APPENDIX 3

Report to the Independent Expert Panel Date: 29/5/2014 & *Addendum* Date: 19/06/2014

Report to Independent Expert Panel
Date: 29/05/2014
&
Addendum
Date: 19/06/2014

Paper prepared at the request of the Independent Expert Panel for the purpose of providing an "*Assessment by EirGrid of the extent to which, in EirGrid's view, the methodologies to be employed on the GW and GL projects are compatible with what has already been done on the N/S project".*

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1. Introduction

This paper reviews the comparative analysis carried out by EirGrid of the underground cable (UGC) and overhead line (OHL) options considered in the case of the North South 400kV Interconnection Development (N/S Project). It compares the methodology employed in that comparative analysis with the terms of reference specified by the Independent Expert Panel (IEP) for the studies to be carried out for the Grid West (GW) and Grid Link (GL) projects and provides an assessment as to whether they are, in EirGrid's view, compatible.

2. History and Context

2.1 Overview

EirGrid and SONI are jointly planning a major cross-border electricity transmission development between the existing high-voltage transmission networks of Ireland and Northern Ireland[1]. The proposed overall interconnection project will link the existing 400 kV substation in Woodland, County Meath with a planned substation in Turleenan, County Tyrone; it will provide a second high capacity electricity interconnector between Ireland and Northern Ireland.

In December 2009, EirGrid submitted an application to An Bord Pleanála for development consent for that portion of the proposed cross-border transmission infrastructure development located in counties Monaghan, Cavan and Meath (An Bord Pleanála Ref. VA0006). During the period January-March 2010, the Board invited written submissions from identified prescribed bodies, other stakeholders, members of the public and all other parties. In May 2010, An Bord Pleanála commenced an Oral Hearing in respect of the proposed development. However, in June 2010, the EirGrid application was withdrawn due to an error in the statutory notices. As such, this application for planning approval was not determined by the Board.

During the period since the withdrawal of the previous application for planning approval, EirGrid has undertaken a comprehensive re-evaluation of that portion of the proposed interconnector located between the existing substation at Woodland, County Meath and the border with Northern Ireland. The re-evaluation process included a review of the previous application in order to ascertain whether the scope, content, conclusions of, and rationale for that development proposal remain applicable for the purposes of informing and shaping the current application for planning approval of the proposed development. The re-evaluation also took into account both the ***Meath-Tyrone Report: Review by the International Expert Commission*** (January 2012) and the ***Government Policy Statement on the Strategic Importance of Transmission and Other Energy Infrastructure*** (July 2012). The ultimate output of this process is the line design of the proposed development that is the subject of the current application for planning approval which is expected to be submitted later this year.

[1] *The planning of that portion of the proposed interconnector within Northern Ireland was originally undertaken by Northern Ireland Electricity (NIE). However, NIE was obligated by the European Commission to transfer its investment planning function (the "Planning Function") to SONI. The SONI transmission system operator licence (the "Licence") was amended on 28th March 2014 to take account of the transfer of the Planning Function following a consultation process by the Northern Ireland Authority for Utility Regulation (NIAUR). The Licence amendments took effect on 30th April 2014. Accordingly, responsibility for the pursuance of the planning application in respect of the proposed interconnector within Northern Ireland has been transferred from NIE to SONI.*

2.2 Identification of OHL and UGC options for the N/S Project

The identification of OHL and UGC options for the N/S Project was completed during the consideration of route alternatives for the project.

The approach adopted by EirGrid in the route selection process is best understood as occurring in a number of phases: The identification of a broad study area for the project (Phase 1); a corridor evaluation and route selection stage (Phase 2) and the identification of a preferred line design (Phase 3).

Phase 1 of the route selection process (c. 2001-2005) involved the identification of a "broad study area" within which to route the planned second interconnector. This derived from a number of technical studies undertaken jointly by ESB National Grid and Northern Ireland Energy over the period 2001-2004. The primary purpose of these studies was to jointly determine best options for the selection of transmission system connection points, the geographic positioning of all associated infrastructure and to quantify the potential improvements in transmission capacity and system security that would be provided by various interconnection solution options.

Phase 2 of the route selection process was twofold: firstly to identify alternative feasible route corridors within the identified project study area, and secondly to identify a preferred route corridor following a strategic analysis of technical and environmental constraints.

For both UGC and OHL options, the corridor evaluation process involved an examination of the proposed study area, taking into account the range of environmental constraints identified within this area.

1. For the OHL assessment, routing criteria and constraints mapping specific to an OHL was identified. The OHL assessment was completed by EirGrid in 2007 and resulted in the identification of a number of feasible route corridor options for the project. Following public consultation a preferred OHL route corridor was confirmed in April 2009.

2. In November 2007 PB Power (now Parsons Brinckerhoff) was also contracted to identify potential route corridors for UGC. The UGC assessment was completed by PB Power in 2009 and resulted in the identification of a "*continuous, technically feasible, strategic UGC route*" for the project.

This corridor evaluation process was undertaken in the context of the general technical parameters for the project, as a high capacity interconnector between the transmission systems of Northern Ireland and Ireland. Specific studies addressing the technical feasibility of UGC options were developed and published in parallel with spatial and environmental studies.

These identified strategic route corridors for OHL and UGC were further assessed as part of the consideration of technology alternatives for the project up to and during the preparation of the draft ***2014 N/S Project EIS***.

The following Section 2.3 of this report provides a summary of reports completed between 2007-2009 in advance of the preparation and submission of a planning application in December 2009.

2.3 Reports and Studies (2007-2009)

1. PB Power Report (2009)

In November 2007 PB Power (now Parsons Brinckerhoff) was contracted to identify potential route corridors for UGC. It's terms of reference in this regard was to apply "*a set of environmentally based routing principles to identify at least one corridor within which the use of UGC could be technically and environmentally feasible as an alternative to the proposed OHL*[2]".

The methodology applied by PB Power is described in detail in chapter 7 of the ***PB Power Report*** (2009). The routing team consisted of:-

- An electricity transmission specialist
- A landscape architect
- The environmental consultants (Tobin & ESBI) responsible for the constraints reports and maps that were used to identify the preferred OHL route corridor
- A UGC installation specialist
- A civil engineer who had worked on the North South Gas Pipeline Project and therefore had local knowledge of issues involved in linear excavations.

All members of the team visited and toured the study area. This was done in small groups, at different times, over a combined duration of about six days. The outcome of the route search exercise was:-

- Routing criteria for identifying UGC corridors were developed to accommodate the landscape characteristics of the terrain encountered in the study area.
- A continuous technically feasible "*viable strategic UGC search corridor*" that satisfied these routing criteria was identified from Woodland in County Meath to Turleenan in County Tyrone.
- The 'most suited' or preferred UGC route corridor passes principally through agricultural land, and avoids routing constraints presented by identified natural, cultural heritage, and landscape features.
- The identification and classification of the different landscapes types encountered along the route corridor was found to be a useful approach to managing routing considerations, assessing UGC route options and estimating cable drum lengths to assist with the subsequent estimating of the civil and overall undergrounding costs.

A composite map showing the most suited UGC and OHL route corridors based on this study is included in **Appendix A**.

In addition and separate to the above, other UGC routing options were considered by EirGrid and assessed as being less preferred to the UGC route identified by PB Power[3]. These less preferred route options were:-

- An off shore undersea route
- A route within the reserve of the M3 motorway

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2 PB Power Report – Executive Summary (2009)

3 See Sections 4.4 and 5.6 of Volume 1, Environmental Impact Statement, Meath –Tyrone 400kV Interconnection development, 2009.

- A route within the reserve of the dis-used railway lines in the study area

During the 2007/2009 period EirGrid also commissioned a number of related project specific environmental and technical studies. These included:-

2. ***Cavan-Tyrone Route Constraints Report*** (ESBI, September 2007 and Addendum May 2008) and ***Meath-Cavan Constraints Report*** (Tobin, 2008)

   These two reports detail corridor options for an OHL route in the Cavan-Monaghan Study Area (CMSA) and Meath Study Area (MSA). They provide baseline studies of the key environmental constraints, including:-

   - Socio Economic;
   - Land Use;
   - Landscape;
   - Flora & Fauna;
   - Water;
   - Soils; and Cultural Heritage.

   The reports were based upon high level analysis, including desk top studies, vantage and driving surreys as well as consultation with interested parties and other stakeholders. The Addendum Reports contained updated constraints information including additional studies, feedback from public consultation and new planning application data

3. ***The TEPCO Study*** (TEPCO, 2009). A system wide study that considered the implications, for transmission system reliability and stability, of incorporating very long lengths, and/or large quantities, of High Voltage Alternating Current (HV AC) UGC transmission infrastructure on the all-island AC transmission network. The study was performed by Tokyo Electric Power Company of Japan (TEPCO) who, as owner and operator of the world's longest existing HV AC UGC circuit operating at a voltage of 400 kV or above, is uniquely placed to bring its specific experience to bear on the subject. The study included specifically an examination of the viability of using this technology for the N/S Interconnector Project.

4. ***The TransGrid Study*** (TransGrid, 2009). A system wide study that considered the implications for transmission system reliability and stability of incorporating HVDC circuits into the integrated all-island AC transmission network. This study was performed by TransGrid Solutions (of Winnipeg, Canada), a consultancy with extensive international experience in the evaluation of HVDC technology. The study included specifically an examination of the viability of using this technology for the N/S Interconnector Project.

   Government also commissioned its own independent study:-

   - **The Ecofys Study** (Department of Communications, Energy and Natural Resources (DCENR) 2008). *A Study on the Comparative Merits of Overhead Electricity Transmission Lines Versus Underground Cables.* Its stated objective "is *to contribute*

in a constructive way to the ongoing discussions between the various stakeholders in Ireland related to specific projects (Tyrone – Cavan - Meath connection)". It includes a technical, economic and environmental comparison of the options.

A brief outline of the Ecofys Report can be found in Appendix C.

These reports, and a number of additional independent studies, reports and papers, supplemented by EirGrid's own internal analysis, provided the basis for the comparative analysis of OHL and UGC options for the project as set out in the ***2009 Meath- Tyrone EIS*** (EirGrid 2009).

2.4 2009 Meath-Tyrone EIS

Schedule 5 of the *Planning and Development Regulations 2001* (as amended) requires an EIS to be carried out for a project where it involves "*Construction of overhead electrical power lines with a voltage of 220 kilovolts or more and a length of more than 15 kilometres*". The North South Project falls within this requirement. The ***2009 Meath-Tyrone EIS*** was prepared in accordance with Schedule 6 of the Planning and Development Regulations (2001) as amended, and having regard to the ***EPA's Guidelines on Information to be contained in Environmental Impact Statements*** (EPA 2002) and ***Advice Notes on Current Practice in the preparation of Environmental Impact Statements*** (EPA 2003).

An EIS must include *"an outline of the main alternatives studied by the developer and an indication of the main reasons for his or her choice, taking into account the effects of the environment"*. The reports which considered alternatives for the North-South Interconnector Project (as described in Section 2.3) fed directly into the ***2009 Meath-Tyrone EIS*** in addressing the main alternatives considered.

In Volume 1, Section 4, "*Transmission & Technology Alternatives*" of the ***2009 Meath-Tyrone EIS*** the range of technical options identified for the proposed development were measured against various technical and environmental criteria. Having eliminated the HVAC Undersea and HVDC Undersea alternatives as viable options for this development at an early stage of the consideration of technical alternatives further consideration was given to the remaining technical alternatives with a view to deciding which should proceed, as the preferred technical option, for the project.

Three technical alternatives were set out and evaluated, namely:-

- AC OHL
- AC UGC
- DC (OHL & UGC)

For this comparative evaluation of technological alternatives, regard was given to all relevant studies, to current international best practice, to feedback received during public consultation, and to the extensive experience and expertise of EirGrid and NIE in respect of transmission infrastructure design, construction and operation. The resulting matrix is shown in ***Figure 1***:

Objective	Description	Technical Options		
		AC Overhead	AC Underground	DC
1	**Comply with EirGrid's Statutory and Regulatory Obligations**			
1.1	Safety	* * *	* * *	* * *
1.2	Reliability and security	* * *	* *	* *
1.3	Cost effectiveness	* * *	*	*
1.4	Due regard for the environment	* *	* *	* *
2	**Meet the Specific Objectives of this Project**			
2.1	1500 MVA Capacity and appropriately strong points of interconnection	* * *	* * *	* *
2.2	Reinforce the North East transmission network	* * *	* * *	* * *
3	**Meet the General Objectives for all projects of this type**			
3.1	Facilitate future grid connections and reinforcements	* * *	* * *	*
3.2	Good Technical Solution - Be 'best international practice' with proven technology	* * *	*	*

Acceptable for this project	* * *
A concern for this project	* *
Unacceptable for this project	*

Figure 1 - Strategic Constraints Matrix of Potential AC OHL, AC UGC and DC Transmission Alternatives (Extract from 2009 Meath-Tyrone EIS)

The matrix in Figure 1 summarises that the only technical alternative that is considered to provide an acceptable method for achieving the strategic and specific objectives of the N/S Project is AC OHL. This derives from a negative response in the case of the AC UGC and DC alternatives to considered issues of cost effectiveness and their departure from being a good technical solution, which is considered to be best international practice with a proven technology, having regard to the specific nature and extent of the proposed development. In addition, in the case of DC, its poor facilitation of future grid connections and reinforcements was considered to be unacceptable for the stated parameters and justification for this project.

2.5 The Re-Evaluation Process (2010-2013)

Following the withdrawal of the 2009 application a re-evaluation of all aspects of the project, including the comparative technology assessment provided in the ***2009 EIS*** was undertaken. This re-evaluation took place over the period 2010/2013.

In May 2011 EirGrid published a ***Preliminary Re-evaluation Report*** (EirGrid, May 2011) for public consultation. This contained a review of the international 'state of the art' in relation to UGC and OHL and updated EirGrid's ***2009 EIS*** comparison of the options in light of same. A brief summary of this report can be found in **Appendix B.**

In July 2011, the Government announced the appointment of an International Expert Commission (IEC) to review the case for, and cost of, undergrounding (all or part of) the N/S Project. This resulted in the publication of the following:-

The International Expert Commission (IEC) Report (January 2012). A review of the case for, and cost of, undergrounding all or part of the Meath–Tyrone 400 kV line (now known as the North-South 400 kV Interconnection Development). This report includes a review of all of the earlier reports carried out in respect of the N/S Project including the ***Ecofys Report*** (2008) and ***PB Power*** report. It concluded that both of these reports were robust and relevant to the comparison of UGC with OHL for the N/S Project but that their economic and technical appraisals were out of date. The IEC report concluded that the cost of an UGC HVDC solution was a factor of three times the costs of the proposed OHL solution for the project and that an AC UGC was not feasible for the entire project. A brief summary of this report can be found in **Appendix C.**

The publication of the IEC Report prompted EirGrid to commission an update of the ***PB Power Report***. This resulted in the publication of the following:-

The ***PB Power Technology and Costs Update Report*** (PB Power, April 2013) and the ***PB Power Supplementary Note*** (PB Power, July 2013).

The ***PB Power Technology and Costs Update Report*** summarises the results of a further study carried out by PB Power to update the information provided in their initial 2009 study. The report includes a review of up to date technology and application developments worldwide. It also draws upon information and conclusions published within a number of recent relevant studies (including the ***UK Electricity Transmission Costing Study*** (2012)[4] and the ***IEC Report*** into the subject of transmission technology alternatives. A key output from the updated study has been to provide up to date comparative costs for the identified alternatives. A brief summary of the ***PB Power Technology and Costs Update Report*** and ***the UK Electricity Transmission Costing Study*** can be found in **Appendix B**.

