EIRGRID

GRID25

A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future

www.eirgrid.com

EirGrid is a state-owned company and is the independent electricity Transmission System Operator (TSO) in Ireland and the Market Operator (MO) of the wholesale electricity trading system. EirGrid's role is to deliver quality connection, transmission and market services to electricity generators, suppliers and customers utilising the high voltage electricity system. We are responsible for the Grid infrastructure required to support the development of Ireland's economy, as well as connecting the Irish Grid to the European Grid. EirGrid plays a key role in the operation of the Single Electricity Market (SEM) which services the island of Ireland.

EIRGRID'S MISSION IS TO DEVELOP, MAINTAIN AND OPERATE A SAFE, SECURE, RELIABLE, ECONOMICAL AND EFFICIENT TRANSMISSION SYSTEM FOR IRELAND.

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FOREWORD

BY THE MINISTER FOR COMMUNICATIONS, ENERGY AND NATURAL RESOURCES,

EAMON RYAN, T.D.

EirGrid is taking on the challenge on behalf of Irish business and consumers, of building a network fit for the 21st century.

The last few years have seen extraordinary changes in global electricity markets, as climate change and energy security have moved to the top of policy imperatives at home, in Europe and across the world.

These issues are likely to continue to put upward pressure on the price of fossil fuels and are thus a call to action in energy policy. EirGrid's Grid Development Strategy, **GRID25**, is a critical element in future-proofing Ireland's electricity needs by facilitating more sustainable, competitive, diverse and secure power supplies in support of economic and social development and renewable energy deployment.

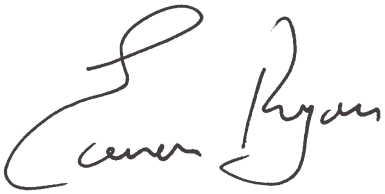
The Strategy, when implemented in full, will provide a platform so that in each region of Ireland we can harness our abundant renewable energy resources and provide clean and competitively priced electricity for homes, businesses and new high-tech industries.

GRID25 builds on the significant investment that has already been made in our transmission network and moves us towards a cutting-edge intelligent electricity system. We are also extending that network by connecting to the UK and in due course to the European Grid. This will enable us to participate in the European market and facilitate both the export and import of electricity.

GRID25 has been informed by the findings of the ground-breaking All-Island Grid study which demonstrates the feasibility of at least 40% renewable electricity in our system by 2020 if we develop our Grid in a smart manner. This level of renewable supplies will help us meet our domestic targets and support the European Union's 2020 climate change targets. However, in developing such long-lasting infrastructure we must be cognisant of the future when larger emissions reductions will be needed and the supply of fossil fuels may be much less secure.

EirGrid is taking on the challenge on behalf of Irish business and consumers, of building a network fit for the 21st century. Doing so is the first crucial step to allow us to position Ireland as a world leader in clean energy production. Getting our Grid development right can give other developers the confidence to invest in the jobs and plant that will power our future. The Grid to be delivered by **GRID25** will ensure our transition to a low-carbon economy.

The delivery of **GRID25** is a collective enterprise and requires all stakeholders including enterprise, local communities and the regions to work with each other. I have every confidence that together we can deliver.



Eamon Ryan, T.D.
Minister for Communications, Energy and Natural Resources

INTRODUCTION

BY DERMOT BYRNE
CHIEF EXECUTIVE, EIRGRID

It is vital that Ireland has the electricity supply infrastructure to ensure our economic growth and maximise our competitiveness.

I am pleased to present EirGrid's Grid Development Strategy, **GRID25**. This is a major initiative to put in place safe, secure and affordable electricity supply throughout Ireland, supporting economic growth and providing a roadmap to a bright future for renewable and sustainable energy.

Electricity is a vital service for domestic, business, farming and industrial customers and this Strategy is designed to ensure that the transmission network has the capacity to provide for growth in electricity demand between now and 2025.

A strong transmission grid is essential for Ireland to attract and retain high-tech industrial investment, for the country to have competitive energy supplies and balanced regional development and in order to reduce our dependence on fossil fuels in light of the major issue of climate change.

It results from a robust and stringent analysis of the long term needs of electricity users nationwide and includes very practical and progressive solutions to deliver high quality, secure and economic power supplies in line with best international practice.

Putting in place infrastructure is never easy and does require sensitivity to differing needs and concerns and this document addresses those issues in a comprehensive way.

It is vital that Ireland has the electricity supply infrastructure to ensure our economic growth and maximise our competitiveness. EirGrid is committed to the delivery of this Strategy for the national good and will consult widely on the Strategy and its implementation.

The implementation of **GRID25** is essential if Ireland is going to meet its targets for generating electricity from renewable sources. It also enables Ireland to link to Britain and further afield with potential to both export and import electricity.

The Strategy reflects the output of the All-Island Grid Study and is consistent with the Gate 3 process for connection of wind generation. I am very grateful for the support of the Minister for Communications, Energy and Natural Resources, Eamon Ryan, T.D., in launching this Strategy.

GRID25 also enables the different regions to develop their potential in attracting new high-tech industry and to accommodate population growth and represents a total investment of €4 billion, which has been carefully considered and will be delivered in a responsible and cost-effective way. The Commission for Energy Regulation (CER) will have an overall monitoring and approval role to ensure the investment is delivered effectively and efficiently.

There are very significant opportunities and challenges over the coming years. The Irish power system has successfully provided the energy for major economic growth in the past 20 years and I am convinced that this Strategy will set the stage for further growth. Developing the National Electricity Grid requires support from all stakeholders and the importance of progress in delivery cannot be over-emphasised.

Putting this Strategy in place will ensure that Ireland has the best possible platform in terms of a world-class, competitive and sustainable electricity system.

Dermot Byrne

Dermot Byrne
Chief Executive, EirGrid

EXECUTIVE SUMMARY

The Transmission Grid provides a vital link between all generators and the users of electricity. It provides physical access to all generators to a central market and it enables all users to avail of electricity from the central market at the most economic rates.

Over the next 15 to 20 years, major changes will take place in Ireland's electricity needs, in its sources of fuel and in its fleet of power stations.

Change will increasingly be driven by issues of energy security, competitiveness, climate change and by the need to move away from imported fuels.

GRID**25** will bring new levels of wind generation, both on and off-shore and an introduction of commercial ocean technology-based generation to Ireland. It will also require flexible conventional generation, as well as market structures and networks that encourage competition, and which enable consumers to benefit from economic electricity.

What will remain constant through this period will be the requirement of all consumers – householders, farmers, small and medium sized businesses and large industries – for high quality, reliable power supplies.

The National Electricity Grid will remain a vital channel for essential supplies delivered reliably, for sustainable and renewable energy and for open competition within the sector. A strong grid will bring the energy supplies which will enable Ireland to prosper economically and to provide good quality of life to its people.

The Grid will be a key pillar supporting balanced regional development, linking parts of the country rich in renewable energy or conventional generation, to the rest of the country, enabling all market users to benefit from reliable electrical energy at the most economical price.

For the Grid to play its part fully, it must be developed. The bulk transmission system, comprising circuits at 220 kV or higher, represents the motorways and dual carriageways of the electricity transport system. Capacity has remained largely unchanged in the last 20 years, a period that has seen a growth of 150% in the electricity demand being carried by the system. EirGrid calculates that to facilitate the necessary increase in renewable generation and to adequately meet the demands of the electricity customer, the capacity of the bulk transmission system will need to be doubled by 2025.

This will be achieved through major reinforcements to the existing network using the best technological solutions available. The Grid will be developed taking account of the continuing need to balance the reliability and security objective with the costs and environmental impact of developments in a sustainable way.

The Strategy described here will involve upgrading the high voltage system and an investment of approximately €4 billion over the period to 2025. This new infra-structure is every bit as essential to the future growth of the country as any investment in road, rail and broadband.

GRID**25** strikes a balance between costs, reliability and environmental impact. It examines the totality of developments and considers a variety of options to minimise the net length of new line build in a region

through a number of initiatives designed to maximise the use of the existing network.

This level of new and upgraded infrastructure represents a major shift in the scale of grid development from today's levels and will present significant challenges to all involved in its delivery. We will have to develop innovative methods for upgrading existing network so that the disturbance and the costs to customers can be minimised. And we will need to find quicker ways of progressing through all the various phases of planning and construction to deliver a system capable of accepting large amounts of new renewable and conventional generation. EirGrid is committed to ensuring that these developments are completed on time and in a cost-effective way.

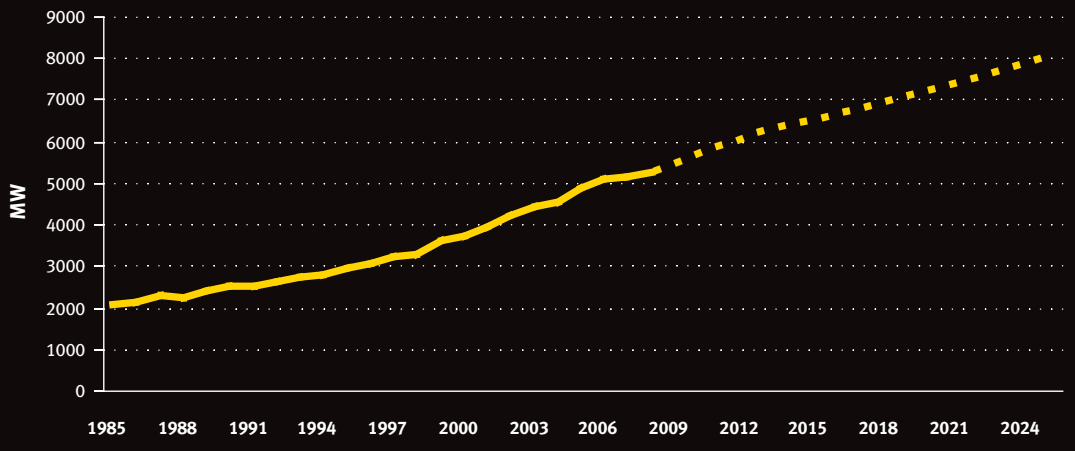
GRID**25** is essential to:

- Supporting growth in the regions and ensuring continued reliability and security of supply;
- Providing high-quality, high-voltage bulk power supply for Ireland that will enable the different regions to attract in future industry and boost existing industry;
- Exploiting Ireland's natural renewable sources of energy (wind and wave);
- Reducing Ireland's carbon emissions by transmitting renewable energy in line with Government policy;
- Increasing Ireland's connectivity to the European Grid, allowing for both bulk exports of electricity and imports of electricity when appropriate.

The consequences of non-action are:

- Within the next five to ten years key parts of the Grid will have reached capacity and will be in danger of overloading, resulting in loss of supply to customers;
- High-tech industry that requires secure, high quality energy supplies will be limited to locations with strong grid infrastructure;
- The needs of new and current residential clients will not be met;
- The power system will not be able to guarantee security of supply;
- Access to the market will not be possible for all low-cost generators limiting competitive-ness in the electricity market;
- The drive to reduce Ireland's CO_2 emissions and meet its targets for the use of renewables in compliance with legislation will be seriously undermined;
- Ireland will not be strongly connected to the European Grid and will be unable to participate fully in a pan-European electricity market.

DEMAND GROWTH 1985-2025



GRID25 IS AN ESSENTIAL INFRASTRUCTURE INITIATIVE TO FACILITATE RELIABLE, SECURE AND AFFORDABLE ELECTRICITY SUPPLIES THROUGHOUT IRELAND.

