Technical Feasibility Study Report

EirGrid PLC

October 2024

CP1214-ATK-RP-N06-S4-R02

0087703DG0027

CP1214 Fingal to East Meath Grid Reinforcement

Notice

This document and its contents have been prepared and are intended solely as information for EirGrid PLC and use in relation to CP1214 Fingal to East Meath Grid Reinforcement project.

WS Atkins Ireland Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 68 pages including the cover.

Document history

Document title: Technical Feasibility Study Report

Document reference: 0087703DG0027

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
0	Draft	KC, AC	JCO	DMK	UOH	Apr 2024
1	Draft	KC, AC	JCO	DMK	UOH	July 2024
2	Final	KC, AC	JCO	DMK	UOH	October 2024

Client signoff

Client	EirGrid PLC
Project	CP1214 Fingal to East Meath Grid Reinforcement
Job number	100087703
Client signature/date	

Contents

Tables

Figures

1. Introduction

1.1 Who is EirGrid?

EirGrid PLC (hereafter referred to as EirGrid) is responsible for a safe, secure, and reliable supply of electricity in Ireland. EirGrid develops, manages, and operates the electricity transmission grid. This brings power from where it is generated to where it is needed throughout Ireland. 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 Capital Project 1214?

The Fingal to East Meath Grid Reinforcement (EirGrid Capital Project CP1214) is a proposed project to address the needs for additional capacity at transmission interface substations in the North Dublin and East Meath area. This project addresses the need for new infrastructure to accommodate the continued growth in electricity demand in the region, which is being driven by several sectors including residential housing, commercial and industrial development, the electrification of heat and transportation, and integration of renewable energy connections.

The existing transmission interface substations and the associated transmission circuits are at risk of reaching their capacity limits and as a result the existing infrastructure will not be capable to supply sufficient power to where it is needed. To address this need, new infrastructure is required to ensure a reliable, sustainable electricity supply to customers in the area.

A high-level project location is identified in Figure 1-1.

The development of this project follows EirGrid's 6-Step approach to Grid Development (refer to Figure 1-2) which sets out the steps to be taken to identify and implement the best performing solution that meets the needs outlined above.

The Fingal to East Meath Grid Reinforcement Project is currently in Step 3, with the objective of identifying a best performing technology solution and associated study area to meet the identified need from the shortlist of options identified previously by EirGrid in Step 1 and Step 2.

This grid reinforcement will create opportunities by providing capacity to supply electricity to areas where it is needed in the future which will enable businesses, schools, hospitals, homes, and farms to prosper and grow, and will also create opportunities for facilitating renewable generation.

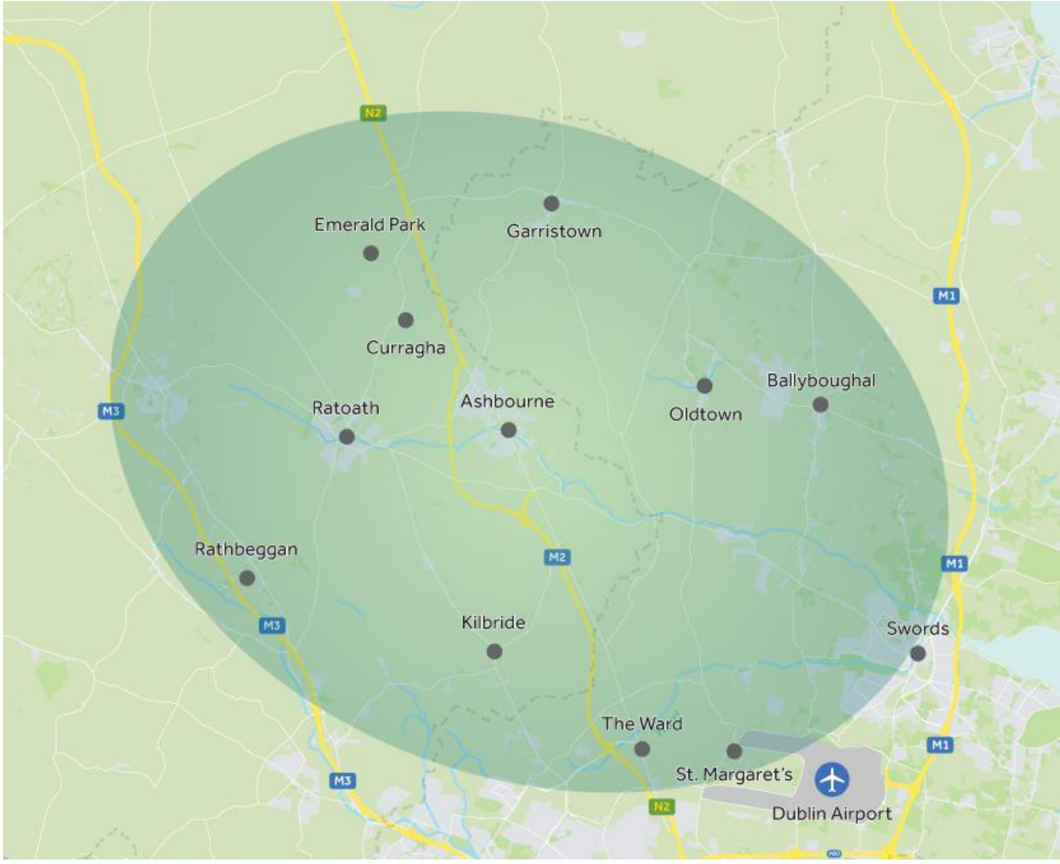


Figure 1-1 - Initial CP1214 Project Location Indicated in June Public Information Leaflet

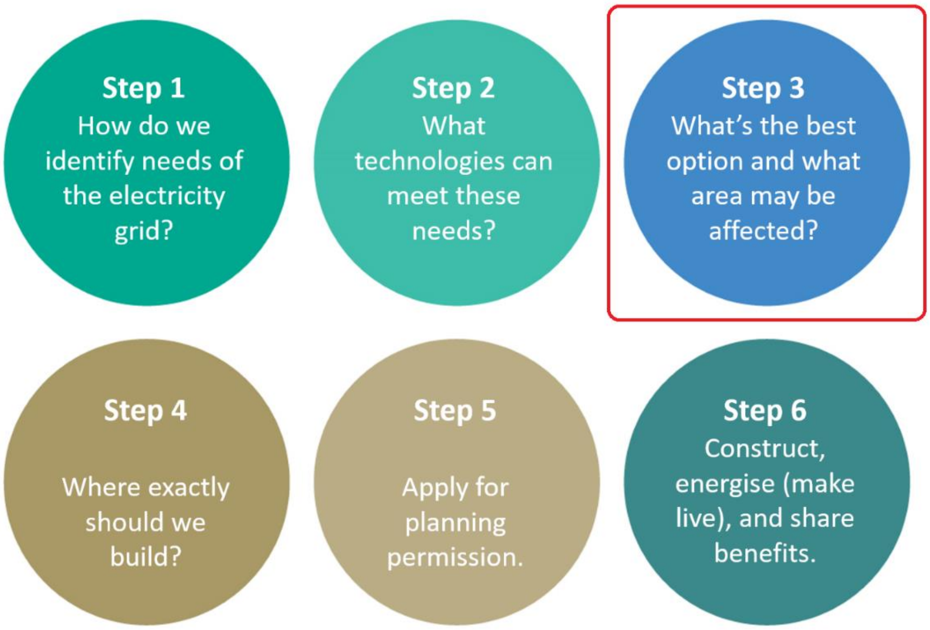


Figure 1-2 - EirGrid's 6-Step approach to Grid Development

2. Background to the Project

2.1 Need for Development

EirGrid, as the Transmission System Operator (TSO) of Ireland, and ESB Networks, as the Distribution System Operator (DSO) of Ireland, work collaboratively to ensure that the needs of transmission and distribution connected customers are met. This includes planning development of transmission interface substations.

As part of feedback received from the 'Shaping Our Electricity Future' consultation, the DSO has highlighted to EirGrid the emerging need for additional capacity at transmission interface substations in the North Dublin and East Meath area. This capacity is needed to accommodate forecast growth of electricity demand in the distribution network. This projected demand growth is driven by a number of factors including residential, electrification of heat and transport, and growth in commercial sectors.

The significant electricity demand growth in the distribution system also leads to a significant burden on the transmission system, particularly at existing transmission interface substations and the associated transmission circuits. The existing transmission interface substations and the associated transmission circuits are at risk of reaching their capacity limits and as a result the existing infrastructure will not be capable to supply sufficient power to where it is needed. To address this need, new infrastructure is required.

2.2 Project Benefits

Figure 2-1 shows the benefits associated with the CP1214 project.

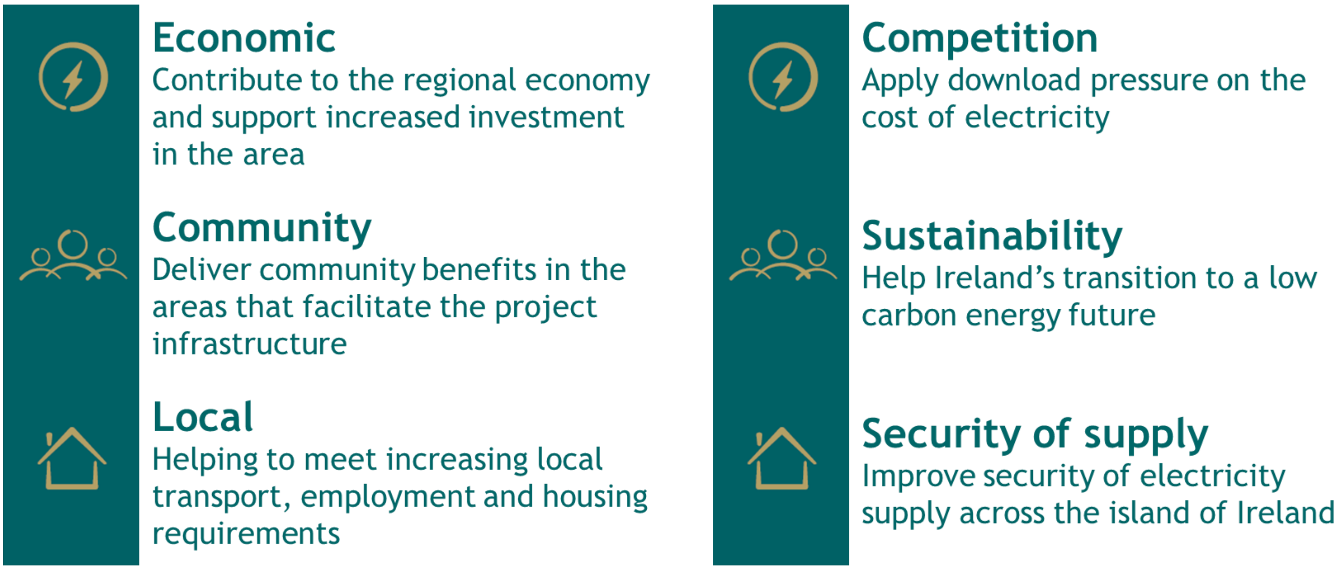


Figure 2-1 - CP1214 Project Benefits

2.3 New Infrastructure Identified in Step 2

The CP1214 infrastructure requirements that were identified by EirGrid during Step 2 and were brought forward into Step 3 are as follows:

- New Fingal 400/220/110 kV transmission interface substation, situated west of Swords, with new 400 kV loop-in circuits from the Fingal 400 kV substation to the proposed CP1021 East Meath-North Dublin 400 kV UGC;
- New East Meath 220/110 kV transmission substation, in the vicinity of Ratoath, with new 220 kV loop-in circuits from the East Meath 220 kV substation to the Louth-Woodland 220 kV OHL; and
- New 220 kV transmission circuit between the proposed East Meath 220 kV substation and the Fingal 400 kV substation (with the abbreviation EME-FGL).

It is noted that general substation names (i.e., East Meath and Fingal) are being used as placeholders in this report to help understanding and communication. When substation sites are confirmed, the substation names will be updated accordingly.

2.4 Development of East Meath 220 kV Substation

During the Step 3 process, a decision was taken by EirGrid for the East Meath 220 kV substation and the associated loop-in circuits to the existing Louth-Woodland 220 kV OHL to be developed by a private entity as a 'contestable build'. An indicative location for this substation is shown in Figure 2-2. The exact location is still to be determined by the private entity.

A contestable build is an element of connection works undertaken by a third-party entity. In this case a station and the associated loop-in to the existing OHL.

In consideration of the above decisions, the East Meath 220 kV substation and the associated loop-in circuits to the existing Louth-Woodland 220 kV OHL were excluded from further assessment in Step 3 of the CP1214 project. As one of the proposed CP1214 circuits will connect to the East Meath 220 kV substation, EirGrid and the project team will continue to liaise with the private entity in Step 4 and Step 5 to ensure that the objectives of CP1214 are met.

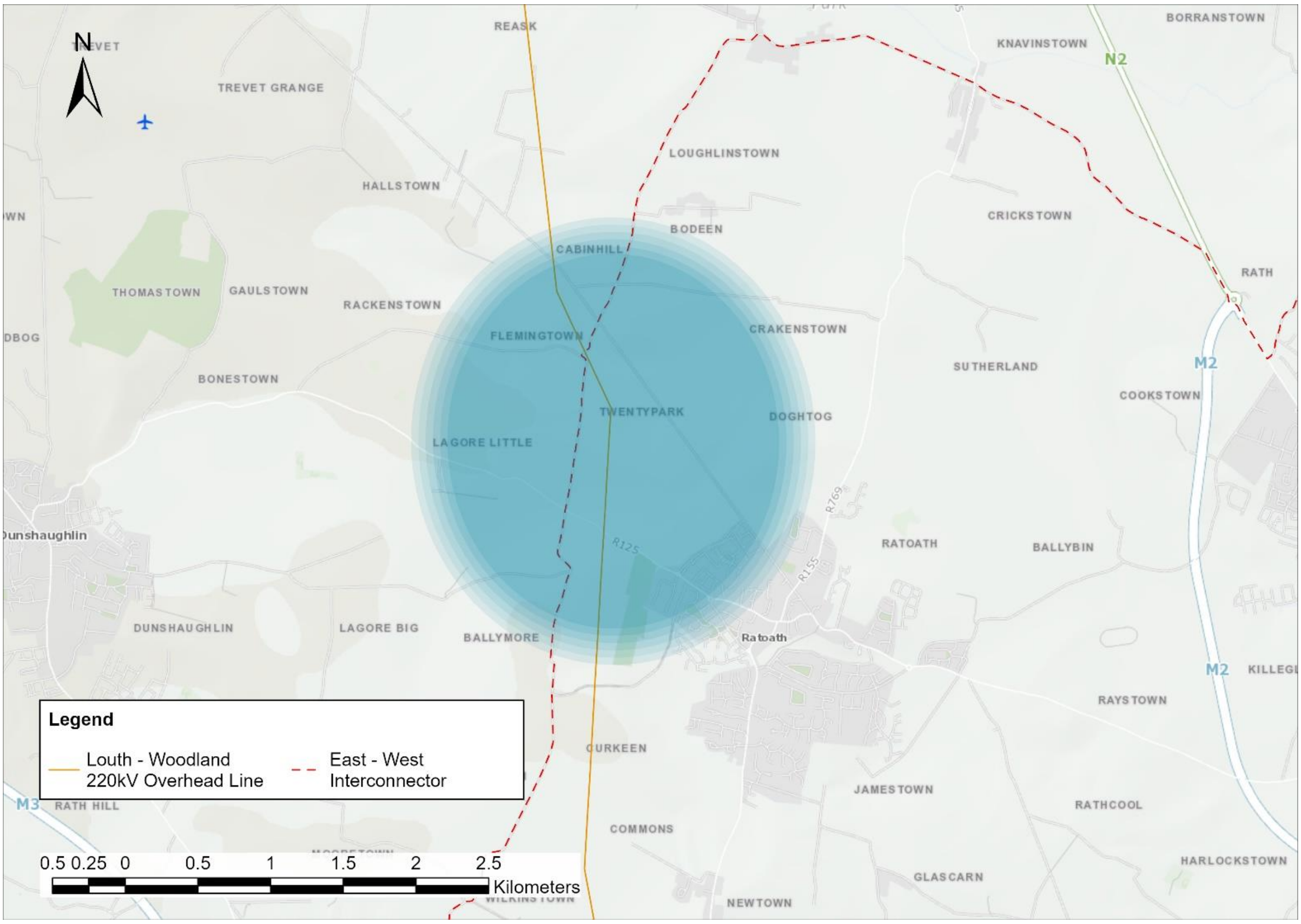


Figure 2-2 - Anticipated Area of Interest for the East Meath 220 kV Substation

2.5 Project Description

The CP1214 project is described as follows:

- New Fingal 400/220/110 kV transmission interface substation, situated west of Swords, with new 400 kV loop-in circuits from the Fingal 400 kV substation to the proposed CP1021 East Meath-North Dublin 400 kV UGC; and
- New 220 kV transmission circuit between the proposed East Meath 220 kV substation and the Fingal 400 kV substation (with the circuit abbreviation EME-FGL).

3. 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. Figure 3-1 shows the process that was followed in Step 3, with a graphical representation provided in Figure 3-2. A high-level summary is outlined below with further detail discussed in this Chapter.

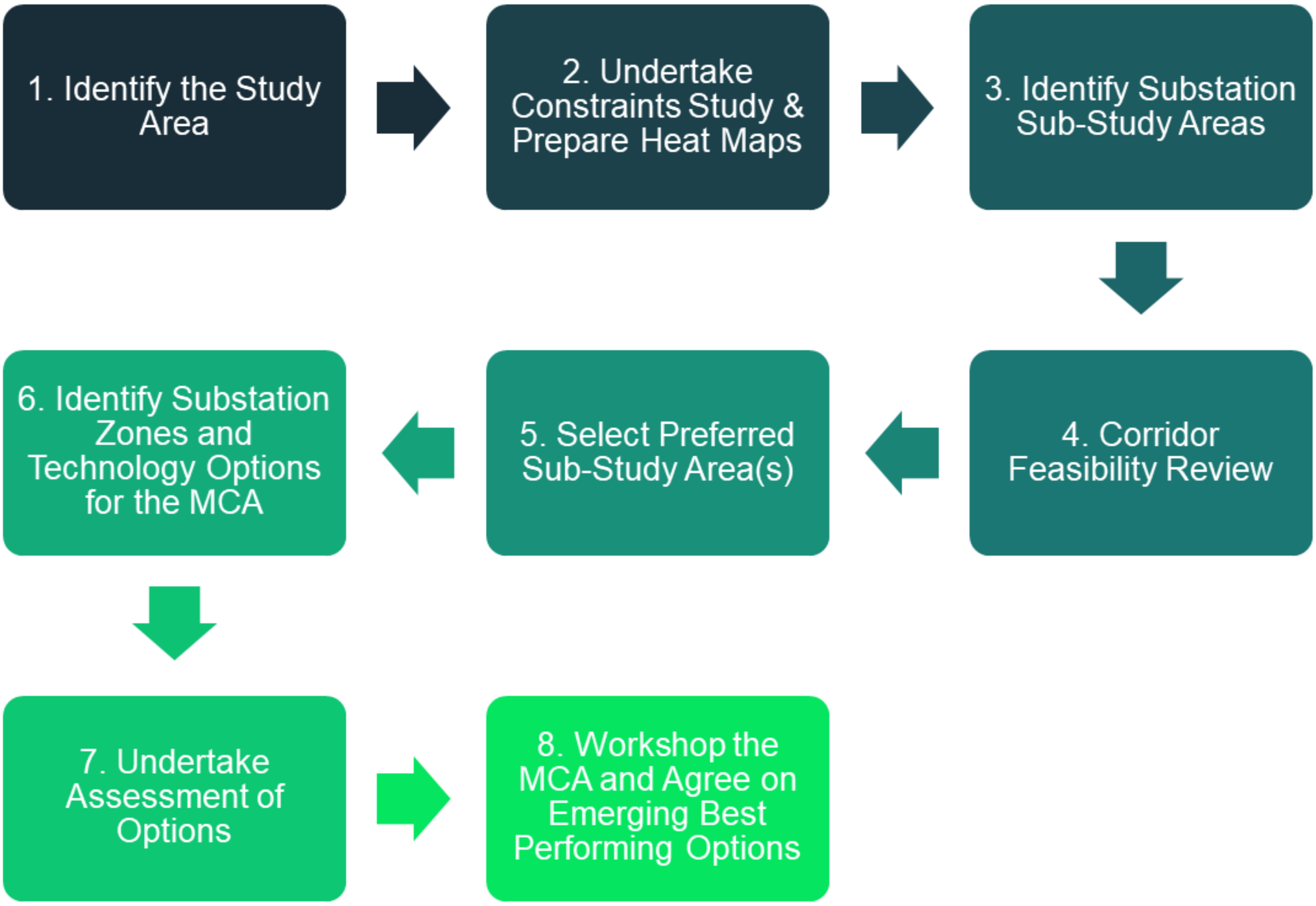


Figure 3-1 - Process Followed in Step 3

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 Fingal 400 kV substation was considered the most applicable. A wider net was cast to identify large sub-study areas where the substation 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. These ranged in size from ± 650 ha to ± 2,100 ha. This process also included a high-level assessment of the proposed 400 kV loop-in circuits to the proposed CP1021 East Meath-North Dublin 400 kV UGC.

