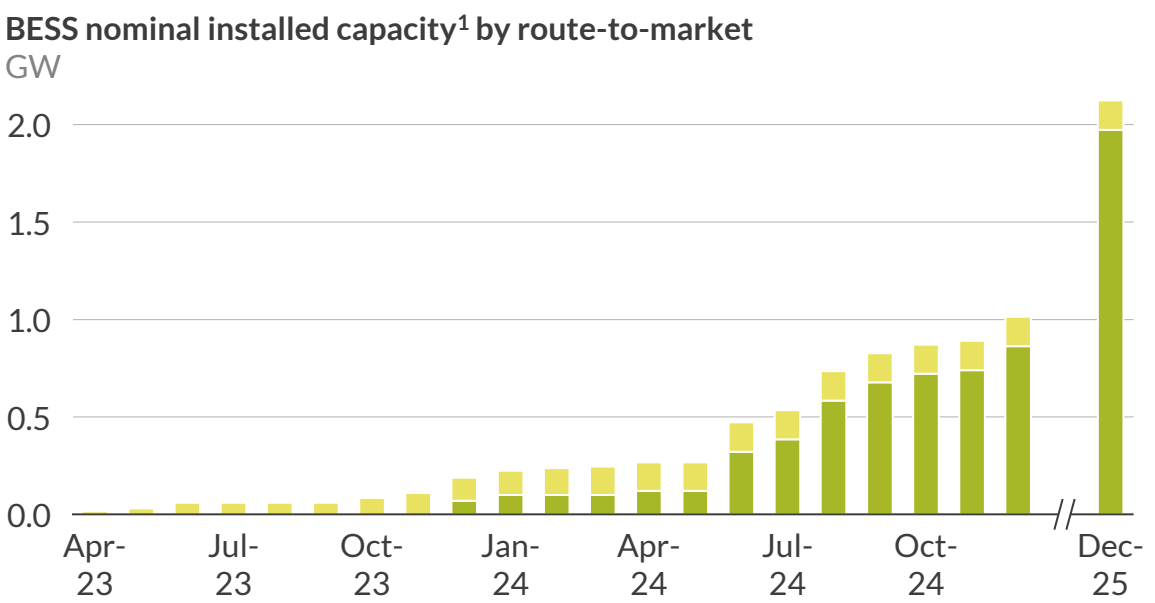
BESS nominal installed capacity[1] by zone



BESS nominal installed capacity[1] by route-to-market



- Utility-scale BESS capacity reached 1GW in December 2024, with 825MW installed in 2024 alone.
- At a zonal level, as of December 2024 74% of the total standalone BESS capacity is located in zone North, followed by C. South (17%) and Sardinia (6%).
- In 2025, a redistribution of BESS capacity is expected, with Sardinia adding 860MW to cover 44% of national capacity and North reaching 870MW (41%).

- Before 2024, pilot projects such as the Fast Reserve scheme were the only route to market for BESS. Capacity not contracted through the Capacity Market reached 119MW in 2023 and 151MW in 2024.
- In 2024, the Capacity Market bore fruit, by adding 793MW of operational BESS capacity, making up 85% of the total fleet.
- In 2025, an additional 1.1GW is expected to come online thanks to the 2024 Capacity Market (delayed assets) and 2025 Capacity Market.

North C. North C. South South Calabria Sicily Sardinia

Other RtM Capacity Market

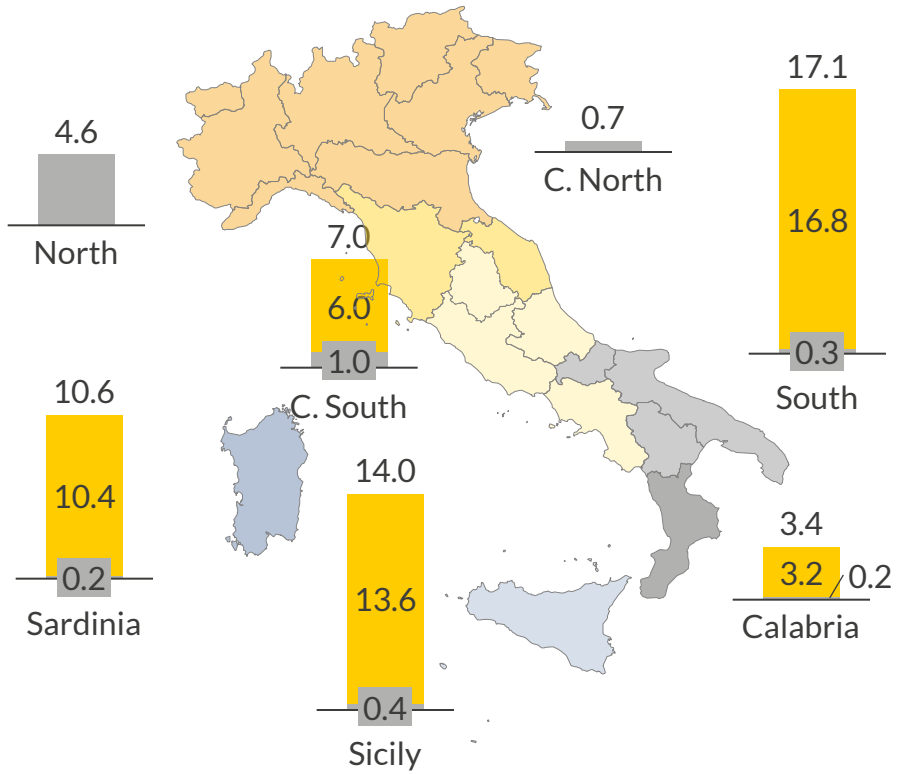
1) Only standalone assets.

Sources: Aurora Energy Research, Terna

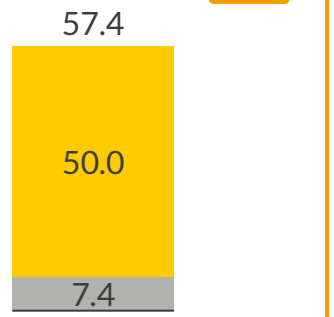
Terna estimates a further 57GWh of battery capacity is required by 2030 to enable renewable deployment in line with targets

Terna have stated the need for 50GWh of new utility-scale BESS by 2030. With well-defined storage requirements, the **opportunity** for battery development in Italy **will continue to increase** in short and medium term, as it takes an ever-increasing role in the energy transition.

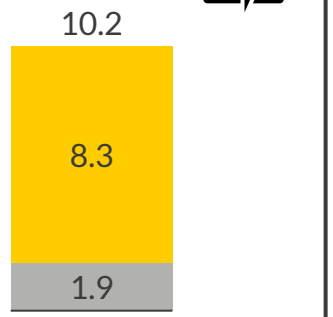
New storage energy capacity required by 2030
GWh



New energy capacity, 2030
GWh



New power capacity[1], 2030
GW



- In their latest 2030 scenario, Terna have identified the need for an additional 57GWh of storage capacity, mostly built in Southern zones and necessary to support renewable build-out in line with Fit-for-55 targets.
- Utility-scale assets make up 50GWh, equivalent to 8.3GW assuming an average asset duration of 6h. These would enable rapid renewable growth in Southern zones.
- A further 7.4GWh would be required from small-scale, 4h batteries co-located with rooftop solar plants in Northern zones especially.

New - Utility-scale New - Small scale

1) Assuming 6h average duration for utility-scale batteries and 4h for small-scale.

