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Insights

BATTERY STORAGE REVENUES AND ROUTES TO MARKET

ENERGY TRANSITION: OPPORTUNITY AND OBSTACLES IN BATTERY STORAGE

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SUMMARY

As covered briefly in our previous article, the “route to market” / offtake arrangements/ revenue contracts are perhaps the key difference between battery energy storage systems (BESS) projects and other project-financed renewable energy projects; often there is material exposure to market (or ‘merchant’) risk and this makes them arguably more challenging to project-finance for lenders. In this article, we discuss the nature of revenue in a (standalone) BESS project, how electricity storage providers “stack” these revenues and we briefly introduce the contractual structures that are used in connection with the route to market for BESS projects (which we will cover in greater detail in our next article).

SOURCES OF REVENUE FOR A BESS PROJECT

In contrast to other project-financed renewable energy projects, revenue under BESS projects is not generally derived from long-term offtake arrangement with (relatively) predictable revenues – instead, a number of revenue streams are often “stacked” (i.e. combined with other sources of revenue) to produce a return for the project. Before we look in greater detail at the how the route to market is structured contractually in a BESS project, it is perhaps worth recapping what the sources of revenue available to a BESS project are.

Subject to our discussion on tolling agreements (please see our next article) the sources of revenue available to (standalone) BESS projects can be broadly grouped as follows: (1) capacity market revenue; (2) arbitrage revenues (in the wholesale market); (3) “post gate” balancing revenues and (4) ancillary services revenues.

Capacity Markets

To start with perhaps the simplest revenue source available – revenues available from being awarded capacity market contracts. In this mechanism BESS projects can bid into capacity market

auctions (bidding to provide reserve generation capacity to the electricity grid if needed). There are two types of capacity market auction – "T-4" and "T-1"; T-4 is procured four years before the relevant year in which the generation capacity is to be made available, with new build generation able to secure a 15-year contract (and thereby a secure, a reliable long-term revenue stream), and the T-1 auction being used as a "top up" auction for the year ahead.

These auctions are open to a wide variety of generation technologies, and "de-rating factors" (a "multiplier" scaling down revenues) are applied to reflect the value that the Electricity Systems Operator (ESO) (soon to become the National Electricity Systems Operator (NESO)) perceives in the different technologies for the purpose of providing capacity – longer duration BESS projects benefit comparatively from the de-rating factors, with those projects with an 8-hour or higher duration achieving c. 90% of tariff, whereas a project with a half-hour duration would only achieve c. 5% of the tariff. However, whilst it potentially provides BESS projects with a reliable long-term revenue stream, in the UK BESS market overall capacity market revenues account for only a small percentage of total BESS revenues (being specific is difficult as there is significant flux in the relative importance of various revenue sources in a rapidly changing market).

Wholesale markets and price arbitrage

Whilst electricity can of course be bought and sold bilaterally through PPAs, as are common in other renewable energy projects, another significant revenue source is arbitrage revenues – (standalone) BESS projects generally buy and sell electricity in the wholesale market, charging from and discharging to the electricity grid as necessary to arbitrage between lower purchase prices (i.e. when supply is high or demand is low, or a factor of cost such as fuel prices, carbon prices or environmental conditions vary) and higher sale prices. Arbitrage revenues are a key revenue source for BESS projects and are likely to remain so (again, being exact is challenging as to relative importance as it changes year-on-year but this has recently been the significant majority of revenues for BESS projects), but with increasing participation in/potential saturation of BESS projects in the Great Britain electricity market may well mean that it will in the future overtake ancillary services (see further below) as the largest revenue generation source for BESS projects.

Perhaps, at this point, it is helpful to step back a bit and briefly summarise the relevant wholesale markets in electricity trading. Broadly there are two distinct markets – (1) the futures/forward trading market and (2) the spot market. These markets provide liquidity and, in some scenarios, transparency. The futures/forward market is, for certain market participants (for example electricity suppliers) used to hedge against volatile spot market prices (further below)

In the futures/forward trading market, market participants agree to buy and sell the relevant product at a specified price in the future. Futures are standardised, exchange-traded instruments, buying and selling the relevant product up to five years in advance – trading baseload (24 hours a day, all week) or peak period (7am – 7pm on weekdays) generation in full-month blocks. In respect of the Great Britain electricity market, these futures are exchange traded.

In contrast to futures, forwards are generally bespoke contracts traded bilaterally and not on an exchange – an "over-the-counter" (OTC) product - such that these contracts can be negotiated to meet specific party requirements.

Both futures and forwards enable risk management for electricity industry participants a significant period of time in advance. The standardised nature of futures mean that market participants can include speculators.