4. **Corridor Feasibility Review:** As the connection of the proposed Fingal 400 kV substation to the proposed East Meath 220 kV substation is required to achieve the overall project need, a feasibility review for both OHL and UGC technologies was undertaken to ensure a route can be found between the anticipated area of interest for the proposed East Meath 220 kV substation and the five (5no.) sub-study areas for the proposed Fingal 400 kV substation.
5. **Select Preferred Sub-Study Area(s):** Based on the initial high-level assessment carried out, two (2no.) of the five (5no.) sub-study areas were selected for further assessment. The key guiding principles that informed this decision were the availability of suitable land and the connectivity to key infrastructure (i.e., the proposed CP1021 East Meath-North Dublin 400 kV UGC and the proposed East Meath 220 kV substation).
6. **Identify Substation Zones and Technology Options for the Multi-Criteria Analysis (MCA):** Although the 2no. preferred sub-study areas had been identified, these areas were considerably larger than the actual size of land required for the proposed substation site. It was 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 five (5no.) substation zones were identified, ranging in size from 205 ha to 525 ha, thereby providing 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 and air-insulated switchgear).
7. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of both technologies 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 to Public Consultation with.

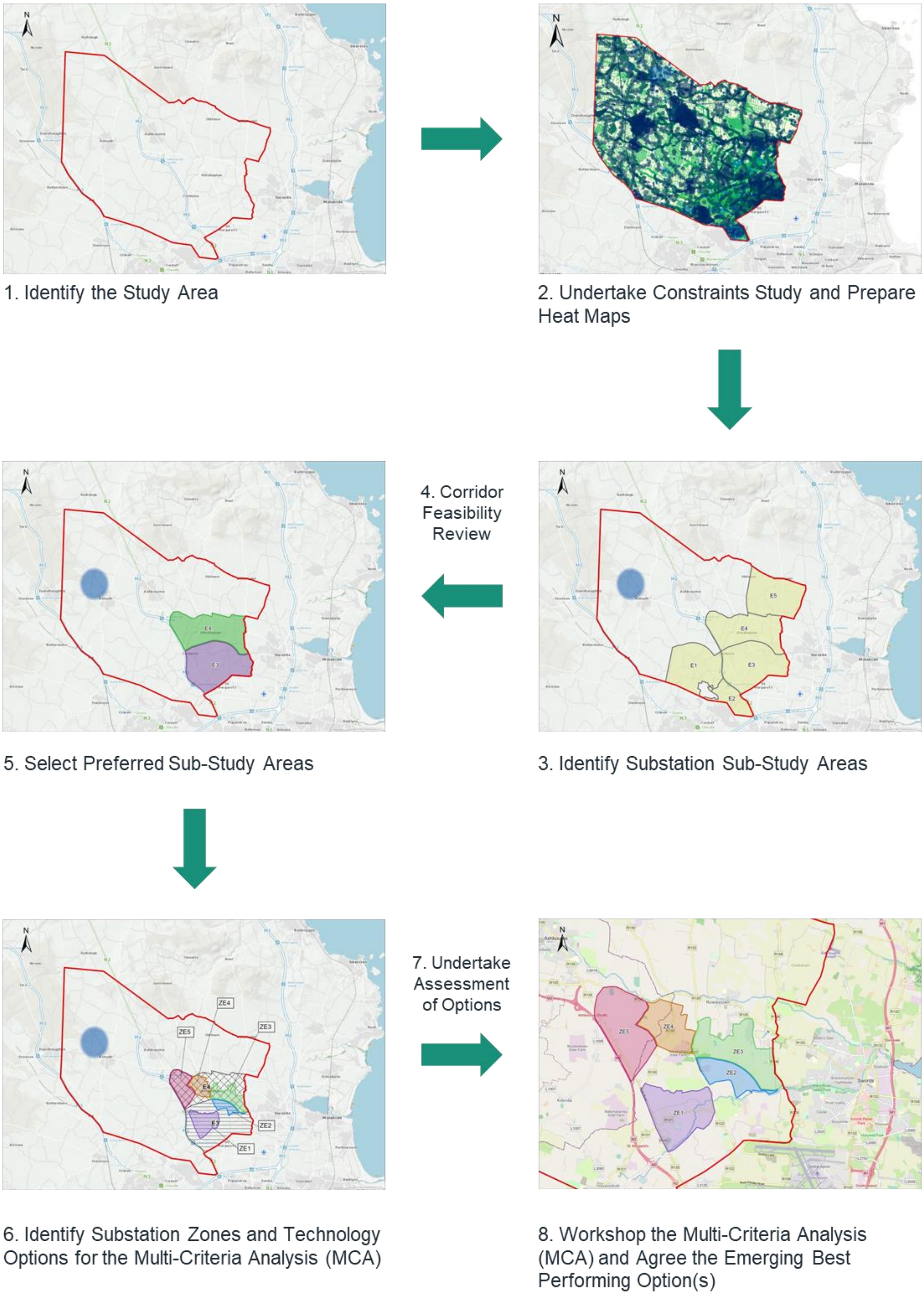


Figure 3-2 - Graphical Representation of the Process Followed in Step 3

3.1 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 3-3.

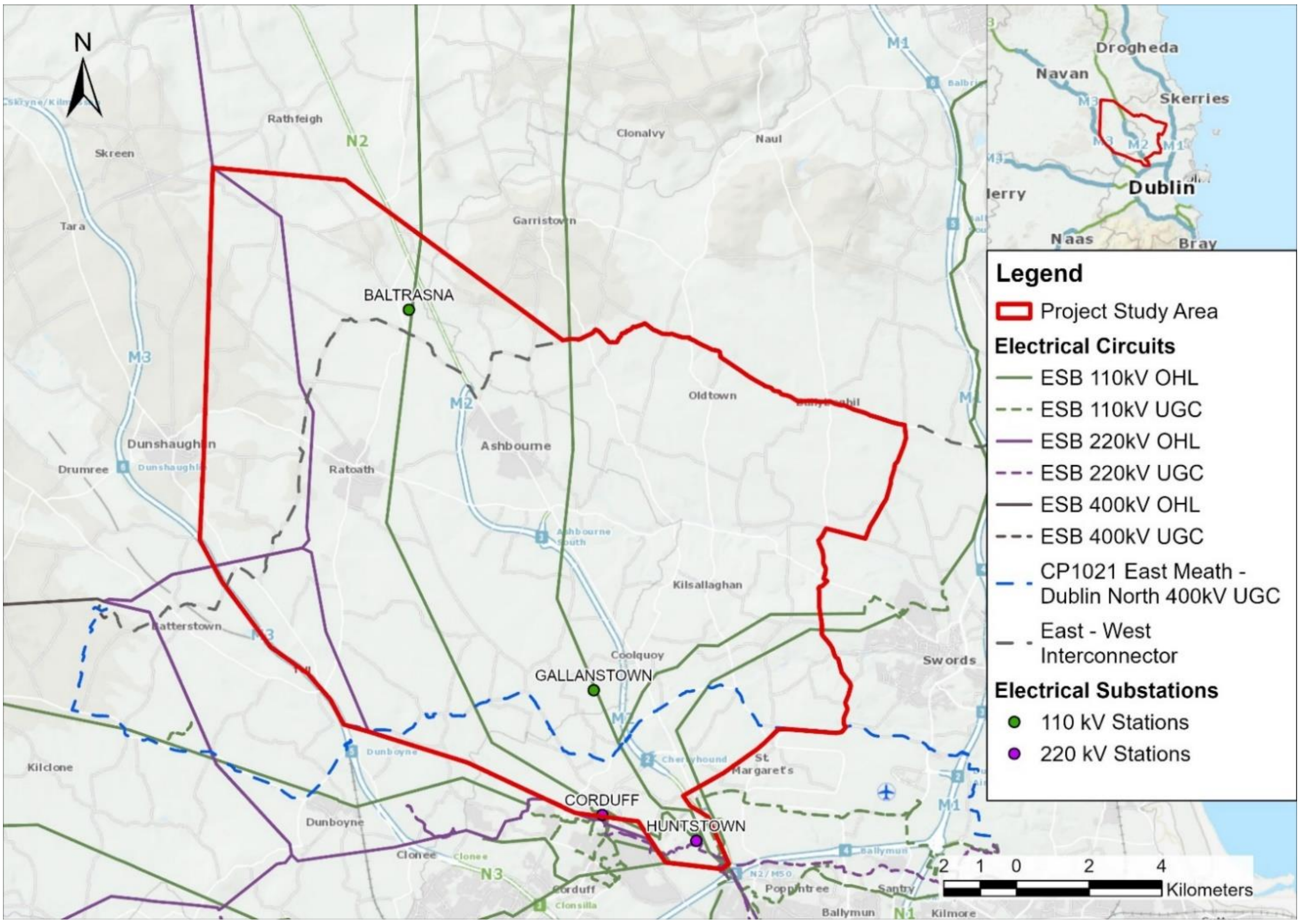


Figure 3-3 - CP1214 Step 3 Study Area

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 existing route for Louth-Woodland 220 kV OHL circuit;
- The proposed route for CP1021 East Meath-North Dublin 400 kV UGC;
- The East-West Interconnector UGC circuit;
- The motorway network e.g., M1, M2, M3, M50;
- Dublin International Airport;
- Significant towns and settlements such as Dunboyne, Ratoath, Ashbourne, Blanchardstown and Mulhuddart;
- Consideration of OHL route options with the shortest and straightest possible routes; and
- Consideration of UGC route options including the use of public roads.

The proposed Study Area (see Figure 3-3) is situated within the boundaries of Meath County Council and Fingal County Council. The western boundary of the Study Area allows for possible new substation locations proximate to the existing Louth-Woodland 220 kV OHL. The areas south of the M3 namely, Dunboyne, Clonee and Mulhuddart are not considered to be feasible for either OHL or UGC for a variety of reasons, namely the proliferation of existing utilities, residential and industrial buildings, and the significant disruption that would be brought to the area. It is considered that built-up industrial areas such as Ballycoolen and Cloghran are also significant constraints and therefore have been excluded from the Study Area. To the east, Dublin Airport and the Swords urban area pose a significant constraint to the identification of feasible circuit routes and have therefore been excluded.

3.2 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;
- Land, Soils and Geology;
- Material Assets;
- Noise and Vibration;
- Water;
- Air and Climate;
- Planning and Policy;
- Landscape and Visual;
- Settlements and Communities;
- Recreation, Amenity and Tourism;
- Cultural Heritage; and
- Aviation and Defence.

With the constraints identified, it was necessary to present the information in a manner that would inform the identification of potential substation sub-study areas and circuit grid route corridors. 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 substation risk, OHL risk and UGC risk, and are shown in Figure 3-4, Figure 3-5, and Figure 3-6 respectively.

The constraints assessment is documented in the CP1214 Environmental Constraints Report.

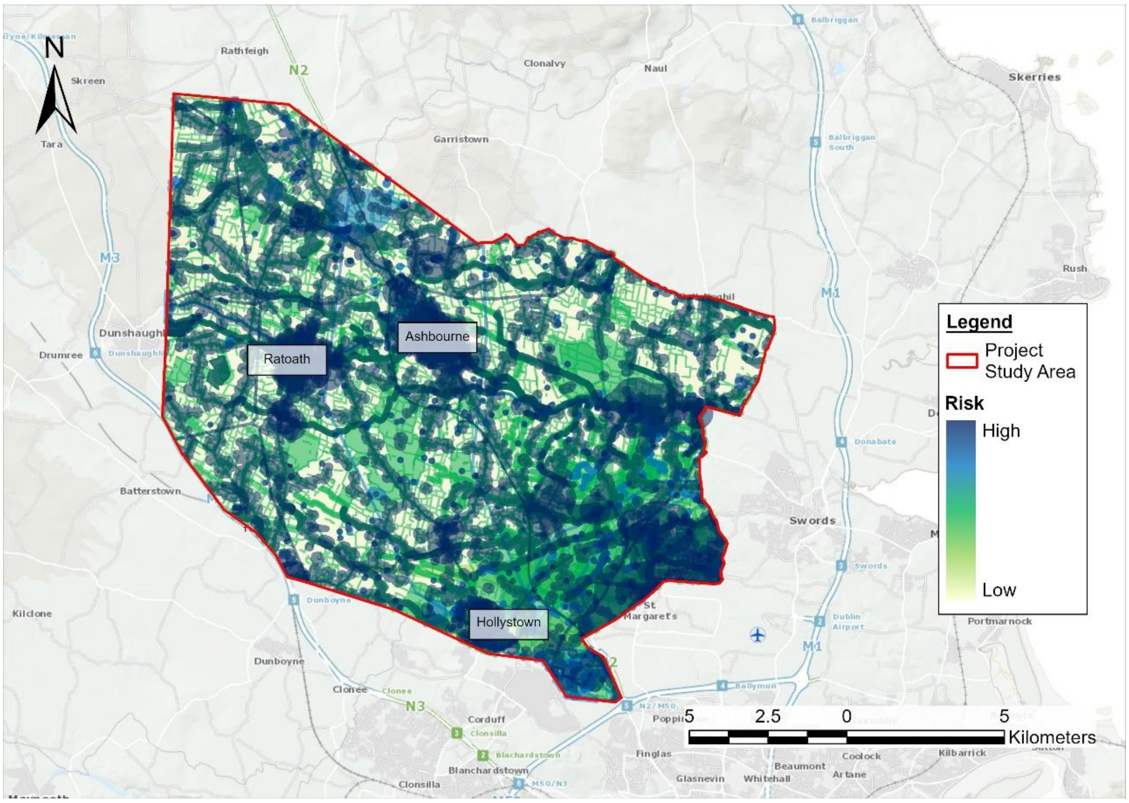


Figure 3-4 - CP1214 Substation Risk Heat Map

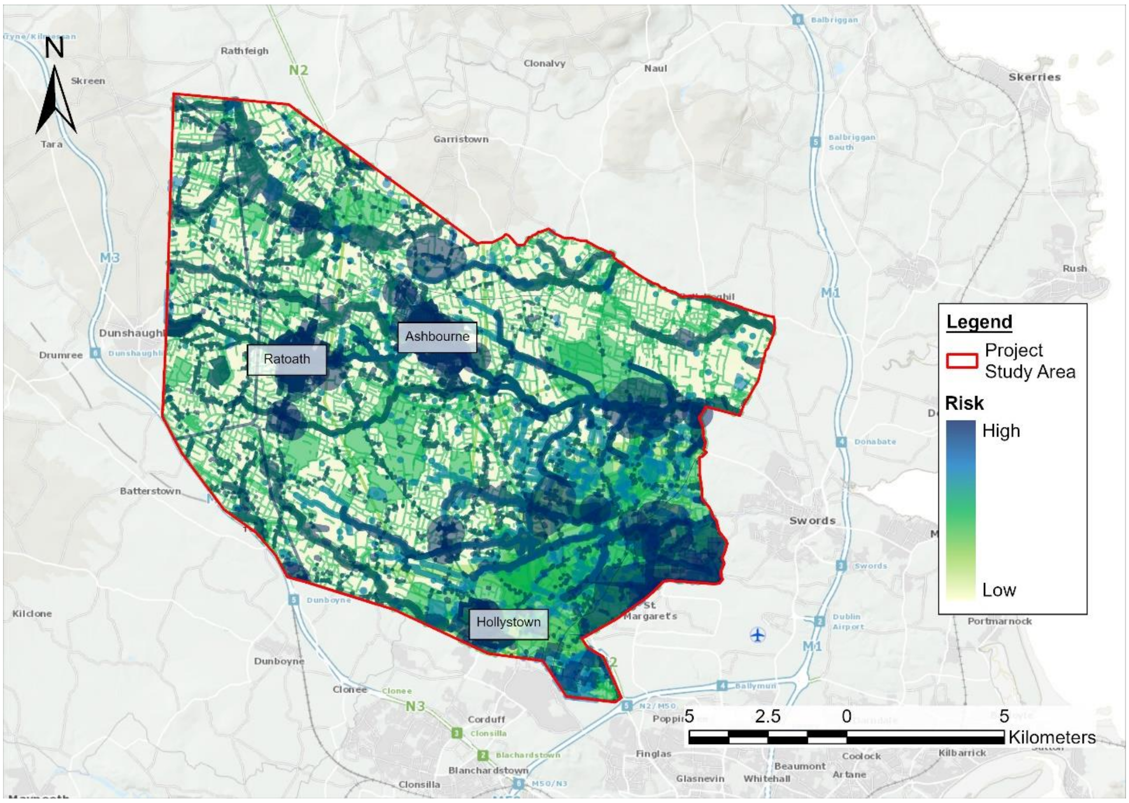


Figure 3-5 - CP1214 OHL Risk Heat Map

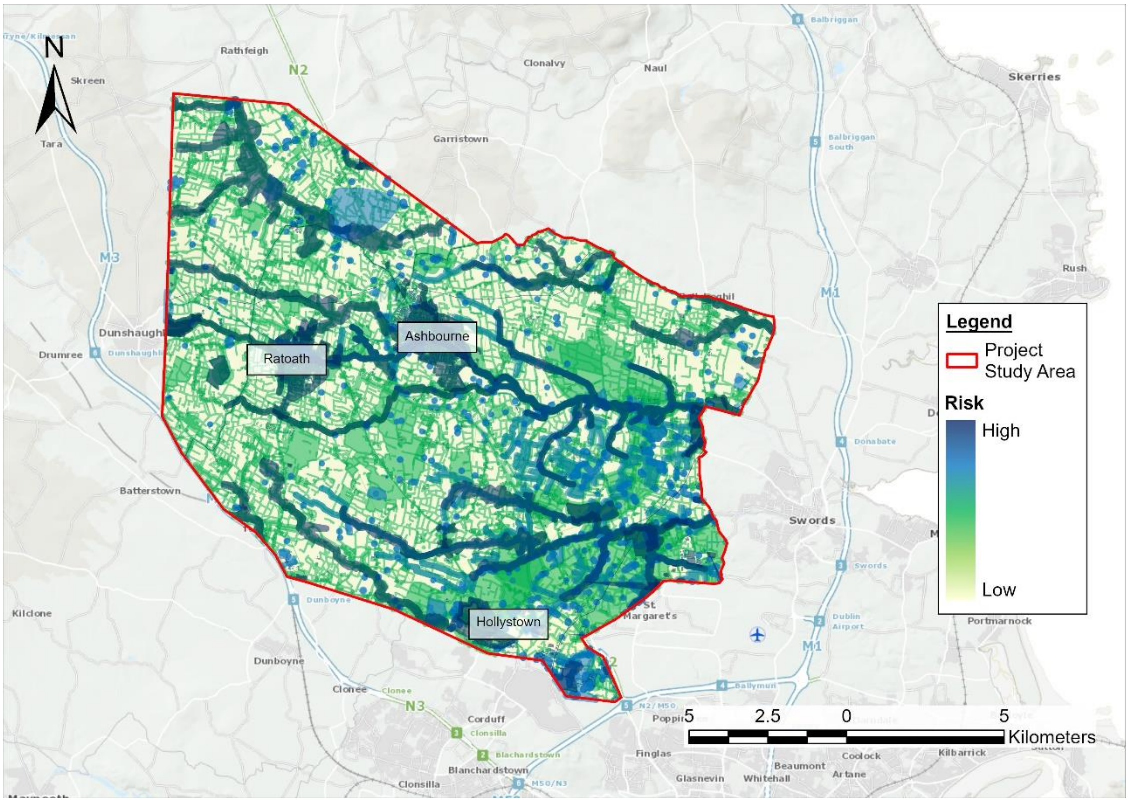


Figure 3-6 - CP1214 UGC Risk Heat Map

3.3 Substation Sub-Study Areas

3.3.1 Search Criteria

The proposed sub-study areas were developed to identify suitable areas for locating potential substation sites. The methods used to determine potential areas take into consideration the technical, economic and deliverability factors for the required loop-in points which may impact the project, as well as the environmental and socio-economic constraints associated with an area.

Fingal 400 kV substation (eastern section of the Study Area)

- Where possible, maintain a 2 km buffer area from the CP1021 East Meath-North Dublin 400 kV UGC, to reduce the distance of required 400 kV loop-in double circuit and thus minimise any associated technical, economic and deliverability constraints;
- Consideration of the ease of connectivity for the proposed 220 kV circuit to the East Meath 200 kV substation and for other future 400 kV, 220 kV and 110 kV circuits which will connect into the substation;
- Avoidance of highly constrained areas such as built-up urban areas, e.g., Hollystown;
- Avoidance of large local amenity areas;
- Avoidance of areas with high risk ratings as identified in project constraint heat maps which could impact either the siting of a substation or the connecting OHL / UGC circuits;
- Limit study areas where possible outside of areas which may be zoned by local councils;
- Inclusion of areas large enough to accommodate substation sites suitable for both AIS and GIS technologies;
- Avoid major elevation changes or areas with unsuitable ground conditions.

3.3.2 Identified Sub-Study Areas

Based on the search criteria, five sub-study areas (E1 to E5) were identified, as shown in Figure 3-7.

