Hynestown to Maynooth: Emerging Best Performing Technology Option Report

EirGrid PLC

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Kildare-Dublin Grid Reinforcement

Notice

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Abbreviation	
A	Amperes
AC	Alternating current
ACSR	Aluminium conductor steel reinforced
AIS	Air-insulated switchgear
ALU	Aluminium
BOCCI	Birds of Conservation Concern in Ireland
BPO	Best Performing Option
CAPEX	Capital expenditure
CENELEC	European Committee for Electrotechnical Standardisation
CU	Copper
EBPO	Emerging Best Performing Option
EMF	Electromagnetic field
ESBN	ESB Networks
EU	European Union
FRA	Flood Risk Assessment
GIS	Gas-insulated switchgear
GPR	Ground penetrating radar
GSI	Geological Survey Ireland
GZTACSR	Gap-type ZT-aluminium conductor steel reinforced
ha	Hectare
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HTLS	High temperature low sag
HV	High voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
KCC	Kildare County Council
kV	Kilovolt
LCIM	Line cable interface mast
m	Metres
MCA	Multi-criteria analysis
MHz	Megahertz
MTTR	Mean time to repair
OHL	Overhead line

Abbreviation	
OPEX	Operating expenditure
pNHA	proposed Natural Heritage Area
PVC	Polyvinyl chloride
RFI	Radio frequency interference
RPS	Record of Protected Structures
SAC	Special Area of Conservation
SDCC	South Dublin County Council
SEM	Single electricity market
SMR	Sites and Monuments Record
SPA	Special Protection Area
TUoS	Transmission use of system
UGC	Underground cable
XLPE	Cross-linked polyethylene

Glossary of Terms	
Capital Project Number	Each project has a Capital Project Number to help coordination between EirGrid and the Transmission Asset Owner (TAO), and for reporting purposes.
Circuit	A line or cable, including associated switchgear, which carries electrical power.
Corridor	A designated study area (often 1 km wide) within which a proposed overheal line or underground cable route is evaluated.
Distribution System Operator (DSO)	In the electrical power business, a distribution system operator is the licensed entity responsible for: ▪ Operating and ensuring the maintenance and development of the distribution system in a given area (and its interconnections), if necessary and where applicable; and ▪ Ensuring the long-term ability of the system to meet reasonable demands for electrical power.
EirGrid	The independent statutory electricity Transmission System Operator in Ireland.
Flood Zone A	High probability of flooding - Where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
Grid	A network of high voltage lines and cables (400 kV, 275 kV, 220 kV and 110 kV) used to transmit bulk electricity supplies around Ireland. The terms grid, electricity transmission network, and transmission system are used interchangeably.
Loop-In Circuits	Loop-In Circuits are circuits used to connect a new substation by connecting or looping into an existing circuit.
Outage	Times when transmission infrastructure (i.e., lines, cables and transformers, etc.) will be out of service for maintenance or capital works.

Glossary of Terms	
Study Area	A geographic boundary defined such that it is appropriate to the scale of the proposed development, thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
Substation Zone	A substation zone is a subset of a sub-study area, and is developed to identify suitable areas for locating potential substation sites.
Substations	Contains the specialist equipment that allows the voltage of electricity to be transformed.
Transmission circuit	An overhead line, underground cable, or combination of both, used for the bulk movement of electrical energy from one node to another node within the electrical grid.
Transmission interface substation	A Transmission Interface Substation is a specific substation that serves as the critical point of connection between a Transmission System Operator (TSO) and a Distribution System Operator (DSO). This substation plays a vital role in managing the transfer of electrical power from the high-voltage transmission grid (operated by EirGrid as its role as the TSO) to the lower-voltage distribution network (operated by ESB as its role as the DSO). A Transmission Interface Substation is responsible for stepping down the voltage from transmission levels to distribution levels.
Transmission substation	A Transmission Substation is a substation within the high-voltage transmission network where electrical power is transformed, switched, and routed. It typically steps up or steps down voltage levels to facilitate efficient power transmission over long distances. Transmission substations are integral to the operation of the transmission grid, helping to control and protect the network, manage power flows, and ensure the reliable delivery of electricity across regions where it is needed.
Transmission System Operator (TSO)	In the electrical power business, a transmission system operator is the licensed entity responsible for the management of the flow of power on the electricity grid, moving high-voltage electricity around the country, from where it is produced to where it is used, supplying large energy users and the distribution network that powers homes and businesses.

1. Introduction

1.1 Who is EirGrid?

EirGrid PLC (hereafter referred to as EirGrid) operates and develops and enhances the electricity transmission system and the wholesale electricity market in Ireland and, more recently, has been mandated to operate, develop and own Ireland's offshore transmission grid. EirGrid also develops and operate interconnections with neighbouring grids and enables third-party interconnectors. EirGrid sends power from where it is generated to where it is needed.

EirGrid uses the grid to supply power to industry and businesses that use large amounts of electricity. The grid also powers the distribution network. This supplies the electricity used every day in homes, businesses, schools, hospitals, and farms.

1.2 What is the Kildare-Dublin Grid Reinforcement (Capital Project 1226)?

The current electricity network in the east of Ireland does not have the required capacity to accommodate anticipated future electrical generation and maintain compliance with the Transmission System Security and Planning Standards (TSSPS). New infrastructure is also needed to accommodate the continued growth in electricity demand in the East Kildare and South West Dublin area, which is being driven by several sectors including:

- The transfer of power in the East Kildare and South West Dublin area is encountering capacity problems on the existing 220 kV circuits during various generation and demand scenarios. This includes scenarios when the network is intact and in the case of the unplanned loss of a single circuit or piece of transmission equipment.
- The transmission system in the area needs additional capacity to facilitate the integration of renewable energy generation both from onshore and offshore, integration of new interconnectors and connection demand in counties Dublin, Meath, and Kildare. This need was identified in Shaping Our Electricity Future roadmap published in 2021.
- Additionally, new interface points or Bulk Supply Points (BSPs) that connect the Transmission System and Distribution System are needed to supply the projected demand growth in this area, including increasing demand related to new residential housing, commercial loads, as well as electrification of the heat and transport sectors with the latter as a result of the Governments Climate Action Plan 2021.

The Kildare-Dublin Grid Reinforcement (CP1226) is the Capital Project identified under the Infrastructure Agreement to address these significant additional capacity needs in East Kildare and South West Dublin while also contributing to the Government's Climate Action Plan target of 80% of electricity supplied from renewable sources. As such, it is a part of EirGrid's statutory objective to plan and develop the grid infrastructure needed to support Ireland's economy in accordance with Regulation 8(6) of SI No 445/2000 - European Communities (Internal Market in Electricity) Regulations, 2000 (SI 445/2000).

The specific new substations and circuits requirements, identified for delivery through the Kildare-Dublin Grid Reinforcement programme of works, include:

- New Hynestown 220/110 kV transmission interface substation, situated near West County Dublin;
- New Steelstown 220/110 kV transmission interface substation, situated near the South Dublin / East Kildare boundary, with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit;
- New transmission circuit between the proposed Hynestown Substation and the existing Maynooth 220 kV Substation;
- New transmission circuit between the proposed Hynestown Substation and the proposed Steelstown Substation;
- New transmission circuit between the proposed Hynestown Substation and either the existing Castlebagot 220 kV Substation or the existing Inchicore 220 kV Substation; and
- New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation.

The Kildare-Dublin Grid Reinforcement contains several individual and autonomous projects, which can each be considered standalone projects in their own right and which can be progressed through separate planning consents (albeit together they will meet the objective of the Capital Project identified in the Transmission Development Plan).

In the interests of future-proofing, all new substations and circuits are now to be designed for 400 kV (but to be operated at 220 kV initially, where relevant).

There are four projects currently identified to deliver the new substations and circuits requirements, identified by the Kildare-Dublin Grid Reinforcement. This reflects a snapshot in time, and should be viewed as a flexible, evolving tool that will require adaptation and refinement as those projects develop and new information emerges. EirGrid has determined that this approach is correct, appropriate and the most efficient way to deliver this programme of work at this time.

1. New transmission interface substation, situated near West Dublin ('Hynestown Substation', abbreviated as HTN) and new transmission circuit connecting to the existing Maynooth 220 kV Substation ('Hynestown-Maynooth Circuit', abbreviated as HTN-MAY).
2. New transmission interface substation, situated near South Dublin / East Kildare boundary ('Steelstown Substation', abbreviated as SLN) with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit; and a new transmission circuit to the proposed Hynestown Substation ('Hynestown-Steelstown Circuit', abbreviated as HTN-SLN).
3. New transmission circuit between the proposed Hynestown Substation and the existing Castlebagot or Inchicore substation ('Hynestown-Castlebagot Circuit' or 'Hynestown-Inchicore Circuit', abbreviated as HTN-CBT or HTN-INC, respectively).
4. New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation ('Steelstown-Carrickmines Circuit', abbreviated as SLN-CKM).

1.3 New Transmission Interface Substation Connecting to the Existing Maynooth 220 kV Substation

The new Hynestown Substation and new transmission circuit connecting to the existing Maynooth 220 kV Substation (i.e., the Hynestown-Maynooth Circuit) is a key project under Kildare-Dublin Grid Reinforcement. It comprises a transmission interface substation which enables higher voltage levels (in this case 220 kV) to step down to 110 kV which in turn is stepped down to 38 kV (and below) at substations on the distribution system. In connecting to the existing 220 kV network (via the existing Maynooth 220 kV Substation), the proposed development will become a critical node on the transmission network; and a point of connection for future transmission and distribution circuits.

1.4 Purpose of this Report

This Emerging Best Performing Technology Option Report provides an update on the progress of the new Hynestown Substation and new Hynestown-Maynooth Circuit. The report documents the decision for the substation technology and identifies the emerging best performing option for the circuit technology.

Feasibility work on other individual elements / projects forming part of the Kildare-Dublin Grid Reinforcement is ongoing.

2. Project Progression Through Step 3

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2. Whilst there are similarities between the process that is followed for a substation and a circuit, they are best represented individually.

2.1 Hynestown Substation

2.1.1 Overview

Figure 2-1 outlines the process that was followed in Step 3 for the identification of the search area and emerging best performing technology for the Hynestown Substation – items no.1 through to no. 8 were carried out and documented in the previous Step 3 Report (which presented the substation technologies and zones; document ref. 0088248DG0098). A high-level summary for those items is outlined below with further detail on items no. 9 to no. 12 discussed in this section.

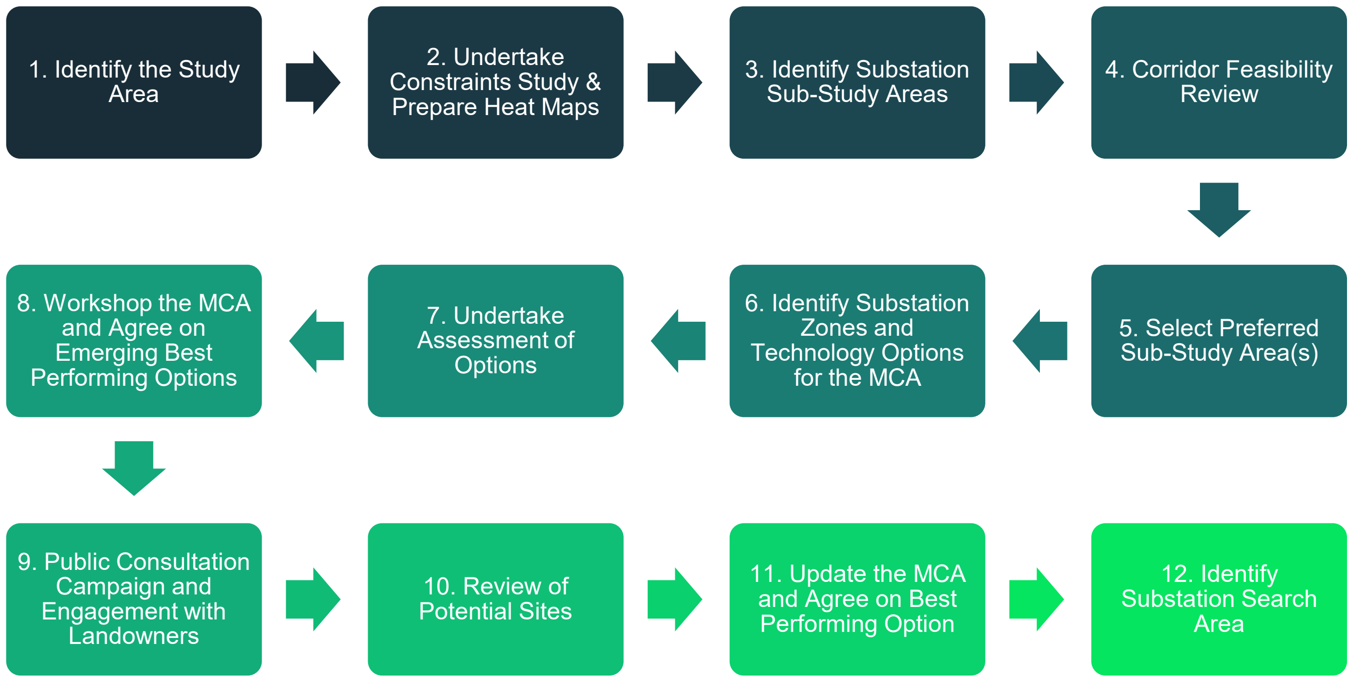

Figure 2-1 - Process Followed for Hynestown Substation in Step 3

1. **Identify the Study Area:** The Study Area was defined such that it is appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
2. **Undertake Constraints Study and Prepare Heat Maps:** Once the Study Area was defined, a constraints assessment was carried out. The identified constraints were then assigned a risk, and heat maps generated to graphically represent the constraints. The heat maps were used as a 'guide' to determine locations where the proposed infrastructure could be best positioned (when considering the constraints).
3. **Identify Substation Sub-Study Areas:** Given the greenfield nature of the Study Area, a phased approach to identify feasible sub-study areas for the location for the proposed substations was considered the most applicable. A wider net was cast to identify large sub-study areas where the substations could be positioned. Key technical, economic and deliverability guiding principles, together with the environmental and socio-economic constraints

identified in the heat maps, were used to identify five (5no.) sub-study areas for the proposed Hynestown Substation. These ranged in size from ± 345 ha to ± 515 ha.

4. **Corridor Feasibility Review:** A feasibility review for both OHL and UGC technologies was undertaken for the proposed Hynestown-Maynooth circuit to ensure that a route can be found between Maynooth and the sub-study areas for the proposed Hynestown Substation.
5. **Select Preferred Sub-Study Area(s):** Based on the initial high-level assessment carried out, four (4no.) of the five (5no.) sub-study areas for the proposed Hynestown Substation were selected for further assessment. The key guiding principles that informed this decision were the availability of suitable land and the connectivity to key existing electrical infrastructure.
6. **Identify Substation Zones and Technology Options for the Multi-Criteria Analysis (MCA):** Although the preferred sub-study areas had been identified, these areas were considerably larger than the actual size of land required for the proposed substation. The project team decided that substation zones (within the preferred sub-study areas) would be identified to allow a more detailed assessment to be undertaken. A total of three (3no.) substation zones were identified for the proposed Hynestown Substation, ranging in size from 150 ha to 345 ha. The range in size of the substation zones provided flexibility for the identification of multiple substation sites which are suitable to accommodate the land take required for either substation technology option under consideration (i.e., Gas-Insulated Switchgear (GIS) and Air-Insulated Switchgear (AIS)).
7. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of both technologies (i.e., Air Insulated Switchgear and Gas Insulated Switchgear) was undertaken for each substation zone. The sub-criteria were scored from low to high risk and the overall performance for each option determined.
8. **Workshop the Multi-Criteria Analysis (MCA) and Agree the Emerging Best Performing Option(s):** The EirGrid Cross-Functional Team and the AtkinsRéalis team conducted an MCA workshop where the options were presented and the MCA scoring of each of the options discussed. The MCA workshop concluded with a decision on the Best Performing Options to proceed with to the Step 3 Public Consultation for the Hynestown Substation.
9. **Public Consultation Campaign and Engagement with Landowners:** A public consultation campaign was carried out to seek feedback from the public. During the consultation campaign and afterwards, EirGrid engaged with landowners within the substation zones.
10. **Review of Potential Sites:** Potential sites were identified through the landowner engagement process. These were then reviewed to identify a shortlist of potential substation sites to be brought forward for more detailed assessment in Step 4.
11. **Update the MCA and Agree on Best Performing Option:** Following the review of the potential sites and review of feedback from the public consultation campaign, the MCA was updated and a Best Performing Technology Option for the substation was chosen.
12. **Identify Substation Search Area:** The search area for where the substation will likely be located was then defined based on the shortlisted sites.

