The Grid Link Project

Summary of the Report for the Independent Expert Panel

EIRGRID

The current. The future.

Who are EirGrid - and what do we do?

EirGrid is responsible for a safe, secure and reliable supply of electricity: now and in the future.

We work to ensure there is enough electricity for industry to prosper and for employment to grow. We also keep the electricity transmission grid secure and reliable. We provide electricity to the distribution network. This network sends electricity to homes, businesses, schools, hospitals, factories and farms.

EirGrid is a state-owned company. This means we do our work for the benefit and safety of every citizen in Ireland.

Finally, we are committed to engaging with people as we develop our projects. This happens long before we finalise a plan or build new infrastructure.

Executive Summary

EirGrid launched the Grid Link project in 2012. The project was a response to identified electricity transmission needs in the south and South-East of Ireland. Our studies showed that a high-voltage, overhead transmission line would best meet these needs.

In March 2015, EirGrid published a draft strategy for the development of Ireland's electricity grid. This strategy highlights that there remains a strategic need for the Grid Link project.

However, it is now possible to consider other technical options to meet the need of the Grid Link project. This is due to a slower rate of growth affecting the demand for electricity, and developments in transmission technology.

The Grid Link project now has three technical options which can practically meet the need:

- HVDC Underground Cable Option
- HVAC 400 kV Overhead Line Option
- Regional Option

In January 2014, Minister Pat Rabbitte established an Independent Expert Panel. As the then Minister for Communications, Energy and Natural Resources, he asked this panel to review the Grid Link project.

Their terms of reference call for an assessment using technical, economic and environmental criteria.

We submitted our report on the Grid Link project to the Panel on 28 September 15.

When we submitted the report we indicated a preference to proceed with the Regional Option.

Our new Agricultural Liaison Officers

This is based on a number of factors. First, it minimises the need to develop new large scale infrastructure. Second, it uses a technology known as Series Compensation, that allows more power to flow through existing lines. This eases existing limitations while minimising impact on the environment. Finally, it achieves these results at a reasonable cost.

The following is a summary of the Grid Link report to the Independent Expert Panel.

It is our intention to develop the Regional Option further over the coming months. We will no longer progress the overhead or underground options.

We will now consider the next steps. In doing so, we look forward to engaging with communities, businesses and interest groups on this solution. This project remains a key element of our programme to provide a world-class electricity grid for Ireland: now and into the future.

Our Report on Grid Link to the Independent Expert Panel

The full report for the Independent Expert Panel is a detailed, technical publication. The aim of the document you are now reading is to present a synopsis of that full report. It outlines our analysis of the options using technical, environmental and economic criteria.

The main report contains a detailed overview of each option:

- HVDC Underground Cable
- 400 kV Overhead Line
- Regional Option

The main report to the Independent Expert Panel is set out as follows:

Section 1 – Executive Summary

Section 2 – An introduction that explains EirGrid's role, the Grid Link project and the role of the Independent Expert Panel

Section 3 – Scope of the Independent Expert Panel Report

Section 4 – An outline of the need for the Grid Link project

Section 5 – Details of the three options considered

Section 6 – Option 1 – HVDC underground cable option

Section 7 – Option 2 – 400kV HVAC overhead line option

Section 8 – Option 3 – Regional Option

Section 9 – Summary

Section 10 – Conclusion

Lastly, we outline the next steps that we propose to take.

Introduction

Our Statutory Role
It is our responsibility to ensure Ireland has the electricity transmission infrastructure it needs. We work to ensure there is enough electricity for industry to prosper, and for employment to grow. We also keep the electricity transmission grid secure and reliable. The grid carries high-voltage electricity from where it is generated, to where it is needed. Industrial or high-tech companies connect directly to the transmission grid. This is because they use large amounts of electricity. Homes and small businesses get their electricity from the lower-voltage distribution network.

Project Development to Date
EirGrid launched the Grid Link project in 2012. The project was a response to identified electricity transmission needs in the south and South-East of Ireland. Our studies showed that a high-voltage, overhead transmission line would best meet these needs.

In March 2015, EirGrid published a draft strategy for the development of Ireland's electricity grid. This strategy highlights that there remains a strategic need for the Grid Link project.

