Connect West

Options Report

December 2025

SONI

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Contents

1 Introduction

A need has been identified for reinforcing the transmission system in the corridor between Omagh and Tamnamore, which is detailed in the ***Connect West Needs Report***.

There are presently three 110 kV circuits between Omagh and Tamnamore. At times of low renewable generation output, they supply power from Tamnamore grid supply point to the wider Omagh and Fermanagh area. At times of high renewable generation output, they facilitate the export of generation from the Tyrone and Fermanagh area onto the high capacity 275 kV transmission network at Tamnamore. Two of the three 110 kV circuits also have renewable generation cluster substations connected along their route, adding to the power flows on these circuits.

Under contingency conditions, there is a risk of overloading these 110 kV circuits. This risk is expected to grow as additional renewable generation continues to connect in order to help achieve Northern Ireland's statutory targets as set out in the Climate Change Act[1] (Northern Ireland) 2022.

This report describes the optioneering process undertaken as part of Part 1 of SONI'S Grid Development Framework and ultimately determines a preliminary preferred option for addressing this need. The report includes:

- The selection of an initial long list of options to address the need;
- A high-level appraisal of the long list, reducing this list to a short list of options.
- A more detailed appraisal of the short list, ultimately determining a preliminary preferred option.

The short list of options has been subject to an environmental assessment, and a summary of the findings for each option is included in this report. Full details are available in the accompanying ***Connect West Environmental Desktop Report***.

Initial stakeholder engagement has been carried out, and a summary of the process is included in this report. Full details including all feedback received are available in the accompanying ***Connect West Part 1 Stakeholder Engagement Report***.

The preliminary preferred option will be taken to the Utility Regulator for Transmission Network Pre-construction Project (TNPP) approval, and progression to Part 2 of SONI's Grid Development Framework.

[1] Climate Change Act (Northern Ireland) 2022, https://www.legislation.gov.uk/nia/2022/31/enacted

2 Grid development framework

To ensure transmission system reliability and security, predicted power flows of the network are compared with the requirements of the Transmission System Security and Planning Standards (TSSPS[2]).

The TSSPS establishes a set of design criteria for the transmission system. This includes setting the minimum level of redundancy that should be incorporated into the design to deal with credible faults and outages. The standard includes checking for any circuits that would be overloaded or where voltages would fall below statutory levels.

SONI assesses the present and future transmission system against these standards and, when breaches are forecast, establishes plans to address these breaches.

The planning of new transmission development projects by SONI follows a three-part process, shown in figure 2.1. The process includes stakeholder and public participation in the development of projects.

Figure 2.1: SONI's Grid Development Process

A need has been identified on the corridor between Omagh and Tamnamore, which is detailed in the ***Connect West Needs Report***.

This Options Report for Connect West summarises the process of identifying the preliminary preferred option, and forms part of Part 1 of the grid development process

[2] Transmission System Security and Planning Standards, SONI, 2023, https://cms.soni.ltd.uk//sites/default/files/2024-09/Transmission-System-Security-and-Planning-Standards-June-2023.pdf

3 Long list of options

We have investigated a number of ways of providing additional network capacity, and these include:

- The use of HVDC circuits;
- Providing additional capacity on existing circuits and routes;
- Providing additional capacity with new circuits; and
- Providing additional capacity through the use of new technologies.

For some of these methods, a number of sub options were developed. Table 3.1 provides a brief overview of the long list of options.

Table 3.1: Longlist of options

Summary	Option	Description
None	0	Do nothing
HVDC	1A	HVDC Coolkeeragh – Kilroot
	1B	HVDC Coolkeeragh – Magherafelt
	1C	HVDC Omagh – Tamnamore
Use of existing circuits	2A	Mid Tyrone 275 kV
	2B	Omagh 275 kV
	2C	110 kV uprates
Develop new circuits	3A	Dromore – Tamnamore 110 kV
	3B	Dromore – Turleenan 275 kV overhead line
	3C	Dromore – Turleenan 275 kV underground cable
Use of new technology	4	Virtual Line

The subsections below provide an overview of the options on the longlist. **Note that any circuit routes shown in diagrams are for illustrative purposes only**. Should the preferred option require a new circuit, the final route would be subject to detailed design taking into consideration a range of criteria[3] and include extensive stakeholder engagement. Any new infrastructure would also require planning permission.

[3] See section 6 below

3.1 Option 0: Do nothing

This option would involve not reinforcing the transmission system in the Mid Tyrone area and using operational measures in real time to ensure the power system is safe and secure.

3.2 Option 1: HVDC Reinforcement

Option 1 considers the establishment of a new 500 MW HVDC link between the west and east of Northern Ireland. A number of routes were identified and included as sub-options.

3.2.1 Option 1A: HVDC Coolkeeragh - Kilroot

Option 1A is based on establishing converter stations near Coolkeeragh and Kilroot 275 kV substations, connected via a 500 MW submarine HVDC cable along the Antrim coast. Although this option is not in the Mid Tyrone area, it would indirectly address the constraints in that area associated with the loss of the 275 kV double circuit between Coolkeeragh and Magherafelt.

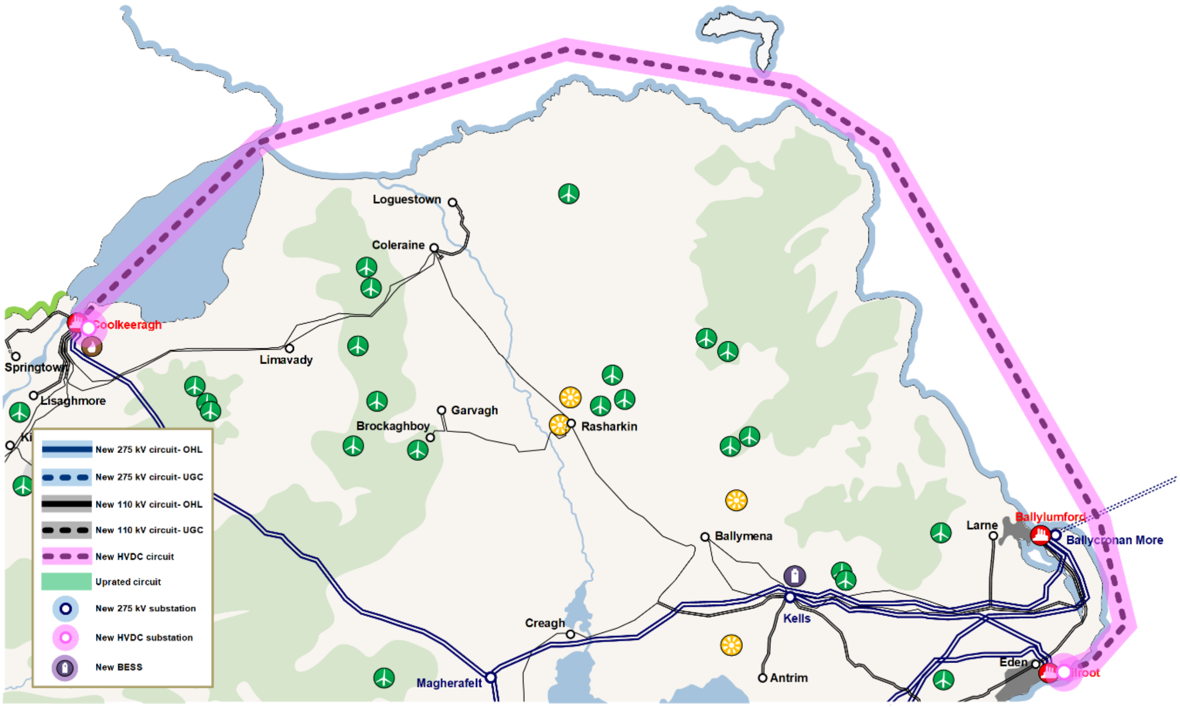

Figure 3.1: Illustrative configuration of Option 1A

3.2.2 Option 1B: HVDC Coolkeeragh - Magherafelt

Option 1B is based on establishing converter stations near Coolkeeragh and Magherafelt 275 kV substations, connected via a 500 MW HVDC cable. Similar to Option 1A, this would also indirectly address the constraints in the Mid Tyrone area caused by the loss of the 275 kV double circuit between Coolkeeragh and Magherafelt.

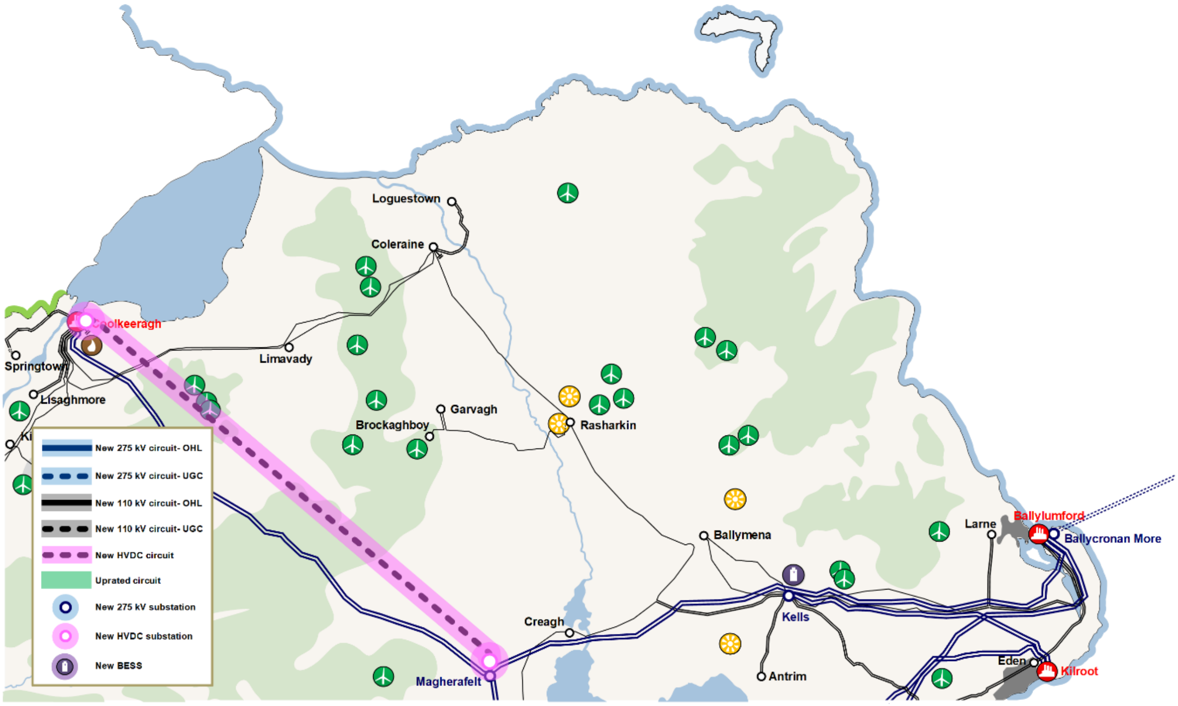

Figure 3.2: Illustrative configuration of Option 1B

3.2.3 Option 1C: HVDC Omagh to Tamnamore

Option 1C is based on establishing converter stations near Omagh 110 kV substation and Tamnamore 275 kV substation, connected via a 500 MW HVDC cable. Option 1C provides additional transmission capacity in the Mid Tyrone area, helping reduce power flows on the 110 kV circuits between Omagh and Tamnamore.

Option 1C is shown in figure 3.3 below.

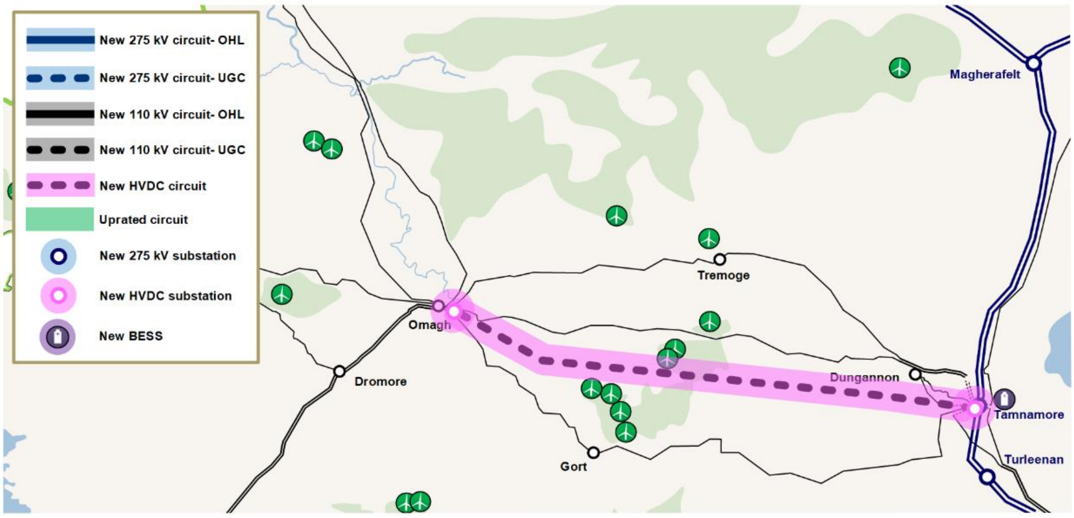

Figure 3.3: Illustrative configuration of Option 1C

3.3 Option 2: Use of existing circuits

3.3.1 Option 2A: Mid Tyrone 275 kV

Option 2A develops a new 275/110 kV substation between Tamnamore and Omagh, connected via a new 275 kV overhead line circuit from Tamnamore. This new circuit would follow the route of one of the existing 110 kV circuits between Tamnamore and Dungannon to a location near Dungannon 110 kV substation. From there, a short cable section would be laid to bypass Dungannon, and the 275 kV circuit would continue along the route of the Dungannon to Omagh 110 kV circuit to a point approximately half-way between Tremoge and Gort cluster substations.

