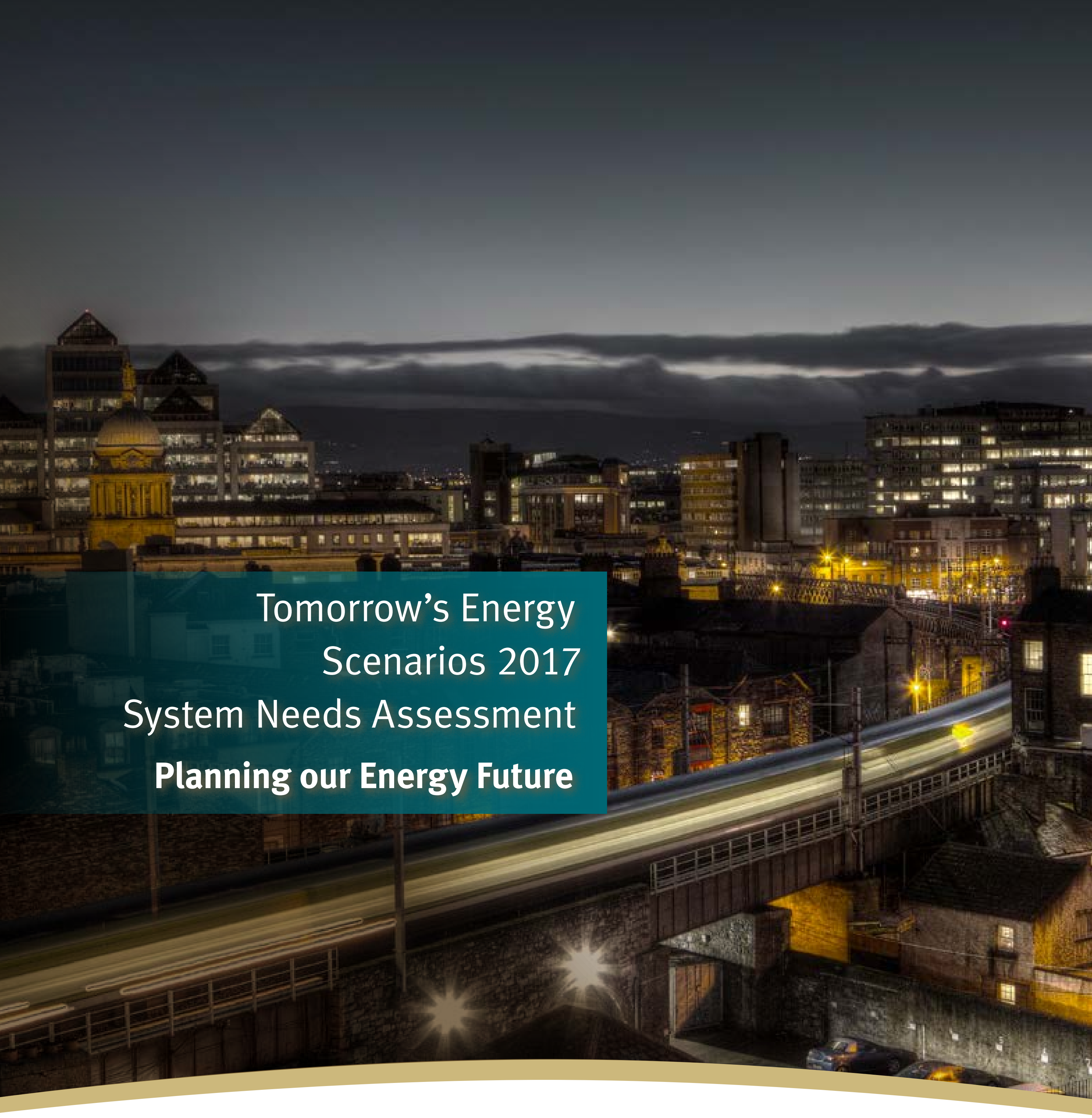

Tomorrow's Energy Scenarios 2017

System Needs Assessment

Planning our Energy Future

EIRGRID

The current. The future.

Disclaimer

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For queries relating to this document please contact: scenarios@eirgrid.com

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Table of contents

Foreword

We're delighted to present the *Tomorrow's Energy Scenarios 2017 System Needs Assessment* report, the culmination of our inaugural scenario development cycle.

In 2017 we introduced scenario planning into our grid development process. Four scenarios, detailing credible futures for the electricity sector in Ireland, were developed as part of Tomorrow's Energy Scenarios 2017. Our stakeholders helped to shape and enhance these scenarios, providing valued feedback as part of two consultations. Our scenarios show that Ireland's shift towards a low carbon electricity system is set to continue into the future. To facilitate this ongoing transition we must understand the development needs of the electricity grid.

Developing the grid, where required, is a crucial part of our role as transmission system operator (TSO) for Ireland, part of which is to ensure that the electricity grid continues to support Ireland's economic growth, expanding population, and society as a whole. Analysing our scenarios, and understanding their potential impacts, enables us to identify the future needs of the grid, in both infrastructural and technological terms, as part of our integrated grid development process.

This report outlines the long-term needs of the electricity transmission grid out to 2040. The results show how needs change over time depending on how the scenarios evolve and help to provide insight into how each scenario might impact the grid.

Future needs arise from changes in the usage of the grid, and are influenced by the speed and scale of changes to electricity consumption, generation, interconnection and storage. We are already tackling some of the needs identified as detailed in our *Transmission Development Plan 2017-2027*. We will continue to monitor and assess these, and other long-term needs, as conditions change and new information becomes available.

We very much welcome your feedback on how we can improve this document. Thank you to those who provided feedback during our Tomorrow's Energy Scenarios 2017 consultations.

Our scenario development cycle will recommence in spring 2019. We look forward to continuing to engage with you on Tomorrow's Energy Scenarios.

Mark Foley
Chief Executive, EirGrid Group
November 2018

Document structure

This document contains a glossary of terms, an executive summary, five main chapters, a next steps chapter, and an appendix. The structure of the document is as follows.

The **Glossary of terms** explains some technical terms used in the document.

The **Executive summary** summarises the main highlights of the document.

Chapter 1 explains the purpose of the *System Needs Assessment*, outlines why we use scenarios, and lists other related publications.

Chapter 2 explains the scenario development cycle and describes the storylines behind our four scenarios.

Chapter 3 describes our grid development strategy and our grid development process.

Chapter 4 outlines the approach taken to identifying needs and the types of needs and drivers.

Chapter 5 presents the results of the *System Needs Assessment* by grid area and scenario.

Glossary of terms

Area
A part of the transmission grid that contains a number of needs.

Circuit
An element of the transmission grid that carries electricity.

Conventional generation
A large power plant which typically uses fossil fuel(s) to generate electricity.

Driver
A factor that influences a need.

EirGrid
The independent statutory electricity transmission system operator in Ireland.

Fault
An unexpected loss of a grid element, such as a generation unit, transmission line, transformer or other electrical element.

Generation dispatch
A set of indicative outputs for generators, storage, interconnectors and demand side units required to meet system demand over a given time horizon.

Grid
The network of high voltage (400 (kilovolts) kV, 275 kV, 220 kV and 110 kV) circuits used to transmit bulk electricity supplies around Ireland. The terms grid, electricity transmission network, and electricity transmission system can be used interchangeably.

Limit exceedance
An instance of a grid element performing outside of the technical planning standards.

Need
A deficiency or problem on the grid which arises as a result of one or more drivers.

Rating
An operating limit for an element of the grid.

Reactor
A technology that can help limit a rise in short circuit level or voltage, depending on its installation and configuration.

Series compensation
A technology that can increase the power flow on an existing line.

Statcom
A technology that can help regulate the voltage.

Transmission system operator
In the electrical power business, a transmission system operator is the licensed entity that is responsible for transmitting electrical power from generation plants to regional or distribution operators.

Technical planning standards
The set of standards, set out in the *Transmission System Security and Planning Standards*, that the grid is designed to meet. Our technical planning standards are a licence obligation and are approved by the Commission for Regulation of Utilities (CRU).

Executive summary

Scenario planning

At EirGrid, one of our roles is to plan the development of the electricity transmission system to meet the future needs of society. Key to this process is considering a range of possible ways that energy usage may change in the future. We call this scenario planning.

As part of our first Tomorrow's Energy Scenarios (TES) cycle, we developed a set of scenarios outlining four possible futures for the supply and consumption of electricity out to 2040. Our scenarios are:

- **Steady Evolution**
- **Low Carbon Living**
- **Slow Change**
- **Consumer Action**

Looking to the future needs of the grid

EirGrid is responsible for a safe, secure and reliable supply of electricity – now and in the future. We develop, manage and operate the electricity transmission grid. This brings power from where it is generated to where it is needed – throughout Ireland. We use our grid to supply power to industry and businesses that use large amounts of electricity. Our grid also powers the distribution network. This supplies the electricity you use every day in your homes, businesses, schools, hospitals, and farms.

We develop new electricity infrastructure only when it is needed. EirGrid answers to Government and to the regulator. We obey all laws, and meet all applicable health and safety standards. We work for the benefit and safety of every citizen in Ireland.

This document, the *Tomorrow's Energy Scenarios 2017 System Needs Assessment*, highlights the long-term needs of the grid in Ireland out to 2040. These needs are due to forecasted changes in how electricity will be generated, used, interconnected and stored in future. These future needs are based on potential problems identified in the four scenarios.

These potential problems were calculated using a series of grid simulation models. EirGrid created the models using the four scenarios, and on the responses to consultation we received about the scenarios. These models simulate future patterns of energy consumption and production. We apply these patterns to thousands of grid simulations, using the technical planning standards that we use to develop the grid. The outcome of this process then finds the areas of the existing grid that may need to be further developed or strengthened.

Areas of greatest need

We have identified six areas of the country where we believe there is a potential need to develop the grid.

Our assessment of the scale of the need at each location is based on two factors. Firstly, the cause or driver of the local challenge to the grid, and secondly what kind of problem or need this creates.

In terms of the cause or driver of the issue in each location, we've identified a range of three possible reasons:

- Increased demand for electricity
- New sources of electricity generation
- New interconnection

In terms of the potential problems or needs that are created by these causes, there are typically two kinds:

- **Power Transfer Capacity:** This means that the amount of electricity that now has to be carried by local lines or cables is too high for their rated capacity.
- **Voltage Support:** This means that there is not enough capability in the region to control voltage and reliably supply the electricity that is now needed.

Our analysis reveals that changes in grid usage across scenarios and locations drive varying levels of need over time in different areas. These areas of need are summarised in Figure 1.

Area 1
Dublin Mid-East

The grid in this area is mainly made up of 220 kV underground cable and overhead lines, with two 400 kV lines connecting to the rest of the country. The expected growth in onshore wind generation outside of the area and offshore wind generation in the Irish Sea will be a challenge. Equally, the anticipated growth in high volume energy users such as data centres will also be significant. These two factors will create difficulties for this area of the grid. In particular, it will struggle to carry the amount of power we expect, and also to have enough capability to reliably supply the electricity needed. The need for grid development in this area is very high.

Area 2
West

Currently this area of the grid relies on low capacity 110 kV lines, and has some 220 kV connections to the wider grid. All four scenarios will see this infrastructure at potential risk due to growth in renewable energy sources (RES) in the area. The consequences of these new connections will be a lack of capacity to carry this clean energy, and a potential lack of capability to control voltage and reliably supply the electricity needed. The need for grid development in this area is high.

Area 3
North-West Border

At present, the grid in this area is made up of 110 kV lines – which are low capacity. All four scenarios see the local grid struggling to carry the amount of power required, and a potential lack of capability to control voltage and reliably supply the electricity needed. The cause of these issues is the forecasted connection of new renewable energy projects in this area. The need for grid development in this area is high.

Area 4
Midlands

The existing grid in this area uses 110 kV and 220 kV lines, with power flowing west to east through this network. We expect that this area will be challenged during high wind conditions, as anticipated wind farms to the north and west of the area add more power to the grid. Because of this, the local lines will not have enough capacity to carry the expected amounts of power. The need for grid development in this area is moderate.