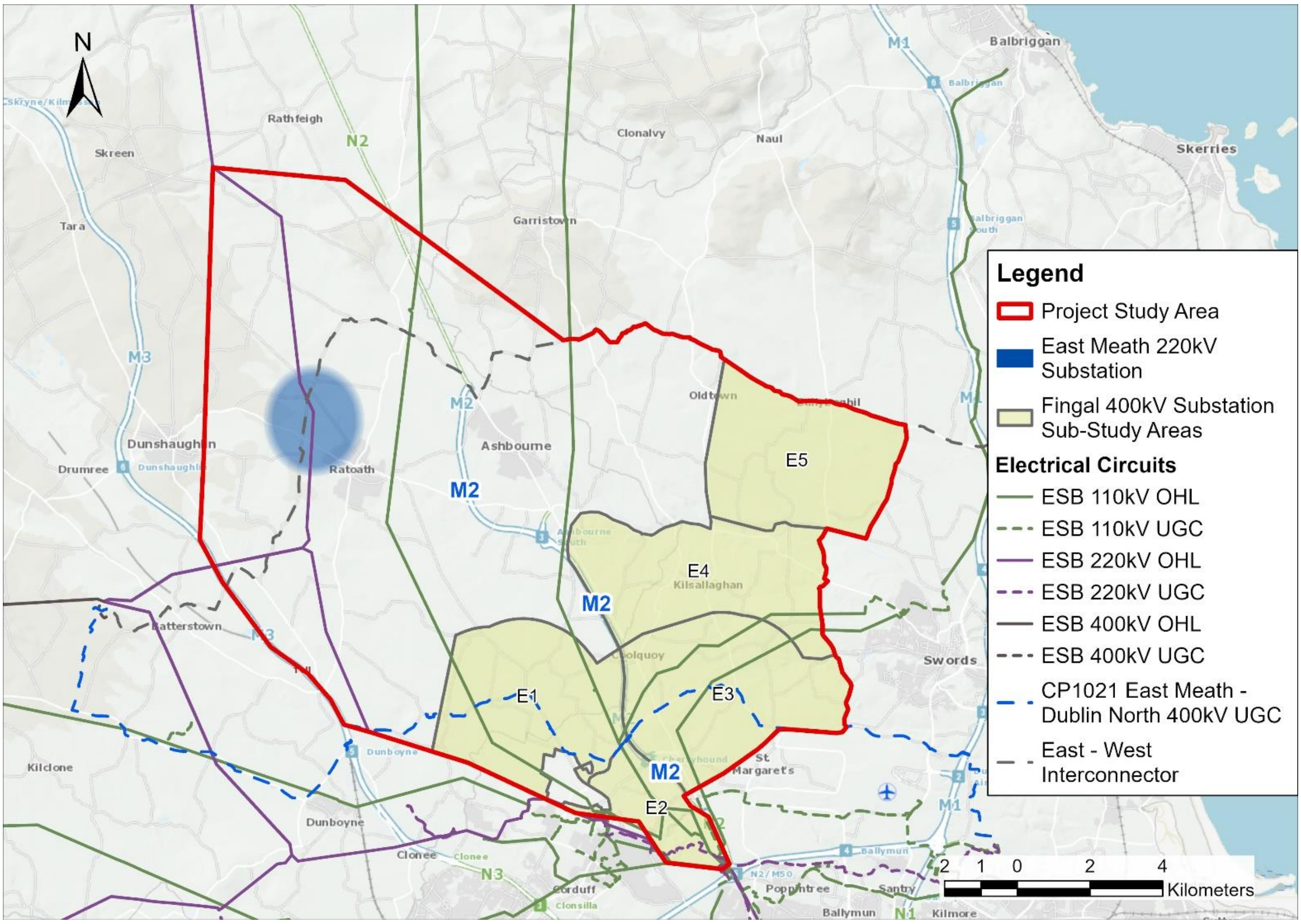


Figure 3-7 - Fingal 400 kV Substation – Identified Sub-Study Areas

3.3.2.1 Sub-Study Area E1

- This sub-study area was assessed as it has potential to present the shortest 220 kV grid connection option between the two new proposed substations. The area was limited to that west of the M2 motorway, which was used as a natural boundary for this sub-study area. The built-up area of Hollystown to the south of the sub-study area has also been used as a natural exclusion buffer for the substation area due to the built-up residential nature of the town.
- The area further west of this proposed sub-study area was deemed not feasible as this area does not fulfil the scope to bolster the electrical grid infrastructure in the North Dublin (West of Swords) area as outlined by EirGrid in Step 1 and Step 2.
- The area is primarily rural and there is potential to accommodate an AIS substation depending on the selection of a specific site.
- Based on the OHL and UGC constraint heatmaps generated, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options.

Table 3-1 illustrates positives and negatives associated with this sub-study area.

Table 3-1 - Positive and Negative Attributes of Sub-Study Area E1

Positive	Negative
By keeping the sub-study area to the west of the M2 motorway it negates the requirement for the 220 kV grid connection circuit to the East Meath 220 kV substation to cross the M2 motorway.	The sub-study area is a substantial distance from EirGrid's identified demand area (West of Swords / North Dublin).
Primarily rural area with large private land folios which may have the potential to accommodate an AIS substation.	The sub-study area is not centrally located in the vicinity to existing/proposed 110 kV circuits and substations in the Swords area, which does not achieve the project objective of better facilitating growing electricity demand in Swords.
Due to the proximity of the identified study area to CP1021 East Meath-North Dublin 400 kV UGC circuit the cost of a loop-in connection can be reduced.	The most southern point of the sub-study area borders built-up urban areas of Hynestown and Hollystown which on the heatmap present a large constraint, in particular for AIS substations.
Potential to keep within Meath County Council area (i.e., only one council to interact with).	Several granted grid connection projects / solar farms are located in this area which may constrain substation and route corridor development.
The heat map indicates pockets of potential areas which may be suitable for substation construction from an environmental perspective.	Flood areas are present within a large section of the sub-study area.
Although the sub-study area falls within Dublin Airport's Aviation Safeguarding area, it is not seen to present a constraint. The proposed sub-study area is located in an area where infrastructure exceeding 90 m needs consultation with DAA.	Sections of the sub-study area lie within designated Greenbelt zones which will require consultation with the relevant county council (Meath and Fingal County Councils).
	The sub-study area has a substantial number of watercourses which will need to be considered when siting a potential substation.

3.3.2.2 Sub-Study Area E2

- This sub-study area is located in the most southern area within the overall Study Area. This area was selected using the M2 motorway and N2 national road as a natural buffer. Dublin Airport is in close proximity to the east of the proposed sub-study area. The southern boundary of the sub-study area borders some of the more heavily built-up areas around the outskirts of North Dublin City. To the north, this area borders both Sub-Study Areas E1 and E3.
- Although a rural area, it is relatively built up with a mixture of industrial and residential areas predominantly in the south. It is likely the spatial requirements for the substation will not be sufficient for an AIS substation.
- Similar to Sub-Study Area E1, based on the OHL and UGC heatmaps generated and a high-level technical evaluation, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options.
- As with Sub-Study Area E3 and E4, the area is near the Dublin Airport Safeguarding zones. The Aviation safeguarding height allowances for new structures decreases closer to the airport. Whereas the Aviation Safeguarding height limits in this study area should not impact on any proposed substation

infrastructure/buildings, it could have an impact on potential future OHL circuits needing to connect to the substation, especially any circuits needing to connect to the North Dublin area around Swords.

Table 3-2 illustrates positives and negatives associated with this sub-study area.

Table 3-2 - Positive and Negative Attributes of Sub-Study Area E2

Positive	Negative
Potential to blend a GIS substation in with the surrounding buildings in an urban / industrial environment with a high prevalence of existing electrical infrastructure.	Heavily built-up area which potentially restricts access to the substation for future circuits connecting into the proposed Fingal 400 kV substation.
Whilst largely inside the Dublin Airport Safeguarding area, the constraint heatmap indicates pockets of potential areas not affected by any height restrictions.	High pressure gas lines run through the centre of the sub-study area.
This area is located to the west of the M2 motorway and therefore the proposed 220 kV grid connection with the East Meath 220 kV substation will not be required to cross the M2 motorway.	The sub-study area largely falls within Dublin Airport's Aviation Safeguarding area.
Due to the proximity of the identified study area to CP1021 East Meath-North Dublin 400 kV UGC circuit the constraints of a loop-in connection to the Fingal 400 kV substation can be reduced.	The most northern section of the study area is marginally located within a Greenbelt area which will require consultation with the relevant county council (Fingal County Council).
	The sub-study area is on western side of M2 motorway which may affect the feasibility of future connections to the proposed Fingal 400 kV substation.
	Several granted grid connection projects / solar farms are located in this area which may constrain substation and route corridor development.

3.3.2.3 Sub-Study Area E3

- This sub-study area is located immediately to the west / north-west of Dublin Airport and the M2 motorway was used as a natural buffer to the west of the sub-study area. From a technical and economic perspective, a buffer of 2 km from the CP1021 East Meath-North Dublin 400 kV UGC circuit is used to define the sub-study area boundary to the north. To the south / east of the proposed study area Dublin Airport is considered a restriction for future development so this area was omitted.
- This sub-study area can be considered as an area which EirGrid can utilise as a central hub due to its proximity to existing overhead electrical infrastructure. Similar to Sub-Study Area E1, this area is primarily in a rural area and there is potential to accommodate an AIS substation depending on the selection of a specific site.
- Similar to Sub-Study Area E1, based on the OHL and UGC heatmaps generated and a high-level technical evaluation, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options.
- As with Sub-Study Area E2 and E4, the area is in close proximity to Dublin Airport Safeguarding zones. The Aviation safeguarding height allowances for new structures decreases closer to the airport. Whereas the Aviation Safeguarding height limits in this study area should not impact on any proposed Substation infrastructure/buildings, it could have an impact on potential future OHL circuits needing to connect to the proposed Fingal 400 kV substation.

Table 3-3 illustrates positives and negatives associated with this sub-study area.

Table 3-3 - Positive and Negative Attributes of Sub-Study Area E3

Positive	Negative
The sub-study area suits the project objective of siting the proposed Fingal 400 kV substation in the vicinity of Swords to better facilitate growing electricity demand in this area.	This sub-study area will require the proposed 220 kV grid connection to the East Meath 220 kV substation to cross the M2 motorway.
Primarily rural area with large private land folios which may have the potential to accommodate an AIS substation.	High pressure gas is located within the sub-study area.
Due to the proximity of the identified study area to CP1021 East Meath-North Dublin 400 kV UGC the constraints of a loop-in connection can be reduced.	The sub-study area falls with Dublin's Aviation Safeguarding area. Consultation will be required with DAA to ensure the height of any proposed development will comply with the guidelines outlined by the aviation authority. This sub-study area primarily falls within an area which states all structures over 15 m / 45 m will require consultation with DAA.
The heat map identifies pockets of potential areas with limited constraints against substation construction.	Sections of the sub-study area lie within designated Greenbelt zones which will require consultation with the relevant county council (Meath and Fingal County Councils).
Area centrally located in the vicinity to existing circuits which will assist with upgrading and futureproofing the existing electrical infrastructure.	Large local amenity areas located within the sub-study area, e.g., golf courses, which will need careful consideration when siting a substation.
	The sub-study area has a substantial number of watercourses which will need to be considered when siting a potential substation position.

3.3.2.4 Sub-Study Area E4

- This sub-study area is in the most eastern portion of the overall study area. The eastern border of the sub-study area has been determined using the Greenbelt zones located on the outskirts of Swords. Sub-Study Area E3 has been used as the boundary to the south, with Sub-Study Area E5 / the R125 to the north and the M2 to the west.
- Although this is largely a rural area, the eastern portion of the sub-study area is relatively built up with dwellings which are densely located in the area. It is likely that only a GIS substation could be accommodated in the eastern portion of the sub-study area, whereas either an AIS or a GIS substation could be accommodated in the western portion of the sub-study area.
- Similar to Sub-Study Area E2, based on the OHL and UGC heatmaps generated and a high-level technical evaluation, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options.
- As with Sub-Study Area E2 and E3, portions of the sub-study area are in close proximity to Dublin Airport Safeguarding zones. The Aviation safeguarding height allowances for new structures decreases closer to the airport. Whereas the Aviation Safeguarding height limits in this study area should not impact on any proposed substation infrastructure/buildings, it could have an impact on potential future OHL circuits needing to connect to the proposed Fingal 400 kV substation.

Table 3-4 illustrates positives and negatives associated with this sub-study area.

Table 3-4 - Positive and Negative Attributes of Sub-Study Area E4

Positive	Negative
The sub-study area suits the project objective of siting the proposed Fingal 400 kV substation in the vicinity of Swords, to better facilitate growing electricity demand in this area.	This sub-study area will require the proposed 220 kV grid connection to the East Meath 220 kV substation to cross the M2 motorway.
Largely rural area which presents less issues regarding substation siting and construction when compared to built-up areas.	High pressure gas is located within the most northern end of the sub-study area.
Heatmap indicates pockets of potential areas with limited constraints against substation construction identified.	The sub-study area falls with Dublin's Aviation Safeguarding area. Consultation will be required with DAA to ensure the height of any proposed development will comply with the guidelines outlined by the aviation authority. Portions of this sub-study area fall within an area which states all structures over 15 m / 45 m will require consultation with DAA.
Area centrally located in the vicinity to existing circuits which will assist with upgrading and futureproofing the existing electrical infrastructure.	Sections of the sub-study study area lie within designated Greenbelt zones which will require consultation with the relevant county council (Fingal County Council).
The western portion of the sub-study area is the closest to the proposed East Meath 220 kV substation, which would reduce the length of the future 220 kV grid connection.	Technical, economic and construction constraints associated with developing the required 400 kV double circuit loop-in from this sub-study area to CP1021 East Meath-North Dublin 400 kV UGC circuit (approximately 3-4 km long).
	The sub-study area has a substantial number of watercourses which will need to be considered when siting a potential substation.

3.3.2.5 Sub-Study Area E5

- This sub-study area is located to the north-eastern portion of the overall study area. The eastern border of the proposed sub-study area has been determined using the Greenbelt area West of Swords as the limiting buffer. The southern section of this sub-study area borders that of Sub-Study Area E4. The northern border of the area is formed by the restrictions of the overall study area.
- The connection between the proposed Fingal 400 kV substation and the CP1021 East Meath-North Dublin 400 kV UGC circuit would be by means of a double circuit 400 kV. This can be seen as a large constraint for this sub-study area due to the technical, economic, and socio-economic complexity of installing the overhead/underground infrastructure to accommodate this connection (approximately 6-7 km long).
- This sub-study area is primarily rural and there is potential to accommodate an AIS substation depending on the selection of a specific site.
- From an overview of the constraint heat maps generated and a high-level technical evaluation it appears the sub-study area has potential to accommodate both overhead line and underground cable grid connection options.

Table 3-5 illustrates positives and negatives associated with this sub-study area.

Table 3-5 - Positive and Negative Attributes of Sub-Study Area E5

Positive	Negative
Although a high pressure gas main runs through the sub-study area, it is only a very small section in the south-east of the sub-study area.	This sub-study area will require the proposed 220 kV grid connection to the East Meath 220 kV substation to cross the M2 motorway.
The sub-study area does not contain any designated Greenbelt zones.	Technical, economic and construction constraints associated with developing the required 400 kV double circuit loop-in from this sub-study area to CP1021 East Meath-North Dublin 400 kV UGC circuit (approximately 6-7 km long).
The heat map indicates there are potential areas available which may be suitable for substation construction.	The sub-study area has a substantial number of watercourses which will need to be considered when siting a potential substation position.
The sub-study area lies predominantly outside the Aviation Safeguarding zone of Dublin Airport.	

3.3.3 Preferred Sub-Study Areas for Further Assessment

Following the initial assessment of the five no. potential sub-study areas for locating the proposed Fingal 400 kV substation, together with a high-level assessment of the East Meath to Fingal 220 kV Grid Route Corridor (refer to Section 3.4), it was recommended to bring forward Sub-Study Areas E3 and E4 as the most suitable for further assessment. The additional assessment was carried out considering the following criteria (as aligned with the EirGrid Multi-Criteria Analysis Guidelines):

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

Given the large extent of the substation sub-study areas, the Environmental and Socio-Economic aspects were taken into consideration by using the heat maps.

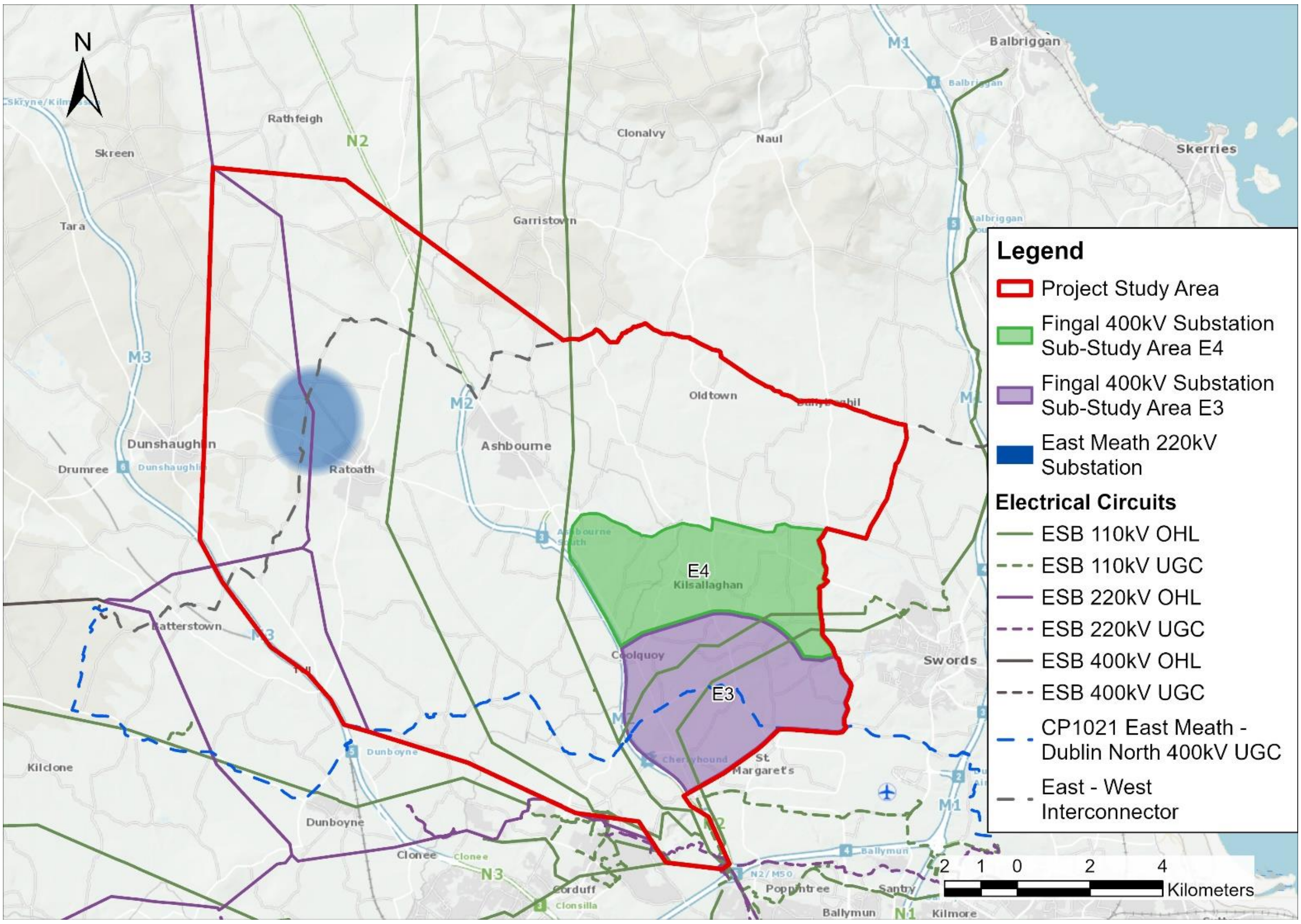


Figure 3-8 - Fingal 400 kV Substation – Preferred Sub-Study Areas

3.3.3.1 Sub-Study Area E3

3.3.3.1.1 Technical Performance

This sub-study area suits the project objective of siting the proposed Fingal 400 kV substation in the vicinity of Swords to better facilitate the growing electricity demand in this area. The sub-study area is centrally located in the vicinity to existing circuits which will assist with upgrading/expansion and futureproofing the existing electrical infrastructure.

Taking future projects into consideration, this sub-study area is located primarily in a rural area and will prove beneficial as it provides a less restrictive path for future projects to connect into the proposed Fingal 400 kV substation. This sub-study area has several inherent features which may prove advantageous:

- This sub-study area is primarily rural in nature which typically contain less services within the public road and will provide more space to incorporate future circuits within the existing road network;
- Installation of future overhead line circuits in a rural area will generally provide less constraints than those encountered in urban areas; and
- This sub-study area is in the vicinity of existing 110 kV circuits which, if required in future, are easily accessible to help provide future reinforcements to the local electrical grid.

However, the area is close to the Dublin Airport safeguarding zones. The aviation safeguarding height allowances for new structures decreases the closer the location is to the airport. Whereas the aviation safeguarding height limits in this study area should not impact on any proposed substation infrastructure/buildings, it could have an impact on potential future OHL circuits needing to connect to the proposed Fingal 400 kV substation.

The planned CP1021 East Meath-North Dublin 400 kV UGC circuit bisects the sub-study area (running approximately west to east) dividing the area into northern and southern sections. Considering the likely geographical spread of future connections, a possible need to cross the CP1021 East Meath-North Dublin 400 kV UGC circuit and the aviation safeguarding limits closer to Dublin Airport, there would be obvious advantages to siting the substation in the northern section of the sub-study area compared to the south.

