ESB NETWORKS

ELECTRICITY DISTRIBUTION NETWORK CAPACITY PATHWAYS

CONSULTATION REPORT

Delivering the Electricity Network for Ireland's Clean Electric Future

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esbnetworks.ie

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Executive Summary

The ESB Networks' **Networks for Net Zero Strategy**[1], launched in January 2023, contains a commitment to developing the Net Zero Ready Distribution Network by 2040 to enable Ireland's achievement of net zero no later than 2050. The electricity distribution network is critically important national infrastructure and an enabler for achieving the Government's Climate Action Plan[2] targets, for supporting a growing economy, and for delivering Housing for All[7] targets.

The electricity distribution network will need to both support a step change in the amount of renewable generation connected to the distribution network, and to meet significantly increased electricity demand from across all sectors with the electrification of heat, transport, and industry. This will require considerable investment and will serve to fundamentally transform the ability of the electricity system to empower and enable Ireland to reach net zero.

ESB Networks is committed to taking all necessary steps to develop a safe, reliable, and efficient network with the appropriate capacity, flexibility, and resilience to meet these requirements.

This Capacity Pathways Consultation Report sets out ESB Networks' analysis of the future distribution system capacity required and proposed pathways to deliver this by 2040. We are inviting stakeholders to engage with us, to share ideas, challenge us, and work with us to refine and improve these pathways so that we can plan the way forward together. This feedback will be incorporated into an expanded report in 2024 as we prepare to submit detailed investment plans for 2026 to 2030 to the Commission for Regulation of Utilities (CRU) for Price Review 6 (PR6).

The analysis in this Report takes into account historic demand growth and outlines three scenarios for additional capacity demand arising from the electrification of heat, transport, and industry, as well as from population growth, new housing developments, and economic growth. The Report also considers the network capacity required to bring clean electricity to customers from new renewable generation connected to the distribution network.

The Report highlights the growing need for additional investment to ensure adequate capacity is available to facilitate major growth in both electricity demand connections and renewable generation connections to the distribution system from now until 2030 and beyond. This Report also supports the delivery of actions set out in the Government Energy Security in Ireland to 2030[20] package.

A number of proposed pathways to deliver additional capacity are outlined, comprising but not limited to some key initiatives;

- **Changes to design standards**
- **Smart connections and demand side management**
- **Potential regulatory changes**
- **Engineering changes**

The electricity distribution network will need to operate in new ways to leverage the benefits of increasing renewable generation. There is a well-established programme of work being progressed through the National Network, Local Connections Programme[18] on future system operation, system flexibility, demand response, energy storage, and other technologies. While these important developments are mentioned in this report, and will work in parallel with building new network infrastructure, the main focus of this Report is on distribution network capacity requirements.

We invite your feedback on how ESB Networks can enable net zero, and whether there are further improvements in focus or scope that can be suggested to meet the challenges of connecting our customers to a clean electric future.

Delivering the Electricity Network for Ireland's Clean Electric Future

SECTION

02

INTRODUCTION

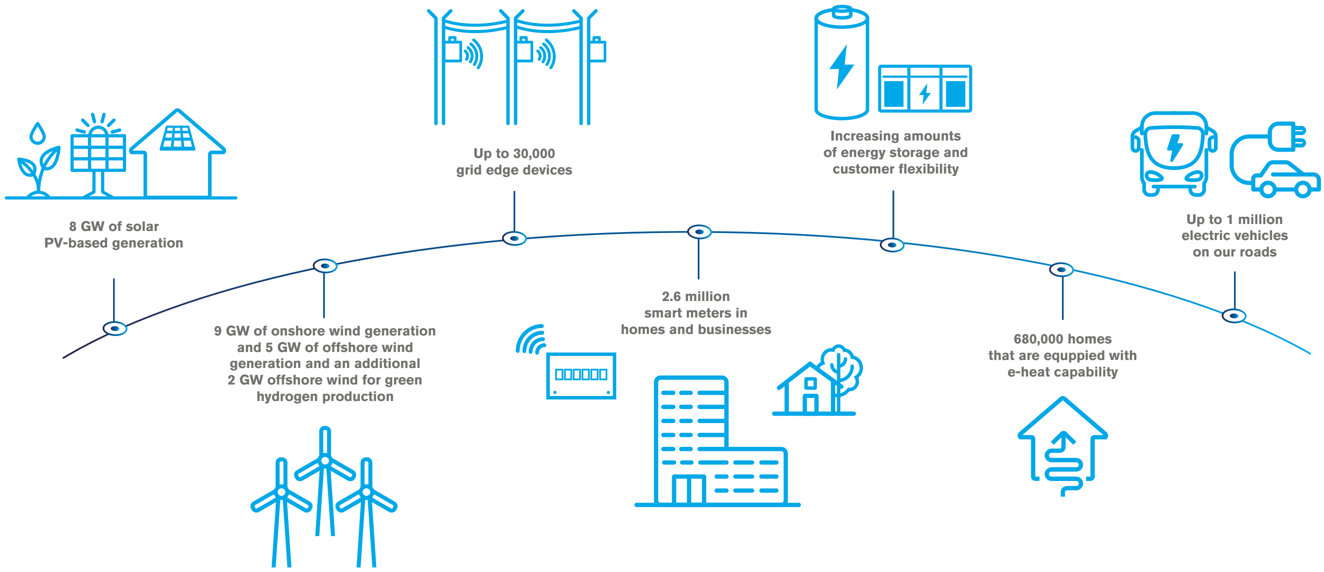
Introduction

Our Networks for Net Zero Strategy[1] sets out ESB Networks' role in enabling the delivery of the Government's Climate Action Plan[2] and supports the decarbonisation of electricity by 2040, which will enable the achieving of Ireland's net zero ambition no later than 2050.

Our Strategy is based on our role in transforming the electricity distribution network to empower all of our customers to decarbonise their energy consumption, and on our role as onshore Transmission Asset Owner (TAO) in delivering the electricity transmission programme. As we implement our Strategy[1], we will ensure that we have a safe, reliable, and efficient network with the required capacity, flexibility, and resilience for the electricity system of 2040.

The Energy Security in Ireland to 2030[20] package, published by the Department of Environment, Climate and Communications in November 2023, states that *'A major finding of the technical analysis undertaken to inform this package is that energy security is systemically linked and dependent upon the twin pillars of harnessing our indigenous renewable energy resources at speed and at scale and the rapid electrification of energy demand.'*

It is in this context that we are publishing the pathways we are working on to deliver distribution system capacity for both demand and generation connections, in our role as Distribution Asset Owner (DAO) and Distribution System Operator (DSO).



The Electricity Grids and Secure Energy Transitions Report[3], published by the International Energy Agency in October 2023, includes the following on grid investment:

'To meet national climate targets, grid investment needs to nearly double by 2030 to over USD 600 billion per year after over a decade of stagnation at the global level, with emphasis on digitalising and modernising distribution grids.'...'Delays in grid investment and reform would substantially increase global carbon dioxide (CO_2) emissions, slowing energy transitions and putting the 1.5 °C goal out of reach.'...'Grid expansion and modernisation needs to happen at speed and scale, and building new grids needs to go hand in hand with improved use of existing infrastructure and new technologies. Policy makers can speed up progress on grids by ensuring regulatory risk assessments allow for anticipatory investments, streamlining administrative processes, fostering societal support, and ensuring there are incentives for better use of existing infrastructure, as well as for new capacity.'

ESB Networks develop investment programmes through a process called Price Reviews (PR) that are approved and governed by the Commission for Regulation of Utilities (CRU). Price Reviews set the revenue that ESB Networks can recover from electricity customers and are agreed every five years. The CRU Price Review periods clearly mandate what is expected of ESB Networks as Distribution System Operator (DSO), Distribution Asset Owner (DAO), and onshore Transmission Asset Owner (TAO). The current Price Review (PR5)[4] determination was finalised in 2020 and runs from 2021 to 2025. When developing this five-year programme, both ESB Networks and the CRU considered all factors relating to the development and investment required to support economic growth, network resilience, and delivery of national decarbonisation targets.

ESB Networks has a long-term investment programme of ongoing development of 20 kV network and conversion of the existing 10 kV to 20 kV network to build capacity at the medium voltage level.*

This Report presents the solutions we are working on to build the distribution network capacity out to 2030 and beyond, with PR6 (2026 to 2030) being of critical importance to continued momentum to achieve net zero. Numerous additional external factors have impacted on the energy landscape since the determination of PR5[4] in 2020, including Fit for 55[5], REPowerEU[6], Housing for All[7], the National Energy Security Framework[8], the Alternative Fuel Infrastructure Regulation (AFIR)[9], CAP21[10], and CAP23[2]. Furthermore, the scale of work required has substantially increased, driven by the high levels of wind, solar, and energy storage solutions required to connect to the network together with accelerating mass electrification.

We have been developing solutions to deliver on these significant changes in energy transition. These include, for example, the anticipatory build of electrical infrastructure such as Renewable Hubs, and the accelerated introduction of Demand Side Management (DSM). These solutions are discussed later in the Report.

Grids, the missing link - An EU Action Plan for Grids[22] states that '*The socio-economic welfare losses of delaying the network upgrades necessary to connect renewables and flexible demand will frequently outweigh the additional initial cost of anticipatory investments. Moreover, given the long lifespan of network assets, significant cost reductions can occur in the future when today's investments are done already considering upcoming needs.*'

**Medium Voltage means 10 kV or 20 kV.*

SECTION

03

THE IRISH ELECTRICITY SYSTEM

ESB Networks is the electricity Distribution System Operator (DSO), Distribution Asset Owner (DAO), and onshore Transmission Asset Owner (TAO) in the Republic of Ireland. We work to meet the needs of all Irish electricity customers, delivering the electricity network for Ireland's clean electric future.

In 1929 ESB began supplying the cities, towns, and villages of Ireland with electricity generated at Ardnacrusha[11] and transmitted through the new national Shannon Scheme[12] network.

In 1946 the Rural Electrification Scheme[13] began connecting rural homes located beyond the towns and villages. By 1964 ESB had connected over 300,000 homes and businesses in all of its 792 rural areas. The Rural Electrification Scheme[13] was then extended following amendments to the Electricity Supply Act. This allowed homes which had missed out first time around another chance to get connected on a subsidised basis. All 792 areas were systematically revisited, and the scheme continued through various phases until 1978 when 99% of the country was electrified and our one millionth customer was connected.

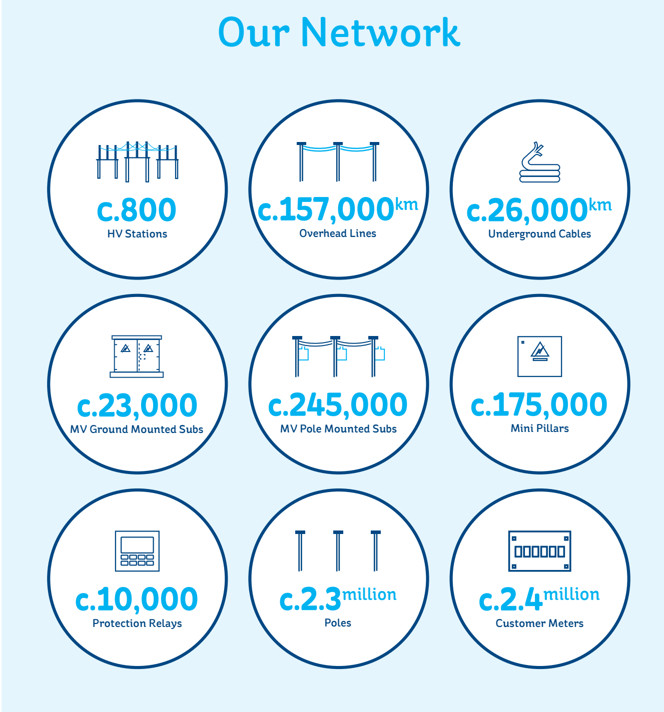
ESB Networks has continued to develop and refurbish the Irish electricity infrastructure, supporting the extensive range of needs across the Irish economy. In 2000, ESB Networks began the rollout of the Network Renewal Programme to refurbish all medium voltage (MV) network and convert a significant proportion (currently 52% and increasing) to operate at 20 kV.

Climate change is one of the greatest challenges facing humanity and it is widely accepted that rapid action is required to limit greenhouse gas (GHG) emissions to avert the worst consequences of climate change and protect both current and future generations. Through the rapid growth and development of renewable power, Ireland's electricity system has been significantly decarbonised over the last decade, which had utilised much of the capacity for generation connections on the distribution system to date, with accelerating progress now needed to continue to build increased momentum towards achieving a net zero society. The scale of demand growth driven by electrification requires investment in capacity for domestic, farming, industrial, and commercial demand connections across all voltage levels. ESB Networks' role is to deliver the electricity distribution network that will empower all our customers to decarbonise their energy consumption.

3.1 DISTRIBUTION NETWORK INFRASTRUCTURE

The electricity system comprises of transmission and distribution network that includes all substations, overhead electricity lines, and underground cables that are used to bring power to Ireland's 2.4 million domestic, commercial, and industrial customers. We work to meet the needs of all Irish electricity customers, delivering the electricity network necessary for Ireland's clean electric future. Our current network comprises 157,000 km of overhead network, 26,000 km of underground cables, and over 800 high voltage substations (these include both customer owned substations as well as ESB Networks owned substations), serving all our customers as shown in **Figure 1**.

Figure 1



At ESB Networks we build and maintain the high voltage transmission system and carry out all the functions relating to the electricity distribution system. This includes asset management, planning, construction, maintenance, and operation of the high, medium, and low voltage distribution network. Our role is to deliver a clean electric future through the electrification of heat, transport, and industry, as well as connecting renewable generation at scale to the electricity network.

The DSO (ESB Networks) to TSO (EirGrid) interface boundary typically occurs at the 110 kV busbar in 110 kV stations nationally, as shown in **Figure 2**. Within the Dublin City area, the boundary occurs at the 220 kV interface as the DSO operate a number of the 220/110 kV transformers and 110 kV circuits within Dublin City.

Figure 2 - Typical DSO-TSO Control Boundaries in 110 kV Station

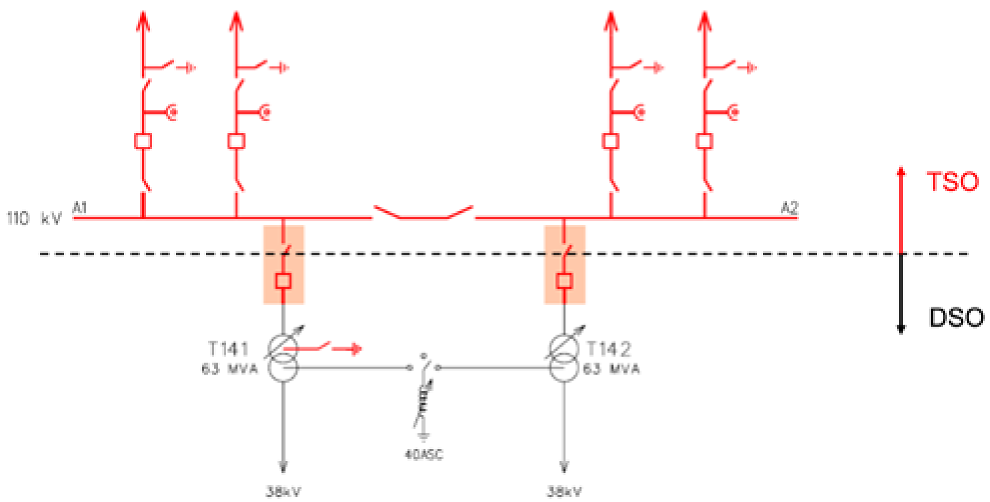
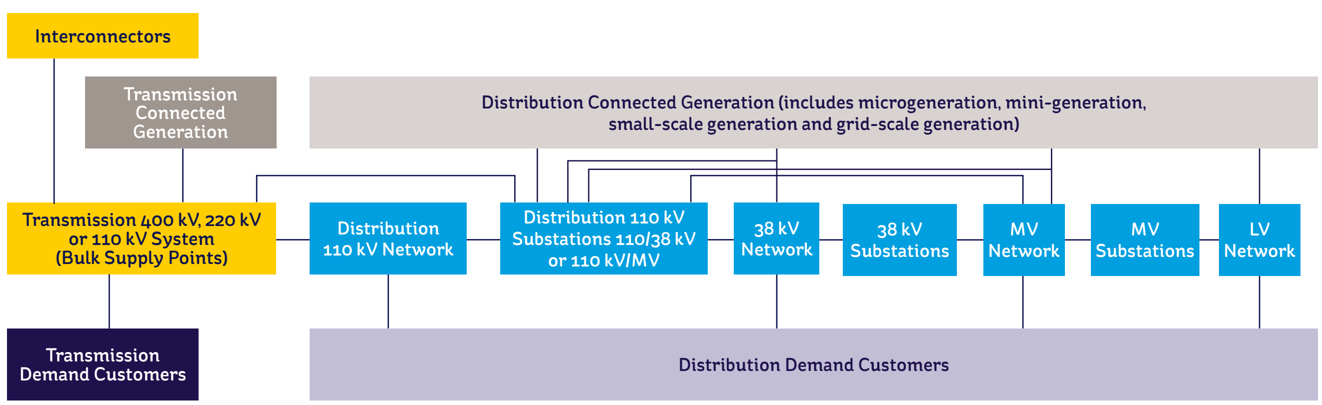


Figure 3 shows demand and generation customer connections in the electricity system in Ireland.

