Capital Project 966

Substation Feasibility Assessment - Woodland 400kV Connection

321084AE-REP-006 | B

27 April 2020

EirGrid

CP966

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Contents

Figures

Executive Summary

Jacobs was requested to prepare a set of substation feasibility reports for EirGrid CP966 project, which is a proposed development that will help transfer electricity to the east of the country and distribute it within the network in Meath, Kildare and Dublin. The project will help meet the growing demand for electricity in the east. This growth is due to increased economic activity and the planned connection of new data centres in the region. It will therefore require significant substation changes at Dunstown and Woodland to accommodate these system upgrades.

The report content and format are suitable to support EirGrid's network development process, in step 3. The options to be investigated by Jacobs are as follows:

- Woodland 220kV AIS C-Type Extension
- Woodland 220kV Connection
- Woodland 400kV Connection
- Woodland 400kV Ring configuration
- Dunstown 220kV AIS C-Type Extension
- Dunstown 220kV Connection
- Dunstown 400kV Connection

Specialists were sent, during the month of November 2019, to visit each of the substation sites to investigate the current infrastructure and what would be needed for the proposed substation connections and modifications. Further to this, sets of drawings have produced for the reports to give an indicative view of how each of the above substation modifications will look and have been referenced throughout all the reports.

This technical report examines the options for a new 400kV line bay at Woodland substation and highlights these findings by describing technical, environmental, deliverability, and economic factors. Throughout each of the reports, the design methodology and construction approach, and their costs have been detailed.

The following three options were considered:

i. 400kV Under Ground Cable (UGC), 1 cable per phase

ii. 400kV UGC, 2 cables per phase

iii. 400kV Over Head Line (OHL)

The 400kV connection options at Woodland substation are all technically feasible and require the extension of the substation boundary fence.

No major planning works involving land acquisition are anticipated to be required for all the three options considered. Earthworks and civil works will also be required for the extension as well as for a new road accessway for the delivery of the shunt reactors for UGC 2 cables per phase option.

The requirement for shunt reactors associated with options (i) and (ii) is a significant differentiator with option (iii) which represents a 'standard' solution.

1. Introduction

1.1 What is Capital Project 966?

Capital Project 966 is a proposed development that will help transfer electricity to the east of the country and distribute it within the network in Meath, Kildare and Dublin.

The project will help meet the growing demand for electricity in the east. This growth is due to increased economic activity and the planned connection of new data centres in the region.

A significant number of Ireland's electricity generators are located in the south and south west. This is where many wind farms and some modern, conventional generators are located. This power needs to be transported to where it is needed.

The power is mainly transported cross-country on the two existing 400 kV lines from the Moneypoint station in Clare to the Dunstown substation in Kildare and Woodland substation in Meath. Transporting large amounts of electricity on these 400 kV lines could cause problems that would affect the security of electricity supply throughout Ireland, particularly if one of the lines is lost unexpectedly.

To solve this emerging issue, we need to strengthen the electricity network between Dunstown and Woodland to avoid capacity and voltage problems.

Capital Project 966 aims to strengthen the transmission network between Dunstown and Woodland substations. and suggests a number of technical solutions to do so.

1.2 Framework for grid development explained

EirGrid follow a six step approach when they develop and implement the best performing solution option to any identified transmission network problem. This six step approach is described in the document 'Have Your Say' published on EirGrid's website1. The six steps are shown on a high-level in Figure 1. Each step has a distinct purpose with defined deliverables and represents a lifecycle of a development from conception through to implementation and energisation.