In April 2013 EirGrid published a ***Final Re-evaluation Report*** (EirGrid, April 2013) for public comment. This updated the consideration of OHL and UGC based on the findings of the ***IEC Report*** and the ***PB Power Update Technology and Costs Update Report***. EirGrid's comparative analysis of OHL and UGC options in this report is based on the following methodology:-

- The first step in the analysis was to carry out a general evaluation of HVDC technology, as an alternative to the standard HVAC technology regardless of whether the HVDC scheme is to be implemented using OHL, UGC or a combination of both. The overall findings of this analysis were that any DC option whether implemented using UGC, OHL or off-shore submarine cable would not facilitate the future development of the transmission network. Nor would the DC option be considered as complying with 'best international practice'. While the cost of the DC options (UGC or OHL) would be

[4] Available at http://www.theiet.org/factfiles/transmission-report.cfm

comparable with an AC UGC option they would all be significantly more expensive to implement than the proposed 400 kV AC OHL option. In addition the proposed interconnector is required to be an integral part of the 'all-island' AC transmission network and will therefore be required to operate like any other AC circuit within the network. It is possible, in theory at least, to embed[5] a DC circuit into an AC transmission network and make it operate like an AC circuit however this would require a complex and be-spoke control system. The risk of failure, and the consequence of failure, must be a factor in the consideration of any technical alternative. Introducing a complex and be-spoke control system into the operation of a strategically important part of the 'all-island' transmission network brings with it considerable risk for system security and stability. Such risk taking is unnecessary in the case of this proposed development as there is a technically superior and less risky option readily available. As a result of all of the foregoing EirGrid concluded that any option using HVDC technology is not an appropriate or acceptable option for implementing the proposed interconnector.

- Having eliminated all HVDC options the next step in the analysis was to compare an entirely undergrounded 400kV AC option with a 400kV AC OHL. The conclusions of this analysis were that undergrounding a 400kV circuit of the length (c. 135km) required for the N/S Project using AC UGC would not be in compliance with good utility practice and in addition would cost substantially more than the OHL option. As a result the entirely undergrounded option, using 400kV AC UGC, was eliminated from further consideration. This conclusion was supported by the findings of the International Expert Commission (IEC).

- Although the entirely undergrounded AC option was eliminated, as consistent with the findings of the IEC report, the option of using a hybrid AC solution, i.e. a combination of AC UGC and AC OHL, commonly referred to as 'partial undergrounding', remained an option for consideration. Indeed the IEC found in this regard that partial undergrounding is technically feasible but within limitations on the cumulative length of the UGC sections. The next step in the comparative analysis was therefore to consider the option of undergrounding part of the proposed development using AC UGC but within these recognised constraints. The analysis showed that in the case of the North South Interconnector Project partial undergrounding is feasible but only if the length to be undergrounded is restricted, for technical and operation reason, to less than approximately 10km in one continuous length or an accumulation of shorter lengths; and the cost premium of using the short length(s) of UGC is an environmentally advantageous and cost-effective way of overcoming an environmental or technical constraint to the preferred OHL. Following consultation and engagement with the relevant planning authorities, prescribed and non prescribed bodies, and the general public including where possible landowners, EirGrid concluded however that there was no section of the preferred OHL route where the above applies and is therefore proposing that the entire 400 kV circuit be implemented using 400 kV AC OHL.

This comparative re-evaluation of technology choice has been further reviewed and is updated in the draft ***N/S Project EIS (2014)*** which is currently at an advanced stage of production.

[5] There are a few working examples in the world today of a DC circuit embedded in an AC transmission network however these networks are not representative of the small and isolated AC transmission network on the island of Ireland. The closest comparable scheme is probably the 1,400MW Kii Channel project in Japan which uses OHL and submarine cable. Although an island network, Japan represents a much larger generation and load base than Ireland.

As a final stage in the Re-Evaluation Process, in July 2013 EirGrid published its ***Preferred Project Solution Report (EirGrid, July 2013)*** confirming that OHL is the preferred option and that an application for planning approval and an EIS would now be prepared on that basis. A brief summary of reports associated with The Re-Evaluation Process can be found in Appendix B.

2.6 N/S Project EIS (2014)[6]

The preparation of a new application for planning approval and an associated EIS commenced following publication of the ***Preferred Project Solution Report (July 2013)***.

As part of this preparation, in August 2013, EirGrid requested An Bord Pleanála provide a "scoping" opinion in respect of the EIS for the proposed development. The scoping process involves assessing the project's possible impacts, considering available alternatives and deciding which impacts are likely to occur and likely to be significant based on the proposed development. To complete this assessment, An Bord Pleanála consulted with various parties, including local and prescribed authorities (including certain statutory agencies in Northern Ireland), before providing its scoping opinion to EirGrid on 11th December 2013.

The scoping opinion confirmed many of the issues identified during the informal scoping process undertaken by EirGrid during public consultation on the ***Preferred Project Solution Report.*** A summary of the Board's scoping opinion is presented in **Table 1**.

Table 1: An Bord Pleanála Scoping Opinion

An Bord Pleanála Scoping Opinion		
Topic	**Specific Issue Raised**	**Relevant Chapter N/S Project EIS (2014)**
Alternatives – considered (national, regional and local)	The need to outline the alternatives considered prior to the selection of the development option including: interconnection / network reinforcement options, technologies, corridor options, design & scale of development / structures, inclusion of substation(s) along route and construction methodologies.	Volume 3B, Chpts 4, 5 and 7

[6] A finalised EIS has not been published and the draft EIS may be subject to change

An Bord Pleanála Scoping Opinion		
Topic	**Specific Issue Raised**	**Relevant Chapter N/S Project EIS (2014)**
Human Beings	Identification of potential impacts on: settlement patterns along the route; on residential amenities from construction and siting of support structures and OHL; human health including noise and EMF, based on recognised international standards. An assessment and comparison of the effects of above and below ground development alternatives. An assessment of the likely impacts on the linguistic or cultural heritage of the Gaeltacht area, or on the promotion of Irish as the community language. Implications / impacts on the local, regional or national economy.	Volume 3B, 3C and 3D and other elements of the application documentation
Flora and Fauna	Baseline data should include an ecological survey of all works sites at an appropriate time of the year. Assessment of the impacts on flora, fauna and habitats to have regard to Natura 2000 sites, other (proposed) designated sites, Habitats Directive, Birds Directive, Wildlife Acts, Red Data Book species and biodiversity in general. The assessment should include: indirect effects of construction activities and access; long term impacts of fragmentation and severance; impacts on the aquatic environment; invasive alien plant and animal species and methods to ensure they are not introduced or spread; assessment of the extent and impact of hedgerow removal or linear woodland and identification of any requirement for licenses or derogations.	Volumes 3C and 3D, Chpt 6
Soils and Geology	The main items raised were: the inclusion of an assessment of potential soil erosion, the submission of a construction method statement (to include peat mitigation) and identification and assessment of potential impacts on sites of geological heritage interest (including Altmush Stream and Galtrim Moraine).	Volumes 3C and 3D, Chpt 7

An Bord Pleanála Scoping Opinion		
Topic	**Specific Issue Raised**	**Relevant Chapter N/S Project EIS (2014)**
Water	Identification and assessment of the potential water quality impacts of excavation / construction activities proximate to water courses; assessment of potential hydrogeological impacts and submission of a construction method statement and management plan (including measures to protect water quality when diverting field drains / pumping groundwater).	Volumes 3C and 3D, Chpt 8
Air and Climate / Noise	A description and assessment of the noise environment at construction and operational phases (clearly measurable against the existing ambient noise environment) is required.	Volumes 3C and 3D, Chpt 10
Landscape	An overview of defined landscape character areas affected; identification of the area of visual influence of the development; an assessment of the impacts on landscape character and visual amenity including designated landscapes and views of amenity value; In addition the Board require consideration of the potential for alternative routing or partial undergrounding.. The rationale for the route / design approach adopted should be identified and the cumulative visual and landscape impacts of the development with the existing and proposed 110 kV and 220 kV network should be considered.	Volumes 3C and 3D, Chpt 11
Material Assets	The identification of the enhancement of existing electrical network infrastructure; the identification and assessment of public road crossings (including construction methodology); information on the likely effects on public utilities and services; submission of a construction management plan (addressing stringing options, road closures, detours, and impacts on railway infrastructure, access for construction, on-going maintenance and treatment of new / widened construction entrances). In addition the likely impact / restrictions for agriculture or commercial forestry	Volumes 3C and 3D, Chpts 4, 12 and 13

An Bord Pleanála Scoping Opinion		
Topic	**Specific Issue Raised**	**Relevant Chapter N/S Project EIS (2014)**
	and the assessment of the effects on the amenity / tourism value of the area including designated tourism routes (the Monaghan way) and impacts on fishing and fisheries tourism, the potential future use of disused railways and impacts on aviation transport (including Trim airfield).	
Cultural Heritage	Identification and assessment of: archaeological heritage (including impacts on the character and setting of features of interest) as well as relationships between sites; and areas of social, cultural and historic interest (including Bective Abbey, Donaghpatrick, Teltown Zone of Archaeological Amenity and Muff Crossroads). Identification of any pre-application archaeological excavation or site investigation undertaken; any heritage in the vicinity of the route corridor; indirect effects of construction activity including access / routes on structures and buildings; and the impact on longer views from sites of national importance and significance.	Volumes 3C and 3D, Chpt 14
Transboundary Effects	The Board requested that a *Joint Environmental Report* be prepared. The joint report should ensure the implementation of a common approach and methodology for the identification and assessment of impacts arising across the overall project.	Volume 4 of the application documentation

Having ascertained which environmental topics are of most significance and having due regard in particular to the content of the Board's scoping opinion in relation to the proposed development, the draft ***N/S Project EIS (2014)*** was prepared in accordance with the relevant legislation.

The ***N/S Project EIS (2014)*** and associated planning application particulars are now in final draft status following the completion of pre-application consultation with ***An Bord Pleanála*** in January 2014.

3. The IEP Terms of Reference

In the following section the **technical**, **economical** and **environmental** analysis parameters proposed by the IEP for the Grid West and Grid Link projects are compared against work completed to date on the N/S Project. For each parameter listed by the IEP a breakdown is given of the compatibility of this requirement with the N/S Project.

3.1 Technical Criteria

In its Terms of Reference the IEP specified a number of technical criteria against which the alternatives for GW and GL shall be compared. These are:-

a. *Compliance with all relevant safety standards;*

b. *Compliance with system reliability and security standards;*

c. *The average failure rates during normal operation, average repair times and availabilities of the main elements of each option;*

d. *The expected impact on reliability of supply of or unavailability of the development;*

e. *Implementation timelines, including procurement and availability of key equipment and resources;*

f. *The extent to which future reinforcement of, and/or connection to, the transmission network is facilitated;*

g. *The risk associated with use of any untried technology solution that would be required as part of a development option; and*

h. *Compliance with good utility practice.*

Each of the criteria specified by the IEP is addressed in turn below.

a. Compliance with all relevant safety standards;

This is addressed by EirGrid in Chapter 4, Volume 1 of the ***Meath-Tyrone EIS,*** chapter 3 of the ***Final Re-evaluation Report*** and Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

b. Compliance with system reliability and security standards;

This is addressed by EirGrid in Chapter 4, Volume 1 of the ***Meath-Tyrone EIS,*** chapter 3 of the ***Final Re-evaluation Report*** and Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

c. The average failure rates during normal operation, average repair times and availabilities of the main elements of each option;

This was addressed in detail in chapter 4 of the **PB Power report** and chapter 5 of the **Ecofys Report**. It was treated by EirGrid as a sub-criterion of the main criterion

'Compliance with system reliability and security standards' in the ***Meath- Tyrone EIS*** and the ***Final Re-evaluation Report***.

d. The expected impact on reliability of supply of or unavailability of the development;

This was addressed in chapter 4 of the ***PB Power report*** and chapter 5 of the ***Ecofys Report***. It was also covered under 'Compliance with system reliability and security standards' in Chapter 4, Volume 1 of the ***Meath- Tyrone EIS*** , was reviewed and updated in chapter 3 of the ***Final Re-evaluation Report*** and is addressed in Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

e. Implementation timelines, including procurement and availability of key equipment and resources;

This was addressed in chapter 3 of the ***PB Power Report***, Chapter 4, Volume 1 of the ***Meath-Tyrone EIS***, chapter 3 of the ***Final Re-evaluation Report*** and Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

f. The extent to which future reinforcement of, and/or connection to, the transmission network is facilitated;

This is addressed by EirGrid in Chapter 4, Volume 1 of the ***Meath-Tyrone EIS,*** chapter 3 of the ***Final Re-evaluation Report*** and Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

g. The risk associated with use of any untried technology solution that would be required as part of a development option;

This is included in EirGrid's comparative analysis and is covered under the heading of 'Comply with 'Good Utility Practice' or 'best international practice''. This is addressed by EirGrid in Chapter 4, Volume 1 of the ***Meath-Tyrone EIS,*** chapter 3 of the ***Final Re-evaluation Report*** and Chapter 4, Volume 3B of the ***N/S Project EIS (2014)***.

h. Compliance with good utility practice.

This is set out in in Chapter 4, Volume 1 of the ***Meath-Tyrone EIS*** and was reviewed and updated in chapter 3 of the ***Final Re-evaluation Report*** and ***N/S Project EIS (2014)***. In this instance the term 'Good Utility Practice' is defined as –

> *"Good Utility Practice means any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry in Europe during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result of the lowest reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the ENTSO-E region and consistently adhered to by EirGrid."*

This definition is a modified or Europeanised version (modifications are underlined) of the North American Electric Reliability Corporation's (NERC) definition which is endorsed by the US Federal Energy Regulatory Commission (FERC) and which was

adopted by most US and Canadian electric utilities following the widespread blackout of August 2003 in the US and Canada.

It should be noted that compliance with good utility practice does not preclude the use of innovative practices, methods or technologies; however, when such innovative practices, methods or technologies are under consideration, the accompanying risk of failure and consequence of such failure must also be considered, hence the reason why EirGrid considers criterion 'g' above to be a sub-criterion of 'h'.

It is EirGrid's view that, the technical criteria considered in the comparative analysis of UGC and OHL for the N/S Project are compatible with those specified by the IEP for the GW and GL projects.

3.2 Economic Criteria

In its Terms of Reference the IEP specified a number of technical criteria against which the alternatives for GW and GL shall be compared. These are:–

a. *Project pre-engineering costs, including costs of evaluation of route, line technology and substation options;*

b. *Project implementation costs including:*

- *cost of procurement, installation and commissioning of overhead line and/or underground cable for the required continuous pre-fault, continuous post-fault and short-term post-fault ratings;*
- *costs of substations including procurement, installation and commissioning of required protection and control equipment and any equipment necessary for compliance with relevant technical standards;*
- *all relevant civil works for construction, including: for access to sites; for any necessary river/road/rail crossings or diversions, any tunnels necessary for any sections of underground cable, and for towers plus their foundations for sections of overhead line; and for post-construction restoration;*
- *Third Party Payments (wayleaves, community gain, rates etc);*
- *Interest During Construction; and*
- *the costs of any environmental monitoring deemed necessary to mitigate the impact of the development during construction or on-going operation.*

c. *Project life cycle costs (including Losses, Operation & Maintenance, Decommissioning and the costs of retaining any necessary specialist repair teams);*

d. *The expected costs to operation of the Single Electricity Market arising from unavailability of the development; and*

e. *Estimates of the range of uncertainty attaching to all of the cost components under all options.*

Comparative cost estimates for the transmission options under consideration in the case of the N/S Project are presented in the ***PB Power Report*** and reviewed and updated in

the ***PB Power Technology and Costs Update Report.*** These assessments are also presented in the ***IEC Report*** and Section 4.6 and Section 4.7, Volume 3B of the ***N/S Project EIS (2014)***.

