Carnmoney – Eden Reinforcement

Preliminary Preferred Options Report

16-12-2022

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Summary

A 110 kV double circuit overhead line was constructed between Carnmoney and Eden (Carrickfergus) substations in 1943 as part of a winder connection between Ballylumford Power Station and Belfast. This tower line is now 79 years old and in need of refurbishment or replacement to ensure continued security of supply at Carnmoney.

A Needs Report has been prepared highlighting the need for development.

An options assessment was carried out, and the options were appraised on the basis of technical, environmental, deliverability, cost and lifecycle cost criteria. A long list of options was reduced to a shortlist and a preliminary preferred option was selected from that shortlist. The shortlisted options were:

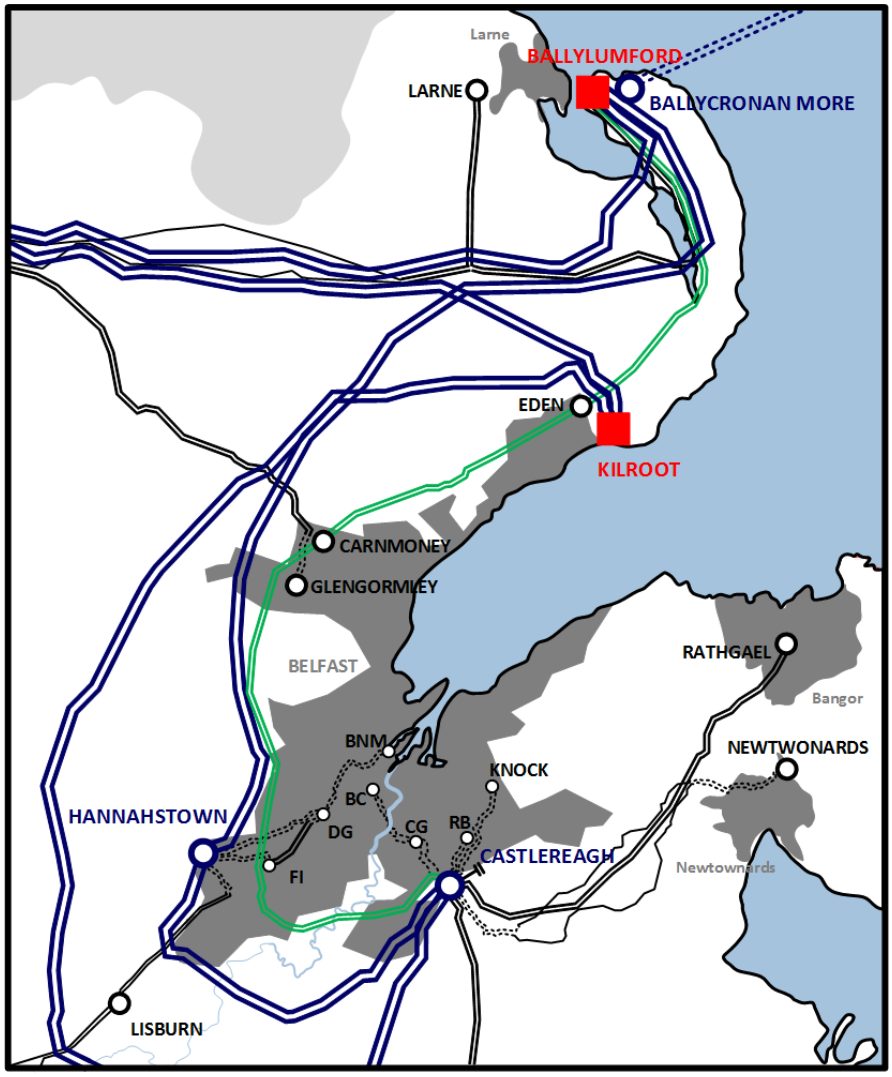
1. Refurbishment of the entire tower line in-situ
2. Removal of the overhead line in Carnmoney and Carrickfergus, replacement of these sections with underground cable, and refurbishment of the remaining overhead line
3. Removal of the overhead line in Carnmoney and replacement with underground cable, and refurbishment of the remaining overhead line

The option comparison presented in this report includes an assessment completed by RPS on environmental aspects of Options 1-3. This assessment has provided information to SONI in identifying the preliminary preferred option.

Additionally, SONI have sought feedback from NIEN on the project delivery and asset management aspects of the options comparison. Stakeholder engagement has also been carried out in the area affected by the project. Where relevant this feedback has been noted in this report.

Based on a multi-criteria analysis option 2 was found to be the preliminary preferred option. This is the highest-cost option but is considered to be the best long term option as well as being most deliverable and having the lowest social impact.

1 INTRODUCTION



Figure

Figure 1.1 - Line in context

The Electricity Board for Northern Ireland (EBNI) constructed a double circuit 110 kV tower line in 1943 between Ballylumford Power Station in Islandmagee and Rosebank Main in East Belfast. The tower line also supplied Eden, Carnmoney, and Finaghy bulk supply points along the route. This formed part of the original transmission system for Northern Ireland.

In the late 1960s the 275 kV system was constructed in Northern Ireland. As part of this project, the 110 kV double circuit was diverted into the newly constructed Castlereagh grid supply point. Since that work was completed, the double circuit has served to supply load at Eden Main and Carnmoney Main as well as provide a 110 kV feed to Castlereagh.

The tower line is now 79 years old. An assessment in 2016 found the conductor on the 'B' circuit (composed of steel-cored copper) to be at end of life, while the conductor on the 'A' circuit (made from cadmium copper) was found to be within 10 years of end of life. Subsequent assessment (detailed below) has found degradation of towers and concrete foundations along the route. The

condition of the conductor and towers, along with the low capacity of the circuits (supplying only a maximum of 70 MVA to Castlereagh during summer) mean that there is an urgent need to address the issues with the tower line.

Work required along the double circuit is being considered in four sections:

- Ballylumford to Eden;
- Eden to Carnmoney;
- Carnmoney to Finaghy; and
- Finaghy to Castlereagh.

Approval has been granted within SONI for the Ballylumford - Eden section to be refurbished. A TNPP submission was approved by the Utility Regulator and this project is now being progressed by NIE Networks.

In regard to the Castlereagh to Finaghy and Finaghy to Carnmoney sections, a TNPP submission was approved by the Utility Regulator in 2021. This project is known as the Energising Belfast Project. The Preliminary Preferred Option is to recover both sections, which are in densely populated areas, and establish a cable connection between Hannahstown and Castlereagh through the city centre.

This report focuses on the issues and solutions relating to the section between Carnmoney and Eden.

Over the course of the 79 years' existence of this double circuit, the route of the line between Eden and Carnmoney has become partially urbanised. In particular the approach to Carnmoney and Eden substations are heavily developed making the refurbishment of the tower line extremely challenging. The double circuit now crosses several busy transport links including the main Belfast – Derry/Londonderry railway, and traverses many residential areas, where access to towers is intrusive. In both Carrickfergus and Carnmoney, towers have become effectively landlocked by housing. In Carrickfergus the tower line traverses an area that is currently being developed. It is expected more towers will become land locked as a result.

In this report, the feasibility of refurbishing the existing tower line is assessed, as well as alternative options which involve either the full or partial removal of the double circuit. The results of technical, economic, deliverability and socio-economic studies are presented, and a preliminary recommendation, based on the information available at present, is made on the preferred option.

