Coleraine Capacity Upgrade

Options Report

November 2025

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2 Summary

Coleraine Main 110/33 kV substation currently has two 60 MVA 110/33 kV transformers. There is 108 MW of large scale renewable generation capacity connected at 33 kV at Coleraine, and a further 11.5 MW of small scale generation. With a peak demand of 47 MVA supplied from at Coleraine, there is a risk of exceeding the firm capacity of the transformers at times of high renewable generation output. This risk is currently managed by a Special Protection Scheme (SPS) and the pre-fault constraint of renewable generation. However, it is not viable to further expand the SPS as future small scale connections are not suitable for inclusion in the scheme, and existing generators cannot retrospectively be added.

Additional transformer capacity will be needed to facilitate increasing renewable generation connections, expected to support the target of supplying 80% of electricity demand from renewable energy sources (RES-E) by 2030 as set by the Climate Change Act (Northern Ireland) 2022.

Lastly, there is a potential overload risk on the 33 kV distribution network under credible contingency conditions associated with the embedding of Gruig and Garves wind farms at Ballymoney. Addressing this issue is likely to require work on both the transmission and distribution networks.

This report compares a number of options for reinforcement at Coleraine against a range of criteria. The preferred option is the replacement of the existing 60 MVA transformers with new 90 MVA units. Additionally, the connection point of Gruig wind farm is to be transferred from Coleraine to Rasharkin.

3 Introduction

Coleraine Main 110/33 kV substation supplies approximately 27,000 customers in Coleraine as well as the surrounding areas. The substation has two 110/33 kV 60 MVA transformers. The transformers were manufactured in 2001 and are now 23 years old.

The peak demand at Coleraine is estimated at 47 MVA which is within the transformer nameplate rating under single circuit outage conditions. There are also five large scale wind farms with an installed capacity of 108 MW, as well as approximately 11.5 MW of small-scale renewable generation, totalling 119.5 MW (exceeding the firm transformer capacity by 59.5 MW). The risk of exceeding the firm capacity is managed by use of a Special Protection Scheme (SPS) to prevent an overload on the remaining transformer during a trip of the other; under this SPS, Dunbeg wind farm is automatically tripped after a loss of a Coleraine transformer. However, during periods of low demand and high wind generation, there remains a risk that transformer flows at Coleraine could still exceed the 60 MVA static rating, even with the disconnection of Dunbeg wind farm. The minimum demand at Coleraine is approximately 8 MW, and the maximum output of Dunbeg is 42 MW. At 90% wind output, a transformer fault could see 60 MVA flowing through the remaining transformer. This is equal to the static rating of the transformer, and only 6 MVA less than the 66 MVA summer cyclic overload rating. This severely limits the ability to connect any further generation (especially small scale generation) to the distribution system at Coleraine.

Gruig wind farm is embedded within the 33 kV network downstream of Coleraine Main. Under high wind and low demand, there exists an N-1 risk associated with the two 33 kV circuits connecting Coleraine and Ballymoney under high output at this wind farm. Consideration will be given here to solutions to this problem at the transmission level.

Coleraine 110 kV is a mesh-type substation, with no spare bays. Future expansion of this to enable new circuits or new connections would require the existing transformers to be moved.

Within the NIE Networks Statement of Connection Charges[1], 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”. The SONI Transmission Connection Charging Methodology Statement (TCCMS)

[1] https://www.nienetworks.co.uk/documents/connections/statement-of-connection-charges-august-2024-v1-11.aspx

has a similar clause. Therefore, whilst an upgrade is required, the assets are not Connection Assets (and therefore not chargeable to any individual connection) as each individual connection does not cause the firm capacity to be exceeded after disregarding other flows.

4 Longlist of Options

There are five different options as follows:

- Option 1 – Do nothing
- Option 2 – Replace the transformers with 90 MVA units
- Option 3 – Install an additional transformer at Coleraine
- Option 4 – Transfer of Gruig wind farm to Rasharkin Main
- Option 5 – Replace transformers at Coleraine and transfer Gruig to Rasharkin Main

4.1 Option 1 – Do Nothing

Capital cost estimate: £0

The "do nothing" option would be to leave the current transformers in place with the SPS. There is no direct cost associated with this option; however, it would prevent any further generation connections of any scale at Coleraine for the foreseeable future.

