



Standard Battery Energy Storage System (BESS) Connection Arrangements

Introduction

A battery energy storage system (BESS) can be operated in a number of different ways to provide benefit to a customer. Some customers are using a BESS to reduce their overall reliance on the GB electricity network for their own electrical needs, while others are using a BESS to actively support the GB network through commercial contracts. The cost of connection for these two scenarios can be very different, with the active support option often being the more expensive.

A BESS installation always needs a power controller to determine when to charge and discharge the battery for the benefit of the customer. Most BESS installations also need an Export Limiting Scheme (ELS) to ensure that network operating limits are not exceeded. In most cases these two schemes will be within the same overall control system. When a customer needs an ELS, it should comply with [Engineering Recommendation G100](#), which is a technical guidance document for a customer ELS.

To help you obtain the right sort of connection for your BESS we have developed some standard connection arrangements. When you apply to connect a BESS this guide should help you to tell us which type of connection you require. If you are not sure which type to choose then we will work with you to agree the type of connection required before we provide you with a quotation.

A BESS also has the potential to provide reactive power services to the network. However, we do not currently have a standard connection arrangement for this. Any requests would be dealt with on a case-by-case basis, but are currently unlikely to be feasible for sites with a connection voltage of 20kV or less.

Constrained connections and reinforcement

Some parts of our network have reached a point where the unrestricted connection of additional load or generation would require network reinforcement. In such cases, if the reinforcement cost is disproportionately expensive then you may be offered a constrained connection, whereby you agree to reduce or limit your import or export of power under certain network operating conditions.

A BESS installation can help you to improve your overall site utilisation by using the BESS to store surplus energy or by topping up the site requirements when a constraint scheme is in operation. However, the installation of a BESS in a constrained area will always require an additional network assessment to ensure that its operation does not unduly impact on other connected customers. If the new BESS does impact on the operations of other customers then additional restrictions / works may be required.

All generating equipment makes some contribution to network short circuit levels. The short circuit contribution from the BESS needs to be considered, but is normally relatively small. If the BESS installation causes network short circuit levels to exceed plant ratings then reinforcement works will be required.

The typical costs and capacities stated in following standard BESS connection arrangements **are not** applicable to customers with a constrained connection or where reinforcement is required.

Arrangement 1 – Self consumption

This type of arrangement is generally suitable for customers that want to minimise the amount of power imported from or exported to the Northern Powergrid distribution network. This type of installation is more commonly found at sites with both on-site local load and a renewable energy source such as a wind turbine or solar panels. However, this type of installation is also permitted without a local generation source.

Suitable for: site load balancing, time-of-day electricity trading, load shifting, peak lopping

Not suitable for: providing 3rd party electrical energy services, such as STOR and other capacity market services, support services for the System Operator, bi-directional frequency response services, reactive power services.

Installation requirements

Installation of a BESS:

- at a site with an existing connection
- with or without existing generation on site
- with limited power ramp rates
- including a G100 compliant Export Limiting Scheme (ELS)
- with no increase in agreed import or export capacities
- for on-site load balancing / load shifting

Capacity limits and cost of connection

Domestic and other small low voltage (LV) customers can generally connect up to a 16 Amps BESS with a G100 ELS, alongside up to 16 Amps of other generation. However, where multiple applications are received in close proximity to each other, you might have to wait until we have carried out reinforcement works on the local network at our cost.

Customers with larger LV connections will be limited by the assessment process for the G100 ELS. Generally, the closer the customer is located to our source substation, the larger the capacity of the BESS that can be accommodated.

A G100 compliant ELS will be required for all LV connections. Customers connected at higher voltages may also be limited by the assessment process for the G100 ELS. If you are not able to comply with G100 then we might be able to install additional network protection at the point of supply, which would then allow you to connect. These works would be at your cost.

The above criteria have been chosen to reduce the likelihood of any need for network reinforcement or modification of your existing connection. Where all of the above criteria are met, in most cases the cost of connection will be limited to witness testing of the customer's G59 protection and the ELS.

The additional cost to fit network protection at the point of supply depends on the type of switchgear installed. In some cases it may be necessary to replace the existing switchgear to accommodate the new protection.

Arrangement 2 – Reserve capacity

This type of arrangement is generally suitable for customers that are primarily generators of electricity, with a view to exporting power to the Northern Powergrid network. It could also be suitable for demand customers with existing or new on-site generation who want to support the GB network via contracted capacity market services such as STOR, or other generation contracts that utilise generated power.

The permissible power ramp rate will generally make this type of connection suitable for exporting power at a steady level, with managed start up and shut down regimes to limit the power ramp rate. The limitation in power ramp rate will generally allow the customer to install a larger capacity BESS than arrangement 3 (response services), but the connection is unlikely to be suitable for fast response services such as frequency response.

The agreed export capacity will normally be matched to the capacity of the on-site generation excluding the BESS installation.

