ALL-ISLAND TEN YEAR

Transmission Forecast Statement 2014

EIRGRID semo SONI

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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.

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FOREWORD

I am pleased to introduce the All-Island Ten Year Transmission Forecast Statement (TYTFS) 2014, which describes the development of the transmission system on the island of Ireland over the ten-year period from 2014 to 2023.

EirGrid and SONI, as the Transmission System Operators (TSOs) for Ireland and Northern Ireland respectively, have collaborated to produce an all-island ten year Transmission Forecast Statement.

This 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).

In the TYTFS[1] we present information which will assist existing and prospective customers in assessing opportunities available to them for connecting generation or demand to the transmission system. The document also contains comprehensive information relating to the transmission system over the ten years of the statement.

It is our aim that the information contained in this document is informative, pertinent and accessible and we welcome and value your feedback on the presentation, style and content of this Transmission Forecast Statement.

Fintan Slye

Chief Executive, EirGrid Group

[1] This Statement is based on assumed power system data from 2013. A review of Grid 25 Projects is on-going at the time of printing. It is expected that this review will have impacts for some of the findings in this Statement.

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EXECUTIVE SUMMARY

The All-Island Ten Year Transmission Forecast Statement 2014 (TYTFS) describes the development of the transmission system on the island of Ireland over the ten-year period from 2014 to 2023.

This statement has been prepared jointly by EirGrid and SONI and supersedes the All-Island Transmission Forecast Statement 2013-2022, published in October 2013.

In this statement, the Transmission System Operators (TSOs) for Ireland and Northern Ireland, EirGrid and SONI respectively, have updated previously published information in light of transmission system developments over the period covered by the statement.

The transmission system is planned and developed by EirGrid and SONI to ensure it meets projected transmission operating conditions while maintaining its performance within defined security standards (see Chapter 2 – Governance and Planning Strategy). To continue to meet these standards, in the context of forecasted electricity demand and new generation and demand connections, requires continuous planning and development of the transmission system.

Both TSOs have undertaken a review of the existing and planned transmission system topology, existing and projected demand and generation data. The results of this review are presented in a number of formats including; geographical maps, transmission system diagrams, data tables and network models.

The results of this analysis determines likely available capacity, or demand opportunities, at various nodes on the all-island transmission system, assuming an average growth peak demand of 1% year on year over the period 2014 to 2023. In Ireland the analyses point to opportunities of up to 10 MW (the consumption of a typical pharmaceutical plant) at the majority of stations tested, with several stations capable of accommodating major industrial loads. There are also opportunities for the connection of demand across Northern Ireland; these demand opportunities are dependent on installed transformation capacity and expected demand growth at the individual substations.

This statement also provides information on the opportunities for generator connections. In Ireland, this information is based on EirGrid's transmission system development strategy, GRID25, and analysis undertaken as part of the Gate 3 group processing scheme for generators. The report also discusses opportunities beyond Gate 3.

In Northern Ireland this information is based on analysis carried out to assess the ability of the Northern Ireland transmission system to accommodate new generation in the year 2023. The results highlight that new generation connections can be accommodated without system reinforcement in the Eastern region of Northern Ireland. Conversely, the results also show that even with the timely delivery of NIE's planned reinforcements; the North West region of Northern Ireland cannot accommodate further generation connections in 2023. To facilitate the future generation connections in the North West, network reinforcements are required. In addition, the installation of considerable levels of reactive compensation will be required to ensure system voltage stability is maintained.

This TYTFS includes maximum and minimum short circuit current levels at each 110 kV, 220 kV, 275 kV and 400 kV node on the transmission system, for the following years; – 2014, 2017 and 2020. The analysis indicates that several stations in Northern Ireland are approaching, or would exceed, their rated short circuit current level under maximum generation conditions. Investment plans are in place to resolve these issues, and the TSOs will manage the transmission system to mitigate possible risks. .

The information presented in this statement assumes the timely completion of planned transmission system reinforcements. The opportunities and in particular the generation adequacy of Northern Ireland are dependent on the completion of the planned North – South 400 kV tie line. For the purpose of the 2014 TYTFS analysis, the North – South 400 kV tie line is assumed to be completed by Winter 2017/18[1]. This tie line will also increase security of supply, support the development of renewable power generation and provide economic benefits to customers on the island.

This statement presents the most up-to-date available information at the respective data freeze dates of 4th of October 2013 (Ireland) and 1st of December 2013 (Northern Ireland). The system data presented in the statement provides customers with information on the transmission system, electricity demand, generation and interconnection with other electricity transmission systems. It will assist prospective customers to identify and evaluate the opportunities available for connecting to or making use of the transmission system.

In addition, the system data contained within the report could also be used by multiple stakeholders including customers, developers, and researchers to undertake their own power flow analyses for research or commercial purposes.

Those who are considering connecting generation or demand to the transmission systems of Ireland or Northern Ireland should contact the relevant TSO at info@eirgrid.com or enquiries@soni.ltd.uk for further information. It is advisable to consult the respective TSO early in the project connection process to understand all Grid Code obligations, explore options relating to the proposal and to enable timely decision making.

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[1] It is estimated that the North-South 400kV tie-line will be constructed and fully operational in 2019; http://www.uregni.gov.uk/uploads/publications/DETI_-_Utility_Regulator_-_Updated_Security_of_Supply_Paper_-_22_Dec_14_draft_2.pdf

The TYTFS team: Back Row, from Left to Right: Paul Horan, Alejandro Rivera, and Daniel McSwiggan. Front Row, from Left to Right: Yvonne Coughlan and Conleth McAteer.

1 Introduction

1 INTRODUCTION

The transmission system is a high voltage network of circuits and stations used for the bulk transfer of electrical energy from generators to demand centres. The flow of power is determined by the levels of demand across the transmission system and by the size and location of generation supplying that demand. Interconnection with other systems can be a source of generation or a demand for power.

The TYTFS 2014 is prepared in accordance with Section 38 of Ireland's Electricity Regulation Act, 1999 and Condition 33, Part 1 of Northern Ireland's "Licence to Participate in the Transmission of Electricity".

This statement presents information on, and projections for; the transmission system; electricity demand; generation and interconnection with other electricity transmission systems. The appendices provide the reader with detailed system information to enable the reader to perform power flow analysis if required.

EirGrid and SONI published the *All-Island Generation Capacity Statement 2014-2023* (GCS) in February 2014. That document assesses the generation adequacy situation over the ten-year period to 2023. Insofar as possible the TYTFS complements the demand information presented in the GCS.

EirGrid issues its Transmission Development Plan (TDP) annually. The most recent TDP[1] provides details of the transmission system developments expected to be progressed in the period up to 2023.

[1] http://www.eirgrid.com/aboutus/transmission/transmissiondevelopmentplan/

1.1 OUTLINE OF THE ALL-ISLAND TEN YEAR TRANSMISSION FORECAST STATEMENT

The format of the All-Island Ten Year *Transmission Forecast Statement* 2014 is as follows:

- Chapter 2 provides a brief overview of the governance arrangements for the all-island transmission system. Additionally, it outlines the main technical requirements of the all-island transmission system.
- Chapter 3 describes the existing all-island transmission system, including connections between the transmission systems of Northern Ireland and Ireland, and provides a brief outline of transmission system development plans for both jurisdictions. Maps, schematic diagrams and network details are included in Appendix A and Appendix B. Geographical maps of the transmission system are provided in A3 format in Appendix J.
- Chapter 4 describes the demand forecasts and Chapter 5 describes the generation projections. Details of the demand forecasts and generation assumptions are in Appendix C and Appendix D respectively.
- The short circuit current level analysis results are presented in Chapter 6 and Appendix E. These are based on Chapters 3 to 5 which outline the transmission system development, demand and generation assumptions.
- Chapter 7 outlines the analysis methods used to carry out the demand and generation opportunities' analyses.
- Chapters 8 and 9 present the generation and demand opportunities' analysis results, based on Chapters 3 to 5.
- Diagrams showing typical power flows on the transmission system for a number of different conditions are presented in Appendix I.

1.2 OVERVIEW OF INFORMATION

1.2.1 Demand Forecasts

The transmission system must be capable of transporting power flows for varying levels of power production and demand consumption. Table 1-1 shows the forecasts of peak transmission demand for the years 2014 to 2023 covered in this TYTFS. These are equivalent to projections of total system peak exported generation requirements and are derived from models based on historical trends and economic forecasts that have an Average Cold Spell (ACS) temperature correction applied. Appendix C presents how this total system demand is proportioned at each transmission station.

As outlined in the All-Island *Generation Capacity Statement* 2014-2023, the TSOs expect in overall terms that the all-island peak demand will increase by an average of approximately 1% year on year over the period of the TYTFS[2]. This corresponds to an average increase of

[2] Note figures quoted in the TYTFS are a ten year average and growth will vary each year

0.5% in Northern Ireland and 1.2% in Ireland. For more information on this, please see the All-Island *Generation Capacity Statement* 2014-2023[3].

Table 1-1 Forecast of Peak Transmission Demand

Year	Ireland Peak Demand (MW)	Northern Ireland Peak Demand (MW)	All-Island Peak Demand (MW)[4]
2014	4,774	1,728	6,473
2015	4,806	1,733	6,510
2016	4,861	1,739	6,571
2017	4,911	1,746	6,628
2018	4,971	1,755	6,696
2019	5,030	1,764	6,765
2020	5,104	1,775	6,849
2021	5,169	1,786	6,925
2022	5,236	1,797	7,002
2023	5,301	1,808	7,078

1.2.2 Generation

The TYTFS provides information on connected, committed and retiring generation in both Northern Ireland and Ireland. It should be noted that a renewable energy target level of 40% has been set for the year 2020 in Ireland[5] and Northern Ireland[6]. In order for Northern Ireland to meet this target a total of approximately 1,600 MW of installed renewable generation capacity would be required. For Ireland it has been estimated that between 3,200 - 3,700 MW of installed wind generation will be required to meet circa 37% of electricity demand in 2020. The remaining 3% is expected to be sourced from hydro generation, bio-energy and renewable CHP. This represents a considerable challenge for the industry to manage; this is discussed in more detail in Chapter 5.

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

[4] Please note jurisdictional Peak Demand may occur at a different date and time to the All-Island Peak

[5] White Paper on Delivering a Sustainable Energy Future for Ireland (2007); the National Climate Change Strategy (2007); the Carbon Budget (2008); Smarter Travel-A Sustainable Transport Future (2009); the Programme for Government (2011); the Strategy for Renewable Energy 2012-2020 (2012); and the National Renewable Energy Action Plan (NREAP) Update (2012). Together these documents chart a course for Ireland's renewable energy sector out to 2020.

[6] http://www.detini.gov.uk/strategic_energy_framework__sef_2010_-3.pdf

Ireland

At the data freeze date (October 2013), some 8,731 MW of generation capacity was installed in Ireland; of which 7,504 MW is connected to the transmission system and 1,227 MW to the distribution system. Table 1-2 summarises the planned connections in Ireland as at the data freeze date.

Table 1-2 Summary of Generators with Signed Connection Agreements (October 2013)

Type of Generation	Connected to	Number of Connections	Capacity (MW)
Thermal	Transmission	7	1,268
Pumped Storage	Transmission	1	70
Wind Farm	Transmission	32	1,439
Thermal	Distribution	13	176
Hydro	Distribution	3	16.7
Wind Farm	Distribution	140	2,142
Total		**193**	**5,112**

Taking account of these committed connections, expected unit de-ratings and unit closures, the installed generating capacity would be 13,600 MW by the end of 2023, of which 10,038 MW will be transmission-connected.

In the period up to the 4th October 2013 data freeze date, three Gate 3 applicants had connected, one hundred and twenty three Gate 3 applicants were contracted to connect, with a further nineteen applicants having live Gate 3 offers and ten offers having lapsed.

Northern Ireland

At the data freeze date (December 2013), some 2,995 MW of generation capacity was installed, of which 2,365 MW was connected to the transmission system and 630 MW to the distribution system.

It has been assumed that 1,441 MW of generation capacity will connect in Northern Ireland over the ten year period covered by the TYTFS. The Heavy Fuel Oil Directive is anticipated to result in the decommissioning[7] of some 510 MW of capacity at Ballylumford Power Station by the end of 2015. By the year 2023 the total Northern Ireland installed capacity will be circa 3,926MW, however it should be noted that only 1781 MW of this is from conventional generation.

[7] AES and SONI have now concluded a separate Local Reserve contract for 250 MW. This will result in Ballylumford ST4 and ST5 remaining connected (at reduced capacity), while Ballylumford ST6 will be decommissioned.

Table 1-3 summarises the Northern Ireland generators included in the analyses. The implications of these developments are discussed in Chapters 8 and 9, which deal with transmission system capability.

Table 1-3 Summary of assumed Northern Ireland Future Generation Connections (December 2013)

Type of Generation	Connected to	Number of Connections	Capacity (MW)
Offshore Wind	Transmission	1	324
Tidal	Transmission	2	200
Biomass	Distribution	2	33
Onshore Wind	Transmission	1	45
Onshore Wind	Distribution	39	571
Storage	Transmission	2	268
Total		47	1,441

1.2.3 Opportunities for New Demand

The transmission system is planned and developed to meet forecast demand growth across the island. The TYTFS provides indicative information on the opportunities for new demand connections in both jurisdictions over the period of the statement by examining the capability of selected stations to accept a new demand connection additional to those already forecast. As a general rule, opportunity at a particular node tends to reduce over the period of the statement as normal demand growth uses the available capacity; however, in many cases demand opportunities improve in later years as a result of planned transmission system or generation developments. The results of the analysis, which can be found in Chapter 9, point to opportunities at the majority of the stations tested. In Ireland; analysis of the 220 kV transmission system shows that several strategic sites have the capability today to accommodate major industrial developments in excess of 200 MW. In Northern Ireland the analysis shows that demand opportunities vary across the country depending on installed transformation capacity and expected demand growth at individual stations.

1.2.4 Opportunities for New Generation

The TYTFS provides information on the opportunities for generator connections in both jurisdictions. The analysis in Chapter 8 shows that several 275 kV nodes in Northern Ireland could accept a new generator of size 160 MW without requiring significant transmission system reinforcement. However, the analysis also highlights areas where there is no capacity, for example the North-West area (Omagh South and Coolkeeragh). For Ireland, a summary of the possible generation opportunities beyond Gate 3 are displayed and discussed in Chapter 8.

1.2.5 Short Circuit Current Level Analysis

Short circuit current levels have been calculated in accordance with Engineering Recommendation G74, which is based upon International Standard IEC60909. This statement provides short circuit currents for summer night valley and winter peak, for 2014, 2017 and 2020.

The short circuit current level analysis (Ref. Chapter 6 and Appendix E) shows that a number of stations are approaching, or would exceed, their short circuit current level, under maximum generation conditions. The analysis also shows that short circuit current levels are expected to increase in the future in certain areas, because of the introduction of the new North-South 400 kV tie-line[8], other transmission system reinforcements and increasing generation levels. Transmission reinforcement work is planned to resolve these short circuit issues, and in the interim risk mitigation measures have been employed by EirGrid and SONI to ensure equipment ratings are not exceeded. The high short circuit levels at some stations mean that future connections to the transmission system will require careful analysis. Figure 1-1 presents the short circuit results for the winter peak 2014 case as a percentage of standard equipment rating for the transmission system of Ireland and the actual equipment rating for the Northern Ireland transmission system. Three percentage ranges are represented by different colours as indicated. The yellow dots represent stations where short circuit currents may exceed 80% of the ratings; the orange dots represent stations where short circuit currents may exceed 90% of the ratings and the red dots where short circuit currents may exceed 100% of the ratings.

[8] It is estimated that the North-South 400kV tie-line will be constructed and fully operational in 2019; http://www.uregni.gov.uk/uploads/publications/DETI_-_Utility_Regulator_-_Updated_Security_of_Supply_Paper_-_22_Dec_14_draft_2.pdf

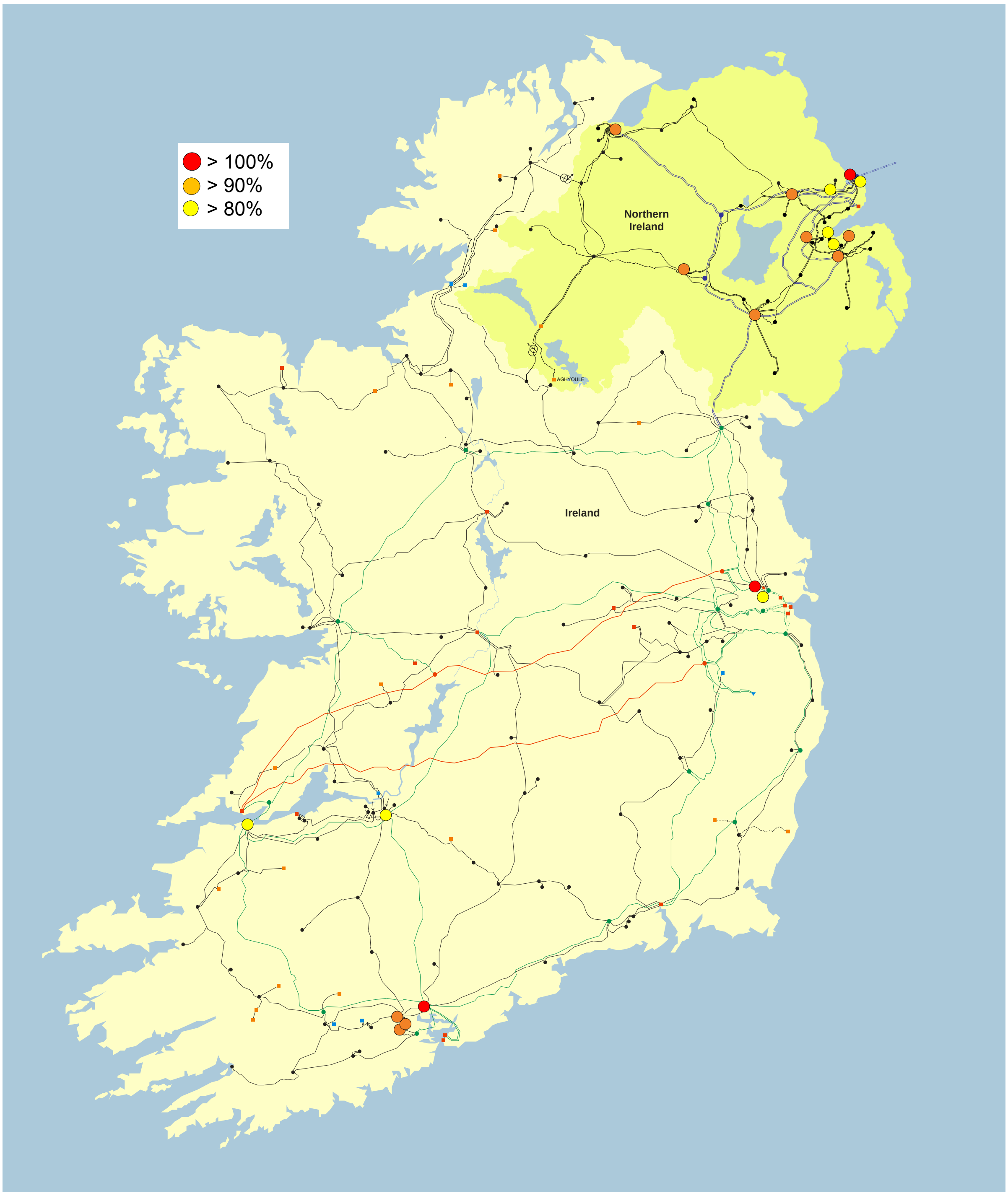

Figure 1-1 Fault Levels for Winter Peak 2014

1.3 OTHER INFORMATION

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

- SONI Grid Code[9]
- EirGrid Grid Code[10]
- Northern Ireland Licence Standards – Transmission and Distribution System Security and Planning Standards[11]
- The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[12]
- EirGrid Transmission Planning Criteria[13] and Operating Security Standards[14]
- SONI Transmission Connection Charging Methodology Statement[15]
- EirGrid Transmission Connection Charging Methodology Statement 2008[16]
- Statement of Charges for Use of the NIE Transmission and Distribution System 2014[17]
- EirGrid Statement of Charges 2014[18]
- All-Island Transmission Forecast Statement 2013-2022[19]
- All-Island Generation Capacity Statement 2014-2023[20]
- All-Island Transmission System Performance Report[21]

[9] http://www.soni.ltd.uk/Operations/GridCodes/
[10] http://www.eirgrid.com/operations/gridcode/
[11] http://www.nie.co.uk/About-NIE/Electricity-industry/Security-planning
[12] http://www.legislation.gov.uk/nisr/2012/381/pdfs/nisr_20120381_en.pdf
[13] http://www.eirgrid.com/media/Transmission%20Planning%20Criteria.pdf
[14] http://www.eirgrid.com/media/Operating%20Security%20Standards%20December%202011.pdf
[15] http://www.soni.ltd.uk/media/documents/Archive/SONI%20Charging%20Methodology%20Statement%20December%202009%20-%20Approved%2022%20December%202010.pdf
[16] http://www.eirgrid.com/media/Connection%20Charging%20Statement.pdf
[17] http://www.nie.co.uk/documents/Connections/NIE-Distribution-Connection-Charging-Statement-Oct.aspx
[18] http://www.eirgrid.com/media/2013-2014StatementofChargesCERApproved(180913)v20.pdf
[19] http://www.eirgrid.com/transmission/transmissionforecaststatement/tenyeartransmissionforecaststatement2013/
[20] http://www.eirgrid.com/media/Generation%20Capacity%20Statement%202014.pdf
[21] http://www.eirgrid.com/media/All-Island%20Transmission%20System%20Preformance%20Report%202013.pdf

1.4 DATA MANAGEMENT

Transmission system development is continuously evolving. In order to carry out analyses and to update the system models and appendices for the TYTFS, EirGrid and SONI froze all data relating to demand, generation and the transmission systems at the beginning of October 2013 and December 2013 respectively. All data for the network files, and associated sequence data for use with short circuit current level analysis, was collected on these dates.

Since the data freeze, a number of changes in projections have emerged.

The following transmission system developments have been initiated as projects:

- CP0705 New Woodhouse 110 kV station
- CP0819 Bellacorick - Moy 110kV line uprate
- CP0824 Moneypoint - Oldstreet 400kV line refurbishment
- CP0825 Oldstreet - Woodland 400kV line refurbishment
- CP0829 New Clashavoon - Macroom No. 2 110kV circuit & 250 MVA transformer
- CP0835 Coolnabacky - Portlaoise 110 kV line uprate
- CP0847 Arva - Shankill No. 1 110 kV line uprate
- CP0850 New 110 kV station for Oweninney Power 1 & 2
- CP0859 New Cloghran - Corduff 110 kV cable
- CP0860 Finglas 220kV station (T2101) transformer replacement
- CP0861 New Sliabh Bawn 110 kV station
- CP0863 Midleton 110 kV Station - new T101 transformer
- CP0865 Cashla - Salthill 110 kV line uprate
- CP0872 New West Dublin 220/110 kV Station
- CP0873 Dunstown - Moneypoint 400kV Refurbishment
- CP0874 Booltiagh 110 kV Station Extension
- CP0883 Ballyvouskill - Knockanure (North Kerry) 220 kV line uprate

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

- Ballylumford 110 kV Switchgear uprate
- Coolkeeragh - Magherafelt 275 kV
- Drumquin Cluster
- Coolkeeragh - Limavady - Coleraine 110 kV restring
- Castlereagh IBTX 1
- CP0197 Mount Lucas - Thornsberry New 110 kV Line
- CP0585 Laois - Kilkenny 400 kV reinforcement scheme
- CP0596 Kinnegad - Mullingar 110 kV new circuit
- CP0603 Mulreavy Wind Farm 110kV Shallow Connection
- CP0668 Corduff - Ryebrook 110 kV uprate
- CP0692 Inchicore - 220kV GIS Station Upgrade
- CP0697 Carrick-on-Shannon 110 kV Station busbar uprate

- CP0709 Dunmanway 110 kV Station Busbar Uprate
- CP0716 Carrigadrohid - Macroom 110 kV line uprate
- CP0724 Thornsberry 110 kV busbar uprate
- CP0731 Bellacorick - Castlebar 110kV line uprate Phase 2
- CP0732 Grid Link Project
- CP0734 Cathaleen's Fall 110 kV station busbar uprate
- CP0747 Maynooth - Ryebrook 110 kV line uprate
- CP0764 Clogher – Drumkeen 110 kV line uprate
- CP0800 North West Project
- CP0830 Raffeen - Trabeg 1 110 kV line uprate
- CP0839 Moy 110 kV Station reconfiguration and busbar uprate

The following transmission system developments have been terminated as projects:

- CP0506 Finnstown 220/110kV Station
- CP0776 Kilbarry - Mallow 110 kV line uprate
- South Down Offshore

The following transmission system developments have been completed:

- CP0228 Marina 110 kV Station Replacement
- CP0265 Cullenagh - Great Island 220 kV Line Refurbishment and Uprate
- CP0371 Ballydine - Doon 110 kV line uprate
- CP0421 Binbane - Letterkenny 110 kV Line - New Line[22]
- CP0479/CP06707 Athea 110 kV station- Loop In to Dromada - Trien 110 kV line
- CP0507 Arklow 220/110 kV Station - New 2x20 MVA Transformers (T101/T102)
- CP0559 Butlerstown - Killoteran 110 kV line uprate
- CP0559 Butlerstown 110 kV station busbar uprate
- CP0623 Great Island 220 kV Station Refurbishment/Replacement[23]
- CP0682 Woodland 400 kV Station - 3rd 400/220 500MVA Transformer
- CP0683 Dunstown 400 kV Station - 2nd 400/220 500MVA Transformer
- CP0689 Ennis 110 kV station busbar uprate
- CP0698 Prospect - Tarbert 220 kV line uprate
- CP0701 Cullenagh - Dungarvan 110 kV line uprate
- CP0702 Butlerstown - Cullenagh 110 kV line uprate
- CP0708 Navan 110 kV stationbusbar uprate
- CP0717 Clashavoon - Knockraha 220 kV line uprate
- CP0719 Inniscarra - Macroom 110 kV line uprate
- CP0723 Cushaling 110 kV station busbar uprate
- CP0739 Mount Lucas 110 kV station
- CP0745 Cathaleen's Fall - Srananagh No. 2 110 kV line uprate
- CP0748 Cashla Prospect 220 kV line resagging

[22] Station works remain to be completed

[23] Decommissioning works remain to be completed

- CP0761 Bruckana 110 kV Windfarm Connection
- CP0762 Charleville - Mallow 110 kV line uprate
- CP0772 Sligo 110 kV station busbar uprate
- CP0783 Kilbarry - Knockraha 110 kV No. 1 line uprate
- CP0791 Cunghill - Glenree 110 kV line uprate
- Tandragee IBTX 3
- Coolkeeragh IBTX 1

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

- The CP0763 Clashavoon Tarbert 220 kV line uprate project now refers to CP0763 Kilpaddoge - Knockanure 220 kV line uprate, Ballyvouskil - Clashavoon 220 kV line uprate and the refurbishment of Kilpaddoge - Tarbert 220 kV circuits. The remaining works are captured under the new CP0883.
- CP0883 Uprate of the Ballynahulla - Ballyvouskill and Ballynahulla - Knockanure 220 kV circuits and associated works, previously part of Clashavoon Tarbert 220kV line uprate [see CP0763].
- A Local Reserve contract has been agreed between AES and SONI for 250 MW, thus Ballylumford ST4 and ST5 will remain connected (at reduced capacity)
- Contracted generation at Caulstown, Ralappane and Knocknagreenan is no longer being progressed by their respective developers

The following transmission system developments are under review:

- North-South 400 kV tie-line[24]

1.5 PUBLICATION

This TYTFS is available in pdf format on the EirGrid website (www.eirgrid.com) and the SONI website (http://www.soni.ltd.uk/). For a hard-copy version, please send a request to info@eirgrid.com or enquiries@soni.ltd.uk. Transmission system data is also available on the websites in electronic format.

[24] It is estimated that the North-South 400kV tie-line will be constructed and fully operational in 2019; http://www.uregni.gov.uk/uploads/publications/DETI_-_Utility_Regulator_-_Updated_Security_of_Supply_Paper_-_22_Dec_14_draft_2.pdf

2 Governance and Planning Strategy

2 GOVERNANCE AND PLANNING STRATEGY

2.1 GOVERNING ARRANGEMENTS

2.1.1 Duty to prepare a Statement

EirGrid, the Transmission System Operator (TSO) in Ireland, is required to publish a Forecast Statement as set out in Section 38 of the Electricity Regulation Act 1999. Similarly, SONI, the TSO in Northern Ireland, is required to produce an annual Transmission System Capacity Statement in accordance with Condition 33 of the Licence to participate in the Transmission of Electricity granted to SONI Ltd by the Department of Enterprise Trade and Investment. This statement has been prepared in accordance with and in fulfilment of these obligations. The form of the statement is as approved by the Commission for Energy Regulation (Ireland) and the Utility Regulator (Northern Ireland).

2.1.2 System Operator Agreement

An agreement exists between SONI and EirGrid called the System Operator Agreement (SOA). This agreement sets out the key principles and arrangements at the interface between the two companies as TSOs in Northern Ireland and Ireland, respectively. The agreement describes the information exchange requirements to enable each TSO to meet its licence and respective Grid Code obligations and to facilitate all-island system planning. All-island system planning is covered in Schedule 4, which deals with the sharing of information to facilitate the preparation of this statement.

2.1.3 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, reduced energy costs and improved reliability of supply.

The Transmission Systems of Ireland and Northern Ireland are electrically connected by means of one 275 kV double circuit connection from Louth station in Co. Louth (Irl) to Tandragee station, in Co. Armagh (NI) and two 110 kV 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)

In order to reflect the way in which the all-island Transmission System is operated, the Transmission Systems of Northern Ireland and Ireland were assessed with generation dispatched on an all-island basis in the network models.

2.1.4 Roles and Responsibilities (Governance)

Northern Ireland

To provide compliance with the European Union's third Energy Package (IME3[1]), both SONI's and NIE's (the Transmission System Owner) licences were modified in early 2014. SONI now has licence obligations to plan[2] as well as operate the Northern Ireland Transmission System, while NIE has a licence obligation to develop and maintain the Northern Ireland Transmission System. In doing so, both SONI and NIE must comply with both the Transmission and Distribution System Security and Planning Standards and the SONI Grid Code. A Transmission Interface Agreement (TIA), which was updated in 2014 to reflect the revised licences, exists between SONI and NIE which sets out how the two parties are required to cooperate to discharge their respective licence obligations.

Ireland

EirGrid has obligations set out in licence and statute to operate and ensure the development and maintenance of a safe, secure, reliable, economical and efficient Transmission System for Ireland as part of an efficient economical, co-ordinated, safe, secure and reliable electricity Transmission System on the Island of Ireland as a whole. In doing so EirGrid must comply with the both the Transmission Planning Criteria and the Grid Code.

2.2 MAIN TECHNICAL REQUIREMENTS OF THE TRANSMISSION SYSTEM

It is important for parties proposing to connect to either the Transmission System in Ireland or Northern Ireland to be aware that there are technical requirements and standards to which each of the Transmission Systems is planned and operated.

The development and operation of the Transmission Systems must be managed to provide safe, secure and economic supplies of electricity at a satisfactory quality level.

2.2.1 SECURITY AND PLANNING STANDARDS

Ireland

The Transmission System of Ireland is planned in accordance with the document entitled 'Transmission Planning Criteria' (TPC), which has been approved by the Commission for Energy Regulation (CER). The standards for day to day operation of the system are set out in the 'Operating Security Standards'.

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[1] The European Union's Third Energy Package (IME3) legislates for an internal gas and electricity market in the European Union. The package came into force on 3 September 2009.

[2] 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).

The TPC describes the main objective of Transmission System planning as maintaining the integrity of the bulk Transmission System for any credible contingency and that the adequacy and security of supply to any particular load or area is secondary to this primary aim. The TPC outlines that the system integrity will be maintained for more probable and less probable contingencies and that there is no loss of load for the more probable contingencies. The core principle of allowing a single contingency loss in a variety of operating scenarios is aligned to that of the 'Transmission and Distribution System Security and Planning Standards' for the Northern Ireland Transmission network. Probable contingencies include a single contingency (for example loss of a line) in normal and during maintenance situations. Less probable contingencies include busbar faults, busbar coupler faults, breaker failures, relay maloperation, loss of double circuit to avoid a widespread or catastrophic failure.

The TPC was adopted in the late 1990s. In the intervening years the electricity supply industry in Ireland has undergone major changes with the introduction of the SEM; Irish Government targets on renewable generation and the movement away from a vertically integrated industry. A review of the Transmission Planning Criteria was recently undertaken and the updated TPC, which will be known as the Transmission System Security and Planning Standards (TSSPS), are currently being considered by CER.

Northern Ireland

The Northern Ireland Transmission System is planned and operated in accordance with a set of standards known as the 'Transmission and Distribution System Security and Planning Standards', which are approved by the Utility Regulator (UREGNI)[3]. The full set includes individual standards relevant to both Transmission and Distribution and others that are common to both. The relevant standards applicable to the Northern Ireland Transmission System are described in Table H-1 of this document.

The ability of SONI to supply customers during circuit outages is governed by the Security and Planning Standard P2/5, as amended on the 7th August 1992. The standard generally requires that the main Northern Ireland Transmission System will continue to supply all customers in the event of a single unexpected event during the winter. In other seasons, the system should supply all or a defined percentage of load for an unexpected event during the maintenance of another circuit. The standard applies increasing security requirements as the demand increases. In this TYTFS, a double circuit failure at 275 kV is considered to be a single event. This is to ensure that the system does not suffer possible cascade tripping, voltage instability or other catastrophic failures.

The Security and Planning Standards were first written in the 1970s. In the intervening 40 years the electricity supply industry in Northern Ireland has undergone major changes with the introduction of the SEM; the large penetration of renewable generation and the movement away from a vertically integrated industry. Following the transfer of planning,

[3] http://www.uregni.gov.uk/electricity/

SONI has recently carried out a review and consultation on the Transmission System Security and Planning Standards (TSSPS). Subject to Regulatory approval it is planned to introduce updated Standards in 2015.

2.2.2 ELECTRICITY SUPPLY REGULATIONS

The two most important technical characteristics that determine the quality of electricity supply are frequency and voltage. The Electricity Supply Regulations (NI) 1991 set out the statutory obligations in relation to both frequency and voltage for Northern Ireland. The Transmission Planning Criteria and Operating Security Standards do the same for Ireland.

FREQUENCY

The declared frequency of the all-island Transmission System is 50 Hz, and is normally controlled within the range 49.95 Hz to 50.05 Hz.

The TSOs balance generation and demand to maintain the frequency within the above range. The all-island system is not synchronously interconnected with Great Britain or the greater European network, and thus remains an 'island system'. As a result, the loss of a large infeed could cause a significant frequency deviation in the all-island system frequency. In such circumstances interruptible load will be automatically shed to assist in recovery of the frequency. Normal tariff and under frequency load shedding are set to operate automatically below 48.85 Hz, in Ireland and Northern Ireland.

The two Transmission Systems are connected via the 275 kV double circuit between Louth and Tandragee stations and the two 'power flow controlled' 110 kV circuits between Letterkenny – Strabane and Corraclassy – Enniskillen 110 kV stations. These 110 kV tie-lines provide an AC connection between the two Transmission Systems, which allows emergency flows of active and reactive power for frequency and voltage support, increasing system stability.

The all-island Transmission System carries reserves on centrally dispatched generating units, the Moyle and East West Interconnectors and contracted demand customers (the Short Term Active Response (STAR) scheme) to cover the loss of the largest infeed tripping off the system[4]. This reserve is allocated on an economic all-island basis. In 2014 the maximum reserve provided by the Moyle Interconnector is 50MW; 25 MW of reserve is provided when the frequency falls below 49.6 Hz and a further 25 MW of reserve is provided when the frequency falls below 49.4Hz. Note that for imports of power from Great Britain greater than 175 MW the reserve available from Moyle will be reduced. The Moyle Interconnector also automatically reduces the import of power by 50 MW when the Northern Ireland system frequency exceeds 50.3 Hz.

The East West Interconnector provides 50 MW of reserve when the frequency falls below 49.6 Hz and a further 50 MW of reserve when the frequency falls below 49.5 Hz; the

[4] Triggered at 49.3 Hz

amount of reserve available is limited by the difference between the physical flow on the interconnector and the maximum available capacity. Any export from Ireland to Great Britain is reduced in proportion to the frequency when the frequency falls below 49.0 Hz, with export reduced to 0 MW at 48.0 Hz. The East West Interconnector reduces import by 50 MW when the frequency exceeds 50.4 Hz.

VOLTAGE

The voltage variation permitted by The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[5], on the Northern Ireland Transmission System is ±10%. The permitted step voltage changes are specified in the Transmission and Distribution System Security Planning Standards (PLM-ST-9). The permitted step voltage changes are described below:

- For a secured single circuit outage: not greater than 6%
- For a secured double circuit outage: not greater than 10%
- For both conditions, the 110 kV voltages at BSPs should not drop below 90%

The Transmission Planning Criteria states that the Transmission System of Ireland shall be so planned that voltage shall remain within the limits, outlined in Table 2-1 below. It is acceptable for the voltage to fall within the post contingency limits for the duration of an outage or contingency.

Table 2-1 Voltage Limits for Ireland

Nominal Voltage	Pre-Contingency limits (meshed network)	Post-Contingency limits (all busbars)
400 kV	370 – 410 kV	350 – 410 kV
220 kV	210 – 240 kV	200 – 240 kV
110 kV	105 – 120 kV	99 – 120 kV

The permitted step voltage changes, as specified in the Transmission Planning Criteria, are:

- The voltage step resulting from capacitor switching shall not exceed 3.0%
- For single contingencies, the maximum step change between pre- and post-contingency steady-state voltages shall be no more than 10%.

The voltage at any point on the Transmission System is determined by the reactive power output of the generating plant and of capacitors, reactors and SVC's, the tap position of each generator/system transformer, the electrical characteristics of the Transmission and Distribution Systems, the level of system load and its power factor.

Voltage control is affected by dispatching generator reactive power, providing automatic voltage control on generators, altering transformer tap positions and the switching of

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

shunt reactors, capacitors and SVCs. These operational measures do not compromise the security standards imposed by the Transmission System Operators licence.

2.2.3 GRID CODE REQUIREMENTS

The main obligations and technical conditions to be met by users of the Transmission Systems of Northern Ireland and Ireland are outlined in the SONI Grid Code and EirGrid Grid Code, respectively.

The respective Grid Codes set out the principles governing the TSOs' relationship with users of the Transmission System as well as the technical conditions for users wishing to connect to or use the Transmission Systems. The Grid Codes specify procedures for both planning and operation and covers both normal and exceptional circumstances.

2.3 SYSTEM RELIABILITY, STABILITY AND QUALITY

The operation of the Transmission Systems of Northern Ireland and Ireland are planned in accordance with the Transmission and Distribution Security and Planning Standards and the Operating Security Standards, respectively, where particular consideration is given to avoiding potential problems due to forced circuit outages occurring during a planned outage. The location and connection arrangement of generators is very important in this context.

As well as considering the reliability of circuits and load flows following outages (overload situations), it is necessary to consider the stability of the Transmission System. When proposals for new generation, demand connections or interconnection are being considered, it is necessary to investigate both transient stability (the resilience of the system to faults) and dynamic stability (the resilience of the system to generator trips or circuit switching).

Transmission system instability can usually be prevented by the application of fast acting and reliable protection and control systems. Instability can result in the following:

- Loss of synchronism between generators
- Consequential tripping of circuits
- Mismatched pockets of generation and load
- Possible plant damage
- Loss of customer supply
- Voltage collapse

With regard to the relatively small size of the all-island Transmission System, it is also necessary to consider the adequacy of the response characteristics of generating units[6].

[6] http://www.eirgrid.com/operations/ds3/communications/consultations/

2.4 PLANNING STRATEGY

2.4.1 INCREASED RENEWABLE GENERATION LEVELS

The connection of generation from renewable sources such as biomass, tidal, hydro and particularly wind, changes the all-island generation portfolio. An ever increasing proportion of the generation portfolio has characteristics which differ from those of conventional fossil fuel generators. The TSOs face many challenges to manage the all-island Transmission System in a safe, secure and reliable manner; these challenges include different operating conditions caused by:

- The connection of renewable generation to the Transmission and Distribution networks which displaces the output of conventional power plants
- The introduction of new generator technologies
- Increased distances between sources of generation and load centres
- Increased risk of overloads on heavily loaded Transmission corridors

In order to facilitate the successful transition towards increasing levels of renewable generation on the power system, a number of interrelated studies have been undertaken. The first of these - the All-Island Grid Study - was published in 2008. The All-Island Grid study concluded that up to 42% of renewable generation could be accommodated on the power system of Ireland and Northern Ireland. This was subject to the delivery of the necessary infrastructure and further investigation into the underlying technical aspects of a power system operating with large amounts of variable, non-synchronous generation sources. Since the publication of this study, the System Operators have been working to integrate increasing levels of renewable generation. The Grid25 programme was formed to ensure Ireland will have the necessary infrastructural elements in place to enable this transition. In Northern Ireland, following the transfer of responsibility for the planning of the Transmission System from NIE, SONI will be taking forward the Network25 development strategy to ensure the development of the required network infrastructure.

In June 2010, EirGrid and SONI published the findings of the Facilitation of Renewables (FoR) suite of studies. This publication was an important step towards providing a more complete picture of the operational implications of managing high levels of variable renewable generation on the power system, and provided the basic foundation of understanding the power system in this new context. This was followed in 2011 with a more in-depth analysis which is outlined in the report "Ensuring a Secure, Reliable and Efficient Power System in a Changing Environment"[7].

In 2011, EirGrid and SONI embarked upon a multi-year programme "Delivering a Secure, Sustainable Electricity System" (DS3). At its core, DS3 is designed to ensure the secure and safe operation of the power system in Ireland and Northern Ireland with increasing

[7] http://www.eirgrid.com/media/Ensuring_a_Secure_Reliable_and_Efficient_Power_System_Report.pdf

levels of variable renewable generation. In order to achieve the renewable targets, the generation plant portfolio on the Island will be transformed from the traditional mix of conventional generation (mostly of gas and other thermal plant), to a portfolio where in 2020, variable non-synchronous wind generation will account for 37% of all electrical power generated on the Island.

The power system is currently operated at a maximum SNSP (System Non Synchronous Penetration) level of 50% in real-time. However in order for the Transmission System Operators (TSOs) to efficiently achieve the 40% RES-E[8] targets by 2020 the system will need to be operated in real-time with SNSP levels of up to 75%. Operating the system in this manner creates a range of technical challenges that are being managed by the TSOs through the DS3 Programme.

The DS3 programme is made up of 11 work streams which fall under three main pillars: System Performance, System Policies and System Tools. Each pillar is fundamental to the success of the DS3 programme and the delivery of the 40% renewable electricity target. The DS3 programme brings together many different strands, including development of financial incentive products for improved plant performance, and the development of new operational policies and system tools in order to accommodate increasing levels of renewable generation on the grid in a secure and sustainable manner. Standards for wind farms and conventional plant are also being reviewed to provide enhanced operational flexibility for the future. The programme involves many different stakeholders, including the Distribution System Operators (DSOs), Regulatory Authorities, Conventional Generators, Renewable Generators, as well as the TSOs.

Over recent years the electricity sector has entered a period of considerable change. This change has been characterised by a drive toward increased environmental sustainability, energy security and economic competitiveness, and is being delivered primarily through a commitment to increase the level of renewable generation on the power system. The DS3 Programme is about developing solutions to the challenges of operating the electricity system in a secure manner while achieving 2020 renewable electricity targets.

There are three main work areas within the DS3 programme and their objectives are outlined below:

System Performance

- To provide certainty around current and future plant performance capability and to ensure the continued reliable performance of all plant connected to the power system in Ireland and Northern Ireland
- Enhancing existing performance monitoring processes and highlighting Grid Code compliance
- To ensure the development of a portfolio of plant aligned with the long term needs of the system

[8] http://www.eirgrid.com/renewables/policyandtargets/irelandandnorthernireland/

- Review standards for Rate of Change of Frequency (RoCoF) for plant connected to the system

System Policies

- Adapting and refining system operational policies to assist in securely managing the voltage and frequency on the Ireland and Northern Ireland power systems
- Collation and analysis of data relating to renewable generation and using this to inform system operational policy development

System Tools

- Design, development and implementation of enhanced system tools in order to manage the increased operational complexity
- Provide decision support tools to assist the operators in the Control Centres (e.g.) stability analysis tools such as the Wind Security Assessment Tool (WSAT) and forecasting tools.
- Updating system models with actual plant performance capability and carrying out further studies to investigate a secure system with high levels of non-synchronous penetration.

In order to achieve the deliverables in the DS3 programme, the programme can be further broken down into 11 work streams.

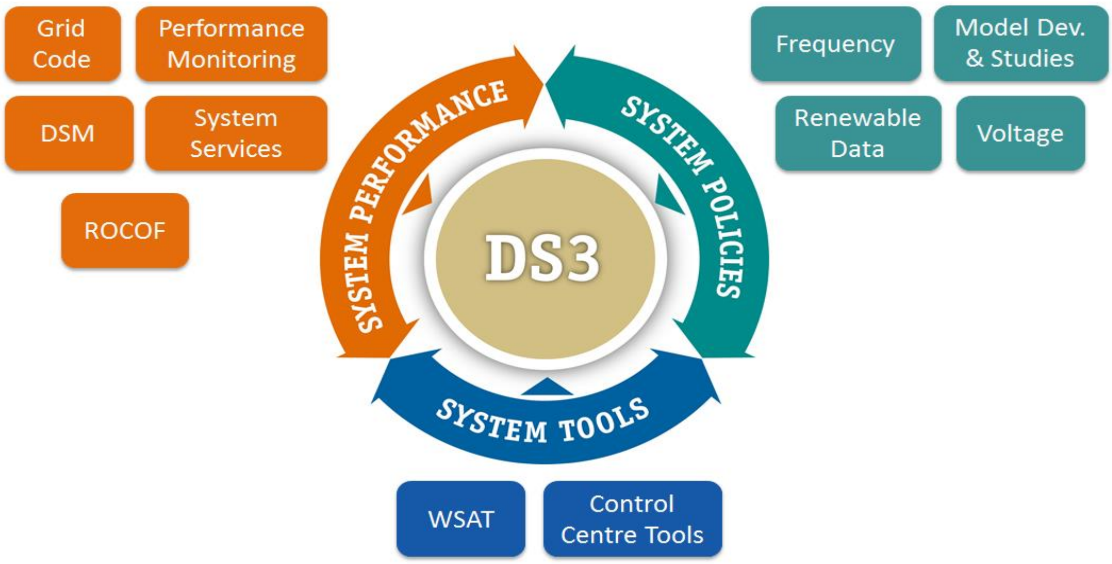


Figure 2-1 DS3 Programme Work Streams

2.4.2 Smart Grids

Background

The Smart Grid for Ireland and Northern Ireland comprises an electrical power system which facilitates the large-scale integration of renewable energy sources, utilises the electricity infrastructure efficiently through the optimal use of Information and Communications Technology (ICT) and seamlessly integrates the actions of all users connected to the power system in order to deliver sustainable, economic and secure electricity supplies for all consumers.

Ireland and Northern Ireland have binding targets to increase the level of renewable electricity on the power system to 40% by 2020. Integrating variable renewable energy sources on the power system presents a complex set of system challenges and the DS3 programme has been devised to evolve system policy, system tools and system performance.

Coupled with the diversification of energy sources, electrical energy usage is changing with the electrification of new sectors such as transport through Electrical Vehicles (EVs) and electrification of heat through new smart space and water heating devices. These new sectors will be powered by a decarbonised electricity sector. EirGrid and SONI must maintain security of supply with increased system complexity due to the integration of variable renewable energy sources and the integration of new electricity sectors and changes to electricity usage (Demand Side Management (DSM), Electric Vehicles (EVs) etc).

EirGrid and SONI's role is to optimise the power system now and into the future – both in terms of power system operation today and planning for the power system of the future – in the most cost-effective optimum way to drive cost benefits for all consumers. The Smart Grid challenge is effectively a system integration challenge. It involves the integration of multiple energy sources (traditional large scale conventional generation, diverse smaller-scale renewable energy sources and active demand sites) and all energy users – large and small – and co-optimises their interactions to balance supply and demand in the most economical, efficient way.

EirGrid and SONI have already shown that they are capable of operating a power system with large amounts of renewable energy sources (up to 50%), without compromising the safe, secure and efficient operation of the system. EirGrid Group, as Transmission System Operator (TSO) in Ireland and Northern Ireland and wholesale electricity Market Operator (MO) on the island of Ireland is uniquely placed on the global stage, with complete alignment of the technical (power system operation) and commercial (market operation) aspects within the organisation.

The benefit of the Smart Grid for consumers is that it facilitates the use of sustainable energy sources, in the most cost effective way. Through Smart Meters and the appropriate tariffing mechanisms, consumers can play an active part of the Smart Grid and will have access to information on their electricity use and the ability to make smarter decisions about their energy usage.

EirGrid and SONI's Smart Grid Programme is embedded across the company, with a focus on four key areas:

- **Technical** – the core of the Smart Grid programme for EirGrid and SONI is a focus on the necessary changes in operating and planning the system for the emergence of the Smart Grid. There will be a need for new Control Centre Tools to support the real-time decisions made by the control centre and this is underpinned by operational policies. Advanced System Planning techniques will be developed which take account of increased uncertainties with a more holistic set of base-case assumptions. In addition, a TSO-led group of transmission technology trials will allow the System Operators to gain experience and knowledge about enhanced and optimised system operation with new smarter technologies embedded on the system.
- **Engagement** – actively engaging and supporting the wider Smart Grid community is a core part of the programme. There are two external support programmes: the Smart Grid Innovation Hub, which supports SMEs[9], entrepreneurs and academics to develop Smart Grid products, services and solutions from concept to commercialisation; and the Demonstration Projects initiative which enables the trialling of transmission-scale technologies on the power systems of Ireland and Northern Ireland by third parties.
- **Vision** – Applied Research is a key element of the Smart Grid Programme. The system-level issues that the System Operators are seeking to solve require close collaboration and interaction with leading-edge research in Ireland, Northern Ireland and further afield. Coupled with this Applied Research, is a robust plan to manage input and steer energy policy in both jurisdictions.
- **Transformation** – the final area is related to growing the capacity – knowledge and skills – of the organisation to facilitate the Smart Grid; and designing and deploying a data management system to manage increased amounts of data from new System Service providers and as well as enhanced Performance Monitoring.

[9] Small or Medium Enterprise

3 The Electricity Transmission System

3 THE ELECTRICITY TRANSMISSION SYSTEM

3.1 OVERVIEW OF THE ELECTRICITY TRANSMISSION SYSTEM

The transmission system in Ireland and Northern Ireland plays a vital role in the supply of electricity, providing the means to transport energy from generators to demand centres across the island. The transmission system is comprised of 400 kV, 275 kV, 220 kV and 110 kV electricity networks. The Northern Ireland transmission system is operated at 275 kV and 110 kV while the transmission system of Ireland is operated at 400 kV, 220 kV and 110 kV. The transmission systems – North and South - are electrically connected by means of one 275 kV double circuit connection from Louth station in Co. Louth (Irl) to Tandragee station in Co. Armagh (NI) and two 110 kV 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 400 kV, 275 kV and 220 kV networks form the backbone of the transmission system. They have higher power carrying capacity and lower losses than the 110 kV network. In Ireland, the 400 kV network provides a high capacity link between the Moneypoint generation station and Galway on the west coast and Dublin on the east. EirGrid and SONI are planning a new 400 kV cross-border circuit, which for the purposes of the 2014 TYTFS analysis is anticipated to be installed by the end of 2017[2]. The 275 kV network is comprised of a double circuit ring in Northern Ireland with a double circuit spur to Coolkeeragh Power Station and another double circuit spur southwards into Co. Louth, in Ireland. The 220 kV network along with the 400 kV network form the backbone of the transmission system in Ireland, while the 275 kV network forms the backbone of the Northern Ireland transmission system. Typically large generation stations (greater than 100 MW) are connected to the 220 kV, 275 kV or 400 kV networks. The 110 kV[3] circuits provide parallel paths to the 220 kV, 275 kV and 400 kV networks and is the most extensive element of the all-island transmission system, reaching into every county on the island of Ireland.

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

[2] It is estimated that the North-South 400kV tie-line will be constructed and fully operational in 2019; http://www.uregni.gov.uk/uploads/publications/DETI_-_Utility_Regulator_-_Updated_Security_of_Supply_Paper_-_22_Dec_14_draft_2.pdf

[3] A number of radial 110 kV circuits in Ireland and the 110 kV 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.

The transmission system generally comprises of overhead lines, except in certain circumstances, such as in the city centres of Belfast, Cork and Dublin, where some underground cables are used. Table 3-1 presents the total lengths of overhead lines[4] and cables at the different voltage levels. Revision of individual line lengths “may change” following completion of network development projects.

Table 3-1 Total Length of Existing Transmission System Circuits as at the Data Collection Freeze Date

Voltage Level	Total Line Lengths (km)	Total Cable Lengths (km)
400 kV	439	0
275 kV	825	<1
220 kV	1787	129
110 kV	5811	363

Transformers 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 3-2

Table 3-2 Total Transmission System Transformer MVA Capacity as at the Data Collection Freeze Date[5]

Voltage Level	Capacity (MVA)	Number of transformers
400/220 kV	2,550	5
275/220 kV	1,200	2
275/110 kV	3,840	16
220/110 kV	10929	59

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 3-3 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.

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

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

Table 3-3 Total Reactive Compensation as at as at the Data Collection Freeze Date[6]

Voltage Level	Type	Capacity (Mvar)	Number of Devices
400 kV	Line Shunt Reactor	160	2
	Voltage Source Converter Interconnector	+/- 175	1
275 kV	Shunt Capacitor	236	4
220 kV	Shunt Reactor	100	1
110 kV	Static Var Compensator	90	3
	Shunt Capacitor	861	36
33 kV	Shunt Capacitor	29	5
22 kV	Shunt Reactor	210	7
	Shunt Capacitor	125	5

3.2 EXISTING CONNECTIONS BETWEEN THE TRANSMISSION SYSTEMS

As illustrated in Figure 3-1, the transmission systems of Ireland and Northern Ireland are connected via a double circuit 275 kV line running from Louth in Ireland to Tandragee in Northern Ireland. There are three 275/220 kV transformers in Louth station, one 600 MVA unit and two ganged[7] 300 MVA units, connected to the 275 kV double circuit, with three 240 MVA 275/110 kV transformers in Tandragee station.

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

While the design capacity of each of the 275/220 kV cross-border circuits is 600 MVA, 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, including the ability to deal with system separation.

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

[7] Plant connected in parallel through common switchgear.

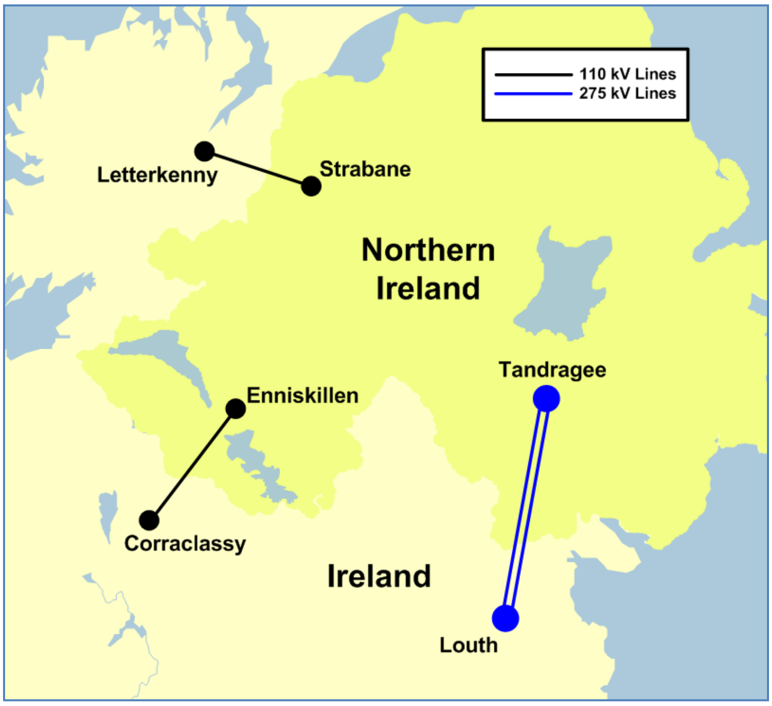


Figure 3-1 Existing Cross-Border Circuits

3.3 INTERCONNECTION WITH GREAT BRITAIN

With imports of power from Scotland and Wales across the Moyle Interconnector and the East-West Interconnector respectively, conventional generation in Northern Ireland and Ireland is 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 frequency dynamics and transmission system stability and operation. Frequency dynamics 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, whereas the East West Interconnector 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) and Moyle Interconnector Limited (MIL)[8]. The capacity is purchased by market participants and utilised in the Single Electricity Market (SEM). Figure 3-2 shows the location of the Moyle interconnector and EirGrid East-West Interconnector.

[8] http://www.mutual-energy.com/The_Moyle_Interconnector/Role_in_the_Electricity_Market.php

Figure 3-2 Existing Interconnectors

The amount of power that can currently be traded between Northern Ireland and Scotland across the Moyle Interconnector is constrained (due to on-going outage/fault) to 250 MW[9] all year. The amount of power that is permitted to be traded between Ireland and Wales across the East-West Interconnector is 500 MW all year, as measured at the SEM and BETTA (British Electricity Trading and Transmission Arrangements) market reference point in Deeside 400 kV station in Wales. Table 3-4 below details the available capacity of the interconnectors.

Table 3-4 Available Capacity on Existing Interconnectors

Interconnector	Direction	Summer	Winter
Moyle	SCO – NI[10]	250 MW	250 MW
	NI – SCO[11]	250 MW	250 MW
EWIC[12]	WAL – IRL	500 MW	500 MW
	IRL – WAL	500 MW	500 MW

[9] http://www.mutual-energy.com/Media/Press_Archive/operationalUpdate.php

[10] The Moyle Interconnector import capacity increases to 450 MW in all seasons in 2018 due to repair works being completed.

[11] The Moyle Interconnector export capacity decreases to 80 MW in all seasons from 2017 due to network limitations in Scotland.

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

3.3.1 Moyle Interconnector

The Northern Ireland transmission system is currently connected to Great Britain via a 500 MW High Voltage Direct Current (HVDC) link, the Moyle interconnector. The Moyle Interconnector commenced commercial operation in 2002 and is constructed as a dual monopole HVDC link with two coaxial sub-sea cables from Ballycronan More in Islandmagee, Northern Ireland to Auchencrosh in Ayrshire, Scotland. The link has a physical installed capacity of 500 MW. An emergency flow of up to 75 MW is available should the frequency on the island drop below 49.4 Hz.

The convertor station at Ballycronan More is looped into one of the 275 kV Ballylumford to Hannahstown circuits. The Moyle Interconnector is a Line Commutated Converter (LCC) HVDC link. The Moyle link is self-compensating for reactive power losses. There are 4 x 59 Mvar capacitor banks at the Ballycronan More converter station with 3 of these capacitor banks acting as filters.

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

At present a cable fault on Pole 1 of the Moyle Interconnector means that 250 MW of the capacity is unavailable. Moyle Interconnector Limited (MIL)[13] 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 2018. Therefore the import capacity of the Moyle Interconnector is restored to 450 MW from 2018. The export capacity of the Moyle Interconnector however will not increase with the reintroduction of Pole 1. This is because from 2017 onwards, the export capacity of the Moyle Interconnector will be limited to 80 MW, due to the commissioning of a large wind farm in Scotland which will use up capacity on the single circuit from Auchencrosh to Coylton.

3.3.2 East-West Interconnector

The East-West Interconnector is a 500 MW HVDC link which runs between Woodland, County Meath in Ireland and Deeside in North Wales. The link comprises approximately 186 km of sub-sea cable and 70 km 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, does not suffer from commutation failures, and is capable of offering emergency power control in the event of low or high frequency events. In addition, due to the VSC technology, the East-West Interconnector provides black start capability. The link can operate in either voltage control or reactive power control mode independently in both converter stations and can supply or absorb up to 175 Mvar at Portan 400 kV station which is connected directly to Woodland 400 kV station. The East-West Interconnector commenced commercial operation in December 2012.

