# Preliminary Route Development

# Lissnagroaragh Wind Farm
# 110kV Grid Connection

**Report Ref:** 05773-R01-02

**Client:** Coillte C/o Tobin Consulting

| Revision: | Author: | Checked: | Date: | Notes: |
|---|---|---|---|---|
| 00 | DB | SK | 27.10.20 | Issued for Client Review |
| 01 | DB | RG | 19.01.20 | Revised to include Budgetary Costs and addition of OHL Grid Route Option |
| 02 | DB | SK | 04.06.21 | Revised to include route elements in proximity to Srananagh Substation and Tullintowel |

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## 1.0 Introduction

TLI Group were engaged by Coillte C/o Tobin Consulting to identify and analyse potential 110kV grid connection options available for the Lissnagroaragh Wind Farm Project which is currently being developed by the Client. This analysis was to examine the various underground cable (UGC) options available for a 110kV grid connection to an existing ESB Substation or to explore the possibility to Loop-In to an existing Overhead Line (OHL) asset that traverses in the proximity of the development area.

This exercise was to examine underground cable (UGC) options which would facilitate the wind farm to connect to Srananagh 220kV Substation or to connect into the existing Cathleen Falls to Srananagh OHL via a loop in connection. These options were focused primarily at Srananagh Substation to maximise the export capacity available, with a connection to the 220kV node.

The exercise also included an examination for the feasibility of routing an option to bring onstream Tullintowel Windfarm which is also being considered for generation by the client. The location of Srananagh substation in relation to both Lissnagroaragh and Tullintowel wind farms is shown in Fig 1 below.