Sources: Aurora Energy Research, Terna, Snam

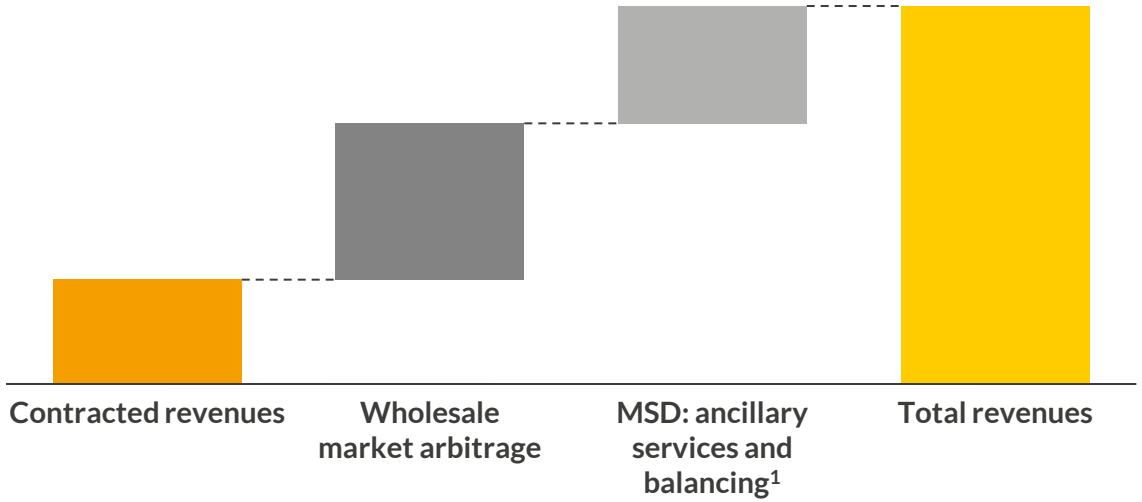
Current routes-to-markets for BESS involve a Capacity Market or MACSE contract, with different levels of merchant exposure

Merchant business model

Deep-dive A

Capacity Market + merchant trading

€/kW



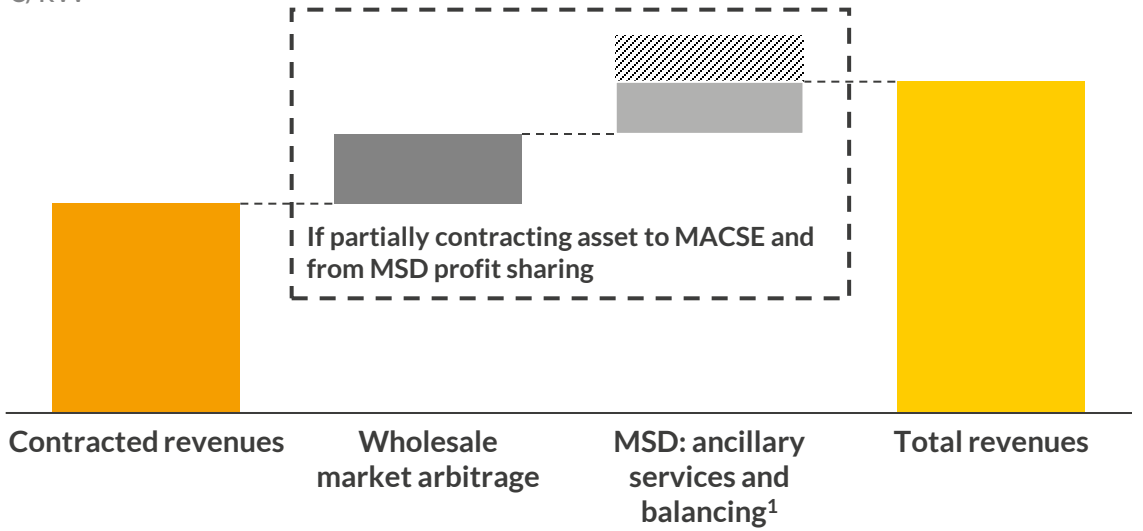
Illustrative revenue split – contracted vs merchant

MACSE business model

Deep-dive B

MACSE + potential merchant trading

€/kW



Illustrative revenue split – contracted vs merchant

Contracted revenues | Variability[2] | Merchant revenues

1) *Mercato dei Servizi di Dispacciamento*; 2) Variability comes from COD and zonal differences in the Capacity Market business case, and from increasing merchant exposure by contracting only part of the asset to MACSE for the MACSE business case.

Sources: Aurora Energy Research

The Capacity Market has awarded contracts to 2.4GW of BESS, but stagnating demand curves limit the value of future auctions

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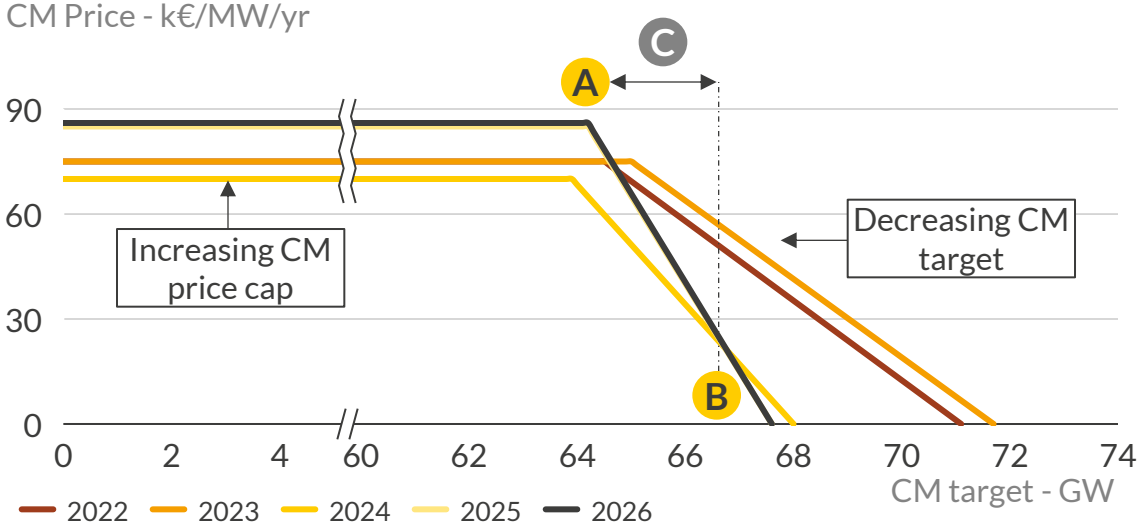
Auction demand curves, national aggregate

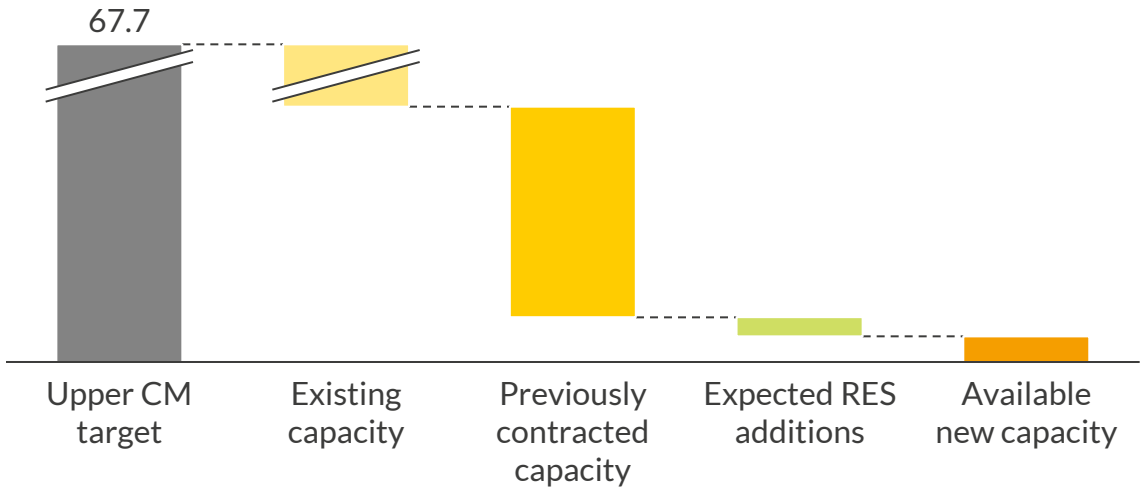
CM Price - k€/MW/yr



Expected Capacity Market supply stack for 2027 auction

GW CDP

2027 Auction



- The overall CM target has been decreasing, with the maximum contractable capacity (B) dropping from 71.7GW CDP[1] for 2023 to 67.7GW CDP for 2026.
- While the CM cap has increased to 86 k€/MW (A), demand curve elasticity has decreased, with capacity on offer below the cap reducing (C), producing a steeper curve: demand curves now better estimate system requirements.

- In the 2026 auction, existing and previously contracted CDP accounted for ~97% of Capacity Market needs. This includes the 1.3GW of CDP BESS capacity awarded in the first 4 auctions.
- The published demand curves for 2027 match the 2026 ones, leaving limited opportunities for new BESS assets, which also need to compete with the expected RES additions.

While future auctions will maintain existing capacity in operation through annual contracts, the **opportunities available for new BESS have diminished**. For the value of the Capacity Market to increase, either **demand curves need to grow**, or there needs to be a **decrease in the participation of existing capacity**.

