

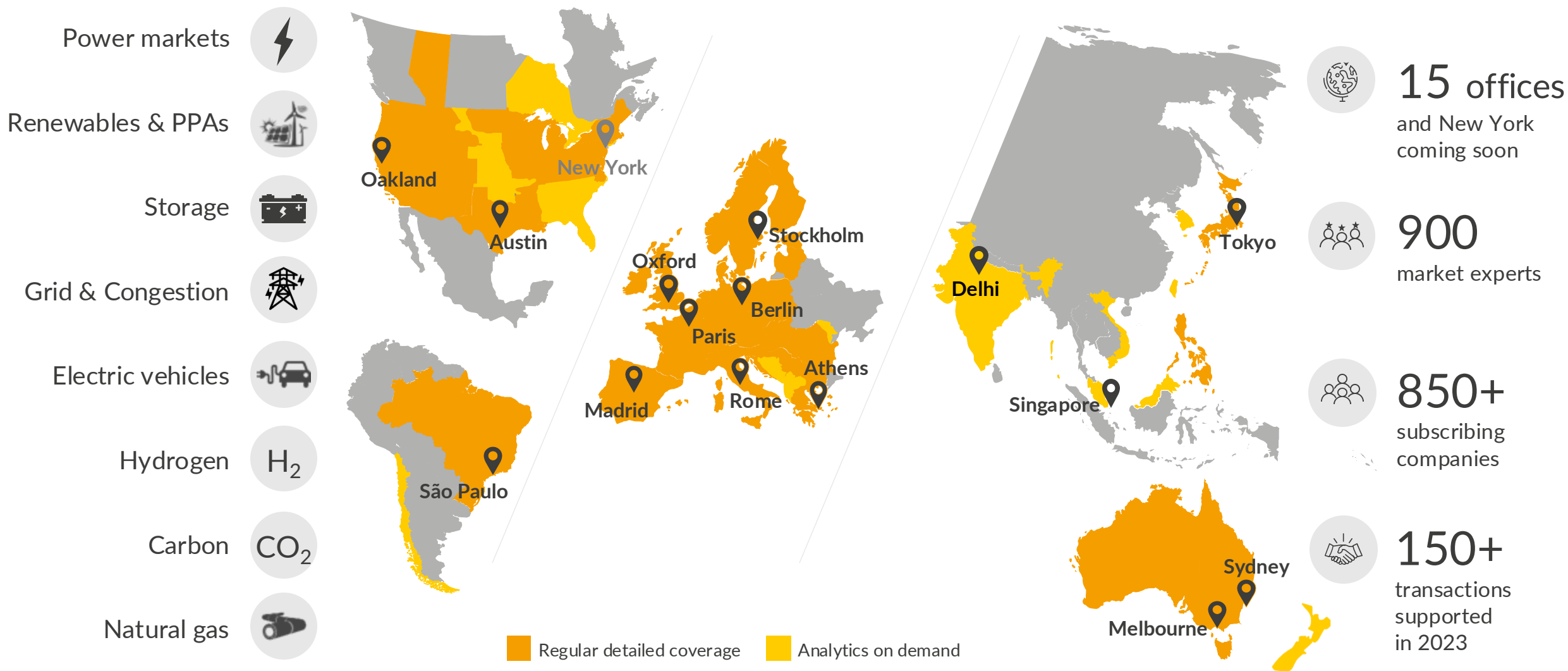
# Nordic battery boom: Powering growth amid saturation risks

Public Report

22 January 2025



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



# Our **Nordic Flexibility Market Add-on Service** provides you with detailed power market analysis and investment case data for batteries



## Forecast Reports & Data

### Technology and market development reports

- Overview of battery pipeline development
- Regulatory framework and qualification criteria 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

- Hourly Day-Ahead and Intraday power prices, including spread achievable for arbitrage
- Hourly ancillary service prices for FCR-D up, FCR-D down, FCR-N and FFR in Sweden (SE4), Finland (FI) and Denmark (DK2)
- Including a projection of the ancillary market size in the Nordics until 2035