[1] http://www.eirgridgroup.com/the-grid/have-your-say/

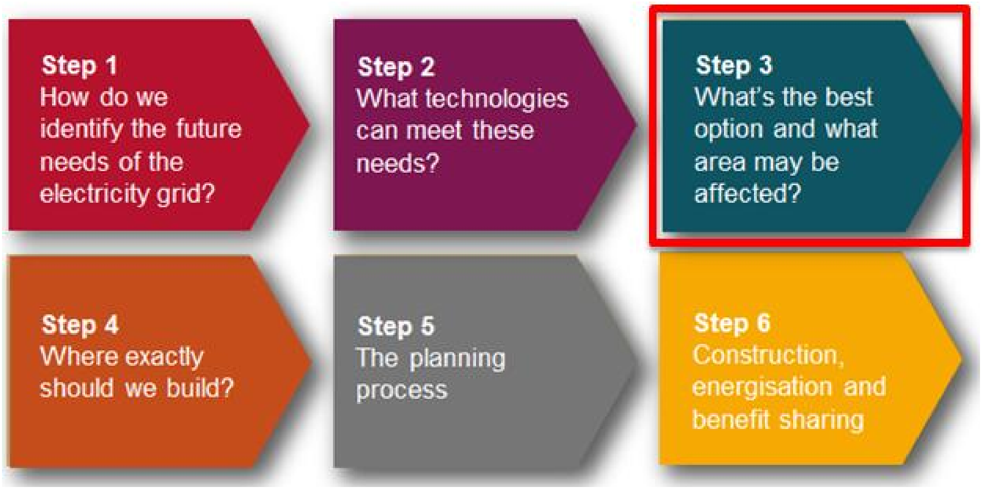

Figure 1 : EirGrid's Six-Step Framework for Grid Development

Capital Project 966 is in Step 3 of the above process. The aim of Step 3 is to identify a best performing solution option to the need identified. There are four remaining technical viable options to be investigated in Step 3. All options create a connection between Woodland and Dunstown substations and have common reinforcements associated in relation to voltage support devices and 110 kV uprates. The main four options are:

- Up-voltage existing 220 kV circuits to 400 kV to create new Dunstown – Woodland 400 kV overhead line (OHL);
- A new 400 kV overhead line;
- A new 220 kV underground cable,
- A new 400 kV underground cable.

Common reinforcements to all four options (outcome of Step 2, may change in Step 3):

- Uprating of the Bracklone – Portlaoise 110 kV overhead line
- Dynamic reactive support device in greater Dublin area rated at approximately ±250 Mvar

These options will be evaluated against five criteria: technical, economic, environmental, deliverability and socio-economic and each criteria incorporates a number of sub-criteria. It shall be noted that the overall assessment is carried out by EirGrid, but certain aspects are investigated and assessed by various consultants and their assessment will feed into the overall assessment.

1.3 Aim and context of this report

EirGrid (the Client) has engaged Jacobs to assess the required substation modifications at Woodland and Dunstown to accommodate these network changes specified by EirGrid. This report is aimed at presenting the findings of this investigation regarding a 400kV bay for cable and overhead line options at Woodland. The findings will feed into EirGrid's overall evaluation of the four remaining options.

1.4 Description of criteria used to assess the options

This report uses the following criteria to assess each substation option:

- Technical

As part of technical feasibility assessment, substation layouts were developed in accordance with relevant EirGrid design standards to indicate a proposed solution. Constructability and health and safety implications for operation and maintenance activities through the achievement of appropriate electrical clearances have been considered.

- Environmental

As part of environmental feasibility, only the impact arising from any extension to the existing substation boundary has been identified and examined. For a broader environmental assessment, please refer to report 321084AE-REP-002 – Environmental Feasibility Report.

- Deliverability

As part of deliverability assessment, existing access roadways and operational/maintenance assessments were made to ensure that the solution can be safely constructed, maintained and operated.

- Economic

An approximate bill of quantities and cost estimate has been produced for each option.

- Socio-economic

As part of the social feasibility, a socio-economic assessment has been included as part of this report for the substation works only. For a broader social impact assessment, please refer to the report 321084AE-REP-003 – CP966 Social Impact Assessment Report.

1.5 Scale used to assess each criteria

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”. The following scale is used to illustrate each criteria parameter:

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

In the text this scale is quantified by text for example mid-level/moderate (Dark Green), low-moderate (Green), low (Cream), high-moderate (Blue) or high (Dark Blue).

1.6 Relationship to other technical documents

Parallel to this report, Cable Feasibility, Environmental and a Social Impact studies are being prepared to investigate the impact of proposed solutions on the study area.

Please read in conjunction with the following reports;

- 321084AE-REP-001 – Cable Route Feasibility Report
- 321084AE-REP-002 – Environmental Feasibility Report
- 321084AE-REP-003 – Social Impact Report

2. The Project

2.1 Site Description

Woodland 400/220kV AIS substation is an existing substation located in County Meath and is surrounded by farmland in a rural area. Aerial views of the area and substation are shown in Figure 2 and Figure 3 respectively. Further to this, Figure 4 shows the extent of land ownership held by the Transmission Assets Owner (TAO).

The substation presently contains both 400kV and 220kV equipment in a double busbar arrangement with 3 x 400/220kV transformer bays, 2 x 400kV line bays and 4 x 220kV line bays.