However, it is now possible to consider other technical options to meet the needs of the Grid Link project. This is due to a slower rate of growth affecting the demand for electricity, and developments in transmission technology.

The Grid Link project now has three technical options which can practically meet the need:

- HVDC Underground Cable Option
- HVAC 400 kV Overhead Line Option
- Regional Option

Scope of the Report

The Independent Expert Panel Report presents our investigation into these three options, based on the information available to date.

We do this looking at technical, environmental and economic criteria for each of the three options. Finally, we ensure that we present our analysis of the three options on an equal and comparable basis.

On balance, our preference is for the Regional Option.

The Need for the Grid Link Project

It is our role to ensure that a safe, secure, reliable and efficient transmission grid is in place. This is necessary so we can move electricity from where it is generated to high demand centres. When developing the grid, we work closely with the Department of Communications, Energy and Natural Resources. We do this to ensure we align our work with its energy strategy, and that our plans deliver for the entire country now, and in the years ahead.

The Grid Link project was originally developed in response to the following drivers:

- The integration of new generation
- Maintaining security of supply
- Meeting future need including possible interconnections with Great Britain or France

These remain as the key drivers for the Grid Link project. There are still projections of large regional electricity flows from the south of Ireland to the Dublin region. This is due to planned new energy generation in the region, and potential future interconnection.

These projected electricity flows will cause three problems that the Grid Link project needs to solve:

- **Voltage collapse**
  The loss of ability to maintain the transmission grid within acceptable voltages.
- **Large voltage phase angles**
  The phase angle is the difference in time between the peaks of the voltage and current waves, expressed in degrees. Large phase angles – if above a certain size – can cause one or more failures in the transmission system. The phase angle limit is currently set at a maximum of 40 degrees.
- **Thermal overloads**
  These occur when heat, created by large flows of power, causes the conductor to sag below its intended lowest level.

The Options We Considered

Doing nothing is not an option. However, it is now possible to consider other technical options to meet the need of the Grid Link project. This is due to a slower rate of growth affecting the demand for electricity, and developments in transmission technology.

We identified three options that meets the need for regional reinforcement of the grid in the South-East. These options are:

Option 1: Underground Cable

An underground cable that runs between transmission stations at Knockraha in Co Cork and Dunstown in Co Kildare.

Option 2: Overhead Line

A 400 kV overhead line that runs between transmission stations at Knockraha in Co Cork and Dunstown in Co Kildare.

Option 3: Regional Option

A package of transmission network reinforcements:

- Series Compensation installed in three existing 400 kV stations.
- A new 400 kV under water cable. This would link the existing Moneypoint and Kilpaddoge transmission substations
- Uprates to some existing lines and upgrades to some existing stations.

Grid Link: The Underground Cable Option

To achieve a fully underground option from Knockraha, Co. Cork to Dunstown, Co. Kildare, we would need to use high voltage direct current (HVDC) technology.

When investigating the underground options, we considered both onshore and offshore routes.

For this report, we focused on the onshore option, as it is much shorter than the offshore alternative.

The offshore route option length is 330 km in length, including 110 km onshore. By comparison, the onshore route option is 242 km long.

A longer offshore route would have higher costs and poorer technical performance. It would also offer less potential for development, as it is not near the existing transmission network.

Delivering the necessary capacity

The initial capacity required for the scheme is 750 MW. The best solution would be to use a VSC (Voltage Source Convertor) HVDC cable. This would operate at ±320 kV and would be rated to a capacity of 750 MW.

Estimated Present Value Cost

€643.4 million

Grid Link: The Overhead Line Option

The proposed technology for this option is a line carrying 400 kV high voltage alternating current, or HVAC.

This option would use a 400 kV overhead line. This would link existing transmission substations in Knockraha, Co Cork and Dunstown, Co Kildare.

The 400 kV HVAC overhead line would have a rated capacity of approximately 1580 MW, and would cover a distance of circa 220 km.

Potential for partial undergrounding

We also investigated an underground cable using high voltage alternating current (HVAC).

We concluded that less than 10 km of a 400 kV HVAC line could run underground in this context.

Estimated Present Value Cost

€215.4 million

Grid Link: The Regional Option

The Regional Option is a suite of transmission network reinforcements, based mainly on existing 400 kV lines.