Without it, within the next five to ten years key parts of the Grid will have reached capacity and will be in danger of overloading, resulting in 'blackouts'.

01 INTRODUCTION TO GRID25

Grid25 provides a common understanding of how the development of the Grid should be undertaken to support a long-term sustainable and reliable electricity supply.

The need for change

Electricity is a fundamental component of life in the modern world. Ireland, like many countries, faces the challenge of providing the platform on which we will continue to support reliable and affordable electricity services in the coming decades.

The world's energy industry is changing significantly to counter the declining stocks of fossil fuels and to limit the production of harmful greenhouse gasses. The Government in its White Paper on *"Delivering a Sustainable Energy Future for Ireland"*, published in 2007, has set targets for the electricity industry in Ireland to meet these challenges. A significant contribution to our sustainable energy future will come from renewable energy sources.

Energy efficiency will be increasingly important in moderating growth driven by population numbers and economic development. EirGrid will continue with active campaigns to encourage savings in power use where possible and will also support smart metering which will enable consumers to more directly participate in managing their own consumption.

The transmission network plays an important role in transporting the power from the variety of generation sources, both conventional and renewable, to the towns and cities, for onward distribution to every home, farm and business across the country. EirGrid is responsible for developing the transmission network in Ireland. It does this to ensure that there is adequate network capacity to carry power from new generation stations and to ensure a reliable supply to meet growing demand for electricity.

A balanced forward-thinking approach will be adopted to minimise the impact on the environment while providing the necessary capacity for transporting power from source to point of use.

GRID**25** provides an outline design for how the transmission network will be developed in the long-term to meet the challenges ahead.

The overall goal of GRID**25** is to develop the network economically to reliably meet anticipated transport needs of users of the Grid. In achieving this goal GRID**25** supports the Government's priority actions of increasing the penetration of renewable energy technologies and of improving energy efficiency and energy savings.

The reasons for GRID25

GRID**25** provides a common understanding of how the development of the Grid should be undertaken to support a long-term sustainable and reliable electricity supply.

The long-term view of transmission infrastructure requirements provides a guide to the scale of grid development required to correctly match the anticipated long-term needs. In the absence of a long-term view, the developments may otherwise be planned piecemeal to only meet the short-term needs as they arise, resulting in inefficient investment and in many cases an ineffective grid.

High voltage networks provide much greater capacity than lower voltages. For instance a 400 kV line provides about three times the capacity of a 220 kV line. Another way of expressing this is that it would take three 220 kV lines to provide the same capacity as a 400 kV line. So, where the long-term need may be for a 400 kV line, without foresight, three 220 kV lines may be installed. Developments based on a long-term view are therefore more economic and have less impact on the environment

and the communities through which the circuits pass.

Next steps

GRID**25** provides an approach to grid development over the next decade and beyond. It also provides a scale to the necessary infrastructure required on a national and regional level. As a matter of priority, EirGrid will progress network development to meet anticipated needs in line with the GRID**25** Strategy.

EirGrid has begun to undertake detailed studies to more clearly specify reinforcement project requirements. The studies will assess environmental impact, technical issues and route identification for the many necessary schemes.

Once the information already contained in this Strategy, such as the needs of a region, is collated with the information from the studies, plans for specific projects will be drawn up and implemented in consultation with the public and all key stakeholders, and subject to regulatory oversight by the Commission for Energy Regulation (CER).

THE GRID25 PROCESS

02 VISION

By 2025, the Grid will carry 60% more power to cities and towns across Ireland.

The demands for transmission services will be far different in 2025 to what they are today. We must plan now to meet these changing needs.

Our vision is of a grid developed to match future needs, so it can safely and reliably carry power all over the country to the major towns and cities and onwards to every home, farm and business where the electricity is consumed and so it can meet the needs of consumers and generators in a sustainable way.

The drivers of grid investment are complex in nature and require careful analysis.

In many cases growth in demand for electricity results in higher power flows on the transmission network. Where the power flows exceed the capability of the Grid, reinforcement is necessary. Demand forecasts are therefore a good indicator of the need for grid investment.

In general, the addition of generation creates a much greater and immediate impact on the Grid than demand increases because of the size of a generator relative to the more gradual increases in local demand. The Grid often has to be reinforced to facilitate the flow of power from the generator to the rest of the system. This is true whether the generator is connected to the transmission system or to the distribution system.

Customer demand close to a generator can reduce the amount of power that must be transported away from the area. In certain parts of the network, therefore, higher demand levels may result in a reduced infrastructure build.

Demand for electricity

Demand for electricity has grown steadily since the early days of a national electricity supply. Electricity is a safe, versatile and economic form of energy favoured by industrial, commercial and domestic customers. A well established relationship exists between economic growth and electricity consumption. The forecast for demand levels in 2025 are based on the Economic and Social Research Institute's long-term forecast of moderate growth in economic activity.

One of the Government's main priorities towards creating a sustainable energy future is the area of energy efficiency and savings. A successful energy efficiency campaign will improve performance across all energy sectors including the electricity sector. One plausible outcome of the energy efficiency campaign is an increase in the share of electricity in the transport market. While **GRID25** is designed to meet increasing demand for electricity, albeit at a slower growth than experienced over the previous decade, EirGrid will continue to monitor the success of the Government's National Energy Efficiency Action Plan and adapt its transmission development programme as appropriate.

This Strategy envisages the use of new 'Smart Grid' technology in the form of smart metering, which will play a key role in giving customers control over their consumption and in efficient use of grid infrastructure.

The trend in geographical distribution of loads is regularly monitored by EirGrid. Analysis of the current distribution indicates that about 58% of the demand is in the gateway cities and towns. The National Spatial Strategy (NSS) defines gateways as having a strategic location, nationally and relative to their surrounding areas and providing national-scale social and economic infrastructure and support services. **GRID25** supports the NSS goal of developing gateways and achieving

balanced regional development through planning for an increased 65% share of the total system demand figure for the gateways and through growing other demands at an equal rate across the country.

Renewable generation
Generation from renewable energy sources is a key plank in the Strategy to reduce carbon emissions and to maintain a sustainable energy supply. The Government has set a target of meeting at least 33% of electricity demand from renewable generation by 2020. It also intends setting further targets jointly with the relevant Northern Ireland authorities.

It is recognised in the Government's White Paper on *"Delivering a Sustainable Energy Future for Ireland"* that wind energy will play a pivotal contribution to meeting that goal. Ocean technologies and biomass are also expected to contribute.

Many of the locations suitable for renewable energy generation schemes are in areas where there have been little or no generation developments heretofore. The aggregate of renewable generation capacity in some areas is equivalent to large conventional generation stations and in many cases the network is not capable of carrying the power from these generation sources. Significant reinforcement of the Grid will therefore be required to cater for the new power flows from renewable generation. It will not be possible to utilise Ireland's natural resources of renewable energy without the essential upgrades outlined in GRID**25**.

The power flow analysis underpinning this Strategy considered the impact on grid development requirements of two distinct levels of renewable generation:

- **Meeting 33% of electricity consumption from renewable energy;**
- **Meeting 40% of consumption from renewables.**

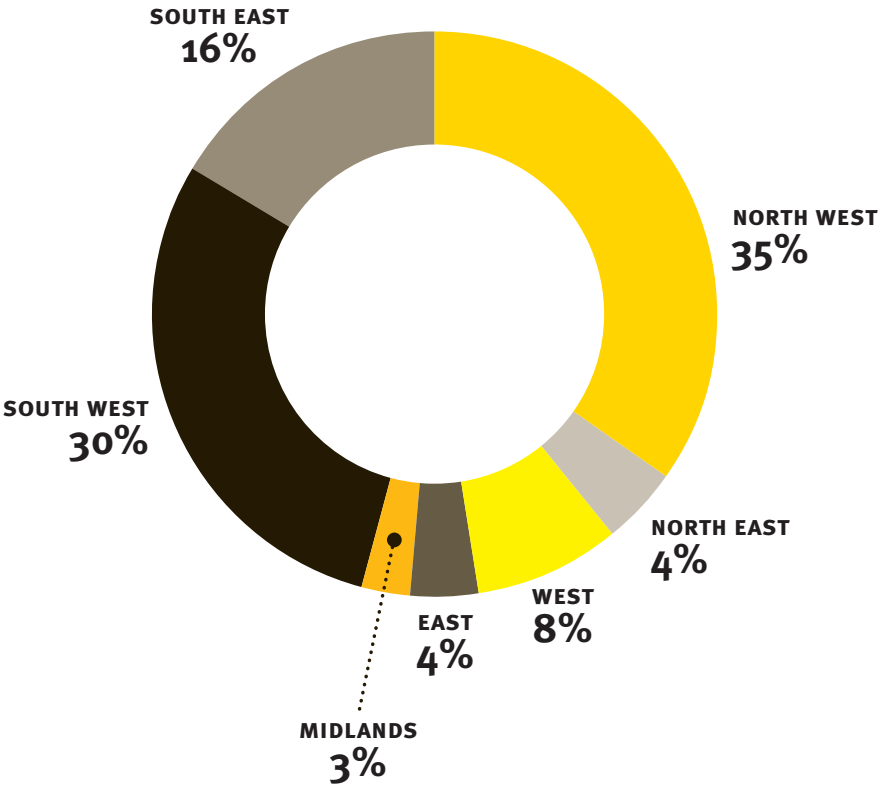
The following diagram illustrates the expected regional distribution of the renewable generation capacity.

Conventional generation
If 40% of electrical consumption is met by renewable generation, it follows that 60% must be supplied from non-renewable "conventional" generation or imports from abroad. Given that wind is expected to make up most of the renewable portfolio, the amount of conventional generation capacity must be adequate to ensure a reliable power supply for those hours when wind generation output is low.