[13] http://www.uregni.gov.uk/publications/correspondence_between_the_ur_and_moyle_interconnector_regarding_the_repair

3.4 IRELAND TRANSMISSION SYSTEM DEVELOPMENTS

3.4.1 Grid25

Over the next 10 years, major changes are forecast in Ireland's generation portfolio and in its fleet of power stations. Change will increasingly be driven by issues of energy and system security, competitiveness, climate change and by a shift away from imported fossil fuels. The transmission system is a vital channel for supplying reliable and sustainable energy to Ireland's demand centres and is crucial to facilitating competition in the electricity market. Reinforcing and upgrading the transmission system is required in order to maintain a robust electricity transmission system into the future. The capacity of the bulk transmission system, comprising circuits at 220 kV or higher, has remained largely unchanged in the last 20 years, a period that has seen a growth of 150% in the electricity demand. In order to facilitate the necessary increase in renewable generation and to adequately meet the demands of the electricity customer, the capacity of the bulk transmission system is being continually increased over the period of this statement.
EirGrid's Grid25 strategy was launched in 2008. It is our plan to develop and upgrade the electricity transmission network from now until 2025. It will put in place a safe, secure and affordable electricity supply throughout Ireland. EirGrid carries out regular assessments of the country's energy needs, based on projected population and projected requirements of business, as well as Government and EU policy.

The Grid25 strategy was previously reviewed and updated in 2011 to adjust for the downturn in the economy. The scale of the strategy was revised downwards from €4 billion to €3.2 billion. In line with EirGrid's on-going policy of assessment and review, we will continue to take into account the most up-to-date information available, including technical feasibility, future economic and demand projections, and environmental impacts.

Appendix B of this TYTFS outlines Transmission System developments which have received capital approval. These projects are currently scheduled to be completed by 2023. Table 3-5 shows the level of transmission system developments delivered by EirGrid (in conjunction with ESB Networks and independent contestable build contractors) over the past 5 years.

Table 3-5 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

EirGrid's Transmission Development Plan (available here), details the transmission system development projects that have been initiated by EirGrid while also discussing 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 and new generation and demand connections[14] 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.

It should be noted that the information presented here is a snapshot of an evolving transmission system development plan. While EirGrid is 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 2013-2023 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 at the beginning of October 2013, when data was frozen in order to facilitate the completion of the TYTFS is given 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.

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 3-3. 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.

[14] For example data centres or large industrial sites

Figure 3-3 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 3-4.

Figure 3-4 Project certainty dependent on project constituents

EirGrid has 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 2017 are considered to be within the moderate risk category while those large scale linear developments scheduled to be completed post 2017 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 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[15].

All developments included in this section have received capital approval.

Moneypoint-Kilpaddoge 220 kV Circuit

A planned new submarine cable across the Shannon estuary from Moneypoint in Co. Clare to Kilpaddoge in north Co. Kerry will create a necessary new path for power out of the Dublin-Moneypoint group of generators into the South West and a path for power out of the South

[15] Since the data freeze dates in 2013, some project timelines have been subject to change. For information, the latest scheduled completion date statuses for Associated Transmission Reinforcements (ATRs) can be viewed on the EirGrid website;
http://www.eirgrid.com/customers/gridconnections/generatorconnections/associatedtransmissionreinforcements/

Ballyvouskill 220 kV Development

Ballyvouskill 220 kV station will be looped into the existing Clashavoon-Tarbert 220 kV line. The station will be linked to the existing Garrow 110 kV station by one new 110 kV underground cable. Ballyvouskill 220/110 kV project is needed to accommodate renewable generation in the south-west. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2015.

Knockanure 220 kV Development[15]

Knockanure 220 kV station will be looped into the existing Clashavoon-Tarbert 220 kV line as well as the existing Trien-Tarbert 110 kV circuit and the planned Trien-Athea 110 kV circuit. Knockanure 220/110 kV project is needed to accommodate part of the renewable generation in the south-west. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2015.

Ballynahulla 220 kV Development

Ballynahulla 220 kV station will be looped into the existing Clashavoon-Tarbert 220 kV line. The station will be linked to the existing Glenlara 110 kV station by a new 110 kV circuit. Ballynahulla 220/110 kV project is needed to accommodate part of the renewable generation in the south-west. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2015.This station was formerly known as Kishkeam but has been renamed.

Clogher 110 kV Development

Clogher 110 kV GIS station will be looped into the existing Cathaleen's Fall – Drumkeen and Cathaleen's Fall – Golagh T – Letterkenny 110 kV lines. Mulreavy and Cronacarkfree wind farms will connect at 110 kV into the new Clogher 110 kV station. This 110 kV transmission station is being built contestably. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2016.

Poolbeg 220 kV Development

Two 50 Mvar shunt reactors will be installed in Poolbeg 220 kV station, in Co. Dublin. The cumulative effect of the large number of cable circuits and a reduction in the usage of the conventional generation in Dublin 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 2014 TYTFS analysis, the reactors are expected to be completed in the latter half of 2016.

Moneypoint Redevelopment

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

[15] http://www.eirgridprojects.com/projects/eastkerrynorthwestcorkproject/overview/

busbar. The station will also accommodate a second 400/220 kV transformer. For the purpose of the 2014 TYTFS analysis, the new 400 kV substation and 400/220 kV transformer are expected to be completed in 2016.

As part of this project a new 220 kV busbar will be developed at Moneypoint. This will accommodate a 220/110 kV transformer which is required to reinforce the transmission network in Co. Clare. It will also accommodate the planned two Moneypoint-Kilpaddoge 220 kV circuits. For the purpose of the 2014 TYTFS analysis, the new 220 kV substation and 220/110 kV transformer are expected to be completed in 2016.

Kilpaddoge 220 kV Development[16]

Kilpaddoge 220 kV station, in north Co. Kerry, will be connected into the existing Clashavoon-Tarbert and Killonan-Tarbert 220 kV lines. All existing 110 kV circuits currently connecting at the existing Tarbert 220 kV station will be transferred to Kilpaddoge 220 kV station, making Kilpaddoge a new hub for power flows into the south-west. Kilpaddoge 220/110 kV project is needed to replace Tarbert 220 kV station as the main transmission station in north Co. Kerry as the location was restricting further access and development of the transmission station. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2016.

Finglas 220 kV Redevelopment

The 220 kV and 110 kV busbars in the existing Finglas 220 kV station will be reconfigured and redeveloped into 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 220 kV expansion. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2016.

Belcamp 220 kV Development[17]

Belcamp 220 kV station, in north Co. Dublin, will be connected to the 220 kV network by an underground cable from Finglas. A number of the existing 110 kV circuits in the area will be connected to the new Belcamp station. This development will offload demand from Finglas 220 kV station and 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 2014 TYTFS analysis, this project is expected to be completed in 2017.

Knockraha 220 kV Reconfiguration

The 220 kV busbar in Knockraha 220 kV station will be reconfigured from the existing double busbar configuration to a ring busbar arrangement. The third Knockraha 220/110 kV

[16] http://www.eirgridprojects.com/projects/northkerryproject/

[17] http://www.eirgridprojects.com/projects/dublinnorthfringe/

transformer will be decommissioned resulting in the station having only two 220/110 kV transformers. The project will resolve issues regarding security of supply, increase operational flexibility and improve maintainability of station equipment. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2017.

400 kV station near Portlaoise[18]

A new 400/110 kV station to be located near Portlaoise, Co. Laois, with an associated 110 kV circuit to Kilkenny 110 kV station via Ballyragget station. The 400/110 kV station will be looped into the existing Moneypoint-Dunstown 400 kV line and the existing Portlaoise-Athy 110 kV line. The proposed infrastructure will improve quality of supply to Laois, Carlow, Kildare, Wicklow, Kilkenny, ensure security of supply to Kilkenny and will also increase capacity to the region. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2017.

Inchicore Redevelopment

The oldest section of the existing Inchicore 220 kV station, in Co. Dublin will be replaced with a new GIS compound. This project will address issues with the condition of existing equipment, inadequate circuit breaker ratings, and the need for upgrade of the protection systems. The new GIS compound will increase operational flexibility, improve maintainability of station equipment and allow for future 220 kV expansion. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2018.

Aghada 220 kV kV Development

The 220 kV busbar in Aghada 220 kV station will be reconfigured from the existing double busbar into a 'C' configuration. The 110 kV 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 2014 TYTFS analysis, this project is expected to be completed in 2018.

Louth 110 kV Development

Louth station comprises three voltage levels, 275 kV, 220 kV and 110 kV. The station will undergo a major refurbishment of assets at all three voltage levels. The 110 kV busbar will be reconfigured from the existing double busbar configuration to ring busbar arrangement. The project also involves the relocation of the existing capacitor bank from the A1/B1 110 kV busbar section to the A2/B2 110 kV busbar section. . The project will address 110 kV busbar capacity issues and short circuit problems, increase operational flexibility and improve maintainability of station equipment. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2019.

Moneypoint – Kilpaddoge - Knockanure 220 kV Development

A planned new 220 kV cable from Moneypoint in Co. Clare to Knockanure in north Co. Kerry, via Kilpaddoge also in north Co. Kerry will create a necessary new path for power out of the

[18] http://www.eirgridprojects.com/projects/laoiskilkenny/

South West to the existing 400 kV network. The project will comprise a submarine 220 kV cable under the Shannon and a 21 km 220 kV land cable. It is expected to be completed in 2019.

Grid West Project[19]

A new substation is required in the vicinity of Bellacorick, Co. Mayo, to facilitate the large quantities of renewable generation in the area. EirGrid is currently investigating both overhead and underground options utilising various technologies for the Grid West circuit which is being overseen by the Independent Expert Panel (IEP). It will create a necessary new path for power out of the Mayo region to the existing meshed 220 kV transmission system. For the purpose of the 2014 TYTFS analysis, this project is assumed to be completed in 2019. The preferred location of the substation sites in the Bellacorick and Flagford areas are currently under investigation and the substation locations shown in the geographical maps are only indicative.

Grid Link Project[20]

The Grid Link development project comprises a new 400 kV circuit connecting Knockraha 220 kV substation, in Co. Cork and Dunstown 400 kV substation, in Co. Kildare, via Great Island 220 kV station, in Co. Wexford. Two new 400 kV substations will have to be built at Knockraha substation Co. Cork and at Great Island substation Co. Wexford. The Grid Link development project will facilitate the integration of renewable and conventional generation in the south of Ireland, 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. EirGrid is currently investigating both overhead and underground options utilising various technologies for the Grid Link circuit which is being overseen by the IEP. For the purpose of the 2014 TYTFS analysis, this project is assumed to be completed in 2020.

North Connaught 110 kV Reinforcement[21]

The North Connaught Reinforcement comprises a planned new 110 kV circuit from the existing Castlebar 110 kV station to the existing Moy 110 kV station. The project will facilitate the connection of renewable generation in the area and ensure security of supply is maintained in North Connaught. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed in 2020.

[19] http://www.eirgridprojects.com/projects/gridwest/overview/

[20] http://www.eirgridprojects.com/projects/gridlink/overview/

[21] Since the data freeze date this project is under review, awaiting confirmation of need and an investigation of overhead and underground options utilising various technologies for the North Connaught circuit.

Finnstown 220 kV Development[22]

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

North West Project[23]

The North West Project comprises a planned new 220 kV circuit from the existing Srananagh 220 kV station to the area around the planned Clogher 110 kV station in Donegal. It involves the construction of a new 220 kV line bay in Srananagh 220 kV station and construction of a new 220 kV station at or near Clogher, including two 250 MVA 220/110 kV transformers. The project will facilitate the connection of renewable generation in Co. Donegal. The studies that identified the need for the North West project were part of the cross-border Renewable Integration Development Project (RIDP). For the purpose of the 2014 TYTFS analysis this project is assumed to be completed in 2020.

3.5 NORTHERN IRELAND TRANSMISSION SYSTEM DEVELOPMENTS

This section contains the details of the transmission system projects that are planned to take place in Northern Ireland, subject to regulatory approval as part of the overall price review settlement, over the next ten years.

The following sections provide details of the planned works as well as the date the project is included in the TYTFS study files. In order to create TYTFS study files that are as representative as possible of the future Northern Ireland transmission system unapproved projects have been included using provisional completion dates provided by NIE at the time of the data freeze (1st December 2013).

Hannahstown 275 kV

A third interbus transformer is planned to be installed and commissioned at Hannahstown. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed by winter 2014.

[22] Since the data freeze date this project has been cancelled. A new West Dublin 220 kV project to reinforce the transmission and distribution systems in order to facilitate the connection of a significant volume of new load in the area has been initiated since the data freeze date.

[23] Since the data freeze date this project is under review, awaiting an investigation of overhead and underground options utilising various technologies for the North West Project circuit.

Tandragee 275 kV IBTX 3

The interbus transformer IBTX3 at Tandragee is to be replaced. The replacement transformer will have a 60 MVA tertiary winding. For the purpose of the 2014 TYTFS analysis, the asset replacement is planned to be installed and commissioned by winter 2014.

Castlereagh 275 kV IBTX 1

The interbus transformer IBTX 1 at Castlereagh is to be replaced. The replacement transformer will have a 60 MVA tertiary winding. For the purpose of the 2014 TYTFS analysis, the asset replacement is planned to be installed and commissioned by winter 2014.

Coleraine-Kells 110kV Circuits

The section of the Coleraine-Kells circuit between Coleraine and the connection point to the proposed Mid-Antrim cluster substation is to be uprated. The line will be restrung with sections of Invar and GAP conductor, as there are both tower and portal sections to this circuit. It is also proposed to uprate one side of the double-circuit Terrygowan-Kells section with gap conductor. This network reinforcement has construction approval and for the purpose of the 2014 TYTFS analysis it is assumed to be completed by winter 2015.

Knock Main

It is planned to replace the two 60 MVA transformers at Knock Main with two 90 MVA transformers. For the purpose of the 2014 TYTFS analysis it is assumed to be completed by winter 2015.

Tamnamore Main 275 kV Substation - Phase 2

The Tamnamore Phase 2 project is the further development and completion of the Tamnamore 275/110 kV substation. It is proposed to extend the existing 275 kV and 110 kV double busbars at Tamnamore, connect a second 275 kV transformer and loop in the Dungannon-Drumnakelly and Dungannon-Creagh 110 kV 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 275 kV Magherafelt-Tandragee circuit into the substation. For the purpose of the 2014 TYTFS analysis, the network reinforcement is planned to be installed and commissioned by summer 2016.

Belfast North Main

A new 110 kV substation at Whitla Street is to be established, allowing for the retirement of the 110kV 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 33 kV switchboard and pair of 90 MVA transformers. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by winter 2015.

Tremoge 110 kV Cluster

The proposed establishment of a 110 kV cluster substation, with one transformer at a site adjacent to the existing 110 kV Omagh – Dungannon circuit '2'. The existing circuit will be looped into this new cluster substation. For the purpose of the 2014 TYTFS analysis, the Tremoge cluster is planned to be installed and commissioned by winter 2016.

Dungannon-Omagh 110 kV Circuits

Both Omagh-Dungannon 110 kV circuits will be diverted into Tamnamore Main. The current Omagh-Dungannon '2' circuit will by this stage 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 against N-2 contingencies. For the purpose of the 2014 TYTFS analysis, this work is planned to be installed and commissioned by winter 2016.

Omagh-Tamnamore New 110 kV Circuit

It is proposed to construct a new circuit from Omagh-Tamnamore 110 kV. This circuit will be approximately 57 km in length on Portal construction and conductored with Zebra (with a DOT of 75°C). The circuit will also be used to connect the proposed Gort cluster substation. For the purpose of the 2014 TYTFS analysis, the network reinforcement is planned to be installed and commissioned by winter 2015.

Mid-Antrim 110 kV Cluster

The construction of a 110 kV substation with one transformer at a site adjacent to the existing Coleraine-Kells 110 kV. The existing circuit will be used to connect this new cluster substation. For the purpose of the 2014 TYTFS analysis, this cluster substation is planned to be installed and commissioned by winter 2016.

Coolkeeragh 275 kV IBT X 1

The interbus transformer IBTX 1 at Coolkeeragh is to be replaced with a transformer that will have a 60 MVA tertiary winding. For the purpose of the 2014 TYTFS analysis, the asset replacement is planned to be installed and commissioned by winter 2015.

Donegall Main (North)

One 60 MVA transformer at Donegall North is to be replaced by one 90 MVA transformer which for the purpose of the 2014 TYTFS analysis, is due to be installed and commissioned by winter 2016. Donegall North will then have two 90 MVA transformers in operation.

Gort 110 kV Cluster

It is proposed to construct a 110 kV substation with one transformer at a site adjacent to the proposed new 110 kV Omagh-Tamnamore circuit approximately 19 km east of Omagh Main and 38 km west of Tamnamore Main. For the purpose of the 2014 TYTFS analysis, the Gort cluster substation is planned to be installed and commissioned by winter 2016.

Coolkeeragh-Limavady-Coleraine 110 kV Circuits

It is proposed to uprate the Coolkeeragh-Limavady, Coleraine-Limavady and Coleraine-Coolkeeragh 110 kV circuits. When works are complete, the circuits will be uprated to a minimum of 185 MVA. For the purpose of the 2014 TYTFS analysis, this network reinforcement is planned to be installed and commissioned by winter 2016. This project is subject to Regulatory approval.

Airport Road Main

It is planned to construct a new 110kV substation including 2 x 90 MVA transformers and a 33 kV switchboard at Airport Road. The substation will be connected as a transformer feeder arrangement from Castlereagh Main 110 kV. The substation will supply both Airport Road and Queens Road 33 kV substations which are to be transferred from Cregagh Main and Ballymacarrett 33 kV substation which is to be transferred from Knock Main. For the purpose of the 2014 TYTFS analysis, Airport Road is planned to be installed and commissioned by winter 2016. The project is subject to Regulatory approval.

Castlereagh-Rosebank 110 kV Circuits

It is proposed to replace the two existing cable circuits which will increase the rating of each circuit to a minimum of 144 MVA. For the purpose of the 2014 TYTFS analysis, this network reinforcement has approval and is planned to be completed by winter 2016.

Ballylumford Switchgear

The existing 110kV switchgear at Ballylumford is to be replaced with new indoor GIS switchboard. A new GIS double busbar 110 kV (40 kA switchboard) will be installed and the 110 kV circuits diverted accordingly. For the purpose of the 2014 TYTFS analysis, this project is expected to be completed by winter 2017. Currently one 275 kV interbus transformer at Ballylumford is operated out of service to ensure the fault level is kept within existing switchgear fault rating. After this work takes place both interbus transformers at Ballylumford can be in service.

Drumquin 110 kV Cluster

It is planned to establish a new 110 kV cluster substation close to Drumquin village with one transformer. The Drumquin cluster is to be connected to the existing Enniskillen-Omagh 110 kV circuits by establishing a new switching station (Omagh South) north of Dromore village and a single portal overhead line from the new station to the cluster site. This project is subject to Regulatory pre-construction and construction approval. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by summer 2018.

Omagh-South Reactive Compensation

It is planned to install reactive support at the proposed Omagh South switching station substation. For the purpose of the 2014 TYTFS analysis, the proposed Omagh South switching station has a static var compensator (SVC) with a range of ± 100 Mvar connected to the 110 kV bus from 2018. This project is subject to Regulatory approval.

Coolkeeragh-Magherafelt 275 kV Circuits

It is planned to replace the conductor on the existing double circuit tower line. The new circuits are assumed to have minimum ratings of 761 MVA based on the rating of the existing cable element in each circuit. For the purpose of the 2014 TYTFS analysis, this asset upgrade in capacity is planned to be installed and commissioned by winter 2017. This project is subject to Regulatory approval.

Hannahstown-Lisburn 110 kV Circuits

It is planned to restring the Hannahstown-Lisburn '1' and '2' 110 kV single circuits with a UPAS conductor. It is planned to change the conductors to match the cable sections, i.e. a rating of 144MVA. For the purpose of the 2014 TYTFS analysis, the project is expected to be completed by 2018. This project is subject to Regulatory approval.

Coleraine Reactive Compensation

It is planned to install reactive support at Coleraine. It is proposed that the reactive compensation scheme will be a static var compensator (SVC) or statcom with a range of ± 100 Mvar connected to the 110 kV bus. The existing 36Mvar Capacitor at Coleraine is to be switched out. For the purpose of the 2014 TYTFS analysis, this scheme is planned to be installed and commissioned by 2020. This project is subject to Regulatory approval.

Garvagh 110 kV Cluster

It is planned to establish a 110 kV cluster substation, with one transformer, at a site near Garvagh village. It is planned that the Garvagh cluster will be connected to the proposed Mid-Antrim cluster via a portal overhead line. For the purpose of the 2014 TYTFS analysis, this cluster is planned to be installed and commissioned by 2020.

Kells-Mid-Antrim New 110 kV Circuit

It is proposed to construct a second 110 kV circuit between Kells and Mid-Antrim cluster. This circuit will have a minimum rating of 188 MVA. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by 2020. This project is subject to Regulatory approval.

Tamnamore Reactive Compensation

It is planned to install reactive support at Tamnamore. It is planned that the reactive compensation scheme will be a static var compensator (SVC) or statcom with a range of ± 175 Mvar connected to the 110 kV bus. For the purpose of the 2014 TYTFS analysis, this scheme is planned to be installed and commissioned by 2020. This project is subject to Regulatory approval.

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 established by installing a pair of 275 kV transformers close to the existing Ballylumford 275kV switch house, and laying duplicate 110kV 200MVA cables across Larne Lough to the CAES plant. For the purpose of the 2014 TYTFS analysis, the connection is planned to be installed and commissioned by winter 2018.

South Down (Offshore Wind[24])

A developer plans to establish a 324MW wind farm initially off the east County Down coast. For the purposes of including the scheme in the TYTFS, it is assumed that the connection will be established by installing a 275/220kV substation close to Castlereagh substation and laying a 220kV cable, rated at 500MVA, to the offshore platform. It should be noted that this plan is currently under further assessment and is subject to change. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by winter 2020.

North Antrim (Tidal)

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, the connection is modelled by establishing a new 110kV node close to Ballymoney with duplicate 110kV circuits to Kells and Coleraine. The connection methodology of these tidal schemes is currently under further assessment and is subject to change. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by winter 2020. This project is subject to Regulatory approval.

Omagh South-Turleenan 275 kV Circuit

It is further planned to extend the proposed Omagh South switching station site (see Drumquin cluster) to accommodate a 275kV substation. It is planned that this will be connected by constructing a 275kV single circuit from Omagh South to Turleenan. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by winter 2023. This project is subject to Regulatory approval.

[24] Since the freeze date the developer has announced they are ceasing development of the offshore wind farm off the coast of Co. Down.

3.6 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.

A new 400 kV line is currently being progressed by EirGrid and SONI. The project also consists of a new 400/220 kV station, provisionally referred to as the Mid-Cavan station, this station is being deferred outside the period of this statement. The 400 kV line will connect Woodland 400 kV station in County Meath (Irl) and Turleenan 400 kV station in County Tyrone (NI). A new 400 kV station at Turleenan is also required. The Turleenan station will initially be equipped with two 500 MVA transformers with a spare bay and switchgear bays for a third. The Tamnamore-Tandragee and Magherafelt- Tandragee circuits will be looped into the 275 kV double busbar in Turleenan 400 kV station. The project has Regulatory, NIE Executive and EirGrid approval.

In the event of a loss of the existing 275 kV double circuit connecting the transmission system of Ireland and the Northern Ireland transmission system, the pre-fault transfers would be directed across the Letterkenny - Strabane and Corraclassy - Enniskillen 110 kV cross-border circuits. In this instance, to guard against damage to these lines, protection equipment will switch out the 110 kV circuits resulting in separation of the two systems. System separation, depending on the pre-separation flow on the Louth - Tandragee 275 kV double circuit, 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 impact of potential system separation on each system does result in constraints on the amount of power that can be transferred between the two systems.

The new circuit will have a rating of approx. 1500 MVA. However, with only two transformers in service initially at Turleenan, power flows on the circuit will be limited to 1000 MVA. All switchgear will have a fault rating of 40 kA. For the purpose of the 2014 TYTFS analysis, this project is planned to be installed and commissioned by winter 2017[25]. Once this connection is established, the constraints on the existing Tandragee-Louth 275 kV double circuit will be significantly reduced.

[25] It is estimated that the North-South 400kV tie-line will be constructed and fully operational in 2019; http://www.uregni.gov.uk/uploads/publications/DETI_-_Utility_Regulator_-_Updated_Security_of_Supply_Paper_-_22_Dec_14_draft_2.pdf

3.7 CONNECTION OF NEW GENERATION STATIONS

Chapter 5 describes the future generators that are included in this TYTFS.

Table 3-6 Planned Connection Methods of Future Generators

Generator	Planned Connection Method
Altamuskin	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Altaveedan	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit
Athea	New Athea 110 kV substation, looped into the Dromada-Trien 110kV circuit
Athea Wind Farm (Extension)	Connected into the planned Athea 110 kV substation
Barnadivane	New Barnadivane 110 kV Station, looped into the Dunmanway-Macroom 110 kV circuit
Ballakelly	Construction of a new 220 kV station tailed out of Louth 220 kV station.
Beltonanean	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon ‘B’ circuit
Bindoo Wind Farm (Extension)	Connected into the existing Ratrussan 110 kV substation
Boggeragh 2	Connected into the existing Boggeragh 110 kV substation
Booltiagh Wind Farm (Extension)	Connected into the existing Booltiagh 110 kV substation
Brockaghboy	Connected into a new Garvagh 110 kV cluster substation, itself connected into the future Mid-Antrim 110 kV substation
Bruckana	Connected into Lisheen 110 kV station.
CAES	Connected into existing Ballylumford 110kV substation.
Castlecraig	Connected into the future Drumquin 110 kV cluster substation, itself tail-connected into Omagh South 110 kV substation
Clahane Wind Farm (Extension)	Connected into the existing Clahane 110 kV substation
Cloghboola	Connected to a new Cloghboola 110 kV substation; itself tailed into Trien 110 kV substation
Cordal	Construction of the new Cordal 110 kV station tailed out of Ballynahulla.
Cornavarrow	Connected into the future Drumquin 110 kV cluster substation, itself tail-connected into Omagh South 110 kV substation
Cronacarkafree	Connected into the proposed Clogher 110 kV substation
Cregganconroe	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon ‘B’ circuit
Crockandun	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon ‘B’ circuit
Crockbaravally	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Crockbrack	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon ‘B’ circuit

Table 3-6 Planned Connection Methods of Future Generators (continued)

Generator	Planned Connection Method
Crockdun	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon 'B' circuit
Cuilleen	Connected to a new Cuilleen 110 kV substation, itself tail-connected into Athlone 110 kV substation
Eshmore	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Glanlee Wind Farm (Extension)	Connected into the existing Glanlee 110 kV substation
Glenbuck 1 & 2	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit
Gortfinbar	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon 'B' circuit
Great Island CCGT	Connected to a new Great Island 220 kV GIS station.
Innishative	Connected to a new Tremoge 110 kV substation, itself looped into the existing Omagh – Dungannon 'B' circuit
Keelderry	New Knockavanna 110 kV substation looped into the Agannygal-Derrybrien 110 kV circuit
Killinaparson	New Killinaparson 110 kV station tail fed from Portlaoise 110 kV station
Kill Hill	Construction of Kill Hill 110kV substation, looping into the Thurles – Cahir 110 kV circuit.
Knockacummer	Permanent connection of the new Knockacummer 110 kV substation, tailed out of Glenlara.
Knockavanna	Construction of a new Knockavanna 110 kV station, looped into Agannygal – Derrybrien 110 kV circuit.
Long Mountain	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit
Mayo	Mayo Renewable Power Biomass (Shallow Connection).
Moneypoint	Connected into existing Moneypoint substation at 110 kV
Mount Lucas	Construction of Mount Lucas 110kV substation, looping into the Cushaling-Thornsberry 110 kV circuit.
Mulreavy	New Mulreavy 110 kV substation tail-connected into the planned Clogher 110 kV substation
Nore Power	Construction of Nore 110kv substation, tailed out of Kilkenny 110 kV station.
Off-Shore Wind (South Down)	Connected to a new South Down 220 kV substation, itself connected into Castlereagh 275 kV substation
Oweninney	Connected to a new Bellacorick 400 kV substation, itself tail-connected into the new Flagford 400 kV substation
Pigeon Top	Connected into the future Drumquin 110 kV substation, itself tail-connected into Omagh South 110 kV substation
Rhode Biomass	Rhode Biomass (Shallow Connection).
Seegronan	Connected into the future Magherakeel 110 kV substation, itself tail-connected into Omagh 110 kV substation

Table 3-6 Planned Connection Methods of Future Generators (continued)

Generator	Planned Connection Method
Shantavny Scotch	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Sliabh Bawn	New Sliabh Bawn 110kV station tailed out of Lanesboro 110 kV station
Slieve Divena 2	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Slieveglass	Connected into the future Drumquin 110 kV cluster substation, itself tail-connected into Omagh South 110 kV substation
Smulgedon	Connected into a new Brockaghboy 110 kV cluster substation, itself connected into the future Mid-Antrim 110 kV substation
Suir	Construction of Suir 110kV substation, tailed out of Cahir 110 kV station.
Thornog	Connected into the future Magherakeel 110 kV cluster substation, itself tail-connected into Omagh 110 kV substation
Tidal	Connected into the new North-Antrim 110kV substation, which itself is looped into Coleraine-Kells 110kV circuit.
Tievenameenta	Connected into the future Magherakeel 110 kV cluster substation, itself tail-connected into Omagh 110 kV substation
Uggool and Seecon	Connected into the planned Uggool 110 kV substation, itself tail-connected into the planned West Galway 110 kV substation
Upper Ballyrogan	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit

3.8 CONNECTION OF NEW INTERFACE STATIONS

Transmission interface stations are the points of connection between the transmission system and the distribution system, or connecting 110 kV connected customers. Table 3-7 lists the planned new 110 kV stations connecting the distribution system or connecting 110 kV 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 3-7 Planned 110 kV Stations

Station	Code	Nearest Main Town or Load Centre	County
Adamstown	ADM	Lucan	Dublin
Airport Road	AIR	Belfast	Down
Ardnagappary	AGY	Na Doiri Beaga	Dun na nGall

Table 3-7 Planned 110 kV Stations (continued)

Station	Code	Nearest Main Town or Load Centre	County
Ballyragget	BGT	Ballyragget	Kilkenny
Belfast North Main	BNM	Belfast	Antrim
Blackpool	BLP	Kilbarry	Cork
Bracklone	BRA	Portarlington	Laois
Cherrywood	CHE	Loughlinstown	Dublin
Corkagh	CKG	Grange Castle	Dublin
Hartnett's Cross	HTS	Macroom	Cork
Heuston	HEU	Heuston Station	Dublin
Knockmullen	KNM	New Ross	Wexford
Nenagh	NEN	Nenagh	Tipperary
Newbury	NBY	Clonshaugh	Dublin
Screeb	SCR	Camus Iochtar	Gallimh
Stephenstown	SVN	Drogheda	Louth

3.9 DETAILED TRANSMISSION SYSTEM INFORMATION

Figure A-1 in Appendix A presents a geographical map of the all-island transmission system at the beginning of October 2013. This is also available in A3 format in Appendix J.

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.
- Figure A-2 in Appendix A presents a geographical map of the all-island transmission system as forecast in 2023, including the planned developments. The all-island

schematic network diagrams in Appendix A show snapshots of the existing and planned transmission developments at the end of 2014 and 2023. The diagrams indicate stations, circuits, transformers, generation, reactive devices and phase shifting transformers.

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 which 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 and will be reviewed when the plant is commissioned.

4 Demand

4 DEMAND

The flow of power on the Transmission System is determined largely by the generation feeding into it and the demand that is drawn from it. This chapter deals with forecasts of the total peak demand on the Transmission System and of demand at individual transmission-connected stations.

The *All-Island Generation Capacity Statement 2014-2023 (GCS)*, published by EirGrid and SONI in February 2014 contains forecasts of future energy consumption and demand for the ten-year period 2014 to 2023.

4.1 FORECASTS OF TRANSMISSION PEAKS

Table 4-1 presents the median winter peak forecasts of Transmission demand for the ten years 2014 to 2023, as published in the GCS, and compares them with those from the previous GCS. The current demand forecasts reflect an average annual increase in winter peak demand of 1% over the period 2014 to 2023. This is a slight decrease to the demand increase predicted in the All-Island Generation Capacity Statement 2013-2022, which forecast 1.4% average annual increase in winter peak demand over the period 2013-2022. This change is mostly due to changing economic predictions and increasing levels of energy efficiency.

Table 4-1 Comparison of Peak Demand Forecast with Previous GCS

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
GCS 2014-2023 (MW)	6,473	6,510	6,571	6,628	6,696	6,765	6,849	6,925	7,002	7,078
GCS 2013-2022 (MW)	6,501	6,590	6,674	6,751	6,829	6,923	7,049	7,148	7,241	N/A
Difference (MW)	-28	-80	-103	-123	-133	-158	-200	-223	-239	N/A

While it is difficult to accurately predict a peak demand figure for a particular year, the forecasts in Table 4-1 may be taken as indicative of a general trend in demand growth. In Table 4-2, four demand values are presented for each year: the winter peak; summer peak; summer valley; and autumn peak.

Table 4-2 Transmission Demand Forecast

Year	All-Island Winter Peak (MW)			All-Island Summer Peak (MW)			All-Island Summer Valley (MW)			Autumn Peak (MW)
		Ireland	Northern Ireland		Ireland	Northern Ireland		Ireland	Northern Ireland	Northern Ireland
2014	6,473	4,774	1,728	5,214	3,819	1,358	2,201	1,671	506	1,551
2015	6,510	4,806	1,733	5,244	3,845	1,362	2,213	1,682	508	1,556
2016	6,571	4,861	1,739	5,293	3,889	1,367	2,234	1,701	509	1,561
2017	6,628	4,911	1,746	5,339	3,929	1,372	2,254	1,719	512	1,568
2018	6,696	4,971	1,755	5,394	3,977	1,379	2,277	1,740	514	1,576
2019	6,765	5,030	1,764	5,449	4,024	1,387	2,300	1,761	517	1,584
2020	6,849	5,104	1,775	5,517	4,083	1,395	2,329	1,786	520	1,594
2021	6,925	5,169	1,786	5,578	4,135	1,404	2,355	1,809	523	1,604
2022	7,002	5,236	1,797	5,640	4,189	1,412	2,381	1,833	526	1,614
2023	7,078	5,301	1,808	5,701	4,241	1,421	2,407	1,855	530	1,624

All-Island Transmission Peaks

The winter peak figures represent the expected annual peak demands that are forecast to occur during the winter period of each year e.g. the 2014 forecast of 6,473 MW is the maximum demand projected to occur in winter 2014/15. The Northern Ireland and Ireland winter peaks are generally not coincidental as the Northern Ireland winter peak usually occurs later in the evening than in Ireland.

The summer peak refers to the average peak demands that are forecast to occur during the summer period of each year. For the purposes of illustration the Ireland and Northern Ireland summer peaks were summed to produce an all-island summer peak. While the overall Transmission System power flow may be lower in summer than in winter, this may not be the case for flows on all circuits. In addition, the capacity of overhead lines is lower because of higher ambient temperatures, while network maintenance, normally carried out in the March to September period, can restrict the network, further reducing its capability to transport power.

The annual minimum is referred to as the summer valley and represents the expected annual demand valleys that are forecast to occur during the summer period of each year. For the purposes of illustration the Ireland and Northern Ireland summer valleys were summed to produce an all-island summer valley. 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. With local demand at a minimum, the connecting generator must export more of its power across the Transmission System than at peak times.

Northern Ireland Transmission Peaks

The winter peak represents the expected annual sent out peak demands that are forecast to occur during the winter period defined as between November and February e.g. the 2014 forecast of 1,728 MW is the maximum demand projected to occur in winter 2014/15.

The summer peak refers to the average peak value between May and August. This is typically 21% lower than the winter peak.

The summer minimum is referred to as the summer valley in this TYTFS. The forecasts of summer valley demands in Table 4-2 assume a figure of 30% of the annual maximum demand, which is consistent with historical summer valley demand data.

The autumn peak refers to the average peak value in the spring-autumn season which occurs between September - October and March - April. This is typically 14% lower than the winter peak. While the overall Transmission System power flow may be lower in autumn than in winter, this may not be the case for flows on all circuits. In addition, the capacity of overhead lines is lower because of higher ambient temperatures, while Transmission System maintenance, normally carried out in the summer/autumn periods, can restrict the Transmission System, further reducing its capability to transport power.

Ireland Transmission Peaks

The winter peak represents the expected annual peak demands that are forecast to occur between November and February of each year e.g. the 2014 forecast of 4,774 MW is the maximum demand projected to occur in winter 2014/15.

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

The forecast summer valley demands, in Table 4-2, assume a figure of 35% of the annual maximum demand, which is consistent with historical summer valley demand data.

4.2 DEMAND PROFILES

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

Generated Peak Demand Profiles

Figure 4-1 shows the Generated Peak Demand Profiles of Ireland and Northern Ireland on the day of the winter peak period of 2013. The Ireland and Northern Ireland peaks did not occur on the same day, but both occurred during January 2013.

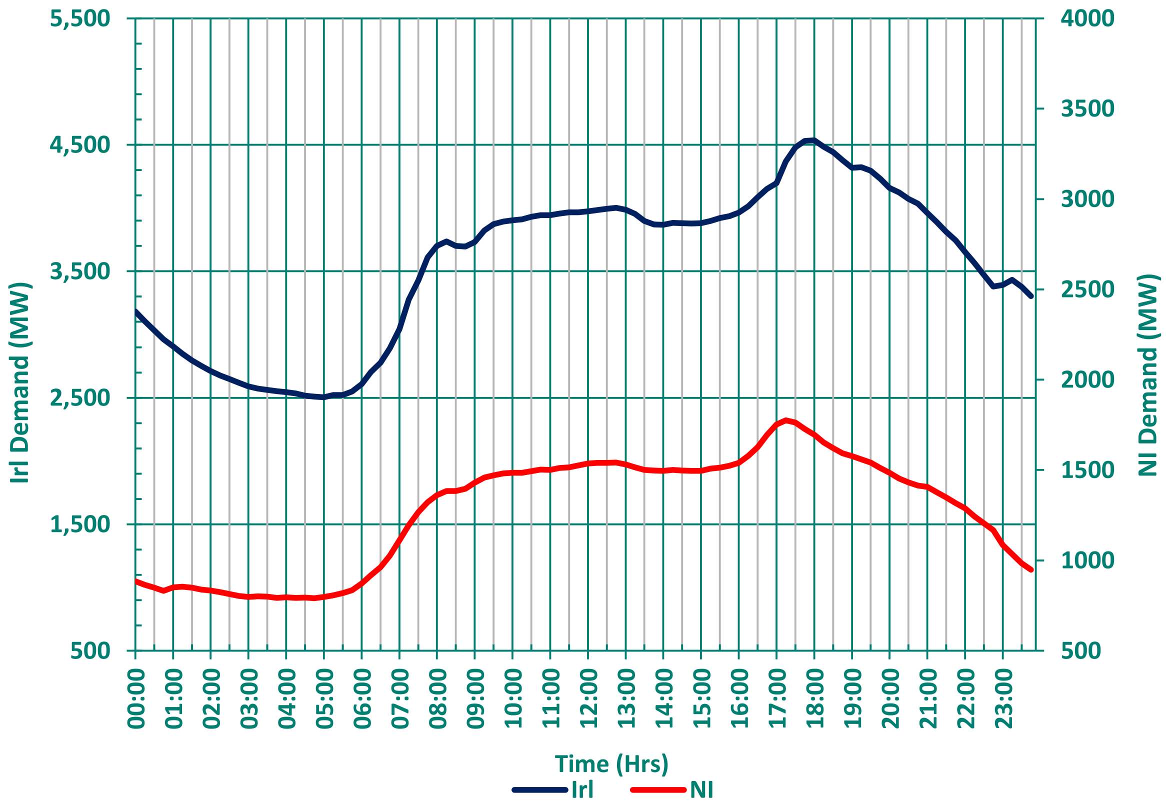


Figure 4-1 Generated Peak Demand Profiles for 2013

All-Island Demand Profiles

Figure 4-2 shows the profiles of the 2013 All-Island winter peak, summer peak and summer valley, along with the percentage demand attributable to each jurisdiction during the peak and valley scenarios.

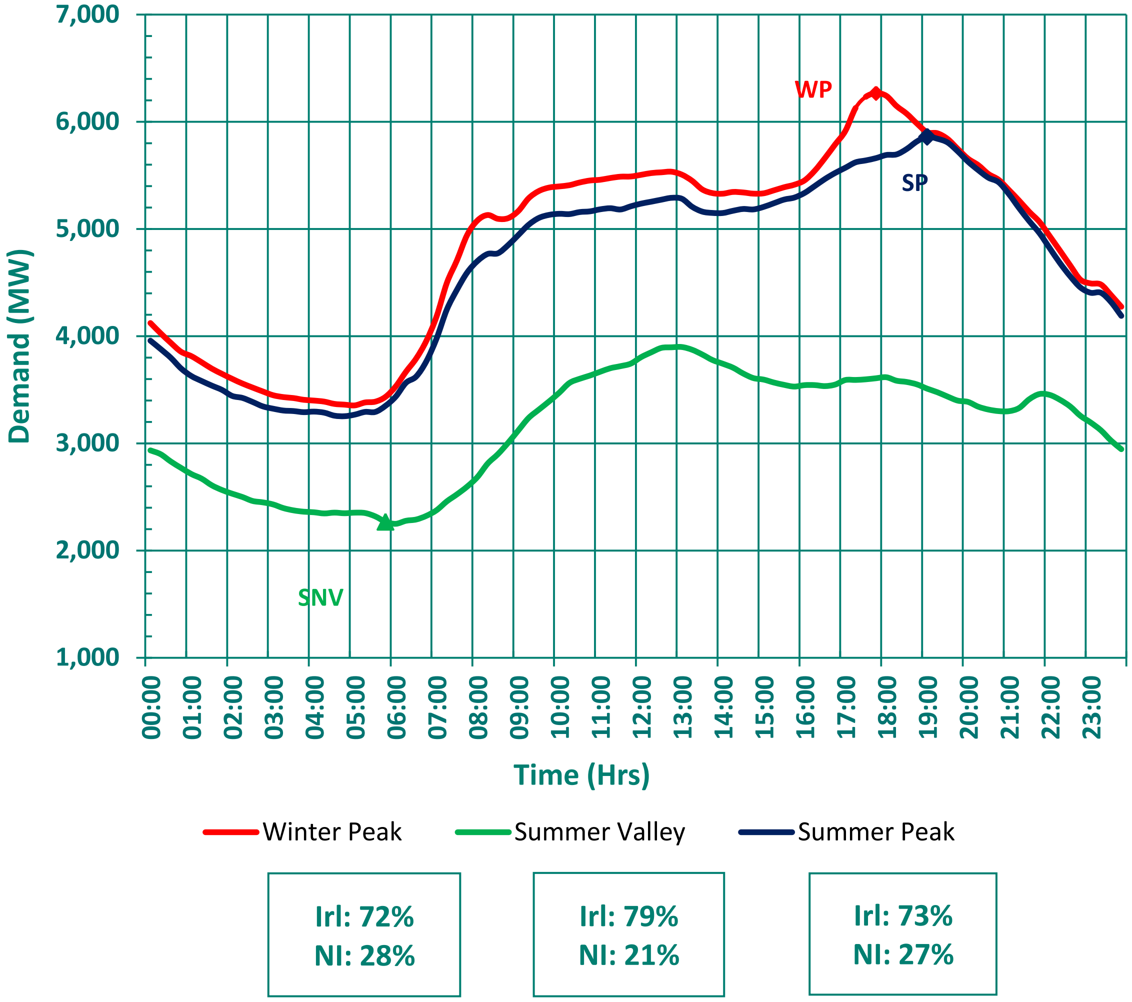


Figure 4-2 All-Island Daily Demand Profiles for Year 2013

All-Island Weekly Demand Peaks

Figure 4-3 shows the profile for the All-Island, Northern Ireland and Ireland weekly peaks across the year for 2013.

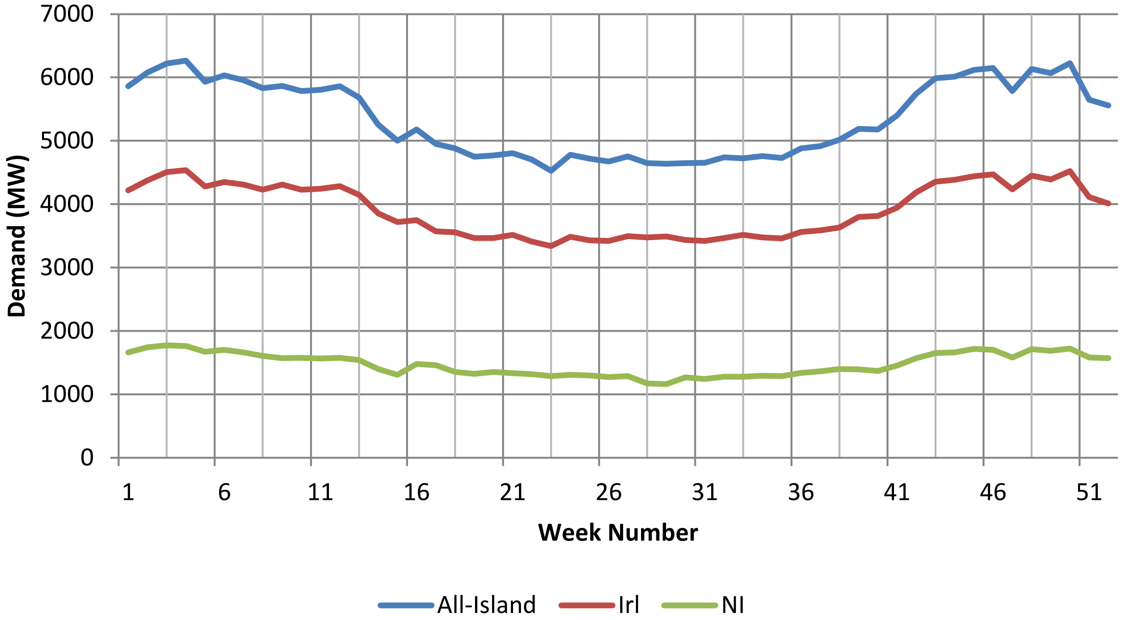


Figure 4-3 Weekly Demand Peak Values for Year 2013

4.3 NORTHERN IRELAND LOAD DURATION CURVE

Figure 4-4 shows the Northern Ireland load duration curve for 2013. The curve shows the percentage of time in the year that a particular demand value was exceeded. For example, demand exceeded 1,000 MW for 54% of the year.

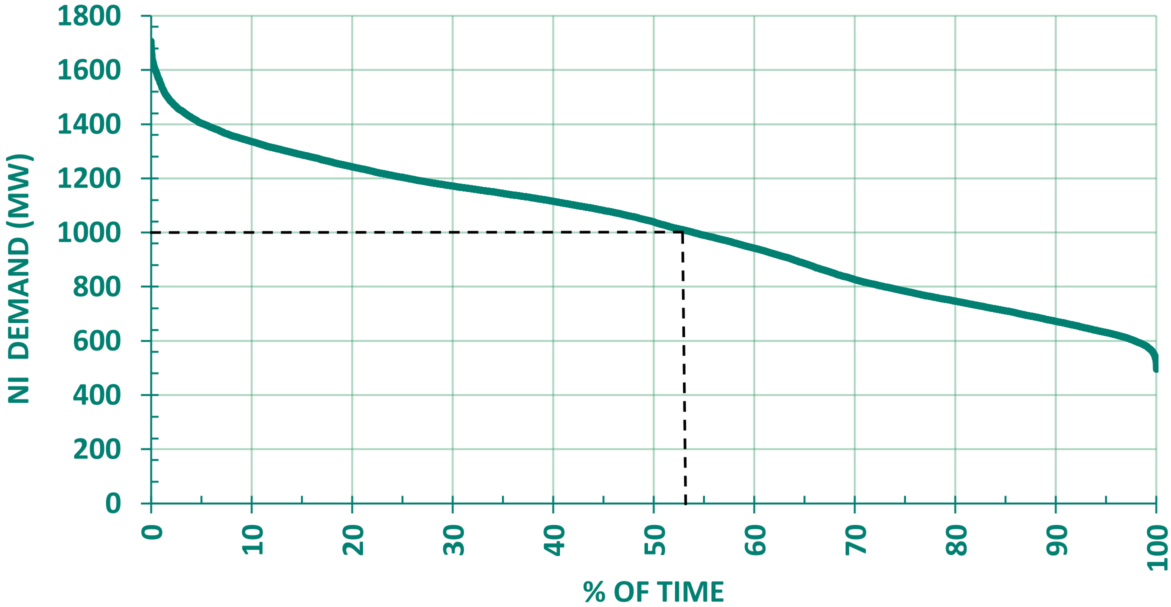


Figure 4-4 Northern Ireland Load Duration Curve 2013

4.4 FORECAST DEMAND AT TRANSMISSION INTERFACE STATIONS

Transmission interface stations are the points of connection between the Transmission System and the distribution system or connecting 110 kV connected customers. These are mostly 110 kV stations. In Dublin city, where the Distribution System Operator (DSO) operates the 110 kV network, the interface is usually at 220 kV stations.

Appendix C lists the forecast demands at each Transmission interface station at winter peak, summer peak and summer valley for all years from 2014 to 2023. 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 trends in consumption in all parts of the country. The allocation of the system demand forecast to each station is pro-rata based on an up-to-date measurement of actual peak demand at each station. Account is taken of planned transfers of demand between stations as agreed with the DSOs. 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 4-1, include Transmission losses whereas the individual station demand forecasts do not. Transmission losses therefore account for the difference between the system-wide demand forecasts and the sum of the forecasts at each interface station 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, but 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 to ensure that the contracted MIC is preserved.

Although demand-side units may reduce some customers' demands over winter peak hours, the normal demand levels are included in the winter peak demand forecasts shown in Table C-1 in Appendix C and are used in the power flow diagrams in Appendix I, as they are more indicative of general power flows.

4.5 NORTHERN IRELAND BULK SUPPLY POINT (BSP) DEMAND

The 110/33 kV BSP demand forecasts are provided by NIE and 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 Generation

5 GENERATION

This chapter gives information about existing generation capacity and future projections for the ten years 2014 to 2023. All generation capacity and dispatch figures in this statement are expressed in exported or net terms i.e. generation unit output less the unit's own auxiliary load.

In Ireland, renewable energy policy is driven by a binding European legal requirement to ensure that 16% of the country's total energy consumption is derived from Renewable Energy Sources (RES) by 2020. In order to achieve this total energy target, the Irish government is aiming for (40%) renewable electricity (12%) renewable heat and (10%) renewable transport. In the electricity sector, it has been estimated that between 3,200 - 3,700 MW of installed wind generation will be required to meet circa 37% of electricity demand in 2020. The remaining 3% is expected to be sourced from hydro generation, bio-energy and renewable CHP.

The Strategic Energy Framework (SEF)[1] 2010 for Northern Ireland states that 40% of electricity consumption in Northern Ireland should come from renewable sources by the year 2020. Currently SONI, along with NIE, EirGrid and ESB, are planning for this 40% target to be met by the year 2020. This 40% government target translates into approximately 1,200 MW of renewable generation capacity in Northern Ireland.

On the 4th of October 2013 (Ireland) and 1st December 2013 (Northern Ireland), the data was frozen in order to permit TYTFS analyses to be carried out. Based on those freeze dates, some 8,731 MW of generation capacity was installed in Ireland and 2,995 MW of generation capacity was installed in Northern Ireland.

5.1 IRELAND

5.1.1 Existing and Planned Transmission-Connected Generation

Of this 8,731 MW of generation capacity, 7,504 MW is connected to the Transmission System and 1,227 MW is connected directly to the Distribution System. Sections 5.1.1 to 5.1.4 detail planned developments with respect to generation in Ireland over the period covered by this TYTFS. The 7,504 MW figure for Transmission System-connected generation capacity does not include the East West Interconnector.

On the 4th October 2013, 31 connection agreements were executed for a total generation capacity of 2,641 MW due to be connected to the Transmission System. These planned generators are listed in Table 5-1 Planned Transmission-Connected Generation as at 4th October 2013 with their expected connection dates as at the time of the data freeze.

[1] http://www.detini.gov.uk/strategic_energy_framework__sef_2010_-3.pdf

Table 5-1 Planned Transmission-Connected Generation as at 4th October 2013

Generator	Description	Expected Connection Date as of 4th October 2013
Athea Wind Farm	51 MW wind farm in Co. Limerick	Oct-13
Great Island CCGT	431 MW CCGT in Co. Wexford	Oct-13
Mountlucas Wind Farm	79.2 MW wind farm in Co. Offaly	Dec-13
Glanlee Wind Farm (Extension)	6 MW wind farm extension in Co. Cork	Dec-13
Kill Hill Wind Farm	62.5 MW wind farm in Co. Tipperary	Mar-14
Athea Wind Farm (Extension)	22 MW wind farm extension in Co. Limerick	Sep-14
Boggeragh (phase 2)	47.7 MW wind farm in Co. Cork	Oct-14
Woodhouse	23.28 wind farm in Co. Tipperary	Oct-14
Clahane Wind Farm	13.8 MW wind farm in Co. Kerry	Nov-14
Killinaparson	55 MW wind farm in Co. Offaly	Jan-15
Caulstown[2]	58 MW OCGT in Co. Meath	Apr-15
Seecon Wind Farm	105 MW wind farm in Co. Galway	Apr-15
Ugool Wind Farm	64 MW wind farm in Co. Galway	Apr-15
Mulreavy Wind Farm	89.85 MW wind farm in Co. Donegal	Jun-15
Cloghboola Wind Farm	46 MW wind farm in Co. Kerry	Sep-15
Sliabh Bawn	58 MW wind farm in Co. Roscommon	Oct-15
Moneypoint Wind Farm	21.9 MW wind farm located at Moneypoint coal-fired power station in Co. Clare	Dec-15
Barnadivane	60 MW wind farm in Co. Cork	Jul-16
Ratrussan Wind Farm (Extension)	22 MW wind farm in Co. Cavan	Oct-16
Cronacarkfree	105 MW wind farm in Co. Donegal	Dec-16
Ralappane CHP[2]	40 MW CHP plant in Co. Kerry	Dec-16
Oweninney (1) Wind Farm	34 MW wind farm in Co. Mayo	Apr-20
Oweninney (2) Wind Farm	48 MW wind farm in Co. Mayo	Apr-20
Oweninney (3) Wind Farm	56 MW wind farm in Co. Mayo	Apr-20
Oweninney (4) Wind Farm	34 MW wind farm in Co. Mayo	Apr-20
Oweninney (5) Wind Farm	198 MW wind farm in Co. Mayo	Apr-20
Ballakelly CCGT	445 MW CCGT in Co. Louth	Dec-22
Cuilleen OCGT	98.4 MW OCGT in Co. West Meath	Dec-22
Knocknagreenan[2]	70 MW pumped storage in Co. Cork	Dec-22
Nore Power	98 MW OCGT in Co. Kilkenny	Dec-22
Suir OCGT	98 MW OCGT in Co. Tipperary	Dec-22

[2] As of the actual publishing date of the All-Island Transmission Forecast Statement 2014 the project is no longer advancing.

5.1.2 Demand Side Units

As at the data freeze date, two Demand Side Units (DSU)[3] have entered the Single Electricity Market with a combined dispatchable capacity of 60 MW.

5.1.3 Planned Retirement/Divestiture of Generation Plant

The divestiture or closure of generation plant could have a significant impact on the ability of the Transmission System to comply with standards. Under the EirGrid Grid Code, a minimum of 24 months' notice is required by the TSO to address the potential implications of any generation closures.

ESB Generation and Wholesale Markets have confirmed that Marina OCGT has a limited number of run hours before the plant needs to be either shut down or upgraded. The exact timing of this is dependent on running regime.

5.1.4 Embedded Generation

On the 4th October 2013, there was approximately 1,227 MW of embedded generation plant i.e. plant connected to the Distribution System or to the system of a directly-connected demand customer. This figure comprises combined heat and power (CHP) schemes, small industrial thermal units and renewable generation from wind, small hydro, land-fill gas (LFG) and biomass sources. Table 5-2 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 5-2 Existing Embedded Generation as at 4th October 2013

	Wind	Small Hydro	Biomass/ LFG	CHP	Peaking	Total
Net Capacity (MW)	978	26	50	59	114	1,227

Embedded generators reduce the demand supplied through Transmission Interface Stations. Forecasts of demand at the relevant Transmission Interface Stations, presented in Table 4-2 of Chapter 4, take account of the contribution of the existing non-wind embedded generators[4]. The *All-Island Generation Capacity Statement 2014-2023 (GCS)* estimated biomass CHP to grow steadily to 150 MW capacity by 2020, while conventional CHP capacity was estimated to not change significantly during the period.

As at 4th October 2013, five generators have executed connection agreements committing to connecting to the Distribution System over the next few years.

[3] As of the publishing date of the All-Island Transmission Forecast Statement 2014 there are now 5 DSU Operators in the Single Electricity Market with 7 DSUs providing circa 160 MW of capacity with another 3 expected to enter the market shortly.

[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 5-3 shows the total amount of conventional generation capacity connected or committed to the Distribution System.

Table 5-3 Connected and Committed Embedded Generation as at 4th October 2013

Station	Description	Connection Date
Tawnaghmore	2*52 MW Distillate Peaker generators in Co. Mayo	Aug-08
Drybridge	17 MW Waste to Energy generator in Co. Meath	Feb-11
Blake	5 MW LFG generator in Co. Kildare	Oct-13
Navan	13 MW Biogas generator in Co. Meath	Aug-14
Tawnaghmore	49 MW Biomass generator in Co. Mayo	Jun-15
Ringsend	72 MW Waste to Energy generator in Co. Dublin	Aug-15
Derryiron	14.49 MW Biomass generator in Co. Offaly	Dec-15
Bellacorick	10 MW Wave Energy generator in Co. Mayo	Dec-22

5.1.5 Wind Generation

Over the past two decades wind power generation in Ireland has increased from 6 MW (one wind farm) to 1,772 MW (161 wind farms) at the beginning of October 2013. The information presented in Figure 5-1 is a combination of connected and contracted wind generation figures as presented in Tables D-1, D-2, D-5 and D-6 in Appendix D. Energisation dates for contracted wind generation contained within Tables D-1 and D-2 are based on the best information available at the time of the data freeze (4th October 2013). Wind generators which did not have an estimated energisation date at the time of the data freeze have been included in Tables D-5 and D-6. Projects listed in Tables D-5 and D-6 have been assigned an energisation date based on information obtained after the data freeze date and have been included to illustrate the expected growth of wind energy in Ireland over the forthcoming ten year period.

