

Piecing together the 'jigsaw of value' in UK energy storage

The UK | With a project pipeline in excess of 14GW, a developing regulatory envelope and maturing revenue streams, the UK's energy storage sector continues to be at the forefront globally. Molly Lempriere charts the market's development to date and uncovers how it has responded to deployment barriers.

The UK's utility-scale battery energy storage sector is widely considered to be amongst the world's leaders, with a quickly expanding pipeline of assets along with a growing number of potential revenue streams. With renewables producing a record 41% of Britain's energy mix in 2020, the challenge of balancing the grid has become ever more present, and batteries are stepping up to the plate.

A number of significant changes in revenue streams and planning legislation has further spurred on the market, with changes to legislation allowing projects over 50MW in England without the need for Nationally Significant Infrastructure Project (NSIP) status, as well as the hugely attractive Dynamic Containment (DC) frequency regulation service launched by system operator National Grid ESO attracting attention for its high rewards.

Growth so far has matched demand, with increased renewables demanding increased flexibility from the grid, a service batteries are exceptionally well placed to meet. But how much more storage will be needed, and could we see the market become oversaturated?

Growing pipeline and expanding assets

In the UK, there is currently a pipeline of just over 14GW of storage projects, and around 1.2GW of operational projects, according to research from Solar Media Market Research. Of this, around 7.5GW already has planning permission. This has grown dramatically in recent years, with the pipeline jumping from just 2.3GW in 2017.

The number of projects has grown, but so has the size of the assets, with 2020 seeing a raft of 50MW storage projects energised. This included Gresham House Energy Storage Fund (GRID) acquiring a number of assets, such as the 50MW Wickham Market site in November, while

Northern Ireland's largest battery storage project, 50MW site in Drumkeel, Co. Tyrone was energised in the same month by developers Low Carbon and Gore Street Energy Storage Fund.

According to Gore Street, this growth in size has been driven by both demand and economies of scale, something it has seen in its portfolio of around 100MW of operational energy storage since it acquired its first battery site – the 6MW Boulby battery in North Yorkshire – in 2015.

"It's funny that 6MW site – which was our first asset and we still own it – at the time that was commissioned was the largest privately owned lithium-ion facility in Britain and the largest in the world, providing frequency services," explains Gore Street Capital CEO Alex O'Connell. "Our average deal size now is 50MW, because there is this huge maturity of the sector, the assets are getting bigger and bigger, which is what the grid operators want, and we want them to be bigger because we've got economies of scale with the manufacturers."

Whilst there are currently no projects larger than 50MW in operation, there are a number of co-located projects that have a total capacity greater than 50MW. This includes the Minety battery storage scheme in Wiltshire, which secured land rights, planning permission and a grid connection offer back in March 2020 to extend its current 100MW project by a further 50MW. The initial 100MW is made up of two 50MW ternary lithium batteries provided by Penso Power and, at the time the extension was announced, was the biggest battery storage project in Europe.

A key change to planning legislation in July 2020 opened up the possibility of



Gresham House Energy Storage Fund acquired the 40MW facility in Glassenbury battery site in Kent, England, in 2019. It forms part of the company's nearly 400MW strong portfolio.

Credit: GRID.

14GW
The UK's current
energy storage
pipeline

large-scale battery storage sites. Ministers passed secondary legislation to allow battery storage to bypass the NSIP process in Britain, meaning storage projects above 50MW in England and 350MW in Wales can proceed without approval through the national planning regime.

Unlike projects like Minety – which are made up of multiple co-located batteries, with multiple grid connections – single-site large-scale battery storage is now possible in the UK, and companies were quick to set their sights on it.

The largest in this pipeline is InterGen's 320MW London Gateway Project, announced in November and quickly hailed as a significant moment for the UK's storage sector. The London Gateway Project will be InterGen's first – and rather dramatic – step into the storage sector, having focused on flexible assets in the form of Combined Cycle Gas Turbines (CCGTs) previously. By dint of how large the project is, however, it will propel it to being one of the major players in the sector.

Currently, GRID has the largest portfolio of operating battery storage sites in the UK, with 395MW of operational storage at the time of publication and a number of other

InterGen's London Gateway: The first of the giants?