Area 5
South-West/South-East

This area has an urban centre, but is otherwise dominated by 110 kV lines and 220 kV lines. This area sees a lot of power moving through the region and contains sources of conventional electricity generation. We expect that growth in onshore wind generation in the South-West will create a challenge to this area. In addition, the flow of power through new interconnection will also be a factor. Both of these anticipated changes will see the local grid struggle to carry the amount of forecasted power. The need for grid development in this area is moderate.

Area 6
South-East

As with other mostly rural areas of the grid today, this area uses 110 kV and 220 kV lines. There is a lot of power moving through this area to large electricity demand centres in Dublin and Cork. Growth in renewable energy – such as solar and offshore wind – will combine with new interconnection to create a challenge for this area. In particular, the existing line capacity will struggle to carry and transfer the power in some scenarios. The need for grid development in this area is moderate.

Figure 1: Summary of system needs

1. Introduction

1.1. Report purpose

The purpose of the *System Needs Assessment* report is to highlight the long-term development needs of the electricity transmission grid brought about by the forecasted changes to electricity generation, demand, interconnection and storage.

This document should be read together with our *TES 2017*[1] and *TES 2017 Locations*[2] publications.

1.2. Why we use scenario planning

EirGrid is the licensed transmission system operator in Ireland. As the licence holder, we are responsible for the ongoing development of the transmission grid so that it continues to meet the needs of electricity consumers into the future. The factors that influence the future usage of the transmission grid are changing and becoming more varied. The level of uncertainty of each of these factors can be high.

In 2017 we introduced scenario planning as part of our grid development process so that it continues to support Ireland's economic growth and expanding population in the face of an uncertain future. Scenario planning allows us to assess the performance of the electricity grid against credible potential futures. This helps us maintain required levels of system safety, security and reliability over the long-term.

Our scenario planning process does not identify short-term needs or constraints which materialise on the system, for example those arising from unforeseen plant closures, new connections or project delays. The grid development process adapts to these changes as they occur.

1.3 Related publications

EirGrid produce a number of statutory network planning documents that share a relationship with the suite of TES documents. These, and other related publications, are shown in Figure 2.

They alongside TES provide a holistic view of the future electricity transmission grid. TES aligns with these reports and provides a wider view of the electricity transmission grid beyond a ten-year planning horizon.

The *All-Island Generation Capacity Statement*[3] outlines the likely generation capacity required to achieve an adequate supply and demand balance for electricity on the island of Ireland over ten years. This report forms the basis for underlying demand growth assumptions used in TES.

The *All-Island Ten Year Transmission Forecast Statement*[4] provides detailed data by transmission network node which provides the basis for the existing grid model used in the *System Needs Assessment*. This report also provides other information such as demand and generation opportunities on the transmission grid.

The *Transmission Development Plan*[5] outlines development plans for the transmission grid over a ten year period. This report shares an important relationship with the *System Needs Assessment* report. This relationship is underpinned by the grid development process with the *System Needs Assessment* forming step 1 of the process.

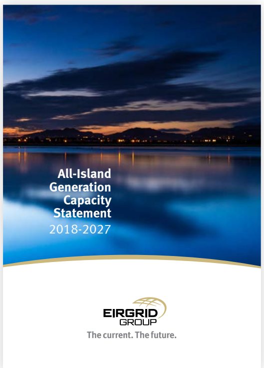
The *Transmission Development Plan* lists projects required to address network development needs that materialise over a ten year period. Some of these needs will also appear in the *System Needs Assessment* report.

Long-term development needs, identified in the *System Needs Assessment* report, may lead to projects listed in future editions of the *Transmission Development Plan*.

1 http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Tomorrows-Energy-Scenarios-Report-2017.pdf
2 http://www.eirgridgroup.com/site-files/library/EirGrid/Tomorrows-Energy-Scenarios-2017-Locations-Report.pdf
3 http://www.eirgridgroup.com/site-files/library/EirGrid/Generation_Capacity_Statement_2018.pdf
4 http://www.eirgridgroup.com/site-files/library/EirGrid/All-Island-Ten-Year-Transmission-Forecast-Statement-2016.pdf
5 http://www.eirgridgroup.com/site-files/library/EirGrid/TDP_2017_Final_for_Publication.pdf

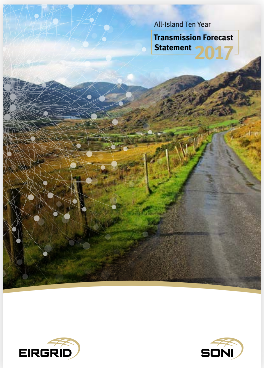
TES outlines future electricity scenarios for Ireland incorporating stakeholder feedback received as a part of a consultative process. The *TES System Needs Assessment* uses these scenarios to identify the long-term needs of the electricity transmission system brought about changes to electricity demand, generation, interconnection and storage. These TES reports are reviewed and updated every two years.

European Network of transmission system operator for Electricity (ENTSO-E)'s *Ten Year Network Development Plan (TYNDP)*[6] is an important reference for TES providing guidance on growth rates for emerging technologies affecting future demand. EirGrid, along with other European transmission system operators, contribute to the development and publication of this biennial report.



All Island Generation Capacity Statement

Ten year electricity demand forecast.

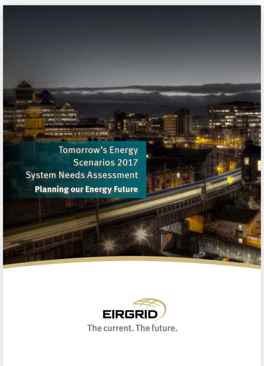


All Island Ten Year Transmission Forecast Statement

Detailed information on demand and generation opportunities.

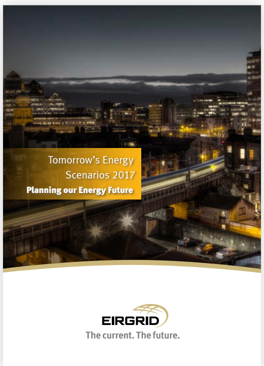
Ten Year National Development Plan - Scenarios Report

Possible energy scenarios for Europe out to 2040.



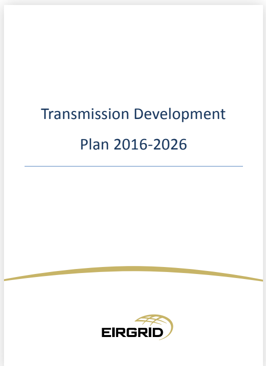
TES System Needs Assessment

Long-term needs of the electricity transmission grid out to 2040.



Tomorrow's Energy Scenarios

Credible electricity scenarios for Ireland out to 2040.



Transmission Development Plan

Ten year network and interconnection development plan.

Figure 2: Related publications

6 https://docstore.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/Scenario_Report_2018_Final.pdf

2. Tomorrow's Energy Scenarios

2.1. Scenario development

We take a cyclic approach to scenario development. Involving our stakeholders in the development cycle helps us to ensure the continuous improvement of our scenarios.

Figure 3 illustrates the consultation milestones and publications as part of the current scenario development cycle. The *System Needs Assessment* concludes the TES cycle.

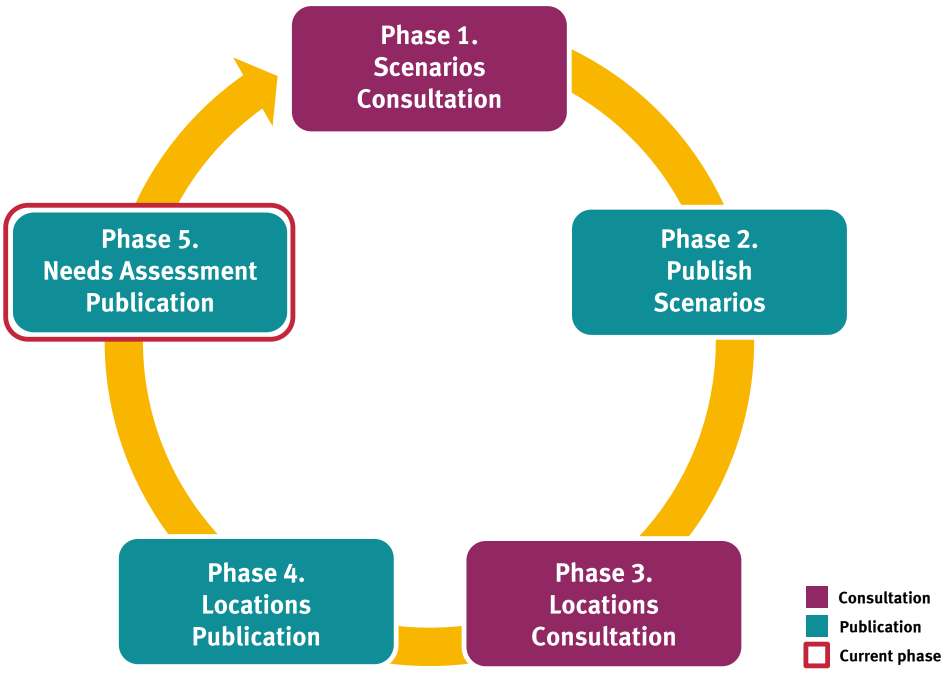


Figure 3: Current scenario development cycle

Data captured during the consultation phases reflects the best information available at the time and remains unchanged, or frozen, since then. The following freeze dates apply to data used in the *TES 2017 System Needs Assessment*:

- July 2017 for scenario portfolio data, and
- August 2018 for locations data and grid data.

Our next scenario development cycle will begin in spring 2019. We will streamline TES development in 2019 by combining the consultations on scenarios and locations and by producing one consolidated report. This will result in a shorter three phase development cycle.

We look forwarding to engaging with our stakeholders as part of TES 2019 scenario development.

2.2. Summary of our scenarios

In July 2017, we published *TES 2017*, a document outlining four possible futures for the supply and consumption of electricity in Ireland out to 2040. These scenarios are summarised in Figure 4.

