Jacobs

Capital project 966

Substation Feasibility Assessment - Dunstown 220kV Connection

321084AE-REP-012 | A

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EirGrid

CP966

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Contents

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Executive Summary

Jacobs was requested to prepare a set of substation feasibility reports for the 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. The project will therefore require substation modifications 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. substation modification 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 been 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 option for an incoming 220kV cable connection at Dunstown 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 connection of the incoming 220kV underground cable circuit at Dunstown substation is technically feasible, however the viability of this solution is severely impacted by a number of oversailing conductor hazards that will affect construction and deliverability and will require appropriate mitigation. Issues associated with this hazard need further investigation.

Minimal environmental impact is expected, and low deliverability challenges are foreseen however access and delivery of the shunt reactor are to be taken in consideration.

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/

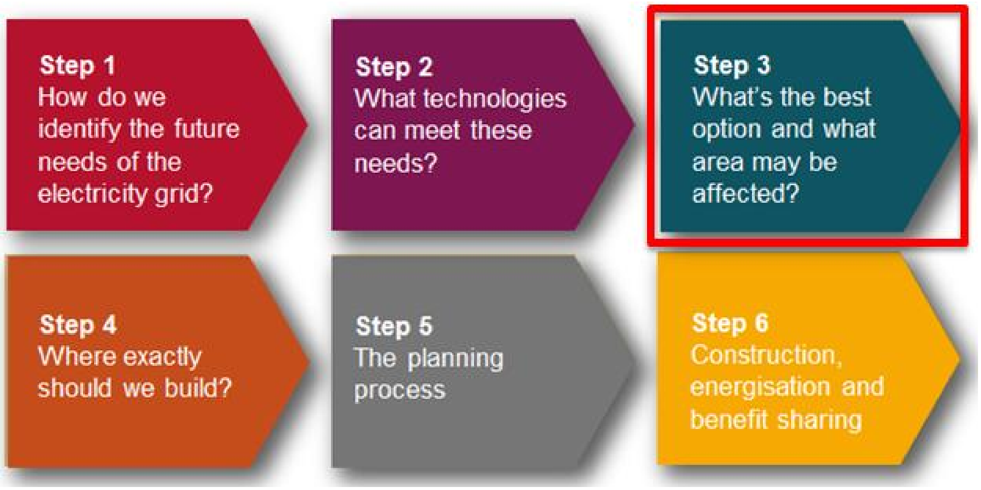


Figure 1 : EirGrid's Six-Step Framework for Grid Development

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 in regard to a 220kV cable connection at Dunstown Substation. The finding 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 – CP966 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 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 – CP966 Cable Route Feasibility Report
- 321084AE-REP-002 – CP966 Environmental Feasibility Report
- 321084AE-REP-003 – CP966 Social Impact Report

2. The Project

2.1 Site Description

Dunstown 400/220kV AIS substation is an existing substation located in County Kildare and is surrounded by farmland and is 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 Asset Owner (TAO).

The substation presently contains both 400kV and 220kV equipment in a double busbar arrangement with 2 x 400/220kV transformer bays, 5 x 220kV line bays and 1 x 400kV line bay.

