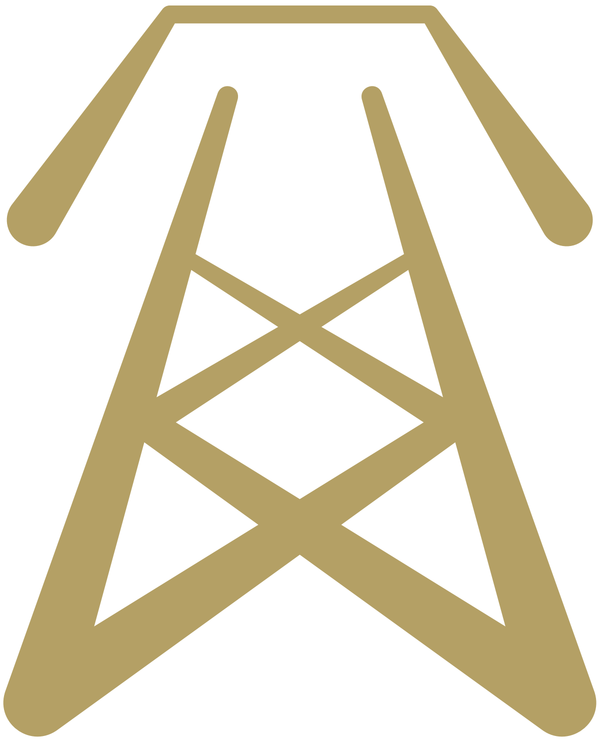
All-Island Ten-Year

Transmission Forecast Statement 2022



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This document incorporates the Transmission System Capacity Statement for Northern Ireland and the Transmission Forecast Statement for Ireland.

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Document structure

This document contains an Abbreviations and Terms section, an Executive Summary, eight main sections and eight appendices. The structure of the document is as follows:

Abbreviations and terms provides a list of abbreviations and terms used in the document.

The **Executive summary** gives an overview of the main highlights of the document.

Chapter 1: Introduction presents the purpose and context of the All-Island Transmission Forecast Statement. Our statutory and legal obligations are also introduced.

Chapter 2: The electricity transmission system describes the existing all-island transmission system. A brief outline of transmission system development plans for both Ireland and Northern Ireland is also given.

Chapter 3: Demand describes the demand forecast assumptions over the study period of 2022–2031.

Chapter 4: Generation describes the projected generation connection assumptions over the study period of 2022–2031.

Chapter 5: Transmission system performance provides information on power flow and short circuit study results.

Chapter 6: Overview of transmission system capability analysis outlines the analysis methods used to carry out the demand and generation opportunities' analyses.

Chapter 7: Transmission system capability for new generation describes the opportunities for connection of new generation on the all-island transmission system.

Chapter 8: Transmission system capability for new demand describes the opportunities for connection of new demand on the all-island transmission system.

Appendix A: Maps and schematic diagrams

Appendix B: Transmission system characteristics

Appendix C: Demand forecasts at individual transmission interface stations

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Abbreviations and terms

Abbreviations

AC	Alternating Current
ACS	Average Cold Spell
ATR	Associated Transmission Reinforcement
BETTA	The British Electricity Trading and Transmission Arrangements
BSP	Bulk Supply Point
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CRU	Commission for the Regulation of Utilities
DC	Direct Current/Double Circuit
DCCAE	Department of Communications, Climate Action and Environment
DfE	Department for the Economy
DO	Distillate Oil
DSM	Demand Side Management
DSO	Distribution System Operator
EIDAC	EirGrid Interconnector DAC
ESB	Electricity Supply Board
ESRI	Economic and Social Research Institute
EU	European Union
FAQ	Firm Access Quantity
GCS	Generation Capacity Statement
GIS	Gas Insulated Switchgear
HFO	Heavy Fuel Oil
HVDC	High Voltage Direct Current
IA	Interconnector Administrator
IME	Internal Market for Electricity
IMP	Independent Market Participant
IPP	Independent Power Producer
IRL	Ireland
ITC	Incremental Transfer Capability
kV	Kilo Volts
LFG	Land Fill Gas
MIL	Moyle Interconnector Limited
MCR	Maximum Continuous Rating
MEC	Maximum Export Capacity
MIC	Maximum Import Capacity
MVA	Megavolt-Amperes
MW	Megawatt
NI	Northern Ireland
NIEN	Northern Ireland Electricity Networks
NTC	Net Transfer Capacity
PPB	Power Procurement Business
PU	Per Unit
PST	Phase Shifting Transformer
RES	Renewable Energy Schemes
RIDP	Renewable Integration Development Project
RMS	Root Mean Square
RP	Review Period
SEM	Single Electricity Market
SONI	System Operator for Northern Ireland
SOEF	Shaping Our Electricity Future
SPS	Special Protection Scheme
SVC	Static Var Compensator
SP	Summer Peak
SS	Substation
SV	Summer Valley
TDP	Transmission Development Plan
TDPNI	Transmission Development Plan Northern Ireland
TYTFS	Ten Year Transmission Forecast Statement
TRM	Transfer Reserve Margin
TSO	Transmission System Operator
TTC	Total Transfer Capacity
TX	Transformer
WFPS	Wind Farm Power Station
WP	Winter Peak

Terms

Active Power
The product of voltage and the in-phase component of alternating current measured in Megawatts (MW). When compounded with the flow of 'reactive power', measured in Megavolt-Amperes Reactive (Mvar), the resultant is measured in Megavolt-Amperes (MVA).

Autumn Peak
This is the maximum Northern Ireland demand in the period September to October inclusive.

Associated Transmission Reinforcement
Associated Transmission Reinforcements (ATRs) are all of the transmission reinforcements that must be completed in order for a generator to be allocated Firm Access Quantity (FAQ). ATRs include reinforcements such as line and busbar upratings, new stations and new lines.

Bulk Supply Point
A point at which the Northern Ireland transmission system is connected to the distribution system.

Busbar
The common connection point of two or more circuits.

Capacitor
An item of plant normally utilised on the electrical network to supply reactive power to loads (generally locally) and thereby supporting the local area voltage.

Circuit
An element of the transmission system that carries electrical power.

Combined Cycle Gas Turbine
A collection of gas turbines and steam units; waste heat from the gas turbine(s) is passed through a heat recovery boiler to generate steam for the steam turbine(s).

Combined Heat and Power
A plant designed to produce both heat and electrical power from a single heat source.

Constraint
A transfer limit imposed by finite network capacity.

Contingency
The unexpected failure or outage of a system component, such as a generation unit, transmission line, transformer or other electrical element. A contingency may also include multiple components, which are related by situations leading to simultaneous component outages.

Commission for Regulation of Utilities
The Commission for Regulation of Utilities (CRU) is the regulator for the electricity, natural gas and public water sectors in Ireland.

Data Freeze Date
The dates on which the Transmission Forecast Statement data was effectively 'frozen' for both EirGrid and SONI. Changes to transmission system characteristics made after these dates do not feature in the analyses carried out for this Transmission Forecast Statement.

Deep Reinforcement
Refers to transmission system reinforcement additional to the shallow connection that is required to allow a new generator or demand to operate at maximum capacity.

Demand
The peak demand figures in Table 3-1 in the introduction refer to the power that must be transported from transmission system-connected generation stations to meet all customers' electricity requirements. These figures include transmission losses.

Demand-Side Management
The modification of normal demand patterns usually through the use of financial incentives.

EirGrid
EirGrid plc is the state-owned company established to take on the role and responsibilities of Transmission System Operator in Ireland as well as market operator of the wholesale trading system.

EirGrid Interconnector DAC
EIDAC is an organisation that is part of the EirGrid Group. EIDAC owns the East West Interconnector linking the electricity grids in Ireland and Wales. EIDAC sell capacity and services on the East West Interconnector through auctions.

Embedded Generation
Refers to generation that is connected to the distribution system or at a customer's site.

Firm Access Quantity
The level of firm financial access available in the transmission network for a generator is that generator's Firm Access Quantity or 'FAQ'. Firm financial access means that if a generator is constrained on or off, it is eligible for compensation in the manner set out in the Trading & Settlement Code.

Gate 2
The term given to the group-processing scheme that applies to approximately 1,300 MW of renewable generation seeking connection to the transmission and distribution systems.

Gate 3
The term given to the group-processing scheme that applies to approximately 10,000 MW of generation seeking connection to the transmission and distribution systems.

Generation Dispatch
The configuration of outputs from the connected generation units.

Grid Code (EirGrid)
The EirGrid Grid Code is designed to cover all material technical aspects to the operation and use of the transmission system of Ireland. The code was prepared by the TSO (pursuant to Section 33 of the Electricity Regulation Act, 1999) and approved by the CER. The Grid Code is available on www.eirgrid.com.

Grid Code (SONI)
The SONI Grid Code is designed to permit the development, maintenance and operation of an efficient, co-ordinated and economical transmission system in Northern Ireland. It is prepared by the TSO (SONI) pursuant to condition 16 of SONI's Licence. The SONI Grid Code is available at www.soni.ltd.uk

Interconnector Administrator
An Interconnector Administrator (IA) facilitates the allocation of capacity and energy trading. Trading is carried out using an Interconnector Management Platform (ICMP) for the Moyle and East West Interconnectors.

Incremental Transfer Capability
A measure of the transfer capability remaining in the physical transmission system for further commercial activity over and above anticipated uses.

Interconnector
The tie line, facilities and equipment that connect the transmission system of one independently supplied transmission system to that of another.

Loadflow
Study carried out to simulate the flow of power on the transmission system given a generation dispatch and system load.

Maximum Continuous Rating
The maximum capacity (MVA) modified for ambient temperature conditions that the circuit can sustain indefinitely without degradation of equipment life.

The MCR of a generator is the maximum capacity (MW) modified for ambient temperature conditions that the generation unit can sustain indefinitely without degradation of equipment life. All generation capacity figures in this Transmission Forecast Statement are maximum continuous ratings (defined as its MCR at 10°C), expressed in exported terms, i.e., generation unit output less the unit's own load.

Maximum Export Capacity
The maximum export value (MW) provided in accordance with the generator's connection agreement. The MECs are contract values which the generator chooses to cater for peaking under certain conditions that are not normally achievable or sustainable, e.g., a CCGT plant can produce greater output at lower temperatures.

Net Zero Emissions
Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period.

Node
Connecting point at which several circuits meet. Node and station are used interchangeably in this Transmission Forecast Statement.

Parametric Analysis (P-V) curves
A parametric study involves a series of power flows that monitor the changes in one set of power flow variables with respect to another in a systematic fashion. In this Transmission Forecast Statement the two variables are voltage and ITC.

Per Unit (pu.)
Ratio of the actual electrical quantity to the selected base quantity. The base quantity used here for calculation of per unit impedances is 100 MVA.

Phase Shifting Transformer
An item of plant employed on the electrical network to control the flow of active power.

Power Factor
The power factor of a load is a ratio of the active power requirement to the reactive power requirement of the load.

Reactive Compensation
The process of supplying reactive power to the network.

Reactor
An item of plant employed on the electrical network to either limit short circuit levels or prevent voltage rise depending on its installation and configuration.

RES-E
Renewable Electricity.

Shallow Connection
Shallow Connection means the local connection assets required to connect a customer to the Transmission System and which are for the specific benefit of that particular customer.

Single Electricity Market
The Single Electricity Market (SEM) is the wholesale electricity market operating in Ireland and Northern Ireland. Further information is available at http://www.sem-o.com/ and https://www.semcommittee.com/

SONI
System Operator for Northern Ireland (SONI) Ltd is owned by EirGrid plc. SONI ensures the safe, secure and economic operation of the high-voltage electricity system in Northern Ireland and in cooperation with EirGrid is also responsible for running the all-island wholesale market for electricity.

Split Busbar
Refers to the busbar(s) at a given substation which is operated electrically separated. Busbars are normally split to limit short circuit levels or to maintain security of supply.

Static Var Compensator
Device which provides fast and continuous capacitive and inductive reactive power supply to the power system.

Summer Valley
This is the minimum system demand. It occurs in the period March to September, inclusive in Ireland and May to August, inclusive in Northern Ireland

Summer Peak
This is the maximum system demand in the period March to September, inclusive in Ireland and May to August, inclusive in Northern Ireland.

Tee Connection
Un-switched connection into existing line between two other stations.

Total Transfer Capability
The total capacity available on cross-border circuits between Ireland and Northern Ireland for all flows, including emergency flows that occur after a contingency in either system.

Transformer
An item of equipment connecting busbars at different nominal voltages. (See also Phase Shifting Transformer)

Transmission Interface Station
A station that is a point of connection between the transmission system and the distribution system or directly-connected customers.

Transmission Losses

A small proportion of energy is lost mainly as heat whilst transporting electricity on the transmission system. These are known as transmission losses. As the amount of energy transmitted increases, losses also increase.

Transmission Peak

The peak demand that is transported on the transmission system. The transmission peak includes an estimate of transmission losses.

Transmission Planning Criteria

The set of standards that the transmission system of Ireland is designed to meet.

Transmission System

The transmission system is a meshed network of high-voltage lines and cables (400 kV, 275 kV, 220 kV and 110 kV) for the transmission of bulk electricity supply around Ireland and Northern Ireland. The transmission system and network are used interchangeably in this Transmission Forecast Statement.

Uprating

To increase the rating of a circuit. This is achieved by increasing ground clearances and/or replacing conductor, together with any changes to terminal equipment and support structures.

Utility Regulator (UR)

UR is an independent non-ministerial government department set up to ensure the effective regulation of the Electricity, Gas and Water and Sewerage industries in Northern Ireland.

Winter Peak

This is the maximum annual system demand. It occurs in the period October to February, inclusive in Ireland and in the Period November to February in Northern Ireland.

Contents

Executive summary

The All-Island Ten-Year Transmission Forecast Statement (TYTFS) 2022 provides the following information:

- Network models and data for the all-island transmission systems;
- Forecast generation capacity and demand growth;
- Maximum and minimum fault levels at transmission system stations;
- Predicted transmission system power flows at different points in time; and
- Demand and generation opportunities on the transmission system.

Boggeragh Mountains, Co. Cork

Introduction

TYTFS 2022 is prepared in accordance with the statutory and licence obligations outlined in Table S-1.

Table S-1: Statutory regulations requiring the TSOs to produce a Transmission Forecast Statement

Ireland	Northern Ireland
Section 38 of the Electricity Regulation Act 1999 (as amended)	Condition 33 of the Licence to participate in the Transmission of Electricity

TYTFS 2022 describes the transmission system on the island of Ireland, from 2022 to 2031. EirGrid and SONI have jointly prepared TYTFS 2022. This document supersedes the All-Island Ten-Year Transmission Forecast Statement 2021–2030.

This document presents information available for the all-island transmission system at the data freeze date of January 2022. Where applicable we provide information on transmission system projects under development. Where multiple solutions are presented for a transmission system project, no preference is given to one solution[1].

Context

In December 2022, the Irish Government launched its Climate Action Plan 2023. The Action Plan sets out an ambitious course of action over the coming years. The plan sets a target that 80% of electricity will come from renewable energy sources by 2030.

For Northern Ireland, the United Kingdom's Committee on Climate Change advised that it is necessary, feasible and cost-effective for the UK to set a target of net zero Green House Gas (GHG) emissions by 2050. The new Climate Change Act (Northern Ireland) 2022 came into effect on the 08 June 2022. The revised legally binding target towards net zero emissions covers all sectors of the economy. This update to the Order demonstrates the UK's commitment to targeting a challenging ambition in line with the requirements of the Paris Agreement on climate change.

Energy Policy is a devolved matter for Northern Ireland, and in December 2021, the Northern Ireland Executive published its new Energy Strategy for Northern Ireland[2]. The Energy Strategy sets out a goal of at least 70% of electricity consumed to come from renewable sources by 2030. It sets out a pathway for energy to 2030 that will mobilise the skills, technologies and behaviours needed to take us towards our vision of net zero carbon and affordable energy by 2050. Since its publication, two Action Plans have been subsequently published in 2022 and 2023[3].

1 In line with our strategy to consider all practical technology options for network development.
2 https://www.economy-ni.gov.uk/publications/energy-strategy-path-net-zero-energy
3 https://www.economy-ni.gov.uk/publications/energy-strategy-action-plan-2023

Table S-2: Extract from the Climate Action Plan – electricity sector 2023 targets

Key target	2025	2030
Renewable electricity share	50%	80%
Onshore wind	6 GW	9 GW
Solar	Up to 5 GW	8 GW
Offshore wind	–	At least 5 GW
New flexible gas plant	–	At least 2 GW
Demand side flexibility	15–20%	20–30%

The new Climate Change Act (Northern Ireland) sets a new target of 80% of electricity consumption to come from renewable energy sources by 2030. The Climate Change Act mandates the publication of a Climate Action Plan for Northern Ireland by the end of 2023, which would include the carbon budget targets.

The Department for the Economy is currently consulting on the Draft Offshore Renewable Energy Action Plan, which contains the ambition to deliver 1 GW of offshore wind from 2030[4]. The Department is also consulting on the design considerations for a Renewable Electricity Support Scheme for Northern Ireland[5].

In order to meet Ireland's and Northern Ireland's future commitments, investment will be needed in new renewable generation capacity and electricity networks. The transition to low-carbon and renewable energy will have widespread consequences; it will require a significant transformation of the electricity system.

In 2019, EirGrid and SONI launched new corporate Strategies 2020–2025 which are shaped by two factors: climate change and the impending transformation of the electricity sector. Together, EirGrid and SONI are committed to leading the change towards a carbon-free electricity system and achieving the renewable energy ambitions of both jurisdictions.

4 https://consultations.nidirect.gov.uk/dfe/consultation-on-the-draft-oreap/
5 https://www.economy-ni.gov.uk/consultations/design-considerations-renewable-electricity-support-scheme-northern-ireland

To realise these ambitions and to enable transformation of the electricity system, EirGrid and SONI launched Shaping Our Electricity Future v1.0 (SOEF v1.0) Roadmap[6] in November 2021. The Roadmap is informed by a comprehensive consultation process with stakeholders across society, policy makers, industry, market participants and electricity consumers. The valued feedback has contributed to our growing body of knowledge on how to decarbonise the electricity system and to support decarbonisation of the broader economy while maintaining a safe and secure supply of electricity for consumers.

The Roadmap provides an outline of the key developments from a networks, engagement, operations and market perspective needed to support a secure transition to at least 70% renewables on the electricity grid by 2030 – an important step on the journey to 80% and to net zero by 2050.

Inherent in this is a secure transition to 2030 whereby we continue to operate, develop and maintain a safe, secure, reliable, economical and efficient electricity transmission system with a view to ensuring that all reasonable demands for electricity are met.

An updated SOEF roadmap will be published later in 2023 and will be reflected in future TYTFS documents considering the impact of 80% RES-E in both Ireland and Northern Ireland for 2030.

High level results

TYTFS 2022 includes maximum and minimum short circuit current levels at transmission system stations. This information is given at each 110 kilovolt (kV), 220 kV, 275 kV and 400 kV transmission system station. Short circuit levels at each transmission system station are provided for the following years: 2022; 2025; and 2028.

Results show that several stations on the island are approaching, or have the potential to exceed, their rated short circuit current level. This can be seen in the maximum short circuit current level analysis, when there are high generation levels on the system. We manage the transmission system to mitigate possible risks while investment plans are in place to resolve these issues. Information on short circuit current levels is presented in Chapter 5.

Ireland and Northern Ireland are currently connected to Great Britain though the Moyle and East-West Interconnector (EWIC) high voltage direct current (HVDC) interconnectors. Interconnection with neighbouring countries offers many benefits, which include:

- Enhancing the security of supply of the transmission system;
- Facilitating the integration of variable renewable generation; and
- Facilitating greater competition and the potential for wholesale electricity prices to be reduced.

6 http://www.eirgridgroup.com/site-files/library/EirGrid/Shaping_Our_Electricity_Future_Roadmap.pdf

Our analyses assumed the planned North South Interconnector is in place in winter 2025 at the time of data freeze. This reinforcement will increase security of supply, support the development of renewable power generation and provide economic benefits to energy customers in both jurisdictions.

For the purpose of our analysis, we assume the planned Greenlink Interconnector is in place in 2024. The connection application for the proposed Celtic Interconnector between Ireland and France was executed in November 2021. Thus, this interconnector was included in this forecast statements' analyses. Our analyses assumed the Celtic Interconnector is in place in 2026 at the time of data freeze.

TYTFS 2022 includes information on generation and demand opportunities for interested parties. This information is based on assessments and studies carried out on an all-island basis. The methodologies applied to the all-island opportunity analyses are presented in Chapter 6. Information on opportunities is presented in Chapter 7 and Chapter 8.

The generation portfolio assumed in this statement is based on connected generation and generation that had contracts in place, at the data freeze date, to connect to the transmission or distribution system. The all-island generation opportunities assessment in Chapter 7 provides information for generators wishing to connect to the transmission system.

Generation opportunity is assessed at a number of 110 kV, 220 kV, 275 kV and 400 kV nodes across the all-island transmission system. The results show that there are opportunities for new generation in the east of the island, in particular in the east of Northern Ireland and in the North-East of Ireland. The results also show that future generation connections in the North-West, West, and South regions would require network reinforcements.

Regional changes in locational tariff signals are also described in Chapter 7. This information is provided to help network users make informed decisions when exploring potential transmission network connection locations. Regions with generation capacity in excess of local demand in the South West, West and North West of Ireland have lower Transmission Loss Adjustment Factors and higher Generator Transmission Use of System charges than Eastern regions with higher demand levels and less surplus generation.

The all-island demand opportunity results, based on the 2027 transmission system, are presented in Chapter 8. The demand forecast used in our analysis is the median all-island transmission peak demand forecast which is taken from the All-Island Generation Capacity Statement 2022–2031 (GCS)[7]. The demand forecast represents an average annual increase in all-island winter peak demand of 2.06% over the period of GCS 2022–2031[8].

7 https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_SONI_Ireland_Capacity_Outlook_2022-2031.pdf
8 The cumulative forecast increase in demand over the period of GCS 2021–2030 is 16.5%.

The study indicates that there are a number of stations which have the capability to accommodate large demand connections. The planned North South Interconnector improves generation adequacy across the island. It is also an important factor when considering the capacity of the system to connect significant amounts of additional demand in Ireland and Northern Ireland.

Chapter 8 includes a qualitative assessment of the demand capability in the Dublin area and an overview of the CRU's direction on the data centre connections. This has been included as a result of the large volume of connections and enquiries from data centres and other large energy users in the Dublin area.

In late 2021, the CRU issued a direction related to the processing of Data Centre connections to the grid in Ireland[9] to EirGrid, and ESB as DSO. The direction requires EirGrid, and ESB, respectively, to assess future data centre connection applications based on:

- The location of the data centre applicant with respect to whether they are within a constrained or unconstrained region of the electricity system;
- The ability of the data centre applicant to bring onsite dispatchable generation (and/or storage) equivalent to or greater than their demand in order to support security of supply;
- The ability of the data centre applicant to provide flexibility in their demand by reducing consumption when requested to do so by the System Operator at times of system constraint through the use of dispatchable on-site generation (and/or storage) in order to support security of supply; and
- The ability of the data centre applicant to provide flexibility in their demand by reducing consumption when requested to do so by the relevant system operator, during times of system constraint, in order to support security of supply.

In the context of the CRU's direction on the connection of data centres, EirGrid clarified in a December 2021 webinar that the greater Dublin area is considered a constrained region for the purpose of processing of data centre connections.

It is important to note that demand and generation opportunity studies in this TYTFS are based on contracted customer connections and approved transmission reinforcements at the data freeze date of January 2022. This differs from Shaping Our Electricity Future v1.0 which assumes connections of demand and generation in addition to those already contracted.

9 https://cruie-live-96ca64acab2247eca8a850a7e54b-5b34f62.divio-media.com/documents/CRU21124-CRU-Direction-to-the-System-Operators-related-to-Data-Centre-grid-connection-.pdf

For example, Shaping Our Electricity Future v1.0 assumes that new large energy user demand will connect at Cashla, Coolkeeragh, Killonan and Knockraha; however, there are currently no connection agreements for this demand. Therefore, future iterations of the TYTFS will take the outcome and progress of both versions of Shaping Our Electricity Future (v1.0 and v1.1) into account, including new demand and generation customer connections.

A significant amount of conventional generation in Ireland and Northern Ireland is expected to close over the period covered by this statement. For the purpose of the TYTFS 2022 analysis, it is assumed that sufficient generation capacity will be delivered in appropriate locations to ensure generation adequacy and security of supply are maintained.

Note that in Ireland, significant security of supply concerns over the next ten years have been highlighted by EirGrid in the Generation Capacity Statement (GCS) 2022–2031. EirGrid is working with CRU and the Department of the Environment, Climate and Communications (DECC) to address the short to medium term generation adequacy concerns in Ireland. In September 2021, the CRU first published a Programme of Actions to increase generation capacity to provide additional stability and resilience to the Irish energy system for the coming years. This includes retention of existing units that are scheduled to close and the availability of temporary emergency generation. Capacity shortfalls will continue to be regularly assessed, and action plans will be further developed and updated as necessary to maintain security of supply.

The GCS 2022–2031 capacity adequacy analysis for Northern Ireland indicates that the capacity outlook drops into deficit in 2024 and 2025 as the existing coal fired generation at Kilroot closes, the new OCGTs at Kilroot are delayed and when they do connect will be subject to Annual Run hour Limits (ARHLs). The adequacy position for NI is being monitored on an on-going basis and SONI is working with the Department for the Economy and the Utility Regulator in addressing these issues.

The results of demand and generation opportunity analyses are based on high level transmission network assessments. The results provide guidance; the actual connection capacity and possible connection solutions can only be determined following detailed individual connection studies. We will continue to examine innovative solutions and technologies in response to future connection enquiries.

Those who are considering connecting generation or demand to the transmission systems of Ireland or Northern Ireland should contact us. It is advisable to consult us early in the project process. In Ireland customers can contact us at info@eirgrid.com while in Northern Ireland customers can contact us at info@soni.ltd.uk.

1. Introduction

EirGrid is the Transmission System Operator (TSO) in Ireland, and SONI is the TSO in Northern Ireland. The TSOs jointly prepare and publish the All-Island Ten Year Transmission Forecast Statement (TYTFS) each year.

1.1 Introduction to the Transmission Forecast Statement

The transmission system is a network of 400 kV, 275 kV, 220 kV and 110 kV high-voltage lines and cables. It is the backbone of the power system, efficiently delivering large amounts of power from where it is generated to where it is needed. EirGrid plans and develops the transmission system in Ireland to ensure it meets forecast transmission system operating conditions. SONI is responsible for planning and operating the transmission system in Northern Ireland within defined security standards.

The TYTFS 2022 provides the following information:

- Network models and data of the all-island transmission system;
- Forecast generation capacity and demand growth;
- Maximum and minimum fault levels at transmission system stations;
- Predicted transmission system power flows at different points in time; and
- Demand and generation opportunities on the transmission system.

The TYTFS is designed to assist users and potential users of the transmission system to identify opportunities to connect to and make use of the transmission system. The appendices provide further information and transmission system data to enable the reader to perform power flow analysis.

When using data provided in the TYTFS 2022, readers should consider other documents we produce, or are involved in producing, including:

- All-Island Generation Capacity Statement (GCS);
- Shaping Our Electricity Future Roadmap;
- EirGrid's Transmission Development Plan for Ireland;
- SONI's Transmission Development Plan for Northern Ireland;
- EirGrid's Tomorrow's Energy Scenarios for Ireland;
- SONI's Tomorrow's Energy Scenarios for Northern Ireland; and
- European Network of Transmission System Operators for Electricity's (ENTSO-E's) Ten Year Network Development Plan for Europe.

Each year, EirGrid and SONI jointly prepare the All-Island Generation Capacity Statement. The GCS outlines demand forecasts and assesses the generation adequacy of the island of Ireland over the ten year period covered by the GCS. The TYTFS complements the demand information presented in the GCS.

EirGrid and SONI also publish Transmission Development Plans (TDP) for Ireland and Northern Ireland respectively. The TDPs are available on the EirGrid and SONI websites. The TDPs for Ireland and Northern Ireland provide details of the transmission system developments expected to be progressed in Ireland and Northern Ireland in the coming 10 years. These transmission system developments are also included in the data, assumptions and analyses in the TYTFS.

To cater for the increased level of uncertainty over the future usage of the grid, EirGrid and SONI carry out scenario planning for Ireland and Northern Ireland respectively. We call our scenarios Tomorrow's Energy Scenarios (TES), acknowledging that there is no single pathway to a low carbon future. The European Network of Transmission System Operators for Electricity (ENTSO-E), of which EirGrid and SONI are members, publishes a Ten Year Network Development Plan (TYNDP) every two years. The TYNDP outlines projects of European significance.

1.2 Governance

1.2.1 Roles and responsibilities

Northern Ireland

Under the licence in Northern Ireland, held by SONI, we are required to plan and operate the Northern Ireland transmission system. In doing so we must comply with both the SONI Transmission System Security and Planning Standards (TSSPS) and the SONI Grid Code.

Ireland

Under the licence in Ireland, held by EirGrid, we are required to operate, develop and ensure the maintenance of the Irish transmission system. In doing so we must comply with both the EirGrid TSSPS and the EirGrid Grid Code.

1.2.2 Duty to prepare a statement

EirGrid and SONI are each required to publish a Transmission Forecast Statement in line with the Statutory Regulations in Table 1-1. Since 2012 we have jointly prepared and produced an all-island document, following an agreement with the Commission for Regulation of Utilities (CRU) in Ireland and the approval of the Utility Regulator (UR) in Northern Ireland. TYTFS 2022 has been prepared in accordance with and in fulfilment of these obligations.

Table 1-1: Statutory regulations requiring the TSOs to produce a Transmission Forecast Statement

Ireland	Northern Ireland
Section 38 of the Electricity Regulation Act 1999 (as amended)	Condition 33 of the Licence to participate in the Transmission of Electricity

1.2.3 Single electricity market

The Single Electricity Market (SEM) has been operating on the island of Ireland since 2007. The all-island wholesale electricity market allows consumers in both Ireland and Northern Ireland to benefit from increased competition. This in turn allows consumers to benefit from reduced energy costs and improved reliability of supply.

The model of the SEM changed considerably on 1 October 2018 to take account of the requirements of the European Network Codes and the Target Model. The project to develop and realise the new market was called the Integrated - Single Electricity Market (I-SEM). The market remains the Single Electricity Market (SEM).

The transmission systems of Ireland and Northern Ireland are electrically connected by means of a 275 kV tie-line. This tie-line connects Louth station in Co. Louth (Ireland) to Tandragee station, in Co. Armagh (Northern Ireland). There are also two 110 kV connections between Ireland and Northern Ireland:

- Letterkenny station in Co. Donegal (Ireland) and Strabane station in Co. Tyrone (Northern Ireland);
- Corraclassy station in Co. Cavan (Ireland) and Enniskillen station in Co. Fermanagh (Northern Ireland).

Generation on the transmission systems of Ireland and Northern Ireland is dispatched on an all-island basis. The TYTFS transmission network models are also dispatched in this manner, to reflect how the all-island transmission system is operated.

1.3 Data management

Transmission system development is continuously evolving. A data freeze date of 1st January 2022 applies to TYTFS 2022. All data for system model files, and sequence data for use with short circuit current level analysis, was collected on this date. A data freeze date enables us to update system models in order to perform analyses and also allows us to update the appendices of the TYTFS.

1.4 Other information

Potential users of the transmission system should also be aware of the following key documents:

- EirGrid Grid Code and SONI Grid Code
- SONI Transmission System Security and Planning Standards
- The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012
- EirGrid Transmission System Security and Planning Standards
- EirGrid Operating Security Standards
- SONI Transmission Connection Charging Methodology Statement
- EirGrid Transmission Connection Charging Methodology Statement 2008
- EirGrid Statement of Charges 2022/2023
- Statement of Charges – For Use of Northern Ireland Electricity Ltd Transmission System
- EirGrid Transmission Loss Adjustment Factors 2022–2023
- SONI Transmission Loss Adjustment Factors 2022–2023
- All-Island Generation Capacity Statement 2022–2031
- EirGrid Transmission Development Plan for Ireland 2021–2030
- SONI Transmission Development Plan for Northern Ireland 2021–2030

1.5 Publication

The TYTFS 2022 is available in pdf format on our websites: www.eirgridgroup.com and www.soni.ltd.uk

For a hard-copy version, please send a request to info@eirgrid.com or info@soni.ltd.uk.

Transmission system model files are also available on both websites.

2. The electricity transmission system

The transmission system in Ireland and Northern Ireland plays a vital role in the supply of electricity. It provides the means to transport energy from generators to demand centres across the island.

2.1 Overview of the all-island electricity transmission system

The transmission system in Northern Ireland is operated at 275 kV and 110 kV.
The transmission system in Ireland is operated at 400 kV, 220 kV and 110 kV. The two transmission systems are connected by means of a 275 kV double circuit from Louth station in Co. Louth in Ireland to Tandragee station in Co. Armagh in Northern Ireland. There are also two 110 kV connections between Letterkenny (IE) and Strabane (NI) stations, and between Corraclassy (IE) and Enniskillen (NI) stations.

See Section 2.2 below for further information on the existing transmission connections between Ireland and Northern Ireland.

EirGrid and SONI together operate the transmission systems – North and South – on an all-island basis. The 400 kV, 275 kV and 220 kV networks form the backbone of the transmission system. They have higher power carrying capacity and lower losses than the 110 kV network. In Ireland, the 400 kV network provides a high capacity link between the Moneypoint generation station on the west coast and Dublin on the east. A new 400 kV interconnector between Ireland and Northern Ireland, called the Second North South Interconnector, has received planning approval and is now ready to enter the construction phase.

In Northern Ireland the 275 kV network comprises:

- A double circuit ring;
- A double circuit spur to Coolkeeragh Power Station; and
- A double-circuit spur southwards into Co. Louth, in Ireland.

In Ireland the transmission network comprises single circuit lines which are interconnected to cover the wider geographical distances between stations. Typically, large generation stations (greater than 200 MW) are connected to the 220 kV or 400 kV networks.

The 110 kV circuits provide parallel paths to the 220 kV, 275 kV and 400 kV networks and are the most extensive element of the all-island transmission system, reaching into every county on the island of Ireland.

The all-island transmission system generally consists of overhead lines. There are exceptions to this, such as in the city centres of Belfast, Cork and Dublin, where underground cables are used. Table 2-1 presents the total lengths of overhead lines and cables at the different voltage levels (as of the data freeze date). Revision of individual line lengths may change following completion of network development projects.

Transformers are located at substations that link the different voltage networks together, providing paths for power flow between voltage levels. The total transformer capacity between the different voltage levels on the all-island system is presented in Table 2-2.

Table 2-1: Total length of installed transmission circuits

Voltage level (kV)	Total length (km)
400	439
275	825
220	1,985
110	6,791

Reactive compensation devices are used to improve transmission system voltages in local areas. Existing reactive compensation devices connected to the transmission system include shunt capacitors, static var compensators (SVCs) and shunt reactors.

Table 2-2: Total installed transformer capacity

Voltage level (kV)	Capacity (MVA)	Number
400/220	4,050	8
275/220	1,200	3
275/110	4,280	19
220/110	14,799	70
110/33	6,507	89

Capacitors and SVCs help to support local voltages in areas where low voltages may otherwise occur. Shunt reactors suppress voltages in areas where they would otherwise be too high, most likely during periods of low demand and/or high wind. Table 2-3 displays the reactive compensation on the all-island transmission system.

Table 2-3: Installed reactive compensation			
Voltage level (kV)	**Type**	**MVArs**	**No. devices**
400	Line shunt reactor	160	2
	Voltage source converter (EWIC)	+/– 175	1
275	Shunt capacitor	236	4
220	Shunt reactor	250	4
110	Static var compensator	90	2
	Shunt capacitor	996	44
38	Shunt reactor	100	5
33	Shunt capacitor	29	5
22	Shunt reactor	210	7
	Shunt capacitor	125	5
20	Shunt capacitor	92	14
	Shunt reactor	9	1

Note that EirGrid and SONI will launch a procurement for Low Carbon Inertia Services (LCIS) in 2023, ultimately awarding fixed contracts to service providers. LCIS comprises the provision of synchronous, inertia, short-circuit contribution and reactive power support. To meet our 2026 requirements, we expect that 3 to 6 large devices will be procured in Ireland and 2 to 4 large devices in Northern Ireland. Although we target a volume of inertia for this procurement, the capacity of these devices is likely to range from 100 MVA to 300 MVA rating, likely to provide a substantial amount of reactive power capability.

Additional capability shall be procured in 2025 to meet our 2030 requirements.

2.2 Existing connections between Ireland and Northern Ireland transmission systems

The existing cross-border circuits are shown in Figure 2-1, where the transmission systems of Ireland and Northern Ireland are connected via a double circuit 275 kV line. This line connects the Northern Ireland transmission system at Tandragee to the Irish transmission system in Louth. There are three 275/220 kV transformers in Louth station, one 600 MVA transformer and two ganged 300 MVA transformers (sharing a connection).

The design capacity of each of the 275/220 kV cross-border circuits is 600 MVA. However, the actual capacity of the circuits to accommodate transfers between the two systems at any time depends on the prevailing system conditions on either side of the border. This includes the ability to deal with system separation.

In addition to the main 275/220 kV double circuit, there are two 110 kV connections:

- A phase-shifting transformer (PST) between Letterkenny, Co. Donegal and Strabane, Co. Tyrone; and
- A phase-shifting transformer (PST) between Corraclassy, Co. Cavan and Enniskillen, Co. Fermanagh.

The purpose of these 110 kV PSTs is to provide support to either system under certain system conditions. Phase shifting transformers (PSTs) allow the flow of power to be controlled. Usually the flow is zero but flows of up to about 30 MW can be scheduled in either direction during outages if required. They also provide voltage support by tying the two systems together electrically.

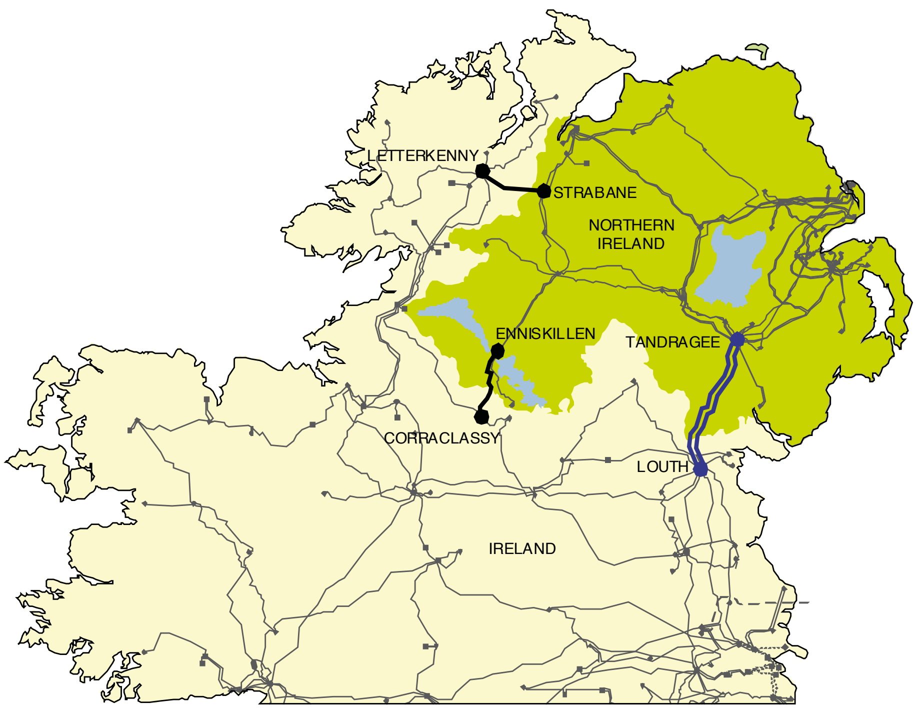


Figure 2-1: Existing cross-border circuits

2.3 Interconnection with Great Britain and Europe

Transmission grids are often interconnected so that energy can flow from one country to another. By linking to other transmission systems, we can:

- Increase the diversity and security of energy supplies;
- Facilitate competition in the European and GB markets; and
- Aid the transition to a low carbon energy sector by integrating renewable sources.

The East West Interconnector links the electricity grids in Ireland and Wales, while the Moyle Interconnector links the electricity grids in Northern Ireland and Scotland. Further interconnectors are planned: see Section 2.3.3 Future European and GB Interconnection.

Power can be either imported or exported on the interconnectors. Interconnector power flows have system impacts that need to be managed operationally. For example, during times of import, conventional generation is displaced by non-synchronous power sources. This reduces the all-island system inertia. Interconnector flows can also have implications for the system frequency and transmission system stability and operation. Frequency changes are faster in transmission systems with low rotational inertia, making frequency control and system operation more challenging.

The Moyle Interconnector also increases the dynamic reactive support required by the transmission system as the link does not have dynamic reactive power export capability[10].

SONI acts as Interconnector Administrator (IA) for the Moyle interconnector. Interconnector capacity is auctioned by SEMOpx on behalf of EirGrid Interconnector DAC (EIDAC) and Moyle Interconnector Limited (MIL) in two intra-day ex-ante auctions. The capacity is allocated for use by market participants in the wholesale electricity markets on the islands of Ireland and Great Britain. Figure 2-2 shows the location of the Moyle Interconnector and EirGrid East-West Interconnector.

10 Unlike Moyle the East West Interconnector has dynamic reactive power export capability.

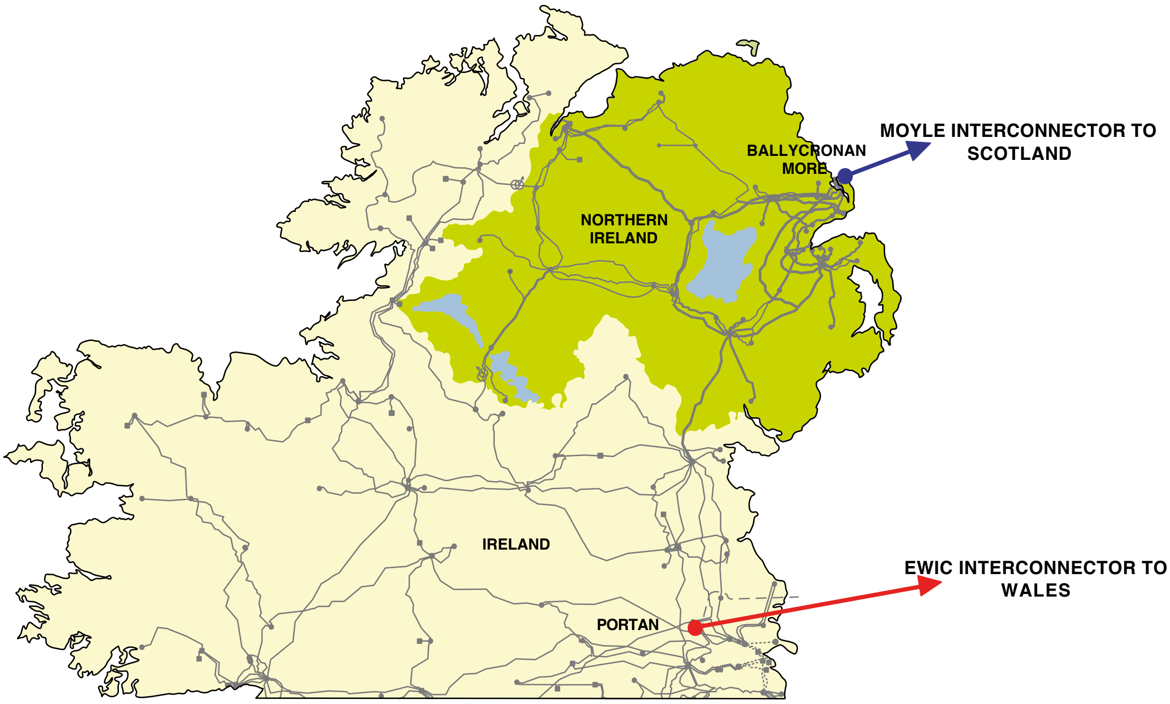


Figure 2-2: Existing interconnectors

The amount of power that is permitted to be traded between Ireland and Wales across the East-West Interconnector is detailed in Table 2-4.

The available capacity is measured at the SEM and BETTA market reference point in Deeside 400 kV station in Wales.

Table 2-4: Contracted capacity on EWIC Interconnector

Direction	Summer (MW)	Winter (MW)
Wales to Ireland	500	500
Ireland to Wales	500	500

The amount of power that can be traded between Northern Ireland and Scotland across the Moyle Interconnector is detailed in Table 2-5.

Table 2-5: Capacity on Moyle Interconnector[11]				
Flow	**Dates**	**Firm capacity available (MW)**	**Extra capacity potentially available (MW)**	**Potential total capacity (MW)**
NI to GB	1/10/21 to 31/3/22	270	205	400
	1/4/22 to 30/7/22	475	0	400
	1/8/22 onwards	500	0	400
GB to NI	1 Apr – 31 Oct	450	N/A	N/A
	1 Nov – 31 March	450	N/A	N/A

2.3.1 Moyle Interconnector

The Northern Ireland transmission system is currently connected to Scotland via a 500 MW High Voltage Direct Current (HVDC) link called the Moyle Interconnector. It is a Line Commutated Converter (LCC) HVDC link, which commenced full commercial operation in 2002.

It is constructed as a dual monopole HVDC link with two coaxial sub-sea cables from Ballycronan More in Islandmagee, Northern Ireland to Auchencrosh in Ayrshire, Scotland. The link has a physical installed capacity of 500 MW. The link has the capacity to provide reserve of up to 75 MW should the frequency on the island drop below 49.4 Hz.

The converter station at Ballycronan More is looped into one of the 275 kV Ballylumford to Hannahstown circuits. The Moyle link is self-compensating for reactive power losses. There are 4 x 59 Mvar capacitor banks at the Ballycronan More converter station with three of these capacitor banks acting as filters.

Where there are faults on the transmission system, effects are limited to a brief distortion of the HVDC 50 Hz AC synchronous waveform in import mode. The rapid response means that the HVDC link can have a net stabilising effect on the transmission system in the event of generation loss.

11 Electricity – Mutual Energy (mutual-energy.com)

2.3.2 East-West Interconnector

The East-West Interconnector is a 500 MW HVDC link which runs between Woodland, County Meath in Ireland and Deeside in North Wales. The link comprises approximately 186 km of sub-sea cable and 76 km of land underground cable.

The East-West Interconnector uses Voltage Source Converter (VSC) technology. VSC technology offers independent and rapid control of active and reactive power. It does not suffer from commutation failure, and is capable of offering emergency power control in the event of low or high frequency events.

In addition, due to the VSC technology, the East-West Interconnector provides black start capability. The link can operate in either voltage control or reactive power control mode independently in both converter stations. It can supply or absorb up to 175 Mvar at Portan 400 kV station which is connected directly to Woodland 400 kV station. The East-West Interconnector commenced commercial operation in December 2012.

2.3.3 Future interconnection with GB and Europe

Currently, there are two proposed interconnectors that are deemed Projects of Common Interest (PCIs) by the European Commission. PCIs are intended to help the EU achieve its energy policy and climate objectives: affordable, secure and sustainable energy for all citizens. At the TYTFS data freeze date the planned Greenlink Interconnector, connecting Great Island in Co. Wexford to Pembrokeshire in Wales, was expected to be completed by Winter 2024. Before the same data freeze date, the connection application for the proposed Celtic Interconnector between Ireland and France was executed in November 2021. Thus, this interconnector was included in this forecast statements' analyses. Our analyses assumed the Celtic Interconnector is in place in 2026 at the time of data freeze.

In Northern Ireland, SONI has received a connection application from Transmission Investment (TI) for a new interconnector (LirIC) to Scotland. Transmission Investment (TI) is the sole developer of LirIC. The project is currently in the relatively early stages of development. In Ireland, there is a further interconnector project (MARES Connect) from Ireland to GB. Due to the early development status of these projects, they are not included within any studies or tables in this report.

2.4 Transmission development plans

EirGrid's Transmission Development Plan (TDP) and SONI's Transmission Development Plan Northern Ireland (TDPNI) detail the transmission system development projects that have been initiated by EirGrid and SONI respectively. They also discuss further developments that may arise in the period of the plans. The TDP and TDPNI describe projects that are required to:

- Facilitate demand growth;
- Provide new generation and demand connections;
- Ensure the transmission system is in compliance with the EirGrid Transmission System Security and Planning Standards (TSSPS) and SONI TSSPS;
- Provide interconnection capacity; and
- Refurbish or replace existing assets.

The planned transmission system developments presented in this statement are based on those projects that have received internal approval by the data freeze date. Appendix B outlines these developments. These projects are currently scheduled to be completed at various stages between now and 2030. It should be noted that the information presented in later chapters on transmission system transfer capabilities and opportunities is dependent on the completion of these development projects in the assumed timeframe.

Information presented in the TDP, TDPNI and TYTFS documents represent a snapshot of an evolving transmission system development plan. While we are considering other reinforcements, these are not at the stage of maturity required for inclusion in this statement.

The Transmission Development Plans include details of major transmission system developments planned for the transmission system of Ireland and Northern Ireland. Each planned development is illustrated in the maps and schematics in Appendix A. New generation connections and new transmission interface stations are described in Sections 2.8 and 2.9 respectively.

2.5 Ireland transmission system developments

This section details the transmission system projects that are planned to take place in Ireland over the period covered by this forecast statement. Project completion dates in the TYTFS are forecasts based on the best project information available at the time of the data freeze date (January 2022).

2.5.1 Grid Development Strategy

EirGrid published the updated Grid Development Strategy (GDS) Your Grid, Your Tomorrow in 2017. The GDS documents our strategy for the long-term development of the network and includes three strategy statements:

- Inclusive consultation with local communities and stakeholders will be central to our approach;
- We will consider all practical technology options; and
- We will optimise the existing grid to minimise the need for new infrastructure.

The GDS aims to achieve a balance between the costs and impact of new infrastructure, while maximising the capability of the existing network.

2.5.2 Our public consultation process

Our approach to developing the grid and how the public can engage with us at each stage of project development is outlined in our Have Your Say brochure.

Our approach comprises a six-step process that provides an 'end-to-end' structure for all our grid projects. It ensures an appropriate balance between technical, economic, environmental, social and community considerations, with significant provision for stakeholder engagement at all stages. A general structure of the process is set out in Figure 2-3.

Figure 2-3: General structure of the six-step process for our grid projects

2.5.3 Tomorrow's energy scenarios

In 2017, to cater for the increased level of uncertainty over the future usage of the grid, we introduced scenario planning into our grid development process. We call our scenarios Tomorrow's Energy Scenarios (TES).

Our scenarios detail credible futures for the electricity sector in Ireland, with specific focus on what this means for the electricity transmission system over the next twenty years and beyond. The underlying assumptions in the scenarios are validated using feedback received from policy makers, industry and the general public as part of an open consultation.

When the scenarios are finalised, we use them to test the performance of the electricity transmission grid and publish the results in the TES System Needs Assessment (SNA). The TES process occurs every two years.

The needs identified in the TES process are brought through our six-step process for developing the grid. As needs and projects progress through the six-step process they are included in the TDP and TYTFS.

EirGrid and SONI are currently working on the next iteration of the Tomorrows Energy Scenarios – a consultation on draft scenarios is planned for summer 2023 with a view to publishing final scenarios in autumn 2023.

2.5.4 Descriptions of Ireland transmission development projects

Ballynahulla station STATCOM

A new ±100 Mvar STATCOM will be installed and commissioned on the 110 kV busbar at Ballynahulla. At the TYTFS data freeze date this project was expected to be completed in 2022.

Ballyvouskill station STATCOM

A new ±100 Mvar STATCOM will be installed and commissioned on the 110 kV busbar at Ballyvouskill. At the TYTFS data freeze date this project was expected to be completed in 2022.

Belcamp phase 2 220/110 kV development

A 220 kV cable will connect Shellybanks station to Belcamp station, by utilising the existing Finglas – Shellybanks and Dardistown – Finglas cables, and continuing the cable connection to Belcamp. This will lead to a revision in the feeding arrangements of the underlying Finglas and Belcamp 110 kV network. A new 220 kV indoor ring-type GIS busbar and a second transformer is to be installed at Belcamp. At the TYTFS data freeze date this project was expected to be completed in 2022.

Bracklone 110 kV station

A new 110 kV substation will be constructed near Portarlington. It will be looped into the existing Newbridge – Portlaoise 110 kV circuit. It will facilitate more demand in the area and also improve security of supply. At the TYTFS data freeze date this project was expected to be completed in 2023.

Carrickmines 220/110 kV redevelopment

This project involves installation of a fourth 220/110 kV transformer at Carrickmines 220 kV station as well as upgrading to Gas Insulated Switchgear (GIS) and reconfiguration of the existing busbar. At the TYTFS data freeze date this project was expected to be completed in 2023.

Castlebagot 220/110 kV development

Castlebagot 220/110 kV station, in west Co. Dublin, will be connected into the existing Inchicore-Maynooth No. 1 and No. 2 220 kV lines. A number of the existing 110 kV circuits in the area will be connected to the new Castlebagot station. This development will offload demand from Inchicore 220 kV station. It will also ensure compliance with the distribution system planning standards as new demand connects to the system in the West Dublin area. At the TYTFS data freeze date this project was expected to be completed in 2022.

Clashavoon – Tarbert 220 kV uprate

This 220 kV circuit is being uprated to accommodate increased power flows arising from an increase in wind generation. The uprated circuit will enable the export of wind power out of the southwest. Following the connection of four 220 kV stations, the original Clashavoon – Tarbert 220 kV circuit became five circuits: Tarbert – Kilpaddoge, Kilpaddoge – Knockanure, Knockanure – Ballynahulla, Ballynahulla – Ballyvouskil, and Ballyvouskil – Clashavoon. At the TYTFS data freeze date this project was expected to be completed in 2022.

Coolnabacky – Portlaoise 110 kV uprate

The 110 kV circuit between Coolnabacky and Portlaoise will be uprated due to higher power flows arising once the Coolnabacky 400/110 kV station has been looped into the existing Athy – Portlaoise 110 kV circuit. The higher flows occur during high renewable generation in the southwest which flows towards the east. At the TYTFS data freeze date this project was expected to be completed in 2023.

Corduff – Ryebrook 110 kV uprate

The 110 kV circuit between Corduff and Ryebrook will be uprated due to increases in demand and an increase in flows on the overlying 220 kV network. At the TYTFS data freeze date this project was expected to be completed in 2022.

Finglas 220 kV and 110 kV redevelopment

The 220 kV and 110 kV busbars in the existing Finglas 220 kV station will be reconfigured and redeveloped into a ring busbar arrangement. This project will address the following issues: ability to accommodate future load growth; security of supply to north Dublin; asset condition of existing equipment; inadequate circuit breaker ratings and the need to upgrade the protection systems. The project will also increase operational flexibility and improve maintainability of station equipment. At the TYTFS data freeze date this project was expected to be completed in 2023.

Galway 110 kV station redevelopment

The existing Galway 110 kV station will be replaced with a GIS station in order to accommodate increased power flows due to an increase in wind generation. The project will also increase operational flexibility and improve maintainability of station equipment. At the TYTFS data freeze date this project was expected to be completed in 2024.

Greenlink Interconnector

The Greenlink Interconnector, connecting Great Island in Co. Wexford to Pembrokeshire in Wales, will have an import and export capacity of 500 MW. The project to facilitate the connection of the interconnector to the transmission system will consist of the construction of a new 220 kV GIS station 'Loughtown'. Loughtown will connect to Great Island 220 kV GIS station via approximately 400m of underground cable. At the TYTFS data freeze date this project was expected to be completed in 2024.

Inchicore 220 kV redevelopment

The oldest section of the existing Inchicore 220 kV station, in Co. Dublin will be replaced with a new GIS compound. This project will address issues with the condition of existing equipment, inadequate circuit breaker ratings, and the need to upgrade the protection systems. The new GIS compound will increase operational flexibility, improve maintainability of station equipment and allow for future 220 kV expansion. At the TYTFS data freeze date this project was expected to be completed in 2027.

Kildare-Meath grid upgrade (capital project 966)

This project will involve reinforcement of the network between Dunstown and Woodland 400 kV stations.

We are progressing this project in line with our six-step process for our grid projects. The six-step process is introduced above and outlined in our Have Your Say brochure. In summer 2022, the project completed Step 4 and moved into Step 5. For the most up to date information on the project please visit the project page on the EirGrid website.

New 110 kV station close to Kilbarry 110 kV station

A new 110 kV substation will be constructed adjacent to the existing station. This will facilitate more demand in the area and also improve security of supply. Some of the existing circuits connecting into the existing Kilbarry 110 kV station will be transferred into the new station. At the TYTFS data freeze date this project was expected to be completed in 2024.

Killonan 220/110 kV redevelopment

The existing Killonan 220/110 kV station, in Co. Limerick will be replaced with a new GIS compound. This project will address issues with the condition of existing equipment, inadequate circuit breaker ratings, and the need to upgrade the protection systems as well as to accommodate increased power flows. The new GIS compound will increase operational flexibility and improve maintainability of station equipment. At the TYTFS data freeze date this project was expected to be completed in 2027.

Lanesboro 110 kV station redevelopment

The existing Lanesboro 110 kV station will be replaced with a GIS station in order to accommodate increased power flows due to an increase in wind generation in the north-west. The project will also increase operational flexibility and improve maintainability of station equipment. At the TYTFS data freeze date this project was expected to be completed in 2024.

Laois-Kilkenny reinforcement project

This project involves a new 400/110 kV station at Coolnabacky near Portlaoise, Co. Laois, with an associated 110 kV circuit to Kilkenny 110 kV station via a new 110/38 kV station at Ballyragget. The 400/110 kV station will be looped into the existing Dunstown-Moneypoint 400 kV line and the existing Athy-Portlaoise 110 kV line. The proposed infrastructure will improve quality of supply to the south-east and midlands. It will also increase capacity in the region. At the TYTFS data freeze date this project was expected to be completed in 2025.

Louth station redevelopment

Louth station comprises three voltage levels, 275 kV, 220 kV and 110 kV. The station will undergo a major refurbishment of assets at all three voltage levels. The 110 kV busbar will be reconfigured from the existing double busbar configuration to ring busbar arrangement. At the TYTFS data freeze date this project was expected to be completed in 2030.

Maynooth station redevelopment

This project involves refurbishment and reconfiguration of the entire 220 kV and 110 kV busbars, and an increase in the short circuit rating of both busbars. Series reactors will be incorporated to manage short circuit levels within limits. At the TYTFS data freeze date this project was expected to be completed in 2027.

Maynooth – Woodland 220 kV refurbishment and uprate

The 220 kV circuit between Maynooth and Woodland will be refurbished and uprated to facilitate increased power flows arising from an increase in demand. At the TYTFS data freeze date this project was expected to be completed in 2022.

North Connacht 110 kV reinforcement

This project includes a new 110 kV circuit from Moy station in Co. Mayo to Tonroe station in Co. Roscommon. The new circuit will facilitate the connection of renewable generation in Co. Mayo. For the most up to date information on the project please visit the project website on the EirGrid website. At the TYTFS data freeze date this project was expected to be completed in 2024.

Regional solution

The Regional Solution is made up of a number of projects, with the objective of improving security of supply in the south-east and facilitating connection of generation in the south-west.

(i) **Cross-Shannon 400 kV cable**
A 400 kV cable crossing the Shannon estuary will be installed between Kilpaddoge and Moneypoint stations. The cable length is estimated at approximately 6 km consisting of approximately 3 km land cable and approximately 3 km submarine cable. A new 400/220 kV 500 MVA transformer will also be required at Kilpaddoge station. At the TYTFS data freeze date this project was expected to be completed in 2024.

(ii) **Great Island – Kilkenny 110 kV line uprate**
At the TYTFS data freeze date this project was expected to be completed in 2022.

(iii) **Dunstown, Moneypoint and Oldstreet series compensation**
Series compensation will be installed at Dunstown, Moneypoint and Oldstreet 400 kV stations to compensate the Coolnabacky – Moneypoint, Coolnabacky – Dunstown and Oldstreet – Woodland 400 kV lines. At the TYTFS data freeze date these projects were expected to be completed in 2025.

Thurles station STATCOM

One of the existing 15 Mvar capacitor banks on the 110 kV busbar at Thurles will be removed and replaced with a new ±30 Mvar STATCOM. At the TYTFS data freeze date this project was expected to be completed in 2023.

Baroda 110 kV station

2 x 20 MVA 110/10 kV transformers to be installed. This is to facilitate the connection of a new customer (MIC = 3 MVA) and the transfer of 7 MVA existing demand from the 110/38 kV transformers at Newbridge 110 kV station. The total MIC at Baroda amounts to 10 MVA. For the purpose of TYTFS 2022 analysis, at the TYTFS data freeze date, this project was expected to be completed in 2022.

Cow Cross

1 x 20 MVA 110/10 kV transformers to be installed at the Cow Cross 110 kV busbar. This is to facilitate the retirement of the Cobh 38 kV substation. There will be no new loads or load transfers associated with the retirement of this substation. For the purpose of TYTFS 2022 analysis, at the TYTFS data freeze date, this project was expected to be completed in 2022.

2.6 Northern Ireland transmission system developments

This section details the transmission system projects that are planned to take place in Northern Ireland over the period covered by this forecast statement. Projects have been included using completion dates assessed to be appropriate at the time of the data freeze (January 2022).

2.6.1 Grid development process

SONI updated the Northern Ireland Grid Development Process. This is a three part process which includes stakeholder and public participation (as appropriate) in the development of projects, see Figure 2-4.

The approach taken to developing the grid is described by the following:

- The projects listed here have all progressed through either the SONI approval and governance process or have been identified to SONI by NIE Networks. In cases where the project is at an early stage, i.e., Part 1, this approval may be limited to the investigation of feasibility of several options prior to shortlisting and selection of preferred option and identification of study areas. Therefore, the outline design that progresses to the consents stage may vary from that assumed in the forecast statement study files.
- Developments are based on assumptions relating to the forecast change in demand and generation.
- Studies have concluded that the following projects are required to address forecast non-compliance with standards, subject to the forecast change in demand and generation. However, further cost benefit analysis may result, in some cases, in the identification of alternative solutions or operational interventions.

Part 1
Identifying the optimum solution and what area may be affected

Part 2
Identifying where the project will be built

Part 3
Planning application to project handover to NIE Networks

Figure 2-4: SONI's grid development process

Further projects for which a need has been identified but approval has not yet been granted have not been included in the TYTFS analysis. These are discussed in more detail in Transmission Development Plan for Northern Ireland TDPNI 2021–2030.

SONI published its first 'Tomorrow's Energy Scenarios Northern Ireland' (TESNI) which outlines three possible energy futures. These acknowledge that there is no single pathway to a low carbon future. We also analysed how the existing and planned transmission grid performs under each of the scenarios over a range of timeframes.

The results of this analysis, known as TESNI 2020 System Needs Assessment, are also available on the SONI website.

To realise an ambition towards a carbon-free electricity system, both EirGrid and SONI launched the Shaping Our Electricity Future v1.0 Roadmap in November 2021. The Roadmap provides an outline of the key developments from a networks, engagement, operations and market perspective needed to support a secure transition to at least 70% renewables on the electricity grid by 2030 – an important step on the journey to 80% and to net zero by 2050. The Shaping Our Electricity Future roadmap is a dynamic plan that has been updated and published in July 2023. This new version, Shaping Our Electricity Future v1.1, reflects the best available information, including changes in climate and energy policy, and reports on progress against specific actions within the roadmap, including the necessary changes for achieving the government's target of up to 80% RES-E by 2030.

2.6.2 Descriptions of Northern Ireland development projects

Additional shunt reactors

With an increase in small scale generation and increasing energy efficiency, the minimum load seen on the NI transmission system has dropped, leading to an increased need to reduce system voltages during these periods. Shunt reactors suppress system voltages. This project involves installation of two new shunt reactors at Castlereagh, and one at each of Tandragee and Tamnamore, connected to tertiary windings of interbus transformers. At the TYTFS data freeze date this project was expected to be completed by summer 2022.

Banbridge transformer replacement

The 30 MVA 110/33 kV transformers T1–T4 at Banbridge are to be replaced by two new 90 MVA units. At the TYTFS data freeze date this project was expected to be completed by winter 2026.

Enniskillen transformer replacement

The 45 MVA 110/33 kV transformers T1 and T2 at Enniskillen are to be replaced by new 90 MVA units. At the TYTFS data freeze date this project was expected to be completed by winter 2024.

Donegall Main (North) transformer replacement

The 60 MVA 110/33 kV transformer TxB at Donegall North is to be replaced by a new 90 MVA unit. At the TYTFS data freeze date this project was expected to be completed by summer 2023.

Glengormley transformer replacement

The 60 MVA 110/33 kV transformer TxB at Glengormley is to be replaced by a new 90 MVA unit. At the TYTFS data freeze date this project was expected to be completed by winter 2023.

Omagh Main – Dromore 110 kV circuit uprate

With the connection of Drumquin cluster substation to Dromore it will be necessary to restring the Omagh Main – Dromore tower line with a higher capacity conductor. At the TYTFS data freeze date this project was expected to be completed by 2023.

Airport Road main

It is planned to construct a new 110/33 kV substation including 2 x 60 MVA transformers and a 33 kV switchboard in the Belfast Harbour Estate, close to Airport Road. The substation will be connected as a teed transformer feeder arrangement from Rosebank Main 110 kV. The substation will supply both Airport Road and Queens Road 33 kV substations which are to be transferred from Cregagh Main. At the TYTFS data freeze date this project was expected to be completed by winter 2024.

Ballylumford – Eden 110 kV circuit uprate

The conductor on the existing tower line will be replaced and uprated. At the TYTFS data freeze date this project was expected to be completed by winter 2023.

Ballylumford switchgear

The existing 110 kV switchgear at Ballylumford is to be replaced with a new 110 kV GIS double busbar and the 110 kV circuits diverted accordingly. At the TYTFS data freeze date this project was expected to be completed by winter 2023. Currently one 275/110 kV interbus transformer at Ballylumford is operated out of service to ensure the fault level is kept within existing switchgear fault rating. After this work is completed, this restriction can be removed.

Castlereagh IBTx 1

The interbus transformer IBTX 1 at Castlereagh is to be replaced. The replacement transformer will have a 240 MVA primary winding and a 60 MVA tertiary winding. At the TYTFS data freeze date this project was expected to be completed by 2027.

Coolkeeragh – Magherafelt 275 kV circuits

It is planned to replace the conductor on the existing double circuit tower line. The rating of the replacement conductor will be defined as part of the redesign of the circuit. At the TYTFS data freeze date this project was expected to be completed by winter 2022.

Mid Antrim Upgrade (formerly Kells – Rasharkin new 110 kV circuit)

As a result of increasing growth in renewable generation there will be a need to construct a second 110 kV circuit between Kells and Rasharkin 110/33 kV cluster substations. This circuit will be required to have a minimum rating of approximately 190 MVA. At the TYTFS data freeze date this project was expected to be completed by 2028.

Windfarm Clusters Development

(i) **Kells 110/33 kV cluster**
It is planned to establish a 110/33 kV cluster substation near Kells, connected to the existing Kells station via an overhead line. At the TYTFS data freeze date this project was expected to be completed by 2024.

(ii) **Gort Main 2nd transformer**
It is planned to install a 2nd 110/33 kV transformer at Gort Main cluster substation, allowing the transfer of a nearby wind farm from the Omagh distribution system to a more direct connection to the transmission system. At the TYTFS data freeze date this project was expected to be completed by winter 2023.

Belfast Metropolitan reinforcement project: Hannahstown – Castlereagh reinforcement

The first phase of this project comprises the installation of a fourth transformer at Castlereagh and diverting the Carnmoney to Castlereagh circuit into the Finaghy substation. For the purposes of TYTFS 2022 analysis, this phase of the project is expected to be completed in 2025.

The second phase of this project includes the establishment of new 110 kV double busbar stations at Belfast North Main and Belfast Central Main and installation of new double circuit cables. For the purposes of TYTFS 2022 analysis, this phase of the project is expected to be completed in 2027.

The redundant section between Finaghy and Carnmoney will subsequently be removed.

Belfast Metropolitan reinforcement project: asset removal

Once the necessary assets have been installed and the network reconfigured, the Carnmoney to Castlereagh circuit will be removed. The section between Finaghy and Carnmoney will be removed after Phase 1 and the Finaghy to Castlereagh section after Phase 2.

2.6.3 Projects not included in the 2022 TYTFS analysis

Several projects have not been included in the TYTFS analysis due to uncertainty at this time over either:

- The case of need; and/or
- Scope; and/or
- Timescales.

The following projects have not been included in the 2022 TYTFS analysis. However, they are under consideration and are included for information. These projects are described in more detail in TDPNI which is available on the SONI website.

TDPNI projects advanced in Part 1

Coolkeeragh 110 kV extension

The driver for this project is renewable integration and security of supply. This project will facilitate the future connection of a third interbus transformer, the restoration of the second busbar coupler and section switches and other improvements. Following an assessment of options based on a range of criteria, the preliminary preferred option selected is the extension of the existing outdoor Coolkeeragh 110 kV substation into the old bund area through treating and redistributing bund material onsite.

The project has been submitted to the Utility Regulator for approval of pre-construction costs. The estimated completion date is 2029.

Mid Tyrone reinforcement project

The drivers for the project are RES integration and security of supply. A significant quantity of renewable generation has been connected in the North and West of Northern Ireland. Capacity issues on the 110 kV network have led to a need to constrain this generation at times, representing a loss of otherwise available generation. Following the completion of the Mid Antrim project, the main constraint area on the 110 kV network will be in the corridor between Omagh and Tamnamore. The Mid Tyrone Reinforcement Project will increase the capacity of the transmission network in this area. Options being considered include reinforcement in the area between Omagh, Dromore and Tamnamore substations.

This project is expected to be submitted to the Utility Regulator for approval in late 2023 and has an estimated completion date of 2029.

Armagh and Drumnakelly reinforcement project

The driver for this project is security of supply. NIE Networks and SONI are jointly assessing the level of security of supply on the distribution system supplying Armagh and the 110/33 kV substation at Drumnakelly. It is forecast that demand will exceed capacity at the existing Drumnakelly 110/33 kV substation. In addition, there is a risk of overload on the distribution system between Drumnakelly and Armagh following a circuit outage.

Options being considered include:

- Reinforcement of the distribution system in the area between Drumnakelly, Tullygoonigan and Armagh; and
- Reinforcement of the transmission system in the area between Drumnakelly, Tandragee and Armagh.

This project is expected to be submitted to the Utility Regulator for approval in mid-2023 and has an estimated completion date of this project is 2027.

East Tyrone reinforcement project

The driver for this project is security of supply. NIE Networks and SONI are jointly assessing the level of security of supply on the distribution system supplying Cookstown and the 110/33 kV substation at Dungannon. It is forecast that demand will exceed capacity at the existing Dungannon 110/33 kV substation. In addition, there is a particular risk to supplies following a second circuit outage. Options being considered include:

- Installation of a 2nd transformer at Tremoge and further distribution reinforcement from Tremoge to Cookstown;
- Construction of a 2nd 110/33 kV substation at Dungannon; and
- Establishing a new 110/33 kV substation at Cookstown with transmission reinforcement from Dungannon, Tremoge or Tamnamore.

The estimated completion date of this project has been updated from Winter 2026 to Summer 2027.

Moyle 275 kV reinforcement

The drivers for this project are market integration, security of supply and RES integration. At present, full utilisation of the 500 MW export capability of the Moyle Interconnector is prevented by the potential for network overloads and voltage steps in the event of the loss of the 275 kV double circuit between the Moyle converter station at Ballycronan More and the nearby Ballylumford substation. This project involves works to allow reconfiguration of the connection to Moyle to address this contingency.

The estimated completion date of this project has been updated from 2024 to Winter 2026.

2.7 Joint Ireland and Northern Ireland approved transmission system developments

This section includes transmission system developments which both EirGrid and SONI have identified the need for.

We are proposing a new 400 kV circuit which will connect Woodland 400/220 kV station in County Meath (Ireland) and Turleenan 400/275 kV station in County Tyrone (Northern Ireland). A new 400 kV station at Turleenan is required.

At present, the transmission transfer capacity between Ireland and Northern Ireland is not sufficient. Due to the risk of a forced outage, we must limit power flows across the border to prevent stress on the grid and risk to security of supply. The North South Interconnector will deliver a more secure and reliable electricity supply throughout the island of Ireland. It will bring about major cost savings and address significant issues around the security of electricity supply.

A key benefit is that it will remove bottlenecks between the two systems. This will enable the two systems to work together as a single network. This will benefit residents and businesses on both sides of the border. Other benefits will include cost savings for consumers, as larger electricity systems operate more efficiently than smaller ones.

The North South Interconnector will also allow for greater connection of renewable generation. This will help Ireland and Northern Ireland achieve future renewable energy targets. At the TYTFS data freeze date this project was expected to be completed by the end of 2025. Once this connection is established, the constraints on the existing Tandragee-Louth 275 kV double circuit will be significantly reduced.

2.8 Connection of new generation stations

New generators will connect over the period covered by this statement. Table 2-6 lists the transmission system developments associated with future generation. New generators are included in the appropriate network models according to their expected connection date. Details of these generators and their expected connected dates are given in Appendix D.

Table 2-6: Transmission system station development to facilitate the connection of future generation

Generator	Planned connection method	Location
Castlereagh battery storage	New Castlereagh Battery Storage station, connected into Castlereagh 110 kV station	Northern Ireland
Kells battery storage	New Kells Battery energy storage station, connected into Kells 110 kV station	Northern Ireland
Kells cluster	Future Kells 110/33 kV cluster substation is planned to be tail-connected into Kells 275/110 kV switching station at 110 kV	Northern Ireland
Ardderoo wind farm	New Buffy 110 kV station, connected into Knockranny 110 kV station	Ireland
Aghada bess 02	New Aghada battery energy storage station, connected into Aghada 220 kV station	Ireland
Ballinknockane solar park	New Ballinknockane 110 kV station, connected into the existing Aughinish – Kilpaddoge 110 kV circuit	Ireland
Banemore solar farm	New Banemore solar farm, connected into the existing Clahane 110 kV station	Ireland
Blackwater Bog solar 1	New Blackwater Bog Solar farm, connected into Shannonbridge 220/110 kV station	Ireland
Blundlestown solar park	New Blundelstown 110 kV station, connected into the existing Corduff – Mullingar 110 kV circuit	Ireland
Croaghonagh wind farm	New Croaghonagh 110 kV station, connected into Clogher 110 kV station	Ireland
Carrigdangan wind farm (formerly Barnadivane)	New Carrigdangan 110 kV station, connected into Dunmanway 110 kV station	Ireland
Cloghan wind farm	New Cloghan windfarm, connected into the existing Derrycarne 110 kV substation east of Cloghan	Ireland
Drombeg solar park	New Drombeg 110 kV station, connected into the existing Kilpaddoge – Tralee 110 kV circuit	Ireland
Gallanstown solar park	New Gallanstown 110 kV station, connected into the existing Corduff – Platin 110 kV circuit	Ireland

Table 2-6: Transmission system station development to facilitate the connection of future generation

Generator	Planned connection method	Location
Harristown solar park	New Harristown 110 kV station, connected into the existing Kinnegad – Dunfirth/Rinawade 110 kV circuit	Ireland
Lumcloon energy storage	New Derrycarney 110 kV station, connected into the existing Portlaoise – Dallow/Shannonbridge 110 kV circuit	Ireland
Monatooreen solar park	New Monatooreen 110 kV station, connected into Knockraha 220/110 kV station	Ireland
Oriel wind farm	New Oriel 220 kV station, connected into the existing Louth – Woodland 220 kV circuit	Ireland
Oweninny wind farm 3	New Oweninny windfarm 3, connected into existing Bellacorick 110 kV substation	Ireland
Rosspile solar park	New Rosspile 110 kV station, connected into the existing Great Island – Wexford 110 kV circuit	Ireland
Shantallow solar park	New Shantallow 110 kV station, connected into the existing Cashla-Shannonbridge/Somerset 110 kV circuit	Ireland
Timahoe North solar park	New Timahoe North 110 kV station, connected into the existing Derryiron – Maynooth 110 kV circuit	Ireland
Tullabeg solar park	New Tullabeg 110 kV station, connected into the existing Banoge – Crane 110 kV circuit	Ireland

2.9 Connection of new interface stations

Transmission interface stations are the points of connection between the transmission system and the distribution system or large energy users connecting directly to the transmission system.

The planned new interface stations, for the period covered by this statement, are listed in Table 2-7. These stations are included in the network models according to their expected connection date. Details of the connections and dates are given in Section B.2, Appendix B. At present, there are emerging needs for additional transformer capacity at transmission interface stations in the Dublin area to accommodate forecasted growth of electricity demand due to large energy users, electrification of heat and transport and growth in commercial connections on the distribution network. The summary of these emerging needs at Transmission interface stations are captured in the 'Shaping Our Electricity Future v1.0 – a roadmap to achieve our renewable ambition' document.

Table 2-7: Planned transmission interface stations

Station	Nearest main town or load centre	County
Airport Road 110 kV station	Belfast	Down
Aungierstown 110 kV station	Transmission connected demand	Kildare
Ballyragget 110 kV station	Ballyragget	Kilkenny
Barnageeragh 110 kV station	Transmission connected demand	Dublin
Baroda 110 kV station	Newbridge	Kildare
Bracklone 110 kV station	Portarlington	Laois
Kellystown 220 kV station	Transmission connected demand	Kildare
New 110 kV station near Kilbarry	Cork	Cork

2.10 Detailed transmission network information

Appendix A includes geographical maps and network schematic diagrams of the existing and planned all-island transmission system.

The maps and schematic diagrams show snapshots of the all-island transmission system at January 2022 and the planned transmission system expected by the end of 2031. The diagrams indicate stations, circuits, transformers, generation, reactive devices and phase shifting transformers.

The electrical characteristics and capacity ratings of the existing and planned transmission system are included in Appendix B. Characteristics of existing and planned overhead lines, underground cables, transformers and reactive compensation devices are provided.

3. Demand

This chapter provides information on the all-island, Ireland and Northern Ireland demand forecasts.

3.1 Introduction to demand forecast data

The forecasts are taken from the All-Island Generation Capacity Statement 2022–2031 (GCS) which was published by EirGrid and SONI in October 2022. GCS 2022 contains forecasts of future energy consumption and demand levels between 2022 and 2031. This chapter also describes the anticipated large demand increase in the Dublin area. This potential demand increase is associated primarily with the connection of new large energy users such as data centres. The impact of these data centres on the future all-island demand forecast is also discussed.

3.2 Transmission demand forecast

Table 3-1 presents the median all-island, Ireland and Northern Ireland, Winter Peak demand forecast over the period 2022–2031, as published in the GCS. It is difficult to accurately predict a peak demand figure for a particular year in the future. This is due to several factors that can cause fluctuations in the forecast. These factors include weather conditions, economic activity, electricity usage patterns, and government policy.

The annual peak demand figures listed in Table 3-1 are expected to occur during winter of each year. In Ireland and Northern Ireland, the Winter Peak demand usually occurs between 17:00 and 18:00 on a weekday evening in the month of December.

The median demand forecast represents an average annual increase in all-island Winter Peak demand of 2.06% over the period of 2022–2031[12]. This represents an increase in demand forecast relative to GCS 2021–2030, when the forecast average annual increase in all-island Winter Peak demand was 1.7%[13].

Table 3-1: All-island, Ireland and Northern Ireland median peak demand forecast

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Northern Ireland (GW)	1.62	1.64	1.66	1.68	1.70	1.75	1.77	1.79	1.81	1.83	1.86
Ireland (GW)	5.53	5.73	5.99	6.25	6.40	6.45	6.57	6.68	6.78	6.87	6.94
All-island (GW)	**7.15**	**7.34**	**7.62**	**7.90**	**8.07**	**8.16**	**8.30**	**8.43**	**8.56**	**8.67**	**8.77**

12 The cumulative forecast in demand over the period of GCS 2022–2031 is 22.7%.
13 The cumulative forecast increase in demand over the period of GCS 2021–2030 was 16.5%.

As well as Winter Peak forecasts, we also develop Summer Peak and Summer Valley forecasts for Ireland and Northern Ireland, and Autumn Peak forecasts for Northern Ireland.

The Summer Peak demand refers to the average peak demand levels that are forecast to occur during the summer period of each year. The Ireland and Northern Ireland Summer Peaks are combined to produce an all-island Summer Peak.

The overall transmission system power flows are usually lower in summer than in winter. However, this may not be the case for flows on all circuits. The capacity of overhead lines is lower during the summer period because of higher ambient temperatures. Network maintenance is also usually carried out during the summer/autumn period. Both factors can restrict the network, reducing its capability to transport power.

The annual minimum expected demand is referred to as the Summer Valley. It represents the lowest annual demand that is forecasted and is expected to occur during the summer of each year.

The Ireland and Northern Ireland Summer Valley demands are combined to produce an all-island Summer Valley demand. The Summer Valley cases examine the impact of the combination of low demand and low levels of conventional generation on the transmission system.

This minimum condition is of particular interest when assessing the capability of the transmission system to connect new generation. This is because with local demand at a minimum, the connecting generator will export more of its power across the transmission system. The Summer Peak and Summer Valley demands occur between March and August. The Autumn Peak demand refers to the peak demand value expected in September and October.

Summer Peak, Summer Valley and Autumn Peak demand forecasts can be expressed in terms of percentage of Winter Peak demand. These are shown in Table 3-2.

These figures are consistent with historical demand data.

Table 3-2: Ireland and Northern Ireland seasonal demand forecast as a percentage of winter peak demand

Season	Ireland seasonal demand forecast as a percentage of winter peak (%)	Northern Ireland seasonal demand forecast as a percentage of winter peak (%)
Winter Peak	100	100
Autumn Peak	N/A	87
Summer Peak	80	79
Summer Valley	35	29

3.2.1 Dublin area demand

Background

Over the past few years, the number of connections and requests to connect to the transmission network in the Dublin area has increased. This document includes information on both current demand connections and future demand opportunities at the freeze date of January 2022.
Our assessment of demand opportunities is presented in Chapter 8 and includes sections focused on the Dublin area and data centres.

The level of enquiries in the Dublin area is principally driven by the need for Information, Communications and Technology (ICT) industries, electrification of heat and transport and high-tech manufacturing companies to connect to a high-quality power supply in the Dublin area.

New interface points that connects the Transmission System and Distribution System, also called Bulk Supply Points (BSP) are being planned. The justification for the new BSPs in Dublin is to supply the projected electricity demand growth in this area, including increasing demand related to residential, commercial and electrification of the heat and transport sectors.

A summary of the Bulk Supply Points that are being planned is as follows:

- New North County Dublin Bulk Supply Point Station and associated new grid connection;
- New Dublin Central Bulk Supply Point Station and associated new grid connection; and
- New West County Dublin Bulk Supply Point Station and associated new grid connection.

Data centres

As of 1st January 2022, there are five (5) data centres connected to the Transmission System with a total power demand of 406.5 MVA. Contracts are in place for a total of 1648.10 MVA of data centre connections. There continues to be ongoing enquiries regarding further large demand connections in the Dublin region.

Impact on the system demand forecast

The potential connection of data centre demand on the scale discussed represents significant demand growth. This is having an impact on the all-island system demand forecast and generation capacity adequacy. Generation adequacy is assessed and discussed in the GCS.

The focus of the majority of the connection enquiries have been in the greater Dublin area. Depending on the number and scale of projects that materialise, new transmission solutions will be required to strengthen the grid to facilitate these connections. These transmission solutions are under investigation and could vary from short lead-time to longer lead-time developments. EirGrid has clarified that the greater Dublin area is a constrained region for the purpose of processing of data centre connections. The impact of these Dublin demand connections are described in greater detail in Chapter 8, Section 8.3.

SONI is preparing a connection offer for a data centre in the North West which is expected to connect at Coolkeeragh 110 kV. If this offer is accepted, this might have an impact on the generation and demand opportunities in the North West.

What is a data centre?

A data centre is a facility used to house computer systems and associated components, such as telecommunications and storage systems. They underpin the operations of companies in the broad ICT sector, particularly those in social media and cloud computing. The size of the individual electricity demand connections depends on the scale of the business operation. These have varied from 20 MW with some possibly extending to 250 MW in the final stages of development. Their use of electricity tends to be constant throughout the year. The modern world increasingly requires the retention and use of vast volumes of data, so this trend is likely to continue for the foreseeable future.

3.3 Demand data

Electricity usage follows some generally accepted patterns. For example, annual peak demand occurs between 17:00–19:00 hrs on winter weekday evenings. Minimum usage usually occurs during summer weekend night-time hours.

3.3.1 Generated peak demand profiles

Figure 3-1 shows the generated peak demand profiles of Ireland and Northern Ireland on the day of the 2021. The individual peaks for Ireland and Northern Ireland did not occur on the same day. Peak demand for Ireland occurred on 8th December 2021, while peak demand occurred in Northern Ireland on 6th January 2021.

3.3.2 All-island demand profiles

Figure 3-2 shows the profiles of the 2021 all-island Winter Peak, Summer Peak and Summer Valley. The percentage demand attributable to each jurisdiction during the peak and valley scenarios is also shown.

Minimum demand is normally seen during the summer. The demand reported here is that which was seen at the transmission system Bulk Supply Points (BSP), which does not count the effect of small scale generation such as rooftop solar panels. These are not metered in the same way as larger sources of generation and serve to reduce the demand observed rather than increasing the generation.

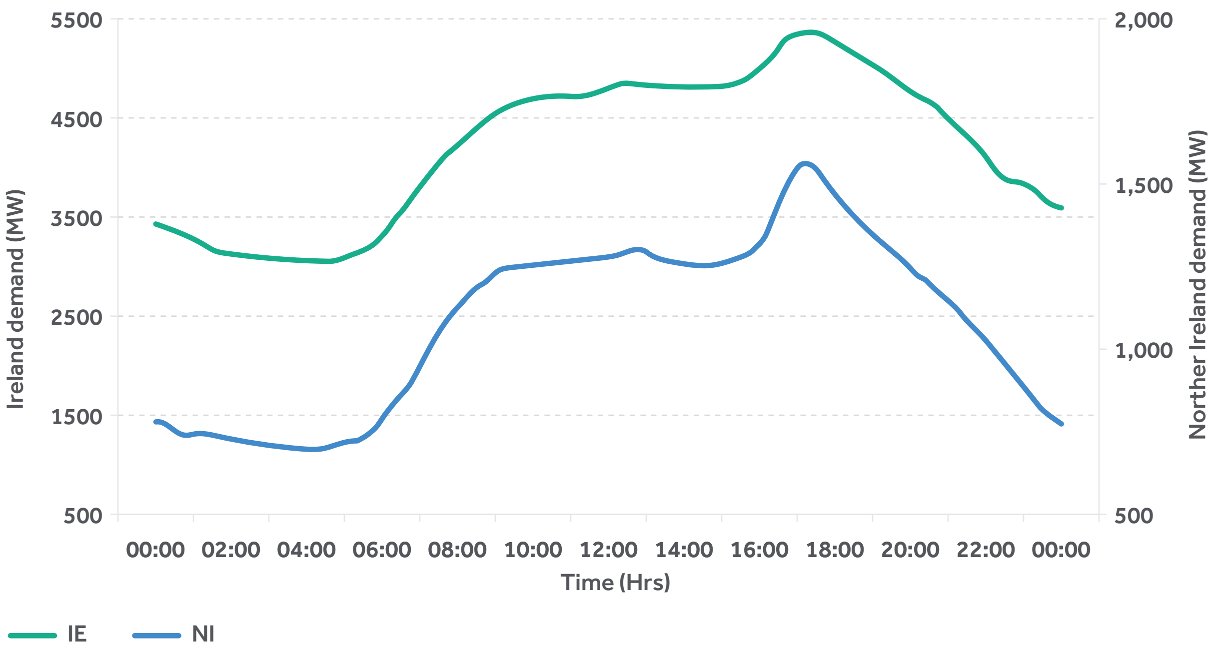


Figure 3-1: Generated peak demand profiles for 2021

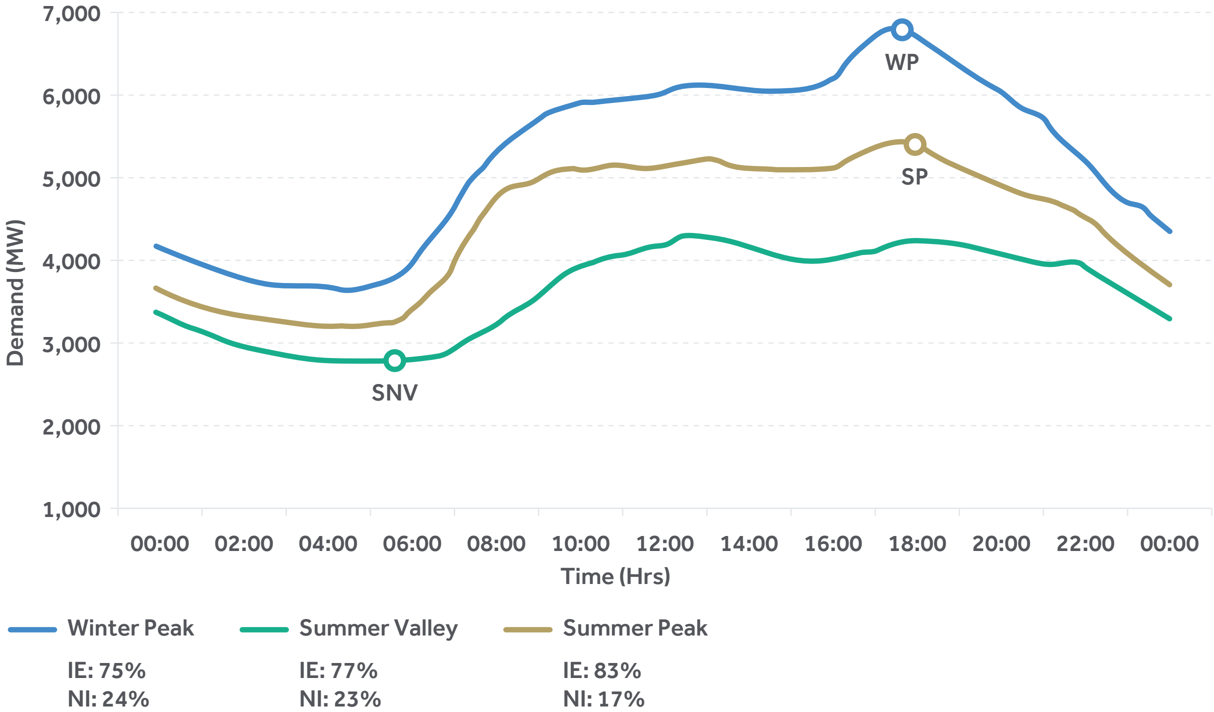


Figure 3-2: All-island Winter Peak, Summer Peak, and Summer Valley demand profiles

Table 3-3: Ireland and Northern Ireland peak and minimum demand, 2021

2021	Ireland		Northern Ireland	
	Date and time	Demand (MW)	Date and time	Demand (MW)
Winter Peak	08/12/2021 17:30	5,366	06/01/2021 17:15	1,561
Summer Peak	20/05/2021 17:30	4,285	03/03/2021 17:30	1,352
Minimum demand	08/08/2021 04:15	2,277	31/10/2021 03:30	443

3.3.3 All-island weekly demand peaks

Figure 3-3 shows the profile for the Ireland, Northern Ireland and All-island weekly peaks during 2021.

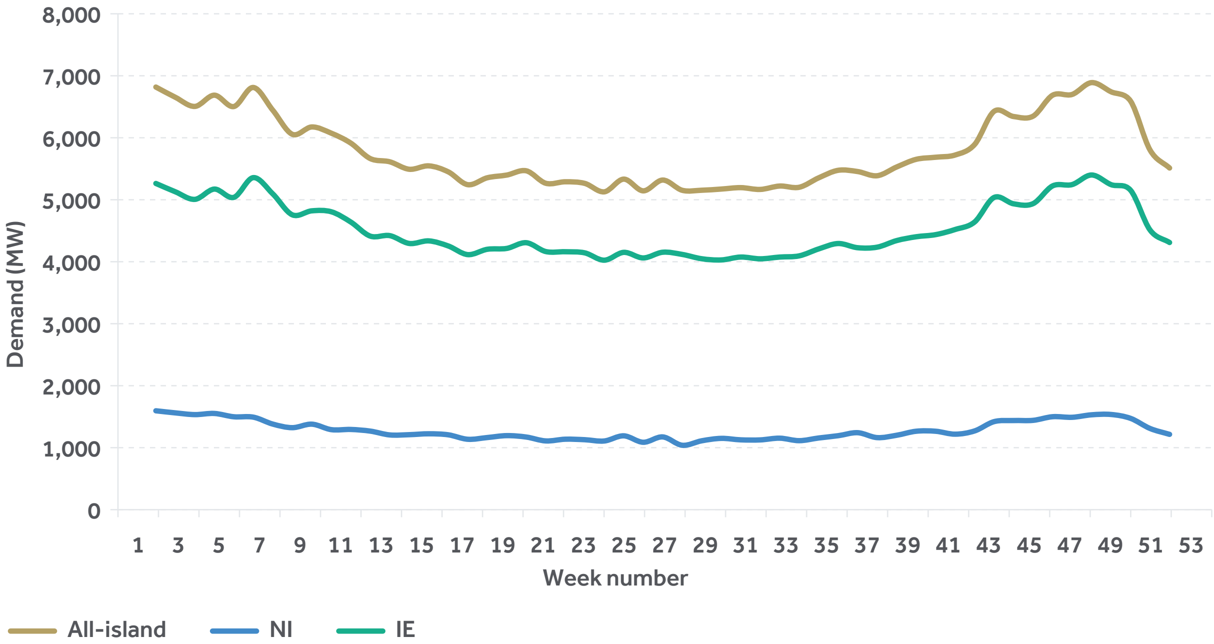


Figure 3-3: Weekly demand peak values for year 2021

3.3.4 Load duration curves

Figure 3-4 show the Ireland and Northern Ireland 2021 load duration curves, respectively. The curves show the percentage of time in the year that a particular demand value was exceeded. For example, demand exceeded 3500 MW in Ireland for 50% of the time. Demand in Northern Ireland exceeded 750 MW for 67% of the year.

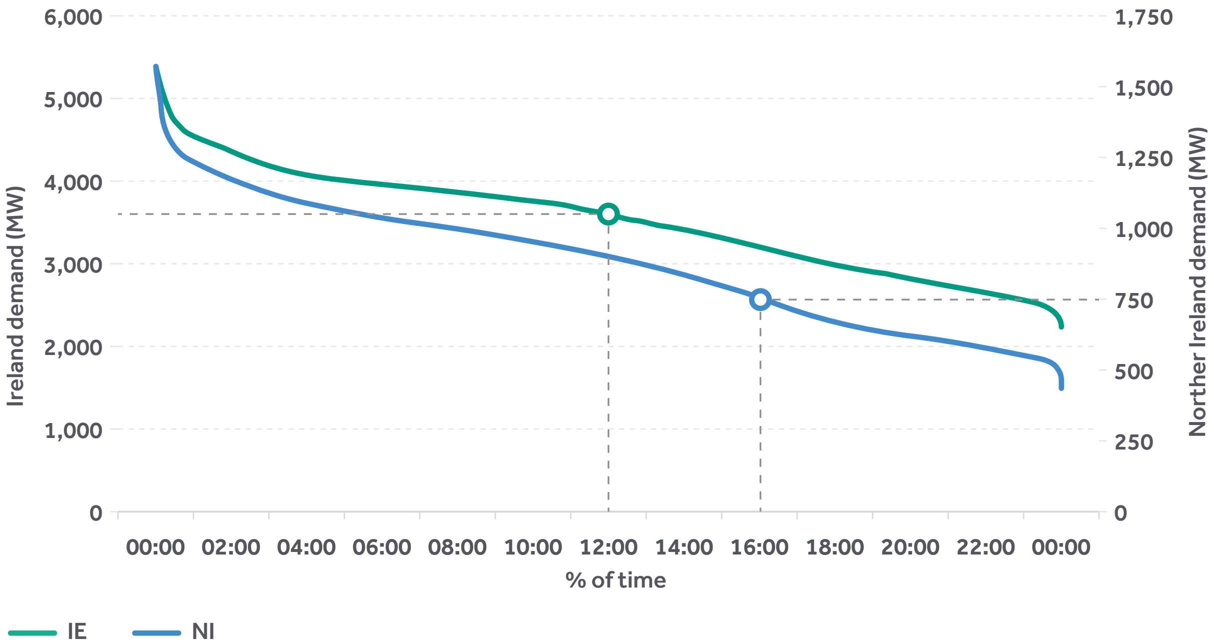


Figure 3-4: Load duration curves for Ireland and Northern Ireland

3.4 Forecast of electrical demand at transmission interface stations in Ireland

Transmission interface stations are the points of connection to the transmission system. These interfaces include:

- Connections between the transmission and the distribution systems; and
- Customers connected directly to the transmission system at 220 kV or 110 kV.

The interfaces are mostly 110 kV stations. In Dublin city, where the Distribution System Operator (DSO) operates the 110 kV network, the interface is usually at 220 kV stations. The Transmission System Operator (TSO) and the DSO work collaboratively to ensure that the needs of transmission and distribution connected customers are met through planning the development of these transmission interface stations.