It is worth noting that the objective of the PB Power studies was to establish an estimate of the *difference* in costs between the options as opposed to the *overall* cost of each option. The capital cost estimates produced are not 'whole of project' cost estimates. This point was further clarified in the ***PB Power Technology and Costs Update Report*** wherein each option or scheme is presented in the form of a single line diagram with the elements provided for in the cost estimates shown in the colour red and the elements excluded shown in blue.

As a result, those elements that are common to all options were specifically excluded from the cost estimates. This has relevance in particular to criteria a, b and c listed by the IEP; however insofar as the net difference in cost between each option is fully identified, this exclusion does not impact on the overall aims or objectives of the comparative cost assessment.

Each of the criteria specified by the IEP is addressed below with reference to these reports.

a. Project pre-engineering costs, including costs of evaluation of route, line technology and substation options;

Pre-engineering costs including desktop surveys, line design and route evaluation costs are identified as being broadly similar in cost and therefore have not been explicitly costed and set out comparatively as part of the PB Power study.

b. Project Implementation Costs

The build costs for implementation included in the PB Power assessment includes costs of procurement, installation and commissioning for each option but excludes the build cost for common items such as "terminating switch gear"; A comparative assessment of civil work costs and IDC is however fully included.

In the case of N/S Project the '*most suited'* UGC option, like the preferred OHL option, is a route across private lands. This means that 'third party payments' and 'costs of any environmental monitoring' would arise in the case of both options. As the UGC option would place a greater burden on private lands than would the OHL option it is likely that these costs would be greater in the case of UGC than in the case of OHL. It was considered however that this difference would not have a significant impact on the overall difference in cost between the options and as a result they excluded from the PB Power cost estimates.

When preparing their cost estimates PB Power was of the view that the cost of UGC projects are influenced to a much greater extent by the local ground conditions, terrain and crossings (rivers, roads etc.) than is the case with OHL projects. It was concluded in this regard that the cost per km for OHL projects of similar design (voltage and support structures) would not vary much from project to project. On this basis PB Power using its extensive experience of OHL projects from around the world was able to estimate the capital cost of the OHL option by determining, what it

considered to be, a suitable cost per km for Ireland and then multiplying this by the length in km of the OHL route. A similar methodology for estimating the capital cost of OHL options was applied by the respective authors of the ***Ecofys Report***, the ***Askon Report*** (2008) and the ***IEC Report***. This is also the methodology typically applied by EirGrid when preparing cost estimates for OHL projects during the pre-planning stage.

It was recognised that in the case of the N/S Project the relatively simple methodology applied in estimating the cost of the OHL option would not be adequate for the UGC cost estimates. Robust UGC cost estimates must be project and site specific. It was necessary therefore for the PB Power cost estimating team to tour the UGC route to identify the landscape types and the number and extent of the crossings encountered and using this knowledge and applying a bottom up cost estimating methodology produce a robust cost estimate for the UGC option. This process is described in detail in chapter 8 of the ***PB Power Report***.

c. Project Lifecycle Costs

Project lifecycle costs including lifetime energy losses costs, annualised power losses and asset replacement costs over the lifetime of the proposed solution are fully included in the comparative assessment (see ***PB Power Report***, Section 9.3).

d. The expected costs to operation of the Single Electricity Market arising from unavailability of the development;

EirGrid has analysed the impact of the unavailability of the N/S Interconnector on the Single Electricity Market. The results, which provide annualised savings figures, were published in the ***Final Re-evaluation Report*** and are also included the ***2014 N/S EIS (Draft)***.

e. Estimates of the range of uncertainty attaching to all of the cost components under all options

Uncertainty in the cost estimates was considered in both the ***PB Power Report*** and in EirGrid's analysis of the impact on SEM costs.

It is EirGrid's view that, the economic criteria considered in the comparative analysis of UGC and OHL for the N/S Project are compatible with those specified by the IEP for the GW and GL projects.

3.3 Environmental Criteria

In its Terms of Reference the IEP specified a number of environmental criteria against which the alternatives for GW and GL shall be compared. These are:-

a. The environmental impact of OHL and UGC options on the following:

- *Biodiversity, flora and fauna*
- *Water (surface, ground, estuarine and coastal)*
- *Soil*
- *Landscape and Visual*
- *Cultural Heritage (architectural and archaeological heritage)*
- *Communities*
- *Air*
- *Climatic Factors*
- *Material Assets*
- *Tourism, and*
- *Traffic and noise.*

Notes:

1. *A distinction should be made between the impact (the action being taken) and the effect (the change resulting from that action).*
2. *The type of effect should be identified (e.g. positive/beneficial, negative/adverse, direct, indirect, cumulative, short-, medium-, long-term, permanent, temporary).*
3. *The assessment should identify all likely significant environmental effects.*

b. Identification of, and potential for impact and effect (e.g. positive/beneficial, negative/adverse, direct, indirect, cumulative, short-, medium-, long-term, permanent, temporary) upon, any Natura 2000 and/or other sites with environmental designations;

c. Potential impacts in the construction phase and during on-going operation, including in the event of any necessary repair to the installation;

d. Potential for imposing new limits on existing land use, both during the construction phase and during on-going operation; and

e. Proposed mitigation measures, their effectiveness and cost.

Annex IV to the Environmental Impact Assessment (EIA) Directive and Schedule 6 of the *Planning and Development Regulations 2001* (as amended), both require that information to be contained in an EIS includes "*An outline of the main alternatives studied by the developer and an indication of the main reasons for his or her choice, taking into account the effects of the environment".* As part of the preparation of the ***N/S Project EIS (2014)***, EirGrid has given significant consideration to the issue of an overhead line (OHL) or underground cable (UGC) or partial underground solution having regard to the nature and parameters of the proposed development.

Of particular note in this regard, Table 6-1 of the ***Ecofys Report*** compares OHLs and UGCs in terms of "Environmental Impact and Ease of Potential Mitigation". This table identifies that, for the majority of environmental topics, an OHL has an equal or lesser environmental impact to a UGC; clear exceptions to this include bird strike, landscape character, visual impact, and certain community issues. For the most part in these instances however, Table 6-1 identifies that the "ease of mitigation" might be 'remedial measures only', although in respect of topics such as bird strike, landscape and Electric and Magnetic Fields (EMF), mitigation measures 'likely to reduce the adverse scale of impact', or 'likely to avoid adverse discernible impact' could be employed:

Table 2: "OHL versus UGC: Environmental Impact & Ease of Potential Mitigation" **(*Table 6-1 Ecofys Report*)**

NOTE: Signif[1] = "Significance of Impact"

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
LAND USE				
Time and Flexibility of Construction	***	●●	**	●●
Length of Construction	***	●●	**	●●
Disrupt. To Agric. Operations	***	●●●	**	●●●
Land Take	**	●●	*	●●●
Effect on Field Boundaries	***	●●	**	●●●●
Effects on Farm Buildings	**	●	**	●●●
Effects on Drainage Patterns	***	●●	*	●●●●
Catastrophic Event Implications	***	●●	**	●●●
Repair & Maintenance	***	●●	*	●●●●
GEOLOGY and SOILS				
Soil Cover	***	●●●	**	●●●●
Excavated Material	***	●●	**	●●●●
Quarrying and Mining	**	●●●	**	●●●
EFFECTS ON WATER				
Disruption to Groundwater incl. Wetland	***	●●	*	●●●●
Effect on Surface Waters	***	●●●	*	●●●●
GROUND RESTORATION	***	●●●	**	●●●
ECOLOGY and NATURE CONSERVATION				
Bird Strike	N/A	N/A	***	●●●
Risk to Flora (construction)	***	●●	**	●●●

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
Risk to Flora (operations)	**	●●	*	●●●
Risk to Mammals	**	●●	*	●●●
Risk to Insects	**	●●	*	●●
Loss of Habitat (construction)	***	●●●	**	●●●
Loss of Habitat (operations)	**	●	**	●
Risk to Aquatic Ecosystems	***	●●●	*	●●●●
Restoration	***	●●●	*	●●●
LANDSCAPE and VISUAL				
Landscape Character	*	●●●	***	●●
Landscape Features	**	●●	*	●●●
Visual Impact (construction)	***	●●	**	●●
Visual Impact (operations)	*	●●●	***	●●
Access Tracks/Haul Roads	***	●●●	**	●●●●
Communities	**	●●●	***	●●
CULTURAL HERITAGE				
Archaeological Resources	***	●●	*	●●●
Cultural/Historic Resources	**	●●	**	●●●
Language and Culture	*	●●●	***	●●
TRAFFIC AND NOISE				
Traffic	***	●●	**	●●
Noise (construction)	***	●●	**	**
Noise (operations)	*	●●●●	**	●●
AIR QUALITY				
Construction	***	●●	**	●●
Operations	N/A	N/A	**	●
COMMUNITIES				
Quality and Cohesiveness	*	●●●●	***	●●
Business, Economy and Employment	*	●●●●	**	●●
Tourism Industry	*	●●●●	**	●●
Fishing	*	●●●●	**	●●●
Animal Breeding	*	●●●●	**	●●●

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
Health & Safety and Electromagnetic Fields	*	●●●●	**	●●●●
Property Prices	**	●●	***	●
Severance	*	●●●●	***	●●
Educational Enrolment	*	●●●●	***	●●
Future Development	**	●●●	***	●●
RECREATION and TOURISM	*	●●●	***	●●

Significance:

*** Major: a fundamental change to a sensitive environment

** Moderate: a material but non-fundamental change to the environment

* Minor: a detectable but non-material change to the environment

N/A Not applicable

Mitigation:

● No practicable mitigation possible

●● Remedial measures only

●●● Mitigation likely to reduce adverse scale of impact

●●●● Mitigation likely to avoid adverse discernible impact

N/A Not applicable

The findings of the Ecofys Report, particularly its "*Comparison of Environmental Impacts"*, though published in 2008, clearly remain relevant for the proposed development, and thus were taken into consideration by EirGrid in its consideration of technology alternatives and environmental assessment (including partial undergrounding) for the ***N/S Project EIS (2014)***. In particular, as outlined in table 6-1, an OHL has an equal or lesser environmental impact to a UGC; this is of specific relevance for any comparative assessment.

As noted under section 2.5, in August 2014, EirGrid requested An Bord Pleanála provide a "scoping" opinion in respect of the EIS for the proposed development. This formal scoping opinion and also the informal scoping process that EirGrid completed in the context of the ***Preferred Project Solutions Report*** provided a framework for the environmental assessment included in the ***N/S Project EIS (2014)***. This assessment includes a full assessment and consideration of technical alternatives including UGC and OHL options and a comprehensive and detailed assessment of each of the specific criteria listed by the IEP.

Each of these criteria is addressed as follows:-

a. The environmental impact of OHL and UGC options

As noted above, when choosing its preferred option for the N/S Project EirGrid had regard for the comprehensive environmental analysis of OHL and UGC in the ***Ecofys Report***. The Ecofys analysis considered the "*potential positive and negative impacts of the installation and subsequent operation of EHV OHL and UGC*" and addresses all of the topics identified in the IEP's Terms of Reference. The ***Ecofys Report*** states that the purpose of this environmental analysis "*is to provide decision-makers with an unbiased, comparative assessment of the general environmental implications of either scenario in environments typical of Ireland to enable them to make informed decisions in this regard".*

It is explained in chapter 2 of the ***Ecofys Report*** that prior to commencing the environmental analysis a public consultation exercise was undertaken and that 522 stakeholder submissions were received. Due to timing of this consultation most of these 522 submissions were received from stakeholders associated with the N/S Project. The environmental specialists reviewed and considered these submissions when carrying out their comparative environmental analysis resulting in an output that is clearly relevant and specific to the N/S Project.

In making its choice on the transmission options EirGrid also had regard for the environmental analysis set out in chapter 7 of the ***PB Power Report***. The reasons for EirGrid's choice of preferred option are set out in the ***Final Re-evaluation Report*** and confirmed in both the ***Preferred Project Solution Report*** and the ***N/S Project EIS (2014).***

A summary of how and where each of the specific environmental sub-criteria listed by the IEP under Section a) Environmental Criteria is referenced in the ***N/S Project EIS (2014)*** and related publications is included in **Table 3.**

Table 3: Assessment of IEP Environmental Sub-Criteria

IEP Sub-Criteria	Relevant EirGrid Report	Reference / Summary
Biodiversity, Flora and Fauna	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Ecology and Nature Conservation*. It included consideration of the following parameters: bird strike, flora, mammals, insects, habitat loss and aquatic ecosystems. It also considers restoration techniques and options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential

IEP Sub-Criteria	Relevant EirGrid Report	Reference / Summary
		mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Flora and Fauna' as an environmental topic.
Water (Surface, Ground, Estuarine and Coastal)	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Water Resources*. It included consideration of the following: disruption to groundwater including wetland and surface waters. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Soils, Geology and Hydrogeology' as an environmental topic.
Soil	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Geology and Soils.* It included consideration of the following: soil cover, soil type, excavated material and quarrying and mining. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Soils, Geology and Hydrogeology' as an environmental topic.
Landscape and Visual	2008 ECOFYS Report	Landscape Character and Visual Effects. The topic included consideration of the following: natural features and historical monuments, access tracks / haul roads and

IEP Sub-Criteria	Relevant EirGrid Report	Reference / Summary
		communities. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Landscape' as an environmental topic.
Cultural Heritage (Architectural and Archaeological Heritage)	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Cultural Resources.* The topic included consideration of the following: archaeological, historic monuments and buildings, language and culture. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Cultural Heritage' as an environmental topic.
Communities	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Communities*. It topic included consideration of the following: quality and cohesiveness, business, economy and employment, tourism industry, filming, animal breeding, EMFs, Health and Safety, Property Prices, severance, educational enrolment, impact on future developments. It also considers options for mitigation. 2009 EIS, Chapter X – Add brief 1-2 line

IEP Sub-Criteria	Relevant EirGrid Report	Reference / Summary
		summary. Section 4.5.2 provides a summary of the Ecofys Report.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Human Beings – Population and Economic; Human Beings – Land Use; Human Beings – Tourism and Amenity; and Human Beings – EMF' as environmental topics.
Air	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Air Quality. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report (in Section 5.4.2.4). EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Air – Climate' as an environmental topic.
Climatic Factors	See above.	
Material Assets	2008 ECOFYS Report	N/A
	2009 Meath-Tyrone EIS	N/A
	N/S Project EIS 2014	Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report (in Section 5.4.2.4). EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the

IEP Sub-Criteria	Relevant EirGrid Report	Reference / Summary
		environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Material Assets – General' as an environmental topic.
Tourism	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Communities. The topic included consideration of the tourism industry. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Human Beings – Tourism and Amenity' as an environmental topic.
Traffic and Noise	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Traffic and Noise. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Material Assets – Traffic' as an environmental topic.

b. Identification of, and potential for impact and effect (e.g. positive/beneficial, negative/adverse, direct, indirect, cumulative, short-, medium-, long-term, permanent, temporary) upon, any Natura 2000 and/or other sites with environmental designations;

The Identification of, and potential for impact and effect upon Natura 2000 and/or other sites with environmental designations has been addressed by the N/S Project as follows:

- The ***2009 Meath-Tyrone EIS*** Volumes 2A and 2B, Chapters 7 (Flora and Fauna) and Appendix 4A – Appendix 7.3 (Appropriate Assessment of the River Boyne and River Blackwater).

- ***The Final Re-evaluation Report*** in Chapter 5 (Identification of Environmental and Other Constraints within the Project Study Area), Chapter 6 (Identification of Feasible Route Corridor Options), and Chapter 7 (Comparative Evaluation of Feasible Route Corridors).

