

The 2023 battery investment landscape

Charging ahead: 7 Lessons for BESS investors on how to outperform rivals



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Foreword

Battery storage revenues may have peaked in 2021 and 2022, but there is still significant opportunity

The battery storage market in GB continues to accelerate and is attracting significant volumes of investment and interest. However, revenues in 2023 are down compared to the unprecedented highs of 2021 and 2022 that were caused by external shocks to the energy system and lucrative new frequency response products. This report by LCP Delta explores what the future holds for battery storage in GB and identifies the lessons to learn to continue to maximise returns from storage in more stable energy markets.

The impact of wholesale market volatility over recent years caused by tight system margins, war in Ukraine and an economic recovery post-Covid has provided a great opportunity for battery storage operators to capture exceptional margins in 2021 and 2022. High energy market value also passed through into the frequency response markets, which, combined with limited competition across the range of new services, led to high prices and high returns for the GB battery fleet.

Investors, attracted to the potential returns, are continuing to commit to the UK. **LCP Delta expect the GB battery pipeline to grow to 4GW before the end of 2023 and could grow as high as 18GW by 2030.** But, as frequency response markets become saturated, the real question is whether the current and future market can sustain and reward this high amount of sector growth.

The risk is that those looking at battery storage projects will focus too heavily on the recent downturn in achieved revenues and not see the bigger picture when it comes to battery storage opportunities.

It is well recognised that battery storage will have a significant role in a future decarbonised GB power system. The external shocks in 2021 and 2022 should not set expectations of future revenue but should provide insights and lessons to how battery storage owners and operators can maximise value in more stable periods. **Those trading battery assets will need to become more sophisticated in how they engage in markets**, owners will need to ensure they select the right optimiser to manage their assets, and investors will need to select the right locations and configurations for their assets and manage their expectations of achievable returns.

This report aims to help investors, owners, and operators of GB battery assets to further understand the landscape they are operating in and the challenges of the future investment environment. There is a risk that those currently looking at GB projects will focus heavily on the downturn in achieved revenues since late 2022 and miss the greater opportunities in battery storage. This report aims to help its readers see the complete picture and how to outperform rivals in this competitive landscape.

For further discussion, please contact Chris, or your usual contact through our [website](#).



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Lessons for 2023 and beyond

Lesson 1: Margins will not meet the highs of 2021 and 2022 but sustainable growth can be captured

- Battery Energy Storage System (BESS) assets captured unprecedented margins in 2021 and 2022 in the GB market. Investors need to be mindful that much of this was from a tight global gas market and these levels of revenue may be unachievable in the future.

Lesson 2: Operators need to develop more sophisticated strategies to outperform competitors

- The high revenues enjoyed by GB's current BESS fleet have been primarily based on trading in the frequency response markets. These markets have become saturated with competition eating into margins.
- Traders will need to adopt more sophisticated strategies whilst investors must focus on selecting the right optimiser to unlock the best returns.

Lesson 3: System balancing is a potentially lucrative revenue stream, but comes with a high amount of risk

- When stacking revenues, system price spreads offer the most lucrative opportunities for BESS. However, these can also be the hardest to efficiently utilise and opportunity cost exists in other markets.
- A sustainable trading strategy that mitigates risk and exposure, one that aligns with the more realistic growth in the GB power market post-2022 volatility, should be used.

Lesson 4: Frequency Response markets have saturated, and will become a less important part of the BESS revenue stack in the future

- The frequency response markets have historically provided good returns for battery storage operators particularly with strict warranty parameters. However, since mid-2022 these markets have shown significant levels of saturation which has eroded the price that can be achieved.
- There are some signs that the price could increase with the expected uplift in procurement volumes – but this price response is unlikely to be significant considering the strong battery storage pipeline in development which will compete for these contracts.

Lessons for 2023 and beyond

Lesson 5: Connection timeframes must be realistic with such a strong BESS pipeline

- Achieving 18GW of pipeline battery capacity will be a formidable undertaking, which is made more difficult by the current delays in obtaining grid connection agreements.
- National Grid ESO (NGESO) have introduced a five-point plan to ease this connection bottleneck, including offering non-firm connection agreements, allowing for Transmission Entry Capacity (TEC) amnesty, improving their modelling assumption for impact assessment of storage projects, and relaxing the requirement for non-critical connection works.

Lesson 6: Selecting the right location and site configuration is now more important to maximise your revenue opportunities

- Location is becoming a critical factor for developers. The prospect of the GB market moving to Locational Marginal Pricing (LMP), and additional changes to the Transmission Network Use of System (TNUoS) regime will materially impact the profitability of a BESS asset.
- With long connection lead-times and lower availability of connections, now may be a more appealing time to consider co-location of storage. This will also help an intermittent renewable asset to mitigate the impact of negative pricing on the unit.

Lesson 7: The Capacity Market can underpin investment cases, but bidding strategies need to consider future deratings

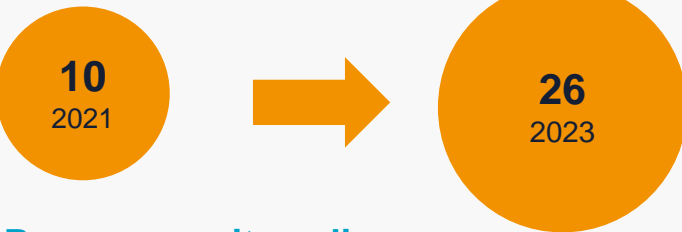
- There has been significant decline in derating factors for the upcoming T-4 capacity auction for 2027-28.
- Unless Capacity Market auctions clear at higher prices than have been observed in recent years, it is unlikely that BESS operators will be able to turn to the Capacity Market to sufficiently recuperate their own missing money in other markets.

Case study: GB demonstrates a successful route-to-market template for other markets

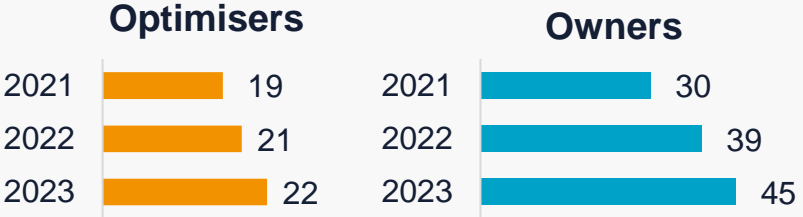
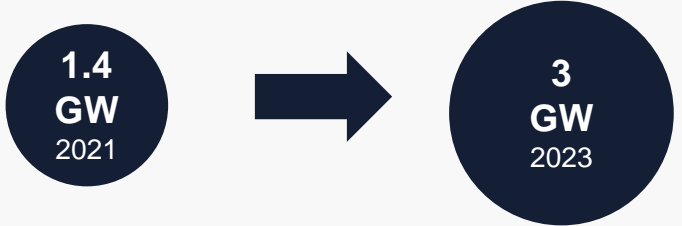
- GB has seen rapid battery deployment due to the full opening up of flexibility markets such as Dynamic Containment for BESS, greater transparency in market data to enable trading in real-time, and an ongoing improvement to regulations for storage.
- Spain is one market where we believe conditions are right for a battery revolution given the prevalence of solar generation.
- Solar based energy system like Spain means the duration of excess or shortfall of electricity will be shorter in Spain than Great Britain, which needs greater buildout of intraday storage assets like BESS.