Technology

The Regional Option is a combination of related elements.

First of these is a set of reinforcements to existing 400 kV circuits on the transmission network. This would see us install Series Compensation devices in three locations on the existing 400 kV system.

- Oldstreet 400 kV station
- Moneypoint 400 kV station
- Dunstown 400 kV station

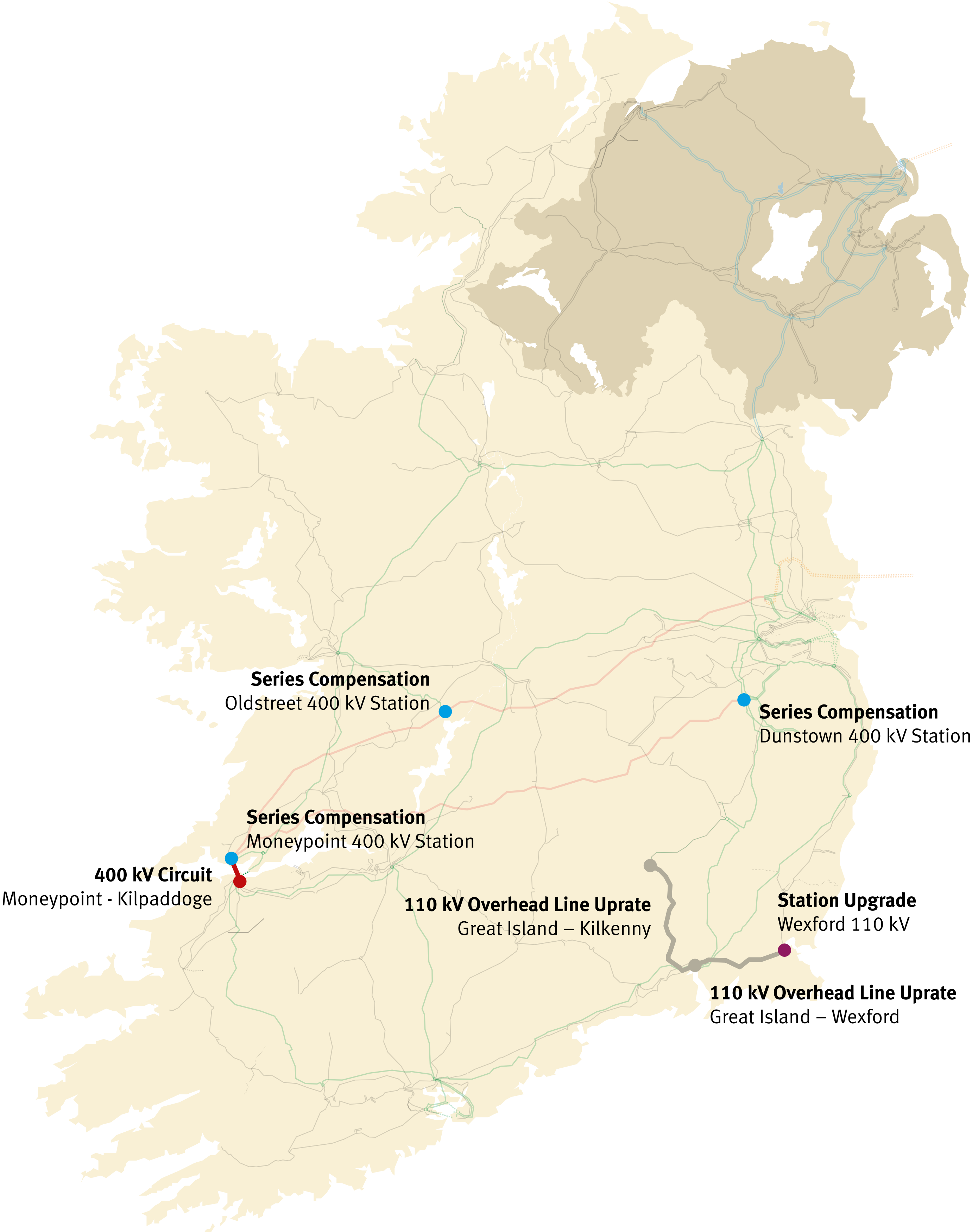
Series Compensation works by changing the characteristics of overhead lines to increase their capacity.