A new Mid Tyrone 275/110 kV substation is constructed at this point with the remainder of the 110 kV circuit between Omagh and Dungannon turned in, establishing a 110 kV connection between Mid Tyrone and Omagh. The portion of the 110 kV circuit between Dungannon and Tamnamore is dismantled and removed.

The proposed configuration of Option 2A is shown in figure 3.4 below.

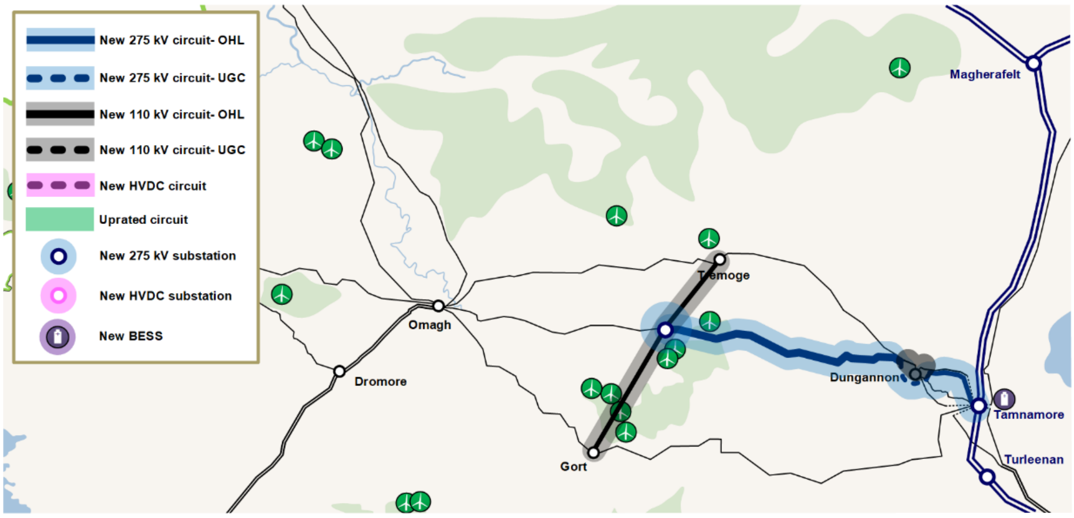

Figure 3.4: Illustrative configuration of Option 2A

To replace the circuit capacity at Dungannon, the 110 kV circuit between Tamnamore and Tremoge is turned into Dungannon. New 110 kV circuits are built connecting Gort and Tremoge cluster substations to Mid Tyrone. The connections on the double busbar arrangement at these substations would be organised such that the generation clusters would become radial connections into the new 275/110 kV substation, effectively removing the generation clusters from the 110 kV circuits from Omagh to Dungannon/Tamnamore.

This option is an innovative approach that provides a strong connection from the Gort and Tremoge generation clusters to the backbone 275 kV network. It also reduces loading on the existing 110 kV connections in the Mid Tyrone area.

3.3.2 Option 2B: Omagh 275 kV

This option adopts a similar approach to Option 2A but is of a larger scale. As with Option 2A, one of the 110 kV circuits between Dungannon and Tamnamore is removed. In this option, the entire 110 kV circuit from Omagh to Dungannon is removed and replaced with a 275 kV circuit from Tamnamore to Omagh. A new 275/110 kV substation is constructed at Omagh, with two 275/110 kV transformers. The 110 kV circuits from Gort and Tremoge that connect into the existing Omagh 110 kV substation are turned into the new substation. As with Option 2A, the 110 kV circuit from Tamnamore to Tremoge is turned into Dungannon.

The proposed configuration of Option 2B is shown in figure 3.5.

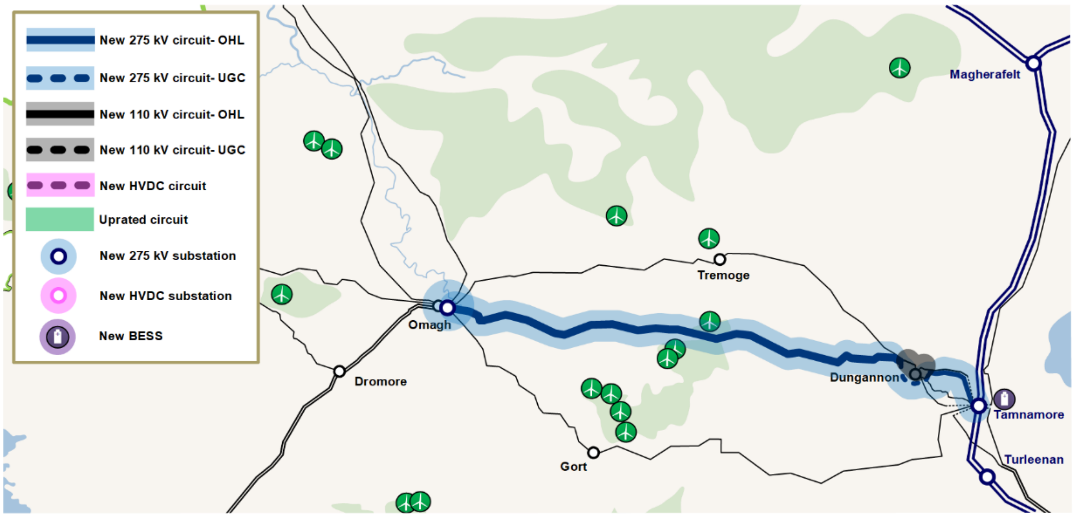

Figure 3.5: Illustrative configuration of Option 2B

Option 2B provides a higher capacity, low impedance path from Omagh to Tamnamore, in parallel with the 110 kV circuits to which Gort and Tremoge clusters are connected.

This option also includes an extension of Tamnamore 110 kV substation to construct a second 110 kV bus coupler to improve resilience.

3.3.3 Option 2C: 110 kV Uprates

Option 2C demonstrates what may be achievable in Mid Tyrone by simply upgrading all of the existing infrastructure. This approach uprates all of the 110 kV circuits between Omagh and Tamnamore to Oslo Aluminium Conductor Composite Core (ACCC) with a rating of 250/250/249 MVA in winter, autumn and summer respectively, with any 110 kV cable sections uprated to 250 MVA year-round.

The 110 kV circuits from Omagh to Tamnamore and Tremoge circuits are currently rated at 193/191/186 MVA in winter, autumn and summer respectively, and the 110 kV circuits connecting Gort are rated at 200 MVA year-round.

No new circuits are constructed, with all existing circuits seeing a capacity increase of between 50 to 60 MVA.

The proposed reinforcement is shown in figure 3.6.

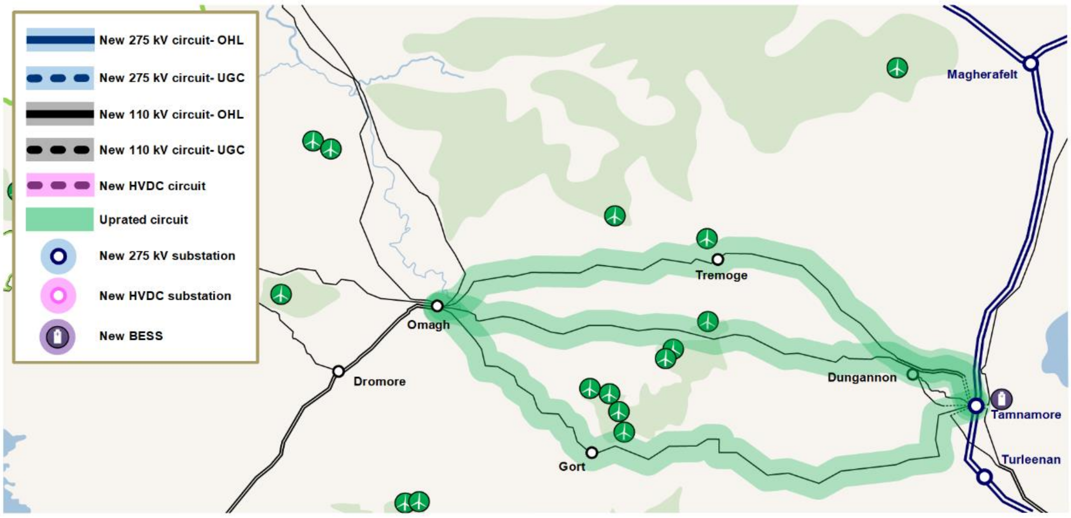

Figure 3.6: Illustrative configuration of Option 2C

3.4 Option 3

3.4.1 Option 3A: Dromore – Tamnamore 110 kV

This option is based on establishing a new 110 kV circuit from Tamnamore to Dromore. At this stage, the circuit is proposed to be overhead line, but it is expected that a short section of cable will be required to connect into Tamnamore 110 kV substation. The route shown in figure 3.8 is purely illustrative.

This new circuit is assumed to be constructed of Oslo ACCC conductor, with any cable sections using 250 MVA cable, giving an overall rating of 250/250/249 MVA in winter, autumn and summer respectively.

An illustrative configuration of Option 3A is shown in figure 3.7.

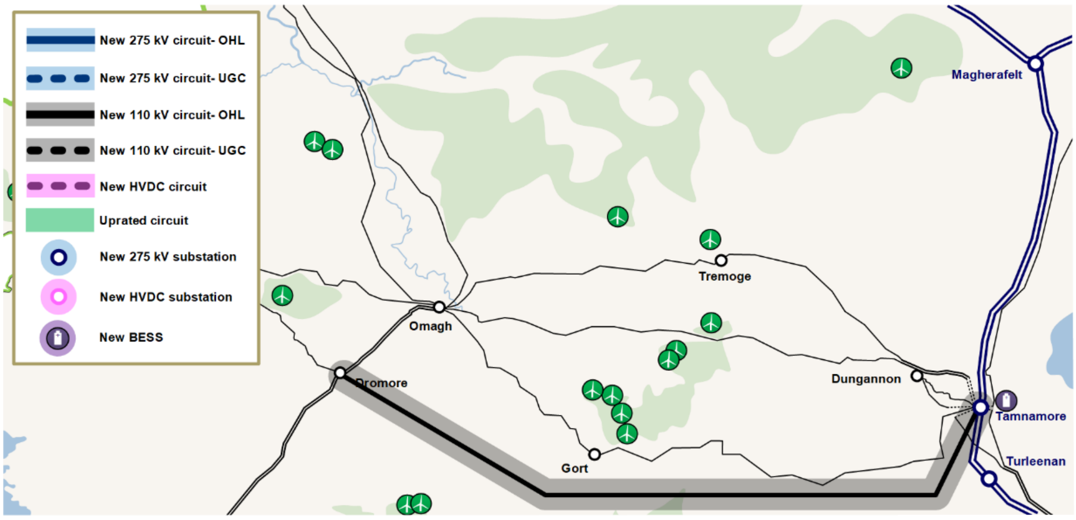

Figure 3.7: Illustrative configuration of Option 3A

This option would require the extension of both 110 kV substations at Dromore and Tamnamore. Land for a substation extension at Tamnamore is currently being purchased under a different project. This option includes the physical works required to extend both Dromore and Tamnamore substations, but only the cost of purchasing the land at Dromore.

3.4.2 Option 3B: Dromore – Turleenan 275 kV overhead line

Option 3B effectively uses a similar solution to Option 3A, but in this case the overhead line reinforcement is 275 kV construction. Unlike Option 2A, the proposed new 275 kV circuit terminates at Turleenan rather than Tamnamore, as this is closer[4]. This option requires construction of a new 275 kV substation at Dromore with two new 275/110 kV transformers, each with a capacity of 240 MVA. The proposed new 275 kV circuit would have a rating greater than 600 MVA. It is assumed that short underground cable sections will be required at both ends.

This option includes a Special Protection Scheme (SPS) which trips wind generation local to Dromore in the event of the loss of the 275 kV overhead line, allowing a reduction in pre-fault constraint.

An illustrative configuration of Option 3B is shown in figure 3.8.

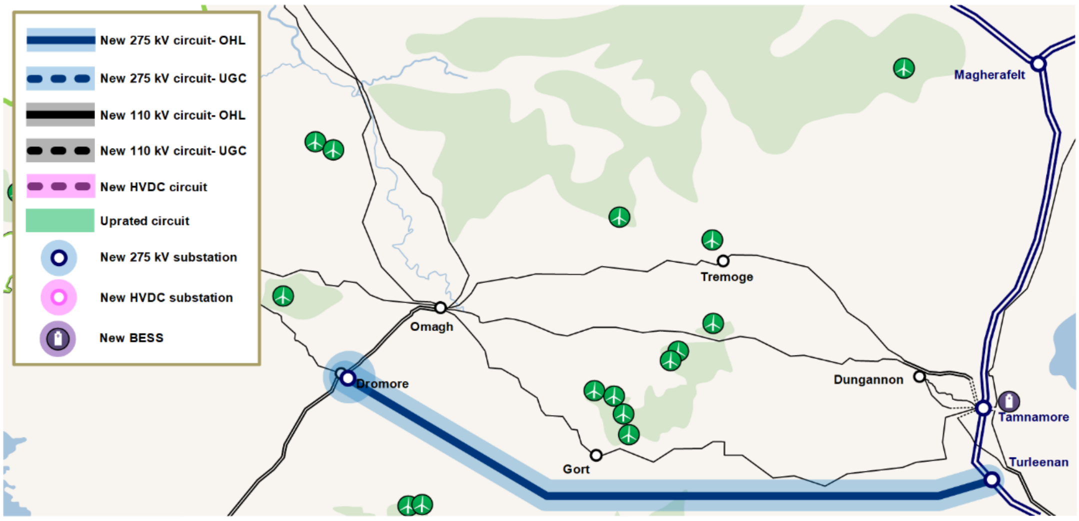

Figure 3.8: Illustrative configuration of Option 3B

[4] Turleenan is not suitable for Option 2A as it does not have 110 kV infrastructure.