Figure 3 - Demand and generation customer connections in the electricity system in Ireland



For the DSO to develop new 110 kV stations or to add capacity to existing stations, an agreement is required with the TSO (EirGrid) to ensure the transmission capacity required is available and to ensure the development of the overall electricity system is optimised. Therefore, close collaboration is required with EirGrid in the process of developing new 110 kV distribution station capacity to supply the customers connected to the distribution system.

The electricity network has enabled rapid economic growth and has allowed for growth in housing, industrial development and renewable generation, and the progress made to date on the electrification of transport, heat, and industry. With growing demand and associated take up of existing network capacity, significant investment is required to ensure our electricity infrastructure continues to support a thriving economy that is on an accelerating journey towards net zero.

The distribution system assets in the Republic of Ireland at end of 2022 are shown in **Table 1** below.

Table 1 - Register of Distribution System Assets in the Republic of Ireland at end of 2022

Asset	Units	Volume
220 kV		
220 kV Substations	No.	2
220/110 kV Transformer Capacity	MVA	2,500
110 kV		
110 kV Overhead Lines	km	388
110 kV Underground Cable	km	238
110 kV Substations	No.	128
110 kV Switching Substations	No.	11
110/38 kV Transformer Capacity	MVA	7,081
110 kV/MV Transformer Capacity	MVA	1,558
38 kV		
38 kV Overhead Lines	km	5,637
38 kV Underground Cable	km	1,286
38 kV Substations	No.	422
38 kV Transformer Capacity	MVA	5,390
MV		
20 kV 3-ph Overhead Lines	km	15,517
20 kV 1-ph Overhead Lines	km	31,996
10 kV 3-ph Overhead Lines	km	12,273
10 kV 1-ph Overhead Lines	km	23,883
20 kV Underground Cable	km	1,960
10 kV Underground Cable	km	8,670
3-ph Pole-mounted Transformers	No.	22,568
1-ph Pole-mounted Transformers	No.	226,580
MV Ground-mounted Substations	No.	23,343
LV		
LV 3-ph Overhead Lines	km	4,747
LV 1-ph Overhead Lines	km	56,995
LV Underground Cable	km	15,351
Mini-Pillars	No.	180,493

We are continuing to invest in the electricity distribution network during PR5. There are large parts of the network where there is capacity today for electricity demand connections, but this will require investment in advance of 2030 to meet the growing needs of the distribution network. There are also a number of areas on the distribution network where there is limited capacity available for continued electricity demand growth. Examples of the types of investment required across the distribution network are:

- 220/110 kV transformer capacity and 110 kV circuit capacity in Dublin (within the Dublin geographic area the 110 kV system is part of the distribution system. Outside Dublin the 110 kV system is generally part of the transmission system).
- 110/38 kV and 110 kV/MV transformer capacity.
- 38 kV/MV transformer capacity.
- 38 kV and MV circuit capacity (most of these circuits were developed organically with the demand growth over the decades, and are built of many different types of electrical conductors with various power ratings).

A key enabler of a smooth transition to a zero-carbon society is having the physical distribution network infrastructure that can transfer the additional power required by newly electrified transport, heat, and other Low Carbon Technologies (LCTs) from renewable generation sources.

As will be described in the sections that follow, this readiness is required across all voltage levels of the distribution network. ESB Networks has already commenced a dedicated programme of work to ready our medium voltage (MV) and low voltage (LV) network for new and additional load. This upgrading of the MV and LV network is required due to the nature of electrifying sectors of transport and heat, as well as the installation of more renewable generation sources, such as rooftop solar, at low voltage level. The Low Carbon Technologies are impacting the distribution network more substantially at the lower voltage levels and in a much more distributed and localised manner.

3.2 INVESTMENT IN THE ELECTRICITY DISTRIBUTION NETWORK

The major drivers for investment in the electricity network come from:

- Electricity demand growth which increases power flow across the network.
- Connection of new renewable electricity generation sources, which require reinforcement of the electricity network to allow the electricity to be transported from the generation site to where it is consumed.
- Replacement of ageing infrastructure that has reached the end of its life (this is called asset replacement).
- Reinforcements to improve continuity and security of supply. As our customers decarbonise their energy usage and rely on electricity for their heat and transport needs, increased resilience of the electricity network will be essential. A significant number of single transformer substations and tail-fed networks* require reinforcement to improve resilience.
- Investment in digitalisation to provide smart solutions such as Demand Side Management and the information to empower customers to make informed decisions regarding their energy use, such as that provided by smart meters.

A major investment in network capacity/infrastructure across the distribution network is needed to deliver a Net Zero Ready Distribution Network by 2040. These investments need to have two strands:

- The development of new transmission and distribution lines and cables, electricity substations, and transformers.
- Increases in the capacity of existing infrastructure, alongside strategic replacement of critical aging infrastructure.

We will need to deliver this expanded programme of work across the period 2026 to 2040, following completion of the current PR5[4] work programme. The profile of investment across three Price Reviews will be part of our PR6 submission. These estimates are based on forecasted network requirements for customers in these periods, and this approach makes the programme delivery and the cost of investments more manageable and focused.

In addition to the expanded work programme, we have developed and will continue to develop new tools and procedures to enable the use of new innovative technologies and concepts to solve constraints on the distribution network. Our aim is to optimise the investment by maximising the use of existing distribution network and smart solutions, and optimising where (and when) investment is used for new network build/expansion.

In **Sections 4 and 5** we set out the current state of play for the distribution network demand capacity and the distribution network renewable generation capacity.

In **Section 6** we set out different pathways to add capacity to the distribution network and we also discuss the role of modern and digital distribution network to optimise the network investments in transition to a clean electric future.

While investment in digitalisation will aid efficiency and is likely to enable additional energy flows on the existing network, significant investments are nevertheless required in electricity network infrastructure before the existing capacity is exhausted.

** Tail-fed network is network that is supplied via a radial circuit from an existing electricity system.*

SECTION

04

DISTRIBUTION NETWORK DEMAND CAPACITY

4.1 HISTORICAL DEMAND GROWTH

The transition to a low-carbon future requires sufficient network capacity to accommodate a significant increase in new and additional demand due to electrification of heat, transport, and industry, as well as providing capacity for the demand associated with the economic growth, population growth, and new housing developments.

Figure 4 below shows the historical growth in the total system demand in TWh as well as the growth in consumption by the distribution and transmission connected customers of approximately 25% over the last ten years.* The difference between the total system demand and the consumption by the transmission and distribution connected customers represents losses across the electricity system.

Figure 4 – Historical growth in system demand and consumption by distribution and transmission connected customers

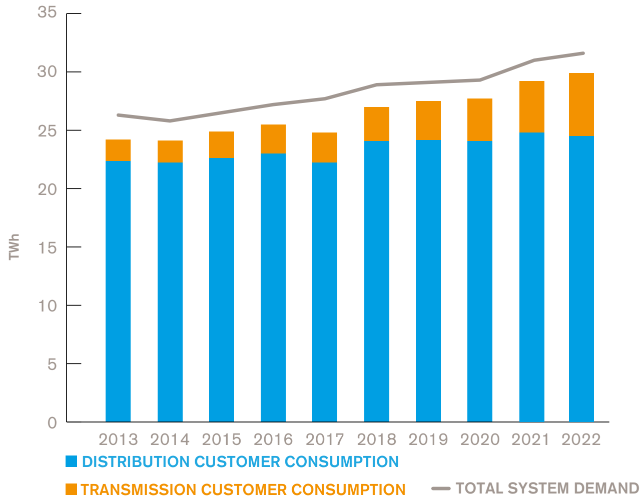


Figure 5– Historical consumption growth per type of load (SEAI)

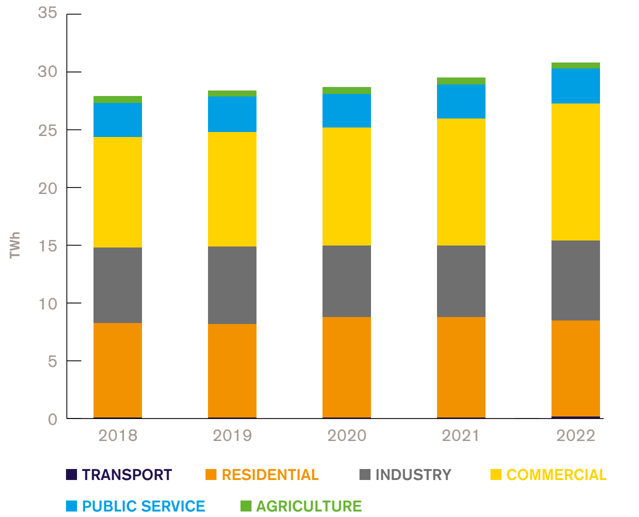


Figure 6 – Historical Republic of Ireland system peak demand (EirGrid System Peak)

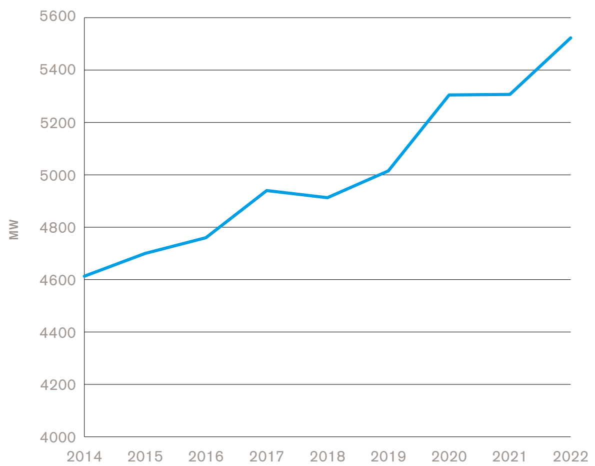


Figure 5 shows the historical consumption growth in TWh per type of load (SEAI data).

Figure 6 shows the historical Republic of Ireland peak demand in MW (EirGrid System Peak).

ESB Networks has carried out an analysis on the distribution network to determine the available capacity at the TSO/DSO interface nodes, to connect additional demand.

There is a high volume of 110 kV TSO/DSO interface nodes where investment is required to ensure adequate capacity is available to facilitate demand connections from now to 2030 and beyond. This will require upstream transmission capacity to supply the distribution network.

In urban areas such as Dublin, additional capacity is needed due to a tangible and significant ramp up in the electrification of transport, taking place in both the public and private transport spheres, alongside high demand for both new housing and new technology loads.

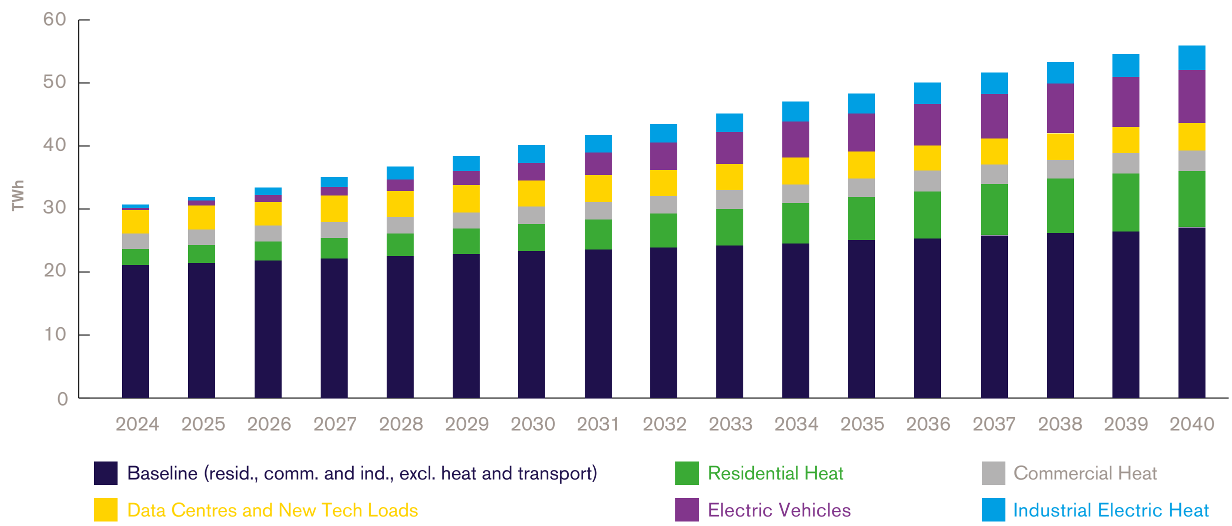
** The figures quoted are net of self-generation and consumption. This electricity demand would become evident in a "dunkelflaute" event. "Dunkelflaute" is a period of time in which little or no energy can be generated with wind or solar power, because there is neither wind nor sunlight. The electricity network must be resilient to cater for such events.*

4.2 ELECTRICITY DEMAND GROWTH FORECAST

ESB Networks commissioned a study by Charles River Associates (CRA) to provide a detailed analysis of the demand growth rates and the peak demand values for the electricity distribution system in Ireland for the period 2023 to 2040. This approach is consistent with our 'Build Once for 2040'* concept and our commitment to have a Net Zero Ready Distribution Network by 2040 that should enable all our customers to decarbonise their energy consumption by 2050. The methodology, analysis, and results will be used for the demand growth rates and peak demand values for consideration in PR6. The approach used is consistent with the approach used by other similar DSOs (such as UK Power Network, Northern Power Grid, Scottish Power, Australian Energy Market Operator, etc.).

Figure 7 below shows the forecasted distribution system consumption in the Base Scenario (excludes transmission connected customers consumption), described further in this section, per type of load from 2023 to 2040.

Figure 7– Forecasted distribution system consumption 2023-2040, per type of load



There are four main drivers of demand growth for electricity on the distribution network:

- **Residential**
  (excluding heat and transport).
- **Industrial and Commercial**
  (excluding heat and transport).
- **Heat**
  – industrial, commercial, and residential; National Heat Study[14], Net Zero by 2050, commissioned by SEAI, explored decarbonisation pathways for heating and cooling in Ireland.
- **Transport**
  – residential, public re-charging infrastructure installation including en-route electric vehicle (EV) charging network, shore-side charging facilities at ports and airports to comply with Alternative Fuel Infrastructure Regulation[9] (AFIR), as well as the electrification of public transport modes such as Irish Rail, DART, bus fleet, and associated depots charging.

** The 'Build Once for 2040' concept was introduced in our Networks for Net Zero Strategy. The aim is to ensure that the distribution network and supporting services such as demand management are designed and developed to meet the anticipated needs of customers in 2040. This will eliminate the need for repeated, costly, and resource intensive interventions on the network. Essentially, where possible, we will deploy solutions today which are scalable to meet the needs of customers and stakeholders in 2040.*

In the context of these drivers of demand, the demand growth rates and peak demand values were developed for three scenarios. All three scenarios consider full roll-out of smart meters with an associated take up rate of Time-of-Use tariff that encourages reduction of electricity usage at peak times (peak time is between 5pm and 7pm, Monday to Friday).

The impact of solar PV on potential demand side reduction was analysed. As peak demand occurs at some time between 5pm and 7pm, solar PV has a limited ability to reduce this. Furthermore, peak demand is higher in winter than in summer, so even though solar PV generation in summer months may overlap with peak demand, this will not reduce annual peak demand.

The three scenarios developed are as follows:

1. **Base Scenario:**
   - this Scenario is aligned with delivery of CAP23 targets for 2030.

   a. Customer numbers assumed to grow at 2016 to 2021 Compound Annual Growth Rate (CAGR).

   b. Limited distribution system data centre connections. All other large non-domestic loads known today are included.

   c. Electrification of heat follows the CAP23 targets.

   d. Electrification of transport follows the CAP23 targets.

2. **Conservative Scenario**
   – same as the Base Scenario with following adjustments:

   a. Electrification of residential and commercial heat is slower than in the Base Scenario.

   b. Electrification of passenger cars is slower than Base Scenario and follows the EV deployment in Norway (623,000 EVs by 2030, which is two thirds of CAP23 being achieved).

