All-Island Ten Year

Transmission Forecast Statement 2015

EIRGRID

SONI

DISCLAIMER

EirGrid and SONI have followed accepted practice in the collection and analysis of data available. While all reasonable care has been taken in the preparation of this statement, EirGrid and SONI/NIE are not responsible for any loss that may be attributed to the use of this information. Prior to taking business decisions, interested parties are advised to seek separate and independent opinion in relation to the matters covered by this statement and should not rely solely upon data and information contained herein. Information in this document does not amount to a recommendation in respect of any possible investment. This document does not purport to contain all the information that a prospective investor or participant in the Single Electricity Market may need. Furthermore, all interested parties are strongly advised to channel any enquiries through EirGrid and SONI.

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

For queries relating to this document or to request a copy contact enquiries@soni.ltd.uk or info@eirgrid.com.

COPYRIGHT NOTICE

Foreword

EirGrid and SONI, as the transmission system operators (TSOs) for Ireland and Northern Ireland respectively, have collaborated to produce the latest all-island Ten Year Transmission Forecast Statement (TYTFS).

This 2015 statement has been prepared in accordance with the provisions of Section 38 of the Electricity Regulation Act, 1999 (EirGrid) and Condition 33 of the "Licence to participate in the Transmission of Electricity" (SONI).

The TYTFS 2015 presents the most up-to-date available transmission system information at the data freeze date of July 2015.

The statement shows that data centres now represent significant demand connections in Ireland. Based on customer enquiries, a large portion of these centres plan to connect in the Dublin area. If these data centres connect as predicted, new transmission system solutions may be required in the Dublin area.

Northern Ireland results presented in the TYTFS 2015 highlight new generation opportunities in the eastern region. The results also show that to allow future generation connections in the North-West region of Northern Ireland, network reinforcements would be required. The opportunites shown to connect new demand in Northern Ireland assume sufficient generation adequacy in Northern Ireland which is linked to the completion of the planned North – South 400 kV tie line.

This planned development will increase security of supply on the island. It will also support the development of renewable power generation and provide economic benefits to customers on the island.

Those who are considering connecting generation or demand to the transmission systems of Ireland or Northern Ireland should contact us at info@eirgrid.com or enquiries@soni.ltd.uk.

I hope you find this document informative and we welcome any feedback and suggestions.

Fintan Slye

Chief Executive, EirGrid Group

DOCUMENT STRUCTURE

EIRGRID GROUP

The current. The future.

Document Structure

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

The **Abbreviations and Terms** provides a glossary of 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 2015 – 2024.

Chapter 4: Generation: describes the projected generation connection assumptions over the study period of 2015 – 2024.

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.

ABBREVIATIONS & GLOSSARY OF TERMS

EIRGRID GROUP

The current. The future.

Abbreviations and Glossary Terms

Abbreviations

AC	Alternating Current
ACS	Average Cold Spell
ATR	Associated Transmission Reinforcement
BSP	Bulk Supply Point
CAES	Compressed Air Energy Storage
CCGT	Combined Cycle Gas Turbine
CER	Commission for Energy Regulation
CHP	Combined Heat and Power
DC	Direct Current / Double Circuit
DCENR	Department of Communications, Energy and Natural Resources
DETI	Department of Enterprise Trade and Investment
DO	Distillate Oil
DSM	Demand Side Management
DSO	Distribution System Operator
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
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
MCR	Maximum Continuous Rating
MEC	Maximum Export Capacity
MIC	Maximum Import Capacity
MVA	Megavolt-Amperes
MW	Megawatt
NI	Northern Ireland
NIE	Northern Ireland Electricity
NTC	Net Transfer Capacity
PPB	Power Procurement Business
PU.	Per Unit
PST	Phase Shifting Transformer
RES	Renewable Energy Schemes
RMS	Root Mean Square
RP	Review Period
SEM	Single Electricity Market
SONI	System Operator for Northern Ireland
SPS	Special Protection Scheme
SVC	Static Var Compensator
SP	Summer Peak
SS	Substation

SV	Summer Valley
TDP	Transmission Development Plan
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 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.
Commission for Energy Regulation	The Commission for Energy Regulation (CER) is the regulator for the electricity and natural gas sectors in Ireland. The CER was initially established as the Commission for Electricity Regulation under the Electricity Regulation Act, 1999. The functions of the CER along with its name were changed by the Gas (Interim Regulation) Act, 2002. Under that Act, the remit of the CER was expanded to include the regulation of the natural gas sector and the name changed to the Commission for Energy Regulation.
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.
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 1-1 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.
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
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.
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 (p.u.)	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.
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	In November 2004 the governments of the Republic of Ireland and the UK announced the future establishment of a Single Electricity Market on the island of Ireland. This has replaced the previous bilateral trading model in Ireland. Further details can be found on the All Island Project website, www.allislandproject.org.
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 NI	UREGNI are 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.

TABLE OF CONTENTS

EIRGRID GROUP

The current. The future.

Contents

Appendices

EXECUTIVE SUMMARY

EIRGRID GROUP

The current. The future.

Executive Summary

The All-Island Ten Year Transmission Forecast Statement (TYTFS) 2015 provides the following information:

- network models and data of the All-Island transmission system,
- forecasted 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 2015 is prepared in accordance *with Section 38 of Ireland's Electricity Regulation Act, 1999.* The TYTFS 2015 is also prepared in accordance with *Condition 33, Part 1 of SONI's Licence to Participate in the Transmission of Electricity.*

The information in the TYTFS 2015 is shown for the island of Ireland from 2015-2024. EirGrid and SONI have jointly prepared the TYTFS 2015 which supersedes the All-Island Transmission Forecast Statement 2014-2023.

We have updated previously published information in light of modified transmission system developments over the period covered by the TYTFS 2015.

The TYTFS 2015 presents the most up-to-date available all- island transmission system information at the data freeze date of July 2015. Where applicable, data provided on transmission system projects under development have been provided in accordance with EirGrid's draft grid development strategy[1].

Data for transmission system projects under development is provided such that no particular preference is given to one solution[2].

[1] EirGrid recently published a discussion paper on Ireland's draft grid development strategy. The review outlines our proposed strategy for the long-term development of the network. https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf

[2] Strategy Statement 2 "Consider all practical technology options for network development" from EirGrid's Discussion Paper on Ireland's Draft Grid Development Strategy.

For our analysis the current demand forecast utilised in this TYTFS represents an average annual increase in winter peak demand of 0.5% between 2015 and 2024[3]. The forecast in demand is taken from the *All-Island Generation Capacity Statement 2015-2024 (GCS)*[4].

Since the freeze date there has been an increase in activity in the demand sector. We have therefore provided additional information this year due to the considerable interest and enquiries for data centre connections to the grid.

All-island renewable generation capacity is expected to increase rapidly up to 2020 reaching circa 7000 megawatts (MW) of generation capacity. In this TYTFS onshore wind contributes to the majority of renewable generation, however, since the freeze date there has been a significant increase in solar generation applications[5]. Some large conventional plants are expected to retire/divest from 2015-2024, a total capacity of 1788MW.

TYTFS 2015 includes maximum and minimum short circuit current levels[6] at transmission system stations. This information is given at each 110kilovolt (kV), 220kV, 275kV and 400kV transmission system station. Short circuit levels at each transmission system station are given for the following years; – 2015, 2018 and 2021.

Results show that several stations in Northern Ireland are approaching, or would exceed, their rated short circuit current level. This typically occurs under times of high generation. We will manage the transmission system to mitigate possible risks while investment plans are in place to resolve these issues. Further details of short circuit studies can be seen in Chapter 5.

Interconnection with neighbouring countries enhances the transmission system security of supply through access to a broader generation base. Interconnection also allows greater competition and the potential for prices to be reduced.

[3] http://www.eirgridgroup.com/site-files/library/EirGrid/Eirgrid_Generation_Capacity_Statement_2015.-2024.pdf

[4] The TYTFS 2015 references documents that where published at the July 2015 data freeze date. The All-Island Generation Capacity Statement 2016-2025 is due to be published at the beginning of March 2016. The information in the 2016 GCS however does not fundamentally impact studies presented in the 2015 TYTFS.

[5] See Chapter 4 for more information on the increase in solar generation applications post the June 2015 data freeze date.

[6] A description of short circuit levels is given in Chapter 5 and Appendix E

Our analysis includes the Moyle and EWIC high voltage direct current (HVDC) interconnectors. These interconnectors connect the all-island transmission system to the UK transmission system.

The generation adequacy of Northern Ireland is dependent on the completion of the planned North – South 400kV tie line. The planned North – South 400kV tie line will increase security of supply on the island. It will also support the development of renewable power generation and provide economic benefits to customers on the island. Information on the North - South 400kV tie line can be viewed in Chapter 2.

TYTFS 2015 presents 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 methodology applied to the all-island generation opportunities can be seen in Chapter 6, while the details of the assessment can be viewed in Chapter 7.

The all-island generation opportunities assessment provides information for generators wishing to connect to the transmission system. This is done through identifying regions where there is a generation capacity deficit and others where there is a surplus. In practice, regional generation levels will vary considerably, for example, depending on wind generation power output levels. Each region is interconnected by a meshed, high capacity transmission system. This is essential to maintain security and reliability of supply for demand customers across the Island of Ireland.

Regional changes in locational tariff signals are also described. This is done to help network users make informed decisions when exploring potential transmission network connection locations.

The main trend that emerges is there are high levels of generation, relative to local demand levels in Western regions and central Ireland, in comparison to regions along the Eastern seaboard. Dublin currently is the only region where demand exceeds generation.

Regions with surplus generation capacity 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.

In general, generation connections can be more readily accommodated in locations close to existing demand centres.

All-island Demand Opportunities calculated using an incremental transfer capability analysis of the 2020 transmission system are presented in Chapter 8.The study indicates that all stations studied across the island have the capability to accommodate demand connections, some to a lesser degree than others. This analysis assumes that the planned North-South 400 kV tie-line is in place by 2020. This new line improves the overall generation adequacy situation in Northern Ireland and is an important factor when considering the capacity of the system to connect significant amounts of additional demand in Northern Ireland.

Chapter 8 also includes a qualitative assessment of the demand capability in the Dublin area. This assessment has been included as a result of the recent large volume of data centre enquires in the Dublin area. The Dublin area assessment provides:

- A description of the Dublin transmission network
- Areas of focus for demand connections in Dublin and the scale of interest in each zone
- Planned transmission developments in Dublin

The results of demand and generation opportunity analysis 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.

It is advisable to consult us early in the project process. We are working to understand the needs of developers and their impact in terms of our grid development strategy.

Those who are considering connecting generation or demand to the transmission systems of Ireland or Northern Ireland should contact us. In Ireland customers can contact us at info@eirgrid.com while Northern Ireland customers can contact us at enquiries@soni.ltd.uk for further information.

1 INTRODUCTION

EIRGRID GROUP

The current. The future.

1 Introduction

The transmission system is a network of 400kV, 275kV, 220kV and 110kV 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.

Electricity supply is essential, and a reliable network is the means by which we move electricity around the country. The development of transmission network infrastructure is therefore of national strategic importance.

EirGrid is the Transmission System Operator (TSO) in Ireland, while SONI is the TSO in Northern Ireland. As TSOs, we jointly prepare and publish the all island Ten Year Transmission Forecast Statement (TYTFS) on an annual basis.

In Ireland, EirGrid plan and develop[1] the transmission system to ensure it meets forecasted transmission system operating conditions. In Northern Ireland SONI are responsible for planning the transmissions system. We must also ensure the transmission system is planned and operated to maintain its performance within defined security standards.

The TYTFS 2015 provides information on planned developments for the transmission system. It also provides information on electricity demand growth, generation capacity and interconnection with other electricity transmission systems. The appendices provide the reader with transmission system data to enable the reader to perform power flow analysis.

Readers should also consider other documents we produce when using data provided by the TYTFS 20152, including the All-Island Generation Capacity Statement 2015-2024 (GCS)3 published in February 2015.

The GCS assesses the generation adequacy of the island of Ireland from 2015 to 2024. Where possible the TYTFS 2015 complements the demand information presented in the GCS.

[1] EirGrid recently published a discussion paper on Ireland's draft grid development strategy. This review is available at http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf . The review outlines our proposed strategy for the long-term development of the network.

[2] The TYTFS 2015 references documents that where published at the July 2015 data freeze date

[3] The All-Island Generation Capacity Statement 2016-2025 is due to be published *a*t the beginning of March 2016. The information in the 2016 GCS however does not fundamentally impact studies presented in the 2015 TYTFS.

For Ireland, EirGrid also publish a Transmission Development Plan (TDP) annually. The most recent TDP (2015-2025)4 was recently consulted on by the Commission for Energy Regulation. It provides details of the transmission system developments expected to be progressed in the period up to 2025. The final version is awaiting approval and will be published shortly.

1.1 Grid Development Strategy

EirGrid recently published a discussion paper on Ireland's draft grid development strategy[5]. The review outlines our proposed strategy for the long-term development of the network. The proposed grid development strategy was developed in consideration of our three new strategy statements:

- Strategy statement 1: Open engagement and inclusive consultation with local communities and stakeholders will be central to our approach to network development.
- Strategy statement 2: All practical technology options will be considered for network development.
- Strategy statement 3: The network will be optimised to minimise requirements for new infrastructure.

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

1.2 Governing Arrangements

1.2.1 Duty to Prepare a Statement

EirGrid is the Transmission System Operator (TSO) in Ireland, while SONI is the TSO in Northern Ireland. As TSO's, we are each required to publish a Transmission Forecast Statement. Following agreement from the Regulatory Authorities[6] in Ireland and Northern Ireland, we have jointly prepared and published a single document for the island of Ireland since 2012.

In Ireland this is set out in Section 38 of the Electricity Regulation Act 1999 (as amended). Similarly for Northern Ireland, this is done in accordance with Condition 33 of the Licence to participate in the Transmission of Electricity.

[4] www.cer.ie

[5] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf

[6] The Commission for Energy Regulation (Ireland) and the Utility Regulator (Northern Ireland)

TYTFS 2015 has been prepared in accordance with and in fulfilment of these obligations. The format was approved by the Commission for Energy Regulation (Ireland) and the Utility Regulator (Northern Ireland).

1.2.2 Single Electricity Market

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

The transmission systems of Ireland and Northern Ireland are electrically connected by means of a 275kV interconnector.

The existing 275kV interconnector connects Louth station in Co. Louth (Irl) to Tandragee station, in Co. Armagh (NI). There are an additional two 110kV connections between:

- Letterkenny station in Co. Donegal (Irl) and Strabane station in Co. Tyrone (NI)
- Corraclassy station in Co. Cavan (Irl) and Enniskillen station in Co. Fermanagh (NI)

The transmission systems of Northern Ireland and Ireland were assessed with generation dispatched on an all-island basis in the network models. This is done to reflect the way in which the all-island transmission system is operated.

1.2.3 Roles and Responsibilities (Governance)

Northern Ireland

Under our licence in Northern Ireland, held by SONI, we are required to plan[7] and operate the Northern Ireland Transmission System.

In doing so we must comply with both the SONI Transmission System Security and Planning Standards and the SONI Grid Code.

[7] Under the direction of the Utility Regulator (NI), investment planning functions are now the responsibility of SONI as of May 2014 (ref: Commission Decisions 12.4.2013 pursuant to Article 3(1) of Regulation (EC) No 714/2009 and Article 10(6) of Directive 2009/72/EC – United Kingdom (Northern Ireland) – SONI / NIE).

Ireland

Under our 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 Transmission Planning Criteria and the EirGrid Grid Code.

1.3 Other Information

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

- SONI Grid Code[8]
- EirGrid Grid Code[9]
- SONI Transmission System Security and Planning Standards[10]
- The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[11]
- EirGrid Transmission Planning Criteria[12] and Operating Security Standards[13]
- SONI Transmission Connection Charging Methodology Statement[14]
- EirGrid Transmission Connection Charging Methodology Statement 2008[15]
- Final Statement of Charges For Use of Northern Ireland Electricity Ltd Transmission System [16]
- EirGrid Statement of Charges 2015-2016[17]
- All-Island Generation Capacity Statement 2015-2023[18]

---

[8] http://www.soni.ltd.uk/Operations/GridCodes/

[9] http://www.eirgrid.com/operations/gridcode/

[10] http://www.soni.ltd.uk/media/documents/Projects/Publications/Northern%20Ireland%20TSSPS%20-%20September%202015.pdf

[11] http://www.legislation.gov.uk/nisr/2012/381/pdfs/nisr_20120381_en.pdf

[12] http://www.eirgrid.com/media/Transmission%20Planning%20Criteria.pdf

[13] http://www.eirgrid.com/media/Operating%20Security%20Standards%20December%202011.pdf

[14]http://www.soni.ltd.uk/media/documents/Archive/SONI%20Charging%20Methodology%20Statement%20December%202009%20-%20Approved%2022%20December%202010.pdf

[15] http://www.eirgrid.com/media/Connection%20Charging%20Statement.pdf

[16]http://www.soni.ltd.uk/media/documents/Customers/TUOS/Final%20TUoS%20Statement%20of%20Charges%202015-16.pdf

[17] http://www.eirgrid.com/media/2013-2014StatementofChargesCERApproved(180913)v20.pdf

1.4 Data Management

Transmission system development is continuously evolving. We froze all data for analysis at the beginning of July 2015. This was done to carry out analyses and to update system models and appendices for the TYTFS 2015.

All data for system model files, and sequence data for use with short circuit current level analysis, was collected on this date.

Since the data freeze, a number of changes in the following areas have emerged. The capital approval (CP) numbers enable readers to cross reference transmission projects in Ireland with the TDP.

The following transmission system developments have been initiated as projects:

- CP0740 Letterkenny 110kV station - Relocation of Trillick bay
- CP0840 Ballynahulla 220kV station – 2nd Transformer
- CP0868 Knockraha Raffeen 220kV Line Refurbishment
- CP0867 Flagford Louth 220kV Line RefurbishmentCP0871 Galway 110kV busbar refurbishment and uprate
- CP0928 Cloghran 110kV Station Project Phase 3
- CP0904 Kells & Hannahstown 275kV Substation Developments(NI)
- CP0934 Ballynahulla 220/110kV Station – STATCOM
- CP0935 Ballyvouskil 220/110kV Station – STATCOM
- CP0933 Thurles 110kV Station - STATCOM
- CP0936 Knockanure 220/110kV Station – Reactor
- CP0941 Moneypoint Windfarm Shallow Connection
- CP0951 Garvagh 110kV Station Shallow Works

The expected completion date of the following transmission system developments has shifted out by in excess of one year:

- CP0688 Moneypoint 400kV GIS station 2018
- CP0839 Moy 110kV Station reconfiguration and busbar uprate 2019

[18] http://www.eirgrid.com/media/Generation%20Capacity%20Statement%202014.pdf

The following transmission system development has been terminated as projects:

- CP0673 Knocknagreenan Pumped Storage connection project

The following transmission system developments have been completed:

- CP0507 Arklow 220kV Station - New 20 MVA Transformer (T102)
- CP0728 Kill Hill 110kV Station Shallow Connection Works
- CP0657 Ikerrin - Thurles 110kV Line Uprate (Including Thurles 110kV Busbar Uprate)
- CP0697 Carrick-on-Shannon 110kV Station Busbar Uprate
- CP0709 Dunmanway 110kV Station Busbar Uprate
- CP0716 Carrigadrohid - Macroom 110kV Line Uprate
- CP0736 Cunghill - Sligo 110kV Line Uprate
- CP0744 Cahir - Tipperary 110kV Line Uprate (Including Tipperary 110kV Busbar Uprate)
- CP0747 Maynooth - Ryebrook 110kV Line Uprate
- CP0761 Bruckana 110kV Windfarm Connection
- CP0851 Kilbarry 110kV Station Replacement of three 110kV Circuit Breakers

The assumptions/parameters of following transmission system developments have changed:

- CP0732 Grid Link – *Now Regional Solution*

The following transmission system developments are under review:

- CP0624 Killonan 220kV station refurbishment

1.5 Publication

The TYTFS 2015 is available in pdf format on our websites (www.eirgridgroup.com) (http://www.soni.ltd.uk/).

Transmission system model files are also available on the websites.

2 THE ELECTRICITY TRANSMISSION SYSTEM

EIRGRID GROUP

The current. The future.

2 The Electricity Transmission System

2.1 Overview of the All-Island 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.

The transmission system in Northern Ireland is operated at 275kV and 110kV. The transmission system in Ireland is operated at 400kV, 220kV and 110kV. The two transmission systems are connected by means of one 275kV double circuit.

That connection is from Louth station in Co. Louth (Irl) to Tandragee station in Co. Armagh (NI). There are also two 110kV connections[1]:

- Letterkenny station in Co. Donegal (Irl) to Strabane station in Co. Tyrone (NI); and
- Corraclassy station in Co. Cavan (Irl) to Enniskillen station in Co. Fermanagh (NI)

The 400kV, 275kV and 220kV networks form the backbone of the transmission system. They have higher power carrying capacity and lower losses than the 110kV network.

In Ireland, the 400kV network provides a high capacity link between the Moneypoint generation station on the west coast and Dublin on the east. We are planning a new 400kV cross-border circuit. For the purposes of the 2015 TYTFS analysis it is anticipated to be installed by the end of 2019.

The 275kV network is comprised of a double circuit ring in Northern Ireland. There is also a double circuit spur to Coolkeeragh Power Station and another double circuit spur southwards into Co. Louth, in Ireland.

In Ireland the transmission network is comprised of single circuit lines which are interconnected to cover the wider geographical distances between stations. Typically large generation stations (greater than 100MW) are connected to the 220kV, 275kV or 400kV networks.

[1] Eirgrid and SONI together operate the transmission systems - North and South- on an all island basis.

The 110kV[2] circuits provide parallel paths to the 220kV, 275kV and 400kV networks and is the most extensive element of the all-island transmission system, reaching into every county on the island of Ireland.

The transmission system is generally comprised 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 lines3 and cables at the different voltage levels. Revision of individual line lengths may change following completion of network development projects.

Table 2-1 Total Length of Existing Transmission System Circuits as at the Data Collection Freeze Date (July 2015)

Voltage Level	Total Line Lengths (km)	Total Cable Lengths (km)
400kV	439	0
275kV	825	‹1
220kV	1786	129
110kV	5877	372

Transformers located sub stations are required to link the different voltage networks, providing paths for power to flow from the higher to the lower voltage networks. The total transformer capacity between the different voltage levels is presented in Table 2-2.

Table 2-2 Total Transmission System Transformer MVA Capacity as at the Data Collection Freeze Date[4] (July 2015)

Voltage Level	Capacity (MVA)	Number of transformers
400/220kV	3,050	6
275/220kV	1,200	3
275/110kV	3,840	16
220/110kV	11,679	58

[2] A number of radial 110kV circuits in Ireland and the 110kV lines and cables within Dublin City are operated by the Distribution System Operator (DSO). The DSO licence is held by ESB Networks. Details of the distribution network in Dublin are not included in this All-Island Transmission Forecast Statement.

[3] Some lines may contain short sections of cable.

[4] Transformer details are provided in Tables B-6, B-7, B-8, B-9 and B-10 in Appendix B.

Reactive compensation devices are used to improve transmission system voltages in local areas. Existing reactive devices connected to the transmission system include shunt capacitors, static var compensators (SVCs) and shunt reactors. Table 2-3 shows the total amounts of each type. 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 Total Reactive Compensation as at as at the Data Collection Freeze Date[5] (July 2015)

Voltage Level	Type	Capacity (Mvar)	Number of Devices
400kV	Line Shunt Reactor	160	2
	Voltage Source Converter Interconnector	+/- 175	1
275kV	Shunt Capacitor	236	4
220kV	Shunt Reactor	100	1
110kV	Static Var Compensator	90	2
	Shunt Capacitor	921	42
33kV	Shunt Capacitor	29	5
22kV	Shunt Reactor	210	7
	Shunt Capacitor	125	5

2.2 Existing Connections between Ireland and Northern Ireland Transmission Systems

As illustrated in Figure 2-1, the transmission systems of Ireland and Northern Ireland are connected via a double circuit 275kV line. This line directly connected to the Northern Ireland transmission system at Tandragee runs to Louth in Ireland. There are three 275/220kV transformers in Louth station, one 600MVA unit and two ganged[6] 300MVA units.

In addition to the main 275/220kV double circuit, there are two 110kV connections. One is between Letterkenny in Co. Donegal and Strabane in Co. Tyrone, and the other between Corraclassy in Co. Cavan and Enniskillen in Co. Fermanagh.

[5] Details of existing reactive compensation devices are provided in Table B-12 in Appendix B

[6] Plant connected in parallel through common switchgear.

The purpose of these 110kV circuits is to provide support to either system for certain conditions or in the event of an unexpected circuit outage. Phase shifting transformers in Strabane and Enniskillen are used to control the power flow under normal conditions.

The design capacity of each of the 275/220kV cross-border circuits is 600MVA. 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.

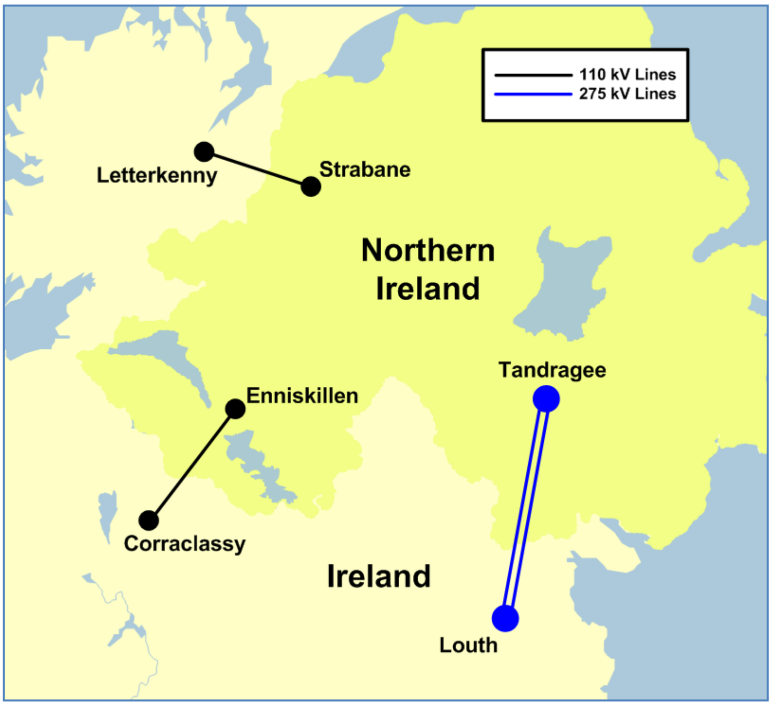


Figure 2-1 Existing Cross-Border Circuits

2.3 Interconnection with Great Britain and Europe

Power is imported from Scotland and Wales across the Moyle Interconnector and the East-West Interconnector respectively. This has caused conventional generation in Northern Ireland and Ireland to be displaced by these non-synchronous power sources.

This reduces the all-island system inertia; which is also reduced by the increased wind penetration, which is another form of non-synchronous generation.

This has 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.

The East West Interconnector however does have dynamic reactive power export capability. SONI acts as Interconnector Administrator (IA) for the East West and Moyle interconnectors.

Interconnector capacity is auctioned by the IA on behalf of EirGrid Interconnector Limited (EIL)[7] and Moyle Interconnector Limited (MIL)[8]. The capacity is purchased by market participants and utilised in the Single Electricity Market (SEM). Figure 2-2 shows the location of the Moyle interconnector and EirGrid East-West Interconnector.

Figure 2-2 Existing Interconnectors

[7] http://www.eirgridgroup.com/customer-and-industry/interconnection/

[8] http://www.mutual-energy.com/mutual-energy-continues-to-contribute-to-lower-electricity-prices/

The amount of power that can currently be traded between Northern Ireland and Scotland across the Moyle Interconnector is constrained (due to an ongoing outage/fault[9]) to 250MW[10] all year (see section 2.3.1 for details).

The amount of power that is permitted to be traded between Ireland and Wales across the East-West Interconnector is 500MW all year. This is measured at the SEM and BETTA (British Electricity Trading and Transmission Arrangements) market reference point in Deeside 400kV station in Wales. Table 2-4 below details the available capacity of the interconnectors.

Table 2-4 Available Capacity on Existing Interconnectors

Interconnector	Direction	Summer	Winter
Moyle	SCO – NI[11]	250MW	250MW
	NI – SCO[12]	250MW	250MW
EWIC[13]	WAL – IRL	500MW	500MW
	IRL – WAL	500MW	500MW

2.5.1 Moyle Interconnector

The Northern Ireland transmission system is currently connected to Great Britain via a 500MW High Voltage Direct Current (HVDC) link, the Moyle interconnector. The Moyle Interconnector commenced 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 500MW. An emergency flow of up to 75MW is available should the frequency on the island drop below 49.4Hz.

The convertor station at Ballycronan More is looped into one of the 275kV Ballylumford to Hannahstown circuits. The Moyle Interconnector is a Line

[9] http://www.mutual-energy.com/moyle-link-to-be-restored-ahead-of-schedule/

[10] As of the publication date of the 2015 TYTFS, the Moyle interconnector has returned to full capacity on an interim basis (http://www.mutual-energy.com/project-update-8). At the data freeze date and for the purposes of the 2015 TYTFS studies the Moyle Interconnector is assumed to be constrained to 250MW.

[11] The Moyle Interconnector import capacity increases to 450MW in winter 2016 due to repair works being completed.

[12] The Moyle Interconnector export capacity is expected to increase to 295MW in winter 2016 due to repair works being completed. However this export capacity is expected to be limited to 80MW from winter 2017 due to network limitations in Scotland.

[13] Power delivered to connection point at receiving power system.

Commutated Converter (LCC) HVDC link. The Moyle link is self-compensating for reactive power losses. There are 4 x 59Mvar 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 50Hz 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.

At present a cable fault on Pole 1 of the Moyle Interconnector means that 250MW of the capacity is unavailable. Moyle Interconnector Limited (MIL)14 believes the fault is due to movements of the seabed, causing cracks which allowed seawater to enter and create an electrical short circuit. MIL has indicated a prudent base case assumption would be to assume that Pole 1 will return to operation in winter 2016.

The export capacity of the Moyle Interconnector will however be limited to 295MW from winter 2016 onwards. This is due to the commissioning of a large wind farm in Scotland which will use up capacity on the single circuit from Auchencrosh to Coylton.

2.5.2 East-West Interconnector

The East-West Interconnector is a 500MW HVDC link which runs between Woodland, County Meath in Ireland and Deeside in North Wales. The link comprises approximately 186km of sub-sea cable and 70km of land underground cable.

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

[14] http://www.uregni.gov.uk/publications/letter_from_utility_regulator_to_moyle_interconnector_ltd_5_february_2015/

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 175Mvar at Portan 400kV station which is connected directly to Woodland 400kV station. The East-West Interconnector commenced commercial operation in December 2012.

2.5.3 Future European Interconnection

Eirgrid are currently working with RTE, the French TSO, on a joint project investigating the business case for an interconnector between Ireland and France. The potential connection point is expected to be in the south of the country. The main drivers of this future potential project are market integration and generation integration.

2.4 Ireland Transmission System Developments

2.5.4 Grid Development Strategy

We published "Your Grid, Your Views, Your Tomorrow", a discussion paper on Ireland's Grid Development Strategy in March 201515. Three main factors have influenced our strategy to develop the national transmission grid:

- Feedback received during the consultation process on major projects[16]
- Advances in technology
- Changes in the external economic environment

These factors are the basis for EirGrid's three new strategy statements:

- Open engagement and inclusive consultation with local communities and stakeholders will be central to EirGrid's approach to network development
- All practical technology options will be considered for network development
- The network will be optimised to minimise requirements for new infrastructure

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

[15] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf

[16] http://www.eirgridgroup.com/site-files/library/EirGrid/Reviewing-and-Improving-Our-Public-Consultation-Process.pdf

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

Reinforcing and upgrading the transmission system is required in order to maintain a safe, secure, reliable, economical and efficient electricity transmission system into the future. We carry out regular assessments of the country's energy needs, based on future economic and demand projections, as well as Government and EU policy.

2.5.5 Reviewing and Improving our Public Consultation Process

In December 2014, EirGrid published a commitment paper – Reviewing and Improving our public consultation process[17].

This paper is a response to feedback received on our public consultations and took into consideration the following four inputs:

- A review of public feedback;
- A review of international best practice in public consultation;
- An independent external expert review carried out by SLR Consulting Limited; and
- An independent external expert review carried out by the Chartered Institute of Arbitrators.

Three common themes emerged from the examination of our public consultation process:

- A need to develop a participative approach;
- Change our Culture and Processes; and
- Encourage Leadership & Advocacy.

In response to the stakeholder feedback, we proposed 12 commitments[18] intended to improve the way we engage with the public and stakeholders in the development of network projects.

[17] http://www.eirgridgroup.com/site-files/library/EirGrid/Reviewing-and-Improving-Our-Public-Consultation-Process.pdf

[18] The 12 commitments can be found in the commitment paper - Reviewing and Improving our public consultation process

In line with our ongoing policy of assessment and review, we will continue to take into account the most up-to-date information available when we are developing the transmission system.

Appendix B of this TYTFS outlines Transmission System developments which have received capital approval. These projects are currently scheduled to be completed by 2024. Table 2-5 shows the level of transmission system developments delivered by EirGrid (in conjunction with ESB Networks and independent contestable build contractors) over the past five years.

Table 2-5 Recent Historical Level of Transmission Developments

Year	Circuit Uprate (km)	New Line Build (km)	New Station Build
2009	168	104	7
2010	215	37	5
2011	340	76	3
2012	215	128	2
2013	225	38	3
2014	167	79	2

2.5.6 Transmission Development Plan in Ireland

EirGrid's Transmission Development Plan19 (TDP), details the transmission system development projects that have been initiated by us. It also discusses further developments that may arise in the period of the plan.

The transmission system development plan includes projects that are required to facilitate demand growth, new generation and demand connections20. This is done in compliance with the Transmission Planning Criteria (TPC).

The planned transmission system developments presented in this statement are based on those projects that have received capital approval by the data freeze date. All information presented on transmission system transfer capabilities and opportunities is contingent on the completion of these development projects in the assumed timeframe.

[19] The latest TDP can be obtained from the EirGrid website http://www.eirgridgroup.com/

[20] For example data centres or large industrial sites

It should be noted that the information presented here is 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. In addition, the connection of new generation or an increase in demand could drive further development requirements.

The Transmission Development Plan 2015-2025 includes details of major transmission system developments planned for the transmission system of Ireland. An overview of these major transmission system developments planned for the transmission system of Ireland on July 1st 2015, when data was frozen.

This was in order to facilitate the completion of the TYTFS and is detailed in the next pages of this section. Each planned development is illustrated on the maps in Appendix A. New generation connections and new transmission interface stations are described in Sections 3.7 and 3.8 respectively.

2.5.7 Project Delivery

By its very nature, development of the transmission system is subject to risk. Project completion dates in the TYTFS are forecasts based on the best project information available at the time of the data freeze date. Certainty with regard to completion dates increases as a project moves through the various phases in its lifecycle, as represented below in Figure 2-3.

The project schedule at the concept stage is developed based on standard lead times for generic project types. As a project moves forward, a detailed schedule is developed, milestones are achieved and greater certainty as to the completion date exists.

Figure 2-3 Relationship between project lifecycle and completion date certainty

The level of certainty or risk in a project is also dependent on the project type as shown in Figure 2-4.

Figure 2-4 Project certainty dependent on project constituents

We have differentiated between moderate and high-risk projects based on project type and project status. Thus, line and station busbar uprate projects which are due to be completed by 2018 are considered to be within the moderate risk category. Those large-scale linear developments scheduled to be completed post 2018 have a higher level of risk.

Projects due for completion in the near-term are inherently less risky than those due for completion in later years It should be kept in mind that the completion dates are subject to change and that the level of change typically depends on the type of project and the stage the project is at in its lifecycle.

All developments included in this section have received capital approval.

Kilpaddoge 220kV Development[21]

Kilpaddoge 220kV station, in north Co. Kerry, will be connected into the existing Clashavoon-Tarbert and Killonan-Tarbert 220kV lines. All existing 110kV circuits currently connecting at the existing Tarbert 220kV station will be transferred to Kilpaddoge 220kV station. This will make Kilpaddoge a new hub for power flows into the south-west. The Kilpaddoge 220/110kV project is needed to replace Tarbert 220kV station as the main transmission station in north Co. Kerry. This is because the location was restricting further access and development of the transmission station. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2016.

[21] http://www.eirgridgroup.com/the-grid/projects/north-kerry/the-project/

Finglas 220kV Redevelopment

The 220kV and 110kV busbars in the existing Finglas 220kV station will be reconfigured and redeveloped into a ring busbar arrangement. This project will address issues regarding the stations ability to: accommodate future load growth; security of supply to north Dublin; asset condition of existing equipment; inadequate circuit breaker ratings and the need for upgrade of the protection systems. The project will also increase operational flexibility, improve maintainability of station equipment and allow for future 220kV expansion. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2016.

Belcamp 220kV Development[22]

Belcamp 220kV station, in north Co. Dublin, will be connected to the 220kV network by an underground cable from Finglas. A number of the existing 110kV circuits in the area will be connected to the new Belcamp station. This development will offload demand from Finglas 220kV station. It will also ensure compliance with the transmission and distribution system planning standards as new demand connects to the system in the North East Dublin area. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2018.

Knockraha 220kV Reconfiguration

The 220kV busbar in Knockraha 220kV station will be reconfigured from the existing double busbar configuration to a ring busbar arrangement. The third Knockraha 220/110kV transformer will be decommissioned resulting in the station having two 220/110kV transformers. The project will resolve issues regarding security of supply, operational flexibility and improve maintainability of station equipment. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2017.

[22] http://www.eirgridgroup.com/the-grid/projects/dublin-north-fringe/the-project/

Laois-Kilkenny Reinforcement Project[23]

A new 400/110kV station to be located near Portlaoise, Co. Laois, with an associated 110kV circuit to Kilkenny 110kV station via Ballyragget station. The 400/110kV station will be looped into the existing Moneypoint-Dunstown 400kV line and the existing Portlaoise-Athy 110kV line. The proposed infrastructure will improve quality of supply to south-east. It will also increase capacity in the region. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2017.

Inchicore 220kV Redevelopment

The oldest section of the existing Inchicore 220kV 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 for upgrade of the protection systems. The new GIS compound will increase operational flexibility, improve maintainability of station equipment and allow for future 220kV expansion. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2018.

Aghada 220kV Development

The 220kV busbar in Aghada 220kV station will be reconfigured from the existing double busbar into a 'C' configuration. The 110kV busbar will also be uprated. The project will increase security of supply, increase operational flexibility and improve maintainability of station equipment. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2018.

Louth Development

Louth station comprises three voltage levels, 275kV, 220kV and 110kV. The station will undergo a major refurbishment of assets at all three voltage levels. The 110kV busbar will be reconfigured from the existing double busbar configuration to ring busbar arrangement.

[23] http://www.eirgridgroup.com/the-grid/projects/laois-kilkenny/the-project/

Moneypoint-Kilpaddoge 220kV Circuit

There is a planned new submarine cable across the Shannon estuary from Moneypoint in Co. Clare to Kilpaddoge in north Co. Kerry. This will create a new path for power out of the Dublin-Moneypoint group of generators into the South West. It will also create a path for power out of the South West to the 400kV network. At the data freeze date and for the purpose of the 2015 TYTFS analysis, this project is expected to be completed by winter 2015.

Ballyvouskill 220kV Development

Ballyvouskill 220kV station will be looped into the existing Clashavoon-Tarbert 220kV line. The station will be linked to the existing Garrow 110kV station by one new 110kV underground cable. The Ballyvouskill 220/110kV project is needed to accommodate renewable generation in the south-west. At the data freeze date and for the purpose of the 2015 TYTFS analysis, this project is expected to be completed by winter 2015.

Knockanure 220kV Development[24]

Knockanure 220kV station will be looped into the existing Clashavoon-Tarbert 220kV line as well as the existing Trien-Tarbert 110kV circuit and the planned Trien-Athea 110kV circuit. The Knockanure 220/110kV project is needed to accommodate renewable generation in the south-west. At the data freeze date and for the purpose of the 2015 TYTFS analysis, this project is expected to be completed by winter 2015.

Ballynahulla 220kV Development

Ballynahulla 220kV station will be looped into the existing Clashavoon-Tarbert 220kV line. The station will be linked to the existing Glenlara 110kV station by a new 110kV circuit. The Ballynahulla 220/110kV project is needed to accommodate renewable generation in the south-west. At the data freeze date and for the purpose of the 2015 TYTFS analysis, this project is expected to be completed by winter 2015. This station was formerly known as Kishkeam but has been renamed.

[24] http://www.eirgridgroup.com/the-grid/projects/millstreet/the-project/

Clogher 110kV Development

Clogher 110kV GIS station will be looped into the existing Cathaleen's Fall – Drumkeen and Cathaleen's Fall – Golagh T – Letterkenny 110kV lines. Mulreavy and further gate 3 wind farms will connect at 110kV into the new Clogher 110kV station. This 110kV transmission station is being built contestably. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2016.

Poolbeg 220kV Development

Two 50Mvar shunt reactors will be installed in Poolbeg 220kV station, in Co. Dublin. There has been an increase in the number of cable circuits and a reduction in the usage of the conventional generation in Dublin. This has made it more difficult to control voltage during low-demand periods. These reactors will help to adequately control the voltages by alleviating the operational constraint of running generators outside of merit order. For the purpose of the 2015 TYTFS analysis, the reactors are expected to be completed in the latter half of 2016.

Moneypoint Redevelopment

A new 400kV substation will replace the existing Moneypoint 400kV substation, which will be retired. The existing Moneypoint-Oldstreet and Moneypoint-Dunstown 400kV circuits and Moneypoint 400/220kV transformer will be transferred to the new Moneypoint 400kV busbar. The station will also accommodate a second 400/220kV transformer.

The project also involves the relocation of the existing capacitor bank from the A1/B1 110kV busbar section to the A2/B2 110kV busbar section. The project will address 110kV busbar capacity issues and short circuit problems, increase operational flexibility and improve maintainability of station equipment. For the purpose of the 2015 TYTFS analysis, this project is expected to be completed in 2019.

Moneypoint – Kilpaddoge - Knockanure 220kV Development

There is a planned new 220kV cable from Moneypoint in Co. Clare to Knockanure in north Co. Kerry, via Kilpaddoge also in north Co. Kerry. This will create a new path for power out of the South West to the existing 400kV network. The project will comprise a submarine 220kV cable under the Shannon and a 21 km 220kV land cable. It is expected to be completed in 2019.

Grid West Project[25]

We conducted a comprehensive analysis on both underground and overhead solutions for the Grid West Project. We submitted a report on this analysis to the Government appointed Independent Expert Panel[26].

The report, based on this detailed analysis, considers three options:

- A HVDC underground cable and associated convertor stations;
- A 400kV overhead line; and
- A 220kV overhead line which may incorporate sections of underground AC cable.

The report was published in July 2015.

Grid West will create a new path for power out of the North Mayo region to the meshed 220kV transmission system at the existing Flagford 220kV station.

The preferred location of the substation sites in the North Mayo and Flagford areas and will undergo further investigation before any final decision is made. The substation locations shown in the geographical maps are only indicative.

For the purpose of the 2015 TYTFS analysis, all three options have been studied and are assumed to be completed in 2019.

Regional Solution (formerly Grid Link) Project[27]

We conducted a comprehensive analysis on both underground and overhead solutions for the Grid Link Project. In addition to this, we analysed a new and innovative technical solution, referred to as the ‘Regional Option’, based on technology which is capable of improving the existing grid infrastructure. This meets the needs of the project without building new large scale overhead infrastructure. In September 2015 we submitted a report on this analysis to the Government appointed Independent Expert Panel.

In October 2015 we announced the Regional Option as our preferred solution. We are now moving forward with this option.

The Regional Solution uses a technology called ‘series compensation’. This would be the first time it will be deployed on the Irish transmission grid. It technology that will enable more power to flow through existing lines.

---

[25] http://www.eirgridgroup.com/the-grid/projects/millstreet/the-project/

[26] http://www.eirgridgroup.com/site-files/library/EirGrid/Summary-of-IEP-Report-Grid-West.pdf

[27] http://www.eirgridgroup.com/the-grid/projects/grid-link/the-project/

Therefore, previously proposed new 400kV overhead lines are not required. To complete this solution, an underwater cable across the Shannon estuary is required in addition to some upgrade works to existing transmission lines.

The Regional Solution will facilitate the integration of renewable and conventional generation in the south of Ireland. It will also facilitate potential future interconnection with Great Britain or France and ensure security of supply is maintained for the south east and south midlands in Ireland.

For the purpose of the 2015 TYTFS analysis, it is assumed to be completed in 2020.

North Connaught 110kV Reinforcement

This project is under review. Confirmation of the need is required. Should it progress, an investigation of overhead and underground options utilising various technologies will be undertaken in line with our strategy statements.

For the purpose of the 2015 TYTFS analysis, both an 110kV overhead line and underground option has been presented[28]. It is assumed that both options will connect the existing Castlebar 110kV station to the existing Moy 110kV station. It is assumed to be completed in 2020.

Finnstown 220kV Development

This project has been cancelled. However, a new West Dublin 220kV station has been initiated to reinforce the transmission and distribution systems. This is in order to facilitate the connection of a significant volume of new load in the area, see details below.

West Dublin 220kV Development

West Dublin 220kV station, in west Co. Dublin, will be connected into the existing Inchicore-Maynooth No. 1 and No. 2 220kV lines. A number of the existing 110kV circuits in the area will be connected to the new West Dublin station. This development will offload demand from Inchicore 220kV station. It will also ensure compliance with the distribution system planning standards as new demand connects to the system in the West Dublin area.

[28] This project is under review and therefore generic models have been provided in Appendix B for information. As the project certainty increases and detailed studies of solutions become available, data in future TYTF's will be updated accordingly.

North-West Project

The cross-border Renewable Integration Development Project (RIDP) identified that the existing network in the north west of the island is insufficient to accommodate the future wind generation in the area. The original preferred solution option involved progressing the North-West project as the first element of RIDP. The timing of the progression of the elements is now under review.

Should the North-West progress, an investigation of overhead and underground options utilising various technologies will be undertaken in line with our strategy statements. For the purpose of the 2015 TYTFS analysis both an 220kV overhead line and underground options have been presented[29]. Both options will connect the existing Srananagh 220kV station to the planned Clogher 110kV station in Donegal. It is assumed to be completed in 2022.

2.5 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. Unapproved projects have been included using provisional completion dates provided by NIE at the time of the data freeze (1st July 2015). In considering this plan it should be noted that:

- The majority of projects have still to go through EirGrid/SONI governance process to secure both internal and regulatory approval.
- The plan is based on assumptions relating to the forecast growth of demand and generation.
- With regard to the majority of the projects, there has been only a limited level of optioneering. As part of the more detailed planning process, closer consideration of a wider range of potential solutions may result in a development that differs from that detailed in this plan.
- Whilst studies have concluded that, subject to the forecast growth in demand and generation, the projects are required to address non-compliance with standards, no cost benefit analysis at this stage been carried out.

[29] As this project is at an early stage, generic models have been provided in Appendix B for information. As the project certainty increases and detailed studies of solutions become available, data in future TYTF's will be updated accordingly.

- This will also form part of the more detailed planning process and may result in alternative solutions, or perhaps operational interventions, that could avoid the need for development.

Coleraine-Kells 110kV Circuit

The uprating of the section of the Coleraine-Kells circuit between Kells and the connection point to the proposed Rasharkin cluster substation is presently ongoing. The wood pole section of the circuit has been restrung with high temperature conductor. The tower line section (one side of the double-circuit between Terrygowan and Kells)is being replaced with gap conductor. For the purpose of the 2015 TYTFS analysis it is expected that this work will be completed by winter 2016

Knock Main

It is planned to replace the two 60MVA transformers at Knock Main with two 90MVA units. For the purpose of the 2015 TYTFS this work is expected to be completed by winter 2016.

Tamnamore/Dungannon/Omagh Developments

(i) Tamnamore Main 275kV Substation - Phase 2

The Tamnamore Phase 2 project is a further development of the Tamnamore 275/110kV substation. It is proposed to extend the existing 275kV and 110kV double busbars at Tamnamore and to connect a second 275kV transformer. It is also proposed to connect in the Dungannon-Drumnakelly and Dungannon-Creagh 110kV circuits. Dungannon Main will be supplied by two radial circuits from Tamnamore Main (one of these circuits is already constructed). It is proposed to divert the remaining 275kV Magherafelt-Tandragee circuit into the substation. This work is ongoing; for the purpose of the 2015 TYTFS analysis, this work is expected to be completed by winter 2016.

(ii) Dungannon-Omagh 110kV Circuits

Both of the Omagh-Dungannon 110kV circuits will be diverted into Tamnamore Main. The current Omagh-Dungannon ‘2’ circuit, which is planned to be connected into the Tremoge cluster, will connect directly into Tamnamore. The Omagh-Dungannon ‘1’ circuit will use a mesh corner at Dungannon Main to connect through to Tamnamore. This design will provide resilience to Dungannon Main against N-2 contingencies. For the purpose of the 2015 TYTFS analysis, this work is expected to be completed by winter 2016.

(iii) Dungannon-Tamnamore Restring

The section of 110kV tower line from Dungannon Main to Tamnamore is planned to be restrung with high temperature conductor. As part of the Tamnamore Phase 2 project the Dungannon – Tremoge circuit will bypass Dungannon Main and be connected directly to Tamnamore. For the purpose of the 2015 TYTFS analysis, this work is expected to be complete by winter 2016.

(iv) Omagh-Tamnamore New 110kV Circuit

It is proposed to construct a new circuit from Omagh-Tamnamore 110kV. This circuit will be approximately 57km in length on Portal construction with Zebra conductor (with a DOT of 750C). The circuit will also be used to connect the proposed Gort cluster substation. For the purpose of the 2015 TYTFS, the work is expected to be completed by winter 2016.

(v) Dungannon Main refurbishment

The 110kV mesh at Dungannon Main is currently undergoing refurbishment. All switchgear is being replaced with 40kA equipment. For the purpose of the 2015 TYTFS this work is expected to be completed by winter 2017.

Windfarm Clusters Development

(i) Tremoge 110kV Cluster

It is proposed to establish a 110/33kV windfarm cluster substation at a site adjacent to the existing 110kV Omagh – Dungannon circuit ‘2’. This circuit will supply the new cluster substation. For the purpose of the 2015 TYTFS, Tremoge cluster is expected to be complete by winter 2016.

(ii) Rasharkin 110kV Cluster (formally Mid-Antrim)

It is proposed to establish a 110/33kV substation at a site adjacent to the existing Coleraine-Kells 110kV cricuit. This circuit will supply the new cluster substation. For the purpose of the 2015 TYTFS, this cluster substation is expected to be complete by winter 2016.

(iii) Gort 110kV Cluster

It is proposed to establish a 110/33kV substation at a site adjacent to the proposed new 110kV Omagh-Tamnamore circuit. This circuit will supply the new cluster substation. For the purpose of the 2015 TYTFS, the Gort cluster substation is expected to be complete by winter 2016.

(iv) Curraghmulkin 110/33kV Cluster (formerly Drumquin)

It is planned to establish a new 110/33kV cluster substation close to Drumquin village. The Curraghmulkin cluster is to be connected to the existing Enniskillen - Omagh 110kV circuits by means of a new switching station (Omagh South) north of Dromore village. A single portal overhead line will be built from the new station to the cluster site. For the purpose of the 2015 TYTFS, this project is planned to be complete by summer 2019.

(v) Garvagh 110kV Cluster

It is planned to establish a 110/33kV cluster substation near Garvagh, connected to the proposed Rasharkin cluster via a portal overhead line. For the purpose of the 2015 TYTFS, this work is planned to be complete by 2020.

(vi) Newtownstewart 110kV Cluster

It is planned to establish a 110/33kV cluster substation near Newtownstewart, connected to the 110kV circuits between Omagh and Strabane. For the purpose of the 2015 TYTFS, this work is planned to be complete by 2020.

(vii) Cam 110kV Cluster

It is planned to establish a 110/33kV cluster substation near to Cam, Coleraine, connected to the existing Coleraine station via an overhead line. For the purpose of the 2015 TYTFS, this work is planned to be complete by 2020.

(viii) Kells Wind 110kV Cluster

It is planned to establish a 110/33kV cluster substation near to Kells, connected to the existing Kells station via an overhead line. For the purpose of the 2015 TYTFS, this work is planned to be complete by 2020.

Belfast North Main

A new 110/33kV substation at Whitla Street is to be established. This will allow for the decommissioning of the 110/33kV substation at Belfast Power Station West (PSW). The existing Whitla Street 33/6.6kV substation site is to be redeveloped allowing room for a new 33kV switchboard and pair of 90MVA transformers. This work is ongoing; for the purpose of the 2015 TYTFS, this project is expected to be complete by winter 2016.

Donegal Main (North)

The 60MVA transformer TxB at Donegall North is to be replaced by a new 90MVA unit. For the purpose of the 2015 TYTFS this work is expected to be complete by winter 2016.

Castlereagh-Rosebank 110kV Circuits

It is planned to replace the two existing 110kV cable circuits between Castlereagh and Rosebank substations, increasing the rating of each circuit to a minimum of 144MVA. For the purpose of the 2015 TYTFS, this work is expected to be complete by winter 2016.

Castlereagh 275kV IBTX 1

The interbus transformer IBTX 1 at Castlereagh is to be replaced. The replacement transformer will have a 240MVA primary winding and a 60MVA tertiary winding. For the purpose of the 2015 TYTFS analysis, the asset replacement is expected to be installed and commissioned by 2017.

Omagh Main – Omagh South restring

With the connection of Curraghmulkin cluster substation to Omagh South it will be necessary to restring the Omagh Main – Omagh South tower line with high temperature conductor. This work is planned to be completed by winter 2018.

Compressed Air Energy Storage Scheme (CAES)

A developer has planned the construction of a Compressed Air Energy Storage facility close to Larne. For the purposes of including the scheme in the TYTFS, the connection of the plant is modelled on the assumption that it will be supplied by installing a pair of 275/110kV transformers close to the existing Ballylumford 275kV switch house, and laying duplicate 110kV 200MVA cables to the CAES plant. For the purpose of the 2015 TYTFS, the connection is planned to be installed and commissioned by winter 2018.

Reactive Compensation

(i) Omagh-South Reactive Compensation

It is planned to install reactive support at either the proposed Omagh South switching station or adjacent to Omagh Main. For the purpose of the 2015 TYTFS, a static var compensator (SVC) or Statcom is planned at the proposed Omagh South switching station connected to the 110kV bus from 2019.

(ii) Tamnamore Reactive Compensation

It is planned to install reactive support at Tamnamore. For the purpose of the 2015 TYTFS, it is planned that the reactive compensation scheme will be a static var compensator (SVC) or statcom. This scheme is planned to be connected to the 110kV bus and is to be complete by 2020.

(iii) Coleraine Reactive Compensation

It is planned to install reactive support at Coleraine. For the purpose of the 2015 TYTFS, it is proposed that the reactive compensation scheme will be a static var compensator (SVC) or statcom. This scheme is planned to be connected to the 110kV bus and is to be completed by 2020. The existing 36Mvar Capacitor at Coleraine is to be recovered.

Airport Road Main

It is planned to construct a new 110/33kV substation including 2 x 60MVA transformers and a 33kV switchboard at Airport Road. The substation will be connected as a teed transformer feeder arrangement from Rosebank Main 110kV. The substation will supply both Airport Road and Queens Road 33kV substations which are to be transferred from Cregagh Main. Addittionally, Ballymacarrett 33kV substation is also to be transferred from Knock Main. For the purpose of the 2015 TYTFS, this work is planned to be completed by winter 2019.

Ballylumford Switchgear

The existing 110kV switchgear at Ballylumford is to be replaced with a new a new 110kV GIS double busbar and the 110kV circuits diverted accordingly. For the purpose of the 2015 TYTFS, this project is planned to be completed by winter 2019. Currently one 275/110kV 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 complete, this restriction can be removed.

Brockaghboy 110kV Windfarm

It is planned that the Brockaghboy windfarm will be connected to the proposed Garvagh cluster via an overhead line. For the purpose of the 2015 TYTFS, this work is planned to be complete by 2020.

Coolkeeragh-Limavady-Coleraine 110kV Circuits

As a result of increasing growth in renewable generation it is anticipated that there will be a need to uprate the Coolkeeragh-Limavady, Coleraine-Limavady and Coleraine-Coolkeeragh 110kV circuits to a minimum of 185MVA. For the purpose of the 2015 TYTFS, this work is planned to be complete by winter 2020.

Coolkeeragh-Magherafelt 275kV 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. This work is expected to be complete by winter 2020.

Tidal Scheme

Developers are planning to establish two 100MW tidal generation schemes off the County Antrim coast close to Torr Head and Fair Head. For the purposes of including the schemes in the TYTFS (connection method is subject to change), the connection is modelled as a new 110kV circuit from Kells to a collector station close to the coastline. For the purpose of the 2015 TYTFS, this project is planned to be complete by winter 2020.

Coolkeeragh-Killymallaght-Strabane 110kV Circuits

It is planned to uprate the Coolkeeragh-Killymallaght, Killymallaght-Strabane and Coolkeeragh-Strabane 110kV circuits. When works are complete, the circuits will be uprated to a minimum of 185MVA. For the purpose of the 2015 TYTFS, this work is planned to be complete by winter 2020.

Turleenan-Tamnamore 275kV

With the connection of Turleenan substation it will be necessary to restring the Turleenan-Tamnamore tower line with high temperature conductor. For the purposes of the 2015 TYTFS, this work is planned to be complete by winter 2020.

Kells-Rasharkin New 110kV Circuit

It is planned to construct a second 110kV circuit between Kells and Rasharkin 110/33kV cluster substation. This circuit will have a minimum rating of 88MVA. For the purpose of the 2015 TYTFS, this project is planned to be complete by 2022.

Armagh Main

Due to capacity limitations on the distribution system that supplies Armagh identified by the DSO, it is proposed to establish a new 110/33kV substation to the south of Armagh city. For the purposes of the 2015 TYTFS, this project is planned to be completed by 2022.

The following projects have not been included in the 2015 TYFTS analysis. The projects are however under consideration and are included for information

(i) Omagh South-Turleenan 275kV Circuit

It is planned to extend the proposed Omagh South switching station site (see Curraghmulkin cluster) to accommodate a 275/110kV substation. A 275kV single circuit is planned from Omagh South to Turleenan. However this 2015 forecast statement does not make provision for this development.

(ii) Castlereagh 275kV IBTX 4

Taking account of future growth in demand, consideration is also presently being given to the need for a 4th transformer at Castlereagh. However this 2015 forecast statement does not make provision for this development.

(iii) Coolkeeragh-Trillick 110kV Circuit

It is planned to develop a new circuit from Trillick in Co Donegal, Ireland to Coolkeeragh in Northern Ireland. This new circuit is anticipated to be the optimal reinforcement to provide for the connection of renewable generation in Co. Donegal. The proposal will be considered alongside the overall programme of developments in Northern Ireland to cater for increased renewable generation.

(iv) Ballylumford-Eden 110kV Circuit

It is planned to restring the above circuit in conjunction with asset replacement works that are under consideration by the TAO. Consideration is also being given to the restring of the circuits from Eden-Carnmoney and Carnmoney-Castlereagh. In this statement, the existing ratings are applied to these circuits.

2.6 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 400kV circuit rated at 1500MVA which will connect Woodland 400kV station in County Meath (Irl) and Turleenan 400/275kV station in County Tyrone (NI). A new 400kV station at Turleenan is required.

In the event of a loss of the existing 275kV double circuit connecting the transmission system of Ireland and the Northern Ireland transmission system, the post-fault transfers would be directed across the Letterkenny-Strabane and Corraclassy-Enniskillen 110kV cross-border circuits.

In this instance, to guard against damage to these lines, protection equipment will switch out the 110kV circuits, resulting in separation of the two systems.

This may result in a generation surplus on one system and a deficit on the other. The system with a supply deficit may be required to disconnect demand customers.

The system with the supply surplus may have difficulty stabilising the system frequency. The risk of impact of potential system separation on each system has resulted in constraints on the amount of power that can be transferred between the two systems.

For the purpose of the 2015 TYTFS analysis, this project is planned to be installed and commissioned by winter 2019. Once this connection is established, the constraints on the existing Tandragee-Louth 275kV double circuit will be significantly reduced.

2.7 Connection of New Generation Stations

Chapter 4 describes the future generators that are included in this TYTFS.

Table 2-6 Planned Connection Methods of Future Generators

Generator	MEC	Planned Connection Method
Altamuskin	14.1	Connected to a new Gort 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Altaveedan	18	Connected into the future Rasharkin 110/33kV substation looped into the Coleraine-Kells 110kV circuit
Athea Wind Farm (Extension)	99	Connected into the planned Athea 110kV substation
Aught	45	Connected into Springtown 110/33kV substation at 33kV
Ballykeel	10	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Ballyreagh Tempo	2.5	Connected into Enniskillen 110/33kV substation at 33kV
Barnadivane	60	New Barnadivane 110kV Station, looped into the Dunmanway-Macroom 110kV circuit
Beltonanean	2.3	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Bessy Bell 3	23	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits ‘A’ and ‘B’
Bessy Bell 4	9.2	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits ‘A’ and ‘B’
Bindoo Wind Farm (Extension)	22	Connected into the existing Ratrussan 110kV substation
Boggeragh 2	47.7	Connected into the existing Boggeragh 110kV substation
Booltiagh Wind Farm (Extension)	103	Connected into the existing Booltiagh 110kV substation
Brackagh Quarry	6	Connected into Ballymena 110/33kV substation at 33kV
Brockaghboy	56.5	Connected at 110kV into a new Garvagh 110/33kV cluster substation, itself connected into the future Rasharkin 110/33kV substation
Bunkimalta	46.5	Connected into the planned Cureeny 110kV substation
CAES	268	Connected into existing Ballylumford 275kV substation.
Carnalbanagh	28.5	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV

Table 2-6 Planned Connection Methods of Future Generators (continued)

Generator	MEC	Planned Connection Method
Castlecraig	25	Connected into the future Curraghamulkin 110/33kV cluster substation, itself tail-connected into Omagh South 110kV substation
Castlegore	10	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Clahane Wind Farm (Extension)	13.8	Connected into the existing Clahane 110kV substation
Cloghinarney	13.8	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Clunahill	15	Connected into the future Curraghamulkin 110/33kV cluster substation, itself tail-connected into Omagh South 110kV substation
Connaught Road	1.7	Connected into Antrim 110/33kV substation at 33kV
Coomataggart	172.4	Connected into the planned Ballyvouskill 220kV substation
Cordal	176.6	Construction of the new Cordal 110kV station tailed out of Ballynahulla.
Corkey Extension	5	Connected into Ballymena 110/33kV substation at 33kV
Cornavarrow	36	Connected into the future Curraghamulkin 110/33kV cluster substation, itself tail-connected into Omagh South 110kV substation
Craiggore	34	Connected into the future Garvagh 110/33kV cluster substation, itself tail-connected into Rasharkin 110/33kV cluster substation
Craignagapple	20.7	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits ‘A’ and ‘B’
Creganconroe	13.8	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Crockandun	18	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Crockbaravally	7.5	Connected to a new Gort 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Crockdun	15	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Croghan	12.5	Connected into the future Cam 110/33kV cluster substation, itself looped into the existing Coolkeeragh-Coleraine 110kV circuit
Cronacarkafree	105	Connected into the proposed Clogher 110kV substation

Table 2-6 Planned Connection Methods of Future Generators (continued)

Generator	MEC	Planned Connection Method
Cuilleen	98.4	Connected to a new Cuilleen 110kV substation, itself tail-connected into Athlone 110kV substation
Cureeny	94	Connected into the existing Nenagh-Killonan 100kV circuit
Drumadarragh	3.6	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Dunmore 2	24	Connected into the future Cam 110/33kV cluster substation, itself looped into the existing Coolkeeragh – Coleraine 110kV circuit
Eglish	18	Connected into Killymallaght 110/33kV substation at 33kV
Elginny Hill	23	Connected into Ballymena 110/33kV substation at 33kV
Eshmore	6.9	Connected to a new Tremoge 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Glanlee Wind Farm (Extension)	6	Connected into the existing Glanlee 110kV substation
Glenbuck 1	9.2	Connected into the future Rasharkin 110/33kV substation looped into the Coleraine-Kells 110kV circuit
Gortfinbar	15	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Innishative	13.8	Connected to a new Tremoge 110/33kV substation, itself looped into the existing Omagh-Dungannon ‘B’ circuit
Killyglen	10	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Knockacummer	87	Permanent connection of the new Knockacummer 110kV substation, tailed out of Glenlara.
Knockavanna	27	Construction of a new Knockavanna 110kV station, looped into Agannygal-Derrybrien 110kV circuit
Knockranny	54	Connected into the excising Salthill-Screen 100kV circuit
Koram Hill	13.8	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits ‘A’ and ‘B’
Lisnaharney	42	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits ‘A’ and ‘B’
Long Mountain	27.6	Connected into the future Rasharkin 110/33kV substation looped into the Coleraine-Kells 110kV circuit

Table 2-6 Planned Connection Methods of Future Generators (continued)

Generator	MEC	Planned Connection Method
Mayo	49	Mayo Renewable Power Biomass (Shallow Connection)
Moneypoint	21.9	Connected into existing Moneypoint substation at 110kV
Mount Lucas	79.2	Construction of Mount Lucas 110kV substation, looping into the Cushaling-Thornsberry 110kV circuit
Mullynaveagh	2.6	Connected into Drumnakelly 110/33kV substation at 33kV
Mulreavy	128.4	New Mulreavy 110kV substation tail-connected into the planned Clogher 110kV substation
Nore Power	98	Construction of Nore 110kv substation, tailed out of Kilkenny 110kV station
Ora More	15	Connected into Enniskillen 110/33kV substation at 33kV
Oriel	210	Connected into the existing Louth-Woodland 220kV circuit
Oweninney	370.9	Connected to a new Bellacorick 400kV substation, itself tail-connected into the new Flagford 400kV substation
Rathsherry	21.5	Connected into Ballymena 110/33kV substation at 33kV
Reamore	98.5	Connected into the existing Tralee 110kV substation
Rhode Biomass	14.6	Rhode Biomass (Shallow Connection)
Shantavny Scotch	16.1	Connected to a new Gort 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Slieveard	17.5	Assumed connected into the future Newtownstewart 110/33kV cluster substation, itself looped into the existing Omagh-Strabane 110kV circuits 'A' and 'B'
Slieve Divena 2	20	Connected to a new Gort 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Slieveglass	6.9	Connected into the future Curraghamulkin 110/33kV cluster substation, itself tail-connected into Omagh South 110kV substation
Sliabh Bawn	58	New Sliabh Bawn 110kV station tailed out of Lanesboro 110kV station
Smulgedon	16.1	Connected into a Limavady Main 110/33kV substation at 110kV
Suir	98	Construction of Suir 110kV substation, tailed out of Cahir 110kV station
Teiges	12.5	Connected to a new Gort 110/33kV cluster substation, itself looped into the future Omagh-Tamnamore 110kV circuit
Thornog	20	Connected into the Magherakeel 110/33kV cluster substation, itself tail-connected into Omagh 110kV substation

Table 2-6 Planned Connection Methods of Future Generators (continued)

Generator	MEC	Planned Connection Method
Tidal	210	Assumed connected into Kells 275/110kV substation at 110kV.
Tievenameenta	34.5	Connected into the Magherakeel 110/33kV cluster substation, itself tail-connected into Omagh 110kV substation
Tullynageer	11.5	Connected into Newry 110/33kV substation at 33kV
Whappstown	9.2	Connected into the future Kells 110/33kV cluster substation, itself tail-connected into Kells 275/110kV switching station at 110kV
Windy Hill	52	Connected into the future Cam 110/33kV cluster substation, itself looped into the existing Coolkeeragh-Coleraine 110kV circuit
Uggool and Seecon	169	Connected into the planned Uggool 110kV substation, itself tail-connected into the planned Knockranny 110kV substation

2.8 Connection of New Interface Stations

Transmission interface stations are the points of connection between the transmission system and the distribution system, or connecting 110kV connected customers.

Table 2-7 lists the planned new 110kV stations connecting the distribution system or connecting 110kV customers to the transmission system, for the period covered by this statement. These stations are included in the appropriate network models according to their expected connection date. Details of the connections and dates are given in Section B.2 in Appendix B.

Table 2-7 Planned 110kV Stations

Station	Code	Transformer Size (MVA)	Nearest Main Town or Load Centre	County
Adamstown	ADM	2 x 20	Lucan	Dublin
Airport Road	AIR	2 x 90	Belfast	Down
Ardnagappary	AGY	31.5	Derrybeg	Donegal
Armagh	ARM	2 x 90	Armagh	Armagh
Ballyragget	BGT	31.5	Ballyragget	Kilkenny
Barnakyle	BKY	2 x 38	Inchicore	Dublin
Belfast North Main	BNM	2 x 90	Belfast	Antrim
Bracklone	BRA	2 x 20	Portarlington	Laois

Table 2-7 Planned 110kV Stations (continued)

Station	Code	Transformer Size (MVA)	Nearest Main Town or Load Centre	County
Cherrywood	CHE	2 x 20, 2 x 63	Loughlinstown	Dublin
Corkagh	CKG	2 x 38	Grange Castle	Dublin
Castletownmoor	CTO	2 x 120	Kells	Meath
Hartnett's Cross	HTS	20	Macroom	Cork
Newbury	NBY	2 x 28	Clonshaugh	Dublin
North Mayo	NMO	63	Ballina	Mayo
Rasharkin	RSK	90	Ballymena	Antrim

2.9 Detailed Transmission Network Information

The all-island schematic network diagrams in Appendix A show snapshots of the existing and planned transmission developments at the end of 2015 and 2024. The diagrams indicate stations, circuits, transformers, generation, reactive devices and phase shifting transformers.

- Figure A-1 in Appendix A presents a geographical map of the all-island transmission system at the beginning of July 2015.
- Figure A-2 in Appendix A presents a geographical map of the all-island transmission system as forecast in 2024, including the planned developments.

The electrical characteristics and capacity ratings of the existing transmission system are included in the following tables in Section B.1 of Appendix B:

- Tables B-2 to B-5 list the electrical characteristics of the existing overhead lines and underground cables at the different voltage levels. Equipment ratings for Ireland's transmission system are shown in MVA for winter and for summer reference temperature conditions, 5°C and 25°C respectively. The ratings of the Northern Ireland transmission system equipment are shown in MVA for winter, autumn and summer.

- Tables B-6 to B-10 list data for each existing transmission system connected transformer. The data includes impedance values, nameplate ratings and tap ranges. The voltage tapping range for each transformer is given as the percentage deviation from the nominal voltage ratio at the two extreme tap positions.
- Table B-11 lists details of the phase shifting transformers throughout the island.
- Table B-12 includes the Mvar capacity data for existing reactive compensation devices.

The electrical characteristics and capacity ratings of planned transmission system developments are included in the following tables in Section B.2 of Appendix B:

- Tables B-13 to B-17 contains data for new lines and cables and planned changes to existing line and cable data on an annual basis. These tables include a column to indicate whether each listed item of plant is being added, amended or deleted. Changes relating to a particular development project are grouped together and headed by a project description. This includes the Capital Project (CP) number with respect to Ireland and a SONI description heading for Northern Ireland.
- Tables B-18 to B-31 list the details of the planned network transformers.
- Tables B-32 to B-33 include the Mvar capacity data for planned reactive compensation devices.

Electrical characteristics of future transmission system plant or changes to the electrical characteristics brought about by planned transmission system developments are subject to change. These will be reviewed when the plant is commissioned.

3 DEMAND

EIRGRID GROUP

The current. The future.

3 Demand

This chapter provides information on forecasts for the all-island demand on the transmission system. The forecast is taken from the All-Island Generation Capacity Statement 2015-2024 (GCS) [1] which was published by EirGrid and SONI in February 2015.

The 2015 GCS contains forecasts of future energy consumption and demand between 2015 and 2024. It concludes that there should be sufficient generation plant on the island to meet the forecasted demand during these years.

Provided the North-South interconnector is completed in 2019, the GCS states that there will be no significant transmission constraints between Ireland and Northern Ireland after this interconnection.

This chapter also provides an introduction to the anticipated large demand increases in the Dublin area. This anticipated increase in demand is associated primarily with the connection of data centres. The impact of these data centres on the future all-island demand forecast will also be discussed.

3.1 Forecasts of Transmission Peaks

Table 3-1 presents the median winter peak transmission demand forecasts over the period 2015-2024, as published in the GCS.

Table 3-1 also compares the most recent winter peak forecasts with those from the previous GCS. The current demand forecast shows an average annual increase in winter peak demand of 0.5% between 2015 and 2024.

This is less than the predicted demand increase of 1% in the All-Island Generation Capacity Statement 2014-2025. This change is mostly due to changing economic predictions and increasing levels of energy efficiency.

[1] The TYTFS 2015 references documents that where published at the July 2015 data freeze date. The All-Island Generation Capacity Statement 2016-2025 is due to be published at the beginning of March 2016. The information in the 2016 GCS however does not fundamentally impact studies presented in the 2015 TYTFS.

Table 3-1 Comparison of Peak Demand Forecast with Previous GCS

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
GCS2015-2024(MW)	6,505	6,532	6,561	6,585	6,614	6,646	6,678	6,729	6,788	6,847
GCS2014-2023(MW)	6,510	6,571	6,628	6,696	6,765	6,849	6,925	7,002	7,078	N/A
Difference (MW)	-5	-39	-67	-111	-151	-203	-247	-273	-290	N/A

It is difficult to accurately predict a peak demand figure for a particular year in the future. This is due to a number of factors that can cause fluctuations in the forecast. These factors include weather conditions, economic activity, electricity usage patterns and government policy.

The forecasts in Table 3-1 may be taken as indicative of a general trend in demand growth. These forecasts are based on the current information available. In Table 3-2, four demand values are presented for each year: the winter peak; summer peak; summer valley; and autumn peak.

3.1.1 All-Island Transmission Peaks

The winter peak figures represent the expected annual peak demand to occur during the winter period of each year. For example, the 2015 forecast of 6,505 megawatts (MW) is the maximum demand projected to occur in winter 2015/16. The Northern Ireland and Ireland winter peaks generally do not occur at the same time. The Northern Ireland winter peak usually occurs earlier in the evening than in Ireland.

The summer peak 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 often 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 of these factors can restrict the network, reducing its capability to transport power.

The annual minimum is referred to as the summer valley. It represents the expected annual demand valleys that are forecast to occur during the summer period of each year.

The Ireland and Northern Ireland summer valleys were combined to produce an all-island summer valley. The summer valley cases examine the impact of less demand and less conventional generation dispatched.

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 must export more of its power across the transmission system.

Table 3-2 Transmission Demand Forecast

Year	All-Island Winter Peak (MW)		All-Island Summer Peak (MW)		All-Island Summer Valley (MW)		Autumn Peak(MW)
	Ireland	NI	Ireland	NI	Ireland	NI	NI
2015	6,505		5,240		2,212		1,472
	4,831	1,694	3,865	1,290	1,691	477	
2016	6,532		5,262		2,221		1,473
	4,856	1,696	3,885	1,291	1,700	477	
2017	6,561		5,285		2,231		1,477
	4,881	1,700	3,905	1,294	1,708	478	
2018	6,585		5,304		2,239		1,483
	4,898	1,707	3,918	1,300	1,714	480	
2019	6,614		5,328		2,249		1,491
	4,919	1,716	3,935	1,306	1,722	483	
2020	6,646		5,353		2,260		1,500
	4,939	1,727	3,951	1,315	1,729	486	
2021	6,678		5,379		2,271		1,511
	4,959	1,739	3,967	1,324	1,736	489	
2022	6,729		5,420		2,288		1,520
	4,999	1,750	3,999	1,332	1,750	492	
2023	6,788		5,468		2,308		1,531
	5,045	1,762	4,036	1,341	1,766	496	
2024	6,847		5,515		2,328		1,541
	5,093	1,774	4,074	1,351	1,783	499	

3.1.2 Large Demand Increases in the Dublin Area

Background

Since the freeze date of data for this statement (July 2015), there has been an unprecedented level of enquiries for connection to the transmission system in the Dublin area. It was therefore decided to include greater detail on current demand connections and future demand opportunities in this year's statement. This assessment of demand opportunities is included in Chapter 8 with a particular focus on the Dublin area.

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

Data Centres

Ireland is an attractive business location and continues to attract world-class investments. The Industrial Development Authority (IDA) Ireland has cited access to a high-quality electricity grid as critically important for attracting new investment. This is particularly important in the ICT and high-tech manufacturing sectors.

Some of the world's best known companies have chosen Ireland as the location for their European data centre operations. Factors such as temperate, climate, stable power sources, internet connectivity and skilled workforce have influenced their decisions. This is emphasised by nine out of the top 10 global software companies and US ICT companies locating strategic business activities in Ireland[2].

At present there is 250MW of connected data centres. Beyond this, there is significant interest in connecting other data centres to the grid in Ireland. There is approximately 550MW of data centres with either contracted capacity for connection to the grid or in the EirGrid connection offer process. In addition to this, there is approximately 1000MW of enquiries regarding further demand connections.

[2] http://www.idaireland.com/business-in-ireland/industry-sectors/ict/

To put this in context, the current winter peak demand on the all-island transmission system is approximately 6500MW. If all of these enquiries were to connect, the data centre load could account for 20% of the all-island system peak demand.

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 20MW with some possibly extending to 250MW 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.

Impact on System Demand Forecast

The all-island demand forecast used in this statement is based on an underlying growth rate trend of 0.5%. This includes a small amount of industrial block demand increases contracted in advance of this statement freeze date.

Clearly the potential connection of demand on this scale is equivalent to decades of natural demand growth. This will have an impact on the all island system demand forecast and generation capacity adequacy. This is assessed and discussed in the All-Island Generation Capacity Statement[3] (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 now under initial investigations and could vary from short lead time to longer lead time developments. The impact of these Dublin demand connections are described in greater detail in Chapter 8, section 8.3.

[3] http://www.eirgridgroup.com/site-files/library/EirGrid/Eirgrid_Generation_Capacity_Statement_2015.-2024.pdf

3.1.3 Northern Ireland Transmission Peaks

The winter period is defined as November to February and the 2015 forecast of 1,694MW is the maximum demand projected to occur in winter 2015/16.

The summer peak occurs between May and August and is typically 21% lower than the winter peak.

Summer valley demand forecasts in Table 3-2 assume a figure of 30% of the annual maximum demand. This figure is consistent with historical summer valley demand data.

The autumn peak refers to the average peak value in the spring-autumn season. The autumn peak occurs between September - October and March - April. This is typically 14% lower than the winter peak. The overall transmission system power flow is often lower in autumn than in winter. However, this may not be the case for flows on all circuits.

The capacity of overhead lines is lower because of higher ambient temperatures during this period. Network maintenance is also usually carried out during the summer/autumn period. Both of these factors can restrict the network, reducing its capability to transport power.

3.1.4 Ireland Transmission Peaks

The 2015 winter peak forecast is 4,831MW, ie the maximum demand projected to occur in winter 2015/16.

The summer peak refers to the average peak value between March and September. This is typically 20% lower than the winter peak.

The forecasted summer valley demands, in Table 3-2, assume a figure of 35% of the annual maximum demand. This is consistent with historical summer valley demand data.

3.2 Demand Data

Electricity usage follows some generally accepted patterns. For example, annual peak demand occurs between 17.00 and 19.00 on winter weekday evenings. Minimum usage occurs during summer weekend night-time hours.

3.2.1 Generated Peak Demand Profiles

Figure 3-1 shows the generated peak demand profiles of Ireland and Northern Ireland on the day of the 2014 winter peak. The Ireland and Northern Ireland peaks did not occur on the same day. Peak demand for Ireland occurred on 8 December 2014, while peak demand occurred in Northern Ireland on 14 January 2014.

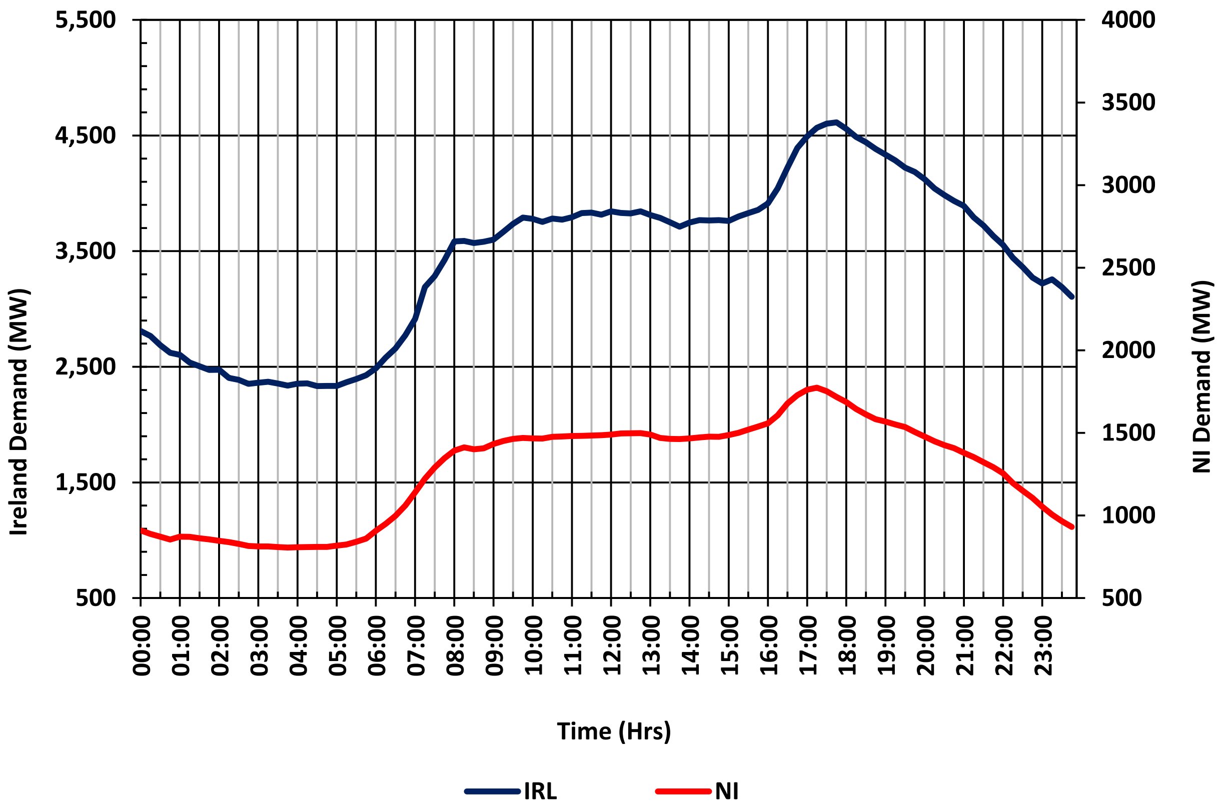


Figure 3-1 Generated Peak Demand Profiles for 2014

3.2.2 All-Island Demand Profiles

Figure 3-2 shows the profiles of the 2014 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.