## Investment cases

### Standalone Battery

- At least four investment cases per country including:
  - Battery duration: 1h vs 2h
  - Aurora Central and Low scenario
  - Participation in both wholesale and ancillary markets
- Projection of annual project margins to 2050
- IRR and net present value for entry years 2025 and 2028
- Overview of benefits for co-location with wind, solar and hydropower

**For ongoing analyst support, bi-annual workshops and interaction with our market experts, get in touch!**



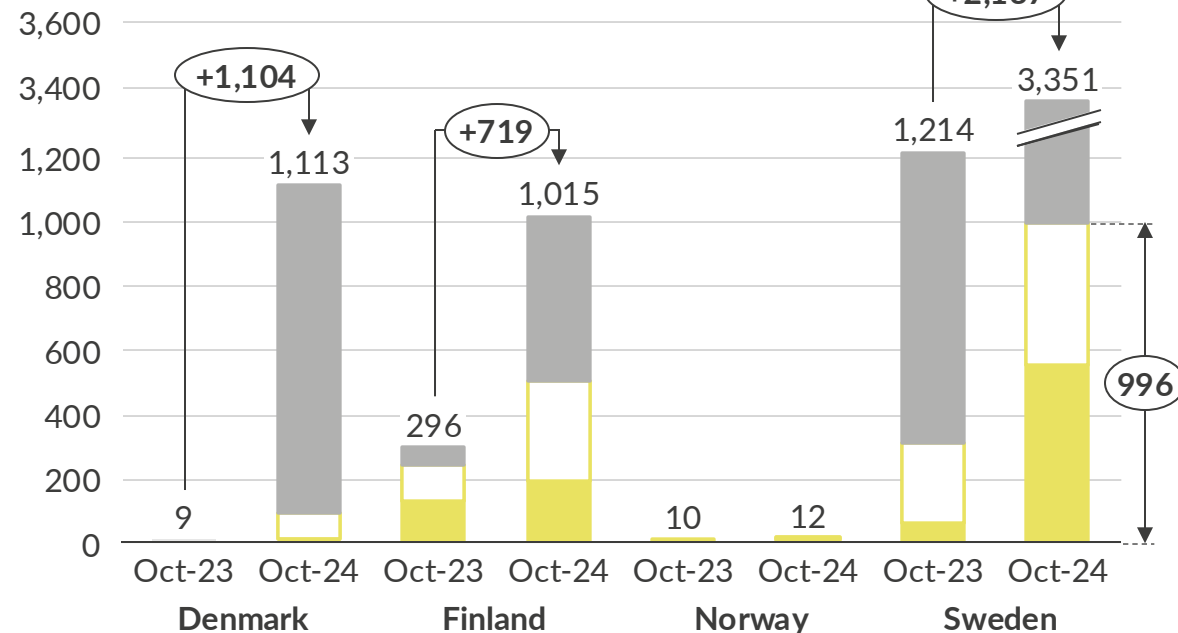
**Laura Raud Pettersson, Commercial Associate**

[Laura.pettersson@auroraer.com](mailto:Laura.pettersson@auroraer.com)

# Nordic BESS capacity has skyrocketed over the last year, with 4GW added to the pipeline; the fleet consists mostly of stand-alone batteries in SE3 and SE4

