AURORA ENERGY RESEARCH

Transatlantic Opportunities:

Battery Storage Investments in Europe

PUBLIC WEBINAR

5 October 2023

Agenda

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I. Introduction to Aurora

II. European market outlook

III. Value drivers

IV. Europe's most attractive markets

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

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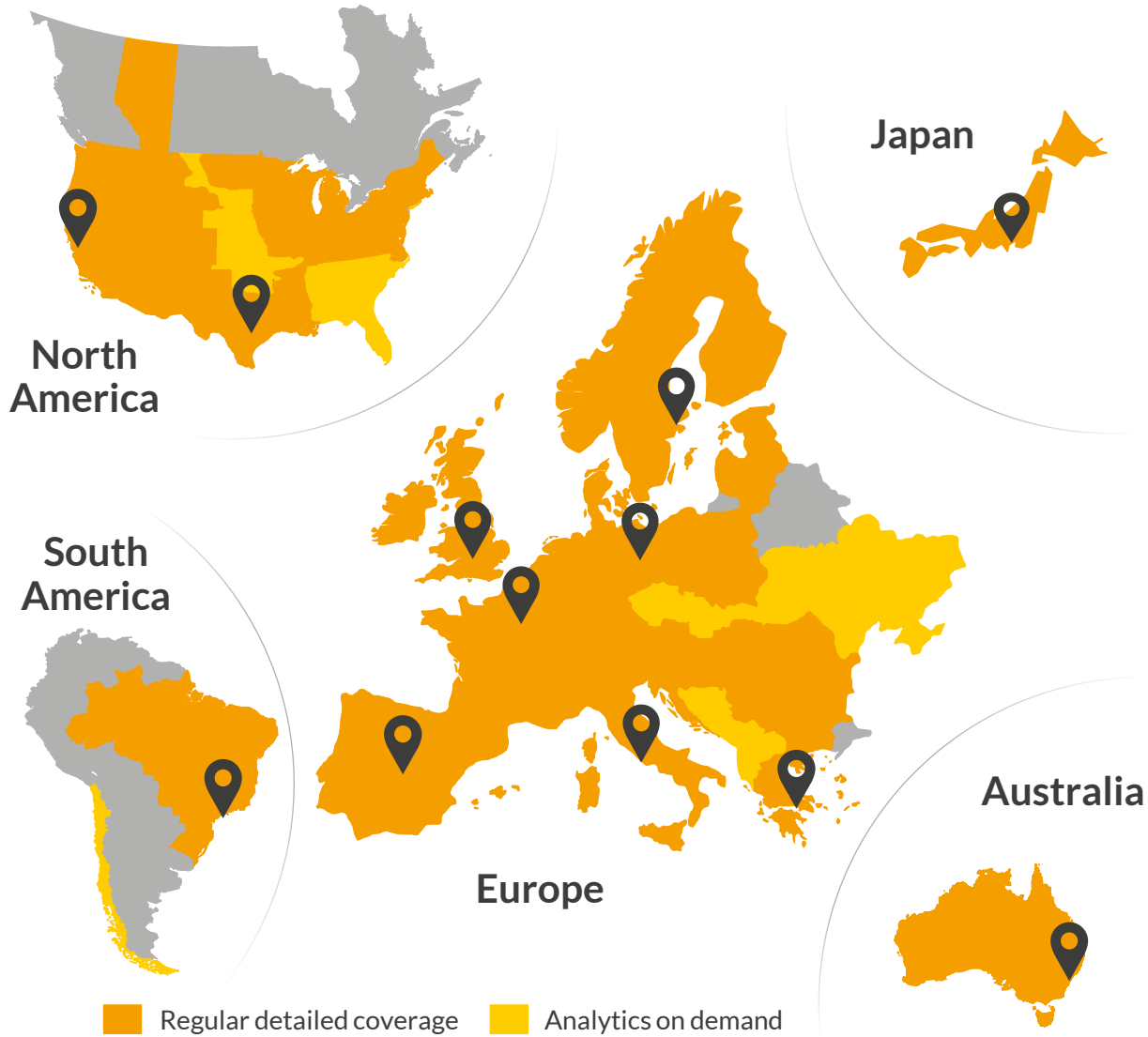
- Power markets
- Renewables
- Storage
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



12 Offices

Oxford | Berlin | Madrid | Athens
Paris | Sydney | Austin | Oakland
Rome | Stockholm | Tokyo
São Paulo

600+

market experts (incl. 65 in USA)

750+

subscribing companies

150+

transactions supported in 2022

Source: Aurora Energy Research

Aurora is the leading commercial advisor for battery storage investments and transactions in Europe

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Deeply experienced in investment & business case analysis

- Aurora have advised >3GW of battery storage projects in Europe
- Our forecasts have enabled battery investments of >£1.5bn
- Over 250 developers, investors, utilities and banks subscribe to Aurora's regular revenue stream and battery business case forecasts in Europe

Extensively relied upon for debt financing

- Aurora forecasts have helped to raise >£600m of debt financing for battery storage projects
- We provided reliance to 10+ banks to debt finance battery projects

Widely trusted for regular fund valuations

- Aurora provides forecasts for regular valuation of 3 listed battery funds with total Net Asset Value of >£1.6bn
- Renewable & Energy Transition funds with >£100bn AUM use Aurora forecasts for their battery storage valuations & investments

Source: Aurora Energy Research

Modelling storage is complex. Aurora's forecasts have underpinned the deployment of over 2.5 GW of operational battery assets globally

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What is the challenge?

- Modelling a consistent set of day-ahead, real-time and Ancillary service prices accounting for opportunity costs
- Understanding and modelling detailed rules in AS[1] markets, including responding to market changes
- Capturing the role of weather in driving scarcity and AS[1] procurement – annual averages are irrelevant to storage economics, especially as renewables penetration increases

Future of the market (difficult to model)

- Dispatching assets against multiple price series accounting for imperfect foresight, degradation, warranties, route to market, and asset characteristics

Future of the asset in the market (easier to model)

How do we address it?