3. **Aggressive Scenario**
   – same as the Base Scenario with the following adjustments:

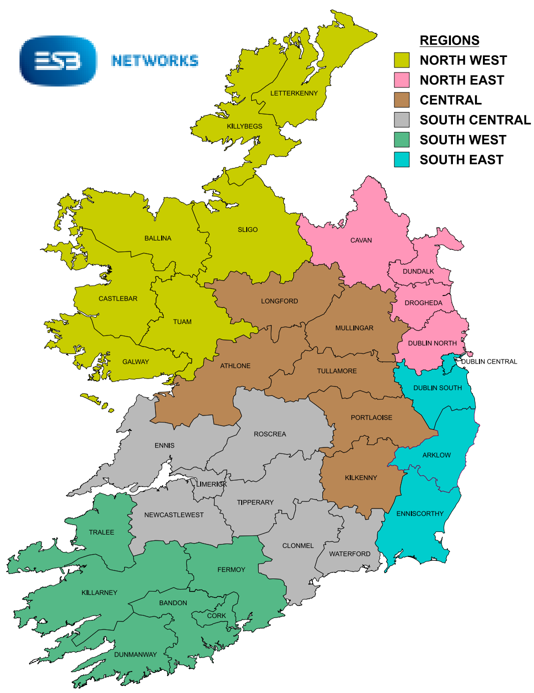
   a. All data centres in application for connection to the distribution system are approved.

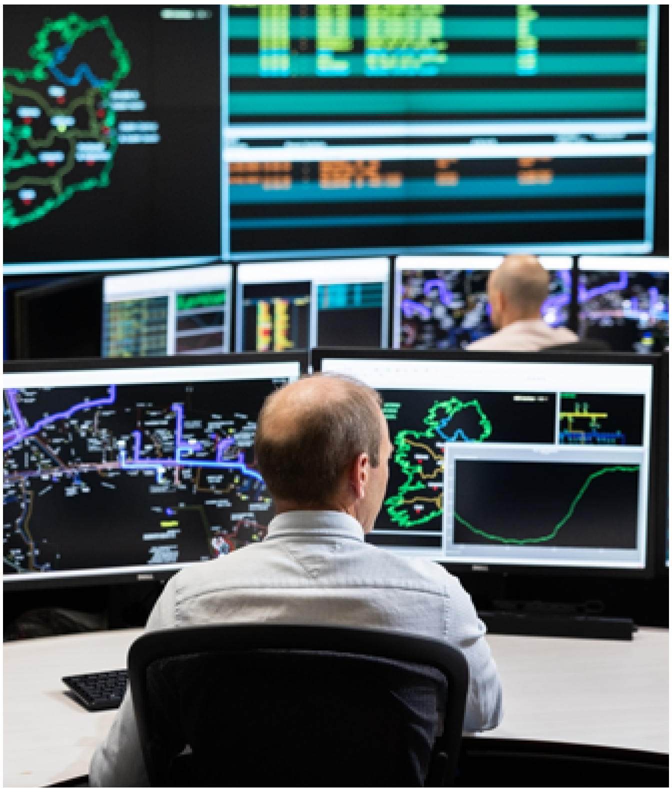
   b. Faster industrial heat electrification rate: 35% low grade and 64% high grade heat electrification by 2025, 55% low grade and 88% high grade heat electrification by 2030 (% out of electrifiable heat).

   c. More public EV charging infrastructure is installed (follows European Commission guide of one charger per 10 EVs).

The ESB Networks organisation is divided into six regions and, below this, into 34 "Planner Groups" as shown in **Figure 8**.

Figure 8– Distribution System Division into Six Regions and 34 Planner Groups





National demand growth rates and peak demand values were developed for each of the three scenarios, as well as for each of the 34 Planner Groups. National demand growth rates and peak demand values for each of the three scenarios for the distribution network are shown in the **Table 2** below.

Table 2 – National demand average growth rates and peak demand values for three scenarios

	CONSERVATIVE SCENARIO	BASE SCENARIO	AGGRESSIVE SCENARIO
2023-2025 growth rate	**2.8%**	**3.2%**	**8.3%**
2026-2030 growth rate	**2.6%**	**4.1%**	**4.0%**
2030 peak value (GW)	**6.4**	**6.9**	**7.7**

Figure 9 below shows the forecasted national growth in distribution system peak demand for all three scenarios from 2023-2040.

Figure 9 – National growth in the distribution system peak demand

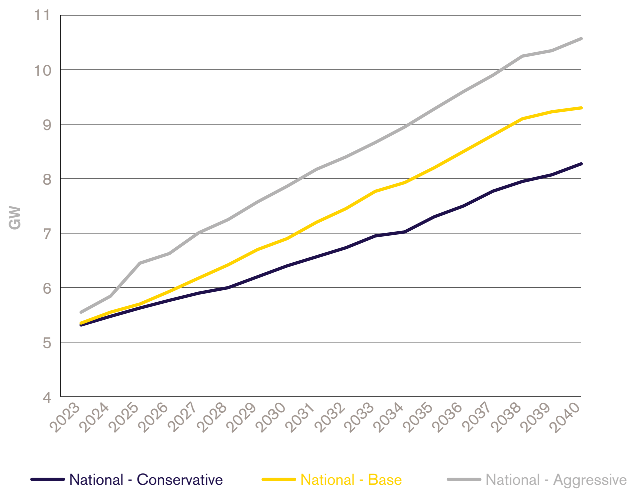
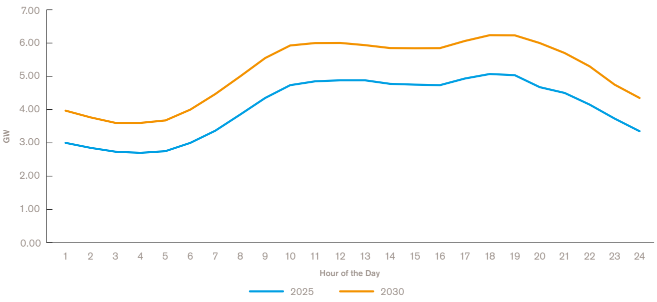


Figure 10 below shows the forecasted average winter 24-hour distribution system demand profile nationally for 2025 and 2030 in the Base Scenario.

Figure 10 – Forecasted average winter 24 hour distribution system demand profile nationally for 2025 and 2030 in the Base Scenario



In **Section 4.3**, we will discuss forecasted electricity demand growth on the distribution network for the Greater Dublin Area. In **Section 4.4**, we discuss forecasted demand growth for the rest of Ireland. In both cases, we cover the Base Scenario, which follows the expected electricity demand associated with achieving the targets set out in CAP23[2] as well as other electricity demand growth to support a growing economy and Housing for All[7] targets.

When considering investment in the distribution network during the remainder of PR5[4] and in PR6, the Base Scenario is the likely scenario that will inform the scale of new projects and the investment profile. This will be updated each year based on the adoption rate of Low Carbon Technologies and the rate of connection of renewable generation. While the Aggressive Scenario shows electricity demand growth that is accelerated in the period to 2030 when compared to the Base Scenario, the higher forecasted peak demand in 2040 in this scenario is an important guide as to what will be required to have a Net Zero Ready Distribution Network by 2040 .This will be further refined over the years ahead and we will be seeking to invest, where appropriate, during PR6, PR7, and PR8 to have the distribution network ready for a decarbonised future.

4.3 DEMAND GROWTH IN THE GREATER DUBLIN AREA

There is a major growth in demand in the Greater Dublin Area driven by the electrification of public transport (including Dublin Bus, DART +, Metrolink, Irish Rail, and Bus Eireann), private transport (passenger cars, commercial vehicle fleets, freight, public charging infrastructure developers/operators, and the provision of on-street charging by local authorities, ports, airports, etc.), and heat (small commercial, public buildings, etc.), as well as economic growth and growth in population, alongside new technology loads. Many of these electricity connections are large commercial loads and present significant challenges to deliver in a dense urban area. Much of the demand growth in the Greater Dublin Area is also impacted by the significant population growth* in satellite towns such as Naas (22%), Greystones-Delgany (21%), Malahide (12%), Balbriggan (12%), and Newbridge (7%).

The distribution system in the Greater Dublin Area is supplied at 110 kV, 38 kV, medium voltage (mainly 10 kV), and low voltage network. ESB Networks has divided the Greater Dublin Area into three Planner Groups: Central, North, and South as shown in **Figure 11**.

The demand growth rates and peak demand values for the three Dublin Planner Groups were developed, and the three scenarios are shown in the **Table 3** below.

Figure 11 – Map of three Dublin Planner Groups

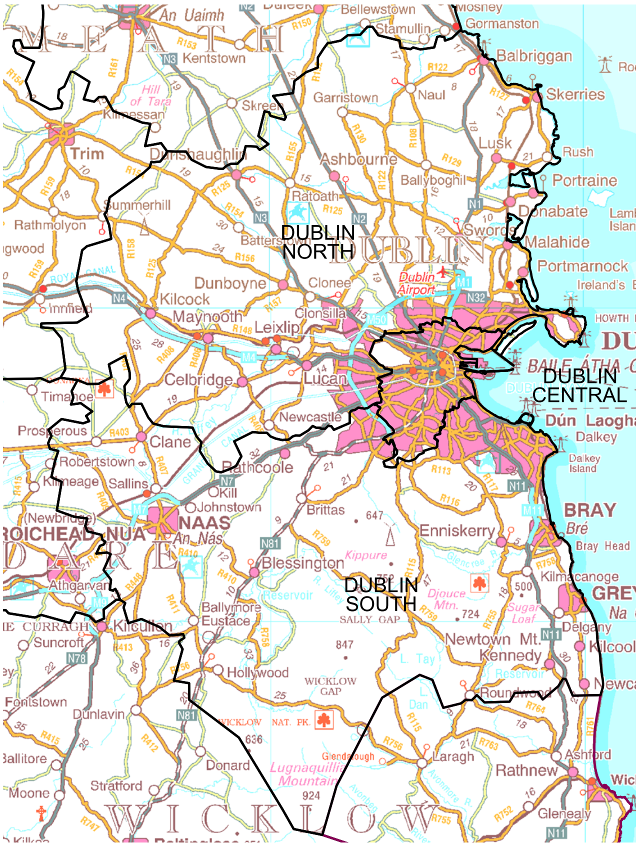


Table 3 – Demand growth rates and peak demand values for the Greater Dublin Area

	CONSERVATIVE SCENARIO			BASE SCENARIO			AGGRESSIVE SCENARIO		
	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (GW)	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (GW)	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (GW)
Dublin Central	3.2%	3.0%	0.7	3.5%	4.6%	0.8	5.8%	4.8%	0.8
Dublin North	5.7%	2.9%	1.1	5.9%	4.1%	1.2	15.1%	3.8%	1.4
Dublin South	2.8%	2.4%	0.6	3.0%	3.6%	0.6	9.1%	3.5%	0.7
Greater Dublin Area Total			2.4			2.6			2.9

*census data from 2016-2022

Figure 12 below shows the forecasted growth in distribution system peak demand in the Greater Dublin Area for all three scenarios from 2023 to 2040.

Figure 12 – Forecasted growth in the distribution system peak demand in the Greater Dublin Area

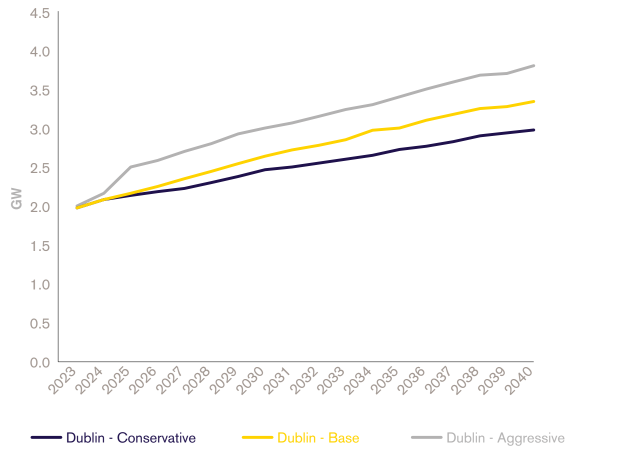
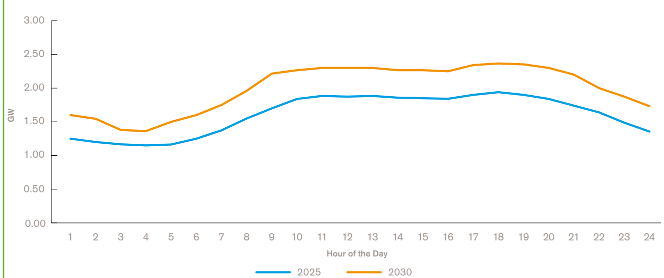


Figure 13 below shows the average 24-hour distribution system winter demand profile in the Greater Dublin Area for 2025 and 2030 in the Base Scenario.

Figure 13 – Forecasted average 24 hour distribution system winter demand profile in the Greater Dublin Area for 2025 and 2030 in the Base Scenario

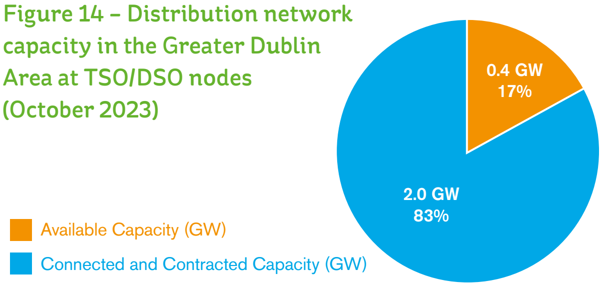


4.3.1 Transmission to Distribution Transformer Capacity

The distribution system in Dublin is currently supplied through four 220/110 kV Bulk Supply Points (BSPs) connected to the transmission system. These four BSPs can provide the total network demand capacity of approximately 2.1 GW to the distribution 110 kV network in Dublin. There is an additional 300 MW capacity available to the 110 kV distribution system in the Greater Dublin Area from other TSO/DSO interface nodes. The energy flows in the electricity system are shown in **Figure 3, Section 3.1**.

The Greater Dublin Area peak demand value today is approximately 1.5 GW, in addition to which another 0.5 GW of distribution network capacity is already contracted by customers. The connected, contracted, and available capacity for demand connections in the Greater Dublin Area 110 kV network based only on transformer capacity at TSO/DSO interface nodes (after losses in transformers are considered) is shown in **Figure 14** below.

Figure 14 – Distribution network capacity in the Greater Dublin Area at TSO/DSO nodes (October 2023)



As shown in **Table 3** in the previous section, we're forecasting 2.6 GW peak demand value for the Greater Dublin Area in 2030 in the Base Scenario. We are also forecasting a Greater Dublin Area peak demand value of approximately 3.7 GW in 2040, based on the Aggressive Scenario and our commitment to develop a Net Zero Ready Distribution Network by 2040. This is significantly more than total transformer capacity between transmission and distribution system in the Greater Dublin Area today and indicates that significant growth in investment is required to meet the electricity needs of this area for the future.

4.3.2 Distribution Network in the Greater Dublin Area

As shown in **Figure 3, Section 3.1**, the electricity distribution system consists of many different parts (substations, transformers, overhead lines, underground cables, etc.) at different voltage levels, and each part has its own capacity limitations. Even if/when capacity is available at the TSO/DSO interface nodes, it may not be available at the lower voltage levels unless constraints can be addressed at each point downstream.

Table 4 below shows the total transformer capacity at different voltage levels in the Greater Dublin Area available for demand connections, as well as forecasted required additional capacity for demand connections in 2030 and 2040, based on the Base Scenario growth rates for 2030 and Aggressive Scenario growth rates for 2040. Required distribution network capacity in the Greater Dublin Area for 2030 and 2040 includes the additional capacity required for operational switching (transfer of loads during outages).

