Your Grid, Your Views, Your Tomorrow.

A Discussion Paper on Ireland's Grid Development Strategy

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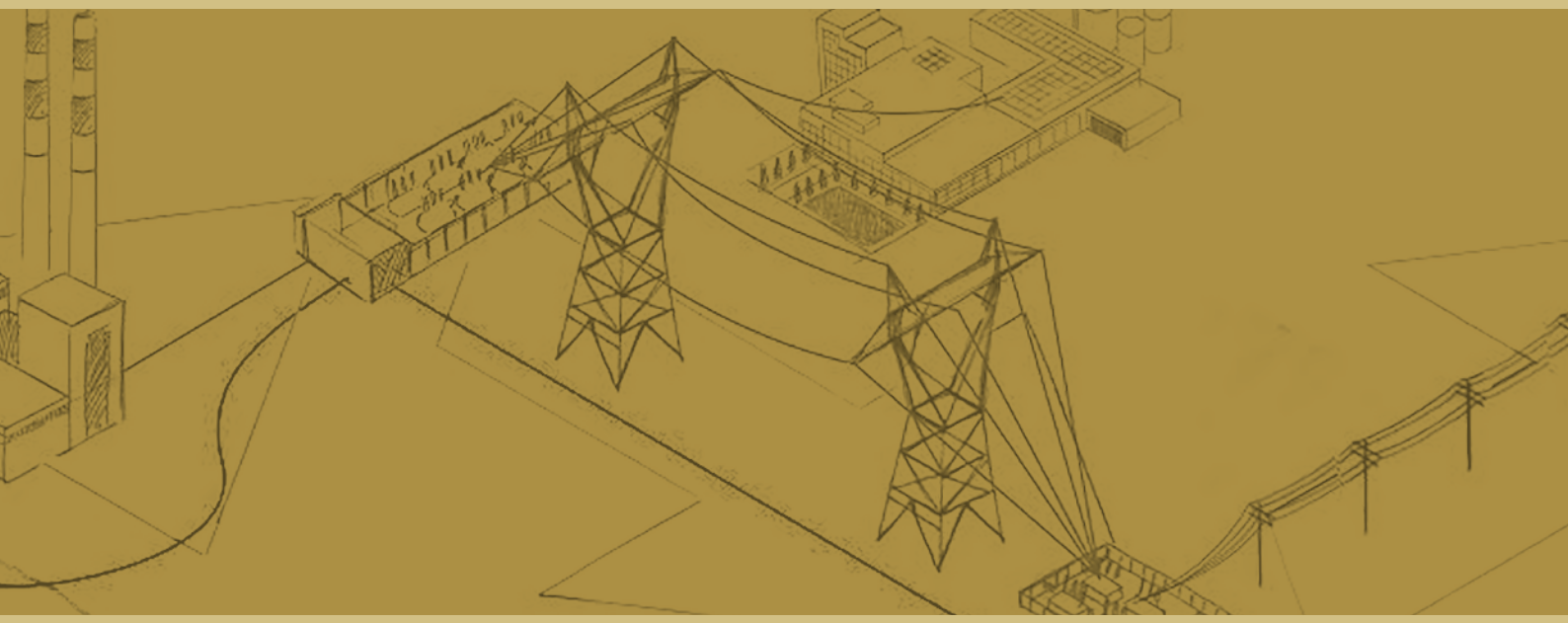


Electricity: Powering Ireland

Electricity is essential to our economy and way of life. It powers everything from our household appliances to complex, multi-million euro industries. It is one of the core infrastructures that keeps our society functioning and our economy operating.

The electricity industry directly employs thousands of Irish people. At its core is the high-voltage transmission grid, a state-owned asset that is operated by EirGrid.

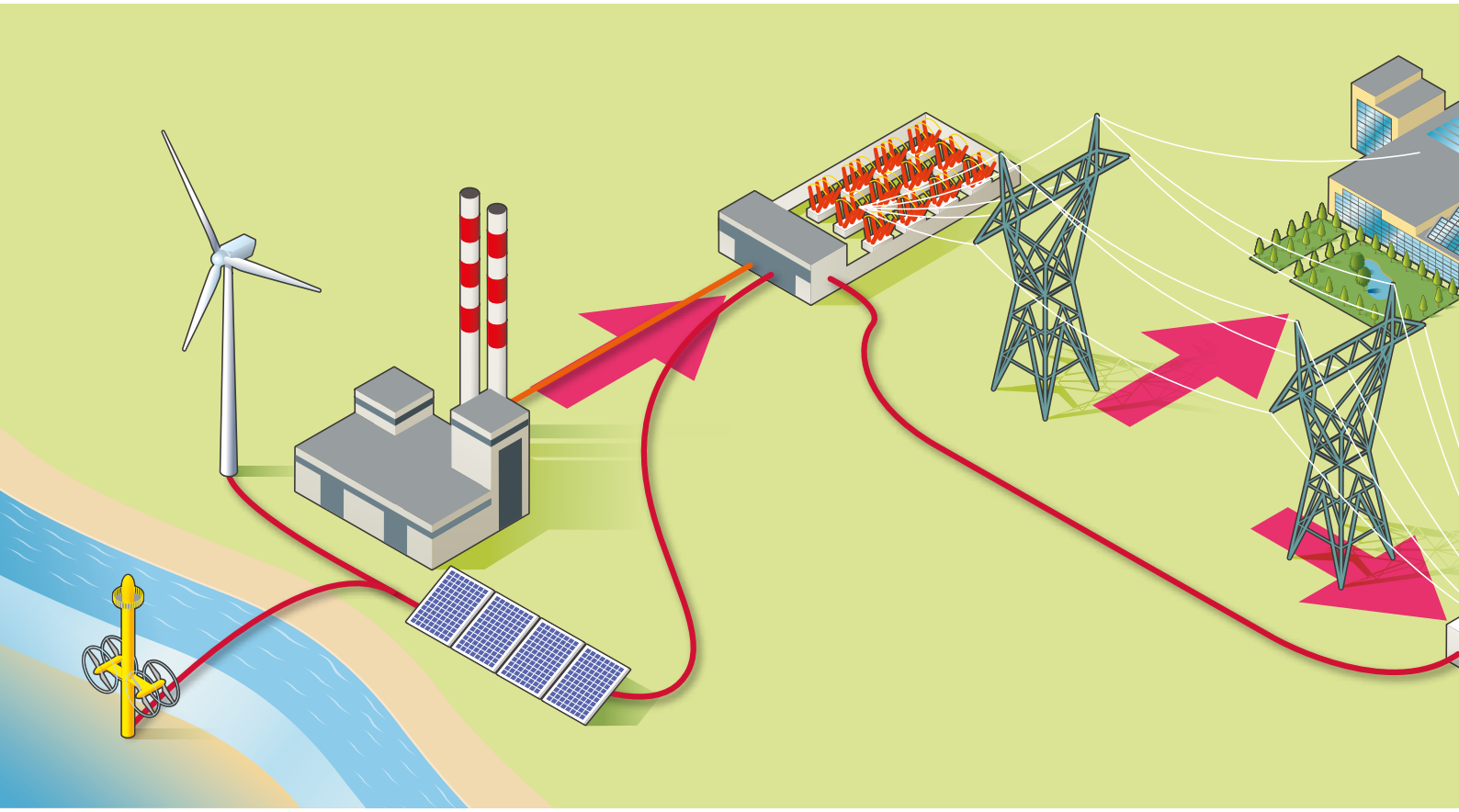
Our primary responsibility is the consistent and reliable transmission of electricity. EirGrid is the independent guardian of the grid: We are charged with operating a world-class system that homes and businesses can rely on.

We also make sure the system is planned and developed to meet Ireland's future needs. The European energy market is evolving, with the ultimate aim of establishing a single market for electricity. At EirGrid, we are transforming our operations to best meet this changing environment. In tandem, we are also developing the physical infrastructure of the grid. We want to make sure your views on your electricity transmission grid are at the core of our thinking.

This document aims to explain the need for and drivers of grid development. These factors are the context for a broader discussion about how we should respond to these needs.

We want to know what you think - this is your grid.

EirGrid's core responsibility is the consistent and reliable transmission of electricity.