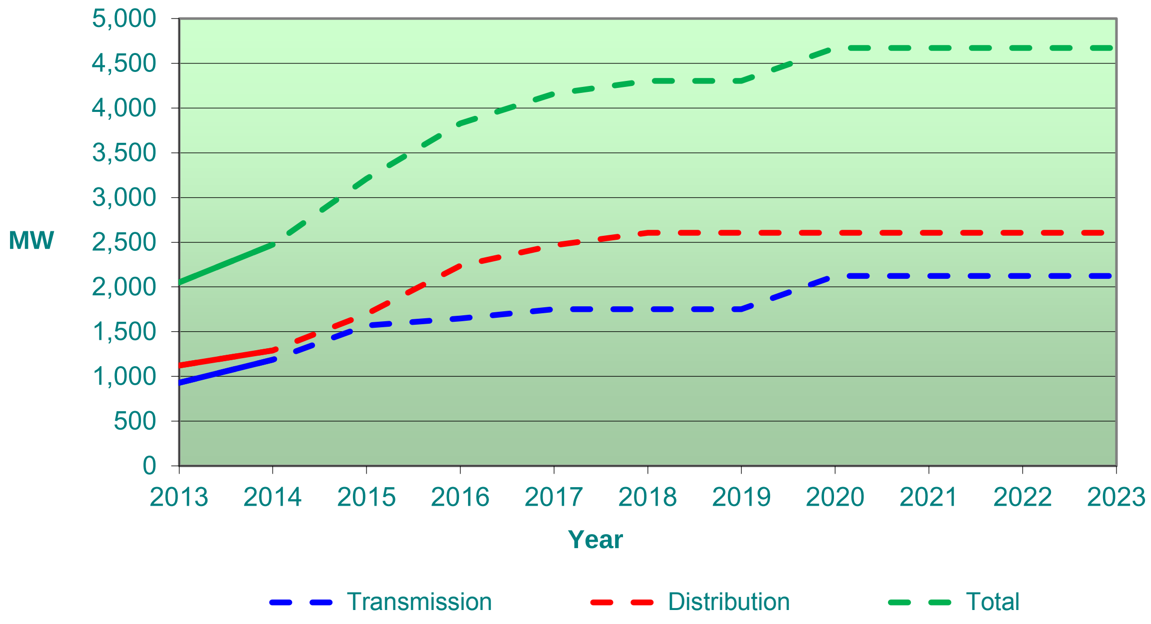


Figure 5-1 Expected Growth in Wind Capacity, 2013 to 2023

As at 4th October 2013, 172 wind farms totalling 3,581 MW have signed connection offers and are committed to connecting to the Transmission or Distribution Systems over the next few years. Table 5-4 shows the total amount of existing and committed wind generation capacity expected to be connected at the end of each year from the existing situation at the end of 2013 to 2023. The individual wind farm details are included in Tables D-1, D-2, D-5 and D-6 of Appendix D.

Table 5-4 Existing and Committed Wind Capacity Totals, MW

Connection	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Transmission	930	1,186	1,568	1,648	1,753	1,753	1,753	2,123	2,123	2,123	2,123
Distribution	1,122	1,289	1,696	2,237	2,464	2,605	2,605	2,605	2,605	2,605	2,605
Total	**2,053**	**2,475**	**3,208**	**3,830**	**4,162**	**4,302**	**4,302**	**4,673**	**4,673**	**4,673**	**4,673**

As at 4th October 2013, there are a total of 366 applications totalling 23,149 MW in the applications queue, including 15 (3,076MW) non-Group Processing Approach applications to the TSO and DSO.

In the period up to the 4th October 2013 data freeze date, three Gate 3 applicants had connected, a further one hundred and twenty-three Gate 3 applicants were contracted to connect, with a further nineteen applicants having live Gate 3 offers and ten offers having lapsed. The number of offers associated with each grouping as well as the MWs associated with these offers and the separation between TSO and DSO are shown in Figure 5-2.

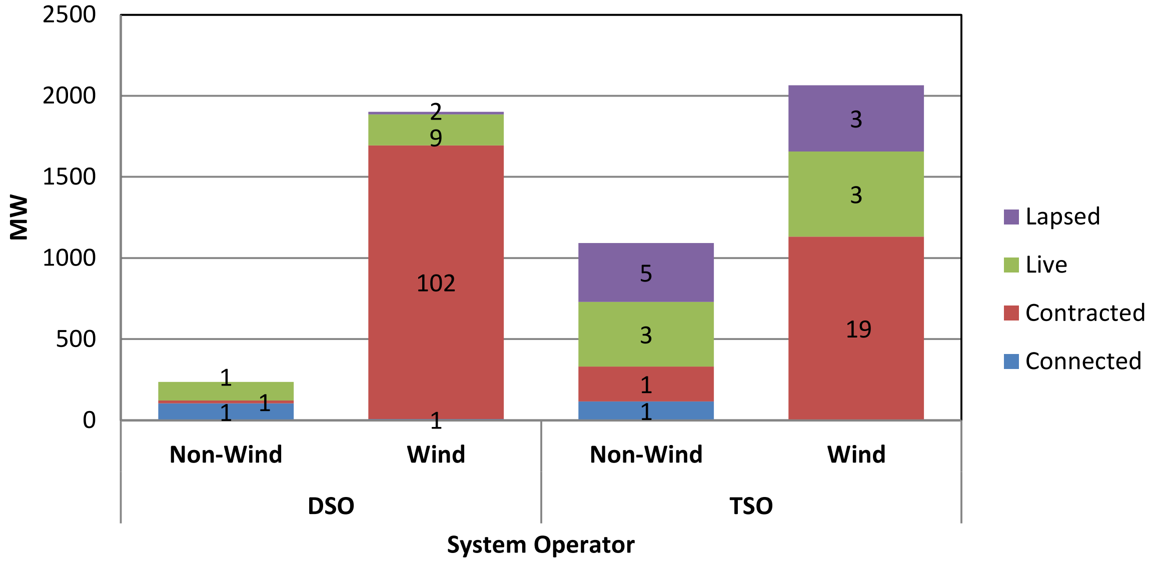


Figure 5-2 Gate 3 Offer Status

5.1.6 Offshore Generation

In February 2014, the Irish Government published an Offshore Renewable Energy Development Plan (OREDP)[5], with the aim of implementing 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 and;

Third, that offshore renewable energy development does not adversely impact our rich marine environment and its 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 progression of the US/Ireland Memorandum of Understanding (MoU) on Ocean Energy.

The Department of Communications, Energy and Natural Resources (DCENR) is leading the implementation of OREDP and has developed a robust governance structure to deliver on the aims of the Plan. EirGrid are sitting on the Steering Group and are on a number of Working Groups of the OREDP.

[5] http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/OREDP.htm

5.2 NORTHERN IRELAND

Of the 2,995 MW of generation capacity connected in Northern Ireland as at December 2013, 2,365 MW of generation capacity is connected to the Northern Ireland Transmission System and 630 MW is connected to the Northern Ireland Distribution System.

The 2,365 MW of transmission connected generation capacity does not take into account the Moyle Interconnector capacity, and is made up of Slieve Kirk wind farm power station (WFPS) with a capacity of 73.6 MW and 2,291 MW of conventional generation capacity.

5.2.1 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)
- Independent Market Participants (Non-Contracted Plant)

Table D-9 provides a complete 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 577 MW[6], 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 (UREGNI) 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)

UREGNI 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), which was introduced in June 2003. As at December 2013 there is 1,714 MW of IMP capacity in Northern Ireland.

[6] As of the actual publishing date of the All-Island Transmission Forecast Statement 2014, UREGNI has issued a decision not to cancel the two GUA's; http://www.uregni.gov.uk/uploads/publications/2014-10-10_GUA_Decision_Paper.pdf

5.2.2 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, SONI understood that Ballylumford Gas/HFO ST4, ST5 and ST6 were to be decommissioned by 2016 and assessments in this statement are based on that assumption[7].

The generation output of Kilroot ST1 and ST2 is anticipated to be restricted due to the Industrial Emissions Directive (IED)[8]. This includes limited emissions each year from 2016-2020, followed by severely restricted running hours from 2021-2022. This applies whether the units are run on either Oil (combined capacity of 476 MW) or Coal (combined capacity of 348 MW).

5.2.3 Embedded Generation

Existing Embedded Generation

Table 5-5 shows a breakdown of the existing Northern Ireland Embedded Generation. There is a 74 MW Aggregated Generating Unit (AGU) operated by iPower in the SEM. The AGU is made up of diesel generator sets located around Northern Ireland.

Contour Global currently operate 9 MWs of fully dispatchable gas generation in Northern Ireland (CHP), these units currently participate in the Single Electricity Market. There is 11 MW of CHP plant connected to the Northern Ireland Distribution System; this 11 MW is expected to rise to 12 MW by 2023.

There is currently 4 MW of small-scale hydro generation installed on the waterways of Northern Ireland. This is a mature technology however due to the lack of suitable new locations; the small-scale hydro capacity is not expected to increase in the foreseeable future.

In Northern Ireland there is currently 13 MW of landfill gas generation; it is assumed that by 2023 biogas generation capacity will increase to 27 MW.

[7] AES and SONI have now concluded a separate Local Reserve for 250 MW. This will see Ballylumford ST4 and ST5 remaining connected (at reduced capacity), while Ballylumford ST6 will be de-commissioned.

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

Table 5-5 Northern Ireland Embedded Generation

Generation	Net Capacity
Large Scale Wind	481
Small Scale Wind	22
Small Scale Biogas	7
Small Scale Biomass	5
Small Scale Solar	2
Small Scale Hydro	4
Biofuels	1
Landfill Gas	13
CHP	20
AGU	74
Tidal/Wave	1
Total	630

A number of customers have been reducing energy consumption at times of peak demand 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

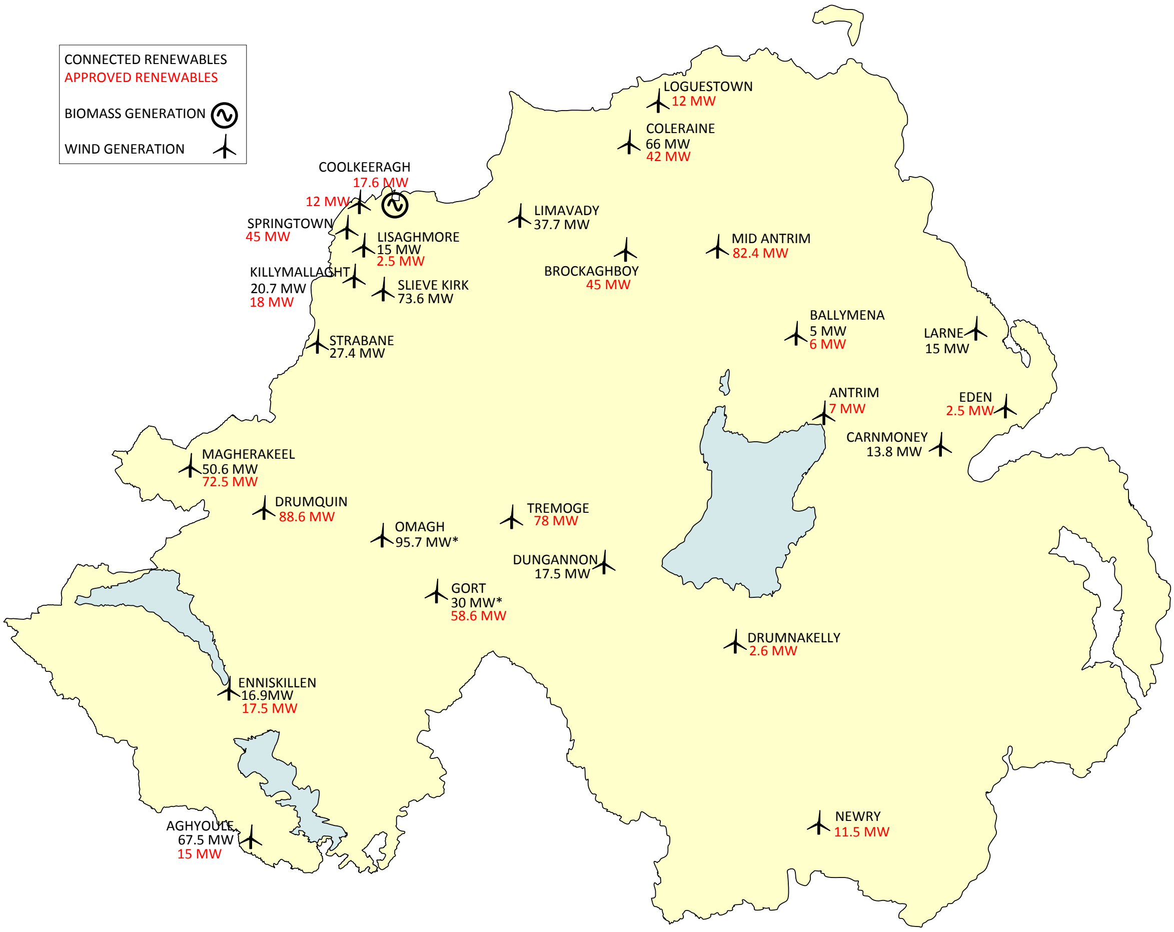
Based on winter 2012/13, generation of this type is estimated to total 31 MW. This total figure is not anticipated to deviate from 31 MW in the foreseeable future.

5.2.4 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 5-3. The map indicates the various 110/33 kV Bulk Supply Points (BSPs) and WFPS clusters substations which renewable generation is connected to or is assumed to connect to.

NIE/SONI are planning to develop WFPS clusters which consist of a 110/33 kV substation in the vicinity of a number of WFPS locations. These WFPSs would connect into the cluster at the 33 kV level. One such WFPS cluster substation already exists in NI at Magherakeel.



*Slieve Divena 1 transferring from Omagh in 2017

Figure 5-3 Existing and Committed Northern Ireland Renewable Generation

Unapproved Renewable Generation

A number of renewable generation projects are assumed to be commissioned in Northern Ireland over the ten years modelled in the TYTFS study files. These assumptions have been derived from a number of sources, including 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], all produced by the Department of Enterprise, Trade and Investment (DETI). Renewable generation that has been included in the TYTFS study files are detailed in Table 5-6.

[9] http://www.detini.gov.uk/strategic_energy_framework__sef_2010_.pdf

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

[11] http://www.onshorerenewablesni.co.uk/

Table 5-6 Capacity and Location of Renewable Generation by Year End

Transmission Node	Northern Ireland Renewable Capacity (MW)									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Aghyoule	67.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
Antrim	-	4.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Ballymena (Rural)	5	11	11	11	11	11	11	11	11	11
Belfast North Main	-	-	15	15	15	15	15	15	15	15
Brockaghboy	-	-	-	-	-	45	45	45	45	45
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	17.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6
Drumnakelly	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Drumquin	-	-	-	-	88.6	88.6	88.6	88.6	88.6	88.6
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	19.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Gort	-	-	-	88.6	88.6	88.6	88.6	88.6	88.6	88.6
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
Magherakeel	70.6	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1
Mid Antrim	-	-	54.8	54.8	54.8	82.4	82.4	82.4	82.4	82.4
Newry	-	-	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Off-Shore Wind	-	-	-	-	-	-	324	324	324	324
Omagh	125.7	125.7	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
Slieve Kirk	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
Springtown	-	-	-	45	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	-	-	-	-	-	-	200	200	200	200
Tremoge	-	-	78	78	78	78	78	78	78	78
Totals	642.1	765.5	938.8	1042.4	1131	1203.6	1727.6	1727.6	1727.6	1727.6

Figure 5-4 uses information from the list of renewable generation applications in the planning service to demonstrate where renewable generation may be located in 2020.

It is clear from Figure 5-4 that the majority of the renewable connections are in the Northern and Western regions of the province. This coincides with some of the weakest areas of the existing 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)[12] has investigated the optimum reinforcement of the electricity Transmission Grid in the north and the north west of the island 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 3.

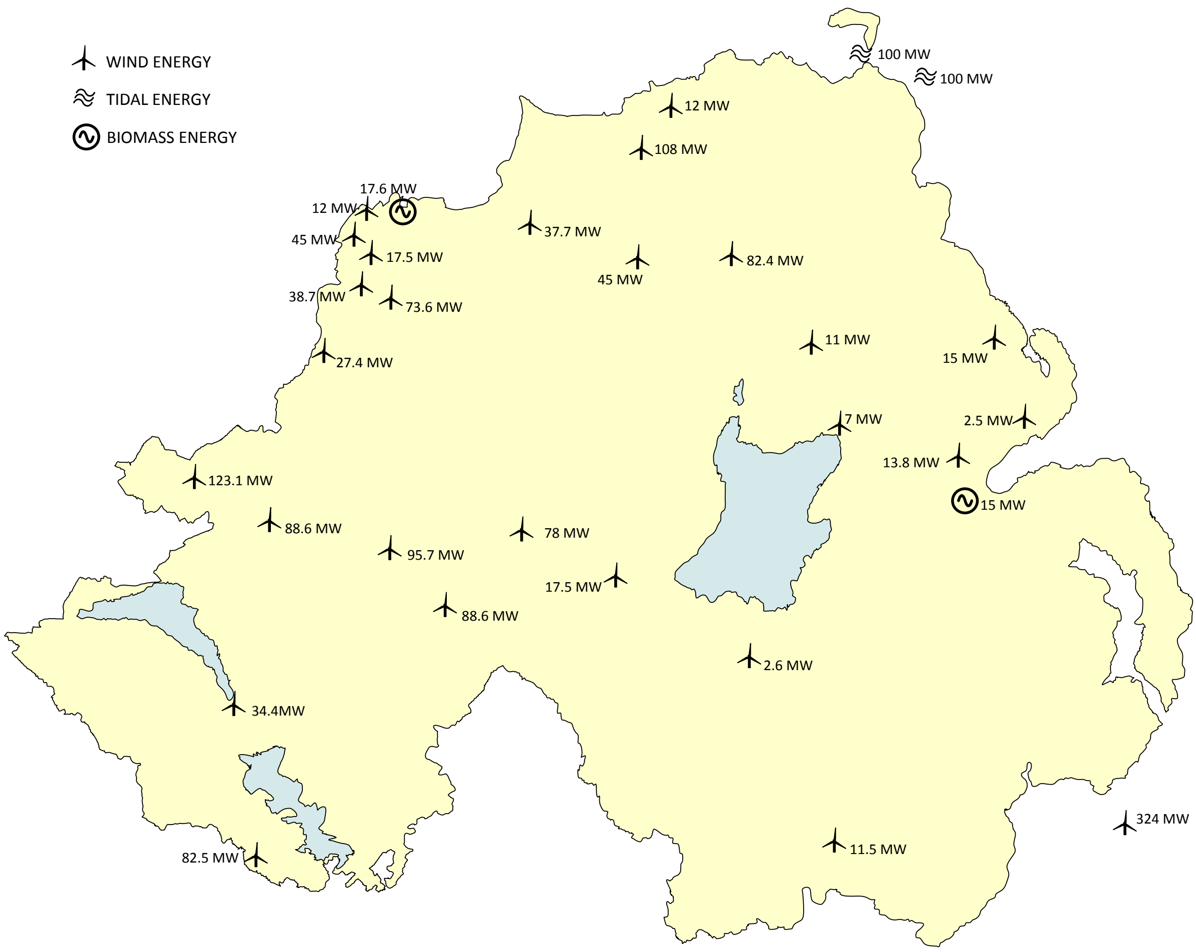


Figure 5-4 Northern Ireland Renewable Generation in 2020

[12] www.ridp2020.com

Offshore Renewable Generation

On the 11th October 2012 the Crown Estates[13] announced the award of development rights for a 600 MW off-shore wind farm off the coast of County Down in Northern Ireland waters[14]. The development rights were also announced for two 100 MW tidal developments along the North coast. SONI is in contact with these developers 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 (1st December 2013).

Compressed Air Energy Storage

As of the 1st December 2013 freeze date, it is anticipated that a Compressed Air Energy Storage (CAES) scheme will be operating at Larne Lough by the end of 2018[15]. This scheme can operate in storage mode or generation mode. In storage mode, air is compressed and stored in underground caverns. This has a result of adding demand - it is anticipated the scheme will require a demand of circa 210 MW, connected in to Ballylumford 275 kV substation. It is anticipated that the CAES unit will compress and store air when energy prices are low and there is an excess of electricity on the grid (typically during the night). When energy prices are higher (typically during peak hours) it is anticipated that the CAES unit will then operate in generation mode. The generation output of the CAES unit is circa 268 MW. Table 5-7 displays both the minimum and maximum generation/storage of the CAES units.

Table 5-7 Minimum and Maximum Generation/Storage of CASE Units

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

5.2.5 Northern Ireland Generation Mix

The chart in Figure 5-5 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 2014-2023.

Figure 5-5 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

[13] www.thecrownestate.co.uk

[14] As of the actual publishing date of the All-Island Transmission Forecast Statement 2014, the developer has informed SONI of their intention not to advance the off-shore wind farm project.

[15] In October 2014 the CAES scheme developer signed a connection agreement with SONI.

requirements and actual HVDC interconnector flows are not taken into account. The chart also shows the large increase in wind generation expected over the next ten years.

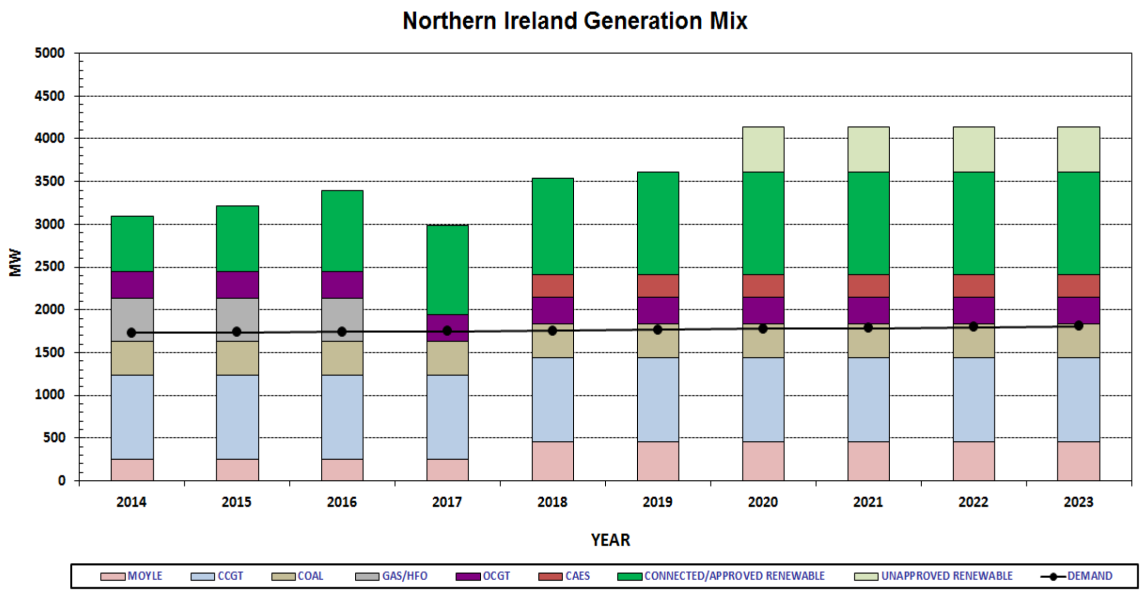


Figure 5-5 Northern Ireland Generation Mix

6 Transmission System Performance

6 TRANSMISSION SYSTEM PERFORMANCE

This chapter describes the future performance of the Transmission System in terms of forecast power flows, compliance with planning standards and short circuit current levels.

The analysis of the short circuit current levels in this TYTFS is based on updated data and includes any changes to the existing and planned Transmission System, demand projections and generation connections. This analysis is based on a data freeze date of October and December 2013 for Ireland and Northern Ireland respectively.

6.1 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 (i.e. dispatches) that can meet the Transmission System demand requirements at any given time and many possible demand scenarios. One of the main factors causing changes to the power flows on the network is the increasing levels of renewable generation connecting to the Transmission and Distribution Systems in Ireland and Northern Ireland. This increased penetration is detailed in Tables D-2 and D-3 in Appendix D.

In examining Transmission System performance and Transmission System capability for new generation and demand, a range of economic generation dispatches are considered. As stated in Section 2.1.3 in Chapter 2, dispatches were prepared on an all-island basis, with power flows across the existing 275 kV and planned 400 kV cross-border circuits permitted within network transfer limits. Dispatches considered included imports and exports of power across the existing Moyle and East-West interconnectors.

Transmission System power flows are represented on the schematic diagrams found in Appendix I. The power flow diagrams display the flow of real and reactive power around the All-Island Transmission System under normal conditions.

It can be seen from Appendix I that as the levels of renewable generation increase over the ten year period; power flows on the circuits from the North West of Northern Ireland to larger load centres in the East of Northern Ireland are also increased. These increased power flows are most pronounced at times of minimum demand and high renewable generation output.

Another effect of increased renewable generation levels is the amount of reactive support required on the Northern Ireland Transmission System to keep voltages within standards. In the 2014 winter case, 222 Mvars of reactive support was in service in Northern Ireland, this figure increases to 462 Mvars in the winter 2023 case. This reactive support is in addition to the reactive power supplied by Northern Ireland conventional generation.

6.2 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

EirGrid issues its Transmission Development Plan (TDP) annually (available here). The plan indicates the areas of the Transmission System likely to be outside thermal, i.e. circuit loading, and voltage standards over the period of the plan, based on the assumed Transmission System reinforcements, demand and generation scenarios.

EirGrid has plans in place to address many of these problems and is actively considering options for addressing other future Transmission System problems. The TDP details the Transmission System development projects that have received capital approval, in addition to a discussion of further Transmission System developments that may arise in the period of the plan.

The circa 5,500 MW of generation that received offers in Gate 3, may significantly impact on the Transmission System performance, potentially putting some areas, in addition to those identified in the TDP, outside 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

This TYTFS is based on project specific information provided by NIE as part of the investment planning process. The planned projects are new capital works and asset replacement works which may have capital approval or be unapproved. Details of these projects can be found in Chapter 3; they cover the ten year period of this TYTFS. Capital projects are mainly driven by increases in the Northern Ireland demand and renewable penetration levels.

The adequacy of the Transmission System including planned projects is determined by comparing the performance of the Transmission System to Transmission and Distribution Security and Planning Standards; these standards define the thermal limits and voltage stability under certain contingencies. The results of this comparison are presented as part of the Generator Opportunity Analysis in Chapter 8.

6.3 SHORT CIRCUIT CURRENT LEVELS[1]

All Transmission System equipment must be capable of carrying very high currents that may occur in the event of a fault. In particular, circuit breakers must be capable of closing onto faults and opening to isolate a fault, thereby minimising risk to personnel, preventing damage to transmission equipment, and maintaining system stability, security and quality of supply.

The short circuit current level is a factor to be considered as the Transmission System is developed and in the connection of new generation or demand. The EirGrid Grid Code requires that users connecting to the Transmission System design their plant and apparatus including the design of equipment at lower voltage levels, to withstand the short circuit current levels, set out in Table 6-1, at the transmission connection point.

New users connecting to the Northern Ireland Transmission System are recommended to, as a minimum, design their plant and apparatus to withstand the short circuit current levels set out in Table 6-1, however the design of a user's plant is 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. Where the forecast short circuit current levels would exceed the rating of a circuit breaker or other equipment, it would be necessary to replace the equipment with higher rated plant or implement other risk mitigation measures to reduce the short circuit current levels.

Table 6-1 Standard Equipment Rating and Maximum Design Short Circuit Currents

Voltage Level	Standard Equipment Short Circuit Rating		
	Ireland		Northern Ireland
400 kV	50 kA		50 kA
275 kV	n/a		40 kA
220 kV	40 kA		n/a
110 kV	Countrywide	25 kA[2]	40 kA
	Designated sites	31.5 kA	

Short circuit current levels were calculated for all Transmission System nodes in accordance with engineering recommendation G74; which is based on international standards. The analysis was carried out for single-phase and three-phase faults for winter peak and summer valley, for the years 2014, 2017 and 2020. A description of the calculation methods used and the results are given in Appendix E, as well as an explanation of the terms used.

[1] 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.

[2] New equipment installed at 110 kV level must have a short circuit rating of 31.5 kA.

Winter peak analysis was carried out to represent the most onerous system conditions with maximum short circuit currents on the Transmission System. Conversely, analysis of summer valley was carried out as the results should indicate the minimum short circuit currents based on intact network conditions. In reality the minimum short circuit current at each bus could be lower depending on the 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 EirGrid or SONI directly.

The economic generation dispatches for the winter peak and summer valley studies are presented in Appendix D. For the calculations of short circuit current levels at winter peak, generators that are not dispatched are switched on in the study and dispatched at 0 MW. This measure ensures a high infeed to faults from all generator sources in the studies, ensuring that the most onerous, but credible, conditions are considered for the calculation of short circuit current levels at each bus. For the calculations of short circuit current levels at summer valleys, 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) and that all circuits connected to a bus contribute to the fault. These results correspond to total busbar short circuit current level. The short circuit current that could flow through each individual circuit breaker may be less than the total busbar short circuit current depending 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 listed at each voltage level in Table 6-1 In planning the system a 10% margin is applied, so that 220 kV short circuit currents, for example, will be kept below 36 kA.

It should be noted that while most 110kV stations are designated as 25 kA, the EirGrid Grid Code stipulates that certain 110kV stations may be designated as 31.5 kA. This may happen either for a new station (31.5 kA from the start) or when an existing 25 kA station is changed to 31.5 kA. When a station changes from 25 kA to 31.5 kA, then the equipment at these stations including equipment at lower voltages may need to be modified or replaced in order to comply with this design rating. The stations currently designated with a 31.5 kA 110 kV 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.

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 listed in the tables in Appendix E. 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 assess the rating of equipment that closed onto the Transmission System; IB and asymB assess the capability of the equipment to open and break short circuit current.

6.3.1 Short Circuit Current Results

The results indicate a number of Northern Ireland transmission nodes would experience short circuit current levels in excess of 90% of their current rated capability; if these issues were not managed by SONI.

In Ireland short circuit currents are relatively low, except at a number of stations in Dublin and Cork where short circuit current levels are above 80% of the standard ratings. Short circuit current levels are also high at Louth, where the 275 kV double circuit tie line between the Transmission Systems is located.

The TSOs will continue to monitor short circuit current levels at all stations to ensure that they remain within safety standards. Figure 6-1 indicates the locations where short circuit current levels are high, in 2020. Figure 6-1 presents the short circuit current level results for the winter peak 2020 case as a percentage of standard equipment rating for the Transmission System of Ireland and the actual equipment rating for the Northern Ireland Transmission System. Three percentage ranges are represented by different colours as indicated. The yellow dots represent substations where short circuit currents may be between 80% and 90% of the ratings. The orange dots represent substations where short circuit currents may exceed 90% of the ratings and the red dots are for substations where the rating has been exceeded.

The analysis this year also shows that the Ballylumford, Castlereagh, Coolkeeragh and Kells nodes have all been found to experience short circuit current levels that exceed 100% of their current rated capability. Table 6-2 provides a list of transmission nodes where the short circuit current level is approaching or would exceed the rating for the years 2014, 2017 and 2020. Where plans are in place to uprate equipment or mitigate the risk these are discussed below, 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.

Table 6-2: Nodes Approaching or Exceeding Rating

% Rating	2014	2017	2020
>100%	BPS 110 kV	BPS 110 kV	BPS 110 kV
	CDU 110 kV	CAS 110 kV	CPS 110 kV
	KRA 110 kV[3]	CDU 110 kV	CAS 110 kV
	CAS 110kV		KEL 110 kV
			CDU 110 kV
			KRA 110kV
>90%	BPS 275 kV	CPS 110 kV	BPS 275 kV
	CPS 110 kV	HAN 110 kV	BVG 110 kV
	DUN 110 kV	KNO 110 kV	HAN 110 kV
	HAN 110 kV	KEL 110 kV	KNO 110 kV
	KEL 110 kV	COL[4] (I) 110 kV	TAN 110 kV
	KNO 110 kV	KBY 110 kV	BVG 110 kV
	TAN 110 kV	MR 110 kV	KBY 110 kV
	KBY 110 kV[4]	TBG 110 kV	MR 110 kV
	MR 110 kV[4]	KRA 110 kV	TBG 110 kV
	TBG 110 kV[4]		

Stations where the rating has been exceeded

Ballylumford 110 kV

The short circuit current levels at the Ballylumford 110 kV node for both three-phase and single-phase faults exceed the substation ratings. This occurs under maximum generation conditions when both of the 275/110 kV interbus transformers (IBTXs) are in service. The substation is programmed to be replaced with a substation incorporating a new 110 kV GIS switchboard, with work planned to be completed by 2018. In the interim, SONI manages this risk by operating with one IBTX out of service, which reduces the short circuit current level below the equipment rating. With the expected decommissioning of ST4, ST5 and ST6[5]

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

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

[5] AES and SONI have now concluded a separate Local Reserve contract for 250 MW. This will see ST4 and ST5 remaining connected (at reduced capacity) for at least another five years and ST6 decommissioned.

level below the equipment rating. With the expected decommissioning of ST4, ST5 and ST6[5] at Ballylumford after 2015 there is an overall reduction in the short circuit current level at Ballylumford, however the substation ratings are still exceeded in all years of study.

Castlereagh 110 kV

The rating of Castlereagh 110 kV substation is limited by the disconnectors which have a certified rating of 26.2 kA. With all available generation in service, the single phase short circuit current level exceeds the rating of the substation equipment.

The Castlereagh short circuit current level results are based on the assumption that only three out of the four IBTXs will be in service at any point in time. The fourth IBTX at Castlereagh is scheduled to be commissioned in 2017; its primary purpose is to facilitate outages on the other transformers.

Coolkeeragh 110 kV

Single-phase short circuit current levels at Coolkeeragh 110 kV substation have been found to 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 110 kV

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

Corduff 110 kV

Short circuit current levels at Corduff 110 kV station exceed 100% of the standard equipment rating for 110 kV equipment, 25 kA, as per the EirGrid Grid Code. Corduff 110 kV station is a designated station. A designated station, as per the EirGrid Grid Code, is a station with 110 kV equipment designed to 31.5 kA. Therefore, in actuality there is not an issue at Corduff 110 kV station, as the equipment is rated to 31.5 kA.

Summer Minimum Results

As expected the 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 3.15 kA. Below this short circuit current level the HVDC interconnector fails to commutate. However, as shown in appendix E, this is not an issue over the period covered by this TYTFS.

[5] AES and SONI have now concluded a separate Local Reserve contract for 250 MW. This will see ST4 and ST5 remaining connected (at reduced capacity) for at least another five years and ST6 decommissioned.

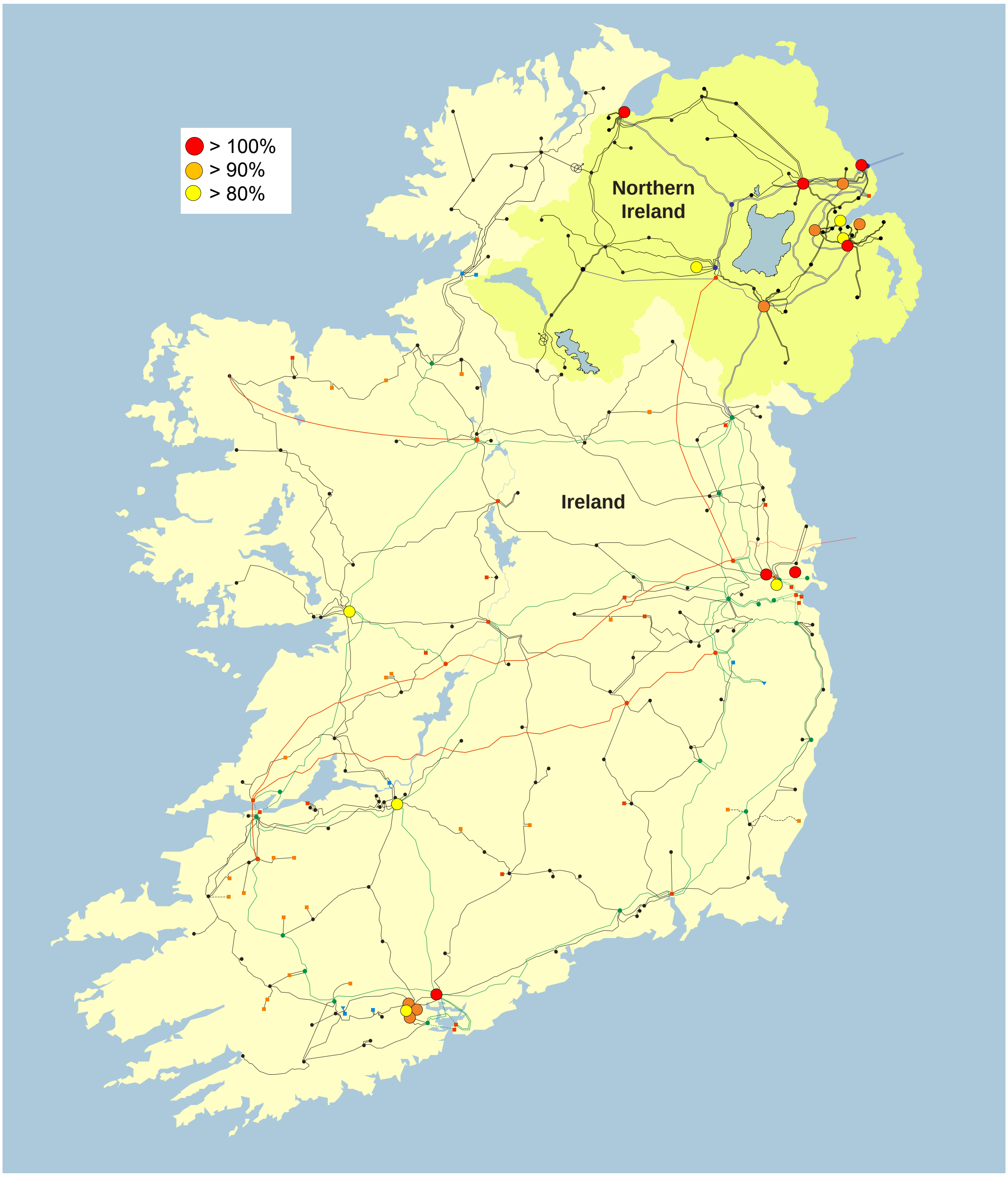


Figure 6-1 Short Circuit Current Levels for Winter Peak 2020

7 Overview of Transmission System Capability Analyses

7 OVERVIEW OF TRANSMISSION SYSTEM CAPABILITY ANALYSES

This chapter describes the analyses carried out to determine the capability of the Transmission System to accommodate additional demand and generation 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 in Chapter 8 and Chapter 9.

7.1 GENERATION OPPORTUNITY ANALYSIS IN IRELAND

This section describes the analyses carried out to determine the capability of the Transmission System of Ireland to accommodate additional generation at various parts of the Transmission System. The results of the analysis, together with information in other chapters, act as a guide to provide the basis for the statements of opportunity in Chapter 8.

The analysis was carried out in two specific workstreams:

- Highlighting the relationship between Transmission System reinforcements and the creation of firm access.
- Calculating possible opportunities for generation beyond that which is currently connected, contracted or in receipt of a connection offer.

7.1.1 System Reinforcements and Firm Access

As the GRID25 programme of Transmission System reinforcements is constructed, firm access is provided for generators. Specific projects within GRID25 are termed Associated Transmission Reinforcements (ATRs) when these are specifically associated with granting firm access to generators. The capacity created by GRID25 will facilitate the generation in the Gate process, although currently not all this generation is contracted, and this is evident in graphical and tabular form in Chapters 5 and 8

7.1.2 Calculating Possible Opportunities

This section deals with the analysis of the Transmission System's capability to accommodate power flows from new wind generators. The method of analysis used is the same as the methodology utilised for the 2012 re-calculation of FAQs for Gate 1, 2 and 3 Wind Generators. The results of the analysis, presented in Chapter 8, outlines the opportunity for further generation activity, over and above that which is currently connected, contracted or in receipt of a connection offer.

The addition of Transmission System infrastructure generally provides a step increase in Transmission System capacity (as illustrated in Figure 7-1) and hence opportunities for additional wind generation, beyond that connected, contracted or in receipt of a connection offer, may be created under GRID25. The method of analysis used assesses the opportunity for additional wind generation in a specific area, in the year subsequent to the year in which the final Gate 3 wind applicant in that area receives scheduled firm access. Studies were carried out for the summer and winter periods of that year, using information describing the existing and planned Transmission System as per the 2012 FAQ analysis[1]. The locations analysed were chosen to allow a good representation of the potential opportunities across the various group processing areas.

It should be noted that the results of these studies were dependent on the assumptions made about generation[2] and demand, and on the completion dates of Transmission System development projects. Factors that may influence the results are discussed in Section 7.2.4.

7.1.3 Methodology for Wind Generation Opportunity Analysis

An AC load flow numerical linear technique was used to screen for critical contingencies and thermal overloads or voltage limitations. A linear algorithm is a simple yet robust method where the solution is determined using a step approach.

The dispatch scenarios used were designed to create credible power flows along identified Transmission network corridors. They were designed so that the main Transmission corridors out of a group processing area were tested by generally increasing particular generation in particular group processing areas (the set-point areas) and reducing generation in others (the back-off areas) to create the initial power transfer.

To calculate the opportunity, generation at +/- 0.95 power factor (controlling voltage at the connecting bus) was added at the chosen test node[3] in increasing amounts. This was balanced by a reduction in generation output from generators in the group processing areas at the receiving end of the test corridor (the back-off areas). The limit for increased transfers from the test node was established by checking the intact system and single contingency (N-1) performance of the Transmission System against thermal and then voltage standards. The process was repeated for each of the Transmission corridors out of the group processing area of the test node, with the result presented in section 8.1.3 being the lowest amount that could be accommodated following each of the tests.

7.2 DEMAND OPPORTUNITY ANALYSIS IN IRELAND

This section describes the analysis carried out to determine the capability of the Transmission System of Ireland to accommodate additional demand at various parts of the Transmission System. The results of this analysis, together with information in other chapters, provide the basis for the statements of opportunity in Chapter 9.

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[1] Transmission network reinforcements assumed study dates as per the 2012 FAQ analysis and can be found on the EirGrid website.

[2] All wind generation was dispatched at 100% in study cases as per the 2012 FAQ analysis.

[3] Test nodes are identified in Table 8-1 in chapter 8.

The analysis was carried out for three specific years:

2014: This is the first year of the period of the TYTFS. The information provided for 2014 gives developers a useful indication as to the opportunities that exist in the short-term.

2017: This year represents a more realistic beginning of the period of interest for developers at a pre-feasibility stage wishing to connect to the Transmission System because of typical lead-times for construction of demand plant.

2020: This year gives developers a useful indication as to the opportunities that exist in the longer-term.

Studies were carried out for the summer and following winter of each year using information describing the existing and planned Transmission System, as known, at the beginning of December 2012; which is predominantly the same as the Transmission System known at the beginning of October 2013. The base case generation dispatch scenarious used for the studies are presented in Table D-5 in Appendix D of the 2013 TYTFS.

The locations analysed for new demand have been carefully reviewed based on feedback from industry sources. The chosen stations have been tailored to match more closely the needs of customers.

It should be noted that the results of these studies are dependent on the assumptions made about generation and demand, and on the completion dates of Transmission System development projects. Factors that may influence the results are discussed in Section 7.2.4.

7.2.1 Transfer Capability Analysis for New Demand

The Transmission System is planned to meet forecast demands at all stations in Ireland. The demand forecast for each 110 kV station is a proportion of the overall system demand forecast based on historical demand distributions. Future demand customers that have signed connection agreements are also included in station demand forecasts.

While additional demands above the forecast levels are not explicitly catered for in Transmission System plans, there may be capacity for additional demand inherent in the Transmission System at certain locations. New demand can generally locate in an area that has excess generation capacity, as this will reduce power flows out of the area. Alternatively, the addition of Transmission System infrastructure generally provides a step increase in Transmission System capacity, which may permit demands higher than forecast levels, as illustrated in Figure 7-1. The blue line represents the required 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, thus providing spare capacity for a period of time.

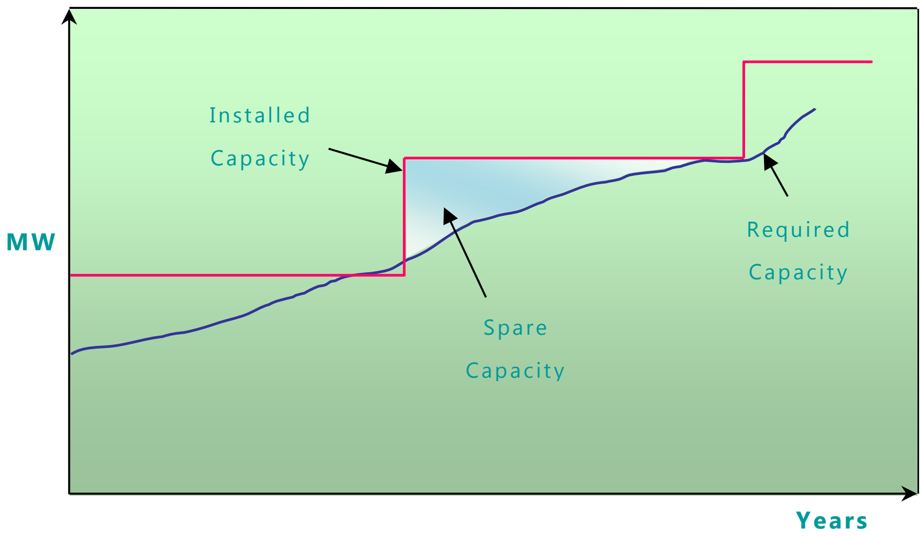

Figure 7-1 Illustration of Typical Step Change in Network Capacity

Figure 7-2 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 at selected 110 kV and 220 kV stations. The selected 110 kV and 220 kV stations, which feed principal towns and demand centres distributed throughout the country, are shown in Figure 9-1 in Chapter 9. The results of this analysis are useful in identifying opportunities for the connection of new or increased demand of a size typical of industrial development in Ireland. The capacity value calculated is a measure of the transfer capability remaining in the physical Transmission System for further commercial activity over and above already anticipated uses. It provides an indication of the flexibility of the Transmission System to accommodate future demand increases in selected areas without the requirement for further reinforcements.

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.

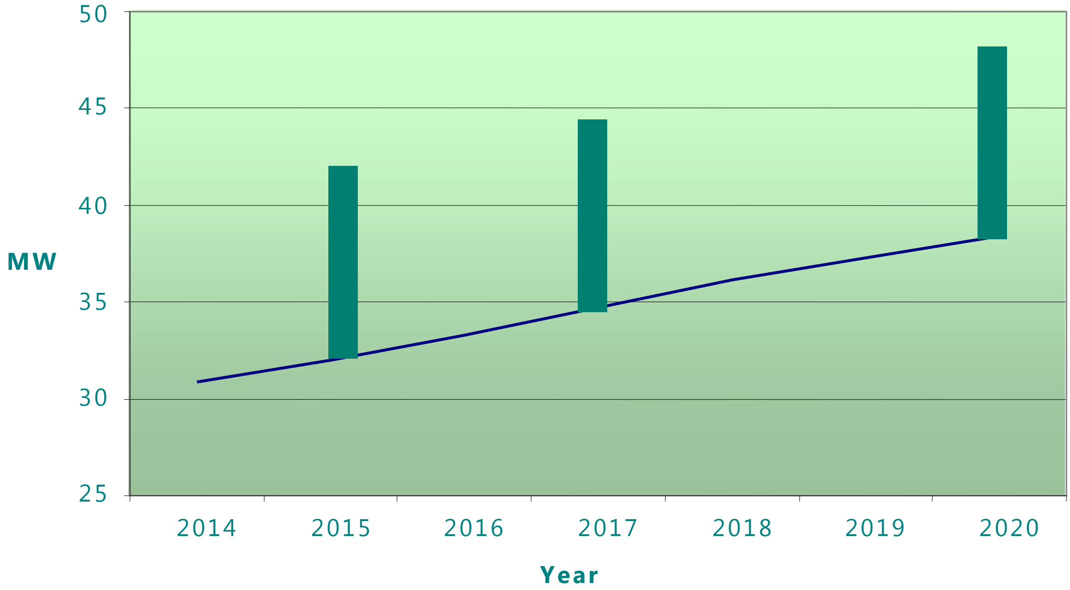

Figure 7-2 Demand Profile at Typical Station

In previous statements the application of planning standards for the analyses of demand and generation was the same in all respects except for the contingencies considered and voltage analysis. In the generation studies, maintenance-trip (N-1-1) contingencies were not considered. An assumption was made that the hypothetical generator could be constrained down or off during Transmission System maintenance. However, demands are not dispatchable, and so it is not acceptable to assume that the hypothetical demand may be constrained off during a maintenance outage. It is necessary, therefore, to assess the Transmission System performance against standards for maintenance-trip contingencies in the analysis of increased demands. The reason voltage analysis was performed as part of the demand capacity studies is because the addition of demand is likely to impact on local voltages levels.

7.2.2 Method for Calculating Transfer Limits for Increased Demand

An AC loadflow numerical linear technique was used to screen for critical contingencies and thermal overloads or voltage limitations. A linear algorithm is a simple yet robust method where the solution is determined using a step approach.

Transfers were considered between the “Dublin”, “Northern Ireland” and “South” generation blocks. The 36 “test nodes” selected for analysis are outlined in Chapter 9.

The initial generator dispatches for the transfer capability studies are presented in Table D-5 in Appendix D in the 2013 TYTFS. Generators were modelled with their maximum output equivalent to their Maximum Export Capacity (MEC). As wind energy is variable in nature, it cannot be relied upon to serve demand. As such, local wind generation was switched out in the vicinity of the test node for the purposes of assessing new demand that can be accommodated on the network. These dispatches, with wind generation local to the test node switched out, were used for single contingency (N-1) studies. For N-G-1 and N-1-1 contingencies, some centrally-dispatchable generation local to the test node was maximised to its MEC value, to create a more favourable dispatch for the maintenance case.

To calculate the opportunity, demand at 95% power factor was added at the test node in increasing amounts. This was balanced by an equivalent increase in generation output from existing generation within one of the three generation blocks. This is illustrated in Figure 7-3. In cases where full capacity was reached on all generation units within a generation block, the maximum capacity was increased to allow further transfer. The limit for increased transfers from the generation block to the test node was established by checking the post-contingency performance of the Transmission System against thermal and then voltage standards. The process was then repeated for the two remaining generation blocks.

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

To assist the reader, the information from this analysis is presented concisely by combining the results from the “Dublin”, “Northern Ireland” and “South” generation blocks to each of the 36 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 Dublin, Northern Ireland or the South was chosen. However, when considering maintenance-trip contingencies (N-1-1), the greater of the capacities from Dublin, Northern Ireland or the South 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 9.1 of Chapter 9.

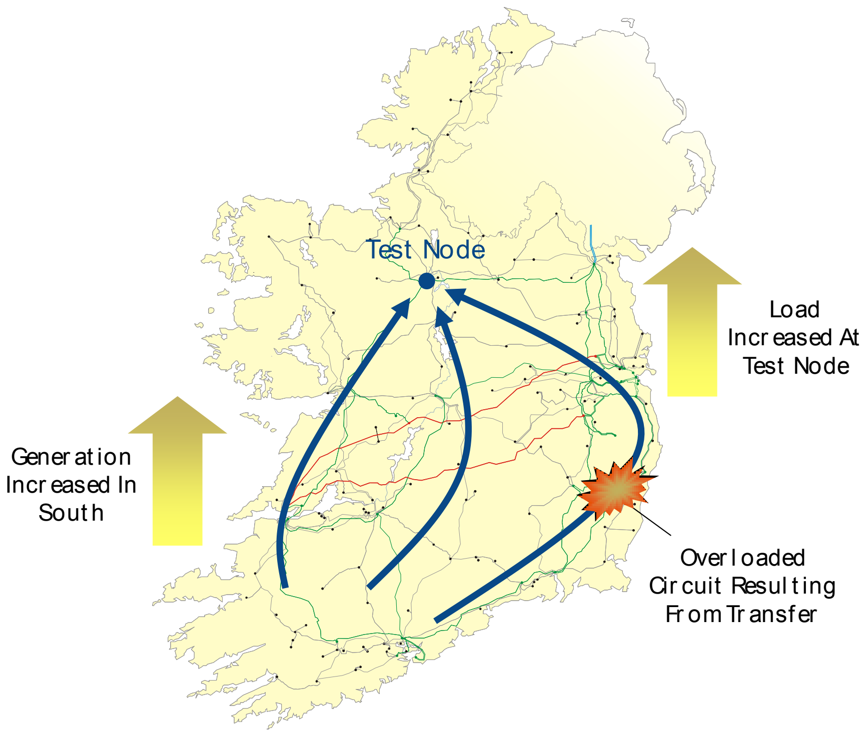

Figure 7-3 Illustration of Incremental Transfer Capability Study Method for Demand

7.2.3 Example: Calculation of Capability for Demand at Ennis 110 kV Station

This section provides an example of the analysis of the capability of Ennis 110 kV station to accommodate increased demand at summer peak 2014. The example illustrates the steps taken towards deriving the demand opportunity at Ennis 110 kV station.

The assessment was carried out by simulating the Transmission System for summer peak 2014 using the relevant demand forecasts and generator dispatches.

Due to its variable nature, wind generation cannot be relied on to meet the demand at all times. Therefore, to prepare the model for testing the capability for additional demand at Ennis, all wind generation in the vicinity of Ennis, was switched off.

Three sets of studies were carried out, with the extra demand in each met by increasing generation in one or other of the "Dublin", "Northern Ireland" and "South" generation blocks. For each study in turn, the AC loadflow linear technique was used to add a test demand of 160 MW to Ennis 110 kV station. An equivalent amount of generation was increased in each generation block in order to meet the increased demand at Ennis, which set up incremental power transfers between each generation block and Ennis. 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. Assuming some contingencies cause violations of overload or voltage standards at the maximum capacity, the analysis reverted to 0 MW and performed the test in increasing steps, each step 10 MW in size until a violation of overload or voltage standards occurred. The preceding step value is then the calculated opportunity value.

In this example, regardless of whether the extra demand was supplied from Dublin, Northern Ireland or the South, an outage of the Ardnacrusha-Drumline 110 kV line during the maintenance outage of the Ardnacrusha-Ennis 110 kV line would result in a voltage violation at Drumline 110 kV busbar when the demand at Ennis was increased by 70 MW. The preceding value of 60 MW was therefore the limit of additional demand permissible at Ennis taking account of voltage standards.

The Transmission System was next tested against overload standards with the 60 MW of additional demand modelled at Ennis. All possible circuit and generator outage combinations were simulated and voltages checked. The analysis showed that the Transmission System remained within standards with the additional demand connected at Ennis. As such, the limit of additional demand permissible at Ennis 110 kV station is 60 MW for summer peak 2014.

In assessing opportunities for new demand, the TYTFS considers the capability of the Transmission System only. The capability of the Distribution System 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 2014-2023 (GCS)*.

7.2.4 Factors Impacting On Results

The results of the analyses described in this section are based on a set of assumptions about future demand growth, generation connections and Transmission System developments. The key forecast factors on which the results depend are dynamic, and 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

7.3 GENERATOR OPPORTUNITY ANALYSIS IN NORTHERN IRELAND

Generator opportunity analysis determines the incremental transfer capability when a generator is located at a node. The methodology captures the present and future challenges to be met by the TSOs with large penetration of renewable generation connected to the Distribution and Transmission Systems. Using A.C. steady state contingency analysis (see Table 7-1), the capability of a node to accept new generation is recorded, along with the corresponding contingency and resultant network constraint.

The year studied in this TYTFS is 2022, and the connection of new generation has been facilitated by one of three scenarios:

Supplying the Northern Ireland Existing Load

In this scenario, new generation is connected to a node. As this new generation output increases in size, a corresponding amount is scaled off the existing conventional generation in Northern Ireland. The renewable generation, however, remains at full output. In effect, the new generation is supplying the existing Northern Ireland load.

Supplying Load in Ireland

In this scenario, the new generation connected to a node is transferred across the tie-lines from Northern Ireland to Ireland. This is facilitated by increasing demand in Ireland.

Reducing Imports from Great Britain

In this scenario, as the new generation is connected to a node, the amount of energy being transferred across the Moyle Interconnector is correspondingly adjusted. In effect, imports are reduced, and can result in power being exported to Great Britian. It should be noted that these studies do not take into consideration any existing or future restrictions of export capacity on the Scottish system.

For each of these scenarios, the winter, autumn and summer peak demand as well as the summer night valley demand have been studied. For all scenarios and seasons, new generation is connected to a particular node, contingency analysis is performed, and the maximum amount of generation that can be connected is recorded. This results in a set of twelve values of generation capacities for each node. The minimum of these values is then selected as the maximum generation capacity that can be accommodated at that node.

It is important to note that when a generation node is tested, the existing generation connected at that node is maximised before capability analysis is performed. This generation is also not scaled back as the new generation is increased in size.

7.3.1 New Generation Connection Location

Analysis of generation connections has been carried out at all nodes on the 275 kV and 110 kV networks in Northern Ireland.

7.3.2 Contingency Analysis Performed

Table 7-1 below describes the contingency analysis performed in each set of studies.

Table 7-1: Range of Contingency Analysis Performed

Season	Contingency analysis
Winter	n-1[4] and n-dc[5]
Autumn	n-m-t[6]
Summer	n-m-t

Maintenance-trip analysis is carried out in summer and autumn as the TSO can carry out system maintenance as required by the Transmission Owner (NIE) without the constraint of generation. There may however be times when it is necessary to curtail Northern Ireland generation for system security reasons.

7.3.3 Voltage Support

The amount of generation that can be added to a node in Northern Ireland may be limited by voltage issues, e.g. after contingency analysis the voltage is outside limits imposed by the Security and Planning standards.

The base case study files were preconditioned so that Network Reactive Compensation Schemes could provide instantaneous reactive support under outage conditions to ensure, where possible, that 'under voltage' did not limit the capacity of the network.

7.4 DEMAND OPPORTUNITY ANALYSIS IN NORTHERN IRELAND

This section describes the analysis carried out to determine the capability of the Northern Ireland Bulk Supply Point (BSP) substations to accommodate additional demand. The results of this analysis, together with information in other chapters, provide the basis for the statements of opportunity in section 9.2 of Chapter 9. The analysis assumes there is adequate capacity on the main back-bone of the Northern Ireland Transmission System to accommodate these small local demand increases.

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[4] A single transmission circuit is tripped

[5] A transmission double-circuit is tripped

[6] A single transmission circuit is out of service for maintaince and then a second transmission circuit is tripped

The demand forecasts for winter peak and summer peak conditions are used without wind generation supplying local load. The maximum demand will be seen at the BSPs in Northern Ireland under single circuit outage conditions.

Under single circuit outage conditions the BSP load will be supplied through a single impedance path for example through a single 110 kV branch and a 110/33 kV transformer. The resulting power flow has a higher Mvar flow and thus gives a true picture of when improvements are required on the Northern Ireland Transmission System. The maximum demand from the analysis is compared against BSP substation ratings, provided by NIE. The available capacity is presented in Chapter 9 of the TYTFS.

8 Transmission System Capability for New Generation

8 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION

This chapter provides indicative information on the opportunities for generator connections in both Ireland and Northern Ireland.

8.1 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION IN IRELAND

This section gives indicative information on:

- Generation opportunities created by GRID25.
- Potential future opportunities for generation beyond that currently contracted or in receipt of a connection offer.

This chapter of the TYTFS is published solely for the purposes of Section 38 of the 1999 Electricity Act and is not intended to have any legal effect in relation to the negotiation of contractual terms for connections to the Transmission System. Before making any commercial decisions developers should contact EirGrid for discussions on their proposed developments.

8.1.1 Gate 3 and Post Gate 3 Generation Applications

In the period 2010-2011 3,989 MW of wind generation (on-shore and off-shore) and 1,429 MW of non-wind generation received connection offers under Gate 3 from the TSO and DSO. As at 4th October 2013 (TYTFS data freeze date) one hundred and twenty-three Gate 3 applicants totalling 3,054 MW had accepted their connection offers, ten Gate 3 applicants had let their offers lapse and all other offers remained live.

As at 4th October 2013 (TYTFS data freeze date), there are a further 366 applications, beyond Gate 3, for connections totalling circa 23,000 MW. The manner in which post Gate 3 applications will be processed has yet to be decided by the Commission for Energy Regulation (CER).

8.1.2 Generation Connection Opportunities Created By GRID25

Please refer to section 3.4.1 of chapter 3 for information in relation to the on-going strategy for the GRID25 program. Figure 8-1 gives an indication of the level of Gate 1, 2 and 3 wind and non-wind generation that is expected to be facilitated in the form of firm access under GRID25.

The concept of firm access represents a transmission capacity guarantee for generators and is only granted once sufficient network capacity is available to accommodate the generator. Particular projects under GRID25, referred to as a generator's Associated Transmission Reinforcements (ATRs), are required to be completed to provide this capacity. If a generator has firm access to the Transmission Network it will be financially compensated, in line with the Trading and Settlement Code, on occasions where the generator was scheduled in the unconstrained electricity market but the generators actual power output was reduced as a result of a network constraint.

