Power

Battery revenues report

No 1 – May 2023

KYOS

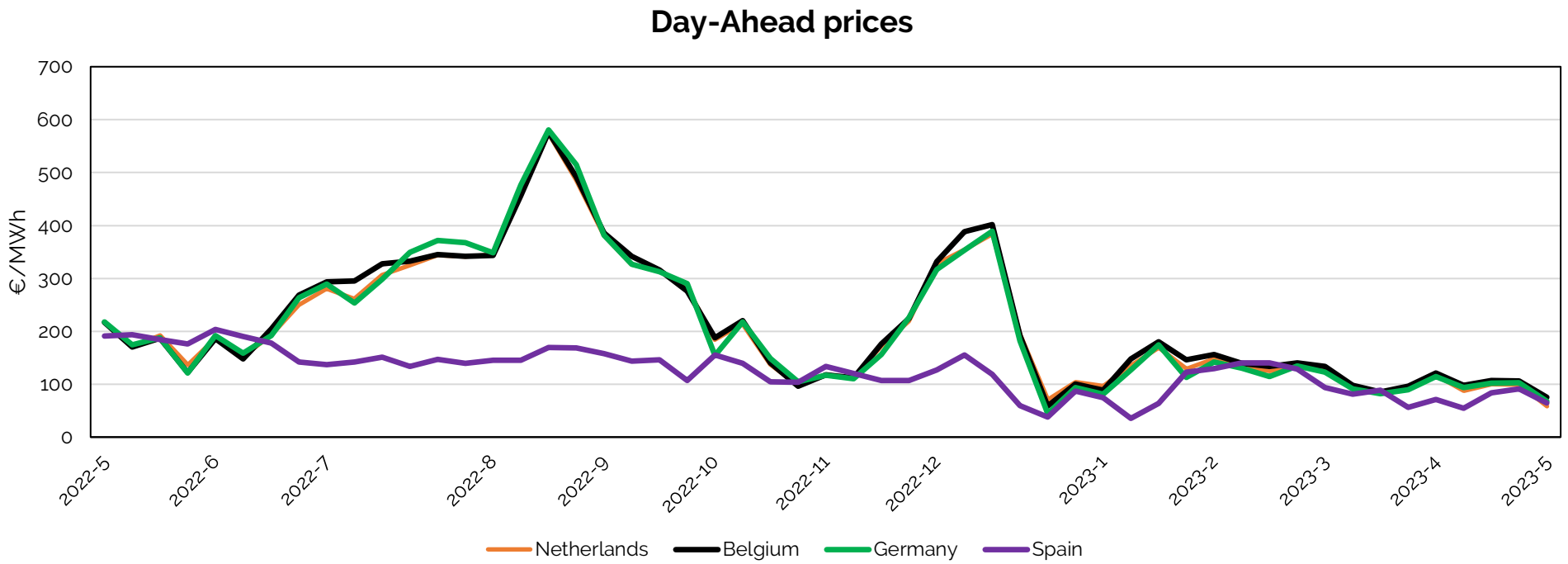
Battery revenue projections

Revenues (€/kWh/y)	Market	Period	Day-Ahead		Intraday		Intraday + imbalance	
			Average	10%	Average	10%	Average	10%
	NL	Cal2024	45.0	35.0	71.0	65.8	117.4	108.5
	BE	Cal2024	49.2	34.8	70.1	61.5	113.7	104.2
	DE	Cal2024	49.7	25.5	70.2	55.6	n/a	n/a
	ES	Cal2024	29.9	20.8	36.2	28.5	n/a	n/a

- Battery revenues in €/kWh/y for a stand-alone located, 0.5C battery with a roundtrip efficiency of 86% and a warranty constraint of 730 cycles per year.
- Batteries are placed in 4 different countries (NL, BE, DE, ES) participating on three different market strategies: Day-Ahead, Intraday, and Intraday and Imbalance (where applicable).
- For more details, see page 7 of this report.

