SP Energy Networks

December 2016

Electrical Energy Storage (EES) – A Supplementary Connection Guide

Introduction

This document is aimed at Developers who are seeking to connect an Electrical Energy Storage (EES) system to our network. This includes both first-time Developers and Developers who may have previously made applications to us for the connection of Generation, such as wind or solar PV. This document aims to provide supplementary information which relates specifically to EES, describing how energy storage differs from Generation (and Demand) specifically in the context of the technical and commercial requirements of its connection to our network.

There is growing interest in EES technologies, especially battery electricity storage. This is a new technology, and whilst it has characteristics similar to conventional generation and demand, it has many features that merit special consideration at the Connection stage. EES can be operated in many different ways, depending on the intended end-use application(s). This will influence the choice of connection arrangement, both in terms of technical and commercial arrangements.

This guidance document has been produced as an interim measure, pending the final conclusions and outcomes from the formal Department for Business, Energy & Industrial Strategy (BEIS)/Ofgem Call for Evidence. This document is therefore subject to change and will be reviewed and finalised once the BEIS/Ofgem Call for Evidence has been completed.

This guide is intended to supplement our existing documents and processes. We therefore recommend that you make full use of our Connections Website, making use of the available capacity maps and taking advantage of our regular stakeholder workshops.

A Smart, Flexible Energy System

The UK electricity system is currently undergoing major transformation and EES is a significant component of these changes. As part of this transformation process, The Government department of Business, Energy & Industrial Strategy (BEIS) and the Electricity Regulator (Ofgem) are jointly reviewing the legal and regulatory framework surrounding storage.

Key elements of this Call for Evidence, entitled "*A Smart, Flexible Energy System"*, include:

- **A legal and regulatory definition for storage** – to differentiate it from generation (and demand)
- **Ownership** – storage a network asset or should it be owned by third parties?
- **Licensing** – should the operation of storage be a licensed activity?

If you are considering becoming an **EES** developer, we strongly recommend that you familiarise yourself with the BEIS/Ofgem Call for Evidence. **Click here** for more information.

Flexibility

One of the most important features of EES is its flexibility. EES does not exist in its own right, it is there to help demand or generation (or both) perform more cost-effectively. It can also provide

technical system benefits beyond the simple trading of energy – it can provide network ancillary services that are essential to the real-world operation of the System.

As a DNO looking to make the transition to a **Distribution System Operator** (DSO), we at SP Energy Networks are keen to support the development of EES. Therefore, if you are looking to connect an EES system to our network, here is some supplementary guidance.

Currently, because of the lack of a specific definition of EES within the legal and regulatory frameworks, EES is being treated as generation. And so, until changes are made to these frameworks, SP Energy Networks will continue to treat the connection of EES in the same way as we treat generation.

However, we recognise some of the unique characteristics of EES and so we have worked with the Energy Networks Association (ENA) to produce an EES **supplementary connection form** to capture some of these special features in the connections process.

Applications for Storage

We anticipate that the applications which are likely to be of most interest to Developers are those that are aimed at meeting National Grid's requirements for network ancillary services. Commercial mechanisms are currently in place to access these services, so present an immediate opportunity for EES developers.

1) Network Ancillary Services

There are a range of network ancillary services, collectively known as Balancing Services, that can be made directly available to National Grid. These include:

Enhanced Frequency Response (EFR) – this is a relatively new service, which is ideally suited to modern, utility scale, battery storage due to the very fast response, tight control and relatively modest energy requirements (i.e. up to 15 minutes). The recent inaugural tender process for EFR completed in 2016 and a second round is anticipated once the learning becomes available from the first round – most likely in 2018.

Firm Frequency Response (FFR) – is based on requirements that are mandatory for larger generators. But now that an increasing number of the large power stations are closing, these requirements are being provided as a service by smaller generators, i.e. distributed generation and storage. The speed of response and ramp rates are not as onerous as EFR (they are equivalent to conventional generator performance capabilities).

Short-Term Operating Reserve (STOR) – is a service which customers (service providers) can provide to National Grid to deliver either a specific level of power from their generators or a reduction of demand. The service is limited to the timings that are agreed in the contract. Such timings are known as the "Availability Windows" which are the periods where the provider is obliged to deliver the specified power.

Capacity Market (CM) – The Capacity Market is open to all capacity providers including new and existing power stations, electricity storage plant, capacity provided by voluntary demand reduction

and, from 2015 onwards, interconnectors. It offers a steady, predictable revenue stream on which providers can base their future investments. In return for Capacity Payments revenue, providers must deliver energy at times of system stress, or face penalties. Potential providers secure the right to receive capacity revenues by participating in a competitive auction process which will set the level of Capacity Payments. Capacity Auctions are held four years ahead of delivery, with a subsequent auction held one year ahead. The first Capacity Auction took place in December 2014, for delivery obligations beginning in October 2018.

Click here for more information on these services from the National Grid website.

2) Services to Load Customers

This is often referred to as a "behind the meter" installation, where the EES is installed on the consumer side of the electricity meter and would typically be co-located with a high energy user. This business model is based on the avoidance of costs related to energy consumption, including arbitrage, peak shaving and triad avoidance.

3) Services to Generation Customers

This is also a "behind-the-meter" installation, but this time on a generator site. This business model is primarily based on the reduction of imbalance charges, which can be a particular issue for intermittent, renewable generation.