- The ***Preferred Project Solution Report*** in Chapter 3 (Line Design Guidelines).

- This is further addressed in the ***N/S Project EIS (2014)***:-

  Volume 3C and 3D, Chapter 6: These chapters look at 'Flora and Fauna' and include consideration of the positive/beneficial, negative/adverse, direct, indirect, short-, medium-, long-term, permanent and temporary impacts on Natura 2000 and other sites with environmental designations. The cumulative impacts, impact interactions and transboundary impacts in respect of Flora & Fauna are addressed in Chapters 9 and 10 of Volume 3B of the draft EIS.

  Draft Volume 5 – Natura Impact Statement. This report specifically looks at the likely or potential effects, if any, of the proposed development on sites designated as Natura 200 conservation areas.

c. The Potential impacts in the construction phase and during on-going operation, including in the event of any necessary repair to the installation

The Potential impacts in the construction phase and during on-going operation have been addressed by the N/S Project as follows:-

- In the ***Meath-Tyrone EIS*** (Volumes 2A and 2B, Chapter 4 (Project Description and Methodology), the construction of the proposed development including maintenance during on-going operation is described. Each environmental topic (Chapters 5–15) considers the potential impacts for the construction, operational and decommissioning phases of the proposed development.

- In the ***Preferred Project Solution Report***, Chapter 3 (Line Design Guidelines), the construction of the proposed development including maintenance during on-going operation is described.

- This is further addressed in the ***N/S Project EIS (2014)***:-

  Volume 3B – Chapter 7 describes the construction of the proposed development including maintenance during on-going operation. Each environmental topic in the draft EIS (Volumes 3C and 3D) considers the potential impacts for the construction, operational and decommissioning phases of the proposed development.

d. The potential for imposing new limits on existing land use, both during the construction phase and during on-going operation

The Potential for imposing new limits on existing land use, both during the construction phase and during on-going operation has been addressed by the N/S Project as follows:-

- In the ***Meath-Tyrone EIS*** (Volumes 2A and 2B) Chapter 5 (Human Beings) considers the potential impacts for the construction, operational and decommissioning phases of the proposed development on inter alia land use.

- This is further addressed in the ***N/S Project EIS (2014)***:-

  Volume 3C and 3D – Chapter 3 (Human Beings – Population & Economic), *Chapter 4* (Human Beings – Land Use), and Human Beings - Tourism and Amenity) considers the potential impacts for limits on existing land use for the construction, operational and decommissioning phases of the proposed development.

f. Proposed mitigation measures, their effectiveness and costs

- In the ***Meath-Tyrone EIS*** (Volumes 2A and 2B, Chapters 5 – 15 considers and proposes mitigation measures.

- This is further addressed in the ***N/S Project EIS (2014)***:-

  Each environmental topic in the ***N/S Project EIS*** (Volumes 3C and 3D) considers and proposes mitigation measures. A summary of mitigation measures is also provided in *Volume 3B – Chapter 11*.

It is EirGrid's view that, the environmental criteria considered for the comparative analysis of UGC and OHL in the N/S Project are compatible with those specified by the IEP for the GW and GL projects.

4. Overall Conclusion

This paper has set out the various criteria identified in the Terms of Reference published by the IEP and assessed the compatibility of these criteria with the studies and work completed to date on the N/S Project.

The comparative analysis of the OHL and UGC options for the nature, location, extent, and justification for the N/S Project has been informed by a wide range of project specific studies, general technical reports and international reports. These include independently commissioned reports such as the 2009 ***Ecofys Report*** and the 2011 ***IEC Report*** and a number of reports published by internationally recognised experts including the 2009 ***TEPCO*** and ***TransGrid*** studies. Throughout the Environmental Impact assessment (EIA) process OHL and UGC were assessed to a comparable level of detail and were set out in a manner that facilitates comparison between them. All assumptions made, and the sources of data used, were clearly stated.

The Technical, Economic and Environmental criteria considered as part of the comparative analysis for the N/S Project are compatible with those specified by the IEP in respect of the studies required for the Grid Link and Grid West projects.

In summary:

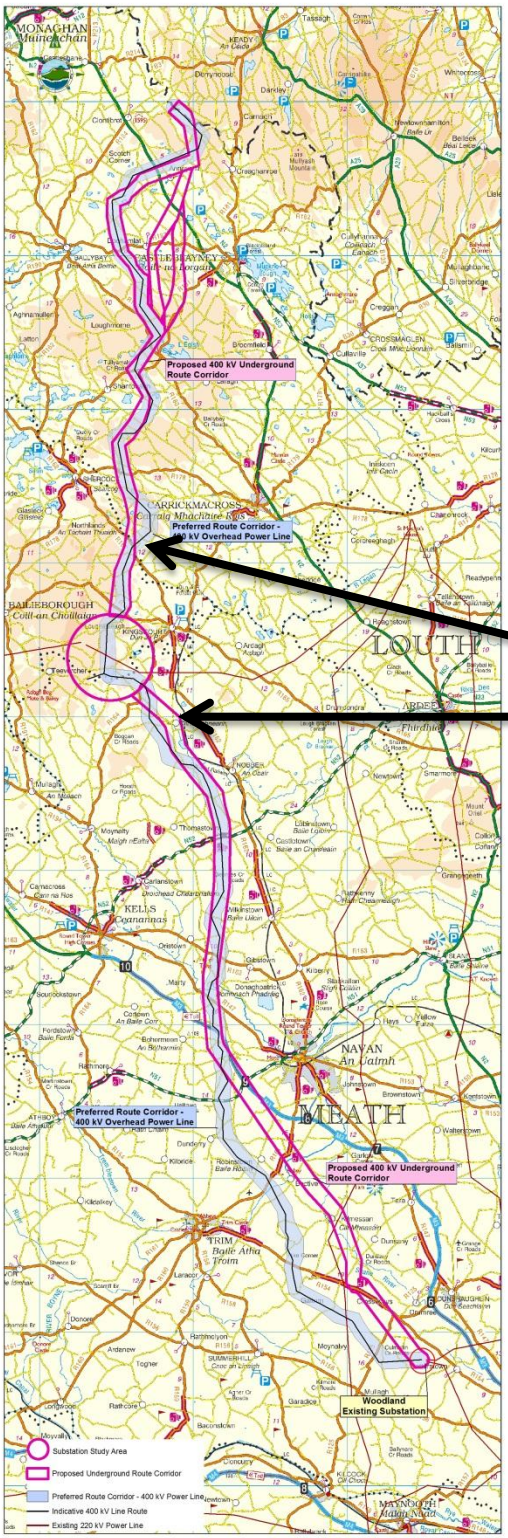
1. The **technical criteria** considered in the comparative analysis of UGC and OHL for the N/S Project are compatible with those specified by the IEP for the GW and GL projects. Differences in the number of listed criterion between the IEP and EirGrid relates to the fact that some were considered as sub-criteria of specific main criterion identified by EirGrid.There is no material difference in the criteria listed.

2. The **economic criteria** considered in the comparative analysis of UGC and OHL for the N/S Project are compatible with those specified by the IEP for the GW and GL projects. With reference to some of the economic criterion listed by the IEP, the methodological exclusion of “common costs” during N/S Project studies does not impact on the objective of comparative cost assessment.

3. The **environmental criteria** considered in the comparative analysis of UGC and OHL for the N/S Project are compatible with those specified by the IEP for the GW and GL projects. A comparative environmental assessment of OHL and UGC options for the project was a key input into the evaluation of alternatives undertaken for the project and the overall environmental assessment which has been progressed.

It is therefore EirGrid’s overall view that “*the methodologies to be employed on the GW and GL projects are compatible with what has already been done on the N/S project”.*

Appendix A – Composite Map (UGC / OHL)



The diagram attached is an excerpt from the 2009 PB Power Report. For comparative purposes It shows both UGC and OHL corridor options overlaid on the study area identified for the proposed development.
Legends are included at points of overlay and intersection for clarity
OHL (Blue) Corridor Option
UGC (Pink) Corridor Option

Appendix B – Reports Commissioned or Prepared by EirGrid

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
PB Power Preliminary Briefing Note - *Island of Ireland Cavan-Tyrone and Meath - Cavan 400 kV projects Preliminary Briefing Note Overhead and Underground Energy Transmission Options* Prepared by Parsons Brinckerhoff this was issued as an interim report **February 2008**	The *Preliminary Briefing Note* sets out a comparative overview of the technical and economic issues arising in respect of OHL and UGC transmission infrastructure options, with particular reference to the proposed Tyrone to Cavan element of the proposed interconnector. The document notes that both OHL and UGC technologies are proven in service, but includes a number of observations. The Briefing Note focused primarily on HVAC technology. The document did not include a review of HVDC technology because, at this early stage in the project, it appeared that the high land-take and high costs of terminal stations would not offer any benefits over the AC solutions.	UGC technology has not yet been tried anywhere in the world for a transmission infrastructure circuit approaching the route length of that proposed. HVAC OHL technology accounts for over 99% of Extra High Voltage (EHV) transmission infrastructure worldwide as it is considered to represent the best balance from an economic, technical and environmental perspective. UGC technology is noted to play an important role in urban and congested areas, or where site specific environmental constraints occur, for example within an area of outstanding scenic beauty. UGC technology is significantly more expensive than OHL technology. There can be considerable variation in cost ratios dependent upon the terrain and the circumstances. The Briefing Note stated that further work would be undertaken to examine the specific feasibility issues relevant to the prospect of undergrounding the proposed interconnector.
The PB Power Study - *Cavan-Tyrone and Meath-Cavan 400 kV Transmission Circuits Comparison of high-voltage transmission options: Alternating current overhead and underground, and direct current underground* Prepared by Parsons Brinckerhoff **February 2009**	This study considers use of alternative technologies for the proposed interconnector. It makes two sets of comparisons: • HVAC UGC as an alternative to the proposed HVAC OHL; and • HVDC UGC as an alternative to the proposed 400 kV HVAC technology. In each case the comparison of the technologies addresses routing feasibility, high-level environmental considerations, and the installation and cost differences that would be associated with the alternatives.	HVAC OHL transmission is the most widely used method of bulk power transfer in Europe and represents the lowest cost technically feasible approach to establishing and maintaining a secure electrical power grid. Global transmission development activity suggests that this preference by utilities for the use of OHLs is likely to persist into the future. The longest XLPE transmission cable (in the range 380 kV to 500 kV) is 40km and runs in a tunnel. If implemented using AC UGC the proposed interconnector would be the longest such cable circuit worldwide at approximately 135km. HVAC OHLs are susceptible to environmental effects and thus normally exhibit fault rates higher than those of UGC circuits. However, average repair times of UGC are much higher than those of OHL. High voltage UGC has the capacity to inflict considerable short-term (construction period) and long-term operational negative impact on the environment - however, mitigation measures can be put in place. Both high voltage OHL and UGC produce power frequency magnetic fields whose strengths would be directly proportional to the electrical load being carried at any instant. The insertion of a HVDC transmission circuit into the HVAC transmission network would introduce more system complexity than an HVAC OHL. Cost estimates for each option were calculated. The construction cost estimate for the UGC option was calculated by firstly identifying a potential

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
		route for the UGC alternative from County Meath to County Tyrone (See **Figure 4.1**)**;** then identifying the different types of landscape along this route as well as all rivers and roads that would have to be crossed; then calculating a cost per km per landscape type, a cost per major and per minor river and road crossing and using this data to build up a cost for installing UGC along the entire route. The cost of the OHL option was calculated by estimating a cost per km for 400 kV OHL (based on PB Power's international experience) and multiplying this by the length of the OHL in kilometres. Whole–of-project cost estimates (construction and lifetime running costs) for high voltage AC and DC UGC compared to 400 kV OHL shows OHL to be significantly more cost effective.
The TEPCO Technical Study *Assessment of the Technical Issues relating to Significant Amounts of EHV Underground Cable in the All-Island Electricity Transmission System* Prepared by Tokyo Electrical Power Company of Japan (TEPCO) **November 2009**	EirGrid and NIE jointly commissioned TEPCO to undertake a system-wide study that considers the implications, for transmission system reliability and stability, of incorporating very long lengths, and large quantities, of HV UGC transmission infrastructure on the AC transmission network of the island of Ireland. The Study was carried out in 3 parts: Part 1: Evaluation of the potential impact on the all-island transmission system of significant lengths of EHV UGC, either individually or in aggregate. Part 2: Feasibility study on the 400 kV Woodland – Kingscourt – Turleenan line as AC UGC for the entire length. Part 3: Feasibility study of the 400 kV Woodland – Kingscourt – Turleenan line as mixed OHL / UGC.	The study concludes: Part 1: Identified a potential for the occurrence of 'severe' Temporary Overvoltage's (TOVs) which would exceed the withstand capability of the installed equipment. The Study concludes that the magnitude of these TOV's is such that there are no technical solutions currently available to mitigate this risk and the only option available would be to use operational counter measures. Part 2: To achieve the required 1,500MW capacity, the optimum UGC solution is a 400 kV double circuit 1,400mm^2 aluminium cable - requiring a total of 2,600MVArs (1,300MVArs per circuit) of reactive compensation would be required at the proposed terminal points and an additional reactive compensation installation approximately half-way between Turleenan and Moyhill (Kingscourt). Part 3: No significant TOVs were identified for the mixed OHL / UGC. However, further detailed studies relating to the particular positions and lengths of cable sections in order to determine the measures that may be taken to ensure safety and stability from the overall circuit would be necessary.
The TransGrid Study - *Investigating the Impact of HVDC Scheme in the Irish Transmission Network* Prepared by TransGrid solutions Inc. of Canada **October 2009**	The study involved a technical comparison of HVAC OHL versus HVDC UGC and one section dealt in particular with the proposed Meath-Tyrone 400 kV Interconnection Development.	There are no working examples in the world of a multi-terminal HVDC scheme, embedded in a meshed AC network as would be required for the proposed Meath-Tyrone Interconnection Development. Such a scheme is however in theory at least, technically feasible. Having carried out a technical comparison of HVDC versus HVAC technology for this proposed development it was found that there are no significant reasons to select HVDC over HVAC. The AC option showed significantly lower loses, fewer overloads in the Louth / Tandragee / Turleenan area, a stronger system at the Moyle Interconnector terminal and a less complex control and protection scheme. Embedding a HVDC circuit in a meshed AC network "*can impose an added complexity to future network planning and expansion. For instance when planning the system it is difficult and expensive to tap into an existing HVDC circuit whereas an AC circuit can be easily tapped to serve new load or build a new AC station and lines."* A technical comparison of the two technologies (HVAC and HVDC) concluded that, for the scenarios and contingencies studied, there were no significant technical advantages identified for the use of a HVDC circuit in place of the HVAC circuit proposed.
The PB Power Technology and Cost Update - *Comparison of High*	EirGrid and NIE requested PB Power to update their 2009 report to take account of scientific advances in the development of new,	The most cost effective solution for the proposed scheme would be a 400 kV AC OHL, estimated

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
Voltage Transmission Options: Alternating Current Overhead and Underground and Direct Current Underground [This is an addendum to the 2009 PB Power Study and should be read in conjunction with that 2009 report] **April 2013**	feasible transmission technologies, and also to review the cost estimates for practical transmission configurations. The updated PB Power Report does not revisit the landscape aspects and most of the technical aspects as these remain unchanged. The *PB Power Electricity Transmission Costing Study* published in 2012 by the UK Department of Energy and Climate was used as a source of information for the technology and cost update.	to cost around €165 million to construct A 400 kV AC UGC is estimated to cost €935 million, or over 5.7 times as much as an equivalent OHL to construct, and would also cost significantly more than an OHL to operate and maintain over its lifetime. A HVDC UGC is estimated to cost €1,005 million, or 6 times as much as an equivalent 400 kV AC OHL to construct, and twice as much as an OHL to operate and maintain over its lifetime.