Nordic battery capacity by status and location

MW



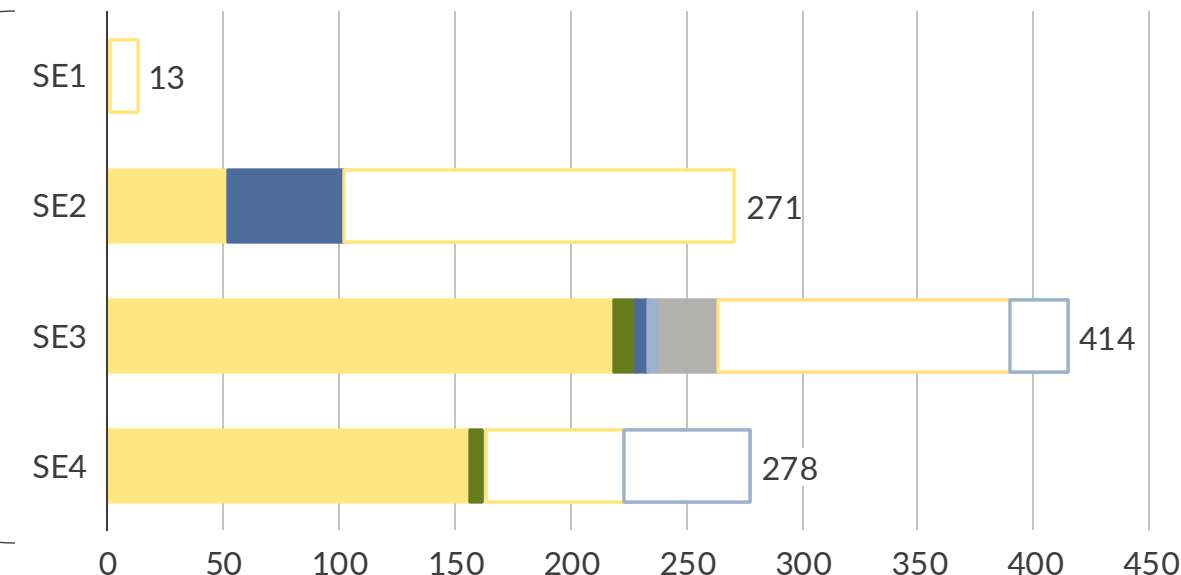
- Over the last year BESS<sup>1</sup> capacity in the Nordics grew by over 600MW and the total pipeline by around 4GW. The largest growth is in the established Finnish and Swedish markets, while Denmark is quickly ramping up.
- The current Nordic fleet is over 750MW. Additionally, 850MW of projects are under construction and another 3.9GW have been announced. Sweden is the biggest market with 3.3GW in the pipeline and over 500MW operational.

■ Announced/planned ■ Under construction ■ Operational

1) Battery energy storage system.

Operational and under construction batteries in Sweden

MW



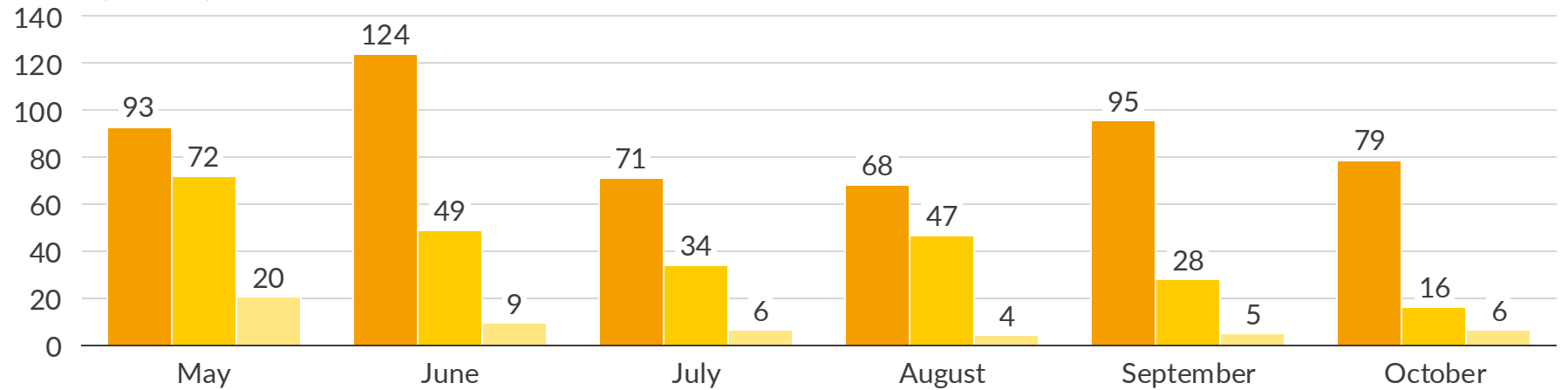
- 80% of the operational Swedish BESS capacity is situated in SE3 and SE4, the zones with undersupply of energy and higher power prices. SE2 has the largest amount of capacity under construction.
- Over 80% of the capacity consists of stand-alone assets. SE2 has 50MW of assets co-located with hydropower. Projects co-located with other energy sources have started to come online in SE3 and SE4.