2 CHALLENGES WITH REFURBISHING THE DOUBLE CIRCUIT

In 2016 SONI engaged a consultant, LSTC, to assess how a refurbishment of the double circuit could be carried out. The consultant performed a tower by tower assessment of the route, noting the work required and any difficulties likely to be encountered. This also enabled an estimation of the cost of the refurbishment work to be determined. The findings were provided to SONI in a buildability report. This report also covered the sections between Carnmoney and Castlereagh.

The report finds that the refurbishment of the Carnmoney to Eden section is technically feasible. However, the report stresses that the refurbishment, in certain sections, would be extremely complex and disruptive to residents and landowners. As of 2022, further development has occurred in proximity to towers in Carrickfergus, making the prospect of refurbishment even more challenging.

This report can be seen in Appendix C.

2.1 Stringing issues

As part of any refurbishment, the double circuit would be restrung with upas conductor. This conductor is planned to be used for the already UR approved Ballylumford to Eden section of the double circuit. The LSTC report recommends that, prior to commencing any restringing operation, a condition assessment of the existing conductors is required.

For the Carnmoney to Eden section of the double circuit, the report finds that:

- Stringing will be very difficult at 8 angle towers surrounded by residential development;
- 8 sites will require scaffolding likely to raise disruption to traffic and public transport; and
- 6 spans would have clearance infringements with a higher rated conductor (operated at 75ºC), which would need to be addressed through mitigation measures.

2.2 Tower steelwork and foundations

To refurbish the double circuit and restring with upas conductor, all towers and their foundations along the route will need assessment to ensure the structures are capable of carrying the new conductor. An initial inspection of 23 towers along the Carnmoney to Eden section found the following:

- Most towers had varying degrees of corrosion; and
- Two towers, one of which is located adjacent to residential properties, were identified as having extensive corrosion and would require replacement.

No towers on this section have had any foundation assessment performed. However, an assessment of 8 towers along the Castlereagh to Finaghy section found the following issues:

- Some degree of spalling or honeycombing was present within the foundations at the majority of the assessed towers; and
- Varying degrees of steelwork corrosion was observed at all towers, with steelwork replacement necessary.

Typically, foundation repair would consist of excavating around each leg in turn, breaking away existing concrete, establishing new casings and pouring new concrete. However, in cases where space is limited it may not be possible to establish stays to secure the tower during foundation repair. In this circumstance the tower foundation can be reinforced by establishing a concrete ring beam with associated piles at the base of the tower, as indicated in figure 2.1.

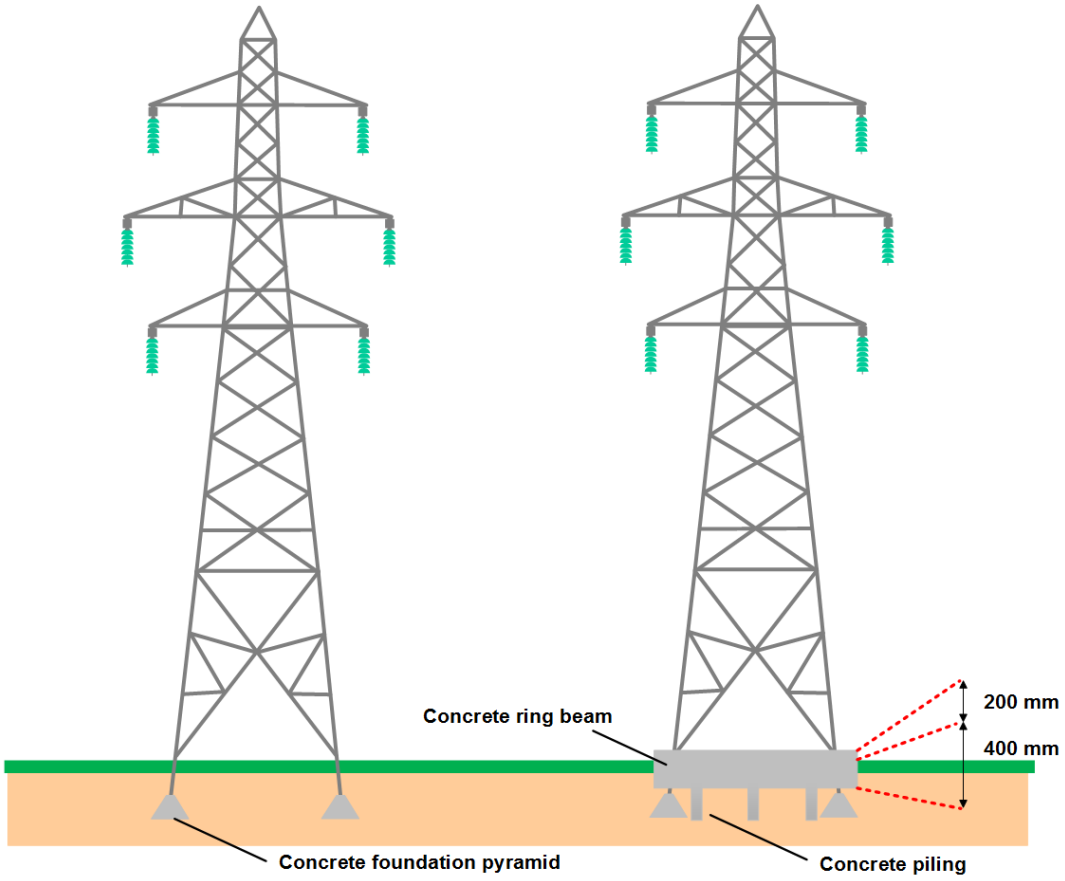


Figure 2.1: Tower foundation reinforcement

The social and environmental impact of this remediation method must also be considered in any decisions. As shown in figure 2.1, up to 20 cm of the ring beam would exist above the surface. Furthermore, it is important to consider whether such work can be undertaken within the terms of the existing wayleaves and also whether planning permission would be required.

3 CHALLENGES WITH REMOVING THE DOUBLE CIRCUIT

3.1 Impact of removal on the network

As discussed in the Needs Report and in Section 1 above, the four identified double circuit sections between Ballylumford and Castlereagh provides resupply to Castlereagh. This is important for both during the annual maintenance season and in the event of a High Impact Low Probability (HILP) event at Castlereagh.

The Preliminary Preferred Options Report for the Castlereagh – Carnmoney section has concluded that the Castlereagh – Carnmoney section of the tower line should be recovered and the provision of resupply to Castlereagh provided through an underground cable connection through Belfast city centre[1]. This will then reconfigure the Carnmoney and Eden substations to become radially fed directly from Ballylumford.

3.2 Recovery of the tower line

The recovery of sections of the tower line between Carnmoney and Eden would also cause some disruption. For major road crossings scaffolding may be required to allow sections of conductor to be safely recovered. For towers that are being recovered, the process of removal will depend on the level of access. Towers with relatively easy access would be removed in larger sections using an appropriate crane. Where towers are land locked, it may not be possible to make use of a crane for removal. In this case, the towers would have to be cut into smaller sections and removed top down, piece by piece.

There would have to be a decision in regard to steelwork and foundation materials below ground level which would probably depend on the site and the views of the landowners. The preferred approach, particularly in sites that are land locked, would be to cut the tower legs just below ground level and reinstate the surface. The concrete stub/pyramid for each corner would be left in situ. This would ultimately involve the least disruption and ground works. For towers that are accessible for plant the foundations could also be removed and the ground reinstated; however, this would involve excavation of a significant quantity of earth.