GB market in numbers

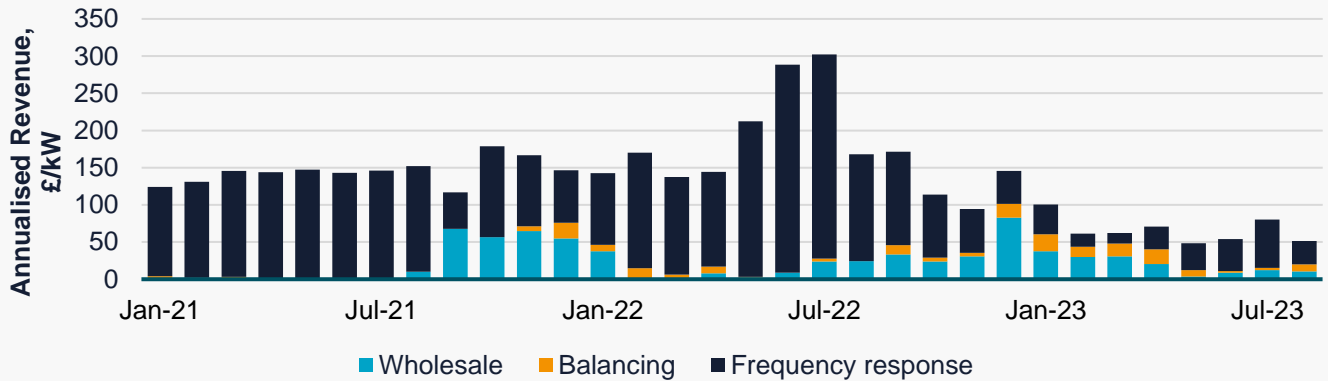
Number of 49MW+ assets:



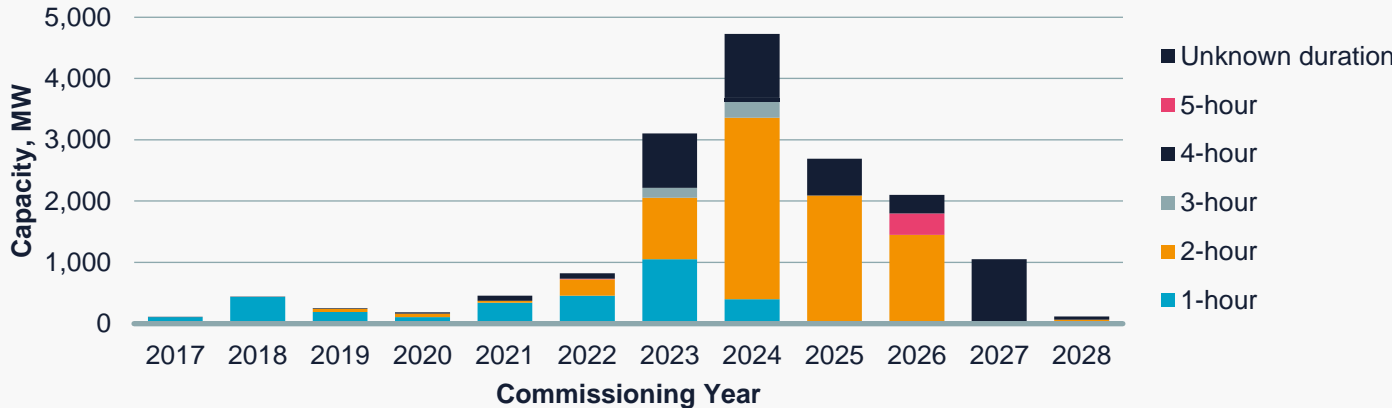
Power capacity online:



Sample 50MW (1.5h) BESS – annualised monthly revenue from Jan '21 to Aug '23



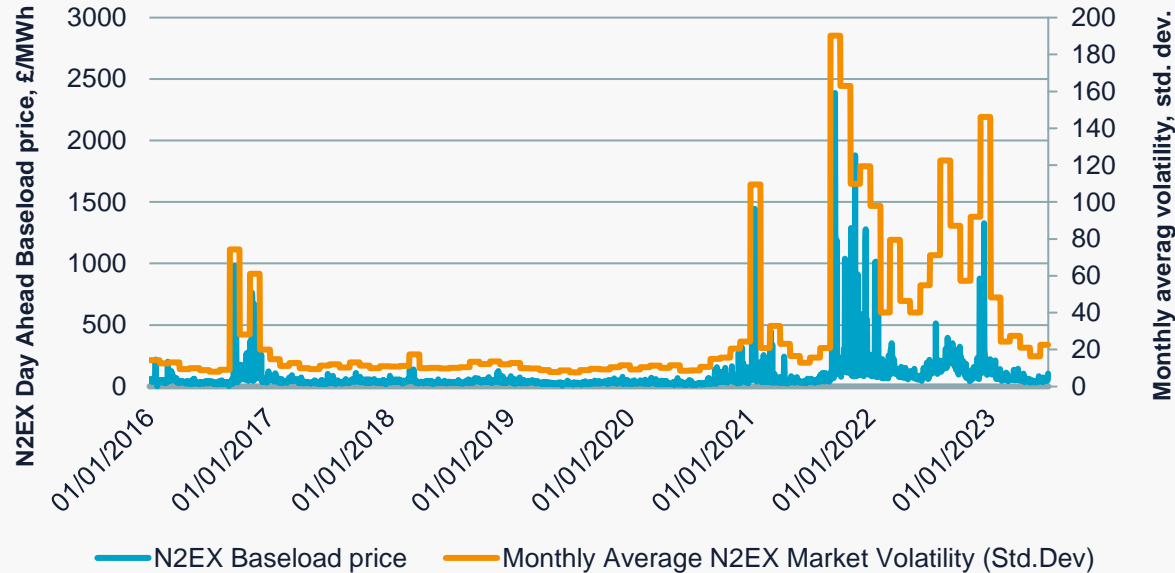
Pipeline of GB's BESS by commissioning year and duration (all announced)



The graph above shows annual BESS capacity additions based on commissioned or announced projects. Sometimes, the durations of BESS (particularly non-BM Units) are not publicly known.

The high market prices and volatility that storage profited from in 2021 and 2022 have softened

Wholesale power price and its volatility



Battery Energy Storage Systems (BESS) generate revenue through price shape and price volatility. BESS shift energy from periods of low prices to periods of high prices, arbitraging the spread in prices across the day. High volatility creates opportunities for BESS to capture lucrative price spreads more often.

The unprecedented power prices and price volatility over 2021 and 2022 presented a sizeable opportunity for BESS. The high revenues available through energy trading also meant that the saturation of frequency response markets did not cause an immediate problem, as frequency response prices were kept high due to the opportunity cost provided by energy trading.

We have arguably witnessed the most extreme periods of price volatility on the GB power system, and as a result, BESS owners have been able to capture high profits. As we exit the current energy crisis, the challenge will be for BESS owners and traders to extract maximum value across all the markets they participate in.

Since late 2022, the picture has changed. Gas prices have fallen significantly since their peak in August 2022, with European gas supply chains showing greater resilience than expected (pivoting to the global Liquefied Natural Gas (LNG) market to meet inter-seasonal gas storage requirements), and Europe experiencing generally a mild winter. This fall in gas prices led to a corresponding fall in power prices.