EirGrid's 2012 re-calculation of FAQs re-assessed the potential levels of firm access available in the Transmission System, for each project, for each year up to the year that firm access for the full MEC was achieved. Details on FAQs are available on the EirGrid website[1]. Delivery of the Transmission System upgrades and new build reinforcements associated with GRID25 will create sufficient capacity on the Transmission System to provide firm access for all generation included in the various Gates and all generators currently in receipt of a connection offer outside the Gate process.

It should be noted that particular ATR projects under GRID25 are forecast to have later scheduled completion dates than those used in the 2012 re-calculation of FAQs by EirGrid. The latest scheduled completion date statuses for all ATRs are communicated via the EirGrid website[2] on a quarterly basis and should be checked regularly by all generator projects which have ATRs.

The following points in relation to transmission reinforcements should also be noted:

- A re-designation of the estimated completion dates for any of the Transmission System reinforcements listed on the EirGrid website will affect the firm access achievement date for any applicants associated with it.
- Generally no one transmission reinforcement solely creates firm access and it is a combination of transmission reinforcements that leads to the delivery of firm access across different areas on a yearly basis.

[1] http://www.eirgrid.com/customers/gridconnections/generatorconnections/firmaccessquantities/

[2] http://www.eirgrid.com/customers/gridconnections/generatorconnections/associatedtransmissionreinforcements/

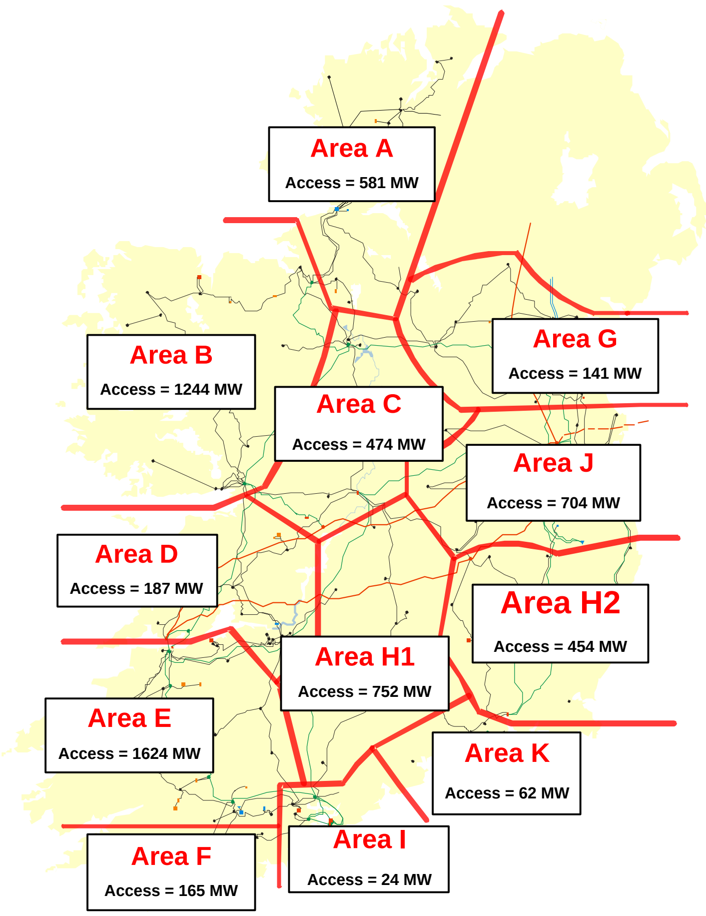


Figure 8-1 Generation facilitated per area

While firm access is a useful indicator of the capacity available to accommodate new generation it should be noted that:

- Firm Access is not as relevant for generators whose level of reduction in output due to network congestion is expected to be low.
- Firm Access is not as relevant for some generation types as it is to others e.g. peaking type plants.

8.1.3 Opportunities for Additional Generation beyond Gate 3

The results of the opportunities for additional generation beyond Gate 3 remain unchanged from that published in the 2013 Ten Year Transmission Forecast Statement. EirGrid made the decision not to re-run the analysis given the high volume of Gate 3 offer acceptance, the uncertainty surrounding how post Gate 3 applications will be processed and the fact that some of the scheduled completion dates for certain ATR projects under GRID25 have remained the same or are deferred.

It must be stressed that this information on generation opportunities is presented as a general guide only. It is based on the GRID25 network assumed for the most recently published Gate 3 FAQs and is subject to change.

The methodology applied to determine the capability of the Transmission System to accommodate additional wind generation beyond Gate 3 follows the methodology applied for EirGrid's 2012 re-calculation of FAQ for Gate 3 wind generation projects. Studies were undertaken on an area by area basis in the year following the year that the last Gate 3 wind applicant in an area received firm access. Please note that all wind generation was dispatched at 100% in study cases as per the 2012 FAQ analysis. More information on the method of analysis used is described in Chapter 7. The results of the wind generation opportunity analysis are presented in Table 8-1. These results indicate the amount of additional wind generation that could be accommodated beyond Gate 3, without the need for additional Transmission System reinforcement. The results are given to the nearest 10 MW.

Table 8-1 Firm Access Opportunities beyond Gate 3 for Wind Generation Projects

Area	Year of Study	Node	Opportunity (MW)
A	2021	Corderry	< 10
		Letterkenny	< 10
B	2021	Galway	20
		Sligo	50
C	2019	Carrick-on-Shannon	0
		Shannonbridge	0
D	2017	Ardnacrusha	0
		Booltiagh	0
E	2021	Ballyvouskil 220 kV	0
		Kilonan 220 kV	0
		Kilpaddogue 220 kV	0
F	2021	Dunmanway	0
G	2018	Gorman	180
		Louth	30
H1	2021	Cahir	0
H2	2013	Arklow	0
		Kellis	0
I	2021	Midleton	0
J	2021	Woodland 220 kV	20
		Portlaoise	130
		Carrickmines 220 kV	90
K	2018	Cullenagh	0

Table 8-1 could be used to form an opinion on what areas might have additional network capacity in the medium to long-term (i.e. 5-10 years) to accommodate additional wind generator connections over and above those currently connected, contracted or in receipt of a connection offer. The results are not cumulative. Studies indicate that there is no available capacity for potential wind generator connections in Areas C, D, E, F, H1, H2, I and K in the year after the last Gate 3 applicant receives full firm access for that area as these areas require further significant transmission reinforcements beyond those already planned to create additional capacity. Area A has little firm access available while areas, B, G and J will have surplus firm access available and this can be attributed to the completion of the major transmission reinforcements in these areas.

The following additional points in relation to generation opportunities should also be noted:

- While some areas of the network may appear to have little or no additional capability for wind generator connections, these areas could potentially accommodate generation technologies which complement the existing generation portfolio. For example, an area may have reached capacity for one form of generation technology, but it could possibly accommodate a flexible form of generation such as pumped storage or peaking capacity plants.
- In the majority of cases, lack of transmission capacity is the limiting element in accommodating additional generation onto the network. It is logical that generator connections are easier to accommodate in locations closest to existing load centres as the power does not have to be transported over long distances from source to load. This is evident from the results in Area J (Dublin region) as the results show opportunities beyond 2020.
- The connection of a large new, non-Gate 3 generator to the Transmission System could significantly alter the available opportunities.

8.2 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION IN NORTHERN IRELAND

When SONI receives generation related connection enquiries, there are a wide range of technical assessments necessary in advance of offering a connection proposal to the potential Transmission System user. Detailed connection studies are required which take into consideration the full impact on short circuit current levels, transient stability and dynamic stability. The development must also meet the technical connection requirements set out in the SONI Grid Code. The capacities identified in these capability studies are only indicative. The general information provided in this report may be used as a guide only, with generation connection enquiries requiring analysis using detailed plant models provided by potential network users.

The two factors which significantly affect the available generator opportunity at a node are the capacity on the Transmission Network and the existing generation connected at the node. Section 3.5 in chapter 3 details the proposed transmission network developments in Northern Ireland completed by 2023. Similarly, section 5.2 in chapter 5 details the generation proposed to connect in Northern Ireland by 2023. Since there are no significant changes when compared to the assumptions made in the analysis for TYTFS 2013-2022, the generator opportunity analysis has not been updated for Northern Ireland for this TYTFS.

It should be noted that the results presented in this TYTFS are merely indicative, and that generation opportunities presented are not cumulative - if a new generator agrees to connect at a particular node, it will have an impact on the capabilities of many other nodes on the Transmission System.

8.2.1 Generation Opportunities at 275 kV

In the generator opportunity analysis, the connection of up to 400 MW of generation at each 275 kV node was investigated. The results are shown below in Figure 8-2.

The results of the capability analysis in the TYTFS 2013-2022, show that there is capacity for generator connections at a number of locations on the grid in 2022/23. The Castlereagh, Hannahstown, Kells, Tamnamore and Tandragee 275 kV substations, as well as the new 275 kV substation at Turleenan, could all accommodate up to 160 MW of additional generation. As can be seen from the results the Kilroot node has the greatest generation opportunity with a spare capacity of 400 MW.

As detailed in section 5.2, subsequent to the freeze date of the 2013-2022 TYTFS, an application has been accepted for the connection of a Compressed Air Energy Storage plant at Ballylumford. Clearly, this has not been included in the opportunity analysis and will therefore impact on the generation opportunity at Ballylumford indicated in figure 8-2.

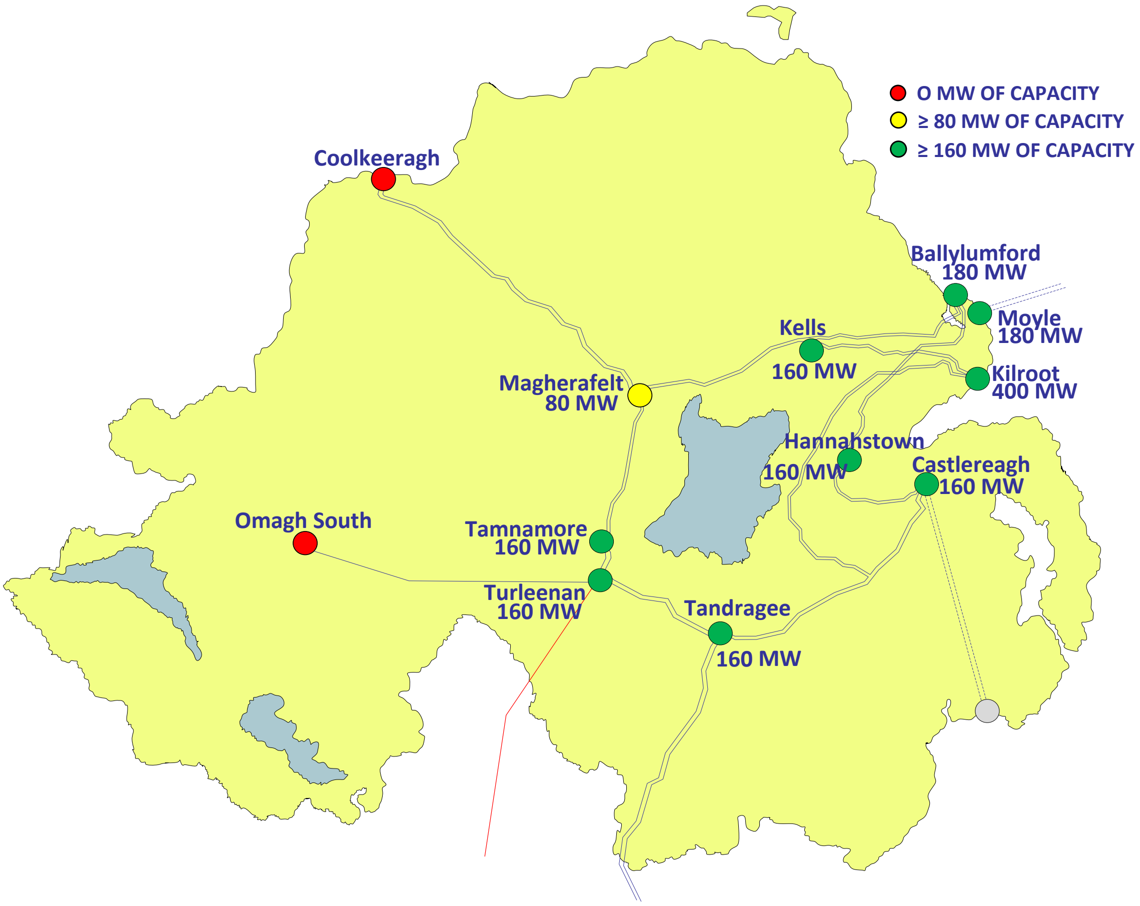


Figure 8-2 Generator Opportunities at 275 kV

8.2.2 Generation Opportunities at 110 kV

In the generator opportunity analysis, the connection of new generation at each 110 kV node in Northern Ireland was assessed. The results are shown below in Figure 8-3. Each 110 kV node was considered individually to determine its characteristics and the resulting maximum generation opportunity. Radially fed 110 kV substations will be limited by the loss of a single circuit, and the capability of the radial substation will be constrained by the capacity of the remaining circuit. Interconnected 110 kV substations have a variety of critical outages which limit the generation opportunity. These are listed in Appendix F, Table F-4.

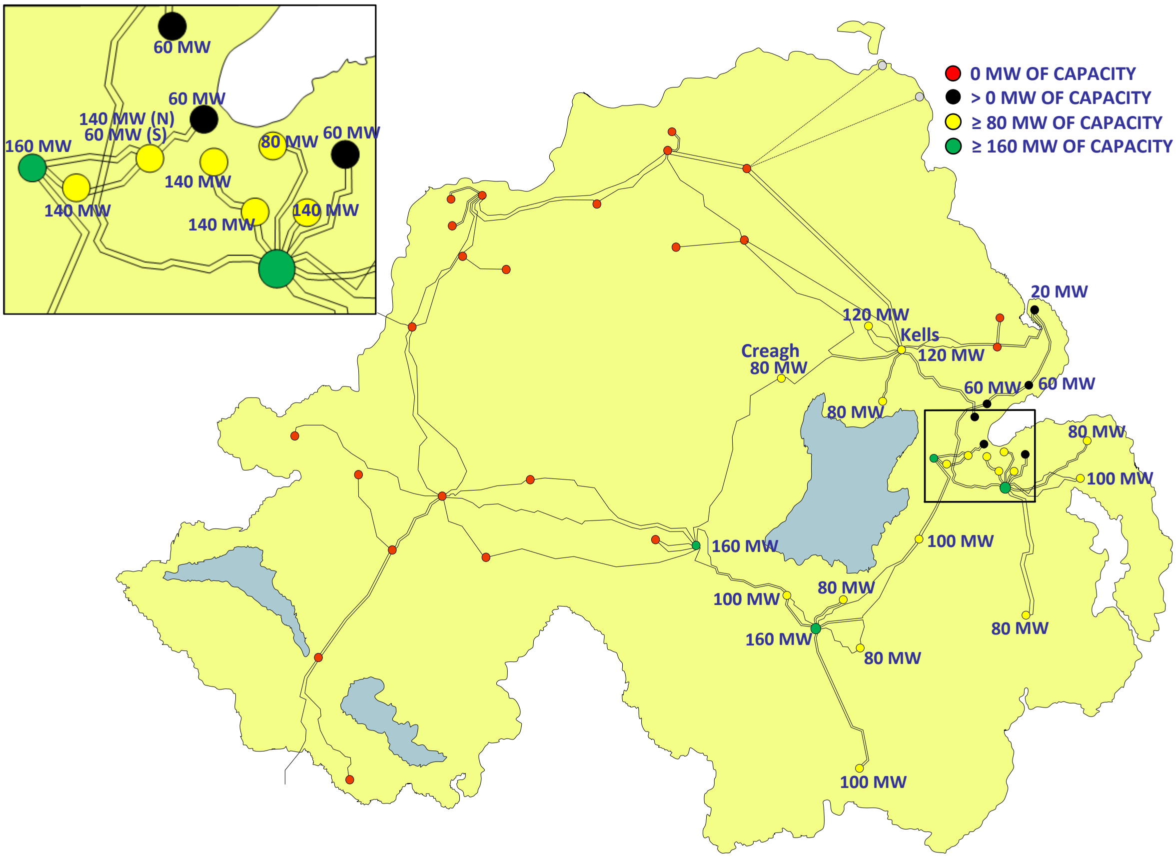


Figure 8-3 Generator Opportunities at 110 kV

There is no capacity for additional generation at 110 kV in the North and West of Northern Ireland, as a result of the significant quantity of renewable generation proposed to connect in the area. Towards the East of Northern Ireland, opportunities for generation become more substantial, with the potential for up to 160 MW of capacity at some nodes in the greater Belfast area.

8.2.3 Northern Ireland Generation Opportunities Conclusions

The Transmission System in Northern Ireland was originally built to a high standard, with many years of spare capacity, but the effects of load growth and the increasing renewable generation levels are starting to stress network capability.

It must be stressed that all the capabilities shown are very much dependent on the timely installation of the planned 110 kV and 275 kV reinforcements and the delivery of the network reactive compensation schemes described in Chapter 3 of this TYTFS.

9 Transmission System Capability for New Demand

9 TRANSMISSION SYSTEM CAPABILITY FOR NEW DEMAND

The Transmission System is being planned to meet anticipated demand growth across the Transmission System. Appendix C provides projections of demand at each transmission station. This chapter presents the results of analysis of the capability of the transmission system to accommodate increased demand, above projected demand levels, and discusses the opportunities for increased demand in Ireland and Northern Ireland.

9.1 TRANSMISSION SYSTEM CAPABILITY FOR NEW DEMAND IN IRELAND

The results of the opportunities for additional demand in excess of projected demand remain unchanged from that published in the 2013 Ten Year Transmission Forecast Statement. EirGrid made the decision not to re-run the analysis given the flat nature of the demand forecast as indicated in the 2013-2022 GCS and the inability to initiate new transmission projects in the data freeze period December 2012 – October 2013[1]; meaning the capacity of the existing and planned Transmission System remains largely unchanged from the analysis carried out in the 2013 TYTFS.

Twenty-nine 110 kV stations, which feed principal towns and demand centres throughout Ireland, were chosen for this analysis. These are shown in Figure 9-1. In response to stakeholder feedback, this TYTFS also includes an analysis of a number of 220 kV stations to help identify potentially suitable locations for major industrial load centres.

[1] As indicated in section 1.4 of the 2013 TYTFS

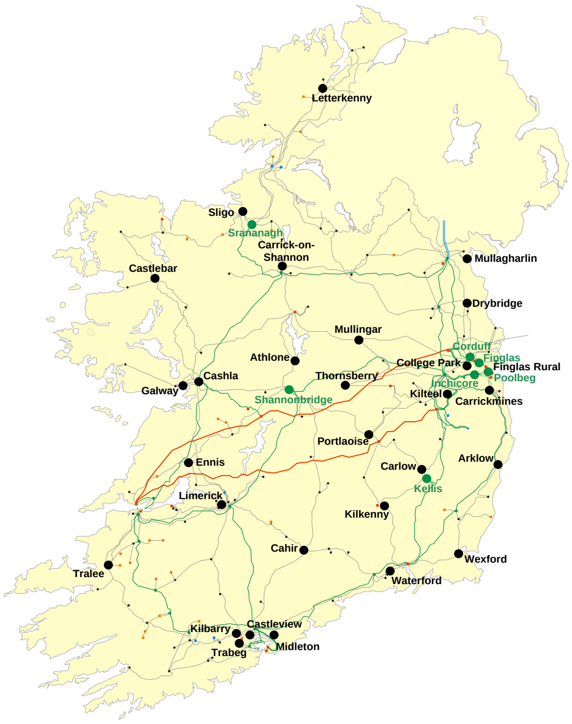


Figure 9-1 110 kV and 220 kV Stations Studied for Demand Opportunities

9.1.1 Incremental Transfer Capability Results for New Demand

The method of analysis used to determine the capability of the Transmission System to accommodate additional demand is described in Chapter 7. The results of the analysis is presented in Table 9-1. The results indicate the amount of additional demand, in excess of projected demand, that could be accommodated at each of the twenty-nine 110 kV stations and seven 220 kV stations, without the need for additional Transmission System reinforcement. The results are given to the nearest 10 MW.

Table 9-1 Capability for Additional Demand at 220 kV and 110 kV Stations, MW

Region	Station	2014	2017	2020
Dublin[2]	Carrickmines	120	100	90
	College Park	30	40	40
	Corduff 220 kV	230	280	230
	Finglas 220 kV	240	190	90

[2] EirGrid are aware of increased activity at Transmission and Distribution level in the Dublin region. Prospective developers seeking to connect in the Dublin region should contact EirGrid directly.

Table 9-1 Capability for Additional Demand at 220 kV and 110 kV Stations, MW (continued)

Region	Station	2014	2017	2020
Dublin	Finglas Rural 110 kV	40	50	50
	Inchicore 220 kV	130	350	90
	Poolbeg 220 kV	130	260	200
Midlands	Athlone	20	20	20
	Cahir	50	90	90
	Kilteel	40	50	50
	Mullingar	30[C2]	60	60
	Portlaoise	50	70	80
	Shannonbridge 220 kV	170	200	200
	Thornsberry	10[C3]	20	30
Mid-West	Cashla	50	60	60
	Ennis	60[C1]	120	110
	Galway	20	40	60
	Limerick	100	100	100
North-East	Drybridge	90	110	110
	Mullagharlin	40	40	40
North-West	Carrick-on-Shannon	30	40	30
	Castlebar	<10	10	10 [P1]
	Letterkenny	<10	40	30
	Sligo	70	40	50
	Srananagh 220 kV	10	40	50
South-East	Arklow	90	80	80
	Carlow	20	30	50
	Kellis 220 kV	10	30	50
	Kilkenny	<10	20	10
	Waterford	120	110	100
	Wexford	50	40	30
South-West	Castleview	50	60	60
	Kilbarry	<10	40	30
	Midleton	50	70	60
	Trabeg	10	130	110
	Tralee	10	60	90

The superscripts in Table 9-1 provide a cross reference between the capacities and the tables in Appendix F; which provide additional information regarding the constraints limiting the capacities and the likely scale of development required to increase the capacities. Reference numbers prefixed with a “P” indicate that EirGrid has initiated specific projects which will overcome the constraint; a “C” indicates that plans are being progressed to deal with the constraint; an “F” means that further investigation is required before a solution is selected. The numerical suffixes serve to uniquely identify the constraints for reference purposes.

9.1.2 Opportunities for New Demand

"Opportunity" relates to where there is or will be capacity for greater use of the Transmission System without the need for further reinforcements. However, if a developer chooses to connect a demand in an area that requires reinforcement, the TSO will progress relevant Transmission System developments. Potential demand customers should consult the TSO early in their development process to explore options relating to their proposal; thus enabling timely decision making.

As a general rule, opportunity at a particular station would tend to reduce over the course of the study period covered by the TYTFS as normal demand growth uses up available capacity. However, in many cases demand opportunities improve in later years as a result of planned Transmission System or generation developments.

In 2014 there will be opportunities for an additional large demand[3] at twenty three of the twenty nine 110 kV stations examined and in 2020 there will be opportunities at twenty four of the twenty nine stations.

Opportunities for increased demands are spread around Ireland. In general, individual demands up to 10 MW can be connected to most of the other stations on the Transmission System. An additional demand of 10 MW or more, over and above forecast demand, represents a significant increase for most locations. To put this in context, a demand of 10 MW represents the consumption of a typical pharmaceutical plant.

Following consultations with stakeholders, this TYTFS includes an assessment of seven 220 kV nodes to determine the capability of the transmission system to accommodate a major industrial load centre in the order of three times the size of what today would be a major customer load. The results show that Corduff and Shannonbridge 220 kV stations would be suitable connection points for a major industrial load centre, with each capable of accommodating in excess of 200 MW without additional network reinforcements.

Figure 9-2 illustrates the opportunities for demand in 2017 and 2020. The graphics show that there will be significant demand opportunities in most parts of Ireland through to 2020.

It should be noted that demand opportunity is tested for each station on an individual basis. As such, the opportunities presented are not cumulative i.e. if new demand connects in an area that is shown to have opportunity they will use up some or all of the available capacity in that area.

[3] 10 MW or more

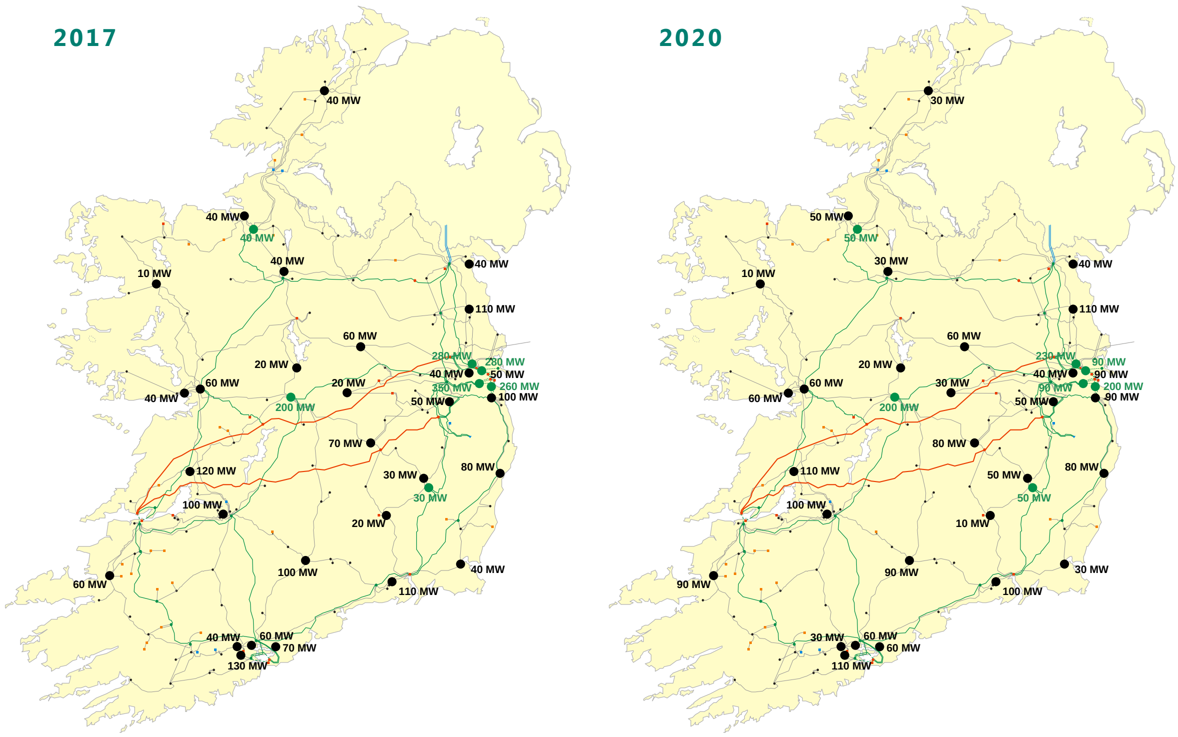


Figure 9-2 Capability for New Demand in 2017 and 2020

9.1.3 Impact of Changes since the Data Freeze

Since 4th October 2013, a number of developments have occurred that could impact on the results in Table 9-1. Project changes since 4th October 2013 are listed in Section 1.4. Of these projects the new West Dublin 220/110 kV station should significantly improve demand opportunities in the Dublin region.

9.1.4 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. Those considering development of a significant demand in Ireland should take the following approach for an indication of whether their demand is likely to be accommodated without the need for additional reinforcements that could potentially delay their connection.

The first step is to consult the maps in Appendix A to find the nearest transmission station to the proposed development and where different, the nearest station for which opportunity has been assessed. The anticipated demand growth at the relevant station can be deduced from the demand forecasts presented in Appendix C. The Transmission System is being planned to meet this level of demand increase. However, if the proposed new demand is far greater than the annual forecast increase the potential developer should check the opportunity at the nearest 110 kV station presented in Table 9-1 in this chapter. The potential developer should then check the assumptions in Chapters 3 to 5 and also consider the impact of changes to the Transmission System since the analysis was carried out.

To illustrate this approach, the following is an example of how a developer planning to connect a new large demand of 100 MW near the town of Ennis in 2017 might use the TYTFS. The maps in Appendix A show that the nearest 110 kV station is Ennis station. Appendix C shows that the demand at Ennis 110 kV station will be about 59.8 MW at winter peak 2014. This is forecast to grow by 5.3 MW between 2014 and 2023 i.e. by 0.53 MW per annum. The proposed 100 MW large new demand is far greater than the annual forecast increase. It therefore represents a step change in the demand at Ennis i.e. the type of increase that is the subject of the transfer capability analysis presented in this chapter.

The results for Ennis in Table 9-1 show that the opportunity for increased demand is less than 100 MW in 2014. The table directs the potential developer to constraint C1 in Appendix F for additional information on the constraint and the plans that the TSO have in place to address the constraint. Table F-7 in Appendix F shows that potential overloading of the Ardnacrusha – Limerick 110 kV line is responsible for limiting the opportunity. The overload occurs under summer peak maintenance-trip conditions. Capital project CP0688, which entails the installation of a new 220/110 kV transformer at Moneypoint station has been initiated by the TSO to relieve the constraint. Following completion of this project towards the end of 2015 the opportunity at Ennis increases to 120 MW in 2017. This indicates that the Transmission System is likely to be capable of connecting and supplying the proposed demand once capital project CP0688 has been fully implemented.

9.3 TRANSMISSION SYSTEM CAPABILITY FOR NEW DEMAND IN NORTHERN IRELAND

This section presents the forecast loading under single circuit outage conditions at Bulk Supply Point (BSP) substations, in Northern Ireland. The analysis presented in the following tables covers winter and summer peak conditions for the ten year period.

The BSP demand forecasts are provided by NIE and are adjusted to align with the overall system 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. All of the peak demand forecasts have been calculated without wind generation supplying local load.

Under single circuit outage conditions the BSP load will be supplied through a single impedance path for example through a single 110 kV branch and a 110/33 kV transformer. The resulting power flow has higher Mvar flow and thus gives a true picture of when improvements are required on the Northern Ireland Transmission System.

The BSP forecast loading single outage conditions, total installed transformer capacity, substation firm capacity and predicted peak demand forecasts, in MVA, are given in Table 9-2 and Table 9-3.

The firm capacity is based on the loss of one infeed (or transformer) to the substation, and is the capability of the remaining circuit. The geographical location and connectivity of the BSPs can be determined from the geographical maps in Appendix J.

Notes Relating To the Tables

The tables below contain a column headed limiting factor. These notes refer to the factor that determines the firm capacity of the BSP substation:

1. The normal rating of the transformer, as it is greater than 40 years old
2. The cyclic rating of the transformer
3. The 110 kV line rating
4. Substation components
5. Voltage performance under outage conditions
6. The 110 kV line rating in summer, substation components in winter
7. The firm capacity of the BSP is based upon support from connected 33 kV cables
8. The firm capacity of the Glengormley BSP is based upon the rating of the 33 kV cable to Carnmoney

Table 9-2 Winter BSP Peak Demand: Single Circuit Outage Conditions

BSP Location	Tx[4] MVA	SS[5] MVA	WINTER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)										Limiting factor
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Aghyoule Main	90	29.0	17.1	17.2	17.4	17.5	17.7	17.8	18.0	18.2	18.3	18.5	5
Antrim Main	180	55.3	46.1	46.4	47.0	47.6	48.1	48.7	49.3	49.8	50.4	51.0	4
Ballymena Mesh (Rural)	180	55.3	46.9	35.1	35.8	36.4	37.1	37.8	38.4	39.1	39.8	40.5	4
Ballymena SWBD (Town)	120	72.8	50.2	50.8	51.8	52.6	53.4	54.2	55.1	55.9	56.8	57.6	4
Ballynahinch Main	180	71.4	58.9	59.3	60.0	60.7	61.3	62.0	62.6	63.3	64.0	64.7	4
Banbridge Main	120	71.4	40.7	41.0	41.6	42.0	42.5	43.0	43.4	43.9	44.4	44.9	4
Coleraine Main	120	71.4	46.8	47.1	47.8	48.4	49.0	49.6	50.2	50.8	51.4	52.1	4
Coolkeeragh Main	180	114.0	32.0	32.4	33.0	33.5	34.0	34.4	34.9	35.4	35.9	36.4	4
Creagh Main	120	78.0	24.8	37.1	37.6	37.9	38.3	38.6	39.0	39.3	39.7	40.1	2
Drumnakelly Main	180	111.0	99.9	92.0	93.5	94.7	96.0	97.3	98.7	100.0	101.3	102.7	4
Dungannon Main	180	114.0	94.0	91.5	93.1	94.4	95.7	97.1	98.4	99.8	101.2	102.6	4
Eden Main	90	37.4	32.8	33.0	33.5	33.8	34.2	34.6	35.0	35.3	35.7	36.1	4
Enniskillen Main	150	73.0	53.9	54.3	55.1	55.8	56.5	57.2	58.0	58.7	59.5	60.2	4
Larne Main	90	55.3	45.8	46.1	46.7	47.2	47.8	48.3	48.9	49.4	50.0	50.5	4
Limavady Main	90	40.3	26.1	26.3	26.7	27.0	27.4	27.7	28.1	28.5	28.8	29.2	4
Lisaghmore Main	90	58.5	50.6	51.0	51.7	52.4	53.1	53.8	54.4	55.1	55.9	56.6	2
Lisburn Main	180	100.0	66.5	67.0	68.0	68.9	69.7	70.6	71.5	72.4	73.3	74.2	3
Loguestown Main	90	58.5	41.3	41.7	42.3	42.8	43.3	43.8	44.3	44.8	45.3	45.8	2
Newry Main	180	103.0	79.3	80.0	81.3	82.3	83.4	84.5	85.6	86.7	87.8	88.9	3
Newtownards Main	120	78.0	44.7	45.0	45.7	46.2	46.8	47.4	48.0	48.5	49.1	49.7	2
Omagh Main	180	106.0	60.6	61.1	62.1	63.0	63.8	64.7	65.6	66.4	67.3	68.3	4
Rathgael Main	180	103.0	66.4	66.9	67.8	68.6	69.4	70.3	71.1	71.9	72.8	73.6	3
Rosebank Main	180	111.0	32.9	33.1	33.6	33.9	34.3	34.7	35.1	35.5	35.9	36.3	4
Springtown Main	180	87.9	31.6	31.9	32.4	32.7	33.1	33.4	33.8	34.2	34.5	34.9	4
Strabane Main	90	55.3	38.2	38.4	39.0	39.4	39.8	40.3	40.7	41.2	41.6	42.1	4

[4] Installed Transformer Capacity

[5] Substation Firm Capacity

Table 9-2 Winter BSP Peak Demand: Single Circuit Outage Conditions (continued)

BSP Location	Tx MVA	SS MVA	WINTER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)										Limiting factor
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Waringstown Main	180	114.3	52.1	64.8	65.5	66.0	66.6	67.1	67.7	68.3	68.8	69.4	4
Belfast - Airport Road Main	180	103	N/A	N/A	22.5	22.7	23.0	23.3	23.6	23.9	24.2	24.5	3
Belfast Central Main	180	110	63.3	64.2	66.0	67.7	69.4	71.1	72.9	74.7	76.5	78.4	7
Belfast North Main*	180	100	N/A	53.5	54.2	54.8	55.3	55.9	56.5	57.2	57.8	58.4	7
Belfast - PSW	150	100	53.2	BSP will be decommissioned									7
Carnmoney Main	180	68.5	42.0	42.4	43.0	43.6	44.1	44.7	45.2	45.8	46.4	46.9	4
Glengormley Main	60	30.8	15.1	15.3	15.5	15.7	15.9	16.1	16.3	16.5	16.7	16.9	8
Cregagh Main	150	78.9	68.1	68.7	56.0	56.8	57.6	58.4	59.2	60.0	60.9	61.7	4
Belfast - Knock Main	120	71	70.2	70.5	62.7	63.5	64.3	65.2	66.0	66.9	67.7	68.6	4
Finaghy Main	90	58.5	33.5	33.8	34.3	34.6	35.0	35.4	35.8	36.2	36.5	36.9	2
Donegall Main (North)	150	68.5	60.4	60.6	61.3	61.9	62.5	63.1	63.8	64.4	65.0	65.7	4
Donegall Main (South)	120	68.5	51.7	52.0	52.7	53.3	53.8	54.4	55.0	55.6	56.2	56.8	4

Table 9-3 Summer BSP Peak Demand: Single Circuit Outage Conditions

BSP Location	Tx MVA	SS MVA	SUMMER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)										Limiting factor
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Aghyoule Main	90	29	13.7	13.8	13.9	14.1	14.2	14.3	14.4	14.6	14.7	14.8	5
Antrim Main	180	55.3	37.0	37.2	37.7	38.2	38.6	39.1	39.5	40.0	40.4	40.9	4
Ballymena Mesh (Rural)	180	55.3	37.6	28.1	28.7	29.2	29.8	30.3	30.8	31.4	32.0	32.5	4
Ballymena SWBD (Town)	120	72.8	40.3	40.8	41.5	42.2	42.8	43.5	44.2	44.9	45.5	46.2	4
Ballynahinch Main	180	71.4	47.3	47.5	48.2	48.7	49.2	49.7	50.2	50.8	51.3	51.9	4
Banbridge Main	120	71.4	32.7	32.9	33.3	33.7	34.1	34.5	34.8	35.2	35.6	36.0	4
Coleraine Main	120	71.4	37.5	37.8	38.4	38.8	39.3	39.8	40.3	40.8	41.3	41.8	4

Table 9-3 Summer BSP Peak Demand: Single Circuit Outage Conditions (continued)

BSP Location	Tx MVA	SS MVA	SUMMER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)										Limiting factor
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Coolkeeragh Main	180	114	25.7	26.0	26.5	26.9	27.2	27.6	28.0	28.4	28.8	29.2	4
Creagh Main	120	78	19.9	29.8	30.1	30.4	30.7	31.0	31.3	31.6	31.8	32.1	2
Drumnakelly Main	180	111	80.1	73.8	75.0	76.0	77.1	78.1	79.2	80.2	81.3	82.4	4
Dungannon Main	180	114	75.4	73.4	74.7	75.7	76.8	77.9	79.0	80.1	81.2	82.3	4
Eden Main	90	37.4	26.3	26.5	26.9	27.2	27.4	27.7	28.0	28.4	28.7	29.0	4
Enniskillen Main	150	73	43.2	43.5	44.2	44.8	45.3	45.9	46.5	47.1	47.7	48.3	4
Larne Main	90	55.3	36.7	37.0	37.5	37.9	38.3	38.8	39.2	39.6	40.1	40.5	4
Limavady Main	90	40.3	20.9	21.1	21.4	21.7	22.0	22.3	22.5	22.8	23.1	23.4	4
Lisaghmore Main	90	58.5	40.6	40.9	41.5	42.0	42.6	43.1	43.7	44.2	44.8	45.4	2
Lisburn Main	180	100	53.4	53.8	54.6	55.3	56.0	56.6	57.4	58.1	58.8	59.5	3
Loguestown Main	90	58.5	33.2	33.4	33.9	34.3	34.7	35.1	35.5	35.9	36.3	36.8	2
Newry Main	180	103	63.7	64.2	65.2	66.0	66.9	67.8	68.6	69.5	70.4	71.4	3
Newtownards Main	120	78	35.8	36.1	36.7	37.1	37.6	38.0	38.5	38.9	39.4	39.9	2
Omagh Main	180	106	48.6	49.1	49.8	50.5	51.2	51.9	52.6	53.3	54.0	54.8	4
Rathgael Main	180	103	53.3	53.7	54.4	55.1	55.7	56.4	57.0	57.7	58.4	59.1	3
Rosebank Main	180	111	26.4	26.6	26.9	27.2	27.5	27.8	28.1	28.5	28.8	29.1	4
Springtown Main	180	87.9	25.3	25.6	26.0	26.2	26.5	26.8	27.1	27.4	27.7	28.0	4
Strabane Main	90	55.3	30.6	30.8	31.3	31.6	31.9	32.3	32.7	33.0	33.4	33.8	4
Waringstown Main	180	114.3	41.8	52.0	52.5	53.0	53.4	53.9	54.3	54.8	55.2	55.7	4
Belfast - Airport Road Main	180	103	N/A	N/A	18.0	18.3	18.5	18.7	18.9	19.2	19.4	19.7	3
Belfast Central Main	180	110	50.8	51.5	53.0	54.3	55.7	57.1	58.5	59.9	61.4	62.9	7
Belfast North Main*	180	100	N/A	42.9	43.5	43.9	44.4	44.9	45.4	45.9	46.4	46.9	7
Belfast - PSW	150	100	42.7	BSP will be decommissioned									7
Carnmoney Main	180	68.5	33.7	34.0	34.5	35.0	35.4	35.8	36.3	36.7	37.2	37.7	4
Glengormley Main	60	30.8	12.1	12.3	12.4	12.6	12.7	12.9	13.0	13.2	13.4	13.5	8
Cregagh Main	150	78.9	54.7	55.2	44.9	45.6	46.2	46.9	47.5	48.2	48.8	49.5	4
Belfast - Knock Main	120	71	56.3	56.6	50.3	51.0	51.6	52.3	53.0	53.6	54.3	55.0	4

Table 9-3 Summer BSP Peak Demand: Single Circuit Outage Conditions (continued)

BSP Location	Tx MVA	SS MVA	SUMMER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)										Limiting factor
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Finaghy Main	90	58.5	26.9	27.1	27.5	27.8	28.1	28.4	28.7	29.0	29.3	29.6	2
Donegall Main (North)	150	68.5	48.4	48.6	49.2	49.7	50.2	50.7	51.2	51.7	52.2	52.7	4
Donegall Main (South)	120	68.5	41.5	41.7	42.3	42.7	43.2	43.7	44.1	44.6	45.1	45.6	4

9.3.1 Bulk Supply Point Available Capacity

The available capacity at each BSP can be determined by comparing the forecast loading to the substation's firm capacity over the study period. It will be necessary to carry out further detailed analysis depending on the magnitude and type of load to be connected, to establish if a connection is viable.

9.3.2 Conclusion

Currently, all Northern Ireland customers are connected to the Distribution System at 33 kV level or below. The Transmission System could cope with continued small scale customer connections at 33 kV and below, but the cumulative impact on the Transmission System must be carefully monitored.

In general, the connection of additional load assists the process of connecting local variable distributed generation. The difficulty for network planning is that the system must be able to maintain supplies to customers at times of low renewable generation output. SONI is aware of the increased generation connection activity at distribution level are are liaising closely with NIE to ensure Transmission Planning and Security Standards are maintained.

Large bulk transmission demand connections in excess of 50 MW will require careful study to determine their impact. Large 275 kV demand connections at major power sources such as Ballylumford, Moyle, Coolkeeragh and Kilroot could be connected without major 275 kV upgrading. However, large connections in the North West area, or in Belfast, will be dependent on additional reactive power support to ensure voltage stability for critical 275 kV contingencies.

A Maps and Schematic Diagrams

A.1 Network Maps
A.2 Short Bus Codes
A.3 Schematic Diagrams of the All-Island Transmission System

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 2013 and as planned for 2023. These maps are also included in A3 format in Appendix J for greater legibility.

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 2013;
- Figure A-2 is a map of the existing Transmission System including planned Transmission System developments as at December 31^{st} 2023.

Note 1: The location of Bellacorick 400/110 kV station is currently unknown but shown at Bellacorick existing 110 kV station in the geographical maps of the All-Island Transmission System for simplicity. The meshed node for connecting Bellacorick 400 kV circuit has yet to be determined.

Note 2: The location of Great Island and Knockraha 400/220 kV stations are currently unknown but shown at Great Island and Knockraha existing 220 kV stations in the geographical maps of the All-Island Transmission System for simplicity.

These maps are also included in A3 format in Appendix J for greater legibility.

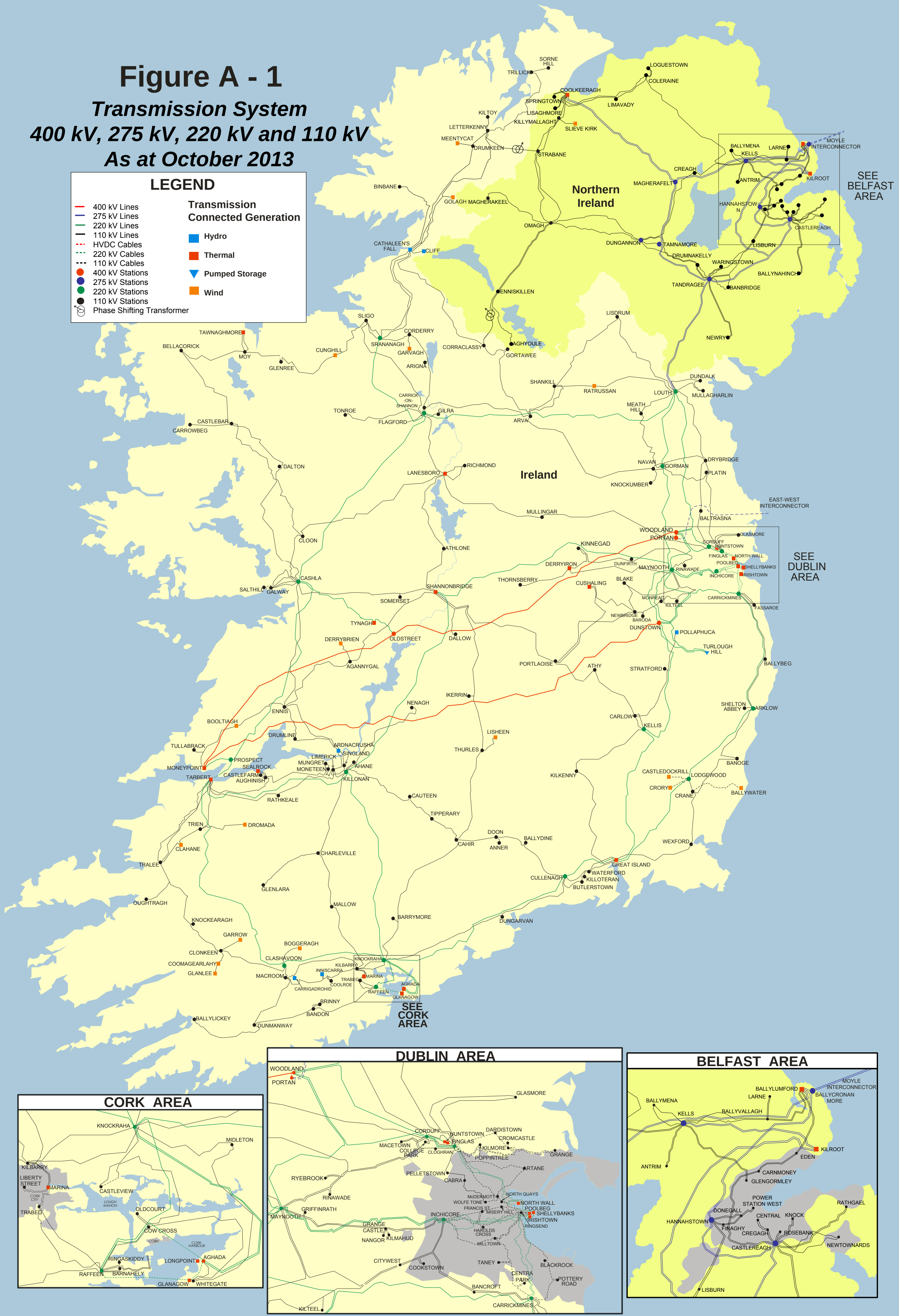


Figure A - 1

Transmission System

400 kV, 275 kV, 220 kV and 110 kV

As at October 2013

Figure A - 2

Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at Year End 2023

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
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
BLC	Belcamp
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
BRY	Barnahely
BUT	Butlerstown
BVG	Ballyvallagh
BVK	Ballyvouskill
BWR	Ballywater
BY	BallaKelly
BYC	Ballycronan More (Moyle)
BYH	Ballynahulla
CAH	Cahir
CAR	Belfast - Carnmoney Main
CAS	Castlereagh

Short Bus Code	Full Name
CBG	Carrowbeg
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
CKG	Corkagh
CKM	Carrickmines
CKN	Clonkeen
CL	Cliff
CLA	Clashavoon
CLG	Cloghran
CLH	Clahane
CLN	Cloon
CLO	Clogher
CLW	Carlow
COL (I)	College Park
COL (N)	Coleraine Main
COR	Corraclassy
COS	Carrick-on-Shannon
COW	Cow Cross

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
CPS	Coolkeeragh Main
CRA	Crane
CRE	Belfast - Cregagh Main
CRF	Cronacarkfree
CRG	Creagh Main
CRO	Coolroe
CSH	Cashla
CTN	Cauteen
CUI	Cuilleen
CUL	Cullenagh
CUN	Cunghill
CUS	Cushaling
CVW	Castleview
DAL	Dallow
DDK	Dundalk
DER	Derryiron
DFR	Dunfirth
DGN	Dungarvan
DLN	Derrylyn
DLT	Dalton
DMY	Dunmanway
DON	Belfast - Donegall Main (North)
DON	Belfast - Donegall Main (South)
DOO	Doon
DQN	Drumquin Cluster
DRM	Drumkeen
DRO	Dromada
DRU (I)	Drumline
DRU (N)	Drumnakelly Main
DRY	Drybridge
DSN	Dunstown
DUN	Dungannon Main

Short Bus Code	Full Name
DYN	Derrybrien
EDE	Eden Main
ENN (I)	Ennis
ENN (N)	Enniskillen Main
FAS	Fassaroe
FIN (I)	Finglas
FIN (N)	Belfast - Finaghy Main
FLA	Flagford
FNT	Finnstown
GAE	Glanlee
GAL	Galway
GAR	Garvagh
GCA	Grange Castle
GGO	Glanagow
GI	Great Island
GIL	Gilra
GLA	Glasmore
GLE (I)	Glenlara
GLE (N)	Belfast - Glengormley Main
GLR	Glenree
GOL	Golagh
GOR (I)	Gorman
GOR (N)	Gort
GRA	Grange
GRI	Griffinrath
GRO	Garrow
GWE	Gortawee
HAN	Hannastown
HN	Huntstown
HTS	Hartnett's Cross
IA	Inniscarra
IKE	Ikerrin

Short Bus Code	Full Name
INC	Inchicore
ISH	Irishtown
KBY	Kilbarry
KCR	Knockacummer
KEL	Kells
KER	Knockearagh
KHL	Kill Hill
KIN	Kinnegad
KKY	Kilkenny
KLM	Kilmore
KLG	Kilgarvan
KLN	Killonan
KLS	Kellis
KMT	Killymallaght
KNG	Knocknagashel
KNO	Belfast - Knock Main
KNR	Knockanure
KNV	Knockavanna
KNY	West Galway
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

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
LIM (N)	Limavady Main
LIS (I)	Lisdrum
LIS (N)	Lisburn Main
LMR	Lisaghmore Main
LOG	Loguestown Main
LOU	Louth
LPT	Longpoint
LSE	Laois
LSN	Lisheen
LWD	Lodgewood
MAC	Macroom
MAG	Magherafelt
MAL	Mallow
MAN	Mid Antrim
MAY	Maynooth
MCE	Macetown
MEE	Meentycat
MID	Midleton
MHL	Misery Hill
MIL	Milltown
MKL	Magherakeel
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
NAN (N)	North Antrim
NAR	Newtownards Main
NAV	Navan
NBY	Newbury
NEN	Nenagh

Short Bus Code	Full Name
NEW (I)	Newbridge
NEW (N)	Newry Main
NO	Nore
NW	North Wall
NQS	North Quays
OLD	Oldcourt
OMA	Omagh Main
OMS	Omagh South
OST	Oldstreet
OUG	Oughtragh
PA	Pollaphuca
PB	Poolbeg
PLA	Platin
PLS	Portlaoise
PRO	Prospect
PSW	Belfast - PSW
RAF	Raffeen
RAT (I)	Rathkeale
RAT (N)	Rathgael Main
RE	Ringsend
REM	Reamore
RIC	Richmond
RNW	Rinawade
ROS	Rosebank Main
RRU	Ratrussan
RSY	Ringaskiddy
RYB	Ryebrook
SAL	Salthill
SBN	Strabane
SCR	Screeb
SDN	South Down
SH	Shannonbridge
SHE	Shelton Abbey
SHL	Shellybanks
SK	Sealrock
SKL	Shankill
SLI	Sligo
SLB	Sliabh Bawn

Short Bus Code	Full Name
SNG	Singland
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
TIP	Tipperary
TIV	Tievebrack
TLK	Trillick
TMN	Tamnamore
TON	Tonroe
TID	Tidal
TRE	Tremoge
TRI	Trien
TRL	Tralee
TSB	Thornsberry
TYN	Tynagh
UGL	Uggool
WAR	Waringstown Main
WAT	Waterford
WEX	Wexford
WHI	Whitegate
WOO	Woodland

A.3 SCHEMATIC DIAGRAMS OF THE ALL ISLAND TRANSMISSION SYSTEM

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 or hydro) at a station is also displayed. Table A-2 indicates the diagram conventions.

The schematic diagram for 2014 highlights the developments due to be completed in 2014. The schematic diagram for 2023 highlights the developments due to be completed in 2023.

In all diagrams blue shading represents a new development and orange shading denotes a circuit uprating.

Table A-2 Schematic Legend

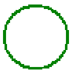
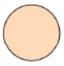
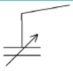
Symbol	Network Element Represented
	110 kV circuit
	220 kV circuit
	275 kV circuit
	400 kV circuit
	System Link
	110 kV Busbar
	220 kV Busbar
	275 kV Busbar
	400 kV Busbar
	Busbar with Thermal Generation
	Busbar with Wind Generation
	Busbar with Hydro Generation
	Busbar with Wind and Thermal Generation
	Busbar with Wind and Hydro 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
	Normally Open Point

Figure A-3 Schematic Diagram of the All-Island Transmission System at Year End 2014

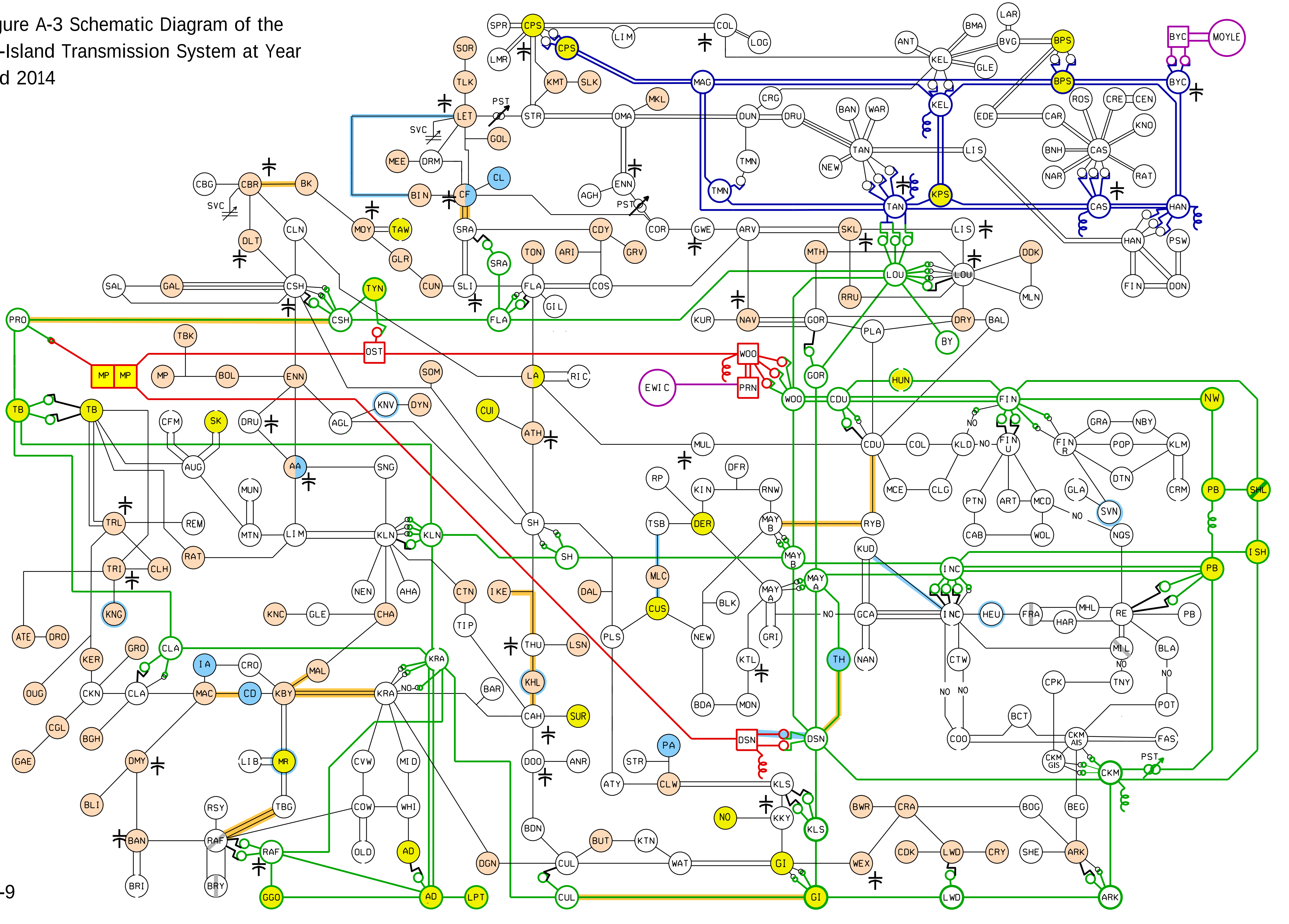
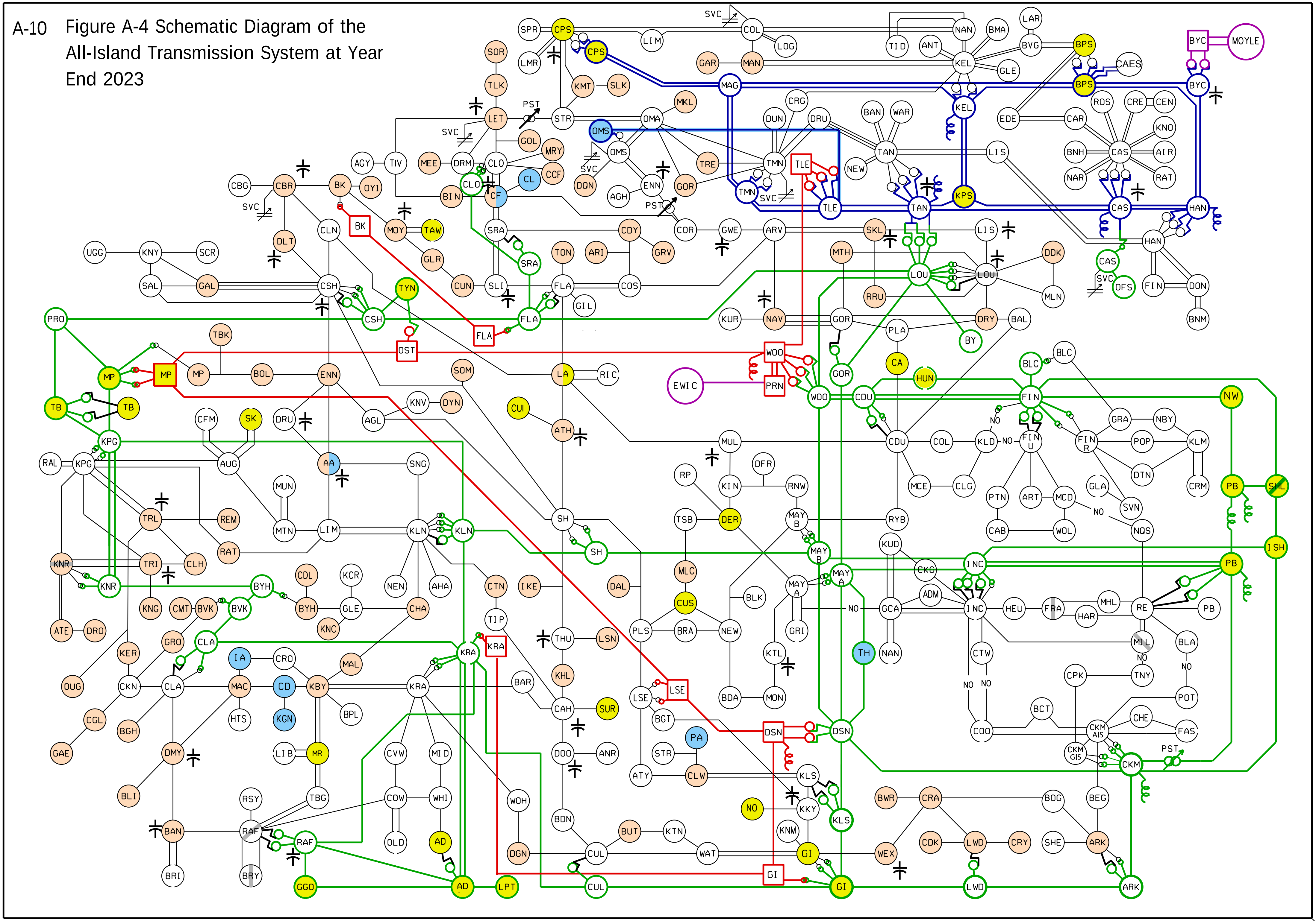


Figure A-4 Schematic Diagram of the All-Island Transmission System at Year End 2023



B Transmission System Characteristics

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, and developments necessary to connect new generation and demands to the transmission system as at the beginning of October and December 2013.