Appendix C lists forecast demands at each transmission interface station. The forecast demands are given for Winter Peak, Summer Peak and Summer Valley for all years from 2022–2031. Demand projections at individual transmission stations are developed from the system demand forecasts on a top-down basis.

This approach takes the overall demand forecast and breaks it down – using transmission system information, including historical data – to gain better knowledge of the sub-components of the demand forecast.

The forecasting process includes regular monitoring and review of consumption trends in all parts of the country. The allocation of the system demand forecast to each station is pro-rata. This is based on an up-to-date measurement of actual peak demand at each station. Account is taken of planned transfers of demand between stations, as agreed with the DSO (ESB Networks). In this way, changes in the location of electricity consumption are captured. This process provides a station demand forecast and by extension a regional demand forecast for the short to medium term.

The system-wide demand forecasts, presented in Table 3-1, include transmission losses whereas the individual station demand forecasts do not. Transmission losses therefore account for the difference between system-wide demand and the sum of the demand at each interface station. The demand at each interface is given in Appendix C.

Demand forecasts in Appendix C include the small number of directly connected customers. The values in Appendix C were the best estimates of requirements at the data freeze date and do not reflect contractual status or the level of firm capacity that may be available in the network. In some cases, the estimates may be less than contracted maximum import capacity (MIC) values. These values are chosen to give a better projection of expected demand on a system-wide basis. When analysing the capacity for new demand in a particular area, the MIC values of local directly connected and contracted customers are used. It is important to note that some contracted MIC is non-firm and subject to flexible demand arrangements.

A demand-side unit (DSU) consists of one or more demand sites that can be instructed by EirGrid and SONI to reduce electricity demand. DSUs are usually medium to large industrial premises. A DSU uses a combination of on-site generation or plant shutdown to deliver a demand reduction. Providing this dispatch availability means that the DSU is eligible for capacity payments in the Single Electricity Market (SEM).

It is noted that DSUs may reduce some customers' demands from time to time over Winter Peak hours. However, normal demand levels are included in the Winter Peak demand forecasts shown in Table C-1 in Appendix C. Normal demand levels are also used in the power flow tables in Appendix H. These normal demand levels are used since they are more indicative of general power flows.

It is identified that there are emerging needs for additional transformer capacity at transmission interface stations in the Dublin area to accommodate forecasted growth of electricity demand due to large energy users, electrification of heat and transport and growth in commercial connections in the distribution network.

3.5 Forecast demand at Northern Ireland bulk supply points (BSP)

The 110/33 kV BSP demand forecasts are provided by NIE Networks, the DSO in Northern Ireland. These forecasts are based on demand trends at an individual nodal level and adjusted to align with system average cold spell (ACS) forecasts. ACS analysis produces a peak demand which would have occurred had conditions been averagely cold for the time of year. This ACS adjustment to each Winter Peak seeks to remove any sudden changes caused by extremely cold or unusually mild weather conditions. Consideration is also given to future block load transfers from one BSP to another. Tables and information relating to demand forecasts are contained in Appendix C.

4. Generation

This chapter gives information about existing generation capacity. This chapter also defines future projections for the next ten years from 2022 to 2031.

All generation capacity and dispatch figures given in this statement are expressed in exported or net terms. This is the generation unit output less the unit's own auxiliary load.

In December 2022, the Irish Government launched its Climate Action Plan 2023. The revised plan reflects increased ambitions for the decarbonisation of Ireland's economy, including a revised target of renewable sources (RES-E). Among the most important measures in the CAP 2023 is to increase the proportion of renewable electricity to 80% by 2030 and a target of 9 GW from onshore wind, 8 GW from solar, and at least 5 GW of offshore wind energy plus 2 GW for green hydrogen production. In order to meet this target, investment will be needed in new renewable generation capacity, system service infrastructure and electricity networks.

In Northern Ireland, the United Kingdom's Committee on Climate Change advised that it is necessary, feasible and cost-effective for the UK to set a target of net zero Green House Gas (GHG) emissions by 2050. The new Climate Change Act (Northern Ireland) 2022 (legislation.gov.uk) came into effect on 08 June 2022 The revised legally binding target towards net zero emissions covers all sectors of the economy. This update to the Order demonstrates the UK's commitment to targeting a challenging ambition in line with the requirements of the Paris Agreement on climate change.

Energy Policy is a devolved matter for Northern Ireland, and the DfE has worked with stakeholders, including SONI and developed the Energy Strategy for Northern Ireland. This strategy was published in December 2021. The Energy Strategy sets out a goal of at least 70% of electricity consumed to come from renewable sources by 2030. It sets out a pathway for energy to 2030 that will mobilise the skills, technologies and behaviours needed to take us towards our vision of net zero carbon and affordable energy by 2050. Subsequent Energy Strategy Action Plans were published in 2022 and 2023.

The new Climate Change Act (Northern Ireland) 2022 sets a new target of 80% of electricity consumption to come from renewable energy sources by 2030. The Climate Change Act mandates the publication of a Climate Action Plan for Northern Ireland by the end of 2023, which would include the carbon budget targets.

The Department for the Economy is currently consulting on the Draft Offshore Renewable Energy Action Plan, which contains the ambition to deliver 1 GW of offshore wind from 2030.[14] The Department is also consulting on the design considerations for a Renewable Electricity Support Scheme for Northern Ireland.[15]

A freeze date for data was applied when compiling this TYTFS. A freeze date enables transmission system analyses to be carried out for inclusion in the document. The data freeze date for TYTFS 2022 is January 2022.

14 https://consultations.nidirect.gov.uk/dfe/consultation-on-the-draft-oreap/
15 https://www.economy-ni.gov.uk/consultations/design-considerations-renewable-electricity-support-scheme-northern-ireland

4.1 Generation in Ireland

At the data freeze date 11,494 MW of generation capacity was installed in Ireland, as detailed in Table 4-1.

Table 4-1: Installed generation capacity in Ireland

Transmission system connected (MW)	Distribution system connected (MW)	Total generation capacity (MW)
8,969[16]	2,525	11,494

4.1.1 Existing and planned transmission connected generation

Table 4-2 lists planned generators that have signed transmission connection agreements in place not yet connected, along with their expected energisation dates if available, at the data freeze date. It should be noted that this position might have changed somewhat since the data freeze date.

Table 4-2: Contracted transmission generation at data freeze date

Generator	Generation type	Generation capacity (MW)	Expected energisation date
Ardderoo (formerly Buffy)	Wind	91.20	2022
Aghada BESS 02	Battery	159	2022
Ballinknockane	Solar	50	2023
Banemore SOLAR farm	Solar	34	2023
Blackwater Bog solar 1	Solar	65	Date unavailable
Blundlestown	Solar	60	2022
Cloghan	Wind	34	2024
Cloncreen WIND farm	Wind	100	2025 & beyond
Clonfad Solar	Solar	100	2023
Croaghonagh[17]	Wind	138.10	2023
Cushaling wind farm	Wind	50	2024
Drehid	Wind	60	2024

16 Please note this figure does not include the East West Interconnector.
17 Formed by the merger of Carrickaduff and Carrickalangan wind farms.

Table 4-2: Contracted transmission generation at data freeze date

Generator	Generation type	Generation capacity (MW)	Expected energisation date
Drombeg	Solar	50	2022/23
Drumlins Park	Wind	48.80	Date unavailable
Erkina	Solar	66.6	Data unavailable
Firlough	Wind	48.30	2022/23
Gallanstown	Solar	119	2022
Gaskinstown	Solar	85	2023
Gillinstown	Solar	95	2023
Glen solar	Solar	40	2024
Harristown	Solar	42.3	2023
Knocknamona (Prev. Crohaun)	Wind	34	2023 (as per DOC)
Lenalea	Wind	30.5	2025 & beyond
Lisheen 3	Wind	28.8	2023
Loughteague solar park	Solar	55	2025 & beyond
Lysaghtstown solar park	Solar	87	2024
Moanvane wind farm	Wind	60	2024
Monatooreen	Solar	25.7	2023
Mully Graffy wind farm (Kilgorman)	Wind	29.9	2023
Oriel (1)	Wind	210	2025 & beyond
Oweninny 3	Wind	50	2023
Pinewoods wind farm	Wind	49.5	2025 & beyond
Poolbeg energy storage	Battery	75	2022
Poolbeg flexgen	OCGT	70	2022
Porterstown battery storage facility	Battery	30	2022
Rathnaskilloge	Solar	95	Date unavailable
Rosspile solar farm	Solar	95	2022/23

Table 4-2: Contracted transmission generation at data freeze date

Generator	Generation type	Generation capacity (MW)	Expected energisation date
Shannonbridge B	Battery	63.2	2022
Shantallow	Solar	35	2023
SouthWall BESS	Battery	30	2022
Timahoe North	Solar	70	2023
Tullabeg solar park	Solar	50	2023
Yellow River wind farm	Wind	110.2	Date unavailable

4.1.2 Planned closure of generation plant

The closure of a generation plant could have a significant impact on the ability of the transmission system to comply with standards. The EirGrid Grid Code specifies the minimum length of notice a generator must give the TSO before retirement or divestiture. The closure of a generator with capacity less than or equal to 50 MW requires at least 24 months' notice. Generators with larger capacity than this must give at least 36 months' notice.

Some older generators will come to the end of their lifetimes over the next ten years. Some generators are also assumed to close as they don't comply with the carbon limits imposed by the Clean Energy Package. These generators are noted in the All-Island Generation Capacity Statement 2022–2031 (GCS) and are listed in Table 4-3. In line with this, On 29 September 2021, the CRU published a Programme of Actions to increase generation capacity to provide additional stability and resilience to the Irish energy system for the next four or five years. Under the published Programme of Work, the CRU, in conjunction with EirGrid and the DECC, developed several Key Actions to be delivered by this group. Potential capacity shortfalls will continue to be assessed, and action plans will be further developed and updated as necessary to maintain the security of the electricity supply.

Table 4-3: Closure of conventional generation

Generator	Generation capacity (MW)	Expected to close by end of year
Aghada (AT1)	90	2023
Tarbert 1, 2, 3, 4	590	2023
Moneypoint 1,2,3	820	2025

4.1.3 Wind and solar generation

Over the past two decades, wind power generation in Ireland has increased significantly. The level of wind generation in Ireland is expected to continue to grow over the period of this TYTFS.

While there is currently no grid scale solar generation connected, solar connections are expected to increase significantly over the course of this TYTFS. The information presented in Figure 4-1 is a combination of connected and contracted wind and solar generation as of data freeze date[18].

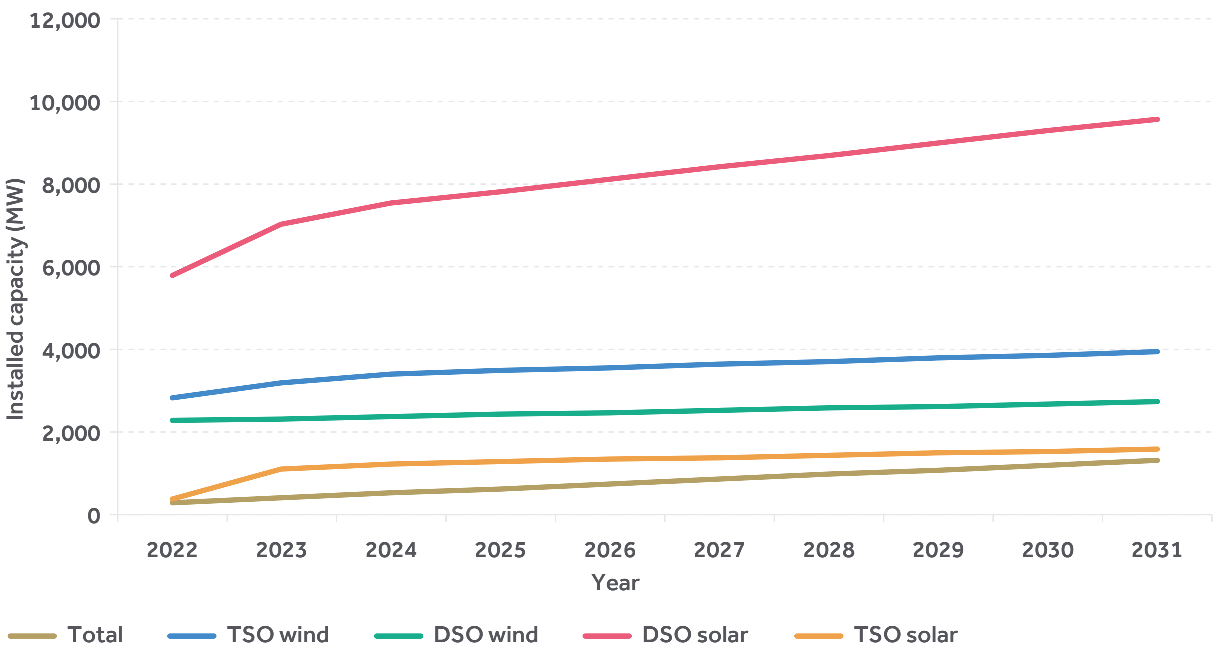


Figure 4-1: Connected and contracted wind and solar capacity, 2022 to 2031

18 Detailed information on these figures is presented in Tables D-2 and D-3 in Appendix D.

Table 4-4 shows the existing and committed wind and solar generation capacity totals expected to be connected by the end of each year[19]. These generators have signed connection agreements and are committed to connecting to either the transmission or distribution system over the next few years.

Generators with no estimated connection dates were assumed to connect at a steady rate from 2022 onwards.

Table 4-4: Existing and committed wind and solar capacity totals (MW)

Connection	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Wind (transmission)	2,841	3,198	3,402	3,480	3,558	3,636	3,714	3,792	3,870	3,948
Wind (distribution)	2,269	2,320	2,371	2,422	2,473	2,524	2,575	2,626	2,677	2,728
Solar (transmission)	379	1,111	1,238	1,288	1,338	1,388	1,438	1,488	1,538	1,588
Solar (distribution)	296	409	522	635	748	861	974	1,087	1,200	1,313
Total	**5,785**	**7,038**	**7,533**	**7,825**	**8,117**	**8,409**	**8,701**	**8,993**	**9,285**	**9,577**

4.1.4 Offshore generation

In December 2022, the Irish Government launched the Climate Action Plan 2023 which includes an action to develop Designated Maritime Area Plans (DMAPs)for Offshore Renewable Energy (ORE) following the Offshore Renewable Energy Development Plan II (OREDP II)

The Climate Action Plan 2023 increases the targets for renewable electricity to up to 80% by 2030 and a target of 9 GW from onshore wind, 8 GW from solar, and at least 5 GW of offshore wind energy by 2030.

In order to meet the Climate Action Plan target, investment will be needed in new renewable generation capacity. Offshore wind will be a significant part of the renewable generation mix in the future. Currently there is one 25 MW offshore wind farm in Ireland. The Climate Action Plan outlines that at least 5 GW of offshore wind will be connected to the grid by 2030. As connection agreements are put in place to meet this level of capacity, we will include them in future TYTFS analyses.

4.1.5 Demand side units

In 2022, demand side units (DSUs) in Ireland had a combined dispatchable capacity of 604 MW.

19 The individual wind farm details are included in Tables D-2 and D-3 of Appendix D.

4.1.6 Distribution-connected generation

Table 4-5 details the existing distribution-connected generation capacity by generation type. This generation plant comprises of small conventional and renewable units. Conventional units include CHP schemes and small industrial thermal units.

Renewable generation consists of:

- Wind;
- Small Hydro;
- Land-fill gas (LFG);
- Biogas; and
- Biomass.

Table 4-5: Existing distribution-connected generation in ireland at data freeze date

	Wind[20]	Small hydro	Biomass/ LFG	CHP	Diesel	Solar	Total
Net capacity (MW)	2,269	27	88	125	18	<5	2,456

Distribution-connected generators reduce the demand supplied through Transmission Interface Stations. Forecasts of demand levels at individual Transmission Interface Stations are presented in Appendix C. These forecasts take account of the contribution of the existing non-wind distribution-connected generators[21].

20 Table D-3 in Appendix D provides details of the existing distribution-connected wind farms and their capacities.
21 Because of the variability of wind, a fixed contribution from distribution-connected wind farms is not taken into account in the calculation of the peak transmission flow forecasts. Rather a number of wind scenarios are considered in the TYTFS analyses.

4.2 Generation in Northern Ireland

At the data freeze date 3,677 MW of generation capacity was installed in Northern Ireland, as detailed in Table 4-6.

The 2,247 MW connected to the transmission system consists of:

- Conventional generation,
- Battery Storage;
- Brockaghboy Wind Farm; and
- Slieve Kirk Wind Farm.

Table 4-6: Northern Ireland installed generation capacity

Transmission system connected (MW)	Distribution system connected (MW)	Total generation capacity (MW)
2,051[22]	1,626	3,677

4.2.1 Existing and planned transmission connected generation

Existing conventional generation

In Northern Ireland, conventional thermal generation plant was split into two contractual categories:

- Plant contracted to Power NI Energy Limited via their Power Procurement Business (PPB) (Contracted Plant); and
- Independent Market Participants (IMP) (Non-Contracted Plant).

The PPB contracts will expire in September 2023. More up to date information on the existing conventional Generation are presented in the Generation Capacity Statement 2022 to 2031.

Planned conventional generation

It should be noted that SONI is assuming timely delivery of new capacities at Kilroot KGT6 and KGT7 that were successful in the 2023/24 & 2024/25 T-4 capacity auctions from the beginning of 2024. On March 2022, SONI received an application from EPKL, seeking a connection offer from SONI to connect a steam turbine ('ST2') with MEC of 300 MW as part of a Combined Cycle Gas Turbine scheme at Kilroot Power Station. This capacity will be included in the next version of the TYTFS.

4.2.2 Planned closure of generation plant

Kilroot ST1 and ST2 did not qualify for inclusion in the T-4 2023/24 auction in April 2020 and the developer subsequently issued a Closure Notice for ST1 and ST2 confirming its intention to close both units on 30th September 2023. The units each have HFO rating of 238 MW, however the station has been declared unavailable for HFO operation for significant periods during 2021 and 2022. Hence these generators were not considered in this analysis.

22 Please note this figure does not include the Moyle Interconnector capacity.

4.2.3 Northern Ireland renewable generation

Existing/Approved Renewable Generation

Existing and approved renewable generation in NI is shown geographically in Figure 4-2. The totals are derived from locational and capacity information on:

- Large scale renewable generation schemes that are connected to the Northern Ireland network;
- Small scale renewable generation schemes with installed capacity at each Bulk Supply Point (BSP) greater than 0.5 MW;
- Large scale schemes that are currently in construction; and
- Schemes approved by the planning service.

The map indicates points at which renewable generation is connected to or is assumed to connect to. These points include 110/33 kV Bulk Supply Points and 110/33 kV Cluster substations[23].

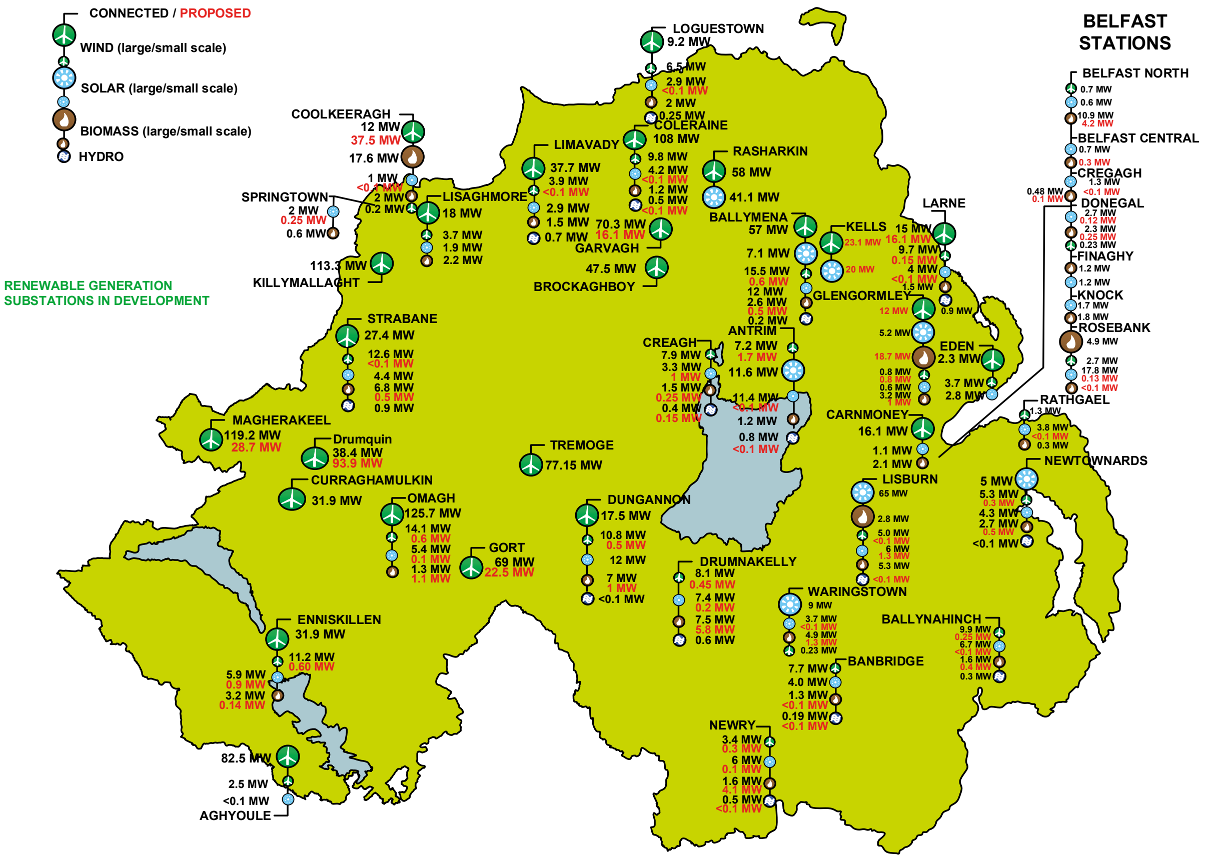


Figure 4-2: Existing and committed Northern Ireland renewable generation

23 A Cluster substation is a 110/33 kV substation in the vicinity of a number of wind farms. It acts as a local hub to group or 'cluster' the wind farms. The wind farms are connected by short individual 33 kV lines to the Cluster substation. Cluster substations already exist at Magherakeel, Tremoge, Gort, Rasharkin and Curraghmulkin, with a further two planned at Agivey and Kells (see Chapter 2). SONI is responsible for the delivery of the transmission elements of the Cluster substation, in line with the criteria set out in 'Statement of Charges for Connection to the Northern Ireland Electricity Networks' Distribution System': https://www.nienetworks.co.uk/statementofcharges

Figure 4-3 shows the expected change in wind and solar generation in Northern Ireland. Only committed generators are included.

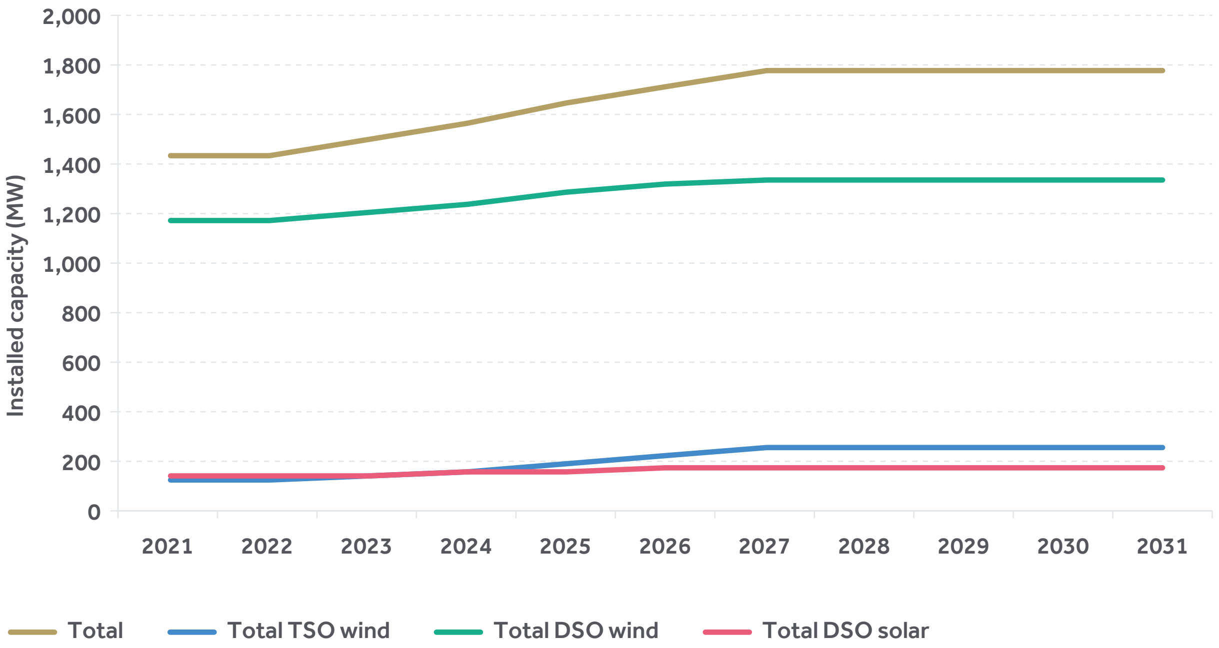


Figure 4-3: Connected and contracted wind and solar capacity in Northern Ireland, 2022 to 2031

Table 4-7 shows the existing and committed wind and solar generation capacity totals expected to be connected by the end of each year[24].

These wind and solar farms have signed connection agreements and are committed to connecting to either the transmission or distribution system over the next few years.

Table 4-7: Existing and committed wind and solar capacity totals (MW)

Connection	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Wind (transmission)	121	145	167	192	221	253	253	253	253	253
Wind (distribution)	1,177	1,212	1,249	1,286	1,318	1,346	1,346	1,346	1,346	1,346
Solar (distribution)	144	151	159	167	175	183	183	183	183	183
Total	1,442	1,509	1,574	1,645	1,714	1,784	1,784	1,784	1,784	1,784

24 The individual wind farm details are included in Tables D-2 and D-3 of Appendix D.

Offshore renewable generation

Our assumptions regarding the level and location of offshore renewable generation connected to the NI transmission system are based on best information available at the data freeze date.

For the purpose of this TYTFS analyses we assumed that there will not be any offshore renewable generation connected as at present there are no connection agreements in place. We will continue to monitor the progress with a view to incorporating offshore renewable generation if available in future TYTFS analyses.

4.2.4 Demand side units

In 2022, demand side units (DSUs) in Northern Ireland had a combined dispatchable capacity of 143 MW.

4.2.5 Distribution-connected generation

Existing distribution-connected generation

Table 4-8 shows a breakdown of the existing Northern Ireland distribution-connected generation. In Northern Ireland there are more small Scale Generation compared to Ireland.

Table 4-8: Northern Ireland distribution-connected generation

Generation	Net capacity (MW)
Large scale wind	1,146
Small scale wind	174
Large scale biomass	36
Small scale biomass, CHP and landfill gas	90
Large scale solar	152
Small scale solar	214
Small scale hydro	7
Large scale landfill gas	3
CHP	15
AGU	79
Total	**1,626**

There is a total of 79 MW of Aggregated Generating Units (AGUs) in Northern Ireland registered in the SEM by three parties. Two of these AGUs, iPower and EmPower, consist of mostly distribution connected diesel generator sets located around Northern Ireland. The third, ContourGlobal, consists of CHP gas generation. These units currently participate in the SEM.

There is currently 6 MW of small-scale hydro generation installed on the waterways of Northern Ireland. This is a mature technology. Due to the lack of suitable new locations, limited increase in the small-scale hydro is expected in the foreseeable future.

5. Transmission system performance

This chapter describes the future performance of the transmission system in terms of compliance with planning standards in the respective jurisdictions. System performance levels are assessed using forecast power flows and short circuit levels.

The power flow and short circuit analyses results presented in this document are based on updated information such as changes to transmission infrastructure, new demand projections and new generation connections, with a data freeze date of January 2022.

5.1 Forecast power flows

The power flows on the all-island transmission system, at any given time, depend on a number of factors, such as:

- The transmission system configuration;
- The level of demand; and
- The power output from each generator.

There are many possible combinations of generator dispatches that can meet the demand requirements. There are also many demand scenarios that may occur on the transmission system.

When examining transmission system performance a range of economic generation dispatches are considered. The generation dispatches used in our power flow analysis are prepared on an all-island basis. Power flows across the existing 275 kV and planned 400 kV internal[25] interconnectors are modelled to operate within transfer limits. The dispatch scenarios also consider imports and exports of power across the existing and planned interconnectors which are considered for this year's TYTFS analyses.

Transmission system power flows are described in Appendix H. The power flow tables show the flow of real power on the transmission system under normal conditions.

The level of renewable generation increases over the ten-year period under study. As renewable generation increases, power flows from the West of the island to the East can be seen to increase. This is because renewable power generated in the Western regions is supplying the larger demand levels in the East (Belfast and Dublin). These increased power flows are more significant at times of minimum demand and high renewable generation output.

Another effect that can be seen in Appendix H is the effect of increased renewable generation levels on reactive power requirements on the transmission system. At high levels of renewable generation, reactive power support is needed to keep voltages within planning standard limits.

25 Internal to the all-island transmission system. These are the interconnectors between Ireland and Northern Ireland. This type of interconnector is also known as a tie line.

5.2 Compliance with planning standards

The transmission system is planned and operated to technical requirements and standards in Ireland and Northern Ireland. These requirements are laid out in the Transmission System Security and Planning Standards (TSSPS) documents. These standards are in line with best international practice.

The standards are deterministic, meaning they set out an objective standard which delivers an acceptable compromise between the cost of development and service delivered. Rather than conducting subjective benefit analysis in each case, it is preferable to plan to meet an objective standard and carry out analysis of the options available to meet the standard.

The need for transmission system development is identified when the simulation of future conditions indicates that the TSSPS would be breached.

5.2.1 Ireland

EirGrid's view of future transmission needs and our plan to develop the Irish network through specific projects to meet these needs over the next ten years is presented in our Transmission Development Plan (TDP). The TDP presents the projects which are currently being advanced to solve the needs of the transmission network. In addition, future needs that drive future potential projects are also discussed in the TDP.

It is possible that changes will occur in the need for, scope, and timing of the developments in the TDP. Similarly, it is likely, given the continuously changing nature of electricity requirements, that new developments will emerge that could impact the plan as presented. The long-term development of the network is under review on an on-going basis.

TYTFS 2022 includes transmission system development projects that have received capital approval.

5.2.2 Northern Ireland

The Northern Ireland transmission projects included in TYTFS 2022 are based on the Transmission Development Plan Northern Ireland (TDPNI). Capital projects are mainly driven by increases in Northern Ireland demand levels and renewable generation connections. Planned developments also include load related and asset replacement projects. These projects mainly impact on the rating of switchgear and circuits.

It is possible that changes will occur to the developments outlined in the TDPNI. Similarly, it is likely, given the continuously changing nature of electricity requirements, that new developments will emerge that could impact the plan as presented. The long-term development of the network is under review on an on-going basis.

TYTFS 2022 includes transmission system development projects that have received capital approval.

5.3 Short circuit current levels

Short circuit currents occur during a fault condition on the transmission system. Depending on the type of fault, these short circuit currents can be very high. All transmission system equipment must be capable of carrying these very high currents.

Protection devices, in particular circuit breakers, must be capable of closing onto high currents created by a fault on the transmission system. They must also be capable of interrupting high currents to isolate a fault. Correct operation is essential for minimising risk to personnel and preventing damage to transmission equipment. Correct operation of protection devices is also necessary for maintaining system stability, security and quality of supply.

Short circuit current levels must be considered as the transmission system is developed and as new generation or demand is connected. In Ireland the EirGrid Grid Code specifies short circuit current levels; these values are shown in Table 5-1. Users connecting to the transmission system are required to design their plant and apparatus to these specified levels. Equipment at lower voltage levels must also be designed to withstand short circuit current levels.

Table 5-1 also includes short circuit requirements for new users connecting to the Northern Ireland transmission system. Northern Ireland system users are recommended to design their plant and apparatus to withstand short circuit current levels set out in Table 5-1, as a minimum. The design of a user's plant is also subject to detailed short circuit current level assessment.

Table 5-1: Short circuit current levels

Voltage level (kV)	Short circuit current levels (kA)		
	Ireland		Northern Ireland
400	50		50
275	n/a		40
220	40		n/a
110	Countrywide	25	40
	Designated sites	31.5	

Changes to the transmission system or the addition of generation can increase the short circuit current levels at nearby[26] stations. Forecast increases in short circuit current levels can indicate transmission system equipment at risk of having its rating exceeded. Should this be the case, it may be necessary to replace this equipment with higher rated plant. Risk mitigation measures may also be implemented to reduce short circuit current levels. Short circuit current levels are calculated for all transmission system nodes in accordance with engineering recommendation G74. Engineering recommendation G74 is based on international standards.

The analysis was carried out for single and three phase faults in both winter peak and summer valley studies. Short circuit current levels were assessed for the years 2022, 2025 and 2028, and the results are presented in Section 5.3.1. A description of the calculation methods used are given in Appendix E. Appendix E also provides the results of the short circuit analysis alongside an explanation of the terms used in short circuit discussions in this document.

Winter peak analysis is carried out to represent the most onerous transmission system conditions, where maximum short circuit currents on the transmission system are most likely to occur. During winter peak analysis, generators that are not providing real or reactive power are switched on in the study and dispatched at zero MW.

This measure allows short circuit current contributions from all generator sources to be considered in the studies and ensures the most onerous, but credible conditions are used for the calculation of short circuit current levels at each bus.

Analysis of summer valley is carried out to indicate minimum short circuit currents on the transmission system based on intact network conditions. The minimum short circuit current at each bus is dependent on generation dispatch and transmission system conditions. Customers requiring the expected minimum short circuit current level at a particular bus are advised to contact us directly, as planned and forced outages will reduce the short circuit level further. During summer valley analysis, generators that were not dispatched were not connected to the system.

Both the maximum and minimum short circuit current level studies assume that the transmission system is in the normal intact condition. The economic generation dispatches for the winter peak and summer valley studies are presented in Appendix D.

The results presented in Section 5.3.1 are the total busbar short circuit current levels. Short circuit current that could flow through each individual circuit breaker may be less than the total busbar short circuit current. This is dependent on network configuration and conditions.

26 This means stations that are electrically nearby, which does not necessarily mean those geographically closest.

5.3.1 Assessment of short circuit current levels in Ireland

The transmission system in Ireland is designed and operated to maintain short circuit current levels below the levels in Table 5-1. In planning the system, a 10% margin is applied (for example 220 kV short circuit currents will be kept below 36 kA). This is done for security reasons.

As Table 5-1 indicates, while most 110 kV stations in Ireland are designated as 25 kA, the EirGrid Grid Code stipulates that certain 110 kV stations may be designated as 31.5 kA. A new station could be designated as 31.5 kA from the start, or an existing 25 kA station may be changed to 31.5 kA. When a station changes from 25 kA to 31.5 kA, the equipment at that station may need to be modified. Station equipment at lower voltages also needs to be replaced in order to comply with this design rating.

Short circuit current results are presented in Appendix E. The results for Ireland include X/R ratios, transient AC (Ik′) and subtransient AC (Ik′′) currents. These results provide an indication of the strength of the transmission system.

5.3.2 Assessment of short circuit current levels in Northern Ireland

The Northern Ireland transmission system is designed and operated to maintain short circuit current levels below equipment ratings. These ratings are listed in the tables in Appendix E, Section E.6.3. The individual substation ratings are based on the lowest rated equipment at each substation.

The Northern Ireland results in Appendix E include transmission substation ratings for:

- AC & DC X/R Ratios;
- Initial Short Circuit Current (I′′);
- Peak Make Current (ip); and
- RMS Break Current (IB).

The I′′ and ip values are used to assess the necessary rating of electrical equipment required to close onto short circuit currents. The IB values are used to assess the capability of electrical equipment required to open and break short circuit current.

5.3.3 Maximum Short circuit current results

Short circuit current results show that a number of Ireland and Northern Ireland transmission nodes have short circuit current levels with the potential to be close to or exceed acceptable levels. Careful management of these issues is needed to ensure short circuit currents remain within acceptable levels.

Figure 5-1 indicates the locations where short circuit current levels are high in 2028. In Ireland the short circuit current level results are represented as a percentage of the levels specified in the Grid Code which are outlined in Table 5-1.

In Northern Ireland, the short circuit level results are represented as a percentage of actual equipment ratings.

Three short circuit level ranges are represented in Figure 5-1:

- Yellow dots represent substations where short circuit current results are between 80% and 90% of the ratings;
- Orange dots represent substations where short circuit current results are between 90% and 100% of the ratings; and
- Red dots indicate substations where the short circuit current results exceed ratings.

There are a number of stations where short circuit current levels are anticipated to be above 80% of standard levels and these are indicated in Figure 5-1. We continue to monitor short circuit current levels at all stations and if required we will put mitigation plans and measures in place to ensure that they remain within safety standards. Mitigations include operational measures such as sectionalising parts of the network and investing in new equipment.

The short circuit ratings of Castlereagh, Kells, Magherafelt, Tandragee and Coolkeeragh 275 kV substations in Northern Ireland have been reduced to 10 kA following a review by NIE Networks of the design of concrete structures at these substations when applying design standards that have been issued since these structures were built. Under these modern standards, the mechanical force exerted on the structures during fault conditions limits these to a rating of 10 kA. However, this does not necessarily prevent any future development at or near these stations, and SONI and NIE Networks are reviewing the impact of all developments on a case by case basis.

SONI and NIE Networks are also bringing forward redevelopment projects at all five substations to address this issue.

Figure 5-1: Short circuit current levels for Winter Peak 2028

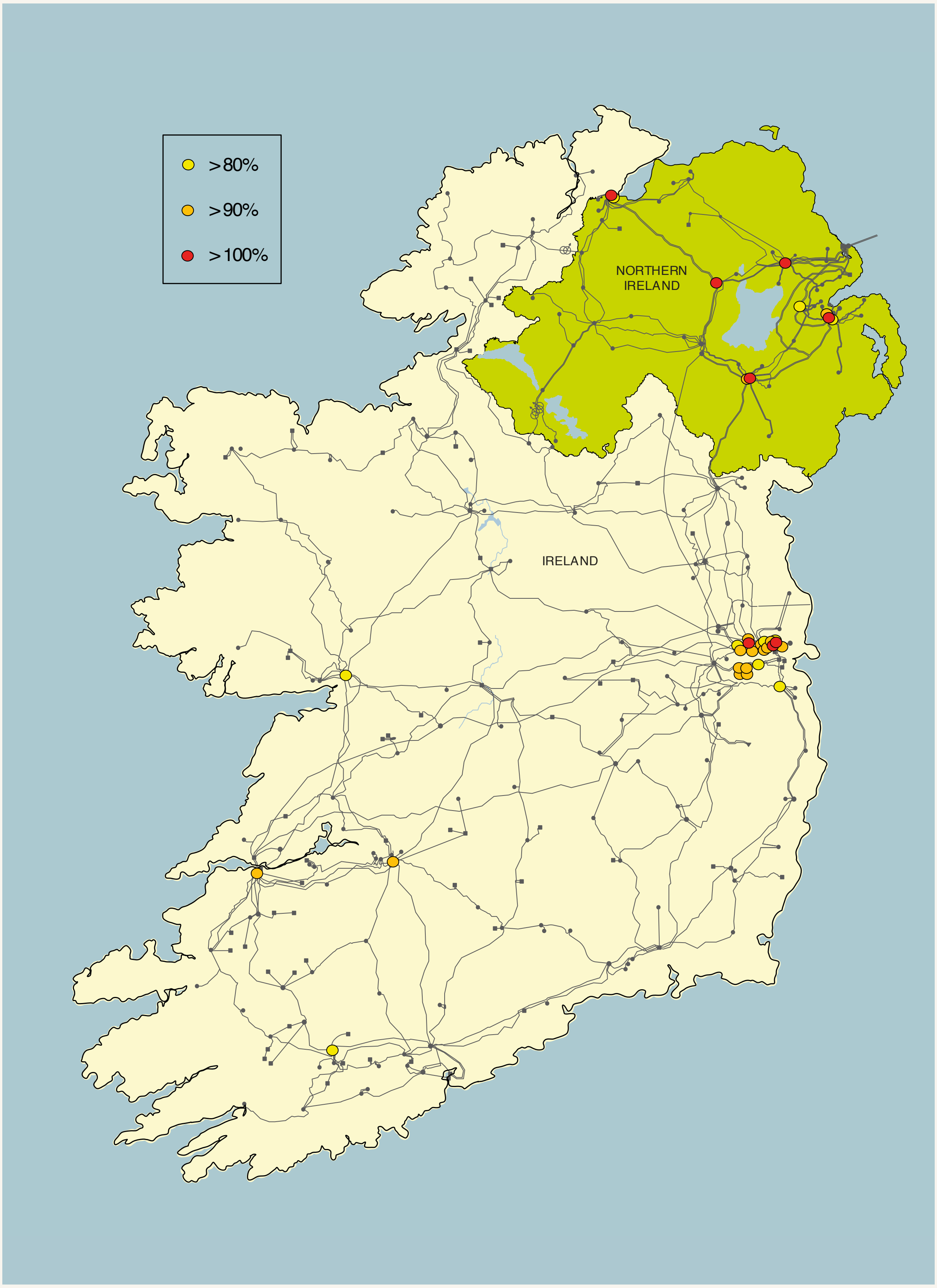


Table 5-2 below provides information on the transmission nodes for 2022; 2025; and 2028 where the short circuit current level is above 90% of the relevant level[27].

Table 5-2: Nodes approaching or exceeding short circuit current levels

Rating (%)	2022	2025	2028
>100	CAS 275 kV	CAS 275 kV	CAS 275 kV
	CPS 275 kV	CPS 275 kV	CPS 275 kV
	KEL 275 kV	KEL 275 kV	KEL 275 kV
	MAG 275 kV	MAG 275 kV	MAG 275 kV
	TAN 275 kV	TAN 275 kV	TAN 275 kV
	BPS 110 kV	CDU 110 kV	CDU 110 kV
		DTN 110 kV	KLM 110 kV
		DRN 110 kV	NBY 110 kV
		FIN (I) 110 kV	
		KLN 110 kV	
		KLM 110 kV	
		KRA 110 kV	
		NBY 110 kV	

27 In Ireland these results are presented as a percentage of the short circuit current levels specified in the Grid Code which are outlined in Table 5-1, with the exception of KLN/Killonan 110 kV which is presented as a percentage of actual equipment ratings. In Northern Ireland they are a percentage of actual equipment ratings. Please note the Northern Ireland results in 2022 and 2025 take account of planned switchgear upratings in deriving this percentage.

Table 5-2: Nodes approaching or exceeding short circuit current levels

Rating (%)	2022	2025	2028
>90	BLC 110 kV	FIN (I) 220 kV	CDU 220 kV
	CLA 110 kV	INC 220 kV	CRH 220 kV
	CLA 110 kV	BKY 110 kV	FIN (I) 220 kV
	FIN (I) 110 kV	CBT 110 kV	BKY 110 kV
	KBY 110 kV	CLA 110 kV	CBT 110 kV
	KLM 110 kV	CLG 110 kV	CLG 110 kV
	KRA 110 kV	COL 110 kV	CKG 110 kV
	KRA 110 kV	CRM 110 kV	CRM 110 kV
	STR (N) 110 kV	CRM 110 kV	CRM 110 kV
		GRA 110 kV	DRN 110 kV
		KUD 110 kV	KLN 110 kV
		MEN 110 kV	KUD 110 kV
		SBH 110 kV	KPG 110 kV
		TAN 110 kV	SBH 110 kV
			CRE 110 kV
			TAN 110 kV

5.3.4 Rating breaches

Transmission stations in Ireland where the rating has been breached

(i) killonan 110 kV (KLN 110 kV), Kilmore 110 kV (KLM 110 kV), Knockraha 110 kV (KRA 110 kV), Corduff (CDU 110 kV), Dardistown (DTN 110 kV), Darndale (DRN 110 kV), Finglas (FIN 110 kV), Newbury (NBY 110 kV)

Studies indicate that the short circuit current level at Killonan, Kilmore and Knockraha 110 kV station has the potential to exceed 100% of the existing substation ratings.

The existing Killonan 110 kV substation is being refurbished to a 220 kV and 110 kV GIS station. The existing AIS station will be decommissioned. This work is due to be completed in 2027.

The increase in short-circuit current levels at the stations Corduff, Dardistown, Darndale, Finglas and Newbury is due to more generation at Corduff.

In the interim, we will continue to monitor and manage the risk. We will be putting mitigation plans and measures in place to ensure that the short circuit current levels at these stations remain within safety standards.

Northern Ireland stations where the rating has been exceeded

(i) Castlereagh, Coolkeeragh, Kells, Magherafelt and Tandragee 275 kV

The short circuit rating of these stations have been reduced to 10 kA following a review by NIE Networks of the design of concrete structures at these substations when applying design standards that have been issued since these structures were built. Under these modern standards, the mechanical force exerted on the structures during fault conditions limits these to a rating of 10 kA. However, this does not necessarily prevent any future development at or near these stations, and SONI and NIE Networks are reviewing the impact of all developments on a case by case basis.

SONI and NIE Networks are also bringing forward redevelopment projects at all five substations to address this issue.

(ii) Ballylumford 110 kV
Short circuit current level at the Ballylumford 110 kV node exceed the existing substation ratings. This occurs under maximum generation conditions when both of the 275/110 kV interbus transformers are in service.

The existing substation is programmed to be replaced with a substation incorporating a new 110 kV GIS switchboard. As the replacement of this new 110 kV GIS double busbar and the 110 kV circuits diverted accordingly, the need for a higher shot-circuit rating will be met and the short-circuit current levels could be expected to decrease due to flexibility in configuring the connection of the bays in the station. This work is planned to be completed by 2023 as per the data freeze date. In the interim, we manage this risk by operating with one interbus transformer out of service. This reduces the short circuit current level below the equipment rating.

5.3.5 Minimum short circuit current results

The minimum short circuit current results are presented in Appendix E. These results indicate minimum short circuit currents on the transmission system based on intact network conditions. These results are representative of the assumed generation dispatch and transmission system conditions.

Any parties requiring the expected minimum short circuit current level at a particular bus are advised to contact us directly.

The Moyle Interconnector has a minimum operating requirement of 1,500 MVA. This is equivalent to a short circuit current level of 3.15 kA. Below this short circuit current level the high voltage direct current (HVDC) interconnector fails to commutate. However, as shown in Appendix E, this is not an issue over the period covered by this TYTFS.

6. Transmission system capability

This chapter describes the analysis carried out to determine the capability of the transmission system to accommodate additional demand and generation.

6.1 Introduction

The results of these studies provide the basis for the statements of opportunity discussed in Chapter 7 and Chapter 8. The ability of the system to accommodate new generation and new demand varies throughout the year. As system planners, EirGrid and SONI must ensure that the Transmission System Planning Standards are not breached under reasonable contingencies when the system is most stressed.

6.2 All-island demand opportunity analysis

The all-island demand opportunity analysis is carried out for a single year, 2027. This year gives developers a useful indication as to the demand opportunities that exist in the medium-term on the transmission system. Studies are carried out for the summer period and the winter period of 2027/2028.

In Northern Ireland the demand opportunity analysis provides an indication of capability of the backbone[28] transmission network to accommodate additional demand. In Ireland, the locations analysed for new demand have been carefully chosen based on feedback from industry sources to align with areas that are of interest to customers seeking connection to the transmission system.

The results of these studies are dependent on generation and demand assumptions, and completion dates of transmission system development projects. Factors that may influence the results are discussed in Section 6.4.

28 The backbone transmission system connects local area networks together, enabling the efficient bulk transfer of electricity around the country and beyond.

6.2.1 Approach to calculation of demand opportunities

The transmission system is planned to meet forecast demand levels at all stations in Ireland and Northern Ireland. The demand forecast for each 110 kV station is a proportion of the overall system demand forecast. This forecast is based on historical demand distributions. Future demand customers that have signed connection agreements are also included in station demand forecasts as presented in Chapter 3.

Additional demand connections above the forecast levels are not explicitly catered to in transmission system development plans. However, capacity for additional demand on the transmission system may exist in certain locations. For example, the addition of transmission system infrastructure generally provides a step increase in transmission system capacity. This addition may permit demand connections higher than forecast levels, as illustrated in Figure 6-1.

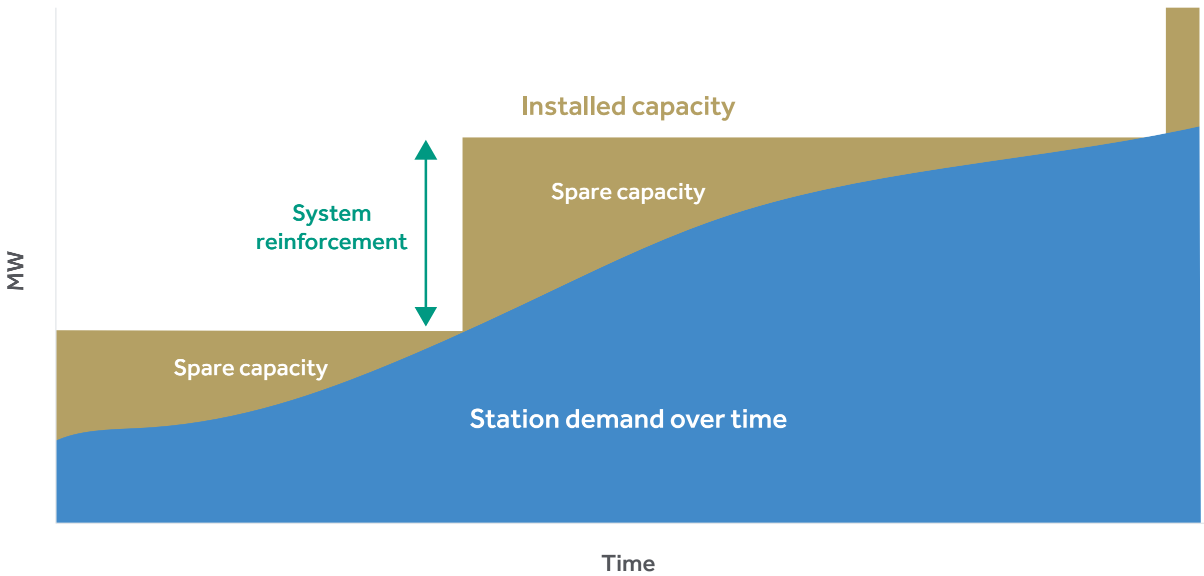


Figure 6-1: Illustration of typical step change in system capacity due to the addition of transmission system infrastructure

In Figure 6-1, the blue line represents the required MW capacity at a particular location on the transmission system. The red line represents the installed transmission system capacity. As Figure 6-1 shows, changes in installed capacity generally appear as a step increase following completion of a network reinforcement project.

In general, demand for electricity increases over time. Figure 6-2 below displays the typical demand growth profile of a typical station. The blue line represents the demand forecast at the station. The green arrows represent potential new step increases in demand that could potentially be accommodated at this typical station.

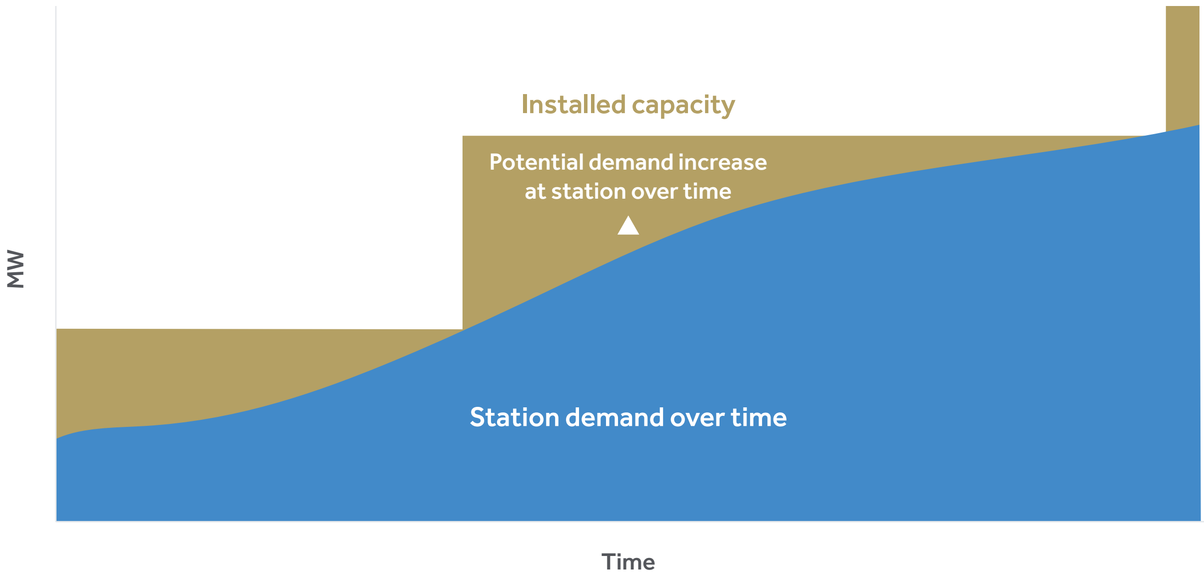


Figure 6-2: Forecast demand profile of a typical station and station potential to accommodate additional step increase in demand

The analysis examines the transmission system's capability to accept such increased demand above forecast levels. Capability to accept additional demand is examined at particular 110 kV, 220 kV and 275 kV stations. The stations analysed are distributed throughout Ireland and Northern Ireland, as shown in Figure 8-1 in Chapter 8.

The results of this analysis are useful in identifying opportunities for the connection of new or increased demand.

The opportunity value calculated is a measure of the transfer capability remaining in the physical transmission system. It provides an indication of the flexibility of the transmission system to accommodate future demand increases before additional reinforcements are required.

The transfer analysis is intended as a pre-feasibility indication of opportunity for increased demands. The method for determining capacity closely aligns with pre-feasibility study techniques.

In Ireland, the Ireland Transmission System Security and Planning Standards (TSSPS) are applied in the analyses of demand opportunities. The transmission system is assessed for the loss of any single item of plant (N-1). Unlike generators, demand stations are typically not dispatchable. It is therefore necessary to assess the transmission system performance against standards for maintenance-trip contingencies (N-1-1) in the analysis of increased demand in Ireland.

In Northern Ireland, the Northern Ireland Transmission System Security and Planning Standards (TSSPS) have been applied for analyses of demand opportunities. The transmission system is assessed for loss of any single item of transmission plant (N-1) and loss of a double circuit (N-DCT) all year round. During the summer season the Northern Ireland transmission system is also assessed for maintenance-trip (N-1-1) contingencies for specific cases.

Voltage analysis is performed as part of the demand capacity studies in both Ireland and Northern Ireland. This is because the addition of demand can act to depress system voltages.

6.2.2 Method for calculating limits for increased demand connections

Specialised power system software is used to screen critical contingencies for thermal overloads or voltage limitations.

A load flow is a numerical analysis of the flow of electricity in a power system based on fundamental physics and electrical characteristics of the system. Load flow analysis is used to calculate values such as voltage, current, and power flowing around the transmission system, given a defined generation dispatch and system demand level.

Power transfers are considered using dispatch scenarios typically experienced on the transmission system. While these dispatches are typical, we choose them for our analysis to stress the network in terms of power transfers.

By analysing different scenarios that stress the transmission system, we can reasonably try to ensure that the demand opportunities reported in our analysis will not breach our Transmission System Security and Planning Standards. The conventional units selected for each dispatch scenario align with market projections for the study year 2027.

Modelling details: single N-1 and double circuit (N-DC) contingency studies

- Generators are modelled with their maximum output equivalent to their Maximum Export Capacity (MEC); and
- Local wind generation is switched out in the vicinity of the test station.

Modelling details: maintenance trip studies (N-1-1)

- Generators are modelled with their maximum output equivalent to their Maximum Export Capacity (MEC); and
- Some centrally-dispatchable generation local to the test station is maximised to its MEC value.

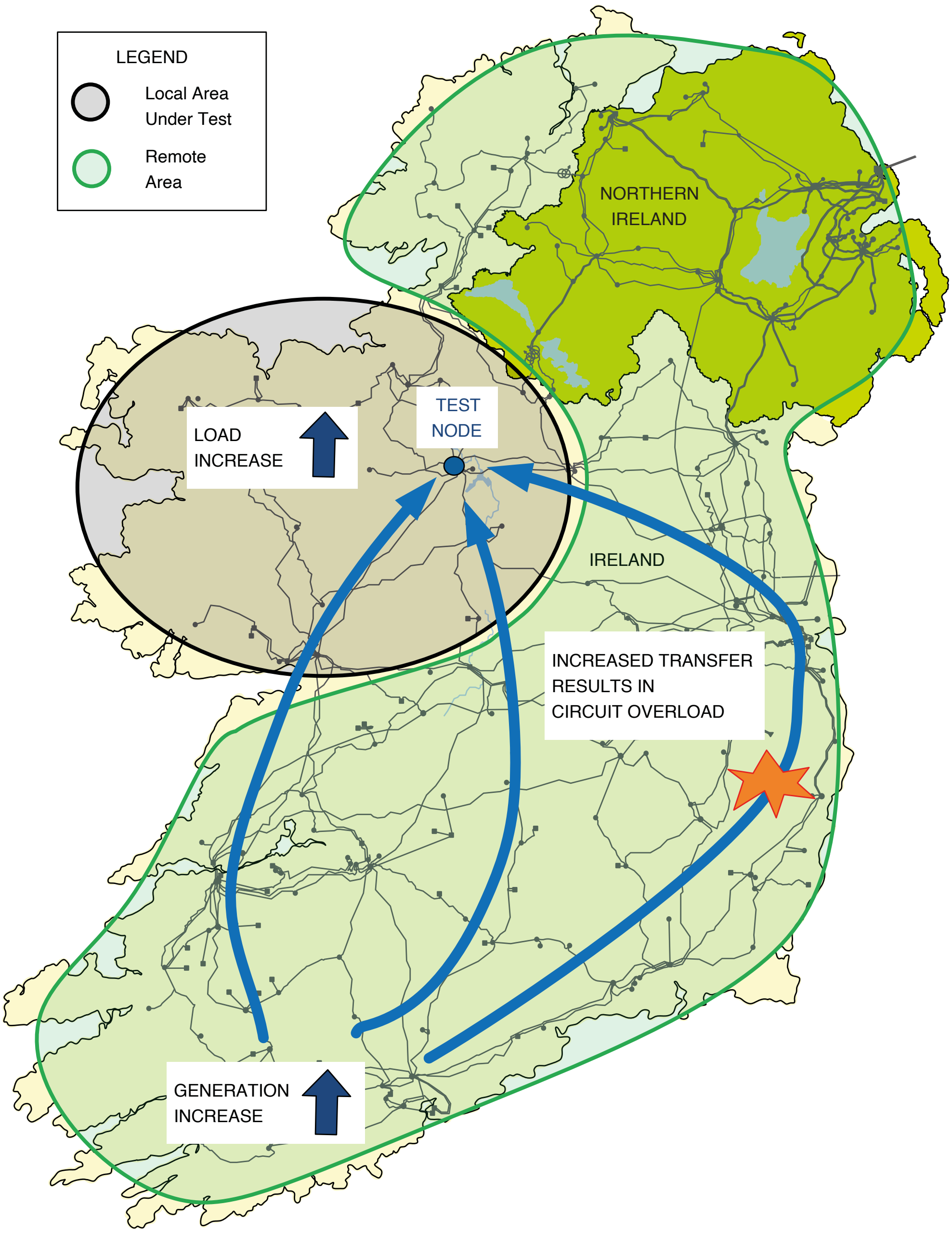


Fig `ure 6-3: Illustration of incremental transfer capability study method for assessing demand opportunities

To calculate the opportunity, demand at 0.95 power factor is added to a test station in increasing amounts. This is balanced by an increase in generation[29] outside the local test area. This is illustrated in Figure 6-3 above.

The limit for increased transfers to the test station is then established. This is achieved by checking the post-contingency performance of the transmission system against thermal and voltage standards. This process is carried out for each dispatch scenario studied. Issues on the transmission system are not considered limiting unless they are sensitive to the incremental transfers under examination.

Calculation of results

As noted above we undertake a range of contingency studies (N-1, N-1-1, N-DCT) to calculate the capability for increased demand at each station studied. For the maintenance-trip studies (N-1-1) in Ireland, less onerous generation dispatches can be scheduled to accommodate maintenance outages.

The results of this analysis are reported in Chapter 8. The demand opportunity reported is the lowest demand increase achieved from the range of studies undertaken. It is important to note that results of the demand opportunity analysis are indicative only. Demand opportunity is tested at each station on an individual basis. As such, the opportunities presented are not cumulative. If new demand connects in an area that is currently shown to have capacity, this will then use up some or all of the available capacity in that area.

Potential demand customers should not be discouraged by choosing a site in which there appears to be a lack of transmission system capacity. The actual transmission capacity can only be determined during the connection offer process. Early consultation is encouraged so that options can be explored relating to any potential proposals and enable timely decision making. Customers considering connecting demand to the transmission system are advised to contact us as early in the project as possible.

6.2.3 Calculation of Dublin demand capability

The Dublin region is the largest demand centre on the all-island transmission system. Dublin has been and remains the focus of continued interest for the connection of new large demand. There has been a significant increase in the number of enquiries and applications for new demand connections in the Dublin region and its environs in recent years. Many of these requests are for data centres. Data centres present relatively flat load profiles that impact on both the minimum and maximum demand requirements in the region.

The Dublin 220 kV transmission network is operated by EirGrid, the transmission system operator (TSO). The radial 110 kV circuits are operated by ESB Networks, the distribution system operator (DSO). System development and operation in the area requires both system operators to work closely together. This is to ensure power flows are optimised and to facilitate new connections.

29 Generation increased as per merit order.

Due to the volume of demand enquiries and applications received for the Dublin area, and their potential impact, Section 8.3 of this document focuses on the demand opportunities in the Dublin region.

The Dublin region has been divided into three geographic zones (see Figure 8-3 in Chapter 8), namely the North, West and South. This is aimed at providing a more detailed insight into the available connection capacity, considering the three main corridors servicing the main bulk supply-points.

The methodology used to consider demand opportunities in the Dublin region is based on the existing transmission system. It also includes criteria, such as how each zone is expected to develop, and the associated lead times for project delivery.

6.2.4 Calculation of demand capability in Northern Ireland and Ireland outside Dublin

This section provides a general example of the analysis of the capability of any station studied in Chapter 8 to accept additional new demand. The assessment is carried out by simulating the transmission system for summer peak and winter peak 2027. The station is tested to accommodate increased demand. The relevant demand forecasts and generator dispatches are used.

Due to its intermittency, wind generation cannot be relied on to be available to meet demand. Therefore, all wind generation in the vicinity of the test station is turned off. Studies are carried out according to the dispatch scenario assumed. The extra demand in each study is met by increasing generation according to the merit order. For each study in turn, a test demand (for example 100 MW) is added to the station under study. The power system is then simulated with the extra demand in place.

The analysis tests an exhaustive range of N-1 contingencies (individual circuit/transformer or generator outages) to identify any resultant TSSPS violations, thus identifying a capacity limit. Some contingencies cause violations of thermal overload or voltage standards when the full test demand is added. In these cases, the test demand is reduced to zero MW and the simulation is re-run with the demand increasing in 10 MW steps. The simulation runs until a violation of thermal overload or voltage standards occurs. The preceding step value is then the calculated capacity value.

In assessing opportunities for new demand, the TYTFS considers the capability of the transmission system only. The capability of the distribution system is not addressed in Ireland or Northern Ireland. The implications for generation adequacy of demand growth above the median forecast levels are dealt with separately in the All-Island Generation Capacity Statement 2022–2031 (GCS) which is available on the EirGrid and SONI websites.

6.3 All-island generation opportunity analysis

This section describes the generation opportunity analysis performed on the Ireland and Northern Ireland power systems. This analysis is used to determine the capability of the transmission system to accommodate additional generation connections at the defined areas. The statements of opportunity presented in Chapter 7 are a result of this generation opportunity analysis. The final year of this forecast statement, 2030, is used in the analysis. The analysis is performed using specialised load flow software, the same approach used in the demand opportunity analysis.

In Chapter 7, we also include information on the harmonised all-island Generation Transmission Use of System (TUoS) tariffs and Transmission Loss Adjustment Factor (TLAF) arrangements in the SEM. The all-island TUoS and TLAF arrangements have an objective to provide locational signals to generators that reflect the costs they impose on the transmission system. This information is provided to help generators make informed decisions when exploring potential transmission network connection locations.

All information relating to generation opportunity presented in Chapter 7 is indicative only. The actual transmission system capacity can only be determined during the connection offer process.

6.3.1 Calculation of generation opportunities

Generation opportunity at a node is assessed based on the premise that new generation at a particular point on the network will displace generation at a different point on the network.

All existing generation, and all generation planned to connect in Ireland and Northern Ireland during the period covered by the TYTFS, is considered for dispatch before assessing any further generation opportunity on the all-island transmission network.

We compiled a list of 110 kV, 220 kV, 275 kV and 400 kV nodes for generation opportunity analysis. These nodes are distributed across the all-island network so that potential users can understand how opportunities vary across the network.

When testing a node, existing generation in the area around the node is maximised. This group of generators is referred to as the source region. The remaining generation required to meet the demand is dispatched based on a merit order. Finally, the test generator is then dispatched.

As the output of the test generator increases, the output from other generation in a separate area of the network – the sink area – is reduced. This forces power flows along specific corridors of the transmission network.

For each incremental increase in new generation capacity at the test node, an AC load flow linear algorithm is used to test the network for compliance with the TSSPS. The generation opportunity is determined once overloads are detected on the network. For the generation opportunity analysis, single (N-1) and double circuit (N-DC) contingency studies only are considered. For each node assessed, three different analyses are performed. Figure 6-4 demonstrates an example of this approach.

For each scenario in the illustration, the purple area represents the source region where generation is maximised. The test generator is then increased, and generation in the orange area – the sink region – is reduced. The blue arrows represent the resulting power flows. These three scenarios are then repeated for the following network demand scenarios:

- Winter peak;
- Autumn peak (Northern Ireland only);
- Summer peak; and
- Summer valley.

The lowest result from all of the scenarios analysed is used to determine the capacity of the node under test. By analysing several scenarios across different demand scenarios that stress the transmission system, we can reasonably ensure that the generation opportunities reported in our analysis will not breach our Transmission System Security and Planning Standards.

It is important to note that results of the generation opportunity analysis are indicative only. The results of the analysis are not cumulative, as the capability of a node to accept new generation capacity is tested individually.

The transmission system is planned to meet forecast generation levels at all stations in Ireland and Northern Ireland. Additional generation connections above the forecast levels are not explicitly catered for in transmission system development plans. However, capacity for additional generation on the transmission system may exist at certain locations.

Because of the relative size of individual generators, changes in generation installations, whether new additions or closures, can have a more significant impact on power flows than demand. New generation capacity will inevitably alter the power flows across the network, which has the potential to create overload problems deep into the network. Problems deep into the network are resolved by network reinforcements known as deep reinforcements.

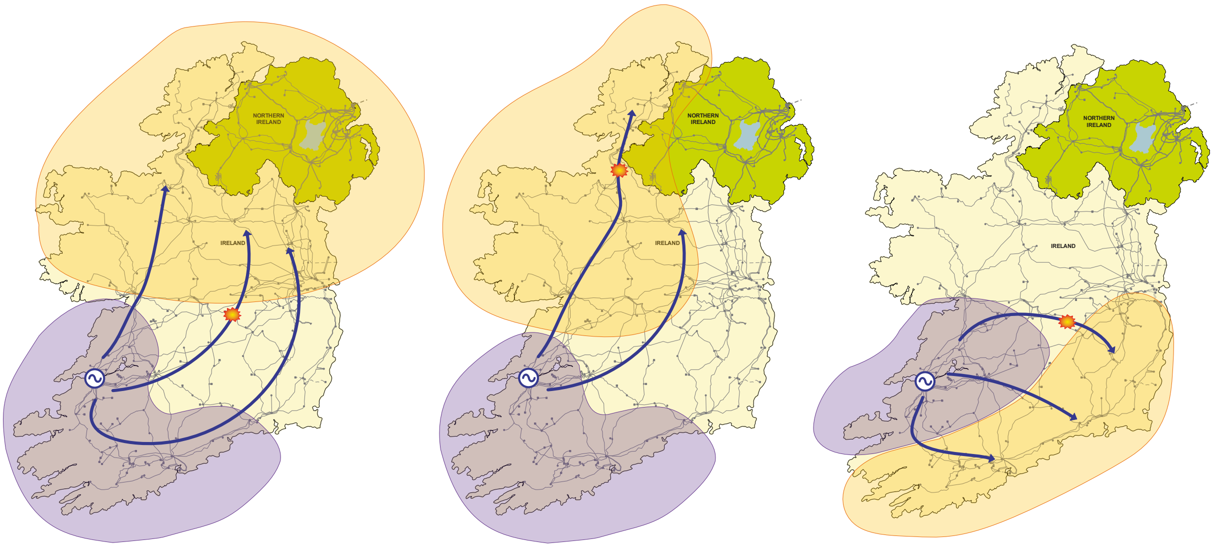


Figure 6-4: Illustration of incremental transfer capability study method for generation

The generation opportunity analysis presents the level of generation that can be accommodated on the planned transmission system without the need for deep reinforcements to allow full network access.

6.4 Interpreting the results

The results of the analyses[30] described in this chapter are based on a set of assumptions. These assumptions are associated with:

- Future demand growth;
- Generation connections; and
- Transmission system developments.

The key forecast factors on which the results depend are dynamic. Therefore, the reality that emerges will not exactly match the forecasts. Consequently, the results, while reasonably indicative, should not be interpreted as definitive projections.

The factors likely to have an impact on the outcomes include:

- The signing of a connection agreement by a new generator;
- Delays in connection of committed new generation stations;
- Closure of existing generation stations;
- Changes in the economy which give rise to changes in the overall demand for electricity;
- Changes in demand in a particular region or area, arising from new industry developments or closures;
- Delays in the provision of transmission system reinforcements; and
- Selection and construction of new transmission system reinforcement developments which may significantly increase transmission system capacity.

30 The results are presented in Chapter 7 and Chapter 8.

7. Transmission system capability for new generation

The results of the Generation opportunity analysis for this statement show that there are opportunities for new generation of in the east of the island, in particular in the east of Northern Ireland and in the North-East. Generation opportunities in other areas will rely on delivery of network reinforcements including those identified in Shaping Our Electricity Future v1.1 analysis. With significant quantities of renewable generation connected across the island, future generation connections in the North-West, West, and South regions would require network reinforcements.

7.1 Summary of analysis

The areas with the greatest opportunity for additional generation are at nodes on the 275 kV ring in Northern Ireland. Power system studies for Dublin region shows that, due to high short circuit levels, further capacity cannot be accommodated on the 110 kV or 220 kV networks but connections at 400 kV could be investigated through the Connection Offer Process. While an area may have capacity for new generation connections, it should be noted that development of substantial levels of generation in a concentrated area of the network could create a range of complex issues, in particular breaches of short circuit levels.

7.2 Background

In this chapter we provide the results of the detailed generation capacity opportunity analysis, of which the calculation methodology is described in Chapter 6.

The analysis considers the final year of this statement (2031) and details the opportunity for connecting further generation beyond the assumed installed generation portfolio. The results provide potential network users with an indication of the capacity of the all-island transmission system to accept new generation. It must be emphasised that this analysis is purely indicative. The actual transmission network capacity can only be determined during the connection offer process. This process requires detailed network assessments in order to determine the optimal connection arrangement that complies with the Transmission System Security and Planning Standards (TSSPS) in Ireland and Northern Ireland.

Changes to generation dispatch patterns and the geographical location of generation can have an impact on all-island transmission network power flows. As a result, Generator Transmission Use of System (GTUoS) tariffs and Transmission Loss Adjustment Factors (TLAFs) can change, resulting in an impact on the economics of power generation. Resulting regional changes in GTUoS and TLAFs are described to help participants make informed decisions when exploring potential transmission network connection locations.

It is important to note that generation opportunity studies in this TYTFS are based on contracted customer connections and approved transmission reinforcements at the data freeze date, therefore, differing from Shaping Our Electricity Future v1.0 which assumes generation connections in addition to those already contracted. Shaping Our Electricity Future v1.0 envisions that aggregated renewable generation capacities in 2030 exceed those assumed in the TYTFS. Future iterations of the TYTFS will take the outcome and progress of Shaping Our Electricity Future v1.0 and v1.1 into account, including new generation customer connections.

7.3 New generation capacity

The level of generation expected to connect to the all-island transmission system is described in detail in Chapter 4 of this statement.

The largest recent generation capacity increase has been wind generation. At the freeze date of January 2022 there was approximately 6400 MW connected to the all-island transmission system.

This generation is mainly connected in remote locations in the South-West, West and North-West of the island of Ireland. At times of high wind generation, this can result in very high power flows on transmission circuits supplying power to the large demand centres on the East coast of Ireland and Northern Ireland.

There is a relatively small amount of solar generation capacity connected to the all-island transmission system.

In contrast, there are several large conventional power stations due to retire, or to have restricted output, due to the EU Industrial Emissions Directive. These are detailed in All-Island Generation Capacity Statement 2022–2031 and are noted in Chapter 4 of this document. For the purpose of the TYTFS 2021 analysis, it is assumed that sufficient generation capacity will be delivered in appropriate locations to ensure that generation adequacy and security of supply are maintained.

It is important to note that we are currently working with CRU and the Department of the Environment, Climate and Communications (DECC) to address short to medium term generation adequacy concerns in Ireland. Current analysis and projections for Northern Ireland indicate there is sufficient capacity in the short to medium term to meet system needs. However, there are risks around low plant availability, plant run hour restrictions, delays to the North-South Interconnector which would impact the adequacy position in the short to medium term. The adequacy position for Northern Ireland is being monitored on an on-going basis.

7.4 Generation opportunity

7.4.1 Assessment of selected 220 kV, 275 kV and 400 kV stations

This section provides the opportunities for additional generation on the 220 kV, 275 kV and 400 kV networks in 2031. For these high voltage stations, new generation of up to 600 MW in size was considered for assessment. Figure 7-1 illustrates the stations selected across the all-island network, as well as their associated generation opportunity. It is important to note that the results are not cumulative, as the opportunity at each station is assessed individually. The capacities shown are relevant to the station tested, but also provide an indication of the opportunities available at neighbouring stations.

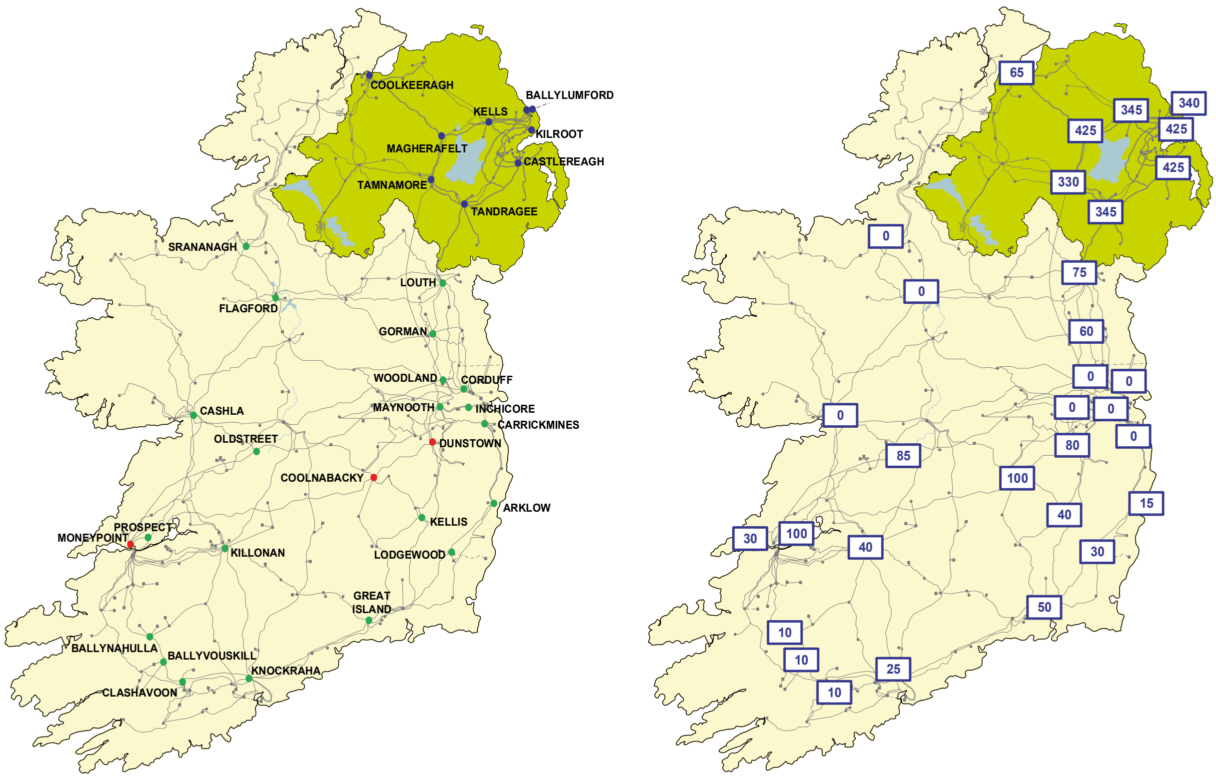


Figure 7-1: Generation opportunity at 220 kV, 275 kV and 400 kV stations in 2031

In general, there is very little opportunity for new generation in the North, West and South of Ireland, as well as the Dublin region. The transmission network in these areas has significant levels of connected and planned renewable generation. Moreover, the southern region contains efficient conventional gas generators and plans for further interconnection. In the East, and to a lesser extent South-Eastern and South-Western regions, there are opportunities for new generation connections near the large demand centres on the East Coast, and near the 400 kV corridors on the West Coast.

With the potential development of large data centres in the greater Dublin area, there will be increased demand and network constraint challenges to face. Therefore, new generation capacity remains tight as the rate of reinforcements is potentially insufficient to deliver new generation adequacy in the short to medium term. Grid reinforcements in urban areas such as Dublin require extensive public engagement and consent building. Whilst additional studies to the load flow studies indicated that, due to high short circuit levels, further capacity cannot be accommodated on the 110 kV or 220 kV networks, some opportunities for new generation projects in areas outside North Dublin exist. In the long term, connections at 400 kV networks could be investigated through the Connection Offer Process .Particularly Northern Dublin's transmission network is being monitored on an ongoing basis and one of the focus points for future transmission grid planning and the exploration of new technology in Dublin and beyond.

In Northern Ireland, there is currently very little opportunity for new generation in the North-West region, although this may change in future. This area has significant levels of renewable generation, both connected and planned, and the transmission network consists almost entirely of 110 kV circuits. There is capacity for new generation to be directly connected at Coolkeeragh, Magherafelt, Tandragee, Castlereagh and Kells 275 kV stations.

The fault contribution from non-synchronous connections such as wind farms and data centres tend to be significantly smaller, particularly those likely to connect at 110 kV. Any potential connection at these nodes would therefore be assessed based on its fault current contribution.

7.4.2 Assessment of selected 110 kV stations

Numerous 110 kV stations were analysed to complement the higher voltage stations analysed in Section 7.4.1. For these stations, new generation of up to 200 MW in size was considered in the assessment for all 110 kV nodes. Selected stations are displayed in Figure 7-2, and the associated generation opportunity for each of the stations is displayed in Figure 7-3.

As in the previous section, the results are not cumulative, as the opportunity at each station is assessed individually. The capacities shown are relevant to the station tested, but also provide an indication of the opportunities available at neighbouring stations.

The results show that there is little opportunity for generation connections at 110 kV. By 2031, there is a high level of renewable generation connected to both the transmission and distribution systems in Ireland.

The renewable connections are concentrated in the North-West, West and South-West. The installed capacities will exceed the demand in these areas, resulting in limited opportunities for new connections without additional reinforcements.

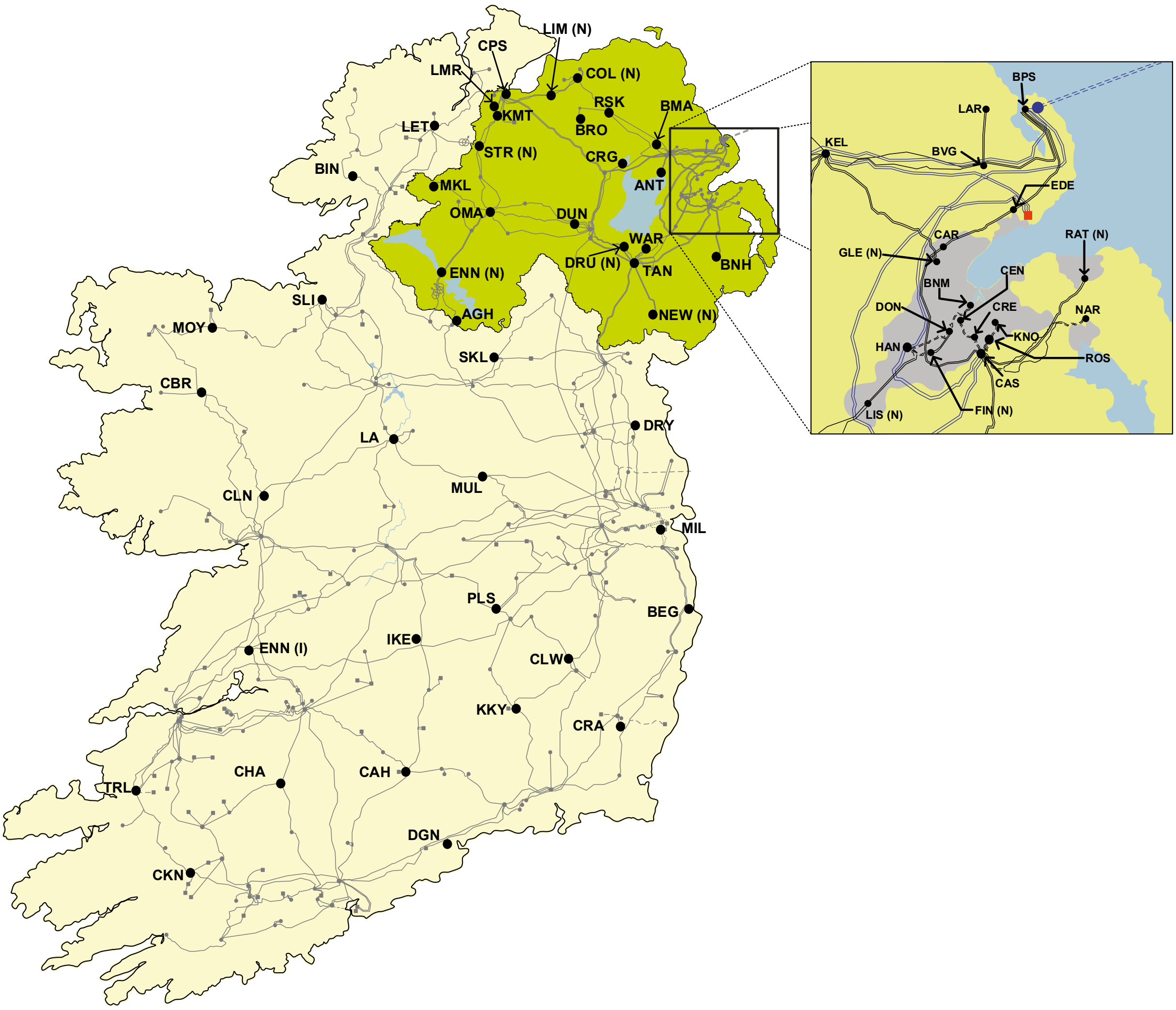


Figure 7-2: Selected 110 kV stations for the generation opportunity studies

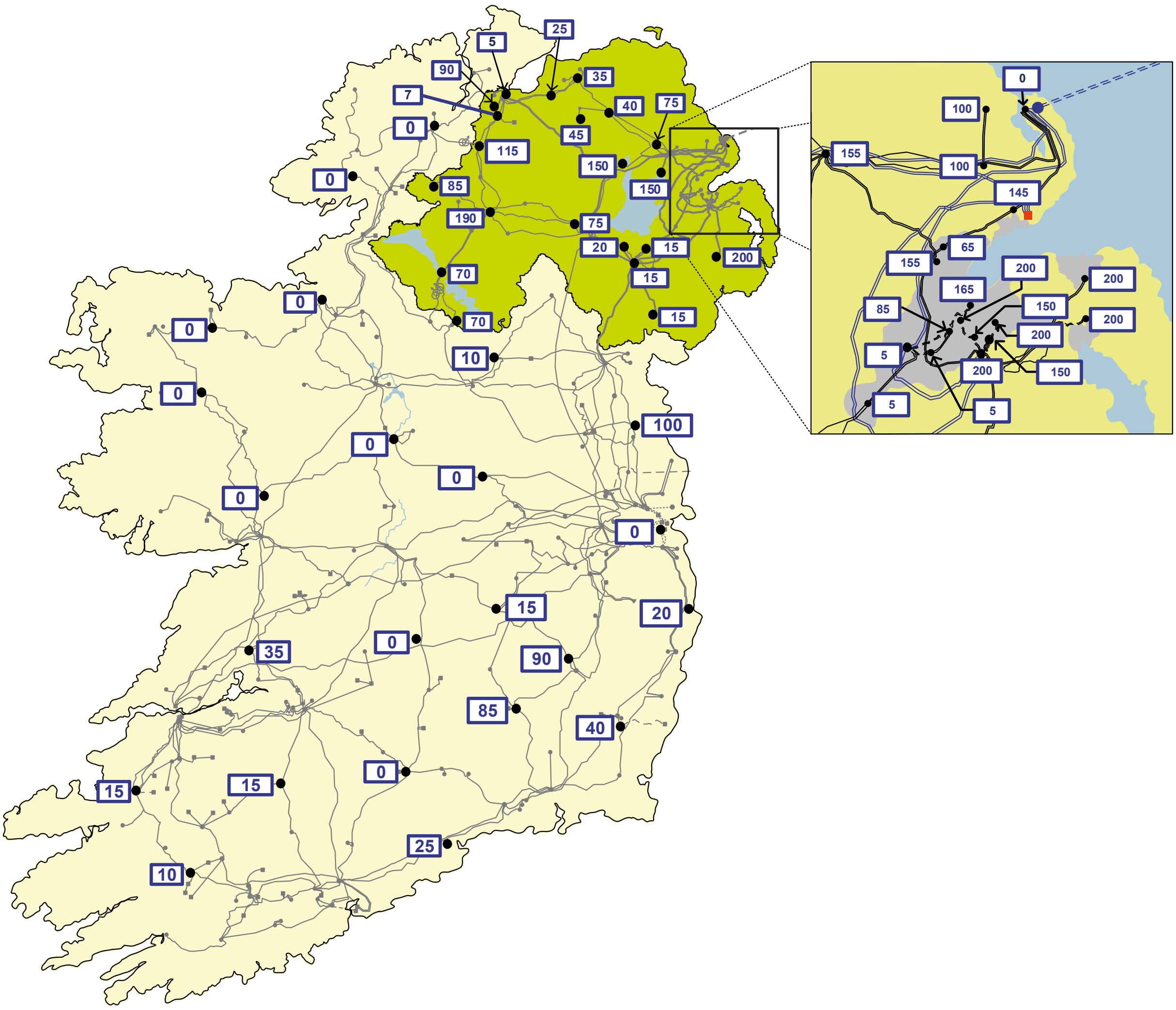


Figure 7-3: Generation opportunity at the selected 110 kV stations in 2031

Some capacity for additional generation is available within the 110 kV network at some nodes in the South-East and South-West of Ireland. This is due to the presence of large demand centres, the lower penetration of renewable generation, as well as the strength of the transmission network in these regions. Detailed connection studies are required to determine more accurate quantities of available capacity and connection arrangements.

High levels of additional renewable generation are expected to connect to the distribution and transmission systems in Northern Ireland by 2031. This generation in the North and West of Northern Ireland is greater than local demand and causes congestion in the transmission network. Consequently, these regions have less potential for additional connections than the East of Northern Ireland.

Greater opportunities for generation connections are possible in the East of Northern Ireland. This is due to lower congestion within the transmission network, and higher demand density. Similarly, with the assessment of the generator opportunities for the high voltage network, these results are only indicative of the potential for connection in the network. These figures are, furthermore, not cumulative as the nodes are assessed in isolation.

7.5 Generation locational tariff signals and their impact on transmission network capacity

Harmonised transmission arrangements provide locational signals to users reflecting the costs they impose on the transmission system. TLAFs and GTUoS tariffs, as part of harmonised transmission arrangements, can provide generators with locational signals informing their decision on where to connect to the grid and incentivise efficient generation dispatch.

Electrical losses, which occur as electricity is transported along transmission circuits, are accounted for in the settlement process with the application of TLAFs. Some units are responsible for proportionally more transmission losses than others, depending on heir point of connection to the grid and use of transmission network capacity.

The methodology used by the transmission system operators (TSOs) to calculate the TLAFs has been approved by the regulatory authorities.

The most efficient way to transfer power in terms of losses is to minimise the distance between generation and demand, and not to heavily load lines. Due to the location and amount of demand and generation, power can be transmitted over sizeable distances. If the power generated in a region is in excess of the demand in that region, the excess generation will be utilised some distance away from the source.

The transmission network consists of high voltage overhead lines and cables ranging from 110 kV to 400 kV. When current flows across these circuits, some energy is lost as heat. The higher the power transmitted on a line, the higher the current. Current has a squared relationship to power losses, therefore if the power on a line is doubled, the losses will increase by a factor of four.

In general, transmitting power on a higher voltage level will lower the associated current. The associated losses will be dependent on how congested the line is; increasing power on an already congested line will result in greater losses than increasing power on a similar less congested line.

The Transmission Use of System (TUoS) tariff is the main tariff for transporting power in bulk, across the power system. Generator Transmission Use of System (GTUoS) tariffs contains a locational component, which provides a signal of the costs associated with a generator's use of the transmission network.

Such signals provide a commercial incentive for generators to make informed decisions (both siting/entry and exit decisions) concerning their use of the transmission system. This is intended to improve efficiency in respect of both the use of, and investment in, the transmission system.

7.5.1 TLAFs

Generator TLAFs are reflective of their contribution to transmission losses. The principle is that market participants that contribute more to transmission losses, due to their location, should have a lower TLAF, than those generators who contribute less to transmission losses.

The regional average 2022/23 TLAF values are shown in Figure 7-4 and are based on the published approved 2022/23 TLAF values.

Figure 7-5 shows the change in TLAFs between 2021/22 and 2022/23. These changes are influenced by yearly dispatch, demand and topology changes.

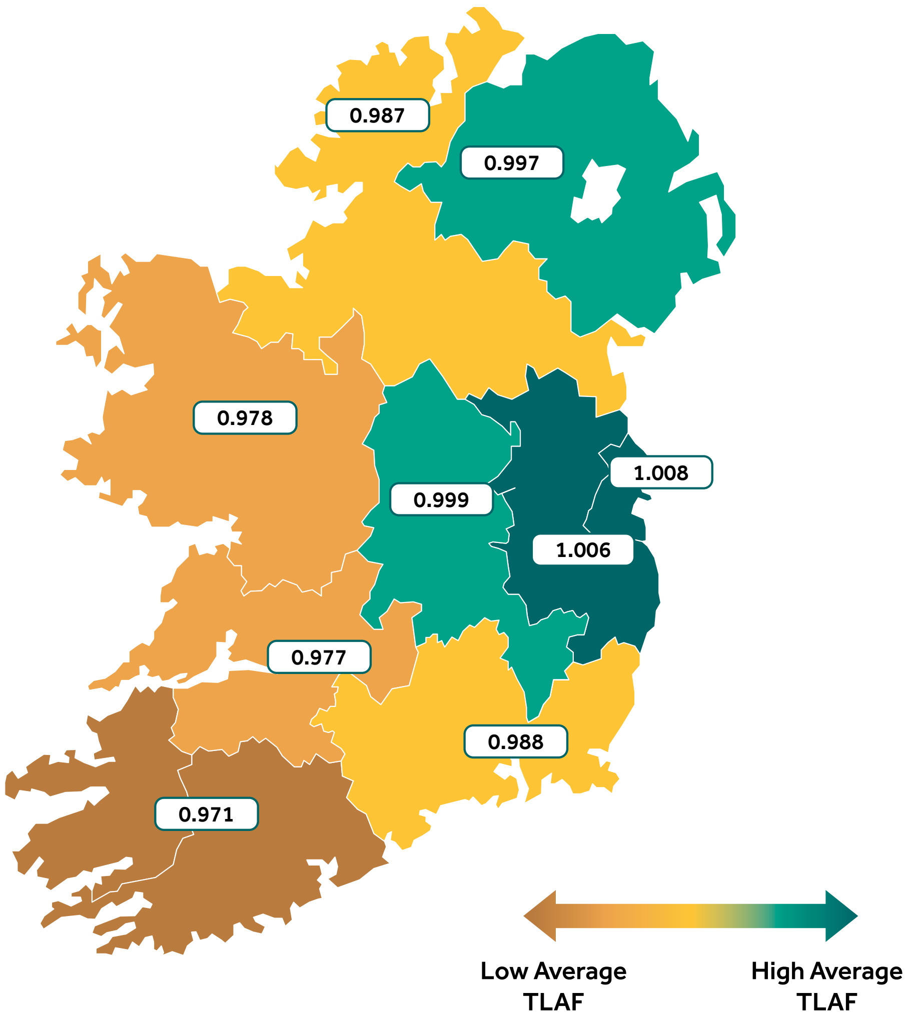


Figure 7-4: All-island 2022/23 regional average TLAF values

The information presented in Figures 7-4 and 7-5 should be used as regional indicators. For the 2022/23 tariff year, the average all-island TLAF has decreased by 0.66%. The average TLAFs for the Dublin and Northern Ireland areas have seen the largest decrease between 2021/22 and 2022/23.

TLAFs for the Dublin region are relatively high as there tends to be local use of generation, with an increasing demand. Local use of generation also typically supports the relatively high Northern Ireland TLAFs. Further information on the 2022/23 TLAFs can be found on the EirGrid and SONI websites.

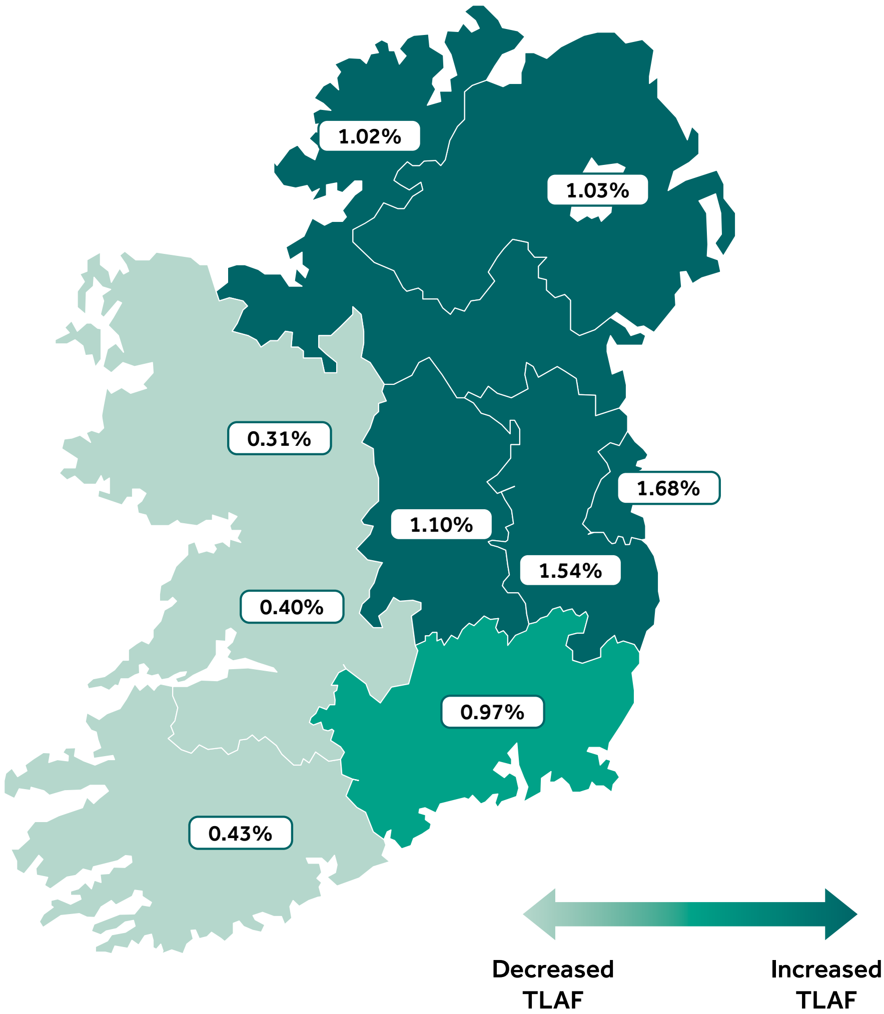


Figure 7-5: % TLAF change between 2021/22 & 2022/23

7.6 GTUoS

The regional average 2022/23 GTUoS tariffs are shown in Figure 7-6, and are based on the approved 2022/23 GTUoS tariffs. Higher GTUoS tariffs are reflective of transmission investment costs linked to a generator's use of the system. This promotes efficient use of the transmission system by generators, which should, in turn, facilitate efficient investment in the transmission system.