■ Stand-alone ■ Co-located with hydro ■ Undisclosed  
■ Co-located with biomass/CCGT ■ Co-located with solar/wind ■ Under construction

# FCR-D up prices in Sweden have declined for two consecutive years, raising the question of market saturation

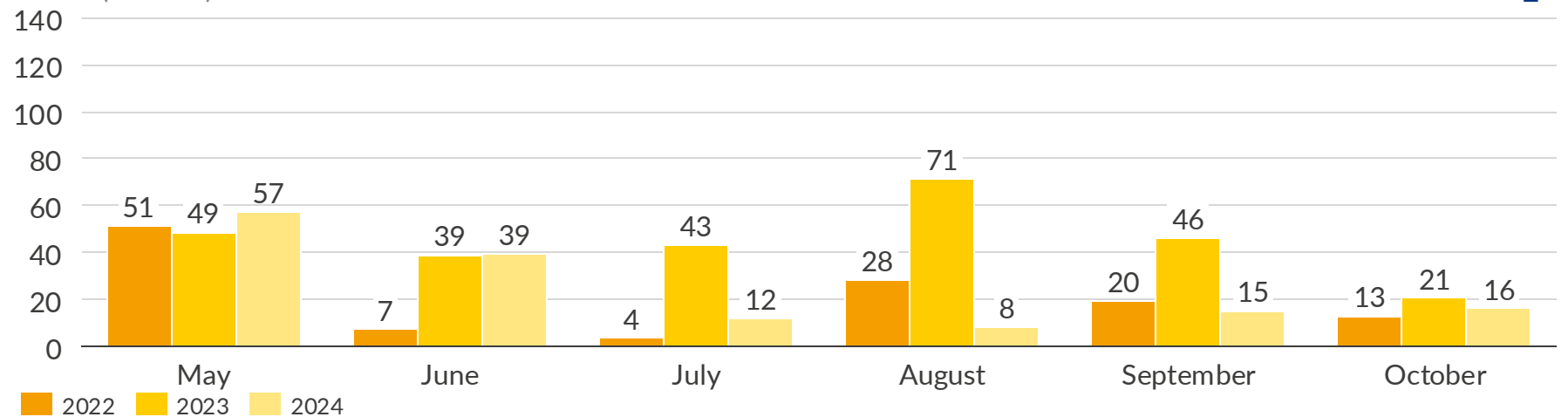
Historical FCR-D up prices in Sweden and DK2<sup>1</sup>

€/MW (nominal)



Historical FCR-D up prices in Finland

€/MW (nominal)