Figure 2: Map View of Woodland Substation (From Google Earth)

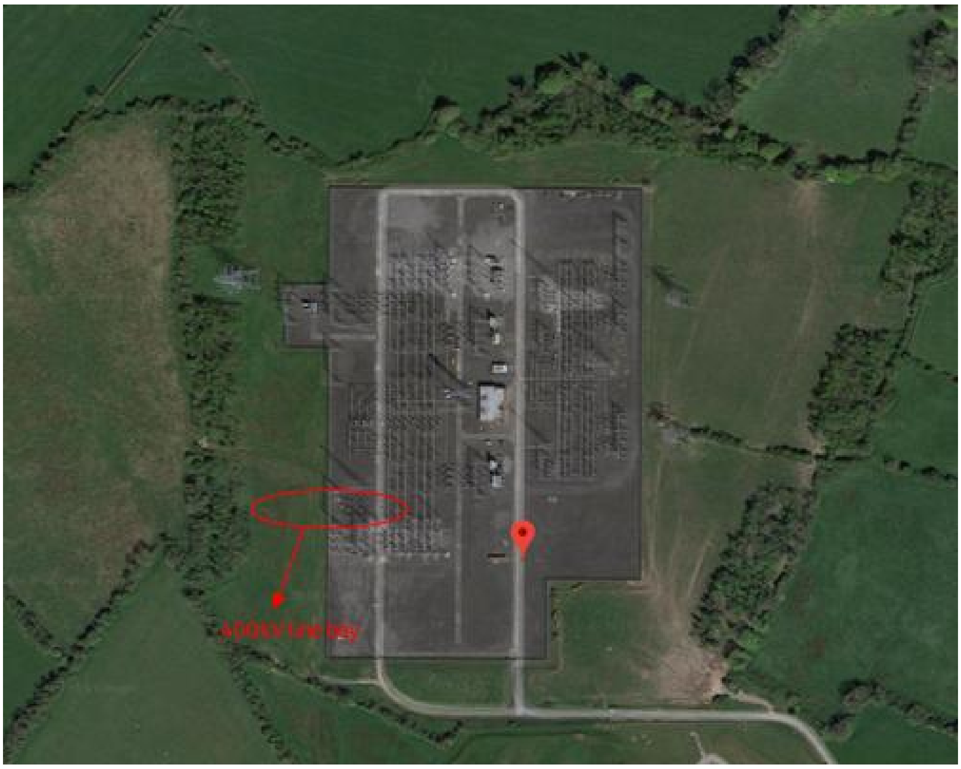

Figure 3: Location of 400kV Connection (From Google Earth)

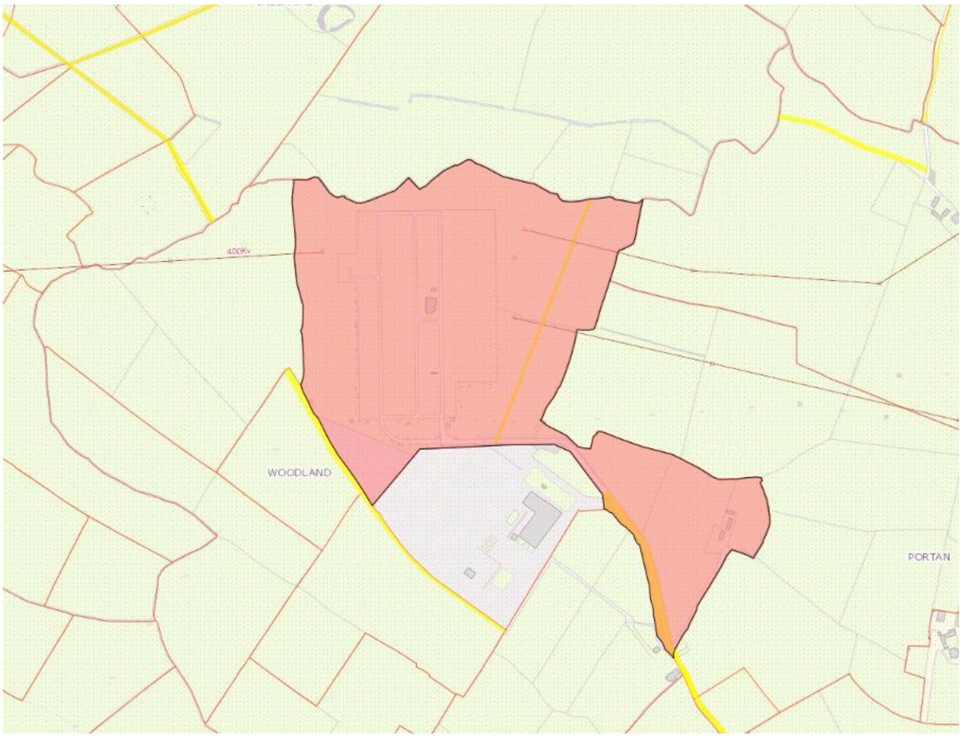

Figure 4 : Extent of Land Ownership Boundary

2.2 Objective

This report will provide a feasibility assessment of an option to reutilise a spare 400kV bay for the CP966 connection with Woodland Substation. This will cover the following three options:

(i) 400kV Under Ground Cable (UGC), 1 cable per phase

(ii) 400kV UGC, 2 cables per phase

(iii) 400kV Over Head Line (OHL)

Note that throughout this report, the above OHL option is in application for both the up-voltage of the existing 220 kV circuits from Maynooth and the new 400 kV overhead line connection from Dunstown.