4.2 Option 2 – Replace Transformers with 90 MVA units

Capital Cost estimate: £9.2m (including £2.5m of distribution costs)

Option 2 is to replace the two existing 60 MVA transformers with new 90 MVA units on a new alignment (see Figure 1). This would minimise the need for outages and leave room for a future extension of the 110 kV mesh. It would not be necessary to uprate the existing 33 kV switchboard as it is already designed to 2000 A. This would create an additional 30 MVA of firm capacity at Coleraine.

This option also requires NIE Networks to build a new 33 kV circuit between Ballymoney and Coleraine to address 33 kV overload risks associated with Gruig wind farm.

Figure 1 – New alignment of transformers

4.3 Option 3 – Install a 3rd transformer

Capital cost estimate: £9.4m (including £2.5m of distribution costs)

Option 3 sees the installation of an additional transformer to increase the firm capacity to a point where the SPS is no longer needed. A third transformer would give a firm capacity of 120 MVA which is above the generation capacity of 108 MW. NIE Networks also have existing spare 60 MVA transformers which could be used here. However, this option would significantly increase the fault level at 33 kV, requiring the replacement of the current 33 kV switchboard. This is presently not possible under existing NIE Networks equipment contracts and would likely need to be built to 50 kV specification. This would also require to provision of specific spares that could not be used elsewhere on the network.

Option 3 would also require the existing 110/33 kV transformers to be moved to make room for an extension of the 110 kV mesh to enable the connection of a third transformer.

This option also requires NIE Networks to build a new 33 kV circuit between Ballymoney and Coleraine to address 33 kV overload risks associated with Gruig wind farm.

This option is not carried forward to the shortlisted due to the complexity of delivery and operation.

4.4 Option 4 - Transfer of Gruig wind farm to Rasharkin

Capital cost estimate: £3m (distribution only)

This option includes transferring the 25 MW Gruig wind farm to a different transmission node, ensuring the firm capacity of the transformers is not exceeded following the operation of the SPS. This would create some additional capacity at Coleraine.

Gruig wind farm is located to the South-east of Coleraine Main, connected initially to Ballymoney Main via 33 kV overhead line (OHL) and ultimately into Coleraine 33 k V substation.

The 33 kV circuit between Ballymoney and Gruig wind farm crosses the Finvoy Road approximately 8 km north of Rasharkin Main. This option includes laying a 33 kV underground cable circuit from Rasharkin Main along this road to this crossing point at Finvoy Road, and connecting to the 33 kV circuit (see Figure 2). The section of the 33 kV circuit from Finvoy Road to Ballymoney Main would then be removed.