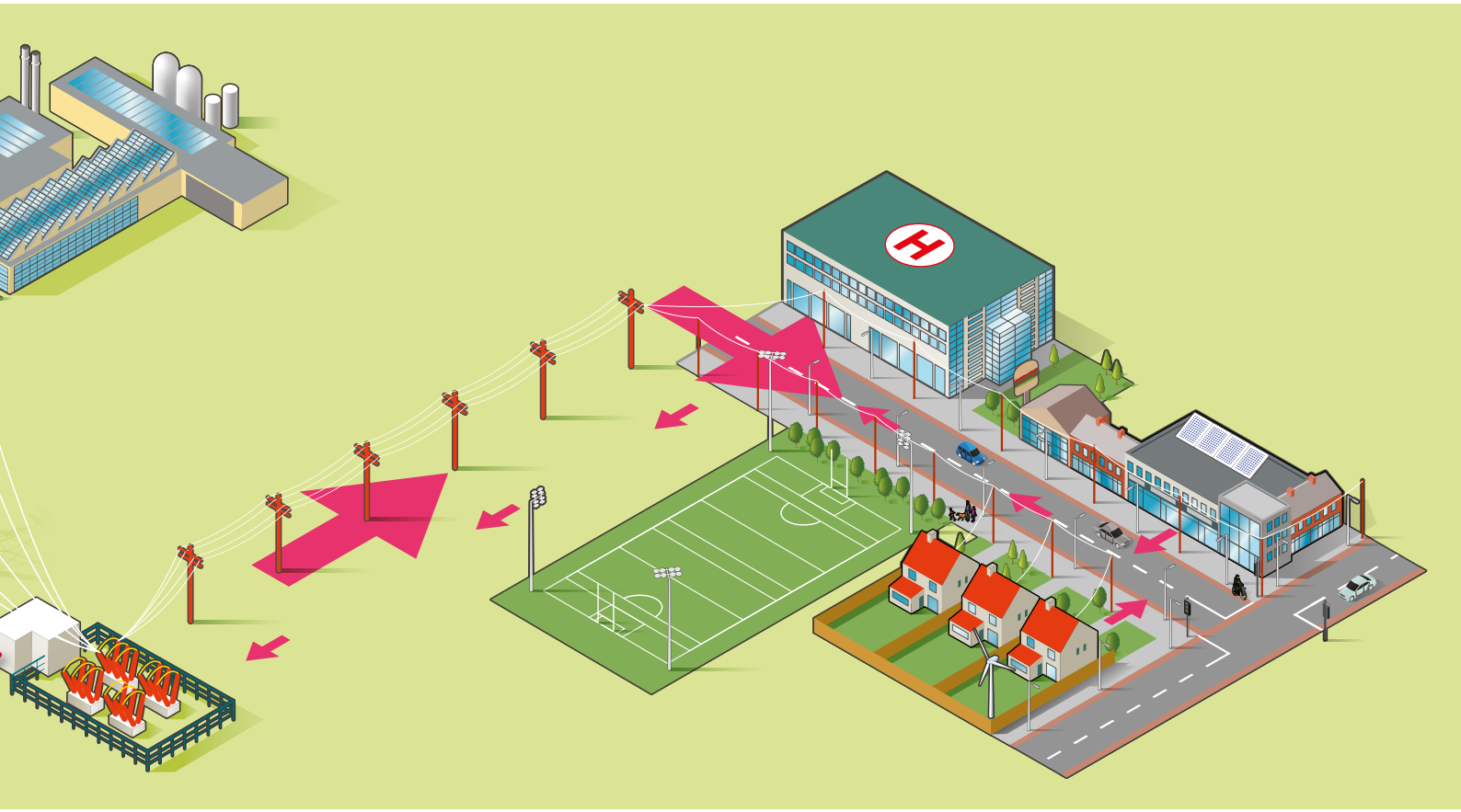
It is our responsibility to manage the need for power across the electricity transmission grid. We forecast when and where electricity is needed; hour-to-hour, day-to-day, and year-to-year.

We work closely with government to make sure there is sufficient electricity for industry to prosper and employment to grow.

We also keep the grid secure and reliable. Homes and small businesses connect to the lower-power distribution network; large industry and enterprise needs high-power, high-quality electricity that is supplied via the transmission grid.

We review our grid development plans regularly. Our last major review reflected the economic and energy demand forecasts of the time, and the objectives of local, national and European policy.

Generators supply the energy into key transmission stations around the country. We move this energy around the country via the transmission grid. The lower voltage distribution network, operated by ESB Networks, then supplies electricity to homes and businesses.



It is time once again to review the grid development strategy outlined in Grid25, our long-term approach to develop the transmission grid published in 2008. This review reflects the changes that have occurred in the intervening period. Our draft strategy reflects a changed economic context and, importantly, opportunities offered by advanced transmission technologies.

With this, our aim is to start a dialogue about the need for grid development, and to seek opinions and suggestions from anyone impacted by our plans.

Throughout this paper, certain topics are highlighted for your specific consideration. Your responses are valuable in helping develop the final strategy.

We will reflect the themes and issues you raise in our final strategy, which will be published later this year.

Ireland's Draft Grid Development Strategy

Executive Summary

EirGrid is a state-owned company, responsible for managing and operating Ireland's transmission grid. We work to ensure a safe, secure supply of electricity to homes, businesses and industry across the island of Ireland. We need to develop the transmission grid to guarantee a secure supply of electricity now and for future generations, and to facilitate local, national and European policies.

In 2008 we published Grid25, our long-term strategy to develop the grid. The strategy outlined the investment required to develop the transmission network in order to future-proof Ireland's electricity needs. We are now reappraising the need and the drivers for these investments.

This draft strategy responds to feedback received from the public, as a key part of our renewed efforts to encourage greater participation in our decision-making process. It also reflects an updated view of the economic context, and incorporates our growing experience of promising new transmission technologies.

The final strategy, to be published later this year, will support Ireland's wider policy objectives; economic, environmental and social – including the Government's Action Plan for Jobs and the IDA's Regional Development Strategy.

In addition, it will take into account the views of communities and representative groups, whilst also ensuring sufficient capacity is available for regional economic development.

In managing the overall cost, we will do our part to ensure that Ireland remains competitive – fostering economic growth, attracting new investments, and supporting indigenous jobs.

As we considered the options for our new strategy we faced a key question: How do we balance all these considerations? We have to ensure that our plans meet Ireland's electricity needs, without placing too great a burden on communities, or too high a cost on industry. How much investment is needed to adequately future-proof the grid? Too little investment now may have negative economic impacts in the future.

We want to deliver best value for the Irish people. We will build new infrastructure only when this is the right solution. We will select appropriate technology to get more from existing grid infrastructure, depending on the needs and circumstances in each case.

In summary: We will do more with the existing grid and make it work harder – before we build new transmission infrastructure.

Executive Summary

In 2015, we are nearly half of the way through the time period originally covered by the Grid25 Strategy. Since 2008, EirGrid has completed the construction of over 330 km of new circuits. We have also uprated over 1,200 km of circuits – adding capacity without building new infrastructure.

We previously reviewed this strategy in 2011. At that stage, the cost of Grid25 was reduced from €4bn to €3.2bn. This was possible because of revised future demand forecasts and through to the use of new technologies.

The need remains to reinforce the transmission grid. How this reinforcement is technically achieved may change in certain circumstances.

On the North South project[1], a new 400kV AC overhead line is still the most effective and appropriate solution.

However, for Grid West and Grid Link projects, alternatives to building 400kV overhead lines are being carefully considered. These are described in more detail in Chapter 5.

Grid25 delivered significant direct economic benefits[2], and the proposed revision to our grid development strategy will continue this trend.

Electricity transmission infrastructure has two additional long-term benefits for the overall economy:

- the availability of power capacity to support new investment and jobs;
- ensuring competitiveness by having cost-effective power capacity.

We confirm that our revised strategy will provide enough transmission capacity in all regions to meet demand forecasts.

We also highlight the connections and interdependencies that exist between national and European policies, and the balance that must be achieved between social, environmental and economic factors. These are the key drivers of our grid development strategy.

For example, the IDA has in recent years been extraordinarily successful in attracting high-tech foreign direct investment to Ireland.

One impact of these high-demand customers is potentially a need for additional capacity in Dublin, where a significant portion have chosen to locate.

An independent economic analysis carried out by Indecon has considered a number of scenarios and the impact these will have on the grid.

This publication sets out our view on the major investment projects necessary to meet Ireland's needs. This draft strategy relates only to Ireland, but is cognisant of the all-island energy market, and of the urgent need to secure electricity supply in Northern Ireland.

We want to start a discussion about the options open to us all. Some grid development is essential, as this document shows, but in certain cases it may be appropriate to reconsider how we deliver this.

1 The North-South 400kV Interconnection Development
2 Indecon Report, 2013

For particular projects, we consider in more detail the decisions that must be made to support energy policy objectives. These decisions will impact on local communities, and on the national economy, so they need careful consideration.

We are eager to hear your views on our draft strategy – and we have identified a number of specific questions throughout this document where we are particularly looking for your feedback. We have set up an online feedback service for this purpose at eirgrid.com/yourgridyourviews

We are publishing some supporting material to this document which provides more detailed information. These are found attached as appendices.

We will closely engage with the Department of Communications, Energy and Natural Resources and the Commission for Energy Regulation to ensure that our final strategy is consistent with their forthcoming Energy White Paper, and with wider government, regulatory, economic, and energy policies.

When responding to this draft strategy, we ask you to be aware of the trade-offs between technical, economic and social considerations. We want to work together to find an acceptable and effective outcome for Ireland. We encourage the participation of all stakeholders. This is your opportunity to influence our thinking as we develop our strategy for grid development across Ireland.

How this draft strategy document works

There are five main sections in this draft strategy.

Chapter 1 explains the need to develop the grid.

Chapter 2 outlines the work we've done to meet this need since 2008.

Chapter 3 sets out the broader context - looking at how the economy, the environment, government policy and other external factors affect what we do, and how we have responded.

Chapter 4 details the technical developments that have the potential to affect our future strategy.

Chapter 5 talks about the implications for our current projects.

Chapter 6 puts forward a summary and some overall conclusions. We've also provided a glossary at the back to help with some of the technical terms

Throughout this document, we ask for your views on particular topics. Please use our website to tell us what you think.

1 The Need to Develop the Electricity Grid

Patterns of power-flow across the transmission grid can change over time, such as when there is significant growth in demand, or following requests to connect to the grid from new electricity generators. Like other major infrastructure - road, water or telecommunications - electricity transmission assets have a finite lifespan and need to be upgraded and refurbished.

A secure supply of electricity is the lifeblood of any economy. Our transmission system must remain stable and secure under a broad range of possible circumstances.

These include:

- Changes to expected demand for electricity
- The closure of generators
- Changes to generation sources and their effect on operations

Demand for Electricity

There is a relationship between economic growth and electricity consumption. Due to more efficient energy use, this relationship is changing – meaning proportionately less energy is required as the economy grows. EirGrid's demand forecasts are based on the Economic and Social Research Institute's (ESRI) long-term forecast of moderate growth in economic activity. These forecasts are updated annually in the *All Island Generation Capacity Statement*[3].