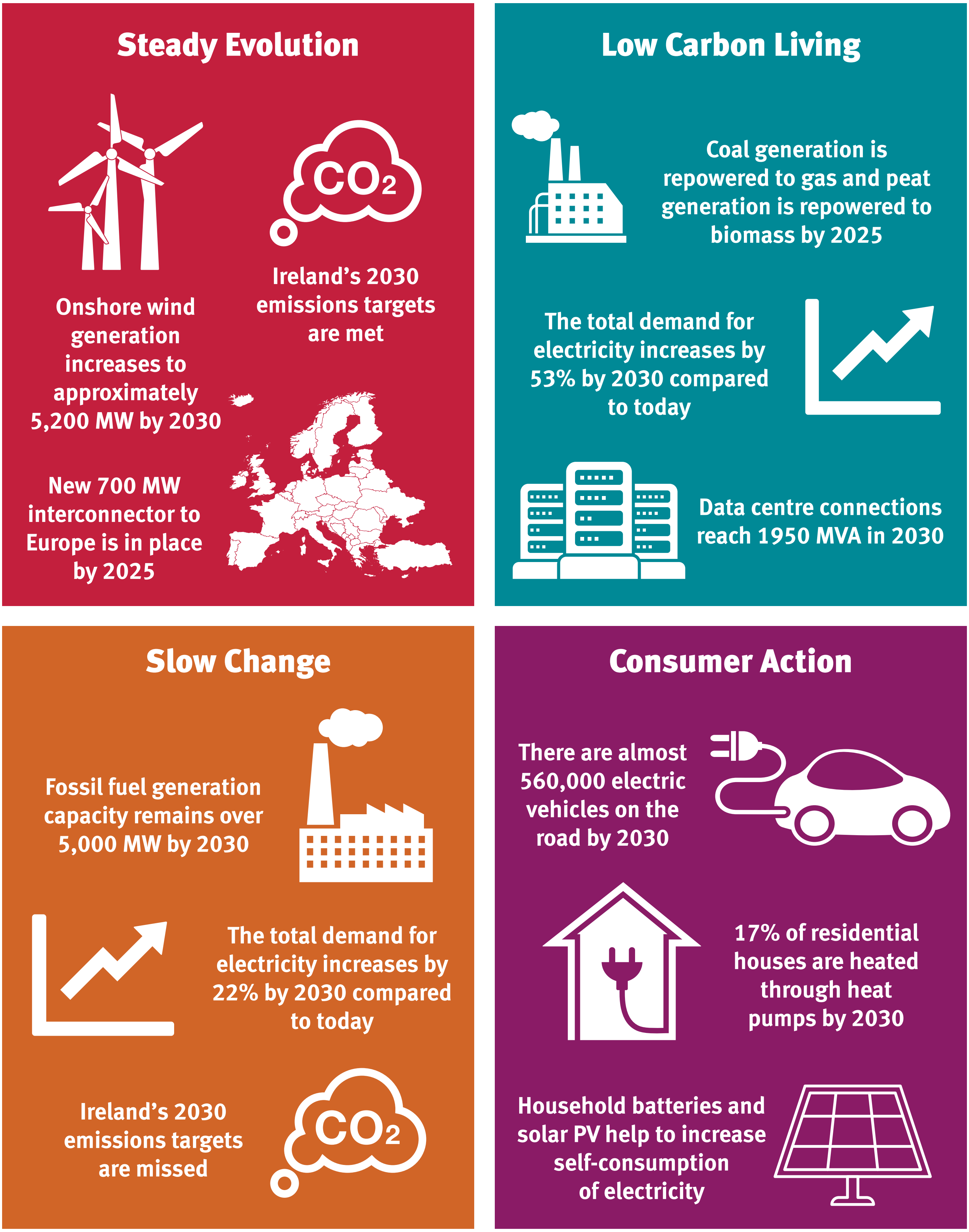


Figure 4: *Tomorrow's Energy Scenarios 2017* storylines

3. How we develop the grid

3.1. Grid development strategy

EirGrid is responsible for a safe, secure and reliable electricity transmission system, now and in the future. To achieve this we must continue to maintain and develop the grid.

Our approach to the development of Ireland's electricity infrastructure is set out in the *Grid Development Strategy*[7]. Our strategy assists us to meet projected demand levels, to meet Government policy objectives, and to ensure a long-term sustainable and competitive energy future for Ireland.

The *Grid Development Strategy* is influenced by three main factors, as shown in Figure 5.

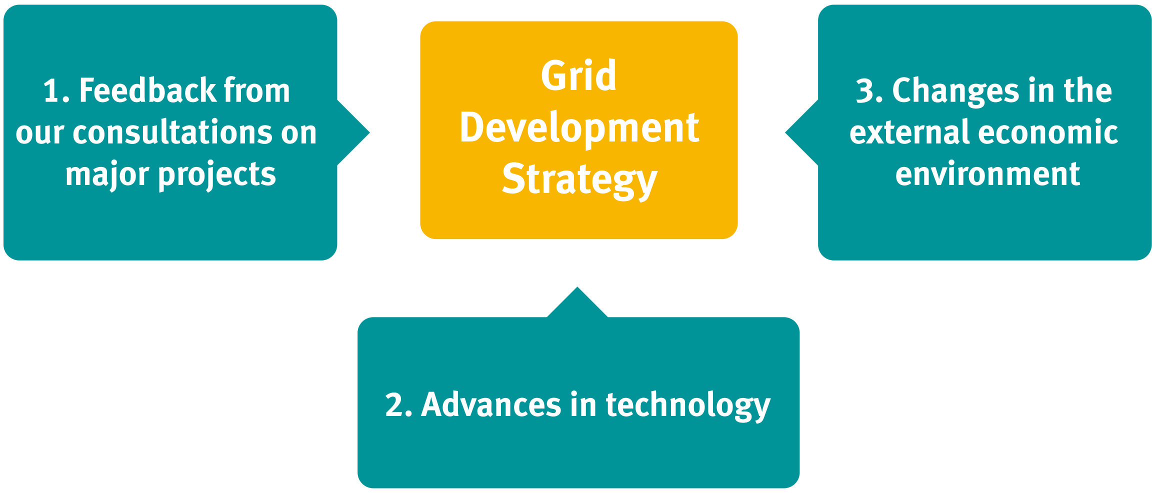


Figure 5: Factors influencing our *grid development strategy*

These factors led to the development of three strategic statements which underpin our *Grid Development Strategy*. The statements are as follows:

Statement 1: We are committed to continually improving public participation and community engagement as part of grid development process. For more on our commitment to public consultation, see our *Reviewing and Improving Our Consultation Process*[8] publication.

Statement 2: We continually review technological developments to assess their potential use on the Irish transmission system. Technologies are categorised into three types: technology available now, new technology ready for trial use, and new technology at research and development stage.

For a given grid development project, each technology is assessed for suitability with respect to cost, ease of project delivery, improved grid performance and security of supply, environmental friendliness, and system flexibility. This will assist us in determining the best transmission technology for future projects.

Statement 3: We will continue to maximise the use of the existing grid infrastructure. This can be achieved by increasing the capacity of existing infrastructure, or by using new technologies, depending on the requirements and circumstances in each case. We will build new infrastructure only when this is the right solution.

7 https://issuu.com/designtactics/docs/eirgrid_-_ireland_s_grid_developmen?e=1919908/43298204
8 http://www.eirgridgroup.com/site-files/library/EirGrid/Reviewing-and-Improving-Our-Public-Consultation-Process.pdf

We work with industry partners, technology innovators and with other transmission system operators to identify, research and trial possible innovations.

3.2. Grid development process

We are committed to delivery of our grid development strategy and have designed processes that ensure our overall strategy and strategic statements are achieved. Our *Have Your Say*[9] publication details our six-step grid development process, which is shown in Figure 6.

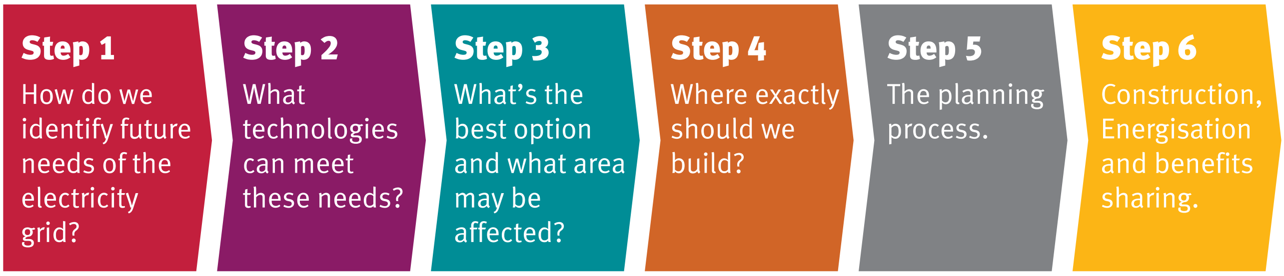


Figure 6: Grid development process

In step 1 of the process we identify future needs of the electricity transmission grid brought about by changes to:

- Electricity demand,
- Electricity generation and storage,
- Electricity interconnection, and
- Asset condition.

Our scenarios play an important role in our grid development process. We use scenarios to identify potential system needs brought about by changes to electricity demand, generation, storage and interconnection. Our scenarios are not used to identify network refurbishment needs. These are determined based on changes to the condition of existing electricity transmission assets.

> ***Scenarios are used in step 1 of the grid development process to test the future performance of the grid.***

Scenario planning is performed in step 1 of the grid development process. As part of scenario planning we test the performance of the transmission grid against each of our scenarios and detail the results in the *TES 2017 System Needs Assessment*. Needs identified in this report are subsequently assessed in more detail before proceeding to step 2 of the grid development process.

We use our scenarios throughout the grid development process, ensuring that needs remain valid as the electricity transmission grid changes over time and more information becomes available.

9 http://www.eirgridgroup.com/__uuid/7d658280-91a2-4dbb-b438-ef005a857761/EirGrid-Have-Your-Say_May-2017.pdf

4. Our approach to identifying needs

As part of step 1 of the grid development process, we simulate potential future conditions on the grid. Changes to the grid can have distinct impacts on how we match electricity supply and demand. For example, grid conditions can fluctuate due to, among others, changes in:

- local and system weather patterns, which impact the level of electricity generated by RES,
- human behaviour, which impacts the shape of electricity demand,
- electricity market prices, which impacts the level of electricity imported/exported with neighbouring systems via interconnectors.

The way electricity generation, storage, interconnection and demand change throughout the day affects the flows across the grid.

However grid conditions change, our goal is to ensure a reliable and efficient supply of electricity. By simulating future conditions, we can identify where the grid may need to be developed so that the grid remains safe, secure and reliable under a broad range of possible circumstances.

4.1. Analysing how the grid performs into the future

The information gathered from the *TES 2017* consultations is the starting point for how we simulate the future performance of the grid. We do this using our energy and grid simulation models. Our energy model determines the hourly patterns of generation, demand, storage and interconnection for each scenario and study year. Our grid model determines how these patterns may change the usage of the transmission grid. We analyse the hourly electricity flows on each circuit and the voltage at each station. We do this for each of our scenarios and the study years of 2025, 2030 and 2040.

A summary of the process used to analyse the future performance of the grid is shown in Figure 7.

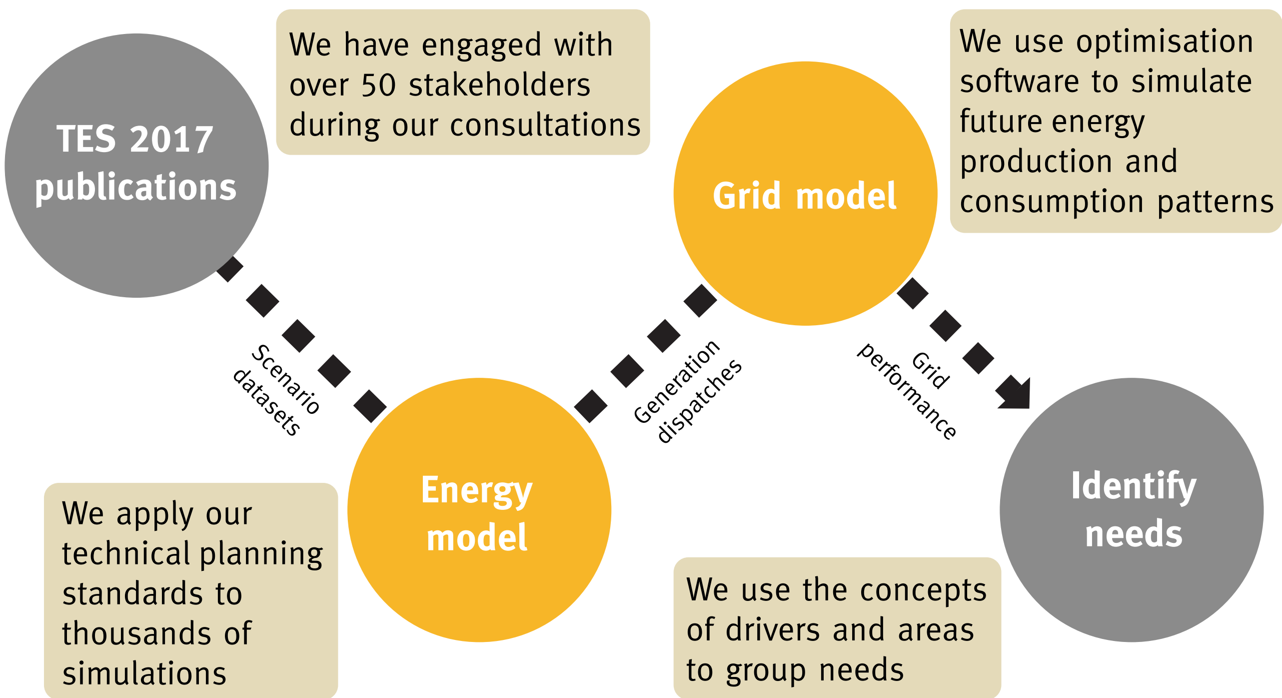


Figure 7: Overview of our approach to identifying needs

By applying our technical planning standards[10] to the results of our grid simulations, we can determine when and where the grid may perform outside its limits. If an element of the grid is performing outside of our technical planning standards, we identify it as a limit exceedance. We do this for each of our scenarios and the study years of 2025, 2030 and 2040.