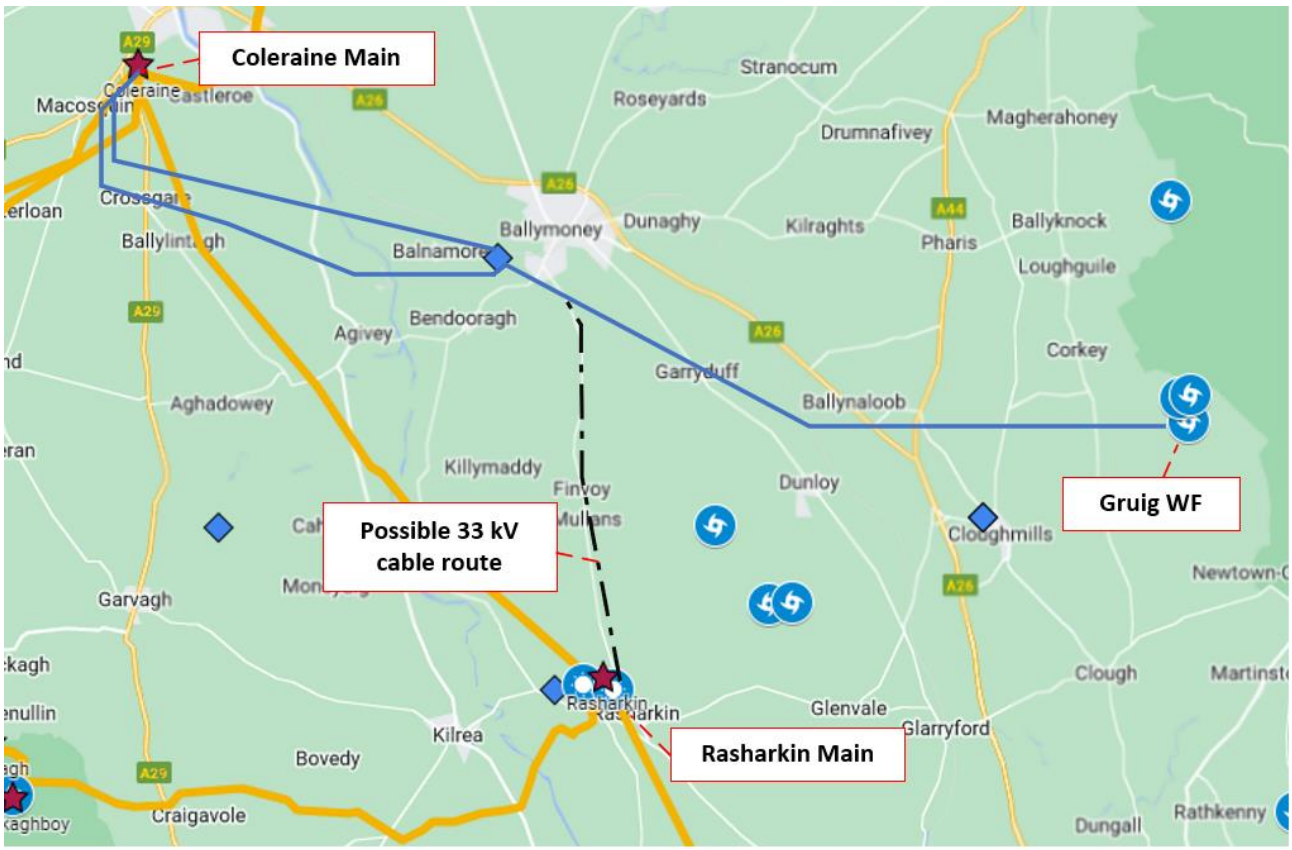

Figure 2 – Reconfiguraiton of Gruig connection (existing 33 kV circuits in blue)

Rasharkin Main is a cluster substation, designed solely for the connection of generation. There is one 90 MVA transformer connected, with 90 MW of associated generation. A second transformer is planned at Rasharkin Main, adding 90 MVA of new cluster generation capacity. Under NIE Networks' Statement of Charges[2] connecting generators at clusters are liable for the proportion of capacity that they use. Gruig would take up 26.3 MVA, meaning that the cost to transfer the wind farm to Rasharkin is 26.3/90 of the cost of the second transformer (approximately £0.99m).

Note that the cost of this option includes costs at both transmission and distribution levels.

This option addresses the overload risk to the 33 kV circuits between Coleraine and Ballymoney.

4.5 Option 5 - Replace transformers at Coleraine and transfer Gruig to Rasharkin Main

Capital cost estimate: £9.7m (including £3m of distribution costs)

This option is a combination of Options 2 and 4, and therefore includes both the replacement of the 60 MVA transformers at Coleraine with 90 MVA units, and the transfer of Gruig wind farm from Coleraine to Rasharkin. This option addresses all of the issues seen at Coleraine and is therefore shortlisted.

[2] https://www.nienetworks.co.uk/documents/connections/statement-of-connection-charges-august-2024-v1-11.aspx

5 Appraisal of short list of options

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

5.1 Technical performance

5.1.1 Option 1: Do nothing

As described in the Needs Report, the current level of generation connected at Coleraine exceeds the firm capacity of the transformers. In the event of an outage of one transformer this would cause the remaining in-service transformer to become overloaded. This would be a breach of the requirements set out in the Transmission System Security and Planning Standards (TSSPS).

This risk is presently managed by a SPS; it should be noted that SPS are intended as temporary measures until a longer-term solution is found, as an SPS increases the complexity of grid operation.