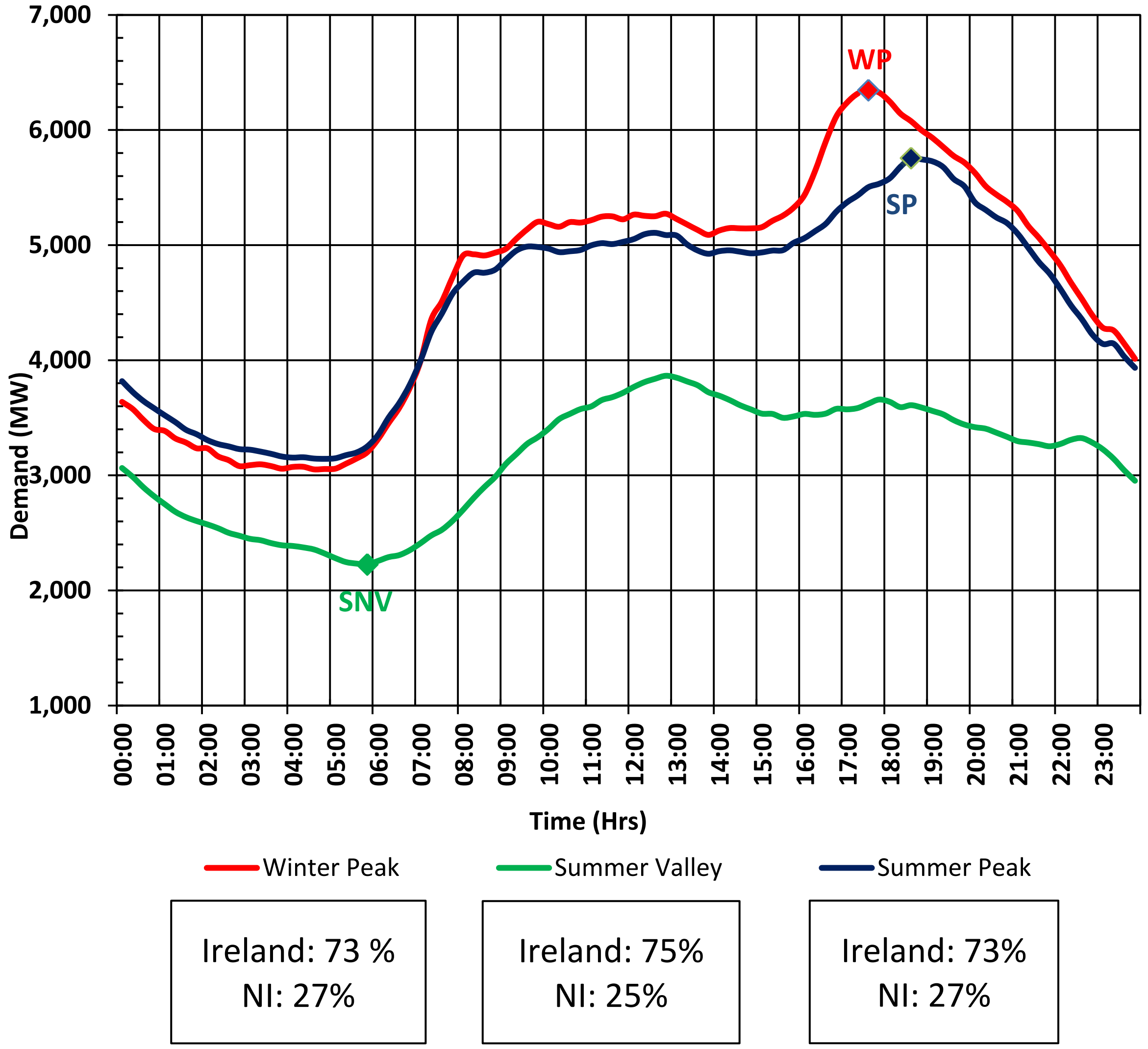


Figure 3-2 All-Island Daily Demand Profiles for Year 2014

3.2.3 All-Island Weekly Demand Peaks

Figure 3-3 shows the profile for the all-island, Northern Ireland and Ireland weekly peaks across the year for 2014.

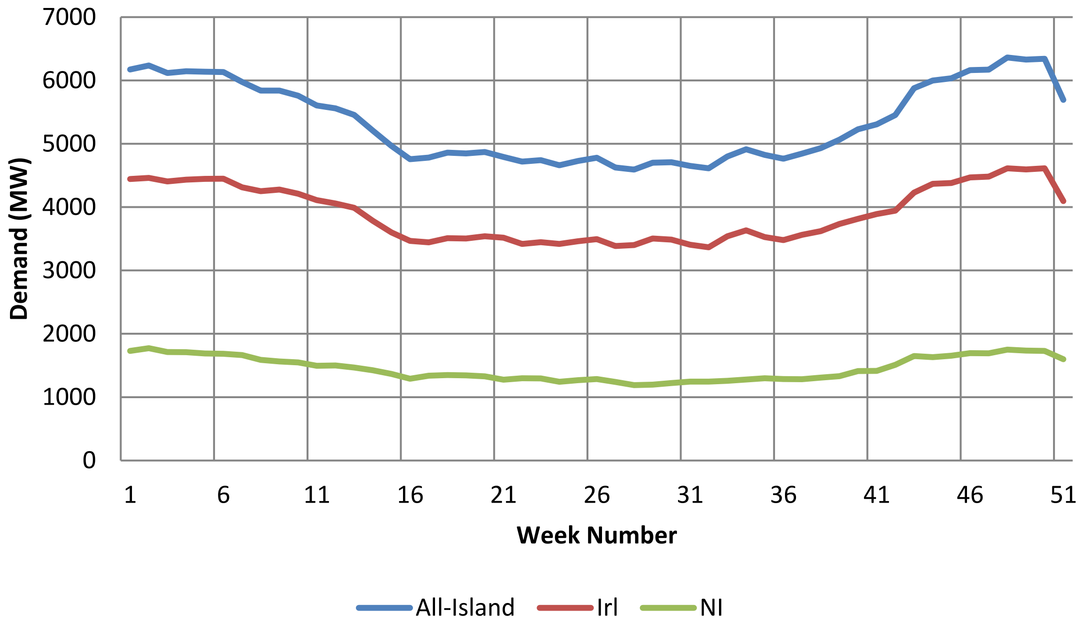


Figure 3-3 Weekly Demand Peak Values for Year 2014

3.2.4 Load Duration Curves

Figures 3-4 and 3-5 shows the Ireland and Northern Ireland 2014 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 3,000 MW for 51% of the year in Ireland. Demand in Northern Ireland exceeded 1,000 MW for 53% of the year.

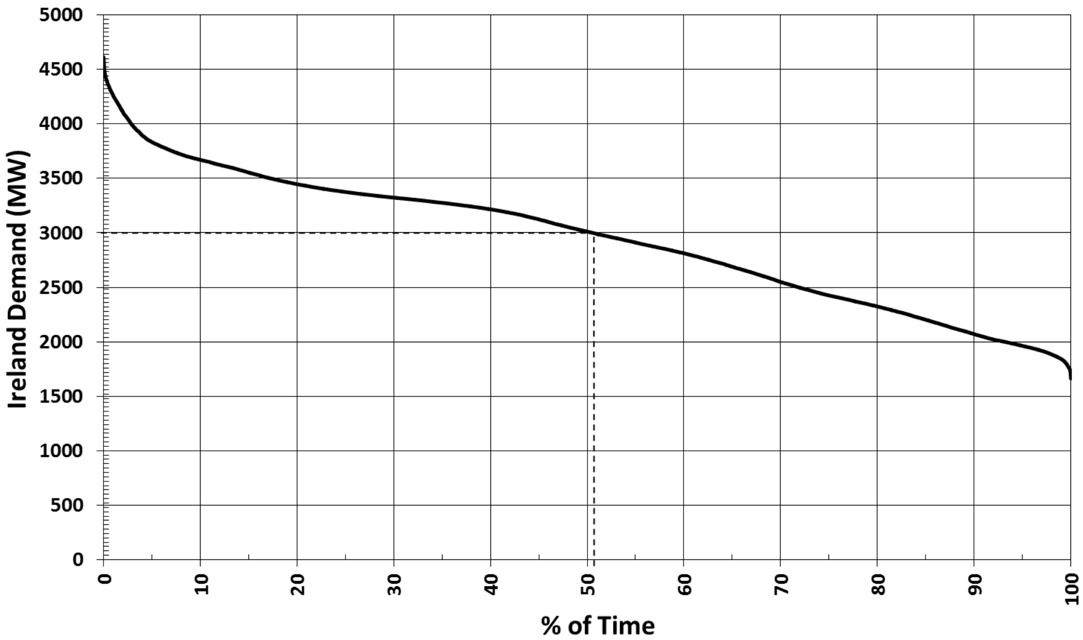


Figure 3-4 Ireland Load Duration Curve 2014

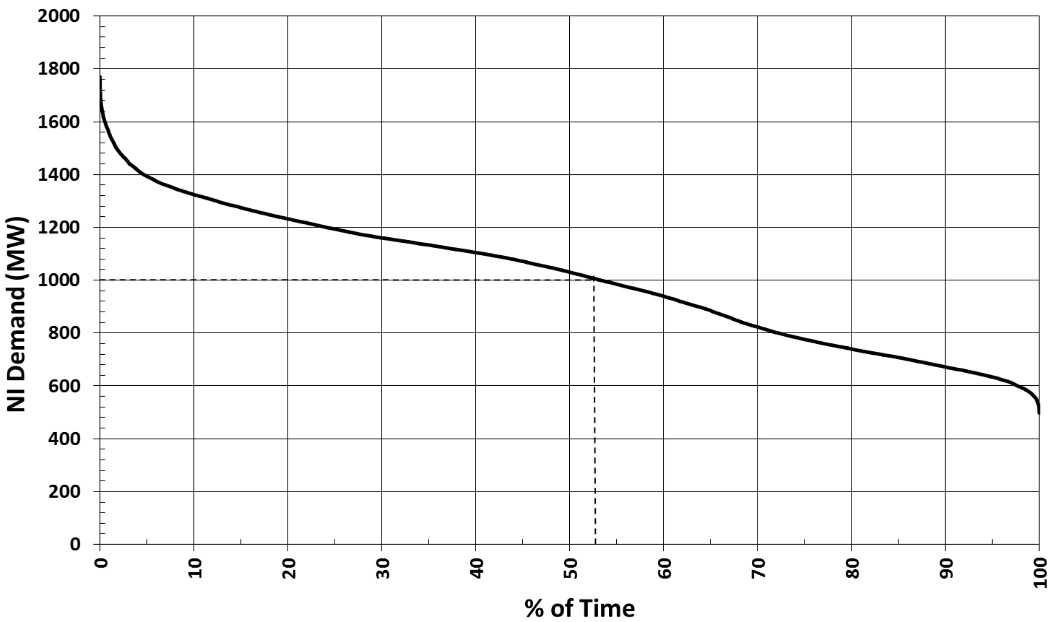


Figure 3-5 Northern Ireland Load Duration Curve 2014

3.3 Forecast 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 system and the distribution system or 110 kilovolts (kV) connected customers. The interfaces are mostly 110kV stations. In Dublin city, where the Distribution System Operator (DSO) operates the 110kV network, the interface is usually at 220kV 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 2015-2024. Demand projections at individual transmission stations are developed from the system demand forecasts on a top-down basis.

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 ESB[4]. In this way, changes in the geo-diversity 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 for the small number of directly-connected customers are the current best estimates of requirements. 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. However, when analysing the capacity for new demand in a particular area, the MIC values of local directly-connected customers are assumed. These values are assumed to ensure that the contracted MIC is preserved.

[4] ESB are the Distribution System Operator (DSO) in Ireland

A demand-side unit (DSU) consists of one or more demand sites that can be instructed by EirGrid 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 diagrams in Appendix I. These normal demand levels are used since they are more indicative of general power flows.

3.4 Northern Ireland Bulk Supply Point (BSP) Demand

The 110/33kV BSP demand forecasts are provided by NIE[5]. They are adjusted to align with the overall system average cold spell (ACS) forecasts. These demand forecasts are based on localised demand trends at individual nodal level. Consideration is given to future block load transfers from one BSP to another. Tables and information relating to demand forecasts are contained in Appendix C.

[5] NIE are the DSO in Northern Ireland

4 GENERATION

4.1 Ireland Generation

4.2 Northern Ireland Generation

EIRGRID GROUP

The current. The future.

4 Generation

This chapter gives information about existing generation capacity. The chapter also defines future projections for the ten years 2015 to 2024. All generation capacity and dispatch figures in this statement are expressed in exported or net terms. This is the generation unit output less the unit's own auxiliary load.

In Ireland, renewable energy policy is driven by a binding European legal requirement. The requirement is for 16% of the country's total energy consumption to be met by renewable energy sources (RES) by 2020.

The Irish Government aims to achieve 40% renewable electricity, 12% renewable heat and 10% renewable transport to meet this overall requirement. 3,200 - 3,800MW of installed wind generation will be needed to meet approximately 37% of electricity demand in 2020.

The remaining 3% is expected to be sourced from hydro generation, solar, bio-energy and renewable Combined Heat and Power (CHP) energy production.

The Strategic Energy Framework (SEF)[1] 2010 for Northern Ireland sets the renewable energy policy in Northern Ireland. It states that 40% of electricity consumption in Northern Ireland should come from renewable sources by the year 2020. It should be noted that this figure is currently under review[2].

Currently SONI, along with NIE, are working to facilitate the connection of the renewable generation required to meet the 40% target by the year 2020. This 40% government target translates into approximately 1,600MW of renewable generation capacity in Northern Ireland. The main contributing technology to this figure being wind (approximately 1,200MW).

The data was frozen on the 1st of July 2015 (Ireland and Northern Ireland). A data freeze was implemented to allow for TYTFS analyses to be carried out. Based on that freeze dates, 9,088MW of generation capacity was installed in Ireland. A further 3,201MW was installed in Northern Ireland.

1 https://www.detini.gov.uk/articles/strategic-energy-framework-2010

2 https://www.detini.gov.uk/publications/review-costs-and-benefits-ni-executives-40-renewable-electricity-target

4.1 Ireland Generation

4.1.1 Existing and Planned Transmission-Connected Generation

Of the 9,088MW of generation capacity, 7,741MW is connected to the Transmission System. The remaining 1,347MW is connected directly to the Distribution System. Sections 4.1.1 to 4.1.4 detail planned developments in generation in Ireland over the period covered by this TYTFS. The 7,741MW figure for Transmission System-connected generation capacity does not include the East West Interconnector.

On the 1st July 2015, 33 transmission connection agreements were executed for a total generation capacity of 2,111MW. These planned generators are listed in Table 4-1 with their expected connection dates at the time of the data freeze.

4.1.2 Demand Side Units

As at the data freeze date, in Ireland ten demand side units (DSU) had entered the Single Electricity Market. These DSUs have a combined dispatchable capacity of 221MW.

4.1.3 Planned Retirement/Divestiture of Generation Plant

The closure of 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 50MW 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. Great Island units 1, 2 and 3 were decommissioned in 2015 and Tarbert units 1, 2, 3 and 4 are expected to be decommissioned in 2022.

Other than the Great Island and Tarbert units listed, EirGrid has received no other notification of plant closures. However, we have assumed that some older generators will shut towards the latter end of the 10 year period. This is for the purposes of our studies.

Table 4-1 Contracted Transmission-Connected Generation as at 1st July 2015

Generator	Description	Expected Connection Date
Athea Phase 2	19MW wind farm in Co. Limerick	Jul-20[3]
Athea Phase 3	20MW wind farm in Co. Limerick	Sep-15
Athea Phase 4	26MW wind farm in Co. Limerick	Jul-20[2]
Barnadivane	60MW wind farm in Co. Cork	Oct-16
Boggeragh 2	48MW wind farm in Co. Cork	Nov-15
Cahernagh Mid Merit	101MW OCGT in Co. Limerick	Aug-20[2]
Castletownmoor	120MW wind farm in Co. Meath	Aug-20[2]
Clahane Phase 2	14MW wind farm in Co. Kerry	Sep-15
Cloghboola Phase 2	10MW wind farm in Co. Kerry	Jul-20[2]
Coomataggart (formerly Kilgarvan)	62MW wind farm in Co. Cork	Jul-20[2]
Cordal Phase1	84MW wind farm in Co. Kerry	Sep-15
Cordal Phase 2	17MW wind farm in Co. Kerry	Jul-20[2]
Cronacarkfree	105MW wind farm in Co. Donegal	Jun-17
Cuilleen	98MW OCGT in Co. Westmeath	Jul-20[2]
Dooray	55MW wind farm in Co. Laois	Jul-20[2]
Dromada Phase 2	18MW wind farm in Co. Limerick	Jul-20[2]
Garvagh Phase 2	10MW wind farm in Co. Leitrim	Jul-20[2]
Glanlee Phase 2	6MW wind farm in Co. Cork	Jul-20[2]
Keelderry	27MW wind farm in Co. Clare	Jul-20[2]
Kill Hill Phase 2	23MW wind farm in Co. Tipperary	Sep-15
Loughaun North	27MW wind farm in Co. Clare	Apr-17
Moneypoint	22MW wind farm in Co. Clare	Dec-15
Mulreavy	95MW wind farm in Co. Donegal	Nov-16
Nore	98MW OCGT in Co. Kilkenny	Jul-20[2]
Oriel	210MW wind farm in Co. Meath	Jul-20[2]
Oweninney Power 1	89MW wind farm in Co. Mayo	Oct-16
Oweninney Power 2	83MW wind farm in Co. Mayo	Oct-16
Oweninney 5	199MW wind farm in Co. Mayo	Dec-20
Ratrussan Phase 2	22MW wind farm in Co. Cavan	Oct-16
Seecon	105MW wind farm in Co. Galway	May-16
Sliabh Bawn	58MW wind farm in Co. Roscommon	Jun-16
Suir	98MW OCGT in Co. Tipperary	Jul-20[2]
Uggool	64MW wind farm in Co. Galway	May-16

[3] At the date of the data freeze (July 2015), this generation project did not have an estimated energisation date available. As no additional information was available, we have assumed that this project would connect over this period for the purpose of TYTFS 2015 studies.

4.1.4 Embedded Generation

On the 1st July 2015, there was approximately 1,554MW of embedded generation plant. This includes plant connected to the distribution system or to the system of a directly-connected demand customer. This figure comprises of small conventional and renewable units. Conventional units include CHP schemes and small industrial thermal units.

Renewable generation included in this figure consists of wind, small hydro, land-fill gas (LFG), tidal, biogas and biomass sources. Table 4-2 lists the existing embedded generation capacity totals by generation type. Table D-2 in Appendix D provides details of the existing embedded wind farms and their capacities.

Table 4-2 Existing Embedded Generation as at 1st July 2015

	Wind	Small Hydro	Biomass/ LFG	CHP	Peaking	Total
Net Capacity (MW)	1254	26	70	71	131	1,552

Embedded generators reduce the demand supplied through Transmission Interface Stations. Forecasts of demand at the relevant Transmission Interface Stations is presented in Table 3-2 of chapter 3.

These forecasts take account of the contribution of the existing non-wind embedded generators[4]. The *All-Island Generation Capacity Statement 2015-2024 (GCS)* estimated biomass CHP to grow steadily to 150MW capacity by 2020. It is not expected that conventional CHP capacity will change significantly during this period.

As at 1st July 2015, seven generators have executed connection agreements committing to connecting to the distribution system. Table 4-3 shows details of the total amount of conventional generation capacity connected or committed to the distribution system.

[4] Because of the variability of wind, a fixed contribution from embedded 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.

Table 4-3 Connected and Committed Embedded Generation as at 1st July 2015

Station	Description	Connection Date
Bellacorick	10MW Wave Energy generator in Co. Mayo	Mar-16
Thornsberry	10MW Biomass generator in Co. Offaly	Sep-15
Blake	5MW LFG generator in Co. Kildare	Oct-13
Ringsend	72MW Waste to Energy generator in Co. Dublin	Aug-16
Tawnaghmore	49MW Biomass generator in Co. Mayo	Jun-16
Drybridge	20MW Waste to Energy generator in Co. Meath	Feb-11
Derryiron	15MW Biomass generator in Co. Offaly	Feb-17
Navan	13MW Biogas generator in Co. Meath	Jun-16
Tawnaghmore	Two 52MW Distillate Peaker generators in Co. Mayo	Jan-12
Tullabrack	6MW Wave Energy generator in Co.Clare	Dec-17

4.1.5 Wind Generation

Over the past two decades wind power generation in Ireland has increased from 6MW to 2,129MW. This represents an increase from 1 wind farm to 176 wind farms, at the beginning of July 2015. The information presented in Figure 4-1 Figure 4-1 is a combination of connected and contracted wind generation. These figures are as presented in Tables D-1 and D-2 in Appendix D.

Energisation dates for contracted wind generation contained within Tables D-1 and D-2. These dates are based on the best information available at the time of the data freeze (1st July 2015).

As at 1st July 2015, 179 wind farms totalling 3,564MW have signed connection offers. These wind farms are committed to connecting to the Transmission or Distribution Systems over the next few years.

Table 4-4 shows the amount of existing and committed wind generation capacity expected to be connected each year. The individual wind farm details are included in Tables D-1 and D-2 of Appendix D.

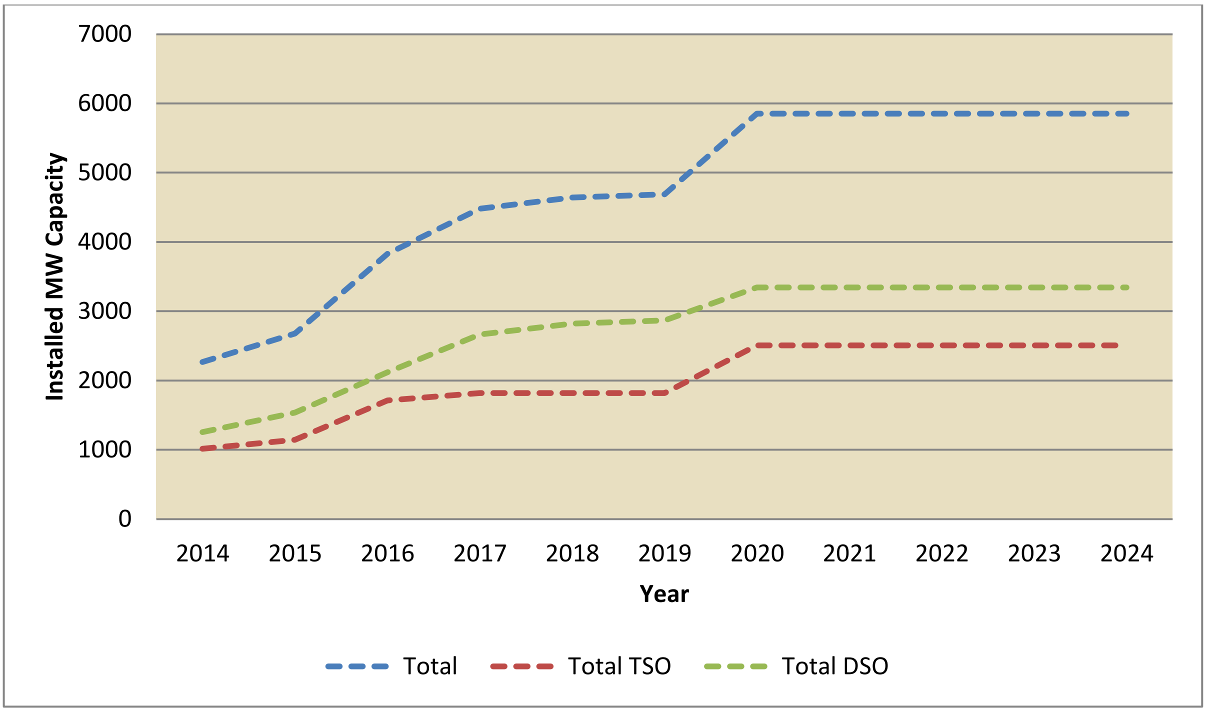


Figure 4-1 Expected Growth in Wind Capacity, 2014 to 2024

Table 4-4 Existing and Committed Wind Capacity Totals, MW

Connection	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Transmission	1013	1142	1713	1818	1818	1818	2507	2507	2507	2507	2507
Distribution	1254	1536	2117	2663	2821	2868	3345	3345	3345	3345	3345
Total	2267	2678	3830	4481	4639	4686	5852	5852	5852	5852	5852

As at 1st July 2015, there are a total of 352 applications totalling 14,889MW in the applications queue. This includes 14 (370MW) Non-Group Processing Approach applications to the TSO and DSO.

In the period up to the 1st July 2015 data freeze date, eight Gate 3 applicants had connected. A further one hundred and twenty-four Gate 3 applicants were contracted to connect and eight applicants had live Gate 3 offers. Twelve offers had lapsed. The number of TSO and DSO offers associated with each grouping as well as the MWs associated with them are shown in Figure 4-2.

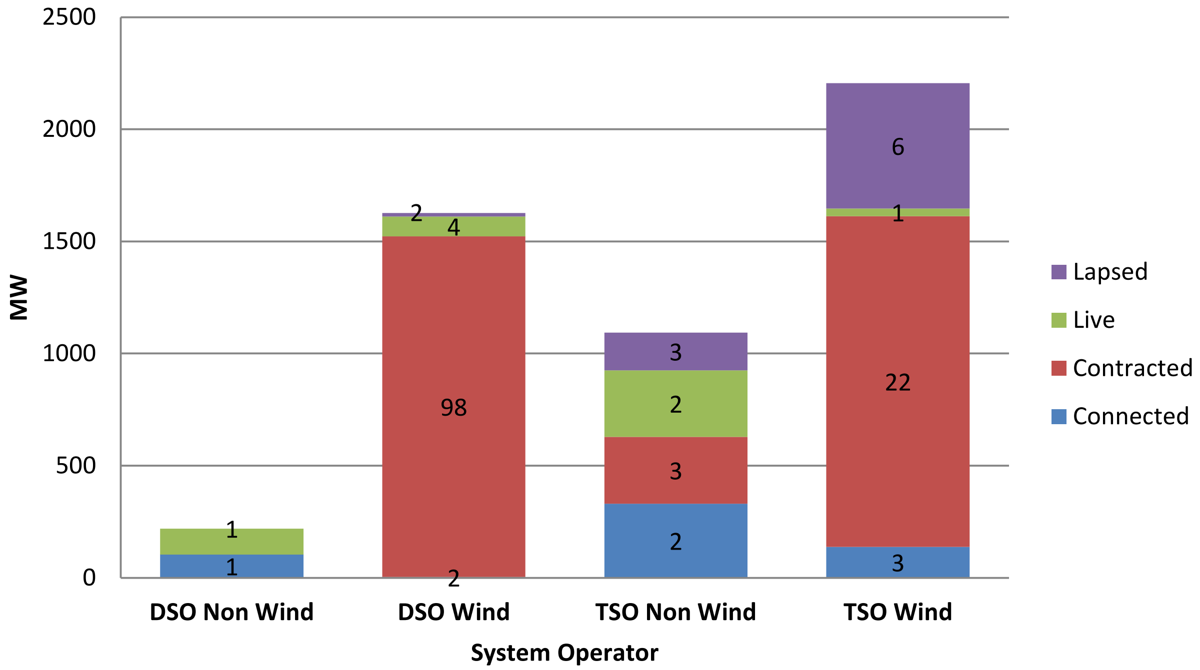


Figure 4-2 Gate 3 Offer Status

4.1.6 Offshore Generation

Currently there is one offshore generation unit in Ireland. 25MWs of offshore wind generation is located on the Arklow bank. The offshore wind farm consists of seven 3.6MW turbines, operational since the end of 2003.

In February 2014, the Irish Government published an Offshore Renewable Energy Development Plan (OREDP)[5]. The aim of this work is to implement a framework for the sustainable development of offshore renewable generation in Ireland. The OREDP identifies three high level goals.

First, that Ireland harnesses the market opportunities presented by offshore renewable energy to achieve economic development, growth and jobs.

Second, to increase awareness of the value, opportunities and societal benefits of developing offshore renewable energy.

Third, that offshore renewable energy development does not adversely impact our rich marine environment and it's living and non-living resources[5].

The OREDP will also provide a structure through which Ireland can input to the development of the European Blue Energy Strategy and the US/Ireland Memorandum of Understanding (MoU) on Ocean Energy.

[5] http://www.dcenr.gov.ie/energy/en-ie/Renewable-Energy/Pages/OREDP-Landing-Page.aspx

The Department of Communications, Energy and Natural Resources (DCENR) is leading the implementation of OREDP. It has developed a robust governance structure to deliver on the aims of the plan. EirGrid sits on the steering group and are on a number of OREDP working groups.

4.1.7 Solar Generation

Since the data freeze date (June 2015) interest in the connection of solar generation has increased significantly. Solar generation applications for connection to the power system are currently in excess of 2,000MW[6]. The vast majority of these solar generation applications are seeking connection to the distrubition system in the south-west and south-east of Ireland.

It should be noted that this solar generation has not been included in the study results presented in this TYTFS. However, should this level of solar generation connect to the distribution system, it would have a significant impact on the transmission system. As these solar generation projects progress, we will continue to monitor and revise assumptions presented in future versions of the TYTFS as necesary.

4.2 Northern Ireland Generation

3,201MW of generation capacity is connected in Northern Ireland as at July 2015. 2,365MW is connected to the transmission system and 836MW is connected to the distribution system.

The 2,365MW of transmission connected generation capacity does not take into account the Moyle Interconnector capacity. It is mainly made up of conventional generation capacity along with Slieve Kirk, the only transmission connected wind farm power station (WFPS) which consists of a capacity of 73.6MW.

4.2.1 Existing and Planned Transmission-Connected Conventional Generation

Existing Conventional Generation

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

- Plant contracted to Power NI Energy Limited PPB (Contracted Plant)

[6] http://www.eirgridgroup.com/site-files/library/EirGrid/Connection-Offer-Disclosure-of-Applications-as-published-31th-March-2016.pdf

- Independent Market Participants (Non-Contracted Plant)

Table D-9 provides a list of contracted and non-contracted generators connected to the Northern Ireland Transmission System.

Contracted Conventional Generation

Plant contracted to Power NI Energy Limited via their Power Procurement Business (PPB) under pre-vesting contracts, or contracts negotiated thereafter, totals 577MW. It is measured as output capacity at generator terminals. Details of capacity and contract information for individual generators can be seen in Tables D-1 and D-9. The contracts contain expiry dates, though the Utility Regulator may cancel contracts at earlier cancellation dates.

The Power Purchasing Agreements (PPA) or Generating Unit Agreements (GUAs) cover availability, operating characteristics, payments, metering etc. These agreements cover matters such as outage planning, emissions and fuel stocks.

Independent Market Participants (IMP)

The Utility Regulator has a duty to promote competition in the generation and supply of electricity. This is in line with the EU IME Directive (concerning common rules for the internal market in electricity 2003/54/EC). This directive was introduced in June 2003. As at July 2015 there is 1,714MW of IMP capacity in Northern Ireland.

4.2.2 Planned Retirement/Divestiture of Northern Ireland Generation Plant

In line with the latest information available to SONI, the following assumptions have been made:

At the data freeze date, AES Ballylumford had entered into a Local Reserve Services Agreement (LRSA) with SONI for the provision of 250MW of local reserve. This will see Ballylumford ST4 and ST5 remaining connected (at reduced capacity) until the end of 2018 with an option for SONI to extend this by a further 2 years if deemed required. Ballylumford ST6 will be de-commissioned at end of 2016.

The generation output of Kilroot ST1 and ST2 is anticipated to be restricted. The restriction is due to the Industrial Emissions Directive (IED)[7]. The restriction includes limited emissions each year from 2016-2020, followed by severely restricted running hours from 2021-2022. Kilroot ST1 and ST2 are currently due to be decommissioned by 2024.

4.2.3 Embedded Generation

Existing Embedded Generation

Table 4-5 shows a breakdown of the existing Northern Ireland Embedded Generation. There is a total of 89MW of Aggregated Generating Units (AGUs) in Northern Ireland registered in the SEM by 3 parties.

Two of these AGUs are made up of mainly distribution connected diesel generator sets located around Northern Ireland (iPower and EmPower). The third is made up from CHP gas generation (ContourGlobal). These units currently participate in the SEM.

There is 11MW of CHP plant connected to the Northern Ireland Distribution System. This 11MW is not expected to increase in the foreseeable future.

There is currently 4MW 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.

In Northern Ireland there is currently 15MW of landfill gas generation. It is assumed that by 2024 biogas generation capacity will increase to 22MW.

Table 4-5 Northern Ireland Embedded Generation

Generation	Net Capacity
Large Scale Wind	561
Small Scale Wind	74
Large Scale Biomass	17
Small Scale Biomass	5
Small Scale Solar	59
Small Scale Hydro	4
Landfill Gas	15
CHP	11
AGU	89
Tidal/Wave	1
Total	836

[7] http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

A number of customers have been reducing energy consumption at times of peak demand. This is achieved by load shifting or by running private generation. SONI has tended to view this generation as non-permanent due to a number of factors:

- The operation of this plant is not as reliable as conventional contracted plant
- Variable generation costs, e.g. diesel and hire charges
- Variable tariff price signals

Based on winter 2014/15, generation of this type is estimated to total 9MW. This total figure is not anticipated to increase from 9MW in the foreseeable future.

4.2.4 Northern Ireland Renewable Generation

Existing/Approved Renewable Generation

Renewable generation schemes that are connected to the Northern Ireland network, schemes approved by the planning service and schemes that are in construction at the time of the data freeze, are shown in Figure 4-3.

The map indicates points at which renewable generation is connected to or is assumed to connect to. These points include 110/33kV Bulk Supply Points (BSPs) and 110/33kV Clusters substations.

In line with the criteria set out in the NIE Distribution Charging Statement[8], NIE, in its role as Distribution Network Owner (DNO), have identified a number of Clusters substations that they wish to develop. These Clusters substations consist of a 110/33kV substation in the vicinity of a number of distribution generator locations.

These distribution generators would connect into the cluster at the 33kV level. SONI would be responsible for the delivery of the transmission elements of the Cluster substation. One such Cluster substation already exists in NI at Magherakeel.

[8] Statement of Charges for Connection to the Northern Ireland Electricity Networks' Distribution System: http://www.nienetworks.co.uk/documents/Connections/NIE-Distribution-Connection-Charging-Statement-ver.aspx

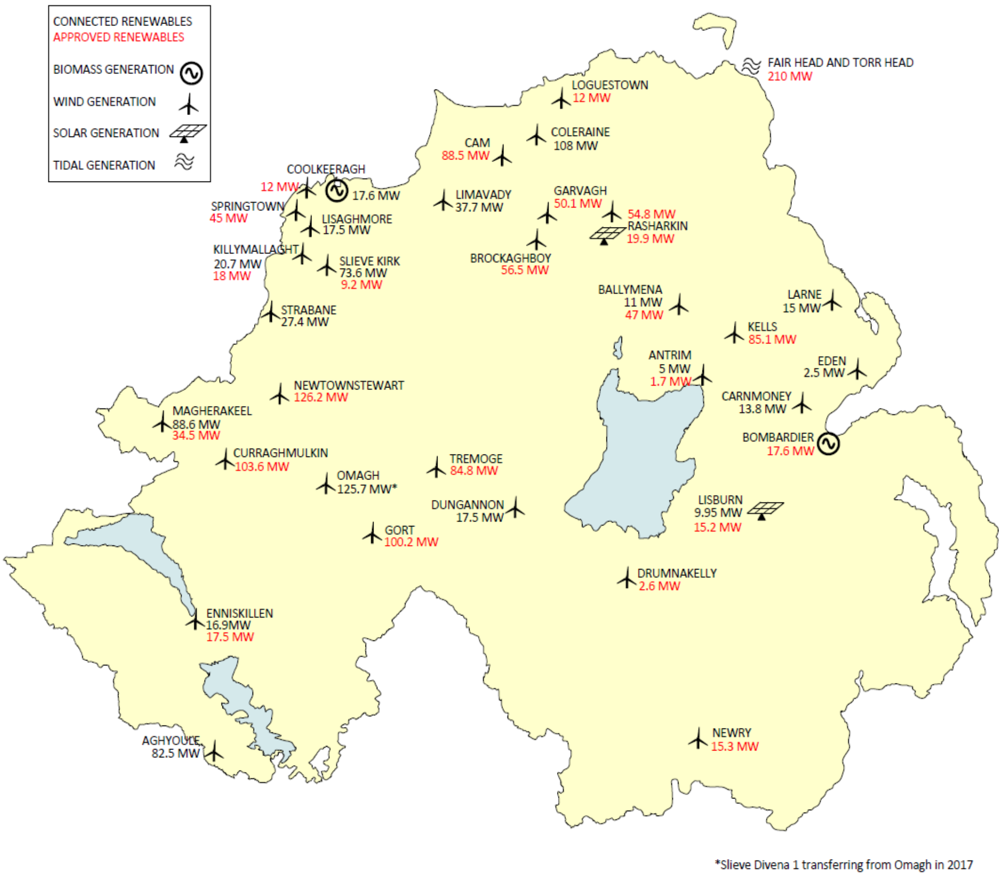


Figure 4-3 Existing and Committed Northern Ireland Renewable Generation

Unapproved Renewable Generation

A number of renewable generation projects are assumed to be commissioned in Northern Ireland between 2015-2024. These assumptions have been derived from a number of sources.

The sources include NIE, the Strategic Energy Framework for Northern Ireland[9], the Strategic Environmental Assessment of offshore wind and marine renewable energy[10] and the Onshore Renewable Electricity Action Plan (OREAP)[11]. Renewable generation that has been included in the TYTFS study files are detailed in Table 4-6.

[9] https://www.detini.gov.uk/articles/strategic-energy-framework-2010

[10] http://www.offshorenergyni.co.uk/

[11] https://www.detini.gov.uk/publications/onshore-renewable-electricity-action-plan-publications

Table 4-6 Capacity and Location of Renewable Generation by Year End

Transmission Node	Northern Ireland Renewable Capacity (MW)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Aghyoule	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
Antrim	5	5	5	5	5	6.7	6.7	6.7	6.7	6.7
Ballymena (Rural)	5	11	55.5	55.5	55.5	58	58	58	58	58
Brockaghboy	-	-	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5
CAM	-	-	-	-	-	88.5	88.5	88.5	88.5	88.5
Carnmoney	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
Coleraine	108	108	108	108	108	108	108	108	108	108
Coolkeeragh	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6
Curraghmulkin	-	-	-	-	103.6	103.6	103.6	103.6	103.6	103.6
Drumnakelly	-	-	-	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Dungannon	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Eden	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Enniskillen	16.9	31.9	31.9	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Garvagh	-	-	-	-	50.1	50.1	50.1	50.1	50.1	50.1
Gort	-	-	87.7	100.2	100.2	100.2	100.2	100.2	100.2	100.2
Kells	-	-	-	-	-	85.1	85.1	85.1	85.1	85.1
Killymallaght	20.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Larne	15	15	15	15	15	15	15	15	15	15
Limavady	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
Lisaghmore	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Lisburn	-	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Loguestown	12	12	12	12	12	12	12	12	12	12
Magherakeel	88.6	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1
Newry	-	3.8	3.8	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Newtownstewart	-	-	-	-	-	126.2	126.2	126.2	126.2	126.2
Omagh	125.7	125.7	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
Rasharkin	-	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7
Rosebank	-	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
Slieve Kirk	74	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Springtown	-	-	-	-	45	45	45	45	45	45
Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Tidal	-	-	-	10	10	210	210	210	210	210
Tremoge	-	82.5	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8
Total	699	986	1177	1186	1384	1888	1888	1888	1888	1888

Figure 4-4 uses information from the list of renewable generation applications in the planning service[12]. The figure demonstrates where renewable generation may be located in 2020.

It is clear from Figure 4-4 that the majority of renewable connections are in the northern and western regions of the province. This coincides with some of the weakest areas of the transmission system. It can be concluded that for Northern Ireland to meet renewable targets, improvements will have to be made to the transmission network in these areas.

The Renewable Integration Development Project (RIDP)[13] investigated the optimum reinforcement of the transmission grid in the north and the north west of the island. RIDP identified a preferred scheme based on a set of under pinning assumptions.

As these assumptions have since changed, in the respect of the extent of off-shore generation as well renewables peak operating levels, the preferred scheme is now under review.

These reinforcements are advised to cater for expected power output from renewable energy sources. For more detailed information on network reinforcements in these areas and throughout Northern Ireland please see Chapter 2.

[12] In Northern Ireland the Utility Regulator determination (DET-572) occurred just after the TYTFS freeze date. This has led to an unexpected large scale increase in connection applications in Northern Ireland (approximately 900MW). This has resulted in NIE networks and SONI considering alternative connection process options. To this effect SONI and NIE Networks will shortly issue a public consultation.

[13]http://www.uregni.gov.uk/uploads/publications/Renewable_integration_status_report_June13_2.pdf

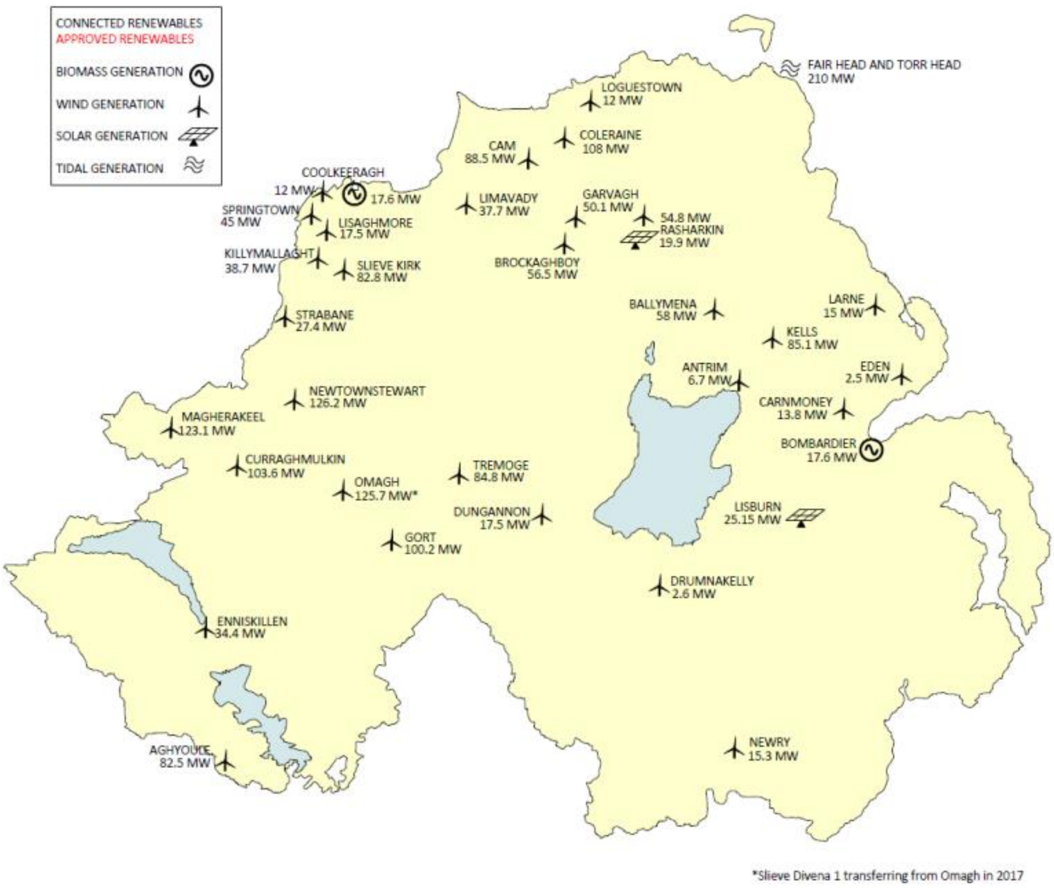


Figure 4-4 Northern Ireland Renewable Generation in 2020

Offshore Renewable Generation

For the purpose of these studies we assume that by 2024 there will not be any offshore wind connected. A 600MW offshore wind farm was to be installed off the County Down coast, but has recently been withdrawn. Development rights are still in place for tidal sites in Northern Ireland's coastal waters.

The development rights were also announced for two 100MW tidal developments along the north coast. The developers who were granted these developments rights have been in contact with SONI regarding the connection of off-shore renewable generation. SONI's assumptions regarding the 2020 levels and location of offshore generation are based on best information available at the data freeze.

Solar Generation

At the data freeze date there was approximately 45MW of solar generation planned to be connected to the distribuition system in Northern Ireland (see Figure 4.3 and Appendix D, Table D-4). This generation has formed part of the 2015 TYTFS assumptions and has been modelled in our study files accordingly.

However, since the data freeze date there has been a significant increase in enquiries for connection of solar generation. The level of solar generation enquiries in the SONI/NIE connection process amounts to approximately 300MW. The majority of enquiries have expressed interest in locating solar projects in the east of Northern Ireland.

It should be noted that solar generation beyond the 45MW described above has not been included in the study results presented in this TYTFS. As these additional solar generation projects progress we will continue to monitor and revise assumptions presented in future versions of the TYTFS as necesary.

Compressed Air Energy Storage

Gaelectric is proposing a Compressed Air Energy Storage (CAES) Plant in the Larne area, to be connected to the transmission system. SONI has an accepted an offer with Gaelectric Energy Storage for this project for the capacities noted in Table 4-7. Gaelectric is however designing the facility to realise 330MW of generation and 250MW of compression. This energy storage facility could provide ancillary services and balancing facilities for renewable generation.

A CAES plant uses a large compressor to store excess energy off the grid. It does this by converting the excess electric energy into compressed air which is stored in an underground geological cavern. This is then released through an electric generator for later use. This technology can be applied to store surplus renewable energy, whilst also enabling variability balancing on the transmission system.

CAES has gained Project of Common Interest (PCI) status. In the last 12 months it has seen considerable progress. It has been awarded Connecting Europe Facility (CEF) grant funding of up to €6.45 million to complete, among other things, the environmental impact assessment (EIA) and submission of planning application at the end of 2015.

Table 4-7 Minimum and Maximum Generation/Storage of CAES Units

Unit	Minimum (MW)	Maximum (MW)
Generator 1	13.4	134
Generator 2	13.4	134
Pumping 1	68	105
Pumping 2	68	105

4.2.5 Northern Ireland Generation Mix

The chart in Figure 4-5 shows all existing and planned generation over the ten year period covered by this TYTFS. Superimposed onto the chart is the median demand forecast from the All-Island Generation Capacity Statement 2015-2024.

Figure 4-5 illustrates a surplus of generation in relation to the demand from a deterministic point of view. However, factors such as economic dispatch, wind variability, reserve requirements and actual HVDC interconnector flows are not taken into account. The chart also shows the relatively large increase in wind generation expected over the next ten years.

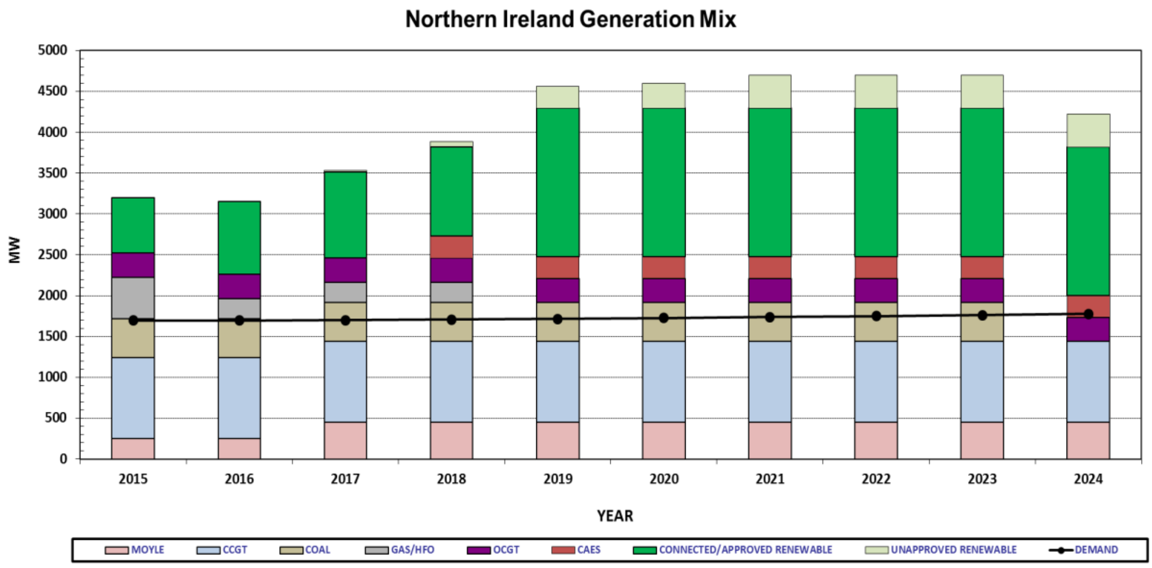


Figure 4-5 Northern Ireland Generation Mix

5 TRANSMISSION SYSTEM PERFORMANCE

5.1 Forecast Power Flows

5.2 Compliance with Planning Standards

5.3 Short Circuit Current Levels

The current. The future.

5 Transmission System Performance

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

Analysis of short circuit current levels in the TYTFS 2015 is based on updated data. Updated data includes any changes to the existing and planned transmission system, demand projections and generation connections. Analysis is based on a data freeze date of July 2015 for both Ireland and Northern Ireland.

5.1 Forecast Power Flows

The power flow at any given time depends on transmission system configuration, demand levels and the output from each generator. There are many possible combinations of generator outputs (or dispatches) that can meet the transmission system demand requirements. At any given time there are also many possible demand scenarios.

Renewable generation connected to the transmission and distribution systems in Ireland and Northern Ireland has the effect of altering power flows. The increase in renewable generation is one of the main factors behind recent changes to power flows on the transmission system. Projected levels of renewable generation connections are detailed in Tables D-2 and D-3 in Appendix D.

In examining transmission system performance a range of economic generation dispatches are considered. Generation dispatches used in studies were prepared on an all-island basis.

Power flows across the existing 275kV and planned 400kV interconnectors where modelled to operate within transfer limits. Dispatches also considered imports and exports of power across the existing Moyle and East-West interconnectors.

Transmission system power flows are shown on the schematic diagrams found in Appendix H. The power flow diagrams display the flow of real and reactive power around the transmission system under normal conditions.

As shown in Appendix H, the amount of renewable generation increases over the ten year period. As renewable generation increases, power flows on circuits from the North West of Northern Ireland to the East of Northern Ireland are also increased.

This is due to power generated in the North West transferring to larger demand levels in the East. These increased power flows are more significant at times of minimum demand and high renewable generation output.

Another effect of increased renewable generation levels is the amount of reactive power support required on the Northern Ireland transmission system. Due to high levels of renewable generation, reactive power support is needed to keep voltages within transmission system planning standards.

In the 2015 winter case, 260Mvars of reactive power support was in service in Northern Ireland. In the winter 2024 case this figure increases to 380Mvars. This reactive power support is in addition to the reactive power assumed to be supplied by Northern Ireland generation.

5.2 Compliance with Planning Standards

The need for transmission system development is determined by assessing long-term future transmission system performance against the respective technical standards.

Ireland

We issue the TDP annually, which is available at www.eirgridgroup.com. The TDP indicates the areas of the transmission system likely to be outside thermal limits[1] and voltage standards. This information is presented over a ten year period and is based on assumed transmission system reinforcements, demand and generation scenarios.

We have plans in place to address many of these problems. We are also actively considering options[2] for addressing other future transmission system problems.

The TDP details transmission system development projects that have received capital approval. In addition to this further transmission system developments that may arise in the period of the plan are also discussed.

[1] A circuit's thermal limit influences its physical capability to carry electrical current.

[2] Eirgrid recently published a discussion paper on Ireland's grid development strategy. This review is available at www.eirgridgroup.com. The review outlines our proposed strategy for the long-term development of the network.

The 5,500MW (see Chapter 4) of generation that received offers in Gate 3 may significantly impact on transmission system performance. This may potentially put some areas, in addition to those identified in the TDP, outside planning standards.

Similarly, other developments such as the connection of a new large generator or demand may put areas of the transmission system outside standards. In such cases, further investment may be required.

Northern Ireland

The TYTFS 2015 is based on the transmission investment plan. Planned developments include load related and asset replacement projects. These projects mainly impact on the rating of switchgear[3] and circuits.

Details of these projects can be found in Chapter 2. Capital projects are mainly driven by increases in Northern Ireland demand and renewable generation connection levels.

The adequacy of the transmission system including planned projects is compared to transmission and distribution security and planning standards. These standards define the thermal limits and voltage stability under certain contingencies.

5.3 Short Circuit Current Levels[4]

Short circuit[5] currents may 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 that may occur in the event of a fault.

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 interrupting high currents to isolate a fault.

Their correct operation is essential for minimising risk to personnel and preventing damage to transmission equipment. They are also necessary for maintaining system stability, security and quality of supply.

[3] Devices used to control, protect and isolate electrical equipment.

[4] A decision was made to use the term “Short Circuit Currents”. This is a change in terminology rather than a change in information when “Fault Levels” was previously used.

[5] A short circuit is an electrical circuit that allows a current to travel along an unintended path, often where essentially no (or a very low) electrical impedance is encountered. The currents generated by the short circuit can be extremely high and may cause harm to personnel or damage equipment.

The short circuit current level is a factor to be considered as the transmission system is developed. It must also be considered in the connection of new generation or demand.

The EirGrid Grid Code specifies short circuit levels at the transmission connection point. These values are shown in Table 5-7. Users connecting to the transmission system are required to design their plant and apparatus to the levels in Table 5-7. This also includes the design of equipment at lower voltage levels to withstand short circuit current levels.

Table 5-7 also applies to new users connecting to the Northern Ireland transmission system. They are recommended to, as a minimum, design their plant and apparatus to withstand short circuit current levels set out in Table 5-7. Design of a user's plant is also subject to detailed fault level assessment.

Changes to the transmission system or the addition of generation can increase the short circuit current levels at adjacent stations. Forecasted increases in short circuit current levels indicate circuit breakers or other equipment potentially exceeding their rating. Should this occur it may be necessary to replace circuit breakers or other equipment with higher rated plant. Risk mitigation measures may also be implemented to reduce short circuit current levels.

Table 5-7 Standard Equipment Rating and Maximum Design Short Circuit Currents

<table>
<tr><th rowspan="2">Voltage Level</th><th colspan="3">Standard Equipment Short Circuit Rating</th></tr>
<tr><th colspan="2">Ireland</th><th>Northern Ireland</th></tr>
<tr><td>400kV</td><td colspan="2">50kA</td><td>50kA</td></tr>
<tr><td>275kV</td><td colspan="2">n/a</td><td>40kA</td></tr>
<tr><td>220kV</td><td colspan="2">40kA</td><td>n/a</td></tr>
<tr><td rowspan="2">110kV</td><td>Countrywide</td><td>25kA[6]</td><td rowspan="2">40kA</td></tr>
<tr><td>Designated sites</td><td>31.5kA</td></tr>
</table>

[6] New equipment installed at 110kV level must have a short circuit rating of 31.5kA (outside Dublin) or 40kA (Dublin).

Short circuit current levels were 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-phase and three-phase faults for winter peak and summer valley. This was completed for the years 2015, 2018 and 2021. A description of the calculation methods used and the results are given in Appendix E. Appendix E also provides as an explanation of terms used.

Winter peak analysis was carried out to represent the most onerous transmission system conditions. Winter peak represents the case where maximum short circuit currents on the transmission system are most likely to occur. Conversely, analysis of summer valley was carried out as results should indicate minimum short circuit currents based on intact network conditions.

In reality minimum short circuit current at each bus could be lower depending on actual generation dispatch and transmission system conditions. Those who require the expected minimum short circuit current level at a particular bus are advised to contact us directly.

The economic generation dispatches for the winter peak and summer valley studies are presented in Appendix D.

During winter peak analysis, generators that are not dispatched are switched on in the study and dispatched at 0MW. This measure ensures a high fault current infeed to faults from all generator sources in the studies. This means that the most onerous, but credible, conditions are used for the calculation of short circuit current levels at each bus. During summer valley analysis, generators that were not dispatched were not connected to the system.

The studies assume that the transmission system is in the normal intact condition (as indicated in the power flow diagrams). This means that all circuits connected to a bus contribute to the fault.

These results correspond to 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 however, dependent on network conditions.

Assessment of Short Circuit Levels: Ireland

The transmission system in Ireland is designed and operated to maintain short circuit current levels below the standard equipment ratings. These are listed at each voltage level in Table 5-7.

In planning the system a 10% margin is applied. This is done so that 220kV short circuit currents, for example, will be kept below 36kA.

It should be noted that most 110kV stations are designated as 25kA. The EirGrid Grid Code, however, stipulates that certain 110kV stations may be designated as 31.5kA. This may happen for a new station which is designated as 31.5kA from the start. It may also occur when an existing 25kA station is changed to 31.5kA.

When a station changes from 25kA to 31.5kA, the equipment at that station may need to be modified. Station equipment at lower voltages will also need to be replaced in order to comply with this design rating.

The stations currently designated with a 31.5kA 110kV equipment rating are; Barnahely, Cloghran, College Park, Corduff, Finglas, Kilbarry, Knockraha, Louth, Marina, Raffeen, Tarbert and Trabeg. EirGrid will annually publish an updated list of designated stations.

In Appendix E, the results for Ireland include X/R ratios, transient AC (I_k') and subtransient AC (I_k'') currents. In summary, these provide an indication of the strength of the transmission system and are defined in Appendix E.

Assessment of Short Circuit Levels: Northern Ireland

The Northern Ireland transmission system is designed and operated to maintain short circuit current levels below the equipment ratings. These ratings are listed in Appendix E's tables. Individual ratings are applied to substations based on the equipment at the substation.

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

- Initial Short Circuit Current (I''),
- Peak Make Current (ip),
- RMS Break Current (IB) and,
- Asymmetrical Break Current (asym B).

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

5.3.1 Short Circuit Current Results

Short circuit results show that a number of Northern Ireland transmission nodes are experiencing increased short circuit current levels. If we do not manage these issues, these nodes may be in excess of 90% of their current rated capability.

In Ireland short circuit currents are relatively low. There are a number of stations in Dublin and Cork where short circuit current levels are above 80% of standard ratings.

We will continue to monitor short circuit current levels at all stations to ensure that they remain within safety standards.

Figure 5-1 indicates the locations where short circuit current levels are high, in 2021. Values shown represent a percentage of standard equipment rating for the transmission system of Ireland. Actual equipment ratings are shown in Figure 5-1 for the Northern Ireland transmission system.

Three percentage ranges are represented by different colours in Figure 5-1. Yellow dots represent substations where short circuit currents may be between 80% and 90% of the ratings. Orange dots represent substations where short circuit currents may exceed 90% of the ratings. Red dots indicate substations where the rating has been exceeded.

Several nodes have been found to experience short circuit current levels that exceed 100% of their current rated capability. Analysis indicates that the nodes at Ballylumford, Castlereagh, Coolkeeragh and Kells in Northern Ireland will exceed 100% of their current rated capability.

Table 5-2 provides a list of transmission nodes where the short circuit current level is approaching or would exceed their rating. This is presented for the study years of 2015, 2018 and 2021.

We have put in place plans to uprate equipment or mitigate risks. These plans are discussed below and are based on the best information available at the time of publishing.

In the interim risk mitigation measures such as system reconfiguration have been employed to maintain short circuit current levels at safe levels.

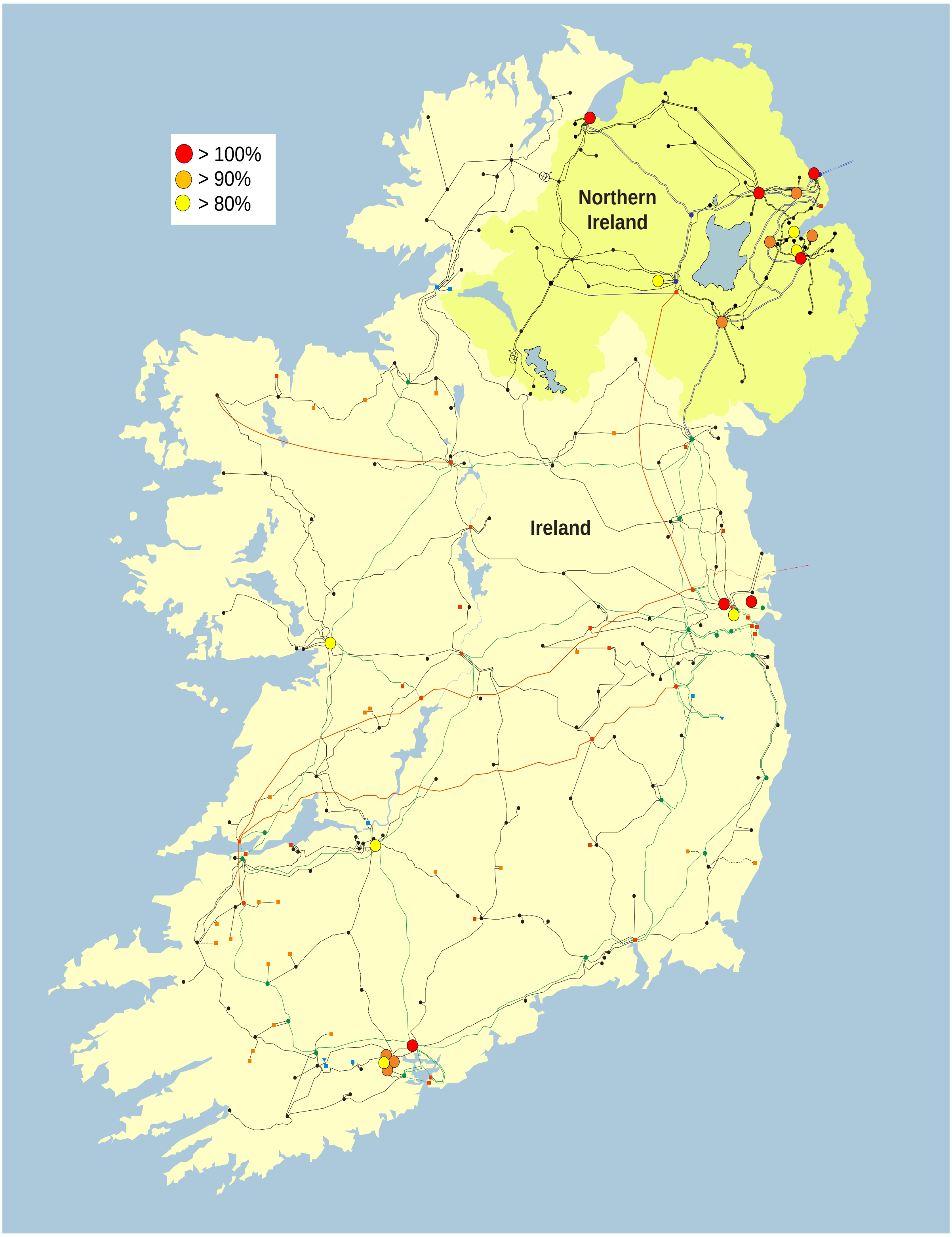


Figure 5-6 Short Circuit Current Levels for Winter Peak 2021

Table 5-8: Nodes Approaching or Exceeding Rating

% Rating	2015	2018	2021
>100%	BPS 110kV	BPS 110kV	BPS 110kV
	CDU 110kV[7]	CAS 110kV	CPS 110kV
	KRA 110kV[7]	CSH 110kV	CAS 110kV
		CDU 110kV	KEL 110kV
		KRA 110kV	BLP 110kV
			CSH 110kV
			CDU 110kV
			KBY 110kV
			KPG 110kV
			KRA 110kV
>90%	BPS 275kV	CPS 110kV	BPS 275kV
	CAS 110kV	HAN 110kV	BVG 110kV
	CPS 110kV	KNO 110kV	HAN 110kV
	DUN 110kV	KEL 110kV	KNO 110kV
	HAN 110kV	BPL 110kV	TAN 110kV
	KEL 110kV	CLG 110kV	BVG 110kV
	KNO 110kV	COL (I) 110kV	CLG 110kV
	TAN 110kV	KBY 110kV	COL (I) 110kV
	CLG 110kV[8]	KLN 110kV	KBY 110kV
	COL (I) 110kV[7]	KPG 110kV	KLN 110kV
	KBY 110kV[7]	MR 110kV	KRA 110kV
	MR 110kV[7]	TBG 110kV	MR 110kV
	TBG 110kV[7]		TBG 110kV

[7] Knockraha 220/110kV station is currently operated with a third transformer in hot-standby to mitigate short circuit current levels exceeding the 90% threshold.

[8] Short circuit current levels at Trabeg, Marina, Cloghran, College Park and Kilbarry 110kV stations exceed 90% of the standard equipment rating. The standard rating for 110kV equipment is 25kA, as per the EirGrid Grid Code. These 110kV stations are designated stations. A designated station, as per the EirGrid Grid Code, is a station with 110kV equipment designed to 31.5kA. Therefore, in actuality there is not an issue at these 110kV station, as the equipment is rated to 31.5kA.

Stations where the rating has been exceeded

Ballylumford 110kV

Short circuit current levels at the Ballylumford 110kV node for both three-phase and single-phase faults exceed the substation ratings. This occurs under maximum generation conditions when both of the 275/110kV interbus transformers (IBTXs) are in service.

The substation is programmed to be replaced with a substation incorporating a new 110kV GIS switchboard. This work is planned to be completed by 2019. In the interim, we manage this risk by operating with one IBTX out of service. This reduces the short circuit current level below the equipment rating.

There will be an overall reduction in the short circuit current level at Ballylumford with the future decommissioning of plant. Ballylumford ST6 is expected to decommission after 2015, while ST4 and ST5 will be decommissioned after 2018. However, even with this reduction Ballylumford substation ratings are still exceeded in all years of study.

Castlereagh 110kV

The rating of Castlereagh 110kV substation is limited by the disconnectors which have a certified rating of 26.2kA. With all available generation in service, the single phase short circuit current level exceeds the rating of the substation equipment. The Castlereagh 110kV substation is planned to be refurbished with switchgear rated at 40kA. This will alleviate this risk in the long term.

Coolkeeragh 110kV

Single-phase short circuit current levels at Coolkeeragh 110kV substation exceed 100% of the substation assigned rating in 2020. This is a result of increased renewable generation levels. It is important that NIE put plans in place to address this issue at Coolkeeragh before 2020.

Kells 110kV

Single-phase short circuit current levels at Kells 110kV substation exceed 100% of the substation assigned rating in 2020. This is a result of increased renewable generation levels. The Kells 110kV substation is planned to be refurbished with switchgear rated at 40kA. This will alleviate this risk in the long term.

Corduff 110kV

Short circuit current levels at Corduff 110kV station exceed 100% of the standard equipment rating for 110kV equipment. The standard rating for 110kV equipment is 25kA, as per the EirGrid Grid Code.

Corduff 110kV station is a designated station. A designated station, as per the EirGrid Grid Code, is a station with 110kV equipment designed to 31.5kA. Therefore, in actuality there is not an issue at Corduff 110kV station, as equipment is rated to 31.5kA.

Knockraha 110kV

Short circuit current levels at Knockraha 110kV station exceed 100% of the standard equipment rating for 110kV equipment. The standard rating for 110kV equipment is 25kA, as per the EirGrid Grid Code.

Knockraha 110kV station is a designated station. A designated station, as per the EirGrid Grid Code, is a station with 110kV equipment designed to 31.5kA. Therefore, in actuality there is not an issue at Knockraha 110kV station, as equipment is rated to 31.5kA.

Summer Minimum Results

As expected summer minimum short circuit current level results shown in Appendix E show that no station ratings are exceeded.

The Moyle Interconnector has a minimum operating requirement of 1,500 MVA. This is equivalent to a short circuit current level of 3.15kA. Below this short circuit current level the high voltage direct current (HVDC) interconnector fails to commutate[9]. However, as shown in Appendix E, this is not an issue over the period covered by this TYTFS.

[9] Commutation is the process of reversing the direction of electric current. It is commonly used when turning alternating current to a direct current.

6 OVERVIEW OF TRANSMISSION SYSTEM CAPABILITY ANALYSES

6.1 All-Island Demand Opportunity Analysis

6.2 All-Island Generator Opportunity Analysis

EIRGRID GROUP

The current. The future.

6 Overview of Transmission System Capability Analyses

This chapter describes analyses carried out to determine the capability of the transmission system to accommodate additional demand and generation. This additional demand and generation capability is tested at various parts of the transmission system. The results of these analyses, together with information in other chapters, provide the basis for the statements of opportunity. These statements are found in Chapter 7 and Chapter 8.

6.1 All-Island Demand Opportunity Analysis

This section describes the demand opportunity analysis carried out for the Ireland and Northern Ireland power system. This analysis is used to determine the capability of the transmission system to accommodate additional demand connections in certain areas. The results of this analysis, together with information in other chapters, provide the basis for the statements of opportunity. These statements are given in Chapter 8.

In previous versions of the TYTFS, Northern Ireland demand opportunities analysis was based on an assessment of forecast loading at bulk supply points (110/33kV) under single outage conditions. This analysis gave little indication of the Northern Ireland transmission system network capability to accept large demand customers.

In this TYTFS Northern Ireland has now been included in an all-island demand opportunity analysis. Results from the all-island analysis provide an indication of backbone transmission network capability in Northern Ireland.

The all-island demand opportunity analysis was carried out for one specific year:

2020: This year gives developers a useful indication as to the demand opportunities that exist in the medium-term on the transmission system.

Studies were carried out for the summer period and the winter period of 2020/2021.

The locations analysed for new demand have been carefully chosen based on feedback from industry sources. The chosen stations have been tailored to align with potential areas that are of interest to customers seeking connection to the transmission system.

It should be noted that the results of these studies are dependent on the assumptions made about generation and demand. The results are also dependent on the completion dates of transmission system development projects. Factors that may influence the results are discussed in Section 6.2.4.

6.1.1 Approach for Calculation of Demand Opportunity

The transmission system is planned to meet forecast demand levels at all stations on the island of Ireland. The demand forecast for each 110kV 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 for in transmission system plans. However, there may be capacity for additional demand inherent in the transmission system at certain locations.

Alternatively, 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.

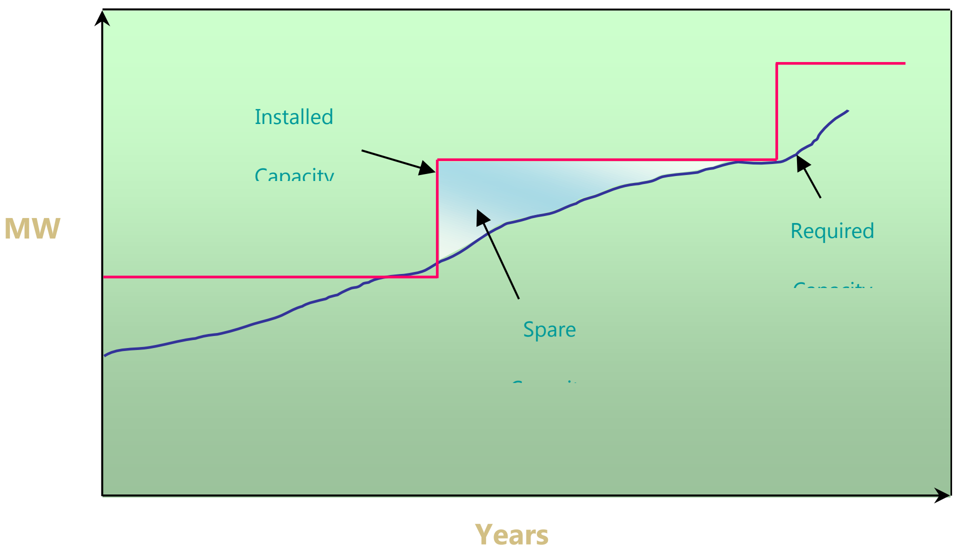


Figure 6-1 Illustration of Typical Step Change in Network Capacity

The blue line represents the required MW capacity at a particular point in the transmission system. The red line represents the installed transmission system capacity. Changes in installed capacity generally come in discrete steps following completion of a network development project, thus providing spare capacity for a period of time.

Figure 6-2 illustrates the demand profile for a representative station. The blue line represents the demand forecast at the station. The green bars represent a new step increase in demand. The analysis carried out for this TYTFS examines the transmission system's capability to accept such increased demand above forecast levels.

The capability is examined at selected 110, 220 and 275kV stations. These selected stations feed principal towns and demand centres distributed throughout the country. The selected 110, 220 and 275kV stations are 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.

Transmission Planning Criteria (TPC)[1] standards have been applied for analyses of demand opportunities in Ireland. 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 demands in Ireland.

In Northern Ireland, Transmission System Security and Planning Standards (TSSPS)[2] have been applied for analyses of demand opportunities.

The transmission system was assessed for loss of any single item of transmission plant (N-1) and loss of a double circuit (N-dc). During the

[1] http://www.eirgrid.com/media/Transmission%20Planning%20Criteria.pdf

[2] http://www.soni.ltd.uk/media/documents/Projects/Publications/Northern%20Ireland%20TSSPS%20-%20September%202015.pdf

summer season the Northern Ireland transmission system was also assessed for a maintenance-trip (N-1-1) contingency.

It should be noted that as the North-West of Northern Ireland is supplied by a single double circuit 275kV, it requires specific assessment in line with the TSSPS.

Voltage analysis was performed as part of the demand capacity studies in both Ireland and Northern Ireland. This is because the addition of demand is likely to impact on local voltages levels.

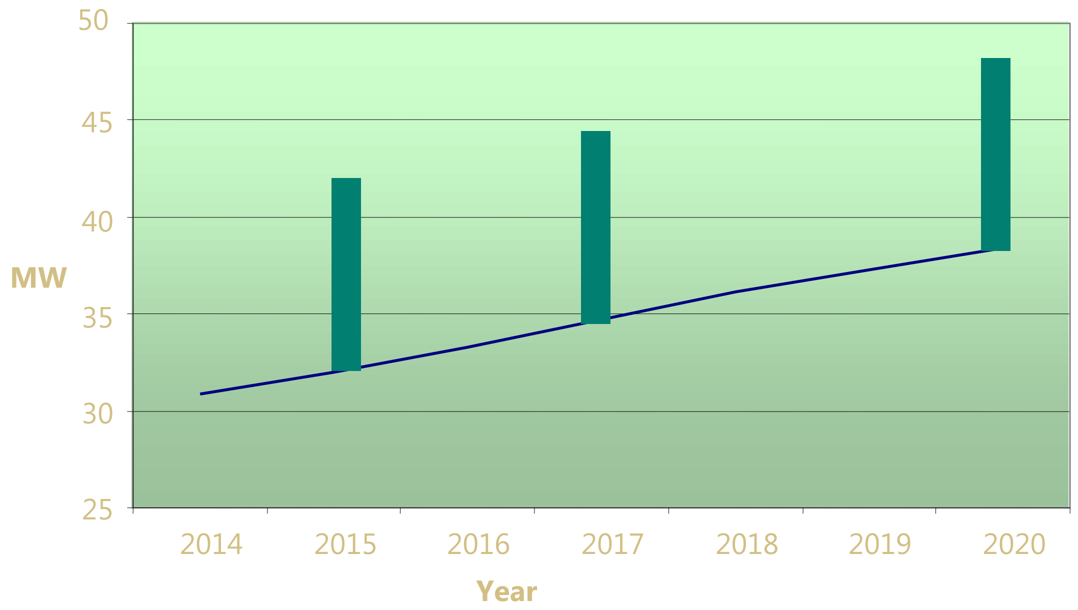


Figure 6-2 Demand Profile at Typical Station

6.1.2 Method for Calculating Limits for Increased Demand Connections

An AC load flow linear algorithm was used to screen for critical contingencies and thermal overloads or voltage limitations.

What is a load flow?
A load flow is a numerical analysis of the flow of electric power in an interconnected system. The load flow analyses a power system model to determine steady-state (normal operation) values such as voltages, voltage angles, real power and reactive power.

What is a linear algorithm?
A linear algorithm uses an interactive approach to find the solution to a numerical problem, such as determining voltages on the power system. A linear algorithm is simple and robust method of finding a solution.

Power transfers were considered using dispatch scenarios typically experienced on the transmission system. While these dispatches are typical, the particular dispatches were aimed to stress the network differently in terms of power transfers.

By analysing different power transfer stresses on the transmission system, we can ensure that demand opportunities reported in our analysis will not breach our TPC standards in Ireland and TSSPS in Northern Ireland.

The conventional units selected for each dispatch scenario aligned with market projections for the study year 2020.

Modelling Details

Generators were modelled with their maximum output equivalent to their Maximum Export Capacity (MEC). As renewable generation is classified as a variable energy source, it cannot be relied upon to serve demand. As such, local wind generation was switched out in the vicinity of the test station.

This is for the purposes of assessing new demand that can be accommodated on the network. These dispatches, with wind generation local to the test station switched out, were used for single contingency (N-1) studies. For N-1-1 contingencies, some centrally-dispatchable generation local to the test station was maximised to its MEC value. This was implemented to create a more favourable dispatch for the maintenance case.

To calculate the opportunity, demand at 0.90 power factor was added at the test station in increasing amounts. This was balanced by an equivalent increase in generation output from existing generation according to the merit order. This is illustrated in Figure 6-3.

The limit for increased transfers from the generators to the test station was established. This was achieved by checking the post-contingency performance of the transmission system against thermal and voltage standards. This process was done for each dispatch scenario studied.

Problems on the transmission system were not considered limiting unless they were sensitive to the incremental transfers under examination.

The information from this analysis provides a single capability figure at each station by combining the results from each dispatch scenario to each of the selected stations. This provides an indication of the capabilities for increased demand at each station.

When considering single contingencies (N-1) on an intact transmission system the minimum capacity from the dispatches used was chosen. However, when considering maintenance-trip contingencies (N-1-1) in Ireland, the greater of the capacities from each dispatch was chosen.

This was based on the assumption that less onerous generation dispatches could be scheduled to accommodate maintenance outages. The results are presented in Section 8.2 of Chapter 8.

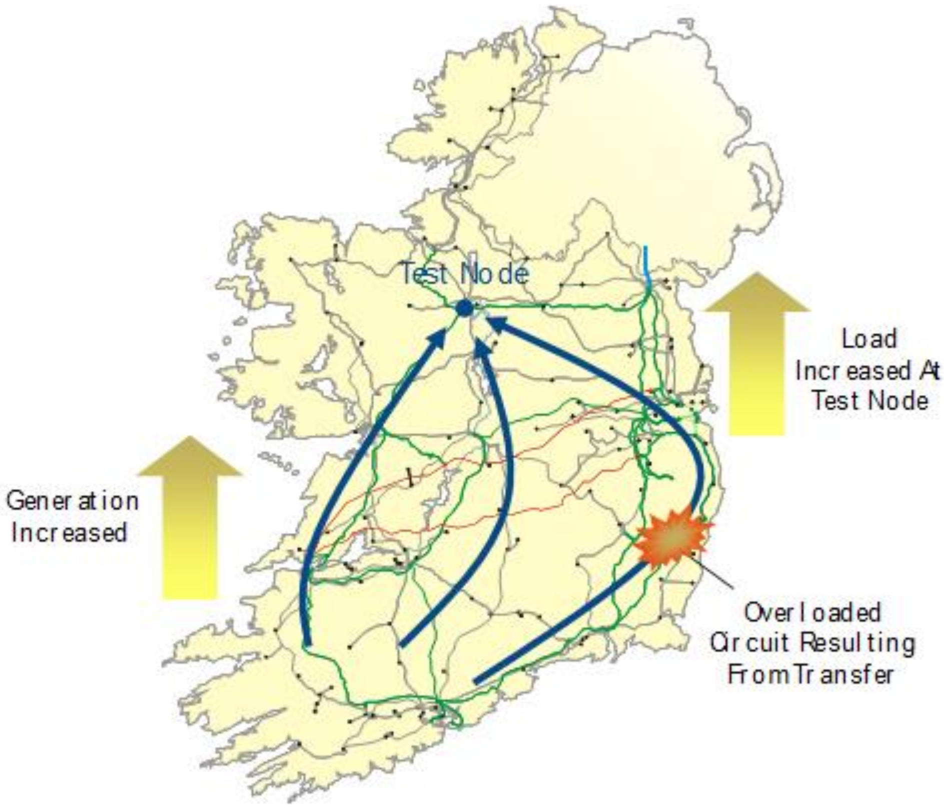


Figure 6-3 Illustration of Incremental Transfer Capability Study Method for Demand

6.1.3 Calculation of Capability for Demand at Any Station outside Dublin

This section provides a general example of the analysis of the capability of any of station studied in chapter 8. The station was tested to accommodate increased demand in summer peak 2020.

The assessment was carried out by simulating the transmission system for summer peak 2020. The relevant demand forecasts and generator dispatches were used.

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, the AC loadflow linear technique was used to add a test demand. For example, 100MW to a station.

The analysis tested an exhaustive range of N-1 contingencies (individual circuit/transformer or generator outages) to identify any resultant thermal overloads or voltage violations and to thus identify a capacity limit. Some contingencies cause violations of thermal overload or voltage standards at the maximum capacity.

In these cases, the analysis reverted to 0MW and performed the test in increasing steps. Each step was 10MW in size. The test ran in increasing steps until a violation of thermal overload or voltage standards occurred. 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 of island of Ireland is not addressed. The implications for generation adequacy of demand growth above the median forecast levels are dealt with separately in the *All-Island Generation Capacity Statement 2015-2024 (GCS)*.

6.1.4 Calculation of Capability for Demand in Dublin

The Dublin region is the largest demand centre on the all -island transmission network. It has and remains the focus of continual interest for the connection of large new demand.

There has been a significant upsurge in the number of enquiries and applications for new demand connections in the Dublin region and its environs since 2014. Many of these requests are for data centres which present relatively flat load profiles that would impact on both the minimum and maximum demand requirements in the region. If all of these enquiries were to materialise and connect, the maximum demand of Dublin could exceed 3000MW (see chapter 3 Demand).

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

Due to the volume of enquiries and applications received and their potential interactions, EirGrid are providing additional information on demand opportunities and, in particular, in the Dublin area for this year’s statement.

The Dublin region has been divided into three geographic zones (see fig 8-3 in Chapter 8), namely the North, West and South clusters, in order to give more useful insights into the connection capacity that is available.

This takes into account the three main corridors servicing the main bulk supply points, which act as the transmission to distribution interfaces in the region.

The methodology used to consider demand opportunities in the Dublin region is based on the existing tans mission system. It also includes criteria such as how each zone is expected to develop and the associated lead times for project delivery. The Dublin methodology is applied in chapter 8 section 8.1.1.

6.1.5 Factors Impacting On Results

The results of the analyses described in this section 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/divestiture of existing generation stations
- changes in the economy which give rise to consequential 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
- selection and construction of new transmission system reinforcement developments which may significantly increase transmission system capacity

6.2 All-Island Generator Opportunity Analysis

6.2.1 Change in Approach

In previous years the TYTFS carried out detailed load flow analysis to determine the capability of the transmission system of Ireland and Northern Ireland to accommodate additional generation.

Generation was increased steadily at transmission nodes and the performance of the transmission system was tested against thermal and voltage standards. In doing so the capability of the transmission network to accept additional generation was determined for a number of power flow scenarios.

In the preparation of this statement there have been a number of developments that mean that this type of assessment at this point in time would not provide useful information to transmission system users.

- Since the 2013 TYTFS analysis was completed it is unlikely that many significant new opportunities have developed in the intervening period.
- In Ireland, we published our Grid Strategy "Your Grid, Your Views, Your Tomorrow." a discussion paper on Ireland's Grid Development Strategy for public consultation in March 2015. Since then the Grid West and Grid Link (Chapter 2) reports to the Independent Expert Panel (IEP) were published and are available on the EirGrid website. We are currently updating and finalising our Grid Development Strategy taking all comments and feedback received into consideration.
- The anticipated policy for energy in Ireland was not available at the data freeze date and could have an impact on the outcome of TYTFS capability analysis. Therefore, it was decided to wait until the outcome of the Department of Communications, Energy and Natural Resources white paper entitled "Ireland's Transition to a Low Carbon Energy Future 2015-2030[3]" was known.

[3] As of the publication date of the 2015 TYTFS, the Department of Communications, Energy and Natural Resources white paper can be seen here: http://www.dcenr.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf

- The CER had signalled their intention to review Grid Access Policy in Ireland and a proposed paper on the matter was anticipated at the TYTFY data freeze date. Again, it was decided to be prudent to await the outcome of this paper (CER/15/284) before assessing any new generation opportunities in Ireland.
- In Northern Ireland the Utility Regulator determination (DET-572) occurred just after the TYTFS freeze date. This unexpected large scale increase in connection applications in NI (approximately 900MW) has led to NIE networks and SONI to consider alternative connection process options. To this effect SONI and NIE Networks will shortly issue a public consultation.