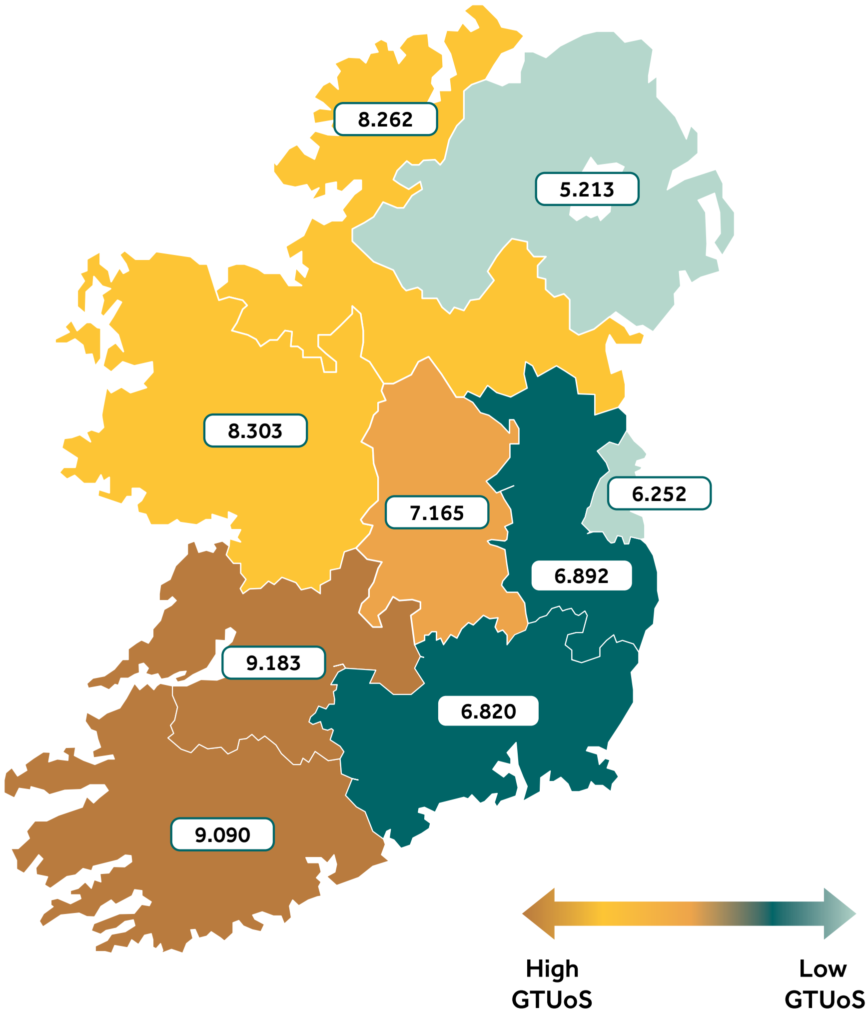


Figure 7-6: All-island 2022/23 regional average GTUoS values

Figure 7-7 shows the change in GTUoS tariffs between 2021/22 and 2022/23.

For 2022/23, there is an overall decrease in tariffs due to a 16.4% increase in the all-island revenue. Regional changes are attributed to changes in network flows and local reinforcements.

The annual revenue is the amount allowed to build, operate and maintain the transmission network, and this has increased in Ireland and increased in Northern Ireland for 2022/23.

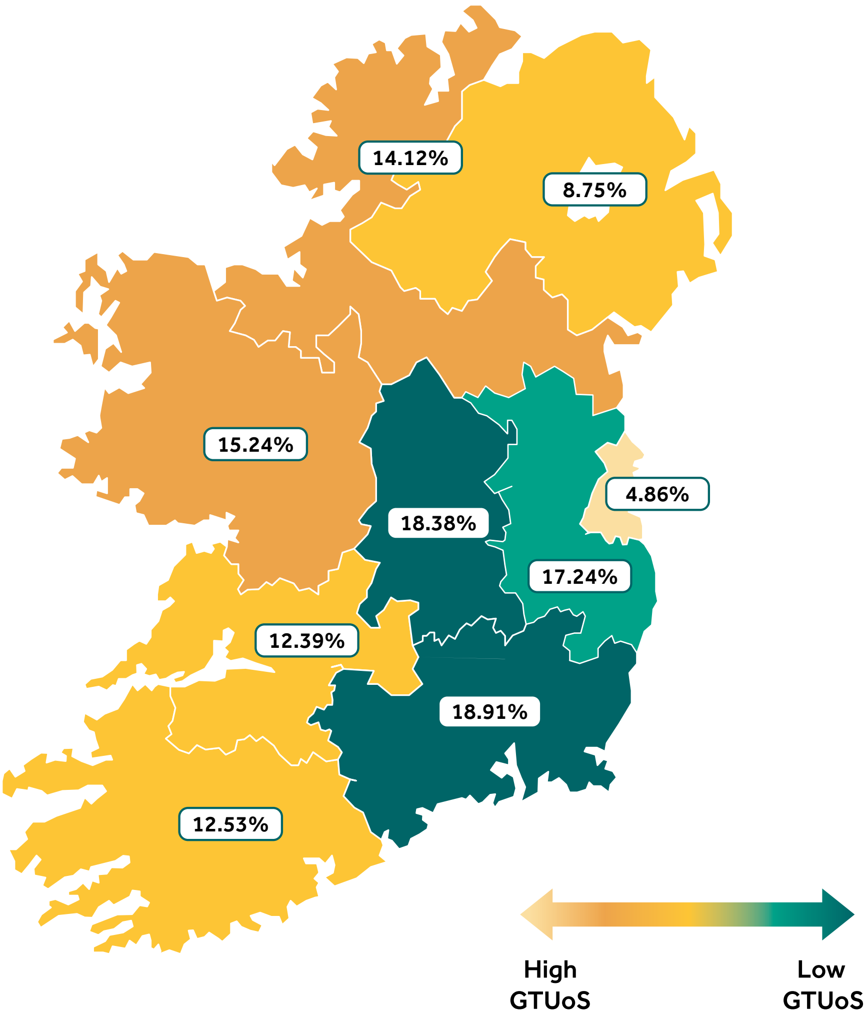


Figure 7-7: % GTUoS change between 2021/22 & 2022/23

GTUoS tariffs for 2022/23 have increased, on average, by 12.3% from those for 2021/22, which is lower than the revenue change. This is driven by the 16.4% increase in approved revenue to be recovered by GTUoS and offset by the 3.5% increase in MWs (MEC) in the model.

Significant changes were observed in some areas due to reinforcements joining or leaving the 12 year cost window. As shown in Figure 7-6, median GTUoS tariffs for Northern Ireland in 2022/23 are 8.75% higher than those of 2021/22 and are also around 35% lower than the average Ireland GTUoS tariff for 2022/23[31]. The base flows in 2022/23 are otherwise relatively similar to those of 2021/22 and as a result there are similar trends to those of 2021/22. Further information on the 2022/23 GTUoS can be found on the EirGrid and SONI websites.[32]

7.7 Assumptions behind the TLAF and GTUoS models

7.7.1 TLAFs

The assumptions used to determine TLAFs come from the Imperfections Forecast model, and essentially are a snapshot of a particular study year, comprised of complex and detailed data. This data is collected up to a data freeze point just before the calculation process. This ensures they are as reflective as reasonably practicable for the study year.

For the level of detail involved specifically for calculating TLAFs, the assumptions are only valid for the study year.

Due to the complexity and variability of these assumptions, their collective impact on TLAFs is neither predictable nor forecastable. Looking beyond the study year, assumption data becomes increasingly speculative and could not be considered as reasonable data for the TLAF model.

31 https://www.eirgridgroup.com/site-files/library/EirGrid/2223-Approved-GTUoS-Tariffs-EirGrid-v2.pdf
https://www.soni.ltd.uk/media/documents/2223-Approved-GTUoS-Tariffs-SONI-v2.pdf
32 https://www.eirgridgroup.com/site-files/library/EirGrid/2223-Approved-GTUoS-Tariffs-Accompanying-Note-EirGrid-v1.0.pdf
https://www.soni.ltd.uk/media/documents/2223-Approved-GTUoS-Tariffs-Accompanying-Note-SONI-v1.0.pdf

7.7.2 GTUoS

The GTUoS model includes an element of 'looking to the future' by adopting the principle of incorporating the future network. Looking at the future network involves including the next five years of network files in the model. The network files are consistent with the information published in the latest version of this document available at the time of calculation. Indicative asset costs for a 12 year window are also included in the GTUoS model (looking five years forward and seven years back). Under normal circumstances this starts when the asset first appears in the 'Year+5' network file, until seven years post-commissioning. GTUoS tariffs are calculated on an all-island basis, but assumptions or network changes from one jurisdiction can have an impact on the other. For example, if the revenue to be recovered in Ireland significantly increased, but the revenue to be recovered in Northern Ireland remained the same as the previous year, the average all-island tariff would increase as there is a greater all-island pot to recover. Local variations would then be related to changes in network flows. Another example could be when looking at interconnector flows, where an assumption for Moyle impacts flows in Ireland, and an assumption for EWIC impacts flows in Northern Ireland. Although there is an element of forecasting in the GTUoS model by looking at the future network and associated costs, alongside this are many assumptions and variables that only apply for the study year.

7.8 How to use the information for generation

Generation developers wishing to use the information contained within this section when considering where to connect should follow these steps:

- Consult the maps in Appendix A to find the nearest transmission station to the proposed development. Also, consider the regions and nodes identified in Section 7.4 which are indicating opportunity for generation connections.
- Consult the forecast increase and retirement of generation within a region. Consider the impact of changes to the transmission system since the analysis was carried out. Consider short circuit current levels at the nearest transmission station.
- Discuss your project with EirGrid or SONI as early as possible.
- If seeking to apply for a connection, refer to the EirGrid connection application process[33] or the SONI connection application process[34].

33 http://www.eirgridgroup.com/customer-and-industry/becoming-a-customer/
34 https://www.soni.ltd.uk/Customers/howconnected/

8. Transmission system capability for new demand

This chapter presents the demand opportunity analysis which assesses the capability of the existing and planned transmission system to accommodate increased demand, based on information available at the data freeze date of January 2022. Opportunities for further demand connections in Ireland and Northern Ireland are also discussed.

A significant amount of conventional generation in Ireland and Northern Ireland is expected to close down over the period covered by this statement. However, for the purpose of the TYTFS 2022 analysis, it is assumed that sufficient generation capacity will be delivered in appropriate locations to ensure generation adequacy and security of supply are maintained.

Note that in Ireland, significant security of supply concerns over the next ten years have been highlighted by EirGrid in the Generation Capacity Statement (GCS) 2022–2031. EirGrid is working with CRU and the Department of the Environment, Climate and Communications (DECC) to address the short to medium term generation adequacy concerns in Ireland. In September 2021, the CRU first published a Programme of Actions to increase generation capacity to provide additional stability and resilience to the Irish energy system for the coming years. This includes retention of existing units that are scheduled to close and the availability of temporary emergency generation. Capacity shortfalls will continue to be regularly assessed, and action plans will be further developed and updated as necessary to maintain security of supply.

The GCS 2022–2031 capacity adequacy analysis for Northern Ireland indicates that the capacity outlook drops into deficit in 2024 and 2025 as the existing coal fired generation at Kilroot closes, the new OCGTs at Kilroot are delayed and when they do connect will be subject to Annual Run hour Limits (ARHLs). The adequacy position for NI is being monitored on an on-going basis and SONI is working with the Department for the Economy and the Utility Regulator in addressing these issues.

There continues to be a significant volume of enquiries and applications for the connection of large energy users such as data centres in the Dublin region (see Chapter 3). This is addressed in Section 8.3, in which a qualitative approach to describe demand opportunities in the Dublin area is presented.

In November 2021, the CRU published direction CRU21124 to the System Operators relating to data centre grid connection processing. Since that direction there have been a number of further developments including the Government Policy Statement on Security of Electricity Supply (November 2021), the Government Strategy on the Role of Data Centres in Ireland's Enterprise Strategy (July 2022), Ireland's Sectoral Emissions Ceilings under the Climate Action and Low Carbon Development (Amendment) Act 2021 and the Climate Action Plan 2023 (December 2022). EirGrid is continuing to work with the CRU, and all other relevant parties, on these matters.

It should be noted that results relating to demand opportunities in this forecast statement are indicative only and are based on information available at the data freeze date of January 2022. It is advised that any potential new demand consumers contact EirGrid in the first instance so that the available connection options can be considered. In particular, data centres need to consider the status of Dublin as a constrained area in the context of the CRU's direction to System Operators relating to data centre grid connection processing.

8.1 Transmission system demand capability obligations

This chapter of the TYTFS is published in order to meet the requirements on providing high-level indication of transmission network capacity under EirGrid's Section 38 of the 1999 Electricity Act and Condition 33 of SONI's TSO licence. Results from demand capability studies are based on a specific set of assumptions (see Chapter 6) which may be subject to change.

Developers wishing to connect to the transmission system will require further detailed studies. The TYTFS is not intended to have any legal effect on the negotiation of contractual terms for transmission system connections. Before making any commercial decisions, developers should contact the appropriate TSO and engage in a formal application/offer process for their proposed developments.

8.2 All-island transmission system capability for new demand

As detailed in Chapter 6, the transmission system's capacity to accommodate new demand is assessed using demand opportunity analysis. The study was performed for 2027 winter and summer peaks.

Data used for the demand opportunity analysis is based on the best available information at the January 2022 data freeze date. The results of the demand opportunity analysis presented in this chapter are based on the following assumptions:

- Year 2027 demand forecast was used (see Appendix C);
- Only transmission reinforcements with capital approval which were planned to be completed by 2027 at the data freeze date were included in the analysis;
- Planned generation up until 2027 at the data freeze date was included in the analysis;
- Variable generation cannot continuously serve demand. As such, variable generation local to the test station was switched out; and
- The 2027 transmission system was assessed for the following contingencies: the loss of a single transmission asset (N-1); a maintenance-trip (N-1-1); and loss of a double transmission circuit (N-DC, Northern Ireland).

We analysed a number of transmission stations throughout Ireland (excluding Dublin) and Northern Ireland for Demand Opportunities. These consisted of 110 kV, 220 kV and 275 kV stations.

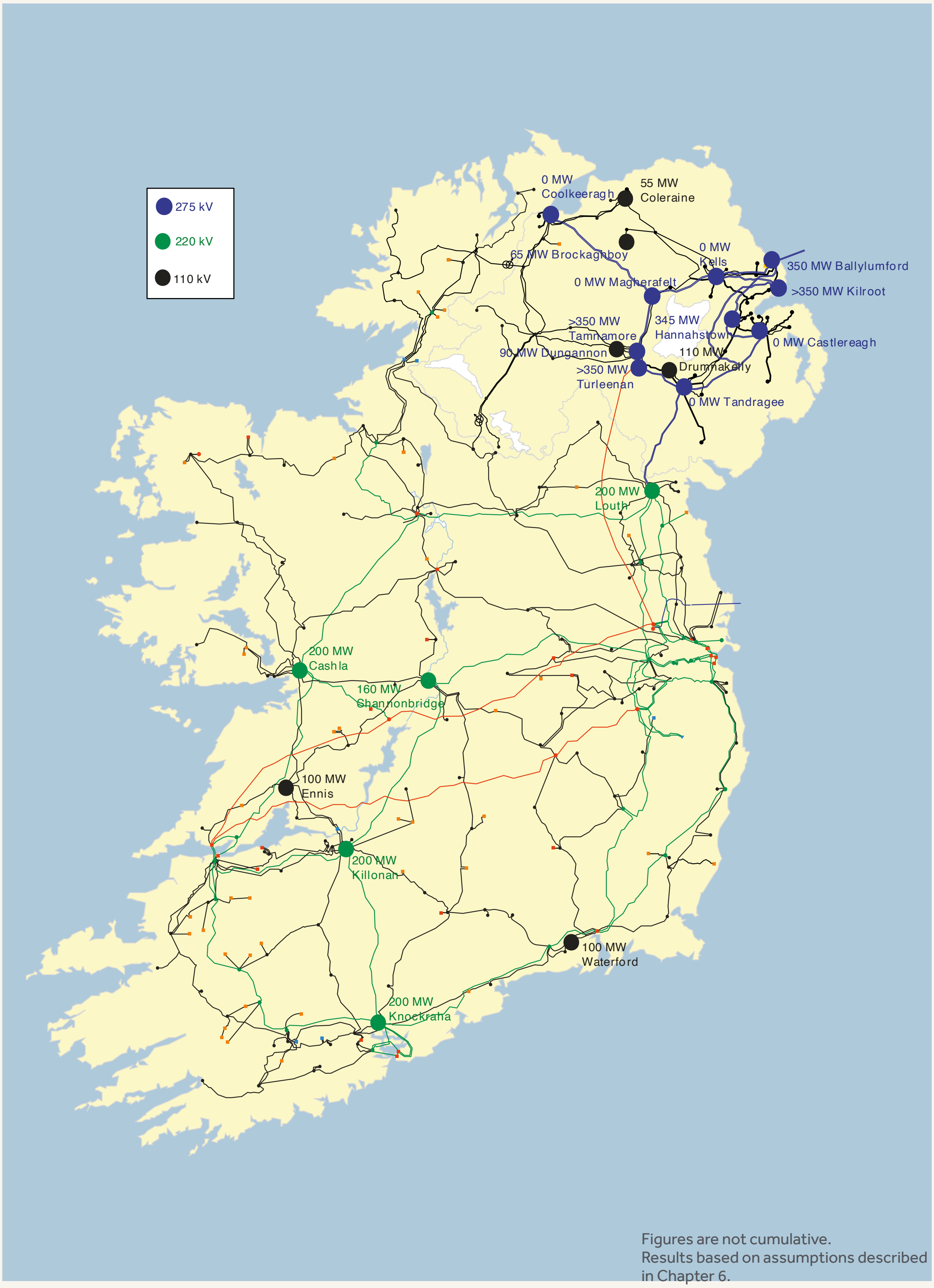
These stations were analysed to help identify locations that are potentially suitable for major industrial load centres with large power requirements. The stations examined and their accompanying results are shown in Figure 8-1. The stations with the capacity to accommodate at least 100 MW additional demand are reported for Ireland. There may be some limited opportunities for demand increase at other nodes but these should be discussed with EirGrid on a case by case basis. Opportunities in Dublin are discussed separately in Section 8.3.

It should be noted that demand opportunity is tested at each station on an individual basis. As such, the opportunities presented are not cumulative. If new demand connects in an area that is currently shown to have capacity, it will consume some, or all of, the available capacity in that area.

As a general rule, demand opportunity at a particular station would tend to reduce over time. This is due to normal demand growth using up available capacity. Yet, in some cases, demand opportunities can improve as a result of planned transmission system or generation developments.

The results of the analysis are presented on a regional basis below. The results provide a high-level indication that in 2027, there will be opportunities at the stations examined based on the data assumptions applied in the analysis. It should be noted that the analysis does not reflect changes that have occurred since the data freeze such as changes to contracted demand connections. These opportunities are all subject to adequacy requirements being met and other policy requirements as determined by the CRU.

Figure 8-1: Capability for additional demand at 275 kV, 220 kV and 110 kV stations in 2027



8.3 Transmission system capability for new demand in the Dublin Area

Dublin is the largest load centre on the island of Ireland. We include this section due to the considerable interest and number of enquiries for connection to the grid around Dublin (see Chapter 3 on Demand). The volume of enquiries and the uncertainty of their final power requirements require us to make a qualitative assessment of demand opportunities for the future.

The scale of individual demand connection enquiries to the transmission system vary from 20 MW to over 250 MW. The enquiries mainly comprise data centres supporting the information, communications, and technology (ICT) infrastructure of large multi-national companies. Any potential new consumer looking to connect in the Dublin area should contact EirGrid as early as possible to review available connectivity options. In particular, data centres and large energy users need to consider the status of Dublin as a constrained area for demand per CRU21124.

8.4 Dublin transmission development plans

The demand connections in Dublin fall into three zones: North, West and South Dublin. Each zone is described below with consideration given to existing transmission infrastructure, transmission network projects and lead times.

Should the reader require more detailed transmission network project information please read our latest Transmission Development Plan and Associated Transmission Reinforcement[35] (ATR) update, both of which are available on the EirGrid website.

35 https://www.eirgridgroup.com/customer-and-industry/general-customer-information/operational-constraints/

8.4.1 North Dublin

North Dublin has three 220/110 kV interface stations at Corduff, Finglas, and Belcamp. In addition, there is a 220 kV directly connected customer interface station at Clonee. The level of interest for connection in North Dublin is the highest of all Dublin areas.

A number of transmission projects are in place to increase the network capacity and security of supply in this area. They are summarised in Table 8-1 below.

As noted in our Transmission Development Plan we have confirmed the need for further infrastructure investment in North Dublin. In response, we are progressing the East Meath-North Dublin Network Reinforcement (CP1021). This will increase the network connectivity between Woodland 400 kV station and a transmission station in North Dublin. Typically, such major projects delivering additional network capacity have significant lead times (five to ten years or more), and are dependent on the chosen technology.

Table 8-1: North Dublin projects

Project name/number	Project description	Estimated delivery date at data freeze
Belcamp Phase 2 (CP0984)	Additional 220/110 kV transformer and second circuit	2022
Finglas (CP0646)	110 kV station redevelopment	2023
Finglas (CP0792)	220 kV station redevelopment	2023

8.4.2 West Dublin

West Dublin has an existing 220/110 kV interface station at Inchicore, with another 220/110 kV station recently developed at Castlebagot, formerly known as West Dublin 220 kV station. These stations are supported by the Maynooth 220 kV station in Kildare, just outside Dublin.

A number of transmission projects are in place to increase the network capacity and security of supply in this area. They are summarised in Table 8-2 below.

As noted in our Transmission Development Plan we have confirmed the need for further infrastructure investment in this area.
In response, we are progressing the Kildare-Meath Grid Upgrade (also known as Capital Project 966) which seeks to increase the strength of the link between two existing 400 kV stations at Dunstown and Woodland.

Table 8-2: West Dublin projects

Project name/number	Project description	Estimated delivery date at data freeze
Castlebagot (CP0872)	New 220/110 kV station	2022
Barnageeragh (CP1093)	New 110 kV station	2025
Maynooth-Woodland (CP0869)	Uprate 220 kV line	2022
Ryebrook-Corduff (CP0668)	Uprate 110 kV line	2022
Inchicore (CP0692)	220 kV station upgrade	2027
Maynooth (CP0808)	220/110 kV station redevelopment	2027

8.4.3 South Dublin

South Dublin has one main 220/110 kV interface station at Carrickmines. Carrickmines is connected at 220 kV to Dunstown 400/220 kV station and Arklow 220/110 kV station.

A transmission project was being progressed on the data freeze date, to increase the network capacity and ensure continued security of supply in this area as summarised in Table 8-3 below.

Table 8-3: South Dublin projects

Project name/number	Project description	Estimated delivery date at data freeze
Carrickmines (CP0580)	New 220/110 kV 250 MVA transformer and GIS development	2023

8.4.4 Additional transmission capacity required in the Dublin Area

EirGrid published Shaping Our Electricity Future v1.0 in November 2021. This report and the associated study identifies the need for further transmission capacity in the Dublin area in addition to the Dublin network reinforcements described above.

The study indicates that a new 220 kV circuit is required in South Dublin along with replacement of five 220 kV underground circuits in the Dublin area. There are a number of drivers for these reinforcements including growth of demand in the area due to data centres and electrification of heat and transport, as well as connections of new offshore wind capacity.

8.4.5 CRU direction on data centre connections

The greater Dublin area has experienced high levels of data centre growth in recent years. This demand growth is expected to continue over the coming years as existing data centres utilise their full contracted MIC.

Connecting more data centres to the greater Dublin area will exacerbate the constraint issues that have developed in this area and present risks associated with security of the transmission system.

In light of these issues and the CRU's direction on the connection of data centres (CRU21124), EirGrid has clarified that the greater Dublin area is considered a constrained region for the purpose of processing of data centre connections.

8.4.6 Looking forward

In January 2017, EirGrid published an updated grid development strategy for the long-term development of the network. In the strategy paper, we explain the role of electricity transmission infrastructure in supporting new investments and jobs as well as ensuring competitiveness by offering cost-effective power capacity.

The strategy puts forward a number of major projects to upgrade the transmission network. The Regional Solution (see Chapter 2) and the Kildare-Meath Grid Upgrade (Capital Project 966) have many system benefits, which include providing additional network capacity and improving security of supply for the eastern side of Ireland.

The Regional Solution involves a new circuit across the Shannon Estuary and the installation of series compensation equipment on the 400 kV circuits that extend from Moneypoint 400 kV power station in the West of Ireland towards Woodland and Dunstown 400 kV stations located on the western outskirts of Dublin.

This project will greatly enhance the capability of the existing 400 kV circuits to transfer bulk power generated in the South-West and West to Dublin and other demand centres in the East, as illustrated in Figure 8-2.

The Kildare-Meath Grid Upgrade is at step 4 now in EirGrid's six step approach. This project will provide a high capacity link between two 400 kV stations at Dunstown and Woodland. This will provide benefits by reducing power flows that pass through the Dublin 220 kV transmission network.

To maintain system stability and facilitate significant inter-regional power flows we are also developing a number of voltage support solutions across Ireland.

In addition, as noted in our Transmission Development Plan, we have confirmed the need for investment in North Dublin. The future project is called the East Meath-North Dublin Network Reinforcement (CP1021) which is also at step 4 of EirGrid's six step approach.

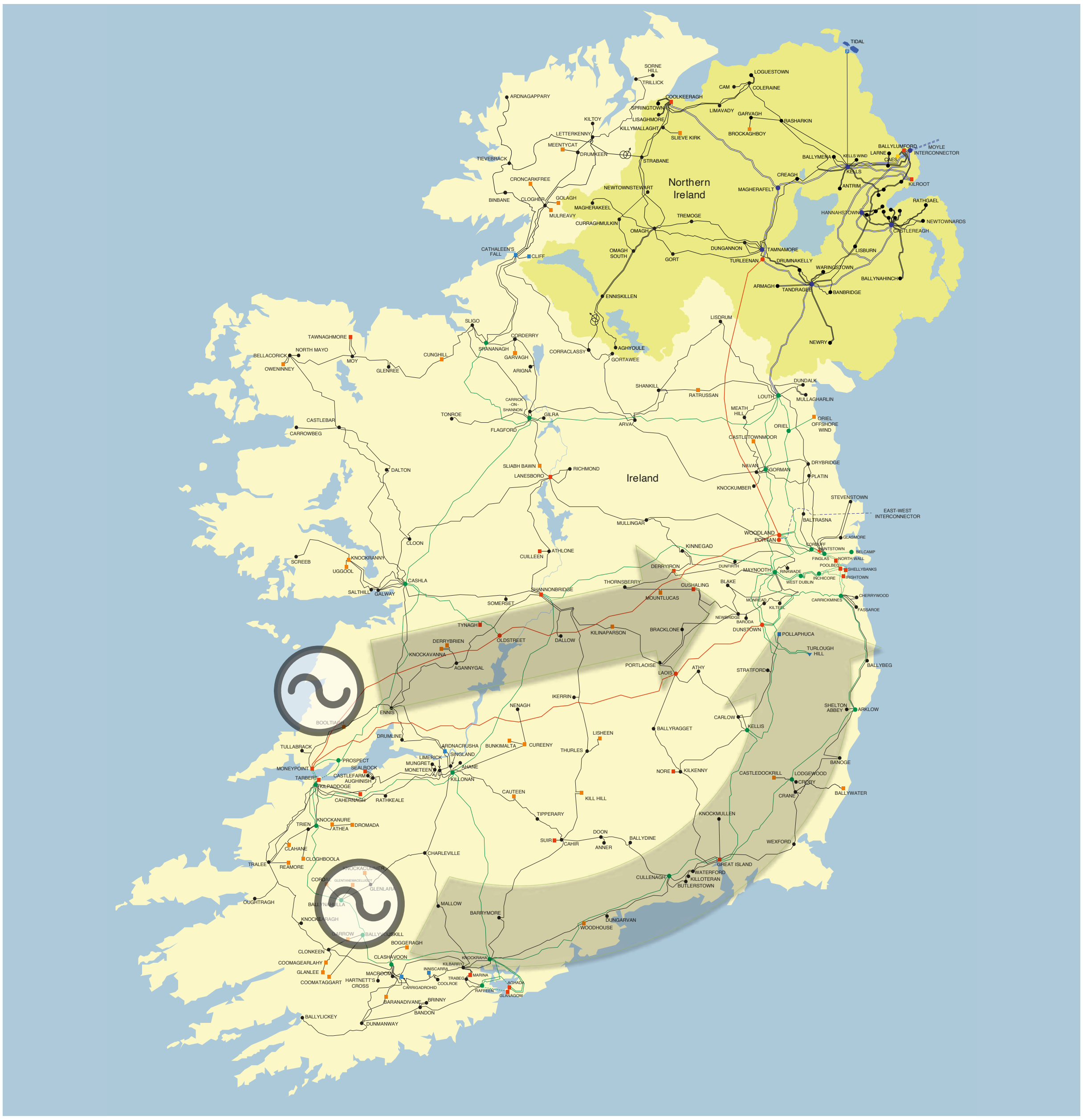


Figure 8-2: Transfer of power generated in the West and South-West regions to the East

EirGrid's Shaping Our Electricity Future v1.0 report identified the need for a new 220 kV circuit in South Dublin along with replacement of five 220 kV underground circuits in the Dublin area. There are a number of drivers for these reinforcements including growth of demand in the area due to data centres and electrification of heat and transport, as well as connections of new offshore wind capacity. However, despite these additional reinforcements, Dublin will still have to be treated as a constrained region and adhere to CRU's direction for connection of additional data centres as per Section 8.3.7.

8.4.7 Summary

New transmission solutions will be required to strengthen the grid and to maintain security of supply. These solutions are being progressed.

We continue to apply a strategic approach to network development and we are continuously considering the approach to the level of demand enquiries. Our strategic approach takes account of the following:

- Companies developing data centres operate in a rapid and dynamic environment. Their business requires connection timescales that are short relative to time taken for transmission reinforcement. Most are considering being operational within two to three years and growing their power usage rapidly thereafter.
- We are working to understand the needs of these developers and their impact in terms of our grid development strategy and Shaping Our Electricity Future v1.0 and v1.1. We are publishing information on the system adequacy, grid needs and opportunities to ensure transparency so that the impacts of this sector and its developments are known.
- We will continue to examine innovative solutions and technologies in response to future requests.
- As interest in connecting additional demand has developed into contracted connections, the available capacity on the existing transmission network for further large scale demand connections has been depleted. As such, the Dublin region is considered a constrained region in the context of additional demand.

It is advised that any potential new demand consumers contact EirGrid early so that the available connection options can be considered. In particular, data centres need to consider the status of Dublin as a constrained area for demand and be aware of connection policy developments.

8.5 Transmission system capability for new demand in Ireland

Demand opportunities available on an Ireland regional basis are discussed below. These are all subject to adequacy requirements being met and other policy requirements as determined by the CRU. Results presented in this section are based on the assumptions detailed in Chapter 6.

8.5.1 Opportunities for New Demand in the Midlands and West

The indicative demand opportunities available in the Midlands and West are shown in Figure 8.3. It is shown that there is potential demand opportunities available for new customers in the region[36]. Cashla 220 kV station would be suitable connection point for major industrial load centres. This station is capable of accommodating additional demand without additional network reinforcements.

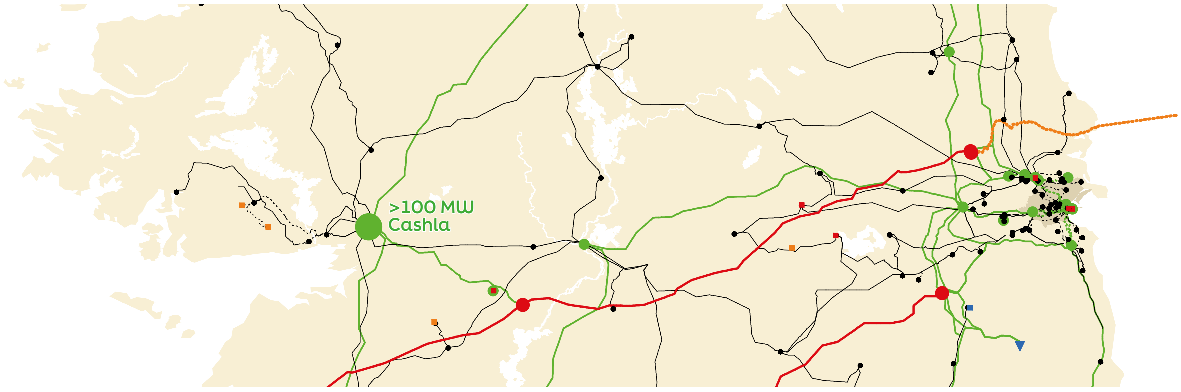


Figure 8-3: Capability for Additional Demand in Midlands and West Regions

36 Please note that the demand opportunities results are not cumulative. Each station is assessed individually, taking account of forecast demand growth only at stations outside of the test node. These figures are indicative only, with further detailed assessment of each station required. Customers considering connecting demand to the Irish transmission system are advised to contact EirGrid as early in the project as possible.

8.5.2 Opportunities for new demand in the North-East

The demand opportunity available for the North-East region is shown in Figure 8-4. Demand opportunity studies were performed at Louth 220/110 kV station in this region.

From the study it is observed that Louth is capable of accommodating significant additional demand without additional network reinforcements in the North-East region.

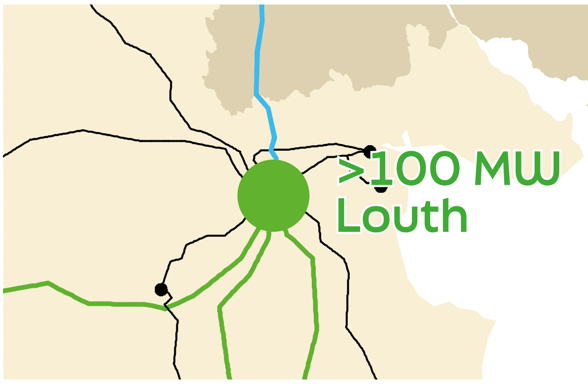


Figure 8-4: Capability for additional demand in North-East region

8.5.3 Opportunities for new demand in the South-East

The demand opportunity available for the South-East region is shown in Figure 8-5. Demand opportunity studies were performed at Waterford 110 kV station in this region.

In our studies we identified an opportunity for 100 MW at Waterford 110 kV station in the South-East region.

Figure 8-5: Capability for additional demand in the South-East region

8.5.4 Opportunities for new demand in the South-West

The demand opportunities available for the South-West region are shown in Figure 8-6. It can be seen that there are potential opportunities available for industrial customers in this region.

In particular the Killonan and Knockraha 220 kV stations would be suitable connection points for major industrial load centres, with the capability of accommodating in excess of 200 MW at each station without additional network reinforcements.

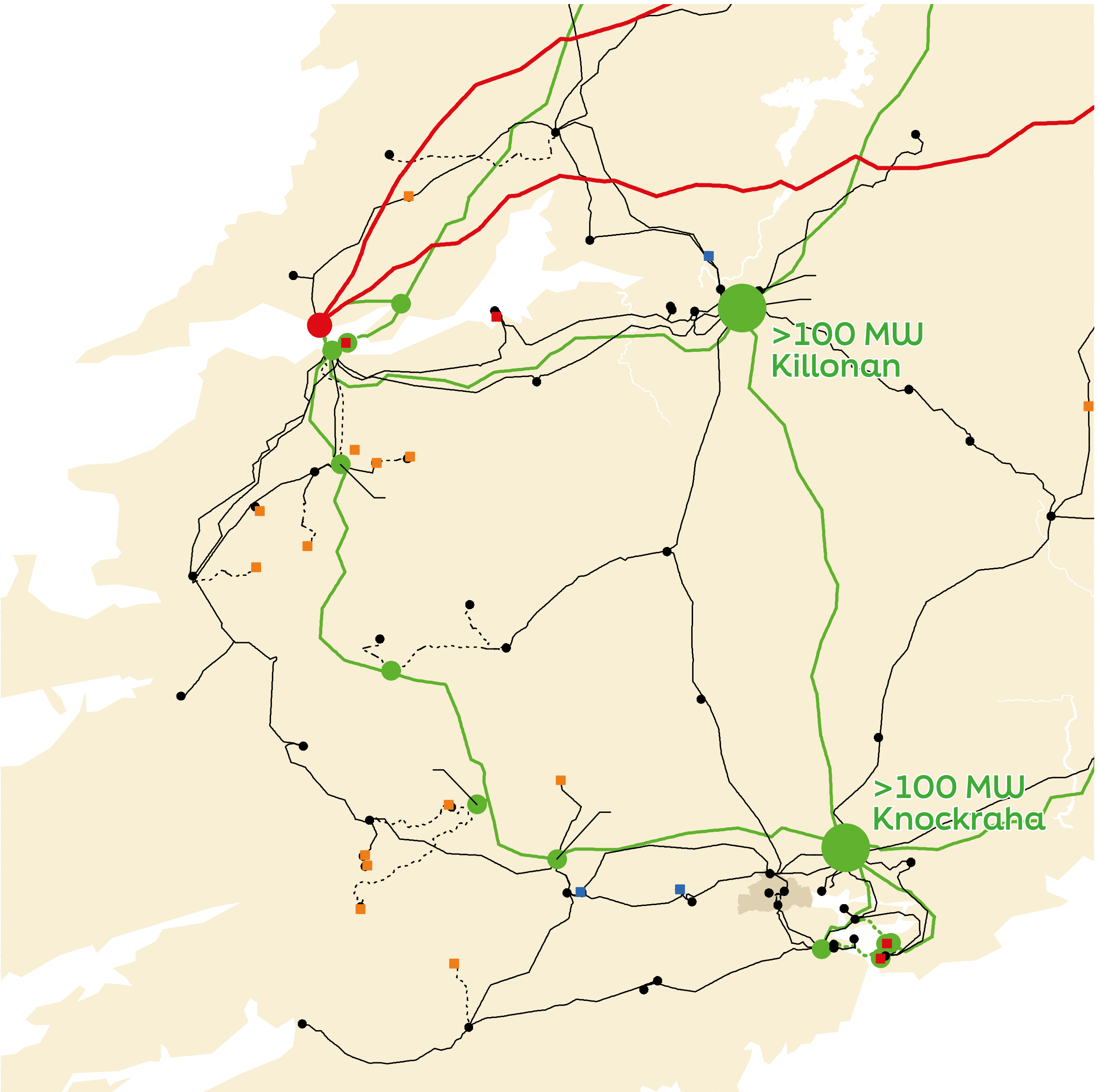


Figure 8-6: Capability for additional demand in South-West region

8.6 Transmission system capability for new demand in Northern Ireland

Section 8.5.1 discusses the demand opportunities available in the South-Eastern region of Northern Ireland. Section 8.5.2 discusses the demand opportunities available in the Northern and Western region. These results are based on the assumptions detailed in Chapter 6.

8.6.1 Opportunities for new demand in South-East of Northern Ireland

The demand opportunities available in the South-Eastern region are shown in Figure 8-7.

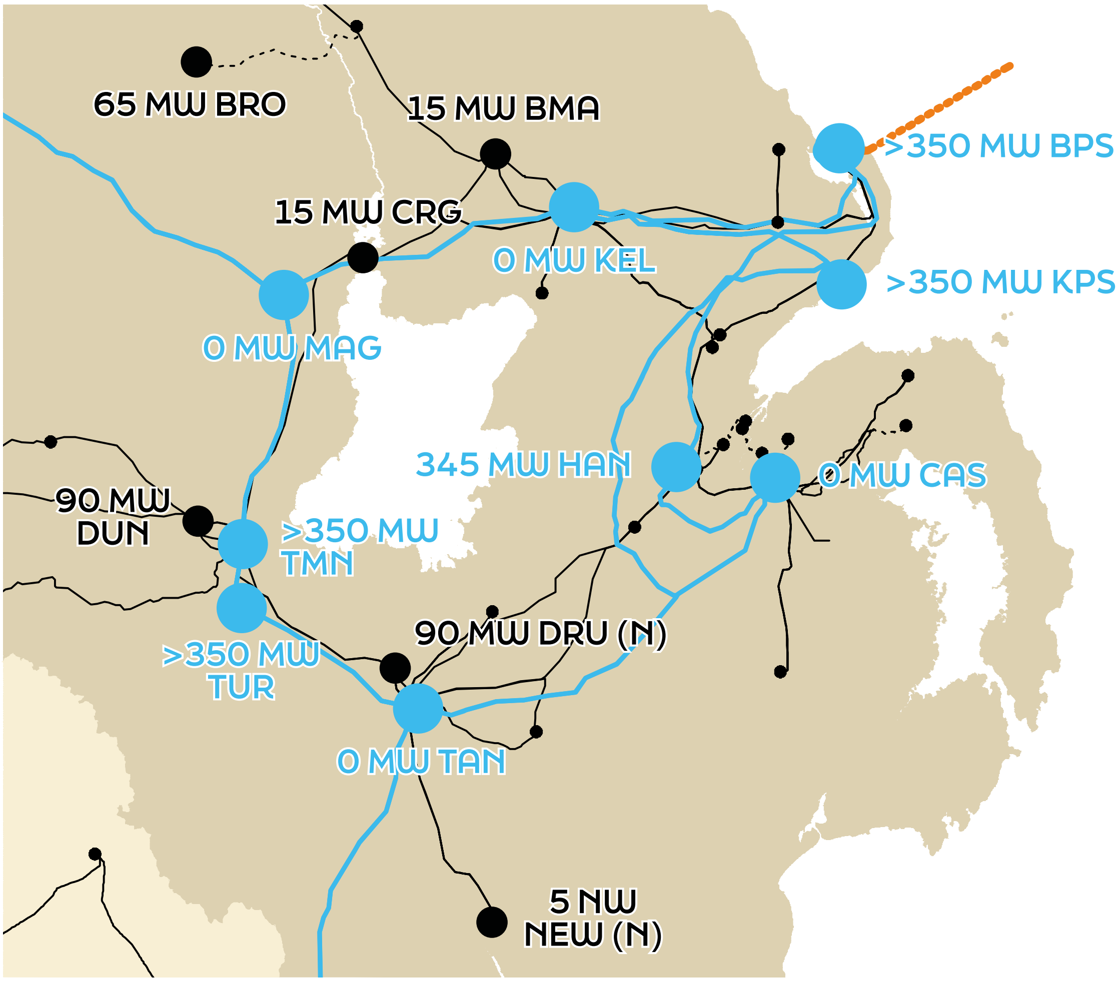


Figure 8-7: Capability for additional demand (MW) in the East of Northern Ireland

It can be seen that there are potential opportunities available for industrial customers at most stations examined in the region. Those stations with capacity are capable of accommodating approximately 350 MW[37] of additional demand without additional network reinforcements.

Those 275 kV stations with an identified capacity of 0 MW are restricted by the ability of the structures and busbars to withstand mechanical forces arising from potential faults. SONI and NIEN will be bringing forward projects to address this issue, however, these are at an early stage and no additional capacity can as yet be identified with sufficient certainty. The fault contributions from non-synchronous connections such as data centres tend to be significantly smaller, particularly those likely to connect at 110 kV. Any such potential connection at these nodes would be assessed based on its fault current contribution.

8.6.2 Opportunities for new demand in North and West of Northern Ireland

The demand opportunities available for the North and West of Northern Ireland are shown in Figure 8-8.

It can be seen that there are potential opportunities available for industrial customers at all stations examined in the region except Coolkeeragh. It should be noted that the North-West of Northern Ireland requires specific assessment in line with the TSSPS (see Chapter 6). As the North-West is connected by a single double circuit 275 kV spur, an N-1-1 contingency is performed as a credible contingency:

- The loss of the Coolkeeragh-Magherafelt 275 kV double circuit; and
- Coolkeeragh steam and gas units are out on maintenance.

However, the capacity at Coolkeeragh is limited by the ability of the 275 kV structures to withstand mechanical loading from potential faults. SONI and NIEN will be bringing forward projects to address this issue, however, these are at an early stage.

Enniskillen station represents the second lowest capability of the 110 kV nodes assessed. Enniskillen 110 kV is connected to Dromore 110 kV station via two 110 kV circuits. The loss of one of these circuits creates a thermal overload on the other. This limits demand connection capability.

37 Please note that the demand opportunities results are not cumulative. Each station is assessed individually, taking account of forecast demand growth only at stations outside of the test node. These figures are indicative only, with further detailed assessment of each station required. Customers considering connecting demand to the NI transmission system are advised to contact SONI as early in the project as possible.

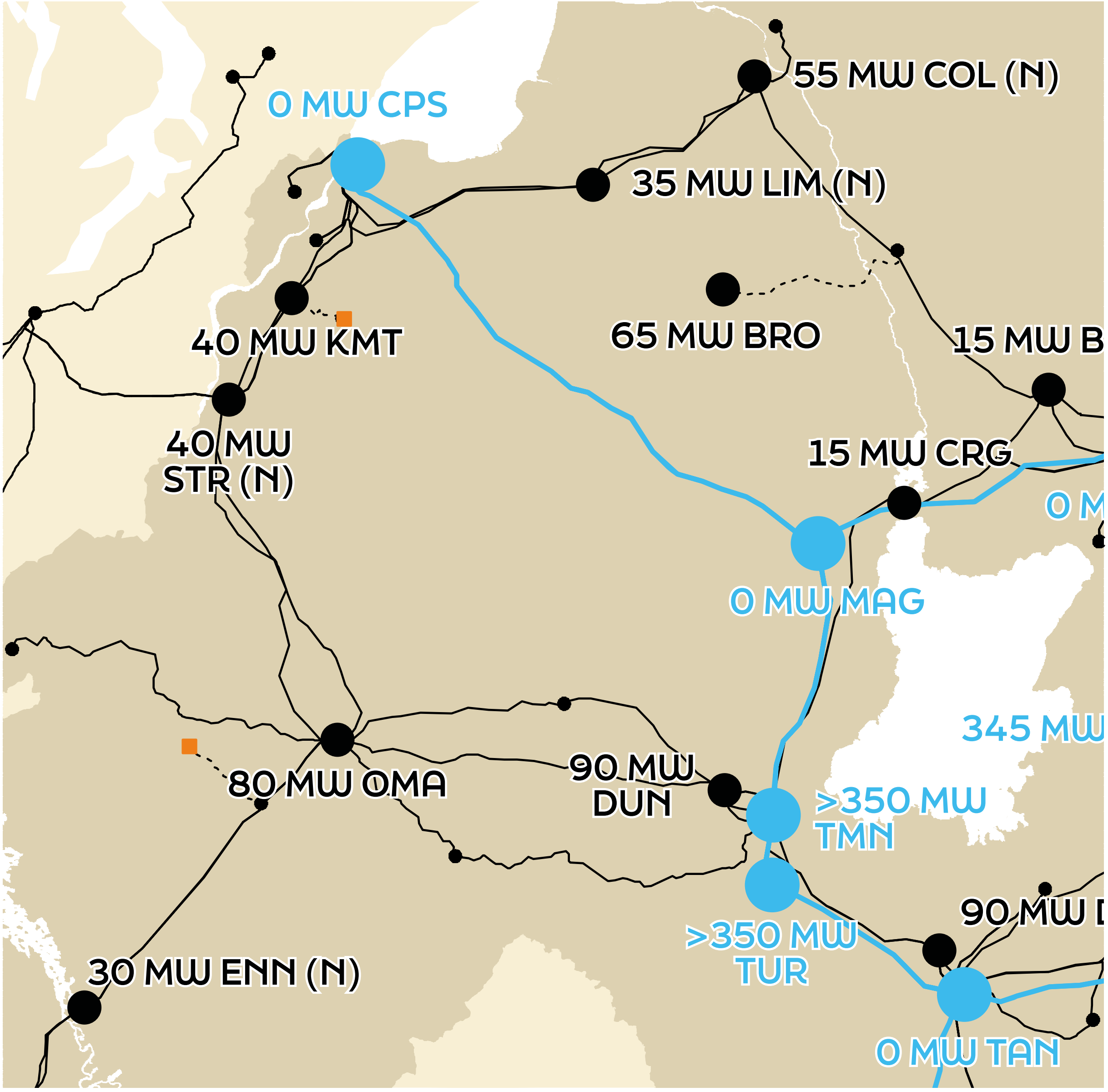


Figure 8-8: Capability for additional demand in the North and West of Northern Ireland

8.7 How to use the information for demand

Although not every station was considered, the results presented can be regarded as a guide to opportunities at other stations in the same area.

Customers wishing to use the demand opportunity results described in this chapter when considering where to connect should follow these steps:

Consult the maps in Appendix A to find the nearest transmission station to the proposed development. Also, the nearest station for which opportunity has been assessed should be identified, where it differs from the nearest transmission station.

The anticipated demand growth at the relevant station can be obtained from the demand forecasts presented in Appendix C. The transmission system is being planned to meet this level of demand increase.

Consider the impact of changes to the transmission system since the analysis was carried out.

Consult with EirGrid or SONI on the proposed location as early as possible as well as consulting the EirGrid application process or SONI application process.

Early consultation with us is encouraged so that we can work jointly to explore options relating to any potential proposals and enable timely decision making.

Note that all opportunities are all subject to adequacy requirements being met and other policy requirements as determined by the CRU.

Appendix A: Maps and schematic diagrams

Appendix A contains geographical maps of the All-Island Transmission System and short bus codes for every transmission voltage node on the island. Geographical maps are presented illustrating the All-Island Transmission System in 2022 and as planned for in 2030 as at data freeze date of 1st January 2022.

A.1 Network maps

This section includes two network maps:

- Figure A-1 is a map of the All-Island Transmission System as at January 2022; and
- Figure A-2 is a map of the planned All-Island Transmission System in 2031.

Note: There are a number of network reinforcement projects that do not have a finalised reinforcement solution. They are shown on the Transmission System Map as a transparent bubble in Figure A-2. The solutions that will be used for these projects have not yet been finalised.

Figure A-1: Transmission system 400 kV, 275 kV and 110 kV, January 2022

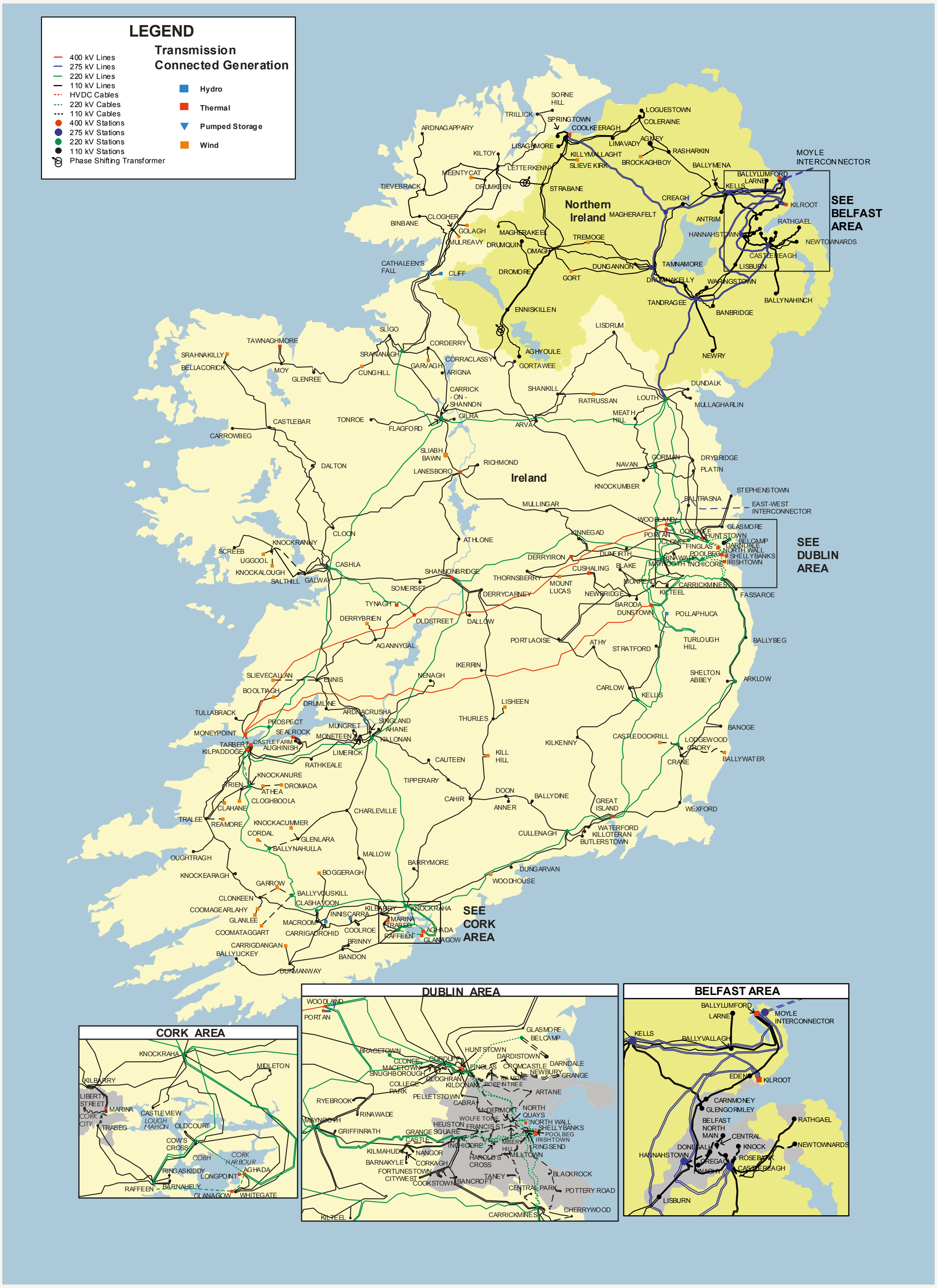
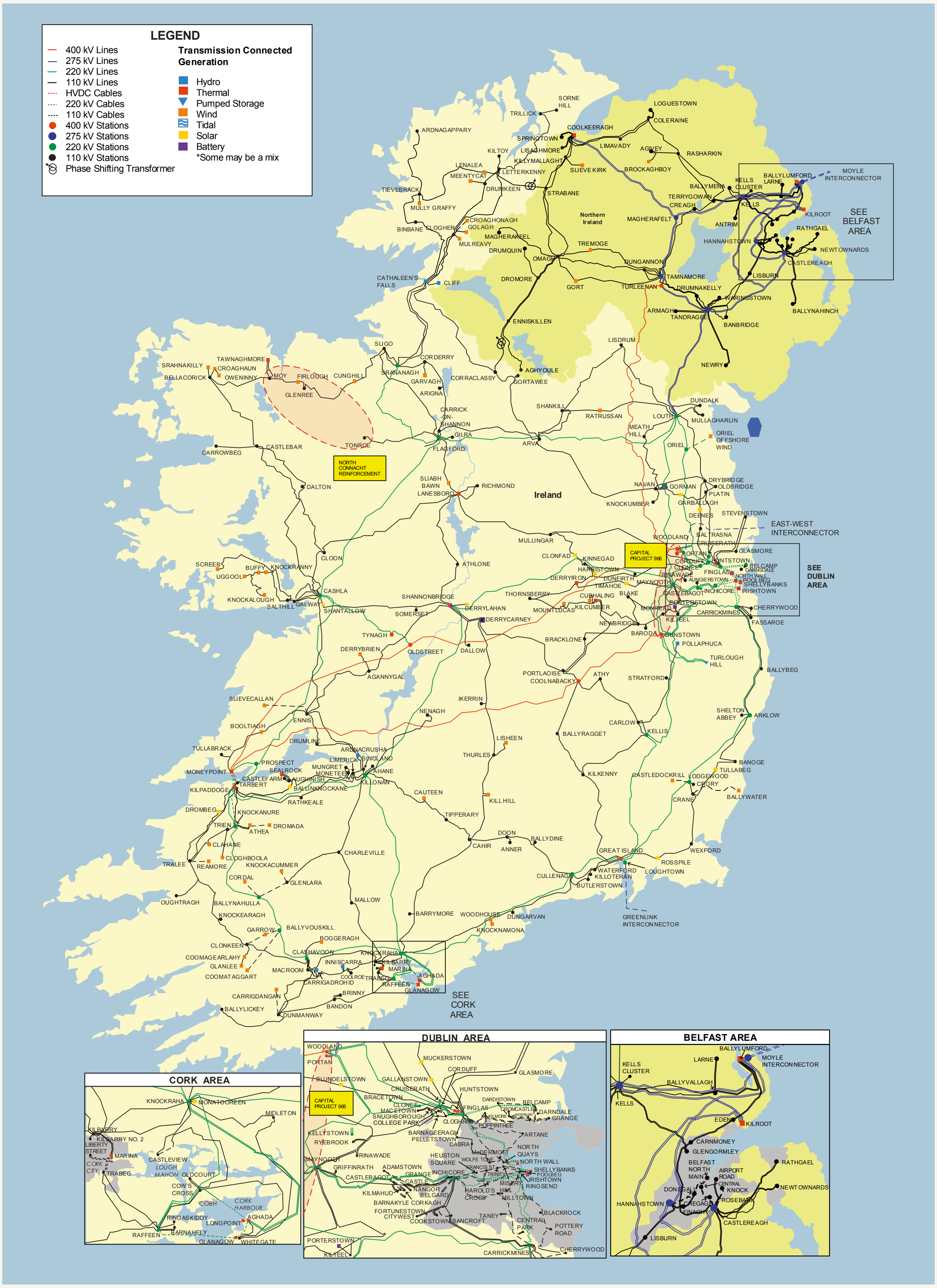


Figure A-2: Planned transmission system 400 kV, 275 kV and 110 kV, December 2031



A.2 Short bus codes

The following table associates full station names with the two or three letter codes used in the schematic diagrams in Section A.3, in the tables in Appendices B and C, and the power flow tables in Appendix H. Stations in Northern Ireland and Ireland with the same three letter bus code are distinguished with (N) for Northern Ireland and (I) for Ireland.

Table A-1: Short bus codes

Short bus code	Full name
AA	Ardnacrusha
AD	Aghada
ADM	Adamstown
AGH	Aghyoule
AGL	Agannygal
AGN	Aungierstown
AGI	Agivey Cluster
AGT	Aught
AGY	Ardnagappary
AHA	Ahane
AIR	Airport Road
ANR	Anner
ANT	Antrim
ARI	Arigna
ARK	Arklow
ARM	Armagh
ART	Artane
ARV	Arva
ATE	Athea
ATH	Athlone
ATY	Athy
AUG	Aughinish
BAG	Barnageeragh
BAL	Baltrasna
BAN (I)	Bandon
BAN (N)	Banbridge
BAR	Barrymore
BCM	Ballycummin
BCT	Bancroft
BDA	Baroda
BDM	Ballydam
BDN	Ballydine
BDV	Barnadivane
BEG	Ballybeg
BFP	Belfast Power Station
BGD	Belgard Road
BGH	Boggeragh
BGN	Bogtown
BGT	Ballyragget
BIN	Binbane
BK	Bellacorick
BKM	Bunkimalta
BKY	Barnakyle
BLA	Blackrock
BLC	Belcamp
BLE	Ballinknockane
BLI	Ballylickey
BLK	Blake
BLU	Blundelstown
BMA	Ballymena
BNH	Ballynahinch
BNM	Belfast North
BOG	Banoge
BOL	Booltiagh

Table A-1: Short bus codes

Short bus code	Full name
BPS	Ballylumford Power Station
BRA	Bracklone
BRI	Brinny
BRO	Brockaghboy
BRT	Bracetown
BRY	Barnahely
BUF	Buffy
BUT	Butlerstown
BVG	Ballyvallagh
BVK	Ballyvouskill
BWR	Ballywater
BYC	Ballycronan More (Moyle)
BYH	Ballynahulla
CAB	Cabra
CAE	CAES
CAG	Carrickalangan
CAH	Cahir
CAM	Cam Cluster
CAR	Carnmoney
CAS	Castlereagh
CBG	Carrowbeg
CBL	Cloghboola
CBR	Castlebar
CBT	Castlebagot
CCN	Cloncreen
CD	Carrigadrohid
CDN	Carrigdangan
CDF	Carrickaduff
CDK	Castledockrill
CDL	Cordal
CDU	Corduff
CDY	Corderry
CEN	Belfast Central

Short bus code	Full name
CF	Cathaleen's Fall
CFD	Clonfad
CFM	Castlefarm
CGL	Coomagearlahy
CH	Cahernagh
CHA	Charleville
CHE	Cherrywood
CHR	Cahernagh
CKG	Corkagh
CKM	Carrickmines
CKN	Clonkeen
CL	Cliff
CLA	Clashavoon
CLD	Coolderrig
CLE	Clonee
CLG	Cloghran
CLH	Clahane
CLM	Culmore_RD
CLN	Cloon
CLO	Clogher
CLS	Clonshaugh
CLW	Carlow
CNB	Coolnabacky
CNG	Coolnanoonag
CNF	Caraunduff
CNN	Croaghnagawna
COL (I)	College Park
COL (N)	Coleraine
COO	Cookstown
COR	Corraclassy
COS	Carrick-on-Shannon
COW	Cow Cross
CPK	Central Park

Table A-1: Short bus codes

Short bus code	Full name
CPS	Coolkeeragh Power Station
CRA	Crane
CRD	Croaghonagh
CRE	Cregagh
CRG	Creagh
CRH	Cruiserath
CRM	Cromcastle
CRN	Croaghaun
CRO	Coolroe
CRR	Curragha
CRY	Crory
CSH	Cashla
CTG	Coomataggart
CTN	Cauteen
CTY	City West
CUL	Cullenagh
CUN	Cunghill
CUR	Cureeny
CUS	Cushaling
CVW	Castleview
DAL	Dallow
DRN	Darndale
DDK	Dundalk
DEE	Deenes
DER	Derryiron
DEY	Derrycarney
DFR	Dunfirth
DGN	Dungarvan
DHN	Derrylahan
DJG	Drombeg
DLN	Derrylyn
DLT	Dalton
DMY	Dunmanway

Short bus code	Full name
DON	Donegall
DOO	Doon
DRM	Drumkeen
DRN	Darndale
DRO	Dromada
DRO (N)	Dromore
DRQ	Drumquin Cluster
DRU (I)	Drumline
DRU (N)	Drumnakelly
DRY	Drybridge
DSN	Dunstown
DTN	Dardistown
DUN	Dungannon
DYN	Derrybrien
EDE	Eden
ENN (I)	Ennis
ENN (N)	Enniskillen
FAS	Fassaroe
FAS E	Fassaroe East
FGH	Firlough
FIN (I)	Finglas
FIN (N)	Finaghy
FLA	Flagford
FNT	Finnstown
FRN	Francis Street
GAE	Glanlee
GAL	Galway
GRV	Garvagh
GCA	Grange Castle
GGO	Glanagow
GGT	Garrintaggart
GI	Great Island
GIL	Gilra

Table A-1: Short bus codes

Short bus code	Full name
GLA	Glasmore
GLE (I)	Glenlara
GLE (N)	Glengormley
GLN	Glen
GAN	Gallanstown
GLH	Glencloosagh
GLR	Glenree
GOL	Golagh
GOR (I)	Gorman
GOR (N)	Gort Cluster
GRA	Grange
GRH	Garballagh
GRI	Griffinrath
GRO	Garrow
GWE	Gortawee
HAN	Hannastown
HAR	Harolds Cross
HEU	Heuston Square
HN	Huntstown
HRR	Harristown
IA	Inniscarra
IKE	Ikerrin
INC	Inchicore
ISH	Irishtown
KBY	Kilbarry
KBY2	Kilbarry No. 2
KCR	Knockacummer
KCY	Kilcarbery
KDN	Kildonan
KEL	Kells
KLC	Kells Cluster
KER	Knockearagh
KHL	Kill Hill

Short bus code	Full name
KIN	Kinnegad
KKY	Kilkenny
KLH	Knockalough
KLM	Kilmore
KLN	Killonan
KLS	Kellis
KMA	Knocknamona
KMT	Killymallaght
KNO	Knock
KNR	Knockanure
KNV	Knockavanna
KNY	Knockranny
KPG	Kilpaddoge
KPN	Killinaparson
KPS	Kilroot Power Station
KRA	Knockraha
KSE	Kishoge
KTL	Kilteel
KTN	Killoteran
KUD	Kilmahud
KUR	Knockumber
KYT	Kellystown
LA	Lanesboro
LAR	Larne
LCK	Lickny
LET	Letterkenny
LGT	Lysaghtstown
LIB	Liberty Street
LIM (I)	Limerick
LIM (N)	Limavady
LIS (I)	Lisdrum
LIS (N)	Lisburn
LMR	Lisaghmore

Table A-1: Short bus codes

Short bus code	Full name
LNA	Lenalea
LOG	Loguestown
LOU	Louth
LPT	Longpoint
LSN	Lisheen
LUM	Lumcloon
LWD	Lodgewood
MAC	Macroom
MAG	Magherafelt
MAL	Mallow
MAY	Maynooth
MCD	McDermott
MCE	Macetown
MEE	Meentycat
MEN	Monatooreen
MGT	Mulgeeth
MHL	Misery Hill
MID	Midleton
MIL	Milltown
MKL	Magherakeel Cluster
MLC	Mountlucas
MLG	Mully Graffy
MLN	Mullagharlin
MNH	Metro North
MON	Monread
MOY	Moy
MP	Moneypoint
MR	Marina
MRN	Mooretown
MRY	Mulreavy
MTA	Metro Airport
MTH	Meath Hill
MTN	Moneteen
MUC	Muckerstown
MUL	Mullingar
MUN	Mungret
NAN (I)	Nangor
NAR	Newtownards
NAV	Navan
NBY	Newbury
NEN	Nenagh
NEW (I)	Newbridge
NEW (N)	Newry
NQS	North Quays
NW	North Wall
OLD	Oldcourt
OMA	Omagh
ORL	Oriel
OST	Oldstreet
OUG	Oughtragh
PA	Pollaphuca
PB	Poolbeg
PGN	Pigeon Top
PLA	Platin
PLS	Portlaoise
PMT	Peamount
POP	Poppintree
POT	Pottery Road
PPT	Philipstown
PRO	Prospect
PRT	Portan
PTN	Pelletstown
RAF	Raffeen
RAT (I)	Rathkeale
RAT (N)	Rathgael
RE	Ringsend

Table A-1: Short bus codes

Short bus code	Full name
REM	Reamore
RIC	Richmond
RNW	Rinawade
ROP	Rosspile
ROS	Rosebank
RRU	Ratrussan
RSK	Rasharkin Cluster
RSY	Ringaskiddy
RTO	Rathnaskillo
RYB	Ryebrook
SAL	Salthill
SBH	Snughborough
SCR	Screeb
SH	Shannonbridge
SHE	Shelton Abbey
SHL	Shellybanks
SK	Sealrock
SKL	Shankill
SKY	Srahnakilly
SLB	Sliabh Bawn
SLC	Slievecallan
SLI	Sligo
SLK	Slieve Kirk
SNG	Singland
SOM	Somerset
SOR	Sorne Hill
SPR	Springtown
SRA	Srananagh
STR (I)	Stratford
STR (N)	Strabane
SVN	Stevenstown
SXH	Shantallow

Short bus code	Full name
TAN	Tandragee
TAW	Tawnaghmore
TB	Tarbert
TBG	Trabeg
TBK	Tullabrack
TEN	Timahoe
TGW	Terrygowan
TH	Turlough Hill
THU	Thurles
TIP	Tipperary
TIV	Tievebrack
TLK	Trillick
TLY	Tanley
TMN	Tamnamore
TON	Tonroe
TRE	Tremoge Cluster
TRI	Trien
TRL	Tralee
TRN	Trinity
TSB	Thornsberry
TTU	Tullabeg
TUR	Turleenan
TYN	Tynagh
UGL	Uggool
WAR	Waringstown
WAT	Waterford
WEX	Wexford
WH	Woodhouse
WHI	Whitegate
WOL	Wolfe Tone
YLW	Yellowmeadow

A.3 Schematic diagrams of the all-island transmission system

Schematic diagrams of the all-island transmission system are included to assist users in understanding the transmission system and in the identification of the changes outlined in Appendix B. Lines, cables, transformers, station busbars and reactive compensation devices are illustrated in the diagrams. The type of generation (thermal, wind, hydro or solar) at a station is also displayed. Table A-2 indicates the diagram conventions.

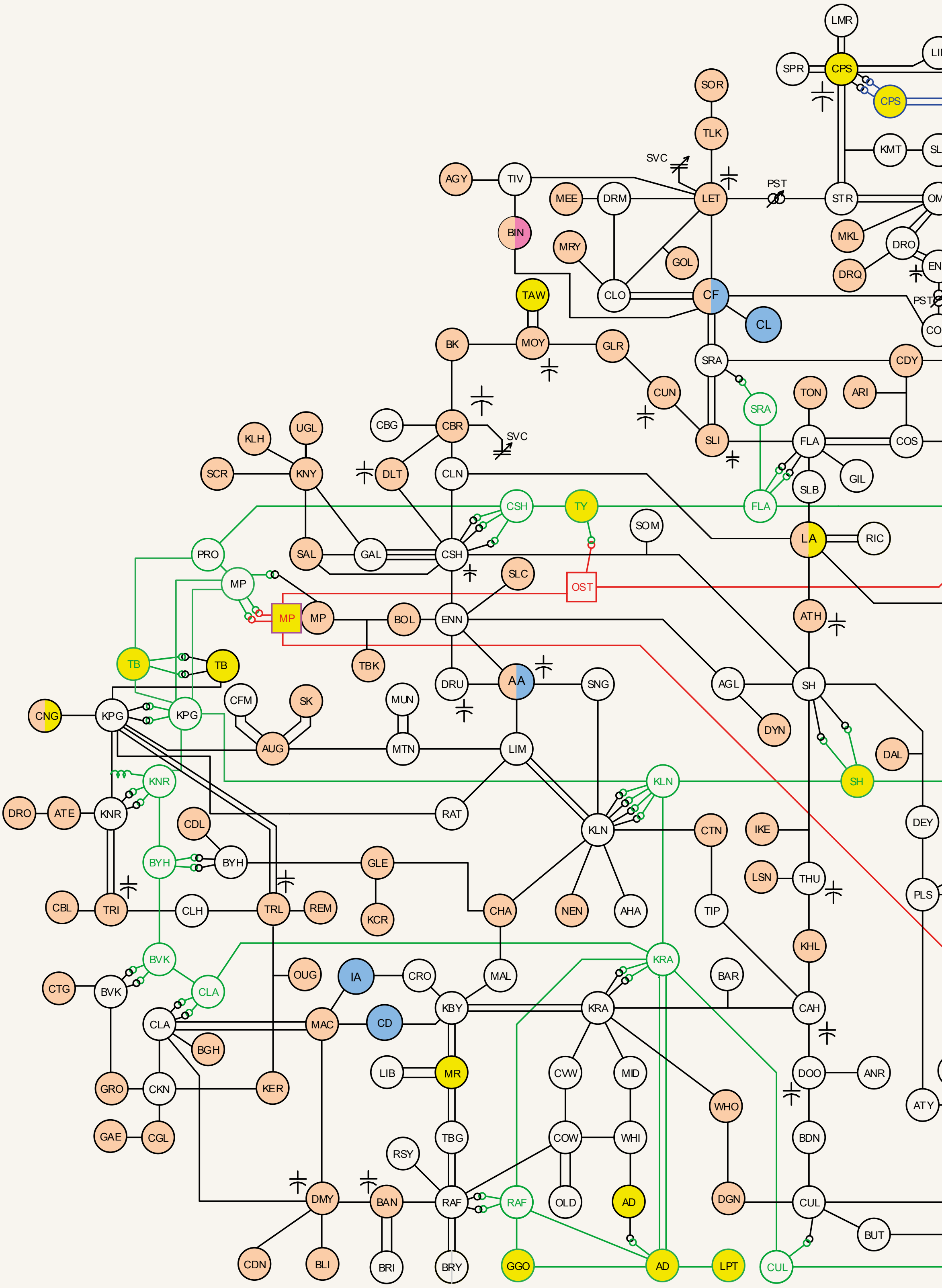
The schematic diagram for 2021 shows the transmission system as of January 2021. The schematic diagram for 2030 shows the planned transmission system due to be completed by the end of 2030.

Table A 2: Schematic Legend

Symbol	Network element represented
	110 kV Circuit
	220 kV Circuit
	275 kV Circuit
	400 kV Circuit
	System Link
	110 kV Busbar
	220 kV Busbar
	275 kV Busbar
	400 kV Busbar
	Busbar with thermal generation
	Busbar with wind generation (>5 MW)
	Busbar with hydro generation

Symbol	Network element represented
	Busbar with solar generation (> 5 MW)
	Busbar with wind and thermal generation
	Busbar with wind and hydro generation
	Busbar with wind and solar generation
	Capacitor
	Static Var compensator/STATCOM
	Reactor
PST	Phase shifting transformer
NO	Transformer
	Normally open point
SC	Series compensation

Figure A-3: Schematic diagram of the all-island transmission system as of January 2022



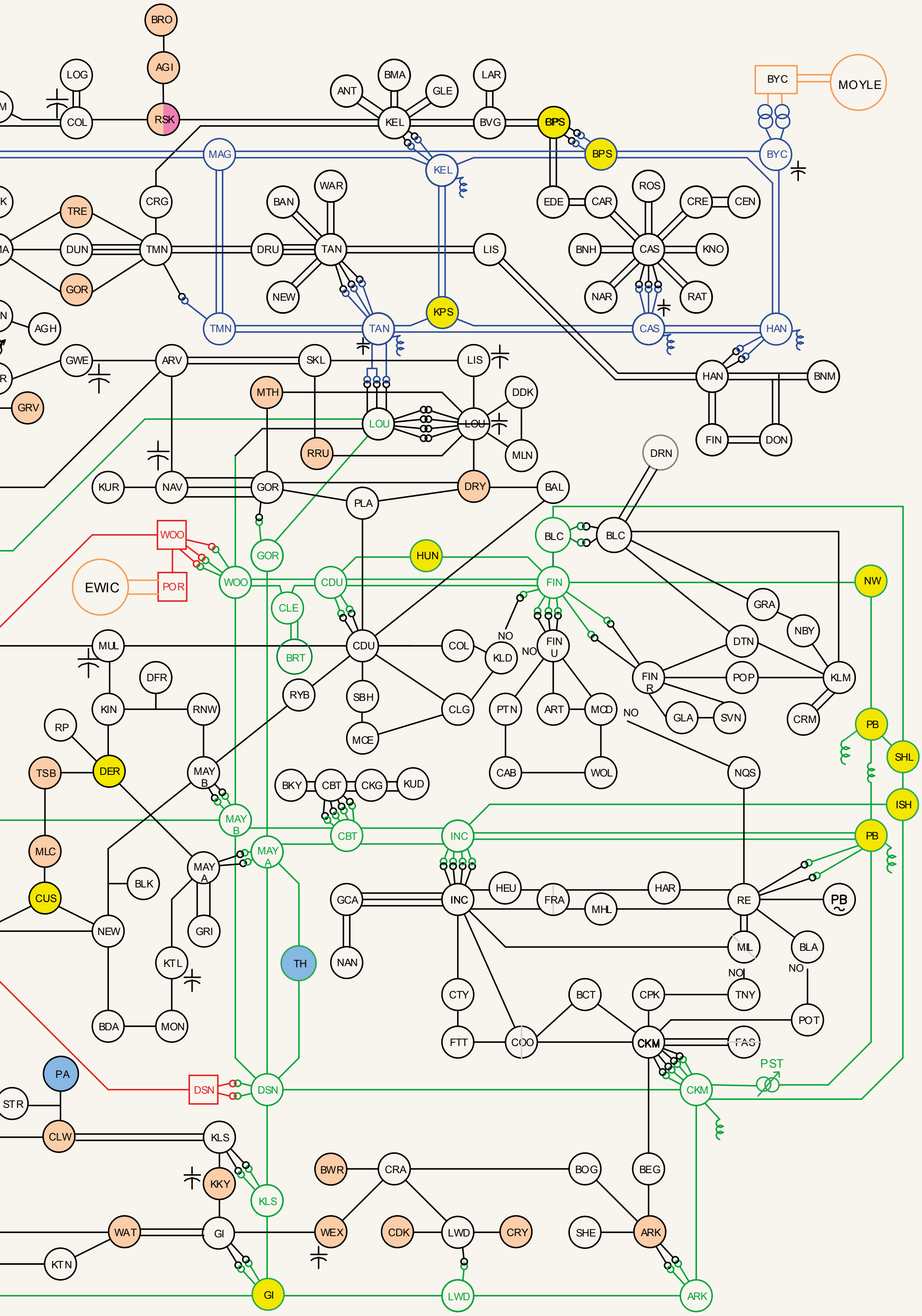

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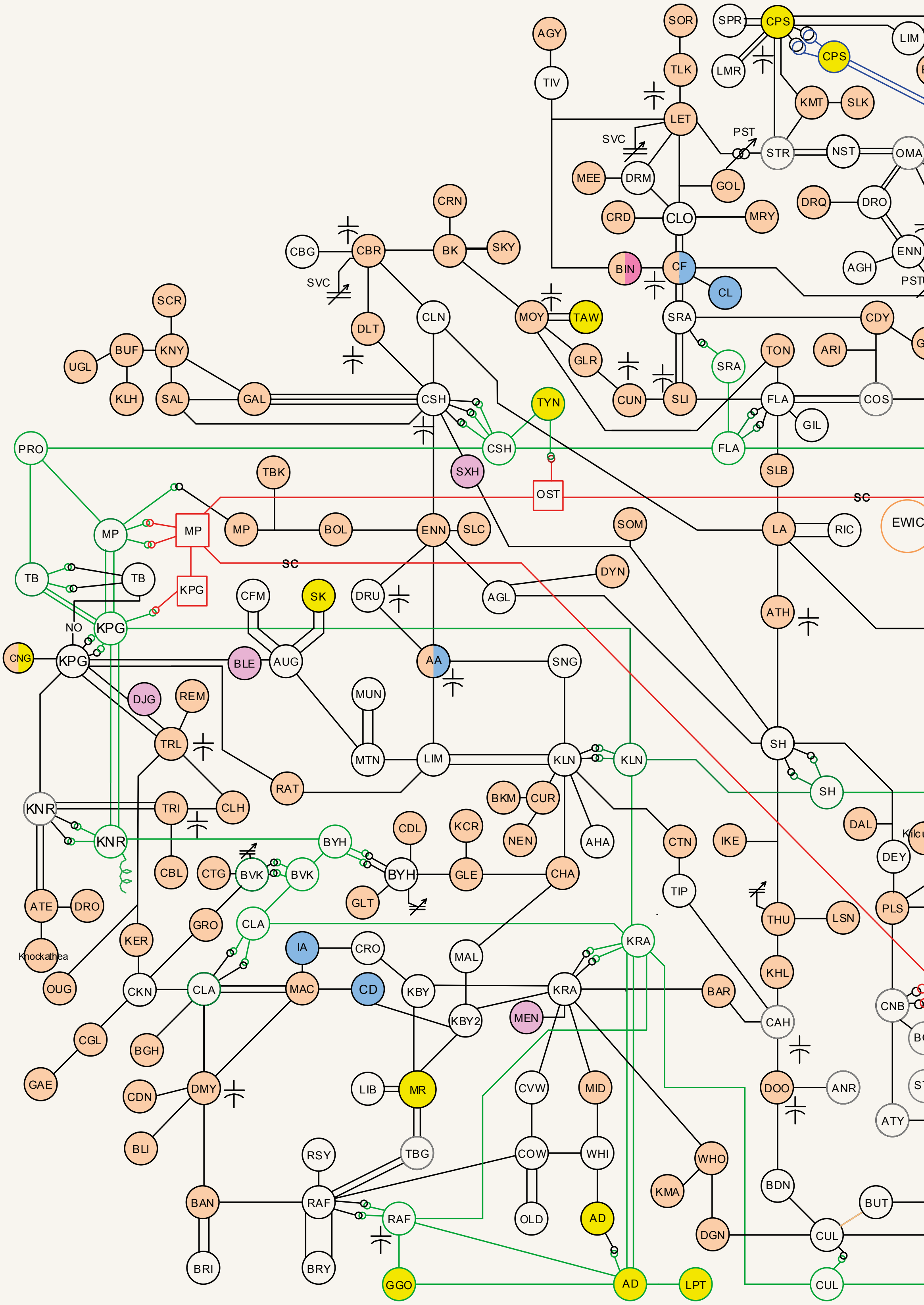
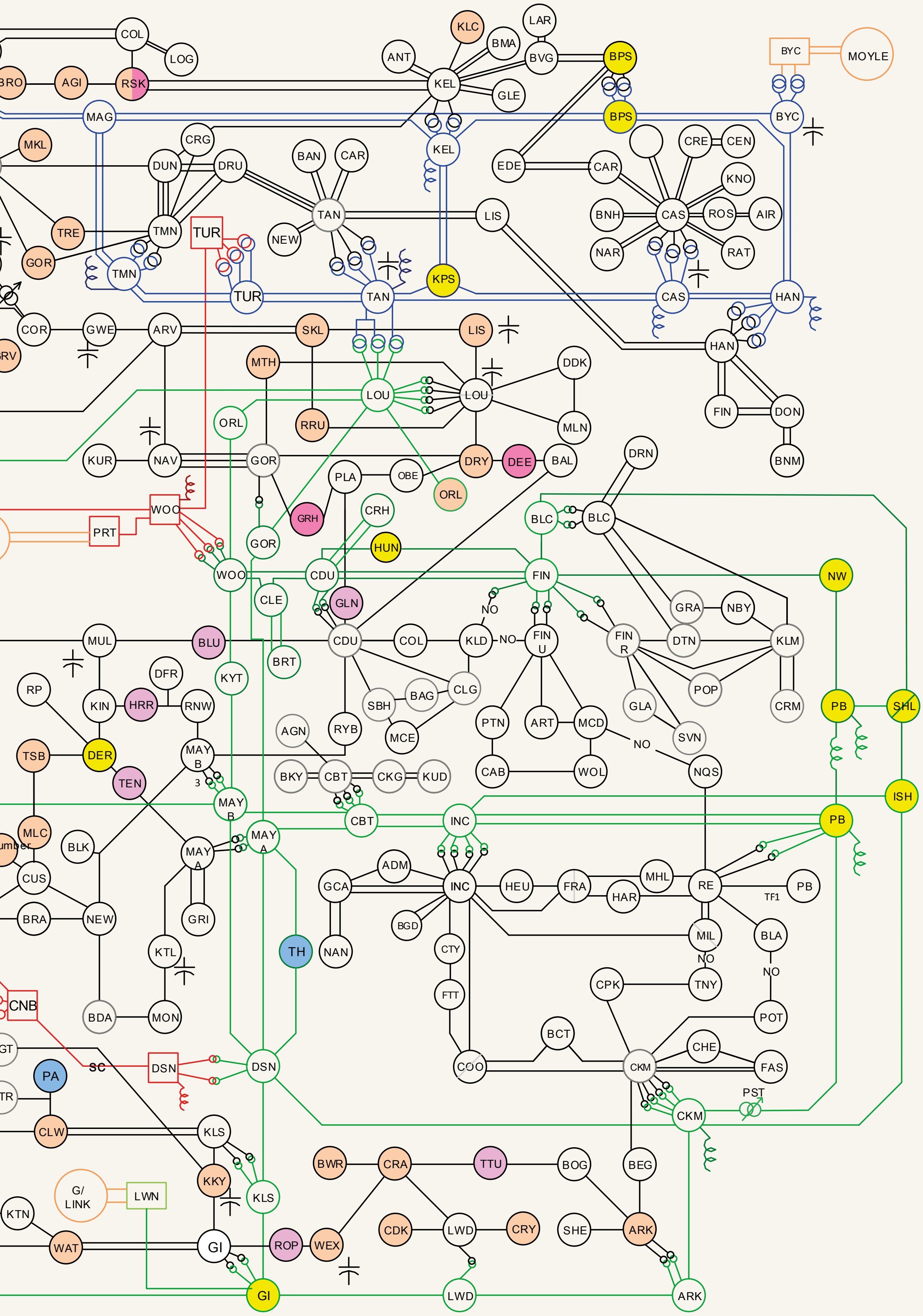
Figure A-4: Schematic diagram of the planned all-island transmission system as at December 2031

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Appendix B: Transmission system characteristics

This appendix presents details of the physical and electrical characteristics of the all-island transmission system.

Data is presented in tabular form:

- Section B.1 details the data for the existing[38] transmission system; and
- Section B.2 details the data for planned transmission system developments[39].

The following is a list of tables in Section B.1:

- Table B2 Characteristics of Existing Transmission Circuits;
- Table B3 Characteristics of Existing Transformers in Ireland;
- Table B4 Characteristics of Existing 3 Winding Transformers in Northern Ireland;
- Table B-5 Characteristics of Existing 2 Winding Transformers in Northern Ireland;
- Table B6 Characteristics of Existing Power Flow Controllers; and
- Table B7 Characteristics of Existing Reactive Compensation.

The following is a list of tables in Section B.2:

- Table B8 Expected Changes in Transmission Circuits;
- Table B9 Expected Changes in Transformers in Ireland;
- Table B10 Expected Changes in 3 Winding Transformers in Northern Ireland;
- Table B11 Expected Changes in 2 Winding Transformers in Northern Ireland; and
- Table B12 Expected Changes in Reactive Compensation.

Tables B-2 and B-8 include the ratings for lines and cables in MVA for winter and summer reference temperature conditions at 1 per unit (pu) voltage. The higher ambient temperature in summer dictates a reduced thermal rating for overhead lines. The rating is the maximum permissible power that the circuit can transport on a continuous basis.

Reference ambient temperatures are:

- Winter: 11°C[40]; and
- Summer: 25°C.

38 As at January 2022.
39 Includes transmission system reinforcement projects and developments necessary to connect new generation and demand.
40 ESB Networks previously calculated winter ratings based on an assumed winter temperature of 5°C. In 2018 this was changed to 11°C.

The electrical characteristics of the all-island transmission system at the four nominal voltage levels are documented. They are represented in per unit values, with a 100 MVA base, and the applicable reference voltage. Table B-1 below displays the four nominal and reference voltage levels on the all-island transmission system.

Table B-1: Nominal and reference voltage levels

Nominal voltage level (kV)	Reference voltage (kV)
400	400
275	275
220	220
110	110

In some cases, equipment associated with a line or cable may be lower rated than the circuit or line. However, this equipment[41] is easier to upgrade than lines and cables and is therefore not expected to restrict access to the transmission system.

A small number of 110 kV stations are connected to the transmission system via a tee. A tee is an un-switched connection into an existing line between two other stations. For the purposes of describing the various sections of lines in the following tables, tee points are identified by the name of the tee'd 110 kV station with a suffix 'T' added.