- ✓ Offer valuations for a range of standard and bespoke market scenarios
- ✓ Work closely with clients to ensure the valuation is specific to their asset or portfolio characteristics
- ✓ Model storage margins for all major business models including arbitrage, Ancillary Services, and hybrid
- ✓ Dispatch against consistent day-ahead, real-time and AS prices
- ✓ Account for degradation and imperfect foresight
- ✓ Present results in slides and cashflow model at monthly, quarterly and annual granularity

Example transactions

2018
- Banked by Santander on first project financing of battery storage in the UK for 100 MW Zenobe portfolio
- Sell-side market advisory for then-largest operational battery storage portfolio in Europe, STEAG's 90 MW bid into the FCR market

2019
- Supported Pivot Power on sale of company and 2GW portfolio to EDF
- Supported PE fund on $50m acquisition of storage developer; bidding support for large developer for DS3 auctions

2020
- AUS $50m in debt financing for 50MW extension of Neoen's Hornsdale battery – first battery project financing in Australia
- Debt and equity raise for 100 MW battery portfolio

2021
- Development/financing of 150MW Hazelwood BESS project

2022
- Sell-side advisor for 1.1 GW of battery storage from BMES to UBS Asset Management and Cypress Creek Renewables

2023
- Buy-side advisor for Engie's acquisition of Broad Reach Power

1) Ancillary Services.

Source: Aurora Energy Research

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Battery Energy Storage Systems (BESS) are crucial for managing key challenges and speeding up the energy transition

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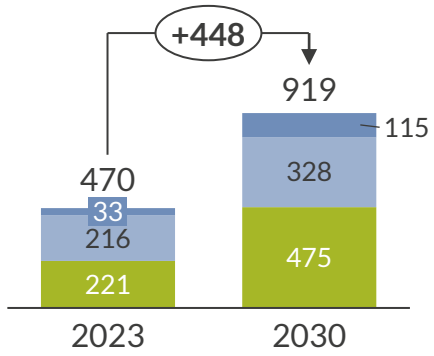
Renewables (RES) deployment

- Europe's installed variable renewables capacity is forecast to rise above 900 GW by 2030

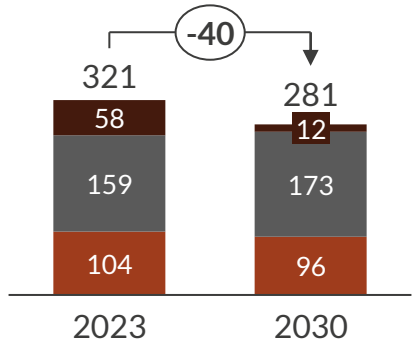


- BESS are crucial for **balancing intermittency of RES** generation and **managing grid congestion**

Offshore Wind | Onshore Wind | Solar PV

Thermal generation phase-out

- Retirement of over 40 GW of conventional assets results in loss of grid services including inertia

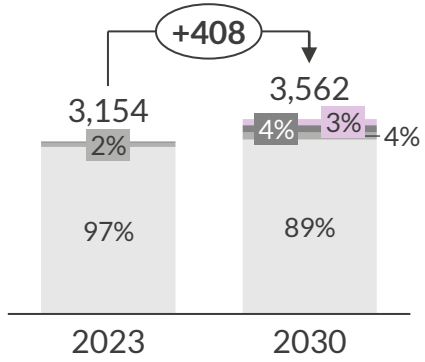


- BESS are crucial for **providing ancillary services** to ensure grid stability and flexibility

Nuclear | CCGT | Coal

Increased electrification

- Power demand is forecast to increase by 400 TWh to 2030, driven by increased electrification across sectors



- BESS are crucial for **supplying increased power demand**

Hydrogen | Heat | Road transport | Base power demand[3]

Source: Aurora Energy Research

Aurora forecasts grid scale battery storage to grow to almost 100GW by 2050, Great Britain continues to lead the way