2.1.2 Step 3 Substation Zones and Technology Public Consultation

In 2025, a multi-criteria analysis (MCA) was carried out on substation ‘zones’ (an area developed to identify suitable areas for locating potential substation sites). A total of three (3no.) substation zones were identified for the proposed Hynestown Substation, ranging in size from 150 ha to 345 ha. The range in size of the substation zones provided flexibility for the identification of multiple substation sites which would be suitable to accommodate the land take required for either substation technology option under consideration (i.e., gas-insulated switchgear (GIS) and air-insulated switchgear (AIS)).

The results of the MCA were documented in the Step 3 Report and across May and June 2025, EirGrid carried out a Step 3 public consultation campaign for the Kildare-Dublin Grid Reinforcement. The consultation sought feedback from the public regarding the substation zones and technologies for the proposed Hynestown Substation.

2.1.3 Review of Potential Sites

Following the Step 3 public consultation process, EirGrid's Land Management team engaged with landowners within the substation zones to identify landowners who were willing to explore the possibility of selling a portion of their land to facilitate the proposed Hynestown substation development .

Several sites were identified and were subjected to a high-level MCA assessment, which sought to identify any significant risks to the proposed development, either on the sites themselves, or in the nearby vicinity of the sites. Upon completion of the review and site walkover surveys, sites were shortlisted to advance to Step 4. These sites will undergo further detailed assessment in Step 4 in order to identify the emerging best performing site.

2.1.4 Selection of Best Performing Technology Option for the Hynestown Substation

Following the identification of the shortlisted sites, the previous MCA was updated to reflect site-specific risks that may impact on the selection of a preferred substation technology. Table 2-1 shows the overall performance of the AIS and GIS technologies for the proposed Hynestown Substation. The following lists a summary of the key outcomes from the MCA:

- **Technical:** AIS performs better than GIS (Moderate-Low vs. Moderate); AIS substations are typically easier to expand and carry a lower technology operational risk.
- **Economic:** Both technologies perform similar (Moderate-Low); although GIS substations are more expensive to construct, they do have lower project life-cycle costs (when compared to AIS substations). Land costs are generally more for AIS substations due to their larger size footprint.
- **Deliverability:** AIS performs worse than GIS (Moderate-High vs. Moderate); this is largely driven by land availability i.e., the spatial requirement for an AIS is considerably larger than for a GIS.
- **Environment:** AIS performs worse than GIS (Moderate vs. Moderate-Low); given the larger footprint of AIS (4.5 times larger than GIS), the impacts on the environment for most of the criteria would be considered worse for AIS than for GIS.
- **Socio-Economic:** AIS performs worse than GIS (Moderate vs. Moderate-Low); although for a substation the impact on traffic and transport, and recreation and tourism, may not be impacted by the technology, the same cannot be said for the impact on settlements and communities, nor amenity. As per the Step 3 Engagement and Consultation Report (M-CO, July 2025), the preference from the public is for GIS.

Based on the above MCA assessment, it was decided that the Best Performing Technology Option for the Hynestown Substation is GIS.

Table 2-1 - Hynestown Substation Step 3 Substation Technology MCA Results

Criteria	AIS	GIS
Technical		
Economic		
Deliverability		
Environment		
Socio-Economic		
OVERALL		

Table 2-2 - Criteria Scoring Scale

More significant / difficult / risk — Less significant /difficult / risk

High Risk (Dark Blue)	Moderate-High (Blue)	Moderate (Dark Green)	Moderate-Low (Green)	Low (Cream)

2.1.5 Substation Search Area

The area encompassing the shortlisted sites has been used to define the Hynestown Substation search area, as shown in Figure 2-2.

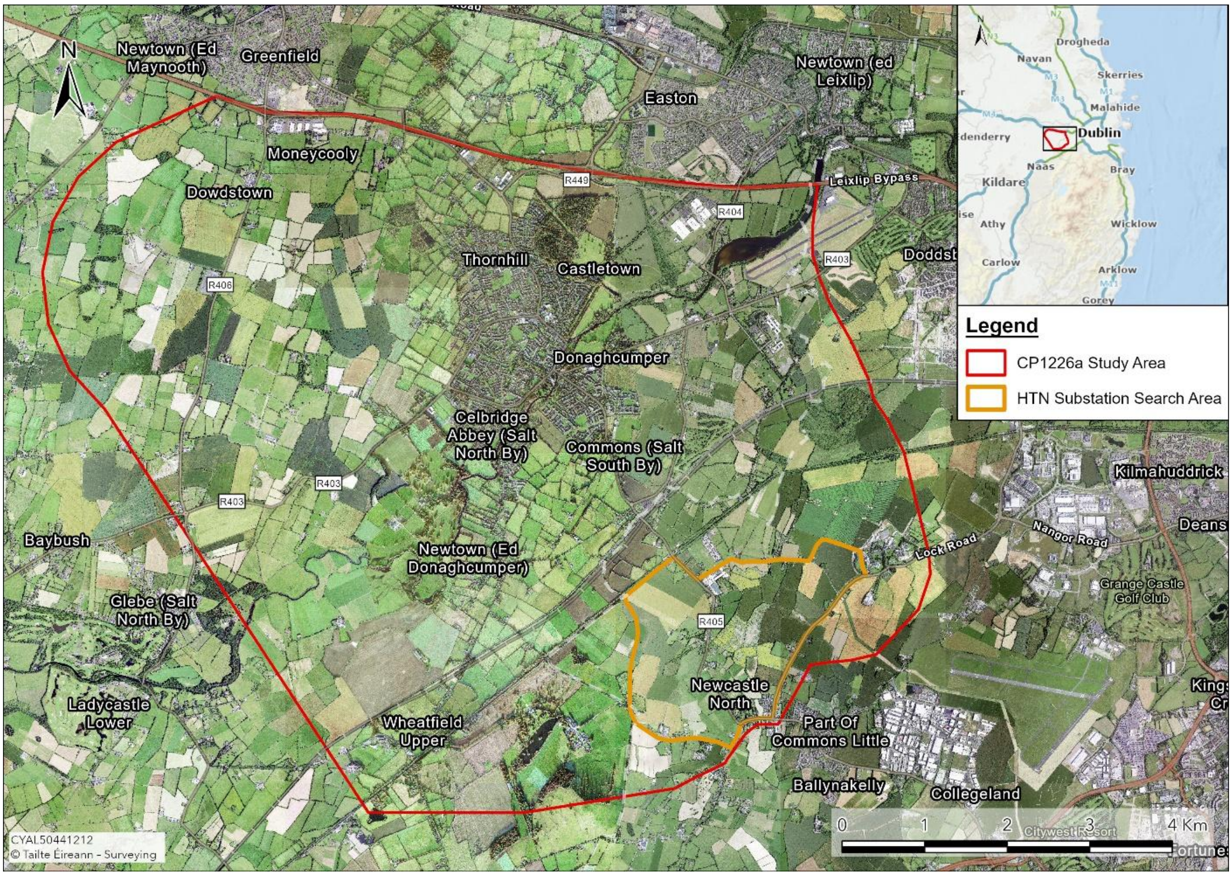

Figure 2-2 - Hynestown Substation Search Area

2.2 Hynestown-Maynooth Circuit

2.2.1 Overview

Figure 2-3 shows the process that was followed in Step 3 for the identification of the search area and emerging best performing technology for the Hynestown-Maynooth circuit. A high-level summary is outlined below with further detail discussed in this section.

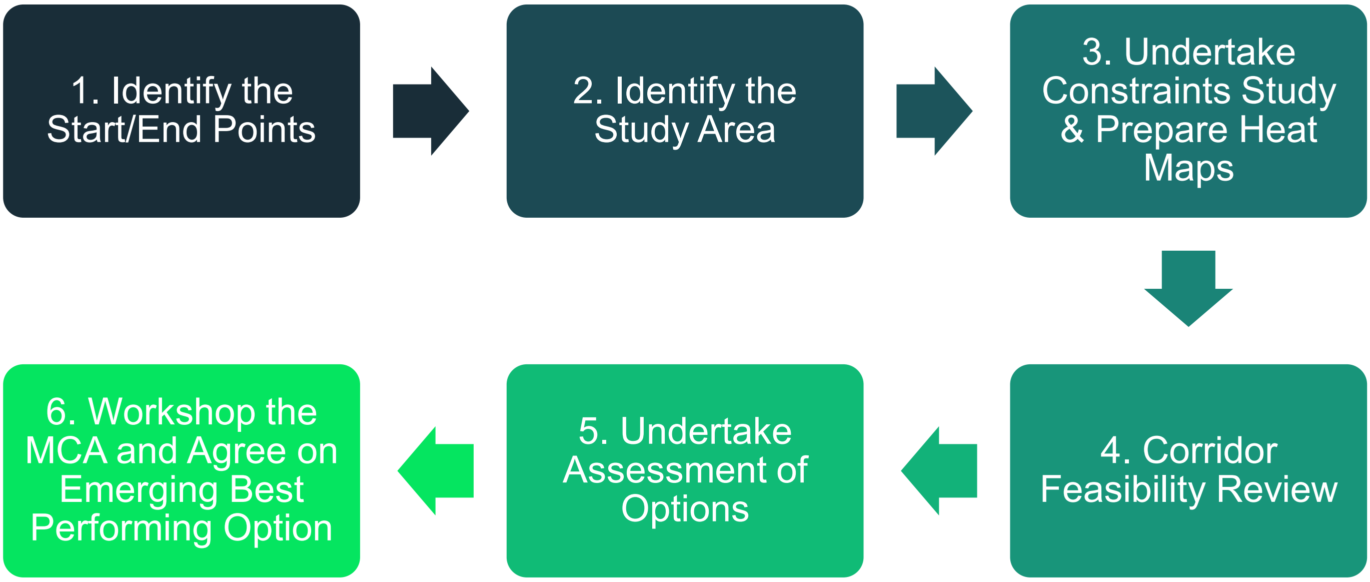

Figure 2-3 - Process Followed for Hynestown-Maynooth Circuit in Step 3

1. **Identify the Start/End Points:** The circuit will connect into substations on either end of the circuit. The proposed Hynestown Substation does not yet have a site selected, and therefore the Hynestown Substation search area was considered as the 'start' of the circuit. The Maynooth Substation is an existing substation, and therefore that point is fixed and considered the end of the circuit.
2. **Identify the Study Area:** The Study Area was defined such that it is appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
3. **Undertake Constraints Study and Prepare Heat Maps:** Once the Study Area was defined, a constraints assessment was carried out. The identified constraints were then assigned a risk, and heat maps generated to graphically represent the constraints. The heat maps were used as a 'guide' to determine locations where the proposed infrastructure could be best positioned (when considering the constraints).
4. **Corridor Feasibility Review:** A feasibility review for both OHL and UGC technologies was undertaken for the proposed Hynestown-Maynooth circuit. This feasibility review considered indicative corridors for both technologies and assessed constraints along each indicative corridor.
5. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of both technologies (i.e., OHL and UGC) was undertaken for the Study Area. The sub-criteria were scored from low to high risk and the overall performance for each option determined.
6. **Workshop the Multi-Criteria Analysis (MCA) and Agree the Emerging Best Performing Option(s):** The EirGrid Cross-Functional Team and the AtkinsRéalis team conducted a MCA workshop where the technology options were presented and the MCA scoring of each of the technology options discussed. The MCA workshop

concluded with a decision on the Emerging Best Performing Technology Option to proceed with for the Step 3 Public Information Campaign for the Hynestown-Maynooth circuit.

2.2.2 Study Area

The Study Area was defined such that it was appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area. The Study Area is presented in Figure 2-4. The Study Area bisects Kildare County Council and South Dublin County Council administrative regions.

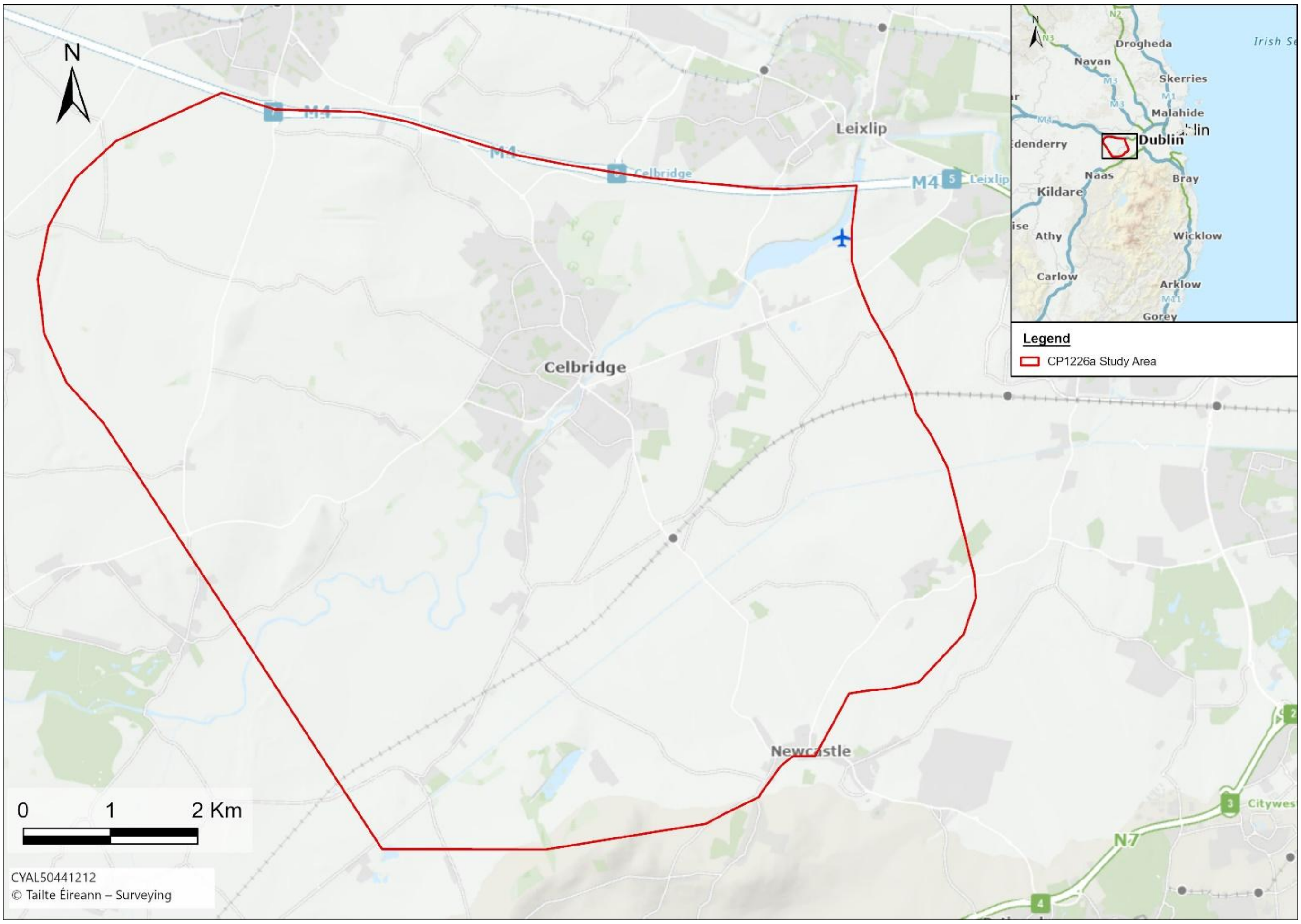

Figure 2-4 - Study Area

The identification of the Study Area was based primarily on a high-level assessment of the factors that present a significant constraint to the development of feasible solutions.

A desktop study, which was supplemented by site visits and windshield surveys, identified some key factors which influenced the identification of the Study Area from a technical development aspect:

- The location of the existing Maynooth 220 kV Substation;
- The potential locations for the proposed Hynestown Substation (i.e., the substation zones identified in the Step 3 Report; document ref. 0088248DG0098);
- The existing 220 kV network routes for:

- Castlebagot-Inchicore 220 kV double circuit OHL/UGC; and
- Castlebagot-Maynooth 220 kV double circuit OHL/UGC.
- The motorway network e.g., M4;
- The rail network e.g., Dublin-Cork railway line;
- Weston Airport (Civil);
- Significant towns and settlements such as Celbridge and Newcastle;
- Consideration of OHL route options with the shortest and straightest possible routes; and
- Consideration of UGC route options including the use of public roads and potential off-road sections.

The Study Area (see Figure 2-4) is situated within the boundaries of South Dublin County Council and Kildare County Council. The area to the north of the M4 Motorway / N4 National Road and the densely populated areas of Maynooth and Leixlip have not been included in the Study Area. To the southwest, the village of Straffan is situated just outside the Study Area boundary. The Study Area extends 2 km to the west of the existing Maynooth 220 kV Substation to allow for multiple approach options to the substation for the proposed Hynestown-Maynooth circuit. The eastern boundary of the Study Area encompasses the potential locations for the proposed Hynestown Substation, with Grange Castle Business Park, Baldonnel Airport, Greenoge Business Park and portions of Newcastle town situated east of the Study Area.