41 For example, current transformers.

B.1 Characteristics of the existing transmission system (January 2022)

Characteristics of existing transmission circuits

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
380	DSN	MP	1	208.5	0.004	0.044	1.14	1,283	1,331	1,454
380	MP	OST	1	104.14	0.004	0.027	0.489	1,283	1,331	1,454
380	OST	WOO	1	126	0.004	0.032	0.572	1,577	1,749	1,944
380	WOO	PRT	1	0.5	0	0	0.043	685	685	685
275	BPS	HAN	2	45.5	0.002	0.019	0.114	710	820	881
275	BPS	KEL	1	34.5	0.002	0.014	0.089	710	820	881
275	BPS	MAG	1	65.5	0.003	0.027	0.169	710	820	881
275	BPS	BYC	1	0.8	0	0	0.002	710	820	881
275	CAS	HAN	1	18.4	0.001	0.008	0.046	710	820	881
275	CAS	HAN	2	18.4	0.001	0.008	0.046	710	820	881
275	CAS	KPS	1	66.8	0.003	0.028	0.171	710	820	881
275	CAS	TAN	1	45.6	0.002	0.019	0.114	710	820	881
275	CPS	MAG	1	56.2	0.006	0.025	0.151	412	477	513
275	CPS	MAG	2	56.2	0.006	0.025	0.151	412	477	513
275	HAN	BYC	1	44.7	0.002	0.019	0.112	710	820	881
275	KEL	KPS	1	29	0.001	0.012	0.075	710	820	881
275	KEL	KPS	2	29	0.001	0.012	0.075	710	820	881
275	KEL	MAG	1	31.1	0.001	0.013	0.08	710	820	881
275	KPS	TAN	1	80.8	0.004	0.034	0.206	710	820	881
275	LOU	TAN	1	50	0.003	0.021	0.127	710	820	881
275	LOU	TAN	2	50	0.003	0.021	0.127	710	820	881
275	MAG	TMN	1	25.68	0.001	0.011	0.065	710	820	881
275	MAG	TMN	2	25.68	0.001	0.011	0.065	710	820	881
275	TAN	TMN	1	25.74	0.001	0.011	0.065	710	820	881
275	TAN	TMN	2	25.74	0.001	0.011	0.065	710	820	881
220	AD	AD	1	1.4	0	0.001	0.038	593	593	593
220	AD	GGO	1	3.78	0	0.002	0.104	536	573	573
220	AD	KRA	1	25.6	0.003	0.022	0.034	393	429	468

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
220	AD	KRA	2	25.6	0.003	0.022	0.034	393	429	468
220	AD	LPT	1	0.97	0	0	0.0265	593	593	593
220	AD	RAF	1	14.4	0.001	0.009	0.252	434	481	513
220	ARK	CKM	1	53.61	0.006	0.046	0.081	434	481	513
220	ARK	LOD	1	39.02	0.005	0.034	0.051	434	481	513
220	BLC	FIN	1	10	0	0.002	0.332	570	570	570
220	BTN	CLE	1	2.5	0.0001	0.0004	0.083	570	570	570
220	BTN	CLE	2	2.5	0.0001	0.0004	0.083	570	570	570
220	BVK	BYH	1	28.57	0.003	0.0246	0.05	434	473	513
220	BVK	CLA	1	16.78	0.002	0.014	0.025	740	769	792
220	CBT	INC	1	14.3	0.002	0.009	0.014	761	780	794
220	CBT	INC	2	14.32	0.002	0.012	0.02	761	780	794
220	CBT	MAY	1	11.72	0.002	0.012	0.018	761	780	794
220	CBT	MAY	2	11.7	0.002	0.01	0.016	761	780	794
220	CDU	FIN (I)	1	3.73	0	0.003	0.005	434	481	513
220	CDU	FIN (I)	2	3.73	0	0.003	0.005	434	481	513
220	CDU	HN	1	3.73	0	0.001	0.134	555	555	555
220	CDU	WOO	2	17.84	0.002	0.016	0.023	434	481	513
220	CKM	DSN	1	41.61	0.005	0.036	0.109	434	481	513
220	CKM	ISH	1	11.89	0	0.005	0.326	593	593	593
220	CLA	KRA	1	42.93	0.005	0.037	0.057	646	704	751
220	CLE	CDU	1	5.06	0.001	0.004	0.007	434	481	513
220	CLE	WOO	1	13.5	0.002	0.012	0.018	434	473	513
220	CSH	FLA	1	88.09	0.01	0.076	0.115	350	393	436
220	CSH	PRO	1	88.54	0.01	0.077	0.116	392	429	468
220	CSH	TYN	1	39.89	0.005	0.034	0.058	761	777	792
220	CUL	GI	1	23.34	0.003	0.02	0.044	746	746	793
220	CUL	KRA	1	86	0.012	0.074	0.117	646	704	765
220	DSN	KLS	1	59.3	0.007	0.051	0.078	393	429	468
220	DSN	MAY	1	36.29	0.004	0.032	0.048	350	393	436

Table B-2: Characteristics of existing transmission circuits										
Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
220	DSN	MAY	2	30.55	0.004	0.026	0.04	350	393	436
220	DSN	TH	1	26.62	0.003	0.022	0.144	351	351	351
220	FIN	HN	1	1.4	0	0.001	0.038	593	593	593
220	FIN	NW	1	11.85	0.001	0.004	0.67	332	332	332
220	FIN	SHL	1	13.4	0	0.005	0.367	536	557	557
220	FLA	LOU	1	110.08	0.013	0.098	0.145	384	430	475
220	FLA	SRA	1	56.01	0.006	0.047	0.077	434	481	513
220	GGO	RAF	1	9.5	0	0.005	0.414	570	570	570
220	GI	KLS	1	70.43	0.008	0.061	0.101	393	429	468
220	GI	LWD	1	48.08	0.006	0.042	0.07	434	481	513
220	GOR	LOU	1	32.41	0.004	0.028	0.042	434	473	476
220	GOR	MAY	1	42.19	0.005	0.037	0.055	350	393	436
220	INC	ISH	1	12.06	0	0.005	0.33	562	582	634
220	INC	PB	1	12.5	0.001	0.004	0.498	267	267	267
220	INC	PB	2	11.3	0	0.003	0.722	351	351	351
220	ISH	SHL	1	1.31	0	0.001	0.036	593	593	593
220	KLN	KPG	1	70.57	0.008	0.061	0.114	434	481	513
220	KLN	KRA	1	82.16	0.013	0.069	0.107	512	536	564
220	KLN	SH	1	89.7	0.014	0.08	0.12	269	322	354
220	KLP	KNR	1	21.4	0.003	0.015	0.054	731	750	762
220	KLP	KNR	2	20	0	0.01	0.971	731	750	762
220	KLP	MP	1	5.4	0	0.002	0.236	660	660	660
220	KLP	MP	2	5.4	0	0.002	0.236	660	660	660
220	KLP	TB	1	2.8	0	0.002	0.026	350	393	436
220	KLP	TB	2	2.8	0	0.002	0.028	350	393	436
220	KNR	BYH	1	37.79	0.005	0.033	0.061	434	473	513
220	KRA	RAF	1	19.25	0.002	0.017	0.026	353	405	454
220	LOU	WOO	1	61.2	0.007	0.053	0.08	350	393	436
220	MAY	SH	1	105.6	0.017	0.094	0.142	269	322	354
220	MAY	TH	1	53.1	0.006	0.044	0.184	325	351	351

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
220	MAY	WOO	1	22.3	0.003	0.02	0.03	350	393	436
220	MP	PRO	1	12.7	0.001	0.011	0.017	537	600	663
220	NW	PB	1	4.5	0	0.001	0.261	332	332	332
220	OST	TYN	1	10.04	0.001	0.008	0.014	434	481	513
220	PB	CKM	1	14.5	0.001	0.005	0.579	267	267	267
220	PB	PB	1	1	0	0.037	0	450	450	450
220	PB	SHL	1	0.12	0	0	0.003	593	593	593
220	PRO	TB	1	10.16	0.001	0.007	0.173	467	467	467
110	AA	DRU	1	18.15	0.027	0.063	0.006	99	110	121
110	AA	ENN (I)	1	32.33	0.048	0.111	0.012	99	110	121
110	AA	LIM (I)	1	11.7	0.007	0.037	0.012	178	194	209
110	AA1	SNG	1	5.46	0.003	0.017	0.007	145	161	177
110	AD	WHI	1	3.1	0.005	0.011	0.001	99	110	121
110	ADM	GCA	1	2.5	0.002	0.004	0.025	140	140	140
110	ADM	INC	1	10.5	0.009	0.027	0.024	103	123	134
110	AGH (N)	ENN (N)	1	31.1	0.039	0.095	0.019	109	114	124
110	AGL	DYN	1	8	0.012	0.028	0.003	105	116	123
110	AGL	ENN (I)	1	38.2	0.059	0.131	0.012	99	110	121
110	AGL	SH	1	45.88	0.068	0.157	0.017	104	113	119
110	AHA	KLN	1	3.77	0.004	0.012	0.004	112	112	112
110	ANR	DOO	1	2	0.003	0.007	0.001	105	116	123
110	ANT	KEL	1	8.93	0.012	0.03	0.003	82	95	103
110	ANT	KEL	2	8.93	0.012	0.03	0.003	82	95	103
110	ARD	TIV	1	35	0.054	0.12	0.011	105	116	123
110	ARI	ARI-T	1	0.21	0	0.001	0	105	116	123
110	ARK	BEG	1	21.94	0.01	0.079	0.007	99	111	122
110	ARK	BOG	1	29	0.021	0.095	0.01	178	197	210
110	ARK	SHE	2	2.2	0.004	0.008	0.001	34	46	57
110	ART	FIN (I)	1	9	0.005	0.01	0.055	120	120	131
110	ART	MCD	1	4.9	0.003	0.006	0.03	120	120	131

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	ARV	COS	1	43.04	0.067	0.148	0.014	104	113	123
110	ARV	GWE	1	30.6	0.019	0.099	0.011	178	197	210
110	ARV	NAV	1	65.5	0.041	0.213	0.023	178	197	210
110	ARV	SKL	1	18.52	0.012	0.06	0.007	178	197	210
110	ARV	SKL	2	23.56	0.015	0.076	0.01	178	197	210
110	ATE	DRO	1	5.47	0.001	0.006	0.06	120	124	140
110	ATE	KNR	1	6.71	0.004	0.021	0.007	178	197	210
110	ATH	LA	1	35.78	0.054	0.123	0.012	99	110	121
110	ATH	SH	1	21.63	0.014	0.07	0.011	178	190	190
110	ATN	INC	1	6.5	0.005	0.01	0.065	140	140	140
110	ATN	INC	2	6.5	0.005	0.01	0.065	140	140	140
110	ATY	CLW	1	24.23	0.036	0.083	0.008	99	110	121
110	ATY	PLS	1	25.48	0.038	0.088	0.008	99	110	121
110	AUG	CFM	1	0.65	0.001	0.002	0.001	96	96	96
110	AUG	CFM	2	0.67	0.001	0.002	0.001	96	96	96
110	AUG	KPG	1	32.83	0.021	0.107	0.012	178	197	210
110	AUG	MTN	1	27.5	0.017	0.089	0.01	178	197	210
110	AUG	SK	3	1	0.001	0.001	0.006	120	120	120
110	AUG	SK	4	1	0.001	0.001	0.006	120	120	120
110	BAL	CDU	1	15.93	0.011	0.055	0.006	178	194	209
110	BAL	DRY	1	20	0.013	0.065	0.007	178	197	210
110	BAN	BRI	1	2.6	0.004	0.009	0.001	105	116	123
110	BAN	BRI	2	2.5	0.004	0.009	0.001	99	110	121
110	BAN	DMY	1	25.9	0.04	0.089	0.008	99	110	121
110	BAN	RAF	1	26.89	0.041	0.091	0.012	99	110	121
110	BAN (N)	TAN	1	18.4	0.024	0.062	0.006	82	95	103
110	BAN (N)	TAN	2	18.4	0.019	0.049	0.005	82	95	103
110	BAR	BAR	1	0.31	0	0.001	0	136	150	159
110	BCT	CKM	1	3.1	0.002	0.005	0.031	140	140	140
110	BCT	COO	1	15.1	0.014	0.045	0.027	130	130	130

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	BDA	MON	1	11.2	0.01	0.03	0.029	99	110	121
110	BDA	NEW (I)	1	7.2	0.006	0.017	0.028	122	122	122
110	BDN	CUL	1	21.8	0.031	0.075	0.007	196	216	217
110	BDN	DOO	1	11.3	0.007	0.037	0.004	178	197	210
110	BEG	CKM	1	32.3	0.015	0.116	0.01	136	150	159
110	BIN	CF	1	34.26	0.053	0.118	0.011	99	110	121
110	BIN	TIV	1	23.2	0.024	0.077	0.008	136	150	159
110	BK	CBR	1	37.39	0.053	0.128	0.014	195	202	221
110	BK	MOY	1	27	0.017	0.088	0.01	178	197	210
110	BK	SKY	1	4	0.001	0.004	0.044	192	192	192
110	BK	CGW	1	3.3	0.002	0.011	0.001	178	197	210
110	BK	SKY	1	4	0.001	0.004	0.044	187	206	223
110	BKT	CUR	1	7.3	0.004	0.007	0.072	120	120	120
110	BLA	POT	1	5.2	0.002	0.004	0.092	119	119	119
110	BLA	RE	1	7.7	0.003	0.006	0.136	119	119	119
110	BLC	GRA	1	4.3	0.0025	0.005	0.031	140	140	140
110	BLC	KLM	1	4	0.002	0.005	0.029	140	140	140
110	BLI	DMY	1	27.57	0.043	0.094	0.01	105	116	123
110	BLK	BLK	1	0.5	0.001	0.002	0	136	150	159
110	BMA	KEL	1	10	0.013	0.035	0.003	109	119	124
110	BMA	KEL	2	11.5	0.015	0.04	0.004	109	119	124
110	BNH	CAS	1	21.2	0.028	0.071	0.007	82	95	103
110	BNH	CAS	2	21.2	0.028	0.071	0.007	82	95	103
110	BKY	CBT	1	1	0	0.001	0.011	187	206	223
110	BKY	CBT	2	0.6	0	0.001	0.011	187	206	223
110	BNM	DON	1	6.02	0.005	0.005	0.053	75	75	82
110	BNM	DON	2	5.81	0.005	0.005	0.053	75	75	82
110	BGH	CLA	1	13.5	0.008	0.04	0.027	178	197	210
110	BOG	CRA	1	24.67	0.018	0.081	0.009	178	197	210
110	BOL	ENN	1	24.69	0.016	0.08	0.009	178	197	210

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	BOL	TBK T	1	18.289	0.012	0.059	0.006	178	197	210
110	BPS	BVG	1	17.3	0.023	0.058	0.006	82	95	103
110	BPS	BVG	2	17.3	0.023	0.058	0.006	82	95	103
110	BPS	EDE	1	15.1	0.023	0.054	0.005	69	80	86
110	BPS	EDE	2	15.1	0.023	0.053	0.005	70	81	87
110	BRK.	RSK	1	17.44	0.01	0.062	0.02	144	144	144
110	BRY	RAF	1	1.7	0.003	0.006	0.001	63	82	92
110	BRY	RAF	2	1.8	0.002	0.006	0.001	99	110	121
110	BUT	CUL	1	12.32	0.008	0.038	0.013	178	192	192
110	BUT	KTN	1	2.72	0.004	0.01	0.001	200	209	216
110	BVG	KEL	1	21.2	0.028	0.073	0.007	109	119	124
110	BVG	KEL	2	20.3	0.027	0.07	0.007	109	119	124
110	BVG	LAR	1	7.1	0.007	0.023	0.002	79	79	113
110	BVG	LAR	2	7.1	0.007	0.023	0.002	79	79	113
110	BVK	CTG	1	31.7	0.006	0.036	0.386	228	228	228
110	BWR	CRA	1	22.4	0.008	0.023	0.137	115	115	115
110	BYH	CDL	1	9.54	0.002	0.011	0.105	195	201	220
110	BYH	GLE	1	19.1	0.006	0.022	0.186	124	124	124
110	CAB	PTN	1	2.66	0.002	0.007	0.005	80	105	119
110	CAB	WOL	1	4.7	0.003	0.005	0.029	120	120	131
110	CAH	BAR	1	43.69	0.065	0.15	0.014	105	116	123
110	CAH	DOO	1	15.73	0.01	0.051	0.006	178	197	210
110	CAH	KHL	1	17.95	0.011	0.058	0.006	178	197	210
110	CAH	TIP	1	18.06	0.011	0.059	0.006	178	197	210
110	CAR	CAS	1	24.7	0.037	0.088	0.008	69	80	86
110	CAR	CAS	2	24.7	0.037	0.086	0.008	70	81	87
110	CAR	EDE	1	12.4	0.019	0.043	0.004	69	80	86
110	CAR	EDE	2	12.4	0.019	0.044	0.004	69	80	86
110	CAS	CRE	1	2.96	0.001	0.004	0.061	132	132	145
110	CAS	CRE	2	2.96	0.001	0.004	0.061	132	132	145

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	CAS	KNO	1	4.59	0.005	0.004	0.044	66	66	73
110	CAS	KNO	2	4.52	0.005	0.004	0.044	66	66	73
110	CAS	NAR	1	18	0.015	0.04	0.071	109	109	124
110	CAS	NAR	2	19.8	0.018	0.046	0.07	109	124	124
110	CAS	RAT (N)	1	18.9	0.025	0.064	0.006	82	95	103
110	CAS	RAT (N)	2	18.9	0.025	0.064	0.006	82	95	103
110	CAS	ROS	1	1.83	0.001	0.003	0.015	144	144	152
110	CAS	ROS	2	1.83	0.001	0.003	0.015	144	144	152
110	CAU	KLN	1	29.24	0.018	0.095	0.01	178	197	210
110	CBA	TRI	1	13.62	0.007	0.019	0.099	124	124	124
110	CBG	CBR	1	26.71	0.035	0.078	0.059	99	110	121
110	CBR	CLN	1	57.52	0.089	0.198	0.02	99	110	121
110	CBR	DLT	1	27.77	0.043	0.096	0.009	99	110	121
110	CCF	CAD	1	5.5	0.001	0.007	0.061	140	140	140
110	CCF	CKL	1	7	0.002	0.009	0.077	140	140	140
110	CD	KBY	1	32.338	0.02	0.104	0.025	178	194	209
110	CD	MAC	1	2.41	0.002	0.008	0.001	178	197	210
110	CDK	LWD	1	8.4	0.003	0.009	0.051	115	115	115
110	CDU	MUL	1	73.26	0.093	0.242	0.038	104	113	122
110	CDU	PLA	1	37	0.023	0.12	0.013	178	197	210
110	CDU	RYB	1	13.01	0.014	0.043	0.005	103	123	128
110	CDU	SBH	1	1.77	0	0.003	0.015	238	238	238
110	CDY	ARI T	1	13.68	0.009	0.045	0.005	178	197	210
110	CDY	GRV	1	5.83	0.004	0.019	0.003	132	137	150
110	CDY	SRA	1	12.7	0.02	0.044	0.004	178	197	210
110	CEN	CRE	1	3.22	0.001	0.004	0.03	144	144	144
110	CEN	CRE	2	3.22	0.001	0.004	0.03	144	144	144
110	CF	CL	1	5.5	0.006	0.018	0.002	136	150	159
110	CF	CLO	2	25.74	0.039	0.088	0.009	178	194	209
110	CF	COR	1	61.3	0.039	0.199	0.022	178	194	209

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	CF	SRA	1	52.98	0.065	0.179	0.021	196	214	234
110	CF	CLO	1	26.07	0.016	0.088	0.016	178	194	209
110	CF	SRA	2	49.2	0.031	0.16	0.017	178	197	210
110	CGL	GAE	1	2	0.001	0.001	0.011	130	130	130
110	CHA	GLE	1	28.06	0.042	0.096	0.009	99	110	121
110	CHA	KLN	1	36.9	0.039	0.123	0.013	136	150	159
110	CHA	MAL	1	22.5	0.014	0.073	0.008	178	197	210
110	CHE	FAS	1	2.2	0.004	0.008	0.001	105	116	123
110	CKG	CBT	1	0.75	0	0.001	0.008	187	206	223
110	CKG	CBT	2	0.75	0	0.001	0.008	187	206	223
110	CKG	KUD	1	0.75	0	0.001	0.008	187	206	223
110	CKM	CHE	1	4	0.004	0.008	0.03	105	116	123
110	CKM	COO	2	16	0.013	0.042	0.06	130	130	130
110	CKM	FAS	1	2.9	0.005	0.01	0.001	105	116	123
110	CKM	FAS	1	7.5	0.012	0.026	0.002	105	116	123
110	CKM	POT	1	3.2	0.001	0.003	0.057	119	119	119
110	CKN	CGL	1	6.3	0.004	0.02	0.003	178	190	190
110	CKN	GRO	1	15.17	0.009	0.008	0.137	120	120	120
110	CKN	KER	1	20.3	0.013	0.066	0.007	178	197	210
110	CLA	CKN	1	29.97	0.019	0.096	0.015	178	190	190
110	CLA	DMY	1	38.83	0.024	0.126	0.015	178	197	210
110	CLA	MAC	1	5.66	0.004	0.018	0.002	161	176	191
110	CLA	MAC	2	5.66	0.002	0.01	0.099	161	176	192
110	CLG	CDU	1	2.5	0.001	0.003	0.028	187	206	219
110	CLG	FIN (I)	1	3.64	0.004	0.011	0.007	124	124	124
110	CLH	TRI	1	9	0.014	0.031	0.003	99	110	121
110	CLH	TRL	1	13.5	0.02	0.045	0.013	105	114	123
110	CLN	LA	1	64.76	0.095	0.222	0.021	63	78	92
110	CLO	CCF	1	18	0.011	0.059	0.006	178	197	210
110	CLO	GOL-T	1	0.25	0	0.001	0.001	187	206	217

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	CLO	MRY	1	7.687	0.002	0.009	0.09	136	136	136
110	CLW	KLS	1	5.4	0.008	0.019	0.002	99	110	121
110	CLW	KLS	2	5.28	0.008	0.019	0.002	99	110	121
110	CLW	STR	1	17.6	0.027	0.061	0.006	105	116	123
110	CMC (GARROW)	BVK	1	4.91	0.002	0.002	0.054	195	201	220
110	COL	CDU	1	2.66	0.001	0.004	0.02	143	143	143
110	COL (I)	FIN (I)	1	5.02	0.003	0.013	0.037	104	124	124
110	COL (N)	CPS	1	46.7	0.061	0.161	0.015	82	95	103
110	COL (N)	LIM (N)	1	18.63	0.024	0.064	0.006	82	95	103
110	COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
110	COL (N)	LOG	2	8.1	0.011	0.027	0.003	82	95	103
110	COL (N)	RSK	1	20.01	0.024	0.069	0.007	186	191	193
110	COO	FTT	1	4.4	0.004	0.011	0.019	124	124	132
110	COO	INC	1	6.17	0.006	0.016	0.029	136	140	140
110	COR	ENN (N)	1	27.5	0.041	0.095	0.009	99	110	121
110	COR	GWE	1	10.9	0.007	0.036	0.004	178	197	210
110	COS	ARI-T	1	20.7	0.013	0.065	0.007	178	197	210
110	COS	FLA	1	3.4	0.005	0.012	0.001	99	110	121
110	COS	FLA	2	3.3	0.005	0.011	0.001	99	110	121
110	COW	OLD	1	2.3	0.004	0.008	0.001	105	116	123
110	COW	OLD	2	2.2	0.003	0.008	0.001	105	116	123
110	COW	RAF	1	6.9	0.01	0.024	0.003	99	110	121
110	COW	WHI	1	17.79	0.027	0.062	0.006	99	110	121
110	CPK	CPK	1	3.38	0.002	0.004	0.025	100	100	100
110	CPK	TNY	1	5.59	0.003	0.006	0.072	100	100	100
110	CPS	KMT	1	14.5	0.011	0.048	0.005	143	158	166
110	CPS	LIM (N)	1	29.5	0.039	0.101	0.01	82	95	103
110	CPS	LMR	1	9	0.012	0.03	0.003	82	95	103
110	CPS	LMR	2	9	0.012	0.03	0.003	82	95	103
110	CPS	SPR	1	9.23	0.011	0.029	0.012	82	95	103

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	CPS	SPR	2	9.38	0.011	0.029	0.013	82	95	103
110	CPS	STR (N)	1	27	0.018	0.053	0.017	109	119	124
110	CRA	LWD	1	6.692	0.004	0.022	0.004	178	197	210
110	CRA	WEX	1	22.82	0.024	0.076	0.008	99	110	113
110	CRG	KEL	1	23.1	0.029	0.077	0.013	82	95	103
110	CRG	TMN	1	36.24	0.045	0.119	0.022	109	114	124
110	CRM	KLM	1	1.35	0.001	0.002	0.014	140	140	140
110	CRM	KLM	2	1.35	0.001	0.002	0.014	140	140	140
110	CRO	IA	1	2.74	0.004	0.01	0.001	196	216	217
110	CRO	KBY	1	14.35	0.02	0.049	0.016	178	194	200
110	CSH	CLN	1	22.8	0.014	0.074	0.008	178	197	210
110	CSH	DLT	1	60.76	0.075	0.205	0.02	99	110	121
110	CSH	ENN	1	53.47	0.034	0.174	0.019	178	197	210
110	CSH	GAL	1	13.8	0.022	0.048	0.004	99	110	121
110	CSH	GAL	2	11.3	0.018	0.039	0.004	99	110	121
110	CSH	GAL	3	11.3	0.018	0.039	0.004	99	110	121
110	CSH	SAL	1	24.85	0.024	0.074	0.068	97	97	97
110	CSH	SOM	1	50.02	0.078	0.172	0.016	99	110	121
110	CTN	TIP	1	13.15	0.008	0.043	0.005	178	197	210
110	CTY	FTT	1	1.5	0.001	0.001	0.018	124	124	132
110	CTY	INC	1	8.9	0.011	0.03	0.003	103	116	123
110	CUL	DGN	1	34.24	0.022	0.109	0.02	178	192	192
110	CUL	WAT	1	13.14	0.007	0.03	0.055	178	194	200
110	CUN	GLR	1	26.29	0.039	0.09	0.009	178	194	209
110	CUN	SLI	1	21.1	0.03	0.073	0.007	178	194	209
110	CUR	BKM	1	17.3	0.004	0.019	0.192	190	190	190
110	CUR	NEN	1	18.83	0.029	0.065	0.006	105	116	123
110	CUS	MLC	1	13.67	0.015	0.048	0.005	136	150	159
110	CUS	NEW (I)	1	24.61	0.026	0.082	0.008	134	147	152
110	CUS	PLS	1	42.14	0.044	0.14	0.014	136	150	159

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	CVW	COW	1	17.22	0.025	0.054	0.018	99	110	121
110	CVW	DKL	1	0.36	0.001	0.001	0	105	116	123
110	CVW	KRA	1	7.59	0.012	0.026	0.004	99	110	121
110	DAL	DAL	1	12.2	0.019	0.042	0.004	105	116	123
110	DDK	LOU	1	16.81	0.026	0.058	0.005	99	110	121
110	DDK	MLN	1	7.5	0.012	0.026	0.002	99	110	121
110	DER	KIN	1	15.11	0.012	0.05	0.005	99	110	121
110	DER	MAY	1	43.45	0.028	0.146	0.018	74	84	93
110	DER	TSB	1	19.67	0.031	0.068	0.006	99	110	121
110	DEY	DAL-T	1	6.35	0.004	0.021	0.002	178	197	210
110	DEY	PLS	1	48.45	0.031	0.157	0.017	178	197	210
110	DGN	WHE	1	8.65	0.006	0.028	0.003	178	197	210
110	DMY	CDN	1	10.88	0.016	0.04	0.004	211	216	217
110	DMY	MAC	1	26.22	0.039	0.09	0.009	196	213	217
110	DON	FIN (N)	1	3.67	0.004	0.011	0.008	69	81	86
110	DON	FIN (N)	2	3.74	0.004	0.011	0.007	69	80	86
110	DON	HAN	1	6.07	0.002	0.005	0.14	144	144	158
110	DON	HAN	2	5.89	0.002	0.005	0.14	144	144	158
110	DRM	CLO	1	27	0.039	0.091	0.015	103	116	123
110	DRM	LET	1	8.35	0.013	0.028	0.003	99	110	123
110	DRM	MEE	1	5	0.008	0.017	0.002	99	110	121
110	DRO	EKN	1	24.59	0.032	0.082	0.008	82	95	103
110	DRO	EKN	2	24.59	0.032	0.082	0.008	82	95	103
110	DRO	OMA	1	9.23	0.018	0.047	0.005	82	95	103
110	DRO	OMA	2	9.23	0.018	0.047	0.005	82	95	103
110	DRU	ENN	1	17.44	0.027	0.06	0.006	99	110	121
110	DRU	TAN	1	4.4	0.004	0.014	0.002	79	96	113
110	DRU	TAN	2	4.4	0.004	0.014	0.002	79	96	113
110	DRU	TAN	3	4.1	0.005	0.014	0.001	108	119	126
110	DRU	TMN	1	22.69	0.029	0.075	0.008	109	119	124

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	DRU	TMN	2	21.53	0.028	0.073	0.012	109	119	124
110	DRY	GOR	1	19.39	0.029	0.067	0.006	99	110	121
110	DRY	LOU	1	31.9	0.02	0.104	0.011	99	110	121
110	DRY	PLA	1	5.3	0.008	0.018	0.002	99	110	121
110	DTN	BLC	2	8	0.004	0.009	0.049	140	140	143
110	DTN	FIN (I)	1	9.25	0.002	0.014	0.111	140	140	140
110	DTN	KLM	1	3.2	0.002	0.005	0.032	140	140	140
110	DUN	OMA	1	36.1	0.042	0.124	0.012	186	191	193
110	DUN	TMN	1	6.53	0.004	0.017	0.005	157	171	178
110	DUN	TMN	2	5.82	0.009	0.023	0.002	144	144	144
110	DUN	TMN	3	6.01	0.004	0.02	0.019	186	191	193
110	ENN	SLC	1	31	0.003	0.048	0.271	195	201	220
110	FAS	FAS	1	5	0.008	0.017	0.002	105	116	123
110	FIN	GLA	1	14.02	0.022	0.048	0.005	105	116	123
110	FIN	GRA	1	13.2	0.005	0.012	0.236	119	119	119
110	FIN	MCD	1	7.9	0.003	0.007	0.141	119	119	119
110	FIN	POP	1	4.3	0.002	0.005	0.026	120	120	131
110	FIN	PTN	1	3.52	0.003	0.01	0.006	80	105	119
110	FIN	SVN	1	32.22	0.039	0.104	0.056	105	115	115
110	FIN (N)	HAN	1	3.03	0.001	0.003	0.022	144	144	144
110	FIN (N)	HAN	2	3.21	0.001	0.003	0.022	144	144	144
110	FLA	GIL	1	10.6	0.017	0.037	0.003	105	116	123
110	FLA	SLB	1	21.7	0.034	0.075	0.007	99	110	123
110	FLA	SLI	1	50.5	0.079	0.174	0.016	99	110	121
110	FLA	TON	1	32.31	0.05	0.111	0.01	98	111	126
110	FRS	HAR	1	2.28	0.002	0.004	0.03	107	107	107
110	FRS	HEU	1	2.4	0.002	0.004	0.024	140	140	140
110	FRS	INC	1	5.6	0.004	0.01	0.073	107	107	107
110	FRS	TRN	1	2.8	0.002	0.004	0.028	140	140	140
110	GAL	SEE	1	25.53	0.005	0.031	0.138	99	110	121

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	GAL	SAL	1	6.12	0.003	0.003	0.067	99	106	106
110	GCA	GRI-T	1	8.87	0.009	0.029	0.006	103	120	131
110	GCA	INC	1	8.1	0.008	0.025	0.009	103	123	134
110	GCA	INC	2	8.1	0.008	0.025	0.009	103	123	134
110	GCA	NAN	1	1.82	0.001	0.002	0.011	120	120	131
110	GCA	NAN	2	1.74	0.001	0.002	0.011	120	120	131
110	GI	KKY	1	49.2	0.031	0.16	0.017	99	110	121
110	GI	WAT	1	11.7	0.007	0.038	0.004	178	197	210
110	GI	WAT	2	12.92	0.008	0.042	0.005	178	197	210
110	GI	WEX	1	34.5	0.022	0.112	0.012	178	197	210
110	GLA	SVN	1	18	0.017	0.055	0.052	136	150	154
110	GLE	KCR	1	11.32	0.003	0.013	0.124	122	122	122
110	GLE (N)	KEL	1	21.4	0.027	0.068	0.027	82	82	90
110	GLE (N)	KEL	2	21.4	0.027	0.068	0.027	82	82	90
110	GOL	GOL-T	1	3.9	0.006	0.014	0.001	105	116	123
110	GOR	MTH	1	26.39	0.026	0.087	0.012	99	110	121
110	GOR	NAV	1	5.33	0.008	0.019	0.002	99	110	121
110	GOR	NAV	2	6.3	0.009	0.022	0.002	99	110	121
110	GOR	NAV	3	5.49	0.005	0.017	0.007	99	110	121
110	GOR	PLA	1	19.732	0.03	0.068	0.006	99	110	121
110	GOR (N)	OMA	1	17.12	0.009	0.067	0.02	200	200	200
110	GOR (N)	TMN	1	34.83	0.019	0.161	0.029	200	200	200
110	GRA	NBY	1	5.05	0.002	0.005	0.089	119	119	119
110	GRI	GRI-T	1	1	0.002	0.004	0	105	116	123
110	GRI	MAY	1	2.2	0.003	0.009	0.001	105	116	123
110	HAN	LIS (N)	1	9.2	0.01	0.026	0.018	82	95	103
110	HAN	LIS (N)	2	9.2	0.009	0.026	0.018	80	93	100
110	HAR	RE	1	5.63	0.005	0.01	0.073	107	107	107
110	HEU	INC	1	3.6	0.003	0.005	0.036	140	140	140
110	IA	MAC	1	18.16	0.027	0.062	0.006	196	213	217

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	IKE	IKE-T	1	0.15	0	0.001	0	80	105	119
110	INC	MIL	1	8.4	0.004	0.009	0.051	120	120	131
110	KBY	KRA	1	11.9	0.008	0.039	0.004	178	197	210
110	KBY	KRA	2	12.5	0.018	0.043	0.004	99	110	121
110	KBY	MAL	1	29.2	0.018	0.095	0.01	134	147	159
110	KBY	MR	1	4.44	0.004	0.015	0.004	103	119	130
110	KBY	MR	2	4.65	0.005	0.015	0.004	103	119	130
110	KEL	RSK	1	25.9	0.039	0.133	0.013	185	190	193
110	KER	OUG-T	1	22.6	0.014	0.074	0.008	178	197	210
110	KMT	STR (N)	1	11.2	0.008	0.037	0.004	143	158	166
110	KMT	SLK	1	6.2	0.007	0.018	0.006	109	119	124
110	KIN	DFR	1	29.25	0.021	0.096	0.01	99	110	121
110	KIN	MUL	1	24.92	0.016	0.077	0.023	178	197	210
110	KLH	THU	1	21.24	0.013	0.069	0.008	178	197	210
110	KLM	NBY	1	1.2	0.001	0.001	0.02	119	119	119
110	KLM	POP	1	6	0.003	0.007	0.036	120	120	131
110	KLN	CUR	1	14.77	0.011	0.048	0.005	136	150	159
110	KLN	LIM (I)	1	9	0.014	0.031	0.003	99	110	121
110	KLN	LIM (I)	2	11.7	0.018	0.04	0.009	80	95	110
110	KLN	SNG	1	4.05	0.003	0.013	0.003	178	194	209
110	KLP	CNG	1	0.3	0	0	0.003	140	140	140
110	KLP	KNR	1	14.95	0.015	0.05	0.005	136	150	159
110	KLP	RAT (I)	1	32.42	0.033	0.107	0.018	136	150	159
110	KLP	TB	1	1.61	0.002	0.006	0.001	99	110	121
110	KLP	TB	2	1.61	0.002	0.006	0.001	99	110	121
110	KLP	TRL	1	39.38	0.06	0.135	0.013	99	110	121
110	KLP	TRL	2	43.58	0.027	0.14	0.023	178	190	190
110	KLS	KKY	1	34.3	0.053	0.118	0.011	99	110	121
110	KNR	TRI	1	4.29	0.003	0.013	0.005	178	194	209
110	KNR	TRI	2	4.21	0.004	0.013	0.004	99	110	121

Table B-2: Characteristics of existing transmission circuits										
Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	KRA	BAR	1	19.45	0.02	0.065	0.007	136	150	159
110	KRA	MID	1	10.7	0.017	0.037	0.004	99	110	121
110	KRA	MEN	1	2.8	0.002	0.002	0.034	124	124	124
110	KRA	WH0	1	41.46	0.026	0.135	0.015	178	197	210
110	KTL	MAY	1	21.39	0.022	0.072	0.007	99	110	121
110	KTL	MON	1	8.88	0.009	0.03	0.003	136	150	159
110	KTN	WAT	1	3.3	0.001	0.003	0.039	99	110	121
110	KUD	CBT	1	0.75	0	0.001	0.008	187	206	223
110	KUR	NAV	1	6.1	0.01	0.021	0.002	99	110	123
110	LA	MUL	1	46.27	0.072	0.16	0.015	99	110	121
110	LA	RIC	1	15.74	0.024	0.054	0.007	99	110	123
110	LA	RIC	2	12.55	0.02	0.043	0.005	99	110	123
110	LA	SLB	1	9.1	0.014	0.031	0.003	99	110	123
110	LET	GL-T	1	38.4	0.058	0.132	0.014	99	110	121
110	LET	STR (N)	1	22.25	0.035	0.076	0.007	99	110	123
110	LET	TIV	1	45.2	0.047	0.151	0.015	136	150	159
110	LET	TLK	1	34.05	0.051	0.117	0.012	105	116	123
110	LIB	MR ~	1	2.7	0.001	0.003	0.017	100	100	100
110	LIB	MR ~	2	2.74	0.002	0.003	0.017	99	110	119
110	LIM	MTN	1	6.47	0.005	0.025	0.003	178	197	210
110	LIM	RAT	1	28.35	0.041	0.096	0.012	99	110	121
110	LIS	LOU	1	40.4	0.063	0.139	0.013	99	110	123
110	LIS	SKL	1	39.3	0.061	0.135	0.013	99	110	123
110	LIS (N)	TAN	1	31	0.04	0.106	0.01	82	95	103
110	LIS (N)	TAN	2	29.2	0.034	0.1	0.009	80	93	100
110	LOU	MLN	1	13	0.02	0.045	0.004	99	110	121
110	LOU	MTH	1	15.1	0.024	0.052	0.005	99	110	121
110	LOU	RRU	1	38.82	0.058	0.133	0.014	95	103	112
110	LSN	THU	1	10.4	0.016	0.036	0.003	104	113	122
110	MAY	BLK	1	30.9	0.032	0.103	0.011	99	110	121

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	MAY	GRI	1	2.2	0.002	0.007	0.002	99	110	120
110	MAY	RNW	1	7.1	0.008	0.024	0.002	80	92	103
110	MAY	RYB	1	9.02	0.009	0.03	0.005	178	197	219
110	MCD	NQS	1	2	0.001	0.002	0.036	119	119	119
110	MCD	WOL	1	1.4	0.001	0.002	0.009	120	120	131
110	MHL	RE	1	3	0.002	0.004	0.03	140	140	140
110	MHL	TRN	1	1.4	0.001	0.002	0.014	140	140	140
110	MID	WHI	1	20.02	0.03	0.069	0.007	99	110	121
110	MIL	RE	1	4.9	0.003	0.005	0.075	100	100	100
110	MIL	RE	2	5.55	0.003	0.006	0.034	120	120	131
110	MKL	OMA	1	37.5	0.028	0.113	0.015	139	150	157
110	MLC	TSB	1	18.29	0.016	0.056	0.028	135	147	159
110	MOY	TAW	1	8.39	0.013	0.028	0.004	99	110	123
110	MOY	TAW	2	8.3	0.012	0.029	0.004	99	110	121
110	MP	TBK-T	1	7.29	0.005	0.024	0.003	178	197	210
110	MR	TBG	1	3.25	0.001	0.002	0.036	178	198	219
110	MR	TBG	2	2.8	0.001	0.001	0.031	178	206	219
110	MTN	MUN	1	0.7	0.001	0.002	0	105	116	123
110	MTN	MUN	2	0.7	0.001	0.002	0	105	116	123
110	NEW (I)	BLK	1	12.2	0.013	0.041	0.004	136	150	159
110	NEW	PLS	1	43.02	0.055	0.146	0.014	105	116	123
110	NEW (N)	TAN	1	24.1	0.031	0.08	0.008	82	95	103
110	NEW (N)	TAN	2	24	0.031	0.08	0.008	82	95	103
110	NQS	RE	1	2.1	0.001	0.002	0.038	119	119	119
110	OMA	STR (N)	1	35.5	0.046	0.123	0.012	109	119	124
110	OMA	STR (N)	2	35.5	0.047	0.125	0.012	82	95	103
110	OMA	TRE	1	21.45	0.025	0.073	0.007	186	191	193
110	ONH	MOY	1	13.96	0.022	0.048	0.005	105	116	123
110	OUG	OUG-T	1	11	0.017	0.038	0.004	105	116	123
110	PA	STR	1	22.4	0.035	0.077	0.007	105	116	123

Table B-2: Characteristics of existing transmission circuits

Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA base (pu)			Rating (MVA)		
					R	X	B	Summer	Autumn	Winter
110	PB	RE	3	1.4	0	0.002	0.046	269	269	269
110	PB	RE	4	1.4	0	0.002	0.046	269	269	269
110	RAF	RSY	1	2.1	0.003	0.007	0.001	63	82	92
110	RAF	TBG	1	11.038	0.016	0.037	0.005	195	201	2,200
110	RAF	TBG	2	9.5	0.006	0.031	0.005	178	194	209
110	RE	WBK	1	0.62	0	0	0.021	125	130	141
110	REA	TRL	1	11.99	0.005	0.003	0.11	125	130	141
110	RNW	DFR	1	25.9	0.02	0.085	0.009	99	110	121
110	RRU	SKL	1	12.67	0.02	0.044	0.004	95	103	112
110	KNY	BUF	1	0.5	0	0.001	0.006	140	140	140
110	KNY	KLH	1	11.7	0.003	0.015	0.107	190	190	190
110	KNY	SCR	1	33.33	0.031	0.108	0.04	135	147	159
110	KNY	SHL	1	22.71	0.019	0.063	0.081	195	201	220
110	KNY	UGL	1	3.42	0.001	0.004	0.04	195	201	220
110	SH	DAL	1	12	0.008	0.039	0.007	178	197	210
110	SH	IKE-T	1	53.94	0.034	0.175	0.019	178	197	210
110	SH	SOM	1	13.8	0.021	0.047	0.006	105	116	123
110	SLI	SRA	1	10.772	0.017	0.038	0.004	99	110	121
110	SLI	SRA	2	11.186	0.019	0.041	0.004	99	110	121
110	SBH	MCE	1	4.727	0.005	0.015	0.005	99	110	121
110	SOM	SOM	1	2	0.003	0.007	0.001	105	116	123
110	SOR	TLK	1	4.4	0.007	0.015	0.002	105	116	123
110	STR	STR	1	2	0.003	0.007	0.001	105	116	123
110	TAN	WAR	1	12.9	0.013	0.042	0.005	79	96	113
110	TAN	WAR	2	12.9	0.013	0.042	0.005	79	96	113
110	TBK	TBK-T	1	2.9	0.005	0.01	0.001	105	116	123
110	THU	IKE-T	1	25.68	0.016	0.083	0.009	178	197	210
110	TRE	TMN	1	42.93	0.025	0.082	0.025	186	191	193
110	TRL	OUG-T	1	11.3	0.007	0.037	0.004	178	197	210

Characteristics of existing transformers in Ireland

Table B-3: Characteristics of existing transformers in Ireland							
Station	Transformer	Rating (MVA)	HV/LV (kV)	Impedance on 100 MVA base (pu)		Voltage ratio tapping range	
				R	X	+	-
AD	T2101	125	220/110	0.001	0.124	-0.1	0.18
ARK	T2101	63	220/110	0.007	0.18	-0.23	0.19
ARK	T2102	125	220/110	0.0021	0.1237	-0.097	0.182
BLC	T2101	250	220/110	0.001	0.0646	-0.097	0.179
BVK	T2101	250	220/110	0.001	0.064	-0.097	0.178
BVK	T2102	250	220/110	0.001	0.064	-0.097	0.178
BYH	T2101	250	220/110	0.001	0.064	-0.097	0.178
BYH	T2101	250	220/110	0.001	0.064	-0.097	0.178
CBT	T2101	250	220/110	0.001	0.0646	-0.097	0.179
CBT	T2102	250	220/110	0.001	0.0646	-0.097	0.179
CBT	T2103	250	220/110	0.001	0.0646	-0.097	0.179
CBT	T2104	250	220/110	0.001	0.0646	-0.097	0.179
CDU	T2101	250	220/110	0.00093	0.06152	-0.097	0.178
CDU	T2102	250	220/110	0.00066	0.061	-0.099	0.177
CKM	PST2201	350	220/220	0	0.029	-14.3	16.3
CKM	T2101	250	220/110	0.001	0.0646	-0.097	0.179
CKM	T2102	250	220/110	0.001	0.0646	-0.097	0.179
CKM	T2103	250	220/110	0.001	0.0646	-0.097	0.179
CKM	T2104	250	220/110	0.0004	0.0631	-0.096	0.182
CLA	T2102	250	220/110	0.0013	0.0647	-0.097	0.179
CSH	T2101	238	220/110	0.0004	0.0631	-0.096	0.182
CSH	T2102	250	220/110	0.0004	0.0631	-0.096	0.182
CSH	T2104	175	220/110	0.0021	0.1332	-0.227	0.182
CUL	T2101	250	220/110	0.0005	0.064	-0.09	0.182
DSN	T4201	500	380/220	0.0002	0.0317	-0.013	0.156
DSN	T4202	500	380/220	0.0003	0.027	-0.105	0.079
FIN	T2101	250	220/110	0.0013	0.0651	-0.098	0.18
FIN	T2102	250	220/110	0.0013	0.0648	-0.099	0.18
FIN	T2103	250	220/110	0.001	0.064	-0.099	0.177

Table B-3: Characteristics of existing transformers in Ireland

Station	Transformer	Rating (MVA)	HV/LV (kV)	Impedance on 100 MVA base (pu)		Voltage ratio tapping range	
				R	X	+	-
FIN	T2104	250	220/110	0.001	0.0638	-0.099	0.177
FIN	T2105	250	220/110	0.001	0.064	-0.099	0.177
FLA	T2101	125	220/110	0.0027	0.128	-0.097	0.182
FLA	T2102	125	220/110	0.0008	0.1331	-0.097	0.182
GI	T2101	125	220/110	0.0026	0.1331	-0.097	0.182
GI	T2102	125	220/110	0.0023	0.1237	-0.229	0.182
GOR	T2101	250	220/110	0.001	0.064	-0.097	0.182
INC	T2102	250	220/110	0.001	0.0564	-0.095	0.178
INC	T2104	250	220/110	0.0001	0.06	-0.09	0.182
INC	T2101	250	220/110	0.001	0.0564	-0.095	0.178
INC	T2103	250	220/110	0.0001	0.06	-0.09	0.182
KLN	T2101	63	220/110	0.0065	0.2453	-0.229	0.182
KLN	T2102	63	220/110	0.0095	0.2473	-0.229	0.182
KLN	T2103	250	220/110	0.0004	0.0631	-0.096	0.182
KLN	T2104	125	220/110	0.001	0.123	-0.097	0.182
KLP	T2101	250	220/110	0.0004	0.0631	-0.096	0.182
KLP	T2102	250	220/110	0.0004	0.0631	-0.096	0.182
KLS	T2101	125	220/110	0.00132	0.1237	-0.097	0.182
KLS	T2102	125	220/110	0.0008	0.1237	-0.097	0.182
KNR	T2101	250	220/110	0.001	0.064	-0.097	0.178
KNR	T2102	250	220/110	0.001	0.064	-0.097	0.178
BLC	BELCAMP	250	220/110	0.001	0.0646	-0.1	0.1
CLA	T2101	250	220/110	0.0013	0.0647	-0.1	0.1
KRA	T2101	250	220/110	0.0013	0.0647	-0.097	0.179
KRA	T2102	250	220/110	0.0013	0.0652	-0.097	0.179
LOD	T2101	250	220/110	0.001	0.064	-0.099	0.18
LOU	T2101	125	220/110	0.0022	0.1331	-0.229	0.182
LOU	T2103	125	220/110	0.0023	0.1324	-0.229	0.182
LOU	T2102	125	220/110	0.0022	0.1324	-0.23	0.182
LOU	T2104	250	220/110	0.001	0.064	-0.097	0.178

Table B-3: Characteristics of existing transformers in Ireland							
Station	**Transformer**	**Rating (MVA)**	**HV/LV (kV)**	**Impedance on 100 MVA base (pu)**		**Voltage ratio tapping range**	
				R	**X**	**+**	**-**
LOU	AT1	300	220/275	0.0008	0.03	-0.154	0.154
LOU	AT2	600	220/275	0.0008	0.015	-0.154	0.154
LOU	AT3	300	275/220	0.0008	0.0303	-0.154	0.154
MAY	T2101	125	220/110	0.0021	0.1339	-0.227	0.182
MAY	T2102	238	220/110	0.001	0.064	-0.097	0.178
MAY	T2103	125	220/110	0.0021	0.1324	-0.227	0.182
MAY	T2104	250	220/110	0.001	0.064	-0.099	0.177
MP	T4202	500	380/220	0.0003	0.027	-0.105	0.079
MP	T2101	250	220/110	0.001	0.064	-0.097	0.178
MP	T4202	500	380/220	0.0002	0.0329	-0.013	0.156
OST	T4202	500	380/220	0.0003	0.027	-0.105	0.079
PB	T2103	250	220/110	0.0013	0.059	-0.089	0.173
PB	T2104	250	220/110	0.0013	0.0609	-0.089	0.173
RAF	T2101	238	220/110	0.001	0.064	-0.097	0.178
RAF	T2102	250	220/110	0.000446	0.0558	-0.097	0.178
SH	T2102	125	220/110	0.00131	0.1237	-0.097	0.182
SH	T2101	125	220/110	0.00574	0.1237	-0.097	0.182
SRA	T2102	250	220/110	0.001	0.064	-0.097	0.182
TB	T2101	238	220/110	0.00099	0.0554	-0.097	0.179
TB	T2102	238	220/110	0.00099	0.0554	-0.097	0.179
WOO	T4201	500	380/220	0.0002	0.0316	-0.014	0.155
WOO	T4202	500	380/220	0.0002	0.0316	-0.014	0.155
WOO	T4204	550	380/220	0.0002	0.027	0.018	0.018
WOO	WOODLAND	582	380/260	0	0.024	-0.225	0.195

Characteristics of existing 3 winding transformers in Northern Ireland

Table B-4: Characteristics of existing 3 winding transformers in Northern Ireland													
Substation/ Transformer	HV/LV (kV)	Impedance pu on 100 MVA base						Rating (MVA)			Off nominal ratio (pu)		No. of taps
		W1-2		W2-3		W3-1							
		R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
BPS IBTx 1	275/110	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
BPS IBTx 1	275/110	0.0018	0.0641	0.0018	0.2059	0	0.128	240	240	30	1.15	0.85	19
CAS IBTx 1	275/110	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	30	1.15	0.85	19
CAS IBTx 1	275/110	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
CAS IBTx 1	275/110	0.0018	0.0656	0.0018	0.2375	0	0.1593	240	240	30	1.15	0.85	19
CPS IBTx 1	275/110	0.001	0.0699	0.0032	0.2173	0.003	0.123	240	240	60	1.15	0.85	19
CPS IBTx 1	275/110	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	30	1.15	0.85	19
HAN IBTx 1	275/110	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	45	1.15	0.85	19
HAN IBTx 1	275/110	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	45	1.15	0.85	19
HAN IBTx 1	275/110	0.001	0.07	0.0031	0.2166	0.003	0.1233	240	240	60	1.15	0.85	19
KEL IBTx 1	275/110	0.0018	0.0609	0.0018	0.1273	0	0.057	240	240	45	1.15	0.85	19
KEL IBTx 1	275/110	0.0018	0.0607	0.0018	0.1317	0	0.057	240	240	45	1.15	0.85	19
TAN IBTx 1	275/110	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
TAN IBTx 1	275/110	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
TAN IBTx 1	275/110	0.001	0.0698	0.0032	0.217	0.003	0.123	240	240	60	1.15	0.85	19
TMN IBTx 1	275/110	0.0014	0.0644	0.0037	0.2315	0	0.1514	240	240	60	1.15	0.85	19
TMN IBTx 1	275/110	0.0014	0.0644	0.004	0.2299	0	0.15	240	240	60	1.15	0.85	19

Characteristics of existing 2 winding transformers in Northern Ireland

Table B-5: Characteristics of existing 2 winding transformers in Northern Ireland[42]

Station	HV/LV (kV)	Rating (MVA)	Impedance pu on rating base		Off nominal ratio		No. of taps
			R	X	Upper	Lower	
AGH	110/33	90	0.0039	0.2464	1.1	0.8	19
ANT	110/33	90	0.0039	0.2464	1.1	0.8	19
ANT	110/33	90	0.0039	0.2473	1.1	0.8	19
MKL	110/33	90	0.0039	0.2502	1.1	0.8	19
MKL	110/33	90	0.0039	0.2502	1.1	0.8	19
BMA	110/33	90	0.0039	0.2447	1.1	0.8	19
BMA	110/33	90	0.0039	0.2463	1.1	0.8	19
BMA	110/33	90	0.0065	0.2893	1.1	0.8	19
BMA	110/33	90	0.0065	0.2867	1.1	0.9	33
BAN	110/33	30	0.0171	0.4133	1.1	0.8	15
BAN	110/33	30	0.019	0.414	1.1	0.8	15
BAN	110/33	30	0.019	0.4167	1.1	0.8	15
BAN	110/33	30	0.019	0.415	1.1	0.8	15
BNH	110/33	90	0.0037	0.2419	1.1	0.8	19
BNH	110/33	90	0.0038	0.2413	1.1	0.8	19
BNM	110/33	90	0.0039	0.2461	1.1	0.8	19
BNM	110/33	90	0.0039	0.2461	1.1	0.8	19
BRO	110/33	100	0.0035	0.16	1.1	0.9	33
CAR	110/33	90	0.0039	0.248	1.1	0.8	19
CAR	110/33	90	0.0039	0.248	1.1	0.8	19
CEN	110/33	90	0.0037	0.2422	1.1	0.8	19
CEN	110/33	90	0.0038	0.2419	1.1	0.8	19
COL (N)	110/33	60	0.0074	0.2512	1.1	0.8	19
COL (N)	110/33	60	0.0075	0.2508	1.1	0.8	19
CPS	110/33	90	0.0087	0.2559	1.1	0.8	19
CPS	110/33	90	0.0087	0.2573	1.1	0.8	19
CRG	110/33	60	0.0074	0.2515	1.1	0.8	19
CRG	110/33	60	0.0074	0.2508	1.1	0.8	19

42 110/33 kV transformers in Northern Ireland are included here as these are controlled by SONI. 110/38 kV transformers in Ireland are not included here as these are controlled by ESB Networks.

Table B-5: Characteristics of existing 2 winding transformers in Northern Ireland[42]							
Station	HV/LV (kV)	Rating (MVA)	Impedance pu on rating base		Off nominal ratio		No. of taps
			R	X	Upper	Lower	
CRE	110/33	75	0.0091	0.1953	1.1	0.8	19
CRE	110/33	75	0.0091	0.1967	1.1	0.8	19
DON	110/33	60	0.0119	0.3607	1.1	0.8	19
DON	110/33	60	0.0119	0.3658	1.1	0.8	19
DON	110/33	90	0.004	0.2403	1.1	0.8	19
DON	110/33	60	0.0119	0.3658	1.1	0.8	19
DRU (N)	110/33	90	0.0061	0.2423	1.1	0.8	19
DRU (N)	110/33	90	0.0061	0.2426	1.1	0.8	19
CRR	110/33	90	0.0039	0.2461	1.1	0.8	19
DUN	110/33	90	0.0087	0.2566	1.1	0.8	19
DUN	110/33	90	0.0087	0.2599	1.1	0.8	19
EDE	110/33	45	0.0125	0.2733	1.1	0.8	19
EDE	110/33	45	0.0123	0.2738	1.1	0.8	19
ENN (N)	110/33	45	0.0126	0.272	1.1	0.8	19
ENN (N)	110/33	45	0.0126	0.2733	1.1	0.8	19
ENN (N)	110/33	60	0.0078	0.2512	1.1	0.8	19
FIN (N)	110/33	45	0.0076	0.2533	1.1	0.8	19
FIN (N)	110/33	45	0.0076	0.2549	1.1	0.8	19
GLE (N)	110/33	60	0.0119	0.2692	1.1	0.8	19
GOR (N)	110/33	90	0.0039	0.2461	1.1	0.8	19
KMT	110/33	90	0.0039	0.2461	1.1	0.8	19
KNO	110/33	90	0.0039	0.2461	1.1	0.8	19
KNO	110/33	90	0.0039	0.2461	1.1	0.8	19
LAR	110/33	45	0.0116	0.2778	1.1	0.8	15
LAR	110/33	45	0.0116	0.2771	1.1	0.8	15
LIM (N)	110/33	45	0.0125	0.2809	1.1	0.8	15
LIM (N)	110/33	45	0.0122	0.2764	1.1	0.8	15
LIS (N)	110/33	90	0.0087	0.254	1.1	0.8	19
LIS (N)	110/33	90	0.0086	0.2569	1.1	0.8	19
LMR	110/33	45	0.0076	0.254	1.1	0.8	19
LMR	110/33	45	0.0076	0.2533	1.1	0.8	19

Table B-5: Characteristics of existing 2 winding transformers in Northern Ireland[42]							
Station	HV/LV (kV)	Rating (MVA)	Impedance pu on rating base		Off nominal ratio		No. of taps
			R	X	Upper	Lower	
LOG	110/33	45	0.0126	0.2738	1.1	0.8	19
LOG	110/33	45	0.0128	0.28	1.1	0.8	19
NAR	110/33	60	0.0075	0.2505	1.1	0.8	19
NAR	110/33	60	0.0073	0.25	1.1	0.8	19
NEW (N)	110/33	90	0.0038	0.2427	1.1	0.8	19
NEW (N)	110/33	90	0.0038	0.2419	1.1	0.8	19
OMA	110/33	90	0.0039	0.2481	1.1	0.8	19
OMA	110/33	90	0.0039	0.249	1.1	0.8	19
RSK	110/33	90	0.0039	0.2461	1.1	0.8	19
RAT (N)	110/33	90	0.0087	0.2549	1.1	0.8	19
RAT (N)	110/33	90	0.0046	0.2402	1.1	0.8	19
ROS	110/33	90	0.0087	0.2576	1.1	0.8	19
ROS	110/33	90	0.0087	0.2533	1.1	0.8	19
SPR	110/33	90	0.0039	0.247	1.1	0.8	19
SPR	110/33	90	0.0039	0.2471	1.1	0.8	19
STR (N)	110/33	45	0.0076	0.2522	1.1	0.8	19
STR (N)	110/33	45	0.0076	0.2516	1.1	0.8	19
TRE	110/33	90	0.0039	0.2461	1.1	0.8	19
TMN	110/33	60	0.0265	0.3076	1.1	0.8	19
WAR	110/33	90	0.0039	0.2481	1.1	0.8	19
WAR	110/33	90	0.0039	0.2488	1.1	0.8	19

Characteristics of existing power flow controllers

Table B-6: Characteristics of existing power flow controllers							
Station	Voltage (kV)	Circuit	Rating (MVA)	Impedance on 100 MVA Base (pu)		Phase angle range (electrical degrees)	
				R	X	+	-
CKM	220	CKM – PB	350	0.000	0.029	15.3	15.3
ENN (N)	110	ENN (N) – COR	125	0.000	0.0213	45	45
STR (N)	110	STR (N) – LET	125	0.000	0.0213	45	45

Characteristics of existing reactive compensation

Table B-7: Characteristics of existing reactive compensation				
Station	Voltage (kV)		Capability (Mvar)	
			Generate	Absorb
AA	110	1 Capacitor	30	
ATH	110	3 Capacitors (1 Mobile)	90	
BAN (I)	110	1 Capacitor	15	
BYC	275	4 Capacitors (4 x 59)	236	
BK	110	1 Capacitor	10	
BVK	110	1 Static Var Compensator	-50	50
CAH	110	4 Capacitors (4 x 15)	60	
CAS	22	3 Shunt Reactor (2 x 30)		60
CAS	22	3 Capacitors (2 x 25)	50	
CAS	220	1 Static Var Compensator	-60	60
CBR	110	2 Capacitor	60	
CBR	110	1 Static Var Compensator	10	60
CF	110	1 Capacitor	15	
CGL	20	3 Capacitors (3 x 3)	9	
CKM	220	1 Shunt Reactor		100
CKM	38	1 Shunt Reactor		20
COL (N)	110	1 Capacitor	36	
CPS	110	1 Capacitor	40	
CSH	110	2 Capacitors (2 x 40)	80	
CUN	20	2 Capacitors (2 x 4)	8	
DLT	110	1 Capacitor	15	
DMY	110	1 Capacitor	15	
DOO	110	1 Capacitor	15	
DRU (I)	110	1 Capacitor	15	
DYN	20	2 Capacitors (2 x 6.5)	13	
ENN (N)	33	4 Capacitors (4 x 6)	24	
ENN (N)	33	1 Capacitor	5	
FIN (I)	38	1 Shunt Reactor		20
GRV	20	1 Static Var Compensator	7.5	7.5
GRV	20	2 Capacitors (1 x 12.38, 1 x 1.5)	13.9	
GRV	21	1 Shunt Reactor		9

Table B-7: Characteristics of existing reactive compensation				
Station	**Voltage (kV)**		**Capability (Mvar)**	
			Generate	**Absorb**
GIL	20	1 Capacitor	12	
GWE	110	1 Capacitor	15	
HAN	22	2 Shunt Reactors (2 x 30)		60
INC	38	2 Shunt Reactors (2 x 20)		40
KEL	22	2 Shunt Reactors (2 x 30)		60
KKY	110	2 Capacitor (2 x 15)	30	
KNR	220	1 Shunt Reactor		50
KNY	110	1 Capacitor	30	
KTL	110	1 Capacitor	30	
LET	110	2 Capacitor (1 Mobile)	45	
LET	110	1 Static Var Compensator	30	
LIS (I)	110	2 Capacitors (2 x 15)	30	
LOU	110	1 Capacitor	30	
LSN	20	1 Capacitor	4	
MOY	110	2 Capacitors (2 x 15)	30	
MP	6.6	1 Capacitor	1	
MRY	20	1 Capacitor	4	
MUL	110	2 Capacitors (2 x 15)	30	
PB	220	2 Shunt Reactors (2 x 50)		100
RAF	110	1 Capacitor	60	
RE	38	1 Shunt Reactor		20
SKL	110	1 Capacitor (1 Mobile)	30	
SLB	20	1 Capacitor	15	
SLI	110	1 Capacitor	15	
SLK	20	1 Capacitor	13	
TAN	22	2 Capacitors (2 x 25)	50	
TAN	22	2 Shunt Reactors (2 x 30)		60
THU	110	1 Capacitor	15	
THU	110	1 Static Var Compensator	30	30
TRI	110	1 Capacitor	30	
TRL	110	1 Capacitor	30	
WEX	110	2 Capacitors (2 x 15)	30	

B.2 Transmission system developments

Future developments of the transmission system are listed in this section according to the year in which they are expected to be completed. The physical and electrical characteristics of future transmission plant or changes to the characteristics brought about by planned developments are listed in the tables. These characteristics are indicative at this stage and will be reviewed when the item of plant is commissioned.

Expected changes in transmission circuits

Table B-8: Expected changes in circuit characteristics

Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Add	220	KYT	MAY	1	13.5	0.003	0.011	0.112	761	746	2022
Add	220	BLC	SHL	1	23.4	0.001	0.003	0.777	570	570	2022
Add	220	KYT	WOO	1	13.8	0.003	0.011	0.112	761	746	2022
Remove	220	MAY	WOO	1	22.3	0.003	0.020	0.030	350	436	2022
Remove	220	FIN	SHL	1	13.4	0.001	0.005	0.367	536	557	2022
Add	110	THU	THU	1	0.001	0.000	0.000	0.000	218	232	2022
Remove	110	BRO	RSK	1		0.010	0.062	0.020	144	144	2022
Add	110	BRO	GRV	1		0.003	0.016	0.005	144	144	2022
Add	110	BLU	MUL	1	56.18	0.079	0.191	0.025	105	123	2022
Add	110	INC	YLW	1	3.18	0.001	0.004	0.035	187	223	2022
Add	110	CCN	CUS	1	0.5	0.000	0.001	0.006	140	140	2022
Remove	110	CKG	KUD	1	0.75	0.000	0.001	0.008	187	223	2022
Amend	110	AGN	CBT	2	0.2	0.000	0.000	0.002	187	223	2022
Add	110	GRV	RSK	1		0.010	0.059	0.017	187	200	2022
Add	110	RSP	WEX	1	15.2	0.010	0.049	0.009	178	210	2022
Remove	110	CDU	PLA	1	37	0.023	0.120	0.013	178	210	2022
Remove	110	CDU	MUL	1	73.255	0.093	0.242	0.038	104	122	2022
Add	110	CDU	GLN	1	11.05	0.007	0.036	0.004	178	210	2022
Add	110	CLU	CBT	1	0.1	0.000	0.000	0.001	187	223	2022
Add	110	FIN (I)	MCE	1	8.37	0.008	0.026	0.013	124	124	2022
Add	110	AGN	CBT	1	0.2	0.000	0.000	0.002	187	223	2022
Add	110	CLU	KUD	1	0.9	0.000	0.001	0.010	187	223	2022
Add	110	DRY	DEE	1	9.55	0.006	0.031	0.004	178	210	2022

Table B-8: Expected changes in circuit characteristics											
Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Remove	110	BAL	DRY	1	20	0.013	0.065	0.007	178	210	2022
Add	110	GI	RSP	1	19.7	0.012	0.064	0.010	178	210	2022
Remove	110	GI	WEX	1	34.5	0.022	0.112	0.012	178	210	2022
Add	110	Blu	CDU	1	18.33	0.017	0.056	0.031	130	130	2022
Remove	110	GCA	INC	3	7.71	0.005	0.004	0.094	124	124	2022
Add	110	GOR	GOR (I)	1	0.5	0.000	0.001	0.006	187	223	2022
Add	110	GCA	YMD	1	5.09	0.001	0.006	0.056	187	223	2022
Add	110	BAL	DEE	1	10.75	0.007	0.035	0.004	178	210	2022
Add	220	GI	LWN	1	0.4	0.000	0.000	0.011	593	593	2023
Add	220	GLH	KPG	1	0.5	0.000	0.000	0.017	570	570	2023
Remove	110	GOR	PLA	1	19.732	0.030	0.068	0.006	99	121	2023
Add	110	CUL	RTO	1	19.175	0.012	0.062	0.007	178	210	2023
Remove	110	CUL	DGN	1	34.239	0.022	0.109	0.020	178	192	2023
Add	110	DGN	RTO	1	15.475	0.010	0.050	0.006	178	210	2023
Remove	110	LET	TIV	1	45.2	0.047	0.151	0.015	136	159	2023
Add	110	LNA	TIV	1	33.13	0.035	0.111	0.011	136	159	2023
Add	110	CRA	TUL	1	13.653	0.011	0.045	0.005	178	210	2023
Add	110	LET	LNA	1	12.23	0.013	0.041	0.004	136	159	2023
Remove	110	KIN	FR	1	29.25	0.021	0.096	0.010	99	121	2023
Remove	110	DER	MAY	1	43.448	0.028	0.146	0.018	74	93	2023
Add	110	DER	TIM	1	25.125	0.016	0.082	0.009	178	210	2023
Amend	110	HWN	DFR-T	1	24.503	0.016	0.080	0.009	104	157	2023
Add	110	DRY	OBE	1	2.875	0.002	0.009	0.004	178	210	2023
Add	110	DLN	SH	1	3.5	0.001	0.004	0.039	140	140	2023
Add	110	CBT	PMT	1	0.75	0.000	0.001	0.008	187	223	2023
Remove	110	DRY	PLA	1	5.3	0.008	0.018	0.002	99	121	2023
Add	110	DRG	KPG	1	13.895	0.008	0.045	0.010	178	210	2023
Remove	110	KUD	CBT	1	0.75	0.000	0.001	0.008	187	223	2023
Add	110	KUD	PMT	1	0.75	0.000	0.001	0.008	187	223	2023
Remove	110	KPG	TRL	2	43.578	0.027	0.141	0.023	178	190	2023

Table B-8: Expected changes in circuit characteristics

Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Add	110	CSH	SHN	1	4.65	0.007	0.016	0.002	105	123	2023
Add	110	DRG	TRL	1	32.333	0.020	0.105	0.014	178	210	2023
Remove	110	KIN	MUL	1	24.919	0.016	0.077	0.023	178	210	2023
Add	110	HWN	KIN	1	5.825	0.006	0.019	0.003	136	159	2023
Add	110	AGT	CLM	1		0.008	0.022	0.050	200	200	2023
Add	110	BRA	NEW (i)	1	22.7	0.024	0.076	0.008	136	159	2023
Add	110	BLC	NBY	2	2.3	0.001	0.003	0.025	140	140	2023
Add	110	BGT	KKY	1	22	0.014	0.072	0.008	178	210	2023
Remove	110	CAR	CAS	1		0.037	0.088	0.008	69	86	2023
Remove	110	CAR	CAS	2		0.037	0.086	0.008	70	87	2023
Amend	110	CAS	FIN (N)	1	9.1	0.014	0.032	0.003	69	86	2023
Remove	110	BOG	CRA	1	24.677	0.018	0.081	0.009	178	210	2023
Add	110	CPS	CRD	1		0.001	0.003	0.087	200	200	2023
Add	110	KMA	WHO	1	1.5	0.001	0.002	0.015	124	124	2023
Add	110	CRR	CRR	1		0.001	0.002	0.016	80	50	2023
Add	110	CRR	PGN	1	2.4	0.002	0.003	0.019	60	60	2023
Add	110	GLE (N)	KEL	1		0.027	0.068	0.027	82	90	2023
Remove	110	AUG	KPG	1	32.83	0.021	0.107	0.012	178	210	2023
Add	110	AUG	BKE	1	4.56	0.003	0.015	0.002	178	210	2023
Add	110	BLE	KPG	1	28.23	0.018	0.092	0.010	178	210	2023
Remove	110	CSH	SOM-T	1	50.019	0.078	0.172	0.016	99	121	2023
Amend	110	CAS	FIN (N)	1	9.1	0.014	0.032	0.003	70	87	2023
Add	110	PLA	OBE	1	2.955	0.002	0.009	0.004	178	210	2023
Add	110	MAY	TIM	1	18.71	0.012	0.061	0.009	112	112	2023
Add	110	CFD	MUL	1	18.97	0.012	0.062	0.007	178	210	2023
Remove	110	NEW (I)	PLS	1	43.02	0.055	0.146	0.014	105	123	2023
Remove	110	GLR	MOY	1	13.956	0.022	0.048	0.005	105	123	2023
Add	110	BLC	NBY	1	2.3	0.001	0.003	0.025	140	140	2023
Add	110	CLD	GCA	2	2.02	0.001	0.003	0.022	140	140	2023
Remove	110	SLI	SRA	1	11.1	0.017	0.038	0.004	99	121	2023

Table B-8: Expected changes in circuit characteristics

Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Add	110	SLI	SRA	2	11.1	0.017	0.038	0.004	105	123	2023
Add	110	BOG	TUL	1	11.15	0.007	0.036	0.005	178	210	2023
Add	110	SHN	SOM-T	1	45.45	0.071	0.156	0.015	105	123	2023
Add	110	TIV	MLG	1	6.1	0.004	0.009	0.061	140	140	2023
Add	110	CLD	GCA	1	1.87	0.001	0.002	0.021	140	140	2023
Add	110	CFD	KIN	1	6.59	0.004	0.022	0.002	178	210	2023
Add	380	KPG	MP	1	6	0.001	0.000	0.549	1,210	1,210	2024
Add	220	DSN	MAY	2	30.55	0.004	0.027	0.040	434	513	2024
Remove	220	DSN	MAY	2	30.55	0.004	0.027	0.040	350	436	2024
Add	110	BDM	MID	1	3.516	0.005	0.012	0.001	99	121	2024
Add	110	ARK	PHY	1	2.25	0.002	0.007	0.001	178	210	2024
Add	110	ARK	PHY	2	2.38	0.002	0.008	0.001	178	210	2024
Remove	110	ARK	SHE	2	2.2	0.004	0.008	0.001	34	57	2024
Remove	110	KBY	KRA	2	12.5	0.018	0.043	0.004	99	121	2024
Add	110	CUS	PPT	1	2	0.001	0.005	0.011	136	159	2024
Remove	110	CD	KBY	1	32.338	0.020	0.104	0.025	178	209	2024
Add	110	ATY	CNB	1	21.94	0.034	0.076	0.007	105	123	2024
Add	110	BDM	WHI	1	18.306	0.027	0.063	0.006	99	121	2024
Remove	110	CUS	PLS	1	42.14	0.044	0.140	0.014	136	159	2024
Add	110	BGN	MLC	1	10	0.007	0.015	0.100	124	124	2024
Add	110	CD	KLP	1	32.091	0.020	0.104	0.011	178	210	2024
Amend	110	BGT	CNB	1	28	0.018	0.091	0.010	178	210	2024
Remove	110	ATY	PLS	1	25.482	0.038	0.088	0.008	99	121	2024
Add	110	PHY	SHE	1	0.375	0.000	0.001	0.000	178	210	2024
Add	110	BKY	KCY	1	0.75	0.000	0.001	0.008	187	223	2024
Remove	110	BKY	CBT	1	1	0.000	0.001	0.011	187	223	2024
Add	110	AGN	KSE	1	1.7	0.000	0.002	0.019	187	223	2024
Add	110	MID	LGT	1	3.13	0.005	0.011	0.003	105	123	2024
Remove	110	MID	WHI	1	20.022	0.030	0.069	0.007	99	121	2024
Add	110	GAR	GLN	1	0.1	0.000	0.000	0.001	140	140	2024

Table B-8: Expected changes in circuit characteristics

Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Add	110	CNB	PLS	1	8.36	0.005	0.026	0.008	178	210	2024
Add	110	KRA	LGT	1	7.83	0.012	0.027	0.004	105	123	2024
Add	110	MOY	TON	1	58	0.037	0.188	0.021	178	210	2024
Add	110	DFR	MGT	1	6.175	0.004	0.019	0.011	104	157	2024
Add	110	KLP	KRA	2	12.5	0.018	0.043	0.004	99	121	2024
Add	110	KLP	MAL	1	29.2	0.018	0.095	0.010	134	159	2024
Add	110	AIR	ROS	1		0.013	0.034	0.003	82	103	2024
Add	110	AIR	ROS	1		0.013	0.034	0.003	82	103	2024
Add	110	KEL	KLC	1		0.000	0.001	0.008	144	144	2024
Add	110	KLC	KEL C	1		0.005	0.031	0.003	126	156	2024
Add	110	PPT	PLS	1	42.14	0.043	0.138	0.028	136	159	2024
Add	110	CBT	KCY	1	0.75	0.000	0.001	0.008	187	223	2024
Remove	110	KRA	MID	1	10.7	0.017	0.037	0.004	99	121	2024
Add	110	HWN	MGT	1	18.127	0.013	0.059	0.006	136	159	2024
Remove	110	KBY	MAL	1	29.2	0.018	0.095	0.010	134	159	2024
Add	110	CBT	KSE	1	1.9	0.001	0.002	0.021	187	223	2024
Add	110	LCK	MUL	1	26	0.019	0.039	0.261	124	124	2024
Remove	110	KBY	MR	1	4.438	0.004	0.015	0.004	103	130	2024
Add	380	TUR	WOO	1		0.003	0.031	0.707	1,424	1,731	2025
Add	380	CNB	MP	1		0.003	0.011	0.858	1,577	1,944	2025
Remove	380	DSN	MP	1	208.5	0.004	0.044	1.140	1,283	1,454	2025
Add	380	CNB	DSN	1		0.001	0.003	0.226	1,577	1,944	2025
Remove	275	TAN	TMN	1		0.001	0.011	0.065	710	881	2025
Add	275	TMN	TUR	1		0.000	0.002	0.014	710	881	2025
Add	275	TAN	TUR	2		0.001	0.009	0.051	710	881	2025
Add	275	TAN	TUR	1		0.001	0.009	0.051	710	881	2025
Remove	275	TAN	TMN	2		0.001	0.011	0.065	710	881	2025
Add	275	TMN	TUR	2		0.000	0.002	0.014	710	881	2025
Add	220	ORL	ORL	1	20.1	0.001	0.008	0.550	593	593	2025
Add	220	HN	MRN	1	0.15	0.000	0.000	0.004	593	593	2025

Table B-8: Expected changes in circuit characteristics											
Action	Voltage (kV)	From	To	No.	Length (km)	Impedance on 100 MVA Base (pu)			Rating (MVA)		Year
						R	X	B	Summer	Winter	
Add	220	FIN (I)	MRN	1	1.4	0.000	0.001	0.038	593	593	2025
Remove	220	FIN (I)	HN	1	1.4	0.000	0.001	0.038	593	593	2025
Add	220	ORL	ORL	1	15.9	0.001	0.002	0.528	570	570	2025
Add	220	CDU	MRN	1	3.728	0.000	0.002	0.102	593	593	2025
Remove	220	CDU	HN	1	3.728	0.000	0.001	0.134	555	555	2025
Add	220	WOO	ORL	1	49.2	0.006	0.043	0.064	434	513	2025
Add	220	LOU	ORL	1	14.5	0.002	0.013	0.019	434	513	2025
Add	220	HN	MRN	1	0.15	0.000	0.000	0.004	593	593	2025
Remove	220	LOU	WOO	1	61.2	0.007	0.053	0.080	350	436	2025
Add	110	BAH	SBH	1	1.2	0.000	0.001	0.013	192	192	2025
Add	110	CNB	CNB	1	0	0.000	0.000	0.000	178	210	2025
Remove	110	SBH	MCE	1	4.7271	0.005	0.015	0.005	99	121	2025
Add	110	BAH	CLG	1	0.85	0.000	0.001	0.009	192	192	2025
Remove	110	CLG	FIN (I)	1	3.64	0.004	0.011	0.007	124	124	2025
Add	400	CEL	KRA	1	0.1	0.000	0.000	0.018	1,100	1,100	2026
Add	110	CEN	CEN	1	0.001	0.000	0.000	0.000	187	223	2026
Add	110	BNM	CEN	1		0.000	0.002	0.019	200	200	2026
Add	110	BNM	CEN	1		0.000	0.002	0.019	200	200	2026
Add	110	CNB	GGT	1	13.85	0.009	0.045	0.005	178	210	2026
Add	110	BGT	GGT	1	13.45	0.009	0.044	0.005	178	210	2026
Add	380	DSN	WOO	1	50	0.000	0.008	5.263	1,577	1,867	2027
Add	110	BNM	BNM	1	0	0.000	0.000	0.000	228	228	2027
Add	110	GI	WAT	2	12.901	0.008	0.042	0.005	178	210	2027
Add	110	RSK	TGW	1		0.013	0.072	0.031	211	235	2028
Add	110	KEL	TGW	1		0.010	0.041	0.004	200	200	2028
Remove	110	CRG	KEL	1		0.029	0.077	0.013	82	103	2028
Add	110	CRG	TGW	1		0.013	0.034	0.009	109	124	2028
Add	110	MNH	MTA	1	3	0.001	0.003	0.033	190	190	2029
Add	110	BLC	MNH	1	5	0.003	0.002	0.195	842	746	2029
Add	110	NBY	MTA	1	2.5	0.001	0.003	0.028	190	190	2029

Expected changes in transformers in Ireland

Table B-9: Characteristics of transformer changes in Ireland									
Action	**Station**	**Transformer**	**Rating (MVA)**	**HV/LV (kV)**	**Impedance on 100 MVA base (pu)**		**Voltage ratio tapping range**		**Year**
					R	**X**	**+**	**-**	
Add	KPG	T4101	500	380/220	0.0003	0.027	0.105	0.079	2024
Add	BLC	T2102	250	220/110	0.001	0.0646	0.0974	0.179	2022
Add	CNB	T4101	500	380/110	0.00048	0.072	0.157	0.1579	2025
Add	CNB	T4102	500	380/110	0.00048	0.072	0.157	0.1579	2025
Add	KLN	T2104	250	220/110	0.0004	0.0631	0.1	0.18	2027
Remove	KLN	T2104	125	220/110	0.001	0.123	0.1	0.18	2027
Remove	KLN	T2102	63	220/110	0.0095	0.2473	0.2289	0.182	2027
Remove	KLN	T2101	63	220/110	0.0065	0.2453	0.2288	0.182	2027

Expected changes in 3 winding transformers in Northern Ireland

Table B-10: Characteristics of 3 winding transformer changes in Northern Ireland															
Action	Sub-station/ Trans-former	Voltage (kV)	Impedance on 100 MVA Base (pu)						Rating (MVA)			Off nominal ratio (pu)		No. of taps	Year
			W1-2		W2-3		W3-1								
			R	X	R	X	R	X	W1	W2	W3	Upper	Lower		
Add	TUR IBTx 1	400/275	0.0003	0.0329	0.0001	0.18	0.0001	0.23	500	500	60	1.1	0.9	2025	15
Add	TUR IBTx 2	400/275	0.0003	0.0329	0.0001	0.18	0.0001	0.23	500	500	60	1.1	0.9	2025	15
Add	TUR IBTx 3	400/275	0.0003	0.0329	0.0001	0.18	0.0001	0.23	500	500	60	1.1	0.9	2025	15
Winding 1 (110 kV) out of service	CSTAT1R	110/275	0.0018	0.0656	0.0018	0.2375	0	0.1593	240	240	30	1.15	0.85	19	2023
Add	CAST2-	110/275	0.001	0.689	0.0031	0.217	0.0031	0.1223	240	240	240	1.1	0.9	2023	23
Add	HNNHAT2	110/275	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19	2023
Remove	HNNHAT1	110/275	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	45	1.15	0.85	19	2023

Expected changes in 2 winding transformers in Northern Ireland

Table B-11: Characteristics of 2 winding transformer changes in Northern Ireland

Action	Station	HV/LV (kV)	Rating (MVA)	Impedance pu on rating base		Off nominal ratio		No. of taps	Year
				R	X	Upper	Lower		
Add	DON	110/33	90	0.0039	0.2461	1.1	0.8	19	2022
Add	BMA	110/33	90	0.0065	0.2867	1	0.9	33	2022
Add	GRT	110/33	90	0.0039	0.2461	1	0.8	19	2022
Add	GRV	110/33	90	0.0039	0.2461	1.1	0.8	19	2022
Add	AIR	110/33	60	0.0073	0.25	1.1	0.8	19	2023
Add	CAS	110/33	60	0.0159	0.2292	1.1625	0.9125	21	2023
Add	AIR	110/33	60	0.0073	0.25	1.1	0.8	19	2023
Add	CRR	110/33	50	0.0071	0.4126	1.1	0.9	33	2023
Add	PGN	110/33	60	0.0228	0.3201	1.1	0.9	33	2023
Add	GLE (N)	110/33	90	0.0119	0.2692	1.1	0.8	19	2023
Add	KEL	110/33	60	0.0265	0.3076	1.1	0.8	19	2023
Add	AGT	110/33	80	0.0266	0.335	1.1	0.9	33	2023
Add	ENN (N)	110/33	90	0.0126	0.272	1.1	0.9	33	2024
Add	ENN (N)	110/33	90	0.0126	0.2733	1.1	0.9	33	2024
Add	BAN	110/33	90	0.0039	0.2461	1.1	0.9	33	2026
Add	BAN	110/33	90	0.0039	0.2461	1.1	0.9	33	2026

Expected changes in reactive compensation

Table B-12: Changes in the characteristics of reactive compensation						
Action	**Station**	**Voltage**	**Plant**	**Mvar capability**		**Year**
				Generate	**Absorb**	
Add	KNR	110	Reactor		50	2021
Remove	THU	110	Capacitor	30		2023
Add	THU	110	Capacitor	15		2023
Add	xxx	110	STATCOM	30	30	2022
Add	BNH	110	STATCOM	100	100	2022
Add	BVK	110	STATCOM	100	100	2022
Remove	CAS	22	Capacitor	25		2022
Add	CAS	22	STATCOM	25	30	2023
Remove	CAS	22	Capacitor	25		2022
Add	CAS	22	STATCOM	25	30	2027
Add	TMN	22	Reactor		30	2022
Add	TAN	22	Reactor		30	2022
Add	LCK	110	Capacitor	15		2024
Add	BLC	220	STATCOM	250	250	2027

Appendix C: Demand forecasts at individual transmission interface stations

Transmission Interface Stations and Bulk Supply Points are connection points to the transmission system. These connection points include transmission system connections to the distribution system or directly-connected customers. Table C-1 to Table C-4 list the demand forecasts at each Transmission Interface Station and Bulk Supply Point. The forecasts are noted for each node between 2022 and 2031 at the winter peak, summer peak, and summer valley. The autumn peak forecasts are also given for Northern Ireland.

The station demand values do not include transmission losses. Demand values at stations that interface with the distribution system do include distribution losses.

Transmission Interface Stations are generally 110 kV stations. The exceptions to this are six 220/110 kV interface stations that supply the Dublin network. These interface stations are Belcamp, Carrickmines, Castlebagot, Finglas, Inchicore and Poolbeg.

Only stations feeding demand are included in the tables below, generation stations are not included.

Demand forecasts at time of Winter Peak

Table C-1: Demand forecasts at time of Winter Peak												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
AA	Ardnacrusha	0.992	63.9	65.3	67.5	68.3	68.0	68.6	69.1	68.9	69.2	69.6
AGH	Aghyoule	0.99	20.5	20.9	20.6	20.6	20.9	20.7	20.5	20.2	19.8	19.7
AGN	Aungierstown	0.95	7.6	15.2	22.8	25.2	27.6	29.9	32.3	34.7	37.1	39.4
AHA	Ahane	0.999	5.1	5.2	5.4	5.4	5.4	5.4	5.5	5.5	5.5	5.5
AIR	Airport Road	0.99			20.8	20.9	21.3	21.3	21.2	21.0	20.9	20.9
ANR	Anner	0.95	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
ANT	Antrim	0.98	42.3	43.2	43.1	43.5	44.7	45.0	45.4	45.7	46.0	46.5
ARD	Ardnagappary	0.99	16.2	16.6	17.1	17.3	17.2	17.4	17.5	17.5	17.6	17.6
ARI	Arigna	1	5.6	5.7	5.9	6.0	5.9	6.0	6.0	6.0	6.1	6.1
ARK	Arklow	1	42.1	43.0	44.5	45.0	44.8	45.2	45.6	45.4	45.6	45.8
ATH	Athlone	0.997	83.0	84.8	87.7	88.7	88.3	89.1	89.8	89.5	89.9	90.3
ATY	Athy	0.966	19.6	20.0	20.7	20.9	20.8	21.0	21.2	21.1	21.2	21.3
BAG	Barnageeragh	0.95				7.1	9.5	11.9	14.3	16.6	19.0	21.4
BAL	Baltrasna	0.999	16.6	17.0	17.6	17.8	17.7	17.9	18.0	17.9	18.0	18.1
BAN	Bandon	0.95	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
BAN	Bandon	0.989	49.3	54.2	52.1	52.7	52.5	53.0	53.4	53.2	53.5	53.7
BAN (N)	Banbridge	0.99	35.4	36.4	36.5	37.1	38.4	39.2	39.9	40.8	41.6	42.6
BAR	Barrymore	0.998	31.9	32.6	33.7	34.1	34.0	34.3	34.6	34.4	34.6	34.8
BDA	Baroda	0.95	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
BDN	Ballydine	0.95	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
BDN	Ballydine	0.984	15.4	15.7	16.2	16.4	16.3	16.5	16.6	16.6	16.6	16.7
BEG	Ballybeg	1	15.7	16.0	16.6	16.8	16.7	16.9	17.0	16.9	17.0	17.1
BIN	Binbane	1	4.7	4.8	5.0	5.1	5.0	5.1	5.1	5.1	5.1	5.1
BK	Bellacorick	0.999	6.1	6.2	6.4	6.5	6.4	6.5	6.6	6.5	6.6	6.6
BLC	**Belcamp**	**0.951**	**91.2**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**
BLI	Ballylickey	0.999	14.3	14.6	15.1	15.3	15.2	15.3	15.5	15.4	15.5	15.5
BLK	Blake	0.994	28.3	28.9	29.9	30.2	30.1	30.3	30.6	30.5	30.6	30.8
BMA	Ballymena	0.95	58.4	59.2	59.3	60.0	60.8	62.6	61.1	59.0	57.0	65.8
BNH	Ballynahinch	0.99	56.4	57.9	58.0	58.9	60.9	61.9	62.9	64.1	65.2	66.6
BNM	Belfast North	0.99	47.0	47.6	47.8	48.5	49.3	51.0	49.7	48.0	46.4	54.8

Table C-1: Demand forecasts at time of Winter Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
BOG	Banoge	0.997	8.7	8.9	9.2	9.3	9.3	9.4	9.4	9.4	9.5	9.5
BRI	Brinny	0.95	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
BRY	Barnahely	0.977	35.7	36.5	37.7	38.2	38.0	38.3	38.6	38.5	38.7	38.9
BUT	Butlerstown	0.989	42.1	43.1	44.5	45.0	44.8	45.2	45.6	45.4	45.7	45.9
CAH	Cahir	0.989	27.6	28.2	29.1	29.4	29.3	29.6	29.8	29.7	29.9	30.0
CAR	CARNMONEY	0.99	32.6	33.5	33.5	34.0	35.1	35.6	36.2	36.8	37.4	38.2
CBG	Carrowbeg	0.991	18.8	19.2	19.9	20.1	20.0	20.2	20.3	20.3	20.4	20.5
CBR	Castlebar	0.993	34.7	35.5	36.6	37.1	36.9	37.2	37.5	37.4	37.6	37.8
CEN	Belfast Central	0.99	52.0	53.1	52.1	52.1	53.6	53.4	53.1	52.6	52.0	51.9
CF	Cathaleens Fall	0.998	21.6	22.1	22.8	23.1	23.0	23.2	23.4	23.3	23.4	23.5
CFM	Castlefarm	0.95	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
CHA	Charleville	0.988	21.1	21.5	22.2	22.5	22.4	22.6	22.8	22.7	22.8	22.9
CKM	**Carrickmines**	**0.998**	**350.8**	**357.7**	**368.5**	**372.4**	**370.8**	**373.8**	**376.5**	**375.2**	**377.0**	**378.5**
CLE	Clonee	0.95	90.3	105.5	120.7	135.4	135.4	135.4	135.4	135.4	135.4	135.4
CLG	Cloghran	0.95	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2
CLN	Cloon	1	27.7	28.3	29.3	29.6	29.5	29.7	30.0	29.9	30.0	30.1
CLU	Clutterland	0.95	3.8	3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
CLW	Carlow	0.992	72.4	74.0	76.5	77.4	77.0	77.7	78.3	78.0	78.4	78.8
COL	College Park	0.994	17.0	17.4	18.0	18.2	18.1	18.3	18.4	18.3	18.4	18.5
COL (N)	Coleraine	0.99	40.2	41.3	41.4	42.0	43.4	44.1	44.8	45.7	46.5	47.5
COS	Carrick on Shannon	0.996	30.1	30.7	31.8	32.1	32.0	32.3	32.5	32.4	32.6	32.7
COW	Cow Cross	1	17.5	17.9	18.5	18.7	18.6	18.8	19.0	18.9	19.0	19.1
CPS	Coolkeeragh	0.99	35.4	36.1	35.4	35.8	36.4	36.2	36.0	35.6	35.2	35.1
CRA	Crane	0.992	32.9	33.7	34.8	35.2	35.0	35.3	35.6	35.5	35.7	35.8
CRE	Cregagh	0.99	66.3	54.1	54.2	55.0	56.8	57.7	58.6	59.5	60.5	61.7
CRG	Creagh	0.99	48.2	49.3	49.2	49.7	51.0	51.5	51.9	52.3	52.6	53.3
CRO	Coolroe	1	11.1	11.3	11.7	11.8	11.8	11.9	12.0	11.9	12.0	12.0
CRU	Cruiserath	0.95	31.4	45.6	59.9	74.1	88.4	102.6	116.9	131.1	145.4	159.6
CVW	Castleview	0.95									8.8	8.8
CVW	Castleview	0.989	33.9	34.6	35.8	36.2	36.1	36.4	36.7	36.5	36.7	36.9

Table C-1: Demand forecasts at time of Winter Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
DAL	Dallow	0.981	19.4	19.8	20.5	20.8	20.7	20.8	21.0	20.9	21.0	21.1
DDK	Dundalk	0.99	68.9	70.4	72.8	73.6	73.3	73.9	74.5	74.2	74.6	75.0
DFR	Dunfirth	0.96	11.2	11.5	11.9	12.0	12.0	12.1	12.2	12.1	12.2	12.2
DGN	Dungarvan	0.991	51.1	52.2	54.0	54.6	54.3	54.8	55.3	55.1	55.4	55.6
DLT	Dalton	0.99	29.6	30.3	31.3	31.7	31.5	31.8	32.1	31.9	32.1	32.2
DMY	Dunmanway	0.991	36.1	36.9	38.1	38.6	38.4	38.7	39.0	38.9	39.1	39.3
DON	Donegall	0.99	81.5	83.9	84.4	86.0	89.4	91.3	93.4	95.7	98.0	100.6
DOO	Doon	0.991	28.7	29.4	30.3	30.7	30.6	30.8	31.1	31.0	31.1	31.3
DRU	Drumline	0.952	32.0	32.7	33.8	34.2	34.0	34.3	34.6	34.5	34.6	34.8
DRU (N)	Drumnakelly	0.99	83.2	84.3	84.4	85.4	86.6	89.2	87.0	84.0	81.1	93.7
DRY	Drybridge	0.994	93.5	95.6	98.8	99.9	99.5	100.4	101.1	100.8	101.3	101.8
DUN	Dungannon	0.99	90.2	92.2	91.7	92.2	94.2	94.4	94.5	94.3	94.2	94.7
EDE	Eden	0.99	31.6	32.4	32.5	33.1	34.3	34.9	35.5	36.3	37.0	37.9
ENN	Ennis	0.986	64.3	65.7	67.9	68.7	68.4	69.0	69.6	69.3	69.7	70.0
ENN (N)	Enniskillen	0.99	59.5	61.0	61.0	61.7	63.5	64.2	65.0	65.7	66.4	67.5
FIN (I)	**Finglas**	**0.984**	**478.6**	**488.6**	**504.0**	**509.5**	**507.3**	**511.6**	**515.4**	**513.6**	**516.1**	**518.3**
FIN (N)	Finaghy	0.99	31.9	32.8	32.8	33.2	34.2	34.7	35.2	35.7	36.1	36.8
FTT	Fortunestown	0.998	14.5	14.8	15.3	15.5	15.4	15.6	15.7	15.6	15.7	15.8
GAL	Galway	0.994	98.9	101.1	104.5	105.7	105.2	106.2	106.8	106.6	107.2	107.7
GI	Great Island	0.964	16.7	17.1	17.6	17.9	17.8	17.9	18.1	18.0	18.1	18.2
GIL	Gilra	0.95	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
GLE	Glenlara	0.994	17.9	18.3	18.9	19.2	19.1	19.3	19.4	19.3	19.4	19.5
GLE (N)	Glengormley	0.99	28.7	29.3	29.1	29.2	29.7	29.7	29.7	29.5	29.3	29.3
GRI	Griffinrath	0.994	65.9	67.3	69.6	70.4	70.1	70.7	71.3	71.0	71.4	71.7
GWE	Gortawee	0.991	11.2	11.4	11.8	11.9	11.9	12.0	12.1	12.0	12.1	12.1
GWE	Gortawee	0.95	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
HN	Huntstown	0.95			7.6	15.2	22.8	30.4	38.0	45.6	53.2	60.8
IKE	Ikerrin	0.981	32.1	32.8	33.9	34.3	34.2	34.5	34.8	34.6	34.8	35.0
INC	**Inchicore**	**0.999**	**527.7**	**567.2**	**599.5**	**623.1**	**643.8**	**669.5**	**689.9**	**706.6**	**716.0**	**721.3**
KBY	Kilbarry	0.991	89.0	90.9	94.0	95.1	94.7	95.5	96.3	95.9	96.4	96.9
KCY	Kilcarbery	0.95			3.8	7.6	11.4	15.2	19.0	22.8	26.6	30.4

Table C-1: Demand forecasts at time of Winter Peak												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
KER	Knockearagh	0.981	41.7	42.7	44.1	44.6	44.4	44.8	45.1	45.0	45.2	45.4
KGE	Kishoge	0.95			4.8	9.5	14.3	19.0	23.8	23.8	23.8	23.8
KIL	Kilteel	0.97	36.7	37.5	38.7	39.2	39.0	39.4	39.7	39.5	39.7	39.9
KIN	Kinnegad	0.95	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	Kilkenny	0.988	62.4	51.8	53.6	54.2	53.9	54.4	54.9	54.7	54.9	55.2
KLM	Kilmore	0.99	20.3	20.7	21.4	21.7	21.6	21.8	22.0	21.9	22.0	22.1
KNO	Knock	0.99	50.0	45.9	46.3	47.3	49.4	50.8	52.2	53.9	55.6	57.4
KTN	Killoteran	0.982	14.7	15.1	15.6	15.7	15.7	15.8	15.9	15.9	16.0	16.0
KUR	Knockumber	0.95	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
KYT	Kellystown	0.95	59.9	114.0	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9
LA	Lanesborough	0.989	17.3	17.7	18.3	18.5	18.4	18.6	18.8	18.7	18.8	18.9
LAR	Larne	0.99	42.2	43.4	43.5	44.3	45.9	46.7	47.6	48.6	49.6	50.8
LET	Letterkenny	0.986	66.3	67.8	70.1	70.9	70.5	71.2	71.7	71.5	71.8	72.2
LIB	Liberty Street	0.994	26.0	26.6	27.5	27.8	27.7	27.9	28.2	28.1	28.2	28.3
LIM	Limerick	0.995	87.5	89.4	92.4	93.5	93.1	93.9	94.7	94.3	94.8	95.2
LIM (N)	Limavady	0.99	20.9	21.4	21.5	21.8	34.6	23.0	23.5	24.0	24.5	25.1
LIS	Lisdrum	0.975	32.5	33.2	34.3	34.7	34.6	34.9	35.2	35.0	35.2	35.4
LIS (N)	Lisburn	0.99	78.2	80.0	79.8	80.6	82.7	83.4	84.1	84.6	85.2	86.3
LMR	Lisaghmore	0.98	38.8	39.8	39.9	40.6	42.0	42.7	43.4	44.3	45.1	46.1
LOG	Loguestown	0.98	36.5	37.5	37.6	38.2	39.5	40.1	40.8	41.6	42.3	43.2
MAC	Macroom	0.994	18.2	18.6	19.2	19.4	19.3	19.5	19.7	19.6	19.7	19.8
MAL	Mallow	0.989	25.0	25.5	26.4	26.7	26.6	26.8	27.0	26.9	27.1	27.2
MCE	Macetown	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
MCE	Macetown	0.997	29.3	29.8	30.6	30.9	30.8	31.0	31.2	31.1	31.2	31.4
MID	Midleton	0.985	45.1	46.1	47.7	48.2	48.0	48.4	48.8	48.6	48.9	49.1
MLN	Mullagharlin	0.95	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
MON	Monread	0.992	14.5	14.8	15.3	15.5	15.4	15.6	15.7	15.6	15.7	15.8
MOY	Moy	0.993	31.7	32.4	33.4	33.8	33.7	34.0	34.2	34.1	34.3	34.5
MR	Marina	0.996	17.7	18.1	18.7	18.9	18.8	19.0	19.1	19.0	19.1	19.2
MTA	Metro Airport	0.95								23.8	23.8	23.8
MTH	Meath Hill	0.96	59.1	60.4	62.5	63.2	62.9	63.5	64.0	63.7	64.1	64.4

Table C-1: Demand forecasts at time of Winter Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
MTN	Metro North	0.95								29.5	29.5	29.5
MUL	Mullingar	0.989	46.8	47.8	49.4	50.0	49.8	50.2	50.6	50.4	50.7	50.9
MUN	Mungret	0.95	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
NAR	Newtownards	0.99	37.9	38.9	39.2	39.9	41.5	42.5	43.5	44.6	45.8	47.0
NAV	Navan	0.987	65.0	66.5	68.7	69.5	69.2	69.8	70.3	70.1	70.4	70.8
NEW	Newbridge	0.991	43.9	44.9	46.4	46.9	46.7	47.1	47.5	47.3	47.6	47.8
NEW (N)	Newry	0.99	73.1	74.9	74.9	75.8	78.1	79.1	80.0	81.0	82.0	83.4
NNA	Nenagh	0.947	23.3	23.8	24.6	24.9	24.8	25.0	25.2	25.1	25.2	25.4
OBE	Oldbridge	0.95		3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
OLD	Oldcourt	0.95	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	Omagh	0.99	59.1	60.4	60.2	60.8	62.3	62.7	63.1	63.3	63.6	64.3
OUG	Oughtragh	0.998	27.9	28.5	29.4	29.8	29.6	29.9	30.2	30.0	30.2	30.3
PB	**Poolbeg**	**0.989**	**188.2**	**192.4**	**198.9**	**201.2**	**200.3**	**202.1**	**203.7**	**202.9**	**204.0**	**204.9**
PLA	Platin	0.95	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
PLS	Portlaoise	0.984	56.5	42.5	44.0	44.5	44.3	44.7	45.0	44.9	45.1	45.3
RAT	Rathkeale	0.996	43.8	44.7	46.2	46.8	46.5	47.0	47.3	47.2	47.4	47.6
RAT (N)	Rathgael	0.99	50.1	51.7	10.9	53.2	55.5	56.9	58.4	60.1	61.8	63.7
RIC	Richmond	0.98	38.1	39.0	40.3	40.8	40.6	40.9	41.3	41.1	41.3	41.5
RNW	Rinawade	0.95	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
ROS	Rosebank	0.99	32.8	32.2	32.3	32.8	33.9	34.4	35.0	35.6	36.2	37.0
RYB	Ryebrook	0.95	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5
SCR	Screebe	0.992	17.5	17.9	18.5	18.7	18.6	18.8	19.0	18.9	19.0	19.1
SHE	Shelton Abbey	0.95	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SHL	Salthill	1	45.9	46.9	48.5	49.0	48.8	49.3	49.6	49.5	49.7	49.9
SKL	Shankill	0.995	60.0	61.3	63.4	64.1	63.8	64.4	64.9	64.7	65.0	65.3
SLI	Sligo	0.997	57.4	58.6	60.6	61.3	61.0	61.6	62.1	61.8	62.2	62.4
SNG	Singland	0.995	18.4	18.8	19.5	19.7	19.6	19.8	19.9	19.8	20.0	20.0
SBH	Snughborough	0.95	14.3	17.1	19.0	21.9	23.8	26.6	28.5	31.4	33.3	33.3
SOM	Somerset	0.989	24.0	24.5	25.4	25.6	25.5	25.8	26.0	25.9	26.0	26.1
SPR	Springtown	0.99	32.3	33.1	33.0	33.3	34.2	34.4	34.7	34.9	35.1	35.5
STR	Stratford	0.989	24.5	25.0	25.8	26.1	26.0	26.3	26.5	26.4	26.5	26.6

Table C-1: Demand forecasts at time of Winter Peak												
Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
STR (N)	Strabane	0.99	46.0	47.1	46.9	47.4	48.7	49.1	49.5	49.8	50.1	50.8
TBG	Trabeg	0.997	74.6	76.3	78.8	79.8	79.4	80.1	80.7	80.4	80.8	81.2
TBK	Tullabrack	0.961	13.1	13.4	13.8	14.0	13.9	14.0	14.1	14.1	14.2	14.2
THU	Thurles	0.982	30.7	31.3	32.4	32.8	32.6	32.9	33.2	33.1	33.2	33.4
TIP	Tipperary	0.984	21.7	22.2	23.0	23.2	23.1	23.3	23.5	23.4	23.5	23.7
TLK	Trillick	0.987	23.1	23.6	24.4	24.7	24.6	24.8	25.0	24.9	25.0	25.1
TON	Tonroe	0.988	15.5	15.9	16.4	16.6	16.5	16.7	16.8	16.7	16.8	16.9
TRI	Trien	0.992	18.5	18.9	19.5	19.7	19.6	19.8	20.0	19.9	20.0	20.1
TRL	Tralee	0.992	58.9	60.2	62.2	63.0	62.7	63.2	63.7	63.5	63.8	64.1
TSB	Thornsberry	0.986	36.5	37.3	38.5	39.0	38.8	39.2	39.5	39.3	39.5	39.7
WAR	Waringstown	0.99	57.1	58.5	58.4	59.0	60.6	61.1	61.6	62.1	62.6	63.4
WAT	Waterford	0.996	56.7	57.9	59.9	60.6	60.3	60.9	61.3	61.1	61.4	61.7
WEX	Wexford	0.985	61.7	63.1	65.2	66.0	65.7	66.3	66.8	66.5	66.9	67.2
WHI	Whitegate	0.95	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0

Demand forecasts at time of Summer Peak

Table C-2: Demand forecasts at time of Summer Peak												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
AA	Ardnacrusha	0.993	49.0	50.0	51.0	51.4	50.9	51.2	51.4	50.8	51.0	51.1
AGH	Aghyoule	0.99	16.1	16.4	16.2	16.2	16.4	16.3	15.9	15.3	14.8	15.5
AGN	Aungierstown	0.95	7.6	15.2	22.8	25.2	27.6	29.9	32.3	34.7	37.1	39.4
AHA	Ahane	0.998	3.9	4.0	4.0	4.1	4.0	4.1	4.1	4.0	4.0	4.1
AIR	Airport Road	0.99			16.4	16.5	16.8	16.7	16.3	15.8	15.2	16.4
ANR	Anner	0.95	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
ANT	Antrim	0.98	33.2	34.0	33.9	34.2	35.1	35.4	34.5	33.3	32.2	36.6
ARD	Ardnagappary	0.99	12.4	12.7	12.9	13.0	12.9	13.0	13.0	12.9	12.9	13.0
ARI	Arigna	0.998	4.3	4.4	4.5	4.5	4.4	4.5	4.5	4.4	4.5	4.5
ARK	Arklow	0.997	32.3	33.0	33.6	33.9	33.5	33.7	33.9	33.5	33.6	33.7
ATH	Athlone	0.998	63.7	65.0	66.2	66.8	66.1	66.5	66.8	66.0	66.2	66.4
ATY	Athy	0.968	15.0	15.3	15.6	15.8	15.6	15.7	15.8	15.6	15.6	15.7
BAG	Barnageeragh	0.95				7.1	9.5	11.9	14.3	16.6	19.0	21.4
BAL	Baltrasna	1	12.8	13.0	13.3	13.4	13.3	13.3	13.4	13.2	13.3	13.3
BAN	Bandon	0.987	37.9	38.6	39.4	39.7	39.3	39.5	39.7	39.3	39.4	39.5
BAN (N)	Banbridge	0.99	27.8	28.6	28.7	29.2	30.2	30.8	30.0	29.0	28.0	33.5
BAR	Barrymore	1	24.5	25.0	25.5	25.7	25.4	25.6	25.7	25.4	25.5	25.5
BDA	Baroda	0.95	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
BDN	Ballydine	0.96	11.8	12.0	12.2	12.4	12.2	12.3	12.4	12.2	12.3	12.3
BDN	Ballydine	0.95	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
BEG	Ballybeg	1	12.0	12.3	12.5	12.6	12.5	12.6	12.6	12.5	12.5	12.6
BIN	Binbane	0.99	12.0	12.2	12.5	12.6	12.4	12.5	12.6	12.4	12.5	12.5
BIN	Binbane	0.99	3.6	3.7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
BK	Bellacorick	0.996	4.6	4.7	4.8	4.9	4.8	4.9	4.9	4.8	4.8	4.8
BLC	**Belcamp**	**0.95**	**91.2**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**
BLI	Ballylickey	0.991	11.0	11.2	11.4	11.5	11.4	11.4	11.5	11.4	11.4	11.4
BLK	Blake	0.99	21.7	22.1	22.5	22.7	22.5	22.6	22.8	22.5	22.6	22.6
BMA	Ballymena	0.95	45.9	47.1	47.1	47.7	49.2	49.8	48.5	46.9	45.3	52.6
BNH	Ballynahinch	0.99	44.3	45.5	45.6	46.3	47.9	48.7	47.4	45.8	44.2	52.4
BNM	Belfast North	0.99	36.9	37.9	38.0	38.6	39.9	40.6	39.5	38.2	36.9	43.8