When there is clarity around these points and the impact to the All Island transmission network is determined, there would be value in EirGrid and SONI carrying out detailed future load flow based generation capacity assessments.

6.2.2 All Island Generation Opportunity Analysis.

As an interim measure we have described changes that have occurred in terms of generation capacity connected and capacity that could connect depending on generation project completion rates.

We have also carried out a regional generation and demand balance analysis. Whilst we have not identified generation capacity at a transmission nodal level, it does give a view of those areas where there is a generation capacity surplus and those where there is a deficit.

It should be noted that each region in the generation and demand balance analysis is interconnected by a meshed, high capacity transmission network. This is essential to maintain security and reliability of supply for demand customers across the Island of Ireland.

The harmonised all-island transmission charge and losses arrangements in SEM have an objective amongst others to provide locational signals that reflect the costs they impose on the transmission system.

We have described the changing connection capacity locations, the impact on network power flows and the resulting effect on Transmission Use of System (TUoS) charges and Transmission Loss Adjustment Factors (TLAF). These TUoS and TLAF values have an impact on power generation costs.

It is intended that the results of this overall this methodology will help transmission network users make informed decisions when exploring potential transmission network connection locations.

This section and associated information is indicative only; EirGrid and SONI will provide guidance to transmission system users regarding the connection offer process and updates of any changes in policy that could influence generation connection opportunities on the all-island transmission grid.

We encourage generators wishing to connect to the transmission grid to consult with EirGrid and SONI on the proposed connection location as early as possible.

7 TRANSMISSION CAPABILITY FOR NEW GENERATION

EIRGRID GROUP

The current. The future.

7 Transmission System Capability for New Generation[1]

7.1 Background

In this chapter we provide information based on a 2020 forecast for the demand/generation capacity balance on a regional basis. From this assessment it is possible to identify regions where there is a generation capacity deficit and others where there is a surplus. This generation and demand balance has a resultant impact on power flow which in turn heavily influences transmission network capacity and investment.

As well as transmission network capacity there are many factors that influence the location of new generation, such as fuel sources for conventional generation or primary energy sources for renewable generation, as can be seen with the high level of wind generation found in the West of Ireland.

Significant changes to generation dispatch patterns and the geographical location of generation have had an impact on all-island transmission network power flows. As a consequence, generator transmission use of system[2] (GTUoS) tariff signals and transmission loss adjustment factors[3] (TLAF) have changed, resulting in an impact on the economics and location of power generation. Resulting regional changes in TUoS and TLAFs are also described to help network users make informed decisions when exploring potential transmission network connection locations.

As explained in Chapter 6, it is not practical to carry out a detailed generation capacity opportunity analysis in this statement. However, we do provide information on a regional basis to enable potential transmission system users to evaluate locations where there may be transmission network capacity available.

[1] This chapter of the TYTFS is published for EirGrid to meet its obligations in Section 38 of the 1999 Electricity Act and for SONI to meet condition 33 of the SONI TSO Licence. It 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 EirGrid for discussions on their proposed developments.

[2] Transmission use of system (TUOS) is the charge associated with transporting power in bulk across the transmission system (see http://www.eirgridgroup.com/site-files/library/EirGrid/2015-2016-Statement-of-Charges-CER-Approved-final-290915.pdf and http://www.soni.ltd.uk/media/documents/Customers/TUOS/Final%20TUoS%20Statement%20of%20Charges%202015-16.pdf)

[3] Transmission loss adjustment factors (TLAF) is a factor derived for the purpose of apportioning responsibility for transmission losses amongst users of the transmission system (see http://www.eirgridgroup.com/site-files/library/EirGrid/2015-2016-Statement-of-Charges-CER-Approved-final-290915.pdf)

The actual transmission network capacity can only be determined during the connection offer process. This process requires detailed network assessments to determine the optimal connection arrangement that complies with the Transmission Planning Criteria[4] in Ireland and the Transmission System Security and Planning Standards[5] in Northern Ireland.

7.2 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 the 1 July 2015 there was circa. 2700MW connected to the all-island transmission system. Depending on project completion rates this all-island figure could increase to more than 7000MW of wind generation capacity by 2020 and beyond (see Chapter 4).

This generation is mainly connected in remote locations to 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.

In contrast there are a number of large conventional power stations due for retirement/divestiture or to have restricted output due to the EU Industrial Emissions Directive[6].

7.3 Regional Generation and Demand Balance

Typically as generation builds up in a particular region, and is less than the local demand, it can normally be accommodated with little impact to the backbone transmission network.

As generation grows to a level that exceeds local demand, it is possible to accommodate this up to a point. This is largely dependent on the presence of adequate transmission network capacity to facilitate the flow of excess generated power to other regional demand centres.

[4] http://www.eirgridgroup.com/site-files/library/EirGrid/Transmission%20Planning%20Criteria.pdf

[5] http://www.soni.ltd.uk/media/documents/Projects/Publications/Northern%20Ireland%20TSSPS%20-%20September%202015.pdf

[6] http://www.eirgridgroup.com/site-files/library/EirGrid/Eirgrid_Generation_Capacity_Statement_2015.-2024.pdf

A number of regions have reached the point where further generation cannot be accommodated due to limited transmission network capacity. A number of major projects identified in EirGrid's draft grid development strategy document published in 2015[7] or the current Transmission Development Plan (TDP)[8] address these future transmission network capacity needs, in Ireland.

It was felt that it would be beneficial to include a review of the regional demand and generation balance. This identifies areas where demand may potentially exceed generation, creating unfavourable transmission system scenarios whereby power has to flow over greater distances. This in turn can have significant impacts on generation economics and location as discussed in Section 7.4.

Figure 7-1 below shows the regional demand and generation balance across the island of Ireland for the year 2020.

2020 regional demand values are based on the summated demand forecasts of all transmission to distribution interface stations in that region (see appendix C). 2020 regional generation values are based on the summated existing and planned generation developments in each region (appendix D).

Generation figures shown in Figure 7-1 are based on installed MW capacity. For information purposes we have provided a breakdown of generation in both renewables and conventional generation categories.

It should be noted that wind generation which comprise the majority renewable generation figures shown in Figure 1 are based on installed MW capacity. As a capacity credit[9] exists for wind generation, the MW installed capacity of wind cannot be simply applied to generation adequacy studies as detailed in the 2015 Generation Capacity Statement (GCS)[10].

In Figure 7-1 the generation capacity shown in each region represents the maximum possible capacity (installed MW) available.

[7] EirGrid Grid Development Strategy, Your Grid, Your Views, Your Tomorrow. A Discussion Paper on Ireland's draft grid development strategy: http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf

[8] Transmission Development Plan 2015 available at http://www.eirgridgroup.com

[9] Contribution of wind generation to generation adequacy is referred to as the capacity credit of wind.

[10] http://www.eirgridgroup.com/site-files/library/EirGrid/Eirgrid_Generation_Capacity_Statement_2015.-2024.pdf

In practice, regional generation levels will vary considerably depending on a number of conditions including;

- system demand levels,
- power system economics,
- wind power output,
- generation availability,
- interconnector imports and exports,
- and operating/market conditions.

Therefore the information provided here is intended to provide an indication of regional demand and generation balance only. Generation developers should consider the conditions above during project proposals.

Each region displayed in Figure 7-1 is interconnected by a meshed, high capacity transmission system. This is essential to maintain security and reliability of supply for demand customers across the Island of Ireland.

The main trend that emerges is there are high levels of generation, relative to local demand levels in Western regions and central Ireland, in comparison to regions along the Eastern seaboard.

In general, generation connections can be more readily accommodated in locations close to existing demand centres. This is due to the fact that generated power can be absorbed close to the demand centre. This means that power does not have to be transported over long distances from generation source to demand.

Historically, in Ireland and Northern Ireland, large conventional generation plants would be sited as close as practically possible to large demand centres. This reduced the need to transport power across the transmission network, reduced power transfer losses and improved the security and reliability of supply.

In recent times, large renewable energy resources, principally wind energy located to the South West, West and North West, has led to high penetrations of generation in these regions. As a consequence, we see much more widely dispersed generation. At times this results in high power flows and congestion on many transmission circuits that provide power to demand centres in the East.

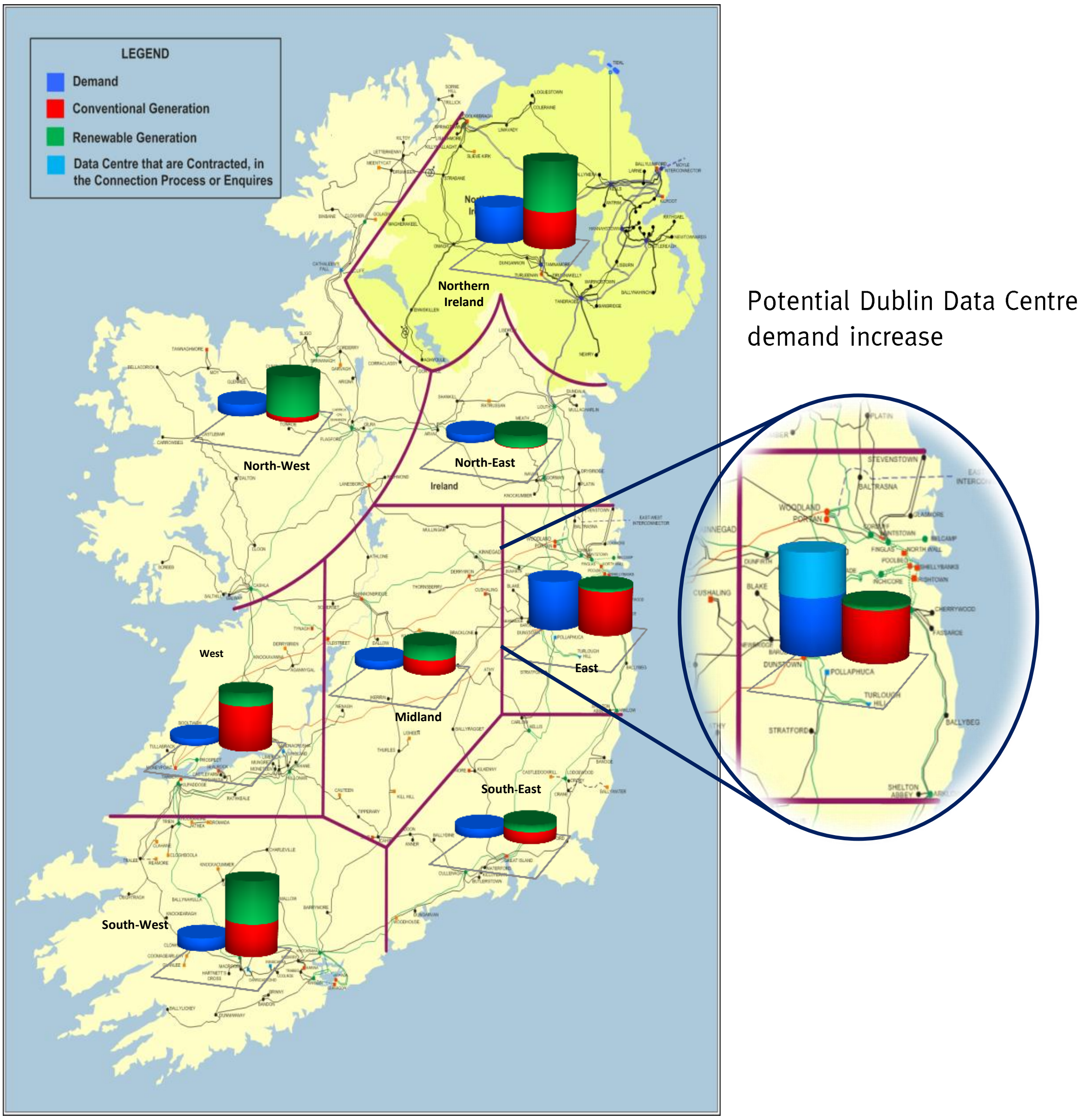


Figure 7-1: All-island 2020 regional demand and generation balance

Dublin Area

In contrast with other regions, Dublin currently is the only region where demand exceeds generation. This deficit will become more significant with approximately 550MW (see Chapter 3) of increased demand capacity that is either contracted or in the EirGrid connection offer process.

In addition to this, there is around 1000MW of potential demand connection enquiries, many of which are in the Dublin region (see Chapter 3). If all of these enquiries were to materialise and connect they would summate to around a 70% increase in the current Dublin peak demand.

Without new generation capacity located in Dublin, under these high demand conditions, Dublin would be dependent on substantial power flows into the region from remote generation sources.

Northern Ireland

Not dissimilar to Ireland, Northern Ireland is connecting high levels of wind generation, with more planning to connect to the transmission and distribution systems. This generation in the North and West of Northern Ireland is greater than local demand and causes congestion on the transmission network.

In the East of Northern Ireland, opportunities for generation connection are possible, with a less congested transmission network and higher demand density. Connection studies would be required to determine the available capacity and connection arrangements[11].

7.4 Generation Locational Tariff Signals and Their Impact on Transmission Network Capacity

The Single Electricity Market's (SEM) harmonised transmission arrangements[12] provide locational signals to users reflecting the costs they impose on the transmission system. TLAFs and GTUOS, as part of harmonised transmission arrangements, provide generators with locational signals informing their decision on where to connect to the grid.

Electrical losses[13] which occur as electricity is transported along transmission circuits are accounted for in the SEM settlement processes with the application of TLAFs.

Some units are responsible for proportionally more transmission losses than others, depending on their point of connection to the grid and use of transmission network capacity.

[11] In this TYTFS we are considering the capability of the transmission network to meet the needs of transmission network users. Care should be taken when interpreting these regional results; we are not evaluating the adequacy of generation capacity to meet peak demand. This is evaluated in the Generation Capacity Statement. As an example Figure 1 shows a generation capacity surplus in Northern Ireland (NI). However the largest component of generation capacity in NI is from wind generation. This generation is variable and is not always available to meet the peak demand. In addition, the generation capacity figure includes generation with restricted hours of running from 2021 as a result of EU Industrial Emissions Legislation (IEL). As a result of these capacity limitations in NI the security of supply would be at risk if the second North - South interconnector is delayed further.

[12] The development of harmonised all-island transmission charge and losses arrangements was an objective stated in the original SEM high level design.

[13] The transmission of electricity results in a proportion of energy being lost as heat.

The methodology used by the transmission system operators (TSOs) to calculate the TLAFs has been approved by the regulatory authorities [14 /15 /16 /17].

Transmission losses are minimised when generation is located close to demand centres and a generation/demand balance is achieved. When this balance changes, and generation is in excess of local demand, power flows increase across the transmission system and transmission losses also increase.

The Transmission Use of System Charge (TUoS) is the main charge for transporting power in bulk across the power system. Generator Transmission Use of System Charge (G-TUoS) contains a locational component, in order to provide a signal of the costs associated with a generator's use of the 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.

The regional average 2015/16 TLAF values are shown in Figure 7-2. Values shown in Figure 7-2 are based on published 15/16 TLAF[18] values.

Generator TLAF's 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

[14] The Single Electricity Market (SEM) High Level Design Decision Paper, 10 June2005, AIP/SEM/42/05.

[15] Decision on all-island harmonised Transmission Loss Adjustment Factors (TLAFs), SEM-10-066, September 2010

[16] Decision Paper, Treatment of Losses in the SEM, SEM-11-067, Aug 2011

[17] Decision Paper Treatment of Losses in the SEM, SEM-12-049, 26 June 2012

[18] SEMO, Transmission Loss Adjustment Factors(TLAF): http://www.sem-o.com/Publications/Pages/MarketParameters.aspx?documentarchivestatus=Active

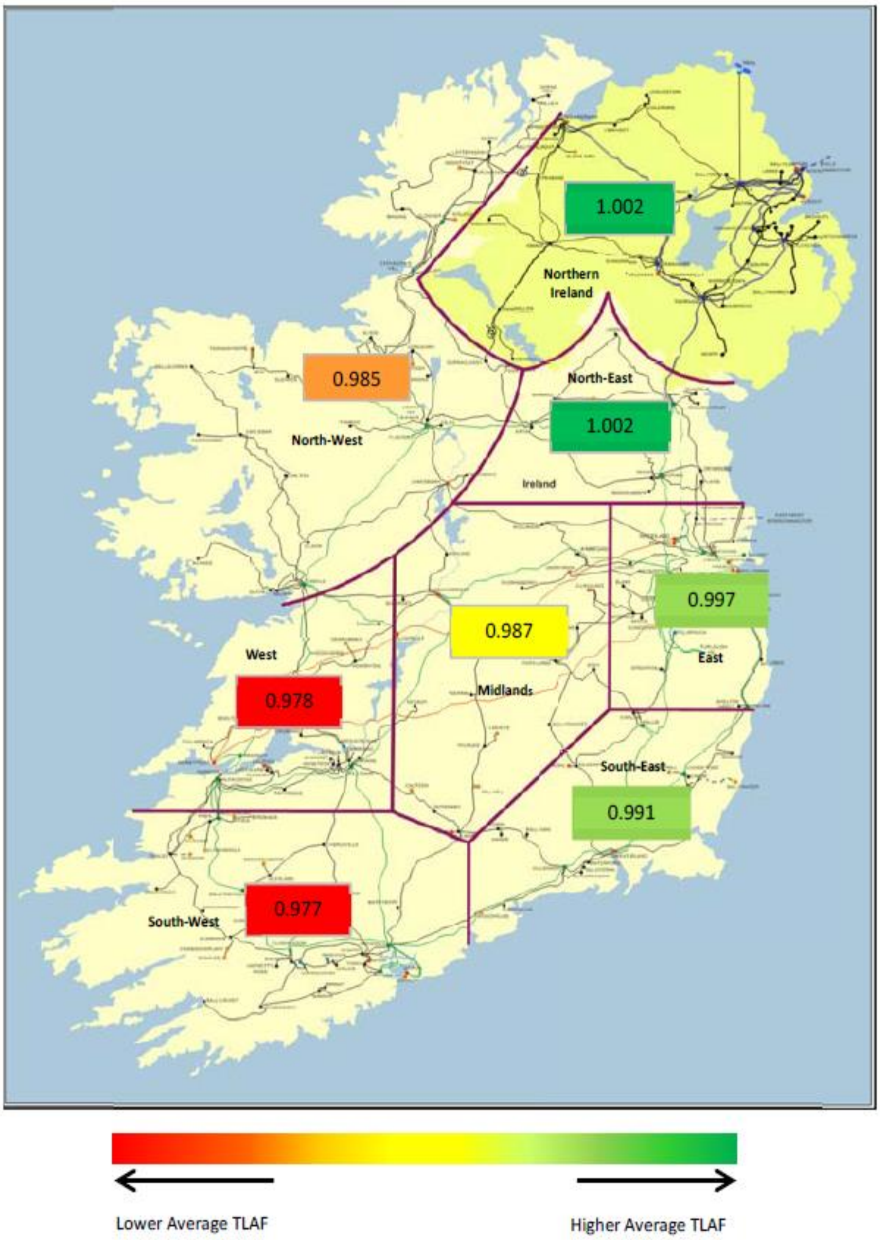


Figure 7-2: All-island 2015/16 regional average TLAF values

The regional average 2015/16 GTUoS values are shown in Figure 7-3. Values shown in Figure 7-3 are based on 15/16 GTUoS values[19].

Higher GTUoS charges 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.

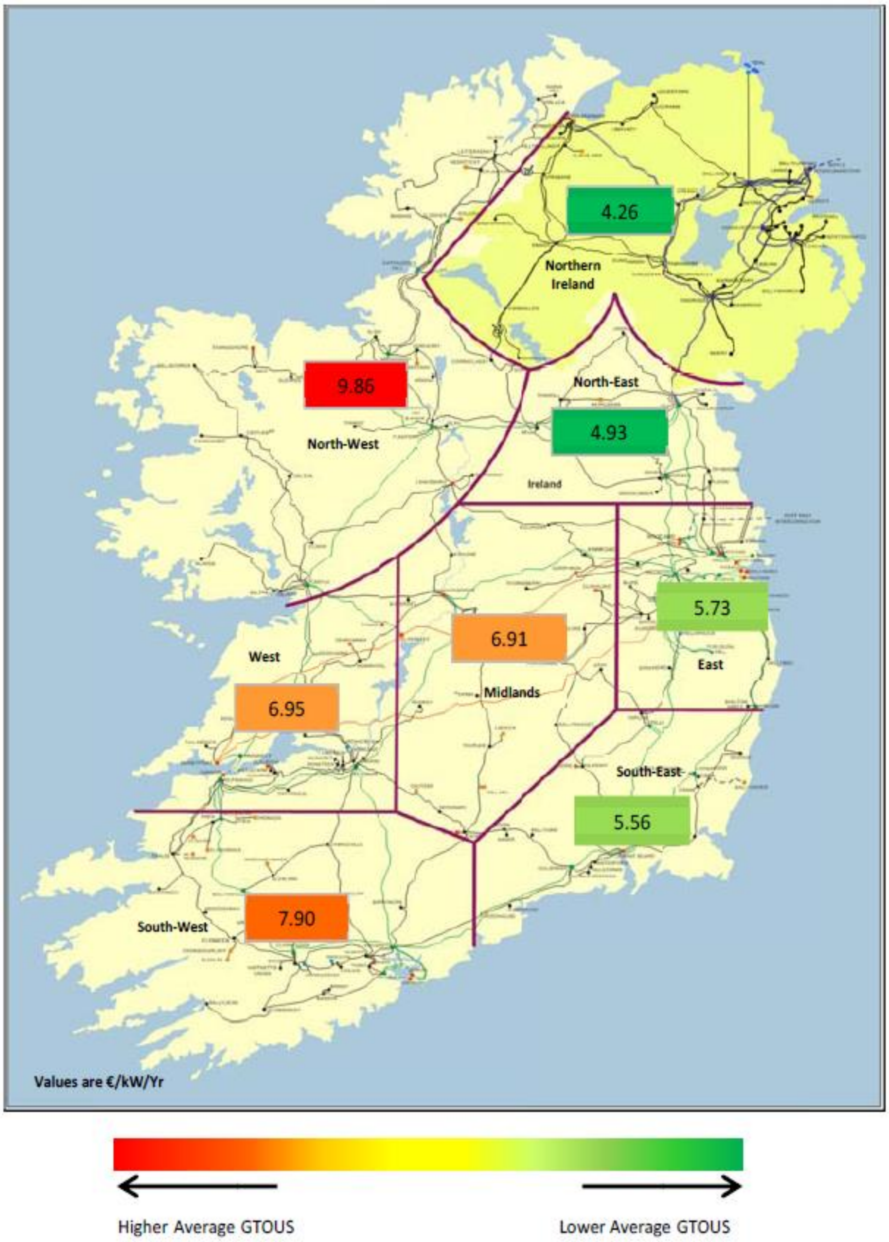


Figure 7-3: All-island 2015/16 regional average GTUoS values

[19] http://www.eirgridgroup.com/site-files/library/EirGrid/2015-2016-Statement-of-Charges-CER-Approved-final-290915.pdf and http://www.soni.ltd.uk/media/documents/Customers/TUOS/Final%20TUoS%20Statement%20of%20Charges%202015-16.pdf

As shown in Figure 7-2 and Figure 7-3, a clear trend emerges. Regions with surplus generation capacity in the South West, West and North West have lower TLAF and higher GTUoS values than Eastern regions with higher demand levels and less surplus generation. These trends should be taken into consideration by generators when considering options to connect to the all-island transmission system.

7.4.1 How to Use the Information for Generation

Generation developers wishing to use the information on regional demand/generation balance and locational tariff signals when considering where to connect should follow these steps:

1. Consult the maps in Appendix A to find the nearest transmission station to the proposed development. Also, regions identified in Section 7.3 and 7.4 which are indicating optimal opportunities for generation connections.

2. Consult the forecasted increase and retirement/divestiture of generation within a region shown in Appendix D.

3. Review assumptions in Chapters 2 to 4 and consider the impact of changes to the transmission system since the analysis was carried out. Chapter 5 and Appendix E should also be considered to determine short circuit levels at the nearest tranmssion station.

4. Consult with EirGrid and SONI on the proposed location as early as possible as well as consulting the EirGrid application process[20] and SONI application process[21]

Potential generator developers should not be discouraged by choosing a site in which there appears to be a lack of transmission network capacity. 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.

[20] http://www.eirgridgroup.com/customer-and-industry/becoming-a-customer/

[21] http://www.soni.ltd.uk/Customers/howconnected/

7.5 Looking to the Future

Ireland

The Commission for Electricity Regulation (CER) policy for connection of generation to the electricity network in Ireland is captured under the Group Processing Approach (GPA) and Non-Group Processing Approach directions. Under the GPA, offers for connection to the electricity network have been issued in batches called 'gates'.

Eligibility for inclusion in a Gate has been based on criteria set out by the CER in its decisions on each of the three gates to date, Gate 1 in 2004, Gate 2 in 2006 and Gate 3 in 2008 and 2009. The Non-Group Processing Approach applies to small scale generation and specific technologies.

The CER is now reviewing connection and grid access policy to ensure it is fit for purpose for future grid access requirements. The CER published Consultation CER/15/284 on the 11th December titled "Review of Connection and Grid Access Policy: Initial Thinking & Proposed Transitional Arrangements".

This paper represents an initial step in the development and implementation of an integrated and enduring connection policy for the electricity system in Ireland. Potential generator project promoters should be aware of these developments.

EirGrid will incorporate relevant policy directions. We will also provide assistance and guidance regarding the connection processes, requirements and arrangements for potential new transmission system users.

Northern Ireland

In the past, the connection process in Northern Ireland operated on the basis that statutory planning permission was required before a grid connection application could be processed by SONI and NIE Networks.

However, a recent Utility Regulator determination led to the removal of the planning permission requirement for distribution connection applications to NIE Networks. The planning permission requirement currently remains in place for transmission connection applications to SONI.

Towards the end of 2015, NIE Networks received a large number of applications for generation connections to the NI distribution system (approximately 900MW). This comes on top of approximately 1300MW of generation capacity connected and committed to connect to the NI grid.

This presents significant challenges for both the transmission and distribution systems. The current process for assessing connections, which adopts an incremental approach for assessing the impact on the grid, is not appropriate.

An alternative process must be implemented which addresses the challenges involved in processing this volume of applications. SONI and NIE Networks are due to issue a consultation on this matter shortly.

SONI will continue to provide guidance regarding the connection offer processes and provide updates regarding any changes to connection policy. SONI would welcome any feedback in relation to this consultation.

8 TRANSMISSION CAPABILITY FOR NEW DEMAND

EIRGRID GROUP

The current. The future.

8 Transmission System Capability for New Demand

This chapter presents demand opportunity analysis which assesses the capability of the existing and planned transmission system to accommodate increased demand. Opportunities for further demand connections in Ireland and Northern Ireland are discussed.

Demand opportunity analysis is studied in 2020 which includes the planned second North-South 400kV tie-line. Analysis of the 2020 transmission system indicates that all regions studied across the island have opportunities to connect demand at 275, 220 and 110kV stations.

There has recently been a significant volume of enquiries and applications for the connection of data centres in the Dublin region (see Chapter 3). Due to this, we have added section 8.2.1 which presents a qualitative approach describing demand opportunities in the Dublin area. The qualitative analysis of Dublin indicates that there is network capacity available for the connection of data centres.

8.1 Transmission System Demand Capability Obligations

This chapter of the TYTFS is published in order to meet the requirements of EirGrid's Section 38 of the 1999 Electricity Act and Condition 33 of SONI's licence.

The analysis illustrated in Chapter 8 is presented to provide a high-level indication of transmission network capacity for developers. 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 therefore require further detailed studies.

It 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 us for discussions on their proposed developments.

8.2 All-Island Transmission System Capability for New Demand

As detailed in Chapter 6, the transmission system's capability to accommodate new demand is assessed using demand opportunity analysis. The study was performed for 2020 winter and summer peak.

Data used for the demand opportunity analysis is based on the best available information at the July 2015 data freeze date. The results of the demand opportunity analysis presented in this chapter are based on the following assumptions:

- Demand forecast was based on 2020 figures (see Appendix C)
- Only transmission reinforcements with capital approval (Ireland) which are planned to be completed by 2020 where included in analysis (see Chapter 2)
- Planned generation up until 2020 was included in the analysis (see Appendix D)
- As wind energy is variable, it cannot be relied upon to serve demand. As such, wind generation local to the test station was switched out.
- The 2020 transmission system was assessed for the loss of a single transmission asset (N-1), maintenance-trip (N-1-1) and loss of a double transmission circuit (N-DC, Northern Ireland) contingences.

Twenty-eight 110kV stations, which feed principal towns and main load centres throughout Ireland were chosen for this analysis. The stations examined and their accompanying results are shown in Figure 8-1. In response to stakeholder feedback, this TYTFS also includes analysis at ten 275kV stations and four 220kV stations. These stations were included to help identify potentially suitable locations for major industrial load centres with large power requirements.

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, this will then use up 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 many 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 through Figure 8-5 to Figure 8-11. Each Figure is accompanied by a description of factors restricting demand opportunity and future network reinforcements which may release demand capacity in the area. The results indicate that in 2020 there will be opportunities at each of the forty-two stations examined.

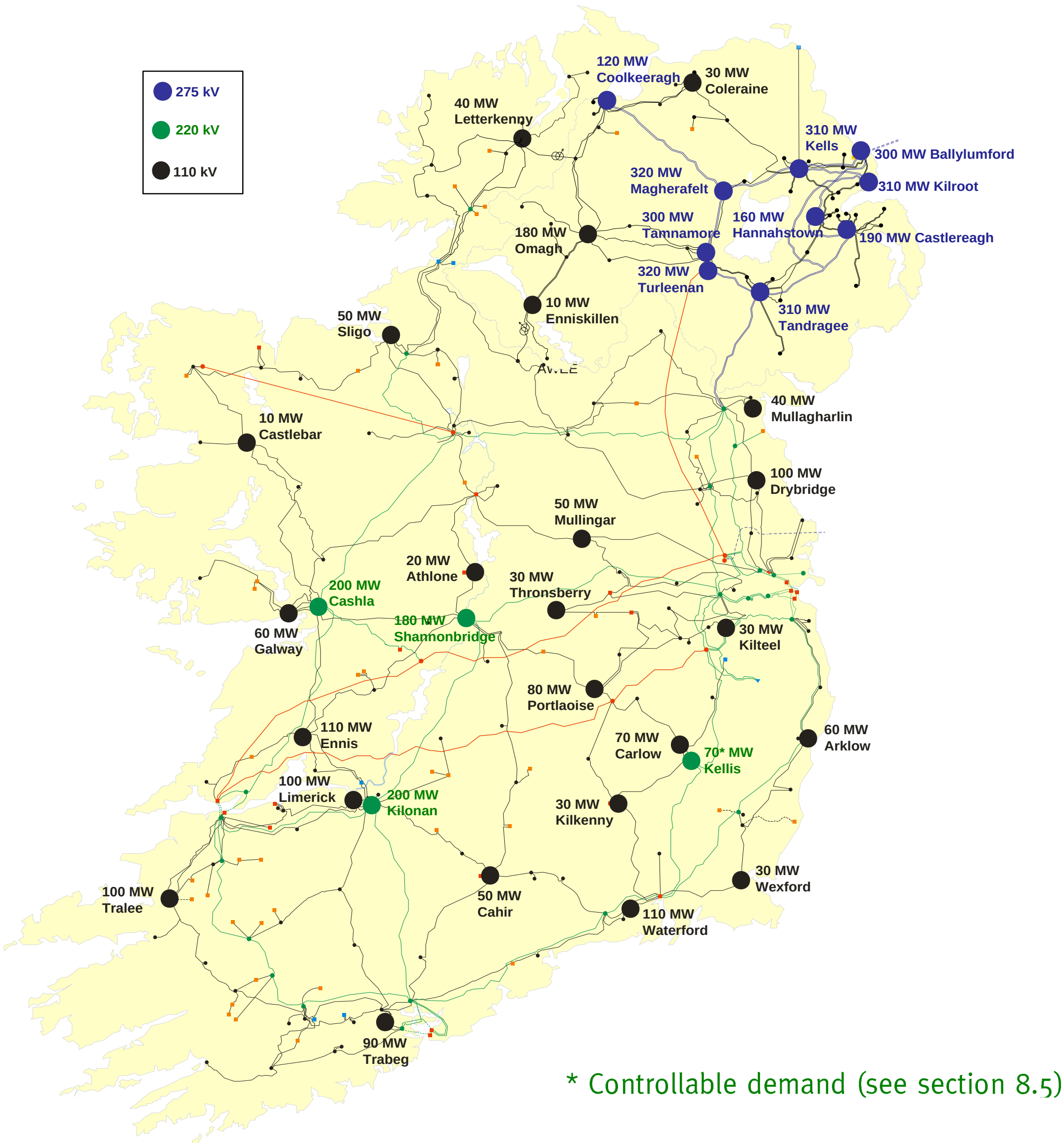


Figure 8-1 Capability for Additional Demand at 275kV, 220kV and 110kV Stations (given to the nearest 10MW)

8.3 New Demand Opportunities for the Dublin Area

Context

Dublin is the largest load centre on the island of Ireland. We have expanded this section this year due to the considerable interest and number of enquiries for connection to the grid around Dublin (see chapter 3 Demand). The volume of enquiries and the uncertainty of their final outcome and interaction 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 20MW to some possibly extending to 250MW in the final stages of development. The connections are mainly comprised of data centres that support the information, communications and technology (ICT) infrastructure of large multinational companies.

There is currently around 550MW of demand capacity either contracted or in the EirGrid connection offer process. In addition to this, there is approximately 1000MW of enquiries regarding further demand connections from 2019 onwards.

To put this figure in perspective, the current winter peak demand in Dublin and on the all-island system is approximately 2100MW and 6500MW respectively. If all of these enquiries were to materialise and connect, they would sum to around 20% of the all island system peak demand and 70% of Dublin peak demand.

Connections on this scale cannot be managed solely at distribution level. Rather they will require connections to the 220kV and 110kV transmission network. EirGrid is working with customers and the distribution system operator ESB Networks to meet their individual needs and to ensure optimal network development and solutions.

The Dublin Network:

The diagram in Figure 8-2 represents the 220kV backbone transmission system in the greater Dublin area in 2020. There also exists a 110kV network in the Dublin area however, for clarity we have not shown it in Figure 8-2.

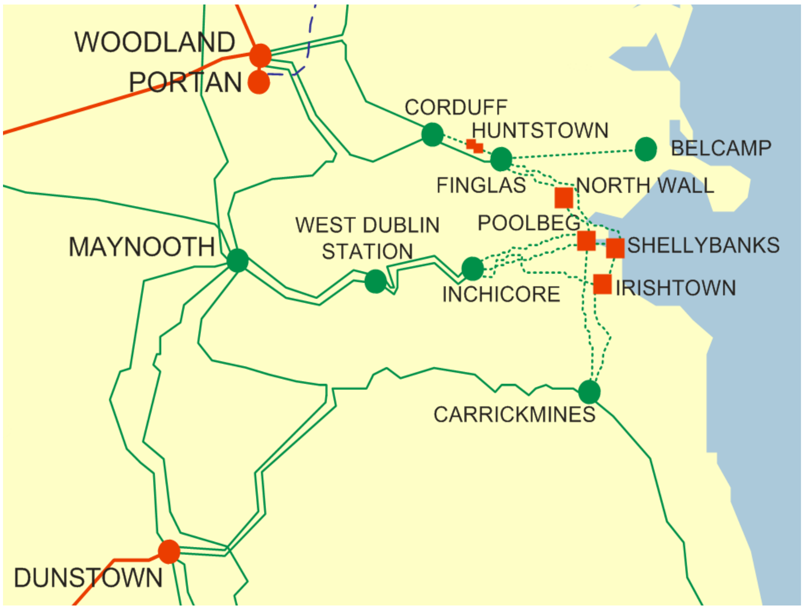


Figure 8-2: Dublin area 220kV transmission system

Electricity is supplied within Dublin via a 220kV network arranged in a figure of eight. A combination of operational arrangements and network devices (normally open points at Shellybanks 220kV station and a reactor at Poolbeg 220kV station) effectively divides the Dublin 220kV network into North and South rings.

This network configuration is primarily used to maintain fault currents at safe levels should a network fault occur. It also prevents excessive power flows through the Dublin region. Dublin is then fed via the underlying 110kV distribution infrastructure which is mainly arranged radially from transmission bulk supply point (BSP) interface stations (220/110kV).

The larger Dublin power stations are located at Huntstown in North Dublin and at Irishtown and Shellybanks in Dublin Bay. The combined capacity of these stations is approximately 1600MW. The 500MW East West Interconnector also feeds into Woodland 400kV station on the periphery of North Dublin.

Analysis is carried out to ensure compliance with the Transmission Planning Criteria (TPC) for all new connections to the transmission system.

This ensures the co-ordinated development of a reliable, efficient, and economical system for transmission system users. EirGrid must ensure the performance requirements of the TPC are met, for example the thermal capacity limits of equipment must be maintained for all operating conditions.

There are three primarily limitations that can restrict the availability of transmission capacity in Dublin;

(1) Limitations at the 220/110kV interface stations, these can include restrictions due to the 220/110kV transformers or spatial constraints,

(2) Power flow limitations on local transmission circuits within Dublin,

(3) Limited capacity on circuits outside Dublin in terms of facilitating large power flows across the transmission network.

Generation dispatch is critical in assessing the capability of the network and can have a significant impact on (2) and (3) above, especially in the case of Dublin.

The power delivered to Dublin demand centres can originate from power stations located within or outside Dublin or a combination of both. This is dependent on wholesale electricity market generation costs in the Single Electricity Market (SEM) as well as network/system issues.

Recently there has been a tendency for increased high power flows into Dublin from generation located outside the area. This is a result of the increased penetration of wind generation and the commissioning of other high merit order generators outside of Dublin.

In some instances these high power flows from outside the Dublin area can be reduced when power is generated inside Dublin. This could release network capacity for transmission users.

Dublin Transmission Development Plans

Figure 8-3 below describes the areas of focus for demand connections in Dublin and the scale of interest in each zone. The connections fall into three zones North, West and South Dublin.

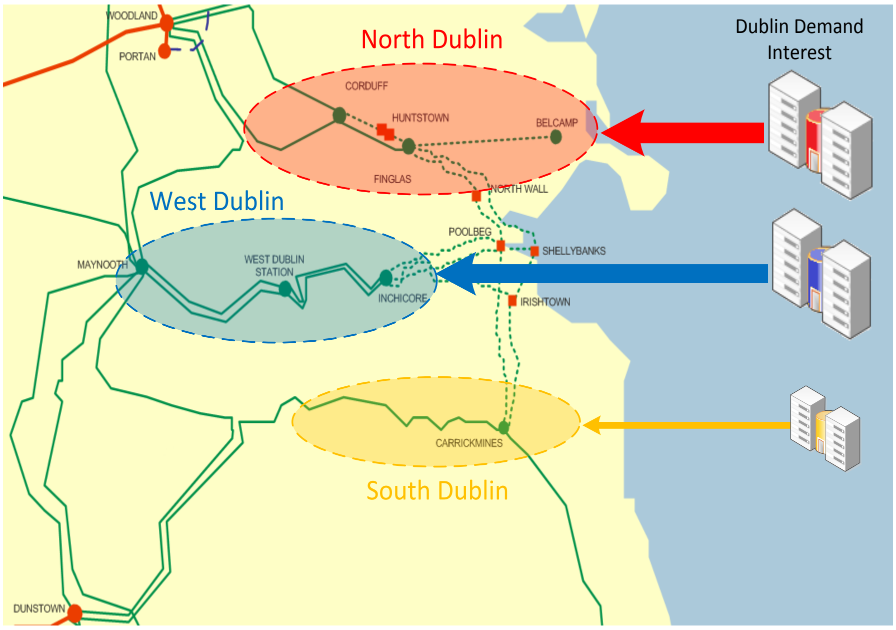


Figure 8-3: Dublin potential demand connections

Each zone is described below with consideration given to potential levels of connection demand, existing transmission infrastructure, transmission network projects and lead times.

Should the reader require more detailed transmission network project information please reference the EirGrid draft grid development strategy document published in 2015[1], the current Transmission Development Plan[2] and the latest associated transmission reinforcement (ATR) update[3].

The project table provides a brief description of the project, the estimated lead-time and the projects status. Project status is categorised into three areas; pre-planning, planning, approved. In construction and complete are subsets of approved. A description of each project status category is given in Appendix F, section F.1.

[1] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Draft-Grid-Development-Strategy.pdf

[2] The latest TDP can be found on the EirGrid website http://www.eirgridgroup.com/

[3] http://www.eirgridgroup.com/site-files/library/EirGrid/Q4-2015-ATR-Status-Update-as-at-31-Dec-15-published-01-Feb-16.pdf

North Dublin

North Dublin includes two 220/110kV interface stations at Corduff and Finglas with another planned at Belcamp. 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.

Table 8-1: North Dublin projects

North Dublin			
Project Name	**Project Description**	**Status**	**Estimated lead-time**
Cloghran	Uprate/Modify 110kV station	In construction	2016
Maynooth - Woodland	220kV line refurbishment	Planned	2016
Cloghran-Corduff	New 110kV cable	Approved	2016
Belcamp	New 220/110kV station	Approved	2018
Finglas	Uprate/Modify 220/110kV station	Approved	2018
Macetown	110kV busbar uprate	Pre-planning	2018

The transmission projects described above are sufficient to meet the current level of demand connections either contracted or in the EirGrid connection offer process. However, this area of Dublin has limited additional network capacity available to meet demand connections based on the present level of interest.

It is envisaged that facilitating further high levels of demand connections will require additional network capacity in the area. This could be in the form of increased network connectivity with Woodland 400kV station for example. Typically, such major projects delivering additional network capacity have significant lead times (five to eight years) which are dependent on the chosen technology.

West Dublin

West Dublin includes two main 220/110kV interface stations at Inchicore and Poolbeg with another planned at West Dublin station. These stations are supported by the Maynooth 220kV station on the outer rim of the Dublin region. The level of interest for connection in the West Dublin area is very high, second only to North 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.

Table 8-2: West Dublin projects

West Dublin			
Project Name	**Project Description**	**Status**	**Estimated lead-time**
Inchicore-Maynooth[4]	Uprate No.1 & No.2 line uprates	Complete	2015
Maynooth-Ryebrook[2]	Uprate 110kV line	Complete	2015
Poolbeg	Installation of 100 Mvar reactive support	Approved	2016
Ryebrook-Corduff	Uprate 110kV line	Approved	2016
Ryebrook	Refurbish 110kV station	Approved	2017
North Wall - Poolbeg	Replacement of cable due to a requirement to divert the circuit to make way for development at Dublin Port.	Pre-planning	2018
West Dublin	New 220/110kV station	Planning	2019
Inchicore	Uprate/Modify 220/110kV station	Pre-planning	2022
Maynooth	Uprate/Modify 220/110kV station	Pre-planning	2023

It is anticipated that this area of Dublin will have a reasonable level of network capacity upon completion of the new West Dublin 220kV station.

It will facilitate connections either contracted or in the EirGrid/ESB Networks connection offer process. There will also be some further network capacity available to transmission network users beyond what is currently contracted or in the EirGrid/ESB Networks connection offer process.

After the construction of the new West Dublin 220kV station, it is expected that additional transmission network capacity at Inchicore 220kV station may be available. This is due to the transferring of some existing demand at Inchicore to the new West Dublin 220kV station.

South Dublin

South Dublin includes one main 220/110kV interface station at Carrickmines connected at 220kV to Dunstown 400kV station and Arklow 220kV station. The level of interest for connections in South Dublin area is lower in comparison to the interest in North and West Dublin.

[4] This project has been completed since the data freeze date of July 2015

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 8-3 below.

Table 8-3: South Dublin projects

South Dublin			
Project Name	**Project Description**	**Status**	**Estimated lead-time**
Dunstown[5]	New 400/220kV 500 MVA transformer	Completed	2015
Carrickmines	New 220/110kV 250 MVA transformer & GIS development	Approved	2017

Considering the South Dublin transmission projects and the level of connection enquiries, this area of Dublin has a reasonable level of network capacity available to facilitate connections either contracted or in the EirGrid/ESB Networks connection offer process. Indeed there is further network capacity available to transmission network users beyond these connections.

Impact of Generation on North, West and South Dublin

As described in Chapter 7 there is currently a small generation deficit in the Dublin region which has the potential to increase. If additional generation was to locate in the Dublin area this would generally have a positive impact by releasing network capacity available for transmission system users in North, West and South Dublin zones.

However, the specific location of any proposed additional generation would have to be assessed to fully understand its full impact on the network.

[5] This project has been completed since the data freeze date of July 2015

Looking Forward

In 2015 EirGrid released a discussion paper on Ireland's draft grid development strategy. In this paper, we explained the role of electricity transmission infrastructure in supporting new investments and jobs as well as ensuring competitiveness by offering cost-effective power capacity.

This strategy put forward a number of major projects to upgrade the transmission network. The Regional Solution (see Chapter 2) and Dunstown – Woodland corridor reinforcement[6] projects have many system benefits, which include providing additional network capacity and improving security of supply for the eastern side of Ireland.

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

This project will greatly enhance the capability of the existing 400kV circuits to transfer bulk power generated in remote locations in the South-West, West and North-West to Dublin and other demand centres in the East as illustrated by the green arrows in Figure 8-4.

The Dunstown – Woodland corridor reinforcement is at an early point in the project life-cycle. The project will increase the strength of the link between two 400kV stations at Dunstown and Woodland. This will provide benefit by reducing power flows that pass through the Dublin transmission 220kV network, thus releasing network capacity on several key constrained circuits.

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

[6] This project is at an early stage of development and has therefore has not formed part of the 2015 TYTFS studies.

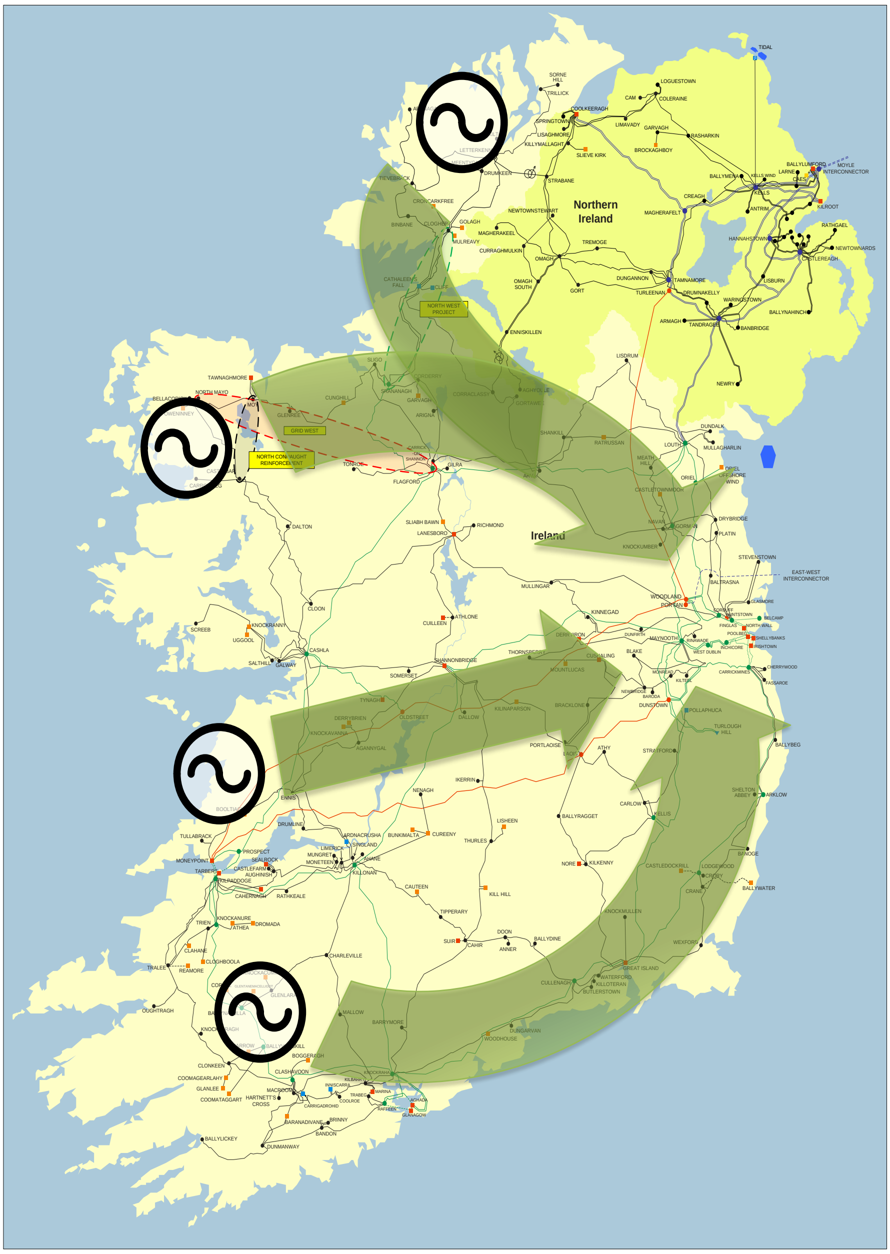


Figure 8-4: Transfer of power generated in the North-West, West and South-West regions to the East

Summary

Depending on the location, number and scale of projects that materialise and the capacity limitations of the existing network in Dublin, new transmission solutions will be required to strengthen the grid. These solutions are now under initial investigation and could vary from short to longer lead time developments.

EirGrid continues to apply a strategic approach to network development and is now considering the approach to the level of demand enquires. Our strategic approach will take 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. 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.

- To date, we have been able to facilitate connections for developers who have applied. We will continue to examine innovative solutions and technologies in response to future requests. However, with each application, the opportunity to utilise the existing transmission network becomes more challenging.

It is advised that any potential new demand consumers with EirGrid early so that we can work jointly to achieve a connection solution. This facilitates the optimisation of transmission reinforcements so that the requested capacity can be delivered.

It is also recommended to locate any new data centres in close proximity to existing 220kV stations or circuits as this may help expedite the provision of a suitable connection.

As a prudent system operator, EirGrid ensures that adequate spare capacity for regional and national demand growth is available, while avoiding unnecessary overinvestment in grid capability. Therefore a balance is maintained between the reasonable expectations placed on the network and the cost of grid development and maintenance. Delivering an efficient transmission grid requires that this balance of investment is maintained.

8.4 Transmission System Capability for New Demand in Ireland

Demand opportunities available on an Ireland regional basis are discussed in sections 8.4.1 to 8.4.5. Results presented in Section 8.4 are based on the assumptions detailed in Chapter 6.

8.4.1 Incremental Transfer Capability Results for New Demand in the Midlands and Mid-West

The demand opportunities available for the Midlands region are shown in Figure 8-5. It is shown that there are potential demand opportunities available for industrial customers at all stations examined in the region. In particular, Cashla and Shannonbridge 220kV stations would be suitable connection points for major industrial load centres. Both of these stations are capable of accommodating in the order of 200MW without additional network reinforcements.

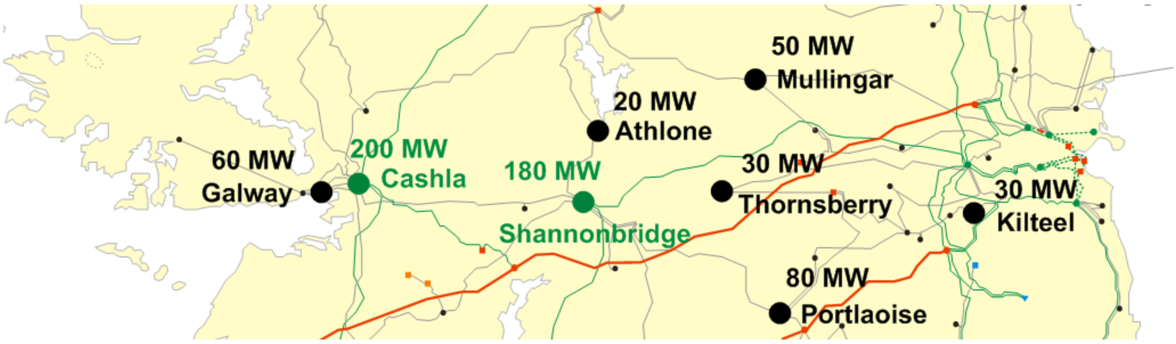


Figure 8-5 Capability for Additional Demand in Midlands and Mid-West Regions

8.4.2 Incremental Transfer Capability Results for New Demand in the North-East

The demand opportunities available for the North-East region are shown in Figure 8-6. It is shown that there are potential demand opportunities available for industrial customers at all stations examined in the region. The delivery of the North-South interconnector aids demand opportunity in the North-East. The North-South interconnector provides a route for large power transfers to flow between Northern Ireland and the Republic of Ireland via the North-East region of Ireland. The North-South interconnector will benefit potential demand customers connecting in this region by releasing more capacity on the underlying 110kV network.

Potential overloading of the Louth – Mullagharlin 110kV line is responsible for limiting the opportunity at Mullagharlin (40MW). The overload occurs during winter and summer peaks for single circuit outage conditions. This is a local issue as only two circuits supply the load at Mullagharlin. Drybridge (100MW), however, is more interconnected with four circuits supplying the station from disparate locations.

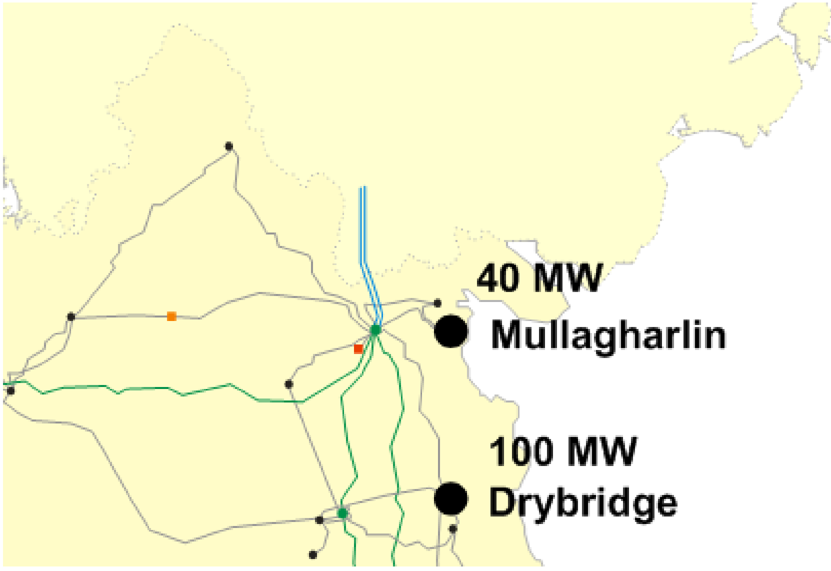


Figure 8-6 Capability for Additional Demand in North-East Region

8.4.3 Incremental Transfer Capability Results for New Demand in the North-West[7]

The demand opportunities available for the North-West region are shown in Figure 8-7. It is shown that there are potential demand opportunities available for industrial customers at all stations examined in the region. The potential demand opportunity at Castlebar (10MW) could be viewed as limited when compared with other stations in the North West. Analysis has shown that the Castlebar – Cloon 110kV line[8] could overload as power tries to flow to Castlebar under certain maintenance-trip scenarios (see Chapter 6). The uprate of Castlebar – Cloon 110kV line would allow for more demand opportunity at Castlebar.

[7] Results shown for the North-West region are based on the assumption of the HVDC option being the chosen solution for the Grid West project (see Chapter 2). This assumption was based on the HVDC option providing the least transmission network capacity. It should be noted therefore, that as the project matures and further detailed analysis is carried out, the capability in the area potentially could increase dependent on the final solution chosen.

[8] As of the July 2015 data freeze date this project was still in pre-planning and is therefore not included in demand opportunity studies

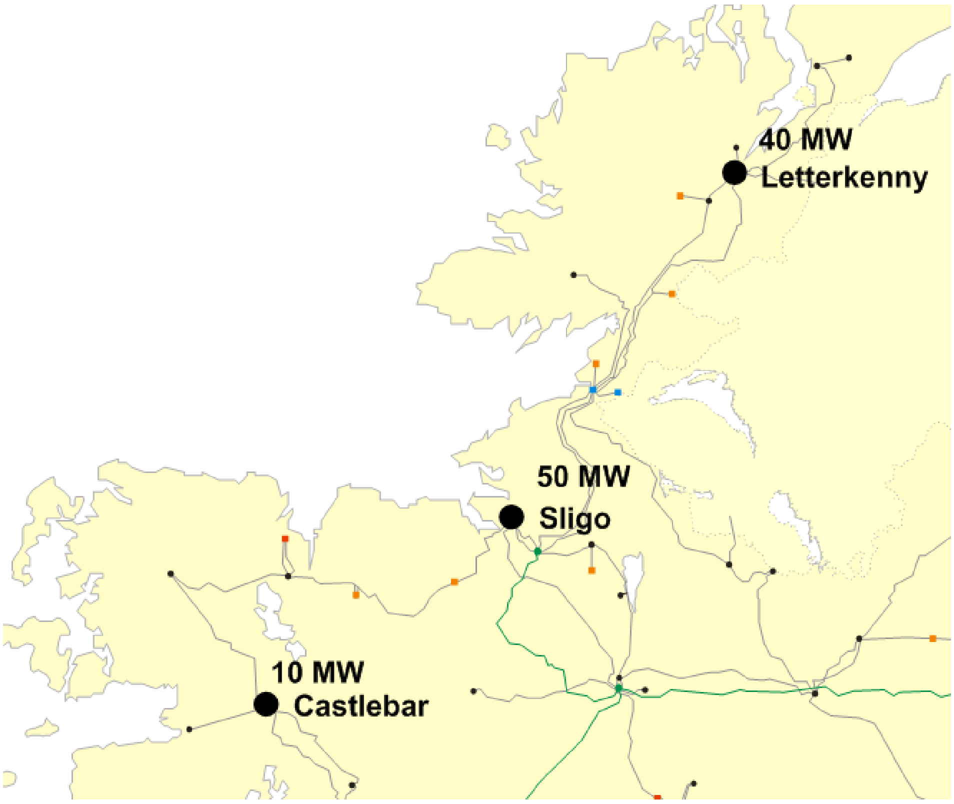


Figure 8-7 Capability for Additional Demand in North-West Region

8.4.4 Incremental Transfer Capability Results for New Demand in the South-East

The demand opportunities available for the South-East region are shown in Figure 8-8. It is shown that there are potential opportunities available for industrial customers at all stations examined in the region. The demand opportunity at Kellis 220kV station is limited to 70MW due to the maintenance-trip scenario (see Chapter 6) where both 220kV lines supplying Kellis are assumed to be out of service.

This scenario means that demand at Kellis 220kV station must be supplied by the underlying 110kV network, which does not have the capacity to carry as much power as the 220kV network. However, should a demand facility wishing to connect at Kellis 220kV station implement a ‘Controllable Demand’ strategy there would be potential for much greater capacity of demand to connect to Kellis 220kV. This is explained further in section 8.5 on ‘Controllable Demand’.

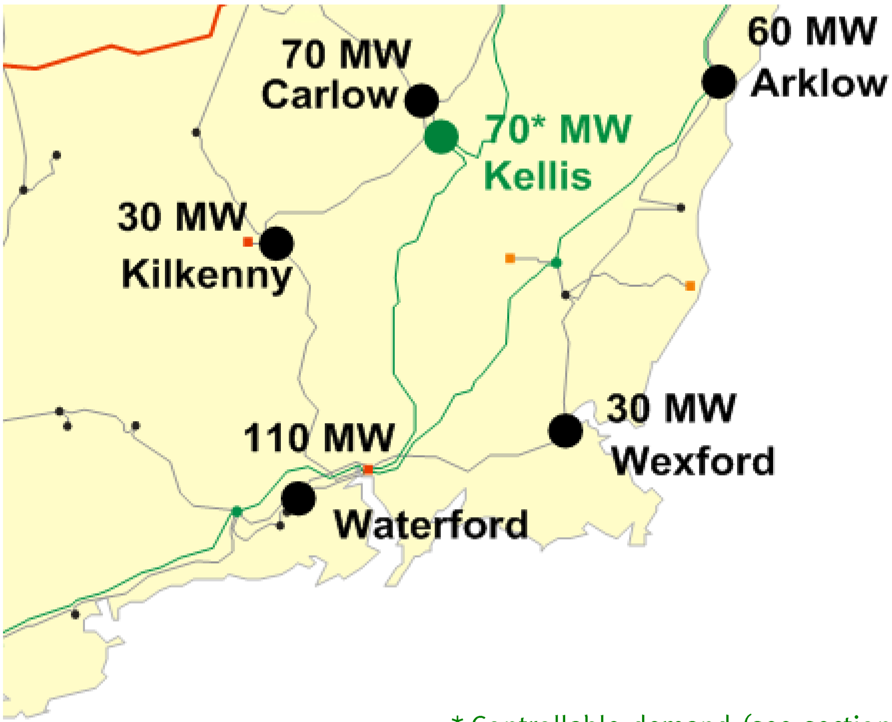


Figure 8-8 Capability for Additional Demand in the South-East Region

8.4.5 Incremental Transfer Capability Results for New Demand in the South-West

The demand opportunities available for the South-West region are shown in Figure 8-9. It can be seen that there are potential opportunities available for industrial customers at all stations examined in the region. In particular the Killonan 220kV station would be a suitable connection point for a major industrial load centre, with the capability of accommodating in excess of 200MW without additional network reinforcements.

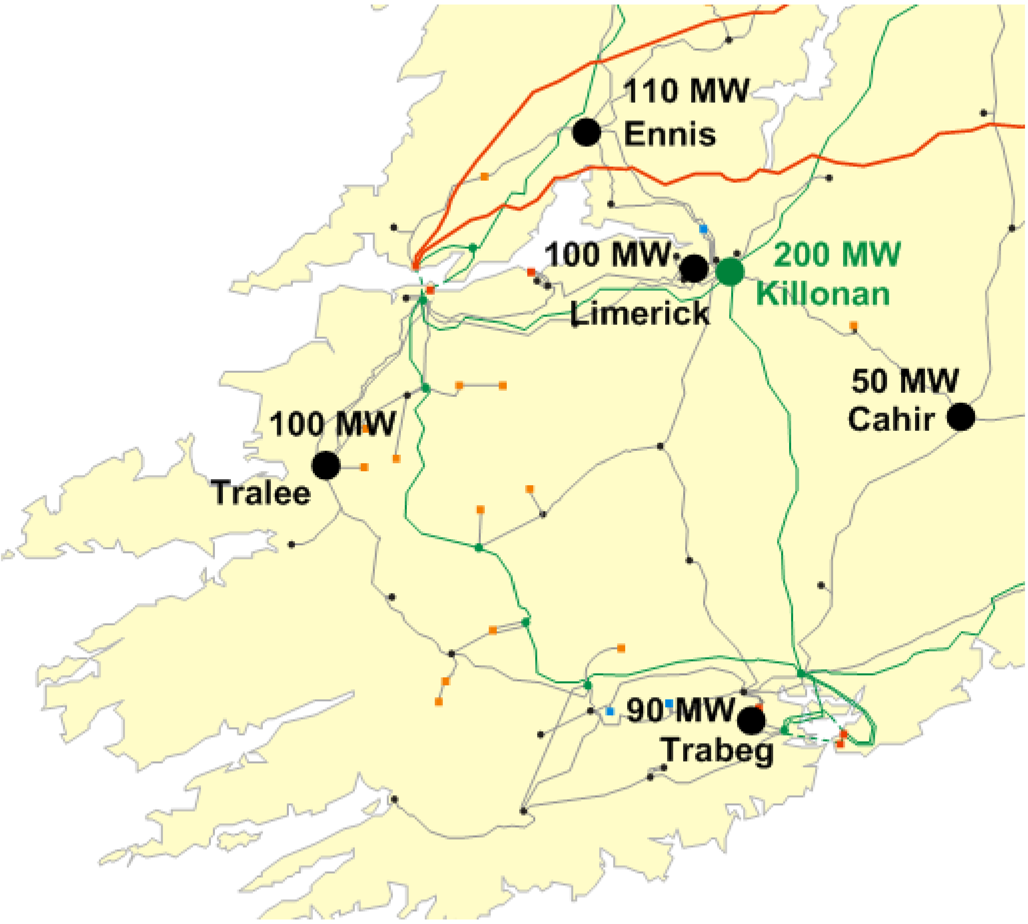


Figure 8-9 Capability for Additional Demand in South-West Region

8.5 Controllable Demand

Section 8.1.5 used Kellis 220kV station as an example to demonstrate the potential to increase the assessed capacity of a station through the concept of 'controllable demand'. In the case of Kellis 220kV station, demand opportunity is limited to 70MW due to a maintenance-trip scenario where both 220kV lines supplying Kellis 220kV station are assumed to be out of service. The next limiting scenario after the outage of both 220kV lines supplying Kellis would allow for much greater demand opportunity at Kellis 220kV station.

Maintenance-trip contingency planning forms part of a suite of contingencies considered by EirGrid for prudent planning of the transmission system. However, it is also recognised in the Transmission Planning Criteria that exposure to maintenance-trip events is much less than the other contingency events considered.

This means that under certain circumstances, potential demand customers may enter an agreement with EirGrid to connect a higher level of demand at a particular station, on the condition that the customer would reduce load if certain contingencies came to fruition.

Using Kellis 220kV station as an example, a potential demand customer may enter an agreement with EirGrid to connect 200MW of load at Kellis, but drop to 70MW if either of the 220kV lines supplying Kellis are out of service.

It should be noted that Kellis has been used as an example however, depending on reliability requirements, this type of agreement may not be suitable for all types of demand facilities or locations. We encourage any potential customers to discuss the possibility of controllable demand with us at an early stage of project planning and development.

8.6 Transmission System Capability for New Demand in Northern Ireland

Demand opportunities available for the Eastern region of Northern Ireland are discussed in section 8.6.1, while section 8.6.2 presents the Western region. Results presented in Section 8.6 are based on the assumptions detailed in Chapter 6.

Readers should be aware that the analysis is based on the year 2020 and includes an assumption that North – South 400 kV tie line is in place. The completion of this new line improves the generation adequacy situation in Northern Ireland and is an important factor when considering the capacity of the system to connect significant amounts of additional demand in Northern Ireland. The All Island Generation Adequacy Statement 2016-2025, published on the EirGrid and SONI websites, describes the overall generation adequacy situation in detail.

8.6.1 Incremental Transfer Capability Results for New Demand in East of Northern Ireland

The demand opportunities available for the East of Northern Ireland are shown in Figure 8-10. It can be seen that there are potential opportunities available for industrial customers at all stations examined in the region.

The majority of 275kV stations in the East of Northern Ireland can accommodate approximately 300MW of additional demand.

Castlereagh and Hannahstown are slightly more limited by thermal overloading on the 110kV network in the central Belfast area. This occurs during the loss of a 275kV circuit supplying either station.

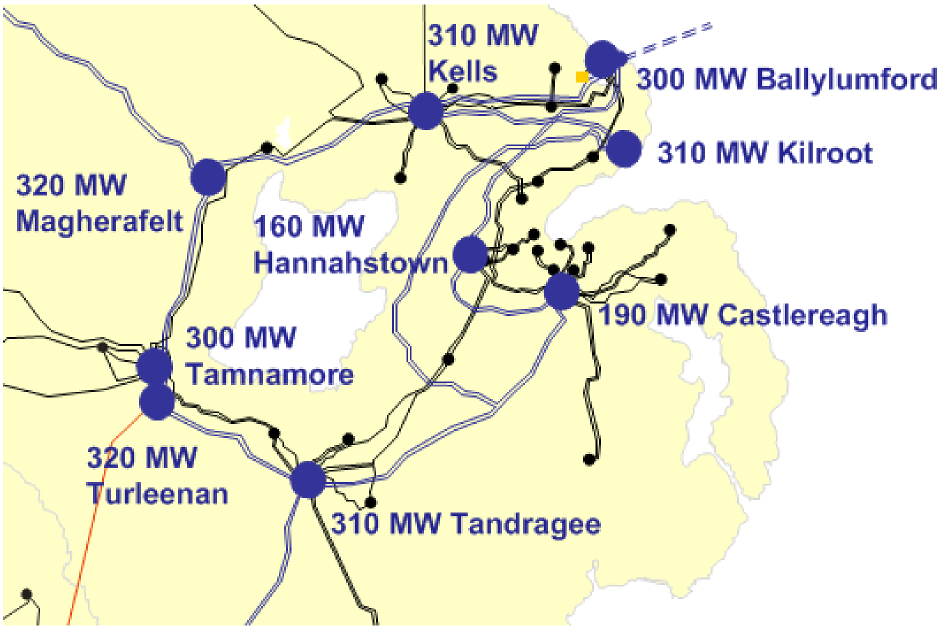


Figure 8-10 Capability for Additional Demand in the East of Northern Ireland

8.6.2 Incremental Transfer Capability Results for New Demand in West of Northern Ireland

The demand opportunities available for the West of Northern Ireland are shown in Figure 8-11. It can be seen that there are potential opportunities available for industrial customers at all stations examined in the region.

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 275kV spur, an N-1-1 contingency is performed as a credible contingency.

Under N-1-1 the demand capability of Coolkeeragh is limited to 120MW following the loss of the Coolkeeragh-Magherafelt 275kV double circuit while the Coolkeeragh steam and gas units are out on maintenance and Coolkeeragh G8 is dispatched.

Enniskillen 110kV station which represents the lowest capability is connected to Omagh South station via two 110kV circuits. The loss of one of these circuits creates a thermal overload on the other which limits demand connection capability.

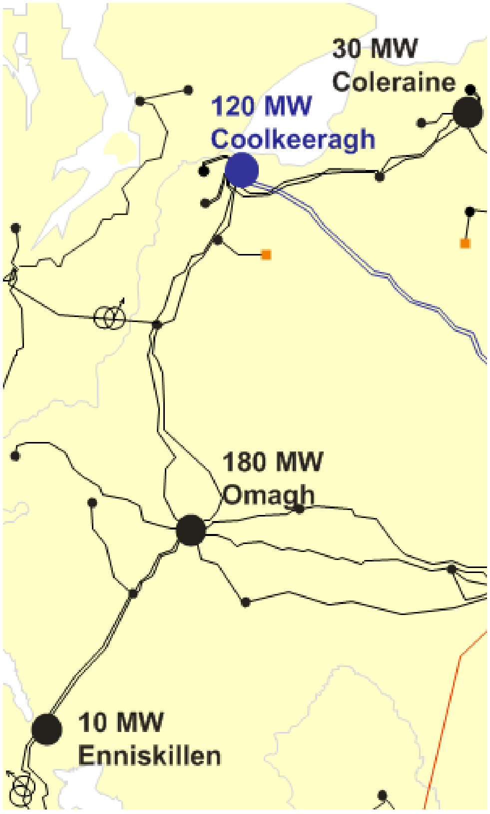


Figure 8-11 Capability for Additional Demand in the West of Northern Ireland

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:

1. 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 (section 8.4 and 8.6) should be identified, where it differs from the nearest transmission station.

2. 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.

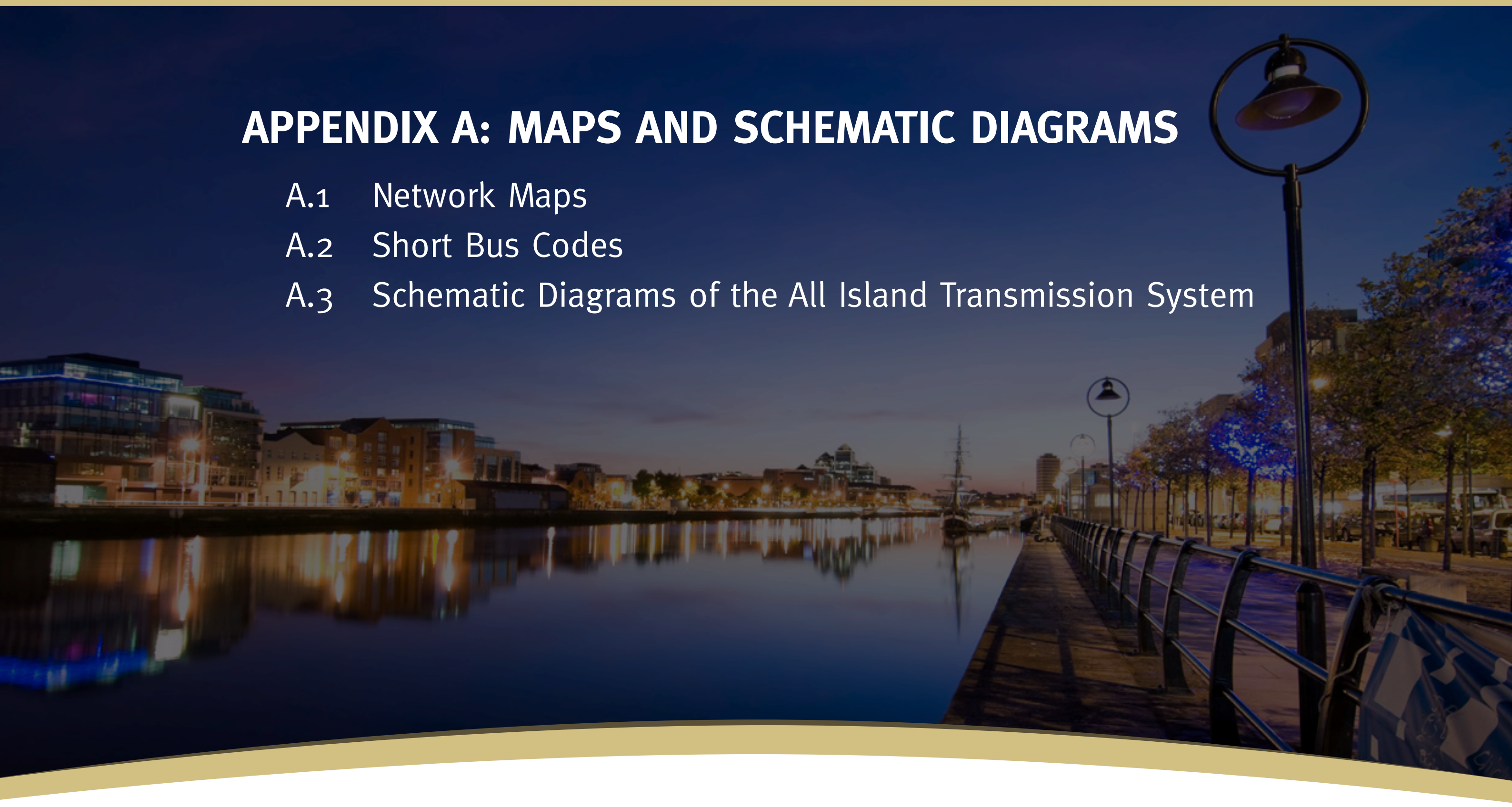
3. Review assumptions in Chapters 2 to 4 and consider the impact of changes to the transmission system since the analysis was carried out.

4. Consult with EirGrid and SONI on the proposed location as early as possible as well as consulting the EirGrid application process[9] and SONI application process[10]

Potential demand customers should not be discouraged by choosing a site in which there appears to be a lack of transmission system capacity. 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.

[9] http://www.eirgridgroup.com/customer-and-industry/becoming-a-customer/

[10] http://www.soni.ltd.uk/Customers/howconnected/



APPENDIX A: MAPS AND SCHEMATIC DIAGRAMS

A.1 Network Maps

A.2 Short Bus Codes

A.3 Schematic Diagrams of the All Island Transmission System

EIRGRID GROUP

The current. The future.

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 as it exists at the beginning October of 2014 and as planned for 2024.

A.1 Network Maps

This section includes two network maps:

- Figure A-1 is a map of the existing All-Island Transmission System as at October 2014;
- Figure A-2 is a map of the existing Transmission System including planned Transmission System developments as at December 31st 2024.

Note: Grid Link, Grid West, The North West Project and The North Connaught Reinforcement are all new devolopments. The solution that will be used for these projects have not yet been finalised. They are shown on the Transmission System Map as a transparent bubble.

Figure A - 1

Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at July 2015

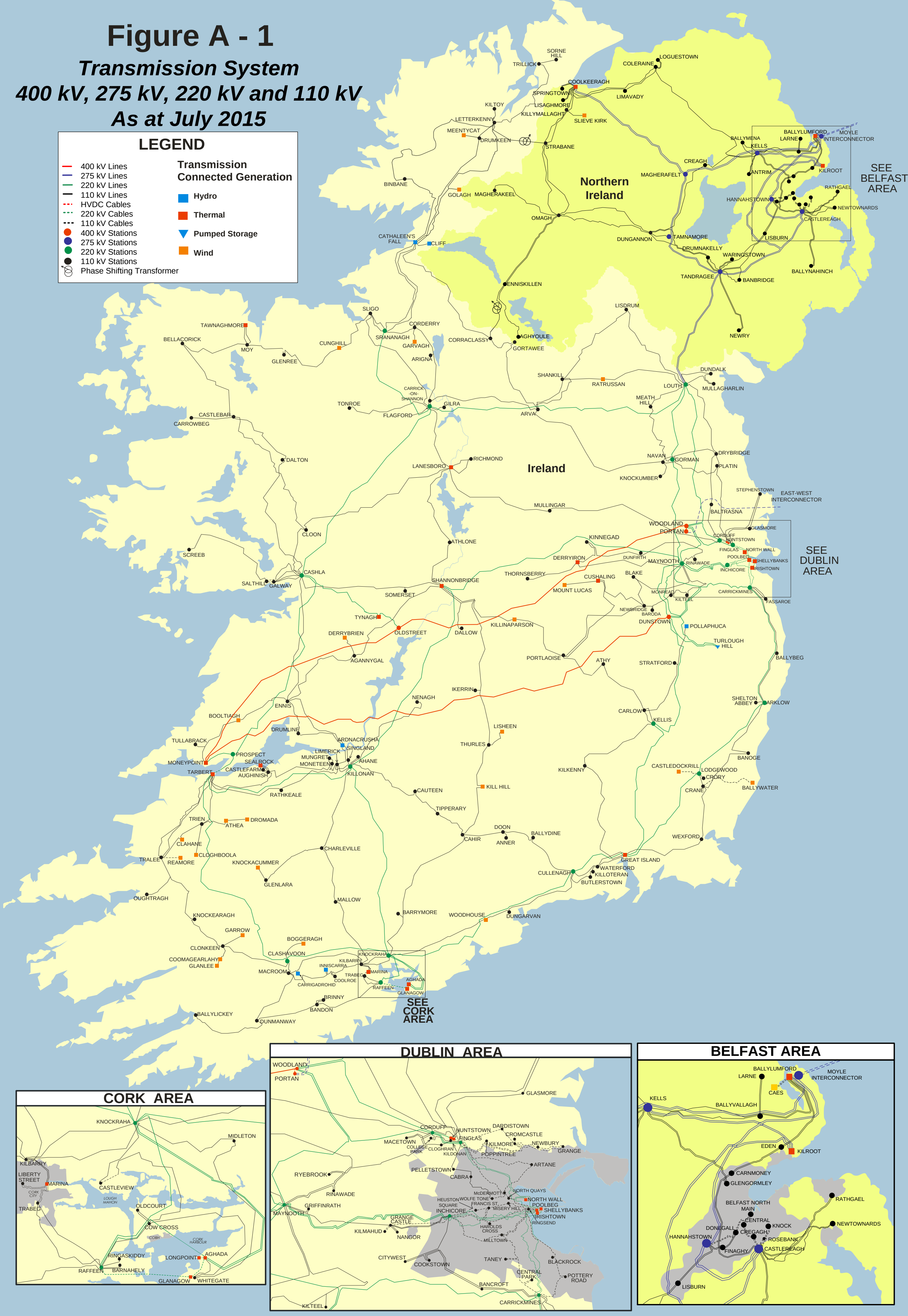


Figure A - 2

Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at Year End 2024

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 diagrams in Appendix I. 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 Main
AGL	Agannygal
AGY	Ardnagappary
AHA	Ahane
AIR	Belfast - Airport Road Main
ANR	Anner
ANT	Antrim Main
ARI	Arigna
ARK	Arklow
ARM	Armagh Main
ART	Artane
ARV	Arva
ATE	Athea
ATH	Athlone
ATY	Athy
AUG	Aughinish
BAL	Baltrasna
BAN (I)	Bandon
BAN (N)	Banbridge Main
BAR	Barrymore
BCM	Ballycummin
BCT	Bancroft
BDA	Baroda
BDN	Ballydine
BDV	Barnadivane
BEG	Ballybeg
BGH	Boggeragh

Short Bus Code	Full Name
BGT	Ballyragget
BIN	Binbane
BK	Bellacorick
BKM	Bunkimalta
BKY	Barnakyle
BLC	Belcamp
BLA	Blackrock
BLI	Ballylickey
BLK	Blake
BLP	Blackpool
BMA	Ballymena Mesh (Rural)
BMA	Ballymena SWBD (Town)
BNH	Ballynahinch Main
BNM	Belfast - Belfast North Main
BOG	Banoge
BOL	Booltiagh
BPS	Ballylumford Power Station
BRA	Bracklone
BRI	Brinny
BRO	Brockaghboy Main
BRY	Barnahely
BUT	Butlerstown
BVG	Ballyvallagh
BVK	Ballyvouskill
BWR	Ballywater
BY	BallaKelly
BYC	Ballycronan More (Moyle)
BYH	Ballynahulla
CAB	Cabra
CAH	Cahir

Short Bus Code	Full Name
CAM	Cam Cluster
CAR	Belfast - Carnmoney Main
CAS	Castlereagh Main
CBG	Carrowbeg
CBL	Cloghboola
CBR	Castlebar
CD	Carrigadrohid
CDK	Castledockrill
CDL	Cordal
CDU	Corduff
CDY	Corderry
CEN	Belfast - Belfast Central Main
CF	Cathaleen's Fall
CFM	Castlefarm
CGL	Coomagearlahy
CHA	Charleville
CHE	Cherrywood
CHR	Cahernagh
CKG	Corkagh
CKM	Carrickmines
CKN	Clonkeen
CL	Cliff
CLA	Clashavoon
CLG	Cloghran
CLH	Clahane
CLN	Cloon
CLO	Clogher
CLW	Carlow
CMK	Curraghmulkin Cluster
COL (I)	College Park

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
COL (N)	Coleraine Main
COO	Cookstown
COR	Corraclassy
COS	Carrick-on-Shannon
COW	Cow Cross
CPK	Central Park
CPS	Coolkeeragh Power Station
CRA	Crane
CRE	Belfast - Cregagh Main
CRF	Cronacarkfree
CRG	Creagh Main
CRM	Cromcastle
CRO	Coolroe
CRY	Crory
CSH	Cashla
CTG	Coomataggart
CTN	Cauteen
CTO	Castletownmoor
CTY	City West
CUI	Cuilleen
CUL	Cullenagh
CUN	Cunghill
CUR	Cureeny
CUS	Cushaling
CVW	Castleview
DAL	Dallow
DDK	Dundalk
DER	Derryiron
DFR	Dunfirth
DGN	Dungarvan
DLN	Derrylyn
DLT	Dalton
DMY	Dunmanway
DON	Belfast - Donegall Main
DOO	Doon
DRM	Drumkeen
DRO	Dromada
DRU (I)	Drumline
DRU(N)	Drumnakelly Main

Short Bus Code	Full Name
DRY	Drybridge
DSN	Dunstown
DTN	Dardistown
DUN	Dungannon Main
DYN	Derrybrien
EDE	Eden Main
ENN (I)	Ennis
ENN (N)	Enniskillen Main
FAS	Fassaroe
FAS E	Fassaroe East
FIN (I)	Finglas
FIN (N)	Belfast - Finaghy Main
FLA	Flagford
FNT	Finnstown
FRN	Francis Street
GAE	Glanlee
GAL	Galway
GAR (I)	Garvagh
GAR (N)	Garvagh Cluster
GCA	Grange Castle
GGO	Glanagow
GI	Great Island
GIL	Gilra
GLA	Glasmore
GLE (I)	Glenlara
GLE (N)	Belfast - Glengormley Main
GLR	Glenree
GLT	Glentanemacelligot
GOL	Golagh
GOR (I)	Gorman
GOR (N)	Gort Cluster
GRA	Grange
GRI	Griffinrath
GRO	Garrow
GWE	Gortawee
HAN	Hannastown
HAR	Harolds Cross
HEU	Heuston Square
HN	Huntstown

Short Bus Code	Full Name
HTS	Hartnett's Cross
IA	Inniscarra
IKE	Ikerrin
INC	Inchicore
ISH	Irishtown
KBY	Kilbarry
KCR	Knockacummer
KDN	Kildonan
KEL	Kells Main
KER	Knockearagh
KHL	Kill Hill
KIN	Kinnegad
KKY	Kilkenny
KLM	Kilmore
KLN	Killonan
KLS	Kellis
KLW	Kells Wind Cluster
KMT	Killymallaght
KNO	Belfast - Knock Main
KNR	Knockanure
KNV	Knockavanna
KNY	Knockranny
KPG	Kilpaddoge
KPN	Killinaparson
KPS	Kilroot Power Station
KRA	Knockraha
KTL	Kilteel
KTN	Killoteran
KUD	Kilmahud
KUR	Knockumber
LA	Lanesboro
LAR	Larne Main
LET	Letterkenny
LIB	Liberty Street
LIM (I)	Limerick
LIM (N)	Limavady Main
LIS (I)	Lisdrum
LIS (N)	Lisburn Main
LMR	Lisaghmore Main

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
LOG	Loguestown Main
LOU	Louth
LPT	Longpoint
LSE	Laois
LSN	Lisheen
LWD	Lodgewood
MAC	Macroom
MAG	Magherafelt
MAL	Mallow
MAY	Maynooth
MCD	McDermott
MCE	Macetown
MEE	Meentycat
MID	Midleton
MHL	Misery Hill
MIL	Milltown
MKL	Magherakeel Cluster
MLC	Mountlucas
MLN	Mullagharlin
MON	Monread
MOY	Moy
MP	Moneypoint
MR	Marina
MRY	Mulreavy
MTH	Meath Hill
MTN	Moneteen
MUL	Mullingar
MUN	Mungret
NAN (I)	Nangor
NAR	Newtownards Main
NAV	Navan
NBY	Newbury
NEN	Nenagh
NEW (I)	Newbridge
NEW (N)	Newry Main
NMO	North Mayo
NO	Nore
NQS	North Quays
NST	Newtownstewart Cluster
NW	North Wall

Short Bus Code	Full Name
OLD	Oldcourt
OMA	Omagh Main
OMS	Omagh South Main
ORL	Oriel
OST	Oldstreet
OUG	Oughtragh
OWN	Oweninney
PA	Pollaphuca
PB	Poolbeg
PLA	Platin
PLS	Portlaoise
POP	Poppintree
PRT	Portan
POT	Pottery Road
PRO	Prospect
PTN	Pelletstown
RAF	Raffeen
RAT (I)	Rathkeale
RAT (N)	Rathgael Main
RE	Ringsend
REM	Reamore
RIC	Richmond
RNW	Rinawade
ROS	Belfast - Rosebank Main
RRU	Ratrussan
RSK	Rasharkin Cluster
RSY	Ringaskiddy
RYB	Ryebrook
SAL	Salthill
SBN	Strabane
SCR	Screeb
SH	Shannonbridge
SHE	Shelton Abbey
SHL	Shellybanks
SK	Sealrock
SKL	Shankill
SLI	Sligo
SLB	Sliabh Bawn
SLK	Slieve Kirk
SNG	Singland

Short Bus Code	Full Name
SOM	Somerset
SOR	Sorne Hill
SPR	Springtown Main
SRA	Srananagh
STR (I)	Stratford
STR (N)	Strabane Main
SUR	Suir
SVN	Stevenstown
TAN	Tandragee
TAW	Tawnaghmore
TB	Tarbert
TBG	Trabeg
TBK	Tullabrack
TH	Turlough Hill
THU	Thurles
TID	Tidal
TIP	Tipperary
TIV	Tievebrack
TLK	Trillick
TLY	Tanley
TMN	Tamnamore
TON	Tonroe
TRE	Tremoge Cluster
TRI	Trien
TRL	Tralee
TRN	Trinity
TSB	Thornsberry
TUR	Turleenan
TYN	Tynagh
UGL	Uggool
WAR	Waringstown Main
WAT	Waterford
WDU	West Dublin
WEX	Wexford
WH	Woodhouse
WHI	Whitegate
WOL	Wolfe Tone
WOO	Woodland

A.3 Schematic Diagrams of the All Island Transmission System

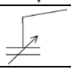
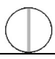
Appendix A Schematic diagrams of the Transmission System of Ireland are included to assist users in understanding the Transmission System and in the identification of the changes outlined in Appendix B. Lines, cables, transformers, station busbars and reactive compensation devices are illustrated in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

Appendix B The schematic diagram for 2015 highlights the developments due to be completed by July 2015. The schematic diagram for 2024 highlights the developments due to be completed by the end of 2024.

