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AURORA KEYNOTE

Opportunities & challenges for storage investments in Europe

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The essential steps towards the decarbonisation of power systems all contribute to increased need for storage…

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Decarbonisation drivers

1 **Variable renewables (RES) deployment**

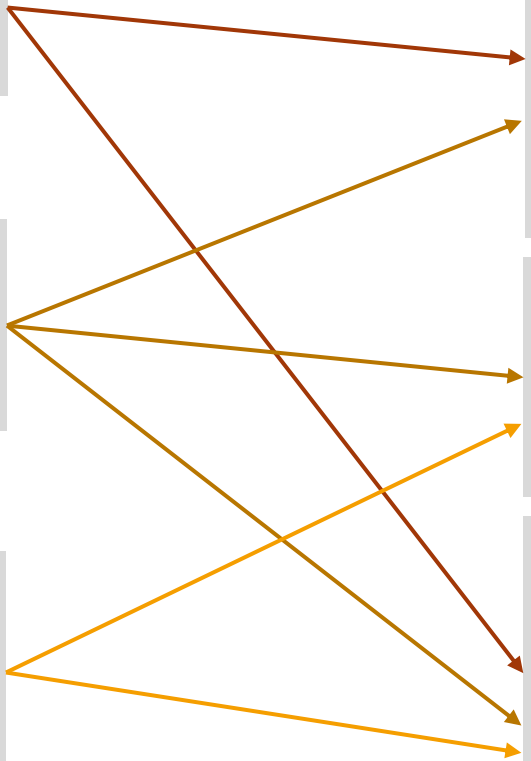
Growing variable renewables capacity in countries' energy mixes

2 **Thermal generation phase-out**

Retirement of traditional baseload and thermal assets

3 **Electrification of other sectors**

Growing electricity demand thanks to electrification of transport, heat and hydrogen production (electrolysis)



Effects on power markets and battery storage requirements

Energy markets (wholesale)

- Low marginal cost techs pushing average prices down – capture prices for RES assets increasingly decoupled from commodity prices
- Increases the intermittency of energy generation (increasingly reliant on weather patterns) leading to an increase in price volatility

Battery storage complements RES intermittency by charging in periods of high renewables production and discharging when needed

Capacity Markets

- Thermal retirement and non-firm RES contribute to drop in firm capacity
- Increase in peak electricity demand can also increase the need for firm capacity

Battery storage contributes to availability of firm capacity on the system

Balancing and Ancillary Services

- Growth of variable renewables and general power demand increase the need for energy balancing and system services
- Thermal generation currently provides majority of these services, putting pressure to find alternatives to accommodate it retirement

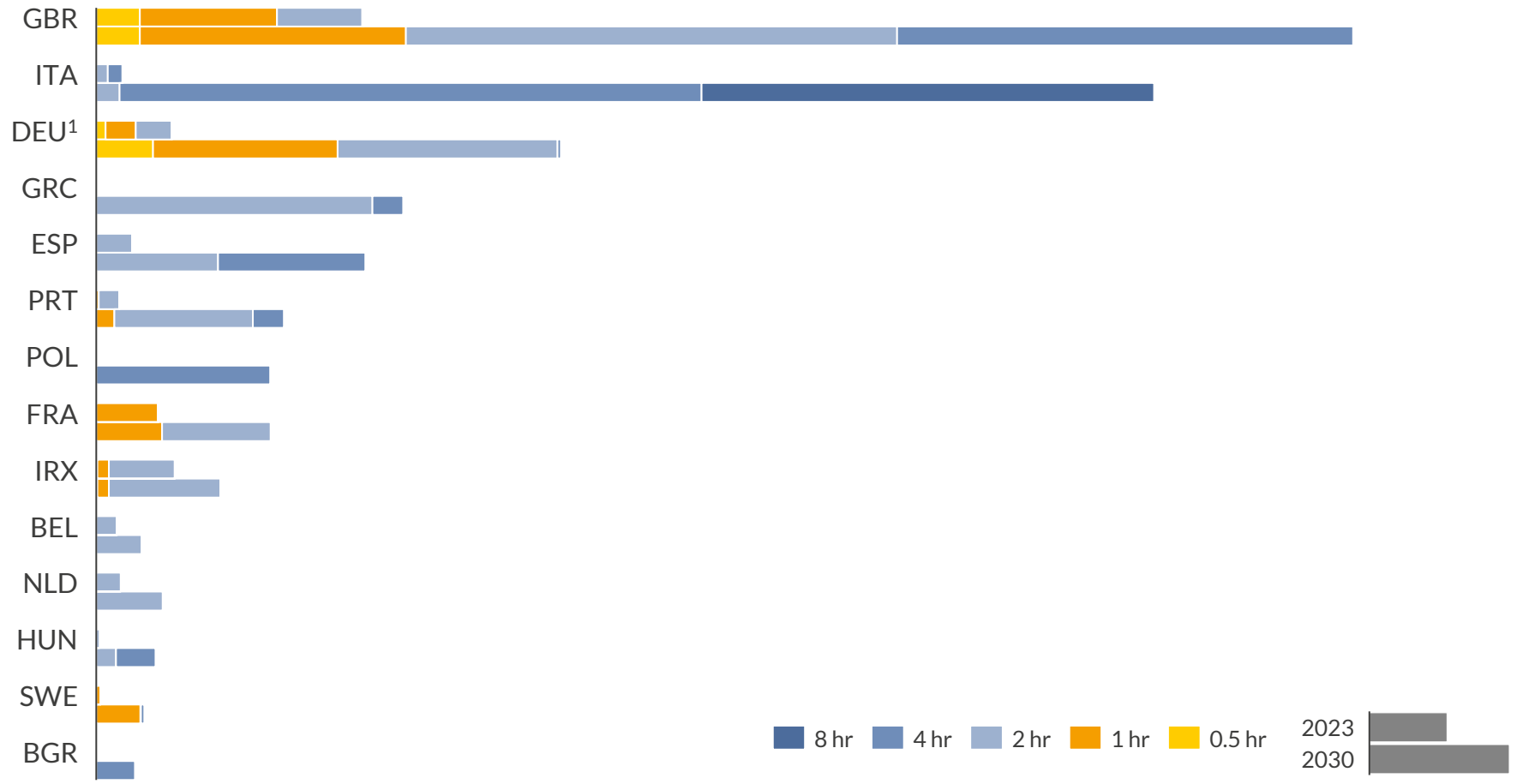
Battery storage contributes to maintaining security of the grid