InterGen's London Gateway project is set to be the biggest battery facility in the UK by a significant measure, utilising energy storage technology from the company's partner Fluence. The project is expected to use the company's sixth-generation Gridstack system design.

It will be a merchant risk project, but speaking to PV Tech Power, InterGen's Jim Lightfoot says he isn't concerned about attracting investment given the strong appetite for carbon free flexibility projects in the UK.

Lightfoot is more conservative in his predictions for large-scale battery storage projects in the UK following in InterGen's footsteps however.

"I think there will be larger scale batteries, but I think there's a limit to the amount that can be put on the system... Ones of this scale are very, very big and the costs associated with them aren't insignificant. So I think you'll see less of them."

projects in the pipeline. It has grown this substantially over the past year, and has expanded its portfolio by 80MW in 2021 already through the acquisition of a 25MW battery-only Tynemouth site, the 35MW Port of Tyne site, the 10MW Nevendon site, and the completion of its Glassenbury B extension.

The 'hot new investment class'

With a growing market has come new revenue opportunities for battery storage, featuring increased demand leading for a growing number of services playing into the UK's ancillary market in particular.

"The fundamental... relatively islanded nature of the UK is a big driver," explains Marek Kubik, managing director for UK, Ireland and Israel at Fluence. "Limited interconnection, aging thermal generation, the variable and distributed nature of renewables... all trend towards an increased need for locational and temporal flexibility – batteries can solve both, easing congestion by offering virtual transmission line solutions, and by shifting wind and solar from when it is available to when supply is tightest."

The need for further flexibility services was identified almost a decade ago, with both the UK Government and the country's energy market regulator Ofgem embarking on work to address the "missing money" problem, says Alastair Martin, founder and COO of aggregator Flexitricity. This effectively sought to tackle the challenge of power stations being underfunded for the security role they provided, and saw the government launch the Capacity Market (CM) and Ofgem sharpen imbalance prices, although "no-one was quite sure why we needed both," adds Martin.

"It looks like Ofgem's measures have

finally stolen the lead from the CM. Batteries, which the CM largely spurns, are the hot new investment class. The volatility seen in day-ahead auctions – by far the most accessible of the short-term market opportunities – is driven directly by cash-out risk. As real time approaches, intraday churn opportunities arise as uncertainty gradually diminishes and system stress either becomes real or melts away," Martin says.

"Most importantly, National Grid ESO's ability to make use of batteries in the Balancing Mechanism (BM), has leapt ahead, despite the burden of legacy IT. The BM contributes one extra feature of great importance to battery investment: a directly attributable track record of revenue performance."

The need for these flexibility services has led to new pathways opening up, with battery storage playing into services such as the BM, Fast Frequency Response

There are three general stages of market development, the first of which sees the first assets entering the market, with companies still focused on managing construction and operation risks, and requiring subsidies of some kind, he says. Then you move onto the fierce competition stage, where falling prices of the technology and in the Capacity Market have helped drive a swift development of assets.

"And then you move into what I think we're into now, which is the integration stage," Murphy says. "These assets now become fully integrated into the wholesale market, and that's when they find their value, they find it in the wholesale market, they find it in ancillary services, they find it in stacking multiple revenue streams, and getting comfortable with managing merchant risk. And I think that's the long-term future for the sector, getting comfortable with how you manage merchant risk."

O'Conneide says that when Gore Street entered the market in 2015, there were only about three revenue streams for batteries; frequency regulation, the Capacity Market and potentially agreements with industrial partners.

"You still have those three revenue streams, but now you have DC, you have localised revenues, things like reactive power, that are location dependent, and you also have trading, and there's actually more and more opportunities around trading. Trading, not so much in selling and buying electricity, but in the second-to-second work, keeping the grid in balance."

Localised flexibility tenders have grown substantially over the last year, with distribution network operators such as Western Power Distribution tendering for hundreds of megawatts of reactive power capacity.

"Limited interconnection, aging thermal generation, the variable and distributed nature of renewables etc all trend towards an increased need for locational and temporal flexibility – batteries can solve both."