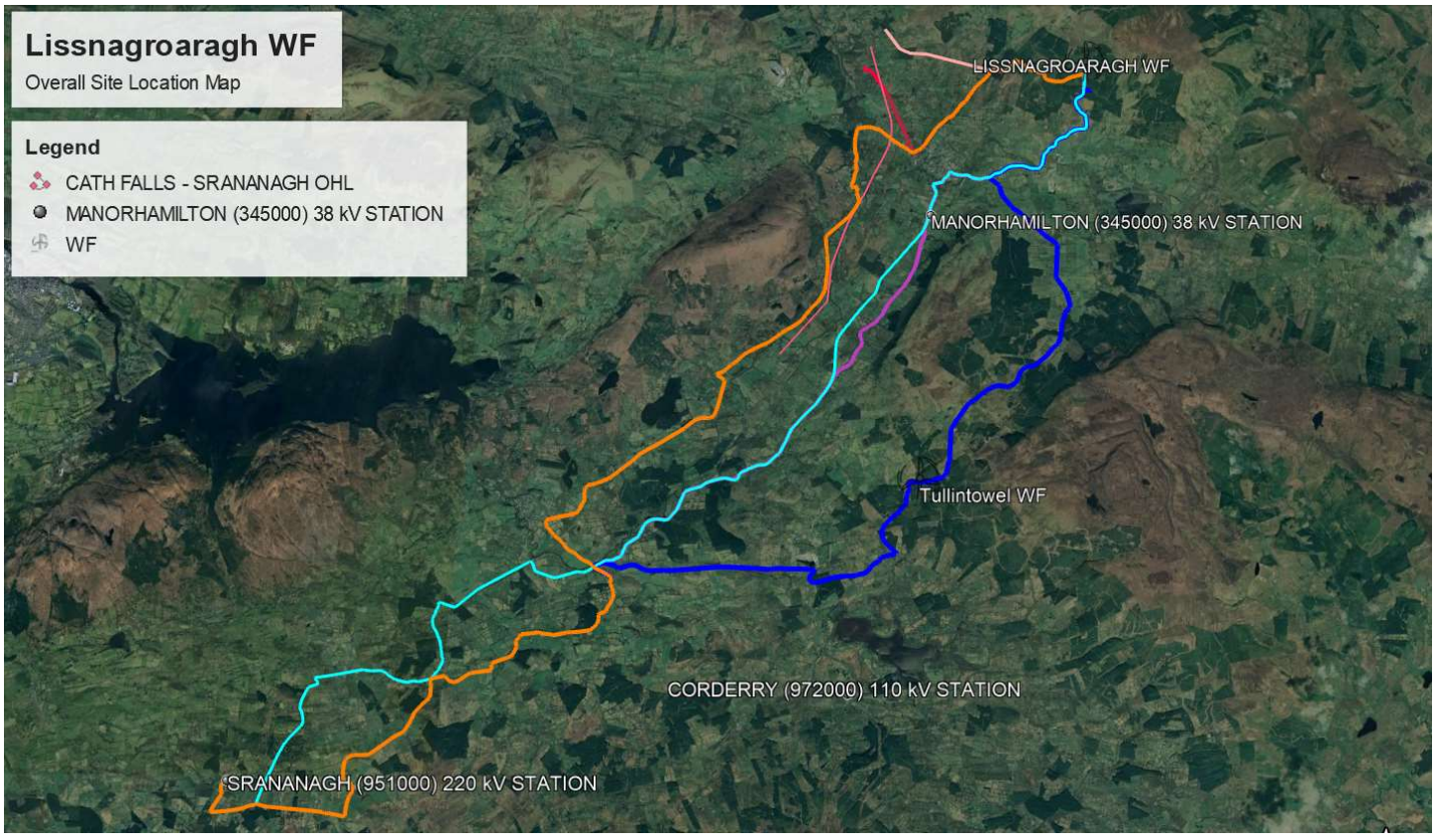


*Figure 1 – Location overview of potential grid connection options*

## 2.0 Route Development Overview

In order to identify potential route corridors between the windfarm site and the 220kV substation location, a detailed study area constraints map was created in AutoCAD. The study area map combined data from numerous sources including OSI mapping, aerial imagery, protected areas, river networks, ESB network data, existing turbine locations, architectural heritage and monuments data.

A desktop analysis was carried out using the study area constraints map to identify potential underground cable routes between the windfarm site and Srananagh substation. The possibility of extending the scope to include Tullintowel wind farm was also determined, procuring a route between both windfarms for interconnection with a feeder circuit back to Srananagh node from Tullintowel.

Alternative options to connect the windfarm to the existing Cathleen Falls overhead line was also considered as part of this study. These considered facilitating Loop In substation options within existing Coillte property whilst also in close proximity to Srananagh OHL. A high-level evaluation of the potential interconnection between these OHL Loop In options and the wind farm was considered with both UGC and OHL offered.

Initially the following preliminary routes were identified from the desktop analysis:

*Srananagh 220kV Substation to Lissnagroaragh WF Substation location*

- *UGC Route Option 1 (Orange) – 33.5km*
- *UGC Route Option 2 (Cyan) – 29.9km*
- *UGC Route Option 3 (Purple) – 30.3km*
- *UGC Route Option 4 (Blue) – 36.4km*

*Cathleen Falls - Srananagh OHL Loop In to Lissnagroaragh WF Substation location*

- *OHL Loop In UGC Route Option 1 (Green) – 6.8km*
- *OHL Loop In UGC Route Option 2 (Ruby) – 5.6km*
- *OHL Loop In OHL Route Option 1 (Peach) – 2.7km*

Surveys of the preliminary route options identified were carried out onsite in order to examine the feasibility of each route corridor and identify any additional constraints which were not visible during the desktop analysis (i.e. ground conditions, additional infrastructure, etc.) The proposed routes were analysed and altered based on the site conditions in order to select the most feasible route corridors available.

### 2.1 IPP Substation Locations

*Refer to attached Drawings 05773-DR-005 & 05773-DR-006*

The Consultant has identified a number of potential substations within the EIAR site boundary. These locations have been selected based on the methods to integrate the wind farm generation onto the Grid network, whether it be a EirGrid 110kV AIS Single Transformer Tail Station, EirGrid 110kV AIS Tail Station Extendable "Type C" connection or a EirGrid 110kV AIS Loop Station. Considerations towards minimising the length of the grid connection cable infrastructure, access, suitability of the ground conditions and adequate flat level gradients established. With these conditions met, potential locations have been identified during site investigations.

- Proposed Substation Location 1 *(ITM 591900.452, 841689.2)*
- Proposed Substation Location 2 *(ITM 592063.211, 841309.5)*
- Proposed Substation Location 4 *(ITM 587177.175, 841803.6)*
- Proposed Substation Location 5 *(ITM 587460.47, 842822.8)*
- Proposed Substation Location 6 *(ITM 588689.36, 832027.21) [Tullintowel WF]*

## 3.0 Initial Grid Connection Route Options

The following potential 110kV grid connection routes have been identified for Lissnagroaragh Windfarm at this stage of the process based on desktop analysis and initial site surveys.

### 3.1 UGC Route Option 1: Srananagh 220kV Substation to Lissnagroaragh WF (Orange)

*UGC Grid Connection route from Srananagh 220kV to Proposed Substation Loc. 1 – 33.5km*

Grid Connection Route Option 1 is approximately 33.5km and utilises a section of private access tracks, for the majority localised road network and sections of forestry within the windfarm site boundary. Exiting from Srananagh 220kV Substation, the route heads souths initially and traversing through an access track to converge onto the local secondary L5204. This secondary roadway carries the UGC in an east facing direction before the route changes course to continue north, crossing county jurisdictions whilst carrying until the UGC will approach a junction to converge onto the primary road network.

The UGC carries in a predominantly east to north east direction from this point, all of which is within the road network until coming upon the first pinch point which will require the UGC to depart the road network to facilitate a drilling corridor away from a major watercourse river crossing (Bridge 3). This will also traverse through a section of the environmentally sensitive area of the Lough Gill SAC and pNHA). Subsequent to crossing this river (fig 2), the UGC route will re-establish within the local road L4165 to traverse towards the catchment of Dromahair. Skirting the southern side of the town, passing outside the local national primary school, the UGC will continue to carry within this local road heading in a north eastly direction, converging onto a section of the L4171 to accommodate the UGC route within the network before approaching the N16 southwest of Manorhamilton Town. Within these varying road segments, the UGC will carry through sections of the environmentally sensitive area of the (Lough Gill SAC).