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.

The electrical characteristics of the all-island transmission system at the four nominal voltage levels are quoted in per unit to an MVA base of 100, and the applicable reference voltage as reflected in Table B-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 i.e. 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	0.029	0.000	1424	1713

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	0.002	0.021	0.128	710	820	881
LOU	TAN	2	49.8	0.002	0.021	0.128	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	0.039	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	0.035	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	26.1	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	KRA	1	25.6	0.003	0.022	0.034	434	534
AD	RAF	1	15.2	0.001	0.008	0.259	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	0.0053	0.039	0.059	434	534
CLA	TB	1	97.3	0.011	0.084	0.127	434	534
CSH	FLA	1	88.1	0.010	0.076	0.115	405	405
CSH	PRO	1	88.5	0.0103	0.077	0.116	434	436
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	23.0	0.0027	0.020	0.030	248	414
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
GI	LWD	1	47.9	0.006	0.042	0.063	434	534
GOR	LOU	1	32.4	0.004	0.028	0.042	434	534

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
GOR	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	19.1	0.002	0.017	0.025	323	389
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
KRA	RAF	1	23.4	0.003	0.020	0.031	405	405
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	0.002	0.017	0.025	323	389
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	CKM	1	14.5	0.001	0.005	0.618	267	267
PB	INC	1	12.5	0.001	0.004	0.504	267	267
PB	INC	2	11.3	0.001	0.003	0.722	351	351
PRO	TB	1	10.3	0.001	0.007	0.173	381	381

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		125
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	1	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

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
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	178		219
DRO	TRI	1	16.3	0.011	0.044	0.057	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	178		219
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
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	1	14.2	0.019	0.049	0.005	82	95	103
BCT	CKM	1	3.1	0.002	0.005	0.031	140		140
BDA	MON	1	12.5	0.012	0.037	0.031	120		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	187		221
BDN	DOO	1	11.3	0.018	0.039	0.004	105		128
BEG	CKM	1	32.3	0.015	0.116	0.010	136		166

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
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		185
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
BMA	KEL	1	10	0.013	0.035	0.003	109	119	124
BMA	KEL	1	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	1	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	1	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	11.6	0.018	0.04	0.004	105		128
BUT	KTN	1	2.7	0.004	0.009	0.001	105		128
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	1	7.1	0.007	0.023	0.002	79	96	113
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	39	0.041	0.130	0.013	99		219
CAH	TIP	1	18.1	0.028	0.063	0.006	105		128
CAH	THU	1	39.0	0.041	0.130	0.013	136		166

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
CAR	CAS	1	24.7	0.037	0.087	0.008	69	80	86
CAR	CAS	1	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	1	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	1	3	0.001	0.004	0.061	132	132	145
CAS	KNO	1	4.6	0.005	0.004	0.044	66	66	73
CAS	KNO	1	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	1	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)	1	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	1	1.9	0.001	0.002	0.026	117	117	128
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	105		128
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	0.012	0.039	0.021	103		130
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	1	4.2	0.001	0.004	0.030	144	144	144
CF	CL	1	5.5	0.006	0.018	0.002	136		166
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
CF	GOL T	1	25.5	0.036	0.093	0.009	99		125
CF	SRA	1	53	0.065	0.179	0.021	187		190
CGL	CKN	1	6.3	0.004	0.021	0.002	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
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
CHA	KLN	1	36.9	0.039	0.123	0.013	136		166
CHA	MAL	1	22.5	0.035	0.077	0.007	63		99
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
CKM	FAS T	1	2.9	0.005	0.010	0.001	107		126
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	KLN	1	3.6	0.003	0.011	0.008	136		166
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)	KLN	1	5.1	0.003	0.013	0.038	99		124
COL (N)	CPS	1	46.7	0.061	0.161	0.015	82	95	103
COL (N)	KEL	1	58.9	0.070	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	1	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	178		219
COS	ARI T	1	20.7	0.022	0.069	0.007	120		125
COS	FLA	1	3.4	0.005	0.012	0.001	99		125
COS	FLA	2	3.3	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

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
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
CPK	TAN	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	1	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	0.048	0.127	0.018	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	0.002	0.009	0.001	178		219
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	0.021	0.046	0.004	105		128
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	34.3	0.053	0.116	0.016	105		128
CUL	WAT	1	13.1	0.006	0.033	0.055	178		219
CUN	GLR	1	25.9	0.040	0.089	0.008	99		222
CUN	SLI	1	21.3	0.033	0.073	0.007	99		126

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
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
DAL	DAL T	1	12.2	0.019	0.042	0.004	105		128
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
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)	1	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	1	5.8	0.002	0.005	0.140	144	144	158
DON	PSW	1	6.3	0.006	0.006	0.066	75	75	82
DON	PSW	1	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
DRO	TRI	1	16.3	0.011	0.044	0.057	140		140
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	0.097	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	96	106	119
DRY	GOR	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	0.043	0.125	0.012	186	191	193
DUN	OMA	2	39.5	0.047	0.136	0.013	186	191	193
DUN	TMN	1	5.9	0.004	0.016	0.005	139	144	152
ENN (N)	OMA	1	33.8	0.044	0.113	0.011	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
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
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	1	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	99		125
FLA	TON	1	32.3	0.050	0.111	0.010	99		126
FRA	HAR	1	2.3	0.002	0.004	0.030	107		107
FRA	HEU	1	2.4	0.002	0.004	0.024	140		140
FRA	INC	1	5.6	0.004	0.010	0.073	107		107
FRA	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	124		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
GLA	SVN	1	18	0.017	0.055	0.052	136		154
GLE (N)	KEL	1	21.4	0.027	0.068	0.027	82	82	90

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
GLE (N)	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	MTH	1	27.3	0.028	0.090	0.013	136		166
GOR	NAV	1	5.3	0.008	0.019	0.002	99		125
GOR	NAV	2	6.3	0.009	0.022	0.002	99		125
GOR	NAV	3	6.5	0.007	0.022	0.002	136		166
GOR	PLA	1	19.7	0.030	0.068	0.006	99		125
GRA	KLM	1	5.9	0.002	0.005	0.106	119		119
GRI	GRI T	1	1.0	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
HAN	LIS (N)	1	9.2	0.009	0.026	0.018	80	93	100
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	18.1	0.028	0.063	0.006	105		128
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
KER	OUG T	1	22.6	0.014	0.074	0.008	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	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	LIM (I)	2	11.7	0.018	0.040	0.009	80		110
KLN	NEN	1	33.6	0.052	0.116	0.011	105		128
KLN	SNG	1	4.1	0.003	0.013	0.003	178		219
KMT	SLK	1	6.2	0.008	0.018	0.006	97	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	0.014	0.04	0.004	105		128
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

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
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
LA	RIC	2	12.5	0.020	0.043	0.005	105		124
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
LIB	MR	2	2.7	0.002	0.003	0.017	120		131
LIM (I)	MTN	1	6.5	0.005	0.025	0.003	178		219
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	1	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	105		128
MAL	KBY	1	29.1	0.03	0.097	0.01	136		166
MAY	BLK T	1	30.9	0.032	0.103	0.011	136		166
MAY	GRI	1	2.2	0.002	0.007	0.002	103		120
MAY	GRI T	1	2.2	0.003	0.009	0.001	105		128
MAY	RNW	1	7.1	0.008	0.024	0.002	103		128
MAY	RYB	1	9	0.009	0.030	0.005	136		166
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	130		130
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	120		131
MIL	TAN	1	5.5	0.003	0.006	0.070	100		100

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
MKL	OMA	1	37.5	0.028	0.107	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		128
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		143
MR	KBY	2	4.0	0.004	0.013	0.003	99		143
MR	TBG	1	3.3	0.004	0.005	0.044	79		79
MR	TBG	2	2.9	0.002	0.003	0.028	79		79
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	1	24	0.031	0.080	0.008	82	95	103
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	82	95	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	DAL T	1	54.7	0.034	0.178	0.019	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 C	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
SH	DAL T	1	12	0.008	0.039	0.007	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
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
SOM	SOM T	1	2.0	0.003	0.007	0.001	105		128
SOR	TLK	1	4.4	0.007	0.015	0.002	105		128
SRA	CF	2	49.2	0.062	0.166	0.016	105		128
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	1	12.9	0.013	0.042	0.005	79	96	113
TB	TRI	1	20.5	0.021	0.069	0.007	120		128
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	0.027	0.087	0.009	80		129
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	0.018	N/A	
Total	2,550				

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	30	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
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
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	0.0018	0.0656	0.0018	0.2375	0	0.1575	240	240	30	1.15	0.85	19
Tamnamore IBTx 1	0.0018	0.0656	0.0018	0.2375	0	0.1449	240	240	30	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	0.0000	0.1635	0.0000	0.3040	0	0.1635	110	55	55	1.15	0.85	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%
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	7%	17%
Cashla T2101[1]	250	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 T2106	250	0.001	0.064	9%	17%
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 T2102	250	0.001	0.056	9%	17%
Inchicore T2103	250	0.000	0.060	9%	18%
Inchicore T2104	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	63	0.000	0.063	9%	18%
Killonan T2104	125	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%	17%

[1] 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	+	-
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[2]	250	0.001	0.064	9%	17%
Maynooth T2103	125	0.002	0.132	27%	18%
Maynooth T2104	250	0.001	0.064	9%	17%
Poolbeg TF3	250	0.001	0.059	8%	17%
Poolbeg TF4	250	0.001	0.061	8%	17%
Raffeen T2101[2]	250	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[2]	250	0.001	0.055	9%	17%
Tarbert T2102[2]	250	0.001	0.055	9%	17%
Total	10,802				

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

[2] Transformer limited to 238 MVA at 110 kV by the 110 kV switchgear

Table B-12 Characteristics of Existing Reactive Compensation

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Athlone	ATH 110	2 Capacitors (1 Mobile)	60	
Bandon	BAN 110	1 Capacitor	15	
Cahir	CAH 110	4 Capacitors	60	
Carrickmines	CKM 220	1 Shunt Reactor		100
Cashla	CSH 110	2 Capacitors	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	1 Capacitor	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	30	
Moyle	BYC 275	4 Capacitors (4 x 59)	236	
Mullingar	MUL 110	2 Capacitors (2x15)	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	
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	30	
Tralee	TRL 110	1 Capacitor	30	
Trien	TRI 110	1 Capacitor	30	
Wexford	WEX 110	2 Capacitors	30	
Woodland	WOO 400	1 Shunt Reactor		80
Slieve Kirk	SKIR20 20	1 Capacitor	13	-
Total			1,559	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 2014

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Add	110	AGL	KNV	1	6.0	0.0	0.021	0.002	128		141
Remove	110	AGL	DYN	1	...	...	...	...	...		...
Add	110	ATE	DRO	1	7.2	0.005	0.011	0.072	140		140
Add	110	ATE	TRI	1	11.2	0.007	0.036	0.004	178		219
Amend	110	BDN	DOO	1	11.3	0.007	0.037	0.004	178		219
Add	110	BIN	LET	1	69.0	0.072	0.230	0.024	136		166
Amend	110	BK	CBR	1	37.4	0.058	0.128	0.013	99		185
Amend	110	BUT	KTN	1	2.7	0.004	0.010	0.001	200		221
Amend	110	BUT	CUL	1	12.3	0.008	0.038	0.013	192		192
Add	110	CAH	KHL	1	21.8	0.0	0.066	0.033	219		241
Remove	110	CAH	THU	1	...	...	...	...	...		...
Amend	110	CD	MAC	1	2.4	0.004	0.008	0.001	99		219
Amend	110	CDU	RYB	1	13.0	0.014	0.043	0.005	218		236
Amend	110	CHA	MAL	1	22.5	0.014	0.073	0.008	178		219
Amend	220	CLA	KRA	1	45.0	0.006	0.039	0.061	761		804
Amend	110	COL(N)	KEL(N)	1	58.9	0.1	0.201	0.020	109	119	124
Amend	220	CSH	PRO	1	88.5	0.010	0.077	0.116	327		534
Amend	110	CUL	DGN	1	34.3	0.021	0.110	0.021	178		219
Amend	220	CUL	GI	1	23.0	0.003	0.020	0.031	248		833
Add	110	CUS	MLC	1	13.7	0.015	0.048	0.005	136		166
Add	110	ATH	CUI	1	2.3	0.002	0.003	0.023	140		140
Add	220	BY	LOU	1	1.5	0.000	0.001	0.041	593		593

Table B-13 Changes in Circuit Characteristics Expected in 2014 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Remove	110	DGN	KRA	1	...	...	...	...	...		...
Remove	110	DRO	TRI	1	...	...	...	...	...		...
Add	110	DYN	KNV	1	2.03	0.0	0.007	0.001	128		141
Add	110	DGN	WOH	1	8.7	0.0	0.028	0.003	219		241
Amend	110	IA	MAC	1	18.6	0.027	0.068	0.006	187		222
Add	110	INC	KUD	1	9.8	0.0	0.011	0.108	171		188
Amend	220	INC	MAY	2	19.1	0.003	0.016	0.026	793		833
Add	110	KHL	THU	1	21.8	0.0	0.066	0.033	219		241
Add	110	KNG	TRI	1	13.5	0.0	0.029	0.089	177		195
Add	110	KRA	WOH	1	45.4	0.0	0.147	0.016	219		241
Amend	110	KRA	KBY	1	11.9	0.014	0.040	0.004	99		219
Amend	110	MAL	KBY	1	29.1	0.030	0.097	0.010	136		219
Amend	110	MAY	RYB	1	8.9	0.009	0.030	0.003	136		166
Amend	220	MAY	INC	1	19.1	0.003	0.016	0.026	793		833
Add	110	MLC	TSB	1	19.2	0.020	0.064	0.007	136		166
Amend	110	MR	TBG	1	3.3	0.001	0.004	0.036	187		223
Amend	110	MR	TBG	2	3.3	0.001	0.004	0.036	187		223
Amend	220	PRO	TB	1	10.3	0.001	0.007	0.173	461		461
Amend	110	RAF	TBG	1	10.6	0.016	0.036	0.005	105		219
Amend	110	SRA	CF	2	49.2	0.062	0.166	0.016	99		219
Amend	110	THU	IKE T	1	25.9	0.027	0.087	0.009	80		219
Add	110	KKY	NO	1	3.6	0.003	0.005	0.036	140		140

Table B-14 Changes in Circuit Characteristics Expected in 2015

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Add	110	AGY	TIV	1	35	0.054	0.12	0.011	105		128
Add	110	ATE	KNR	1	9	0.006	0.029	0.003	178		219
Add	110	PLS	SLB	1	9.2	0.006	0.030	0.0033	178		219
Add	110	LA	KPN	1	32	0.020	0.104	0.0113	178		219

Table B-14 Changes in Circuit Characteristics Expected in 2015(continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Remove	110	ATE	TRI	1	...	...	...	...	...		...
Remove	110	BIN	LET	1	...	...	...	...	...		...
Add	110	BIN	TIV	1	23.2	0.024	0.077	0.008	136		166
Add	110/33	BNM	BNM	1	...	0.004	0.246	...	90	90	90
Add	110/33	BNM	BNM	2	...	0.004	0.246	...	90	90	90
Add	110	BNM	DON	1	5.1	0.005	0.005	0.053	75	75	82
Add	110	BNM	DON	2	5.1	0.005	0.005	0.053	75	75	82
Add	110	BRA	NEW(I)	1	9.3	0.01	0.031	0.003	136		166
Add	110	BRA	PLS	1	19.3	0.03	0.067	0.006	105		128
Add	220	BVK	BYH	1	14.5	0.002	0.012	0.02	761		804
Add	220	BVK	CLA	1	18.4	0.003	0.016	0.025	761		804
Add	110	BVK	GRO	1	7	0.004	0.023	0.003	178		219
Add	110	BYH	GLE (I)	1	12.5	0.008	0.041	0.004	178		219
Add	110	CA	CDU	1	36.9	0.023	0.12	0.013	178		219
Add	110	CA	PLA	1	0.9	0.001	0.003	0	178		219
Add	110	CAH	SUR	1	0	0.002	0.005	0.035	118		118
Amend	110	CAH	TIP	1	18.1	0.011	0.059	0.006	178		219
Add	110	CDL	BYH	1	9	0.002	0.01	0.099	209		223
Remove	110	CDU	PLA	1	...	...	...	...	...		...
Add	110	CKG	INC	1	9.6	0.002	0.011	0.105	187		223
Add	110	CKG	KUD	1	0.8	0	0.001	0.008	187		223
Add	110	CLA	DMY	1	35	0.022	0.114	0.012	178		219
Remove	220	CLA	TB	1	...	...	...	...	...		...
Remove	110	CRG	DUN	1	...	...	...	...	...	...	...
Amend	110	CTN	KLN	1	28	0.018	0.091	0.01	178		219
Amend	110	CTN	TIP	1	13.2	0.008	0.043	0.005	178		219
Amend	110	CUN	SLI	1	21.3	0.03	0.073	0.007	187		222
Remove	110	DON	PSW	1	...	...	...	...	...	...	...
Remove	110	DON	PSW	2	...	...	...	...	...	...	...
Remove	110	DRU (N)	DUN	1	...	...	...	...	...	...	...
Remove	110	DRU (N)	DUN	2	...	...	...	...	...	...	...

Table B-14 Changes in Circuit Characteristics Expected in 2015(continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Add	110	DRU (N)	TMN	1	22.2	0.028	0.073	0.012	82	95	103
Add	110	DRU (N)	TMN	2	22.5	0.029	0.075	0.008	82	95	103
Add	110	GLE (I)	KCR	1	11.2	0.008	0.017	0.112	140		140
Remove	110	GRA	KLM	1	...	...	...	...	...		...
Add	110	GRA	NBY	1	5.1	0.002	0.005	0.089	119		119
Add	110	HTS	MAC	1	4.5	0.007	0.016	0.002	105		128
Remove	110	INC	KUD	1	...	...	...	...	...		...
Add	110	KIN	MUL	1	27	0.017	0.088	0.01	178		219
Add	110	KLM	NBY	1	1.2	0.001	0.001	0.02	119		119
Add	110/33	KNO	KNO	1	...	0.004	0.246	...	90	90	90
Add	110/33	KNO	KNO	2	...	0.004	0.246	...	90	90	90
Remove	110/33	KNO	KNO	1	...	...	...	...	...	...	...
Remove	110/33	KNO	KNO	2	...	...	...	...	...	...	...
Add	220	KNR	BYH	1	47	0.006	0.04	0.064	761		804
Add	220	KNR	KPG	1	20	0.001	0.008	0.547	593		593
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
Add	110	KNY	GAL	1	20.9	0.009	0.045	0.121	178		219
Add	110	KNY	SAL	1	16.8	0.009	0.046	0.049	178		219
Add	110	KNY	UGL	1	7	0.004	0.023	0.003	178		219
Add	220	KPG	MP	1	5	0	0.002	0.137	593		593
Add	110	KLG	BVK	1	30	0.019	0.098	0.011	178		219
Add	110	LET	TIV	1	45.2	0.047	0.151	0.015	136		166
Remove	275	MAG	TAN	1	...	...	...	...	...	...	...
Add	275	MAG	TMN	2	25.6	0.001	0.011	0.065	710	820	881
Amend	110	MP	TBK T	1	6.6	0.004	0.022	0.002	178		219
Remove	110	NEW (I)	PLS	1	...	...	...	...	...		...
Remove	110/33	PSW	PSW	1	...	...	...	...	...	...	...
Remove	110/33	PSW	PSW	2	...	...	...	...	...	...	...
Add	110	SCR	KNY	1	26	0.027	0.087	0.009	136		166
Remove	110	TB	TRI	1	...	...	...	...	...		...

Table B-14 Changes in Circuit Characteristics Expected in 2015(continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Add	110	TMN	CRG	1	35.5	0.045	0.119	0.022	109	119	124
Add	110	TMN	DUN	2	7	0.009	0.023	0.002	82	95	103
Add	275	TMN	TAN	2	5.4	0.001	0.011	0.065	710	820	881
Remove	110	TRE	DUN	1	...	...	...	...	...	...	...
Add	110	TRE	TMN	1	25.2	0.025	0.08	0.024	185	190	193

Table B-15 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	August	Winter
Amend	110	AA	ENN(I)	1	33	0.021	0.107	0.012	178		219
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	110/33	AIR	AIR	1	...	0.004	0.246	...	90	90	90
Add	110/33	AIR	AIR	2	...	0.004	0.246	...	90	90	90
Add	110	AIR	CAS	1		0.009	0.022	0.004	82	95	103
Add	110	AIR	CAS	2		0.009	0.022	0.004	82	95	103
Add	110	AUG	KPG	1	32.8	0.021	0.107	0.012	178		219
Remove	110	AUG	TB	1	...	...	...	...	...		...
Add	110	BAR	CAH	1	44.5	0.066	0.153	0.014	105		128
Add	110	BAR	KRA	1	19.7	0.02	0.066	0.007	136		166
Amend	110	BOL	ENN (I)	1	24	0.015	0.078	0.009	105		219
Amend	110	BOL	TBK T	1	19.6	0.012	0.064	0.007	105		219
Remove	110	CAH	BAR	1	...	...	...	...	...		...
Amend	110	CAS	ROS	1	1.9	0.001	0.003	0.015	144	144	144
Amend	110	CAS	ROS	2	1.9	0.001	0.003	0.015	144	144	144
Add	110	CF	CLO	2	25.9	0.037	0.094	0.009	187		222
Remove	110	CF	DRM	1	...	...	...	...	...		...
Remove	110	CF	GOL T	1	...	...	...	...	...		...

Table B-15 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	August	Winter
Add	110	CHE	FAS	1	2.2	0.004	0.008	0.001	105		128
Add	110	CKM	CHE	1	4	0.004	0.008	0.03	105		128
Add	110	CLO	CF	1	26.5	0.016	0.085	0.016	178		219
Add	110	CLO	GOL T	1	0.3	0	0.001	0.001	187		222
Add	110	CLO	MRY	1	7.4	0.005	0.011	0.074	124		124
Amend	110	COL(N)	CPS	1	46.6	0.053	0.16	0.016	185	190	193
Remove	110	COL(N)	KEL	1	...	...	...	...	...	...	...
Amend	110	COL(N)	LIM(N)	1	18.6	0.022	0.064	0.006	185	190	193
Add	110	COL(N)	MAN	1	26	0.024	0.069	0.007	185	190	193
Amend	110	CPS	LIM(N)	1	29.5	0.032	0.101	0.01	185	190	193
Add	110	DRM	CLO	1	27	0.039	0.091	0.015	103		128
Remove	110	DUN	OMA	2	...	...	...	...	...	...	...
Remove	110	FAS	CKM	1	...	...	...	...	...		...
Add	110	FRA	TRN	1	2.8	0.002	0.004	0.028	140		140
Remove	110	GCA	INC	1	...	...	...	...	...		...
Add	110	GOR (N)	OMA	1		0.011	0.066	0.006	190	200	213
Add	110	GOR (N)	OMA	1		0.011	0.066	0.006	190	200	213
Add	110	GOR (N)	TMN	1		0.021	0.131	0.013	190	200	213
Add	110	KEL	MAN	1	44.9	0.039	0.133	0.013	185	190	193
Add	110	KEL	MAN	1	44.9	0.039	0.133	0.013	185	190	193
Add	110	KNR	KPG	1	15	0.015	0.05	0.005	136		166
Add	110	KPG	RAT(I)	1	32.2	0.033	0.108	0.011	136		166
Add	220	KPG	TB	1	2.8	0	0.003	0.004	120		802
Add	110	KPG	TB	1	1.6	0.002	0.006	0.001	120		128
Add	220	KPG	TB	2	2.8	0	0.002	0.004	120		804
Add	110	KPG	TB	2	1.6	0.002	0.006	0.001	120		128
Add	110	KPG	TRL	1	39.4	0.06	0.135	0.013	105		128
Add	110	KPG	TRL	2	44.4	0.028	0.144	0.016	178		219
Remove	110	DMY	MAC	1	...	...	...	...	...		...
Add	110	DMY	BDV	1	15.6	0.0223	0.057	0.0052	187		222
Add	110	MAC	BDV	1	10.61	0.0152	0.0388	0.0036	187		222

Table B-15 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	August	Winter
Remove	110	KRA	BAR	1	...	...	...	...	...		...
Add	110	MHL	TRN	1	1.4	0.001	0.002	0.014	140		140
Add	110	OMA	TRE	1	21.3	0.025	0.073	0.007	186	190	193
Remove	110	RAT(I)	TB	1	...	...	...	...	...		...
Remove	110	TB	TRL	1	...	...	...	...	...		...
Add	110	CRF	CLO	1	18	0.011	0.059	0.006	178		219
Add	110	TRE	DUN	1	24.6	0.021	0.062	0.006	185	190	193
Remove	110	TRL	TB	2	...	...	...	...	...		...

Table B-16 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	August	Winter
Amend	110	AA	LIM(I)	1	11.7	0.007	0.037	0.012	178		219
Add	110	ATY	LSE	1	21.9	0.032	0.075	0.007	105		128
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	BLC	KLM	1	4.0	0.002	0.005	0.029	140		140
Add	110	BLC	GRA	1	4.3	0.003	0.005	0.031	140		140
Add	220	BLC	FIN(I)	1	10.0	0.000	0.002	0.332	570		570
Amend	275	CACO	MAG	1	56	0.002	0.024	0.140	1000	1000	1000
Amend	275	CACO	MAG	2	56	0.002	0.024	0.140	1000	1000	1000
Amend	275	CPS	CACO	1	0.2	0.000	0.000	0.040	761	761	837
Amend	275	CPS	CACO	2	0.2	0.000	0.000	0.034	761	761	837
Add	380	DSN	LSE	1	44.8	0.001	0.010	0.226	1577		1944
Remove	380	DSN	MP	1	...	...	...	...	...		...
Remove	110	FIN(I)	GRA	1	...	...	...	...	...		...
Add	110	FIN(I)	KLM	2	9.3	0.005	0.010	0.056	140		143
Add	110	LSE	PLS	1	8.4	0.015	0.033	0.003	105		128

Table B-16 Changes in Circuit Characteristics Expected in 2017 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Add	380	LSE	MP	1	170.0	0.003	0.038	0.858	1577		1944
Add	275	TAN	TLE	1		0.001	0.009	0.051	710	820	881
Add	275	TAN	TLE	2		0.001	0.009	0.051	710	820	881
Remove	275	TAN	TMN	1	...	...	...	...	...		...
Remove	275	TAN	TMN	2	...	...	...	...	...		...
Add	275	TMN	TLE	1		0.000	0.002	0.014	710	820	881
Add	275	TMN	TLE	2		0.000	0.002	0.014	710	820	881
Add	380	WOO	TLE	1	140.0	0.003	0.031	0.707	1577		1944

Table B-17 Changes in Circuit Characteristics Expected after 2017

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Add	380	BK	FLA	1	123.0	0.002	0.027	0.621	1577		1944
Add	110	BPS	CAE	1		0.001	0.007	0.082	200	200	220
Add	110	BPS	CAE	2		0.001	0.007	0.082	200	200	220
Add	220	CAS	SDN	1		0.014	0.057	0.350	500	500	550
Add	110	CBR	MOY	1	37.0	0.023	0.120	0.013	178		219
Add	220	CLO	SRA	1	83.0	0.010	0.072	0.109	434		534
Add	110	COL (N)	NAN (N)	1	43.8	0.014	0.053	0.007	186	191	193
Add	110	COL (N)	NAN (N)	2	43.8	0.014	0.053	0.007	186	191	193
Add	380	DSN	GI	1	110.0	0.002	0.025	0.555	1577		1944
Remove	110	ENN (N)	OMA	2	...	...	...	...	...		...
Remove	110	ENN (N)	OMA	1	...	...	...	...	...		...
Add	110	TID	NAN (N)	1		0.028	0.107	0.015	139	150	157
Add	110	GAR	MAN	1	16	0.012	0.045	0.006	139	150	157
Add	380	GI	KRA	1	108.0	0.002	0.024	0.545	1577		1944
Amend	110	HAN	LIS	1	9.2	0.006	0.026	0.018	144	144	144

Table B-17 Changes in Circuit Characteristics Expected after 2017 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Amend	110	HAN	LIS	2	9.2	0.006	0.026	0.018	144	144	144
Add	110	KEL	NAN (N)	1	43.8	0.057	0.147	0.015	186	191	193
Add	110	KEL	NAN (N)	2	43.8	0.057	0.147	0.015	186	191	193
Add	110	KEL	MAN	2		0.022	0.134	0.013	188	204	213
Add	220	KLN	KPG	1	70.0	0.008	0.061	0.092	434		534
Remove	220	KLN	TB	1	...	...	...	...	...		...
Add	220	KNR	KPG	2	20.0	0.001	0.008	0.547	593		593
Add	220	KPG	MP	2	5.0	0.000	0.002	0.137	593		593
Add	110	OMS	DRU (N)	1	13	0.007	0.045	0.004	167	180	188
Add	110	OMS	OMA	1	14	0.018	0.047	0.005	82	95	103
Add	110	OMS	ENN(N)	1	19.7	0.026	0.066	0.007	82	95	103
Add	275	OMS	TLE	1	62.5	0.035	0.216	0.021	710	820	881
Add	110	OMS	OMA	2	14	0.018	0.047	0.005	82	95	103
Add	110	OMS	ENN(N)	2	19.7	0.026	0.066	0.007	82	95	103
Add	110	TID	NAN (N)	2		0.028	0.107	0.015	139	150	157
Add	110	FNT	GCA	1	0.9	0.001	0.001	0.009	140		140
Add	110	FNT	GCA	2	0.9	0.001	0.001	0.009	140		140
Add	110	FNT	ADM	1	1.6	0.001	0.002	0.016	140		140
Add	110	FNT	ADM	2	1.6	0.001	0.002	0.016	140		140
Remove	110	INC	ADM	1	...	...	...	...	...		...
Remove	110	ADM	GCA	1	...	...	...	...	...		...
Add	220	INC	FNT	1	10.6	0.002	0.009	0.015	761		804
Add	220	INC	FNT	2	10.6	0.002	0.009	0.015	761		804
Add	220	MAY	FNT	1	9.7	0.001	0.008	0.013	761		804
Add	220	MAY	FNT	2	9.7	0.001	0.008	0.013	761		804
Remove	220	INC	MAY	1	...	...	...	...	...		...
Remove	220	INC	MAY	2	...	...	...	...	...		...

Table B-18 Characteristics of 275/110 kV Transformer Changes in 2014

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	Hannahstown IBTx 3	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Amend	Castlereagh IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Amend	Tandragee IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-19 Characteristics of 400/220 kV Transformer Changes in 2014

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	380 /220	0.0003	0.027	0.1	0.07

Table B-20 Characteristics of 275/110 kV Transformer Changes in 2015

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 IBTx 2	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-21 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	BALLYNAHULLA T2101	250	220 /110	0.001	0.064	0.09	0.17
Add	BALLYNAHULLA T2101	250	220 /110	0.001	0.064	0.09	0.17
Add	BALLYVOUSKILL T2101	250	220 /110	0.001	0.064	0.09	0.17
Add	KNOCKANURE T2101	250	220 /110	0.001	0.064	0.09	0.17
Add	KNOCKANURE T2102	250	220 /110	0.001	0.064	0.09	0.17

Table B-22 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	
Amend	Coolkeeragh IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-23 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	CARRICKMINES T2104	250	220 /110	0.0004	0.0631	0.08	0.18
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	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 B T2101	250	220 /110	0.001	0.064	0.09	0.17

Table B-24 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	MONEYPOINTG1 T4201	500	380 /220	0.0003	0.027	0.1	0.07

Table B-25 Characteristics of 275/110 kV Transformer Changes in 2017

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	Castlereagh IBTx 4	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-26 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	0.001	0.0646	0.09	0.17
Remove	KNOCKRAHA T2103	250	0.001	0.065	9%	18%	250

Table B-27 Characteristics of 400/275 kV Transformer Changes in 2017

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 IBTx 1	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23
Add	Turleenan IBTx 2	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23
Add	Turleenan IBTx 3	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23

Table B-28 Characteristics of 400/220 kV Transformer Changes After 2017

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	0.027	0.1	0.07
Add	GREAT ISLAND T4201	250	380 /220	0.00048	0.072	0.15	0.15
Add	KNOCKRAHA T4202	500	380 /220	0.0003	0.027	0.1	0.07

Table B-29 Characteristics of 275/110 kV Transformer Changes After 2017

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
Add	Omagh South IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.1	0.8	19

Table B-30 Characteristics of 275/220 kV Transformer Changes After 2017

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	Castlereagh IBTx 4	0.0008	0.03	0.002	0.02	0.0003	0.025	250	250	60	1.1	0.9	23
Add	Castlereagh IBTx 5	0.0008	0.03	0.002	0.02	0.0003	0.025	250	250	60	1.1	0.9	23

Table B-31 Characteristics of 220/110 kV Transformer Changes After 2017

Change	Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
				R	X	+	-
Add	Finnstown T2101	250	220/110	0.001	0.064	9%	17%

Table B-32 Changes in the Characteristics of Reactive Compensation Expected in 2016

Add/Remove	Station	Bus	Plant	Mvar Capability	
				Generate	Absorb
Add	Poolbeg	PB 220	2 Reactors (2 x 50)	-	100

Table B-33 Changes in the Characteristics of Reactive Compensation Expected after 2017

Add/Remove	Station	Bus	Plant	Mvar Capability	
				Generate	Absorb
Add	Coleraine	COLE_SVC 110.00	1 SVC	100	100
Remove	Coleraine	COLE1_CA 110.00	1 Capacitor	36	-
Add	Tamnamore	TAMN1_SV 110.00	1 SVC	175	175
Add	Omagh South	OMAS- 110.00	1 SVC	100	100
Add	Castlereagh	CAST2-220 220.00	1 SVC	100	100

C Demand Forecasts at Individual Transmission Interface Stations

APPENDIX C DEMAND FORECASTS AT INDIVIDUAL TRANSMISSION INTERFACE STATIONS

Transmission Interface Stations and Bulk Supply Points are the points of connection between the transmission system and 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 for each of the ten years to 2023 at the time of system winter peak, summer peak, summer valley, and Northern Ireland autumn peak respectively.

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

All Transmission Interface Stations are 110 kV stations except for the four 220 kV interface stations that supply the Dublin City networks operated by the DSO of Ireland. These 220 kV interface stations, Carrickmines, Finglas, Inchicore and Poolbeg, are included in the tables.

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)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AA	ARDNACRUSHA	0.99	32.49	32.21	32.22	32.60	33.04	33.48	34.04	34.53	35.02	35.37
AD	AGHADA	0.99	1.65	1.64	1.64	1.66	1.68	1.70	1.73	1.76	1.78	1.80
AGH	AGHYOULE MAIN	0.98	16.72	16.84	17.02	17.17	17.32	17.48	17.63	17.79	17.94	18.10
AGY	ARDNAGAPPARY	0.94	n/a	14.58	14.58	14.75	14.96	15.16	15.41	15.63	15.85	16.01
AHA	AHANE	0.97	5.94	5.89	5.89	5.96	6.04	6.12	6.22	6.31	6.40	6.46
AIR	BELFAST - AIRPORT ROAD MAIN	0.98	n/a	n/a	22.02	22.29	22.57	22.85	23.14	23.43	23.72	24.02
ANR	ANNER	0.91	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	45.21	45.43	46.08	46.62	47.16	47.71	48.27	48.83	49.40	49.97
ARI	ARIGNA	0.99	4.49	4.45	4.46	4.51	4.57	4.63	4.71	4.77	4.84	4.89
ARK	ARKLOW	0.95	23.67	23.47	23.47	23.75	24.07	24.40	24.80	25.15	25.52	25.77
ATH	ATHLONE	0.95	66.33	65.78	65.79	66.55	62.69	63.53	64.58	65.51	66.46	67.09
ATY	ATHY	0.89	18.80	18.64	18.64	18.86	19.12	19.38	19.70	19.98	20.27	20.47
BAL	BALTRASNA	0.99	15.29	15.16	15.16	15.34	15.55	15.76	16.02	16.25	16.48	16.64
BAN	BANBRIDGE MAIN	0.98	39.89	40.19	40.73	41.17	41.63	42.09	42.56	43.03	43.50	43.98
BAN	BANDON	0.97	28.75	40.21	40.22	40.67	41.20	41.73	42.39	42.96	43.56	43.96
BAR	BARRYMORE	0.99	27.26	27.03	27.04	27.35	27.73	28.10	28.56	28.97	29.39	29.67
BDA	BARODA	0.96	5.26	5.26	5.26	17.67	17.84	18.01	18.22	18.41	18.60	18.72
BDN	BALLYDINE	0.96	17.59	17.49	17.49	17.63	17.79	17.94	18.14	18.32	18.49	18.61
BEG	BALLYBEG	0.99	13.65	13.54	13.54	13.70	13.89	14.07	14.31	14.51	14.72	14.86
BGT	BALLYRAGGET	0.95	n/a	n/a	n/a	24.22	24.56	24.89	25.30	25.66	26.03	26.28
BIN	BINBANE	0.98	27.65	17.62	17.62	17.83	18.08	18.32	18.62	18.89	19.16	19.35
BK	BELLACORICK	0.97	10.82	10.73	10.73	10.85	11.00	11.15	11.34	11.49	11.66	11.77
BLI	BALLYLICKEY	0.99	10.48	10.39	10.39	10.51	10.66	10.80	10.98	11.14	11.30	11.41
BLK	BLAKE	0.99	25.59	12.62	12.62	12.77	12.94	13.12	13.33	13.52	13.72	13.85

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BMA	BALLYMENA MESH (RURAL)	0.98	45.94	34.36	35.08	35.71	36.36	37.01	37.67	38.35	39.03	39.71
BMA	BALLYMENA SWBD (TOWN)	0.98	49.20	49.82	50.74	51.53	52.33	53.13	53.95	54.79	55.63	56.49
BNH	BALLYNAHINCH MAIN	0.98	57.73	58.07	58.82	59.44	60.08	60.72	61.37	62.03	62.69	63.36
BNM	BELFAST - BELFAST NORTH MAIN	0.98	n/a	52.40	53.09	53.66	54.24	54.82	55.41	56.01	56.61	57.22
BOG	BANOGE	0.95	20.35	20.18	20.19	20.42	20.70	20.98	21.33	21.63	21.95	22.16
BRA	BRACKLONE	0.94	n/a	12.75	12.76	12.91	13.08	13.26	13.48	13.67	13.87	14.00
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	33.44	33.16	33.16	33.55	34.02	34.47	35.04	35.54	36.06	36.41
BUT	BUTLERSTOWN	0.98	38.16	37.84	37.85	38.29	38.82	39.34	39.99	40.56	41.15	41.54
CAH	CAHIR	0.98	24.24	24.04	24.04	24.32	24.66	24.99	25.40	25.77	26.14	26.39
CAR	BELFAST - CARNMONEY MAIN	0.98	41.17	41.56	42.18	42.71	43.24	43.78	44.32	44.87	45.43	46.00
CBG	CARROWBEG	0.98	27.54	27.35	27.35	27.62	27.94	28.25	28.65	28.99	29.35	29.59
CBR	CASTLEBAR	0.97	27.55	27.32	27.32	27.64	28.02	28.39	28.86	29.28	29.70	29.99
CEN	BELFAST - BELFAST CENTRAL MAIN	0.98	62.04	62.87	64.71	66.36	68.00	69.69	71.41	73.18	75.00	76.85
CF	CATHALEEN'S FALL	0.95	18.52	18.37	18.37	18.58	18.84	19.09	19.41	19.69	19.97	20.16
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	18.77	18.61	18.62	18.83	19.09	19.35	19.67	19.95	20.24	20.43
CKG	CORKAGH	0.94	n/a	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25
CKM	CARRICKMINES	0.97	346.53	343.82	362.87	366.60	371.08	375.48	380.98	385.80	390.79	394.10
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	25.19	24.98	24.98	25.28	30.40	30.81	31.32	31.77	32.23	32.54
CLW	CARLOW	0.99	53.32	52.87	52.88	53.50	54.24	54.96	55.87	56.67	57.50	58.05
COL	COLERAINE MAIN	0.98	45.83	46.17	46.85	47.42	48.01	48.60	49.20	49.80	50.41	51.03
COL	COLLEGE PARK	0.97	27.11	26.88	26.89	27.20	27.58	27.95	28.41	28.81	29.23	29.51
COS	CARICKONSHANNON	0.98	30.72	30.46	30.47	30.82	31.25	31.67	32.19	32.65	33.13	33.44
COW	COW CROSS	0.98	11.51	11.41	11.41	11.55	11.71	11.87	12.05	12.23	12.41	12.53

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPS	COOLKEERAGH MAIN	0.98	31.35	31.78	32.33	32.80	33.27	33.74	34.22	34.71	35.20	35.70
CRA	CRANE	0.99	32.10	31.83	31.85	32.22	32.66	33.09	33.64	34.12	34.62	34.95
CRE	BELFAST - CREGAGH MAIN	0.98	66.78	67.37	54.89	55.66	56.44	57.22	58.02	58.82	59.64	60.46
CRG	CREAGH MAIN	0.98	24.29	36.39	36.81	37.15	37.49	37.84	38.19	38.54	38.90	39.26
CRO	COOLROE	0.99	14.53	14.41	14.42	14.58	14.78	14.98	15.23	15.45	15.67	15.82
CVW	CASTLEVIEW	0.98	21.64	21.46	21.46	21.71	22.01	22.31	22.67	23.00	23.33	23.56
DAL	DALLOW	0.99	16.91	16.77	16.77	16.97	17.20	17.43	17.72	17.97	18.23	18.41
DDK	DUNDALK	0.98	65.99	65.43	65.44	42.63	43.22	43.80	44.52	45.16	45.81	46.25
DFR	DUNFIRTH	0.99	8.68	8.60	8.61	8.71	8.83	8.94	9.09	9.22	9.36	9.45
DGN	DUNGARVAN	0.98	40.83	40.49	40.50	40.97	41.54	42.09	42.79	43.40	44.03	44.45
DLT	DALTON	0.97	24.31	24.11	24.11	24.39	24.73	25.06	25.47	25.84	26.21	26.46
DMY	DUNMANWAY	0.99	41.32	36.56	36.56	36.99	37.50	38.00	38.63	39.18	39.75	40.13
DON	BELFAST - DONEGALL MAIN(NORTH)	0.98	59.16	59.37	60.09	60.68	61.27	61.87	62.48	63.10	63.72	64.34
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.98	50.69	50.97	51.64	52.19	52.76	53.33	53.90	54.49	55.08	55.67
DOO	DOON	0.97	30.27	30.01	30.02	30.37	30.79	31.20	31.72	32.17	32.64	32.95
DRU	DRUMNAKELLY MAIN	0.98	97.88	90.13	91.59	92.84	94.11	95.39	96.68	97.99	99.32	100.66
DRU	DRUMLINE	0.97	26.92	26.70	26.70	27.01	27.39	27.75	28.21	28.61	29.03	29.31
DRY	DRYBRIDGE	0.98	84.25	83.54	83.56	78.87	79.96	81.03	82.37	83.55	84.77	85.58
DUN	DUNGANNON MAIN	0.98	92.12	89.69	91.20	92.49	93.79	95.11	96.44	97.79	99.16	100.55
EDE	EDEN MAIN	0.98	32.12	32.38	32.81	33.16	33.53	33.89	34.26	34.63	35.01	35.39
ENN	ENNISKILLEN MAIN	0.98	52.82	53.19	54.00	54.69	55.38	56.09	56.80	57.52	58.26	59.00
ENN	ENNIS	0.98	59.79	59.29	59.30	59.99	60.82	61.63	62.65	63.55	64.47	65.09
FIN	BELFAST - FINAGHY MAIN	0.98	32.83	33.15	33.58	33.94	34.31	34.68	35.05	35.43	35.81	36.20
FIN	FINGLAS	0.98	457.69	471.93	472.02	477.19	483.39	489.49	497.12	503.83	510.76	515.36
GAL	GALWAY	0.99	73.80	73.18	73.19	74.06	75.07	76.08	77.33	78.44	79.58	80.34
GI	GREAT ISLAND	0.94	17.8	17.8	17.7	17.9	18.1	18.4	18.7	18.9	19.2	19.5

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
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 - GLENGORMLEY MAIN	0.98	14.82	14.97	15.19	15.37	15.56	15.75	15.94	16.13	16.32	16.52
GLE	GLENLARA	0.94	15.03	14.90	14.91	15.08	15.29	15.49	15.75	15.97	16.21	16.36
GRI	GRIFFINRATH	0.95	66.69	66.13	64.65	65.40	66.30	67.19	68.30	69.28	70.29	70.96
GWE	GORTAWEE	0.95	31.71	31.62	31.62	31.74	31.89	32.03	32.21	32.37	32.54	32.65
HTS	HARNETTS CROSS	0.98	n/a	8.74	8.74	8.85	8.97	9.09	9.24	9.37	9.51	9.60
IKE	IKERRIN	0.98	26.41	27.19	27.19	27.50	27.86	28.22	28.67	29.07	29.48	29.75
INC	INCHICORE	0.98	344.39	342.12	353.16	356.29	360.05	363.73	368.36	372.43	376.61	379.42
KBY	KILBARRY	0.98	88.88	88.14	88.15	89.18	90.41	91.62	93.14	94.47	95.84	96.76
KER	KNOCKERAGH	0.96	32.24	31.97	31.97	32.34	32.79	33.23	33.78	34.26	34.76	35.09
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	70.34	69.75	69.76	59.95	60.78	61.59	62.61	63.51	64.43	65.05
KNO	BELFAST - KNOCK MAIN	0.98	68.77	69.13	61.47	62.26	63.06	63.87	64.69	65.51	66.35	67.20
KTL	KILTEEL	0.98	39.57	39.24	39.24	39.70	40.25	40.79	41.46	42.05	42.67	43.07
KTN	KILLOTERAN	0.96	16.45	16.33	16.34	16.50	16.69	16.88	17.12	17.33	17.54	17.69
KUR	KNOCKUMBER	0.92	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14
LA	LANESBORO	0.93	12.18	12.08	12.08	12.22	12.39	12.56	12.76	12.95	13.13	13.26
LAR	LARNE MAIN	0.98	44.86	45.16	45.77	46.29	46.81	47.34	47.87	48.41	48.96	49.51
LET	LETTERKENNY	0.97	67.67	62.32	62.33	63.06	63.93	64.79	65.86	66.80	67.77	68.42
LIB	LIBERTY	0.94	18.77	18.61	18.62	18.83	19.09	19.35	19.67	19.95	20.24	20.43
LIM	LIMAVADY MAIN	0.98	25.57	25.76	26.16	26.49	26.83	27.18	27.53	27.88	28.24	28.60
LIM	LIMERICK	0.98	80.03	79.36	79.38	80.29	81.38	82.46	83.81	84.99	86.21	87.03
LIS	LISBURN MAIN	0.98	65.20	65.69	66.67	67.50	68.34	69.19	70.05	70.92	71.80	72.69
LIS	LISDRUM	0.97	27.75	27.52	27.53	27.85	28.23	28.61	29.08	29.50	29.93	30.21
LMR	LISAGHMORE MAIN	0.98	49.58	49.93	50.70	51.35	52.01	52.68	53.35	54.04	54.73	55.43
LOG	LOGUESTOWN MAIN	0.98	40.51	40.85	41.42	41.90	42.39	42.88	43.37	43.87	44.38	44.89

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
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	0.97	18.27	4.07	4.07	4.12	4.18	4.23	4.30	4.36	4.43	4.47
MAL	MALLOW	0.99	22.41	22.22	22.23	22.49	22.80	23.10	23.48	23.82	24.17	24.40
MCE	MACETOWN	0.97	29.41	29.20	29.20	29.49	29.83	30.17	30.59	30.97	31.35	31.61
MID	MIDLETON	0.98	35.79	35.50	35.50	35.90	36.37	36.84	37.43	37.94	38.47	38.83
MLN	MULLAGHARLIN	0.95	4.46	4.46	4.46	33.70	34.10	34.50	34.99	35.43	35.88	36.18
MON	MONREAD	0.98	13.14	13.03	13.03	13.18	13.37	13.54	13.77	13.97	14.17	14.30
MOY	MOY	0.98	25.56	25.34	25.35	25.64	26.00	26.34	26.78	27.16	27.56	27.82
MR	MARINA	0.96	17.30	17.15	17.15	17.35	17.59	17.83	18.12	18.38	18.65	18.83
MTH	MEATH HILL	0.98	38.55	38.23	38.23	38.68	39.21	39.74	40.39	40.97	41.57	41.96
MUL	MULLINGAR	0.97	49.94	49.52	49.52	50.11	50.79	51.47	52.32	53.08	53.84	54.36
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	0.98	43.78	44.13	44.77	45.32	45.87	46.43	47.00	47.57	48.15	48.73
NAV	NAVAN	0.97	62.16	61.64	61.65	62.36	63.22	64.07	65.13	66.06	67.02	67.67
NEN	NENAGH	0.98	28.20	27.96	27.97	28.29	28.68	29.07	29.55	29.97	30.41	30.70
NEW	NEWRY MAIN	0.98	77.75	78.40	79.62	80.66	81.71	82.77	83.84	84.93	86.03	87.15
NEW	NEWBRIDGE	0.99	38.47	38.15	38.15	26.19	26.55	26.91	27.35	27.74	28.15	28.41
OLD	OLDCOURT	0.95	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	59.40	59.91	60.88	61.71	62.54	63.39	64.25	65.12	66.00	66.89
OUG	OUGHTRAGH	0.98	24.90	24.70	24.70	24.99	25.33	25.67	26.10	26.47	26.85	27.11
PB	POOLBEG	0.98	194.24	192.62	192.64	194.89	197.59	200.22	203.55	206.44	209.44	211.46
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	52.58	52.14	52.15	39.15	39.69	40.23	40.89	41.48	42.08	42.48
PSW	BELFAST - PSW	0.98	52.12	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAT	RATHGAEL MAIN	0.98	65.05	65.53	66.46	67.25	68.04	68.85	69.66	70.48	71.31	72.16
RAT	RATHKEALE	0.96	26.04	25.82	25.83	26.13	26.49	26.84	27.29	27.68	28.08	28.35

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RIC	RICHMOND	0.97	32.31	32.03	32.04	32.41	32.86	33.30	33.85	34.34	34.83	35.17
RNW	RINAWADE	0.98	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	32.23	32.44	32.87	33.24	33.61	33.99	34.37	34.75	35.14	35.54
RSY	RINGASKIDDY	0.95	1.75	1.74	1.74	1.76	1.78	1.81	1.84	1.86	1.89	1.91
RYB	RYEBROOK	0.95	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52
SAL	SALTHILL	0.98	86.09	71.63	71.64	72.48	73.48	74.47	75.70	76.78	77.90	78.65
SCR	SCREEB	0.95	n/a	13.74	13.74	13.90	14.09	14.28	14.52	14.72	14.94	15.08
SHE	SHELTON ABBEY	0.95	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
SKL	SHANKILL	0.96	55.34	54.88	54.88	55.52	56.29	57.04	57.99	58.82	59.67	60.24
SLI	SLIGO	0.98	56.90	56.43	56.44	57.09	57.88	58.66	59.63	60.48	61.36	61.95
SNG	SINGLAND	0.98	15.14	15.01	15.01	15.19	15.40	15.60	15.86	16.09	16.32	16.48
SOM	SOMERSET	0.97	30.40	30.14	30.15	30.50	30.92	31.33	31.85	32.31	32.78	33.09
SPR	SPRINGTOWN MAIN	0.98	30.95	31.29	31.71	32.06	32.41	32.76	33.12	33.48	33.84	34.21
STR	STRABANE MAIN	0.98	37.39	37.67	38.17	38.59	39.02	39.45	39.89	40.33	40.78	41.23
STR	STRATFORD	0.98	20.69	20.52	20.52	20.76	21.04	21.33	21.68	21.99	22.31	22.52
TBG	TRABEG	0.98	73.05	72.44	72.45	73.30	74.31	75.30	76.54	77.64	78.77	79.52
TBK	TULLABRACK	0.99	11.81	11.71	11.72	11.85	12.02	12.18	12.38	12.56	12.74	12.86
THU	THURLES	0.97	29.42	29.17	29.17	29.51	29.92	30.32	30.82	31.27	31.72	32.02
TIP	TIPPERARY	0.98	17.14	16.99	17.00	17.19	17.43	17.67	17.96	18.21	18.48	18.66
TLK	TRILLICK	0.94	22.95	22.75	22.76	23.02	23.34	23.65	24.04	24.39	24.74	24.98
TON	TONROE	0.98	13.24	13.13	13.13	13.28	13.47	13.65	13.87	14.07	14.28	14.41
TRI	TRIEN	0.98	24.14	23.94	23.94	24.22	24.56	24.89	25.30	25.66	26.03	26.28
TRL	TRALEE	0.99	46.46	46.07	46.08	46.62	47.26	47.90	48.69	49.38	50.10	50.58
TSB	THORNSBERRY	0.97	33.05	32.77	32.78	33.16	33.62	34.07	34.63	35.12	35.64	35.98
WAR	WARINGSTOWN MAIN	0.98	51.09	63.47	64.16	64.69	65.24	65.79	66.34	66.90	67.47	68.04
WAT	WATERFORD	0.98	48.35	47.95	47.96	48.52	49.19	49.84	50.67	51.39	52.14	52.64
WEX	WEXFORD	0.98	53.03	52.59	52.59	53.22	53.95	54.66	55.57	56.37	57.18	57.74

Table C-1 Demand Forecasts at Time of Winter Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
WHI	WHITEGATE	0.87	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)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AA	ARDNACRUSHA	0.99	15.74	15.50	15.48	15.55	15.77	15.99	16.27	16.51	16.76	17.00
AD	AGHADA	0.98	1.29	1.28	1.27	1.28	1.30	1.32	1.34	1.36	1.38	1.40
AGH	AGHYOULE MAIN	0.96	13.14	13.23	13.38	13.50	13.62	13.74	13.86	13.98	14.10	14.23
AGY	ARDNAGAPPARY	0.94	n/a	n/a	12.51	12.57	12.75	12.93	13.15	13.34	13.55	13.74
AHA	AHANE	0.97	4.69	4.62	4.61	4.63	4.70	4.76	4.84	4.92	4.99	5.06
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	n/a	n/a	17.30	17.52	17.74	17.96	18.19	18.41	18.65	18.88
ANR	ANNER	0.91	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	35.53	35.71	36.22	36.64	37.07	37.50	37.94	38.38	38.83	39.28
ARI	ARIGNA	0.99	3.34	3.29	3.28	3.30	3.35	3.39	3.45	3.50	3.56	3.61
ARK	ARKLOW	0.99	12.87	12.68	12.66	12.72	12.90	13.08	13.30	13.50	13.71	13.91
ATH	ATHLONE	0.98	57.2	56.4	56.3	56.6	57.4	54.7	55.7	56.5	57.3	58.2
ATY	ATHY	0.83	10.28	10.13	10.11	10.16	10.31	10.45	10.63	10.79	10.95	11.11
BAL	BALTRASNA	0.99	10.62	10.46	10.45	10.50	10.65	10.80	10.98	11.15	11.31	11.48
BAN	BANBRIDGE MAIN	0.96	31.35	31.59	32.01	32.36	32.72	33.08	33.45	33.82	34.19	34.57
BAN	BANDON	0.96	34.66	36.13	44.43	44.62	45.23	45.83	46.59	47.24	47.93	48.59
BAR	BARRYMORE	0.98	19.11	18.82	18.80	18.88	19.16	19.42	19.76	20.05	20.35	20.64
BDA	BARODA	0.96	5.26	5.26	5.26	5.26	15.99	16.13	16.32	16.49	16.65	16.82
BDN	BALLYDINE	0.94	14.51	14.38	14.37	14.41	14.53	14.65	14.79	14.93	15.06	15.19
BEG	BALLYBEG	0.97	8.30	8.18	8.17	8.21	8.32	8.44	8.58	8.71	8.84	8.97
BGT	BALLYRAGGET	0.95	n/a	n/a	n/a	n/a	20.94	21.23	21.59	21.91	22.24	22.56
BIN	BINBANE	0.98	16.48	16.23	7.80	7.83	7.95	8.06	8.19	8.32	8.44	8.56

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BK	BELLACORICK	0.94	6.23	6.13	6.13	6.16	6.24	6.33	6.44	6.53	6.63	6.73
BLI	BALLYLICKEY	0.99	7.57	7.46	7.45	7.49	7.59	7.70	7.83	7.95	8.07	8.18
BLK	BLAKE	0.99	19.20	18.91	7.95	7.98	8.10	8.21	8.35	8.47	8.60	8.73
BMA	BALLYMENA MESH (RURAL)	0.96	36.11	27.01	27.57	28.07	28.58	29.09	29.61	30.14	30.67	31.22
BMA	BALLYMENA SWBD (TOWN)	0.96	38.67	39.16	39.88	40.50	41.13	41.76	42.41	43.06	43.73	44.40
BNH	BALLYNAHINCH MAIN	0.96	45.38	45.64	46.23	46.72	47.22	47.73	48.24	48.75	49.27	49.80
BNM	BELFAST - BELFAST NORTH MAIN	0.96	n/a	41.19	41.73	42.17	42.63	43.09	43.55	44.02	44.50	44.98
BOG	BANOGE	0.95	14.70	14.48	14.46	14.53	14.74	14.94	15.20	15.42	15.66	15.88
BRA	BRACKLONE	0.94	n/a	n/a	10.95	11.00	11.15	11.31	11.50	11.67	11.85	12.02
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	34.99	34.45	34.42	34.58	35.07	35.56	36.17	36.71	37.26	37.79
BUT	BUTLERSTOWN	0.98	26.22	25.83	25.80	25.92	26.29	26.65	27.11	27.51	27.93	28.33
CAH	CAHIR	0.97	23.01	22.67	22.64	22.74	23.07	23.39	23.79	24.15	24.51	24.86
CAR	BELFAST - CARNMONEY MAIN	0.96	32.36	32.66	33.15	33.57	33.99	34.41	34.84	35.27	35.71	36.15
CBG	CARROWBEG	0.97	19.01	23.22	23.20	23.29	23.56	23.82	24.16	24.45	24.75	25.04
CBR	CASTLEBAR	0.98	31.59	31.12	31.08	31.22	31.67	32.11	32.66	33.15	33.65	34.13
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	48.76	49.42	50.86	52.16	53.45	54.77	56.13	57.52	58.95	60.41
CF	CATHALEEN'S FALL	0.95	13.97	13.76	13.74	13.81	14.01	14.20	14.45	14.66	14.88	15.10
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	14.34	14.12	14.10	14.17	14.37	14.57	14.82	15.04	15.27	15.49
CKG	CORKAGH	0.94	n/a	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25
CKM	CARRICKMINES	0.97	254.41	250.91	269.67	270.71	273.97	277.18	281.23	284.74	288.39	291.93
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	0.95	23.62	23.27	23.24	23.35	23.68	28.14	28.63	29.05	29.49	29.91
CLW	CARLOW	0.98	45.21	44.53	44.48	44.68	45.32	45.95	46.74	47.44	48.15	48.85
COL	COLERAINE MAIN	0.96	36.02	36.29	36.82	37.28	37.73	38.20	38.67	39.14	39.63	40.11