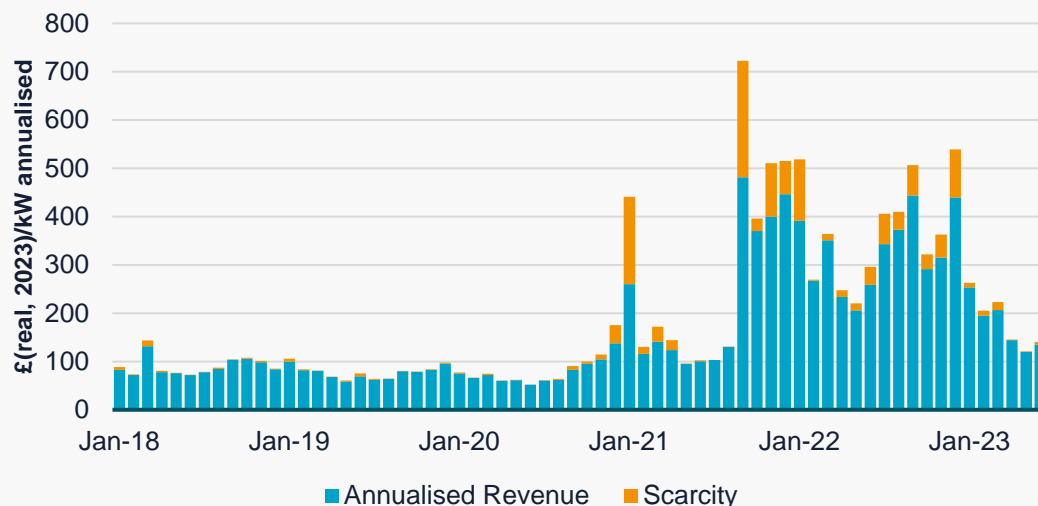
We saw considerable further disruption to GB energy markets in 2022. Gas markets tightened as a direct result of the war in Ukraine, whilst the continued global economic recovery following the Covid-19 pandemic put upward pressure on demand. In power markets, nuclear plant outages in France were compounded by a long hot summer in Europe which led to low reservoir levels affecting hydro plant across Europe. These factors created doubts on the ability of interconnection to provide power to GB if needed in winter 2022-23.

To prepare for winter 2022-23 several mitigation measures were enacted in Europe with the EU mandating minimum stock levels of 90% at gas storage facilities and targeting voluntary reduction in gas and electricity demand of 15% and 5% respectively. Meanwhile, in GB, winter contingency contracts were issued by NGENSO to coal units to delay their planned closures, the Rough gas storage facility was re-opened and the Demand Flexibility Service (DFS) was launched.

Winter weather, apart from a short cold spell (the 'Arctic blast'), was generally warmer than expected - removing concerns on both power and gas markets. Meanwhile, the UK Government struck contracts with coal units as a strategic reserve; these coal units were operated outside of the markets as a strategic reserve which led to lower-than-expected prices in wholesale and balancing markets throughout 2023.

Lesson 1: Margins will not meet the highs of 2021 and 2022 but sustainable growth can be captured

Theoretical historic revenues for a 2-hour BESS participating in wholesale and balancing markets



The above graph shows the theoretical total margin of a 2-hour BESS, based on modelling against historic prices, and represents a theoretical maximum level. The impact of high prices (where prices exceeded levels that would be set by the short-run marginal cost of the most expensive asset on the system) is demonstrated by Scarcity in the chart.

2021 began with a period of exceptionally high prices driven by plant unavailability (see LCP Delta analysis [here](#)). During this period, wholesale prices peaked at **£1,500/MWh** with balancing prices reaching **£4,000/MWh**. Prices in the newly established Dynamic Containment (DC) market remained near the price cap of **£17/MW/hr** (or £149/kW/yr) up until November 2021, well above the fundamental levels implied by the opportunity cost of operating short duration BESS in the energy markets.

Whilst BESS captured unprecedented margins in 2021 and 2022 in the GB market, Investors need to be mindful that much of this was from a tight global gas market and seeking overly optimistic revenues may be unachievable in the future.

Since late 2022, we have seen BESS revenues soften significantly. Whilst falling revenues are disappointing for investors and developers of BESS assets, it is important to emphasise that 2021 and 2022 were exceptional years in many respects. The factors that drove revenues in 2021-22 were not long-term structural features of any well-functioning wholesale electricity market.

So far, 2023 has seen calmer conditions. Gas markets are loosening as new markets open and prices are falling from the highs of previous years. Warmer weather has meant limited price spikes which would otherwise suit BESS looking to arbitrage, and Dynamic Frequency Response (DFR) markets have matured - with DC in particular becoming increasingly competitive.

Bullish market conditions over the past few years have meant regulators and politicians are focussing on market reform. This has led to a review into the high prices set in balancing markets by NGENSO, and for Ofgem to launch new initiatives to curb excessive prices. These factors have meant storage revenues for 2023 have, as a result, been below the expectations of many.

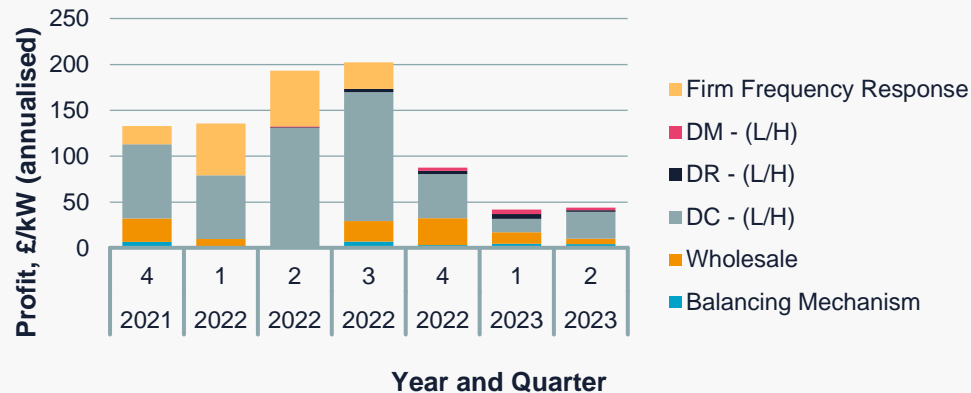
The importance of not relying on historic performance

As highlighted, 2021 and 2022 were exceptional years within the GB power market and BESS were well placed to extract value from this. However, performance over this period should not be seen as a baseline to set expectations and investors should be wary of overly optimistic margin forecasts.

Carrying out robust, fundamentals-based modelling, including sensitivities such as modelling downside cases, is prudent in this environment.

Lesson 2: Operators need to develop more sophisticated strategies to outperform competitors

Evolution of profits obtained by the top five BESS in Q4-2021 (Enact leaderboard)



Until recently, BESS in GB had been trading profitably by allocating almost all volume to frequency response markets, in particular Firm Frequency Reserve (FFR) and DC services. The chart above tracks the profit sources for the five most profitable BESS units in GB in the fourth quarter of 2021. This was an important quarter for the BESS sector as it signalled the first full quarter following the phased introduction of the DFR markets; initially with DC Low in September 2021, and then DC High in October 2021.

Since the final quarter of 2022, we have observed a sizeable drop in profits coming from FFR and DC products for these units, without a corresponding increase in profits from other energy products (i.e. wholesale and balancing markets). This drop has been driven by the saturation of frequency response markets and NGENO's decision to phase-out the FFR market, at a time when wholesale power prices and energy trading value has decreased significantly.

The strengths of short-duration BESS really do lie in the short-term balancing and management of the electricity system. As such, the prices captured in NGENO's balancing services have provided fair value for relatively low amounts of cycling. This has meant that these revenue streams have been heavily utilised by BESS operators. These prices, however, have come off dramatically since 2022.

In the near-term, trading a BESS asset on FFR and DC products alone will not yield as much profit as harvested recently. Those trading BESS assets will need to devise and exercise more sophisticated ways in which to buy and sell multiple products with stackable revenue sources. This may lead to the emergence of a wider variation in the performance of BESS optimisers. For investors and developers, selecting the right optimiser will be pivotal to maximise returns.

Why leaderboards do not give you the complete picture

In an article published in [Current-News](#), LCP Delta considered how the term "leaderboard" can be misleading to investors as it does not provide a full picture. This is because a significant portion of the strategy of an asset is hidden.