1) *Capacity Disponibile in Probabilita'* – technology-specific derated capacity valid for Capacity Market participation.

Sources: Aurora Energy Research, Terna

The MACSE scheme awards fully contracted revenues to BESS assets for 15 years, with limited merchant exposure

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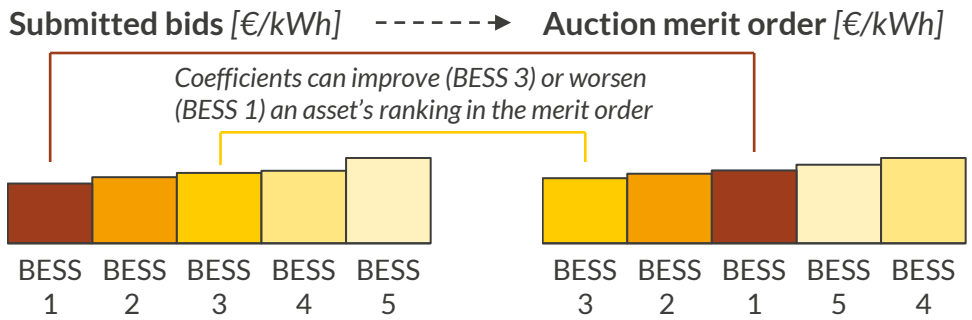
MACSE auction

- **Authorised, new-build battery capacity**[1] participates in **pay-as-bid** auctions in **€/kWh**.
- To ensure competition, **auction volumes will be the minimum between the target volume and 80% of the pre-qualified capacity.**
- **Extra-performance coefficients**[2] are applied to bids to create **the auction merit order,** due to different system benefits across durations and efficiencies.



Adjusted bids with extra-performance coefficients – COD 2028 – 6% WACC
€/kWh (nominal)

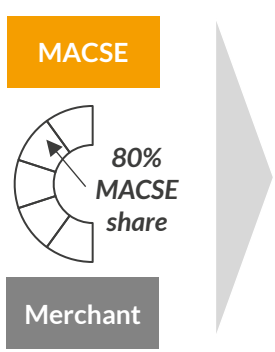
	4h	6h	8h	10h
80%	38			
90%				
95%			27	

The adjusted bids for shorter duration assets remain above 8h asset bids, but can be improved through efficiency gains

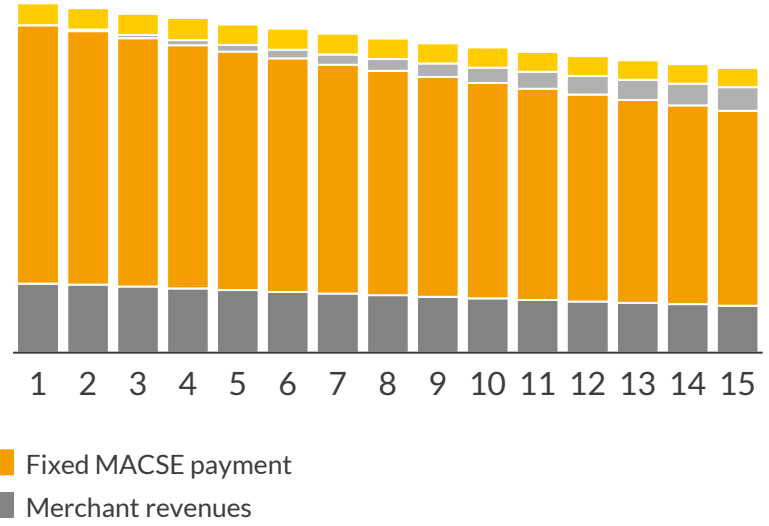
Remuneration

- Awarded capacity receives **monthly fixed payments for 15 years**. Payment is **updated** monthly based on a **% of inflation**[3].
- MSD profit sharing: **MSD market prices are capped at the Strike Price**, with **20% of MSD revenues** retained by the operator.
- An asset can **contract only part of its capacity under MACSE**, with the rest trading on the markets, increasing or decreasing its merchant exposure.

Hybrid model



Revenue stack *[€/kW, real]*



1) Construction work must start after the auction; 2) The product of participant's bid price and coefficient must be lower than the auction cap; 3) The consultation indicated this percentage as "Opex quota" and set it at 20%. The value will be confirmed in the final Technical Report.

Sources: Aurora Energy Research, Terna

Competition in the 1st MACSE auction will be highest in South and C. South, where large project pipelines are developing

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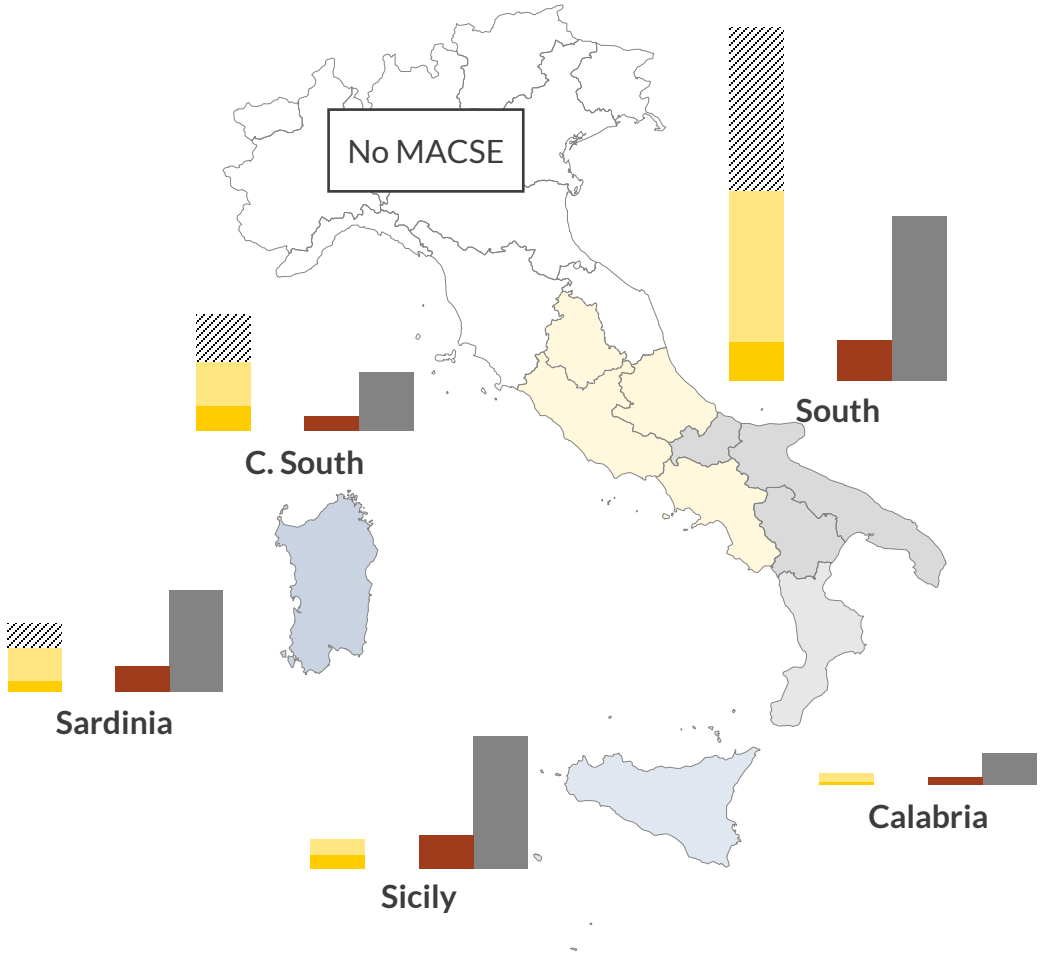
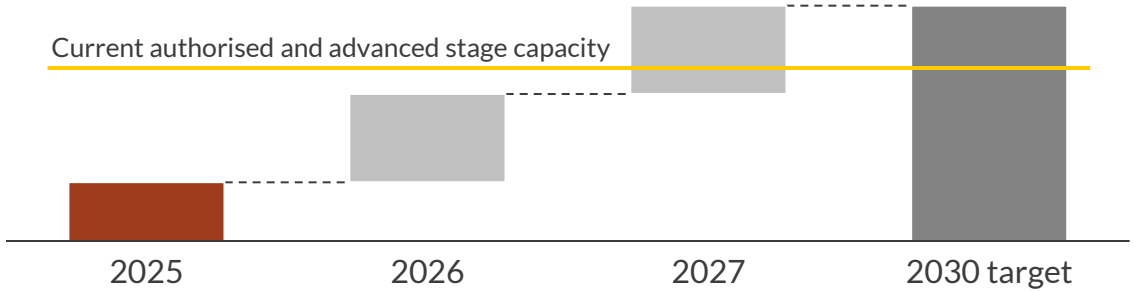
BESS capacity pipeline by authorisation status[1,2] vs MACSE target[3]
GWh