2.2.3 Constraints Study and Heat Mapping

Once the Study Area had been defined, a constraints assessment was carried out. The following topics were included within the constraints assessment of the Study Area:

- Biodiversity, Flora and Fauna;
- Aquatic Environment;
- Land, Soils and Geology;
- Groundwater
- Land Use and Planning Policy;
- Landscape and Visual;
- Cultural Heritage;
- Noise and Vibration;
- Climate;
- Amenity;
- Settlements and Communities;
- Recreation and Tourism; and
- Traffic and Transport.

With the constraints identified, it was necessary to present the information in a manner that would inform the assessment of the circuit technologies. This was done by developing a series of illustrative heat maps which presented the aggregated individual constraints (and their associated risks) into areas of low to high risk. Maps were created for OHL risk and UGC risk as shown in Figure 2-5 and Figure 2-6, respectively.

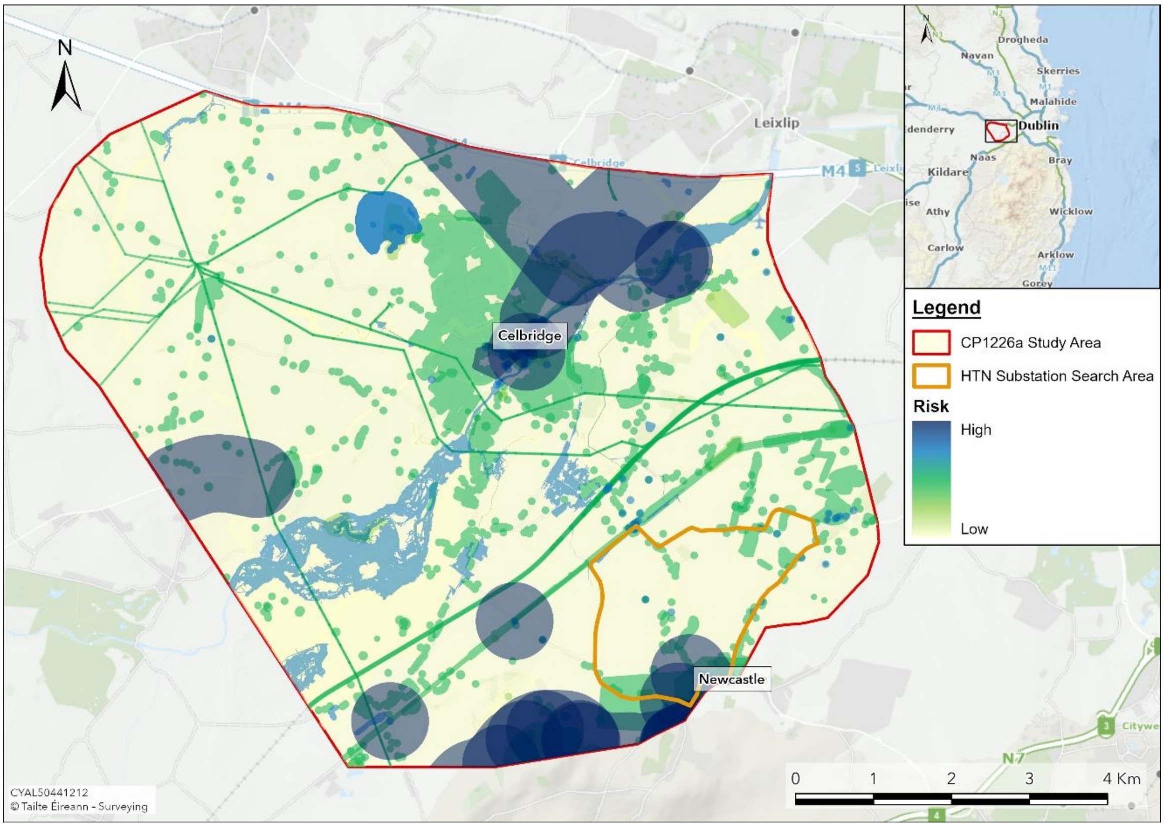

Figure 2-5 - OHL Heat Map

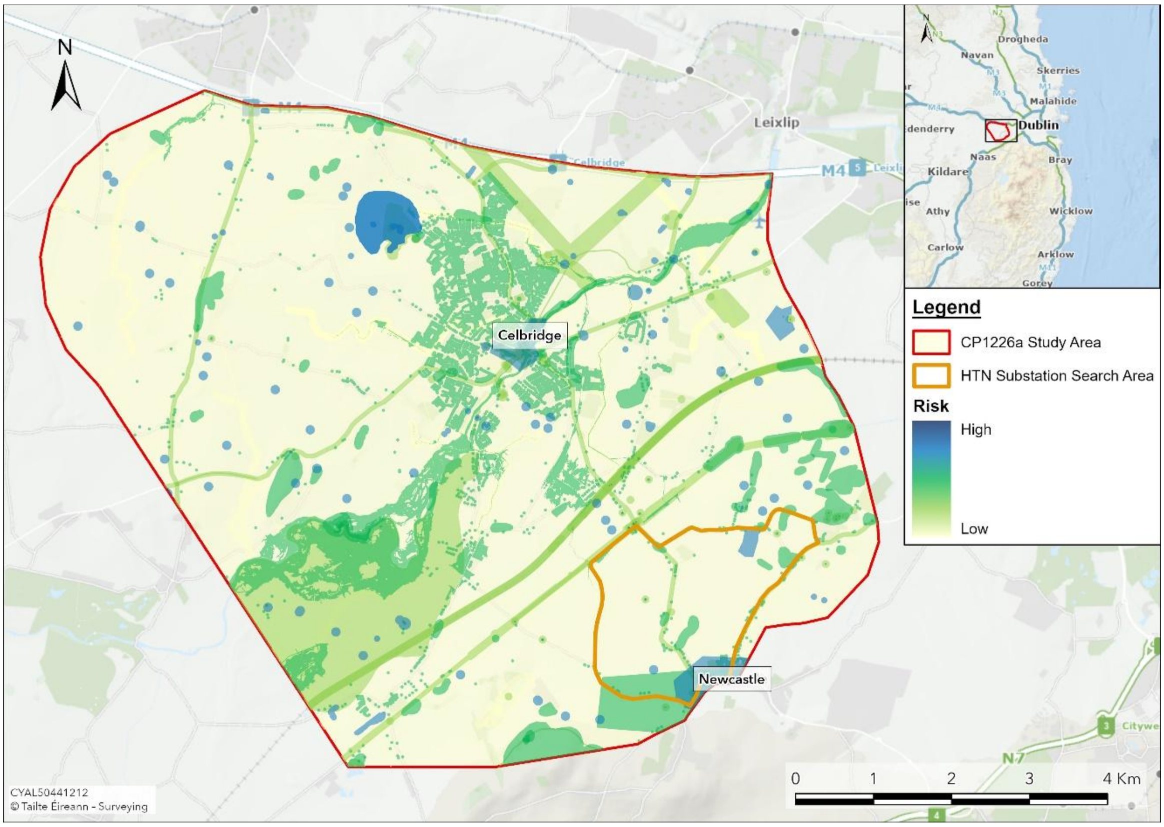

Figure 2-6 - UGC Heat Map

2.2.4 Corridor Feasibility Review

A feasibility review for both OHL and UGC technologies was undertaken for indicative circuit corridors to ensure that a route can be found between the substation search area for the proposed Hynestown Substation and the existing Maynooth Substation.

The review considered the heat maps produced as part of the constraints assessment and considered the viability of both OHL and UGC corridor options between the proposed and existing substations.

2.2.5 Description of Circuit Technologies

Two main technology options are available for developing the required circuit, namely overhead lines (OHL) or underground cables (UGC).

2.2.5.1 HV AC Overhead Lines (OHL) Technology

- Overhead lines strung on steel lattice towers have been used traditionally in Ireland for high voltage alternating current (HV AC) electrical transmission including 400 kV. A steel lattice tower with one or more conductors per phase, supported on insulator strings to insulate the live conductors from the earthed tower, is commonly used. Figure 2-7 shows a standard hot rolled lattice steel tower that contains bracing. For this circuit application:
  - A typical 400 kV single circuit intermediate tower is 26.3-54.3 m high and the maximum width at ground level is 14.4 m.
  - A typical 400 kV single circuit angle/strain tower is 28.0-37.0 m high and the maximum width at ground level is 12.0 m.
- When routeing OHLs, EirGrid will seek to maximise the distance of OHLs from buildings and dwellings, and for the purpose of general amenity will seek a minimum separation distance of 50 m wherever possible.
- OHLs will be routed to minimise impacts on all constraints. However, it is not possible to avoid all constraints, and in some circumstances, OHLs will need to be routed through forestry or through developed areas. In these circumstances an easement will be required. The typical easement widths (i.e., corridors) for 400 kV OHLs are:
  - Forestry:
    - 400 kV OHLs – 74 m easement corridor (i.e., 37 m either side of the line);
    - Within these corridors trees are allowed grow to a maximum height of 3 m. However, a 4 m maintenance access corridor directly under the line must be left clear at all times to allow access.
  - Buildings:
    - 400 kV Lines – 60 m easement corridor (i.e., 30 m either side of the line).
- Lattice towers can be maintained via climbing which means maintenance of access routes is not as vital because access can be achieved using 4x4 vehicles or quad bikes.

Figure 2-7 - Typical 220 kV OHL Single and Double Circuit Lattice Towers

- An alternative to lattice towers are steel monopole pylons (Figure 2-8). They offer a different aesthetic and spatial profile compared to traditional lattice towers. Steel monopoles are typically made from several steel sections either compressed or bolt flanged together. The construction can involve fabricating the monopole in sections and assembling them on site or in some cases as a single piece depending on transportation constraints. Often used in areas with limited space such as urban areas, the single pole structure requires a smaller footprint compared to lattice towers, although a large below ground foundation is needed and the easement width remains the same. To date, steel monopoles have only been used in Ireland up to 110 kV.

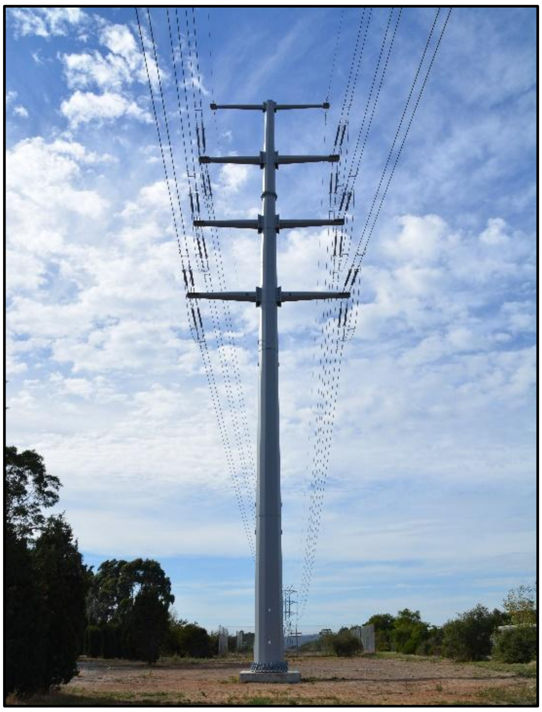

Figure 2-8 - Examples of HV Circuit Steel Monopole Towers (110 kV single circuit and 220 kV double circuit)

2.2.5.2 HV AC Underground Cables (UGC) Technology

- Modern HV AC cables are made of either copper or aluminium conductor, sized for high current capacity. Cross-linked polyethylene (XLPE) insulating material is extruded around the conductor for its excellent thermal and electrical insulating properties.
- XLPE cables require little maintenance. The cables are installed (i.e., pulled) through HDPE ducting buried in trenches, with the ducts buried to a certain depth in set configurations and spacings from each other as per EirGrid specifications.
- Similar to other utility services, UGCs are typically routed along public roads for ease of construction and access for future maintenance and inspection activities. However, sometime the UGC may have to be routed off-road in order to avoid / bypass particular constraints or pinch-points, site joint bays / passing bays, etc.
- Joint bays (8-10 m x 2.5 m x 2 m) are required to join sections of cable and will be located at intervals of approximately 600-800 m along the route. This is because the cable is supplied in fixed lengths dictated by the cable drum diameter, the diameter of the cable itself, and the maximum weight that can be transported. The joint bays will be located entirely underground and will be completely backfilled/reinstated. Each joint bay has a link box chamber and C2 chamber (for communication ducts running parallel to the power ducts) which are ancillary inspection chambers adjacent to the joint bay. These chamber covers will be visible at ground level after reinstatement. Access to these chambers is required for maintenance activities and access to the joint bays is only required in the event of cables repairs / fault correction / cable replacement.

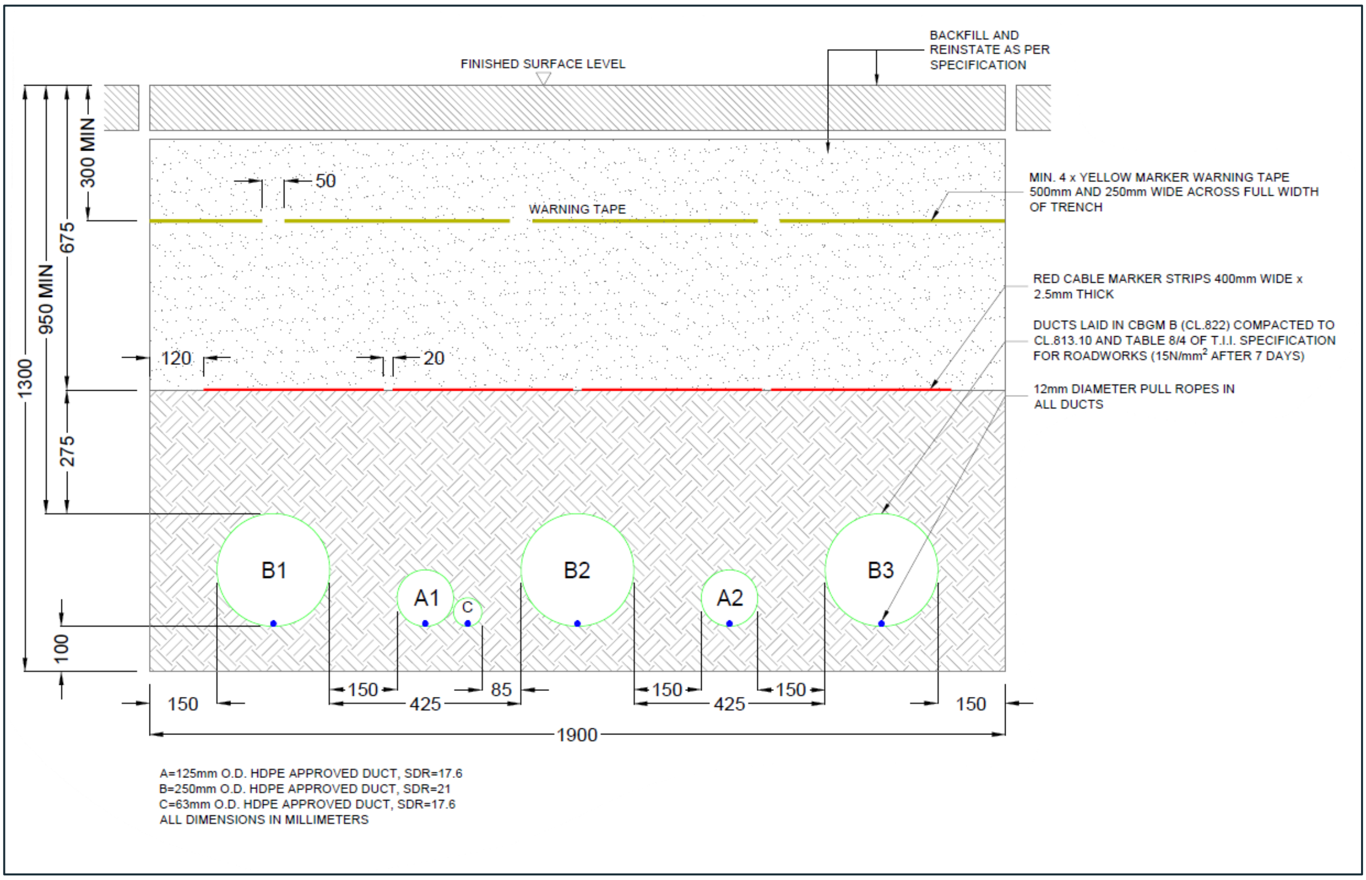

Figure 2-9 - 400 kV Standard Flat Wide Arrangement with ECC (Extract from drawing XDC-CBL-SLND-E-008)

- During construction, a temporary works area (approximately 25 m by 5 m) will be needed either side of the joint bay to allow for excavation equipment, cable pulling and cable joining works. This will be a key requirement for the selection of joint bay locations. The location of all joint bays will be required to be proven by site investigation, including ground proving.
- Where the joint bay position / construction area is significantly impeding or stopping traffic flow (i.e. on a narrow, busy country lane), a localised traffic management plan may have to be put in place and if required, a passing bay (temporary road surface) constructed to widen the existing road such than normal traffic can pass (+3.5 m).