The UGC will turn left onto a very minor section of the national carriageway, exploiting a considerable grass margin avoiding the N16 as much as possible before availing of a secondary road route to head north. This route will bring the UGC infrastructure upon the L2136 roadway, converging onto this local road heading east of Manorhamilton before approaching a junction to merge onto the regional roadway R280. The route crosses this to access a grassed section of County Council land before accessing the public road network once more to carry within Castle Street, and Castle View roadways, passing within the zone of notification for the architectural Manorhamilton Castle. Traversing the northern outskirt of the town and availing of the R282 to allow the Cable infrastructure to head north towards the Windfarm.

Within this R282 roadway, the UGC route will utilise a local secondary roadway to carry within the final section of roadway towards the Lissnagroaragh site, accessing from the western entrance and utilising a forestry access track. This access track will carry eastwards within the existing forestry parcel and will allow the UGC to reach the proposed location 1, a EirGrid 110kV AIS Tail Station Extendable “Type C” within a mature forestry.

Eight bridge crossing points have been identified on this route. Bridge surveys would need to be carried to determine if the UGC can cross in the deck of the bridge or if horizontal directional drilling or bridge replacement may be required.

This grid connection option is shown as ***UGC Route Option 1*** in Drawings ***05773-DR-001 - 05773-DR-005***

*UGC Route Option 1 Constraints:*

- *Consultation with Sligo County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within secondary roads*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within National, regional and secondary roadways*
- *Single lane closures for national & regional roads and full road closures on secondary roadways*
- *Disruption to commuting traffic in the catchment of Dromahair due construction activities.*
- *Disruption to localised traffic in the outskirts of Manorhamilton town due construction activities*
- *Road opening license for sections of the UGC in the public road*
- *UGC passes Lurganboy Wastewater pumping station on the western outskirt of Manorhamilton.*
- *Water utility services exist within a large majority of the road alongside the UGC.*
- *UGC traverses through sections of (Lough Gill SAC and pNHA)*
- *One difficult Bridge Crossing with possible route traversing third party land to carry UGC beneath Bonet River*

*Figure 2 - Bridge structure within L4165 crossing Bonet River (Lough Gill SAC & pNHA)*

## 3.2 UGC Route Option 2: Srananagh 220kV Substation to Lissnagroaragh WF (Cyan)

*UGC Grid Connection route from Srananagh 220kV to Proposed Substation Loc. 2 – 29.9km*

An alternative Grid Connection route has been identified between Srananagh 220kV Substation and the proposed substation location 2 within Lissnagroaragh Windfarm. The UGC route follows the same initial route outlined exiting Srananagh, heading east within the local secondary L5204, the variation will entail the UGC carrying within a predominantly northerly route immediately east of Srananagh within a secondary road route in the direction of

Ballintogher village. Coming upon the southern outskirt of this village, the route accesses another secondary roadway carrying the UGC in an easterly direction, crossing between county jurisdictions before the route changes course to continue north within a varying local secondary. Within this section, the UGC will be required to migrate between road junctions and carry along a short section where the terrain is undulating before re-establishing within the local secondary route L4252 towards the regional road R287.

On converging onto the R287, the route will travel through the environmentally sensitive area of (Lough Gill SAC) and in conjunction the UGC will encounter its first significant pinch point within this route option, a bridge crossing (Bridge 6) which is situated in an acute position without sufficient deck cover. There is however an extended walkway which could allow strapping of the duct to the under carriage to facilitate the grid connection cabling. As-builts of the remedials works to the bridge can be requested from the local authority to provide a detail engineering design to cross within this structure.

*Figure 3 – Extended walkway attached a bridge.*


*Figure 4 – Typical view of UGC directional course*

Once navigating a route past this bridge crossing, the UGC traverses within the R287 heading in north easterly direction and travelling close to the River Bonet for a section before encountering a second pinch point bridge crossing. This bridge (Bridge 7) is in situ over a tributary watercourse flowing into the River Bonet and initial site investigatory work has found this structure to be a flat slabbed bridge with no adequate cover and has an increased drilling difficulty due to the nature of the road network with a sweeping bend at one side of the bridge which will require third party involvement if proposing to drill under the watercourse.