Assumed auction volumes by auction year
GWh



- The target for the 1st auction has not yet been announced by Terna in the *Documento Fabbisogni*. We assume ¼ of the 2030 storage requirement from the Terna-Snam scenario for the 1st auction.
- Only authorised capacity can participate in MACSE: ~9GWh of the active 59GWh BESS pipeline was fully authorised as of December 2024.
- While national pipeline capacity is sufficient for MACSE targets:
  - Competition will vary across market zones, with higher competition in the South and C. South, especially in the 1st and future auctions.
  - Calabria, Sicily (particularly), and Sardinia fall short of MACSE targets, offering opportunities for strategic auction participation.
  - Project mortality rate will streamline the remaining pipeline.
- Final auction participation will depend on authorisation status and market access strategies.

1) Assets authorised through the AU - *Autorizzazione Unica;* 2) Energy capacity (GWh) was calculated according to Aurora's assumption on the distribution of 4h, 6h and 8h batteries (60%, 20%, 20% respectively); 3) Based on Terna-Snam 2024 Scenarios, as target announcement has been delayed by Terna.

Sources: Aurora Energy Research, MASE, Regional Administrative Bulletins

To estimate the likely outcome of 2025 MACSE auctions, Aurora has developed a proprietary model in a flexible Excel tool

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Step 1

Auction Participation

- To estimate the expected participation to 2025 MACSE auctions, we collect detailed data on authorized plants classified based on provinces
- Authorized capacity figures come from MASE official sources
- Information not publicly available will be estimated by Aurora with all assumptions made transparent
- Different scenarios can be analyzed with varying level of target capacity and participation

Step 2

Minimum Bid

- Based on size, region and storage duration (which determines the extra-performance coefficient applied to the bid when determining the merit order), we calculate key financial metrics for all plants expected to bid in the auctions using assumptions from the Aurora Central Scenario[1]
- The minimum bid necessary to recover the costs, including capital remuneration, is assessed considering also the MSD margins the MACSE scheme leaves available to the assets

Step 3

Auction Outcome

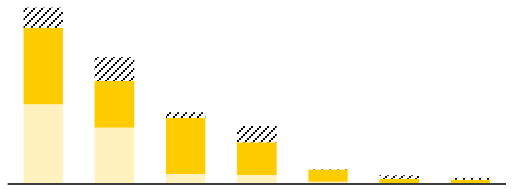
- The clearing price and quantity of the auction are calculated at the intersection of the market demand and supply curves at the national level:
  - The demand will be a fixed volume as defined by the MACSE auction rules
  - The supply curve determined by aggregating homogenous plants bids and considering the extra-performance coefficients

Tool

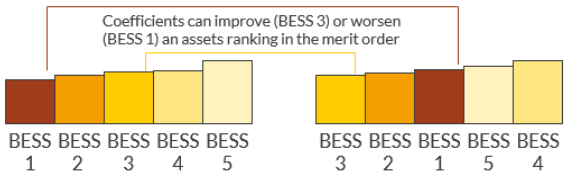
Simulation tool

- A dynamic tool in Excel allows to study the sensitivity of 2025 auction equilibria following changes in the underlying assumptions on:
  - target capacity
  - participation
  - Capex and Opex
  - IRR
  - etc.

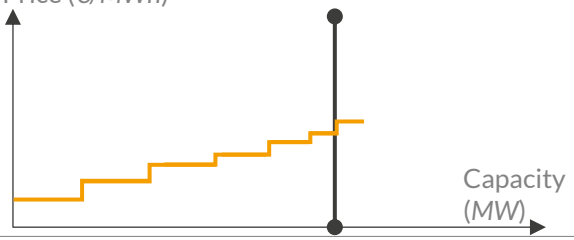
Capacity per technology, size and market zone
GW



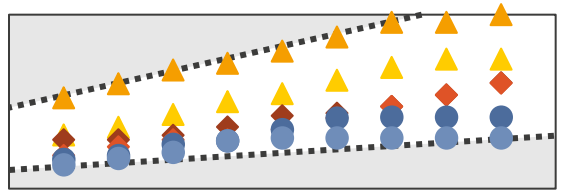
Minimum bid and merit-order bid
€/MWh



Auction curve
Price (€/MWh)



Auction clearing prices
€/MWh

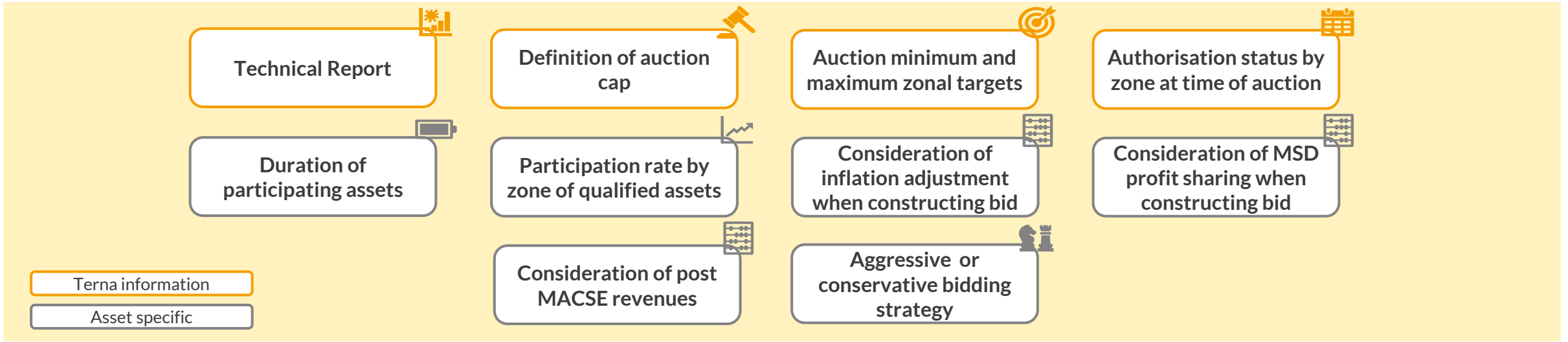


1) October 2024 Update.

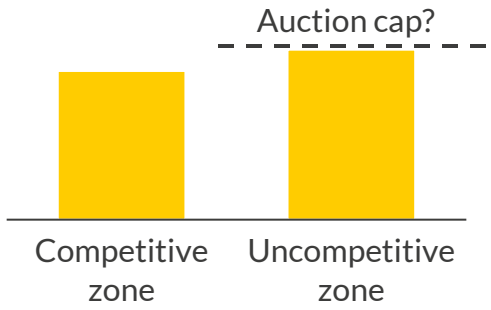
Sources: Aurora Energy Research

South and C. South could see marginal MACSE bids below the cap, but yet to be published documentation can alter bidding behaviour

Terna is **yet to publish key documentation for the MACSE**, making clearing prices subject to several assumptions. Among these, the updated **Technical Report** with the **extra-performance coefficients and degradation requirements**, the **auction cap,** the **zonal auction targets** and the **auction date.**