3.4.3 Option 3C: Dromore – Turleenan 275 kV underground cable

This option is similar to Option 3B except that it uses an entirely underground cable route with no overhead line. This requires approximately 320 Mvar of reactive compensation, assumed here in the form of shunt reactors, with two reactors in series with the circuit (one at each end) and a further two reactors connected into separate bays at either end. The higher cost of this option compared to Option 3C is due to the higher cost of underground cable compared to overhead line, and the need for reactors (and consequent increased substation sizes).

An illustrative configuration of Option 3C is shown in figure 3.9.

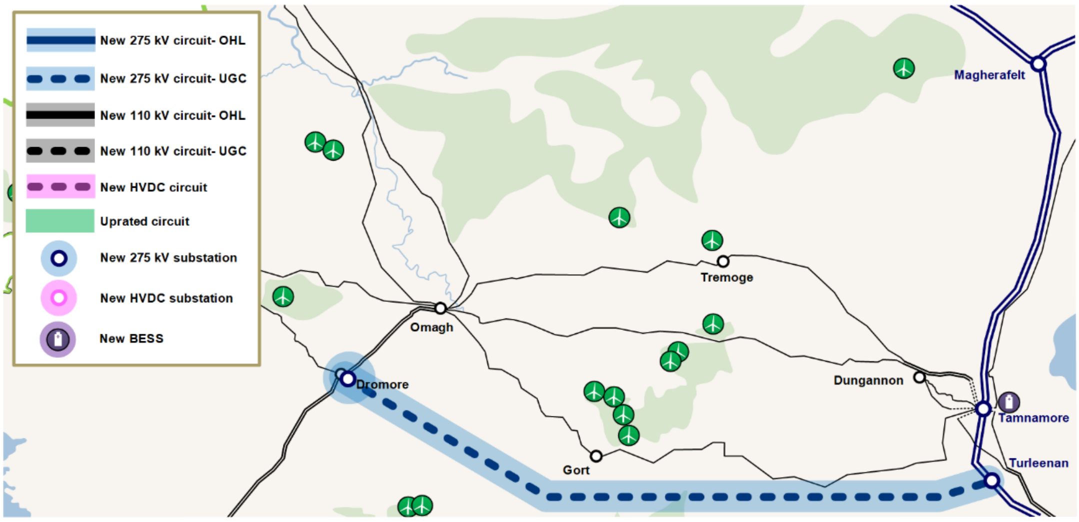

Figure 3.9: Illustrative configuration of Option 3C

3.5 Option 4: Virtual Line

Option 4 is based on similar projects being delivered in Germany to remove the need for pre-fault constraint.

The technology utilises high power batteries installed at both Coolkeeragh and Magherafelt 275 kV stations, effectively enabling the transmission network to run unconstrained against the Coolkeeragh to Magherafelt 275 kV double circuit contingency.

In the event of the loss of this double circuit, the battery installed at Coolkeeragh would immediately start to charge at or close to the previous power flow on the double circuit, and the Magherafelt battery would discharge by an equal amount, in effect, creating a ‘virtual line’. This would allow time for the double circuit to be restored and/or generation to be re-dispatched without overloading the 110 kV network.

The proposed reinforcement is shown in figure 3.10.

Figure 3.10: Illustrative configuration of Option 4

4 Comparison of long list of options

4.1 Criteria for comparing the options

The appraisal of the long list is against three criteria:

- A high-level technical assessment of the option;
- A high-level capital cost of the option; and
- A high-level deliverability assessment of the option.

As this is high-level screening, environmental considerations are not yet taken into account. However, these are a key consideration at the later shortlisting stage.

4.2 Technical

Option 1A: HVDC Coolkeeragh - Kilroot

This option requires integration into the existing AC transmission network. For contingencies occurring on the AC transmission network, the set point of the HVDC option would be required to modulate to a new set point through a complex control system to manage post contingency loading of transmission circuits. This option significantly reduces constraints.

Option 1B: HVDC Coolkeeragh - Magherafelt

Similar to Option 1A, for contingencies occurring on the AC transmission network, the set point of the HVDC option would be required to modulate to a new set point through a complex control system to manage post contingency loading of transmission circuits. As with 1A, this option has the potential to reduce constraints by a significant amount.

Option 1C: HVDC Omagh - Tamnamore

As with Options 1A and 1B, for contingencies occurring on the AC transmission network, the set point of the HVDC option would be required to modulate to a new set point through a complex control system to manage post contingency loading of transmission circuits. As the HVDC circuit is located within the Mid Tyrone area, Option 1C is expected to be the best performing HVDC option from a technical perspective as it alleviates congestion in this corridor.

Option 2A: Mid Tyrone 275 kV

This option takes an innovative approach to allow generation at Gort and Tremoge to operate in an unconstrained manner, thus allowing more headroom on the network for generation further to the West. It also establishes a new 275 kV substation in mid Tyrone, allowing further 275 kV infrastructure to be built further west if the need arises in future.

Option 2B: Omagh 275 kV

This option adds a new high capacity 275 kV circuit in Tyrone, replacing an existing 110 kV circuit. This significantly increases network capacity in this area. This option also includes construction of a new substation at Omagh and allows for future expansion of the 275 kV network if necessary.

Option 2C: 110 kV Uprates

Ultimately this option provides very limited increase in capacity. The Oslo conductor only provides an additional 60 MVA capacity, and no additional redundancy or resilience. Underground cable sections would remain a limiting factor in circuit capacity, with cable ratings typically lower than the overhead line rating.

Option 3A: Dromore – Tamnamore 110 kV

This option seeks to alleviate constraints in Mid Tyrone by providing an additional 110 kV circuit between Dromore and Tamnamore substations. By connecting into Dromore 110 kV substation, Option 3A allows power from Enniskillen and Curraghmulkin cluster to avoid the heavily loaded 110 kV circuits between Omagh and Tamnamore. Option 3A improves resilience in the Mid Tyrone area by establishing a fourth 110 kV circuit to Tamnamore.

This option significantly reduces (if not removes) a need to reinforce the network between Dromore and Omagh and improves security of supply in the Fermanagh and Omagh areas. However, it does not completely eliminate constraints in this area.

Option 3B: Dromore – Turleenan 275 kV overhead line

Through establishing a fourth circuit in the Mid Tryone area, Option 3B provides the same benefits to those of Option 3A. However, the use of a 275 kV circuit, with its lower impedance and higher capacity compared to a 110 kV circuit, means the performance of Option 3B is superior, almost entirely eliminating all constraints in the Mid Tyrone and Fermanagh areas.

Option 3C: Dromore – Turleenan 275 kV underground cable

This option behaves almost identically to Option 3B in terms of constraint reduction. The capacitance of the long 275 kV underground cable requires approximately 320 Mvar of reactive compensation in the form of shunt reactors, assumed here to be composed of four 80 Mvar reactors with two at either end, one of which is connected directly to the circuit in a T configuration.

The use of a long, high-capacity underground cable is expected to introduce a number of challenged, including:

- A need for harmonic filtering;
- Mitigation of the risk of transient overvoltages during cable energisation; and
- Mitigation of “zero miss” phenomenon during cable energisation.

Detailed studies would be required to ensure this option could be safely incorporated in the grid without introducing unacceptable operational risks. At this stage it is assumed that integration is technically feasible.

Option 4: Virtual Line

Option 4 would allow a significant portion of the generation constraints to be managed post fault. The actions of the batteries would reduce the phase angle difference following the loss of the 275 kV double circuit between Coolkeeragh and Magherafelt meaning any auto-reclose action would not be blocked.

The use of batteries only provides a temporary relief of overloads associated with the outage of the 275 kV double circuit between Coolkeeragh and Magherafelt. The batteries would have to be of sufficient size and duration to allow for post fault redispatch of generation. A similar scheme in Germany is based upon batteries providing 250 MW of capacity for one hour which would appear quite similar in scale.

Unlike other options which reinforce the transmission network with additional circuit capacity, Option 4 would not address localised overloads on the 110 kV transmission system, for example between Omagh and Dromore. Under regulatory rules neither SONI nor NIE Networks can own a storage scheme, so under this approach it was be necessary to procure this capability from a third party as a system service.

From a reliability perspective, this is a complex solution, which would require a robust set of input signals to operate correctly. Any error in those signals would result in maloperation of the system with the potential to cause a cascade tripping event and loss of supply to the west of Northern Ireland. Option 4 would be very difficult if not impossible to type test without fully committing to its use and as such it would be difficult to guarantee its availability and reliability.

4.3 Capital cost

Table 4.1 summarises the capital costs of all options, broken down into TSO (preconstruction and consents) and TO (construction) costs. Standard cost information has been used to determine the costs of each option where available.

There is significant uncertainty around the costs of the HVDC options due to special engineering difficulties and low experience with projects of this scale and type. These options are the most expensive, with a high probability that actual costs would increase significantly compared to those here.

As with the HVDC options, there is considerable uncertainty with the cost for Option 3C as an underground cable project of this scale has not previously been attempted in Northern Ireland. Experience in both the Republic of Ireland and in Great Britain has found that cable costs can increase significantly once detailed design has commenced due to special engineering difficulties such as narrow roads, existing utilities and traffic restrictions.

Option 4, the use of Virtual Line technology, is also expensive. The cost is based on data from research performed by the US Department of Energy[5] and is based on installing a 250 MW/250 MWh battery at both Coolkeeragh and Magherafelt 275 kV substations. The batteries have an estimated lifespan of 10 to 15 years before requiring replacement. Factoring in the need to replace these from time to time means the cost of Option 4 is likely to be much higher than presented in table 4.1.

Table 4.1: High level costs of the longlist of options

Option	Description	Capital Cost (£m)		
		Preconstruction	Construction	Total
0	Do nothing	0.0	0.0	**0.0**
1A	HVDC Coolkeeragh – Kilroot	10.0	614.2	**624.2**
1B	HVDC Coolkeeragh – Magherafelt	15.2	490.5	**505.6**
1C	HVDC Omagh – Tamnamore	13.8	401.4	**415.2**
2A	Mid Tyrone 275 kV	16.3	96.7	**104.5**
2B	Omagh 275 kV	14.3	113.8	**128.1**
2C	110 kV uprates	3.5	82.9	**86.4**
3A	Dromore – Tamnamore 110 kV	15.0	59.1	**74.1**
3B	Dromore – Turleenan 275 kV overhead line	16.8	107.1	**124.0**
3C	Dromore – Turleenan 275 kV underground cable	12.3	336.9	**349.2**
4	Virtual Line	5.0	150.0	**155.0**

[5] '2020 Grid Energy Storage Technology Cost and Performance Assessment', DOE-PA-0204, PNNL, 2020

4.4 Deliverability

Option 1A: HVDC Coolkeeragh - Kilroot

For Option 1A, suitable locations for the converter stations at Kilroot and Coolkeeragh would be difficult to obtain. It is more likely that these would need to be located further inland where land may be available with new connection substations being needed.

There are no 275 kV bays available at either Coolkeeragh or Kilroot 275 kV substations. Additionally, Coolkeeragh 275 kV substation is due to be refurbished/replaced due to asset condition. Achieving consents and designing a route for the offshore cable is expected to be very complex.

Deliverability of Option 1A is expected to be extremely challenging due to the scale and finaceability difficulties of the project and take between 10 to 15 years to complete.

Option 1B: HVDC Coolkeeragh - Magherafelt

Both Coolkeeragh and Magherafelt 275 kV substations require refurbishment/replacement due to asset condition. For Option 1B, this work would require to be complete before the HVDC converter stations could be connected.

Design and consenting of an appropriate cable route through the Sperrin Area of Outstanding Natural Beauty would also be challenging. Due to the size of the cable, it would be necessary to undertake directional drilling for all river crossings along the route.

Deliverability of Option 1B is expected to be extremely challenging and take between 10 to 15 years to complete.

Option 1C: HVDC Omagh - Tamnamore

With a shorter length of cable route required, and no dependency on the refurbishment of 275 kV substations, Option 1C is expected to be the most deliverable of all of the HVDC options.

Due to the size of the cable, it would be necessary to undertake directional drilling for all river crossings along the route.

Deliverability of Option 1C is expected to be challenging due to the scale and financeability challenges and take between 10 to 15 years to complete.

Option 2A: Mid Tyrone 275 kV

The key risks relate to obtaining a viable route for the 275 kV circuit as, although this would ultimately be replacing an existing circuit, it would require new wayleaves, as well as identifying new routes for the new 110 kV radial circuits to Gort and Tremoge clusters.

This option would see a 275 kV single circuit built in Northern Ireland for the first time, which would require type testing of the towers.

Deliverability of this option is expected to be challenging, with an estimated completion date of 2037.

Option 2B: Omagh 275 kV

As a 275 kV project, this option will involve physically larger infrastructure than the 110 kV options, including the need for a new 275 kV substation site at Omagh. The new 275 kV circuit would have a greater visual impact through rural areas, although this could potentially be mitigated to an extent by using less intrusive tower designs.

This option would see a 275 kV single circuit built in Northern Ireland for the first time, which would require type testing of the towers.

Deliverability of Option 2B is expected to be very challenging, with an estimated completion date of 2037.

Option 2C: Mid Tyrone 110 kV Upgrades

Delivery of this option would involve a number of lengthy circuit outages, which will impede timelines as it will only be possible to take one outage at a time. It is likely that constraint levels would be significant during these outages. This option also requires replacement of existing 200 MVA cable with new 250 MVA cable, which may require new easements and cable routes.

Deliverability of Option 2C is expected to be less complex than other options; however, the volume of circuit outages required means Option 2C is expected to have a lengthy delivery time, with an estimated completion date of 2036.