(FFR) and Enhanced Frequency Response (EFR). As Colm Murphy, head of Electricity Market Change Delivery at National Grid ESO explains, some of this is driven by the maturity of the market.

InterGen's London Gateway site is set to be the largest in the UK, with Fluence's sixth-generation Gridstack system design (seen in this render) to be used for the 320MW site.



Credit: InterGen.

This is a sector that is expected to grow even further over the next few years, with more than 1.3GW of flexibility required across the UK's electricity grid in 2021 as the country accelerates the transition to renewable energy, according to research from Cornwall Insight.

While the electricity trading market has always been large, says Aaron Lally of 'cleantech trading house' VEST, it has previously been focused on the futures market and aimed specifically at centralised assets like nuclear, gas and coal. But over the past few years with the move to decentralised assets such as battery storage, things are changing. Traders have shifted to focus more on intraday and BM markets, as well as shifting away from utilities and traditional generators to the more flexible and reactive decentralised assets that have come into play.

"Utilities have shown they cannot integrate technology into their existing businesses and I think this is exactly what is starting to happen on the generation side now," Lally says. But in order for this to participation to grow further, he adds, changes to market frameworks are necessary.

"We need to develop more long-term trading products for flexible assets to allow them to hedge their activities ahead of the day ahead auction and give investors certainty in longer term revenues. We also need exchanges for futures to look at reducing capital requirements for trading as these are a large barrier to entry to a lot of new companies entering the space as it means tying up hundreds of thousands or millions of pounds as collateral to trade."

Whilst more could be done, the market expansion over the past decade means that for asset operators there are probably seven or eight different types of contracts available for each storage asset now. While this adds a level of complexity, it can provide multiple routes that asset managers can utilise to maximise their revenue streams.

"We are actively managing those assets and making decisions about which contracts our assets should go for this week, next month, six months, two years' time, and moving around to get best value," Gore Street's O'Conneide says.

The value available in the asset optimisation area has grown to the point where some companies are moving away from asset ownership, most notably Arenko, which sold its Bloxwich battery to GRID to become a pure play software company last

summer. Since then, it has focused in on optimising the battery in markets like the BM and DC.

There has been significant activity in this space over the past year in particular, with the volatility of the supply profile in the UK allowing assets to cash in during particularly tumultuous periods. For example, the imbalance price skyrocketed to £4,000/MWh (US\$5,400) in January due to low winds and low temperatures driving up demands. Providing such balancing and stability services, while less predictable as a revenue stream, offers substantial benefits and there is a growing interest in these more high risk, high reward areas.

"Before I think maybe investors were looking for stable returns," explains

"The fundamental requirements of operating a secure electricity system transitioning to net zero are driving opportunities across the different revenue categories. The investment case for batteries has never been stronger."

Murphy. "So they probably wanted a guaranteed contract that's going to pay them out for 15 years. That's not in the interest of the consumer because the cost of technology comes down, you get more competitions, the cost of commodities come down. Whereas now what we're doing is offering deep, liquid, competitive regular markets every day sending out a really stable price signal. And so now what we're seeing is hopefully more investment and more batteries coming online."

The 'brutal' nature of Dynamic Containment

One of the most significant changes to battery revenue recently has been the introduction of DC by National Grid ESO. Introduced in October 2020, the day-ahead ancillary service is the first of three new frequency services designed to meet trips and outages incredibly fast.

It has been particularly significant in the industry as it offers the highest price for frequency, with a cap of £17/MW/h, equivalent to almost three times what is offered by other services. Given the challenges of operating in the market, it has remained

undersubscribed and therefore prices have remained high.

There are a number of challenges assets face when participating in Dynamic Containment, in particular the technical demands of the control system capability. Arenko's chief technology officer Roger Hollies describes these technical requirements as "pretty brutal" and says they have proven difficult for a number of system operators.

The speed of the required response falls somewhere between being very fast and not fast enough so as to require tunable onsite control, a spanner in the works for some operators. "The data reporting requirements require two separate data management dances working on two timelines: Second by second operational reporting and hourly upload of high-resolution performance data. These both require rich data collection and flexible communication interfaces at the same time. Many assets have been built with controllers that serve the current market at the time of the business case: That was firm frequency response (FFR). DC is out of their reach for the moment," Hollies says.