The duration of the work to remove sections of double circuit would be much shorter than the work associated with refurbishment.

Overall, it is expected that residents and landowners would be more amenable to the disruption associated with the recovery of the tower line.

1 This is now known as the Energising Belfast Project

4 REINFORCEMENT OPTIONS

4.1 Long list of options

Taking account of the considerable difficulties involved in refurbishing the double circuit (including foundation remedial works, replacement of some steel sections and conductor replacement), in particular through the urban areas, a long list of options that would allow sections of the tower line to be recovered was developed.

The options range from removing it entirely to retaining sections of the circuit and introducing underground cable along more difficult sections. The long list of five options, including indicative capital costs, is displayed in table 4.1.

Table 4.1: Long list of reinforcement options

Option	Description	Cost (£m)
1	Refurbishment of entire double circuit	12.7
2	Refurbishment with undergrounding in Carrickfergus and Carnmoney	27.9
3	Refurbishment with undergrounding in Carnmoney only	15.1
4	Global Point connection	31.2/43.8[2]
5	Remove and supply Carnmoney from Glengormley	8.5

4.2 Rationalising the long list

Option 4 builds on Option 2 and Option 3, where the Carnmoney underground section will be connected into a new switching station at Global Point Invest NI site in Newtownabbey. This allows the Carnmoney – Eden circuits and the Kells – Glengormley circuits to be connected into the new switching station, thus establishing a second double circuit connection between Ballylumford and Kells. This new switching station and its associated connections could be required in future for several reasons:

- Export capacity from Ballylumford may need to be increased in future to cater for generation; or
- The level of demand connecting at Global Point, Carnmoney, Glengormley or Eden requires a parallel connection between Ballylumford and Kells.

[2] Lower cost represents retaining the line in Carrickfergus as per option 3 while the higher cost includes undergrounding in Carrickfergus, as with option 2

The expected demand based on current connection applications at Global Point is currently estimated at less than 10 MVA and based on this it is considered that suggested future proofing entailed by Option 4 is not required at this stage. For the above reasons Option 4 is therefore not brought forward to the short list for further more detailed assessments and investigations. If required in the future, Options 1-3 would allow the proposed switching station in Option 4 to be developed at a later date at a cost of £15-20m if the need arose.

Option 5 will not be brough forward into the short list either as it is deemed not feasible or economic to develop the distribution network as required for this option to address the identified need. Option 5 would involve installing a 2nd 110/33 kV transformer at Glengormley station and recovering the 110 kV circuits from Eden to Carnmoney, disconnecting Carnmoney from the 110 kV system. Carnmoney has two 33 kV cable connections, rated at 17 MVA each, to Glengormley station. Whilst these cable connections could supply the Carnmoney demand of 25.5 MVA there would be no security of supply during a cable fault. Therefore, this option includes for 33 kV reinforcement between Glengormley and Carnmoney. The 110 kV connection from Kells – Glengormley would have sufficient capacity to cater for the combined demand of Carnmoney and Glengormley during the unexpected loss of a single circuit or piece of equipment (An N-1 scenario).

However, the supply to Glengormley and Carnmoney would not be secure for an N-2 event, for example loss of both transformers at Glengormley, or both circuits on the 110 kV double circuit tower line or cable section. Glengormley and Carnmoney have very poor 33 kV resupply as the two sites historically secured each other but were not strongly connected to any other bulk supply points.

Discussions with NIE Networks have shown that this is not a good option. Glengormley has one 33 kV connection to a local 33/11kV substation at Roughfort Central, which is normally supplied from Ballyclare Central. This 33 kV connection would not be sufficient to secure both Glengormley and Carnmoney in the event of an N-2 event (unexpected loss of two circuits, pieces of equipment or one of each) at Glengormley. It would be necessary to establish new 33 kV connections into Carnmoney from a bulk supply point other than Glengormley, however the nearest 33 kV node is at Ballyclare, which has no additional capacity. A connection from Glengormley Main to Belfast North Main could also in theory establish resupply to cater for an ~N-2 condition. It is not considered feasible or economic to establish a 33 kV connection between Carnmoney and Belfast North Main due the urbanised nature of the land between the two stations and the transport infrastructure that would have to be crossed (including the M2 motorway, the Belfast – Antrim railway line and the York Street Interchange).

This option would also significantly reduce the demand capacity at Glengormley and Carnmoney and remove is one of the strongest points on the Northern Ireland 110 kV network. In particular it would diminish the capacity and security of supply to the Invest NI site at Global Point

4.3 Short list of options

Table 4.2 details the short list of three options that will be assessed in detail to ultimately determine a preliminary preferred option.

Table 4.2: Short list of reinforcement options

Option	Description
1	Refurbishment of entire double circuit
2	Refurbishment with undergrounding in Carrickfergus and Carnmoney
3	Refurbishment with undergrounding in Carnmoney only in Carnmoney only

5 ASSESSMENT OF SHORT LIST OF OPTIONS

5.1 Criteria

To help reduce the short list to a preferred option, the options were assessed against the following five criteria:

- Technical performance;
- Longer term technical performance;
- Economic performance
- Deliverability; and
- Environmental and Socio-Economic impact.

Technical performance

Two different considerations are included when assessing the technical performance of an option, and are as follows:

- **Capacity**: the ability to fulfil load at Eden, Carnmoney and Glengormley under all credible contingencies is assessed**;** and
- **Additional load at Carnmoney:** the capacity to support additional load in the Carnmoney area is assessed - this reflects the potential to develop the Global Point site as well as load growth from decarbonisation of heat and transport.

Economic performance

The options will be assessed for the following costs:

- **Capital cost of option**: the cost of all equipment associated with the option will be assessed. The cost of all work associated with the Carnmoney to Eden 110 kV double circuit will be assessed based on costs from NIE and LSTC; and
- **Net Present Cost**: all options will be subject to an NPC calculation.

Deliverability

A high level assessment of the challenges associated with delivering the option is considered. This includes:

- **Issues relating to refurbishment**: The difficulties associated with any refurbishment of the Carnmoney to Eden 110 kV double circuit, informed by the SONI buildability report;
- **Issues relating to removal**: The difficulties associated with any removal of the Carnmoney to Eden 110 kV double circuit, again informed by the SONI buildability report; and
- **Issues relating to all other elements of option**: Where new circuits or substations are required, particular difficulties presented by transport and land use are noted.

Socio and environmental performance

Each option will have a high level assessment of its potential social and environmental impacts. Consideration is given to:

- The impact of the option on residential areas;
- The visual impact of the option; and
- The long term benefits of the project.

Full details of the social and environmental analysis can be seen in Appendix E.

5.2 Works at Eden Main

Both transformers at Eden Main are connected in a 'T' arrangement (see figure 5.1). Following removal of the Carnmoney – Castlereagh double circuit, a fault on the Eden – Carnmoney 'B' circuit would also lose supply, due to the location of its circuit breaker. This is not an issue with the 'A' circuit.

To prevent this issue, all options assessed here also include moving the T2 transformer 'T' to the Ballylumford side of circuit breaker 2T0 so that both the 'A' and 'B' sides of Eden have the same configuration.