Appendix C In the 2024 diagram blue shading represents a new development since summer 2015.

Appendix D In all diagrams orange shading denotes a circuit uprating. In the 2015 diagram this is any uprate that has occurred since winter 2014. In the 2024 diagrams this is any uprate between summer 2015 and the end of 2024.

Table A-2 Schematic Legend

Appendix E Symbol	Appendix F 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 (>5MW)
	Busbar with Hydro Generation
	Busbar with Solar Generation
	Compressed Air and Energy Storage (CAES)
	Busbar with Wind and Thermal Generation
	Busbar with Wind and Hydro Generation
	Busbar with Wind and Solar Generation
	Busbar with Tidal Generation
	Capacitor
	Static Var Compensator (SVC)
	Reactor
	Phase Shifting Transformer
	Double-Wound Transformer
	Auto-Transformer
	Split Busbar
	Busbar Operated as Split
—— NO ——	Normally Open Point

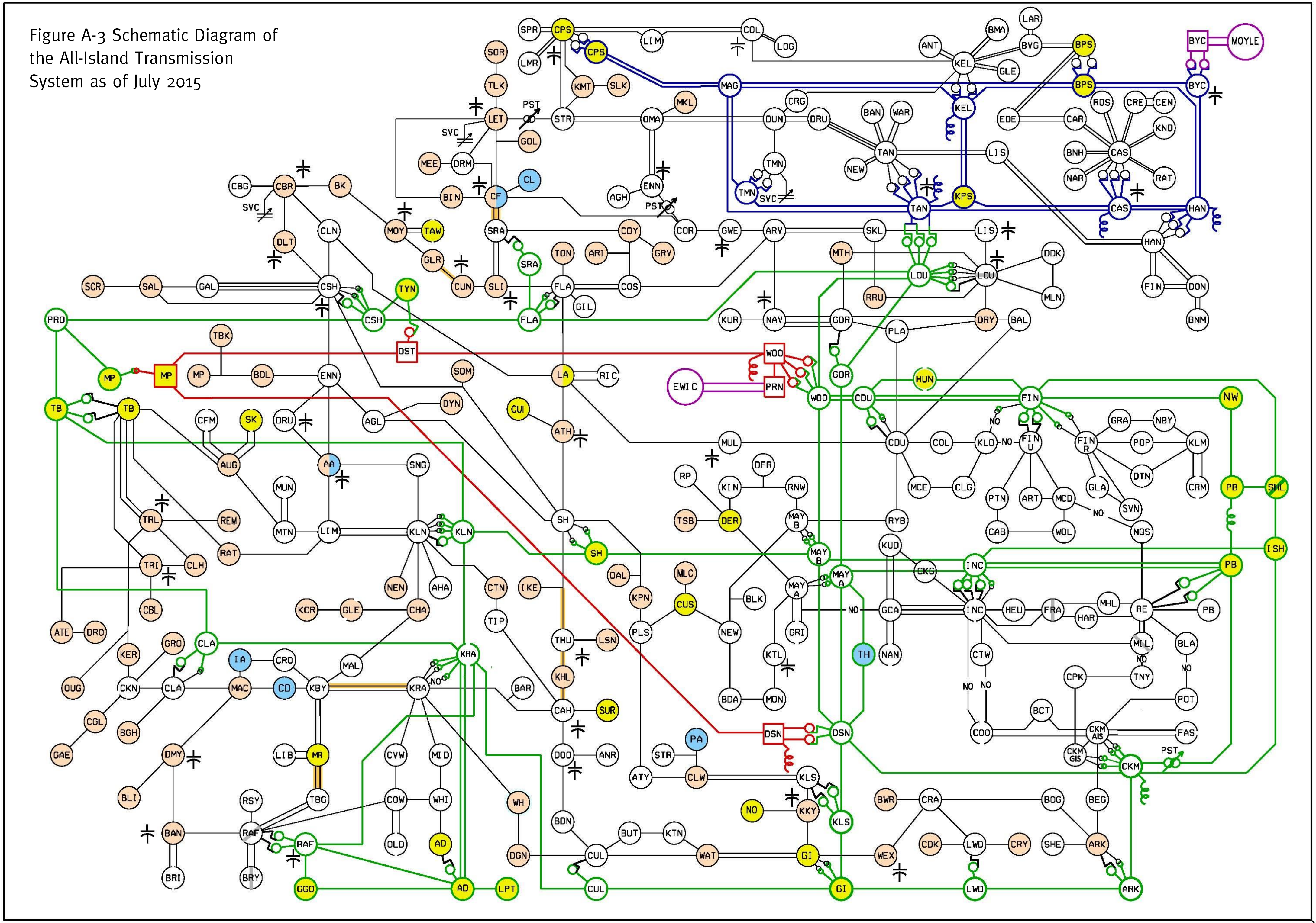


Figure A-3 Schematic Diagram of the All-Island Transmission System as of July 2015

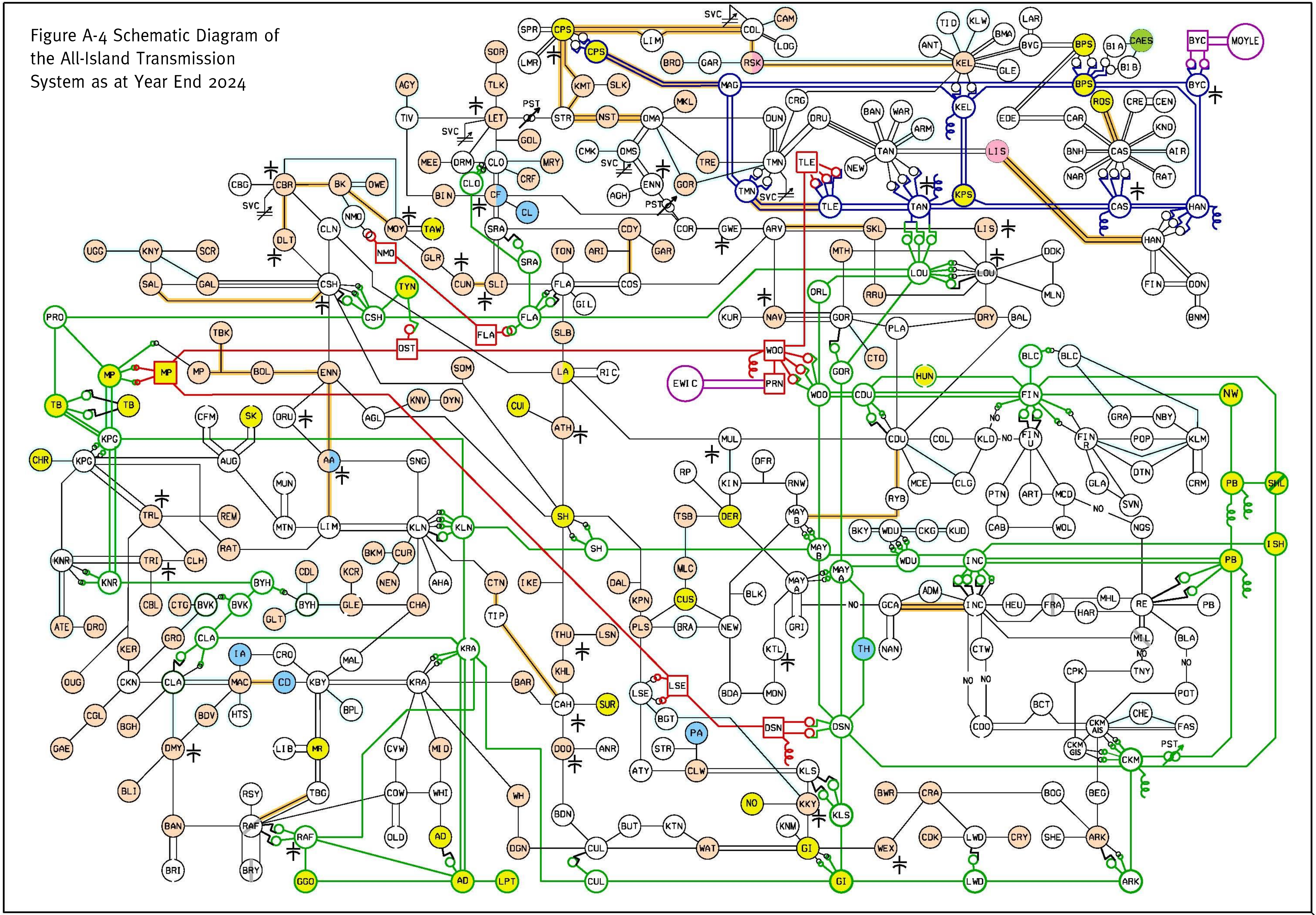
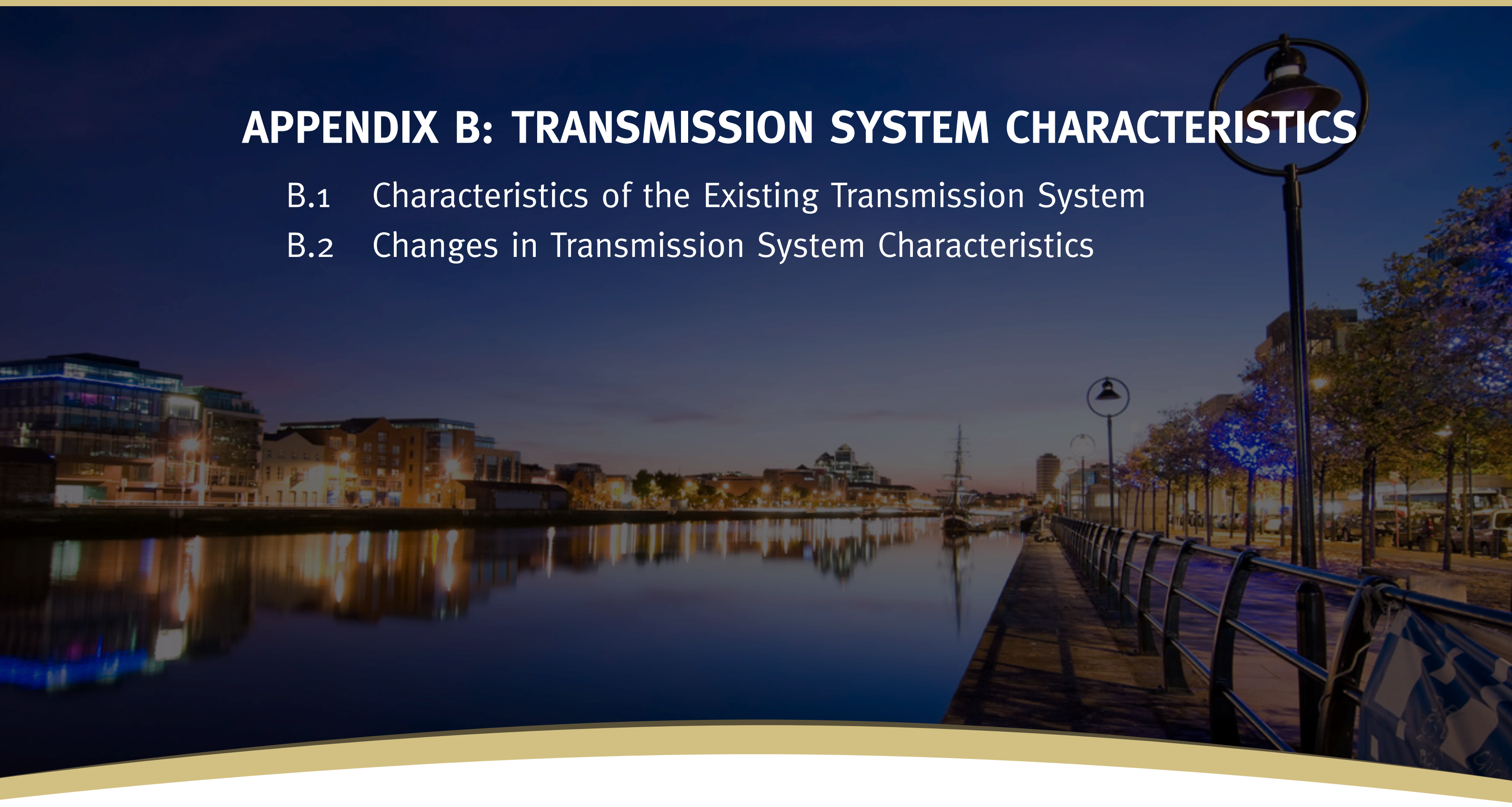


Figure A-4 Schematic Diagram of the All-Island Transmission System as at Year End 2024



APPENDIX B: TRANSMISSION SYSTEM CHARACTERISTICS

EIRGRID GROUP

The current. The future.

Appendix B Transmission System Characteristics

This appendix presents details of the physical and electrical characteristics of the all-island transmission system in tabular form. Data for the existing transmission system is presented first, followed by the data for planned transmission system developments.

The planned developments include transmission system reinforcement projects that have been selected by the TSOs. It also includes developments necessary to connect new generation and demands to the transmission system as at the beginning of October and December 2014.

Readers should refer to Section 1.4 in Chapter 1 of the main text to obtain information on projects approved since the respective data freeze dates.

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

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

Tables B-2 to B-5 and Tables B-12 to B-17 include the ratings for lines and cables in MVA for winter and summer reference temperature conditions at 1 per unit (p.u.) 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 - 5°C;

summer - 25°C.

Appendix G The electrical characteristics of the all-island transmission system at the four nominal voltage levels are quoted. They are in per unit to an MVA base of 100, and the applicable reference voltage as reflected in Table 8-1.

Table B-1 Nominal and Reference Voltage Levels

Nominal Voltage Level	Reference Voltage
400 kV	380 kV
275 kV	275 kV
220 kV	220 kV
110 kV	110 kV

In some cases, other equipment associated with a line or cable, such as current transformers, may have lower ratings. However, as these are easier to uprate or change out than the line or cable, they are not expected to restrict access to the transmission system.

Historically, a small number of 110 kV stations were 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, the tee point is identified by the name of the teed 110 kV station with a suffix “T” added.

B.1 Characteristics of the Existing Transmission System

Table B-2 Characteristics of Existing 400 kV Lines

400 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
DSN	MP	1	208.5	0.004	0.047	1.049	1577	1944
MP	OST	1	105.0	0.002	0.023	0.530	1577	1944
OST	WOO	1	125.0	0.0024	0.028	0.631	1577	1944
WOO	PRN	1	0.5	0	0	0.043	685	685

Table B-3 Characteristics of Existing 275 kV Lines and Cables

275 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
LOU	TAN	1	49.8	0.003	0.021	0.127	710	820	881
LOU	TAN	2	49.8	0.003	0.021	0.127	710	820	881
BPS	HAN	2	45.5	0.002	0.019	0.114	710	820	881
BPS	KEL	1	34.5	0.002	0.014	0.089	710	820	881
BPS	MAG	1	65.5	0.003	0.027	0.169	710	820	881
BPS	BYC	1	0.8	0.000	0.000	0.002	710	820	881
CACO2A	CPS	1	0.2	0.000	0.000	0.040	761	761	837
CACO2A	MAG	1	56.0	0.006	0.025	0.151	412	477	513
CACO2B	CPS	1	0.2	0.000	0.000	0.034	761	761	837
CACO2B	MAG	1	56.0	0.006	0.025	0.151	412	477	513
CAS	HAN	1	18.4	0.001	0.008	0.046	710	820	881
CAS	HAN	2	18.4	0.001	0.008	0.046	710	820	881
CAS	KPS	1	66.8	0.003	0.028	0.171	710	820	881
CAS	TAN	1	45.6	0.002	0.019	0.114	710	820	881
HAN	BYC	1	44.7	0.002	0.019	0.112	710	820	881
KEL	KPS	1	29.0	0.001	0.012	0.075	710	820	881
KEL	KPS	2	29.0	0.001	0.012	0.075	710	820	881
KEL	MAG	1	31.1	0.001	0.013	0.080	710	820	881
KPS	TAN	1	80.8	0.004	0.034	0.206	710	820	881
MAG	TAN	1	51.6	0.002	0.022	0.129	710	820	881
MAG	TMN	1	25.8	0.001	0.011	0.065	710	820	881
TAN	TMN	1	25.8	0.001	0.011	0.065	710	820	881

Table B-4 Characteristics of Existing 220 kV Lines and Cables

220 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
AD	AD	1	1.4	0.000	0.001	0.038	593	593
AD	KRA	1	25.6	0.003	0.022	0.034	434	534
AD	RAF	1	15.2	0.001	0.009	0.245	434	534
AD	LPT	1	1.0	0.000	0.000	0.027	593	593
AD	GGO	1	3.8	0.000	0.002	0.104	593	593
AD	KRA	2	25.6	0.003	0.022	0.034	434	534
ARK	CKM	1	53.3	0.006	0.046	0.070	434	534
ARK	LWD	1	39.0	0.005	0.034	0.051	434	534
CLA	KRA	1	45.0	0.006	0.039	0.061	644	788
CLA	TB	1	97.3	0.011	0.084	0.127	476	476
CSH	FLA	1	88.1	0.010	0.076	0.115	405	405
CSH	PRO	1	88.5	0.010	0.077	0.116	392	482
CSH	TYN	1	33.8	0.005	0.029	0.046	761	804
CKM	DSN	1	41.6	0.005	0.036	0.054	434	534
CKM	ISH	1	11.5	0.000	0.005	0.315	593	593
CUL	GI	1	23.3	0.003	0.020	0.045	761	804
CUL	KRA	1	86.0	0.012	0.074	0.117	761	804
CDU	FIN(I)	1	3.7	0.001	0.003	0.005	434	534
CDU	HN	1	4.5	0.000	0.002	0.123	593	593
CDU	WOO	1	18.4	0.002	0.016	0.024	434	534
CDU	FIN(I)	2	3.7	0.001	0.003	0.005	434	534
CDU	WOO	2	17.8	0.002	0.016	0.023	434	534
DSN	KLS	1	59.3	0.007	0.051	0.077	434	534
DSN	MAY	1	36.3	0.004	0.032	0.048	434	534
DSN	MAY	2	30.6	0.004	0.027	0.040	434	534
DSN	TH	1	26.6	0.003	0.022	0.144	351	351
FLA	LOU	1	110.1	0.013	0.095	0.144	434	534
FLA	SRA	1	55.0	0.006	0.048	0.072	434	534
FIN(I)	HN	1	1.4	0.000	0.001	0.038	593	593
FIN(I)	SHL	1	13.4	0.001	0.005	0.367	593	593
FIN(I)	NW	1	11.9	0.001	0.004	0.680	332	332
GI	KLS	1	69.3	0.008	0.060	0.091	434	534
GOR (I)	LOU	1	32.4	0.004	0.028	0.042	434	534
GOR (I)	MAY	1	42.2	0.005	0.037	0.055	434	534
GGO	RAF	1	9.5	0.000	0.005	0.414	593	593
INC	ISH	1	12.1	0.000	0.005	0.330	593	593
INC	MAY	2	19.2	0.003	0.017	0.025	548	548
ISH	SHL	1	1.3	0.000	0.001	0.036	593	593
KRA	KLN	1	82.4	0.015	0.073	0.107	512	565

Table B-4 Characteristics of Existing 220 kV Lines and Cables (continued)

220 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
KRA	RAF	1	23.4	0.003	0.020	0.031	353	454
KLN	SH	1	89.7	0.014	0.080	0.115	269	377
KLN	TB	1	70.6	0.008	0.061	0.092	434	534
LOU	WOO	1	61.2	0.007	0.053	0.080	405	454
MAY	TH	1	53.1	0.006	0.044	0.184	351	351
MAY	INC	1	19.1	0.003	0.016	0.026	793	833
MAY	SH	1	105.6	0.017	0.094	0.135	269	377
MAY	WOO	1	22.3	0.003	0.020	0.030	434	534
MP	PRO	1	12.7	0.001	0.009	0.021	868	1070
NW	PB	1	4.5	0.000	0.001	0.261	332	332
OST	TYN	1	14.5	0.002	0.013	0.019	434	534
PB	SHL	1	0.1	0.000	0.000	0.003	593	593
PB	INC	1	12.5	0.001	0.004	0.504	267	267
PB	INC	2	11.3	0.001	0.003	0.722	267	351
PRO	TB	1	10.3	0.001	0.007	0.173	467	467

Table B-5 Characteristics of Existing 110 kV Lines and Cables

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
AA	DRU (I)	1	18.4	0.029	0.067	0.006	99		125
AA	ENN (I)	1	32.9	0.051	0.114	0.012	99		124
AA	LIM (I)	1	11.7	0.007	0.037	0.012	99		125
AD	WHI	1	3.1	0.005	0.011	0.001	99		125
AGH	ENN(N)	1	31.1	0.039	0.095	0.019	109	119	124
AGL	DYN	1	8.0	0.013	0.028	0.003	105		128
AGL	KEE	1	38.2	0.059	0.131	0.012	99		128
AGL	SH	1	46.2	0.072	0.159	0.015	105		128
AHA	KLN	1	3.8	0.004	0.012	0.004	112		112
ANR	DOO	1	2.0	0.003	0.007	0.001	105		128
ANT	KEL	1	8.9	0.012	0.030	0.003	82	95	103
ANT	KEL	2	8.9	0.012	0.030	0.003	82	95	103
ARI	ARI T	1	0.2	0.000	0.001	0.000	105		128
ARK	BEG	1	21.9	0.010	0.079	0.007	136		166
ARK	BOG	1	29.0	0.021	0.095	0.010	178		219
ARK	SHE	2	2.2	0.004	0.008	0.001	34		57
ART	FIN (I)	1	9.0	0.005	0.010	0.055	120		131
ART	MCD	1	4.9	0.003	0.006	0.030	120		131
ARV	COS	1	43	0.067	0.148	0.014	99		125
ARV	GWE	1	30.6	0.019	0.099	0.011	178		219
ARV	NAV	1	65.5	0.041	0.213	0.023	178		219
ARV	SKL	1	18.6	0.029	0.065	0.006	80		110
ARV	SKL	2	23.6	0.015	0.076	0.010	80		219
ATE	DRO	1	5.5	0.003	0.003	0.064	140		140
ATH	CUI	1	2.3	0.002	0.003	0.023	140		140
ATH	LA	1	35.8	0.054	0.123	0.012	105		128
ATH	SH	1	21.6	0.014	0.070	0.011	178		219
ATY	CLW	1	25	0.039	0.086	0.008	99		125
ATY	PLS	1	26.6	0.041	0.092	0.009	99		125
AUG	CFM	1	0.7	0.001	0.002	0.001	96		96
AUG	CFM	2	0.7	0.001	0.002	0.001	96		96
AUG	MTN	1	27.5	0.017	0.089	0.010	178		219
AUG	SK	3	1	0.001	0.001	0.006	120		131
AUG	SK	4	1	0.001	0.001	0.006	120		131
AUG	TB	1	34	0.021	0.111	0.012	152		152
BAL	CDU	1	16.8	0.011	0.055	0.006	178		219
BAL	DRY	1	20	0.013	0.065	0.007	178		219
BAN (I)	BRI	1	2.6	0.004	0.009	0.001	105		128
BAN (I)	BRI	2	2.5	0.004	0.009	0.001	105		128

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
BAN (I)	DMY	1	25.9	0.040	0.089	0.008	99		125
BAN (I)	RAF	1	26.9	0.041	0.091	0.012	105		128
BAN (N)	TAN	1	18.4	0.024	0.062	0.006	82	95	103
BAN (N)	TAN	2	14.2	0.019	0.049	0.005	82	95	103
BAR	BAR T	1	0.3	0.000	0.001	0.000	136		166
BCT	CKM	1	3.1	0.002	0.005	0.031	140		140
BDA	MON	1	12.5	0.012	0.037	0.031	99		124
BDA	NEW (I)	1	7.9	0.007	0.021	0.030	120		124
BDN	CUL	1	21.8	0.031	0.075	0.007	196		222
BDN	DOO	1	11.3	0.00	0.037	0.004	178		219
BEG	CKM	1	32.3	0.015	0.116	0.010	136		166
BGH	CLA	1	13.5	0.008	0.040	0.039	178		219
BIN	CF	1	34.3	0.053	0.118	0.011	105		128
BK	CBR	1	37.4	0.058	0.128	0.013	99		125
BK	MOY	1	27	0.042	0.093	0.009	99		114
BLA	POT	1	5.2	0.002	0.004	0.092	119		119
BLA	RE	1	7.7	0.003	0.006	0.136	119		119
BLI	DMY	1	27.6	0.043	0.094	0.010	105		128
BLK	BLK T	1	0.5	0.001	0.002	0.000	136		166
BMA	KEL	1	10	0.013	0.035	0.003	109	119	124
BMA	KEL	2	11.5	0.015	0.040	0.004	109	119	124
BNH	CAS	1	21.2	0.028	0.071	0.007	82	95	103
BNH	CAS	2	21.2	0.028	0.071	0.007	82	95	103
BOG	CRA	1	24.7	0.018	0.081	0.009	178		219
BOL	ENN (I)	1	24	0.037	0.083	0.008	105		128
BOL	TBK T	1	19.6	0.031	0.067	0.006	105		128
BPS	BVG	1	17.3	0.023	0.058	0.006	82	95	103
BPS	BVG	2	17.3	0.023	0.058	0.006	82	95	103
BPS	EDE	1	15.1	0.023	0.054	0.005	69	80	86
BPS	EDE	2	15.1	0.023	0.053	0.005	70	81	87
BRY	RAF	1	1.7	0.003	0.006	0.001	63		99
BRY	RAF	2	1.8	0.002	0.006	0.001	105		128
BUT	CUL	1	12.3	0.08	0.04	0.013	178		219
BUT	KTN	1	2.7	0.004	0.010	0.001	200		221
BVG	KEL	1	21.2	0.028	0.073	0.007	109	119	124
BVG	KEL	2	20.3	0.027	0.070	0.007	109	119	124
BVG	LAR	1	7.1	0.007	0.023	0.002	79	96	113
BVG	LAR	2	7.1	0.007	0.023	0.002	79	96	113

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
BWR	CRA	1	21.9	0.011	0.030	0.137	116		116
CAB	PTN	1	2.7	0.002	0.007	0.005	80		129
CAB	WOL	1	4.7	0.003	0.005	0.029	120		131
CAH	BAR T	1	43.7	0.065	0.150	0.014	105		128
CAH	DOO	1	15.7	0.010	0.051	0.006	178		219
CAH	KHL	1	21.8	0.013	0.066	0.033	178		219
CAH	TIP	1	18.1	0.011	0.059	0.006	105		219
CAR	CAS	1	24.7	0.037	0.088	0.008	69	80	86
CAR	CAS	2	24.7	0.037	0.086	0.008	70	81	87
CAR	EDE	1	12.4	0.019	0.043	0.004	70	81	87
CAR	EDE	2	12.4	0.019	0.044	0.004	69	80	86
CAS	CRE	1	3	0.001	0.004	0.061	132	132	145
CAS	CRE	2	3	0.001	0.004	0.061	132	132	145
CAS	KNO	2	4.5	0.005	0.004	0.044	66	66	73
CAS	NAR	1	18	0.015	0.040	0.071	109	119	124
CAS	NAR	2	19.8	0.018	0.046	0.070	109	119	124
CAS	RAT (N)	1	18.9	0.025	0.064	0.006	82	95	103
CAS	RAT (N)	2	18.9	0.025	0.064	0.006	82	95	103
CAS	ROS	1	1.9	0.001	0.002	0.026	117	117	128
CAS	ROS	2	1.9	0.001	0.002	0.026	117	117	128
CBL	TRI	1	13.8	0.009	0.029	0.090	124		124
CBR	CBG	1	26.5	0.038	0.083	0.052	99		124
CBR	CLN	1	57.5	0.089	0.198	0.020	99		125
CBR	DLT	1	27.8	0.043	0.096	0.009	90		95
CD	KBY	1	32.1	0.020	0.104	0.011	178		219
CD	MAC	1	2.4	0.004	0.008	0.001	99		219
CDK	LWD	1	6.6	0.003	0.009	0.041	116		116
CDU	MUL	1	73.3	0.088	0.237	0.041	105		128
CDU	PLA	1	37	0.023	0.120	0.013	178		219
CDU	RYB	1	13	0.014	0.043	0.005	178		219
CDY	ARI T	1	13.7	0.014	0.046	0.005	136		166
CDY	GRV	1	7.3	0.005	0.024	0.003	178		219
CDY	SRA	1	12.7	0.020	0.044	0.004	99		125
CEN	CRE	1	4.2	0.001	0.004	0.030	144	144	144
CEN	CRE	2	4.2	0.001	0.004	0.030	144	144	144
CF	CL	1	5.5	0.006	0.018	0.002	178		219
CF	COR	1	61.3	0.039	0.199	0.022	178		219
CF	DRM	1	51.3	0.077	0.176	0.017	99		125

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
CF	GOL T	1	25.5	0.036	0.093	0.009	196		222
CF	SRA	1	53	0.065	0.179	0.021	187		190
CGL	BVK	1	30	0.019	0.098	0.011	178		219
CGL	CKN	1	6.3	0.004	0.021	0.002	178		219
CGL	GAE	1	2	0.001	0.003	0.015	130		130
CHA	GLE (I)	1	30	0.047	0.103	0.010	105		128
CKM	CPK	1	0.1	0.000	0.000	0.000	136		166
CKM	POT	1	3.2	0.001	0.003	0.057	119		119
CKN	KER	1	20.3	0.013	0.066	0.007	178		219
CLA	CKN	1	29.8	0.019	0.097	0.011	178		219
CLA	MAC	1	5.7	0.004	0.018	0.002	160		196
CLG	KDN	1	3.6	0.004	0.011	0.007	124		124
CLG	MCE	1	4.7	0.005	0.015	0.005	99		125
CLH	TRI	1	9	0.014	0.031	0.003	99		125
CLH	TRL	1	13.5	0.020	0.045	0.025	105		128
CLN	LA	1	64.8	0.095	0.222	0.021	99		125
CLW	KLS	1	5.4	0.008	0.019	0.002	99		125
CLW	KLS	2	5.3	0.008	0.019	0.002	99		125
CLW	STR (I)	1	17.6	0.027	0.061	0.006	105		128
COL (I)	CDU	1	2.7	0.001	0.004	0.020	130		130
COL (I)	KDN	1	5	0.003	0.013	0.037	104		124
COL (N)	CPS	1	46.7	0.061	0.161	0.015	82	95	103
COL (N)	KEL	1	58.9	0.067	0.201	0.020	109	119	124
COL (N)	LIM (N)	1	18.6	0.024	0.064	0.006	82	95	103
COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
COL (N)	LOG	2	8.1	0.011	0.027	0.003	82	95	103
COO	BCT	1	15.1	0.014	0.045	0.027	130		130
COO	CKM	2	16	0.013	0.042	0.060	130		130
COR	ENN(I)	1	27.5	0.043	0.095	0.009	105		128
COR	GWE	1	10.9	0.007	0.036	0.004	161		196
COS	ARI T	1	20.7	0.022	0.069	0.007	120		128
COS	FLA	1	3.4	0.005	0.012	0.001	99		125
COS	FLA	2	3.4	0.005	0.011	0.001	99		125
COW	CVW	1	17.2	0.025	0.054	0.018	99		125
COW	OLD	1	2.3	0.004	0.008	0.001	105		128
COW	OLD	2	2.2	0.003	0.008	0.001	105		128
COW	RAF	1	6.9	0.010	0.024	0.003	99		125
COW	WHI	1	17.8	0.027	0.062	0.006	105		128

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
CPK	TLY	1	5.6	0.003	0.006	0.073	100		100
CPK	CPK T	1	3.4	0.002	0.004	0.025	100		100
CPS	KMT	1	14.5	0.011	0.048	0.005	143	158	166
CPS	LIM (N)	1	29.5	0.039	0.101	0.010	82	95	103
CPS	LMR	1	9	0.012	0.030	0.003	82	95	103
CPS	LMR	1	9	0.012	0.030	0.003	82	95	103
CPS	SPR	1	9.2	0.011	0.029	0.012	82	95	103
CPS	SPR	2	9.4	0.011	0.029	0.013	82	95	103
CPS	STR (N)	1	27	0.018	0.053	0.017	143	158	166
CRA	LWD	1	8	0.005	0.026	0.003	178		219
CRA	WEX	1	21.3	0.022	0.071	0.007	136		166
CRG	DUN	1	37.4	0.047	0.125	0.017	82	95	103
CRG	KEL	1	23.1	0.029	0.077	0.013	82	95	103
CRM	KLM	1	1.4	0.001	0.002	0.014	140		140
CRM	KLM	2	1.4	0.001	0.002	0.014	140		140
CRO	IA	1	2.7	0.004	0.0010	0.001	196		222
CRO	KBY	1	14.4	0.009	0.047	0.005	178		219
CSH	CLN	1	22.8	0.014	0.074	0.008	178		219
CSH	DLT	1	60.8	0.075	0.205	0.020	99		125
CSH	ENN (I)	1	53.5	0.034	0.174	0.019	178		219
CSH	GAL	1	13.8	0.022	0.048	0.005	99		125
CSH	GAL	2	11.3	0.018	0.039	0.004	99		125
CSH	GAL	3	11.3	0.018	0.039	0.004	99		125
CSH	SAL	1	24.9	0.025	0.072	0.068	99		105
CSH	SOM T	1	50	0.078	0.172	0.016	99		125
CTN	KLN	1	28.1	0.044	0.098	0.009	105		128
CTN	TIP	1	13.2	0.008	0.043	0.005	105		129
CTY	COO	1	2.9	0.004	0.010	0.001	103		128
CTY	INC	1	8.9	0.011	0.030	0.003	103		128
CUL	DGN	1	34.2	0.022	0.109	0.020	178		219
CUL	WAT	1	13.1	0.006	0.033	0.055	178		219
CUN	GLR	1	25.9	0.037	0.095	0.009	178		219
CUN	SLI	1	21.3	0.033	0.073	0.007	99		126
CUS	MLC	1	13.7	0.015	0.048	0.005	136		166
CUS	NEW (I)	1	24.6	0.026	0.082	0.008	136		166
CUS	PLS	1	42.1	0.044	0.140	0.014	136		166
CVW	DKL	1	0.4	0.001	0.001	0.000	105		128
CVW	KRA	1	7.6	0.012	0.026	0.004	99		125

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (Km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
DAL	DAL T	1	12.2	0.019	0.042	0.004	105		128
DAL T	KPN	1	25.5	0.016	0.083	0.009	178		219
DDK	LOU	1	16.8	0.026	0.058	0.005	105		128
DDK	MLN	1	7.5	0.012	0.026	0.003	105		128
DER	KIN	1	15.1	0.012	0.050	0.005	99		125
DER	MAY	1	43	0.027	0.139	0.018	74		93
DER	TSB	1	19.7	0.031	0.068	0.006	105		128
DFR	DFR T	1	0.1	0.000	0.000	0.000	105		128
DGN	WH	1	8.7	0.006	0.028	0.003	178		219
DMY	MAC	1	26.2	0.037	0.096	0.009	120		222
DON	FIN (N)	1	3.7	0.004	0.011	0.008	69	80	86
DON	FIN (N)	2	3.7	0.004	0.011	0.007	69	80	86
DON	HAN	1	5.8	0.002	0.005	0.140	144	144	158
DON	HAN	2	5.8	0.002	0.005	0.140	144	144	158
DON	BNM	1	6.3	0.006	0.006	0.066	75	75	82
DON	BNM	2	6.3	0.006	0.006	0.066	75	75	82
DRM	LET	1	8.3	0.013	0.028	0.003	105		128
DRM	MEE	1	5	0.008	0.017	0.002	105		128
DRU (I)	ENN (I)	1	17.4	0.027	0.060	0.006	99		125
DRU (N)	DUN	1	25.5	0.033	0.087	0.009	82	95	103
DRU (N)	DUN	2	28.7	0.037	0.095	0.010	82	95	103
DRU (N)	TAN	1	4.4	0.004	0.014	0.002	79	96	113
DRU (N)	TAN	2	4.4	0.004	0.014	0.002	79	96	113
DRU (N)	TAN	3	4.1	0.005	0.014	0.001	79	96	113
DRY	GOR (I)	1	19.4	0.029	0.067	0.006	99		125
DRY	LOU	1	31.9	0.020	0.104	0.011	178		219
DRY	PLA	1	5.3	0.008	0.018	0.002	105		128
DTN	FIN (I)	1	9.2	0.002	0.014	0.111	140		140
DTN	KLM	1	3.2	0.002	0.005	0.032	140		140
DUN	OMA	1	36.1	0.042	0.124	0.012	150	150	150
DUN	OMA	2	39.5	0.047	0.135	0.013	150	150	150
DUN	TMN	1	5.9	0.004	0.017	0.005	132		152
ENN (N)	OMA	1	33.8	0.044	0.113	0.011	82	95	103
ENN (N)	OMA	2	33.7	0.044	0.113	0.011	82	95	103
FAS	CKM	1	7.5	0.012	0.026	0.002	105		128
FIN (I)	GLA	1	14	0.022	0.048	0.005	105		128
FIN (I)	GRA	1	13.2	0.005	0.012	0.236	119		119
FIN (I)	MCD	1	7.9	0.003	0.007	0.141	119		119

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
FIN (I)	POP	1	4.3	0.002	0.005	0.026	120		131
FIN (I)	PTN	1	3.5	0.003	0.010	0.006	80		129
FIN (I)	SVN	1	32.2	0.039	0.104	0.056	105		115
FIN (N)	HAN	1	3.1	0.001	0.003	0.022	144	144	144
FIN (N)	HAN	2	3.1	0.001	0.003	0.022	144	144	144
FLA	GIL	1	10.6	0.017	0.037	0.003	105		128
FLA	LA	1	30.6	0.048	0.105	0.010	99		125
FLA	SLI	1	50.5	0.079	0.174	0.016	105		128
FLA	TON	1	32.3	0.050	0.111	0.010	99		126
FRN	HAR	1	2.3	0.002	0.004	0.030	107		107
FRN	HEU	1	2.4	0.002	0.004	0.024	140		140
FRN	INC	1	5.6	0.004	0.010	0.073	107		107
FRN	MHL	1	4.2	0.003	0.006	0.042	140		140
GAL	SAL	1	6.1	0.004	0.009	0.061	105		105
GCA	GRI	1	8.9	0.009	0.029	0.006	103		131
GCA	INC	1	8.1	0.008	0.025	0.009	103		143
GCA	INC	2	8.1	0.008	0.025	0.009	103		143
GCA	INC	3	7.7	0.005	0.004	0.004	103		124
GCA	KUD	1	2.1	0.002	0.003	0.021	140		140
GCA	KUD	2	2.1	0.002	0.003	0.021	140		140
GCA	NAN	1	1.8	0.001	0.002	0.011	120		131
GCA	NAN	2	1.7	0.001	0.002	0.011	120		131
GCA	GRI T	1	8.9	0.009	0.029	0.006	103		131
GI	KKY	1	49.2	0.077	0.169	0.016	99		125
GI	WAT	1	11.7	0.007	0.038	0.004	178		219
GI	WAT	2	12.9	0.008	0.042	0.005	178		219
GI	WEX	1	34.5	0.054	0.119	0.011	99		125
GLE (N)[1]	KEL	1	21.4	0.027	0.068	0.027	82	82	90
GLE (N)[2]	KEL	1	21.4	0.027	0.068	0.027	82	82	90
GOL	GOL T	1	3.9	0.006	0.014	0.001	105		128
GOR (I)	MTH	1	27.3	0.028	0.090	0.013	99		125
GOR (I)	NAV	1	5.3	0.008	0.019	0.002	99		125
GOR (I)	NAV	2	6.3	0.009	0.022	0.002	99		125
GOR (I)	NAV	3	6.5	0.007	0.022	0.002	99		125
GOR (I)	PLA	1	19.7	0.030	0.068	0.006	103		143

[1] Glengormely A section

[2] Glengormely B section

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
GRA	NBY	1	5.1	0.002	0.005	0.089	119		119
GRI	GRI T	1	1	0.002	0.004	0.000	105		128
GRO	CKN	1	15.2	0.008	0.014	0.150	120		120
HAN	LIS (N)	1	9.2	0.010	0.026	0.018	82	95	103
HAR	RE	1	5.6	0.005	0.010	0.073	107		107
HEU	INC	1	3.6	0.003	0.005	0.036	140		140
IA	MAC	1	18.6	0.027	0.068	0.006	211		222
IKE	IKE T	1	0.2	0.000	0.001	0.000	80		129
INC	COO	1	6.2	0.006	0.016	0.029	136		140
INC	MIL	1	8.4	0.004	0.009	0.051	120		131
KCR	GLE (I)	1	11.2	0.008	0.017	0.115	140		140
KRA	WH	1	45.4	0.029	0.147	0.016	178		219
KER	OUG T	1	22.6	0.014	0.074	0.008	178		219
KHL	THU	1	21.8	0.013	0.066	0.033	178		219
KIN	DFR T	1	29.3	0.021	0.096	0.010	99		125
KKY	KLS	1	34.3	0.053	0.118	0.011	99		125
KLM	NBY	1	1.2	0.001	0.001	0.020	119		119
KLM	POP	1	6	0.003	0.007	0.037	120		131
KLN	LIM (I)	1	9	0.014	0.031	0.003	99		125
KLN	SNG	1	4.1	0.003	0.013	0.003	178		219
KMT	SLK	1	6.2	0.007	0.018	0.006	98	105	110
KMT	STR (N)	1	11.2	0.008	0.037	0.004	143	158	166
KRA	BAR	1	19.5	0.020	0.065	0.007	136		166
KRA	KBY	1	11.9	0.008	0.039	0.004	178		219
KRA	KBY	2	12.5	0.018	0.043	0.004	99		125
KRA	MID	1	10.7	0.017	0.037	0.004	99		125
KTL	MAY	1	21.4	0.022	0.072	0.007	99		125
KTL	MON	1	8.9	0.009	0.030	0.003	136		166
KTN	WAT	1	5	0.004	0.008	0.050	99		125
KUR	NAV	1	6.1	0.010	0.021	0.002	105		128
LA	MUL	1	46.3	0.072	0.160	0.015	105		128
LA	RIC	1	15.7	0.024	0.054	0.007	105		128
LET	GOL T	1	38.4	0.058	0.132	0.012	103		128
LET	STR (N)	1	22.3	0.035	0.077	0.007	105		128
LET	TLK	1	34.9	0.054	0.120	0.013	105		128
LIB	MR	1	2.7	0.001	0.003	0.017	100		100
LIM (I)	KLN	1	11.7	0.018	0.040	0.009	80		110
LIM (I)	MTN	1	6.5	0.005	0.025	0.003	178		219

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
LIM (I)	RAT (I)	1	29.1	0.044	0.101	0.012	99		125
LIS (I)	LOU	1	40.4	0.063	0.139	0.013	105		128
LIS (I)	SKL	1	39.3	0.061	0.135	0.013	105		128
LIS (N)	TAN	1	31	0.040	0.106	0.010	82	95	103
LIS (N)	TAN	2	29.2	0.034	0.100	0.009	80	93	100
LOU	MLN	1	13	0.020	0.045	0.004	105		128
LOU	RRU	1	37.5	0.058	0.129	0.012	105		128
LSN	THU	1	10.4	0.016	0.036	0.003	99		125
MAL	KBY	1	29.2	0.018	0.095	0.01	178		219
MAY	BLK T	1	30.9	0.032	0.103	0.011	136		166
MAY	GRI	1	2.2	0.003	0.009	0.001	105		128
MAY	GRI T	1	2.2	0.002	0.007	0.002	103		120
MAY	RNW	1	7.1	0.008	0.024	0.002	103		128
MAY	RYB	1	9	0.009	0.030	0.005	178		219
MCD	NQS	1	2	0.001	0.002	0.036	119		119
MCD	WOL	1	1.4	0.001	0.002	0.009	120		131
MCE	CDU	1	4.1	0.003	0.010	0.016	99		125
MHL	RE	1	3	0.002	0.005	0.030	140		140
MID	WHI	1	20	0.030	0.069	0.007	99		125
MIL	RE	1	4.9	0.003	0.005	0.075	100		100
MIL	RE	2	5.6	0.003	0.006	0.034	100		131
MIL	TLY	1	5.5	0.003	0.006	0.070	100		100
MKL	OMA	1	37.5	0.028	0.113	0.015	139	150	157
MOY	GLR	1	14	0.022	0.048	0.005	99		125
MOY	TAW	1	8.4	0.013	0.029	0.003	105		125
MOY	TAW	2	8.3	0.013	0.029	0.003	105		128
MP	TBK T	1	6.6	0.010	0.023	0.002	105		128
MR	KBY	1	4.0	0.004	0.013	0.003	99		115
MR	KBY	2	4.0	0.004	0.013	0.003	99		115
MR	TBG	1	3.3	0.001	0.004	0.036	178		219
MR	TBG	2	3.3	0.001	0.004	0.036	178		219
MTH	LOU	1	15.1	0.024	0.052	0.005	99		125
MTN	MUN	1	0.7	0.001	0.003	0.000	105		128
MTN	MUN	2	0.7	0.001	0.002	0.000	105		128
NEW (I)	BLK T	1	12.2	0.013	0.041	0.004	136		166
NEW (I)	PLS	1	43	0.055	0.146	0.014	105		128
NEW (N)	TAN	1	24.1	0.031	0.080	0.008	82	95	103
NEW (N)	TAN	2	24	0.031	0.080	0.008	82	95	103

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
NQS	RE	1	2.1	0.001	0.002	0.038	119		119
OMA	STR (N)	1	35.5	0.046	0.123	0.012	109	119	124
OMA	STR (N)	2	36.1	0.047	0.125	0.012	109		103
OUG	OUG T	1	11.0	0.017	0.038	0.004	105		128
PA	STR (I)	1	22.4	0.035	0.077	0.007	105		128
PB	RE	3	1.4	0.000	0.002	0.046	269		269
PB	RE	4	1.4	0.000	0.002	0.046	269		269
PLS	KPN	1	32	0.020	0.104	0.011	178		219
RAF	RSY	1	2.1	0.003	0.007	0.001	63		99
RAF	TBG	1	10.6	0.016	0.036	0.005	105		128
RAF	TBG	2	9.5	0.006	0.031	0.005	178		219
RAT (I)	TB	1	33.6	0.035	0.112	0.012	136		166
RE	PB	1	1.2	0.001	0.001	0.016	112		112
REM	TRL	1	12	0.006	0.018	0.120	106		106
RNW	DFR T	1	25.9	0.020	0.085	0.009	99		125
RRU	SKL	1	14.5	0.023	0.050	0.005	99		125
SCR	SAL	1	51.8	0.053	0.166	0.056	136		140
SH	DAL T	1	12	0.008	0.039	0.007	178		219
SH	IKE T	1	53.7	0.034	0.175	0.019	178		219
SH	SOM T	1	13.8	0.021	0.047	0.006	105		128
SLI	SRA	1	11.1	0.017	0.038	0.004	99		125
SLI	SRA	2	12	0.019	0.041	0.004	99		125
SNG	AA	1	5.6	0.004	0.018	0.004	178		219
SOR	TLK	1	4.4	0.007	0.015	0.002	105		128
SRA	CF	2	49.2	0.031	0.160	0.017	178		219
STR (I)	STR T	1	2.0	0.003	0.007	0.001	105		128
TAN	WAR	1	12.9	0.013	0.042	0.005	79	96	113
TAN	WAR	2	12.9	0.013	0.042	0.005	79	96	113
TB	TRL	1	42	0.063	0.147	0.014	99		125
TBK	TBK T	1	2.9	0.005	0.010	0.001	105		128
THU	IKE T	1	25.9	0.016	0.084	0.009	178		219
TRL	OUG T	1	11.3	0.007	0.037	0.004	178		219
TRL	TB	2	45.7	0.028	0.148	0.024	178		219

Table B-6 Characteristics of Existing 400/220 kV Transformers

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
		R	X	+	-
Dunstown T4201	500	0.000	0.032	1%	15%
Moneypoint T4201	500	0.000	0.033	1%	15%
Oldstreet T4202	500	0.000	0.027	10%	7%
Woodland T4201	500	0.000	0.032	1%	15%
Woodland T4202	550	0.000	0.027	N/A	
Woodland T4204	500	0.000	0.0316	1%	15%
Total	3,050				

Table B-7 Characteristics of Existing 275/220 kV Transformers

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
		R	X	+	-
Louth AT1	300	0.001	0.030	15%	15%
Louth AT2	600	0.001	0.015	15%	15%
Louth AT3	300	0.001	0.030	15%	15%
Total	1,200				

Table B-8 Characteristics of Existing 275/110 kV Interbus Transformers

Substation/ Transformer	Impedance p.u. 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	
Ballylumford IBTx 1	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Ballylumford IBTx 2	0.0018	0.0641	0.0018	0.2059	0	0.128	240	240	30	1.15	0.85	19
Castlereagh IBTx 1	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	60	1.15	0.85	19
Castlereagh IBTx 2	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	30	1.15	0.85	19
Castlereagh IBTx 3	0.0018	0.0656	0.0018	0.2375	0	0.1593	240	240	30	1.15	0.85	19
Coolkeeragh IBTx 1	0.0018	0.0609	0.0018	0.1273	0	0.057	240	240	60	1.15	0.85	19
Coolkeeragh IBTx 2	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	30	1.15	0.85	19
Hannahstown IBTx 1	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	45	1.15	0.85	19
Hannahstown IBTx 2	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	45	1.15	0.85	19
Hannahstown IBT x 3	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Kells IBTx 1	0.0018	0.0609	0.0018	0.1273	0	0.057	240	240	45	1.15	0.85	19
Kells IBTx 2	0.0018	0.0607	0.0018	0.1317	0	0.057	240	240	45	1.15	0.85	19
Tandragee IBTx 1	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19

Table B-8 Characteristics of Existing 275/110 kV Interbus Transformers (Continued)

Substation/ Transformer	Impedance p.u. 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	
Tandragee IBTx 2	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Tandragee IBTx 3	0.0014	0.0639	0.0018	0.2375	0	0.1575	240	240	60	1.15	0.85	19
Tamnamore IBTx 1	0.0014	0.0656	0.0018	0.2375	0	0.1449	240	240	60	1.15	0.85	19

Table B-9 Characteristics of Existing 275/11.5 kV Generator Transformers

Substation/ Transformer	Impedance p.u. 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	
Kilroot IBTx1	0	0.1635	0	0.3040	0	0.1635	110	55	55	1.15	0.938	33

Table B-10 Characteristics of Existing 220/110 kV Transformers

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
		R	X	+	-
Aghada T2102	125	0.001	0.124	10%	18%
Arklow T2101	63	0.007	0.180	23%	19%
Arklow T2102	125	0.002	0.124	9%	18%
Ballyvouskill T2101	255	0.001	0.064	10%	18%
Carrickmines T2101	250	0.001	0.065	9%	17%
Carrickmines T2102	250	0.001	0.065	9%	17%
Carrickmines T2103	250	0.001	0.065	9%	17%
Cashla T2101[3]	238	0.000	0.063	9%	18%
Cashla T2102	250	0.000	0.063	9%	18%
Cashla T2104	175	0.002	0.133	22%	18%
Clashavoon T2101	125	0.001	0.124	9%	17%
Clashavoon T2102	250	0.001	0.065	9%	17%
Corduff T2101	250	0.001	0.062	9%	17%
Corduff T2102	250	0.001	0.061	9%	17%
Cullenagh T2101	250	0.001	0.064	9%	18%
Finglas T2101	250	0.001	0.065	9%	18%
Finglas T2102	250	0.001	0.065	9%	18%
Finglas T2103	250	0.001	0.064	9%	17%
Finglas T2104	250	0.001	0.064	9%	17%
Finglas T2105	250	0.001	0.064	9%	17%

[3] Transformer limited to 238 MVA at 110 kV by the 110 kV switchgear

Table B-10 Characteristics of Existing 220/110 kV Transformers (continued)

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
		R	X	+	-
Flagford T2101	125	0.003	0.128	9%	18%
Flagford T2102	125	0.001	0.133	9%	18%
Gorman T2101	250	0.001	0.064	9%	18%
GreatIsland T2101	125	0.003	0.133	9%	18%
GreatIsland T2102	125	0.002	0.124	22%	18%
Inchicore T2101	250	0.001	0.056	9%	17%
Inchicore T2103	250	0.000	0.060	9%	18%
Kellis T2101	125	0.001	0.124	9%	18%
Kellis T2102	125	0.001	0.124	9%	18%
Killonan T2101	63	0.007	0.245	22%	18%
Killonan T2102	63	0.010	0.247	22%	18%
Killonan T2103	250	0.000	0.063	9%	18%
Killonan T2104	120	0.001	0.123	9%	18%
Knockraha T2101	250	0.001	0.065	9%	17%
Knockraha T2102	250	0.001	0.065	9%	17%
Knockraha T2103	250	0.001	0.065	9%	18%
Lodgewood T2102	250	0.001	0.064	9%	18%
Louth T2101	125	0.002	0.133	22%	18%
Louth T2102	125	0.002	0.132	23%	18%
Louth T2103	125	0.002	0.132	22%	18%
Louth T2104	250	0.001	0.064	9%	17%
Maynooth T2101	125	0.002	0.134	22%	18%
Maynooth T2102[4]	238	0.001	0.064	9%	17%
Maynooth T2103	125	0.002	0.132	22%	18%
Maynooth T2104	250	0.001	0.064	9%	17%
Knockanure T2101	250	0.001	0.064	10%	18%
Knockanure T2102	250	0.0001	0.064	10%	18%
Poolbeg TF3	250	0.001	0.059	8%	17%
Poolbeg TF4	250	0.001	0.061	8%	17%
Raffeen T2101[4]	238	0.001	0.064	9%	17%
Raffeen T2102	250	0.000	0.056	9%	17%
Shannonbridge T2101	125	0.006	0.124	9%	18%
Shannonbridge T2102	125	0.001	0.124	9%	18%
Srananagh T2101	250	0.001	0.064	9%	18%
Tarbert T2101[4]	238	0.001	0.055	9%	17%
Tarbert T2102[4]	238	0.001	0.055	9%	17%
Total	11.679				

[4] Transformer limited to 238 MVA at 110 kV by the 110 kV switchgear

Table B-11 Characteristics of Existing Power Flow Controllers

Station	Rating (MVA)	Circuit	Impedance p.u. on 100 MVA base		Phase Angle Range (electrical degrees)	
			R	X	+	-
Carrickmines	350	CKM – PB 220 kV	0.000	0.029	15.3	15.3
Enniskillen	125	ENNK – COR 110 kV	0.000	0.0213	1.2	0.8
Strabane	125	STRA – LET 110 kV	0.000	0.0213	1.2	0.8

Table B-12 Characteristics of Existing Reactive Compensation

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Ardnacrusha	ARD 110	1 Capicator	30	
Athlone	ATH 110	2 Capacitors (1 Mobile)	60	
Bandon	BAN 110	1 Capacitor	15	
Cahir	CAH 110	4 Capacitors (4 x 15)	60	
Carrickmines	CKM 220	1 Shunt Reactor		100
Cashla	CSH 110	2 Capacitors (2 x 40)	80	
Castlebar	CBR 110	1 Capacitor	30	
Castlebar	CBR 110	1 Static Var Compensator	60	10
Castlereagh	CAS 22	3 Capacitors (3 x 25)	75	
Castlereagh	CAS 22	1 Shunt Reactor		30
Cathaleen's Fall	CF 110	1 Capacitor	15	
Coleraine	COL 110	1 Capacitor	36	
Coolkeeragh	CPS 110	1 Capacitor	40	
Dalton	DLT 110	1 Capacitor	15	
Derrylin	DLN 33	1 Capacitor	5	
Doon	DOO 110	1 Capacitor	15	
Drumline	DRU 110	1 Capacitor	15	
Dunmanway	DMY 110	1 Capacitor	15	
Dunstown	DSN 400	1 Shunt Reactor		80
Enniskillen	ENN 33	4 Capacitors (4 x 6)	24	
Gortawee	GWE 110	1 Capacitor	15	
Hannahstown	HAN 22	2 Shunt Reactors (2 x 30)		60
Kells	KEL 22	2 Shunt Reactors (2 x 30)		60
Kilkenny	KKY 110	2 Capacitor (2 x 15)	30	
Kilteel	KTL 110	1 Capacitor	30	
Letterkenny	LET 110	1 Capacitor	15	
Letterkenny	LET 110	1 Static Var Compensators	30	
Lisdrum	LIS 110	2 Capacitors (2 x 15)	30	
Louth	LOU 110	1 Capacitor	30	
Moy	MOY 110	2 Capacitors (2 x 15)	30	
Moyle	BYC 275	4 Capacitors (4 x 59)	236	
Mullingar	MUL 110	2 Capacitors (2 x 15)	30	
Navan	NAV 110	1 Capacitor (1 Mobile)	30	
Portlaoise	PLS 110	1 Capacitor (1 Mobile)	30	
Portan	POR 400	EWIC HVDC	175	175
Raffeen	RAF 110	1 Capacitor	60	

Table B-12 Characteristics of Existing Reactive Compensation (Continued)

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Shankill	SKL 110	1 Capacitor (1 Mobile)	30	
Sligo	SLI 110	1 Capacitor	15	
Tandragee	TAN 22	2 Capacitors (2 x 25)	50	
Tandragee	TAN 22	2 Shunt Reactors (2 x 30)		60
Thurles	THU 110	2 Capacitor (2 x 15)	30	
Tralee	TRL 110	1 Capacitor	30	
Trien	TRI 110	1 Capacitor	30	
Wexford	WEX 110	2 Capacitors (2 x 15)	30	
Woodland	WOO 400	1 Shunt Reactor		80
Slieve Kirk	SKIR 20	1 Capacitor	13	
Total			1,589	655

B.2 Changes in Transmission System Characteristics

Future developments of the transmission system are listed in this section according to the year in which they are expected to be completed. The network changes related to each development project are grouped together and collectively headed by a Capital Project (CP) number and title. 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.

Table B-13 Changes in Circuit Characteristics Expected in Winter 2015

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	110	ADM	GCA	1	2.5	0.002	0.004	0.025	140	140
Add	110	ADM	INC	1	10.5	0.009	0.027	0.024	103	143
Add	110	ATE	KNR	1	9.0	0.006	0.029	0.003	178	219
Add	220	BVK	CLA	1	18.4	0.002	0.016	0.024	761	534
Add	110	BVK	GRO	1	7.0	0.004	0.023	0.003	178	219
Add	220	BVK	KNR	1	61.5	0.008	0.053	0.082	…	804
Amend	110	CAH	TIP	1	18.1	0.011	0.059	0.006	178	219
Amend	110	CD	MAC	1	2.4	0.002	0.008	0.001	178	219
Amend	110	CDU	RYB	1	13.0	0.014	0.043	0.005	218	236
Add	110	CF	CLO	1	25.9	0.037	0.094	0.009	187	222
Add	110	CLO	GOL T	1	0.3	0.000	0.001	0.001	187	222
Add	110	CLG	CDU	1	2.5	0.001	0.003	0.028	187	219
Add	110	CTG	BVK	1	30.0	0.019	0.098	0.011	178	219

Table B-13 Changes in Circuit Characteristics Expected in Winter 2015 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Amend	110	CTN	TIP	1	13.2	0.008	0.043	0.005	178	219
Add	110	CKG	BKY	1	3.0	0.001	0.003	0.033	187	223
Add	110	CKG	KUD	1	0.8	0.000	0.001	0.008	187	223
Add	110	DRM	CLO	1	27.0	0.039	0.091	0.015	103	128
Add	110	INC	BKY	1	10.0	0.002	0.011	0.110	187	223
Add	110	KLM	NBY	1	1.2	0.001	0.001	0.020	119	119
Add	110	KNR	TRI	1	4.4	0.005	0.017	0.002	120	128
Add	110	KNR	TRI	2	5.7	0.004	0.019	0.002	178	219
Amend	110	KRA	KBY	1	11.9	0.008	0.039	0.004	178	219
Amend	110	MAY	RYB	1	9.0	0.009	0.030	0.005	178	219
Remove	110	SH	IKE T	1	53.7	0.034	0.175	0.019	178	219

Table B-14 Changes in Circuit Characteristics Expected in 2016

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Amend	110	ARV	SKL	1	18.6	0.012	0.061	0.007	178	219
Add	110	AUG	KPG	1	32.8	0.021	0.107	0.017	178	219
Remove	110	AUG	TB	1	...	...	...	...	...	...
Remove	110	BAR	BAR T	1	...	...	...	...	...	...
Add	110	BAR	CAH	1	44.5	0.066	0.153	0.014	105	128
Add	110	BAR	KRA	1	19.7	0.020	0.066	0.007	136	166
Remove	110	BIN	LET	1	...	...	...	...	...	...
Add	110	BIN	TIV	1	23.2	0.024	0.077	0.008	136	166
Amend	110	BK	CBR	1	37.4	0.053	0.128	0.014	178	219
Add	110	BYH	GLE (I)	1	12.5	0.005	0.024	0.244	178	219
Add	110	BNM	DON	1		0.005	0.005	0.053	75	82
Add	110	BNM	DON	2		0.005	0.005	0.053	75	82
Amend	110	BOL	ENN (I)	1	24.0	0.015	0.078	0.009	178	219
Add	220	BVK	BYH	1	14.5	0.002	0.012	0.054	660	660
Amend	110	BVK	CLA	1	18.4	0.002	0.002	0.054	761	804
Remove	220	BVK	KNR	1	...	...	...	...	...	...
Remove	110	CAH	BAR T	1	...	...	...	...	...	...
Amend	110	CAS	ROS	1	1.9	0.001	0.003	0.015	144	152
Amend	110	CAS	ROS	2	1.9	0.001	0.003	0.015	144	152
Amend	110	CDY	ARI T	1	13.7	0.009	0.045	0.005	178	219
Add	110	CHE	FAS	1	2.2	0.004	0.008	0.001	105	128

Table B-14 Changes in Circuit Characteristics Expected in 2016 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	110	CKM	CHE	1	4.0	0.004	0.008	0.030	105	128
Add	110	CKM	FAS	1	2.9	0.005	0.010	0.001	105	128
Add	110	CLA	DMY	1	35.0	0.022	0.114	0.012	178	219
Remove	220	CLA	TB	1	...	...	...	...	...	...
Add	110	CLO	MUL	1	7.4	0.005	0.011	0.074	124	124
Remove	110	COL (N)	KEL	1	...	...	...	...	...	...
Add	110	COL (N)	RSK	1		0.024	0.069	0.007	185	193
Amend	110	COS	ARI T	1	20.7	0.013	0.067	0.007	178	219
Remove	110	CRG	DUN	1	...	...	...	...	...	...
Add	110	CRG	TMN	1		0.045	0.119	0.022	109	124
Add	110	CRF	CLO	1	18.0	0.011	0.059	0.006	178	219
Amend	110	CSH	SAL	1	24.9	0.024	0.074	0.068	178	219
Amend	110	CTN	KLN	1	28.0	0.018	0.091	0.010	178	219
Amend	110	CUN	SLI	1	21.3	0.030	0.073	0.007	211	222
Add	110	DMY	BDV	1	15.6	0.022	0.057	0.005	187	222
Remove	110	DMY	MAC	1	...	...	...	...	...	...
Remove	110	DON	BNM	1	...	...	...	...	...	...
Remove	110	DON	BMN	2	...	...	...	...	...	...
Remove	110	DRU (N)	DUN	1	...	...	...	...	...	...
Remove	110	DRU (N)	DUN	2	...	...	...	...	...	...
Add	110	DRU (N)	TMN	1		0.028	0.073	0.012	82	103
Add	110	DRU (N)	TMN	2		0.029	0.075	0.008	82	103
Add	110	DUN	TMN	1		0.004	0.017	0.005	139	152
Add	110	DUN	TMN	2		0.009	0.023	0.002	139	103
Remove	110	DUN	OMA	2	...	...	...	...	...	...
Remove	110	DUN	TMN	1	...	...	...	...	...	...
Add	110	DUN	TMN	1		0.004	0.020	0.019	185	195
Remove	110	FAS E	CKM	1	...	...	...	...	...	...
Add	110	FAS E	FAS	1	5.0	0.008	0.017	0.002	105	128
Remove	110	FLA	LA	1	...	...	...	...	...	...
Add	110	FLA	SLB	1	21.7	0.034	0.075	0.007	105	128
Remove	110	FRN	MHL	1	...	...	...	...	...	...
Add	110	FRN	TRN	1	2.8	0.002	0.004	0.028	140	140
Add	110	GOR (N)	OMA	1		0.011	0.066	0.006	188	213
Add	110	GOR (N)	TMN	1		0.021	0.131	0.013	188	213
Add	110	KEL	RSK	1		0.039	0.133	0.013	188	193
Add	110	KIN	MUL	1	27.0	0.017	0.088	0.010	178	219
Amend	110	KPG	KNR	1	15.0	0.015	0.050	0.005	136	166

Table B-14 Changes in Circuit Characteristics Expected in 2016 (continued)

Change	Voltage (kV)	From	To	No	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	220	KPG	MP	1	5.4	0.000	0.002	0.236	660	660
Add	110	KPG	RAT (I)	1	32.2	0.033	0.108	0.011	136	166
Add	220	KPG	TB	1	2.8	0.000	0.002	0.026	761	802
Add	110	KPG	TB	1	1.6	0.002	0.007	0.001	120	128
Add	110	KPG	TB	2	1.6	0.002	0.007	0.001	120	128
Add	110	KPG	TRL	1	39.4	0.060	0.135	0.013	105	128
Add	110	KPG	TRL	2	44.4	0.028	0.144	0.016	105	219
Add	220	KNR	BYH	1	47	0.006	0.040	0.064	660	660
Add	110	KNY	GAL	1	26.5	0.005	0.036	0.303	228	228
Add	220	KNR	KPG	1	21.4	0.003	0.015	0.054	660	660
Add	110	KNR	KPG	1	15.0	0.015	0.050	0.005	136	166
Add	110	KNY	SAL	1	28.4	0.024	0.081	0.079	187	223
Add	110	KNY	UGL	1	3.4	0.001	0.005	0.039	228	228
Remove	110	KRA	BAR T	1	...	...	...	...	...	...
Add	110	LA	SLB	1	9.1	0.014	0.031	0.003	105	128
Add	110	LET	TIV	1	45.2	0.047	0.151	0.015	136	166
Add	110	MAC	BDV	1	10.6	0.015	0.039	0.004	187	222
Remove	275	MAG	TAN	1	...	...	...	...	...	...
Add	110	MHL	TRN	1	1.4	0.001	0.002	0.014	140	140
Add	110	MP	KPG	1	5.4	0.000	0.002	0.236	660	660
Amend	110	MP	TBK T	1	6.6	0.004	0.022	0.002	178	219
Add	110	OMA	TRE	1		0.025	0.073	0.007	186	193
Amend	110	RAF	TBG	1	10.6	0.007	0.035	0.004	178	219
Remove	110	RAT (I)	TB	1	...	...	...	...	...	...
Add	110	SCR	KNY	1	28.4	0.028	0.089	0.035	136	166
Remove	110	SCR	SAL	1	...	...	...	...	...	...
Add	220	TB	KPG	1	2.8	0.000	0.020	0.028	660	660
Remove	110	TB	TRL	1	...	...	...	...	...	...
Add	110	TRE	TMN	1		0.025	0.082	0.025	185	193
Remove	110	TRL	TB	1	...	...	...	...	...	...

Table B-15 Changes in Circuit Characteristics Expected in 2017

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Remove	110	AGL	DYN	1	...	...	...	...	...	...
Add	110	AGL	KNV	1	6.0	0.009	0.021	0.002	105	128
Add	110	AGY	TIV	1	35.0	0.054	0.120	0.011	105	128
Amend	110	BK	MOY	1	27.0	0.017	0.088	0.010	178	219
Add	110	BLC	GRA	1	4.3	0.003	0.005	0.031	140	140
Add	110	BLC	KLM	1	4.0	0.002	0.005	0.029	140	140
Add	110	BLC	FIN (I)	1	10.0	0.000	0.002	0.332	570	570
Amend	220	BVK	BYH	1	14.5	0.002	0.012	0.054	660	660
Add	110	CDL	BYH	1	9.0	0.002	0.010	0.099	209	223
Add	110	CTO	GOR (I)	1	14.0	0.003	0.015	0.154	187	223
Amend	110	CUS	MLC	1	13.7	0.015	0.048	0.005	178	219
Add	110	DYN	KNV	1	2.0	0.003	0.007	0.001	105	128
Remove	110	FIN (I)	GRA	1	...	...	...	...	...	...
Add	110	FIN (I)	KLM	1	9.3	0.005	0.010	0.056	140	143
Add	110	GAR (N)	BRO	1		0.000	0.000	0.000	178	219
Add	110	GLT	BYH	1	9.3	0.006	0.030	0.003	178	219
Add	110	HTS	MAC	1	4.5	0.007	0.016	0.002	105	128
Amend	220	KNR	BYH	1	47.0	0.006	0.040	0.064	660	660
Remove	220	LOU	WOO	1	...	...	...	...	...	...
Add	110	MLC	TSB	1	19.2	0.012	0.063	0.007	178	219
Remove	275	TAN	TMN	1	...	...	...	...	...	...
Remove	275	TAN	TMN	2	...	...	...	...	...	...

Table B-16 Changes in Circuit Characteristics Expected in 2018

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	110	BPS	CAES	1		0.001	0.007	0.082	200	200
Add	110	BPS	CAES	2		0.001	0.007	0.082	200	200
Add	110	BK	NMO	1	3.3	0.002	0.011	0.001	178	219
Add	110	BK	NMO	2	3.3	0.002	0.011	0.001	178	219
Add	110	BLP	KBY	1	0.2	0.000	0.000	0.002	124	124
Add	110	BRA	NEW (I)	1	9.3	0.010	0.031	0.003	136	166
Add	110	BRA	PLS	1	19.3	0.030	0.067	0.006	105	128
Add	110	BKM	CUR	1	7.3	0.004	0.007	0.072	120	120
Add	110	CLO	CF	1	26.5	0.016	0.085	0.016	178	219
Add	110	CUR	NEN	1	18.8	0.029	0.065	0.006	105	128
Add	110	CUR	BKM	1	17.3	0.004	0.019	0.192	190	190
Add	110	OMS	ENN (N)	1		0.026	0.066	0.007	82	103
Add	110	OMS	ENN (N)	2		0.026	0.066	0.007	82	103
Add	110	OMS	OMA	1		0.018	0.047	0.005	82	103
Add	110	OMS	OMA	1		0.018	0.047	0.005	82	103
Remove	110	ENN (N)	OMA	1	...	...	...	...	...	...
Remove	110	ENN (N)	OMA	2	...	...	...	...	...	...
Add	110	KEL	RSK	2		0.022	0.134	0.013	188	213
Add	110	KBY	KBY	1	0.2	0.000	0.000	0.002	130	130
Add	110	KLN	CUR	1	17.8	0.011	0.048	0.005	136	166
Remove	110	KLN	NEN	1	...	...	...	...	...	...
Add	110	MAC	CLA	1	9.0	0.002	0.010	0.070	140	140
Remove	110	NEW (I)	PLS	1	...	...	...	...	...	...

Table B-17 Changes in Circuit Characteristics Expected after 2018

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	110	AIR	CAS	1		0.009	0.022	0.004	82	103
Add	110	AIR	CAS	2		0.009	0.022	0.004	82	103
Add	110	ARM	TAN	1		0.024	0.057	0.007	103	103
Add	110	ARM	TAN	2		0.024	0.057	0.007	103	103
Add	110	ATY	LSE	1	21.9	0.014	0.071	0.008	178	219
Remove	110	ATY	PLS	1	...	...	...	...	...	...
Add	110	BGT	KKY	1	22.0	0.014	0.072	0.008	178	219
Add	110	BGT	LSE	1	28.0	0.018	0.091	0.010	178	219
Add	110	BK	NMO	3	14.1	0.009	0.046	0.005	178	219
Add	110	BK	NMO	4	38.5	0.024	0.125	0.014	178	219
Add	110	BK	OWN	1	4.0	0.001	0.004	0.044	187	223
Add[5]	380	BK	FLA	1	123.0	0.002	0.027	0.621	1577	1944
Add[6]	220	SRA	FLA 1	1	47.0	0.005	0.041	0.061	434	353
		FLA 1	FLA	1	8.0	0.000	0.003	0.324	680	680
		NMO	NMO 1	1	2.0	0.000	0.001	0.081	680	680
		NMO 1	NMO 2	1	11.0	0.001	0.010	0.014	434	535
		NMO 2	NMO 3	1	20.0	0.001	0.009	0.809	680	680
		NMO 3	FLA	1	72.0	0.008	0.062	0.094	434	535
Add[7]	320	NMO	FLA	1	112.5	...	...	...	500	500
Add	110	CAH	SUR	1		0.002	0.005	0.035	118	118
Add[8]	110	CBR	MOY	1	37.0	0.023	0.120	0.013	178	219
Add[9]	110	CBR	MOY1	1	11.0	0.001	0.017	0.134	295	295
		MOY1	CBR	1	26.0	0.016	0.084	0.092	178	219
Add[10]	220	CLO	SRA	1	83.0	0.010	0.072	0.109	434	534
Add[11]	220	CLO	CLO1	1	25.0	0.001	0.010	0.684	593	593
		CLO1	SRA	1	58.0	0.007	0.050	0.076	434	534
Remove	110	CKG	BKY	1	...	...	...	...	...	...
Add	110	CKG	WDU	1	0.8	0.000	0.001	0.008	187	223

[5] Grid West 400kV overhead line option (may be subject to change in future TYTFS versions)

[6] Grid West 220kV partial cable option (may be subject to change in future TYTFS versions)

[7] Grid West 320kV HVDC option (generic model provided, this information may be subject to change in future TYTFS versions as the project matures)

[8] North Connaught Reinforcement 110kV overhead line option (may be subject to change in future TYTFS versions)

[9] North Connaught Reinforcement 110kV partial cable option (generic model provided, this information may be subject to change in future TYTFS versions as the project matures)

[10] North-West Project 220kV overhead line option (may be subject to change in future TYTFS versions)

[11] North-West Project 220kV partial cable option (generic model provided, this information may be subject to change in future TYTFS versions as the project matures)

Table B-17 Changes in Circuit Characteristics Expected after 2018 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	110	CKG	WDU	1	0.8	0.000	0.001	0.008	187	223
Add	110	COL (N)	CAM	1		0.000	0.000	0.000	105	128
Add	380	DSN	LSE	1	44.8	0.001	0.010	0.226	1577	1944
Remove	380	DSN	MP	1	...	...	...	...	...	...
Add	110	GAR (N)	RSK	1		0.004	0.031	0.210	178	219
Remove	110	GCA	KUD	1	...	...	...	...	...	...
Remove	110	GCA	KUD	2	...	...	...	...	...	...
Remove	110	INC	BKY	1	...	...	...	...	...	...
Add	220	INC	WDU	1	14.3	0.002	0.012	0.020	761	804
Add	110	KEL	KLW	1		0.000	0.001	0.008	144	144
Add	110	KEL	TID	1		0.035	0.192	0.019	309	309
Add	110	KKY	NO	1	3.6	0.003	0.005	0.036	140	140
Remove	220	KLN	TB	1	...	...	...	...	...	...
Add	220	KLS	KPG	1	70.0	0.009	0.060	0.119	660	660
Add	110	KPG	CHR	1	22.6	0.024	0.075	0.008	136	166
Add	220	KPG	MP	1	5.4	0.000	0.002	0.236	660	660
Add	220	LOU	ORL	1	14.5	0.002	0.013	0.019	434	534
Add	110	LSE	PSE	1	8.4	0.005	0.026	0.008	178	219
Add	380	LSE	MP	1	170.0	0.003	0.038	0.858	1577	1944
Remove	110	OMA	STR	1	...	...	...	...	...	...
Remove	110	OMA	STR	2	...	...	...	...	...	...
Add	110	OMA	NST	1		0.023	0.061	0.006	186	193
Add	110	OMA	NST	2		0.023	0.061	0.006	186	193
Add	110	OMS	CMK	1		0.007	0.045	0.004	167	188
Add	220	ORL	ORL L	1	20.1	0.001	0.008	0.550	593	593
Add	220	ORL L	ORL O	1	15.9	0.001	0.002	0.528	570	570
Add	110	OWN	OWN	1	4.4	0.003	0.014	0.002	178	219
Add	110	STR	NST	1		0.023	0.061	0.006	186	193
Add	110	STR	NST	2		0.023	0.061	0.006	186	193
Add	275	TMN	TUR	1		0.000	0.002	0.014	710	881
Add	275	TMN	TUR	2		0.000	0.002	0.014	710	881
Add	275	TAN	TUR	1		0.001	0.009	0.051	710	881
Add	275	TAN	TUR	2		0.001	0.009	0.051	710	881
Add	110	WDU	BKY	1	1.0	0.000	0.001	0.011	187	223
Add	110	WDU	BKY	2	0.6	0.000	0.001	0.011	187	223
Add	220	WDU	MAY	1	11.7	0.002	0.012	0.018	761	804
Add	220	WDU	MAY	2	11.7	0.002	0.010	0.016	761	804

Table B-17 Changes in Circuit Characteristics Expected after 2018 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)	
						R	X	B	Summer	Winter
Add	220	WDU	INC	1	14.3	0.002	0.009	0.014	761	804
Add	220	WOO	ORL	1	49.2	0.043	0.043	0.064	434	534
Add	380	WOO	TUR	1	140.0	0.003	0.031	0.707	1424	1731

Table B-18 Characteristics of 220/110 kV Transformer Changes in 2015

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Ballyvouskill T2101	250	220 / 110	0.0010	0.0640	0.09	0.17
Add	Knockanure T2101	250	220 / 110	0.0010	0.0640	0.09	0.17
Add	Knockanure T2102	250	220 / 110	0.0010	0.0640	0.09	0.17

Table B-19 Characteristics of 400/220 kV Transformer Changes in 2016

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Dunstown T4202	500	400 / 220	0.0003	0.0270	0.10	0.07
Add	MoneypointG1 T4202	500	400 / 220	0.0002	0.0329	0.01	0.15

Table B-20 Characteristics of 275/110 kV Transformer Changes in 2016

Action	Substation/ Transformer	Impedance p.u. on 100 MVA Base						Rating in MVA			Off Nominal Ratio (p.u.)		No. of Taps
		W1-2		W2-3		W3-1							
		R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
Add	Tamnamore IBTx2	0.0014	0.0644	0.0040	0.2299	0	0.1500	240	240	60	1.15	0.85	19

Table B-21 Characteristics of 220/110 kV Transformer Changes in 2016

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Ballynahinch T2101	250	220 / 110	0.0010	0.0640	0.09	0.17
Add	Ballynahinch T2102	250	220 / 110	0.0010	0.0640	0.09	0.17

Table B-21 Characteristics of 220/110 kV Transformer Changes in 2016 (continued)

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Carrickmines T2104	250	220 / 110	0.0004	0.0631	0.09	0.18
Add	Kilpaddoge T2101	250	220 / 110	0.0004	0.0631	0.09	0.18
Add	Kilpaddoge T2102	250	220 / 110	0.0004	0.0631	0.09	0.18
Add	Moneypoint T2101	250	220 / 110	0.0010	0.0640	0.09	0.17

Table B-22 Characteristics of 220/110 kV Transformer Changes in 2017

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Belcamp T2101	250	220 / 110	0.0010	0.0646	0.09	0.17

Table B-23 Characteristics of 275/110 kV Transformer Changes in 2018

Action	Substation/ Transformer	Impedance p.u. on 100 MVA Base						Rating in MVA			Off Nominal Ratio (p.u.)		No. of Taps
		W1-2		W2-3		W3-1							
		R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
Add	Ballylumford IBTx3	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Add	Ballylumford IBTx4	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-24 Characteristics of 220/110 kV Transformer Changes in 2018

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Amend	Clashavoon T2102	250	220 / 110	0.0013	0.0647	0.09	0.17
Remove	Killonan T2103	250	220 / 110	0.0004	0.0631	0.09	0.18
Remove	Killonan T2104	250	220 / 110	0.0004	0.0631	0.09	0.18
Remove	Knockraha T2101	250	220 / 110	0.0013	0.0647	0.09	0.17

Table B-25 Characteristics of 400/275 kV Transformer Changes After 2018

Action	Substation/ Transformer	Impedance p.u. on 100 MVA Base						Rating in MVA			Off Nominal Ratio (p.u.)		No. of Taps
		W1-2		W2-3		W3-1							
		R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
Add	Turleenan IBTx1	0.0008	0.0150	0	0.0001	0	0.0001	600	600	60	1.10	0.90	23
Add	Turleenan IBTx2	0.0008	0.0150	0	0.0001	0	0.0001	600	600	60	1.10	0.90	23
Add	Turleenan IBTx3	0.0008	0.0150	0	0.0001	0	0.0001	600	600	60	1.10	0.90	23

Table B-26 Characteristics of 400/220 kV Transformer Changes After 2018

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Flagford T4201	500	380 / 220	0.0003	0.0270	0.10	0.07
Add	Great Island T4201	250	380 / 220	0.0005	0.0720	0.15	0.15
Add	Knockraha T4202	500	380 / 220	0.0003	0.0270	0.10	0.07

Table B-27 Characteristics of 400/110 kV Transformer Changes After 2018

Action	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Laois T4101	250	380 / 110	0.0005	0.0720	0.15	0.15
Add	Laois T4101	250	380 / 110	0.0005	0.0720	0.15	0.15
Add	North Mayo T4101	500	380 / 110	0.0005	0.0360	0.15	0.15

Table B-28 Characteristics of 275/110 kV Transformer Changes After 2018

Action	Substation/ Transformer	Impedance p.u. on 100 MVA Base						Rating in MVA			Off Nominal Ratio (p.u.)		No. of Taps
		W1-2		W2-3		W3-1							
		R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
Add	Omagh South IBTx1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	30	1.10	0.80	19

Table B-29 Characteristics of 220/110 kV Transformer Changes After 2018

Change	Station/ Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Clogher T2101	250	220 / 110	0.0004	0.0631	0.09	0.18
Add	Clogher T2102	250	220 / 110	0.0004	0.0631	0.09	0.18
Add	West Dublin T2101	250	220 / 110	0.0010	0.0646	0.09	0.17
Add	West Dublin T2101	250	220 / 110	0.0010	0.0646	0.10	0.10
Add	West Dublin T2101	250	220 / 110	0.0010	0.0646	0.10	0.10

Table B-30 Changes in the Characteristics of Reactive Compensation Expected in 2016

Add/Remove	Station	Bus	Plant	Mvar Capability	
				Generate	Absorb
Add	Knockranny	KNY 110	1 Capacitor	30	-
Add	Poolbeg	PB 220	2 Reactors (2 x 50)	-	100

Table B-31 Changes in the Characteristics of Reactive Compensation Expected in 2017

Add/Remove	Station	Bus	Plant	Mvar Capability	
				Generate	Absorb
Add	Castletown	CASTLETO 110	1 Capacitor	15	-

Table B-32 Changes in the Characteristics of Reactive Compensation Expected after 2018

Add/Remove	Station	Bus	Plant	Mvar Capability	
				Generate	Absorb
Add	Coleraine	COLE_SVC 110.00	1 SVC	100	100
Add	Coleraine	COLE_SVC 110.00	1 SVC	120	120
Remove	Coleraine	COLE1_CA 110.00	1 Capacitor	36	-
Add	Omagh South	OMAS- 110.00	1 SVC	100	100
Add	Tamnamore	TAMN1_SV 110.00	1 SVC	180	180

APPENDIX C: DEMAND FORECASTS AT INDIVIDUAL TRANSMISSION INTERFACE STATIONS

EIRGRID GROUP

The current. The future.