The spot market has "day-ahead" and "intra-day" auctions (notwithstanding that, perhaps counterintuitively, the "intra-day" market starts at 11pm on the previous day) – determining whether the electricity traded is for delivery the next or the same day. From an electricity market perspective, the day is split into six four-hour EFA periods and forty-eight half-hour periods. Electricity auctions in Great Britain are run by the EPEXspot exchange (four day-ahead and intra-day auctions) and Nordpool exchange (one day-ahead auction). The relevant day-ahead and intra-day auctions are listed below:

- EPEX Day-Ahead 60 Minute – occurs at 9.20am day-ahead
- N2EX Day-Ahead Hourly - occurs at 9.50am day-ahead
- EPEX Day-Ahead 30 Minute – occurs at 3.30pm day-ahead
- EPEX Intraday 1 - occurs at 5.30pm day-ahead
- EPEX Intraday 2 - occurs at 8am intra-day
- (A frequency response and quick reserve auction – see further below - is also run at 2pm day ahead by the ESO.)

The liquidity provided by these auctions allows market participants (and, in particular, suppliers) to match their requirements - whether generators selling electricity or suppliers optimising their purchases, buying or selling electricity so that their aggregate purchases more accurately reflect their latest customer usage forecasts (or other market participants such as speculators looking to gain revenue by arbitraging prices) – the granularity of the products traded allows the "shaping" of generation purchased to reflect latest, updated demand forecasts (i.e. so that marginal amounts are bought or sold to more closely match latest, more accurate usage forecasts).

It is also worth noting that there is a continuous intra-day market as well (for hourly, half-hourly and quarter-hourly generation), which also provides liquidity in the Great Britain electricity market. In this market, transactions occur under an order book system (matching buy and sell prices), whereas the other markets referenced above operate on a "pay as clear" basis with the market setting a clearing price based on all buy and sell orders submitted. The continuous intra-day market trades generation up to five minutes prior to the relevant delivery period.

The Balancing Mechanism

In order to discuss the third key revenue source, post-gate balancing services – the "Balancing Mechanism" (BM), it is important to know that "gate closure" occurs one hour prior to the relevant half-hourly settlement period (so "post-gate" balancing services are revenue potentially available to a BESS project after the gate has closed). At this point, "final physical notifications" (FPNs) of generation and demand for each settlement period are published by generators and suppliers and through this the ESO has a projection of electricity system imbalance (please see our previous article on why the electricity grid needs to maintain balance) and this is then when the balancing mechanism comes to the fore. Registered participants can submit "bids" and "offers" in respect of balancing mechanism units (BMUs) – bids are prices that the participants are willing to accept to "flex down" (decrease generation or increase demand, noting that participants can bid negative amounts), whilst offers are in respect of willingness to "flex up" (increase generation or decrease demand) for the relevant settlement period (such bids and offers submitted in the half hour prior to gate closure). There are penalties for non-compliance with FPNs and accepted bid/offers under the BM. The BM operates on a "pay as bid" system – as discussed previously, the Great Britain electricity grid is not one 'uniform' system and the Electricity National Control Centre (ENCC) may consider operational and locational factors as well as bid and offer prices.

Ancillary Services

So we have discussed post-gate balancing of supply and demand through the balancing mechanism, but how does the ESO maintain the stability and reliability of the electricity grid after this time? This is done through the provision of "ancillary services" – which services currently provide the significant majority of revenue for BESS projects in Great Britain is derived from "ancillary services" – but what are they? Below we set out a (non-exhaustive) review of some of the key ancillary services.

Ancillary services are a set of services which help maintain grid stability and reliability. To do this, the ESO purchases certain services to maintain a 50 Hz frequency (see previous article) and regulate voltage across the various parts of the electricity grid.

The key types of ancillary services can be categorised into 'frequency-related' and 'non frequency-related' services.

Key frequency-related services include:

1. **firm frequency response** ("FFR"): whilst dynamic FFR has now ceased (replaced by the new dynamic services – see below), static frequency response continues – in this service (procured day ahead) the relevant project is set to 'frequency sensitive mode' and, from a set, pre-fault frequency deviation triggering the response service, the project adjusts its output to regulate electricity grid frequency (the response occurring within 30 seconds and maintainable for up to

30 minutes). By “pre-fault” we mean that they are services provided prior to deviation from the ESO’s license requirement that operational frequency stays within +/- 1% of 50 Hz;

2. **new dynamic services**: dynamic containment, dynamic moderation and dynamic regulation. Dynamic moderation and dynamic regulation are pre-fault – with dynamic moderation responding within 1 second in high volatility periods to stop frequency deviating from operational limit, and dynamic regulation being a slower response (within 10 seconds) to continuously adjust minor deviations in frequency. Dynamic containment is post-fault and looks to bring frequency back within operational requirements (responding within 1 second); and

3. **inertia**: “inertia” is defined as a tendency to remain unchanged. Non-renewable energy sources often contain spinning parts (e.g. generators and turbines) which provide inertia to the electricity grid (i.e. a tendency to keep frequency at or near the operational requirement) even where there is a loss of power (for up to five seconds), providing sufficient bridging time for other sources of supply and demand to respond and maintain frequency. (Inertia also has a cross-over element in that it helps maintain voltage as well.)