*Figure 5 – Bridge 7 located within R287 with sweeping bend.*

After crossing this bridge, the route with cross an additional bridge immediately after Bridge 7, mobilising a horizontal drill to cross beneath and continuing within the remainder of this R287 roadway until the route merges with the regional road R280 to traverse towards Manorhamilton. The UGC will be carried within this regional road for a considerable 7.23km, at which point the infrastructure will be south of the Manorhamilton catchment. To purposely avoid continuing towards the town centre, the route will carry into a parcel of undeveloped land subsequent to crossing a river. This river crossing will carry again encounter the sensitive area of (Lough Gill SAC) and continuing to traverse within a land parcel which carries a pre-2000 planning application attached to construct a Hotel, dwellings, access roads and a bridge but none of which has ever been facilitated under the Planning Ref No 00491. The consultant views this as a major constraint but no obvious road alternatives exist south east of Manorhamilton to avoid the town centre. The UGC will exit this area and converge onto the N16, on the western side of Manorhamilton town.

The UGC carries within this national roadway encountering a third pinch point within this option, in the form of another bridge crossing (Bridge 11). Field survey work on this structure indicate insufficient cover in the road deck to accommodate 160mm ducts and numerous utility have been found to exist within and strapped to both parapets. It is envisaged that this will require an HDD to cross the bridge structure setting up within the national roadway. Once across this structure, the route remains within the N16 roadway for an additional 1.60km prior to utilising a local secondary road L6184, crossing a section of the Lough Gill SAC before carrying the UGC northwards towards the windfarm site location and towards the proposed location 1, a EirGrid 110kV AIS Tail Station Extendable "Type C" within a mature forestry.

Thirteen bridge crossing points have been identified on this route. Bridge surveys would need to be carried to determine if the UGC can cross in the deck of the bridge or if horizontal directional drilling or bridge replacement may be required.

This grid connection option is shown as ***UGC Route Option 2*** in Drawings ***05773-DR-001 - 05773-DR-005***

*UGC Route Option 2 Constraints:*

- *Increased number of bridge crossings, thirteen in total and multiple culverts along proposed route*
- *Bridge Crossing with walkway requires consultation with local authority to facilitate cable ducts beneath extended walkway.*

- *Derogation to be sought from EirGrid and ESBN to incorporate power ducts beneath extended walkway.*
- *Major constraint in requiring a route through undeveloped lands east of Manorhamilton.*
- *Consultation with Sligo County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within secondary roads*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within National, regional and secondary roadways*
- *Single lane closures for national & regional roads and full road closures on secondary roadways*
- *Disruption to localised traffic in the outskirts of Manorhamilton town due construction activities*
- *Road opening license for sections of the UGC in the public road*
- *UGC passes Lurganboy Wastewater pumping station on the western outskirt of Manorhamilton.*
- *Water utility services exist within a large majority of the road alongside the UGC.*
- *UGC traverses through sections of (Lough Gill SAC)*

## 3.3 UGC Option 3: Srananagh 220kV Substation to Lissnagroaragh WF (Purple)

*UGC Grid Connection route from Srananagh 220kV to Proposed Substation Loc. 2 – 30.3km*

UGC Option 3 is predominantly a variation of both UGC Option 2 and UGC Option 1. Initially this option traverses the same route within the first section, as covered within UGC option 1. This varies at the point where the UGC route traverses within the R289 and will converge onto the R287 in close proximity to the Bonet River. From here the UGC will encounter a flat slabbed bridge crossing as previously stated and carry within this regional road for approximately 4.88km. The UGC will encounter a bridge crossing (Bridge 9) immediately when joining the R280, which can sufficiently carry grid cabling infrastructure due to the presence of adequate deck cover.

The UGC will be carried within this regional road for 2.07km, encountering another bridge crossing which can be cross by mobilising an HDD before the route carries within a local secondary road L62031 to minimise further use the regional road. Within this section of roadway, the UGC will encounter two more bridge structures which can sufficiently be drilled within the road corridor and re-joining the regional road after utilising circa 4.2km of secondary carriageway. From this point, this option follows the same route in principle as that of UGC option 2, avoiding the town centre of Manorhamilton, accessing through private lands and utilising the N16 and L6184 roadways to carry the cable infrastructure towards the windfarm and the proposed location 2 in particular which is sited immediately within the EIAR site boundary on the right-hand side with relative access gained via an existing forestry access track. This arrangement would consist of a EirGrid 110kV Extendable "Type C" AIS Tail Station.

Twelve bridge crossing points have been identified on this route. Bridge surveys would need to be carried to determine if the UGC can cross in the deck of the bridge or if horizontal directional drilling or bridge replacement may be required.