Source: Aurora Energy Research

… therefore leading to a massive increase in forecasted installed battery capacity across Europe

Installed battery capacity in 2023 and 2030 (Aurora Central scenario)

GW

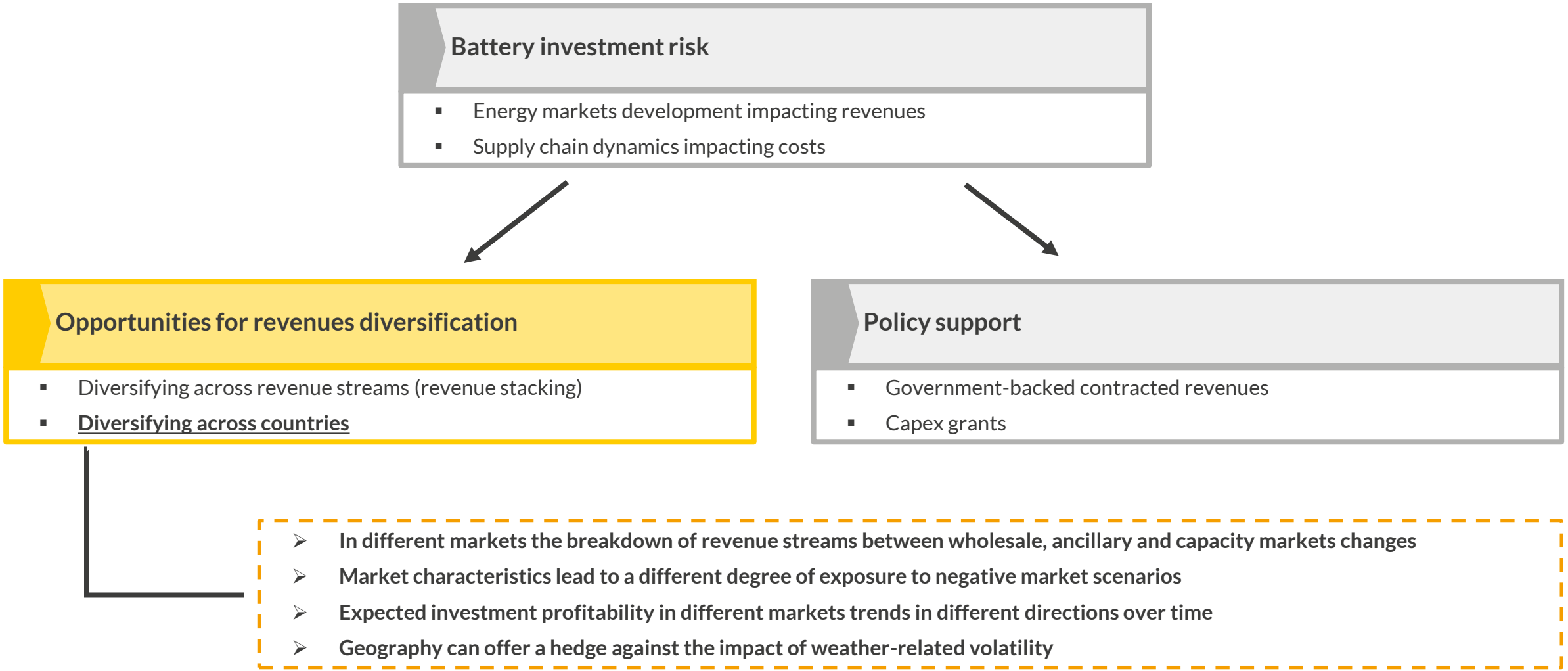


- Overall, battery capacity in Europe[2] is expected to grow almost 6 times, from the current 6 GW to 42 GW in 2023
- Italy, Great Britain, and Germany see the largest capacity additions between 2023 and 2030, with the former two together making up about 50% of total Europe capacity
- Key emerging markets including Greece, Spain and Portugal are also expected to see significant growth, largely driven by established deployment targets
- Other European markets not shown see increases of 300 MW or less over the coming 7 years

1) Battery capacity split by duration in 2030 is estimated based on historical installed capacity; 2) Considering 14 largest forecasted battery markets.