Suitable for: site load balancing, time of day electricity trading, load shifting, peak lopping, providing 3rd party electrical energy services, such as STOR and other capacity market services, potential support services for the System Operator

Not suitable for: bi-directional frequency response services and other fast response services, reactive power services

Installation requirements

Installation of a BESS:

- at a new or existing site
- with new or existing generation on site
- with limited power ramp rates
- where the agreed export capacity is not more than the capacity of any existing on-site generation, excluding the BESS installation
- including a G100 compliant Export Limiting Scheme (ELS)
- with no increase in agreed import capacity (for existing sites)
- for on-site load balancing / load shifting

Capacity limits and cost of connection

Domestic and other small LV customers can generally connect up to a 16 Amps BESS with a G100 ELS, alongside up to 16 Amps of other generation. However, where multiple applications are received in close proximity to each other, you might have to wait until we have carried out reinforcement works on the local network at our cost.

Existing customers with larger LV connections will be limited by the assessment process for the G100 ELS. Generally, the closer the customer is located to our source substation, the larger the capacity of the BESS that can be accommodated.

New LV connections will be subject to normal design studies to determine what works are required to accommodate your requirements.

A G100 compliant export limiting scheme (ELS) will be required for all LV connections. Customers connected at higher voltages may also be limited by the assessment process for the G100 ELS. If you are not able to comply with G100 then we might be able to fit additional network protection at the point of supply, which would then allow you to connect. These works would be at your cost.

The above criteria have been chosen to reduce the likelihood of any need for network reinforcement or modification of existing connections. For sites with existing generation and no changes to the import and export requirements, the cost of connection will normally be limited to witness testing of the customer's G59 protection and the customer's ELS.

For sites where new generation is being installed along with the BESS, the connection cost will be similar to the cost of installing the new generation without a BESS. If your site is remote from our main substation then the connection cost will generally be higher and the permissible generation capacity will generally be lower.

Arrangement 3 – Response services

Some customers may wish to provide fast-acting frequency response schemes, whereby the BESS can switch from its maximum charge rate to its maximum discharge rate within one second. This type of power swing can cause unacceptable voltage fluctuations on parts of our network. Under this arrangement the size of the power swing will often determine the maximum permissible size BESS that can be installed at a particular point without incurring reinforcement or extensive dedicated connection costs.

Customer offering response services normally require import and export capacities of the same size. Whereas customers offering reserve services (arrangement 2) generally only need a limited import capacity.

Suitable for: site load balancing, time of day electricity trading, load shifting, peak lopping, providing 3rd party electrical energy services, such as STOR and other capacity market services, potential support services for the System Operator, bi-directional frequency response services and other fast response services.

Not suitable for: reactive power services

Installation requirements

Installation of a BESS:

- at a new or existing site
- with or without other generation or load on site
- with capability for managed power ramp rates
- where the agreed export capacity matches the capacity of all on-site generation, including or excluding the BESS installation
- where the agreed import capacity matches the charging capacity of the BESS and/or any other site load

Capacity limits and cost

BESS schemes providing response services can cause significant voltage fluctuations on the local electricity network and will always require a detailed network assessment.

The available import and export capacities will be assessed based on the demand and generation requirements of the customers already connected to the network.

Where a BESS is installed without any other on-site generation or load, then the energy capacity of the BESS will limit the overall time that the BESS can continuously operate at a particular power setting. We may take this into account to avoid incurring reinforcement when considering the loading on the network.

Generally, LV connections are not suitable for providing response services, as the cumulative impact of many customers providing a full response service at the same time would result in unacceptable network voltage fluctuations. However, it may be permissible to provide response services at sites where there are no other customers connected to the same LV network.

This type of scheme can only be accommodated with any reasonable capacity if it is located very close to our source substation. Typically, up to 3MVA may be connected at 11kV if the site is next to one of our dual transformer primary substations. As the distance from the source substation increases, the network capability decreases significantly.

Reinforcement solutions to address voltage fluctuation issues are generally very expensive. It is usually cheaper to connect the customer at a higher voltage rather than reinforcing the lower voltage network.

Our designer will carry out a bespoke assessment based upon your request. If your requested capacity cannot be connected at your preferred connection voltage without incurring significant reinforcement costs then we will advise you of the capacity that can be connected without incurring reinforcement. You can then decide what capacity you want to be quoted for.

Under some network operating conditions (typically during a transformer outage) the power ramp rate may need to be restricted to avoid unacceptable voltage fluctuations on the network.

Due to the nature of operations for customers providing response services, multiple response customers connected to the same network can have a cumulative impact on the local network. Therefore, the presence of other response customers on the same network is likely to reduce the remaining available capacity before reinforcement would be required.

Where reinforcement is not required, the cost of connection may be similar to the cost of connecting other types of generation with a similar capacity. However, the import requirements for the site can result in increased cost.