Around the world, 2008 saw the most severe recession in decades. This resulted in significant variation between demand forecasts from 2008 to those from 2015. The graph in Figure 1-1 on page 10 illustrates the 2008 and 2015 peak demand forecasts up to 2025.

The 2015 peak demand forecast for 2025 has been scaled back considerably. It is now approximately 5,100 MW, compared to the 2008 peak demand forecast of approximately 8,000 MW.

In 2011 our population was 4.57 million, up 17% from 2002. The CSO projects that this will grow – up to an average of 1% a year from 2011 to 2026. This is an increase of 734,000 people in this period. This is a key consideration when planning the development of the transmission system.

3 www.eirgrid.com

1 The Need to Develop the Electricity Grid

Regional Demand Growth

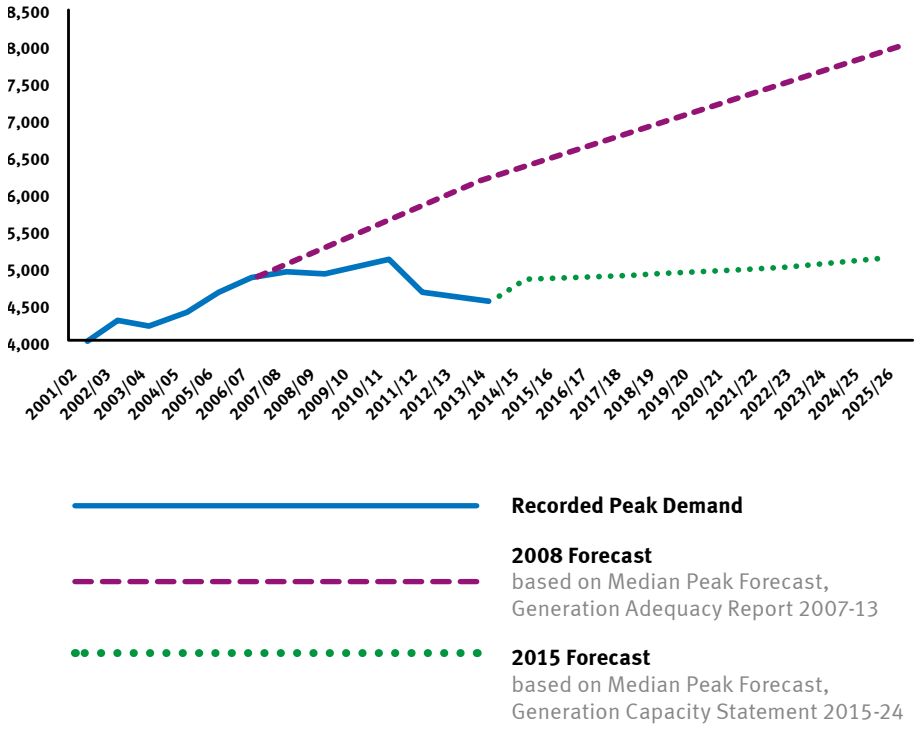
Our economy is returning to growth. This means renewal and expansion of the electricity transmission system becomes even more critical. This work will support job creation, economic development and economic competitiveness. Developing a 21st century transmission system will deliver real social, economic and environmental benefits for every person in Ireland.

By investing in a secure transmission grid we can create a balanced playing-field across the regions, and open the entire country to investment opportunities. Currently the majority of foreign direct investments are clustered around our larger cities. That's why developing the transmission grid is an important element in supporting the Government's drive to create jobs in the regions of Ireland.

A number of data centre operators have expressed interest in connecting large-scale facilities in the Dublin area.

Figure 1.1

Ireland Transmission Peak Demand (MW)



These proposals would see substantial power loads connecting in this region by 2020 – this would represent a significant increase on current and forecast demand. Depending on the number and scale of projects that materialise, this may require new transmission solutions. EirGrid is working to ensure that all reasonable requests for demand can be facilitated.

Changing Generation Patterns

Ireland is on course to meet the Government's renewable energy target of 40% of electricity demand from renewable energy by 2020. A large proportion of this renewable electricity will come from wind power.

In Ireland, the Commission for Energy Regulation has directed that all generator applications for grid connections are processed using the Group Processing Approach - or 'Gate' Process. To date, there have been three 'Gates'. In Gate 1 and 2 (2004/5 and 2006/7 respectively) a total of approximately 1,700 MW of connection offers were made and accepted. In Gate 3, approximately 4,000 MW of renewable generation capacity received connection offers.

The uptake of Gate 3 offers is particularly high. As of January 2015 82% of offers had been accepted, 7% were under consideration and only 11% have been declined by applicants.

This high rate of acceptance of connection offers is in line with our original Grid25 assumptions. These additional connections indicate generation growth in areas that are distant from the urban centres where we typically have greater demand.

As peak demand and energy forecasts have been scaled back since 2008, there will be between 3,200 and 3,800 MW of renewable energy sources required to deliver the 40% target.

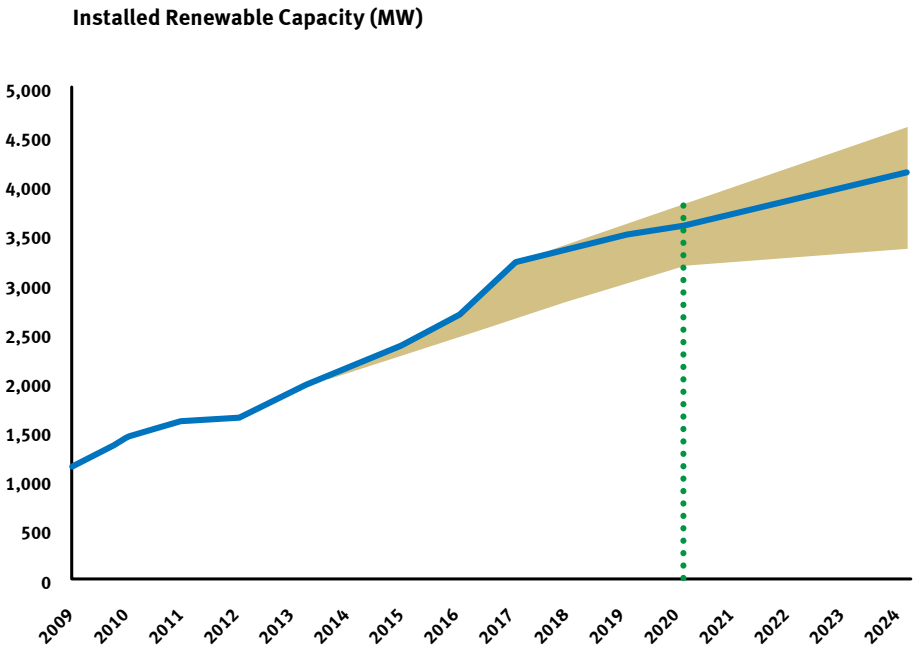


Figure 1-2
Band of Possible Renewable Requirements to meet the 2020 Renewable Target

This graph shows how much additional capacity from renewable sources will be required to meet EU targets by 2020. Whilst Ireland is on target to meet this goal, doing so will add almost 4000MW of generative capacity, which is simply not possible on the current grid. We must add additional transmission capacity to meet this need.

This draft strategy suggests how EirGrid can meet contractual obligations to offer connections to new generators – without overbuilding the grid. Crucially, we need to achieve this balance whilst also meeting national energy policy objectives and increasing Irish competitiveness.

Conventional Generation

Grid25 considered how a range of conventional generation scenarios would affect electricity transmission. These included connecting new generation capacity and the closure of existing plants. Developments including new generation capacity in east Cork and in the south east, were predicted and planned for.

Peak demand and energy forecasts have been scaled back – so the additional required capacity from conventional thermal generators is reduced. Grid25 assumed that capacity would be constructed at brownfield sites closer to traditional load centres along the east coast.

Based on analysis carried out for this draft strategy, we now consider that this construction is unlikely to happen in the timeframe originally envisaged. Instead, new generation is now expected to be located in the west, southwest and southeast. The location of these new generators will only serve to increase the main power flows from these remote locations.

Historically, Ireland benefited from electricity imports from Northern Ireland in order to balance supply and demand and maintain security of supply. In recent times the generation portfolio has changed, with the commissioning of new and more efficient plant in Ireland. This will change further as a result of anticipated plant retirements in Northern Ireland. It is therefore likely that Northern Ireland will need more generation imports from Ireland at times of high demand in the next decade, in order to balance supply and demand and maintain security of supply. For more details and analysis, please see the All Island Generation Capacity Statement.

1 The Need to Develop the Electricity Grid

East West Interconnector

High-voltage direct current cable
Runs undersea & underground
Links grids in Ireland & Great Britain

Completed **2012**

264km Long

187km undersea

500 Mw Capacity

Powers **300,000** homes

Interconnection

In addition to investing in the electricity grid within Ireland, the transition to a competitive, low-carbon, energy system requires us to explore opportunities for increased interconnection to other countries.

The current level of interconnection capacity linking Ireland to other markets is in line with the current EU objective of 10%.

The European Commission is now considering 2030 targets, one of which is a possible increase in interconnection targets to 15%.

In 2007, EirGrid commenced work on an interconnector between Ireland and the UK. This project was delivered on time and in budget, and has been operational since 2012.

EirGrid is now working in co-operation with our French counterparts - Réseau de Transport d'Électricité (RTE) - to explore the possibility of an Ireland-France interconnector.