By analysing the energy model and grid model simulation results, we can pinpoint which factors influence the limit exceedances. We call these factors drivers.

A need is a deficiency or problem on the grid which arises as a result of one or more drivers

By grouping the limit exceedances by their driver(s) and their location on the grid, we can identify the needs of the system. Grouping in this way creates an area.

When determining the areas, we analyse all scenarios and study years. Establishing areas can facilitate more local studies at later stages in the grid development process.

An example of the area concept is shown in black in Figure 8. The limit exceedances shown in this illustrative area are in relation to line loading, and to station voltage. Typically, an area can present a mixture of these forms of limit exceedances.

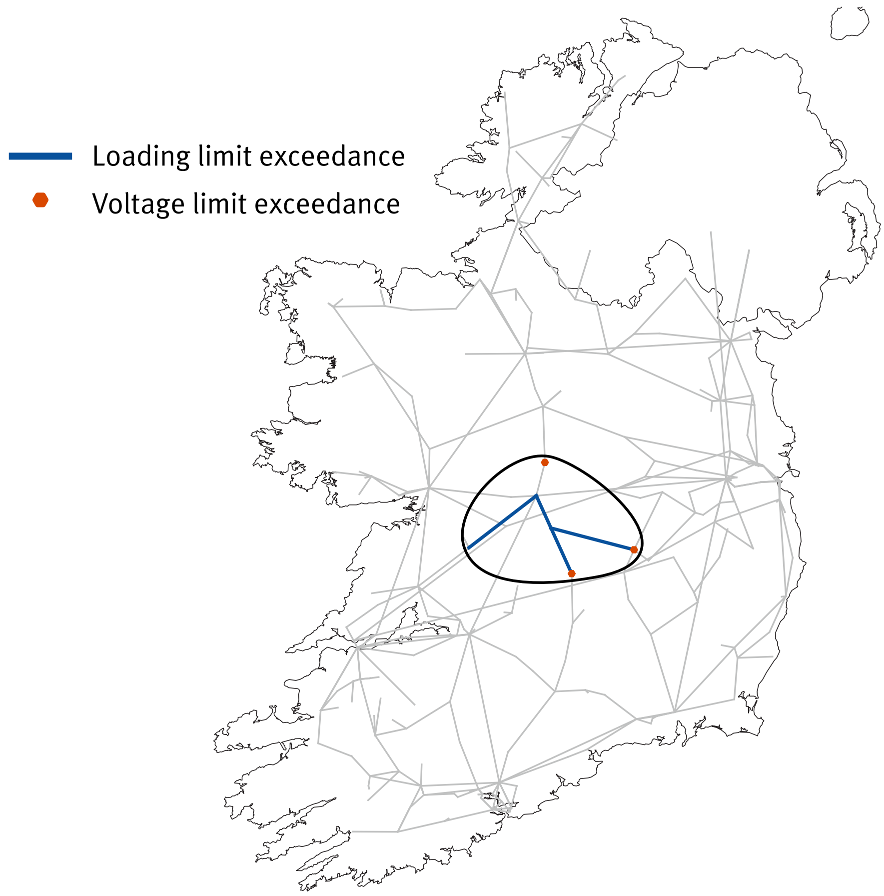


Figure 8: Area concept example

10 http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Transmission-System-Security-and-Planning-Standards-TSSPS-Final-May-2016.pdf

The extent to which the grid within an area performs outside of the technical planning standards can change for different scenarios and study years. Performance against the technical planning standard is captured for each area using a need score. A need score can be categorised as moderate, high or very high. Note that only areas with grid elements performing outside of the technical planning standards are given need scores.

By tracking each area's need scores across scenarios and study years, we can determine how the grid performance in the areas may change. Need scores for each area are depicted using charts, an illustrative example of which is shown in Figure 9. Need scores vary across all four scenarios in the illustrative example shown in Figure 9. In this example there is a moderate need for grid development in the Slow Change scenario. The need score for Steady Evolution and Consumer Action suggests a high need for grid development. Low Carbon Living shows a very high need score and therefore the need for grid development is very high in this scenario.

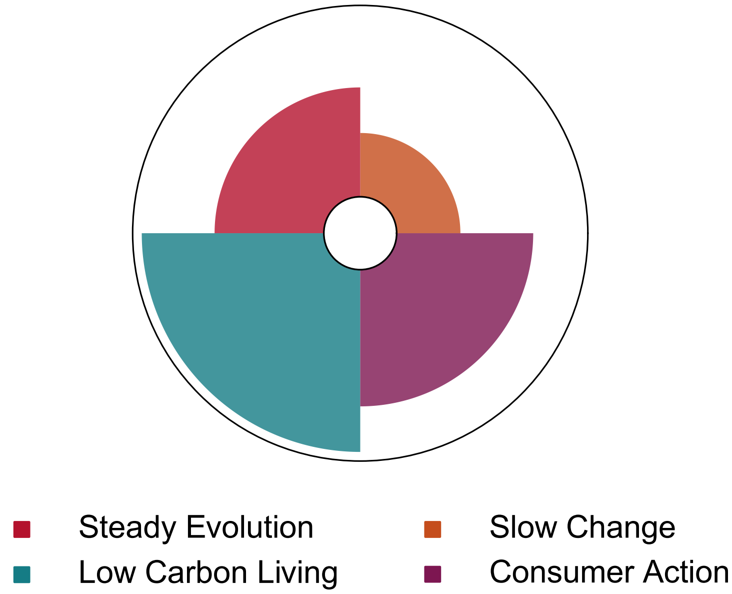


Figure 9: Need scores example

Note that for the 2025 study year there are only three scenarios, as our Consumer Action scenario does not appear until 2030 as per the *TES 2017* report.

4.2. Types of drivers

Drivers are a key part of understanding needs, as they identify what is influencing a need. Our analysis identifies a number of driver types. The predominant influencing factors identified in this analysis are due to changes in:

Electricity demand: Demand growth and the connection of new demand can give rise to higher electricity flows. The change in demand identified as the greatest influence on needs is the addition of large energy users, such as new data centres. Large energy users can give rise to a step change in electricity flow at specific grid locations.

Electricity generation: New connections or closures of generators can have a significant impact on electricity flows. The changes in generation identified as the greatest influence on needs is the addition of spatially distributed RES, such as onshore wind generation, solar photovoltaic (PV), and the addition of large RES producers, such as offshore wind parks. RES can often be located in remote areas, meaning that the electricity they produce may need to be transported over a greater distance to large demand centres. Large energy producers can give rise to a step change in electricity flow at particular grid locations.

Interconnection: New interconnectors can result in large electricity flows into and out of particular grid locations. Such connectivity with other countries can result in a step change in electricity flow at specific grid locations.

4.3. Types of needs

We have identified two types of needs.

Power Transfer Capacity	Voltage Support
This means that the amount of electricity that now has to be carried by local lines or cables is too high for their rated capacity.	This means that there is not enough capability in the region to control voltage and reliably supply the electricity that is now needed.

The presented needs are solely for the transmission grid of Ireland.

4.4. Ireland's regions

EirGrid uses regions to plan the development of the transmission grid in Ireland, as described in the *Transmission Development Plan*. These regions[11], known as Nomenclature of Territorial Units for Statistics (NUTS) 3 regions, have been in use in Ireland since 1994 and comprise the eight regional authorities established under the local Government act, 1991.

NUTS 3 regions are also used by Government agencies in Ireland, including IDA Ireland and the Central Statistics Office. The eight regions are illustrated in Figure 10. These regions are referred to in this report when describing needs.

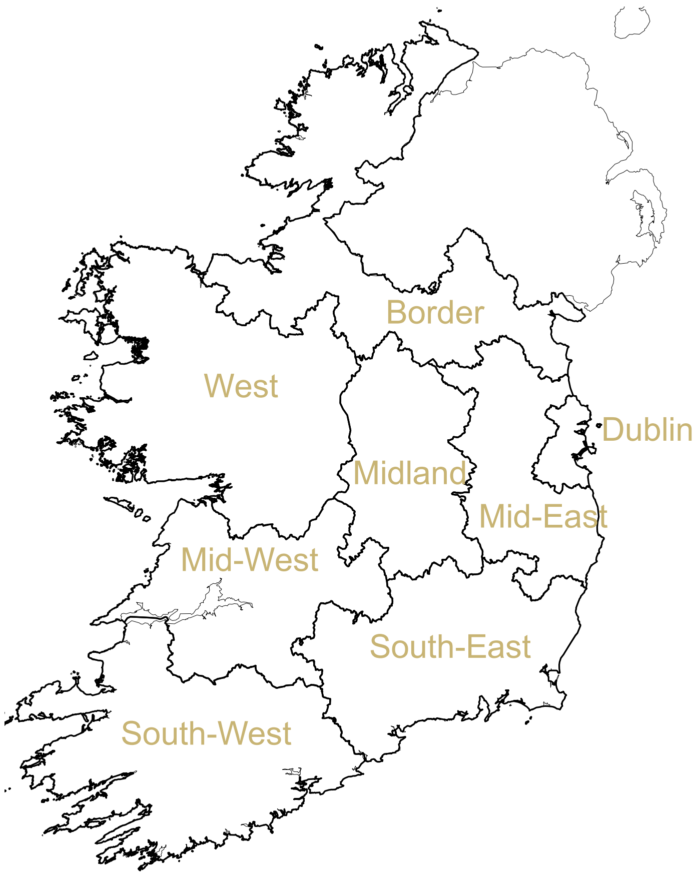


Figure 10: Ireland's regions

11 https://data.gov.ie/dataset/nuts3-boundaries-ungeneralised-osi-national-statistical-boundaries-2015

5. System needs

The *TES 2017* and *TES 2017 Locations* consultations and publications are key inputs to the *System Needs Assessment* analysis. Together they provide an envelope for the future levels and locations of electricity demand and generation categories. A high level recap of some of the portfolio trends is given in Figures 10 and 11, showing the scale of the deployment assumed for each technology across scenarios and study years.

Figure 11 illustrates the peak electricity demand across scenarios and study years. Figure 12 shows electricity supply capacity. For full details of our assumptions on our generation and demand portfolios and connection locations, refer to *TES 2017* and *TES 2017 Locations* reports.