This grid connection option is shown as ***UGC Route Option 3*** in Drawings ***05773-DR-001 - 05773-DR-005***

*UGC Route Option 3 Constraints:*

- *Twelve bridge crossings in total, two other watercourse crossings and multiple culverts along proposed route*
- *Major constraint in requiring a route through undeveloped lands east of Manorhamilton.*

- *Consultation with Sligo County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within secondary roads*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within National, regional and secondary roadways*
- *Single lane closures for national & regional roads and full road closures on secondary roadways*
- *Disruption to localised traffic in the outskirts of Manorhamilton town due construction activities*
- *Road opening license for sections of the UGC in the public road.*
- *UGC traverses through sections of (Lough Gill SAC)*

*Figure 6 - Fragile bridge crossing within local secondary road L62031*

## 3.4 OHL Loop In UGC Route Option 1: Cathleen Falls - Srananagh OHL Loop In to Lissnagroaragh WF (Green)

*UGC route from Cable Interface structures located beneath Cathleen Falls – Srananagh OHL to Proposed Substation Loc. 3 – 6.8km*

Alternatively, to the UGC grid connection options discussed, the option to utilise the existing Cathleen Falls – Srananagh OHL to offer a potential grid connection interface point has also been considered at this stage. This option explores the possibility of using a radial arrangement to create a looped circuit between the existing OHL and the proposed Substation location 1, a EirGrid 110kV AIS Loop In Station.

The proposed design for the Loop-In from the existing OHL will require two new Interface Mast structures which will be constructed under the existing OHL, proposing to erect these mid span between Poleset No's 142 to 143 respectively (fig 7). The existing OHL conductor will be terminated with the existing conductor removed between two new Interface Mast structures in order to transition from an overhead line to an underground cable arrangement to facilitate the radial circuit back towards the EirGrid 110kV AIS Loop In Station.

To facilitate this new connection beneath the OHL, the footprint in which the existing Poleset 142 and 143 are located within the (Folio no LM8931). The composition of the terrain is suitable and access can be easily gained from traversing road network in close proximity to the OHL.

Accessing the road network, the 2-way UGC route carries southwards, encountering a bridge with insufficient cover but can be easily drilled within the road corridor. Once navigating this bridge, the UGC will migrate towards Manorhamilton within the local secondary roadway and once reaching Castle Street, the circuit carries left within this road and immediately turns left again to access Castle View road. In doing so, the UGC routes passes Manorhamilton Castle. Traversing this road, a second bridge is encountered. During field investigation work for the bridge, adequate cover was found to exist over the existing flat slab before continuing on the northern outskirt of the town and converging onto the R282. Within this R282 roadway, the UGC route will utilise a local secondary roadway to carry within the final section of roadway towards the Lissnagroaragh site. Two further bridges will be crossed within this section of local secondary and both appear to adequately allow an HDD to cross both in tandem, and within the corridor of the road network. The windfarm site is accessing from an entrance at the western side and utilising a forestry access track. This access track will carry eastwards within the existing forestry parcel and will allow the UGC to reach the proposed substation location 1, within mature forestry.

Four bridge crossing points have been identified on this route. Bridge surveys would need to be carried to determine if the UGC can cross in the deck of the bridge or if horizontal directional drilling or bridge replacement may be required.

This grid connection option is shown as ***OHL Loop In - UGC Option 1*** in Drawings ***05773-DR-001 & 05773-DR-005***

*OHL Loop-In UGC Route Option 1 Constraints:*

- *Agreement with EirGrid/ESB for looping into existing OHL*
- *Limited capacity on the Cathleen Falls – Srananagh OHL*
- *Disruption to localised traffic in the outskirts of Manorhamilton town due construction activities*
- *Road opening license for sections of the UGC in the public road.*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to construct a 2-way 110kV UGC circuit within regional and secondary roadways.*
- *One private landowner required to facilitate grid connection onto existing OHL*
- *Easements/wayleave agreements required for UGC route with landowner folio*
- *Existing water utilities within secondary road on approach to site boundary*

*Figure 7 - Panoramic view of proposed site area to break existing OHL*

## 3.5 OHL Loop In - UGC Route Option 2: Cathleen Falls - Srananagh OHL Loop In to Lissnagroaragh WF (Red)

*UGC route from Cable End Mast structures located beneath Cathleen Falls – Srananagh OHL to Proposed Substation Loc. 4 – 5.6km*

Another variation of the proposed OHL Loop In option described above has been identified between the proposed windfarm and the Cathleen Falls – Srananagh OHL. Alternatively, to the OHL Loop In- UGC Route Option 1 discussed, this option will utilise the majority of public road for an interconnecting cabling works between a proposed EirGrid 110Kv AIS Loop In Station located within existing Coillte property, location 4 and a IPP compound proposed EirGrid 110kV AIS Single Transformer Tail Station at location 3 within the Windfarm site boundary. This option will contain a bespoke underground connection within the public road network before converging into the Coillte folio.
The Coillte property is bounding the local public road network and has undergone clear felling in recent times. The footprint of the EirGrid Substation will fit within the folio situated in close proximity to the existing OHL, the proposed Loop In circuits will carry eastwards, converging onto the local road network with the presence of water utility services existing and continues towards folio LM13666 where it's proposed to install the Cable Interface masts mid span between Poleset No's 139 to 140 respectively.