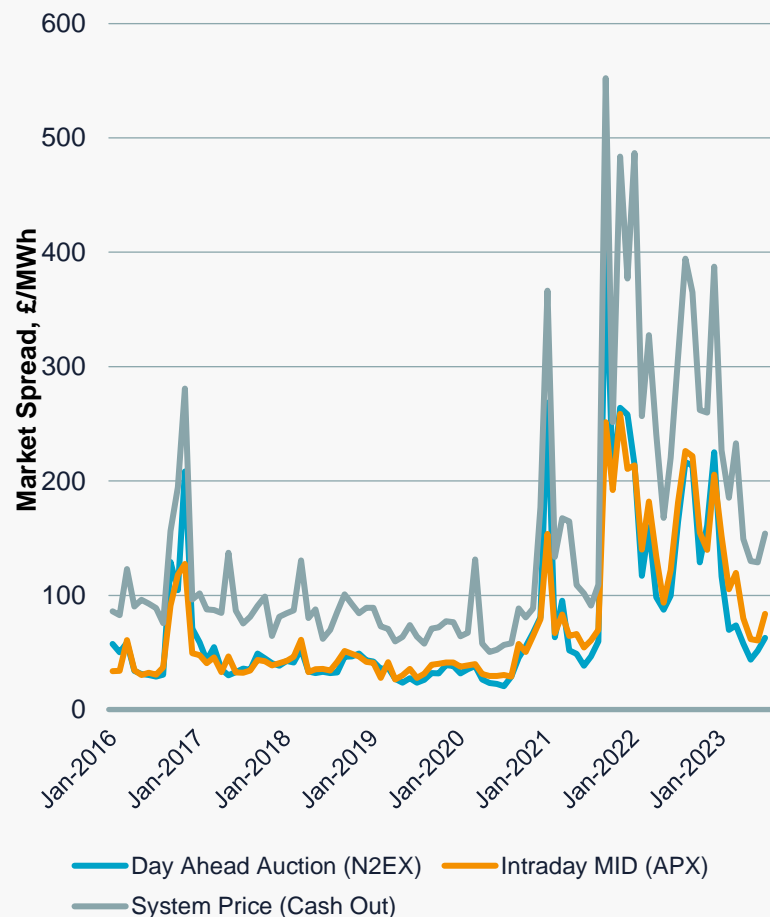
Assets participating in the wholesale market only publicly report on their market position (what has been bought or sold) if they are a Balancing Mechanism Unit (BMU) and submit a Final Physical Notification (FPN). How a BESS trader trades throughout the various wholesale market timeframes to reach their FPN is not disclosed.

The commercial sensitivity of each unit's trading strategy and dispatch (for example, there is no public visibility of optimising through the system price, also known as Net Imbalance Volume (NIV) chasing) means that leaderboard providers are left needing to make assumptions in order to benchmark each unit against one another.

For BESS investors and developers, using leaderboards to view the profitability of BESS optimisers can provide an incomplete picture. Instead, they should use leaderboards as the first step to uncovering the rest of the iceberg that an optimiser is capturing.

Lesson 3: System balancing is a potentially lucrative revenue stream, but comes with a high amount of risk

System Price spreads and volatility



Looking to secure revenue from NIV chasing can be highly profitable, as demonstrated by the system price spread, but can be risky due to difficulties with forecasting. Whilst the potential for high profitability will likely persist in the future, further-ahead-of-time markets should be utilised to structure a trading strategy that captures the system price value but mitigates risk.

When assessing the potential margins available across the different energy markets, the system price spread continues to outperform the day ahead and the intraday spreads. Over 2021 and 2022, the system price daily spread traded at an average premium over the intraday and day ahead by over £120/MWh.

As demonstrated by the chart, there is the potential for significant value to be captured through balancing – either through the system price or participating in the Balancing Mechanism (BM). However, this trading strategy brings with it considerable risk. A NIV forecast is only as good as its constituent parts, the key factors of this being a good outlook of wind, demand and generation (both embedded and transmission-connected). As a greater amount of intermittent generation gets connected, the problem will only become more challenging.

To a greater extent, ageing conventional firm generation exiting the market will be replaced with intermittent renewables. This will increase arbitrage opportunities in the further-ahead-of-time markets (i.e., the Day-ahead auctions) going forwards and offer alternative markets to mitigate NIV chasing risk with a good return.

What is Net Imbalance Volume (NIV) chasing and why is it so risky?

NIV chasing is a trading strategy where a trader either does not trade or acts contrary to its traded position based on forecasted system need. If there's excess power, you aim to import more or export less than your planned trade. If there's a shortage, you target exporting more or importing less. This ensures you are paid rather than penalised.

Your rewards (or penalties) depend on the system price. If you align with system needs (ie you are long on your traded position in a system with undersupply, or you are short on your traded position in a system with oversupply), you are rewarded with the system price for that half hour; if not, you are penalised with it.

LCP Delta works with both physical and non-physical traders, helping them forecast the direction of the system, allowing them to reduce the risks and increase potential earnings of NIV chasing.

Lesson 3 continued: System balancing is a potentially lucrative revenue stream, but comes with a high amount of risk

The BM has disappointed BESS operators in GB due to market rules and Electricity National Control Centre (ENCC) processes and infrastructure increasing dispatch risk. However, the BM should be considered as a small market which carries dispatch risk, which should be mitigated with a suitable trading strategy.

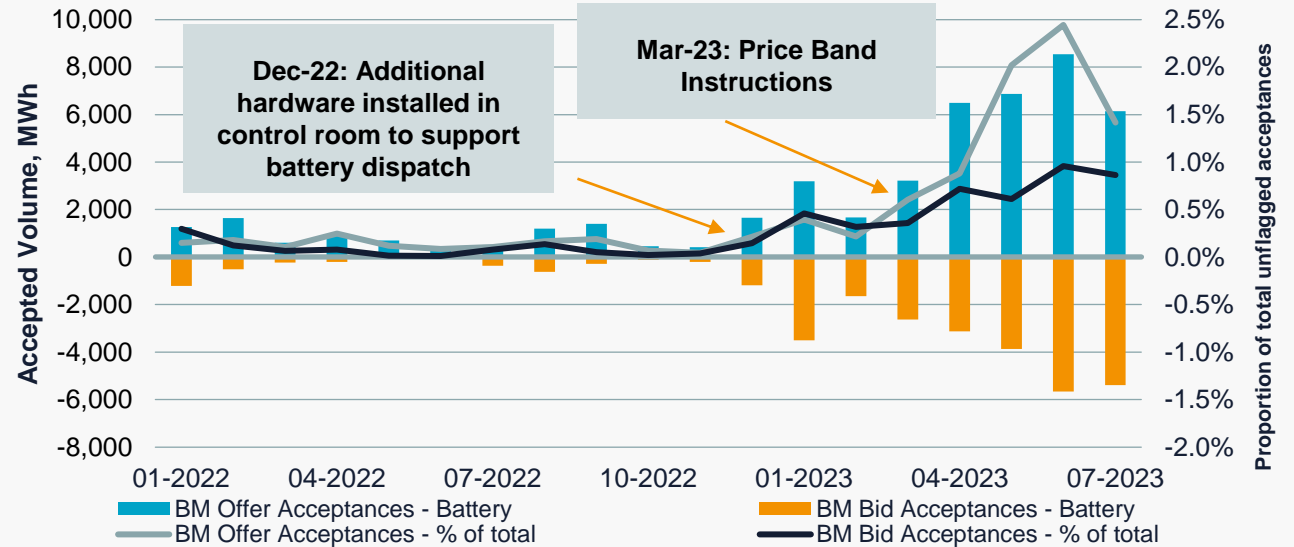
For some time now, BESS operators have highlighted concerns around their lack of dispatch in the BM. This can be put down to a market rules and legacy IT infrastructure across Elexon and NGENSO that limits NGENSO's ENCC ability to efficiently dispatch storage.

Since late 2022, the ESO has brought about additional hardware into the ENCC and introduced Price Band instructions in March 2023. **This resulted in BESS dispatch instructions in the BM increasing by around 175% in volume (MWh) over 2023.** However, these still only make up around 2% of accepted unflagged offers and less than 1% of accepted unflagged bids.