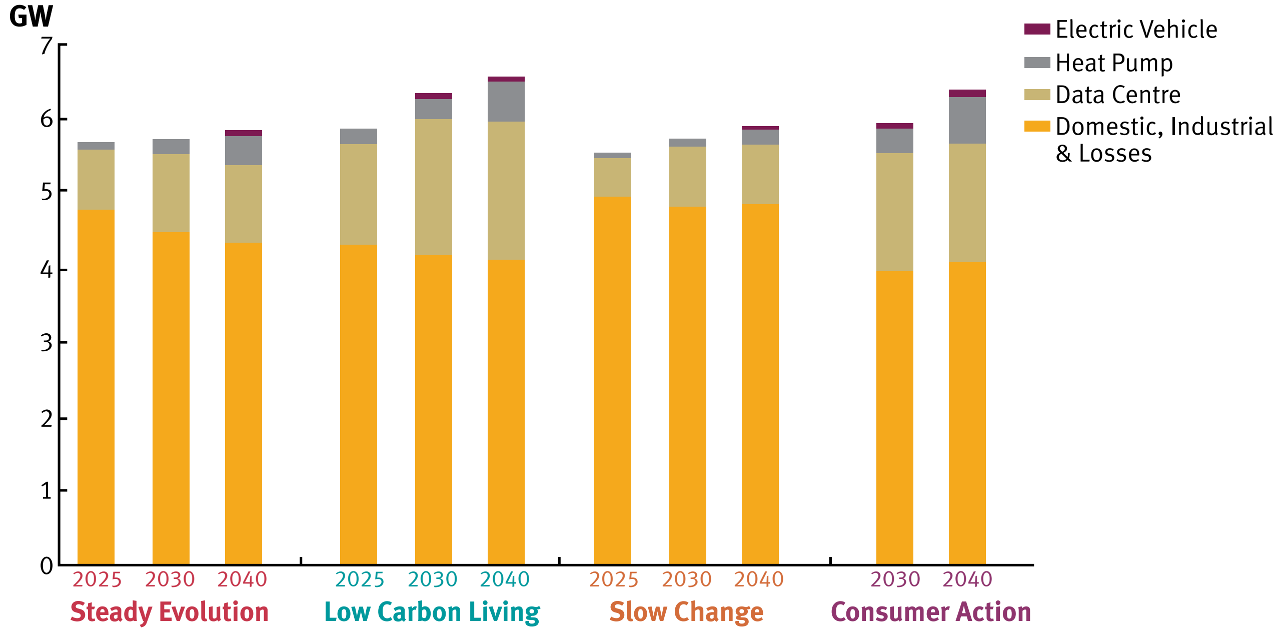


Figure 11: Peak electricity demand by scenario and year

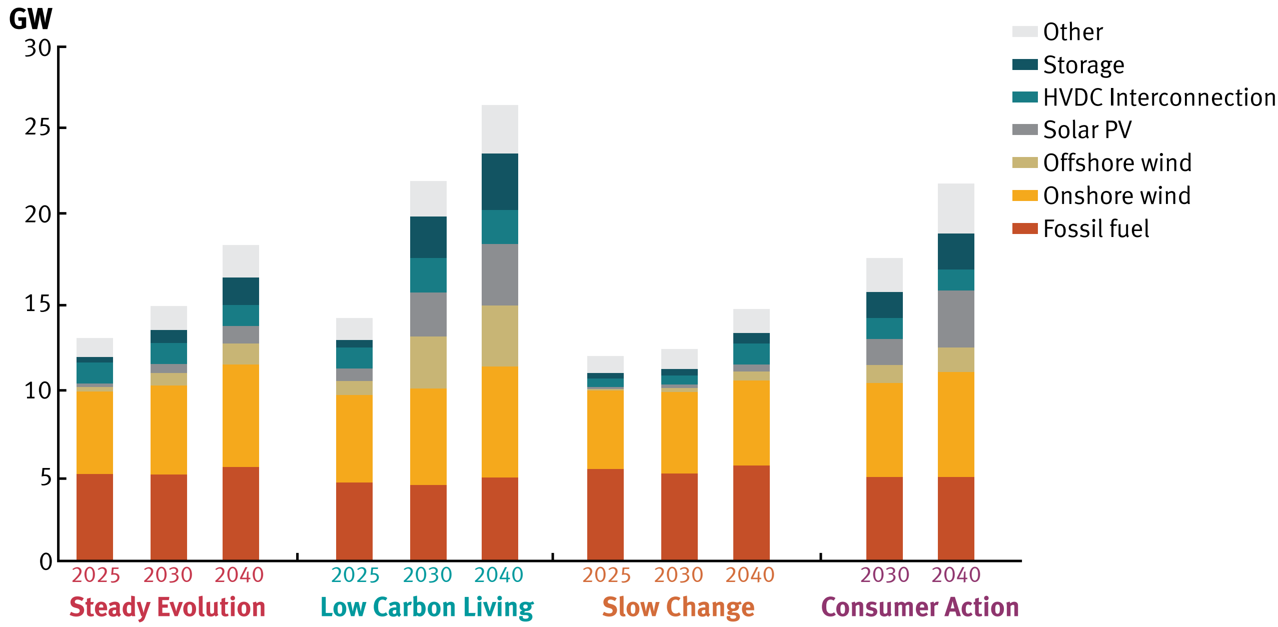


Figure 12: Electricity supply capacity by scenario and year

Each scenario, due to the portfolio and location mix assumed, has a distinct impact on the usage of the grid. The key drivers of needs, for each scenario, are shown in Figure 13. As the scale of a given technology increases across scenarios and study years, it can become a driver of needs.

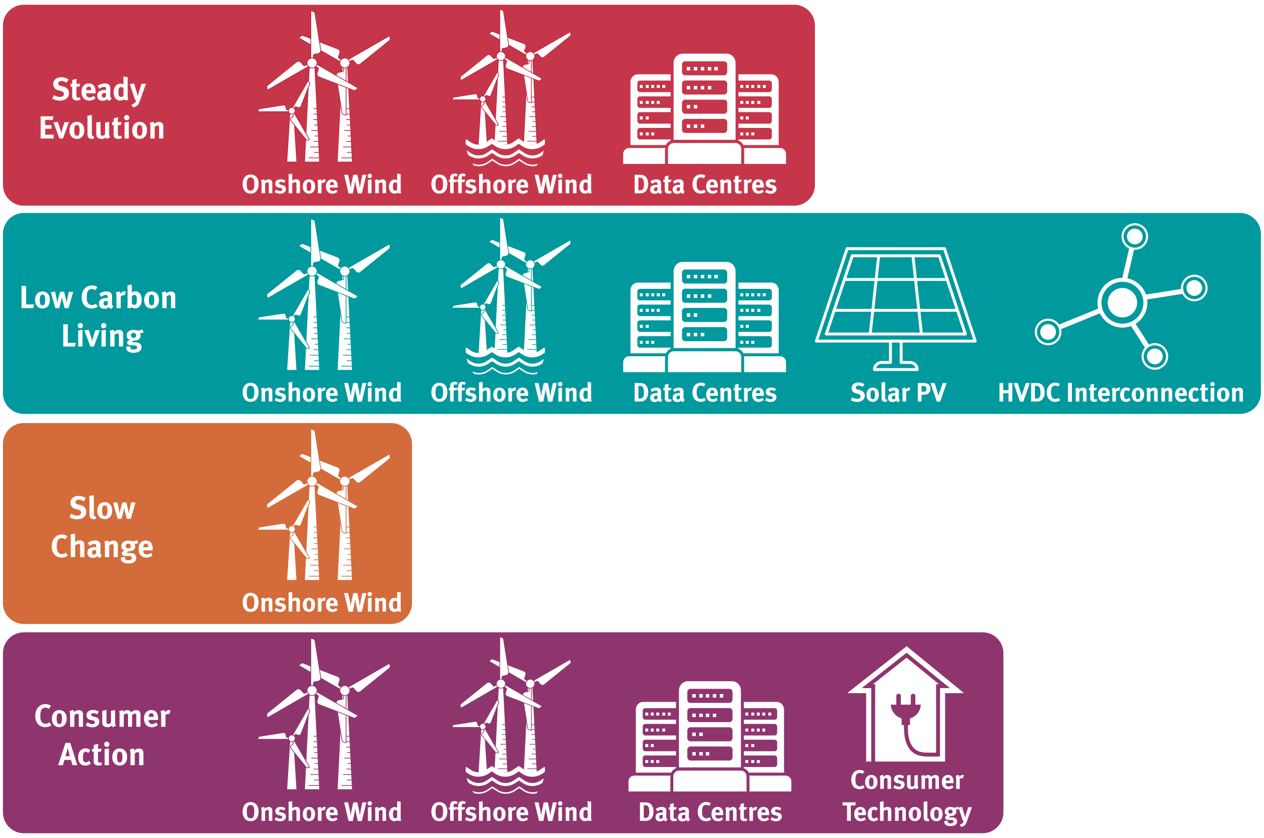


Figure 13: Key drivers by scenario

We have identified six areas of need. Each area is treated individually, and is accompanied with a description of the types of drivers, the types of needs, and the change in need scores over the study year horizon and across the scenarios. It is possible that development needs may materialise outside of the areas identified as conditions change and more information becomes available.

The presented areas of need show the geographic extent of limit exceedances for all scenarios and study years out to 2040. They are long-term areas of need, going beyond the 10-year planning horizon used in our *Transmission Development Plan*, *All-Island Ten Year Transmission Forecast Statement* and *All-Island Generation Capacity Statement*. Analysing multiple scenarios and study years beyond the 10-year planning horizon allows us to monitor how the needs within an area may change into the more distant future.

The grid simulations assume today's grid. A number of projects from our latest *Transmission Development Plan*, which are planned to be delivered in the coming years before our 2025 study year, are also assumed in all scenarios. More information on the new grid projects assumed in our grid simulations can be found in appendix 1.

5.1. Area 1 – Dublin Mid-East

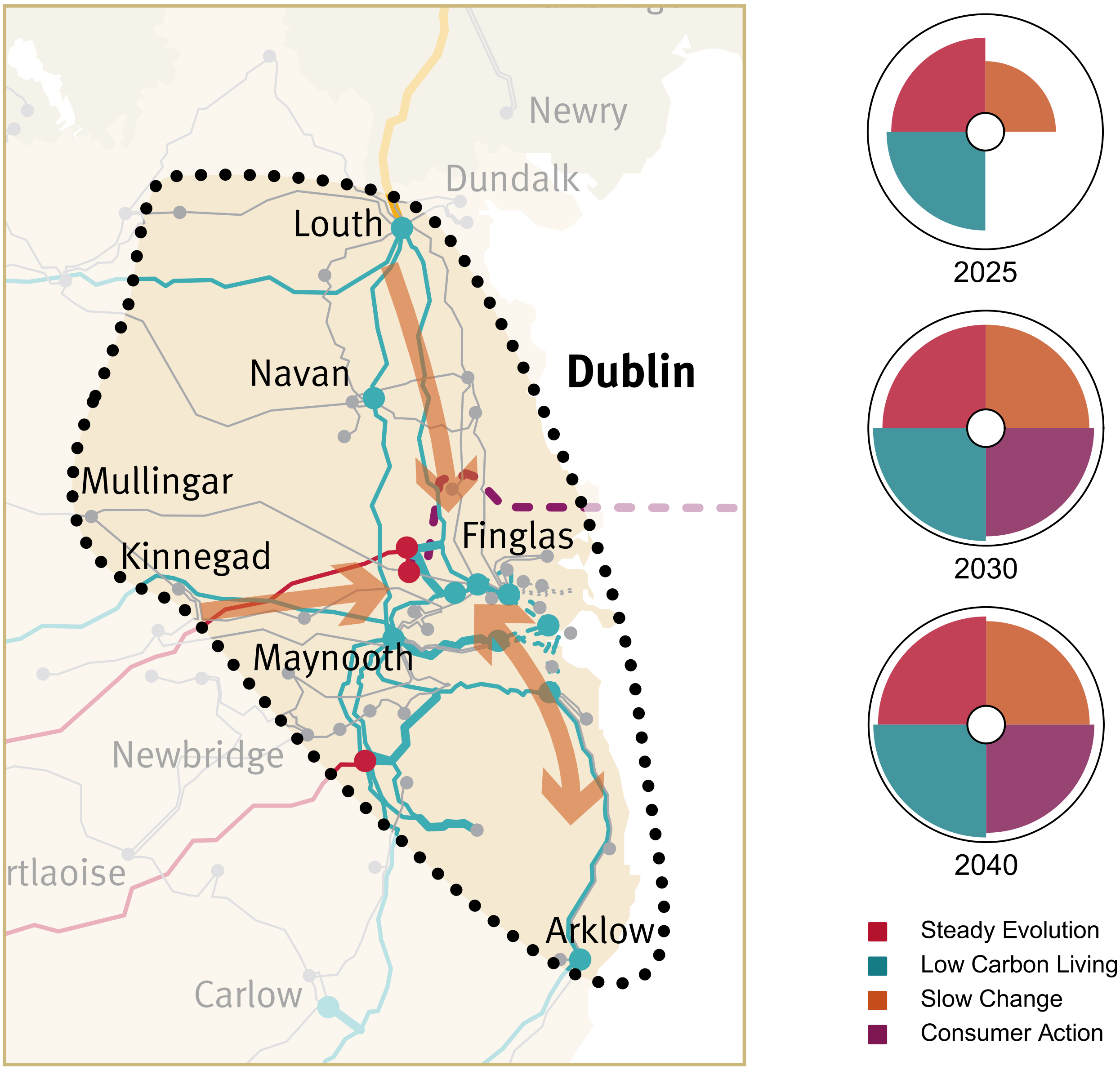


Figure 14: Geographic extent, and need scores for Area 1

Driver(s)	Need(s)
Large energy user demand growth	Power transfer capacity
RES integration	Voltage support

Table 1: Driver(s) and need(s) for Area 1

Area 1 is located in the Dublin, Mid-East and Border regions. The area comprises mainly of 220 kV grid, much of which is underground cable, as well as overhead lines. Two 400 kV lines provide the area with high capacity connections to the rest of the grid. The role of this grid is to ensure flexible power transfer into, around and through the area for varying system conditions. It is characterised by having conventional generation and a high level of electricity demand.