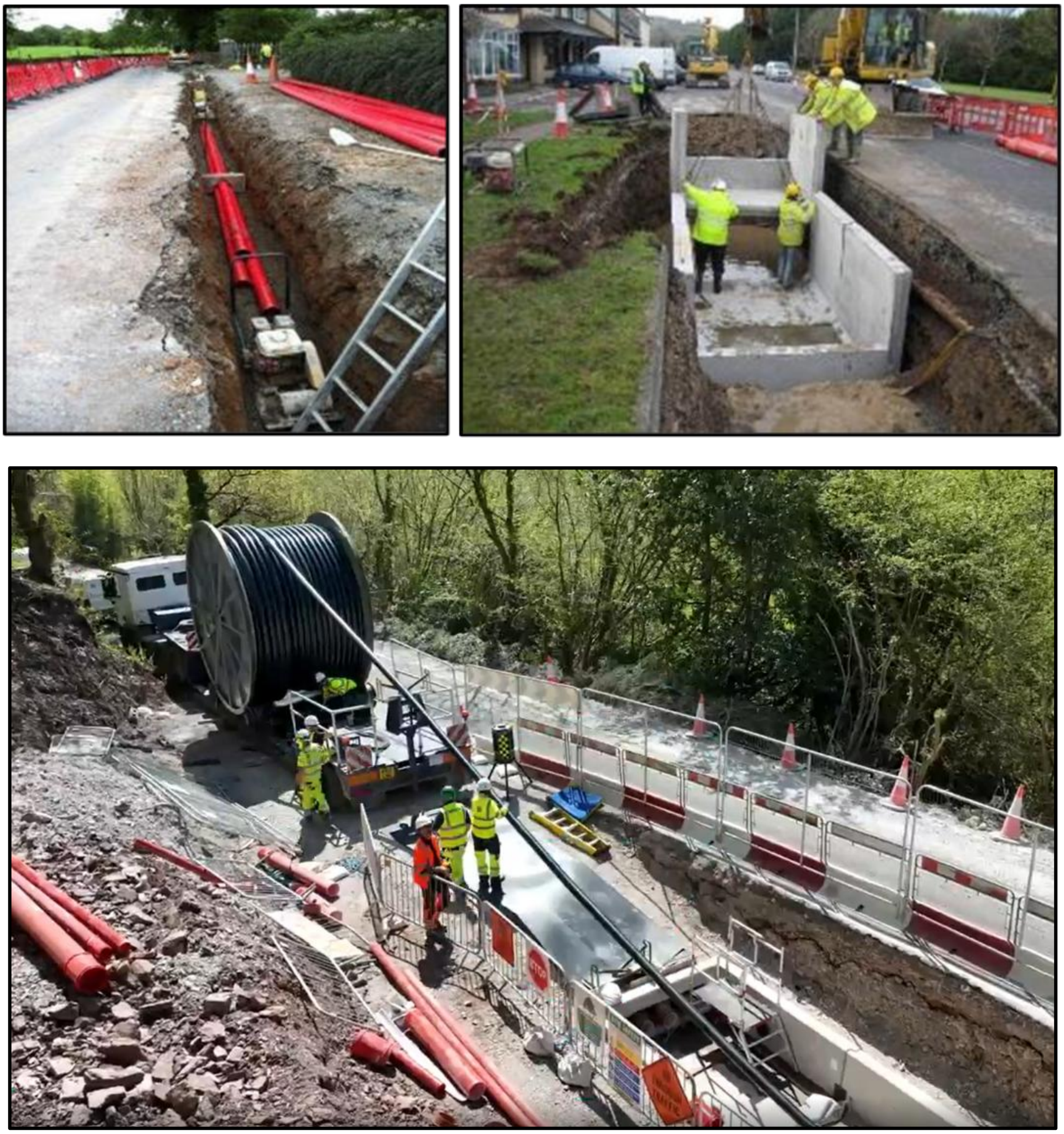

Figure 2-10 - Typical HV UGC laid in ducts / Joint Bay under construction (pre-cast) / Cable pulling (Celtic Interconnector Project)

- At highly constrained locations such as watercourse, motorway, rail crossings, etc., special installation techniques such as horizontal directional drilling (HDD) may be used to install the cable ducts at a sufficient depth to pass under the obstacle. Detailed site investigation works (i.e., boreholes) would be required at each HDD location to confirm ground conditions for detailed design stage.

Figure 2-11 - HDD rig drilling a pilot hole for HV UGCs

- Minimum wayleave widths required for 400 kV UGC is 5 m (centred on centre phase).
- UGCs would have difficulty achieving the same transmission capacity as OHL conductors as burying the cables underground will impact the capacity of a cable due to thermal affects (i.e., heating). Rating studies are carried out to determine the capacity of a circuit, as certain constraints will impact on a cable's performance, e.g., bridge crossings, HDDs, etc.
- An alternative to UGC trenching in highly constrained urban environments, where direct bury installation would cause unacceptable disruption, is deep / micro-bore tunnelling. The method of excavation and tunnel design is largely dependent on the size of the tunnel required and the type of ground in which it is to be bored. The depth of a tunnel is typically around 25-30 m, with a tunnel diameter of 3-4 m required to provide sufficient room for up to 12no. cable cores and joint bays. Tunnel construction requires a significant amount of land at either end for constructing the large diameter (8-12 m) vertical launch shafts. In addition, tunnels of significant length require inspection and emergency access/egress points along the route to ensure escape from the tunnel within safe limits. Tunnels have not yet been used in Ireland for any HV grid connection projects but are being considered for projects in the Dublin urban area. Development costs associated with microbore tunnelling solutions can be expected to be much greater than conventional open trench methods.

Figure 2-12 - Deep Bore HV Cable Tunnel and Vertical Access Shaft

2.2.6 Circuit Technology MCA Process

To assist in identifying the best performing technology option and associated study area, a Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical Performance,
- Economic Performance,
- Deliverability Aspects,
- Environmental Aspects, and
- Socio-Economic Aspects.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to identify the best performing option(s) that will be brought forward to Step 4.

2.2.6.1 Technical Performance

The following sub-criteria were scored:

- **Availability Levels:** The predicted availability level rates for the overhead line or underground cable can be calculated using, for example, recorded industry failure rates, average Mean Time To Repair (MTTR) and the length of the line or cable.
- **Circuit Ratings / Headroom:** This is an estimate of the Circuit Rating (Amps) achievable and whether it fulfils the project rating requirements (as set out in EirGrid's Cable Calculation documentation). It will consider possible circuit constraints which may limit the maximum circuit rating. Headroom is the amount of additional capacity that is available for the future without upgrades.
- **Expansion / Extendibility:** This considers the ease with which the option can be expanded.
- **Repeatability:** 'Repeatability' means whether the option can be readily repeated in the EirGrid network.
- **Technology Operational Risk:** 'Technology Operational Risk' aims to capture the risk of operating different technologies on the network.
- **Geotechnical Conditions:** Considers the impact of known ground conditions (from GSI data or other available datasets), and would include depth to bedrock, likely water table depth, known areas of poor ground / marsh etc.
- **Electromagnetic Compatibility:** Impact on wireless services such as radars, radio communications, TV, flight paths, etc.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Compliance with Safety Standards:** The project should comply with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). Materials should comply with IEC or CENELEC standards.
- **Compliance with System Reliability, Security Standards:** The project should comply with the reliability and security standard defined in the Transmission System Security and Planning Standards and the Operation Security Standards.

2.2.6.2 Economic Assessment

The following sub-criteria were scored:

- **Project Implementation Costs:** Costs associated with the procurement, installation and commissioning of the grid development (including land cost) and therefore includes all the transmission equipment that forms part of the project's scope.
- **Project Life-Cycle Costs:** Costs incurred over the useful life of the reinforcement and include the on-going cost of ensuring that it remains viable for the evaluation period. Includes operating expenditure (OPEX), maintenance, replacement, cost of losses, decommissioning, etc.
- **Cost to SEM:** Cost to Single Energy Market from Development Unavailability (Reliability) i.e., the loss of energy due to unavailability, impact on the Grid, as well as other costs or transmission losses.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Project Benefits:** Avoided costs and difference in constraint costs for example due to the lack of capacity to export a forecast volume of generation.
- **Pre-Engineering Costs:** Costs associated with the design and specification, route evaluation and management of the statutory planning application, including contingencies for such activities.

2.2.6.3 Deliverability Aspects

The following sub-criteria were scored:

- **Implementation Timelines:** Relative length of time until energisation (assess significant differences).
- **Permits & Wayleaves:** Various permissions and wayleaves required to proceed to construction (e.g., number or level).
- **Land Availability:** Considers land availability for the construction of the circuit, in addition to working space during construction.
- **Ease of Construction:** Considers elements such as working time constraints, outage impact, utility congestion, etc. and how that may impact the Contractor during construction.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Dependence on other Projects:** Does the project depend on the completion of other projects?
- **Risk of Untried Technologies:** Has the technology been used by EirGrid and ESBN in the past?
- **Supply Chain Constraints:** Any constraints (e.g., small number of suppliers in Ireland or internationally) that would affect the procurement of materials or services (e.g., cable laying vessels waiting list lead time) to complete the project.
- **Planning and other statutory requirements:** Considers the requirement for planning, foreshore licenses or other statutory requirements.

2.2.6.4 Environmental Aspects

The following sub-criteria were scored:

- **Biodiversity, Flora & Fauna:** Assessment of the impact on biodiversity, flora and fauna, which could include an ecological desktop study. The following topics were assessed as part of this sub-criterion:
  - Impacts on protected areas: National and European sites (e.g. SAC, SPAs, RAMSAR), National sites (e.g. NHAs) and other Natural Heritage Sites and Conservation Interest Sites e.g. refuge for fauna or flora, wildfowl reserves).
  - Impacts on sensitive bird species and/or their habitats and impacts on protected species (e.g., Annex II, IV and V of the EU Habitats Directive) and Flora Protection Order and species outside of Natura 2000 sites.
  - Impacts on Annex I Habitats outside of Natura 2000 sites (i.e., undesignated habitats).
  - Impacts on aquatic environment (including watercourses and waterbodies).
- **Soil:** Impact on soil/subsoil geology, Irish geological heritage sites, and bedrock geology, etc.
- **Water:** Impact on river crossings, lakes, and groundwater based on established methodologies.
- **Planning Policy and Land Use:** Considers whether the circuit is consistent with the local authorities Development Plans.
- **Landscape & Visual:** Assessment of landscape constraints and designations and the impact on visual amenity.
- **Cultural Heritage:** The impact of a proposed circuit on recorded cultural heritage resources.
- **Noise & Vibration:** Vibrations and operational noise impact of lines and sub-stations, taking into account sensitive receptors.

The following sub-criterion is considered neutral (between OHL and UGC technologies) and has not been scored in the MCA process.

- **Climate & Sustainability:** The potential for release of greenhouse gasses or impacts on climatic change on the asset.

2.2.6.5 Socio-Economic Aspects

The below sub-criteria were scored:

- **Amenity:** The potential impact on the overall pleasantness or attractiveness of surroundings. This includes effects on community facilities, and recreation and tourism assets (not already captured).
- **Settlements and Communities:** The expected impact of a grid development on towns, villages and rural housing, and the way of life of their communities, residents, workers and visitors (e.g., severance, settlement patterns, etc.).
- **Recreation and Tourism:** Impact on recreational activities (e.g., fishing, sports) and tourism, during and after construction, that are not included in the other sub-criteria.
- **Traffic and Transport:** This considers potential effects on traffic and transport in the study area during the construction phases of the different solutions. Of concern to communities is the potential of severance, isolation and significant delays during the construction phase.

The following sub-criterion is considered neutral (between OHL and UGC technologies) and has not been scored in the MCA process.

- **Health:** To determine potential effects on humans, this considers WHO health thresholds. Electromagnetic field (EMF) is considered as set out in EirGrid's 'Your guide to understanding electric and magnetic fields (EMFs)'.

2.2.6.6 MCA Scoring Scale

The effect on each criteria parameter is presented along a range from "more significant / more difficult / more risk" to "less significant / less difficult / less risk". Table 2-3 shows the criteria performance/scoring scale used to illustrate each criteria parameter in a comparative assessment with other options.

Table 2-3 - Criteria Scoring Scale

More significant / difficult / risk — Less significant /difficult / risk

High Risk (Dark Blue)	Moderate-High (Blue)	Moderate (Dark Green)	Moderate-Low (Green)	Low (Cream)

3. Multi-Criteria Analysis – Circuit Technology Selection

3.1 Emerging Best Performing Technology Option

Table 3-1 shows the overall performance of the 2no. technology options (i.e., OHL and UGC) for the Hynestown-Maynooth circuit.

From a Technical performance standpoint, OHLs can achieve higher circuit ratings and have higher availability levels (less failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk. In the Economic assessment, OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower Single Energy Market (SEM) costs over the project lifetime.

However, when considering Deliverability, UGC technology clearly performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and multiple high-risk crossing points. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting, reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution.

When considering Environmental and Socio-Economic aspects, UGC technology offers lower long-term impact, greater compatibility with sensitive landscape and community settings, and a lower risk profile in the context of the Study Area. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the construction phase. OHL, on the other hand, introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. For a project located within a landscape featuring significant wetlands, ecological corridors, protected views, and sensitive communities, the long-term resilience and lower operational footprint of UGC make it the more appropriate option given these constraints.

Although both technology options score ‘Moderate’ risk overall, UGC technology is assessed as the Emerging Best Performing Technology Option due to its better performance in the Deliverability, Environmental and Socio-Economic criteria. UGC technology will provide a more robust and deliverable solution than OHL technology when considering the constraints of the Hynestown-Maynooth circuit.

Table 3-1 - MCA Scoring – Overall Score (Hynestown-Maynooth Circuit)

Assessment Criteria	OHL	UGC
Technical Performance		
Economic Assessment		
Deliverability Aspects		
Environmental Aspects		
Socio-Economic Aspects		
Overall Score		

3.2 Technical Performance

Table 3-2 shows a summary of the scores for the Technical Performance of each technology option.

Table 3-2 - MCA Scoring – Technical Performance

Sub-Criteria	OHL	UGC
Average Failure Rates		
Circuit Ratings / Headroom		
Expansion / Extendibility		
Repeatability		
Technology Operational Risk		
Geotechnical Conditions		
Electromagnetic Compatibility		
Overall Technical Score		

Circuit Availability Levels are found to be higher for OHL technology compared to UGC circuits over equivalent circuit lengths.

Compared to UGC technology, the maximum circuit rating of an OHL connection from Hynestown to Maynooth Substation will not be limited by external constraints. A UGC circuit will be constrained due to the high volume of existing services in the local road network, especially around the Celbridge urban area and the requirement for HDDs along the route.

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. At 400 kV, further uprating of the line rating capacity could be achieved by replacing the 'curlew' conductor line with High Temperature Low Sag (HTLS) conductor (noting that this technology is not currently approved for use by ESBN at 400 kV).

There is a lower risk associated with operating HV OHL circuit compared to UGC (especially at 400 kV). OHL options are deemed to have lower geotechnical impact than UGC options due to their smaller overall footprint.

3.2.1 Average Failure Rates

Average failure rates are predicted based on the circuit length and technology. Published and internal EirGrid Asset Reliability survey data indicate that failure rate statistics for 220 kV and 400 kV OHL circuits are much less compared to UGC technology.

The mean time to repair (MTTR) is much shorter for OHL circuits (matter of hours to days) as faults / failures are much easier to detect and access. For UGC circuits, significant lead time is required to locate the fault, organise access to joint bays, organise road closures, etc. Even after determining / locating the fault, more time may be required to source new cables, specialist equipment or qualified personnel, such as HV cable jointers, to make the repairs.

Overall, Availability Levels are found to be higher for OHL technology compared to UGC circuits over equivalent circuit lengths.

3.2.2 Circuit Ratings / Headroom

Compared to an UGC circuit, the maximum circuit rating of an OHL connection from Hynestown to Maynooth Substation will not be limited by external constraints. At 400 kV, the target ampacity ratings for twin 'Curlew' 600mm² ACSR conductor is more than the equivalent 400 kV UGC circuit rating (refer to Table 3-3). If a higher ampacity rating is required, then the conductor technology can be swapped out to HTLS (pending technology approval by ESBN).

A UGC circuit connection from Hynestown to Maynooth Substation will be constrained due to the high volume of existing services in the local road network, especially around the Celbridge urban area. Compared to OHL technology, an UGC connection from Hynestown to Maynooth will have difficulty achieving the required ampacity ratings, due to the number of existing services and major constraints along the route. A UGC circuit corridor will include a crossing over the River Liffey, but it is unlikely that either of the two existing bridges in the Study Area have adequate cover to accommodate an HV UGC. Multiple HDDs will be required with any UGC corridor option to cross the River Liffey, Dublin-Cork railway line and the Grand Canal. To achieve maximum possible ratings, the HDD bores will need to be spaced adequately apart (up to 5 m separation distance for 400 kV circuit HDDs).