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
COL	COLLEGE PARK	0.96	25.55	25.16	25.13	25.25	25.61	25.97	26.41	26.81	27.21	27.60
COS	CARICKONSHANNON	0.96	27.85	27.43	27.40	27.52	27.92	28.31	28.79	29.22	29.66	30.09
COW	COW CROSS	0.99	13.28	13.08	13.06	13.13	13.31	13.50	13.72	13.93	14.14	14.34
CPS	COOLKEERAGH MAIN	0.96	24.64	24.98	25.41	25.78	26.15	26.52	26.90	27.28	27.67	28.06
CRA	CRANE	0.99	25.00	24.62	24.60	24.71	25.06	25.42	25.85	26.23	26.63	27.01
CRE	BELFAST - CREGAGH MAIN	0.96	52.49	52.95	43.14	43.74	44.36	44.98	45.60	46.24	46.87	47.52
CRG	CREAGH MAIN	0.96	19.09	28.60	28.93	29.20	29.47	29.74	30.01	30.29	30.57	30.86
CRO	COOLROE	0.99	12.08	11.90	11.88	11.94	12.11	12.28	12.49	12.67	12.86	13.05
CVW	CASTLEVIEW	0.97	24.97	24.59	24.56	24.68	25.03	25.38	25.82	26.20	26.59	26.98
DAL	DALLOW	0.98	13.27	13.07	13.05	13.11	13.30	13.48	13.72	13.92	14.13	14.33
DDK	DUNDALK	0.98	49.22	48.47	48.41	48.64	28.96	29.36	29.86	30.31	30.76	31.21
DFR	DUNFIRTH	0.99	6.17	6.08	6.07	6.10	6.19	6.27	6.38	6.48	6.57	6.67
DGN	DUNGARVAN	0.98	33.17	32.67	32.63	32.78	33.25	33.71	34.29	34.80	35.32	35.83
DLT	DALTON	0.95	0.60	0.59	0.59	0.59	0.60	0.61	0.62	0.63	0.64	0.65
DMY	DUNMANWAY	0.99	23.27	22.92	19.10	19.19	19.47	19.74	20.08	20.37	20.68	20.98
DON	BELFAST - DONEGALL MAIN(NORTH)	0.96	46.50	46.66	47.23	47.69	48.16	48.63	49.11	49.59	50.08	50.57
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.96	39.84	40.06	40.59	41.02	41.47	41.92	42.37	42.83	43.29	43.76
DOO	DOON	0.96	14.69	14.47	14.45	14.52	14.73	14.93	15.19	15.41	15.64	15.87
DRU	DRUMNAKELLY MAIN	0.96	76.93	70.84	71.99	72.98	73.97	74.97	75.99	77.02	78.06	79.12
DRU	DRUMLINE	0.96	27.79	27.37	27.33	27.46	27.85	28.24	28.73	29.15	29.59	30.02
DRY	DRYBRIDGE	0.97	66.33	65.33	65.25	65.56	61.61	62.46	63.53	64.48	65.45	66.39
DUN	DUNGANNON MAIN	0.96	72.41	70.50	71.68	72.70	73.72	74.75	75.80	76.87	77.94	79.03
EDE	EDEN MAIN	0.96	25.25	25.45	25.79	26.07	26.35	26.64	26.93	27.22	27.52	27.82
ENN	ENNISKILLEN MAIN	0.96	41.52	41.81	42.44	42.98	43.53	44.09	44.65	45.21	45.79	46.37
ENN	ENNIS	0.97	38.94	38.36	38.31	38.49	39.04	39.58	40.26	40.86	41.48	42.07
FIN	BELFAST - FINAGHY MAIN	0.96	25.81	26.05	26.40	26.68	26.97	27.26	27.55	27.85	28.15	28.45

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
FIN	FINGLAS	0.97	354.21	349.02	366.58	368.17	373.03	377.84	383.84	389.13	394.56	399.85
GAL	GALWAY	0.99	56.48	55.64	55.56	55.82	56.62	57.41	58.39	59.26	60.15	61.01
GI	GREAT ISLAND	0.95	12.84	12.64	12.63	12.69	12.87	13.05	13.27	13.47	13.67	13.87
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 - GLENGORMLEY MAIN	0.96	11.64	11.77	11.94	12.08	12.23	12.38	12.53	12.68	12.83	12.99
GLE	GLENLARA	0.96	12.61	12.42	12.41	12.47	12.64	12.82	13.04	13.23	13.43	13.63
GRI	GRIFFINRATH	0.99	53.40	52.59	51.25	51.49	52.23	52.95	53.86	54.66	55.48	56.28
GWE	GORTAWEE	0.94	33.85	33.66	33.65	33.70	33.88	34.06	34.28	34.48	34.68	34.88
HTS	HARNETTS CROSS	0.98	n/a	n/a	7.50	7.54	7.64	7.75	7.88	8.00	8.12	8.24
IKE	IKERRIN	0.95	24.52	25.15	25.12	25.23	25.58	25.92	26.35	26.73	27.12	27.49
INC	INCHICORE	0.96	213.33	232.87	243.45	244.18	246.48	248.75	251.58	254.05	256.61	259.07
KBY	KILBARRY	0.98	87.55	86.22	86.12	86.52	87.77	88.99	90.52	91.86	93.24	94.58
KER	KNOCKERAGH	0.96	33.57	33.07	33.03	33.18	33.66	34.12	34.71	35.22	35.76	36.27
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	52.38	51.59	51.53	51.77	43.33	43.93	44.69	45.35	46.03	46.70
KNO	BELFAST - KNOCK MAIN	0.96	54.05	54.34	48.31	48.93	49.56	50.20	50.84	51.49	52.15	52.82
KTL	KILTEEL	0.98	30.50	38.47	38.42	38.60	39.16	39.70	40.38	40.98	41.60	42.20
KTN	KILLOTERAN	0.96	20.27	20.00	19.98	20.06	20.31	20.56	20.87	21.14	21.43	21.70
KUR	KNOCKUMBER	0.92	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14	28.14
LA	LANESBORO	0.98	11.2	11.1	11.0	11.1	11.3	10.7	10.9	11.1	11.2	11.4
LAR	LARNE MAIN	0.96	35.26	35.50	35.98	36.38	36.79	37.21	37.63	38.05	38.48	38.91
LET	LETTERKENNY	0.98	48.54	47.81	43.65	43.85	44.48	45.10	45.87	46.56	47.26	47.94
LIB	LIBERTY	0.94	18.87	18.59	18.57	18.65	18.92	19.18	19.51	19.80	20.10	20.39
LIM	LIMAVADY MAIN	0.96	20.10	20.25	20.56	20.82	21.09	21.36	21.64	21.91	22.20	22.48
LIM	LIMERICK	0.98	63.25	62.31	62.23	62.52	63.40	64.27	65.35	66.31	67.29	68.25
LIS	LISBURN MAIN	0.96	51.25	51.63	52.41	53.06	53.72	54.38	55.06	55.74	56.43	57.13

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
LIS	LISDRUM	0.95	20.51	20.20	20.18	20.27	20.56	20.85	21.20	21.52	21.84	22.16
LMR	LISAGHMORE MAIN	0.96	38.97	39.24	39.85	40.36	40.88	41.40	41.93	42.47	43.02	43.57
LOG	LOGUESTOWN MAIN	0.96	31.84	32.11	32.56	32.93	33.32	33.70	34.09	34.48	34.88	35.28
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	16.1	16.1	3.9	4.0	4.0	3.1	3.1	3.2	3.2	3.3
MAL	MALLOW	0.97	17.63	17.37	17.34	17.43	17.68	17.92	18.23	18.50	18.78	19.05
MCE	MACETOWN	0.98	25.42	25.11	25.08	25.18	25.47	25.76	26.13	26.45	26.78	27.10
MID	MIDLETON	0.97	32.26	31.80	31.75	31.90	32.34	32.76	33.30	33.77	34.26	34.73
MLN	MULLAGHARLIN	0.95	4.46	4.46	4.46	4.46	29.73	30.08	30.52	30.91	31.31	31.69
MON	MONREAD	0.97	10.55	10.39	10.38	10.43	10.57	10.72	10.91	11.07	11.23	11.40
MOY	MOY	0.97	19.24	18.95	18.92	19.01	19.28	19.55	19.89	20.18	20.49	20.78
MR	MARINA	0.97	17.67	17.41	17.39	17.47	17.72	17.96	18.27	18.54	18.82	19.09
MTH	MEATH HILL	0.94	35.33	34.79	34.75	34.91	35.41	35.91	36.52	37.07	37.62	38.17
MUL	MULLINGAR	0.97	40.63	40.01	39.96	40.14	40.73	41.29	42.00	42.63	43.26	43.89
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	34.41	34.68	35.19	35.62	36.05	36.49	36.94	37.39	37.84	38.31
NAV	NAVAN	0.97	38.72	38.13	38.09	38.27	38.81	39.35	40.03	40.62	41.24	41.83
NEN	NENAGH	0.98	24.39	24.02	24.00	24.11	24.45	24.79	25.22	25.59	25.98	26.35
NEW	NEWRY MAIN	0.96	61.12	61.62	62.58	63.40	64.22	65.06	65.90	66.76	67.62	68.50
NEW	NEWBRIDGE	0.98	27.39	18.55	18.52	18.61	8.15	8.26	8.41	8.53	8.66	8.78
OLD	OLDCOURT	0.95	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	46.69	47.09	47.85	48.50	49.16	49.82	50.50	51.18	51.87	52.57
OUG	OUGHTRAGH	0.97	20.14	19.83	19.81	19.90	20.18	20.47	20.82	21.13	21.44	21.75
PB	POOLBEG	0.98	204.04	200.98	200.73	201.66	204.56	207.39	210.94	214.09	217.32	220.44
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	0.96	39.54	38.95	38.90	39.08	27.89	28.27	28.76	29.18	29.63	30.05

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PSW	BELFAST - PSW	0.96	40.97	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAT	RATHGAEL MAIN	0.96	51.13	51.51	52.24	52.85	53.48	54.11	54.75	55.40	56.05	56.72
RAT	RATHKEALE	0.94	18.38	18.10	18.08	18.17	18.43	18.68	19.00	19.28	19.58	19.86
RIC	RICHMOND	0.96	28.79	28.36	28.32	28.45	28.86	29.26	29.77	30.21	30.66	31.10
RNW	RINAWADE	0.98	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	25.33	25.49	25.84	26.13	26.42	26.72	27.01	27.32	27.62	27.93
RSY	RINGASKIDDY	0.78	2.67	2.63	2.63	2.64	2.68	2.72	2.77	2.81	2.85	2.89
RYB	RYEBROOK	0.95	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52	104.52
SAL	SALTHILL	0.97	68.31	67.27	55.40	55.66	56.46	57.24	58.23	59.09	59.98	60.84
SCR	SCREEB	0.95	n/a	n/a	11.79	11.84	12.01	12.18	12.39	12.57	12.76	12.95
SHE	SHELTON ABBEY	0.95	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
SKL	SHANKILL	0.94	53.15	52.35	52.29	52.53	53.28	54.02	54.95	55.77	56.61	57.42
SLI	SLIGO	0.98	43.33	42.68	42.62	42.82	43.44	44.04	44.80	45.46	46.15	46.81
SNG	SINGLAND	0.97	10.88	10.72	10.70	10.75	10.91	11.06	11.25	11.42	11.59	11.75
SOM	SOMERSET	0.98	15.56	15.32	15.30	15.37	15.59	15.81	16.08	16.32	16.57	16.81
SPR	SPRINGTOWN MAIN	0.96	24.32	24.60	24.93	25.20	25.47	25.75	26.03	26.31	26.60	26.89
STR	STRABANE MAIN	0.96	29.39	29.61	30.00	30.33	30.67	31.01	31.35	31.70	32.05	32.41
STR	STRATFORD	0.98	12.72	12.53	12.51	12.57	12.75	12.93	13.15	13.35	13.55	13.74
TBG	TRABEG	0.99	37.22	36.66	36.62	36.79	37.31	37.84	38.48	39.05	39.64	40.21
TBK	TULLABRACK	0.98	9.12	8.98	8.97	9.01	9.14	9.26	9.42	9.56	9.71	9.85
THU	THURLES	0.95	30.78	30.32	30.28	30.42	30.86	31.28	31.82	32.29	32.78	33.25
TIP	TIPPERARY	0.97	15.04	14.82	14.80	14.87	15.08	15.29	15.55	15.78	16.02	16.25
TLK	TRILLICK	0.95	21.51	21.18	21.15	21.25	21.56	21.86	22.23	22.56	22.90	23.23
TON	TONROE	0.94	13.27	13.07	13.05	13.11	13.30	13.48	13.72	13.92	14.13	14.33
TRI	TRIEN	0.97	22.59	22.24	22.22	22.32	22.64	22.96	23.35	23.70	24.05	24.40
TRL	TRALEE	0.99	34.66	34.14	34.10	34.26	34.75	35.23	35.84	36.37	36.92	37.45

Table C-2 Demand Forecasts at Time of Summer Peak (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TSB	THORNSBERRY	0.96	27.84	27.42	27.38	27.51	27.91	28.29	28.78	29.21	29.65	30.08
WAR	WARINGSTOWN MAIN	0.96	40.15	49.89	50.43	50.85	51.28	51.71	52.14	52.59	53.03	53.48
WAT	WATERFORD	0.95	38.41	37.83	37.78	37.96	38.50	39.04	39.71	40.30	40.91	41.49
WEX	WEXFORD	0.96	46.97	46.26	46.20	46.42	47.08	47.73	48.56	49.28	50.02	50.75
WHI	WHITEGATE	0.87	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)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AA	ARDNACRUSHA	0.99	12.54	11.98	11.71	11.87	12.07	12.26	12.44	12.72	12.94	13.08
AD	AGHADA	0.99	0.56	0.53	0.52	0.53	0.54	0.54	0.55	0.56	0.57	0.58
AGH	AGHYOULE MAIN	0.96	4.90	4.93	4.99	5.03	5.08	5.12	5.17	5.21	5.26	5.30
AGY	ARDNAGAPPARY	0.94	n/a	n/a	4.04	4.10	4.17	4.24	4.30	4.39	4.47	4.52
AHA	AHANE	1.00	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	n/a	n/a	6.45	6.53	6.61	6.70	6.78	6.86	6.95	7.04
ANR	ANNER	0.91	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	13.25	13.31	13.50	13.66	13.82	13.98	14.14	14.31	14.47	14.64
ARI	ARIGNA	0.95	1.65	1.58	1.54	1.56	1.59	1.62	1.64	1.68	1.70	1.72
ARK	ARKLOW	0.95	7.46	7.12	6.96	7.05	7.17	7.28	7.39	7.56	7.69	7.77
ATH	ATHLONE	0.98	20.42	19.49	19.06	19.32	19.65	18.61	18.88	19.30	19.63	19.86
ATY	ATHY	0.87	3.69	3.53	3.45	3.50	3.55	3.61	3.66	3.74	3.81	3.85
BAL	BALTRASNA	0.93	3.71	3.54	3.46	3.51	3.57	3.63	3.68	3.76	3.83	3.87
BAN	BANBRIDGE MAIN	0.96	11.69	11.78	11.93	12.06	12.20	12.33	12.47	12.61	12.75	12.89
BAN	BANDON	0.97	11.77	13.24	15.68	15.87	16.10	16.33	16.54	16.86	17.12	17.29
BAR	BARRYMORE	0.99	8.74	8.34	8.16	8.27	8.41	8.54	8.67	8.86	9.01	9.12

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BDA	BARODA	0.98	3.22	3.22	3.22	3.22	6.73	6.78	6.84	6.92	6.98	7.02
BDN	BALLYDINE	0.96	5.26	5.11	5.04	5.08	5.14	5.19	5.24	5.31	5.37	5.41
BEG	BALLYBEG	0.97	2.69	2.57	2.52	2.55	2.59	2.63	2.67	2.73	2.78	2.81
BGT	BALLYRAGGET	0.95	n/a	n/a	n/a	n/a	6.84	6.96	7.06	7.21	7.34	7.42
BIN	BINBANE	0.99	5.55	5.30	2.46	2.49	2.54	2.58	2.61	2.67	2.72	2.75
BK	BELLACORICK	0.97	2.93	2.80	2.73	2.77	2.82	2.86	2.91	2.98	3.02	3.06
BLI	BALLYLICKEY	0.88	4.14	3.95	3.86	3.91	3.98	4.04	4.10	4.19	4.27	4.31
BLK	BLAKE	0.94	7.02	6.71	3.02	3.06	3.11	3.16	3.21	3.28	3.34	3.37
BMA	BALLYMENA MESH (RURAL)	0.96	13.46	10.07	10.28	10.46	10.65	10.84	11.04	11.24	11.43	11.64
BMA	BALLYMENA SWBD (TOWN)	0.96	14.41	14.60	14.87	15.10	15.33	15.57	15.81	16.05	16.30	16.55
BNH	BALLYNAHINCH MAIN	0.96	16.91	17.02	17.23	17.42	17.60	17.79	17.98	18.17	18.37	18.56
BNM	BELFAST - BELFAST NORTH MAIN	0.96	n/a	15.35	15.55	15.72	15.89	16.06	16.24	16.41	16.59	16.77
BOG	BANOGE	0.94	5.65	5.39	5.27	5.34	5.43	5.52	5.60	5.73	5.82	5.89
BRA	BRACKLONE	0.94	n/a	n/a	3.54	3.59	3.65	3.71	3.76	3.84	3.91	3.95
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	18.43	17.59	17.20	17.44	17.73	18.01	18.29	18.69	19.02	19.23
BUT	BUTLERSTOWN	0.99	10.37	9.90	9.68	9.82	9.98	10.14	10.29	10.52	10.70	10.82
CAH	CAHIR	0.99	7.65	7.30	7.14	7.24	7.36	7.48	7.59	7.76	7.89	7.98
CAR	BELFAST - CARNMONEY MAIN	0.96	12.06	12.18	12.36	12.51	12.67	12.83	12.99	13.15	13.31	13.48
CBG	CARROWBEG	0.98	9.27	13.35	13.15	13.27	13.42	13.56	13.69	13.90	14.06	14.17
CBR	CASTLEBAR	0.98	8.17	7.80	7.63	7.73	7.86	7.99	8.11	8.29	8.43	8.53
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	18.18	18.42	18.96	19.44	19.92	20.42	20.92	21.44	21.97	22.52
CF	CATHALEEN'S FALL	0.95	5.39	5.14	5.03	5.10	5.19	5.27	5.35	5.46	5.56	5.62
CFM	CASTLEFARM	0.87	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79	45.79
CHA	CHARLEVILLE	0.99	5.58	5.32	5.20	5.28	5.36	5.45	5.53	5.65	5.75	5.82
CKG	CORKAGH	0.94	n/a	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CKM	CARRICKMINES	0.95	117.23	112.98	130.01	131.24	132.67	134.13	135.47	137.51	139.15	140.25
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	6.12	5.84	5.71	5.79	5.89	7.34	7.45	7.61	7.74	7.83
CLW	CARLOW	0.98	14.01	13.38	13.08	13.26	13.48	13.70	13.90	14.21	14.45	14.62
COL	COLERAINE MAIN	0.96	13.43	13.53	13.73	13.90	14.07	14.24	14.41	14.59	14.77	14.95
COL	COLLEGE PARK	0.97	13.89	13.26	12.96	13.15	13.36	13.58	13.78	14.08	14.33	14.49
COS	CARICKONSHANNON	0.99	8.15	7.78	7.60	7.71	7.84	7.96	8.08	8.26	8.40	8.50
COW	COW CROSS	0.99	2.92	2.79	2.73	2.77	2.82	2.86	2.90	2.96	3.01	3.05
CPS	COOLKEERAGH MAIN	0.96	9.19	9.31	9.47	9.61	9.75	9.89	10.03	10.17	10.31	10.46
CRA	CRANE	0.99	9.90	9.45	9.24	9.37	9.52	9.68	9.82	10.04	10.21	10.32
CRE	BELFAST - CREGAGH MAIN	0.96	19.57	19.74	16.08	16.31	16.54	16.77	17.00	17.24	17.47	17.71
CRG	CREAGH MAIN	0.96	7.12	10.66	10.79	10.88	10.98	11.09	11.19	11.29	11.40	11.50
CRO	COOLROE	0.99	6.34	6.05	5.91	6.00	6.10	6.19	6.28	6.42	6.53	6.61
CVW	CASTLEVIEW	0.98	9.69	9.25	9.05	9.17	9.33	9.48	9.61	9.83	10.00	10.11
DAL	DALLOW	0.99	4.41	4.21	4.11	4.17	4.24	4.31	4.37	4.47	4.55	4.60
DDK	DUNDALK	0.99	16.91	16.14	15.78	16.01	9.61	9.76	9.91	10.13	10.30	10.42
DFR	DUNFIRTH	0.99	2.78	2.66	2.60	2.63	2.68	2.72	2.76	2.82	2.87	2.90
DGN	DUNGARVAN	0.99	12.41	11.85	11.59	11.75	11.94	12.14	12.31	12.59	12.80	12.95
DLT	DALTON	0.99	7.45	7.11	6.95	7.05	7.17	7.28	7.39	7.55	7.68	7.77
DMY	DUNMANWAY	0.98	10.60	10.12	8.67	8.79	8.94	9.08	9.22	9.42	9.58	9.69
DON	BELFAST - DONEGALL MAIN(NORTH)	0.96	17.33	17.39	17.61	17.78	17.95	18.13	18.31	18.49	18.67	18.85
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.96	14.85	14.93	15.13	15.29	15.46	15.63	15.79	15.96	16.14	16.31
DOO	DOON	0.99	12.55	11.98	11.71	11.87	12.07	12.27	12.45	12.72	12.94	13.09
DRU	DRUMNAKELLY MAIN	0.96	28.68	26.41	26.84	27.20	27.57	27.95	28.33	28.71	29.10	29.49

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
DRU	DRUMLINE	0.99	9.45	9.02	8.82	8.94	9.09	9.23	9.37	9.58	9.74	9.85
DRY	DRYBRIDGE	0.99	23.96	22.87	22.36	22.68	21.45	21.80	22.12	22.61	23.00	23.26
DUN	DUNGANNON MAIN	0.96	26.99	26.28	26.72	27.10	27.48	27.87	28.26	28.65	29.05	29.46
EDE	EDEN MAIN	0.96	9.41	9.49	9.61	9.72	9.82	9.93	10.04	10.15	10.26	10.37
ENN	ENNISKILLEN MAIN	0.96	15.48	15.58	15.82	16.02	16.23	16.43	16.64	16.85	17.07	17.29
ENN	ENNIS	0.98	16.44	15.70	15.35	15.56	15.82	16.07	16.31	16.67	16.96	17.15
FIN	BELFAST - FINAGHY MAIN	0.96	9.62	9.71	9.84	9.94	10.05	10.16	10.27	10.38	10.49	10.61
FIN	FINGLAS	0.98	147.24	140.84	155.85	157.69	159.91	162.08	164.10	167.18	169.67	171.31
GAL	GALWAY	0.99	27.29	26.05	25.46	25.82	26.25	26.68	27.06	27.66	28.15	28.46
GI	GREAT ISLAND	0.97	5.7	5.5	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
GIL	GILRA	0.98	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
GLE	BELFAST - GLENGORMLEY MAIN	0.96	4.34	4.39	4.45	4.50	4.56	4.61	4.67	4.73	4.78	4.84
GLE	GLENLARA	0.94	4.91	4.69	4.59	4.65	4.73	4.80	4.87	4.98	5.07	5.13
GRI	GRIFFINRATH	0.99	18.99	18.12	17.31	17.55	17.84	18.13	18.40	18.80	19.13	19.35
GWE	GORTAWEE	0.96	22.30	22.11	22.02	22.07	22.14	22.21	22.27	22.36	22.44	22.49
HTS	HARNETTS CROSS	0.97	n/a	n/a	2.42	2.46	2.50	2.54	2.58	2.63	2.68	2.71
IKE	IKERRIN	0.98	7.24	7.91	7.75	7.85	7.96	8.07	8.18	8.34	8.46	8.55
INC	INCHICORE	0.98	140.13	153.94	161.82	163.07	164.58	166.07	167.45	169.57	171.24	172.37
KBY	KILBARRY	0.99	36.05	34.41	33.64	34.12	34.68	35.24	35.75	36.55	37.19	37.61
KER	KNOCKERAGH	0.99	12.85	12.26	11.99	12.16	12.36	12.56	12.74	13.03	13.25	13.40
KIN	KINNEGAD	0.95	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12	7.12
KKY	KILKENNY	0.99	17.45	16.66	16.29	16.52	13.79	14.01	14.22	14.53	14.78	14.95
KNO	BELFAST - KNOCK MAIN	0.96	20.15	20.26	18.01	18.24	18.48	18.71	18.95	19.20	19.44	19.69
KTL	KILTEEL	0.98	14.32	16.45	16.09	16.31	16.58	16.85	17.10	17.48	17.78	17.98
KTN	KILLOTERAN	0.96	9.62	9.30	9.15	9.24	9.35	9.46	9.56	9.72	9.85	9.93
KUR	KNOCKUMBER	0.95	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14	20.14

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
LA	LANESBORO	0.99	3.56	3.40	3.32	3.37	3.43	3.48	3.53	3.61	3.67	3.71
LAR	LARNE MAIN	0.96	13.15	13.23	13.41	13.56	13.72	13.87	14.03	14.18	14.34	14.51
LET	LETTERKENNY	0.99	16.87	16.10	14.42	14.62	14.86	15.10	15.32	15.66	15.93	16.12
LIB	LIBERTY	0.94	8.47	8.09	7.91	8.02	8.15	8.28	8.41	8.59	8.74	8.84
LIM	LIMAVADY MAIN	0.96	7.49	7.55	7.66	7.76	7.86	7.96	8.07	8.17	8.27	8.38
LIM	LIMERICK	0.99	26.71	25.54	25.00	25.33	25.74	26.14	26.50	27.07	27.52	27.82
LIS	LISBURN MAIN	0.96	19.10	19.25	19.54	19.78	20.02	20.27	20.52	20.78	21.04	21.30
LIS	LISDRUM	0.98	8.59	8.20	8.02	8.13	8.26	8.40	8.52	8.71	8.86	8.96
LMR	LISAGHMORE MAIN	0.96	14.53	14.63	14.85	15.04	15.24	15.43	15.63	15.83	16.04	16.24
LOG	LOGUESTOWN MAIN	0.96	11.87	11.97	12.14	12.28	12.42	12.56	12.71	12.85	13.00	13.15
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	0.83	5.17	4.93	0.93	0.94	0.96	0.97	0.99	1.01	1.03	1.04
MAL	MALLOW	0.99	7.35	7.02	6.86	6.96	7.07	7.19	7.29	7.45	7.58	7.67
MCE	MACETOWN	0.99	12.05	11.63	11.44	11.55	11.70	11.84	11.97	12.17	12.33	12.44
MID	MIDLETON	0.98	15.92	15.27	14.96	15.15	15.37	15.60	15.81	16.12	16.37	16.54
MLN	MULLAGHARLIN	0.95	0.35	0.35	0.35	0.35	8.61	8.74	8.87	9.06	9.21	9.31
MON	MONREAD	0.98	3.82	3.64	3.56	3.61	3.67	3.73	3.79	3.87	3.94	3.98
MOY	MOY	0.99	7.42	7.08	6.93	7.02	7.14	7.26	7.36	7.53	7.66	7.74
MR	MARINA	0.98	5.74	5.48	5.36	5.44	5.53	5.61	5.70	5.82	5.92	5.99
MTH	MEATH HILL	0.98	8.19	7.82	7.64	7.75	7.88	8.01	8.12	8.30	8.45	8.54
MUL	MULLINGAR	0.99	12.16	11.61	11.35	11.50	11.70	11.88	12.06	12.32	12.54	12.68
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	12.83	12.93	13.12	13.28	13.44	13.60	13.77	13.94	14.11	14.28
NAV	NAVAN	0.99	9.92	9.47	9.26	9.39	9.55	9.70	9.84	10.06	10.23	10.35
NEN	NENAGH	0.98	8.31	7.93	7.76	7.86	7.99	8.12	8.24	8.43	8.57	8.67
NEW	NEWRY MAIN	0.96	22.78	22.97	23.33	23.63	23.94	24.25	24.57	24.88	25.21	25.53

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NEW	NEWBRIDGE	0.99	13.09	9.71	9.49	9.62	6.28	6.38	6.47	6.62	6.73	6.81
OLD	OLDCOURT	0.95	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	17.41	17.55	17.84	18.08	18.33	18.57	18.82	19.08	19.34	19.60
OUG	OUGHTRAGH	0.99	9.55	9.12	8.91	9.04	9.19	9.34	9.47	9.68	9.85	9.96
PB	POOLBEG	0.99	75.07	71.66	70.08	71.05	72.23	73.39	74.47	76.14	77.44	78.33
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	0.99	13.87	13.24	12.95	13.13	9.50	9.66	9.80	10.02	10.19	10.30
PSW	BELFAST - PSW	0.96	15.27	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAT	RATHGAEL MAIN	0.96	19.06	19.20	19.47	19.70	19.94	20.17	20.41	20.65	20.90	21.14
RAT	RATHKEALE	0.97	7.74	7.39	7.22	7.33	7.45	7.57	7.68	7.85	7.98	8.07
RIC	RICHMOND	0.99	9.51	9.08	8.87	9.00	9.15	9.29	9.43	9.64	9.81	9.92
RNW	RINAWADE	0.99	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	9.44	9.50	9.63	9.74	9.85	9.96	10.07	10.18	10.30	10.41
RSY	RINGASKIDDY	0.95	2.92	2.79	2.73	2.77	2.81	2.86	2.90	2.97	3.02	3.05
RYB	RYEBROOK	0.95	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
SAL	SALTHILL	0.99	27.26	26.02	21.64	21.94	22.30	22.66	23.00	23.51	23.91	24.19
SCR	SCREEB	0.94	n/a	n/a	3.81	3.86	3.93	3.99	4.05	4.14	4.21	4.26
SHE	SHELTON ABBEY	0.95	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
SKL	SHANKILL	0.98	16.09	15.36	15.02	15.23	15.48	15.73	15.96	16.31	16.60	16.79
SLI	SLIGO	0.99	15.50	14.79	14.46	14.67	14.91	15.15	15.37	15.71	15.99	16.17
SNG	SINGLAND	0.98	4.46	4.26	4.16	4.22	4.29	4.36	4.43	4.52	4.60	4.65
SOM	SOMERSET	0.99	6.20	5.92	5.79	5.87	5.97	6.06	6.15	6.29	6.40	6.47
SPR	SPRINGTOWN MAIN	0.96	9.07	9.17	9.29	9.39	9.50	9.60	9.70	9.81	9.92	10.02
STR	STRABANE MAIN	0.96	10.95	11.04	11.18	11.31	11.43	11.56	11.69	11.82	11.95	12.08
STR	STRATFORD	0.99	4.64	4.43	4.33	4.39	4.46	4.53	4.60	4.70	4.78	4.84
TBG	TRABEG	0.99	15.83	15.11	14.77	14.98	15.23	15.47	15.69	16.04	16.32	16.51

Table C-3 Demand Forecasts at Time of Summer Valley (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TBK	TULLABRACK	0.98	4.15	3.96	3.88	3.93	4.00	4.06	4.12	4.21	4.28	4.33
THU	THURLES	0.98	9.22	8.81	8.61	8.73	8.87	9.02	9.15	9.35	9.51	9.62
TIP	TIPPERARY	0.99	6.12	5.84	5.71	5.79	5.89	5.99	6.07	6.21	6.32	6.39
TLK	TRILLICK	0.95	5.84	5.57	5.45	5.53	5.62	5.71	5.79	5.92	6.02	6.09
TON	TONROE	0.97	4.92	4.70	4.59	4.66	4.73	4.81	4.88	4.99	5.08	5.13
TRI	TRIEN	0.98	12.18	11.62	11.36	11.52	11.71	11.90	12.08	12.34	12.56	12.70
TRL	TRALEE	0.97	13.78	13.16	12.86	13.04	13.26	13.47	13.67	13.98	14.22	14.38
TSB	THORNSBERRY	0.98	8.99	8.59	8.39	8.51	8.65	8.79	8.92	9.12	9.28	9.38
WAR	WARINGSTOWN MAIN	0.96	14.97	18.60	18.80	18.95	19.11	19.28	19.44	19.60	19.77	19.94
WAT	WATERFORD	0.99	12.97	12.38	12.11	12.28	12.48	12.68	12.87	13.15	13.38	13.53
WEX	WEXFORD	0.99	15.77	15.06	14.72	14.93	15.17	15.41	15.65	15.99	16.27	16.45
WHI	WHITEGATE	0.80	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)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AGH	AGHYOULE MAIN	0.96	15.01	15.12	15.28	15.42	15.56	15.69	15.83	15.97	16.11	16.26
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	n/a	n/a	19.77	20.02	20.27	20.52	20.78	21.04	21.30	21.57
ANT	ANTRIM MAIN	0.96	40.60	40.80	41.38	41.86	42.35	42.85	43.35	43.85	44.36	44.88
BAN	BANBRIDGE MAIN	0.96	35.82	36.09	36.57	36.97	37.38	37.80	38.22	38.64	39.07	39.50
BMA	BALLYMENA MESH (RURAL)	0.96	41.25	30.85	31.50	32.07	32.65	33.24	33.83	34.43	35.05	35.66
BMA	BALLYMENA SWBD (TOWN)	0.96	44.18	44.73	45.56	46.27	46.99	47.71	48.45	49.20	49.96	50.73
BNH	BALLYNAHINCH MAIN	0.96	51.84	52.15	52.82	53.38	53.95	54.53	55.11	55.70	56.29	56.89
BNM	BELFAST - BELFAST NORTH MAIN	0.96	n/a	47.06	47.67	48.18	48.70	49.23	49.76	50.30	50.84	51.39

Table C-4 Demand Forecasts at Time of Autumn Peak – Northern Ireland only (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CAR	BELFAST - CARNMONEY MAIN	0.96	36.97	37.32	37.88	38.35	38.83	39.31	39.80	40.30	40.80	41.30
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	55.71	56.46	58.11	59.59	61.07	62.58	64.13	65.72	67.35	69.02
COL	COLERAINE MAIN	0.96	41.15	41.46	42.07	42.59	43.11	43.64	44.18	44.72	45.27	45.83
CPS	COOLKEERAGH MAIN	0.96	28.15	28.54	29.03	29.45	29.87	30.30	30.73	31.17	31.61	32.06
CRE	BELFAST - CREGAGH MAIN	0.96	59.97	60.49	49.29	49.98	50.68	51.39	52.10	52.82	53.55	54.29
CRG	CREAGH MAIN	0.96	21.81	32.68	33.06	33.36	33.67	33.98	34.29	34.61	34.93	35.26
DON	BELFAST - DONEGALL MAIN(NORTH)	0.96	53.13	53.31	53.96	54.49	55.02	55.56	56.11	56.66	57.22	57.78
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.96	45.52	45.77	46.37	46.87	47.38	47.89	48.41	48.93	49.46	49.99
DRU	DRUMNAKELLY MAIN	0.96	87.90	80.94	82.25	83.37	84.51	85.66	86.82	88.00	89.19	90.39
DUN	DUNGANNON MAIN	0.96	82.72	80.55	81.90	83.06	84.22	85.41	86.60	87.82	89.05	90.30
EDE	EDEN MAIN	0.96	28.84	29.08	29.46	29.78	30.11	30.43	30.76	31.10	31.44	31.78
ENN	ENNISKILLEN MAIN	0.96	47.43	47.76	48.49	49.11	49.73	50.37	51.01	51.66	52.31	52.98
FIN	BELFAST - FINAGHY MAIN	0.96	29.48	29.77	30.16	30.48	30.81	31.14	31.48	31.81	32.16	32.50
GLE	BELFAST - GLENGORMLEY MAIN	0.96	13.30	13.45	13.64	13.81	13.97	14.14	14.31	14.48	14.66	14.84
KNO	BELFAST - KNOCK MAIN	0.96	61.76	62.08	55.20	55.91	56.63	57.35	58.09	58.83	59.58	60.34
LAR	LARNE MAIN	0.96	40.29	40.56	41.11	41.57	42.04	42.51	42.99	43.47	43.96	44.46
LIM	LIMAVADY MAIN	0.96	22.96	23.13	23.49	23.79	24.10	24.41	24.72	25.04	25.36	25.69
LIS	LISBURN MAIN	0.96	58.55	58.99	59.87	60.62	61.37	62.13	62.90	63.68	64.47	65.27
LMR	LISAGHMORE MAIN	0.96	44.53	44.84	45.53	46.11	46.70	47.30	47.91	48.52	49.15	49.78
LOG	LOGUESTOWN MAIN	0.96	36.38	36.68	37.20	37.63	38.06	38.50	38.95	39.40	39.85	40.31
NAR	NEWTOWNARDS MAIN	0.96	39.32	39.63	40.21	40.69	41.19	41.69	42.20	42.72	43.24	43.76
NEW	NEWRY MAIN	0.96	69.82	70.41	71.50	72.43	73.37	74.33	75.29	76.27	77.26	78.26
OMA	OMAGH MAIN	0.96	53.35	53.80	54.67	55.41	56.17	56.92	57.69	58.47	59.26	60.07
PSW	BELFAST - PSW	0.96	46.80	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAT	RATHGAEL MAIN	0.96	58.41	58.85	59.68	60.39	61.10	61.82	62.55	63.29	64.04	64.80

Table C-4 Demand Forecasts at Time of Autumn Peak – Northern Ireland only (continued)

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
ROS	ROSEBANK MAIN	0.96	28.94	29.13	29.52	29.85	30.18	30.52	30.86	31.21	31.56	31.91
SPR	SPRINGTOWN MAIN	0.96	27.79	28.10	28.48	28.79	29.10	29.42	29.74	30.06	30.39	30.72
STR	STRABANE MAIN	0.96	33.57	33.82	34.28	34.65	35.04	35.43	35.82	36.22	36.62	37.03
WAR	WARINGSTOWN MAIN	0.96	45.88	57.00	57.61	58.09	58.58	59.08	59.57	60.08	60.59	61.10

D Generation Capacity and Dispatch Details

APPENDIX D GENERATION CAPACITY AND DISPATCH DETAILS

Table D-1 lists existing and committed future generation and the Registered Capacity[1] of each unit for each year up to 2023. All generation capacity figures in Table D-1 are expressed in exported terms i.e. generation unit output less the unit's own auxiliary load. The units are grouped in these tables on a geographical basis.

Table D-2 lists the existing and committed future wind generation that feeds into each 110 kV transmission station, from the distribution system, for each year up to 2023. Table D-2 is based on the wind farms that currently have signed connection agreements with the DSO (as at the beginning of December 2013).

Table D-3 lists the existing and committed future distribution generation and their respective MW capacity over the period of the statement, in Ireland.

Please see EirGrid's website[2] for an update on the Gate 3 generators which have committed to connecting to the transmission system 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.eirgrid.com/customers/#d.en.9619

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)									
						2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dublin	Dublin Bay Power	DB1	Irishtown	220 kV	Gas/DO	415	415	415	415	415	415	415	415	415	415
	EWIC	EW1	Woodland	400 kV	N/A	500	500	500	500	500	500	500	500	500	500
	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
	Mount Lucas	-	Mount Lucas	110 kV	Wind	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
	North Wall	NW4	North Wall	220 kV	Gas/DO	163	163	163	163	163	163	163	163	163	163
	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
	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	TH3	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
Total						2782	2782	2782	2782	2782	2782	2782	2782	2782	2782
Midlands	Cuilleen OCGT	-	Athlone	110 kV	Gas/DO	98	98	98	98	98	98	98	98	98	98
	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
	Lisheen	-	Lisheen	110 kV	Wind	55	55	55	55	55	55	55	55	55	55
	Kill Hill	-	Kill Hill	110 kV	Wind	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
	Killinaparson	-	Killinaparson	110 kV	Wind	-	55	55	55	55	55	55	55	55	55
	Rhode PCP	RP1	Derryiron	110 kV	Distillate	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	Rhode PCP	RP2	Derryiron	110 kV	Distillate	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	Sliabh Bawn	-	Sliabh Bawn	110 kV	Wind	-	58	58	58	58	58	58	58	58	58
	West Offaly Power	WO4	Shannonbridge	110 kV	Peat	141	141	141	141	141	141	141	141	141	141
Total						698	811	811	811	811	811	811	811	811	811

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (continued)

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MEC)									
						2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
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
	Booltiagh	-	Booltiagh	110 kV	Wind	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
	Booltiagh Extension	-	Booltiagh	110 kV	Wind	12	12	12	12	12	12	12	12	12	12
	Derrybrien	-	Derrybrien	110 kV	Wind	59.5	59.5	59.5	59.5	59.5	59.5	59.5	59.5	59.5	59.5
	Moneypoint	MP1	Moneypoint	380 kV	Coal	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5
	Moneypoint	MP3	Moneypoint	380 kV	Coal	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5
	Seecon	-	West Galway	110 kV	Wind	-	105	105	105	105	105	105	105	105	105
	Tynagh	TY	Tynagh	220 kV	Gas	404	404	404	404	404	404	404	404	404	404
	Uggool	-	West Galway	110 kV	Wind	-	64	64	64	64	64	64	64	64	64
Total						1156	1325	1325	1325	1325	1325	1325	1325	1325	1325
North-East	Ballakelly CCGT	-	Ballakelly	220 kV	Gas/DO	445	445	445	445	445	445	445	445	445	445
	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
	Caulstown		Platin	110 kV	Gas/DO	-	58	58	58	58	58	58	58	58	58
	Mountain Lodge	-	Ratrussan	110 kV	Wind	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Total						523.6	581.6	603.6	603.6	603.6	603.6	603.6	603.6	603.6	603.6
Northern Ireland	Ballylumford CCGT 10	B10	Ballylumford	110 kV	Gas/Gasoil	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4
	Ballylumford CCGT 31	B31	Ballylumford	275 kV	Gas/Gasoil	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5
	Ballylumford CCGT 32	B32	Ballylumford	275 kV	Gas/Gasoil	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5	239.5
	Ballylumford GT 7	BGT1	Ballylumford	110 kV	Gasoil	58	58	58	58	58	58	58	58	58	58
	Ballylumford GT 8	BGT2	Ballylumford	110 kV	Gasoil	58	58	58	58	58	58	58	58	58	58
	Ballylumford ST4	B4	Ballylumford	275 kV	Gas/HFO	170	170	-	-	-	-	-	-	-	-

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (continued)

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MEC) 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Northern Ireland	Ballylumford ST5	B5	Ballylumford	275 kV	Gas/HFO	170	170	-	-	-	-	-	-	-	-
	Ballylumford ST6	B6	Ballylumford	275 kV	Gas/HFO	170	170	-	-	-	-	-	-	-	-
	Brockaghboy	-	Brockaghboy	110 kV	Wind	-	-	-	-	-	45	45	45	45	45
	CAES	-	Ballylumford	275 kV	Comp. Air	-	-	-	-	268	268	268	268	268	268
	Coolkeeragh CCGT	C30	Coolkeeragh	275 & 110 kV	Gas/Gasoil	413	413	413	413	413	413	413	413	413	413
	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	240	240	240	240	240	240	240	240	240	240
	Kilroot ST2	K2	Kilroot	275 kV	Coal/Oil	240	240	240	240	240	240	240	240	240	240
	Moyle	-	Ballycronan More	275 kV	N/A	250	250	250	250	450	450	450	450	450	450
	Slieve Kirk	SLK	Killymallaght	110 kV	Wind	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
Total						2615	2615	2105	2105	2573	2618	2618	2618	2618	2618
North-West	Cronacarkfree	-	Cronacarkfree	110 kV	Wind	-	-	-	105	105	105	105	105	105	105
	Erne	ER3	Cathaleen's Fall	110 kV	Hydro	22	22	22	22	22	22	22	22	22	22
	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	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2
	Kingsmountain	-	Cunghill	110 kV	Wind	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8
	Lough Ree Power	LR4	Lanesboro	110 kV	Peat	94	94	94	94	94	94	94	94	94	94
	Meentycat	-	Meentycat	110 kV	Wind	85	85	85	85	85	85	85	85	85	85

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (continued)

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MEC)									
						2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
North - West	Mulreavy	-	Mulreavy	110 kV	Wind	-	82	82	82	82	82	82	82	82	82
	Mulreavy Ext.	-	Mulreavy	110 kV	Wind	-	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85
	Oweninney (1)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	-	34	34	34	34
	Oweninney (2)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	-	48	48	48	48
	Oweninney (3)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	-	56	56	56	56
	Oweninney (4)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	-	34	34	34	34
	Oweninney (5)	-	Bellacorick	400 kV	Wind	-	-	-	-	-	-	198.9	198.9	198.9	198.9
Total						352.0	441.9	546.9	546.9	546.9	546.9	917.8	917.8	917.8	917.8
South-East	Ballywater	-	Ballywater	110 kV	Wind	42	42	42	42	42	42	42	42	42	42
	Castledockrill	-	Castledockrill	110 kV	Wind	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4
	Great Island	GI1	Great Island	110 kV	HFO	54	-	-	-	-	-	-	-	-	-
	Great Island	GI2	Great Island	110 kV	HFO	54	-	-	-	-	-	-	-	-	-
	Great Island	GI3	Great Island	220 kV	HFO	108	-	-	-	-	-	-	-	-	-
	Great Island	-	Great Island	220 kV	Gas	431	431	431	431	431	431	431	431	431	431
	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
	Nore Power	NO1	Nore	110 kV	Gas/DO	98	98	98	98	98	98	98	98	98	98
	Woodhouse	-	Woodhouse	110 kV	Wind	23.28	23.28	23.28	23.28	23.28	23.28	23.28	23.28	23.28	23.28
Total						670.7	454.7	669.7	669.7	669.7	669.7	669.7	669.7	669.7	669.7
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	ADC	Longpoint	220 kV	Gas	431	431	431	431	431	431	431	431	431	431

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (continued)

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MEC)									
						2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
South - West	Athea	-	Athea	110 kV	Wind	51	51	51	51	51	51	51	51	51	51
	Athea Extension	-	Athea	110 kV	Wind	22	22	22	22	22	22	22	22	22	22
	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
	Barnadivane	-	Barnadivane	110 kV	Wind	-	-	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	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
	Clahane	-	Clahane	110 kV	Wind	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
	Clahane	-	Clahane	111 kV	Wind	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
	Cloghboola	-	Cloghboola	110 kV	Wind	-	46	46	46	46	46	46	46	46	46
	Coomacheo	-	Garrow	110 kV	Wind	41.23	41.23	41.23	41.23	41.23	41.23	41.23	41.23	41.23	41.23
	Coomacheo Extension	-	Garrow	110 kV	Wind	18	18	18	18	18	18	18	18	18	18
	Coomagearlahy	-	Coomagearlahy	110 kV	Wind	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5
	Coomagearlahy Extension	-	Coomagearlahy	110 kV	Wind	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
	Dromada	-	Dromada	110 kV	Wind	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
	Glanlee	-	Glanlee	110 kV	Wind	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8
	Glanlee Extension	-	Glanlee	110 kV	Wind	6	6	6	6	6	6	6	6	6	6
	Knockacummer	-	Knockacummer	110 kV	Wind	87	87	87	87	87	87	87	87	87	87
	Knocknagreenan	KGN	Carrigadrohid	110 kV	Hydro	70	70	70	70	70	70	70	70	70	70
	Lee Hydro	LE1	Inniscarra	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Lee Hydro	LE2	Inniscarra	111 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
	Moneypoint	MP2	Moneypoint	380 kV	Coal/HFO	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5
	Moneypoint	-	Moneypoint	110 kV	Wind	-	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9

Table D-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation (continued)

Area	Generator	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MEC) 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Ralappane	-	Ralappane	220 kV	CHP	40	40	40	40	40	40	40	40	40	40
	Suir OCGT	SUR	Cahir	110 kV	Gas/DO	98	98	98	98	98	98	98	98	98	98
	Tarbert	TB1	Tarbert	110 kV	HFO	54	54	54	54	54	54	54	54	54	54
	Tarbert	TB2	Tarbert	110 kV	HFO	54	54	54	54	54	54	54	54	54	54
	Tarbert	TB3	Tarbert	220 kV	HFO	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7
	Tarbert	TB4	Tarbert	220 kV	HFO	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7	240.7
	Whitegen CCGT	WG	Glanagow	220 kV	Gas/DO	445	445	445	445	445	445	445	445	445	445
Total						3252	3320	3380	3380	3380	3380	3380	3380	3380	3380

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dublin	Glasmore	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Grange	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Griffinrath	0.0	0.0	0.0	0.0	0.0	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
Midlands	Cauteen	95	95	95	95	95	95	95	95	95	95
	Dallow	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
	Ikerrin	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
	Lisheen	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
	Nenagh	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
	Thurles	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
	Tipperary	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Midlands Area Total		201.5	201.5	201.5	201.5	201.5	201.5	201.5	201.5	201.5	201.5
Mid-West	Ardnacrusha	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
	Tullabrack	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Mid-West Area Total		20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
North-East	Drybridge	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	Meath Hill	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
	Shankill	3	3	3	3	3	3	3	3	3	3
North-East Area Total		32	32	32	32	32	32	32	32	32	32
North-West	Arigna	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6
	Bellacorick	6.45	9	9	9	9	9	9	9	9	9
	Binbane	46	46	46	46	46	46	46	46	46	46
	Castlebar	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8
	Corderry	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2
	Dalton	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
	Galway	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
	Glenree	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
North - West	Gortawee	3	3	3	3	3	3	3	3	3	3
	Lanesboro	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
	Letterkenny	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3
	Moy	6	6	6	6	6	6	6	6	6	6
	Salthill	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
	Sligo	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
	Somerset	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
	Sorne Hill	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7
	Tonroe	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
	Trillick	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
North-West Area Total		392.8	395.3	395.3	395.3	395.3	395.3	395.3	395.3	395.3	395.3
South-east	Arklow	25.2	61.7	61.7	61.7	61.7	61.7	61.7	61.7	61.7	61.7
	Butlerstown	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Carlow	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7
	Crane	5	5	5	5	5	5	5	5	5	5
	Crory	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
	Knocknagoshel	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	Waterford	18.25	18.25	18.25	18.25	18.25	18.25	18.25	18.25	18.25	18.25
	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		179.0	215.5	215.5	215.5	215.5	215.5	215.5	215.5	215.5	215.5
South - West	Athea	4	4	4	4	4	4	4	4	4	4
	Ballylickey	36.45	36.45	36.45	36.45	36.45	36.45	36.45	36.45	36.45	36.45
	Bandon	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	Boggeragh	20	20	20	20	20	20	20	20	20	20
	Cordal	-	83.85	83.85	83.85	83.85	83.85	83.85	83.85	83.85	83.85
	Dunmanway	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
	Garrow	15	15	15	15	15	15	15	15	15	15

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
South - West	Glenlara	53	53	53	53	53	53	53	53	53	53
	Knockearagh	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
	Macroom	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8
	Midleton	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Rathkeale	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5
	Tralee	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9
	Trien	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4
South-West Area Total		353.5	437.3	437.3	437.3	437.3	437.3	437.3	437.3	437.3	437.3
Northern Ireland	Aghyoule	67.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
	Antrim	-	4.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
	Ballymena (Rural)	5	11	11	11	11	11	11	11	11	11
	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
	Drumnakelly	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
	Drumquin	-	-	-	-	88.6	88.6	88.6	88.6	88.6	88.6
	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	19.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
	Gort	-	-	-	88.6	88.6	88.6	88.6	88.6	88.6	88.6
	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
	Magherakeel	70.6	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1
	Mid Antrim	-	-	54.8	54.8	54.8	82.4	82.4	82.4	82.4	82.4
	Newry	-	-	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5

Table D-2 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Northern Ireland	Omagh	125.7	125.7	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
	Springtown	-	-	-	45	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	-	-	78	78	78	78	78	78	78	78
Northern Ireland Total		562.9	674.3	832.6	936.2	1024.8	1052.4	1052.4	1052.4	1052.4	1052.4

Table D-3 Existing and Committed Distribution-Connected Dispatchable Conventional Generation

Area	110 kV station	Conventional Capacity (MW)										
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dublin	Ringsend			72	72	72	72	72	72	72	72	72
	Derryiron			15	15	15	15	15	15	15	15	15
North-east	Drybridge	17	17	17	17	17	17	17	17	17	17	17
	Navan			13	13	13	13	13	13	13	13	13
North-west	Bellacorick										10	10
	Tawnaghmore	104	104	104	153	153	153	153	153	153	153	153
Midlands	Blake		5	5	5	5	5	5	5	5	5	5
Total		121	126	226	275	275	275	275	275	275	285	285

D.1 UPDATED WIND GENERATION INFORMATION

At the October 2013 freeze date, approximately 1100 MW of Transmission and Distribution wind generation had been contracted to connect but did not have an estimated energisation date. This wind generation is presented in Table D-4 and Table D-5.The estimated connection dates for the wind generation detailed in Table D-4 and Table D-5 was obtained after the data freeze. This information has been included in the TYTFS to illustrate the expected growth of wind energy in Ireland over the forthcoming ten year period and will be included in future TYTFS studies.

It should be noted that an additional 708 MW of Transmission and Distribution wind generation did not have an estimated energisation date at the time of the data freeze (October 2014) or at the time of publication of the All-Island Transmission Forecast Statement 2014. It is envisaged that this information will be updated in due course and included in future TYTFS analysis.

Table D-4 Updated Transmission Contracted Wind Farm Capacity Connection Information

Area	Generator	Unit ID	Connected At		Maximum Export Capacity (MW)									
					2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
South-West	Ateha (3 and 4)	-	Athea 2	110 kV	26	26	26	26	26	26	26	26	26	26
Total					26	26	26	26	26	26	26	26	26	26

Table D-5 Updated Distribution Contracted Wind Farm Capacity Connection Information

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Midlands	Carrick on Shannon	-	-	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Dallow	-	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Doon	-	-	25	25	25	25	25	25	25	25
	Portlaoise	-	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Midlands Area Total		0	13.5	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Mid-West	Ballydine	-	-	24	24	24	24	24	24	24	24
	Booltiagh	-	-	101.6	101.6	101.6	101.6	101.6	101.6	101.6	101.6
	Tullabrack	4.6	4.6	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4
Mid-West Area Total		4.6	4.6	144	144	144	144	144	144	144	144
North-East	Dundalk	-	15	15	15	15	15	15	15	15	15
	Meath Hill	-	-	29	29	29	29	29	29	29	29
North-East Area Total		0	15	44	44	44	44	44	44	44	44
North-West	Ardnagappary	-	-	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16
	Bellacorick	-	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
	Binbane	-	9.35	23.45	50.45	50.45	50.45	50.45	50.45	50.45	50.45
	Glenree	-	-	-	40.5	40.5	40.5	40.5	40.5	40.5	40.5
	Knockranny	-	-	100.8	100.8	100.8	100.8	100.8	100.8	100.8	100.8
	Letterkenny	-	-	34.4	45.2	45.2	45.2	45.2	45.2	45.2	45.2

Table D-5 Updated Distribution Contracted Wind Farm Capacity Connection Information (continued)

Area	110 kV station	Wind Farm Capacity (MW)									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
North-West	Mulreavy	-	-	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
	Sorne Hill	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
	Tawnaghmore	-	30	30	30	30	30	30	30	30	30
	Tonroe	2.5	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
	Trillick	-	13	13	13	13	13	13	13	13	13
Nort-West Area Total		4.8	77.6	273.5	351.8	351.8	351.8	351.8	351.8	351.8	351.8
South-East	Arklow	-	24	24	24	24	24	24	24	24	24
	Cureeny	-	-	-	-	140.5	140.5	140.5	140.5	140.5	140.5
	Dungarvan	-	-	34	34	34	34	34	34	34	34
	Midleton	-	-	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
	West Galway	-	-	3	3	3	3	3	3	3	3
Sout-East Area Total		0	24	82.6	82.6	223.1	223.1	223.1	223.1	223.1	223.1
South-West	Athea-2	-	-	-	77.6	77.6	77.6	77.6	77.6	77.6	77.6
	Aughinish	-	-	-	20	20	20	20	20	20	20
	Ballylickey	-	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
	Charleville	-	-	69.8	69.8	69.8	69.8	69.8	69.8	69.8	69.8
	Dunmanway	-	17	17	17	17	17	17	17	17	17
	Knockearagh	-	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	Reamore	-	-	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8
	Tarbert	-	-	-	18	18	18	18	18	18	18
	Trien	-	-	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
South-West Area Total		0	33.9	156	271.6	271.6	271.6	271.6	271.6	271.6	271.6

D.2 GENERATION DISPATCH DETAILS

Table D-6 through to Table D-8 list generation dispatch profiles 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. Wind farms were dispatched at 30% of their rated capacity, which equates approximately to their average expected output for summer valley and at 10% for summer peak and winter peak in Table D-6 and at 30% in Table D-8. The values shown are in exported terms i.e. they are the net of each generation unit's own consumption. They indicate the power delivered to the transmission system.

In all instances, except the dispatch profiles used for the winter peak short circuit current level studies, a dispatch of 0 MW indicates that the unit is not synchronised to the system and is effectively off. For the calculations of short circuit currents at winter peaks, 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, using a forecast of transmission losses. The transmission loss figures calculated by the network models used in this TYTFS may differ from the forecast figures and hence the dispatch totals may differ from the system demand forecasts in Table 3-1 in Chapter 3.

Table D-9 lists the existing and proposed generating plant contract details in Northern Ireland.