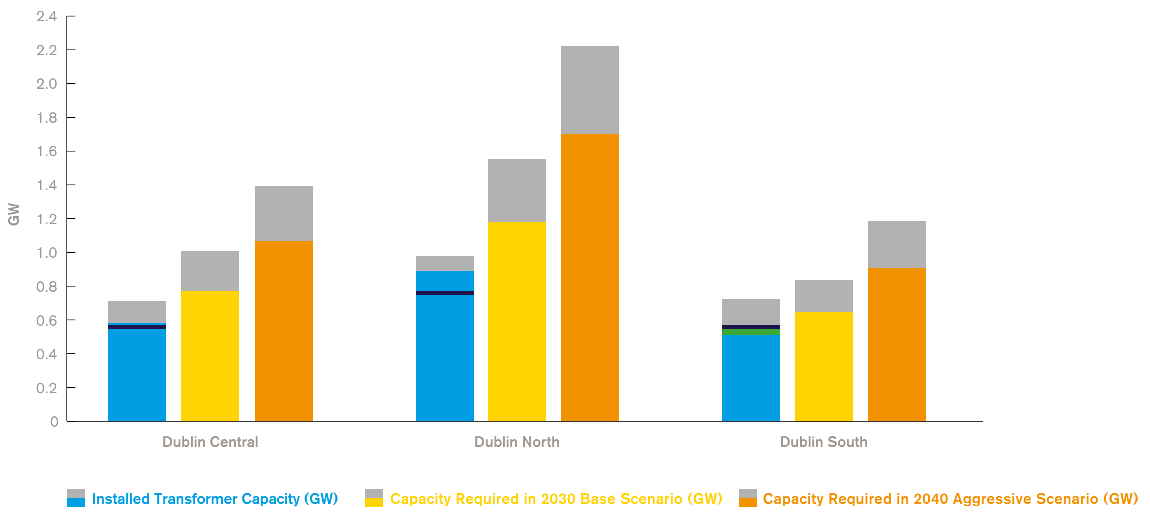
Table 4 – Transformer capacity for demand connections at different voltage levels in the Greater Dublin Area

	Total Capacity (GW)	Currently Available Capacity (GW)	Required Additional Capacity in 2030 (GW)	Required Additional Capacity in 2040 (GW)
Capacity available from transmission system (after losses are accounted for)	**2.4**	**0.4**	**1.0**	**2.4**
110/38 kV transformer capacity	**1.5**	**0.3**	**1.0**	**2.4**
110 kV/MV transformer capacity	**0.9**	**0.2**		

It is important to note that new demand connections are not always requested at the locations where the network capacity is available, and while **Table 4** shows some available capacity at an overall level at the different voltages, there are parts of Dublin where there are some capacity limitations today due to localised growth.

Figure 15 below shows the currently installed transformer capacity across the fleet of 110 kV substations in the Greater Dublin Area. It includes both 110/38 kV and 110 kV/MV transformer capacity per Dublin Planner Group where the blue part of the bar represents utilised transformer capacity. The part of the bar above the black line represents additional capacity required for operational switching (transfer of loads during outages). While there is some network capacity in Dublin North, growth in this area is reducing the available capacity for operational switching and this is a priority area for new capacity. The available capacity in Dublin Central has also reached a requirement for investment in additional capacity to enable future demand connections and accelerated electrification. There is some available capacity in Dublin South, which is represented by the green part of the bar. The other two bars represent the forecasted capacity requirement in 2030 for the Base Scenario and 2040 for the Aggressive Scenario, representing our commitment to deliver on the targets set in the Government's Climate Action Plan 2023, and the commitment in our Strategy to deliver a Net Zero Ready Distribution Network by 2040. The grey part of the bar represents the additional capacity required for operational switching.

Figure 15 – Distribution network capacity and forecasted capacity in the Greater Dublin Area



Historically, once 75% of installed transformer capacity is utilised at any voltage level for demand connections, it triggered the requirement to add new capacity to enable growth. This approach is necessary due to the time it takes to build new electricity infrastructure. A timeframe to construct new shovel ready HV electrical infrastructure is typically of the order of 18 to 24 months. The project development process, which includes the identification and securing of a suitable site as well as consenting and planning, can typically bring project delivery times to five to six years, while in more complex projects this could take up to eight years and in exceptional circumstances 10 years.

Considering the forecasted peak demand value in the Base Scenario for the Greater Dublin Area in 2030 of 2.6 GW, and in the Aggressive Scenario in 2040 of 3.7 GW, and the requirement of additional capacity for operational switching, there is a need to develop a minimum of 1.0 GW of new transformer capacity across all voltage levels in the Greater Dublin Area by 2030, and more capacity will need to be added by 2040. That is the equivalent of two to three new BSPs to add capacity at TSO/DSO interface nodes, an additional 15 to 25 110 kV substations (a combination of 110/38 kV, each with capacity of 88 MVA, and 110 kV/MV, each with the minimum capacity of 30 MVA), as well as many MV/LV substations and network capacity at all voltage levels, all of which need to be developed by 2030.

It is important that the development of new transmission Bulk Supply Point capacity for the provision of energy to distribution connected customers is prioritised, due to the critical role the distribution system is playing in delivering the climate action and enabling the electrification of the heat and transport sectors.

Due to the time it takes to build new electricity infrastructure, combined with the need to accelerate the energy transition, overall network capacity for a zero-carbon electricity system has to be considered, and the pathway selected to deliver the network capacity for 2030 has to be scalable to meet the demand capacity requirement in 2040.

In **Section 6.1.1.** we are presenting various pathways to add network capacity for demand connections in the Greater Dublin Area.

4.4 DEMAND GROWTH NATIONALLY (EXCLUDING THE GREATER DUBLIN AREA)

There is a major growth in demand across Ireland driven by the electrification of public transport (including Bus fleets, Irish Rail, Bus Eireann, ports, and airports), private transport (commercial vehicle fleets, freight, public charging infrastructure developers/operators and the provision of on-street and destination charging by local authorities, residential charging, etc.), and heat (residential, small commercial, public building, etc.), as well as economic growth and growth in population, alongside new technology loads. Many of these electricity connections are large spot loads and present significant challenges to deliver in a rural area, such as motorway service stations, due to the historically low electricity demand in these areas and therefore less capacity on the existing distribution network.

Annual demand growth rates and peak demand values were developed for each Planner Group for PR5 to PR8, and three scenarios for PR5[4] (the period from now to 2025) and PR6 (2026 to 2030) are shown in the **Table 5** below.

Table 5– Annual demand growth rates and peak demand values per Planner Group for all three scenarios

	CONSERVATIVE SCENARIO			BASE SCENARIO			AGGRESSIVE SCENARIO		
	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (MW)	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (MW)	2023-2025 growth rate	2026-2030 growth rate	2030 peak value (MW)
Arklow	2.7%	2.8%	115	2.9%	4.0%	122	4.0%	4.0%	127
Athlone	2.5%	2.6%	126	3.4%	4.5%	141	7.9%	4.4%	161
Ballina	1.9%	2.0%	79	2.3%	3.1%	84	7.5%	3.8%	101
Bandon	2.7%	2.7%	135	3.5%	4.7%	151	8.7%	4.6%	175
Castlebar	1.9%	1.9%	78	2.5%	3.2%	85	9.0%	4.0%	107
Cavan	2.2%	2.4%	169	2.7%	3.6%	182	6.1%	3.7%	202
Clonmel	2.1%	2.1%	112	2.5%	3.3%	120	5.7%	3.5%	132
Cork City	2.7%	2.7%	266	3.5%	4.7%	300	8.7%	4.6%	346
Drogheda	3.2%	3.0%	142	3.9%	4.9%	158	7.7%	4.7%	176
Dundalk	2.9%	2.9%	116	3.6%	4.7%	129	6.5%	4.7%	141
Dunmanway	2.7%	2.7%	92	3.5%	4.7%	103	8.7%	4.6%	119
Ennis	2.3%	2.3%	125	3.1%	4.2%	140	9.2%	5.0%	172
Enniscorthy	2.3%	2.5%	149	2.4%	3.4%	156	3.3%	3.4%	161
Fermoy	2.7%	2.7%	162	3.5%	4.6%	182	8.6%	4.6%	210
Galway	2.6%	2.8%	154	3.4%	4.3%	169	6.3%	4.3%	185
Kilkenny	2.2%	2.3%	137	2.3%	3.2%	143	3.0%	3.3%	147
Killarney	2.1%	2.2%	116	2.5%	3.4%	124	5.0%	3.4%	133
Killybegs	2.0%	2.1%	82	2.1%	2.9%	86	5.3%	2.8%	91
Letterkenny	2.0%	2.1%	127	2.0%	2.8%	131	4.9%	2.6%	138
Limerick	2.4%	2.4%	146	3.2%	4.2%	163	7.0%	4.6%	185
Longford	1.9%	2.1%	95	2.2%	3.0%	100	3.9%	3.1%	106
Mullingar	3.1%	3.0%	114	4.2%	5.4%	133	10.8%	5.1%	160
Newcastlewest	2.4%	2.4%	110	3.2%	4.2%	123	6.8%	4.5%	138
Portlaoise	2.9%	2.8%	133	3.0%	4.0%	142	4.5%	4.3%	151
Roscrea	2.1%	2.1%	111	2.6%	3.4%	120	6.7%	3.6%	135
Sligo	2.0%	2.1%	134	2.6%	3.5%	146	6.3%	3.5%	163
Tipperary	2.1%	2.0%	106	2.6%	3.4%	115	6.0%	3.5%	127
Tralee	1.8%	2.0%	107	2.0%	2.8%	111	3.3%	2.8%	115
Tuam	2.4%	2.5%	109	3.0%	3.9%	119	6.9%	4.1%	134
Tullamore	2.9%	2.8%	133	3.1%	4.0%	142	7.8%	3.8%	156
Waterford	2.3%	2.3%	136	2.5%	3.4%	145	4.7%	3.6%	155
National (excl. Dublin)	2.4%	2.4%	3,913	2.9%	3.9%	4,266	6.5%	4.0%	4,748

4.4.1 Distribution Network Nationally (excluding the Greater Dublin Area)

The distribution system nationally is supplied, from the transmission system, through 110/38 kV and 110 kV/MV transformers. The demand and generation customer connections in the electricity system in Ireland are shown in **Figure 3, Section 3.1**.

As set out in Section 4.2, the ESB Networks' organisation is divided into six regions and, below this, into 34 Planner Groups, as shown in **Figure 16**. This section considers 31 Planner Groups as the three Dublin Planner Groups were discussed in Section 4.3.

Figure 16 – Map of Six Regions and 34 Planner Groups Nationally

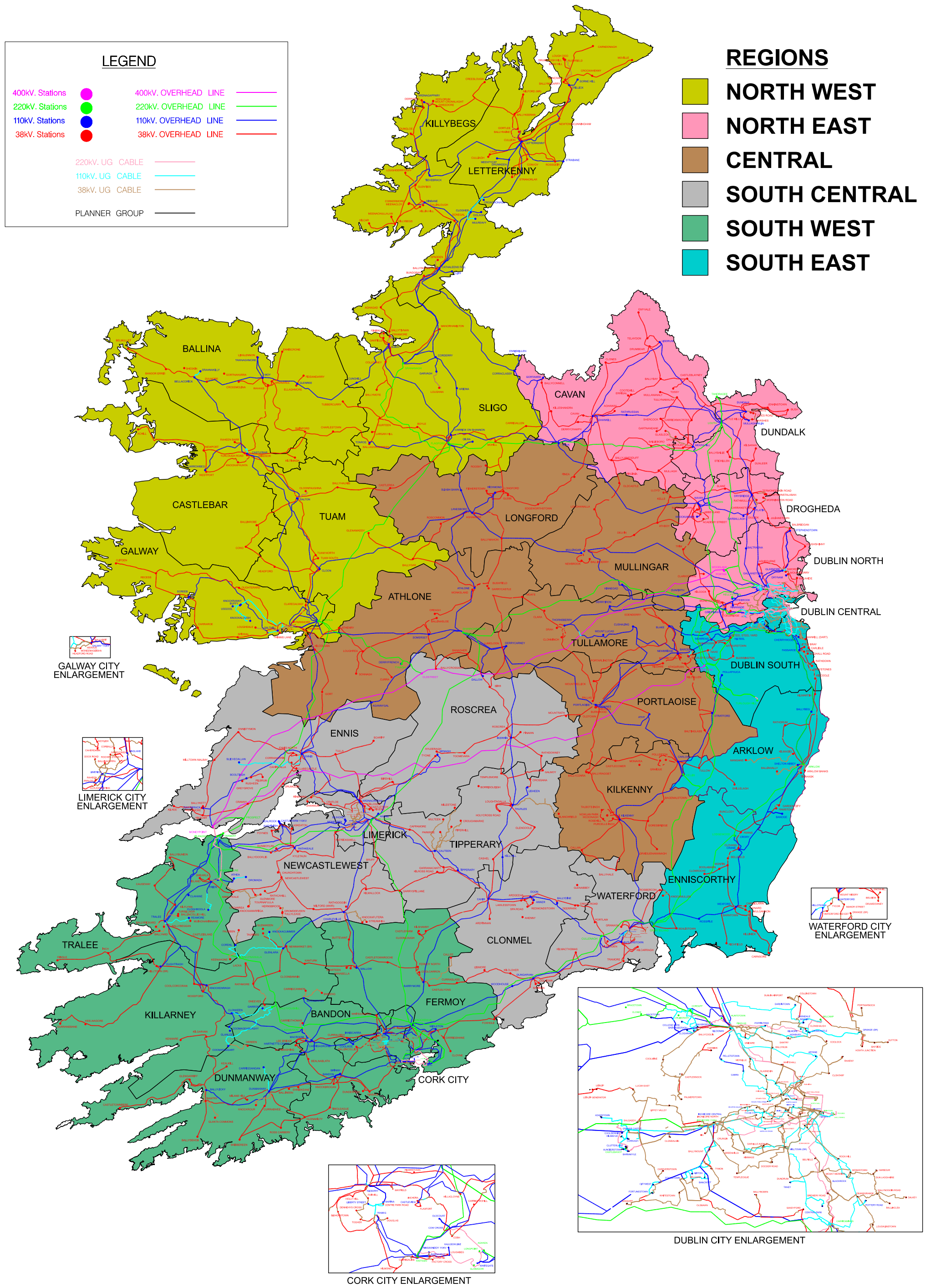
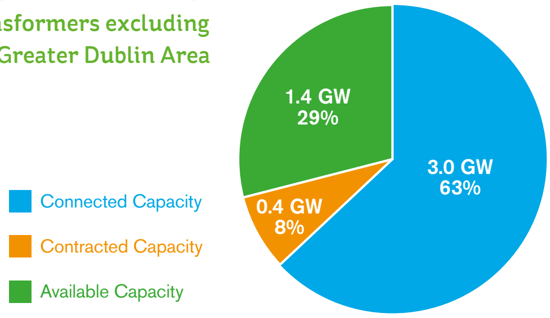


Figure 17 below shows the connected and contracted peak demand capacity and available capacity at distribution 110/38 kV and 110 kV/MV transformers nationwide (excluding the Greater Dublin Area) as of the end of October 2023.

Figure 17 – Available, connected, and contracted demand capacity on all distribution 110/38 kV and 110 kV/MV transformers excluding the Greater Dublin Area



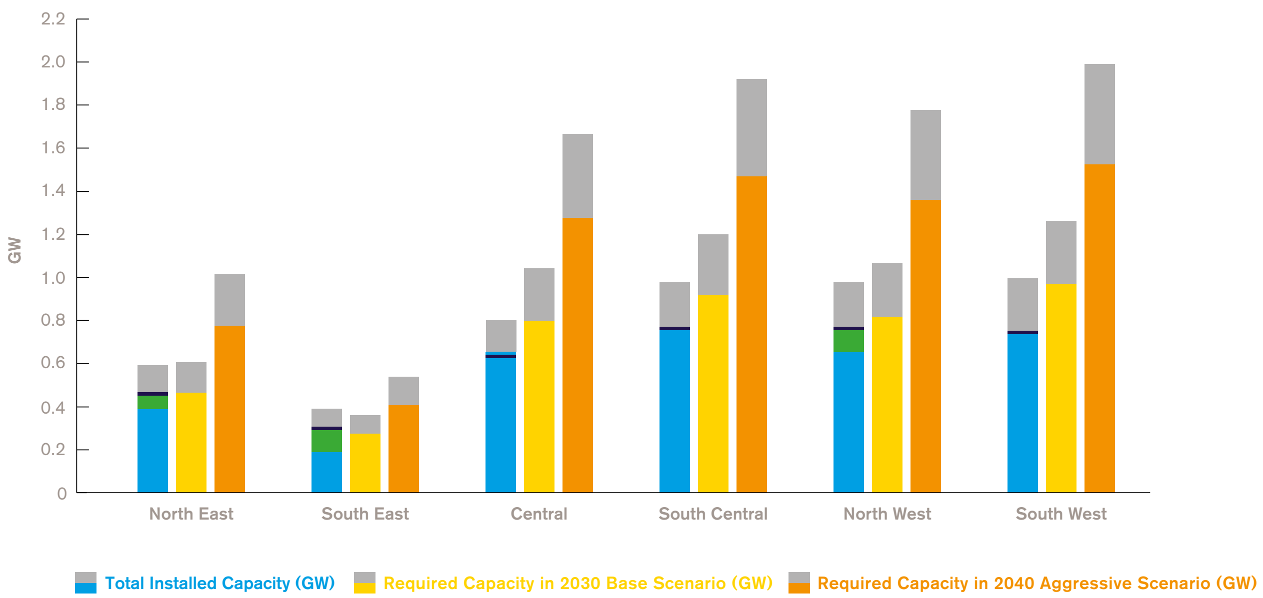
It is important to note that new demand connections are not always requested at the locations where the network capacity is available, and while **Figure 17** shows some available capacity at the national level, there are parts of the distribution system nationally where there are some capacity limitations today.