Sources: Aurora Energy Research, Eurostat

In order to deploy the capital necessary to bring this capacity online, flexibility investors need to tools to manage investment risk

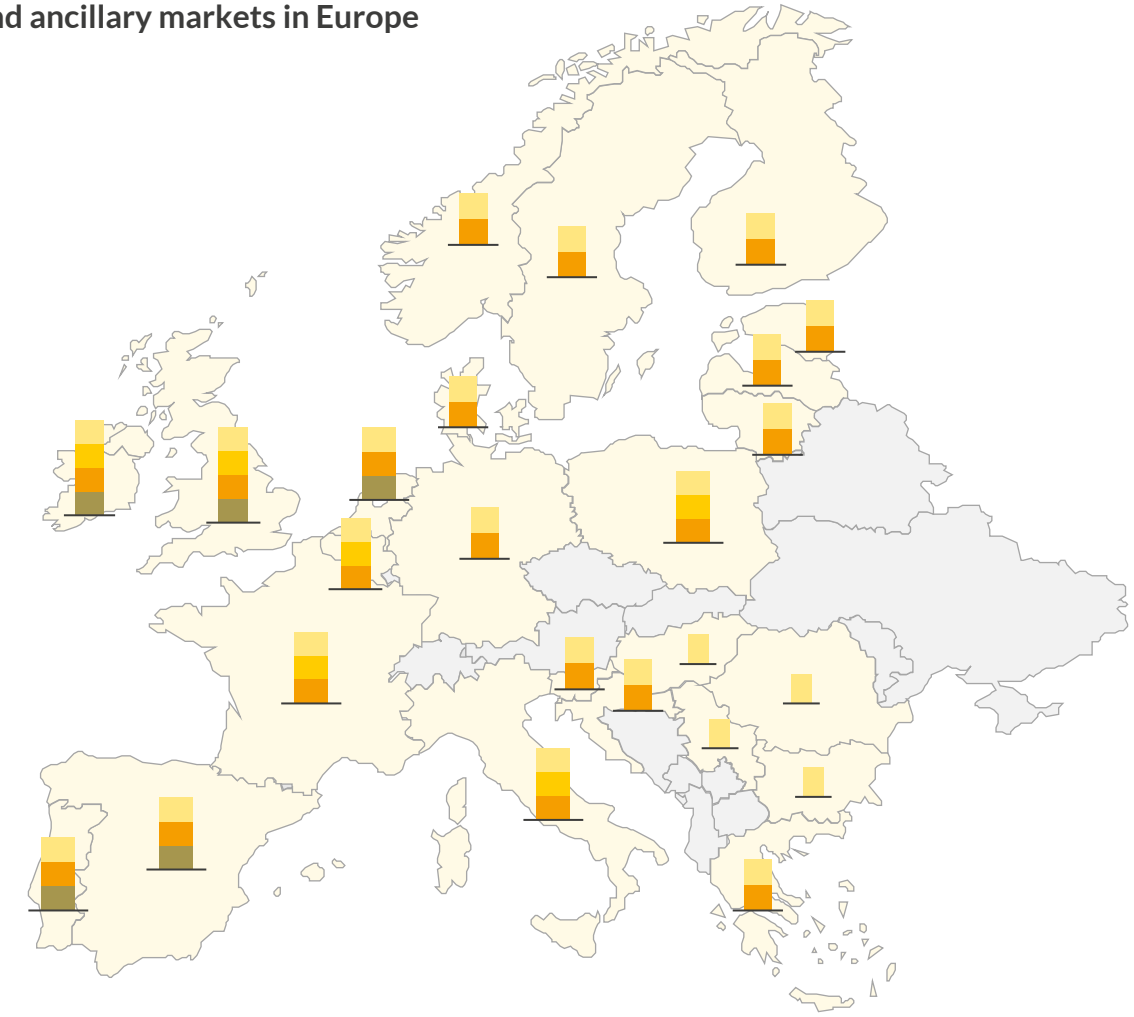


Sources: Aurora Energy Research

European countries present a different balance in the revenue stacking opportunities available to batteries

Availability of capacity, balancing and ancillary markets in Europe

- Wholesale market
- Capacity market
- Balancing markets/frequency response
- Other ancillary markets[1]