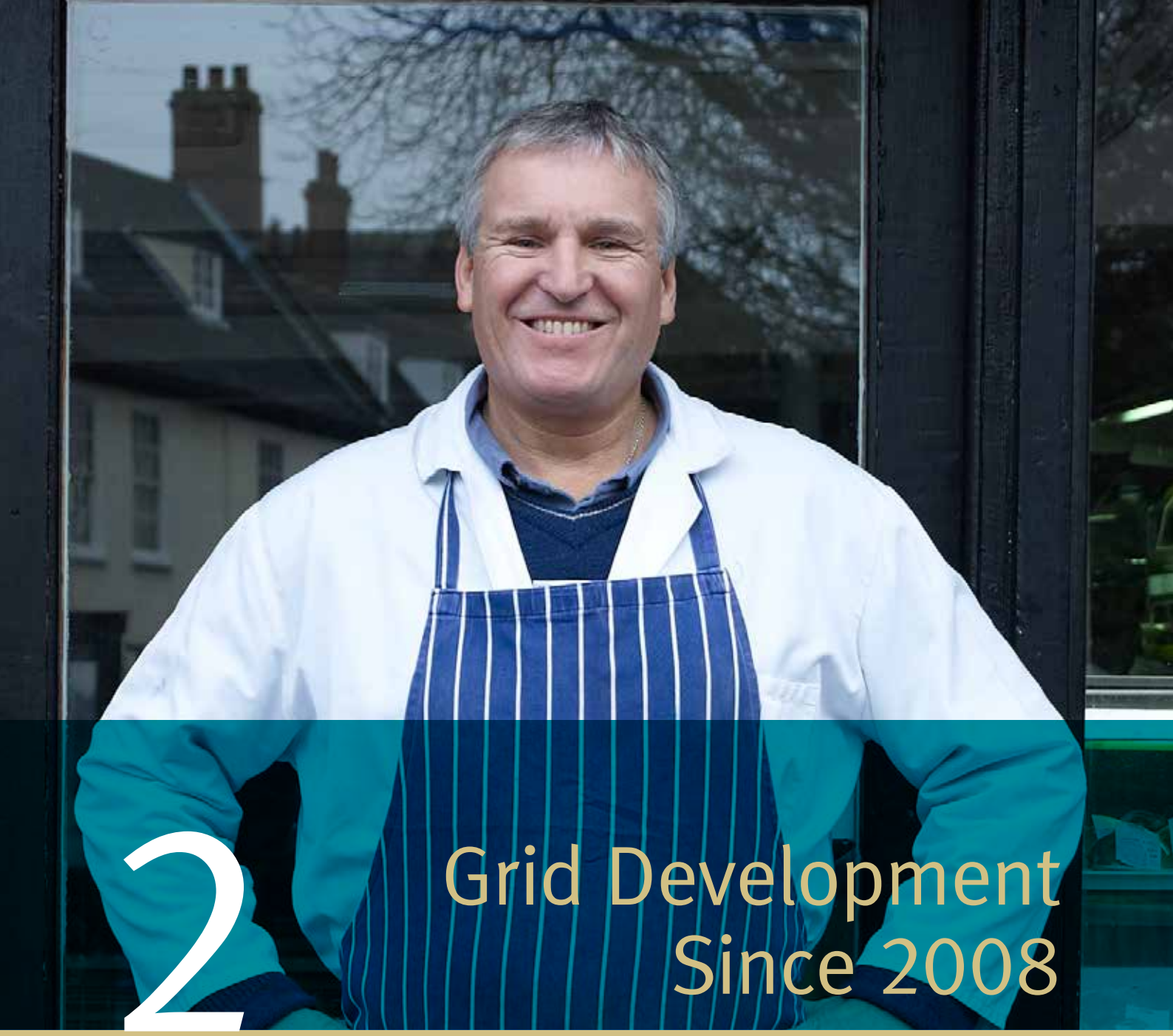
Who pays for these improvements to the grid?

EirGrid is state-owned, public limited company. We are funded by the "Transmission Use of System" charge, which is levied to users of the transmission network. These charges are approved by the Commission for Energy Regulation. For the most part, this funding system is designed to ensure that heavier users pay more for the grid.

Development Needs

1. What are your views on our proposals to develop the electricity grid to support Government plans for new investment and jobs?
2. What are your views on our other reasons for continuing to develop the electricity grid?

Tell us your views
eirgrid.com/yourgridyourviews



2 Grid Development Since 2008

Our Grid25 strategy was published in 2008. Electricity demand had grown by an average of 4% per year over the previous decade and forecasts up to that point had predicted this trend would continue. A driver of our 2008 strategy was to promote efficient and cost-effective development and, importantly, to avoid multiple projects in an area if a single solution was viable. These factors combined to favour overhead solutions as opposed to underground alternatives.

Grid25 identified the need for several projects of varying scope. We planned to upgrade existing lines to allow for increased capacity transfer; we planned to build new lines and stations; and we planned significant new regional connections, such as the Grid West and Grid Link projects. Progress on these projects is shown in the tables on the following page.

Given the scale of the Grid25 Strategy, EirGrid prepared and implemented policies concerning planning and environmental issues, including landowner engagement, wayleaving and project communications - to ensure a consistent approach for all Grid25 projects.

In comparison to previous electricity transmission investment strategies, the scale of Grid25 was much greater. Delivering this strategy presented challenges.

Since then, EirGrid has gained considerable experience in areas such as project delivery, risk management, project lead-times, landowner engagement and access agreements. We also learned greatly from our engagements with the public and with communities.

Project Delivery

For the minor projects - such as line uprates - the estimated lead-times have been broadly accurate. This is also the case for new substation builds. However, for new and large-scale linear projects, our original estimates for lead-times have proven to be overly optimistic.

A number of factors contributed to this - including time required to select a route and time for public consultation and evaluation.

EirGrid and ESB Networks are now jointly reassessing project lead-times based on our joint experience of grid delivery since 2008. We have created a joint programme management office to improve the efficiency of our project delivery process.

Over the last seven years a considerable number of grid development projects have been delivered. A summary of the transmission projects that were delivered is described in Tables 2-1 and 2-2 on the following page.

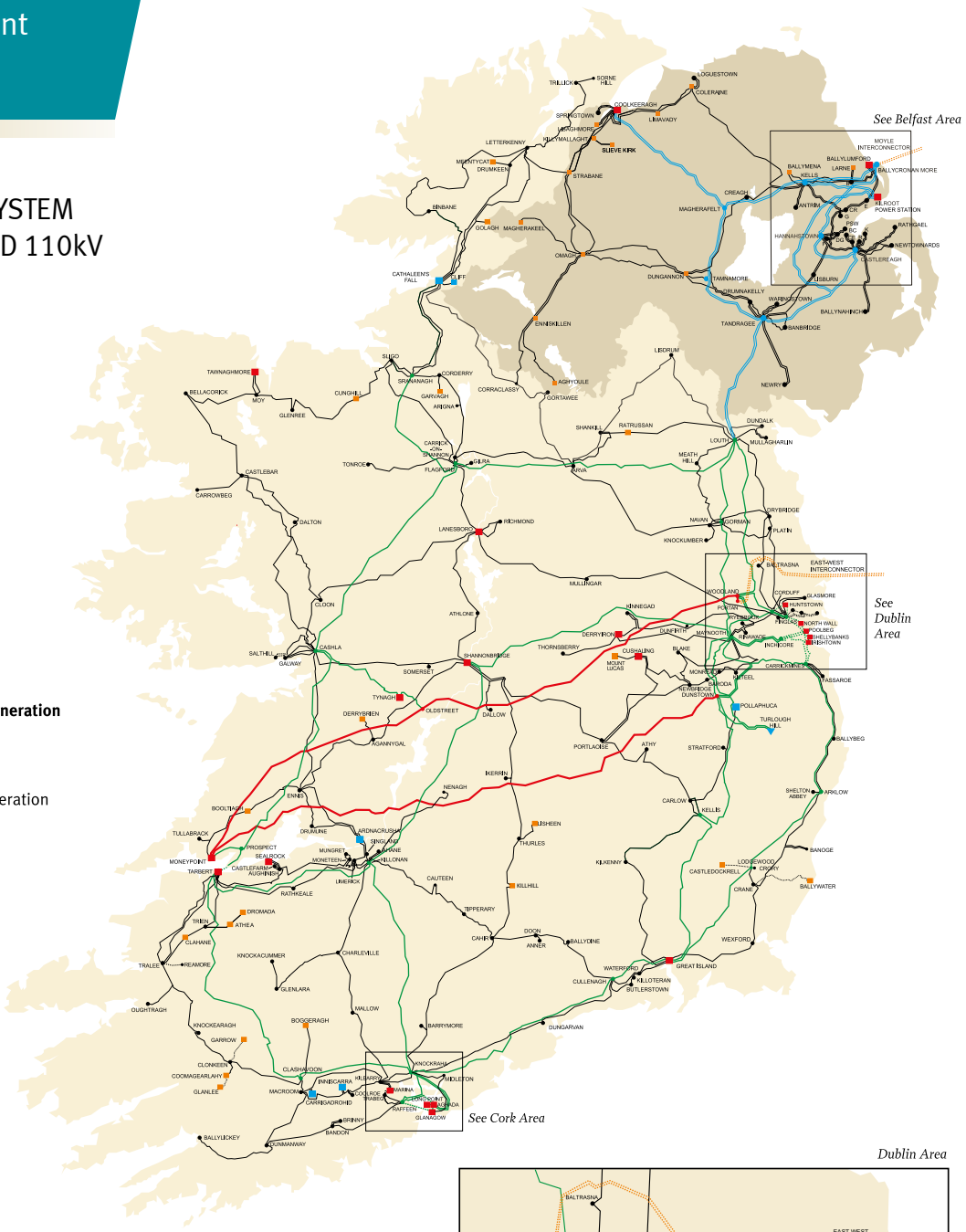
2 Grid Development since 2008

TRANSMISSION SYSTEM 400, 275, 220 AND 110kV JANUARY 2015

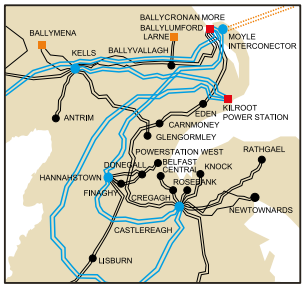
- 400kV Lines
- 275kV Lines
- 220kV Lines
- 110kV Lines
- 220kV Cables
- 110kV Cables
- HVDC Cables
- 400kV Stations
- 275kV Stations
- 220kV Stations
- 110kV Stations