Option 3A: Dromore – Tamnamore 110 kV

Option 3A sees the building of a new overhead line circuit of c.55 km in length. However, being at 110 kV and of a relatively unobtrusive design. Option 3A is expected to be the least challenging option to deliver of all the options involving new circuit build. Due to congestion around Tamnamore substation, it is likely that this new circuit would require some cabling at its eastern end.

Option 3A is expected to be deliverable with an estimated completion date of 2037.

Option 3B: Dromore – Turleenan 275 kV

Option 3C is a large-scale 275 kV project and would be challenging to deliver. As well as a new 275 kV circuit, a new 275 kV substation will be required at Dromore substation, as well as expansion of the 110 k V substation. The new 275 kV circuit would have a greater visual impact through rural areas, although this could potentially be mitigated to an extent by using less intrusive tower designs.

This option would see a 275 kV single circuit built in Northern Ireland for the first time, which would require type testing of the towers.

Deliverability of Option 3B is expected to be very challenging, with an estimated completion date of 2037.

Option 3C: Dromore – Turleenan 275 kV Underground Cable

Option 3C is a large-scale 275 kV project with challenging deliverability. As with Option 3B, this option requires delivery of a new 275 kV substation at Dromore substation, as well as expansion of the 110 kV substation. Option 3C would also require expansion of Turleenan 275 kV substation to make room for reactive compensation equipment. There are also potential implications for existing equipment planned at Turleenan, which may need to be upgraded.

As far as possible SONI would seek to lay the cable in roads. However, opportunities for this may be limited due to the relatively narrow roads in much of the Mid Tyrone area, and it is likely that much of the route would be across agricultural land, requiring trenching and preventing any development or hedge/tree planning on the affected land in the long term. However, it may be possible to utilise some of the proposed A5 road upgrade to lay cable ducting, depending on when work on the section of this road in the Mid Tyrone area is planned to occur.

Due to the use of underground cable this option is likely easier to bring through consenting and the planning process compared to options proposing new overhead line.

Deliverability of Option 3C is expected to be extremely challenging due to the large scale of the project and challenges with financing, with an estimated completion date of 2038.

Option 4: Virtual Line

Option 4 proposes the use of system services to mitigate generation constraints. As a result, at this present time, this option could not be delivered directly by SONI and NIE Networks. A similar project in Germany sees the service provided by a third party through a form of contract with the TSO. In Northern Ireland there is not yet a system service that would fund this.

Both Coolkeeragh and Magherafelt 275 kV substations are planned to be refurbished, and it would not be possible to install the batteries proposed with Option 4 until after this work is complete, which is not expected until the mid to late 2030s. Therefore, any expected time savings to be gained from not building new circuit infrastructure may be negated by waiting for the completion of the substation refurbishments.

Deliverability of Option 4 is expected to be less complex than other options; however, the time needed for the completion of the Coolkeeragh and Magherafelt 275 kV substation refurbishments means Option 4 still has a lengthy delivery time, with an estimated completion date of 2037.

4.5 Assessment of the longlist

The combined performance of the long list of options is shown in table 4.2.

Less favourable [dark blue] [light blue] [green] [light green] [yellow] **More favourable**

Table 4.2: Comparative performance of longlist of options

Option	Description	Score			
		Technical	Cost	Deliverability	Overall
0	Do nothing	[dark blue]	[yellow]	[yellow]	[green]
1A	HVDC Coolkeeragh – Kilroot	[green]	[dark blue]	[dark blue]	[dark blue]
1B	HVDC Coolkeeragh – Magherafelt	[green]	[dark blue]	[dark blue]	[dark blue]
1C	HVDC Omagh – Tamnamore	[light green]	[light blue]	[light blue]	[light blue]
2A	Mid Tyrone 275 kV	[green]	[green]	[green]	[green]
2B	Omagh 275 kV	[light green]	[light blue]	[green]	[green]
2C	110 kV uprates	[dark blue]	[light green]	[light green]	[green]
3A	Dromore-Tamnamore 110 kV	[green]	[yellow]	[yellow]	[yellow]
3B	Dromore-Turleenan 275 kV overhead line	[yellow]	[light blue]	[green]	[light green]
3C	Dromore-Turleenan 275 kV underground cable	[light green]	[dark blue]	[dark blue]	[light blue]
4	Virtual Line	[dark blue]	[dark blue]	[green]	[dark blue]

5 Short list of options

Following assessment of the longlist of options, table 5.1 lists the options shortlisted for further investigation.

Table 5.1: Shortlist of options

Option	Description
0	Do nothing
1C	HVDC Omagh – Tamnamore
2A	Mid Tyrone 275 kV
2B	Omagh 275 kV
2C	110 kV uprates
3A	Dromore – Tamnamore 110 kV
3B	Dromore – Turleenan 275 kV overhead line
3C	Dromore – Turleenan 275 kV underground cable

6 Comparison of short list of options

6.1 Criteria for comparing the options

6.1.1 Technical performance

The shortlisted options will be compared against the following technical criteria:

- The reduction in renewable generation constraints in the study year (2030);
- The reduction in the percent of the study year that the phase angle difference between Coolkeeragh and Magherafelt exceeds 20° following the loss of the 275 kV double circuit between Coolkeeragh and Magherafelt;
- Other technical complexities; and
- Futureproofing: additional capacity created for future expansion.

6.1.2 Cost

The shortlisted options will be compared against the following cost criteria:

- The capital cost of the option; and
- The Net Present Cost of the option.

Full details of the breakdown in costs for each option are presented in **Appendix A**. Details on the Net Present Cost methodology are presented in **Appendix B**.

6.1.3 Deliverability

The shortlisted options will be compared against the following deliverability criteria:

- The complexity and potential challenges associated with delivering the option; and
- The estimated year the option can be delivered.

For each shortlisted option, the estimated completion date has been informed by the development of an indicative programme through SONI and NIE Networks Joint Programme Management Office (JPMO).

6.1.4 Environmental

Each option will have a high-level assessment of its potential social and environmental impacts. An overall assessment will be determined taking into consideration:

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

Full details of the environmental assessment are provided in an accompanying ***Connect West Environmental Desktop Report***.

6.2 Technical performance

6.2.1 Impact on constraints

Tables 6.1 shows the reduction in constraints in 2030 for each option compared to the do-nothing baseline. All options show a reduction in constraints, with a varied performance across the options. Options 1C, 2A, 2B, 3B and 3C have good performance, with Options 1C and 3C having the greatest impact on reducing generation constraints.

Table 6.1: Reduction in annual generation constraints of the shortlisted options

Option	Description	Reduction in constraints	
		Energy (GWh)	Cost (£m)
0	Do nothing	0	0
1C	HVDC Omagh – Tamnamore	297	23.5
2A	Mid Tyrone 275 kV	275	21.6
2B	Omagh 275 kV	271	21.5
2C	110 kV uprates	244	19.3
3A	Dromore – Tamnamore 110 kV	183	14.5
3B	Dromore – Turleenan 275 kV overhead line	296	23.4
3C	Dromore – Turleenan 275 kV underground cable	297	23.5

6.2.2 Impact on phase angle

Tables 6.2 shows the percentage of the year during which the phase angle could exceed 20° following a credible contingency event. All options show a reduction in the percent of the year, with a varied performance across the options. Options 2B, 3B and 3C have the best performance. Option 2B has the biggest impact on reducing the phase angle, although this is only marginally better than 3B and 3C.

Table 6.2: Reduction in phase angle difference for the shortlisted options

Option	Description	% of year phase angle exceeds 20°
0	Do nothing	26.8
1C	HVDC Omagh – Tamnamore	19.1
2A	Mid Tyrone 275 kV	20.9
2B	Omagh 275 kV	15.0
2C	110 kV uprates	26.6
3A	Dromore – Tamnamore 110 kV	24.0
3B	Dromore – Turleenan 275 kV overhead line	15.5
3C	Dromore – Turleenan 275 kV underground cable	15.5

6.2.3 Technical complexity

Option 1C would require complex control systems and scheduling which has not to date been seen on the all-island power system. Development and testing of these would be critical to effective implementation of this option.

Option 2C requires the use of new conductor types, which will require type testing and familiarisation, and potentially replacement of a significant number of existing poles as well as erection of new intermediate poles.

Options 2A, 2B, 3A and 3B are conventional overhead line projects and have no special technical considerations. 3A and 3B include a SPS, but this is of the "local only" type, which is compliant with the TSSPS.

3C would be the largest AC cable project ever attempted in Northern Ireland and would require reactive compensation. Detailed technical studies would be required to understand the risk of temporary overvoltages and oscillations and consequent impact on security of supply.

6.2.4 Futureproofing

The technical studies performed in assessing the short list consider the required additional renewable generation capacity needed to deliver the 80% RES-E target. However, the Climate Change Act (Northern Ireland) 2022 set an overall target of net zero emissions by 2050, which will require the connection of further renewable generation capacity as well as energy storage. How much additional generation is required, and where it will connect, is currently unknown. However, it would be prudent for new transmission network development to include headroom for capacity beyond that needed for the 80% RES-E target. This reduces the risk of having to upgrade the network multiple times within the same area. This is in line with the approach taken in the past, particularly during the construction of the 275 kV system, and has significant advantages in the long term.

Option 1C (HVDC Omagh – Tamnamore) provides significant additional transmission capacity, beyond that needed for the 80% RES-E target. However, making use of this would require substantial reinforcement of the 110 kV network in the Mid Tyrone area, particularly around Omagh.

Option 2A (Mid Tyrone 275 kV) increases transmission capacity significantly and reduces the loading on the existing 110 kV network. It also extends the 275 kV network westwards, allowing for further extension into the future. Option 2B is similar but takes the new 275 kV reinforcement further westwards to Omagh.

Options 2C (110 kV uprates) and 3A (Dromore – Tamnamore 110 kV) provide additional capacity on the 110 kV network, but this capacity is almost fully utilised in delivering the 80% RES-E target. As such, these options effectively provide no future proofing, as integration of any additional renewable generation in the Fermanagh and Tyrone area required to achieve net zero emissions would require further transmission network reinforcement in the Mid Tyrone area.

Options 3B and 3C (Dromore – Turleenan 275 kV overhead and cable respectively) provide the largest degree of futureproofing by creating a new, high capacity path for power in the west whilst retaining the three existing 110 kV circuits between Omagh and Tamnamore. Option 3B is the best performing, as the use of overhead line allows for dynamic line rating to be introduced if needed or the conductor to be uprated at some point in the future. If required, it is also possible to build this line as a double circuit, providing a significant amount of new transmission capacity.

6.2.5 Summary of technical performance

The combined technical performance of the shortlisted options is shown in table 6.3.

Less favourable **More favourable**

Table 6.3: Technical assessment of shortlist of options

Option	Description	Score				
		Constraint	Phase angle	Complexity	Future-proofing	Overall
0	Do nothing					
1C	HVDC Omagh – Tamnamore					
2A	Mid Tyrone 275 kV					
2B	Omagh 275 kV					
2C	110 kV uprates					
3A	Dromore – Tamnamore 110 kV					
3B	Dromore – Turleenan 275 kV overhead line					
3C	Dromore – Turleenan 275 kV underground cable					

6.3 Cost

6.3.1 Capital cost

The capital cost of each of the options is shown in table 6.4. Full details of the costs are presented in **Appendix A**. Option 3A is the least expensive reinforcement option. Options 1C and 3C, which involve lengthy underground cable development, are significantly more expensive than the other options.

Table 6.4: Capital cost of shortlist of options

Option	Description	Capital cost of option (£m)
0	Do nothing	0
1C	HVDC Omagh – Tamnamore	415.2
2A	Mid Tyrone 275 kV	113.0
2B	Omagh 275 kV	128.2
2C	110 kV uprates	86.4
3A	Dromore – Tamnamore 110 kV	74.1
3B	Dromore – Turleenan 275 kV overhead line	124.0
3C	Dromore – Turleenan 275 kV underground cable	349.2

6.3.2 Net Present Cost

Table 6.5 presents the results of the Net Present Cost (NPC) analysis. The results for both the standard NPC analysis, and the NPC analysis taking the impact of CO_2 emissions into account, are shown. A negative value denotes an improvement over the do-nothing baseline. Option 3B sees the biggest reduction in NPC compared to the baseline do-nothing option for both calculations.

Table 6.5: Net Present Cost of shortlist of options

Option	Description	Change in NPC (£m)	
		Without CO_2	With CO_2
0	Do nothing	0	0
1C	HVDC Omagh – Tamnamore	185	-525
2A	Mid Tyrone 275 kV	-152	-852
2B	Omagh 275 kV	-124	-815
2C	110 kV uprates	-165	-785
3A	Dromore – Tamnamore 110 kV	-131	-600
3B	Dromore – Turleenan 275 kV overhead line	-183	-937
3C	Dromore – Turleenan 275 kV underground cable	19	-715

6.3.3 Summary of cost

The combined cost performance of the shortlisted options is shown in table 6.6.

More expensive **Less expensive**

Table 6.6: Cost assessment of shortlist of options

Option	Description	Score		
		Cost	NPC	Overall
0	Do nothing			
1C	HVDC Omagh – Tamnamore			
2A	Mid Tyrone 275 kV			
2B	Omagh 275 kV			
2C	110 kV uprates			
3A	Dromore – Tamnamore 110 kV			
3B	Dromore – Turleenan 275 kV overhead line			
3C	Dromore – Turleenan 275 kV underground cable			

6.4 Deliverability

6.4.1 Complexities and challenges

Option 1C: HVDC Omagh - Tamnamore

There would be challenges in obtaining a suitable route for this option. It is anticipated that the cables could not be laid in rural roads due to the size of work area required and also to avoid the risk of third-party damage during road works. It is more likely that a dedicated cable easement would be required for the entire distance. There would also be significant and lengthy procurement and design processes necessary to deliver a project of this scale and complexity.

With no available bays at the existing Omagh 110 kV substation, this option requires a second 110 kV substation to be constructed near the current one, with the 110 kV circuits to Dungannon, Gort and Tremoge turned into this new substation. The new converter station at Omagh would also be connected to this new substation.