The second element of the Regional Option is an underwater 400 kV cable under the Shannon Estuary. This would run between Moneypoint and Kilpaddoge station.

Finally, the third part of the Regional Option would be to uprate some existing 110 kV lines. This would include the lines running from Great Island to Kilkenny, and from Great Island to Wexford. We would also need to uprate the Wexford 110 kV station busbar.

Estimated Present Value Cost

€ 156.8 million



Series Compensation
Oldstreet 400 kV Station
Series Compensation
Dunstown 400 kV Station
Series Compensation
Moneypoint 400 kV Station
400 kV Circuit
Moneypoint - Kilpaddoge
110 kV Overhead Line Uprate
Great Island – Kilkenny
Station Upgrade
Wexford 110 kV
110 kV Overhead Line Uprate
Great Island – Wexford

Grid Link: The Regional Option

Summary Environmental Analysis	Scale of Impact	Potential to reduce impact	Risk of lower, but lasting effects
Biodiversity, flora and fauna;			
Aquatic Ecology /Water (during construction)			
Soil, Geology, Hydrology and Hydro-geology			
Landscape and Visual			
Cultural Heritage			
Settlements and Communities			
Recreation and Tourism			
Air Quality (during construction)			
Climatic Factors			
Material Assets			
Traffic and noise (during construction)			
Noise (during operation)			