Line or cable faults result in a power transfer capacity shortfall to and from the rest of the grid, in particular the loss of any of:

- the 400 kV lines, which results in power transfer shortfall into the area, and
- the 220 kV lines and cables, which results in a shortfall in power transfer capacity within and out of the area.

This need is greatest for the following conditions:

- high onshore wind generation output outside of the area,
- high demand from large energy users within the area, or
- high offshore wind generation output in the Irish Sea.

In addition, a number of stations within the area experience voltage support needs due to further RES integration and demand growth.

Figure 14 shows the need scores for the Dublin area across scenarios and study years. The need exists in all scenarios from 2025.

The need scores indicate that, by 2025, in Low Carbon Living the need for grid development is very high. There is a high need for grid development in Steady Evolution and Slow Change by 2025. By 2030 and 2040 the need for grid development is very high in all scenarios. This is because there are a relatively high number of high capacity circuits in this area, many of which are already approaching shortfalls in capacity for a diverse set of different power flows.

Shortfalls in capacity and voltage support can occur during times of high demand in the area, high onshore and offshore wind generation, high interconnector flows or high generation within the area.

5.2. Area 2 – West

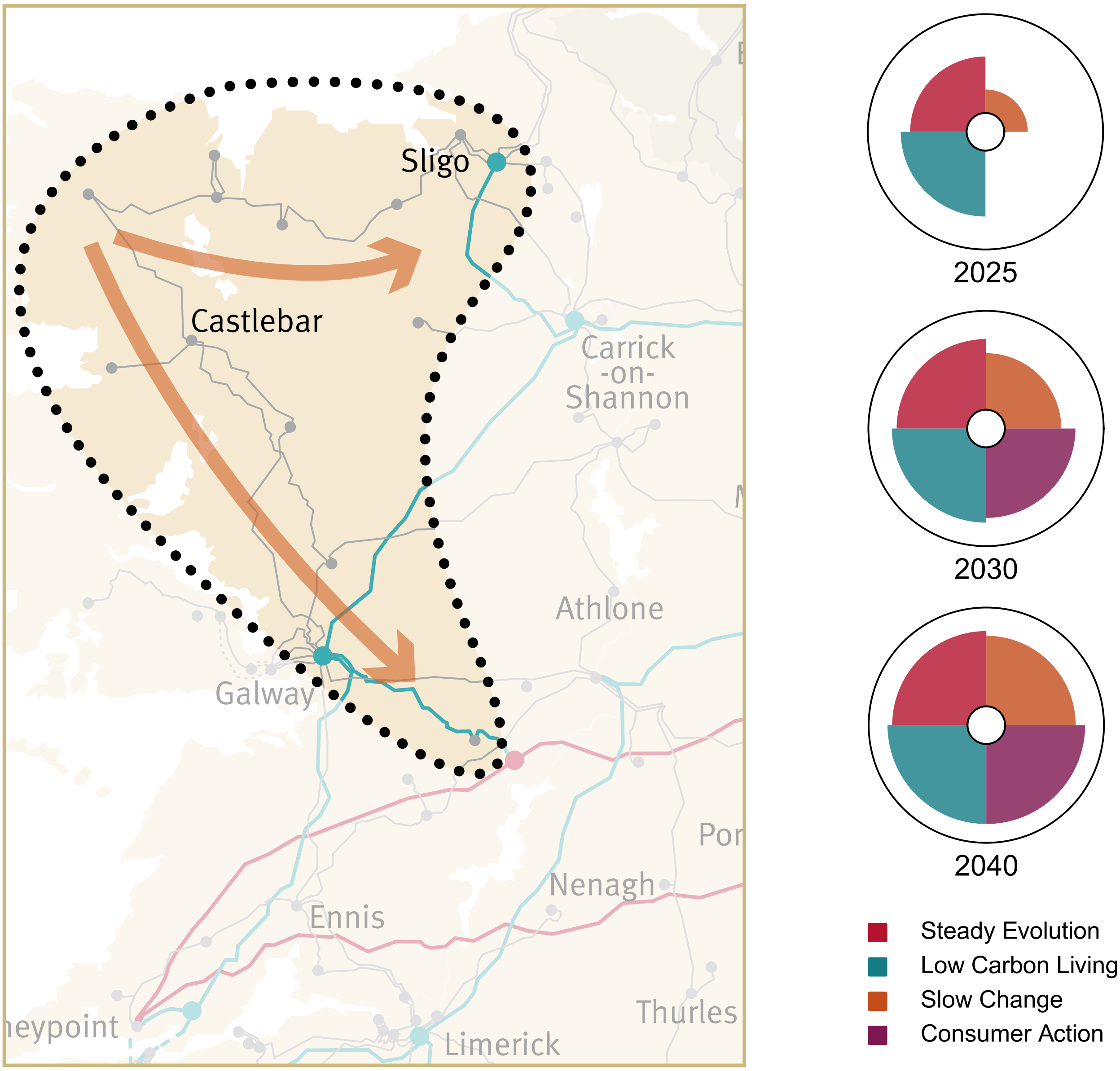


Figure 15: Geographic extent, and need scores for Area 2

Driver(s)	Need(s)
RES integration	Power transfer capacity Voltage support

Table 2: Driver(s) and need(s) for the Area 2

Area 2 is located in the West and Border regions. The area mainly comprises of 110 kV grid. It is characterised by a high level of RES connections and low electricity demand.

Line faults, particularly those in the north of the area, result in a power transfer capacity shortfall to the rest of the grid. This need typically arises during high onshore wind generation export from the area. In addition, a number of stations experience voltage support needs due to further RES integration.

Figure 15 shows the need scores for the West area across scenarios and study years. The need scores indicate that the scale of the need increases over time as more RES connects within the area.

The need exists in all scenarios from 2025.

The need scores indicate that, by 2025, in Steady Evolution and Low Carbon Living the need for grid development is high. There is a moderate need for grid development in Slow Change by 2025. By 2030 the need for grid development is high in all scenarios.

There is a very high need for grid development in 2040 in Low Carbon Living and Consumer Action and a high need in Steady Evolution and Slow Change.

Many circuits in this area are already approaching shortfalls in power transfer capacity during times of high onshore wind generation export. The need scores are highest in scenarios and years with the highest levels of onshore wind generation in the area.

5.3. Area 3 – North-West Border

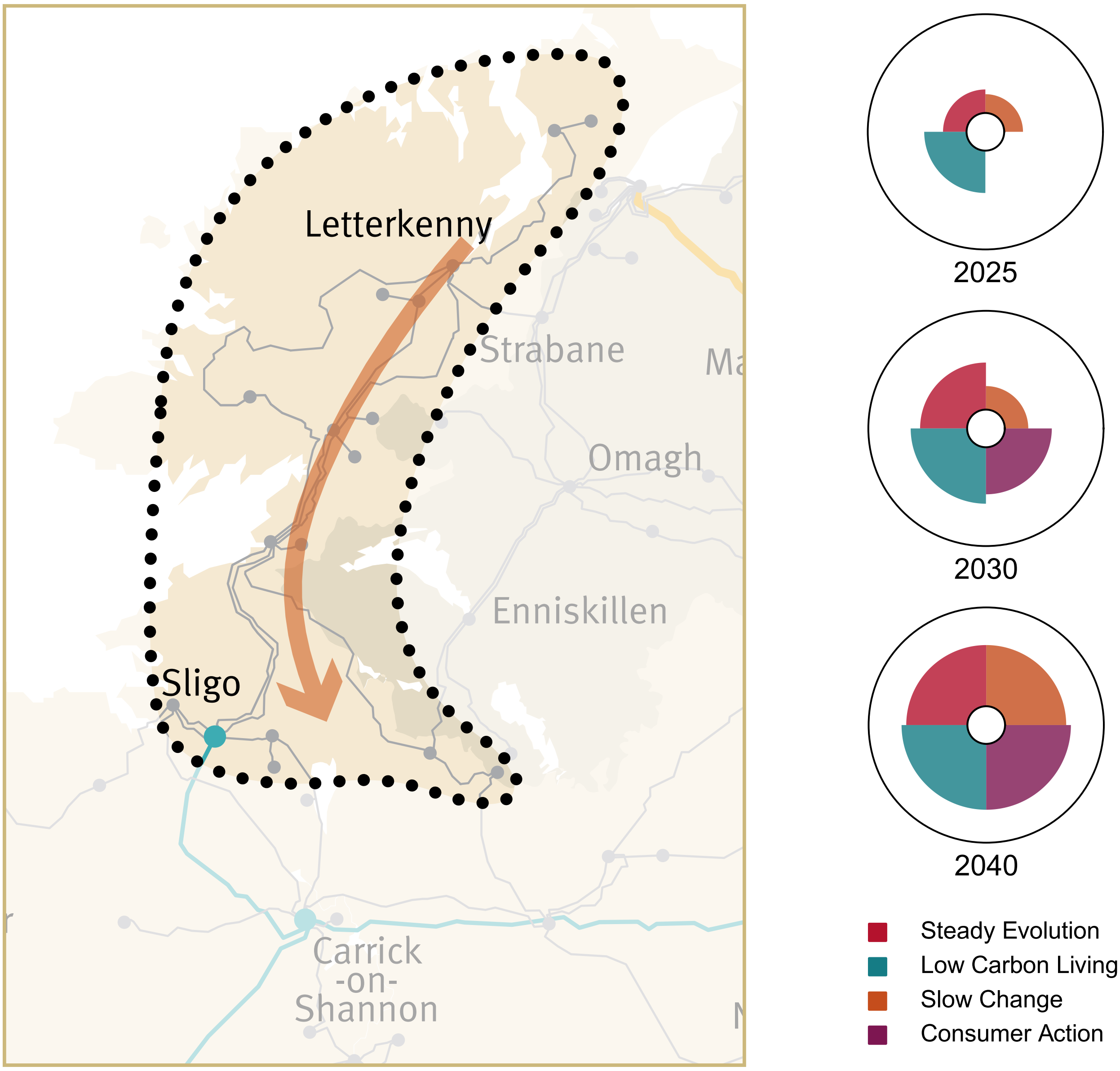


Figure 16: Geographic extent, and need scores for Area 3

Driver(s)	Need(s)
RES integration	Power transfer capacity Voltage support

Table 3: Driver(s) and need(s) for Area 3

Area 3 is located in the Border region. The area comprises 110 kV grid and has a very limited interconnection with Northern Ireland. It is characterised by a relatively high level of RES connections and low electricity demand. At times of high wind generation there are high power flows out of the area to meet demands elsewhere.

Line faults, particularly to the south and the north of the area, result in a power transfer capacity shortfall to the rest of the grid. This need typically arises during high onshore wind generation export from the area. In addition, a number of stations experience voltage support needs due to further RES integration.

Figure 16 shows the need scores for the North-West area across scenarios and study years. The need scores indicate that the scale of the need increases over time as more RES connects within the area.

The need exists in all scenarios from 2025.