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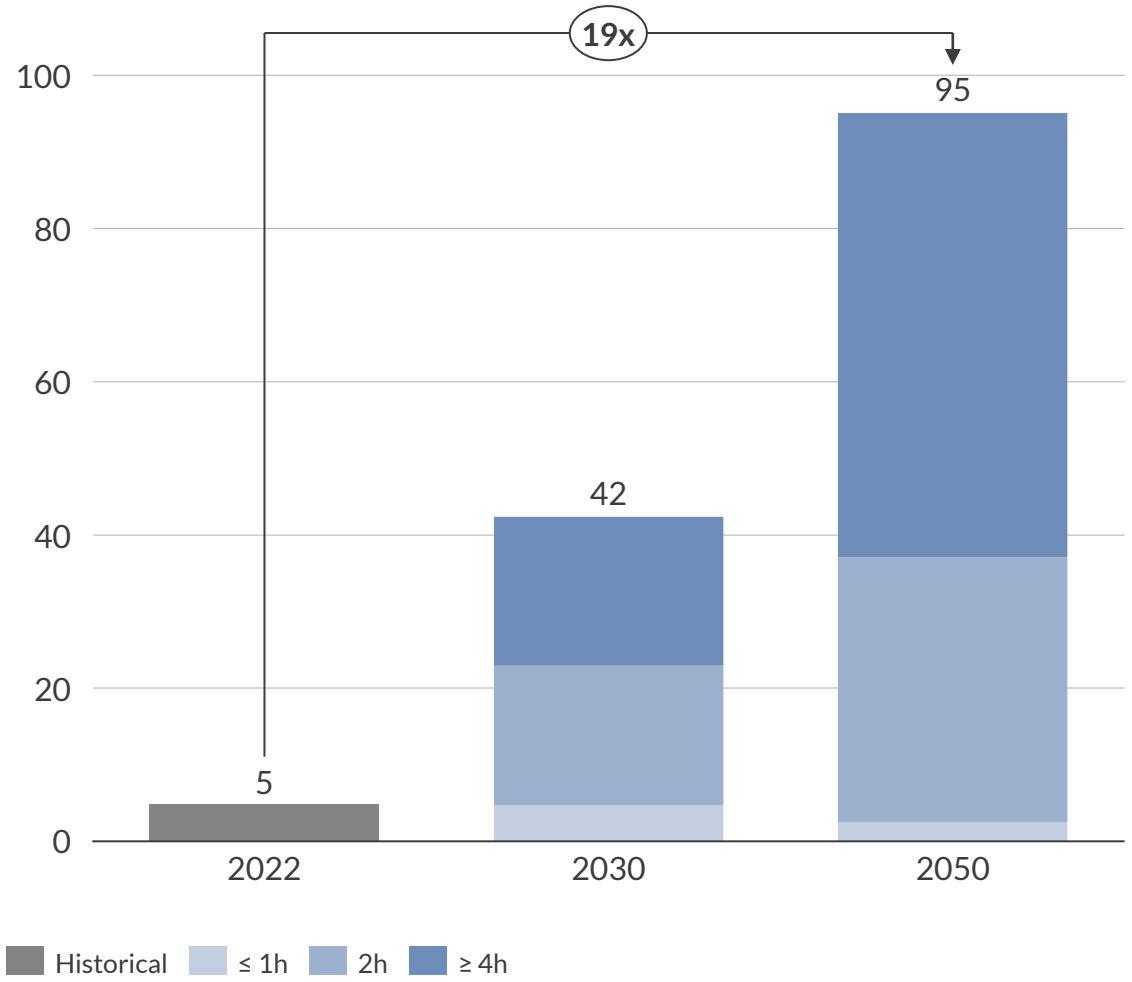
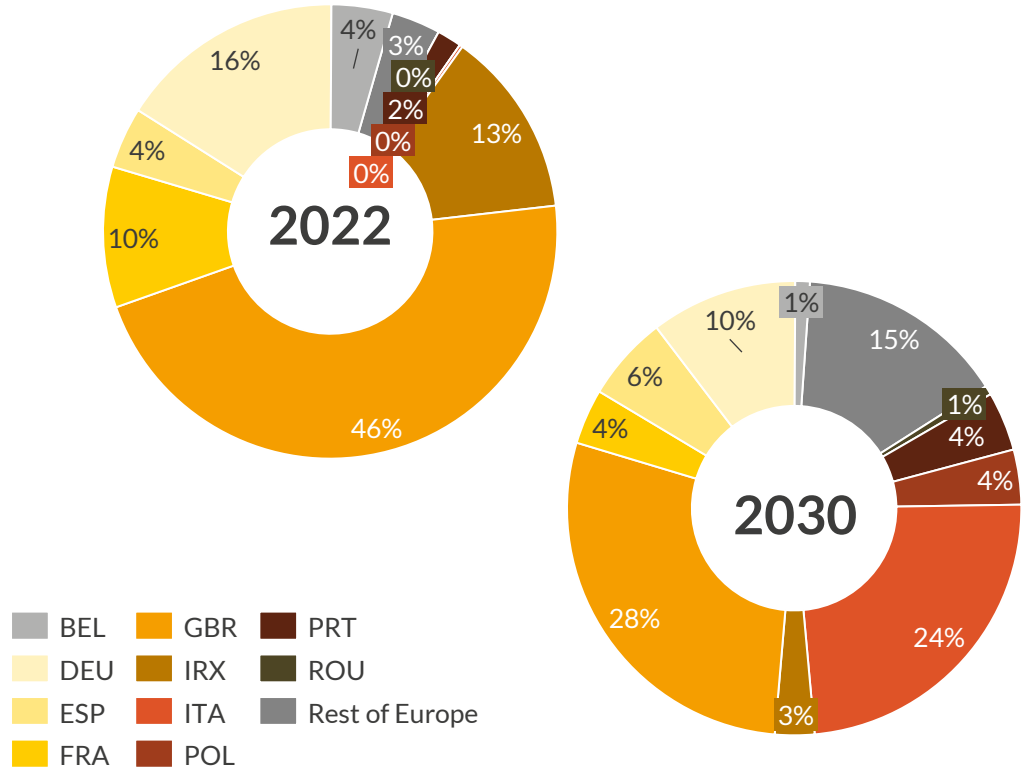
Installed grid-scale battery capacity in Europe (Aurora Central scenario)

GW



Market share of installed capacity by country

%

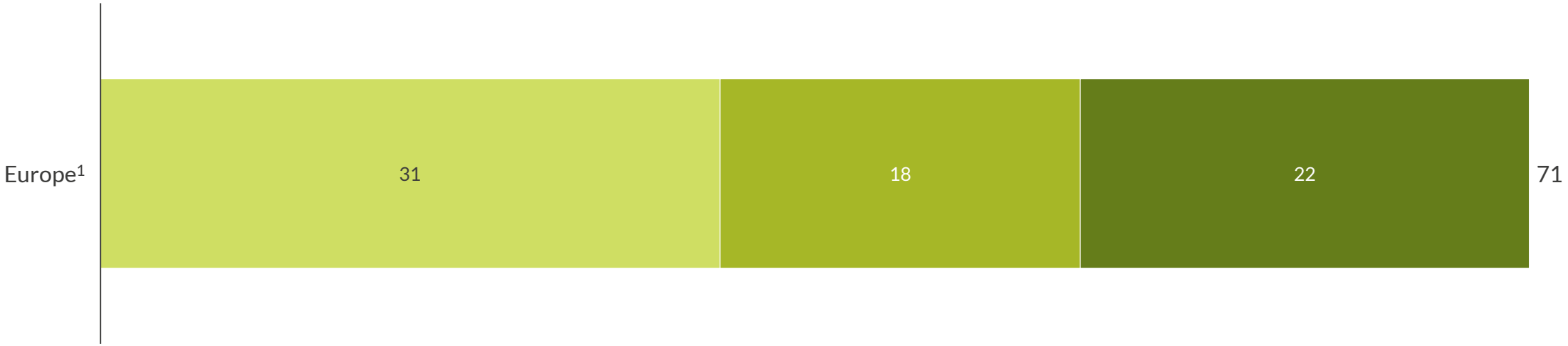


1) Installed capacity expected by the end of 2023.