The highest requirement for outages on the existing network arising from this option would relate to the construction of this new 110 kV substation and associated circuit transfers. Delivery of this project is not likely to be held up by outage availability, but may be constrained by procurement of HVDC equipment, which has long lead times due to high global demand.

It is estimated that at least 10 watercourses will need to be crossed as part of this option, requiring directional drilling as it is unlikely that it will be possible to lay the cable in road bridges.

Delivery of Option 1C is expected to be extremely complex.

Option 2A: Mid Tyrone 275 kV

Option 2A would have relatively few outage requirements, with significant outages only required to turn in the 110 kV circuits between Tamnamore and Tremoge, and Omagh and Dungannon, into Dungannon 110kV substation and the new Mid Tyrone substation respectively. These outages are anticipated to be fairly short in duration.

The new 275 kV circuit would be constructed offline and connected to the existing spare bay at Tamnamore. The 110 kV circuits between Dungannon and Omagh, and Dungannon and Tamnamore, would be recovered following the completion and commissioning of the new 275 kV assets. Likewise, the new 110 kV circuits connecting both Gort and Tremoge generation clusters to the new Mid Tyrone substation would be constructed offline. Delivery of this project is therefore not likely to be held up by outage availability.

With increased flows into Tamnamore substation, Option 2A would require the 275 kV double circuit between Tamnamore and Turleenan 275 kV to be uprated.

Delivery of Option 2A is expected to be very complex.

Option 2B: Omagh 275 kV

Option 2B would have relatively few outage requirements, similar in scale to Option 2A in that they would be limited to the turn in of some 110 kV circuits into substations to establish connections. Construction of the new 275 kV infrastructure would be progressed offline and the 110 kV circuits from Dungannon to Omagh and Tamnamore would only be retired upon completion of the new 275 kV circuit.

With no room to expand the Omagh 110 kV substation, a new site would be required for the 275/110 kV substation and associated transformers.

As with Option 2A, increased flows into Tamnamore substation requires the 275 kV double circuit between Tamnamore and Turleenan to be uprated.

Delivery of Option 2A is expected to be very complex.

Option 2C: 110 kV uprates

Delivery of Option 2C would be onerous due to the significant outage requirements. This includes outages to replace the conductors on the existing circuits, and outages to replace existing cables. Outages for circuit uprates typically occur from the beginning of April to the end of October, a period of 30 weeks. Estimates from NIE Networks for similar uprates suggest that a total of 125 weeks' worth of outages would be required for this option.

Table 6.7 shows an indicative programme of the required uprating works. A start date of 2032 has been assumed as there is unlikely to be availability for outages prior to this due to existing planned works on 110 kV circuits in the North and West of Northern Ireland.

Table 6.7: Indicative phasing of outages for Option 2C

Uprate required		Number of weeks of outage per year				
110 k V circuit	Duration (weeks)	2032	2033	2034	2035	2036
Omagh – Dungannon	30	30				
Tremoge – Tamnamore	36		30	6		
Gort – Tamnamore	28			24	4	
Omagh – Gort	13				13	
Omagh – Tremoge	18				13	5
Total	**125**	**30**	**30**	**30**	**30**	**5**

Delivering the uprates associated with Option 2C would require more than 4 years to deliver, and potentially more should other significant outages be programmed in for other parts of the transmission network. It would not be possible to uprate two circuits simultaneously due to security of supply issues.

Option 2C also requires the replacement of any 200 MVA cable on uprated circuits with new 110 kV cable capable of 250 MVA; such cable has not been used on the transmission system in Northern Ireland to date.

The outages required for the duration of the works would also increase the constraint of renewable generation during the construction period.

Delivery of Option 2C is expected to be complex.

Option 3A: Dromore – Tamnamore 110 kV

This option requires the extension of Tamnamore substation and, due to increased flows, sees a need for the installation of a third 275/110 kV transformer at Tamnamore GSP as well as the 275 kV double circuit between Tamnamore and Turleenan. The cost estimate for this project includes the Tamnamore extension and third interbus transformer but does not include the cost of the 275 kV uprate, which would be a separate project but is accounted for in the later Net Present Cost analysis.

The outage requirements for the establishment of the new Dromore – Tamnamore circuit would be low, however there would be a series of outages required at Tamnamore in order to reconfigure existing connections during the substation extension. The full scope of outages would be determined later in project development, but it is expected that works could proceed on the substation extensions ahead of completion of planning and consenting of the new circuit. Delivery of the new circuit is not likely to be held up by outage availability.

Delivery of Option 3A is expected to be the least complex of all of the options.

Option 3B: Dromore – Turleenan 275 kV overhead line

Outage requirements for this option would largely be related to the extension works at Dromore. The new circuit would be constructed offline. Delivery of the new circuit is not likely to be held up by outage availability. Turleenan 275 kV substation will have available spare bays and all works at Turleenan are solely related to establishing the connection. It is assumed that the circuit includes cable sections at both ends. Note that Turleenan substation is being developed as part of the North-South Interconnector project, and so this option is dependent on its completion.

This option does not require any further works to strengthen the network in order to enable the full use of its capacity.

Due to the scale of this option delivery would be challenging, with the main difficulties likely relating to obtaining planning permission and consents for the overhead line.

Delivery of Option 3B is expected to be very complex.

Option 3C: Dromore – Turleenan underground cable

Unlike Option 3B, this option requires the installation of reactive compensation to balance the capacitance of the underground cable. The cable is estimated to require 320 Mvar, composed of four 80 Mvar shunt reactors with two at each end of the cable. This would require an extension of Turleenan substation as well as the extension works at Dromore.

Although obtaining planning permission for this cable may be easier than for an overhead line, it is likely that much of the cable will need to cross third party land as it is unlikely to be suitable to go in roads due to the space requirement and the size of the predominantly rural roads in the area. It will also be necessary to cross approximately 17 watercourses along the route, which will require directional drilling. This option is of a considerably larger scale than any cable project previously delivered in Northern Ireland, and there are limited resources available with the expertise to deliver it. Procurement of sufficient 275 kV cable may be protracted, as this is a rare voltage level outside of the UK and therefore global production capacity is low compared to more common voltages such as 110 kV or 220 kV.

Detailed technical studies would be required to integrate the cable safely into the transmission network without undue risks during cable energisation or during faults. There are significant risks to timelines and costs with this option due to uncertainties that will not be possible to resolve until the detailed design phase.

Delivery of Option 3C is expected to be extremely complex.

6.4.2 Indicative estimated completion dates

The estimated completion date of the shortlisted options is shown in table 6.8. Note that these dates are indicative.

Table 6.8: Capital cost of shortlist of options

Option	Description	Estimated year of delivery
0	Do nothing	N/A
1C	HVDC Omagh – Tamnamore	2040
2A	Mid Tyrone 275 kV	2037
2B	Omagh 275 kV	2037
2C	110 kV uprates	2036
3A	Dromore – Tamnamore 110 kV	2037
3B	Dromore – Turleenan 275 kV overhead line	2037
3C	Dromore – Turleenan 275 kV underground cable	2038

6.4.3 Summary of deliverability

The combined delivery performance of the shortlisted options is shown in table 6.9.

Less favourable **More favourable**

Table 6.9: Deliverability assessment of shortlist of options

Option	Description	Score		
		Complexity	Date	Overall
0	Do nothing			
1C	HVDC Omagh – Tamnamore			
2A	Mid Tyrone 275 kV			
2B	Omagh 275 kV			
2C	110 kV uprates			
3A	Dromore – Tamnamore 110 kV			
3B	Dromore – Turleenan 275 kV overhead line			
3C	Dromore – Turleenan 275 kV underground cable			

6.5 Environmental assessment

This section provides an overview of the environmental assessment of each option. Full details are provided in the accompanying ***Connect West Environmental Desktop Report.***

6.5.1 Option 1C: HVDC Omagh - Tamnamore

Those living along the cable route would experience some disruption during construction but following this the cable would not be visually intrusive. There would also be some traffic disruption which may impact a significant number of people depending the specific route. There are at least 10 watercourses which would likely need to be crossed by directional drilling underneath.

Any potential environmental impacts are anticipated to be short term and temporary in nature and confined to the construction phase.

Figure 6.1 shows the least cost environmental line from the environmental desktop report. This route is mostly within the existing road network; however, it is likely that it would not be possible to lay the cables associated with this option exclusively within existing roads due to the size of the excavations required. This would result in a need to cross open fields or hillside, resulting in a higher environmental impact.

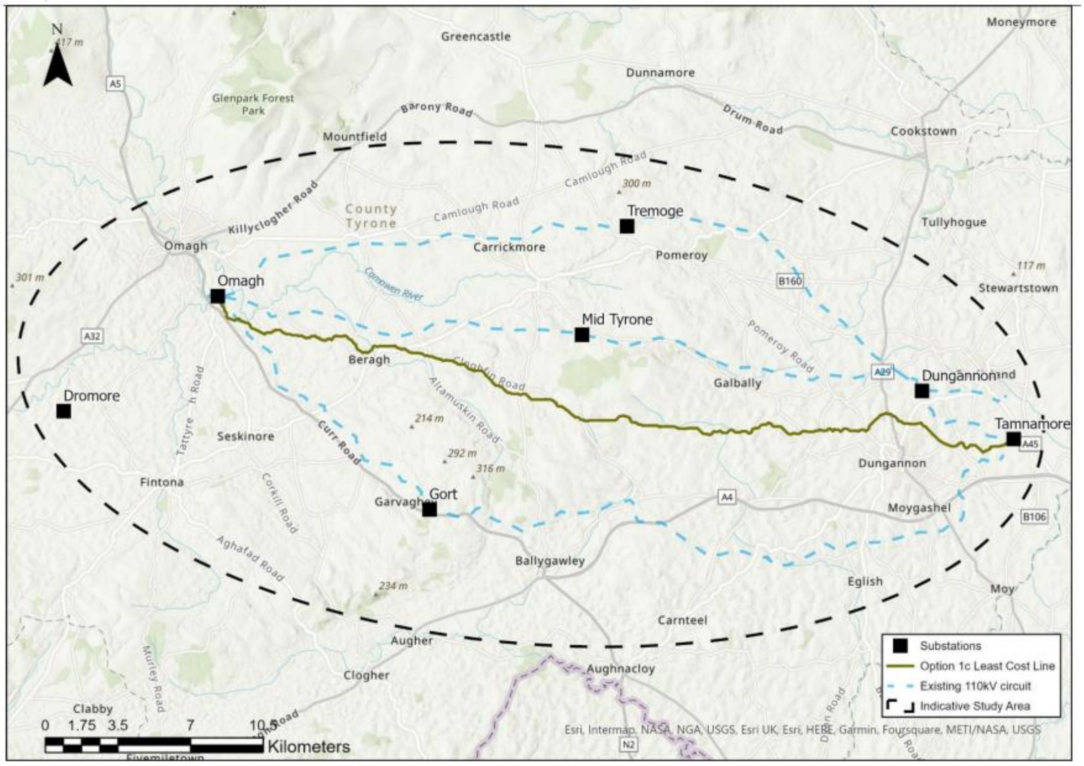

Figure 6.1: Indicative best environmental line for Option 1C

6.5.2 Option 2A: Mid Tyrone 275 kV

Option 2A involves a new 275 kV circuit between Tamnamore and the new Mid Tyrone substation. The option also involves two new 110 kV circuits from the new Mid Tyrone substation to the cluster substations at Gort and Tremoge. Upon completion, the existing 110 kV circuit between Omagh and Tamnamore will have the section from Tamnamore to the new Mid Tyrone substation removed.

Any construction impacts are anticipated to be short term and temporary in nature. However, there would be long term visual impacts due to the installation of new 110 kV portal overhead circuits from Mid Tyrone to Gort and Tremoge, and the 275 kV steel tower circuit between Tamnamore and Mid Tyrone. This will be balanced by the recovery of the Tamnamore – Dungannon and Dungannon – Mid Tyrone 110 kV wood pole lines. It should be noted that the visual impact of the transmission infrastructure will not be in the same immediate area as the present day following completion of this option.

Figure 6.2 shows the least constrained environmental line for the three new circuits required for Option 2A from the environmental desktop report. Also shown are areas within 10% of the least constrained line. This shows that it would not be possible to remain close to the existing route of the Omagh – Tamnamore 110 kV for the new section of 275 kV circuit.