Transmission Connected Generation

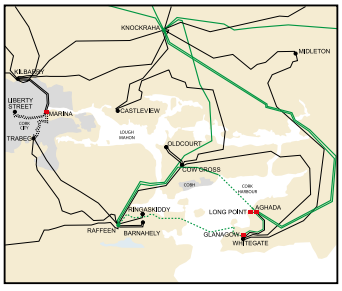
- Hydro Generation
- Thermal Generation
- Pumped Storage Generation
- Wind Generation



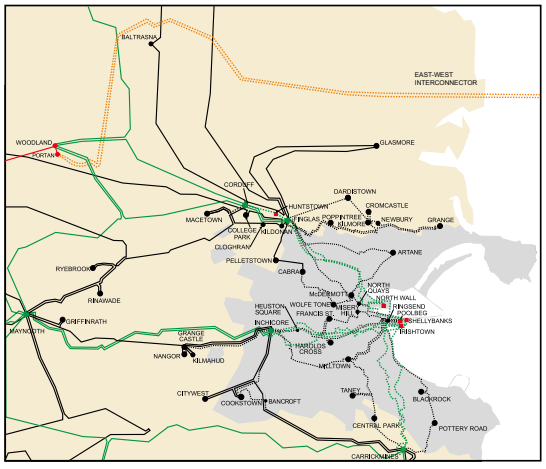
Belfast Area



Cork Area



Dublin Area



	Submitted	Granted [1]	Application Withdrawn
An Bord Pleanála	13	12	1[2]
Local Planning Authority	20	17	0

Table 2-1 – Summary of Planning Consents

1 The "Granted" figures include those projects granted with conditions.

2 The North-South 400kV Interconnection Development Project planning application, submitted to An Bord Pleanála in December 2009, was withdrawn in June 2010 on account of an error in the public notice of the planning application.

Planning Consents

Most electricity transmission projects are classed as Strategic Infrastructure Development, which means EirGrid makes a direct application to An Bord Pleanála for planning consent.

Table 2-1 summarises applications that we have submitted since 2008. These include projects classed as strategic electricity transmission infrastructure development, where we applied to An Bord Pleanála, and projects that were not deemed to meet this classification, where we applied to the relevant planning authorities.

Capital Expenditure

€938 million was spent between 2009 and 2013 on transmission projects. The figure does not include the cost of the East West Interconnector or the circuits required to connect new generation stations to the grid.

Projects Completed

Table 2-2 summarises line uprates and new build projects since 2008. EirGrid has completed over 330 km of new lines and over 1,200 km of line uprating. Of this 1,200 km, approximately 510 km were uprated using high-temperature low-sag (HTLS) conductors. This technology allows for significant increase in capacity to the grid at a much lower cost. The remainder were uprated using more conventional conductors. As these figures demonstrate, we maximised existing network capacity by upgrading the infrastructure already in place.

In addition, a number of new 220kV and 110kV substations that have progressed through planning are currently in the construction and energisation phase. All projects are detailed in the annual Transmission Development Plan, and are available on the EirGrid website.

Project Completions (km)*		
Voltage	New Circuit	Line Uprating
110kV	244	956
220kV	93	325
400kV	0	0
Total	**337**	**1281**

Table 2-2 – Summary of New and Uprated Circuits

* The project completion figures do not include the East West Interconnector or the circuits required to connect new generation stations to the grid.

3 The Wider Context

Delivering an efficient transmission grid requires long-term planning and must be consistent with wider national social, economic and energy policies. The Department of Communications, Energy and Natural Resources is currently carrying out a review of Ireland's energy policy for an Energy White Paper, which it will publish later this year. Our draft strategy will be submitted for the Department to consider. EirGrid will then assess the implications of any significant changes in energy policy before we publish our final grid development strategy.

EU Policy Trends

Emerging EU policies aim for smart, low-carbon, economies centred on energy efficiency. To achieve this, the EU encourages the use of low or zero carbon generation technologies, and the deployment of smart grid technologies. To deliver these policies, Ireland's electricity grid must be developed.

EirGrid is committed to maintaining a reliable grid, providing high-quality, affordable electricity supplies to all consumers.

Our final strategy will deliver a transmission grid that can support potential economic opportunities, whilst also enabling continued recovery, and facilitating balanced regional development.

Energy Policy

In common with many other EU member states, Ireland faces three crucial and inter-related energy challenges: energy security, sustainability and competitiveness. We are heavily reliant on energy imports, leaving us particularly vulnerable to the fluctuations of international energy prices.

In 2013, 89% of Ireland's total energy use was imported, costing an estimated €6.7 billion[4]. That same year, almost 50% of Ireland's electricity generation came from imported natural gas.

4 Source: SEAI

3 The Wider Context

Ireland has a target to increase its share of renewable energy in the electricity sector to 40% by 2020. This is a step towards reducing our dependence on imported energy. The development of a sustainable energy power system requires the modernisation and strengthening of the electricity transmission grid.

In addition to increasing capacity, EirGrid is also investing in operational technology – including advanced information and communication systems.

These will allow us to operate the grid securely, while increasing our ability to take variable generation from renewable sources like wind. New technology will also empower consumers to have more say on how and when they consume electricity.

The central role of the transmission grid to Irish society and the economy was confirmed in the 2012 Government policy statement on the strategic importance of transmission energy infrastructure.

It reaffirmed "the imperative need for development and renewal of our energy networks, in order to meet both economic and social policy goals". It also recognised "the need for social acceptance and the appropriateness of building community gain considerations into project planning and budgeting."

In addition to investing in the transmission grid within Ireland, the transition to a competitive, low-carbon, energy system requires us to explore opportunities for increased interconnection to other countries.

The Economic Context

As outlined in Chapter 1, EirGrid bases our demand forecasts on technical, economic and environmental analyses - and changes to these factors will impact on our forecasts. In 2008, we anticipated that the grid would need to carry 60% more power by 2025. This estimate was based on a predicted average yearly growth in Gross Domestic Product (GDP) of 4% over the same period[5].

However - between 2008 to 2012, Ireland's Gross National Product (GNP) actually declined by 10%[6].

Electricity demand in Ireland has closely matched recent economic volatility. Following a 7.1% fall in demand between 2008 and 2012, electricity demand grew once again in 2013 by 1.1%. This was in line with an increase of 3.4% of Ireland's Gross National Product. The demand for electricity is now expected to grow on average by 1.3% per annum from now to 2025.

Thus, while the economic downturn reduced electricity demand, recent trends now point to steady growth in the economy – and in electricity use – out to 2025. Although this is now at lower levels than previously predicted.

The total scope of Grid25 was revised down by almost 20% in the 2011 review. This was possible because of new transmission technologies, and a reduction in projects. We are now closely examining, once again, all of the information available to us – to ensure that our grid development strategy meets the needs of all users.

5 Previously, the economic parameters of GDP were employed in the forecast model as advanced by ESRI. In 2014, the ESRI recommended the use of a modified GNP parameter, which has led to a more robust model.

6 Percentage figures for Gross National Product (GNP) adjusted for re-domiciled public limited companies (historic and future) was provided by the ESRI in October 2014.

Region	€ Million	
	1 Hour Outage	24 Hour Outage
Republic of Ireland	24.2	579.6
Border	2.6	63.4
Midland	1.5	36.5
West	2.3	55.0
Dublin	6.7	160.3
Mid-West	2.0	47.6
South-East	2.6	63.5
South-West	3.5	84.7
Mid-East	2.9	68.8

Table 3-1 – Economic cost of an electricity disruption for residential users, by region. Note: Based on applying London Economics' estimates. Source: Indecon analysis

Contributing to the Local Economy

The economic benefits of developing grid infrastructure are spread throughout the economy. A modern grid can help reduce energy costs and provide a secure basis upon which businesses can invest and expand.

As Ireland returns to economic growth, the renewal and expansion of the electricity transmission system is important to support job creation, economic development and regional competitiveness. Developing a 21st century transmission system will deliver concrete social, economic and environmental benefits for every person in Ireland. In particular, only by investing in a secure transmission grid will we open up large areas of the country to investment from the types of high-tech industries currently clustered around our larger cities. Economics consultancy Indecon has proposed a number of possible measures to increase the attractiveness of regional locations for investment. In this way, developing the transmission grid is an important element in supporting the Government's drive to create jobs in the regions of Ireland.

The Action Plan for Jobs and IDA's Regional Development Strategy

Ireland is a small, open economy with over 1,000 international companies operating across a wide range of business activities. Indeed, Ireland is ranked as one of the most attractive business locations in the world and continues to attract world-class investments. The IDA has cited access to a high quality electricity grid as critically important for attracting new investment[7].

It highlights the ICT and high-tech manufacturing sectors in particular as requiring a high-quality power supply. This is supported by the Indecon Report, published as an appendix to this document.

The second progress report on the Government's first Action Plan for Jobs emphasised the importance of access to a secure and affordable supply of electricity – for new and future investment. The importance of energy costs to Ireland's overall economic competitiveness is further emphasised in the Government's 2015 Action Plan for Jobs.