More Difficult, More Risk **Less Difficult, Less Risk**

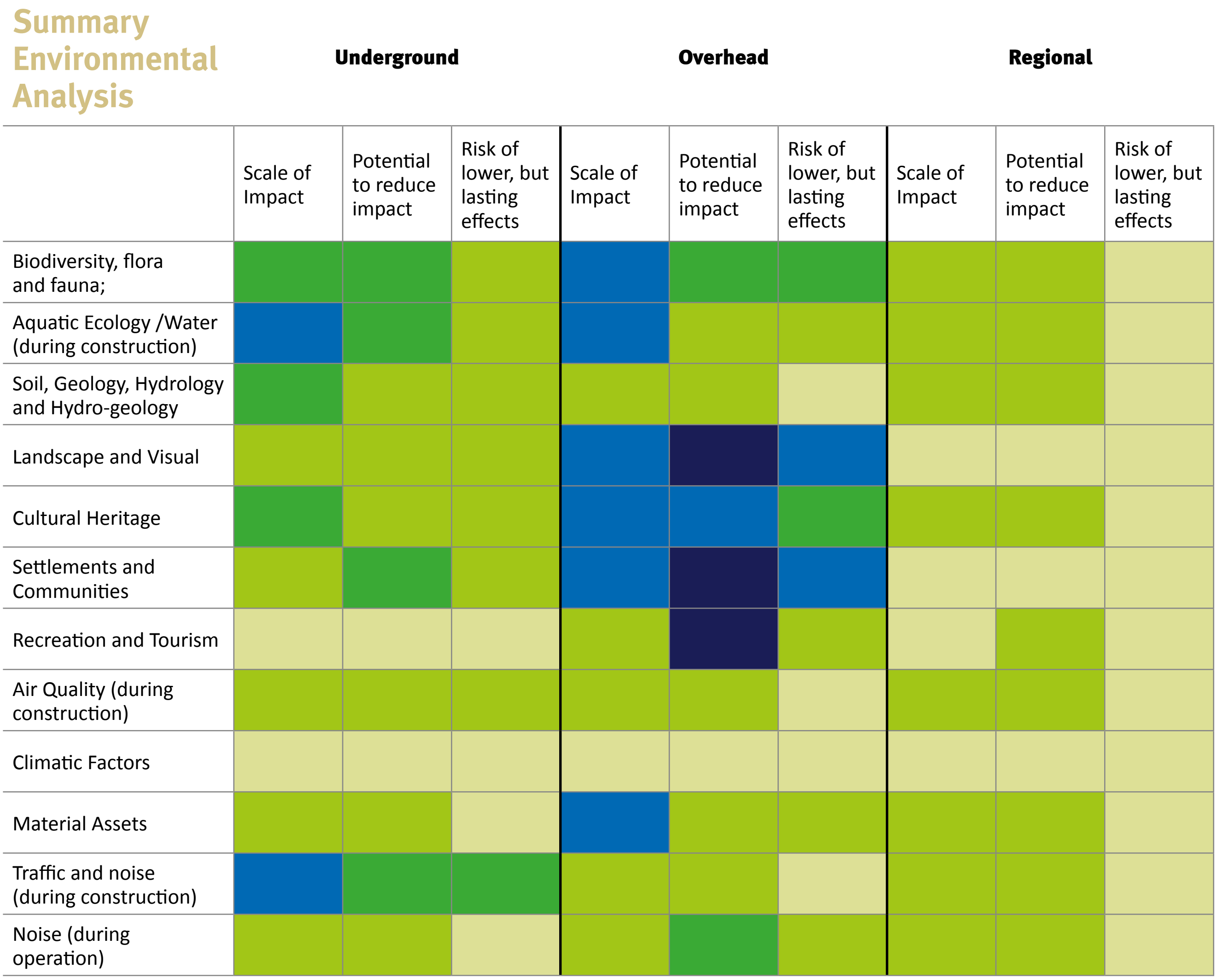
Summary Technical Analysis

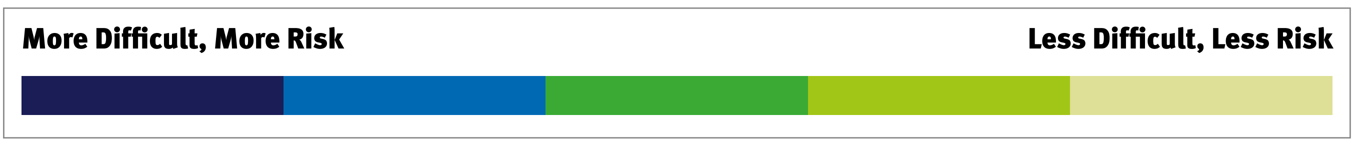
Does this option meet all relevant safety standards?	
Does this option meet system reliability and security standards?	
Does this option follow best practice for utilities?	
What are the average failure rates for this option during normal operation? (This includes average repair times and the availability of the main components required for repairs.)	
If the option breaks down, how will this impact on reliability of power supply?	
How long will it take to build this option?	
How will this option help with future reinforcement and / or connection to the transmission grid?	
What is the risk of untried technology for this option?	

More Difficult, More Risk **Less Difficult, Less Risk**

Grid Link: Comparing Three Options

We want you to understand all three Grid Link options. To help with this, these two pages show side-by-side comparisons. They cover environmental, technical and economic criteria.





Grid Link: Comparing Three Options

Summary Technical Analysis	Underground	Overhead	Regional
Does this option meet all relevant safety standards?			
Does this option meet system reliability and security standards?			
Does this option follow best practice for utilities?			
What are the average failure rates for this option during normal operation? (This includes average repair times and the availability of the main components required for repairs.)			
If the option breaks down, how will this impact on reliability of power supply?			
How long will it take to build this option?			
How will this option help with future reinforcement and / or connection to the transmission grid?			
What is the risk of untried technology for this option?			

More Difficult, More Risk **Less Difficult, Less Risk**

Grid Link: Comparing Three Options

Summary of Cost Assessment	Present Value (€ M)		
	Underground	**Overhead**	**Regional**
Capacity of option in MVA	750	1580	750*
Pre-Engineering Costs	15.8	28.7	14.0
Project Implementation Costs	556.7	238.5	138.6
Project Life Cycle Costs			
Cost of Losses	-59.00**	-70.**	-47.1**
Operating and Maintenance Costs	62.6	2.6	1.0
Decommissioning & Replacement	-0.5***	-0.7***	0.0
Cost of Reliability			
Cost of Unplanned Outages	0	0	0
Cost of Planned Outages	5.5	0	36.2
Contingency Cost Provisions			
Pre-Engineering Costs	0.3	1.0	0.1
Project Implementation Costs	55.7	23.6	13.9
Operations & Maintenance	6.3	0.3	0.1
Decommissioning & Replacement	0	0	0
Total	**643.4**	**215.4**	**156.8**
Cost per MVA of Capacity	**0.9**	**0.1**	**0.2**

* Additional power transfer level provide by option
** This figure represents a benefit rather than a loss
*** This figure represents the residual value of the option

Conclusion & Next Steps

Conclusion

We submitted our report on the Grid Link project to the government appointed Independent Expert Panel in September 2015.