MACSE marginal awarded bid – competitive vs uncompetitive zones
€/kWh

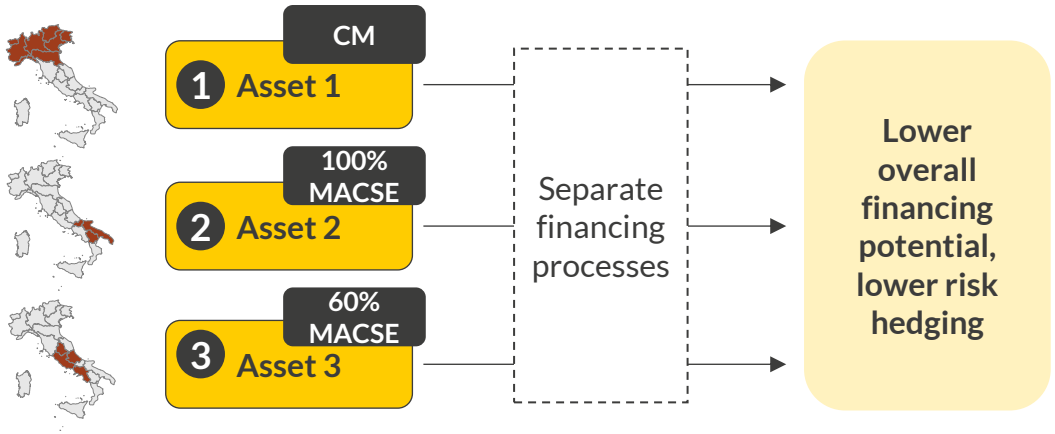


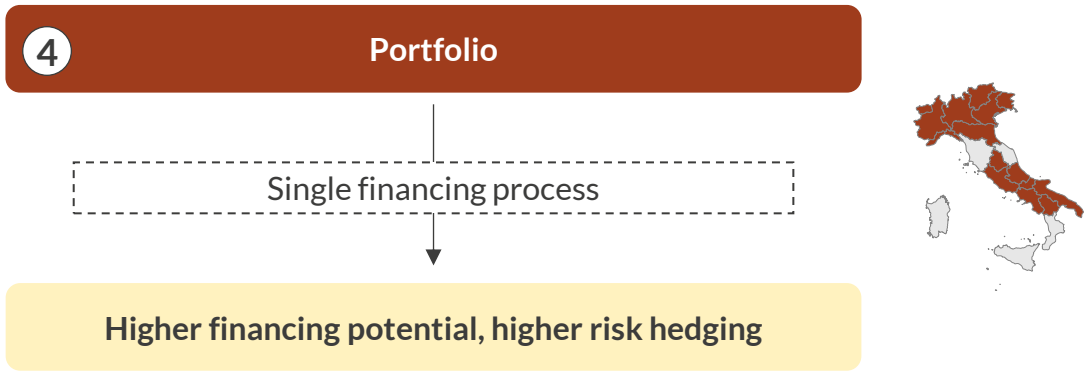
- MACSE clearing prices will depend on the zone and the supply/demand relationship at the time of the auction.
- Oversizing requirements especially (due to degradation) push up bid prices, but consideration of additional revenue contributions (MSD, inflation adjustment, post-MACSE lifetime) can make bids more competitive.
- Zones with more competition (like South and C. South) could see bids below the auction cap, while zones where pipelines do not reach the potential zonal target could see bids closer to the auction cap.

Sources: Aurora Energy Research, Terna

A portfolio approach to battery financing can maximise investor returns, by fully leveraging the bankability of contracted revenues

Multiple assets can be financed individually or aggregated in a portfolio and financed together. **Financing multiple assets amplifies the value of contracted revenues, maximising the bankability of capacity contracts and providing scenario hedging through diversification.**





- The BESS pipeline has been developing for several years, and authorisation requests are not limited to zones which will host MACSE auctions.
  - Batteries in North and C. North will only be able to bid for CM contracts.
- While MACSE contracts are extremely attractive from a financing perspective, volumes are not spread evenly between Southern zones.
  - Certain zones will experience high MACSE participation, and competition will push bids, and resulting project returns, down.

- Batteries will be developed across zones and through both MACSE and Capacity Market.
- Combining these into a portfolio can lead to financing and portfolio benefits, allowing for a higher amount of investible assets.
- A portfolio also allows for different strategies across assets, taking varying levels of merchant exposure and/or upside.

Sources: Aurora Energy Research

The MACSE scheme offers high shares of contracted revenues, leading to easier access to financing with higher gearing ratios

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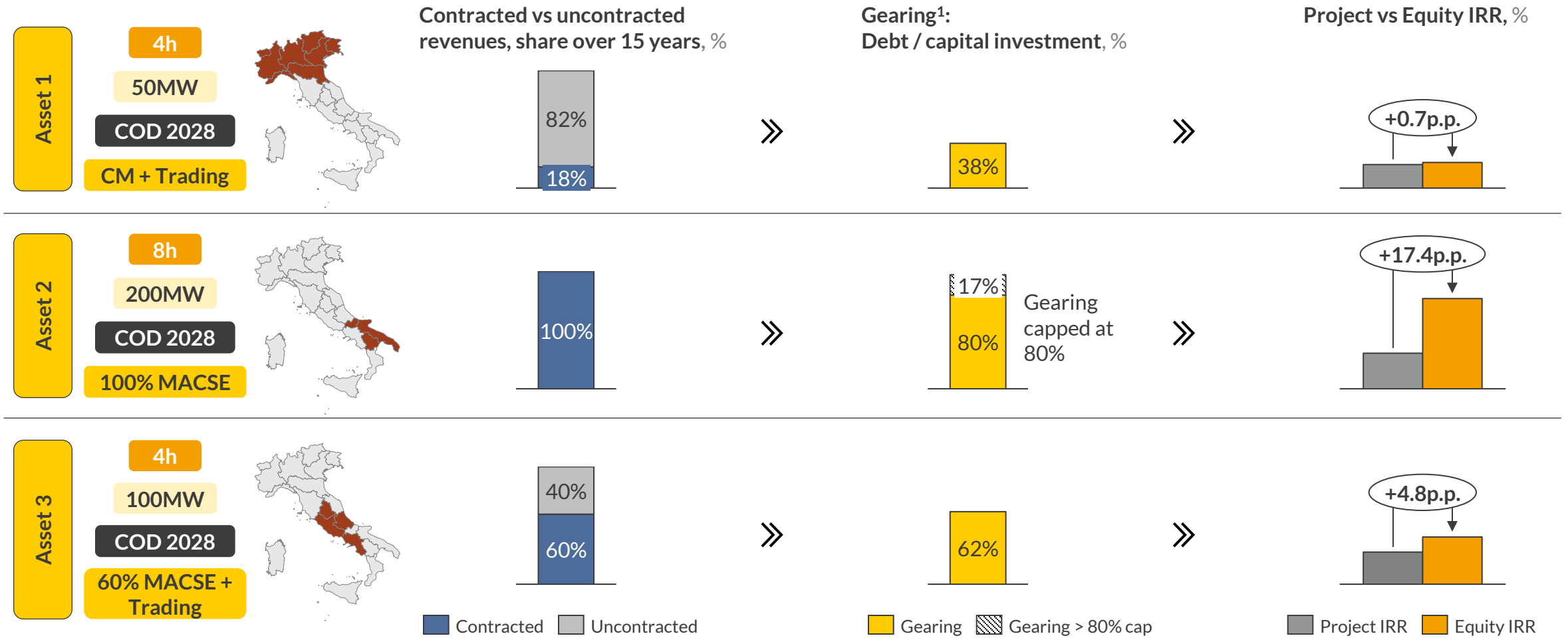
Revenues guaranteed through **long-term contracts**, such as MACSE or the Capacity Market, play a **significant role in securing financing**. Contracted revenues therefore can be considered as a **"bankability metric"**, as their low risk profile is attractive for securing **higher leverage on asset investments**.



1) Gearing is the ratio of obtained debt over total capital expenditure required to finance the project. Debt Service Cover Ratios assumed: 1.3 for contracted revenues, 2.5 for uncontracted revenues. 5% interest rate.