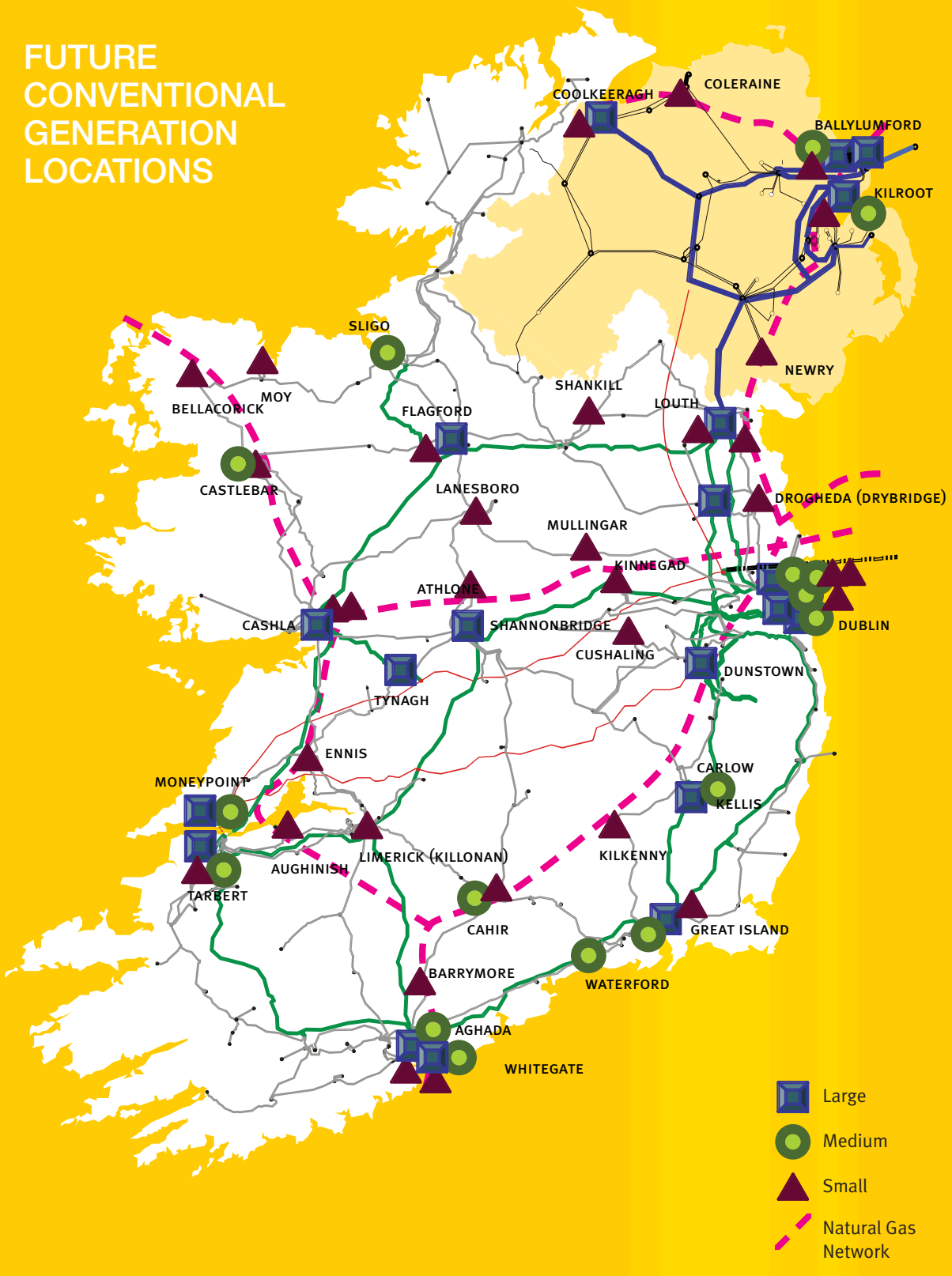
GRID**25** provides for a range of conventional generation scenarios locating close to:

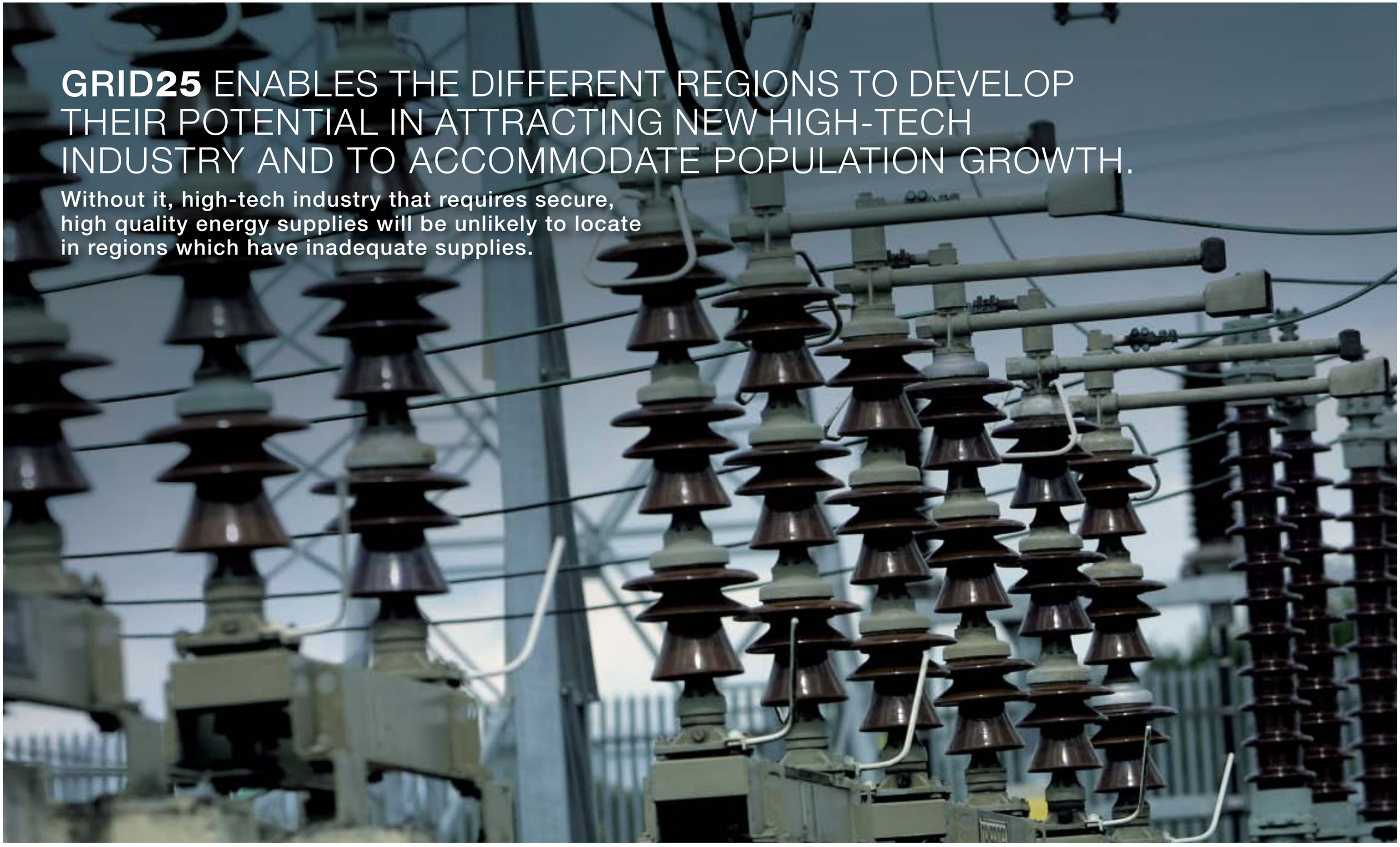
- principal sea ports;
- existing station sites;
- strong transmission nodes.

REGIONAL DISTRIBUTION OF RENEWABLE CAPACITY



FUTURE CONVENTIONAL GENERATION LOCATIONS





GRID25 ENABLES THE DIFFERENT REGIONS TO DEVELOP THEIR POTENTIAL IN ATTRACTING NEW HIGH-TECH INDUSTRY AND TO ACCOMMODATE POPULATION GROWTH.

Without it, high-tech industry that requires secure, high quality energy supplies will be unlikely to locate in regions which have inadequate supplies.

Interconnection

The East-West interconnection project currently being progressed by EirGrid will provide a 500 MW link with the UK Grid. It is likely that by 2025 at least one further interconnector from this system to another off-shore system, either Britain or France, will be in place. Greater penetration of renewable sources may provide a case for still further interconnection projects.

GRID**25** will provide for the connection of further interconnectors along the south-east or southern coast as these are the most likely regions for interconnectors to connect to the system.

These interconnectors could play a significant role in internationalising the Irish energy market and in facilitating the anticipated high levels of renewable generation on the island by providing a means to export excess generation when output from renewable generation is high and to import power when it is low.

03 FUTURE GRID REQUIREMENTS

Through forward planning we will achieve increased capacity with only a 20% increase in the total length of the network.

Additional grid capacity required

The Transmission Grid in Ireland is made up of circuits and equipment at three voltage levels 400 kV, 220 kV and 110 kV. The 400 kV network and the more extensive 220 kV network are the main means of transporting bulk power around the country.

The 220 kV network was first introduced in the early 1960s and the 400 kV network was built in the early 1980s. Since the mid-1980s this bulk power network has changed little while demand in the same period has grown by over 150%, leaving little capacity for further growth. The anticipated increasing power flows on the system means that between now and 2025 the capacity of the bulk transmission system will need to be doubled.

The key factors that will cause power to flow and that therefore drive future investment in the Grid are:

- **Higher demand levels, up to and including maximum forecast demand of 60% distributed throughout every region;**
- **Significantly higher renewable generation capacity levels;**
- **Location of new conventional generators and output levels;**
- **Connection point of further interconnectors and transfer levels.**

The 110 kV network, which brings power from the bulk networks to individual towns and large loads, also needs to be substantially upgraded.

Estimated grid development requirements

The following indicates the amount of infrastructure development required to strengthen the Grid[1].

- **Approximately 1,150 km of new circuits will be required. This represents an increase of about 20% on the total length of the existing network. Of this, 800 km will need to be at 220 kV or higher; the other 350 km will be at 110 kV. In addition to these circuits, others will be needed to connect many of the new generators to the Grid;**
- **2,300 km of the existing transmission network will need to be upgraded to provide greater capacity. This includes 1,100 km or 70% of the existing 220 kV network and 1,200 km of the 110 kV network.**

There are a number of technical options to achieve this increase in network capacity. These are further discussed in Appendix A, *"Technical Options for Grid Development"*.

This level of new build and upgrading represents a major shift in the scale of infrastructure development from today's levels and will present significant challenges to all involved in its delivery.

Upgrading existing lines generally requires taking the lines out of service for lengthy periods of time to make changes to conductors and /or the structures supporting them. The reason the lines are being upgraded is that the power trying to flow on them exceeds their existing capabilities. Taking them out of service for

1 These figures do not include the current development programme as detailed in the *"Transmission Development Plan 2007-2011"*, or any new interconnectors, or the circuits that will be required to connect new generation stations, both renewable and conventional, to the Grid.

upgrading will put a severe strain on the operability, reliability and efficiency of the power system. EirGrid will have to develop innovative upgrading methods to limit the impact on customers both in terms of costs and supply security.

Building 800 km of 220 kV or 400 kV lines will present its own challenges. In many cases, the new capacity provided by these lines will need to be in place before some of the existing lines can be upgraded. We will have to find quicker ways of progressing through all the various phases of planning and construction to deliver a system capable of accepting large amounts of new renewable and conventional generation.

04 THE GRID DEVELOPMENT STRATEGY

New bulk transmission lines will be built at 400 kV. Building one 400 kV circuit avoids the need for building a multiplicity of 220 kV lines and so has less long-term impact on the environment and on local communities.

GRID**25** will deliver an efficient transmission network for Ireland's social and economic development. It will have the necessary capacity to reliably transport the future anticipated power levels from renewable and conventional generators and interconnectors to the cities and towns and the villages and homes where the power is required.

We will follow international best practice and innovative methods to provide the necessary transmission capacity. The technology options available to implement GRID**25** will increase as research and development is carried out. We will be proactive in investigating and adopting new technologies taking due consideration of the cost and effectiveness of the technology.

New transmission lines will be built at 400 kV and at 110 kV. Building at 400 kV rather than 220 kV is more efficient and provides greater power carrying capability. Building one 400 kV circuit avoids the need for building a multiplicity of 220 kV lines and so has less long-term impact on the environment and on local communities.

In the longer term it may be appropriate to upgrade the 220 kV network to 400 kV for similar reasons of efficiency and capacity. We will examine each case as the need to upgrade arises and consider the option of using a higher capacity conductor at 220 kV or rebuilding at 400 kV.