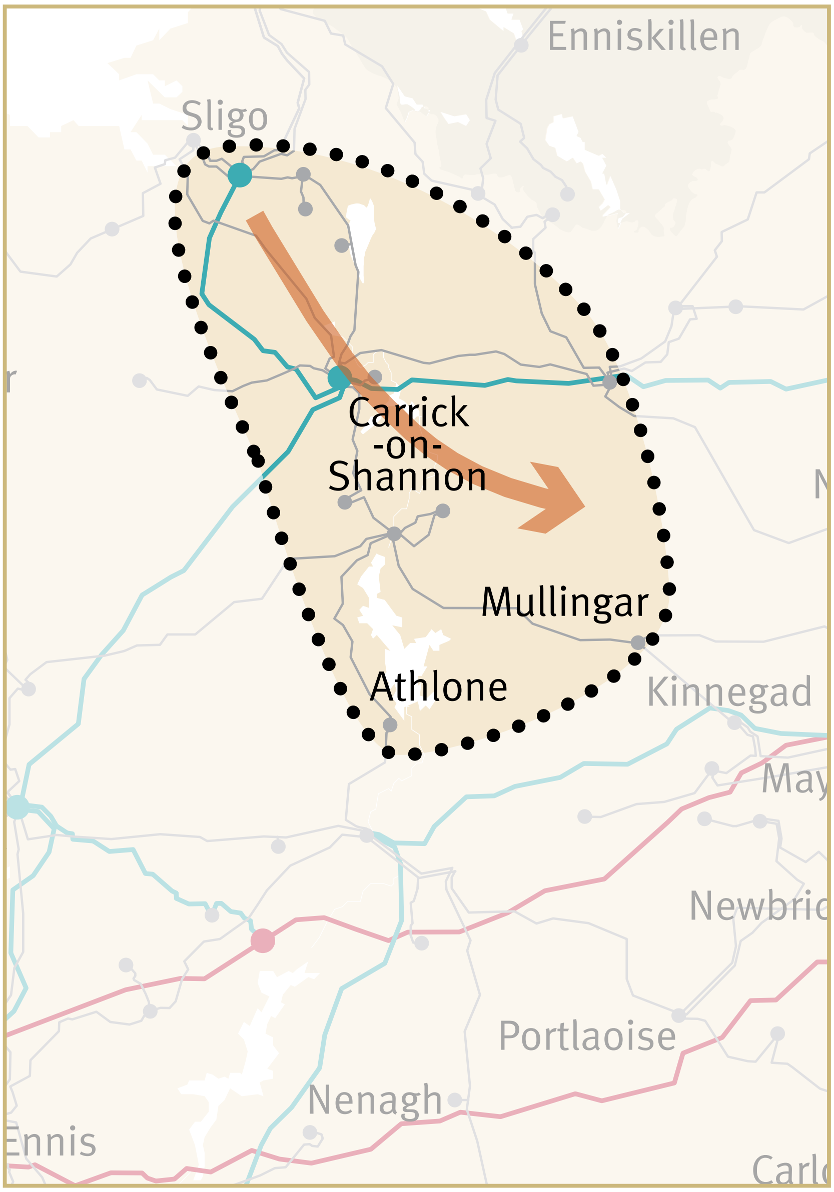
The need scores indicate that, by 2025, there is a moderate need for grid development.

By 2030, there is a high need for grid development in Low Carbon Living. Steady Evolution, Slow Change and Consumer Action all exhibit a moderate need for grid development by 2030.

There is a high need for grid development by 2040 in all scenarios.

Many circuits in this area experience shortfalls in capacity during times of high onshore wind generation export. The need scores are highest in scenarios and years with the highest levels of onshore wind generation in the area.

5.4. Area 4 – Midlands



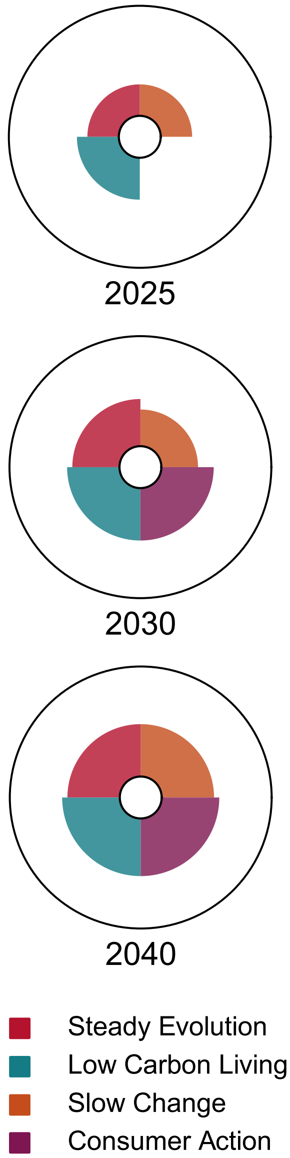


Figure 17: Geographic extent, and need scores for Area 4

Driver(s)	Need(s)
RES integration	Power transfer capacity

Table 4: Driver(s) and need(s) for Area 4

Area 4 is located in the Midland, Border and West regions. The area includes 110 kV and 220 kV grid. It is characterised by high levels of West-to-East power transfer through the area.

Line faults, particularly the 220 kV lines within the area, result in a power transfer capacity shortfall to the rest of the grid. This need typically arises during high onshore wind generation outputs to the North and West of the area.

Figure 17 shows the need scores for the Midland area across scenarios and study years. The need scores indicate that the scale of the need increases over time as more RES connects within the area and to the west and north of the area.

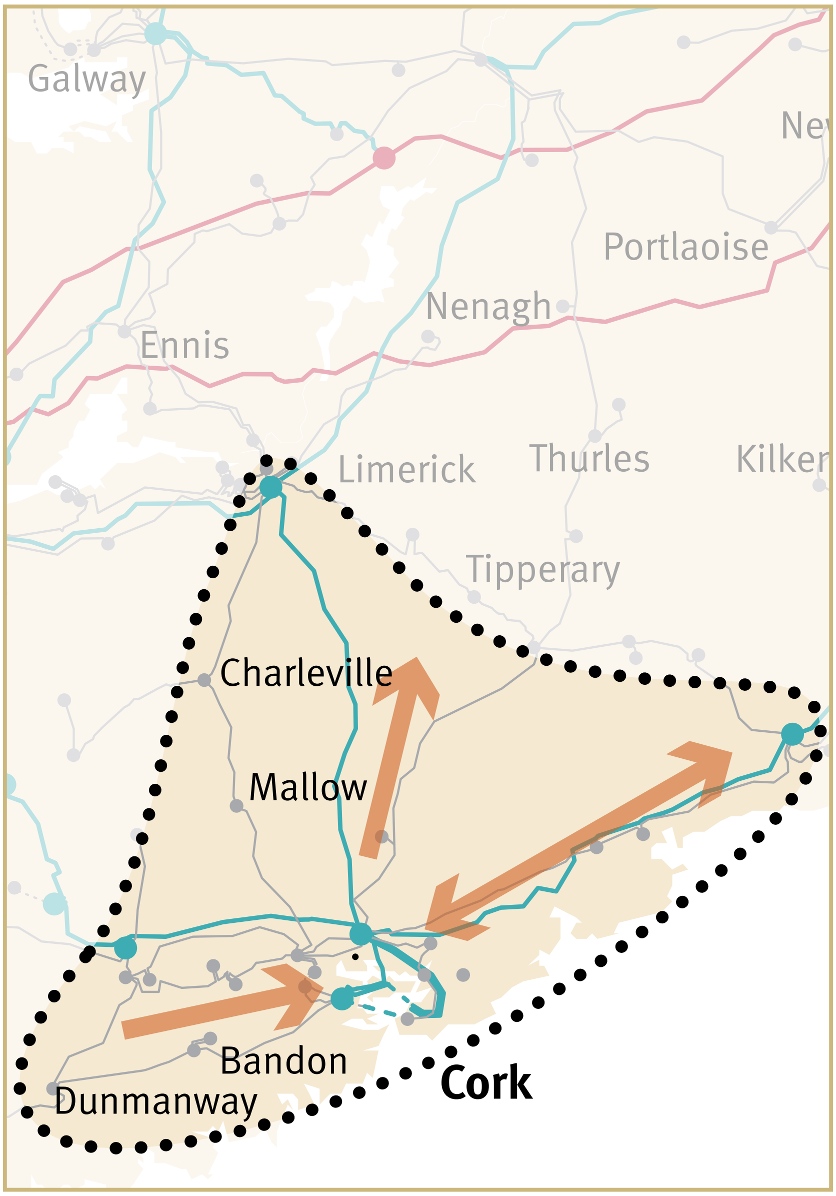
The need exists in all scenarios from 2025.

The need scores indicate that, by 2025 and 2030, there is a moderate need for grid development in all scenarios.

By 2040, there is a high need for grid development in Low Carbon Living and Consumer Action and a moderate need in Steady Evolution and Slow Change.

Many circuits in this area experience shortfalls in capacity during times of high onshore wind generation in the West and Border regions. The need scores are highest in scenarios and years with the highest levels of onshore wind generation.

5.5. Area 5 – South-West/South-East



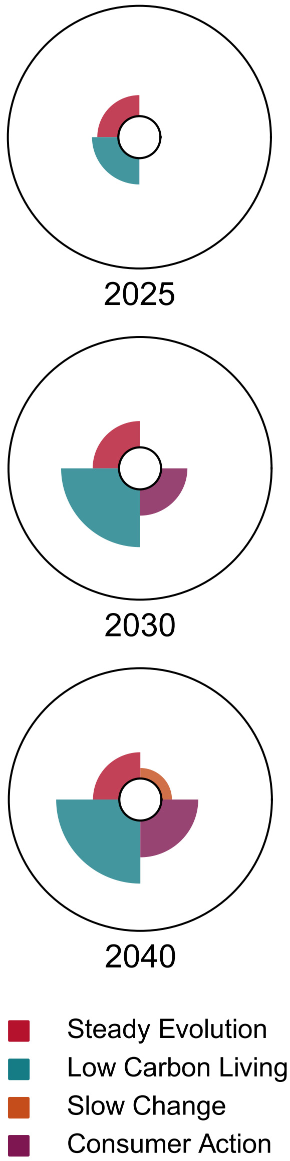


Figure 18: Geographic extent, and need scores for Area 5

Driver(s)	Need(s)
Large energy user demand growth New HVDC interconnection RES integration	Power transfer capacity

Table 5: Driver(s) and need(s) for Area 5

Area 5 is located in the South-West and South-East regions. It includes 110 kV and 220 kV grid and is characterized by high levels of power transfer through the area, conventional generation within the area and high levels of electricity demand within the area.

Line faults, particularly 220 kV lines within the area, result in a power transfer capacity shortfall to the rest of the grid. This need is greatest for the following conditions:

- high onshore wind outside of the area and interconnection export, or
- high conventional generation within the area and interconnection import, or
- high demand from large energy users within the area, or
- high offshore wind generation in the Irish Sea and interconnection export.

Figure 18 shows the need scores for the South-West/South-East area across scenarios and study years. The need scores indicate that the scale of the need increases over time as more RES connects to the west and east of the area and as the level of interconnection increases.

The need exists from 2025 onwards in Steady Evolution and Low Carbon Living and in all scenarios by 2040.

The need scores indicate that, by 2025, there is a moderate need for grid development in Steady Evolution and Low Carbon Living.

By 2030, there is a high need for grid development in Low Carbon Living and a moderate need in Steady Evolution and Consumer Action.

By 2040, there is a high need for grid development in Low Carbon Living and a moderate need in Steady Evolution, Slow Change and Consumer Action.

Many circuits in this area experience shortfalls in capacity during times of high onshore wind generation in the South-West region, high interconnection flows, high demand from large energy users within the area or high conventional generation within the area. The need scores are highest in scenarios and years with the highest levels of onshore wind generation and interconnection.