NGESO is expecting to bring about additional changes to the BM and the ENCC in the coming months, including multiple dispatch. This should allow the ENCC to dispatch multiple units at once, preventing manual skips of smaller assets when the ENCC is busy and therefore providing more opportunity for BM dispatch. It also plans to address the '15-minute rule' where BESS assets are only able to provide data informing of how much power can be imported or exported in the next 15-minutes which limits dispatch opportunities.

It is important, however, for BESS operators to be realistic of dispatch opportunities in the BM and not to expect it to be a reliable source of capturing scarcity or value in the market. The volumes dispatched on a day-to-day basis in the BM are exceptionally low compared to those self-dispatched through the wholesale markets across all technology classes. There is a fair argument for reform of the BM which could provide additional dispatch opportunity, particularly against large gas generators. For the time-being we advise on suitable caution to be applied to any expectations of what revenue this route to market could achieve.

BESS acceptances in the BM and key National Grid ESO changes



Skip rates in the BM – what are they?

In recent months, the issue of 'Skip Rates' for BESS in the BM has come to the fore. Skips are defined as a unit that is not dispatched by NGENSO in the BM despite its bid or offer being cheaper than the units that were dispatched – i.e. not being dispatched when 'in-merit'. In an open letter from the Electricity Storage Network (ESN) to NGENSO, a skip rate of 80% for BESS in the BM was identified (based on June 2023 data of energy actions for less than 3 settlement periods).

Though skip rates for BESS may improve, the issue highlights the need for GB power market participants to consider the BM for its intended purpose – a tool for the system balancing of relatively limited volumes.

Lesson 4: Frequency Response markets have saturated, and will become a less important part of the BESS revenue stack in the future

The saturation of the DFR auctions has reduced clearing prices. With lower but still sustainable returns available in the market likely attracting investors with a lower risk-return profile, business decisions should ensure that they are not restricting an optimiser's ability to utilise all revenue streams profitably.

Since its introduction in 2021, DC has been an important proportion of a BESS assets revenues. High prices were achievable, as providers were paid by NGENSO for their ability to respond very quickly to deviations in system frequency (as the system became less stable due to less inertia from conventional synchronous generators).

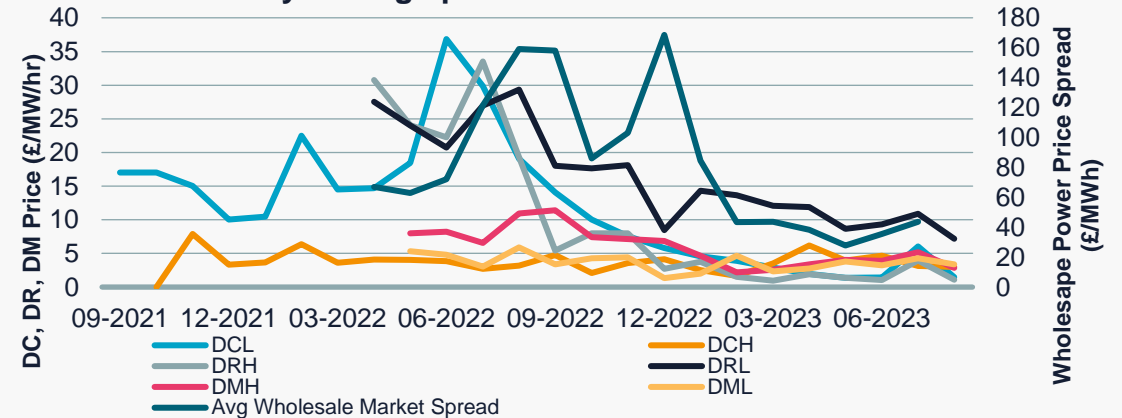
Like FFR, DFR is well suited to BESS assets which commonly have more prohibitive warranties. These warranties limit BESS to a low number of cycles, more cautious temperature controls and mandated periods of rest. These are particularly prevalent with investors who have a lower risk-return profile and particular Original Equipment Manufacturers (OEMs). With these parameters applied, it can be difficult to outperform DFR in wholesale market arbitrage.

The strong BESS pipeline, and strict warranties, combined with falling wholesale market opportunity has led to the saturation of DFR market and lowering of auction prices.

NGESO dynamically sets DFR procurement levels based on day-ahead system requirements. For instance, in July 2023, DC Low procurement levels rose, with a responding price increase to £8/MW/hr due to concerns in Scotland. By March 2024, FFR will be phased out in favour of DFR and the upcoming Firm Recovery product. **This, coupled with the lowering of inertia requirements from 140GVA.s to 120GVA.s (with a 130GVA.s interim step), will boost DFR procurement levels.**

However, this optimism may be short-lived. While the BESS pipeline is shifting towards 2-hour+ assets, which are less suitable for DFR, there remains a substantial number of short-duration BESS in the pipeline. Consequently, any increase in procurement will likely be offset by higher competition in auctions, driving prices downward.

D-1 (N2EX) Average Monthly Spread and Dynamic Frequency Response Products Monthly Average prices



Enduring Auction Capability (EAC)

Due to start in October 2023, NGENSO will transition its DFR markets to its Enduring Auction Capability (EAC) platform to replace the current EPEX based platform. For units bidding into balancing services, this will simplify co-optimisation across DFR, allowing a participant to place multiple bids across services for NGENSO to dispatch the unit in the service that best suits the system need for that period through a new optimisation algorithm.

As well as the DFR markets, it is expected that once launched both Quick and Slow Reserve will also be included in the EAC. This will further simplify and enable co-optimisation for BESS across the most relevant balancing services that they will be able to provide. It will also enable negative pricing, so there is a question how the market will react considering the high amount of sub £1/MW/hr bids submitted in the DFR auctions.

Lesson 5: Connection timeframes must be realistic with such a strong BESS pipeline

High margins achieved in 2021 and 2022 have attracted investors to the BESS sector and as a result BESS capacity in GB is forecast to almost double between 2022 and 2023 to 4GW of installed capacity (LCP Delta, [STOREtrack](#)). Looking further out, BESS capacity could reach over 18GW by 2030 with increasing levels of longer duration storage (majority of BESS pipeline is 2+ hour storage).

Given that developers are already experiencing severe delays in obtaining grid connection agreements, achieving this pipeline may prove difficult. NGENSO have announced a five-point plan to alleviate this bottleneck, including a TEC amnesty that will remove an estimated 8GW of generation from the TEC register without levying of the cancellation charge.

Further, NGENSO is offering developers the option to obtain a non-firm connection agreement in a shorter timeframe. A non-firm commitment would mean that a BESS asset may be curtailed during constrained periods without compensation. We do not expect this to have a significant impact on revenues as BESS commonly exports during periods of generation shortfalls and imports during periods of excess.

The strong pipeline underlines the increasing competition for capturing storage revenue opportunities. Even though achieving the pipeline will be difficult, measures being introduced by NGENSO means that developers will likely have alternative, and quicker routes to getting BESS connected to the grid. However, developers will need to increase focus on their due diligence to ensure that the project specifics such as duration, technology and location maximise efficiency gains and revenue opportunities.

National Grid ESO's [Five-point plan](#) to ease the connection bottleneck

TEC Amnesty

Operating a TEC Amnesty until April 2023, allowing developers to terminate their connection contracts without incurring liabilities, freeing up capacity in the queue.

Updating modelling assumptions

NGESO is updating modelling assumptions to reflect current connection rates and reducing the assumption that most projects in the queue will connect.

Amending treatment of storage

Changing the treatment of storage, including BESS on the network to allow them to connect faster and free up capacity for other projects.

New contractual terms

NGESO is developing new contractual terms for connection contracts to manage the queue more efficiently so that those projects that are progressing can connect and those that are not can leave the queue.