This grid connection option is shown as ***OHL Loop In - UGC Option 2*** in Drawings ***05773-DR-001 & 05773-DR-005***

*OHL Loop-In UGC Route Option 2 Constraints:*

- *Agreement with EirGrid/ESB for looping into existing OHL.*
- *Limited capacity on the Cathleen Falls – Srananagh OHL*
- *Disruption to localised traffic in the outskirts of Manorhamilton town due construction activities*
- *Road opening license for sections of the UGC in the public road.*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to install interconnecting 110kV UG cabling within regional and secondary roadways.*
- *One private landowner required to facilitate grid connection onto existing OHL*
- *Easements/wayleave agreements required for UGC route with landowner folio.*
- *Increased Substation associated construction works with two separate entities required.*

## 3.6 OHL Loop In - OHL Option 1: Cathleen Falls - Srananagh OHL Loop In to Lissnagroaragh WF (Peach)

It has been proposed to incorporate an OHL Loop In route option from the Proposed Substation location 3 sited on the western edge of the Wind farm to carry north west to the location of Proposed Substation location 5 which is the proposed EirGrid Loop In Substation within existing Coillte property. This line will allow interconnection between the loop in station and a Tail fed station at proposed Substation location 3.

The OHL will originate within the Wind farm site boundary in close proximity to the proposed Substation location 3 and head in a north-western direction traversing across agricultural lands and through forestry towards the Coillte owned property for an approximate range of 2.7km. The OHL will keep a sufficient clearance from all dwellings and buildings along the proposed OHL route and will carry on a slight upward gradient to the Coillte property. The existing Cathleen Falls - Srananagh OHL is located approximately 360m west of the proposed Substation, where the loop-in circuits will carry on a downward slope traversing folio LM8914 where it is proposed to install the Cable Interface masts mid span between Poleset No's 135 to 136 respectively.

This grid connection option is shown as ***OHL Loop In - OHL Option 1*** in Drawings ***05773-DR-001 & 05773-DR-005***

*OHL Loop-In OHL Route Option 1 Constraints:*

- *Landowner consent for sections of the UGC Looped circuits within private lands*
- *Landowner consent for the OHL traversing private lands.*
- *Agreement with EirGrid/ESB for looping into existing OHL.*
- *Limited capacity on the Cathleen Falls – Srananagh OHL.*
- *Increased Substation associated construction works with two separate entities required.*

## 3.7 UGC Route Option 4: Srananagh 220kV Substation via Tullintowel to Lissnagroaragh WF (Blue)

*UGC Grid Connection route from Srananagh 220kV to Proposed Substation Loc. 2 (at Lissnagroaragh WF) – 36.4km*

Grid Connection Route Option 4 is assessed to review the route the UGC to consider a second point of generation in the form Tullintowel windfarm and connect to the grid via the connection between Srananagh to Lissnagroaragh WF.

The UGC will leave Srananagh substation on the western side and converge into private lands (Folio SL19876). This will allow the UGC to traverse within this parcel within grassland and permanent access lane into this property for circa. 850m. This will allow the UGC to continue within the public road network heading south initially before heading in a predominantly eastly direction to carry towards Killenummery. Within this area the UGC will Bridge 2 which requires drilling to cross the Killenummery river. The UGC carries on a tertiary road (avoiding the L4264) for approx. 3.35km, approaching the R289. the UGC route traverses within the R289 and will converge onto the R287 in close proximity to the Bonet River.

From this point the UGC will traverse along the L4230 that allow a path for the UGC to transit towards the townland of Tullintowel in an easterly direction. The UGC carries within the local road network, crossing a bridge in situ, before approaching a small section of regional roadway and continuing towards a tertiary road to allow the route head north with large parcels of Coillte properties are located. The consultant has taken the approach to site a high-level Substation location within these properties to act as the support infrastructure for Tullintowel Windfarm.

Tullintowel WF can be assessed further later once a final layout for the windfarm is confirmed, screening the grid routes as separate entities for each project is required but an arrangement to connect Tullintowel WF onto the grid via the Lissnagroaragh to Srananagh UGC could be facilitated by appropriately siting straight through Joint Bays that would allow the underground cable to be broken at these points once the operation of Lissnagroaragh is taken out and to tee into a “C-Type” Extendable Tail Substation at Tullintowel, integrating generation from this point and sharing a connection with the remainder of the Lissnagroaragh UGC back towards Srananagh Node.

The feasibility of this arrangement would be dependent on the MEC (Lissnagroaragh 81.6 MW and another for Tullintowel 76.8 MW) of the two windfarms. It would be considered that 1000sq Al will be limited to carry both, sufficiently carrying the load under Winter operating conditions but would exceed the Summer operating parameters of the cable. The shared connection back to Srananagh node will require 1600sq Al to sufficiently carry the MEC of both windfarms.

On the northern side of Tullintowel Substation, the grid route will encounter four bridge crossings, one of these would require the route to come off the road corridor but the bridge resides within Coillte property so could utilise an avenue through this folio to allow a passage. This secondary road route will carry the UGC in a predominantly northerly direction for approx. 9.4km prior to converging onto the N16, east of Manorhamilton catchment.
The route remains within the N16 roadway for an additional 1km prior to utilising a local secondary road L6184, crossing a section of the Lough Gill SAC before carrying the UGC northwards towards the windfarm site location and towards the proposed Extendable "C Type" Station at location 2.