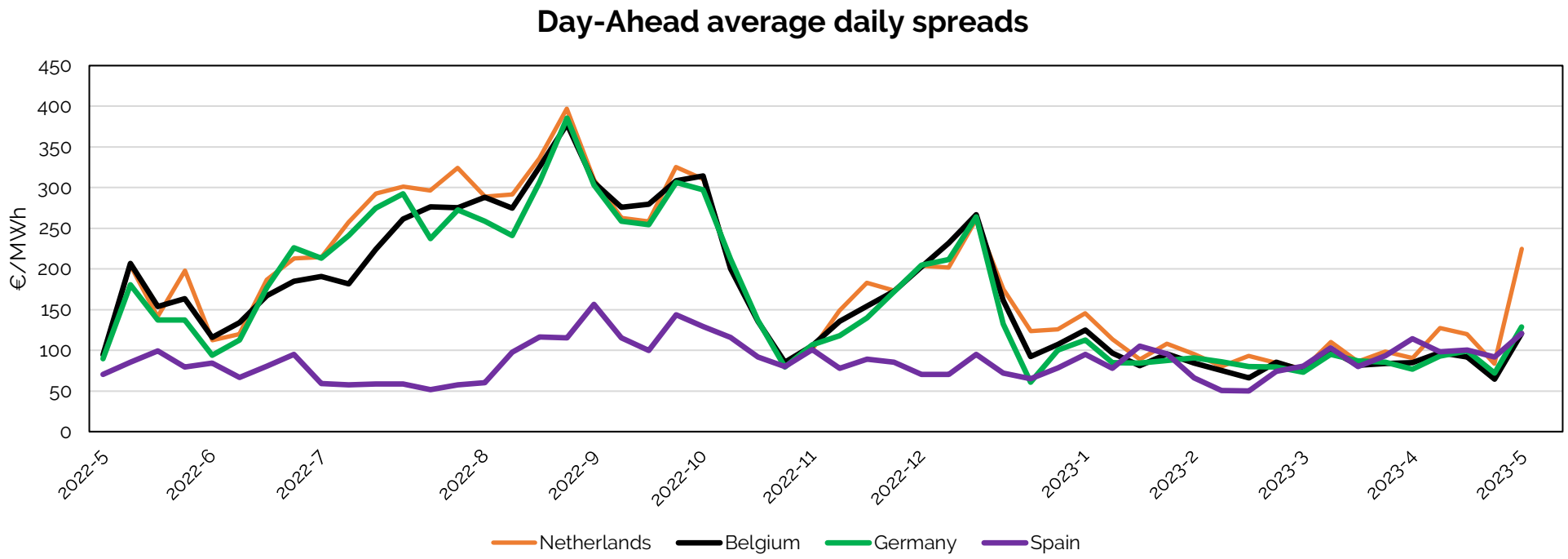
Day-ahead price history

- The chart represents the trend over the last 12 months of the weekly average Day-Ahead price across the four selected countries.
- Day-Ahead prices largely followed gas prices, which increased significantly in summer and autumn 2022 and later dropped thanks to a mild winter and ample LNG supply.
- Day-Ahead prices in the selected countries have been on average close to each other, with Spain being the only exception because of its cap on gas price set from June 2022.