As shown in **Table 5**, we are forecasting the Base Scenario distribution system peak demand requirement outside the Greater Dublin Area in 2030 to be 4.3 GW. We are also forecasting 6.9 GW distribution system peak demand requirement outside the Greater Dublin Area in 2040 based on the Aggressive Scenario to enable a Net Zero Ready Distribution Network by 2040.

Figure 18 below shows the currently installed transformer capacity across the fleet of 110 kV substations per region nationally (excluding the Greater Dublin Area) in the blue/green/grey bar, where the blue part of the bar represents utilised capacity and the green part of the bar represents the available transformer capacity. The part of the bar above the black line represents additional capacity required for operational switching (transfer of loads during outages). This additional capacity has already been utilised in the Central Region which makes it a priority area for new investment. As shown in **Figure 18** below, the installed network capacity in the South Central and South West Region have reached the requirement for upgrades across all voltage levels. The other two bars represent the forecasted capacity requirement in 2030 for the Base Scenario and 2040 for the Aggressive Scenario, representing our commitment to deliver on the targets set in the Government's Climate Action Plan 2023[2], and the commitment in our Strategy[1] to deliver a Net Zero Ready Distribution Network by 2040. The grey part of the bar represents the additional capacity required for operational switching.

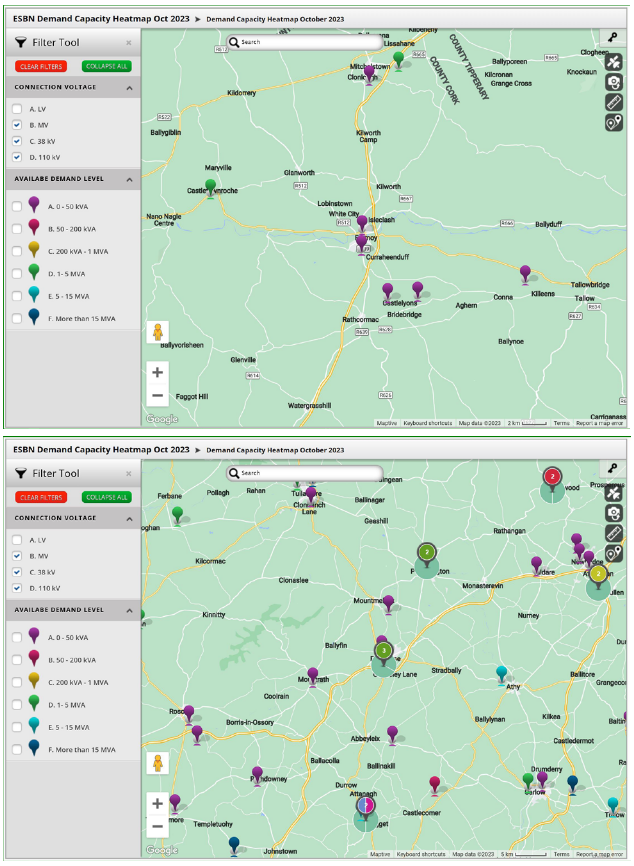
Although from **Figure 18** it looks like there is sufficient transformer capacity in 110 kV substations for demand connections in several regions, there are parts of the distribution system nationwide where the network capacity for demand growth is constrained. The distribution system capacity heatmap for both demand and generation connections is available on our website[15].

Figure 18 – Distribution network demand capacity and forecasted capacity per region (excluding the Greater Dublin Area)



Two examples of areas where the network capacity is constrained are shown in **Figure 19**. The purple pin on the map represents substations where less than 50 kVA demand capacity is available for new connections. This is the equivalent of one on-street charger for electric cars or nine houses.

Figure 19 – Areas where network capacity is limited for demand connections



These are mainly areas where large towns have been impacted by significant population growth* over the last decade, such as Carlow (19%), Navan (19%), Portlaoise (17%), Drogheda (14%), Dundalk (14%), Mullingar (13%), and some smaller towns that had major population growth over the last six years**, such as Ennis (10%) and Tralee (10%). There are also more rural areas that had steep growth in electricity demand recently due to the electrification of transport and their proximity to major motorway junctions, such as Moneygall and Fermoy. These capacity constraints are shown on demand capacity heatmaps published on our website.

As with the network in the Greater Dublin Area, historically, once 75% of installed transformer capacity is utilised at any voltage level for demand connections, it triggered the requirement to add new capacity to enable growth. This approach is necessary due to the time it takes to build new electricity infrastructure. A timeframe to construct new shovel ready HV electrical infrastructure is typically of the order of 18 to 24 months.

The project development process, which includes the identification and securing of a suitable site as well as consenting and planning, can typically bring project delivery times to five to six years, while in more complex projects this could take up to eight years and in exceptional circumstances 10 years.

The size of demand connection requests relative to the existing demand at more rural locations, driven by electrification of transport, creates the need for much larger available demand connection capacity at these locations (the high power EV public charging infrastructure requirement alone at many service stations could range from 1 to 10 MW and take all the capacity available at existing locations).

As shown in **Figure 17**, there is 4.8 GW of currently installed transformer capacity in 110 kV substations (excluding the Greater Dublin Area) nationally. We are forecasting peak demand value for the Base Scenario nationally (excluding the Greater Dublin Area) in 2030 of 4.3 GW, and in the Aggressive Scenario in 2040 of 6.9 GW. Due to the time it takes to build new electricity infrastructure, and the need to accelerate the energy transition, overall network capacity for a zero-carbon electricity system has to be considered, and the pathway selected to deliver network capacity for 2030 has to be scalable to be able to meet demand capacity requirement in 2040. The overall transformer capacity requirement across all voltage levels for distribution system nationally (excluding the Greater Dublin Area) in 2040 is approximately 9.0 GW, and this includes the requirement of additional capacity for operational switching. This represents the need to build additional 4.2 GW of new transformer capacity across all voltage levels nationally by 2040. At least 1.5 GW of that capacity should be built by 2030 to allow for change in the pace of energy transition and accelerated climate action. That is the equivalent of an additional 20 to 30 110 kV substations (a combination of 110/38 kV, each with capacity of 88 MVA, and 110 kV/MV, each with capacity of 30 to 45 MVA), as well as many MV/LV substations and network capacity at all voltage levels, all of which need to be developed by 2030.

We are collaborating with many different stakeholders, from TSO (EirGrid) to local authorities, industry, and developers, and developing individual plans for each region that will facilitate the growth in demand anticipated over the coming years.

Given the growth of electricity demand on the distribution network, ESB Networks will require future capacity at transmission level at each TSO/DSO node, to ensure that capacity is available for the broad range of customers who wish to connect to the distribution system (homes, businesses, farms, essential services, etc.).

The significant electricity infrastructure investment is needed across the whole distribution system to enable the energy transition to a zero-carbon future.

In **Section 6** we are presenting various pathways to add network capacity for demand connections across the whole distribution system, from technical solutions and additional infrastructure, to smart solutions and the revision of current policies and standards.

**census data from 2011-2016 and 2016-2022*
***census data from 2016-2022*

SECTION

05

DISTRIBUTION NETWORK RENEWABLE GENERATION CAPACITY

5.1 HISTORICAL RENEWABLE GENERATION GROWTH

Every renewable energy generation technology, from domestic roof top solar to large offshore wind installations, will be required to meet our net zero targets. This renewable generation, connected at all voltage levels to the electricity network, from low voltage (230 V and 400 V), and medium voltage (10 kV and 20 kV) to high voltage (38 kV and 110 kV), will impact on how our customers in every home and business in Ireland are interacting with the electricity distribution system, and how they are using renewable electricity produced locally on their net zero journey.

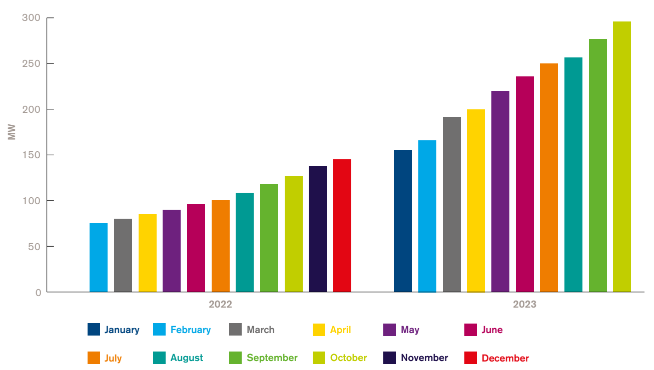
Offshore wind is now a proven and mature technology. Ireland is blessed with both a large seabed on which to develop this technology (both fixed and floating wind farms) and some of the best wind generation resources in the world. ESB Networks is responsible for the delivery of the onshore reinforcement projects to enable offshore wind once these projects are finalised and consented by EirGrid.

A key part of our role at ESB Networks is to facilitate the physical electrical connection between new renewable generators and the electricity network to help decarbonise electricity.

Since the early 2000s, more than 300 grid-scale renewable generators have been connected to the electricity network, with a total capacity of nearly 6.0 GW. Grid-scale renewable projects are installed from 10 kV to 110 kV on the distribution system, and at 110 kV on the transmission system. The projects are geographically distributed throughout the country but can cluster dependent on weather patterns. Approximately one third (114 projects) of all grid-scale projects are connected to the 38 kV distribution system. These represent nearly 75% of distribution connected wind generation capacity (1710 MW). ESB Networks process approximately 90 grid-scale renewable electricity generation applications every year under the regulated Enduring Connection Policy (ECP). These include commercial solar and wind projects, community projects, and auto-producers*.

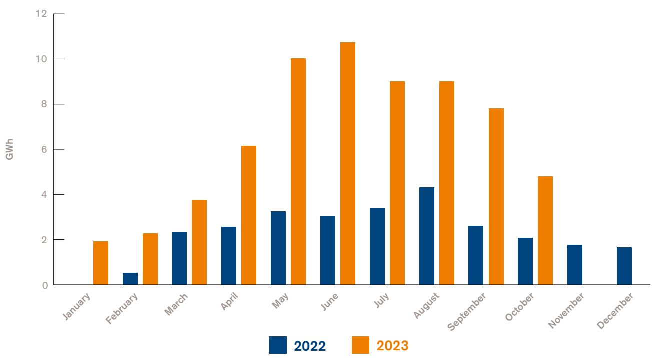
By the end of October 2023, there was approximately 300 MW of rooftop solar (Microgeneration: each connection with an export capacity of <11 kW) connected to the distribution system as shown in **Figure 20**.

Figure 20 – Cumulative Microgeneration (<11 kW) Total Maximum Export Capacity (MW)



These generators are already exporting significant renewable generation to our low voltage network as shown in **Figure 21**.

Figure 21 – Microgeneration (<11 kW) export to the distribution system (GWh)



ESB Networks carried out an analysis on the distribution network to determine the available capacity at the TSO/DSO interface nodes to connect distribution connected generators, subject to available upstream transmission capacity. **Table 6** presents an overview of this analysis. Please note that customer connection applications under study in the ECP2.3 batch are not included in the figures below.

Table 6 - Analysis of available transformer capacity for generation connections at TSO/DSO interface nodes (October 2023)

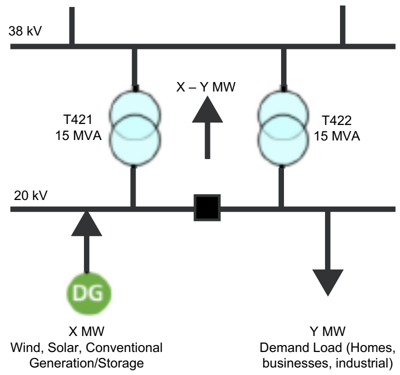
110/38 kV TRANSFORMERS	
Number of transformers with loading <50%	**47**
Number of transformers with loading 50% - 80%	**31**
Number of transformers with loading 80% - 100%	**30**
Number of transformers with loading >100%	**10**
Total number of 110/38 kV transformers	**118**
110 kV/MV TRANSFORMERS	
Number of transformers with loading <50%	**49**
Number of transformers with loading 50% - 80%	**5**
Number of transformers with loading 80% - 100%	**11**
Number of transformers with Loading >100%	**2**
Total number of 110 kV/MV transformers	**67**

** Auto-producer is an electricity generation facility used and managed by an industrial or commercial energy user for their own energy consumption.*

When assessing available capacity for a firm access generation connection at a substation, the most onerous scenarios are studied for the parameters being assessed. When assessing the impact of a generator connection, this is under minimum load conditions. Use of minimum load in determining transformer loading is shown in **Figure 22**.

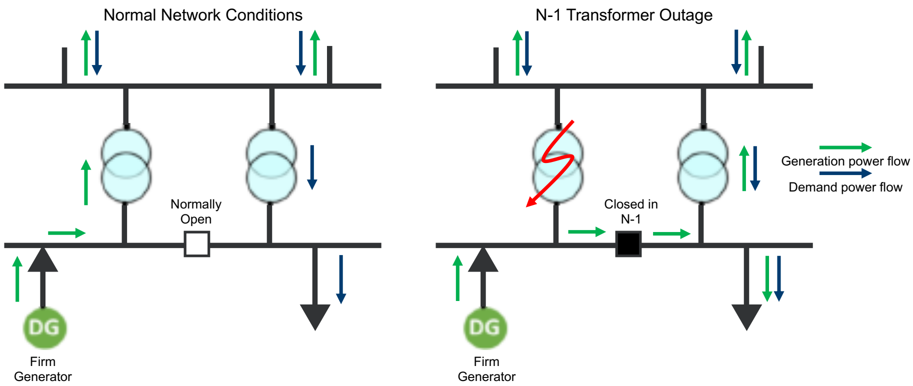
Minimum load occurs when the network demand at the location is at its lowest point. The minimum values are taken on the Sunday of the August Bank Holiday weekend at 6am and are commonly referred to as the summer valley load. The generation connection capacity in a substation that is determined by installed transformers is increased in consideration of the minimum load connected to allow more renewable generation connections.

Figure 22 - Use of minimum load in determining transformer loading



In the two transformer substations, the capacity available for firm access connection of generation considers the installed capacity of one transformer only. This is to allow one of the transformers to be taken out of service when required, for example for maintenance, without causing an outage for the firm access generators. This is shown in **Figure 23**.

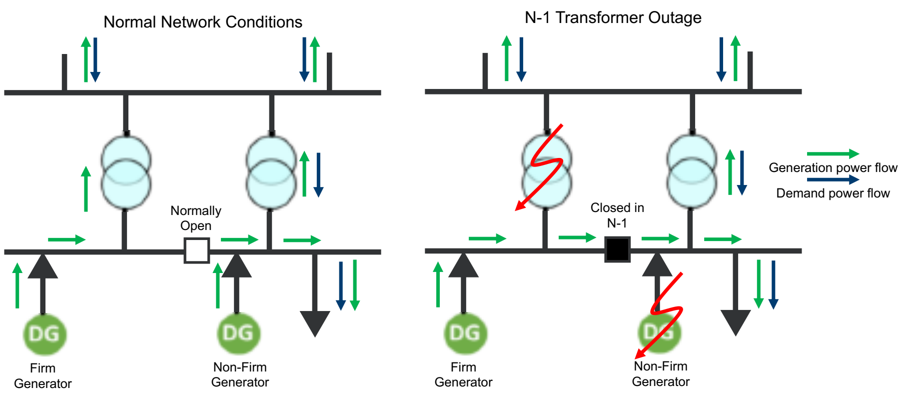
Figure 23 - Diagram of firm access in normal and N-1 network conditions



To facilitate and maximise the connection of further distribution generation, generator connections can be offered a flexible connection on a non-firm access (NFA) basis where eligible. In the NFA arrangement, the available capacity is based on the capacity of the second transformer in the substation.

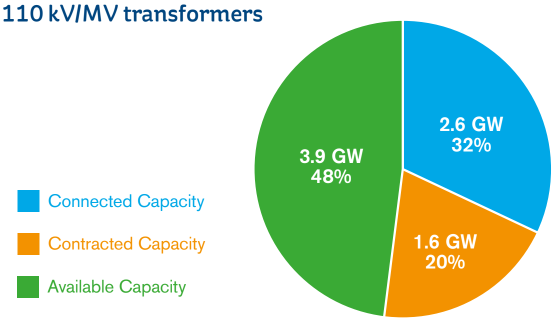
As shown in **Figure 24**, in the event of an outage of one of the transformers in the substation, the NFA connected generator would have its output reduced or disconnected from the system to ensure that the remaining plant is not overloaded. The firm generator would remain connected, and its output accommodated through the remaining in-service transformer.