There is also a security of supply risk in a case where there is high renewable generation output and a Coleraine transformer trips. In this case, the SPS at Dunbeg may not reduce the generation enough to prevent overload of the remaining transformer, especially if further small scale generation connects at Coleraine, which is considered likely. If there are no pre-fault constraints in place and a transformer trip occurred during low load and 90% wind output, there could potentially be in excess of 60 MVA flowing through the remaining in-service transformer, putting it within its cyclic overload rating and risking an overload depending on the prevailing power factor.

Other than Dunbeg, all large scale generation at Coleraine has full firm network access. These generators must therefore be compensated for any constraint. Managing the transformer capacity in the long term by constraining these generators would come at considerable expense.

This option also does not address the distribution network issues between Coleraine and Ballymoney.

This option is not technically acceptable.

5.1.2 Option 2: Replace transformers with 90 MVA units

Replacing the 60 MVA transformers with new 90 MVA units would increase the firm capacity for both generation and demand at Coleraine by 30 MVA. This would result in a reduced risk of the SPS operating as the SPS would be enabled at a higher wind generation threshold. However, the installed generation capacity would still exceed the transformer capacity at Coleraine, with more than 110 MVA of generation currently installed. Therefore the SPS would still need to remain in place, and would have to be expanded if any future generation connected at 33 kV at Coleraine.

This option does not address the distribution network issues at Coleraine and would require NIEN to construct a third 33 kV circuit between Coleraine and Ballymoney.

This option leaves room for a future extension of Coleraine 110 kV mesh, considered likely to be required by 2030 to facilitate either new connections or a new 110 kV circuit.

This option is technically acceptable.

5.1.3 Option 4: Transfer of Gruig wind farm to Rasharkin

With the installation of the already planned second transformer, Rasharkin Main will have shallow capacity for an additional 90 MVA of generation. At present, Gruig wind farm is connected to the 33 kV distribution network fed from Coleraine Main which is in turn directly connected to Rasharkin Main via the 110 kV system. Coleraine Main and Rasharkin Main are subject to the same transmission network constraints and Gruig's existing capacity has been allocated within this constraint. Consequently, the transfer of Gruig between the two sites will not impact on existing transmission network constraints or affect its firm access.

This option reduces the generation at Coleraine by 25 MW/26.3 MVA. However, it does allow the removal of the SPS as potential flows on a transformer under outage conditions could exceed the 66 MVA summer cyclic overload rating:

- Existing wind gen. at Coleraine: **125.8 MVA**[3]
- Minus Gruig : **99.5 MVA**
- @90% output: **89.6 MVA**
- Minimum demand: **8 MVA**
- **Net flow on transformer:** **81.6 MVA** *(66 MVA overload rating)*

Consequently, this option does considerably increase headroom at Coleraine, but does not remove the need for the SPS. It addresses the distribution network issues at Coleraine identified by NIE Networks.

This option does not allow room for a future extension of Coleraine 110 kV mesh, considered likely by 2030 to facilitate either new connections or a new 110 kV circuit.

This option is technically acceptable.

5.1.4 Option 5: Replace transformers at Coleraine and Transfer Gruig and Garves to Rasharkin Main

By moving 26.3 MVA of generation off Coleraine onto Rasharkin and installing new 90 MVA transformers, this option both creates more than 30 MVA of additional generation capacity at Coleraine

[3] 119.5 MW at 0.95 power factor

and defers the need for an SPS until more generation connects at Coleraine. As with option 4, the transfer of Gruig from Coleraine to Rasharkin will not impact on existing transmission network constraints or affect Gruig's current level of firm access.

This option leaves room for a future extension of Coleraine 110 kV mesh, considered likely by 2030 to facilitate either new connections or a new 110 kV circuit.

This option addresses all of the issues identified in the Needs Report and is technically acceptable.

5.2 Deliverability

5.2.1 Option 1: Do nothing

This option does not include any actual immediate works, and is therefore deliverable.

5.2.2 Option 2 – Replace Transformers with 90 MVA units

Replacement of the transformers at Coleraine is considered highly deliverable as there is room within the existing substation for the new units (on the old 33 kV mesh site). Planning permission is not necessary for this work as it does not require the construction of new buildings and is considered Permitted Development. This option requires the purchase and installation of two 110/33 kV transformers which have considerable lead times; however, NIE Networks have gained approval for advance procurement of transformers and therefore the necessary equipment should be available for project completion by 2027.