- Grid scale battery storage assets typically participate in four key markets – Capacity market, Wholesale market, Balancing/Frequency markets and other ancillary markets
- Across Europe, fast frequency services tend to be the most valuable market for batteries due to high reservation and/or energy payments.
- However, as frequency services across Europe face increased saturation risk, battery business models will rely more on revenue stacking

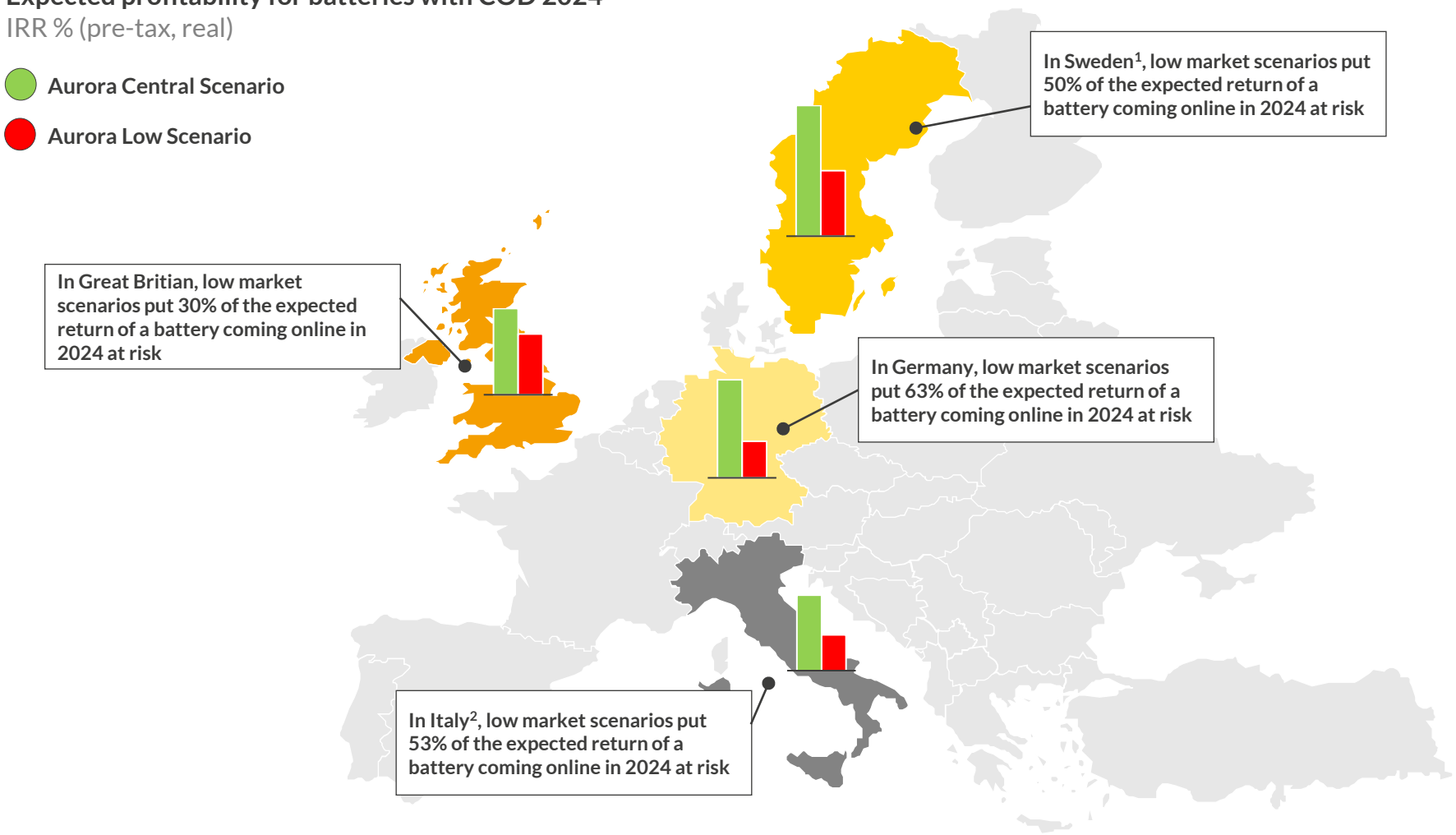
➢ ***Investing in countries with different revenue stacking mixes increases revenue diversification beyond what is currently allowed by any individual market***

1) Includes inertia, black start, technical restrictions, congestion management etc.