Due to the close proximity to the CP1021 East Meath-North Dublin 400 kV UGC circuit, there is obvious technical and economic advantages associated with minimising the required distance of the 400 kV loop-in circuits to the proposed Fingal 400 kV substation (less installation works and disruption, reduced number of joint bays, reduced maintenance, less faults/possible outages, etc).

Based on the OHL and UGC constraint heatmaps generated and a high-level technical evaluation, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options for the 220 kV grid connection circuit and future TSO/DSO connections into the Fingal 400 kV substation (but with possible limitations on HV OHL connections nearby Dublin Airport).

3.3.3.1.2 Deliverability Assessment

Although this is largely a rural area, it is relatively built-up with dwellings which are densely located in the sub-study area. It is likely that the spatial requirements for the substation may not be sufficient for an AIS substation. Although both options will be looked at in further detail, it is likely that a GIS substation will be more advantageous in this sub-study area.

Overall, the sub-study area is relatively flat with good ground conditions which will assist with minimising construction costs. The reason for preference of a relatively flat area is to reduce the requirement for cut and fill groundworks across the footprint of the required compound.

The sub-study area minimises loop-in circuits distance between CP1021 East Meath-North Dublin 400 kV UGC circuit and the proposed Fingal 400 kV substation. By limiting the overall distance to the proposed Fingal 400 kV substation it can help:

- Minimise impact on public roads / private land requirements;
- Reduce construction constraints (traffic management requirements, encountering of third-party services); and
- Reduced construction costs.

On review of available flood mapping the area appears to have minimal locations which are prone to flooding. This is a key aspect which needs to be considered when identifying suitable sites for the final substation location.

3.3.3.1.3 Economic Assessment

This area is in close proximity to the CP1021 East Meath-North Dublin 400 kV UGC circuit. This will reduce the distance required for the 400 kV loop-in circuits to the proposed Fingal 400 kV substation.

Although this is largely a rural area, it is likely that the spatial requirements for the proposed Fingal 400 kV substation may be too large for siting an AIS substation within this sub-study area. The requirement for a GIS substation (or a hybrid AIS/GIS solution) would have an economic impact on the project costs.

3.3.3.2 Sub-Study Area E4

3.3.3.2.1 Technical Performance

This sub-study area suits the project objective of siting the proposed Fingal 400 kV substation in the vicinity of Swords, to better facilitate the growing electricity demand in this area. The sub-study area is centrally located in the vicinity of existing circuits which will assist with upgrading/expansion and futureproofing the existing electrical infrastructure. Taking future projects into consideration, this sub-study area is located primarily in a rural area and will prove beneficial as it provides a less restrictive path for future projects to connect into the proposed Fingal 400 kV substation. This sub-study area has a number of inherent features which may prove advantageous:

- This sub-study area is primarily rural in nature which typically contain less services within the public road and will provide more space to incorporate future circuits within the existing road network;
- Installation of future overhead line circuits in a rural area will generally provide less constraints than those encountered in urban areas; and
- This sub-study area is in the vicinity of existing 110 kV circuits which, if required in future, are easily accessible to help provide future reinforcements to the local electrical grid.

Compared to Sub-Study Area E3, this area is sufficiently distant from Dublin Airport so as not to be adversely impacted by the aviation safeguarding height restrictions. This will simplify the selection of suitable substation sites and future connecting circuit routes.

Compared to Sub-Study Area E3, the increased distance from the CP1021 East Meath-North Dublin 400 kV UGC circuit will have technical and economic disadvantages associated with the required 400 kV loop-in circuits to the proposed Fingal 400 kV substation (i.e., more installation works and disruption, increased number of structures / joint bays, increased maintenance, possibly more faults / outages, etc).

Based on the OHL and UGC constraint heatmaps generated and a high-level technical evaluation, the sub-study area has potential to accommodate both overhead line and underground cable grid connection options for the 220 kV grid connection circuit and future TSO/DSO connections into the proposed Fingal 400 kV substation.

3.3.3.2.2 Deliverability Assessment

Sub-Study Area E4 is largely a rural area, with a smaller dwelling density compared to Sub-Study Area E3. This makes the area more suitable for an AIS substation.

Overall, the sub-study area is relatively flat with good ground conditions which will assist with minimising construction costs. The reason for preference of a relatively flat area is to reduce the requirement for cut and fill groundworks across the footprint of the required compound.

Compared to Sub-Study Area E3, this sub-study area is a further distance from the CP1021 East Meath-North Dublin 400 kV UGC circuit and the increased length of 400 kV loop-in circuits will impact on:

- Increased public road sterilisation / private land requirements;
- Increase in construction constraints (traffic management requirements, encountering of third-party services); and
- Increased construction costs.

However, this may be offset somewhat by a decrease in the required length of 220 kV grid connection from this sub-study area to the East Meath 220 kV substation.

On review of available flood mapping the area appears to have minimal locations which are prone to flooding. This is a key aspect which needs to be considered when identifying suitable sites for the final substation location.

3.3.3.2.3 Economic Assessment

Compared to Sub-Study Area E3, this sub-study area is further distant from the CP1021 East Meath-North Dublin 400 kV UGC circuit. This will increase the distance and costs required for the 400 kV loop-in circuits to the proposed Fingal 400 kV substation location. However, this may be offset somewhat by a decrease in the required length of 220 kV grid connection from this sub-study area to the East Meath 220 kV substation.

The area is deemed suitable with adequate land parcels available for both AIS and GIS substation solutions for the proposed Fingal 400 kV substation. If deemed suitable, an AIS substation would have significant economic advantages for the project over an GIS substation due to decreased capital and future operational/maintenance costs.

3.4 Corridor Feasibility Review

As the connection of the proposed Fingal 400 kV substation to the proposed East Meath 220 kV substation is required to achieve the overall project need, a feasibility review was undertaken to ensure a route can be found between the anticipated area of interest for the proposed East Meath 220 kV substation and the five (5no.) sub-study areas for the proposed Fingal 400 kV 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 substations. Further assessment of the potential circuit corridors and associated technologies will be undertaken in Step 4.

3.5 Identification of Substation Zones

The preferred 2no. sub-study areas are considerably larger than the actual size of land required for the proposed Fingal 400 kV substation site. It was decided that substation zones (within the preferred 2no. sub-study areas) would be identified to allow a more detailed assessment to be undertaken.

These substation zones were identified following analysis of constraint heatmaps which take into consideration several different factors which may affect the siting of the proposed Fingal 400 kV substation. These factors include, but are not limited to, technical performance, economic assessment, deliverability aspects, environmental aspects, and socio-economic aspects.

The substation zone boundaries have been defined by either existing constraints or linear features such as roads, rivers, county boundaries, etc. (as discussed further in this Section). However, depending on the availability of suitable land within a zone or along its boundary, it would be acceptable to modify/extend the zone if suitable land / sites are identified adjacent to the current boundaries.

A total of five (5no.) substation zones (ZE1 to ZE5), ranging in size from 205 ha to 525 ha, were identified and are shown in Figure 3-9 and Figure 3-10. The zones were sized to accommodate either substation technologies under consideration (i.e., gas-insulated switchgear and air-insulated switchgear).

All five of the substation zones were brought forward for further detailed assessment as part of the MCA process.

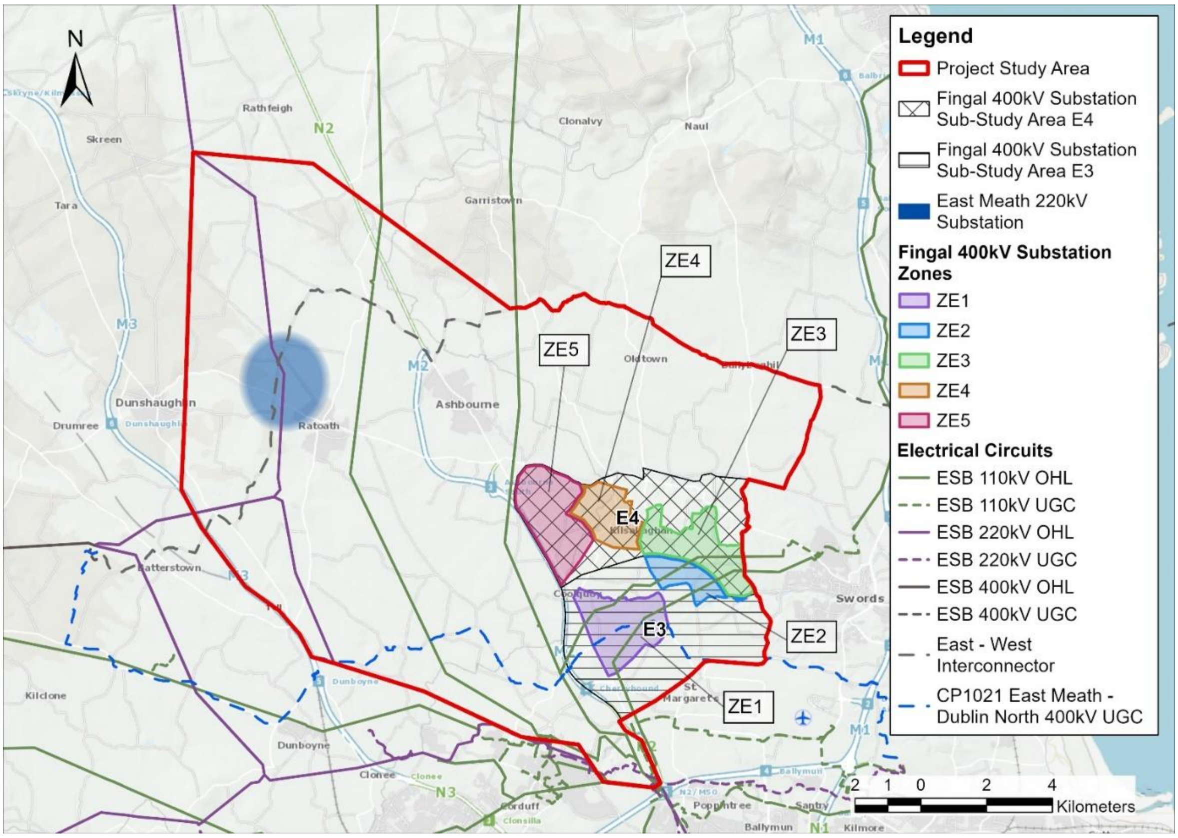


Figure 3-9 - Fingal 400 kV Substation Zones (ZE1 to ZE5) Within the Study Area

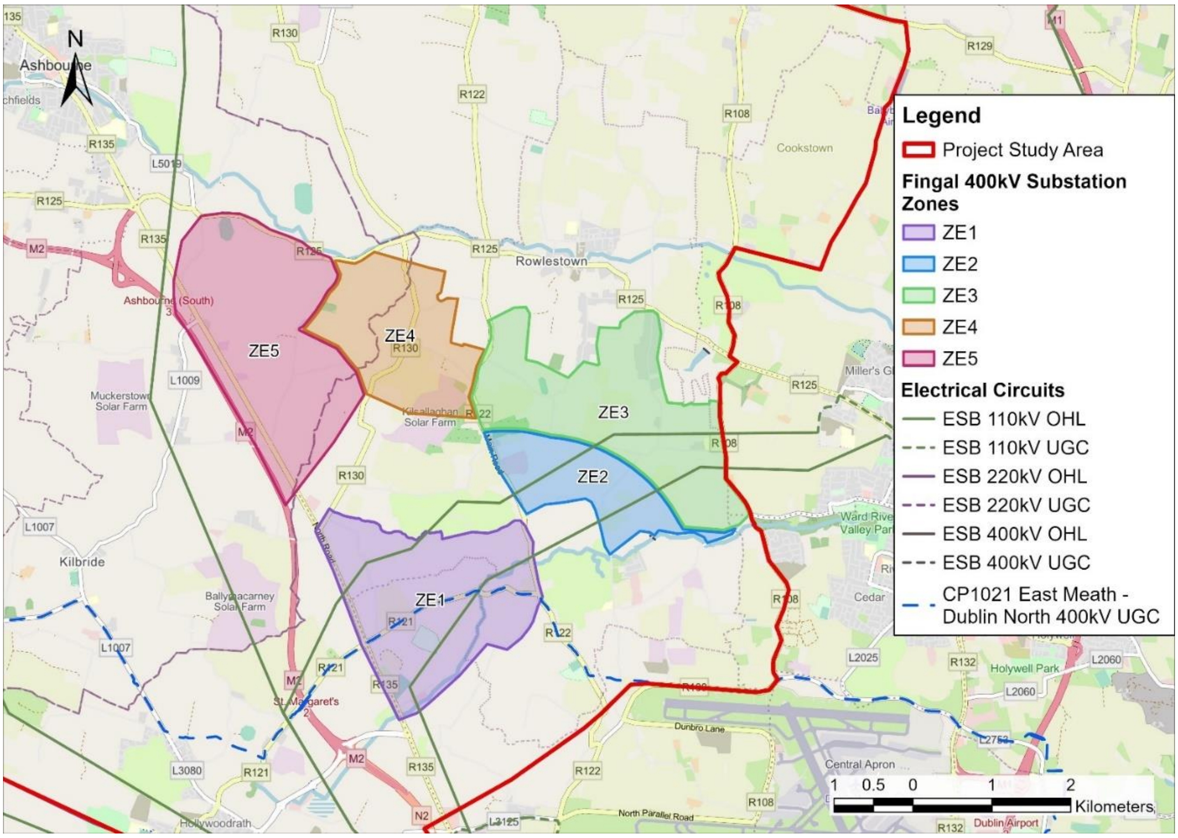


Figure 3-10 - Fingal 400 kV Substation Zones (ZE1 to ZE5) - Detailed View (© OpenStreetMap)

3.5.1 Substation Zone ZE1

Substation Zone ZE1 is situated within Sub-Study Area E3. The boundaries of ZE1 are defined by the following constraints which are situated just outside of the proposed zone:

- To the north, there are wetlands and amenity grasslands.
- To the south, the Dublin Airport Safeguarding Zone. Initial consultation with DAA has taken place, and further consultation will take place moving into Step 4.
- To the east, there are wetlands, high-pressure gas mains and St. Margaret's Golf & Country Club. The R122 borders the zone.
- To the west, the R135 borders the zone.

3.5.2 Substation Zone ZE2

Substation Zone ZE2 is situated within Sub-Study Area E3. The boundaries of ZE2 are defined by the following constraints which are situated just outside of the proposed zone:

- To the north and east, the boundary of the zone is defined by the 2 km buffer from the CP1021 East Meath-North Dublin 400 kV UGC.
- To the south, the Dublin Airport Safeguarding Zone. Initial consultation with DAA has taken place, and further consultation will take place moving into Step 4.
- To the west, there are wetlands. The R122 borders the zone.

3.5.3 Substation Zone ZE3

Substation Zone ZE3 is situated within Sub-Study Area E4. The boundaries of ZE3 are defined by the following constraints which are situated just outside of the proposed zone:

- To the north, there are areas zoned for residential and the town of Rath, where there are several residential properties.
- To the south, the boundary of the zone is defined by the 2 km buffer from the CP1021 East Meath-North Dublin 400 kV UGC.
- To the east, the edge of the overall Study Area (defined by the Greenbelt zones located on the outskirts of Swords).
- To the west, the R122 borders the zone.

3.5.4 Substation Zone ZE4

Substation Zone ZE4 is situated within Sub-Study Area E4. The boundaries of ZE4 are defined by the following constraints which are situated just outside of the proposed zone:

- To the north, there are flood risk areas and the distance to the CP1021 East Meath-North Dublin 400 kV UGC becomes a key consideration. The R125 borders the zone.
- To the south, there are areas zoned for residential.
- To the east, the R122 borders the zone.
- To the west, a border is shared between ZE4 and ZE5.

3.5.5 Substation Zone ZE5

Substation Zone ZE5 is situated within Sub-Study Area E4. The boundaries of ZE5 are defined by the following constraints which are situated just outside of the proposed zone:

- To the north, there are flood risk areas and the distance to the CP1021 East Meath-North Dublin 400 kV UGC becomes a key consideration. The R125 borders the zone.
- To the south, there are areas zoned for residential and an existing solar farm.
- To the east, a border is shared between ZE5 and ZE4.
- To the west, the M2 borders the zone and the R135 is situated just within the western boundary of the zone.

3.6 Options under Consideration in 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.

3.6.1 Substation Technologies Under Consideration

The following two substation technologies have been considered:

- GIS – A Gas Insulated Switchgear substation (GIS substation) normally uses sulphur hexafluoride gas (SF6 Gas) whose dielectric strength is higher than air, to provide the phase to ground insulation for the switchgear of an electrical substation (note, other suitable gases can also be utilised). This works whereby the conductors and contacts are insulated by pressurised SF6 gas meaning clearances required are smaller than that of AIS substations. The main advantage of the GIS substation is that this phase to phase spacing can be reduced significantly resulting in a substation with comparable load capability to an AIS substation but with a much smaller compound footprint. This is particularly advantageous in an urban environment where land size is at a premium. It also results in a smaller visual impact on a landscape as it can result in a significantly smaller footprint than its AIS counterpart. The main disadvantage of the GIS substation type is the reduction in scope of the substation for future connections, as equipment can be costly and difficult to source over the long term (usually all equipment necessary for future connections is procured and installed during initial substation commissioning). However, with GIS substations becoming a much more established technology globally, more standardisation has been introduced into manufacturing of the GIS equipment and therefore sourcing of any such required equipment has become less onerous and costly. As per EirGrid standards, GIS equipment are installed indoors within dedicated GIS buildings. Refer to Figure 3-11 for an example of a GIS substation.

  Note, recent EU legislation requires GIS substation switchgear to be F-gases free from 2028 (<145 kV) and 2032 (>145 kV).
- AIS – An Air Insulated Switchgear substation (AIS substation) uses atmospheric air as the phase to ground insulation for the switchgear of an electrical substation. The main advantage of the AIS substation is the scope of the substation for future offloading, for this reason AIS substations tend to be the most popular 400 kV substation type. The equipment of an AIS substation is easily sourced and has a short lead-time; this means that the required future offloading does not need to be built immediately, unlike GIS where it must be considered with the initial build. The main disadvantage to the AIS substation is its overall size. At 400 kV level these substations can have a significant footprint and require sensitive locating in any rural environment. AIS are usually installed outdoor. Refer to Figure 3-12 for an example of an AIS substation.

A third hybrid option known as H-GIS, features a substation comprising of elements of both AIS and GIS technology. This allows the developer to potentially optimise a substation’s use of available land whilst also optimising the systems performance and cost characteristics. This has not been considered in Step 3; however, it will be considered (if applicable) in Step 4.

Figure 3-11 - Example of substation with gas insulated switchgear (GIS) – Kilpaddoge 220 kV Substation

Figure 3-12 - Example of substation with air insulated switchgear (AIS) – Cashla 220 kV Substation

3.6.2 List of Options Considered for Step 3

Given that suitability for AIS and GIS technologies was considered when identifying the substation zones, all five substation zones are therefore capable of siting an AIS or GIS substation. Allowing for an AIS and GIS option for each zone resulted in a total of ten (10no.) options being identified to be assessed in accordance with the Step 3 MCA process:

- Substation zone east no. 1, AIS technology (ZE1-AIS)
- Substation zone east no. 1, GIS technology (ZE1-GIS)
- Substation zone east no. 2, AIS technology (ZE2-AIS)
- Substation zone east no. 2, GIS technology (ZE2-GIS)
- Substation zone east no. 3, AIS technology (ZE3-AIS)
- Substation zone east no. 3, GIS technology (ZE3-GIS)
- Substation zone east no. 4, AIS technology (ZE4-AIS)
- Substation zone east no. 4, GIS technology (ZE4-GIS)
- Substation zone east no. 5, AIS technology (ZE5-AIS)
- Substation zone east no. 5, GIS technology (ZE5-GIS)

The 400 kV loop-in circuits from the proposed Fingal 400 kV substation to the proposed CP1021 East Meath-North Dublin 400 kV UGC will be considered in further detail once the search area for the Fingal 400 kV substation has been narrowed down to specific sites. This process will occur in Step 4 and will include an MCA assessment to identify the best performing technology (i.e., OHL or UGC) and corridor for the circuit.

3.7 MCA Process

To assist in identifying the best performing technology solution 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.

The Environmental Aspects and Socio-Economic Aspects are discussed in the CP1214 Environmental and Socio-Economic MCA Scoring Report.

3.7.1 Technical Performance

- **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.
- **Average Failure Rates**: The average failure rates for the OHL or UGC can be calculated using, for example, estimated availability figures (unplanned outages/100km/year), Mean Time To Repair and the length of the line or cable. A more detailed calculation could also take into account failure rates of transformers, switchgear and other items.
- **Headroom / Connectivity**: This is the amount of additional generation/demand capacity that the transmission network is able to facilitate in the future without upgrades following implementation of the solution option. Ease of connecting planned and future circuits is also examined.
- **Expansion / Extendibility**: This considers the ease with which the option can be expanded, i.e. it may be possible to uprate an OHL to a higher capacity or a new voltage in the future.
- **Repeatability**: This criterion examines whether this option can be readily repeated in the EirGrid network. For example, an OHL HVAC option is very repeatable, but a partially underground HVAC option is less repeatable as there can only be a certain amount of underground HVAC cable in each area of the network.
- **Technical Operational Risk**: “Technical 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), this would include depth to bedrock, likely water table depth, known areas of poor ground / marsh.