Sources: Aurora Energy Research

Position on the risk/return matrix of the portfolio is improved overall compared to the individual assets

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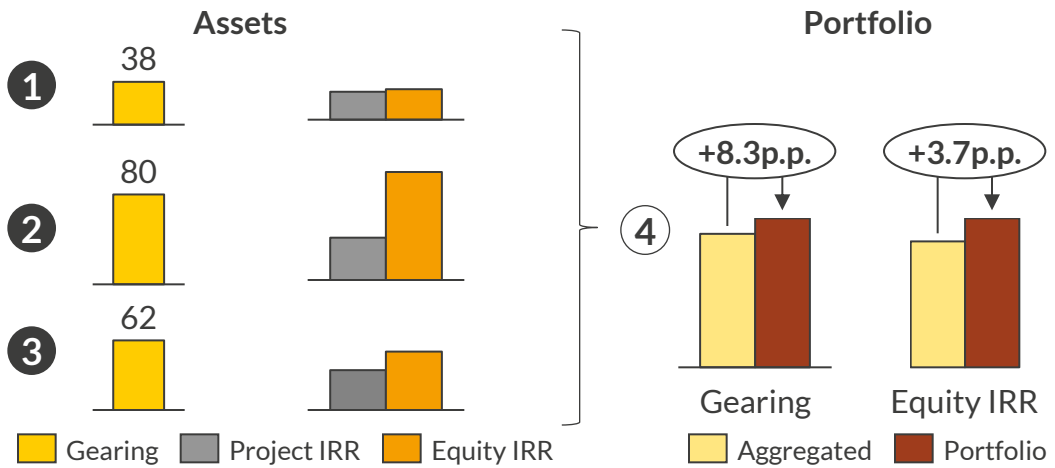
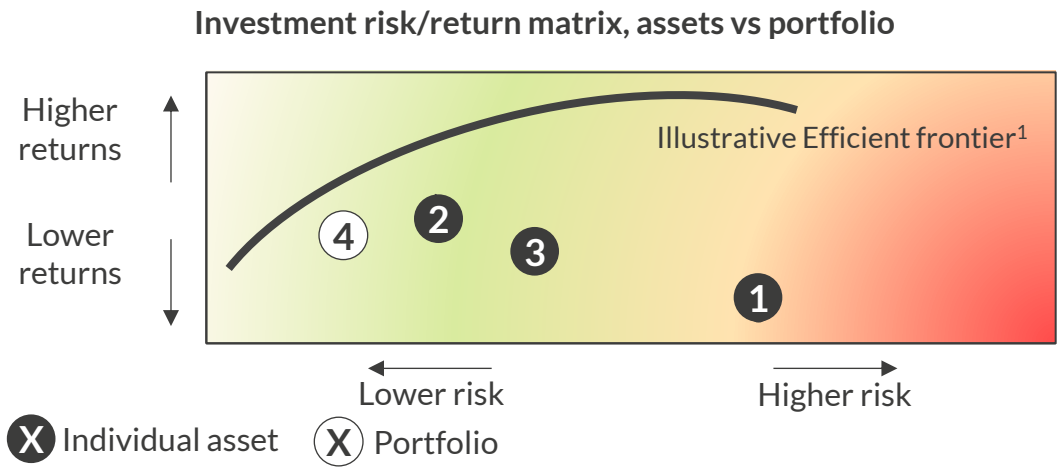
Contracted revenues: effect on financing and portfolio upside

- High shares of contracted revenues increase opportunities for debt financing, with MACSE assets able to leverage > 80% gearing.
- Equity IRRs benefit massively from increased financing, with increases from project IRRs ranging from 17p.p. for MACSE assets to just 1p.p. for Capacity Market assets in North.
- Portfolio financing optimises the use of leverage from MACSE assets, leading to 3.7p.p. higher equity IRR vs the combined assets.

Portfolio benefits

- A portfolio view levels the risk profile of the underlying assets and further hedges against:
  - Policy risk, by diversifying across multiple support schemes
  - Auction over/undersubscription, which could alter the relative attractiveness of MACSE and Capacity Market
  - Market price volatility, affecting zonal merchant trading
  - Weather conditions and technical failures





MACSE will become the dominant route-to-market for new battery investments, as operators tap into its potential for debt financing. Other investment strategies can be combined with MACSE and benefit from a portfolio approach, which can also help finance batteries with a higher merchant potential.

1) Illustrative. Curve formed by points that maximize returns for a given level of risk.

Sources: Aurora Energy Research

Merchant batteries benefit massively from the price volatility caused by unpredictable, non-equilibrium events

Aurora Central forecast provides an **equilibrium outcome** for electricity markets. However, it is built on a system based upon **representative ordinary conditions**....

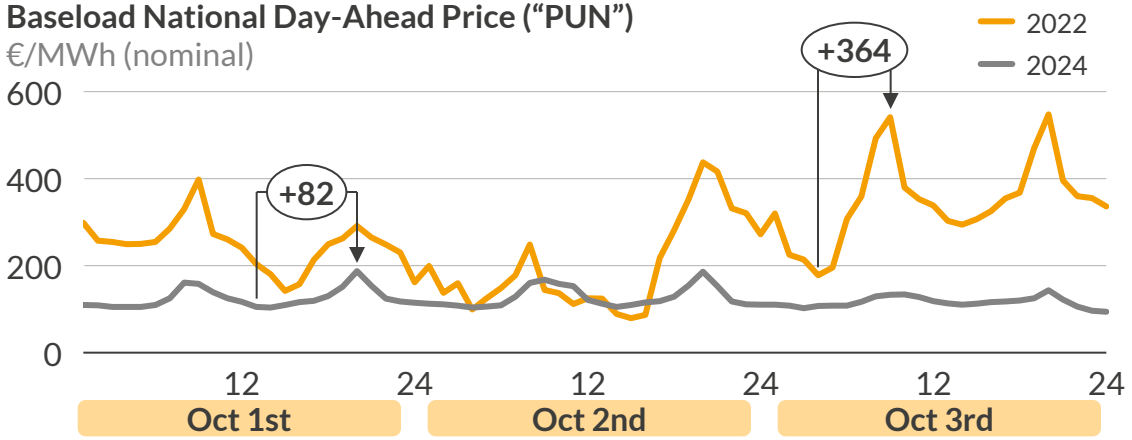
- **Commodity prices** based on fundamentals
- **Representative Average Weather Year**
- **Perfect foresight** for investment
- **Policy plans** are exogenous inputs

... but misses out on **unpredictable events,** which significantly disrupt market dynamics. These can take different forms:

- **Market Shocks**
- **Policy and Infrastructure Delays**

Market effects

Baseload National Day-Ahead Price ("PUN")
€/MWh (nominal)



Merchant BESS opportunities

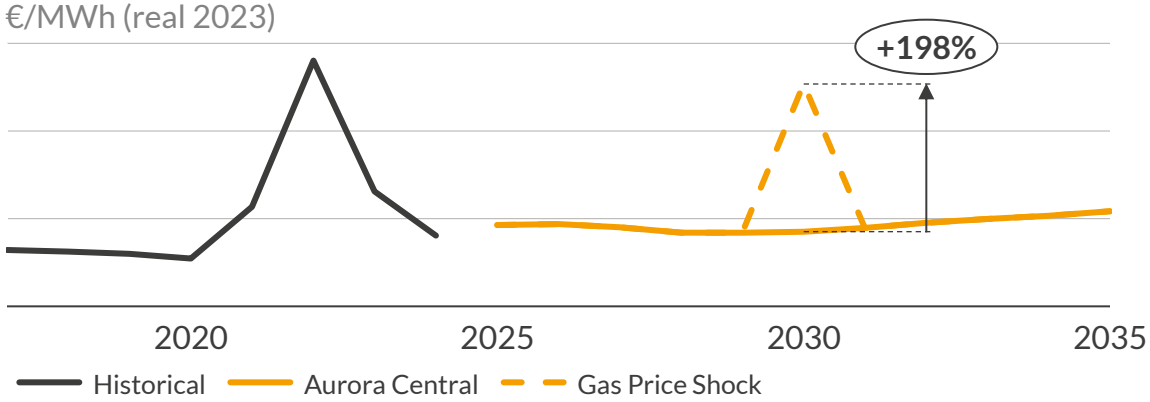
- Unpredictable events often propel price volatility, with batteries best placed to capture the growing price spreads it creates.
- Merchant exposure is necessary for batteries to benefit from market shocks. MACSE batteries in particular will experience little to no upside due to their high share of contracted revenues.
- The profitability of these events is not bankable. However, events such as commodity price shocks or infrastructure delays will occur at some point over the investment horizon and the upside they bring should not be overlooked.

Sources: Aurora Energy Research, GME

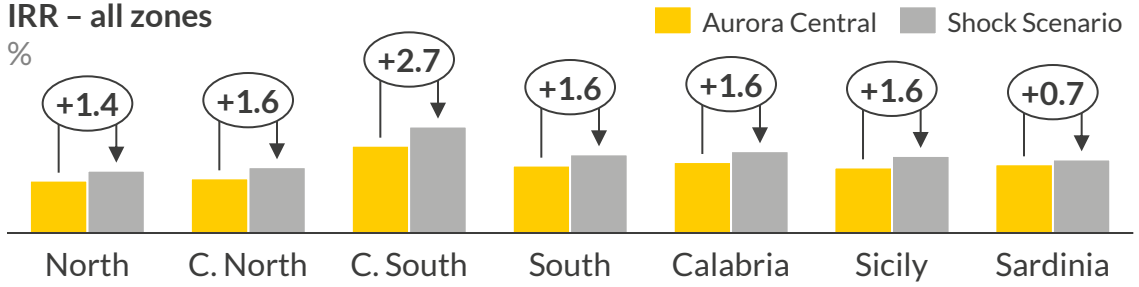
Unpredictable events are not bankable, but the disruptive impact of a single occurrence increases project IRR by 1-2p.p.