Source: Aurora Energy Research

Based on their characteristics, current battery investments have a different degree of exposure to negative market scenarios

Expected profitability for batteries with COD 2024
IRR % (pre-tax, real)



- The evolution of the power market has a direct impact on the expected profitability of battery investments
- While Aurora Central scenario represents the forecasted most likely outcome, exposure to negative market scenario is a factor
- The reduction in expected profitability decreases thanks to the number of revenue streams available to batteries and the presence of fixed revenue components, both factors being at play in the case of GB

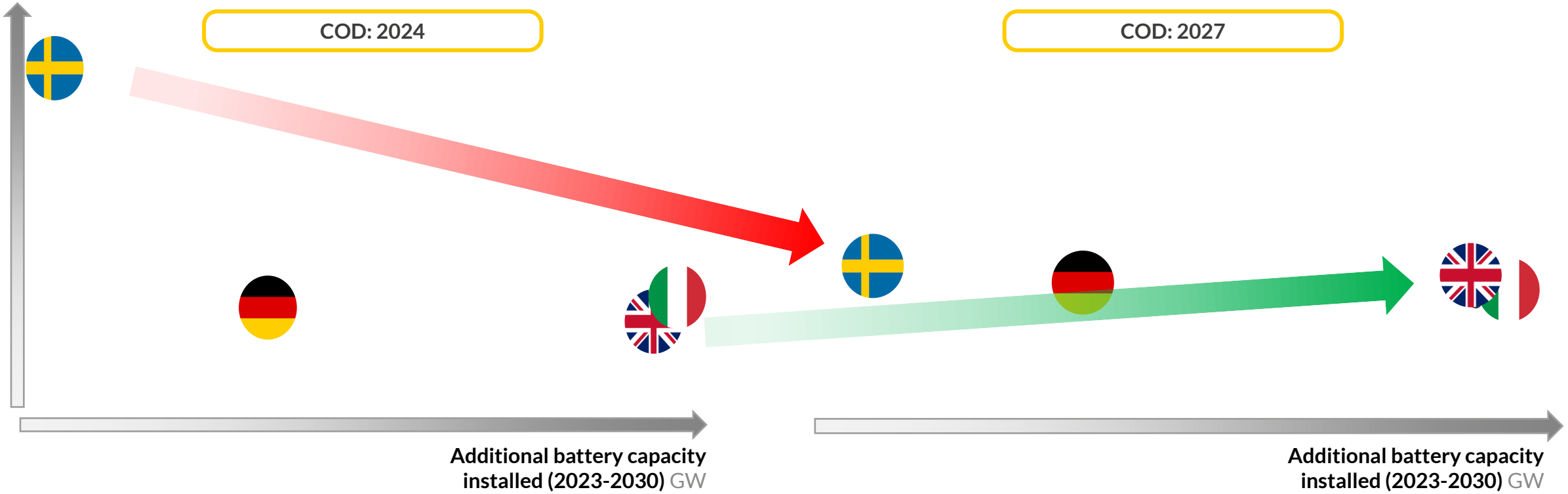
➢ ***Diversifying across countries allows to create a portfolio which balances different degrees of exposure to negative market scenarios***

1) Sweden expected profitability figures refers to the price zone SE4; 2) Italy expected profitability figures are an average of the returns across the seven Italian price zones

Sources: Aurora Energy Research

The attractiveness of battery investments changes over time, with smaller markets saturating earlier while larger market trend upwards

Expected profitability for batteries
IRR % (pre-tax, real)



- Sweden offers short-term returns much higher than most larger markets thanks to small yet attractive FCR market
- While smaller markets saturate quickly, returns in Italy, GB and Germany increase over time thanks to better arbitrage opportunities and lower costs