Sources: Aurora Energy Research,,

The forecasted battery capacity additions represent a cumulative new build investment opportunity of over 70bn € between 2023-50

Total CAPEX spent on grid-scale batteries
bn € (real 2022)



2024-30

- Strong battery buildout is expected across Europe in the 2020s as countries strive to achieve their legislated decarbonisation targets.
- There is significant investment in longer duration batteries (2, 4, and 8 hr) as high renewables penetration increases the need for longer storage times

2031-40

- The investment pace is expected to slow down in the 2030s
- The investment focus is mainly on longer duration batteries (4 hr) in the 2030s due to favourable economics and as shorter frequency product markets become increasingly saturated

2041-50

- CAPEX investment ramps up in the 2040s as existing baseload capacities retire off the system
- Investment opportunities are also focused on 4 hr and longer batteries in the 2040s, which comprise almost 70% of required CAPEX investments within the period

2024 - 2030 2031 - 2040 2041 - 2050

1) EU27 plus UK and Norway, minus Cyprus and Malta. 2) We assume batteries are eventually allowed to participate in the Mercato per il Servizio di Dispacciamento (MSD) 3) Assuming the proportion of battery buildout by duration remains constant from 2023 until 2050
Source: Aurora Energy Research

Across Europe, a rising number of countries have introduced strategies and targets for energy storage deployment

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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

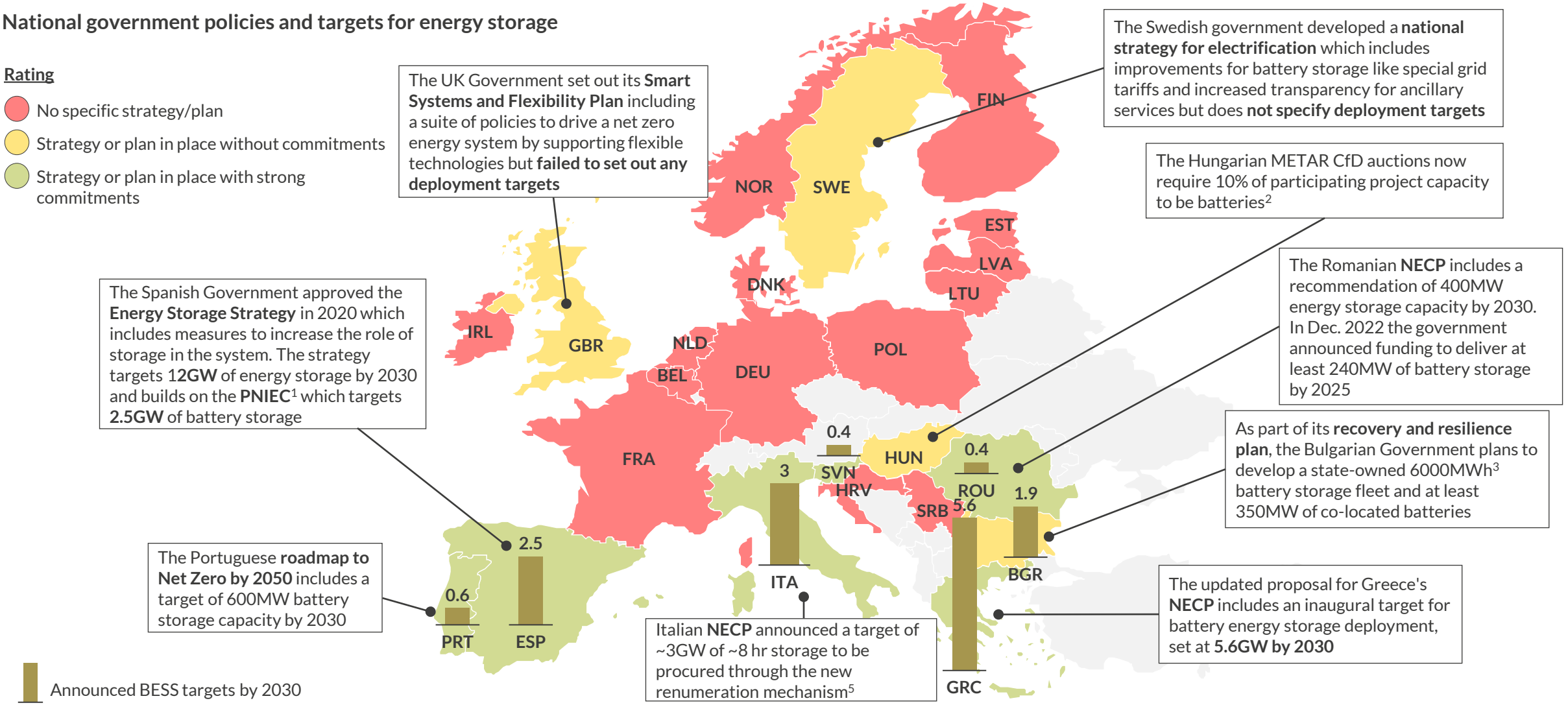
The Spanish Government approved the **Energy Storage Strategy** in 2020 which includes measures to increase the role of storage in the system. The strategy targets 12**GW** of energy storage by 2030 and builds on the **PNIEC**[1] which targets **2.5GW** of battery storage

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

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

Italian **NECP** announced a target of ~3GW of ~8 hr storage to be procured through the new renumeration mechanism[5]



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; 5) Italy's new NECP has announced a higher target of 9 GW expected for June 2023

Sources: Aurora Energy Research, National Governments

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Grid scale battery storage assets typically participate in four key markets, with further access to additional ancillary services

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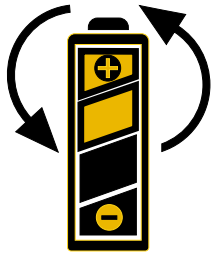
Revenue strategies / business cases

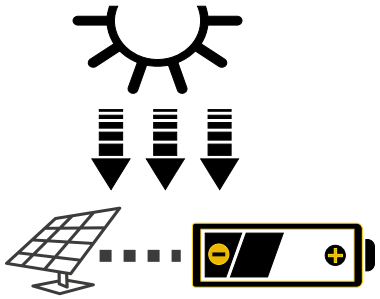
Battery revenue streams	Description	Energy Arbitrage	Frequency response	Optimised Hybrid
Energy arbitrage (Wholesale market)	▪ Margin from buying and selling power in the day ahead / intraday wholesale markets on a 15 min to hourly basis	✓	✗	✓
Energy arbitrage (Balancing market)	▪ Margin from bids (to charge) and offers (to discharge) in the BM to support balancing in the grid	✓	✗	✓
Capacity Market Payments	▪ Revenue based on a 1 to 15-year contract awarded via Capacity Market auctions, according to the market clearing price	✓	✗	✓
Fast Frequency services	▪ Revenue from providing fast-acting power injection to arrest fast changes in system frequency, through sub-second to minutes long response	✗	✓	✓
Other ancillary markets	▪ Revenue based on ancillary services such as black start capability, inertia, and local congestion mitigation services	✗	✓	✓

Business models / configurations

1 Standalone



2 Co-location



Source: Aurora Energy Research

Across most of Europe, fast frequency and balancing services offer the most valuable margins[1] for batteries