Non-firm connection agreement

An interim option for storage projects to connect to the network sooner is to use a non-firm connection agreement. This comes with the caveat that they may be required to turn off more frequently when the system is under stress without being paid to do so.

Lesson 6: Location and site configuration is now more important to maximise your revenue opportunities

Locational signals may sharpen in the future, bringing about higher profit margins from being in a more competitive location that is closer to demand or assists with network constraints.

There are two key considerations when deciding the location of a standalone BESS site: i) Network charging, such as Transmission Network Use of System (TNUoS) or Distribution Use of System (DUoS) charges, and ii) the impact of system balancing actions from NGESO in the BM to resolve network constraints. However, with proposed changes to the TNUoS regime, and the possibility of the GB market moving to a Locational Marginal Pricing (LMP), these considerations are becoming more important and complex.

If LMP were to be implemented, asset margins may erode for assets in unfavourable locations, for example where oversupplied with wind and therefore subject to long continuous periods of low prices. BESS located close to demand centres with relatively under-supplied zones could see periods of favourable price spreads.

One of the proposed changes to TNUoS is CMP405, under which storage would receive a locational demand signal. This would recognise storage's contribution towards alleviating grid congestion through charging, and hence deferring network investment. This may act as an incentive for storage to locate in export-constrained areas, such as north of the B6 boundary (i.e. in Scotland).

Co-locating BESS with complementary renewables can maximise the use of scarce grid connections and minimise renewable curtailment. However, if combined exports exceed the shared grid connection there will be revenue conflict.

Competition for grid connections highlights the opportunity to share underutilised connections with renewables, maximising the use of scarce connections.

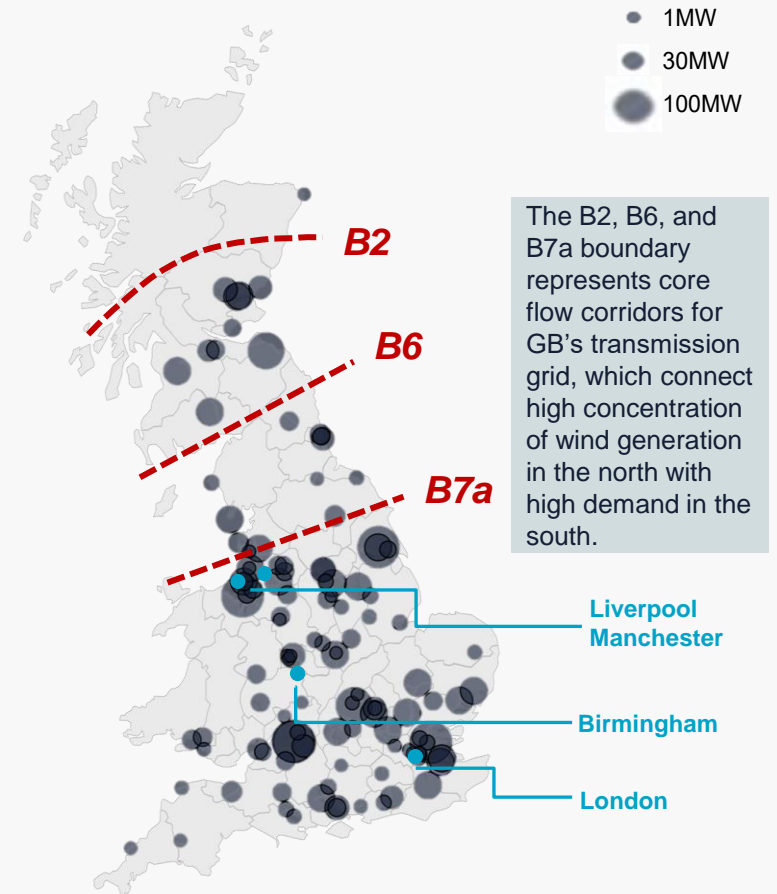
Solar PV, in particular, complements BESS well due to low interference. Solar output is typically high during periods when BESS would be unlikely to discharge. The case for co-location is strengthened as solar deployment increases and solar's captured prices fall.

Co-location also allows for oversizing of the renewable asset in relation to the grid connection. Excess generation can be used to charge the BESS, particularly in a DC-coupled arrangement.

The Contract for Difference (CfD) scheme's metering arrangements allows for either DC or AC coupled co-location, with DC coupling providing benefits in reduced losses when BESS charges directly from the renewable asset.

However, when dimensioning the renewable asset, BESS and connection, the developer should consider the risk of revenue interference. This occurs when the BESS and renewable asset would both gain value from exporting at the same time (or having available export capacity to provide a balancing service), but the grid connection cannot accommodate both.

Map of existing BESS capacity in the UK



Lesson 7: The Capacity Market can underpin investment cases, but bidding strategies need to consider future deratings

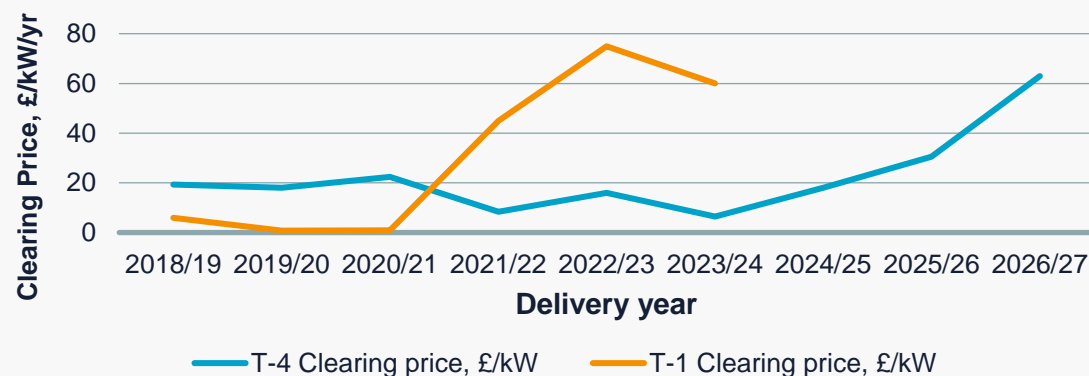
The Capacity Market (CM) is the GB power sector’s security of supply mechanism. It was introduced in the 2013 Electricity Market Reform (EMR) package. It does this through pay-as-clear competitive auctions, which take place four (T-4) and one (T-1) year ahead of delivery, where successful bidders are remunerated based on their de-rated capacity.

These de-ratings are determined by NGENSO based on detailed stochastic modelling (using LCP Delta’s modelling tools) and vary for storage based on duration. They have declined over time based on increasing storage build out.

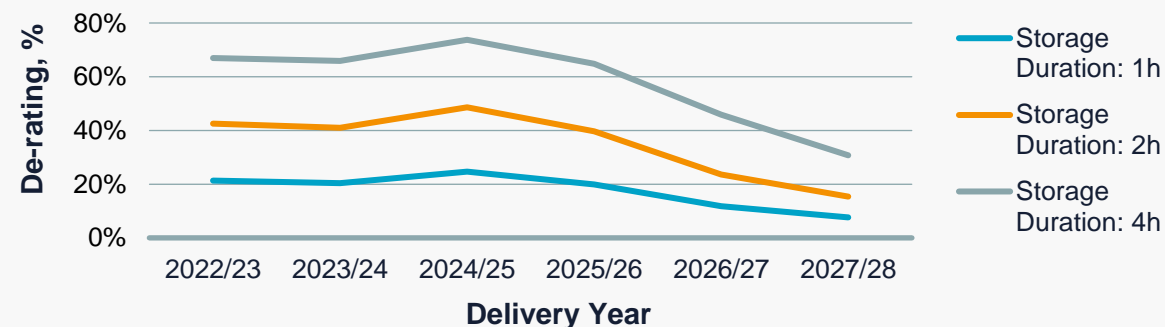
Up to the 2019-20 capacity auction round (for T-1 deliver in 2020-21, and T-4 delivery in 2023-24), the clearing prices of the CM had generally disappointed market expectations and requirements to successfully underpin investment in the GB electricity market.