This option requires NIE Networks to construct a new 33 kV circuit between Ballymoney and Coleraine to address distribution network congestion. NIE Networks have advised that this has proved to be challenging given the planning and consenting requirements.

Overall this option is considered to be of challenging deliverability and could be delivered by 2028.

5.2.3 Option 4 – Transfer of Gruig Wind Farm to Rasharkin

This option involves the construction of new underground 33 kV cable circuits along the Finvoy Road from Rasharkin Main to an intercept point with the existing Gruig 33 kV connection circuits. This work does not require planning permission and could be delivered by 2028

This option has a high degree of deliverability.

5.2.4 Option 5: Replace transformers at Coleraine and Transfer Gruig to Rasharkin Main

This option has high deliverability. None of the works required require planning permission. This is a combination of options 2 and 4 and is considered deliverable by 2028.

5.3 Capital cost

Table 1 shows the capital cost of the four shortlisted options. Please see Appendix 1 for a breakdown of costs for each option. Not that options 2 and 5 include both Transmission and Distribution costs, while all costs associated with option 3 are Distribution only.

Table 1 - Capital cost comparison

Option	Capital cost
1 – Do nothing	£0
2 – Replace Transformers with 90 MVA units	£6.7m TO, £2.5m DSO
4 – Transfer of Gruig to Rasharkin	£3m DSO
5 – Replace transformers at Coleraine and Transfer Gruig and Garves to Rasharkin Main	£6.7m TO, £3m DSO

5.4 Lifecycle costs

Net Present Cost (NPC) analysis was carried out to assess the lifecycle cost of each of the shortlisted options.Other than the capital cost of the work required, this was based on certain assumptions (Table 2:

Table 2 - NPC assumptions

Option	Assumption	Explanation
1 – Do nothing	Transformers require replacing by 2030 in any case	Increasing small scale connections will force a transformer replacement if not done now
	New 33 kV circuit required between Coleraine and Ballymoney (2028)	Needed to address identified distribution network constraint
2 – Replace Transformers with 90 MVA units	New 33 kV circuit required between Coleraine and Ballymoney (2028)	Needed to address identified distribution network constraint
	Constraint of Gruig wind farm until new circuit is constructed. 1308 MWh per year at £90/MWh[4] - £118k/year	Constraint necessary to prevent 33 kV overload risk. Gruig output constrained to ensure that combination of Gruig and local embedded generation does not exceed rating of single 33 kV line (26 MVA)
4 – Transfer of Gruig wind farm to Rasharkin	Transformers need to be replaced/moved by 2030	To allow for mesh extension for connections/new circuit. New transformers required to prevent security of supply risk during construction work, allowing old transformers to remain operational during installation of new units and minimising outages

[4] Cost estimate taken from SOEF v1.1 for year 2030: https://www.soni.ltd.uk/future-energy/shaping-our-electricity-future

Table 3 shows the NPC results for the shortlisted options.

Table 3 - NPC Results

Option	NPV (£, 2025)
1 – Do nothing	£10m
2 – Replace Transformers with 90 MVA units	£11m
4 – Transfer of wind farm to Rasharkin	£10m
5 - Replace transformers at Coleraine and Transfer Gruig and Garves to Rasharkin Main	£11m

It should be noted that option 5 is the only option that allows the SPS at Coleraine to be mothballed. This has the advantage of reducing the complexity of operating the system and reducing the risk of a protection maloperation which could ultimately lead to a disconnection of load at Coleraine. It has not been possible to quantify the impact of this in financial terms as there is insufficient data to undertake a probabilistic assessment, but in reality this would improve the relative performance of this option in the NPC calculation.

All options have very similar performance in the NPC calculation.

5.5 Environmental impact

On the transmission system, all of the options assessed involve works within existing substations only, requiring no substation expansion or major civil works. The environmental impact is therefore anticipated to be low.

Options 1 and 2 require the construction of a new 33 kV overhead line, which will have limited environmental impacts during construction. NIE Networks as Distribution System Operator (DSO) would have responsibility for managing and mitigating these impacts from design to construction.