7 "Winning: Foreign Direct Investment 2015-2019" www.idaireland.com

3 The Wider Context

Public Engagement

In 2014, the Department of Communications, Energy and Natural Resources issued a public consultation on Energy Policy in Ireland – the Green Paper. This paper highlighted the challenge of seeking acceptance from communities of electricity transmission infrastructure. This means that when designing future energy policy, we must consider how to build social support for energy initiatives.

For EirGrid, it was clear towards the end of 2013 that we needed to review how we consulted on our projects. Throughout 2014 we carried out a comprehensive review of our approach to public consultation. This concluded with a detailed report, supported by analysis from independent experts the Institute of Arbitrators and SLR Consulting.

This review reaffirmed the importance of engagement with people and communities directly impacted by planned development to the transmission grid, and by current grid projects. The review highlighted where we did not meet people's expectations and where changes would improve future engagement.

EirGrid has obligations under the Aarhus Convention in relation to early public participation in environmental decision making. We have ensured, and will continue to ensure, that the principles in the Aarhus Convention are integrated into our processes. This will be done through public consultation and feedback during all stages of transmission projects.

Public consultation also forms part of any application by EirGrid for statutory planning consent on our projects.

EirGrid is committed to engaging with communities to provide clearer information on the work that we are doing - and most importantly, why we are doing it. We are in the process of creating a tool-kit to enable people to participate more effectively in the project development process. We will also locate more EirGrid staff around the country to support our consultation process.

In addition, we will hold a series of Regional Discussion Forums in the coming months. These will be independently chaired, and will facilitate more detailed and technical discussions on our grid development strategy.

Community Gain Fund

We have committed to implementing a Community Gain Fund made up of two elements:

Community Payments

An EirGrid funded payment of €40,000 per kilometre to communities in proximity either to new 400kV pylons or to new outdoor rural stations.

We will pilot a number of implementation methods before we roll this out on a national basis.

Proximity Payments

A once-off payment to owners of occupied residential properties (or those with full planning permission) within 200 metres from the closest point of the property to the new transmission pylons, or within 200 metres from a new outdoor rural station.

We always seek to locate overhead transmission lines and stations at least 50m from homes. In exceptional cases where this is not achievable, EirGrid will engage with the affected property owners on an individual basis.

Protecting our Environment

It is an essential part of EirGrid's work to understand how the development of the transmission system has potential to affect the environment. Consideration of the environment is central to how we work – whether we are looking at a review of our overall grid strategy, or simply the progress of a particular project. We ensure that we comply with all national and EU guidelines.

A full SEA was applied to the original Grid25 implementation plan (IP) 2011-2016, with both documents published in April 2012. The results of this SEA are available on www.eirgrid.com. It was intended that following adoption, the IP and associated SEA would have a 5–year lifespan, with the review and drafting process for the subsequent IP and SEA commencing within the final year of that lifespan. Therefore when this grid development strategy is finalised, it will form a fundamental element of the next implementation plan and associated SEA, the preparation of which will commence in the second half of 2015.

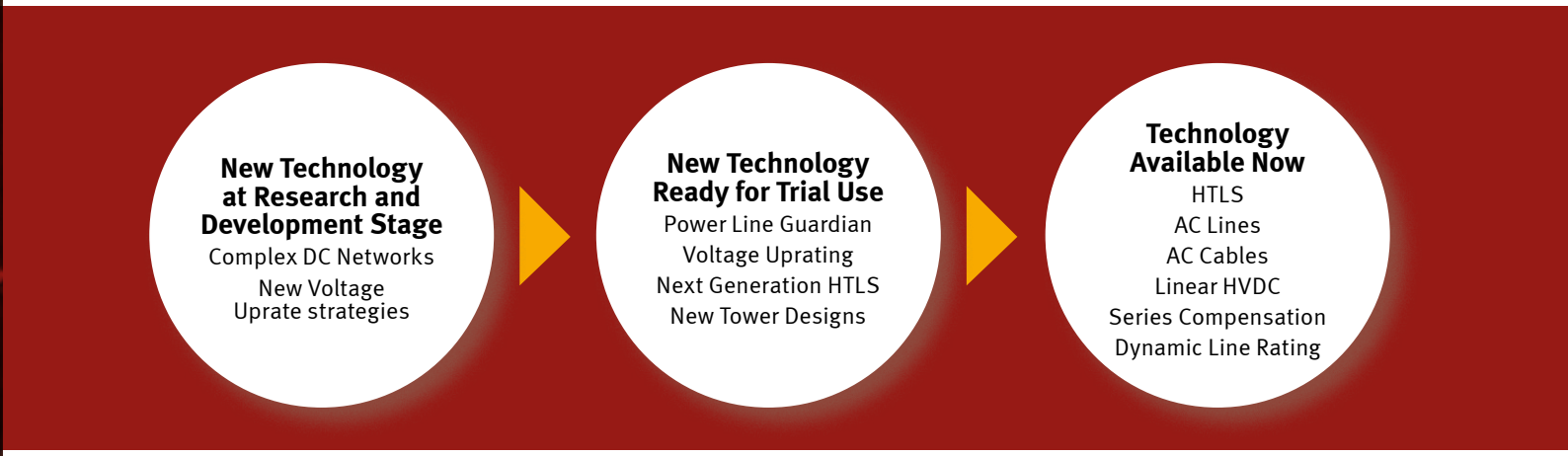
Health & Safety

EirGrid regards the protection of the health, safety and welfare of its staff and the general public as a core company value.

We design and operate the transmission network to the highest relevant safety standards and to comply with the most up to date international guidelines.

4 New Transmission Technologies

EirGrid continually reviews technological developments to assess their potential use on the Irish transmission system. New transmission technologies can offer a number of advantages. These include: reduced capital and operational costs, reduced social and environmental impacts, improved system reliability.



The possible advantages of new technologies will always be balanced with the need to ensure a reliable, secure electricity supply. EirGrid characterises new technologies in three broad categories, as shown above. We work with industry partners, technology innovators and with other transmission service operators to identify, research and trial possible innovations. The following section describes many of the most promising technologies in each of these categories.

EirGrid is assisting industry in identifying, developing and trialling new technologies, new products and new services. To manage the operation of the power system over the coming years, we have a world-leading initiative called “Delivering a Secure, Sustainable Electricity System DS3”.

4 New Transmission Technologies

Technology Available Now

AC Overhead Lines

AC overhead transmission lines have been in operation for many years, and they represent a highly efficient and reliable means of transmitting electricity. They comprise the vast majority of transmission infrastructure in use across the world today. In Europe, approximately 98% of transmission circuits are overhead AC lines.

High-Temperature Low-Sag (HTLS) overhead line conductors

HTLS technology was introduced to the Irish transmission system in 2011. These higher capacity conductors can operate at higher temperatures with lower sag characteristics, ensuring we can maintain critical clearances from trees and other obstacles.

These first generation HTLS conductors have been used successfully by EirGrid and ESB Networks as part of the Grid25 strategy, achieving approximately a 60% increase in capacity on over 500km of our existing 110 and 220kV overhead lines.

AC underground cable technology

Underground cable technology has been used in Ireland for many decades. Traditionally it was used in limited cases, where a route for an overhead line could not be found. However, the capacity of underground cables continues to increase. Similarly, there is also growing international expertise in determining how greater amounts of underground cable can be reliably incorporated onto a transmission system.

Our most recent analysis has identified that Ireland, due to its smaller size compared to other networks, is at greater risk of issues arising through the use of AC underground cables. We have concluded that a number of techniques existed which could reduce - but not avoid - these issues.

Investigations into the use of longer lengths of underground AC cable on the Irish transmission network have typically found that for 220kV cable, the maximum feasible length is up to 30km – depending on the specific situation. For 400kV, it is considerably shorter – approximately 5 to 10km.

HVDC and DC transmission

The transmission grid in Ireland, like other European and international grids, uses High Voltage Alternating Current (HVAC). Where power is transferred from point to point over long distances it may be cost-effective and technically possible to use High Voltage Direct Current (HVDC) instead.

One advantage of HVDC is that a full circuit can be placed underground. HVDC is a mature technology that is available for integration on the Irish transmission system. This technology is considered, where appropriate, on each project. EirGrid has included this technology in a number of recent project evaluations. In 2012, we developed a HVDC interconnection between Ireland and Wales.

Series Compensation

Series compensation has been used to boost flows on very long transmission lines in some parts of the world - such as Russia and the US - for several years. It has traditionally not been used on smaller systems such as some of those found in Europe. Recent advances in technology and control systems allow greater flexibility in and benefits from the application of series compensation.

Dynamic Line Rating

The capacity of an overhead line is influenced by conditions such as temperature, wind speed, wind direction and other factors. Dynamic line rating involves the installation of devices to monitor these conditions and allow higher power flows when conditions permit.

However, as long-term variations in meteorological conditions are difficult to predict, these enhanced ratings are not generally used for system development. Instead, the technology can be used in the short-term to reduce potential network bottle-necks while awaiting delivery of grid development projects. EirGrid has trialled Dynamic Line Rating on several lines, and will continue to evaluate whether additional use is appropriate in specific circumstances.

New Technology Ready for Trial Use

Power Line Guardian

Power management technologies have been increasingly used in recent years to make better use of existing grid infrastructure. We are investigating technologies to consider their use on the Irish grid. A pilot trial using new technology known as *Power Line Guardian*[8] is underway. These devices can be rapidly deployed onto existing overhead lines. They allow power flows to be diverted from heavily loaded overhead lines or cables to more lightly loaded ones. This allows the existing grid to be used more effectively.

Voltage Uprating

It is possible to increase the capacity of a line by increasing its operating voltage. This generally requires considerable modifications within substations and a complete rebuild of the overhead line. In many cases, the length of time the line must remain off makes this prohibitive.