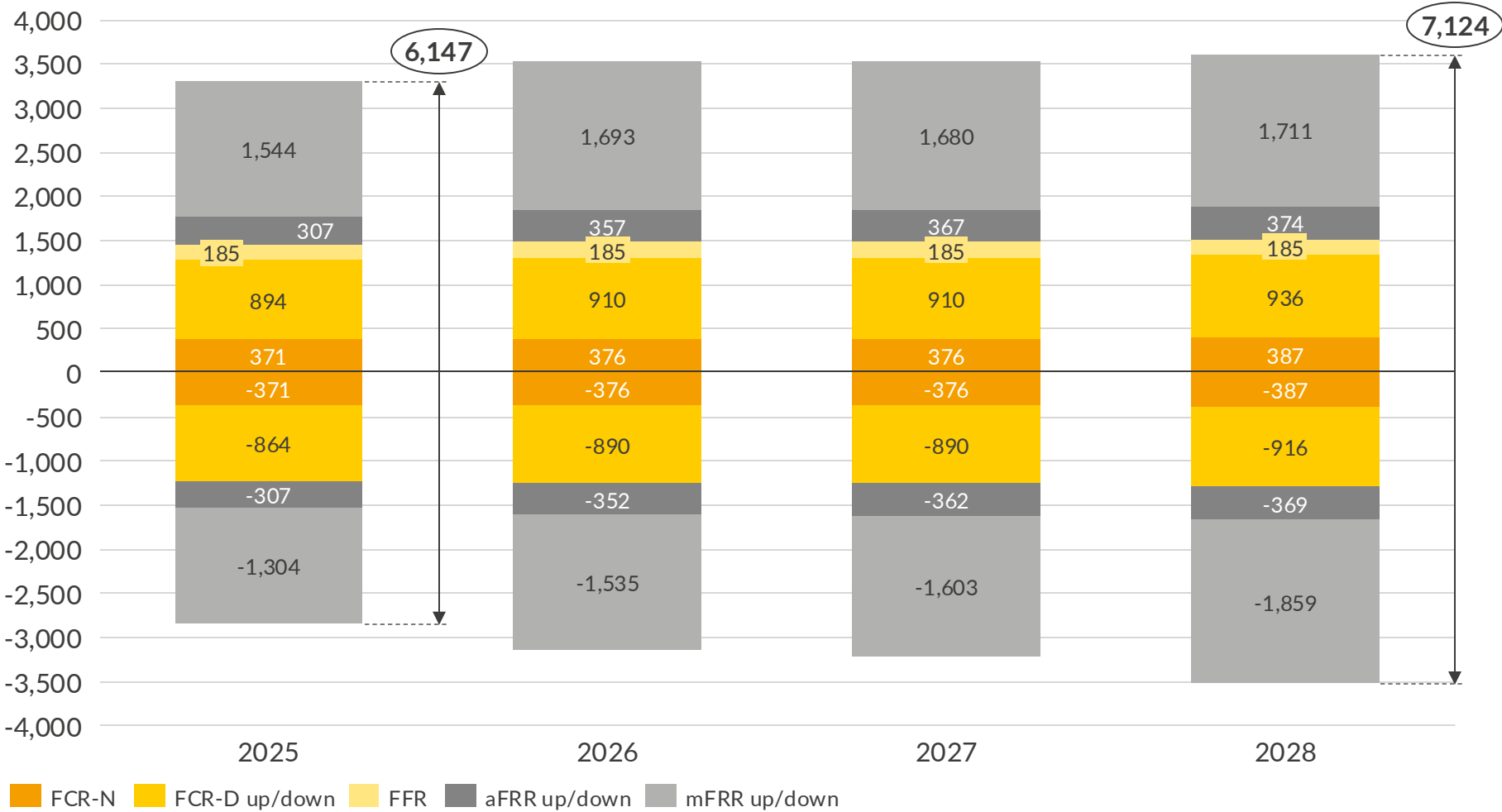
1) 2022 and 2023 show volume weighted average pay-as-bid prices whereas 2024 shows the marginal price.

## Price drivers

- Over the last two summers we have seen significant drops in FCR-D up prices in Sweden, despite the shift to from pay-as-bid to marginal pricing in 2024.
- In Finland, prices increased significantly in 2023 but have rebalanced since July 2024.
- The decline in FCR-D up prices is driven by several factors:
  - Increased competition from BESS has displaced costly hydro units from the market.
  - Lower Day-Ahead power prices have led to decreases in hydro water valuations, resulting in lower bids into FCR from price-setting hydro assets.
  - The hydrology for 2024 was favourable meaning hydro assets were flexible to provide FCR at a low cost.