1 Gas Price Shock Scenario

Average daily 4-hour spread - Italy
€/MWh (real 2023)

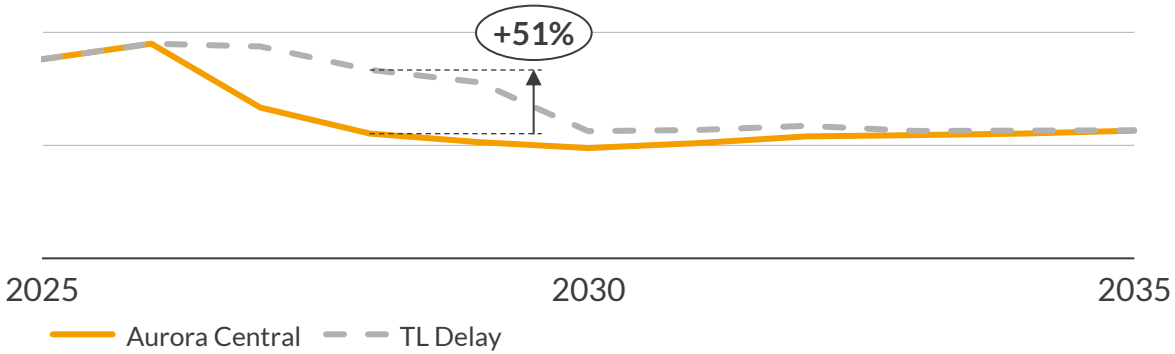


IRR – all zones
%

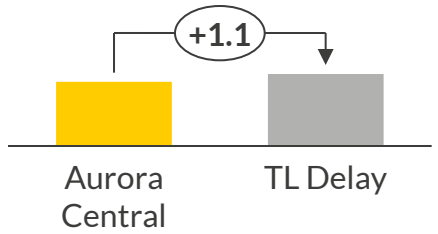


2 Tyrrhenian Link (TL) Delay Scenario

Average daily 4-hour spreads - Sicily
€/MWh (real 2023)



IRR – Sicily
%



Equilibrium modelling focuses on investment bankability. While they do not improve financing opportunities due to their inherent randomness, unpredictable market events will occur over the asset's lifetime, and equity investors can profit massively from merchant batteries exposed to the ensuing price volatility.

Sources: Aurora Energy Research

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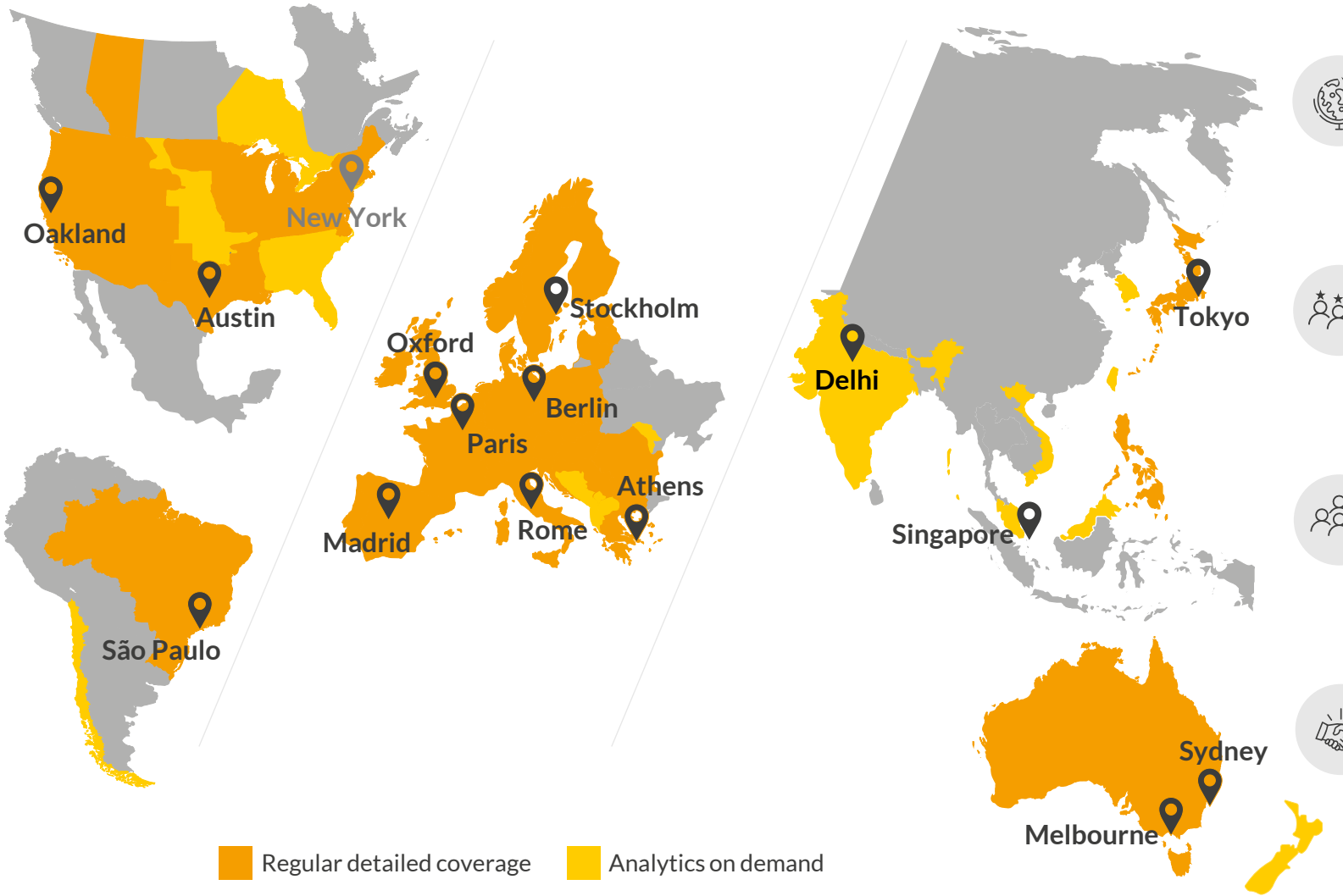
- Hydrogen H_2
- Carbon CO_2
- Natural gas



15 offices
and New York coming soon

900
market experts

850+
subscribing companies

150+
transactions supported in 2023

Source: Aurora Energy Research

Our market leading models underpin a comprehensive range of seamlessly integrated services to best suit your needs