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
The PB Power Technology and Cost Update – Cavan-Tyrone & Meath-Cavan 400 kV Transmission Circuits Technology and costs Update**.** *Supplementary Note to the April 2013 Addendum* **July 2013**	In April 2013 EirGrid published its *Final Re-evaluation Report* and at the same time announced its decision to defer the previously proposed intermediate substation near Kingscourt, Co. Cavan. A consequence of the deferment of this substation, regardless of which technology option is chosen, is that it would reduce the initial investment required to develop the interconnector so EirGrid requested PB to provide, in a supplementary note, an indication of the impact of the deferment on the initial investment.	The most cost effective technology option remains a 400 kV AC OHL, estimated to cost around €140 million. With the deferment of Kingscourt, 400 kV AC UGC becomes the most costly option, estimated at around €880 million, or €740 million more than the equivalent AC OHL. The deferment of Kingscourt has little or no impact on the cost differential with the AC OHL as similar costs are deferred in the case of both options. The deferment of the substation near Kingscourt will however have a significant impact on the initial investment required to develop the HVDC option. This is due to the very high cost of HVDC converters, and the fact that, with the deferment, converters would only be required initially at Turleenan and Woodland not Kingscourt. Under this scenario, the HVDC option, at an estimated cost of around €810 million, is no longer the most costly option. It is still, however, €670 million more costly than the least cost option, the 400 kV AC OHL. The initial investment cost of the HVDC option is reduced, due to the deferment of the substation near Kingscourt, by around €160 million (€970M - €810M), whilst the initial investment costs of the two AC options are only reduced by around €20 - €25 million. The disparity of the effects on the AC and HVDC options highlights one major disadvantage of the HVDC option for the Ireland N-S Link. This is that, if the N-S Link is developed using HVDC technology, future 'tap-ins' to the circuit for the substation near Kingscourt and / or for some other (as yet unknown) requirement at some other location along the route, will be many times more expensive than tapping into an AC circuit.

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
Route Constraints Report (July 2007) and Addendum Report (May 2008) ***ESBI and AOS Planning for EirGrid***	These reports detail corridor options considered for a potential overhead line route in the Cavan-Monaghan Study Area (CMSA) and Meath Study Area (MSA). They provide baseline studies of the key environmental constraints, including: • Socio Economic; • Land Use; • Landscape; • Flora & Fauna; • Water; • Soils; and Cultural Heritage. The reports were based upon initial high level analysis, including desk top studies, vantage and driving surreys as well as consultation with interested parties and other stakeholders. The Addendum Reports updated constraints information including *inter alia* Whooper Swan studies, feedback from public consultation and new planning application data.	In the Cavan-Monaghan Study Area (CMSA) a number of route corridor options were identified connecting a border crossing point near Clontibret, County Monaghan to a new substation near Kingscourt (namely Route Corridor Options A, B and C). A substation site search area was also identified for further investigation. The ***Route Constraints Report (July 2007)*** as updated by the ***Addendum Report (May 2008)*** identified Route Option A to be the Emerging Preferred Route Corridor Option.

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
Kingscourt to Woodland Constraints Report Volume 1: Route Constraints Report (July 2007) and Addendum Report (May 2008) ***Socoin and TOBIN Consulting Engineers for EirGrid***		In the Meath Study Area (MSA) a number of route corridor options were identified connecting the existing Woodland Substation and a site identified for a new substation near Kingscourt (namely Route Corridor Options 1, 2, 3A and 3B). The ***Kingscourt to Woodland Constraints Report Volume 1: Route Constraints Report (July 2007)***, as updated by the ***Addendum Report (May 2008),*** identified Route Option 3B to be the Emerging Preferred Route Corridor Option.

Reports prepared or commissioned by EirGrid on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report in Respect of the Different Technologies**
North-South 400 kV Interconnection Development Preliminary Re-evaluation Report *(PRR)*, EirGrid **May 2011**	This report comprises a comprehensive re-evaluation of EirGrid's previous application to An Bord Pleanála for approval of the Meath-Tyrone 400 kV Interconnection Development, being that portion of the proposed interconnector occurring within Ireland. It includes review and consideration of the approximately 950 submissions to An Bord Pleanála in respect of that previous application and the statements presented at the associated oral hearing of 2010.	Having reviewed all the technology options the report concludes that: HVDC technology and HVAC undersea cable do not comply with the project objectives / design criteria for the proposed interconnector. There have not been any developments in transmission technology which would alter EirGrid's opinion that the use of long HVAC cables on the Irish transmission system is not feasible. No new information has come to EirGrid's attention which would alter its opinion that a 400 kV AC OHL is the best technical solution for this development. Partial undergrounding using 400 kV AC technology may be feasible, but only if the length to be installed is relatively short.
North-South 400 kV Interconnection Development Final Re-evaluation Report *(FRR)* EirGrid **April, 2013**	The FRR represents the culmination of a detailed re-evaluation process, undertaken by EirGrid and its consultants, of all aspects of the proposed development. It includes consideration of the feedback received during the public consultation in respect of the PRR. It also considered documents issued since the publication of the PRR, which are relevant to the overall re-evaluation process including the IEC Report. It provides an update on reliability statistics for high voltage AC UGC and OHL, and updates on the world's longest high voltage AC XPLE cable circuits and the cost comparison between 400 kV AC UGC and AC OHL. It includes an Appendix setting out the review and consideration of the approximately 950 submissions to An Bord Pleanála in respect of that previous application and the statements presented at the associated oral hearing of 2010.	Having reviewed all the technology options the report concludes that: The DC option, even one using the latest VSC HVDC technology, is not acceptable for the proposed development as it would be too costly and (for this specific application) would not operate as effectively as a standard 400 kV AC OHL. An entirely underground 400 kV AC option is not an acceptable solution. There have not been any developments in transmission technology which would alter EirGrid's opinion that the use of long HVAC cables (that is greater than approximately 10km in length) on the Irish transmission system is not feasible. A 400 kV AC OHL is the best technical solution for this development and would be significantly less costly than any UGC alternative. Partial undergrounding using 400 kV AC UGC will be considered, but only if the length of UGC to be installed is relatively short (less than approximately 10km in one continuous length or an accumulation of shorter lengths). The emerging preferred support structure for use on the proposed 400 kV OHL development is the lattice steel structure known as the 'IVI' tower. However, EirGrid will further consider alternative structures, including consideration of any feedback on the matter received during the public engagement in respect of the FRR, before finalising the preferred project solution.
North-South 400 kV Interconnection Development Preferred Project Solution Report (PPSR) EirGrid **July 2013**	The PPSR provides detail on the preferred line design for the proposed development. It considers and includes responses to the feedback received during the public engagement in respect of the FRR. It includes the identification of feasible locations for, and design of, the planned transmission line infrastructure, such as tower positions, tower types and associated construction related details (e.g. indicative access tracks). It includes reference to EirGrid's consideration of tower designs and the basis for confirmation of the IVI tower as the preferred support structure for the development.	This report outlines the background to the identification of the preferred line design of the proposed development. It explains how the process generally involves consideration of a range of environmental and technical matters relevant to OHL design and how other considerations specific to the particular development (including feedback from stakeholders and landowners) have fed into the process. It identifies feasible locations for, and design of, the planned transmission line infrastructure, such as tower positions, tower types and associated construction related details (e.g. indicative access tracks).

Appendix C – Additional Reports Prepared on Alternative Transmission Technologies

Additional Reports Prepared on Alternative Transmission Technologies		
Report Title	**Context of Report**	**Main Findings / Observations of Report**
The Ecofys Study - *Study on the Comparative Merits of Overhead Electricity Transmission Lines versus Underground Cables* Prepared by Department of Communications, Energy and Natural Resources (DCENR) **May 2008**	The aim of the study was to provide the best available professional advice on the relative merits of constructing and operating OHL compared to UGC, having regard to technical characteristics, reliability, operation and maintenance factors, environmental impact, possible health issues, and cost.	Globally the vast majority (approximately 99.5%) of UGC is generally used in areas of high population density or high land values – generally urban areas - where it is difficult to find suitable OHL routes. International experience shows that extra high voltage (EHV) UGC is generally not used for any great distance, e.g. the longest such UGC is in Tokyo and is only 40km in length. Whilst decisions may be taken to underground lower voltage networks of distribution systems, this is not normally applied to the higher voltage networks of transmission systems, as the technology involved is substantially different and more demanding. Both EHV UGC and OHL are found to have an environmental impact but these impacts are different for the different technologies, and in most cases mitigation measures are available, e.g. UGC has a greater impact on water resources and soils and geology, whereas OHL has a greater impact on Landscape and Visual and Communities. The study distinguishes between the perceived health risks associated with Electro-Magnetic Fields (EMF) and actual health risks associated with EMF and cites the International Commission of Non-Ionising Radiation Protection (ICNIRP) recommendation. The study concludes that the construction and operation of an EHV UGC in Ireland with a length of 100km would not be backed by worldwide experience. Mitigation measures are proposed to reduce the potential impact of the planned Interconnector on the environment.
The IEC Report - *Meath- Tyrone Report Review by the International Expert Commission* August – November 2011. *(A review of the case for, and cost of undergrounding all or part of the Meath-Tyrone 400 kV Interconnection Development*.) Prepared by Normak B., et al. **November 2011**	In July 2011 the Minister for Communications, Energy and Natural Resources appointed the IEC to:- Examine the case for, and cost of, undergrounding all or part of the Meath–Tyrone 400 kV line (now known as the North-South 400 kV Interconnection Development – the subject of this instant application); Review expert literature already available both in Ireland and internationally in relation to undergrounding high voltage [HV] power lines; Consider the route or routes proposed by EirGrid (see **Figure 4.1**); and Consult with EirGrid, the North East Pylon Pressure Committee and the County Monaghan Anti-Pylon Committee, and other bodies / organisations.	The main findings of the report are as follows:- Based on an analysis of a number of different high capacity transmission projects in Europe, it is clear "*that there is no single "right" solution. Each project must be judged on its own merits and hybrid solutions, i.e. combining different technologies, have been applied in many cases, for instance partially undergrounding a link. A specific technical solution must be derived accounting for local conditions*"; There have been advances in transmission technology in recent years, examples being "*the development of VSC HVDC technology and its deployment in transmission projects and the introduction of new tower designs for overhead lines*"; The only recommendation the IEC made was "*against fully undergrounding using an AC cable solution*"; While the report does not recommend that the interconnector be undergrounded it does find that if the interconnector has to be undergrounded for all, or a significant portion, of its length then with today's technology the best solution would be "*a VSC HVDC solution combined with XLPE cables*"; and The report concludes that a high voltage AC OHL solution for the proposed interconnector still offers "*significantly lower investment costs than any underground alternative and could also be made more attractive by investing slightly more in new tower designs than the classical steel lattice towers now proposed".*

Appendix D – Design Criteria (EirGrid)

Before commencing its comparative analysis of the alternatives for the N/S project, EirGrid identified the key performance objectives and design criteria against which the alternatives would be measured. These are:-

a. Comply with all relevant safety standards;

b. Comply with all system reliability and security standards;

c. Provide an environmentally acceptable and cost effective solution;

d. Have a power carrying capacity in the region of 1,500MW, and connect between appropriately robust points on the transmission networks north and south of the border;

e. Facilitate future reinforcement of the local transmission network in the north-east area;

f. Facilitate future grid connections and reinforcements; and

g. Comply with 'Good Utility Practice'[7] or 'best international practice'.

Criteria 'a.', 'b.' and 'c.' derive from EirGrid's statutory and licence obligations while criteria 'd.' and 'e.' are specific objectives identified for this project. Criteria 'f.' and 'g.' are general criteria that would apply to all projects of this type.

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Report to Independent Expert Panel
ADDENDUM
Date: 19/06/2014

Paper prepared at the request of the Independent Expert Panel for the purpose of providing an "*Assessment by EirGrid of the extent to which, in EirGrid's view, the methodologies to be employed on the GW and GL projects are compatible with what has already been done on the N/S project".*

1. Introduction

At a meeting on 10 June 2014 some additional information and clarifications were requested by the Independent Expert Panel in relation to EirGrid's *Report to the Independent Expert Panel* of 29 May 2014 (the Report). The requests are addressed in this paper which should be considered as an Addendum to the Report.

The IEP requested details of EirGrid's consideration of the suitability of public roads and disused railway lines for an underground cable route. In addition clarification was sought as to the origin of the designations "Phase 1" and "Phase 2" as they appear in the Section 2.2 of the Report. The requested information in this regard is provided in Section 2 of this Addendum.

The IEP referred to "Table 3: Assessment of IEP Environmental Sub-Criteria" of the Report as a useful aid for comparing the environmental criteria set out in the IEP's Terms of Reference with the work already carried out for the N/S Project and requested that similar tables be provided for the Technical and Economic criteria. The requested Tables are provided in Section 3 of this Addendum.

The IEP noted reference in the Report to a comparative environmental assessment of the overhead line and underground cable options contained in the draft N/S Project EIS 2014 and requested sight of same. This is addressed under Section 4 of this Addendum and the extract is provided in Appendix A.

2. Specific Clarifications

2.1 Consideration of suitability of road network and disused railway lines for UGC route

Section 2.3 of the Report refers to the 2009 PB Power Report. As part of this study PB Power was required to establish the layout (spatial and configuration requirements) for the underground cable option. This was derived from the specified technical and operational requirements and from the access requirements during construction and subsequent operation. The resultant layout design by PB Power is shown in Figure 1 below.

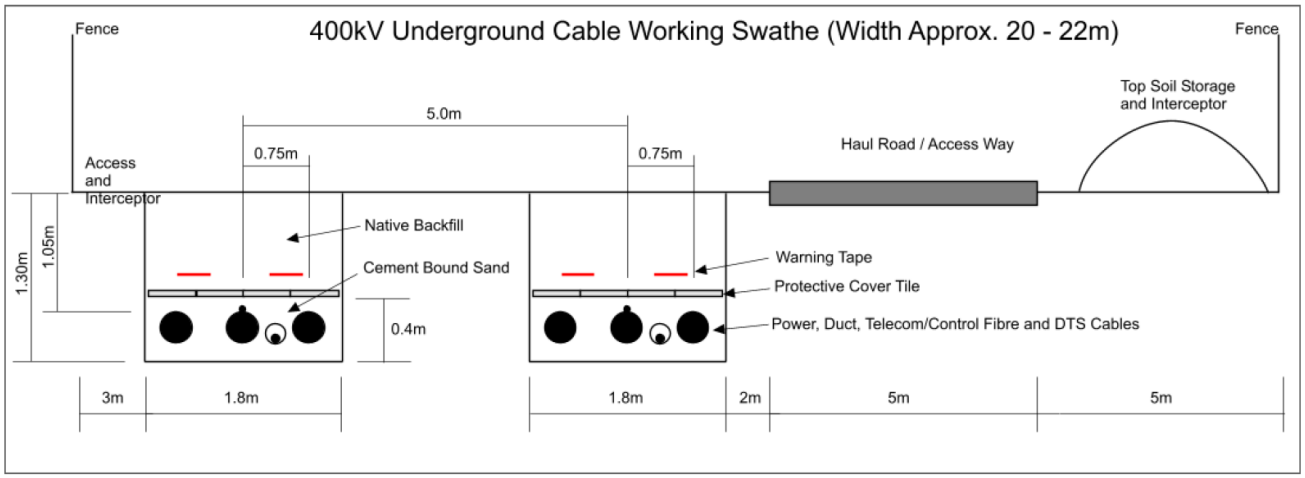

Figure 1 – Extracted from 2009 PB Power Report

The extent of this layout is such that it was immediately apparent that the local and regional roads between the existing Woodland Substation in County Meath and the proposed substation in Turleenan in County Tyrone are not sufficiently wide to accommodate such a development.