OHLs are ideally suited for crossing linear constraints such as rivers, railway lines, motorways, other services, etc, without directly impacting on the constraint or the circuit itself (i.e., rating). However, further liaison with Iarnród Éireann and Waterways Ireland is required to confirm whether any buried crossings using UGCs is required and could impact (restrict) the maximum circuit rating. Current Iarnród Éireann standards (CCE-TMS-313) state that new crossings of the Dublin-Cork railway line using OHLs are not permitted.

Table 3-3 - Circuit ratings summary

Technology	Voltage	Target Rating Sumer (A)	Target Rating Winter (A)	Standard Cable
UGC	220 kV	1,410	1,591	2500 mm^2 ALU
UGC*	400 kV	1,969	2,103	2500 mm^2 CU
OHL – "Curlew"	220 kV	1,139	1,347	600 mm^2 ACSR
OHL – Twin "Curlew"	400 kV	2,278	2,694	2x 600 mm^2 ACSR
OHL – HTLS "Traonach"	220 kV	2,081	2,161	586 mm^2 GZTACSR
OHL – Twin HTLS "Traonach"	400 kV	Not currently available	Not currently available	2x 586 mm^2 GZTACSR

** 400 kV UGC target ratings are currently under review. CP1021 target ratings included.*

3.2.3 Expansion / Extendibility

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. Further uprating of the line rating capacity could be achieved by replacing the 'curlew' conductor line with HTLS conductor, but this technology is not currently approved / available for use in Ireland at 400 kV.

Further expansion (uprating) of a 400 kV UGC circuit will be very difficult and is constrained by current limitations on cable technology and any rating constraints (i.e., 'pinch-points') encountered along a route such as HDDs, circuit crossings, etc. As the circuit will be operated at 220 kV initially, certain circuit components (e.g., sheath voltage limiters, compensation equipment, etc.) will need to be changed out when switching to 400 kV operation.

UGC circuits are generally more difficult to loop new circuits into compared to OHLs due to physical accessibility of the circuit, outage requirements, network issues and the cable sheath bonding arrangements.

3.2.4 Repeatability

Both OHL and UGC technology are used in the Irish transmission system however, HV OHL circuits are considered more repeatable than HV UGC circuits as there are fewer potential impact / complications to the network (e.g., need for additional power compensation equipment). The circuits length under consideration for the Hynestown-Maynooth circuit (approximately 8.5 km) would not be considered unsuitable for HV OHL technology.

However, the possibility of laying 400 kV UGC circuits within the local road network, if it is used, could be restrictive and limit future use of the roads for UGC circuits (but not other services such as telecoms, low pressure water pipes, etc). For a 400 kV circuit, a width of approximately 5 m on either side of the circuit will need to be kept clear of other electrical UGC circuits.

3.2.5 Technology Operational Risk

Overall, there is a lower risk associated with operating HV OHL circuits compared to UGC (especially at 400 kV).

The most significant risk factors associated with HV OHL circuits are as follows:

- Weather Vulnerability:
  - Storms and Lightning: Susceptible to faults from wind, ice, and lightning strikes.
  - Conductor Galloping: Very rare wind-induced oscillations can cause mechanical damage.
- Maintenance and Access:
  - Easier Fault Detection: Visual inspection and remote sensing are effective.
  - Faster Repairs: Typically resolved in hours to days.
  - Live Line Work: Possible with trained crews and specialised equipment.
- Environmental Impact:
  - HV corona can generate noise and RFI.
  - Electromagnetic Fields (EMFs): Elevated exposure levels as conductor are unshielded however this is mitigated by using minimum mast heights to ensure restriction level are met.
- Flexibility and Uprating:
  - Easier to Uprate: Can replace conductors with new technology (i.e., HTLS) to achieve better ratings.
  - Adaptable Routeing: Can span rivers, roads, and uneven terrain.

The most significant risk factors associated with HV UGC circuits are as follows:

- Fault Detection and Repair:
  - Slow Fault Location: Faults are harder to detect and pinpoint due to lack of visual access.
  - Long Repair Times: Repairs can take up to 2–6 weeks, requiring excavation, specialist jointers, and imported components.
  - Third-Party Damage: Risk from construction, excavation, or utility interference.
- Thermal Management:

    - Heat Dissipation: Underground cables dissipate heat during operation; poor thermal conductivity of surrounding material can reduce the current-carrying capacity of the cable / prematurely age or damage the cables due to thermal stress.
- Uprating Limitations:
    - Difficult to Uprate: Increasing capacity will require full excavation and replacement of cables and equipment.
- Limited Flexibility:
    - Cannot easily adapt to changing grid demands.

3.2.6 Geotechnical Conditions

OHL options due to their smaller overall footprint, are deemed to have lower geotechnical impact than UGC options

Any proposed OHL corridor departing Maynooth Substation will be mostly via a landscape physiography described initially as ‘flat to gently undulating glacial sediments’ with the area adjacent / immediately south of the River Liffey (south of Celbridge) described as having ‘hummockly sediments’. The area immediately adjacent to the River Liffey banks (north and south) comprises of alluvium sediments, with a band of gravelly sediments immediately to the south of the river.

South of Celbridge, any OHL corridor route will pass through a large area prone to flooding adjacent to the River Liffey (wetlands) which is not of major concern to OHL technology but careful consideration will be needed when siting the OHL masts and foundation designs, with more specific site investigation and flood risk assessment required.

Any UGC circuit corridor will follow along existing public roads, where geotechnical conditions can be taken as low risk. The general landscape physiography after departing Maynooth Substation is described as being ‘flat to gently undulating glacial sediments’ and GSI Bedrock data indicates that the initial section of any UGC circuit out from Maynooth Substation will be situated within nodular and muddy limestone and shale (Boston Hill Formation).

By following the existing road network any UGC corridor should avoid passing though flood areas associated with the River Liffey south of Celbridge town, except for very localised sections when crossing the river. Any buried crossings (e.g., HDDs) of the River Liffey, the Dublin-Cork railway line, and the Grand Canal could be at risk of encountering onerous ground conditions (e.g., shallow bedrock, karst limestone, gravel, etc.) and will need detailed geotechnical surveys and designs to reduce construction or environmental contamination risks. Likewise, for any off-road sections of UGC the prevalent geotechnical conditions will need to be established and considered in further detail.

Specific site investigation works will be required for assessment and selection of final UGC circuit routes, joint bay locations and HDD crossing sites.

3.2.7 Electromagnetic Compatibility

Any electrical conductor will generate a magnetic field when electrical current is passed through it. HV circuits are assessed to electromagnetic compatibility standards including IEC 61000 series and ICNIRP guideline to ensure magnetic field emissions are within allowable limits for the public / equipment, (as per EU 1999/519/EC and ICNIRP (1998) restriction levels).

Regarding OHLs, the standard 400 kV tower design heights ensure that the magnetic and electric field levels at ground height are well within ICNIRP (1998) restriction levels (note, the 1998 levels are more stringent than the more recent 2010 published levels). Likewise, any OHL circuit corridor will need to be carefully routed to ensure it can maintain a 60 m wide clearance corridor (i.e., 30 m each side of the line) from nearby buildings (residential).

The time-varying magnetic fields produced by alternating current circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of HV OHLs in proximity to metallic structures such as steel pipelines and telecoms cables (such as railway line signalling communication cables). When routeing a circuit close to such pipelines or signal cabling, care needs to be taken to avoid parallel circuits and ensuring any crossings are as close as possible to 90 degrees.

Any OHL corridor will need to be routed to avoid close proximity to existing telecommunication masts (such as at Hazelhatch train station). Final siting of the OHL masts needs to be carefully selected and assessed to ensure there is no interference with nearby airport telecommunications, radar or navigation systems at Casement Aerodrome or Weston Airport, especially on any final OHL corridor approach into Hynestown Substation (approximately 3-4 km from both airports).

Corona discharge around HV OHLs can be a source of high-frequency RFI (i.e., generate radio noise) which can affect AM radio (0.15-30 MHz) and nearby telemetry systems. In such circumstances, corona mitigation measures can be employed to reduce the effects.

Compared to OHLs, the electric fields generated by UGCs are effectively blocked by the surrounding soil/bedding material and cable sheath and are of little relevance / insignificant.

The time-varying magnetic fields produced by alternating current UGC circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of UGCs in proximity steel pipelines such as high-pressure gas and water mains including their cathodic protection systems and telecoms cables (such as rail line signalling communication cables). When approaching such pipelines or signal cabling care needs to be taken to ensure the UGC circuits do not interfere by maintaining a set separation distance and ensuring any crossings are as close as possible to 90 degree.

Additional mitigation measures include using trefoil cable arrangements which will minimise magnetic fields (but potentially reduce overall circuit ratings).

3.3 Economic Assessment

Table 3-4 shows a summary of the scores for the Economic Assessment of each technology option.

Table 3-4 - MCA Scoring – Economic Assessment

Sub-Criteria	OHL	UGC
Project Implementation Costs		
Project Life-Cycle Costs		
Cost to SEM		
Overall Economic Score		

The cost of implementing a new circuit connection depends mainly on the circuit length, chosen technology (OHL vs UGC), and any specialised equipment needed at the substations to facilitate the circuit / connection. In general, OHL circuits are cheaper to construct and operate than UGC circuits of equivalent length.

Life-cycle costs are lower for OHL circuits because they have longer asset lifespans, lower failure rates, cheaper and faster fault repairs, and less frequent maintenance. UGC circuits age faster due to thermal and electrical stresses and require more expensive and time-consuming fault rectification.

In terms of impact on the Single Electricity Market (SEM), OHLs are more economical. UGCs have higher capital and operational costs, leading to increased Transmission Use of System (TUoS) charges. Their lower availability and longer repair times increase constraint and imperfection charges. OHLs, while having higher electrical losses, still offer better overall market efficiency due to flexibility in upgrades, easier integration of renewables, and support for meshed network operation, which reduces redispatch costs.

3.3.1 Project Implementation Costs

Assuming no additional land procurement is required at either substation, the circuit implementation costs will be driven predominantly by the length / technology of the required circuit connection and any bespoke equipment required at the connecting substation (i.e., for OHLs; LCIMS or conductor gantries).

HV OHL circuit development costs are approximately half those of equivalent UGC circuits. Considering the relatively short length of OHL circuit expected there is no need for any additional circuit/network compensation equipment. Considering the use of UGC technology, additional circuit and network compensation equipment (e.g., shunt reactors) may also be required, particularly if the length of UGC circuit involved are considerably long.

OHLs by their nature will be able to span over the major constraints along the route such as the River Liffey, Dublin-Cork railway line and the Grand Canal. However, further engagement is required with Iarnród Éireann to confirm if OHLs are permitted over the Dublin-Cork railway line or if the circuit will have to be undergrounded when crossing. This will obviously add complexity and cost to the project due to additional equipment such as LCIM compounds and UGCs / HDDs.

Future-proofing the OHL circuit for 400 kV will require higher specification equipment and masts sizes, increasing procurement and construction costs. Future-proofing the UGC circuit for 400 kV will require higher specification equipment and trench sizes, increasing procurement and construction costs. Rather complex and large crossing designs / land takes will be required to cross under the river Liffey, Dublin-Cork railway line and possibly the Grand Canal.

3.3.2 Project Life-Cycle Costs

Life cycle costs are less for HV OHL circuits compared to UGC circuits. This is due to:

- Lower equipment failure rates and replacement costs.
- Longer expected lifespan of the OHLs (40-60 years) compared to UGC (30-40 years). Even though OHL equipment is exposed to the environment / weather, it is not impacted as much as UGC technology which has shorter life spans due to thermal stress / electrical aging effects.
- Fault correction costs are lower for OHL as it is easier to determine fault locations and typically requires less time to gain access to rectify (hours compared to days).
- Longer inspection / maintenance intervals required for OHL due to the longer lifespans of the equipment.

3.3.3 Cost to SEM

The cost to the Single Energy Market is generally less for OHL circuits compared to equivalent UGC circuits. This is for a number of factors:

- Capital and Operational Costs:
  - UGCs are more expensive to construct than OHLs.
  - Higher capital and operational costs translate into higher TUoS charges.
- Reliability and Outage Costs:
  - Availability Levels are found to be much lower for UGC technology compared to equivalent OHL circuits. This is due to higher failure rates for UGC technology (at 220 kV and 400 kV), coupled with UGCs having longer fault repair times (MTTR) on the order of days to weeks for UGC compared to hours to days for OHL.
  - This increases constraint costs and imperfections charges in the SEM.
- Transmission Losses:
  - OHLs generally have higher electrical losses, which can increase wholesale energy costs. However, this disadvantage is often outweighed by the lower capital and maintenance costs.
- Flexibility and Grid Integration:
  - OHLs are easier to upgrade or reroute, supporting dynamic grid needs and renewable integration (e.g., loop-ins).
  - UGCs are less flexible, which can lead to higher curtailment costs for renewables and reduced market efficiency.
- Impact on Market Dispatch:
  - OHLs support more robust meshed networks, reducing the need for costly redispatch.

3.4 Deliverability Aspects

Table 3-5 shows a summary of the scores for the Deliverability aspects of each technology option.

Table 3-5 - MCA Scoring – Deliverability Aspects

Sub-Criteria	OHL	UGC
Implementation Timelines		
Permits & Wayleaves		
Land Availability		
Ease of Construction		
Overall Deliverability Score		

Due to the relatively large number of existing OHLs in the area / connecting into the existing Maynooth Substation, there are limited options for routeing a HV OHL. Due to the high number of dwellings in the Study Area, it is considered difficult/high risk to find OHL corridors of sufficient wayleave width (74 m) between the two substations. Whereas an UGC circuit will deliberately make use of available, wide road corridors (i.e., regional roads), routed predominantly through largely rural areas except for the Celbridge urban area which will likely force the UGC circuit to divert to either the north or south of the town.

Compared to UGC, construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be more straight forward unless any sections of the circuit must be undergrounded (for example, if not permitted to cross over the Dublin-Cork railway line). Construction of an UGC circuit along the road network will likely cause local disruption and impact on traffic around the Celbridge area. There are only two existing bridge crossings over the River Liffey within the Study Area. These bridges are deemed unlikely to be suitable for a HV UGC. As such, crossing under the river will need to be facilitated via HDD. Likewise, crossing of the Dublin-Cork railway lines will also require a HDD. For the Grand Canal, the geotechnical conditions will play a factor in determining whether the combination of a cofferdam and trenching across the canal is more or less likely than a HDD crossing.

A number of off-road sections are likely to be required for an UGC circuit to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require an easement from the relevant landowners / statutory authority. Obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

Future-proofing a UGC circuit to 400 kV specifications will require marginally larger trench, joint bay and HDD designs which could cause further disruption. Future-proofing an OHL circuit to 400 kV specifications will require larger/taller tower masts and foundations to be constructed but this would be considered more straight forward to implement.

3.4.1 Implementation Timelines

Construction of an UGC circuit between Hynestown and Maynooth is expected to be longer than an OHL option, on account that an UGC will need to route via suitable roads within the road network, whereas an OHL circuit can be more direct going off-road / cross country. Construction of an OHL circuit is estimated to take approximately 6-9no.

months (compared to approximately 12no. months for an UGC circuit) depending on the number of construction crews deployed and the number / specification of masts to be constructed.

All materials and components are considered standard and should not represent any risk or delays to the usual procurement timelines, including 400 kV cables (approximately 9+ months).

For both technologies, no major circuit outages will be required except possibly for a partial busbar outage when connecting into the Maynooth 220 kV Substation.

Regarding the overall development timeframe, obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

3.4.2 Permits & Wayleaves

An OHL circuit will predominately route via private, agricultural based land which will require easements (68-74 m wide) to be negotiated and agreed with the relevant landowners. Current Iarnród Éireann standards (CCE-TMS-313) indicate that new OHLs are not permitted to cross the Dublin-Cork railway line. Further consultation and agreements / easements will be required from Iarnród Éireann for the OHL circuit to either cross over the Dublin-Cork railway line or to cross under the line via a HDD. Permission / easements will be required from Waterways Ireland for the OHL to cross the Grand Canal. If the OHL masts on the final approach into Hynestown Substation are assessed to encroach / impede on the AirNav height restrictions around Casement Aerodrome then further permissions will be required from the relevant Aviation authorities / Air Corps. For the construction phase, further liaison and possibly a Special Aeronautical Study may need to be carried out to determine any potential restrictions on allowable crane heights so as not to impact on flight operations at Casement Aerodrome.

Compared to UGC technology, it is considered that it will be more difficult to obtain public acceptance and the necessary landowner wayleaves for an OHL circuit within the Study Area and as such is scored at higher risk.