# Procured volumes of ancillary services are expected to grow by almost 1,000 MW, driven by increasing mFRR up and down volumes

Procured capacity per ancillary market in Denmark<sup>1</sup>, Finland and Sweden, MW



## Capacity drivers

- The largest projected growth in volumes is from mFRR, particularly in the down direction, which is expected to increase by 550MW between 2025 and 2028.
- The demand for mFRR capacity is forecasted to grow to match the dimensioning fault for each price zone.
- Procurement of FCR and FFR is forecasted to grow slightly, primarily due to adjustments in the allocation among the Nordic countries.
- aFRR capacity procurement is expected to increase from around 300MW to around 375MW in both directions.

1) DK2



# In more mature battery markets, such as Great Britain, arbitrage revenues are a cornerstone of the business case



Summary of gross margin stack market composition<sup>1</sup>  
% of 2027 – 2041, 2h duration batteries

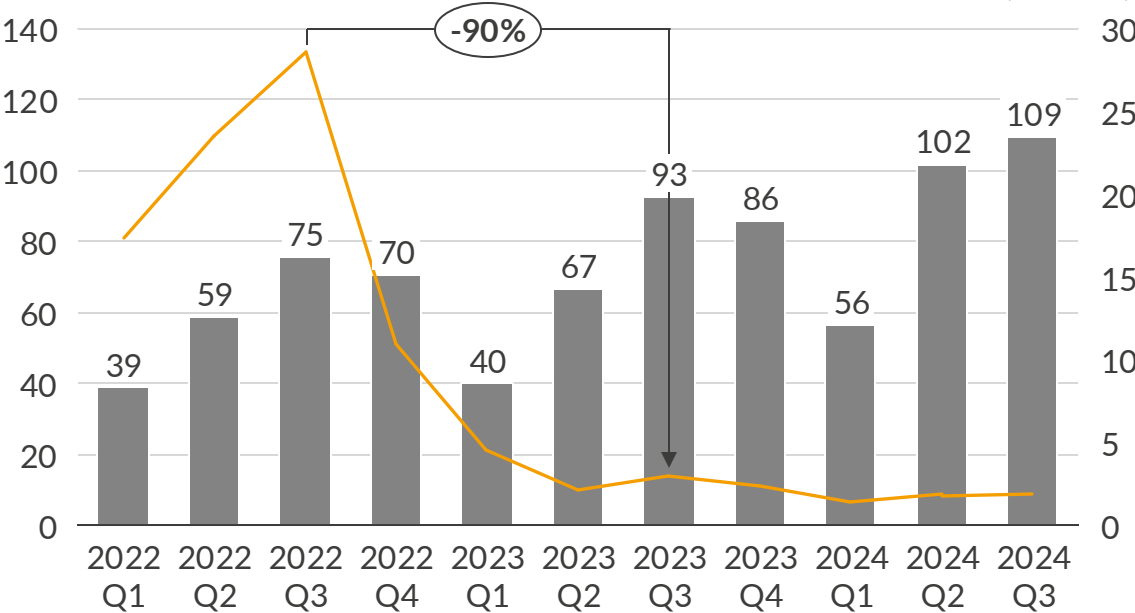
Region	Average composition of gross margin stack	
SE4	29%	71%
DK2	51%	49%
Germany	67%	33%
Great Britain	84% 1% 10% 5%	
Greece	45%	55%
Ireland	71% 17% 12%	
North Italy	75% 25%	

- In the Nordics, the business case for most operational batteries is mainly based on capacity payments for ancillary services. In many other countries, energy arbitrage between energy-remunerated ancillary services<sup>2</sup>, wholesale, and balancing markets<sup>3</sup> often represents the most valuable revenue stream.
- In more mature markets, such as Great Britain, frequency services tend to already be saturated or will likely saturate early, further increasing the importance of arbitrage for the business case.