Table D-6 Dispatch Profiles – Ireland Short Circuit

Area	Generation Station	Unit ID	2014		2017		2020	
			SV	WP	SV	WP	SV	WP
Dublin	Dublin Bay Power	DB1	163	330	163	330	163	350
	EWIC	EW1	0	250	0	200	100	300
	Huntstown	HNC	188	229.2	0	343	0	280
	Huntstown	HN2	0	325	0	380	0	360
	North Wall	NW4	0	0	0	0	0	0
	North Wall	NW5	0	0	0	0	0	0
	Poolbeg	PBC	0	0	0	130	0	150
	Turlough Hill	TH1,2,3,4	-328	268.3	-292	86	-309	17
	Installed Wind		24	8	24	8	24	8
Dublin Area Total			47	1410	-105	1477	-22	1465
South-West	Aghada	AD1	0	259	0	40	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	350	222	356	222	400
	Aughinish	SK3	54	80	39	75.5	20	77.5
	Aughinish	SK4	75	80	39	75.5	20	77.7
	Knocknagreenan	KGN	0	0	0	0	0	0
	Lee Hydro	LE1	0	0	4	0	4	14
	Lee Hydro	LE2	0	0	1	0	1	4
	Lee Hydro	LE3	0	0	2	2	2	8
	Marina	MRT	0	0	0	0	0	0
	Moneypoint	MP2	0	270	60	260	100	276
	Suir	SUR	0	0	0	0	0	0
	Tarbert	TB1	0	0	0	0	0	0

Table D-6 Dispatch Profiles – Ireland Short Circuit (continued)

Area	Generation Station	Unit ID	2014		2017		2020	
			SV	WP	SV	WP	SV	WP
South-West	Tarbert	TB2	0	0	0	0	0	0
	Tarbert	TB3	0	38	0	0	0	0
	Tarbert	TB4	0	38	0	0	0	0
	Whitegate CCGT	WG	220	360	0	375	110	380
	Installed Wind	-	262	87	326	109	326	109
South-West Area Total			611	1562	693	1293	805	1346
Mid-West	Ardnacrusha	AA1	0	10	5	21	5	9
	Ardnacrusha	AA2	0	10	5	21	5	22
	Ardnacrusha	AA3	0	10	5	18	5	9
	Ardnacrusha	AA4	0	10	5	23	5	23
	Moneypoint	MP1	60	270	60	260	100	266.9
	Moneypoint	MP3	0	270	60	260	100	250
	Tynagh	TY	0	362	0	366	0	400
	Installed Wind	-	33	11	84	28	84	28
Mid-West Area Total			93	953	224	997	304	1008
South-East	Great Island	GI1	0	0	0	0	0	0
	Great Island	GI2	0	0	0	0	0	0
	Great Island	GI3	0	0	0	0	0	0
	Great Island	GI4	235	300	235	380	235	438
	Liffey Hydro	LI1	0	0	3.8	14	5	14
	Liffey Hydro	LI2	0	0	5	4	5	14
	Liffey Hydro	LI4	0	0	5	5	1	3.5
	Nore Power	NO1	0	0	0	0	0	0

Table D-6 Dispatch Profiles – Ireland Short Circuit (continued)

Area	Generation Station	Unit ID	2014		2017		2020	
			SV	WP	SV	WP	SV	WP
South-East	Installed Wind	-	262	87	326	109	326	109
South-East Area Total			321	329	345	435	343	502
Midlands	Cuilleen	-	0	0	0	0	0	0
	Edenderry Power	ED1	55	119	60	113	0	119
	Edenderry PCP	ED3	0	0	20	55.4	0	55.4
	Edenderry PCP	ED5	0	0	20	55.4	0	55.4
	Rhode PCP	RP1	0	0	0	0	0	0
	Rhode PCP	RP2	0	0	0	0	0	0
	West Offaly Power	WO4	0	138	0	141.3	0	138
	Installed Wind	-	96	32	130	43	130	43
Midlands Area Total			151	289	230	408	130	411
North-West	Erne	ER3	0	0	5	21	5	20.9
	Erne	ER4	0	10	5	22	5	22.5
	Erne	ER1	0	0	3	10	3	10
	Erne	ER2	0	0	3	9.5	3	10
	Lough Ree Power	LR4	80	0	0	0	0	91
	Installed Wind	-	176	59	235	78	346	115
North-West Area Total			256	69	251	141	362	270
North-East	Installed Wind	-	33	11	40	13	40	13
North-East Area Total			33	11	40	13	40	13

Table D-7 Dispatch Profiles – Northern Ireland Short Circuit Current Level

Area	Generation Station	Unit ID	2014		2017		2020	
			SV	WP	SV	WP	SV	WP
Northern Ireland	Ballylumford CCGT10	B10	65	90	65	80	65	80
	Ballylumford CCGT20	B20	0	150	0	130	0	140
	Ballylumford CCGT21	B21	0	150	0	130	0	140
	Ballylumford CCGT22	B22	0	170	0	130	0	140
	Ballylumford GT7	BGT1	0	0	0	0	0	0
	Ballylumford GT8	BGT2	0	0	0	0	0	0
	Ballylumford ST4	B4	0	60	0	0	0	0
	Ballylumford ST5	B5	0	60	0	0	0	0
	Ballylumford ST6	B6	0	0	0	0	0	0
	CAES	-	0	0	0	0	0	80
	Coolkeeragh CCGT	C30	260	380	260	390	260	335
	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	35	0	0
	Kilroot GT4	KGT4	0	0	0	35	0	0
	Kilroot ST1	K1	110	140	110	130	110	170
	Kilroot ST2	K2	0	140	0	130	0	170
	Moyle (Import positive)	-	-80	250	-60	250	-80	450
	Wind Generation	-	30%	10%	30%	10%	30%	10%

Table D-8 Dispatch Profiles – Power Flow Diagrams

Please note that the summer valley short circuit dispatch in Table D-6 was used for the power flow diagrams and as such has not been included in Table D-8.

Area	Generation Station	Unit ID	2014		2023	
			SP	WP	SP	WP
Dublin	Dublin Bay Power	DB1	300	330	300	350
	EWIC	-	300	300	300	300
	Huntstown	HN1	300	229.2	330	280
	Huntstown	HN2	0	325	0	360
	North Wall	NW4	0	0	0	0
	North Wall	NW5	0	0	0	0
	Poolbeg	PBC	0	0	0	150
	Turlough Hill	TH1,2,3,4	130	268.3	140	17
	Installed Wind		24	24	24	24
Dublin Area Total			1054	1476	1094	1481
South-West	Aghada	AD1	0	259	0	0
	Aghada	AT1	0	0	0	0
	Aghada	AT2	0	0	0	0
	Aghada	AT4	0	0	0	0
	Aghada CCGT	ADC	200	350	222	400
	Aughinish	SK3	54	80	75	77.5
	Aughinish	SK4	75	80	75	77.7
	Knocknagreenan	KGN	0	0	0	0
	Lee Hydro	LE1	0	0	4	14
	Lee Hydro	LE2	0	0	1	4
	Lee Hydro	LE3	0	0	2	8
	Marina	MRT	0	0	0	0
	Moneypoint	MP2	230	270	230	276
	Ralappane	-	0	0	0	0
	Suir	SUR	0	0	0	0
	Tarbert	TB1	0	0	0	0
	Tarbert	TB2	0	0	0	0
	Tarbert	TB3	0	38	0	0
	Tarbert	TB4	0	38	0	0
	Whitegate CCGT	WG	220	360	330	380
	Installed Wind	-	262	262	326	326
South-West Area Total			1041	1737	1265	1563
Mid-West	Ardnacrusha	AA1,2,3,4	0	40	0	63
	Moneypoint	MP1	230	270	230	266.9
	Moneypoint	MP3	230	270	230	250
	Tynagh	TY	0	362	0	400
	Installed Wind	-	33	33	84	84
Mid-West Area Total			493	975	544	1064

Table D-8 Dispatch Profiles – Power Flow Diagrams (continued)

Area	Generation Station	Unit ID	2014		2023	
			SP	WP	SP	WP
South-East	Great Island	GI1	0	0	0	0
	Great Island	GI2	0	0	0	0
	Great Island	GI3	0	0	0	0
	Great Island	GI4	235	300	300	438
	Liffey Hydro	LI1	5	14	5	14
	Liffey Hydro	LI2	5	14	5	14
	Liffey Hydro	LI4	1	3.5	1	3.5
	Nore Power	NO1	0	0	0	0
	Installed Wind	-	86	86	97	97
South-East Area Total			332	417	408	566
Midlands	Cuilleen	-	0	0	0	0
	Edenderry Power	ED1	100	119	119	119
	Edenderry PCP	ED3	0	0	0	55.4
	Edenderry PCP	ED5	0	0	0	55.4
	Rhode PCP	RP1	0	0	0	0
	Rhode PCP	RP2	0	0	0	0
	West Offaly Power	WO4	0	138	138	138
	Installed Wind	-	96	96	130	130
Midlands Area Total			196	353	387	497
North-West	Erne	ER3	0	0	5	20.9
	Erne	ER4	0	10	5	22.5
	Erne	ER1	0	0	3	10
	Erne	ER2	0	0	3	10
	Lough Ree Power	LR4	80	0	0	91
	Installed Wind	-	176	176	346	346
North-West Area Total			256	186	362	501
North-East	Ballakelly	-	0	0	0	0
	Caulstown	-	0	0	0	0
	Installed Wind	-	33	33	40	40
North-East Area Total			33	33	40	40
Northern-Ireland	Ballylumford CCGT10	B10	65	0	65	80
	Ballylumford CCGT20	B20	120	150	110	140
	Ballylumford CCGT21	B21	100	150	90	140
	Ballylumford CCGT22	B22	100	170	90	140
	Ballylumford GT7	BGT1	0	90	0	0
	Ballylumford GT8	BGT2	0	0	0	0
	Ballylumford ST5	B5	0	60	0	0
	Ballylumford ST6	B6	0	0	0	0

Table D-8 Dispatch Profiles – Power Flow Diagrams (continued)

	Generation Station	Unit ID	2014		2023	
			SP	WP	SP	WP
Northern Ireland	CAES	-	0	0	120	200
	Coolkeeragh CCGT	C30	260	380	300	335
	Coolkeeragh CGT8	CGT8	0	0	0	0
	Kilroot GT1	KGT1	0	0	0	0
	Kilroot GT2	KGT2	0	0	0	0
	Kilroot GT3	KGT3	0	0	0	0
	Kilroot GT4	KGT4	0	0	0	0
	Kilroot ST1	K1	110	140	140	170
	Kilroot ST2	K2	110	140	140	170
	Moyle (Import positive)	-	-80	250	-80	450
	Tidal	-	0	0	60	60
Northern Ireland Area Total			951	1777	1477	2327

Table D-9 Existing and Proposed Northern Ireland Generating Plant Contract Details

Centrally Dispatched Generating Unit	Fuel Type	Contract	
		Type	Details
Ballylumford ST 4[3]	GAS/HFO	IPP	See Note 1
Ballylumford ST 5[3]	GAS/HFO	IPP	See Note 1
Ballylumford ST 6	GAS/HFO	IPP	See Note 1
Ballylumford CCGT 21	GAS/GASOIL	NIE	See Note 2
Ballylumford CCGT 22	GAS/GASOIL	NIE	See Note 2
Ballylumford CCGT 20	STEAM	NIE	See Note 2
Ballylumford CCGT 10	GAS/GASOIL	NIE	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
Kilroot ST 2	COAL/OIL	IPP	Independent from 01/11/10
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 3

NOTE 1: This is an Independent Power Producer (IPP); due to EU legislation it is assumed that this generation will be decommissioned beyond 2015.

NOTE 2: In a GUA with PowerNI PPB, the contract expiry date is 23rd September 2018 (with a five-year extension option).

NOTE 3: Capacity is auctioned regularly (daily, monthly, seasonally and annually) to the market participants. Capacity is also available in SEM through implicit auction process.

[3] AES and SONI have now concluded a separate Local Reserve contract for 250 MW. This will see Ballylumford ST4 and ST5 remaining connected (at reduced capacity), while Ballylumford ST6 will be de-commissioned.

E Short Circuit Currents

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 the very high currents that may 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, thereby minimising risk to human life, preventing damage to transmission system equipment, and 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, and hence 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, since the strong generation infeeds minimise 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.

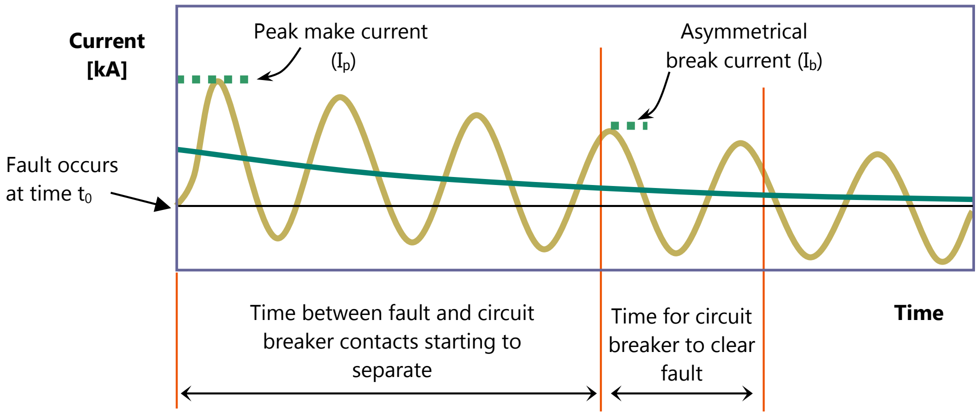


Figure E-1 Typical Short Circuit Current

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 E-1), 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[12]). For summer night valley studies, only generators dispatched on a merit order are considered in the model.

[12] Minimum fault levels including maintenance outages are currently provided to generator applicants wishing to connect to the transmission system as part of the connection offer process to allow developers to design the plant in accordance with the Grid Code requirements.

E.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.

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-8. 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[13]	25 kA
	Designated sites	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)

$$I_b = \sqrt{I_{DC\_b}^2 + I_{RMS\_AC\_b}^2}$$

[13] New equipment installed at 110 kV level must have a short circuit rating of 31.5 kA.

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Agannygal 110 kV	3.0	6.1	5.3	4.2	4.8	4.6	3.1	5.4	4.6	4.3	4.3	4.2
Aghada 110 kV	4.6	10.1	9.5	5.7	11.4	11.1	4.8	7.8	7.2	5.7	9.1	8.9
Aghada A 220 kV	15.1	18.5	15.6	16.0	20.7	19.3	9.4	8.9	7.7	10.2	11.5	10.7
Aghada B 220 kV	14.8	17.6	15.0	12.3	19.9	18.7	10.9	10.0	8.4	10.4	12.6	11.6
Aghada C 220 kV	14.2	17.8	15.1	13.5	20.0	18.8	9.3	8.8	7.5	9.6	11.2	10.5
Aghada D 220 kV	15.1	18.5	15.6	16.0	20.7	19.3	9.4	8.9	7.7	10.2	11.5	10.7
Ahane 110 kV	4.7	14.0	12.8	5.7	10.8	10.6	4.9	11.2	9.9	5.7	9.3	9.0
Anner 110 kV	4.1	7.7	7.0	4.6	5.6	5.5	3.6	6.0	5.6	4.3	4.8	4.7
Ardnacrusha 110 kV	5.9	16.6	14.6	7.4	16.8	16.0	5.4	12.1	10.5	6.6	13.3	12.6
Arigna 110 kV	3.8	7.8	7.0	4.9	5.5	5.4	3.9	7.0	6.2	5.0	5.1	5.0
Arklow 110 kV	10.3	9.3	8.6	11.2	11.2	10.8	10.6	8.3	7.7	11.4	10.0	9.7
Arklow 220 kV	8.8	8.4	7.8	10.4	7.6	7.4	9.3	7.3	6.7	10.7	6.8	6.6
Artane 110 kV	13.3	13.2	11.9	5.7	15.2	14.6	13.3	10.0	9.1	6.2	11.9	11.5
Arva 110 kV	3.7	9.9	8.9	4.9	7.2	7.0	3.9	8.9	7.8	5.0	6.7	6.5
Athea 110 kV	5.9	7.3	5.9	7.4	7.0	6.5	5.9	6.5	5.2	7.6	6.3	5.8
Athlone 110 kV	5.0	9.7	8.7	5.9	9.7	9.4	4.1	6.8	6.3	4.8	7.6	7.4
Athy 110 kV	3.0	6.6	6.2	4.3	5.3	5.2	3.2	5.6	5.3	4.4	4.7	4.6
Aughinish 110 kV	7.9	10.8	9.5	10.0	11.3	10.8	8.2	9.8	8.5	10.2	10.5	9.9
Ballakelly 220 kV	10.8	21.1	19.1	11.7	24.7	23.7	9.6	13.6	11.5	10.3	16.9	15.7
Ballybeg 110 kV	9.4	7.1	6.7	9.6	8.2	8.0	9.5	6.3	6.0	9.7	7.4	7.2
Ballydine 110 kV	4.1	8.2	7.6	3.8	6.3	6.2	3.8	6.7	6.3	3.7	5.5	5.4
Ballylickey 110 kV	2.9	3.2	3.0	4.0	1.9	1.9	3.0	2.9	2.7	4.1	1.8	1.7
Ballywater 110 kV	4.6	6.1	5.7	3.2	6.0	5.9	4.8	5.6	5.3	3.3	5.5	5.4
Baltrasna 110 kV	5.9	11.3	10.6	7.2	8.4	8.3	6.2	9.7	9.0	7.3	7.5	7.4
Bancroft 110 kV	10.5	16.3	14.4	5.9	17.0	16.2	10.7	13.3	11.9	6.2	14.4	13.9
Bandon 110 kV	3.0	6.6	6.0	4.4	5.2	5.0	3.2	5.5	5.0	4.5	4.6	4.5
Banoge 110 kV	5.9	6.5	6.0	6.8	5.6	5.5	6.1	5.8	5.5	6.9	5.2	5.1
Barnahealy A 110 kV	5.4	14.5	13.2	6.2	14.1	13.7	4.9	10.4	9.3	5.6	11.0	10.6
Barnahealy B 110 kV	6.9	13.8	12.6	7.5	13.4	12.9	6.7	10.2	9.1	7.3	10.7	10.2
Baroda 110 kV	4.0	9.2	8.5	4.8	10.2	9.9	4.2	7.6	7.1	5.0	8.9	8.6
Barrymore 110 kV	3.6	8.7	8.1	4.8	4.9	4.9	3.7	6.8	6.3	4.8	4.3	4.2
Bellacorick 110 kV	3.2	4.3	3.8	3.7	3.6	3.5	2.8	3.3	3.0	3.5	3.4	3.3
Binbane 110 kV	3.5	4.9	4.3	5.0	4.2	4.1	3.4	4.3	3.8	4.8	3.9	3.7
Blackrock 110 kV	8.2	15.4	13.6	2.2	12.3	11.9	8.5	12.6	11.3	2.3	10.8	10.5
Blake 110 kV	3.9	8.8	8.1	5.0	5.7	5.6	4.1	7.3	6.8	5.1	5.1	5.0
Boggeragh 110 kV	17.4	4.0	3.6	17.6	4.5	4.3	16.6	3.5	3.1	17.2	4.2	3.9

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Booltiagh 110 kV	2.9	4.3	3.9	4.3	3.5	3.4	3.1	3.9	3.5	4.4	3.4	3.3
Brinny A 110 kV	2.9	5.9	5.4	4.2	4.4	4.3	3.1	5.0	4.6	4.3	4.0	3.9
Brinny B 110 kV	2.9	5.9	5.4	4.2	4.4	4.3	3.1	5.0	4.6	4.3	4.0	3.9
Butlerstown 110 kV	5.4	11.4	10.5	5.3	11.2	10.9	5.8	9.7	9.0	5.6	9.8	9.6
Cabra 110 kV	12.2	12.7	11.4	4.6	13.5	13.0	12.4	9.6	8.8	5.1	10.8	10.5
Cahir 110 kV	4.8	11.9	10.4	5.7	11.5	11.0	3.5	7.6	6.9	4.2	8.4	8.1
Carlow 110 kV	5.2	9.8	9.0	6.0	10.0	9.7	5.3	7.7	7.1	6.1	8.3	8.1
Carrickmines 110 kV	22.4	18.9	16.4	16.4	20.0	19.0	20.4	15.1	13.3	15.9	16.7	15.9
Carrickmines 220 kV	13.7	21.6	18.1	8.4	25.0	23.2	13.5	15.4	12.8	9.1	18.7	17.3
Carrickmines County 110 kV	22.4	18.9	16.4	16.4	20.0	19.0	20.4	15.1	13.3	15.9	16.7	15.9
Carrick-on-Shannon 110 kV	4.1	12.3	11.0	4.9	12.7	12.2	4.3	10.6	9.4	5.1	11.3	10.8
Carrigadrohid 110 kV	6.2	12.6	11.4	7.3	9.7	9.5	5.6	9.8	8.7	6.5	8.1	7.9
Carrowbeg 110 kV	2.7	3.0	2.6	3.6	2.6	2.5	2.7	2.6	2.3	3.6	2.4	2.3
Cashla 110 kV	6.9	17.3	15.4	7.6	20.9	19.9	6.9	13.2	11.7	7.5	16.4	15.6
Cashla 220 kV	7.8	11.8	10.7	9.4	11.4	11.0	8.1	8.2	7.4	9.2	8.7	8.4
Castlebar 110 kV	3.2	5.3	4.6	4.0	5.2	4.9	3.1	4.4	3.9	4.0	4.5	4.3
Castledockrill 110 kV	6.9	8.1	7.6	4.7	9.2	9.0	7.1	7.4	6.9	4.8	8.5	8.3
Castlefarm A 110 kV	7.1	10.4	9.2	8.7	10.5	10.1	7.4	9.4	8.2	8.9	9.8	9.3
Castlefarm B 110 kV	7.2	10.4	9.2	8.7	10.5	10.0	7.4	9.4	8.2	8.9	9.8	9.3
Castleview 110 kV	3.8	14.4	13.2	4.5	9.8	9.6	4.2	10.3	9.3	4.7	8.0	7.8
Cathaleen's Fall 110 kV	5.0	10.4	8.8	6.1	9.6	9.1	3.9	7.8	6.8	4.9	8.1	7.7
Cauteen 110 kV	3.0	7.9	7.3	4.1	4.5	4.5	3.0	6.3	5.8	4.0	4.0	3.9
Central 110 kV	10.6	16.5	14.5	5.5	16.9	16.2	10.8	13.4	12.0	5.8	14.4	13.8
Charleville 110 kV	4.5	7.6	6.7	5.4	5.3	5.1	4.3	6.6	5.8	5.2	4.8	4.7
City West 110 kV	6.0	8.6	7.6	6.0	6.1	5.9	6.2	7.3	6.6	6.1	5.6	5.4
Clahane 110 kV	4.1	9.2	8.0	5.0	7.9	7.6	4.3	8.1	6.9	5.3	7.0	6.7
Clashavoon 220 kV	8.8	9.3	8.6	9.7	8.7	8.5	8.9	7.1	6.3	9.6	7.2	6.9
Clashavoon A 110 kV	7.5	13.7	12.3	8.8	11.5	11.1	7.6	10.9	9.5	8.7	9.8	9.4
Clashavoon B 110 kV	27.7	4.7	4.3	27.5	5.3	5.2	26.0	4.1	3.6	26.4	4.8	4.6
Cliff 110 kV	4.6	7.9	6.9	5.9	6.7	6.4	3.7	6.1	5.4	4.9	5.8	5.6
Cloghran 110 kV	6.7	18.1	16.7	7.0	15.8	15.4	7.0	14.6	13.1	7.2	13.6	13.1
Clonkeen A 110 kV	6.7	8.2	6.9	7.6	8.1	7.7	7.0	7.4	6.1	7.8	7.5	7.0
Clonkeen B 110 kV	6.8	8.1	6.9	7.7	8.1	7.6	7.0	7.4	6.1	7.8	7.5	7.0
Cloon 110 kV	4.2	8.0	7.4	5.2	5.3	5.2	4.4	6.8	6.3	5.3	4.8	4.7
College Park 110 kV	9.3	23.4	21.1	6.3	24.7	23.8	9.4	18.2	16.0	6.7	20.1	19.1
Cookstown 110 kV	6.3	10.5	9.7	5.5	8.0	7.8	6.6	9.0	8.3	5.6	7.2	7.0

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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	5.4	11.2	10.2	7.0	9.9	9.6	5.2	8.5	7.7	6.6	8.2	7.9
Coomagearlahy 110 kV	7.0	7.0	5.8	8.4	7.6	7.1	7.2	6.4	5.2	8.6	7.0	6.5
Corderry 110 kV	4.0	8.8	7.6	5.2	7.9	7.5	4.1	7.8	6.6	5.3	7.3	6.9
Corduff 110 kV	10.2	26.5	23.7	11.3	28.0	26.9	10.2	20.2	17.5	10.9	22.5	21.3
Corduff 220 kV	15.8	26.9	22.3	13.4	29.9	27.8	14.1	16.0	13.2	12.7	19.2	17.7
Corraclassy 110 kV	4.2	7.0	6.4	5.5	5.2	5.1	4.2	6.4	5.9	5.4	4.9	4.8
Cow Cross 110 kV	4.4	14.4	13.2	4.9	11.4	11.1	4.5	10.4	9.3	4.9	9.2	8.9
Crane 110 kV	6.6	9.0	8.2	6.5	9.1	8.8	6.8	8.1	7.5	6.7	8.3	8.0
Cromcastle A 110 kV	12.0	12.3	10.8	7.2	13.1	12.5	12.1	9.7	8.8	7.5	10.9	10.5
Cromcastle B 110 kV	12.0	12.3	10.8	7.2	13.1	12.5	12.1	9.7	8.8	7.5	10.9	10.5
Crory 110 kV	8.8	9.3	8.6	9.0	11.0	10.6	9.1	8.5	7.8	9.3	10.0	9.7
Cuilleen 110 kV	4.9	9.3	8.4	6.1	9.5	9.1	3.9	6.5	6.0	4.8	7.4	7.1
Cullenagh 110 kV	7.1	14.3	13.1	7.8	16.1	15.6	7.6	11.9	10.9	8.2	13.6	13.2
Cullenagh 220 kV	8.4	9.7	9.1	9.0	9.5	9.3	9.2	8.5	7.8	9.9	8.2	8.0
Cunghill 110 kV	3.1	5.8	5.3	4.4	4.9	4.8	3.0	4.9	4.4	4.1	4.4	4.3
Cushaling 110 kV	7.0	12.3	10.8	8.8	13.2	12.5	5.9	8.9	7.8	7.2	10.5	10.0
Dallow 110 kV	3.4	5.6	5.3	4.6	3.3	3.3	3.5	4.7	4.4	4.6	3.0	3.0
Dalton 110 kV	3.0	4.4	3.9	4.2	3.5	3.4	3.0	3.8	3.5	4.2	3.2	3.2
Dardistown 110 kV	15.7	12.5	11.0	12.0	13.7	13.0	15.3	9.9	8.9	12.0	11.3	10.8
Derrybrien 110 kV	3.0	5.0	4.2	4.4	4.4	4.2	3.2	4.5	3.7	4.5	4.1	3.8
Derryiron 110 kV	6.0	8.7	8.0	7.6	8.4	8.1	5.0	6.1	5.7	6.1	6.6	6.4
Doon 110 kV	4.5	8.6	7.8	4.9	6.4	6.3	3.8	6.6	6.1	4.4	5.4	5.3
Dromada 110 kV	5.0	6.5	5.3	4.5	6.2	5.8	5.1	5.8	4.7	4.7	5.6	5.2
Drumkeen 110 kV	3.9	7.4	6.3	5.0	6.1	5.8	3.9	6.7	5.5	4.9	5.9	5.6
Drumline 110 kV	3.2	8.3	7.6	4.5	6.8	6.7	3.4	7.0	6.3	4.5	6.1	5.9
Drybridge 110 kV	5.3	14.9	13.7	6.4	11.8	11.6	5.5	12.3	11.1	6.5	10.4	10.1
Dundalk 110 kV	3.4	9.5	8.8	4.5	8.4	8.2	3.6	8.1	7.5	4.6	7.5	7.3
Dunfirth 110 kV	4.7	6.2	5.9	6.4	4.8	4.7	4.7	5.3	5.1	6.3	4.4	4.3
Dungarvan 110 kV	5.8	6.6	6.1	7.7	5.3	5.2	5.8	5.5	5.3	7.6	4.7	4.6
Dunmanway 110 kV	3.3	6.7	6.0	4.6	5.3	5.1	3.5	5.7	5.1	4.7	4.8	4.6
Dunstown 220 kV	10.9	20.6	18.2	10.8	22.9	21.8	11.8	15.5	13.1	11.1	15.1	14.2
Dunstown 400 kV	17.3	7.5	7.0	20.1	8.0	7.8	20.8	4.5	4.1	14.9	3.9	3.8
Ennis 110 kV	3.6	10.3	9.1	4.9	9.0	8.7	3.9	8.5	7.5	5.1	8.0	7.6
Fassaroe East 110 kV	4.9	10.1	9.2	5.3	7.0	6.8	5.1	8.6	8.0	5.4	6.3	6.1
Fassaroe West 110 kV	4.6	10.0	9.2	5.1	6.9	6.8	4.9	8.6	8.0	5.2	6.2	6.1
Finglas 220 kV	17.1	26.9	22.0	15.2	30.8	28.4	14.9	16.0	13.1	13.8	19.6	18.0

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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 A 110 kV	36.1	14.6	12.7	30.9	15.6	14.8	28.6	11.2	10.0	26.2	12.6	12.1
Finglas B 110 kV	37.0	15.0	13.3	31.7	18.1	17.3	28.7	11.1	10.1	26.1	13.8	13.3
Flagford 110 kV	4.4	12.9	11.5	5.3	14.9	14.3	4.6	11.0	9.7	5.5	13.0	12.4
Flagford 220 kV	7.3	7.9	7.3	9.6	7.0	6.9	7.5	6.7	6.0	9.6	6.3	6.0
Francis Street A 110 kV	11.0	12.3	11.0	5.5	14.6	14.0	11.1	10.1	9.2	5.7	12.3	11.9
Francis Street B 110 kV	12.7	13.4	12.2	6.5	16.0	15.4	12.7	11.2	10.2	6.8	13.6	13.1
Galway 110 kV	4.6	12.9	11.5	5.2	13.2	12.7	4.8	10.2	9.2	5.4	11.0	10.6
Garrow 110 kV	4.9	6.8	5.9	4.7	6.9	6.6	5.0	6.2	5.3	4.8	6.4	6.1
Garvagh 110 kV	4.4	6.7	5.8	5.9	5.8	5.5	4.5	6.0	5.1	6.0	5.4	5.2
Gilra 110 kV	3.0	6.7	6.3	4.0	5.0	4.9	3.1	6.0	5.6	4.0	4.7	4.6
Glanagow 220 kV	15.5	18.2	15.4	14.5	20.7	19.4	11.2	10.3	8.6	11.4	13.0	12.0
Glanlee 110 kV	6.9	6.7	5.6	7.6	7.4	6.9	7.1	6.2	5.0	7.8	6.8	6.3
Glasmore 110 kV	4.7	7.6	6.7	5.2	5.0	4.9	4.9	6.2	5.8	5.3	4.5	4.4
Glenlara A 110 kV	4.2	4.4	3.5	4.3	4.6	4.2	4.3	4.1	3.2	4.3	4.4	4.0
Glenlara B 110 kV	4.2	4.4	3.5	4.3	4.6	4.2	4.3	4.1	3.2	4.3	4.4	4.0
Glenree 110 kV	3.5	4.9	4.5	4.4	3.9	3.8	2.8	3.6	3.3	3.6	3.2	3.1
Golagh 110 kV	3.2	4.9	4.4	4.2	3.1	3.0	3.1	4.3	3.9	4.1	2.9	2.8
Gorman 110 kV	6.1	15.9	14.5	7.2	16.9	16.3	6.5	13.1	11.8	7.4	14.5	13.9
Gorman 220 kV	8.7	12.8	11.9	9.7	10.1	9.9	9.0	10.2	9.0	9.9	8.6	8.3
Gortawee 110 kV	4.3	6.7	6.1	6.0	5.2	5.1	4.4	6.1	5.6	6.0	5.0	4.9
Grange 110 kV	13.3	12.7	11.1	4.3	12.5	12.0	13.2	10.0	9.0	4.6	10.5	10.1
Grange Castle 110 kV	16.9	14.2	12.3	10.8	17.3	16.3	12.6	11.5	10.2	8.9	14.3	13.6
Great Island 110 kV	6.8	14.3	13.1	7.6	18.0	17.4	7.3	11.9	11.0	8.1	15.3	14.8
Great Island 220 kV	10.8	12.5	11.5	12.3	14.3	13.9	11.7	11.1	10.1	13.3	13.1	12.6
Griffinrath A 110 kV	6.9	11.2	10.5	7.3	11.1	10.8	7.3	9.3	8.7	7.6	9.5	9.3
Griffinrath B 110 kV	8.1	12.1	11.2	8.3	12.4	12.1	8.6	10.6	10.4	8.6	10.6	10.4
Harolds 110 kV	11.1	12.3	11.0	5.2	14.6	13.9	11.3	10.1	9.2	5.4	12.3	11.8
Heuston 110 kV	13.8	13.7	12.4	7.8	16.5	15.8	13.7	11.4	10.4	8.1	14.0	13.5
Huntstown A 220 kV	16.2	25.8	21.3	12.9	29.6	27.4	14.8	15.7	12.9	12.7	19.2	17.7
Huntstown B 220 kV	15.0	23.8	20.2	10.3	26.9	25.2	13.4	14.4	12.1	10.5	17.5	16.2
Ikerrin 110 kV	5.8	5.6	5.1	6.5	3.8	3.7	4.6	4.5	4.1	5.5	3.2	3.1
Inchicore 220 kV	13.6	26.0	21.3	9.9	30.0	27.7	13.4	17.6	14.2	10.5	21.4	19.5
Inchicore A 110 kV	29.9	15.1	13.7	25.9	18.7	17.9	26.2	12.4	11.3	23.6	15.6	15.0
Inchicore B 110 kV	47.6	15.3	13.2	35.8	19.1	17.9	37.3	12.4	11.0	30.6	15.8	15.0
Inniscarra 110 kV	5.2	10.7	9.8	6.7	9.3	9.0	5.0	8.2	7.4	6.3	7.8	7.5
Irishtown 220 kV	15.1	24.4	20.1	11.3	28.7	26.4	14.1	16.6	13.6	11.7	20.6	18.9

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Kellis 110 kV	6.2	10.5	9.8	7.2	12.0	11.7	6.3	8.2	7.6	7.3	9.7	9.4
Kellis 220 kV	7.9	8.7	8.2	9.7	7.2	7.1	8.0	7.3	6.8	9.8	6.3	6.2
Kilbarry 110 kV	7.6	24.1	20.4	8.4	22.7	21.5	6.4	15.0	12.8	7.2	16.1	15.1
Kildonan 110 kV	8.6	20.6	18.8	6.1	16.7	16.3	8.8	16.3	14.5	6.3	14.2	13.7
Kilkenny 110 kV	4.4	7.9	7.4	5.2	8.7	8.4	3.0	4.8	4.6	3.4	5.8	5.7
Kill Hill 110 kV	5.9	7.6	6.7	6.9	6.2	5.9	-	-	-	-	-	-
Killonan 110 kV	6.1	20.8	18.2	7.6	21.3	20.3	6.1	15.3	13.1	7.3	16.9	15.9
Killonan 220 kV	7.5	11.4	10.4	10.0	10.3	10.0	7.5	8.6	7.5	9.5	8.4	8.0
Killoteran 110 kV	5.5	12.2	11.2	4.9	13.0	12.5	5.9	10.3	9.5	5.2	11.3	11.0
Kilmahud 110 kV	17.0	13.9	12.1	9.6	16.7	15.8	10.9	11.1	9.8	7.2	13.7	13.0
Kilmore 110 kV	15.2	12.9	11.3	9.4	13.9	13.2	14.9	10.1	9.1	9.6	11.4	10.9
Kilteel 110 kV	4.3	8.2	7.6	5.4	7.1	7.0	4.5	6.9	6.5	5.5	6.4	6.3
Kinnegad 110 kV	5.1	6.4	6.1	6.7	5.6	5.5	4.8	5.1	4.8	6.2	4.8	4.7
Knockacummer 110 kV	4.1	4.0	3.2	4.7	4.4	4.0	4.2	3.8	3.0	4.7	4.2	3.9
Knockavanna 110 kV	3.0	5.2	4.5	4.3	4.5	4.3	-	-	-	-	-	-
Knockearagh 110 kV	5.7	6.9	6.0	7.3	5.8	5.6	5.9	6.1	5.3	7.4	5.4	5.1
Knocknagoshel 110 kV	4.1	6.7	5.9	4.8	7.4	7.0	-	-	-	-	-	-
Knockraha A 110 kV	9.0	26.5	23.0	9.8	24.6	23.5	23.2	5.9	5.6	24.9	6.1	6.0
Knockraha A 220 kV	10.9	16.7	14.5	11.4	16.3	15.5	9.6	11.0	9.2	10.1	12.6	11.8
Knockraha B 110 kV	9.0	26.5	23.0	9.8	24.6	23.5	7.6	15.8	13.6	8.4	16.4	15.5
Knockraha B 220 kV	10.1	11.5	10.5	10.9	10.8	10.5	9.6	11.0	9.2	10.1	12.6	11.8
Knockraha C 110 kV	9.0	26.5	23.0	9.8	24.6	23.5	7.6	15.8	13.6	8.4	16.4	15.5
Knockumber 110 kV	3.6	8.9	8.2	4.5	6.4	6.3	3.8	7.8	7.2	4.6	5.9	5.8
Lanesboro 110 kV	3.7	10.9	9.8	4.9	10.8	10.4	4.0	9.5	8.5	5.1	9.9	9.5
Letterkenny110 kV	4.3	9.0	7.4	5.4	8.1	7.6	4.4	7.9	6.5	5.3	8.1	7.5
Liberty A 110 kV	6.2	20.3	17.5	5.1	20.8	19.8	5.6	13.1	11.3	5.0	14.9	14.1
Liberty B 110 kV	6.0	20.2	17.5	4.9	20.8	19.7	5.5	13.1	11.3	4.8	14.9	14.1
Limerick 110 kV	4.9	17.7	15.5	5.9	15.6	15.0	5.0	13.5	11.6	5.9	12.9	12.3
Lisdrum 110 kV	2.7	5.4	5.0	4.1	4.4	4.3	2.8	4.9	4.5	4.1	4.3	4.2
Lisheen 110 kV	5.1	5.2	4.4	5.1	7.8	7.2	3.9	3.9	3.4	3.9	5.9	5.5
Lodgewood 110 kV	8.8	9.3	8.6	9.0	11.0	10.6	9.1	8.5	7.8	9.3	10.0	9.7
Lodgewood 220 kV	8.7	8.1	7.5	9.9	7.5	7.4	9.3	7.2	6.6	10.4	6.8	6.6
Longpoint 220 kV	14.6	18.2	15.4	13.7	20.2	18.9	9.2	8.8	7.6	9.6	11.3	10.5
Louth 220 kV	10.9	21.8	19.7	12.3	25.4	24.4	9.8	14.1	11.8	10.7	17.4	16.2
Louth A 110 kV	6.8	14.1	13.0	7.9	16.6	16.1	6.8	11.9	10.7	7.9	14.3	13.7
Louth B 110 kV	7.4	15.3	14.2	8.3	18.6	18.0	7.3	12.7	11.4	8.1	15.7	15.0

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Macetown 110 kV	7.2	20.0	18.3	7.1	18.6	18.1	7.5	15.9	14.2	7.3	15.7	15.1
Macroom 110 kV	6.3	13.9	12.4	7.2	11.0	10.7	6.4	10.7	9.4	7.1	9.3	8.9
Mallow 110 kV	5.1	7.5	6.9	6.9	5.9	5.8	4.2	6.3	5.7	5.8	5.1	5.0
Marina 110 kV	7.9	23.0	19.6	9.1	23.7	22.3	6.4	14.3	12.2	7.2	16.4	15.4
Maynooth A 110 kV	10.9	14.2	13.1	11.6	17.0	16.5	11.2	11.5	10.6	11.8	14.1	13.7
Maynooth A 220 kV	9.7	19.4	17.1	9.5	17.6	16.9	10.5	14.6	12.4	10.2	14.2	13.4
Maynooth B 110 kV	7.7	18.5	17.1	9.6	17.1	16.7	8.5	15.2	13.7	10.0	14.8	14.3
Maynooth B 220 kV	9.8	22.6	19.8	9.5	20.3	19.5	10.7	16.2	13.6	10.2	15.8	14.9
McDermott 110 kV	16.5	13.7	12.2	5.8	15.4	14.7	15.7	10.2	9.3	6.3	12.0	11.6
Meath Hill 110 kV	3.8	9.6	8.9	5.1	7.6	7.5	4.0	8.3	7.7	5.1	7.0	6.8
Meentycat 110 kV	3.7	6.3	5.3	5.1	5.1	4.9	3.8	5.7	4.8	5.0	5.1	4.8
Midleton 110 kV	3.4	11.8	10.9	4.6	8.8	8.6	3.8	8.9	8.1	4.8	7.4	7.2
Milltown A 110 kV	15.0	13.3	11.8	7.1	16.0	15.2	14.8	10.8	9.8	7.4	13.4	12.8
Milltown B 110 kV	8.7	12.1	11.0	4.0	14.1	13.6	9.0	10.1	9.4	4.2	12.1	11.8
Misery Hill 110 kV	13.6	13.0	11.6	7.8	15.8	15.0	13.5	10.6	9.6	8.0	13.2	12.7
Moneteen 110 kV	5.2	12.1	11.0	6.2	8.7	8.4	5.3	10.0	9.0	6.2	7.7	7.5
Moneypoint 110 kV	2.6	2.5	2.3	3.9	1.6	1.6	2.7	2.3	2.1	3.9	1.6	1.5
Moneypoint 220 kV	12.8	10.5	9.5	10.1	10.2	9.9	9.5	6.2	5.6	8.8	6.9	6.6
Moneypoint G1 400 kV	21.5	7.6	6.9	17.2	7.4	7.2	18.9	5.0	4.5	17.2	5.5	5.3
Moneypoint G2 400 kV	29.4	3.9	3.5	23.4	4.1	4.0	16.1	2.1	2.0	15.9	2.5	2.5
Moneypoint G3 400 kV	21.5	7.6	6.9	17.2	7.4	7.2	18.9	5.0	4.5	17.2	5.5	5.3
Monread 110 kV	4.0	8.1	7.5	5.0	7.8	7.6	4.2	6.8	6.4	5.1	6.9	6.8
Mount Lucas 110 kV	4.7	8.2	7.5	6.1	6.9	6.7	4.8	6.5	6.0	6.0	6.0	5.8
Moy 110 kV	4.0	5.1	4.6	5.1	5.1	5.0	2.7	3.4	3.1	3.3	3.8	3.7
Mullagharlin 110 kV	3.5	9.5	8.9	4.6	8.9	8.7	3.7	8.3	7.7	4.7	8.0	7.8
Mullingar 110 kV	2.7	4.6	4.3	3.7	4.6	4.5	2.8	4.1	3.9	3.8	4.3	4.2
Mungret A 110 kV	4.9	11.4	10.4	5.9	8.0	7.8	5.0	9.6	8.6	5.9	7.2	7.0
Mungret B 110 kV	4.8	11.5	10.5	5.9	8.0	7.9	5.0	9.6	8.6	5.9	7.2	7.0
Nangor 110 kV	14.7	13.8	12.0	8.6	16.7	15.8	11.5	11.2	9.9	7.5	13.9	13.2
Navan 110 kV	5.2	13.8	12.6	6.1	13.0	12.6	5.5	11.6	10.5	6.3	11.4	11.0
Nenagh 110 kV	2.6	3.9	3.6	3.9	2.1	2.1	2.7	3.5	3.2	3.9	2.0	2.0
Newbridge 110 kV	4.2	11.1	10.1	5.0	10.3	9.9	4.4	8.9	8.2	5.1	8.8	8.6
Nore 110 kV	4.5	7.6	7.1	5.8	8.5	8.3	2.9	4.5	4.3	3.4	5.6	5.5
North Quays 110 kV	18.2	13.5	12.0	6.6	16.0	15.2	17.5	11.0	10.0	6.9	13.4	12.8
North Wall 220 kV	15.8	24.5	20.2	8.4	24.9	23.3	13.8	14.6	12.1	9.2	16.6	15.4
Oldcourt A 110 kV	3.8	11.8	11.0	4.5	8.5	8.4	4.0	8.9	8.1	4.6	7.1	7.0

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Oldcourt B 110 kV	3.8	11.9	11.0	4.5	8.6	8.5	4.1	8.9	8.1	4.6	7.2	7.0
Oldstreet 220 kV	15.2	11.1	10.2	12.6	11.7	11.3	12.7	7.0	6.5	11.6	8.2	7.9
Oldstreet 400 kV	17.2	7.8	7.3	11.0	7.2	7.0	15.1	5.5	5.0	11.1	5.5	5.3
Oughtragh 110 kV	3.6	5.1	4.7	4.7	3.2	3.1	3.7	4.6	4.2	4.8	2.9	2.9
Pelletstown 110 kV	13.7	12.8	11.5	7.5	13.2	12.7	13.8	9.7	8.9	8.0	10.6	10.3
Platin 110 kV	4.7	13.5	12.5	5.5	9.8	9.6	5.0	11.4	10.3	5.7	8.7	8.5
Pollaphuca 110 kV	3.3	3.1	3.0	4.7	2.6	2.5	2.8	2.4	2.4	4.0	2.2	2.2
Poolbeg A 110 kV	25.8	14.2	12.6	21.4	17.6	16.8	23.4	11.5	10.4	20.1	14.6	14.0
Poolbeg A 220 kV	16.3	24.4	20.3	7.0	23.3	21.8	14.4	14.6	12.2	8.0	15.8	14.7
Poolbeg B 110 kV	25.8	14.1	12.6	21.4	17.6	16.7	23.4	11.5	10.3	20.1	14.6	13.9
Poolbeg B 220 kV	13.0	23.9	19.8	9.4	25.8	24.0	13.0	16.5	13.5	10.1	18.9	17.4
Poolbeg C 220 kV	20.3	13.8	12.2	7.7	16.3	15.6	19.2	11.2	10.1	7.9	13.7	13.1
Poppintree 110 kV	16.2	13.3	11.7	9.5	14.2	13.5	15.6	10.4	9.4	9.7	11.7	11.2
Portan 260 kV	53.3	6.5	6.3	-	-	-	43.4	5.4	5.2	-	-	-
Portan 400 kV	21.2	9.0	8.4	-	-	-	19.8	6.5	5.8	-	-	-
Portlaoise 110 kV	3.8	9.3	8.5	5.3	7.3	7.1	4.0	7.6	7.1	5.4	6.4	6.3
Pottery 110 kV	12.7	17.4	15.2	4.1	16.4	15.7	12.7	14.0	12.5	4.3	14.0	13.5
Prospect 220 kV	11.5	13.4	11.9	10.2	13.2	12.7	9.0	7.7	6.8	8.9	8.8	8.3
Raffeen 220 kV	7.4	17.3	15.5	8.4	19.4	18.6	5.9	11.8	10.5	6.6	14.2	13.5
Raffeen A 110 kV	14.2	18.9	15.9	12.9	21.3	19.9	10.3	10.2	8.5	10.4	12.9	11.9
Raffeen B 110 kV	9.1	16.4	14.7	10.0	18.4	17.6	8.0	11.6	10.3	8.9	13.9	13.2
Rathkeale 110 kV	3.4	8.0	7.3	4.8	6.0	5.8	3.5	6.8	6.2	4.8	5.4	5.3
Ratrussan 110 kV	3.6	8.1	6.8	4.7	8.4	7.9	3.8	7.4	6.1	4.9	8.0	7.4
Reamore 110 kV	4.2	7.8	7.0	3.3	6.5	6.3	4.4	6.9	6.1	3.5	5.9	5.7
Richmond A 110 kV	3.0	7.3	6.7	4.2	6.4	6.3	3.2	6.5	6.0	4.4	6.0	5.8
Richmond B 110 kV	3.0	7.3	6.7	4.2	6.4	6.3	3.2	6.5	6.0	4.4	6.0	5.8
Rinawade 110 kV	4.8	11.3	10.7	5.9	7.9	7.8	5.0	9.7	9.0	6.0	7.2	7.0
Ringaskiddy 110 kV	5.9	13.3	12.2	6.3	12.3	11.9	5.9	9.9	8.9	6.3	9.9	9.6
Ringsend 110 kV	25.7	14.2	12.6	22.2	17.7	16.8	23.3	11.5	10.3	20.8	14.6	14.0
Ryebrook 110 kV	5.1	15.6	14.3	6.5	12.8	12.4	5.7	13.4	11.9	6.8	11.7	11.4
Salthill 110 kV	4.2	11.5	10.3	3.9	11.5	11.1	4.4	9.3	8.4	4.1	9.8	9.4
Seal Rock A 110 kV	7.6	10.6	9.4	9.4	11.1	10.6	7.9	9.6	8.3	9.6	10.4	9.8
Seal Rock B 110 kV	7.6	10.6	9.4	9.4	11.1	10.6	7.9	9.7	8.3	9.6	10.4	9.8
Shankill 110 kV	3.5	9.2	8.0	4.7	8.0	7.6	3.6	8.2	7.1	4.8	7.3	7.0
Shannonbridge 110 kV	6.4	17.8	15.8	8.0	19.2	18.4	4.9	11.7	10.5	5.9	13.9	13.3
Shannonbridge 220 kV	7.4	7.6	7.3	9.9	6.4	6.3	6.6	6.2	5.7	8.9	5.6	5.4

Table E-2 Short Circuit Currents for Maximum and Minimum Demand in 2014 (continued)

Bus	Winter Peak 2014						Summer Valley 2014					
	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]
Shellybanks A 220 kV	15.9	24.4	20.2	6.8	26.8	24.9	14.1	14.6	12.2	7.9	17.5	16.2
Shellybanks B 220 kV	14.5	23.6	19.4	9.8	27.2	25.2	13.5	16.0	13.1	10.3	19.7	18.0
Shelton Abbey 110 kV	7.3	8.2	7.7	7.4	8.4	8.2	7.5	7.3	6.8	7.6	7.7	7.5
Singland 110 kV	6.0	16.9	15.0	7.2	15.5	14.9	5.8	12.7	11.1	6.8	12.7	12.1
Sligo 110 kV	3.7	10.0	8.8	4.7	8.9	8.5	3.7	8.4	7.3	4.6	7.8	7.5
Somerset 110 kV	2.9	8.2	7.6	4.0	5.1	5.0	3.0	6.6	6.1	4.0	4.5	4.4
Sorne Hill 110 kV	3.3	3.4	2.9	4.1	3.4	3.3	3.3	3.1	2.7	4.1	3.2	3.0
Srananagh 110 kV	4.7	11.7	10.2	5.7	12.1	11.5	4.5	9.8	8.4	5.4	10.5	9.9
Srananagh 220 kV	7.3	4.9	4.6	9.7	3.8	3.8	7.1	4.3	3.9	9.3	3.5	3.4
Stevenstown 110 kV	4.6	6.2	5.7	5.0	3.9	3.8	4.7	5.3	4.9	5.1	3.6	3.5
Stratford 110 kV	3.3	4.7	4.4	4.3	3.4	3.3	3.1	3.7	3.6	4.1	3.0	3.0
Suir 110 kV	4.9	11.2	9.8	6.2	11.5	11.0	3.5	7.0	6.4	4.3	8.2	7.9
Taney 110 kV	6.6	14.0	12.5	2.5	12.7	12.3	6.9	11.6	10.5	2.6	11.1	10.8
Tarbert 110 kV	12.0	22.1	18.9	13.7	20.6	19.6	9.9	16.8	13.9	11.6	17.0	15.9
Tarbert 220 kV	13.9	15.8	13.6	15.3	17.4	16.5	9.8	8.7	7.5	10.7	10.8	10.1
Tawnaghmore A 110 kV	3.9	4.2	3.9	5.1	3.9	3.8	2.6	2.8	2.6	3.4	3.0	2.9
Tawnaghmore B 110 kV	3.9	4.3	3.9	5.2	4.1	4.0	2.6	2.8	2.6	3.3	3.1	3.0
Thornsberry 110 kV	4.0	7.0	6.4	5.3	6.3	6.1	4.2	5.4	5.1	5.3	5.2	5.1
Thurles 110 kV	6.2	6.6	5.6	6.5	6.8	6.4	4.2	4.9	4.3	4.7	5.3	5.1
Tipperary 110 kV	3.0	7.8	7.2	4.1	4.8	4.7	3.0	6.0	5.6	3.9	4.2	4.1
Tonroe 110 kV	2.6	3.5	3.3	3.8	2.1	2.0	2.7	3.2	3.0	3.8	2.0	1.9
Trabeg 110 kV	7.9	22.7	19.3	8.8	23.0	21.8	6.4	14.1	12.1	7.1	16.1	15.2
Tralee 110 kV	4.8	10.6	9.1	5.9	8.4	8.1	5.1	9.2	7.8	6.2	7.6	7.3
Trien A 110 kV	5.0	10.4	8.6	5.7	10.4	9.7	5.2	9.1	7.4	6.5	8.2	7.7
Trien B 110 kV	5.0	10.4	8.6	5.7	10.4	9.7	5.2	9.1	7.4	6.5	8.2	7.7
Trillick 110 kV	3.4	3.7	3.2	4.2	3.4	3.3	3.4	3.4	2.9	4.2	3.2	3.0
Tullabrack 110 kV	2.7	2.7	2.5	3.9	1.8	1.7	2.7	2.4	2.3	3.9	1.7	1.7
Turlough 220 kV	10.6	13.0	11.7	12.0	11.3	11.0	11.5	11.1	9.6	12.9	10.0	9.6
Tynagh 220 kV	14.7	12.5	11.2	16.5	13.5	12.9	10.2	6.9	6.3	11.2	8.5	8.2
Waterford 110 kV	6.5	13.5	12.3	6.8	14.4	13.9	7.0	11.2	10.4	7.2	12.4	12.0
Wexford 110 kV	4.0	7.2	6.4	5.3	6.1	5.9	4.2	6.5	5.9	5.4	5.7	5.6
Whitegate 110 kV	4.3	10.9	10.2	5.1	10.7	10.5	4.5	8.3	7.6	5.2	8.7	8.5
Wolfe Tone 110 kV	14.4	13.4	12.0	5.3	14.8	14.2	14.1	10.0	9.2	5.8	11.7	11.2
Woodhouse 110 kV	5.9	6.5	6.1	7.3	4.6	4.6	-	-	-	-	-	-
Woodland 220 kV	12.3	24.7	21.5	11.9	24.7	23.5	13.0	16.5	13.8	12.3	17.8	16.6
Woodland 400 kV	21.3	9.1	8.5	20.9	8.8	8.6	19.8	6.5	5.9	19.4	6.6	6.4

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017

Bus	Winter Peak 2017						Summer Valley 2017					
	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	13.2	13.9	12.0	8.0	14.4	13.6	12.7	11.1	9.9	7.9	13.8	13.2
Agannygal 110 kV	3.0	6.3	5.6	4.2	4.9	4.7	2.9	5.0	4.9	4.2	4.3	4.3
Aghada 110 kV	4.7	10.1	9.5	5.7	11.3	11.1	4.9	7.9	7.7	5.8	9.4	9.3
Aghada A 220 kV	14.7	18.7	15.9	15.7	20.8	19.5	10.7	9.8	9.4	11.5	13.0	12.8
Aghada B 220 kV	14.5	17.8	15.2	12.1	20.1	18.9	9.9	8.8	8.4	9.5	11.7	11.5
Aghada C 220 kV	13.9	18.0	15.4	13.2	20.1	18.9	10.5	9.6	9.2	10.6	12.7	12.5
Aghada D 220 kV	14.7	18.7	15.9	15.7	20.8	19.5	10.7	9.8	9.4	11.5	13.0	12.8
Ahane 110 kV	5.1	14.3	13.2	6.0	10.9	10.7	5.6	11.8	11.4	6.2	9.8	9.7
Anner 110 kV	4.3	7.8	7.1	4.8	5.6	5.5	4.2	6.2	6.0	4.6	4.9	4.9
Ardnacrusha 110 kV	6.6	17.3	15.4	8.3	17.3	16.6	7.3	14.1	13.5	8.7	15.4	15.2
Ardnagappary 110 kV	2.9	2.2	1.9	4.2	1.3	1.2	2.8	2.0	2.0	4.1	1.2	1.2
Arigna 110 kV	3.8	7.9	7.0	4.9	5.6	5.4	3.8	6.6	6.4	4.9	5.1	5.1
Arklow 110 kV	10.6	9.5	8.8	11.4	11.4	11.0	10.7	8.1	7.8	11.5	10.1	9.9
Arklow 220 kV	8.9	8.5	7.9	10.4	7.6	7.5	9.3	7.0	6.7	10.6	6.7	6.7
Artane 110 kV	13.3	13.3	12.0	5.6	15.4	14.7	11.9	9.2	8.6	6.2	11.4	11.1
Arva 110 kV	3.7	10.1	9.0	4.9	7.3	7.1	3.9	8.5	8.1	5.0	6.7	6.6
Athea 110 kV	11.0	9.4	7.8	11.2	8.8	8.3	11.5	7.1	7.0	11.5	7.7	7.7
Athlone 110 kV	4.9	9.9	9.0	5.8	9.9	9.5	4.0	6.7	6.4	4.7	7.6	7.5
Athy 110 kV	3.2	7.7	7.4	4.4	6.1	6.1	3.2	5.9	5.8	4.4	4.9	4.9
Aughinish 110 kV	8.3	10.8	9.6	10.3	11.3	10.8	8.5	9.3	8.9	10.5	10.4	10.3
Ballakelly 220 kV	10.9	21.4	19.5	11.7	25.0	24.1	9.9	13.1	11.7	10.3	16.9	16.1
Ballybeg 110 kV	9.6	7.0	6.6	9.9	8.1	7.9	9.7	6.0	5.9	9.9	7.2	7.2
Ballydine 110 kV	4.2	8.3	7.7	3.9	6.3	6.2	4.2	6.8	6.6	3.9	5.7	5.6
Ballylickey 110 kV	2.9	3.8	3.6	4.0	2.2	2.2	3.0	3.4	3.3	4.1	2.0	2.0
Ballynahulla 110 kV	14.8	10.8	9.6	13.1	10.5	10.1	15.8	8.7	8.6	13.5	9.3	9.3
Ballynahulla 220 kV	8.4	9.9	8.8	8.5	10.3	9.9	9.4	7.6	7.4	9.0	8.7	8.7
Ballyragget 110 kV	5.4	7.8	7.4	6.3	5.5	5.4	-	-	-	-	-	-
Ballyvouskill 110 kV	16.8	7.8	6.8	15.1	8.3	7.9	19.3	6.2	6.1	15.9	7.3	7.3
Ballyvouskill 220 kV	8.4	10.0	8.9	8.9	10.8	10.3	9.3	7.7	7.4	9.4	9.2	9.1
Ballywater 110 kV	4.6	6.1	5.7	3.2	6.0	5.9	4.8	5.4	5.3	3.3	5.5	5.5
Baltrasna 110 kV	5.9	11.3	10.7	7.2	8.4	8.3	6.1	9.3	8.9	7.2	7.5	7.4
Bancroft 110 kV	12.2	13.1	12.1	6.8	15.0	14.5	11.9	10.7	10.1	7.0	12.8	12.5
Bandon 110 kV	3.1	7.4	6.8	4.2	6.8	6.6	3.3	6.2	5.9	4.4	6.1	6.0
Banoge 110 kV	5.9	6.5	6.1	6.7	5.6	5.5	6.1	5.7	5.6	6.9	5.2	5.1
Barnadivane 110 kV	4.4	9.9	8.8	5.2	8.8	8.5	4.9	8.4	7.7	5.5	8.1	7.9
Barnahealy A 110 kV	5.5	14.5	13.2	6.2	14.2	13.7	5.7	10.6	10.1	6.2	11.4	11.2