This report and its analysis is a comprehensive review of the Grid Link project. We considered technical, environmental and economic criteria for underground and overhead technology options. We also applied the same process to the Regional Option.

Our analysis points to the Regional Option as the preferred solution for the Grid Link project.

Next steps

It is our preference is to proceed with developing the Regional Option.

It is our intention to develop this option over the coming months. We will no longer progress the overhead or underground options.

We will now consider the next steps on this project. We look forward to engaging with communities, businesses and interest groups on this solution.

EirGrid is committed to open and transparent consultation, in line with our new approach to engagement.

Glossary

AC
AC is a type of electrical current, in which the direction of the flow of electrons switches back and forth at regular intervals or cycles. An Bord Pleanála Ireland's independent national planning authority.

Assets
All substations and electricity transmission lines that form the transmission network. ESB owns the transmission network, and EirGrid operates it.

Capacity
The amount of electricity that can be safely transferred on the system or a circuit.

CER ('the regulator')
The Commission for Energy Regulation. The CER is Ireland's independent energy regulator with a range of economic, customer and safety functions.

Circuit
The overhead line or underground cable linking two substations. For example, the Moneypoint – Dunstown 400kV circuit.

DC
Direct current (DC) is electrical current which flows consistently in one direction.

Demand
The amount of electrical power that consumers take from the network. This is often expressed as 'peak demand', which is the largest amount of power used in a given period.

Distribution Network
Our high-voltage transmission network supplies power to the distribution network. This lower voltage network delivers power to households and businesses. In Ireland, the ESB owns and ESB Networks Ltd operates the distribution network.

Generator
A facility that produces electricity. Generators use a variety of sources to generate power. This can include coal-fired power plants, gas fired power plants and wind farms.

Kilovolt (kV)
Operating voltage of electricity transmission equipment. One kilovolt is equal to one thousand volts. The highest voltage on the Irish transmission system is 400kV.

Large voltage phase angles
The phase angle is the difference in time between the peaks of the voltage and current waves, expressed in degrees. Large phase angles – if above a certain size – can cause one or more failures in the transmission system. The phase angle limit is currently set at a maximum of 40 degrees.

Megavolt-ampere
(MVA) is the unit used for power in an electrical line or cable. In direct current (DC) circuits, this product is equal to the real power in watts.

Megawatt (MW)
A unit of measurement for the amount of power produced by a generator or transported on the transmission grid. The rating of high voltage direct current (HVDC) circuits is generally quoted in MW. For ease of comparison, we use a unity power factor and displayed the rating in MVA. This allows for a better comparison with the high voltage alternating current (HVAC) options.

Present Value
All life-cycle costs including construction, maintenance and electrical losses etc. over the assumed 50 year life of the asset are shown as a single equivalent value today.

Reinforcement
Increasing the capacity of the existing electricity transmission network. We do this by building new lines or cables, or by uprating existing ones.

Renewable generation
The generation of electricity using renewable energy, such as wind, solar, tidal and biomass.

Substation
A set of electrical equipment used to step high-voltage electricity down to a lower voltage. We use substations to create lower voltages to safely deliver power to small businesses and homes.

Thermal overloads
These occur when heat, created by large flows of power, causes the conductor to sag below its intended lowest level.

Transmission line
A high-voltage power line running at 400kV, 220kV or 110kV on the Irish transmission system. The high-voltage allows delivery of bulk power over long distances with minimal power loss.

Transmission Network or Grid
This is a network of around 6,500 km high-voltage power lines, cables and substations. It links generators of electricity to the distribution network. EirGrid operates Ireland's transmission network.

Voltage
Voltage is a measure of 'electric potential'. It is like 'pressure' in a water system.

Voltage collapse
The loss of ability to maintain the transmission grid within acceptable voltages.

Grid Link Project Contact Details

If you have any questions on this document, or on the Grid Link project in general, please contact us using the details below.

You can also visit our project offices. Phone us on **1890 422 122** for opening hours and locations near you.

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