However, in recent auctions clearing prices have increased – with a clearing price of £63/kW/yr in the most recent T-4 auction. These have been driven by closures (such as nuclear and coal) driving greater requirement, as well as higher capital costs and lower long-term market revenue expectations. These higher prices have helped support a number of new projects come to market.

Capacity Market clearing prices



Capacity Market storage de-rating factors



It is expected that the CM will continue to clear at these increased prices as peak demand increases, and gas generators become increasingly reliant on the CM as their energy margins are eroded due to the penetration of renewable generation. NGENSO’s recommended requirement for the next T-4 auction (for delivery in 2027-28), was 0.6GW higher than for 2026-27, despite more than 3GW of new contracted capacity being held outside the auction. The ending of CfD/ROC support of biomass units in 2027 being the main driver of this increase.

Despite the positive outlook on CM prices, BESS assets must contend with declining de-rating factors, limiting the value they can achieve in the CM. This makes longer durations, which command higher derating factors, more attractive. NGENSO has now commenced a review of its storage de-rating factor methodology in line with the CM Panel of Technical experts 2022 recommendation to consider storage operational data instead of a model-based approach.

As displayed in the graph above, we have seen another significant decline in de-rating factors for the upcoming T-4 capacity auction for 2027-28. Unless these auctions clear at higher prices than have been observed in recent years, it is unlikely that BESS operators will be able to turn to the CM to sufficiently recuperate their own missing money in other markets.

The outlook: The fundamental need for BESS to support the energy transition remains

The fundamental need for BESS to support the decarbonisation of the electricity sector remains. The market signals to build additional storage are expected to soften in the short term but remain sustainable in the long term as the system decarbonises.

Over the next few years:

- There will be limited growth in demand as the economy recovers from the cost-of-living crisis. The roll-out of heat pumps and electric vehicles remains nascent. In the absence of cold shocks and as European countries reduce their reliance on Russian sources of fossil fuels **power markets will cool**.
- **Intraday prices are likely to become more volatile** as renewable capacity continues to increase and as baseload nuclear decommissions (such as, Heysham-1 and Hartlepool in 2026).
- Imbalance volumes are expected to grow due to greater forecasting errors as both demand and wind generation, increases. However **new initiatives proposed by NGESO for the Balancing Reserve product and Ofgem's Inflexible Offers Licence Condition (IOLC) seek to both cool and restrict the behaviours of market participants driving excessively high balancing prices**.
- The volume requirements for DFR services are due to increase but will not be expected to materially change clearing prices. Growth in BESS capacity will mean **these markets become increasingly competitive**, increasing the importance of other energy market revenue.
- The new **Quick and Slow Reserve** products expected to go-live this year have been **delayed until at least next year** by NGESO owing to ENCC implementation problems. The Quick Reserve product with its maximum activation time of 15 minutes offers a potential new revenue stream for some BESS assets.

In the longer term:

- There will be **limited growth in the volume requirements for DFR services further out**. The largest credible loss may increase to c.1.6 – 2GW with the commissioning of large new interconnectors and frequency deviations themselves may become more volatile as renewable penetration increases which DFR will largely protect against. However, NGESO is contracting low carbon providers of system inertia to contain these (through the stability pathfinder framework and the newly proposed stability market arrangements).
- **Increasing demand from the electrification of transport and heat**, and with it the growth in renewable capacity to both meet this requirement and support the decarbonisation of the power sector, will mean that the fundamental requirement for flexibility, and in particular storage, will continue to grow.
- The **need for zero carbon sources of flexibility will grow**. Current viable technologies are limited to hydrogen-fired thermal generators, storage and interconnection. BESS, for which supply chains are becoming increasingly developed, is the most mature technology suited to this role.



Case study: GB demonstrates a successful route-to-market template for other markets

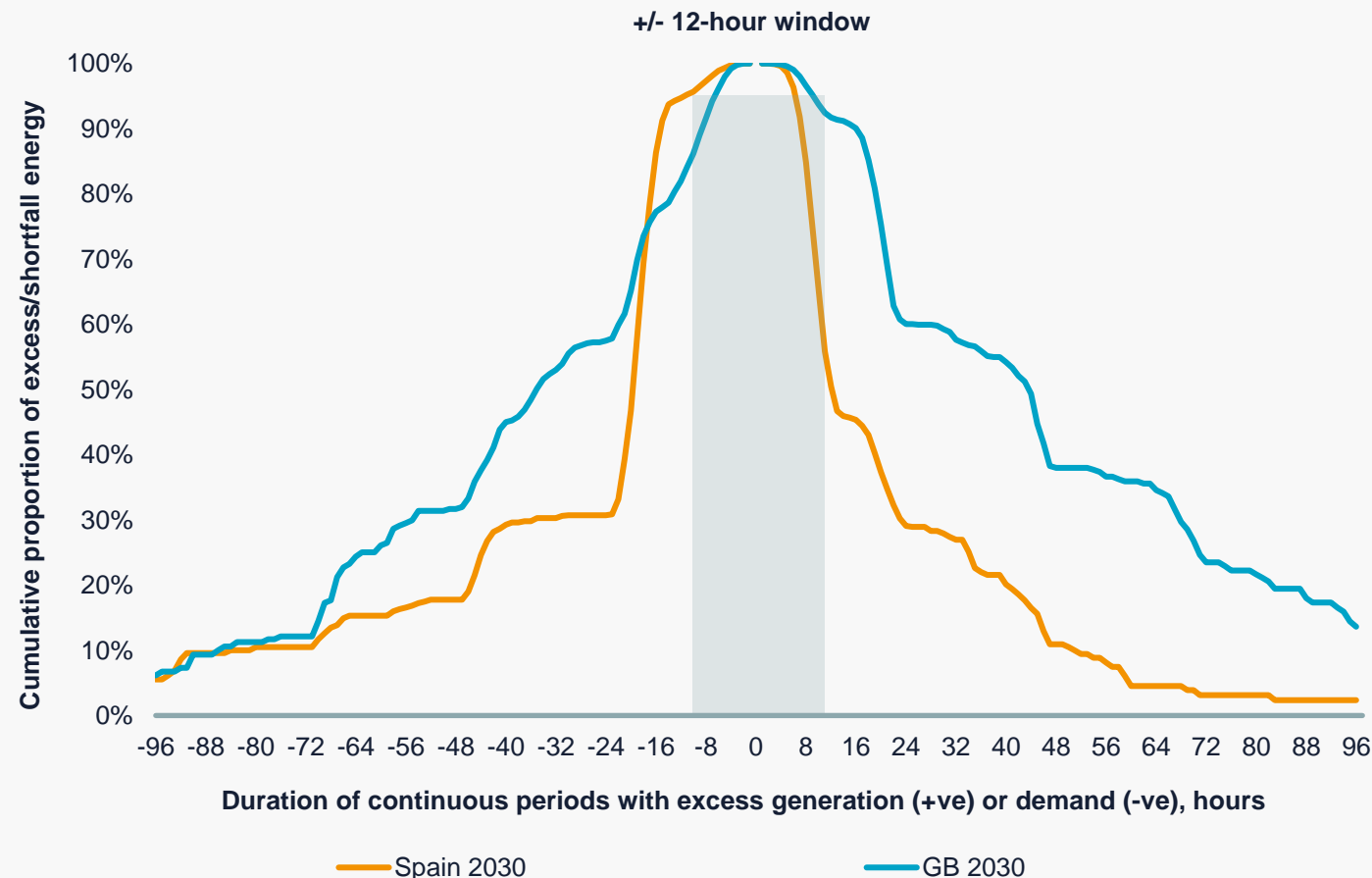
Some of the key reasons GB has seen such rapid deployment of BESS are the full opening up of flexibility markets such as DFR and the BM, greater transparency in market data to enable trading in real-time, and ongoing improvements to regulations. GB's success in these areas provides a template for BESS across Europe.