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Summary of most valuable markets for batteries (on average between 2025 - 2040)

Region	Wholesale market	Capacity markets	Fast frequency services[1,2]	Other balancing services[1,3]
Belgium	Secondary	Secondary	Main	Secondary
Denmark	Secondary	Minimal	Main	Minimal
Finland	Secondary	Minimal	Main	Minimal
France	Secondary	Secondary	Main	Minimal
Germany	Secondary	Minimal	Main	Minimal
Great Britain	Main	Secondary	Secondary	Main
Greece	Secondary	Minimal	Main	Secondary
Ireland	Secondary	Secondary	Main	Main
Italy	Secondary	Secondary	Main	Main
Netherlands	Secondary	Minimal	Main	Secondary
Poland	Secondary	Main	Main	Minimal
Portugal	Secondary	Minimal	Secondary	Main
Spain	Secondary	Minimal	Secondary	Main
Sweden	Secondary	Minimal	Main	Minimal

Main revenue stream Secondary revenue stream Minimal to zero revenues

1) Represents gross margins based on charging and discharging within the same revenue market; 2) Includes fast frequency products with full activation time < 10 minutes such as FFR, FCR and aFRR; 3) Includes Balancing Mechanisms in Great Britain and Ireland and slower frequency products with full activation time > 10 minutes such as mFRR, RR, Secondary/Tertiary Reserves within Italy's MSD, and reactive balancing in Belgium and the Netherlands

Source: Aurora Energy Research

Revenue stacking across markets is fundamental for battery profitability

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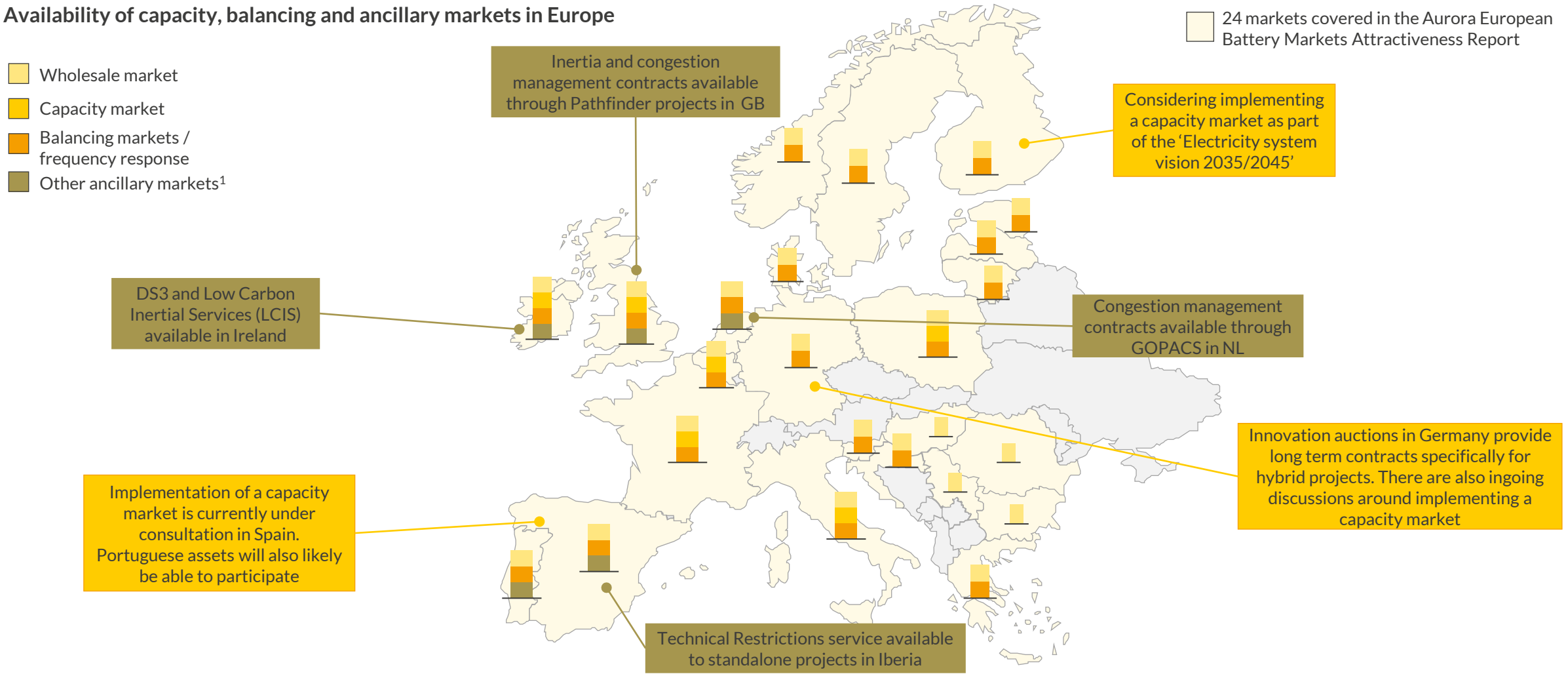
Availability of capacity, balancing and ancillary markets in Europe



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

Source: Aurora Energy Research

The energy transition in Europe is threatened by an increasingly constrained grid, requiring significant investment