3.7.2 Economic Assessment

- **Project Implementation Costs**: Costs associated with the procurement, installation and commissioning of the grid development and therefore includes all the transmission equipment that forms part of the project’s scope.
- **Project Life-Cycle Costs**: These costs are 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.
- **Project Benefits**: Avoided costs and difference in constraint costs for example due to the lack of capacity to export a forecast volume of generation.
- **Cost to Single Energy Market (SEM)**: Cost to SEM from Development Unavailability (Reliability) i.e., the loss of energy due to unavailability.
- **Contingency Costs**: Estimate of unforeseeable expenditure that an individual option may incur.
- **Pre-Engineering Costs**: Costs associated with the design and specification, route evaluation and management of the statutory planning application, including contingencies for such activities.

3.7.3 Deliverability Aspects

- **Implementation Timelines**: Relative length of time until energisation (assess significant differences).
- **Project Plan Flexibility**: Does the project plan allow for some flexibility if issues arise during design and construction?
- **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 to complete the project.
- **Permits & Wayleaves**: Various permissions and wayleaves required to proceed to construction.
- **Planning and other statutory requirements**: Considers the requirement for planning, foreshore licenses or other statutory requirements.
- **Land Availability**: Considers land availability for the construction of the substation or 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.

3.7.4 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 3-6 shows the criteria performance/scoring scale used to illustrate each criteria parameter in a comparative assessment with other options.

Table 3-6 - 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)

4. Methodology

4.1 Relevant Documentation

The following documents have formed part of the input information to the technical feasibility study:

4.1.1 Project Documentation

1. RFP - SCF17163L2 – Assessing solution options for Capital Project 1214 (North County Dublin Bulk Supply Point and Associated New Transmission Circuit), prepared by Celine Howlett, 15th June 2023
2. Appendix 2 20230523 v1 Dublin Demand Projects - 400-220-110 SLD CP1214
3. FGD004-Multi_Criteria_Analysis_Methodology_DRAFT
4. Step 2 - CP1214 North Dublin BSP Options Report

4.1.2 EirGrid Documents

5. EirGrid Policy Statement on Busbar Configuration for 110 kV, 220 kV and 400 kV Transmission Substations, V4, Oct 2020
6. 110/220/400 kV Station General Requirements (XDS-GFS-00-001-R4)
7. 110/220/400 kV GIS Functional Specification (XDS-GFS-25-001-R4)
8. Substation Civil and Building Works (XDS-GFS-13-001-R2)

4.1.3 Reference Documents

9. CIGRE AG A3.01, CIGRE Reliability Survey on Equipment, H. Ito N. Uzelac, F. Richter, R. Le Roux, W. Pepper, L. Peng, A. Man-Im, I. Hategan, CSE N°23 December 2021
10. Study on the Comparative Merits of Overhead Electricity Transmission Lines versus Underground, ECOFYS / Golder Associates Ireland, May 2008
11. EirGrid AM-SYS-ARel-001, Asset Reliability Report - Years 2011-2016, V2.0, June 2020

4.2 Description of Process

This report details the findings of the more detailed evaluation of the Options identified in Step 3. The evaluation of the options uses a multi-criteria comparison against five main criteria, as outlined in Section 3.7.

Each of these five criteria are divided again into sub-criteria which are listed in Section 3.7. These sub-criteria were used in Step 3 to evaluate the Options in more detail and to select at least one best performing option.

In order to populate each individual sub-criterion in the multi-criteria performance matrix, information can be obtained from various sources including in-house databases, publicly available datasets or in-house experts/consultants. In some areas information obtained in earlier steps or in a previous project, if applicable, are used and improved with more accurate information which has come to light during the process of development.

5. Fingal 400 kV Substation

5.1 Substation Description

5.1.1 Project Description

From Step 2, EirGrid have indicated that the Fingal 400 kV substation is required in the general North County Dublin (west of Swords) area and will have a loop-in connection with the proposed 400 kV underground circuit going from Woodland to Belcamp (CP1021).

5.1.2 Single Line Diagram

The proposed Fingal 400 kV substation will comprise of:

- 8no. 400 kV bays,
- 16no. 220 kV bays, and
- 16no. 110 kV bays.

A high-level Single Line Diagram (SLD) for the substation including its associated equipment such as busbar rings, sectionalisers/circuit-breakers, transformers and compensating equipment is shown in Figure 5-1.

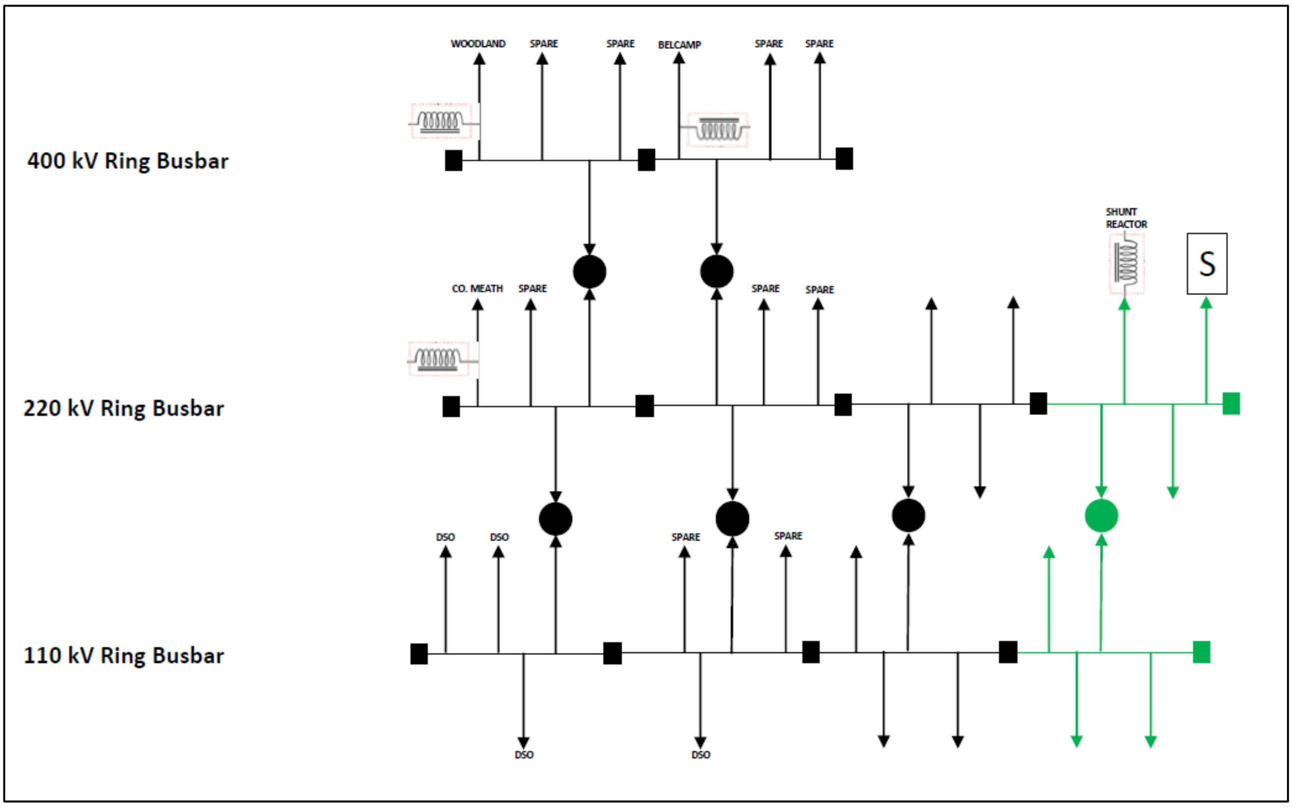


Figure 5-1 - Fingal Substation SLD (future bays/equipment shown in green)

5.1.3 Design Options

As discussed in Section 3.6.1, two main technology options are available for developing the substation, namely a Gas Insulated Switchgear substation (GIS substation) and an Air Insulated Switchgear substation (AIS substation).

5.1.4 Layout

5.1.4.1 AIS Substation

A preliminary substation layout based on AIS technology and the SLD from Figure 5-1 (encompassing all planned and future 400 kV, 220 kV and 110 kV electrical line bays and infrastructure) is depicted in Figure 5-2, based on EirGrid standards and specifications. The full layout drawing can be found in Appendix A.1. The layout encompasses a substation footprint of approximately 460m x 380m (17.5 hectares or 43 acres).

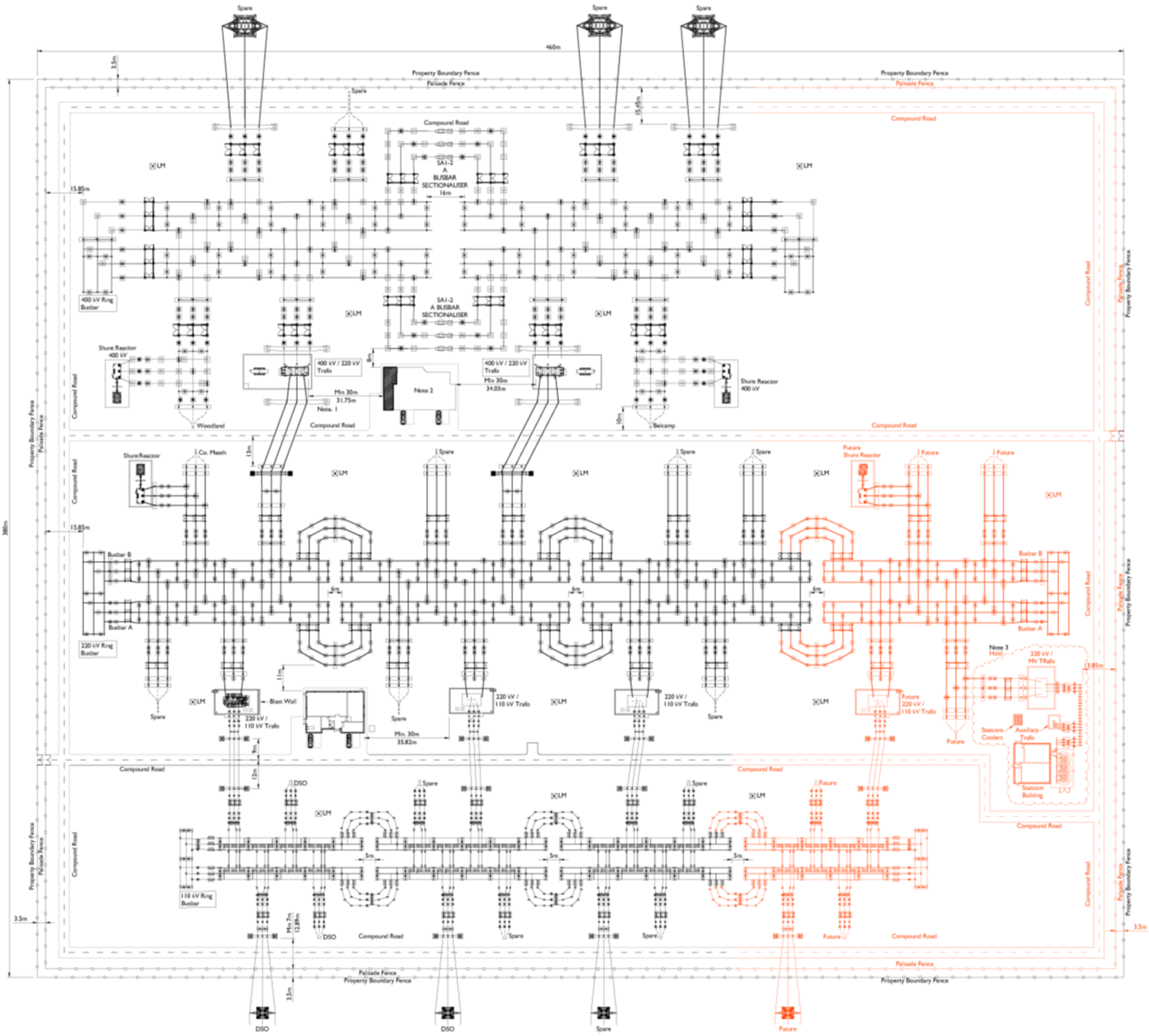


Figure 5-2 - Fingal 400 kV Substation – Preliminary AIS Layout (future bays/equipment shown in red)

5.1.4.2 GIS Substation

A preliminary substation layout based on GIS technology is depicted in Figure 5-3. The substation footprint is approximately 180m x 230m (4.1 hectares or 10 acres), which is approximately four times smaller than the AIS substation footprint. The full layout drawing can be found in Appendix A.2.

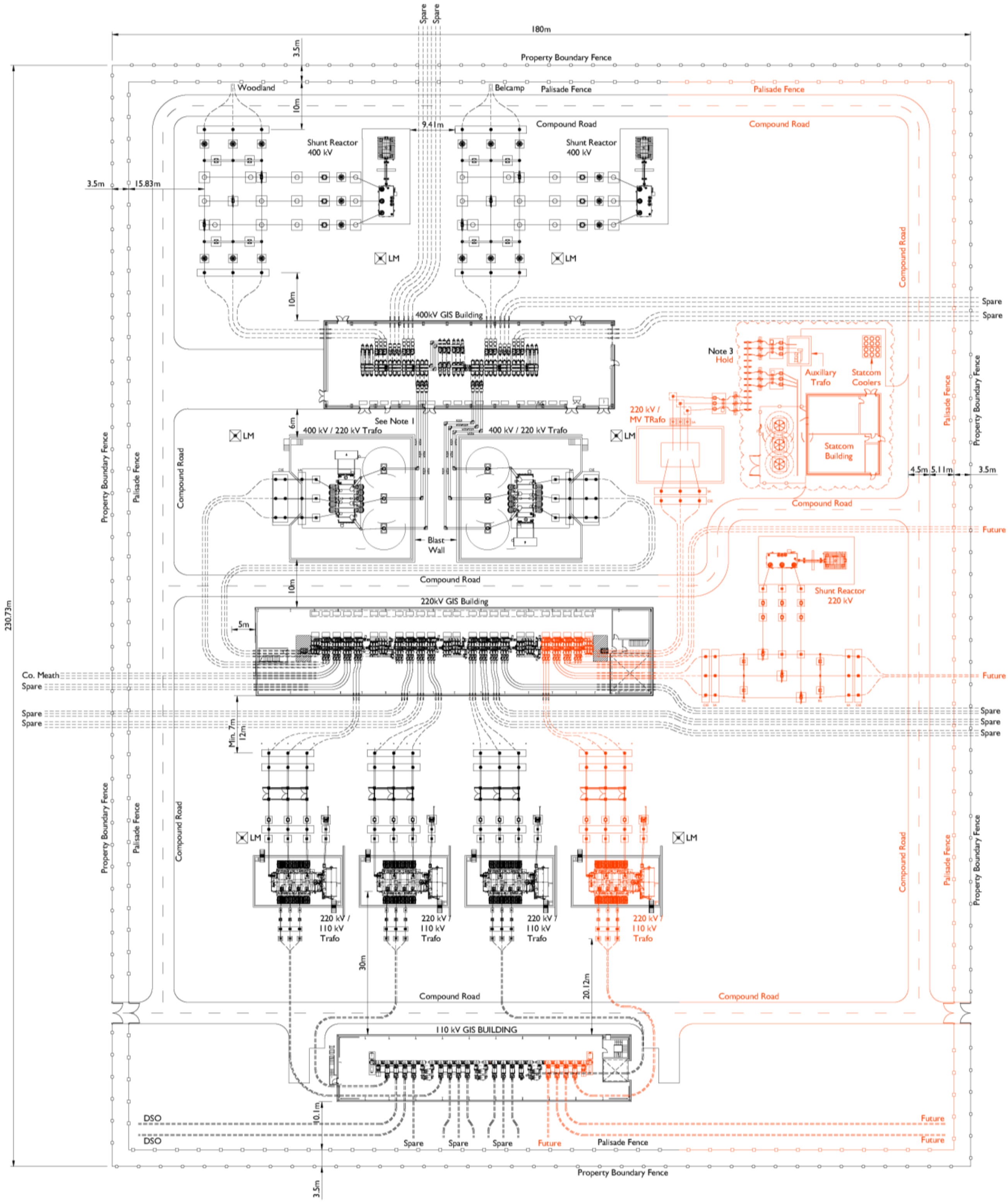


Figure 5-3 - Fingal 400 kV Substation – Preliminary GIS Layout (future bays/equipment shown in red)

5.1.5 Assumptions

Several assumptions have been taken into consideration with regards to the layout of the AIS and GIS substations and subsequent MCA. These are as follows:

- A mixture of Over and Under the Fence connections will be made in future into the compound, as the likely means of connecting future circuits could be both OHL and UGC technology.
- Designated line bays have been modified from Step 2 SLD (Figure 5-1) to facilitate the laying out of substation busbar rings and alignment of connecting transformer bays.
- Layouts accommodate compensation equipment (e.g., reactors and STATCOM) as shown in the Step 2 SLD. If additional compensation equipment is required in future, then additional compound space may be required.
- Additional lands should be acquired surrounding the substation, for contingency (e.g., future connections into the substation, OHL drop down masts / LCIMs, UTF gantries, etc.).
- Provision can be made for another 400/220 kV transformer if required, replacing a spare line bay.
- For the first phase of the substation build the construction compound could be sited within the area sited for future line bays / compensation equipment.
- Access roads, groundworks, cut and fill, landscaping requirements, etc. are unknown until specific sites are identified during Step 4.
- The MCA economic appraisal is based on the full substation configuration (including all future line bays and electrical infrastructure).
- Telecommunication mast not shown within substation compound but can be added later if required.
- Substation GIS building layouts are subject to change (possible 20% enlargement) pending possible future switchgear change to F-gases free technology however, overall compound footprint is not expected to increase significantly.
- A hybrid AIS-GIS substation solution has not been explicitly assessed in this study.

5.2 Fingal 400 kV Substation Zones

As discussed in Section 3.5, 5no. substation zones were identified for the proposed Fingal 400 kV substation and are shown in Figure 5-4.

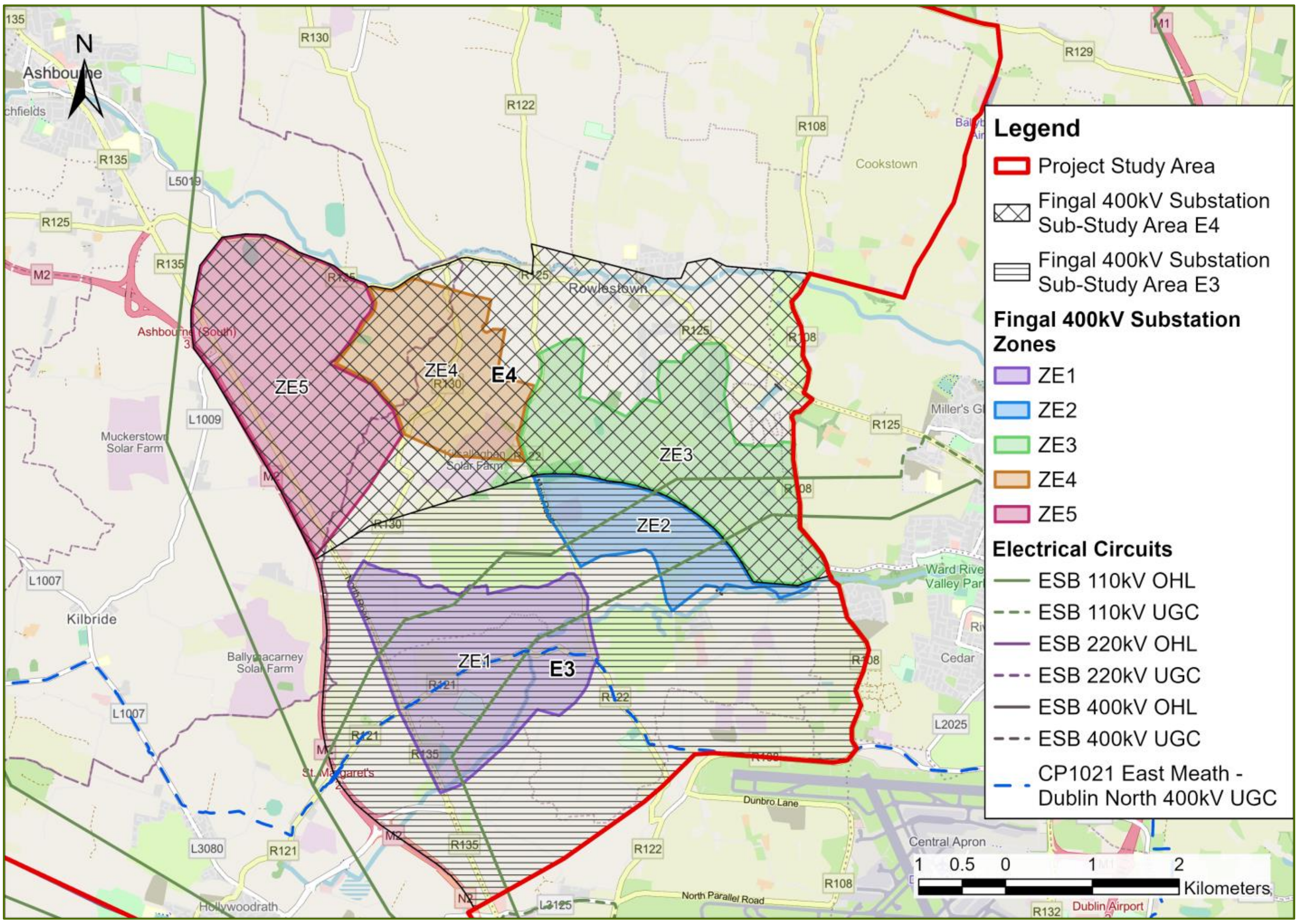


Figure 5-4 - Fingal 400 kV Substation Zones for Evaluation

A layout of each zone, together with the substation heatmap, is shown in the below sections.