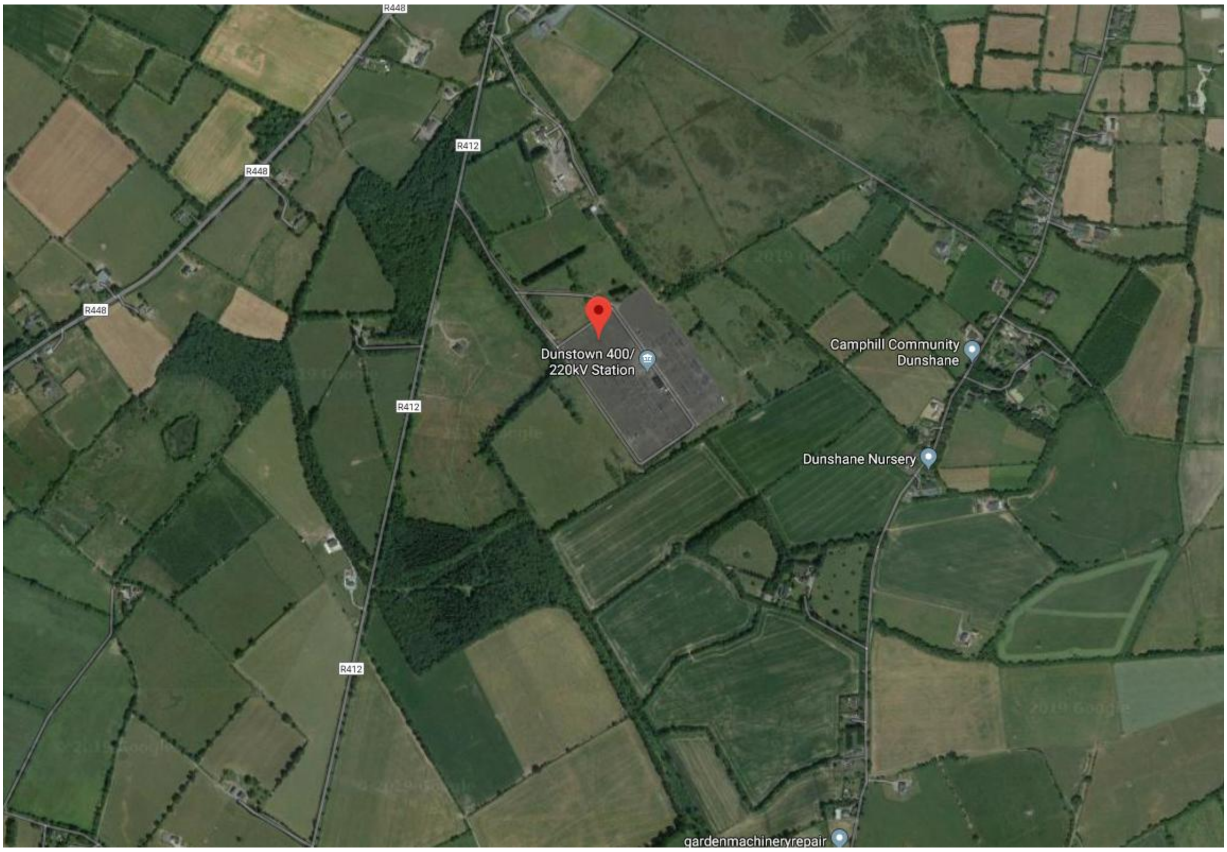


Figure 2 : Aerial View of Dunstown Substation (From Google Earth)

Figure 3 : Location of 220kV extension (From Google Earth)