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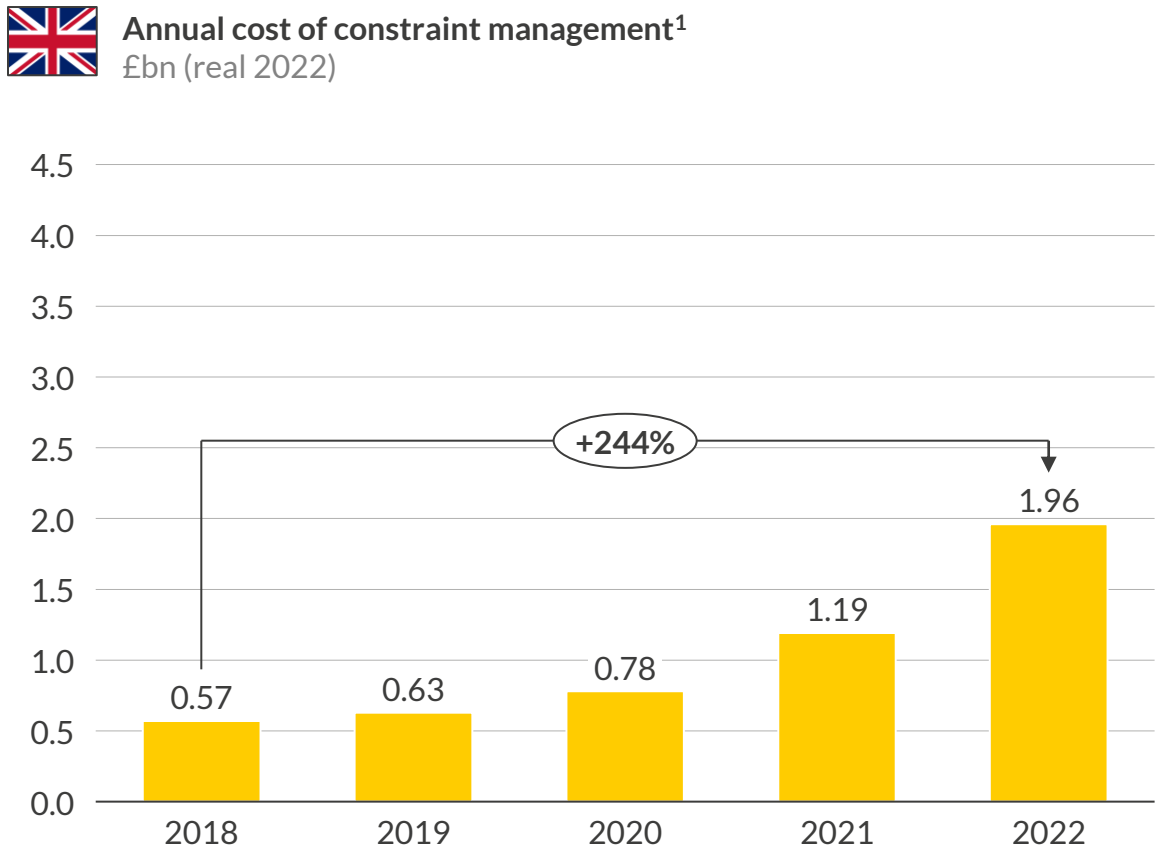
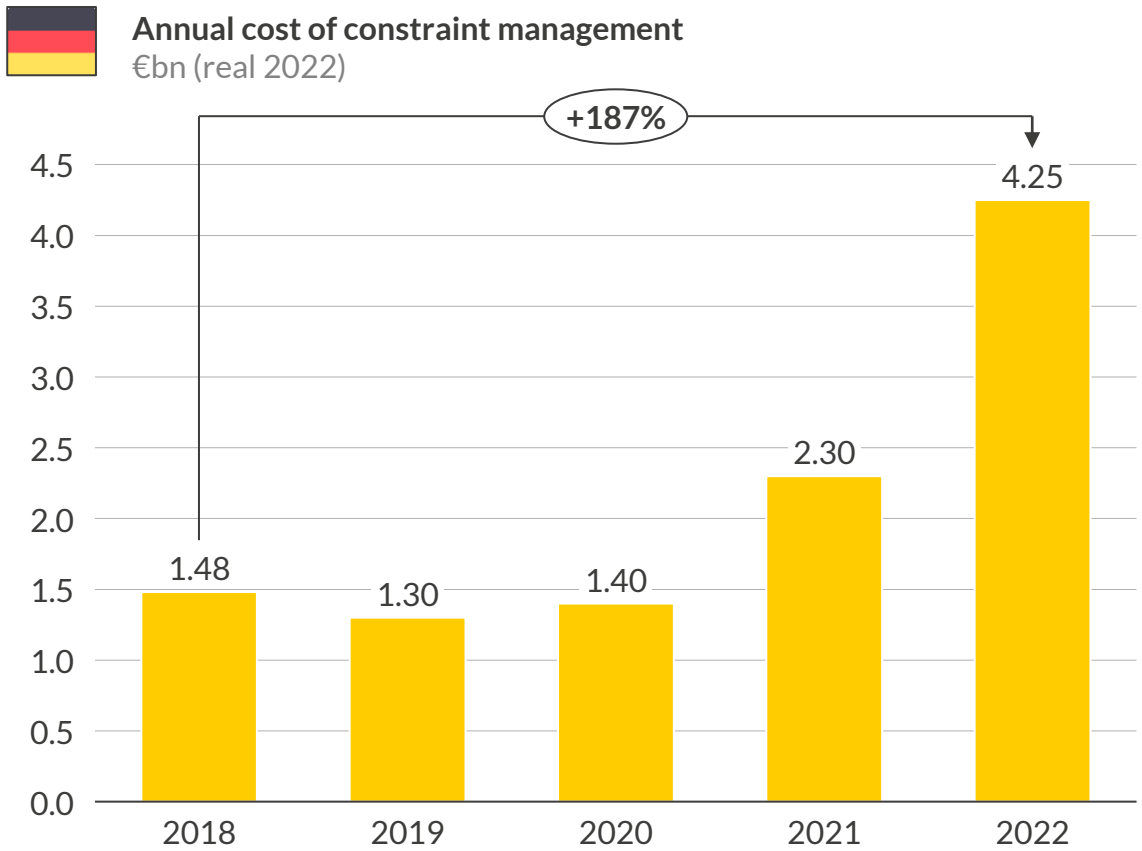
The volume of wind curtailed due to thermal constraints is growing with RES deployment, leading to the cost of managing the transmission network system to increase substantially over recent years





1) Covers any actions taken due to limitations on transmission network, whether for thermal, voltage or stability reasons.