Any UGC circuit will predominately route along public roads. A number of off-road sections are likely to be required to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require a wayleave from the relevant landowners / statutory authority. Off-road wayleaves required for 400 kV UGC circuits will need to be minimum 5 m wide, with the additional requirements for a 3.5 m access track along the off-road routes to ensure subsequent access for maintenance activities, etc. Wayleaves will be required from Waterways Ireland for the UGC circuit to cross the Grand Canal. Wayleaves will be required from CIÉ / Iarnród Éireann for the UGC circuit to cross under (HDD) the Dublin-Cork railway line. On approach into the Hynestown Substation search area (after crossing the Grand Canal) the UGC circuit will need to cross the planned Uisce Éireann Shannon-Dublin water supply pipeline which is routed through the Study Area from Grange Castle West Business Park.

The UGC routes will likely encounter medium pressure underground gas pipelines, especially in the vicinity of Celbridge, but no high-pressure gas pipelines are known to traverse the Study Area. During the construction phase, a road opening licence will be required from the local road authority (KCC and SDCC) to construct the UGC circuit trenches and joint bays along any sections of public road. Engagement with the local authorities' road engineers is required to confirm trench designs, reinstatement details and exact joint bay locations. Principal inspection reports and technical assessment reports may also be required for any existing or proposed structures affected by the UGC, for example bridges, culverts or project joint bays.

3.4.3 Land Availability

Due to the relatively large number of existing OHLs in the area / connecting into the existing Maynooth Substation, there are limited options for routeing an HV OHL. Heading south-east from Maynooth Substation represents the only feasible OHL route to the Hynestown Substation search area which would not have to cross another existing HV OHL circuit. An OHL corridor would need to route south-eastwards to bypass around Celbridge and the Pickering Forest Solar Farm before heading east, crossing over the Liffey, Dublin-Cork railway line and the Grand Canal. Due to the high number of dwellings in the Study Area, it is considered difficult/high risk to find OHL corridors of sufficient wayleave width between the two substations.

Any OHL circuit corridor will require easements (68-74 m wide) to be negotiated and agreed with the relevant landowners, including a permanent 4 m access corridor directly under the line which needs to be kept clear at all times. Obtaining the necessary land easements from private landowners will likely be more onerous compared to UGC circuit technology options.

Depending on permissions from Iarnród Éireann and Waterways Ireland, if the OHL circuit needs to cross under either the Dublin-Cork railway line or the Grand Canal using an UGC then a LCIM compound (approximately 23 m x 32 m) including access road will be required wherever a crossover from OHL to UGC technology takes place.

Due to the large number of existing OHLs leaving Maynooth Substation, it is likely that a final section of UGC will be required (with the necessary wayleaves 5m wide) to connect the circuit to the designated bay / entry ducting at the planned new 220 kV GIS building. This new Maynooth GIS substation is to be built to the southwest of the existing substation.

Routeing a 400 kV UGC circuit corridor from Hynestown to Maynooth is constrained by Celbridge town located in the middle of the Study Area. An UGC circuit corridor will need to avoid Celbridge by bypassing either to the south or north of the town centre where the roads are not as constrained with existing services. After bypassing Celbridge an UGC circuit will need to cross the River Liffey, most likely by HDD. Landowner engagement will be required to secure viable HDD crossing points (wayleaves) on either bank of the river.

After crossing the River Liffey, further off-road land wayleaves will be required to cross under the Dublin-Cork railway line and the Grand Canal, before entering the Hynestown Substation search area from the northwest. UGC circuit corridors will predominately route along public roads. However, several off-road sections will be required to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc.

Any off-road sections of the UGC circuit including joint bays, passing bays, HDDs, etc. will require a wayleave from the relevant landowners. Off-road wayleaves of 5 m are required for 400 kV UGC circuits.

3.4.4 Ease of Construction

An OHL circuit will predominately route via private, agriculturally based land which should have good access and ground conditions for siting and constructing the overhead masts and foundations (>20no. masts required in total). The only area of concern would be where the OHL circuit traverses wetlands/flood areas in the vicinity of the River Liffey, but the indicated ground conditions are not deemed high-risk. Compared to an UGC circuit, construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be more straight forward unless any sections of the circuit must be undergrounded (for example, if not permitted to cross over the Dublin-Cork railway line). Some limitations of construction crane heights may be imposed in the vicinity of Casement Aerodrome.

Any UGC circuit will deliberately make use of wide road corridors (i.e., regional roads), routed predominantly through largely rural areas or alongside business parks. The Celbridge urban area will likely force the UGC circuit to divert to either the north or south of the town. Construction of the UGC circuit along a northern corridor around Celbridge may be easier compared to a southern UGC corridor which must pass through the southern sections of Celbridge town or alternatively go off-road in order to cross the River Liffey. Local disruption and complex traffic management arrangements can be expected for constructing the UGC trench along roads close to or passing through the Celbridge urban area. Additional space requirements for the large joint bays including cable pulling equipment will put additional constraints on the cable routeing and construction. Passing bays may also need to be constructed on any busy, smaller/local roads used along the circuit route.

There are only two existing bridge crossings over the River Liffey within the Study Area. These bridges are deemed unlikely to be suitable for a HV UGC to be installed in the bridge deck, both from a technical standpoint of having minimum depth of cover and from the perspective of gaining acceptance by the relevant authority's roads engineer. As such, crossing under the river may need to be facilitated via HDD. Likewise, crossing of the Dublin-Cork railway line will also require a HDD. For the Grand Canal, the geotechnical conditions will play a factor in determining whether the combination of a cofferdam and trenching across the canal is more or less likely than a HDD crossing.

3.5 Environmental Aspects

Table 3-6 shows a summary of the scores for the Environmental aspects of each technology option[1].

Table 3-6 - MCA Scoring – Environmental Aspects

Sub-Criteria	**OHL**	**UGC**
Biodiversity, Flora & Fauna		
Soil		
Water		
Planning Policy and Land Use		
Landscape & Visual		
Cultural Heritage		
Noise & Vibration		
Overall Environmental Score		

Both UGC and OHL technologies present different risks within the Study Area and the overall risk profile differs between these technologies.

OHL development generally results in less ground disturbance, but presents a higher overall level of risk in the Study Area context due to long-term landscape and visual impacts and the limited opportunities for alternative routeing within the Study Area. While micro-siting can help avoid sensitive cultural and ecological features, OHL infrastructure introduces additional considerations such as avian collision risk and operational noise. The presence of designated sites such as the Grand Canal proposed Natural Heritage Area (pNHA) also constrains viable tower locations, increasing sensitivity.

UGC development involves extensive excavation, which increases the potential for disturbance to wetlands, watercourses and hydrological systems, particularly in areas of soft soils, groundwater vulnerability and flood risk. These construction-phase impacts require robust mitigation, however UGC offers greater certainty in avoiding direct impacts on above-ground cultural heritage features and allows routeing within existing road corridors. While UGC introduces a higher level of construction-phase disturbance (principally through trenching, excavation, and horizontal directional drilling) these impacts are temporary, predictable, and can be effectively managed through established mitigation measures and careful construction planning. The most pronounced environmental sensitivities in the Study Area relate to wetlands, watercourses, and hydrologically connected habitats such as the Grand Canal pNHA and Liffey Oxbow wetland; although UGC interacts more intensively with these receptors during installation, the resulting risks are short-term and can be reduced through avoidance of high-value features during routeing.

[1] Note: Planning, Policy and Land use scored equal for both technologies and this sub-criterion did not contribute to differentiating between these technologies. Information on this sub-criterion is given in Appendix A.

3.5.1 Biodiversity, Flora & Fauna

3.5.1.1 National and European Sites

There are no Special Areas of Conservation (SAC) or Special Protection Areas (SPA) within the Study Area. The nearest European site is Rye Water Valley/Carton SAC (approximately 3.7 km downstream) and the Study Area is hydrologically connected via the Taghadoe River. The Grand Canal pNHA bisects the Study Area and represents a key ecological constraint due to its extent and ecological value (Figure 3-1). Two additional wetlands within the Study Area are designated as pNHAs (Grand Canal [Kildare] – Grand Canal pNHA and Gollierstown – Grand Canal pNHA [Dublin]), along with one nationally important wetland (Liffey Oxbow – River Liffey [Kildare]). These habitats are highly sensitive to hydrological changes and physical disturbance and conflicts between grid infrastructure and high-value habitats typically occur in wetland areas[2].

For OHL technology, potential impacts include bird collision risk for Annex I species and Birds of Conservation Concern in Ireland (BOCCI) that use local wetlands for foraging or roosting. Risks to watercourses and water-dependent habitats arise mainly during OHL tower foundation construction, but these can generally be mitigated through careful tower placement and standard construction measures. UGC technology removes collision risk entirely but may cause temporary disturbance to birds during construction activities. More importantly, UGC presents a greater potential for disturbance to water-dependent habitats due to the need for trenching, excavation, and longer construction periods, which can increase the risk of sedimentation or hydrological disruption.

Overall, both OHL and UGC technologies present comparable ecological risks within the Study Area, though the risk pathways differ. OHL carries a low risk of water-quality impacts, and collision risks can be mitigated if required. UGC presents a low risk of bird disturbance but a higher potential for impacts on water-dependent habitats during excavation.

[2] cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-4-Habitats.pdf

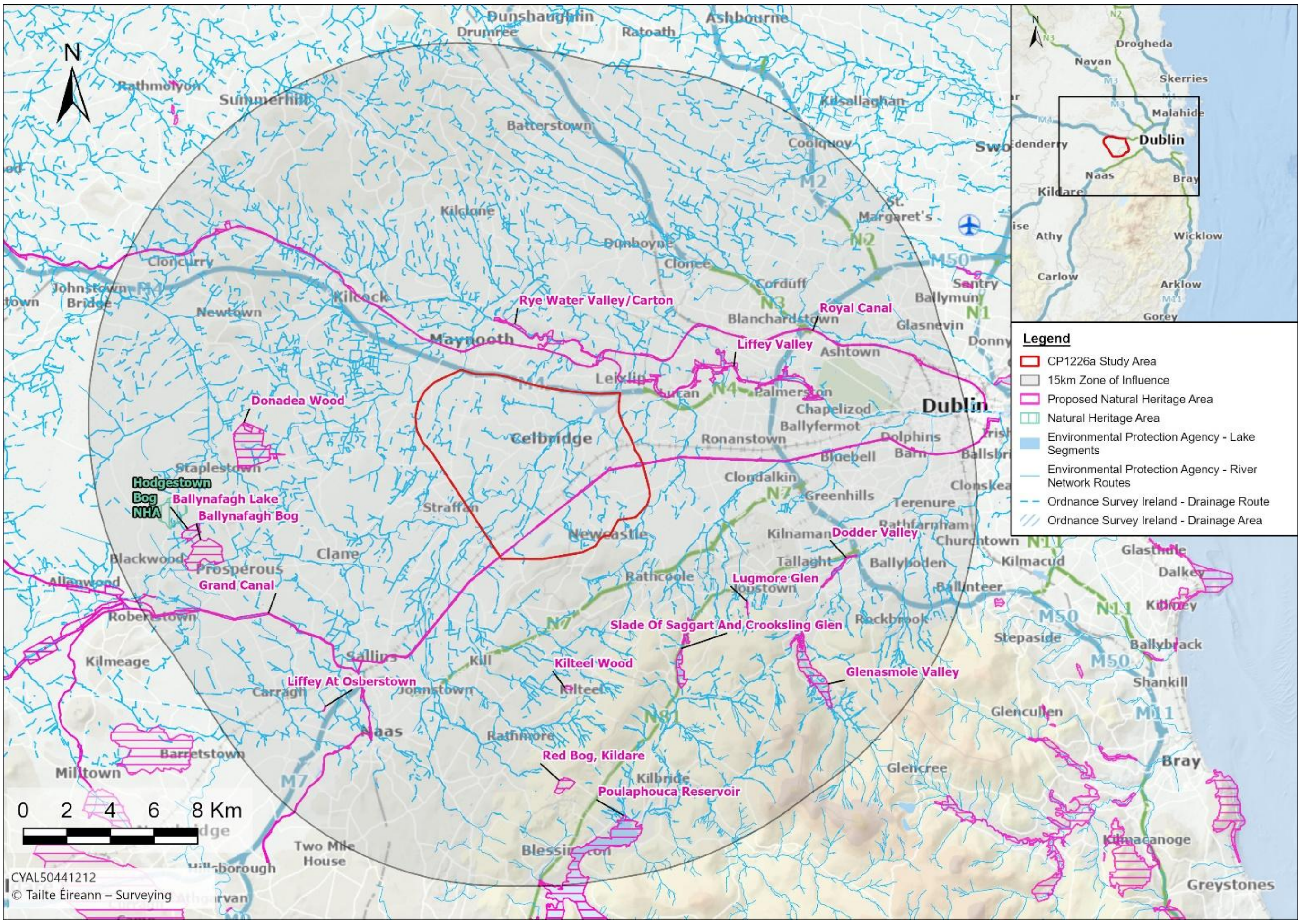

Figure 3-1 - Proposed Natural Heritage Areas within the Study Area and 15 km Zone of Influence

3.5.1.2 Protected Species and Habitats

OHL presents a higher risk to sensitive bird species and habitats within the Study Area compared to UGC, primarily due to potential collision risk for Annex I species (e.g., Red Kite) and BOCCI-listed species that may use local wetlands. While mitigation measures such as tower siting and bird flight diverters can reduce residual risk, it cannot be fully eliminated. UGC removes collision risk but may cause temporary disturbance to birds during construction.

OHL results in lower physical disturbance to ground and aquatic habitats, reducing impacts on Annex II and IV species such as white-clawed crayfish, common frog, and bats. In contrast, UGC introduces greater potential for disturbance to water-dependent habitats and Annex II/IV species due to trenching, soil excavation, and sedimentation, which can affect aquatic species and disrupt riparian corridors used by bats.

3.5.1.3 Aquatic Environment

OHL involves minimal ground disturbance, reducing direct interaction with watercourses, wetlands (Figure 3-2), and riparian habitats. Tower foundations and access tracks can be sited to avoid sensitive aquatic features, limiting sedimentation and hydrological alteration risks. The main residual risk is sediment runoff during foundation works, which is typically low and manageable with standard mitigation. In contrast, UGC requires extensive trenching and soil excavation, significantly increasing the potential for sediment runoff, hydrological disruption, and contamination of watercourses and wetlands, which could degrade habitats for species such as white-clawed crayfish and amphibians and impact riparian corridors used by bats. Flood-prone areas located along the River Liffey can generally be avoided with OHL, whereas UGC works within these areas elevate the risk of pollutant mobilisation and downstream impacts.

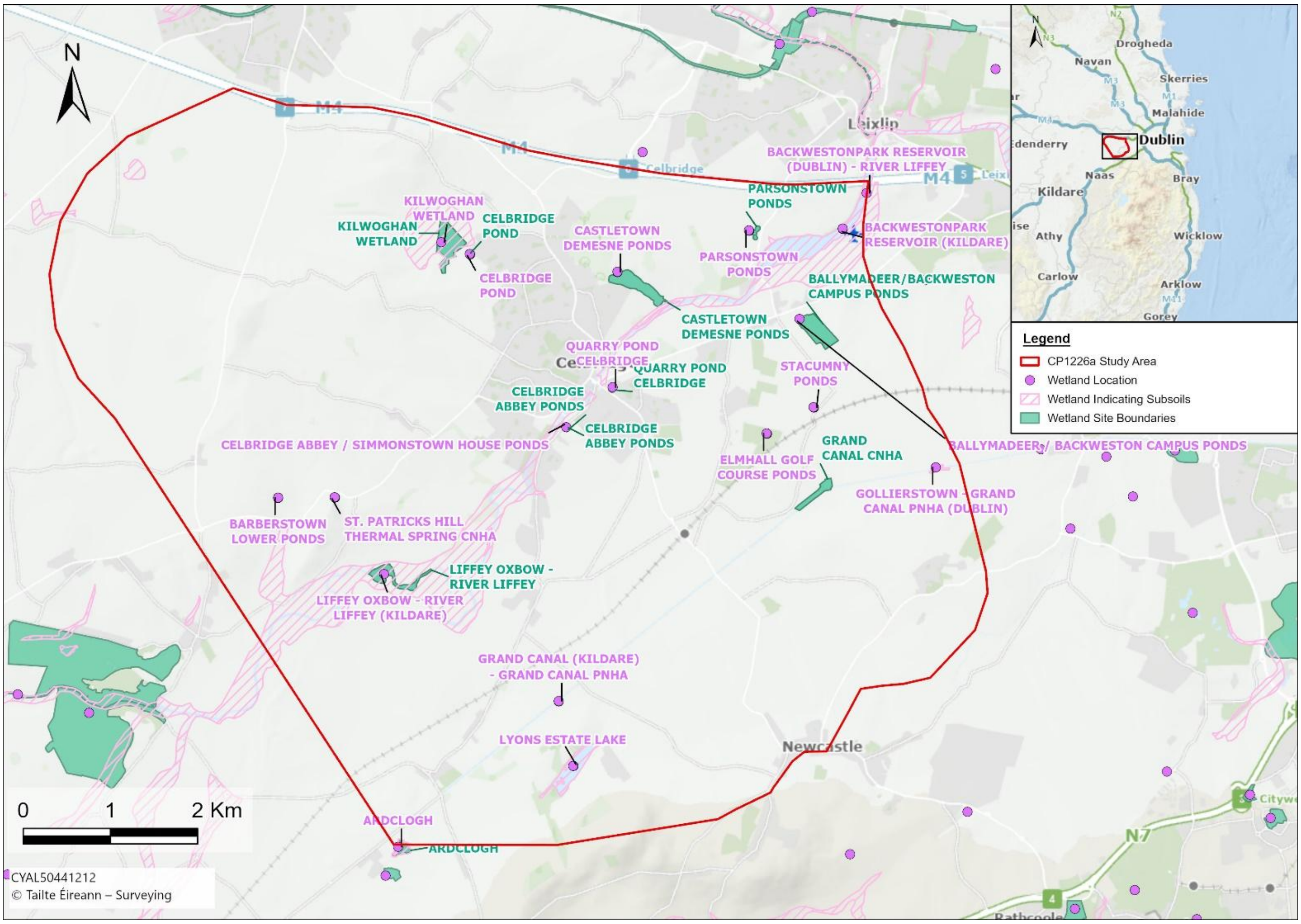

Figure 3-2 - Wetlands within the Study Area

3.5.2 Soil

The Study Area contains three Geological Heritage Sites: Newcastle Buried Channel, Liffey Oxbow, and St. Patrick's Well No. 2. These are nationally and/or county-significant features and considered sensitive receptors. These sites should be avoided during route selection and may influence alignment of access tracks, tower locations, or cable routes.