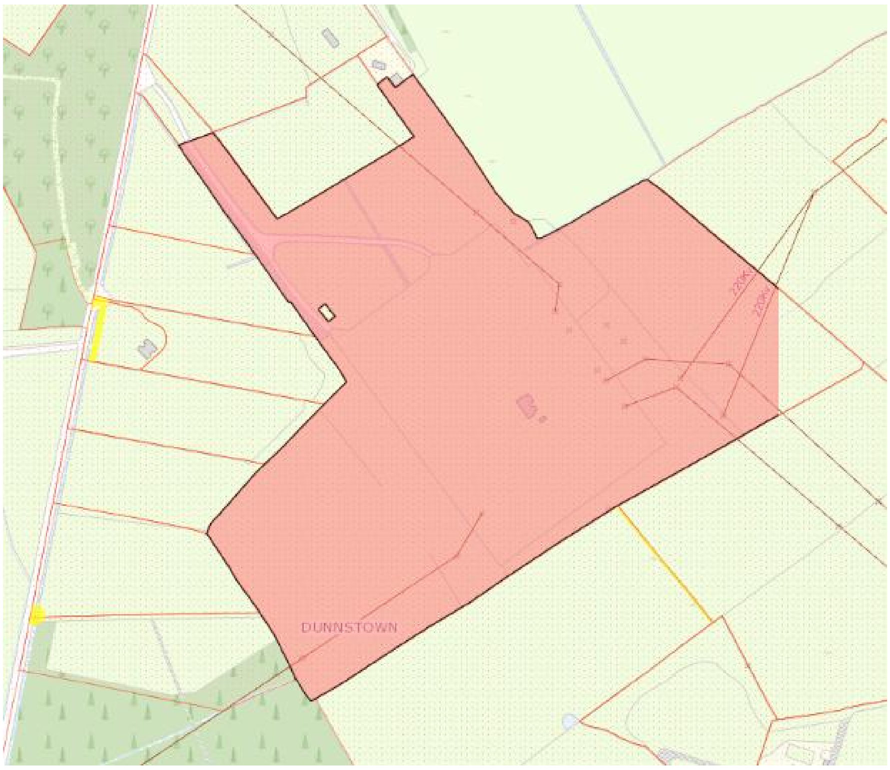


Figure 4: Extend of Land Ownership Boundary

2.2 Objective

This report will provide a feasibility assessment of the works required to accommodate a new bay for the CP966 220kV connection between Dunstown and Woodland Substation. An assessment has been undertaken on how to accommodate a new bay for the 220kV Underground Cable CP966 connection which requires a 220kV circuit entry into the substation which will also require a new HV cable bay with Shunt Reactor.

2.3 Technical

2.3.1 Project Requirements

The new 220kV 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 220kV connection bay is based on the existing bay designs at Dunstown substation excluding the shunt reactor connection.

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. See drawing 321084AE-LAY-017 in Appendix A for the substation layout arrangement of the proposed works.

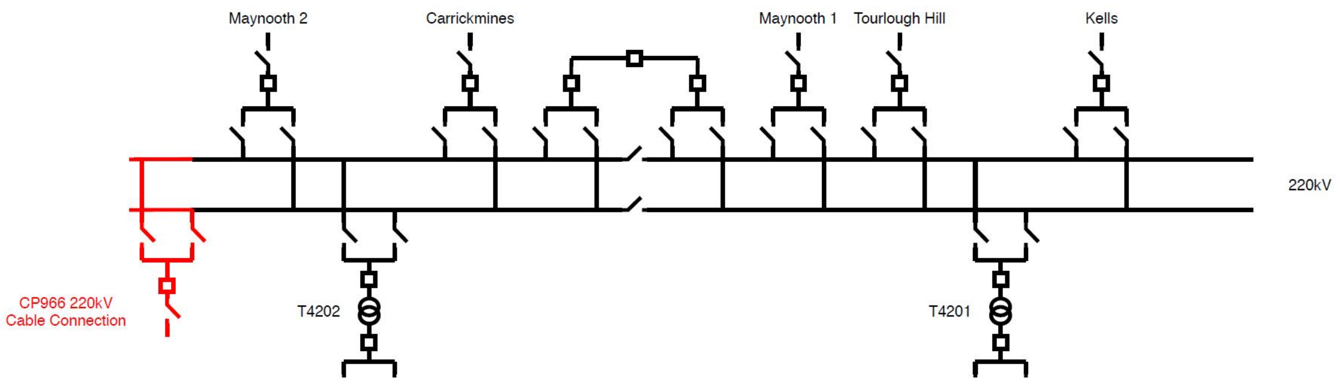


Figure 5 : Dunstown 220kV Connection

For the 220kV underground cable, the CP966 connection bay has been shown as a single cable per phase circuit. EirGrid have indicated that reactive compensation will be required with a specified value of 99MVAr, therefore additional space is needed to accommodate this equipment. A 100MVAr shunt reactor has therefore been shown on the layout drawing 321084AE-LAY-017 in Appendix A for the purposes of reactive compensation for the new CP966 connection.

Initial consideration was given to utilising the existing 'spare' bay on the south-east end of the substation adjacent to the Kells circuit. However, it was noted that this would create a 'fifth' bay and thus is not available for use due to EirGrids requirement to have no more than four bays on one side of a section. As such, options for development in this area have not been considered further. Due to the proximity to the Kells circuit and potential oversailing conductor issues, some technical complexity may also have resulted from attempts to utilise this 'spare' bay.