5.2.1 Substation Zone ZE1

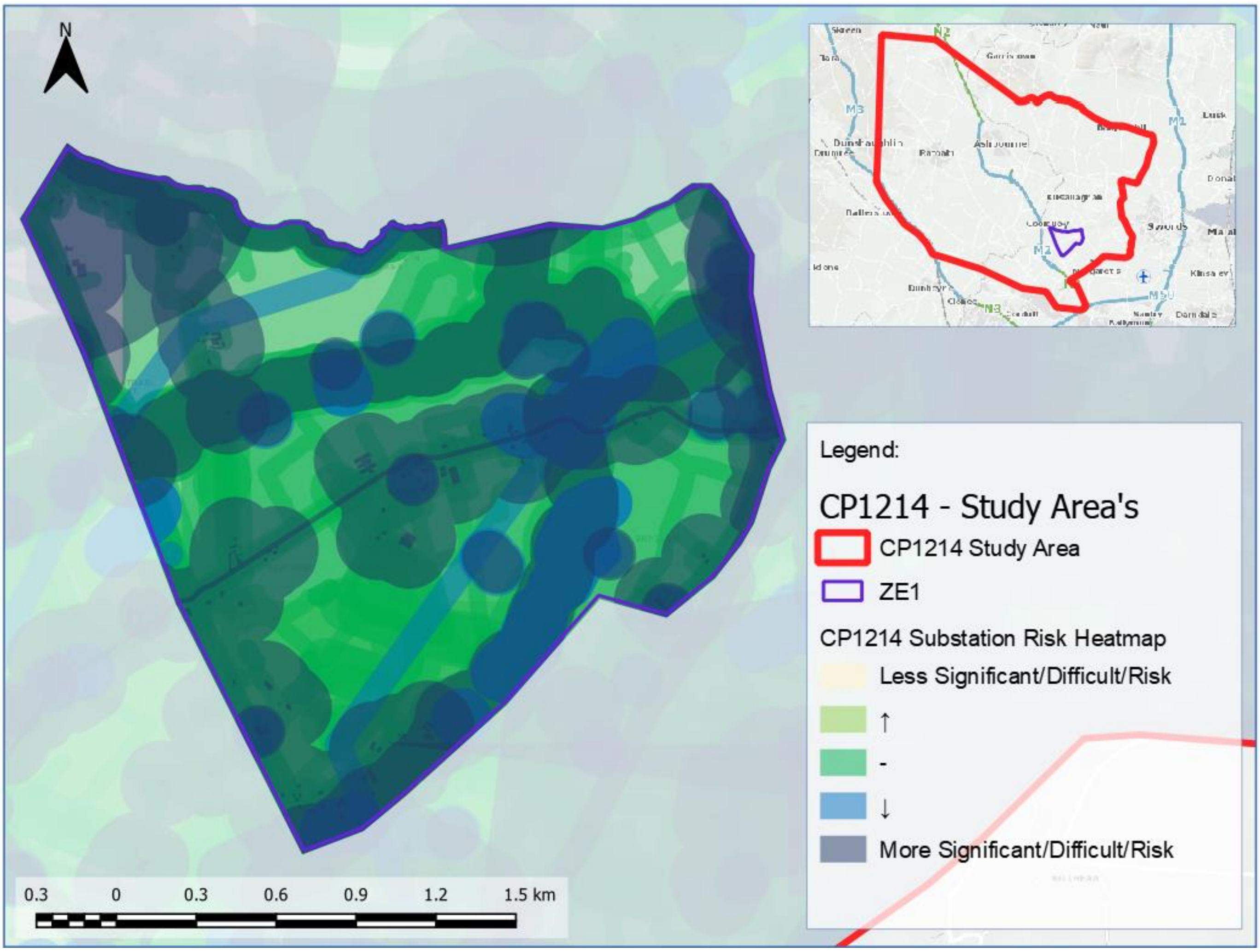


Figure 5-5 - Zone ZE1 & Constraints Heatmap

5.2.2 Substation Zone ZE2

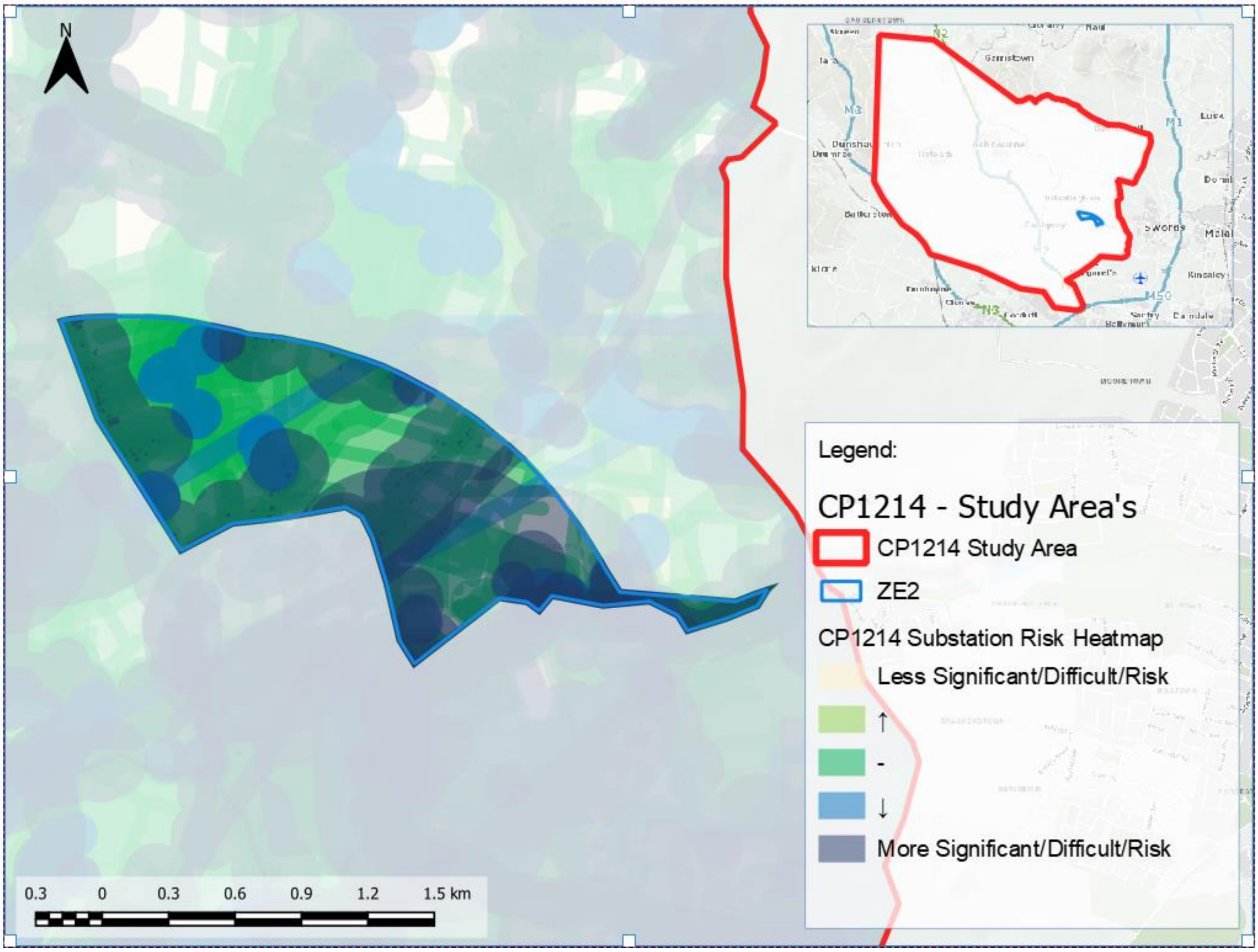


Figure 5-6 - Zone ZE2 & Constraints Heatmap

5.2.3 Substation Zone ZE3

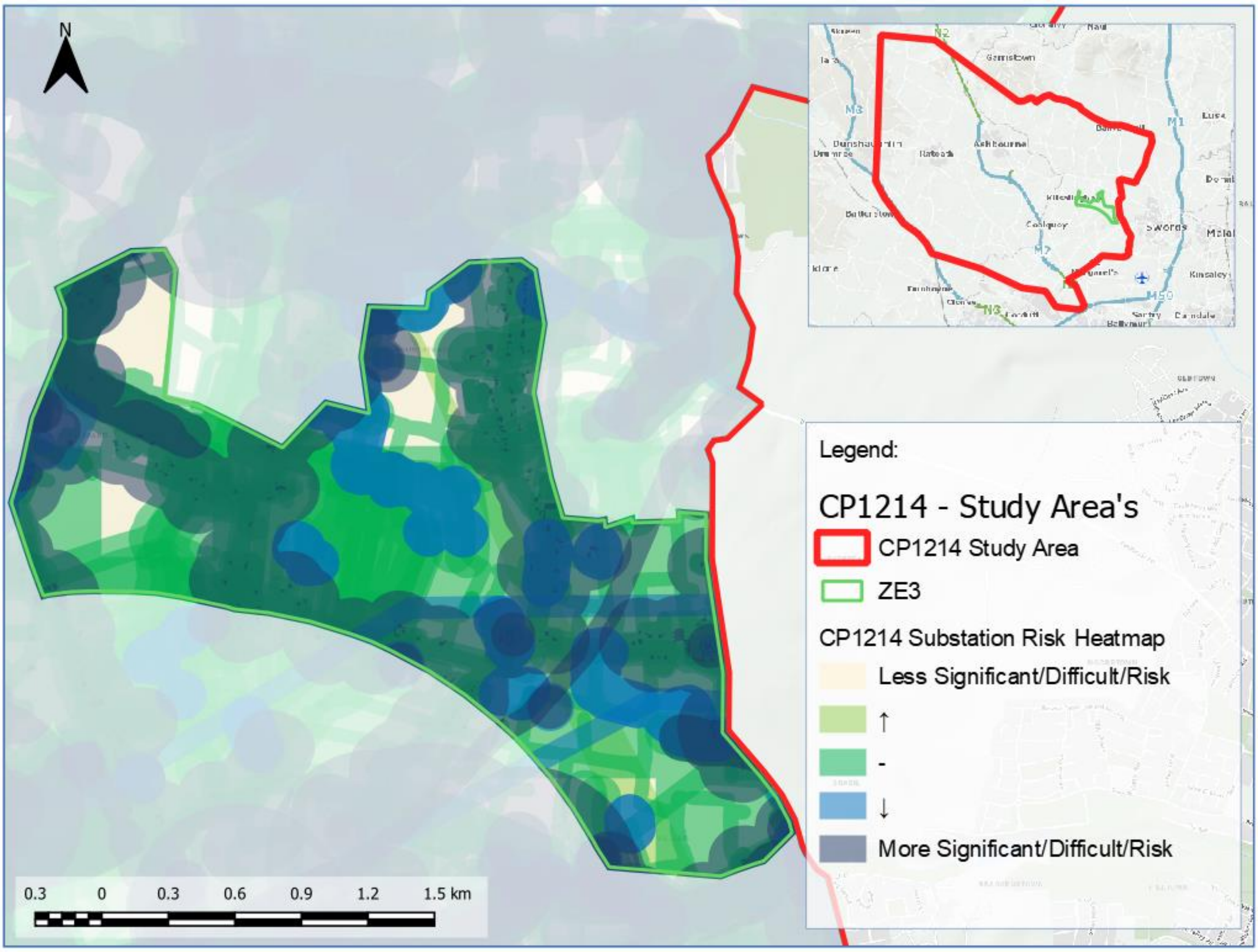


Figure 5-7 - Zone ZE3 & Constraints Heatmap

5.2.4 Substation Zone ZE4

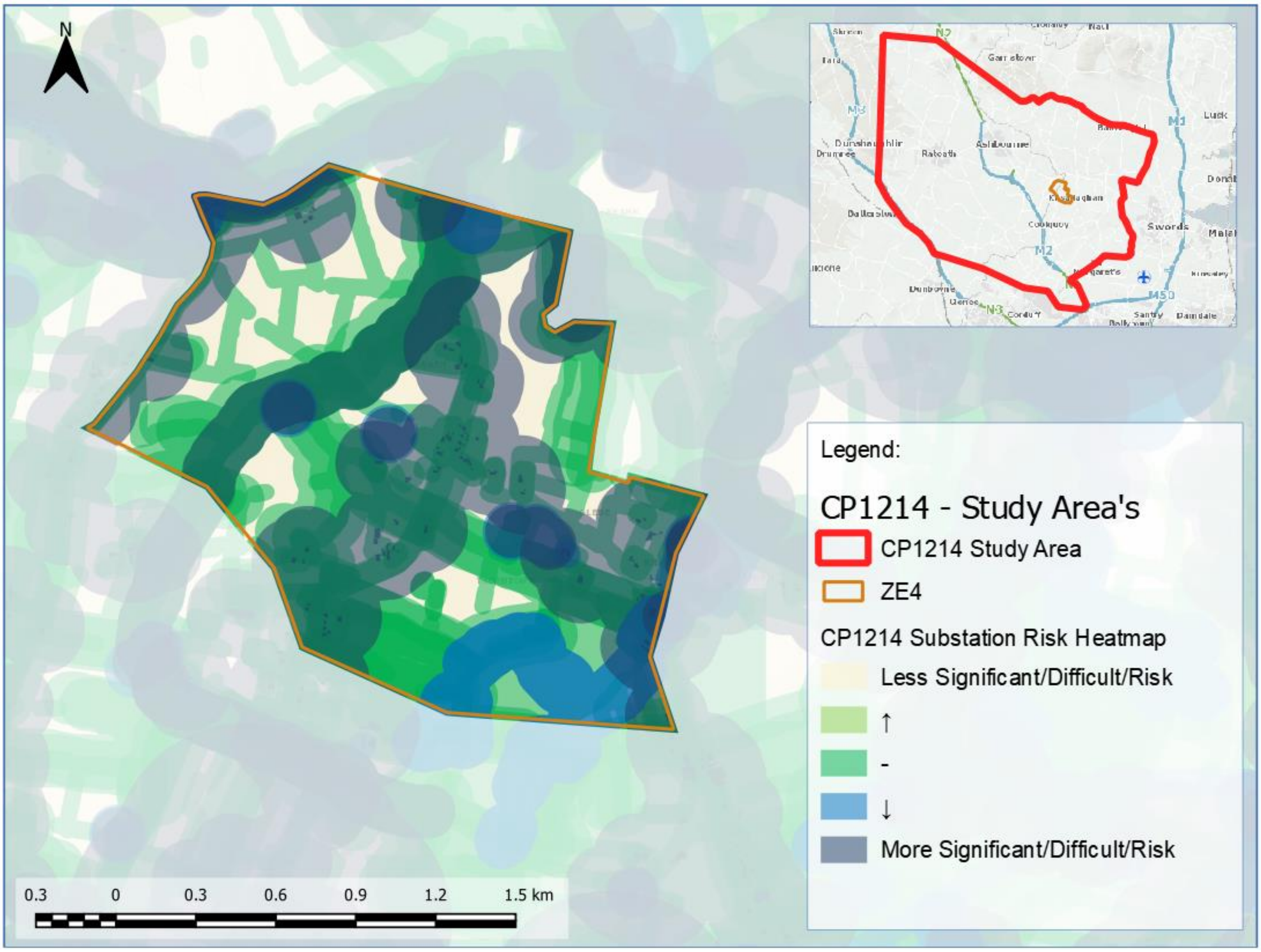


Figure 5-8 - Zone ZE4 & Constraints Heatmap

5.2.5 Substation Zone ZE5

Figure 5-9 - Zone ZE5 & Constraints Heatmap

5.3 Substation Options Evaluation

5.3.1 Technical Performance

Table 5-1 shows a summary of the scores for the Technical Performance of each option.

Table 5-1 - Technical Performance

Zone / ID	**ZE1-AIS**	**ZE1-GIS**	**ZE2-AIS**	**ZE2-GIS**	**ZE3-AIS**	**ZE3-GIS**	**ZE4-AIS**	**ZE4-GIS**	**ZE5-AIS**	**ZE5-GIS**
Type	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**
Compliance with Safety Standards	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Compliance with System Reliability, Security Standards	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Average Failure Rates	Moderate-Low	Low	Moderate-Low	Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low
Headroom / Ease of Connectivity	Moderate-High	Moderate-High	High Risk	High Risk	Moderate-High	Moderate-High	Moderate	Moderate	Moderate-Low	Moderate-Low
Expansion/extendibility	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate
Repeatability	Low	Low	Low	Low	Moderate-Low	Moderate-Low	Moderate-Low	Moderate-Low	Moderate-Low	Moderate-Low
Technology Operational Risk	Low	Moderate-Low	Low	Moderate-Low	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate
Geotechnical Conditions	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low
Overall	Moderate-Low	Moderate-Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate-Low	Moderate-Low

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

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

5.3.1.1 Summary

Zones ZE2, ZE3 and ZE4 are found to score the highest risk (Moderate) compared to the other two zones on account of relatively longer loop-in circuits with CP1021 and the risk to the 'ease of connectivity' for any substation sited within this zone.

The other two zones are found to score Low-Moderate risk with ZE1 scoring marginally higher risk compared to ZE5 due to a higher risk for 'ease of connectivity'.

AIS and GIS technologies have the same overall score for each zone from a Technical Performance point of view.

The evaluation of each option is made under each technical sub criterion and is elaborated further in the following sections.

5.3.1.2 Compliance with Safety Standards

As all options propose using tested and approved technology, they will comply with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). The materials used comply with IEC or CENELEC standards.

The busbar arrangement and layout (shown in Figure 5-2 and Figure 5-3) complies with EirGrid substation standards and policy for busbar configuration. The AIS and GIS substation arrangements remain the same for all the considered zones and as such all options are considered to score equally.

5.3.1.3 Compliance with System Reliability, Security Standards

As the substation SLD is the same for all options, they all scored as compliant / stable in terms of network stability (i.e., Voltage, Frequency, EMT Limits, Thermal Limits, Short Circuit Levels, Phase Angle, etc.). The present substation SLD and layouts have made provision onsite for future compensation equipment including Shunt Reactors and STATCOM.

It is noted that Zones ZE3, ZE4 and ZE5 are further distant from the CP1021 400 kV circuit and thus will require longer loop-in circuits (either UGC or OHL). However, it is deemed that these longer circuits will not substantially alter the network stability.

5.3.1.4 Average Failure Rates

SLD are identified for all substation options under consideration so Failure Rates are predominantly driven by the chosen switchgear technology (AIS or GIS). Published failure rate statistics for GIS switchgear are less compared to AIS switchgear for 110 kV – 400 kV technology (see Reference 9, 11). The mean time to repair (MTTR) is approximately double for GIS equipment but overall, Availability Levels are found to be higher for GIS technology.

Slightly higher failure rate levels are considered for zones ZE3, ZE4 and ZE5 due to the longer 400 kV loop-in circuits (Reference 10).

5.3.1.5 Headroom / Ease of Connectivity

As it is unknown at this stage what the future Generation and Demand requirements are on the substation and connecting circuits, all options are considered to score equally in terms of headroom.

The substation layout is extensive with the provision for 28no. individual circuit connection (6x 400 kV, 10x 220 kV, 12x 110 kV) within the substation. The placement of the substation is critical in terms of ensuring there is adequate space and corridors / public road network in the vicinity surrounding the substation for ease of connection of all future UGC or OHL connections. Based on the quantity of connections required all options are scored with a baseline risk of Moderate before other factors are considered.

For zone ZE1, future access may be limited for UGC circuits within the public road network due to the 400 kV CP1021 UGC circuit which traverses the zone and the possible UGC loop-in circuits to the 400 kV substation (UGC loop-in will affect all zones). There may be restrictions on OHLs along the southern section of zones ZE1, ZE2 and ZE3 due to the proximity to Dublin Airport and its associated height restrictions and it is noted that the 2no. Finglas-Glasmore 110 kV OHL circuits also traverse these zones.

Several regional roads traverse or border most of the zones with a network of additional local roads however, longer 400 kV loop-in circuits would restrict circuit connectivity from the south.

Zones ZE2, ZE3, ZE4 and to a lesser degree ZE1 will be impacted by known Solar Farm circuits within the local road network which will impact on future connectivity and the loop-in circuits with CP1021.

5.3.1.6 Site Expansion/Extendibility

The design for the 400 kV substation (no. of line bays) has already made provision for future connection of potential circuits to the substation, so all options are deemed to start at low risk.

The current design has 4no. spare 400 kV bays, 6no. spare 220 kV bays and 5no spare 110 kV bays for future connections. The design has also allocated space for 4no. future bays on the 220 kV busbar and 4no. future bays on the 110 kV busbar (including a connecting transformer bay). Further expansions are possible but for the GIS options there will be restrictions on expanding the GIS switchgear and building.

The proposed layout for the AIS substation already has very large footprint so it may be difficult to acquire additional adjacent land for future expansions. The GIS assets would be more onerous to extend unless the GIS building specification have already made provisions for additional space to accommodate additional bays (note, the 110 kV and 220 kV GIS buildings are already 16-bay standard EirGrid design).