2.3 Technical Feasibility

2.3.1 Project Requirements

A spare 400kV bay located between the T4201 transformer bay and the Portan line bay has been identified by EirGrid for the CP966 project. The new CP966 line bay will be installed adjacent to, and parallel with, the Portan bay. A separation distance of at least 10m has been allowed between live conductors on each bay to facilitate both construction works in the new CP966 bay and for future maintenance access to either bay. If for any reason a greater separation to the Portan bay from the CP966 bay was required, then a busbar extension of two standard bay widths would be needed.

The new 400kV connection option utilises standard substation design parameters in determining the scope and extent of the substation extension works. These standard parameters ensure a safe and effective design. The 400kV line bay is based on the existing line bay designs at Woodland substation, although high-level busbars have been allowed for spanning the access road as a gantry arrangement (as used on the Portan bay) would likely interact with the Portan bay gantries which is considered undesirable given the strategic importance of the Portan circuit (which is the UK-Ireland interconnector).

Refer to Figure 5 for a single line diagram for a schematic representation of proposed extension works to the existing substation. Existing substation is indicated in black, new works are indicated in red with future spare bays in blue. For all three options a typical feeder connection bay and all other required equipment will be connected at Woodland substation for the CP966 connection. This will be at the existing spare bay E3 connected to busbar sections A1/B1 as highlighted previously in Figure 3. For substation layout arrangement of the proposed works, see drawings in Appendix A:

(i) 321084AE-LAY-009 (UGC, 1 cable/phase)

(ii) 321084AE-LAY-010 (UGC, 2 cables/phase)

(iii) 321084AE-LAY-011 (OHL)

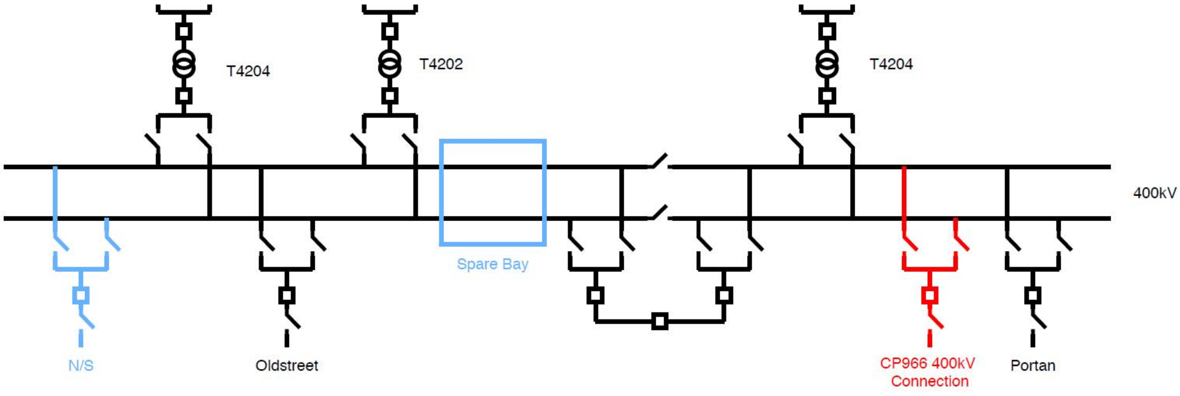

Figure 5 : New Woodland 400kV Connection Bay

EirGrid have indicated that reactive compensation will be required at each substation with underground cable options in order to offset reactive power due to the capacitive nature of UGC's once energised, where the 1 cable per phase option needs 280MVAr and the 2 cables per phase needs 630MVAr. It should be noted that the compensation requirements for the cable options are extremely high and push the limits of reactor technology for the 2 cables per phase. Based on initial manufacturer feedback, we would currently understand that the maximum size of Shunt Reactor available on the market would be approximately 300MVAr.

Additional space is therefore needed to accommodate the equipment to do this. The OHL option does not need this compensation. The following equipment and their footprints are considered.

- 1 x 300MVAr 400kV shunt reactor for 1 cable per phase (see drawing 321084AE-LAY-009), and
- 630MVAr reactors cannot be built due to technical limitations therefore 2 banked 300MVar 400kV shunt reactors for 2 cables per phase are needed (see drawing 321084AE-LAY-010).

It should be emphasised that it is the requirement for reactive compensation (or not) that is the most significant difference between the different 400kV connection options being considered, without the need for the shunt reactors the extent of substation works required would be very similar between all three options.