Source: Aurora Energy Research

Scarcity and restrictions around grid connections complicate RES deployment, making hybridisation more attractive in some countries

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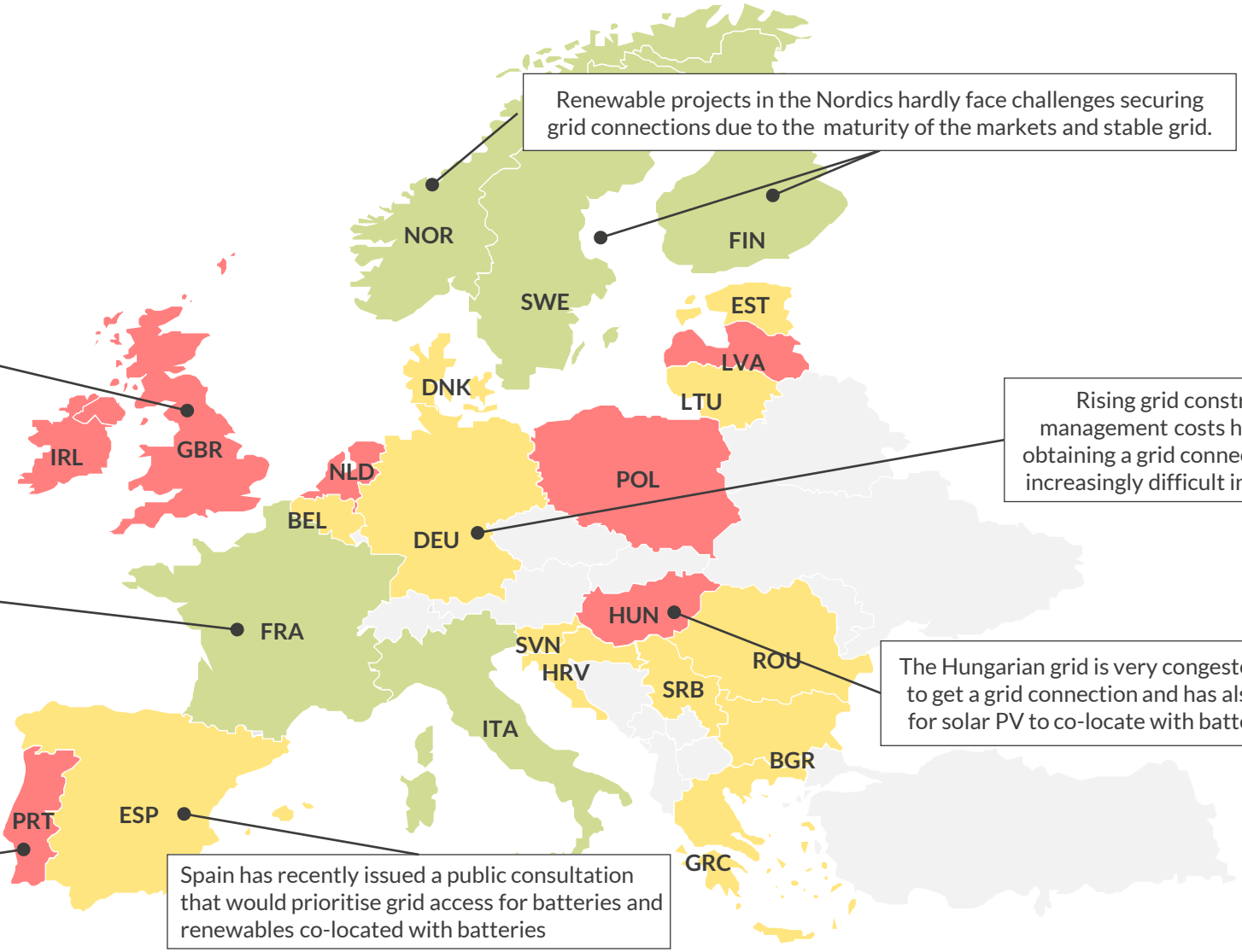
Grid availability rating

- High difficulty (*limited availability, high costs*)
- Moderately challenging
- Relatively simple



Renewable projects in the Nordics hardly face challenges securing grid connections due to the maturity of the markets and stable grid.

Current queue of ~300 GW for grid connections and up to 14 year wait times in GB have incentivised hybridisation of existing connections.

Rising grid constraints and management costs has resulted in obtaining a grid connection becoming increasingly difficult in some regions.

Projects awarded bids in CRE tenders automatically receive a grid connection

The Hungarian grid is very congested, making it very difficult to get a grid connection and has also led to the requirement for solar PV to co-locate with batteries to receive subsidies

Grid connections only available through auctions, limiting merchant projects

Spain has recently issued a public consultation that would prioritise grid access for batteries and renewables co-located with batteries

1) Allows multiple RES plants to use a single connection to feed into the grid.

Source: Aurora Energy Research

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The most attractive markets[1] for these grid-scale BESS investments are Germany, Great Britain, Greece, Ireland and Italy

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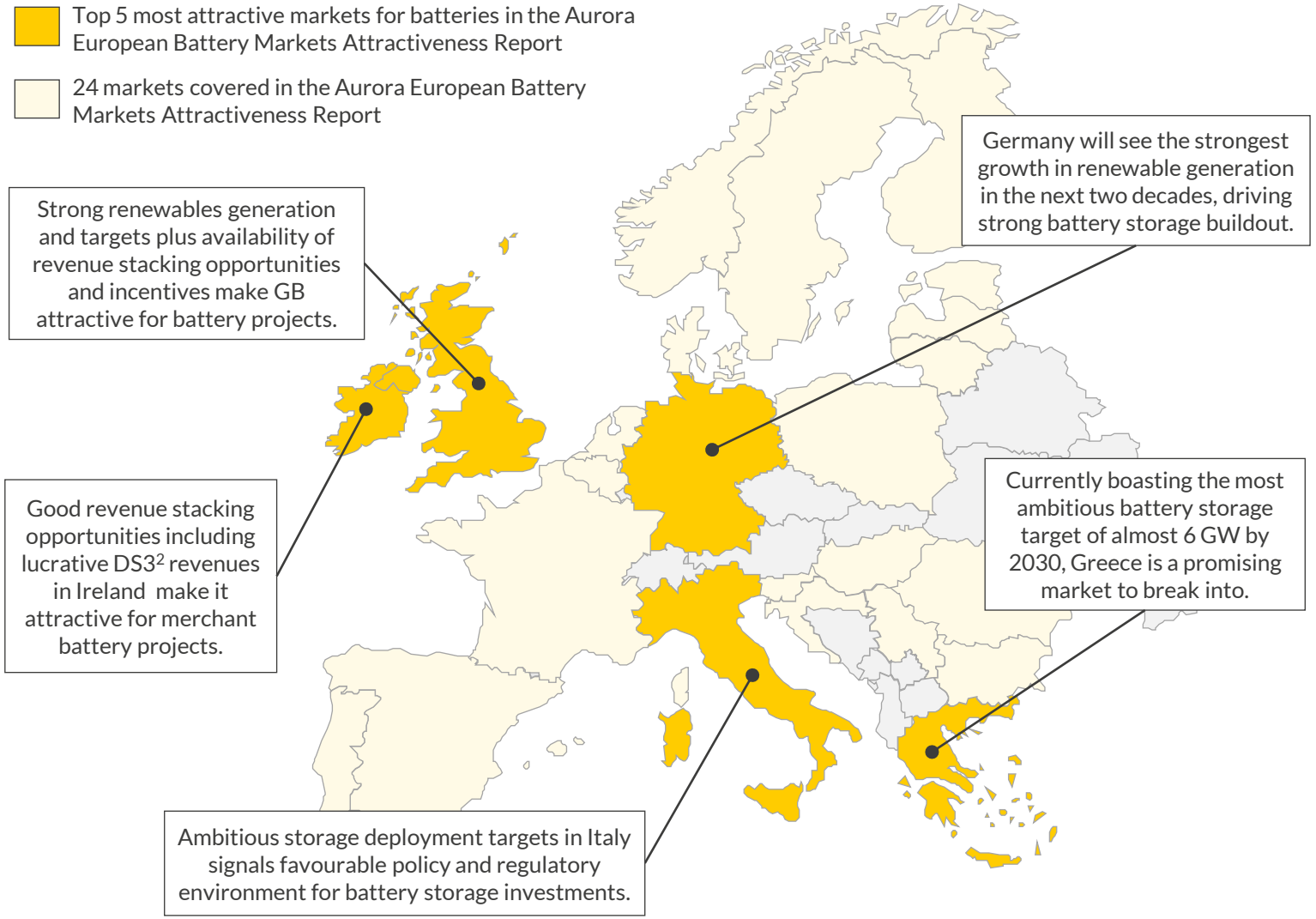