Nine bridge crossing points have been identified on this route. Bridge surveys would need to be carried to determine if the UGC can cross in the deck of the bridge or if horizontal directional drilling or bridge replacement may be required.

This grid connection option is shown as ***UGC Route Option 4*** in Drawings ***05773-DR-001 - 05773-DR-008***

*UGC Route Option 4 Constraints:*

- *Longest cable route out of all options identified.*
- *Wayleave required to access Srananagh through private property (SL19876)*
- *Consultation with Sligo County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within secondary roads.*
- *Consultation with Leitrim County Council's Roads Department in relation to proposals to construct a 110kV UGC circuit within National, regional and secondary roadways.*
- *Single lane closures for national & regional roads and full road closures on secondary roadways*
- *Road opening license for sections of the UGC in the public road*
- *Water utility services exist within a large majority of the road alongside the UGC.*
- *UGC traverses through sections of (Lough Gill SAC and pNHA)*
- *Tullinamoyle WF UGC infrastructure to be installed within same section of public roadway for roughly 2km*

*Figure 8 - Bridge 3 located along R4230.*

*Figure 9 - Bridge 4 situated north of proposed SS location.*

## 4.0 Budgetary Costs for the Proposed Routes

It should be noted that for all of the proposed routes identified, the costs associated with each route will vary depending on the route length, number of structures, landowner compensation and sections of UGC. The Consultant has developed an 'estimated budgetary build price' per km for 110kV OHL and UGC which can be used in determining high level budgetary costs for the proposed routes. The price per km costs do not account for landowner compensation for the OHL sections and assumes a number of bridge crossings and full road width reinstatement for the UGC sections. There are compensation figures for 110kV pole sets and angle masts which have been agreed with the IFA which can also be used in building up budgetary pricing. The values used in determining the budget costs for the proposed routes is detailed in Table 1.

| ***110kV Budgetary Cost Unit Values*** | | |
|---|---|---|
| *Cost Item* | *Unit Cost* | *Note* |
| *Management and Design* | *€150,000 - €600,000* | *Design, PM, Site Supervision, Quality, Safety* |
| *Extendable "C" Type 110kV Substation* | *€3,400,000.00* | *Civils/Elec and WF Traffo inclusive* |
| *EirGrid 110kV AIS Loop In Substation* | *€5,300,000.00* | *Civils/Elec and WF Traffo inclusive* |
| *110kV UGC Trenching, Ducting and Cable Install all inclusive* | *€700,000* | *Provisional to 1600sq XLPE Cabling with full road width reinstatement per km* |
| *110kV OHL (430's Conductor per km)* | €320,000 | *OHL, Hardware, price per km* |
| *110kV Poleset Compensation* | *€11,000* | *Compensation per Structure IFA agreed* |
| *Angle Mast/End Mast Compensation* | *€22,000* | *Compensation per Structure IFA agreed* |
| *Contingency* | *(10%)* | *Contingency for route alterations* |
| **Note: The average span between structures is assumed to be 200m* | | |

*Table 1 – 110kV Budgetary Cost Unit Value*

Using the high level 110kV Budgetary Cost Unit Values detailed in Table 2, the Consultant has calculated high-level estimated budget costs for each of the 7 routes identified as part of the Feasibility Study. A summarised table incorporating the consultants ranking of the proposed grid connection routes for Lissnagroaragh Windfarm.

*Note: All of the costs detailed below are budgetary only and should only be used for the purpose of comparing the various routes identified as part of this Feasibility Study.*

**Lissnagroaragh WF - 110kV Grid Connection**
**Route Summary & Budgetry Prices**
*Rev 2 (26.05.21)*

| Route Option | Point of Connection | Length of UGC (km) | Access to SS | Length of UGC in Primary roads (km) | Length of UGC in Secondary/Tertiary road (km) | Access to Lissnagroragh SS | Off road/Private | No. of Major Watercourse/HDD Crossings | "C Type" AIS 110kV substation | AIS Loop In 110kV substation | Civils and Cabling Install | Design & Management | Contingency | Overall Budgetry Cost of Routes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UGC Route Option 1 | Extendable "C Type" Tail | 33.5 | 0.630 | 16.25 | 14.26 | 2.34 | N/A | 8 | €3,400,000.00 | N/A | €23,438,100.00 | €600.000 | 10.00% | €29,522,570.00 |
| UGC Route Option 2 | Extendable "C Type" Tail | 29.9 | 0.630 | 15.57 | 12.59 | 0.57 | 0.55 | 13 | €3,400,000.00 | N/A | €20,939,100.00 | €600.000 | 10.00% | €23,033,670.00 |
| UGC Route Option 3 | Extendable "C Type" Tail | 30.3 | 0.630 | 12.05 | 16.50 | 0.57 | 0.55 | 14 | €3,400,000.00 | N/A | €21,214,900.00 | €600.000 | 10.00% | €23,337,050.00 |
| UGC Route Option 4 (Tullintowel) | Extendable "C Type" Tail | 36.4 | 0.630 | 8.12 | 25.3 | 0.20 | 0.84 | 9 | €3,400,000.00 | N/A | €25,480,000.00 | €600.000 | 10.00% | €31,768,660.00 |
| OHL Loop In - UGC Option 1 | AIS Loop Connection connection | 4.77 | 0.026 | 1.16 | 3.19 | 0.31 | 0.09 | 4 | N/A | €5,400,000.00 | €3,341,800.00 | €300.000 | 10.00% | €9,616,310.00 |
| OHL Loop In - UGC Option 2 | AIS Loop Integrated connection | 5.57 | 0.246 | 1.16 | 3.85 | 0.31 | N/A | 4 | €6,800,000.00 | N/A | €3,896,900.00 | €300.000 | 10.00% | €11,766,920.00 |