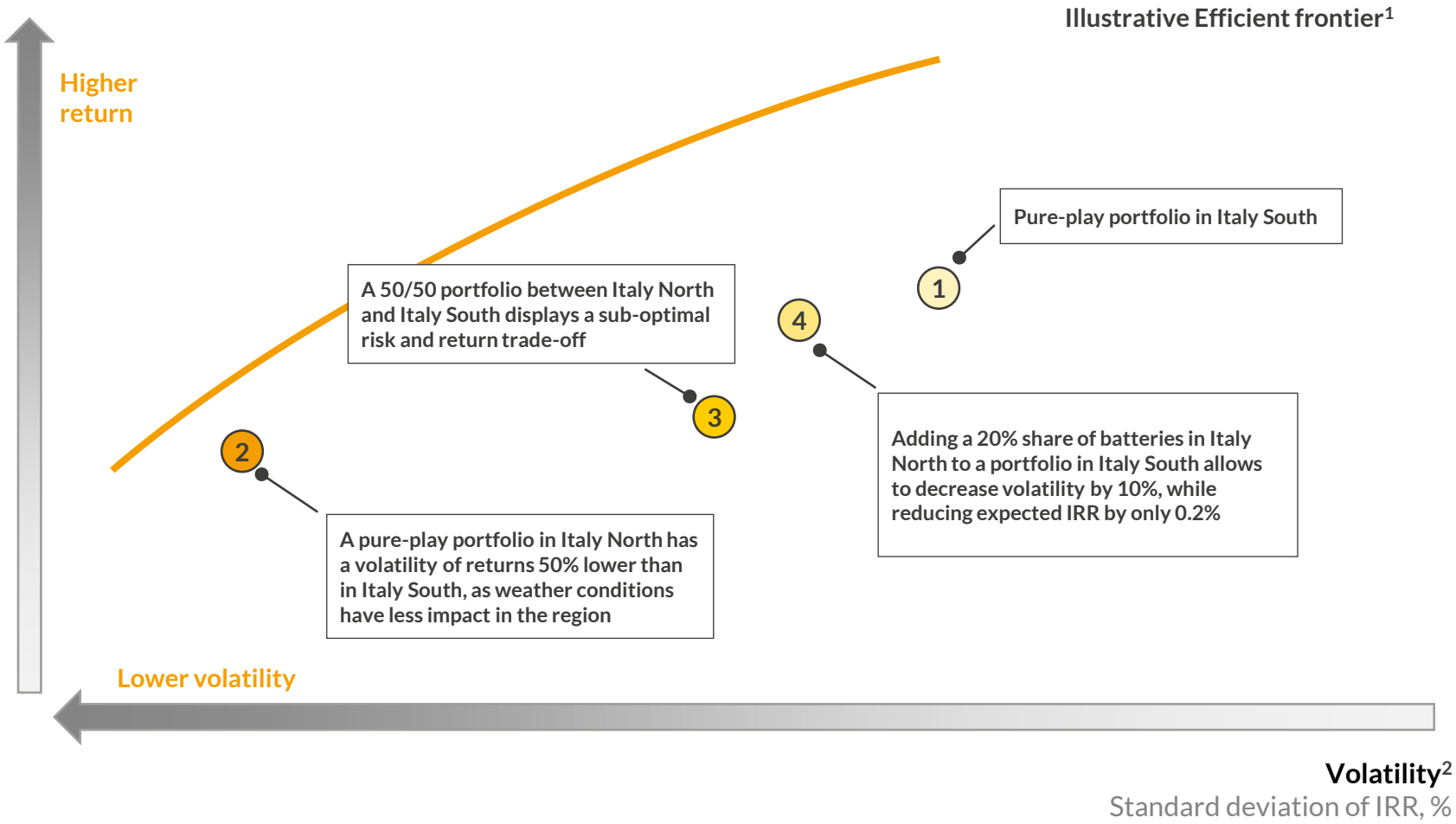
➢ ***When creating a battery portfolio in Europe, it is crucial to time the investments correctly: opportunities in smaller high-upside markets should be seized immediately, to then complement the portfolio over time with strategic investments in larger markets***

1) Sweden expected profitability figures refers to the price zone SE4; 2) Italy expected profitability figures are an average of the returns across the seven Italian price zones

Sources; Aurora Energy Research

Geographical diversification of battery investments can lower the impact on expected returns due to weather-related volatility

Expected profitability for battery portfolios with COD 2027[2]
IRR % (pre-tax, real)



- Power markets in different geographies have different degree or a negative correlation in their exposure to weather conditions, which can be used to achieve a better risk – return trade-off
- The geographical hedge against weather-related volatility can be exploited by investing in different countries or different market zones within the same country, like in the case of Italy shown in the chart

➢ ***Adding to the core of a battery portfolio even a small share of assets in a zone with negative correlation in weather conditions can substantially improve the portfolio's risk – return trade-off***