The extent of the layout was also a factor when EirGrid considered the use of the disused railway lines in the study area as a potential route for the UGC option. A summary of this consideration, and its conclusions, can be found in Section 5.6.2 of Volume 1 of the 2009 Meath-Tyrone EIS.

In the case of the motorway network it is described in the 2009 Meath-Tyrone EIS how during the "*public consultation process, it was queried whether EirGrid considered putting the planned transmission infrastructure along the M3 Motorway corridor, either as OHL or UGC. EirGrid has consulted with the NRA regarding the overall proposed Interconnection development*."

The M3 motorway was being constructed at that time under a Public Private Partnership (PPP) arrangement. Locating the underground cable (UGC) option within the reserve of the M3 was discussed with the National Roads Authority (NRA). The 2009 Meath-Tyrone EIS describes how the NRA advised that such a UGC "*would only be permitted within the motorway reserve if indemnities regarding damage, disruption, costs, etc acceptable to both NRA and the PPP (public-private partnership) company, that will construct and*

operate the motorway, were received. In EirGrid's opinion, even if UGC was a viable option, this requirement introduces such complexity, uncertainty and risk that it would render this route, a less favourable UGC route than a direct cross county route, such as that identified in the PB Power Report".

The sequence of photographs in Figure 2 show the works required for a recent repair of the DC underground cable that forms part of the Moyle Interconnector between Northern Ireland and Scotland. The extent of the works shown and the duration (some weeks) goes some way to explaining NRA's concerns about locating high voltage underground cables within motorway reserves.

Figure 2 - Repair work on HVDC cable: Moyle Interconnector

2.2 Origin of the designations "Phase 1" and "Phase 2"in Section 2.2 of the Report

Section 2.2 of the Report provides some background on how OHL and UGC options were initially identified for the N/S Project. Reference to the "phases" of route selection in Section 2.2 is based on the terminology used in the public consultation road map associated with the 2009 application for planning approval. For clarity a copy of this early roadmap, which includes a description of each phase, is included as Figure 3 below.

This early roadmap was subsequently replaced by a new roadmap following the withdrawal of the 2009 application for planning approval. In line with the later Roadmap, the N/S project reviewed all technology options again (and all other options and issues arising) during the effective application of Stage 1 and Stage 2 of this roadmap which took place through the Re-Evaluation Process as set out in Section 2.5 of the *Report to the Independent Expert Panel*. As also noted under Section 2.2 of this report, strategic route corridors for OHL and UGC were further assessed as part of the consideration of technology alternatives for the project up to and during the preparation of the draft *N/S Project EIS (2014)*.

This iterative and parallel process of review for both corridor and technology options is consistent with the long established requirements for Environmental Impact Assessment (EIA) in respect of consideration of the main alternatives associated with a project, both as established under the governing European Directive, the implementing Irish legislation, and established Guidelines for EIA published by the Environmental Protection Agency (EPA).

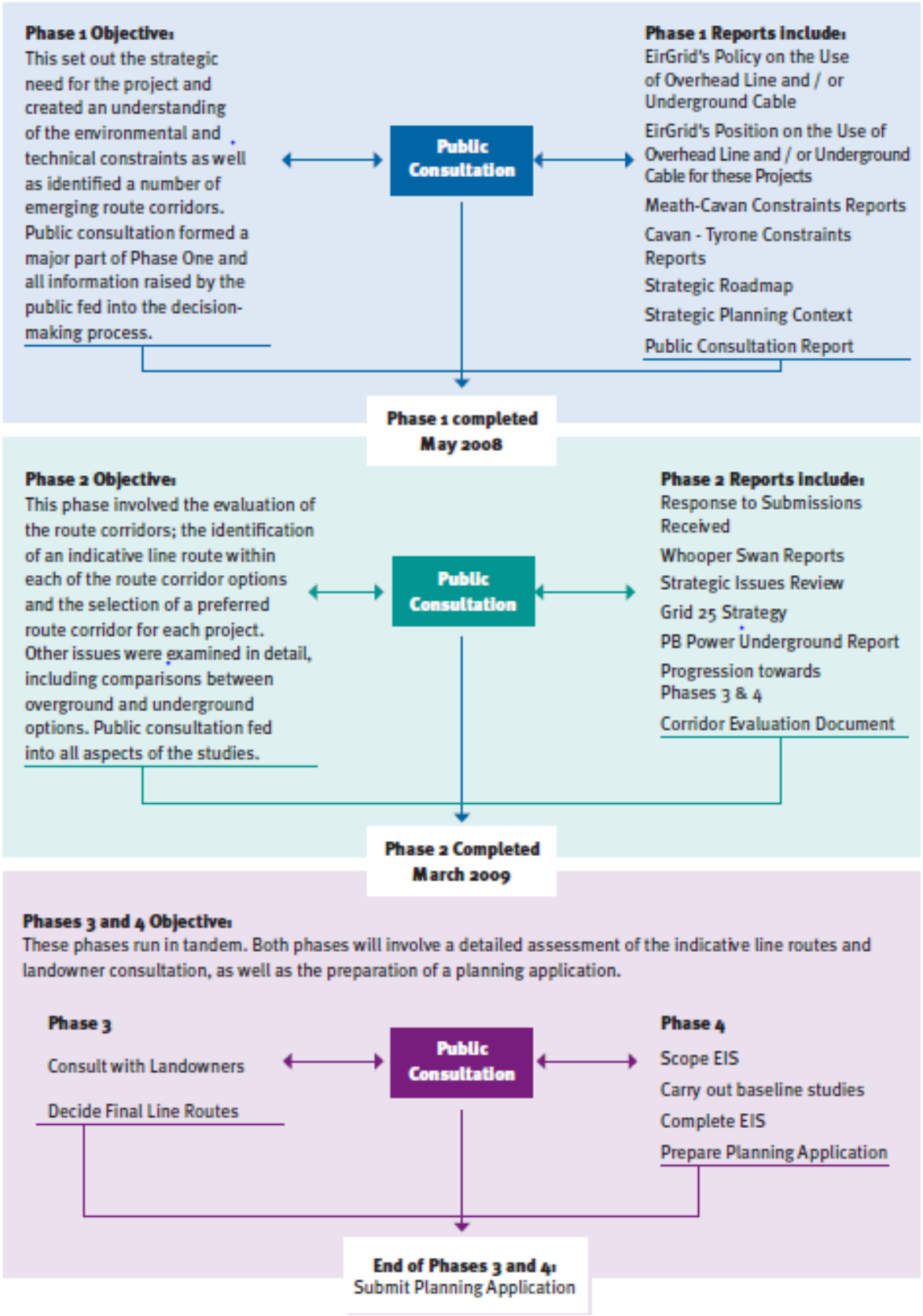

Figure 3 – 2007/2009 Strategic Roadmap

3. Summary Tables comparing IEP's Terms of Reference with work already done for N/S Project

The Report included a summary table (Table 3: Assessment of IEP Environmental Sub-Criteria) that listed the environmental criteria specified by the IEP in its Terms of Reference and referenced where each of these criteria has been considered in the case of the N/S Project. A brief summary or 'key point of note' is also provided against each reference.

Similar tables are now provided below for the Technical and Economic criteria, see Section 3.1 and 3.2 respectively. For the sake of completeness the original environmental table is also included below, see Section 3.3.

3.1 Summary Table of Technical Criteria

IEP Technical Criteria	Relevant N/S Project Report	Reference / Summary
a. Compliance with all relevant safety standards	2009 Meath-Tyrone EIS	Chapter 4 of Volume 1 confirms that the proposed overhead line and the identified underground cable options are equally compliant.
	Final Re-evaluation Report	Chapter 3 reaffirms that the most suited overhead line and underground cable options are equally compliant.
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B confirms that the proposed overhead line and the underground cable options are equally compliant.
b. Compliance with system reliability and security standards	2009 Meath-Tyrone EIS	Chapter 4 of Volume 1 considered the expected fault rates and average fault repair times for overhead line and underground cables and found that overhead lines are susceptible to environmental effects and thus normally exhibit fault rates higher than those of UGC circuits. However, average repair times of UGC are much higher than those of OHL. This causes the long-term availability of OHL to be significantly higher than that of UGC. In the comparative assessment of the options this was rated as a concern for the underground cable alternatives
	Final Re-evaluation Report	Chapter 3 considered the most suited underground option to be a HVDC scheme. AC overhead line has a proven track record for applications such as this whereas HVDC does not. For this reason a standard AC circuit is considered to be preferable to a DC circuit when rated against this criterion and for the specific characteristics of this development.
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B reviewed and updated the assessment in the Final Re-evaluation Report and reached the same conclusion.

c. The average failure rates during normal operation, average repair times and availabilities of the main elements of each option	PB Power Report (2009)	Chapter 4 considers these and calculates the expected circuit availabilities for both the AC overhead line and AC underground cable options. In the case of the underground cable option it also considers the fact that to achieve the required power carrying capacity two parallel cables would be needed and evaluates the impact that this would have on overall circuit availability. Chapter 6 considers the reliability and availability statistics for HVDC schemes.
	Ecofys Report	Chapter 5 considers the availability of underground cable and overhead line circuits and the implications of same for transmission system adequacy. It then carries out a metadata analysis of previous studies of failure rates and repair times.
	2009 Meath-Tyrone EIS	In Chapter 4 of Volume 1 this was treated as a sub-criterion of the main criterion 'Compliance with system reliability and security standards' in the comparative assessment matrix. The consideration was supported by the findings of the PB Power and Ecofys Reports.
	Final Re-evaluation Report	Chapter 3 considers the latest international fault and repair time statistics for underground cables published by Cigre and comparable statistics for overhead lines in Ireland based on EirGrid's records and using this data calculates the projected fault rate and repair times for the overhead line and underground cable options.
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B reviews and updates the calculations in the Final Re-evaluation Report based on latest statistics.
d. The expected impact on reliability of supply of or unavailability of the development;	PB Power Report (2009)	Chapter 4 considers this and calculates that the overhead line option would have an expected level of availability of around 99.8% compared to 90.3% for the underground cable option. It concludes that the introduction of significant quantities of underground cable into the network may therefore compromise system security.
	Ecofys Report	Chapter 5 finds that the forced outage rate for an underground cable is estimated to be "one or two orders of magnitude higher" than that of overhead line.
	2009 Meath-Tyrone EIS	In Chapter 4 of Volume 1 this was treated as a sub-criterion of the main criterion 'Compliance with system reliability and security standards' in the comparative assessment matrix. The consideration was supported by the findings of the PB Power and Ecofys Reports.
	Final Re-evaluation Report	Covered under 'Compliance with system reliability and security standards' in Chapter 3

e. Implementation timelines, including procurement and availability of key equipment and resources;	PB Power Report (2009)	Chapter 3 considers the quantity of cable that would be required for the underground cable option and estimates that its manufacture time would be seven factory-years. Also considers the number of cable joints required and estimates the number of jointer team-years required to make these joints. Concludes that procurement and installation periods would be greater for an underground cable than for an overhead line.
	2009 Meath-Tyrone EIS	Chapter 4 notes the finding of PB Power regarding the lengthy procurement and production timeline in the case of the underground cable option.
f. The extent to which future reinforcement of, and/or connection to, the transmission network is facilitated;	2009 Meath-Tyrone EIS	Chapter 4 of Volume 1 identifies the facilitation of future grid connections and reinforcements as a key criterion in a comparative assessment of options for all projects of this type. As the existing grid is an AC grid the report notes that implementing the development using DC technology would have the disadvantage that future 'tap-ins' to a DC circuit regardless of whether that was an overhead line or underground cable would "be much more expensive than a 'tap-in' to an equivalent AC circuit and will further complicate" an already complex control system.
	Final Re-evaluation Report	Chapter 3 contains a general evaluation of HVDC technology, as an alternative to the standard HVAC technology regardless of whether the HVDC scheme is to be implemented using OHL, UGC or a combination of both. One of criteria considered in this comparative assessment was the ability to facilitate future grid connections and reinforcements. The DC option was rated as less preferred than a standard AC option against this criterion.
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B reviews the evaluation, and reconfirms the conclusions, of the Final Re-evaluation Report in respect of this criterion.

g. The risk associated with use of any untried technology solution that would be required as part of a development option	2009 Meath-Tyrone EIS	Chapter 4 of Volume 1 identified the AC overhead line option as being a standard tried and tested technology for this application whereas an AC underground cable of the length required here has not been implemented anywhere in the world. Similarly embedding a DC circuit, regardless of whether it is achieved using overhead line or underground, into an AC grid like Ireland's has also never been implemented anywhere in the world. The risk of using untested and un-tried technology to form a circuit that is as strategically important to the country as the North South Interconnector was considered and it was concluded that to do so would be unacceptable
	Final Re-evaluation Report	Chapter 3 notes that there are no working examples in the world today of a DC circuit embedded in a small and isolated AC transmission network such as that on the island of Ireland. It also notes that the longest AC underground cable of comparable rating to that required for this development is in Tokyo and is 40 km in length whereas a length in the region of 135km is required for this project. The risk of failure, and the consequence of failure, is identified as an important factor when considering technology options. The risk of using untested and un-tried technology to form a circuit that is as strategically important to the country as the North South Interconnector was considered and it was concluded that to do so would be unacceptable
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B reviews the evaluation, and reconfirms the conclusions, of the Final Re-evaluation Report in respect of this criterion.
h. Compliance with good utility practice	2009 Meath-Tyrone EIS	Chapter 4 of Volume 1 rated all of the identified technological options against this criterion and based on the definition of what constitutes best international practice or 'Good Utility Practice' as set out below.
	Final Re-evaluation Report	Chapter 3 contains a general evaluation of HVDC technology, as an alternative to the standard HVAC technology regardless of whether the HVDC scheme is to be implemented using OHL, UGC or a combination of both. One of criteria considered in this comparative assessment was 'Comply with Good Utility Practice' and assumes the definition below
	Draft N/S Project EIS (2014)	Chapter 4 of Volume 3B reviews the evaluation, and reconfirms the conclusions, of the Final Re-evaluation Report in respect of this criterion.

	In this instance the term 'Good Utility Practice' is defined as: *"Good Utility Practice means any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry in Europe during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result of the lowest reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the ENTSO-E region and consistently adhered to by EirGrid."* This definition is a modified or Europeanised version (modifications are underlined) of the North American Electric Reliability Corporation's (NERC) definition which is endorsed by the US Federal Energy Regulatory Commission (FERC) and which was adopted by most US and Canadian electric utilities following the widespread blackout of August 2003 in the US and Canada.

3.2 Summary Table of Economic Criteria

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
a. Project pre-engineering costs: a1. Costs of evaluation of route a2. Line technology a3. Substation options	PB Power Report (2009 & 2013)	The installation cost estimate for the overhead line (OHL) option was prepared using the typical 'pre detailed design' methodology which is - a suitable cost per km (for this project) was first identified and this was then multiplied by the length in km of the OHL route to arrive at the overall cost estimate. Pre-engineering costs are not therefore specifically identified in the OHL estimates but are provided for in the cost per km; refer Appendix 1 of PB Power Report (2009). It is recognised that this relatively simple methodology would not provide a robust cost estimate for the underground cable (UGC) option as the cost of UGC projects are significantly more sensitive to the terrain through which the UGC is to be routed than are OHL projects. A bottom-up methodology was therefore applied and specific provision was made in the UGC estimate for pre-engineering costs, refer Table 8-6 of PB Power Report (2009 & 2013) and Appendix 7 of PB Power Report (2009). Note: The objective of the PB Power study was to establish an estimate of the difference in costs between the options as opposed to the overall cost of each option. As a result those elements that are common to all options were specifically excluded from the estimates. As AC substations are required for all options much of the costs of these are excluded from the estimates.