Figure 24 - Diagram of non-firm access in normal and N-1 network conditions



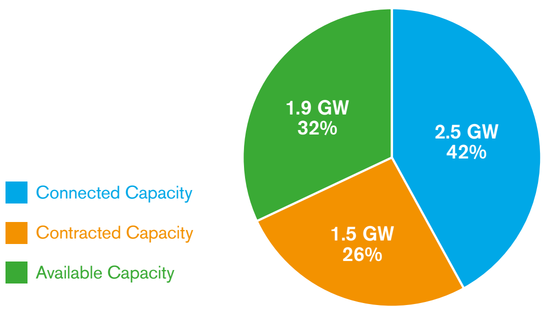
Based on the success of the connection of renewables on the distribution network to date, much of the firm capacity on the network has been utilised or committed to future contracted projects as shown in **Figure 25** below. There is 2.6 GW of currently connected generation capacity as well as 1.6 GW of contracted but not yet connected generation capacity on the distribution system.

Figure 25 - Available, connected, and contracted generation capacity on all distribution 110/38 kV and 110 kV/MV transformers



While high density urban areas will have a role in the connection of of Microgeneration, Mini-Generation and Small Scale Generation, it is not envisaged that large scale distribution connected generators will locate in areas with access to this capacity. Once the available generation capacity in 110/38 kV and 110 kV/MV transformers in high density urban areas in Dublin, Cork, and Limerick is excluded, the pie chart in **Figure 26** shows that there is approximately **1.9 GW** of renewable generation capacity currently available on the distribution system to connect grid-scale renewable projects. This is based on using the existing connection methods, and does not account for increase in non-firm access connections.

Figure 26 - Available, connected, and contracted generation capacity on distribution 110/38 kV and 110 kV/MV transformers, excluding Dublin, Cork, and Limerick



Certain parts of the network that have seen a large volume of connected and contracted distribution generation, due to their optimal location for wind and solar, will now need significant reinforcement at both distribution and transmission levels to accommodate any further generation connections. For example, Letterkenny 110 kV substation in Donegal has successfully connected 61 MW of distribution generation (which represents 80% of substation generation capacity); Kilkenny 110 kV substation has facilitated the connection of 63 MW of distribution generation (which represents 86% of substation generation capacity); and Arklow 220 kV substation has facilitated the connection and contracting of approximately 160 MW of distribution generation (which represents 100% of substation generation capacity).

Figure 27 – Map of six regions

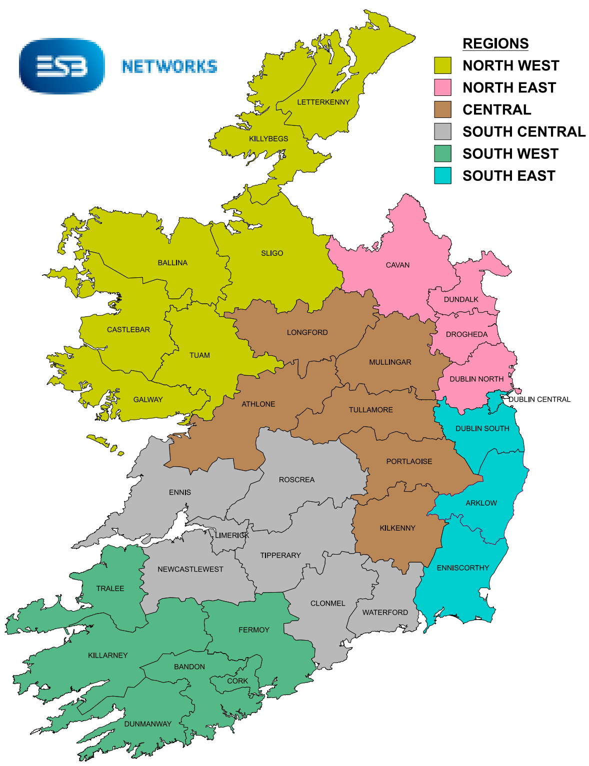
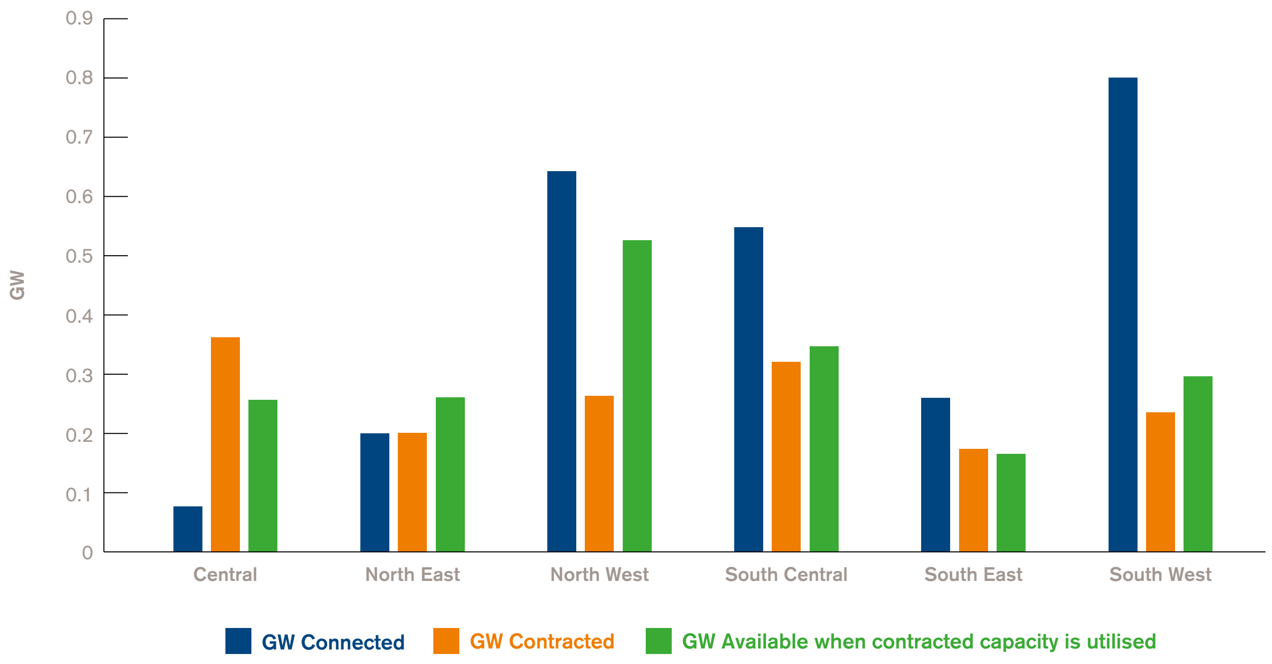


Figure 28 shows the committed and available network capacity in the six distribution network regions, excluding high density urban areas (Dublin, Cork, and Limerick). In **Figure 28** the blue bar represents the connected generation in each region, the orange bar represents the contracted generation in each region, and the green bar represents the remaining available capacity for generation in each region. This demonstrates both the success of facilitating connections in the regions and highlights the challenges in ensuring network capacity is available to continue to connect generation to the distribution system and enable decarbonisation.

Figure 28 - Regional view of generation GWs connected, contracted, and available in 110/38 kV and 110 kV/MV substations (excluding Dublin, Cork, and Limerick)

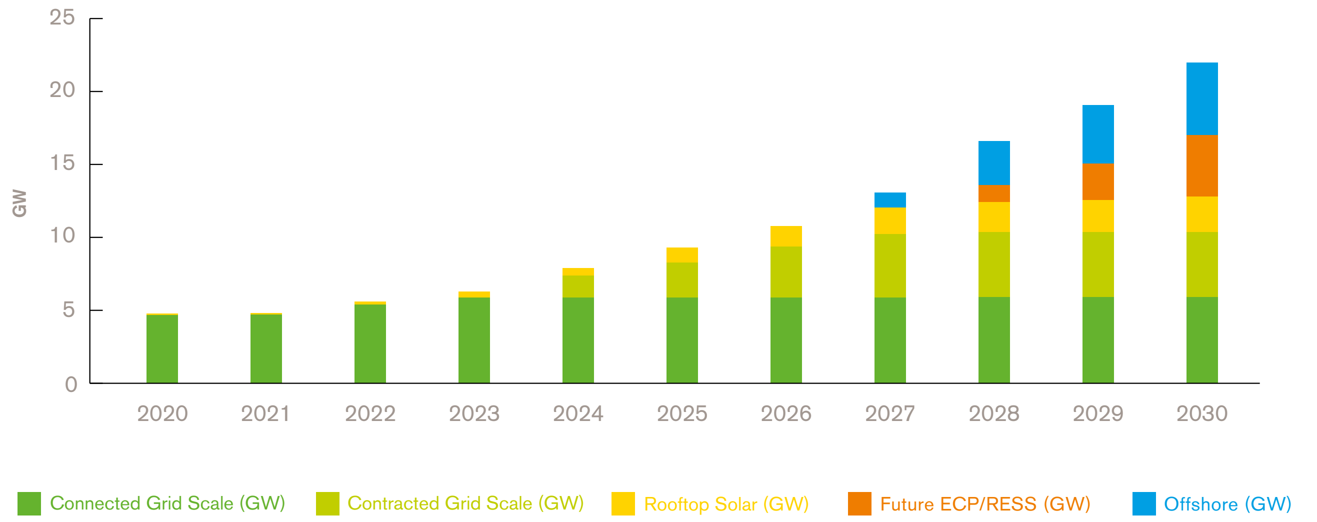


5.2 DISTRIBUTION CONNECTED RENEWABLE GENERATION GROWTH FORECAST

The Climate Action Plan 2023[2] sets the target of more than 22.0 GW of renewable generation to be connected to Ireland's electricity system by 2030. This is made up of a mix of solar and wind, both onshore and offshore.

At least 5.0 GW of additional renewable generation is planned in CAP23[2] to come from offshore wind (and an additional 2.0 GW offshore wind for green hydrogen production) by 2030. That leaves more than 17.0 GW of renewable generation to be connected onshore. This is represented in **Figure 29**.

Figure 29 – Forecast of renewable generation growth to meet CAP23[2] targets



There will be approximately 6.0 GW of renewable generation capacity connected to the electricity system by the end of 2023. That means that a further 11.0 GW of renewable generation capacity should be connected onshore over the next seven years.

A 2022 study funded by ISEA (Irish Solar Energy Association) and conducted by MaREI (SFI Research Centre for Energy, Climate and Marine research and innovation)[16], established a view on the potential for rooftop solar in Ireland. In this study they proposed that, if just six solar PV panels are installed on 1 million homes (every suitable home, which represents approximately 50% of homes in Ireland), this could lead to up to 2.5 GW capacity and production of 1.8 TWh per year (approximately 22% of the residential electricity demand in 2021).

The target in CAP23[2] is for 2.5 GW of the renewable generation capacity by 2030 to be connected as non-new grid solar. These are mainly Microgenerators, as per current connection policy, and non-exporting generation connected to the distribution system (Maximum Export Capacity = 0, called MEC0). As shown in the previous section, there is already approximately 300 MW of Microgeneration rooftop solar installed at the low voltage network. Once Mini-Generation (from 11 kW up to 50 kW), Small Scale Generation (50 to 200 kW), and MEC0 are considered, the currently installed capacity totals approximately 400 MW.

Considering the CAP23[2] target of 2.5 GW non-new grid solar by 2030 and currently installed 400 MW of rooftop solar, that leaves 2.1 GW of rooftop solar to be installed by 2030 that would not require electricity network upgrades to the customers' existing connection network. To ensure that Mini-Generation and Small Scale Generation do not drive the upgrades in the connected low voltage network, we have enabled the connection of Mini-Generation up to the allowed import capacity for each individual connection. However, aggregation of these generators in the same area is likely to drive upgrades to the medium and high voltage network, including additional transformer capacity needs. Historically, the cost-efficient development of the distribution system used the assumption that all demand customers will not be using their maximum import capacity at the same time (during the system peak). However, due to the nature of solar generation, generation connected in the same geographical area will be producing the maximum solar power at the same time, and therefore the aggregation of these generators in the same LV network will still drive network upgrades in many areas (an example is the solar panels on school rooftops that will be exporting their maximum power to the local distribution network on the sunny summer days when schools are closed).

Considering all of the above, an addition of at least **8.9 GW** of renewable generation **(22.0 GW CAP23[2] target for 2030* - 5.0 GW offshore – 6.0 GW already connected – 2.1 GW non-new grid solar left to be connected = 8.9 GW)** will need to be installed onshore and connected to the electricity system by 2030, requiring additional network infrastructure. Historically, approximately half of the renewable generation capacity has been installed to the distribution system. If that continues over the coming years until 2030, approximately 4.4 GW of further grid-scale renewable generation should be connected to the distribution system by 2030. Approximately 1.6 GW of that generation has already been contracted, so based on the historical trends combined with the industry pipeline of projects, we are forecasting that at least an additional 2.8 GW of grid-scale onshore wind and solar projects need to be connected to the distribution system to meet CAP23[2] targets for 2030.

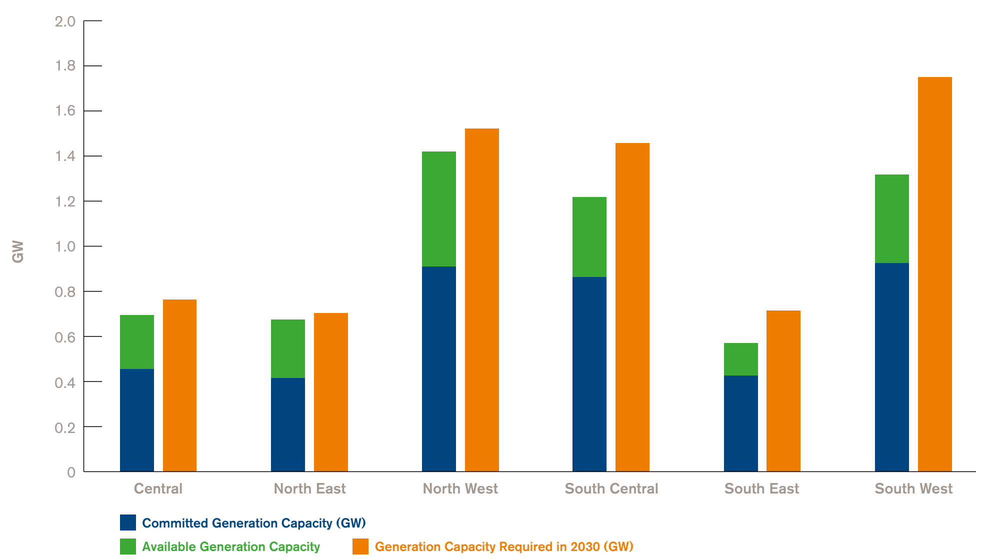
Figure 30 below shows the available distribution system generation capacity and forecasted generation capacity per region (excluding Dublin, Cork, and Limerick) required on the network by 2030 to meet CAP23[2] targets. The blue and green bars in each region are a representation of the committed generation (connected and contracted) in blue and the remaining available capacity in green. The orange bar represents our forecast of the required distribution system generation capacity in 2030 to meet CAP23[2] targets.

We have stated in the previous section that there is approximately 1.9 GW of distribution system generation capacity available at the TSO/DSO nodes. However, this capacity does not necessarily coincide with the renewable generator connection locations and, as stated previously, Mini-Generation and Small Scale Generation are driving upgrades and reducing the available capacity as well. Therefore, there is additional network capacity needed at TSO/DSO nodes as well as the feeder capacity in the downstream network to meet the CAP23[2] renewable generation targets for 2030.

To create the required capacity, a combination of traditional network reinforcements combined with innovative solutions to increase utilisation of existing assets is required.

In **Section 6** we set out pathways to add network capacity, and we're asking you to share your opinion with us.

Figure 30 - Distribution system generation capacity per region



** CAP23[2] target for renewable generation by 2030 = 9.0 GW onshore wind + 8.0 GW solar (of which 2.5 GW non-new grid solar) + 5.0 GW offshore wind = 22.0 GW, and additional 2.0 GW offshore wind for hydrogen production*

SECTION

06

PATHWAYS TO ADD NETWORK CAPACITY

There are various changes on the horizon that will impact upon the electricity industry, most notably; decarbonisation, including the increasing prevalence of Distributed Energy Resources (DER); Demand Side Management and the electrification of heat and transport; advancements in technology; and changing customer requirements.

The growth rate applied to planning studies is an essential component which informs ESB Networks' Network Investment Plans for each Price Review period. Network Investment Plans are based on these growth rates and approval is sought from the CRU to invest in the network in the areas identified from planning studies. Therefore, having a predicted growth rate for the PR period that is as accurate as possible is crucial for both ensuring we optimise system development and for justifying investment plans to the CRU.