 Energy arbitrage (over all markets)  Capacity payments for ancillary services  
 Capacity Market Payments  Other Ancillary Markets

Dynamic Containment (DC) low volumes<sup>4</sup>  
GW

Average DC low prices<sup>5</sup>  
£/MW/h (nominal)















- Dynamic Containment is the primary reserve, with a separate up and down service. It is procured through Day-Ahead auction and provides availability payments (per MW) only on a pay-as-clear basis.
- Historically, exclusively participating in DC could yield sufficient revenue for a viable business case. However, due to the rapid battery build-out starting Q3 2022, regardless of the higher uptake volume the market saturated and prices fell by 90% over the course of a year.

 Cleared volume  Average price

1) Discounted. 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 and Secondary/Tertiary Reserves within Italy's Mercato per il Servizio di Dispacciamento. 4) Average cleared volumes across all regions in a month. 5) Average accepted prices across regions in with non-zero procurement.  
Sources: Aurora Energy Research, National Energy System Operator

# Several additional revenue streams and trading strategies can give a further upside to the business case for BESS in the Nordics

Strategy	Potential impact	Accessibility	Opportunities and challenges
aFRR energy and capacity			<ul style="list-style-type: none"> <li>Arbitrage on aFRR energy under PICASSO creates an opportunity, but capacity bids will be cannibalised by wind &amp; DSR partly also due to shallow market size.</li> <li>Pre-qualification requirement for aFRR is stricter than for mFRR and currently, no batteries are pre-qualified for aFRR in Sweden.</li> </ul>
mFRR energy and capacity			<ul style="list-style-type: none"> <li>Go-live of the automated Nordic mFRR energy activation market in Q1 2025 will include a shift to 15-minute market time unit, increasing suitability for the battery.</li> </ul>
Financial asset backed trading			<ul style="list-style-type: none"> <li>Pure financial trading on the continuous Intraday market can increase arbitrage revenues, without increasing cycling.</li> </ul>
Local flexibility market			<ul style="list-style-type: none"> <li>Local flexibility markets can provide additional revenues for the battery, but markets are not standardised and dependent on the geographical placement of the battery.</li> </ul>
Repowering			<ul style="list-style-type: none"> <li>Repowering can extend the lifetime of the asset and allow for more arbitrage possibilities which could improve profitability.</li> </ul>
Co-location			<ul style="list-style-type: none"> <li>Co-location of batteries and renewable assets is primarily an upside from a grid perspective due to better utilisation of grid-connection which can often be a bottleneck.</li> </ul>



- 1** Grid-scale battery capacity in Sweden has surged in 2024, rising from 80MW pre-qualified for ancillary services in January to 530MW by October. With the current project pipeline, capacity in Sweden and DK2 could soar to 1,100MW by 2025 and 1,450MW by 2026, if all projects are realised.
- 2** Prices for ancillary services in Sweden have declined for two consecutive years, with FCR-D averaging just 6 €/MW since June. This drop is driven by abundant hydropower, low Day-Ahead prices, and rapidly rising battery capacity displacing costlier units. FCR-N prices have been more resilient, averaging 40 €/MW during the same period.
- 3** As seen in other European countries, arbitrage revenues become increasingly critical for the battery business case as competition in ancillary markets grows with expanding battery capacity. The upcoming shift to a 15-minute market time unit in 2025 for both Intraday and Day-Ahead markets is likely to benefit batteries by increasing daily price spreads. Additionally, strategic market churn—closing Day-Ahead positions in the Intraday market—offers further potential to enhance arbitrage revenues.
- 4** There are multiple potential upsides for Nordic batteries in the future which are likely increase revenue potential, including accessing new ancillary markets such as mFRR, aFRR, exploring financial asset backed trading or co-location and local flexibility markets. While the scale of these benefits will depend on market developments, they offer potential for strengthening the battery business case.

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