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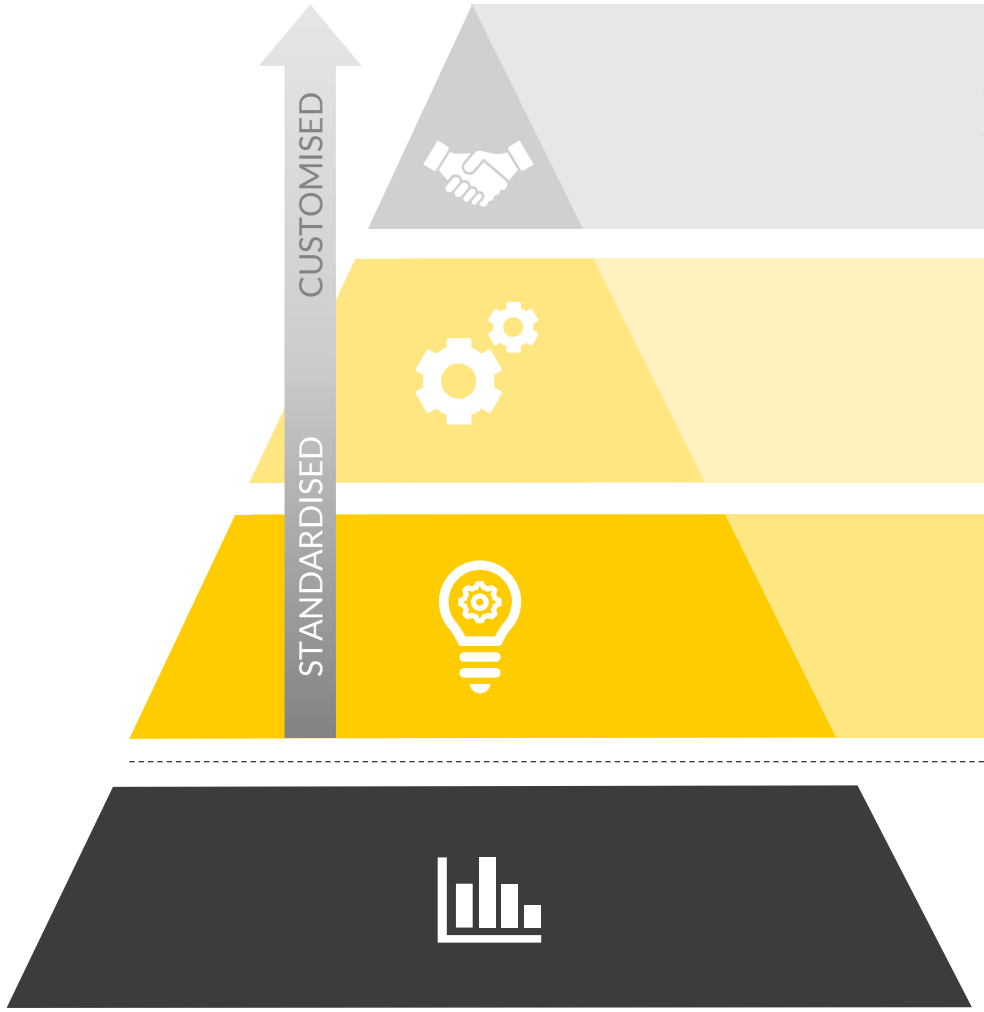


Advisory

Access tailored expert advice and analytics for your crucial projects

Trusted advice and dedicated support for strategy, investments, transactions and policy engagement

1400+ projects globally

Software Solutions

Make standard analysis bespoke through direct access to our models

Unique SaaS subscriptions to create your own scenarios and asset-specific investment cases

100+ company licenses

Subscription Analytics

Receive regularly updated forecasts, sample investment cases and timely deep-dives

Industry-standard outlook reports, bankable price forecasts and strategic insights for power and commodities

600+ subscribing companies

Models & Data

Market-leading models for power, gas, hydrogen, carbon, oil & coal markets

Proprietary and continuously updated cutting-edge models populated with highest quality curated datasets

Developed over 10 years, 40+ dedicated modellers

Source: Aurora Energy Research

Italian Power & Renewables Market Service:

Dive into key market analysis and forecasts for the Italian power and renewables markets

AURORA

Full Power & Renewables Market Service

Forecast Reports & Data

Biannual forecast reports with quarterly data updates

- **Forecast data of** wholesale, capacity, and capture prices to **2060** with annual, monthly, and quarterly granularity
- **Data under Central, Low, High, and Net Zero** Scenarios
- **Quarterly updates** to reflect near term commodity price changes
- **Capacity development**, generation mix, interconnector capacity, capacity buildout, and exports
- **Capture prices** and evaluation of profile risk remaining within CfD for solar PV, onshore, and offshore wind
- **Utilisation rates** of key thermal technologies along different efficiencies
- **Capacity market clearing price** forecast and entries delivered by the mechanism by technology
- **EU-ETS carbon price forecasts**
- All forecast data easily downloadable in Excel format and available as **interactive dashboards** on our EOS platform

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

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

Analyst Support

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

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

AURORA

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

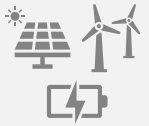
- Central case forecast prices until 2060
  - Hourly Day-ahead power prices
  - Hourly Ancillary Services Market (MSD) power prices
  - Yearly Capacity Market prices

Investment Cases

Standalone battery

- Investment cases for each individual Italian market zone for multiple entry years, including:
  - Arbitrage of wholesale market and balancing market
  - Capacity Market participation
- Undegraded energy arbitrage margins to 2060
- MACSE battery investment cases and further auction tools

Investment Cases



Co-location

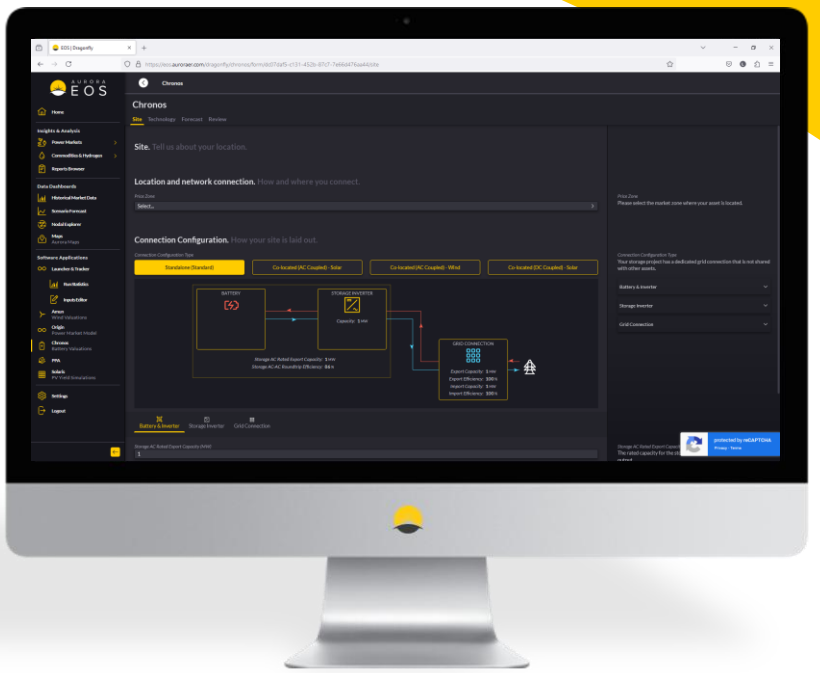
- 2 investment cases for batteries co-located with solar PV in two different battery durations (2-hour, 4-hour)

CHRONOS

Battery valuations, perfected

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



What can Chronos be used for?

Intuitive 4-step process:

1. Input your site settings
2. Input your technology settings
3. Select your market scenario
4. Analyse your result

- Transactions
- Project Design Optimisation
- Portfolio Valuation
- Optimisation Benchmarking

Trusted by industry leaders:

Adaptogen Capital · Brookfield Renewable Energy Partners · FORSA Energy · Harmony Energy Income Trust PLC · Constantine · Renewable Power Capital · West Burton Energy · frv · telis · Eku · Field · centrica · Elgin Energy · CIP · Sunco Capital · Thrive Renewables · Redelfi Corp · TotalEnergies · Cubico · SandbrookCapital · PacificGreen Technologies Group · British Solar Renewables · equitix · Qualitas energy · SMS · InterGen · Armstrong · OnPathEnergy · Apatura · tagenergy · Integrum Renewable Energy

Aurora provides all necessary analyses to develop an optimal auction strategy for MACSE auctions

AURORA

The tool allows to simulate the expected outcome of MACSE auctions under a number of different scenarios, accounting for the existing asset pipeline, the auction design and the strategic bidding of participants

1	**Overview of MACSE scheme**	▪ The tool reflects the MACSE auction scheme design, such as procurement targets, auction clearing rules and eligibility criteria
2	**Analysis of MACSE auction participation**	▪ The supply stack is estimated on databases of storage capacity that received authorizations by Italian province, as well the additional storage capacity that is currently undergoing the authorization process

3	**2025 MACSE auction simulations**	▪ The auction simulations will be developed based on the interactions between the following elements:
		  ▪ Construction of auction demand curve, based on the MACSE volumes definition
		  ▪ Construction of auction supply curve, reflecting the competitive bidding of cluster of assets based on regional authorized capacity, extra-performance coefficients, zonal MSD forecasts, ranges in cost of capital
		  ▪ Auction clearing price based on the interaction between supply and demand curves, taking into account strategic bidding from auction participants in case participation is below target volumes

- Deliverables include the Excel-based auction simulation tool, which allows to estimate the auctions in a flexible way considering different
- combination of assumptions, and PPT-based summary report, providing description of the model methodology and sources

Source: Aurora Energy Research

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Source: Aurora Energy Research

Details and disclaimer

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