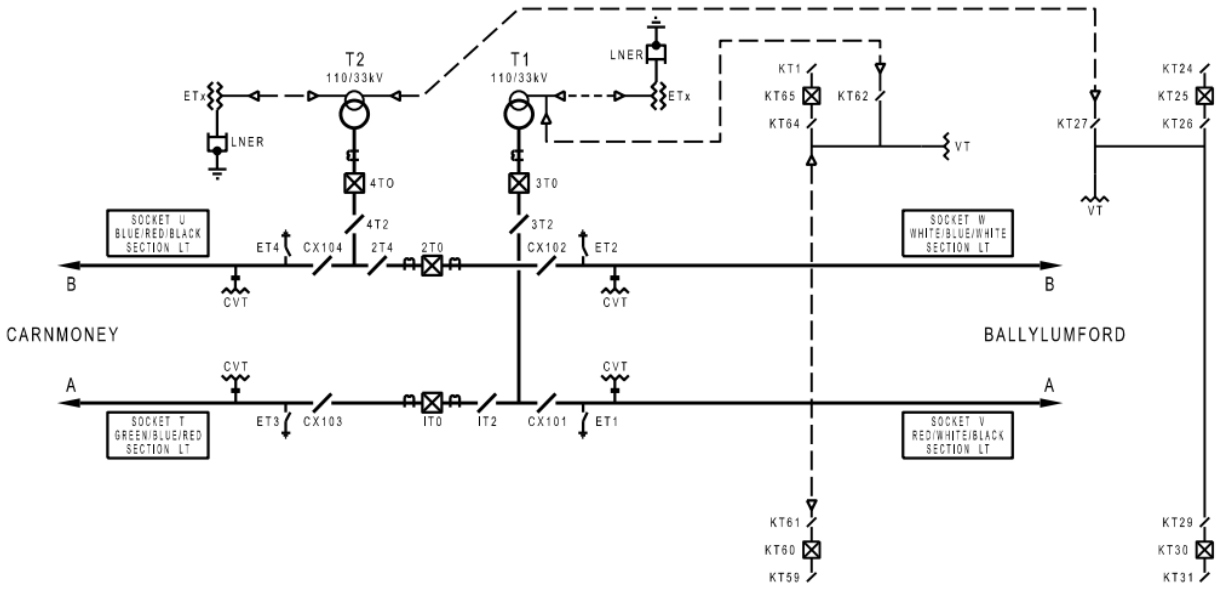


Figure 5.1 - Eden Main SLD

5.3 Undercrossings

In order to allow refurbishment work to proceed safely, all overhead lines which pass beneath the tower line would have the relevant spans undergrounded. All costs below include an allowance for undergrounding of 6.6 kV, 11 kV and 33 kV spans.

5.4 Option 1: Refurbishment of entire double circuit

Summary of option

The Carnmoney to Eden section of the Ballylumford to Castlereagh 110 kV double circuit is retained and refurbished, while the double circuit is restrung with upas conductor, giving a minimum rating of 144 MVA. A second 110/33 kV transformer is installed at Glengormley to secure supply to Glengormley and resupply to Carnmoney in the likely event that any double circuit outages will be required.

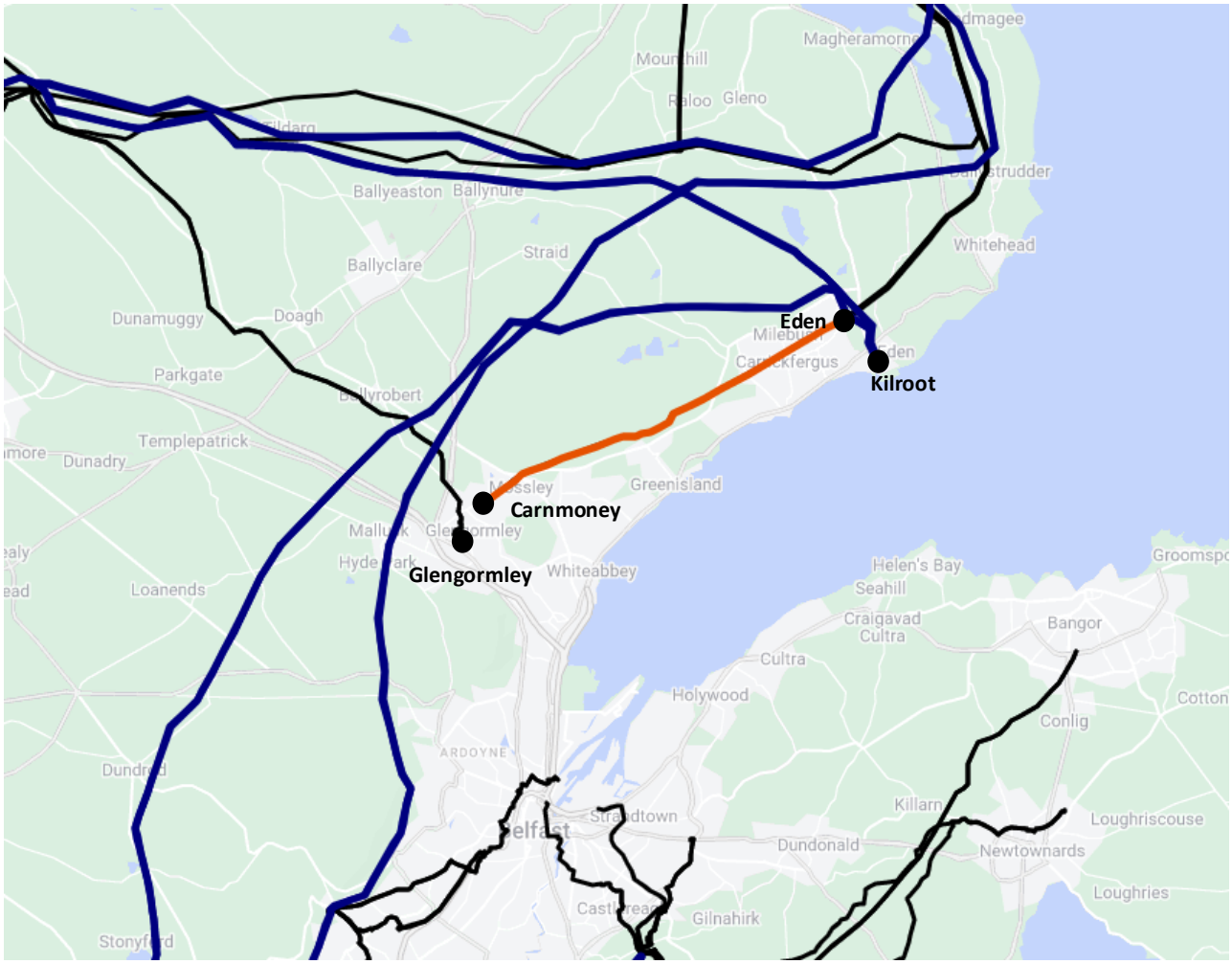


Figure 5.2: Geographic map of Option 1

Summary of performance

Capacity, and Additional Load at Carnmoney

Peak demand at Carnmoney was 25.5 MVA in 2020. The projections published in the Ten Year Transmission Forecast Statement 2021-2030[3] show a slight decline to 24.4 MVA in 2030. SONI's scenario analysis published in Tomorrow's Energy Scenarios 2020[4] show that demand could increase by more than 30% by 2030 depending on the pace of decarbonisation of heat and transport. The nearby Invest NI site at Global Point is also a potential connection point for large scale demand, with approx. 10 MVA of demand currently planned. This option would give Carnmoney a capacity of approximately 90 MVA. Ultimate capacity at Carnmoney would depend on the demand connected to Eden as both Carnmoney and Eden will be ultimately fed from Ballylumford following the disconnection of the Carnmoney - Castlereagh 110 kV link in 2024.