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 2015 and 2024 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 four 220 kV interface stations that supply the Dublin City networks. These four interface stations, namely Carrickmines, Finglas, Inchicore and Poolbeg, are operated by the DSO of Ireland.

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

Table C-1 Demand Forecasts at Time of Winter Peak

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
AA	ARDNACRUSHA	1.00	31.39	31.36	31.54	30.75	30.90	31.06	31.20	31.50	31.84	32.21
AD	AGHADA	1.00	1.60	1.60	1.60	1.56	1.57	1.58	1.59	1.60	1.62	1.64
AGY	ARDNAGAPPARY	0.95	0.00	0.00	14.28	13.92	13.99	14.06	14.12	14.26	14.42	14.58
AHA	AHANE	0.98	5.74	5.73	5.77	5.62	5.65	5.68	5.70	5.76	5.82	5.89
AA	ARDNACRUSHA	1.00	31.39	31.36	31.54	30.75	30.90	31.06	31.20	31.50	31.84	32.21
AIR	BELFAST - AIRPORT ROAD MAIN	0.98	-	-	-	-	23.22	23.36	23.53	23.71	23.87	24.04
ANR	ANNER	0.92	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04
ANT	ANTRIM MAIN	0.98	43.15	43.21	43.31	43.49	43.12	43.39	43.69	44.03	44.33	44.64
ARI	ARIGNA	1.00	4.34	4.34	4.36	4.25	4.27	4.29	4.32	4.36	4.40	4.45
ARK	ARKLOW	0.95	22.87	22.84	22.98	22.41	22.52	22.63	22.73	22.95	23.21	23.46
ARM	ARMAGH	0.98	-	-	-	-	-	-	-	37.11	37.36	37.61
ATH	ATHLONE	0.95	64.10	59.50	59.85	58.34	58.64	58.92	59.21	59.77	60.43	61.10
ATY	ATHY	0.90	18.17	18.15	18.26	17.80	17.89	17.97	18.06	18.23	18.43	18.64
BAL	BALTRASNA	1.00	14.77	14.76	14.84	14.47	14.55	14.62	14.69	14.83	14.99	15.16
BAN	BANBRIDGE MAIN	0.98	39.81	39.86	39.95	40.12	39.77	40.02	40.30	40.61	40.90	41.17
BAN	BANDON	0.97	29.77	39.20	39.42	38.48	38.67	38.84	39.02	39.38	39.78	40.21
BAR	BARRYMORE	1.00	26.34	26.31	26.47	25.80	25.94	26.06	26.19	26.44	26.73	27.03
BDA	BARODA	0.97	5.26	5.26	17.27	16.97	17.03	17.08	17.14	17.25	17.39	17.52
BDN	BALLYDINE	0.96	17.20	17.18	17.25	16.97	17.02	17.08	17.13	17.24	17.36	17.49
BEG	BALLYBEG	0.99	13.20	13.18	13.26	12.93	12.99	13.05	13.12	13.24	13.39	13.54
BGT	BALLYRAG	0.95	0.00	0.00	0.00	0.00	22.97	23.08	23.19	23.41	23.67	23.94
BIN	BINBANE	0.99	26.73	26.70	17.26	16.82	16.91	16.99	17.07	17.23	17.42	17.62
BK	BELLACORICK	0.97	10.45	10.44	10.51	10.24	10.29	10.34	10.38	10.49	10.60	10.72

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
BKY	BARNAKYLE	0.95	9.08	9.07	9.13	8.90	8.94	8.99	9.03	9.12	9.22	9.32
BLI	BALLYLICKEY	1.00	10.13	10.11	10.18	9.92	9.97	10.02	10.07	10.16	10.27	10.39
BLK	BLAKE	0.98	24.73	24.70	24.85	12.05	12.11	12.17	12.22	12.34	12.48	12.62
BMA	BALLYMENA MAIN	0.98	74.74	74.83	75.00	75.31	74.67	75.15	75.67	76.24	76.77	77.30
BNH	BALLYNAHINCH MAIN	0.98	60.57	60.64	60.78	61.03	60.51	60.90	61.32	61.79	62.22	62.64
BNM	BELFAST - BELFAST NORTH MAIN	0.98	50.25	50.30	50.43	50.63	50.19	50.51	50.86	51.26	51.61	51.97
BOG	BANOGE	0.96	19.67	19.65	19.76	19.27	19.37	19.46	19.55	19.74	19.95	20.18
BRA	BRACKLON	0.95	0.00	0.00	0.00	12.18	12.24	12.30	12.36	12.47	12.61	12.75
BRI	BRINNY	0.97	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
BRY	BARNAHELY	0.98	32.32	32.29	32.47	31.65	31.82	31.97	32.13	32.43	32.79	33.16
BUT	BUTLERSTOWN	0.99	36.88	36.84	37.06	36.13	36.31	36.49	36.66	37.01	37.42	37.84
CAH	CAHIR	0.98	23.43	23.40	23.54	22.95	23.06	23.18	23.29	23.51	23.77	24.03
CAR	BELFAST - CARNMONEY MAIN	0.98	29.07	29.10	29.16	29.29	29.04	29.22	29.42	29.66	29.86	30.06
CBG	CARROWBEG	0.98	26.77	26.75	26.88	26.31	26.43	26.53	26.64	26.85	27.09	27.35
CBR	CASTLEBAR	0.97	26.62	26.59	26.75	26.08	26.21	26.34	26.46	26.72	27.01	27.31
CDY	CORDERRY	0.07	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.53	0.53	0.54
CEN	BELFAST - BELFAST CENTRAL MAIN	0.98	55.21	55.28	55.40	55.64	55.16	55.51	55.90	56.33	56.72	57.10
CF	CATHALEEN'S FALL	0.95	17.90	17.88	17.99	17.53	17.62	17.71	17.79	17.96	18.16	18.36
CFM	CASTLEFARM	0.90	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80
CHA	CHARLEVILLE	0.98	18.14	18.12	18.23	17.77	17.86	17.94	18.03	18.20	18.40	18.61
CKG	CORKAGH	0.95	33.25	33.25	33.25	152.00	152.00	152.00	152.00	152.00	152.00	152.00
CKM	CARRICKMINES	0.98	380.69	399.35	401.20	393.31	394.89	396.35	397.82	400.81	404.20	407.77

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CLG	CLOGHRAN	0.95	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
CLN	CLOON	0.97	24.35	28.85	29.03	28.30	28.44	28.58	28.72	28.99	29.31	29.63
CLW	CARLOW	0.99	51.53	51.47	51.78	50.48	50.73	50.98	51.22	51.71	52.28	52.86
COL	COLERAINE MAIN	0.98	41.74	41.77	41.87	42.05	41.70	41.96	42.25	42.59	42.87	43.16
COL	COLLEGE PARK	0.98	26.20	26.17	26.33	25.66	25.80	25.92	26.04	26.29	0.00	26.88
COS	CARICKONSHANNON	0.99	29.69	29.66	29.83	29.08	29.23	29.37	29.51	29.80	30.12	30.46
COW	COW CROSS	0.99	11.12	11.11	11.17	10.89	10.95	11.00	11.05	11.16	11.29	11.41
CPS	COOLKEERAGH MAIN	0.98	32.64	32.69	32.76	32.90	32.62	32.83	33.05	33.31	33.54	33.76
CRA	CRANE	0.99	31.03	30.99	31.18	30.39	30.55	30.70	30.84	31.13	31.48	31.83
CRE	BELFAST - CREGAGH MAIN	0.98	77.63	77.73	77.92	78.23	77.56	78.07	78.61	79.21	79.75	80.30
CRG	CREAGH MAIN	0.98	35.84	35.89	35.97	36.13	35.81	36.04	36.29	36.57	36.83	37.08
CRO	COOLROE	1.00	14.05	14.03	14.11	13.76	13.83	13.90	13.96	14.10	14.25	14.41
CVW	CASTLEVIEW	0.98	20.91	20.89	21.01	20.48	20.59	20.69	20.79	20.99	21.22	21.45
DAL	DALLOW	1.00	16.34	16.32	16.42	16.01	16.09	16.17	16.24	16.40	16.58	16.76
DDK	DUNDALK	0.99	63.77	63.70	41.26	40.22	40.42	40.62	40.82	41.21	41.65	42.12
DFR	DUNFIRTH	1.00	8.39	8.38	8.43	8.21	8.26	8.30	8.34	8.42	8.51	8.60
DGN	DUNGARVAN	0.98	39.46	39.42	39.65	38.66	38.85	39.04	39.23	39.60	40.03	40.48
DLT	DALTON	0.98	23.49	23.47	23.61	23.01	23.13	23.24	23.35	23.58	23.83	24.10
DMY	DUNMANWAY	0.99	39.93	35.59	35.80	34.90	35.08	35.25	35.42	35.75	36.14	36.55
DON	BELFAST - DONEGAL MAIN	0.98	103.94	104.08	104.33	104.74	103.86	104.51	105.24	106.05	106.79	107.51
DOO	DOON	0.97	29.25	29.22	29.39	28.65	28.80	28.94	29.08	29.35	29.67	30.01
DRU	DRUMNAKELLY MAIN	0.98	91.04	91.16	91.38	91.75	90.96	91.54	92.18	53.39	53.76	54.13

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
DRU	DRUMLINE	0.98	26.02	25.99	26.14	25.49	25.62	25.74	25.86	26.11	26.40	26.69
DRY	DRYBRIDGE	0.98	81.42	81.33	76.34	74.42	74.80	75.16	75.52	76.24	77.07	77.94
DUN	DUNGANNON MAIN	0.98	96.19	96.30	96.53	96.93	96.10	96.73	97.39	98.14	98.81	99.48
EDE	EDEN MAIN	0.98	32.05	32.09	32.16	32.30	32.02	32.22	32.45	32.70	32.92	33.15
ENN	ENNISKILLEN MAIN	0.98	48.97	49.04	49.15	49.35	48.92	49.25	49.59	49.97	50.32	50.66
ENN	ENNIS	0.98	57.78	57.72	58.06	56.60	56.89	57.16	57.44	57.99	58.62	59.28
FIN	BELFAST - FINAGHY MAIN	0.98	33.04	33.08	33.16	33.29	33.01	33.21	33.45	33.70	33.94	34.17
FIN	FINGLAS	0.98	484.96	484.48	487.05	476.12	478.27	480.30	482.38	486.49	474.84	496.15
GAL	GALWAY	1.00	71.32	71.25	71.67	69.87	70.22	70.56	70.90	71.57	72.35	73.17
GI	GREAT ISLAND	0.94	17.30	17.28	17.38	16.94	17.03	17.11	17.19	17.36	17.55	17.75
GIL	GILRA	0.97	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42
GLE	BELFAST - GLENGORMELY MAIN	0.98	27.71	27.74	27.81	27.92	27.67	27.87	28.06	28.27	28.47	28.65
GLE	GLENLARA	0.95	14.52	14.51	14.60	14.23	14.30	14.37	14.44	14.58	14.74	14.90
GRI	GRIFFINRATH	0.95	53.91	53.85	54.17	52.81	53.08	53.33	53.59	54.10	54.69	55.31
GWE	GORTAWEE	0.96	31.35	31.34	31.40	31.14	31.19	31.24	31.29	31.39	31.50	31.62
HTS	HARNETTS CROSS	0.98	0.00	0.00	8.56	8.35	8.39	8.43	8.47	8.55	8.64	8.74
IKE	IKERRIN	0.99	26.52	26.49	26.64	26.00	26.13	26.25	26.37	26.61	26.89	27.18
INC	INCHICORE	0.98	352.87	362.07	363.66	357.03	358.32	359.56	360.83	363.31	353.96	369.16
KBY	KILBARRY	0.99	85.89	85.81	86.31	85.03	85.46	85.87	86.29	87.11	88.06	89.05
KER	KNOCKERAGH	0.96	31.15	31.12	31.30	30.52	30.67	30.82	30.97	31.26	31.60	31.96
KIN	KINNEGAD	0.97	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19
KKY	KILKENNY	0.97	67.98	67.90	58.03	56.56	56.85	57.13	57.40	57.95	58.58	59.24

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KNO	BELFAST - KNOCK MAIN	0.98	51.42	51.49	51.61	51.82	51.38	51.70	52.06	52.47	52.82	53.19
KTL	KILTEEL	0.99	38.24	38.20	38.42	37.46	37.65	37.83	38.01	38.37	38.79	39.23
KTN	KILLOTERAN	0.96	15.98	15.97	16.05	15.71	15.77	15.84	15.90	16.03	16.18	16.33
KUR	KNOCKUMBER	0.93	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14
LA	LANESBORO	0.93	11.77	11.76	11.83	11.53	11.59	11.64	11.70	11.81	11.94	12.08
LAR	LARNE - MAIN	0.98	42.76	42.80	42.91	43.08	42.72	42.99	43.30	43.62	43.92	44.22
LET	LETTERKENNY	0.98	65.40	65.32	61.03	59.50	59.80	60.09	60.38	60.95	61.62	62.31
LIB	LIBERTY	0.95	18.14	18.12	18.23	17.77	17.86	17.94	18.03	18.20	18.40	18.61
LIM	LIMAVADY MAIN	0.98	24.20	24.23	24.29	24.39	24.18	24.34	24.51	24.70	24.86	25.03
LIM	LIMERICK	0.99	77.37	77.29	77.74	75.81	76.19	76.55	76.92	77.64	78.48	79.35
LIS	LISBURN MAIN	0.98	60.94	61.02	61.16	61.42	60.89	61.29	61.71	62.18	62.61	63.04
LIS	LISDRUM	0.97	26.82	26.79	26.95	26.27	26.41	26.53	26.66	26.92	27.21	27.52
LMR	LISAGHMORE MAIN	0.98	47.64	47.69	47.81	48.00	47.59	47.90	48.23	48.60	48.94	49.27
LOG	LOUGUESTOWN MAIN	0.98	39.73	39.77	39.87	40.04	39.70	39.95	40.23	40.54	40.81	41.10
LSN	LISHEEN	0.96	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50
MAC	MACROOM	0.98	17.65	12.47	3.99	3.89	3.91	3.93	3.94	3.98	4.03	4.07
MAL	MALLOW	0.99	21.66	21.63	21.76	21.22	21.32	21.43	21.53	21.73	21.97	22.22
MCE	MACETOWN	0.98	28.57	28.54	28.69	28.08	28.20	28.31	28.43	28.66	28.92	29.19
MID	MIDLETON	0.98	34.64	34.60	34.79	33.96	34.12	34.28	34.44	34.75	35.11	35.49
MLN	MULLAGHARLIN	0.95	4.46	4.46	32.76	32.04	32.18	32.32	32.45	32.72	33.03	33.35
MON	MONREAD	0.99	12.70	12.68	12.76	12.44	12.50	12.56	12.62	12.74	12.88	13.03
MOY	MOY	0.99	24.70	24.67	24.82	24.19	24.32	24.43	24.55	24.79	25.06	25.34
MR	MARINA	0.96	16.71	16.70	16.80	16.37	16.46	16.54	16.62	16.77	16.96	17.15

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MTH	MEATH HILL	0.98	37.25	37.21	37.43	36.49	36.68	36.85	37.03	37.39	37.79	38.22
MUL	MULLINGAR	0.98	48.26	48.21	48.49	47.28	47.52	47.74	47.97	48.43	48.96	49.51
MUN	MUNGRET	0.88	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13
NAR	NEWTOWNARDS	0.98	41.41	41.46	41.56	41.73	41.37	41.64	41.93	42.25	42.54	42.83
NAV	NAVAN	0.98	60.07	60.00	60.36	58.84	59.14	59.43	59.71	60.28	60.94	61.62
NEN	NENAGH	0.98	27.25	27.22	27.38	26.69	26.83	26.96	27.09	27.35	27.65	27.96
NEW	NEWRY MAIN	0.98	80.25	80.33	80.53	80.86	80.17	80.68	81.24	81.87	82.43	83.00
NEW	NEWBRIDGE	1.00	37.18	37.14	25.35	24.71	24.83	24.95	25.07	25.31	25.59	25.88
OLD	OLDCOURT	0.96	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
OMA	OMAGH MAIN	0.98	58.99	59.04	59.18	59.43	58.91	59.30	59.72	60.18	60.59	60.99
OUG	OUGHTRAGH	0.98	24.07	24.04	24.18	23.58	23.70	23.81	23.92	24.15	24.42	24.69
PB	POOLBEG	0.99	187.71	187.49	188.61	183.87	184.83	185.70	186.60	188.40	202.65	192.58
PLA	PLATIN	0.96	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65
PLS	PORTLAOISE	0.98	50.81	50.76	37.90	36.94	37.13	37.31	37.49	37.85	38.26	38.69
RAT	RATHGAEL MAIN	0.98	61.81	61.89	62.03	62.29	61.74	62.15	62.57	63.06	63.49	63.93
RAT	RATHKEALE	0.96	25.17	25.14	25.29	24.65	24.78	24.90	25.02	25.26	25.53	25.82
RIC	RICHMOND	0.98	31.22	31.19	31.37	30.58	30.74	30.89	31.03	31.33	31.67	32.03
RNW	RINAWADE	0.99	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13
ROS	ROSEBANK MAIN	0.98	31.45	31.48	31.55	31.69	31.41	31.62	31.83	32.08	32.31	32.52
RSY	RINGASKIDDY	0.95	1.69	1.69	1.70	1.66	1.67	1.67	1.68	1.70	1.72	1.74
RYB	RYEBROOK	0.96	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52
SAL	SALTHILL	0.98	69.81	69.73	70.15	68.38	68.74	69.07	69.39	70.06	70.82	71.61
SCR	SCREEB	0.95	13.39	13.37	13.45	13.11	13.18	13.24	13.31	13.43	13.58	13.73
SHE	SHELTON ABBEY	0.96	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SKL	SHANKILL	0.97	53.48	53.42	53.74	52.39	52.65	52.91	53.16	53.67	54.26	54.87
SLI	SLIGO	0.98	54.99	54.93	55.26	53.87	54.14	54.40	54.66	55.19	55.79	56.42
SNG	SINGLAND	0.99	14.63	14.61	14.70	14.33	14.40	14.47	14.54	14.68	14.84	15.01
SOM	SOMERSET	0.98	29.37	29.34	29.52	28.77	28.92	29.06	29.20	29.48	29.80	30.14
SPR	SPRINGTOWN MAIN	0.98	30.50	30.54	30.62	30.74	30.48	30.68	30.89	31.12	31.34	31.56
STR	STRABANE MAIN	0.98	37.59	37.62	37.70	37.85	37.53	37.76	38.03	38.34	38.58	38.85
STR	STRATFORD	0.98	19.99	19.97	20.09	19.59	19.69	19.78	19.88	20.07	20.28	20.51
TBG	TRABEG	0.99	70.60	70.52	70.94	69.16	69.50	69.84	70.18	70.85	71.62	72.43
TBK	TULLABRACK	1.00	11.42	11.40	11.47	11.18	11.24	11.29	11.35	11.46	11.58	11.71
THU	THURLES	0.97	28.43	28.40	28.57	27.85	27.99	28.12	28.26	28.53	28.84	29.16
TIP	TIPPERARY	0.98	16.56	16.54	16.64	16.22	16.31	16.38	16.46	16.62	16.80	16.99
TLK	TRILLICK	0.95	22.17	22.15	22.28	21.72	21.83	21.94	22.04	22.25	22.50	22.75
TON	TONROE	0.98	12.79	12.78	12.86	12.53	12.60	12.66	12.72	12.84	12.98	13.13
TRI	TRIEN	0.99	23.33	23.31	23.44	22.85	22.97	23.08	23.19	23.41	23.67	23.94
TRL	TRALEE	1.00	44.90	44.85	45.12	43.99	44.21	44.42	44.64	45.06	45.55	46.07
TSB	THORNSBERRY	0.98	31.94	31.90	32.09	31.28	31.44	31.60	31.75	32.05	32.40	32.76
WAR	WARINGSTOWN MAIN	0.98	63.97	64.05	64.20	64.47	63.92	64.32	64.77	65.27	65.72	66.16
WAT	WATERFORD	0.99	46.73	46.68	46.04	44.88	45.11	45.33	45.55	45.98	46.49	47.01
WEX	WEXFORD	0.98	51.25	51.19	51.50	50.21	50.46	50.70	50.94	51.43	51.99	52.58
WHI	WHITEGATE	0.88	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19

Table C-2 Demand Forecasts at Time of Summer Peak

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
AA	ARDNACRUSHA	1.00	15.65	14.84	14.93	14.99	14.50	14.57	14.65	14.80	14.96	15.15
AD	AGHADA	0.99	1.29	1.22	1.23	1.23	1.19	1.20	1.21	1.22	1.23	1.25
AGH	AGHYOULE	0.96	13.77	13.78	13.82	13.88	13.95	13.84	13.93	14.03	14.15	14.23
AGY	ARDNAGAPPARY	0.95	0.00	0.00	12.07	12.12	11.72	11.78	11.84	11.96	12.10	12.24
AHA	AHANE	0.97	4.66	4.42	4.45	4.46	4.32	4.34	4.36	4.41	4.46	4.51
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	-	-	-	-	-	17.79	17.91	18.02	18.18	18.30
ANR	ANNER	0.92	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04	16.04
ANT	ANTRIM MAIN	0.96	32.86	32.90	32.97	33.11	33.28	33.03	33.26	33.47	33.75	33.98
ARI	ARIGNA	1.00	3.32	3.15	3.17	3.18	3.08	3.09	3.11	3.14	3.17	3.21
ARK	ARKLOW	1.00	12.79	12.13	12.21	12.26	11.86	11.92	11.98	12.10	12.24	12.39
ARM	ARMAGH	0.96	-	-	-	-	-	-	-	-	28.44	28.63
ATH	ATHLONE	0.98	68.08	64.55	61.10	61.36	59.35	59.65	59.96	60.56	61.26	61.98
ATY	ATHY	0.83	10.22	9.69	9.75	9.79	9.47	9.52	9.57	9.67	9.78	9.89
BAL	BALTRASNA	1.00	10.56	10.02	10.08	10.12	9.79	9.84	9.89	9.99	10.10	10.22
BAN	BANBRIDGE MAIN	0.96	30.31	30.35	30.41	30.54	30.70	30.47	30.69	30.88	31.14	31.35
BAN	BANDON	0.96	34.46	34.67	42.91	43.09	41.74	41.94	42.15	42.55	43.02	43.50
BAR	BARRYMORE	0.99	19.00	18.01	18.13	18.20	17.61	17.70	17.79	17.97	18.17	18.39
BDA	BARODA	0.99	5.26	5.26	5.26	15.45	15.12	15.17	15.22	15.32	15.44	15.56
BDN	BALLYDINE	0.94	14.46	14.02	14.07	14.10	13.84	13.88	13.92	14.00	14.09	14.19
BEG	BALLYBEG	0.97	8.26	7.83	7.88	7.91	7.65	7.69	7.73	7.81	7.90	7.99
BGT	BALLYRAG	0.95	0.00	0.00	0.00	0.00	0.00	19.34	19.44	19.64	19.86	20.10
BIN	BINBANE	0.99	16.38	15.53	7.52	7.55	7.30	7.34	7.38	7.45	7.54	7.63
BK	BELLACORICK	0.95	6.19	5.87	5.91	5.93	5.73	5.77	5.80	5.86	5.92	5.99

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
BKY	BARNAKYLE	0.95	0.00	7.67	7.71	7.75	7.49	7.53	7.57	7.65	7.73	7.82
BLI	BALLYLICKEY	1.00	7.53	7.14	7.19	7.22	6.98	7.02	7.05	7.12	7.20	7.29
BLK	BLAKE	0.98	19.10	18.10	18.22	7.69	7.44	7.48	7.52	7.60	7.68	7.77
BMA	BALLYMENA MAIN	0.96	56.91	56.96	57.10	57.34	57.64	57.20	57.61	57.96	58.45	58.86
BNH	BALLYNAHINCH MAIN	0.96	46.11	46.16	46.28	46.46	46.71	46.36	46.68	46.98	47.37	47.69
BNM	BELFAST - BELFAST NORTH MAIN	0.96	38.25	38.29	38.38	38.55	38.75	38.45	38.73	38.97	39.29	39.56
BOG	BANOGE	0.95	8.74	13.86	13.95	14.00	13.55	13.62	13.68	13.82	13.98	14.15
BRA	BRACKLON	0.95	0.00	0.00	0.00	10.60	10.25	10.31	10.36	10.46	10.58	10.71
BRI	BRINNY	0.97	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
BRY	BARNAHELY	0.97	34.79	32.98	33.18	33.33	32.24	32.40	32.57	32.90	33.27	33.66
BUT	BUTLERSTOWN	0.99	26.07	24.72	24.88	24.98	24.16	24.29	24.41	24.66	24.94	25.24
CAH	CAHIR	0.98	22.88	21.70	21.83	21.92	21.21	21.31	21.42	21.64	21.89	22.15
CAR	BELFAST - CARNMONEY MAIN	0.96	22.13	22.15	22.20	22.30	22.41	22.25	22.40	22.54	22.73	22.88
CBG	CARROWBEG	0.98	23.40	22.42	22.54	22.61	22.02	22.11	22.20	22.38	22.58	22.80
CBR	CASTLEBAR	0.98	31.41	29.78	29.97	30.10	29.11	29.26	29.41	29.71	30.05	30.40
CDY	CORDERRY	0.04	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	42.03	42.08	42.19	42.35	42.58	42.26	42.55	42.83	43.18	43.47
CF	CATHALEEN'S FALL	0.95	13.89	13.17	13.26	13.31	12.88	12.94	13.01	13.14	13.29	13.45
CFM	CASTLEFARM	0.90	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80
CHA	CHARLEVILLE	0.97	14.25	13.52	13.60	13.66	13.21	13.28	13.35	13.48	13.64	13.80
CKG	CORKAGH	0.95	0.00	33.25	33.25	33.25	152.00	152.00	152.00	152.00	152.00	152.00
CKM	CARRICKMINES	0.97	253.09	305.22	306.57	307.50	300.33	301.40	302.49	304.65	307.13	309.73

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CLG	CLOGHRAN	0.95	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
CLN	CLOON	0.96	23.49	22.27	26.27	26.38	25.52	25.64	25.78	26.03	26.33	26.65
CLW	CARLOW	0.98	44.96	42.62	42.89	43.07	41.66	41.88	42.09	42.51	43.00	43.51
COL	COLERAINE MAIN	0.96	31.78	31.81	31.89	32.01	32.18	31.94	32.17	32.38	32.63	32.86
COL	COLLEGE PARK	0.96	25.40	24.09	24.24	24.34	23.54	23.66	23.78	24.02	24.30	24.59
COS	CARICKONSHANNON	0.97	27.69	26.25	26.42	26.53	25.66	25.79	25.92	26.19	26.49	26.80
COW	COW CROSS	0.99	13.20	12.52	12.60	12.65	12.23	12.30	12.36	12.49	12.63	12.78
CPS	COOLKEERAGH MAIN	0.96	24.85	24.88	24.94	25.04	25.18	24.99	25.16	25.33	25.53	25.70
CRA	CRANE	0.99	30.73	23.57	23.72	23.82	23.04	23.15	23.28	23.51	23.78	24.06
CRE	BELFAST - CREGAGH MAIN	0.96	59.09	59.18	59.32	59.56	59.88	59.43	59.84	60.22	60.72	61.13
CRG	CREAGH MAIN	0.96	27.30	27.33	27.39	27.50	27.64	27.44	27.63	27.81	28.03	28.22
CRO	COOLROE	1.00	12.01	11.39	11.46	11.51	11.13	11.19	11.24	11.36	11.49	11.62
CVW	CASTLEVIEW	0.97	24.83	23.54	23.69	23.79	23.01	23.13	23.25	23.48	23.75	24.03
DAL	DALLOW	0.98	13.19	12.51	12.59	12.64	12.23	12.29	12.35	12.47	12.62	12.77
DDK	DUNDALK	0.97	48.93	46.40	46.69	27.52	26.62	26.75	26.89	27.16	27.47	27.80
DFR	DUNFIRTH	0.99	6.14	5.82	5.86	5.88	5.69	5.72	5.75	5.80	5.87	5.94
DGN	DUNGARVAN	0.98	32.98	31.27	31.46	31.59	30.56	30.72	30.87	31.19	31.54	31.92
DLT	DALTON	0.96	19.89	18.86	18.98	19.06	18.44	18.53	18.62	18.81	19.03	19.25
DMY	DUNMANWAY	0.99	23.14	21.94	18.42	18.50	17.89	17.99	18.08	18.26	18.47	18.69
DON	BELFAST - DONEGAL MAIN	0.96	79.14	79.23	79.42	79.74	80.16	79.57	80.11	80.63	81.30	81.85
DOO	DOON	0.96	14.61	13.85	13.94	13.99	13.54	13.61	13.67	13.81	13.97	14.14
DRU	DRUMNAKELLY MAIN	0.96	69.32	69.40	69.56	69.84	70.22	69.69	70.17	70.62	40.93	41.21

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
DRU	DRUMLINE	0.97	27.63	26.19	26.36	26.47	25.60	25.73	25.86	26.13	26.43	26.74
DRY	DRYBRIDGE	0.97	65.96	62.54	62.93	58.54	56.63	56.92	57.21	57.78	58.45	59.14
DUN	DUNGANNON MAIN	0.96	73.24	73.32	73.49	73.79	74.18	73.63	74.14	74.61	75.22	75.74
EDE	EDEN MAIN	0.96	24.40	24.43	24.49	24.59	24.72	24.53	24.70	24.86	25.06	25.24
ENN	ENNISKILLEN MAIN	0.96	37.29	37.33	37.42	37.57	37.77	37.49	37.76	37.99	38.30	38.56
ENN	ENNIS	0.98	38.72	36.71	36.94	37.10	35.89	36.07	36.25	36.62	37.04	37.48
FIN	BELFAST - FINAGHY MAIN	0.96	25.15	25.18	25.24	25.35	25.48	25.28	25.47	25.63	25.84	26.01
FIN	FINGLAS	0.98	370.23	376.79	378.82	380.21	369.49	371.10	372.71	375.94	379.66	383.54
GAL	GALWAY	0.99	56.15	53.25	53.57	53.80	52.05	52.31	52.57	53.11	53.72	54.36
GI	GREAT ISLAND	0.95	12.77	12.10	12.18	12.23	11.83	11.89	11.95	12.07	12.21	12.36
GIL	GILRA	0.97	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42	11.42
GLE	BELFAST - GLENGORMELY MAIN	0.96	21.10	21.12	21.17	21.26	21.37	21.21	21.36	21.50	21.67	21.82
GLE	GLENLARA	0.97	12.54	11.89	11.97	12.02	11.62	11.68	11.74	11.86	12.00	12.14
GRI	GRIFFINRATH	0.99	53.09	41.45	41.71	41.88	40.51	40.72	40.93	41.34	41.82	42.31
GWE	GORTAWEE	0.95	33.78	33.12	33.20	33.25	32.85	32.91	32.97	33.09	33.23	33.37
HTS	HARNETTS CROSS	0.98	0.00	0.00	0.00	7.26	7.03	7.06	7.10	7.17	7.25	7.34
IKE	IKERRIN	0.96	25.38	24.12	24.26	24.36	23.60	23.71	23.83	24.06	24.32	24.60
INC	INCHICORE	0.96	232.41	252.90	253.89	254.52	249.49	250.24	251.01	252.53	254.28	256.08
KBY	KILBARRY	0.98	87.05	82.53	83.05	83.40	81.42	81.84	82.26	83.08	84.04	85.04
KER	KNOCKERAGH	0.97	33.38	31.65	31.85	31.98	30.94	31.09	31.25	31.57	31.93	32.31
KIN	KINNEGAD	0.97	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19	10.19
KKY	KILKENNY	0.96	52.08	49.38	49.69	41.18	39.83	40.03	40.24	40.64	41.11	41.60

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KNO	BELFAST - KNOCK MAIN	0.96	39.14	39.19	39.29	39.45	39.66	39.36	39.63	39.89	40.22	40.48
KTL	KILTEEL	0.98	38.84	36.83	37.06	37.21	36.00	36.18	36.36	36.73	37.15	37.59
KTN	KILLOTERAN	0.96	20.17	19.25	19.36	19.43	18.88	18.96	19.04	19.21	19.40	19.60
KUR	KNOCKUMBER	0.93	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14
LA	LANESBORO	0.98	11.10	11.00	11.10	11.30	10.70	10.90	11.10	11.20	11.40	11.40
LAR	LARNE - MAIN	0.96	32.55	32.59	32.66	32.80	32.98	32.73	32.96	33.17	33.44	33.66
LET	LETTERKENNY	0.98	48.26	45.76	42.09	42.27	40.89	41.10	41.31	41.72	42.20	42.70
LIB	LIBERTY	0.95	18.77	17.79	17.90	17.98	17.39	17.48	17.57	17.75	17.95	18.16
LIM	LIMAVADY MAIN	0.96	18.42	18.45	18.49	18.57	18.66	18.52	18.66	18.78	18.93	19.07
LIM	LIMERICK	0.98	62.89	59.68	60.05	60.30	58.36	58.65	58.94	59.53	60.20	60.90
LIS	LISBURN MAIN	0.96	46.40	46.46	46.56	46.76	47.00	46.65	46.98	47.27	47.66	47.99
LIS	LISDRUM	0.96	20.39	19.34	19.46	19.54	18.90	19.00	19.09	19.28	19.51	19.74
LMR	LISAGHMORE MAIN	0.96	36.27	36.31	36.40	36.54	36.74	36.46	36.71	36.95	37.25	37.50
LOG	LOUGUESTOWN MAIN	0.96	30.25	30.28	30.35	30.48	30.64	30.41	30.63	30.81	31.07	31.29
LSN	LISHEEN	0.96	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50
MAC	MACROOM	0.94	16.10	3.90	4.00	4.00	3.10	3.10	3.20	3.20	3.30	3.30
MAL	MALLOW	0.97	17.53	16.62	16.73	16.80	16.25	16.33	16.41	16.58	16.77	16.97
MCE	MACETOWN	0.98	25.30	24.23	24.35	24.43	23.79	23.88	23.98	24.18	24.40	24.64
MID	MIDLETON	0.98	32.08	30.50	30.68	30.80	29.84	29.99	30.13	30.43	30.76	31.10
MLN	MULLAGHARLIN	0.96	4.46	4.46	4.46	28.47	27.69	27.81	27.92	28.16	28.43	28.72
MON	MONREAD	0.97	10.49	9.95	10.01	10.05	9.72	9.77	9.82	9.92	10.03	10.15
MOY	MOY	0.98	19.13	18.14	18.25	18.33	17.73	17.82	17.91	18.09	18.30	18.51
MR	MARINA	0.97	17.57	16.66	16.77	16.84	16.29	16.37	16.45	16.62	16.81	17.01

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MTH	MEATH HILL	0.94	35.13	33.31	33.51	33.65	32.55	32.72	32.89	33.22	33.60	34.00
MUL	MULLINGAR	0.97	40.39	38.30	38.54	38.70	37.44	37.63	37.81	38.20	38.64	39.10
MUN	MUNGRET	0.88	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13	19.13
NAR	NEWTOWNARDS MAIN	0.96	31.52	31.57	31.64	31.77	31.93	31.70	31.92	32.12	32.39	32.61
NAV	NAVAN	0.97	38.50	36.50	36.73	36.88	35.68	35.86	36.04	36.41	36.83	37.26
NEN	NENAGH	0.98	24.25	23.00	23.14	23.24	22.48	22.59	22.71	22.94	23.20	23.47
NEW	NEWRY MAIN	0.96	61.09	61.16	61.30	61.55	61.89	61.42	61.85	62.24	62.75	63.18
NEW	NEWBRIDGE	0.99	18.72	17.75	17.86	7.75	7.49	7.53	7.57	7.65	7.73	7.82
OLD	OLDCOURT	0.96	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
OMA	OMAGH MAIN	0.96	44.90	44.94	45.06	45.25	45.48	45.16	45.47	45.75	46.12	46.45
OUG	OUGHTRAGH	0.98	20.02	18.98	19.10	19.18	18.55	18.65	18.74	18.93	19.15	19.38
PB	POOLBEG	0.98	202.89	192.35	193.57	194.37	188.02	188.98	189.94	191.87	194.06	196.36
PLA	PLATIN	0.96	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65
PLS	PORTLAOISE	0.97	39.32	37.28	37.51	26.50	25.63	25.76	25.90	26.16	26.45	26.76
RAT	RATHGAEL MAIN	0.96	47.05	47.12	47.23	47.41	47.67	47.31	47.64	47.94	48.34	48.67
RAT	RATHKEALE	0.95	18.28	17.33	17.44	17.51	16.94	17.02	17.11	17.28	17.48	17.69
RIC	RICHMOND	0.96	28.63	27.14	27.31	27.43	26.53	26.67	26.80	27.07	27.38	27.71
RNW	RINAWADE	0.99	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13
ROS	ROSEBANK MAIN	0.96	23.94	23.97	24.02	24.12	24.25	24.07	24.24	24.39	24.59	24.76
RSY	RINGASKIDDY	0.78	2.66	2.52	2.54	2.55	2.46	2.48	2.49	2.51	2.54	2.57
RYB	RYEBROOK	0.96	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52
SAL	SALTHILL	0.98	56.00	53.09	53.43	53.65	51.90	52.16	52.43	52.95	53.57	54.20
SCR	SCREEB	0.95	11.91	11.30	11.37	11.41	11.04	11.10	11.15	11.27	11.40	11.53
SHE	SHELTON ABBEY	0.96	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SKL	SHANKILL	0.95	52.85	50.11	50.42	50.63	48.98	49.23	49.48	49.98	50.55	51.15
SLI	SLIGO	0.98	43.08	40.85	41.10	41.28	39.93	40.13	40.34	40.74	41.21	41.70
SNG	SINGLAND	0.97	10.82	10.26	10.32	10.37	10.03	10.08	10.13	10.23	10.35	10.47
SOM	SOMERSET	0.99	15.47	14.67	14.76	14.82	14.34	14.41	14.48	14.63	14.80	14.97
SPR	SPRINGTOWN MAIN	0.96	23.23	23.25	23.31	23.40	23.52	23.36	23.52	23.67	23.86	24.03
STR	STRABANE MAIN	0.96	28.60	28.63	28.70	28.82	28.97	28.75	28.97	29.13	29.38	29.58
STR	STRATFORD	0.99	12.65	11.99	12.07	12.12	11.72	11.78	11.84	11.96	12.10	12.24
TBG	TRABEG	0.99	37.01	35.09	35.31	35.46	34.30	34.48	34.65	35.00	35.40	35.82
TBK	TULLABRACK	0.98	9.06	8.59	8.65	8.68	8.40	8.44	8.49	8.57	8.67	8.77
THU	THURLES	0.96	30.61	29.02	29.20	29.32	28.36	28.51	28.65	28.94	29.27	29.62
TIP	TIPPERARY	0.97	14.96	14.18	14.27	14.33	13.86	13.93	14.00	14.14	14.31	14.48
TLK	TRILLICK	0.95	21.38	20.27	20.40	20.49	19.82	19.92	20.02	20.22	20.45	20.69
TON	TONROE	0.95	13.19	12.51	12.59	12.64	12.23	12.29	12.35	12.47	12.62	12.77
TRI	TRIEN	0.97	22.46	21.29	21.43	21.52	20.81	20.92	21.02	21.24	21.48	21.73
TRL	TRALEE	1.00	34.47	32.68	32.88	33.02	31.94	32.11	32.27	32.59	32.97	33.36
TSB	THORNSBERRY	0.97	27.68	26.24	26.41	26.52	25.65	25.78	25.91	26.18	26.48	26.79
WAR	WARINGSTOWN MAIN	0.96	48.70	48.77	48.88	49.08	49.34	48.97	49.31	49.62	50.03	50.37
WAT	WATERFORD	0.95	38.19	36.21	36.44	35.81	34.64	34.82	35.00	35.35	35.76	36.18
WEX	WEXFORD	0.97	46.70	44.28	44.56	44.74	43.28	43.50	43.72	44.17	44.67	45.20
WHI	WHITEGATE	0.88	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19

Table C-3 Demand Forecasts at Time of Summer Valley

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
AA	ARDNACRUSHA	0.99	12.25	10.53	10.60	10.67	9.60	9.67	9.73	9.86	10.01	10.17
AD	AGHADA	0.99	0.54	0.47	0.47	0.47	0.43	0.43	0.43	0.44	0.44	0.45
AGH	AGHYOULE	0.96	5.09	5.09	5.11	5.13	5.16	5.12	5.15	5.18	5.23	5.26
AGY	ARDNAGAPPARY	0.95	0.00	0.00	3.66	3.68	3.32	3.34	3.36	3.41	3.46	3.51
AHA	AHANE	1.00	0.81	0.70	0.70	0.71	0.64	0.64	0.64	0.65	0.66	0.67
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	-	-	-	-	-	6.57	6.62	6.66	6.72	6.76
ANR	ANNER	0.92	11.78	11.78	11.78	11.78	11.78	11.78	11.78	11.78	11.78	11.78
ANT	ANTRIM MAIN	0.96	12.14	12.16	12.18	12.23	12.30	12.21	12.29	12.37	12.47	12.55
ARI	ARIGNA	0.95	1.61	1.39	1.40	1.40	1.26	1.27	1.28	1.30	1.32	1.34
ARK	ARKLOW	0.95	7.28	6.26	6.30	6.34	5.70	5.74	5.78	5.86	5.95	6.04
ARM	ARMAGH	0.96	-	-	-	-	-	-	-	-	10.51	10.58
ATH	ATHLONE	0.99	19.94	17.14	16.10	16.18	14.57	14.66	14.76	14.96	15.19	15.43
ATY	ATHY	0.88	3.61	3.10	3.12	3.14	2.83	2.85	2.86	2.90	2.95	2.99
BAL	BALTRASNA	0.93	3.62	3.11	3.14	3.15	2.84	2.86	2.88	2.92	2.96	3.01
BAN	BANBRIDGE MAIN	0.96	11.20	11.21	11.24	11.29	11.35	11.26	11.34	11.41	11.50	11.58
BAN	BANDON	0.98	11.50	11.87	14.40	14.46	13.22	13.29	13.36	13.52	13.69	13.88
BAR	BARRYMORE	1.00	8.54	7.33	7.39	7.43	6.69	6.73	6.78	6.87	6.97	7.08
BDA	BARODA	1.00	3.22	3.22	3.22	6.32	6.01	6.03	6.05	6.08	6.13	6.17
BDN	BALLYDINE	0.97	5.19	4.73	4.75	4.76	4.48	4.50	4.52	4.55	4.59	4.63
BEG	BALLYBEG	0.97	2.63	2.26	2.28	2.29	2.06	2.08	2.09	2.12	2.15	2.18
BGT	BALLYRAG	0.95	0.00	0.00	0.00	0.00	0.00	5.48	5.52	5.59	5.68	5.77
BIN	BINBANE	0.99	5.42	4.66	2.23	2.24	2.02	2.03	2.04	2.07	2.10	2.14
BK	BELLACORICK	0.98	2.86	2.46	2.48	2.50	2.25	2.26	2.27	2.30	2.34	2.38

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
BKY	BARNAKYLE	0.95	0.00	2.32	2.34	2.35	2.12	2.13	2.15	2.18	2.21	2.25
BLI	BALLYLICKEY	0.89	4.04	3.47	3.50	3.52	3.16	3.19	3.21	3.25	3.30	3.35
BLK	BLAKE	1.00	6.86	5.90	5.94	2.75	2.47	2.49	2.51	2.54	2.58	2.62
BMA	BALLYMENA MAIN	0.96	21.03	21.05	21.10	21.19	21.30	21.14	21.29	21.42	21.60	21.75
BNH	BALLYNAHINCH MAIN	0.96	17.04	17.06	17.10	17.17	17.26	17.13	17.25	17.36	17.50	17.62
BNM	BELFAST - BELFAST NORTH MAIN	0.96	14.13	14.15	14.18	14.24	14.32	14.21	14.31	14.40	14.52	14.62
BOG	BANOGE	0.95	3.55	4.74	4.78	4.80	4.32	4.35	4.38	4.44	4.51	4.58
BRA	BRACKLON	0.95	0.00	0.00	0.00	3.22	2.90	2.92	2.94	2.98	3.02	3.07
BRI	BRINNY	0.97	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
BRY	BARNAHELY	0.98	18.01	15.47	15.59	15.67	14.10	14.20	14.29	14.49	14.71	14.94
BUT	BUTLERSTOWN	1.00	10.13	8.71	8.77	8.82	7.94	7.99	8.05	8.15	8.28	8.41
CAH	CAHIR	1.00	7.47	6.42	6.47	6.51	5.86	5.90	5.93	6.01	6.11	6.20
CAR	BELFAST - CARNMONEY MAIN	0.96	8.18	8.18	8.20	8.24	8.28	8.22	8.28	8.33	8.40	8.46
CBG	CARROWBEG	0.98	13.55	12.28	12.34	12.38	11.59	11.64	11.69	11.79	11.90	12.01
CBR	CASTLEBAR	0.99	7.98	6.86	6.91	6.95	6.25	6.30	6.34	6.42	6.52	6.62
CDY	CORDERRY	0.54	1.22	1.05	1.05	1.06	0.95	0.96	0.97	0.98	0.99	1.01
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	15.53	15.55	15.59	15.65	15.73	15.62	15.72	15.83	15.95	16.06
CF	CATHALEEN'S FALL	0.95	5.26	4.52	4.56	4.58	4.12	4.15	4.18	4.24	4.30	4.37
CFM	CASTLEFARM	0.88	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79
CHA	CHARLEVILLE	1.00	5.45	4.68	4.72	4.74	4.27	4.30	4.32	4.38	4.45	4.52
CKG	CORKAGH	0.95	0.00	33.25	33.25	33.25	152.00	152.00	152.00	152.00	152.00	152.00

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CKM	CARRICKMINES	0.96	115.06	166.25	166.86	167.27	159.34	159.81	160.30	161.30	162.38	163.56
CLG	CLOGHRAN	0.95	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
CLN	CLOON	0.99	5.98	5.14	6.35	6.38	5.75	5.78	5.82	5.90	5.99	6.09
CLW	CARLOW	0.99	13.69	11.76	11.85	11.91	10.72	10.80	10.87	11.02	11.18	11.36
COL	COLERAINE MAIN	0.96	11.74	11.75	11.78	11.83	11.89	11.80	11.89	11.96	12.06	12.14
COL	COLLEGE PARK	0.97	13.57	11.66	11.75	11.81	10.63	10.70	10.77	10.92	11.08	11.26
COS	CARICKONSHANNON	1.00	7.96	6.84	6.89	6.93	6.23	6.28	6.32	6.40	6.50	6.60
COW	COW CROSS	1.00	2.86	2.45	2.47	2.49	2.23	2.25	2.27	2.30	2.33	2.37
CPS	COOLKEERAGH MAIN	0.96	9.18	9.19	9.22	9.25	9.30	9.23	9.30	9.36	9.43	9.50
CRA	CRANE	1.00	11.64	8.31	8.37	8.42	7.57	7.63	7.68	7.78	7.90	8.03
CRE	BELFAST - CREGAGH MAIN	0.96	21.83	21.87	21.92	22.01	22.12	21.96	22.11	22.25	22.43	22.59
CRG	CREAGH MAIN	0.96	10.09	10.10	10.12	10.16	10.21	10.14	10.21	10.28	10.36	10.43
CRO	COOLROE	0.99	6.19	5.32	5.36	5.39	4.85	4.88	4.91	4.98	5.06	5.14
CVW	CASTLEVIEW	0.98	9.47	8.13	8.20	8.24	7.42	7.47	7.52	7.62	7.73	7.86
DAL	DALLOW	1.00	4.31	3.70	3.73	3.75	3.37	3.40	3.42	3.47	3.52	3.57
DDK	DUNDALK	1.00	16.52	14.19	14.30	8.49	7.64	7.69	7.75	7.85	7.97	8.09
DFR	DUNFIRTH	1.00	2.72	2.34	2.35	2.37	2.13	2.14	2.16	2.19	2.22	2.26
DGN	DUNGARVAN	1.00	12.13	10.42	10.50	10.55	9.50	9.56	9.63	9.76	9.91	10.06
DLT	DALTON	1.00	7.28	6.25	6.30	6.33	5.70	5.74	5.78	5.85	5.94	6.04
DMY	DUNMANWAY	0.98	10.36	8.90	7.86	7.90	7.11	7.16	7.21	7.30	7.41	7.53
DON	BELFAST - DONEGAL MAIN	0.96	29.24	29.28	29.34	29.46	29.62	29.40	29.60	29.79	30.04	30.24
DOO	DOON	0.99	12.26	10.53	10.61	10.67	9.60	9.67	9.73	9.86	10.01	10.17

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
DRU	DRUMNAKELLY MAIN	0.96	25.61	25.64	25.70	25.81	25.95	25.75	25.93	26.09	15.12	15.23
DRU	DRUMLINE	1.00	9.23	7.93	7.99	8.03	7.23	7.28	7.33	7.42	7.54	7.66
DRY	DRYBRIDGE	0.99	23.41	20.11	20.27	18.96	17.07	17.18	17.30	17.53	17.80	18.08
DUN	DUNGANNON MAIN	0.96	27.06	27.09	27.15	27.27	27.41	27.21	27.39	27.57	27.79	27.98
EDE	EDEN MAIN	0.96	9.01	9.03	9.05	9.09	9.13	9.06	9.13	9.18	9.26	9.33
ENN	ENNISKILLEN MAIN	0.96	13.78	13.79	13.83	13.88	13.96	13.85	13.95	14.04	14.15	14.25
ENN	ENNIS	0.99	16.06	13.80	13.91	13.98	12.58	12.67	12.75	12.93	13.12	13.33
FIN	BELFAST - FINAGHY MAIN	0.96	9.29	9.30	9.32	9.37	9.41	9.34	9.41	9.47	9.55	9.61
FIN	FINGLAS	0.98	161.97	166.89	167.83	168.44	156.50	157.22	157.94	159.41	161.09	162.87
GAL	GALWAY	1.00	26.66	22.90	23.08	23.20	20.87	21.02	21.16	21.46	21.77	22.12
GI	GREAT ISLAND	0.97	5.62	4.83	4.86	4.89	4.40	4.43	4.46	4.52	4.59	4.66
GIL	GILRA	0.99	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
GLE	GLENLARA	0.95	4.80	4.12	4.16	4.18	3.76	3.78	3.81	3.86	3.92	3.98
GRI	GRIFFINRATH	1.00	18.55	13.24	13.34	13.41	12.07	12.15	12.24	12.40	12.59	12.79
GWE	GORTAWEE	0.96	22.20	21.61	21.64	21.66	21.29	21.32	21.34	21.38	21.43	21.49
HTS	HARNETTS CROSS	0.98	0.00	0.00	0.00	2.21	1.99	2.00	2.02	2.04	2.07	2.11
IKE	IKERRIN	0.98	8.07	7.07	7.12	7.15	6.54	6.58	6.61	6.69	6.77	6.87
INC	INCHICORE	0.98	157.90	172.68	173.30	173.71	165.57	166.07	166.56	167.56	168.71	169.94
KBY	KILBARRY	1.00	35.22	30.26	30.49	30.65	27.79	27.99	28.18	28.55	28.98	29.44
KER	KNOCKERAGH	1.00	12.55	10.78	10.87	10.92	9.83	9.90	9.96	10.10	10.25	10.41
KIN	KINNEGAD	0.96	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12
KKY	KILKENNY	0.99	17.05	14.65	14.76	12.18	10.97	11.04	11.11	11.26	11.44	11.62
KNO	BELFAST - KNOCK MAIN	0.96	14.46	14.48	14.52	14.58	14.65	14.54	14.64	14.74	14.86	14.96

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KTL	KILTEEL	0.99	16.84	14.47	14.58	14.66	13.19	13.28	13.37	13.55	13.76	13.97
KTN	KILLOTERAN	0.96	9.46	8.48	8.52	8.55	7.95	7.99	8.02	8.10	8.18	8.27
KUR	KNOCKUMBER	0.95	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14
LA	LANESBORO	1.00	3.48	2.99	3.01	3.03	2.72	2.74	2.76	2.80	2.84	2.89
LAR	LARNE - MAIN	0.96	12.03	12.04	12.07	12.12	12.18	12.09	12.18	12.26	12.35	12.44
LET	LETTERKENNY	1.00	16.48	14.16	13.07	13.13	11.82	11.90	11.98	12.14	12.33	12.52
LIB	LIBERTY	0.95	8.28	7.11	7.17	7.20	6.48	6.53	6.57	6.66	6.76	6.87
LIM	LIMAVADY MAIN	0.96	6.81	6.82	6.83	6.86	6.90	6.84	6.89	6.94	6.99	7.04
LIM	LIMERICK	1.00	26.11	22.58	22.75	22.86	20.68	20.81	20.94	21.21	21.52	21.84
LIS	LISBURN MAIN	0.96	17.14	17.17	17.20	17.28	17.37	17.24	17.36	17.47	17.61	17.73
LIS	LISDRUM	0.99	8.39	7.21	7.26	7.30	6.57	6.62	6.66	6.75	6.85	6.96
LMR	LISAGHMORE MAIN	0.96	13.40	13.42	13.45	13.50	13.57	13.47	13.57	13.65	13.76	13.86
LOG	LOUGUESTOWN MAIN	0.96	11.18	11.19	11.21	11.26	11.32	11.24	11.32	11.39	11.48	11.56
LSN	LISHEEN	0.98	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
MAC	MACROOM	0.95	5.05	4.34	3.04	0.85	0.76	0.77	0.77	0.78	0.80	0.81
MAL	MALLOW	0.99	7.18	6.17	6.22	6.25	5.63	5.66	5.70	5.78	5.87	5.96
MCE	MACETOWN	1.00	11.83	10.58	10.63	10.67	9.90	9.95	9.99	10.09	10.20	10.31
MID	MIDLETON	0.98	15.58	13.60	13.70	13.76	12.53	12.61	12.68	12.83	13.01	13.19
MLN	MULLAGHARLIN	0.99	0.35	0.35	0.35	7.65	6.92	6.97	7.01	7.10	7.20	7.31
MON	MONREAD	0.98	3.73	3.20	3.23	3.25	2.92	2.94	2.96	3.00	3.05	3.09
MOY	MOY	1.00	7.25	6.23	6.28	6.31	5.68	5.72	5.76	5.83	5.92	6.02
MR	MARINA	0.98	5.61	4.82	4.86	4.88	4.40	4.42	4.45	4.51	4.58	4.66
MTH	MEATH HILL	0.99	8.00	6.87	6.93	6.96	6.27	6.31	6.35	6.44	6.54	6.64
MUL	MULLINGAR	1.00	11.88	10.21	10.28	10.33	9.30	9.37	9.43	9.56	9.71	9.86

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MUN	MUNGRET	0.94	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
NAR	NEWTOWNARDS MAIN	0.96	11.65	11.66	11.69	11.74	11.80	11.71	11.79	11.87	11.97	12.05
NAV	NAVAN	1.00	9.69	8.33	8.39	8.44	7.59	7.64	7.70	7.80	7.92	8.04
NEN	NENAGH	0.98	8.12	6.97	7.03	7.06	6.36	6.40	6.45	6.53	6.63	6.74
NEW	NEWRY MAIN	0.96	22.57	22.60	22.65	22.74	22.87	22.70	22.85	23.00	23.19	23.35
NEW	NEWBRIDGE	1.00	9.93	8.54	8.60	5.55	4.99	5.03	5.06	5.13	5.21	5.29
OLD	OLDCOURT	0.96	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
OMA	OMAGH MAIN	0.96	16.59	16.61	16.65	16.72	16.81	16.69	16.80	16.90	17.04	17.16
OUG	OUGHTRAGH	1.00	9.33	8.02	8.08	8.12	7.31	7.36	7.41	7.51	7.62	7.74
PB	POOLBEG	1.00	73.34	63.00	63.50	63.82	57.45	57.85	58.24	59.02	59.90	60.87
PLA	PLATIN	0.93	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41
PLS	PORTLAOISE	1.00	13.55	11.64	11.73	8.39	7.56	7.61	7.66	7.77	7.88	8.01
RAT	RATHGAEL MAIN	0.96	17.39	17.41	17.45	17.52	17.61	17.48	17.60	17.71	17.86	17.98
RAT	RATHKEALE	0.98	7.56	6.50	6.55	6.58	5.92	5.96	6.00	6.08	6.18	6.27
RIC	RICHMOND	1.00	9.29	7.98	8.04	8.08	7.28	7.32	7.37	7.47	7.59	7.71
RNW	RINAWADE	1.00	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75
ROS	ROSEBANK MAIN	0.96	8.85	8.86	8.88	8.91	8.96	8.90	8.96	9.01	9.09	9.15
RSY	RINGASKIDDY	0.95	2.86	2.45	2.47	2.49	2.24	2.25	2.27	2.30	2.33	2.37
RYB	RYEBROOK	0.96	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
SAL	SALTHILL	0.99	22.64	19.46	19.61	19.72	17.74	17.86	17.98	18.23	18.50	18.79
SCR	SCREEB	0.95	3.99	3.43	3.45	3.47	3.12	3.14	3.17	3.21	3.26	3.31
SHE	SHELTON ABBEY	0.96	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
SKL	SHANKILL	0.98	15.72	13.50	13.61	13.68	12.31	12.40	12.48	12.65	12.84	13.04
SLI	SLIGO	1.00	15.14	13.01	13.11	13.18	11.86	11.94	12.02	12.18	12.37	12.56

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SNG	SINGLAND	0.98	4.36	3.74	3.77	3.79	3.41	3.44	3.46	3.51	3.56	3.62
SOM	SOMERSET	1.00	6.06	5.21	5.25	5.27	4.75	4.78	4.81	4.88	4.95	5.03
SPR	SPRINGTOWN MAIN	0.96	8.58	8.59	8.61	8.65	8.69	8.63	8.69	8.75	8.82	8.88
STR	STRABANE MAIN	0.96	10.57	10.58	10.61	10.65	10.71	10.62	10.70	10.76	10.86	10.93
STR	STRATFORD	0.99	4.53	3.89	3.92	3.94	3.55	3.57	3.60	3.65	3.70	3.76
TBG	TRABEG	1.00	15.46	13.28	13.39	13.46	12.11	12.19	12.27	12.44	12.63	12.83
TBK	TULLABRACK	0.99	4.06	3.49	3.51	3.53	3.18	3.20	3.22	3.26	3.31	3.37
THU	THURLES	0.98	9.01	7.74	7.80	7.84	7.06	7.11	7.15	7.25	7.36	7.48
TIP	TIPPERARY	1.00	5.98	5.14	5.18	5.21	4.69	4.72	4.75	4.81	4.89	4.96
TLK	TRILLICK	0.95	5.70	4.90	4.94	4.97	4.47	4.50	4.53	4.59	4.66	4.73
TON	TONROE	0.98	4.81	4.13	4.16	4.18	3.77	3.79	3.82	3.87	3.93	3.99
TRI	TRIEN	0.98	11.89	10.22	10.30	10.35	9.32	9.38	9.44	9.57	9.72	9.87
TRL	TRALEE	0.98	13.46	11.57	11.66	11.72	10.55	10.62	10.69	10.83	11.00	11.17
TSB	THORNSBERRY	0.99	8.79	7.55	7.61	7.65	6.88	6.93	6.98	7.07	7.18	7.29
WAR	WARINGSTOWN MAIN	0.96	17.99	18.02	18.06	18.14	18.23	18.10	18.22	18.33	18.49	18.61
WAT	WATERFORD	1.00	12.67	10.89	10.97	10.79	9.71	9.78	9.85	9.98	10.13	10.29
WEX	WEXFORD	1.00	15.40	13.23	13.34	13.41	12.07	12.16	12.23	12.40	12.59	12.78
WHI	WHITEGATE	0.81	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52

Table C-4 Demand Forecasts at Time of Autumn Peak – Northern Ireland only

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
AGH	AGHYOULE	0.97	15.71	15.73	15.77	15.83	15.70	15.80	15.90	16.03	16.14	16.14
AIR	BELFAST - AIRPORT ROAD MAIN	0.97	-	-	-	-	20.17	20.29	20.44	20.60	20.74	20.74
ANT	ANTRIM MAIN	0.97	37.49	37.53	37.63	37.78	37.45	37.69	37.96	38.25	38.51	38.51
ARM	ARMAGH	0.97	-	-	-	-	-	-	-	32.24	32.45	32.45
BAN	BANBRIDGE MAIN	0.97	34.58	34.63	34.71	34.85	34.55	34.77	35.01	35.28	35.53	35.53
BMA	BALLYMENA MAIN	0.97	64.93	65.01	65.15	65.42	64.87	65.28	65.73	66.23	66.69	66.69
BNH	BALLYNAHINCH MAIN	0.97	52.62	52.68	52.80	53.02	52.56	52.90	53.27	53.68	54.05	54.05
BNM	BELFAST - BELFAST NORTH MAIN	0.97	43.65	43.70	43.81	43.98	43.60	43.88	44.18	44.53	44.84	44.84
CAR	BELFAST - CARNMONEY MAIN	0.97	25.25	25.28	25.33	25.44	25.23	25.39	25.56	25.76	25.94	25.94
CEN	BELFAST - BELFAST CENTRAL MAIN	0.97	47.96	48.02	48.13	48.33	47.92	48.22	48.56	48.93	49.27	49.27
COL	COLERAINE MAIN	0.97	36.26	36.29	36.38	36.53	36.22	36.45	36.70	37.00	37.24	37.24
CPS	COOLKEERAGH MAIN	0.97	28.36	28.40	28.46	28.58	28.34	28.52	28.71	28.94	29.13	29.13
CRE	BELFAST - CREGAGH MAIN	0.97	67.43	67.52	67.69	67.96	67.38	67.82	68.29	68.81	69.27	69.27
CRG	CREAGH MAIN	0.97	31.14	31.18	31.25	31.38	31.11	31.31	31.53	31.77	31.99	31.99
DON	BELFAST - DONEGAL MAIN	0.97	90.30	90.41	90.63	90.99	90.22	90.79	91.42	92.13	92.77	92.77
DRU	DRUMNAKELLY MAIN	0.97	79.09	79.19	79.38	79.70	79.02	79.52	80.07	46.38	46.70	46.70
DUN	DUNGANNON MAIN	0.97	83.56	83.66	83.85	84.20	83.49	84.03	84.60	85.25	85.84	85.84
EDE	EDEN MAIN	0.97	27.84	27.87	27.94	28.06	27.81	27.99	28.19	28.40	28.60	28.60
ENN	ENNISKILLEN MAIN	0.97	42.54	42.60	42.70	42.87	42.50	42.78	43.08	43.41	43.71	43.71
FIN	BELFAST - FINAGHY MAIN	0.97	28.70	28.74	28.80	28.92	28.67	28.85	29.06	29.28	29.48	29.48
GLE	BELFAST - GLENGORMELY MAIN	0.97	24.07	24.10	24.16	24.25	24.04	24.21	24.37	24.55	24.73	24.73
KNO	BELFAST - KNOCK MAIN	0.97	44.67	44.73	44.83	45.02	44.63	44.91	45.22	45.58	45.89	45.89
LAR	LARNE - MAIN	0.97	37.15	37.18	37.28	37.43	37.11	37.35	37.61	37.89	38.15	38.15
LIM	LIMAVADY MAIN	0.97	21.02	21.05	21.10	21.19	21.00	21.14	21.29	21.45	21.60	21.60
LIS	LISBURN MAIN	0.97	52.94	53.01	53.13	53.35	52.90	53.24	53.61	54.02	54.39	54.39

Table C-4 Demand Forecasts at Time of Autumn Peak – Northern Ireland only (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
LMR	LISAGHMORE MAIN	0.97	41.38	41.43	41.53	41.70	41.34	41.61	41.89	42.22	42.51	42.51
LOG	LOUGUESTOWN MAIN	0.97	34.52	34.55	34.63	34.78	34.48	34.70	34.95	35.22	35.45	35.45
NAR	NEWTOWNARDS MAIN	0.97	35.97	36.01	36.10	36.25	35.94	36.17	36.42	36.70	36.95	36.95
NEW	NEWRY MAIN	0.97	69.71	69.79	69.96	70.24	69.64	70.09	70.58	71.12	71.61	71.61
OMA	OMAGH MAIN	0.97	51.25	51.29	51.41	51.63	51.18	51.51	51.88	52.28	52.64	52.64
RAT	RATHGAEL MAIN	0.97	53.69	53.76	53.88	54.11	53.64	53.99	54.36	54.78	55.16	55.16
ROS	ROSEBANK MAIN	0.97	27.32	27.35	27.41	27.53	27.29	27.47	27.65	27.87	28.07	28.07
SPR	SPRINGTOWN MAIN	0.97	26.50	26.53	26.60	26.70	26.48	26.65	26.83	27.04	27.22	27.22
STR	STRABANE MAIN	0.97	32.65	32.68	32.75	32.88	32.61	32.80	33.04	33.30	33.51	33.51
WAR	WARINGSTOWN MAIN	0.97	55.57	55.64	55.77	56.00	55.52	55.87	56.26	56.70	57.09	57.09

APPENDIX D: GENERATION CAPACITY AND DISPATCH DETAILS

D.1 Generation Dispatch Details

The current. The future.

Appendix D Generation Capacity and Dispatch Details

Table D-1 lists existing and committed future generation and the Registered Capacity[1] of each unit. This is noted for each year up to 2024. All generation capacity figures in Table E- are expressed in exported terms. Exported terms are given by the generation unit output less 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 results for each year up to 2024 are included. Table D-2 is based on the wind farms that currently have signed connection agreements with the DSO. The connection agreements are based on the best available knowledge as at the beginning of July 2015.

Table D-3 lists the existing and committed dispatchable distribution connected conventional generation in Ireland. Their respective MW capacity over the period of the statement is included.

Table D-4 lists the existing and committed distribution connected renewable generation in Northern Ireland, excluding wind generation. Their respective MW capacity over the period of the statement is included.

Please see EirGrid's website[2] for an update on the Gate 3 generators which have committed to connecting to the transmission system. This commitment is given by executing connection agreements with EirGrid.

Where dual fuel capability exists, the fuel type highlighted in red is utilised to meet peak demand.

[1] The Registered Capacity of future units will not be known until the unit enters the Single Electricity Market. Therefore, for future units the Maximum Export Capacity of the unit appears in Table D-1.

[2] http://www.eirgridgroup.com/customer-and-industry/general-customer-information/connections-and-contracts/

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Dublin	Dublin Bay Power	DB1	Irishtown	220 kV	Gas/DO	415	415	415	415	415	415	415	415	415	415
	Huntstown	HNC	Huntstown A	220 kV	Gas/DO	352	352	352	352	352	352	352	352	352	352
	Huntstown	HN2	Huntstown B	220 kV	Gas/DO	412	412	412	412	412	412	412	412	412	412
	North Wall	NW5	North Wall	220 kV	Gas/DO	109	109	109	109	109	109	109	109	109	109
	Poolbeg	PBC	Shellybanks	220 kV	Gas/DO	460	460	460	460	460	460	460	460	460	460
	Liffey Hydro	LI1	Pollaphuca	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Liffey Hydro	LI2	Pollaphuca	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Liffey Hydro	LI4	Pollaphuca	110 kV	Hydro	4	4	4	4	4	4	4	4	4	4
	Turlough Hill	TH1	Turlough Hill	220 kV	Hydro	73	73	73	73	73	73	73	73	73	73
	Turlough Hill	TH2	Turlough Hill	220 kV	Hydro	73	73	73	73	73	73	73	73	73	73
	Turlough Hill	TP	Turlough Hill	220 kV	Hydro	73	73	73	73	73	73	73	73	73	73
	Turlough Hill	TH4	Turlough Hill	220 kV	Hydro	73	73	73	73	73	73	73	73	73	73
Dublin Area Total						2074	2074	2074	2074	2074	2074	2074	2074	2074	2074

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Midlands	Cuilleen OCGT	-	Athlone	110 kV	Gas/DO	-	-	-	-	-	98	98	98	98	98
	Dooray	-	Killinaparson	110 kV	Wind	-	-	-	-	-	55	55	55	55	55
	Edenderry Power	ED1	Cushaling	110 kV	Peat	122	122	122	122	122	122	122	122	122	122
	Edenderry PCP	ED3	Cushaling	110 kV	Distillate	58	58	58	58	58	58	58	58	58	58
	Edenderry PCP	ED5	Cushaling	110 kV	Distillate	58	58	58	58	58	58	58	58	58	58
	Kill Hill	-	Kill Hill	110 kV	Wind	59	59	59	59	59	59	59	59	59	59
	Lisheen	-	Lisheen	110 kV	Wind	59	59	59	59	59	59	59	59	59	59
	Mount Lucas	-	Mount Lucas	110 kV	Wind	79	79	79	79	79	79	79	79	79	79
	Rhode PCP	RP1	Derryiron	110 kV	Distillate	52	52	52	52	52	52	52	52	52	52
	Rhode PCP	RP2	Derryiron	110 kV	Distillate	52	52	52	52	52	52	52	52	52	52
	Suir OCGT	SUR	Cahir	110 kV	Gas/DO	-	-	-	-	-	98	98	98	98	98
	West Offaly Power	WO4	Shannonbridge	110 kV	Peat	141	141	141	141	141	141	141	141	141	141
Midlands Area Total						680	680	680	680	680	931	931	931	931	931

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Mid-West	Ardnacrusha	AA1	Ardnacrusha	110 kV	Hydro	22	22	22	22	22	22	22	22	22	22
	Ardnacrusha	AA2	Ardnacrusha	110 kV	Hydro	22	22	22	22	22	22	22	22	22	22
	Ardnacrusha	AA3	Ardnacrusha	110 kV	Hydro	21	21	21	21	21	21	21	21	21	21
	Ardnacrusha	AA4	Ardnacrusha	110 kV	Hydro	21	21	21	21	21	21	21	21	21	21
	Aughinish	SK3	Sealrock	110 kV	Gas/DO	65	65	65	65	65	65	65	65	65	65
	Aughinish	SK4	Sealrock	110 kV	Gas/DO	65	65	65	65	65	65	65	65	65	65
	Booltiagh	-	Booltiagh	110 kV	Wind	20	20	20	20	20	20	20	20	20	20
	Booltiagh Extension	-	Booltiagh	110 kV	Wind	12	12	12	12	12	12	12	12	12	12
	Cahernagh Mid Merit	-	Cahernagh Mid Merit	110 kV	OCGT	-	-	-	-	-	101	101	101	101	101
	Derrybrien	-	Derrybrien	110 kV	Wind	60	60	60	60	60	60	60	60	60	60
	Keelderry (1)	-	Knockavanna	110 kV	Wind	-	-	-	-	-	27	27	27	27	27
	Loughaun North	-	Ennis	110 kV	Wind	-	-	27	27	27	27	27	27	27	27
	Moneypoint	MP1	Moneypoint	380 kV	Coal	288	288	288	288	288	288	288	288	288	288
	Moneypoint	MP2	Moneypoint	380 kV	Coal/ HFO	288	288	288	288	288	288	288	288	288	288
	Moneypoint	MP3	Moneypoint	380 kV	Coal	288	288	288	288	288	288	288	288	288	288

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Mid-West	Moneypoint	-	Moneypoint	110 kV	Wind	22	22	22	22	22	22	22	22	22	22
	Tarbert	TB1	Tarbert	110 kV	HFO	54	54	54	54	54	54	54	54	-	-
	Tarbert	TB2	Tarbert	110 kV	HFO	54	54	54	54	54	54	54	54	-	-
	Tarbert	TB3	Tarbert	220 kV	HFO	241	241	241	241	241	241	241	241	-	-
	Tarbert	TB4	Tarbert	220 kV	HFO	241	241	241	241	241	241	241	241	-	-
	Tynagh	TY	Tynagh	220 kV	Gas	404	404	404	404	404	404	404	404	404	404
Mid-West Area Total						2188	2188	2215	2215	2215	2343	2343	2343	1753	1753

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-East	Bindoo	-	Ratrussan	110 kV	Wind	48	48	48	48	48	48	48	48	48	48
	Bindoo Extension	-	Ratrussan	110 kV	Wind	-	22	22	22	22	22	22	22	22	22
	Castletown-moor	-	Castletown-moor	110 kV	Wind	-	-	-	-	-	120	120	120	120	120
	Mountain Lodge	-	Ratrussan	110 kV	Wind	31	31	31	31	31	31	31	31	31	31
	Oriel	-	Oriel	110kV	Wind	-	-	-	-	-	210	210	210	210	210
North-East Area Total						79	101	101	101	101	431	431	431	431	431

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northern Ireland	Ballylumford CCGT10	B10	Ballylumford	110 kV	Gas/Gas oil	101	101	101	101	101	101	101	101	101	101
	Ballylumford CCGT31	B31	Ballylumford	275 kV	Gas/Gas oil	247	247	247	247	247	247	247	247	247	247
	Ballylumford CCGT32	B32	Ballylumford	275 kV	Gas/Gas oil	247	247	247	247	247	247	247	247	247	247
	Ballylumford GT7	BGT1	Ballylumford	110 kV	Gasoil	58	58	58	58	58	58	58	58	58	58
	Ballylumford GT8	BGT2	Ballylumford	110 kV	Gasoil	58	58	58	58	58	58	58	58	58	58
	Ballylumford ST4,5 &6	B 4,5 & 6	Ballylumford	275 kV	Gas/HFO	510	250	250	250	-	-	-	-	-	-
	Brockaghboy	-	Brockaghboy	110 kV	Wind	-	-	57	57	57	57	57	57	57	57
	CAES	-	Ballylumford	275 kV	Comp. Air	-	-	-	268	268	268	268	268	268	268
	Coolkeeragh CCGT	C30	Coolkeeragh	275 & 110 kV	Gas/Gas oil	425	425	425	425	425	425	425	425	425	425
	Coolkeeragh GT8	CGT8	Coolkeeragh	275 kV	Gasoil	53	53	53	53	53	53	53	53	53	53
	Kilroot GT1	KGT1	Kilroot	275 kV	Gasoil	29	29	29	29	29	29	29	29	29	29
	Kilroot GT2	KGT2	Kilroot	275 kV	Gasoil	29	29	29	29	29	29	29	29	29	29
	Kilroot GT3	KGT3	Kilroot	275 kV	Gasoil	42	42	42	42	42	42	42	42	42	42
	Kilroot GT4	KGT4	Kilroot	275 kV	Gasoil	42	42	42	42	42	42	42	42	42	42
	Kilroot ST1	K1	Kilroot	275 kV	Coal/Oil	238	238	238	238	238	238	238	238	238	-
	Kilroot ST2	K2	Kilroot	275 kV	Coal/Oil	238	238	238	238	238	238	238	238	238	-

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northern Ireland	Slieve Kirk	SLK	Killymallaght	110 kV	Wind	74	83	83	83	83	83	83	83	83	83
	Torr Head and Fair Head	-	Kells	110 kV	Tidal	-	-	-	10	10	210	210	210	210	210
Northern Ireland Area Total						2391	2140	2197	2475	2225	2425	2425	2425	2425	1949

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-West	Cronacarkfree	-	Cronacarkfree	110 kV	Wind	-	-	105	105	105	105	105	105	105	105
	Erne	ER3	Cathaleen's Fall	110 kV	Hydro	23	23	23	23	23	23	23	23	23	23
	Erne	ER4	Cathaleen's Fall	110 kV	Hydro	23	23	23	23	23	23	23	23	23	23
	Erne	ER1	Cliff	110 kV	Hydro	10	10	10	10	10	10	10	10	10	10
	Erne	ER2	Cliff	110 kV	Hydro	10	10	10	10	10	10	10	10	10	10
	Golagh	-	Golagh	110 kV	Wind	15	15	15	15	15	15	15	15	15	15
	Garvagh	-	Garvagh	110 kV	Wind	26	26	26	26	26	32	32	32	32	32
	Garvagh	-	Garvagh	110 kV	Wind	22	22	22	22	22	27	27	27	27	27
	Kingsmountain	-	Cunghill	110 kV	Wind	35	35	35	35	35	35	35	35	35	35
	Lough Ree Power	LR4	Lanesboro	110 kV	Peat	94	94	94	94	94	94	94	94	94	94

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-West	Meentycat	-	Meentycat	110 kV	Wind	85	85	85	85	85	85	85	85	85	85
	Mulreavy	-	Mulreavy	110 kV	Wind	-	82	82	82	82	82	82	82	82	82
	Mulreavy Ext.	-	Mulreavy	110 kV	Wind	-	13	13	13	13	13	13	13	13	13
	Oweninney (1)	-	Bellacorick	400 kV	Wind	-	89	89	89	89	89	89	89	89	89
	Oweninney (2)	-	Bellacorick	400 kV	Wind	-	83	83	83	83	83	83	83	83	83
	Oweninney (5)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	199	199	199	199	199
	Seecon	-	Ugool	110 kV	Wind	-	105	105	105	105	105	105	105	105	105
	Sliabh Bawn	-	Sliabh Bawn	110 kV	Wind	-	58	58	58	58	58	58	58	58	58
	Uggool	-	Ugool	110 kV	Wind	-	64	64	64	64	64	64	64	64	64
North-West Area Total						343	837	942	942	942	1152	1152	1152	1152	1152

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
South-East	Ballywater	-	Ballywater	110 kV	Wind	42	42	42	42	42	42	42	42	42	42
	Castledockrill	-	Castledockrill	110 kV	Wind	41	41	41	41	41	41	41	41	41	41
	Great Island	GI4	Great Island	220 kV	Gas	431	431	431	431	431	431	431	431	431	431
	Nore Power	NO1	Nore	110 kV	Gas/DO	-	-	-	-	-	98	98	98	98	98
South-East Area Total						514	514	514	514	514	612	612	612	612	612

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
South-West	Aghada	AD1	Aghada	220 kV	Gas	258	258	258	258	258	258	258	258	258	258
	Aghada	AT1	Aghada	220 kV	Gas/DO	90	90	90	90	90	90	90	90	90	90
	Aghada	AT2	Aghada	220 kV	Gas/DO	90	90	90	90	90	90	90	90	90	90
	Aghada	AT4	Aghada	220 kV	Gas/DO	90	90	90	90	90	90	90	90	90	90
	Aghada CCGT	AD2	Longpoint	220 kV	Gas	431	431	431	431	431	431	431	431	431	431
	Athea	-	Athea	110 kV	Wind	53	53	53	53	53	99	99	99	99	99
	Barnadivane	-	Barnadivane	110 kV	Wind	-	60	60	60	60	60	60	60	60	60
	Boggeragh	-	Boggeragh	110 kV	Wind	57	57	57	57	57	57	57	57	57	57
	Boggeragh (2)	-	Boggeragh	110 kV	Wind	48	48	48	48	48	48	48	48	48	48
	Clahane	-	Clahane	110 kV	Wind	38	38	38	38	38	38	38	38	38	38
	Clahane (2)	-	Clahane	110 kV	Wind	14	14	14	14	14	14	14	14	14	14
	Cloghboola	-	Cloghboola	110 kV	Wind	46	46	46	46	46	46	46	46	46	46
	Cloghboola (2) ext	-	Cloghboola	110 kV	Wind	-	-	-	-	-	10	10	10	10	10
	Coomacheo	-	Garrow	110 kV	Wind	41	41	41	41	41	41	41	41	41	41
	Coomacheo Extension	-	Garrow	110 kV	Wind	18	18	18	18	18	18	18	18	18	18
	Coomagearlahy	-	Coomagearlahy	110 kV	Wind	43	43	43	43	43	43	43	43	43	43

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (Continued)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
South-West	Coomagearlahy Extension	-	Coomagearlahy	110 kV	Wind	39	39	39	39	39	39	39	39	39	39
	Cordal	-	Cordal	110kV	Wind	84	84	84	84	84	101	101	101	101	101
	Dromada	-	Dromada	110 kV	Wind	29	29	29	29	29	29	29	29	29	29
	Dromada (1a)	-	Dromada	110 kV	Wind	-	-	-	-	-	18	18	18	18	18
	Glanlee	-	Glanlee	110 kV	Wind	30	30	30	30	30	30	30	30	30	30
	Glanlee (2)	-	Glanlee	110 kV	Wind	-	-	-	-	-	6	6	6	6	6
	Kilgarvan (1)	-	Coomataggart	110kV	Wind	-	-	-	-	-	62	62	62	62	62
	Lee Hydro	LE1	Inniscarra	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Lee Hydro	LE2	Inniscarra	110 kV	Hydro	4	4	4	4	4	4	4	4	4	4
	Lee Hydro	LE3	Carrigadrohid	110 kV	Hydro	8	8	8	8	8	8	8	8	8	8
	Marina	MRT	Marina	110 kV	Gas/DO	85	85	85	85	85	85	85	85	85	85
	Whitegen CCGT	WG	Glanagow	220 kV	Gas/DO	445	445	445	445	445	445	445	445	445	445
	Woodhouse	-	Woodhouse	110 kV	Wind	23	23	23	23	23	23	23	23	23	23
South-West Area Total						2079	2139	2139	2139	2139	2298	2298	2298	2298	2298

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Dublin	Glasmore	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Griffinrath	0	0	0	0	0	0	0	0	0	0
Dublin Area Total		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Midlands	Barrymore	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9
	Cauteen	78.4	115.4	142.9	142.9	142.9	180.6	180.6	180.6	180.6	180.6
	Dallow	6.8	6.8	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
	Doon	-	25	25	25	25	25	25	25	25	25
	Dungarvan	4.6	4.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6
	Ikerrin	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9
	Lisheen	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
	Nenagh	14	14	14	14	14	14	14	14	14	14
	Portlaoise	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
	Thurles	11.5	30.1	30.1	30.1	30.1	41.8	41.8	41.8	41.8	41.8
	Tipperary	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Midlands Area Total		241.5	322.1	387.9	387.9	387.9	437.3	437.3	437.3	437.3	437.3

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Mid-West	Ardnacrusha	8	8	8	8	8	8	8	8	8	8
	Booltiagh	-	-	103	103	103	103	103	103	103	103
	Tullabrack	17.2	31	31	31	31	31	31	31	31	31
Mid- West Area Total		25.2	39	142	142	142	142	142	142	142	142

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (Continued)

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-East	Drybridge	6.5	6.5	6.5	6.5	6.5	7	7	7	7	7
	Dundalk	0.5	0.5	0.5	0.5	0.5	15.5	15.5	15.5	15.5	15.5
	Lisdrum	-	-	33.1	33.1	33.1	49.2	49.2	49.2	49.2	49.2
	Meath Hill	22.5	24.5	50.7	68.7	68.7	68.7	68.7	68.7	68.7	68.7
	Navan	-	-	-	-	-	5	5	5	5	5
	Shankill	3	3	3	3	3	3	3	3	3	3
North-East Area Total		32.5	34.5	93.8	111.8	111.8	148.4	148.4	148.4	148.4	148.4

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-West	Ardnagappary	5	13	13	13	13	13	13	13	13	13
	Arigna	15.6	15.6	15.6	15.6	15.6	49.6	49.6	49.6	49.6	49.6
	Bellacorick	6.5	25.8	25.8	25.8	35	35	35	35	35	35
	Binbane	29.3	40.2	76.4	76.4	76.4	76.4	76.4	76.4	76.4	76.4
	Carrick on Shannon	-	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Castlebar	36.2	36.2	36.2	36.2	36.2	43	43	43	43	43
	Cathleen Falls	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
	Cloon	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Corderry	39.5	39.5	39.5	39.5	39.5	53	53	53	53	53
	Dalton	2.4	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2
	Doolick	-	100.8	100.8	100.8	100.8	100.8	100.8	100.8	100.8	100.8
	Glenree	36.8	36.8	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3
	Gortawee	3	3	3	3	3	3	3	3	3	3
	Knockranny	-	-	-	-	-	24	24	24	24	24
	Lanesboro	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (Continued)

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
North-West	Letterkenny	40.9	60.9	86.1	86.1	86.1	88.2	88.2	88.2	88.2	88.2
	Moy	6	6	6	6	6	6	6	6	6	6
	Mulreavy	-	-	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1
	Salthill	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1
	Screeb	-	3	3	3	3	3	3	3	3	3
	Sligo	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
	Somerset	7.7	7.7	7.7	7.7	7.7	19.5	19.5	19.5	19.5	19.5
	Sorne Hill	54.7	54.7	54.7	54.7	54.7	61.3	61.3	61.3	61.3	61.3
	Tawnaghmore	-	30	30	30	30	30	30	30	30	30
	Tonroe	10	10	10	10	10	12.5	12.5	12.5	12.5	12.5
	Trillick	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8
North-East Area Total		438.5	675.6	810.6	810.6	819.8	921.1	921.1	921.1	921.1	921.1

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
South-East	Arklow	49.2	85.7	85.7	85.7	85.7	85.7	85.7	85.7	85.7	85.7
	Ballydine	-	24	24	24	24	24	24	24	24	24
	Butlerstown	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Carlow	34.4	34.4	34.4	34.4	34.4	39.4	39.4	39.4	39.4	39.4
	Crane	5	5	5	5	5	7.5	7.5	7.5	7.5	7.5
	Crory	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5
	Waterford	18	18	18	18	18	18	18	18	18	18
	Wexford	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9
South-East Area Total		208.7	269.2	269.2	269.2	269.2	276.7	276.7	276.7	276.7	276.7

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (Continued)

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
South-West	Athea	-	4	4	4	4	4	4	4	4	4
	Athea-2	-	-	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6
	Aughinish	-	-	20	20	20	20	20	20	20	20
	Ballylickey	48	48	48	48	48	50.3	50.3	50.3	50.3	50.3
	Bandon	4.9	4.9	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
	Boggeragh	20	20	20	20	20	44	44	44	44	44
	Charleville	-	45.3	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
	Coomataggart	-	-	-	-	-	116.2	116.2	116.2	116.2	116.2
	Cordal	65.45	65.45	65.45	65.45	65.45	69.25	69.25	69.25	69.25	69.25
	Cloghboola	22.6	32.6	32.6	32.6	32.6	44.6	44.6	44.6	44.6	44.6
	Dunmanway	24.8	32.6	63.6	63.6	63.6	63.6	63.6	63.6	63.6	63.6
	Garrow	15	15	15	15	15	15	15	15	15	15
	Glenlara	53	53	53	53	53	59	59	59	59	59
	Kilpaddoge	-	18	18	18	18	18	18	18	18	18
	Knockacummer	105	105	105	105	105	105	105	105	105	105
	Knockearagh	13.9	13.9	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
	Macroom	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
	Midleton	1.6	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2
	Oughtragh	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
	Rathkeale	30	30	30	30	30	30	30	30	30	30
	Reamore	57.4	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2
	Tralee	45.9	45.9	45.9	45.9	45.9	47.6	47.6	47.6	47.6	47.6
	Trien	52.6	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1
South- West Area Total		603.5	762.5	903.7	903.7	903.7	1069.7	1069.7	1069.7	1069.7	1069.7

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (Continued)

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northern Ireland	Aghyoule	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
	Antrim	5	5	5	5	5	6.7	6.7	6.7	6.7	6.7
	Ballymena (Rural)	5	11	55.5	55.5	55.5	58	58	58	58	58
	CAM	-	-	-	-	-	88.5	88.5	88.5	88.5	88.5
	Carnmoney	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
	Coleraine	108	108	108	108	108	108	108	108	108	108
	Coolkeeragh	12	12	12	12	12	12	12	12	12	12
	Curraghmulkin	-	-	-	-	103.6	103.6	103.6	103.6	103.6	103.6
	Drumnakelly	-	-	-	2.6	2.6	2.6	2.6	2.6	2.6	2.6
	Dungannon	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
	Eden	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Enniskillen	16.9	31.9	31.9	34.4	34.4	34.4	34.4	34.4	34.4	34.4
	Garvagh	-	-	-	-	50.1	50.1	50.1	50.1	50.1	50.1
	Gort	-	-	87.7	100.2	100.2	100.2	100.2	100.2	100.2	100.2
	Kells	-	-	-	-	-	85.1	85.1	85.1	85.1	85.1
	Killymallaght	20.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
	Larne	15	15	15	15	15	15	15	15	15	15
	Limavady	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
	Lisaghmore	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
	Loguestown	12	12	12	12	12	12	12	12	12	12
	Magherakeel	88.6	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1
	Newry	-	3.8	3.8	15.3	15.3	15.3	15.3	15.3	15.3	15.3
	Newtwonstewart	-	-	-	-	-	126.2	126.2	126.2	126.2	126.2
	Omagh	125.7	125.7	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (Continued)

Area	110 kV Station	Wind Farm Capacity (MW)									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northern Ireland	Rasharkin	-	54.8	54.8	54.8	54.8	54.8	54.8	54.8	54.8	54.8
	Springtown	-	-	-	-	45	45	45	45	45	45
	Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
	Tremoge	-	82.5	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8
Northern Ireland Area Total		607.8	822.4	956.9	956	1154.7	1458.7	1458.7	1458.7	1458.7	1458.7

Table D-3 Existing and Committed Distribution-Connected Dispatchable Conventional Generation

Area	110 kV Station	Conventional Capacity (MW)										
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Dublin	Ringsend	-	-	72	72	72	72	72	72	72	72	72
	Derryiron	-	-	-	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
North-East	Drybridge	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
	Navan	-	-	13	13	13	13	13	13	13	13	13
North-West	Bellacorick	-	-	10	10	10	10	10	10	10	10	10
	Tawnaghmore	104	104	153	153	153	153	153	153	153	153	153
	Tullabrack	-	-	-	6	6	6	6	6	6	6	6
Midlands	Thornsberry	-	10	10	10	10	10	10	10	10	10	10
	Blake	5	5	5	5	5	5	5	5	5	5	5
Total		129.2	139.2	283.2	303.8	303.8	303.8	303.8	303.8	303.8	303.8	303.8

Table D-4 Existing and Committed Distribution-Connected Renewables in Northern Ireland (exluding wind)

Area	Generation Station	Unit ID	Connected At		Fuel Type	Renewable Capacity (MW)									
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northern Ireland	Maydown	-	Coolkearagh	33kV	biomass	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
	Lisburn PV	-	Lisburn	33kV	PV	-	9.95	9.95	9.95	9.95	9.95	9.95	9.95	9.95	9.95
	Lough Road Solar	-	Lisburn	33kV	PV	-	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
	Bombardier	-	Rosebank	33kV	biomass	-	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
	Ban Road PV	-	Rasherkin	33kV	PV	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9

D.1 Generation Dispatch Details

Table D-5 through to Table D-7 lists generation dispatch profiles. These dispatch profiles are used for the purposes of the short circuit current level analyses and power flow diagrams. In the tables the SV column represents the dispatch at summer valley. SP denotes the summer peak dispatch and WP denotes the winter peak dispatch.