4) Services to the Distribution Network Operator

As a Distribution Network Operator (DNO), we are interested in how EES can be used to reduce costs to our customers by reducing our network costs. However, at present, the regulatory framework does not yet recognise the benefits of EES as an alternative to conventional network reinforcement. But recent EES trial projects, supported by Ofgem's Low Carbon Network Fund (LCNF), have illustrated the technical feasibility of such systems and have pointed the way for the necessary regulatory changes. So, in anticipation of those regulatory changes, we would like to make you aware of the following potential future opportunities.

Peak Load Reduction – The primary method by which EES can reduce distribution network costs is by reducing local network peaks, especially during the winter evening peak period. The need for network reinforcement is driven by the peak power flows on the network, so if EES can be used to reduce these network peaks, by charging up at times of low demand and discharging at times of peak demand, then this should allow us to defer network reinforcement. The use of utility-scale EES for this purpose has been demonstrated technically in the UK by the Ofgem LCNF **Smarter Network Storage** trial project.

Network Constraint Reduction – Increasingly, distributed generation, especially from renewables, is connected via cost-effective actively managed constrained connections. These significantly reduce the cost of network connection, but result in some of the available energy being lost when the constraint is activated. Some of this energy that would otherwise be lost can be captured by an EES system, if it is located on the unconstrained side of the network constraint. The use of utility-scale EES for this purpose has been demonstrated technically in the UK by the Ofgem LCNF **Orkney Storage Park** trial project.

We have completed an initial review of our two network licence areas and have identified a key location for storage in each area.

In the SP Distribution licence area we have identified the Dunbar GSP group and in the SP Manweb licence area we have identified the North Wales Group as areas with the most potential for utility-scale energy storage systems. This is principally in relation to either a "behind the meter" installation at an existing generation site or close to one of the existing GSP, Grid or Primary substations, since these are areas with a high density of generation connections with associated constrained connections. We are still at an early stage of thinking in this area, but, depending on the level of interest from the Developer community, we will look to move forward on this subject to the expected changes in the regulatory framework.

5) Stacking Multiple Benefits

In general, the business case for EES requires stacking multiple benefits from a suitable combination of the above applications. This is where EES becomes most challenging, because increasing the number of applications that an EES system is designed to deliver will often increase the technical and commercial requirements on the connection arrangement, which is in turn also dependent on the characteristics of the network sitting behind that connection.

The greater clarity we have over your use case(s), the more likely we can tailor a connection offer to meet your requirements.

Finding the optimal location for storage

The optimal location for storage requires the consideration of several factors, including:

i) End-Use Applications(s)
ii) Network Capability
iii) Site Availability

If your application is going to require a fast response from your storage device, with large, rapid power swings (such as required by EFR), this is going to need to be connected to a "stiff" or "strong" part of the network, because otherwise it is likely to cause power quality disturbances to other connected customers Typically, this is going to be close to major substation locations, such as 132/32kV substations – these are Grid Supply Points (i.e. National Grid Infeed locations) in our SP Distribution license area and Bulk Supply Points in the SP Manweb license area. Interestingly, many of the current EFR schemes are not connected to the distribution network at all, but are located at major generation sites (i.e. directly connected to the transmission network). These sites are good because they provide "stiff" connection points and have no other customers connected to it.

Deciding on the correct level of Connection Security

The level of connection security is fundamental in determining the cost of connection. Connections are generally defined as firm or unfirm, but also as constrained. Firm connections are the most

expensive to provide, whilst constraint management can be applied to reduce the cost of connection. Options for connection security are described below:

1) Option One - Firm connection

In this arrangement, the connection is considered firm when the customer can continue to operate with their maximum agreed import and export capacity for the loss (either through a fault or during a maintenance outage) of either one of the two connecting feeder circuits, transformers or circuit breakers used to provide their connection.

2) Option Two - Unfirm Connection

In this arrangement, the customer is connected via a single circuit/transformer/circuit breaker, so any loss of these assets will result in a complete loss of supply to the customer.

3) Option Three - Firm, constrained connection

In this arrangement, the customer has good connection security in respect to the network assets close to their connection point, but outages at more remote locations have some knock-on effect, such that import/export is affected, requiring a reduction in available network capacity, which can then be managed though an active network management scheme.

4) Option Four - Unfirm, constrained connection

In this arrangement, as well as having the unfirm arrangement described in Option 2, it also has the constrained element, as described in Option 3. That is to say, the customer is connected via a single circuit/transformer/circuit breaker, so any loss of these assets will result in a complete loss of supply to the customer. In addition, outages at more remote locations have some knock-on effect, such that import/export is affected, requiring a reduction in available network capacity, which can then be managed though an active network management scheme.

However, whilst some unfirm connections may look to be less reliable and therefore less desirable, in practice they can perform well and therefore be a cost-effective option. For example, if the unfirm connection consists of a short (i.e. <100m) length of cable, which does not cross into public land and remains wholly within the confines of a network substation and the customer premises (i.e. the customer premises adjoins the substation) it is unlikely to be subject to 3rd party damage or joint failures, which are the primary causes of cable faults.

It is also worth noting that connection options are also generally site-specific – i.e. not all connection options are available at all sites, due to the non-homogeneous, varying nature of the network.

Next steps

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