5.6. Area 6 – South-East

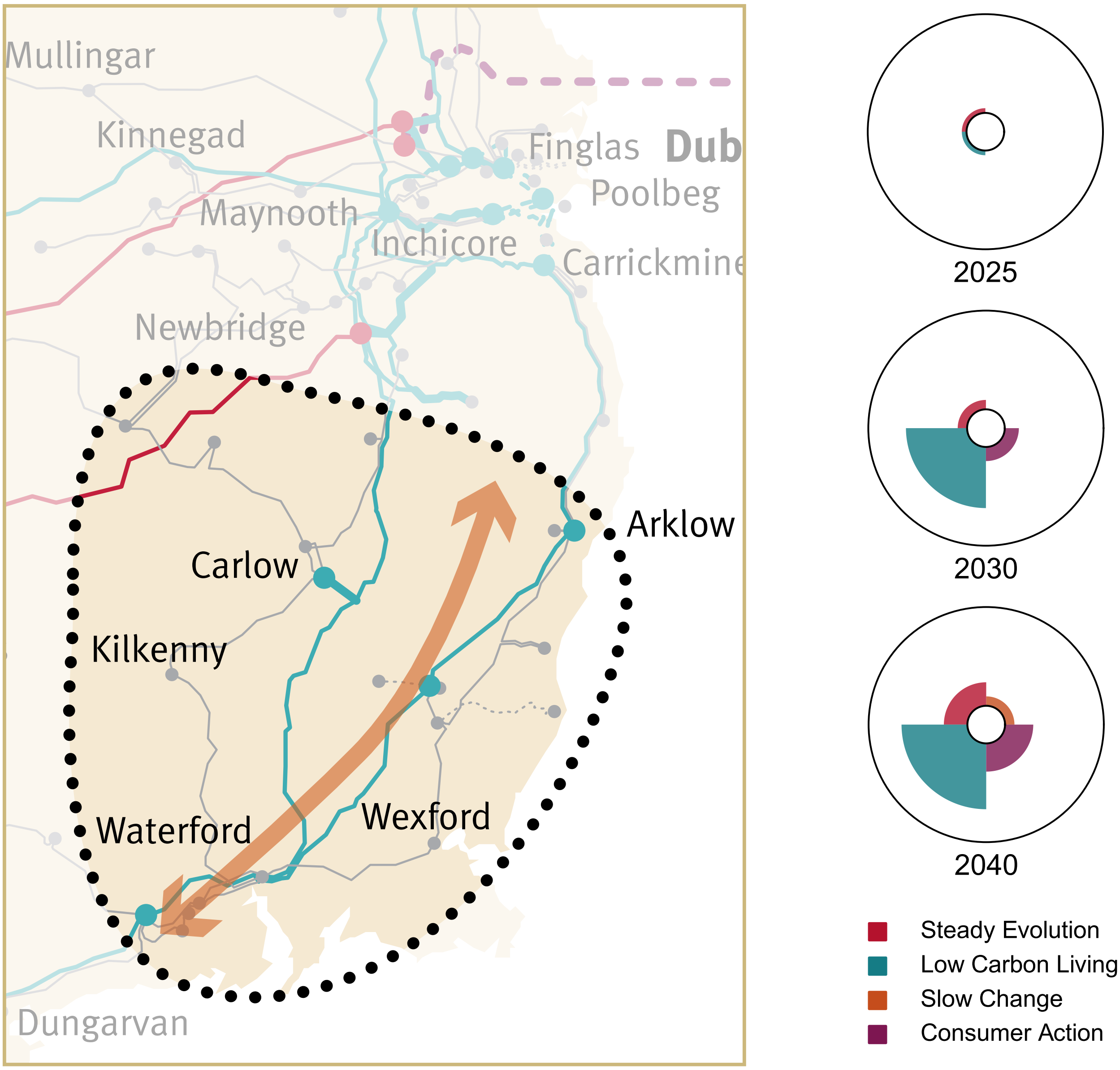


Figure 19: Geographic extent, need scores for Area 6

Driver(s)	Need(s)
Large energy user growth New HVDC interconnection RES integration	Power transfer capacity

Table 6: Driver(s) and need(s) summary for Area 6

Area 6 is located in the South-East and Mid-East regions. The area comprises of 110 kV and 220 kV grid. It is characterized by a high level of electricity transfer through the area to high electricity demand centres in Dublin and Cork.

Line faults, particularly 220 kV lines inside the area, result in a power transfer capacity shortfall to the rest of the grid. This need is greatest for the following conditions:

- high solar PV generation in the South-East and interconnection import and conventional generation in the South-East and South-West regions, or
- high offshore wind generation in the Irish Sea and interconnection export/import.

The needs are further increased if electricity demand increases, particularly if this involves large energy users locating in Dublin or Cork.

Figure 19 shows the need scores for the South-East area across scenarios and study years. The need scores indicate that the scale of the need increases over time as more RES connects, as the level of new interconnection increases, and as the system demand increases.

The need exists from 2025 onwards in Steady Evolution and Low Carbon Living and in all scenarios by 2040.

The need scores indicate that, by 2025, there is a moderate need for grid development in Steady Evolution and Low Carbon Living.

By 2030, there is a high need for grid development in Low Carbon Living and a moderate need in Steady Evolution and Consumer Action.

By 2040, there is a high need for grid development in Low Carbon Living and a moderate need in Steady Evolution, Slow Change and Consumer Action.

Many circuits in this area experience shortfalls in capacity during times of high offshore wind generation in the Irish sea, high solar PV generation in the South-East and high interconnection flows. The need scores are highest in scenarios and years with the highest levels of offshore wind generation, solar PV generation and new interconnection.

Next steps

The System Needs Assessment concludes the TES 2017 development cycle. However, we will continue to monitor the needs identified in this report.

Development projects have already been initiated for some of the needs identified as detailed in the *Transmission Development Plan 2017-2027*. These projects will be included in our grid model if a preferred solution option is selected and they proceed to step 4 in the grid development process. Including these projects in our grid model will reduce the needs presented in this report.

Long-term needs, not covered in the *Transmission Development Plan*, must be investigated further. If verified, these needs will appear in future editions of the *Transmission Development Plan*.

Our biennial scenario development cycle will begin again in **spring 2019** starting with a revision of our current scenarios and their portfolios, including locations. We will use the revised scenarios to perform the next *System Needs Assessment*.

We are committed to involving our stakeholders in how we plan the future transmission grid, as reflected in our *Have Your Say* document. We will engage with our stakeholders throughout our **TES 2019** scenario development process.

For more information on TES, or to access other TES publications, please visit our website, **www.eirgridgroup.com**.

Alternatively, you can email your views on TES to: **scenarios@eirgrid.com** and one of our team will be in touch.

Appendix 1 – New grid project assumptions

This section outlines the new grid project assumptions used in our grid simulations for the *TES 2017 System Needs Assessment* studies. Any changes to the existing grid included are based on the *Transmission Development Plan 2017-2027.*

Projects in steps 4, 5 and 6 of the grid development process are assumed to be in place in the grid simulations. This ensures that the only future projects included are those that have a single preferred solution identified.

The new grid projects assumed are given in Table 7, which presents the project name, Capital Project Identification Number (CP No.) and study year included.

Project	CP No.	2025	2030	2040
Ballynahulla 110 kV Statcom	CP0934	✓	✓	✓
Ballyvouskil 110 kV Statcom	CP0935	✓	✓	✓
Cross-Shannon 400 kV Cable	CP0970	✓	✓	✓
Dunstown 400 kV Series Compensation	CP0968	✓	✓	✓
Moneypoint – Knockanure 220 kV Project	CP0726	✓	✓	✓
Knockanure 220 kV Reactor	CP0936	✓	✓	✓
Laois-Kilkenny Reinforcement Project	CP0585	✓	✓	✓
North South 400 kV Interconnection Development	CP0466	✓	✓	✓
Oldstreet 400 kV Series Compensation	CP0969	✓	✓	✓
Moneypoint 400 kV Series Compensation	CP0967	✓	✓	✓
Shellybanks – Belcamp 220 kV Cable	CP0984	✓	✓	✓
Thurles 110 kV Statcom	CP0933	✓	✓	✓

Table 7: New grid projects included in the grid simulations

Appendix 2 –
All island electricity transmission grid

The Ireland and Northern Ireland grid, as of September 2017, is shown in Figure 20.

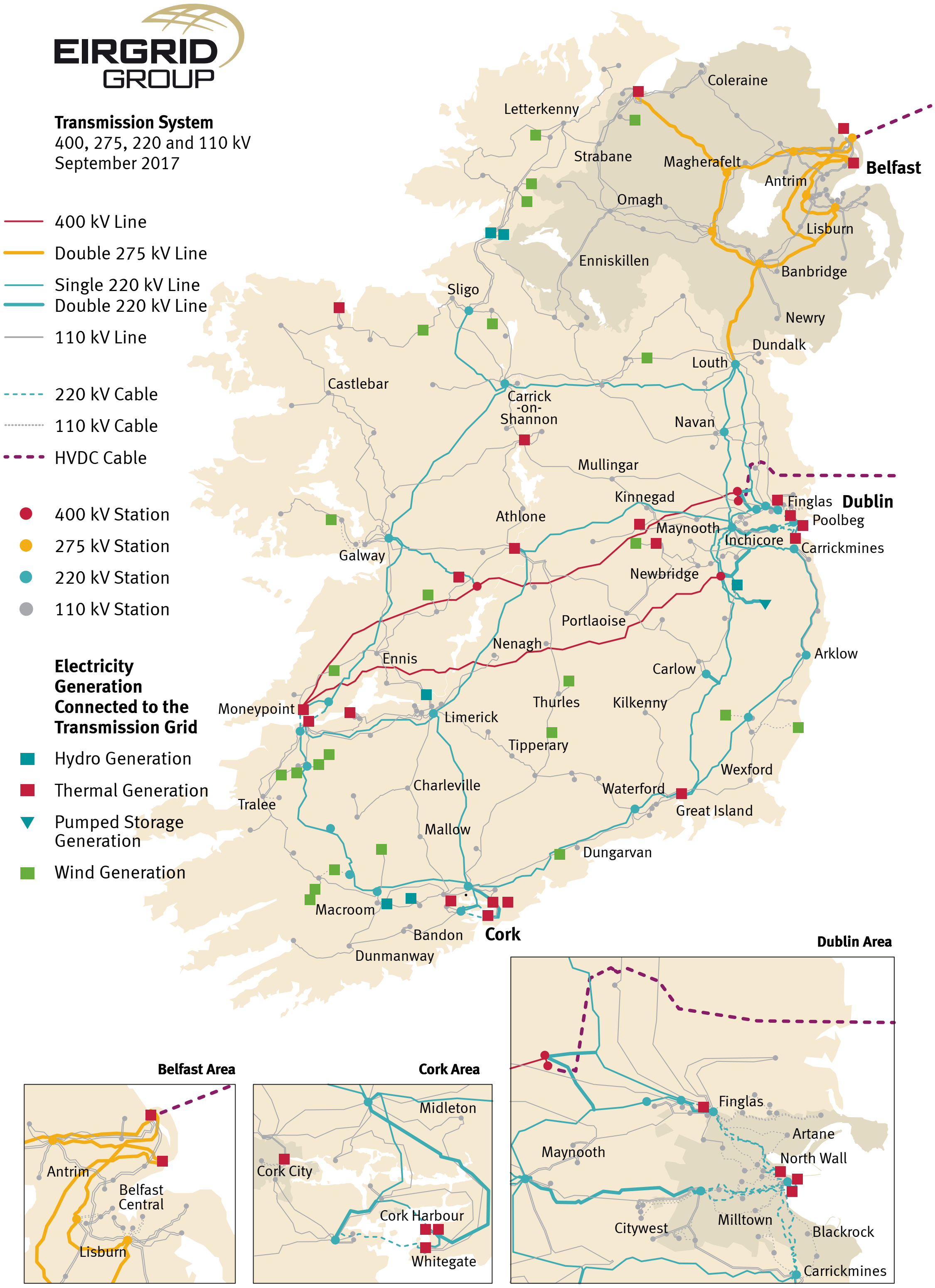


Figure 20: Ireland and Northern Ireland electricity transmission grid, as of September 2017

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