2.3.2 Other Requirements

All 400kV connection options reutilise an existing spare bay, therefore existing protection panels/or allocated space for the spare bay in the control building will be used. An assessment of the existing LVAC and DC systems should also be undertaken to confirm adequate capacity, especially if cable options are considered.

2.3.3 Technical Feasibility

As per Section 1.5, the following scale is used to assess the technical feasibility of this option. The scale assigned to each option is primarily driven by the implications associated with the need to accommodate reactive compensation. For the 1 conductor/phase cable option, the reactive compensation is possible with a single shunt reactor and can therefore meet the requirements of the project. This has therefore been given a moderate-low risk (Green). On the other hand, the 2 conductors/phase cable requires two, which is already technically challenging, and falls short on the reactive power requirements (630MVAr) therefore has been assigned a moderate-high rating (Blue). Lastly, since there is no requirement for compensation, the OHL has been assigned low risk (Cream).

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

400kV Connection Options	Technical Feasibility
(i) UGC, 1c/phase	
(ii) UGC, 2 c/phase	
(iii) OHL	

2.4 Site Modifications

All three options will require a substation perimeter fence extension to accommodate the new 400kV connection bay as shown in the drawings in Appendix A. For options (i) and (iii) (drawings 321084AE-LAY-009 and 321084AE-LAY-011) the substation perimeter fence on the south west side will need to be extended by approximately 40 meters and 18 meters, respectively. For option (ii) the substation perimeter fence will need to be extended by approximately 60 meters as shown in the drawing 321084AE-LAY-010. This is to accommodate the 2 x 300MVAr shunt reactors as well as a new road accessway for the delivery of the shunt reactors. Existing palisade fence will need to be removed and new palisade fencing to be installed to accommodate the larger substation space requirement, along with associated civil earthworks to provide a flat and level platform for the extended substation.

Figure 3 shows the location of the proposed site extension work and Figure 4 shows the extent of the land ownership boundary of the substation.

All three options are within the land ownership boundary of the substation, so no third-party land acquisition is foreseen. However, option (iii) comes very close to the land ownership boundary of the substation on the west side and this should be further explored during concept designs.

2.5 Environmental Constraints

2.5.1 Biodiversity, Flora & Fauna

There are no designated sites in the vicinity of Woodland substation, however an extension to the substation footprint to facilitate works would have potential temporary and definite permanent impacts on biodiversity.

Potential impacts during construction include:

§ Temporary loss of terrestrial habitat within the footprint of the Project to facilitate access roads and construction compounds;

§ Disturbance, and temporary displacement of birds, mammals, amphibians, fish and other aquatic species in habitats within or in close proximity to the Project footprint; and

§ Temporary loss of foraging habitat for mammals such as badger and bat.

During operation, all options have the potential for permanent loss of grassland habitat, with Option (ii) being the greatest as a result of having the largest footprint. There would be a permanent loss of a portion of biodiversity-rich hedgerows to the west of the substation as a result of Option (ii) as the 60m extension would impinge upon the established hedgerow on the field margin, although not result in a total loss.

As such, Option (i) would be low, Option (ii) moderate and Option (iii) neutral.

2.5.2 Soils and Water Impacts

The subsoils around Woodland substation are shale and sandstone till (Namurian) with an area of Alluvium to the north of the substation. There is a significant Karst Landforms to the north west of Woodland Substation, however it is not within or in close proximity to the footprint of the proposed extension and so it is not likely that there would be any effects.

In terms of surface water, Woodland substation is within the Tolka WFD sub basin. The Tolka_020 water body, as has been outlined in Biodiversity, runs west to east immediately to the north of the substation. It is of Poor status and considered to be At Risk (www.epa.ie). Pressures on the water body, upstream and in the vicinity of the substation, are from diffuse agricultural sources, such as silage runoff and have resulted in nutrients being high which is the main reason for its Poor WFD status.

The Tolka_020 is on the far side of the existing substation from the proposed extensions, for all options. There is no watercourse nearby. As a result, it is not anticipated there would be any effects on surface water as a result of any of the options. All would be neutral.

2.5.3 Impact on Land Use (forestry, farmland, bogs/peats, horticulture, roads)

The lands immediately surrounding Woodland are arable agricultural lands. There is no forestry or peat/bogs present. The Trim Road is about 750m from the site. There would be no requirement for land outside of TAO ownership.

As a result, the risk to land use is considered to be neutral for all options.

2.5.4 Landscape & Visual

The substation is within the Tara Skryne Hills LCA which is a high sensitivity landscape. However, there are no protected views or prospects within 2km of the Woodland substation and the extension would be continuous development with the existing substation.