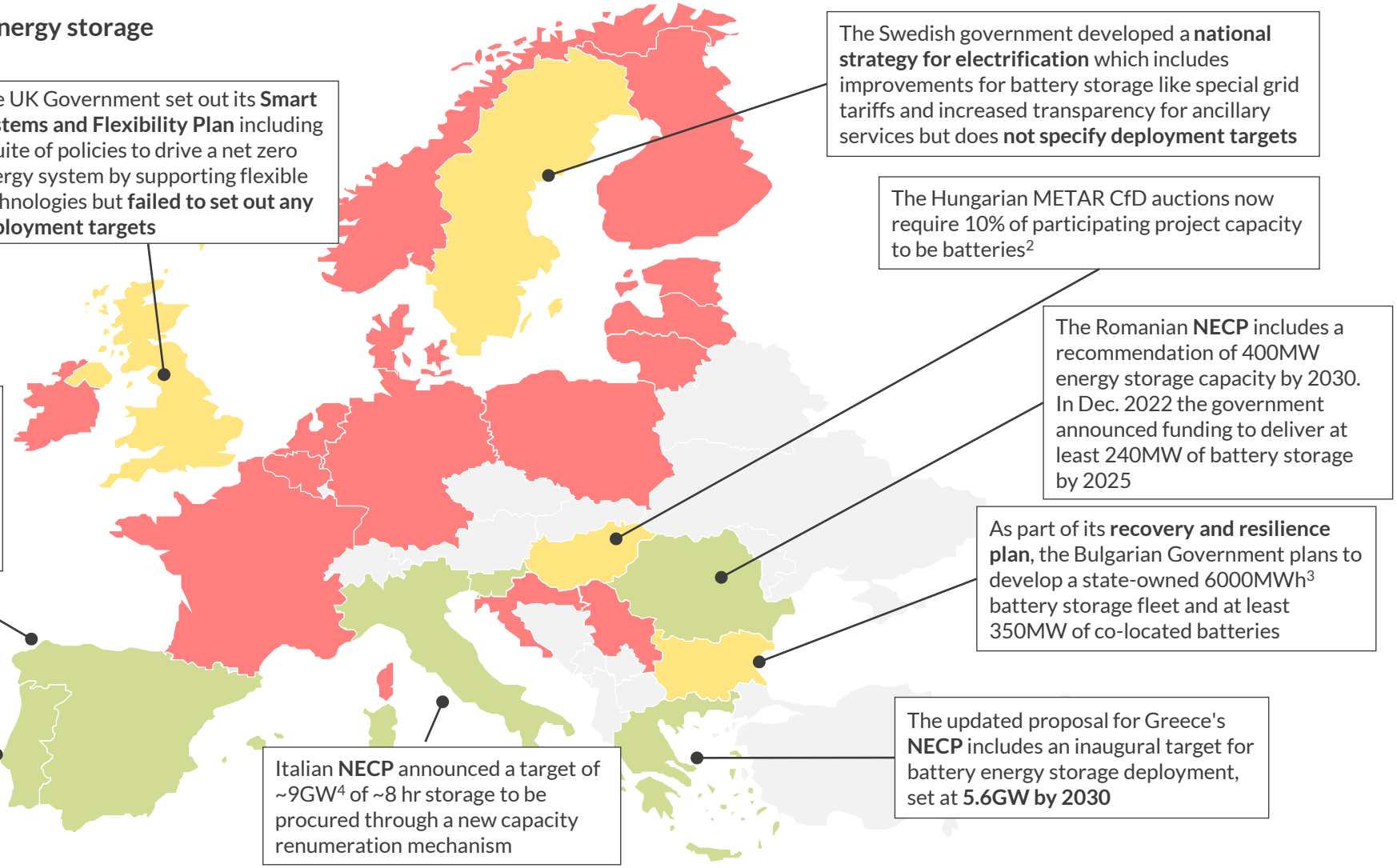
1) Illustrative. Curve formed by points that maximize returns for a given level of risk; 2) For each portfolio, the return is calculated as the average return of the portfolio across different weather scenarios, while the volatility is calculated as the standard deviation across the returns of the portfolio in the different weather scenarios.
Sources: Aurora Energy Research

Policy to facilitate energy storage deployment can play an important role in reducing the risk associated with battery investments

National government policies and targets for energy storage

Rating

- No specific strategy/plan
- Strategy or plan in place without commitments
- Strategy or plan in place with strong commitments



The UK Government set out its **Smart Systems and Flexibility Plan** including a suite of policies to drive a net zero energy system by supporting flexible technologies but **failed to set out any deployment targets**

The Swedish government developed a **national strategy for electrification** which includes improvements for battery storage like special grid tariffs and increased transparency for ancillary services but does **not specify deployment targets**

The Hungarian METAR CfD auctions now require 10% of participating project capacity to be batteries[2]

The Romanian **NECP** includes a recommendation of 400MW energy storage capacity by 2030. In Dec. 2022 the government announced funding to deliver at least 240MW of battery storage by 2025

The Spanish Government approved the **Energy Storage Strategy** in 2020 which includes measures to increase the role of storage in the system. The strategy targets 1**2GW** of energy storage by 2030 and builds on the **PNIEC**[1] which targets **2.5GW** of battery storage

As part of its **recovery and resilience plan**, the Bulgarian Government plans to develop a state-owned 6000MWh[3] battery storage fleet and at least 350MW of co-located batteries

The Portuguese **roadmap to Net Zero by 2050** includes a target of 600MW battery storage capacity by 2030

Italian **NECP** announced a target of ~9GW[4] of ~8 hr storage to be procured through a new capacity renumeration mechanism

The updated proposal for Greece's **NECP** includes an inaugural target for battery energy storage deployment, set at **5.6GW by 2030**

1) Spain's Integrated National Energy and Climate Plan 2021-2030 (PNIEC); 2) METAR scheme is only open to solar projects; 3) Assuming 4hr duration batteries; 4) Includes pumped storage

Sources: Aurora Energy Research, National Governments

Conclusions

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1. Decarbonizing the power systems will require a massive increase in storage capacity, leading to installed battery capacity all across Europe to grow almost 6x between now and 2030
2. The European scale of the opportunity allows flexibility investors to use portfolio diversification across countries as an effective tool to reduce the investment risk
3. Revenue stacking is crucial for any battery investment: developing in countries with different revenue stacking mixes increases revenue diversification beyond what is currently allowed by any individual market
4. The evolution of the power market has a direct impact on the expected profitability of battery investments: diversifying across countries allows to create a portfolio which balances different degrees of exposure to negative market scenarios
5. When creating a battery portfolio in Europe, it is crucial to time the investments correctly: smaller high-upside markets will saturate quickly, while returns in larger battery markets increase over time thanks to better arbitrage opportunities and lower costs
6. Geographical diversification can lower the impact on expected returns due to weather-related volatility, as investing across areas with negative correlation in weather conditions can substantially improve the portfolio's risk – return trade-off
7. In addition to portfolio diversification, policies to facilitate energy storage deployment play an important role in reducing the battery investments risk: international investors are faced with many different national policies and targets for energy storage across Europe