The ease of connecting future circuits into the substation via each zone is also assessed, whether by the existing road network for UGC or via likely land corridors for OHL.

5.3.1.7 Repeatability

AIS and GIS substations (up to 400 kV) are already used in the Irish Transmission system and no limits are envisaged regarding repeatability of such technology.

The loop-in circuits' technology is not yet known but the circuit lengths under consideration for the 400 kV circuits (up to 5km) would not be prohibitive for either UGC or OHL options. However, the possibility of laying two 400 kV UGC circuits alongside each other within the local road network, if it is used, could be prohibitive and limit future use of the roads for UGC circuits. As such zones ZE3, ZE4 & ZE5 are scored at a higher risk.

5.3.1.8 Technical Operational Risk

AIS and GIS substation technologies are seen as a tried and tested technology on the EirGrid transmission network from 110 kV up to 400 kV. However, GIS equipment require specialist skills for the maintenance and repair of such equipment which may have to be sourced from the original equipment manufacturer (OEM) / outside of Ireland. As such there is higher technical operating risk associated with the GIS technology options.

Longer loop-in circuits length (associated with ZE3, ZE4 & ZE5) increases the operational risk, more so for 400 kV UGC (higher risk of faults or damage requiring key skills to repair).

5.3.1.9 Geotechnical Conditions

Until specific sites are available to consider, only a high-level appraisal of the geotechnical conditions within a zone is possible. The ground conditions in all zones can be taken to be relatively flat and rural in nature, with suitable ground conditions for siting a substation without major ground works. ZE1 through ZE4 are characterised as Rolling

Hills with Tree Belts or “Low Lying Agricultural”. ZE5 is characterised as the Ward Lowlands, with a landscape character type of “Lowland Landscapes”.

All zones considered are noted to contain waterways which may constrain the development of a substation (especially the AIS option) and some areas of localised flooding are noted within ZE1 and ZE5.

Areas of exposed bedrock are noted in all zones except ZE5.

More specific site investigation would be required for assessment and selection of specific substation sites.

5.3.2 Economic Assessment

Table 5-2 shows a summary of the scores for the Economic Assessment of each option.

Table 5-2 - Economic Assessment

Zone / ID	ZE1-AIS	ZE1-GIS	ZE2-AIS	ZE2-GIS	ZE3-AIS	ZE3-GIS	ZE4-AIS	ZE4-GIS	ZE5-AIS	ZE5-GIS
Type	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**
Project Implementation Costs	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate	Moderate-High	Moderate	Moderate-High	Moderate	Moderate-High
Project Life-Cycle Costs	Moderate	Low	Moderate-Low	Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low
Project Benefits	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Cost to SEM	Moderate-Low	Low	Moderate-Low	Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low
Contingency Costs	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High
Pre-Engineering Costs	Moderate	Moderate	Moderate	Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High
Overall	Moderate-Low	Moderate-Low	Moderate-Low	Moderate-Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

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

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

5.3.2.1 Summary

From an economic performance perspective zones ZE1 and ZE2 are found to score the lowest risk. This is on account of Implementation and Life-cycle costs being more for zones ZE3, ZE4 and ZE5 due to the longer CP1021 loop-in circuits required for these zones.

Until specific substation sites have been identified for appraisal in Step 4, all zones are scored high risk for Contingency Costs due to relatively high amount of uncertainty, i.e., lands costs, geotechnical conditions, required ground works, etc.

From an economic performance perspective, AIS technology is seen to perform marginally poorer compared to GIS. Even though GIS technology would have higher procurement (Implementation) costs, these are more than offset by higher life-cycle costs and higher land costs for AIS.

An evaluation of each option is made under each economic sub criterion and is elaborated further in the following sections.

5.3.2.2 Project Implementation Costs

The overall project scope will include a large quantity of transmission infrastructure with two high voltage substations, a 220 kV loop-in on the Louth-Woodland OHL, a 400 kV loop-in on the CP1021 UGC and a 220 kV connecting circuit between the two substations. As such, the overall project costs will be extensive. For the purposes of assessing the Fingal 400 kV substation, the overall scope is broken down to just the Fingal 400 kV substation and necessary loop-in circuit and as such, the baseline risk is scored Moderate before other factors are considered.

Assuming no substantial difference in land procurement costs between the different zones, the project implementation costs will be driven predominantly by whether the substation technology is GIS or AIS and the length / technology of the required loop-in circuits with CP1021. Until specific sites have been identified, costs associated with the actual substation construction works such as access roads, etc., are taken to be similar for all options.

GIS substations have a higher procurement cost compared AIS and as such are scored as higher risk for this sub-criteria.

Zones ZE3, ZE4 and ZE5 are a further distance from the CP1021 400 kV UGC circuit compared to ZE1 and ZE2 and as such are scored at a higher risk due to the increased costs of the required 400 kV loop-in circuits.

High-Level Cost Comparison

As part of this comparison study a high-level cost analysis was carried out. The analysis is high-level as a detailed site-specific design has not been identified or carried out to date. Taking this into consideration the following details are noted:

- The common costs for both AIS and GIS options are the HV power transformers, protection, telecoms, professional fees, design fees and other miscellaneous items.
- The costs under comparison are the civil, land, HV equipment provision and installation.
- The detailed design may have an impact on the compound size due to the possible requirements for cut and fill, landscaping, etc.
- Costs are based on a database of material, manufacturers’ and contractors’ costs for similar projects.

Land value in the region was established (pro rata) from CSO agricultural land prices (compiled in 2021) and verified against 2024 survey data (Irish Farmer Journal and Sherry Fitzgerald).

- The national median price of arable land was €16,000 (for use in East County Meath area)
- Dublin has a higher median prices per acre of €40,000 (for use in North County Dublin area).

Based on these values and using the minimum footprints of the two substation types which include the necessary station compound while excluding any road access and potential landscaping / screening areas, the following is the minimum that can be expected to pay for the different sites.

- AIS Substation circa 43 acres = € 1,720,000
- GIS Substation circa 10 acres = € 400,000

It should be noted that these figures are minimum figures and sites have been purchased in the past at multiples of the actual agricultural value after negotiations with the landowners.

Table 5-3 shows the comparison of estimated costs for the substation development including switchgear materials, civils, common costs, and installation. Estimates for the 400 kV loop-in circuits to CP1021 have also been included and all costs are shown normalised against the least costly option.

Table 5-3 - Substation Development Cost Estimate Comparison including Loop-in circuit

Zone / ID	ZE1-AIS	ZE1-GIS	ZE2-AIS	ZE2-GIS	ZE3-AIS	ZE3-GIS	ZE4-AIS	ZE4-GIS	ZE5-AIS	ZE5-GIS
Technology Option	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**
400 kV UGC loop-in	1.05	1.20	1.10	1.25	1.22	1.37	1.25	1.40	1.18	1.33
400 kV OHL loop-in	1.00	1.14	1.01	1.16	1.04	1.18	1.06	1.21	1.07	1.21

5.3.2.3 Project Life Cycle Costs

Project life-cycle costs over the expected useful life of the electrical substation equipment (typical lifespan for transmissions assets in the range of 40 to 50 years) are expected to be similar for each zone.

Substation Maintenance Costs

Like any electrical equipment, AIS and GIS switchgear requires continuous maintenance to prolong the life of the equipment and both AIS and GIS switchgear are subject to EirGrid's maintenance policy / specifications. The incremental maintenance costs are those costs incurred to ensure that the appropriate level of reliability and availability in the new circuit is maintained over its useful life. The annual service costs on both AIS and GIS are considered similar and the costs only vary when the switchgear requires a detailed service or inspection every 5+ years, where this will need the OEMs assistance.

Typical AIS Maintenance Requirements include, but are not limited to:

- Ongoing maintenance requirements, all equipment exposed to weather conditions,
- Disconnect contacts must be cleaned regularly, operating mechanisms must be checked and maintained.

Typical GIS Maintenance Requirements include, but are not limited to:

- Arrangement of switchgear will play a significant role in how maintenance will be carried out,
- Considerable dismantling may be required if a main element fails,

- OEM supervision (likely from Europe) will be required for any major service or fault repair.

In general, the Life Cycle Costs of GIS substations are expected to be approximately 70-80% that of an equivalent AIS substation and thus are scored at lower risk in this assessment.

Loop-in Circuit Maintenance Costs

Two 400 kV circuits will be required to connect the 400 kV substation to the CP1021 UGC circuit. Zones further away from the circuit will include higher maintenance / fault correction costs on account of the longer circuit lengths / increased number of joint bays or towers. This could be offset somewhat if the zone location shortens the required 220 kV connecting circuit between the Fingal 400 kV substation and the East Meath 220 kV substation, but it will not fully cancel out the extra 400 kV loop-in circuits costs. As such, zones situated further from the CP1021 circuit are scored at a higher risk.

Cost of Transmission Losses

All options have the same SLD and connecting circuits working at high voltages (110 kV, 220 kV and 400 kV), and as such the cost of transmission losses can be taken to be the same for all options being evaluated (AIS or GIS).

For the CP1021 loop-in circuits, transmission losses can be taken to be lower for UGC compared to OHL.

Replacement Cost Including the Cost of Decommissioning

The useful life for the electrical assets is considered to be 50 years and as such, no replacement or decommissioning costs are considered for these options.

5.3.2.4 Project Benefits

The benefit of a project can be measured by its ability to supply DSO/distribution demand in an area or the amount of generation that is not constrained due to the lack of transmission capability of the existing infrastructure. The benefit is therefore expressed as savings in generation costs due to the enhanced transmission capability. The constraints calculations would be a result of annual market simulations carried out by EirGrid's energy market experts. The simulations optimise the generation dispatch required to meet the electricity demand while considering the power carrying capability of the transmission system and contingencies.

As the functionality of the substation will be the same for all options evaluated, it is not possible to calculate or differentiate a Reduction in Constraints and an Associated Annual Savings for the various options. As such all options will be score the same at Low risk.

5.3.2.5 Costs to SEM

As the substation SLD is the same for all options, a comparison can only be made on the Availability Levels associated with AIS and GIS switchgear. Availability Levels for AIS Switchgear are lower compared to GIS switchgear and thus have a higher cost impact to the SEM.

Zones ZE3, ZE4 and ZE5 will have reduced Availability Levels due to the longer 400 kV loop-in circuits and as such are scored at higher risk.

5.3.2.6 Contingency Costs

Contingency costs would include an estimate of any unforeseeable expenditure that an individual option may incur, including but not limited to the following:

- Obstructions or delays to granting planning permission / license delays,
- CPO or extended negotiations with private landowners (of particular risk for the AIS options with its associated very large footprint),
- Volatile equipment procurement costs/lead-times,
- Unstable ground conditions. As individual substation sites and associated ground conditions are unknown at this stage, all zones will be scored equally in this regard.

At this step of the project with only high-level budget estimates in place, contingency costs are estimated at 20% of the project implementation costs and all options score a baseline risk of Moderate-High.

5.3.2.7 Pre-Engineering Costs

Pre-Engineering costs are those associated with the design and specification, route evaluation and management of the statutory planning application, which would be affected by the following (non-exhaustive) list of factors:

- Non-Standard equipment / system design & specification,
- Site / technology / grid corridor with multiple violations of planning laws, statutory body guidelines, etc.,
- Site / grid corridor within multiple planning authority boundaries,
- Large volume of existing utility diversions,
- Large number of landowners / stakeholders.

As both technologies will employ standard EirGrid equipment and individual sites have not been identified yet in Step 3, the Pre-Engineering Costs are deemed to be equal for each Technology / Zone, except for Zones ZE1, ZE2 and ZE3 which due to their proximity to Dublin Airport may require additional liaison and authorisation from the DAA / AirNav Ireland if the substation development is likely to exceed height restrictions.

Zones ZE3, ZE4 and ZE5 are scored higher on account of the longer loop-in circuits with their potential for more stakeholder/landholder engagement and diversions of existing utilities.

The boundaries (and associated loop-in circuits' corridors) of zones ZE4 and ZE5 are shared between two planning authorities (county councils).

5.3.3 Deliverability Assessment

Table 5-4 shows a summary of the scores for the Deliverability Assessment of each option.

Table 5-4 – Deliverability Assessment

Zone / ID	ZE1-AIS	ZE1-GIS	ZE2-AIS	ZE2-GIS	ZE3-AIS	ZE3-GIS	ZE4-AIS	ZE4-GIS	ZE5-AIS	ZE5-GIS
Type	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**	**AIS**	**GIS**
Implementation Timelines	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Project Plan Flexibility	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Dependence on other Projects	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High
Risk of Untried Technologies	Low	Moderate	Low	Moderate	Low	Moderate	Low	Moderate	Low	Moderate
Supply Chain Constraints	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate	Moderate-Low	Moderate
Permits & Wayleaves	Moderate-High	Moderate-High	Moderate	Moderate	Moderate-High	Moderate-High	Moderate	Moderate	Moderate	Moderate
Planning and other statutory requirements	Moderate-High	Moderate-High	Moderate	Moderate	Moderate	Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate-High
Land Availability	Moderate-High	Moderate	High Risk	Moderate-High	High Risk	Moderate-High	High Risk	Moderate-High	Moderate-High	Moderate
Ease of Construction	Moderate-High	Moderate	Moderate-High	Moderate	High Risk	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate
Overall	Moderate-High	Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate

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

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

5.3.3.1 Summary

Considering Deliverability for the different zones and technology, it is found that the GIS options for zones ZE1 and ZE5 score marginally better compared to their AIS equivalent or the other three zones. This is predominantly driven by the major advantages of a GIS substation in terms of Land Availability and Ease of Construction. For some zones, e.g., ZE2, it may be difficult to identify and secure land of sufficient area to fit an AIS substation due to the high prevalence of constraints within the zone.

Regarding Permits and Wayleaves, this is mainly influenced by the proximity of Dublin Airport height restriction areas (impacting parts of Zones ZE1, ZE2 and ZE3) and the length of the CP1021 loop-in circuits (impacting Zones ZE3, ZE4 and ZE5). The impact of any height restrictions can be reviewed in more detail when possible substation sites have been identified.

For planning purposes, all 400 kV substation options will likely be considered for Strategic Infrastructure Development (SID), with zones ZE1, ZE4 and ZE5 rating a higher risk on account of several additional constraints / potential zoning conflicts.

An evaluation of each option is made under each deliverability sub-criteria and is elaborated further in the following sections.

5.3.3.2 Implementation Timelines

No project delays are expected for any of the technology options evaluated for several reasons:

- EirGrid's 6-Step approach to Grid Development allocates adequate durations between project Stage Gates for proper planning and procurement of long lead time items;
- At this stage, no major obstacle or impediment to development is anticipated with any of the proposed substation zones; and
- Historically, procurement lead times for GIS substation equipment can be longer than that for equivalent AIS substation equipment but increased use/acceptance of GIS substations within the Irish and Global electrical markets and increased offerings from manufacturers globally has shortened procurement times.

At this step, the chosen zone / technology is not seen to impact on overall project timeline and as such all zones / technology options will be scored equally.

The 400 kV substation development is likely to constitute SID under 'new transmission infrastructure facilitating the transmission of electricity from one substation to another', with an application submitted directly to An Bord Pleanála (ABP). The SID planning process is typically longer than a council planning application and may pose a risk to the overall project timeline.

5.3.3.3 Project Plan Flexibility

The Project Plan is set to be developed in Step 4, and as such this is not applicable to Step 3. All options will be scored equally as Moderate risk until the Project Plan is developed.

5.3.3.4 Dependence on other Projects

All 400 kV substation options are dependent on the CP1021 400 kV UGC circuit being installed along its current planned route, in order to loop in the proposed substation. Any future deviations to this route could affect the viability of a given substation zone and/or its associated loop-in circuits.

As all substation options are fully dependent on CP1021, all zones will be scored equally at Moderate-High risk.

5.3.3.5 Risk of Untried Technologies

AIS and GIS substation technologies are seen as a tried and tested technology on the EirGrid transmission network from 110 kV up to 400 kV.

GIS substation switchgear is legislated to be F-gases free from 2028 (<145 kV) and 2032 (>145 kV). This would be seen as industry emerging technology at TRL 9 (Technology Readiness Level), needing to be qualified against EirGrid/ESBN specifications.

All options will be scored equally at Low risk.

5.3.3.6 Supply Chain Constraints

Both technologies AIS and GIS will employ standard EirGrid equipment, and all options will require procuring power transformers and compensating equipment such as shunt reactors / STATCOM. Transformers are currently experiencing very long lead times and the procurement of such equipment is usually on the critical path.

Historically, longer lead times and a more restrictive supply chain are also associated with GIS switchgear compared to AIS switchgear.

5.3.3.7 Permits & Wayleaves

All options presented will be new infrastructure and will require permits and wayleaves to some extent or another, which elevates the risk for all options. There is a public participation facet to the permitting which often increases the risk to the option and wayleaving requires extensive relationship building with individual landowners, the risk to the option is often in the time required to achieve wayleaving.

At present the route/technology of the required loop-in circuits with CP1021 400 kV UGC are undecided, so it is not possible to evaluate the wayleave requirements for these circuits. Generally, OHL infrastructure tends to traverse private land and carries higher risk in attaining necessary wayleaves and permits. UGC circuits would require road opening licenses from the relevant authority. The longer loop-in circuits associated with ZE3, ZE4 and ZE5 increase the number of wayleaves/permits required and thus elevate the level of risk for these zones.

There is additional risk for substation structures and OHLs in Zones ZE1, ZE2 and ZE3 which are closer to Dublin Airport where height restriction limitations can restrict the development of tall structures such as OHL towers, substation GIS buildings, lightning masts, etc. Zones have been deliberately selected to avoid areas of height restrictions prohibitive of substation/OHLs, but permission will still be required from the DAA/AirNav Ireland for any developments within their designated height restriction zones. The impact of any height restrictions can be reviewed in more detail when possible substation sites have been identified.

Constraints may also be imposed by the DAA on the use of construction cranes / equipment above a certain height limit with these zones.

5.3.3.8 Planning and other Statutory requirements

The 400 kV substation development is likely to constitute SID under ‘new transmission infrastructure facilitating the transmission of electricity from one substation to another’, with an application submitted directly to ABP. The requirements for EIA and AA are to be determined. SID determination has both positive and negative risks associated with it (i.e., positive that it is one planning authority, but also negative as the planning process is typically longer).

The lands in ZE1 are variously zoned as GB – Greenbelt, RU – Rural, and RV – Rural Village. A portion of land at Coolatrath East is not zoned. Utility infrastructure is not listed as a use permitted in principle or not permitted for lands zoned GB. Uses which are neither ‘Permitted in Principle’ nor ‘Not Permitted’ will be assessed in terms of their contribution towards the achievement of the Zoning Objective and Vision and their compliance and consistency with the policies and objectives of the Development Plan. The lists of uses permitted in principle in areas zoned RU and RV include “Utility Installations”.

All substation zones are located in the Dublin Airport Noise Zones to various levels (Zones A through D). As per Fingal Development Plan Objective DMSO105, there is a restriction on the development of noise sensitive uses in the Dublin Airport Noise Zones.

The lands in ZE2 are variously zoned RU – Rural, RV – Village and HA – High Amenity. The area in Rivermeade zoned RV is subject to the Rivermeade LAP 2018. The lists of uses permitted in principle in areas zoned RU and RV include “Utility Installations”. Utility infrastructure is not listed as a use permitted in principle or not permitted for lands zoned HA. Uses which are neither ‘Permitted in Principle’ nor ‘Not Permitted’ will be assessed in terms of their contribution towards the achievement of the Zoning Objective and Vision and their compliance and consistency with the policies and objectives of the Development Plan.

The lands in ZE3 are variously zoned as RU – Rural, RV – Rural Village, RC – Rural Cluster and OS – Open Space. The lists of uses permitted in principle in areas zoned RU, RV and RC include “Utility Installations”. Utility infrastructure is not listed as a use permitted in principle or not permitted for lands zoned OS. Uses which are neither ‘Permitted in Principle’ nor ‘Not Permitted’ will be assessed in terms of their contribution towards the achievement of the Zoning Objective and Vision and their compliance and consistency with the policies and objectives of the Development Plan.

The lands in ZE4 are variously zoned as RU – Rural, RC – Rural Cluster and OS – Open Space under the Fingal County Development Plan 2023 – 2029 and is zoned RA - Rural Area under the Meath County Development Plan 2021-2027. The lists of uses permitted in principle in areas zoned RU and RC include “Utility Installations”. Utility infrastructure is not listed as a use permitted in principle or not permitted for lands zoned OS. Uses which are neither ‘Permitted in Principle’ nor ‘Not Permitted’ will be assessed in terms of their contribution towards the achievement of the Zoning Objective and Vision and their compliance and consistency with the policies and objectives of the Fingal Development Plan. “Utility Structures” are permitted uses on lands zoned RA under the Meath County Development Plan.

The lands in ZE5 are variously zoned as RU – Rural under the Fingal County Development Plan 2023 – 2029 and is zoned RA - Rural Area under the Meath County Development Plan 2021-2027. The list of uses permitted in principle in areas zoned RU includes “Utility Installations”. “Utility Structures” are permitted uses on lands zoned RA under the Meath County Development Plan.