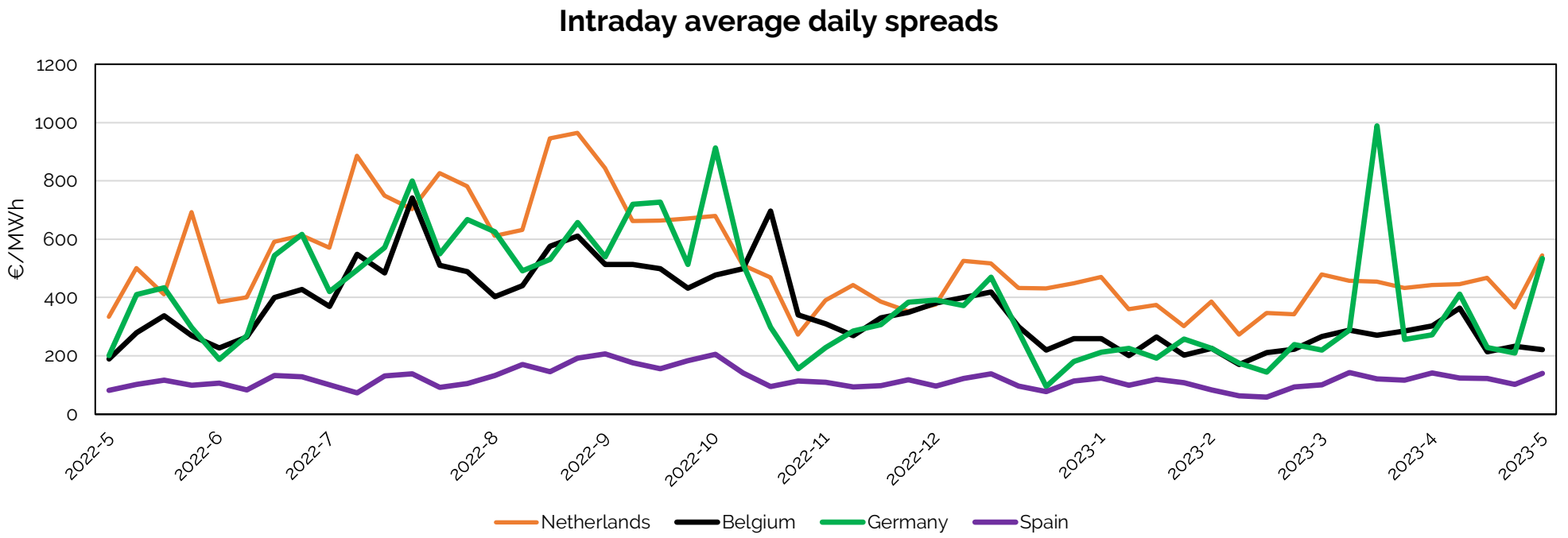
Day-ahead daily spread history

- The chart shows 12 months of weekly average daily spread (difference between max and min hourly price within the day) on the Day-Ahead market across the four selected countries.
- The trend in daily spreads resembles the one of absolute prices, showing an increase in summer and autumn 2022 followed by a decrease since winter 2022.
- Daily spreads in North-West Europe are comparable, while in Spain they have been significantly lower, especially in the second half of 2022.