Installation of the 2nd transformer at Glengormley removes the need to supply the rear busbar at Glengormley from Carnmoney at 33 kV, improving security of supply at both Glengormley and Carnmoney stations. Installation of this transformer is necessary to allow the existing double circuit to come out of service for the refurbishment works.

Cost of option

Refurbishment of the Carnmoney to Eden section is estimated to cost **£11m**.

Along with installation of a second transformer at Glengormley, the total estimated cost for this option is £**12.7m**.

The estimated Net Present Cost is £13m. See Appendix B for details.

Deliverability

Delivery of this option is expected to be extremely difficult. At least 9 towers have difficult access with some towers effectively landlocked by housing – particularly in the approach to Carnmoney substation (the final 6 towers on the approach to Carnmoney station), and around Carrickfergus due to ongoing new housing developments. It is expected that further issues will emerge in Carrickfergus.

3 https://www.soni.ltd.uk/media/All-Island-Ten-Year-Transmission-Forecast-Statement-TYTFS-2021.pdf
4 https://www.soni.ltd.uk/media/documents/TESNI-2020.pdf

The investigations detailed in Appendix C found that at least 5 of the 7 towers closest to Carnmoney substation have overloaded foundations which would require remediation. Due to the proximity of these towers to housing, this work would cause significant and lengthy disruption, requiring residents to be offered alternative accommodation during the works. It is also likely that the access required for these works as well as the works themselves would cause irreversible damage to private property.

At least two towers near Eden Main (63A and 65) are heavily degraded and in the event of this option being progressed would need to be entirely replaced. Difficult stringing positions would be encountered at several towers, including at a railway crossing. Restringing with Upas conductor will present clearance issues across six spans, two of which are in Carrickfergus and the rest between Carrickfergus and Carnmoney. One of these clearance violations is to a building, one to other wires, and the remainder to vegetation. It should be possible to resolve these by reducing the operating temperature of the conductor to 50°C, which would give a minimum multi circuit rating of 117 MVA.

Restringing the double circuit will impact on a number of major transport routes including both the B59 and B90 roads and the Belfast to Derry/Londonderry railway, which will have implications for outage availability.

Social and environmental impact

The option is expected to have a negative social impact due to the sections of the tower line that traverse residential areas. Residents and businesses in Carnmoney and Carrickfergus will continue to be impacted by the presence of the double circuit in the long term, and the required refurbishment work would be very intrusive and lengthy for some residents. The double circuit also crosses land in Carrickfergus which has been zoned for residential development in the Belfast Metropolitan Area Plan. At least one housing development is already underway with one tower in this area already land locked. It is likely further instances of land locking will occur restricting access to towers.

The double circuit passes through three Sites of Local Nature Conservation Importance (SLNCIs). Given that the Carnmoney to Eden 110 kV line already passes through these SLNCIs, any refurbishment works associated with Option 1 will likely be short term and temporary in nature and will be confined to the construction phase. There is also a potential pathway for sediment release during works which may impact water quality in local watercourses, however this is likely to be short term and temporary and would also be confined to the construction phase.

The double circuit passes several heritage sites, but any impact on these is likely to be minimal and work would have to be undertaken with appropriate consideration.

As a number of towers are located in close proximity to residential properties, it is anticipated that if this option were to be selected, during foundation works to towers there would be significant

disruption to residents in the area. At a number of towers this could require residents to be offered alternative accommodation for a period of time to allow access for the works. Given that Carnmoney and Carrickfergus are residential areas, there may be restrictions on accessing the line, which may increase the duration and cost of the works. Refurbishment work for a single tower could take up to three weeks in the case of the landlocked towers in Carnmoney.

5.5 Option 2: Carnmoney and Carrickfergus undergrounding

Summary of option

This option retains the overhead line in the rural area between Carnmoney and Carrickfergus stations but replaces it with double circuit underground cables through the residential areas around Carrickfergus and Carnmoney stations. The existing overhead lines in these areas would be dismantled and removed.

Similarly, to Option 1, the retained section of overhead line would be restrung with upas conductor operated at 50°C with a minimum rating of 117 MVA, and a second 110/33 kV transformer would be installed at Glengormley station.

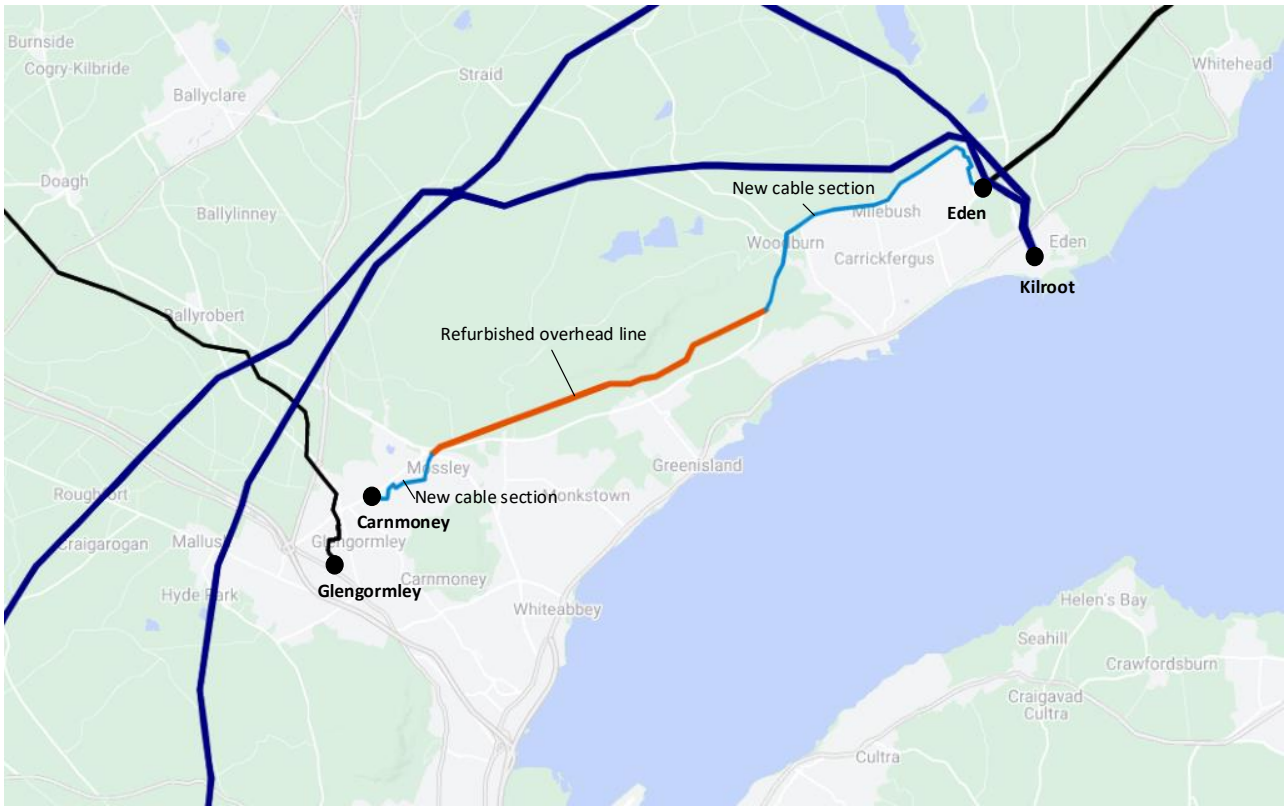


Figure 5.3: Geographic map of Option 2

Summary of performance

Capacity, and Additional Load at Carnmoney

This option would provide the same capacity for additional load as option 1.The use of cables will involve additional reactive power injection, which would need to be managed. It would also require any transient characteristics to be studied during pre-construction stage although it is thought unlikely to be problematic.