With this in mind, Charles Rivers Associates (CRA) has developed for ESB Networks a growth rate tool called PEGASUS 40 (Predicting Energy Growth and Supporting Utility Scenarios for net zero 2040). This tool allows us to predict growth around the country based on differing scenarios/inputs (e.g., CAP targets, housing stock, EV charging demand, AFIR obligations, etc.). PEGASUS 40 will enable us to assess and adapt peak load growth to changes in the electricity landscape and support an efficient delivery of targeted reinforcements.

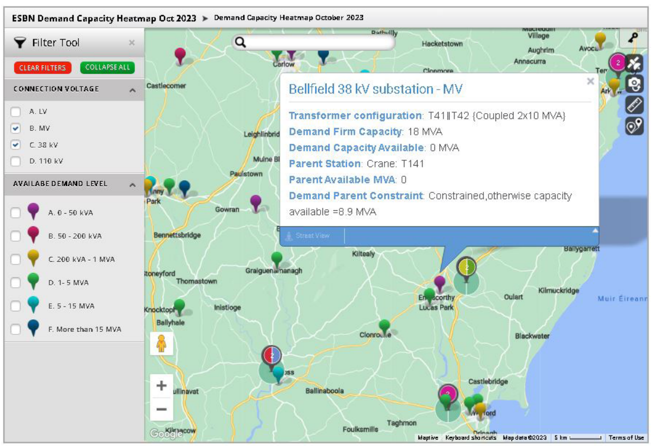
Building on the existing work in the form of our published capacity heatmaps[15], shown in **Figure 31** below, and PEGASUS 40, **we plan to publish detailed Distribution Network Capacity Workbooks (for both Demand and Generation) and a Distribution Network Headroom Report during 2024.** These will inform our plans for PR6 investments.

By the end of 2024 we will publish the Ten-Year Distribution Network Development Plan that will outline the work programme proposed to deliver network capacity. The Ten-Year Distribution Network Development Plan will be reviewed every two years.

The output of PEGASUS 40, the Network Capacity Workbooks, and Network Development Plan will enable our stakeholders to make informed decisions around new demand and generation connections and opportunities for the provision of flexible services. However, our expansion plans can change significantly as new connections are made, and the published capacity workbooks will be updated yearly to reflect updated investment options.

The initial main challenges to network development are carrying out the detailed analysis to identify the required projects, identifying suitable sites, achieving public support for new infrastructure, and having regulatory support for anticipatory investment. Subsequently the main challenges will lie in delivering the projects, which will require skilled internal ESB Networks resources together with our contract partners, and a resilient supply chain of required materials. To support such an accelerated pace of decarbonisation, various regulatory changes are required to keep pace with the rapid changes in electricity demand and supply. Regulatory risk assessments will need to take into account the need for accelerated buildout and efficient use of infrastructure.

Figure 31 – Demand Capacity Heatmap



6.1 ADVANCED INFRASTRUCTURE APPROACH

An 'Advanced Infrastructure' approach will ensure that high voltage network solutions deployed today are scalable to meet the needs of customers and stakeholders in zero-carbon society.

A number of solutions are currently under investigation to address the challenge of developing distribution network to meet these demand and generation capacity requirements out to 2040:

- 2040 planning horizon: we are adopting a longer term planning horizon in formulating our development plans, using the Network Development Plan to determine 2040 capacity needs. We will also adopt the Governments regional electricity spatial policy framework for renewable generation[17] connection forecasts to inform our 2040 plan, once these are available, in addition to the renewable industry project pipeline forecasts. This allows us to propose larger capacity investments and to identify site requirements for new substations earlier.
- We propose to increase the development of 110/20 kV substations and uprate associated circuit feeding capacity, which can provide greater network capacity for both demand and generation customer connections.
- We plan to increase the rate of 10 kV to 20 kV conversion, so that we can connect more customers and provide standby capacity at the 20 kV level where required.
- We will review how the per MW charging approach adopted for the Renewable Hubs **(see Section 6.2)** could be applied to advance build of combined demand and generation capacity hubs.

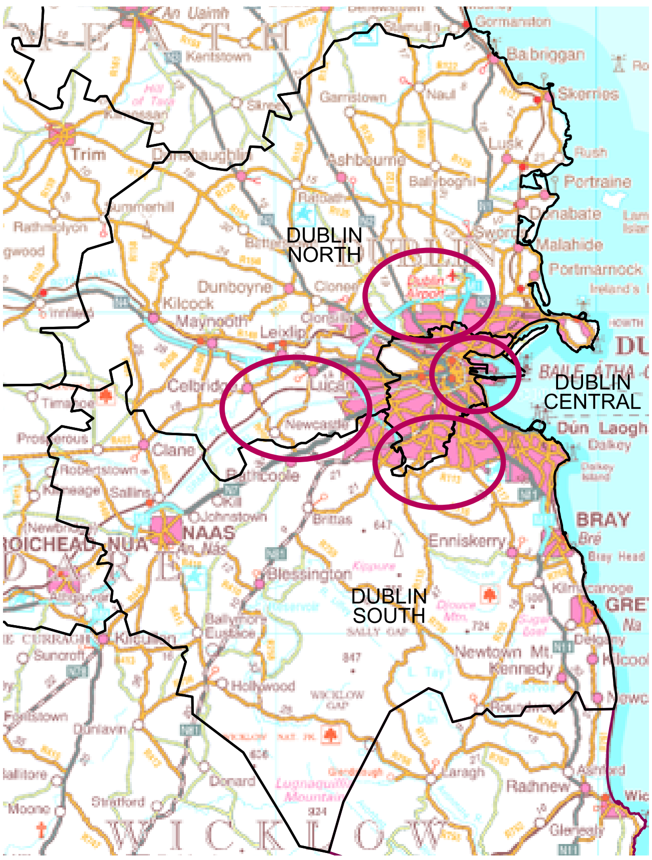
We are engaging specialist consultants to assess our proposed approach to the development of the HV distribution network and recommend further improvements or alternative solutions. The final approach adopted will guide the ESB Networks network planning engineers in their network reinforcement and customer connection decisions. Our approach will be included in our submission for PR6.

6.1.1 Solutions for the Greater Dublin Area

To meet the increased demand in the Greater Dublin Area by 2030, additional transmission infrastructure is required to supply distribution electricity demand. This includes additional transformer capacity at existing Bulk Supply Points and new Bulk Supply Points with associated additional cables. It is anticipated that the provision of flexibility services and storage, to move demand from peak times, will also play a role in meeting this demand. ESB Networks is working with EirGrid to ensure that this essential requirement is fully integrated and forms part of future network development considerations across both transmission and distribution systems to ensure the necessary capacity exists.

Since 2021, we have been engaging with EirGrid to target the development of new BSPs in the Greater Dublin Area. We proposed three new BSPs and an upgrade to an existing BSP as shown in **Figure 32**. These projects are currently part of EirGrid's Network Delivery Portfolio[21] (NDP) and have been targeted for delivery by 2030. Following from these proposals and our regular collaboration with EirGrid on the evolving needs of the Greater Dublin Area, three further new BSPs were identified at the periphery of the Greater Dublin Area.

Figure 32 – Aproximate locations of new BSPs in the Greater Dublin Area



A number of solutions are currently under investigation to address increasing density of energy demand in the Greater Dublin Area HV and MV network. We will continue to evolve our planning standards to enable more customers to connect while maintaining the safety of our assets and our customers. Some of the solutions we are currently working on include:

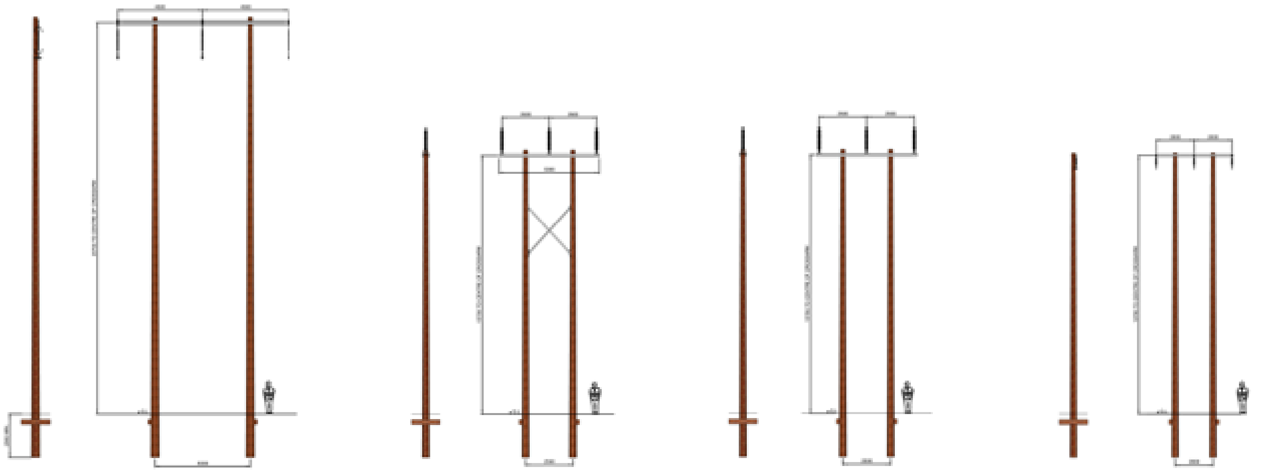
- Injecting additional capacity in the area by adding new 110 kV/MV substations.
- Where greenfield site acquisition proves difficult, converting existing 38 kV substation sites to 110 kV. In this solution, conversion needs to happen before the substations are heavily loaded to enable outages and offloading, and such conversion is also subject to the available site area.
- Upgrading existing sites in the outer suburbs to transfer load from the inner suburbs/city area MV network and reduce requirements in the city for new substations.
- Working with other utilities and infrastructure companies to identify solutions to improve our ability to install new cables. This will offload greater energy capacity from new substations at both HV and MV voltage levels.
- Use of higher capacity/minimal footprint solution. Three winding 110 kV/38 kV/MV transformers and other solutions to inject power into both the MV and 38 kV network, addressing urgent customer demand in dense urban areas.
- Defining minimum footprint 110 kV urban substation sizes and layouts to make use of tighter sites for new substations and/or co-location with other building uses.
- As part of development works, establishing a policy for large new customers (demand and generation) to take supply at HV, with the provision of an associated HV substation site.
- A medium term network development approach that integrates capacity development, asset replacement, and a continuity/resilience improvement plan, to deliver an efficient 'Build Once for 2040' approach with a 'touch the asset once' philosophy.
- Developing timed connection pilots and a flexible connections policy that will facilitate quicker connection for customers with specific electricity usage profiles. An example of this might include transport customers (fleet) that have peak demand overnight, as they seek to use electricity mainly in this period for charging.

6.1.2 Solutions for the National Network

A number of solutions are currently under investigation to address significant network capacity needs nationwide. Some of the solutions we are currently exploring include:

- Conversion of existing overhead line corridors to higher voltages using the existing poles and overhead line corridor. Over the past decade we have uprated several 38 kV overhead lines by replacing their conductors with versions of higher current carrying capacity. However, this approach has technical limits and, in some cases, does not provide the energy capacity required. Therefore, we have engaged a consultant to undertake a feasibility study of converting sample 38 kV lines using the same approach but to operate at a voltage between 66 kV and 110 kV. If the outcome of this study is positive, we are looking to pilot this solution on several projects in PR6. **Figure 33** shows how the polesets would appear if the 38 kV overhead line is converted to 110 kV, while maintaining the current layout of the overhead line. Also shown for comparison are the current standard 110 kV and 38 kV polesets. From a visual perspective, the proposed new distribution standard 110 kV poleset is very similar to the existing 38 kV polesets to be replaced.
- To address demand capacity growth in a number of areas, we propose developing new 110 kV injection nodes in the vicinity of the existing 110 kV electricity infrastructure. We are working with various stakeholders to establish the availability of these sites for infrastructure development and the capacity of the transmission infrastructure to supply them.
- We are developing standard designs for new HV substations. These will incorporate some additional facilities in the initial investment, making it easier to adapt and respond to unpredictable larger customer demand and generation connection requests. Standardised designs will deliver time savings in the infrastructure project build stage.
- We are working on an integrated planning approach that would support co-location of demand customers, renewable generation requirements, and flexibility providers in the new substations proposed.

Figure 33 – Existing 110 kV and 38 kV poleset design, and designs developed as part of proposed overhead line conversion



Intermediate Poleset (23m) Existing 110 kV | Intermediate H Poleset Proposed 110 kV | Intermediate Poleset Proposed 110 kV | Intermediate Poleset Existing 38 kV

In addition to traditional network development, a number of technical solutions are currently under investigation to address significant network generation capacity needs across the country.

- We are in the final stage of the development of a Diversity Factor for renewable generation developments connected to the same TSO/DSO node. This means that instead of considering the full wind and full solar output for capacity, a reduced value would be considered, allowing more renewable generation to connect at the location. Subject to technical approval, **this has the potential to release up to an additional 0.2 GW of transformer capacity for renewable generation connections.** This pathway to add more renewable generation connection capacity should be implemented in Q1 2024.
- We are investigating the feasibility of changing the current generation planning standards to increase the firm generation capacity in two transformer stations where both demand and generation are connected, in line with the current demand planning standards. This analysis should be finalised by the end of 2023 and the new proposal should be implemented in Q1 2024, subject to strict technical and operational compliance. Several technical factors are being considered, including the capability, condition, and age of the transformers. Subject to technical approval, **this proposal has the potential to release up to an additional 1.5 GW of existing transformer capacity where applicable**.
- We are running pilots under the National Network, Local Connections Programme[18] (NNLCP) to enhance the existing non-firm access offering. Currently, non-firm access is available to some MV customers at certain 38 kV/MV substations. We are currently exploring to extend this by offering flexible access to 110/38 kV transformers, therefore enabling more 38 kV and MV customers to avail of this option. Subject to the success of the pilot and transition to business as usual, **this proposal has the potential to release up to an additional 1.0 GW of existing transformer capacity where applicable**.

Table 7 below shows pathways we are currently analysing to add network capacity for renewable generation connections to the distribution system, and how much additional renewable generation connection capacity each of them has the potential to deliver. As noted previously, the proposals are subject to technical approval upon completion of network analysis and studies. The available distribution system capacity is dependent on the available upstream transmission system capacity, which is limited in many locations by transmission connected renewable generation. In some cases, proposals will require regulatory approval.

Table 7 - ESB Networks' pathways to add generation capacity to the distribution network

PROPOSAL	POTENTIAL CAPACITY (GW)
Solar Diversity Factor	**0.2**
Increased Firm Capacity	**1.5**
Extension of Non-Firm Access	**1**
Renewable Hubs / Network Reinforcement (described in Section 6.2)	**1.4**
Total	**4.1**

It is important to note that there is no guarantee that all of the above measures will prove technically acceptable and the figures quoted in **Table 7** are the likely maximum the proposal would yield.

There is a requirement for ongoing engagement with the TSO (EirGrid) to maximise the potential of the distribution network for renewable generation connections, while ensuring an optimal, coordinated approach across the transmission and distribution system.

6.2 RENEWABLE HUBS

In line with our Networks for Net Zero Strategy[1] to 'Build Once for 2040', we are proposing to develop Renewable Hubs and explore advance build network reinforcements so that increased wind, solar, and batteries (including community projects and Small Scale Generation customers) can connect safely to the electricity network. A joint ESB Networks and EirGrid proposal for the implementation of a Renewable Hubs pilot was submitted to the CRU in June 2023 and approved in October 2023.

A Renewable Hub will be electricity infrastructure, which will be developed to accelerate the connection of renewable projects to meet Ireland's Climate Action Plan targets. They will be developed in locations determined by analysis of existing network capacity and the known pipeline of renewable projects. The aim is to build once with a view to minimising the need for future uprates. Renewable Hubs may be new substations/circuits (greenfield), or new development/uprates in existing stations (brownfield). Such advance works could include:

- Installing more transformer capacity than is needed by the current connecting customer.
- Building additional station bays.
- Building the associated station common works that would enable both ECP2.4 applicants and future projects looking to connect to the Renewable Hub.

Figure 34 outlines an existing network configuration, and **Figure 35** details the same network configuration in Figure 34, uprated to a Renewable Hub configuration. The example in Figure 35 creates an additional 94.5 MVA at 110/38 kV and an additional 15 MVA at 38 kV/MV of firm capacity.