Development on the north-west end of the substation adjacent to the Maynooth 2 circuit has therefore been considered. Again, a connection on this side will encounter some technical hurdles due to oversailing conductor hazard issues associated with the Maynooth 2 circuit. Two options for development on this side of the substation have been considered as below;

(i) Installation of a new bay adjacent to the Maynooth 2 circuit, and

(ii) Installation of a new bay in conjunction with a C-type extension as discussed in report 321084AE-REP-005.

In respect of option (i) it is noted that the proximity and angle of the Maynooth 2 circuit would present an oversailing conductor hazard if the new 220kV UGC bay were to be oriented 'out' of the substation, and thus development of an option with this orientation would likely only be feasible if the Maynooth 2 circuit were diverted or undergrounded to remove this hazard. This option has therefore been developed with the bay oriented 'into' the substation to avoid this hazard as per drawing 321084AE-LAY-017a, although this does require the 220kV UGC to be brought into the middle of the substation rather than just to the perimeter, and requires the current access road to be diverted around the end of the bay.

Option (ii) is represented by drawing 321084AE-LAY-017b. It should be noted that the viability of this option is contingent on the diversion or undergrounding of the Maynooth 2 circuit to avoid the oversailing conductor hazard that would otherwise result (this is also discussed in report 321084AE-REP-005). The requirement to extend the substation perimeter fence may also get close to the existing TAO land ownership boundary on the north-eastern side.

Thus, whilst it is technically possible for the 220kV UGC option to be connected into Dunstown substation, there are technical issues to be resolved, principally in respect of the mitigation of the oversailing conductor issues, which would require further investigation.

2.3.2 Other requirements

Although associated work with the new 220kV UGC new bay build and connection includes investigating and allocating space for new protection panels in the existing control building and an assessment of the existing LVAC and DC systems to confirm adequate capacity, these elements have not been considered at this stage as they would have no material impact on the physical extent of the construction works required.

2.3.3 Technical Feasibility

As per Section 1.5, the following scale is used to assess the technical feasibility of the new 220kV connections. This assessment has been based on the requirement for the reactive compensation and the number of oversailing obstacles encountered on the 220kV side of the substation with only the option detailed on 321084AE-LAY-017a avoiding this issue. Option (ii) also potentially impacts on the TAO land ownership boundary and would need to be confirmed. For these reasons, this option has therefore been assigned a moderate to high-risk rating (LightBlue).

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

2.4 Site Modifications

The following site modifications will be required to accommodate the new extension as per drawing 321084AE-LAY-017b in Appendix A.

- Existing palisade fence will need to be removed and new palisade fencing to be installed to accommodate the larger substation perimeter to accommodate cable sealing ends and shunt reactor required for compensation. Further to this, associated civil earthworks to provide a flat and level platform for the extended substation are required.
- Extension of the existing access roadway required.

In respect of the option on drawing 321084AE-LAY-017, no significant site modifications are required apart from the diversion of the internal access road.

Figure 3 shows the location of proposed site extension work and Figure 4 shows the extent of the land ownership boundary of the substation. Although it is currently anticipated that no third-party land is required, further development of 321084AE-LAY-017b would be required to confirm this.

2.5 Environmental and Social Constraints

Given the location of the proposed works, inside the existing substation, and the nature of the project which whilst increasing the amount of electrical infrastructure, would result in no additional height and noise, there are likely to be neutral impacts on almost all aspects of environmental and social constraints.

The construction phase has the potential for amenity impacts as a result of construction traffic, noise and dust for the nearest residential property, however these impacts are likely to low or possibly neutral also.

As a result, the environmental and social effects would be neutral.

2.5.1 Assessment of Substation Extensions and New Connections into Woodland

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

Table 2.1 Constraints Risk Assessment for Substation Extensions and New Connections into Woodland Substation

Constraint	Risk
Environment	
Social	

2.6 Deliverability

2.6.1 Construction

No significant issues are identified for the deliverability of the new 220kV bay and cable connection as the works are in accordance with standard substation construction parameters. New foundations and cable troughs will be required.