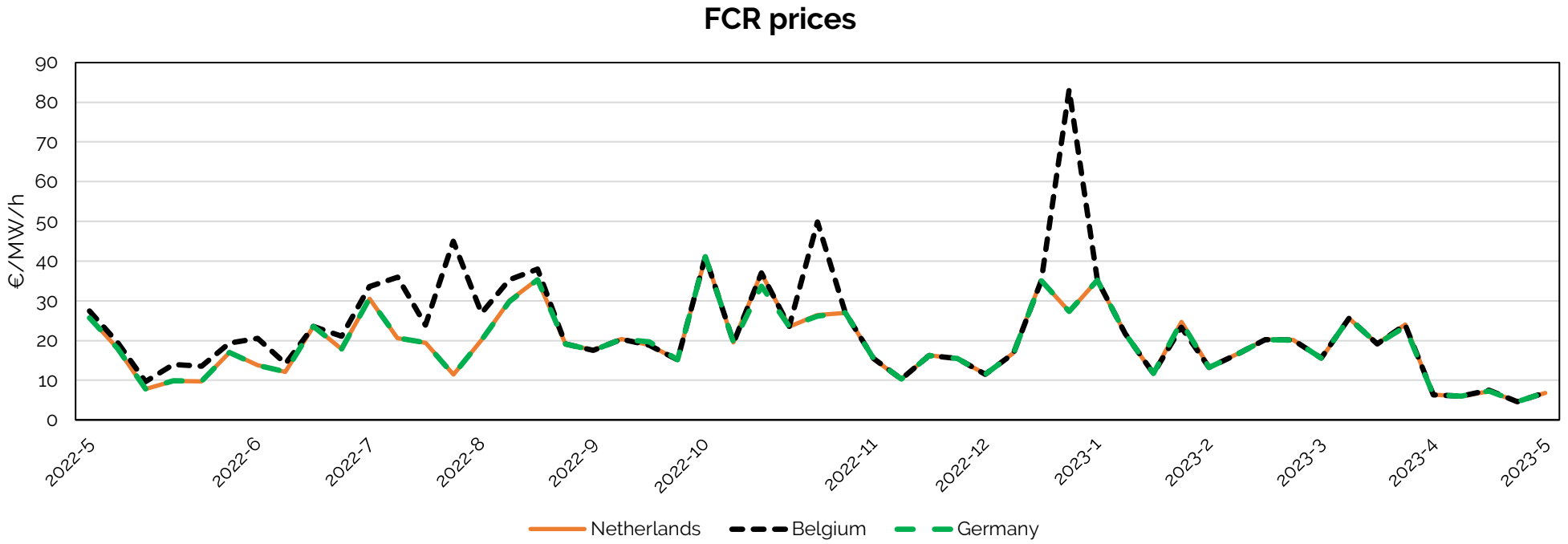
Intraday daily spread history

- The chart shows 12 months of weekly daily spread (difference between max and min hourly price within the day) on the Intraday market across the four selected countries.
- Daily spreads in The Netherlands are the highest among the selected countries, whereas in Spain they are the lowest.
- Intraday daily spreads are on average 2-3 times larger than day-ahead daily spreads, showing that there is more value for batteries in the intraday market.



FCR price history

- The chart shows 12 months of weekly average FCR prices across the four selected countries.
- FCR prices behavior is less influenced by gas prices than wholesale market prices, because FCR is a capacity product and gas fired generation is typically not the marginal provider.
- The graph shows how the Netherlands and Germany have been pegged to each other almost the whole year, and Belgium joining them for most of the time.



Explanation and methodology

Battery definition

- Assessed batteries are of type 0.5C, this means that the battery can be fully charged or discharged in 2 hours
- No degradation assumed over valuation timeframe
- Batteries have round trip efficiency of 86%, this is based on 92.7% charge and discharge efficiency
- Number of cycles per year is limited to 730
- All assets are stand-alone assets.
- Applicable variable grid costs of 1€/MWh are taken into account (based on 2023 fees)

Valuation Methodologies

- All valuations have been performed with KYOS software and models: KyBattery and KySim. The values are expressed in €/MWh.
- The trading date for all values is May 2nd 2023.
- Expected revenues from trading in different markets is displayed. Model is using Monte Carlo simulation and Least Square Monte Carlo optimization techniques
- Day-Ahead (DA): value generated by trading exclusively in the Day-Ahead market, hourly granularity
- Intraday (ID): value generated by trading exclusively in the intraday market, 15 min granularity for NL, DE, BE, and 1 h for ES.
- For markets where passive imbalance trading is allowed (NL, BE), also the additional value of this strategy on top of intraday trading is shown (ID/Imbalance). Simulation model calibrated using 1 year rolling window of historical prices.
- A multi-linear regression on historical imbalance and intraday prices is used to generate imbalance forecasts for the trading strategy.
- ID and imbalance prices simulated by taking historical spread with DA prices.

KYOS - Energy Storage Services

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Software – KyBattery

1) State of the art tool to provide energy storage valuations

2) Based on Monte Carlo price simulations and Least-squares Monte Carlo to perform realistically optimal trading strategy

3) Supports wide range of battery configurations

4) Supports different technologies: Li-ion, CAES, pumped hydro

5) Support different set-ups: standalone assets, co-located assets

6) Participation in multiple markets: day-ahead, intraday, imbalance, and FCR (also combined strategies).

Consulting – examples

1) Valuation of battery cashflows with different market participation approaches to develop business cases

2) Independent assessment of expected revenue streams for third parties

3) Comparison between different storage assets and types to identify competitive advantages per market

4) Battery sizing for optimal network use in combination with co-located generation assets

5) Benchmarks to validate action of storage optimizers

Across all Europe, across all markets, for all storage technologies.