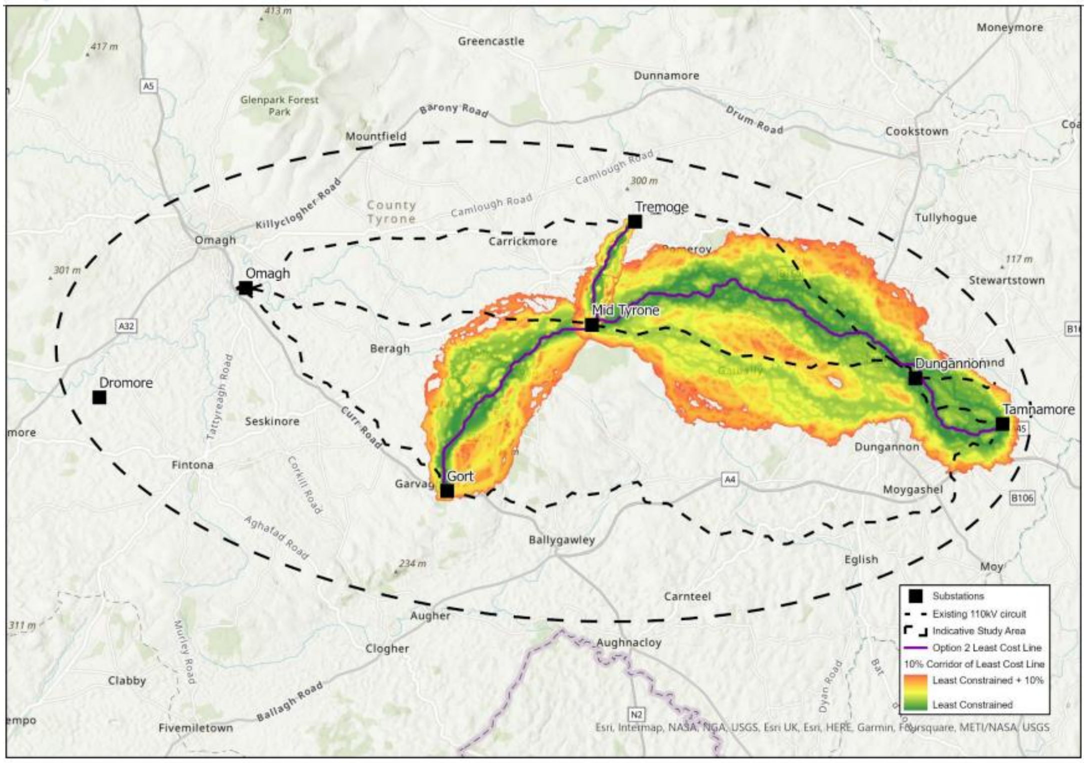

Figure 6.2: Indicative least cost environmental line for Option 2A

6.5.3 Option 2B: Omagh 275 kV

Option 2B involves a new 275 kV circuit, ideally along the path of the existing 110 kV circuit from Omagh to Dungannon and on to Tamnamore. Upon completion, those 110 kV circuits are to be removed. Any construction impacts are anticipated to be short term and temporary in nature. However, there would be long term visual impacts due to the installation of new overhead lines.

Figure 6.3 shows the least constrained environmental lines for the new circuits required for Option 2B from the environmental desktop report. Also shown are areas within 10% of the least constrained line. This shows that it would not be possible to remain close to the existing route of the Omagh – Tamnamore 110 kV for the new 275 kV circuit (existing circuit shown as dashed line).

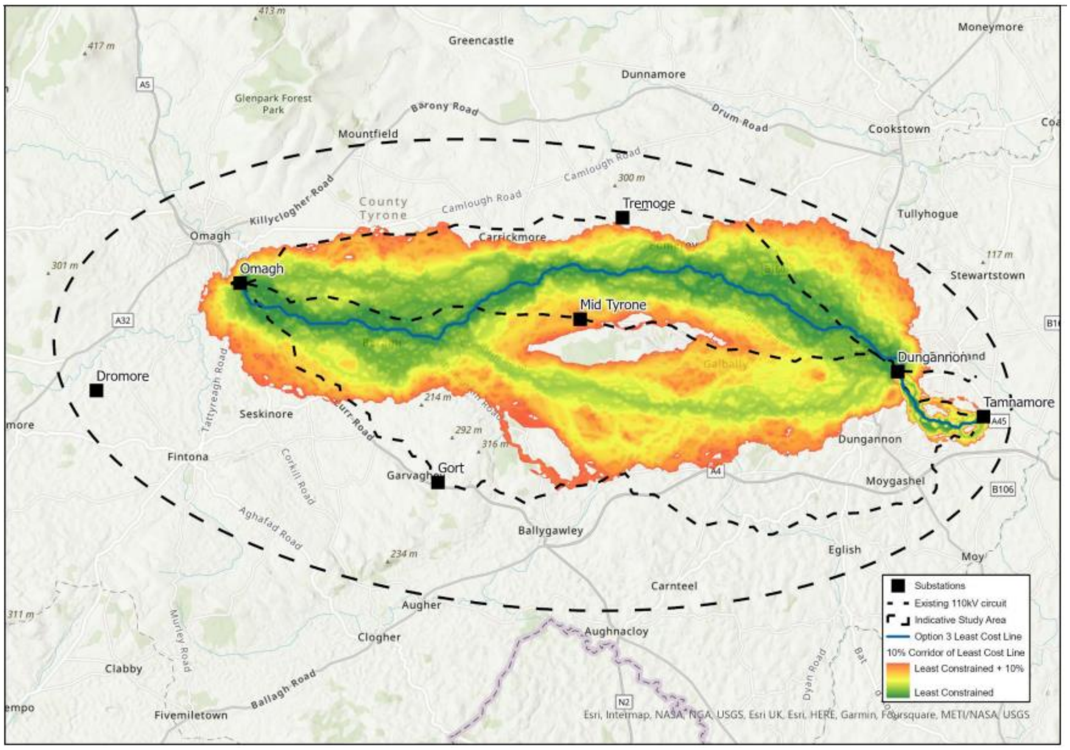

Figure 6.3: Indicative least constrained environmental line for Option 2B

6.5.4 Option 2C: 110 kV Uprates

Option 2C involves uprating the three 110 kV circuits between Omagh and Tamnamore. There would be impacts during the construction phase, for example, the need to develop temporary access lanes. However, this would end once work was complete.

Visual impacts are expected to remain the same as the present arrangement as there is no change to the existing line routes. However, it is likely that additional earth wires may be required on some of the circuits to enhance protection systems and these would require new wayleaves potentially through curtilage.

6.5.5 Option 3A: Dromore – Tamnamore 110 kV

Option 3A requires a new 110 kV circuit to be constructed between Dromore substation and Tamnamore substation. Environmental impacts arising from construction are anticipated to be short term and temporary in nature. However, there would be a long-term visual impact due to the installation of the new overhead line, although this is expected to be relatively unobtrusive. It is expected that there would be a cable section from Tamnamore to south of the M1 motorway.

Figure 6.4 below shows the environmental constraint mapping for Option 3A from the environmental desktop report. Shown is the least constrained environmental line, and all routes within 10% of this line.

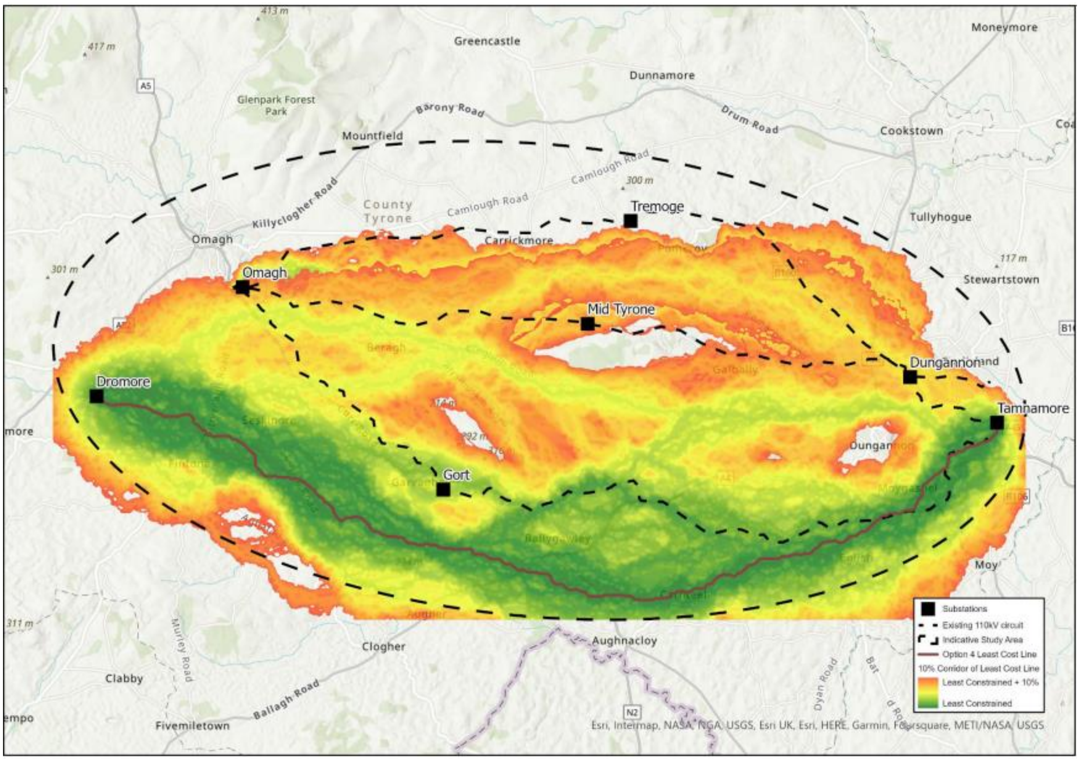

Figure 6.4: Indicative environmental constraints for Option 3A

6.5.6 Option 3B: Dromore – Turleenan 275 kV overhead line

This option sees the construction of a new 275 kV circuit. It is anticipated that most of this circuit would be composed of overhead line, with some underground cable required at the Turleenan end and potentially at the Dromore end also. Compared to Option 3A, there is a lower likelihood of needing to cross the M1 motorway or the existing A5 road. However, there are unavoidable environmental constraints, including the potential for crossing of a Special Area of Conservation. Any effects are anticipated to be short term and limited to the construction phase. No need for directional drilling is currently expected with this option. There would be a long-term visual impact due to the installation of the new overhead line.

Due to the higher voltage of this option than Option 3A, there will be a greater distance between towers and therefore a lower total number of towers required.

Figure 6.5 below shows the environmental constraint mapping for Option 3B from the environmental desktop report. Shown is the least constrained environmental line, and all routes within 10% of this line.

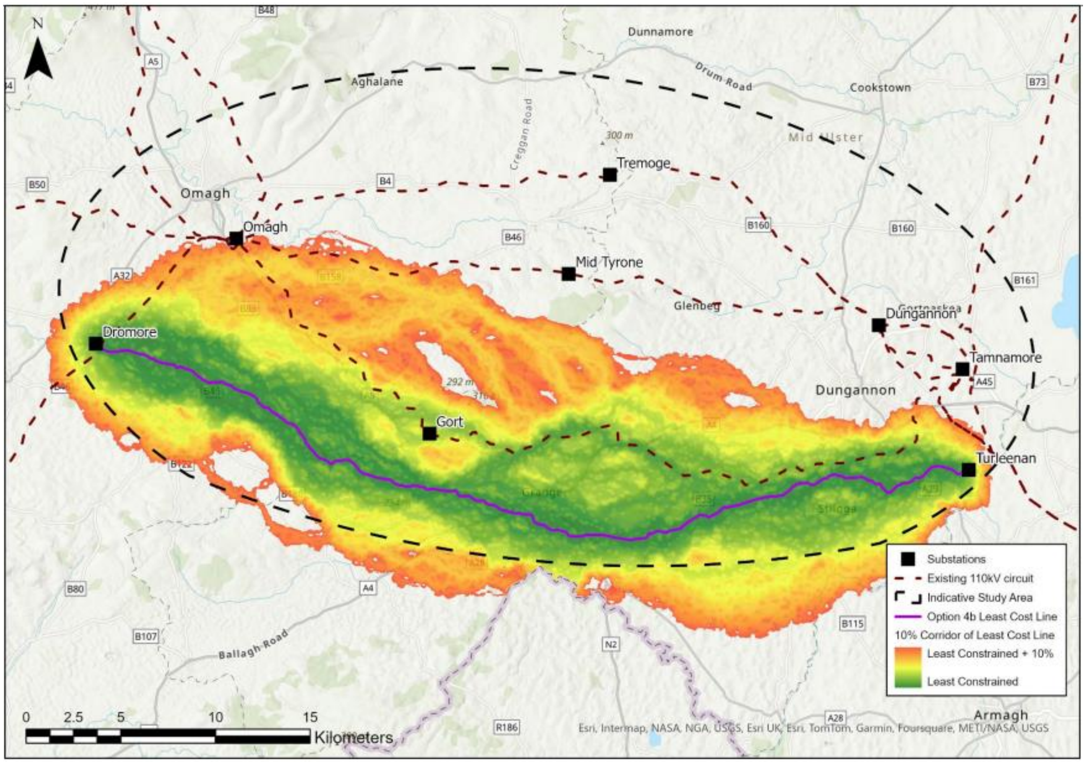

Figure 6.5: Indicative environmental constraints for Option 3B

6.5.7 Option 3C: Dromore – Turleenan 275 kV underground cable

This option is similar to Option 3B except that the entire route is composed of underground cable, and a substation extension is required at Turleenan substation to accommodate the necessary reactive compensation. There are approximately 17 watercourses along the route which would need to be crossed with directional drilling. It would also be necessary to cross gas pipelines in places which would also likely require directional drilling.

It is anticipated that the cable would be laid as much as possible in roads to minimise the need for land access and environmental impact, however, this will cause traffic disruption which is potentially significant if major roads are used. It is unlikely to be possible to use roads for the entire route and it is expected that some of the route would be composed of third-party land. This has the potential for higher impact during the works due to the trenching requirements.

Figure 6.6 below shows the environmental constraint mapping for Option 3C from the environmental desktop report. Shown is the least constrained environmental line, and all routes within 10% of this line.