Unlike mainland Europe, BESS in GB has full access to trade across energy markets (i.e. Day-Ahead, Intra-Day and balancing), flexibility markets (i.e. FFR and DFR), and the CM. This enables BESS to revenue stack, a fundamental trading strategy that allows the assets to maximise revenue by trading sequentially across multiple market windows.

BESS can rapidly regulate their charge and discharge actions, which poses a great opportunity for traders of these assets to capitalise on short-term price movements. Having access to the market data in real time means that BESS optimisers have been able to successfully trade these assets and capture the high price volatility in the past 2-3 years. [LCP Delta's Enact](#) platform helps traders and market operators analyse the large volumes data that is continuously streamed as well as provide novel analytical tools to give a commercial edge over competitors.

The ongoing changes to improving the regulatory environment for BESS have helped attract numerous developers and investors to GB. For instance, removing Balancing Service Use of System (BSUoS) tariffs on charging of BESS meant that they were not charged twice (before BSUoS was completely removed from generation in April 2023).

Renewable generation in continuous periods of excess or shortfall: Spain vs GB in 2030



Case study: GB demonstrates a successful route-to-market template for other markets

Battery storage market in Spain

As the BESS sector matures in GB, we are seeing developers look for further opportunities in emerging markets. Spain is one market where the fundamentals are favourable, with the prevalence of solar generation creating a strong intraday need for flexibility.

A solar-based energy system means the duration of excess or shortfall of electricity will be shorter in Spain than for a wind dominated system like GB. Our analysis of the two systems in 2030 shows that in Spain over 50% of excess renewable energy occurs in periods where there is continuous excess for less than 12 hours, i.e. BESS that charges on this energy would be able to discharge within 12 hours.

Furthermore, BESS inherently has more opportunity where there are periods of excess and shortfall within the same day, driving price differentials which make battery storage profitable. LCP Delta estimate that in 2030 BESS in Spain will have over 300 days when they can cycle within a day, charging from excess renewable energy.

In addition to the high prevalence of solar, there are other factors we believe provide the right conditions for BESS assets in the future:

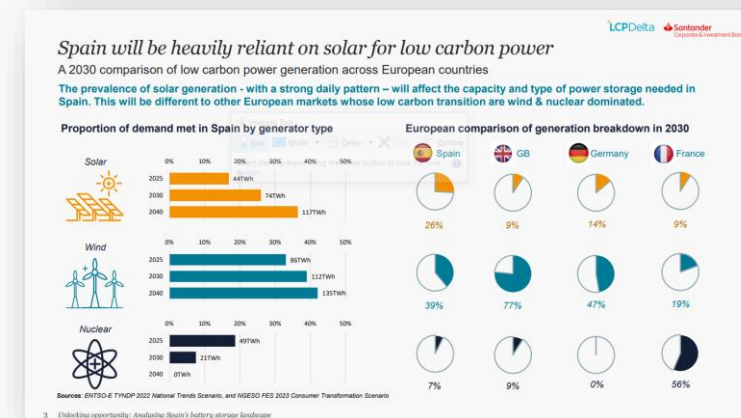
- Spain is relatively isolated from other markets; meaning Spanish storage faces limited competition from cross-border flexibility.

- Spanish wholesale markets have offered increasing revenues with price volatility remaining higher than what has been observed historically.

Sustained investment in BESS would be supported by fully opening markets. We believe that the investment case would be further strengthened where BESS is able to access the TSO spend on flexibility services and the introduction of a capacity mechanism.

The Spanish Government have recognised the need for storage and set a target of 22GW by 2030. We expect this to be predominantly BESS. Whilst the overly restrictive requirements for co-located storage have limited uptake in the latest renewables auction, the recent consultation on grants for 600MW of energy storage is a positive step towards meeting the Government's target.

Working alongside Santander, LCP Delta **published** a report that concluded that while there are positive steps being taken – such as the Spanish government consulting on providing grants to storage – the current regulatory barriers and delayed support are limiting the current pipeline. However, the opportunity for future development is significant; **Spain's ambitions will require considerable investment in BESS projects with senior debt requirements of up to €3.4 billion.**



LCP Delta can help you address these considerations across your full investment journey on storage

Learn

- Helping to build knowledge and understanding of power market fundamentals
- Providing insight and clarity on the investment landscape around policy, regulations, markets, and technologies

Identify

- Providing access to information, data, and tools to analyse storage assets, markets, and companies
- Forecasting evolution of the market fundamentals (e.g., technology buildout, price, generation, emissions) and storage asset performance
- Advising on route-to-market strategies for specific storage technologies in specific markets

Invest

- Independent advice on transaction due diligence through bespoke revenue forecasting of company portfolio (not just storage), conducting red-flag assessments, and benchmarking vendor due diligence

Operate

- Providing access to information and data to benchmark storage assets and identify market leaders
- Providing access to modelling infrastructure to forecast potential revenue and operations of storage assets

Sell

- Independent advice on vendor due diligence through bespoke revenue forecast of vendor portfolio
- Providing vendor due diligence report (market report) and assessment of vendor portfolio

Investing in battery storage assets in an ever-changing regulatory and competitive backdrop has never been more complex. If you would like to hear how we help our clients with their battery assets, from investor due diligence to real time trading, [get in touch with us](#).

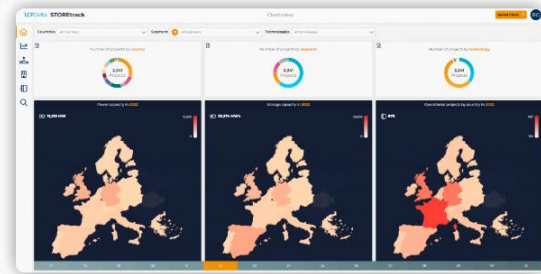
Top picks from LCP Delta and beyond

LCP Enact



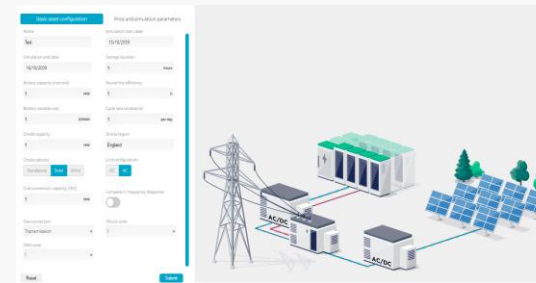
Performance benchmarking, leaderboards and real time trading support for the UK market.

STOREtrack



Live comprehensive dataset tracking the status and parties involved in storage projects across Europe.

STOREcast



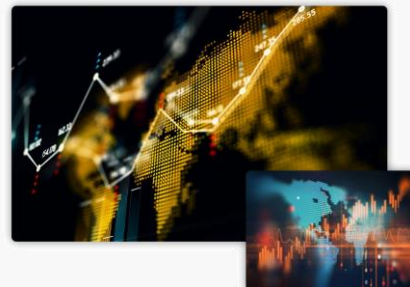
Configurable bespoke asset and portfolio revenue forecasting for the UK storage market for 20+ years.

Unlocking opportunity: Analysing Spain's battery storage landscape



LCP Delta and Santander have combined their expertise to analyse the opportunity for investment in battery energy storage systems in Spain.

Power Market Modelling and Revenue Forecasting



Advising policy makers, lenders, investors and asset owners with expert power market forecasting.

Due diligence support



Quantitative modelling and economic analysis to support transactions

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