Only two companies were successful in their tenders when DC was first launched, Arenko and Flexitricity. While more companies are now participating in the market, it is still falling below its target, with an average daily volume of 333MW in National Grid ESO's newest ancillary service in January 2021, less than half the 600-800MW target set for the month according to consultancy EnAppSys.

Hollies says it is worth highlighting that this is not due to technological challenges with batteries, which are very fast, but the control systems that dispatch them. Currently, although National Grid ESO is technology neutral and the service is open to a wider range of assets, batteries are the only technology playing into DC due to their speed.

As the service has matured, National Grid ESO has opened up DC to allow operators to stack revenues alongside those from the BM. "That means if I'm providing DC with my battery and providing the low frequency service with the BM, when frequency drops, I can discharge my battery. And then I'm able to issue a bid that basically says 'I need to recharge the battery', I will do that at a really competitive price for you. And so they're able then to earn money that they wouldn't have otherwise earned by charging and we were able to take an action that's much cheaper," Murphy says.



Gore Street's 10MW Lower Road storage site forms part of the company's 110MW operational portfolio, which the company utilises in a number of different markets such as the Balancing Mechanism.

Credit: Gore Street.

This is a key area where National Grid ESO has been able to play a role in the development of the battery sector in the UK. The operator has worked to remove barriers for the technology along with other flexibility assets by standardising, simplifying and rationalising necessary processes. It allows for National Grid ESO to ensure that "the jigsaw of value fits together", as Murphy describes it, allowing batteries to maximise their potential.

The move to allow assets to stack DC and BM revenues was welcomed by the storage sector, including Arenko, who began stacking from the first day. As such, when the French interconnector IFA2 tripped just two days after on 29 January 2021, Arenko's assets were able to jump into action in DC and then benefit from charging to aid the BM.

Enabling revenue stacking has increased revenue agility without increasing risk, Flexitricity's Martin adds. The strict requirements of both DC and the BM have not been relaxed, with the onus still on providers to ensure they can meet all the obligations they've committed to. "It's something of a step into the unknown for National Grid ESO, who would previously prefer to have assets 'sterilised' for particular ancillary services which they might provide," Martin says.

"It remains to be seen whether market volatility will continue to deliver the scarcity rents seen in early January. This is, ultimately, the reason that government and Ofgem took different tracks. Paradoxically, volatility has most value when it is consistent. However, the fundamental requirements of operating a secure electricity system transitioning to net zero are driving opportunities across the different revenue categories. The investment case for batteries has never been stronger."

How much is too much?

With the utility-scale battery storage sector going from strength to strength in the UK, there seems a wealth of opportunity still waiting to be tapped into. Despite its exceptional growth, the sector is a long way from being saturated, in particular as the nation's decarbonisation targets loom large on the horizon. In particular, Prime Minister Boris Johnson's 40GW of offshore wind by 2030 target will push the nation's grid dramatically, with increases in flexibility essential to keep it balanced as renewable generation increases.

In National Grid ESO's most recent Future Energy Scenarios publication, a projection for the UK's power system which is published and updated each year, the demand for energy storage in the run up

to net zero by 2050 is clear, with a spike in electricity storage capacity within the most ambitious scenario calling for 40GW by 2050, while even the lowest scenario - which would see the UK fail to meet net zero - still calls for just over 20GW.

This could be needed soon, according to Murphy. "Depending on which scenario you're looking at that could be as quickly as by 2035, so I think there's a huge opportunity there." Furthermore, Murphy highlights the opportunities beyond lithium-ion batteries, highlighting the need for seasonal storage solutions, an area that is much less developed in the UK.

With services like DC still undersubscribed, there remains space in the current frameworks that provide strong financial incentives for those keen to enter the market. These operate on the basis of variable energy prices offering an opportunity, but with a strong increase in storage deployment the endpoint could be a system so balanced there's no spread in electricity prices, suggests O'Connell.

"We're very focused on the services side, and that will need to continue in basically reverse correlation with the decommissioning of baseload power. And that's huge, we still have an enormous way to go on that. So there are gigawatts that need to be built over time," he says.