Fingal Development Plan Policy IUP32 supports the development of the East Meath-North Dublin Grid Upgrade to strengthen the electricity supply network. As per Fingal Development Plan Objective DMSO232, applications for overhead cables of 110 kV or more must be accompanied by a visual presentation of the proposal in the context of the route to assist with assessment of visual impact, as well as details of compliance with all internationally recognised standards regarding proximity to dwellings and other inhabited structures. Fingal Development Plan Objective IUO45 requires the undergrounding of utility infrastructure where possible, in the interests of visual amenity.

Zone ZE4 and ZE5 are within the boundaries of two separate Planning Authorities / councils.

ZE1 is partial situated within a designated Green Belt and the development of any potential sites within the belt which would requirement further liaison with the relevant authorities.

5.3.3.9 Land Availability

At present it is expected that sites within each zone would need to be procured from private landowners. Private land prices in the vicinity of Dublin city are expected to be very high / volatile.

As shown in Figure 5-2, the land requirement for the 400 kV substation AIS option is very large at 43 acres. The GIS option layout (Figure 5-3) has a footprint approximately four times smaller than the AIS option. As such the AIS technology options are scored at a higher risk than the GIS options as procurement of a site of such a large footprint will be more restrictive within all of the zones. The AIS option for zone ZE2 is scored at higher risk as it is uncertain if there are any land parcels available within the zone of sufficient size to accommodate the substation.

Private entity (solar farm) circuits within the local road network will impact on the availability of land for future connectivity with the substation and with the loop-in circuits with CP1021.

A relatively large area of space is allocated within the proposed substation layout for future circuits and this initial space can be used for a construction / storage compound during the initial phases of construction. Additional space around the substation will need to be considered for connecting the planned and future circuits. Additional space within the compound would also be required if it is deemed in future that connecting circuits require additional compensation equipment.

5.3.3.10 Ease of Construction

A relatively large area of space is allocated within the proposed 400 kV substation layout for future circuits and this initial space can be used for a construction / storage compound during the initial phases of construction.

Individual sites have not been identified / assessed to date, but ground conditions and elevations within the zones are generally expected to be suitable for substation construction, e.g., limited amount of cut and fill ground works required. Zone ZE1 is noted to have a limited amount of flood area along the course of the Ward River.

All zones are rural, served by regional roads. Appropriate traffic management plans would need to be put in place for the construction phase but no special constraints on working time limitations are expected.

Zones ZE1, ZE2 and ZE3 are near Dublin Airport and the DAA may impose limits on the use of construction cranes / equipment above a certain height limit.

All options will require outages to loop-in the proposed Fingal 400 kV substation with CP1021. Dependent on the construction timelines for both projects, the required infrastructure for the substation loop-in circuits (for example, UGC cable and ducts, joint bays, etc.) could be installed when the CP1021 cable circuit is constructed. This would be subject to the relevant planning permissions being in place.

5.4 Loop-in Circuits on CP1021 400 kV UGC

For the required substation loop-in connection with the 400 kV UGC circuit CP1021, either an UGC or OHL loop-in could be utilised. The most straight forward option is to use matching 400 kV UGC breaking into the CP1021 circuit at two of its planned joint bays and utilise the existing road network to connect with the planned substation. An OHL loop-in would be a lot more complex to engineer and would require additional LCIM compounds to be built along the route of CP1021.

Several possible UGC route options have been established in order to determine the ease of connecting each of the particular zones. These UGC routes utilise a mixture of regional and local roads and are shown in Figure 5-10.

Each loop circuit will need to start (break-in) at a particular CP1021 joint bay, make use of the local or regional roads to connect with the substation, before returning (either along the same roads if deemed wide/clear enough to accommodate two 400 kV circuits or if not, via new roads) to a joint bay on CP1021.

Only a high-level desktop appraisal of the possible circuit routes has been performed at this stage to assess available road widths, circuit length and any obvious constraints / crossings required along each route. Following the selection of a substation zone/site, a more detailed evaluation of a shortlist of possible circuit routes (including OHL loop-in options) will need to be performed.

The study has shown there is potential UGC loop-in circuits to all zones however, some zones are more suitable than others. Zones ZE2, ZE3, ZE4 and to a lesser degree ZE1 will be impacted by known Solar Farm circuits within the local road network which will impact a possible Loop-in circuit with CP1021. Loop-in circuits will be shortlisted and looked at in more detail once suitable substation sites have been identified.

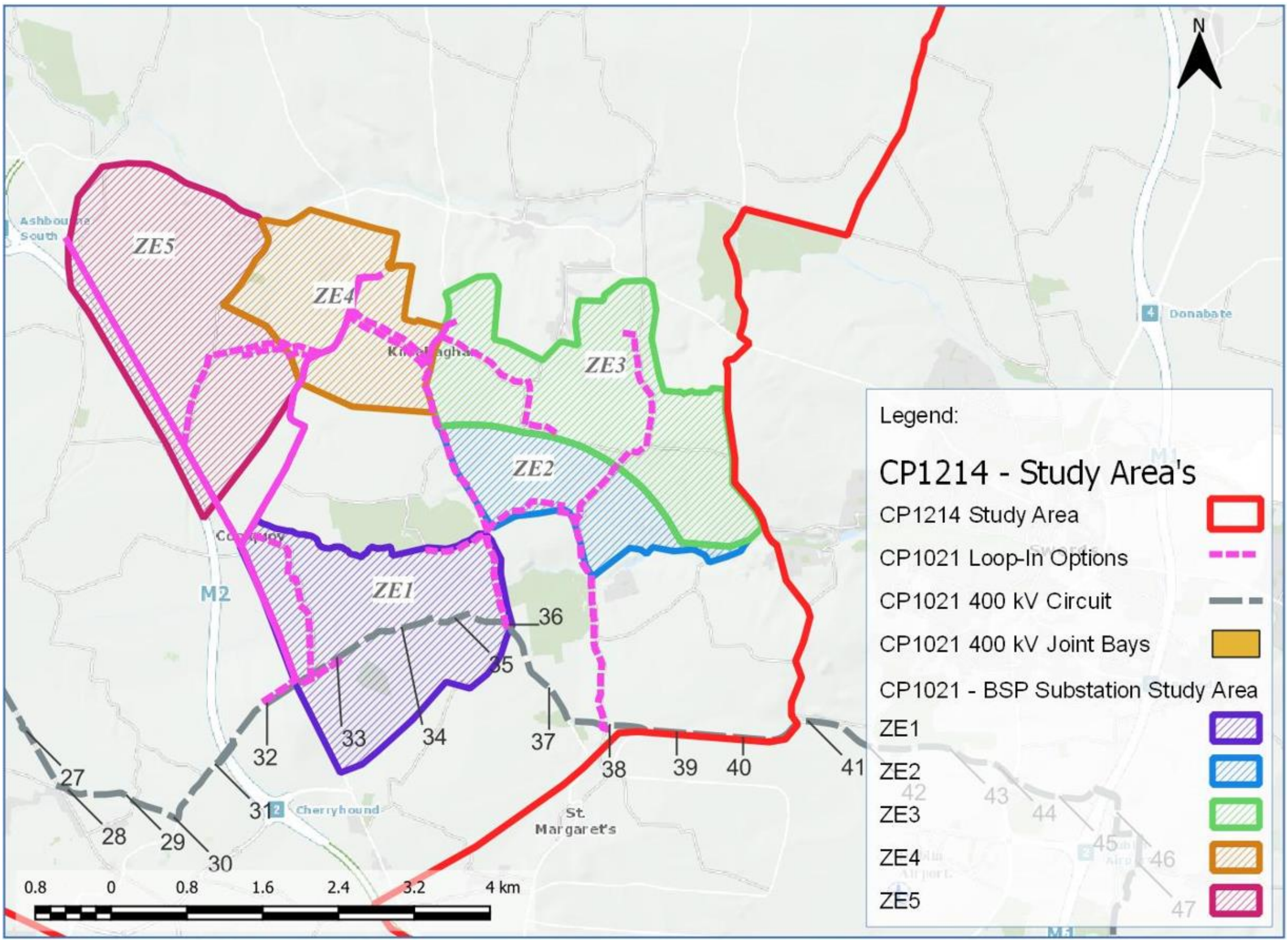


Figure 5-10 - Fingal 400 kV Substation Loop-in Circuits with CP1021 (UGC options shown with CP1021 joint bays numbered)

6. Conclusion/Recommendation

6.1 Conclusions

For the proposed Fingal 400 kV Substation, the electrical configuration (SLD) is equivalent irrespective of which zone or technology is being considered (apart from minor differences in loop-in circuit length and potential technology). As such, it is not possible to establish a discernible score difference for some network related sub-criteria such as:

- Compliance with System Reliability & Security Standards
- Project Benefits

As some zones have large footprints, they can a have mixture of different attributes and constraints distributed within its boundaries. Within a given zone, only part of the zone may have a specific constraint, whereas a substantial remainder of the zone area is free of that constraint. This can create ambiguity whether a specific constraint is significant enough within a zone to score a higher rating/risk and as such, it is difficult to determine a decisive score against certain sub-criteria and the corresponding risk scores tend to be biased on the low side. Until zone areas are reduced / sites have been identified in Step 4, it is difficult to perform decisive scoring accounting for actual localised constraints and geotechnical conditions at a specific location.

6.1.1 Fingal 400 kV Substation Technology and Zones

From a technical performance perspective, Zones ZE2, ZE3 and ZE4 are found to score the highest risk (Moderate) compared to the other two zones on account of relatively longer loop-in circuits with CP1021 and the risk to the 'ease of connectivity' for any substation sited within this zone.

The other two zones are found to score Low-Moderate risk with ZE1 scoring marginally higher risk compared to ZE5 due to a higher risk for 'ease of connectivity' (Headroom).

AIS and GIS technologies have the same overall score for each individual zone.

From an economic performance perspective zones ZE1 and ZE2 are found to score the lowest risk. This is on account of Implementation and Life Cycle Costs being more for zones ZE3, ZE4 and ZE5 due to the longer CP1021 loop-in circuits required for these zones. AIS technology is seen to perform marginally poorer compared to GIS. Even though GIS technology would have higher procurement (Implementation) costs, these are more than offset by higher life-cycle costs and higher land costs for AIS.

Considering Deliverability for the different zones and technology, it is found that the GIS options for zones ZE1 and ZE5 score marginally better compared to their AIS equivalent or the other three zones. This is predominantly driven by the major advantages of a GIS substation in terms of Land Availability and Ease of Construction. For some zones, e.g., ZE2, it may be very difficult to identify and secure land of sufficient area to fit an AIS substation due to the high prevalence of constraints within the zone.

Combining the scoring from all three categories (Technical Performance, Economic Performance and Deliverability) it is seen that all zones and technologies perform similarly with a rating of Low-Moderate. The best performing (lowest scoring) zones are ZE2 followed by ZE1. The best performing technology for the substation is found to be GIS.

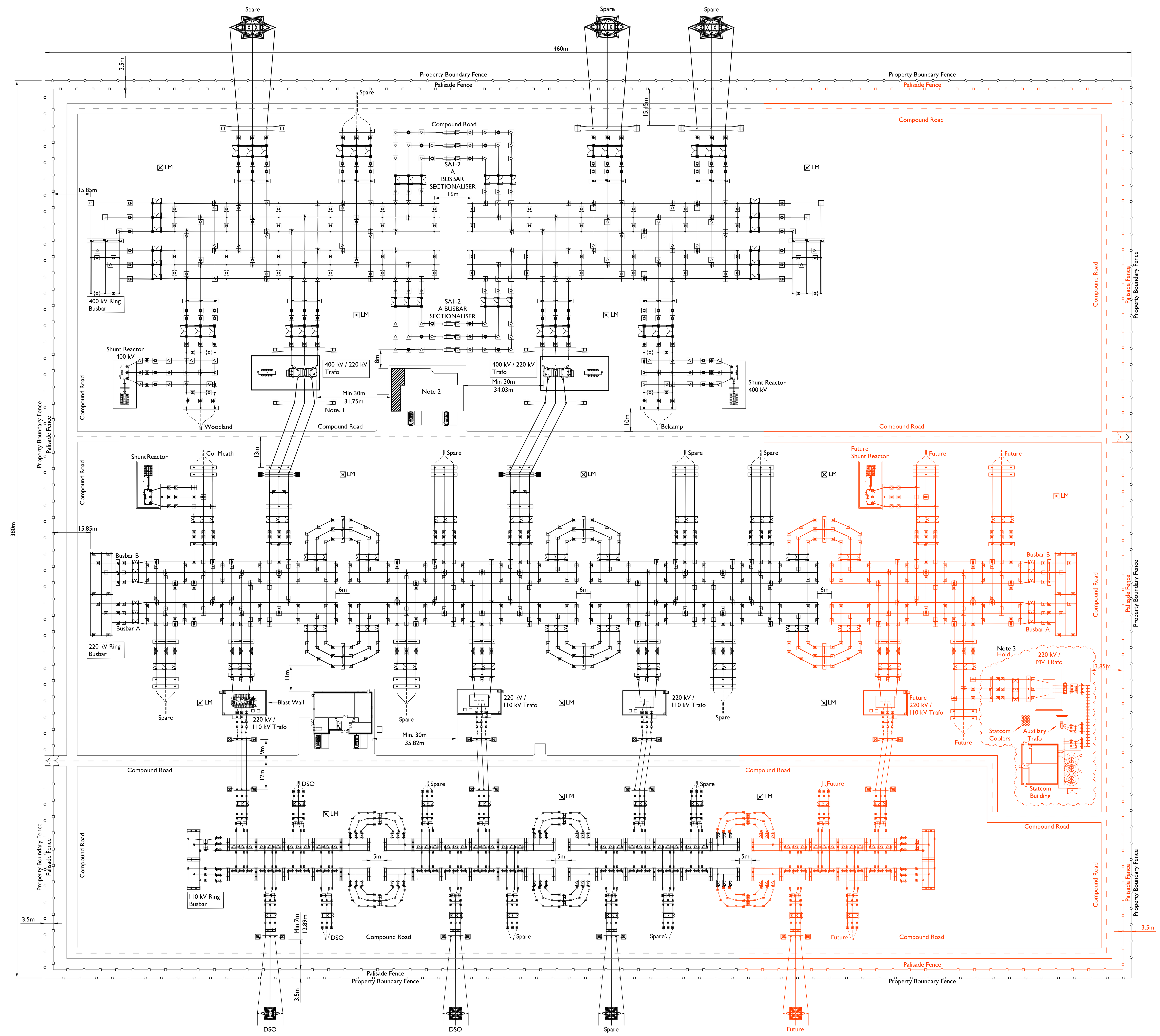
6.2 Recommendations

Following a technical, economic and deliverability assessment of the 5no. zones for the proposed Fingal 400 kV substation zones, it is proposed to bring forward zones ZE1, ZE4 and ZE5 for further consideration, with GIS switchgear as the preferred technology. A landowner engagement review should be performed on these zones to reduce the Areas of Interest to actual substation size. This will allow a decisive Multi-Criteria Analysis to be performed in Step 4 to determine a preferred site location.

APPENDICES

Appendix A. Substation Layouts

A.1 Fingal 400 kV Substation – AIS



tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

Regional Office
Basepoint Business Centre
Stroudley Road, Basingstoke,
Hampshire,
RG24 8UP, UK
Tel: 00 44 1256406664

PROJECT

CP1214 Fingal to East Meath Grid Reinforcement Project

CLIENT

EirGrid

CONSULTANTS

AtkinsRéalis

NOTES: -

1. Gantry details to be confirmed with EirGrid.
2. Control building layout / distribution to be confirmed with EirGrid.
3. Final STATCOM layout dependent on chosen vendor
4. Impact on equipment layouts due to EMF studies to be confirmed during Step 4.
5. Communications Mast optional.

LEGEND: -

- Initial Phase of Construction.
- Future Equipment.

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F2	21.08.2024	Updated as per EirGrid Comments
F1	16.07.2024	Feasibility Study

KEY PLAN

PROJECT NUMBER

05-1030

SHEET TITLE

CP1214 Fingal 400 kV Substation Preliminary AIS Layout Plan

SHEET NUMBER

051030-DR-102

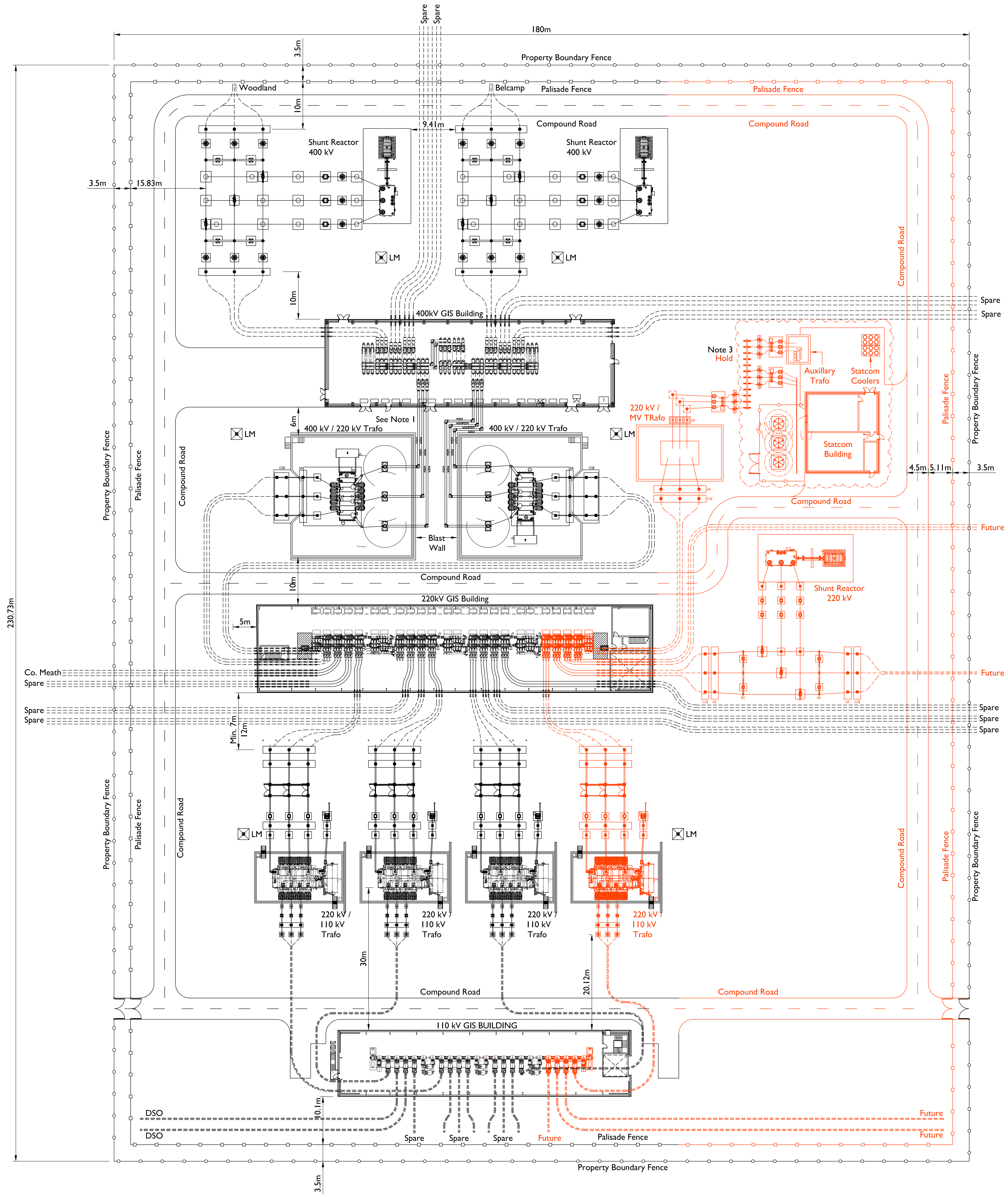
ISO A0 841mm x 1189mm

Project Management Initials: Designer: XX Checked: XX Approved: XX

400 kV - 220 kV - 110 kV AIS Substation Layout Plan - Sheet 1 of 1

Scale: 1:750

A.2 Fingal 400 kV Substation – GIS



400 kV - 220 kV - 110 kV GIS Substation Layout Plan

Scale: 1:500

ISO A1 594mm x 841mm

Project Management Initials: Designer: XX Checked: XX Approved: XX

tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

Regional Office
Basepoint Business Centre
Stroudley Road, Basingstoke,
Hampshire,
RG24 8UP, UK
Tel: 00 44 1256406664

PROJECT

CP1214
Fingal to East Meath Grid Reinforcement Project

CLIENT

EirGrid

CONSULTANTS

AtkinsRéalis

NOTES: -

1. GIS ducting can be interchanged for XLPE if required.
2. 400 kV GIS building standard layout design/size to be to be confirmed with EirGrid.
3. Final STATCOM layout dependent on chosen vendor
4. Impact on equipment layouts due to EMF studies to be confirmed during Step 4.
5. Communications Mast optional

LEGEND: -

- Initial Phase of Construction.
- Future Equipment.

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F2	21.08.2024	Updated as per EirGrid Comments
F1	16.07.2024	Feasibility Study

PROJECT NUMBER

05-1030

SHEET TITLE

CP1214 Fingal 400 kV Substation Preliminary GIS Layout Plan

SHEET NUMBER

051030-DR-104

1:500 — 10m 0 10m 20m 30m 40m 50m

AtkinsRéalis

WS Atkins Ireland Limited
Atkins House
150 Airside Business Park
Swords
Co. Dublin
K67 K5W4

Tel: +353 1 810 8000