For the purpose of short circuit current level studies, wind farms were dispatched at 10% of their rated capacity for winter peak cases. Wind farms were not dispatched in summer valley cases. These dispatches are given in Table D-5 and Table D-6.

For the purpose of power flow diagram dispatches, wind farms were dispatched at 30% of their rated capacity for winter peak and summer peak cases. Wind farms were dispatched at 10% for summer valley cases. These dispatches are given in Table D-7.

The values shown are in exported terms. They are the net of each generation unit's own consumption. They indicate the power delivered to the transmission system.

In all instances, a dispatch of 0 MW indicates that the unit is not synchronised to the system. This means that the generator is effectively off. The only exception to this is the dispatch profiles used for the winter peak short circuit current level studies. For these instances, all generators not dispatched are modelled as synchronised to the system and dispatched at 0 MW.

It should be noted that station demand projections are developed from the system demand forecasts on a top-down basis. The projections use a forecast of transmission losses. The transmission loss figures calculated by the network models used in this TYTFS may differ from the forecast figures. Hence the dispatch totals may differ from the system demand forecasts in Table 2-1 in Chapter 2.

Table D-8 lists the existing and proposed generating plant contract details in Northern Ireland.

Table D-5 Dispatch Profiles – Ireland Short Circuit

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
Dublin	Dublin Bay Power	DB1	345	365	236	345	276	325
	EWIC	EW1	100	350	100	350	100	350
	Huntstown	HNC	0	294	0	236	0	216
	Huntstown	HN2	300	330	300	320	250	380
	Liffey Hydro	LI1	0	10	0	2	0	3
	Liffey Hydro	LI2	0	10	0	2	0	3
	Liffey Hydro	LI4	0	4	0	2	0	3
	North Wall	NW5	0	0	0	0	0	0
	Poolbeg	PBC	0	237	0	295	0	158
	Turlough Hill	TH 1,2,3,4	-129	273	-236	223	-247	235
	Elm Park Development (3)	-	0	1	0	0	0	0
	Keelings CHP	-	0	1	0	1	1	1
	Kilbush Nurseries CHP	-	0	1	0	1	1	1
	Installed wind	-	0	0	0	0	0	56
Dublin Area Total			616	1876	400	1777	381	1731

Table D-5 Dispatch Profiles – Ireland Short Circuit (Continued)

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
South-West	Aghada	AD1	0	96	0	58	0	0
	Aghada	AT1	0	0	0	0	0	0
	Aghada	AT2	0	0	0	0	0	0
	Aghada	AT4	0	0	0	0	0	0
	Aghada CCGT	ADC	0	322	225	293	225	332
	Lee Hydro	LE1	0	15	0	4	0	5
	Lee Hydro	LE2	0	4	0	2	0	4
	Lee Hydro	LE3	0	4	0	4	0	5
	Marina	MRT	0	0	0	0	0	0
	Tarbert	TB1	0	0	0	0	0	0
	Tarbert	TB2	0	0	0	0	0	0
	Pfizer Askeaton	-	0	5	0	5	4	5
	Gortadroma Landfill Gas	-	0	3	0	2	2	2
	Tarbert	TB3	0	0	0	0	0	0
	Tarbert	TB4	0	0	0	0	0	0
	Whitegate CCGT	WG	297	357	238	361	198	356
	Adambridge Manufacturers Ltd	-	0	3	0	3	2	3
	Carbery Milk Products CHP (1)	-	0	4	0	3	3	4
	FMC Gas Turbine Ext.	-	0	2	0	1	1	0
	Shamrock Renewable Fuels formerly Farelly Brothers	-	0	0	0	5	6	7

Table D-5 Dispatch Profiles – Ireland Short Circuit (Continued)

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
	Installed Wind	-	0	94	0	152	0	239
South-West Area Total			297	909	463	893	441	962

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
Mid-West	Ardnacrusha	AA1	0	15	0	15	0	9
	Ardnacrusha	AA2	0	15	0	15	0	22
	Ardnacrusha	AA3	0	15	0	15	0	9
	Ardnacrusha	AA4	0	20	0	15	0	23
	Aughinish	SK3	50	70	60	70	50	70
	Aughinish	SK4	50	70	60	70	50	70
	Moneypoint	MP1	94	234	187	187	131	225
	Moneypoint	MP2	0	234	0	187	131	225
	Moneypoint	MP3	0	234	0	187	0	225
	Tynagh	TY	0	380	0	316	0	385
	Installed Wind	-	0	14	0	28	0	31
Mid-West Area Total			194	1301	307	1105	362	1294

Table D-5 Dispatch Profiles – Ireland Short Circuit (Continued)

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
South-East	Cuilleen	-	0	0	0	0	0	0
	Great Island	GI4	295	345	236	354	236	344
	Ballynagran LFG	-	0	3	0	3	2	3
	Nore Power	NO1	0	0	0	0	0	0
	Ballyshannon Farms (1)	-	0	0	0	0	0	0
	Glanbia Ballyraggett CHP	-	0	5	0	0	4	0
	Installed Wind	-	0	27	0	53	0	59
South-East Area Total			295	380	236	410	242	406

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
Midlands	Edenderry Power	ED1	82	91	64	91	91	101
	Edenderry PCP	ED3	0	0	0	0	0	0
	Edenderry PCP	ED5	0	0	0	0	0	0
	Lough Ree Power	LR4	73	82	64	73	0	0
	Rhode PCP	RP1	0	0	0	0	0	0
	Rhode PCP	RP2	0	0	0	0	0	0
	Rhode Biomass Plant	RP2	0	0	0	12	10	10
	West Offaly Power	WO4	92	128	55	119	0	0
	Dublin Waste to Energy Facility	-	0	1	0	0	35	44
	Dairygold Mitchelstown	-	0	3	0	3	3	3
	Derryclure CHP	-	0	8	0	7	5	8

Table D-5 Dispatch Profiles – Ireland Short Circuit (Continued)

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
Midlands	Arthurstown LFG (1)	-	0	0	0	3	3	3
	Gorteen Lower	-	0	1	0	1	1	0
	Installed Wind	-	0	43	0	79	0	46
Midlands Area Total			247	357	183	388	148	215

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
North-West	Erne	ER3	0	15	0	15	0	15
	Erne	ER4	0	15	0	15	0	15
	Erne	ER1	0	5	0	5	0	10
	Erne	ER2	0	5	0	5	0	10
	Lough Ree Power	LR4	73	82	64	73	0	0
	Tawnaghmore Peaking Plant	-	0	0	0	0	0	0
	Tawnaghmore Peaking Plant	-	0	0	0	0	0	0
	AMETS Belmullet (1)	-	0	1	0	5	5	5
	Clady Hydro	-	0	4	0	3	0	0
	Connaught Regional Residual Landfill	-	0	1	0	0	0	0
	Mayo Renewable Power Biomass CHP	-	0	25	20	45	30	40
	Installed Wind	-	0	86	0	160	0	216
North-West Area Total			73	239	84	326	35	311

Table D-5 Dispatch Profiles – Ireland Short Circuit (Continued)

Area	Generation Station	Unit ID	2015		2018		2021 GW	
			SV	WP	SV	WP	SV	WP
North-East	Bailie Foods CHP (1)	-	0	1	0	1	1	1
	Corranure LFG	-	0	1	0	0	0	1
	Knockharley Landfill	-	0	4	0	4	3	3
	Meath Waste- Energy	-	0	13	9	13	13	14
	Rathdrinagh Biogas	-	0	1	0	1	2	2
	Whiteriver Landfill Gas to Energy	-	0	1	0	1	1	1
	Installed Wind	-	0	10	0	25	0	54
North-East Area Total			0	31	9	45	20	76

Table D-6 Dispatch Profiles – Northern Ireland Short Circuit Current Level

Area	Generation Station	Unit ID	2015		2018		2021	
			SV	WP	SV	WP	SV	WP
Northern Ireland	Ballylumford CCGT10	B10	68	93	68	97	68	78
	Ballylumford CCGT20	-	0	151	0	157	0	146
	Ballylumford CCGT21	B31	0	151	0	146	0	146
	Ballylumford CCGT22	B32	0	165	0	136	0	161
	Ballylumford GT7	BGT1	0	0	0	0	0	0
	Ballylumford GT8	BGT2	0	0	0	0	0	0
	Ballylumford ST4	B4	0	0	0	0	0	0
	Ballylumford ST5	B5	0	0	0	0	0	0
	Ballylumford ST6	B6	0	0	0	0	0	0
	CAES	-	0	1	0	0	0	0
	Coolkeeragh CCGT	C30	253	399	253	399	253	350
	Coolkeeragh CGT8	CGT8	0	0	0	0	0	0
	ROSE_BIO	-	0	2	10	15	10	15
	Bio Maydown	-	10	15	10	15	10	15
	Kilroot GT1	KGT1	0	0	0	0	0	0
	Kilroot GT2	KGT2	0	0	0	0	0	0
	Kilroot GT3	KGT3	0	0	0	0	0	0
	Kilroot GT4	KGT4	0	0	0	0	0	0
	Kilroot ST1	K1	102	166	102	175	138	175
	Kilroot ST2	K2	0	166	0	175	0	175
	Moyle (Import positive)	-	100	150	100	150	100	150
	Installed Wind	-	0	65	0	142	0	212
Northern Ireland Area Total			533	1524	543	1607	579	1623

Table D-7 Dispatch Profiles – Power Flow Diagrams

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
Dublin	Dublin Bay Power	DB1	250	400	400	170	400	400
	EWIC	-	100	350	350	100	350	350
	Huntstown	HNC	0	0	150	0	0	0
	Huntstown	HN2	0	300	400	0	0	350
	Liffey Hydro	LI1	2	5	5	2	5	5
	Liffey Hydro	LI2	2	5	5	2	5	5
	Liffey Hydro	LI4	0	1	1	0	1	1
	North Wall	NW4	0	0	0	0	0	0
	North Wall	NW5	0	0	0	0	0	0
	Poolbeg	PBC	0	0	0	0	0	0
	Turlough Hill	TH1,2,3,4	-126	91	160	-134	80	113
	Installed Wind	-	5	15	15	11	33	33
Dublin Area Total			233	1167	1486	151	874	1257

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
South-West	Aghada	AD1	0	0	0	0	0	0
	Aghada	AT1	0	0	0	0	0	0
	Aghada	AT2	0	0	0	0	0	0
	Aghada	AT4	0	0	0	0	0	0
	Aghada CCGT	ADC	0	280	400	0	0	220
	Lee Hydro	LE1	2	5	5	2	5	5
	Lee Hydro	LE2	0	1	1	0	1	1
	Lee Hydro	LE3	1	2	2	1	2	2
	Marina	MRT	0	0	0	0	0	0
	Whitegate CCGT	WG	120	280	410	110	120	220
	Installed Wind	-	97	331	331	206	619	619
South-West Area Total			220	899	1149	319	747	1067

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
Mid-West	Ardnacrusha	AA1,2,3,4	8	25	25	8	25	25
	Aughinish	SK3	80	80	80	80	80	80
	Aughinish	SK4	80	80	80	80	80	80
	Moneypoint	MP1	100	190	200	0	100	180
	Moneypoint	MP2	100	190	300	170	100	180
	Moneypoint	MP3	0	190	200	0	100	180
	Tarbert	TB1	0	0	0	0	0	0
	Tarbert	TB2	0	0	0	0	0	0
	Tarbert	TB3	0	0	0	0	0	0
	Tarbert	TB4	0	0	0	0	0	0
	Tynagh	TY	0	0	200	0	0	0
	Installed Wind	-	12	44	44	35	105	105
Mid-West Area Total			380	799	1129	373	590	830

Table D-7 Dispatch Profiles – Power Flow Diagrams (Continued)

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
South-East	Great Island	GI4	240	280	300	0	240	380
	Installed Wind	-	24	80	80	34	101	101
South-East Area Total			264	360	380	34	341	481

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
Midlands	Cuilleen	-	-	-	-	-	0	0
	Edenderry Power	ED1	130	130	130	130	130	130
	Edenderry PCP	ED3	0	0	0	0	0	0
	Edenderry PCP	ED5	0	0	0	0	0	0
	Rhode PCP	RP1	0	0	0	0	0	0
	Rhode PCP	RP2	0	0	0	0	0	0
	West Offaly Power	WO4	150	150	150	150	150	150
	Installed Wind	-	36	115	115	94	283	283
Midlands Area Total			316	395	395	374	563	563

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
North-West	Erne	ER3	2	7	7	2	7	7
	Erne	ER4	2	7	7	2	7	7
	Erne	ER1	1	3	3	1	3	3
	Erne	ER2	1	3	3	1	3	3
	Lough Ree Power	LR4	100	100	100	100	100	100
	Tawnaghmore	TW1	0	0	0	0	0	0
	Tawnaghmore	TW2	0	0	0	0	0	0
	Installed Wind	-	55	175	175	193	578	578
North-West Area Total			161	295	295	299	698	698

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
North-East	Installed Wind	-	12	36	36	49	147	147
North-East Area Total			12	36	36	49	147	147

Table D-7 Dispatch Profiles – Power Flow Diagrams (Continued)

Area	Generation Station	Unit ID	2015			2024		
			SNV	SP	WP	SNV	SP	WP
Northern Ireland	Ballylumford CCGT10	B10	0	0	100	0	0	0
	Ballylumford CCGT31	B31	0	150	248	0	120	150
	Ballylumford CCGT32	B32	0	150	248	0	120	150
	Ballylumford GT7	BGT1	0	0	0	-	-	-
	Ballylumford GT8	BGT2	0	0	0	-	-	-
	Ballylumford ST4	B4	0	0	0	-	-	-
	Ballylumford ST5	B5	0	0	0	-	-	-
	Ballylumford ST6	B6	0	0	0	-	-	-
	CAES	-	-	-	-	27	80	80
	Coolkeeragh CCGT	C30	165	360	430	110	260	360
	Coolkeeragh CGT8	CGT8	0	0	0	0	0	0
	Kilroot GT1	KGT1	0	0	0	0	0	0
	Kilroot GT2	KGT2	0	0	0	0	0	0
	Kilroot GT3	KGT3	0	0	0	0	0	0
	Kilroot GT4	KGT4	0	0	0	0	0	0
	Kilroot ST1	K1	120	190	190	110	140	190
	Kilroot ST2	K2	120	190	190	0	0	190
	Moyle (Import positive)	-	100	150	150	100	150	150
	Tidal	-	21	63	63	21	63	63
	Installed Wind	-	68	203	210	169	506	506
Northern Ireland Area Total			594	1456	1829	537	1439	1839

Table D-8 Existing and Proposed Northern Ireland Generating Plant Contract Details

Centrally Dispatched Generating Unit	Fuel Type	Contract	
		Type	Details
Ballylumford ST 4	GAS/HFO	IPP	See Note 1
Ballylumford ST 5	GAS/HFO	IPP	See Note 1
Ballylumford ST 6	GAS/HFO	IPP	See Note 1
Ballylumford CCGT 21	GAS/GASOIL	Power NI (PPB)	See Note 2
Ballylumford CCGT 22	GAS/GASOIL	Power NI (PPB)	See Note 2
Ballylumford CCGT 20	STEAM	Power NI (PPB)	See Note 2
Ballylumford CCGT 10	GAS/GASOIL	Power NI (PPB)	See Note 2
Ballylumford GT 7	GASOIL	IPP	Independent from 01/11/12
Ballylumford GT 8	GASOIL	IPP	Independent from 01/11/12
Kilroot ST 1	COAL/OIL	IPP	Independent from 01/11/10; See Note 3
Kilroot ST 2	COAL/OIL	IPP	Independent from 01/11/10; See Note 3
Kilroot GT 1	GASOIL	IPP	Independent from 01/11/12
Kilroot GT 2	GASOIL	IPP	Independent from 01/11/12
Kilroot GT 3	GASOIL	IPP	Commenced Operation 01/03/2009
Kilroot GT 4	GASOIL	IPP	Commenced Operation 01/03/2009
Coolkeeragh GT8	GASOIL	IPP	Independent from 01/02/2013
Coolkeeragh CCGT	GAS/GASOIL	IPP	Commenced Operation 01/04/2005
Moyle	DC LINK		See Note 4

NOTE 1: This is an Independent Power Producer (IPP). At the data freeze date, Ballylumford has in place a contract to provide 250 MW of local reserve. This will see Ballylumford ST4 and ST5 remaining connected (at reduced capacity) until the end of 2018 with an option for SONI to extend this by a further 2 years if deemed required. Ballylumford ST6 will be de-commissioned at the end of 2015.

NOTE 2: In a Generator Unit Agreement (GUA) with Power NI Energy Limited's Power Procurement Business (PPB), the contract expiry date is 23rd September 2018 (with a five-year extension option)[1].

NOTE 3: Kilroot ST1 and ST2 are currently due to be decommissioned by 2024.

NOTE 4: Capacity is auctioned regularly (daily, monthly, seasonally and annually) to the market participants. Capacity is also available in SEM through implicit auction process.

[1] http://www.uregni.gov.uk/uploads/publications/2014-10-10_GUA_Decision_Paper.pdf

APPENDIX E: SHORT CIRCUIT CURRENTS

EIRGRID GROUP

The current. The future.

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.2 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.

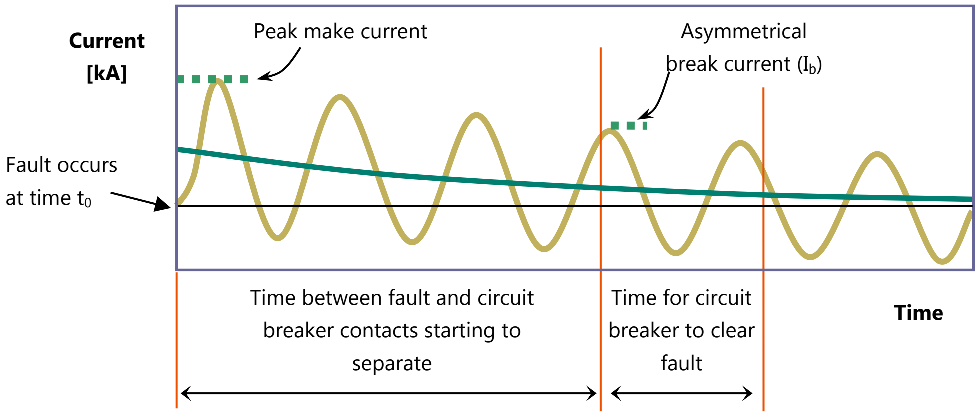


Figure E-1 Typical Short Circuit Current

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, which may result in 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, I_k''.
- 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, I_k'.
- 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, I_k.

E.3 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, and this will occur at approximately 10 milliseconds after the instant of fault (see Figure 8-12), 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.4 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,
- A break time of 50 ms is assumed typical for the circuit breakers at 110 kV, 220 kV, 275 kV and 400 kV.

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[1]). For summer night valley studies, only generators dispatched on a merit order are considered in the model.

E.5 Short Circuit Currents in Ireland

E.5.1 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,
- 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,
- Power station auxiliaries short circuit current level contributions.

[1] 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.

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 use of this calculation method is currently under review by EirGrid.

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-6. In designing the system, a 10% safety margin is applied.

It should be noted that the EirGrid Grid Code Version 4.0 (released in December 2011) contains a modification which 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. The stations currently designated for operation of the 110 kV equipment up to 31.5 kA, as proposed by the TSO, are; Barnahely, Cloghran (future station), College Park, Corduff, Finglas, Kilbarry, Knockraha, Louth, Marina, Raffeen, Tarbert and Trabeg. EirGrid will annually publish an updated list of designated stations.

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 Short Circuit Current Levels - Standard Equipment Rating – Republic of Ireland

Voltage Level		Standard Equipment Short Circuit Current Rating
400 kV		50 kA
220 kV		40 kA
110 kV	Outside the Dublin Area[2]	25 kA
	Designated sites	31.5kA

[2] New equipment installed at 110 kV level must have a short circuit rating of 31.5 kA.

E.5.2 Analysis

The generation dispatches used in the short circuit analysis are shown in Table D-5 in Appendix D.

The total RMS break current at a busbar is an indication of the short circuit 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.5.3 Ireland Short Circuit Currents Level Results

Tables E-9 to E-11 list subtransient (I_k''), transient (I_k') 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 2012, 2015 and 2018. 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)

$$I_{DC\_b} = \sqrt{2} \cdot I_k'' \cdot e^{-2 \cdot \pi \cdot 50 t_b \cdot \frac{R}{X}}$$

- Break current (Ib) at a selected time of break (t_b)

$$I_b = \sqrt{I_{DC\_b}^2 + I_{RMS\_AC\_b}^2}$$

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	-	-	-	-	-	-	13.8	12.8	11.3	8.5	13.8	13.1
Agannygal 110 kV	2.8	4.6	4.4	3.8	4.0	3.9	3.0	6.1	5.4	4.2	4.8	4.6
Aghada 110 kV	5.1	7.2	6.7	5.9	8.7	8.4	4.6	9.9	9.4	5.6	11.2	10.9
Aghada A 220 kV	8.9	7.4	6.7	9.3	9.8	9.3	12.4	17.3	15.4	12.5	19.4	18.6
Aghada B 220 kV	11.8	8.5	7.5	11.2	11.0	10.4	12.8	17.8	15.8	14.0	20.0	19.1
Aghada C 220 kV	9.0	7.5	6.8	9.7	9.9	9.4	13.6	17.2	15.3	11.7	19.5	18.6
Aghada D 220 kV	8.9	7.4	6.7	9.3	9.8	9.3	12.4	17.3	15.4	12.5	19.4	18.6
Ahane 110 kV	5.3	9.6	8.8	6.0	8.6	8.4	4.9	14.0	12.9	5.8	10.8	10.5
Anner 110 kV	3.8	5.7	5.3	4.3	4.3	4.2	3.9	7.0	6.5	4.4	4.9	4.8
Ardnacrusha 110 kV	5.7	10.2	9.3	6.8	11.8	11.4	6.0	16.6	14.9	7.6	16.7	16.1
Arigna 110 kV	3.7	5.9	5.6	4.7	4.7	4.7	3.8	7.8	7.1	5.0	5.5	5.4
Arklow 110 kV	10.3	7.6	7.2	11.1	9.3	9.1	10.4	9.4	8.8	11.2	11.2	10.9
Arklow 220 kV	9.3	6.8	6.4	10.6	6.5	6.4	8.9	8.4	7.9	10.4	7.5	7.4
Artane 110 kV	13.3	9.6	8.9	6.3	11.7	11.3	13.4	12.4	11.2	5.9	14.5	13.9
Arva 110 kV	3.8	7.8	7.3	4.8	6.3	6.2	3.7	9.9	9.0	4.9	7.2	7.0
Athea 110 kV	4.7	4.1	3.9	5.5	4.8	4.7	11.4	9.7	8.2	12.2	9.6	9.0
Athlone 110 kV	4.5	7.0	6.6	5.8	5.4	5.3	4.2	8.2	7.6	5.6	5.9	5.8
Athy 110 kV	3.3	5.4	5.2	4.5	4.5	4.5	3.1	6.4	6.1	4.3	5.2	5.1
Aughinish 110 kV	8.9	8.7	7.7	10.8	9.8	9.3	8.0	10.7	9.6	10.1	11.1	10.7
Ballybeg 110 kV	9.5	6.1	5.8	9.8	7.2	7.1	9.5	7.2	6.9	9.8	8.3	8.1
Ballydine 110 kV	3.9	6.3	6.0	3.7	5.2	5.1	3.9	7.7	7.2	3.7	5.9	5.8
Ballylickey 110 kV	2.7	2.5	2.4	3.9	1.7	1.7	2.9	3.3	3.1	4.0	1.9	1.9
Ballyvouskill 110 kV	-	-	-	-	-	-	8.5	12.3	11.3	9.4	12.3	11.9
Ballyvouskill 220 kV	-	-	-	-	-	-	7.8	9.1	8.5	8.9	10.3	10.0
Ballywater 110 kV	4.7	4.9	4.7	3.3	5.2	5.1	4.7	6.1	5.7	3.2	6.0	5.9
Baltrasna 110 kV	6.4	9.4	8.8	7.5	7.4	7.3	6.0	11.2	10.6	7.2	8.3	8.2
Bancroft 110 kV	11.1	12.9	11.7	6.4	14.1	13.6	10.5	16.5	14.7	5.9	17.1	16.3
Bandon 110 kV	3.3	4.9	4.6	4.5	4.3	4.2	3.0	6.6	6.1	4.1	6.2	6.1
Banoge 110 kV	6.1	5.4	5.2	6.8	4.9	4.8	5.9	6.5	6.1	6.8	5.6	5.5
Barnahealy A 110 kV	5.4	9.4	8.5	5.9	10.3	9.9	4.5	14.0	12.9	5.3	13.8	13.4
Barnahealy B 110 kV	7.3	9.1	8.3	7.7	9.9	9.5	6.7	13.6	12.5	7.3	13.2	12.8
Barnakyle 110 kV	-	-	-	-	-	-	19.3	13.3	11.7	12.1	14.0	13.4
Baroda 110 kV	4.3	7.4	6.9	5.1	8.5	8.3	4.0	9.2	8.5	4.9	10.2	9.9
Barrymore 110 kV	4.0	6.5	6.1	4.9	4.2	4.1	3.6	8.4	7.9	4.8	4.7	4.7
Bellacorick 110 kV	2.6	2.9	2.8	3.3	3.1	3.1	3.1	4.1	3.7	4.1	3.9	3.8
Binbane 110 kV	3.2	3.4	3.2	4.3	3.3	3.3	3.4	4.9	4.4	5.0	4.2	4.1
Blackrock 110 kV	8.8	12.2	11.1	2.4	10.6	10.3	8.2	15.5	13.8	2.2	12.3	11.9
Blake 110 kV	4.2	7.1	6.7	5.1	5.1	5.0	4.0	8.7	8.2	5.0	5.7	5.6

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Boggeragh 110 kV	6.3	5.5	5.2	7.5	6.1	6.0	6.7	8.3	7.6	8.1	8.1	7.9
Booltiagh 110 kV	2.8	3.3	3.2	3.9	3.1	3.1	3.1	4.5	4.1	4.6	3.7	3.6
Brinny A 110 kV	3.2	4.5	4.3	4.3	3.8	3.7	2.9	5.9	5.5	4.0	5.1	5.0
Brinny B 110 kV	3.2	4.5	4.3	4.3	3.8	3.7	2.9	5.9	5.5	4.0	5.2	5.1
Butlerstown 110 kV	6.2	9.1	8.6	5.8	9.4	9.2	5.5	11.1	10.3	5.4	10.9	10.6
Cabra 110 kV	12.4	9.3	8.7	5.2	10.6	10.3	12.3	12.0	10.8	4.8	12.9	12.5
Cahir 110 kV	3.7	6.9	6.4	4.7	5.9	5.8	4.1	9.6	8.8	5.2	7.2	7.1
Carlow 110 kV	5.3	7.2	6.9	6.1	7.9	7.8	5.3	9.2	8.5	6.1	9.5	9.3
Carrickmines 110 kV	21.2	14.5	13.0	16.5	16.2	15.5	22.3	19.1	16.7	16.4	20.1	19.1
Carrickmines 220 kV	14.4	14.4	12.6	9.7	17.8	16.7	13.8	21.4	18.8	8.5	24.7	23.4
Carrickmines County 110 kV	21.2	14.5	13.0	16.5	16.2	15.5	22.3	19.1	16.7	16.4	20.1	19.1
Carrick-on-Shannon 110 kV	4.4	9.2	8.6	5.1	10.3	10.0	4.2	12.2	11.1	5.0	12.7	12.2
Carrigadrohid 110 kV	5.9	8.4	7.7	6.5	7.9	7.7	6.2	13.5	12.3	7.1	10.6	10.4
Carrowbeg 110 kV	2.6	2.4	2.3	3.5	2.3	2.2	2.6	2.8	2.6	3.7	2.5	2.4
Cashla 110 kV	6.8	11.9	10.9	7.4	15.3	14.7	7.0	17.2	15.5	7.7	20.7	19.9
Cashla 220 kV	7.9	7.4	6.9	9.1	8.2	8.0	7.9	11.7	10.9	9.4	11.3	11.1
Castlebar 110 kV	2.9	3.8	3.6	3.6	4.1	4.1	3.1	5.2	4.6	4.1	5.1	4.9
Castledockrill 110 kV	6.9	6.4	6.1	4.9	7.8	7.7	6.9	8.1	7.6	4.7	9.2	9.0
Castlefarm A 110 kV	8.1	8.5	7.5	9.5	9.1	8.7	7.2	10.3	9.3	8.8	10.3	10.0
Castlefarm B 110 kV	8.1	8.4	7.5	9.5	9.1	8.7	7.2	10.2	9.2	8.8	10.3	10.0
Castleview 110 kV	4.6	9.6	8.7	4.9	7.8	7.6	3.8	14.1	13.1	4.5	9.7	9.5
Cathaleen's Fall 110 kV	4.2	6.2	5.8	4.9	6.9	6.8	5.1	10.7	9.3	6.2	9.8	9.4
Cauteen 110 kV	3.0	5.6	5.3	4.0	3.7	3.7	3.6	7.6	7.1	4.8	4.4	4.4
Central 110 kV	11.1	12.9	11.8	6.0	14.0	13.5	10.6	16.6	14.8	5.5	16.9	16.2
Charleville 110 kV	4.6	5.2	4.9	5.3	4.3	4.2	4.6	7.6	6.8	5.4	5.3	5.1
City West 110 kV	6.3	7.2	6.6	6.2	5.5	5.4	6.0	8.6	7.6	6.0	6.1	5.9
Clahane 110 kV	4.2	5.5	5.1	4.9	5.8	5.6	3.6	5.5	5.0	4.6	5.1	4.9
Clashavoon 220 kV	8.3	5.9	5.4	9.2	6.4	6.2	8.2	10.1	9.3	9.1	10.2	10.0
Clashavoon A 110 kV	7.7	9.3	8.5	8.7	10.6	10.2	7.8	15.9	14.3	9.1	15.9	15.3
Clashavoon B 110 kV	7.7	9.3	8.5	8.7	10.6	10.2	7.8	15.9	14.3	9.1	15.9	15.3
Cliff 110 kV	3.9	5.1	4.8	4.9	5.2	5.1	4.6	8.0	7.2	5.9	6.8	6.6
Cloghboola 110 kV	4.1	4.3	4.1	4.5	5.3	5.2	7.0	7.0	5.7	7.8	7.5	7.0
Cloghran 110 kV	7.3	14.0	12.8	7.4	13.1	12.7	9.5	24.1	21.9	9.3	24.1	23.3
Clonkeen A 110 kV	5.8	4.8	4.6	6.4	5.6	5.5	6.5	12.0	10.6	6.1	11.6	11.2
Clonkeen B 110 kV	5.8	4.8	4.5	6.5	5.6	5.5	6.5	12.0	10.7	6.1	11.7	11.2
Cloon 110 kV	4.4	6.4	6.0	5.3	4.7	4.6	4.3	7.9	7.4	5.3	5.3	5.2
College Park 110 kV	9.9	17.3	15.5	7.0	19.4	18.6	9.2	22.9	20.9	6.3	24.4	23.6
Cookstown 110 kV	6.7	8.8	8.2	5.7	7.1	7.0	6.3	10.5	9.7	5.5	8.0	7.8

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	5.6	7.6	7.0	6.8	7.7	7.5	5.1	11.2	10.4	6.7	9.8	9.6
Coomagearlahy 110 kV	5.7	4.0	3.9	6.5	5.0	4.9	6.5	9.2	8.1	7.6	9.5	9.0
Coomataggart110 kV	-	-	-	-	-	-	5.9	3.8	3.7	6.8	4.0	4.0
Corderry 110 kV	3.7	6.1	5.7	4.6	6.2	6.0	4.0	8.8	7.8	5.2	7.9	7.6
Corduff 110 kV	10.8	19.1	17.0	11.7	21.7	20.7	10.3	26.1	23.5	11.6	27.9	26.9
Corduff 220 kV	15.1	14.7	13.0	13.9	18.3	17.3	15.4	25.4	22.2	13.3	28.7	27.2
Corkagh 110 kV	-	-	-	-	-	-	17.9	13.3	11.7	12.0	14.3	13.6
Corraclassy 110 kV	4.2	5.7	5.3	5.3	4.6	4.6	4.2	7.0	6.6	5.5	5.2	5.1
Cow Cross 110 kV	4.9	9.4	8.6	5.2	8.7	8.5	4.1	14.1	13.0	4.7	11.2	10.9
Crane 110 kV	6.5	6.9	6.6	6.5	7.6	7.4	6.6	9.0	8.3	6.6	9.0	8.8
Cromcastle A 110 kV	12.1	9.5	8.6	7.5	10.7	10.3	11.9	12.3	10.9	7.2	13.1	12.5
Cromcastle B 110 kV	12.1	9.5	8.6	7.5	10.7	10.3	11.9	12.3	10.9	7.2	13.1	12.5
Crory 110 kV	8.5	7.2	6.9	8.9	9.1	8.9	8.8	9.3	8.7	9.0	11.0	10.7
Cullenagh 110 kV	8.2	11.1	10.3	8.7	13.1	12.7	7.3	13.9	12.8	7.9	15.7	15.2
Cullenagh 220 kV	9.2	7.9	7.4	9.4	8.2	8.0	8.1	9.8	9.3	8.6	9.6	9.4
Cunghill 110 kV	2.9	4.1	3.9	3.8	4.0	3.9	3.1	5.8	5.3	4.4	4.9	4.8
Cushaling 110 kV	6.0	7.1	6.3	7.1	8.7	8.3	7.9	10.9	9.6	9.8	12.0	11.4
Dallow 110 kV	3.5	4.8	4.6	4.7	3.1	3.0	3.4	5.5	5.2	4.6	3.4	3.3
Dalton 110 kV	3.0	3.5	3.3	4.0	3.1	3.1	3.0	4.3	3.9	4.2	3.5	3.4
Dardistown 110 kV	15.1	9.6	8.7	12.1	11.1	10.7	15.5	12.5	11.1	11.9	13.7	13.0
Derrybrien 110 kV	2.6	3.6	3.5	3.7	3.6	3.5	3.0	5.0	4.4	4.4	4.4	4.2
Derryiron 110 kV	5.6	4.4	4.2	6.6	5.1	5.0	7.7	6.9	6.3	9.2	7.0	6.8
Doon 110 kV	4.0	6.2	5.8	4.4	4.8	4.7	4.1	7.8	7.1	4.6	5.5	5.4
Dromada 110 kV	4.3	4.0	3.8	4.3	4.6	4.5	7.6	9.2	7.8	5.4	8.8	8.3
Drumkeen 110 kV	3.4	4.6	4.4	4.1	4.8	4.7	3.8	7.6	6.5	4.9	6.4	6.1
Drumline 110 kV	3.5	6.3	5.9	4.6	5.7	5.6	3.2	8.4	7.7	4.5	6.8	6.7
Drybridge 110 kV	5.8	11.7	10.7	6.7	10.1	9.8	5.3	14.7	13.6	6.4	11.8	11.5
Dundalk 110 kV	3.8	7.8	7.3	4.8	7.3	7.1	3.4	9.3	8.6	4.5	8.3	8.1
Dunfirth 110 kV	4.9	4.9	4.7	6.4	4.1	4.1	4.9	5.9	5.7	6.5	4.7	4.6
Dungarvan 110 kV	6.0	5.4	5.1	7.8	4.6	4.5	5.8	6.6	6.2	7.7	5.3	5.2
Dunmanway 110 kV	3.4	4.8	4.5	4.5	4.4	4.3	3.3	6.8	6.2	4.5	5.6	5.4
Dunstown 220 kV	12.9	14.6	13.0	11.8	14.6	14.0	10.9	19.9	18.1	10.5	18.2	17.7
Dunstown 400 kV	21.7	4.4	4.1	15.3	3.9	3.8	20.6	5.6	5.4	14.4	4.7	4.6
Ennis 110 kV	3.9	7.4	6.9	4.9	7.2	7.1	3.7	10.5	9.4	5.0	9.1	8.8
Fassaroe East 110 kV	5.2	8.4	7.9	5.5	6.2	6.1	4.9	10.1	9.3	5.3	6.9	6.8
Fassaroe West 110 kV	5.0	8.4	7.8	5.2	6.2	6.1	4.6	10.0	9.3	5.1	6.9	6.8
Finglas 220 kV	14.6	14.1	12.4	14.2	18.0	17.0	16.3	25.2	21.9	14.8	29.4	27.7
Finglas A 110 kV	27.2	10.9	9.8	25.9	12.4	11.9	34.1	14.6	12.8	29.9	15.6	14.9

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	9.2	15.5	14.1	6.5	13.9	13.5	8.9	21.7	20.0	6.6	18.1	17.7
Flagford 110 kV	4.7	9.6	8.9	5.4	11.8	11.4	4.5	12.8	11.6	5.4	14.9	14.3
Flagford 220 kV	7.1	6.0	5.6	9.0	5.9	5.7	7.3	7.8	7.4	9.6	7.0	6.9
Francis Street A 110 kV	11.3	10.0	9.2	5.8	12.3	11.9	11.0	12.2	11.1	5.5	14.5	14.0
Francis Street B 110 kV	13.1	10.9	10.1	6.9	13.4	12.9	12.7	13.3	12.3	6.5	15.9	15.4
Galway 110 kV	4.8	9.4	8.7	5.4	10.5	10.1	4.6	12.8	11.6	5.3	13.1	12.6
Garrow 110 kV	4.7	4.2	4.0	4.6	4.9	4.8	6.6	11.7	10.6	6.2	11.5	11.1
Garvagh 110 kV	3.9	4.8	4.6	5.1	4.7	4.6	4.4	6.7	5.9	5.9	5.8	5.6
Gilra 110 kV	3.3	5.6	5.4	4.1	4.5	4.5	3.1	6.7	6.3	4.0	5.0	5.0
Glanagow 220 kV	12.1	8.8	7.7	12.3	11.4	10.7	14.1	17.7	15.7	13.5	20.3	19.3
Glanlee 110 kV	5.7	4.0	3.8	6.2	4.9	4.8	6.4	8.7	7.7	6.8	9.1	8.7
Glasmore 110 kV	5.0	6.1	5.7	5.4	4.5	4.4	4.7	7.5	6.8	5.2	5.0	4.9
Glenlara A 110 kV	3.0	2.5	2.4	3.2	3.0	3.0	4.2	4.3	3.6	4.3	4.6	4.3
Glenlara B 110 kV	3.0	2.5	2.4	3.2	3.0	3.0	4.2	4.3	3.6	4.3	4.6	4.3
Glenree 110 kV	2.7	3.1	2.9	3.4	3.0	3.0	3.5	4.8	4.4	4.4	3.8	3.7
Golagh 110 kV	3.1	3.6	3.5	4.0	2.7	2.7	3.2	5.0	4.5	4.2	3.2	3.1
Gorman 110 kV	6.8	12.4	11.4	7.7	13.9	13.4	6.1	15.6	14.3	7.1	16.6	16.1
Gorman 220 kV	9.6	9.6	8.8	10.3	8.3	8.1	8.5	12.2	11.6	9.6	9.8	9.6
Gortawee 110 kV	4.3	5.5	5.2	5.7	4.7	4.6	4.4	6.7	6.2	6.0	5.2	5.1
Grange 110 kV	12.9	9.6	8.8	4.6	10.2	9.9	12.9	12.7	11.2	4.3	12.4	11.9
Grange Castle 110 kV	12.9	11.2	10.1	9.2	14.1	13.4	18.2	13.5	11.8	12.8	14.7	13.9
Great Island 110 kV	7.9	11.1	10.4	8.7	14.5	14.1	6.9	13.7	12.6	7.8	17.3	16.7
Great Island 220 kV	12.4	10.3	9.6	13.8	12.5	12.1	10.6	12.5	11.7	12.0	14.4	14.0
Griffinrath A 110 kV	7.6	9.0	8.4	7.8	9.3	9.1	7.0	11.0	10.4	7.4	10.9	10.7
Griffinrath B 110 kV	8.2	9.2	8.7	8.0	9.3	9.1	7.6	11.4	10.7	7.5	10.9	10.6
Harolds 110 kV	11.5	10.0	9.2	5.5	12.3	11.8	11.2	12.2	11.1	5.2	14.5	13.9
Heuston 110 kV	14.1	11.1	10.3	8.3	13.7	13.3	13.8	13.6	12.5	7.8	16.4	15.8
Huntstown A 220 kV	14.0	13.6	12.1	12.7	17.5	16.5	15.6	24.2	21.2	12.9	28.3	26.7
Huntstown B 220 kV	15.1	13.9	12.4	11.7	17.3	16.4	14.7	22.7	20.1	10.4	26.0	24.8
Ikerrin 110 kV	5.2	4.1	3.9	6.0	3.2	3.1	5.8	5.6	5.1	6.5	3.8	3.7
Inchicore 220 kV	14.5	16.2	14.0	11.3	20.2	18.9	13.7	25.6	22.1	10.0	29.5	27.8
Inchicore A 110 kV	27.0	12.1	11.1	24.4	15.3	14.8	29.6	15.1	13.7	25.8	18.6	17.9
Inchicore B 110 kV	38.3	12.1	10.9	31.8	15.5	14.8	46.7	15.5	13.5	35.5	19.2	18.1
Inniscarra 110 kV	5.1	7.3	6.8	6.2	7.2	7.0	4.7	10.8	10.0	6.1	9.2	8.9
Irishtown 220 kV	15.2	15.4	13.3	12.5	19.4	18.2	15.2	24.2	20.9	11.5	28.3	26.7
Kellis 110 kV	6.4	7.8	7.4	7.4	9.3	9.1	6.2	9.8	9.1	7.3	11.2	10.9
Kellis 220 kV	8.2	7.0	6.7	9.9	6.2	6.1	7.7	8.5	8.1	9.6	7.0	6.9
Kilbarry 110 kV	7.5	12.9	11.3	8.0	14.5	13.8	7.2	23.8	20.6	8.0	22.5	21.4

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Kildonan 110 kV	9.2	15.5	14.1	6.5	13.9	13.5	8.9	21.7	20.0	6.6	18.1	17.7
Kilkenny 110 kV	3.0	4.7	4.5	4.3	4.3	4.2	3.0	5.6	5.2	4.3	4.8	4.7
Kill Hill 110 kV	4.4	4.7	4.5	5.4	4.4	4.3	5.5	7.1	6.4	6.6	5.6	5.5
Kilinaparson 110kV	5.1	5.7	5.4	6.8	4.5	4.5	4.9	6.5	6.2	6.7	5.0	4.9
Killonan 110 kV	6.6	12.5	11.2	7.6	14.6	13.9	6.4	20.7	18.4	7.9	21.2	20.3
Killonan 220 kV	7.7	7.2	6.6	9.5	7.5	7.3	7.6	11.5	10.7	10.0	10.3	10.1
Killoteran 110 kV	6.3	9.7	9.1	5.4	10.8	10.5	5.7	11.9	10.9	5.0	12.6	12.2
Kilmahud 110 kV	11.2	10.9	9.8	7.4	13.5	12.9	17.7	13.4	11.7	12.1	14.5	13.8
Kilmore 110 kV	14.6	9.8	9.0	9.7	11.2	10.8	14.9	13.0	11.4	9.3	13.9	13.2
Kilteel 110 kV	4.6	6.8	6.4	5.6	6.3	6.2	4.3	8.2	7.7	5.4	7.2	7.0
Kinnegad 110 kV	5.2	4.2	4.0	6.4	4.2	4.1	5.8	5.7	5.3	7.3	5.1	5.0
Knockacummer 110 kV	2.9	2.3	2.2	3.2	2.9	2.8	4.1	4.0	3.3	4.7	4.4	4.1
Knockanure 110 kV	-	-	-	-	-	-	15.1	12.0	10.0	14.1	12.2	11.5
Knockanure 220 kV	-	-	-	-	-	-	8.5	10.6	9.5	9.4	10.5	10.1
Knockearagh 110 kV	5.5	4.5	4.3	6.7	4.5	4.4	5.6	7.6	6.9	7.1	6.2	6.1
Knockraha A 110 kV	9.3	14.4	12.6	9.9	16.0	15.2	9.0	26.0	22.9	9.8	24.3	23.3
Knockraha A 220 kV	10.3	9.1	8.1	10.6	11.1	10.5	11.2	19.3	17.1	11.2	19.6	18.8
Knockraha B 110 kV	9.3	14.4	12.6	9.9	16.0	15.2	9.0	26.0	22.9	9.8	24.3	23.3
Knockraha B 220 kV	10.3	9.1	8.1	10.6	11.1	10.5	11.2	19.3	17.1	11.2	19.6	18.8
Knockraha C 110 kV	9.3	14.4	12.6	9.9	16.0	15.2	9.0	26.0	22.9	9.8	24.3	23.3
Knockumber 110 kV	3.9	7.6	7.1	4.7	5.8	5.7	3.6	8.8	8.2	4.5	6.3	6.2
Lanesboro 110 kV	4.2	9.1	8.3	5.4	9.4	9.1	3.7	10.6	9.7	4.9	10.5	10.2
Letterkenny 110 kV	3.7	5.4	5.0	4.4	6.2	6.1	4.3	9.2	7.8	5.4	9.0	8.5
Liberty A 110 kV	6.3	11.5	10.2	5.5	13.5	12.9	5.7	20.0	17.6	4.8	20.5	19.5
Liberty B 110 kV	6.2	11.4	10.2	5.3	13.5	12.8	5.6	19.9	17.5	4.7	20.4	19.5
Limerick 110 kV	5.5	11.2	10.1	6.2	11.5	11.0	5.0	17.6	15.8	6.0	15.5	15.0
Lisdrum 110 kV	2.9	4.6	4.5	4.1	4.1	4.0	2.7	5.3	5.0	4.1	4.4	4.3
Lisheen 110 kV	3.9	3.2	3.0	3.9	4.8	4.6	5.0	5.2	4.4	5.0	7.7	7.2
Lodgewood 110 kV	8.5	7.2	6.9	8.9	9.1	8.9	8.8	9.3	8.7	9.0	11.0	10.7
Lodgewood 220 kV	9.0	6.5	6.2	10.2	6.5	6.4	8.8	8.0	7.6	9.9	7.5	7.3
Longpoint 220 kV	8.8	7.4	6.7	9.2	9.7	9.3	12.5	17.5	15.6	12.3	19.5	18.6
Louth 220 kV	10.7	12.6	11.2	11.6	15.0	14.3	9.4	18.9	17.4	10.6	20.6	19.9
Louth A 110 kV	7.3	11.0	10.2	8.3	13.5	13.0	6.6	13.6	12.7	7.7	16.1	15.6
Louth B 110 kV	7.9	11.8	10.9	8.7	14.8	14.3	7.1	14.7	13.7	8.0	17.8	17.3
Macetown 110 kV	7.9	15.2	13.8	7.6	15.3	14.8	7.3	20.2	18.6	7.3	18.9	18.4
Macroom 110 kV	6.6	9.1	8.3	7.1	9.1	8.8	6.3	15.0	13.6	7.1	12.5	12.2
Mallow 110 kV	5.3	5.6	5.2	6.8	4.9	4.8	5.1	7.4	6.9	6.9	5.9	5.8
Marina 110 kV	7.2	12.3	10.9	8.0	14.7	14.0	7.1	22.7	19.7	8.3	23.2	22.1

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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 110 kV	11.8	10.9	10.2	12.3	13.6	13.2	11.2	13.9	12.9	11.9	16.7	16.2
Maynooth A 220 kV	11.3	13.7	12.2	10.7	13.7	13.1	9.7	18.9	17.2	9.6	17.2	16.7
Maynooth B 110 kV	8.9	14.6	13.3	10.4	14.5	14.0	7.8	18.3	17.0	9.4	17.2	16.8
Maynooth B 220 kV	11.8	15.1	13.3	10.9	15.2	14.5	9.8	22.1	20.0	9.6	19.9	19.3
McDermott 110 kV	15.5	9.9	9.1	6.4	11.7	11.4	16.1	12.8	11.5	6.0	14.6	14.0
Meath Hill 110 kV	4.1	7.9	7.4	5.2	6.7	6.6	3.8	9.4	8.8	5.1	7.5	7.4
Meentycat 110 kV	3.2	4.0	3.8	4.0	4.1	4.0	3.7	6.3	5.5	5.0	5.3	5.1
Midleton 110 kV	4.1	8.3	7.6	5.0	7.1	6.9	3.4	11.6	10.8	4.6	8.7	8.5
Milltown A 110 kV	15.1	10.7	9.8	7.5	13.3	12.8	15.0	13.2	11.9	7.1	15.9	15.2
Milltown B 110 kV	9.2	9.9	9.3	4.3	12.0	11.6	8.8	12.0	11.1	4.0	14.1	13.6
Misery Hill 110 kV	13.8	10.5	9.6	8.2	13.1	12.7	13.6	12.9	11.7	7.8	15.7	15.0
Moneteen 110 kV	5.7	8.8	8.0	6.5	7.2	7.1	5.3	12.0	11.1	6.3	8.6	8.4
Moneypoint 110 kV	2.5	2.1	2.0	3.7	1.5	1.5	2.9	2.7	2.5	4.2	1.7	1.7
Moneypoint 220 kV	8.5	5.1	4.8	8.3	6.0	5.9	12.5	10.5	9.8	9.9	10.1	9.9
Moneypoint G1 400 kV	19.7	4.9	4.5	17.8	5.5	5.3	23.3	7.2	6.8	18.9	7.1	6.9
Moneypoint G2 400 kV	13.3	1.9	1.8	13.7	2.4	2.3	29.1	3.9	3.7	23.1	4.1	4.0
Moneypoint G3 400 kV	19.7	4.9	4.5	17.8	5.5	5.3	23.3	7.2	6.8	18.9	7.1	6.9
Monread 110 kV	4.3	6.7	6.3	5.1	6.8	6.6	4.0	8.1	7.6	5.0	7.8	7.6
Mount Lucas 110 kV	4.5	4.2	3.9	5.6	4.1	4.0	5.1	5.9	5.5	6.5	5.1	5.0
Moy 110 kV	2.7	2.9	2.8	3.1	3.5	3.5	4.0	4.9	4.5	5.0	5.2	5.0
Mullagharlin 110 kV	3.9	7.9	7.4	4.9	7.8	7.6	3.5	9.3	8.7	4.6	8.8	8.6
Mullingar 110 kV	2.8	4.1	3.9	3.9	4.2	4.1	2.7	4.6	4.3	3.8	4.7	4.5
Mungret A 110 kV	5.4	8.4	7.7	6.1	6.8	6.6	4.9	11.4	10.5	5.9	8.0	7.8
Mungret B 110 kV	5.4	8.5	7.7	6.1	6.8	6.6	4.9	11.4	10.5	5.9	8.0	7.8
Nangor 110 kV	11.8	11.0	9.9	7.7	13.7	13.1	15.7	13.2	11.5	10.2	14.2	13.5
Navan 110 kV	5.8	11.0	10.2	6.5	11.0	10.7	5.2	13.6	12.5	6.1	12.8	12.5
Nenagh 110 kV	2.7	3.2	3.1	3.8	1.9	1.9	2.7	3.9	3.6	3.9	2.1	2.1
Newbridge 110 kV	4.6	8.4	7.8	5.2	8.4	8.2	4.3	11.0	10.0	5.1	10.2	9.9
Newbury 110kV	13.9	9.8	8.9	7.3	10.9	10.5	14.0	12.8	11.3	6.9	13.4	12.8
North Quays 110 kV	17.9	10.9	9.9	7.1	13.3	12.8	18.1	13.4	12.1	6.6	15.9	15.3
North Wall 220 kV	13.7	13.0	11.6	9.5	15.5	14.7	14.7	22.7	19.9	8.5	23.7	22.6
Oldcourt A 110 kV	4.4	8.2	7.6	4.8	6.9	6.8	3.6	11.6	10.8	4.4	8.4	8.2
Oldcourt B 100 kV	4.4	8.2	7.6	4.8	6.9	6.8	3.6	11.6	10.9	4.4	8.5	8.3
Oldstreet 220 kV	13.2	6.8	6.4	11.9	8.0	7.8	15.2	11.0	10.4	12.5	11.6	11.4
Oldstreet 400 kV	15.7	5.3	4.9	11.2	5.5	5.3	17.7	7.7	7.3	10.9	7.2	7.0
Oughtagh 110 kV	3.8	3.8	3.6	4.8	2.7	2.7	3.7	4.9	4.6	4.8	3.1	3.0
Pelletstown 110 kV	13.7	9.4	8.7	8.1	10.4	10.1	13.9	12.1	10.9	7.8	12.7	12.2
Platin 110 kV	5.3	10.9	10.1	5.8	8.6	8.4	4.7	13.4	12.4	5.5	9.7	9.5

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Pollaphuca 110 kV	2.8	2.4	2.3	4.0	2.2	2.2	3.3	3.1	3.0	4.7	2.6	2.6
Poolbeg A 110 kV	23.9	11.3	10.3	20.7	14.5	13.9	25.6	14.1	12.7	21.3	17.5	16.8
Poolbeg A 220 kV	14.3	13.1	11.7	8.3	14.8	14.1	15.5	22.8	20.0	7.2	22.3	21.3
Poolbeg B 110 kV	23.9	11.3	10.3	20.7	14.5	13.9	25.6	14.0	12.7	21.3	17.5	16.8
Poolbeg B 220 kV	13.9	15.3	13.3	10.7	18.0	17.0	13.1	23.5	20.5	9.6	25.4	24.1
Poolbeg C 110 kV	19.6	11.1	10.1	8.1	13.6	13.1	20.2	13.7	12.4	7.7	16.3	15.6
Poppintree 110 kV	15.4	10.1	9.2	9.8	11.5	11.1	15.9	13.3	11.8	9.5	14.2	13.6
Portan 400 kV	20.1	6.3	5.8	19.1	7.3	7.0	19.6	8.9	8.5	18.9	10.0	9.8
Portlaoise 110 kV	4.2	7.2	6.7	5.5	6.2	6.1	3.9	9.1	8.4	5.4	7.3	7.1
Pottery 110 kV	13.1	13.5	12.2	4.4	13.7	13.2	12.7	17.5	15.5	4.1	16.4	15.7
Prospect 220 kV	8.0	6.1	5.6	8.2	7.4	7.1	11.1	13.6	12.4	9.9	13.4	13.0
Raffeen 220 kV	11.2	8.6	7.6	11.2	11.1	10.5	12.4	18.4	16.3	11.7	20.9	19.9
Raffeen A 110 kV	6.5	10.6	9.5	7.1	13.0	12.4	5.6	16.7	15.2	6.5	18.8	18.1
Raffeen B 110 kV	8.9	10.3	9.2	9.6	12.6	12.0	8.7	16.1	14.6	9.6	18.1	17.4
Rathkeale 110 kV	3.6	5.8	5.4	4.8	4.9	4.8	3.4	7.9	7.4	4.8	5.9	5.8
Ratrussan 110 kV	3.1	5.8	5.5	3.9	6.6	6.5	3.6	8.0	6.8	4.7	8.3	7.8
Reamore 110 kV	4.5	5.1	4.8	3.6	5.0	4.9	4.5	7.0	6.3	3.6	5.9	5.8
Richmond A 110 kV	3.3	6.3	5.9	4.5	5.7	5.6	3.1	7.2	6.7	4.3	6.4	6.2
Richmond B 110 kV	3.3	6.3	5.9	4.5	5.7	5.6	3.1	7.2	6.7	4.3	6.4	6.2
Rinawade 110 kV	5.2	9.3	8.7	6.1	7.1	6.9	4.8	11.1	10.6	5.9	7.9	7.8
Ringaskiddy 110 kV	6.5	8.9	8.1	6.7	9.3	9.0	5.7	13.1	12.1	6.2	12.2	11.9
Ringsend 110 kV	23.9	11.3	10.3	21.4	14.5	13.9	25.5	14.1	12.7	22.1	17.6	16.8
Ryebrook 110 kV	6.0	12.9	11.7	7.0	11.4	11.1	5.1	15.4	14.3	6.2	13.2	12.9
Salthill 110 kV	4.4	8.5	7.9	4.1	9.3	9.0	4.2	11.4	10.4	3.9	11.5	11.1
Screeb 110 kV	3.4	2.3	2.2	4.4	1.4	1.3	3.3	2.6	2.4	4.3	1.4	1.4
Seal Rock A 110 kV	8.6	8.6	7.6	10.3	9.6	9.2	7.7	10.5	9.4	9.5	11.0	10.6
Seal Rock B 110 kV	8.7	8.6	7.6	10.3	9.6	9.2	7.7	10.5	9.4	9.5	11.0	10.6
Shankill 110 kV	3.5	7.0	6.5	4.5	6.6	6.4	3.5	9.1	8.0	4.7	7.9	7.6
Shannonbridge 110 kV	7.1	14.0	12.4	8.7	15.9	15.2	6.1	17.2	15.4	7.7	18.7	17.9
Shannonbridge 220 kV	8.2	6.2	5.8	10.5	5.6	5.5	7.2	7.6	7.3	9.8	6.4	6.3
Shellybanks A 220 kV	14.1	13.1	11.6	8.3	16.2	15.4	15.3	22.7	20.0	7.0	25.5	24.2
Shellybanks B 220 kV	14.5	14.9	12.9	11.0	18.6	17.5	14.6	23.3	20.3	10.0	27.0	25.4
Shelton Abbey 110 kV	7.6	6.8	6.5	7.6	7.3	7.2	7.3	8.3	7.8	7.4	8.5	8.3
Singland 110 kV	6.2	10.7	9.7	7.1	11.4	11.0	6.2	16.8	15.2	7.4	15.5	15.0
Sligo 110 kV	3.8	6.9	6.4	4.5	7.0	6.8	3.7	10.0	9.0	4.7	8.9	8.6
Somerset 110 kV	3.2	6.9	6.5	4.1	4.6	4.5	2.9	8.1	7.6	4.0	5.1	5.0
Sorne Hill 110 kV	2.7	2.2	2.1	3.3	2.6	2.5	3.5	3.6	3.2	4.4	3.6	3.5
Srananagh 110 kV	4.6	7.8	7.3	5.3	9.0	8.8	4.7	11.7	10.4	5.7	12.2	11.6

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2015 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Srananagh 220 kV	6.5	3.8	3.7	8.6	3.3	3.3	7.3	4.9	4.6	9.7	3.8	3.8
Stevenstown 110 kV	4.8	5.2	4.9	5.2	3.6	3.5	4.6	6.1	5.7	5.1	3.9	3.8
Stratford 110 kV	3.2	3.6	3.5	4.1	3.0	2.9	3.4	4.6	4.3	4.4	3.4	3.3
Taney 110 kV	7.2	11.3	10.4	2.7	10.9	10.6	6.6	14.1	12.7	2.5	12.7	12.3
Tarbert 110 kV	8.3	10.5	9.5	9.5	12.4	11.9	12.3	20.8	18.6	14.5	19.3	18.6
Tarbert 220 kV	8.2	6.5	6.0	9.0	8.5	8.2	13.4	16.3	14.4	14.5	18.1	17.3
Tawnaghmore A 110 kV	2.6	2.5	2.4	3.2	2.8	2.8	3.8	4.0	3.8	5.0	3.9	3.8
Tawnaghmore B 110 kV	2.6	2.5	2.4	3.1	3.1	3.0	3.9	4.1	3.8	5.0	4.4	4.2
Thornsberry 110 kV	3.6	2.7	2.6	4.5	2.9	2.9	3.8	3.9	3.6	5.0	3.8	3.7
Thurles 110 kV	4.8	4.1	3.9	5.2	4.7	4.6	6.1	6.5	5.6	6.4	6.7	6.3
Tipperary 110 kV	3.1	5.5	5.2	4.0	3.7	3.7	4.0	7.4	6.9	5.2	4.6	4.5
Tonroe 110 kV	2.7	3.0	3.0	3.7	1.9	1.9	2.7	3.5	3.3	3.8	2.1	2.1
Trabeg 110 kV	7.2	12.3	10.8	7.8	14.4	13.7	7.1	22.3	19.4	8.0	22.6	21.4
Tralee 110 kV	5.0	6.3	5.8	5.8	6.2	6.0	5.2	9.0	8.0	6.3	7.5	7.2
Trien A 110 kV	4.5	5.7	5.3	5.0	6.8	6.6	3.2	4.2	3.8	4.4	4.0	3.8
Trien B 110 kV	4.5	5.7	5.3	5.0	6.8	6.6	10.7	9.4	7.8	8.9	8.9	8.3
Trillick 110 kV	2.7	2.4	2.3	3.4	2.6	2.6	3.6	4.0	3.4	4.5	3.6	3.5
Tullabrack 110 kV	2.6	2.2	2.1	3.7	1.6	1.6	2.9	2.9	2.6	4.2	1.8	1.8
Turlough 220 kV	12.2	10.8	9.7	13.4	9.9	9.6	10.7	12.8	11.9	12.3	11.1	10.8
Tynagh 220 kV	10.4	6.5	6.2	11.4	8.2	8.0	14.8	12.4	11.4	16.5	13.3	13.0
Waterford 110 kV	7.5	10.5	9.8	7.6	11.8	11.5	6.7	13.0	12.0	7.0	14.0	13.6
Wexford 110 kV	4.0	5.6	5.4	5.1	5.2	5.1	4.1	7.2	6.4	5.3	6.1	5.9
Whitegate 110 kV	4.8	7.7	7.1	5.5	8.3	8.1	4.2	10.7	10.1	5.1	10.6	10.4
Wolfe Tone 110 kV	14.0	9.7	9.0	5.9	11.4	11.1	14.2	12.5	11.3	5.5	14.1	13.5
Woodhouse 110 kV	6.0	5.3	5.0	7.3	4.1	4.0	5.9	6.5	6.1	7.3	4.6	4.6
Woodland 220 kV	14.3	15.3	13.5	13.7	17.4	16.5	12.4	23.7	21.4	12.3	24.7	23.8
Woodland 400 kV	21.2	6.3	5.8	20.5	7.3	7.1	21.3	9.0	8.5	20.7	10.0	9.8

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	13.9	10.8	9.6	8.8	12.0	11.5	13.7	13.6	11.8	8.4	14.4	13.7
Agannygal 110 kV	2.8	4.9	4.7	3.9	4.1	4.1	3.0	6.4	5.7	4.2	4.9	4.7
Aghada 110 kV	5.1	8.3	7.9	6.1	9.6	9.4	4.6	10.1	9.6	5.7	11.4	11.1
Aghada A 220 kV	13.1	11.8	10.6	12.4	14.7	14.1	15.6	22.3	19.6	16.6	26.4	25.0
Aghada B 220 kV	13.1	11.8	10.6	12.4	14.7	14.1	15.6	22.3	19.6	16.6	26.4	25.0
Aghada C 220 kV	12.1	12.0	10.8	13.1	14.5	13.9	15.6	22.3	19.6	16.6	26.4	25.0
Aghada D 220 kV	11.8	11.7	10.6	11.9	14.2	13.6	14.5	21.3	18.8	13.2	25.3	24.0
Ahane 110 kV	5.6	10.8	10.2	6.1	9.4	9.2	5.0	15.1	14.0	5.8	9.3	9.1
Anner 110 kV	4.1	5.9	5.6	4.5	4.4	4.4	4.0	7.5	7.0	4.5	5.1	5.0
Ardnacrusha 110 kV	6.3	11.8	10.9	7.5	13.1	12.7	6.5	18.2	16.5	8.5	16.9	16.4
Ardnagappary 110 kV	2.8	1.8	1.8	3.9	1.2	1.2	2.9	2.5	2.3	4.2	1.3	1.3
Arigna 110 kV	4.4	6.1	5.9	5.4	5.2	5.1	4.5	8.3	7.6	5.7	6.1	6.0
Arklow 110 kV	10.3	7.5	7.2	11.1	9.4	9.2	10.6	9.7	9.1	11.4	11.5	11.2
Arklow 220 kV	9.1	6.9	6.5	10.5	6.6	6.5	8.9	8.5	8.1	10.4	7.7	7.6
Artane 110 kV	13.2	9.7	9.1	6.3	11.8	11.5	13.3	12.4	11.3	5.9	14.5	14.0
Arva 110 kV	3.9	7.9	7.5	5.0	6.5	6.4	3.8	10.3	9.4	5.1	7.5	7.3
Athea 110 kV	11.1	6.8	6.6	10.9	7.7	7.6	11.8	11.8	9.9	11.2	11.3	10.6
Athlone 110 kV	4.4	7.2	6.8	5.8	5.5	5.4	4.1	8.4	7.8	5.5	5.9	5.8
Athy 110 kV	3.2	5.6	5.4	4.4	4.7	4.7	3.0	6.6	6.3	4.3	5.3	5.2
Aughinish 110 kV	9.1	9.6	8.6	11.0	10.7	10.2	8.2	11.2	10.0	10.2	11.8	11.4
Ballybeg 110 kV	9.7	5.9	5.7	10.0	7.1	7.0	9.8	7.1	6.8	10.0	8.2	8.1
Ballydine 110 kV	4.1	6.6	6.3	3.8	5.3	5.3	4.0	8.3	7.7	3.7	6.1	6.0
Ballylickey 110 kV	2.8	3.0	2.9	3.9	1.9	1.9	2.9	3.8	3.6	4.1	2.1	2.1
Ballynahulla 110 kV	11.8	7.5	7.2	11.6	8.2	8.1	13.2	11.4	10.3	12.3	10.9	10.6
Ballynahulla 220 kV	7.0	6.9	6.5	7.4	8.0	7.8	6.9	11.0	10.1	7.3	11.1	10.8
Ballyragget 110 kV	11.8	7.9	7.6	12.3	9.1	8.9	12.6	11.7	10.6	13.0	12.0	11.7
Ballyvouskill 110 kV	6.8	7.5	7.1	7.5	9.2	8.9	6.4	12.2	11.1	7.4	13.2	12.8
Ballyvouskill 220 kV	11.8	7.9	7.6	12.3	9.1	8.9	12.6	11.7	10.6	13.0	12.0	11.7
Ballywater 110 kV	4.6	4.9	4.8	3.3	5.2	5.2	4.6	6.2	5.8	3.2	6.0	5.9
Baltrasna 110 kV	6.4	9.6	9.1	7.5	7.6	7.5	5.9	11.3	10.8	7.2	8.4	8.3
Bancroft 110 kV	12.5	11.1	10.1	7.2	13.0	12.5	12.2	13.4	12.3	6.8	15.2	14.7
Bandon 110 kV	3.3	5.9	5.6	4.4	5.8	5.7	3.0	7.4	6.9	4.2	6.8	6.6
Banoge 110 kV	6.1	5.4	5.2	6.8	5.0	4.9	5.9	6.6	6.2	6.7	5.6	5.5
Barnadivane 110 kV	4.2	7.3	7.0	4.9	7.2	7.1	4.1	11.1	10.0	4.9	9.6	9.4
Barnahealy A 110 kV	6.1	11.2	10.4	6.6	11.7	11.4	5.3	14.7	13.6	6.0	14.3	13.9
Barnahealy B 110 kV	7.4	10.8	10.1	7.8	11.2	10.9	6.4	14.1	13.1	7.1	13.6	13.3
Barnakyle 110 kV	18.8	11.1	9.9	12.3	12.2	11.7	19.4	14.1	12.2	12.1	14.8	14.0
Baroda 110 kV	4.2	7.8	7.3	4.9	9.2	9.0	3.9	9.6	9.0	4.7	10.9	10.6

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Barrymore 110 kV	3.9	6.9	6.6	5.5	5.6	5.5	3.7	8.8	8.3	5.5	6.4	6.3
Belcamp 110 kV	14.5	12.8	11.7	9.0	14.5	13.9	14.9	16.9	15.1	8.6	17.9	17.2
Belcamp 220 kV	11.9	13.7	12.3	10.2	17.1	16.3	11.5	22.6	20.1	9.3	25.8	24.6
Bellacorick 110 kV	3.4	3.4	3.2	3.8	4.3	4.2	5.2	7.0	6.0	5.9	7.5	7.1
Binbane 110 kV	3.2	3.4	3.3	4.3	3.4	3.4	3.6	5.9	5.2	5.4	4.7	4.5
Blackpool 110 kV	-	-	-	-	-	-	6.9	24.6	21.5	7.3	23.3	22.3
Blackrock 110 kV	11.2	9.6	8.9	3.0	8.8	8.6	10.9	11.6	10.6	2.8	10.0	9.8
Blake 110 kV	4.1	7.4	7.0	5.1	5.2	5.2	3.9	8.9	8.4	5.0	5.9	5.8
Boggeragh 110 kV	6.2	6.3	6.1	7.5	6.7	6.6	6.3	9.1	8.4	7.8	8.6	8.4
Booltiagh 110 kV	6.3	6.3	6.1	7.9	5.5	5.5	6.8	9.1	8.3	8.7	6.7	6.6
Bracklone 110 kV	3.9	7.4	7.0	4.9	7.1	7.0	3.7	9.1	8.5	4.8	8.2	8.0
Brinny A 110 kV	3.2	5.3	5.1	4.2	4.8	4.7	2.9	6.6	6.1	4.1	5.5	5.4
Brinny B 110 kV	3.2	5.3	5.1	4.2	4.8	4.8	2.9	6.6	6.2	4.1	5.6	5.5
Bunkimalta 110 kV	5.3	5.1	4.9	5.5	5.3	5.3	6.6	8.1	7.1	6.6	7.3	7.0
Butlerstown 110 kV	6.1	9.4	8.9	5.8	9.7	9.5	5.4	11.4	10.6	5.3	11.2	10.9
Cabra 110 kV	12.3	9.4	8.8	5.1	10.7	10.4	12.3	12.0	10.9	4.8	13.0	12.5
Cahernagh 110 kV	4.3	4.6	4.5	5.3	5.1	5.0	4.0	5.2	5.1	5.1	5.5	5.4
Cahir 110 kV	4.4	7.4	7.0	5.4	6.3	6.2	4.5	10.3	9.4	5.7	7.6	7.4
Carlow 110 kV	5.2	7.3	7.0	6.0	8.1	7.9	5.2	9.3	8.6	6.0	9.6	9.3
Carrickmines 220 kV	14.0	15.2	13.4	9.9	18.9	17.8	13.7	22.6	20.0	8.8	26.2	24.9
Carrickmines A 110 kV	27.9	10.9	10.0	23.2	12.1	11.7	31.5	13.5	12.2	24.4	14.3	13.8
Carrickmines B 110 kV	23.2	12.2	11.1	19.9	14.7	14.2	25.0	14.9	13.7	20.5	17.5	16.9
Carrick-on-Shannon 110 kV	4.4	9.6	9.0	5.1	10.6	10.4	4.2	13.1	11.9	5.0	13.3	12.9
Carrigadrohid 110 kV	6.6	10.1	9.5	7.6	10.4	10.1	5.9	16.3	14.8	6.9	14.8	14.3
Carrowbeg 110 kV	2.7	2.5	2.4	3.5	2.4	2.3	2.7	3.2	3.0	3.7	2.8	2.7
Cashla 110 kV	7.0	12.6	11.6	7.7	16.0	15.5	7.3	21.6	18.9	8.3	25.0	23.7
Cashla 220 kV	8.1	7.9	7.4	9.3	8.6	8.4	8.7	13.0	12.1	10.2	12.1	11.9
Castlebar 110 kV	3.1	4.2	3.9	3.7	4.6	4.5	3.3	6.4	5.6	4.1	6.2	5.9
Castledockrill 110 kV	6.8	6.4	6.2	4.9	7.8	7.7	6.9	8.2	7.7	4.7	9.4	9.1
Castlefarm A 110 kV	8.1	9.3	8.3	9.5	10.0	9.6	7.3	10.7	9.6	8.8	10.9	10.5
Castlefarm B 110 kV	8.2	9.2	8.3	9.5	9.9	9.5	7.3	10.7	9.6	8.8	10.9	10.5
Castletown 110 kV	6.0	9.2	8.7	5.8	7.8	7.7	5.5	11.0	10.4	5.5	8.7	8.6
Castleview 110 kV	4.3	10.8	10.1	4.8	8.3	8.2	3.7	14.1	13.2	4.5	9.7	9.5
Cathaleen's Fall 110 kV	4.3	6.3	6.0	4.9	7.3	7.1	5.3	13.0	11.0	6.3	11.7	11.1
Cauteen 110 kV	5.4	6.4	6.1	6.3	4.3	4.3	5.7	8.8	8.2	6.6	4.9	4.8
Central 110 kV	14.4	10.0	9.3	7.9	10.9	10.6	14.3	12.2	11.1	7.6	12.7	12.3
Charleville 110 kV	4.6	5.5	5.3	6.0	5.2	5.1	4.7	7.6	7.0	6.5	6.5	6.3
Cherrywood 110 kV	10.5	9.3	8.6	7.7	9.6	9.4	10.2	11.3	10.3	7.4	11.1	10.7