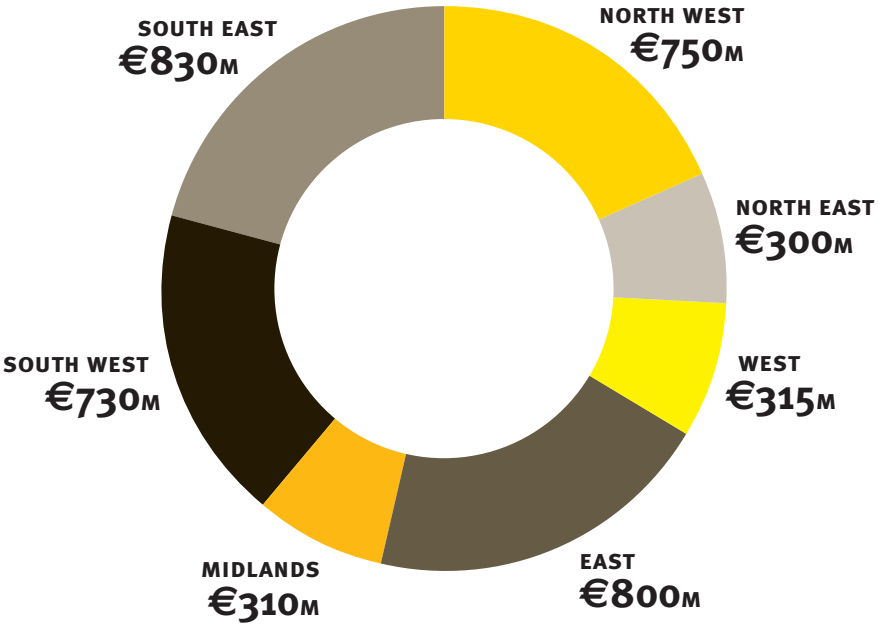
Striking a balance

EirGrid has a statutory obligation to balance the provision of reliable transmission services with the costs to the final customer and with the impact of transmission infrastructure on the environment.

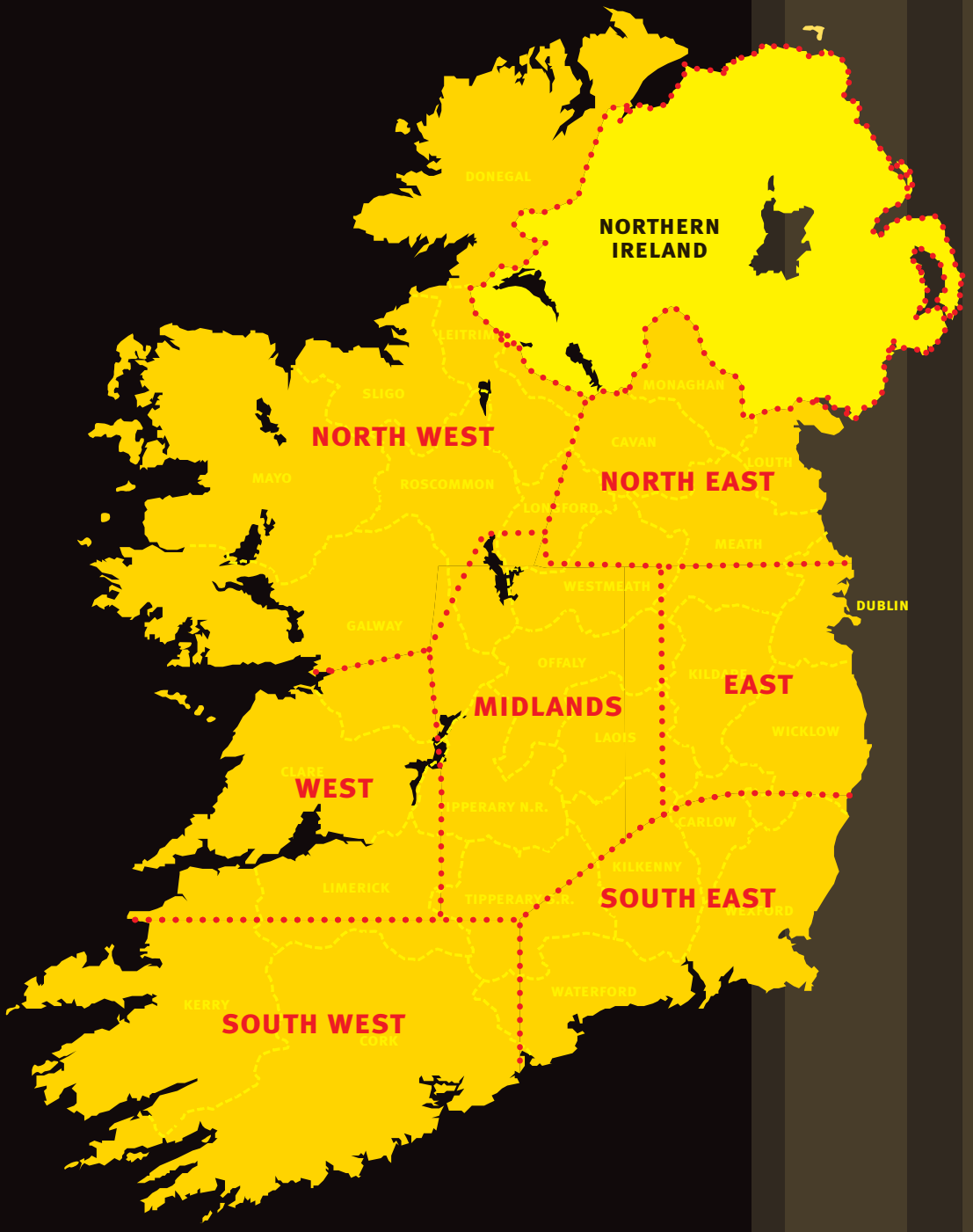
GRID25 strikes a balance between costs, reliability and environmental impact. It examines the totality of developments and considers social acceptance at an affordable price in the context of the overall long-term network development. In particular we will endeavour to minimise the net length of new line build in a region through a number of initiatives:

- **We will utilise the existing network where possible to avoid building new overhead circuits. In many cases re-utilising the existing network is more costly than building new circuits but the Strategy results in less impact on the environment;**
- **We will seek to up-rate existing lines by using a higher capacity conductor, where appropriate. Using traditional conductor types would generally involve modifying or taking down and changing the towers or poles that support the conductor. A change that involves a long circuit outage of one or more years will have serious ramifications for the security of supply during the outage. We will therefore use new light-weight high capacity conductors as they become commercially available and where possible to avoid the need for major structural changes and so to minimise security issues;**
- **Where the required increase in capacity cannot be provided by a new conductor operating at the same voltage, we will consider upgrading the circuit to a higher voltage;**
- **Where appropriate, we will consider replacing an existing line with a double circuit line to provide the required additional capacity. This is a more costly option and is somewhat less reliable than having two separate lines but it avoids building a new line on a separate route;**
- **In certain limited circumstances we will put selected 110 kV circuits underground to minimise the impact of new build in a region. This will be considered in areas where there is congestion of urban development, a multiplicity of overhead lines, a relatively wide expanse of water or an area of unique natural beauty. A 110 kV underground solution would not be advanced where the ground conditions were unsuitable either because of the risk to the environment or because of construction difficulties;**
- **We will examine the potential for using HVDC technology for appropriate applications such as transporting high volumes of power over long distances;**
- **We will consider the appropriateness of new tower designs and other mitigating measures outlined in the Government-sponsored report recently issued on *"The Comparative Merits of Overhead Electricity Transmission Lines Versus Underground Cables"* in order to minimise the landscape and visual impact of necessary infrastructure. We will also take account of the National Landscape Strategy when it is published.**

PROPOSED EXPENDITURE BY REGION

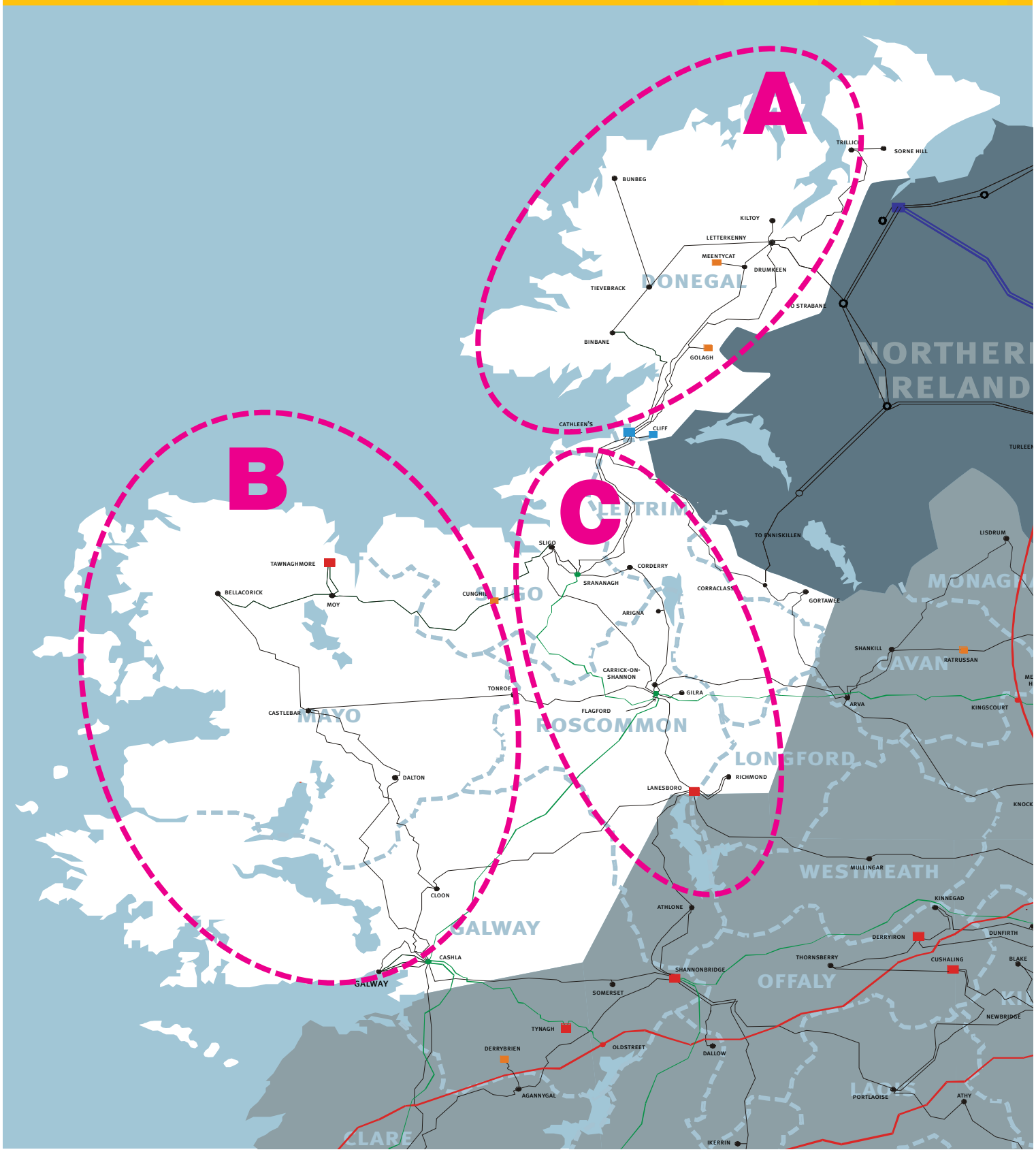


05 A REGIONAL VIEW



EirGrid has divided up the network into seven regions. It is emphasised that the maps here are illustrative only. All areas and regions of Ireland will be covered by GRID**25**.