Cost of option

The estimated cost for this option is £27.9m.

The option has an estimated Net Present Cost of £29m. See Appendix B for details.

Deliverability

Delivery of this option is expected to be much more achievable than Option 1. Removal of towers in urban and residential areas is likely to be less onerous than refurbishment as foundation works will not be necessary.

For the section of tower line being retained, at least 19 towers (of 25) would require foundation works. Difficult stringing positions will be encountered at several towers but access to rural towers is generally good.

As with option 1, restringing with upas conductor and operating this at 65 or 75°C would present clearance issues to buildings and terrain across spans ahead of towers 86, 87 and 100, Undergrouding of other wires would prevent a clearance issue ahead of tower 89 in the rural area between Carrickfergus and Carnmoney. It should be possible to resolve these by specifying the operating temperature of the conductor to 50°C, which will give a minimum multi circuit rating of 117 MVA.

It will be necessary to either restring the double circuit crossing the Belfast – Derry/Londonderry railway and B59/B90 and establish a new terminal tower. Likewise tower 77, adjacent to the Upper Road immediately west of Carrickfergus, would be replaced with a terminal tower and cable laid from here to Eden Main.

In both Carnmoney and Carrickfergus, cable laying would cause some significant traffic disruption depending on the route chosen. Carnmoney station is also effectively ‘landlocked’ by adjacent properties and there are several 33 kV cables already located in the access road. Obtaining a 110 kV cable route into the substation through existing access ways may not be possible. There would be temporary traffic disruption arising from laying 110 kV underground cables, but this is likely to be significantly less than that arising from re-stringing the existing line and in particular replacing tower foundations.

Designing a cable route out of Eden substation and through Carrickfergus will be difficult and may require a more circuitous route (and thus higher cost) that would result in a higher cost than that assumed here.

Social and environmental impact

The option is expected to have a better social impact than Option 1. The required refurbishment work is in a largely rural area and is not expected to be intrusive except where busy transportation links are crossed at the Carnmoney end.

The double circuit currently crosses land in Carrickfergus which has been zoned for residential development in the Belfast Metropolitan Area Plan. Since the LSTC investigation detailed in Appendix C, this development has begun, and tower 62 has already become effectively landlocked, further complicating any refurbishment. Removal of the overhead line will remove an impediment to development of this land.

The security of supply to the Carnmoney and Glengormley areas will be enhanced with the installation of additional transformer capacity at Glengormley and consequent removal of dependence on Carnmoney.

The environmental constraints along both the Carrickfergus and Carnmoney sections of the new double circuit cables include salmon spawning rivers as well as numerous river crossings. Any development particularly adjacent to or hydrologically connected to the river must ensure the conservation of the Atlantic salmon is considered. The salmon rivers could prove to be a constraint to works due to the legislative environmental protection (Fisheries Act) for salmonids. During the dismantling of the line and the undergrounding of the cable there is the potential for significant impacts (via noise, vibration or sediment release) on water quality, however these potential impacts should be short term and confined to the construction phase.

The route of the new double circuit cable in Carrickfergus could pass in close proximity (approximately 15m) to the Oakfield SLNCI and an area of potential ancient woodland. The location and potential impacts on these areas should be considered during the construction phase of any undergrounding works. However, it should be noted that there is anticipated to be an improved visual setting on the Oakfield SLNCI and ancient woodland due to the removal of the overhead 110 kV line.

There may be some localised disruption to residents during the removal of towers, however as the towers would not require any foundation works it is anticipated that these impacts would be less significant than option 1. There are not anticipated to be any impacts on these areas post construction phase.

It should be noted that there is the potential for long term better social impacts associated with the removal of the overhead 110 kV line, with the restrictions on development and improvements in visual amenity.

5.6 Option 3: Carnmoney undergrounding

Summary of option

This option is similar to option 2 except the overhead line in Carrickfergus is retained and refurbished, while the section in Carnmoney is replaced with underground cable and overhead line removed. As with options 1 and 2, the retained sections of overhead line are restrung with upas conductor at 50°C, giving a minimum rating of 117 MVA. Likewise, a 2nd 110/33 kV transformer is installed at Glengormley.