Table C-2: Demand forecasts at time of Summer Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
BOG	Banoge	0.97	6.7	6.8	7.0	7.0	6.9	7.0	7.0	6.9	7.0	7.0
BRI	Brinny	0.95	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
BRY	Barnahely	0.976	27.4	28.0	28.5	28.7	28.4	28.6	28.7	28.4	28.5	28.6
BUT	Butlerstown	0.989	32.3	33.0	33.6	33.9	33.5	33.7	33.9	33.5	33.6	33.7
CAH	Cahir	0.981	21.1	21.6	22.0	22.2	21.9	22.1	22.2	21.9	22.0	22.0
CAR	Carnmoney	0.99	25.6	26.3	26.3	26.7	27.6	28.0	27.3	26.4	25.5	30.0
CBG	Carrowbeg	0.984	14.4	14.7	15.0	15.1	15.0	15.1	15.1	15.0	15.0	15.0
CBR	Castlebar	0.988	26.6	27.2	27.7	27.9	27.6	27.8	27.9	27.6	27.7	27.7
CEN	Belfast Central	0.99	40.9	41.7	41.4	41.5	42.1	42.0	40.9	39.5	38.2	40.8
CF	Cathaleens Fall	0.964	16.6	16.9	17.2	17.4	17.2	17.3	17.4	17.2	17.2	17.3
CFM	Castlefarm	0.95	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
CHA	Charleville	0.96	16.2	16.5	16.8	16.9	16.8	16.9	17.0	16.8	16.8	16.8
CKM	**Carrickmines**	**0.998**	**277.8**	**282.7**	**287.2**	**289.4**	**286.7**	**288.3**	**289.5**	**286.6**	**287.3**	**287.9**
CLE	Clonee	0.95	90.3	105.5	120.7	135.4	135.4	135.4	135.4	135.4	135.4	135.4
CLG	Cloghran	0.95	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2
CLN	Cloon	0.925	21.3	21.7	22.1	22.3	22.0	22.2	22.3	22.0	22.1	22.1
CLU	Clutterland	0.95	3.8	3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
CLW	Carlow	0.991	55.6	56.7	57.7	58.2	57.6	58.0	58.3	57.6	57.7	57.9
COL	College Park	0.986	26.6	27.2	27.7	27.9	27.6	27.8	27.9	27.6	27.7	27.7
COL (N)	Coleraine	0.99	31.6	32.4	32.5	33.0	34.1	34.7	33.8	32.6	31.5	37.4
COS	Carrick on Shannon	0.989	23.1	23.5	24.0	24.2	23.9	24.1	24.2	23.9	24.0	24.1
COW	Cow Cross	0.997	13.5	13.7	14.0	14.1	14.0	14.0	14.1	13.9	14.0	14.0
CPS	Coolkeeragh	0.99	27.8	28.4	28.1	28.2	28.6	28.5	27.8	26.8	25.9	27.6
CRA	Crane	0.979	25.3	25.8	26.3	26.5	26.2	26.4	26.5	26.2	26.3	26.3
CRE	Cregagh	0.99	52.1	42.5	42.6	43.2	44.6	45.3	44.2	42.7	41.2	48.5
CRG	Creagh	0.99	37.9	38.8	38.7	39.1	40.1	40.4	39.4	38.1	36.8	41.9
CRO	Coolroe	1	8.5	8.7	8.8	8.9	8.8	8.9	8.9	8.8	8.8	8.8
CRH	Cruiserath	0.95	31.4	45.6	59.9	74.1	88.4	102.6	116.9	131.1	145.4	159.6
CVW	Castleview	0.982	26.0	26.5	27.0	27.3	27.0	27.1	27.3	27.0	27.0	27.1
DAL	Dallow	0.987	14.9	15.2	15.5	15.6	15.5	15.6	15.6	15.5	15.5	15.5

Table C-2: Demand forecasts at time of Summer Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
DDK	Dundalk	0.986	52.8	53.9	54.9	55.4	54.8	55.1	55.4	54.8	54.9	55.1
DFR	Dunfirth	0.991	8.6	8.8	9.0	9.0	8.9	9.0	9.0	8.9	9.0	9.0
DGN	Dungarvan	0.984	39.2	40.0	40.7	41.1	40.7	40.9	41.1	40.6	40.7	40.9
DLT	Dalton	0.981	22.7	23.2	23.6	23.8	23.6	23.7	23.8	23.6	23.6	23.7
DMY	Dunmanway	0.976	27.7	28.3	28.8	29.0	28.7	28.9	29.0	28.7	28.8	28.9
DON	Donegall	0.99	64.1	65.9	66.3	67.6	70.3	71.8	70.0	67.5	65.3	79.1
DOO	Doon	0.984	22.0	22.5	22.9	23.1	22.9	23.0	23.1	22.9	22.9	23.0
DRU	Drumline	0.945	24.5	25.0	25.5	25.7	25.4	25.6	25.7	25.4	25.5	25.6
DRU (N)	Drumnakelly	0.99	65.4	67.1	67.1	68.0	70.0	70.9	69.1	66.7	64.5	74.8
DRY	Drybridge	0.985	71.7	73.2	74.5	75.2	74.4	74.9	75.2	74.4	74.6	74.8
DUN	Dungannon	0.99	70.9	72.5	72.1	72.5	74.0	74.2	72.3	69.8	67.5	74.4
EDE	Eden	0.99	24.8	25.5	25.6	26.0	26.9	27.4	26.7	25.8	24.9	29.8
ENN	Ennis	0.981	49.3	50.3	51.3	51.7	51.2	51.5	51.7	51.2	51.3	51.4
ENN (N)	Enniskillen	0.99	46.8	48.0	47.9	48.5	49.9	50.5	49.2	47.5	45.9	53.1
FIN (I)	Finglas	0.994	378.3	385.4	392.0	395.2	391.3	393.5	395.3	391.2	392.1	393.0
FIN (N)	Finaghy	0.99	25.1	25.7	25.8	26.1	26.9	27.3	26.6	25.7	24.8	28.9
FTT	Fortunestown	0.997	11.1	11.4	11.6	11.7	11.6	11.6	11.7	11.5	11.6	11.6
GAL	Galway	0.988	75.9	77.5	78.9	79.6	78.7	79.2	79.6	78.7	78.9	79.1
GI	Great Island	0.952	12.8	13.1	13.3	13.4	13.3	13.4	13.4	13.3	13.3	13.4
GIL	Gilra	0.95	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
GLE	Glenlara	0.998	13.8	14.0	14.3	14.4	14.3	14.4	14.4	14.3	14.3	14.3
GLE (N)	Glengormley	0.99	22.6	23.0	22.9	23.0	23.4	23.4	22.8	22.0	21.2	23.1
GRI	Griffinrath	0.997	51.8	52.9	53.9	54.3	53.8	54.1	54.4	53.7	53.9	54.0
GWE	Gortawee	0.98	8.6	8.7	8.9	9.0	8.9	8.9	9.0	8.9	8.9	8.9
GWE	Gortawee	0.95	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
HN	Huntstown	0.95			7.6	15.2	22.8	30.4	38.0	45.6	53.2	60.8
IKE	Ikerrin	0.967	24.6	25.2	25.6	25.8	25.6	25.7	25.9	25.6	25.6	25.7
INC	**Inchicore**	**0.995**	**463.8**	**494.7**	**520.9**	**543.0**	**562.6**	**586.9**	**605.9**	**621.0**	**629.3**	**633.7**
KBY	Kilbarry	0.993	68.3	69.7	71.0	71.6	70.8	71.3	71.6	70.8	71.0	71.2
KCY	Kilcarbery	0.95			3.8	7.6	11.4	15.2	19.0	22.8	26.6	30.4
KER	Knockearagh	0.971	32.0	32.7	33.3	33.6	33.2	33.4	33.6	33.2	33.3	33.4

Table C-2: Demand forecasts at time of Summer Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
KGE	Kishoge	0.95			4.8	9.5	14.3	19.0	23.8	23.8	23.8	23.8
KIL	Kilteel	0.988	28.1	28.7	29.2	29.5	29.2	29.4	29.5	29.2	29.2	29.3
KIN	Kinnegad	0.95	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	Kilkenny	0.978	47.9	48.8	49.7	50.2	49.7	49.9	50.2	49.6	49.8	49.9
KLM	Kilmore	0.989	15.6	15.9	16.2	16.3	16.2	16.3	16.3	16.2	16.2	16.2
KNO	Knock	0.99	39.3	36.1	36.4	37.2	38.9	39.9	38.9	37.6	36.3	45.1
KTN	Killoteran	0.976	11.3	11.5	11.7	11.8	11.7	11.8	11.9	11.7	11.7	11.8
KUR	Knockumber	0.95	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
KYT	Kellystown	0.95	166.3	134.9	114.0	116.9	116.9	116.9	116.9	116.9	116.9	116.9
LA	Lanesborough	0.984	13.3	13.6	13.8	13.9	13.8	13.9	14.0	13.8	13.8	13.9
LAR	Larne	0.99	33.2	34.1	34.2	34.8	36.0	36.7	35.8	34.5	33.4	39.9
LET	Letterkenny	0.987	55.0	56.1	57.1	57.6	57.0	57.4	57.6	57.0	57.1	57.3
LIB	Liberty Street	0.986	20.0	20.4	20.8	20.9	20.7	20.9	21.0	20.7	20.8	20.8
LIM	Limerick	0.993	67.1	68.5	69.8	70.4	69.7	70.1	70.4	69.6	69.8	70.0
LIM (N)	Limavady	0.99	16.4	16.8	16.9	17.2	17.8	18.1	17.7	17.1	16.5	19.7
LIS	Lisdrum	0.952	24.9	25.4	25.9	26.1	25.9	26.0	26.2	25.9	25.9	26.0
LIS (N)	Lisburn	0.99	61.4	62.9	62.7	63.3	65.0	65.6	63.9	61.7	59.6	67.8
LMR	Lisaghmore	0.98	30.5	31.3	31.4	31.9	33.0	33.5	32.7	31.6	30.5	36.3
LOG	Loguestown	0.98	28.7	29.5	29.5	30.0	31.0	31.5	30.7	29.7	28.7	34.0
MAC	Macroom	0.973	13.9	14.2	14.5	14.6	14.5	14.6	14.6	14.5	14.5	14.5
MAL	Mallow	0.981	19.2	19.6	19.9	20.1	19.9	20.0	20.1	19.9	19.9	20.0
MCE	Macetown	0.995	24.3	24.8	25.3	25.5	25.2	25.4	25.5	25.2	25.3	25.4
MCE	Macetown	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
MID	Midleton	0.98	34.6	35.3	36.0	36.3	35.9	36.1	36.3	35.9	36.0	36.1
MLN	Mullagharlin	0.95	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
MON	Monread	0.975	11.1	11.4	11.6	11.7	11.6	11.6	11.7	11.5	11.6	11.6
MOY	Moy	0.989	24.3	24.8	25.2	25.5	25.2	25.3	25.5	25.2	25.2	25.3
MR	Marina	0.992	13.6	13.8	14.1	14.2	14.1	14.2	14.2	14.1	14.1	14.1
MTA	Metro Airport	0.95								23.8	23.8	23.8
MTH	Meath Hill	0.938	45.4	46.3	47.2	47.6	47.1	47.4	47.6	47.1	47.2	47.3
MTN	Metro North	0.95								29.5	29.5	29.5

Table C-2: Demand forecasts at time of Summer Peak

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
MUL	Mullingar	0.985	35.9	36.6	37.3	37.6	37.2	37.5	37.7	37.2	37.3	37.4
MUN	Mungret	0.95	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
NAR	Newtownards	0.99	29.8	30.6	30.8	31.4	32.7	33.4	32.5	31.4	30.4	37.0
NAV	Navan	0.98	49.9	50.9	51.8	52.3	51.8	52.1	52.3	51.7	51.9	52.0
NEW	Newbridge	0.981	33.7	34.4	35.0	35.3	34.9	35.2	35.3	34.9	35.0	35.1
NEW (N)	Newry	0.99	57.5	58.9	58.9	59.6	61.4	62.1	60.6	58.5	56.5	65.6
NNA	Nenagh	0.954	17.9	18.2	18.6	18.7	18.5	18.7	18.8	18.5	18.6	18.6
OBE	Oldbridge	0.95		3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
OLD	Oldcourt	0.95	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	Omagh	0.99	46.4	47.5	47.4	47.8	48.9	49.3	48.0	46.4	44.8	50.5
OUG	Oughtragh	0.992	21.4	21.8	22.2	22.4	22.2	22.3	22.4	22.2	22.2	22.3
PB	**Poolbeg**	**0.989**	**144.5**	**147.4**	**150.1**	**151.5**	**149.9**	**150.7**	**151.5**	**149.8**	**150.2**	**150.6**
PLA	Platin	0.95	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
PLS	Portlaoise 110kv	0.979	43.4	44.3	45.1	45.5	45.0	45.3	45.5	45.0	45.1	45.2
RAT	Rathkeale	0.993	33.6	34.3	34.9	35.2	34.8	35.0	35.2	34.8	34.9	35.0
RAT (N)	Rathgael	0.99	39.4	40.6	41.0	41.8	43.6	44.7	43.6	42.1	40.7	50.1
RIC	Richmond	0.972	29.3	29.9	30.4	30.7	30.4	30.5	30.7	30.3	30.4	30.5
RNW	Rinawade	0.95	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
ROS	Rosebank	0.99	25.8	25.3	25.4	25.8	26.7	27.1	26.4	25.5	24.6	29.1
RYB	Ryebrook	0.95	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5
SCR	Screebe	0.999	13.5	13.7	14.0	14.1	14.0	14.0	14.1	13.9	14.0	14.0
SHE	Shelton Abbey	0.95	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SHL	Salthill	0.997	35.2	35.9	36.6	36.9	36.5	36.7	36.9	36.5	36.6	36.7
SKL	Shankill	0.993	46.0	47.0	47.8	48.3	47.7	48.0	48.3	47.7	47.8	48.0
SLI	Sligo	0.996	44.0	44.9	45.7	46.2	45.7	45.9	46.2	45.6	45.8	45.9
SNG	Singland	0.992	14.1	14.4	14.7	14.8	14.7	14.7	14.8	14.7	14.7	14.7
SBH	Snughborough	0.95	14.3	17.1	19.0	21.9	23.8	26.6	28.5	31.4	33.3	33.3
SOM	Somerset	0.974	18.4	18.8	19.1	19.3	19.1	19.2	19.3	19.1	19.1	19.2
SPR	Springtown	0.99	25.4	26.0	25.9	26.2	26.9	27.1	26.4	25.5	24.6	27.9
STR	Stratford	0.958	18.8	19.2	19.5	19.7	19.5	19.6	19.7	19.5	19.5	19.6

Table C-2: Demand forecasts at time of Summer Peak												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
STR (N)	Strabane	0.99	36.1	37.0	36.9	37.3	38.2	38.6	37.6	36.3	35.1	39.9
TBG	Trabeg	0.994	57.3	58.4	59.5	60.0	59.4	59.8	60.1	59.4	59.5	59.7
TBK	Tullabrack	0.931	10.0	10.2	10.4	10.5	10.4	10.5	10.5	10.4	10.4	10.5
THU	Thurles	0.983	23.5	24.0	24.5	24.7	24.4	24.6	24.7	24.4	24.5	24.5
TIP	Tipperary	0.986	16.7	17.0	17.3	17.5	17.3	17.4	17.5	17.3	17.3	17.4
TLK	Trillick	0.968	17.7	18.1	18.4	18.6	18.4	18.5	18.6	18.4	18.4	18.5
TON	Tonroe	0.925	11.9	12.1	12.4	12.5	12.3	12.4	12.5	12.3	12.4	12.4
TRI	Trien	1	14.2	14.5	14.7	14.9	14.7	14.8	14.9	14.7	14.7	14.8
TRL	Tralee	0.99	45.2	46.1	47.0	47.4	46.9	47.2	47.4	46.9	47.0	47.1
TSB	Thornsberry	0.977	28.0	28.6	29.1	29.4	29.0	29.2	29.4	29.0	29.1	29.2
WAR	Waringstown	0.99	44.9	46.0	45.9	46.4	47.6	48.0	46.8	45.2	43.7	49.8
WAT	Waterford	0.986	43.5	44.4	45.2	45.6	45.1	45.4	45.6	45.1	45.2	45.3
WEX	Wexford	0.979	47.4	48.3	49.2	49.7	49.1	49.4	49.7	49.1	49.2	49.4
WHI	Whitegate	0.95	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0

Demand forecasts at time of Summer Valley

Table C-3: Demand forecasts at time of Summer Valley												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
AA	Ardnacrusha	1	28.6	28.6	28.5	28.5	28.4	28.4	28.3	28.3	28.3	28.2
AGH (N)	Aghyoule	0.99	6.0	6.1	6.0	6.0	6.1	6.1	5.9	5.7	5.5	5.8
AGN	Aungierstown	0.95	7.6	15.2	22.8	25.2	27.6	29.9	32.3	34.7	37.1	39.4
AHA	Ahane	0.965	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
AIR	Airport Road	0.99			6.1	6.1	6.2	6.2	6.1	5.9	5.7	6.1
ANR	Anner	0.95	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
ANT	Antrim	0.98	12.4	12.7	12.6	12.8	13.1	13.2	12.9	12.4	12.0	13.6
ARD	Ardnagappary	0.99	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
ARI	Arigna	0.911	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ARK	Arklow	0.967	15.4	15.4	15.3	15.3	15.3	15.3	15.3	15.2	15.2	15.2
ATH	Athlone	0.995	26.7	26.7	26.6	26.6	26.5	26.5	26.4	26.4	26.4	26.3
ATY	Athy	0.971	6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
BAG	Barnageeragh	0.95				7.1	9.5	11.9	14.3	16.6	19.0	21.4
BAL	Baltrasna	0.998	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
BAN	Bandon	0.993	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
BAN	Bandon	0.99	16.6	16.6	16.5	16.5	16.5	16.5	16.4	16.4	16.4	16.4
BAN (N)	Banbridge	0.958	10.4	10.7	10.7	10.9	11.3	11.5	11.2	10.8	10.4	12.5
BAR	Barrymore	0.95	11.5	11.4	11.4	11.4	11.4	11.4	11.3	11.3	11.3	11.3
BDA	Baroda	0.982	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
BDN	Ballydine	0.95	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
BDN	Ballydine	0.992	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
BEG	Ballybeg	0.992	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1
BIN	Binbane	0.992	6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.1	6.1	6.1
BK	Bellacorick	0.998	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
BLC	**Belcamp**	**0.951**	**91.2**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**	**108.3**
BLI	Ballylickey	0.925	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.9	5.9
BLK	Blake	0.999	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2
BMA	Ballymena	0.95	17.1	17.6	17.6	17.8	18.3	18.6	18.1	17.5	16.9	19.6
BNH	Ballynahinch	0.99	16.5	17.0	17.0	17.3	17.8	18.1	17.7	17.1	16.5	19.5
BNM	Belfast North	0.99	13.8	14.1	14.2	14.4	14.9	15.1	14.7	14.2	13.7	16.3

Table C-3: Demand forecasts at time of Summer Valley												
Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
BOG	Banoge	0.989	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
BRI	Brinny	0.95	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
BRY	Barnahely	0.982	26.6	26.5	26.4	26.4	26.4	26.3	26.3	26.2	26.2	26.2
BUT	Butlerstown	0.999	12.9	12.8	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7
CAH	Cahir	1	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2
CAR	Carnmoney	0.99	9.6	9.8	9.8	10.0	10.3	10.4	10.2	9.8	9.5	11.2
CBG	Carrowbeg	0.996	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.2
CBR	Castlebar	0.984	10.7	10.7	10.7	10.7	10.6	10.6	10.6	10.6	10.6	10.6
CEN	Belfast Central	0.99	15.2	15.6	15.4	15.5	15.7	15.7	15.3	14.7	14.2	15.2
CF	Cathaleens Fall	0.999	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
CFM	Castlefarm	0.95	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
CHA	Charleville	0.999	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5
CKM	**Carrickmines**	**0.998**	**128.9**	**128.7**	**128.4**	**128.3**	**128.2**	**128.1**	**128.0**	**127.7**	**127.6**	**127.6**
CLE	Clonee	0.95	90.3	105.5	120.7	135.4	135.4	135.4	135.4	135.4	135.4	135.4
CLG	Cloghran	0.95	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2
CLN	Cloon	1	7.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
CLU	Clutterland	0.95	3.8	3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
CLW	Carlow	0.982	18.2	18.2	18.1	18.1	18.1	18.0	18.0	18.0	17.9	17.9
COL	College Park	0.993	15.9	15.9	15.8	15.8	15.8	15.8	15.7	15.7	15.7	15.7
COL (N)	Coleraine	0.99	11.8	12.1	12.1	12.3	12.7	12.9	12.6	12.2	11.7	13.9
COS	Carrick on Shannon	1	8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
COW	Cow Cross	1	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.0	8.0
CPS	Coolkeeragh	0.99	10.4	10.6	10.5	10.5	10.7	10.6	10.3	10.0	9.6	10.3
CRA	Crane	0.999	12.0	11.9	11.9	11.9	11.9	11.8	11.8	11.8	11.8	11.8
CRE	Cregagh	0.99	19.4	15.9	15.9	16.1	16.6	16.9	16.5	15.9	15.4	18.1
CRG	Creagh	0.99	14.1	14.5	14.4	14.6	14.9	15.1	14.7	14.2	13.7	15.6
CRO	Coolroe	1	4.7	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.6
CRH	Cruiserath	0.95	31.4	45.6	59.9	74.1	88.4	102.6	116.9	131.1	145.4	159.6
CVW	Castleview	0.95									8.8	8.8
CVW	Castleview	0.992	14.9	14.9	14.8	14.8	14.8	14.8	14.7	14.7	14.7	14.7

Table C-3: Demand forecasts at time of Summer Valley

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
DAL	Dallow	0.993	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
DDK	Dundalk	1	18.3	18.2	18.2	18.2	18.1	18.1	18.1	18.1	18.0	18.0
DFR	Dunfirth	1	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2
DGN	Dungarvan	1	15.1	15.0	15.0	15.0	15.0	14.9	14.9	14.9	14.9	14.9
DLT	Dalton	0.999	10.7	10.7	10.6	10.6	10.6	10.6	10.6	10.6	10.5	10.5
DMY	Dunmanway	0.983	10.1	10.0	10.0	10.0	10.0	10.0	10.0	9.9	9.9	9.9
DON	Donegall	0.99	23.9	24.6	24.7	25.2	26.2	26.7	26.1	25.2	24.3	29.5
DOO	Doon	1	8.9	8.9	8.9	8.8	8.8	8.8	8.8	8.8	8.8	8.8
DRU	Drumline	0.873	12.9	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7	12.7
DRU (N)	Drumnakelly	0.99	24.4	25.0	25.0	25.3	26.1	26.4	25.8	24.9	24.0	27.9
DRY	Drybridge	1	24.3	24.2	24.2	24.1	24.1	24.0	24.0	24.0	23.9	23.9
DUN	Dungannon	0.99	26.4	27.0	26.9	27.0	27.6	27.7	27.0	26.0	25.1	27.7
EDE	Eden	0.99	9.3	9.5	9.5	9.7	10.0	10.2	10.0	9.6	9.3	11.1
ENN	Ennis	0.996	22.0	21.9	21.9	21.8	21.8	21.8	21.8	21.7	21.7	21.7
ENN (N)	Enniskillen	0.99	17.4	17.9	17.9	18.1	18.6	18.8	18.3	17.7	17.1	19.8
FIN (N)	Finaghy	0.99	9.4	9.6	9.6	9.7	10.0	10.2	9.9	9.6	9.2	10.8
FIN (I)	**Finglas**	**0.984**	**181.2**	**182.4**	**180.5**	**180.3**	**180.0**	**179.8**	**179.7**	**179.3**	**179.1**	**179.0**
FTT	Fortunestown	1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
GAL	Galway	1	34.1	34.0	34.0	33.9	33.9	33.8	33.8	33.7	33.6	33.6
GI	Great Island	0.979	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4
GIL	Gilra	0.95	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
GLE	Glenlara	0.956	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.9
GLE (N)	Glengormley	0.99	8.4	8.6	8.5	8.6	8.7	8.7	8.5	8.2	7.9	8.6
GRI	Griffinrath	1	22.5	22.5	22.4	22.4	22.4	22.3	22.3	22.2	22.2	22.2
GWE	Gortawee	0.981	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
GWE	Gortawee	0.95	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
HN	Huntstown	0.95			7.6	15.2	22.8	30.4	38.0	45.6	53.2	60.8
IKE	Ikerrin	0.996	9.7	9.7	9.7	9.6	9.6	9.6	9.6	9.6	9.6	9.6
INC	**Inchicore**	**0.999**	**342.7**	**375.1**	**396.7**	**416.5**	**438.5**	**461.1**	**478.8**	**496.4**	**503.9**	**507.6**
KBY	Kilbarry	1	20.3	20.2	20.2	20.1	20.1	20.1	20.1	20.0	20.0	20.0
KCY	Kilcarbery	0.95			3.8	7.6	11.4	15.2	19.0	22.8	26.6	30.4

Table C-3: Demand forecasts at time of Summer Valley												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
KER	Knockearagh	0.99	15.3	15.2	15.2	15.2	15.2	15.1	15.1	15.1	15.1	15.1
KGE	Kishoge	0.95			4.8	9.5	14.3	19.0	23.8	23.8	23.8	23.8
KIL	Kilteel	0.998	9.8	9.8	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.6
KIN	Kinnegad	0.95	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	Kilkenny	1	18.9	15.5	15.4	15.4	15.4	15.4	15.3	15.3	15.3	15.3
KLM	Kilmore	0.992	9.4	9.4	9.4	9.4	9.3	9.3	9.3	9.3	9.3	9.3
KNO	Knock	0.99	14.7	13.4	13.6	13.9	14.5	14.9	14.5	14.0	13.5	16.8
KTN	Killoteran	0.993	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
KUR	Knockumber	0.95	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
KYT	Kellystown	0.95	59.9	114.0	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9
LA	Lanesborough	1	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.5
LAR	Larne	0.99	12.4	12.7	12.8	13.0	13.4	13.7	13.3	12.9	12.4	14.9
LET	Letterkenny	0.996	17.9	17.8	17.8	17.8	17.7	17.7	17.7	17.7	17.6	17.6
LIB	Liberty Street	0.989	7.9	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.7
LIM	Limerick	1	30.1	30.1	30.0	29.9	29.9	29.9	29.8	29.7	29.7	29.7
LIM (N)	Limavady	0.99	6.1	6.3	6.3	6.4	6.6	6.8	6.6	6.4	6.1	7.3
LIS	Lisdrum	0.992	9.7	9.7	9.7	9.7	9.7	9.7	9.6	9.6	9.6	9.6
LIS (N)	Lisburn	0.99	22.9	23.4	23.4	23.6	24.2	24.4	23.8	23.0	22.2	25.3
LMR	Lisaghmore	0.98	11.4	11.7	11.7	11.9	12.3	12.5	12.2	11.8	11.4	13.5
LOG	Loguestown	0.98	10.7	11.0	11.0	11.2	11.6	11.8	11.5	11.1	10.7	12.7
MAC	Macroom	0.96	7.1	7.1	7.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0
MAL	Mallow	0.988	12.9	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7	12.7
MCE	Macetown	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
MHL	Misery Hill	1	9.8	9.7	9.7	9.7	9.7	9.7	9.7	9.6	9.6	9.6
MID	Midleton	0.99	21.1	21.1	21.0	21.0	21.0	20.9	20.9	20.9	20.8	20.8
MLN	Mullagharlin	0.95	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
MON	Monread	0.999	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.7	4.7
MOY	Moy	1	10.1	10.1	10.1	10.1	10.0	10.0	10.0	10.0	10.0	10.0
MR	Marina	0.999	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
MTA	Metro Airport	0.95								23.8	23.8	23.8
MTH	Meath Hill	0.984	13.5	13.5	13.4	13.4	13.4	13.4	13.4	13.3	13.3	13.3

Table C-3: Demand forecasts at time of Summer Valley

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
MTN	Metro North	0.95								29.5	29.5	29.5
MUL	Mullingar	0.998	13.1	13.1	13.0	13.0	13.0	13.0	13.0	12.9	12.9	12.9
MUN	Mungret	0.95	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
NAR	Newtownards	0.99	11.1	11.4	11.5	11.7	12.2	12.4	12.1	11.7	11.3	13.8
NAV	Navan	0.969	17.7	17.6	17.6	17.6	17.5	17.5	17.5	17.4	17.4	17.4
NEW	Newbridge	1	13.2	13.2	13.1	13.1	13.1	13.1	13.1	13.0	13.0	13.0
NEW (N)	Newry	0.99	21.4	22.0	22.0	22.2	22.9	23.2	22.6	21.8	21.1	24.4
NNA	Nenagh	0.977	8.2	8.2	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
OBE	Oldbridge	0.95		3.8	9.5	14.3	20.0	24.7	30.4	35.2	40.9	45.6
OLD	Oldcourt	0.95	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	Omagh	0.99	17.3	17.7	17.7	17.8	18.2	18.4	17.9	17.3	16.7	18.8
OUG	Oughtragh	0.989	10.6	10.6	10.5	10.5	10.5	10.5	10.5	10.4	10.4	10.4
PLA	Platin	0.95	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
PB	**Poolbeg**	**0.989**	**74.0**	**77.3**	**77.1**	**77.0**	**76.9**	**76.8**	**76.7**	**76.5**	**76.5**	**76.4**
PLS	Portlaoise 110kv	0.996	17.6	13.2	13.2	13.2	13.1	13.1	13.1	13.1	13.1	13.1
RAT	Rathkeale	0.997	9.7	9.7	9.7	9.7	9.7	9.6	9.6	9.6	9.6	9.6
RAT (N)	Rathgael	0.99	14.7	15.1	15.3	15.6	16.3	16.7	16.3	15.7	15.2	18.7
RIC	Richmond	0.997	11.9	11.9	11.8	11.8	11.8	11.8	11.8	11.7	11.7	11.7
RNW	Rinawade	0.95	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
ROS	Rosebank	0.99	9.6	9.5	9.5	9.6	9.9	10.1	9.8	9.5	9.2	10.8
RYB	Ryebrook	0.95	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5
SCR	Screebe	0.976	7.7	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.5
SHE	Shelton Abbey	0.95	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SHL	Salthill	0.997	14.0	14.0	14.0	13.9	13.9	13.9	13.9	13.9	13.8	13.8
SKL	Shankill	0.997	11.5	11.5	11.5	11.5	11.4	11.4	11.4	11.4	11.4	11.4
SLI	Sligo	1	16.6	16.5	16.5	16.5	16.4	16.4	16.4	16.4	16.3	16.3
SNG	Singland	1	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4
SBH	Snughborough	0.95	14.3	17.1	19.0	21.9	23.8	26.6	28.5	31.4	33.3	33.3
SOM	Somerset	0.998	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
SPR	Springtown	0.99	9.5	9.7	9.7	9.8	10.0	10.1	9.8	9.5	9.2	10.4

Table C-3: Demand forecasts at time of Summer Valley

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
STR	Stratford	1	5.1	5.1	5.1	5.1	5.1	5.1	5.0	5.0	5.0	5.0
STR (N)	Strabane	0.99	13.5	13.8	13.8	13.9	14.3	14.4	14.0	13.5	13.1	14.9
TBG	Trabeg	1	26.9	26.8	26.8	26.8	26.7	26.7	26.6	26.6	26.5	26.5
TBK	Tullabrack	0.992	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
THU	Thurles	0.99	10.6	10.6	10.6	10.6	10.5	10.5	10.5	10.5	10.5	10.5
TIP	Tipperary	0.992	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.1
TLK	Trillick	0.994	5.9	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
TON	Tonroe	0.987	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.0	6.0
TRI	Trien	0.962	9.2	9.2	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.1
TRL	Tralee	0.997	15.1	15.1	15.0	15.0	15.0	15.0	14.9	14.9	14.9	14.9
TSB	Thornsberry	0.996	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.8	10.8	10.8
WAR	Waringstown	0.99	16.7	17.1	17.1	17.3	17.7	17.9	17.5	16.8	16.3	18.6
WAT	Waterford	1	28.9	28.8	28.8	28.7	28.7	28.6	28.6	28.5	28.5	28.5
WEX	Wexford	1	20.8	20.8	20.7	20.7	20.7	20.6	20.6	20.6	20.5	20.5
WHI	Whitegate	0.95	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0

Demand forecasts at time of Autumn Peak – Northern Ireland only

Table C-4: Demand forecasts at time of Autumn Peak – Northern Ireland only												
Bus code	**Bus name**	**Power factor**	**Demand forecast (MW)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
AGH	Aghyoule	0.99	17.78	18.12	17.93	17.93	18.14	18.01	17.82	17.51	17.23	17.1
AIR	Airport Road	0.99			18.09	18.19	18.52	18.51	18.45	18.28	18.13	18.13
ANT	Antrim	0.98	36.71	37.58	37.48	37.84	38.82	39.43	39.67	39.67	39.93	40.43
BAN (N)	Banbridge	0.99	30.76	31.6	31.72	32.23	33.4	34.02	34.68	35.42	36.13	37.01
BMA	Ballymena	0.95	50.77	52.06	52.08	52.74	54.35	55.04	53.66	51.8	50.03	58.12
BNH	Ballynahinch	0.99	49.01	50.31	50.42	51.18	52.93	53.79	54.7	55.7	56.67	57.91
BNM	Belfast North	0.99	40.84	41.9	41.99	42.64	44.1	44.84	43.72	42.2	40.76	48.39
CAR	Carnmoney	0.99	28.34	29.07	29.11	29.53	30.5	30.96	31.44	31.96	32.48	33.16
CEN	Belfast Central	0.99	45.2	46.12	45.72	45.85	46.56	46.42	46.16	45.66	45.21	45.13
COL (N)	Coleraine	0.99	34.93	35.85	35.93	36.48	37.72	38.33	38.96	39.67	40.36	41.29
CPS	Coolkeeragh	0.99	30.72	31.34	31.06	31.13	31.59	31.47	31.26	30.89	30.55	30.46
CRE	Cregagh	0.99	57.6	47.02	47.1	47.78	49.36	50.1	50.88	51.71	52.53	53.61
CRG	Creagh	0.99	41.85	42.85	42.75	43.18	44.33	44.72	45.08	45.41	45.74	46.34
DON	Donegall	0.99	70.85	72.9	73.32	74.73	77.66	79.34	77.35	74.67	72.13	87.44
DRU (N)	Drumnakelly	0.99	72.26	74.13	74.18	75.13	77.43	78.4	79.37	80.34	81.32	82.73
DUN	Dungannon	0.99	78.4	80.13	79.68	80.16	81.83	82.04	82.11	81.94	81.82	82.28
EDE	Eden	0.99	27.44	28.19	28.28	28.74	29.77	30.31	30.89	31.53	32.16	32.93
ENN (N)	Enniskillen	0.99	51.74	53.01	52.98	53.6	55.18	55.8	56.44	57.08	57.72	58.68
FIN (N)	Finaghy	0.99	27.74	28.46	28.47	28.85	29.75	30.15	30.56	30.99	31.41	31.99
GLE (N)	Glengormley	0.99	24.93	25.46	25.27	25.38	25.84	25.83	25.76	25.59	25.44	25.48
KNO	Knock	0.99	43.49	39.86	40.22	41.13	42.95	44.11	43	41.51	40.1	49.84
LAR	Larne	0.99	36.71	37.71	37.83	38.46	39.84	40.57	41.35	42.22	43.07	44.11
LIM (N)	Limavady	0.99	18.13	18.61	18.68	18.98	19.66	20.02	20.41	20.84	21.27	21.78
LIS (N)	Lisburn	0.99	67.91	69.52	69.35	70.03	71.88	72.47	73.04	73.53	74.04	74.99
LMR	Lisaghmore	0.98	33.73	34.62	34.71	35.24	36.46	37.09	37.74	38.48	39.2	40.09
LOG	Loguestown	0.98	31.7	32.56	32.64	33.15	34.29	34.86	35.46	36.11	36.75	37.56
NAR	Newtownards	0.99	32.89	33.84	34.05	34.71	36.1	36.91	37.78	38.78	39.76	40.88
NEW (N)	Newry	0.99	63.54	65.12	65.1	65.89	67.87	68.69	69.53	70.39	71.25	72.48
OMA	Omagh	0.99	51.32	52.52	52.35	52.8	54.11	54.48	54.79	55.03	55.27	55.87

Table C-4: Demand forecasts at time of Autumn Peak – Northern Ireland only

Bus code	Bus name	Power factor	Demand forecast (MW)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
RAT (N)	Rathgael	0.99	43.55	44.9	45.27	46.25	48.23	49.44	50.74	52.25	53.7	55.34
ROS	Rosebank	0.99	28.47	28.02	28.08	28.5	29.46	29.93	30.42	30.96	31.49	32.17
SPR	Springtown	0.99	28.09	28.75	28.67	28.94	29.69	29.93	30.14	30.32	30.5	30.88
STR (N)	Strabane	0.99	39.94	40.9	40.79	41.19	42.28	42.63	42.97	43.26	43.56	44.13
WAR	Waringstown	0.99	49.66	50.84	50.74	51.25	52.63	53.1	53.55	53.95	54.37	55.11

Appendix D: Generation capacity details

D.1 Generation capacity details

Table D1 lists existing and committed future transmission connected generation, their connection details and the Registered Capacity[43] of each unit as at the data freeze date.

All generation capacity figures in Table D-1 are expressed in exported terms. Exported terms are given by the generation unit output less than the unit's own auxiliary load. The units are grouped in these tables on a geographical basis. Generation capacity figures are rounded to the nearest MW.

Table D-2 lists the existing and committed future wind generation. The wind generation included in this table is wind generation that feeds into each 110 kV transmission station, from the distribution system. The respective MW capacity over the period of the statement is included. Table D-2 is based on the wind farms that had connection agreements with the DSO at the data freeze date.

Table D-3 lists the existing and committed distribution connected generation, excluding wind generation, as at the data freeze date. Their respective MW capacity over the period of the statement is included.

43 The Registered Capacity of future units will not be known until the unit enters the Integrated Single Electricity Market. Therefore, for future units the Maximum Export Capacity of the unit appears in Table D-1.

MEC of existing and committed transmission-connected generation

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
Border	Carrickaduff		Croaghnagawna	110 kV	Wind	2023	66
	Carrickalangan		Croaghnagawna	110 kV	Wind	2023	72
	Erne Cathleens Fall Hydro (3)		Cath_Fall	110 kV	Hydro		22
	Erne Cathleens Fall Hydro (4)	ER3	Cath_Fall	110 kV	Hydro		23
	Erne Cliff Hydro (1)	ER4	Cliff	110 kV	Hydro		10
	Erne Cliff Hydro (2)	ER1	Cliff	110 kV	Hydro		10
	Firlough WF		Firlough	110 kV	Wind	2023	48.3
	Garvagh – Glebe (1a)	ER2	Garvagh	110 kV	Wind		26
	Garvagh – Tullynahaw (1c)		Garvagh	110 kV	Wind		22
	Golagh (1)		Golagh	110 kV	Wind		15
	Lenalea		Lenalea	110 kV	Wind	2025	30.5
	Kingsmountain (1)		Cunghill	110 kV	Wind		24
	Kingsmountain (2)		Cunghill	110 kV	Wind		11
	Lisdrumdoagh Energy Storage Facility		Lisdrum	110 kV	Battery		60
	Meentycat (1)		Meentycat	110 kV	Wind		71
	Meentycat (2)		Meentycat	110 kV	Wind		14
	Mountain Lodge (1)		Ratrussan	110 kV	Wind		31
	Mullygaffy		Tievebrack	110 kV	Wind	2023	29.9
	Mulreavy (1)		Mulreavy	110 kV	Wind		82
	Oriel (1)		Oriel	0.69 kV	Wind	2025	210
	Ratrussan (1a)		Ratrussan	110 kV	Wind		48
	Border area total						**938.7**

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
Dublin	Corduff		Corduff	220 kV	Battery	2022	70
	Dublin Bay Power		Irishtown	220 kV	Gas/Oil		422
	Gallanstown Solar		Gallanstown	110 kV	Solar	2023	119
	Harristown Solar PV		Harristown	110 kV	Solar	2023	42
	Huntstown (1)	HNC	Huntstown	220 kV	Gas/Oil		236
	Huntstown (1)	HNC	Huntstown	220 kV	Gas/Oil		123
	Huntstown (2)	HN2	Huntstown	220 kV	Gas		412
	Shellybanks Combined Cycle	PBC	Shellybanks	220 kV	Gas/Oil		150
	Shellybanks Combined Cycle	PBC	Shellybanks	220 kV	Gas/Oil		150
	Shellybanks Combined Cycle	PBC	Shellybanks	220 kV	Gas/Oil		173
	Dublin area total						**2,138**
Mid-East	Blundlestown		Blundelstown	110 kV	Solar		60
	Cloncreen Wind farm		Cloncreen	110 kV	Wind	2025	100
	Gaskinstown		Deenes	110 kV	Solar	2023	85
	Gillinstown Solar		Garballagh	110 kV	Solar	2023	95
	Gorman BES		Gorman	110 kV	Battery	2023	50
	Liffey Hydro (1)	LI1	Pollaphuca	110 kV	Hydro		15
	Liffey Hydro (2)	LI2	Pollaphuca	110 kV	Hydro		15
	Porterstown BES		Kilteel	110 kV	Battery		30
	Timahoe North		Timahoe	110 kV	Solar	2023	70
	Turlough Hill (1)	TH1	Turlough Hill	220 kV	Pumped Storage		73
	Turlough Hill (2)	TH2	Turlough Hill	220 kV	Pumped Storage		73
	Turlough Hill (3)	TH3	Turlough Hill	220 kV	Pumped Storage		73
	Turlough Hill (4)	TH4	Turlough Hill	220 kV	Pumped Storage		73
	Mid-East area total						**791**

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
Midlands	Blackwater Bog Solar 1		Derrylahan	110 kV	Solar	2023	65
	Clonfad Solar		Clonfad	110 kV	Solar	2023	100
	Cloghan Wind Farm		Derrycarney	110 kV	Wind	2024	34
	Edenderry Peaking	ED3	Cushaling	110 kV	Conventional		117
	Edenderry Power	ED1	Cushaling	110 kV	Peat		134
	Lanesboro (2)		Lanesboro	110 kV	Peat		40
	Lanesboro (3)		Lanesboro	110 kV	Peat		45
	Loughteague		Coolnabacky	110 kV	Solar	2025	55
	Lumcloon Batt		Derrycarney	110 kV	Battery		100
	Mountlucas (1)		Mountlucas	110 kV	Wind		79
	Rhode PCP (1)	RP1	Derryiron	110 kV	Distillate		52
	Rhode PCP (2)	RP2	Derryiron	110 kV	Distillate		52
	Coole Windfarm		Lickny	110 kV	Wind	2024	88
	Cushaling Windfarm		Philipstown	110 kV	Wind	2024	50
	Drahid		Mulgeeth	110 kV	Wind	2024	60
	Pinewoods Windfarm		Garrintaggart	110 kV	Wind	2026	49.5
	Midlands area total						**873**

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
Mid-West	Alumina CHP (1)	SK3	Aughinish	110 kV	Gas		86
	Alumina CHP (1)	SK4	Aughinish	110 kV	Gas		86
	Ardnacrusha Hydro (1)	AA1	Ardnacrusha	110 kV	Hydro		21
	Ardnacrusha Hydro (2)	AA2	Ardnacrusha	110 kV	Hydro		22
	Ardnacrusha Hydro (3)	AA3	Ardnacrusha	110 kV	Hydro		19
	Ardnacrusha Hydro (4)	AA4	Ardnacrusha	110 kV	Hydro		24
	Boolinrudda		Ennis	110 kV	Wind		46
	Booltiagh (1)		Booltiagh	110 kV	Wind		19
	Booltiagh (2)		Booltiagh	110 kV	Wind		12
	Dromada (1)		Dromada	110 kV	Wind		29
	Kill Hill (1)		Kill Hill	110 kV	Wind		36
	Knockalassa		Ennis	110 kV	Wind		27
	Lisheen (1)		Lisheen	110 kV	Wind		36
	Lisheen (1a)		Lisheen	110 kV	Wind		19
	Lisheen 3		Lisheen	110 kV	Wind	2022	29
	Moneypoint (1)	MP1	MNYPG3	380 kV	Coal		302
	Moneypoint (2)	MP2	MNYPG3	380 kV	Coal		305
	Moneypoint (3)	MP3	MNYPG3	380 kV	Coal		302
	Moneypoint WF		MNYPG3	380 kV	Wind		18
	Mid-West area total						**1,438**

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
Northern Ireland	Ballylumford	BGT20	Ballylumford	275 kV	Gas		500
	Ballylumford 10	B10	Ballylumford	110 kV	Gas		100
	Ballylumford GT1		Ballylumford	110 kV	Gas		58
	Ballylumford GT2		Ballylumford	110 kV	Gas		58
	Castlereagh BES		Castlereagh	110 kV	Battery	2023	50
	Coolkeeragh GT	C30 GT	Coolkeeragh	275 kV	Gas		260
	Coolkeeragh GT8	CGT8	Coolkeeragh	110 kV	Oil		53
	Coolkeeragh ST	C30 GS	Coolkeeragh	110 kV	Gas		170
	Kilroot GT3	KGT3	Kilroot	275 kV	Distillate		42
	Kilroot GT4	KGT4	Kilroot	275 kV	Distillate		42
	KELLS_BES		Kells	110 kV	Battery	2023	50
	Kilroot OCGT6		Kilroot	275 kV	Gas	2023	406
	Kilroot OCGT7		Kilroot	275 kV	Gas	2023	302
	Kilroot ST1	K1	Kilroot	275 kV	Coal/Oil		195
	Kilroot ST2	K2	Kilroot	275 kV	Coal/Oil		195
	Tamnamore BES		Tamnamore	110 kV	Battery		50
	Tandragee BES		Tandragee	110 kV	Battery		50
	Northern Ireland Total						**2,581**

Table D-1: MEC of existing and committed transmission-connected generation

Area	Generation station	Unit ID	Connected at		Fuel type	Connection year (if future)	Maximum export capacity (MW)
South-East	Ballywater		Ballywater	110 kV	Wind		42
	Castledockrell		Castledockrell	110 kV	Wind		42
	Great Island CCGT	GI4	Great Island	220 kV	Conventional		464
	Knocknamona		Dungarvan	110 kV	Wind		34
	Rathnaskilloge		Rathnaskilloge	110 kV	Solar	2023	95
	Rosspile Solar Farm		Rosspile	110 kV	Solar	2023	95
	Woodhouse		Woodhouse	110 kV	Wind		20
	Lysaghtstown Solar		Lysaghtstown	110 kV	Solar	2024	87
	Monatooreen Solar		Knockraha	110 kV	Solar	2023	27.1
	South-East area total						**767**

South-West	Aghada CCGT	AD2	Aghada	220 kV	Gas		442
	Aghada	AT1	Aghada	220 kV	Gas		90
	Aghada	AT2	Aghada	220 kV	Gas		90
	Aghada	AT4	Aghada	220 kV	Gas		90
	Aghada BESS 1		Aghada	220 kV	Storage		19
	Aghada BESS 2		Aghada	220 kV	Storage		159
	Athea		Athea	110 kV	Wind		34
	Ballinknockane Solar Farm		Ballinknockane	110 kV	Solar	2023	50
	Banemore Solar Farm		Clahane	110 kV	Solar		34
	Boggeragh (1)		Boggeragh	110 kV	Wind		57
	Boggeragh (2)		Boggeragh	110 kV	Wind		48
	Clahane (1)		Clahane	110 kV	Wind		38
	Clahane (2)		Clahane	110 kV	Wind		14
	Cloghboola		Cloghboola	110 kV	Wind		46
	Coomacheo (1)		Garrow	110 kV	Wind		41
	Coomacheo (2)		Garrow	110 kV	Wind		18
	Coomagearlahy (1)		Coomagearlahy	110 kV	Wind		43
	Coomagearlahy (2)		Coomagearlahy	110 kV	Wind		9

Table D-1: MEC of existing and committed transmission-connected generation

Area	Generation station	Unit ID	Connected at		Fuel type	Connection year (if future)	Maximum export capacity (MW)
South-West	Coomagearlahy (3)		Coomagearlahy	110 kV	Wind		30
	Cordal		Cordal	110 kV	Wind		90
	Drombeg Solar Park		Drombeg	110 kV	Solar	2023	50
	Glanlee (1)		Glanlee	110 kV	Wind		30
	Glen Solar		Glen	110 kV	Solar	2024	40
	Grousemount		Coomataggart	110 kV	Wind		114
	Kelwin		Kilpaddoge	220 kV	Wind		27
	Kelwin Battery		Kilpaddoge	220 kV	Storage	2024	42
	Killavoy		Boggeragh	110 kV	Wind		18
	Knockacummer (1)		Knockacummer	110 kV	Wind		105
	Lee Carrigadrohid Hydro (1)		Carrigadrohid	110 kV	Hydro		8
	Lee Inniscarra Hydro (1)		Iniscarra	110 kV	Hydro		19
	Tarbert (1)	TB1	Tarbert	110 kV	HFO		57
	Tarbert (2)	TB2	Tarbert	110 kV	HFO		57
	Tarbert (3)	TB3	Tarbert	220 kV	HFO		256
	Tarbert (4)	TB4	Tarbert	220 kV	HFO		258
	Tobertoreen		Athea	110 kV	Wind		34
	Tullabeg Solar Park		Tullabeg	110 kV	Solar	2023	50
	Whitegen CCGT	WG	Glanagow	220 kV	Gas		449
	South-West area total						**3,055**

Table D-1: MEC of existing and committed transmission-connected generation							
Area	**Generation station**	**Unit ID**	**Connected at**		**Fuel type**	**Connection year (if future)**	**Maximum export capacity (MW)**
West	Buffy		Buffy	110 kV	Wind		91
	Ardderoo Extension		Buffy	110 kV	Wind		18
	Carrigdangan		Carrigdangan	110 kV	Wind	2023	68
	Derrybrien (1)		Derrybrien	110 kV	Wind		60
	Knockalough		Knockalough	110 kV	Wind		34
	Killala (1)		Tawnaghmore	110 kV	Wind		19
	Killala (2)		Tawnaghmore	110 kV	Wind	2023	11
	Oweninney (1)		Bellacorick	110 kV	Wind		89
	Oweninney (2)		Bellacorick	110 kV	Wind		83
	Oweninney (3)		Bellacorick	110 kV	Wind	2023	50
	Seecon (1)		Knockranny	110 kV	Wind		108
	Shannonbridge ESS		Shannonbridge	220 kV	Battery		100
	Shannonbridge ESS		Shannonbridge	220 kV	Wind		63
	Shantallow Solar		Shantallow	110 kV	Solar	2023	35
	Sheskin		Bellacorick	110 kV	Wind	2023	33
	Sliabh Bawn (1)		Sliabh Bawn	110 kV	Wind		58
	Tawnaghmore Peaking Plant	TP1	Tawnaghmore	110 kV	Distillate		52
	Tawnaghmore Peaking Plant	TP2	Tawnaghmore	110 kV	Distillate		52
	Tynagh	TY1	Tynagh	220 kV	Gas		268
	Tynagh	TY2	Tynagh	220 kV	Gas		142
	Ugool		Ugool	110 kV	Wind		66
	West area total						**1,482**

Existing and committed distribution-connected wind farm capacity

Table D-2: Existing and committed distribution-connected wind farm capacity

Area	110 kV station	Maximum Export Capacity (MEC)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Border	Ardnagappary	22.94	22.94	22.94	22.94	22.94	22.94	22.94	22.94	22.94	22.94
	Binbane	60.61	60.61	60.61	66.61	66.61	66.61	66.61	66.61	66.61	66.61
	Cath_Fall	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40
	Corderry	63.26	63.26	63.26	63.26	63.26	63.26	63.26	63.26	63.26	63.26
	Crane	7.49	7.49	7.49	7.49	7.49	7.49	7.49	7.49	7.49	7.49
	Drybridge	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30
	Dundalk	16.60	16.60	16.60	16.60	16.60	16.60	16.60	16.60	16.60	16.60
	Garvagh	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00
	Garvagh	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	Glenree	64.80	77.30	77.30	77.30	77.30	77.30	77.30	77.30	77.30	77.30
	Gortawee	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Letterkenny	64.67	69.07	69.07	69.07	69.07	69.07	69.07	69.07	69.07	69.07
	Lisdrum		33.10	33.10	33.10	33.10	33.10	33.10	33.10	33.10	33.10
	Meath Hill	68.65	68.65	68.65	68.65	68.65	68.65	68.65	68.65	68.65	68.65
	Moy	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Shankill	28.02	28.02	28.02	28.02	28.02	28.02	28.02	28.02	28.02	28.02
	Sligo	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65
	Somerset	7.65	7.65	7.65	7.65	7.65	7.65	7.65	7.65	7.65	7.65
	Sorne Hill	62.75	67.75	67.75	67.75	67.75	67.75	67.75	67.75	67.75	67.75
	Trien	72.65	72.65	72.65	72.65	72.65	72.65	72.65	72.65	72.65	72.65
	Trillick	44.69	44.69	44.69	44.69	44.69	44.69	44.69	44.69	44.69	44.69
	Border area total	**767.1**	**822.1**	**822.1**	**828.1**	**828.1**	**828.1**	**828.1**	**828.1**	**828.1**	**828.1**

Table D-2: Existing and committed distribution-connected wind farm capacity

Area	110 kV station	Maximum Export Capacity (MEC)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Dublin	Glasmore	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	Nangor	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40
	Poppintree	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Dublin area total	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**
Mid-East	Arklow	53.50	53.50	53.50	53.50	53.50	53.50	53.50	53.50	53.50	53.50
	Mid-East area total	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**	**53.5**
Midlands	Blake	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Dallow	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95
	Lanesboro	4.60	4.60	4.60	9.55	9.55	9.55	9.55	9.55	9.55	9.55
	Midlands area total	**30.6**	**30.6**	**30.6**	**35.5**	**35.5**	**35.5**	**35.5**	**35.5**	**35.5**	**35.5**
Mid-West	Ardnacrusha	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16
	Booltiagh	85.37	85.37	93.37	108.37	108.37	108.37	108.37	108.37	108.37	108.37
	Cauteen	177.08	177.08	177.08	177.08	177.08	177.08	177.08	177.08	177.08	177.08
	Charleville	70.70	70.70	70.70	70.70	70.70	70.70	70.70	70.70	70.70	70.70
	Cureeny T	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
	Ikerrin	35.95	35.95	35.95	35.95	35.95	35.95	35.95	35.95	35.95	35.95
	Lisheen	39.60	39.60	39.60	39.60	39.60	39.60	39.60	39.60	39.60	39.60
	Nenagh	13.99	13.99	13.99	13.99	13.99	13.99	13.99	13.99	13.99	13.99
	Rathkeale	32.49	32.49	32.49	32.49	32.49	32.49	32.49	32.49	32.49	32.49
	Thurles	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
	Tipperary	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60
	Tullabrack	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00
	Mid-West area total	**624.7**	**624.7**	**632.7**	**647.7**	**647.7**	**647.7**	**647.7**	**647.7**	**647.7**	**647.7**

Table D-2: Existing and committed distribution-connected wind farm capacity

Area	110 kV station	Maximum Export Capacity (MEC)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Northern Ireland	Aghyoule	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50
	Antrim	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	Ballymena	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75
	Brockaghboy	47.50	47.50	47.50	47.50	47.50	47.50	47.50	47.50	47.50	47.50
	Carnmoney	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80
	Coleraine	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00	108.00
	Coolkeeragh	12.00	12.00	49.20	49.20	49.20	49.20	49.20	49.20	49.20	49.20
	Creagh	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98
	Curraghamulkin	67.90	67.90	161.50	161.50	161.50	161.50	161.50	161.50	161.50	161.50
	Drumnakelly	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
	Dungannon	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
	Eden	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
	Enniskillen	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90
	Garvagh	47.50	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	Kells				43.10	43.10	43.10	43.10	43.10	43.10	43.10
	Killymallaght	35.70	35.70	35.70	35.70	35.70	35.70	35.70	35.70	35.70	35.70
	Larne	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Limavady	37.70	37.70	37.70	37.70	37.70	37.70	37.70	37.70	37.70	37.70
	Lisaghmore	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Loguestown	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20
	Magherakeel	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00
	Omagh	95.70	95.70	95.70	95.70	95.70	95.70	95.70	95.70	95.70	95.70
	Rasharkin	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80
	Slieve Kirk	73.60	73.60	73.60	73.60	73.60	73.60	73.60	73.60	73.60	73.60
	Strabane	28.10	28.10	28.10	28.10	28.10	28.10	28.10	28.10	28.10	28.10
	Tremogue	77.15	77.15	77.15	77.15	77.15	77.15	77.15	77.15	77.15	77.15
	Northern Ireland Total	1,058.9	1,101.4	1,232.2	1,275.3	1,275.3	1,275.3	1,275.3	1,275.3	1,275.3	1,275.3

Table D-2: Existing and committed distribution-connected wind farm capacity

Area	110 kV station	Maximum Export Capacity (MEC)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
South-East	Barrymore	32.40	32.40	32.40	32.40	32.40	32.40	32.40	32.40	32.40	32.40
	Butlerstown	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	Barnahely	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
	Carlow	34.35	34.35	34.35	34.35	34.35	34.35	34.35	34.35	34.35	34.35
	Dungarvan	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60
	Lodgewood	60.41	60.41	60.41	60.41	60.41	60.41	60.41	60.41	60.41	60.41
	Portlaoise	9.20	54.20	54.20	54.20	54.20	54.20	54.20	54.20	54.20	54.20
	Waterford	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
	Wexford	39.65	39.65	39.65	39.65	39.65	39.65	39.65	39.65	39.65	39.65
	South-East area total	**204.8**	**249.8**	**249.8**	**249.8**	**249.8**	**249.8**	**249.8**	**249.8**	**249.8**	**249.8**
South-West	Athea	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
	Ballylickey	53.95	59.77	59.77	59.77	59.77	59.77	59.77	59.77	59.77	59.77
	Bandon	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60
	Boggeragh	43.35	43.35	43.35	46.35	46.35	46.35	46.35	46.35	46.35	46.35
	Castleview	–	–	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Cloghboola	54.54	54.54	54.54	54.54	54.54	54.54	54.54	54.54	54.54	54.54
	Coomataggart	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64
	Cordal	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
	Dunmanway	42.26	45.31	59.11	59.11	59.11	59.11	59.11	59.11	59.11	59.11
	Garrow	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Glenlara	66.80	66.80	66.80	66.80	66.80	66.80	66.80	66.80	66.80	66.80
	Kilbarry	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	Kilpaddoge	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
	Knockeragh	13.85	13.85	13.85	13.85	13.85	13.85	13.85	13.85	13.85	13.85
	Macroom	25.30	25.30	25.30	25.30	25.30	25.30	25.30	25.30	25.30	25.30
	Midleton	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60

Table D-2: Existing and committed distribution-connected wind farm capacity

Area	110 kV station	Maximum Export Capacity (MEC)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
South-West	Oughtragh	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
	Reamore	59.65	84.95	84.95	84.95	84.95	84.95	84.95	84.95	84.95	84.95
	Tralee	47.56	47.56	47.56	47.56	47.56	47.56	47.56	47.56	47.56	47.56
	South-West area total	**573.3**	**607.4**	**625.2**	**628.2**	**628.2**	**628.2**	**628.2**	**628.2**	**628.2**	**628.2**
West	Arigna	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60
	Bellacorick	9.00	75.80	75.80	78.30	78.30	78.30	78.30	78.30	78.30	78.30
	Castlebar	43.64	43.64	43.64	43.64	43.64	43.64	43.64	43.64	43.64	43.64
	Cloon	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Dalton	43.35	43.35	43.35	43.35	43.35	43.35	43.35	43.35	43.35	43.35
	Salthill	46.10	46.10	46.10	46.10	46.10	46.10	46.10	46.10	46.10	46.10
	Screeb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Tawnaghmore	19.20	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	Tonroe	12.04	12.04	12.04	12.04	12.04	12.04	12.04	12.04	12.04	12.04
	West area total	**196.2**	**273.8**	**273.8**	**276.3**	**276.3**	**276.3**	**276.3**	**276.3**	**276.3**	**276.3**

Existing and committed distribution-connected generation (excluding wind)

Table D-3: Existing and committed distribution-connected generation (excluding wind)

Area	110 kV station	Type	Maximum Export Capacity (MEC)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Border	Binbane	Hydro	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
	Crane	Battery			16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	Crane	Solar			9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
	Drybridge	Biomass	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
	Drybridge	LFG	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22
	Drybridge	Solar	3.99	3.99	3.99	15.98	15.98	15.98	15.98	15.98	15.98	15.98
	Dundalk	Solar					3.99	3.99	3.99	3.99	3.99	3.99
	Meath Hill	Battery			33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
	Meath Hill	CHP	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90
	Shankill	LFG	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
	Shankill	Solar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Somerset	Solar				4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Stevenstown	Battery				8.50	8.50	8.50	8.50	8.50	8.50	8.50
	Stevenstown	Solar					4.95	4.95	4.95	4.95	4.95	4.95
	Trien	Solar			4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Border area total		**42.1**	**42.1**	**104.1**	**128.6**	**137.5**	**137.5**	**137.5**	**137.5**	**137.5**	**137.5**
Dublin	Blackrock	CHP	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
	Blackrock	CHP	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
	Fin_rural	CHP	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
	Finglas	Solar				8.42	8.42	8.42	8.42	8.42	8.42	8.42
	Glasmore	CHP	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
	Glasmore	Solar				4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Ringsend	CHP	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00	144.00
	Dublin area total		**149.5**	**149.5**	**149.5**	**161.9**	**161.9**	**161.9**	**161.9**	**161.9**	**161.9**	**161.9**

Table D-3: Existing and committed distribution-connected generation (excluding wind)												
Area	110 kV station	Type	Maximum Export Capacity (MEC)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Mid-East	Baltrasna	Solar				10.00	19.99	19.99	19.99	19.99	19.99	19.99
	Arklow	Biomass	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Arklow	Solar	4.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Dunfirth	Solar	14.00	14.00	14.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
	Griffinrath	Hydro	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Griffinrath	Solar				15.50	15.50	15.50	15.50	15.50	15.50	15.50
	Kilteel	LFG + Diesel	9.77	9.77	9.77	9.77	9.77	9.77	9.77	9.77	9.77	9.77
	Kilteel	Solar	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Monread	Solar	4.00	4.00	4.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Newbridge	Solar	3.99	3.99	3.99	15.99	15.99	15.99	15.99	15.99	15.99	15.99
	Mid-East area total		**55.8**	**61.8**	**61.8**	**107.3**	**117.3**	**117.3**	**117.3**	**117.3**	**117.3**	**117.3**
Midland	Athlone	LFG	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	Athlone	Solar					8.00	8.00	8.00	8.00	8.00	8.00
	Blake	Solar				4.99	4.99	4.99	4.99	4.99	4.99	4.99
	Blake	LFG	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Derryiron	Flywheel		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
	Lanesboro	Solar		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Mullingar	Solar	8.00	8.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
	Navan	CHP	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
	Navan	Solar	9.00	9.00	13.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
	Richmond	Solar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Thornsberry	CHP	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90
	Thornsberry	Solar				4.00	8.00	8.00	8.00	8.00	8.00	8.00
	Midland area total		**49.6**	**73.6**	**81.6**	**94.5**	**106.5**	**106.5**	**106.5**	**106.5**	**106.5**	**106.5**

Table D-3: Existing and committed distribution-connected generation (excluding wind)												
Area	110 kV station	Type	Maximum Export Capacity (MEC)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Mid-West	Ballydine	Biogas	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Ballydine	Solar	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80	5.80
	Cahir	Solar	8.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00
	Drumline	Solar			8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Rathkeale	Biogas	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Rathkeale	CHP	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
	Rathkeale	LFG	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
	Mid-West area total		**24.4**	**48.4**	**56.4**	**56.4**	**56.4**	**56.4**	**56.4**	**56.4**	**56.4**	**56.4**
Northern Ireland	Antrim	PV	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.62
	Ballymena	PV	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Coolkeeragh	Battery		50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	Coolkeeragh	Bio	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60
	Lisburn	PV	58.85	58.85	58.85	58.85	58.85	58.85	58.85	58.85	58.85	58.85
	Newtownards	PV	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99
	Rasharkin	PV	35.01	35.01	35.01	35.01	35.01	35.01	35.01	35.01	35.01	35.01
	Rosebank	BIO	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98
	Waringstown	PV	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
	Northern Ireland Total		**154.0**	**204.0**	**204.0**	**204.0**	**204.0**	**204.0**	**204.0**	**204.0**	**204.0**	**204.0**

Table D-3: Existing and committed distribution-connected generation (excluding wind)												
Area	**110 kV station**	**Type**	**Maximum Export Capacity (MEC)**									
			2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
South-East	Athy	Solar	4.00	4.00	4.00	4.00	4.00	8.99	8.99	8.99	8.99	8.99
	Athy	Biogas	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
	Athy	Battery				8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Ballybeg	LFG	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Ballybeg	Solar	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Banoge	Battery			9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
	Banoge	Solar	4.00	4.00	4.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Barrymore	CHP	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
	Barrymore	Solar			9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90
	Butlerstown	Solar	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
	Coolroe	Solar				10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Cow Cross	Solar				4.95	4.95	4.95	4.95	4.95	4.95	4.95
	Doon	Hydro	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Doon	Solar			8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Dungarvan	Solar					3.99	3.99	3.99	3.99	3.99	3.99
	Great Island	Battery				30.00	30.00	30.00	30.00	30.00	30.00	30.00
	Great Island	Solar	4.99	4.99	4.99	16.99	16.99	16.99	16.99	16.99	16.99	16.99
	Kilkenny	Solar	4.00	4.00	4.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Kilkenny	CHP	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
	Portlaoise	Biogas	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
	Portlaoise	Solar				4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Waterford	Solar	3.99	3.99	3.99	3.99	3.99	3.99	3.99	3.99	3.99	3.99
	Wexford	CHP	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Wexford	Solar	7.98	11.98	27.98	27.98	27.98	27.98	27.98	27.98	27.98	27.98
	South-East area total		**70.9**	**74.9**	**117.8**	**194.7**	**198.7**	**203.7**	**203.7**	**203.7**	**203.7**	**203.7**

Table D-3: Existing and committed distribution-connected generation (excluding wind)

Area	110 kV station	Type	Maximum Export Capacity (MEC)									
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
South-West	Ahane	Solar					4.00	4.00	4.00	4.00	4.00	4.00
	Bandon	Solar		7.94	7.94	17.84	17.84	17.84	17.84	17.84	17.84	17.84
	Barnahely	Solar				4.95	4.95	4.95	4.95	4.95	4.95	4.95
	Castleview	Biogas		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Castleview	CHP	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Dunmanway	Biogas	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Glenlara	Solar				4.95	4.95	4.95	4.95	4.95	4.95	4.95
	Kilbarry	Solar	4.95	4.95	4.95	9.90	9.90	9.90	9.90	9.90	9.90	9.90
	Knockeragh	Biomass	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Knockeragh	Solar			8.99	8.99	8.99	8.99	8.99	8.99	8.99	8.99
	Limerick	Solar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Macroom	Solar				4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Mallow	Solar	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95
	Midleton	Solar				3.95	3.95	3.95	3.95	3.95	3.95	3.95
	Oughtragh	Solar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Reamore	Battery	–	–	–	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Trabeg	Solar		4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95
	South-West area total		**28.9**	**45.8**	**54.8**	**95.5**	**95.5**	**95.5**	**95.5**	**95.5**	**95.5**	**95.5**
West	Bellacorick	Wave	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Carrick on Shannon	Solar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Cloon	Solar	4.00	4.00	4.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
	Dalton	Battery			12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
	Dalton	Solar					4.00	4.00	4.00	4.00	4.00	4.00
	Tawnaghmore	Biomass		49.00	49.00	49.00	49.00	49.00	49.00	49.00	49.00	49.00
	West area total		**18.0**	**67.0**	**79.0**	**99.0**	**103.0**	**103.0**	**103.0**	**103.0**	**103.0**	**103.0**

Appendix E:
Short circuit currents

E.1 Background of short circuit currents

The main driver for calculating short circuit current levels is safety. All transmission system equipment must be capable of carrying very high currents. These high currents typically occur in the event of a short circuit fault. In particular, circuit breakers must be capable of closing onto a fault and opening to isolate a fault.

Their correct operation minimises risk to human life and prevents damage to transmission system equipment. It is also crucial for maintaining transmission system stability, security and quality of supply.

Short circuit current levels also give an indication of the electrical strength of the transmission system at each station. This provides an indication of the suitability of a station for connection of 'voltage sensitive' equipment.

A station with a high short circuit current level will be more attractive to these types of load. This is due to strong generation infeeds minimising distortions in voltage and frequency caused by transmission system disturbances. Similarly, generators will have less difficulty to ride through faults and maintain stability when connected to stations with high short circuit current levels.

Short circuit current levels vary across the transmission system. They are affected by the transmission system topology, system impedance and the available short circuit contribution from rotating machines (i.e., generators and large motors).

Changes in the transmission system topology or the addition/retirement of generation units can bring about an increase/reduction in the short circuit current levels on the transmission system. Similarly, seasonal variations in generation dispatches and demand levels combined with possible transmission system sectionalising or plant outages will result in variations of short circuit current levels at different locations. To ensure safe and reliable operation of the transmission system and customer's equipment at all times, two types of short circuit current level calculations are carried out:

- **Maximum short circuit current levels** are required for the specification of transmission system equipment and for connections to the transmission system. Plant in substations is typically subjected to the most onerous short circuit currents. The high capital costs of HV equipment means that it is important to predict the maximum short circuit current the equipment may see in its lifetime, and this must be specified to a rating above the maximum expected short circuit current level. Also, for customers, the design and specification of equipment at lower voltage levels will depend on the short circuit level at the transmission connection point.
- **Minimum short circuit current levels** are required to guarantee reliable and coordinated operation of protection systems or to assess the suitability of a station for the connection of 'voltage sensitive' equipment. Minimum short circuit current levels are also required at the design stage of generation plants to ensure fault ride through capabilities are in accordance with Grid Code requirements.

E.1.1 The nature of short circuit currents

The plot in Figure E-1 shows a typical short circuit current waveform. Short circuit current is normally made up of a symmetrical AC component, with a decay rate, and a DC offset component, which has a much faster decay rate. The combination of AC and DC components results in an asymmetrical current waveform.

While the AC component is always present in the short circuit current, the DC offset is dependent on the instant that the fault occurs within the voltage waveform. For the purposes of this document, it is assumed that the fault occurs at the instant of maximum DC offset in the short circuit current.

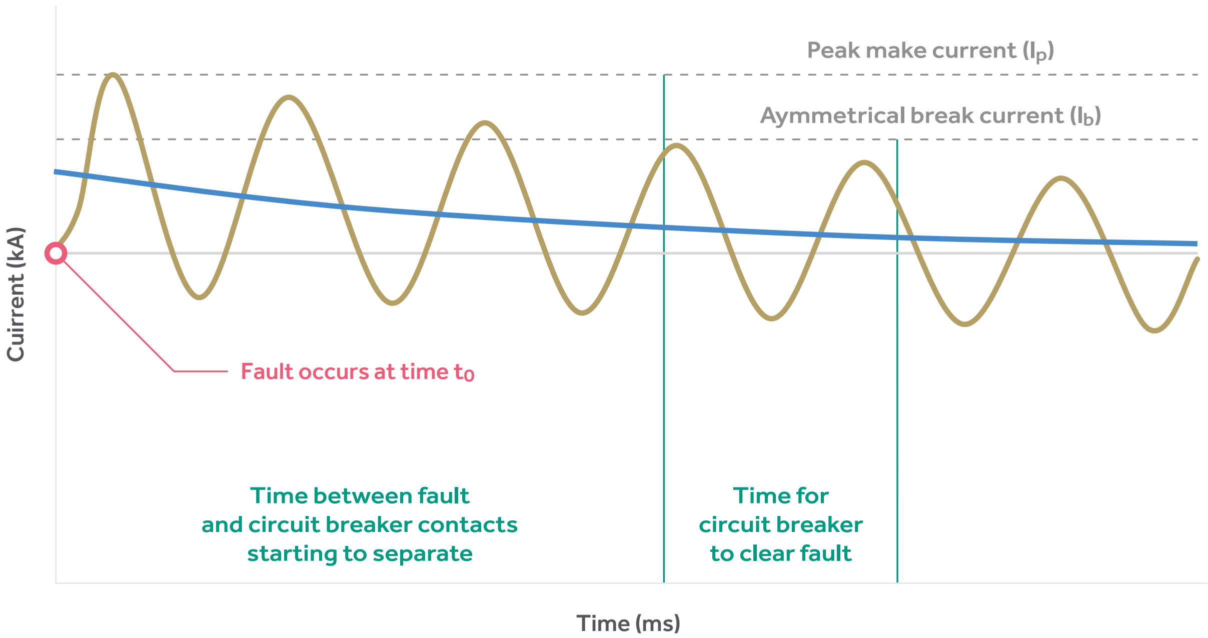

Figure E-1: Typical short circuit current

The DC component of a short circuit current decays exponentially. Its rate of decay is influenced by the individual ratios of the reactance (X) to the resistance (R) of the paths back to the generators feeding power to the fault (the X/R ratio). Transmission nodes where large generators can have high X/R ratios, may have a slower decay time for the DC component of the short circuit current.

The AC component of a short circuit current also decays with time. This is due to the changes in the synchronous generators internal reactance and, thus, the AC reduction effect is more pronounced in the vicinity of large generation plants.

The internal impedance of a synchronous generator is not constant after the start of the fault. It increases progressively and the short circuit current contribution becomes weaker, passing through three characteristic stages:

- **Subtransient: (approx. 0.01 to 0.1 sec)**
  Short-circuit current (RMS value of the AC component) is high: 5 to 10 times permanent rated current. This is called sub-transient short-circuit current, Ik''.
- **Transient: (between 0.1 and 1 sec)**
  Short-circuit current (RMS value of the AC component) drops to between 2 and 6 times rated current. This is called transient short-circuit current, Ik'.
- **Continuous**
  Short-circuit current (RMS value of the AC component) drops to between 0.5 and 2 times rated current. This is called steady-state short-circuit current, Ik.

E.1.2 Duty of circuit breakers

Over the duration of a fault the switchgear has to be able to withstand two events, namely the fault initiation and then the fault clearance. The short circuit currents at these two instances are referred to as the make current and the break current respectively.

(i) The make current (Ip) is the maximum instantaneous current that the circuit breaker is called to withstand. The initiation of a fault causes an instantaneous peak current which results in the generation of electromechanical forces along the busbars and transmission lines. An example of such a fault initiation would be a circuit breaker energising a line that is still earthed following maintenance, hence the term make current.

Make current is expressed in peak values and is comprised of an AC and a DC component. Essentially, the make current is the maximum instantaneous peak of the short circuit current waveform. This will occur at approximately 10 milliseconds (ms) after the instant of fault (see Figure E1), whether the fault is energised through a circuit breaker or it spontaneously occurs on the transmission system. Circuit breakers are typically rated approximately 2.5 times higher for make duty than for break duty, as per IEC 62271-100 standard.

(ii) After the fault initiation, there is a time period during which the protection scheme will identify the fault, make a decision and then instruct the relevant circuit breaker to open to interrupt the fault. This could take anything from 10 ms in modern fast protection systems to 60 ms in older systems. At this point the circuit breaker begins to open and it takes a certain time period before the contacts actually separate, normally around two cycles or 40 ms in modern switchgear equipment. The total time from the start of the fault until the breaker opening or fault clearance time can vary from 50 ms to 120 ms, depending on the protection system. In some cases, if main protection fails and back-up main protection is not installed, clearance times can be considerably longer than 120 ms.

At the point of physical separation, the short circuit current forms an arc and the thermal energy generated by this arc has to be dissipated as the short circuit current is interrupted. The short circuit current when this interruption occurs is referred to as the break current, Ib. This value is expressed in RMS (root mean square) terms and is comprised of an AC component and a DC component. Circuit breakers designed and tested in accordance with the IEC 62271-100 standard can interrupt any short circuit current up to its rated breaking current containing any AC component up to the rated value and, associated with it, any percentage DC component up to that specified (typically 30%).

The duty of the circuit breaker is calculated from the make and break current as a percentage of the circuit breaker rating.

E.2 Short circuit current calculation methodology

Engineering Recommendation G74 has been applied to all short circuit studies reported in this document. Some of the general assumptions applied include:

- Short circuit level contribution from loads has been considered following G74 recommendations. The demand at each node is assumed to contribute 1 MVA of induction motor fault infeed per MW of load. A constant X/R ratio of 2.76 is assumed for all of the loads; and
- A break time of 50 ms is assumed typical for the circuit breakers at 110 kV, 220 kV, 275 kV and 400 kV. A break time of 80 ms is used for the circuit breakers at 110 kV stations in Ireland.

Winter Peak study results give an indication of the maximum prospective short circuit current levels on the transmission system. For winter peak studies, all generators have been included in the calculations. A merit order economic dispatch has been used, and to enable maximum short circuit current level to be calculated, any generators that were not dispatched have been switched in with 0 MW output, thus contributing to short circuit current levels.

Summer Night Valley study results give an indication of the minimum short circuit current levels to be expected on the transmission system under normal transmission system operating conditions (i.e., maintenance outages are not considered in this section[44]). For summer night valley studies, only generators dispatched on a merit order are considered in the model.

44 Minimum fault levels including maintenance outages are currently provided to generator applicants wishing to connect to the transmission system as part of the connection offer process to allow developers to design the plant in accordance with the Grid Code requirements.

E.3 Short circuit currents in Ireland

E.3.1 Methodology used in Ireland

Short circuit current levels are calculated in accordance with the UK Engineering Recommendation G74, which is a computer based analysis, based on the International Standard IEC60909. Compliance with G74 includes:

- Short circuit contributions from rotating plant, including induction motors embedded in the general load;
- Comprehensive plant parameters including impedances, transformer winding and earthing configurations;
- Pre-fault voltage levels at each node which should be obtained from a credible, pre-fault load flow study; and
- Pre-fault transformer tap settings should also be obtained from the load flow study.

The short circuit current level network model includes the following component parameters:

- Transformer impedance variation with tap position;
- Zero sequence mutual coupling effect;
- Saturated generator reactance values; and
- Power station auxiliaries short circuit current level contributions.

The calculation of the X/R ratios, used by EirGrid, is undertaken in accordance with IEC60909-0 Method B. Method B is currently considered to be the most appropriate general purpose method for calculating DC short circuit currents in the transmission system of Ireland.

The transmission system of Ireland is designed and operated to maintain RMS break short circuit levels in accordance with EirGrid Grid Code CC.8.6. A summary of these requirements is set out in Table E-1. In designing the system, a 10% safety margin is applied.

It should be noted that the EirGrid Grid Code stipulates that short circuit current levels at designated stations in Ireland may be allowed to increase to 31.5 kA. If necessary, the equipment at these stations is to be modified or replaced in order to comply with this new rating.

Circuit breakers with a higher rating than the current levels may be necessary for a number of reasons, including, but not limited to the need to provide an adequate safety margin or to cater for a high DC component in the short circuit current.

Table E-1: Ireland short circuit current levels specified in the grid code

<table>
<tr><th colspan="2">Voltage level (kV)</th><th>Short circuit current levels (kA)</th></tr>
<tr><td colspan="2">400</td><td>50</td></tr>
<tr><td colspan="2">220</td><td>40</td></tr>
<tr><td rowspan="2">110</td><td>Countrywide</td><td>25</td></tr>
<tr><td>Designated sites</td><td>31.5</td></tr>
</table>

E.3.2 Analysis

The total RMS break current at a busbar is an indication of the short circuit current level that one could expect at that point in the transmission system. However, they do not necessarily represent the short circuit current that could flow through each individual breaker, which may be lower.

E.3.3 Ireland short circuit current level results

Tables E-2 to E-4 list subtransient (Ik''), transient (Ik') currents and X/R ratios for single-phase to earth and balanced three-phase faults for transmission system busbars of Ireland. These are presented for maximum winter peak and minimum summer valley intact system demand conditions for 2022, 2025 and 2028.

From these values, the relevant currents required to assess circuit breaker duty can be derived using the following equations:

- Peak make current (I_p)

$$I_p = \sqrt{2} \cdot \left[1.02 + 0.98 \cdot e^{-3 \cdot \frac{R}{X}} \right] \cdot I_k''$$

- AC component ($I_{RMS\_AC\_b}$) of short-circuit current at a selected time of break (t_b)

$$I_{RMS\_AC\_b} = I_k' + \left(I_k'' - I_k' \right) \cdot e^{-\frac{t_b}{40ms}}$$

- DC component (I_{DC_b}) of short-circuit current at a selected time of break (t_b)

$$I_{DC\_b} = \sqrt{2} \cdot I_k'' \cdot e^{-2 \cdot \pi \cdot 50 \cdot t_b \cdot \frac{R}{X}}$$

- Break current (I_b) at a selected time of break (t_b)

$$I_b = \sqrt{I_{DC\_b}^2 + I_{RMS\_AC\_b}^2}$$

Ireland short circuit currents for maximum and minimum demand in 2022

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Adamstown 110 kV	11.56	11.69	10.70	6.29	13.93	13.43	14.84	13.54	12.20	8.58	14.42	13.87
Agannygal 110 kV	3.05	5.93	5.31	4.30	4.58	4.45	2.98	6.29	5.66	4.26	4.81	4.68
Aghada 110 kV	4.70	8.90	8.44	5.71	10.22	10.01	4.74	10.15	9.64	5.83	11.43	11.20
Aghada A 220 kV	12.57	15.77	14.02	13.66	19.87	18.85	15.29	21.09	18.54	16.31	25.08	23.75
Aghada B 220 kV	12.57	15.77	14.02	13.66	19.87	18.85	15.29	21.09	18.54	16.31	25.08	23.75
Aghada C 220 kV	12.10	15.24	13.60	11.82	19.20	18.25	14.28	20.22	17.86	13.11	24.10	22.86
Aghada D 220 kV	12.57	15.77	14.02	13.66	19.87	18.85	15.29	21.09	18.54	16.31	25.08	23.75
Ahane 110 kV	5.01	13.16	11.98	5.77	10.37	10.11	4.92	15.31	14.09	5.76	11.41	11.17
Anner 110 kV	4.07	6.67	6.27	4.56	4.74	4.67	4.00	7.33	6.79	4.55	5.00	4.91
Ardnacrusha 110 kV	5.38	14.72	13.11	6.70	15.43	14.79	6.01	18.80	16.74	7.64	18.16	17.46
Ardnagappary 110 kV	2.96	2.29	2.12	4.27	1.27	1.25	2.92	2.57	2.38	4.28	1.34	1.32
Arigna 110 kV	4.64	7.87	7.11	5.80	5.81	5.66	4.52	8.46	7.72	5.73	6.11	5.97
Arklow 110 kV	10.85	8.75	8.24	11.62	10.32	10.07	10.30	9.80	9.19	11.44	11.42	11.13
Arklow 220 kV	9.14	7.72	7.35	10.53	6.96	6.85	8.81	8.73	8.36	10.38	7.68	7.58
Artane 110 kV	12.79	10.24	9.55	6.09	12.34	11.99	13.23	12.61	11.42	5.86	14.69	14.12
Arva 110 kV	4.01	9.51	8.50	5.22	7.11	6.90	3.94	10.59	9.54	5.21	7.59	7.40
Athea 110 kV	11.30	9.60	8.25	12.10	9.01	8.56	11.53	10.45	9.19	12.29	9.58	9.18
Athlone 110 kV	3.89	7.00	6.61	5.33	5.32	5.24	3.87	7.78	7.18	5.35	5.60	5.49
Athy 110 kV	3.30	5.81	5.57	4.49	4.82	4.76	3.19	6.73	6.37	4.45	5.35	5.27
Aughinish 110 kV	5.67	7.17	6.61	6.73	8.33	8.07	7.98	10.78	9.74	10.01	11.10	10.70
Aungierstown 110 kV	18.60	18.86	17.12	19.80	13.36	13.04	19.98	22.07	20.47	20.53	14.73	14.48
Ballybeg 110 kV	9.69	6.35	6.12	9.93	7.43	7.31	9.77	7.20	6.88	10.09	8.26	8.11
Ballydine 110 kV	4.06	7.29	6.89	3.77	5.65	5.57	3.97	8.08	7.54	3.75	6.02	5.91
Ballylickey 110 kV	3.01	3.71	3.47	4.08	2.13	2.10	2.97	3.97	3.69	4.06	2.24	2.21
Ballynahulla 110 kV	15.88	11.08	9.75	12.59	10.24	9.82	16.69	12.15	10.88	13.35	11.28	10.88
Ballynahulla 220 kV	9.52	9.54	8.63	9.20	9.38	9.06	9.27	11.67	10.69	9.26	11.35	11.01
Ballyvouskill 110 kV	14.54	11.43	9.95	13.68	12.07	11.46	15.15	12.52	11.05	14.07	13.06	12.47
Ballyvouskill 220 kV	9.42	9.85	8.88	10.15	11.34	10.87	9.19	11.74	10.71	9.96	13.11	12.64

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Ballywater 110 kV	5.54	6.24	5.94	3.33	6.03	5.94	5.41	6.79	6.42	3.28	6.52	6.40
Baltrasna 110 kV	5.95	10.15	9.54	7.16	7.79	7.67	5.79	11.31	10.72	7.10	8.40	8.29
Bancroft 110 kV	12.18	11.68	10.95	6.87	13.54	13.20	12.28	13.46	12.62	6.69	15.32	14.93
Bandon 110 kV	3.12	6.89	6.36	4.28	6.42	6.26	3.04	7.56	6.88	4.22	6.85	6.65
Banoge 110 kV	6.28	6.03	5.78	7.02	5.25	5.19	6.02	6.62	6.32	6.92	5.62	5.54
Barnahealy A 110 kV	4.64	12.20	11.33	5.40	12.41	12.10	4.52	13.95	12.91	5.32	13.80	13.44
Barnahealy B 110 kV	6.32	12.15	11.28	7.00	12.10	11.80	6.26	13.73	12.68	6.98	13.36	13.01
Barnakyle 110 kV	17.75	18.58	16.89	19.54	13.10	12.80	18.86	21.73	20.17	20.22	14.43	14.19
Baroda 110 kV	3.92	7.61	7.20	4.67	8.87	8.68	4.00	10.15	9.49	4.95	11.00	10.73
Barrymore 110 kV	3.76	7.87	7.45	4.91	4.50	4.45	3.72	8.69	8.21	4.90	4.79	4.74
Belcamp 110 kV	15.30	14.26	12.67	12.16	16.94	16.13	18.50	21.60	19.08	12.66	23.62	22.52
Belcamp 220 kV	10.83	15.72	14.00	9.48	19.33	18.37	12.61	24.73	21.81	10.41	28.21	26.80
Belgard 110 kV	11.90	12.06	11.12	6.71	14.63	14.15	11.99	14.14	12.96	6.51	16.82	16.23
Bellacorick 110 kV	4.60	5.54	4.77	5.18	6.16	5.81	5.09	6.31	5.45	5.65	7.32	6.90
Binbane 110 kV	3.42	4.80	4.29	5.04	4.18	4.04	3.72	6.43	5.94	5.72	4.92	4.82
Blackrock 110 kV	10.46	10.82	10.06	2.68	10.85	10.58	9.89	14.45	13.11	2.36	13.14	12.75
Blake 110 kV	3.95	7.29	6.91	4.95	5.12	5.06	3.89	8.99	8.48	5.01	5.76	5.68
Blundelstown 110 kV							4.25	9.37	9.05	4.99	5.52	5.49
Boggeragh 110 kV	6.81	8.63	7.81	8.08	8.44	8.16	6.69	9.26	8.45	8.00	8.88	8.61
Booltiagh 110 kV	6.84	8.64	7.75	8.62	6.56	6.37	6.71	9.20	8.36	8.57	6.79	6.62
Brinny A 110 kV	3.00	6.11	5.68	4.13	5.23	5.12	2.93	6.66	6.12	4.08	5.55	5.42
Brinny B 110 kV	3.00	6.14	5.71	4.13	5.27	5.16	2.93	6.69	6.15	4.08	5.59	5.46
Bunkimalta 110 kV	6.28	7.01	6.22	6.28	7.01	6.22	6.19	7.69	6.85	6.19	7.69	6.85
Butlerstown 110 kV	6.42	10.67	10.06	6.70	10.63	10.42	6.23	11.97	11.07	6.58	11.68	11.37
Cabra 110 kV	11.92	9.91	9.26	4.98	11.13	10.84	12.18	12.16	11.03	4.76	13.09	12.62
Cahir 110 kV	4.63	9.35	8.56	5.74	7.09	6.93	4.54	10.23	9.26	5.72	7.33	7.15
Carlow 110 kV	5.63	7.99	7.53	6.41	8.57	8.39	5.58	9.61	8.83	6.40	9.83	9.54
Carrickalangan 110 kV	4.89	4.09	3.67	5.81	2.78	2.71	4.89	4.47	4.09	5.82	2.93	2.87
Carrickmines 220 kV	13.43	18.35	16.42	8.51	21.96	20.96	14.47	24.76	22.35	8.02	28.01	26.88

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Carrickmines A 110 kV	29.02	11.45	10.81	22.34	12.51	12.24	33.68	13.51	12.54	23.80	14.29	13.91
Carrickmines B 110 kV	23.55	12.96	12.11	19.42	15.43	15.01	26.32	15.11	14.10	20.59	17.63	17.15
Carrick-on-Shannon 110 kV	4.34	11.88	10.64	5.16	12.32	11.84	4.19	13.11	11.83	5.05	13.36	12.89
Carrigadrohid 110 kV	6.67	13.89	12.59	6.92	12.54	12.16	6.60	15.79	14.35	6.88	13.78	13.38
Carrigdangan 110 kV	4.23	6.50	5.62	5.28	6.91	6.54	4.13	6.87	5.98	5.19	7.17	6.81
Carrowbeg 110 kV	2.75	3.05	2.83	3.80	2.61	2.55	2.73	3.27	2.99	3.78	2.74	2.67
Cashla 110 kV	7.12	17.40	15.52	7.51	21.15	20.16	7.28	20.39	18.14	7.70	24.25	23.10
Cashla 220 kV	8.57	9.77	9.07	9.57	9.94	9.69	8.56	12.55	11.73	9.76	11.88	11.62
Castlebagot 110 kV	19.10	18.96	17.21	21.78	13.45	13.14	20.64	22.21	20.59	22.81	14.84	14.58
Castlebagot 220 kV	10.44	20.75	18.28	9.11	21.74	20.73	9.97	28.18	25.35	8.57	27.30	26.33
Castlebar 110 kV	3.45	5.74	5.09	4.12	5.37	5.16	3.40	6.29	5.51	4.05	5.57	5.35
Castledockrill 110 kV	7.70	7.72	7.33	4.36	8.42	8.26	7.49	8.39	7.93	4.28	9.06	8.87
Castlefarm A 110 kV	5.42	6.98	6.44	6.37	7.87	7.63	7.18	10.36	9.39	8.71	10.33	9.98
Castlefarm B 110 kV	5.43	6.97	6.43	6.37	7.86	7.62	7.19	10.34	9.37	8.72	10.32	9.97
Castleview 110 kV	3.86	12.10	11.27	4.54	8.72	8.57	3.76	13.86	12.85	4.50	9.58	9.41
Cathaleen's Fall 110 kV	4.59	9.44	8.09	5.56	9.55	9.04	5.10	12.35	10.62	6.10	11.35	10.80
Cauteen 110 kV	6.00	8.66	7.87	6.76	4.82	4.73	5.92	9.42	8.56	6.74	5.05	4.96
Central Park 110 kV	14.20	10.48	9.93	7.60	11.23	11.01	14.54	12.26	11.44	7.46	12.72	12.41
Charleville 110 kV	4.85	7.06	6.44	6.57	6.03	5.87	4.75	7.69	6.97	6.50	6.53	6.35
Cherrywood 110 kV	10.24	9.68	9.20	7.45	9.85	9.68	10.20	11.24	10.54	7.33	11.07	10.83
City West 110 kV	5.96	7.58	7.07	6.01	5.67	5.57	5.82	8.82	7.99	5.93	6.22	6.07
CKM Country 110 kV	23.55	12.96	12.11	19.42	15.43	15.01	26.32	15.11	14.10	20.59	17.63	17.15
Clahane 110 kV	4.18	7.90	7.23	5.23	6.76	6.59	4.03	8.68	8.00	5.15	7.19	7.03
Clashavoon 220 kV	9.39	10.57	9.59	10.15	11.68	11.24	9.15	12.43	11.40	9.98	13.38	12.95
Clashavoon A 110 kV	8.05	16.98	15.04	8.34	20.53	19.51	7.95	19.42	17.28	8.27	23.16	22.07
Clashavoon B 110 kV	8.05	16.98	15.04	8.34	20.53	19.51	7.95	19.42	17.28	8.27	23.16	22.07
Cliff 110 kV	4.13	7.04	6.26	5.41	6.49	6.25	4.51	8.91	7.94	5.88	7.37	7.13
Cloghboola 110 kV	7.92	8.83	7.29	11.17	8.24	7.72	7.79	9.45	8.00	11.15	8.51	8.07
Cloghboola 110 kV	7.92	8.83	7.29	11.17	8.24	7.72	7.79	9.45	8.00	11.15	8.51	8.07

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Clogher 110 kV	4.66	8.61	6.98	5.55	8.60	7.97	4.62	10.09	8.38	5.56	9.52	8.94
Cloghran 110 kV	9.45	19.84	17.50	9.56	22.27	21.20	9.38	23.67	21.33	9.58	25.65	24.66
Cloncreen 110 kV							6.63	12.48	11.21	8.10	12.78	12.30
Clonee 220 kV	11.37	16.31	14.56	9.26	15.96	15.34	11.33	22.67	20.44	8.85	20.12	19.47
Clonkeen A 110 kV	5.60	6.20	5.87	6.76	4.32	4.26	5.52	6.70	6.35	6.74	4.58	4.52
Clonkeen B 110 kV	4.87	9.66	8.41	4.15	10.16	9.65	4.69	10.43	9.20	4.00	10.85	10.36
Cloon 110 kV	4.24	7.81	7.30	5.75	6.48	6.36	4.14	8.60	7.97	5.72	6.95	6.80
Clutterland 110 kV							19.47	22.04	20.45	19.86	14.69	14.44
College Park 110 kV	9.08	18.92	16.81	6.36	22.03	20.99	8.98	22.49	20.40	6.14	25.42	24.46
Cookstown 110 kV	7.19	8.21	7.85	5.89	6.94	6.85	7.05	9.23	8.83	5.79	7.61	7.51
Cookstown A 110 kV	4.90	6.47	6.06	5.18	4.57	4.50	4.77	7.48	6.80	5.12	4.97	4.86
Coolnanoonag 110 kV	10.54	17.03	15.10	10.26	19.90	18.94	11.84	20.87	18.85	11.10	23.57	22.65
Coolroe 110 kV	3.46	9.83	9.23	4.75	9.11	8.93	3.49	11.30	10.49	4.88	10.03	9.81
Coomagearlahy 110 kV	5.35	7.82	6.75	5.98	8.45	7.99	5.20	8.33	7.25	5.84	8.96	8.50
Coomataggart 110 kV	9.94	7.43	6.60	6.67	4.08	3.98	9.92	7.76	6.96	6.64	4.14	4.06
Cordal 110 kV	12.66	9.49	8.41	7.60	8.80	8.46	12.83	10.29	9.27	7.63	9.60	9.28
Corderry 110 kV	4.34	8.89	7.77	5.59	7.71	7.40	4.19	9.56	8.47	5.49	8.08	7.80
Corduff 110 kV	10.57	21.90	19.15	11.67	25.81	24.42	10.69	26.45	23.64	11.91	30.13	28.82
Corduff 220 kV	13.16	18.30	16.11	12.34	22.32	21.11	14.45	27.34	24.06	12.79	30.85	29.30
Corkagh 110 kV	18.39	18.73	17.01	20.41	13.23	12.92	19.47	21.83	20.25	20.53	14.46	14.22
Corraclassy 110 kV	4.35	6.82	6.26	5.61	5.05	4.94	4.32	7.32	6.80	5.60	5.27	5.18
Cow Cross 110 kV	4.23	12.22	11.37	4.75	10.13	9.92	4.11	14.03	12.99	4.78	11.56	11.31
Crane 110 kV	7.92	8.59	8.03	7.45	8.77	8.57	7.65	9.46	8.76	7.31	9.57	9.31
Croaghaun 110 kV	4.65	4.98	4.35	5.36	5.03	4.79	5.09	5.60	4.92	5.82	6.33	6.02
Croaghnagawna 110 kV	4.88	4.38	3.90	5.95	3.14	3.05	4.88	4.81	4.38	5.96	3.33	3.25
Cromcastle A 110 kV	11.32	13.38	11.97	7.22	15.67	14.97	10.58	19.36	17.27	6.36	21.03	20.13
Cromcastle B 110 kV	11.32	13.38	11.97	7.22	15.67	14.97	10.58	19.36	17.27	6.36	21.03	20.13
Crory 110 kV	9.87	8.84	8.33	9.79	10.40	10.16	9.56	9.65	9.05	9.60	11.29	11.01
Cruiserath 220 kV	12.97	18.19	16.02	12.05	22.14	20.95	14.10	27.10	23.87	12.36	30.53	29.01