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
City West 110 kV	6.2	7.3	6.7	6.1	5.6	5.4	5.9	8.9	7.9	6.0	6.3	6.1
Clahane 110 kV	4.2	6.3	6.0	5.2	6.0	5.9	4.0	8.4	7.8	5.1	7.0	6.9
Clashavoon 220 kV	7.9	7.7	7.3	8.4	8.6	8.4	7.4	12.4	11.4	8.0	12.0	11.7
Clashavoon A 110 kV	8.0	11.9	11.1	8.8	12.2	11.9	7.2	19.7	17.5	7.5	18.3	17.6
Clashavoon B 110 kV	8.0	11.9	11.1	8.8	12.2	11.9	7.2	19.7	17.5	7.5	18.3	17.6
Cliff 110 kV	4.0	5.2	4.9	5.0	5.3	5.3	4.6	9.2	8.1	6.0	7.5	7.3
Cloghboola 110 kV	6.5	4.8	4.7	6.9	5.7	5.6	6.7	7.7	6.3	7.3	8.1	7.6
Clogher 110 kV	3.9	5.3	5.0	4.2	6.3	6.2	5.2	11.9	9.6	5.5	11.3	10.5
Cloghran 110 kV	9.9	18.5	16.7	9.7	19.8	19.1	9.3	24.5	22.4	9.2	24.4	23.7
Clonkeen A 110 kV	5.8	5.5	5.3	6.9	4.0	4.0	5.4	6.7	6.3	6.7	4.5	4.4
Clonkeen B 110 kV	5.8	5.1	4.9	5.5	5.9	5.8	6.4	7.7	6.8	5.7	8.0	7.7
Cloon 110 kV	4.4	6.7	6.4	5.8	6.0	5.9	4.1	8.7	8.1	5.7	7.1	6.9
College Park 110 kV	9.7	17.8	16.1	6.8	20.0	19.2	9.0	23.3	21.4	6.2	24.7	24.0
Cookstown 110 kV	7.4	7.9	7.4	6.0	6.8	6.6	7.1	9.2	8.6	5.8	7.6	7.4
Coolroe 110 kV	5.4	8.6	8.2	6.7	8.4	8.2	4.8	11.8	11.0	6.3	10.3	10.1
Coomagearlahy 110 kV	5.7	4.2	4.1	6.2	5.1	5.1	6.7	6.7	5.8	7.4	7.4	7.0
Coomataggart 110 kV	6.7	3.2	3.2	7.5	3.5	3.5	6.4	3.7	3.6	7.3	4.0	3.9
Cordal 110 kV	10.0	6.6	6.4	8.4	6.4	6.4	10.6	9.7	8.9	8.2	8.0	7.8
Corderry 110 kV	4.0	6.3	6.0	5.0	6.4	6.3	4.2	9.3	8.2	5.5	8.3	8.0
Corduff 110 kV	10.7	19.8	17.7	11.7	22.5	21.6	10.1	26.5	24.2	11.3	28.4	27.4
Corduff 220 kV	14.7	15.6	13.8	13.6	19.4	18.4	15.0	25.9	22.9	13.1	29.4	27.9
Corkagh 110 kV	17.6	11.2	9.9	12.2	12.4	11.8	18.0	14.2	12.2	11.9	15.1	14.2
Corraclassy 110 kV	4.3	5.8	5.5	5.4	4.7	4.6	4.3	7.3	6.9	5.5	5.3	5.2
Cow Cross 110 kV	5.1	11.1	10.4	5.4	9.9	9.7	4.3	14.5	13.4	4.9	11.8	11.5
Crane 110 kV	6.4	7.0	6.7	6.5	7.6	7.5	6.6	9.1	8.4	6.5	9.2	8.9
Cromcastle A 110 kV	12.3	12.5	11.4	8.0	14.2	13.7	12.2	16.4	14.7	7.5	17.6	16.9
Cromcastle B 110 kV	12.3	12.5	11.4	8.0	14.2	13.7	12.2	16.4	14.7	7.5	17.6	16.9
Cronacarkfree 220 kV	4.3	3.4	3.2	4.4	4.1	4.1	6.0	6.9	5.7	5.7	7.1	6.6
Crory 110 kV	8.4	7.3	7.0	8.8	9.1	9.0	8.8	9.4	8.8	9.0	11.1	10.8
Cullenagh 110 kV	8.2	11.6	10.9	8.7	13.5	13.2	7.1	14.5	13.4	7.8	16.2	15.7
Cullenagh 220 kV	9.0	8.5	8.0	9.2	8.6	8.4	8.0	10.0	9.6	8.5	9.7	9.6
Cunghill 110 kV	3.3	4.5	4.3	3.7	4.4	4.3	3.2	6.6	6.1	3.8	5.5	5.4
Cureeny 110 kV	5.4	6.2	6.0	5.2	6.1	6.0	6.2	9.6	8.5	5.5	7.9	7.6
Cushaling 110 kV	5.7	8.6	7.8	6.8	10.3	9.9	7.0	12.7	11.3	8.8	13.5	12.9
Dallow 110 kV	3.5	4.9	4.7	4.6	3.1	3.1	3.4	5.6	5.3	4.6	3.4	3.4
Dalton 110 kV	3.1	3.7	3.5	4.1	3.2	3.2	3.2	5.2	4.7	4.5	3.9	3.8
Dardistown 110 kV	13.6	12.4	11.3	10.5	14.3	13.8	13.8	16.2	14.5	10.2	17.7	17.0
Derrybrien 110 kV	2.6	3.8	3.7	3.7	3.7	3.6	3.0	5.1	4.5	4.4	4.5	4.3

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Derryiron 110 kV	4.9	7.2	6.8	6.1	7.7	7.6	5.8	10.5	9.8	7.4	10.0	9.8
Doon 110 kV	4.4	6.4	6.1	4.7	5.0	4.9	4.4	8.4	7.7	4.7	5.8	5.7
Dromada 110 kV	7.9	6.5	6.3	5.6	7.2	7.1	7.2	11.0	9.3	4.8	10.2	9.6
Drumkeen 110 kV	3.5	4.8	4.5	4.2	5.0	4.9	3.8	9.2	7.8	4.9	7.5	7.1
Drumline 110 kV	3.6	7.2	6.8	4.7	6.2	6.1	3.2	9.2	8.6	4.6	7.2	7.0
Drybridge 110 kV	5.9	12.1	11.2	6.7	10.3	10.1	5.2	15.0	13.9	6.3	11.9	11.7
Dundalk 110 kV	3.8	7.8	7.4	4.7	7.3	7.2	3.4	9.4	8.8	4.4	8.3	8.1
Dunfirth 110 kV	4.7	5.9	5.7	6.3	4.7	4.6	4.6	6.8	6.6	6.3	5.1	5.1
Dungarvan 110 kV	6.0	5.5	5.3	7.7	4.7	4.6	5.9	7.2	6.7	7.9	5.6	5.5
Dunmanway 110 kV	4.3	6.9	6.6	5.2	6.3	6.2	4.3	10.0	9.0	5.4	7.9	7.7
Dunstown 220 kV	12.8	15.7	14.0	12.4	18.3	17.5	10.8	21.4	19.7	10.8	23.6	22.9
Dunstown 400 kV	17.8	6.2	5.7	20.0	6.8	6.6	16.4	8.0	7.7	19.0	8.5	8.3
Ennis 110 kV	5.0	9.4	8.8	6.2	8.7	8.5	4.8	13.2	12.0	6.4	10.7	10.4
Fassaroe East 110 kV	5.4	7.4	7.0	5.4	5.7	5.6	5.0	8.6	8.1	5.3	6.4	6.3
Fassaroe West 110 kV	5.5	7.6	7.1	5.5	5.9	5.8	5.2	8.8	8.3	5.4	6.6	6.5
Finglas 220 kV	14.3	14.9	13.2	13.9	19.1	18.1	15.9	25.7	22.5	14.6	30.2	28.5
Finglas A 110 kV	20.3	13.7	12.4	17.3	15.7	15.1	23.8	18.4	16.3	18.4	19.8	18.9
Finglas B 110 kV	26.9	10.8	10.0	25.7	13.7	13.2	34.2	14.0	12.7	30.3	17.2	16.5
Flagford 110 kV	4.7	10.0	9.4	5.5	12.2	11.9	4.5	13.7	12.5	5.4	15.7	15.2
Flagford 220 kV	7.2	6.2	5.8	9.1	6.0	5.9	7.3	8.2	7.8	9.7	7.2	7.1
Francis Street A 110 kV	11.2	10.1	9.4	5.8	12.4	12.0	10.4	13.7	12.5	5.0	15.9	15.3
Francis Street B 110 kV	12.9	11.1	10.3	6.8	13.5	13.1	12.7	13.5	12.5	6.4	16.1	15.6
Galway 110 kV	4.9	9.8	9.1	5.4	10.8	10.5	5.5	17.1	14.7	6.2	15.8	15.0
Garrow 110 kV	8.9	5.9	5.7	8.8	6.7	6.6	9.7	8.9	8.0	9.2	9.0	8.7
Garvagh 110 kV	4.2	4.9	4.7	5.4	4.8	4.8	4.6	6.9	6.2	6.1	6.0	5.8
Gilra 110 kV	3.2	5.8	5.5	4.1	4.6	4.5	3.0	6.9	6.6	4.0	5.1	5.1
Glanagow 220 kV	13.7	12.3	11.0	13.7	15.4	14.6	15.3	21.4	18.8	14.5	25.3	24.0
Glanlee 110 kV	5.6	4.1	4.0	5.9	5.0	5.0	6.6	6.4	5.6	6.8	7.2	6.8
Glasmore 110 kV	4.4	6.8	6.4	4.9	4.8	4.8	4.1	8.3	7.7	4.7	5.4	5.3
Glenlara A 110 kV	2.9	2.6	2.5	4.2	2.3	2.2	3.1	3.3	3.0	4.6	2.7	2.6
Glenlara B 110 kV	8.7	5.6	5.5	6.8	5.7	5.7	9.3	8.3	7.5	6.6	7.4	7.2
Glenree 110 kV	3.4	3.8	3.5	4.1	3.7	3.6	4.0	6.5	5.8	5.0	5.1	4.9
Glentanemacelligot 110 kV	8.5	5.3	5.2	8.3	4.5	4.5	8.2	6.9	6.5	8.1	5.1	5.0
Golagh 110 kV	3.6	4.6	4.4	4.0	4.7	4.7	4.0	9.1	7.6	4.6	7.1	6.8
Gorman 110 kV	6.7	12.6	11.7	7.6	14.1	13.7	6.0	16.0	14.8	7.0	16.9	16.4
Gorman 220 kV	9.5	9.8	9.0	10.1	8.5	8.3	8.4	12.5	11.9	9.5	9.9	9.7
Gortawee 110 kV	4.4	5.6	5.3	5.8	4.8	4.7	4.4	6.9	6.4	6.0	5.3	5.2
Grange 110 kV	12.1	12.4	11.3	6.1	13.7	13.2	11.9	16.2	14.6	5.6	16.9	16.2

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Grange Castle 110 kV	17.8	11.3	10.0	13.0	12.7	12.1	18.2	14.4	12.3	12.8	15.4	14.6
Great Island 110 kV	7.8	11.4	10.8	8.6	14.9	14.5	6.8	14.0	13.0	7.6	17.7	17.1
Great Island 220 kV	12.0	10.9	10.2	13.4	13.1	12.7	10.4	12.7	12.0	11.9	14.5	14.2
Griffinrath A 110 kV	7.2	9.5	8.9	7.5	9.7	9.5	6.7	11.4	10.8	7.1	11.2	11.0
Griffinrath B 110 kV	7.7	9.8	9.2	7.7	9.7	9.5	7.2	11.8	11.2	7.3	11.1	10.9
Harolds 110 kV	11.4	10.2	9.4	5.5	12.4	12.0	10.6	13.7	12.5	4.7	15.8	15.2
Hartnett's Cross 110 kV	4.5	8.2	7.8	5.3	7.1	6.9	3.8	12.1	11.2	4.7	9.2	9.0
Heuston 110 kV	13.9	11.3	10.5	8.2	13.9	13.5	13.8	13.8	12.8	7.8	16.6	16.1
Huntstown A 220 kV	13.7	14.4	12.8	12.5	18.5	17.6	15.3	24.7	21.7	12.6	29.1	27.5
Huntstown B 220 kV	14.7	14.7	13.2	11.4	18.4	17.5	14.4	23.0	20.6	10.2	26.5	25.3
Ikerrin 110 kV	5.3	4.2	4.0	6.1	3.2	3.2	5.8	5.7	5.2	6.5	3.8	3.7
Inchicore 220 kV	14.1	17.4	15.0	10.8	21.5	20.2	13.6	27.4	23.8	9.5	31.5	29.7
Inchicore A 110 kV	26.7	12.3	11.4	24.1	15.6	15.0	30.2	15.3	14.1	25.9	18.8	18.2
Inchicore B 110 kV	38.0	12.7	11.2	31.4	16.1	15.3	48.7	16.3	14.0	36.1	20.2	18.9
Inniscarra 110 kV	5.0	8.3	7.9	6.1	7.9	7.7	4.4	11.4	10.6	5.8	9.7	9.5
Irishtown 220 kV	14.8	16.4	14.3	12.1	20.8	19.5	15.1	25.5	22.3	11.3	30.0	28.3
Kellis 110 kV	6.2	7.9	7.5	7.2	9.4	9.3	6.1	9.9	9.2	7.2	11.3	11.0
Kellis 220 kV	8.1	7.2	6.9	9.8	6.3	6.2	7.6	8.6	8.3	9.5	7.2	7.1
Kilbarry 110 kV	7.9	15.7	14.2	8.5	16.9	16.3	7.1	24.9	21.7	8.0	23.8	22.8
Kildonan 110 kV	9.3	17.0	15.4	7.0	15.3	14.9	8.7	22.1	20.4	6.5	18.3	17.9
Kilkenny 110 kV	3.0	4.7	4.5	4.2	4.3	4.3	3.0	5.6	5.2	4.3	4.9	4.8
Kill Hill 110 kV	4.9	4.9	4.7	5.9	4.5	4.4	5.8	7.4	6.6	6.9	5.8	5.6
Killinaparson 110 kV	5.1	5.8	5.6	6.8	4.7	4.6	4.8	6.7	6.4	6.7	5.1	5.1
Killonan 110 kV	7.5	14.6	13.4	8.5	16.7	16.2	7.2	23.3	20.8	7.5	16.2	15.8
Killonan 220 kV	8.3	8.7	8.1	10.3	8.6	8.4	8.0	12.2	11.5	10.8	9.8	9.7
Killoteran 110 kV	6.3	10.0	9.5	5.4	11.1	10.9	5.5	12.2	11.3	4.9	12.9	12.5
Kilmahud 110 kV	17.4	11.2	9.9	12.3	12.6	12.0	17.7	14.2	12.2	12.1	15.3	14.4
Kilmore 110 kV	16.1	13.2	11.9	11.8	15.1	14.5	17.1	17.5	15.6	11.6	18.9	18.1
Kilpaddoge 110 kV	11.9	13.5	12.5	12.3	17.3	16.7	12.1	20.1	18.4	12.6	24.0	23.2
Kilpaddoge A 220 kV	12.2	11.7	10.7	11.2	15.5	14.9	15.2	24.5	22.0	11.9	29.3	28.0
Kilpaddoge B 220 kV	12.2	11.7	10.7	11.2	15.5	14.9	15.2	24.5	22.0	11.9	29.3	28.0
Kilteel 110 kV	4.5	7.0	6.6	5.5	6.5	6.4	4.2	8.4	7.9	5.4	7.3	7.1
Kinnegad 110 kV	4.6	7.1	6.8	5.9	6.6	6.5	4.6	9.1	8.6	6.2	7.6	7.5
Knockacummer 110 kV	5.9	4.8	4.7	6.0	5.2	5.1	6.1	6.8	6.2	6.2	6.7	6.5
Knockanure 110 kV	15.0	8.4	8.0	12.3	10.2	10.0	15.9	14.6	12.2	11.5	15.6	14.6
Knockanure 220 Kv	8.5	8.4	7.9	6.1	11.1	10.8	8.3	14.7	13.4	5.1	17.9	17.2
Knockavanna 110 kV	2.7	4.0	3.9	3.8	3.7	3.7	3.0	5.4	4.8	4.4	4.5	4.4
Knockearagh 110 kV	5.5	5.0	4.8	7.2	4.4	4.3	5.3	6.3	5.9	7.3	5.1	5.0

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Knockraha A 110 kV	27.8	6.1	5.9	28.5	6.2	6.1	7.8	25.3	22.6	8.7	22.9	22.1
Knockraha A 220 kV	9.2	17.0	15.4	9.8	17.6	17.0	10.6	20.5	18.4	10.5	19.8	19.0
Knockraha B 110 kV	11.7	12.8	11.6	11.8	14.4	13.8	7.8	25.3	22.6	8.7	22.9	22.1
Knockraha B 220 kV	11.7	12.8	11.6	11.8	14.4	13.8	10.6	20.5	18.4	10.5	19.8	19.0
Knockranny 110 kV	3.7	3.8	3.6	4.4	2.4	2.4	4.7	5.9	5.3	5.0	2.9	2.8
Knockumber 110 kV	3.9	7.7	7.2	4.7	5.9	5.8	3.5	9.0	8.5	4.5	6.5	6.4
Lanesboro 110 kV	4.1	9.9	9.1	5.2	10.4	10.1	3.7	12.1	11.0	5.0	12.0	11.6
Letterkenny110 kV	3.8	5.5	5.2	4.4	6.4	6.3	4.2	11.2	9.3	5.4	10.5	9.8
Liberty A 110 kV	6.6	13.8	12.6	5.5	15.7	15.2	5.8	20.8	18.4	4.8	21.5	20.6
Liberty B 110 kV	6.5	13.7	12.6	5.3	15.7	15.2	5.7	20.8	18.4	4.7	21.4	20.5
Limerick 110 kV	5.8	12.9	11.9	6.4	12.7	12.3	5.1	19.1	17.2	6.4	14.7	14.3
Lisdrum 110 kV	2.9	4.7	4.5	4.2	4.2	4.1	2.8	5.7	5.3	4.2	4.6	4.5
Lisheen 110 kV	4.0	3.2	3.1	4.0	4.9	4.7	5.0	5.3	4.6	5.0	7.9	7.4
Lodgewood 110 kV	8.4	7.3	7.0	8.8	9.1	9.0	8.8	9.4	8.8	9.0	11.1	10.8
Lodgewood 220 kV	8.8	6.7	6.4	10.0	6.6	6.5	8.7	8.2	7.8	9.9	7.6	7.5
Longpoint 220 kV	12.1	11.9	10.7	12.2	14.3	13.7	14.8	21.8	19.2	12.5	25.4	24.1
Louth 220 kV	10.5	12.8	11.5	11.1	15.4	14.7	9.1	19.2	17.8	10.3	20.8	20.3
Louth A 110 kV	7.3	11.2	10.4	8.3	13.6	13.2	6.4	14.0	13.0	7.5	16.4	15.9
Louth B 110 kV	7.8	11.9	11.1	8.6	14.9	14.5	6.9	15.2	14.2	7.8	18.3	17.8
Macetown 110 kV	7.9	16.0	14.6	7.7	16.0	15.5	7.2	20.5	19.0	7.2	19.1	18.7
Macroom 110 kV	6.7	11.0	10.3	7.4	11.4	11.1	6.0	19.1	17.0	6.5	17.9	17.3
Mallow 110 kV	5.3	6.0	5.7	6.9	5.3	5.2	5.2	7.5	7.0	7.1	6.1	6.0
Marina 110 kV	7.9	15.1	13.7	8.8	17.4	16.7	7.4	23.8	20.7	8.6	24.6	23.4
Maynooth A 110 kV	11.1	11.7	10.9	11.7	14.4	14.0	10.4	14.5	13.6	11.1	17.3	16.9
Maynooth A 220 kV	11.1	14.5	12.9	10.5	14.3	13.7	9.5	19.9	18.2	9.4	17.9	17.4
Maynooth B 110 kV	8.6	15.1	13.8	9.9	15.0	14.5	7.6	18.7	17.6	9.2	17.6	17.2
Maynooth B 220 kV	11.5	16.0	14.2	10.6	15.9	15.2	9.6	23.1	21.1	9.4	20.7	20.1
McDermott 110 kV	15.4	10.0	9.3	6.4	11.9	11.5	16.0	12.8	11.6	6.0	14.6	14.1
Meath Hill 110 kV	4.1	7.9	7.5	5.2	6.8	6.7	3.9	9.9	9.3	5.2	7.7	7.6
Meentycat 110 kV	3.3	4.1	3.9	4.1	4.2	4.1	3.6	7.4	6.4	4.9	5.9	5.7
Midleton 110 kV	3.9	9.3	8.7	4.9	7.6	7.5	3.5	11.8	11.0	4.7	8.7	8.6
Milltown A 110 kV	15.0	10.8	10.0	7.4	13.5	13.0	14.8	14.9	13.5	6.6	17.5	16.9
Milltown B 110 kV	9.1	10.1	9.4	4.3	12.1	11.8	8.7	12.2	11.3	4.0	14.2	13.8
Misery Hill 110 kV	13.7	10.6	9.8	8.1	13.3	12.8	13.2	14.5	13.2	7.2	17.3	16.6
Moneteen 110 kV	5.9	9.8	9.1	6.6	7.7	7.5	5.3	12.6	11.7	6.4	8.5	8.3
Moneypoint 110 kV	13.9	7.9	7.6	16.1	8.3	8.1	15.5	10.5	10.0	17.9	10.0	9.8
Moneypoint 220 kV	12.6	11.8	10.8	11.7	15.6	15.0	15.9	24.0	21.7	12.6	28.9	27.7
Moneypoint G1 400 kV	16.1	7.3	6.7	17.2	9.1	8.8	24.3	13.8	12.7	24.1	15.4	15.0

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Moneypoint G2 400 kV	16.1	7.3	6.7	17.2	9.1	8.8	24.3	13.8	12.7	24.1	15.4	15.0
Moneypoint G3 400 kV	16.1	7.3	6.7	17.2	9.1	8.8	24.3	13.8	12.7	24.1	15.4	15.0
Monread 110 kV	4.2	6.9	6.5	5.0	7.0	6.9	3.9	8.3	7.8	4.9	8.0	7.8
Mount Lucas 110 kV	4.4	6.2	5.8	5.6	5.8	5.7	4.8	8.6	8.0	6.2	7.2	7.1
Moy 110 kV	3.7	3.8	3.5	4.4	4.5	4.4	5.7	7.5	6.6	7.0	7.3	7.0
Mullagharlin 110 kV	3.9	8.0	7.6	4.9	7.8	7.7	3.5	9.6	8.9	4.6	8.9	8.7
Mullingar 110 kV	3.6	6.5	6.2	4.9	6.2	6.1	3.4	7.7	7.3	4.9	7.0	6.9
Mulreavy 110 kV	3.6	4.7	4.5	3.9	5.7	5.6	4.5	10.1	8.2	5.0	10.0	9.3
Mungret A 110 kV	5.5	9.3	8.7	6.2	7.2	7.0	5.0	11.8	11.0	6.1	7.8	7.7
Mungret B 110 kV	5.5	9.3	8.7	6.2	7.2	7.1	4.9	11.9	11.0	6.1	7.9	7.7
Nangor 110 kV	15.6	11.0	9.8	10.4	12.4	11.8	15.7	14.0	12.0	10.1	15.0	14.2
Navan 110 kV	5.7	11.2	10.4	6.5	11.2	10.9	5.2	14.0	13.0	6.1	13.1	12.8
Nenagh 110 kV	3.3	3.5	3.4	4.1	2.4	2.4	3.3	4.6	4.2	4.1	2.7	2.7
Newbridge 110 kV	4.4	9.1	8.5	5.1	9.4	9.2	4.1	11.7	10.8	4.9	11.2	10.9
Newbury 110 kV	14.2	12.9	11.7	7.7	14.4	13.9	14.5	17.1	15.2	7.2	17.9	17.2
North Quays 110 kV	17.7	11.0	10.1	7.0	13.5	13.0	18.6	15.2	13.8	6.1	17.6	16.9
North Wall 220 kV	13.4	13.7	12.3	9.3	16.2	15.4	14.5	23.1	20.4	8.2	24.2	23.1
Oldcourt A 110 kV	4.3	9.4	8.9	4.8	7.6	7.5	3.7	11.9	11.1	4.5	8.7	8.6
Oldcourt B 110 kV	4.4	9.5	8.9	4.9	7.6	7.5	3.8	11.9	11.2	4.5	8.8	8.7
Oldstreet 220 kV	13.1	7.1	6.7	11.6	8.3	8.1	15.6	11.6	11.0	12.3	12.2	11.9
Oldstreet 400 kV	14.3	6.0	5.6	10.0	6.1	5.9	16.2	9.2	8.7	9.6	8.2	8.0
Oriel 220 kV	9.8	10.2	9.4	8.3	10.7	10.4	8.5	13.6	13.0	7.9	10.0	9.9
Oughtragh 110 kV	3.7	4.1	4.0	4.8	2.8	2.8	3.6	5.0	4.7	4.8	3.1	3.0
Oweninney 110 kV	3.4	3.4	3.2	3.8	4.3	4.2	5.2	7.0	6.0	5.9	7.5	7.1
Pelletstown 110 kV	13.6	9.5	8.9	8.1	10.5	10.3	13.8	12.1	11.0	7.8	12.7	12.3
Platin 110 kV	5.2	11.2	10.4	5.8	8.7	8.6	4.6	13.6	12.7	5.5	9.8	9.7
Pollaphuca 110 kV	2.8	2.4	2.4	4.0	2.2	2.2	3.3	3.1	3.0	4.7	2.6	2.6
Poolbeg A 110 kV	23.7	11.5	10.6	20.5	14.7	14.2	28.3	16.0	14.5	22.1	19.5	18.7
Poolbeg A 220 kV	14.0	13.8	12.4	8.1	15.5	14.8	15.3	23.2	20.6	7.0	22.7	21.8
Poolbeg B 110 kV	23.7	11.5	10.5	20.5	14.7	14.1	28.3	15.9	14.4	22.1	19.4	18.6
Poolbeg B 220 kV	13.5	16.3	14.1	10.3	19.0	17.9	13.2	25.2	22.1	9.3	26.8	25.5
Poolbeg C 110 kV	19.5	11.2	10.3	8.0	13.8	13.3	21.3	15.6	14.1	7.1	18.0	17.3
Poppintree 110 kV	13.5	12.8	11.7	8.5	14.6	14.1	13.7	17.0	15.2	8.0	18.2	17.5
Portan 400 kV	18.9	6.6	6.2	18.1	7.7	7.5	18.5	9.5	9.1	17.9	10.4	10.2
Portlaoise 110 kV	4.0	7.9	7.4	5.3	7.5	7.4	3.8	9.9	9.2	5.2	8.7	8.5
Pottery 110 kV	17.1	10.4	9.6	5.9	10.7	10.4	17.4	12.7	11.5	5.6	12.4	12.0
Prospect 220 kV	11.4	10.5	9.7	8.9	12.2	11.8	12.5	19.6	18.1	8.2	19.2	18.6
Raffeen 220 kV	12.6	12.5	11.2	12.1	15.5	14.8	12.6	19.7	17.6	10.5	22.7	21.6

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Raffeen A 110 kV	8.1	12.9	11.9	8.9	15.3	14.9	7.2	17.5	16.0	8.1	19.7	19.0
Raffeen B 110 kV	9.4	12.4	11.5	10.1	14.7	14.3	8.3	16.8	15.4	9.2	18.8	18.2
Rathkeale 110 kV	3.6	6.5	6.2	4.8	5.4	5.3	3.4	8.0	7.5	4.8	6.0	5.9
Ratrussan 110 kV	3.2	5.8	5.6	4.0	6.6	6.5	3.8	8.4	7.1	5.0	8.6	8.1
Reamore 110 kV	4.4	5.8	5.6	3.6	5.5	5.4	4.5	8.0	7.2	3.5	6.5	6.3
Richmond A 110 kV	3.2	6.7	6.3	4.4	6.1	6.0	3.0	7.8	7.3	4.2	6.8	6.7
Richmond B 110 kV	3.2	6.7	6.3	4.4	6.1	6.0	3.0	7.8	7.3	4.2	6.8	6.7
Rinawade 110 kV	5.1	9.8	9.2	6.0	7.3	7.2	4.7	11.6	11.1	5.8	8.1	8.0
Ringaskiddy 110 kV	6.4	10.5	9.8	6.6	10.4	10.2	5.5	13.6	12.7	6.0	12.5	12.2
Ringsend 110 kV	23.7	11.5	10.5	21.2	14.7	14.2	28.8	16.1	14.5	23.4	19.6	18.8
Ryebrook 110 kV	5.6	12.9	11.8	6.5	11.7	11.4	5.1	15.6	14.5	6.1	13.4	13.1
Salthill 110 kV	4.5	8.9	8.3	4.1	9.6	9.3	4.7	14.9	12.9	4.1	13.6	13.0
Screeb 110 kV	3.5	2.3	2.2	4.5	1.3	1.3	4.4	3.5	3.0	5.1	1.5	1.4
Seal Rock A 110 kV	8.7	9.5	8.5	10.3	10.6	10.1	7.8	10.9	9.8	9.5	11.7	11.2
Seal Rock B 110 kV	8.8	9.5	8.5	10.3	10.6	10.1	7.8	11.0	9.8	9.5	11.7	11.2
Shankill 110 kV	3.7	7.1	6.7	4.7	6.7	6.6	3.7	9.6	8.5	5.0	8.2	7.9
Shannonbridge 110 kV	6.8	14.6	13.1	8.4	16.6	15.9	5.8	17.5	15.8	7.4	18.8	18.1
Shannonbridge 220 kV	8.0	6.4	6.1	10.4	5.7	5.6	7.1	7.7	7.4	9.8	6.4	6.3
Shellybanks A 220 kV	13.8	13.8	12.3	8.1	17.1	16.3	15.0	23.2	20.5	6.8	26.1	24.8
Shellybanks B 220 kV	14.1	15.8	13.8	10.6	19.8	18.6	14.5	24.5	21.5	9.6	28.3	26.8
Shelton Abbey 110 kV	7.6	6.8	6.5	7.6	7.3	7.2	7.3	8.5	8.0	7.4	8.7	8.5
Singland 110 kV	6.8	12.3	11.4	7.7	12.6	12.3	6.7	18.5	16.8	7.8	14.3	13.9
Sliabh Bawn 110 kV	3.5	8.2	7.7	4.4	7.9	7.8	3.4	10.6	9.6	4.6	9.3	9.1
Sligo 110 kV	4.0	7.3	6.9	4.5	7.3	7.2	3.6	10.8	9.8	4.4	9.5	9.2
Somerset 110 kV	3.1	7.0	6.7	4.1	4.6	4.6	2.9	8.2	7.7	3.9	5.1	5.0
Sorne Hill 110 kV	2.7	2.2	2.2	3.3	2.6	2.6	3.3	3.7	3.3	4.3	3.7	3.6
Srananagh 110 kV	4.8	8.2	7.7	5.5	9.4	9.2	4.6	12.7	11.4	5.6	12.9	12.4
Srananagh 220 kV	6.7	4.0	3.8	8.8	3.4	3.4	7.4	5.1	4.9	9.7	3.9	3.9
Stevenstown 110 kV	4.3	5.7	5.4	4.8	3.8	3.7	4.1	6.7	6.3	4.7	4.1	4.1
Stratford 110 kV	3.1	3.7	3.6	4.1	3.0	3.0	3.3	4.6	4.3	4.4	3.4	3.3
Taney 110 kV	9.0	9.0	8.4	3.4	9.0	8.8	8.7	10.8	9.9	3.2	10.3	10.0
Tarbert 110 kV	20.6	10.5	10.0	23.2	11.6	11.4	34.6	16.9	15.8	34.8	16.0	15.6
Tarbert 220 kV	11.8	11.4	10.5	11.6	15.0	14.5	15.1	24.1	21.7	13.2	28.0	26.8
Tawnaghmore A 110 kV	3.3	3.1	2.9	4.1	3.3	3.3	4.6	5.8	5.2	6.0	4.9	4.8
Tawnaghmore B 110 kV	3.9	3.4	3.2	4.7	4.0	3.9	5.5	6.2	5.5	7.1	6.0	5.8
Thornsberry 110 kV	4.1	5.6	5.4	5.2	5.4	5.3	4.2	7.7	7.2	5.6	6.7	6.6
Thurles 110 kV	5.1	4.2	4.0	5.5	4.8	4.7	6.2	6.8	5.9	6.5	6.8	6.5
Tievebrack 110 kV	3.4	3.3	3.1	4.5	2.6	2.6	3.7	5.1	4.6	5.1	3.2	3.1

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2018 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	5.0	6.1	5.9	6.1	4.3	4.2	5.2	8.1	7.6	6.3	4.8	4.7
Tonroe 110 kV	2.7	3.1	3.0	3.7	2.0	1.9	2.7	3.6	3.4	3.8	2.1	2.1
Trabeg 110 kV	8.0	15.0	13.6	8.8	17.1	16.5	7.4	23.4	20.5	8.4	23.9	22.8
Tralee 110 kV	5.0	7.3	6.9	6.0	6.8	6.7	5.0	10.4	9.3	6.2	8.2	8.0
Trien A 110 kV	4.7	6.7	6.3	5.8	6.2	6.1	4.4	8.8	8.1	5.7	7.3	7.1
Trien B 110 kV	10.5	6.5	6.3	8.8	7.1	7.0	10.4	10.7	9.0	8.2	10.0	9.4
Trillick 110 kV	2.7	2.4	2.3	3.4	2.6	2.6	3.4	4.1	3.6	4.4	3.7	3.6
Trinity 110 kV	12.3	10.4	9.6	6.9	12.9	12.5	11.6	14.1	12.8	6.0	16.6	16.0
Tullabrack 110 kV	6.8	6.2	6.0	7.4	5.1	5.0	6.7	8.0	7.6	7.4	5.8	5.7
Turlough 220 kV	12.0	11.1	10.1	13.0	10.3	9.9	10.5	13.2	12.3	11.9	11.4	11.2
Tynagh 220 kV	10.3	6.7	6.4	11.3	8.4	8.2	15.0	13.0	12.0	16.7	13.9	13.5
Uggool 110 kV	5.5	5.7	5.4	6.5	6.7	6.5	8.2	10.6	8.7	10.1	10.5	9.8
Waterford 110 kV	7.4	10.8	10.3	7.6	12.1	11.9	6.5	13.4	12.4	6.9	14.3	13.9
Wexford 110 kV	3.9	5.7	5.5	5.0	5.5	5.4	4.0	7.2	6.6	5.3	6.4	6.2
Whitegate 110 kV	4.8	8.9	8.4	5.5	9.2	9.0	4.3	11.0	10.4	5.1	10.8	10.5
Wolfe Tone 110 kV	13.9	9.8	9.1	5.9	11.5	11.2	14.2	12.5	11.4	5.5	14.1	13.6
Woodhouse 110 kV	5.9	5.4	5.2	7.3	4.1	4.1	5.9	6.9	6.5	7.4	4.8	4.7
Woodland 220 kV	13.9	16.1	14.4	13.3	18.2	17.4	12.1	24.6	22.4	12.0	25.4	24.6
Woodland 400 kV	20.1	6.7	6.2	19.5	7.7	7.5	20.0	9.6	9.1	19.6	10.5	10.3

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021[1]

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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	12.1	10.7	9.9	6.6	12.9	12.5	11.6	12.9	11.6	6.2	15.1	14.5
Agannygal 110 kV	2.8	4.7	4.6	3.8	4.1	4.0	3.1	6.9	6.0	4.5	5.0	4.9
Aghada 110 kV	5.1	8.3	7.9	6.1	9.7	9.5	4.6	10.3	9.8	5.6	11.5	11.3
Aghada A 220 kV	14.6	13.4	12.0	15.7	17.3	16.5	15.0	22.5	19.9	16.1	26.5	25.1
Aghada B 220 kV	14.6	13.4	12.0	15.7	17.3	16.5	15.0	22.5	19.9	16.1	26.5	25.1
Aghada C 220 kV	14.6	13.4	12.0	15.7	17.3	16.5	15.0	22.5	19.9	16.1	26.5	25.1
Aghada D 220 kV	14.0	13.0	11.7	13.5	16.8	16.0	14.0	21.5	19.1	12.8	25.4	24.2
Ahane 110 kV	5.5	10.9	10.2	6.0	8.0	7.8	5.0	15.5	14.4	5.8	9.5	9.3
Anner 110 kV	4.0	5.9	5.6	4.5	4.8	4.7	4.3	8.2	7.6	4.8	5.7	5.6
Ardnacrusha 110 kV	6.3	11.8	11.0	7.8	12.8	12.4	6.4	18.7	17.0	8.4	17.5	17.0
Ardnagappary 110 kV	2.8	1.9	1.8	3.9	1.2	1.2	2.9	2.5	2.3	4.2	1.3	1.3
Arigna 110 kV	4.4	6.1	5.8	5.4	5.2	5.1	4.8	9.0	8.2	6.0	6.4	6.2
Arklow 110 kV	10.4	7.6	7.3	11.2	9.4	9.2	10.5	9.6	9.0	11.4	11.4	11.1
Arklow 220 kV	9.1	6.9	6.6	10.5	6.6	6.5	8.8	8.5	8.1	10.4	7.6	7.5
Artane 110 kV	13.4	9.9	9.3	6.3	12.0	11.7	13.2	12.3	11.3	5.8	14.4	13.9
Arva 110 kV	3.9	8.0	7.5	5.0	6.5	6.4	3.8	10.5	9.6	5.1	7.5	7.4
Athea 110 kV	13.2	7.5	7.3	12.7	8.3	8.2	13.6	13.6	11.5	12.8	12.4	11.7
Athlone 110 kV	4.1	6.4	6.1	4.7	7.3	7.2	4.9	9.9	9.2	5.8	9.9	9.7
Athy 110 kV	5.0	6.8	6.5	6.0	5.7	5.7	4.6	7.9	7.5	5.8	6.4	6.3
Aughinish 110 kV	9.1	9.7	8.7	11.1	10.8	10.3	8.0	11.2	10.2	10.1	11.7	11.3
Ballybeg 110 kV	10.0	6.1	5.8	10.2	7.2	7.1	9.8	7.0	6.7	10.0	8.1	8.0
Ballydine 110 kV	4.0	6.6	6.3	3.8	5.5	5.4	4.2	8.8	8.2	3.9	6.5	6.4
Ballylickey 110 kV	2.8	3.0	2.9	3.9	1.9	1.9	2.9	3.8	3.6	4.1	2.1	2.1
Ballynahulla 110 kV	12.7	7.5	7.2	12.3	8.1	8.0	14.5	13.1	11.6	12.9	11.9	11.4
Ballynahulla 220 kV	7.4	7.2	6.8	7.7	8.2	8.1	7.4	12.4	11.4	7.8	12.2	11.9
Ballyragget 110 kV	5.1	6.2	6.0	6.2	4.5	4.5	4.8	7.1	6.8	5.8	5.2	5.2
Ballyvouskill 110 kV	12.3	7.9	7.6	12.8	9.0	8.8	12.8	13.1	11.8	13.2	13.0	12.5
Ballyvouskill 220 kV	6.9	7.7	7.2	7.7	9.3	9.1	6.8	13.5	12.3	7.8	14.3	13.9
Ballywater 110 kV	4.6	4.9	4.8	3.3	5.2	5.2	4.6	6.1	5.8	3.2	6.0	5.9
Baltrasna 110 kV	6.4	9.7	9.2	7.5	7.6	7.5	5.8	11.4	10.8	7.1	8.4	8.3
Bancroft 110 kV	12.6	11.1	10.2	7.2	13.0	12.6	12.1	13.2	12.1	6.8	15.0	14.5
Bandon 110 kV	3.3	5.9	5.6	4.4	5.8	5.7	3.0	7.5	7.0	4.2	6.8	6.6
Banoge 110 kV	6.1	5.4	5.2	6.8	5.0	4.9	5.9	6.5	6.2	6.7	5.6	5.5
Barnadivane 110 kV	4.1	7.5	7.2	4.8	7.5	7.3	4.0	11.2	10.2	4.9	9.7	9.5
Barnahealy A 110 kV	6.0	11.2	10.5	6.5	11.8	11.5	5.2	14.9	13.8	6.0	14.4	14.1
Barnahealy B 110 kV	7.3	10.8	10.1	7.7	11.2	11.0	6.3	14.4	13.4	7.0	13.8	13.4

[1] The results presented for the 2021 maximum and minimum demand short circuit currents are based on Grid West option (see Chapter 2) data that produced the most onererous fault level. It should be noted that short circuit current values may potentially change in future TYTFS versions as the project matures and further detatilted analysis/information becomes available.

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Barnakyle 110 kV	22.1	15.0	13.6	21.9	11.7	11.4	21.9	17.8	16.4	21.7	13.0	12.7
Baroda 110 kV	4.2	8.3	7.8	4.9	9.7	9.5	3.9	10.0	9.4	4.7	11.2	10.9
Barrymore 110 kV	4.0	7.1	6.8	5.5	5.7	5.6	3.7	9.2	8.7	5.4	6.7	6.6
Belcamp 110 kV	14.7	13.1	12.0	9.0	14.7	14.2	14.8	16.9	15.2	8.5	17.9	17.2
Belcamp 220 kV	12.2	14.3	12.8	10.4	17.8	16.9	11.3	23.6	21.0	9.1	26.7	25.5
Bellacorick A 110 kV	3.5	3.5	3.3	3.8	4.5	4.4	5.2	7.0	6.0	5.6	7.9	7.4
Bellacorick B 110 kV	12.6	3.9	3.8	12.1	5.0	5.0	15.8	6.6	5.9	14.0	7.9	7.5
Binbane 110 kV	3.2	3.4	3.3	4.3	3.4	3.4	3.6	5.9	5.2	5.4	4.7	4.5
Blackpool 110 kV	7.7	15.8	14.3	7.8	17.1	16.5	6.8	25.0	22.1	7.2	23.5	22.6
Blackrock 110 kV	11.3	9.5	8.9	3.0	8.8	8.6	10.9	11.5	10.4	2.8	9.9	9.6
Blake 110 kV	4.1	7.7	7.4	5.1	5.4	5.3	3.8	9.1	8.7	5.0	5.9	5.8
Boggeragh 110 kV	6.0	6.4	6.2	7.2	6.9	6.8	6.4	9.4	8.6	7.9	8.8	8.6
Booltiagh 110 kV	6.4	6.4	6.1	8.0	5.6	5.5	6.8	9.2	8.5	8.7	6.9	6.7
Bracklone 110 kV	4.0	8.4	8.0	5.0	7.8	7.7	3.7	10.1	9.6	4.8	8.8	8.6
Brinny A 110 kV	3.2	5.3	5.1	4.2	4.8	4.7	2.9	6.6	6.2	4.1	5.5	5.4
Brinny B 110 kV	3.2	5.3	5.1	4.2	4.8	4.8	2.9	6.7	6.2	4.1	5.5	5.4
Bunkimalta 110 kV	5.3	5.1	4.9	5.6	5.2	5.2	6.6	8.2	7.2	6.6	7.4	7.1
Butlerstown 110 kV	6.0	9.6	9.1	5.7	9.8	9.6	5.3	11.7	11.0	5.2	11.4	11.1
Cabra 110 kV	12.4	9.5	9.0	5.1	10.8	10.6	12.2	11.9	10.9	4.7	12.8	12.4
Cahernagh 110 kV	4.3	4.6	4.5	5.3	5.1	5.1	5.6	7.2	6.8	7.2	6.7	6.6
Cahir 110 kV	4.4	7.4	7.0	5.0	8.3	8.1	5.7	12.8	11.5	6.6	12.1	11.7
Carlow 110 kV	5.7	7.9	7.6	6.4	8.6	8.4	5.6	10.0	9.3	6.4	10.1	9.9
Carrickmines 220 kV	14.6	15.3	13.5	10.0	18.9	17.9	13.6	22.6	20.0	8.7	26.2	24.9
Carrickmines A 110 kV	29.1	10.9	10.1	23.8	12.0	11.7	31.3	13.3	12.0	24.4	14.1	13.6
Carrickmines B 110 kV	24.1	12.2	11.2	20.4	14.7	14.2	24.9	14.8	13.5	20.4	17.2	16.6
Carrick-on-Shannon 110 kV	4.4	9.2	8.7	5.0	10.5	10.3	4.3	13.8	12.5	5.1	14.1	13.7
Carrigadrohid 110 kV	6.4	11.0	10.3	7.1	11.5	11.2	5.9	16.7	15.3	6.9	15.1	14.7
Carrowbeg 110 kV	2.7	2.5	2.4	3.6	2.4	2.3	2.7	3.3	3.0	3.7	2.8	2.7
Cashla 110 kV	7.3	12.4	11.4	7.9	15.9	15.3	7.2	22.0	19.3	8.2	25.4	24.1
Cashla 220 kV	8.3	7.9	7.4	9.3	8.7	8.4	8.6	13.4	12.5	10.1	12.4	12.1
Castlebar 110 kV	3.2	4.2	4.0	3.7	4.7	4.6	3.4	6.5	5.7	4.1	6.2	6.0
Castledockrill 110 kV	6.8	6.4	6.2	4.8	7.9	7.7	6.8	8.2	7.7	4.6	9.3	9.1
Castlefarm A 110 kV	8.1	9.4	8.4	9.5	10.0	9.6	7.2	10.8	9.8	8.7	10.9	10.5
Castlefarm B 110 kV	8.1	9.3	8.4	9.5	10.0	9.6	7.2	10.8	9.8	8.7	10.8	10.5
Castletown 110 kV	6.0	9.4	8.9	5.8	7.9	7.8	6.3	13.0	11.7	5.9	9.4	9.2
Castleview 110 kV	4.4	11.0	10.3	4.8	8.4	8.3	3.6	14.4	13.4	4.4	9.8	9.6
Cathaleen's Fall 110 kV	4.3	6.3	6.0	4.9	7.2	7.1	5.3	13.0	11.1	6.3	11.7	11.1
Cauteen 110 kV	5.4	6.4	6.1	6.3	4.4	4.4	5.9	9.4	8.7	6.7	5.3	5.2
Central 110 kV	14.6	10.0	9.3	7.9	10.8	10.6	14.3	12.1	11.0	7.6	12.5	12.1

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Charleville 110 kV	4.5	5.6	5.4	6.0	5.2	5.1	4.7	7.7	7.0	6.5	6.4	6.3
Cherrywood 110 kV	10.5	9.3	8.7	7.7	9.6	9.3	10.1	11.1	10.1	7.4	10.9	10.6
City West 110 kV	6.2	7.2	6.7	6.1	5.5	5.4	5.9	8.4	7.6	6.0	6.0	5.9
Clahane 110 kV	4.2	6.4	6.1	5.2	6.0	5.9	4.0	8.7	8.1	5.1	7.2	7.1
Clashavoon 220 kV	8.0	7.9	7.4	8.4	8.7	8.5	7.3	13.6	12.5	7.9	12.8	12.4
Clashavoon A 110 kV	7.5	12.4	11.6	7.7	13.5	13.1	7.3	20.5	18.3	7.5	18.8	18.2
Clashavoon B 110 kV	7.5	12.4	11.6	7.7	13.5	13.1	7.3	20.5	18.3	7.5	18.8	18.2
Cliff 110 kV	4.0	5.2	4.9	5.0	5.3	5.3	4.6	9.3	8.2	6.0	7.5	7.3
Cloghboola 110 kV	6.7	5.1	5.0	7.2	6.0	5.9	7.0	8.6	7.1	7.6	8.8	8.2
Clogher 110 kV	3.9	5.3	5.0	4.2	6.3	6.2	5.1	12.0	9.7	5.5	11.3	10.5
Cloghran 110 kV	10.1	18.8	17.0	9.9	20.1	19.4	9.1	24.8	22.8	9.1	24.5	23.9
Clonkeen A 110 kV	5.7	5.5	5.3	6.8	4.0	4.0	5.4	6.8	6.4	6.7	4.5	4.5
Clonkeen B 110 kV	5.8	5.0	4.8	5.5	5.8	5.7	6.1	8.2	7.3	5.5	8.4	8.0
Cloon 110 kV	4.5	6.6	6.3	5.8	5.9	5.9	4.1	8.8	8.2	5.7	7.1	7.0
College Park 110 kV	9.8	18.1	16.4	6.8	20.3	19.5	8.9	23.5	21.7	6.1	24.8	24.1
Cookstown 110 kV	7.4	7.9	7.4	6.0	6.8	6.7	7.1	9.0	8.5	5.8	7.4	7.3
Coolroe 110 kV	5.2	8.8	8.4	6.5	8.6	8.4	4.7	12.0	11.2	6.3	10.4	10.1
Coomagearlahy 110 kV	5.7	4.2	4.1	6.3	5.1	5.0	6.4	7.0	6.1	7.2	7.7	7.2
Coomataggart 110 kV	6.7	3.2	3.1	7.5	3.4	3.4	8.0	5.7	5.0	8.9	5.1	4.9
Cordal 110 kV	10.5	6.5	6.3	8.5	6.2	6.2	11.4	11.1	10.0	8.3	8.6	8.4
Corderry 110 kV	4.0	6.3	6.0	5.0	6.4	6.3	4.4	9.9	8.8	5.7	8.6	8.3
Corduff 110 kV	11.0	20.1	18.1	12.1	22.8	21.9	9.9	27.0	24.7	11.2	28.6	27.7
Corduff 220 kV	15.5	16.3	14.5	14.1	20.3	19.2	14.8	27.5	24.4	12.9	31.0	29.5
Corkagh 110 kV	22.9	15.2	13.7	22.9	11.9	11.5	22.8	17.9	16.5	22.8	13.1	12.9
Corraclassy 110 kV	4.3	5.7	5.5	5.4	4.7	4.6	4.3	7.4	7.0	5.5	5.4	5.3
Cow Cross 110 kV	5.0	11.2	10.5	5.3	10.0	9.8	4.2	14.7	13.7	4.9	11.9	11.7
Crane 110 kV	6.3	7.0	6.7	6.4	7.7	7.5	6.5	9.1	8.4	6.5	9.2	8.9
Cromcastle A 110 kV	12.4	12.7	11.7	8.0	14.4	14.0	12.1	16.4	14.7	7.5	17.5	16.8
Cromcastle B 110 kV	12.4	12.7	11.7	8.0	14.4	14.0	12.1	16.4	14.7	7.5	17.5	16.8
Cronacarkfree 220 kV	4.3	3.4	3.3	4.4	4.1	4.1	6.0	6.9	5.7	5.6	7.1	6.6
Crory 110 kV	8.3	7.3	7.0	8.8	9.2	9.0	8.7	9.4	8.8	8.9	11.1	10.8
Cuilleen 110 kV	3.9	6.1	5.9	4.7	7.1	7.0	4.7	9.5	8.8	6.0	9.7	9.4
Cullenagh 110 kV	8.0	11.7	11.1	8.5	13.7	13.4	6.9	15.0	13.9	7.6	16.6	16.2
Cullenagh 220 kV	8.9	8.5	8.1	9.2	8.6	8.5	8.0	10.3	9.8	8.5	9.9	9.8
Cunghill 110 kV	3.3	4.5	4.3	3.8	4.4	4.3	3.2	6.7	6.1	3.8	5.6	5.4
Cureeny 110 kV	5.4	6.3	6.0	5.2	5.9	5.8	6.2	9.7	8.6	5.5	8.0	7.7
Cushaling 110 kV	5.8	9.5	8.6	7.1	11.2	10.8	6.9	13.3	12.0	8.8	13.9	13.4
Dallow 110 kV	3.5	4.6	4.5	4.5	3.1	3.1	3.5	5.8	5.5	4.7	3.4	3.4
Dalton 110 kV	3.1	3.7	3.6	4.1	3.3	3.2	3.2	5.3	4.8	4.5	3.9	3.8

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Dardistown 110 kV	13.8	12.6	11.6	10.6	14.6	14.1	13.7	16.2	14.6	10.1	17.6	17.0
Derrybrien 110 kV	2.7	3.7	3.7	3.7	3.6	3.6	3.2	5.6	4.7	4.8	4.7	4.5
Derrycarney 110 kV	6.3	5.7	5.4	7.3	7.0	6.8	7.8	8.2	8.0	9.4	9.5	9.4
Derryiron 110 kV	5.1	7.6	7.2	6.2	8.1	7.9	5.7	10.5	9.9	7.3	10.0	9.8
Doon 110 kV	4.3	6.4	6.1	4.7	5.4	5.3	4.8	9.2	8.5	5.1	6.6	6.5
Dromada 110 kV	8.6	7.2	7.0	5.8	7.7	7.6	7.5	12.7	10.8	4.8	11.1	10.6
Drumkeen 110 kV	3.5	4.8	4.5	4.2	5.0	4.9	3.8	9.2	7.8	4.9	7.5	7.1
Drumline 110 kV	3.6	7.2	6.8	4.8	6.2	6.1	3.2	9.3	8.7	4.6	7.3	7.2
Drybridge 110 kV	5.8	12.3	11.4	6.7	10.4	10.2	5.0	15.6	14.4	6.2	12.1	11.8
Dundalk 110 kV	3.8	7.9	7.5	4.7	7.4	7.3	3.3	9.7	9.1	4.4	8.5	8.3
Dunfirth 110 kV	4.7	5.9	5.7	6.3	4.7	4.7	4.5	6.8	6.6	6.3	5.1	5.1
Dungarvan 110 kV	5.9	5.6	5.4	7.7	4.7	4.7	5.9	7.3	6.7	7.9	5.6	5.5
Dunmanway 110 kV	4.3	7.0	6.7	5.2	6.4	6.3	4.2	10.1	9.2	5.4	8.0	7.7
Dunstown 220 kV	13.0	16.3	14.6	12.6	18.9	18.1	10.7	22.1	20.4	10.7	24.2	23.5
Dunstown 400 kV	17.2	6.7	6.2	19.0	7.5	7.3	15.4	8.7	8.3	16.6	9.3	9.2
Clonkeen A 110 kV	5.7	5.5	5.3	6.8	4.0	4.0	5.4	6.8	6.4	6.7	4.5	4.5
Clonkeen B 110 kV	5.8	5.0	4.8	5.5	5.8	5.7	6.1	8.2	7.3	5.5	8.4	8.0
Cloon 110 kV	4.5	6.6	6.3	5.8	5.9	5.9	4.1	8.8	8.2	5.7	7.1	7.0
College Park 110 kV	9.8	18.1	16.4	6.8	20.3	19.5	8.9	23.5	21.7	6.1	24.8	24.1
Cookstown 110 kV	7.4	7.9	7.4	6.0	6.8	6.7	7.1	9.0	8.5	5.8	7.4	7.3
Coolroe 110 kV	5.2	8.8	8.4	6.5	8.6	8.4	4.7	12.0	11.2	6.3	10.4	10.1
Coomagearlahy 110 kV	5.7	4.2	4.1	6.3	5.1	5.0	6.4	7.0	6.1	7.2	7.7	7.2
Coomataggart 110 kV	6.7	3.2	3.1	7.5	3.4	3.4	8.0	5.7	5.0	8.9	5.1	4.9
Cordal 110 kV	10.5	6.5	6.3	8.5	6.2	6.2	11.4	11.1	10.0	8.3	8.6	8.4
Corderry 110 kV	4.0	6.3	6.0	5.0	6.4	6.3	4.4	9.9	8.8	5.7	8.6	8.3
Corduff 110 kV	11.0	20.1	18.1	12.1	22.8	21.9	9.9	27.0	24.7	11.2	28.6	27.7
Corduff 220 kV	15.5	16.3	14.5	14.1	20.3	19.2	14.8	27.5	24.4	12.9	31.0	29.5
Corkagh 110 kV	22.9	15.2	13.7	22.9	11.9	11.5	22.8	17.9	16.5	22.8	13.1	12.9
Corraclassy 110 kV	4.3	5.7	5.5	5.4	4.7	4.6	4.3	7.4	7.0	5.5	5.4	5.3
Cow Cross 110 kV	5.0	11.2	10.5	5.3	10.0	9.8	4.2	14.7	13.7	4.9	11.9	11.7
Crane 110 kV	6.3	7.0	6.7	6.4	7.7	7.5	6.5	9.1	8.4	6.5	9.2	8.9
Cromcastle A 110 kV	12.4	12.7	11.7	8.0	14.4	14.0	12.1	16.4	14.7	7.5	17.5	16.8
Cromcastle B 110 kV	12.4	12.7	11.7	8.0	14.4	14.0	12.1	16.4	14.7	7.5	17.5	16.8
Cronacarkfree 220 kV	4.3	3.4	3.3	4.4	4.1	4.1	6.0	6.9	5.7	5.6	7.1	6.6
Crory 110 kV	8.3	7.3	7.0	8.8	9.2	9.0	8.7	9.4	8.8	8.9	11.1	10.8
Cuilleen 110 kV	3.9	6.1	5.9	4.7	7.1	7.0	4.7	9.5	8.8	6.0	9.7	9.4
Cullenagh 110 kV	8.0	11.7	11.1	8.5	13.7	13.4	6.9	15.0	13.9	7.6	16.6	16.2
Cullenagh 220 kV	8.9	8.5	8.1	9.2	8.6	8.5	8.0	10.3	9.8	8.5	9.9	9.8

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Cunghill 110 kV	3.3	4.5	4.3	3.8	4.4	4.3	3.2	6.7	6.1	3.8	5.6	5.4
Cureeny 110 kV	5.4	6.3	6.0	5.2	5.9	5.8	6.2	9.7	8.6	5.5	8.0	7.7
Cushaling 110 kV	5.8	9.5	8.6	7.1	11.2	10.8	6.9	13.3	12.0	8.8	13.9	13.4
Dallow 110 kV	3.5	4.6	4.5	4.5	3.1	3.1	3.5	5.8	5.5	4.7	3.4	3.4
Dalton 110 kV	3.1	3.7	3.6	4.1	3.3	3.2	3.2	5.3	4.8	4.5	3.9	3.8
Dardistown 110 kV	13.8	12.6	11.6	10.6	14.6	14.1	13.7	16.2	14.6	10.1	17.6	17.0
Derrybrien 110 kV	2.7	3.7	3.7	3.7	3.6	3.6	3.2	5.6	4.7	4.8	4.7	4.5
Derrycarney 110 kV	6.3	5.7	5.4	7.3	7.0	6.8	7.8	8.2	8.0	9.4	9.5	9.4
Derryiron 110 kV	5.1	7.6	7.2	6.2	8.1	7.9	5.7	10.5	9.9	7.3	10.0	9.8
Doon 110 kV	4.3	6.4	6.1	4.7	5.4	5.3	4.8	9.2	8.5	5.1	6.6	6.5
Dromada 110 kV	8.6	7.2	7.0	5.8	7.7	7.6	7.5	12.7	10.8	4.8	11.1	10.6
Drumkeen 110 kV	3.5	4.8	4.5	4.2	5.0	4.9	3.8	9.2	7.8	4.9	7.5	7.1
Drumline 110 kV	3.6	7.2	6.8	4.8	6.2	6.1	3.2	9.3	8.7	4.6	7.3	7.2
Drybridge 110 kV	5.8	12.3	11.4	6.7	10.4	10.2	5.0	15.6	14.4	6.2	12.1	11.8
Dundalk 110 kV	3.8	7.9	7.5	4.7	7.4	7.3	3.3	9.7	9.1	4.4	8.5	8.3
Dunfirth 110 kV	4.7	5.9	5.7	6.3	4.7	4.7	4.5	6.8	6.6	6.3	5.1	5.1
Dungarvan 110 kV	5.9	5.6	5.4	7.7	4.7	4.7	5.9	7.3	6.7	7.9	5.6	5.5
Dunmanway 110 kV	4.3	7.0	6.7	5.2	6.4	6.3	4.2	10.1	9.2	5.4	8.0	7.7
Dunstown 220 kV	13.0	16.3	14.6	12.6	18.9	18.1	10.7	22.1	20.4	10.7	24.2	23.5
Dunstown 400 kV	17.2	6.7	6.2	19.0	7.5	7.3	15.4	8.7	8.3	16.6	9.3	9.2
Ennis 110 kV	5.1	9.3	8.8	6.3	8.7	8.5	4.7	13.5	12.3	6.4	10.9	10.6
Fassaroe East 110 kV	5.3	7.4	7.0	5.4	5.7	5.6	5.0	8.5	8.0	5.3	6.2	6.2
Fassaroe West 110 kV	5.5	7.6	7.1	5.5	5.9	5.8	5.2	8.7	8.1	5.4	6.5	6.4
Finglas 220 kV	15.0	15.5	13.8	14.5	19.9	18.9	15.6	27.1	23.8	14.4	31.6	29.9
Finglas A 110 kV	21.2	14.0	12.7	17.7	16.0	15.4	23.8	18.5	16.4	18.3	19.7	18.9
Finglas B 110 kV	28.4	10.9	10.2	26.9	13.9	13.5	34.3	14.0	12.7	30.4	17.1	16.4
Flagford 110 kV	4.7	9.6	9.0	5.3	12.1	11.8	4.6	14.5	13.2	5.5	17.0	16.3
Flagford 220 kV	7.1	6.1	5.7	7.8	7.4	7.2	7.9	9.2	8.7	8.9	10.3	10.0
Flagford 400 kV	10.8	2.2	2.1	10.9	2.7	2.6	13.6	3.2	3.0	12.8	3.6	3.6
Francis Street A 110 kV	10.9	11.7	10.8	5.3	13.9	13.5	10.4	13.7	12.5	5.0	15.9	15.3
Francis Street B 110 kV	13.1	11.1	10.4	6.8	13.5	13.2	12.7	13.3	12.3	6.4	15.9	15.4
Galway 110 kV	5.0	9.7	9.0	5.5	10.7	10.4	5.4	17.4	15.0	6.1	16.0	15.2
Garrow 110 kV	9.1	5.8	5.6	8.9	6.6	6.5	9.4	9.7	8.6	9.0	9.5	9.2
Garvagh 110 kV	4.2	4.9	4.7	5.4	4.8	4.8	4.8	7.3	6.5	6.4	6.1	5.9
Gilra 110 kV	3.3	5.7	5.4	4.0	4.6	4.6	3.0	7.1	6.8	3.9	5.3	5.2
Glanagow 220 kV	14.9	13.2	11.8	14.7	17.1	16.2	14.8	21.6	19.2	14.1	25.4	24.2
Glanlee 110 kV	5.7	4.0	4.0	6.0	5.0	4.9	6.3	6.8	5.9	6.6	7.4	7.0
Glasmore A 110 kV	4.4	6.9	6.6	4.9	4.9	4.8	4.1	8.3	7.6	4.7	5.3	5.2

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Glenlara A 110 kV	2.9	2.6	2.5	4.2	2.3	2.3	3.1	3.3	3.0	4.6	2.7	2.6
Glenlara B 110 kV	9.0	5.5	5.4	6.9	5.7	5.6	9.2	9.1	8.1	6.5	7.8	7.5
Glenree 110 kV	3.4	3.8	3.6	4.2	3.7	3.6	4.0	6.5	5.8	5.0	5.1	4.9
Glentanemacelligot 110 kV	8.7	5.2	5.1	8.5	4.4	4.3	8.7	8.0	7.4	8.4	5.5	5.4
Golagh 110 kV	3.6	4.6	4.4	4.0	4.7	4.7	3.9	9.1	7.7	4.5	7.1	6.8
Gorman 110 kV	6.7	13.0	12.0	7.6	14.3	13.9	6.5	18.1	16.2	7.6	18.3	17.6
Gorman 220 kV	9.6	9.9	9.2	10.2	8.5	8.4	8.7	13.1	12.4	9.8	10.1	9.9
Gortawee 110 kV	4.4	5.6	5.3	5.8	4.8	4.7	4.4	7.0	6.5	6.0	5.4	5.3
Grange 110 kV	12.2	12.6	11.6	6.0	14.0	13.5	11.8	16.2	14.6	5.6	16.8	16.2
Grange Castle 110 kV	14.5	11.3	10.4	9.5	14.1	13.6	14.1	13.8	12.4	9.1	16.6	15.9
Great Island 110 kV	7.6	11.8	11.2	8.4	15.3	15.0	6.6	14.6	13.6	7.4	18.3	17.8
Great Island 220 kV	12.0	10.9	10.3	13.4	13.1	12.8	10.4	12.9	12.3	11.9	14.8	14.5
Griffinrath A 110 kV	7.1	9.6	9.1	7.5	9.8	9.6	6.6	11.4	10.8	7.1	11.2	11.0
Griffinrath B 110 kV	7.7	10.0	9.4	7.6	9.8	9.6	7.1	11.8	11.2	7.2	11.1	10.9
Harolds 110 kV	11.1	11.7	10.8	5.0	13.9	13.5	10.6	13.8	12.5	4.7	15.8	15.3
Hartnett's Cross 110 kV	4.3	8.8	8.4	5.0	7.6	7.5	3.7	12.4	11.5	4.7	9.3	9.1
Heuston 110 kV	14.2	11.3	10.5	8.2	13.9	13.5	13.8	13.6	12.6	7.8	16.4	15.8
Huntstown A 220 kV	14.3	15.0	13.4	12.9	19.2	18.3	14.9	25.9	22.9	12.3	30.3	28.8
Huntstown B 220 kV	15.4	15.3	13.7	11.7	19.1	18.2	14.2	24.3	21.8	10.0	27.8	26.6
Ikerrin 110 kV	5.1	4.0	3.9	5.9	3.2	3.1	5.8	5.8	5.3	6.5	3.8	3.8
Inchicore 220 kV	14.8	17.4	15.2	11.0	21.5	20.3	13.5	27.0	23.6	9.4	31.0	29.4
Inchicore A 110 kV	28.1	12.3	11.5	25.0	15.5	15.1	29.9	15.1	13.8	25.7	18.6	17.9
Inchicore B 110 kV	41.1	12.2	11.2	32.8	15.5	14.9	47.9	15.0	13.4	35.2	18.6	17.7
Inniscarra 110 kV	4.8	8.5	8.1	5.9	8.1	7.9	4.4	11.6	10.8	5.8	9.8	9.6
Irishtown 220 kV	15.4	16.2	14.2	12.4	20.4	19.3	14.9	25.4	22.2	11.2	29.9	28.3
Kellis 110 kV	6.8	8.5	8.2	7.8	10.1	9.9	6.5	10.6	9.9	7.6	12.0	11.7
Kellis 220 kV	8.5	7.4	7.0	10.1	6.4	6.3	7.9	8.7	8.4	9.7	7.2	7.2
Kilbarry 110 kV	7.8	15.9	14.5	8.4	17.4	16.7	6.9	25.4	22.4	7.9	24.1	23.1
Kildonan 110 kV	9.4	17.3	15.8	7.0	15.5	15.1	8.5	22.3	20.7	6.5	18.3	17.9
Kilkenny 110 kV	4.0	6.8	6.5	5.3	5.8	5.8	3.7	7.9	7.4	4.3	8.7	8.5
Kill Hill 110 kV	4.8	4.8	4.6	5.7	4.7	4.6	6.3	8.0	7.2	7.2	6.4	6.2
Kilnaparson 110 kV	5.4	6.1	5.9	7.0	4.9	4.8	5.9	8.0	7.5	7.7	5.7	5.6
Killonan 110 kV	7.4	14.7	13.5	7.6	12.7	12.3	7.1	24.1	21.6	7.4	16.7	16.2
Killonan 220 kV	7.9	8.7	8.1	10.0	8.1	7.9	7.6	12.8	12.1	10.3	10.2	10.1
Killoteran 110 kV	6.1	10.2	9.7	5.3	11.2	11.0	5.4	12.6	11.7	4.8	13.2	12.8
Kilmahud 110 kV	22.5	15.1	13.6	22.6	11.8	11.5	22.3	17.8	16.4	22.5	13.1	12.8
Kilmore 110 kV	16.4	13.5	12.3	11.9	15.4	14.8	17.0	17.6	15.7	11.5	18.8	18.1
Kilpaddoge 110 kV	12.7	14.1	13.0	13.2	18.0	17.3	12.2	22.3	20.4	12.8	26.1	25.2

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Kilpaddoge 220 kV	13.5	12.6	11.6	12.9	16.8	16.1	15.5	26.7	24.1	13.4	31.8	30.5
Kilteel 110 kV	4.5	7.3	6.9	5.5	6.6	6.5	4.2	8.5	8.0	5.3	7.3	7.2
Kinnegad 110 kV	4.6	7.3	7.0	6.0	6.7	6.6	4.6	9.1	8.7	6.1	7.6	7.5
Knockacummer 110 kV	5.9	4.6	4.5	6.1	5.1	5.1	5.8	7.3	6.6	6.0	6.9	6.7
Knockanure 110 kV	22.1	9.5	9.1	17.5	11.3	11.1	21.7	17.1	14.6	15.6	17.6	16.6
Knockanure 220 kV	11.9	10.7	9.9	8.4	14.1	13.6	12.3	20.4	18.6	7.0	24.5	23.6
Knockavanna 110 kV	2.7	4.0	3.9	3.8	3.7	3.7	3.3	5.9	5.0	4.8	4.8	4.5
Knockearagh 110 kV	5.5	5.1	4.9	7.2	4.4	4.3	5.2	6.4	6.0	7.2	5.1	5.0
Knockraha A 110 kV	9.2	17.1	15.5	9.6	17.6	17.0	7.6	25.9	23.3	8.6	23.4	22.6
Knockraha A 220 kV	11.7	12.8	11.6	11.5	14.2	13.6	10.3	21.0	19.0	10.3	20.2	19.6
Knockraha B 110 kV	9.2	17.1	15.5	9.6	17.6	17.0	7.6	25.9	23.3	8.6	23.4	22.6
Knockraha B 220 kV	11.7	12.8	11.6	11.5	14.2	13.6	10.3	21.0	19.0	10.3	20.2	19.6
Knockranny 110 kV	3.8	3.8	3.7	4.4	2.5	2.5	4.7	6.0	5.4	5.0	2.9	2.8
Knockumber 110 kV	3.8	7.8	7.4	4.7	5.9	5.9	3.5	9.5	8.8	4.5	6.6	6.5
Lanesboro 110 kV	3.2	7.7	7.3	4.0	8.6	8.5	3.7	12.3	11.2	4.9	12.0	11.7
Laois 110 kV	7.7	12.1	11.4	8.0	15.2	14.9	7.0	14.9	14.1	7.4	18.2	17.8
Laois 400 kV	15.4	6.3	5.9	10.8	6.3	6.1	13.9	8.1	7.8	11.9	8.2	8.1
Letterkenny110 kV	3.8	5.5	5.2	4.4	6.4	6.2	4.2	11.2	9.4	5.4	10.4	9.8
Liberty A 110 kV	6.5	13.9	12.7	5.4	15.9	15.4	5.7	21.1	18.9	4.8	21.7	20.8
Liberty B 110 kV	6.4	13.9	12.7	5.2	15.9	15.4	5.6	21.1	18.9	4.6	21.6	20.7
Limerick 110 kV	5.8	13.0	12.0	6.7	11.8	11.5	5.0	19.6	17.8	6.4	15.0	14.7
Lisdrum 110 kV	2.9	4.7	4.6	4.2	4.2	4.1	2.8	6.0	5.5	4.3	4.7	4.6
Lisheen 110 kV	3.9	3.2	3.0	3.9	4.8	4.7	5.0	5.5	4.8	5.0	8.2	7.6
Lodgewood 110 kV	8.3	7.3	7.0	8.8	9.2	9.0	8.7	9.4	8.8	8.9	11.1	10.8
Lodgewood 220 kV	8.8	6.7	6.4	10.0	6.6	6.5	8.6	8.2	7.8	9.8	7.6	7.5
Longpoint 220 kV	14.4	13.3	11.9	13.1	16.9	16.1	14.3	22.0	19.5	12.2	25.5	24.3
Louth 220 kV	11.0	13.3	12.0	11.6	15.8	15.2	9.6	21.4	19.6	10.5	23.0	22.2
Louth A 110 kV	7.3	11.3	10.6	8.3	13.8	13.4	6.3	14.4	13.4	7.5	16.8	16.3
Louth B 110 kV	7.9	12.2	11.4	8.7	15.2	14.7	6.8	15.9	14.8	7.7	19.0	18.4
Macetown 110 kV	7.9	16.2	14.9	7.7	16.2	15.7	7.1	20.6	19.2	7.1	19.1	18.7
Macroom 110 kV	6.5	12.1	11.3	6.8	13.2	12.9	5.9	19.8	17.7	6.4	18.4	17.7
Mallow 110 kV	5.2	6.0	5.8	6.9	5.3	5.2	5.1	7.6	7.1	7.0	6.1	6.0
Marina 110 kV	7.8	15.2	13.8	8.7	17.6	16.9	7.2	24.2	21.3	8.4	24.8	23.6
Maynooth A 110 kV	11.1	12.0	11.2	11.8	14.7	14.3	10.3	14.6	13.7	11.0	17.4	17.0
Maynooth A 220 kV	11.2	15.3	13.7	10.5	15.0	14.5	9.2	21.0	19.3	9.2	18.8	18.3
Maynooth B 110 kV	8.6	15.4	14.2	10.0	15.2	14.8	7.6	18.8	17.7	9.2	17.5	17.2
Maynooth B 220 kV	11.8	17.0	15.1	10.6	17.1	16.4	9.6	24.9	22.7	9.1	22.2	21.6
McDermott 110 kV	15.7	10.1	9.5	6.4	12.0	11.7	15.9	12.8	11.6	5.9	14.5	14.0

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Meath Hill 110 kV	4.1	8.1	7.7	5.2	6.9	6.8	3.8	10.2	9.5	5.1	7.9	7.7
Meentycat 110 kV	3.3	4.1	3.9	4.1	4.2	4.1	3.6	7.4	6.4	4.9	5.9	5.7
Midleton 110 kV	3.9	9.3	8.8	4.9	7.6	7.5	3.5	12.0	11.3	4.6	8.8	8.7
Milltown A 110 kV	15.2	12.6	11.6	6.9	15.3	14.8	14.8	14.9	13.6	6.6	17.5	16.9
Milltown B 110 kV	9.2	10.1	9.5	4.2	12.1	11.8	8.7	12.0	11.2	4.0	14.0	13.6
Misery Hill 110 kV	13.6	12.3	11.4	7.6	15.0	14.5	13.2	14.6	13.2	7.2	17.3	16.6
Moneteen 110 kV	5.9	9.9	9.2	6.7	7.5	7.4	5.2	12.8	11.9	6.4	8.6	8.4
Moneypoint 110 kV	14.7	8.1	7.8	17.2	8.4	8.3	15.5	10.8	10.3	18.5	10.3	10.1
Moneypoint 220 kV	13.8	12.7	11.6	13.2	16.9	16.2	15.9	26.3	23.8	13.7	31.5	30.2
Moneypoint G1 400 kV	18.5	8.9	8.0	19.8	10.9	10.4	23.4	14.5	13.4	23.7	16.1	15.6
Moneypoint G2 400 kV	18.5	8.9	8.0	19.8	10.9	10.4	23.4	14.5	13.4	23.7	16.1	15.6
Moneypoint G3 400 kV	18.5	8.9	8.0	19.8	10.9	10.4	23.4	14.5	13.4	23.7	16.1	15.6
Monread 110 kV	4.2	7.2	6.9	5.0	7.2	7.1	3.9	8.4	8.0	4.8	8.0	7.9
Mount Lucas 110 kV	4.5	6.6	6.2	5.7	6.1	6.0	4.7	8.8	8.2	6.2	7.3	7.2
Moy 110 kV	3.8	3.8	3.6	4.4	4.5	4.4	5.7	7.4	6.5	6.9	7.2	6.9
Mullagharlin 110 kV	3.9	8.1	7.7	4.9	7.9	7.8	3.4	9.9	9.2	4.5	9.1	8.9
Mullingar 110 kV	3.6	6.4	6.1	4.9	6.1	6.1	3.4	7.7	7.3	4.8	7.0	6.8
Mulreavy 110 kV	3.6	4.7	4.5	3.9	5.7	5.6	4.5	10.1	8.2	5.0	10.0	9.3
Mungret A 110 kV	5.5	9.4	8.8	6.3	7.0	6.9	4.9	12.1	11.3	6.0	8.0	7.8
Mungret B 110 kV	5.5	9.4	8.8	6.3	7.0	6.9	4.9	12.1	11.3	6.0	8.0	7.9
Nangor 110 kV	13.0	11.1	10.2	7.9	13.7	13.2	12.6	13.4	12.1	7.5	16.1	15.4
Navan 110 kV	5.7	11.5	10.7	6.5	11.4	11.1	5.3	15.5	14.0	6.3	13.8	13.4
Nenagh 110 kV	3.3	3.5	3.4	4.1	2.4	2.4	3.3	4.6	4.2	4.1	2.7	2.7
Newbridge 110 kV	4.5	10.0	9.4	5.2	10.0	9.8	4.1	12.5	11.6	4.9	11.7	11.4
Newbury 110 kV	14.4	13.2	12.0	7.7	14.7	14.2	14.4	17.1	15.3	7.1	17.8	17.1
North Mayo 110 kV	14.2	4.2	4.1	13.9	5.9	5.8	17.3	7.0	6.3	16.1	9.4	9.0
North Mayo 400 kV	11.0	1.6	1.5	11.7	2.0	2.0	13.9	2.4	2.3	14.6	2.9	2.9
North Quays 110 kV	18.7	12.9	11.9	6.5	15.3	14.8	18.5	15.3	13.8	6.1	17.6	16.9
North Wall 220 kV	14.0	14.2	12.8	9.3	16.7	16.0	14.1	24.0	21.4	8.0	24.8	23.7
Oldcourt A 110 kV	4.3	9.5	9.0	4.8	7.6	7.5	3.7	12.0	11.3	4.5	8.8	8.7
Oldcourt B 110 kV	4.3	9.5	9.0	4.8	7.7	7.6	3.7	12.1	11.4	4.5	8.9	8.8
Oldstreet 220 kV	13.8	7.4	7.0	12.0	8.7	8.5	15.5	11.9	11.4	12.2	12.4	12.2
Oldstreet 400 kV	14.5	6.8	6.3	9.8	6.7	6.5	15.2	9.8	9.4	9.2	8.5	8.4
Oriel 220 kV	9.9	10.4	9.6	8.4	10.8	10.5	9.4	15.9	14.6	7.7	14.3	13.9
Oughtragh 110 kV	3.7	4.1	4.0	4.8	2.8	2.8	3.5	5.1	4.8	4.8	3.1	3.1
Oweniney 110 kV	3.5	3.4	3.2	3.8	4.4	4.3	5.3	6.8	5.8	5.8	7.9	7.4
Pelletstown 110 kV	13.8	9.6	9.1	8.1	10.6	10.4	13.7	12.0	11.0	7.7	12.6	12.2
Platin 110 kV	5.2	11.4	10.6	5.8	8.8	8.6	4.5	14.1	13.1	5.4	9.9	9.7

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Pollaphuca 110 kV	2.8	2.5	2.4	4.0	2.3	2.3	3.3	3.2	3.1	4.7	2.6	2.6
Poolbeg A 110 kV	27.2	13.4	12.3	22.0	16.8	16.2	28.3	16.0	14.5	22.1	19.5	18.7
Poolbeg A 220 kV	14.6	14.3	12.9	8.1	16.0	15.3	14.9	24.2	21.5	6.8	23.2	22.3
Poolbeg B 110 kV	27.2	13.4	12.3	22.0	16.7	16.1	28.2	16.0	14.4	22.0	19.4	18.6
Poolbeg B 220 kV	14.5	16.6	14.6	10.7	19.3	18.2	13.2	24.9	22.0	9.3	26.6	25.3
Poolbeg C 110 kV	21.2	13.1	12.1	7.5	15.6	15.1	21.2	15.6	14.1	7.1	18.0	17.3
Poppintree 110 kV	13.7	13.1	12.0	8.4	14.9	14.4	13.6	17.0	15.2	7.9	18.1	17.4
Portan 400 kV	18.4	8.5	7.7	16.5	9.6	9.3	15.9	12.5	11.9	14.7	13.2	13.0
Portlaoise 110 kV	5.9	11.3	10.6	6.8	11.1	10.9	5.4	14.2	13.3	6.5	13.0	12.7
Pottery 110 kV	17.4	10.4	9.6	5.8	10.6	10.4	17.4	12.6	11.4	5.6	12.3	11.9
Prospect 220 kV	12.2	11.1	10.3	9.2	12.8	12.4	12.4	20.7	19.1	8.1	20.1	19.5
Raffeen 220 kV	13.0	12.4	11.2	11.5	15.6	14.9	12.2	20.0	17.9	10.2	22.9	21.9
Raffeen A 110 kV	8.0	12.9	12.0	8.8	15.4	14.9	7.0	17.8	16.4	8.0	19.9	19.3
Raffeen B 110 kV	9.3	12.4	11.5	10.0	14.8	14.4	8.1	17.2	15.8	9.1	19.2	18.6
Rathkeale 110 kV	3.7	6.7	6.3	4.9	5.4	5.4	3.4	8.2	7.8	4.8	6.1	6.0
Ratrussan 110 kV	3.2	5.9	5.7	4.0	6.6	6.5	3.7	8.6	7.3	4.9	8.7	8.2
Reamore 110 kV	4.4	5.9	5.6	3.6	5.4	5.4	4.4	8.2	7.5	3.4	6.6	6.5
Richmond A 110 kV	2.9	5.6	5.4	3.8	5.5	5.4	3.0	7.9	7.4	4.2	6.8	6.7
Richmond B 110 kV	2.9	5.6	5.4	3.8	5.5	5.4	3.0	7.9	7.4	4.2	6.8	6.7
Rinawade 110 kV	5.1	9.9	9.4	6.0	7.3	7.2	4.7	11.5	11.1	5.8	8.0	8.0
Ringaskiddy 110 kV	6.3	10.5	9.9	6.5	10.4	10.2	5.5	13.9	13.0	5.9	12.7	12.4
Ringsend 110 kV	27.7	13.5	12.4	23.2	16.9	16.3	28.8	16.1	14.6	23.4	19.6	18.8
Ryebrook 110 kV	5.6	13.1	12.0	6.5	11.8	11.5	5.0	15.6	14.6	6.1	13.3	13.0
Salthill 110 kV	4.6	8.8	8.2	4.2	9.5	9.3	4.7	15.1	13.2	4.1	13.7	13.1
Screeb 110 kV	3.5	2.3	2.3	4.5	1.3	1.3	4.4	3.5	3.1	5.1	1.5	1.4
Seal Rock A 110 kV	8.7	9.6	8.6	10.3	10.6	10.2	7.7	11.0	10.0	9.4	11.5	11.1
Seal Rock B 110 kV	8.7	9.6	8.6	10.3	10.7	10.2	7.7	11.0	10.0	9.4	11.5	11.1
Shankill 110 kV	3.7	7.1	6.8	4.7	6.7	6.6	3.7	9.8	8.7	4.9	8.3	8.0
Shannonbridge 110 kV	5.1	10.9	10.2	5.9	13.6	13.3	6.4	19.3	17.5	8.0	21.5	20.7
Shannonbridge 220 kV	6.6	6.0	5.7	7.4	7.2	7.1	8.2	8.7	8.5	9.3	9.8	9.7
Shellybanks A 220 kV	14.4	14.3	12.9	8.0	17.7	16.9	14.6	24.1	21.5	6.6	27.0	25.7
Shellybanks B 220 kV	14.6	15.6	13.8	10.8	19.4	18.4	14.3	24.4	21.5	9.6	28.3	26.8
Shelton Abbey 110 kV	7.6	6.8	6.6	7.6	7.3	7.2	7.3	8.4	7.9	7.4	8.6	8.4
Singland 110 kV	6.8	12.3	11.4	7.7	11.3	11.1	6.6	18.9	17.3	7.7	14.6	14.2
Sluabh Bawn 110 kV	3.1	7.1	6.8	4.0	7.2	7.1	3.4	10.7	9.8	4.5	9.3	9.1
Sligo 110 kV	4.0	7.2	6.8	4.5	7.3	7.2	3.6	11.2	10.1	4.4	9.7	9.4
Somerset 110 kV	3.1	6.4	6.1	4.0	4.5	4.5	2.8	8.5	8.0	3.9	5.2	5.1
Sorne Hill 110 kV	2.7	2.2	2.2	3.3	2.6	2.6	3.4	3.8	3.3	4.3	3.7	3.6

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2021 (Continued)

Bus	Summer Night Valley 2015						Winter Peak 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	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]
Srananagh 110 kV	4.8	8.1	7.7	5.5	9.4	9.2	4.7	13.3	11.9	5.6	13.4	12.9
Srananagh 220 kV	6.7	3.9	3.8	8.3	3.5	3.5	7.6	5.4	5.1	9.5	4.2	4.1
Stevenstown 110 kV	4.3	5.8	5.5	4.8	3.8	3.8	4.0	6.6	6.2	4.7	4.0	4.0
Stratford 110 kV	3.2	3.8	3.7	4.2	3.0	3.0	3.3	4.7	4.5	4.4	3.4	3.4
Suir 110 kV	4.3	6.8	6.5	5.1	8.1	7.9	5.8	11.9	10.7	7.2	12.0	11.5
Taney 110 kV	9.0	9.0	8.4	3.3	8.9	8.8	8.6	10.7	9.8	3.2	10.1	9.8
Tarbert 110 kV	22.7	10.9	10.4	25.5	11.9	11.7	35.2	17.4	16.3	35.9	16.3	16.0
Tarbert 220 kV	12.9	12.2	11.2	12.8	15.9	15.3	15.0	25.6	23.2	13.9	29.6	28.4
Tawnaghmore A 110 kV	3.4	3.1	2.9	4.2	3.4	3.3	4.6	5.7	5.2	6.0	4.9	4.8
Tawnaghmore B 110 kV	4.0	3.4	3.2	4.8	4.0	3.9	5.5	6.1	5.4	7.0	5.8	5.6
Thornsberry 110 kV	4.2	6.1	5.8	5.5	5.7	5.6	4.2	7.7	7.3	5.6	6.7	6.6
Thurles 110 kV	5.0	4.1	3.9	5.4	4.8	4.7	6.4	7.1	6.2	6.6	7.2	6.8
Tievebrack 110 kV	3.4	3.3	3.2	4.5	2.6	2.6	3.6	5.1	4.6	5.1	3.2	3.1
Tipperary 110 kV	5.0	6.1	5.9	6.0	4.6	4.6	5.6	8.9	8.3	6.5	5.5	5.5
Tonroe 110 kV	2.7	3.1	3.0	3.7	2.0	2.0	2.7	3.7	3.5	3.8	2.1	2.1
Trabeg 110 kV	7.9	15.1	13.8	8.6	17.3	16.7	7.2	23.8	21.0	8.2	24.1	23.1
Tralee 110 kV	5.0	7.4	7.0	6.0	6.8	6.7	4.9	10.8	9.7	6.1	8.5	8.2
Trien A 110 kV	4.7	6.7	6.4	5.8	6.2	6.1	4.3	9.2	8.5	5.6	7.5	7.4
Trien B 110 kV	12.2	7.1	6.9	9.8	7.6	7.5	11.2	12.1	10.3	8.7	10.8	10.3
Trillick 110 kV	2.7	2.4	2.3	3.4	2.6	2.6	3.5	4.2	3.6	4.4	3.7	3.6
Trinity 110 kV	12.0	12.0	11.1	6.4	14.5	14.0	11.6	14.2	12.9	6.0	16.6	16.0
Tullabrack 110 kV	6.9	6.3	6.1	7.5	5.1	5.0	6.7	8.2	7.8	7.4	5.9	5.8
Turlough 220 kV	11.9	11.3	10.3	13.0	10.4	10.1	10.3	13.4	12.5	11.8	11.5	11.2
Tynagh 220 kV	10.6	7.0	6.6	11.7	8.6	8.5	14.8	13.3	12.4	16.5	14.2	13.8
Uggool 110 kV	5.6	5.7	5.4	6.6	6.7	6.6	8.2	10.8	8.9	10.0	10.6	9.9
Waterford 110 kV	7.3	11.1	10.5	7.4	12.4	12.1	6.3	13.9	12.8	6.7	14.7	14.3
West Dublin 110 kV	23.9	15.3	13.8	24.5	12.0	11.7	23.9	18.1	16.7	24.5	13.3	13.1
West Dublin 220 kV	12.8	17.6	15.4	10.5	19.3	18.3	10.7	26.3	23.4	9.0	26.0	24.9
Wexford 110 kV	3.9	5.7	5.5	5.0	5.5	5.5	4.0	7.3	6.6	5.3	6.4	6.3
Whitegate 110 kV	4.8	8.9	8.5	5.5	9.2	9.1	4.2	11.2	10.6	5.1	10.9	10.7
Wolfe Tone 110 kV	14.1	9.9	9.3	5.8	11.7	11.4	14.1	12.5	11.3	5.4	14.0	13.5
Woodhouse 110 kV	5.9	5.5	5.3	7.3	4.2	4.1	5.8	7.0	6.5	7.4	4.8	4.7
Woodland 220 kV	15.3	17.3	15.4	14.3	19.5	18.6	12.6	27.2	24.8	12.3	27.5	26.6
Woodland 400 kV	19.8	8.5	7.8	18.3	9.7	9.4	17.6	12.6	12.0	16.6	13.4	13.1

E.6 Short Circuit Currents in Northern Ireland

E.6.1 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,
- 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,
- 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 D.C. 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-1 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 Short Circuit Current Levels - Equipment Rating Range – Northern Ireland

Voltage Level	Short Circuit Current Equipment Rating Range
275 kV	26.5 kA – 31.5 kA
110 kV	18.4kA – 40 kA

E.6.2 Analysis

The generation dispatches used in the short circuit analysis are shown in Table D-6 in Appendix D.