Landslide susceptibility is generally low, though isolated areas of moderate to high susceptibility occur on steeper slopes or weaker soils. Where construction involves significant earthworks, slope stability assessments may be required. For OHL technology, these areas present a higher risk due to tower foundations and associated access works. UGC installation may also require geotechnical assessments, particularly where trenching intersects susceptible slopes.

Made Ground is present in the urbanised area of Celbridge and may contain construction debris, variable soil types, and contaminants. This introduces risks of differential settlement and soft spots, complicating foundation design and trench stability. Detailed site-specific investigations, including contamination assessments and geotechnical testing, will be necessary. While OHL routes are unlikely to traverse major urban areas, UGC routes often follow road networks and may encounter Made Ground, increasing the need for mitigation measures.

3.5.3 Water

The River Liffey bisects the Study Area and includes areas of Flood Zone A, indicating a high probability of flooding. Past flood events have occurred near the Liffey and other low-lying areas, meaning infrastructure such as cable routes and access tracks in these zones may require Flood Risk Assessment (FRA) and climate resilience measures. Tower foundations for OHL in flood-prone areas will need careful consideration, as access and construction could be complicated by flood risk (Figure 3-3).

The Study Area also contains zones of moderate to high groundwater vulnerability, with pockets of extreme vulnerability and shallow bedrock. These areas have limited attenuation capacity, increasing contamination risk during trenching or HDD works associated with UGC. Soft alluvial soils and flood-prone areas near watercourses will require detailed geotechnical investigation to ensure trench stability and HDD feasibility. While these factors could typically result in a moderate-high score, mitigation measures can reduce this to moderate.

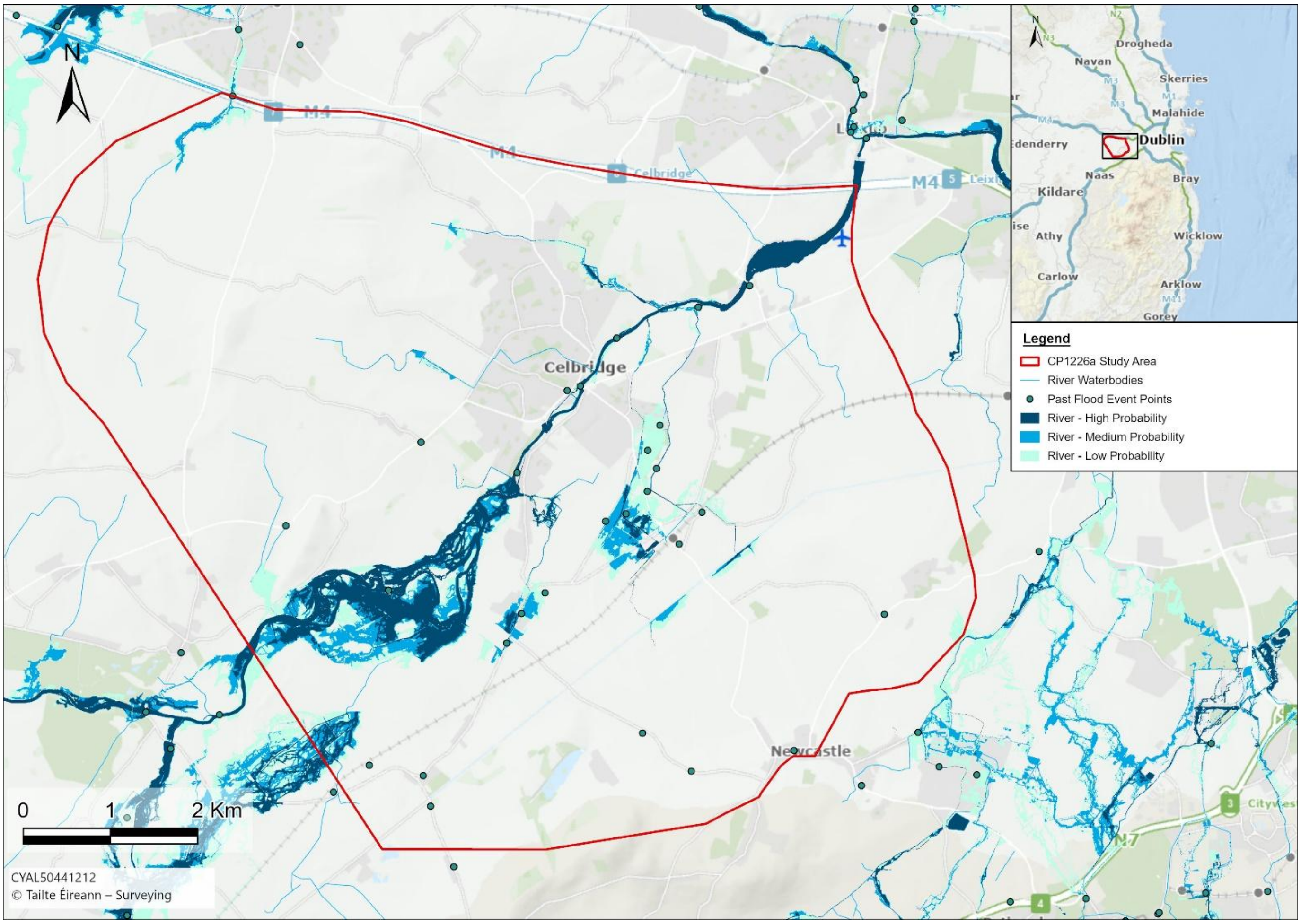

Figure 3-3 - Flood risk within the Study Area

3.5.4 Landscape & Visual

The Study Area includes sensitive landscapes such as the River Liffey valley and Castletown Demesne (a major historic landscape with protected views), as shown in Figure 3-4. Landscape sensitivity is moderate to high in these areas, requiring careful alignment and micro-siting to reduce visual intrusion for OHL structures. Potential OHL crossings near the Grand Canal pNHA could introduce visual and ecological impacts; while physical disturbance is minimal, tall structures may affect the canal's setting. UGC technology has minimal long-term visual impact, but temporary construction compounds and access works can affect the setting of heritage assets. Trenching may disturb subsurface archaeological remains or impact the curtilage of protected structures. Sites of concern include Castletown Demesne (and isolated SMR sites near Dowdstown and Moneycooly). Works near these assets will require careful alignment, screening, and timing to mitigate impacts.

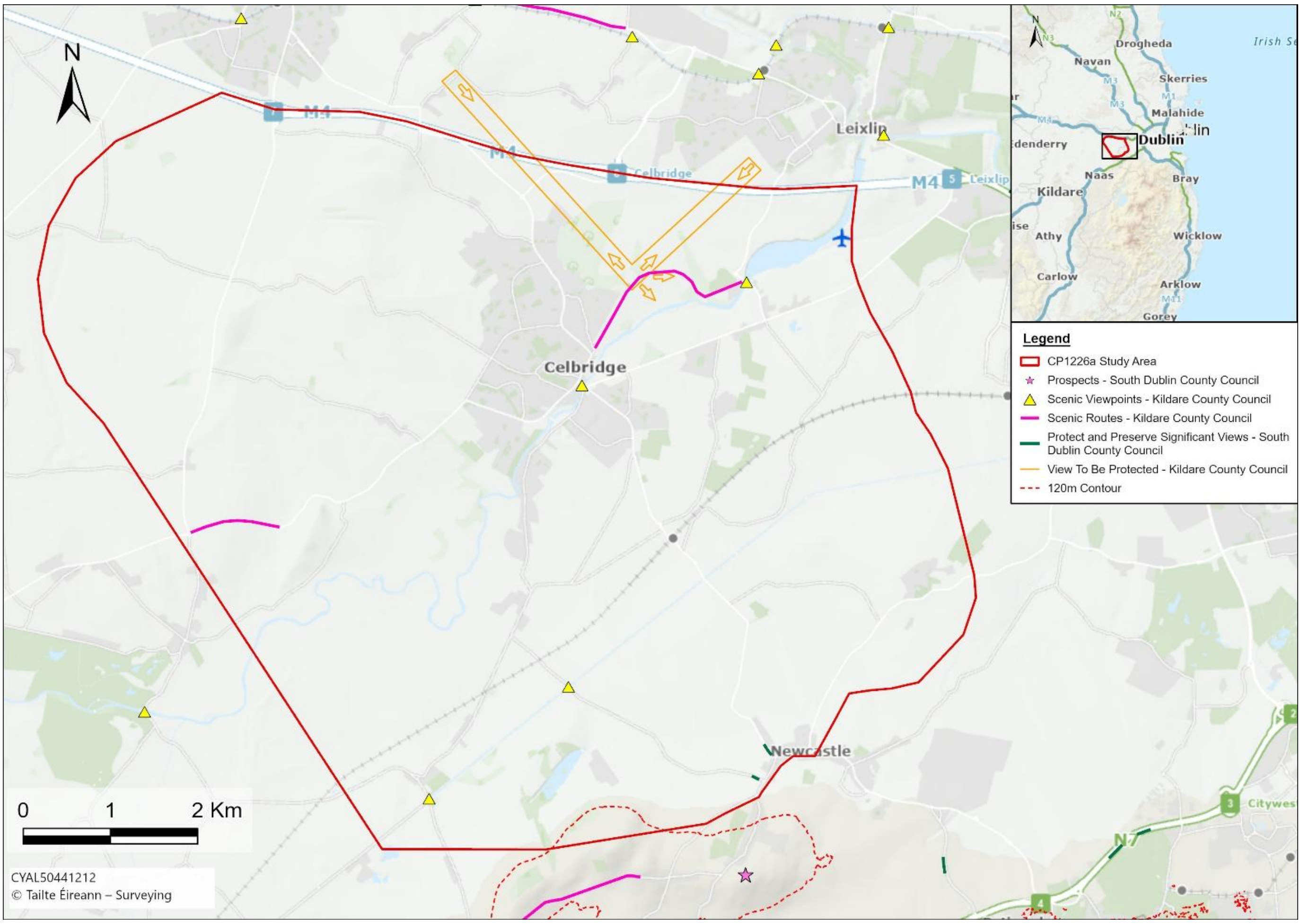

Figure 3-4 - Visual Constraints identified in Kildare and South County Dublin Development Plans

3.5.5 Cultural Heritage

Recorded cultural heritage resources present a low risk for OHL implementation (Figure 3-5), as tower locations can be micro-sited to avoid physical impacts on archaeological remains. Most features in the Study Area are isolated sites such as ringforts and enclosures, allowing flexibility in OHL alignment (Figure 3-5). The visual impacts of OHL on Architectural Conservation Areas (Figure 3-6) and National Inventory of Architectural Heritage records (Figure 3-7) will need further consideration. The Grand Canal is a significant cultural heritage feature due to its historic infrastructure and construction activities will need to avoid direct impacts on locks, bridges, and canal-side structures to maintain historic integrity.

UGC technology may require trenching across road networks, increasing the likelihood of encountering subsurface remains, particularly near Celbridge town, which is rich in cultural heritage. Compound placement must avoid curtilage impacts on protected structures. If canal crossings require coffer dams, this would involve damming and draining a section of the canal, excavating across the bed, and reinstating. Such works pose a high risk of damaging original masonry and altering historic character, as well as archaeological disturbance. Assuming damming is not required, risks remain moderate but require careful planning.

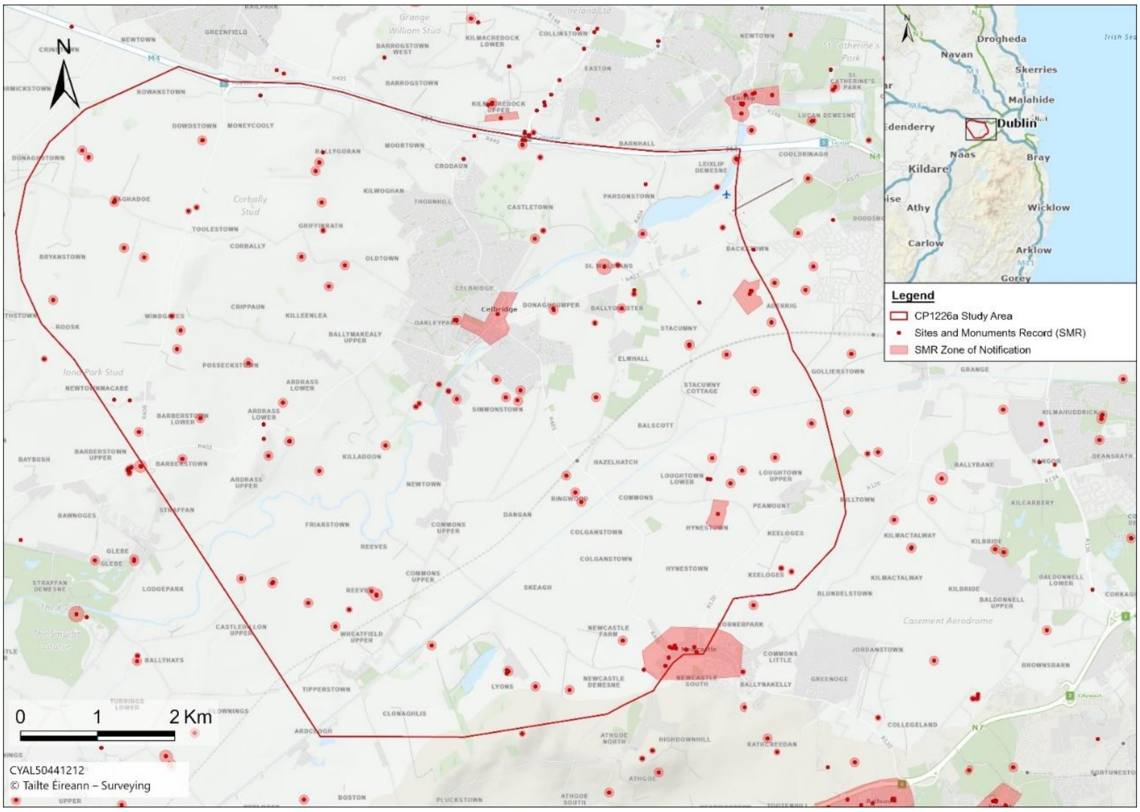

Figure 3-5 - Sites and Monuments (SMR) listed features within Study Area (NMS, 2025)