Mandatory frequency response (MFR) is a service where there is a change in output from a generator in response to a frequency deviation – generally large non-renewable energy generators are key participants in respect of this service but transmission-connected batteries are required to participate. This service is instructed in real time by the ESO via the Balancing Mechanism.

Key non (directly) frequency-related services include:

1. reactive power;

2. congestion management;

3. reserve power; and

4. restoration (formerly known as ‘black start’).

Reactive power is a feature of alternating current (AC) electrical systems – it is non-consumable (i.e. it does not meet demand on the electrical system – and oscillates between the ‘source’ and the ‘load’ on the electrical system. It is important to maintaining voltage on that electrical system. The ESO procures two types of reactive power service, Obligatory Reactive Power Service and Enhanced Reactive Power Services. Historically reactive power requirements have been met by non-renewable generation, but BESS projects may have an increasingly key role in the provision of such services going forwards. The ESO is currently running a pathfinder scheme for BESS projects.

‘Congestion management’ or ‘constraint management’ is a broad category of physical restrictions on the Great Britain electricity grid which are often location dependent (i.e. these constraints are often at ‘bottlenecks’ in the system). These bottlenecks would otherwise potentially require

expensive electricity grid reinforcement (which reinforcement may only be utilised in peak scenarios). Again, the ESO is currently running a pathfinder scheme for BESS projects.

Reserve power has a large number of strands – including balancing reserve, fast reserve, slow reserve, short-term operating reserve (STOR), slow reserve and (to be introduced at the end of 2024) quick reserve. Whilst each service is different, the general characteristics of these services are that they are a reserve that can either take active power off the electricity grid or provide it to the electricity grid if needed to address any ultimate imbalance in the electricity grid – addressing imbalance resolving any frequency deviations (and bring ancillary services back to frequency!). This new service may well be participated in by BESS projects, not least because of the speed required for the response (sub one minute, to last less than 15 minutes). With volatility likely to be high on the electricity grid into the long-term, ancillary services are likely to remain a significant revenue source of BESS projects. Whilst we note that saturation of the market with BESS project.

There is potential that saturation of the BESS market (i.e. a large number of projects being connected to the electricity grid) could significantly reduce revenues available to BESS projects from ancillary services but capacity (or relative lack thereof) of the ESO to connect new BESS projects may delay this saturation occurring.

Revenue stacking and routes to market

So how do BESS projects maximise revenues for their business case? In summary, they 'optimise' revenues by generating revenues from multiple sources. For example: capacity market revenues can be 'stacked' with any of the other forms of revenue discussed above; balancing mechanism revenues can be stacked with balancing reserve revenues (and vice versa); and revenue from wholesale markets/price arbitrage can be stacked with the other revenue streams referred to above subject to certain limitations.

The precise strategies for how to maximise revenue depend on the limitations of the BESS project itself and the prevailing energy market conditions, which conditions are constantly changing. As such the detail of approaches to maximising BESS project revenue is outside the scope of these articles. However, the structures used to contract for these revenues are a key difference between BESS projects and other renewable energy projects. In contrast to some other renewable energy projects, there is a significant 'merchant' element to BESS projects and the contracts that the project company enters into to secure these revenues are often short-term (and to some extent inherently require lenders to have a commercial view of the likely future state of the Great Britain electricity grid and electricity market).

The current Great Britain BESS market heavily relies on 'optimisers' – third parties who provide a revenue optimisation service in return for a service fee and/or a portion of revenues generated by the relevant BESS project (in contrast to some other geographies, such as the USA where BESS market participants often actively trade the BESS projects themselves to maximise revenues).

Whilst the BESS market is developing rapidly, there is no 'standard' approach to these optimisation agreements – and understanding these agreements (including, as applicable, any 'floor' in the revenue flowing under them) is a key element of understanding the contractual structure that surrounds a project-financed BESS project.

Above we have briefly discussed the types of revenue that are available to (standalone) BESS projects (co-located BESS projects can of course benefit from revenue from the co-located generation facility, likely under a PPA, though 'curtailment' may materially restrict the revenue generation potential of the BESS assets). We discuss optimisation agreements (and tolling agreements) in detail in our next article where we look at the transaction documents, and how these are both similar to and differ from typical transaction documents on other project-financed renewable energy projects.

RELATED PRACTICE AREAS

- Energy Transition
- ESG & Energy Transition

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