EirGrid is actively supporting research and development efforts into new voltage uprating technologies that would involve less structural modifications. This makes the uprating quicker to complete and lowers the overall cost of this approach. This technology may become a technically and economically viable option for the grid before 2025.

Second Generation High Temperature Low Sag (HTLS) overhead line conductors

New HTLS conductors that could potentially double line capacity are undergoing field trials. Should they prove successful, they may become available – although their application is likely to be restricted to voltage levels greater than 110kV.

New overhead line structures / new tower designs

EirGrid is actively considering new tower designs and other measures to minimise the visual impact on the landscape. These measures were outlined in a 2008 Government-sponsored report issued by Ecofys on *The Comparative Merits of Overhead Electricity Transmission Lines Verses Underground Cables*. In addition, EirGrid will also take account of the National Landscape Strategy when this is published.

New Technology at Research and Development Stage

For details of these technologies, see Appendix 1. (EirGrid Technical Report)

New tower designs currently under consideration

8 Developed by Smart Wires

5 Proposed Strategy for Grid Development

In this chapter we put forward various solutions to upgrade the transmission network. These reflect the evolving national, economic and social requirements detailed in previous chapters. We outline our updated assumptions for the overall strategy, and describe how these assumptions could impact current projects.

Factors that Influence our Strategy

Three main factors have influenced our strategy to develop the national transmission grid:

- Feedback received during the consultation process on major projects
- Advances in technology
- Changes in the external economic environment

These factors are the basis for EirGrid's three new strategy statements, which we describe below:

Strategy Statement 1

Open engagement and inclusive consultation with local communities and stakeholders will be central to EirGrid's approach to network development

We acknowledge the sensitivities associated with major transmission infrastructure development.

In response to major project consultation feedback, and to follow through on the Grid25 initiatives announced in 2014, EirGrid undertook to carry out thorough internal and external reviews of our consultation process. This task of reviewing and improving the consultation process[9] is now complete. One of the outputs of this is a review of our current *Project Development and Consultation Roadmap*.

We are committed to enhancing public participation and community engagement as part of this process.

Strategy Statement 2

All practical technology options will be considered for network development

One of the themes raised during recent consultations was the need to conduct a comprehensive underground analysis for Grid Link and Grid West. While underground technology has always been considered during initial project scoping and technical analysis, in future, we will always publish underground options for public consultation.

We also commit to engaging with the public before we identify a preferred technology. This consultation will explain the transmission technology options, and then seek feedback from stakeholders.

This will assist us in determining the best transmission technology for future projects. We are committed to looking for alternative options that may avoid or reduce the necessity for new overhead lines.

Strategy Statement 3

The network will be optimised to minimise requirements for new infrastructure

EirGrid will continue to maximise the use of the existing transmission network. Where we can increase the capacity of existing infrastructure, or use new technologies, this can remove the need to construct new lines. This strategy lowers costs and ensures that there will be potentially less impact on the environment and on local communities.

9 http://www.eirgrid.com/aboutus/publications/gridinitiatives/

5 Proposed Strategy for Grid Development

Impact on Strategy

To provide greater transparency and a clearer understanding of the impact of this review of Grid25, the strategy is now broken up into seven individual regions across Ireland as shown in the pie chart in Figure 5-1 below.

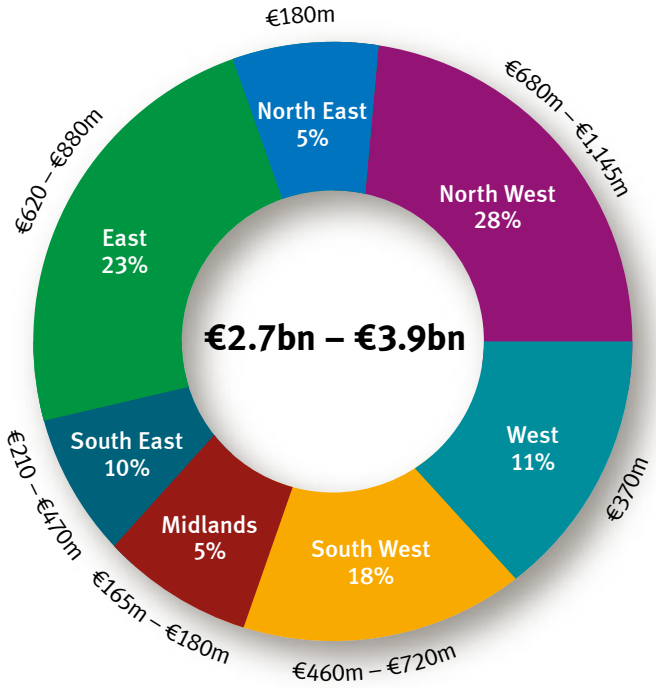


Figure 5.1
Regional breakdown of investment.

For detail on these regions, please consult the supporting appendices.

Major Projects

North South Interconnector

Background

EirGrid and the System Operator for Northern Ireland (SONI) are jointly proposing a new high-capacity electricity interconnector between the electricity networks of Ireland and Northern Ireland.

The proposed development is a 400kV overhead line linking a substation in Woodland, County Meath with a planned substation in Turleenan, County Tyrone.

It will provide a second high-capacity electricity transmission line between the two jurisdictions.

Why is this being proposed?

The interconnector is critical to ensuring a safe, secure supply of electricity throughout the island of Ireland.

It will bring about major cost savings and address significant issues around security of electricity supply, particularly in Northern Ireland.

A key benefit will be the removal of bottlenecks between the two systems. This will enable them to operate together as if they were one network benefiting residents and businesses in both jurisdictions.

This will bring cost savings for electricity consumers, as larger electricity systems operate more efficiently than smaller ones.

Interconnection will also facilitate greater connection of wind generation which will help achieve Ireland's renewable energy targets.

Has EirGrid evaluated an underground option for the project?

There have been numerous studies of underground options.

Most recently, in July 2014, a Government-appointed Independent Expert Panel provided its opinion on whether EirGrid had adequately examined an underground option for this project.

The panel compared the work to date on this project with its recently formulated terms of reference for EirGrid's Grid West and Grid Link projects. It found that, in all material respects, the studies and work undertaken on the interconnector project was compatible with the methodologies now being employed on the Grid West and Grid Link projects.

What has happened recently?

The project was designated a Project of Common Interest (PCI) by the European Commission in October 2013. PCIs are energy projects deemed by the European Commission to be of strategic, trans-boundary importance. This will be the first PCI in Ireland to be submitted for planning approval.

In November 2014, as part of the PCI process, EirGrid submitted a draft planning application file to An Bord Pleanála for review.

What is happening now?

In December 2014, An Bord Pleanála informed EirGrid that it had reviewed the draft planning application file and asked for certain specified missing information to be submitted.

In March 2015, EirGrid submitted the requested information to An Bord Pleanála. It will advise on the timing of the various steps in the statutory planning process.

What happens next?

Our review of Grid25 found there remained a compelling and clear need for the project. We expect to submit a planning application for the North South 400kV Interconnection Development in the coming weeks.

We remain committed to our new standards of consultation to ensure that all interested parties have an opportunity to voice their views. To that end, we have recently opened local offices in Carrickmacross, Navan and Kingscourt.

Grid West

Background

In 2008, as part of its "Gate 3" process, the Commission for Energy Regulation set out the process for EirGrid's consideration of applications from companies that wished to connect to the distribution and transmission networks. In the west of Ireland, 647MW of renewable generation projects have entered into a contract and are awaiting a connection – in areas around the existing Bellacorick 110kV substation in north Mayo.

An assessment of the network capability in north Mayo showed that the existing 110kV network, even if upgraded, could not handle this amount of additional generation.

Therefore, we need to add an additional transmission line or cable. Plans to develop a solution were included as part of our Grid25 Strategy.

Is this still needed?

Yes. The current grid cannot accommodate the volume of power that is proposed in the west.

What was originally proposed?

To meet these connection needs, EirGrid originally looked at a number of factors, including; demand forecasts, available technology, cost, and environmental considerations.

The conclusion of all of these studies was that the best option to meet the needs of the project was a 400kV High-Voltage Alternating Current (HVAC) overhead line.

Are there other solutions?

Yes. The most appropriate solution for any project is determined by the details of that project – its location, scale and purpose. In 2008, EirGrid considered these factors for Grid West, taking into account cost-effectiveness, long-term forecasts, and the known reliability proven transmission technologies.

In 2014 EirGrid agreed with feedback from the public that we had ruled out underground alternatives too soon in the process. We then reassessed underground cables to see if they could meet the needs of the project and to determine how they performed in environmental, economic and technical terms. We also investigated if the capacity needs of the generation companies could be met using a lower voltage solution.

Strategy Statements

3 **Strategy Statement 1**
Optimise the current network in order to minimise requirements for new infrastructure.

4 **Strategy Statement 2**
Consider all practical technology options for network development.

5 **Strategy Statement 3**
Foster open engagement and inclusive consultation with local communities and stakeholders as a central principle to developing the grid

Tell us your views
eirgrid.com/yourgridyourviews

5 Proposed Strategy for Grid Development

Based on this review, we found that there are three possible solutions:

- A High Voltage Direct Current underground cable - which allows for a fully underground solution. Capital Investment: €475m
- a 400kV High Voltage Alternating Current overhead line with 8km of undergrounding. Capital Investment: €220m
- A 220kV High Voltage Alternating Current overhead line with partial use of underground cable to the maximum possible extent – up to 30km. Capital Investment: €205-250m, depending on length of underground sections.

Which solution will be chosen?

A detailed analysis of the economic, technical and environment impacts of the three solutions has been presented to the Government-appointed Independent Expert Panel (IEP).

It is expected that the panel will publish its opinion on the report shortly. The report will then be published and we will be asking you for your feedback, we expect this will occur in May 2015.