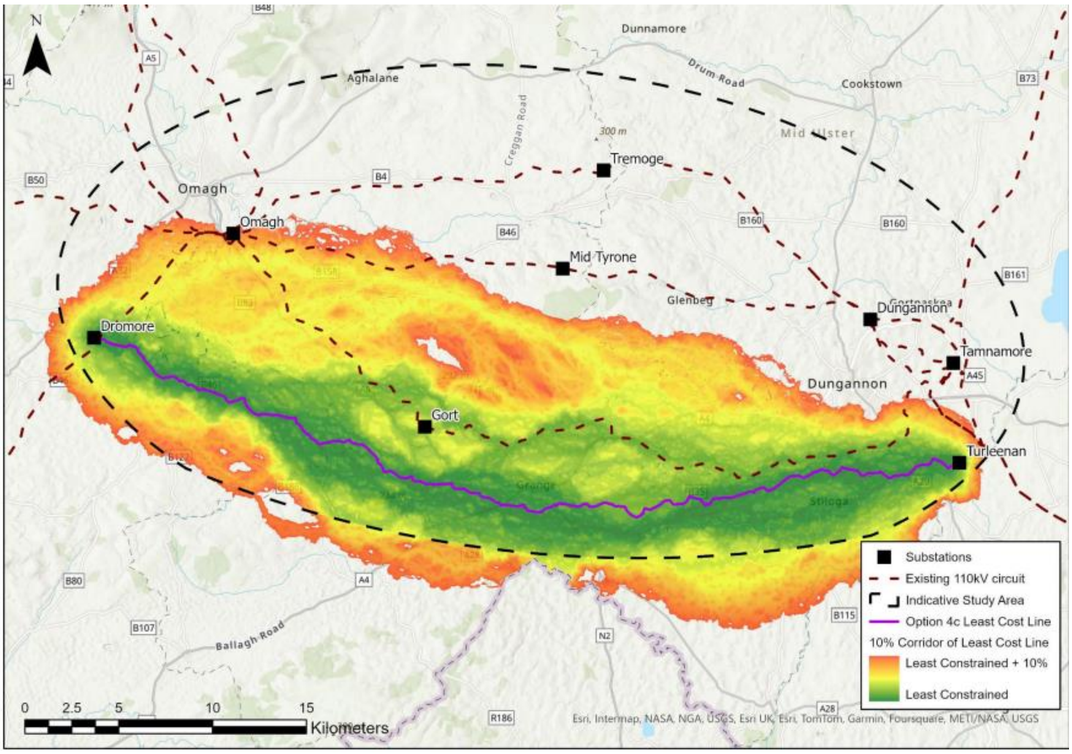

Figure 6.6: Indicative environmental constraints for Option 3C

6.5.8 Summary of environmental assessment

The environmental performance of the shortlisted options is shown in table 6.10.

Less favourable **More favourable**

Table 6.10: Environmental assessment of shortlist of options

Option	Description	Score
0	Do nothing	
1C	HVDC Omagh – Tamnamore	
2A	Mid Tyrone 275 kV	
2B	Omagh 275 kV	
2C	110 kV uprates	
3A	Dromore – Tamnamore 110 kV	
3B	Dromore – Turleenan 275 kV overhead line	
3C	Dromore – Turleenan 275 kV underground cable	

Within all options, there are a number of buildings which cannot completely be avoided by the environmentally best route corridors. All options cross a number of Salmon Rivers, which cannot be avoided. There is the potential for electricity transmission developments to impact on these rivers through increased sediment loading and decreased bank stability due to compromised bank sides, but this can be mitigated during construction. For cable options this will require directional drilling under the watercourse. This is also the case for crossing gas infrastructure.

All options cross existing electrical infrastructure, and this cannot be avoided within any option. Undergrounding of existing distribution lines will need to be considered. Within Options 3A, 3B and 3C the Cranny Bog Special Area of Conservation is potentially unavoidable. There may be potential for direct or indirect effects on the designated feature of this site. This will need to be considered by a screening for Appropriate Assessment and may involve a requirement for mitigation.

6.6 Assessment of the shortlist

The combined performance of the shortlisted options is shown in table 6.11.

Less favourable **More favourable**

Table 6.11: Combined performance of shortlist of options

Criteria	Option							
	0	1C	2A	2B	2C	3A	3B	3C
Technical								
Deliverability								
Cost								
Environmental								
Overall score								

7 Preliminary preferred option

The area between Omagh and Tamnamore has been identified as a bottleneck on the Northern Ireland transmission system, being highlighted in reports such as TESNI 2020 System Needs Assessment and the *Shaping Our Electricity Future* roadmap.

The best performing option has been determined to be a new 275 kV circuit between Dromore and Turleenan. Consideration has been given to delivering this via both overhead line and underground cable technologies in Options 3B and 3C respectively.

Option 3C is composed entirely of underground cable whereas Option 3B is mostly overhead line with short sections of underground cable at both ends for entry into the substations.

Due to the long length of underground cable required for Option 3C, it is anticipated that in the region of 320 Mvar of reactive compensation would be required to maintain voltages within limits. This is a very large and long cable by normal standards and integration of this into the transmission system, while technically possible, would be extremely challenging.

Detailed studies would be required to understand the risk of harmonic resonance and temporary overvoltages and what mitigation measures would be required to manage these.

SONI and NIEN typically seek to lay underground cables in roadways as much as possible. However, given the expected size of this cable, it would be necessary to take it directly across agricultural land for parts of the route to reach major roads which are wide enough to accommodate the cable. The disruption to these major roads from cable laying might make consenting extremely difficult, requiring the further use of agricultural land.

Any land used for the cable route could not be developed on, nor could bushes or trees be planted on it, as the roots would pose a risk to the cable. The routing of cable trenches across agricultural land would have a significantly higher environmental impact than construction of an overhead line on the same land.

All river crossings, of which there would be approximately 17, would have to be crossed via directional drilling for the underground cable option, adding significant cost to the option.

Option 3C is triple the cost of the predominantly overhead line option 3B and has very poor lifecycle economic performance.

Factoring the above considerations in, the preliminary preferred option is Option 3B, a new 275 kV circuit from Turleenan to Dromore, primarily composed of overhead line.

Option 3B is selected because it:

- Reduces loading on the existing three 110 kV circuits between Omagh and Tamnamore by connecting into Dromore and subsequently reversing power flows from Dromore to Omagh.
- Avoids the congested area around Tamnamore by terminating at Turleenan and reduces the need for a future uprate of the 275 kV circuits between Tamnamore and Turleenan.
- Represents the best overall value for money, in spite of a high capital cost estimate, by effectively eliminating generation constraints in the Fermanagh and Tyrone area and increasing demand capacity and security of supply in Fermanagh.
- Defers or removes the need for future reinforcement between Omagh and Dromore, and upgrades and extends Dromore substation, allowing for future development at both sites.
- Provides additional headroom for future development needed to meet 2050 targets that is not provided by other options, particularly those at 110 kV.

8 Summary of stakeholder engagement

8.1 Part 1 engagement

In Spring 2023, SONI completed a round of engagement on initial proposals for this project. At the time, the project was known as the Mid Tyrone Project, and the preliminary preferred option was a new 110 kV circuit in the Mid Tyrone area. A summary of the initial Part 1 engagement is provided in the accompanying ***Connect West Part 1 Stakeholder Engagement Report***.

Subsequent to this engagement, the preliminary preferred option identified for the now renamed Connect West Project was a new 275 kV circuit between Dromore and Turleenan. This was driven by climate targets set out in the Climate Change Act (Northern Ireland) 2022 and updated information on new renewable generation projects proposed in Northern Ireland. The resulting need from this new information is set out in the ***Connect West Needs Report***.

8.2 Changes to constituency boundaries

New constituency boundaries for Westminster have come into effect since the initial round of engagement. With the new boundaries, the study area for the preliminary preferred option now traverses three parliamentary constituencies- from Dromore Substation in the West Tyrone Constituency, through Fermanagh & South Tyrone Constituency and into Turleenan Substation on the boundary of the Mid Ulster Constituency.

While the constituency boundaries for Westminster (MPs) have changed following the election, the boundaries for the Assembly (MLAs) remain as they were during the initial round of engagement. This will change after the next election for the Northern Ireland Assembly (currently planned for 2027), when the Assembly constituencies will follow the same boundaries as have been introduced for Westminster. At Assembly level, the constituencies remain as they were, with the relevant constituencies being West Tyrone and Fermanagh & South Tyrone.

While the final route is yet to be determined, the new circuit is expected to run through the West Tyrone and Mid Tyrone District Electoral Areas (DEAs) in Fermanagh & Omagh District Council and through the Clogher Valley and Dungannon DEAs in Mid Ulster District Council.

8.3 Further engagement

Due to the scale of the proposals, the project is expected be classed as ‘regionally significant’ and hence be determined by the Department for Infrastructure (DfI) according to the ‘Hierarchy of Developments’ contained in the relevant planning legislation.

This phase of engagement was focused on elected representatives in the relevant constituencies as well as DfI Planning Officials. While only a small amount of the study area crosses into the Mid Ulster Constituency and there is considered to be limited impact on this area, it was decided not to engage with Mid Ulster representatives at this stage. Should it become apparent that infrastructure will be located in the Mid Ulster constituency then elected representatives for this constituency will be engaged in the next phase of consultation.

As the majority of elected representatives affected by the project had previously been engaged with on the earlier proposals, letters were issued to representatives with an offer to meet to discuss the updated proposal. If meetings were sought, stakeholders were encouraged to invite other party colleagues to the meetings, as appropriate. Table 8.1 lists details of further engagement carried out for Part 1 of the Connect West Project.

Table 8.1: Part 1 engagement on Connect West Project

Representative/ Council official	Organisation/ Role	Type of engagement	Date of engagement
Alistair Beggs, Kathryn McFerran, Nicole Thompson	DfI Planning Officials	In-person briefing	20.11.24
Deborah Erskine MLA	Fermanagh & South Tyrone DUP	Online briefing	28.11.24
Pat Cullen MP	Fermanagh & South Tyrone Sinn Féin	In-person briefing	04.12.24
Tom Buchanan MLA	West Tyrone DUP	Online briefing	12.02.25
Órfhlaith Begley MP, Declan McAleer MLA, Cllr Paul Boggs	West Tyrone Sinn Féin	Online briefing	22.08.25

A summary of the feedback received is included in the accompanying ***Connect West Part 1 Stakeholder Engagement Report***.

Appendix A

Estimated costs

Table A.1: Estimated costs for Option 1C

Item description	Unit cost (£m)	No.	£m	Notes
Second Omagh 110 kV substation				
Land purchase	0.50	1	0.50	
Substation pre-enabling	3.03	1	3.03	
110 kV AIS DBB bay	0.84	7	5.88	Bus coupler, section switches, 2 x converter station bays, Dungannon 110 kV, Tremoge 110 kV, Gort 110 kV.
Control building	0.40	1	0.40	
Turn in Tremoge circuit	1.00	1	1.00	
Turn in Dungannon circuit	1.00	1	1.00	
Cable in Gort circuit	1.50	0.3	0.45	
Turn in Gort circuit	1.00	1	1.00	
110 kV cable to converter station	2.66	0.2	0.53	Assume 2 x 200m, 250 MVA each.
HVDC Converter Station at Omagh				
Land purchase	0.50	1	0.50	
Converter station	130.00	1	130.00	Based on 500 MW VSC.
HVDC Converter station at Tamnamore				
Land purchase	0.50	1	0.50	
Converter station	130.00	1	130.00	Based on 500 MW VSC.
Works at Tamnamore substation				
Equip 275 kV AIS DBB bay	1.00	1	1.00	
275 kV cable to converter station	0.75	2	1.50	Assumes 200m of cable required.
Underground cable costs				
Polymer symmetric monopole cable	1.512	48	72.58	Cost per km for 500 MW rating.
Directional drilling	1.50	10	15.00	Assumed 10 river crossings.
TO costs				
Estimate of TO costs			364.84	
Contingency (10%)			36.49	
Total			**401.35**	
TSO costs (Preconstruction and consents)				
Preconstruction	10.00	1	10.00	
Easements	0.0167	48	3.80	
Total			**13.80**	
Combined TSO and TO costs				
Total			**415.15**	

Table A.2: Estimated costs for Option 2A

Item description	Unit cost (£m)	No.	£m	Notes
Works at Dungannon substation				
Turn in Tamnamore – Tremoge circuit				
New Mid Tyrone 275/110 kV substation				
Land purchase	0.50	1	0.50	
275/110 kV substation pre-enabling	6.40	1	6.40	
Control building	0.50	1	0.50	
275 kV AIS DBB Bay (excluding cabling)	1.90	5	9.50	
110 kV AIS DBB Bay	0.84	7	5.88	
275 kV cable (100m)	0.75	1	0.75	
110 kV cable (200 MVA)	1.56	0.3	0.47	
275 kV 240 MVA IBTX installed	6.65	2	13.30	
Works at Tamnamore substation				
Pre-enabling	3.00	1	3.00	
Cable diversions	0.65	9	5.85	3 x 300m diversions
OHL diversion	0.445	0.1	0.04	
1x new 110 kV bay	0.84	1	0.84	Bus coupler and new bay for circuit
Control room extension	0.50	1	0.50	
Protection	0.16	1	0.16	
Equip 275 kV bay	0.50	1	0.50	
Mid Tyrone to Tamnamore 275 kV circuit				
275 kV steel tower twin 600mm2 ACSR	9.79	1.84	18.01	
Cable termination at Dungannon	1.00	1	1.00	
Cable section near Dungannon main	3.90	1.5	5.85	
Directional drill	1.50	1	1.50	1 river crossing
Turn in at Tamnamore	1.00	1	1.00	
Mid Tyrone to Tremoge 110 kV circuit				
110 kV single circuit wood pole portal	4.45	0.6	2.67	400mm^2 ACSR conductor
Turn in at Tremoge	1.00	0.5	0.50	
Mid Tyrone to Gort 110 kV circuit				
110 kV single circuit wood pole portal	4.45	1.23	5.56	400mm^2 ACSR conductor
Turn in at Gort	1.00	0.5	0.50	
110 kV circuit recovery				
Dungannon – Tamnamore 110 kV	0.08	6.5	0.52	
Dungannon – Mid Tyrone 110 kV	0.08	20	1.60	
TO costs				
Estimate of TO costs			87.91	
Contingency (10%)			8.79	
Total			**96.70**	

Table A.2: ctd.