There is potential for effects on views but all of the options for the proposed extension would be to the south west of the existing substation, this would not be immediately visible to local residents, screened as it would be by hedgerows, the existing substation and the Converter Station.

As a result, it is anticipated that risks to landscape and visual receptors would be neutral for Option (iii); and low for Options (i) and (ii).

2.5.5 Cultural Heritage

There are two National Monuments (RMP and SMR sites) within 1km of the Woodland substation. Neither is within 300m of the boundaries of the proposed extension and so it is not anticipated there would be any impacts on these sites.

There may also be a risk of unrecorded or undiscovered heritage assets, including unknown archaeology within this area.

As a result, it is anticipated that risks to cultural heritage would be low to moderate for Options (i) and (ii) as these have the greatest soil strip and earthworks; Option (iii) would be neutral.

2.5.6 Assessment of 400kV Connection into Woodland

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

Table 2.1 Constraints Risk Assessment

Constraint	Option (i) UGC, 1c/phase	Option (ii) UGC, 2 c/phase	Option (iii) OHL
Biodiversity			
Soil & Water			
Land Use			
Landscape & Visual			
Cultural Heritage			
Environmental Summary			

Options (i) and (ii) present the most significant risks to the environment, during operation. There would be few risks during construction. Option (ii) is of a higher risk as it requires the loss of some hedgerow habitat.

2.6 Social Constraints

2.6.1 Amenity and Health

There are several residential properties close to Woodland substation. The properties are quite dispersed but in places cluster to form small communities alongside local roads. Small Area statistics for this area show that all households are in houses or bungalows, none in apartments or mobile homes; this is typical of low-density populations. Given its rural nature, background noise levels in the area would be expected to be low; air quality would be good, and traffic would be at a low level: the local roads are narrow and largely serving the local community only.

In terms of amenity effects, these occur when there are two or more significant 'nuisance' effects on communities. These nuisance effects are generally taken to be visual impacts, traffic, noise and air quality. They are most likely to combine to create an amenity effect during the construction phase of any project. As has been stated under Section 2.5.4 Landscape and Visual, it is not considered that there would be significant visual impacts as a result of the proposed extension; traffic impacts are discussed further in 2.6.3 and it is likely that there would be a localised impact on highways and access during the construction phase only. In addition, noise and dust from the construction phase may also impact local properties. As a result, there is likely to be a combination of nuisance effects creating an effect on local amenity during construction. This would be greatest for Options (i) and (ii) as these would require the greatest degree of earthworks.

During operation, there would be no traffic or air quality issues associated with the new equipment. Visual impacts are unlikely to be significant. There may be noise issues from the equipment but as it will be located to the southwest of the existing substation and away from residential properties, it is unlikely to present a significant impact.

There is also potential for cumulative effects on the amenity of the area near Woodland Substation, as a result of other proposed electricity transmission projects in the vicinity. It is difficult to determine the likely extent of this at this stage. There are no timeframes for the construction of these projects, indeed some are still within the pre-planning phase. Two of the three projects are reinforcement or refurbishment; the North south interconnector is proposed to use the spare suspension arm of the double circuit towers of the existing 400kV OHL for its conductors. Notwithstanding this, if all projects were constructed at the same time or sequentially the magnitude on the amenity of the local community would be high as a result of large amounts of construction traffic and potential noise at once, or over a long period of time. This assessment Is not, however, included in the amenity impact assessment set out below.

It is considered that the effects on amenity would be low to moderate for Options (i) and (ii) as much of the noise and dust impacts would be mitigated by distances from local populations, leaving only traffic as a potential impact. Option (iii) would have a neutral effect.

2.6.2 Economy

In local communities close to Woodland Substation, there is a very low level of unemployment, with numbers ranging from 2 to 4%. Most of the working population in this area are in skilled or professional jobs, with a significant minority in the farming industry. In terms of impacts to local businesses or the economy, during construction there may be some disruption and access difficulties as a result of construction traffic to the substation, however this is unlikely to be a significant issue and would likely occur over a short period of time. It is not likely there would be a significant benefit from construction work or local expenditure as a result of this project. During operation there would be no significant effects on land use or existing commercial premises; no significant effects on local industry and commerce are expected. This would be the case for all options.

Land use is discussed in Section 2.5.3; the land surrounding the substation is agricultural and arable. The land required to facilitate the extension under any of the options is not considered to be enough to have an economic impact on the landowner or local farming community. Also, it also owned by TAO and so would have no economic impact as a result of a change in land use.

There are no tourist sites nearby and the local roads are not likely to be used by tourists en route to attractions as there are none near the substation.

As a result, effects on the economy from the proposed extension are likely to be neutral for all options.

