Larne Main Transformer Upgrade

Options Report

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2 Summary

There are two 45 MVA 110/33 kV transformers at Larne Main. Currently there is sufficient firm capacity. But due to the planned connection of a battery as well as load growth the 45 MVA rating will be exceeded under a single circuit outage, requiring constraint of generation and/or a new special protection scheme. Additional capacity is also needed to facilitate connection of additional generation to facilitate the target of 80% renewable generation by 2030 under the Climate Change Act (Northern Ireland) 2022.

This options report compares the options against a range of criteria and finally determines the preferred option to be the uprate to two 90 MVA transformers.

1 Introduction

Larne Main 110/33kV substation supplies approximately 31,000 customers in Larne and Ballyclare as well as the surrounding areas. The substation has two 45 MVA transformers connected to a 33kV switchboard (rated at 2000 amps). The transformers were manufactured in 1968 and are now 55 years old. It is standard policy for transformers in excess of 50 years to have a nameplate rating assigned rather than a cyclic overload capability. This is to protect against failure.

The demand is estimated at 43 MVA which is just within the transformer nameplate rating under single circuit outage conditions. There are also three large scale wind farms with an installed capacity of 31.1 MW as well as approximately 16.1 MW of small-scale renewable generation respectively, totalling 47.2 MW. Whilst this marginally exceeds the rating this does not cause issues as there is sufficient demand to prevent a transformer becoming overloaded.

However, demand is forecast to grow and expected to exceed the rating by 2026. In addition, the developer of a new battery, with a capacity of 20 MW, has applied for a distribution connection. NIE Networks, after appraising other options, has found the least cost technically acceptable solution is to connect to this substation.

A battery export scenario, coinciding with high renewables generation and low demand (estimated at 12.7 MW) could result in a total of 67.4 MW of export capacity which exceeds the capacity of a single transformer by almost 150% and potentially leading to a significant overload risk. Also on a battery import scenario, coinciding with low renewable generation and high demand of 43 MW, there could be 63.4 MW of demand exceeding the capacity of a single transformer.

With the NIE Networks Statement of Connection Charges, the definition of “Connection Assets” (see page 38), states that in the case of a customer connecting at 33 kV, the connection assets would include those at 110 kV, required to enable the maximum export capacity (MEC) to flow. However, the definition has the caveat that this would only be the case after “disregarding electricity flows caused by any other customer”. Therefore, whilst an upgrade is required, the assets are not connection assets (and therefore not chargeable to either of the two wind farms) as neither exceed the rating after disregarding other flows.

2 Options

There are three different options as follows.

2.1 Option 1: Do nothing

The “do nothing” option would be to connect the battery to Larne Main but not change the transformers.

2.2 Option 2: Replace transformers (£3.47m)

The second option is to replace the two existing 45 MVA transformers with new 90 MVA units. This would include retrofitting a new transformer bund either in situ or offset and offline. There is room to install new transformer bund behind the existing units to avoid a lengthy outage.

It would not be necessary to uprate the existing 33 kV switchboard as it is already designed to 2000 amps.

2.3 Option 3: Installing a special protection scheme (£0.3m)

This option is based on installing a scheme that would automatically trip the battery in the event of a forced transformer outage. This is in line with Electricity Networks Association (ENA) recommendations that battery storage should be treated more in line with standard generation to prevent inefficient network investment by providing firm access only under intact network conditions[1] However this does not provide any additional capacity for future demand growth at Larne.

[1] See *ENA Strategic Connections – Electricity Storage Connections: Guidance Note for DNOs*, September 2023

3 Appraisal of options

3.1 Long list and shortlist appraisal

Three options were assessed in the longlist. In this section the appraisal includes technical, deliverability and cost as well as lifecycle and environmental considerations.

3.1.1 Option 1: Do nothing

The connection of the proposed battery would result in the transformers being overloaded by up to 150% of rating. This would result in the remaining in-service transformer becoming overloaded and trip on winding temperature disconnecting all customers connected to Larne Main. This would be a breach of TSSPS.

To manage this risk the controllable wind farms and /or the battery would have to be constrained pre-fault. This would jeopardise achieving renewable targets and transformation, result in high constraint costs and/or may result in the proposed battery not proceeding.

3.1.2 Option 2: Replace transformers (£3.47m)

The changeout to two 90 MVA units would provide sufficient capacity to connect the battery and facilitate further demand and renewables growth. This option is technically acceptable. Whilst more expensive it is technically superior.

This option would result in the replacement of the existing 45 MVA units at year 2 avoiding the need for this in future.

3.1.3 Option 3: Special Protection Scheme (£0.11m)

This solution would facilitate the connection of the battery technically and is definitely cheaper than Option 2 in the short term. However, it is inferior technically to Option 2 as it adds complexity which adds risk of maloperation. It is also ultimately a nugatory step given that the transformers are expected to be replaced within the next five years in any case to avoid the risk of age and condition related failures. This option does not provide any capacity for load growth at Larne. This option is not carried forward for further assessment.

Options 1 and 2 are carried forward to the shortlist.

Table 1 below visualises the points made previously.

Table 1: Multi criteria assessment

Less favourable

More favourable

Option	Technical Performance	Deliverability	Cost of option (£m)	Environmental	Lifecycle implications
1 - Do nothing	Security of supply risk or significant pre-fault constraint of wind farms and/or battery	N/A	N/A	Risk that windfarms withdraw impeding targets	High windfarm constraint costs, transformers to be replaced in future due to age
2 - Replace & Upgrade the Transformers	Low complexity and addresses need	Two years	3.47	No significant impact	Avoids need for future transformer replacement

4 Preliminary preferred option

Transformer capacity at Larne Main needs be increased to accommodate increased generation capacity, both for battery storage connections and renewable generation.

Based on the options assessment the preliminary preferred option is Option 2, i.e., to replace the two 45 MVA transformers with new 90 MVA transformers. This prevents the need for a special protection scheme and also addresses future asset replacement requirements, given the age of the transformers. It is proposed to progress Control Point 1 approval on this basis.

A TNPP is not required for this project as SONI have no preconstruction costs given that no planning permission is required nor any reconfiguration of the system or substation beyond the transformers themselves.

If transformer procurement would be likely to delay connection of the proposed battery storage scheme, it may be appropriate to install a special protection scheme as an interim measure to facilitate an early connection of the battery. This is in line with ENA recommendations. This work would be chargeable to the customer directly.