Options 4 and 5 involve installation of new 33 kV underground cable. As this would be done within the existing road network the environmental impact should be minimised.

5.6 Summary of Multicriteria Analysis

Table 4 below visualises the points made previously.

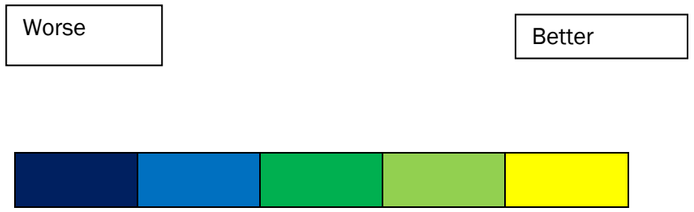

Table 4 Multi criteria assessment

Option	5: Replacement of Transformers at Coleraine, Transfer of wind farms to Rasharkin	4: Transfer of Gruig wind farm to Rasharkin	2: Replace Transformers with 90 MVA units	1: Do nothing
Technical performance	Excellent. Addresses all concerns and removes need for SPS	Acceptable. Increases capacity at Coleraine and removes need for new 33 kV overhead line. Does not allow for future 110 kV expansion. Transformer replacement likely necessary in future. Requires retention of SPS.	Acceptable. Increases capacity at Coleraine, leaves room for future 110 kV expansion. Requires retention of SPS and construction of new 33 kV overhead line.	Poor. Does not address any needs. Transformer replacement still necessary in future and requires construction of new 33 kV overhead line.
Deliverability	High. No planning permission required.	High. No planning permission required.	Medium. Transformer replacement does not require planning but requires NIEN to seek planning & consents for new 33 kV overhead line.	Medium. requires NIEN to seek planning & consents for new 33 kV overhead line.
Capital Cost	£9.72m (of which £6.71m Transmission)	£3.01m (DSO only)	£9.2m (of which £6.7m Transmission)	0
Lifecycle cost	£10m	£10m	£11m	£11m
Environmental Impact	Minimised. All works within roads or existing substations.	Minimised. All works within roads.	Requires new 33 kV OHL with some environmental impact likely during construction which will require mitigation.	Requires new 33 kV OHL with some environmental impact likely during construction which will require mitigation.
Summary	Best performing option. Although the most expensive, this addresses all needs and futureproofs extensively, removing the need for an SPS, creating extra capacity, and removing the need for new 33 kV OHL.	A good option, but does not remove need for SPS at Coleraine, leading to more complex system operation. Does not allow fur future 110 kV expansion at Coleraine.	Increases capacity at Coleraine and allows room for 110 kV expansion, but does not remove need for SPS and still requires construction of new 33 kV OHL.	Poor option. Does not address the needs and merely delays creation of new capacity for generation, while preventing connections in the meantime. Requires construction of new 33 kV OHL.

6 Preliminary preferred option

The preliminary preferred option is to install two new 90MVA 110/33 kV transformers at Coleraine Main along with the transfer of Gruig wind farm from Coleraine to Rasharkin (Option 5). This option addresses all of the needs identified in the Needs Report. This is the most expensive option, but it is less than 10% more expensive than the next option. It also reduces the complexity of system operation by removing the need for the Dunbeg SPS, while providing additional capacity for new generation and also leaving room for a future 110 kV expansion of Coleraine Main. It is very deliverable as it does not require planning permission. This option minimises environmental impact with works contained within the existing Coleraine and Rasharkin substations and cabling in the existing road network, and modification of an existing 33 kV pole.

Note that this option includes significant distribution works which will be progressed by NIE Networks separately in its role as DSO.

A TNPP is not required for this project as SONI have no preconstruction costs.

7 Timeline

Item	Date
SONI Control Point 1 Approval	November 2025
Issuing of functional specifications to NIE Networks	December 2025
Design Specifications from NIE Networks	May 2026
Issue Transmission Project Instruction and enter Transmission Project Agreement	June 2026
Construction	2027-2028
Energisation	April 2028

8 Appendix 1 – Cost Estimates

Option 2 - Replace Transformers with 90 MVA Units

Option 4 - Transfer of Gruig WF to Rasharkin

Option 2+4 - Replace Coleraine Transfomers and trasfer Gruig to Rasharkin