As per section 2.3, for the new HV cable bay of the 220kV UGC option, a 100MVAr shunt reactor is to be installed as part of the CP966 line bay for reactive compensation. A temporary or permanent access roadway and set down area will be needed for the shunt reactor delivery and to provide general maintenance access, as this is a large unit that will require specialised vehicle for delivery. A proposed access roadway is shown on layout drawing 321084AE-LAY-017b.

It is noted that whilst the construction works related to the new cable bay itself are considered a relatively low deliverability risk, should the diversion or undergrounding of the Maynooth 2 circuit be required as enabling works for this new bay, this may increase the deliverability risk. However, any potential diversion/undergrounding works on the Maynooth 2 circuit have not been assessed as part of this report.

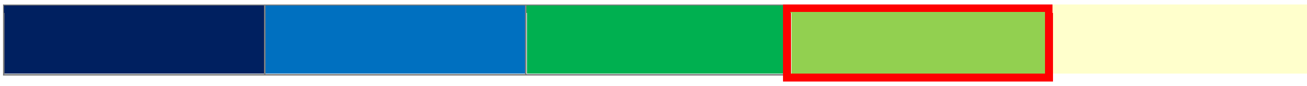
2.6.2 Outage requirements

The majority of the construction and earthworks for the new 220kV UGC connection can be done as an offline build without the need for outages. Horizontal safety distances have been maintained with the adjacent bay, so outages on the adjacent circuits may not be required, although single busbar outages will be required during final busbar connections and commissioning works.

2.6.3 Deliverability Feasibility

As per Section 1.5, the following scale is used to assess the deliverability of the new 220kV cable connection. This is based on how easily the required works can be carried out e.g. implementation of the shunt reactor and perimeter/road extension.

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



2.7 Economic

2.7.1 Cost Estimate

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

- The cost has been developed based on standard equipment configuration using information from the Transmission Asset Owner (TAO) and includes the electrical plant items/works and associated civil works.
- These are for the new cable connection only and no costs associated with other CP966 extension works are considered.
- The shunt reactor costs have been provided by Siemens and are only relevant for the new HV cable bay in support of the 220kV underground cable option. These have been priced for the units only.

2.7.2 220kV Underground Cable Connection

Item No.	TSDC Ref.	Item Description	TAO Rate Gross €	Quantity	Gross Cost Estimate Amount €
1	S220-11	New 220kV AIS Line Bay in existing 200kV Double Busbar Enhanced "C-Type" / Enhanced "Ring-type" Outdoor Station (Strung/Tubular Busbar)	€ 1,550,000	1	€ 1,550,000

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.

Siemens	New 100 MVAr 220kV 3ph 50Hz Shunt Reactor* (SH RX)	-	1	€1,550,000

Due to the non-standard application of reactive compensation, there are no standard pricing methodologies for the arrangements shown in drawings 321084AE-LAY-007 therefore, for comparison, a list of quantities is shown below.

Item No.	Item Name	Quantity
Electrical		
1	Bus Bar	100m
2	Post Insulator (PI)	12
3	Surge Arrestor (SA)	3
Civils		
	Post Insulator type Foundations	15
	Reactor Foundation & Bund Wall	1

* this Shunt Reactor cost represents an additional cost associated with the new HV cable bay in support of the 220kV underground cable option only.

3. Conclusion

The connection of the incoming 220kV underground cable circuit at Dunstown substation is technically feasible, however the viability of this solution is severely impacted by a number of oversailing conductor hazards that will affect construction and deliverability and will require appropriate mitigation. Issues associated with this hazard need further investigation.

Minimal environmental impact is expected, and low deliverability challenges are foreseen however access and delivery of the shunt reactor are to be taken in consideration.

Assessment Criteria	Scale
Technical Feasibility	
Environmental Feasibility	
Social Feasibility	
Deliverability	
Combined Feasibility	

Appendix A. Drawings

321084AE-LAY-017A - Dunstown 220kV Cable Connection RevA

321084AE-LAY-017B - Dunstown 220kV Cable Connection RevA