The total RMS break current at a busbar is an indication of the short circuit 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.6.3 Northern Ireland Short Circuit Current Level Results

Tables E-2 to E-4 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 2015, 2018 and 2021:

- **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.

- **Asymmetrical Break Current (asym B)**

  This is based on the first peak during contact separation (peak break current). It is the highest short circuit current that a circuit breaker is required to extinguish and is the combination of AC and DC components. The asymmetrical break current is expressed as the equivalent RMS value of this peak break current.

In the Northern Ireland results tables, the RMS Break, Peak Make and Asymmetrical Break ratings of the existing nodes are shown. It should be noted that both the Ballylumford and Kells 110 kV nodes (highlighted in the tables with *) have 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.

Table E-6 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2015

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R X/R	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV													
Ballylumford	31.5	79	35.65	11.19	8.14	20.37	7.14	8.41	11.78	10.97	27.61	10.00	11.85
Castlereagh	31.5	79	35.65	10.51	8.17	20.29	7.14	8.27	10.43	9.90	24.57	9.07	10.45
Coolkeeragh	31.5	79	35.3	11.13	8.11	20.29	7.19	8.78	11.84	9.11	22.95	8.52	10.41
Hannahstown	31.5	79	35.65	10.50	7.96	19.78	6.98	8.07	10.57	9.80	24.37	8.99	10.44
Kells	31.5	79	35.65	11.58	8.81	22.13	7.67	9.21	10.92	10.80	26.95	9.90	11.54
Kilroot	31.5	79	45.3	12.16	8.74	22.08	7.62	9.32	12.96	11.65	29.61	10.62	13.09
Magherafelt	31.5	79	35.65	11.67	9.35	23.50	8.14	9.72	9.32	10.09	24.68	9.33	10.15
Moyle	31.5	79	35.65	11.15	8.07	20.18	7.08	8.33	11.66	10.80	27.15	9.86	11.62
Tandragee	31.5	79	35.65	10.81	9.83	24.50	8.54	9.97	10.17	11.54	28.55	10.56	12.14
Tamnamore	40	100	45.6	10.85	8.39	20.93	7.41	8.51	9.53	8.88	21.78	8.27	9.13
110kV													
Aghyoule	40	100		2.94	2.97	5.77	2.88	2.88	3.82	3.27	6.79	3.20	3.21
Antrim	40	100		4.74	7.75	16.89	7.30	7.43	4.88	8.27	18.12	7.99	8.31
Ballylumford*	21.9	55	25.88	10.16	13.95	34.51	12.64	15.57	11.13				
	26.2	65	29.7							17.79	44.50	16.68	20.84
Ballymena	40	100		4.90	7.48	16.42	7.05	7.21	5.45	8.17	18.33	7.89	8.36
Banbridge	18.4	46.8		4.18	5.86	12.42	5.59	5.64	5.14	6.00	13.30	5.85	6.08
Ballyvallagh	18.4	46.8	23	5.46	11.17	25.04	10.28	10.40	5.01	11.51	25.37	11.00	11.11
Ballynahinch	18.4	46.8		4.25	5.06	10.77	4.82	4.88	5.03	5.26	11.60	5.11	5.33
Belfast Central	31.5	79		8.34	11.07	26.68	10.08	11.02	5.56	13.95	31.40	13.07	14.17
Carnmoney	31.5	79	45	4.09	7.13	15.03	6.72	6.78	4.67	7.49	16.27	7.25	7.47
Castlereagh	26.2	65	33.5	10.65	13.03	32.42	11.69	14.10	11.18	17.37	43.46	16.03	19.35
Coleraine	40	100	42.5	3.69	6.33	13.02	5.96	5.96	4.25	7.59	16.14	7.30	7.32
Coolkeeragh	31.5	80	33.5	11.78	15.71	39.53	13.96	18.13	12.11	20.03	50.57	18.59	23.88
Creagh	31.5	80	33.5	3.67	6.71	13.78	6.35	6.35	4.45	7.33	15.75	7.10	7.15
Cregagh	26.2	65		9.14	12.05	29.42	10.89	12.31	7.39	15.57	36.84	14.48	16.06
Donegall North	31.5	79	33.5	8.39	12.45	30.03	11.31	12.41	5.62	16.02	36.32	14.97	15.78
Donegall South				6.13	10.08	23.11	9.31	9.56	5.07	11.49	25.40	10.94	11.29
Drumnakelly	31.5	79	42.5	7.80	14.34	34.21	12.91	14.14	7.74	16.65	39.67	15.57	17.16
Dungannon	18.4	46.8	23	5.85	12.16	27.63	11.10	11.64	6.27	13.14	30.24	12.45	13.36
Eden	25	62.5	45	4.24	7.78	16.54	7.32	7.37	4.67	8.14	17.67	7.86	8.06
Enniskillen	31.5	79	33.5	3.47	5.87	11.89	5.55	5.55	4.08	7.38	15.55	7.09	7.10
Finaghy	31.5	79		9.34	12.77	31.27	11.58	13.11	6.85	16.85	39.38	15.70	16.94
Glengormley	18.4	46.8		3.47	4.84	9.80	4.64	4.64	4.19	4.92	10.43	4.81	4.86
Hannahstown	31.5	80	33.5	10.50	13.82	34.33	12.44	14.83	10.84	18.61	46.40	17.23	20.63

Table E-6 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2015 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R X/R	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Kells*	21.9	55.9	27.4	9.04	13.52	32.95	12.24	14.71	9.46				
	26.2	65	29.7							17.77	43.57	16.59	19.99
Killymallaght	40	100	45	6.13	9.44	21.63	8.77	8.94	5.91	9.65	21.97	9.29	9.70
Knock	18.4	46.8		5.22	11.53	25.63	10.45	10.65	3.39	12.83	25.85	12.09	12.91
Larne	18.4	46.8	42.5	4.61	7.56	16.38	7.13	7.16	5.25	7.70	17.14	7.47	7.65
Limavady	18.4	46.8	23	3.62	5.93	12.14	5.62	5.62	4.28	6.68	14.23	6.47	6.50
Lisburn	18.4	46.8	23	5.36	9.83	21.97	9.10	9.25	4.92	10.37	22.77	9.92	10.29
Lisaghmore	31.5	79		4.83	8.45	18.48	7.89	8.01	5.05	8.59	18.95	8.30	8.64
Loguestown	26.2	65		3.41	4.80	9.69	4.58	4.58	3.99	5.44	11.41	5.29	5.30
Magherakeel	40	100	45	4.08	3.10	6.54	3.02	3.02	5.04	3.70	8.16	3.63	3.65
Newtownards	40	100		4.77	6.73	14.69	6.34	6.42	5.74	6.74	15.27	6.52	6.79
Newry	18.4	46.8	23	4.01	5.02	10.53	4.80	4.85	4.92	5.14	11.29	5.01	5.21
Omagh	40	100	42.5	4.09	9.12	19.22	8.46	8.47	4.68	10.09	21.91	9.63	9.74
Rathgael	26.2	65		4.31	5.39	11.49	5.12	5.17	5.02	5.56	12.26	5.40	5.61
Rosebank	40	100		9.09	12.45	30.37	11.22	12.69	8.75	16.33	39.61	15.14	16.91
Slieve Kirk	40	100		4.57	7.08	15.30	6.69	6.71	5.02	6.33	13.95	6.17	6.47
Springtown	31.5	79	33.6	5.07	8.63	19.06	8.05	8.21	5.22	8.92	19.85	8.62	8.99
Strabane	18.4	46.8	23	5.27	10.97	24.43	10.07	10.18	5.85	12.69	28.83	12.05	12.45
Tandragee	31.5	79	33.6	9.47	15.45	37.89	13.83	16.55	10.09	19.50	48.21	18.06	21.83
Tamnamore	40	100	45	7.46	10.90	25.83	10.07	11.74	8.47	11.90	28.75	11.36	13.39
Waringstown	18.4	46.8		5.13	7.20	15.95	6.80	6.93	5.74	7.23	16.38	7.01	7.36

Table E-7 Northern Ireland Short Circuit Current Levels for Winter Peak 2015

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV													
Ballylumford	31.5	79	35.65	15.74	21.24	54.97	18.76	25.04	16.79	24.82	64.59	23.12	30.78
Castlereagh	31.5	79	35.65	10.67	16.75	41.70	14.88	17.06	10.49	17.10	42.47	16.01	18.36
Coolkeeragh	31.5	79	35.3	8.66	12.56	30.44	11.59	12.88	10.01	12.57	31.03	12.07	13.81
Hannahstown	31.5	79	35.65	11.00	16.78	41.90	14.92	17.29	10.95	17.36	43.34	16.27	19.07
Kells	31.5	79	35.65	12.73	19.11	48.48	17.02	20.50	11.10	19.52	48.80	18.40	21.21
Kilroot	31.5	79	45.3	14.12	18.78	48.12	16.69	20.97	15.68	22.36	57.84	20.92	26.82
Magherafelt	31.5	79	35.65	11.70	18.53	46.61	16.64	19.20	8.80	16.47	39.99	15.67	16.62
Moyle	31.5	79	35.65	15.34	20.69	53.44	18.33	24.11	15.98	23.90	61.94	22.31	29.02
Tandragee	31.5	79	35.65	10.36	19.06	47.28	17.02	19.11	9.64	19.04	46.79	17.91	20.01
Tamnamore	40	100	45.6	10.45	14.74	36.61	13.48	14.85	8.92	12.85	31.25	12.32	13.25
110kV													
Aghyoule	40	100		4.05	4.07	8.56	3.83	3.99	5.37	4.07	9.09	3.91	4.25
Antrim	40	100		4.15	9.81	20.75	9.39	9.49	4.47	9.73	20.94	9.49	9.81
Ballylumford*	21.9	55	25.88	10.99	**24.01**	**59.96**	**22.12**	**29.09**					
	26.2	65	29.7						12.55	**27.77**	**70.37**	**26.50**	**35.38**
Ballymena	40	100		4.35	9.46	20.22	9.01	9.16	5.07	9.68	21.39	9.41	9.90
Banbridge	18.4	46.8		3.78	6.81	14.09	6.56	6.60	4.86	6.64	14.54	6.49	6.72
Ballyvallagh	18.4	46.8	23	4.56	16.40	35.43	15.38	15.43	4.43	14.80	31.77	14.34	14.41
Ballynahinch	18.4	46.8		3.90	5.99	12.48	5.71	5.76	4.81	5.94	12.98	5.77	6.00
Belfast Central	31.5	79		7.34	16.15	38.17	14.74	15.82	4.72	18.95	41.23	17.76	19.04
Carnmoney	31.5	79	45	3.58	9.00	18.38	8.60	8.65	4.31	8.77	18.70	8.55	8.77
Castlereagh	26.2	65	33.5	9.95	20.69	51.05	18.49	22.65	10.74	**26.02**	**64.80**	**23.90**	29.31
Coleraine	40	100	42.5	4.12	9.10	19.22	8.40	8.47	4.87	10.08	22.09	9.53	9.75
Coolkeeragh	31.5	80	33.5	9.30	22.94	56.13	20.71	24.91	10.01	27.48	67.86	25.73	**31.16**
Creagh	31.5	80	33.5	3.24	8.13	16.18	7.77	7.77	4.12	8.45	17.84	8.22	8.26
Cregagh	26.2	65		8.15	18.34	44.04	16.56	18.46	6.43	22.15	51.20	20.55	22.55
Donegall North	31.5	79	33.5	7.68	18.65	44.41	17.14	18.51	4.80	22.47	49.44	21.16	22.03
Donegall South				5.35	13.81	30.84	12.93	13.13	4.52	14.49	31.24	13.92	14.27
Drumnakelly	31.5	79	42.5	6.56	21.41	49.67	19.51	20.74	6.82	22.66	52.92	21.36	23.08
Dungannon	18.4	46.8	23	5.03	**17.36**	38.29	16.07	16.54	5.70	**17.04**	38.53	16.28	17.26
Eden	25	62.5	45	3.67	10.13	20.81	9.68	9.72	4.29	9.72	20.71	9.49	9.69
Enniskillen	31.5	79	33.5	3.70	8.53	17.56	7.90	7.91	4.59	9.98	21.59	9.43	9.49
Finaghy	31.5	79		8.85	19.35	47.01	17.75	19.94	6.02	24.11	55.06	22.63	24.11
Glengormley	18.4	46.8		3.15	5.62	11.10	5.43	5.43	3.97	5.44	11.39	5.34	5.38
Hannahstown	31.5	80	33.5	10.47	21.82	54.19	19.85	24.15	10.94	27.85	69.52	25.95	**31.84**

Table E-7 Northern Ireland Short Circuit Current Levels for Winter Peak 2015 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Kells*	21.9	55.9	27.4	8.19	**20.93**	50.31	19.31	23.15					
	26.2	65	29.7						8.83	**25.85**	**62.79**	**24.43**	**29.53**
Killymallaght	40	100	45	5.63	12.60	28.42	11.87	12.09	5.55	11.64	26.19	11.30	11.82
Knock	18.4	46.8		4.16	**17.06**	36.11	15.50	15.62	2.85	**16.73**	32.21	15.80	16.77
Larne	18.4	46.8	42.5	4.04	9.77	20.54	9.34	9.36	4.89	9.13	20.01	8.92	9.09
Limavady	18.4	46.8	23	3.67	7.82	16.06	7.35	7.35	4.50	8.18	17.62	7.86	7.96
Lisburn	18.4	46.8	23	4.61	13.17	28.52	12.39	12.49	4.44	12.66	27.19	12.22	12.60
Lisaghmore	31.5	79		4.18	10.28	21.78	9.74	9.82	4.62	9.80	21.24	9.53	9.85
Loguestown	26.2	65		3.65	6.31	12.94	5.92	5.95	4.36	6.66	14.25	6.39	6.49
Magherakeel	40	100	45	5.04	4.21	9.28	4.02	4.13	6.24	4.60	10.57	4.44	4.63
Newtownards	40	100		4.20	8.35	17.71	7.91	7.97	5.37	7.77	17.36	7.54	7.81
Newry	18.4	46.8	23	3.74	5.80	11.96	5.55	5.59	4.76	5.71	12.45	5.56	5.77
Omagh	40	100	42.5	4.12	13.92	29.39	12.79	12.86	4.93	13.49	29.63	12.81	13.18
Rathgael	26.2	65		3.89	6.40	13.34	6.10	6.14	4.75	6.26	13.63	6.08	6.29
Rosebank	40	100		8.06	19.26	46.18	17.33	19.33	7.94	23.72	56.75	21.93	24.25
Slieve Kirk	40	100		4.36	8.94	19.12	8.57	8.62	5.04	7.30	16.11	7.16	7.66
Springtown	31.5	79	33.6	4.34	10.47	22.38	9.94	10.04	4.75	10.20	22.23	9.92	10.26
Strabane	18.4	46.8	23	4.62	15.80	34.23	14.58	14.68	5.45	**16.63**	37.28	15.86	16.34
Tandragee	31.5	79	33.6	8.25	23.89	57.48	21.62	25.46	9.18	28.00	68.39	26.12	**31.36**
Tamnamore	40	100	45	6.70	14.65	34.10	13.82	15.80	7.98	14.65	35.08	14.17	16.51
Waringstown	18.4	46.8		4.61	8.73	18.90	8.33	8.44	5.42	8.27	18.53	8.06	8.43

Table E-8 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2018

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV													
Ballylumford	31.5	79	35.65	11.40	8.30	20.82	7.30	8.63	12.01	11.07	27.92	10.11	12.04
Castlereagh	31.5	79	35.65	10.87	8.37	20.89	7.33	8.56	10.78	10.13	25.24	9.29	10.78
Coolkeeragh	31.5	79	35.3	11.12	8.09	20.24	7.20	8.81	12.24	9.19	23.24	8.61	10.65
Hannahstown	31.5	79	35.65	10.84	8.15	20.32	7.15	8.32	10.93	9.99	24.94	9.17	10.71
Kells	31.5	79	35.65	11.73	8.95	22.53	7.82	9.40	11.08	10.93	27.31	10.03	11.73
Kilroot	31.5	79	45.3	12.33	8.89	22.49	7.77	9.52	13.15	11.84	30.14	10.81	13.34
Magherafelt	31.5	79	35.65	11.52	9.33	23.43	8.16	9.70	9.49	9.69	23.77	9.01	9.90
Moyle	31.5	79	35.65	11.36	8.23	20.64	7.24	8.54	11.90	10.91	27.48	9.97	11.82
Tandragee	31.5	79	35.65	10.73	9.83	24.48	8.59	9.93	10.21	10.98	27.18	10.12	11.65
Tamnamore	40	100	45.6	10.69	9.05	22.53	7.95	9.19	10.21	8.42	20.85	7.90	9.15
110kV													
Aghyoule	40	100		3.01	3.02	5.91	2.93	2.93	3.91	3.32	6.92	3.25	3.26
Antrim	40	100		4.74	7.84	17.07	7.39	7.52	4.88	8.32	18.23	8.05	8.36
Ballylumford	21.9	55	25.88	10.12	14.18	35.07	12.86	15.86	11.10	18.03	45.09	16.92	21.15
Ballymena	40	100		4.91	7.56	16.60	7.13	7.30	5.46	8.24	18.47	7.96	8.43
Banbridge	18.4	46.8		4.40	5.68	12.18	5.43	5.49	5.34	5.89	13.14	5.74	5.98
Ballyvallagh	40	100		5.46	11.33	25.40	10.44	10.56	5.01	11.65	25.67	11.15	11.25
Ballynahinch	18.4	46.8		4.24	5.17	10.98	4.92	4.98	5.02	5.34	11.78	5.19	5.41
Belfast Central	31.5	79		8.57	11.54	27.92	10.47	11.53	5.57	14.48	32.61	13.52	14.73
Belfast North	18.4	46.8	1000	5.31	11.30	25.20	10.37	10.64	3.36	12.25	24.62	11.65	12.65
Carnmoney	31.5	79	45	4.08	7.27	15.30	6.85	6.91	4.66	7.61	16.51	7.36	7.58
Castlereagh	31.5	79	33.5	11.18	13.66	34.17	12.20	14.95	11.69	18.15	45.63	16.68	20.41
Coleraine	40	100	45.6	4.13	6.37	13.45	6.00	6.01	4.65	7.72	16.74	7.43	7.47
Coolkeeragh	31.5	80		12.05	15.75	39.73	14.04	18.22	12.53	20.45	51.81	19.00	24.53
Creagh	31.5	80	33.5	3.78	6.87	14.22	6.51	6.52	4.55	7.49	16.18	7.27	7.33
Cregagh				9.46	12.60	30.89	11.34	12.94	7.49	16.21	38.44	15.02	16.74
Donegall North	31.5	79	33.5	8.79	12.61	30.63	11.48	12.65	5.72	16.16	36.78	15.12	16.04
Donegall South	1000	1000		6.28	10.20	23.49	9.44	9.69	5.16	11.61	25.75	11.06	11.42
Drumnakelly	31.5	79	42.5	8.94	12.54	30.52	11.45	12.61	8.85	14.60	35.48	13.77	15.34
Dungannon	40	100	45.6	7.33	10.25	24.21	9.51	10.19	7.76	11.17	26.64	10.70	11.79
Eden	25	62.5		4.22	7.91	16.81	7.45	7.50	4.66	8.25	17.90	7.97	8.18
Enniskillen	31.5	79		3.68	6.03	12.39	5.72	5.72	4.27	7.60	16.18	7.32	7.33
Finaghy	31.5	79	1000	9.85	12.93	31.87	11.75	13.34	7.12	17.03	40.05	15.88	17.16
Glengormley	18.4	46.8	1000	3.47	4.88	9.90	4.69	4.70	4.19	4.96	10.52	4.86	4.91
Hannahstown	31.5	80		11.21	14.00	35.04	12.63	15.14	11.67	18.79	47.24	17.42	20.98
Kells	40	100	45.6	9.23	13.72	33.52	12.45	14.96	9.67	17.99	44.24	16.83	20.27

Table E-8 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2018 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Killymallaght	40	100		6.25	9.52	21.90	8.87	9.05	5.96	9.73	22.19	9.38	9.80
Knock	18.4	46.8		5.23	12.03	26.74	10.87	11.09	3.31	13.27	26.58	12.47	13.31
Larne	18.4	46.8		4.61	7.66	16.57	7.23	7.26	5.25	7.79	17.32	7.55	7.74
Limavady	18.4	46.8		3.79	5.96	12.33	5.65	5.65	4.43	6.71	14.41	6.51	6.55
Lisburn	18.4	46.8		6.88	9.99	23.38	9.26	9.62	5.74	10.51	23.80	10.06	10.67
Lisaghmore	31.5	79	1000	4.85	8.47	18.55	7.93	8.05	5.04	8.64	19.06	8.35	8.69
Loguestown	26.2	65	1000	3.69	4.83	9.93	4.61	4.61	4.24	5.49	11.66	5.33	5.36
Magherakeel	40	100		4.33	3.16	6.76	3.09	3.09	5.33	3.76	8.39	3.70	3.72
Newtownards	40	100		4.76	6.91	15.08	6.50	6.58	5.75	6.87	15.57	6.64	6.92
Newry	18.4	46.8		4.19	4.90	10.38	4.69	4.74	5.08	5.06	11.19	4.94	5.14
Omagh	40	100		4.92	9.57	21.01	8.90	8.97	5.21	11.09	24.63	10.59	10.83
Rathgael	26.2	65		4.30	5.50	11.74	5.23	5.28	5.02	5.65	12.46	5.48	5.70
Rosebank	40	100		10.21	12.87	31.87	11.57	13.56	11.07	16.82	42.03	15.54	18.54
Slieve Kirk	40	100		4.61	7.14	15.46	6.76	6.78	5.08	6.39	14.13	6.24	6.54
Springtown	31.5	79	33.6	5.10	8.65	19.13	8.09	8.24	5.23	8.98	19.96	8.68	9.05
Strabane	18.4	46.8	23	5.47	11.13	24.96	10.25	10.38	6.01	12.87	29.40	12.26	12.70
Tandragee	31.5	79	33.5	11.34	14.06	35.25	12.73	15.39	11.99	17.78	44.84	16.59	20.24
Tamnamore	40	100	45	9.94	12.58	31.05	11.54	14.04	10.17	14.75	36.49	13.97	16.91
Waringstown	18.4	46.8		5.49	6.92	15.53	6.56	6.69	6.04	7.05	16.11	6.84	7.19

Table E-9 Northern Ireland Short Circuit Current Levels for Winter Peak 2018

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV													
Ballylumford	31.5	79	35.65	16.05	22.12	57.34	19.68	25.91	16.97	25.63	66.73	23.85	31.52
Castlereagh	31.5	79	35.65	10.97	17.28	43.15	15.43	17.64	10.77	17.49	43.57	16.36	18.78
Coolkeeragh	31.5	79	35.3	8.57	12.73	30.79	11.82	13.07	10.35	12.84	31.85	12.32	14.20
Hannahstown	31.5	79	35.65	11.33	17.30	43.35	15.47	17.85	11.30	17.76	44.50	16.64	19.50
Kells	31.5	79	35.65	13.16	19.85	50.53	17.78	21.35	11.32	20.07	50.30	18.81	21.74
Kilroot	31.5	79	45.3	14.46	19.39	49.80	17.33	21.63	16.05	23.12	59.94	21.57	27.62
Magherafelt	31.5	79	35.65	11.46	18.77	47.10	16.99	19.34	8.65	15.05	36.45	14.07	14.96
Moyle	31.5	79	35.65	15.62	21.53	55.68	19.20	24.92	16.15	24.66	63.96	23.00	29.72
Tandragee	31.5	79	35.65	10.14	18.90	46.75	17.03	18.77	9.65	17.23	42.36	16.31	18.31
Tamnamore	40	100	45.6	10.28	17.25	42.73	15.70	17.32	9.85	12.06	29.73	10.76	12.48
110kV													
Aghyoule	40	100		4.13	4.22	8.92	3.98	4.16	5.51	4.20	9.43	4.04	4.41
Antrim	40	100		4.16	10.07	21.32	9.63	9.73	4.49	10.06	21.67	9.69	10.01
Ballylumford	21.9	55	25.88	10.76	24.39	60.77	22.56	29.44	12.33	28.25	71.46	26.88	35.76
Ballymena	40	100		4.57	9.92	21.44	9.37	9.64	5.30	10.51	23.44	9.79	10.57
Banbridge	18.4	46.8		4.00	6.58	13.81	6.33	6.37	5.07	6.52	14.41	6.37	6.60
Ballyvallagh	40	100		4.52	16.78	36.17	15.75	15.80	4.40	15.16	32.50	14.58	14.64
Ballynahinch	18.4	46.8		3.88	6.02	12.55	5.75	5.80	4.80	5.95	13.00	5.78	6.01
Belfast Central	31.5	79		7.47	16.68	39.54	15.23	16.38	4.74	19.49	42.47	18.22	19.65
Belfast North	18.4	46.8		4.40	15.97	34.22	14.88	15.09	2.92	15.40	29.86	14.79	15.98
Carnmoney	31.5	79	45	3.57	9.10	18.57	8.71	8.76	4.31	8.87	18.94	8.65	8.88
Castlereagh	31.5	79	33.5	10.32	21.55	53.42	19.24	23.79	11.05	27.03	67.54	24.73	30.56
Coleraine	40	100	45.6	4.59	9.93	21.48	9.13	9.23	5.34	10.91	24.37	10.30	10.60
Coolkeeragh	31.5	80	33.5	9.00	23.76	57.87	21.57	25.69	9.84	29.06	71.62	27.22	32.86
Creagh	31.5	80	33.5	3.30	8.42	16.85	8.07	8.07	4.20	8.75	18.57	8.46	8.51
Cregagh	26.2	65		8.33	19.02	45.83	17.16	19.20	6.49	22.89	53.00	21.18	23.31
Donegall North	31.5	79	33.5	8.02	18.80	45.07	17.35	18.75	4.85	22.53	49.70	21.23	22.22
Donegall South				5.45	13.89	31.14	13.05	13.24	4.57	14.56	31.46	13.98	14.33
Drumnakelly	31.5	79	42.5	7.82	17.89	42.69	16.41	17.59	8.06	19.02	45.59	17.97	19.73
Dungannon	40	100		6.52	14.28	33.09	13.42	14.01	7.28	14.25	33.64	13.27	14.50
Eden	25	62.5	45	3.65	10.23	20.98	9.79	9.83	4.28	9.83	20.95	9.60	9.79
Enniskillen	31.5	79	33.5	3.98	9.20	19.26	8.53	8.58	4.88	10.78	23.62	10.15	10.30
Finaghy	31.5	79		9.33	19.51	47.74	17.96	20.15	6.23	24.26	55.77	22.78	24.25
Glengormley	18.4	46.8		3.13	5.70	11.25	5.51	5.51	3.97	5.54	11.59	5.39	5.43
Hannahstown	31.5	80	33.5	11.29	22.03	55.18	20.11	24.49	11.96	28.02	70.63	26.12	32.10
Kells	40	100	45.6	8.91	22.22	54.03	20.40	24.62	9.57	28.42	69.79	25.88	31.87

Table E-9 Northern Ireland Short Circuit Current Levels for Winter Peak 2018 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Killymallaght	40	100		5.64	13.20	29.78	12.48	12.71	5.56	12.06	27.15	11.71	12.28
Knock	18.4	46.8		4.12	**17.63**	37.23	16.01	16.15	2.81	**17.10**	32.79	16.13	17.14
Larne	18.4	46.8	42.5	4.02	9.89	20.76	9.47	9.49	4.88	9.25	20.28	9.00	9.17
Limavady	18.4	46.8	23	3.71	8.09	16.66	7.61	7.62	4.55	8.38	18.10	8.06	8.16
Lisburn	18.4	46.8		6.14	13.42	30.77	12.64	12.96	6.07	12.57	28.76	12.14	12.77
Lisaghmore	31.5	79		4.11	10.42	22.00	9.91	9.99	4.55	9.93	21.44	9.66	9.98
Loguestown	26.2	65		3.86	6.68	13.88	6.26	6.29	4.56	6.98	15.08	6.69	6.82
Magherakeel	40	100		5.53	4.53	10.18	4.34	4.55	6.95	4.90	11.49	4.74	5.10
Newtownards	40	100		4.19	8.46	17.94	8.02	8.08	5.38	7.86	17.58	7.62	7.90
Newry	18.4	46.8	23	4.06	5.73	12.05	5.44	5.54	5.06	5.62	12.41	5.45	5.74
Omagh	40	100	42.5	4.94	15.73	34.57	14.50	14.73	5.36	16.18	36.16	15.11	15.80
Omagh South	40	100		3.95	11.19	23.39	10.47	10.49	3.98	10.61	22.23	10.12	10.14
Rathgael	26.2	65		3.88	6.47	13.47	6.17	6.21	4.76	6.32	13.78	6.14	6.36
Rosebank	40	100		9.15	19.62	47.89	17.67	20.44	10.39	24.12	59.83	22.25	26.50
Slieve Kirk	40	100		4.34	9.26	19.78	8.89	8.96	5.05	7.47	16.49	7.33	7.86
Springtown	31.5	79	33.6	4.27	10.62	22.62	10.12	10.22	4.67	10.34	22.46	10.07	10.41
Strabane	18.4	46.8	23	4.59	**16.72**	36.16	15.53	15.61	5.43	**17.46**	39.10	**16.68**	17.18
Tandragee	31.5	79	33.5	10.42	21.04	52.21	19.13	22.87	11.38	24.69	61.91	23.06	28.06
Tamnamore	40	100	45	9.35	18.97	46.43	17.72	21.17	9.78	20.31	50.01	18.10	22.17
Waringstown	18.4	46.8		4.94	8.32	18.28	7.93	8.04	5.71	8.00	18.09	7.77	8.14

Table E-10 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2021

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
400 kV													
Turleenan	50	125	57.3	14.15	8.66	22.19	7.91	9.45	11.81	9.62	24.22	9.14	10.58
275kV													
Ballylumford	31.5	79	35.65	14.20	12.29	31.52	11.13	13.62	14.78	15.12	38.91	14.22	17.61
Castlereagh	31.5	79	35.65	12.50	11.60	29.39	10.47	12.32	11.90	13.05	32.88	12.29	14.33
Coolkeeragh	31.5	79	35.3	15.08	10.26	26.47	9.41	11.59	15.52	10.92	28.23	10.45	13.10
Hannahstown	31.5	79	35.65	12.51	11.32	28.68	10.25	12.02	12.22	12.88	32.54	12.14	14.33
Kells	31.5	79	35.65	14.39	13.06	33.54	11.73	14.48	12.40	14.64	37.04	13.79	16.25
Kilroot	31.5	79	45.3	15.71	13.13	33.98	11.74	15.01	16.85	16.51	42.95	15.44	19.97
Magherafelt	31.5	79	35.65	14.46	13.75	35.33	12.36	15.21	9.83	13.15	32.41	12.49	13.52
Moyle	31.5	79	35.65	14.05	12.12	31.05	10.99	13.38	14.52	14.82	38.09	13.95	17.14
Tandragee	31.5	79	35.65	12.88	14.23	36.15	12.75	15.14	11.17	15.46	38.68	14.53	16.80
Tamnamore	40	100	45.6	13.45	14.11	36.01	12.68	15.25	10.82	14.22	35.45	13.44	15.51
Turleenan	40	100	45.6	13.48	14.33	36.56	12.86	15.48	10.66	14.52	36.13	13.71	15.72
110kV													
Aghyoule	40	100		2.96	3.04	5.91	2.97	2.97	3.87	3.34	6.95	3.29	3.29
Airport Road	40	100		5.31	9.78	21.81	9.28	9.44	5.42	10.28	23.03	9.97	10.39
Antrim	40	100		4.56	8.63	18.64	8.31	8.42	4.77	8.89	19.40	8.72	9.04
Ballylumford	40	100	45.6	10.67	17.11	42.58	15.99	20.06	11.83	20.95	52.74	20.11	25.65
Ballymena	40	100		4.74	8.29	18.05	7.98	8.13	5.36	8.78	19.62	8.60	9.07
Banbridge	18.4	46.8		4.26	6.05	12.88	5.88	5.93	5.25	6.12	13.62	6.02	6.26
Ballyvallagh	40	100	45.6	5.17	13.09	29.03	12.40	12.48	4.81	12.76	27.89	12.43	12.51
Ballynahinch	18.4	46.8		4.10	5.47	11.54	5.29	5.34	4.93	5.53	12.16	5.43	5.65
Belfast Central	31.5	79		8.73	13.37	32.44	12.47	13.61	5.29	16.42	36.61	15.65	16.95
Belfast North	18.4	46.8		5.02	13.15	28.99	12.41	12.64	3.16	13.56	26.81	13.14	14.21
Carnmoney	31.5	79	45	3.86	7.94	16.51	7.64	7.69	4.52	8.03	17.32	7.86	8.08
Castlereagh	31.5	79	33.5	12.34	16.34	41.33	15.02	18.71	12.75	21.37	54.24	20.09	24.90
Coleraine	40	100	45.6	4.36	6.68	14.29	6.39	6.40	4.87	8.48	18.59	8.23	8.28
Coolkeeragh	31.5	80	33.5	13.09	17.52	44.57	16.00	20.90	13.49	22.38	57.11	21.16	27.52
Creagh	31.5	80	33.5	3.61	7.42	15.17	7.17	7.17	4.43	7.92	17.01	7.77	7.82
Cregagh	26.2	65		9.87	14.83	36.57	13.73	15.61	7.35	18.72	44.26	17.72	19.64
Donegall North	31.5	79	33.5	9.05	14.98	36.51	14.03	15.34	5.47	18.60	41.73	17.80	18.47
Donegall South				6.09	11.67	26.71	11.08	11.29	4.96	12.77	28.10	12.39	12.73
Drumnakelly	31.5	79	42.5	9.27	14.77	36.12	13.85	15.23	9.04	16.58	40.42	15.94	17.72
Dungannon	40	100	45.6	7.51	11.66	27.65	11.08	11.85	7.87	12.45	29.75	12.09	13.31
Eden	25	62.5	45	4.00	8.69	18.23	8.36	8.40	4.51	8.75	18.86	8.57	8.77
Enniskillen	31.5	79	33.5	3.59	6.25	12.77	6.00	6.00	4.17	7.86	16.65	7.63	7.64
Finaghy	31.5	79		10.44	15.43	38.31	14.43	16.36	7.01	19.80	46.45	18.90	20.26

Table E-10 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2021 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Glengormley	18.4	46.8		3.34	5.16	10.35	5.03	5.03	4.11	5.13	10.83	5.06	5.11
Hannahstown	31.5	80	33.5	12.54	17.01	43.09	15.81	19.24	13.07	22.25	56.60	21.13	25.87
Kells	40	100	45.6	9.72	16.43	40.42	15.35	18.67	10.20	20.98	51.94	20.07	24.51
Killymallaght	40	100	45	6.14	10.05	23.04	9.54	9.68	5.73	10.24	23.17	9.97	10.36
Knock	18.4	46.8		4.92	14.06	30.88	13.07	13.25	3.10	14.85	29.24	14.24	15.16
Larne	18.4	46.8	42.5	4.39	8.38	17.96	8.08	8.10	5.12	8.23	18.22	8.08	8.25
Limavady	18.4	46.8	23	4.18	6.22	13.17	5.98	5.98	4.85	6.97	15.27	6.81	6.88
Lisburn	18.4	46.8	23	6.93	11.48	26.88	10.91	11.25	6.42	11.20	25.87	10.90	11.47
Lisaghmore	31.5	79		4.75	8.90	19.39	8.47	8.57	4.99	8.90	19.61	8.69	9.02
Loguestown	26.2	65		3.81	4.99	10.35	4.82	4.82	4.36	5.73	12.26	5.60	5.63
Magherakeel	40	100	45	4.27	3.18	6.76	3.13	3.13	5.25	3.79	8.43	3.75	3.77
Newtownards	40	100		4.59	7.51	16.25	7.20	7.27	5.64	7.26	16.39	7.10	7.38
Newry	18.4	46.8	23	4.06	5.15	10.85	5.01	5.06	5.00	5.22	11.50	5.13	5.33
Omagh	40	100	42.5	4.76	10.36	22.59	9.83	9.88	5.07	11.85	26.19	11.47	11.67
Omagh South	40	100	42.5	3.92	7.87	16.43	7.54	7.54	4.05	8.68	18.26	8.45	8.46
Rathgael	26.2	65		4.15	5.85	12.38	5.65	5.70	4.92	5.87	12.89	5.75	5.97
Rosebank	40	100		10.87	15.22	37.95	14.06	16.51	11.63	19.52	49.07	18.43	21.96
Slieve Kirk	40	100		4.49	7.39	15.92	7.11	7.13	5.20	7.09	15.75	6.96	7.09
Springtown	31.5	79	33.6	5.00	9.10	20.05	8.66	8.80	5.18	9.27	20.58	9.05	9.42
Strabane	18.4	46.8	23	5.29	11.94	26.60	11.23	11.32	5.88	13.59	30.90	13.11	13.49
Tandragee	31.5	79	33.5	12.79	16.96	43.05	15.78	19.61	13.52	20.94	53.46	19.95	25.02
Tamnamore	40	100	45	11.18	14.89	37.26	14.03	17.74	11.54	17.43	43.76	16.79	21.08
Waringstown	18.4	46.8		5.36	7.51	16.78	7.25	7.38	5.99	7.45	16.99	7.30	7.67

Table E-11 Northern Ireland Short Circuit Current Levels for Winter Peak 2021

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
400 kV													
Turleenan	50	125	57.3	12.97	12.33	31.34	11.51	13.14	10.83	12.65	31.55	12.16	13.67
275kV													
Ballylumford	31.5	79	35.65	14.33	21.02	53.94	18.92	23.63	15.16	23.33	60.18	21.89	27.83
Castlereagh	31.5	79	35.65	10.82	17.69	44.08	15.89	18.02	10.67	17.80	44.30	16.71	19.07
Coolkeeragh	31.5	79	35.3	13.34	13.82	35.22	12.88	15.11	14.37	13.58	34.85	13.08	15.96
Hannahstown	31.5	79	35.65	11.03	17.40	43.47	15.68	17.85	11.13	17.74	44.38	16.68	19.38
Kells	31.5	79	35.65	13.30	20.76	52.90	18.77	22.37	11.18	20.69	51.76	19.53	22.42
Kilroot	31.5	79	45.3	14.43	20.06	51.52	18.08	22.32	16.06	23.64	61.28	22.18	28.18
Magherafelt	31.5	79	35.65	12.61	21.27	53.92	19.34	22.52	8.59	17.28	41.82	16.53	17.39
Moyle	31.5	79	35.65	14.05	20.50	52.52	18.50	22.86	14.73	22.62	58.20	21.26	26.65
Tandragee	31.5	79	35.65	11.15	22.13	55.36	19.94	22.52	9.90	21.19	52.26	20.02	22.46
Tamnamore	40	100	45.6	11.67	21.78	54.75	19.78	22.52	9.59	18.91	46.44	18.01	20.16
Turleenan	40	100	45.6	11.66	22.09	55.54	20.05	22.82	9.40	19.30	47.29	18.38	20.41
110kV													
Aghyoule	40	100		4.07	4.28	9.01	4.04	4.21	5.44	4.21	9.44	4.06	4.42
Airport Road	40	100		4.67	11.43	24.82	10.72	10.85	5.00	11.46	25.25	11.00	11.43
Antrim	40	100		4.01	10.61	22.26	10.20	10.29	4.39	10.32	22.10	9.97	10.29
Ballylumford	40	100	45.6	10.07	24.39	60.27	22.68	29.05	11.60	27.98	70.31	26.70	34.97
Ballymena	40	100		4.41	10.40	22.30	9.90	10.13	5.19	10.77	23.91	10.08	10.82
Banbridge	18.4	46.8		3.97	6.63	13.88	6.39	6.44	5.04	6.50	14.35	6.36	6.59
Ballyvallagh	40	100	45.6	4.34	17.27	36.91	16.32	16.36	4.30	15.35	32.73	14.81	14.86
Ballynahinch	18.4	46.8		3.87	6.01	12.50	5.74	5.79	4.78	5.93	12.93	5.76	5.98
Belfast Central	31.5	79		7.38	16.79	39.71	15.34	16.46	4.64	19.65	42.61	18.37	19.78
Belfast North	18.4	46.8		4.34	16.03	34.27	15.00	15.20	2.90	15.40	29.79	14.81	15.98
Carnmoney	31.5	79	45	3.54	9.05	18.44	8.68	8.73	4.29	8.81	18.78	8.59	8.82
Castlereagh	31.5	79	33.5	10.18	21.78	53.89	19.46	23.97	10.89	27.50	68.60	25.13	30.92
Coleraine	40	100	45.6	5.35	11.35	25.36	10.09	10.44	6.07	12.99	29.72	11.87	12.64
Coolkeeragh	31.5	80	33.5	10.14	25.68	63.52	23.09	28.68	10.98	30.91	77.18	28.78	36.07
Creagh	31.5	80	33.5	3.22	8.64	17.18	8.32	8.32	4.14	8.87	18.76	8.62	8.66
Cregagh	26.2	65		8.22	19.18	46.12	17.32	19.32	6.33	23.16	53.40	21.42	23.49
Donegall North	31.5	79	33.5	7.90	18.91	45.21	17.52	18.84	4.98	22.58	49.71	21.34	22.30
Donegall South				5.36	13.88	31.01	13.08	13.26	4.54	14.56	31.42	14.01	14.35
Drumnakelly	31.5	79	42.5	8.05	18.54	44.44	17.10	18.43	8.20	19.64	47.20	18.62	20.48
Dungannon	40	100	45.6	6.56	14.98	34.75	14.14	14.78	7.24	15.05	35.49	14.42	15.65
Eden	25	62.5	45	3.61	10.16	20.80	9.75	9.79	4.25	9.75	20.74	9.52	9.72
Enniskillen	31.5	79	33.5	4.06	9.72	20.46	9.01	9.08	4.91	11.42	25.07	10.74	10.95
Finaghy	31.5	79		9.18	19.63	47.93	18.15	20.23	6.14	24.33	55.77	22.91	24.30
Glengormley	18.4	46.8		3.05	5.83	11.43	5.66	5.66	3.92	5.61	11.72	5.48	5.52

Table E-11 Northern Ireland Short Circuit Current Levels for Winter Peak 2021 (Continued)

Node	Rating			Three Phase					Single Phase				
	RMS [kA]	Peak [kA]	Asym [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	X/R ratio	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV													
Hannahstown	31.5	80	33.5	11.08	22.21	55.51	20.37	24.58	11.77	28.15	70.84	26.32	**32.11**
Kells	40	100	45.6	8.78	25.34	61.52	23.47	27.78	9.09	31.50	76.81	28.80	34.88
Killymallaght	40	100	45	5.72	13.74	31.09	12.96	13.19	5.41	12.59	28.18	12.20	12.77
Knock	18.4	46.8		4.06	**17.75**	37.35	16.13	16.26	2.76	**17.17**	32.78	16.20	17.20
Larne	18.4	46.8	42.5	3.93	10.02	20.92	9.64	9.65	4.83	9.33	20.41	9.10	9.26
Limavady	18.4	46.8	23	4.16	8.64	18.29	8.05	8.06	5.03	8.82	19.47	8.42	8.59
Lisburn	18.4	46.8	23	6.07	13.51	30.91	12.77	13.07	6.03	12.59	28.77	12.18	12.80
Lisaghmore	31.5	79		4.12	10.76	22.73	10.21	10.29	4.59	10.15	21.95	9.87	10.20
Loguestown	26.2	65		4.09	7.31	15.42	6.72	6.78	4.80	7.57	16.53	7.14	7.34
Magherakeel	40	100	45	5.54	4.60	10.34	4.41	4.62	6.98	4.95	11.61	4.79	5.15
Newtownards	40	100		4.16	8.46	17.90	8.02	8.08	5.27	7.19	16.02	6.99	7.26
Newry	18.4	46.8	23	4.05	5.77	12.14	5.50	5.59	5.05	5.64	12.46	5.48	5.78
Omagh	40	100	42.5	5.16	17.30	38.36	15.86	16.23	5.50	17.77	39.90	16.54	17.42
Omagh South	40	100	42.5	4.29	12.44	26.52	11.57	11.70	4.78	13.26	28.93	12.51	12.86
Rathgael	26.2	65		3.86	6.45	13.42	6.15	6.20	4.76	6.35	13.85	6.16	6.38
Rosebank	40	100		9.03	19.79	48.23	17.84	20.56	10.14	24.46	60.51	22.55	26.60
Slieve Kirk	40	100		4.33	9.50	20.29	9.11	9.18	5.25	8.41	18.71	8.23	8.51
Springtown	31.5	79	33.6	4.44	11.22	24.11	10.57	10.74	4.80	10.66	23.30	10.34	10.79
Strabane	18.4	46.8	23	4.68	**17.86**	38.81	16.50	16.62	5.53	**18.23**	40.99	**17.36**	17.98
Tandragee	31.5	79	33.5	11.11	21.97	54.93	20.08	24.58	12.17	25.88	65.35	24.25	**30.16**
Tamnamore	40	100	45	9.79	20.24	49.84	19.00	23.23	10.48	22.40	55.62	21.25	26.15
Waringstown	18.4	46.8		4.94	8.44	18.56	8.07	8.19	5.71	8.07	18.25	7.85	8.23

APPENDIX F: ADDITIONAL INFORMATION ON OPPORTUNITIES

F.1 EirGrid Draft Approach to Consultation

EIRGRID GROUP

The current. The future.

Appendix F Additional Information on Opportunities

F.1 EirGrid Draft Approach to Consultation

In November 2015 EirGrid launched Lines of Communication[1] which outlines our draft approach to consultation. It follows a review of our consultation activities after which we made a commitment to improve the way we engage with the public and stakeholders.

Lines of Communication outlines the way we develop our projects and how the public can engage with us at each stage of project development.

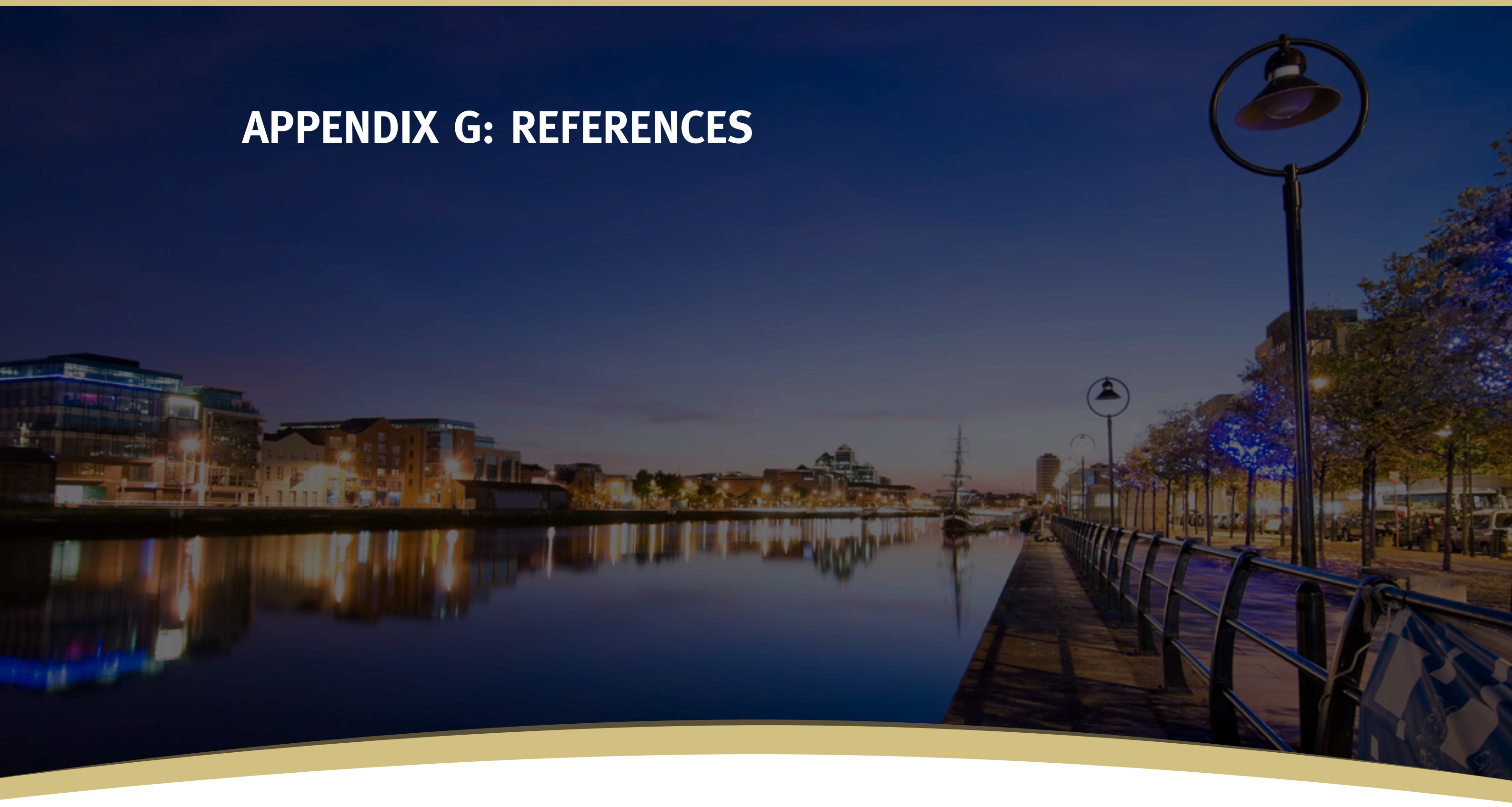
Project Development Status

For the purposes of the TYTFS project status is categorised as pre-planning, planning and approved. (In construction and complete are both subsets of approved.) Each project status category is detailed below. We will continue to participate and encourage public engagement at each project status stage, as per our consultation strategy.

1. Pre-planning – the need for the project is identified and consideration of solutions are formulated
2. Planning – outline design of preferred solutions
3. Approved – detailed design of preferred solution and project agreement (PA) with transmission asset owner (TAO) agreed
    - 3.1 In construction – procurement and construction of transmission assets/works
    - 3.2 Complete – commissioning and energisation of assets/works

[1] http://www.eirgridgroup.com/site-files/library/EirGrid/Consultation-Summary.pdf

APPENDIX G: REFERENCES



EIRGRID GROUP

The current. The future.

Appendix G References

The following documents are referenced in All-Island Ten Year Transmission Forecast Statement 2015:

- 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 Energy Regulation (CER) (previously called the Commission for Electricity Regulation) and gave it the necessary powers to licence and regulate the generation, distribution, transmission and supply of electricity. Available on www.cer.ie.
- Licence to Participate in the Transmission of Electricity Condition 33 requires SONI in consultation with the EirGrid, once every year to prepare a statement (in a form and based on methodologies approved by UREGNI showing, in respect of each of the seven succeeding financial years, circuit capacity, forecast electrical flows and loading on each part of the transmission system and fault levels for each transmission node.
- *All-Island Generation Capacity Statement, 2015-2024*. EirGrid and SONI issued this report in February 2015. 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 2015 to 2024. Available on www.eirgrid.com.
- EirGrid Grid Code Version 5.0, October 2013. 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 www.eirgrid.com.
- 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 the TSO (SONI) pursuant to condition 16 of SONI's Licence. The SONI Grid Code is available at www.soni.ltd.uk

- Transmission Planning Criteria, October 1998. This document sets out the technical standards by which the adequacy of the grid is determined. Available on www.eirgrid.com.
- Statutory Instrument no. 445. These Regulations give legal effect to Directive No. 96/92/EC of the European Parliament and of the Council of 19th December 1996, concerning common rules for the internal market in electricity, not already implemented by the Electricity Regulation Act, 1999, by providing for the designation of a Transmission System Operator, the designation of a Distribution System Operator, and the unbundling of the accounts of electricity undertakings, and other matters. Available on www.cer.ie.
- TSO Licence. On June 29th 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.
- *Delivering a Sustainable Energy Future for Ireland*. Government White Paper on energy policy out to 2020, published by the Department of Communications, Marine and Natural Resources in March 2007.
- *Treatment of Curtailment in Tie Break Situations.* Single Electricity Market (SEM) decision paper (SEM-13-010) in relation to the treatment of curtailment in tie break situations.

Table G-1: Northern Ireland Licence (System and Security) Standards - References

Document	Description
ER P2/5	Security of Supply, dated October 1978, and NIE amendment sheet Issue 2, dated 7th August 1992.
PLM-SP-1	Planning Standards of Security for the Connection of Generating Stations to the System Issue 1, dated 1975, and NIE amendment sheet Issue 2, dated 7th August 1992.
PLM-ST-4	CEGB Criteria for System Transient Stability Studies Issue 1, dated September 1975, and NIE amendment sheet Issue 2, dated 7th August 1992.
PLM-ST-9	Voltage Criteria for the Design of 400 kV and 275 kV Supergrid System Issue 1, date 1st December 1985, and NIE amendment sheet Issue 2, dated 7th August 1992.
ER-P28	Planning Limits for Voltage Fluctuations.
ER-P16	EHV or HV Supplies to Induction Furnaces.
ER-P29	Planning Limits for Voltage Unbalance.
ER-G5/3	Limits for Harmonics (To be replaced by ER-G5/4 following UK practice and in conjunction with a joint review with EirGrid).
EPM-1	Operational Standards of Security and Supply, dated November 2004.

APPENDIX H: POWER FLOW DIAGRAMS

H.1 Guide to the Power Flow Diagrams

EIRGRID GROUP

The current. The future.

Appendix H Power Flow Diagrams

This appendix presents power flow diagrams for the following cases:

- Figure I-1 Summer Night Valley 2015,
- Figure I-2 Summer Peak 2015,
- Figure I-3 Winter Peak 2015,
- Figure I-4 Summer Night Valley 2024,
- Figure I-5 Summer Peak 2024,
- Figure I-6 Winter Peak 2024,

Note that summer cases cover the period between May and August and winter cases cover the period between November and February. As such, the layout of the network in the power flow diagrams may not feature all projects listed in Appendix B for a particular year as these are listed on a yearly basis.

H.1 Guide to the Power Flow Diagrams

Different colours represent each of the voltage levels:

- 400 kV red
- 275 kV blue
- 220 kV green
- 110 kV black

Generation (>5MW) connected at each bus is shown beside a symbol, with the generation dispatched in MW shown beside the symbol. Embedded generation is shown at the transmission bus to which it is connected through the distribution system. The East–West interconnector is denoted by a symbol and the Moyle interconnector is denoted by a symbol. The magnitude of the power on the interconnectors is given beneath the symbol in MW.

There are two values shown at both ends of each circuit. The value above the line is the MW flow and the value below the line is the Mvar flow. A positive value indicates that the direction of flow is away from the bus; a negative value, towards the bus.

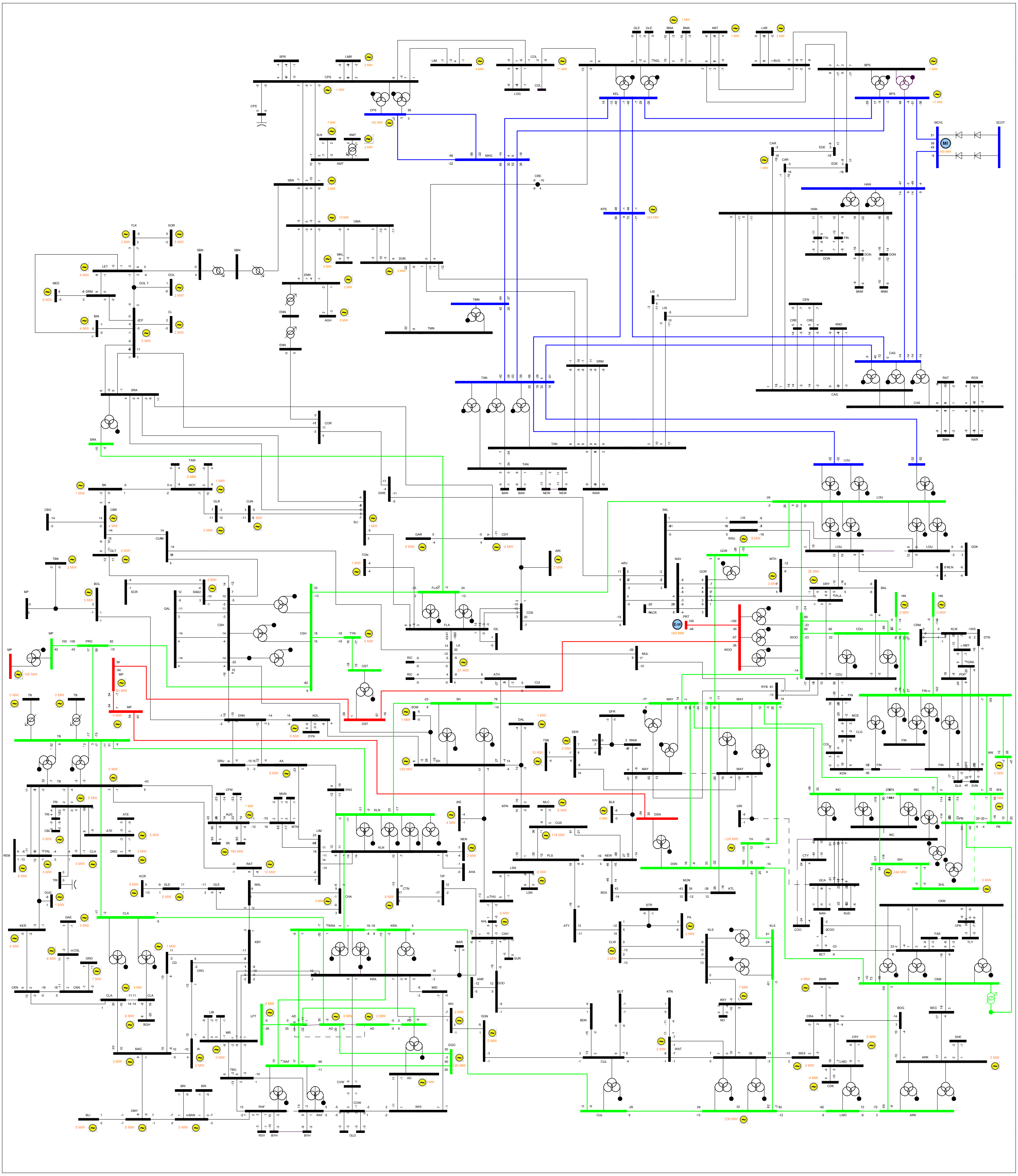


Figure I-1 Power Flow Diagram Summer Night Valley 2015

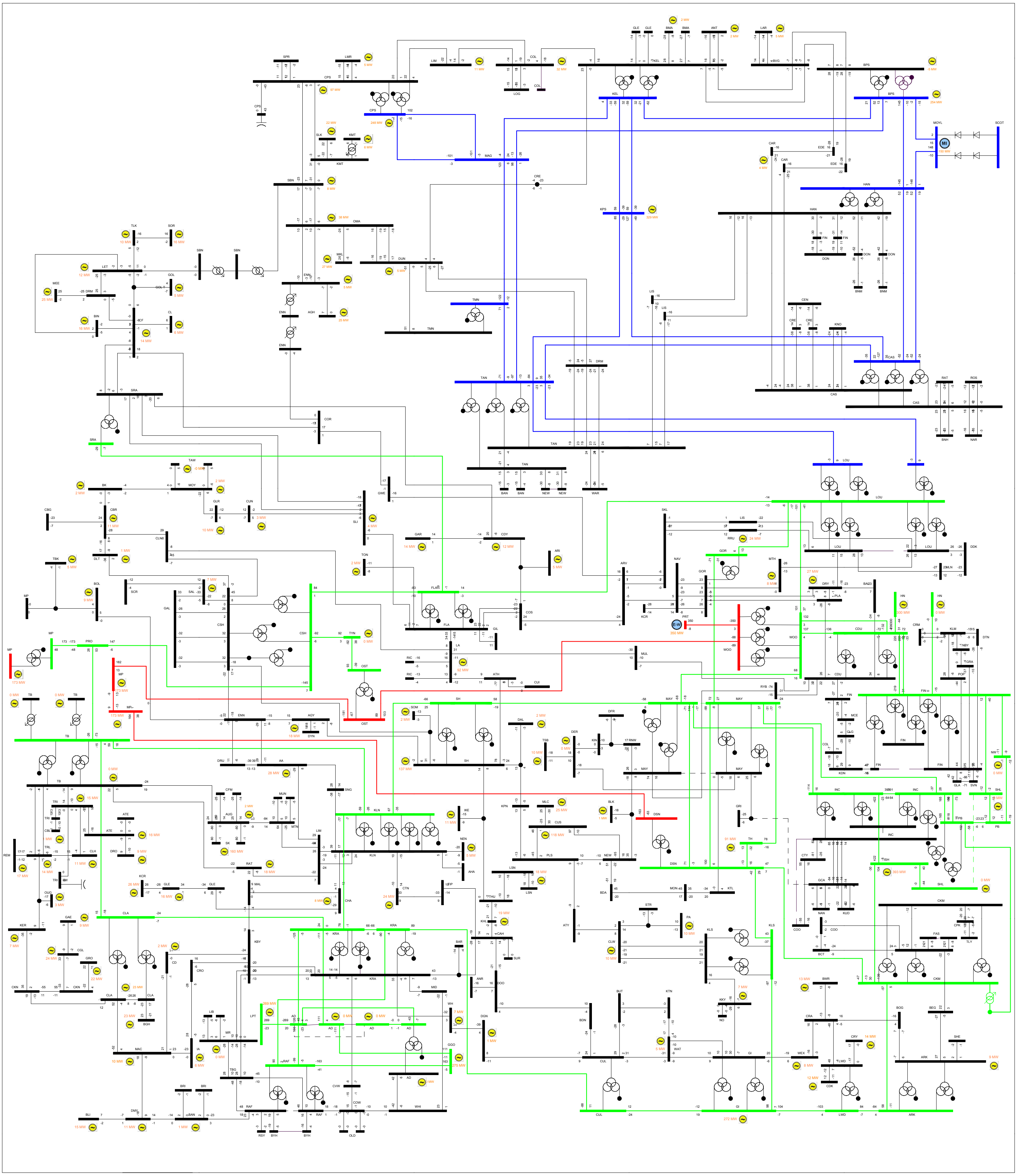


Figure I-2 Power Flow Diagram Summer Peak 2015

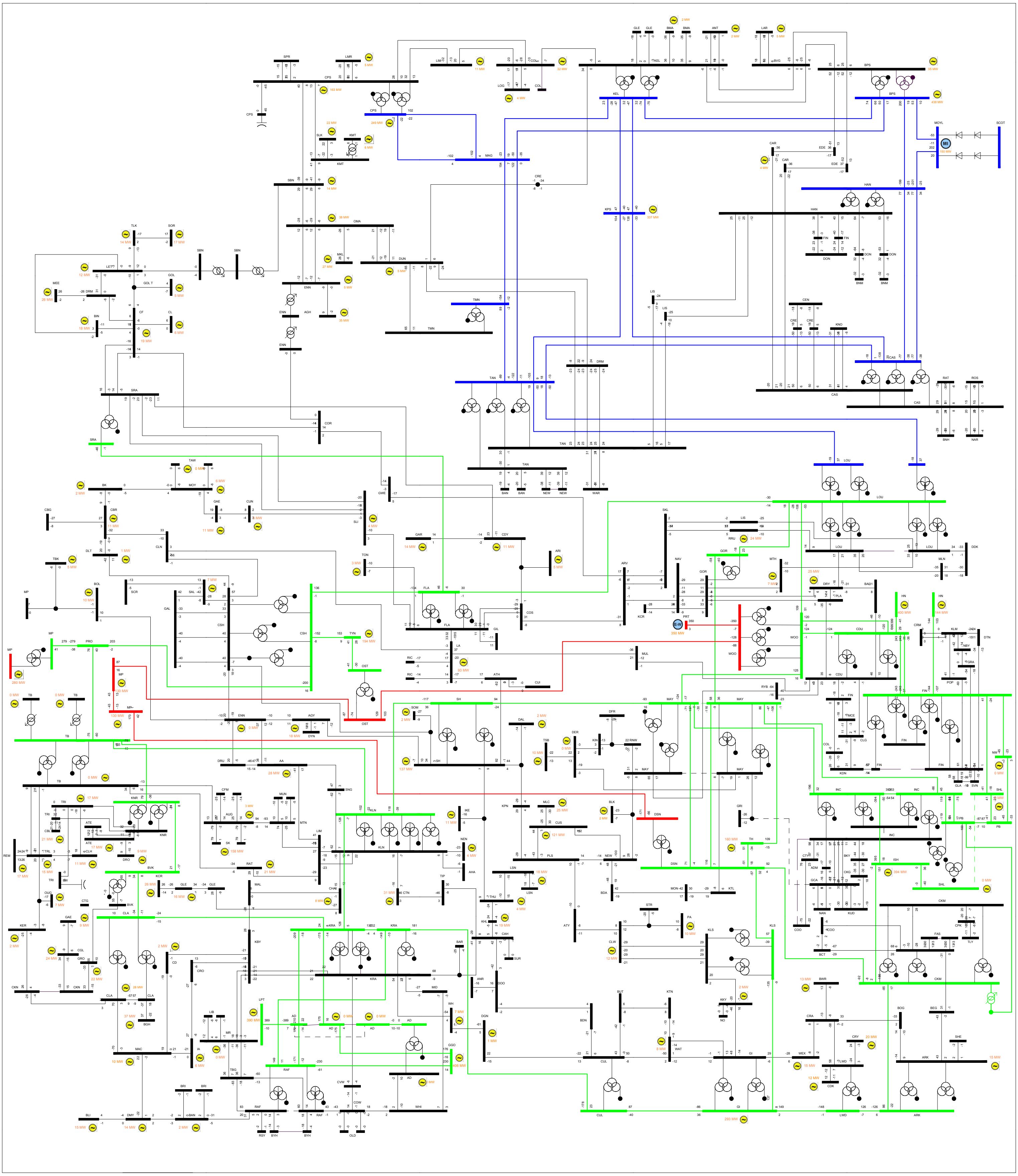


Figure I-3 Power Flow Diagram Winter Peak 2015

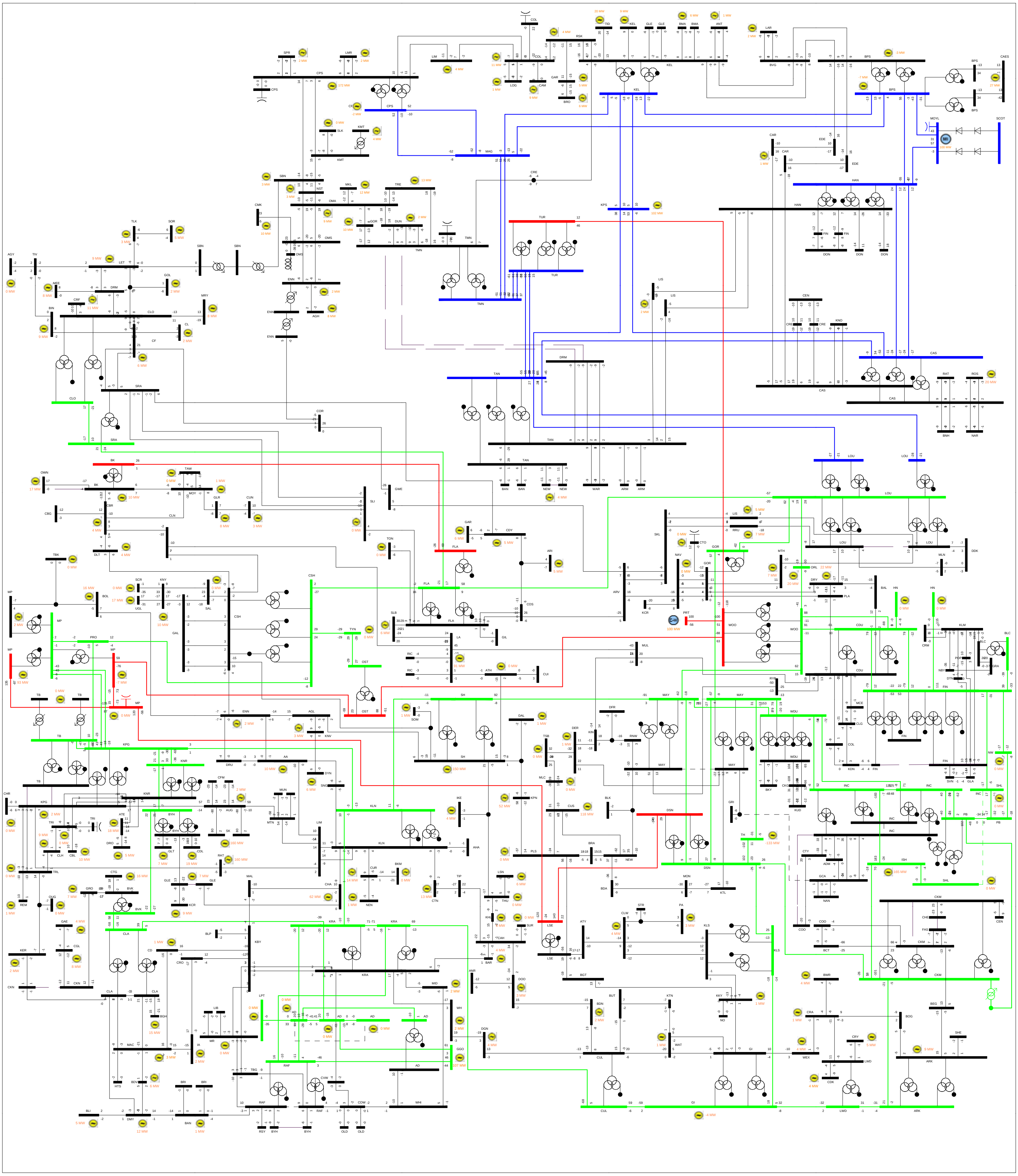


Figure I-4 Power Flow Diagram Summer Night Valley 2024

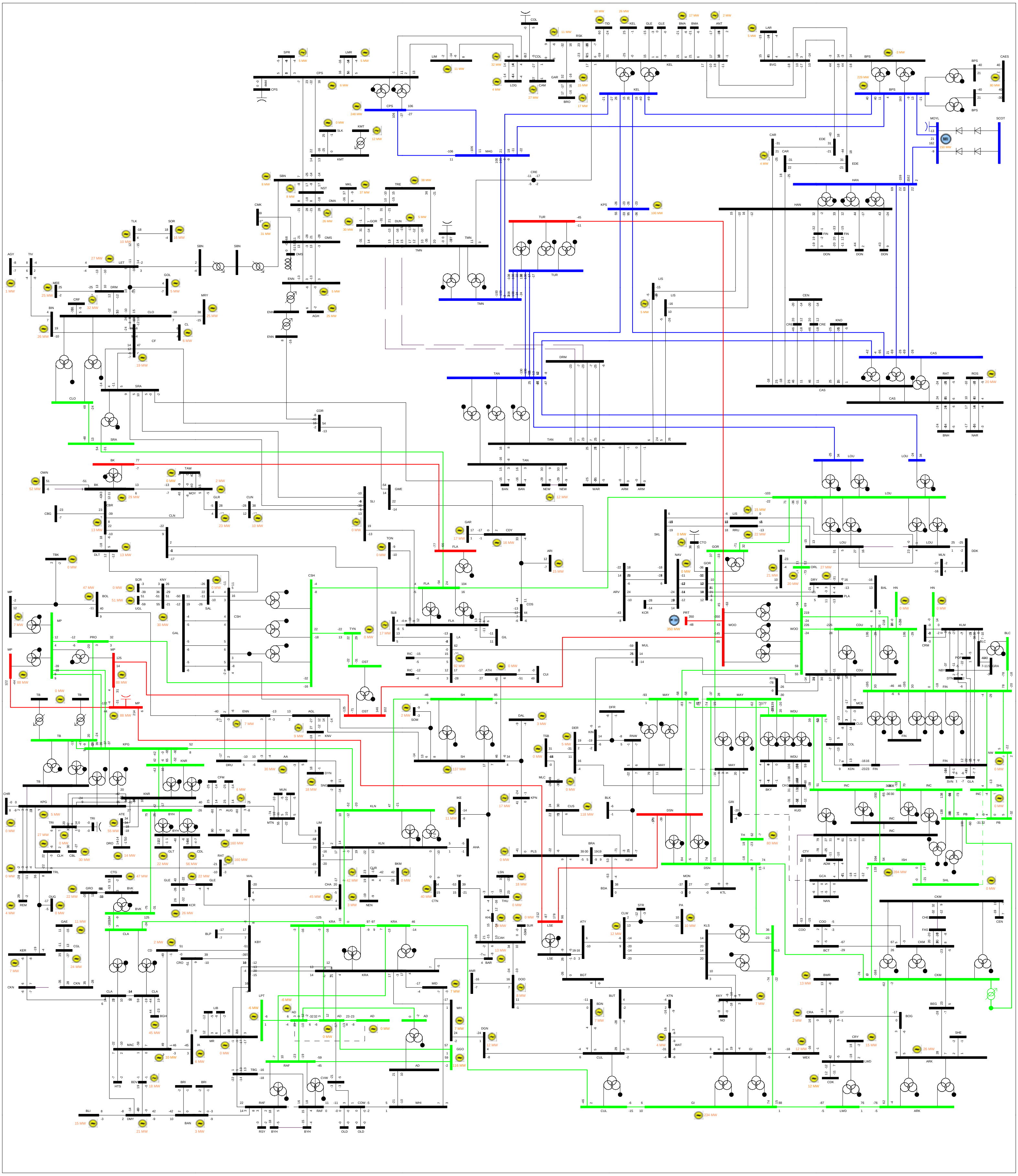


Figure I-5 Power Flow Diagram Summer Peak 2024

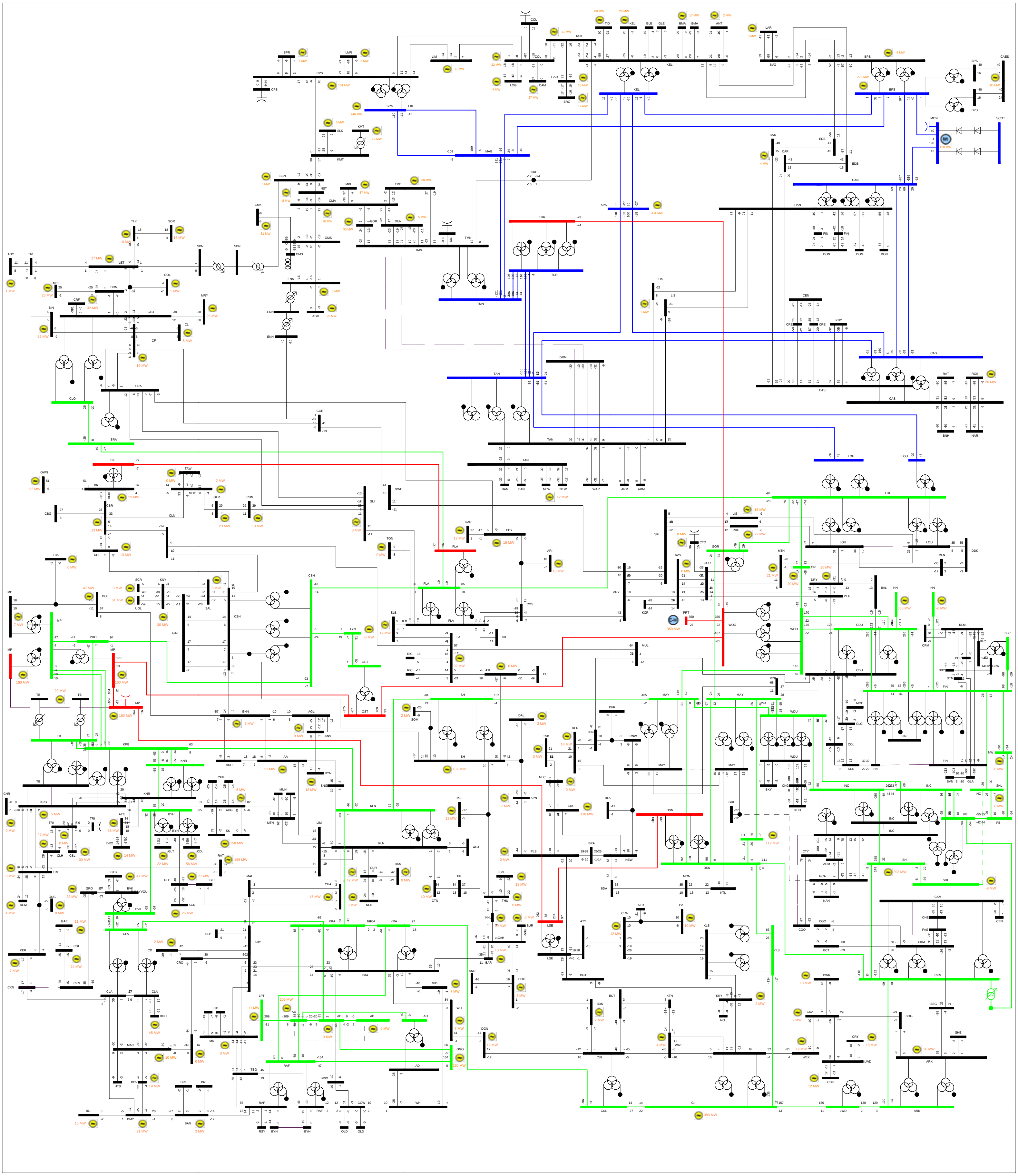


Figure I-6 Power Flow Diagram Winter Peak 2024

EirGrid plc
The Oval
160 Shelbourne Road
Ballsbridge
Dublin 4
Tel: +353 (0)1 677 1700
Fax: +353 (0)1 661 5375
www.eirgrid.com

System Operator for Northern Ireland

SONI Ltd
Castlereagh House
12 Manse Road
Belfast
BT6 9RT
Tel: +44 (0)28 9079 4336
Fax: +44 (0)28 9070 7560
www.soni.ltd.uk