Key drivers of attractiveness for batteries

- Policy and regulatory support for battery storage in decarbonisation strategy
- Subsidies and/or capacity market contracts available for battery projects
- Strong renewables targets and support for solar and wind build, driving demand for grid flexibility
- Good revenue stacking opportunities
- High renewables generation and good power price spreads for energy balancing and arbitrage
- Eligibility for ancillary services participation and strong frequency response revenues
- Established energy storage industry

1) In alphabetical order. 2) Delivering a Secure, Sustainable Electricity System (DS3). Established by EirGrid Group to meet Ireland's 2020 electricity targets by increasing the amount of renewable energy on the Irish power system in a safe and secure manner.

Source: Aurora Energy Research

Key takeaways

1. Battery Storage is crucial to delivering the energy transition and managing key challenges as renewables generation and demand increase and conventional assets retire. Driven by diversity of revenues, they also make for lucrative investments.

2. Aurora forecasts grid scale battery storage to grow to almost 100GW by 2050, creating cumulative new build investment opportunity of over 70bn € between 2023-50. Great Britain continues to lead the way, dominating with market share.

3. Stacking of revenues is fundamental to building battery business cases and driving asset profitability. Although most countries allow for batteries to stack various revenue streams, contractual revenues e.g., through a CM are limited.

4. Business models for battery assets could either be standalone or co-located. Scarcity and restrictions around grid connections complicate BESS deployment, making co-location more attractive in some countries.

5. The deployment of BESS across Europe is inevitable but happening at a different pace across countries. The most attractive countries for these grid-scale BESS investments are Germany, Great Britain, Greece, Ireland and Italy.

Source: Aurora Energy Research

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

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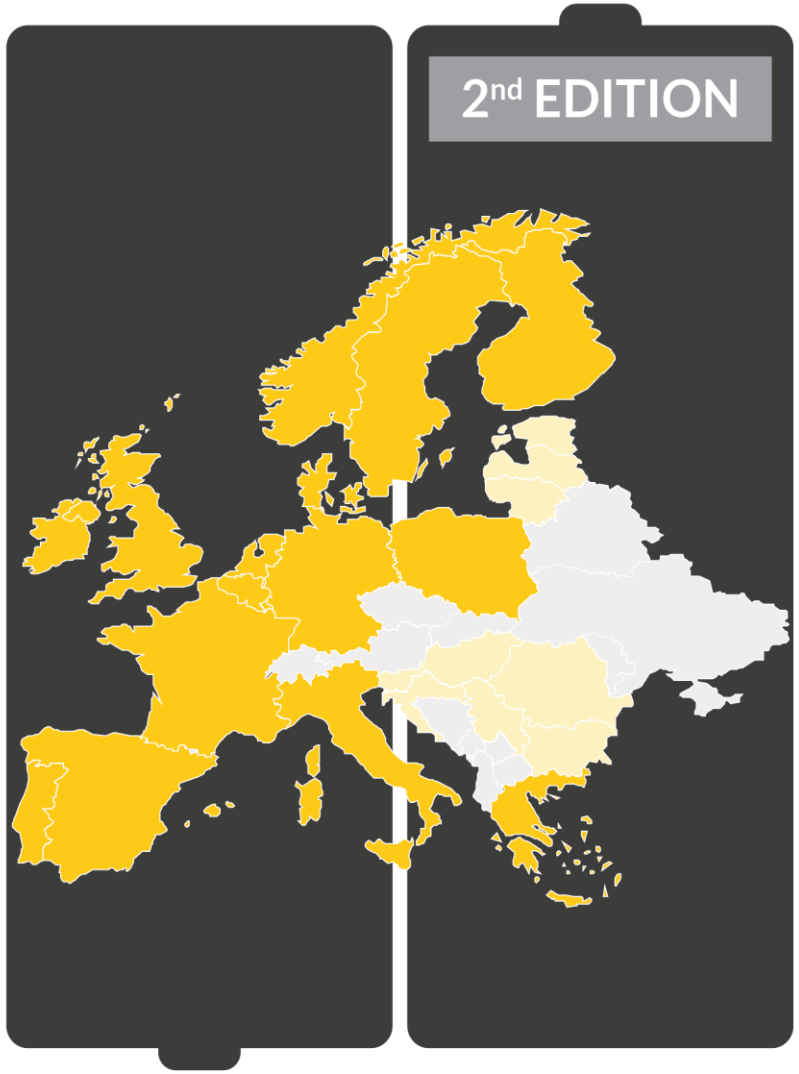
Analysis across 24 European countries:

- 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

Get in Touch to Find Out More

For markets (*) Flexible Energy Market Services with detailed forecasts & business case analysis are available

Source: Aurora Energy Research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