We will then balance the wider economic environment, technical developments and, most importantly, the views of industry, policymakers and the people of the west to find the best outcome.

Grid Link

In 2008, studies indicated that, if left as is, the existing transmission system in the south and east of Ireland would not meet either Ireland's or the region's future electricity requirements.

There are three main drivers for this project:

Security of supply

Despite the recent drop in electricity demand, there remains a risk to the security of supply in the south and east of the country. This is largely caused by heavy power flows through the network.

Integrating renewable energy

To achieve Ireland's target of providing 40% of our electricity from renewables by 2020, significant levels of renewable generation will be connected in the south and east of the country. The transmission system must be able to facilitate the flow of this power from where it is generated to where it is needed.

Future interconnection

EirGrid, with its French counterpart, is currently exploring the feasibility of an interconnector with France. This would give Ireland direct access to a mainland European electricity market, strengthening our security of supply and creating opportunities to import and export electricity. It is important to stress that no decision on a French interconnector will be made for some time. Private developers are also exploring interconnection to Great Britain.

Is this project still needed?

Yes. However, changing demand forecasts, a slower rate of growth, upgrade works on existing lines and advances in technology means it is now possible to consider alternative solutions.

What was originally proposed?

The original Grid Link Project was designed to maximise the long-term benefit of new infrastructure by using the most secure and cost-effective technology. This resulted in a proposal to build a fully overhead 400kV HVAC overhead line at a capital investment of €500-550m.

Are there other solutions?

Yes – we have researched a number of options, and in this discussion paper we are proposing two additional solutions.

Firstly, it is possible to put the line underground using HVDC technology – but at a significantly higher cost. The capital investment of this option would be €800-850m.

Secondly, we can introduce a technology known as 'series compensation' onto the Irish transmission grid for the first time.

This advanced smart grid technology would allow us to put more power on existing lines so that we could address the current weaknesses of the system.

Although it would require no significant new overhead infrastructure in the southeast, an underwater cable would be needed across the Shannon estuary. This will allow electricity generated in the southwest to cross the Shannon and be transferred from there on the existing 400kV line from Moneypoint.

Although series compensation technology has been used mainly on long distance lines for example in the US, this would be one of the first times it has been used in a network the size of Ireland's.

The capital investment for all the elements in this solution is €200-€250m.

Which solution will be chosen?

EirGrid will engage with stakeholders to discuss the possible options as we continue our evaluation of the three potential solutions outlined here, with a view to making a submission to the Independent Expert Panel in Autumn 2015.

Following its review it is expected that there will be public consultation towards the latter part of this year.

Other Projects:

Moneypoint - North Kerry project

This project will facilitate the connection of wind generation in the south west.

The project was initially conceived as a 400kV part overhead and part submarine circuit connecting Moneypoint generation station in Co. Clare and a new 220kV substation in North Kerry.

The project is now a 220kV cable solution using a new type of high-capacity cable. Cost benefit analysis identified that the higher cost of utilising a cable solution would be compensated by the benefits of earlier delivery. This resulted in the land portion of the project being changed from overhead line to underground cable.

The North West project

As part of the overall need to increase capacity for renewable generation across the island of Ireland, we need to strengthen the grid in the North West. We will be consulting with the public on the need for this project, and on a range of possible solutions later this year.

The West Dublin project

This project is at the earliest point in the development cycle. The project will increase the strength of the link between two 400kV stations at Dunstown and Woodland. EirGrid is examining the full range of practical technologies including maximising existing infrastructure.

Scale of our proposed new Grid Development Strategy

The original estimated cost of Grid25 was €4bn; in 2011 the overall scale of the Grid25 strategy was revised down to €3.2bn. This was made possible by falling forecasts for future demands, and through the use of new technologies. For new transmission circuits, the final costs will vary depending on the different technologies that are used on individual projects, but we anticipate that the final cost will be in a range from €2.7bn to €3.9bn.

Proposed Strategy

6 What are your views on EirGrid's proposal to meet project needs but with reduced power capacity in the long-term?

Tell us your views
eirgrid.com/yourgridyourviews

6 Summary & Conclusions

Ireland needs a long-term strategy to develop the electricity grid in a safe and secure manner. This will help us to meet projected demand levels, to meet government policy objectives, and to ensure a long-term, sustainable, and competitive energy future for Ireland. We are now conducting an assessment of the 2008 Strategy, based on the long-term electricity needs of our economy, and of Irish society.

EirGrid's final grid development strategy will provide a comprehensive development strategy for our electricity infrastructure. The main findings and impacts that inform this draft strategy are:

Overall Assessment

- Developments in technology now allows us to achieve improved performance from existing transmission infrastructure.
- The economic downturn has resulted in reduced demand forecasts for 2025 and beyond; however, the need for continuing development to our infrastructure remains.
- The expected level of generation connections remains valid, looking forward from 2015.
- The end-of-life for certain grid assets is now being reached, so maintenance and/or replacements are necessary. More than 60% transmission lines on our system are over 35 years old.
- The overall estimated costs for our proposed new Grid Development Strategy have been revised, and will fall within the range of €2.7 to €3.9 billion.[10]
- Grid investment will have a widespread positive impact on the Irish economy and can help reduce overall energy costs in the market.
- Investing in a modern transmission grid will put Ireland in a strong position to continue to attract foreign investment.

Your Grid, Your Views

We have listened. We have assessed advances in technology, and we have reviewed the forecasted changes in the economic and energy landscape. While these factors will influence how we develop the grid, the basic need for investment remains. We need to invest in a stronger, flexible and future-focused electricity grid.

In some cases, it will be possible to maximise the infrastructure we currently have. However, the consequences of this approach need to be carefully considered.

We are committed to working more closely with local communities to respect their concerns, and to do all we can to help communities and homeowners in response to their concerns about the visual intrusion of new infrastructure on the landscape.

We now need your views. Let us know your thoughts – and we will reflect these in a final strategy. While all submitted feedback will be recorded and analysed, we will not be responding to individual submissions. We will address all themes and issues raised in a feedback report, to be published later this year.

Other Comments

7 Do you have any other comments on this draft Grid Development Strategy?

Tell us your views
eirgrid.com/yourgridyourviews

10 This also includes the cost for the southern portion of the North South Interconnector. In the original Grid25, this cost was not included.

Glossary

AC

Alternating current is a type of electric power and is used on transmission systems around the world. It is the form in which electricity is delivered to homes and businesses.

An Bord Pleanála

Ireland's independent national planning authority.

Assets

All substations and electricity transmission lines that form the transmission network. Operated by EirGrid, the transmission network is owned by ESB.

Capacity

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

CER ('the regulator')

The Commission for Energy Regulation.

Circuit

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

Conductors

An object or material that can transfer electricity, for example, found in underground power cables and overhead lines.

Conventional generation

The generation of electricity using fossil fuels, such as natural gas, coal or peat.

DC

Direct current is a type of electric power particularly suited to underground cables or interconnectors.

Demand

The amount of electrical power that is drawn from the network by consumers. This may be talked about in terms of 'peak demand' (the maximum amount of power drawn throughout a given period).

Distribution Network

This is the lower voltage network that delivers power from the transmission network to households and businesses. The distribution network in Ireland is owned and operated by the ESB.

EMF

Electric and magnetic fields. These occur naturally – the earth itself has natural electric and magnetic fields – or from man-made sources, the most common of which is electricity. They can induce electrical currents in materials capable of conducting electricity.

EWIC

The East West Interconnector, which links the Irish and UK transmission systems. It is owned and operated by EirGrid. It is used both to import and export electricity.

Generation Adequacy Report

EirGrid produced an annual Generation Adequacy Report. The final Generation Adequacy Report was GAR 2010-2016. This was replaced by the All Island Generation Capacity Statement

Generation Capacity Statement

Replacing the Generation Adequacy Report, the first All Island Generation Capacity Statement covered the period 2011-2020.

Generator

A facility that produces electricity. Power can be generated from various sources, for example, coal fired power plants, gas fired power plants and wind farms.

Generation Dispatch

The amount of electricity being produced for the grid by a number of generators at any one time. This will vary as demand for electricity and the amount of renewable energy on the system fluctuates.

Grid25

EirGrid's national strategy for the development of the transmission grid, published in 2008.

HTLS conductors

High-Temperate, Low-Sag conductors were first introduced to the Irish transmission system in 2011. They carry substantially more electricity than the conductors normally used in Ireland.

Glossary

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.

Megawatt (MW)

A unit of measurement for the amount of power produced by a generator or transported on the transmission grid.

Outage

An outage is when part of the network is switched off. This can be either planned (i.e. when work needs to be done on the line) or unplanned (i.e. a system fault caused by storms).

Reinforcement

Increasing the capacity of the existing electricity transmission network by building new lines or uprating existing ones.

Renewable generation

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

Strategic Environmental Assessments (SEA)

SEA is a strategic assessment process for plans and programmes only.

Individual projects are subject to their own assessments outside of the SEA process. If projects fall under a class of development requiring Environmental Impact Assessment (EIA)then an EIA is submitted to the relevant planning authority.

Series Compensation

Series compensation is a technology that would allow us to safely and securely put more power on an existing transmission line. It is used to optimise the power flows on the system. In effect, series compensation allows us to get the most out of the existing transmission grid.

Substation

A set of electrical equipment used to step high-voltage electricity down to a lower voltage. Lower voltages are used to deliver power safely to small businesses and residential consumers.

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

The network of around 6,500 km high-voltage power lines, cables and substations linking generators of electricity to the distribution network. It is operated by EirGrid.

Voltage

Voltage is a measure of ‘electric potential’, which is similar to ‘pressure’ in a water system.


EIRGRID