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Cullenagh 110 kV	7.83	12.97	12.15	8.44	14.69	14.32	7.55	14.56	13.44	8.22	16.24	15.75
Cullenagh 220 kV	8.49	9.17	8.74	8.94	8.94	8.80	8.18	10.08	9.62	8.72	9.69	9.54
Cunghill 110 kV	3.27	5.76	5.27	3.85	5.14	5.00	3.20	6.38	5.89	3.82	5.45	5.33
Cureeny 110 kV	5.83	6.64	5.87	5.83	6.64	5.87	5.72	7.26	6.45	5.72	7.26	6.45
Cureeny T 110 kV	6.01	8.32	7.42	5.53	7.33	7.08	5.93	9.23	8.28	5.47	7.96	7.70
Cushaling 110 kV	3.92	6.61	6.28	4.59	8.30	8.13	6.73	12.68	11.37	8.54	13.33	12.81
Dallow 110 kV	3.51	5.05	4.82	4.70	3.07	3.04	3.49	5.56	5.31	4.73	3.21	3.18
Dalton 110 kV	3.33	4.84	4.41	4.61	3.70	3.61	3.27	5.21	4.69	4.57	3.82	3.72
Dardistown 110 kV	14.26	13.78	12.29	11.00	16.46	15.70	13.86	20.12	17.88	10.16	22.36	21.35
Darndale 110 kV	14.71	13.89	12.36	12.16	16.09	15.35	17.20	20.79	18.41	12.61	22.12	21.14
Deenes 110 kV							5.37	10.90	10.29	6.53	7.66	7.56
Derrybrien 110 kV	3.08	4.82	4.24	4.51	4.22	4.06	3.02	5.08	4.48	4.46	4.45	4.28
Derryiron 110 kV	4.60	7.18	6.85	5.71	7.48	7.36	5.43	10.36	9.70	6.95	9.51	9.32
Doon 110 kV	4.41	7.35	6.87	4.75	5.35	5.27	4.35	8.11	7.47	4.73	5.64	5.53
Dromada 110 kV	10.18	8.80	7.61	6.33	8.14	7.76	10.28	9.54	8.42	6.27	8.64	8.30
Drumkeen 110 kV	4.10	7.61	6.32	5.20	6.39	6.04	3.91	8.61	7.33	5.08	6.86	6.56
Drumline 110 kV	3.32	8.57	7.91	4.63	6.89	6.74	3.22	9.65	8.91	4.60	7.40	7.25
Drybridge 110 kV	5.24	11.55	10.64	6.30	9.69	9.47	5.08	13.35	12.28	6.26	10.67	10.43
Dundalk 110 kV	3.57	8.70	8.07	4.64	7.69	7.52	3.41	9.73	8.98	4.53	8.38	8.18
Dunfirth 110 kV	4.53	5.99	5.77	6.09	4.76	4.71	4.49	6.91	6.69	6.19	5.20	5.16
Dungarvan 110 kV	5.92	6.27	5.95	7.78	5.07	5.00	5.83	6.93	6.44	7.73	5.50	5.39
Dunmanway 110 kV	4.58	9.75	8.53	5.55	8.83	8.46	4.45	10.68	9.32	5.46	9.43	9.04
Dunstown 220 kV	10.66	17.93	16.25	10.75	20.30	19.52	10.07	22.36	20.80	10.24	24.40	23.74
Dunstown 400 kV	15.88	6.66	6.27	18.42	7.25	7.09	15.84	8.00	7.69	18.65	8.42	8.30
Ennis 110 kV	4.67	12.55	11.04	6.10	10.08	9.72	4.45	14.16	12.50	5.98	10.90	10.54
Fassaroe East 110 kV	5.16	7.70	7.37	5.32	5.87	5.80	5.01	8.70	8.28	5.24	6.41	6.33
Fassaroe West 110 kV	5.30	7.86	7.52	5.42	6.06	5.99	5.15	8.89	8.45	5.33	6.63	6.54
Finglas 220 kV	12.97	17.26	15.24	12.78	21.87	20.68	15.40	26.74	23.41	14.33	31.44	29.73
Finglas A 110 kV	20.21	14.98	13.31	15.22	17.69	16.84	19.12	21.74	19.17	13.84	23.82	22.70

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Finglas B 110 kV	26.37	11.43	10.60	25.20	14.38	13.92	33.84	14.27	12.85	30.27	17.47	16.71
Flagford 110 kV	4.63	12.45	11.11	5.53	14.43	13.79	4.47	13.75	12.39	5.39	15.74	15.10
Flagford 220 kV	7.52	7.32	6.83	9.75	6.65	6.51	7.32	8.15	7.74	9.66	7.20	7.09
Fortunestown 110 kV	5.58	7.47	6.96	5.59	5.60	5.50	5.43	8.68	7.86	5.51	6.14	5.99
Francis Street A 110 kV	10.92	10.84	10.07	5.55	13.15	12.76	10.38	14.48	13.13	4.96	16.63	16.00
Francis Street B 110 kV	12.52	12.04	11.15	6.58	14.54	14.09	12.68	14.16	13.01	6.37	16.74	16.17
Galway 110 kV	5.42	14.07	12.54	4.66	16.16	15.44	5.27	16.18	14.25	4.53	18.11	17.22
Garrow 110 kV	10.53	11.04	9.60	10.43	11.74	11.14	10.54	12.06	10.63	10.42	12.67	12.09
Garvagh 110 kV	4.71	7.15	6.27	6.21	6.08	5.85	4.58	7.59	6.74	6.12	6.29	6.08
Gilra 110 kV	3.09	6.53	6.11	4.00	4.89	4.80	3.02	6.96	6.55	3.96	5.15	5.07
Glanagow 220 kV	12.71	15.53	13.82	12.78	19.49	18.50	14.90	20.34	17.96	14.27	24.21	22.96
Glanlee 110 kV	5.17	7.72	6.66	5.45	8.31	7.85	5.02	8.21	7.15	5.32	8.79	8.35
Glasmore A 110 kV	4.25	7.19	6.68	4.71	5.00	4.91	3.78	8.97	8.23	4.47	5.63	5.53
Glenlara A 110 kV	3.29	3.23	2.98	4.80	2.59	2.54	3.25	3.42	3.13	4.77	2.76	2.69
Glenlara B 110 kV	9.42	8.36	7.34	6.21	8.21	7.85	9.31	8.94	7.99	6.09	8.85	8.51
Glenree 110 kV	3.62	4.84	4.43	4.54	4.31	4.20	3.81	5.84	5.38	4.80	4.84	4.72
Golagh 110 kV	3.91	6.98	5.84	4.72	5.89	5.57	3.81	7.97	6.82	4.68	6.37	6.09
Gorman 110 kV	6.56	13.12	11.99	7.53	14.47	13.98	6.27	15.10	13.81	7.33	16.19	15.66
Gorman 220 kV	8.56	10.92	10.15	9.63	8.98	8.80	8.26	12.63	12.01	9.47	9.92	9.79
Gortawee 110 kV	4.49	6.50	5.95	6.13	5.13	5.01	4.46	6.96	6.44	6.14	5.31	5.20
Grange 110 kV	13.47	13.99	12.45	7.23	16.17	15.43	13.39	20.62	18.25	6.35	21.92	20.94
Grange Castle 110 kV	14.02	12.45	11.34	9.15	15.25	14.65	22.35	14.42	12.91	14.32	15.46	14.84
Great Island 110 kV	8.23	12.82	12.00	9.19	15.57	15.15	8.00	14.42	13.30	9.00	17.32	16.75
Great Island 220 kV	11.14	11.79	11.13	12.50	13.32	13.02	10.58	12.74	12.06	12.02	14.01	13.72
Griffinrath A 110 kV	6.94	9.79	9.30	7.32	9.91	9.74	6.57	11.77	11.19	7.08	11.41	11.23
Griffinrath B 110 kV	7.44	10.12	9.60	7.47	9.91	9.74	7.07	12.21	11.60	7.23	11.38	11.19
Harolds Cross 110 kV	11.09	10.87	10.10	5.26	13.12	12.72	10.58	14.52	13.17	4.68	16.57	15.94
Heuston 110 kV	13.51	12.28	11.36	7.89	14.99	14.50	13.80	14.46	13.27	7.70	17.30	16.70
Huntstown A 220 kV	12.46	16.60	14.71	11.44	21.04	19.94	14.82	25.67	22.58	12.32	30.21	28.62

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Huntstown B 220 kV	13.49	17.23	15.29	10.46	21.00	19.95	14.65	24.76	22.06	10.13	28.18	26.89
Ikerrin 110 kV	5.68	5.23	4.81	6.42	3.57	3.50	5.58	5.61	5.11	6.40	3.72	3.64
Inchicore 220 kV	12.73	21.29	18.65	9.65	25.55	24.14	13.60	30.70	27.12	9.22	34.30	32.64
Inchicore A 110 kV	26.77	13.54	12.44	24.00	16.93	16.32	31.43	16.11	14.68	26.65	19.76	19.00
Inchicore B 110 kV	38.80	13.41	12.19	31.23	16.86	16.17	51.79	16.10	14.37	36.82	19.77	18.84
Inniscarra 110 kV	3.43	9.58	9.00	4.64	8.67	8.50	3.50	11.08	10.28	4.82	9.53	9.32
Irishtown 220 kV	13.93	20.35	18.01	11.07	24.92	23.63	15.58	28.87	25.69	10.98	33.05	31.51
Kellis 110 kV	6.85	8.55	8.08	7.93	10.06	9.84	6.69	10.18	9.41	7.82	11.60	11.25
Kellis 220 kV	7.88	7.67	7.35	9.69	6.55	6.46	7.72	8.68	8.35	9.62	7.18	7.11
Kellystown 220 kV	6.92	16.01	14.54	6.17	13.37	13.00	6.16	20.45	18.99	5.74	15.78	15.47
Kilbarry 110 kV	6.38	19.12	17.09	7.27	19.02	18.29	6.28	23.08	20.25	7.24	21.82	20.89
Kildonan 110 kV	7.36	16.47	14.83	6.19	15.67	15.14	7.44	20.27	18.53	6.59	19.09	18.54
Kilgarvan 110 kV	9.94	7.43	6.60	6.67	4.08	3.98	9.92	7.76	6.96	6.64	4.14	4.06
Kilkenny 110 kV	4.07	5.12	4.91	5.55	4.60	4.54	4.08	5.88	5.46	5.64	5.01	4.90
Kill Hill 110 kV	5.64	6.99	6.27	6.80	5.57	5.41	5.51	7.48	6.70	6.76	5.80	5.63
Killonan 110 kV	6.74	19.27	16.86	7.96	20.41	19.42	6.93	23.74	20.98	8.32	23.87	22.85
Killonan 220 kV	7.73	10.67	9.85	9.99	9.78	9.53	7.82	12.58	11.85	10.32	10.98	10.78
Killoteran 110 kV	7.16	11.65	10.93	7.44	12.64	12.34	6.95	13.12	12.07	7.29	13.98	13.55
Kilmahud 110 kV	18.06	18.60	16.90	20.16	13.18	12.88	18.99	21.76	20.20	20.55	14.54	14.29
Kilmore 110 kV	14.63	14.19	12.62	10.45	16.80	16.00	14.94	21.00	18.56	9.73	22.99	21.93
Kilpaddoge 110 kV	10.74	17.23	15.27	11.49	20.89	19.84	12.17	21.17	19.10	12.92	24.93	23.90
Kilpaddoge 220 kV	11.85	16.08	14.22	11.54	20.47	19.37	16.23	24.83	22.13	14.34	29.56	28.15
Kilteel 110 kV	4.29	7.08	6.75	5.33	6.52	6.42	4.59	9.37	8.85	5.81	7.71	7.59
Kinnegad 110 kV	4.27	7.30	6.96	5.14	6.73	6.63	4.45	9.16	8.69	5.43	7.78	7.66
Knockacummer 110 kV	8.33	7.19	6.36	7.03	6.91	6.63	8.19	7.65	6.87	6.90	7.18	6.93
Knockalough 110 kV	5.49	6.15	5.31	4.58	6.80	6.42	5.38	6.54	5.64	4.51	7.16	6.76
Knockanure 220 kV	11.50	13.90	12.34	7.68	17.52	16.60	13.32	19.13	17.26	7.47	23.00	22.01
Knockanure A 110 kV	20.04	13.48	11.39	15.91	14.26	13.38	24.08	15.11	13.10	17.25	15.64	14.84
Knockanure B 110 kV	4.75	8.75	8.02	5.84	6.87	6.71	4.60	9.74	9.02	5.77	7.40	7.25

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Knockearagh 110 kV	5.42	5.78	5.40	7.32	4.72	4.63	5.36	6.35	5.86	7.31	5.09	4.98
Knockraha A 110 kV	7.80	20.30	18.22	8.66	19.53	18.83	7.79	24.31	21.65	8.70	22.28	21.46
Knockraha A 220 kV	10.52	15.77	14.12	10.48	16.51	15.85	10.93	19.99	17.89	10.66	19.77	19.01
Knockraha B 110 kV	7.80	20.30	18.22	8.66	19.53	18.83	7.79	24.31	21.65	8.70	22.28	21.46
Knockraha B 220 kV	10.52	15.77	14.12	10.48	16.51	15.85	10.93	19.99	17.89	10.66	19.77	19.01
Knockranny 110 kV	6.37	8.58	7.99	5.34	10.73	10.41	6.27	9.38	8.71	5.25	11.57	11.21
Knockranny A 110 kV	5.33	7.16	6.10	5.49	7.87	7.39	5.20	7.67	6.52	5.39	8.32	7.81
Knockranny B 110 kV	6.37	8.58	7.99	5.34	10.73	10.41	6.27	9.38	8.71	5.25	11.57	11.21
Knockumber 110 kV	3.82	7.92	7.41	4.65	5.98	5.88	3.67	8.69	8.14	4.57	6.35	6.25
Lanesboro 110 kV	3.15	9.28	8.54	4.30	7.60	7.42	3.07	10.31	9.39	4.25	8.17	7.97
Letterkenny110 kV	4.50	8.91	7.32	5.55	7.93	7.44	4.32	10.43	8.73	5.46	8.79	8.33
Liberty A 110 kV	5.25	16.05	14.56	4.73	16.90	16.31	5.09	18.94	16.91	4.60	19.14	18.39
Liberty B 110 kV	5.17	16.03	14.55	4.59	16.86	16.27	5.01	18.91	16.89	4.45	19.08	18.33
Limerick 110 kV	4.82	15.65	13.90	5.71	14.25	13.72	5.00	19.50	17.38	5.99	16.47	15.92
Lisdrum 110 kV	2.79	5.06	4.77	4.12	4.35	4.27	3.65	7.06	6.20	5.32	5.05	4.89
Lisheen 110 kV	5.00	5.02	4.37	5.01	7.52	7.00	4.83	5.41	4.73	5.00	8.12	7.56
Lodgewood 110 kV	9.87	8.84	8.33	9.79	10.40	10.16	9.56	9.65	9.05	9.60	11.29	11.01
Lodgewood 220 kV	9.09	7.48	7.15	10.14	6.99	6.89	8.74	8.27	7.92	9.93	7.62	7.52
Longpoint 220 kV	12.36	15.56	13.86	11.49	19.33	18.37	14.60	20.66	18.22	12.47	24.19	22.95
Louth 220 kV	9.31	15.70	14.01	10.46	17.70	16.92	9.14	19.32	17.81	10.39	20.83	20.20
Louth A 110 kV	6.64	12.45	11.39	7.69	14.80	14.28	6.36	13.95	12.95	7.48	16.34	15.86
Louth A 275 kV	11.03	9.42	8.56	11.06	11.08	10.65	11.02	11.64	10.90	10.90	13.23	12.89
Louth B 110 kV	7.10	13.55	12.42	7.97	16.51	15.92	6.90	15.80	14.58	7.86	18.80	18.20
Louth B 275 kV	10.41	9.45	8.58	9.84	11.25	10.81	10.36	11.57	10.84	9.59	13.39	13.04
Macetown 110 kV	7.71	17.19	15.42	7.44	17.43	16.78	7.73	20.96	19.10	7.62	20.74	20.09
Macroom 110 kV	6.98	16.06	14.32	6.90	16.44	15.78	6.88	18.41	16.44	6.82	18.34	17.63
Mallow 110 kV	5.23	6.87	6.44	7.05	5.70	5.60	5.15	7.48	6.97	7.01	6.12	6.00
Marina 110 kV	6.11	17.85	16.03	7.10	18.83	18.10	5.99	21.39	18.85	7.06	21.57	20.62
Maynooth A 110 kV	10.56	12.19	11.47	11.24	14.93	14.56	10.35	15.10	14.24	11.17	17.94	17.52

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Maynooth A 220 kV	9.36	17.27	15.59	9.39	16.30	15.75	8.82	21.77	20.17	9.01	19.24	18.80
Maynooth B 110 kV	8.03	16.24	14.91	9.46	15.72	15.28	7.56	19.16	18.01	9.19	17.78	17.43
Maynooth B 220 kV	8.72	19.30	17.24	8.40	18.44	17.75	7.94	25.18	23.11	7.87	22.29	21.70
McDermott 110 kV	14.93	10.53	9.79	6.18	12.41	12.05	15.88	13.04	11.76	5.95	14.80	14.21
Meath Hill 110 kV	4.02	8.94	8.30	5.24	7.22	7.08	3.94	10.16	9.40	5.25	7.87	7.71
Meentycat 110 kV	3.81	6.36	5.36	5.19	5.33	5.07	3.63	7.02	6.06	5.07	5.61	5.39
Midleton 110 kV	3.57	10.17	9.55	4.76	8.58	8.42	3.45	11.52	10.75	4.70	9.31	9.13
Milltown A 110 kV	14.68	11.64	10.78	7.18	14.32	13.86	14.92	15.82	14.28	6.49	18.42	17.67
Milltown B 110 kV	8.77	10.85	10.11	4.09	12.87	12.51	8.63	12.67	11.70	3.92	14.69	14.23
Misery Hill 110 kV	13.34	11.40	10.56	7.85	14.13	13.68	13.22	15.41	13.92	7.18	18.15	17.41
Moneteen 110 kV	4.96	10.47	9.57	5.94	7.89	7.71	5.23	12.69	11.70	6.23	8.83	8.66
Moneypoint 110 kV	14.18	9.69	9.02	16.99	9.41	9.18	15.40	10.73	10.14	18.28	10.16	9.97
Moneypoint 220 kV	12.05	15.99	14.17	11.59	20.37	19.29	16.47	24.43	21.85	14.28	29.17	27.83
Moneypoint G1 400 kV	14.33	6.86	6.41	16.21	8.15	7.93	21.15	11.17	10.47	23.78	11.90	11.62
Moneypoint G2 400 kV	35.22	4.55	4.24	36.60	5.27	5.12	55.66	5.04	4.78	51.69	5.69	5.58
Moneypoint G3 400 kV	14.33	6.86	6.41	16.21	8.15	7.93	21.15	11.17	10.47	23.78	11.90	11.62
Monread 110 kV	4.00	6.98	6.64	4.85	7.11	6.98	4.11	9.09	8.57	5.12	8.49	8.33
Mount Lucas 110 kV	3.99	5.81	5.52	5.03	5.62	5.53	4.58	8.66	8.05	5.94	7.28	7.13
Moy 110 kV	4.06	4.83	4.34	4.95	5.40	5.18	5.13	6.44	5.76	6.29	6.65	6.38
Mullagharlin 110 kV	3.63	8.73	8.14	4.72	8.03	7.86	3.48	9.65	9.02	4.61	8.69	8.51
Mullingar 110 kV	3.39	6.67	6.37	4.36	6.39	6.29	3.44	7.76	7.34	4.48	7.05	6.93
Mulreavy 110 kV	4.83	7.85	6.35	5.93	8.12	7.50	4.78	9.01	7.48	5.94	8.90	8.33
Mungret A 110 kV	4.71	9.95	9.13	5.69	7.34	7.18	4.89	11.96	11.07	5.91	8.17	8.02
Mungret B 110 kV	4.70	9.97	9.15	5.68	7.35	7.19	4.88	11.98	11.09	5.91	8.18	8.03
Nangor 110 kV	12.58	12.16	11.09	7.60	14.80	14.24	18.51	14.04	12.60	10.89	15.04	14.44
Navan 110 kV	5.69	11.74	10.78	6.50	11.60	11.27	5.45	13.42	12.29	6.34	12.81	12.44
Nenagh 110 kV	3.36	4.14	3.82	4.15	2.61	2.56	3.30	4.47	4.12	4.13	2.75	2.70
Newbridge 110 kV	4.00	8.45	7.94	4.71	8.52	8.34	4.19	11.76	10.86	5.04	10.65	10.39
Newbury 110 kV	13.45	13.98	12.44	7.23	16.11	15.37	13.30	20.56	18.21	6.34	21.78	20.82

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
North Quays 110 kV	17.49	11.85	10.96	6.72	14.34	13.88	18.83	16.18	14.59	6.03	18.44	17.69
North Wall 220 kV	12.38	15.73	14.05	8.29	18.11	17.29	13.64	23.91	21.20	7.70	24.92	23.83
Oldcourt A 110 kV	3.74	10.21	9.61	4.42	7.71	7.58	3.63	11.54	10.83	4.42	8.62	8.48
Oldcourt B 110 kV	3.77	10.28	9.67	4.44	7.78	7.66	3.66	11.62	10.90	4.44	8.71	8.57
Oldstreet 220 kV	11.70	7.59	7.25	10.93	8.92	8.76	14.65	11.80	11.12	12.42	12.53	12.26
Oldstreet 400 kV	10.95	6.05	5.72	9.43	6.14	6.02	12.24	8.42	8.05	9.67	7.76	7.66
Oughtragh 110 kV	3.65	4.67	4.39	4.80	2.97	2.92	3.61	5.09	4.74	4.81	3.10	3.06
Pelletstown 110 kV	13.20	10.00	9.34	7.87	10.91	10.64	13.71	12.26	11.14	7.72	12.83	12.39
Platin 110 kV	4.24	9.66	8.99	5.09	7.27	7.14	4.07	10.86	10.12	5.02	7.82	7.69
Pollaphuca 110 kV	2.76	2.48	2.42	4.00	2.27	2.25	3.32	3.14	3.01	4.75	2.59	2.56
Poolbeg A 110 kV	23.93	12.39	11.44	20.46	15.70	15.17	29.55	16.97	15.28	22.63	20.51	19.63
Poolbeg A 220 kV	12.99	15.84	14.15	7.34	17.21	16.48	13.50	24.15	21.40	6.47	23.39	22.42
Poolbeg B 110 kV	23.91	12.37	11.43	20.45	15.68	15.15	29.50	16.94	15.26	22.61	20.49	19.61
Poolbeg B 220 kV	12.45	19.95	17.62	9.49	22.32	21.24	13.54	28.72	25.60	9.20	29.49	28.27
Poppintree 110 kV	13.02	13.98	12.47	7.75	16.37	15.63	11.75	20.08	17.84	6.69	21.86	20.89
Portan 260 kV	17.76	8.75	8.29	69.99	2.98	2.96	18.39	11.45	11.06	18.39	11.45	11.06
Portan 400 kV	14.84	7.04	6.61	14.84	7.04	6.61	14.88	9.21	8.82	14.88	9.21	8.82
Portlaoise 110 kV	3.79	7.45	7.03	5.15	6.91	6.78	3.83	9.52	8.85	5.43	8.11	7.94
Pottery 110 kV	17.04	10.84	10.26	5.61	11.02	10.81	17.83	12.72	11.85	5.46	12.45	12.15
Prospect 220 kV	10.21	13.39	12.10	8.07	14.54	13.99	11.60	19.16	17.54	8.10	18.91	18.34
Raffeen 220 kV	11.85	14.75	13.21	10.52	17.95	17.11	13.37	19.05	16.94	11.00	22.03	20.99
Raffeen A 110 kV	5.63	14.25	13.12	6.49	16.55	16.01	5.54	16.55	15.15	6.45	18.81	18.17
Raffeen B 110 kV	7.77	14.22	13.05	8.66	16.37	15.82	7.84	16.32	14.89	8.76	18.40	17.75
Rathkeale 110 kV	3.48	7.30	6.86	4.76	5.72	5.62	3.45	8.35	7.79	4.82	6.17	6.06
Ratrussan 110 kV	3.87	7.86	6.61	5.05	8.29	7.77	3.73	8.55	7.28	4.94	8.73	8.24
Reamore 110 kV	3.84	8.98	7.99	4.29	7.40	7.16	3.67	10.03	8.94	4.20	7.96	7.71
Richmond A 110 kV	2.80	6.43	6.04	4.11	5.36	5.27	2.75	7.06	6.54	4.09	5.76	5.64
Richmond B 110 kV	2.80	6.43	6.04	4.11	5.36	5.27	2.75	7.06	6.54	4.09	5.76	5.64
Rinawade 110 kV	4.89	10.23	9.66	5.88	7.44	7.33	4.67	11.69	11.21	5.78	8.13	8.05

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Ringaskiddy 110 kV	5.51	11.74	10.93	5.96	11.15	10.89	5.42	13.24	12.28	5.90	12.23	11.94
Ringsend 110 kV	23.87	12.39	11.43	21.16	15.72	15.18	30.09	17.15	15.38	24.02	20.71	19.79
Ryebrook 110 kV	5.41	13.87	12.55	6.35	12.34	11.97	5.08	15.79	14.63	6.14	13.45	13.15
Salthill 110 kV	4.92	13.55	12.07	3.78	15.21	14.54	4.75	15.49	13.65	3.66	16.94	16.14
Screeb 110 kV	4.13	2.98	2.74	5.04	1.89	1.86	4.09	3.17	2.88	5.02	1.97	1.93
Seal Rock A 110 kV	5.51	7.05	6.50	6.47	8.21	7.95	7.66	10.58	9.57	9.39	10.94	10.56
Seal Rock B 110 kV	5.51	7.05	6.50	6.47	8.21	7.95	7.68	10.59	9.58	9.41	10.94	10.56
Shankill 110 kV	3.97	8.87	7.70	5.16	7.77	7.44	3.91	10.16	8.80	5.19	8.50	8.15
Shannonbridge 110 kV	4.79	12.80	11.84	6.06	13.41	13.04	4.85	14.61	13.58	6.24	14.78	14.42
Shannonbridge 220 kV	6.59	6.94	6.65	8.87	5.65	5.58	6.77	7.95	7.73	9.26	6.13	6.09
Shellybanks A 220 kV	12.76	15.81	14.12	7.36	19.28	18.36	13.18	24.12	21.38	8.26	25.07	23.96
Shellybanks B 220 kV	13.21	19.43	17.28	9.61	23.49	22.34	14.79	27.60	24.64	9.31	31.07	29.69
Shelton Abbey 110 kV	7.53	7.72	7.31	7.58	7.86	7.71	7.19	8.57	8.10	7.43	8.59	8.42
Singland 110 kV	6.00	15.41	13.76	7.06	14.63	14.09	6.36	18.89	16.98	7.49	16.75	16.21
Sliabh Bawn 110 kV	3.30	9.14	8.25	3.30	9.14	8.25	3.20	9.93	8.97	3.20	9.93	8.97
Slievecallan 110 kV	7.88	7.14	6.26	9.42	2.33	2.30	7.77	7.61	6.74	9.40	2.42	2.39
Sligo 110 kV	3.74	9.57	8.60	4.49	8.67	8.38	3.62	10.72	9.67	4.42	9.37	9.08
Snugborough 110 kV	10.63	19.87	17.57	9.95	20.40	19.51	10.72	23.70	21.40	9.96	23.23	22.43
Somerset 110 kV	2.93	7.01	6.68	3.98	4.57	4.52	2.87	7.62	7.24	3.96	4.78	4.73
Sorne Hill 110 kV	3.58	3.51	3.07	4.53	3.45	3.30	3.48	3.78	3.34	4.44	3.66	3.51
Srahnakilly 110 kV	4.71	5.45	4.68	5.33	6.10	5.75	5.19	6.16	5.33	5.74	7.09	6.68
Srananagh 110 kV	4.69	11.25	9.94	5.61	11.75	11.23	4.58	12.68	11.34	5.54	12.87	12.37
Srananagh 220 kV	7.31	4.69	4.42	9.62	3.69	3.64	7.29	5.11	4.88	9.65	3.92	3.87
Stevenstown 110 kV	4.20	5.90	5.58	4.66	3.87	3.83	3.80	7.05	6.64	4.47	4.28	4.23
Stratford 110 kV	3.16	3.84	3.72	4.17	3.05	3.02	3.39	4.66	4.38	4.40	3.38	3.33
Taney 110 kV	8.76	9.38	8.93	3.24	9.25	9.10	8.65	10.85	10.19	3.13	10.32	10.11
Tarbert 110 kV	22.24	11.94	11.25	25.17	12.80	12.53	35.48	17.02	15.86	36.35	16.06	15.69
Tarbert 220 kV	11.34	15.33	13.64	11.52	19.24	18.26	15.74	23.96	21.41	14.85	27.82	26.56
Tawnaghmore A 110 kV	3.60	3.92	3.57	4.62	3.93	3.80	4.51	5.19	4.72	5.79	4.67	4.53

Table E-2: Ireland short circuit currents for maximum and minimum demand in 2022

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Tawnaghmore B 110 kV	3.50	3.79	3.48	4.36	4.28	4.14	4.46	5.07	4.64	5.70	5.25	5.08
Thornsberry 110 kV	3.71	5.54	5.29	4.78	5.33	5.25	3.95	7.75	7.25	5.30	6.88	6.74
Thurles 110 kV	6.19	6.41	5.60	6.48	6.55	6.24	5.93	6.87	5.98	6.41	6.89	6.56
Tievebrack 110 kV	3.65	4.43	3.98	5.07	2.95	2.88	3.73	5.30	4.88	5.23	3.23	3.17
Tipperary 110 kV	5.36	7.71	7.15	6.36	4.65	4.58	5.28	8.39	7.73	6.33	4.87	4.79
Tonroe 110 kV	2.77	3.58	3.30	3.88	2.05	2.02	2.73	3.79	3.49	3.86	2.14	2.11
Trabeg 110 kV	6.05	17.78	15.98	7.04	18.78	18.05	5.92	21.29	18.77	6.99	21.50	20.56
Tralee 110 kV	5.21	9.57	8.49	6.24	7.91	7.63	5.04	10.79	9.57	6.17	8.55	8.27
Trien A 110 kV	4.56	8.31	7.59	5.87	6.96	6.78	4.42	9.21	8.47	5.80	7.50	7.33
Trien B 110 kV	12.89	11.10	9.31	9.23	7.96	7.60	13.43	12.14	10.44	9.26	8.32	8.02
Trillick 110 kV	3.70	3.84	3.32	4.65	3.45	3.29	3.59	4.16	3.62	4.56	3.65	3.50
Trinity 110 kV	11.95	11.12	10.32	6.62	13.66	13.24	11.56	14.94	13.52	5.97	17.42	16.73
Tullabrack 110 kV	6.61	7.46	6.98	7.30	5.47	5.38	6.55	8.08	7.64	7.29	5.77	5.69
Turlough 220 kV	10.64	12.04	11.05	12.02	10.80	10.51	10.05	13.53	12.67	11.61	11.59	11.37
Tynagh 220 kV	10.43	7.44	7.10	11.35	9.17	8.99	15.38	12.79	11.85	16.62	13.87	13.47
Uggool 110 kV	6.48	8.20	7.65	5.77	10.30	10.00	6.38	8.93	8.32	5.69	11.07	10.74
Waterford 110 kV	7.35	12.19	11.41	7.87	13.13	12.81	7.13	13.76	12.62	7.72	14.54	14.09
Wexford 110 kV	5.84	6.97	6.37	7.25	6.26	6.09	5.74	7.68	6.91	7.18	6.77	6.56
Whitebank 110 kV	20.94	12.34	11.38	18.29	15.63	15.10	26.00	17.07	15.32	20.44	20.58	19.67
Whitegate 110 kV	4.37	9.60	9.06	5.16	9.72	9.52	4.34	10.94	10.32	5.18	10.77	10.56
Wolfe Tone 110 kV	13.47	10.32	9.61	5.67	12.03	11.69	14.06	12.74	11.51	5.44	14.30	13.74
Woodhouse 110 kV	5.94	6.25	5.93	7.34	4.49	4.43	5.85	6.85	6.41	7.29	4.82	4.75
Woodland 220 kV	10.35	18.70	16.71	10.38	20.41	19.54	9.77	25.34	23.10	10.01	25.98	25.13
Woodland 400 kV	15.57	7.07	6.64	15.64	8.10	7.90	15.83	9.26	8.86	16.08	10.30	10.13
Yellowmeadow 110 kV							29.58	14.94	13.40	17.76	16.68	15.99

Ireland short circuit currents for maximum and minimum demand in 2025

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Adamstown 110 kV	14.23	11.82	10.80	8.59	12.91	12.48	14.76	13.79	12.41	8.51	14.58	14.02
Agannygal 110 kV	3.01	6.05	5.46	4.29	4.63	4.51	2.96	6.39	5.77	4.25	4.86	4.74
Aghada 110 kV	4.39	8.07	7.67	5.29	9.48	9.29	4.69	10.31	9.85	5.81	11.55	11.35
Aghada A 220 kV	7.29	9.14	8.46	7.88	12.27	11.84	15.26	21.77	19.29	16.38	25.71	24.44
Aghada B 220 kV	7.29	9.14	8.46	7.88	12.27	11.84	15.26	21.77	19.29	16.38	25.71	24.44
Aghada C 220 kV	7.26	8.97	8.31	7.52	12.03	11.61	14.23	20.85	18.56	13.10	24.69	23.51
Aghada D 220 kV	7.29	9.14	8.46	7.88	12.27	11.84	15.26	21.77	19.29	16.38	25.71	24.44
Ahane 110 kV	4.89	13.32	12.27	5.71	10.44	10.21	4.84	15.42	14.27	5.71	11.45	11.22
Anner 110 kV	4.02	6.93	6.54	4.57	4.82	4.75	3.96	7.45	6.94	4.53	4.97	4.89
Ardnacrusha 110 kV	5.27	15.05	13.59	6.65	15.67	15.11	5.89	19.01	17.05	7.54	18.19	17.54
Ardnagappary 110 kV	3.06	2.66	2.45	4.24	1.58	1.55	3.05	2.80	2.54	4.23	1.62	1.59
Arigna 110 kV	5.12	8.55	7.92	6.22	6.06	5.94	5.04	9.05	8.40	6.18	6.30	6.19
Arklow 110 kV	10.32	9.45	8.99	11.55	10.98	10.77	10.40	10.48	9.93	11.61	12.02	11.77
Arklow 220 kV	9.14	8.17	7.88	10.69	7.17	7.09	9.04	9.21	8.93	10.65	7.88	7.81
Artane 110 kV	12.56	10.53	9.86	5.98	12.63	12.30	13.08	13.04	11.83	5.74	15.11	14.53
Arva 110 kV	5.02	10.23	9.30	6.20	7.51	7.33	4.95	11.22	10.23	6.18	7.93	7.75
Athea 110 kV	11.08	9.73	8.42	12.00	9.08	8.65	11.03	10.21	8.99	11.96	9.41	9.03
Athlone 110 kV	4.10	7.51	7.18	5.63	5.53	5.47	4.09	8.12	7.55	5.64	5.69	5.59
Athy 110 kV	3.35	7.06	6.84	4.47	5.66	5.61	3.27	7.84	7.53	4.44	6.12	6.05
Aughinish 110 kV	6.25	8.60	8.09	7.67	9.56	9.34	8.32	12.19	11.19	10.62	12.04	11.70
Aungierstown 110 kV	17.91	19.90	17.95	18.34	13.53	13.20	19.52	24.49	22.63	19.11	15.09	14.84
Ballinknocka 110 kV	6.66	9.08	8.60	7.60	8.15	8.02	8.02	11.95	11.17	8.74	9.56	9.38
Ballyadam 110 kV	3.61	8.93	8.45	4.63	7.16	7.06	3.48	10.94	10.37	4.62	8.07	7.96
Ballybeg 110 kV	9.49	6.59	6.39	9.88	7.65	7.56	9.72	7.36	7.07	10.05	8.40	8.27
Ballydine 110 kV	3.95	7.60	7.23	3.74	5.75	5.67	3.89	8.22	7.72	3.70	6.00	5.90
Ballylickey 110 kV	3.05	3.75	3.49	4.12	2.14	2.11	2.97	4.06	3.77	4.08	2.25	2.22
Ballynahulla 110 kV	15.75	11.35	10.02	13.06	10.60	10.17	16.08	12.05	10.80	13.12	11.22	10.83
Ballynahulla 220 kV	9.13	10.16	9.18	9.21	10.16	9.80	8.97	11.42	10.51	9.08	11.18	10.86

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Ballyragget 110 kV	5.61	6.63	6.44	6.60	4.65	4.62	5.56	7.33	7.00	6.59	4.92	4.87
Ballyvouskill 110 kV	14.19	11.58	10.08	13.53	12.21	11.59	14.95	12.48	11.03	13.96	13.02	12.45
Ballyvouskill 220 kV	8.97	10.13	9.11	9.74	11.74	11.24	9.02	11.66	10.67	9.83	13.03	12.59
Ballywater 110 kV	5.56	7.04	6.82	3.23	6.55	6.48	5.52	7.92	7.67	3.16	7.21	7.14
Baltrasna 110 kV	6.12	11.08	10.56	7.39	8.12	8.03	6.04	12.31	11.79	7.38	8.75	8.67
Bancroft 110 kV	11.86	11.94	11.29	6.73	13.78	13.48	12.13	13.67	12.89	6.61	15.47	15.13
Bandon 110 kV	3.12	6.77	6.21	4.29	6.36	6.18	3.08	7.97	7.19	4.35	7.10	6.88
Banoge 110 kV	6.66	7.13	6.95	7.48	5.78	5.73	6.71	7.87	7.65	7.51	6.19	6.14
Barnageeragh 110 kV							10.64	28.78	26.06	10.34	30.56	29.47
Barnahealy A 110 kV	4.20	10.77	10.02	4.91	11.42	11.12	4.37	14.33	13.33	5.20	14.08	13.74
Barnahealy B 110 kV	5.50	10.81	10.03	6.26	11.19	10.89	6.09	14.07	13.05	6.87	13.57	13.23
Barnakyle 110 kV	17.29	19.60	17.70	18.88	13.24	12.93	18.61	24.05	22.25	19.73	14.75	14.51
Baroda 110 kV	4.07	8.96	8.50	4.95	10.06	9.86	4.10	10.33	9.77	5.06	11.21	10.98
Barrymore 110 kV	3.72	7.78	7.38	4.87	4.50	4.45	3.67	8.83	8.40	4.88	4.78	4.74
Belcamp 110 kV	16.32	17.80	15.84	14.83	21.72	20.67	17.70	23.19	20.51	15.75	27.17	25.84
Belcamp 220 kV	10.91	17.82	15.86	9.85	21.81	20.73	11.90	28.33	24.97	9.46	31.89	30.31
Belgard 110 kV	11.69	12.29	11.42	6.60	14.86	14.42	11.56	14.69	13.56	6.30	17.30	16.75
Bellacorick 110 kV	6.00	8.15	6.84	6.73	8.88	8.29	6.16	9.00	7.60	6.86	9.57	8.97
Binbane 110 kV	5.33	6.99	6.32	7.35	5.68	5.52	5.43	7.30	6.60	7.49	5.77	5.61
Blackrock 110 kV	10.28	11.01	10.30	2.64	10.97	10.73	9.80	14.63	13.31	2.34	13.22	12.85
Blake 110 kV	3.98	8.16	7.78	5.04	5.41	5.35	3.92	9.06	8.62	5.04	5.72	5.66
Blundelstown 110 kV	4.25	9.31	8.97	5.02	5.39	5.35	4.14	9.98	9.69	4.97	5.66	5.63
Boggeragh 110 kV	6.75	8.50	7.68	8.01	8.35	8.06	6.60	9.36	8.58	7.93	8.90	8.65
Booltiagh 110 kV	6.75	8.70	7.88	8.59	6.57	6.40	6.90	9.52	8.62	8.78	6.90	6.73
Bracklone 110 kV	4.75	7.79	7.49	6.05	6.94	6.86	4.70	8.50	8.21	6.06	7.34	7.27
Bracklone 110 kV	4.75	7.79	7.49	6.05	6.94	6.86	4.70	8.50	8.21	6.06	7.34	7.27
Brinny A 110 kV	3.00	6.01	5.56	4.14	5.19	5.07	2.96	6.96	6.36	4.18	5.71	5.56
Brinny B 110 kV	2.99	6.04	5.59	4.14	5.23	5.11	2.95	7.00	6.39	4.18	5.75	5.60
Buffy 110 kV	5.32	7.35	6.30	5.54	8.01	7.55	5.27	7.82	6.69	5.50	8.43	7.94
Bunkimalta 110 kV				6.21	7.04	6.27				6.15	7.73	6.90

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Butlerstown 110 kV	6.41	11.66	11.12	6.71	11.21	11.04	6.27	12.98	12.14	6.60	12.19	11.93
Cabra 110 kV	11.70	10.18	9.54	4.89	11.37	11.09	12.04	12.56	11.41	4.67	13.42	12.95
Cahir 110 kV	4.63	9.95	9.11	5.82	7.35	7.18	4.52	10.67	9.68	5.74	7.44	7.27
Carlow 110 kV	5.19	8.73	8.32	6.04	9.12	8.97	5.22	10.24	9.52	6.09	10.25	9.99
Carrickaduff 110 kV	6.18	5.96	5.11	6.18	5.96	5.11	6.18	6.18	5.32	6.18	6.18	5.32
Carrickalangan 110 kV	6.51	6.18	5.23	6.51	6.18	5.23	6.50	6.39	5.43	6.50	6.39	5.43
Carrickmines 220 kV	12.74	19.66	17.82	8.12	23.21	22.27	14.11	26.12	23.86	7.78	29.10	28.08
Carrickmines A 110 kV	28.76	11.67	11.09	22.19	12.68	12.44	33.83	13.69	12.77	23.77	14.38	14.02
Carrickmines B 110 kV	22.92	13.30	12.54	19.11	15.74	15.37	26.16	15.37	14.44	20.43	17.85	17.42
Carrick-on-Shannon 110 kV	5.56	13.62	12.53	6.41	13.66	13.27	5.46	14.80	13.61	6.33	14.60	14.19
Carrigadrohid 110 kV	6.41	13.37	12.08	6.74	12.22	11.83	6.37	16.23	14.79	6.74	13.96	13.58
Carrigdangan 110 kV	4.33	6.59	5.64	5.41	6.98	6.58	4.13	7.13	6.17	5.24	7.37	6.99
Carrowbeg 110 kV	2.87	3.23	3.03	3.98	2.70	2.65	2.85	3.46	3.20	3.97	2.83	2.77
Cashla 110 kV	7.11	18.62	16.92	7.58	22.36	21.49	7.34	21.50	19.37	7.80	25.30	24.24
Cashla 220 kV	8.60	10.39	9.80	9.69	10.35	10.14	8.65	12.82	12.10	9.87	12.03	11.81
Castlebagot 110 kV	18.80	20.12	18.13	21.60	13.72	13.39	20.82	24.80	22.90	23.09	15.32	15.06
Castlebagot 220 kV	9.83	22.81	20.27	8.71	23.20	22.23	9.68	30.80	27.97	8.35	28.80	27.90
Castlebar 110 kV	3.97	6.41	5.75	4.61	5.81	5.62	3.96	7.03	6.25	4.62	6.01	5.80
Castledockrill 110 kV	7.78	8.61	8.33	4.24	9.14	9.03	7.75	9.67	9.36	4.13	10.06	9.94
Castlefarm A 110 kV	5.88	8.32	7.83	7.08	8.95	8.76	7.34	11.66	10.73	9.04	11.14	10.84
Castlefarm B 110 kV	5.89	8.30	7.82	7.09	8.94	8.75	7.36	11.64	10.71	9.05	11.13	10.83
Castleview 110 kV	3.69	11.24	10.48	4.81	11.02	10.76	3.62	14.48	13.51	4.91	13.22	12.94
Cathaleen's Fall 110 kV	4.86	11.40	10.02	5.94	10.92	10.46	5.48	13.58	11.70	6.55	12.06	11.51
Cauteen 110 kV	5.96	8.77	8.01	6.76	4.84	4.76	5.88	9.50	8.66	6.73	5.04	4.95
Central Park 110 kV	14.00	10.67	10.17	7.50	11.36	11.17	14.45	12.41	11.62	7.41	12.79	12.49
Charleville 110 kV	4.77	6.95	6.35	6.47	5.93	5.77	4.73	7.73	7.01	6.50	6.52	6.34
Cherrywood 110 kV	10.08	9.83	9.41	7.37	9.95	9.80	10.12	11.36	10.69	7.28	11.12	10.89
City West 110 kV	5.89	7.69	7.17	5.97	5.70	5.59	5.77	8.90	8.04	5.90	6.21	6.06
CKM Country 110 kV	22.92	13.30	12.54	19.11	15.74	15.37	26.16	15.37	14.44	20.43	17.85	17.42
Clahane 110 kV	4.19	8.98	8.37	5.40	7.28	7.14	4.09	9.57	8.95	5.32	7.59	7.45

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Clashavoon 220 kV	8.61	10.02	9.09	9.45	11.21	10.79	9.05	12.54	11.55	9.93	13.45	13.05
Clashavoon A 110 kV	7.70	16.35	14.44	8.06	19.88	18.86	7.71	20.02	17.88	8.09	23.73	22.65
Clashavoon B 110 kV	7.70	16.35	14.44	8.06	19.88	18.86	7.71	20.02	17.88	8.09	23.73	22.65
Cliff 110 kV	4.22	8.09	7.36	5.63	7.09	6.89	4.65	9.51	8.52	6.09	7.66	7.43
Cloghboola 110 kV	7.78	8.94	7.42	11.05	8.36	7.85	7.69	9.26	7.85	10.98	8.40	7.96
Cloghboola 110 kV	7.78	8.94	7.42	11.05	8.36	7.85	7.69	9.26	7.85	10.98	8.40	7.96
Clogher 110 kV	5.04	11.11	9.02	6.02	10.19	9.50	5.06	12.06	9.83	6.07	10.65	9.97
Cloghran 110 kV	9.38	23.75	21.21	9.60	25.53	24.47	10.50	29.04	26.27	10.84	30.98	29.85
Cloncreen 110 kV	4.50	8.75	7.97	5.81	9.03	8.73	5.24	10.89	10.04	6.86	10.38	10.11
Clonee 220 kV	10.82	17.92	16.03	8.93	17.04	16.41	11.23	25.34	22.83	8.38	21.89	21.20
Clonfad 110 kV	5.42	9.82	9.39	7.00	6.85	6.78	5.58	10.81	10.28	7.18	7.19	7.11
Clonkeen A 110 kV	5.61	6.29	5.98	6.80	4.36	4.31	5.53	6.84	6.51	6.76	4.62	4.57
Clonkeen B 110 kV	4.81	9.75	8.49	4.09	10.24	9.72	4.68	10.40	9.18	4.00	10.83	10.34
Cloon 110 kV	4.64	8.24	7.77	6.29	6.74	6.63	4.67	9.06	8.43	6.37	7.23	7.09
Clutterland 110 kV	17.87	19.97	18.01	19.04	13.59	13.26	19.51	24.59	22.72	19.98	15.16	14.91
College Park 110 kV	8.96	22.50	20.24	6.09	25.21	24.18	9.14	25.97	23.75	5.74	28.30	27.36
Cookstown 110 kV	7.05	8.33	8.01	5.82	6.99	6.91	6.97	9.31	8.95	5.76	7.63	7.54
Cookstown A 110 kV	4.84	6.54	6.13	5.16	4.58	4.51	4.74	7.54	6.83	5.10	4.95	4.84
Coolderrig 110 kV	18.79	12.16	11.09	12.19	12.72	12.30	20.28	14.25	12.78	12.34	14.35	13.81
Coolnabacky 110 kV	7.49	13.62	12.94	7.92	16.76	16.41	7.63	15.92	15.19	8.09	19.13	18.77
Coolnabacky 400 kV	9.23	9.02	8.42	9.30	8.71	8.51	8.73	10.57	10.10	8.90	9.83	9.69
Coolnanoonag 110 kV	10.31	19.72	17.98	10.13	22.23	21.45	10.14	22.16	20.47	9.94	24.57	23.84
Coolroe 110 kV	3.47	9.05	8.48	4.71	8.59	8.41	3.55	11.37	10.48	5.01	9.95	9.71
Coomagearlahy 110 kV	5.30	7.88	6.79	5.93	8.50	8.03	5.19	8.31	7.24	5.84	8.95	8.49
Coomataggart 110 kV	9.83	7.48	6.64	6.65	4.07	3.98	9.88	7.75	6.95	6.64	4.14	4.06
Coomataggart 110 kV	9.83	7.48	6.64	6.65	4.07	3.98	9.88	7.75	6.95	6.64	4.14	4.06
Cordal 110 kV	12.52	9.64	8.59	7.65	9.04	8.70	12.55	10.22	9.22	7.58	9.56	9.24
Corderry 110 kV	4.73	9.90	8.92	6.08	8.18	7.94	4.64	10.45	9.45	6.02	8.47	8.24
Corduff 110 kV	10.74	26.72	23.63	12.03	30.15	28.73	11.60	32.04	28.78	12.77	34.81	33.43
Corduff 220 kV	12.39	20.37	17.95	11.75	24.53	23.23	14.23	31.28	27.41	11.32	35.70	33.82

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Corkagh 110 kV	17.92	19.79	17.85	19.64	13.38	13.06	19.51	24.32	22.48	20.66	14.91	14.66
Corraclassy 110 kV	4.47	7.12	6.65	5.74	5.11	5.03	4.45	7.46	7.00	5.73	5.26	5.18
Cow Cross 110 kV	3.93	10.93	10.18	4.56	10.03	9.81	4.00	14.53	13.54	4.71	12.04	11.80
Crane 110 kV	8.78	10.21	9.76	8.09	9.93	9.79	9.17	11.87	11.32	8.25	11.18	11.01
Croaghaun 110 kV	6.09	7.24	6.13	7.03	7.66	7.19	6.21	7.90	6.73	7.16	8.17	7.71
Croaghnagawna 110 kV	6.29	6.44	5.46	6.90	3.73	3.60	6.29	6.69	5.70	6.90	3.80	3.68
Cromcastle A 110 kV	10.86	16.26	14.60	6.86	19.38	18.54	10.59	20.80	18.60	6.43	23.81	22.77
Cromcastle B 110 kV	10.86	16.26	14.60	6.86	19.38	18.54	10.59	20.80	18.60	6.43	23.81	22.77
Crory 110 kV	10.48	10.04	9.65	10.47	11.53	11.36	10.72	11.41	10.98	10.65	12.91	12.72
Cruiserath 220 kV	12.21	20.23	17.84	11.46	24.31	23.03	13.85	30.97	27.17	10.94	35.27	33.43
Cullenagh 110 kV	7.96	14.33	13.53	8.59	15.71	15.38	7.80	15.99	14.93	8.45	17.21	16.78
Cullenagh 220 kV	8.72	9.66	9.29	9.06	9.09	8.98	8.54	10.89	10.53	8.93	9.98	9.88
Cunghill 110 kV	3.20	6.36	5.96	3.98	5.39	5.29	3.16	6.82	6.39	3.96	5.60	5.50
Cureeny 110 kV				5.76	6.66	5.91				5.68	7.30	6.49
Cureeny T 110 kV	5.93	8.37	7.51	5.49	7.35	7.11	5.87	9.28	8.35	5.45	7.99	7.74
Cushaling 110 kV	4.51	8.85	8.06	5.91	9.32	9.01	5.25	11.01	10.15	7.03	10.74	10.45
Dallow 110 kV	3.52	5.48	5.28	4.76	3.18	3.16	3.50	5.82	5.59	4.77	3.25	3.23
Dalton 110 kV	3.36	5.06	4.66	4.68	3.78	3.71	3.56	5.69	5.23	4.95	4.00	3.92
Dardistown 110 kV	12.95	16.63	14.90	9.52	20.22	19.31	13.11	21.38	19.07	9.26	25.02	23.88
Darndale 110 kV	15.48	17.23	15.36	14.13	20.30	19.37	16.46	22.26	19.74	14.78	25.11	23.96
Deenes 110 kV	6.05	10.95	10.42	7.08	7.56	7.47	5.94	12.15	11.59	7.05	8.04	7.96
Derrybrien 110 kV	3.04	4.89	4.33	4.49	4.26	4.11	3.00	5.15	4.56	4.45	4.51	4.35
Derryiron 110 kV	4.92	9.08	8.75	6.35	9.12	9.00	6.41	11.92	11.26	8.31	10.65	10.46
Derrylahan 110 kV	5.03	13.58	12.88	6.26	11.46	11.28	5.07	14.75	13.99	6.33	12.02	11.84
Doon 110 kV	4.37	7.67	7.21	4.76	5.46	5.37	4.30	8.29	7.67	4.72	5.63	5.53
Dromada 110 kV	10.01	8.90	7.74	6.28	8.19	7.83	9.95	9.33	8.25	6.24	8.50	8.18
Drombeg 110 kV	7.45	9.92	9.41	7.50	7.23	7.14	7.28	10.59	10.11	7.41	7.57	7.49
Drumkeen 110 kV	3.97	9.05	7.59	5.18	7.09	6.74	3.87	9.53	8.04	5.11	7.28	6.95
Drumline 110 kV	3.28	8.75	8.15	4.64	6.97	6.83	3.20	9.81	9.09	4.62	7.49	7.35
Drybridge 110 kV	5.95	12.91	12.03	7.11	10.41	10.21	5.83	15.07	13.94	7.10	11.50	11.27

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Dundalk 110 kV	3.53	8.93	8.35	4.62	7.81	7.65	3.39	9.93	9.21	4.53	8.48	8.30
Dunfirth 110 kV	5.29	7.83	7.65	7.18	5.38	5.35	5.38	8.69	8.38	7.33	5.92	5.87
Dungarvan 110 kV	6.51	7.23	6.59	8.54	5.43	5.30	6.43	7.92	7.11	8.51	5.84	5.69
Dunmanway 110 kV	4.78	9.93	8.52	5.76	8.96	8.53	4.53	11.36	9.79	5.60	9.82	9.38
Dunstown 220 kV	10.02	19.53	17.91	10.30	21.70	20.98	9.50	23.35	21.94	9.83	25.20	24.62
Dunstown 400 kV	9.73	8.94	8.35	11.71	9.38	9.15	9.22	10.42	9.97	11.29	10.63	10.47
Ennis 110 kV	4.57	12.78	11.38	6.05	10.17	9.85	4.42	14.40	12.77	5.98	11.00	10.66
Fassaroe East 110 kV	5.06	7.80	7.51	5.27	5.89	5.84	4.96	8.77	8.38	5.21	6.42	6.35
Fassaroe West 110 kV	5.20	7.97	7.67	5.36	6.09	6.03	5.09	8.97	8.56	5.30	6.64	6.56
Finglas 220 kV	12.19	19.03	16.83	12.13	23.95	22.67	14.81	31.02	27.10	12.93	36.15	34.17
Finglas A 110 kV	16.62	17.75	15.85	11.37	21.29	20.31	18.03	23.30	20.62	11.40	26.71	25.43
Finglas B 110 kV	26.02	11.78	10.97	24.99	14.79	14.34	34.55	14.82	13.36	30.53	18.06	17.29
Firlough 110 kV	4.51	7.27	6.78	5.84	5.66	5.56	4.87	8.45	7.87	6.14	6.15	6.04
Flagford 110 kV	6.12	14.43	13.23	7.31	16.33	15.78	6.03	15.71	14.41	7.23	17.55	16.98
Flagford 220 kV	8.45	7.75	7.37	10.84	6.91	6.80	8.37	8.47	8.13	10.82	7.38	7.29
Fortunestown 110 kV	5.51	7.57	7.06	5.55	5.62	5.52	5.39	8.76	7.92	5.49	6.12	5.98
Francis Street A 110 kV	10.73	11.02	10.31	5.47	13.34	12.98	10.30	14.66	13.32	4.91	16.78	16.15
Francis Street B 110 kV	12.30	12.27	11.45	6.47	14.77	14.35	12.23	14.72	13.62	6.16	17.21	16.68
Gallanstown 110 kV	7.09	10.47	10.03	7.29	6.55	6.49	7.00	11.40	11.02	7.23	6.96	6.91
Galway 110 kV	5.29	14.79	13.38	4.57	16.81	16.17	5.29	16.86	15.00	4.54	18.68	17.85
Garballagh 110 kV	6.73	10.41	9.84	7.26	7.62	7.52	6.68	11.73	11.05	7.25	8.11	8.00
Garrow 110 kV	10.32	11.18	9.72	10.28	11.87	11.27	10.46	12.01	10.61	10.37	12.64	12.07
Garvagh 110 kV	5.25	8.07	7.28	6.88	6.50	6.32	5.17	8.44	7.64	6.82	6.65	6.48
Gilra 110 kV	3.27	7.06	6.72	4.19	5.10	5.04	3.22	7.43	7.08	4.16	5.31	5.25
Glanagow 220 kV	7.33	8.96	8.31	7.70	12.02	11.60	14.86	20.98	18.66	14.28	24.82	23.62
Glanlee 110 kV	5.12	7.77	6.70	5.40	8.35	7.90	5.02	8.19	7.15	5.32	8.78	8.34
Glasmore A 110 kV	3.90	7.74	7.25	4.42	5.24	5.16	3.66	9.32	8.57	4.33	5.80	5.70
Glen 110 kV	5.23	8.05	7.26	6.70	6.46	6.28	5.15	8.41	7.62	6.65	6.61	6.44
Glenlara A 110 kV	3.28	3.21	2.97	4.79	2.58	2.53	3.24	3.42	3.13	4.77	2.75	2.68
Glenlara B 110 kV	9.29	8.47	7.47	6.14	8.40	8.04	9.23	8.94	7.99	6.07	8.83	8.49

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Glenree 110 kV	4.37	6.98	6.52	5.57	5.46	5.36	4.66	7.97	7.45	5.81	5.88	5.78
Golagh 110 kV	3.95	8.52	7.20	4.84	6.59	6.29	3.91	9.13	7.75	4.83	6.85	6.55
Gorman 110 kV	7.08	14.34	13.28	8.15	15.47	15.04	7.37	17.61	16.02	8.52	17.92	17.34
Gorman 220 kV	8.65	11.54	10.86	9.73	9.28	9.12	8.73	13.36	12.81	9.78	10.21	10.10
Gortawee 110 kV	4.73	6.76	6.28	6.42	5.23	5.13	4.70	7.10	6.62	6.41	5.36	5.26
Grange 110 kV	12.74	16.98	15.18	6.73	20.01	19.11	12.83	21.98	19.52	6.27	24.75	23.62
Grange Castle 110 kV	20.34	12.52	11.39	13.92	13.78	13.30	22.32	14.72	13.16	14.25	15.66	15.02
Great Island 110 kV	8.85	14.69	13.99	9.85	17.22	16.89	8.76	16.57	15.55	9.80	19.12	18.65
Great Island 220 kV	12.95	13.61	13.02	13.74	14.32	14.09	12.43	14.84	14.27	13.31	15.17	14.96
Griffinrath A 110 kV	6.58	10.84	10.44	7.09	10.68	10.54	6.43	12.23	11.71	7.00	11.75	11.58
Griffinrath B 110 kV	7.07	11.25	10.81	7.24	10.61	10.47	6.94	12.73	12.17	7.16	11.54	11.39
Harolds Cross 110 kV	10.90	11.05	10.34	5.18	13.30	12.94	10.49	14.70	13.37	4.64	16.71	16.10
Harristown 110 kV	5.26	9.28	8.99	6.68	6.28	6.23	5.37	10.30	9.93	6.81	6.66	6.60
Heuston 110 kV	13.26	12.52	11.67	7.76	15.23	14.79	13.31	15.05	13.91	7.46	17.81	17.25
Huntstown A 220 kV	11.73	18.23	16.20	10.85	22.96	21.78	13.51	30.61	26.82	9.02	34.36	32.58
Huntstown B 220 kV	12.74	19.00	16.89	9.94	22.89	21.77	13.41	30.59	26.81	9.01	34.43	32.63
Ikerrin 110 kV	5.62	5.39	5.00	6.44	3.62	3.56	5.59	5.67	5.18	6.42	3.69	3.61
Inchicore 220 kV	11.94	23.13	20.46	9.14	27.31	25.94	13.15	33.07	29.54	8.87	36.17	34.61
Inchicore A 110 kV	26.37	13.84	12.81	23.73	17.25	16.69	30.92	16.87	15.48	26.45	20.48	19.76
Inchicore B 110 kV	38.47	13.84	12.57	31.01	17.29	16.59	52.85	16.47	14.68	37.10	20.12	19.16
Inniscarra 110 kV	3.44	8.94	8.38	4.61	8.28	8.11	3.54	11.19	10.34	4.90	9.47	9.25
Irishtown 220 kV	13.17	21.84	19.56	10.56	26.41	25.19	15.15	30.55	27.50	10.65	34.42	33.00
Kellis 110 kV	6.23	9.37	8.96	7.34	10.80	10.61	6.18	10.87	10.18	7.33	12.16	11.86
Kellis 220 kV	7.78	8.04	7.78	9.64	6.68	6.62	7.70	8.96	8.70	9.61	7.24	7.18
Kellystown 220 kV	6.57	16.68	15.21	6.02	13.51	13.16	5.97	21.08	19.66	5.66	15.81	15.52
Kilbarry 110 kV	5.23	14.34	13.05	6.27	14.23	13.77	5.54	19.74	17.67	6.73	17.69	17.09
Kilcarbery 110 kV	17.56	19.64	17.74	19.03	13.25	12.94	18.99	24.12	22.31	19.92	14.77	14.53
Kildonan 110 kV	7.39	20.16	18.30	6.56	18.74	18.17	6.38	18.92	17.69	4.87	15.59	15.30
Kilkenny 110 kV	4.85	7.44	7.20	6.41	6.22	6.16	4.82	8.33	7.87	6.44	6.65	6.55
Kill Hill 110 kV	5.57	7.25	6.55	6.83	5.68	5.53	5.49	7.62	6.86	6.77	5.80	5.64

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Killonan 110 kV	6.48	19.63	17.44	7.77	20.67	19.79	6.71	24.02	21.40	8.14	24.04	23.09
Killonan 220 kV	7.62	10.54	9.82	9.92	9.70	9.48	7.67	12.53	11.88	10.18	10.94	10.77
Killoteran 110 kV	7.30	12.88	12.23	7.55	13.50	13.25	7.15	14.43	13.45	7.43	14.82	14.46
Kilmahud 110 kV	16.96	19.57	17.67	18.79	13.36	13.04	18.35	24.06	22.27	19.73	14.88	14.64
Kilmore 110 kV	14.74	17.47	15.58	10.86	21.15	20.15	15.45	22.70	20.11	10.78	26.37	25.10
Kilnap 110 kV	5.07	15.08	13.68	5.78	13.41	13.02	5.16	20.39	18.41	5.94	16.16	15.71
Kilpaddoge 110 kV	10.51	19.98	18.20	11.48	23.47	22.59	10.36	22.49	20.75	11.35	26.04	25.22
Kilpaddoge 220 kV	10.50	17.59	15.83	10.14	21.27	20.34	10.25	20.71	19.11	9.83	24.60	23.80
Kilpaddoge 400 kV	7.76	9.55	8.83	7.04	10.09	9.80	7.14	11.45	10.86	6.55	11.57	11.36
Kilteel 110 kV	4.25	7.92	7.62	5.40	7.00	6.92	4.56	9.48	9.01	5.80	7.77	7.66
Kinnegad 110 kV	5.39	10.41	9.99	7.17	8.15	8.06	5.69	11.87	11.31	7.56	8.75	8.64
Kishoge 110 kV	16.76	19.30	17.46	17.27	12.99	12.69	17.86	23.63	21.90	17.84	14.46	14.23
Knockacummer 110 kV	8.22	7.27	6.45	6.94	6.95	6.68	8.14	7.64	6.86	6.88	7.16	6.91
Knockalough 110 kV	5.48	6.30	5.49	4.56	6.92	6.56	5.44	6.67	5.79	4.53	7.25	6.87
Knockanure 220 kV	10.51	14.87	13.38	7.31	17.98	17.19	10.25	16.98	15.65	6.97	20.29	19.61
Knockanure A 110 kV	19.47	13.78	11.75	15.61	14.33	13.51	19.98	14.57	12.69	15.74	15.11	14.36
Knockanure B 110 kV	4.59	9.63	9.01	5.81	7.22	7.10	4.47	10.32	9.70	5.73	7.61	7.49
Knockearagh 110 kV	5.51	6.04	5.69	7.49	4.87	4.79	5.44	6.58	6.14	7.46	5.19	5.10
Knocknamona 110 kV				6.52	7.28	6.47				6.44	7.92	7.01
Knockraha A 110 kV	6.50	18.34	16.53	7.50	18.83	18.15	7.72	26.53	23.79	8.71	24.32	23.49
Knockraha A 220 kV	7.45	10.96	10.05	8.04	12.66	12.23	11.02	20.75	18.73	10.83	20.41	19.69
Knockraha B 110 kV	6.50	18.34	16.53	7.50	18.83	18.15	7.72	26.53	23.79	8.71	24.32	23.49
Knockraha B 220 kV	7.45	10.96	10.05	8.04	12.66	12.23	11.02	20.75	18.73	10.83	20.41	19.69
Knockranny 110 kV	6.28	8.81	8.28	5.28	10.97	10.69	6.29	9.61	8.98	5.25	11.80	11.47
Knockranny A 110 kV	5.31	7.38	6.34	5.49	8.04	7.58	5.27	7.86	6.72	5.45	8.46	7.97
Knockranny B 110 kV	6.28	8.81	8.28	5.28	10.97	10.69	6.29	9.61	8.98	5.25	11.80	11.47
Knockumber 110 kV	3.90	8.37	7.91	4.76	6.17	6.09	3.76	9.39	8.81	4.71	6.55	6.46
Lanesboro 110 kV	4.51	10.53	9.81	5.90	8.42	8.26	4.44	11.39	10.46	5.85	8.92	8.71
Lenalea 110 kV	4.52	7.96	6.69	5.59	5.10	4.90	4.43	8.31	7.01	5.55	5.23	5.03
Letterkenny110 kV	4.60	11.14	9.11	5.74	9.20	8.66	4.46	11.88	9.73	5.65	9.55	9.01

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Liberty A 110 kV	4.79	14.39	13.07	4.46	15.81	15.24	4.93	19.87	17.82	4.44	20.09	19.33
Liberty B 110 kV	4.73	14.37	13.06	4.34	15.77	15.20	4.85	19.84	17.80	4.30	20.02	19.27
Limerick 110 kV	4.77	16.23	14.65	5.73	14.56	14.10	4.91	19.84	17.84	5.93	16.61	16.11
Lisdrum 110 kV	2.89	5.47	5.11	4.33	4.54	4.45	3.71	7.42	6.48	5.47	5.14	4.97
Lisheen 110 kV	4.84	5.28	4.65	5.02	7.92	7.41	4.81	5.48	4.80	4.98	8.22	7.67
Lodgewood 110 kV	10.48	10.04	9.65	10.47	11.53	11.36	10.72	11.41	10.98	10.65	12.91	12.72
Lodgewood 220 kV	9.42	8.11	7.85	10.53	7.28	7.21	9.35	9.01	8.77	10.50	7.94	7.88
Longpoint 220 kV	7.29	9.14	8.46	7.88	12.27	11.84	15.26	21.77	19.29	16.38	25.71	24.44
Loughtown 220 kV	12.44	13.50	12.92	11.19	13.99	13.78	11.92	14.71	14.15	10.81	14.82	14.63
Louth 220 kV	9.18	16.35	14.83	10.38	18.28	17.60	9.63	21.26	19.81	10.57	22.93	22.33
Louth A 110 kV	7.39	13.04	12.08	8.57	15.39	14.92	7.23	14.59	13.66	8.47	16.93	16.50
Louth A 275 kV	10.93	9.55	8.79	10.98	11.20	10.83	11.42	12.16	11.68	11.09	13.84	13.62
Louth B 110 kV	6.89	14.13	13.09	7.80	17.10	16.57	6.80	16.38	15.25	7.79	19.38	18.83
Louth B 275 kV	10.29	9.58	8.82	9.74	11.38	11.00	10.66	12.14	11.65	9.51	14.14	13.92
Lumcloon 110 kV	5.57	8.32	8.05	6.69	5.28	5.24	5.89	9.29	9.02	6.92	5.52	5.48
Macetown 110 kV	7.68	20.86	18.89	7.60	20.44	19.76	6.93	21.66	20.05	6.47	19.66	19.19
Macroom 110 kV	6.74	15.44	13.71	6.75	15.98	15.30	6.67	19.03	17.04	6.69	18.73	18.03
Mallow 110 kV	5.08	6.65	6.25	6.89	5.55	5.45	5.14	7.56	7.04	7.06	6.08	5.96
Marina 110 kV	5.36	15.82	14.25	6.26	17.50	16.81	5.80	22.61	20.02	6.90	22.81	21.85
Maynooth A 110 kV	10.23	13.87	13.24	11.12	16.66	16.35	10.33	16.01	15.22	11.26	18.79	18.42
Maynooth A 220 kV	9.43	20.34	18.53	9.43	19.02	18.44	8.96	24.99	23.33	9.07	22.04	21.58
Maynooth B 110 kV	7.28	17.63	16.47	8.88	16.53	16.18	7.07	19.86	18.86	8.77	18.06	17.77
Maynooth B 220 kV	7.73	18.75	17.05	7.72	17.21	16.68	7.12	23.64	22.03	7.31	20.21	19.80
McDermott 110 kV	14.66	10.83	10.12	6.07	12.71	12.36	15.77	13.51	12.19	5.83	15.22	14.62
Meath Hill 110 kV	4.06	9.42	8.80	5.33	7.43	7.29	3.90	10.49	9.75	5.24	7.99	7.84
Meentycat 110 kV	3.64	7.27	6.21	5.12	5.77	5.52	3.56	7.59	6.53	5.06	5.87	5.63
Midleton 110 kV	3.72	9.94	9.35	4.88	8.45	8.30	3.56	12.32	11.58	4.86	9.60	9.45
Milltown A 110 kV	14.43	11.86	11.06	7.06	14.55	14.12	14.81	16.05	14.51	6.43	18.61	17.87
Milltown B 110 kV	8.62	11.04	10.35	4.03	13.05	12.72	8.31	13.10	12.17	3.79	15.03	14.60
Misery Hill 110 kV	13.11	11.60	10.82	7.73	14.35	13.93	13.11	15.62	14.14	7.12	18.32	17.60

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Monatooreen 110 kV	5.06	17.24	15.63	5.46	17.59	16.99	5.21	24.34	22.01	5.62	22.35	21.64
Moneteen 110 kV	5.00	11.03	10.24	6.02	8.10	7.95	5.17	13.01	12.11	6.21	8.92	8.77
Moneypoint 110 kV	13.86	9.80	9.21	16.90	9.39	9.20	13.99	10.57	10.01	17.10	9.99	9.81
Moneypoint 220 kV	10.58	17.20	15.52	10.91	20.98	20.08	10.34	20.20	18.70	10.66	24.24	23.47
Moneypoint G1 400 kV	10.03	9.68	8.94	11.77	11.22	10.87	9.51	11.64	11.04	11.36	13.03	12.76
Moneypoint G2 400 kV	29.15	3.32	3.20	29.52	4.31	4.24	30.84	3.63	3.54	30.94	4.66	4.61
Moneypoint G3 400 kV	10.03	9.68	8.94	11.77	11.22	10.87	9.51	11.64	11.04	11.36	13.03	12.76
Monread 110 kV	4.04	7.93	7.60	4.98	7.74	7.63	4.16	9.23	8.77	5.19	8.57	8.44
Mount Lucas 110 kV	4.14	7.01	6.56	5.46	6.23	6.11	4.85	8.35	7.87	6.30	6.82	6.70
Moy 110 kV	5.21	7.71	7.02	6.76	7.65	7.41	6.32	10.16	9.11	8.08	9.11	8.81
Mullagharlin 110 kV	3.63	8.98	8.44	4.75	8.17	8.01	3.48	9.86	9.27	4.65	8.82	8.66
Mullingar 110 kV	5.00	9.57	8.77	7.13	7.70	7.52	4.98	10.28	9.31	7.14	8.00	7.79
Mully Graffy 110 kV				4.56	5.75	4.97				4.53	5.98	5.17
Mulreavy 110 kV	5.15	9.75	7.96	6.40	9.45	8.79	5.16	10.48	8.60	6.45	9.83	9.19
Mungret A 110 kV	4.72	10.45	9.74	5.74	7.52	7.39	4.83	12.24	11.43	5.89	8.25	8.12
Mungret B 110 kV	4.71	10.47	9.75	5.74	7.52	7.39	4.82	12.27	11.46	5.88	8.26	8.13
Nangor 110 kV	17.31	12.22	11.14	10.78	13.43	12.96	18.44	14.32	12.83	10.82	15.22	14.61
Navan 110 kV	6.25	12.76	11.85	7.15	12.36	12.06	6.30	15.37	14.04	7.27	13.99	13.60
Nenagh 110 kV	3.34	4.15	3.84	4.14	2.61	2.56	3.29	4.50	4.14	4.12	2.75	2.71
Newbridge 110 kV	4.34	10.35	9.72	5.13	9.86	9.66	4.37	12.09	11.32	5.21	10.99	10.77
Newbury 110 kV	15.40	17.54	15.63	11.56	21.13	20.13	16.35	22.80	20.19	11.60	26.32	25.06
North Quays 110 kV	17.19	12.08	11.25	6.61	14.57	14.14	18.72	16.42	14.83	5.97	18.62	17.89
North Wall 220 kV	11.32	17.15	15.36	7.73	19.46	18.61	13.18	27.43	24.29	7.06	27.57	26.39
Oldbridge 110 kV	6.15	11.70	10.95	7.05	8.93	8.78	6.06	13.42	12.49	7.02	9.68	9.51
Oldcourt A 110 kV	3.57	9.30	8.75	4.30	7.65	7.52	3.54	11.86	11.19	4.36	8.86	8.73
Oldcourt B 110 kV	3.60	9.35	8.80	4.32	7.73	7.60	3.57	11.95	11.27	4.39	8.96	8.83
Oldstreet 220 kV	12.11	8.49	8.17	11.12	9.70	9.55	14.62	12.75	12.09	12.24	13.23	12.98
Oldstreet 400 kV	9.62	8.09	7.61	8.54	7.34	7.20	9.25	11.56	11.05	8.12	9.28	9.16
Oriel 220 kV										9.27	16.04	14.87
Oughtragh 110 kV	3.63	4.93	4.67	4.83	3.03	3.00	3.58	5.26	4.94	4.81	3.14	3.10

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Pelletstown 110 kV	12.97	10.27	9.63	7.75	11.15	10.88	13.57	12.67	11.52	7.60	13.15	12.70
Platin 110 kV	6.33	10.94	10.28	7.06	8.10	7.97	6.25	12.41	11.61	7.04	8.69	8.55
Pollahoney 110 kV	9.68	8.84	8.44	10.33	9.58	9.41	9.72	9.76	9.28	10.33	10.42	10.23
Pollaphuca 110 kV	2.68	2.54	2.50	3.93	2.30	2.29	3.23	3.19	3.07	4.67	2.60	2.57
Poolbeg A 110 kV	23.55	12.64	11.76	20.19	15.98	15.49	29.52	17.23	15.56	22.54	20.74	19.88
Poolbeg A 220 kV	11.29	17.30	15.49	6.73	18.43	17.67	12.80	27.56	24.41	5.94	25.57	24.55
Poolbeg B 110 kV	23.52	12.62	11.74	20.18	15.96	15.47	29.47	17.20	15.53	22.53	20.72	19.85
Poolbeg B 220 kV	11.70	21.51	19.19	9.04	23.63	22.60	13.06	30.67	27.64	8.89	30.80	29.68
Poppintree 110 kV	11.55	16.65	14.93	6.60	19.81	18.93	11.35	21.49	19.15	6.15	24.49	23.38
Portan 260 kV				14.25	10.13	9.61	16.22	14.66	14.14	16.22	14.66	14.14
Portan 400 kV				11.55	8.41	7.90				12.05	13.25	12.62
Portlaoise 110 kV	6.02	12.63	11.90	7.12	11.81	11.59	6.00	14.38	13.62	7.18	12.87	12.66
Pottery 110 kV	16.81	11.04	10.51	5.54	11.15	10.96	17.76	12.87	12.04	5.42	12.51	12.24
Prospect 220 kV	9.27	14.33	13.16	7.49	14.66	14.22	9.01	16.54	15.53	7.23	16.46	16.10
Raffeen 220 kV	7.26	9.15	8.46	7.28	11.94	11.52	13.34	19.69	17.64	10.98	22.60	21.61
Raffeen A 110 kV	4.80	12.34	11.39	5.53	14.83	14.34	5.33	17.11	15.75	6.26	19.33	18.72
Raffeen B 110 kV	6.26	12.42	11.41	7.12	14.73	14.23	7.59	16.84	15.43	8.59	18.83	18.20
Rathkeale 110 kV	3.41	7.51	7.14	4.73	5.80	5.72	3.39	8.44	7.91	4.77	6.22	6.12
Rathnaskillo 110 kV	6.64	8.13	7.67	7.51	5.60	5.52	6.53	8.75	8.20	7.45	5.89	5.80
Ratrussan 110 kV	5.00	8.34	7.11	6.44	8.68	8.19	4.83	9.03	7.76	6.30	9.10	8.63
Reamore 110 kV	3.76	10.08	9.08	4.30	7.89	7.67	3.66	10.90	9.87	4.24	8.33	8.11
Richmond A 110 kV	3.40	7.05	6.69	4.91	5.68	5.60	3.35	7.57	7.05	4.88	6.05	5.93
Richmond B 110 kV	3.40	7.05	6.69	4.91	5.68	5.60	3.35	7.57	7.05	4.88	6.05	5.93
Rinawade 110 kV	4.83	11.30	10.83	5.92	7.78	7.70	4.69	12.37	11.95	5.86	8.29	8.23
Ringaskiddy 110 kV	4.95	10.48	9.75	5.50	10.37	10.12	5.27	13.56	12.62	5.81	12.39	12.11
Ringsend 110 kV	23.48	12.64	11.74	20.89	16.00	15.50	30.05	17.41	15.65	23.93	20.95	20.04
Rosspile 110 kV	6.94	8.70	8.37	7.55	6.20	6.14	6.84	9.39	8.96	7.49	6.53	6.46
Ryebrook 110 kV	5.02	14.91	13.70	6.07	12.88	12.56	4.83	16.50	15.43	5.96	13.73	13.47
Salthill 110 kV	4.79	14.20	12.85	3.70	15.78	15.19	4.81	16.12	14.34	3.68	17.45	16.69
Screeb 110 kV	4.11	3.02	2.78	5.04	1.90	1.86	4.09	3.20	2.92	5.03	1.97	1.93

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Seal Rock A 110 kV	6.02	8.42	7.93	7.27	9.40	9.18	7.89	11.93	10.97	9.84	11.85	11.51
Seal Rock B 110 kV	6.02	8.42	7.93	7.27	9.40	9.18	7.92	11.94	10.97	9.85	11.85	11.51
Shankill 110 kV	4.70	9.47	8.35	5.94	8.12	7.82	4.63	10.68	9.35	5.94	8.76	8.44
Shannonbridge 110 kV	5.04	14.92	14.06	6.73	14.91	14.61	5.09	16.38	15.43	6.86	15.89	15.58
Shannonbridge 220 kV	6.93	7.19	6.95	9.34	5.76	5.71	7.06	8.11	7.92	9.64	6.18	6.15
Shantallow 110 kV	4.14	13.20	12.39	4.68	10.43	10.25	4.07	14.59	13.65	4.64	11.18	10.98
Shellybanks A 220 kV	11.07	17.27	15.46	8.20	19.59	18.74	12.45	27.51	24.37	7.52	27.84	26.64
Shellybanks B 220 kV	12.51	20.79	18.70	9.18	24.82	23.73	14.36	29.09	26.29	9.02	32.23	30.97
Shelton Abbey 110 kV	9.44	8.65	8.26	9.82	9.15	9.00	9.46	9.54	9.08	9.81	9.93	9.76
Singland 110 kV	5.85	15.70	14.21	6.97	14.80	14.32	6.22	19.09	17.28	7.39	16.82	16.31
Sliabh Bawn 110 kV				5.21	10.34	9.49				5.13	11.06	10.09
Slievecallan 110 kV	7.80	7.19	6.35	9.40	2.33	2.30	7.75	7.67	6.81	9.40	2.43	2.40
Sligo 110 kV	3.36	9.25	8.63	4.23	7.75	7.59	3.31	10.08	9.28	4.20	8.23	8.04
Snugborough 110 kV	10.77	23.80	21.29	9.99	23.08	22.23	11.25	29.07	26.31	10.38	30.59	29.50
Somerset 110 kV	2.88	7.44	7.17	3.99	4.69	4.65	2.84	7.90	7.57	3.98	4.82	4.78
Sorne Hill 110 kV	3.47	3.70	3.27	4.45	3.59	3.44	3.43	3.91	3.45	4.41	3.75	3.60
Srahnakilly 110 kV	6.05	7.86	6.61	6.74	8.50	7.95	6.19	8.62	7.30	6.85	9.10	8.55
Srananagh 110 kV	4.78	12.21	11.18	5.83	12.31	11.94	4.75	13.28	12.15	5.82	13.13	12.73
Srananagh 220 kV	7.86	4.92	4.72	10.20	3.78	3.74	7.88	5.25	5.07	10.24	3.96	3.93
Stevenstown 110 kV	3.91	6.27	5.97	4.44	4.02	3.98	3.65	7.33	6.93	4.37	4.40	4.35
Stratford 110 kV	3.03	4.00	3.89	4.08	3.11	3.09	3.26	4.78	4.52	4.32	3.41	3.36
Taney 110 kV	8.63	9.52	9.12	3.20	9.33	9.20	8.58	10.96	10.33	3.11	10.36	10.16
Tarbert 110 kV	21.07	12.29	11.72	24.71	9.36	9.24	21.75	13.39	12.96	25.23	10.00	9.92
Tarbert 220 kV	10.13	16.68	15.09	9.76	19.09	18.34	9.86	19.52	18.10	9.48	21.86	21.22
Tawnaghmore A 110 kV	3.89	5.57	5.17	5.31	4.93	4.82	4.45	7.14	6.59	6.08	5.70	5.57
Tawnaghmore B 110 kV	3.79	5.36	5.01	5.09	5.52	5.39	5.01	7.44	6.83	6.85	6.82	6.64
Thornsberry 110 kV	3.70	6.52	6.22	4.94	5.91	5.83	5.26	8.15	7.69	6.81	7.10	6.98
Thurles 110 kV	5.97	6.70	5.92	6.46	6.75	6.46	5.92	7.06	6.17	6.42	6.98	6.66
Tievebrack 110 kV	4.87	6.23	5.38	6.25	5.43	5.19	4.84	6.50	5.61	6.23	5.60	5.36
Timahoe 110 kV	6.11	8.75	8.52	6.87	6.06	6.02	6.38	9.81	9.54	7.04	6.44	6.40

Table E-3: Ireland short circuit currents for maximum and minimum demand in 2025												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Tipperary 110 kV	5.34	7.90	7.34	6.38	4.70	4.63	5.26	8.51	7.85	6.34	4.86	4.78
Tonroe 110 kV	5.58	5.76	5.38	6.58	3.61	3.56	5.64	6.22	5.81	6.62	3.78	3.73
Trabeg 110 kV	5.27	15.73	14.17	6.17	17.43	16.74	5.72	22.48	19.91	6.81	22.72	21.76
Tralee 110 kV	5.15	10.80	9.70	6.34	8.45	8.20	5.02	11.75	10.59	6.26	8.94	8.70
Trien A 110 kV	4.43	9.20	8.56	5.89	7.36	7.22	4.32	9.84	9.19	5.80	7.77	7.63
Trien B 110 kV	12.61	11.29	9.54	12.61	11.29	9.54	12.60	11.81	10.18	12.60	11.81	10.18
Trillick 110 kV	3.58	4.08	3.56	4.57	3.58	3.44	3.53	4.31	3.75	4.53	3.74	3.59
Trinity 110 kV	11.75	11.31	10.57	6.52	13.87	13.48	11.46	15.14	13.73	5.92	17.58	16.90
Tullabeg 110 kV	7.40	8.34	8.10	7.20	6.22	6.18	7.39	9.23	8.96	7.17	6.68	6.63
Tullabrack 110 kV	6.52	7.51	7.08	7.28	5.46	5.38	6.47	8.07	7.64	7.26	5.75	5.67
Turlough 220 kV	10.23	12.39	11.48	11.75	10.98	10.72	9.79	13.58	12.81	11.42	11.58	11.39
Tynagh 220 kV	10.55	8.15	7.84	11.56	9.87	9.72	15.02	13.48	12.58	16.32	14.36	14.00
Uggool 110 kV	6.40	8.40	7.91	5.71	10.52	10.25	6.40	9.14	8.56	5.69	11.29	10.99
Waterford 110 kV	7.54	13.56	12.85	8.05	14.08	13.81	7.38	15.24	14.17	7.93	15.49	15.10
Wexford 110 kV	6.85	8.13	7.65	8.39	6.97	6.85	6.79	8.90	8.27	8.36	7.44	7.29
Whitebank 110 kV	20.59	12.58	11.69	18.04	15.91	15.41	25.90	17.33	15.58	20.33	20.81	19.91
Whitegate 110 kV	4.15	8.71	8.23	4.90	9.10	8.92	4.30	11.15	10.59	5.17	10.88	10.70
Wolfe Tone 110 kV	13.23	10.61	9.92	5.57	12.31	11.99	13.92	13.19	11.92	5.33	14.69	14.12
Woodhouse 110 kV	6.79	7.46	6.64	8.06	4.85	4.72	6.72	8.14	7.20	8.04	5.16	5.02
Woodland 220 kV	9.99	20.70	18.56	10.19	22.13	21.24	10.31	29.04	26.47	10.36	28.93	28.01
Woodland 400 kV	12.09	8.45	7.93	12.86	9.48	9.24	13.05	13.35	12.72	13.30	14.14	13.89
Yellowmeadow 110 kV	25.56	12.94	11.79	16.89	14.78	14.24	29.69	15.27	13.66	17.70	16.91	16.20

Ireland short circuit currents for maximum and minimum demand in 2028

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Adamstown 110 kV	14.01	11.54	10.32	8.64	12.66	12.13	14.79	13.74	12.13	8.60	14.55	13.89
Agannygal 110 kV	3.03	5.93	5.31	4.29	4.57	4.44	3.01	6.26	5.61	4.28	4.79	4.65
Aghada 110 kV	4.63	8.41	7.99	5.60	9.69	9.50	4.43	8.27	7.66	5.27	9.59	9.30
Aghada A 220 kV	10.29	12.59	11.45	10.99	15.90	15.24	7.61	9.94	8.94	7.85	12.75	12.16
Aghada B 220 kV	10.29	12.59	11.45	10.99	15.90	15.24	7.61	9.94	8.94	7.85	12.75	12.16
Aghada C 220 kV	10.08	12.25	11.17	10.00	15.47	14.84	7.56	9.74	8.78	7.49	12.49	11.91
Aghada D 220 kV	10.29	12.59	11.45	10.99	15.90	15.24	7.61	9.94	8.94	7.85	12.75	12.16
Ahane 110 kV	5.10	13.61	12.46	5.84	8.69	8.52	5.06	14.58	13.15	5.82	9.14	8.94
Anner 110 kV	4.03	6.81	6.40	4.56	4.76	4.69	4.03	7.13	6.52	4.55	4.88	4.78
Ardnacrusha 110 kV	6.13	16.71	14.89	8.00	16.13	15.51	6.07	17.97	15.68	7.92	16.71	15.98
Ardnagappary 110 kV	3.03	2.46	2.31	4.36	1.29	1.28	3.05	2.81	2.54	4.23	1.63	1.60
Arigna 110 kV	5.04	8.17	7.46	6.13	5.89	5.76	4.95	8.71	7.96	6.08	6.20	6.06
Arklow 110 kV	10.81	8.89	8.34	11.63	10.42	10.15	10.88	9.66	9.00	11.69	11.23	10.92
Arklow 220 kV	9.21	7.79	7.40	10.60	6.95	6.84	9.07	8.69	8.28	10.53	7.59	7.48
Artane 110 kV	12.69	10.53	9.72	6.04	12.64	12.22	13.30	13.22	11.80	5.81	15.27	14.58
Arva 110 kV	5.11	10.04	9.02	6.25	7.42	7.21	5.03	10.93	9.82	6.19	7.92	7.71
Athea 110 kV	11.07	9.69	8.34	11.98	9.04	8.60	11.05	10.18	8.87	11.97	9.38	8.97
Athlone 110 kV	4.07	7.06	6.66	5.52	5.34	5.26	4.11	7.94	7.29	5.59	5.65	5.53
Athy 110 kV	3.44	7.04	6.78	4.52	5.63	5.58	3.33	7.81	7.42	4.45	6.13	6.05
Aughinish 110 kV	5.69	7.18	6.64	6.78	8.39	8.13	5.65	7.66	7.08	6.75	8.77	8.50
Aungierstown 110 kV	17.28	19.65	16.93	17.94	13.45	12.97	19.34	23.09	20.44	18.95	14.79	14.39
Ballinknocka 110 kV	5.81	7.23	6.73	6.68	7.08	6.91	5.77	7.74	7.20	6.66	7.45	7.27
Ballyadam 110 kV	3.50	8.79	8.31	4.52	7.04	6.93	3.47	8.84	8.08	4.44	7.11	6.93
Ballybeg 110 kV	9.62	6.35	6.09	9.89	7.42	7.30	9.67	6.98	6.65	9.92	8.04	7.89
Ballydine 110 kV	3.98	7.48	7.09	3.75	5.69	5.61	4.00	7.84	7.22	3.75	5.85	5.72
Ballylickey 110 kV	3.01	3.72	3.47	4.09	2.12	2.10	3.05	3.95	3.61	4.12	2.23	2.19

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Ballynahulla 110 kV	16.30	11.25	9.89	13.27	10.53	10.09	15.90	11.63	10.27	13.06	11.04	10.59
Ballynahulla 220 kV	9.30	10.28	9.25	9.32	10.18	9.80	9.16	10.48	9.39	9.18	10.34	9.95
Ballyragget 110 kV	5.66	6.63	6.40	6.59	4.68	4.64	5.76	7.67	7.26	6.69	5.10	5.03
Ballyvouskill 110 kV	14.81	11.61	10.10	13.87	12.20	11.58	14.43	12.06	10.49	13.56	12.69	12.05
Ballyvouskill 220 kV	9.35	10.44	9.36	10.08	11.97	11.45	9.09	10.40	9.25	9.75	11.59	11.07
Ballywater 110 kV	5.69	6.45	6.17	3.33	6.16	6.07	5.70	6.78	6.38	3.34	6.48	6.35
Baltrasna 110 kV	6.14	10.18	9.50	7.32	7.79	7.65	6.02	11.75	10.98	7.27	8.70	8.55
Bancroft 110 kV	11.87	11.54	10.71	6.84	13.39	12.99	12.39	13.41	12.48	6.75	15.23	14.81
Bandon 110 kV	3.09	6.79	6.29	4.28	6.36	6.20	3.15	7.14	6.31	4.28	6.61	6.35
Banoge 110 kV	6.39	6.19	5.94	7.12	5.32	5.26	6.33	6.54	6.20	7.06	5.55	5.46
Barnageeragh 110 kV	10.12	20.53	17.91	10.02	23.74	22.47	11.14	27.41	24.04	10.67	29.97	28.50
Barnahealy A 110 kV	4.51	11.56	10.76	5.25	11.89	11.59	4.31	11.35	10.18	4.97	11.77	11.32
Barnahealy B 110 kV	6.07	11.53	10.71	6.77	11.59	11.30	5.69	11.36	10.15	6.33	11.56	11.11
Barnakyle 110 kV	16.74	19.36	16.70	18.44	13.17	12.71	18.54	22.71	20.14	19.53	14.47	14.08
Baroda 110 kV	4.20	8.48	8.04	5.03	9.63	9.44	4.17	10.09	9.40	5.10	11.00	10.71
Barrymore 110 kV	3.72	7.76	7.35	4.88	4.46	4.41	3.73	7.99	7.38	4.85	4.56	4.49
Belcamp 110 kV	16.50	17.81	15.50	14.95	21.75	20.49	20.03	23.39	20.20	16.73	27.72	26.07
Belcamp 220 kV	11.24	17.80	15.28	9.79	21.95	20.51	12.79	28.99	24.77	9.94	32.59	30.55
Belgard 110 kV	11.62	11.89	10.82	6.71	14.44	13.88	11.99	14.11	12.80	6.55	16.77	16.11
Bellacorick 110 kV	6.24	8.11	6.71	6.83	8.82	8.20	6.00	8.36	6.93	6.73	9.07	8.43
Binbane 110 kV	5.30	6.56	6.07	7.63	5.05	4.95	5.45	7.37	6.65	7.51	5.86	5.69
Blackrock 110 kV	10.28	10.66	9.78	2.72	10.70	10.38	10.44	12.91	11.58	2.58	12.19	11.76
Blake 110 kV	4.11	7.77	7.37	5.10	5.29	5.23	4.00	9.00	8.45	5.08	5.77	5.69
Blundelstown 110 kV	4.11	7.83	7.45	4.86	5.01	4.96	3.91	9.07	8.67	4.77	5.52	5.47
Boggeragh 110 kV	6.80	8.49	7.74	8.06	8.24	7.98	6.82	8.92	7.97	8.07	8.62	8.30
Booltiagh 110 kV	6.77	8.69	7.83	8.60	6.53	6.36	7.02	9.34	8.39	8.86	6.76	6.58
Bracklone 110 kV	4.84	7.42	7.13	6.07	6.74	6.65	4.81	8.51	8.14	6.15	7.38	7.28
Bracklone 110 kV	4.84	7.42	7.13	6.07	6.74	6.65	4.81	8.51	8.14	6.15	7.38	7.28