2.6.3 Traffic and Transport

75% of people in this area have journey to work, school or college times of under 45 minutes, indicating local schools and employment locations. Most of the journeys are by car. Local roads in the area are narrow, sometimes only 4m wide, especially near Woodland substation. During construction, the narrow local roads pose a significant constraint to the use of the public highway to deliver materials to the substation to carry out any works required there and the introduction of heavy vehicles on the local roads could have an impact on local communities and their ability to travel to work, school or college. During operation there would be no significant effects on traffic and transport.

As a result, effects on traffic and transport are likely to be moderate for Options (i) and (ii) as these are the largest extensions and of similar requirements in terms of construction equipment and traffic. Option (iii) would be low.

2.6.4 Utilities

Above ground utilities in the area include telephone network cables and OHLs. Near to Woodland substation, there is the existing Moneypoint to Woodland 400kV OHL travelling east to west; the Woodland to Maynooth 220kV OHL travelling north to south; and a 110kV OHL crossing to the south of Woodland substation in a north west to south east direction. During construction, there is some potential for underground utilities in the area of the proposed extension, which would need to be assessed and managed prior to construction commencing. However, given the nature of the land in this location it is not anticipated that this would be a significant issue. Also as this land is already owned by TAO, then it is likely any underground utilities would be known. During operation, there are unlikely to be effects on third part utilities; any effects on the existing arrangements at the substation would be factored into the design of the proposed works.

As a result, the effects on third party utilities are likely to be neutral for all options.

2.6.5 Assessment of Social Impacts

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

Table 2.2 Constraints Risk Assessment

Constraint	Option (i) UGC, 1c/phase	Option (ii) UGC, 2 c/phase	Option (iii) OHL
Amenity & Health			
Economy			
Traffic & Transport			
Utilities			
Social Summary			

The proposed extension has a generally low to moderate risk of social impacts for Options (i) and (ii); it would be largely neutral for Option (iii). The location of the extension to the southwest of the existing substation mitigates or removes many risks that would otherwise have been present. Traffic issues are likely to be the main concern. These can be mitigated through the use of a Construction Traffic Management Plan; timings of deliveries, for example, to avoid hours when local people are travelling to work or school would reduce much of the impact discussed here.

2.7 Deliverability

2.7.1 Construction

New earthworks, foundations and cable troughs may be required for the new 400kV connection. The substation earthing grid will need to be extended as per the new substation boundary.

For UGC options (i) and (ii), shunt reactors are included for reactive compensation. For option (i), it is anticipated that existing access roadways can be utilised for the delivery of the shunt reactor. For option (ii), a temporary or permanent access roadway and set down area will be needed for the shunt reactor delivery and to provide general maintenance access. For the OHL option (iii), a new landing gantry will be required. No additional access roads requirements are expected.

2.7.2 Outage Requirements

The majority of the construction and earthworks for the new bay can be done as an offline build without the need for outages, the exception to this being the works in proximity to the existing busbars which would require appropriate busbar outages. In addition to these construction outages, outages would be required on each of the busbars and an appropriate circuit to enable commissioning of the busbar protection. Such outages are standard for this type of construction work and no unusual outage requirements have been identified.

It should be noted that current proposals envisage the re-use of existing pantograph disconnectors. If the condition of these is assessed as being unsuitable for re-use, then additional busbar proximity outages would be required for the removal of the existing pantograph disconnectors and the installation of new.

Horizontal safety distances have been maintained with the adjacent bay, so outages on the adjacent circuits may not be required.

It is noted that the Portan circuit is the UK-Ireland interconnector and thus is a strategically important circuit. Whilst construction works will be undertaken adjacent to the Portan bay, as indicated in 2.3.1 above a distance of at least 10m has been allowed between each bay to facilitate construction works and it is currently anticipated that with appropriate construction methodologies proximity outages on the Portan circuit would not be required.

2.7.3 Deliverability Feasibility

As per Section 1.5, the following scale is used to assess the deliverability feasibility of this option. No significant issues are identified between the options, although the need for shunt reactors requires additional works for both UGC options. This explains the given moderate-low impact rating (Green) and moderate rating (Dark Green) for (i) and (ii), respectively. No major deliverability issues with the OHL options therefore low risk (Cream).

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

400kV Connection Options	Deliverability Feasibility
(i) (UGC, 1c/phase	
(ii) UGC, 2c/phase	
(iii) OHL	

2.8 Economic

The following assumptions have been made for the cost feasibility assessment:

- The costs have been developed based on standard connection bay equipment conformations using information from the TAO and only includes the electrical plant items/works and associated civil works.
- The shunt reactor costs are based on budget estimates provided by Siemens and are for the units only. Additional quantities of materials for the connection to substation have been included in evaluation.
- The works associated with planning and extension of the substation perimeter fence have not been included.