NORTHWESTREGION



This area is particularly rich in wind and ocean renewable energy resources. The planned gas pipeline, connecting the Corrib gas field off Mayo to Galway, will provide the opportunity for gas fired generation along the route of the pipeline.

The transmission network in the North West is predominately at 110 kV, with very little 220 kV and no 400 kV network in the region. There are two 110 kV circuits linking the Northern Ireland and Republic of Ireland transmission systems, Letterkenny to Strabane and Corraclassy-Enniskillen. These provide standby support between relatively weak parts of the two systems.

Key developments

It is expected that demand in the region will grow by up to 60% by 2025. Area A (Donegal) is expected to have up to 691 MW of wind generation, with Areas B (Mayo/Galway) and C (Leitrim/Roscommon) having 880 MW and 269 MW respectively. Area B is also expected to have up to 240 MW of wave generation and 31 MW of off-shore wind. If ocean technologies, for whatever reason, do not develop sufficiently for such large scale deployment by 2025, the network capacity that might have been attributed to it could be utilised by other more established renewable technologies such as wind generation.

Grid development in the region will include:

- **An additional investment of approximately €750m to upgrade almost 700 km of the existing transmission network and to build new circuits;**
- **Extension of the 220 kV network into Sligo, already in progress;**
- **110 kV reinforcements between Killybegs (Binbane station) and Letterkenny and Ballaghadreen (Tonroe station) and Castlebar;**
- **Major infrastructural development from Mayo to the main bulk transmission system in the eastern part of the region;**
- **Further integration of the Donegal and Northern Ireland networks.**

Benefits

- **The North West can become a net exporter of power to the rest of the island, reducing its reliance on generation from outside the region;**
- **Plans will facilitate the growth of renewable generation connections in the region;**
- **The increased power supply will accommodate and help attract future industry.**

Consequences of non-action

- **By the second half of the next decade, there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will be not be enough capacity in the network to connect further renewable generation; as the north west is a renewable-rich region this will have severe consequences on the ability of Ireland to meet its renewable targets and its long-term sustainable energy supplies.**

€750m estimated total GRID25 investment in the North West Region

IT IS VITAL THAT IRELAND HAS THE ELECTRICITY SUPPLY INFRASTRUCTURE TO ENSURE OUR ECONOMIC GROWTH, AND MAXIMISE OUR COMPETITIVENESS.

Without GRID25, the power system will not be able to guarantee security of supply or competitiveness in the marketplace.

NORTHEASTREGION

This region has some potential for on-shore wind generation and high potential for off-shore wind.

The area shares a border with Northern Ireland, which makes the region and the interconnector that will run through it significantly important to the All-Island Single Electricity Market. The 220 kV and planned 400 kV transmission network in the region provides a strong power corridor between Dublin and Belfast.

A high capacity gas pipeline runs between north Dublin and the Northern Ireland gas system, providing potential for gas-fired generation in the north east.

Key developments

Between 1995 and 2005 the demand in the region has grown by about 55%. It is expected that by 2025 the demand will have grown by a further 60%. Renewable generation connections are expected to include up to 145 MW wind generation in Area A and 125 MW off-shore wind generation in Area B.

Grid development in the region will include:

- **An additional investment of approximately €300m in the region;**
- **The North-South Interconnector (400 kV) connecting Kingscourt in Cavan to Turleenan in Tyrone;**
- **A new 400 kV circuit from Woodland in Meath to Kingscourt in Cavan;**
- **Strengthening of power circuits between the North West region and the North East region facilitating power flows;**
- **Reinforcement of 110 kV networks supplying Cavan and Monaghan;**
- **Upgrading about 240 km of the existing transmission network.**

Benefits

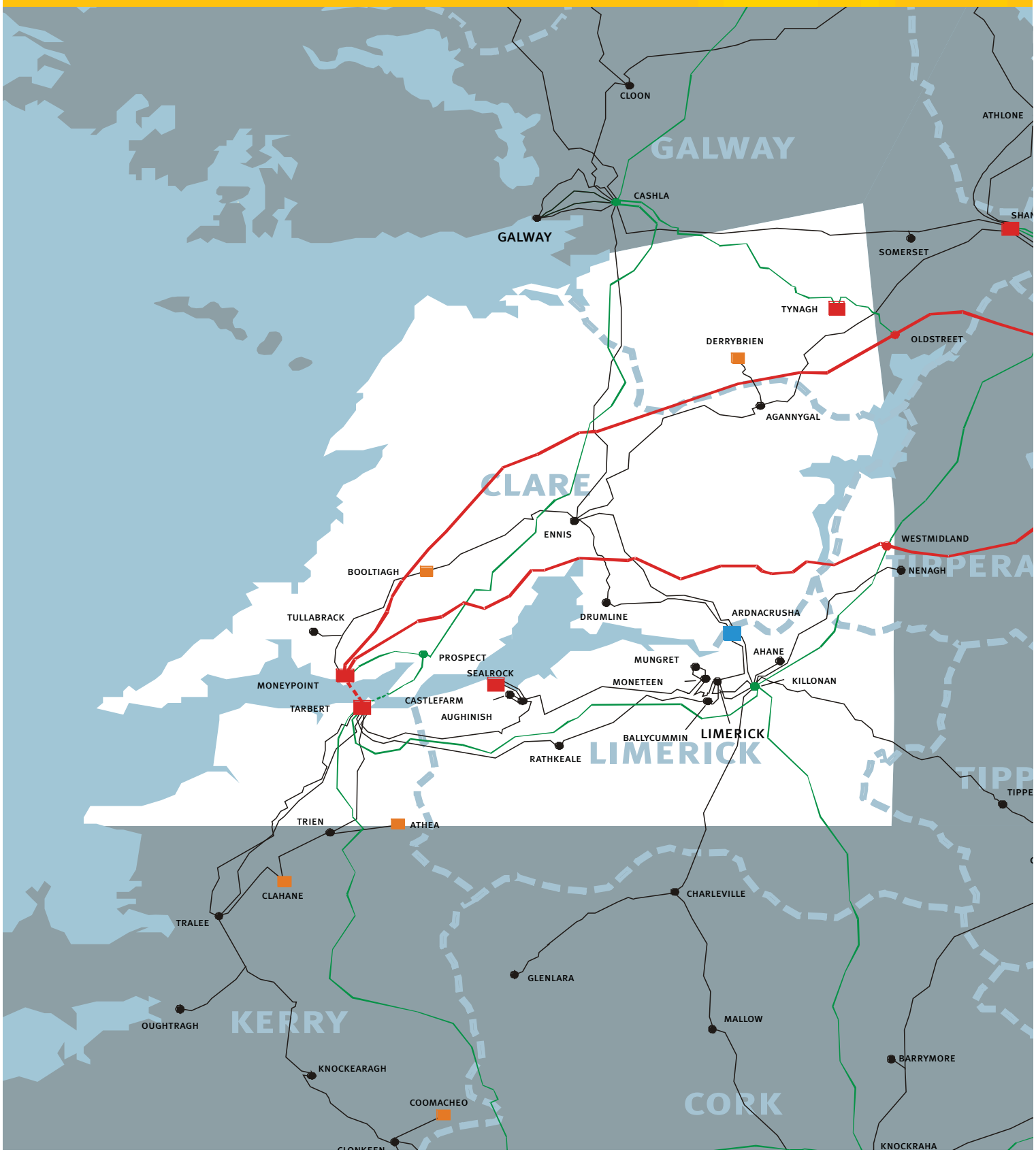
- **The North-South interconnector and the Woodland-Kingscourt line will provide long-term capacity between the Northern Ireland and the Republic of Ireland systems and ensure security of supply to the North East region;**
- **Provides for substantial increase in electricity demand in the region;**
- **There will be increased opportunities to provide renewable energy in the region;**
- **Increased opportunities for gas-fired generation technologies.**

Consequences of non-action

- **Within a matter of years there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **The network will not be adequate to allow efficient operation of the All-Island market, meaning that customers will not benefit from the cheapest electricity available;**
- **There will be no capacity in the network to allow further renewable generation to be connected; this will deny Ireland the opportunity to exploit its off-shore wind resources and will have severe consequences on the ability of Ireland to meet its renewable targets and its long-term sustainable energy supplies.**

€300m estimated total GRID25 investment in the North East Region

WESTREGION


CLOON
ATHLONE
GALWAY
CASHLA
GALWAY
SOMERSET
TYNAGH
OLDSTREET
DERRYBRIEN
AGANNYGAL
CLARE
ENNIS
WESTMIDLAND
NENAGH
BOOLTIAGH
TULLABRACK
DRUMLINE
ARDNACRUSHA
AHANE
PROSPECT
MUNGRET
SEALROCK
MONEYPOINT
MONETEEN
KILLONAN
TARBERT
CASTLEFARM
AUGHINISH
BALLYCUMMIN
LIMERICK
RATHKEALE
LIMERICK
TRIEN
ATHEA
CLAHANE
CHARLEVILLE
TRALEE
GLENLARA
MALLOW
OUGHTRAGH
KERRY
BARRYMORE
KNOCKEARAGH
COOMACHEO
CORK
KNOCKRAHA

This region features an availability of natural resources for wind and ocean technologies. Hydro-generated electricity is already produced on the Shannon Estuary.

The area already has large-scale power stations in Tarbert, Moneypoint and Tynagh and a gas transmission pipeline from Galway to Limerick which passes close to a number of potential locations suitable for gas-fired generation projects.

There are 400 kV, 220 kV and a number of 110 kV circuits in the region.

Key developments

By 2025, peak demand for electricity is expected to increase by 60% (estimated in 2007). The region is expected to have up to 440 MW of wind generation and 75 MW of wave generation.

Grid development in the region will include:

- **An additional investment of approximately €315m in regional transmission network;**
- **Upgraded networks supplying the large urban centres of Ennis and Limerick;**
- **Up-rating over 250 km of existing networks to facilitate higher capacity power flows, using existing corridors where possible;**
- **Strengthening the transmission capacity across the Shannon Estuary.**

Benefits

- **Provides for substantial increase in demand into the future;**
- **Allows for renewable resources from both wind and wave to feed into the National Electricity Grid.**

Consequences of non-action

- **Within the next five to ten years there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will be no capacity in the network to allow further renewable generation to be connected; this will have severe consequences on the ability of Ireland to meet its renewable targets and its long-term sustainable energy supplies.**

€315m estimated total GRID25 investment in the West Region

EASTREGION


ARVA
KINGSCOURT
DRYBRIDGE
NAVAN
GORMAN
PLATIN
KNOCKUMBER
MEATH
STEVENSTOWN
EAST WEST HVDC INTERC
BALTRASNA
MULLINGAR
WOODLAND
CORDUFF
GLASMORE
HUNTSTOWN
KILMORE
GRANGE
DUBLIN
KINNEGAD
FINGLAS
NORTH WALL
MACETOWN
COLLEGE PARK
POOLBEG
DERRYIRON
DUNFIRTH
MAYNOOTH
CLONAWADE
SHELLYBANKS
IRISHTOWN
INCHICORE
COOKSTOWN
CUSHALING
BLAKE
CARRICKMINES
MONREAD
KILDARE
KILTEEL
FASSAROE
BARODA
NEWBRIDGE
CHARLESLAND
DUNSTOWN
POLLAPHUCA
TURLOUGH
HILL
WICKLOW
PORTLAOISE
ATHY
STRATFORD
BALLYBEG
SHELTON
ABBEY
ARKLOW
BALLYRAGGET
CARLOW
KELLIS
CARLOW
BALLYCADDEN
BANOGE
KILKENNY
LONDGEWOOD
CRANE
BALLYWATER
WEXFORD

This region has the potential for high levels of conventional generation as a result of the existing gas grid and the proximity of Dublin Port. Wind resources are confined mainly to off-shore locations. There are large-scale thermal generating stations at Poolbeg, North Wall, Huntstown and Irishtown and a pumped storage facility at Turlough Hill in Wicklow.