| Route Option | Point of Connection | Length of OHL (km) | Length of UGC (km) | No. of Angle Structures Required (est.) | No. of IMP's (est.) | No. of OHL/OHL Crossing Points | No. of UGC/UGC Crossing Points (est.) | No. of Landowners | C Type AIS 110kV substation | AIS Loop In 110kV substation | Civils and Stringing Install | Design & Management | Contingency | Overall Budgetry Cost of Routes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OHL Loop In - Hybrid Option 1 | AIS Loop Integrated connection | 2.72 | 2.35 | 4 | 20 | 4 | 0 | 13 | €3,400,000.00 | €4,500,000.00 | €2,515,400.00 | €150.000 | 10.00% | €11,457,105.00 |

*Table 2 - Summarised breakdown of proposed routes*

## 5.0 Constructability and Feasibility of Routes

On this latest revision of available grid route options, the topology, the road network and potential watercourse crossing schedules that would be encountered, the latest route assessed ***UGC Route Option 4*** offers a viable option whilst also considering the future plans to facilitate the proposed Tullintowel windfarm and the concept of possibility sharing a connection. A breakdown of the costs associated with this build out is considered in Table 2 above which indicates this option is the most expensive but considering this coordinate a grid connection across two operational windfarm with the grid compatibility substations to adhere to TSO functional specification considered.

This arrangement requires a EirGrid 110kV AIS "C Type" Tail Station with a Single 63 MVA Wind farm Transformer on the site of Lissnagroaragh, a feeder cable heading south to Srananagh node will utilise the majority of secondary roadway and traverse Coillte property in the townland of Tullintowel. This grid route from Lissnagroaragh to Srananagh can be screened out for planning whilst keeping the arrangement around Tullintowel as a separate entity.

Tullintowel WF can be assessed further later once a final layout for the windfarm is confirmed, but an arrangement to connect Tullintowel onto the grid via the Lissnagroaragh to Srananagh UGC could be facilitated by appropriately siting straight through Joint Bays in the vicinity of the Extendable "C Type" Tail station required for Tullintowel windfarm and allowing generation through this infrastructure.

This UGC route is approximately 35 km in length and will encounter nine bridges with HDD with all to be drilled within the road network. The majority of this UGC utilises secondary public roads, sections of regional roads and minimises to use of the N16 to a length of 1km. Water utility infrastructure is located within these secondary roads and a maintained separation between HV ducting to third party services of 300mm will be adhered within EirGrid guidelines. Finally, this option avoids traversing Manorhamilton, Dromahair or any other catchment areas between Srananagh and Lissnagroaragh which offers the grid route as a viable option.

*At this stage of the process the Consultant believes, based on this revision, the preferred route the client should pursue is UGC Route Option 4 (Blue) and carry this option to the next stage.*

## 6.0 Progressing the Grid Connection Selection Process

Based on initial analysis and site surveys there appears to be viable grid connection options available to the 220kV node within Srananagh Substation. The routes selected at this stage are indicative only and a more detailed analysis will need to be completed in order to determine the feasibility of each route proposed.

In order to progress the grid connection selection process, it is recommended that the client identifies the preferred Substation site location for the connection point of the wind farm. Once the preferred substation connection point is known then it will be possible for the grid connection process to be advanced to the next stage. This process will involve the following tasks:

- Confirmation of Preferred UGC/OHL Route Option
- More detailed survey and analysis of the preferred route
- Confirmation of the Lissnagroaragh Windfarm Substation location
- Additional surveying for Alternative Routes (if required)
- Siting of Joint Bays (if required)
- Consultation with both Co. Co authorities to further progress to next stage
- Identification of any 3rd party landowners on cable/line route (where required)
- Confirmation of cable route for final section into ESB Substation
- Design of cable trench required for cable route.
- Full survey of all bridge crossings to facilitate the installation of cable trench.
- Review and analysis of existing services on cable routes