Item description	Unit cost (£m)	No.	£m	Notes
TSO costs (Preconstruction and consents)				
Preconstruction	8.00	1	8.00	
Easements			8.25	
Total			**16.25**	
Combined TSO and TO costs				
Total			**112.95**	

Table A.3: Estimated costs for Option 2B

Item description	Unit cost (£m)	No.	£m	Notes
Works at Dungannon substation				
Turn in Tamnamore – Tremoge circuit	1.00	0.89	0.82	
New Omagh 275/110 kV substation				
Land purchase	0.50	1	0.50	
275/110 kV substation pre-enabling	6.40	1	6.40	
Control building	0.50	1	0.50	
275 kV AIS DBB Bay (excluding cabling)	1.90	5	9.50	Bus coupler, section switches, 2 x transformer bay, 275 kV circuit
110 kV AIS DBB Bay	0.84	6	5.04	Bus coupler, section switches, 2 x transformer bay, 2 x 110 kV circuits
275 kV cable (100m)	0.75	1	0.75	
110 kV cable (200 MVA)	1.56	0.4	0.62	
275 kV 240 MVA IBTX installed	6.65	2	13.30	
Turn in Tremoge circuit	1.00	1	1.00	
Cable in Gort circuit	1.50	0.3	0.45	
Turn in Gort circuit	1.00	0.5	0.50	
Works at Tamnamore substation				
Pre-enabling	3.00	1	3.00	
Cable diversions	0.65	9	5.85	3 x 300m diversions
OHL diversion	0.445	0.1	0.04	
1x new 110 kV bay	0.84	1	0.84	Bus coupler and new bay for circuit
Control room extension	0.50	1	0.50	
Protection	0.16	1	0.16	
Equip 275 kV bay	0.50	1	0.50	
Omagh to Tamnamore 275 kV circuit				
275 kV steel tower twin 600mm2 ACSR	9.79	4.08	39.94	
cable termination at Dungannon	1.00	1	1.00	
Cable section near Dungannon main	3.90	1.5	5.85	
Directional drill	1.50	1	1.50	1 river crossing
Turn in at Tamnamore	1.00	1	1.00	
110 kV circuit recovery				
Dungannon – Tamnamore 110 kV	0.08	6.5	0.52	
Dungannon – Mid Tyrone 110 kV	0.08	36.1	2.89	
TO costs				
Estimate of TO costs			103.48	
Contingency (10%)			10.35	
Total			**113.83**	
TSO costs (Preconstruction and consents)				
Preconstruction	5.00	1	5.00	

Table A.3 ctd.

Item description	Unit cost (£m)	No.	£m	Notes
Easements			9.30	
Total			**14.30**	
Combined TSO and TO costs				
Total			**128.13**	

Table A.4: Estimated costs for Option 2C

Item description	Unit cost (£m)	No.	£m	Notes
Works at Dungannon substation				
Omagh cable	3.00	1.13	3.39	
Portal OHL	0.40	16	6.40	
New Omagh 275/110 kV substation				
Tamnamore cable	3.00	1.36	4.08	
Portal OHL	0.40	33.53	13.41	
Works at Dungannon substation				
Portal OHL	0.40	36.1	14.44	
New Omagh 275/110 kV substation				
Portal OHL	0.40	21.45	8.58	
Omagh cable	3.00	0.15	0.45	
Works at Dungannon substation				
Tamnamore cable	3.00	2.37	7.11	
L4 section	0.40	4.5	1.80	
Portal OHL	0.40	39.3	15.72	
TO costs				
Estimate of TO costs			75.38	
Contingency (10%)			7.54	
Total			**82.92**	
TSO costs (Preconstruction and consents)				
Preconstruction	3.50	1	3.50	
Total			**3.50**	
Combined TSO and TO costs				
Total			**86.42**	

Table A.5: Estimated costs for Option 3A

Item description	Unit cost (£m)	No.	£m	Notes
Works at Tamnamore substation				
Pre-enabling	3.03	1	3.03	
Cable diversions	0.65	9	5.85	3 x 300m diversions
OHL diversion	0.445	0.1	0.04	
1x new 110 kV bay	0.84	2	1.68	Bus coupler and new bay for circuit
Control room extension	0.40	1	0.40	
Protection	0.16	1	0.16	
Works at Dromore substation				
110 kV DBB bay	0.84	4	3.36	
New protection	0.16	2	0.32	
Land purchase & pre-enabling	3.03	1	3.03	
Control room extension	0.30	1	0.30	
New Dromore to Tamnamore 110 kV circuit				
Dromore terminal tower and connection	1.00	0.5	0.50	
110 kV single circuit wood pole portal	5.00	4.87	24.35	400mm^2 ACSR
Cable from Tamnamore to Killyman	1.70	4.8	8.16	
Directional drill	1.50	1	1.50	1 river crossing
Cable termination tower	0.50	1	0.50	
Tamnamore terminal tower	1.00	0.5	0.50	
TO costs				
Estimate of TO costs			53.68	
Contingency (10%)			5.37	
Total			**59.05**	
TSO costs (Preconstruction and consents)				
Preconstruction	4.80	1	4.80	
Easements			10.20	
Total			**15.00**	
Combined TSO and TO costs				
Total			**74.05**	

Table A.6: Estimated costs for Option 3B

Item description	Unit cost (£m)	No.	£m	Notes
Works at Turleenan substation				
Cable termination	1.00	1	1.00	
Protection works	0.20	1	0.20	
Works at Dromore substation				
Moving Drumquin cable	1.70	0.4	0.68	
110 kV DBB bay	0.84	7	5.88	
Moving Bus coupler	0.50	1	0.50	
New protection	0.16	7	1.12	
Land purchase & pre-enabling	6.40	1	6.40	
Control room extension	0.50	1	0.50	
275 kV AIS DBB bay	1.90	5	9.50	5 bays
275 kV ancillaries	1.00	1	1.00	
275/110 kV transformer	6.65	2	13.30	
New Dromore to Turleenan 275 kV circuit				
Dromore terminal tower and connection	1.00	0.5	0.50	
275 kV steel tower single circuit	9.79	5.2	50.91	Twin 600mm^2 ACSR
Underground cable	3.90	1	3.90	
Cable termination tower	1.00	2	2.00	1 river crossing
TO costs				
Estimate of TO costs			97.39	
Contingency (10%)			93.74	
Total			**107.13**	
TSO costs (Preconstruction and consents)				
Preconstruction	5.00	1	5.00	
Easements			11.83	
Total			**16.83**	
Combined TSO and TO costs				
Total			**123.96**	

Table A.7: Estimated costs for Option 3C

Item description	Unit cost (£m)	No.	£m	Notes
Works at Turleenan substation				
Cable termination	1.00	1	1.00	
Protection works	0.20	1	0.20	
Land purchase, extend compound	4.50	1	4.50	For reactors
Shunt reactor (80 Mvar)	3.00	2	6.00	
Works at Dromore substation				
Moving Drumquin 110 kV cable	1.7	0.4	0.68	
110 kV DBB bay	0.84	7	5.88	
Moving Bus coupler	0.50	1	0.50	
New protection	0.16	7	1.12	
Land purchase & pre-enabling	6.40	1	6.40	
Control room extension	0.50	1	0.50	
275 kV AIS DBB bay	1.90	6	11.40	6 bays (one for reactor)
275 kV ancillaries	1.00	1	1.00	
275/110 kV transformer and cabling	6.65	2	13.30	
Shunt reactor (80 Mvar)	3.00	2	6.00	
New Dromore to Turleenan 275 kV circuit				
Underground cable	3.90	57	222.30	
Directional drill	1.50	17	25.50	Approximately 17 river crossings
TO costs				
Estimate of TO costs			306.28	
Contingency (10%)			30.631	
Total			**336.91**	
TSO costs (Preconstruction and consents)				
Preconstruction	8.00	1	8.00	
Easements			4.25	
Total			**12.25**	
Combined TSO and TO costs				
Total			**349.16**	

Appendix B

Net Present Cost assumptions

The following assumptions were used in these assessments:

- A reasonable programme of works was assumed, taking into account the difficulty of obtaining outages for uprating works.
- Only 2030 constraints were modelled and were assumed the same in subsequent years.
- All constraints shown are the difference from the 'do nothing' scenario. Hence, this difference is shown as an income (where constraints have reduced).
- No allowance was made for changes in constraints due to completion of subsidiary parts of an option, or increased constraints from outages.

The following reinforcements were assumed complete:

- The Mid Antrim Upgrade project;
- The second North-South Interconnector; and
- The Tamnamore-Drumnakelly uprate project.

Cost of carbon

Carbon costs were calculated on the basis of constrained energy being met by gas generation with average carbon emissions of 539 kg CO_2/MWh and carbon costs as recommended by UK Department for Business, Energy & Industrial Strategy publication Valuation of Energy Use and Greenhouse Gas.

When conducting Net Present Cost assessments on options for network development projects chiefly associated with renewables integration, a cost is included for the energy constrained from renewable sources. This represents future Firmness of this generation (either commercial or physical). This is based on a future estimate of the Average Day Ahead Market Price in the SEM taken from Shaping Our Electricity Future, which for 2030 was €92.13/MWh (approx. £78/MWh).

Renewable generation is promoted as a way of reducing CO_2 emissions associated with electricity generation. In the UK, climate change impacts are increasingly being factored into infrastructure development – for example, in 2020, the proposed 3rd runway at Heathrow Airport was ruled illegal as it did not adequately consider the UK government's commitments to climate change mitigation, and the UK government's road building plan has been challenged over its climate change impacts.

Under the Climate Change Act (Northern Ireland) 2022, the region has a legally binding target of 80% electricity generation from renewable sources, with full decarbonisation by

2050. SONI has included several projects in the Transmission Development Plan NI that will be vital to achieving this aim, and in order to fully account for the impact of the options being assessed for these projects a carbon cost is included in the Cost-Benefit Analysis/Net Present Value assessment of these projects.

UK Government guidance

An approach to this is outlined in HM Treasury's Green Book[6], and is as follows:

1. Quantify energy use in MWh.
2. Value energy or fuel use (Market price of electricity).
3. Convert energy use into Greenhouse Gas (GHG) emissions (tonnes of CO_2 equivalent [tCO_2e] x value of carbon).
4. Value to society of emissions (GHG values are based on the economic cost of mitigating a unit of carbon. For power generation, this depends on the market price for carbon, under the UK Emissions Trading System).

Further detail on the valuation of Carbon is included in the UK Department for Business, Energy & Industrial Strategy publication Valuation of Energy Use and Greenhouse Gas[7]. This document includes guidelines on the analysing of CO_2 costs arising from electricity projects (section 3.27):

When a policy or project results in a switch from using one fuel to another, this may be analysed in a similar way as when only one fuel is affected. In such situations, it is necessary to consider the impact on the consumption of each fuel separately and apply the appropriate emissions factor to the change in consumption of each fuel (an increase in one, and a reduction in the other).

Applying this to the assessment of options in a SONI network development project, this would mean assessing the CO_2 emissions of any plant required to run to make up for constrained zero-emissions renewable generation under each option under appraisal.

On providing a cost for Carbon, section 3.35 states:

Changes in emissions which occur in the traded sector are valued at the Traded Price of Carbon. The value placed on changes in greenhouse gas (GHG) emissions is currently under review, now the UK has increased its domestic and international ambitions. Accordingly, current central carbon values are likely to undervalue GHG emissions, though the scale of undervaluation is under review. The potential impact of placing a higher value

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6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf

7 https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

on GHG emissions can be illustrated by using the existing high carbon values series, in addition to the central values.

Valuation of Energy Use and Greenhouse Gas includes a table of estimates for the Traded Price of Carbon out to the year 2100. From the extract above, in the absence of further detail on Carbon pricing, a reasonable assumption is to use the high estimate in table 1 of the data tables.

Assessing the carbon cost of constrained energy

Constrained renewable generation is zero-carbon energy that is available but cannot be transmitted due to network constraints. This represents energy that must rather come from conventional (non-renewable) sources. In order to assess the carbon cost of constrained, assumptions must be made about the nature of the generation that is required to meet this shortfall.

If renewable generation is being curtailed in Northern Ireland, some or all of this shortfall may be made up by increasing imports on the North-South interconnector(s) and on the Moyle HVDC interconnector. Both the Republic of Ireland and Great Britain have high penetrations of renewable energy – therefore it is reasonable to assume that much of this interconnector flow would come from renewable sources. However, importing electricity into NI by any of these methods serves to increase demand in the source jurisdiction, thus either alleviating renewables curtailment in the source region or increasing generation from non-renewable sources. However, due to the global nature of climate change, all electricity system operators are seeking to minimise the dispatch down of zero carbon generation – thus it is sensible to assume that in the event of curtailment in NI there is no surplus zero carbon generation that can be availed of over the interconnectors, and this energy must come from other sources.

In both the GB and island of Ireland electricity system, peaking generation is provided by gas turbines. In both the Republic of Ireland and Northern Ireland all non-gas fossil fired generation is being replaced by gas-fired units over the coming years. Gas turbine power generators come in two forms: Combined Cycle Gas Turbines (CCGTs) an Open-Cycle Gas Turbines (OCGTs). CCGTs are more efficient while OCGTs are more flexible. CCGTs emit approx. 490 kg CO_2e/MWh, while OCGTs emit approx. 588 kg CO_2e/MWh. A 50/50 mix of both is assumed, giving a CO_2 value for constrained energy of 539 kg CO_2e/MWh.

Methodology for assessing the value of avoided CO_2 emissions

For including the value of avoided CO_2 emissions in the NPC analysis, the following methodology was applied:

1. The magnitude (MWh) of curtailment of renewables is determined for the study area under investigation for all years of the NPC using reasonable assumptions.
2. The total curtailment is multiplied by 0.539 (tCO_2e/MWh of generation 'constrained on') to estimate the CO_2 emissions relating to constrained generation.
3. The total CO_2 emissions in the year is multiplied by a carbon price figure published[8] by the UK government. For this analysis, the 'high' estimate is used.
4. For each year, subtract the emissions associated with constrained generation for the do-nothing baseline case from that associated with the option under assessment.

8 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002889/data-tables-1-19.xlsx