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
b. Project Implementation costs: b1. Cost of procurement, installation and commissioning of overhead line and/or underground cable for the required continuous pre-fault, continuous post-fault and short-term post-fault ratings;	PB Power Report (2009 & 2013)	Before preparing its cost estimates PB Power first considered the 'sizing and layout' of the OHL and UGC options based on the "required continuous pre-fault, continuous post-fault and short-term post-fault ratings". In the case of the OHL option the identified cost per km includes provision for procurement, civil works, installation works, engineering and project management; refer Section 8.3.1 and Appendix 1 of PB Power Report (2009). In the case of the UGC option provision is made in the estimates for procurement, installation and commissioning costs, refer Table 8-16 of PB Power Report (2009 & 2013). Note that while commissioning costs are not specifically mentioned they are provided for in the electrical installation costs.
	IEC Report (2012)	In Chapter 9 the estimates for both the OHL and UGC options was determined by identifying a cost per km (procured, installed and commissioned) and this was then multiplied by the length in km of the route to arrive at the overall cost estimate.
b. Project Implementation costs: b2. costs of substations including procurement, installation and commissioning of required protection and control equipment and any equipment necessary for compliance with relevant technical standards	PB Power Report (2013)	In the case of the OHL option Figure 1 of Section 8.3 shows diagrammatically the extent of the substation works included in the capital cost estimate while Table 8-23b quantifies the substation cost estimates. In the case of the AC and DC UGC options the extent of the AC substation works considered are shown in Figure 2 and Figure 3 respectively while Table 8-23b quantifies the substation cost estimates for both the AC and DC UGC options. Tables 8-13, 8-14 and 8-15 provide details of the provision for reactive compensation in the case of the AC UGC option. Note: The objective of the PB Power study was to establish an estimate of the difference in costs between the options as opposed to the overall cost of each option. As a result those elements that are common to all options were specifically excluded from the estimates. As AC substations are required for all options much of the costs of these are excluded from the estimates.
	IEC Report (2012)	As the objective of the IEC study was to establish the difference in cost between the OHL and UGC options the cost estimates in Chapter 9 provide in both cases for the terminals in the substations but not the full costs of the substation infrastructure as that would be common to both options.

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
b. Project Implementation costs: b3. All relevant civil works for construction, including: for access to sites; for any necessary river/road/rail crossings or diversions, any tunnels necessary for any sections of underground cable, and for towers plus their foundations for sections of overhead line; and for post-construction restoration	PB Power Report (2009 & 2013)	In the case of the OHL option the identified cost per km includes provision for temporary access roads and civil works including tower foundations, refer Section 8.3.1 and Appendix 1 of PB Power Report (2009). In the case of the UGC option provision is made for a temporary haul road and for trenchless crossings of river and roads, Refer Tables 8-9, 8-10 and 8-11 and Appendix 7 of PB Power (2009). No cable tunnels are envisaged.
b. Project Implementation costs: b3. Third Party Payments (wayleaves, community gain, rates etc);	PB Power Report (2009 & 2013)	As noted above, the aim of the PB Power studies (also refer Section 1.4 of PB Power 2013) is to provide comparative cost assessments and common items are therefore excluded: In the case of both the OHL and UGC options the '*most suited'* route is a route across private lands. This means that 'third party payments' would arise in the case of both options. As the UGC option would place a greater burden on private lands than would the OHL option it is likely that these costs would be greater in the case of UGC than in the case of OHL. It was considered however that this difference would not have a significant impact on the overall difference in cost between the options and as a result they were excluded from the PB Power cost estimates. Community Gain costs would arise in the case of the OHL option but not in the case of the UGC option. Provision has not been made for these in the OHL cost estimates however they would not have a significant impact on the overall difference in cost of the options.
b. Project Implementation costs: b4. Interest During Construction;	PB Power Report (2009 & 2013)	Provision for IDC is made in the case of all options, Refer Tables 8-4, 8-22 and 8-23a.

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
b. Project Implementation costs: b5. The costs of any environmental monitoring deemed necessary to mitigate the impact of the development during construction or on-going operation	PB Power Report (2009 & 2013)	As noted above, the aim of the PB Power studies (also refer Section 1.4 of PB Power 2013) is to provide comparative cost assessments and common items are therefore excluded: In the case of both the OHL and UGC options the '*most suited'* route is a route across private lands. During the construction phase 'environmental monitoring' would arise in the case of both options. As the civil works associated with the UGC option would have a greater impact than would be the case for the OHL option it is certain that these costs would be greater in the case of UGC than in the case of OHL. It was considered however that this difference would not have a significant impact on the overall difference in cost between the options and as a result they were excluded from the PB Power cost estimates. However provision is made for on-going monitoring in the Operation & Maintenance portions of both the OHL and UGC options.
c. Project life cycle costs (including Losses, Operation & Maintenance, Decommissioning and the costs of retaining any necessary specialist repair teams)	PB Power Report (2009 & 2013)	Provision for project life cycle costs is made in the case of all options, Refer Tables 8-4, 8-22 and 8-23a. Specialist repair teams are not required in the case of the OHL option as this is standard technology in widespread use in Ireland. Specialist repair teams are required to repair underground cables of the type required here however the practice in such cases is to rely on the manufacturer of the cable to provide the repair team. This is a factor in the length of the average time it takes to repair such cables. Provision is made for these costs in O&M portion of the cost estimate. Specialist repair teams are required to repair HVDC converter stations and again it would be the practice in such cases to rely on the manufacturer of the converter station equipment to provide the repair team. Provision is made for these costs in O&M portion of the cost estimate. In the case of the DC UGC option it is noted (Section 3.4.4 of PB Power 2013) that provision has not been made for the cost of holding strategic spares which cost would be considerable but that its estimation is beyond the scope of this study.
	IEC Report (2012)	Chapter 8 discusses the energy losses associated with both the UGC and OHL options but does not include a provision for these in the respective cost estimates.

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
d. The expected costs to operation of the Single Electricity Market arising from unavailability of the development	2009 Meath-Tyrone EIS	A summary of why the absence of the second interconnector impacts on the efficient running of SEM is provided in Volume 2, Section 2.4.1 "The efficient operation of the SEM on the island of Ireland requires an adequate and appropriate linkage of the separate transmission networks in such a way that they operate as a single synchronised AC transmission network. To achieve this, the level and reliability of interconnection must be such that the demand for cross border power flows can be met at all times even during system disturbances. As described in section 2.3.3 above, to manage the risk of system separation, power transfers on the existing interconnector are currently limited to the level where the generation/load imbalance resulting from system separation can be managed by both systems. The existing reliance on a single interconnector is considered a significant constraint to ensuring an efficient SEM. The constraint creates inefficiency in the market, due to the operational limits on transfer capacity and therefore excess cost for customers because it prevents the most efficient generators having unrestrained access to the market at all times"
	Final Re-Evaluation Report	Section 2.2 summaries latest cost studies at the time of publication by EirGrid which calculated the impact to SEM: "Studies by EirGrid have calculated annualized benefits to the market from the delivery of the second North-South Interconnector of the order of €20m per annum in 2020 rising to closer to €40m over the following decade". (p 29)
	Draft N/S Project EIS (2014)	Volume 3B, Chapter 2, Strategic Need, summaries the benefits to SEM under section 2.3.1 and refers to the cost figures provided in Appendix 2.1. Volume 3B, Appendix 2.1, "*The Need for the Second North South Interconnector*", provides a cost assessment of the benefits of the second North South interconnector and an outline of the methodology applied including sensitivity assessment. The report concludes that "*A range of electricity production cost and security of supply benefit savings can be attributed to the construction of the North South interconnector with annual electricity production cost benefits ranging from €15m to €24m in 2020, and increasing to between €22m and €42m in 2030 and beyond*."

IEP Economic Criteria	Relevant N/S Project Report	Reference / Summary
e. Estimates of the range of uncertainty attaching to all of the cost components under all options	PB Power Report (2009 & 2013)	This is addressed in general in Section 8.2 of the PB Power Report (2009) and is updated in Section 3.2 of the PB Power Report (2013). Specific uncertainties related to the UGC option are discussed and quantified in Section 8.4.
	IEC Report (2012)	Areas of uncertainty with the cost estimates are discussed at a high level in Chapter 7. It is noted that metal prices are a particularly important source of uncertainty in the cost estimates of projects such as this. A provision for this uncertainty is however not specifically identified in the cost estimates in Chapter 9.

3.3 Summary Table of Environmental Criteria

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
Biodiversity, Flora and Fauna	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Ecology and Nature Conservation*. It included consideration of the following parameters: bird strike, flora, mammals, insects, habitat loss and aquatic ecosystems. It also considers restoration techniques and options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Flora and Fauna' as an environmental topic.
Water (Surface, Ground, Estuarine and Coastal)	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Water Resources*. It included consideration of the following: disruption to groundwater including wetland and surface waters. It also considers

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
		options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Soils, Geology and Hydrogeology' as an environmental topic.
Soil	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Geology and Soils.* It included consideration of the following: soil cover, soil type, excavated material and quarrying and mining. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Soils, Geology and Hydrogeology' as an environmental topic.
Landscape and Visual	2008 ECOFYS Report	Landscape Character and Visual Effects. The topic included consideration of the following: natural features and historical monuments, access tracks / haul roads and communities. It also considers options for mitigation.

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Landscape' as an environmental topic.
Cultural Heritage (Architectural and Archaeological Heritage)	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Cultural Resources.* The topic included consideration of the following: archaeological, historic monuments and buildings, language and culture. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Cultural Heritage' as an environmental topic.
Communities	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including *Communities*. It topic included consideration of the following: quality and cohesiveness, business, economy and employment, tourism industry, filming, animal breeding, EMFs, Health and Safety, Property Prices, severance, educational enrolment, impact on future

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
		developments. It also considers options for mitigation. 2009 EIS, Chapter X – Add brief 1-2 line summary. Section 4.5.2 provides a summary of the Ecofys Report.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Human Beings – Population and Economic; Human Beings – Land Use; Human Beings – Tourism and Amenity; and Human Beings – EMF' as environmental topics.
Air	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Air Quality. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report (in Section 5.4.2.4). EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Air – Climate' as an environmental topic.
Climatic Factors	See above.	
Material Assets	2008 ECOFYS Report	N/A

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
	2009 Meath-Tyrone EIS	N/A
	Draft N/S Project EIS 2014	Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report (in Section 5.4.2.4). EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Material Assets – General' as an environmental topic.
Tourism	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Communities. The topic included consideration of the tourism industry. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Human Beings – Tourism and Amenity' as an environmental topic.
Traffic and Noise	2008 ECOFYS Report	Chapter 6 looks at the potential impacts under a number of headings including Traffic and Noise. It also considers options for mitigation.
	2009 Meath-Tyrone EIS	Section 4.5.2 provides a summary of the Ecofys Report.
	Draft N/S Project EIS 2014	Section 4.6.1 / Table 4.3 provides a summary of the Ecofys Report. Section 4.7.3.3 provides an overview of the environmental issues associated with partial undergrounding. The potential for partial undergrounding is further considered having regard to the Ecofys Report in

IEP Environmental Criteria	Relevant N/S Project Report	Reference / Summary
		Section 5.4.2.4. EirGrid's environmental consultants also considered the potential for partial mitigation (and its likely environmental impacts) as a potential mitigation measure in the context of the environmental issues associated with Monaghan, Cavan and Meath study area and the preferred line design (see Table 5.4). This includes 'Material Assets – Traffic' as an environmental topic.

4. Extract from Chapter 5, Volume 3B of Draft EIS (2014)

In the Report to the IEP reference is made to the comparative environmental assessment that was carried out for the 2014 EIS. Specific reference is made in Table 3 of the Report to Chapter 5 and Table 5.4 of the draft N/S Project EIS 2014. The relevant paragraphs (120 to 129) of Section 5 including Table 5.4 are reproduced in Appendix A of this Addendum.

It should be noted however that insofar as extracts from the draft EIS are included here and references are made in the Report and Addendum to the draft EIS a finalised EIS has not been published and the draft EIS, including the extracts and references, may be subject to change.

Appendix A

Extract from Draft N/S Project EIS 2014

120. With the identification of a preferred OHL line design, EirGrid and its consultants were in a position to identify potential significant environmental impacts and to consider likely mitigation measures, which included, *inter alia*, the potential for partial undergrounding. Reference is also made to the Scoping Opinion issued by the Board on 11th December 2013, which stated that "*the potential for alternative routing or partial undergrounding in sensitive landscape areas should be addressed*".

121. Both OHL and UGC technologies result in environmental impacts. These impacts are however different for the different technologies and in most cases, if not all, mitigation measures are available.

122. As referenced in **Section 4.8**, the circuit design and operating voltage are both important variables which determine the eventual size, scale, and ultimately appearance of the necessary support structures for an OHL. In general, the higher the voltage, the larger the support structure that is required with a consequential impact on landscape and visual resources. Therefore, careful route selection during the planning stages is critical in mitigating landscape and visual resources, particularly for high voltage OHLs. It is at this route selection stage where there is maximum potential to achieve avoidance and minimal adverse landscape or visual effects.

123. The potential for undergrounding as a mitigation measure required consideration of the potential environmental impacts associated with partial undergrounding. In this regard, reference is made to **Section 4.7.3.3** of this volume of the EIS which examines some of the environmental implications of partial undergrounding and Chapter 6 of the Government commissioned Ecofys *Study on the comparative merits of overhead electricity transmission lines versus underground cables* (2008) which examines a number of key environmental issues and compares OHL and UGC in terms of 'Environmental Impact' and 'Ease of Potential Mitigation'.

124. The Ecofys Report concludes, in Section 6.12, by stating: "*the purpose of this study is to provide decision-makers with an unbiased, comparative assessment of the general environmental implications of either scenario in environments typical of Ireland to enable them to make informed decisions in this regard."* It then presents its findings in tabular form, see **Figure 5.20** Table 6-1: *High Voltage Transmission Systems – Overhead Lines versus Underground Cables: Environmental Impact & Ease of Potential Mitigation*.