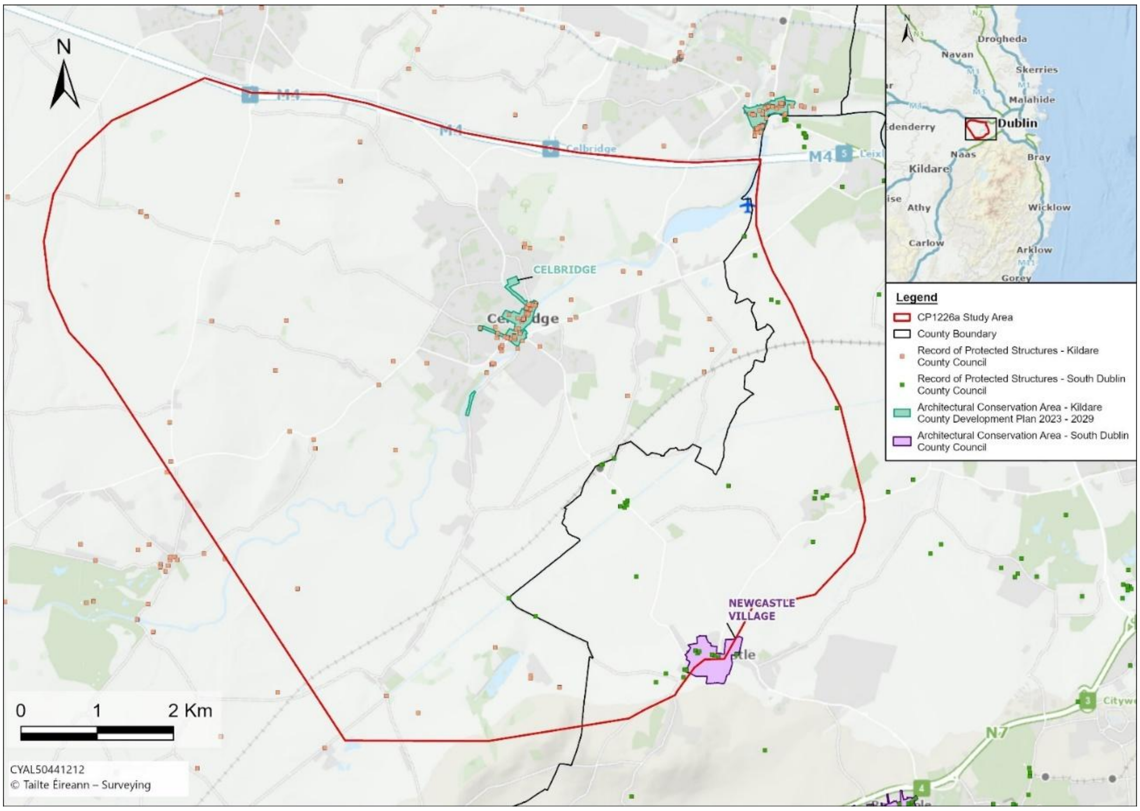

Figure 3-6 - Record of Protected Structures and Architectural Conservation Areas within the Study Area (NMS, 2025)

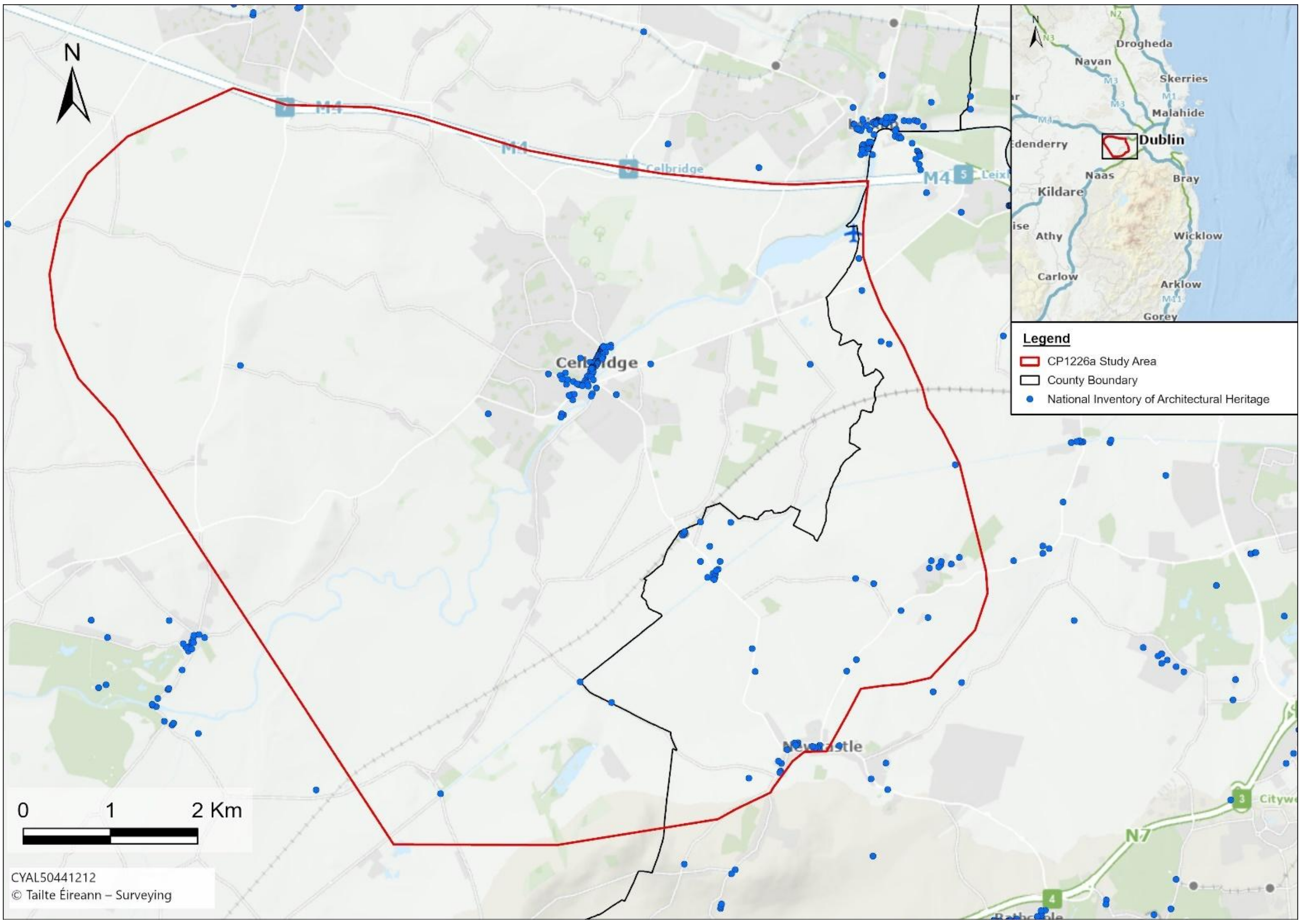

Figure 3-7 - National Inventory of Architectural Heritage recorded within the Study Area

3.5.6 Noise & Vibration

For OHL implementation, isolated rural residences may experience temporary noise impacts during construction. Operational noise from corona discharge is expected and can be significant for higher voltage lines (350-500 kV and above)[3]. Proximity to sensitive habitats and cumulative noise from regional roads in the Study Area must be considered.

UGC construction noise and vibration impacts are short-term but may coincide with proposed housing and infrastructure developments, increasing cumulative effects. No operational noise is expected for UGC technology. UGC alignment should avoid densely populated areas and sensitive habitats to minimise disturbance.

[3] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-8-Noise.pdf

3.6 Socio-Economic Aspects

Table 3-7 summarises scores for the Socio-Economic aspects of each technology option.

Table 3-7 - MCA Scoring – Socio-Economic Aspects

Sub-Criteria	OHL	UGC
Amenity		
Settlements and Communities		
Recreation and Tourism		
Traffic and Transport		
Overall Socio-Economic Score		

Both OHL and UGC technologies present community and socio-economic risks within the Study Area, but their overall risk profiles differ.

OHL presents a greater and more persistent socio-economic risk including permanent changes to visual amenity, restrictions on land management and agricultural practices due to wayleaves, potential community concerns regarding landscape character and perceived safety. These long-term effects outweigh the relatively modest construction impacts associated with OHL installation. There will be additional need for landowner engagement around visual and safety concerns, and the potential for operational impacts such as visual intrusion and community perception. Although traffic impacts for OHL are limited, temporary access tracks may still require local traffic management.

UGC leads to short-term construction disruption, including temporary traffic impacts, restricted access along recreational routes such as the Grand Canal Way, and localised disturbance in rural and peri-urban areas. However, these effects diminish once construction is complete. In the long term, UGC has minimal socio-economic footprint, generating no operational noise, no visual intrusion, and no ongoing constraints on land use or agricultural activities. UGC impacts are largely short-term and construction-related, including temporary traffic disruption at regional road crossings, restricted access along the Grand Canal Way, and potential effects on nearby heritage and tourism receptors. These impacts are generally manageable through phased works and traffic management.

3.6.1 Amenity

Community facilities and recreational areas within the Study Area present constraints for both technologies. OHL implementation may result in long-term amenity impacts where routes traverse open space or rural landscapes with moderate sensitivity. Visual assessments and mitigation measures such as tower siting and vegetation screening will be required.

UGC technology generally has limited long-term amenity impacts but may temporarily disrupt access to recreational routes during construction. The Grand Canal Way, zoned for walking and cycling, is a key constraint where trenching or HDD works could affect public access and diminish amenity value during the construction phase.

3.6.2 Settlements and Communities

OHL routes are constrained by the presence of scattered rural dwellings, agricultural holdings, and pockets of dense settlement. Complete avoidance of these receptors is unlikely, requiring careful alignment and consultation to minimise impacts.

UGC technology is expected to have low to moderate short-term impacts on settlements if routed through predominantly agricultural areas. However, construction activities near sensitive receptors such as schools and retirement homes pose temporary health and safety risks. Proximity to business estates also requires planning to avoid disruption.

3.6.3 Recreation and Tourism

The Study Area includes valued recreational and tourism assets such as the Grand Canal Way and Castletown House and Demesne, a major heritage site. OHL implementation could affect the character of these areas and restrict future recreational development. UGC technology is expected to have low long-term impact but may temporarily affect visitor experience and local tourism during construction near these sites.

3.6.4 Traffic and Transport

Traffic and transport constraints for OHL technology are minimal, as regional road crossings can be managed without major disruption. However, temporary access tracks for tower construction may require traffic management and coordination with local authorities, particularly given proposed housing and infrastructure developments that increase cumulative congestion risk.

UGC technology presents higher traffic management challenges during construction, especially in urban areas such as Celbridge, where residential estates, schools, and healthcare facilities increase sensitivity. Road crossings and HDD works under the Grand Canal will require detailed traffic management plans to maintain safe access. Mitigation measures include selecting routes along wider regional roads and siting joint bays within road verges or private lands.

4. Conclusion

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2. This report provides an update on the technology selection for the Hynestown Substation following the public consultation carried out in May and June 2025. This report also summarises the MCA completed in Step 3 on the two (2no.) options for the Hynestown-Maynooth circuit technology (i.e., underground cable and overhead line).

4.1 Hynestown Substation

Following the work carried out previously, the public consultation campaign (held in 2025), and additional engagement with landowners and assessment of potential sites, the substation technology MCA was updated. Table 4-1 shows the overall performance of the AIS and GIS technologies for the proposed Hynestown Substation. The following lists a summary of the key outcomes from the MCA:

- **Technical:** AIS performs better than GIS (Moderate-Low vs. Moderate); AIS substations are typically easier to expand and carry a lower technology operational risk.
- **Economic:** Both technologies perform similar (Moderate-Low); although GIS substations are more expensive to construct, they do have lower project life-cycle costs (when compared to AIS substations). Land costs are generally more for AIS substations due to their larger size footprint.
- **Deliverability:** AIS performs worse than GIS (Moderate-High vs. Moderate); this is largely driven by land availability i.e., the spatial requirement for an AIS is considerably larger than for a GIS.
- **Environment:** AIS performs worse than GIS (Moderate vs. Moderate-Low); given the larger footprint of AIS (4.5 times larger than GIS), the impacts on the environment for most of the criteria would be considered worse for AIS than for GIS.
- **Socio-Economic:** AIS performs worse than GIS (Moderate vs. Moderate-Low); although for a substation the impact on traffic and transport, and recreation and tourism, may not be impacted by the technology, the same cannot be said for the impact on settlements and communities, nor amenity. As per the Step 3 Engagement and Consultation Report (M-CO, July 2025), the preference from the public is for GIS.

Based on the above MCA assessment, it was decided that the Best Performing Technology Option for the Hynestown Substation is GIS.

Table 4-1 - Hynestown Substation Step 3 Substation Technology MCA Results

Criteria	AIS	GIS
Technical		
Economic		
Deliverability		
Environment		
Socio-Economic		
OVERALL		

4.2 Hynestown-Maynooth Circuit

To assist in identifying the best performing circuit technology, a Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical;
- Economic;
- Deliverability;
- Environmental; and
- Socio-Economic.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to identify the best performing technology option. Table 4-2 shows the overall performance for the 2no. technology options.

Table 4-2 - MCA Scoring – Overall Score (Hynestown-Maynooth Circuit)

Assessment Criteria	OHL	UGC
Technical Performance		
Economic Assessment		
Deliverability Aspects		
Environmental Aspects		
Socio-Economic Aspects		
Overall Score		

Although both technology options score ‘Moderate’ risk overall, UGC technology is assessed as the Emerging Best Performing Technology Option due to its better performance in the Deliverability, Environmental and Socio-Economic criteria. UGC technology will provide a more robust and deliverable solution than OHL technology when considering the constraints within the context of the Study Area for the Hynestown-Maynooth circuit.

Technical: OHLs can achieve higher circuit ratings and have higher availability levels (less failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk.

Economic: OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower SEM costs over the project lifetime.

Deliverability: UGC technology performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and multiple high-risk crossing points. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting, reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution.

Environmental and Socio-Economic: In the context of the Study Area, UGC technology offers lower long-term impact, greater compatibility with sensitive landscape and community settings, and a lower risk. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the development phase. On the other hand, in the context of the Study Area, OHL introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. For a project located within a landscape featuring significant wetlands, ecological corridors, protected views, and sensitive communities, the long-term resilience and lower operational footprint of UGC make it the more appropriate option given these constraints.

5. Next Steps

This report, the Emerging Best Performing Technology Options Report, will be published and presented to the public through an information campaign, led by EirGrid. Should feedback be given in response to this public information campaign it will be documented by EirGrid and considered by the project team in the future steps of the project.

EirGrid has commenced engagement with key stakeholders (e.g., public bodies, local authorities, utility providers, etc.) and this process will continue in parallel with the public information campaign, and into future steps of the project.

EirGrid will continue to engage with landowners regarding the shortlisted substation sites. Once potential circuit corridors are identified in Step 4, landowner engagement for any off-road sections of these potential corridors (if required) will also be carried out.

The substation site and circuit corridor options will then undergo a detailed MCA assessment in Step 4 to identify an Emerging Best Performing Option (EBPO), which will be subject to further public consultation in Step 4.

The assessments in future steps will be aided by site visits, site walkover surveys, and if applicable, site investigations. EirGrid will continue to engage with communities and landowners about relevant surveys and provide updates before they start. These may include, but are not limited to, the following:

- Topographical surveys;
- Ground investigations, including test pits and boreholes;
- Ground penetrating radar (GPR) surveys;
- Slit trench surveys;
- Ground resistivity measurements;
- Soil contamination testing; and
- Ecological and environmental site investigations e.g., geophysical surveys.

For the next steps i.e. Step 4 and Step 5 , the following reports will be prepared:

- Social Impact Assessment;
- Planning and Consent Strategy;
- Screening for Appropriate Assessment and Screening for Environmental Impact Assessment;
- Step 4 Report; and
- All environmental, technical and planning documents associated with the Step 5 planning application submission.

APPENDICES

Appendix A. Additional Information

A.1 Planning, Policy and Land Use

The Study Area includes multiple zoned areas that may constrain infrastructure development. These include lands zoned as Open Space and Amenity (to protect and provide for recreation), Strategic Open Space (to preserve and improve green infrastructure networks), Agricultural (to retain and protect agricultural uses), and Greenbelt (to maintain the character of towns by preventing development). These zones are concentrated in the northern and central sections of the Study Area and will influence route selection for both technologies.

Relevant planning policies from the Kildare County Development Plan (2023–2029) and South Dublin County Development Plan (2022–2028) support the delivery of electricity infrastructure while requiring compliance with environmental, visual, and heritage considerations. Key objectives include:

- Safeguarding reliable electricity supply and facilitating integration of renewable energy projects.
- Minimizing visual impact of overhead lines by avoiding areas of high landscape sensitivity and sites of biodiversity or cultural importance.
- Ensuring compliance with international standards for proximity to sensitive receptors such as dwellings, schools, and healthcare facilities.
- Supporting strategic corridors for grid infrastructure and safeguarding them from encroachment.
- Facilitating grid reinforcements and trans-boundary connections subject to Appropriate Assessment screening.
- Undergrounding utilities in town centres and heritage areas to protect visual amenity.

For OHL implementation, alignment must consider policies requiring avoidance of high-sensitivity landscapes and heritage areas. Micro-siting and visual mitigation measures will be necessary in zones designated for open space or greenbelt. For UGC technology, undergrounding aligns with policy objectives for town centres and heritage areas but requires careful planning to manage construction impacts in sensitive zones such as recreational routes and green infrastructure corridors.

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