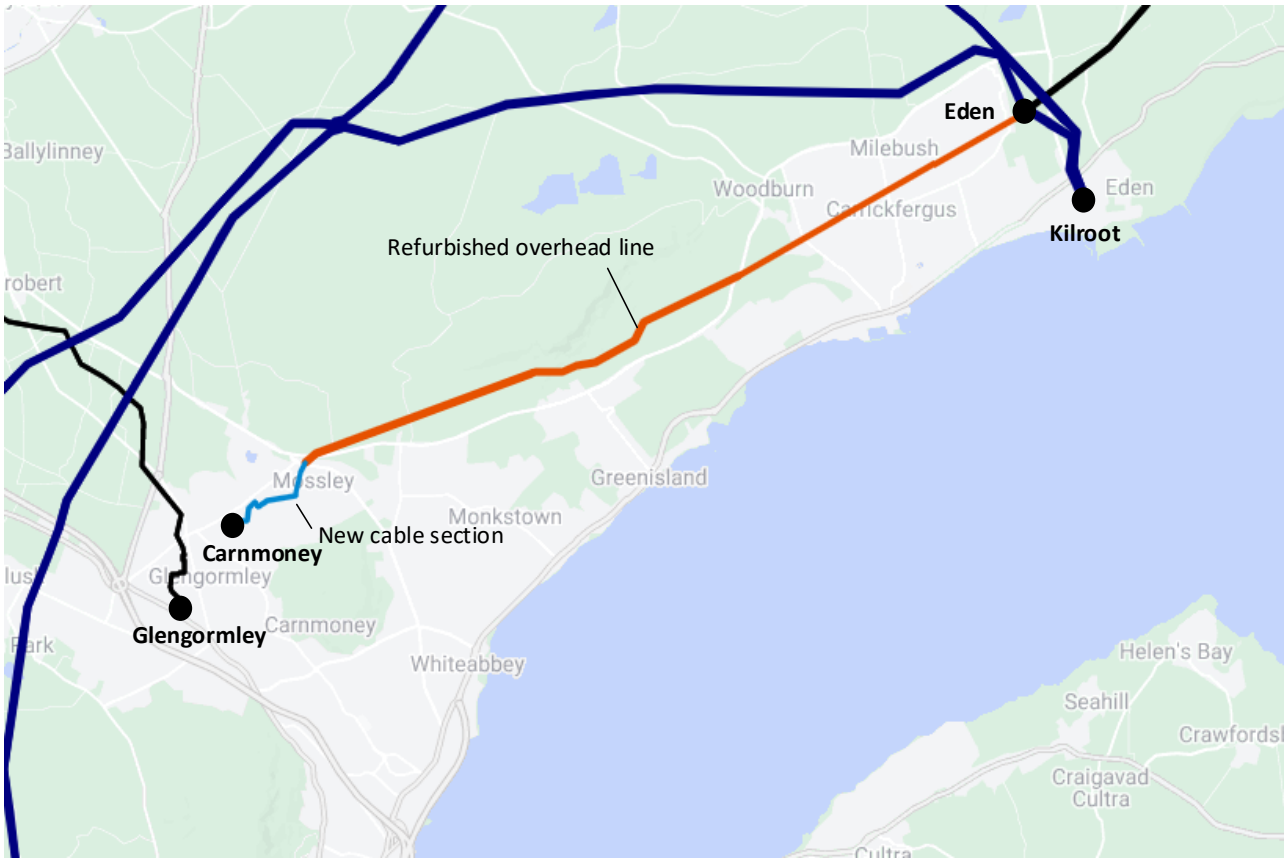


Figure 5.4: Geographic map of Option 3

Summary of performance

Capacity, and Additional Load at Carnmoney

This option provides the same capacity for additional load as options 1 and 2. There is a lower likelihood of transient effects on the voltage than option 2 due to the reduced length of cable required in this option.

Cost of option

The estimated cost for this option is £15.1m.

The option has an estimated Net Present Cost of £16m. See Appendix B for details.

Deliverability

Delivery of this option is expected to be extremely challenging. Removal of towers at the Carnmoney end of the line will be less onerous than replacement as major foundation works are not necessary. This option presents the same difficulties with stringing positions between the edge of Carnmoney and Eden substation as option 1. Likewise, the same clearance issues as option 1 will be seen in this area but would be mitigated by operating the upas conductor at a design operating temperature of 50°C.

As with option 2, there will be difficulties developing a cable route into Carnmoney substation due to its landlocked location. There will also be some disruption to the Belfast – Derry/Londonderry railway and to traffic from refurbishment and cable laying works, but this is less than for option 2 due to the lack of cable laying in Carrickfergus.

Although the LSTC analysis in Appendix C suggests that refurbishment of the tower line through Carrickfergus is achievable, since this analysis was carried out development in Carrickfergus has rendered at least one tower (no. 62) already landlocked. Many of the towers in Carrickfergus lie on land zoned for development, and it is anticipated that this will make access to towers for maintenance and inspection increasingly more difficult over time.

Social and environmental impact

Residents in Carrickfergus would continue to be impacted by its presence in the long term. The required refurbishment work is expected to be intrusive for residents near towers 60, 62 and 63 and at time of writing to a lesser extent at towers 61, 65 and 67 in Carrickfergus.

However as developments continue further land locking of towers are expected. The double circuit crosses land in Carrickfergus which has been zoned for residential development in the Belfast Metropolitan Area Plan and its continued presence would be an impediment to development.

Whilst the towers that traverse the residential areas of Carrickfergus did appear to be more accessible than those in Carnmoney, land locking has now occurred at tower 62. It is expected that there will be further instances of this in the coming months.

Preliminary stakeholder engagement has shown that retention of the overhead line in Carrickfergus is likely to suffer low public acceptance.

6 Comparison of options

The three options are assessed against a number of criteria. The effect on each criterion parameter is qualitatively determined using expert judgement and experience. This is presented by means of colour coding, along a range from “more significant”/”more difficult”/“more risk” to “less significant”/”less difficult”/“less risk”.

The following scale is used to illustrate the performance of each criterion

The summary of the combined performance against all of the criteria is listed in table 6.1.

Table 6.1: Combined performance of options

Less favourable — More favourable

Criteria	Option		
	1 - Refurbishment	2 – Carnmoney and Carrickfergus Undergrounding	3 – Carnmoney Undergrounding
Technical performance	Tower line designed for requirements of 1940s, sub-optimal configuration. Future maintenance work likely to be challenging on towers and spans in urban area. Significant increase in capacity at both Glengormley and Carnmoney. Derating of rural section necessary to prevent clearance infringements	Significant increase in capacity at both Glengormley and Carnmoney. Derating of rural section necessary to prevent clearance infringements. Increased likelihood of Transient Overvoltages due to cable sections.	Significant increase in capacity at both Glengormley and Carnmoney. Derating of rural section necessary to prevent clearance infringements. Future access for maintenance work in Carrickfergus may be challenging if urban development takes place under circuits.
Capital cost	£12.7m	£27.9m	£15.1m
Lifecycle cost	£13m	£29m	£16m
Deliverability	Disruption to residents near towers in Carnmoney and Carrickfergus will be significant, and invasive and destructive works will be required for foundation and tower renewal. Almost certainly not a practical option.	Achievable. Access for tower removal in urban areas will be challenging but not as onerous as would be required for foundation works for refurbishment. Cabling would likely take place in roadways, requiring traffic management. Designing a new cable route into Carnmoney may be challenging due to existing 33 kV cables and access.	Low. Development of previously vacant land in Carrickfergus is causing previously accessible towers to become landlocked, reducing viability of this option. Cabling in Carnmoney would take likely place in roadways, requiring traffic management. Designing a new cable route into Carnmoney may be challenging due to existing 33 kV cables and access.
Socio-economic	Will involve intrusive, lengthy and disruptive works in close proximity to homes and businesses. Likely to have low public acceptance.	Removes overhead lines in urban areas and on land designated for residential development. Likely to be welcomed by those in the path of the line. Cable works would be intrusive and likely to cause disruption in both Carnmoney and Carrickfergus.	Removes intrusive overhead line in Carnmoney and replaces ageing assets elsewhere. Residential and commercial areas in Carrickfergus would not benefit to the extent that those at the Carnmoney end will, but the existing circuits are not situated as close to properties as in Carnmoney. Stakeholder engagement has shown that this is likely to suffer acceptance issues in Carrickfergus
Summary	Complicated delivery, may not be possible due to difficulty of access and disruption. Likely to encounter significant delays.	The most deliverable of all options, with the least overall disruption – however this is the most expensive option.This will provide excellent long-term security of supply to both Glengormley and Carnmoney, and remove impediments to development in Carrickfergus through removal of an overhead line through the town.	Questionable deliverability due to access issues in Carrickfergus. Imbalanced social impact at both ends of the line, and maintenance of the tower line in Carrickfergus is likely to be challenging in the long term.

7 Preliminary preferred option

This assessment is based on the information that is available at present. SONI have come to the following conclusions on the options considered. A tabular comparison of options can be seen in table 6.1 above.

All options assessed include the installation of a second 110/33 kV transformer at Glengormley to address security of supply concerns.

Option 2 is the preliminary preferred option.

Option 1 involves refurbishment of the entire double circuit from Eden to Carnmoney. This option is likely to be impractical as the 6 spans closest to Carnmoney substation (as well as at least one span in Carrickfergus) are located in a dense residential area and would likely result in significant construction challenges and disruption to residents. As time goes on the instances of land locking of towers in Carrickfergus is expected to grow making this option less favourable.

This is the least expensive of the options considered but is likely to encounter public acceptance issues and may not be deliverable. If it did prove possible to refurbish this section of double circuit, it is almost certain that delays would be encountered which would prolong the presence of assets which have judged to have reached their end of life. Option 1 will therefore have an overall performance that is the least favourable compared to the other options considered.