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
LAND USE				
Time and Flexibility of Construction	***	●●	**	●●
Length of Construction	***	●●	**	●●

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
Disrupt. To Agric. Operations	***	●●●	**	●●●
Land Take	**	●●	*	●●●
Effect on Field Boundaries	***	●●	**	●●●●
Effects on Farm Buildings	**	●	**	●●●
Effects on Drainage Patterns	***	●●	*	●●●●
Catastrophic Event Implications	***	●●	**	●●●
Repair & Maintenance	***	●●	*	●●●●
GEOLOGY and SOILS				
Soil Cover	***	●●●	**	●●●●
Excavated Material	***	●●	**	●●●●
Quarrying and Mining	**	●●●	**	●●●
EFFECTS ON WATER				
Disruption to Groundwater incl. Wetland	***	●●	*	●●●●
Effect on Surface Waters	***	●●●	*	●●●●
ECOLOGY and NATURE CONSERVATION				
Bird Strike	N/A	N/A	***	●●●
Risk to Flora (construction)	***	●●	**	●●●
Risk to Flora (operations)	**	●●	*	●●●
Risk to Mammals	**	●●	*	●●●
Risk to Insects	**	●●	*	●●
Loss of Habitat (construction)	***	●●●	**	●●●
Loss of Habitat (operations)	**	●	**	●
Risk to Aquatic Ecosystems	***	●●●	*	●●●●
Restoration	***	●●●	*	●●●
LANDSCAPE and VISUAL				
Landscape Character	*	●●●	***	●●
Landscape Features	**	●●	*	●●●
Visual Impact (construction)	***	●●	**	●●
Visual Impact (operations)	*	●●●	***	●●
Access Tracks/Haul Roads	***	●●●	**	●●●●

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
Communities	**	●●●	***	●●
CULTURAL HERITAGE				
Archaeological Resources	***	●●	*	●●●
Cultural/Historic Resources	**	●●	**	●●●
Language and Culture	*	●●●	***	●●
TRAFFIC AND NOISE				
Traffic	***	●●	**	●●
Noise (construction)	***	●●	**	**
Noise (operations)	*	●●●●	**	●●
AIR QUALITY				
Construction	***	●●	**	●●
Operations	N/A	N/A	**	●
COMMUNITIES				
Quality and Cohesiveness	*	●●●●	***	●●
Business, Economy and Employment	*	●●●●	**	●●
Tourism Industry	*	●●●●	**	●●
Fishing	*	●●●●	**	●●●
Animal Breeding	*	●●●●	**	●●●
Health & Safety and Electromagnetic Fields	*	●●●●	**	●●●●
Property Prices	**	●●	***	●
Severance	*	●●●●	***	●●
Educational Enrolment	*	●●●●	***	●●
Future Development	**	●●●	***	●●
RECREATION and TOURISM	*	●●●	***	●●

(Source: Ecofys *Study on the comparative merits of overhead electricity transmission lines versus underground cables* (2008))

Note: 1 = Significance of Impact

Significance:

*** Major: a fundamental change to a sensitive environment

** Moderate: a material but non-fundamental change to the environment

* Minor: a detectable but non-material change to the environment

N/A Not applicable

Mitigation:

● No practicable mitigation possible

●● Remedial measures only

●●● Mitigation likely to reduce adverse scale of impact

●●●● Mitigation likely to avoid adverse discernible impact

N/A Not applicable

Figure 5.20 Table 6-1: High Voltage Transmission Systems – Overhead Lines versus Underground Cables

(Source: Ecofys *Study on the comparative merits of overhead electricity transmission lines versus underground cables* (2008))

125. Of particular note, the table identifies that, for the majority of environmental topics an OHL has an equal or lesser environmental impact to a UGC, with obvious exceptions (including bird strike, landscape character, visual impact and certain community issues). This is generally consistent with EirGrid's findings.

126. In relation to landscape and visual impact, in particular, Ecofys reported a significance of impact of 'major – a fundamental change to a sensitive environment' in terms of landscape character, visual impact (operations) and communities. Mitigation is identified as 'likely to reduce adverse scale of impact'. Identified mitigation measures include *inter alia* avoiding conspicuous sky lines and horizons, particularly in visually sensitive areas and avoiding, to the extent feasible, areas of high visual amenity and areas with highly sensitive visual receptors. It is important to note that these measures have fed into the line design process for the proposed development**.**

127. **Table 5.4** below summarises EirGrid's consideration of partial undergrounding to mitigate potential significant environmental impacts arising from the preferred OHL line design, based on an understanding of the environmental issues associated with the Monaghan, Cavan and Meath study area. In this regard, the majority of environmental topics identified OHL as having an equal or lesser environmental impact to partial undergrounding. These findings are generally consistent with the comparative environmental implications described in Table 6-1 of the Ecofys Report (as replicated in **Figure 5.20**).

Table 5.4: Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development

Environmental Topic	Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development
Human Beings – Population and Economic	Partial UGC could be considered as an effective mitigation measure in order to reduce the most significant impacts (localised visual impacts) on population, assuming that an appropriate location and screening plan can be identified for minimising the visual effect of the requisite sealing-end compounds. This has been considered by the landscape specialist and it is concluded that, having regard to the above, and the strategy of avoiding those parts of the landscape in

Environmental Topic	Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development
	the study area most sensitive to the landscape effects of OHL (as well as the generally robust character of the study area landscape), there is no particular location along the proposed route which has been identified as presenting a critical need for partial undergrounding within the technical parameters of this project.
Human Beings - Land Use	UGC would cause a greater level of disturbance to livestock, farming operations and has a higher potential to damage soil and land drainage during construction compared to OHL. During the operational phase both UGC and OHL may restrict development in the area immediately above the cable or under the towers, however, the permanently restricted area for both is low. Furthermore, while UGC will only be an obstacle to deep cultivation (e.g. land drainage and sub-soiling); the presence of towers has a higher potential to inconvenience other farming practices (all field operations). In summary both OHL and UGC are likely to have similar residual impacts however they are imperceptible. Therefore there are no impacts of such significance envisaged that would introduce the need for consideration of partial undergrounding for the proposed development from a land use and agronomy perspective.
Human Beings - EMF	A comparative assessment of OHL and UGC from an EMF emissions perspective for this proposed development can be found in the PB Power Report, 2009. The Report confirms that both the proposed 400 kV OHL and a comparable AC UGC (including partial UGC) would comply with the ICNIRP (1998) Guidelines and EC Recommendation (1999/591/EC). Partial undergrounding cannot therefore be considered as a way of mitigating EMF from the proposed overhead line as there is no difference between the two technologies from a compliance perspective. Partial undergrounding is not therefore proposed.
Human Beings – Tourism and Amenity	Partial UGC is an effective mitigation measure in order to reduce localised visual impact and resultant potential impacts on tourism assets, assuming that an appropriate location and screening plan can be identified for minimising the visual effect of the requisite sealing-end compounds. Partial UGC would result in higher temporary physical landscape effects at construction stage, but these effects can be mitigated with reinstatement of planting (excluding tree planting). However, having regard to the above, and the strategy of avoiding those parts of the landscape in the study area most sensitive to the landscape effects of OHL as well as the generally robust character of the study area landscape - no location along the proposed route has been identified where there is a critical need for partial undergrounding within the technical parameters of this project.
Flora & Fauna	Potential impacts on flora and fauna associated with OHL and partial UGC vary. UGC would eliminate the collision risk to Whooper swans and other such collision prone birds; however during the construction phase there is the potential for adverse impacts on sensitive habitats such as wetlands (including rivers and associated riparian habitats), woodlands, hedgerows and treelines. The construction of the cable would result in significant habitat disturbance arising from extensive ground excavations along the length of the cable section. In addition there would be some loss of habitat as a section of every hedgerow intersected by the cable route would be removed and grubbed out during construction and would not be reinstated in its original form. In addition the construction of the cable would result in greater potential for risk of disturbance to protected mammals and birds; for example permanent removal of breeding sites and greater risks of pollutant / soil water runoff to aquatic receptors. During the operational phase, habitat fragmentation could arise with reduced connectivity (e.g. gaps through hedgerows), due to the requirement for a non-wooded corridor along the cable length. In addition UGC would have a greater potential to impact aquatic habitats (rivers and streams – including the River Boyne and Blackwater cSAC / SPA in the case of the proposed development) during both construction and operational phases (i.e. maintenance). Trenchless

Environmental Topic	Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development
	directional drilling methods could be used to install the UGC under rivers and streams, however this introduces the risk of 'frac-out' (fracturing of the bore hole) with the accompanying risk of the escape of bore hole grout into the water which has the potential for severe, albeit short term, impact on water quality (aquatic receptors). UGC would present a greater risk to water quality (aquatic receptors), protected fauna and habitats. The only reason for considering partial UGC from an ecology standpoint regarding the proposed development is to remove the risk of Whooper Swans colliding with an OHL at relevant sections identified in the EIS. In terms of the importance (legal protection) of identified relevant ecological receptors; the most important ecological features are European Sites. These will be subject to greater risk of a significant adverse impact with UGC compared to OHL. This fact must be weighed up when considering UGC in the catchment of the River Boyne and Blackwater rivers. In conclusion, there are no impacts of such significance envisaged that would introduce the need for consideration of partial undergrounding for the proposed development from a flora and fauna perspective.
Soils, Geology and Hydrogeology	The potential impacts from UGC are greater than OHL and would require additional mitigation measures particularly in sensitive areas (i.e., the River Boyne / River Blackwater cSAC). Potential impacts may occur on wetlands and peatlands identified along the line route. Potential impacts include groundwater impact adjacent to wetlands in the CMSA and the Boyne and Blackwater cSAC. Additional soil excavation and disposal will be required in the event of undergrounding. The use of bridge crossings where feasible and directional drilling for the crossing of major water courses would be required. Additional impacts are also likely to occur on the wetlands (i.e., Cashel Bog, Tassan Grassland and Clarderry Bog) and geological heritage sites along the proposed development including the Altmush Stream and Galtrim Moraine CGS. Additional potential impacts may include settlement / disturbance of overlying areas. Additional mitigation measures would be required to deal with the extra groundwater encountered during excavation work and directional drilling. In conclusion, notwithstanding mitigation measures, UGC would present a greater potential risk to soils, water and hydrogeology than OHL. Accordingly, partial undergrounding of the proposed development is not required.
Water	The potential impacts from UGC are greater than OHL and would require additional mitigation and detailed design particularly at the River Boyne / River Blackwater cSAC. Potential impacts include the diversion of numerous land drains and small streams connected to salmonid streams. Potential impacts may also occur on wetlands and peatlands identified along the line route. The use of bridge crossings where feasible and directional drilling for the crossing of major water courses would be required. Diversion of water courses should be avoided where possible to minimise disruption to aquatic ecosystems. Additional mitigation measures would be required to deal with the additional construction periods and excavation areas involved. In conclusion, notwithstanding mitigation measures, UGC would present a greater potential risk to water than OHL. Accordingly, partial undergrounding of the proposed development is not required.
Noise	The construction of UGC would result in greater noise impact than OHL (arising from more extensive, longer lasting and more machinery intensive works; higher traffic volumes; and construction of additional transition stations). In the operational phase the UGC would reduce the effect of corona noise in the UGC sections. However, additional noise and vibration impacts would arise for both the construction and operational phases of UGC due to the introduction of transition

Environmental Topic	Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development
	stations. When the construction phase and operational phase noise and vibration impacts are viewed as a whole, it is considered that there is no significant noise and vibration benefit to be gained by introducing partial undergrounding as part of the proposed development. Noise and vibration impacts of the proposed OHL are predicted to meet all relevant guidelines limit values.
Air - Climate	Undergrounding the proposed line would involve a greater level of groundworks, increased traffic emissions and increased use of natural resources such as concrete and aggregate materials. This would increase the level of impacts associated with the construction phase.
Landscape	The primary mitigation measure in landscape terms is avoidance at route selection stage. The determination of the best route for an OHL resulted in the avoidance of those parts of the landscape in the study area which are most sensitive to the landscape and visual effects of an OHL; including where possible, higher ground and ridgelines, waterbodies, landscape designations and important scenic views. Best practice routing principles (refer to **Section 5.4.2.1)** also informed the line design process including measures to integrate the line within the landscape where possible. The *Preferred Project Solution Report* states that the use of short lengths of UGC will only be considered in the event that an appropriate and acceptable OHL solution could not be found. This is considered to occur if *Profound* impacts, as defined in the EPA Guidelines, were predicted. A profound impact is defined in the Guidelines as one which "*obliterates sensitive characteristics".* This would be the case if, for example, there are major landscape and visual impacts on highly sensitive landscape features of National or International value. The proposed OHL does not result in effects of this magnitude within the study area and therefore there is no critical need for partial UGC along the route. However, the scoping opinion from the Board has also requested that the *potential for partial undergrounding be assessed in sensitive landscape areas*. The approach to landscape and visual impact evaluation for this EIS accepts that it is not possible to eliminate all the landscape and visual effects of OHL and significant visual impacts will potentially occur over the course of the entire length of the line route. The most sensitive landscape areas along the line route have been identified in the EIS (refer to Chapter 11 of **Volume 3C** and **Volume 3D).** In terms of visual impact, it is acknowledged that removing towers from views would reduce the extent of visibility of the proposed development in short lengths of sensitive landscape locations such as the crossings of the Boyne and Blackwater. The precise locations where partial undergrounding may be appropriate have not been identified i.e, with the capacity to screen the UGC associated infrastructure such as sealing-end compounds and absorb the residual landscape effects of partial UCG. Areas where partial UGC might be considered are also the locations that would be most sensitive to the landscape and visual effects of the required sealing-end compounds and permanent haul roads. Partial UGC in these locations would result in new landscape and other environmental impacts. These have been described in detail in **Section 4.7.3.3** this volume of the EIS. For example from a landscape perspective, potential impacts at construction will arise from excavation, haul roads and vegetation removal; and UGC will also introduce additional new permanent features into the receiving environment such as haul roads, sealing-end compounds and manholes. While vegetation needs to be removed during construction stage, reinstatement / screen planting and appropriate siting can reduce the long term impact of, for example, sealing end compounds.

Environmental Topic	Consideration of Partial Undergrounding as a Mitigation Measure for the Proposed Development
Material Assets – General	In comparison to OHL, the construction of underground sections of the proposed development would result in increased volumes of excavated soil (and potentially rock) material which may not be suitable as backfill material and may need to be sent to waste facilities. Furthermore, during the construction phase for both UGC and OHL there is the potential to disrupt other underground and overhead services. During the operational phase, UGC would have no impact on aircraft operating at Trim Airfield or ballooning activities. OHL would also have no impact on these operations as they would be factored into flight planning considerations, along with all similar existing infrastructure in the area. Accordingly it is not considered that there is an overriding need for partial undergrounding along the proposed route.
Material Assets – Traffic	The construction of partially underground sections of the proposed development would have a somewhat different traffic impact to that of the construction of an OHL. The key difference would be the volumes of excavation required to lay the cable and the potential that some or all of that material would have to leave the site via the road network, thus increasing the volumes of traffic generated by the proposed development. The volumes of soil excavated when constructing the underground sections would be greater than those expected for the construction of a similar length of the overhead transmission line. The construction of UGC sections would therefore result in greater volumes of soil leaving the site and being disposed of as waste, thereby increasing the number of vehicles accessing the site compared to an equivalent section of the OHL. Dependent on the design and construction methods used for underground sections, the volumes of construction materials would also likely have implications for the volumes of traffic generated. In conclusion, the construction of underground sections of the proposed transmission line will increase the volumes of construction traffic using the public road network when compared to overhead line construction. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development.
Cultural Heritage	The methods of construction for OHL and UGC have very different impacts upon cultural heritage. OHLs have a very small physical footprint and avoidance of all direct impacts upon known archaeological and architectural sites is usually achievable however, their potential to impact upon the setting of cultural heritage sites is much greater. UGC and associated works are unlikely to impact upon the setting of cultural heritage sites but are more likely to impact physically upon known and previously unrecorded archaeological and architectural sites. In relation to the proposed development, from an archaeological, architectural and cultural heritage perspective, there is no overriding need for partial undergrounding.

128. In conclusion, EirGrid's environmental consultants have considered the potential for partial undergrounding (and its likely environmental impacts) as a potential mitigation measure in the context the environmental issues associated with the Monaghan, Cavan and Meath study area and the preferred line design. However, no particular area(s) have been identified where there is an overriding need for partial undergrounding in order to mitigate significant potential impacts.

129. Also during this process, EirGrid and its consultants gave due consideration to specific requests to partially underground on particular landholdings on the grounds of general amenity; however, having regard to the environmental, technical and cost

considerations set out in **Section 4.7.3** of this volume of the EIS, and the findings of specialists, as set out in **Table 5.4**, EirGrid and its consultants are of the view that, on the basis of the evidence presented to date, there are no areas along the proposed development that would warrant partial undergrounding.