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Brinny A 110 kV	2.98	6.03	5.63	4.13	5.20	5.09	3.02	6.32	5.65	4.14	5.38	5.20
Brinny B 110 kV	2.97	6.06	5.66	4.13	5.23	5.13	3.02	6.35	5.68	4.14	5.42	5.24
Buffy 110 kV	5.34	7.20	6.13	5.55	7.92	7.43	5.37	7.72	6.55	5.57	8.34	7.83
Bunkimalta 110 kV				6.31	7.04	6.28				6.29	7.61	6.72
Butlerstown 110 kV	6.47	11.38	10.78	6.74	10.99	10.79	6.49	12.08	11.03	6.72	11.61	11.26
Cabra 110 kV	11.83	10.18	9.42	4.94	11.36	11.02	12.23	12.73	11.38	4.72	13.54	12.99
Cahir 110 kV	4.64	9.75	8.87	5.80	7.21	7.04	4.61	9.89	8.81	5.75	7.14	6.94
Carlow 110 kV	5.58	9.06	8.58	6.38	9.30	9.12	5.38	10.20	9.38	6.21	10.23	9.94
Carrickaduff 110 kV	6.29	5.92	5.08	6.29	5.92	5.08	6.21	6.17	5.30	6.62	3.38	3.28
Carrickalangan 110 kV	6.62	6.13	5.19	6.62	6.13	5.19	6.53	6.38	5.41	6.71	3.35	3.24
Carrickmines 220 kV	12.46	17.59	15.36	8.34	21.11	19.92	14.57	24.78	21.97	8.14	27.89	26.56
Carrickmines A 110 kV	26.74	11.30	10.55	21.31	12.37	12.05	33.46	13.55	12.48	23.73	14.29	13.87
Carrickmines B 110 kV	21.89	12.81	11.84	18.50	15.25	14.77	26.45	15.05	13.94	20.64	17.54	17.01
Carrick-on-Shannon 110 kV	5.63	13.09	11.84	6.43	13.25	12.79	5.49	14.33	12.91	6.33	14.32	13.81
Carrigadrohid 110 kV	6.74	13.92	12.60	6.98	12.40	12.02	6.65	14.45	12.66	6.88	12.91	12.38
Carrigdangan 110 kV	4.25	6.51	5.63	5.33	6.91	6.54	4.33	6.87	5.82	5.43	7.15	6.73
Carrowbeg 110 kV	2.89	3.20	2.98	3.99	2.70	2.64	2.88	3.39	3.09	3.98	2.80	2.73
Cashla 110 kV	7.39	18.13	16.20	7.78	21.83	20.83	7.27	20.14	17.75	7.68	24.00	22.78
Cashla 220 kV	8.79	10.63	9.83	9.86	10.47	10.20	8.62	11.74	10.92	9.73	11.40	11.12
Castlebagot 110 kV	18.04	19.86	17.09	20.91	13.65	13.16	20.47	23.37	20.67	22.60	15.01	14.60
Castlebagot 220 kV	10.01	20.72	17.62	8.90	21.64	20.34	10.07	28.64	24.98	8.64	27.51	26.23
Castlebar 110 kV	4.02	6.35	5.66	4.63	5.79	5.58	3.99	6.73	5.86	4.62	5.85	5.61
Castledockrill 110 kV	7.97	7.98	7.62	4.38	8.60	8.45	7.99	8.38	7.89	4.39	8.99	8.79
Castlefarm A 110 kV	5.44	6.98	6.47	6.40	7.91	7.68	5.40	7.45	6.89	6.38	8.27	8.03
Castlefarm B 110 kV	5.44	6.97	6.46	6.41	7.90	7.67	5.41	7.44	6.88	6.38	8.26	8.02
Castleview 110 kV	3.79	11.64	10.86	4.96	11.17	10.92	3.74	11.67	10.45	4.81	11.40	10.99
Cathaleen's Fall 110 kV	5.66	12.64	10.83	6.69	11.58	11.02	5.54	13.46	11.50	6.60	11.99	11.41
Cauteen 110 kV	6.02	8.74	7.96	6.75	4.65	4.57	6.00	9.12	8.21	6.73	4.80	4.71

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Central Park 110 kV	13.83	10.35	9.71	7.57	11.11	10.84	14.56	12.29	11.38	7.49	12.71	12.37
Charleville 110 kV	4.81	6.98	6.36	6.56	5.93	5.77	4.78	7.34	6.55	6.51	6.21	6.01
Cherrywood 110 kV	10.12	9.57	9.01	7.43	9.75	9.55	10.23	11.26	10.48	7.35	11.07	10.80
City West 110 kV	5.97	7.55	6.93	6.01	5.63	5.51	5.84	8.89	7.92	5.94	6.20	6.02
CKM Country 110 kV	21.89	12.81	11.84	18.50	15.25	14.77	26.45	15.05	13.94	20.64	17.54	17.01
Clahane 110 kV	4.17	7.99	7.31	5.24	6.80	6.62	4.08	8.54	7.75	5.18	7.12	6.92
Clashavoon 220 kV	9.31	10.62	9.64	10.07	11.56	11.14	8.88	10.58	9.43	9.52	11.68	11.17
Clashavoon A 110 kV	8.16	16.94	15.01	8.48	20.28	19.28	8.01	17.60	15.06	8.25	21.12	19.77
Clashavoon B 110 kV	8.16	16.94	15.01	8.48	20.28	19.28	8.01	17.60	15.06	8.25	21.12	19.77
Cliff 110 kV	4.77	8.94	7.97	6.18	7.38	7.14	4.69	9.45	8.41	6.12	7.63	7.38
Cloghboola 110 kV	7.79	8.89	7.35	11.05	8.31	7.79	7.75	9.26	7.78	11.01	8.38	7.92
Cloghboola 110 kV	7.79	8.89	7.35	11.05	8.31	7.79	7.75	9.26	7.78	11.01	8.38	7.92
Clogher 110 kV	5.25	11.22	9.10	6.22	10.17	9.49	5.11	12.02	9.73	6.11	10.61	9.91
Cloghran 110 kV	10.03	20.67	18.01	10.37	24.01	22.70	11.01	27.64	24.21	11.16	30.37	28.85
Cloncreen 110 kV	4.31	7.37	7.05	5.39	8.00	7.86	5.41	10.59	9.64	6.99	10.20	9.89
Clonee 220 kV	11.36	17.44	15.07	9.00	17.00	16.15	12.15	25.77	22.53	8.74	22.23	21.31
Clonfad 110 kV	4.79	7.03	6.74	6.13	5.79	5.72	5.13	8.65	8.10	6.56	6.54	6.43
Clonkeen A 110 kV	5.62	6.17	5.84	6.79	4.29	4.24	5.58	6.54	6.08	6.76	4.52	4.44
Clonkeen B 110 kV	4.80	9.77	8.51	4.08	10.23	9.72	4.80	10.10	8.79	4.08	10.57	10.04
Cloon 110 kV	4.76	8.07	7.55	6.36	6.68	6.56	4.79	8.77	8.02	6.43	7.17	6.99
Clutterland 110 kV	17.24	19.72	16.98	18.58	13.51	13.03	19.29	23.18	20.51	19.73	14.86	14.45
College Park 110 kV	9.13	18.95	16.71	6.28	22.09	20.98	9.60	24.86	22.07	6.02	27.64	26.38
Cookstown 110 kV	7.16	8.13	7.71	5.88	6.89	6.78	7.10	9.19	8.75	5.82	7.57	7.47
Cookstown A 110 kV	4.91	6.44	5.95	5.19	4.53	4.45	4.80	7.54	6.73	5.13	4.94	4.82
Coolderrig 110 kV	18.13	11.88	10.59	12.11	12.48	11.97	20.12	14.20	12.49	12.40	14.33	13.69
Coolnabacky 110 kV	7.85	13.26	12.50	8.19	16.34	15.94	8.07	15.89	14.94	8.44	19.14	18.66
Coolnabacky 400 kV	10.20	11.05	9.88	9.20	9.95	9.60	10.26	13.30	12.24	9.11	11.42	11.13
Coolnanoonag 110 kV	10.18	16.92	15.16	9.93	19.65	18.79	10.52	19.39	17.25	10.21	22.15	21.14

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Coolroe 110 kV	3.66	9.69	9.02	5.02	8.91	8.71	3.67	9.93	8.94	4.97	9.10	8.80
Coomagearlahy 110 kV	5.28	7.89	6.81	5.92	8.48	8.02	5.29	8.12	7.00	5.92	8.76	8.28
Coomataggart 110 kV	9.94	7.50	6.66	6.66	4.09	4.00	9.87	7.61	6.76	6.65	4.10	4.01
Coomataggart 110 kV	9.94	7.50	6.66	6.66	4.09	4.00	9.87	7.61	6.76	6.65	4.10	4.01
Cordal 110 kV	12.79	9.57	8.50	7.71	8.99	8.64	12.57	9.90	8.82	7.64	9.41	9.06
Corderry 110 kV	4.53	9.19	8.14	5.82	7.81	7.53	4.43	9.70	8.62	5.75	8.13	7.85
Corduff 110 kV	10.65	22.18	19.21	11.56	26.19	24.68	12.13	30.28	26.30	13.09	33.76	31.94
Corduff 220 kV	12.49	19.46	16.52	11.13	24.30	22.57	15.48	31.97	27.05	12.01	36.57	34.09
Corkagh 110 kV	17.29	19.55	16.84	19.14	13.30	12.84	19.34	22.96	20.32	20.38	14.62	14.23
Corraclassy 110 kV	4.54	7.06	6.54	5.79	5.07	4.97	4.48	7.44	6.91	5.75	5.32	5.22
Cow Cross 110 kV	4.15	11.60	10.80	4.76	10.29	10.07	4.01	11.44	10.25	4.59	10.27	9.92
Crane 110 kV	8.57	9.00	8.46	7.93	9.07	8.88	8.53	9.46	8.71	7.86	9.53	9.26
Croaghaun 110 kV	6.29	7.20	6.03	7.13	7.60	7.10	6.09	7.41	6.21	7.03	7.82	7.31
Croaghnagawna 110 kV	6.41	6.40	5.43	6.96	3.68	3.56	6.32	6.68	5.67	6.91	3.80	3.67
Cromcastle A 110 kV	11.02	16.26	14.30	6.96	19.38	18.37	11.46	20.96	18.33	6.67	24.19	22.90
Cromcastle B 110 kV	11.02	16.26	14.30	6.96	19.38	18.37	11.46	20.96	18.33	6.67	24.19	22.90
Crory 110 kV	10.53	9.18	8.70	10.37	10.68	10.45	10.54	9.65	9.01	10.30	11.21	10.90
Cruiserath 220 kV	12.32	19.33	16.43	10.89	24.09	22.38	15.05	31.65	26.81	11.60	36.12	33.70
Cullenagh 110 kV	7.95	13.76	12.96	8.53	15.18	14.84	8.04	14.66	13.29	8.54	16.06	15.47
Cullenagh 220 kV	8.82	9.73	9.32	9.12	9.08	8.96	8.64	9.97	9.43	8.92	9.32	9.16
Cunghill 110 kV	3.32	6.01	5.55	4.02	5.18	5.06	3.20	6.54	6.06	3.98	5.47	5.35
Cureeny 110 kV				5.83	6.65	5.92				5.81	7.21	6.34
Cureeny T 110 kV	6.06	8.40	7.54	5.45	7.06	6.84	6.03	9.07	8.04	5.44	7.62	7.35
Cushaling 110 kV	4.32	7.45	7.11	5.45	8.23	8.09	5.42	10.70	9.74	7.16	10.54	10.21
Dallow 110 kV	3.48	5.01	4.76	4.66	3.07	3.03	3.55	5.77	5.49	4.78	3.27	3.24
Dalton 110 kV	3.39	5.01	4.59	4.70	3.75	3.67	3.37	5.30	4.76	4.69	3.82	3.72
Dardistown 110 kV	13.13	16.63	14.60	9.64	20.23	19.13	14.37	21.54	18.78	9.67	25.41	24.01
Darndale 110 kV	15.66	17.23	15.04	14.25	20.32	19.21	18.41	22.45	19.46	15.60	25.69	24.24

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Deenes 110 kV	5.84	9.85	9.17	6.86	7.18	7.05	5.75	11.20	10.40	6.81	7.90	7.76
Derrybrien 110 kV	3.06	4.81	4.23	4.50	4.22	4.06	3.04	5.06	4.45	4.49	4.41	4.24
Derryiron 110 kV	5.17	7.84	7.50	6.46	8.28	8.15	5.28	9.03	8.55	6.66	9.12	8.95
Derrylahan 110 kV	4.84	11.57	10.76	5.82	10.40	10.16	5.10	13.34	12.42	6.11	11.44	11.20
Doon 110 kV	4.38	7.53	7.04	4.76	5.39	5.30	4.38	7.88	7.16	4.74	5.50	5.37
Dromada 110 kV	10.00	8.86	7.67	6.29	8.15	7.78	9.98	9.32	8.16	6.26	8.49	8.13
Drombeg 110 kV	7.16	8.61	8.03	7.30	6.69	6.57	7.08	9.37	8.71	7.26	7.16	7.02
Drumkeen 110 kV	3.92	8.66	7.36	5.13	6.86	6.55	3.90	9.58	8.01	5.13	7.38	7.02
Drumline 110 kV	3.28	8.92	8.27	4.69	7.01	6.87	3.27	9.50	8.66	4.67	7.30	7.12
Drybridge 110 kV	5.82	11.86	10.78	6.92	9.92	9.65	5.76	13.70	12.25	6.87	11.16	10.81
Dundalk 110 kV	3.59	8.80	8.15	4.67	7.74	7.56	3.53	9.92	9.06	4.62	8.62	8.39
Dunfirth 110 kV	4.59	6.19	5.96	6.30	4.80	4.75	5.25	7.90	7.62	7.05	5.53	5.48
Dungarvan 110 kV	5.90	6.22	5.91	7.78	5.04	4.96	6.41	7.38	6.48	8.35	5.62	5.43
Dunmanway 110 kV	4.59	9.75	8.51	5.59	8.82	8.45	4.81	10.54	8.81	5.78	9.35	8.83
Dunstown 220 kV	12.56	20.07	17.74	12.01	22.18	21.13	12.46	24.64	22.42	11.82	26.35	25.43
Dunstown 400 kV	13.41	11.99	10.64	12.48	12.21	11.69	14.45	14.72	13.48	12.94	14.40	13.97
Ennis 110 kV	4.58	12.89	11.40	6.10	10.15	9.81	4.58	13.93	12.14	6.11	10.73	10.34
Fassaroe East 110 kV	5.16	7.63	7.24	5.32	5.82	5.75	5.05	8.67	8.20	5.26	6.38	6.29
Fassaroe West 110 kV	5.30	7.79	7.39	5.42	6.02	5.93	5.19	8.86	8.38	5.35	6.60	6.50
Finglas 220 kV	12.63	19.04	16.20	11.98	24.20	22.47	16.12	31.80	26.85	13.72	37.09	34.51
Finglas A 110 kV	16.81	17.76	15.51	11.52	21.32	20.13	20.55	23.45	20.25	11.97	27.08	25.50
Finglas B 110 kV	26.14	11.79	10.82	24.92	14.81	14.27	35.46	15.04	13.32	31.04	18.29	17.37
Firlough 110 kV	4.80	6.25	5.69	5.67	5.20	5.06	4.51	7.45	6.86	5.84	5.73	5.61
Flagford 110 kV	6.23	13.84	12.48	7.34	15.76	15.12	6.06	15.18	13.65	7.23	17.14	16.44
Flagford 220 kV	8.57	7.58	7.11	10.88	6.79	6.66	8.38	8.29	7.84	10.77	7.33	7.20
Fortunestown 110 kV	5.59	7.44	6.83	5.60	5.56	5.44	5.46	8.75	7.79	5.53	6.11	5.94
Francis Street A 110 kV	10.71	10.67	9.79	5.57	12.97	12.50	10.92	12.93	11.60	5.39	15.19	14.52
Francis Street B 110 kV	12.19	11.87	10.84	6.58	14.35	13.81	12.66	14.14	12.85	6.41	16.69	16.05

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Gallanstown 110 kV	6.59	8.66	8.16	6.98	6.02	5.94	6.48	10.11	9.62	6.94	6.70	6.62
Galway 110 kV	5.51	14.49	12.95	4.71	16.52	15.80	5.41	16.12	14.09	4.63	18.00	17.07
Garballagh 110 kV	6.39	9.49	8.79	7.02	7.26	7.12	6.33	10.63	9.77	6.97	7.91	7.74
Garrow 110 kV	10.54	11.21	9.74	10.43	11.86	11.25	10.40	11.63	10.11	10.29	12.33	11.70
Garvagh 110 kV	4.88	7.31	6.48	6.42	6.12	5.91	4.80	7.66	6.83	6.36	6.32	6.12
Gilra 110 kV	3.31	6.88	6.49	4.21	5.00	4.93	3.26	7.33	6.91	4.18	5.30	5.22
Glanagow 220 kV	10.14	12.12	11.06	10.30	15.32	14.71	7.64	9.74	8.77	7.67	12.48	11.91
Glanlee 110 kV	5.11	7.78	6.72	5.40	8.34	7.88	5.11	8.01	6.91	5.39	8.60	8.13
Glasmore A 110 kV	3.95	7.73	7.16	4.44	5.23	5.14	3.74	9.29	8.40	4.34	5.81	5.68
Glen 110 kV	4.86	7.28	6.46	6.27	6.09	5.88	4.78	7.64	6.81	6.21	6.29	6.08
Glenlara A 110 kV	3.28	3.20	2.95	4.80	2.59	2.53	3.28	3.33	3.02	4.80	2.68	2.61
Glenlara B 110 kV	9.36	8.36	7.33	6.17	8.32	7.94	9.30	8.66	7.65	6.13	8.69	8.32
Glenree 110 kV	4.59	6.11	5.59	5.43	5.06	4.93	4.37	7.15	6.60	5.57	5.53	5.41
Golagh 110 kV	4.03	8.56	7.23	4.91	6.54	6.24	3.94	9.11	7.69	4.85	6.83	6.53
Gorman 110 kV	7.13	13.45	12.20	8.12	14.74	14.21	7.01	15.40	13.82	8.02	16.59	15.93
Gorman 220 kV	8.74	11.07	10.21	9.73	9.07	8.86	8.57	12.86	12.07	9.64	10.15	9.98
Gortawee 110 kV	4.79	6.69	6.17	6.47	5.20	5.09	4.74	7.12	6.58	6.43	5.45	5.34
Grange 110 kV	12.92	16.99	14.86	6.83	20.01	18.92	14.10	22.16	19.22	6.52	25.18	23.78
Grange Castle 110 kV	19.48	12.22	10.86	13.73	13.52	12.92	22.06	14.67	12.85	14.28	15.65	14.89
Great Island 110 kV	9.05	14.46	13.59	10.01	16.93	16.52	8.86	14.89	13.62	9.69	17.47	16.85
Great Island 220 kV	13.23	13.51	12.82	13.90	14.17	13.91	12.74	13.76	12.95	13.33	14.17	13.87
Griffinrath A 110 kV	6.83	10.53	10.00	7.26	10.43	10.25	6.80	11.77	11.10	7.24	11.45	11.23
Griffinrath B 110 kV	7.35	10.91	10.35	7.42	10.44	10.26	7.34	12.21	11.51	7.40	11.42	11.20
Harolds Cross 110 kV	10.87	10.70	9.82	5.28	12.93	12.47	11.11	12.96	11.63	5.10	15.13	14.47
Harristown 110 kV	4.61	6.85	6.57	5.90	5.42	5.36	4.98	8.45	8.04	6.32	6.11	6.04
Heuston 110 kV	13.09	12.10	11.04	7.84	14.79	14.22	13.76	14.44	13.11	7.74	17.25	16.57
Huntstown A 220 kV	11.81	18.87	16.09	9.43	23.36	21.74	14.71	31.43	26.62	9.55	35.38	33.03
Huntstown B 220 kV	12.17	18.92	16.13	9.62	23.46	21.84	14.59	31.40	26.61	9.53	35.39	33.04

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**	**X/R ratio**	**Ik'' [kA]**	**Ik' [kA]**
Ikerrin 110 kV	5.68	5.23	4.81	6.42	3.56	3.50	5.63	5.61	5.09	6.43	3.75	3.66
Inchicore 220 kV	11.69	20.31	17.23	9.28	24.49	22.78	13.46	30.22	26.01	9.31	33.78	31.78
Inchicore A 110 kV	24.35	13.34	12.07	22.28	16.70	16.00	30.54	16.10	14.50	26.11	19.73	18.87
Inchicore B 110 kV	33.72	13.46	11.92	28.26	16.87	16.00	49.01	16.38	14.29	35.65	20.03	18.89
Inniscarra 110 kV	3.68	9.65	8.96	4.95	8.59	8.40	3.68	9.90	8.92	4.92	8.75	8.47
Irishtown 220 kV	12.77	18.90	16.28	10.57	23.34	21.84	15.53	28.71	25.04	11.07	32.77	30.97
Kellis 110 kV	6.65	9.66	9.16	7.76	10.97	10.74	6.39	10.82	10.02	7.51	12.13	11.77
Kellis 220 kV	8.27	8.13	7.79	10.01	6.71	6.63	8.04	8.89	8.53	9.86	7.21	7.13
Kellystown 220 kV	6.92	16.09	14.18	6.20	13.29	12.80	6.29	20.74	18.81	5.82	15.78	15.37
Kilbarry 110 kV	5.73	15.31	13.91	6.75	14.75	14.28	5.42	15.61	13.36	6.34	15.03	14.25
Kilcarbery 110 kV	16.98	19.40	16.74	18.58	13.18	12.72	18.88	22.77	20.18	19.70	14.48	14.10
Kildonan 110 kV	6.85	14.71	13.31	5.22	13.22	12.81	6.68	18.38	16.78	5.01	15.47	15.07
Kilkenny 110 kV	4.82	7.36	7.07	6.35	6.16	6.09	4.78	8.24	7.68	6.35	6.65	6.53
Kill Hill 110 kV	5.65	7.09	6.35	6.83	5.59	5.43	5.55	7.36	6.52	6.79	5.75	5.56
Killonan 110 kV	7.16	20.40	17.95	7.45	14.94	14.45	7.07	22.12	19.05	7.38	15.78	15.19
Killonan 220 kV	8.07	10.59	9.80	10.68	8.81	8.61	7.98	11.34	10.45	10.56	9.35	9.14
Killoteran 110 kV	7.39	12.56	11.84	7.60	13.21	12.93	7.37	13.31	12.08	7.53	13.94	13.46
Kilmahud 110 kV	16.46	19.32	16.68	18.36	13.28	12.82	18.15	22.67	20.10	19.44	14.58	14.19
Kilmore 110 kV	14.93	17.48	15.24	10.99	21.17	19.97	17.25	22.89	19.80	11.32	26.85	25.28
Kilnap 110 kV	5.74	16.06	14.56	6.47	14.18	13.76	5.45	16.22	13.96	6.15	14.35	13.69
Kilpaddoge 110 kV	10.38	17.15	15.34	11.08	20.64	19.70	10.72	19.64	17.44	11.50	23.32	22.21
Kilpaddoge 220 kV	10.17	17.32	15.29	9.84	20.88	19.79	10.28	19.30	17.19	9.88	23.13	22.02
Kilpaddoge 400 kV	7.28	9.90	8.92	6.75	10.31	9.92	6.82	11.41	10.49	6.39	11.50	11.17
Kilteel 110 kV	4.38	7.68	7.34	5.48	6.84	6.75	4.55	9.13	8.57	5.74	7.63	7.49
Kinnegad 110 kV	4.84	7.69	7.34	6.27	6.89	6.79	5.18	9.45	8.89	6.76	7.82	7.68
Kishoge 110 kV	16.28	19.06	16.49	16.96	12.92	12.48	17.88	22.34	19.84	17.76	14.19	13.82
Knockacummer 110 kV	8.27	7.19	6.35	6.97	6.90	6.62	8.22	7.43	6.61	6.93	7.03	6.76
Knockalough 110 kV	5.50	6.20	5.36	4.58	6.85	6.47	5.52	6.59	5.68	4.57	7.19	6.78

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Knockanure 220 kV	10.30	14.73	13.07	7.24	17.74	16.85	10.36	16.01	14.30	7.16	19.26	18.34
Knockanure A 110 kV	19.31	13.70	11.60	15.51	14.23	13.38	19.56	14.42	12.37	15.58	15.03	14.20
Knockanure B 110 kV	4.72	8.77	8.06	5.82	6.86	6.71	4.63	9.51	8.68	5.78	7.29	7.12
Knockearagh 110 kV	5.46	5.79	5.40	7.38	4.73	4.64	5.41	6.25	5.67	7.32	5.05	4.91
Knocknamona 110 kV				5.64	6.01	5.71				6.50	7.42	6.41
Knockraha A 110 kV	7.30	19.19	17.29	8.13	19.13	18.44	6.57	19.06	16.29	7.30	19.16	18.12
Knockraha A 220 kV	9.80	13.97	12.67	9.80	14.62	14.10	7.91	12.17	10.82	8.04	13.21	12.62
Knockraha B 110 kV	7.30	19.19	17.29	8.13	19.13	18.44	6.57	19.06	16.29	7.30	19.16	18.12
Knockraha B 220 kV	9.80	13.97	12.67	9.80	14.62	14.10	7.91	12.17	10.82	8.04	13.21	12.62
Knockranny 110 kV	6.44	8.70	8.12	5.37	10.83	10.51	6.37	9.38	8.68	5.32	11.53	11.16
Knockranny A 110 kV	5.33	7.24	6.17	5.50	7.94	7.46	5.36	7.76	6.58	5.52	8.37	7.86
Knockranny B 110 kV	6.44	8.70	8.12	5.37	10.83	10.51	6.37	9.38	8.68	5.32	11.53	11.16
Knockumber 110 kV	3.99	8.04	7.50	4.81	6.04	5.94	3.91	8.87	8.21	4.75	6.52	6.40
Lanesboro 110 kV	4.48	9.74	9.01	5.81	7.95	7.78	4.47	11.08	9.99	5.84	8.79	8.55
Lenalea 110 kV	3.95	6.75	6.05	5.16	4.40	4.30	4.46	8.35	7.01	5.56	5.28	5.07
Letterkenny110 kV	4.35	10.32	8.66	5.51	8.66	8.22	4.50	11.94	9.69	5.68	9.75	9.16
Liberty A 110 kV	5.27	15.45	14.02	4.71	16.56	15.97	5.02	15.58	13.34	4.56	16.63	15.68
Liberty B 110 kV	5.19	15.43	14.01	4.57	16.52	15.94	4.96	15.56	13.33	4.44	16.58	15.63
Limerick 110 kV	5.05	16.59	14.81	6.28	13.43	13.00	4.99	18.06	15.74	6.22	14.24	13.70
Lisdrum 110 kV	2.92	5.43	5.03	4.35	4.52	4.42	2.88	5.94	5.42	4.32	4.83	4.71
Lisheen 110 kV	4.98	5.03	4.39	4.99	7.54	7.02	4.86	5.36	4.65	5.04	8.03	7.46
Lodgewood 110 kV	10.53	9.18	8.70	10.37	10.68	10.45	10.54	9.65	9.01	10.30	11.21	10.90
Lodgewood 220 kV	9.38	7.78	7.44	10.39	7.08	6.98	9.18	8.33	7.95	10.20	7.52	7.41
Longpoint 220 kV	10.26	12.49	11.36	9.85	15.57	14.94	7.51	9.79	8.82	7.33	12.44	11.88
Loughtown 220 kV	12.70	13.40	12.72	11.33	13.85	13.60	12.25	13.65	12.85	10.96	13.87	13.58
Louth 220 kV	9.57	15.85	14.13	10.42	18.00	17.19	9.79	19.32	17.56	10.68	21.05	20.30
Louth A 110 kV	7.53	12.71	11.59	8.68	15.07	14.52	7.53	14.29	13.10	8.70	16.79	16.21
Louth A 275 kV	11.06	9.91	9.07	11.02	11.54	11.13	11.64	12.20	11.55	11.30	13.89	13.60

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Louth B 110 kV	7.13	13.86	12.67	8.01	16.84	16.22	7.17	15.74	14.40	8.09	18.92	18.24
Louth B 275 kV	10.47	9.86	9.02	9.68	11.73	11.30	10.89	11.72	11.13	9.74	13.85	13.56
Lumcloon 110 kV	5.21	7.35	7.00	6.34	4.99	4.93	5.95	9.12	8.75	6.91	5.52	5.47
Macetown 110 kV	7.37	16.40	14.68	6.81	16.26	15.65	7.29	20.93	18.86	6.68	19.45	18.81
Macroom 110 kV	7.10	16.08	14.32	7.01	16.28	15.62	7.01	16.71	14.35	6.90	16.96	16.05
Mallow 110 kV	5.15	6.64	6.23	6.98	5.56	5.46	5.10	6.92	6.33	6.89	5.74	5.60
Marina 110 kV	6.11	17.12	15.39	7.04	18.43	17.71	5.68	17.26	14.58	6.45	18.54	17.38
Maynooth A 110 kV	10.69	13.34	12.53	11.48	16.13	15.72	10.97	15.08	14.10	11.75	18.03	17.54
Maynooth A 220 kV	10.15	19.30	16.94	9.86	18.35	17.55	9.78	24.27	21.91	9.56	21.72	21.03
Maynooth B 110 kV	7.72	16.16	14.70	9.17	15.63	15.14	7.44	19.40	18.04	9.05	17.91	17.51
Maynooth B 220 kV	7.88	17.40	15.24	7.81	16.41	15.68	7.43	22.65	20.45	7.50	19.78	19.16
McDermott 110 kV	14.80	10.83	9.98	6.12	12.71	12.29	16.05	13.71	12.16	5.90	15.39	14.68
Meath Hill 110 kV	4.14	9.22	8.51	5.37	7.34	7.18	4.05	10.30	9.42	5.32	8.08	7.88
Meentycat 110 kV	3.63	7.02	6.05	5.10	5.64	5.41	3.58	7.63	6.51	5.08	5.97	5.71
Midleton 110 kV	3.55	9.65	9.07	4.68	8.25	8.10	3.51	9.75	8.81	4.58	8.33	8.09
Milltown A 110 kV	14.14	11.46	10.47	7.16	14.11	13.57	15.07	14.01	12.50	7.02	16.69	15.91
Milltown B 110 kV	8.69	10.71	9.85	4.13	12.71	12.28	8.66	12.66	11.57	3.95	14.65	14.13
Misery Hill 110 kV	12.93	11.22	10.26	7.81	13.92	13.40	13.56	13.68	12.22	7.71	16.47	15.70
Monatooreen 110 kV	5.33	17.93	16.26	5.64	17.80	17.20	5.06	17.79	15.34	5.36	17.81	16.90
Moneteen 110 kV	5.08	10.75	9.88	6.18	7.69	7.53	5.04	11.52	10.47	6.15	8.11	7.92
Moneypoint 110 kV	13.78	9.77	9.12	16.78	9.35	9.14	14.03	10.44	9.77	17.06	9.92	9.71
Moneypoint 220 kV	10.25	16.96	15.03	10.57	20.62	19.57	10.36	18.91	16.90	10.65	22.86	21.79
Moneypoint G1 400 kV	9.43	10.05	9.04	11.14	11.49	11.01	9.01	11.61	10.67	10.76	12.92	12.51
Moneypoint G2 400 kV	28.02	3.29	3.15	28.24	4.25	4.17	29.43	3.60	3.46	29.52	4.62	4.54
Moneypoint G3 400 kV	9.43	10.05	9.04	11.14	11.49	11.01	9.01	11.61	10.67	10.76	12.92	12.51
Monread 110 kV	4.17	7.63	7.29	5.07	7.54	7.42	4.17	8.96	8.40	5.16	8.43	8.25
Mount Lucas 110 kV	4.59	6.34	6.05	5.80	5.87	5.79	4.86	7.89	7.35	6.23	6.65	6.52
Moy 110 kV	5.77	7.61	6.71	7.02	7.60	7.28	5.20	8.01	7.15	6.75	7.84	7.54

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Mullagharlin 110 kV	3.70	8.84	8.22	4.80	8.09	7.91	3.62	9.85	9.11	4.75	8.93	8.71
Mullingar 110 kV	4.40	6.97	6.66	5.97	6.43	6.34	4.86	9.45	8.40	6.82	7.78	7.52
Mully Graffy 110 kV				3.86	4.74	4.42				4.54	6.02	5.18
Mulreavy 110 kV	5.33	9.81	8.00	6.61	9.42	8.77	5.20	10.44	8.52	6.49	9.79	9.13
Mungret A 110 kV	4.80	10.20	9.41	5.89	7.16	7.02	4.77	10.91	9.96	5.87	7.54	7.38
Mungret B 110 kV	4.79	10.21	9.42	5.89	7.17	7.03	4.76	10.93	9.98	5.86	7.55	7.39
Nangor 110 kV	16.82	11.93	10.63	10.76	13.17	12.60	18.36	14.27	12.54	10.89	15.20	14.48
Navan 110 kV	6.34	12.04	10.99	7.18	11.88	11.52	6.20	13.70	12.34	7.06	13.27	12.81
Nenagh 110 kV	3.35	4.13	3.84	4.14	2.55	2.51	3.34	4.45	4.07	4.14	2.71	2.66
Newbridge 110 kV	4.47	9.63	9.07	5.19	9.39	9.21	4.47	11.78	10.85	5.28	10.84	10.56
Newbury 110 kV	15.58	17.55	15.30	11.68	21.14	19.95	18.35	23.00	19.88	12.20	26.82	25.26
North Quays 110 kV	16.62	11.66	10.64	6.71	14.13	13.59	18.31	14.29	12.74	6.55	16.69	15.92
North Wall 220 kV	11.53	17.06	14.75	7.78	19.40	18.27	14.08	27.92	24.01	7.36	27.92	26.41
Oldbridge 110 kV	5.99	10.81	9.87	6.88	8.55	8.34	5.94	12.33	11.11	6.83	9.48	9.22
Oldcourt A 110 kV	3.70	9.76	9.19	4.42	7.78	7.65	3.63	9.66	8.80	4.31	7.80	7.60
Oldcourt B 110 kV	3.73	9.82	9.24	4.44	7.86	7.73	3.65	9.72	8.85	4.34	7.88	7.68
Oldstreet 220 kV	13.40	9.81	9.19	11.83	10.82	10.55	13.40	10.83	10.30	11.76	11.84	11.61
Oldstreet 400 kV	8.87	9.77	8.84	8.04	8.35	8.11	8.44	11.56	10.77	7.74	9.42	9.23
Oriel 220 kV				8.84	11.76	10.81				9.55	15.52	14.12
Oughtragh 110 kV	3.69	4.74	4.44	4.85	2.97	2.93	3.62	5.03	4.62	4.80	3.09	3.04
Pelletstown 110 kV	13.10	10.27	9.50	7.81	11.15	10.83	13.80	12.83	11.49	7.68	13.27	12.75
Platin 110 kV	6.13	10.09	9.27	6.89	7.76	7.58	6.08	11.41	10.37	6.84	8.53	8.32
Pollahoney 110 kV	10.12	8.34	7.86	10.44	9.14	8.94	10.17	9.05	8.47	10.46	9.82	9.58
Pollaphuca 110 kV	3.29	3.02	2.93	4.73	2.57	2.54	3.25	3.17	3.04	4.69	2.57	2.54
Poolbeg A 110 kV	22.04	12.19	11.10	19.26	15.47	14.86	26.40	14.99	13.35	21.64	18.52	17.62
Poolbeg A 220 kV	11.43	17.17	14.84	6.79	18.33	17.31	13.61	28.01	24.10	6.17	25.83	24.53
Poolbeg B 110 kV	22.02	12.17	11.09	19.25	15.46	14.84	26.36	14.97	13.33	21.63	18.49	17.60
Poolbeg B 220 kV	11.45	18.93	16.21	9.15	21.39	20.07	13.02	27.78	24.17	9.17	28.75	27.29

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028												
	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Poppintree 110 kV	11.73	16.65	14.62	6.71	19.81	18.75	12.39	21.63	18.84	6.38	24.83	23.47
Portan 260 kV				17.99	14.07	12.79	20.42	16.95	15.89	20.42	16.95	15.89
Portan 400 kV				13.45	12.54	11.08	14.56	15.95	14.58	14.56	15.95	14.58
Portlaoise 110 kV	6.06	11.66	11.00	7.06	11.21	11.00	6.22	14.28	13.33	7.33	12.86	12.59
Pottery 110 kV	16.42	10.71	10.02	5.63	10.90	10.65	17.84	12.75	11.78	5.48	12.44	12.11
Prospect 220 kV	9.11	14.16	12.79	7.43	14.48	13.95	9.11	15.67	14.27	7.36	15.85	15.33
Raffeen 220 kV	9.87	12.06	11.00	9.19	14.74	14.17	7.58	9.96	8.94	7.26	12.40	11.83
Raffeen A 110 kV	5.38	13.42	12.37	6.17	15.66	15.16	4.97	13.09	11.59	5.61	15.37	14.63
Raffeen B 110 kV	7.31	13.37	12.30	8.17	15.43	14.93	6.55	13.13	11.58	7.23	15.24	14.48
Rathkeale 110 kV	3.46	7.31	6.89	4.79	5.68	5.60	3.43	7.96	7.38	4.77	5.99	5.87
Rathnaskillo 110 kV	6.07	7.10	6.81	7.06	5.24	5.18	6.31	7.89	7.22	7.23	5.62	5.49
Ratrussan 110 kV	5.08	8.22	6.94	6.51	8.58	8.06	5.01	8.83	7.49	6.43	9.02	8.50
Reamore 110 kV	3.96	9.27	8.20	4.40	7.50	7.24	3.85	9.98	8.68	4.33	7.94	7.63
Richmond A 110 kV	3.41	6.65	6.28	4.87	5.49	5.41	3.38	7.43	6.83	4.88	5.99	5.86
Richmond B 110 kV	3.41	6.65	6.28	4.87	5.49	5.41	3.38	7.43	6.83	4.88	5.99	5.86
Rinawade 110 kV	4.88	10.28	9.65	5.90	7.44	7.32	4.82	12.07	11.51	5.91	8.25	8.16
Ringaskiddy 110 kV	5.37	11.17	10.41	5.85	10.74	10.49	5.09	11.00	9.88	5.55	10.67	10.28
Ringsend 110 kV	21.99	12.19	11.08	19.86	15.49	14.86	26.30	15.05	13.35	22.48	18.60	17.66
Rossiple 110 kV	7.04	8.42	7.99	7.59	6.08	6.00	6.55	8.01	7.43	7.21	6.04	5.92
Ryebrook 110 kV	5.38	13.81	12.40	6.32	12.30	11.90	5.05	16.29	14.92	6.12	13.84	13.49
Salthill 110 kV	5.03	13.93	12.45	3.83	15.53	14.87	4.94	15.45	13.51	3.77	16.86	16.01
Screeb 110 kV	4.12	2.99	2.74	5.05	1.89	1.85	4.12	3.18	2.88	5.05	1.96	1.92
Seal Rock A 110 kV	5.53	7.05	6.53	6.51	8.26	8.01	5.49	7.52	6.96	6.48	8.63	8.38
Seal Rock B 110 kV	5.53	7.05	6.53	6.51	8.26	8.01	5.49	7.52	6.96	6.48	8.63	8.38
Shankill 110 kV	4.80	9.30	8.11	5.99	8.01	7.69	4.72	10.21	8.84	5.92	8.61	8.25
Shannonbridge 110 kV	4.85	12.79	11.81	6.13	13.37	13.00	5.14	14.94	13.79	6.59	15.02	14.61
Shannonbridge 220 kV	6.48	6.58	6.27	8.70	5.45	5.38	7.06	7.86	7.57	9.55	6.09	6.03
Shantallow 110 kV	4.07	12.55	11.62	4.60	10.12	9.91	4.00	13.62	12.52	4.56	10.78	10.53

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Shellybanks A 220 kV	11.23	17.15	14.82	8.15	19.57	18.43	13.26	27.97	24.07	7.83	28.24	26.71
Shellybanks B 220 kV	12.25	18.10	15.68	9.36	22.08	20.73	14.80	27.44	24.04	9.42	30.78	29.18
Shelton Abbey 110 kV	9.86	8.17	7.70	9.94	8.75	8.56	9.90	8.86	8.30	9.95	9.39	9.17
Singland 110 kV	6.52	16.64	14.92	7.61	13.42	13.01	6.45	17.94	15.78	7.55	14.07	13.58
Sliabh Bawn 110 kV				5.20	9.64	8.81				5.17	10.81	9.71
Slievecallan 110 kV	7.85	7.17	6.32	9.44	2.31	2.27	7.88	7.49	6.61	9.44	2.41	2.38
Sligo 110 kV	3.46	8.94	8.21	4.28	7.57	7.39	3.38	9.78	8.89	4.25	8.06	7.84
Snugborough 110 kV	10.50	20.68	18.04	10.05	23.76	22.49	11.75	27.67	24.25	10.71	30.00	28.53
Somerset 110 kV	2.93	7.00	6.66	3.98	4.55	4.50	2.91	7.66	7.25	3.99	4.79	4.74
Sorne Hill 110 kV	3.48	3.64	3.23	4.45	3.53	3.39	3.44	3.94	3.46	4.42	3.78	3.62
Srahnakilly 110 kV	6.28	7.81	6.49	6.84	8.46	7.87	6.05	8.05	6.70	6.74	8.66	8.07
Srananagh 110 kV	4.95	11.86	10.67	5.95	11.99	11.56	4.81	12.76	11.48	5.85	12.79	12.32
Srananagh 220 kV	7.99	4.82	4.58	10.25	3.72	3.67	7.85	5.17	4.94	10.18	3.95	3.91
Stevenstown 110 kV	3.95	6.26	5.91	4.46	4.02	3.96	3.78	7.23	6.76	4.38	4.38	4.32
Stratford 110 kV	3.36	4.38	4.23	4.39	3.24	3.22	3.30	4.77	4.48	4.34	3.40	3.35
Taney 110 kV	8.70	9.27	8.74	3.26	9.15	8.97	8.68	10.87	10.14	3.14	10.30	10.07
Tarbert 110 kV	20.49	12.22	11.55	24.18	9.31	9.18	21.11	13.22	12.57	24.66	10.00	9.87
Tarbert 220 kV	9.84	16.44	14.60	9.53	18.77	17.89	9.92	18.28	16.38	9.54	20.72	19.83
Tawnaghmore A 110 kV	4.08	5.46	4.96	5.38	4.87	4.73	3.89	5.74	5.25	5.31	4.98	4.85
Tawnaghmore B 110 kV	4.58	5.74	5.17	5.94	5.83	5.62	3.79	5.52	5.09	5.08	5.58	5.42
Thornsberry 110 kV	4.84	6.09	5.84	6.13	5.74	5.66	4.90	7.20	6.74	6.30	6.59	6.45
Thurles 110 kV	6.19	6.44	5.63	6.49	6.56	6.25	5.97	6.81	5.89	6.45	6.88	6.53
Tievebrack 110 kV	4.19	5.21	4.83	5.61	3.14	3.09	4.85	6.54	5.63	6.25	5.64	5.38
Timahoe 110 kV	6.28	8.30	8.01	6.95	5.93	5.88	6.28	8.32	8.00	6.90	6.07	6.01
Tipperary 110 kV	5.37	7.82	7.25	6.38	4.58	4.51	5.34	8.17	7.44	6.35	4.72	4.63
Tonroe 110 kV	5.71	5.64	5.22	6.62	3.55	3.49	5.57	6.01	5.55	6.58	3.73	3.67
Trabeg 110 kV	6.01	17.03	15.32	6.93	18.36	17.64	5.58	17.15	14.50	6.35	18.45	17.31
Tralee 110 kV	5.32	9.86	8.69	6.37	8.00	7.72	5.15	10.68	9.25	6.25	8.49	8.16

Table E-4: Ireland short circuit currents for maximum and minimum demand in 2028

	Summer						Winter					
	Three phase			Single phase			Three phase			Single phase		
Station	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]	X/R ratio	Ik'' [kA]	Ik' [kA]
Trien A 110 kV	4.53	8.36	7.64	5.86	6.99	6.81	4.46	9.02	8.18	5.81	7.39	7.19
Trien B 110 kV	12.58	11.21	9.42	12.58	11.21	9.42	12.58	11.75	10.01	12.58	11.75	10.01
Trillick 110 kV	3.59	4.00	3.51	4.56	3.52	3.39	3.54	4.35	3.77	4.54	3.77	3.61
Trinity 110 kV	11.67	10.94	10.02	6.61	13.47	12.97	12.04	13.30	11.91	6.46	15.86	15.14
Tullabeg 110 kV	6.42	6.65	6.37	6.59	5.50	5.43	6.39	7.01	6.62	6.56	5.76	5.67
Tullabrack 110 kV	6.52	7.48	7.02	7.28	5.44	5.35	6.53	7.98	7.49	7.30	5.73	5.64
Turlough 220 kV	11.08	12.39	11.26	12.36	10.97	10.65	10.65	13.75	12.78	12.06	11.70	11.44
Tynagh 220 kV	12.19	9.61	8.97	13.35	11.19	10.89	12.07	10.56	9.99	13.24	12.11	11.84
Uggool 110 kV	6.55	8.30	7.77	5.81	10.38	10.09	6.48	8.93	8.29	5.75	11.04	10.70
Waterford 110 kV	7.63	13.22	12.43	8.09	13.77	13.47	7.60	13.99	12.66	8.00	14.52	14.01
Wexford 110 kV	6.93	7.64	7.07	8.39	6.72	6.56	6.81	7.68	6.88	8.12	6.78	6.55
Whitebank 110 kV	19.55	12.14	11.04	17.38	15.41	14.78	22.55	14.97	13.29	19.08	18.47	17.55
Whitegate 110 kV	4.32	9.05	8.55	5.09	9.26	9.08	4.17	8.91	8.19	4.87	9.19	8.92
Wolfe Tone 110 kV	13.37	10.61	9.78	5.62	12.31	11.92	14.16	13.38	11.89	5.39	14.84	14.18
Woodhouse 110 kV	5.91	6.18	5.87	7.32	4.45	4.39	6.74	7.61	6.58	7.99	4.99	4.82
Woodland 220 kV	11.83	20.91	17.99	11.50	22.65	21.35	11.89	29.53	26.00	11.42	29.57	28.25
Woodland 400 kV	14.68	12.64	11.15	13.60	13.79	13.13	16.41	16.11	14.71	14.47	17.03	16.47
Yellowmeadow 110 kV	23.87	12.61	11.22	16.45	14.47	13.80	28.90	15.20	13.33	17.63	16.86	16.02

E.4 Short circuit currents in Northern Ireland

E.4.1 Methodology used in Northern Ireland

Short circuit current levels are calculated in accordance with the UK Engineering Recommendation G74, which is a computer based analysis, based on the International Standard IEC60909. Compliance with G74 includes:

- Short circuit current contributions from all synchronous and non-synchronous rotating plant including induction motors embedded in the general load;
- Comprehensive plant parameters including time-dependent impedances, transformer winding and earthing configurations;
- Pre-fault voltage levels at each node which should be obtained from a credible, pre-fault load flow study; and
- Pre-fault transformer tap settings should also be obtained from the load flow study.

The short circuit current level network model includes the following component parameters:

- Transformer impedance variation with tap position;
- Zero sequence mutual coupling effect;
- Unsaturated generator reactance values; and
- Power station auxiliaries fault level contributions.

The calculation of the X/R ratios, used by SONI, is undertaken in accordance with IEC60909-0 Method C, which is known as the equivalent frequency method. The equivalent frequency method is considered to be the most appropriate general purpose method for calculating the DC component of short circuit currents on the Northern Ireland transmission system.

The Northern Ireland transmission system is designed and operated to maintain short circuit current levels below the ratings of equipment at each substation. Table E-5 below, indicates the range of circuit breaker RMS ratings that are currently installed on the Northern Ireland transmission system, for the respective voltage levels currently operated.

Table E-5 Northern Ireland Station equipment rating range by voltage level

Voltage level (kV)	Short circuit current equipment rating range (kA)
275[45]	31.5–40
110	18.4–40

E.4.2 Analysis

The total RMS break current at a busbar is an indication of the short circuit current level that one could expect at that point in the transmission system. However, they do not necessarily represent the short circuit current that could flow through each individual breaker, which may be lower.

45 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete structures to withstand mechanical loading under fault conditions. This is under constant review and projects will be brought forward to address this issue.

E.4.3 Northern Ireland short circuit current level results

Tables E-6 to E-11 contain the following three-phase and single-phase short circuit current level results for maximum winter peak and minimum summer valley system demand conditions for 2022, 2025 and 2028:

- **Initial short circuit current (I")**
  This is the initial RMS value of the AC component of the short circuit current, prior to contact separation time. It is calculated using generator sub-transient reactances.
- **Peak make current (ip)**
  The largest peak current occurs around 10ms, and is the short circuit current that equipment must be able to withstand, for example, when a circuit breaker is closed directly onto an earthed section of network, thus energising a fault. All equipment in the fault current path will be subjected to the peak make current, and therefore should be rated to withstand this.
- **RMS break current (IB)**
  This is the RMS value of the AC component of the short circuit current at the time of circuit breaker contact separation. The break time at which contact separation occurs varies from circuit to circuit, and depends on protection settings, fault location, circuit breaker design etc. For the purposes of this report, we have used a short circuit current break time of 50ms for all 275 kV and 110 kV calculations.

In the Northern Ireland results tables, the RMS Break and Peak Make ratings of the existing nodes are shown. It should be noted that the Ballylumford 110 kV node (highlighted in the tables with *) currently has separate ratings for three-phase and single-phase faults; these are indicated in the tables. All ratings are in kA.

Single phase to earth short circuit currents tend to be larger than three phase short circuit currents in heavily meshed transmission networks. This is due to the multiplicity of zero phase sequence paths available to earth fault currents. In all tables, any nodes where short circuit currents exceed 90% of the corresponding existing rating are highlighted in **orange**. Any nodes where short circuit currents exceed the corresponding existing ratings are highlighted in **red**.

The results presented in the following section are indicative only. They are based on intact network conditions and are representative of the assumed generation dispatch and transmission system conditions.

Northern Ireland short circuit currents for minimum demand in 2022

Table E-6: Northern Ireland short circuit currents for minimum demand in 2022												
Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
275 kV												
Ballylumford	31.5	79	12.82	21.34	12.35	31.35	10.86	13.71	23.49	15.15	38.72	13.92
Castlereagh	10[46]	79	10.89	16.27	11.01	27.46	9.76	10.85	16.76	12.56	31.33	11.65
Coolkeeragh	10[46]	79	7.42	9.37	8.41	19.92	7.60	8.69	11.76	9.33	22.61	8.77
Hannahstown	31.5	79	11.09	16.73	10.93	27.33	9.71	11.25	18.06	12.58	31.51	11.66
Kells	10[46]	79	11.88	18.17	11.95	30.11	10.52	11.32	17.48	13.61	34.10	12.55
Kilroot	31.5	79	12.25	18.73	11.42	28.87	10.10	12.52	20.21	13.09	33.16	12.13
Magherafelt	10[46]	79	11.07	16.18	12.10	30.25	10.65	9.13	12.02	12.23	29.86	11.38
Moyle	31.5	79	12.71	20.90	12.16	30.86	10.72	13.52	22.80	14.86	37.94	13.68
Tandragee	10[46]	79	10.52	15.23	13.12	32.59	11.54	10.23	15.63	14.85	36.76	13.70
Tamnamore	40	100	10.73	15.39	12.27	30.56	10.82	10.76	17.05	13.42	33.44	12.43

46 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-6: Northern Ireland short circuit currents for minimum demand in 2022

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.12	8.79	4.20	8.86	3.73	5.59	12.30	4.06	9.15	3.85
Antrim	40	100	4.53	7.54	8.95	19.30	8.46	4.71	9.65	9.20	20.03	8.86
Ballylumford	21.9	55	9.26	21.31	15.79	38.60	14.55					
	26.2	65						10.08	24.37	16.19	40.01	15.27
Ballymena	40	100	4.68	8.58	8.09	17.58	7.70	5.35	11.76	8.76	19.56	8.34
Banbridge	18.4	46.8	3.95	6.31	6.28	13.13	6.08	4.91	9.71	6.29	13.81	6.26
Ballyvallagh	21.9	46.8	5.05	6.34	13.01	28.72	12.05	4.75	6.47	12.82	27.94	12.26
Ballynahinch	18.4	46.8	4.13	6.87	5.34	11.28	5.17	4.92	9.88	5.45	11.97	5.42
Belfast Central	n/a	n/a	8.24	12.25	12.30	29.59	11.39	5.29	11.40	15.33	34.17	14.55
Belfast North	n/a	n/a	4.85	7.59	11.45	25.08	10.74	3.17	11.76	12.40	24.56	11.92
Brockaghboy	40	100	5.54	7.09	4.87	10.96	4.22	4.27	5.99	3.24	6.89	3.09
Carnmoney	31.5	79	3.96	6.65	7.73	16.18	7.38	4.53	9.00	7.94	17.13	7.74
Castlereagh	31.5	79	11.30	20.50	14.96	37.47	13.66	12.10	21.48	19.71	49.76	18.46
Coleraine	40	100	4.18	5.74	8.74	18.52	7.72	4.90	7.49	9.79	21.49	9.24
Coolkeeragh	31.5	79	7.16	12.04	16.13	37.97	14.33	7.89	13.38	20.47	48.91	18.90
Creagh	31.5	79	3.51	4.28	7.79	15.83	7.36	4.34	6.84	8.27	17.67	8.07
Cregagh	26.2	65	9.25	14.70	13.62	33.29	12.52	7.27	13.36	17.39	41.03	16.40
Donegall North	31.5	79	8.05	13.13	12.94	31.03	12.06	5.59	10.64	16.61	37.42	15.75
Donegall South	n/a	n/a	5.98	8.59	10.44	23.81	9.84	4.99	8.88	11.85	26.09	11.39
Drumnakelly	31.5	79	7.20	11.72	17.92	42.23	16.36	7.13	12.36	20.16	47.42	19.07
Dungannon	40	100	6.63	11.49	16.45	38.22	14.98	6.71	12.62	18.60	43.32	17.58
Eden	25	62.5	4.07	6.38	8.46	17.80	8.05	4.53	8.56	8.63	18.61	8.41
Enniskillen	31.5	79	3.95	5.05	8.65	18.08	7.59	5.01	7.27	9.35	20.61	8.72
Finaghy	31.5	79	9.08	15.57	13.38	32.63	12.44	6.80	12.23	17.63	41.15	16.68
Glengormley	18.4	46.8	3.28	3.73	5.22	10.42	5.02	4.03	6.80	5.19	10.90	5.09
Gort Cluster	40	100	7.45	10.07	7.88	18.67	7.31	6.64	14.28	7.45	17.32	7.10
Hannahstown	31.5	79	10.19	19.46	14.55	36.02	13.46	10.84	20.67	19.55	48.74	18.40
Kells	40	100	8.97	18.51	17.27	42.04	15.68	9.66	19.99	22.43	55.16	20.56
Killymallaght	40	100	5.71	8.34	11.09	25.08	10.15	5.52	10.24	10.72	24.08	10.22

Table E-6: Northern Ireland short circuit currents for minimum demand in 2022

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Knock	n/a	n/a	5.02	7.44	13.05	28.77	12.04	3.20	11.07	14.14	28.08	13.49
Larne	18.4	46.8	4.35	5.37	8.42	17.99	7.96	5.03	8.41	8.29	18.30	8.08
Limavady	40	100	3.77	4.59	7.32	15.14	6.58	4.55	7.18	7.76	16.75	7.32
Lisburn	18.4	46.8	5.73	8.21	10.71	24.25	10.10	5.37	9.79	10.99	24.56	10.61
Lisaghmore	31.5	79	4.25	6.51	8.63	18.37	8.02	4.59	8.84	8.68	18.78	8.39
Loguestown	26.2	65	3.62	4.95	6.11	12.52	5.56	4.31	6.84	6.48	13.82	6.25
Magherakeel Cluster	40	100	5.42	10.00	4.31	9.66	4.11	7.10	12.78	4.75	11.17	4.57
Newtownards	40	100	4.69	7.04	7.29	15.85	6.95	5.70	9.87	7.14	16.14	7.00
Newry	18.4	46.8	3.82	6.56	5.31	11.01	5.16	4.76	9.62	5.34	11.64	5.34
Omagh	40	100	5.14	7.91	15.20	33.68	13.30	5.47	10.24	15.60	35.01	14.40
Rasharkin	40	100	4.54	6.79	7.83	16.91	6.91	4.93	10.05	7.07	15.54	6.67
Rathgael	26.2	65	4.19	6.62	5.70	12.09	5.50	4.91	9.66	5.78	12.68	5.73
Rosebank	40	100	10.15	16.79	13.99	34.62	12.85	11.28	18.77	18.12	45.39	17.05
Slieve Kirk	40	100	4.52	6.88	8.19	17.66	7.65	5.50	11.51	6.98	15.68	6.77
Springtown	n/a	n/a	4.36	6.66	8.70	18.61	8.11	4.67	8.79	8.97	19.48	8.63
Strabane	18.4	46.8	4.76	6.46	13.96	30.44	12.50	5.15	9.29	14.11	31.27	13.31
Tandragee	31.5	79	8.83	17.61	19.21	46.66	17.45	9.65	19.73	23.90	58.74	22.35
Tremoge	40	100	4.23	5.97	8.95	19.01	8.33	4.64	9.42	8.36	18.12	8.04
Tamnamore	40	100	7.92	16.48	19.42	46.44	17.51	8.81	18.35	25.00	60.72	23.17
Waringstown	18.4	46.8	4.88	7.62	7.92	17.35	7.58	5.55	10.44	7.79	17.54	7.64

Northern Ireland short circuit currents for maximum demand in 2022

Table E-7: Northern Ireland short circuit currents for maximum demand in 2022

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
275 kV												
Ballylumford	31.5	79	13.50	21.33	17.12	43.69	15.09	14.46	24.13	19.42	49.89	18.01
Castlereagh	10[47]	79	10.67	15.37	15.19	37.81	13.39	10.63	16.18	15.78	39.25	14.67
Coolkeeragh	10[47]	79	13.03	18.14	12.22	31.09	11.14	13.78	21.45	12.08	30.89	11.54
Hannahstown	31.5	79	10.89	15.73	14.91	37.19	13.19	11.09	17.55	15.69	39.23	14.61
Kells	10[47]	79	12.70	18.76	17.31	43.92	15.26	11.57	17.52	17.64	44.30	16.46
Kilroot	31.5	79	13.97	21.50	17.08	43.73	15.06	13.83	22.95	17.51	44.79	16.40
Magherafelt	10[47]	79	12.12	17.23	17.40	43.94	15.42	9.06	11.46	15.31	37.32	14.45
Moyle	31.5	79	13.31	20.72	16.78	42.76	14.82	14.19	23.19	18.96	48.63	17.61
Tandragee	10[47]	79	10.58	14.60	18.35	45.62	16.22	10.11	15.21	18.79	46.46	17.53
Tamnamore	40	100		15.16	17.11	42.77	15.19	10.90	17.27	16.81	41.94	15.77

47 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-7: Northern Ireland short circuit currents for maximum demand in 2022

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.13	8.86	4.40	9.30	3.89	5.65	12.48	4.25	9.59	3.97
Antrim	40	100	4.22	7.22	9.95	21.13	9.44	4.52	9.49	9.90	21.34	9.52
Ballylumford	21.9	55	10.38	24.72	22.52	55.86	20.57					
	26.2	65						11.77	28.39	26.28	66.13	22.41
Ballymena	40	100	4.39	8.20	8.92	19.11	8.49	4.79	11.52	8.45	18.46	8.10
Banbridge	18.4	46.8	3.77	6.06	6.80	14.06	6.56	4.79	9.56	6.65	14.52	6.51
Ballyvallagh	21.9	46.8	4.58	5.60	16.11	34.84	14.95	4.45	5.99	14.66	31.50	14.09
Ballynahinch	18.4	46.8	3.93	6.69	5.84	12.20	5.55	4.81	9.83	5.83	12.73	5.65
Belfast Central	n/a	n/a	7.31	11.32	14.99	35.41	13.58	4.74	10.98	17.87	38.93	16.62
Belfast North	n/a	n/a	4.38	7.00	13.17	28.20	12.21	2.94	11.47	13.54	26.29	12.92
Brockaghboy	40	100	6.07	8.95	5.16	11.81	4.45	5.81	9.90	4.18	9.49	3.93
Carnmoney	31.5	79	3.63	6.17	8.75	17.94	8.33	4.30	8.68	8.61	18.36	8.37
Castlereagh	31.5	79	10.07	20.19	19.11	47.23	16.95	11.04	21.25	24.32	60.77	22.15
Coleraine	40	100	4.02	5.59	9.94	20.86	8.69	4.77	7.49	10.94	23.87	10.05
Coolkeeragh	31.5	79	9.60	21.92	22.79	55.99	20.14	10.48	23.40	27.26	67.69	25.23
Creagh	31.5	79	3.31	4.02	8.57	17.16	8.09	4.20	6.62	8.87	18.81	8.51
Cregagh	26.2	65	8.17	13.76	16.99	40.83	15.22	6.50	12.74	20.82	48.22	19.17
Drumquin	40	100	5.33	7.72	6.73	15.03	6.15	5.90	12.20	6.23	14.19	5.95
Donegall North	31.5	79	7.36	12.30	15.21	35.96	13.98	5.11	10.14	18.86	41.75	17.69
Donegall South	n/a	n/a	5.48	7.96	11.87	26.64	11.09	4.66	8.49	12.97	28.16	12.40
Drumnakelly	31.5	79	6.60	10.86	21.99	51.07	19.98	6.68	11.88	23.35	54.35	21.95
Dungannon	40	100	6.13	10.93	19.43	44.54	17.82	6.41	12.40	21.04	48.60	19.89
Eden	25	62.5	3.72	5.78	9.84	20.29	9.35	4.31	8.20	9.55	20.38	9.27
Enniskillen	31.5	79	3.85	4.89	9.46	19.67	8.26	4.95	7.15	10.12	22.24	9.32
Finaghy	31.5	79	8.34	14.77	15.80	38.07	14.49	6.21	11.55	20.19	46.39	18.88
Glengormley	18.4	46.8	3.13	3.53	5.63	11.12	5.40	3.95	6.64	5.48	11.45	5.33
Gort Cluster	40	100	7.23	9.78	8.48	19.98	7.95	6.55	14.25	7.83	18.16	7.51
Hannahstown	31.5	79	9.40	18.90	17.42	42.68	15.87	10.12	20.28	22.76	56.29	21.14
Kells	40	100	8.30	18.49	21.30	51.29	19.35	9.16	20.17	26.51	64.73	24.41

Table E-7: Northern Ireland short circuit currents for maximum demand in 2022

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Killymallaght	40	100	5.75	8.18	13.01	29.47	12.07	5.50	10.23	11.86	26.64	11.42
Knock	n/a	n/a	4.30	6.69	15.98	34.06	14.40	2.89	10.87	16.04	31.00	15.06
Larne	18.4	46.8	4.08	5.09	9.67	20.37	9.18	4.89	8.30	9.10	19.95	8.86
Limavady	40	100	3.62	4.38	8.17	16.73	7.37	4.46	7.10	8.45	18.17	7.94
Lisburn	18.4	46.8	5.25	7.58	12.18	27.10	11.40	5.06	9.41	11.91	26.31	11.44
Lisaghmore	31.5	79	4.23	6.66	10.30	21.88	9.65	4.61	9.26	9.79	21.20	9.49
Loguestown	26.2	65	3.51	4.84	6.72	13.65	6.06	4.23	6.84	7.00	14.87	6.58
Magherakeel Cluster	40	100	5.30	9.85	4.51	10.04	4.31	6.98	12.62	4.94	11.58	4.71
Newtownards	40	100	4.31	6.65	8.13	17.34	7.66	5.44	9.66	7.65	17.14	7.40
Newry	18.4	46.8	3.69	6.38	5.74	11.80	5.52	4.68	9.57	5.63	12.23	5.52
Omagh	40	100	4.74	7.37	16.96	36.94	15.00	5.18	9.84	16.85	37.38	15.69
Rasharkin	40	100	4.56	7.58	8.81	19.03	7.80	4.97	9.92	8.37	18.40	7.82
Rathgael	26.2	65	3.93	6.34	6.22	13.00	5.92	4.74	9.50	6.12	13.33	5.94
Rosebank	40	100	9.04	16.10	17.58	42.84	15.72	10.40	18.42	21.95	54.45	20.15
Slieve Kirk	40	100	4.40	6.48	9.18	19.67	8.70	5.46	11.46	7.46	16.72	7.28
Springtown	n/a	n/a	4.38	6.94	10.44	22.35	9.81	4.72	9.31	10.18	22.15	9.84
Strabane	18.4	46.8	4.62	6.12	16.63	36.02	15.03	5.10	9.34	15.96	35.31	15.12
Tandragee	31.5	79	8.29	17.41	23.96	57.69	21.63	9.18	19.83	28.45	69.49	26.46
Tremoge	40	100	4.01	5.70	9.56	20.07	9.02	4.49	9.23	8.72	18.79	8.44
Tamnamore	40	100	7.36	16.40	23.67	55.96	21.50	8.39	18.56	29.48	71.09	27.48
Waringstown	18.4	46.8	4.59	7.16	8.70	18.83	8.32					

Northern Ireland short circuit currents for minimum demand in 2025

Table E-8: Northern Ireland short circuit currents for minimum demand in 2025

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
275 kV												
Ballylumford	31.5	79	11.74	19.31	11.38	28.63	10.08	12.68	21.44	14.15	35.88	12.99
Castlereagh	10[48]	79	10.22	14.79	9.99	24.74	8.93	10.53	16.18	11.68	29.02	10.82
Coolkeeragh	10[48]	79	9.93	13.14	8.14	20.08	7.40	11.04	15.86	9.08	22.69	8.56
Hannahstown	31.5	79	10.36	15.34	10.03	24.89	8.97	10.17	15.57	11.35	28.08	10.55
Kells	10[48]	79	10.54	15.41	10.60	26.34	9.44	10.39	15.56	12.39	30.73	11.43
Kilroot	31.5	79	10.31	14.37	9.63	23.86	8.67	10.86	16.10	11.45	28.56	10.64
Magherafelt	10[48]	79	10.26	14.70	11.20	27.74	9.95	8.80	11.57	11.57	28.09	10.77
Moyle	31.5	79	11.66	18.98	11.22	28.21	9.95	12.54	20.92	13.89	35.19	12.77
Tandragee	10[48]	79	9.80	13.95	12.27	30.22	10.88	9.72	14.65	14.09	34.66	13.00
Tamnamore	40	100	10.00	14.14	11.46	28.30	10.19	10.21	15.94	12.74	31.54	11.80

48 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-8: Northern Ireland short circuit currents for minimum demand in 2025												
Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.11	8.76	4.29	9.06	3.84	5.72	12.50	4.09	9.26	3.88
Antrim	40	100	4.53	7.45	8.75	18.89	8.31	4.73	9.60	9.06	19.74	8.70
Ballylumford	40	100	10.67	21.46	13.91	34.61	12.92	11.78	23.90	17.73	44.63	16.75
Ballymena	40	100	4.70	8.47	7.93	17.24	7.57	5.01	11.68	7.88	17.38	7.54
Banbridge	18.4	46.8	3.97	6.33	6.13	12.84	5.97	4.94	9.67	6.20	13.63	6.17
Ballyvallagh	21.9	46.8	5.34	6.67	12.20	27.25	11.36	4.94	6.66	12.25	26.93	11.72
Ballynahinch	18.4	46.8	4.76	7.41	4.61	10.05	4.45	5.40	10.32	4.94	11.05	4.86
Belfast Central	n/a	n/a	10.82	13.79	9.08	22.63	8.47	6.35	11.65	11.82	27.27	11.21
Belfast North	n/a	n/a	4.98	8.14	10.64	23.41	10.03	3.43	12.14	11.60	23.45	11.18
Brockaghboy	40	100	6.23	9.10	4.95	11.39	4.23	5.89	10.04	4.01	9.14	3.78
Carnmoney	31.5	79	4.32	7.97	4.63	9.88	4.50	5.09	10.54	4.98	11.01	4.89
Castlereagh	31.5	79	15.51	21.71	10.47	27.06	9.68	16.32	23.07	14.36	37.26	13.47
Coleraine	40	100	4.24	5.91	8.81	18.72	7.81	4.94	7.76	9.95	21.86	9.39
Coolkeeragh	31.5	79	7.41	14.54	15.81	37.43	14.21	8.14	15.98	20.16	48.41	18.74
Creagh	31.5	79	3.51	4.27	7.61	15.46	7.23	4.34	6.76	8.14	17.39	7.94
Cregagh	26.2	65	12.43	16.34	9.79	24.78	9.09	8.65	12.10	13.03	31.55	12.29
Drumquin	40	100	6.27	10.31	7.40	17.03	6.79	6.49	14.92	6.52	15.10	6.26
Donegall North	31.5	79	8.06	14.18	11.93	28.60	11.17	6.10	11.90	15.13	34.64	14.40
Donegall South	n/a	n/a	6.06	9.17	9.75	22.29	9.24	5.29	9.58	11.08	24.69	10.70
Drumnakelly	31.5	79	7.02	11.33	17.20	40.37	15.79	7.03	12.12	19.53	45.83	18.50
Dungannon	40	100	6.47	11.07	16.09	37.24	14.76	6.62	12.40	18.28	42.47	17.32
Eden	25	62.5	4.56	7.24	6.43	13.88	6.18	5.05	9.30	6.93	15.31	6.76
Enniskillen	31.5	79	3.98	5.04	9.27	19.41	8.20	4.88	8.04	8.44	18.49	7.96
Finaghy	31.5	79	9.00	16.71	12.30	29.96	11.50	7.19	13.82	15.94	37.55	15.13
Glengormley	18.4	46.8	4.00	5.62	5.83	12.21	5.63	4.74	9.55	5.58	12.15	5.46
Gort Cluster	40	100	7.62	10.38	8.16	19.40	7.57	7.88	15.01	8.52	20.36	8.05
Hannahstown	31.5	79	9.99	20.83	13.29	32.82	12.37	10.45	21.24	17.49	43.42	16.52
Kells	40	100	8.93	16.88	16.81	40.89	15.29	9.63	18.40	21.85	53.68	19.97
Killymallaght	40	100	5.74	8.70	11.05	25.03	10.22	5.53	10.53	10.66	23.96	10.24

Table E-8: Northern Ireland short circuit currents for minimum demand in 2025

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Knock	n/a	n/a	6.72	8.75	9.51	22.14	8.85	3.98	11.82	11.21	23.47	10.67
Larne	18.4	46.8	4.54	5.71	8.05	17.38	7.65	5.20	8.70	8.06	17.90	7.84
Limavady	40	100	3.79	4.66	7.27	15.05	6.58	4.57	7.31	7.71	16.66	7.32
Lisburn	18.4	46.8	5.79	8.57	10.11	22.94	9.59	5.54	10.20	10.46	23.52	10.14
Lisaghmore	31.5	79	4.32	6.94	8.49	18.13	7.97	4.66	9.28	8.58	18.63	8.34
Loguestown	26.2	65	3.65	5.04	6.13	12.57	5.60	4.33	6.99	6.52	13.93	6.30
Magherakeel Cluster	40	100	5.59	10.77	4.37	9.85	4.19	7.33	13.73	4.89	11.55	4.69
Newtownards	40	100	5.60	7.78	6.00	13.53	5.73	6.33	10.39	6.24	14.39	6.10
Newry	18.4	46.8	3.84	6.55	5.20	10.79	5.08	4.78	9.59	5.27	11.49	5.27
Omagh	40	100	5.23	8.25	15.82	35.17	13.95	5.57	10.47	16.07	36.19	14.91
Omagh South	40	100	4.64	7.33	13.00	28.19	11.57	4.73	7.30	12.01	26.15	11.30
Rasharkin	40	100	4.80	7.85	8.14	17.79	7.19	5.13	10.16	7.87	17.42	7.39
Rathgael	26.2	65	4.83	7.14	4.87	10.64	4.69	5.37	10.04	5.17	11.55	5.10
Rosebank	40	100	13.72	18.37	9.98	25.52	9.26	13.94	19.26	13.50	34.56	12.71
Slieve Kirk	40	100	4.54	7.04	8.14	17.56	7.67	5.54	11.72	6.95	15.62	6.78
Springtown	n/a	n/a	4.43	7.17	8.56	18.37	8.05	4.75	9.30	8.87	19.32	8.57
Strabane	40	100	4.74	6.61	14.21	30.96	12.84	5.16	9.54	14.30	31.71	13.55
Tandragee	31.5	79	8.52	16.53	18.37	44.39	16.78	9.36	18.64	23.02	56.36	21.55
Tremoge	40	100	4.21	5.97	8.91	18.92	8.36	4.64	9.46	8.33	18.06	8.04
Tamnamore	40	100	7.64	15.46	18.93	45.02	17.18	8.50	17.26	24.46	59.10	22.70
Waringstown	18.4	46.8	4.86	7.58	7.69	16.84	7.41	5.53	10.38	7.61	17.10	7.50

Northern Ireland short circuit currents for maximum demand in 2025

Table E-9: Northern Ireland short circuit currents for maximum demand in 2025												
Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
275 kV												
Ballylumford	31.5	79	13.42	20.12	18.89	48.20	17.10	14.36	22.76	20.81	53.43	19.63
Castlereagh	10[49]	79	10.85	14.82	16.52	41.20	14.92	10.94	16.43	16.72	41.72	15.75
Coolkeeragh	10[49]	79	13.07	17.49	13.11	33.35	12.18	13.77	20.94	12.62	32.27	12.16
Hannahstown	31.5	79	10.96	15.06	16.25	40.56	14.73	10.32	15.17	15.80	39.15	14.95
Kells	10[49]	79	12.97	18.43	19.70	50.09	17.89	11.41	16.64	19.21	48.18	18.23
Kilroot	31.5	79	14.73	22.40	19.68	50.64	17.94	13.78	21.99	19.26	49.25	18.36
Magherafelt	10[49]	79	12.42	16.83	20.22	51.18	18.39	8.82	10.90	16.67	40.50	15.96
Moyle	31.5	79	13.22	19.54	18.49	47.08	16.76	14.08	21.90	20.28	51.97	19.15
Tandragee	10[49]	79	11.03	14.73	21.67	54.13	19.58	9.85	14.61	20.91	51.52	19.79
Tamnamore	40	100	11.63	15.45	20.96	52.68	19.05	10.72	17.83	19.27	47.99	18.34

49 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-9: Northern Ireland short circuit currents for maximum demand in 2025

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.09	8.78	4.39	9.25	3.92	5.72	12.58	4.16	9.42	3.94
Agivey	40	100	5.86	9.12	5.67	12.90	4.95	6.40	12.61	5.04	11.64	4.74
Antrim	40	100	4.17	7.08	10.22	21.63	9.74	4.48	9.39	10.04	21.61	9.67
Ballylumford	40	100	12.57	26.26	21.15	53.60	19.63	14.03	29.70	24.81	63.56	23.68
Ballymena	40	100	4.36	8.11	9.14	19.55	8.72	4.79	11.52	8.60	18.78	8.20
Banbridge	18.4	46.8	3.74	5.99	6.89	14.23	6.67	4.77	9.53	6.68	14.58	6.55
Ballyvallagh	21.9	46.8	4.68	5.47	16.18	35.15	15.16	4.51	5.90	14.65	31.57	14.11
Ballynahinch	18.4	46.8	4.35	7.09	5.25	11.21	4.91	5.11	10.15	5.39	11.93	5.16
Belfast Central	n/a	n/a	9.22	13.10	11.86	28.97	10.57	5.46	11.37	14.70	32.95	13.44
Belfast North	n/a	n/a	4.45	7.43	13.04	28.02	12.18	3.14	11.85	13.24	26.17	12.67
Brockaghboy	40	100	6.01	8.85	5.13	11.71	4.46	5.77	9.86	4.15	9.41	3.93
Carnmoney	31.5	79	3.70	6.24	4.95	10.18	4.79	4.52	8.58	5.21	11.25	5.11
Castlereagh	31.5	79	13.40	23.26	14.35	36.61	12.57	14.41	24.29	19.02	48.84	17.04
Coleraine	40	100	3.99	5.56	9.92	20.78	8.66	4.75	7.45	10.90	23.75	9.98
Coolkeeragh	31.5	79	9.62	21.80	23.67	58.16	21.13	10.53	23.37	28.05	69.70	26.10
Creagh	31.5	79	3.26	3.93	8.74	17.43	8.28	4.17	6.54	8.96	18.98	8.63
Cregagh	26.2	65	10.58	16.01	13.10	32.57	11.57	7.38	11.38	16.68	39.46	15.10
Drumquin	40	100	6.07	10.02	7.70	17.61	7.08	6.36	14.66	6.70	15.45	6.40
Donegall North	31.5	79	7.48	13.61	15.04	35.66	13.94	5.58	11.31	18.15	40.87	17.11
Donegall South	n/a	n/a	5.55	8.46	11.76	26.46	11.05	4.93	9.13	12.66	27.80	12.13
Drumnakelly	31.5	79	6.63	10.76	23.36	54.28	21.51	6.68	11.79	24.33	56.60	23.06
Dungannon	40	100	6.13	10.89	20.46	46.89	19.00	6.40	12.40	21.80	50.36	20.75
Eden	25	62.5	3.98	6.05	7.42	15.53	7.12	4.59	8.20	7.65	16.54	7.46
Enniskillen	31.5	79	3.86	4.89	9.92	20.62	8.77	4.81	7.97	8.84	19.32	8.34
Finaghy	31.5	79	8.47	16.54	15.62	37.73	14.46	6.66	13.28	19.32	44.92	18.17
Glengormley	18.4	46.8	3.58	5.59	6.09	12.44	5.89	4.32	8.97	5.90	12.59	5.74
Gort Cluster	40	100	7.38	9.95	8.72	20.62	8.15	7.67	14.71	8.89	21.14	8.43
Hannahstown	31.5	79	9.55	21.88	17.22	42.27	15.84	10.11	21.93	21.62	53.47	20.24
Kells	40	100	8.44	18.45	22.72	54.85	20.89	9.27	19.83	27.95	68.33	25.89

Table E-9: Northern Ireland short circuit currents for maximum demand in 2025

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Killymallaght	40	100	5.69	8.00	13.30	30.05	12.36	5.45	10.07	11.96	26.81	11.49
Knock	n/a	n/a	5.53	7.89	12.50	28.09	11.10	3.43	11.59	13.54	27.36	12.49
Larne	18.4	46.8	4.12	5.02	9.67	20.42	9.22	4.93	8.24	9.08	19.95	8.83
Limavady	40	100	3.59	4.34	8.15	16.66	7.35	4.43	7.08	8.39	18.01	7.90
Lisburn	18.4	46.8	5.29	7.81	12.21	27.20	11.51	5.20	9.77	11.80	26.22	11.37
Lisaghmore	31.5	79	4.19	6.57	10.44	22.14	9.81	4.59	9.21	9.86	21.33	9.55
Loguestown	26.2	65	3.49	4.82	6.68	13.56	6.01	4.22	6.82	6.95	14.75	6.52
Magherakeel Cluster	40	100	5.32	9.95	4.45	9.92	4.40	7.10	13.00	4.83	11.35	4.83
Newtownards	40	100	4.95	7.27	7.06	15.51	6.54	5.86	10.10	6.95	15.79	6.63
Newry	18.4	46.8	3.67	6.34	5.82	11.95	5.60	4.68	9.55	5.68	12.35	5.55
Omagh	40	100	4.84	7.67	17.85	39.07	15.91	5.34	10.15	17.58	39.26	16.32
Omagh South	40	100	4.34	6.93	14.18	30.31	12.72	4.55	7.03	12.73	27.49	11.99
Rasharkin	40	100	4.51	7.51	8.79	18.94	7.81	4.94	9.84	8.33	18.30	7.79
Rathgael	26.2	65	4.38	6.80	5.57	11.93	5.21	5.07	9.85	5.69	12.57	5.45
Rosebank	40	100	11.82	18.75	13.46	33.90	11.87	12.33	19.49	17.55	44.40	15.84
Slieve Kirk	40	100	4.36	6.37	9.35	19.99	8.84	5.40	11.47	7.48	16.74	7.20
Springtown	n/a	n/a	4.32	6.77	10.58	22.60	9.98	4.67	9.16	10.21	22.18	9.90
Strabane	40	100	4.55	5.97	17.10	36.93	15.58	5.04	9.24	16.16	35.67	15.38
Tandragee	31.5	79	8.49	17.95	25.60	61.86	23.45	9.35	20.06	29.93	73.26	28.09
Tremoge	40	100	3.99	5.65	9.74	20.41	9.19	4.50	9.25	8.83	19.03	8.48
Tamnamore	40	100	7.47	16.95	25.29	59.95	23.33	8.53	19.18	31.13	75.25	29.29
Waringstown	18.4	46.8	4.58	7.16	8.90	19.26	8.54	4.58	7.16	8.90	19.26	8.54

Northern Ireland short circuit currents for minimum demand in 2028

Table E-10: Northern Ireland short circuit currents for minimum demand in 2028												
Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
400 kV												
Turleenan	50	125	14.08	17.87	8.47	21.71	7.88	12.53	17.90	9.76	24.73	9.32
275 kV												
Ballylumford	31.5	79	12.21	18.92	13.12	33.16	11.76	13.26	21.37	15.80	40.27	14.67
Castlereagh	10[50]	79	10.61	14.80	11.72	29.15	10.59	10.68	15.99	12.91	32.13	12.09
Coolkeeragh	1023	79	10.55	13.54	9.24	22.97	8.49	11.70	16.59	9.94	25.00	9.44
Hannahstown	31.5	79	10.76	15.22	11.60	28.89	10.48	10.41	15.64	12.45	30.89	11.68
Kells	1023	79	11.03	15.27	12.40	30.99	11.18	10.70	15.45	13.91	34.64	12.97
Kilroot	31.5	79	10.75	14.21	11.14	27.75	10.15	11.30	16.20	12.78	32.02	12.00
Magherafelt	1023	79	11.07	15.20	13.74	34.35	12.33	8.92	11.36	13.23	32.19	12.45
Moyle	31.5	79	12.11	18.58	12.92	32.62	11.60	13.09	20.80	15.49	39.41	14.40
Tandragee	1023	79	10.63	14.65	15.31	38.09	13.67	9.93	14.89	16.45	40.60	15.34
Tamnamore	40	100	11.05	15.17	14.87	37.17	13.32	10.66	17.42	15.40	38.33	14.41
Turleenan	40	100	11.09	15.26	15.18	37.95	13.59	10.13	15.75	15.58	38.52	14.58

50 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-10: Northern Ireland short circuit currents for minimum demand in 2028

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.10	8.75	4.32	9.11	3.86	5.70	12.49	4.11	9.30	3.90
Agivey	40	100	6.04	9.33	5.47	12.50	4.73	6.55	12.86	4.90	11.35	4.59
Antrim	40	100	4.46	7.37	9.05	19.46	8.63	4.68	9.58	9.26	20.11	8.92
Airport Road	40	100	4.46	6.66	8.03	17.26	7.69	5.03	9.58	8.00	17.65	7.79
Ballylumford	40	100	10.80	21.98	14.57	36.32	13.68	12.00	24.62	18.33	46.23	17.46
Ballymena	40	100	4.65	8.44	8.19	17.76	7.84	5.00	11.74	8.09	17.82	7.72
Banbridge	18.4	46.8	3.86	7.00	6.33	13.17	6.15	3.75	5.20	4.86	10.03	4.79
Ballyvallagh	21.9	46.8	5.24	6.37	12.87	28.63	12.07	4.20	4.73	11.27	23.90	10.85
Ballynahinch	18.4	46.8	4.02	6.65	5.54	11.64	5.36	4.86	9.72	5.66	12.39	5.53
Belfast Central	40	100	9.59	15.13	17.54	43.08	16.05	7.31	13.97	21.67	51.19	20.25
Belfast North	40	100	9.59	15.21	17.61	43.26	16.11	46.67	66.26	9.79	26.84	9.49
Brockaghboy	40	100	6.17	9.03	4.95	11.35	4.26	5.87	9.98	4.03	9.16	3.80
Carnmoney	31.5	79	3.90	6.62	4.41	9.18	4.29	4.65	8.82	4.79	10.40	4.71
Castlereagh	31.5	79	10.14	17.04	17.43	43.11	15.93	11.46	18.89	22.68	56.90	21.11
Coleraine	40	100	4.23	5.95	9.22	19.59	8.07	5.01	7.93	10.33	22.77	9.53
Coolkeeragh	31.5	79	7.83	15.88	17.20	41.07	15.47	8.63	17.45	21.60	52.31	20.05
Creagh	31.5	79	3.45	4.20	7.91	16.00	7.53	4.32	6.57	8.51	18.16	8.21
Cregagh	26.2	65	9.31	14.43	16.90	41.34	15.49	7.29	10.56	21.21	50.08	19.84
Drumquin	40	100	6.21	10.23	7.48	17.19	6.89	6.45	14.85	6.57	15.19	6.31
Donegall North	31.5	79	8.88	14.21	17.16	41.72	15.77	5.68	11.16	19.71	44.56	18.57
Donegall South	n/a	n/a	5.46	7.53	12.24	27.44	11.51	5.01	8.60	12.96	28.57	12.46
Drumnakelly	31.5	79	6.95	11.37	19.38	45.40	17.91	7.01	12.38	21.28	49.91	20.19
Dungannon	40	100	6.52	11.29	17.60	40.80	16.28	6.75	12.99	19.67	45.86	18.66
Eden	25	62.5	4.29	6.68	6.32	13.48	6.11	4.81	8.64	6.83	14.93	6.68
Enniskillen	31.5	79	3.94	5.00	9.36	19.55	8.32	4.85	8.02	8.48	18.57	8.02
Finaghy	31.5	79	8.57	13.60	16.53	39.99	15.26	6.99	12.00	19.97	46.82	18.81
Glengormley	18.4	46.8	3.75	5.77	5.61	11.59	5.45	4.45	9.05	5.61	12.06	5.49
Gort Cluster	40	100	7.58	10.27	8.34	19.82	7.77	7.86	14.95	8.65	20.66	8.19
Hannahstown	31.5	79	9.80	17.19	18.37	45.24	16.83	11.02	18.94	22.42	56.02	20.98

Table E-10: Northern Ireland short circuit currents for minimum demand in 2028

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Kells	40	100	8.89	17.23	17.93	43.59	16.47	9.61	18.81	23.05	56.63	21.20
Killymallaght	40	100	5.75	8.58	11.50	26.04	10.67	5.52	10.49	10.91	24.52	10.49
Knock	n/a	n/a	4.42	6.66	14.77	31.70	13.68	3.03	10.91	15.32	29.99	14.61
Larne	18.4	46.8	4.47	5.54	8.35	17.97	7.97	3.84	4.30	6.43	13.35	6.28
Limavady	40	100	3.75	4.58	7.49	15.47	6.77	3.55	4.13	6.12	12.47	5.86
Lisburn	18.4	46.8	5.28	7.43	12.08	26.92	11.42	5.30	9.57	11.73	26.14	11.32
Lisaghmore	31.5	79	4.33	6.99	8.89	18.98	8.34	4.70	9.45	8.90	19.36	8.60
Loguestown	26.2	65	3.65	5.09	6.35	13.01	5.74	4.37	7.02	6.80	14.56	6.42
Magherakeel Cluster	40	100	5.52	10.54	4.38	9.83	4.22	7.26	13.52	4.85	11.45	4.70
Newtownards	40	100	4.40	6.67	7.69	16.48	7.36	5.46	9.62	7.40	16.60	7.21
Newry	18.4	46.8	3.83	6.46	5.46	11.33	5.30	4.84	9.51	5.55	12.14	5.45
Omagh	40	100	5.13	8.06	16.37	36.25	14.55	5.50	10.34	16.44	36.93	15.33
Omagh South	40	100	4.56	7.20	13.30	28.72	11.92	4.68	7.22	12.17	26.45	11.50
Rasharkin	40	100	4.72	7.75	8.31	18.09	7.35	5.08	10.07	7.99	17.66	7.49
Rathgael	26.2	65	4.02	6.36	5.93	12.44	5.72	4.80	9.43	5.99	13.08	5.86
Rosebank	40	100	9.16	14.33	16.12	39.35	14.82	10.12	15.94	20.61	50.97	19.29
Slieve Kirk	40	100	4.50	6.90	8.36	18.01	7.91	5.54	11.62	7.06	15.87	6.88
Springtown	n/a	n/a	4.43	7.16	8.94	19.19	8.43	4.75	9.35	9.12	19.88	8.83
Strabane	40	100	4.70	6.46	14.84	32.28	13.49	5.14	9.48	14.70	32.57	13.96
Tandragee	31.5	79	8.59	17.57	20.93	50.65	19.25	9.45	19.57	25.25	61.90	23.77
Tremoge	40	100	4.15	5.84	9.19	19.44	8.67	4.60	9.40	8.49	18.38	8.21
Tamnamore	40	100	7.89	16.72	21.12	50.47	19.34	8.82	18.78	26.82	65.14	25.08
Waringstown	18.4	46.8	4.80	7.62	8.16	17.82	7.87	5.54	10.53	7.98	17.94	7.80

Northern Ireland short circuit currents for maximum demand in 2028

Table E-11: Northern Ireland short circuit currents for maximum demand in 2028

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
400 kV												
Turleenan	50	125	15.60	19.33	10.24	26.48	9.76	12.96	18.61	11.17	28.41	10.89
275 kV												
Ballylumford	31.5	79	13.38	19.97	19.02	48.50	17.28	14.41	22.71	20.84	53.53	19.74
Castlereagh	10[51]	79	10.80	14.75	16.72	41.67	15.19	10.66	15.94	16.37	40.72	15.52
Coolkeeragh	1025	79	13.01	17.39	13.07	33.23	12.25	13.75	20.88	12.58	32.16	12.21
Hannahstown	31.5	79	10.92	15.02	16.37	40.84	14.88	10.33	15.38	15.59	38.65	14.82
Kells	1025	79	13.03	18.35	19.86	50.52	18.13	11.46	16.65	19.20	48.17	18.31
Kilroot	31.5	79	14.73	22.22	19.80	50.96	18.13	13.84	21.95	19.28	49.33	18.46
Magherafelt	1025	79	12.39	16.71	20.37	51.56	18.67	8.82	10.86	16.70	40.57	16.08
Moyle	31.5	79	13.18	19.40	18.61	47.37	16.93	14.12	21.86	20.31	52.06	19.25
Tandragee	1025	79	10.95	14.60	21.92	54.73	19.95	9.80	14.62	20.92	51.52	19.92
Tamnamore	40	100	11.61	15.38	21.26	53.43	19.47	10.73	17.86	19.44	48.41	18.60
Turleenan	40	100	11.61	15.38	21.66	54.43	19.82	10.05	15.72	19.63	48.49	18.77

51 The switchgear ratings at Castlereagh, Coolkeeragh, Magherafelt, Tandragee and Kells 275 kV substations have been temporarily reduced to 10 kA by NIE Networks following review of the capability of concrete.

Table E-11: Northern Ireland short circuit currents for maximum demand in 2028

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
110 kV												
Aghyoule	40	100	4.09	8.78	4.38	9.24	3.92	5.72	12.57	4.16	9.41	3.94
Agivey	40	100	6.32	8.82	6.54	15.07	5.79	6.99	13.20	5.57	13.06	5.27
Antrim	40	100	4.15	7.00	10.31	21.79	9.86	4.48	9.35	10.06	21.66	9.74
Airport Road	40	100	4.09	6.30	8.92	18.80	8.44	4.77	9.35	8.50	18.54	8.23
Ballylumford	40	100	12.42	26.10	21.23	53.72	19.74	14.01	29.74	24.75	63.40	23.69
Ballymena	40	100	4.34	8.04	9.21	19.68	8.83	4.80	11.48	8.60	18.79	8.28
Banbridge	18.4	46.8	3.71	6.83	6.81	14.02	6.63	3.67	5.10	5.05	10.38	4.99
Ballyvallagh	21.9	46.8	4.65	5.41	16.28	35.32	15.30	3.88	4.24	12.80	26.67	12.44
Ballynahinch	18.4	46.8	3.81	6.45	6.00	12.44	5.71	4.73	9.61	5.95	12.94	5.74
Belfast Central	40	100	8.40	14.50	22.80	55.00	20.16	6.41	13.29	26.03	60.14	23.82
Belfast North	40	100	8.42	14.59	22.88	55.20	20.24	48.19	72.31	10.84	29.75	10.46
Brockaghboy	40	100	6.41	8.53	5.79	13.38	5.09	6.08	9.83	4.50	10.30	4.28
Carnmoney	31.5	79	3.71	6.22	4.96	10.22	4.80	4.54	8.56	5.25	11.33	5.15
Castlereagh	31.5	79	8.90	16.72	22.75	55.31	20.06	10.71	19.22	27.94	69.58	25.37
Coleraine	40	100	3.95	5.22	10.72	22.40	9.61	4.86	7.40	11.32	24.80	10.63
Coolkeeragh	31.5	79	9.52	21.93	23.24	57.04	21.27	10.46	23.49	27.64	68.63	26.24
Creagh	31.5	79	3.69	4.45	9.92	20.41	9.39	5.74	8.31	8.75	19.81	8.43
Cregagh	26.2	65	8.15	13.74	21.79	52.32	19.32	6.52	10.01	25.51	59.11	23.35
Drumquin	40	100	6.08	10.07	7.64	17.49	7.11	6.36	14.70	6.66	15.37	6.44
Donegall North	31.5	79	7.86	13.52	21.88	52.27	19.58	5.08	10.61	23.29	51.48	21.61
Donegall South	n/a	n/a	4.89	6.94	14.36	31.49	13.32	4.63	8.23	14.35	31.11	13.70
Drumnakelly	31.5	79	6.42	10.83	23.41	54.10	21.88	6.59	11.89	24.21	56.21	23.18
Dungannon	40	100	6.13	11.04	20.14	46.18	19.13	6.41	12.59	21.57	49.85	20.88
Eden	25	62.5	3.98	6.04	7.44	15.58	7.14	4.60	8.20	7.68	16.63	7.51
Enniskillen	31.5	79	3.87	4.92	9.89	20.59	8.79	4.85	8.02	8.90	19.48	8.38
Finaghy	31.5	79	7.60	12.90	20.75	49.31	18.73	6.31	11.39	23.62	54.42	21.95
Glengormley	18.4	46.8	3.57	5.55	6.11	12.47	5.94	4.32	8.95	5.90	12.59	5.77
Gort Cluster	40	100	7.37	9.97	8.62	20.38	8.17	7.65	14.70	8.81	20.96	8.45
Hannahstown	31.5	80	8.70	16.94	23.73	57.54	21.16	10.18	18.75	27.24	67.40	25.08

Table E-11: Northern Ireland short circuit currents for maximum demand in 2028

Node	Rating		Three phase					Single phase				
	RMS [kA]	Peak [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]	X/R ratio (AC)	X/R ratio (DC)	I'' [kA]	ip [kA]	IB [kA]
Kells	40	100	8.57	18.21	23.28	56.32	21.44	9.59	19.95	28.06	68.93	26.13
Killymallaght	40	100	5.49	7.31	12.57	28.22	12.31	5.38	9.60	11.57	25.87	11.52
Knock	n/a	n/a	3.77	6.04	18.20	37.63	16.41	2.81	10.77	17.17	32.96	16.15
Larne	18.4	46.8	4.11	4.98	9.72	20.51	9.29	3.66	4.04	6.93	14.23	6.80
Limavady	40	100	3.55	4.23	8.32	16.96	7.66	3.45	3.95	6.47	13.08	6.26
Lisburn	18.4	46.8	4.77	6.87	13.97	30.47	13.09	4.98	9.24	12.74	28.04	12.26
Lisaghmore	31.5	79	4.21	6.67	10.36	21.99	9.88	4.62	9.31	9.84	21.31	9.61
Loguestown	26.2	65	3.45	4.62	7.02	14.21	6.47	4.27	6.68	7.19	15.30	6.85
Magherakeel Cluster	40	100	5.44	10.46	4.50	10.08	4.32	7.18	13.42	4.98	11.72	4.73
Newtownards	40	100	4.07	6.36	8.52	17.93	8.05	5.23	9.44	7.87	17.50	7.59
Newry	18.4	46.8	3.68	6.35	5.83	11.98	5.62	4.74	9.56	5.71	12.44	5.57
Omagh	40	100	4.85	7.64	17.41	38.11	15.90	5.31	10.04	17.23	38.43	16.40
Omagh South	40	100	4.36	6.96	13.97	29.89	12.73	4.56	7.04	12.61	27.23	12.04
Rasharkin	40	100	5.03	7.50	12.02	26.52	10.92	5.52	10.81	10.12	22.73	9.66
Rathgael	26.2	65	3.77	6.12	6.41	13.27	6.11	4.63	9.29	6.25	13.56	6.08
Rosebank	40	100	8.04	13.65	20.54	49.22	18.30	9.24	15.41	24.84	60.71	22.77
Slieve Kirk	40	100	4.07	4.88	8.69	18.29	8.76	5.09	9.55	7.13	15.77	7.25
Springtown	n/a	n/a	4.35	6.90	10.49	22.43	10.05	4.70	9.29	10.18	22.15	9.97
Strabane	40	100	4.53	5.87	16.31	35.18	15.59	5.03	9.06	15.74	34.73	15.50
Tandragee	31.5	79	8.06	17.93	25.73	61.70	23.93	9.09	20.02	29.61	72.20	28.14
Tremoge	40	100	3.72	4.36	9.06	18.67	9.08	4.27	7.84	8.39	17.87	8.47
Tamnamore	40	100	7.44	17.20	24.84	58.83	23.53	8.46	19.39	30.64	73.99	29.51
Waringstown	18.4	46.8	4.53	7.19	8.88	19.17	8.60	5.32	10.19	8.35	18.63	8.20

Appendix F: Approaches to consultation for developing the grid

F-1 EirGrid approach to consultation

In December 2016, EirGrid launched Have Your Say[52], which outlines our approach to consultation. It followed a review of our consultation activities, after which, we made a commitment to improve the way we engage with the public and stakeholders.

Have Your Say outlines the way we develop our projects and how the public can engage with us at each stage of project development.

F-2 SONI approach to consultation

SONI has reviewed its approach to engaging and consulting with the public and stakeholders, this included independent analysis by The Consultation Institute (TCI) which made a number of recommendations. Following engagement with a range of stakeholders and in line with TCI's recommendations, SONI has developed a new Grid Development Process[53]. This three part process puts stakeholders and the community at the heart of what we do. To find out more visit www.soni.ltd.uk and if you have any queries you can contact us at info@soni.ltd.uk.