The 220 kV network within Dublin and the 220 kV and 400 kV network linking the East region with the rest of the island will require significant development to increase the flow of power to and from the region and to accommodate future imports and exports of power through the interconnector between Ireland (Woodland, Co. Meath) and Great Britain (Deeside, Wales), due to be operational during 2012.

Key developments

The demand for electricity in the East region is expected to increase by over 80% by 2025 and will then be 30% of the demand of the island. Up to 240 MW of wind generation is expected to be connected to the Grid in this region.

Grid development in the region will include:

- **An additional investment of approximately €800m through upgrading approximately 450 km of the existing network and building new circuits;**
- **Strengthening of network into and out of the region to allow the demand to be met by renewable generators located mainly in the west of the country;**
- **Strengthening of network serving Dublin City load;**
- **Development to allow north-south flows to by-pass the network serving the Dublin load;**
- **Construction and connection of new 220 kV stations in north and West Dublin to cater for the rapidly growing developments in these areas;**
- **Reinforcement of the network to cater for strong growth in Kildare and North Wicklow.**

Benefits

- **Improvements will ensure security of supply to the region;**
- **Infrastructure to attract future industry;**
- **Provision for the use of renewable energy in the region.**

Consequences of non-action

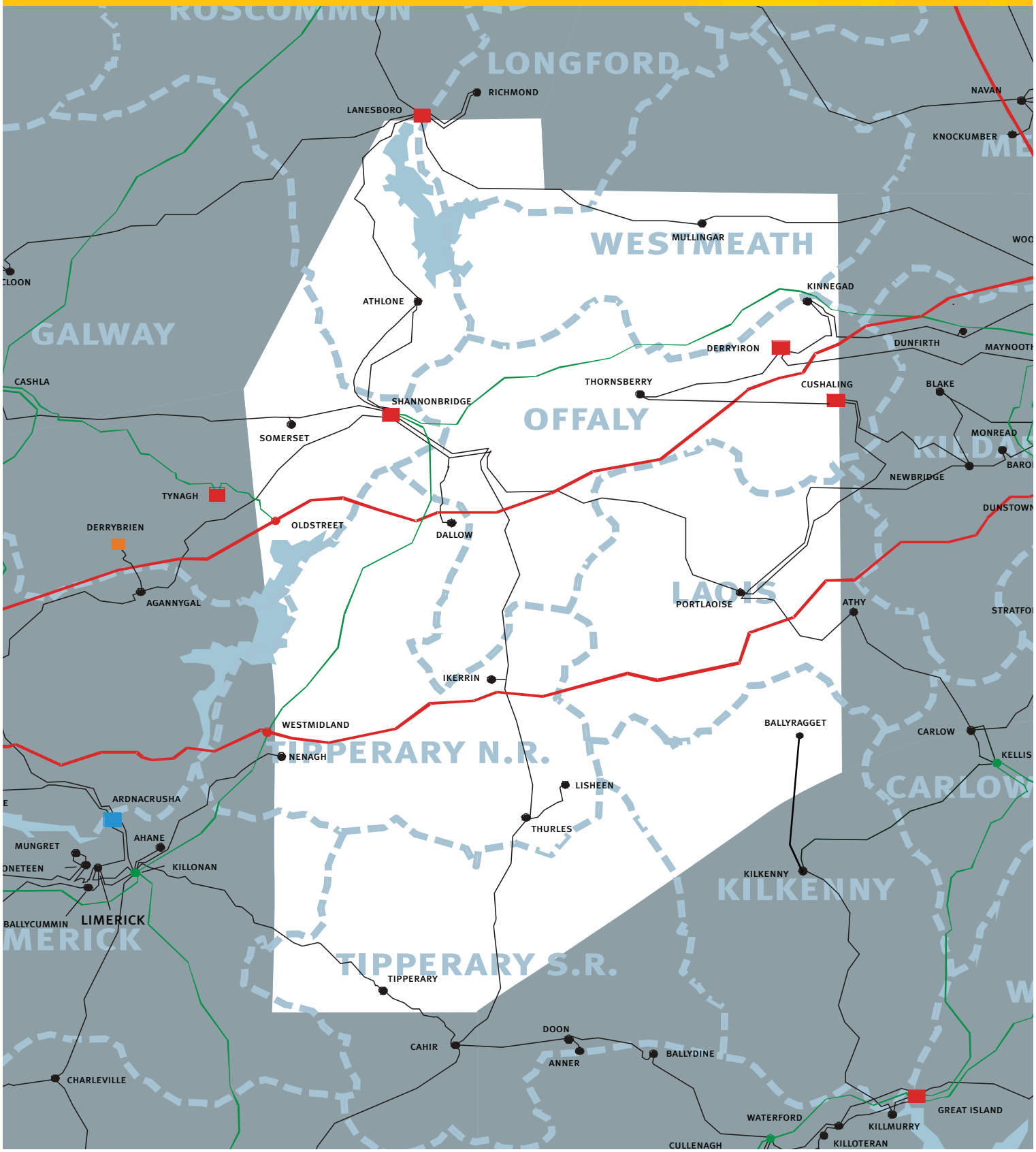
- **In the medium term, there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will not be adequate capacity in the network to allow for excess renewable generation to be exported over the planned East-West interconnector; this will curtail renewable generation at times, reducing the commerciality of renewable developments and consequently the likelihood of necessary progression.**

€800m estimated total GRID25 investment in the East Region

GRID25 WILL ENSURE THAT IRELAND HAS THE BEST POSSIBLE PLATFORM IN TERMS OF A WORLD-CLASS, COMPETITIVE AND SUSTAINABLE ELECTRICITY SYSTEM.

Without it, the needs of new and current residential clients will not be met.

MIDLANDSREGION



The main Dublin-Galway gas transmission pipeline passes through the Midlands region close to transmission stations at Athlone, Edenderry, Kinnegad and Mullingar.

There are modest wind resources available in the Midlands region. There are three peat-burning stations at Lanesboro, Shannonbridge and Cushaling stations. Supply in the region is served mainly through the 110 kV meshed network, although a number of higher capacity 220 kV and 400 kV lines pass through providing potential for substantial increased supplies.

Key developments

By 2025, the demand in the Midlands region is expected to grow by over 40%. It is expected to have up to 160 MW of wind energy.

Grid development in the region will include:

- **An additional investment of approximately €310m through upgrading 225 km of transmission network and new circuit build;**
- **Tapping in to the existing 400 kV line to strengthen the 110 kV network around Portlaoise providing capacity to supply the continuing strong growth in Kildare and Laois;**
- **Reinforcement to cater for continued demand growth in the gateway towns of Athlone, Mullingar and Tullamore;**
- **Upgrading will facilitate power flows from both renewable and conventional sources and maximise the use of existing power corridors.**

Benefits

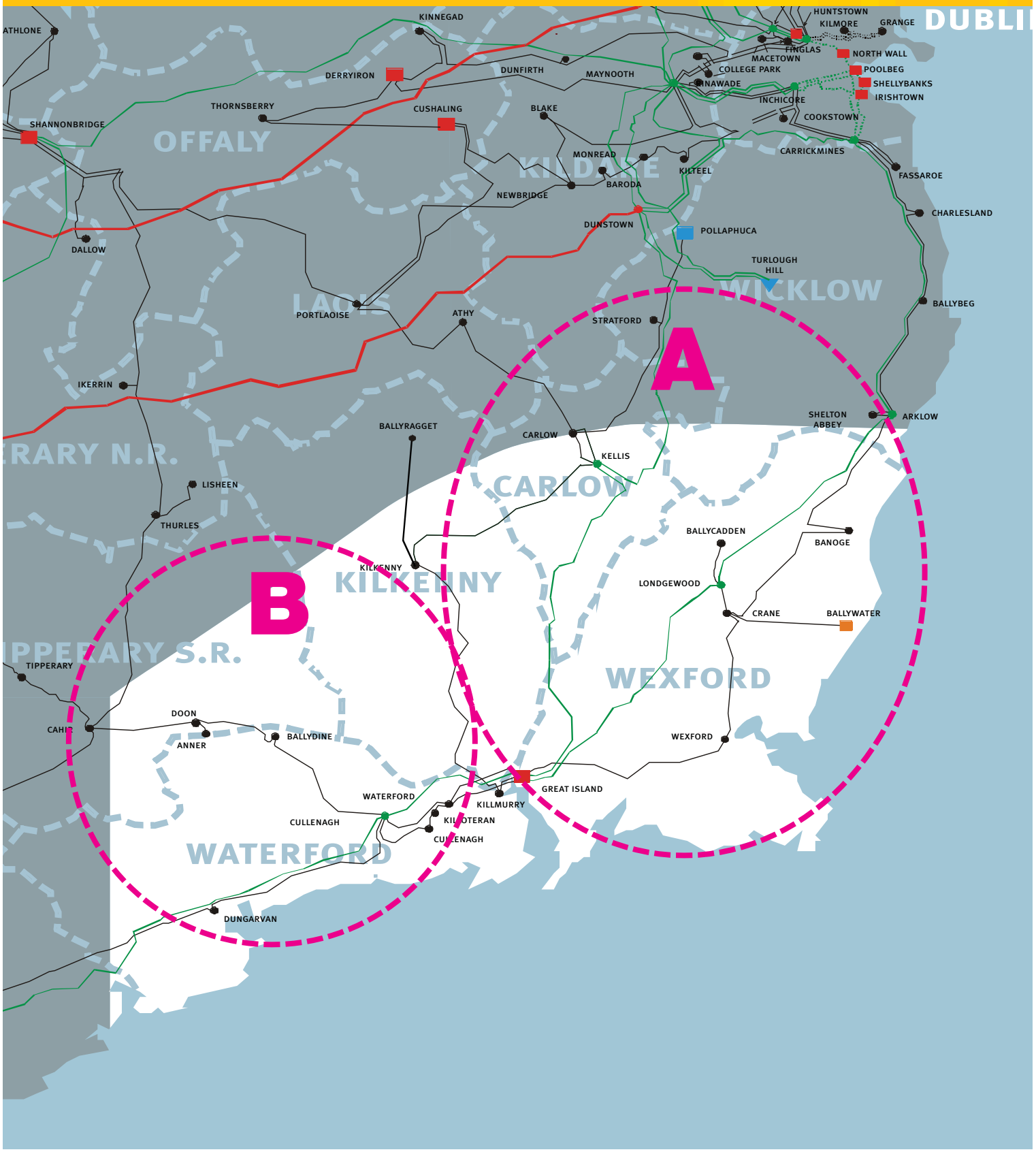
- **Future growth in demand will be accommodated;**
- **There will be increased security of supply to the region;**
- **Increased transmission capacity will allow for growth of renewable generation connections in the region;**
- **Network capacity to allow for small-scale thermal generation in the region.**

Consequences of non-action

- **Over the next five to ten years, there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will be no capacity in the network to allow further renewable generation to be connected.**

€310m estimated total GRID25 investment in the Midlands Region

SOUTHEASTREGION



This region has good wind resources. There is at present a 220 kV network passing through the region providing high-capacity supply to the region and an underlying 110 kV network throughout.