Sources: Aurora Energy Research

European Battery Markets Attractiveness Report (BATMAR):
Inform your next business move in Europe with this comprehensive report

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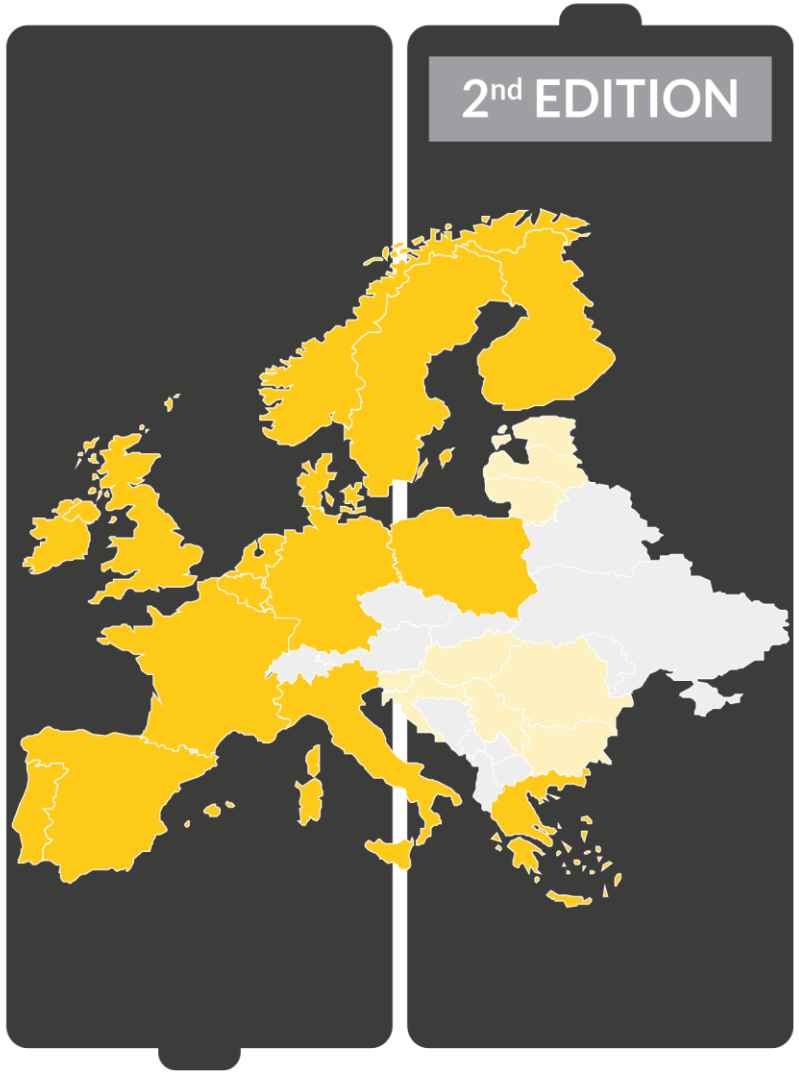
Analysis across 24 European countries:

- Great Britain*
- Ireland (I-SEM)*
- France*
- Belgium*
- The Netherlands*
- Germany*
- The Nordics* (Denmark, Finland, Norway, Sweden)
- Iberia* (Portugal, Spain)
- Italy*
- New Poland*
- New Greece*
- Hungary
- Romania
- Bulgaria
- New Serbia
- New Slovenia
- New Croatia
- New The Baltics (Estonia, Lithuania, Latvia)



With over 100 analysts and modellers working across our European Flexibility Energy Market Services, this report provides you with a summary of our credible, reliable, and bankable forecasts.

Access this report for:

- **European Battery Market Trends – Market Size and Opportunity**
  - Installed capacity, battery investment trends, and near-term pipeline
  - Forecast volumes for battery deployment by year and country
- **Policy and Regulatory Environment analysis**
  - European and national battery strategies, targets and plans
  - Analysis of anticipated regulatory changes impacting battery markets
  - Assessment of policy risks including aggregation of demand side assets, and grid connection
- **Battery Storage Business Models and Value Drivers**
  - Summary of attainable markets and revenue stacking opportunities
  - Comparison of value drivers across markets including RES penetration and daily wholesale market spreads, balancing services and capacity market auctions
  - Assessment of saturation risk for each country
- **Battery Economics and Business Cases. See above plus:**
  - Revenue stacking opportunities and normalised gross margins (1, 2 and 4 hours)
  - Investment cases (estimated IRR ranges) for hybrid business models (optimised between energy arbitrage and ancillary services)

New features:

- 6 new regions covered
- Business cases for 2 new markets: Greece and Poland
- Updated BESS cost projections
- Analysis of recent EU market reforms

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Source: Aurora Energy Research


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