Note: costing assumes feeder connections are lines however from a substation perspective, cable options will be priced the same as it is assumed the cable sealing end costs are associated with the HV cable option as a whole.

2.8.1 UGC – 1 cable per phase option

Item No.	TAO Cost Ref.	Item Description	TAO Rate Gross €	Quantity	Gross Cost Estimate Amount €
1	S400-9	New 400kV AIS Line Bay in existing 400kV AIS Double Busbar Outdoor Station (Strung / Tubular Busbar)	€ 1,710,000	1	€ 1,710,000

This cost may differ slightly due to the need for double the cable sealing ends for the extra conductors.

Siemens	New 300 MVAr 400kV 3ph 50Hz Shunt Reactor (SH RX)	-	1	€2,700,000

Due to the non-standard application of reactive compensation, there are no standard pricing methodologies for the arrangements shown in drawings 321084AE-LAY-009 therefore, for comparison, a list of quantities is shown below.

Item No.	Item Name	Quantity
Electrical		
1	Bus Bar	70m
2	Bus Support (BS)	1
3	Post Insulator (PI)	3
5	Surge Arrestor (SA)	3
Civils		
	Foundations	6
	Reactor Bund Wall	1

2.8.2 UGC – 2 cables per phase option

Item No.	TAO Cost Ref.	Item Description	TAO Rate Gross €	Quantity	Gross Cost Estimate Amount €
1	S400-9	New 400kV AIS Line Bay in existing 400kV AIS Double Busbar Outdoor Station (Strung / Tubular Busbar)	€ 1,710,000	1	€ 1,710,000

This cost may differ slightly due to the need for double the cable sealing ends for the extra conductors.

Siemens	New 300 MVAr 400kV 3ph 50Hz Shunt Reactor (SH RX)	-	2	€ 5,400,000

Due to the non-standard application of reactive compensation, there are no standard pricing methodologies for the arrangements shown in drawings 321084AE-LAY-010 therefore, for comparison, a list of quantities is shown below.

Item No.	Item Name	Quantity
Electrical		
1	Bus Bar	276m
2	Bus Support (BS)	2
3	Post Insulator (PI)	14
5	Surge Arrestor (SA)	6
Civils		
	Foundations	21
	Reactor Bund Wall	2

2.8.3 OHL Option

Item No.	TAO Cost Ref.	Item Description	TAO Rate Gross €	Quantity	Gross Cost Estimate Amount €
1	S400-9	New 400kV AIS Line Bay in existing 400kV AIS Double Busbar Outdoor Station (Strung / Tubular Busbar)	€ 1,710,000	1	€ 1,710,000

2.8.4 Economic Feasibility

As per Section 1.5, the following scale is used to assess the economic feasibility of this option. The scale assigned to each option is primarily driven by the cost of the shunt reactors and the indicative list of quantities derived from drawings 321084AE-LAY-009 and 321084AE-LAY-010 which are a very significant proportion of the overall costs. Since UGC option (i) requires a single shunt reactor the economic impact has been assigned moderate-high (Blue). On the other hand, the UGC option (ii) requires two and therefore doubles the materials quantities further impacting the costs. For this reason, the option has been given a high economic impact (Dark Blue). Lastly, the OHL option (iii) has been given a low economic impact rating (Cream) due to no compensation requirements.

More significant/difficult/risk | Less significant/difficult/risk

400kV Connection Options	Scale
(i) UGC, 1c/phase	
(i) UGC, 2c/phase	
(ii) OHL	

3. Conclusion

The 400kV connection options at Woodland substation are all technically feasible and require the extension of the substation boundary fence.

No major planning works involving land acquisition are anticipated to be required for all the three options considered. Earthworks and civil works will also be required for the extension as well as for a new access roadway for the delivery of the shunt reactors for UGC 2 cables per phase option.

The requirement for shunt reactors associated with options (i) and (ii) is a significant differentiator with option (iii) which represents a 'standard' solution. This is especially true for the economic impact ratings due to the non-standard approach having high unit costs for the shunt reactors and the quantities of materials required for their connection. This equates to higher costs which are significantly larger for the UGC option (ii) due to the need for more materials.

This overall assessment has been presented in the table below.

400kV Connection Options	Technical Feasibility	Environmental Feasibility	Social Feasibility	Deliverability	Economic Feasibility	Combined Performance
(i) UGC, 1 cable per phase						
(ii) UGC, 2 cables per phase						
(iii) OHL						

Appendix A. Drawings

321084AE-LAY-009 - Woodland 400kV 1 Cable per Phase RevA

321084AE-LAY-010 - Woodland 400kV 2 Cables per Phase RevA

321084AE-LAY-011 - Woodland 400kV OHL RevA