There are existing large-scale generation facilities with fuel-handling capabilities at Great Island station. The main Cork to Dublin gas transmission network passes through the region. There is a possibility of connecting the Great Island facility and other potential generation sites to the gas transmission network in the future.

Key developments

Demand in this region is expected to increase by over 45% by 2025. Area A on the map is expected to have 335 MW of on-shore and 445 MW off-shore wind generation, while Area B should have 210 MW on-shore wind generation. A new interconnector from this region to either Great Britain or mainland Europe will enable the export and import of power when appropriate.

Grid developments in the region will include:

- **An additional investment of approximately €830m will be required to upgrade approximately 490 km of the existing network and to build new infrastructure;**
- **Strengthening of the 220 kV links to both Dublin and Cork to facilitate increased power flows;**
- **Strengthening the networks supplying the major cities and towns in the region;**
- **Reinforcement of current infrastructure, including up-rating 110 kV and 220 kV circuits, while maximising the use of existing corridors where possible.**

Benefits

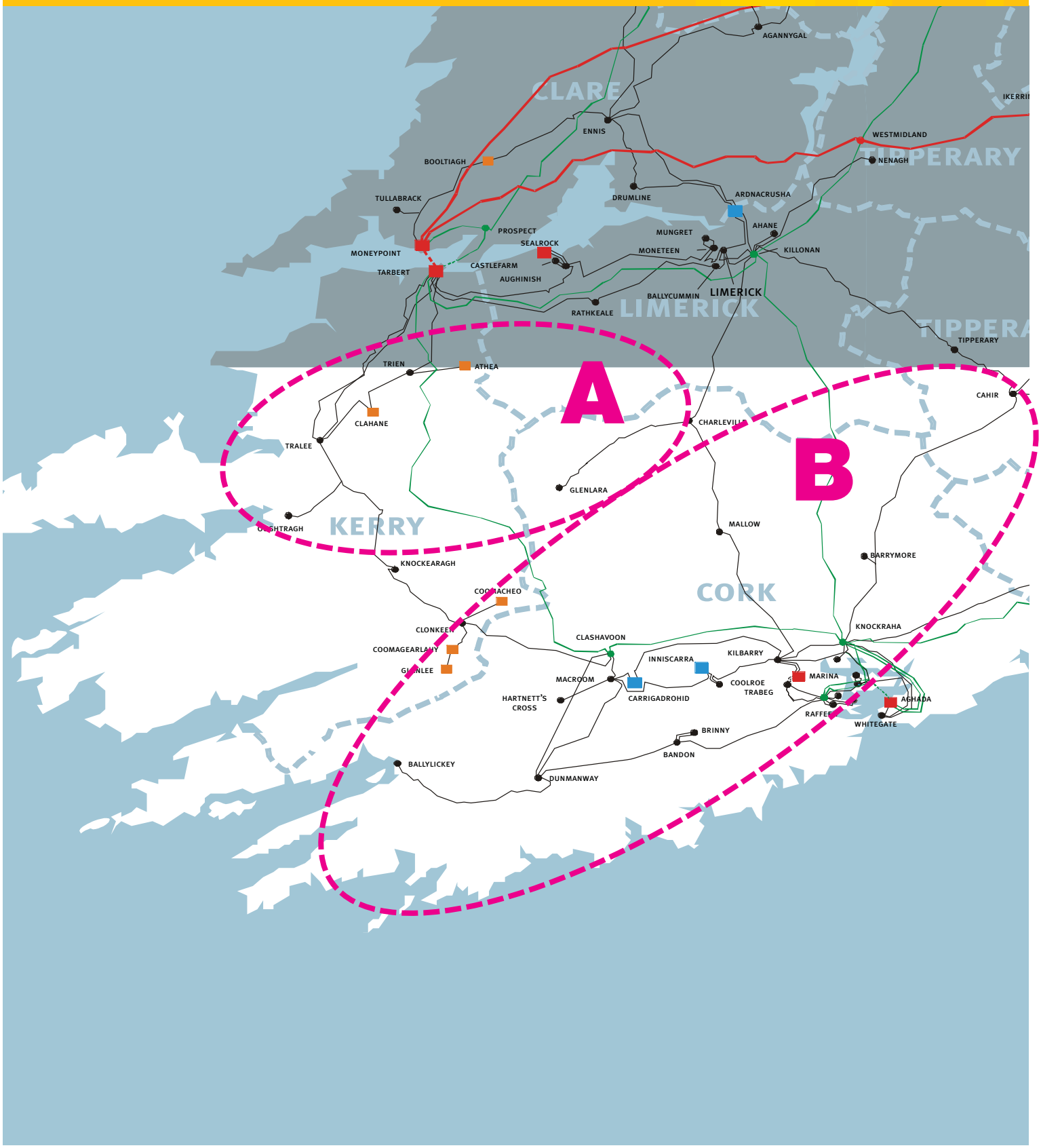
- **Proposals will ensure security of supply to major urban areas and to the region as a whole;**
- **Will allow for substantial growth in renewable generation connections in the region;**
- **Future growth in demand from both industry and domestic users can be accommodated.**

Consequences of non-action

- **Over the next five to ten years, there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will be no capacity in the network to allow further renewable generation to be connected; this will have severe consequences on the ability of Ireland to meet its renewable targets and its long-term sustainable energy supplies;**
- **Further interconnection will not be possible in this region.**

€830m estimated total GRID25 investment in the South East Region

SOUTHWESTREGION



Cork and Kerry in particular feature an abundance of natural renewable resources for wind and ocean technologies. Hydro-generation on the River Lee also contributes renewable energy to the National Electricity Grid.

There are thermal generation facilities at Marina in Cork City and Aghada in East Cork with plans for new generators at Aghada and nearby Whitegate well in advance. The gas network passes close to the transmission system at numerous other points providing further potential for gas-fired generation in the region.

The transmission network in the region consists of both 220 kV and 110 kV circuits.

Key developments

Demand in the region is expected to rise by 60% by 2025. Area A is expected to have up to 730 MW of wind power and 145 MW of wave generated power, with Area B having up to 880 MW and 40 MW of both technologies respectively. Large parts of the network will be upgraded to accommodate this growth in demand and renewable generation.

Grid development in the region will include:

- **€730m will be invested in the infrastructure of the region, to include the upgrading of approximately 130 km of transmission network and new transmission developments;**
- **Strengthening of the Cork network to allow power to be exported from the two large gas-fired generators in East Cork;**
- **Planned grid reinforcements to connect significant amounts of wind generation;**
- **Significant strengthening of capacity between the South West and the South East to allow excess power to flow from both renewable and conventional sources to supply demand in other parts of the country.**

Benefits

- **Increased security of supply to the region;**
- **Greater number of renewable generators connected;**
- **Improved network will allow for exports of renewable generation from the region;**
- **Significant future growth in demand from both industry and domestic users can be accommodated.**

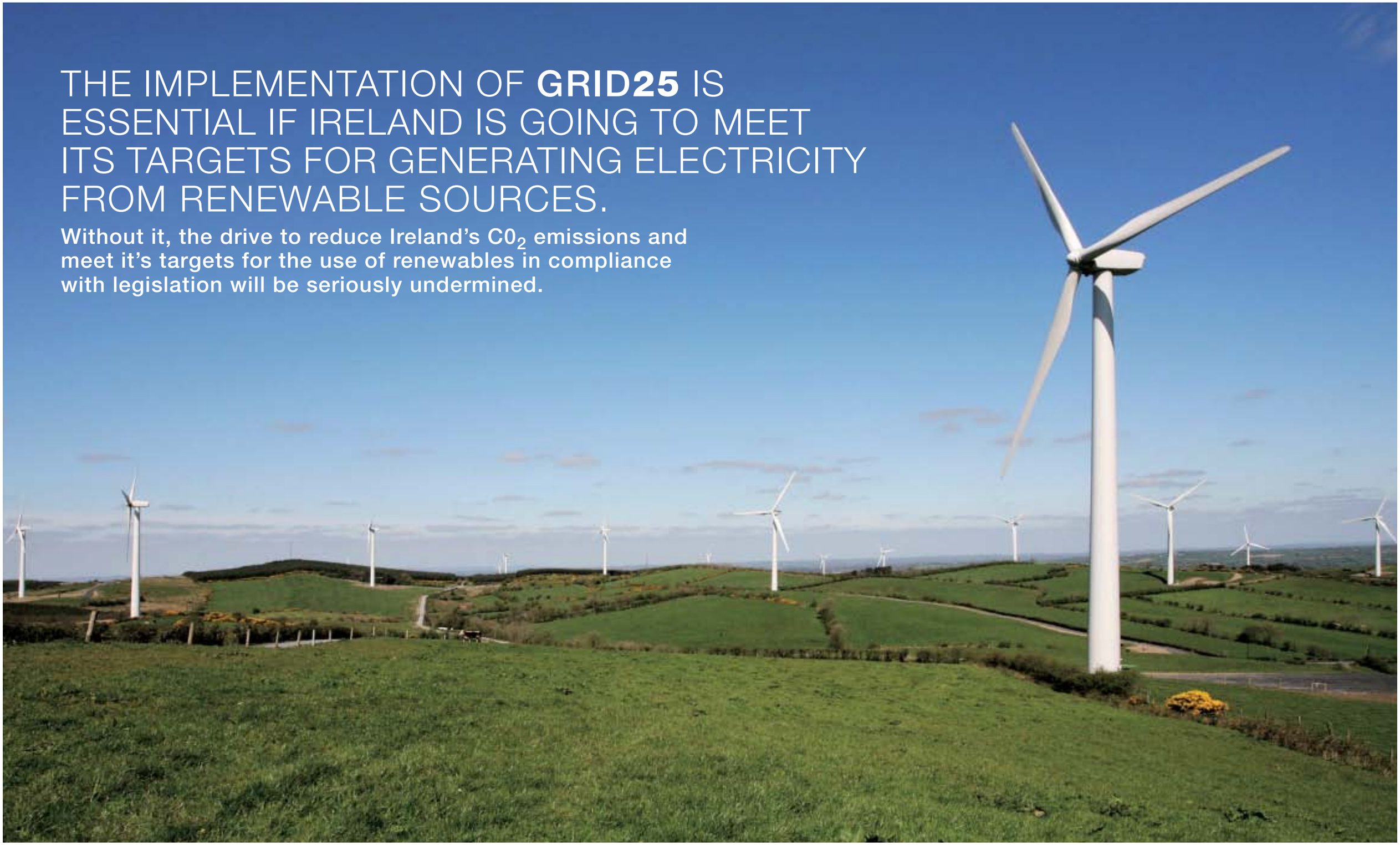
Consequences of non-action

- **In the short to medium term, there will be no capacity in the network to cater for new customers and the reliability of supply to existing customers will fall below normal international standards;**
- **There will be no capacity in the network to allow further renewable generation to be connected; as the South West is a renewable-rich region this will have severe consequences on the ability of Ireland to meet its renewable targets and its long-term sustainable energy supplies.**

€730m estimated total GRID25 investment in the South West Region

THE IMPLEMENTATION OF **GRID25** IS ESSENTIAL IF IRELAND IS GOING TO MEET ITS TARGETS FOR GENERATING ELECTRICITY FROM RENEWABLE SOURCES.