52 http://www.eirgridgroup.com/the-grid/
53 http://www.soni.ltd.uk/media/SONIs-Powering-The-Future-Grid-Development-Process-brochure.pdf

Appendix G: References

The following documents are referenced in this All-Island Ten Year Transmission Forecast Statement.

All-Island Generation Capacity Statement 2022–2031

EirGrid and SONI issued this report in August 2022. Its main purpose is to inform market participants, regulatory agencies and policy makers of the likely minimum generation capacity required to achieve an adequate supply and demand balance for electricity for the period 2022 to 2031.

Available on:
https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_SONI_Ireland_Capacity_Outlook_2022–2031.pdf

Transmission Development Plan Ireland 2021–2030, CRU approved version published in August 2022

The main purpose of this document is to document the plan for the development of the Irish transmission system and interconnection for the following 10 year period.

Available on:
https://www.eirgridgroup.com/site-files/library/EirGrid/Transmission-Development-Plan-2021–2030.pdf

Transmission Development Plan Northern Ireland 2021–2030, UR approved version published in October 2022

The main purpose of this document is to document the plan for the development of the Northern Ireland transmission system and interconnection for the following 10 year period.

Available on:
https://www.soni.ltd.uk/media/documents/Transmission-Development-Plan-Northern-Ireland-2021–2030.pdf

EirGrid Grid Code Version 9.0, December 2020

The EirGrid Grid Code covers technical aspects relating to the operation and use of the transmission system, and to plant and apparatus connected to the transmission system or to the distribution system.

Available on:
http://www.eirgridgroup.com/site-files/library/EirGrid/GridCodeVersion9.pdf

SONI Grid Code, October 2020

The SONI Grid Code is designed to permit the development, maintenance and operation of an efficient, co-ordinated and economical Transmission System in Northern Ireland. The grid code is prepared by SONI pursuant to condition 16 of SONI's Licence.

Available on:
https://www.soni.ltd.uk/media/documents/SONI-Grid-Code-8th-October-2020.pdf

Transmission System Security and Planning Standards Ireland, May 2016

This document sets out the technical standards by which the adequacy of the grid in Ireland is determined.

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

Transmission System Security and Planning Standards Northern Ireland, September 2015

This document sets out the technical standards by which the adequacy of the grid in Northern Ireland is determined.

Available on:
https://www.soni.ltd.uk/media/Northern-Ireland-TSSPS-September-2015.pdf

Electricity Regulation Act, 1999

This act provides the regulatory framework for the introduction of competition in the generation and supply of electricity in Ireland. The Act provided for the establishment of the Commission for Regulation of Utilities (CRU) (previously called the Commission for Energy Regulation) and gave it the necessary powers to licence and regulate the generation, distribution, transmission and supply of electricity.

Available on:
www.cru.ie

EirGrid's TSO Licence

On June 29 2006, the CER issued a Transmission System Operator (TSO) Licence to EirGrid plc. pursuant to Section 14(1)(e) of the Electricity Regulation Act, 1999, as inserted by Regulation 32 of S.I. No. 445 of 2000 – European Communities (Internal Market in Electricity) Regulations 2001. The most recent update was issued in Mach 2017.

Available on:
www.cru.ie

SONI's Licence to Participate in the Transmission of Electricity, updated to February 2019

Condition 33 requires SONI to prepare a statement (in a form; in consultation with EirGrid; and based on methodologies approved by UREGNI) showing in respect of each of the ten succeeding financial years; circuit capacity; forecast electrical flows and loading on each part of the transmission system; and fault levels for each transmission node.

Available on:
www.uregni.gov.uk

Ireland's Climate Action Plan published by the Department of Communications, Climate Action and Environment

Available on:
www.dccae.gov.ie.

Appendix H: Power flows

This appendix presents sample power flows for Summer Valley and Winter Peak for the years 2022 and 2031 based on a particular set of assumptions. Table H-1 shows the MW and MVAR flows on all lines in the transmission system and the percentage loading of the lines relative to their seasonal rating.

The flows shown are based on the following assumptions:

- Wind generation operating at 30% of capacity at the Winter Peak, and 0% at the Summer Valley;
- Solar power operating at 0% of capacity at the Winter Peak and 10% at Summer Valley; and
- Power stations dispatched according to system constraints and merit order.

Indeed, the transmission system needs to be capable of accommodating a diverse range of power flows as they can vary greatly throughout the day and year. Power flows depend on system conditions, such as the level of demand, generation and interconnection, and the availability of plant which can be out of service unexpectedly or due to planned maintenance.

Data fields without data (but with a hyphen) denote lines which do not exist in the associated case, due to either being decommissioned or not yet constructed.

Power flows, Summer Valley and Winter Peak 2022 and 2031

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
DSN	CNB	400	1	–	–	–	–	–	–	-187.7	-44.8	12.2	-213.9	-12.2	11.0
KPG	MP	400	1	–	–	–	–	–	–	166.3	-18.2	13.8	228.7	-16.3	19.0
CNB	MP	400	1	–	–	–	–	–	–	-222.7	-99.4	15.5	-271.7	-90.8	14.7
MP	OST	400	1	35.2	30.3	4.7	278.2	-7.0	27.9	39.0	27.1	4.8	104.7	54.7	11.9
OST	WOO	400	1	-39.4	153.0	15.8	191.7	71.0	20.5	277.0	25.8	27.9	282.5	175.8	33.4
WOO	PRT	400	1	-199.9	173.3	38.6	-399.8	-62.0	59.1	-200.0	63.5	30.6	-499.8	71.3	73.7
WOO	TUR	400	1	–	–	–	–	–	–	-81.3	-41.8	6.4	378.7	-41.3	22.0
LOU	TAN	275	1	108.3	-15.2	15.4	-42.8	0.3	4.9	-120.3	0.2	16.9	57.0	11.4	6.6
LOU	TAN	275	2	108.2	-16.4	15.4	-42.2	1.9	4.8	-120.4	1.5	17.0	57.2	10.8	6.6
BPS	HAN	275	2	-14.8	-16.4	3.1	174.0	9.2	19.8	119.9	1.1	16.9	167.5	-0.6	19.0
BPS	KEL	275	1	-131.9	10.7	18.6	33.0	48.1	6.6	115.2	32.5	16.9	27.4	46.2	6.1
BPS	MAG	275	1	-92.3	-7.0	13.0	22.9	7.9	2.7	73.1	15.2	10.5	27.0	9.6	3.3
BPS	BYC	275	1	280.6	32.6	39.8	95.5	-16.2	11.0	41.5	-31.5	7.3	89.0	-31.3	10.7
CAS	HAN	275	1	34.9	-6.7	5.0	-73.9	-29.4	9.0	-74.7	-29.7	11.3	-90.2	-18.7	10.5
CAS	HAN	275	2	34.9	-6.7	5.0	-73.9	-29.4	9.0	-74.7	-29.7	11.3	-90.2	-18.7	10.5
CAS	KPS	275	1	-74.0	6.4	10.5	-140.0	17.5	16.0	-24.5	-4.4	3.5	-155.6	20.7	17.8
CAS	TAN	275	1	-100.0	22.7	14.4	-20.8	12.7	2.8	68.6	29.5	10.5	-112.9	24.6	13.1
CPS	CPS	275	1	86.2	-17.4	11.6	134.1	-7.8	16.1	62.4	-26.3	8.9	-19.4	-14.0	2.9
CPS	CPS	275	1	86.2	-17.4	11.6	134.1	-7.8	16.1	62.4	-26.3	8.9	-19.4	-13.4	2.8
CPS	MAG	275	1	86.2	-13.1	21.2	134.1	-3.6	16.0	62.4	-22.3	8.7	-19.4	-9.8	2.6
CPS	MAG	275	2	86.2	-13.1	21.2	134.1	-3.6	16.0	62.4	-22.3	8.7	-19.4	-9.8	2.6
HAN	BYC	275	1	20.1	5.1	2.9	-174.7	-16.3	19.9	-121.0	-10.6	17.1	-168.3	-7.0	19.1
KEL	KPS	275	1	-58.6	0.1	8.3	-45.5	25.9	5.9	41.8	-10.6	6.1	-74.0	12.2	8.5
KEL	KPS	275	2	-58.6	0.1	8.3	-45.5	25.9	5.9	41.8	-10.6	6.1	-74.0	12.2	8.5
KEL	MAG	275	1	-47.9	-18.0	7.2	11.4	-27.1	3.3	26.0	4.7	3.7	26.1	-21.5	3.8
KPS	TAN	275	1	4.5	-7.6	1.3	104.0	-18.1	12.0	58.9	6.4	8.4	64.8	-15.2	7.6
MAG	TMN	275	1	15.5	1.5	2.2	150.8	10.7	17.2	111.8	12.7	15.8	7.2	11.8	1.6
MAG	TMN	275	2	15.5	1.5	2.2	150.8	10.7	17.2	111.8	12.7	15.8	7.2	11.8	1.6
TAN	TUR	275	1	–	–	–	–	–	–	-77.0	-22.7	11.3	-119.9	-7.7	13.6

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
TAN	TUR	275	2	–	–	–	–	–	–	-77.0	-22.7	11.3	-119.9	-7.7	13.6
TMN	TUR	275	1	–	–	–	–	–	–	117.9	3.8	16.6	-67.5	12.9	7.8
TMN	TUR	275	2	–	–	–	–	–	–	–	–	–	-67.5	12.9	7.8
AD	AD	220	1	39.7	-23.7	7.8	87.3	-116.0	24.5	-139.2	52.9	25.1	137.1	-115.0	30.2
AD	AD	220	1	39.7	-23.7	7.8	87.3	-116.0	24.5	-139.2	52.9	25.1	69.4	4.9	11.7
AD	KRA	220	1	96.9	-87.6	33.2	105.4	19.8	22.9	79.7	-20.7	21.0	239.0	16.6	51.2
AD	RAF	220	1	62.5	-70.6	21.7	95.3	5.0	18.6	35.9	-25.8	10.2	169.0	-20.4	33.2
AD	AD	220	1	39.7	-23.7	7.8	87.3	-116.0	24.5	-139.2	52.9	25.1	-455.7	102.5	78.8
AD	GGO	220	1	-55.9	62.4	14.6	-16.6	-3.8	3.0	-217.8	73.1	40.1	-98.4	-131.8	28.7
AD	KRA	220	2	95.7	-86.1	32.8	103.8	19.8	22.6	78.6	-20.2	20.7	235.5	16.8	50.5
ARK	CKM	220	1	36.4	-6.4	8.5	82.9	-23.5	16.8	130.0	-18.1	30.2	236.3	-81.1	48.7
ARK	LWD	220	1	-54.6	8.5	12.7	-119.4	6.3	27.5	-134.4	15.4	31.2	-277.9	76.4	66.3
BVK	CLA	220	1	-69.0	175.1	25.4	180.6	-1.6	22.8	-14.0	5.5	2.0	-116.0	36.6	15.4
BVK	BYH	220	1	69.0	-99.7	27.9	-79.7	-6.6	10.1	86.9	-28.6	12.0	216.8	-39.6	27.8
BLC	FIN (I)	220	1	-52.5	11.3	9.4	-151.5	22.1	26.9	-66.0	68.6	16.7	-34.8	-18.9	7.0
BLC	SHL	220	1	–	–	–	-10.8	-48.8	8.8	-35.4	-71.8	14.0	-145.7	-16.5	25.7
CLE	CDU	220	1	-5.3	-1.4	1.3	91.6	-23.0	18.4	148.8	-88.4	39.9	-93.6	-47.6	20.5
CLE	WOO	220	1	-67.7	-8.6	15.7	-183.5	7.7	35.8	-288.9	46.2	67.4	-45.7	10.4	9.1
CLE	BTN	220	1	0.0	-8.5	1.5	0.0	-9.6	1.7	0.0	-8.2	1.4	0.0	-9.5	1.7
CLE	BTN	220	2	0.0	-8.5	1.5	0.0	-9.6	1.7	0.0	-8.2	1.4	0.0	-9.5	1.7
CLA	KRA	220	1	-97.3	155.1	28.3	78.7	-28.0	11.1	-5.4	7.0	1.4	-163.5	15.9	21.9
CSH	FLA	220	1	60.7	11.6	17.7	146.1	-5.5	33.5	46.9	-10.0	13.7	153.0	3.3	35.1
CSH	PRO	220	1	-58.0	-4.5	14.8	-224.7	28.9	48.4	19.2	-24.1	7.9	-86.5	-0.8	18.5
CSH	TYN	220	1	-73.9	63.3	12.8	-83.6	-21.0	10.9	-95.4	48.3	14.1	-201.4	-1.1	25.4
CKM	DSN	220	1	-95.9	-8.3	22.2	-123.7	26.8	24.7	-211.3	25.6	49.0	-70.9	47.4	16.6
CKM	ISH	220	1	140.7	-63.0	26.0	-80.2	-194.2	35.4	204.8	-32.0	35.0	-10.5	-196.8	33.2
CKM	CKM	220	1	-89.6	-19.7	26.2	69.7	-26.3	21.3	62.3	-10.2	18.1	104.7	-8.2	30.0
CUL	GI	220	1	-51.0	54.7	10.0	15.3	-38.4	5.2	52.5	-7.0	7.1	-108.6	44.2	14.8
CUL	KRA	220	1	1.6	-31.5	4.9	-120.5	19.0	16.0	-85.6	7.9	13.3	-40.3	-46.3	8.0
CDU	CRH	220	1	–	–	–	15.7	0.5	2.8	25.4	4.6	4.5	25.4	3.9	4.5

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
CDU	CRH	220	2	–	–	–	15.7	0.5	2.8	25.4	4.6	4.5	25.4	3.9	4.5
CDU	FIN (I)	220	1	54.1	-89.4	24.1	194.3	-25.9	38.2	127.5	-109.1	38.7	-23.0	6.6	4.7
CDU	HN	220	1	-219.5	185.9	51.8	-399.0	-87.7	73.6	0.0	-13.3	2.4	-398.8	-206.1	80.9
CDU	FIN (I)	220	2	54.1	-89.4	24.1	194.3	-25.9	38.2	127.5	-109.1	38.7	-23.0	6.6	4.7
CDU	WOO	220	2	-49.6	-6.8	11.5	-164.6	12.0	32.2	-260.8	61.1	61.7	-8.1	20.7	4.3
DSN	KLS	220	1	-0.8	7.0	1.8	-20.8	18.1	5.9	-66.8	17.8	17.6	-211.7	101.6	50.2
DSN	MAY	220	1	101.8	-17.1	29.5	158.6	-14.7	36.5	130.6	4.5	30.1	176.4	-11.4	34.5
DSN	MAY	220	2	198.4	-31.8	57.4	165.9	-21.2	38.4	130.6	4.5	30.1	176.4	-11.4	34.5
DSN	TH	220	1	-494.0	165.9	148.5	-91.5	8.0	26.2	-220.3	32.5	63.5	1.4	-15.5	4.4
FLA	LOU	220	1	-0.2	57.9	15.1	31.9	-6.2	6.8	56.4	0.8	14.7	49.8	8.0	10.6
FLA	SRA	220	1	31.1	-27.8	9.6	35.3	-2.4	6.9	-23.1	-1.8	5.3	36.5	-10.6	7.4
FIN (I)	HN	220	1	0.0	-4.0	0.7	-214.0	15.4	36.2	0.0	-3.8	0.7	-352.0	-4.6	59.4
FIN (I)	NW	220	1	-24.3	-56.5	18.5	41.5	-61.2	22.3	-0.4	-97.4	29.3	-159.5	-27.4	48.7
GI	KLS	220	1	51.8	-29.3	15.1	139.9	19.4	30.2	74.0	-5.3	18.9	326.6	-8.7	69.8
GI	LWD	220	1	75.2	-37.5	19.4	151.7	2.5	29.6	124.1	-16.7	28.9	330.8	-43.5	65.0
GI	LWN	220	1	–	–	–	–	–	–	-180.0	22.0	30.6	-499.7	306.1	98.8
GOR	LOU	220	1	128.3	-42.6	31.2	-22.3	2.0	4.7	-93.1	7.6	21.5	44.9	6.2	9.5
GOR	MAY	220	1	-192.7	67.4	58.3	-90.4	-17.9	21.1	40.8	-5.1	11.8	-179.1	-19.9	41.3
GGO	RAF	220	1	141.6	-141.8	35.2	181.2	22.5	32.0	137.4	-60.5	26.3	344.9	24.5	60.7
INC	ISH	220	1	-356.9	122.4	67.1	-516.2	-54.0	81.9	-204.5	-33.0	36.9	-735.1	-176.4	119.2
INC	CBT	220	2	-58.0	5.7	7.7	-39.1	63.1	9.4	-66.7	87.4	14.5	59.9	89.5	13.6
ISH	SHL	220	1	0.0	-3.7	0.7	-163.0	18.2	29.9	0.0	-3.6	0.7	-312.7	-103.8	60.1
KNR	BYH	220	1	-68.3	9.8	15.9	-7.0	13.0	1.9	-144.7	57.5	21.0	-304.5	69.3	39.4
KNR	KPG	220	1	27.5	2.0	3.8	29.6	-26.6	5.2	77.4	-42.0	12.1	147.5	-36.3	19.9
KNR	KPG	220	2	40.7	-46.8	8.5	50.0	-85.2	13.0	126.2	-93.5	21.5	231.7	-74.4	31.9
KRA	KLN	220	1	113.5	-94.7	28.9	74.7	12.9	13.4	88.5	-28.4	18.2	274.5	-17.1	48.8
KRA	RAF	220	1	-93.0	82.6	35.2	-85.8	-18.4	19.3	-84.8	17.7	24.6	-220.2	-20.2	48.7
KLN	SH	220	1	22.1	-1.0	8.2	138.7	-5.6	39.2	89.6	-14.8	33.8	135.8	-20.1	38.8
KLN	KPG	220	1	5.1	-80.9	18.7	-178.6	-20.0	35.0	18.1	-32.9	8.7	56.7	-44.4	14.1
KYT	MAY	220	1	–	–	–	75.3	29.9	10.9	14.9	-14.2	2.7	73.6	31.4	10.7

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
KYT	WOO	220	1	–	–	–	-135.2	-50.7	19.4	-132.0	-29.6	17.8	-190.6	-74.4	27.4
KPG	MP	220	1	-7.5	11.7	2.1	22.1	-50.2	8.3	34.3	-28.0	6.7	92.0	-27.0	14.5
KPG	MP	220	2	-7.5	11.7	2.1	22.1	-50.2	8.3	34.3	-28.0	6.7	92.0	-27.0	14.5
KPG	TB	220	1	15.5	-12.3	5.6	-155.2	16.5	35.8	-3.7	-6.7	2.2	27.3	-13.1	6.9
CBT	MAY	220	1	-156.1	30.4	20.9	-75.1	52.8	11.6	-443.8	23.5	58.4	-154.9	63.7	21.1
CBT	MAY	220	2	19.7	-12.7	3.1	-150.4	53.5	20.1	-59.2	32.3	8.9	-50.0	5.4	6.3
CBT	INC	220	1	78.4	-9.5	10.4	52.8	-86.9	12.8	90.2	-118.3	19.6	-80.9	-121.3	18.4
LOU	ORL	220	1	–	–	–	–	–	–	120.1	-7.1	27.7	-215.6	-7.4	42.1
MAY	TH	220	1	-317.7	96.5	102.2	-158.5	12.8	45.3	-186.9	12.4	57.6	-104.7	-4.3	29.9
MAY	SH	220	1	19.4	-65.8	25.5	-64.3	39.2	21.3	-106.7	-3.2	39.7	-95.8	18.0	27.5
MP	PRO	220	1	25.9	-12.3	5.3	72.0	-0.5	11.8	-11.2	1.0	2.1	30.1	-7.2	5.1
NW	PB	220	1	-24.3	12.9	8.3	41.5	-4.1	12.6	-0.4	-30.6	9.2	79.2	-16.8	24.4
OST	TYN	220	1	74.4	-68.6	23.3	84.0	-42.2	18.3	-238.4	35.2	55.5	-178.5	-79.5	38.1
PB	PB	220	1	-45.9	-2.5	10.2	30.6	5.3	6.9	-35.8	1.7	8.0	83.0	25.1	19.3
PB	SHL	220	1	21.7	-9.3	4.0	10.9	20.8	4.0	35.4	-6.2	6.1	-3.8	-11.8	2.1
PB	CKM	220	1	89.7	-37.0	36.4	-69.6	-38.8	29.9	-62.3	-46.5	29.1	-104.6	-54.5	44.2
PB	INC	220	1	-84.3	20.6	32.5	-52.2	22.7	21.3	-25.6	43.9	19.0	-16.7	26.6	11.8
PB	INC	220	2	-118.1	18.1	34.0	-75.1	23.4	22.4	-40.7	54.7	19.4	-27.4	31.8	12.0
PRO	TB	220	1	-32.4	-2.3	6.9	-157.5	8.2	33.8	7.9	-9.8	2.7	-57.1	2.0	12.2
SHL	SHL	220	1	–	–	–	-163.0	18.3	8.8	–	–	–	-163.0	-57.9	9.3
TB	KPG	220	2	-16.9	10.2	5.6	170.7	-22.7	39.5	4.2	4.4	1.7	-29.9	11.5	7.3
WOO	ORL	220	1	–	–	–	–	–	–	-129.1	8.4	29.8	155.2	75.2	33.6
ORL	ORL	220	1	–	–	–	–	–	–	-10.2	0.5	1.7	-62.8	60.2	14.7
ORL	ORL	220	1	–	–	–	–	–	–	-10.2	0.5	1.7	-62.8	7.9	11.1
AA	DRU	110	1	9.9	-14.8	18.0	25.7	-6.0	21.8	12.7	-9.8	16.2	44.3	-12.2	38.0
AA	ENN (I)	110	1	6.2	-19.3	20.5	11.1	-4.7	10.0	7.4	-15.0	16.9	31.0	-12.2	27.6
AA	LIM (I)	110	1	-1.2	15.5	8.7	5.2	15.6	7.9	29.6	2.7	16.7	-8.3	24.9	12.6
AA	AA	110	1	–	–	–	–	–	–	–	–	–	0.0	-33.1	26.9
AD	WHI	110	1	25.5	-14.3	29.5	49.6	9.7	41.7	23.5	-0.5	23.8	69.3	4.0	57.4
ARI	ARI T	110	1	-0.6	0.3	0.7	-0.9	-2.2	1.9	3.8	-6.4	7.1	-1.2	-6.7	5.6

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
AGL	DYN	110	1	0.0	-0.3	0.3	-17.8	1.3	14.5	-17.8	1.0	16.9	-17.8	0.9	14.5
AGL	ENN (I)	110	1	-0.8	-8.9	9.0	-24.4	10.1	21.8	-6.5	6.2	9.1	-9.2	6.9	9.5
AGL	SH	110	1	0.8	9.2	8.9	42.2	-11.5	36.7	24.3	-7.1	24.3	27.0	-7.7	23.6
AHA	KLN	110	1	-0.9	0.2	1.3	-5.1	-0.4	7.5	-1.2	0.3	1.9	-5.3	-0.4	7.8
ADM	GCA	110	1	–	–	–	2.8	-2.7	2.8	8.2	2.2	6.0	9.6	3.0	7.2
ADM	INC	110	1	-32.1	-7.0	31.9	-19.4	-4.3	14.8	-19.7	-6.9	20.3	-26.5	-10.2	21.2
ANR	DOO	110	1	-14.0	-6.9	34.7	-14.0	-6.9	34.7	-14.0	-6.9	34.7	-14.0	-6.9	34.7
ARK	BEG	110	1	13.2	4.9	14.2	29.5	0.4	24.2	37.9	1.5	38.3	62.1	-6.8	51.2
ARK	BOG	110	1	-7.9	-0.7	4.4	-14.0	5.7	7.2	-27.4	7.8	16.0	-41.4	11.5	20.5
ARK	PHY	110	1	–	–	–	–	–	–	1.2	0.3	0.7	1.2	0.3	0.6
ARK	PHY	110	2	–	–	–	–	–	–	1.1	0.3	0.6	1.1	0.3	0.5
ATE	DRO	110	1	0.0	-7.7	6.4	-8.5	-0.6	6.1	-8.5	4.2	7.9	-8.5	3.6	6.6
ATE	ATE	110	1	–	–	–	–	–	–	-2.3	2.2	1.8	-2.3	2.2	1.5
ATE	KNR	110	1	0.0	7.7	4.3	29.0	-24.9	18.2	21.1	-18.9	15.9	31.3	-25.5	19.2
ATH	LA	110	1	19.4	4.2	20.0	10.5	5.1	9.6	3.8	10.5	11.3	26.3	-4.8	22.1
ATH	SH	110	1	-38.4	37.7	30.3	-93.8	48.0	55.5	-30.3	25.5	22.3	-113.5	20.9	60.7
BKE	AUG	110	1	–	–	–	–	–	–	26.4	24.8	20.3	-50.0	15.0	24.9
BKE	KPG	110	1	–	–	–	–	–	–	-26.4	-24.8	20.3	50.0	-15.0	24.9
AUG	CFM	110	1	25.4	14.1	30.3	25.4	14.0	30.2	25.4	14.6	30.5	25.4	14.2	30.4
AUG	MTN	110	1	-16.0	-4.3	9.3	20.6	4.9	10.1	-24.5	-3.2	13.9	61.0	0.8	29.0
AUG	SK	110	3	0.0	-0.7	0.6	0.0	-18.0	15.0	0.0	-0.6	0.5	-80.9	-7.2	67.7
AUG	SK	110	4	0.0	-0.7	0.6	0.0	-18.0	15.0	0.0	-0.6	0.5	-80.9	-7.2	67.7
AUG	CFM	110	2	25.4	14.1	30.3	25.4	14.0	30.2	25.4	14.6	30.5	25.4	14.2	30.3
ARV	COS	110	1	-11.4	-6.0	12.4	-31.2	12.8	27.4	-30.0	6.9	22.5	-55.3	10.0	41.0
ARV	GWE	110	1	24.5	-9.0	14.7	4.5	-1.6	2.3	-12.2	15.4	11.1	31.7	0.5	15.1
ARV	NAV	110	1	-11.3	21.0	13.4	4.8	3.4	2.8	30.3	0.2	17.0	2.8	7.1	3.6
ARV	SKL	110	1	-1.0	-3.2	2.5	12.2	-8.0	10.7	6.6	-12.5	10.3	11.6	-9.7	11.0
ARV	SKL	110	2	-0.8	-2.8	1.6	9.7	-6.6	5.6	5.2	-10.1	6.4	9.1	-7.9	5.8
ART	FIN (I)	110	1	-2.1	0.4	1.8	-35.8	-3.2	27.4	-10.9	-0.2	9.1	-37.4	-3.6	28.7
ART	MCD	110	1	-0.1	-1.1	0.9	20.8	2.2	16.0	7.8	-0.9	6.6	21.8	2.6	16.7

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
BVK	GRO	110	1	0.0	-27.3	14.0	-54.6	19.9	26.4	-54.3	25.1	30.7	-54.4	26.2	27.4
BVK	BVK	110	1	–	–	–	0.0	-20.8	9.0	0.0	35.0	16.0	0.0	15.1	6.5
ATY	CLW	110	1	-32.1	13.8	35.3	-49.6	4.2	41.1	-18.3	4.3	19.0	-36.8	11.8	31.9
ATY	CNB	110	1	–	–	–	–	–	–	12.3	-5.9	7.7	16.2	-19.9	12.2
BWR	CRA	110	1	0.0	-14.4	21.1	12.6	-9.1	22.8	12.6	-7.8	21.8	12.6	3.5	19.2
BOL	ENN (I)	110	1	19.6	-0.1	11.0	93.8	-14.3	45.2	11.7	4.1	7.0	46.0	-1.5	21.9
BOL	TBK T	110	1	-19.6	2.8	11.1	-59.0	-2.8	28.1	3.5	-5.7	3.8	-4.3	-10.1	5.2
BAL	DEE	110	1	–	–	–	31.4	1.8	15.0	-50.9	0.0	28.6	64.0	7.8	30.7
BAL	CDU	110	1	-15.1	23.2	15.5	-48.0	-4.0	23.1	46.4	0.1	26.1	-81.4	-10.2	39.3
BLI	DMY	110	1	-4.3	4.5	9.1	3.5	-6.8	11.2	6.7	-0.3	9.9	4.6	-2.6	7.8
BEG	CKM	110	1	10.2	5.9	8.6	13.7	-2.9	8.8	33.6	1.7	24.7	45.4	-9.5	29.2
CDL	BYH	110	1	0.0	14.3	7.3	43.9	-32.4	24.8	20.0	1.0	10.3	49.3	-38.4	28.4
BLK	BLK T	110	1	-5.9	0.1	4.4	-26.8	-6.3	17.3	-6.7	0.2	5.0	-28.0	-6.1	18.1
BLU	CDU	110	1	–	–	–	-13.9	-9.6	13.0	25.4	-0.7	19.6	-10.1	3.7	8.3
BLU	MUL	110	1	–	–	–	13.9	-10.9	14.3	-25.4	0.7	24.2	10.1	-3.7	8.7
BIN	CF	110	1	-8.7	6.1	10.7	-16.1	-4.6	13.8	-2.5	6.9	7.5	-14.0	2.1	11.7
BIN	TIV	110	1	4.3	-5.4	5.1	32.9	-6.8	21.1	15.6	-14.1	15.5	36.6	-9.4	23.8
BDA	MON	110	1	-15.4	10.0	18.6	-7.1	-3.9	6.7	2.6	-1.5	3.0	17.8	-15.6	19.5
BDA	NEW (I)	110	1	10.2	-10.9	12.2	1.8	3.1	3.0	-7.8	0.7	6.4	-23.0	14.8	22.4
BDN	CUL	110	1	-39.8	25.2	24.0	-22.7	0.1	10.4	-0.8	-7.8	4.0	-64.7	27.7	32.4
BDN	DOO	110	1	31.1	-27.6	23.4	1.3	-6.3	3.1	-8.9	5.2	5.8	42.7	-33.2	25.8
BAH	CLG	110	1	–	–	–	–	–	–	7.2	7.3	5.3	7.2	7.0	5.3
BAH	SBH	110	1	–	–	–	–	–	–	-26.2	-13.6	15.4	-26.3	-13.4	15.3
BRY	RAF	110	1	-13.0	-2.8	21.0	-24.5	-6.5	27.5	-18.0	-4.2	29.3	-25.6	-6.8	28.7
BRY	RAF	110	2	-6.0	-1.2	6.2	-10.0	-64.4	53.9	-8.3	-1.8	8.6	-11.8	-2.9	10.0
BK	CBR	110	1	-9.0	4.0	5.0	21.1	-9.2	10.4	25.6	-12.4	14.6	33.3	-17.5	17.0
BK	MOY	110	1	7.8	2.2	5.9	26.7	-5.4	19.9	26.9	-4.3	19.9	49.6	-14.9	37.8
BGD	INC	110	1	-22.3	-7.3	16.8	-28.5	-9.4	21.4	-26.6	-8.7	20.0	-26.6	-8.7	20.0
BGD	INC	110	2	-22.3	-7.3	16.8	-28.5	-9.4	21.4	-26.6	-8.7	20.0	-26.6	-8.7	20.0

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
BLA	RE	110	1	-11.2	2.6	9.6	-47.1	-6.9	40.0	-15.5	3.5	13.4	-49.2	-7.3	41.8
BGT	KKY	110	1	–	–	–	–	–	–	-13.7	3.3	7.9	-43.5	5.2	20.8
BGT	CNB	110	1	–	–	–	–	–	–	6.0	-5.2	4.5	15.7	-14.4	10.1
BAN	BRI	110	1	2.0	0.4	4.5	2.0	0.4	4.5	2.0	0.4	4.5	2.0	0.4	4.5
BAN	DMY	110	1	2.3	-22.0	22.3	-32.4	2.7	26.9	-13.9	-2.3	14.2	-11.8	-3.1	10.1
BAN	RAF	110	1	-20.0	18.8	27.8	-19.1	-1.6	15.8	-7.1	-1.6	7.3	-44.5	6.6	37.1
BAN	BAN	110	1	–	–	–	0.0	-16.1	13.1	–	–	–	0.0	-16.5	13.4
BAN	BRI	110	2	2.0	0.4	4.5	2.0	0.5	4.5	2.0	0.5	4.5	2.0	0.4	4.5
CLG	CDU	110	1	-76.0	-28.1	43.3	-69.5	-23.6	33.5	-74.7	-24.7	42.1	-74.7	-24.0	35.8
BAR	BAR T	110	1	-8.2	2.2	6.2	-22.3	-9.1	15.2	0.5	2.5	1.9	-23.7	-4.5	15.2
BLC	DRN	110	1	29.5	8.1	13.4	45.7	15.4	21.2	54.3	19.4	25.3	54.3	18.5	25.1
BLC	DRN	110	2	29.5	8.1	13.4	45.7	15.4	21.2	54.3	19.4	25.3	54.3	18.5	25.1
BLC	DTN	110	2	-4.3	-8.9	7.1	9.2	-6.6	7.9	-4.5	-11.4	8.8	9.1	-6.7	7.9
BLC	GRA	110	1	-1.2	-11.5	8.2	36.7	-1.2	26.2	-0.8	-14.9	10.6	37.5	-0.7	26.8
BLC	KLM	110	1	-1.0	-9.0	6.5	25.0	-4.2	18.1	-1.9	-12.9	9.3	25.4	-4.0	18.3
BUT	CUL	110	1	-3.5	-4.3	3.1	-40.1	-3.7	21.0	-20.8	2.5	11.8	-37.3	-8.6	19.9
BUT	KTN	110	1	-5.7	4.7	3.7	-0.4	-6.9	3.2	8.6	-2.1	4.4	-6.2	-2.6	3.1
DEE	DRY	110	1	–	–	–	31.3	1.9	14.9	-51.1	-0.5	28.7	63.7	6.9	30.5
KNG	TRI	110	1	0.0	1.4	1.2	30.1	-22.9	30.5	26.3	-19.3	26.3	30.0	-26.2	32.1
BDM	MID	110	1	–	–	–	–	–	–	10.6	-2.4	11.0	38.4	1.4	31.7
BDM	WHI	110	1	–	–	–	–	–	–	-10.6	2.4	11.0	-38.4	-1.4	31.7
BOG	TUL	110	1	–	–	–	–	–	–	-29.4	7.8	17.1	-50.9	9.9	24.7
BGH	CLA	110	1	0.0	0.7	0.4	49.5	-23.2	26.0	56.6	-26.4	35.1	48.8	-22.2	25.6
AGY	TIV	110	1	-3.4	-0.4	3.2	-9.4	-5.7	8.9	-3.2	-2.0	3.6	-10.1	-6.7	9.9
CAB	PTN	110	1	-1.6	0.4	2.1	-20.2	-5.1	17.5	-7.4	-0.7	9.3	-21.1	-5.5	18.3
CAB	WOL	110	1	-2.0	-1.6	2.1	4.7	-0.2	3.6	2.5	-0.9	2.2	4.9	-0.1	3.7
CFD	KIN	110	1	–	–	–	–	–	–	7.5	4.7	5.0	-21.0	9.2	10.9
CFD	MUL	110	1	–	–	–	–	–	–	-7.5	-4.7	5.0	21.0	-9.2	10.9
CLA	CKN	110	1	26.9	-23.5	20.1	26.3	7.7	14.4	28.1	-11.2	17.0	71.0	3.6	37.4
CLA	DMY	110	1	3.5	5.7	3.8	19.4	3.8	9.4	3.6	-1.5	2.2	6.5	-2.4	3.3

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
CLA	MAC	110	1	-1.1	15.9	9.9	36.8	-1.6	19.3	5.7	-2.3	3.8	6.4	1.7	3.5
CKN	KER	110	1	26.7	-22.9	19.8	26.2	8.7	13.1	27.9	-10.6	16.8	70.2	0.8	33.4
CRO	IA	110	1	3.1	-24.1	12.4	-50.9	6.2	23.6	-25.8	5.7	13.5	-22.8	-1.7	10.5
CRO	KBY	110	1	-6.4	24.0	14.0	39.9	-6.5	20.2	21.2	-5.6	12.3	11.2	1.6	5.7
CDY	GRV	110	1	0.0	9.6	10.5	-24.4	5.2	27.4	-24.5	6.9	27.9	-24.5	2.7	27.1
CDY	SRA	110	1	5.8	-18.2	10.7	21.8	-7.0	10.9	5.8	-2.5	3.6	25.3	-9.2	12.8
CDY	ARI T	110	1	-5.9	9.6	6.3	21.3	-6.7	10.6	30.8	-4.3	17.4	17.9	6.3	9.0
CSH	CLN	110	1	26.0	-1.0	14.6	72.2	-3.1	34.4	18.5	-8.6	11.5	65.3	1.9	31.1
CSH	DLT	110	1	17.7	-9.7	20.4	28.1	-4.7	23.6	-5.1	-3.1	6.1	24.3	-5.0	20.5
CSH	ENN (I)	110	1	-9.6	8.9	7.4	-29.4	16.0	15.9	1.6	0.6	0.9	-31.3	16.4	16.8
CSH	GAL	110	1	9.2	-21.0	23.1	14.5	7.3	13.4	-2.3	2.4	3.2	16.2	5.6	13.9
CSH	GAL	110	2	11.2	-25.5	28.1	17.7	9.1	16.4	-2.8	3.1	4.0	19.7	6.9	17.0
CSH	GAL	110	3	11.2	-25.5	28.1	17.7	9.1	16.4	-2.8	3.1	4.0	19.7	6.9	17.0
CSH	SAL	110	1	8.6	-18.5	21.0	9.6	1.5	10.0	-0.7	-3.1	3.3	11.1	0.2	11.4
CSH	SHN	110	1	-3.2	19.8	19.1	–	–	–	22.8	-8.8	23.3	10.1	7.0	10.0
CSH	CSH	110	1	–	–	–	0.0	-45.5	37.0	–	–	–	0.0	-45.4	36.9
CLH	TRI	110	1	1.0	0.2	1.1	-9.7	-5.2	9.1	13.0	0.3	13.1	5.0	-6.3	6.7
CLH	TRL	110	1	-1.0	-0.2	1.0	25.1	2.3	20.5	-1.7	-0.9	1.8	10.4	5.4	9.5
CBR	CLN	110	1	-12.8	9.2	15.9	-8.9	-2.2	7.6	14.2	0.0	8.0	-4.6	-3.7	2.8
CBR	CBG	110	1	6.0	-6.9	9.2	19.0	-2.3	15.8	8.3	-5.1	9.8	19.8	-2.0	16.5
CBR	DLT	110	1	-9.8	4.7	11.0	-10.8	-1.3	9.0	2.8	0.6	2.9	-5.8	-5.7	6.7
CBR	CBR	110	1	–	–	–	0.0	-33.1	26.9	–	–	–	0.0	-33.1	26.9
CCN	CUS	110	1	–	–	–	0.0	-0.7	0.5	0.0	-0.6	0.4	22.5	-0.7	16.1
CD	MAC	110	1	10.8	-25.3	15.5	-38.5	-1.5	18.4	-9.0	-1.1	5.1	0.9	-4.8	2.3
CD	KLP	110	1	–	–	–	–	–	–	17.0	-0.5	9.6	7.1	3.3	3.7
CPK	TNY	110	1	2.0	-7.5	7.7	10.2	-7.0	12.3	2.8	-7.3	7.8	10.6	-7.0	12.7
CF	CL	110	1	0.0	-0.2	0.4	-19.9	6.1	30.6	-19.9	7.4	31.2	-19.9	6.2	30.6
CF	COR	110	1	1.2	19.0	10.7	15.1	-5.5	7.7	33.5	-6.5	19.2	36.7	0.6	17.5
CF	SRA	110	1	-12.7	14.3	9.7	-15.0	4.9	6.7	8.9	-8.8	6.4	-22.3	6.8	9.9
CF	CF	110	1	–	–	–	0.0	-16.5	13.5	–	–	–	0.0	-16.5	13.5

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
CF	CLO	110	2	5.4	-19.5	11.4	23.3	-11.9	12.5	1.9	-13.6	7.7	21.2	-11.8	11.6
CAH	DOO	110	1	-10.6	33.5	19.8	41.6	1.9	19.8	31.8	0.6	17.9	1.6	30.5	14.5
CAH	KHL	110	1	16.3	-18.2	13.7	4.7	14.8	7.4	-7.2	-1.3	4.1	21.6	0.4	10.3
CAH	TIP	110	1	10.4	-31.8	18.8	-43.5	24.8	23.8	-14.5	-3.2	8.4	-5.6	5.1	3.6
CAH	BAR T	110	1	-21.2	16.1	25.3	-30.4	20.1	29.6	-18.4	3.7	17.8	-46.5	25.4	43.1
CAH	CAH	110	1	–	–	–	0.0	-67.3	54.7	–	–	–	0.0	-66.9	54.4
CKM	CHE	110	1	3.0	-4.5	5.2	16.5	2.0	13.5	4.2	-5.0	6.3	17.2	2.3	14.1
CKM	POT	110	1	4.4	-4.3	5.2	17.4	-3.4	14.9	6.1	-3.5	5.9	18.2	-3.3	15.5
CKM	CPK	110	1	5.4	-10.3	8.5	22.1	-8.7	17.3	7.5	-10.1	9.3	23.1	-8.7	18.0
BRA	NEW (I)	110	1	7.0	7.8	7.7	–	–	–	35.9	-3.3	26.5	52.2	-12.8	33.8
BRA	PLS	110	1	-7.0	-7.8	10.6	–	–	–	-35.9	3.3	36.4	-52.2	12.8	44.4
COO	BCT	110	1	2.7	2.0	2.6	1.9	1.6	1.9	2.7	2.0	2.6	2.7	2.1	2.6
COO	CKM	110	2	-2.7	-2.0	2.6	-1.9	-1.6	1.9	-2.7	-2.0	2.6	-2.7	-2.1	2.6
CLU	KUD	110	1	–	–	–	11.1	2.9	5.2	10.6	2.9	5.9	10.6	2.5	4.9
CLU	CBT	110	1	–	–	–	-14.9	-4.2	7.0	-51.5	-16.9	29.0	-51.4	-16.4	24.2
CLN	LA	110	1	7.9	10.8	13.5	36.2	-8.0	30.6	26.9	-7.4	28.2	32.5	-3.8	27.0
SCR	KNY	110	1	-5.5	1.3	4.2	-16.6	-3.5	10.7	-7.6	1.6	5.7	-17.4	-2.4	11.1
CRA	LWD	110	1	-20.0	11.9	13.1	-60.8	0.3	28.9	-18.4	10.3	11.8	-73.6	12.3	35.5
CRA	TUL	110	1	–	–	–	–	–	–	29.6	-8.0	17.2	51.3	-9.0	24.8
CRA	WEX	110	1	2.2	3.4	4.1	19.8	1.3	17.5	-8.2	3.1	8.9	2.7	3.9	4.2
COS	FLA	110	1	-11.7	3.4	12.3	-20.0	0.3	16.5	-1.9	-1.5	2.5	-35.0	2.0	28.9
COS	FLA	110	2	-12.0	3.6	12.6	-20.5	0.4	16.9	-1.9	-1.6	2.5	-35.8	2.2	29.7
COS	ARI T	110	1	6.5	-11.3	7.3	-20.3	8.1	10.4	-34.3	10.7	20.2	-16.7	-0.5	8.0
COL (I)	FIN (I)	110	1	6.0	-0.3	5.7	4.9	-1.2	4.1	1.1	-2.8	2.9	4.0	-3.4	4.3
COL (I)	CDU	110	1	-17.3	-1.2	12.1	-21.9	-1.0	15.3	-16.8	0.6	11.8	-21.8	1.1	15.3
CHA	GLE	110	1	3.6	0.1	3.6	10.2	5.3	9.5	-2.8	1.0	3.0	11.0	1.9	9.2
CHA	KLN	110	1	14.2	-24.8	21.0	-7.9	-14.7	10.5	16.6	-4.8	12.7	25.5	-16.4	19.1
CHA	MAL	110	1	-22.5	27.4	19.9	-2.3	-2.2	1.5	-2.0	2.3	1.7	-37.5	8.2	18.3

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
CLW	KLS	110	1	-24.5	9.2	26.4	-53.7	-15.6	46.3	0.8	-11.5	11.6	-47.3	-8.3	39.7
CLW	KLS	110	2	-24.7	9.0	26.5	-53.8	-16.2	46.4	1.0	-11.5	11.7	-47.4	-8.8	39.9
CLW	STR T	110	1	3.6	-1.4	5.8	-5.1	15.4	23.8	-28.1	22.2	52.6	-7.9	1.9	12.0
COW	CVW	110	1	8.7	-9.2	12.8	17.0	-0.1	14.0	10.0	-2.8	10.5	29.7	0.4	24.5
COW	OLD	110	1	0.3	0.0	1.0	0.3	0.0	1.0	0.3	0.0	1.0	0.3	0.0	1.0
COW	RAF	110	1	-10.3	0.7	10.5	-22.0	-0.2	18.2	-14.5	-0.1	14.6	-27.0	-5.1	22.7
COW	WHI	110	1	-4.5	8.4	9.7	-12.8	-1.2	10.6	-3.9	2.7	4.7	-21.3	3.1	17.8
CUN	GLR	110	1	-0.5	-6.9	3.9	-21.6	9.4	11.3	-15.3	-0.2	8.6	-34.9	13.2	17.8
CUN	SLI	110	1	0.5	14.3	8.0	31.8	-6.7	15.6	25.5	1.2	14.4	45.1	-7.4	21.9
CUS	MLC	110	1	5.5	-0.9	4.1	-6.1	42.2	26.8	0.7	0.3	0.6	20.3	-17.6	16.9
CUS	NEW (I)	110	1	0.8	6.3	4.7	12.9	29.4	21.1	23.1	-0.5	17.3	36.2	4.4	24.0
CUS	PLS	110	1	-6.3	-5.4	6.1	-6.9	28.5	18.4	-23.9	0.8	17.6	-34.1	13.1	23.0
CVW	KRA	110	1	-1.9	-9.0	9.3	-17.0	-7.4	15.3	-13.6	-6.6	15.3	-13.6	-9.9	13.9
CGL	GAE	110	1	0.0	-2.9	3.2	-8.9	8.5	13.5	-8.9	5.8	11.6	-8.9	8.4	13.4
CGL	CKN	110	1	0.0	2.9	1.6	33.1	-26.1	22.2	33.1	-18.9	21.4	33.1	-22.7	21.1
COR	GWE	110	1	1.3	19.4	10.9	28.6	-3.8	13.7	39.0	-2.3	21.9	0.3	-3.5	1.7
COR	ENN (N)	110	1	-0.3	1.6	1.7	-13.5	0.3	11.2	-6.0	-4.4	7.5	35.9	4.0	29.8
CDK	LWD	110	1	0.0	-5.4	5.9	12.5	-9.0	16.9	12.2	-11.6	18.5	12.5	10.0	17.5
CUL	RTO	110	1	–	–	–	–	–	–	-18.3	2.9	10.4	2.0	1.8	1.3
CUL	WAT	110	1	1.4	3.7	2.2	49.5	-3.9	24.8	29.7	-7.9	17.3	43.2	4.2	21.7
CTY	FTT	110	1	19.1	-5.9	16.1	88.8	16.4	68.4	26.6	-6.2	22.0	92.9	18.3	71.7
CTY	INC	110	1	-26.2	3.4	25.7	-102.0	-20.7	84.6	-36.5	2.6	35.5	-106.6	-22.8	88.6
CDU	GAN	110	1	–	–	–	0.1	22.2	10.6	0.0	-0.4	0.2	0.0	-0.4	0.2
CDU	RYB	110	1	8.1	22.5	13.4	29.7	19.8	16.3	3.6	23.6	13.4	23.1	31.7	17.9
KNY	UGL	110	1	0.0	-5.3	2.7	-52.0	27.4	26.7	-50.5	40.3	33.1	-52.0	26.2	26.5
KNY	GAL	110	1	0.0	44.7	45.1	52.0	-27.4	48.6	50.5	-40.3	36.1	52.0	-26.2	31.5
KNY	KLH	110	1	0.0	-14.2	7.5	-10.0	-0.1	5.3	0.0	-11.3	6.0	-10.1	-11.9	8.2
KNY	SAL	110	1	-5.5	20.8	11.0	20.6	10.7	10.6	-7.6	17.7	9.9	19.9	13.3	10.9
KNY	BUF	110	1	–	–	–	-27.3	-9.9	20.7	0.0	-0.6	0.4	-27.3	0.4	19.5

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
DDK	MLN	110	1	-5.6	-4.6	7.3	-26.5	-11.0	23.8	1.9	-2.6	3.2	-28.5	-16.0	27.0
DDK	LOU	110	1	-7.5	8.5	11.5	-37.5	-3.1	31.1	-15.0	6.1	16.4	-38.7	3.3	32.1
DRU	ENN (I)	110	1	0.7	-19.5	19.7	-6.4	-1.6	5.5	-0.1	-16.9	17.0	10.4	-9.4	11.6
DRU	DRU	110	1	–	–	–	0.0	-16.4	13.4	–	–	–	0.0	-16.4	13.3
DGN	RTO	110	1	–	–	–	–	–	–	18.4	-3.8	10.5	-2.0	-3.2	1.8
DGN	WHO	110	1	-6.8	-5.5	4.9	-57.1	4.8	27.3	-31.9	3.3	18.0	-50.0	-9.4	24.2
DRG	KPG	110	1	–	–	–	–	–	–	7.6	2.3	4.5	-3.7	-8.2	4.3
DRG	TRL	110	1	–	–	–	–	–	–	-7.6	-2.3	4.5	3.7	8.2	4.3
DOO	DOO	110	1	–	–	–	0.0	-16.7	13.6	–	–	–	0.0	-16.2	13.2
DRY	GOR	110	1	-6.1	-8.9	10.9	-19.0	-4.2	16.1	-37.3	-2.2	37.7	-24.1	-3.8	20.2
DRY	LOU	110	1	0.9	-26.8	27.1	-41.0	-20.7	38.0	-58.6	-14.3	60.9	-40.6	-28.8	41.1
DRY	OBE	110	1	–	–	–	–	–	–	22.7	15.4	26.1	32.6	14.1	28.8
DMY	MAC	110	1	-5.9	-4.8	3.9	-19.1	-2.2	8.9	-3.4	0.9	1.8	-6.5	3.4	3.4
DMY	CDN	110	1	0.0	-0.4	0.2	-16.2	-7.3	8.2	0.0	-0.4	0.2	-20.3	0.3	9.4
DMY	DMY	110	1	–	–	–	–	–	–	–	–	–	0.0	-16.7	13.6
DAL	DAL	110	1	0.0	0.4	0.4	-13.2	-7.2	12.2	-1.4	-1.9	2.3	-14.1	-8.4	13.3
DTN	FIN (I)	110	1	-17.2	-6.9	13.2	-7.4	-4.1	6.0	-19.1	-11.0	15.8	-8.3	-4.7	6.9
DTN	KLM	110	1	7.0	2.2	5.3	9.0	2.4	6.7	6.5	3.0	5.1	9.6	2.9	7.1
DER	KIN	110	1	23.2	-9.4	25.3	6.6	4.4	5.8	24.7	-0.9	24.9	25.1	-2.2	20.9
DER	TIM	110	1	–	–	–	–	–	–	-9.8	-0.6	5.5	-18.4	-0.2	8.8
DER	TSB	110	1	2.3	-2.7	3.6	18.1	-3.5	15.2	-14.9	1.5	15.1	-6.8	2.4	5.9
DLT	DLT	110	1	–	–	–	0.0	-16.7	13.6	–	–	–	0.0	-16.8	13.6
DFR	DFR	110	1	-2.3	0.1	4.1	-11.2	-5.9	22.3	-3.2	0.1	5.7	-11.7	-4.2	21.9
DRM	LET	110	1	8.2	2.1	8.5	65.9	-3.7	53.6	43.5	-19.2	48.0	84.5	-19.5	70.5
DRM	MEE	110	1	0.0	-0.2	0.2	-25.4	-8.3	22.1	-25.4	1.8	25.7	-25.4	1.7	21.0
DRM	CLO	110	1	-8.2	-1.9	8.1	-40.5	12.0	34.3	-18.1	17.4	24.4	-59.1	17.8	50.2
ENN (I)	SLC	110	1	0.0	-34.0	17.4	-21.6	-15.2	12.0	-8.1	-18.2	10.2	-21.6	-16.4	12.3
KHL	THU	110	1	16.2	-17.8	13.5	15.5	14.6	10.2	-7.2	-0.7	4.1	32.4	0.4	15.4
MLC	TSB	110	1	5.5	-0.3	4.1	18.7	12.0	14.0	25.9	-3.3	19.3	45.3	4.6	28.6
CKG	CBT	110	1	0.0	-0.9	0.5	-37.7	-13.6	18.0	-64.7	-25.8	37.3	-64.6	-25.2	31.1

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
CKG	CBT	110	2	–	–	–	-37.7	-13.6	18.0	-64.7	-25.8	37.3	-64.6	-25.2	31.1
FAS	FAS	110	1	-5.5	-1.9	5.6	-31.0	-12.4	27.2	-7.7	-2.8	7.8	-32.4	-13.5	28.6
FAS	CKM	110	1	-5.6	-2.0	5.6	-31.1	-12.5	27.3	-7.7	-2.8	7.8	-32.5	-13.7	28.7
FLA	GIL	110	1	11.4	2.9	17.3	11.5	-10.9	23.2	11.4	3.0	17.4	11.5	-10.8	23.2
FLA	SLI	110	1	5.2	-12.9	14.1	-1.2	5.6	4.7	-15.6	6.8	17.2	-0.2	-2.5	2.1
FLA	TON	110	1	4.4	-0.5	5.8	11.7	3.9	16.2	-19.9	2.7	11.3	-16.5	7.8	8.7
FLA	SLB	110	1	-15.4	10.3	18.7	14.6	0.4	11.9	33.7	-14.4	37.0	-1.3	10.2	8.4
FRA	HAR	110	1	-3.2	-1.3	3.2	-10.3	-6.9	11.6	-4.4	-1.4	4.3	-10.8	-6.7	11.9
FRA	TRN	110	1	-3.7	1.1	2.8	-14.9	-6.9	11.7	-5.2	0.7	3.7	-15.6	-6.7	12.1
FRA	HEU	110	1	-1.8	0.2	1.3	-10.0	-1.6	7.2	-2.6	0.1	1.8	-10.5	-1.8	7.6
FRA	INC	110	1	-4.0	-0.9	3.8	-14.5	-4.1	14.0	-5.5	-1.0	5.3	-15.1	-4.3	14.7
FIN (I)	MCD	110	1	3.2	-11.8	10.2	69.7	-2.7	58.6	22.5	-9.7	20.6	72.9	-1.8	61.3
FIN (I)	PTN	110	1	4.5	-2.0	6.1	36.9	5.2	31.3	11.4	-0.9	14.3	38.5	5.8	32.7
FIN (I)	GLA	110	1	15.2	-0.4	14.5	67.6	23.7	58.2	21.1	2.2	20.2	70.7	26.7	61.5
FIN (I)	GRA	110	1	22.3	-16.4	23.3	17.3	-14.8	19.1	26.3	-11.2	24.0	19.1	-13.9	19.8
FIN (I)	POP	110	1	25.3	-6.4	21.7	23.2	-4.4	18.0	30.1	-1.8	25.1	25.3	-3.6	19.5
FIN (I)	SVN	110	1	5.0	-4.6	6.5	21.7	4.1	19.2	6.9	-3.4	7.3	22.7	5.2	20.2
FIN (I)	MCE	110	1	–	–	–	1.1	-0.6	1.0	1.1	0.7	1.0	4.0	0.6	3.3
FTT	COO	110	1	15.4	-4.1	12.9	74.2	16.3	57.6	21.5	-4.6	17.7	77.6	17.9	60.3
FGH	MOY	110	1	–	–	–	–	–	–	4.0	-0.8	3.8	2.2	14.7	12.1
FGH	GLR	110	1	–	–	–	–	–	–	-4.0	0.8	3.8	12.3	-15.0	15.8
GRV	GLN	110	1	–	–	–	–	–	–	0.0	-0.1	0.1	0.0	-0.1	0.1
GRH	GOR	110	1	–	–	–	–	–	–	-36.4	-4.5	35.0	-26.5	-5.5	22.0
GRH	PLA	110	1	–	–	–	–	–	–	36.4	4.5	35.0	26.5	5.5	22.0
GLA	SVN	110	1	-4.0	-6.7	5.8	-17.7	-14.8	15.0	-5.5	-7.3	6.7	-18.5	-15.7	15.8
GRI	GRI	110	1	-8.0	-0.1	7.6	-32.8	-7.5	27.4	-9.1	0.3	8.7	-32.3	-7.6	27.0
GI	KKY	110	1	12.2	-12.5	9.8	53.6	-3.4	25.6	21.1	-7.4	12.6	91.2	-15.4	44.1
GI	WAT	110	1	15.0	-9.3	9.9	9.2	8.8	6.1	-5.0	3.5	3.4	17.3	4.2	8.5
GI	WAT	110	2	13.6	-8.5	9.0	8.4	8.0	5.5	-4.6	3.1	3.1	15.7	3.7	7.7
GI	RSP	110	1	–	–	–	30.4	0.5	14.5	17.3	-4.3	10.0	50.7	-20.9	26.1

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
GRA	NBY	110	1	6.8	-0.1	5.7	-5.7	-6.7	7.4	5.7	0.0	4.8	-5.8	-6.7	7.4
GRO	CKN	110	1	0.0	-20.5	17.1	-32.9	10.7	28.8	-32.9	5.3	27.8	-32.9	7.3	28.1
GAL	SAL	110	1	7.0	-32.1	33.2	2.3	-25.2	23.9	8.6	-36.3	37.7	3.6	-31.6	30.0
GOL	GL T	110	1	0.0	-0.2	0.2	4.5	-3.2	4.5	4.5	-6.6	7.6	4.5	-6.5	6.5
GWE	GWE	110	1	–	–	–	0.0	-16.6	13.5	–	–	–	0.0	-16.1	13.1
GOR	MTH	110	1	4.8	-7.9	9.4	-9.4	9.5	11.0	-33.5	2.6	33.9	-6.1	5.5	6.8
GOR	NAV	110	1	15.4	-13.8	20.9	28.0	-3.8	23.3	3.6	-4.6	5.9	29.6	-4.7	24.8
GOR	NAV	110	2	13.4	-11.9	18.1	24.3	-3.0	20.2	3.2	-3.9	5.1	25.6	-3.9	21.4
GOR	NAV	110	3	18.8	-14.3	23.9	32.0	-1.6	26.5	4.6	-5.0	6.8	33.9	-2.5	28.1
GOR	GOR (I)	110	1	–	–	–	0.0	-0.6	0.3	0.0	-0.6	0.3	0.0	-0.6	0.3
GCA	CLD	110	1	–	–	–	–	–	–	0.0	-2.1	1.5	0.0	-2.3	1.6
GCA	CLD	110	2	–	–	–	–	–	–	0.0	-2.1	1.5	0.0	-2.3	1.6
GCA	INC	110	1	-35.3	-6.8	34.9	-22.0	-3.9	16.7	-23.1	-7.8	23.7	-30.9	-11.7	24.7
GCA	INC	110	2	-35.3	-6.8	34.9	-22.0	-3.9	16.7	-23.1	-7.8	23.7	-30.9	-11.7	24.7
GCA	NAN	110	1	5.4	0.2	4.5	3.5	0.5	2.7	5.4	0.3	4.5	3.5	0.2	2.6
GCA	NAN	110	2	5.7	0.4	4.8	3.6	0.6	2.8	5.7	0.5	4.8	3.7	0.3	2.8
GCA	YLW	110	1	–	–	–	-59.9	-20.2	28.4	-54.7	-28.1	32.9	-75.1	-41.3	38.4
CLO	MRY	110	1	0.0	-17.1	12.6	-28.5	16.7	24.3	-28.5	17.9	24.7	-28.4	19.2	25.2
CLO	CF	110	1	-10.2	17.7	11.5	-27.0	6.0	13.2	-5.2	12.7	7.7	-24.8	6.3	12.2
CLO	GL T	110	1	7.3	-0.1	3.9	37.4	-5.9	17.5	17.1	-10.2	10.6	54.8	-8.3	25.5
HWN	KIN	110	1	–	–	–	–	–	–	-21.8	-1.6	16.1	6.2	-4.9	5.0
HWN	DFR	110	1	–	–	–	–	–	–	21.8	1.6	21.0	-6.2	4.9	5.1
HAR	RE	110	1	-8.1	0.2	7.6	-29.6	-10.0	29.2	-11.2	-0.7	10.5	-30.9	-10.2	30.4
HEU	INC	110	1	-5.8	2.5	4.5	-19.2	-1.1	13.8	-8.1	2.2	6.0	-20.1	-1.4	14.4
IA	MAC	110	1	3.1	-24.0	12.3	-36.1	9.6	17.2	-6.9	-0.7	3.5	-3.9	-5.1	2.9
INC	MIL	110	1	9.9	-5.6	9.5	45.4	0.5	34.6	13.8	-5.4	12.4	47.4	1.0	36.2
INC	YLW	110	1	–	–	–	60.0	10.4	27.3	73.8	26.2	41.9	94.2	38.9	45.7
IKE	IKE T	110	1	-6.9	-0.3	8.6	-21.5	-13.1	21.2	1.1	-1.2	2.0	-23.0	-8.9	20.7
KNR	KPG	110	1	-5.5	3.2	4.7	-20.4	-10.7	14.5	10.3	1.2	7.6	-6.5	-10.7	7.9

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
KNR	TRI	110	2	5.5	-3.2	6.4	20.4	10.7	19.0	-10.3	-1.2	10.5	6.5	10.7	10.3
KNR	KNR	110	1	0.0	5.4	0.3	7.4	4.7	0.5	8.5	6.0	0.7	6.2	5.4	0.4
KNR	TRI	110	1	0.0	-19.3	10.9	-43.6	15.0	22.1	-38.0	6.3	21.6	-43.6	14.3	22.0
KRA	MEN	110	1	–	–	–	0.0	-3.8	3.1	0.0	-3.4	2.8	0.0	-3.8	3.1
KRA	KBY	110	1	19.2	-18.7	15.1	17.1	23.2	13.7	-2.3	2.0	1.7	47.2	13.2	23.3
KRA	BAR T	110	1	30.0	-18.9	26.1	54.1	-9.7	34.6	18.2	-7.5	14.5	73.0	-16.1	47.0
KRA	MID	110	1	3.2	12.7	13.2	17.3	8.1	15.7	9.9	6.4	11.9	8.4	11.4	11.7
KRA	WHO	110	1	6.8	2.1	4.0	51.9	-2.9	24.8	25.2	-5.2	14.4	34.2	8.4	16.8
KRA	KLP	110	2	–	–	–	–	–	–	-2.2	0.6	2.3	35.3	-1.4	29.2
KBY	MR	110	2	-15.8	20.0	24.7	2.3	3.1	3.0	-1.1	-2.2	2.4	-34.5	-8.1	27.3
KCY	CBT	110	1	–	–	–	–	–	–	-38.0	-15.5	21.9	-38.0	-15.1	18.3
KCY	BKY	110	1	–	–	–	–	–	–	14.2	7.4	8.6	14.2	7.0	7.1
KTL	MAY	110	1	-25.9	12.6	29.1	-58.4	14.2	49.7	-11.9	0.6	12.0	-35.8	5.8	30.0
KTL	MON	110	1	18.9	-13.1	16.9	21.7	2.9	13.7	2.2	-1.4	1.9	-2.5	14.8	9.5
KTL	KTL	110	1	–	–	–	0.0	-33.3	27.1	–	–	–	0.0	-32.5	26.4
REM	TRL	110	1	0.0	3.2	2.6	17.8	-4.9	13.1	10.4	2.2	8.5	24.8	0.9	17.6
KKY	KLS	110	1	-1.4	-11.7	11.9	-9.5	-6.7	9.6	-8.2	-2.4	8.6	-7.9	-1.2	6.6
KKY	KKY	110	1	–	–	–	0.0	-16.6	13.5	–	–	–	0.0	-32.2	26.2
KSE	CBT	110	1	–	–	–	–	–	–	-14.7	-5.6	8.4	-14.7	-5.5	7.1
KSE	AGN	110	1	–	–	–	–	–	–	-9.0	-3.2	5.1	-9.0	-3.2	4.3
KLN	LIM (I)	110	1	31.7	-5.7	32.5	32.7	11.5	28.6	27.2	2.9	27.6	41.9	5.6	34.9
KLN	CUR	110	1	6.0	-32.4	24.2	-5.9	4.7	4.7	-37.8	11.7	29.1	-21.6	2.1	13.7
KLN	SNG	110	1	39.3	-18.0	24.3	36.4	2.5	17.4	-4.8	6.1	4.3	65.1	-12.6	31.7
KER	OUG T	110	1	15.7	-20.5	14.5	-11.6	-4.5	5.9	16.8	-9.2	10.7	30.1	-13.6	15.7
KUR	NAV	110	1	-23.7	-13.1	27.3	-23.7	-12.9	21.9	-23.7	-13.3	27.4	-23.7	-13.0	21.9
BYH	GLE	110	1	0.1	-53.8	43.4	-43.1	2.4	34.8	-39.1	-6.1	31.9	-43.2	-7.7	35.4
KCR	GLE	110	1	0.0	8.0	6.6	31.1	-32.7	36.9	31.1	-24.9	32.7	31.2	-25.2	32.8
KTN	WAT	110	1	-9.3	4.4	10.3	-15.1	-10.6	15.3	3.6	-2.7	4.6	-21.6	-6.6	18.7
KLM	CRM	110	2	0.0	-1.4	1.0	0.0	-1.6	1.1	0.0	-1.4	1.0	0.0	-1.5	1.1
KLM	CRM	110	1	0.0	-1.4	1.0	0.0	-1.6	1.1	0.0	-1.4	1.0	0.0	-1.5	1.1

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
KLM	NBY	110	1	25.5	2.2	21.5	36.1	6.6	30.9	26.6	2.8	22.5	38.1	7.7	32.7
KLM	POP	110	1	-19.5	0.2	16.2	-2.1	1.6	2.0	-22.0	-3.9	18.6	-3.2	1.1	2.6
KUD	CBT	110	1	–	–	–	-15.5	-7.2	7.7	-22.8	-12.0	13.8	-22.8	-11.6	11.5
KPG	CNG	110	1	0.0	-2.7	1.9	-7.9	6.9	7.5	0.0	-2.3	1.6	-20.4	-2.0	14.7
KPG	RAT (I)	110	1	11.1	4.5	8.8	61.1	0.7	38.4	-0.9	11.0	8.1	24.3	11.3	16.8
KPG	TRL	110	1	1.7	-2.5	3.0	20.3	5.2	17.3	-8.1	-0.8	8.2	5.8	7.0	7.5
CBT	BKY	110	2	–	–	–	10.0	2.4	4.6	43.0	16.0	24.5	43.0	15.3	20.5
CBT	AGN	110	1	–	–	–	3.8	1.0	1.8	46.1	14.3	25.8	46.1	13.9	21.6
LA	MUL	110	1	-0.3	30.1	30.4	22.9	-12.5	21.6	48.1	-11.5	49.9	18.2	-13.2	18.6
LA	RIC	110	1	3.8	-0.4	3.8	17.1	4.3	14.3	5.3	-0.1	5.3	17.8	4.3	14.9
LA	RIC	110	2	4.7	-0.2	4.8	21.2	5.5	17.8	6.5	0.1	6.6	22.2	5.4	18.6
LA	SLB	110	1	15.5	-11.2	19.3	-31.8	-3.4	26.0	-33.1	14.7	36.6	-16.0	-10.5	15.6
LOU	MLN	110	1	10.1	5.3	11.5	31.3	12.4	27.8	2.6	3.3	4.3	33.3	17.6	31.1
LOU	RRU	110	1	9.0	-18.9	22.0	11.5	0.5	10.3	-18.3	6.3	20.4	11.5	-2.3	10.5
LOU	LOU	110	1	–	–	–	–	–	–	–	–	–	0.0	-33.4	27.1
LIM (I)	MTN	110	1	37.6	16.5	23.1	1.0	7.3	3.5	46.2	16.5	27.6	-38.8	14.5	19.7
LIM (I)	RAT (I)	110	1	-4.1	-8.8	9.7	-25.5	10.9	22.9	1.8	-7.8	8.1	13.1	-0.2	10.8
LIM (I)	KLN	110	2	-24.7	4.0	31.3	-25.5	-9.3	24.7	-21.2	-2.7	26.7	-32.6	-4.6	29.9
CNB	PLS	110	1	–	–	–	–	–	–	52.9	-7.2	30.0	89.1	-13.3	42.9
LIS	SKL	110	1	1.4	-15.3	15.5	-5.0	8.0	7.7	-6.5	-1.0	6.6	-1.2	4.1	3.5
LIS	LOU	110	1	-8.3	14.5	16.8	-27.5	17.0	26.3	3.7	-0.4	3.7	-23.1	19.0	24.3
LIS	LIS	110	1	–	–	–	0.0	-0.2	0.1	0.0	-0.3	0.2	0.0	-0.3	0.1
LIS	LIS	110	1	–	–	–	0.0	-0.2	0.1	0.0	-0.3	0.2	0.0	-33.2	27.0
LUM	PLS	110	1	-1.4	21.4	12.0	44.7	-13.5	22.3	18.1	-3.1	10.3	26.4	-3.8	12.7
LUM	DAL	110	1	1.4	-21.4	12.0	-44.7	2.1	21.3	-18.1	3.1	10.3	33.5	-2.8	16.0
LET	LNA	110	1	–	–	–	–	–	–	-12.2	6.9	10.3	-43.6	9.0	28.0
LET	TLK	110	1	4.2	-3.7	5.3	-8.9	3.1	7.7	-25.6	23.3	33.0	-9.4	2.9	8.0
LET	GLT	110	1	-7.3	-1.9	7.6	-40.9	9.6	34.8	-21.2	16.1	26.9	-57.3	17.6	49.6
LET	LET	110	1	–	–	–	0.0	-16.2	13.2	0.0	-31.3	29.8	0.0	-16.2	13.2
LET	LET	110	1	–	–	–	0.0	-16.2	13.2	0.0	-31.3	29.8	0.0	-10.1	8.2

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
LET	STR (N)	110	1	-0.5	47.8	48.3	91.0	8.3	74.3	102.9	-19.0	105.7	145.8	-27.3	120.6
LNA	TIV	110	1	–	–	–	–	–	–	-12.2	7.3	10.4	-34.7	8.6	22.5
LIB	MR	110	1	-3.7	-0.6	5.6	-17.5	-5.2	26.9	-5.2	-0.9	7.8	-18.3	-5.4	28.1
LIB	MR	110	2	-1.9	-0.3	1.9	-8.5	0.3	7.2	-2.6	-0.5	2.7	-8.9	0.2	7.5
LSN	THU	110	1	0.0	-0.4	0.4	38.4	-5.4	31.8	29.8	-13.9	31.6	38.4	-13.1	33.3
CUR	NEN	110	1	5.8	0.7	5.6	19.2	11.3	18.1	4.0	3.8	5.2	20.3	12.5	19.4
CUR	BKM	110	1	0.0	-32.8	17.3	-25.1	-6.1	13.6	-41.9	7.6	22.4	-42.0	-10.1	22.7
MHL	RE	110	1	-13.5	4.0	10.0	-46.9	-9.2	34.1	-18.8	2.6	13.5	-49.0	-9.6	35.7
MHL	TRN	110	1	6.5	-4.2	5.6	26.6	6.1	19.5	9.1	-3.1	6.9	27.8	6.2	20.3
MCE	CDU	110	1	-7.9	-2.0	8.3	-18.7	-1.9	15.1	-11.2	-1.9	11.6	-25.0	-1.5	20.2
MCD	WOL	110	1	11.9	1.2	9.9	26.7	7.0	21.1	11.3	2.2	9.6	27.9	7.4	22.0
MTH	LOU	110	1	-4.9	-8.1	9.5	-47.3	-20.8	42.7	-27.5	-0.6	27.8	-46.5	-15.4	40.5
MAY	TIM	110	1	–	–	–	–	–	–	9.8	-1.1	8.8	18.5	-1.4	16.5
MAY	GRI	110	1	8.0	-0.1	8.1	32.9	7.3	28.1	9.1	-0.6	9.2	32.4	7.5	27.7
MAY	GRI	110	1	8.0	-0.1	8.1	32.9	7.3	28.1	9.1	-0.6	9.2	32.6	7.1	27.2
MAY	RYB	110	1	97.5	30.8	57.4	75.6	31.3	37.4	102.1	31.1	59.9	82.2	20.1	38.7
MAY	RNW	110	1	13.8	-9.9	21.1	33.6	0.1	32.6	-9.3	-0.9	11.7	27.2	-0.3	26.4
MAY	BLK T	110	1	-2.5	-9.1	9.6	44.3	-8.4	37.3	-30.5	0.7	30.8	9.6	6.4	9.5
MIL	RE	110	1	-5.4	-0.7	5.4	-22.1	-2.7	22.2	-7.5	-0.7	7.5	-23.1	-3.0	23.3
MIL	RE	110	2	-4.4	0.5	3.7	-17.4	-1.9	13.3	-6.0	0.3	5.0	-18.1	-2.2	13.9
MAC	CLA	110	2	1.7	-35.3	22.0	-68.0	-1.3	35.4	-10.4	-0.8	6.5	-11.9	-8.7	7.7
MTN	MUN	110	1	10.8	6.6	28.0	10.8	6.6	28.0	10.8	6.7	28.1	10.8	6.6	28.1
MTN	MUN	110	2	10.8	6.6	28.0	10.8	6.6	28.0	10.8	6.7	28.1	10.8	6.6	28.1
MP	TBK T	110	1	21.0	-4.8	12.1	63.4	12.3	30.7	-11.0	4.6	6.7	8.8	12.6	7.3
MR	TBG	110	1	-19.2	20.2	15.6	-18.0	1.4	8.3	-6.3	1.1	3.6	-47.5	-4.1	21.8
MR	TBG	110	2	-22.3	24.0	18.4	-20.9	2.3	9.6	-7.3	1.9	4.2	-55.1	-4.2	25.2
MR	KLP	110	1	–	–	–	–	–	–	0.0	-3.1	2.6	22.3	-3.5	18.8
MAL	KLP	110	1	–	–	–	–	–	–	-14.7	0.8	11.0	-63.8	2.8	40.1
MOY	TAW	110	1	0.0	-0.5	0.8	-5.7	-3.7	10.0	0.0	-0.4	0.7	-9.0	0.1	13.2

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
MOY	TAW	110	2	0.0	-0.5	0.7	0.0	-6.4	9.3	0.0	-0.4	0.6	0.0	-0.4	0.6
MOY	TON	110	1	–	–	–	–	–	–	22.6	1.3	12.7	29.0	-1.5	13.8
BCT	CKM	110	1	-49.7	-17.3	37.6	-35.2	-9.7	26.1	-49.7	-17.5	37.7	-49.7	-16.6	37.4
NEW (I)	BLK T	110	1	8.5	7.6	8.4	-16.9	15.2	14.3	37.7	-0.7	27.7	18.6	-1.6	11.7
NQS	RE	110	1	-7.0	-0.2	5.9	-24.8	-4.7	21.2	-9.8	-0.4	8.2	-25.9	-5.1	22.2
OUG	OUG T	110	1	-7.5	0.9	7.2	-25.2	-5.9	21.0	-8.4	1.2	8.1	-26.4	-4.4	21.8
PA	STR T	110	1	0.0	-0.8	1.2	30.0	-10.2	46.6	34.0	-21.5	59.2	34.0	3.9	50.3
PHY	SHE	110	1	–	–	–	–	–	–	2.3	0.7	1.4	2.3	0.7	1.1
PB	RE	110	3	33.8	-30.0	16.8	127.0	-10.0	47.4	47.0	-27.6	20.3	132.7	-0.2	49.3
PB	RE	110	4	32.8	-29.1	16.3	123.2	-9.6	45.9	45.6	-26.7	19.7	128.7	-0.1	47.9
PLA	OBE	110	1	–	–	–	–	–	–	18.3	-2.2	17.5	8.4	-1.0	6.8
RE	WBK	110	1	0.0	-2.2	1.8	0.0	-18.6	13.2	0.0	-2.1	1.7	0.0	-2.3	1.7
RAF	TBG	110	1	25.8	-30.9	20.7	47.9	15.9	2.3	11.7	-5.7	6.7	82.2	-1.0	3.7
RAF	TBG	110	2	35.2	-20.7	22.9	66.5	-13.6	32.5	28.6	-4.5	16.3	100.0	19.0	48.7
RNW	DFR	110	1	4.6	-11.3	12.3	24.4	-1.5	20.2	-18.5	-2.4	18.8	18.0	-1.8	15.0
RRU	SKL	110	1	8.8	-17.7	20.8	35.2	-15.1	34.2	5.2	-10.2	12.1	35.2	-8.9	32.4
SH	DLN	110	1	–	–	–	–	–	–	0.0	-4.0	2.8	0.0	-4.2	3.0
SH	DAL	110	1	-1.4	19.6	11.1	58.3	5.4	27.9	19.6	-2.3	11.1	-19.3	10.3	10.4
SH	IKE T	110	1	-1.6	8.5	4.9	-13.5	7.4	7.3	-25.0	9.1	14.9	-27.2	8.3	13.5
SH	SOM T	110	1	5.8	-22.6	22.2	-9.3	2.5	7.8	-21.5	7.2	21.6	12.9	-4.6	11.1
SLI	SRA	110	1	-3.2	2.2	4.0	-12.1	-5.3	10.9	-1.6	4.9	5.2	-6.1	-0.7	5.0
SLI	SRA	110	2	-3.0	2.0	3.6	-11.2	-5.0	10.1	-1.4	4.5	4.8	-5.6	-0.7	4.7
SLI	SLI	110	1	–	–	–	–	–	–	–	–	–	0.0	-16.5	13.4
SOR	TLK	110	1	0.0	-0.3	0.2	18.8	3.3	15.5	18.1	-17.2	23.8	20.2	5.8	17.1
SOM	SOM T	110	1	-2.2	0.8	2.2	-21.7	-5.5	18.2	-0.8	0.5	0.9	-22.8	-4.6	18.9
SRA	CF	110	2	17.6	-16.1	13.4	18.5	-4.7	9.1	-11.6	6.7	7.5	27.3	-4.9	13.2
STR	STR T	110	1	-3.6	-0.1	8.1	-24.5	-5.8	56.0	-5.0	-0.1	11.2	-25.7	-6.3	58.7
SNG	AA	110	1	35.3	-18.1	27.4	17.9	-0.9	10.1	-10.2	6.1	8.2	45.7	-16.6	27.5
SBH	CDU	110	1	-16.5	-5.1	12.6	-22.5	-5.0	16.8	-59.5	-24.5	47.0	-59.5	-23.9	46.8

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
SHN	SOM T	110	1	-3.3	19.9	19.2	–	–	–	22.8	-8.8	23.3	10.1	7.1	10.0
TIV	MLG	110	1	–	–	–	–	–	–	0.0	-6.3	4.5	-9.0	-6.7	8.0
CNN	CLO	110	1	0.0	18.4	10.3	0.0	15.5	7.4	0.0	14.3	8.1	41.3	12.5	20.5
CNN	CAG	110	1	0.0	-10.3	7.4	0.0	-8.7	6.2	0.0	-8.0	5.7	-41.3	-5.6	29.7
CNN	CDF	110	1	0.0	-8.1	5.8	0.0	-6.8	4.9	0.0	-6.3	4.5	0.0	-6.9	4.9
TBK	TBK T	110	1	-1.3	1.0	1.6	-3.8	-7.9	7.1	7.4	0.1	7.1	-4.4	-3.5	4.6
CTN	KLN	110	1	5.0	-20.8	12.0	-12.0	-1.9	5.8	11.0	0.8	6.2	25.1	2.6	12.0
CTN	TIP	110	1	-5.0	32.2	18.3	64.5	-15.8	31.6	21.3	4.5	12.2	27.5	1.0	13.1
TRL	OUG T	110	1	-8.1	18.2	11.2	37.0	9.5	18.2	-8.3	6.7	6.0	-3.4	17.4	8.5
THU	IKE T	110	1	8.6	-11.2	7.9	35.3	4.1	16.9	24.2	-9.0	14.5	50.8	0.8	24.2
THU	THU	110	1	–	–	–	0.0	-32.3	26.3	–	–	–	0.0	-16.5	13.4
RSP	WEX	110	1	–	–	–	30.3	1.1	14.5	17.3	-3.5	9.9	50.3	-21.6	26.1
WEX	WEX	110	1	–	–	–	0.0	-16.6	13.5	–	–	–	0.0	-32.6	26.5
CTG	BVK	110	1	0.0	1.0	0.5	46.5	-48.7	29.5	18.7	0.2	8.2	46.6	-2.1	20.5
WHO	KMA	110	1	0.0	-1.6	1.3	–	–	–	0.0	-1.5	1.2	-10.2	-1.5	8.3
BK	SKY	110	1	0.0	-5.7	3.0	-51.2	13.4	23.7	-51.3	1.2	27.4	-51.3	0.8	23.0
BK	CRN	110	1	0.0	-0.2	0.1	0.0	-0.1	0.1	-0.5	13.5	7.6	-14.9	27.2	14.8
CKM	FAS	110	1	5.5	1.7	5.5	31.2	12.4	27.3	7.7	2.5	7.7	32.6	13.6	28.7
BKM	CUR	110	1	0.0	-9.0	7.5	-25.1	15.0	24.4	-28.1	25.6	31.7	-28.1	10.1	24.9
AGH	ENN (N)	110	1	-2.6	5.2	5.3	0.0	4.2	3.4	1.2	1.7	1.9	-17.3	1.6	14.0
AIR	ROS	110	1	–	–	–	–	–	–	-5.6	-0.9	6.9	-19.0	-3.6	18.8
AIR	ROS	110	1	–	–	–	–	–	–	-5.6	-0.9	6.9	-19.0	-3.6	18.8
ANT	KEL	110	1	-4.5	5.7	8.9	-20.3	0.2	19.7	-6.1	4.4	9.2	-21.8	1.6	21.2
ANT	KEL	110	2	-5.3	-6.0	9.7	-21.5	-10.7	23.3	-6.8	-6.4	11.4	-22.9	-9.7	24.1
BPS	BVG	110	1	7.1	1.3	8.8	11.6	8.0	13.7	8.8	3.5	11.6	55.4	-4.0	53.9
BPS	BVG	110	2	7.1	1.3	8.8	11.6	8.0	13.7	8.8	3.5	11.6	55.4	-4.0	53.9
BPS	EDE	110	1	14.0	-21.9	37.7	47.4	-16.0	58.2	8.2	1.5	5.8	30.9	5.1	18.9
BPS	EDE	110	2	14.0	-22.0	37.3	47.6	-16.1	57.8	8.2	1.5	5.8	31.0	5.1	18.9
BMA	KEL	110	1	-9.7	-1.6	9.0	-21.5	-9.1	18.8	-10.6	-0.5	9.7	-45.6	-10.8	37.8

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
BMA	KEL	110	2	-14.3	-0.9	13.1	-21.0	-8.7	18.3	-10.2	-0.4	9.4	-44.2	-10.0	36.5
BAN	TAN	110	1	-5.6	-1.6	7.1	-17.3	-3.0	17.1	-6.0	-1.7	7.6	-20.5	-5.1	20.5
BAN	TAN	110	2	-5.9	-1.7	7.5	-18.1	-3.4	17.9	-6.3	-1.8	7.9	-21.4	-5.7	21.5
BVG	KEL	110	1	0.7	-1.3	1.3	-4.9	4.1	5.2	2.7	0.0	2.4	30.5	-12.1	26.5
BVG	KEL	110	2	0.7	-1.3	1.4	-5.2	4.4	5.4	2.8	0.0	2.5	31.9	-12.6	27.6
BVG	LAR	110	1	6.4	3.3	9.1	16.5	4.3	15.1	6.1	4.0	9.2	23.5	7.3	21.8
BVG	LAR	110	2	6.4	3.3	9.1	16.6	4.3	15.2	6.1	4.0	9.2	23.6	7.3	21.8
BNH	CAS	110	1	-8.3	-1.0	10.2	-28.2	-5.9	28.0	-8.9	-1.0	10.9	-30.3	-6.1	30.0
BNH	CAS	110	2	-8.4	-0.9	10.3	-28.3	-5.9	28.0	-8.9	-1.0	10.9	-30.4	-6.1	30.1
BNM	DON	110	1	-7.3	-0.2	9.8	-23.5	-3.8	29.0	-14.0	13.4	13.4	-8.2	4.2	6.4
BNM	DON	110	2	-7.4	-0.4	9.8	-23.6	-4.0	29.2	-14.0	9.7	11.8	-8.5	0.4	5.9
AGI	BRO	110	1	–	–	–	14.2	-12.9	13.3	4.8	-10.1	7.8	0.0	-0.5	0.3
AGI	RSK	110	1	–	–	–	41.2	-13.2	21.6	13.7	-9.8	9.0	0.0	0.5	0.3
CAR	EDE	110	1	-8.7	22.9	35.5	-31.2	19.6	42.9	-2.9	-0.7	4.3	-12.2	-1.3	14.3
CAR	EDE	110	2	-8.7	23.0	35.7	-31.3	19.7	43.1	-2.9	-0.7	4.3	-12.2	-1.3	14.3
CAS	CRE	110	1	18.7	-7.6	15.3	59.4	1.5	41.0	11.9	4.6	9.6	80.1	7.3	55.5
CAS	CRE	110	2	18.7	-7.6	15.3	59.2	1.5	40.9	11.8	4.5	9.6	79.9	7.3	55.3
CAS	KNO	110	1	9.2	-3.6	15.0	25.1	-0.2	34.4	8.6	-3.2	13.9	29.5	1.6	40.5
CAS	KNO	110	2	9.2	-3.5	15.0	25.1	-0.2	34.4	8.6	-3.1	13.9	29.5	1.7	40.5
CAS	NAR	110	1	6.5	-6.1	8.2	19.2	-4.1	15.8	7.2	-5.1	8.0	24.5	-5.7	20.3
CAS	NAR	110	2	6.3	-6.0	8.0	18.8	-4.2	15.6	7.0	-5.0	7.9	24.0	-5.8	19.9
CAS	RAT (N)	110	1	8.3	0.2	10.1	24.7	4.5	24.3	8.8	0.4	10.8	30.4	4.0	29.7
CAS	RAT (N)	110	2	8.7	0.4	10.6	25.8	5.0	25.6	9.3	0.6	11.3	31.8	4.5	31.2
CAS	ROS	110	1	4.4	-0.7	3.1	13.6	2.5	9.1	7.2	1.4	5.1	28.6	6.4	19.3
CAS	ROS	110	2	4.5	-0.7	3.2	13.9	2.6	9.3	7.2	1.5	5.1	28.8	6.4	19.4
CEN	CEN	110	1	–	–	–	–	–	–	0.0	-1.8	1.0	-0.1	-1.9	0.9
CEN	CRE	110	1	-7.8	-0.5	5.4	-26.0	-5.3	18.4	-2.2	-11.9	8.4	-47.0	-9.3	33.3
CEN	CRE	110	2	-7.8	-0.5	5.4	-26.1	-5.3	18.5	-2.3	-11.8	8.4	-47.1	-9.3	33.3

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
COL (N)	CPS	110	1	-16.5	-1.5	20.2	-17.3	-10.5	19.7	-17.6	-2.7	21.7	-39.3	-7.1	38.8
COL (N)	LIM (N)	110	1	-11.5	-1.0	14.1	-10.9	-8.0	13.1	-14.6	-0.7	17.9	-22.0	-3.1	21.6
COL (N)	LOG	110	1	5.8	-0.1	7.1	17.1	3.7	17.0	5.7	0.4	7.0	21.1	5.1	21.0
COL (N)	LOG	110	2	5.7	-0.1	6.9	16.8	3.6	16.7	5.6	0.4	6.8	20.7	5.0	20.6
COL (N)	RSK	110	1	4.0	3.0	2.7	-13.8	3.2	7.4	18.4	-4.2	10.2	-26.3	-5.4	13.9
CPS	CLM	110	1	–	–	–	–	–	–	-3.7	-7.6	4.2	0.0	-15.1	7.5
CPS	KMT	110	1	21.2	-31.5	26.6	-13.0	8.2	9.2	-19.4	16.7	17.9	-3.9	6.9	4.8
CPS	LIM (N)	110	1	18.9	0.4	23.1	20.8	10.6	22.7	18.8	2.9	23.2	49.4	10.7	49.1
CPS	LMR	110	1	4.8	0.5	5.9	17.2	4.3	17.2	4.4	1.1	5.5	17.5	3.9	17.4
CPS	LMR	110	2	4.8	0.5	5.9	17.2	4.3	17.3	4.4	1.1	5.5	17.6	3.9	17.5
CPS	SPR	110	1	7.0	-0.5	8.5	16.2	1.7	15.8	7.4	-0.3	9.1	25.4	3.1	24.8
CPS	SPR	110	2	7.0	-0.6	8.5	16.2	1.6	15.8	7.4	-0.4	9.1	25.4	3.0	24.8
CPS	STR (N)	110	1	29.0	-37.6	43.6	2.3	4.7	4.2	-20.7	20.9	27.0	-3.3	25.2	20.5
CLM	AGT	110	1	–	–	–	–	–	–	3.7	-6.6	3.8	0.0	-5.5	2.8
CRG	TGW	110	1	–	–	–	–	–	–	-11.7	3.2	11.1	-16.1	4.0	13.4
CRG	TMN	110	1	-6.1	-12.6	12.8	-15.5	-11.1	15.4	4.4	-5.5	6.5	-10.4	-8.2	10.7
DON	HAN	110	1	-15.5	1.2	10.8	-48.0	-6.0	30.6	-21.1	11.5	16.7	-32.4	1.7	20.5
DON	HAN	110	2	-12.6	7.9	10.3	-39.3	1.4	24.9	-20.7	15.5	18.0	-31.7	5.8	20.4
DON	FIN (N)	110	1	-6.2	6.7	13.2	-20.1	2.7	23.6	-5.5	6.4	12.3	-19.7	5.8	23.9
DON	FIN (N)	110	2	-7.2	-9.0	16.6	-21.4	-12.0	28.5	-6.4	-8.5	15.4	-21.1	-9.7	27.0
DRO (N)	CRR	110	1	0.0	-1.0	0.6	-20.2	0.4	10.1	-16.1	3.3	8.8	0.0	-4.5	2.3
DRO (N)	ENN (N)	110	1	11.1	-13.5	21.3	30.1	1.1	29.3	8.9	-4.7	12.3	22.3	1.4	21.7
DRO (N)	ENN (N)	110	2	11.1	-13.5	21.3	30.1	1.1	29.3	8.9	-4.7	12.3	22.3	1.4	21.7

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
DRO (N)	OMA	110	1	-11.1	14.0	21.8	-20.0	-1.3	19.5	-0.9	3.1	1.6	-22.3	0.9	9.9
DRO (N)	OMA	110	2	-11.1	14.0	21.8	-20.0	-1.3	19.5	-0.9	3.1	1.6	-22.3	0.9	9.9
DRU (N)	TAN	110	1	-5.0	-0.9	6.4	-2.6	-22.0	19.6	4.7	-12.2	16.6	-13.3	-25.6	25.6
DRU (N)	TAN	110	2	-5.0	-0.9	6.4	-2.6	-22.0	19.6	4.7	-12.2	16.6	-13.3	-25.6	25.6
DRU (N)	TAN	110	3	-5.3	-0.7	4.9	-3.7	-22.9	18.4	4.4	-13.0	12.7	-15.1	-26.3	24.0
DRU (N)	TMN	110	1	-5.7	0.5	5.3	-36.1	23.1	34.5	-20.7	17.4	24.8	-27.7	25.6	30.4
DRU (N)	TMN	110	2	-6.0	0.3	5.5	-37.7	23.7	35.9	-21.7	17.9	25.8	-29.0	26.4	31.6
CRR	CRR	110	1	–	–	–	–	–	–	-4.2	0.2	5.3	0.0	-1.6	3.3
CRR	PGN	110	1	–	–	–	–	–	–	-5.2	-0.6	8.6	0.0	-2.0	3.3
DUN	TMN	110	1	-11.2	3.0	7.4	-20.7	-11.4	13.3	0.2	-7.8	5.0	-43.1	-16.3	25.9
DUN	TMN	110	2	-7.5	3.1	5.6	-15.4	-6.0	11.5	-0.5	-5.4	3.8	-31.4	-7.5	22.4
DUN	OMA	110	1	0.2	-14.7	7.9	-31.7	7.4	16.8	-28.8	11.5	16.7	7.5	3.1	4.2
DUN	TMN	110	3	-10.0	1.2	5.4	-17.6	-11.8	11.0	0.6	-7.5	4.1	-36.9	-17.2	21.1
ENN (N)	ENN (N)	110	1	0.3	-2.7	2.2	13.6	-1.1	10.9	6.0	3.5	5.6	-35.3	-3.3	28.4
FIN (N)	HAN	110	1	-11.7	-8.9	10.2	-37.5	-14.1	27.8	-11.3	-8.5	9.8	-37.7	-11.2	27.3
FIN (N)	HAN	110	2	-10.7	6.6	8.7	-36.0	0.5	25.0	-10.3	6.2	8.4	-36.2	4.1	25.3
GLE (N)	KEL	110	1	-6.6	-1.8	8.3	-28.8	-6.3	32.7	-4.8	-1.1	6.0	-16.4	-4.3	18.8
GLE (N)	KEL	110	2	0.0	-3.0	3.6	0.0	-2.9	3.2	-4.8	-1.1	6.0	-16.4	-4.3	18.8
GOR (N)	OMA	110	1	2.7	-6.2	3.4	8.0	0.5	4.0	-12.1	3.2	6.3	8.1	7.8	5.6
GOR (N)	TMN	110	1	-2.7	10.4	5.4	27.7	-2.4	13.9	24.1	-6.0	12.4	-8.1	-4.0	4.5
HAN	LIS (N)	110	1	-7.7	-17.1	22.8	19.9	-6.1	20.2	13.7	-2.6	17.0	9.1	2.9	9.2
HAN	LIS (N)	110	2	-8.0	-18.2	24.9	19.1	-7.1	20.3	13.8	-2.4	17.5	7.2	2.0	7.5
KEL	KLC	110	1	–	–	–	–	–	–	0.0	-1.1	0.8	0.0	-1.2	0.8

Table H-1: Power flows, Summer Valley and Winter Peak 2022 and 2031

Line				2022						2031					
				Summer Valley			Winter Peak			Summer Valley			Winter Peak		
From	To	kV	No.	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%	MW	MVAR	%
KEL	RSK	110	1	-7.4	-13.4	8.3	-42.8	11.0	22.9	-10.1	2.1	5.6	10.0	-3.1	5.4
KEL	RSK	110	2	–	–	–	–	–	–	-10.6	0.9	5.6	10.4	-1.9	5.0
KEL	TGW	110	1	–	–	–	–	–	–	-5.0	-1.9	2.7	22.4	-6.4	11.6
KLC	KLC	110	1	–	–	–	–	–	–	0.0	-0.3	0.2	0.0	-0.3	0.2
KMT	SLK	110	1	0.1	-22.5	20.6	-21.8	11.6	19.9	-7.2	6.4	8.9	0.1	-20.8	16.8
KMT	STR (N)	110	1	21.1	-9.0	16.0	19.5	-2.4	11.8	-8.7	6.2	7.4	-4.0	28.2	17.2
LIS (N)	TAN	110	1	-15.6	-13.5	25.1	-19.5	-12.9	22.7	2.1	-1.4	3.0	-30.7	-2.9	29.9
LIS (N)	TAN	110	2	-16.0	-14.8	27.2	-20.0	-14.0	24.4	2.3	-1.2	3.2	-32.3	-3.9	32.5
MKL	OMA	110	1	0.0	1.1	0.8	35.7	5.2	23.0	13.8	-14.5	14.4	0.0	1.0	0.6
NEW (N)	TAN	110	1	-11.7	-2.0	14.5	-36.6	-8.3	36.4	-12.5	-2.2	15.4	-42.7	-10.1	42.5
NEW (N)	TAN	110	2	-11.7	-2.0	14.5	-36.7	-8.4	36.5	-12.5	-2.2	15.5	-42.8	-10.1	42.6
OMA	STR (N)	110	1	-18.0	0.8	16.6	-35.8	2.9	29.0	-29.3	4.8	27.3	-42.1	6.7	34.4
OMA	STR (N)	110	2	-17.7	0.8	21.6	-35.2	2.9	34.3	-28.9	4.7	35.7	-41.4	6.6	40.7
OMA	TRE	110	1	-1.5	8.2	4.5	11.4	-7.4	7.0	19.4	-9.7	11.7	-10.7	-7.6	6.8
RSK	TGW	110	1	–	–	–	–	–	–	16.8	-5.6	8.8	-6.1	-1.9	3.2
STR (N)	STR (N)	110	1	1.2	-46.6	37.3	-88.2	0.6	70.5	-99.0	31.3	83.1	-138.2	52.1	118.2
TAN	WAR	110	1	9.3	1.4	11.9	28.7	5.9	26.0	10.3	1.9	13.3	35.4	8.7	32.3
TAN	WAR	110	2	9.3	1.4	11.8	–	–	–	10.3	1.9	13.3	35.4	8.7	32.2
TRE	TMN	110	1	-1.5	13.2	7.2	–	–	–	27.0	-10.8	15.6	-10.8	-3.1	5.8

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