Option 3 is a 'hybrid' approach which involves retention and refurbishment of the double circuit from Eden Main as far as the edge of the residential area in Carnmoney, with the final 6 spans removed and replaced with underground cable. This removes the difficulties associated with refurbishment of these six spans while remaining both more deliverable than Option 1 and significantly lower cost than Option 2. New housing developments in Carrickfergus have begun to render previously accessible towers and spans inaccessible. In the long term, access for maintenance would become more and more challenging and this option will not address these concerns.

Option 3 has a lower initial capital cost than option 2, but has a risk of significant delay arising from difficulties in securing access. Preliminary stakeholder engagement conducted by SONI has shown that the public acceptance of this option is likely to be extremely low in Carrickfergus due to the retention of the overhead line there despite its replacement in Carnmoney. This could also have a consequent effect on the deliverability of this project. Compared to Option 2, the overall performance of Option 3 is less favourable, and Option 3 is therefore not the preliminary preferred option.

Option 2 involves removal of the overhead line in urban and residential areas in Carnmoney and Carrickfergus and replacement with underground cable. The overhead line in the rural section

between the two urban areas would be retained. Access for removal of towers in Carnmoney would not be as onerous as for refurbishment, as intrusive foundation works would not be necessary and removal of towers would be a faster process than refurbishment. Removal would nonetheless cause some disruption but is likely to be supported by residents. The towers situated in Carrickfergus previously had much better accessibility for refurbishment than those in Carnmoney, but ongoing development in Carrickfergus has led to at least one tower becoming inaccessible, with more likely to follow. From stakeholder engagement conducted by SONI to date it is also clear that public acceptance of retention of the overhead line in Carrickfergus would be low. Laying new cable through both Carrickfergus and Carnmoney is possible but may cause some traffic disruption depending on the routes chosen – although Carnmoney Main itself is 'landlocked' by surrounding properties and cabling into the substation will be difficult. This option is also the most expensive by far – with a cost 40% more expensive than the next most expensive option. Although the most expensive of the three options considered, this option is likely to be the most deliverable in a timely manner.

Option 2 is therefore selected as the preliminary preferred option. This option will remove the existing tower line through the built-up areas of Carrickfergus and Carnmoney and replace the capacity provided with underground cable, while retaining and refurbishing the overhead line through the rural area between both settlements.

A phased plan of work to deliver Option 2 is shown in Section 8.

8 High Level Programme

Table 8.1 below shows a high level programme for option 2, the preliminary preferred option.

Table 8.1: Programme for option 2

	2023	2024	2025	2026	2027	2028
Preconstruction						
Glengormley transformer installation						
Cable works in Carrickfergus and Carnmoney and tower line refurbishment in rural area						
Removal of tower line in Carrickfergus and Carnmoney						

9 Stakeholder Engagement

SONI have engaged with NIE Networks throughout the development of this Options Report. NIE Networks are supportive of the conclusions reached in this report and have worked with SONI to develop the cost estimates, scoping and project timelines discussed herein.

SONI also discussed this project with the Utility Regulator at monthly SONI-UR meetings.

Preliminary stakeholder engagement has been conducted on this project with representatives of both Mid and East Antrim Borough Council and Antrim and Newtownabbey Borough Council, as well as political representatives in the area. This engagement highlighted sensitivities around retention of the overhead line in the potential development lands in Carrickfergus in Option 3 and was an influence on the selection of the preferred option.

The full list of these stakeholders which SONI have engaged with through the development of this options analysis can be found in Appendix D.

Wider stakeholder engagement will take place as the project progresses in accordance with SONI's Grid Development Process[5].

5 http://www.soni.ltd.uk/media/SONIs-Powering-The-Future-Grid-Development-Process-brochure.pdf

Appendix A – Cost of Options

Option 1 – Double circuit refurbishment

Option 2 – Carnmoney and Carrickfergus Undergrounding

Option 3 – Carnmoney undergrounding

Table 14.3: Option 3 costs

Appendix B –Net Present Costs

See attached spreadsheet:

Carnmoney – Eden Net Present Cost.xlsm

Appendix C – Cost and Scope of Refurbishment

Based on a tower by tower assessment, LSTC provided SONI with a detailed estimate of the total cost associated with refurbishing the double circuit. The costs were assessed by a sub-contractor, who has recent experience of similar types of projects in Great Britain. The costs took the following into consideration:

- An estimate of traffic management and scaffolding costs including design for restringing over public roads;
- A cost estimate for appropriate work methods to ensure the safety of both the general public and landowners;
- An estimate of the costs of tower foundation remedial works;
- An estimate of all labour and CDM costs; and
- A high level estimate of the likely cost to make good any damages.

A number of assumptions were used by the consultant:

- All CDM costs are based on current best practice.
- Where materials are likely to require overnight storage, 24 hour security has been included in costs.
- Where access routes to towers are to be established, the shortest distance was used.
- A daily assumed compensation cost for impacted residents has been assumed on a per-property basis.

Attached PDF files

Buildability Report

LSTC Reference – 49_182245_01_C Eden – Castlereagh Buildability Report.pdf

Norpower Refurbishment/Dismantling Feasibility Report

Norpower Feasibility Study – Summary.pdf

BOQ SONI – Refurbishment of 110KV OHL.pdf

BOQ SONI – Removal of DC 110KV OHL.pdf

Tower Access Assessments

55_182245_108-125_A Compressed (EDE – CNM PT 1).pdf (Tower 59 – 74)

55_182245_126-142_A Compressed (EDE – CNM PT 2).pdf (Tower 75 – 91)

55_182245_143-158_A Compressed (EDE – CNM PT 3).pdf (Tower 92 – 106A)

Appendix D –Stakeholder List

Background

This list collates the main stakeholders engaged with by SONI during Part 1 of grid development project 'Belfast Metropolitan Redevelopment Project Part 2: Carnmoney - Eden'. In accordance with SONI's Grid Development Process for Northern Ireland this stakeholder engagement commenced during Part 1 of project development.

The project area encompasses 2 different council areas and 2 different Parliamentary Constituencies. The project team aim to engage with each council area on separate basis at this stage of the project.

A full stakeholder report will be compromised once engagement has been completed.

Parliamentary Constituencies	Council areas
East Antrim	Mid and East Antrim
South Antrim	Antrim and Newtownabbey

Stakeholder list - Councils

Mid and East Antrim	
Anne Donaghy	Chief Executive
Paul Duffy	Head of Planning
Antrim and Newtownabbey Borough Council	
Jacqui Dixon	Chief Executive
John Linden	Head of Planning

Stakeholder list – Parliamentary

Stakeholder	Party	Constituency
MP		
Sammy Wilson	DUP	East Antrim
Paul Girvan	DUP	South Antrim

MLA	
East Antrim	
Roy Beggs	UUP
Mr Stewart Dickson	Alliance
Gordon Lyons	DUP
John Stewart	UUP
David Hilditch	DUP
South Antrim	
Steve Aiken	UUP
John Blair	Alliance
Pam Cameron	DUP
Trevor Clarke	DUP
Declan Kearney	Sinn Féin

Appendix E – Environmental and Social Constraints

See attached PDF file:

NI 2405 SONI CARNMONEY - EDEN environmental report.pdf