Without it, the drive to reduce Ireland's $C0_2$ emissions and meet it's targets for the use of renewables in compliance with legislation will be seriously undermined.



APPENDIX A

TECHNICAL OPTIONS FOR GRID DEVELOPMENT

As outlined above the future grid capacity requirements will be determined by the customers' long-term demands for electricity, by the output from generators built to supply that demand and by the flows across interconnections with other systems. EirGrid has calculated that, based on its vision of 2025, a significant increase in grid capacity will be required. The following sections discuss the technical options for delivery of the necessary capability and the research and development initiatives that EirGrid is undertaking to ensure that best practice is used.

Overhead and underground electricity lines

Overhead lines are the standard form of transmission throughout the world. Lines are made up of three conductors that carry the power from generators to loads and in many cases two earth wires that help protect the circuit from lightning faults. These wires are supported on either wood pole or steel mast structures.

High voltage (HV) circuits can only be laid underground using special HV cables designed specifically for underground use. The conductors in underground HV cables must be heavily insulated to avoid a short circuit between the conductor and the ground around the cable. As a result, the installation costs for an underground cable are far higher than for a simple overhead line.

Overhead lines cost significantly less to construct than underground cables. They are easier to pinpoint faults on and quicker to repair and so provide a cheaper and more reliable alternative to underground cables. While they do have an impact on the local visual environment, this is minimised as far as possible in construction and planning.

Only where it is not possible to find a route for overhead lines are high voltage (HV) underground cables used worldwide. Such situations arise, for example, when the area that has to be traversed consists of one or more of the following:

- **A built-up urban area where there is no space for support structures;**
- **An area with a multiplicity of existing overhead power lines;**
- **A relatively wide expanse of deep water;**
- **An area of unique natural beauty.**

There are two main reasons why underground cables are used so rarely at transmission voltages (110 kV, 220 kV and 400 kV). Firstly the capital cost of installing a cable is many times that of an equivalent overhead line and secondly the operating performance of an underground cable is not as good as that of an overhead line. The higher the operating voltage the stronger will be the case in favour of an overhead line.

While some lines are placed underground internationally, this is only a small proportion of the amount in place.

Statistics from the 23 European countries that make up the Union for the Co-ordination of Transmission of Electricity (UCTE) show that in 2006 only 1.7% of their combined Extra High Voltage grids (i.e., 220 kV and above) consisted of underground cable. The comparable figure for the Republic of Ireland was 4.7%. By contrast at transmission voltages below 220 kV the level of usage of underground cable in Ireland is lower than our European neighbours. It is therefore at this voltage, 110 kV, that EirGrid can give greater consideration to the use of cable.

When considering a transmission project in isolation however, neither a technical nor an economic case can be made for installing underground cable, even at 110 kV, unless confronted with a built up area, a vast expanse of water or an area where there is a multiplicity of overhead lines. In some countries lower voltage lines have been placed underground but, for the reasons given above, no country has adopted a policy of undergrounding high voltage lines.

Reasons for building at 400 kV

A 400 kV line typically provides three times more capacity than a 220 kV line and will meet long-term needs more effectively. Therefore one way of reducing the number of new lines in the long-term is to use the 400 kV voltage.

Power flow on a 400 kV line experiences much lower losses than the equivalent flow on a 220 kV line. Building at 400 kV therefore supports the EU and the Government's common objective of increasing energy efficiency.

Upgrading an existing 220 kV line to 400 kV can achieve similar efficiency and capacity gains. However, this would involve taking the existing 220 kV line out of service and dismantling it and building a new 400 kV line on the same route. The system could not operate without one 220 kV line for an extended period, it could not operate with a number of lines out of service simultaneously as would be the case if all 220 kV lines were upgraded to 400 kV by 2025.

Up-rating existing circuits

In recent years, a number of factors, including financial constraints and difficulties obtaining planning permissions for new infrastructure, have intensified interest in increasing the ability of existing circuits to carry higher levels of power.

A transmission line's ability to carry power depends largely on the type of

conductor used, the height of the conductor above ground and the operating voltage. Up-rating is a process where the current carrying capacity of existing high voltage lines is increased by using various strategies or techniques.

There are a number of different up-rating scenarios that can be applied to the Irish situation.

Some transmission lines can be up-rated by simply raising some of the support structures so that more power can be transmitted through the conductors without infringing electrical ground clearances. This method will be limited by the capacity of that particular conductor to carry the required power.

To overcome this conductor capacity limit, up-rating can be carried out by replacing the existing conductors with higher capacity conductors and by strengthening and/or raising the support structures. There are an increasing number of conductor types available, each with different current carrying capabilities, costs and service experience. It is our intention to use new high-capacity conductors where appropriate and affordable.

In the case that raising structures and replacing conductors will not meet requirements, further increases in power transfer capability can be achieved by replacing an existing transmission line with a higher voltage line along the same route. Replacing a 110 kV line with a 220 kV line will normally mean using steel lattice towers in place of wood pole structures.

Opportunities also become available to up-rate existing transmission lines during refurbishment programmes where extensive work would have to be carried out in any case on these lines.

Our policy is to examine all up-rating opportunities using existing infrastructure and line routes so as to minimise new build where possible.

As part of the process a rigorous examination of new technologies that can be employed will be initiated. Such opportunities may present themselves in the form of new conductor types or in utilising monitoring techniques which enable existing circuits to carry more power.

Tower design

Transmission tower design has been evolving over the last 70 years from the early double wood pole lines still in operation today to the steel lattice and monopole designs.

For all new projects, efficient and optimally designed towers are being developed, where the main feature of these towers is the reduced visual impact due to lower towers, a lower number of steel struts in the structure or new slimline monopole structures, all in various shapes and sizes.

With the availability of modern materials there are now numerous options available for the internal configurations, size, materials, colour and finish of each structure whilst having regard to the environmental, planning and practical consequences of each option.

As part of all new developments an investigation into the appropriate structure design taking into account all current and emerging designs will take place so as to minimise the impact on the existing environment.

The objective is to limit any impact of new transmission infrastructure on the landscape by combining tower design and robust route selection.

High Voltage Direct Current (HVDC)

In Ireland, like in all other countries of the world, the electricity that is distributed to electricity consumers is of the alternating current (AC) variety. The electricity that is generated by this country's power stations is also AC. The link between the power stations and the distribution network is provided by the high voltage Transmission Grid. Therefore the Transmission Grid also operates with AC electricity.

If a transmission grid was to be operated with direct current (DC) it would be necessary to install an AC/DC converter station at every power station and at every point of connection to the distribution network. Such AC/DC converter stations typically cost many tens of millions of Euro. Although the cost per km of HVDC underground cable and overhead line is cheaper that their AC equivalents the excessive cost of the converter stations makes the widespread use of HVDC unattractive, other than for bulk transfers over long distances where the savings in line or cable outweigh the additional costs of converter stations.

The need of the power system to respond instantaneously to increases in supply and demand, mean that HVDC technology is not feasible for a main grid system, although it may have a role in a few limited circumstances:

- **An AC to DC to AC connection can be used when two independent AC networks are to be linked together and the respective operators want their systems to continue to operate at different frequencies. The operator of the converter station would have complete control over the quantity and direction of flow of electrical power transferred between the two systems. An example of this would be EirGrid's planned East-West Interconnector between Ireland and Wales.**

- **DC transmission is more suitable than AC when a large amount of power is to be transferred over a very long distance on a radial (i.e., not meshed) circuit. HVDC overhead lines would typically be used to move 1,000 MW or more over distances in excess of 650 km. HVDC underground or sub-marine cables are typically used to move 250 MW or more over distances in excess of tens of kilometres. A long sub-sea crossing, such as that proposed for the East-West Interconnector, would be an example of where this would arise.**

EirGrid always investigates and stays up to date on all new technologies. EirGrid can see potential for HVDC in transmitting the bulk energy generated by clusters of renewable energy generators from the remote areas where they are normally located and where one would expect the existing Transmission Grid to be weak to areas where the existing Transmission Grid is already strong. As a result EirGrid, in partnership with Northern Ireland Electricity (NIE), has commissioned a technical study into the possible application of HVDC circuits on the island of Ireland.

Research & development

The technology options available to implement **GRID25** will increase as Research and Development is carried out. EirGrid will be undertaking initiatives in the following areas which will facilitate implementing the Strategy taking account of best practice:

- Dynamic monitoring of line loading;
- Conductor types;
- Tower design;
- 'Smart Grid' concepts;
- Underground cable technology and use.

Dynamic monitoring of line loading involves installing devices to monitor the loading of a line and the climatic environment. Combining dynamic knowledge of the environment, the line design and the system conditions may enable an existing circuit to carry more power. EirGrid has selected a specific line and is implementing a pilot project.

New technologies facilitate the development of new conductor types. High capacity lightweight conductor types are being developed. With lightweight and reduced thermal expansion properties, it may be possible to install such conductors on existing structures and gain increased capacity without visual changes to a line or additional rights-of-way. The availability and applicability of such technologies to the Irish Grid will be examined.

Investigation into the appropriate structure design, taking into account the emerging and current designs will take place so that each development uses the appropriate structure to minimise the impact on the existing environment. The ability to convert existing 220 kV structures to 400 kV operation will also be explored.

The 'Smart Grid' concept is a term used to refer to grids that use robust two-way communications and intelligent equipment and support greater participation of users of the Grid in contributing to the efficiency, reliability and safety of the operation of the Grid and power delivery. Smart Grids includes electronic control measures such as SCADA and remote control switching which have been in effective operation in Ireland for decades. Further developments in Smart Grids such as the integration and use of smart meters in system operation will be monitored and introduced as technology solutions when appropriate.

Underground cable technology and use will be kept under review. In partnership with NIE, EirGrid has commissioned a technical study into the possible application of HVDC circuits on the island of Ireland. EirGrid is participating in work being carried out through the international organisation CIGRE on cables in power systems.

APPENDIX B

GLOSSARY

A
AC
Alternating current

AC/DC converter
An interface between AC and DC systems comprising electronic equipment that rectifies AC current to DC or inverts DC current to AC

C
Circuit
An electrical circuit is a closed path formed by the interconnection of electrical components, such as an overhead line or transformer, through which an electric current can flow.

Conductor
A metal wire capable of carrying electrical current.

Conventional Generation
Types of generation technologies in existence prior to emergence of renewable energy generators

E
EirGrid
A state-owned company, EirGrid is the independent electricity Transmission System Operator (TSO) in Ireland and the Market Operator (MO) in the wholesale electricity trading system.

G
Grid
The transmission system is a meshed network of high voltage lines and cables (400 kV, 220 kV and 110 kV) for the transmission of bulk electricity supply around Ireland. The Grid, electricity transmission network and transmission system are used interchangeably in this document

H
HVAC
High Voltage Alternating Current – the standard for electricity generation, transmission and distribution worldwide.

HVDC
High Voltage Direct Current

O
Overhead line
A circuit comprising conductors and tower or pole support structures.

R
Renewable Generation
Generation from renewable energy sources such as wind, wave, tidal, biomass and photovoltaic cells.

S
Smart Grid
A transformed electricity transmission and distribution network or "Grid" that uses robust two-way communications, advanced sensors and distributed computers to improve the efficiency, reliability and safety of power delivery and use.

T
Transmission System
See "Grid"

U
Underground cable
A reinforced insulated electricity conductor placed underground.

Up-rating
Changing the conductor, the towers or the voltage of an overhead line to increase its power-carrying capability

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