Figure 34 - Existing network configuration

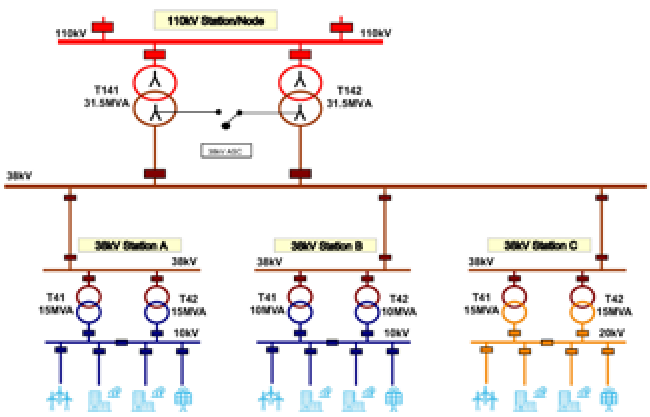
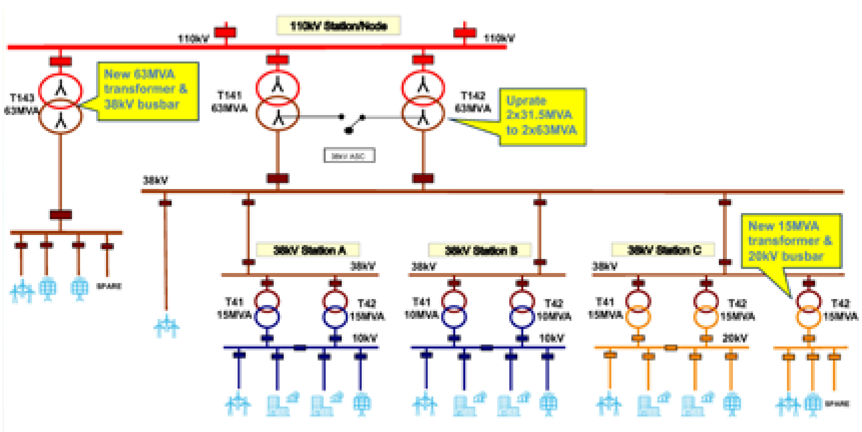


Figure 35 - Example of Renewable Hub network configuration



The development of Renewable Hubs is essential in order to create substation capacity at the necessary pace and scale, and in areas where there is a pipeline of renewable projects. Some likely benefits are outlined as follows:

- Provide more certainty to industry on where there is network capacity to locate their projects.
- As part of the pilot, it is proposed to charge customers connecting into the Renewable Hub on the basis of their per-MVA share of the capacity for the relevant infrastructure. By installing additional station capacity, future applicants will have more certainty on where there is available capacity on both the transmission and distribution network.
- Smaller attrition rate of projects where network uprate works are required. Under current policy these first-mover projects must pay for the full cost of the uprate works and only receive a refund if and when another customer utilises the assets in the future. Under this Renewable Hubs pilot as future projects connect, they will only contribute to a portion of the overall cost of the Renewable Hub.
- Further support the connection of renewables as it will minimise future design, procurement, outages, and construction works for both the renewable developer and system operators.
- Provide additional capacity for smaller scale generation, such as MIcrogeneration, Mini-Generation, and community-led energy projects, all of which are key in supporting the decarbonisation of society.

In October 2023 the Commission for Regulation of Utilities (CRU) approved the Renewable Hubs pilot[19] to advance build capacity, to accelerate the connection of renewables and the electrification of heat and transport at the following locations:

- Butlerstown 110 kV Station
- Trien 110 kV Station
- Mullingar 110 kV Station
- Ennis 110 kV Station
- Kilteel 110 kV

The CRU has also included the provision for identification of additional Renewable Hubs as part of the ECP2.4 process.

In total ESB Networks has identified up to 45 locations where 110/38 kV transformer uprates may be feasible as part of the Renewable Hubs proposal and Advanced Infrastructure work. If feasible, this has the capability to create up to 1.4 GW of distribution generation capacity, subject to available upstream transmission capacity. ESB Networks will continue to assess the feasibility, constructability, and cost of delivering these uprates. We will continue to engage with industry stakeholders, the TSO, and the CRU to seek approval where these locations are shown to be feasible.

6.3 LOW VOLTAGE NETWORK INVESTMENTS

We have a dedicated and significant programme of work fully activated, with a primary aim in the short to medium term to focus on the likely impact of electrified transport and heat, and this new and additional load on the LV network. We have commenced the proactive and planned LV system improvement work to accommodate this on the distribution network.

In the next number of years, LCT adoption will substantially increase, and we are now making provisions for Microgeneration impacts on our LV network. ESB Networks is working as part of various government steering groups to support the acceleration of the electrification of heat and transport, and we are evolving our forecasting tools to include all new data sets as they emerge, alongside accelerated scenario assumptions.

We are basing our approach to network readiness and the development of the distribution network on what we refer to as the FIMSS methodology: Forecast, Identify, Monitor, Smart toolkit and Strengthening of the network.

In our FIMSS methodology we are using novel forecasting techniques based on innovative data analytics to help reduce the uncertainty about the locations and uptake rates for the electrification of heat and transport. We use these forecasts to help us identify appropriate locations for enhanced network monitoring, so as to confirm the need and allow us to plan a programme of activity to address the network challenges. We then seek to use our smart solutions toolkit where possible to provide the additional capability within the distribution system.

We have developed and will continue to develop new tools and procedures to enable the use of new innovative technologies and concepts, to solve constraints on the network using the existing asset base.

We will strengthen the network by conventional reinforcement when appropriate. As our innovation project portfolio and learnings develop, we will continue to explore relevant non-wires alternatives to conventional reinforcement, that will see new solutions added to our smart toolkit.

Despite the uncertainty factor that remains regarding the potential uptake rates and crucially the timing of electrification across the national electricity distribution system, the FIMSS methodology allows us to adopt a clear and consistent approach to ensuring network readiness in a timely and cost-effective manner. It is a methodology directing both investment and resource. As such, we are confident that the FIMSS methodology allows appropriate management of resources, as well as forecasting, underpinned by the stated direction of national policy, to anticipate with sufficient lead time the upcoming market changes, and evidence prudent investment in a timely manner to ensure policy objectives can be fully supported. Should electrification uptake levels grow at a higher rate than our current assumptions, we are confident that this methodology will also be able to provide advance warning of this, again supporting efficient investment on the distribution network as a principle of ESB Networks enabling mass electrification.

Applying the FIMSS methodology in practice

In 2020/2021, we deployed almost 1000 monitoring devices on specific MV/LV transformers so that we could gather real-time data on the existing load, and to record data relating to the winter peak load. These potentially 'at risk' transformers were selected based on detailed load forecasting we completed, which used annual consumption data and considered data which suggested a strong likelihood of LCT uptake in the area. We have planned investment programmes to upgrade the LV network, including the upgrading of pole-mounted transformers in rural areas and ground-mounted substations in urban areas. The FIMSS methodology will allow us to define the sequence where these investments need to happen first, to meet CAP23 targets and enable our customers to decarbonise their energy use.

Renewed approach to LV design and futureproofing

In moving to our proactive approach, we consider and avail of any opportunity to enable our customers for LCT while carrying out other extensive works on the LV network. We are actively renewing our LV design standards to ensure that the Government's CAP targets for 2030 are achieved, but with a futureproofing mindset so that we are also forward planning to consider the complete needs of the zero-carbon system, a time when we expect that there will be almost 100% penetration of electrified heat and transport in Ireland. This approach ensures that we design the network for 2050 but implement only the elements of the design that are needed to meet 2030 demands. This ensures prudent and optimal investment in the next number of years towards 2030 and beyond, where the trajectory of LCT uptake levels remains uncertain, combined with future technological changes and consideration that may yet come to the fore.

6.4 ROLE OF MODERN AND DIGITAL DISTRIBUTION NETWORK

As the share of variable renewable generation on the distribution network increases, the network needs to operate in new ways and leverage the benefits of distribution connected generation, such as wind and rooftop solar, and all sources of flexibility, including unlocking the potential of demand response and energy storage through increased digitalisation.

Flexibility will play a crucial part in the zero-carbon electricity system, balancing times of high renewable generation output with customer demand preferences. Demand will behave differently than it does today, as electric vehicles charge at times of high renewable generation and heat pumps operate in ways which maximise the use of renewable electricity. Batteries in our homes and cars, and at utility scale, will provide short term storage, as will pumped hydro. This will be supported by interconnectors with other countries.

Flexibility will be the key factor for efficient use of the future network through unlocking the potential of demand response and energy storage. As our flexibility market is at an early stage, flexibility is best used at present:

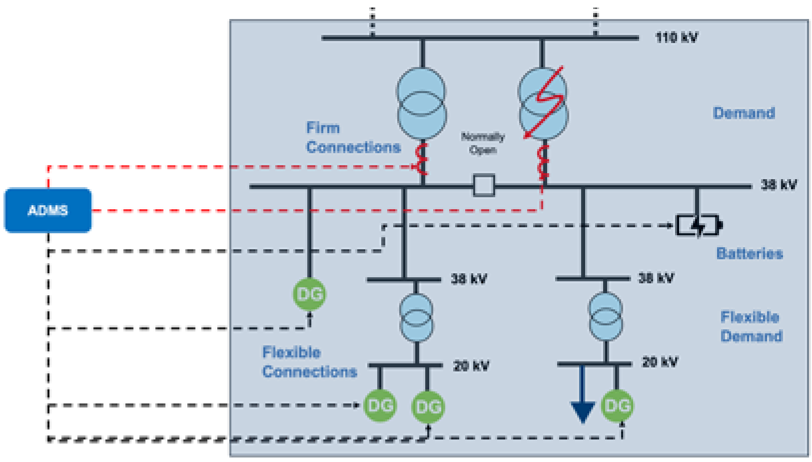
- As a cost-effective means of addressing short term network constraints, allowing a postponement of longer term reinforcements.
- As a means of facilitating outages which are needed to deliver new infrastructure and maintain existing infrastructure.
- As a means to connect load whose ultimate demand is uncertain.

As the flexibility market becomes more mature, flexibility can be used on a wider scale and to drive a flatter daily load profile, thereby maximising the use of infrastructure.

National Network, Local Connections Programme[18] (NN,LCP) was launched in 2021 as a multi-year project that will transform how energy on Ireland's electricity distribution network is managed. The NN,LCP will ensure that the distribution system can monitor, forecast, and manage power at a local level. In this new energy landscape, customers and communities across the country will become more active in managing and controlling their electricity usage. Through active participation by all in the process, we can develop a distribution system that is safe and secure, introducing new localised marketplaces which are responsive to new local and regional needs, and make a positive impact in the fight against climate change. As part of the NN,LC programme[18], ESB Networks is working to enable flexibility markets that would deliver on the system flexibility targets set out in CAP23[2] for 2025 and 2030.

As shown in **Figure 36** below, balancing firm and flexible generation connections, batteries, and firm and flexible demand connections in the local distribution network, through an Advanced Distribution Management System (ADMS) to deliver automated control, will provide the cost-efficient distribution system of the future.

Figure 36 – Automat Management System



Flexibility can quickly and efficiently provide capacity to support low-carbon demand and renewable generation. However, due to the intermittent nature of renewable generation, there will be times when local renewable generation will not be available for prolonged periods of time, and storage installed locally may not be able to provide long term demand requirements. It is at these times that electricity supplied by the renewable generation installed at remote locations, or by the long term storage installed remotely, will have to be transferred through transmission and distribution system to our customers. It is ESB Networks' responsibility to ensure that we have a safe, reliable, and efficient network with the required capacity, flexibility, and resilience for the zero-carbon society.

A modern and digital distribution network, together with updated distribution system management and operations, is essential for the dynamic power system of the future.

SECTION

07

CONCLUSIONS

This Electricity Distribution Network Capacity Pathways Report sets out the electricity network capacity requirement ESB Networks is predicting on the distribution system to deliver on the targets set in the Government's Climate Action Plan 2023[2]. These include the connection of the renewable generation; the electrification of heat, transport, and industry; and demand associated with significant population growth, new housing developments, and economic growth.

In this Report, ESB Networks present for consultation and feedback the various pathways we are working on, to build the distribution network capacity that will support all our customers and communities on their decarbonisation journey.

The pathways to add network capacity consider a range of solutions from changes to design standards, accelerated conventional infrastructure solutions, and regulatory changes to demand side management and smart solutions.

7.1 DISTRIBUTION NETWORK CAPACITY PATHWAYS CONSULTATION

Distribution network capacity plays a critical role in enabling and empowering all of our customers to decarbonise their energy consumption.

We will use your feedback to guide the pathways we explore to add the distribution network capacity to the electricity system.

We will also be continuing to engage with EirGrid as they review the feedback on their current consultation on Tomorrow's Energy Scenarios. Such close coordination of DSO and TSO activities will be vital to have the electricity network ready for a net zero future.

How to respond

To respond to consultation, please send your comments and feedback until 9 February 2024 to **ESBNetworksStrategy@esb.ie**

Consultation Questions

Name Please enter your name here
Organisation Please enter you organisation here
Email Address Please enter your email address here

QUESTIONS

1. **Section 4: Distribution Network Demand Capacity**
   a. Do you have any comments on the three scenarios?
   b. Do you have any comments on the assumptions used in the Base Scenario?
   c. To assess the long-term capacity needs we are using the Base Scenario peak demand values for 2030 and Aggressive Scenario peak demand values for 2040. Do you have any comments on this approach?

2. **Section 6:**
   a. Have you any comments on our published capacity heat maps?

3. **Section 6.1: Advanced Infrastructure Approach**; We have listed a number of solutions
   a. Are there any other solutions you would like added?
   b. Which solutions do you believe would be most effective?
   c. Have you any other comments?

4. **Does an Advanced Infrastructure approach make sense** in the context of the enabling role that the electricity distribution network plays in the achievement of overall National Climate Action Plan targets?

5. **How can stakeholders work together to ensure the success of an Advanced Infrastructure approach?**

6. **Solutions for the Greater Dublin Area:** We have listed a number of solutions to increase capacity.
   a. Are there any other solutions you would like added?
   b. Which solutions do you believe would be most effective?
   c. Have you any other comments?

7. **Solutions for the National Distribution Network:** We have listed a number of solutions to increase capacity.
   a. Are there any other solutions you would like added?
   b. Which solutions do you believe would be most effective?
   c. Have you any other comments?
   d. Do you have any comments on the technical solutions to address significant distribution network generation?

8. **Section 6.2 Renewable Hubs**
   a. Do you have any comments on Renewable Hubs?

9. **Section 6.3 Low voltage Network Investments:** We have explained the FIMSS methodology.
   a. Do you have any comments on the FIMSS methodology?

10. **Other**
    a. We are publishing this Report in 2023 to gather feedback from the stakeholders, and we will publish Distribution Network Capacity Workbooks and a Distribution Network Headroom Report during 2024. These will all inform the investment plans we will propose to the CRU for PR6. Do you have any comments on this approach?
    b. Are there any other comments or suggestions you would like to make in relation to increasing capacity on the Distribution Network?

SECTION

08

GLOSSARY

TERM	DEFINITIONS
AFIR	Alternative Fuels Infrastructure Regulation
BSP	Bulk Supply Point
CAGR	Compaund Annual Growth Rate
CAP	Climate Action Plan
CRU	Commission for the Regulation of Utilities
DAO	Distribution Asset Owner
DART	Dublin Area Rapid Transit
DER	Distributed Energy Resources
DG	Distributed Generator
DSO	Distribution System Operator
DSM	Demand Side Management
ECP	Enduring Connection Policy
EU	European Union
EV	Electric Vehicle
FIMSS	Forecast, Identify, Monitor, Smart Toolkit And Strengthen
GW	Gigawatt (1 GW = 1,000,000,000 Watts)
GWh	Gigawatt-Hour
HP	Heat Pump
HV	High Voltage
ISEA	Irish Solar Energy Association
IT	Information Technology
kV	Kilovolt
kVA	Kilovolt-Amperes
kWh	Kilowatt-Hour
LCT	Low Carbon Technology
LV	Low Voltage
MaREI	Sfi Research Centre For Energy, Climate And Marine Research and Innovation
MEC	Maximum Export Capacity
MECo	Maximum Export Capacity Zero
MIC	Maximum Import Capacity
MV	Medium Voltage
MVA	Megavolt-Amperes
MW	Megawatt (1 MW = 1,000,000 Watts)

TERM	DEFINITIONS
NDP	National Development Plan
NESF	National Energy Security Framework
NFA	Non-Firm Access
NN,LC	National Network, Local Connections
PEGASUS	Predicting Energy Growth and Supporting Utility Scenarios
PR5	Price Review 5
PR6	Price Review 6
PV	Photovoltaic
RES	Renewable Energy Sources
RESS	Renewable Energy Support Scheme
SEAI	Sustainable Energy Authority of Ireland
SSG	Small-Scale Generation
TAO	Transmission Asset Owner
TSO	Transmission System Operator
TWh	Terawatt-hour
V	Volt
V2G	Vehicle to Grid

SECTION

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