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Barnahealy B 110 kV	6.8	14.0	12.8	7.4	13.5	13.1	6.7	10.3	9.8	7.2	11.0	10.8
Baroda 110 kV	3.8	10.0	9.3	4.6	11.2	10.9	4.1	8.2	7.9	4.9	9.6	9.4
Barrymore 110 kV	3.6	8.7	8.1	5.3	6.5	6.4	3.9	7.0	6.8	5.3	5.7	5.7
Belcamp 110 kV	15.2	17.2	15.3	8.6	18.2	17.4	-	-	-	-	-	-
Belcamp 220 kV	11.7	24.6	20.7	9.3	27.5	25.7	-	-	-	-	-	-
Bellacorick 110 kV	3.2	4.4	3.9	3.8	4.3	4.1	2.8	3.2	3.1	3.3	3.1	3.0
Binbane 110 kV	3.7	4.7	3.9	5.2	4.1	3.9	3.4	4.3	4.2	4.9	4.0	4.0
Blackrock 110 kV	11.0	11.7	10.4	2.8	10.0	9.7	10.9	9.4	8.8	3.0	8.8	8.6
Blake 110 kV	3.8	9.2	8.7	4.9	5.9	5.9	4.1	7.7	7.4	5.0	5.4	5.3
Boggeragh 110 kV	17.5	4.1	3.6	17.7	4.6	4.4	17.7	3.5	3.5	17.8	4.2	4.2
Booltiagh 110 kV	6.3	7.9	7.3	8.1	6.3	6.2	6.6	6.7	6.6	8.2	5.9	5.8
Bracklone 110 kV	3.5	10.2	9.5	4.7	8.8	8.6	3.9	8.0	7.7	4.9	7.6	7.5
Brinny A 110 kV	3.0	6.6	6.1	4.1	5.5	5.4	3.2	5.5	5.3	4.2	5.0	4.9
Brinny B 110 kV	3.0	6.6	6.2	4.1	5.6	5.4	3.2	5.6	5.3	4.2	5.0	5.0
Butlerstown 110 kV	5.4	11.6	10.6	5.3	11.3	11.0	5.9	9.6	9.3	5.6	9.9	9.8
Cabra 110 kV	12.1	12.8	11.6	4.6	13.6	13.1	11.3	8.9	8.3	5.1	10.4	10.1
Cahir 110 kV	5.8	12.2	10.6	6.6	11.7	11.2	4.8	8.2	7.9	5.5	9.2	9.1
Carlow 110 kV	5.0	10.2	9.5	5.9	10.3	10.1	5.4	8.0	7.7	6.1	8.6	8.5
Carrickmines 220 kV	13.9	22.7	19.2	8.8	26.4	24.6	12.4	14.2	12.8	9.1	18.6	17.8
Carrickmines A 110 kV	31.9	13.6	12.0	24.6	14.3	13.7	24.7	10.8	10.0	21.6	12.1	11.8
Carrickmines B 110 kV	25.3	14.7	13.4	20.6	17.2	16.6	20.7	11.8	11.1	18.4	14.5	14.2
Carrick-on-Shannon 110 kV	4.1	12.6	11.2	4.9	12.9	12.4	4.4	10.1	9.7	5.1	11.3	11.1
Carrigadrohid 110 kV	6.4	13.4	11.9	7.6	12.5	12.1	7.0	10.7	10.0	7.9	11.0	10.7
Carrowbeg 110 kV	2.6	3.0	2.7	3.6	2.7	2.6	2.6	2.5	2.4	3.6	2.4	2.4
Cashla 110 kV	7.2	19.6	17.0	8.0	23.3	22.0	7.7	14.4	13.7	8.2	18.7	18.3
Cashla 220 kV	8.4	12.6	11.4	9.9	12.0	11.6	9.0	8.7	8.3	10.0	9.4	9.3
Castlebar 110 kV	3.1	5.4	4.6	3.9	5.5	5.2	3.0	4.2	4.0	3.8	4.5	4.4
Castledockrill 110 kV	6.8	8.1	7.6	4.7	9.3	9.1	7.1	7.2	7.0	4.8	8.5	8.4
Castlefarm A 110 kV	7.4	10.4	9.2	8.9	10.5	10.1	7.7	8.9	8.6	9.1	9.7	9.6
Castlefarm B 110 kV	7.4	10.4	9.2	8.9	10.5	10.1	7.7	8.9	8.6	9.1	9.7	9.6
Castleview 110 kV	3.8	13.9	12.8	4.5	9.6	9.4	4.2	10.4	10.0	4.7	8.3	8.2
Cathaleen's Fall 110 kV	6.3	10.4	7.9	7.0	10.0	9.1	5.3	8.9	8.6	6.3	9.6	9.5
Caulstown 110 kV	4.7	13.0	12.2	5.5	9.2	9.1	5.1	10.7	10.0	5.7	8.3	8.1
Cauteen 110 kV	5.9	8.7	8.0	6.7	5.3	5.2	5.7	7.0	6.8	6.6	4.7	4.7
Central 110 kV	14.4	12.3	11.0	7.6	12.7	12.2	13.7	9.9	9.2	7.8	10.9	10.6
Charleville 110 kV	4.5	6.7	6.2	5.9	4.6	4.5	4.6	5.8	5.6	5.9	4.3	4.2

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Cherrywood 110 kV	10.2	11.3	10.1	7.4	11.1	10.7	10.2	9.2	8.6	7.6	9.6	9.4
City West 110 kV	5.9	8.7	7.6	6.0	6.1	5.9	6.2	7.2	6.6	6.1	5.5	5.4
Clahane 110 kV	4.1	8.0	7.4	5.2	6.9	6.7	4.4	6.9	6.7	5.3	6.3	6.3
Clashavoon 220 kV	8.6	10.7	9.6	9.1	10.8	10.4	9.4	8.1	7.8	9.5	9.1	9.0
Clashavoon A 110 kV	7.6	14.5	13.0	8.8	13.2	12.7	8.3	11.6	10.9	9.1	11.5	11.2
Clashavoon B 110 kV	29.0	4.8	4.3	28.7	5.4	5.2	31.1	4.1	4.1	29.0	5.0	4.9
Cliff 110 kV	5.3	7.9	6.3	6.4	6.8	6.4	4.8	6.9	6.7	6.0	6.6	6.5
Clogher 110 kV	6.1	8.1	5.8	6.2	8.6	7.5	4.6	7.2	7.0	5.1	8.6	8.5
Cloghran 110 kV	6.7	18.4	17.0	7.0	15.9	15.5	6.7	13.4	12.4	6.9	13.1	12.8
Clonkeen A 110 kV	5.6	6.3	5.9	6.9	4.3	4.3	5.9	5.5	5.3	7.0	4.0	4.0
Clonkeen B 110 kV	8.7	6.2	5.2	7.4	6.8	6.3	8.8	4.8	4.8	7.5	6.0	5.9
Cloon 110 kV	4.2	8.4	7.7	5.7	6.9	6.7	4.4	6.9	6.7	5.8	6.2	6.1
College Park 110 kV	9.2	23.8	21.7	6.3	25.0	24.2	8.3	16.3	14.9	6.3	19.1	18.4
Cookstown 110 kV	7.1	9.1	8.5	5.8	7.5	7.4	7.3	7.7	7.4	6.0	6.7	6.7
Coolroe 110 kV	5.3	11.3	10.3	6.9	10.0	9.8	5.6	9.0	8.6	7.0	8.8	8.6
Coomagearlahy 110 kV	8.7	5.6	4.6	9.3	6.5	6.0	8.5	4.3	4.3	9.2	5.6	5.6
Cordal 110 kV	11.5	9.3	8.3	8.6	7.8	7.6	12.3	7.6	7.6	8.9	7.0	7.0
Corderry 110 kV	4.0	8.9	7.5	5.2	7.9	7.5	3.9	7.1	6.9	5.1	7.2	7.1
Corduff 110 kV	10.2	27.1	24.4	11.3	28.5	27.5	8.8	17.9	16.3	9.6	21.2	20.4
Corduff 220 kV	15.9	28.4	23.7	13.4	31.5	29.3	10.8	12.3	11.0	10.4	16.4	15.6
Corkagh 110 kV	18.7	14.0	12.0	12.4	14.7	13.9	16.7	11.2	9.9	9.5	13.2	12.6
Corraclassy 110 kV	4.3	7.2	6.6	5.5	5.2	5.1	4.4	6.5	6.2	5.6	5.0	5.0
Cow Cross 110 kV	4.4	14.3	13.1	5.0	11.7	11.4	4.8	10.5	10.1	5.2	9.7	9.6
Crane 110 kV	6.5	9.1	8.3	6.5	9.2	8.9	6.8	7.8	7.6	6.7	8.2	8.2
Cromcastle A 110 kV	12.3	16.7	14.8	7.5	17.8	17.1	11.0	9.1	8.3	7.3	10.5	10.2
Cromcastle B 110 kV	12.3	16.7	14.8	7.5	17.8	17.1	11.0	9.1	8.3	7.3	10.5	10.2
Cronacarkfree 220 kV	5.6	4.3	3.6	5.5	5.0	4.6	4.9	4.0	3.9	5.0	4.9	4.9
Crory 110 kV	8.7	9.4	8.7	8.9	11.0	10.7	9.0	8.2	8.0	9.2	10.0	9.9
Cuilleen 110 kV	4.8	9.5	8.6	6.0	9.6	9.3	3.9	6.4	6.1	4.7	7.4	7.2
Cullenagh 110 kV	7.1	14.5	13.3	7.7	16.2	15.7	7.9	11.9	11.4	8.4	14.0	13.7
Cullenagh 220 kV	8.3	9.8	9.2	9.0	9.6	9.4	9.0	8.4	8.1	9.3	8.6	8.6
Cunghill 110 kV	3.3	5.9	5.3	3.8	5.1	4.9	3.1	4.6	4.5	3.6	4.5	4.5
Cushaling 110 kV	6.5	13.3	11.7	8.3	13.9	13.3	6.8	10.7	10.4	8.7	12.6	12.5
Dallow 110 kV	3.4	5.7	5.4	4.6	3.4	3.3	3.4	4.7	4.6	4.6	3.0	3.0
Dalton 110 kV	3.0	4.5	4.0	4.1	3.6	3.5	3.0	3.8	3.6	4.1	3.3	3.2
Dardistown 110 kV	14.0	16.5	14.7	10.2	18.0	17.2	13.3	9.2	8.4	11.1	10.9	10.5

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Derrybrien 110 kV	3.0	5.1	4.4	4.4	4.5	4.3	2.8	4.0	3.9	4.3	4.0	3.9
Derryiron 110 kV	5.6	10.4	9.6	7.1	9.9	9.6	4.7	7.4	7.1	5.8	7.9	7.9
Doon 110 kV	4.8	8.6	7.8	5.0	6.4	6.2	4.5	6.8	6.5	4.9	5.6	5.6
Dromada 110 kV	7.1	8.1	6.8	5.0	7.6	7.1	7.6	6.2	6.2	5.2	6.7	6.6
Drumkeen 110 kV	4.8	6.1	4.5	5.6	5.7	5.1	4.0	6.4	6.3	5.0	6.4	6.3
Drumline 110 kV	3.3	8.9	8.2	4.6	7.1	7.0	3.5	7.7	7.5	4.7	6.6	6.5
Drybridge 110 kV	5.3	15.0	13.8	6.4	11.9	11.6	5.7	11.9	11.2	6.5	10.4	10.2
Dundalk 110 kV	3.4	9.5	8.8	4.5	8.4	8.2	3.7	8.0	7.6	4.6	7.5	7.3
Dunfirth 110 kV	4.5	6.8	6.6	6.3	5.2	5.1	4.6	5.9	5.7	6.2	4.7	4.7
Dungarvan 110 kV	5.8	6.6	6.2	7.7	5.3	5.2	6.0	5.7	5.5	7.8	4.9	4.8
Dunmanway 110 kV	4.5	10.4	9.2	5.4	8.7	8.4	4.9	8.5	8.0	5.7	7.8	7.7
Dunstown 220 kV	10.9	22.1	19.7	10.9	24.3	23.3	11.9	14.9	13.7	11.5	18.3	17.6
Dunstown 400 kV	15.5	8.7	8.2	17.5	9.3	9.1	16.7	6.1	5.8	18.8	6.9	6.8
Ennis 110 kV	4.7	12.4	11.2	6.2	10.4	10.1	5.1	10.2	9.8	6.4	9.3	9.2
Fassaroe East 110 kV	5.1	8.5	8.0	5.3	6.4	6.2	5.3	7.3	7.0	5.4	5.7	5.7
Fassaroe West 110 kV	5.2	8.7	8.2	5.4	6.6	6.4	5.5	7.4	7.1	5.5	5.9	5.8
Finglas 220 kV	17.1	28.3	23.3	15.3	32.5	30.1	10.9	12.0	10.7	10.7	16.4	15.5
Finglas A 110 kV	25.1	18.8	16.5	18.8	20.1	19.2	20.3	10.4	9.4	20.7	12.2	11.7
Finglas B 110 kV	37.5	15.2	13.5	32.1	18.3	17.5	20.3	10.1	9.4	20.2	13.1	12.7
Flagford 110 kV	4.4	13.2	11.7	5.3	15.2	14.5	4.7	10.6	10.1	5.4	13.0	12.7
Flagford 220 kV	7.4	8.1	7.5	9.7	7.2	7.0	7.6	6.6	6.3	9.7	6.3	6.2
Francis Street A 110 kV	10.4	13.9	12.5	5.0	16.1	15.4	10.8	9.9	9.3	5.7	12.3	12.0
Francis Street B 110 kV	12.8	13.6	12.4	6.4	16.1	15.6	12.3	10.8	10.2	6.7	13.5	13.1
Galway 110 kV	5.1	15.4	13.1	5.8	15.4	14.6	5.6	11.6	11.1	6.0	13.0	12.8
Garrow 110 kV	12.8	6.8	5.8	11.2	7.3	6.9	14.1	5.3	5.3	11.7	6.5	6.4
Garvagh 110 kV	4.4	6.7	5.7	6.0	5.8	5.5	4.2	5.5	5.3	5.8	5.3	5.3
Gilra 110 kV	3.0	6.8	6.3	3.9	5.1	5.0	3.2	5.9	5.7	4.0	4.7	4.6
Glanagow 220 kV	15.2	18.5	15.7	14.2	21.0	19.6	10.0	8.9	8.5	10.2	12.0	11.7
Glanlee 110 kV	8.5	5.5	4.5	8.4	6.4	5.9	8.4	4.2	4.2	8.4	5.5	5.5
Glasmore 110 kV	4.1	8.5	7.7	4.7	5.4	5.3	5.0	6.0	5.6	5.3	4.5	4.4
Glenlara A 110 kV	3.2	3.1	2.9	4.8	2.5	2.4	3.1	2.7	2.7	4.7	2.3	2.3
Glenlara B 110 kV	9.2	6.9	6.0	6.8	6.7	6.4	9.5	5.6	5.5	7.0	6.0	6.0
Glenree 110 kV	3.6	4.9	4.4	4.3	3.9	3.8	3.0	3.5	3.4	3.7	3.2	3.2
Golagh 110 kV	4.8	6.7	5.0	5.0	5.9	5.4	4.0	6.0	5.8	4.5	5.8	5.8
Gorman 110 kV	6.1	16.0	14.6	7.1	17.0	16.4	6.6	12.7	11.9	7.4	14.4	14.0
Gorman 220 kV	8.7	12.9	12.1	9.7	10.1	10.0	9.2	9.8	9.1	9.8	8.6	8.4

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Gortawee 110 kV	4.4	6.8	6.2	6.0	5.3	5.1	4.5	6.1	5.8	6.1	5.0	5.0
Grange 110 kV	12.0	16.6	14.7	5.6	17.1	16.4	11.7	9.3	8.5	4.6	10.1	9.8
Grange Castle 110 kV	17.9	14.2	12.2	11.9	14.9	14.1	16.1	11.3	10.0	9.3	13.7	13.1
Great Island 110 kV	6.5	14.6	13.4	7.3	18.3	17.7	7.5	11.7	11.3	8.2	15.4	15.1
Great Island 220 kV	10.7	12.6	11.7	12.2	14.5	14.1	11.8	10.8	10.4	13.0	13.2	13.0
Griffinrath A 110 kV	6.6	11.5	10.8	7.1	11.2	11.0	6.9	9.4	9.0	7.2	9.7	9.6
Griffinrath B 110 kV	7.7	12.4	11.6	8.0	12.6	12.3	8.0	10.1	9.7	8.1	10.9	10.7
Harolds 110 kV	10.6	13.9	12.5	4.7	16.0	15.3	10.9	9.9	9.3	5.4	12.3	12.0
Hartnett's Cross 110 kV	4.2	10.3	9.4	5.1	8.1	7.9	4.6	8.5	8.1	5.4	7.3	7.2
Heuston 110 kV	13.9	13.9	12.7	7.8	16.6	16.0	13.1	11.0	10.4	8.0	13.8	13.5
Huntstown A 220 kV	16.2	27.1	22.5	12.9	31.2	28.9	10.7	11.7	10.4	10.1	15.9	15.1
Huntstown B 220 kV	15.0	25.0	21.3	10.2	28.2	26.5	10.7	11.4	10.2	9.2	15.2	14.4
Ikerrin 110 kV	5.9	5.7	5.1	6.6	3.8	3.7	5.7	4.6	4.5	6.4	3.5	3.4
Inchicore 220 kV	13.8	27.8	22.9	9.5	31.9	29.4	12.0	15.9	14.0	9.6	21.0	19.8
Inchicore A 110 kV	30.8	15.4	13.9	26.2	18.9	18.1	22.9	12.0	11.3	21.5	15.4	15.0
Inchicore B 110 kV	50.4	15.7	13.5	36.7	19.5	18.3	30.6	12.3	11.0	27.0	16.0	15.2
Inniscarra 110 kV	5.1	10.9	9.9	6.6	9.5	9.2	5.4	8.7	8.3	6.7	8.4	8.3
Irishtown 220 kV	15.2	25.7	21.3	11.3	30.2	27.9	12.7	15.1	13.5	10.8	20.3	19.3
Kellis 110 kV	5.9	11.0	10.2	6.9	12.4	12.0	6.3	8.5	8.2	7.3	10.1	9.9
Kellis 220 kV	7.8	8.8	8.4	9.7	7.3	7.2	8.2	7.3	7.1	9.8	6.4	6.4
Kilbarry 110 kV	7.6	23.8	20.2	8.4	22.6	21.4	7.4	15.4	14.3	8.0	17.1	16.6
Kildonan 110 kV	8.6	20.9	19.2	6.1	16.9	16.5	7.9	14.7	13.6	6.1	13.7	13.4
Kilgarvan 110 kV	7.3	3.3	3.1	8.0	3.6	3.5	7.8	2.9	2.9	8.2	3.3	3.3
Kilkenny 110 kV	4.9	10.2	9.6	5.7	10.7	10.4	3.0	4.8	4.7	3.4	5.9	5.8
Kill Hill 110 kV	6.3	7.7	6.8	7.3	6.2	6.0	5.7	6.0	5.8	6.7	5.5	5.4
Killonan 110 kV	7.1	21.4	18.9	8.7	21.8	20.9	8.0	16.6	15.8	9.2	18.5	18.2
Killonan 220 kV	7.8	11.9	11.0	10.3	10.6	10.3	8.7	9.2	8.8	10.7	9.1	8.9
Killoteran 110 kV	5.5	12.4	11.4	4.8	13.1	12.7	6.1	10.2	9.8	5.2	11.4	11.2
Kilmahud 110 kV	18.1	14.0	12.1	12.2	14.8	14.0	16.2	11.2	10.0	9.0	13.5	12.8
Kilmore 110 kV	17.6	17.9	15.8	11.7	19.2	18.3	12.9	9.4	8.6	9.1	11.0	10.6
Kilpaddoge 110 kV	13.0	19.4	17.6	13.4	23.3	22.3	13.0	15.0	14.5	13.1	19.2	18.9
Kilpaddoge A 220 kV	16.0	24.0	20.5	12.4	28.9	27.0	15.1	13.7	13.1	12.7	18.8	18.5
Kilpaddoge B 220 kV	16.0	24.0	20.5	12.4	28.9	27.0	15.1	13.7	13.1	12.7	18.8	18.5
Kilteel 110 kV	4.2	8.5	7.9	5.3	7.3	7.1	4.4	7.2	6.9	5.4	6.6	6.5
Kinnegad 110 kV	4.5	9.1	8.6	6.1	7.6	7.5	4.4	7.2	6.9	5.7	6.7	6.6
Knockacummer 110 kV	6.5	5.9	5.2	6.5	6.1	5.8	6.7	4.9	4.8	6.7	5.6	5.5

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Knockavanna 110 kV	3.0	5.4	4.6	4.4	4.6	4.4	2.9	4.2	4.2	4.2	4.0	4.0
Knockearagh 110 kV	5.4	6.0	5.5	7.3	4.9	4.8	5.6	5.2	5.0	7.4	4.5	4.5
Knocknagoshel 110 kV	7.1	7.8	6.3	7.6	8.3	7.6	7.2	5.8	5.7	7.7	7.2	7.2
Knocknagreenan 110 kV	6.1	13.3	11.9	7.3	12.4	12.0	6.7	10.6	10.0	7.6	10.9	10.7
Knockraha A 110 kV	8.1	24.4	21.3	9.0	22.4	21.5	8.2	16.1	15.2	8.8	17.3	16.9
Knockraha A 220 kV	10.5	16.7	14.6	10.6	15.2	14.6	9.8	11.0	10.4	10.0	13.3	13.0
Knockraha B 110 kV	8.1	24.4	21.3	9.0	22.4	21.5	8.2	16.1	15.2	8.8	17.3	16.9
Knockraha B 220 kV	9.9	11.6	10.6	10.6	10.8	10.5	9.8	11.0	10.4	10.0	13.3	13.0
Knockumber 110 kV	3.6	8.9	8.3	4.5	6.4	6.3	3.9	7.7	7.3	4.6	5.9	5.8
Lanesboro 110 kV	3.9	12.7	11.2	5.1	12.7	12.2	3.5	8.9	8.2	4.3	9.9	9.6
Laois 110 kV	5.9	14.9	14.0	6.4	18.2	17.7	-	-	-	-	-	-
Laois 400 kV	13.7	8.2	7.7	9.8	7.5	7.4	-	-	-	-	-	-
Letterkenny110 kV	4.9	6.4	4.6	5.8	6.7	5.9	4.4	7.5	7.2	5.4	8.4	8.3
Liberty A 110 kV	6.2	20.2	17.4	5.1	20.8	19.7	6.2	13.3	12.5	5.2	15.7	15.3
Liberty B 110 kV	6.1	20.1	17.4	4.9	20.7	19.7	6.1	13.3	12.5	5.1	15.6	15.3
Limerick 110 kV	5.3	18.2	16.1	6.3	15.8	15.2	6.0	14.5	13.8	6.6	13.8	13.6
Lisdrum 110 kV	2.7	5.4	5.0	4.1	4.5	4.4	2.9	4.8	4.6	4.1	4.3	4.2
Lisheen 110 kV	5.1	5.3	4.4	5.1	7.9	7.2	4.8	4.1	4.0	4.9	6.7	6.5
Lodgewood 110 kV	8.7	9.4	8.7	8.9	11.0	10.7	9.0	8.2	8.0	9.2	10.0	9.9
Lodgewood 220 kV	8.7	8.1	7.6	9.9	7.6	7.4	9.3	7.0	6.7	10.2	6.8	6.7
Longpoint 220 kV	14.2	18.4	15.6	13.5	20.3	19.1	10.7	9.8	9.3	10.8	12.9	12.6
Louth 220 kV	11.0	22.2	20.1	12.4	25.7	24.7	10.1	13.6	12.1	10.8	17.4	16.5
Louth A 110 kV	6.7	14.3	13.2	7.9	16.8	16.3	7.1	11.5	10.8	7.9	14.2	13.9
Louth B 110 kV	7.3	15.4	14.3	8.3	18.7	18.1	7.6	12.3	11.6	8.2	15.6	15.2
Macetown 110 kV	7.2	20.3	18.7	7.1	18.8	18.3	7.0	14.5	13.4	7.0	15.1	14.7
Macroom 110 kV	6.5	14.8	13.1	7.4	14.0	13.4	7.2	11.7	10.9	7.8	12.1	11.8
Mallow 110 kV	5.1	7.2	6.7	7.0	5.7	5.6	5.3	6.1	5.9	7.0	5.2	5.1
Marina 110 kV	8.0	22.9	19.5	9.1	23.6	22.3	7.3	14.6	13.6	8.0	17.3	16.8
Maynooth A 110 kV	10.2	14.6	13.6	11.0	17.4	16.9	10.3	11.7	11.1	10.8	14.6	14.3
Maynooth A 220 kV	9.6	20.2	17.9	9.4	18.1	17.4	8.0	14.7	13.7	9.5	14.7	14.4
Maynooth B 110 kV	7.5	19.0	17.7	9.4	17.4	17.0	10.2	14.7	13.2	9.7	15.5	15.0
Maynooth B 220 kV	9.7	23.9	21.1	9.4	21.1	20.3	10.3	13.8	12.6	9.8	14.2	13.8
McDermott 110 kV	16.5	13.8	12.4	5.7	15.5	14.9	13.5	9.4	8.8	6.3	11.5	11.2
Meath Hill 110 kV	3.8	9.7	9.0	5.1	7.6	7.5	4.1	8.1	7.7	5.2	6.9	6.8
Meentycat 110 kV	4.5	5.3	4.0	5.6	4.8	4.4	3.7	5.4	5.3	4.9	5.3	5.3
Midleton 110 kV	3.5	11.5	10.7	4.6	8.7	8.5	3.9	9.0	8.6	4.8	7.6	7.5

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Milltown A 110 kV	14.9	15.1	13.5	6.6	17.7	16.9	14.0	10.6	9.9	7.3	13.4	13.0
Milltown B 110 kV	8.7	12.2	11.2	4.0	14.2	13.8	8.9	9.8	9.3	4.2	12.0	11.8
Misery Hill 110 kV	13.2	14.8	13.2	7.2	17.5	16.7	12.9	10.4	9.7	7.9	13.2	12.8
Moneteen 110 kV	5.4	12.2	11.2	6.4	8.7	8.5	5.9	10.4	10.0	6.6	8.0	7.9
Moneypoint 110 kV	15.7	10.1	9.6	18.1	9.8	9.6	15.4	8.5	8.3	17.4	8.7	8.6
Moneypoint 220 kV	16.7	23.6	20.3	13.1	28.5	26.8	16.0	13.8	13.3	13.1	18.9	18.5
Moneypoint G1 400 kV	23.2	14.0	12.5	23.2	15.7	15.0	22.8	8.1	7.8	23.6	9.7	9.6
Moneypoint G2 400 kV	23.2	14.0	12.5	23.2	15.7	15.0	41.2	4.2	4.1	39.2	5.1	5.1
Moneypoint G3 400 kV	23.2	14.0	12.5	23.2	15.7	15.0	22.8	8.1	7.8	23.6	9.7	9.6
Monread 110 kV	3.9	8.5	7.9	4.8	8.1	7.9	4.1	7.1	6.8	5.0	7.2	7.1
Mount Lucas 110 kV	4.4	8.6	8.0	5.8	7.2	7.0	4.7	7.2	7.1	6.0	6.5	6.4
Moy 110 kV	4.1	5.0	4.5	5.1	5.1	4.9	2.9	3.3	3.2	3.5	3.8	3.7
Mullagharlin 110 kV	3.5	9.7	9.0	4.6	9.0	8.8	3.8	8.1	7.7	4.8	8.0	7.9
Mullingar 110 kV	3.4	7.8	7.3	4.9	7.1	6.9	3.5	6.4	6.2	4.8	6.2	6.1
Mulreavy 110 kV	5.4	7.2	5.2	5.7	7.8	6.9	4.1	6.3	6.1	4.7	7.7	7.7
Mungret A 110 kV	5.1	11.6	10.6	6.0	8.1	7.9	5.5	9.8	9.5	6.2	7.4	7.3
Mungret B 110 kV	5.1	11.6	10.7	6.0	8.1	7.9	5.5	9.9	9.5	6.2	7.4	7.3
Nangor 110 kV	15.4	13.8	11.9	9.5	14.5	13.7	14.3	11.0	9.8	7.8	13.3	12.7
Navan 110 kV	5.2	13.9	12.7	6.1	13.0	12.7	5.7	11.3	10.6	6.4	11.4	11.1
Nenagh 110 kV	2.7	3.9	3.6	3.9	2.1	2.1	2.7	3.5	3.4	3.9	2.0	2.0
Newbridge 110 kV	4.0	12.5	11.4	4.8	11.8	11.4	4.4	9.9	9.5	5.1	10.0	9.9
Newbury 110 kV	14.8	17.4	15.4	7.2	18.2	17.4	12.4	9.4	8.5	7.1	10.7	10.3
Nore 110 kV	4.8	9.6	9.1	6.1	10.3	10.1	2.9	4.6	4.4	3.4	5.7	5.6
North Kerry 220 kV	13.1	17.1	14.9	5.8	20.3	19.2	13.7	11.1	10.8	6.9	14.9	14.7
North Kerry A 110 kV	4.8	9.1	8.4	5.8	7.2	7.0	5.1	7.7	7.5	5.9	6.5	6.5
North Kerry B 110 kV	22.6	14.6	12.2	13.2	15.5	14.5	24.8	10.6	10.4	14.1	12.9	12.9
North Quays 110 kV	18.7	15.5	13.8	6.1	17.8	17.0	16.2	10.8	10.0	6.8	13.4	13.0
North Wall 220 kV	15.7	25.5	21.3	8.2	25.9	24.2	10.8	11.3	10.1	8.3	14.3	13.7
Oldcourt A 110 kV	3.8	11.7	10.9	4.6	8.7	8.6	4.2	9.0	8.7	4.7	7.5	7.4
Oldcourt B 110 kV	3.9	11.8	11.0	4.6	8.8	8.6	4.2	9.1	8.7	4.7	7.6	7.5
Oldstreet 220 kV	15.7	11.8	10.9	12.4	12.3	12.0	13.4	7.3	7.1	11.8	8.7	8.6
Oldstreet 400 kV	15.5	9.7	9.1	9.5	8.4	8.3	14.7	6.1	5.8	10.3	6.3	6.2
Oughtragh 110 kV	3.6	4.9	4.5	4.8	3.0	3.0	3.8	4.3	4.1	4.8	2.8	2.8
Pelletstown 110 kV	13.7	12.9	11.7	7.5	13.3	12.9	12.3	9.0	8.4	7.8	10.2	10.0
Platin 110 kV	4.7	13.5	12.6	5.5	9.7	9.6	5.1	11.0	10.4	5.6	8.7	8.5
Pollaphuca 110 kV	3.2	3.2	3.1	4.6	2.6	2.6	3.3	2.9	2.8	4.7	2.5	2.5

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Poolbeg A 110 kV	28.8	16.2	14.4	22.3	19.7	18.8	20.8	11.2	10.4	18.6	14.6	14.1
Poolbeg A 220 kV	16.3	25.5	21.3	6.8	24.1	22.7	11.2	11.4	10.2	7.6	13.8	13.2
Poolbeg B 110 kV	28.8	16.2	14.4	22.3	19.7	18.7	20.8	11.2	10.4	18.6	14.6	14.1
Poolbeg B 220 kV	13.4	25.6	21.4	9.3	27.2	25.4	11.5	14.9	13.2	9.3	18.5	17.5
Poolbeg C 220 kV	21.5	15.8	14.1	7.1	18.2	17.4	17.6	10.9	10.2	7.8	13.7	13.2
Poppintree 110 kV	13.9	17.3	15.3	8.0	18.5	17.7	13.4	9.7	8.8	9.3	11.3	10.9
Portan 260 kV	55.3	7.1	6.9	-	-	-	28.4	4.4	4.3	-	-	-
Portan 400 kV	18.3	12.0	11.2	-	-	-	15.1	5.7	5.4	-	-	-
Portlaoise 110 kV	4.4	14.2	13.1	5.4	11.8	11.6	4.2	9.0	8.5	5.5	7.9	7.7
Pottery 110 kV	17.5	12.8	11.4	5.6	12.5	12.0	16.0	10.2	9.5	5.8	10.7	10.4
Prospect 220 kV	13.1	19.5	17.2	8.4	19.3	18.4	13.4	12.1	11.7	9.2	14.1	13.9
Raffeen 220 kV	7.5	17.3	15.6	8.5	19.4	18.6	7.2	12.1	11.5	7.9	14.9	14.5
Raffeen A 110 kV	13.8	19.2	16.3	12.7	21.6	20.2	9.9	9.8	9.3	9.8	13.0	12.7
Raffeen B 110 kV	8.9	16.7	15.0	9.8	18.7	17.9	8.1	11.8	11.2	8.8	14.4	14.1
Rathkeale 110 kV	3.5	8.0	7.4	4.8	6.1	5.9	3.6	6.8	6.6	4.9	5.6	5.5
Ratrussan 110 kV	3.7	8.4	6.9	4.9	8.6	8.0	3.4	6.4	6.2	4.7	7.7	7.6
Reamore 110 kV	4.3	7.3	6.7	3.4	6.2	6.1	4.5	6.3	6.1	3.5	5.7	5.6
Richmond A 110 kV	3.1	8.1	7.3	4.3	7.0	6.8	3.0	6.2	5.8	4.0	5.9	5.8
Richmond B 110 kV	3.1	8.1	7.3	4.3	7.0	6.8	3.0	6.2	5.8	4.0	5.9	5.8
Rinawade 110 kV	4.7	11.6	11.1	5.8	8.1	8.0	5.0	9.7	9.2	6.0	7.3	7.2
Ringaskiddy 110 kV	5.8	13.5	12.4	6.2	12.4	12.1	5.9	10.1	9.6	6.2	10.2	10.1
Ringsend 110 kV	29.3	16.4	14.5	23.6	19.9	18.9	20.7	11.2	10.4	19.1	14.6	14.1
Ryebrook 110 kV	5.0	15.8	14.6	6.5	12.8	12.5	5.4	12.5	11.5	6.6	11.2	10.9
Salthill 110 kV	4.4	13.2	11.5	3.8	13.1	12.4	4.8	10.3	9.8	4.1	11.2	11.0
Screeb 110 kV	3.8	3.2	3.0	4.8	1.8	1.8	3.9	2.8	2.8	4.9	1.7	1.7
Seal Rock A 110 kV	7.9	10.6	9.4	9.6	11.2	10.7	8.1	9.1	8.7	9.8	10.3	10.1
Seal Rock B 110 kV	7.9	10.6	9.4	9.7	11.2	10.7	8.1	9.1	8.7	9.8	10.3	10.1
Shankill 110 kV	3.5	9.4	8.1	4.7	8.0	7.7	3.6	7.6	7.2	4.7	7.1	7.1
Shannonbridge 110 kV	6.3	18.4	16.4	7.9	19.8	18.9	5.0	11.6	11.1	5.9	14.2	13.9
Shannonbridge 220 kV	7.3	7.7	7.4	9.9	6.5	6.4	6.8	6.2	5.9	8.9	5.6	5.6
Shellybanks A 220 kV	15.9	25.4	21.3	6.6	28.0	26.1	11.0	11.4	10.2	7.4	15.0	14.3
Shellybanks B 220 kV	14.6	24.8	20.6	9.6	28.6	26.5	12.3	14.6	13.1	9.6	19.3	18.4
Shelton Abbey 110 kV	7.4	8.4	7.8	7.4	8.6	8.3	7.6	7.2	7.0	7.6	7.7	7.6
Singland 110 kV	6.7	17.4	15.6	7.9	15.8	15.3	7.4	14.0	13.5	8.2	14.0	13.8
Sligo 110 kV	3.8	10.1	8.7	4.6	9.0	8.6	3.9	8.1	7.8	4.5	8.0	7.9
Somerset 110 kV	2.9	8.3	7.8	4.0	5.2	5.1	3.1	6.6	6.4	4.0	4.5	4.5

Table E-3 Short Circuit Currents for Maximum and Minimum Demand in 2017 (continued)

Bus	Winter Peak 2017						Summer Valley 2017					
	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]
Sorne Hill 110 kV	3.7	3.0	2.5	4.4	3.2	2.9	3.2	2.9	2.8	4.0	3.1	3.1
Sranangh 110 kV	4.9	11.8	10.0	5.8	12.3	11.5	4.9	9.5	9.1	5.7	10.8	10.6
Srananagh 220 kV	7.4	5.0	4.6	9.7	3.9	3.8	7.3	4.2	4.1	9.6	3.6	3.5
Stevenstown 110 kV	4.0	6.8	6.3	4.7	4.2	4.1	4.8	5.1	4.8	5.1	3.6	3.5
Stratford 110 kV	3.2	4.8	4.5	4.3	3.4	3.4	3.4	4.1	4.0	4.4	3.2	3.1
Suir 110 kV	5.9	11.3	10.0	7.2	11.5	11.0	4.6	7.5	7.3	5.5	8.9	8.8
Taney 110 kV	8.7	10.9	9.8	3.2	10.3	9.9	8.8	8.9	8.3	3.4	9.0	8.8
Tarbert 110 kV	35.2	17.0	15.7	35.3	16.1	15.7	25.2	11.2	11.0	27.4	12.4	12.3
Tarbert 220 kV	15.8	23.6	20.2	13.7	27.6	25.9	14.3	13.3	12.8	13.1	18.0	17.7
Tawnaghmore A 110 kV	3.9	4.2	3.8	5.1	3.9	3.8	2.8	2.7	2.6	3.5	3.0	2.9
Tawnaghmore B 110 kV	3.9	4.2	3.8	5.2	4.0	3.9	2.8	2.7	2.7	3.4	3.0	3.0
Thornsberry 110 kV	3.7	7.5	6.9	5.1	6.6	6.4	3.9	6.1	5.9	5.1	5.6	5.6
Thurles 110 kV	6.4	6.7	5.7	6.7	6.8	6.4	6.0	5.2	5.0	6.4	6.0	5.9
Tievebrack 110 kV	3.9	4.1	3.4	5.1	2.9	2.7	3.6	3.9	3.8	4.9	2.9	2.9
Tipperary 110 kV	5.7	8.5	7.8	6.5	5.5	5.4	5.3	6.7	6.5	6.2	4.9	4.8
Tonroe 110 kV	2.6	3.5	3.3	3.7	2.1	2.1	2.7	3.1	3.1	3.8	2.0	2.0
Trabeg 110 kV	8.0	22.6	19.3	8.9	23.0	21.8	7.3	14.4	13.5	7.9	17.0	16.5
Tralee 110 kV	5.0	9.7	8.7	6.0	8.0	7.7	5.2	8.0	7.7	6.2	7.2	7.1
Trien A 110 kV	4.5	8.4	7.7	5.7	7.2	7.0	4.8	7.1	6.9	5.9	6.5	6.4
Trien B 110 kV	11.9	10.8	8.9	8.8	10.1	9.5	13.1	8.0	7.9	13.1	8.0	7.9
Trillick 110 kV	3.8	3.3	2.6	4.5	3.2	2.9	3.2	3.1	3.0	4.1	3.1	3.1
Trinity 110 kV	11.6	14.3	12.8	6.0	16.8	16.1	11.7	10.2	9.4	6.7	12.8	12.4
Tullabrack 110 kV	6.7	7.6	7.2	7.4	5.7	5.6	7.0	6.5	6.4	7.5	5.2	5.1
Turlough 220 kV	10.5	13.4	12.1	11.9	11.5	11.2	11.3	10.3	9.8	12.4	10.0	9.9
Tynagh 220 kV	14.9	13.1	11.7	16.6	14.0	13.5	10.7	7.1	6.9	11.6	9.0	8.9
Uggool 110 kV	7.8	8.2	6.6	8.8	9.2	8.4	7.1	6.3	6.1	8.4	8.2	8.1
Waterford 110 kV	6.4	13.7	12.5	6.8	14.5	14.1	7.2	11.1	10.7	7.3	12.5	12.3
West Galway A 110 kV	6.5	9.1	7.6	7.0	8.2	7.7	6.4	7.1	7.0	7.0	7.3	7.2
West Galway B 110 kV	4.7	6.4	5.9	5.1	4.3	4.3	4.9	5.4	5.3	5.1	4.0	4.0
Wexford 110 kV	4.0	7.2	6.5	5.3	6.4	6.2	4.0	6.1	5.9	5.3	5.9	5.9
Whitegate 110 kV	4.3	10.9	10.2	5.2	10.7	10.5	4.7	8.5	8.2	5.3	9.0	8.9
Wolfe Tone 110 kV	14.3	13.5	12.1	5.2	15.0	14.3	12.5	9.2	8.6	5.8	11.2	10.9
Woodhouse 110 kV	5.8	6.5	6.1	7.3	4.6	4.6	6.0	5.6	5.4	7.4	4.3	4.2
Woodland 220 kV	12.9	27.2	23.8	12.1	26.8	25.6	11.0	13.7	12.3	11.0	16.5	15.8
Woodland 400 kV	18.3	12.2	11.3	15.7	11.3	11.0	15.1	5.8	5.4	16.3	6.6	6.5

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020

Bus	Winter Peak 2020						Summer Valley 2020					
	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	13.2	14.0	12.1	7.7	16.6	15.6	12.9	11.7	10.2	7.8	14.2	13.4
Agannygal 110 kV	3.0	6.3	5.6	4.2	4.9	4.7	3.1	5.7	5.0	4.3	4.5	4.3
Aghada 110 kV	4.7	10.2	9.6	5.7	11.4	11.2	4.8	8.7	8.3	5.8	10.1	9.8
Aghada A 220 kV	14.9	19.7	16.9	15.8	21.7	20.4	12.1	13.6	11.8	13.2	16.4	15.4
Aghada B 220 kV	14.7	18.8	16.2	12.1	21.1	19.9	12.3	13.3	11.5	11.2	16.0	15.0
Aghada C 220 kV	14.1	19.0	16.3	13.2	20.9	19.8	11.7	13.2	11.5	11.8	15.9	15.0
Aghada D 220 kV	14.9	19.7	16.9	15.8	21.7	20.4	12.1	13.6	11.8	13.2	16.4	15.4
Ahane 110 kV	5.1	14.3	13.2	6.1	8.6	8.5	5.3	12.8	11.8	6.2	8.0	7.9
Anner 110 kV	4.3	7.8	7.1	4.8	5.6	5.5	4.1	6.5	6.1	4.6	5.0	4.9
Ardnacrusha 110 kV	6.6	17.4	15.5	8.8	16.4	15.8	6.9	15.5	13.9	9.0	15.3	14.7
Ardnagappary 110 kV	2.9	2.2	2.0	4.1	1.3	1.2	2.9	2.0	1.8	4.2	1.2	1.2
Arigna 110 kV	3.9	8.0	7.0	5.0	5.6	5.4	3.9	7.5	6.6	5.0	5.4	5.2
Arklow 110 kV	10.6	9.6	8.9	11.4	11.5	11.1	10.6	8.6	7.9	11.5	10.3	10.0
Arklow 220 kV	8.9	8.6	8.1	10.5	7.7	7.6	9.2	7.5	6.9	10.6	6.9	6.7
Artane 110 kV	13.3	13.4	12.1	5.6	15.5	14.8	12.2	9.7	8.9	6.1	11.8	11.4
Arva 110 kV	3.7	9.4	8.3	4.9	7.0	6.7	3.8	9.3	8.3	5.0	6.9	6.7
Athea 110 kV	11.0	9.7	8.0	11.6	9.0	8.4	11.0	9.0	7.4	11.6	8.5	7.9
Athlone 110 kV	4.9	9.9	8.9	5.8	9.9	9.6	3.9	6.9	6.5	4.6	7.7	7.5
Athy 110 kV	3.3	7.7	7.4	4.4	6.2	6.1	3.4	6.7	6.5	4.5	5.5	5.5
Aughinish 110 kV	8.3	10.6	9.5	10.3	11.1	10.6	8.5	10.2	9.0	10.5	10.8	10.3
Ballakelly 220 kV	10.8	21.6	19.5	11.7	25.1	24.2	9.7	14.7	12.8	10.3	18.1	17.0
Ballybeg 110 kV	9.6	7.0	6.6	9.9	8.1	7.9	9.6	6.2	5.9	9.9	7.4	7.2
Ballydine 110 kV	4.2	8.4	7.7	3.9	6.4	6.2	4.0	7.1	6.7	3.8	5.8	5.7
Ballylickey 110 kV	2.9	3.8	3.5	4.0	2.2	2.1	3.0	3.6	3.4	4.1	2.1	2.0
Ballynahulla 110 kV	14.7	11.0	9.8	13.2	10.6	10.2	14.9	10.3	9.0	13.3	10.0	9.5
Ballynahulla 220 kV	8.3	10.2	9.1	8.4	10.5	10.1	8.7	9.1	8.0	8.7	9.5	9.1
Ballyragget 110 kV	5.4	7.8	7.5	6.3	5.5	5.5	4.8	6.3	6.0	5.8	4.8	4.8
Ballyvouskill 110 kV	16.7	7.8	6.9	15.1	8.3	7.9	16.8	7.4	6.4	15.2	7.8	7.4
Ballyvouskill 220 kV	8.2	10.2	9.1	8.8	10.9	10.5	8.7	9.2	8.1	9.2	10.0	9.5
Ballywater 110 kV	4.6	6.2	5.8	3.2	6.1	6.0	4.7	5.6	5.3	3.2	5.6	5.5
Baltrasna 110 kV	5.9	11.4	10.7	7.2	8.4	8.3	6.0	9.6	9.0	7.2	7.6	7.5
Bancroft 110 kV	12.3	13.2	12.2	6.8	15.1	14.6	12.0	11.2	10.4	6.9	13.1	12.7
Bandon 110 kV	3.1	7.4	6.7	4.2	6.7	6.5	3.2	6.6	6.2	4.3	6.3	6.1
Banoge 110 kV	5.9	6.6	6.2	6.7	5.6	5.5	6.0	5.9	5.6	6.8	5.2	5.1
Barnadivane 110 kV	4.0	8.8	8.2	4.8	8.2	8.0	4.6	9.1	8.0	5.4	8.4	8.1
Barnahealy A 110 kV	5.5	14.7	13.4	6.2	14.3	13.9	5.6	12.2	11.2	6.3	12.4	12.0

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Barnahealy B 110 kV	6.8	14.1	12.9	7.4	13.6	13.2	6.8	11.9	10.9	7.4	11.9	11.6
Baroda 110 kV	3.8	10.0	9.3	4.6	11.2	10.9	3.9	7.9	7.4	4.6	9.3	9.1
Barrymore 110 kV	3.6	8.7	8.2	5.3	6.5	6.4	3.7	7.4	7.1	5.3	5.8	5.8
Belcamp 110 kV	15.2	17.3	15.3	8.6	18.3	17.5	13.0	12.5	11.3	8.6	14.3	13.7
Belcamp 220 kV	11.7	24.7	20.8	9.2	27.6	25.8	10.0	12.9	11.2	8.9	16.3	15.3
Bellacorick 400 kV	19.6	8.6	6.5	17.9	11.7	10.1	19.2	8.8	6.6	17.7	11.9	10.3
Bellacorick A 110 kV	4.4	6.6	5.3	5.0	6.5	6.0	4.3	5.8	4.6	4.8	5.9	5.4
Bellacorick B 110 kV	15.5	2.8	2.3	16.3	3.3	3.0	15.3	2.6	2.2	16.1	3.1	2.8
Binbane 110 kV	3.6	4.9	4.1	5.1	4.2	4.0	3.7	4.4	3.7	5.2	3.9	3.7
Blackpool 110 kV	7.6	23.6	20.3	7.7	22.7	21.6	7.3	18.2	16.0	7.6	18.8	18.0
Blackrock 110 kV	11.0	11.8	10.5	2.8	10.1	9.8	10.9	9.8	9.0	3.0	8.9	8.7
Blake 110 kV	3.8	9.2	8.7	4.9	5.9	5.9	3.9	7.4	7.1	4.9	5.3	5.2
Boggeragh 110 kV	17.1	3.8	3.4	17.6	4.5	4.3	17.5	4.0	3.5	17.8	4.5	4.3
Booltiagh 110 kV	6.3	7.9	7.3	8.1	6.3	6.2	6.5	7.3	6.7	8.2	6.0	5.9
Bracklone 110 kV	3.5	10.1	9.4	4.6	8.8	8.6	3.6	8.0	7.6	4.6	7.6	7.4
Brinny A 110 kV	3.0	6.5	6.0	4.1	5.5	5.4	3.1	5.9	5.5	4.2	5.1	5.0
Brinny B 110 kV	3.0	6.5	6.1	4.1	5.5	5.4	3.1	5.9	5.5	4.2	5.2	5.1
Butlerstown 110 kV	5.4	11.8	10.9	5.3	11.5	11.2	5.6	10.2	9.6	5.5	10.2	10.0
Cabra 110 kV	12.1	12.9	11.6	4.6	13.7	13.2	11.5	9.4	8.7	5.1	10.7	10.4
Cahir 110 kV	5.8	12.2	10.7	6.6	11.7	11.2	4.6	8.9	8.0	5.4	9.5	9.2
Carlow 110 kV	5.0	10.3	9.6	5.9	10.4	10.1	5.4	8.7	8.1	6.2	9.1	8.9
Carrickmines 220 kV	13.9	23.1	19.5	8.7	26.8	25.0	12.7	16.3	13.7	9.1	20.1	18.6
Carrickmines A 110 kV	32.1	13.7	12.1	24.7	14.5	13.8	26.8	11.2	10.2	22.5	12.4	11.9
Carrickmines B 110 kV	25.4	14.8	13.5	20.7	17.4	16.7	22.0	12.4	11.4	19.0	14.9	14.4
Carrick-on-Shannon 110 kV	4.3	12.9	11.3	5.1	13.5	12.8	4.4	11.6	10.2	5.1	12.3	11.8
Carrigadrohid 110 kV	6.2	12.8	11.7	7.4	12.2	11.8	6.7	11.9	10.6	7.8	11.5	11.1
Carrowbeg 110 kV	2.8	3.5	3.1	3.8	2.9	2.8	2.8	3.1	2.8	3.8	2.7	2.6
Cashla 110 kV	7.1	20.4	17.7	8.0	24.1	22.7	7.2	16.9	14.7	7.9	20.4	19.3
Cashla 220 kV	8.4	13.0	11.7	9.9	12.2	11.8	8.7	10.0	8.9	9.9	10.2	9.8
Castlebar 110 kV	3.9	7.4	6.2	4.7	7.1	6.7	3.7	6.3	5.4	4.5	6.5	6.1
Castledockrill 110 kV	6.9	8.3	7.7	4.7	9.4	9.2	7.0	7.5	7.1	4.8	8.6	8.4
Castlefarm A 110 kV	7.4	10.2	9.1	9.0	10.3	9.9	7.6	9.8	8.7	9.1	10.1	9.6
Castlefarm B 110 kV	7.4	10.2	9.1	9.0	10.3	9.9	7.6	9.8	8.7	7.6	9.8	8.7
Castleview 110 kV	3.8	14.1	13.0	4.5	9.8	9.6	4.0	11.8	10.9	4.6	8.7	8.5
Cathaleen's Fall 110 kV	6.1	10.9	8.5	6.9	10.6	9.7	6.3	9.9	7.5	7.1	9.7	8.8
Caulstown 110 kV	4.7	13.1	12.2	5.5	9.2	9.1	4.9	11.0	10.2	5.6	8.3	8.2

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Cauteen 110 kV	5.9	8.7	8.0	6.7	5.1	5.0	5.7	7.5	6.9	6.6	4.6	4.6
Central 110 kV	14.4	12.4	11.1	7.6	12.8	12.3	13.9	10.3	9.4	7.7	11.1	10.7
Charleville 110 kV	4.5	6.8	6.2	5.9	4.5	4.5	4.5	6.1	5.7	6.0	4.3	4.2
Cherrywood 110 kV	10.2	11.4	10.2	7.4	11.2	10.8	10.2	9.6	8.8	7.6	9.8	9.5
City West 110 kV	5.9	8.8	7.7	6.0	6.2	6.0	6.1	7.5	6.7	6.1	5.6	5.5
Clahane 110 kV	4.1	8.0	7.4	5.2	6.9	6.7	4.2	7.4	6.8	5.2	6.5	6.4
Clashavoon 220 kV	8.4	11.0	9.9	8.9	11.1	10.7	8.9	9.8	8.6	9.3	10.0	9.6
Clashavoon A 110 kV	7.4	14.1	12.8	8.6	12.9	12.6	8.0	13.0	11.6	9.0	12.1	11.6
Clashavoon B 110 kV	30.7	4.5	4.1	29.3	5.4	5.1	28.8	4.6	4.1	28.5	5.2	5.0
Cliff 110 kV	5.2	8.2	6.7	6.4	7.0	6.6	5.3	7.6	6.1	6.5	6.6	6.2
Clogher 110 kV	7.0	10.4	7.8	7.5	13.0	11.4	6.1	7.8	5.6	6.2	8.4	7.3
Clogher 220 kV	8.4	4.5	3.7	10.1	4.8	4.5	-	-	-	-	-	-
Cloghran 110 kV	6.7	18.4	17.0	7.0	15.9	15.5	6.6	14.3	12.9	6.9	13.5	13.1
Clonkeen A 110 kV	5.6	6.2	5.9	6.9	4.3	4.3	5.7	5.8	5.4	6.9	4.1	4.0
Clonkeen B 110 kV	8.6	6.2	5.2	7.3	6.8	6.3	8.7	5.9	4.9	7.4	6.5	6.0
Cloon 110 kV	4.1	8.7	8.0	5.7	7.1	6.9	4.2	7.7	7.1	5.7	6.5	6.3
College Park 110 kV	9.3	23.9	21.7	6.3	25.1	24.2	8.4	17.6	15.7	6.4	19.8	18.9
Cookstown 110 kV	7.1	9.1	8.6	5.8	7.6	7.4	7.2	8.0	7.5	5.9	6.8	6.7
Coolroe 110 kV	5.4	11.2	10.3	7.0	10.0	9.7	5.5	9.9	9.1	7.0	9.2	9.0
Coomagearlahy 110 kV	8.6	5.6	4.6	9.2	6.5	6.0	8.7	5.4	4.4	9.3	6.2	5.7
Cordal 110 kV	11.5	9.4	8.5	8.6	7.9	7.6	11.6	8.8	7.8	8.7	7.4	7.1
Corderry 110 kV	4.1	9.1	7.6	5.3	8.1	7.6	4.1	8.5	7.2	5.3	7.7	7.3
Corduff 110 kV	10.2	27.1	24.4	11.3	28.6	27.5	9.0	19.4	17.2	9.9	22.1	21.1
Corduff 220 kV	15.9	28.6	23.8	13.3	31.6	29.4	11.4	14.4	12.3	10.9	18.1	16.9
Corkagh 110 kV	18.8	14.1	12.1	9.5	15.8	14.9	17.4	11.7	10.2	9.6	13.6	12.9
Corraclassy 110 kV	4.9	4.8	4.4	6.5	3.5	3.4	4.4	6.9	6.3	5.6	5.1	5.0
Cow Cross 110 kV	4.5	14.5	13.3	5.0	11.8	11.5	4.6	12.1	11.1	5.1	10.4	10.2
Crane 110 kV	6.5	9.2	8.4	6.5	9.3	9.0	6.7	8.3	7.6	6.6	8.4	8.2
Cromcastle A 110 kV	12.3	16.8	14.8	7.5	17.9	17.1	11.2	12.2	11.0	7.7	14.0	13.5
Cromcastle B 110 kV	12.3	16.8	14.8	7.5	17.9	17.1	11.2	12.2	11.0	7.7	14.0	13.5
Cronacarkfree 220 kV	5.9	4.9	4.2	5.7	5.6	5.3	5.6	4.1	3.4	5.5	4.8	4.5
Crory 110 kV	8.8	9.5	8.9	9.0	11.2	10.9	9.0	8.6	8.0	9.1	10.2	9.9
Cuilleen 110 kV	4.8	9.4	8.6	6.0	9.6	9.3	3.8	6.6	6.2	4.6	7.5	7.3
Cullenagh 110 kV	7.3	14.9	13.7	7.9	16.7	16.1	7.5	12.7	11.8	8.1	14.5	14.1
Cullenagh 220 kV	8.6	10.5	9.8	8.9	10.2	10.0	8.6	9.1	8.5	9.1	9.0	8.8
Cunghill 110 kV	3.2	6.4	5.7	3.8	5.4	5.2	3.2	5.8	5.2	3.8	5.1	4.9

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Cushaling 110 kV	6.5	13.2	11.7	8.3	13.9	13.3	4.0	7.1	6.7	4.7	8.8	8.6
Dallow 110 kV	3.4	5.7	5.4	4.6	3.4	3.3	3.4	4.9	4.6	4.6	3.1	3.0
Dalton 110 kV	3.0	5.1	4.6	4.3	3.9	3.8	3.1	4.5	4.2	4.3	3.6	3.5
Dardistown 110 kV	14.0	16.6	14.7	10.2	18.0	17.2	12.3	12.1	11.0	9.9	14.1	13.6
Derrybrien 110 kV	3.0	5.1	4.4	4.4	4.5	4.3	3.1	4.7	4.0	4.5	4.2	4.0
Derryiron 110 kV	5.6	10.5	9.6	7.1	9.9	9.6	4.6	7.1	6.8	5.7	7.7	7.5
Doon 110 kV	4.8	8.7	7.9	5.0	6.4	6.3	4.4	7.1	6.6	4.8	5.7	5.6
Dromada 110 kV	7.0	8.3	7.0	5.0	7.7	7.3	7.1	7.8	6.4	5.0	7.3	6.8
Drumkeen 110 kV	4.6	6.8	5.2	5.4	6.2	5.7	4.9	5.8	4.3	5.6	5.5	5.0
Drumline 110 kV	3.3	8.9	8.2	4.6	7.1	6.9	3.4	8.1	7.6	4.7	6.6	6.5
Drybridge 110 kV	5.3	15.1	13.8	6.4	12.0	11.7	5.4	12.3	11.2	6.4	10.4	10.2
Dundalk 110 kV	3.4	9.5	8.8	4.5	8.4	8.2	3.6	8.3	7.7	4.6	7.6	7.4
Dunfirth 110 kV	4.5	6.8	6.6	6.3	5.2	5.1	4.6	5.9	5.7	6.2	4.7	4.7
Dungarvan 110 kV	5.8	6.7	6.2	7.7	5.4	5.3	6.0	5.9	5.6	7.8	4.9	4.8
Dunmanway 110 kV	4.4	9.9	9.0	5.3	8.5	8.2	4.7	9.4	8.4	5.6	8.1	7.8
Dunstown 220 kV	11.8	23.6	21.0	11.4	25.7	24.6	11.6	17.2	14.8	11.4	19.7	18.6
Dunstown 400 kV	16.3	10.6	9.9	16.6	11.1	10.8	15.2	7.1	6.4	17.1	7.8	7.5
Ennis 110 kV	4.7	12.5	11.2	6.2	10.4	10.1	4.9	11.1	10.1	6.3	9.6	9.3
Fassaroe East 110 kV	5.1	8.6	8.1	5.3	6.4	6.3	5.2	7.5	7.1	5.4	5.8	5.7
Fassaroe West 110 kV	5.2	8.8	8.2	5.4	6.6	6.5	5.4	7.7	7.2	5.5	6.0	5.9
Finglas 220 kV	17.1	28.4	23.4	15.3	32.7	30.2	11.4	13.9	11.9	11.3	18.0	16.8
Finglas A 110 kV	25.1	18.9	16.5	18.8	20.2	19.2	17.1	13.4	12.0	15.3	15.5	14.8
Finglas B 110 kV	37.5	15.3	13.6	32.1	18.4	17.6	22.3	10.7	9.8	21.8	13.6	13.1
Flagford 110 kV	4.7	13.6	11.9	5.6	16.1	15.2	4.7	12.1	10.7	5.6	14.5	13.8
Flagford 220 kV	8.3	9.7	8.4	9.2	10.7	10.1	8.5	8.3	7.2	9.3	9.4	8.9
Flagford 400 kV	14.5	3.5	3.0	13.3	3.9	3.7	14.0	3.2	2.8	13.1	3.6	3.4
Francis Street A 110 kV	10.4	14.0	12.5	5.0	16.2	15.5	10.4	11.9	10.8	5.2	14.1	13.6
Francis Street B 110 kV	12.8	13.7	12.5	6.4	16.3	15.7	12.4	11.4	10.5	6.6	13.9	13.4
Galway 110 kV	5.1	15.8	13.5	5.7	15.7	14.9	5.3	13.5	11.7	5.9	13.9	13.2
Garrow 110 kV	12.7	6.8	5.8	11.2	7.3	6.9	12.8	6.5	5.5	11.2	7.0	6.5
Garvagh 110 kV	4.5	6.8	5.8	6.0	5.9	5.6	4.5	6.4	5.5	6.0	5.6	5.4
Gilra 110 kV	3.1	6.9	6.4	4.0	5.2	5.1	3.1	6.4	6.0	4.0	4.9	4.8
Glanagow 220 kV	15.4	19.5	16.7	14.2	21.9	20.6	12.9	13.8	11.9	12.9	16.7	15.7
Glanlee 110 kV	8.5	5.5	4.5	8.4	6.3	5.8	8.5	5.2	4.3	8.5	6.1	5.6
Glasmore A 110 kV	4.1	8.5	7.7	4.7	5.4	5.3	4.3	6.8	6.4	4.8	4.9	4.8
Glenlara A 110 kV	3.2	3.1	2.8	4.8	2.5	2.4	3.2	2.9	2.7	4.8	2.3	2.3

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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 B 110 kV	9.2	7.0	6.1	6.8	6.7	6.4	-	-	-	-	-	-
Glenree 110 kV	3.5	6.1	5.4	4.3	4.5	4.3	3.3	5.1	4.6	4.1	4.0	3.9
Golagh 110 kV	4.9	8.2	6.4	5.2	7.7	7.1	4.8	6.4	4.8	5.1	5.7	5.2
Gorman 110 kV	6.1	16.0	14.5	7.2	17.0	16.4	6.4	13.3	12.1	7.3	14.7	14.2
Gorman 220 kV	8.7	13.0	12.2	9.7	10.2	10.0	8.9	10.5	9.4	9.7	8.8	8.6
Gortawee 110 kV	4.8	5.2	4.7	6.6	4.1	4.0	4.5	6.5	5.9	6.1	5.1	5.0
Grange 110 kV	12.0	16.6	14.7	5.6	17.2	16.4	11.1	12.1	11.0	5.9	13.6	13.1
Grange Castle 110 kV	18.0	14.3	12.3	9.2	16.5	15.5	16.7	11.8	10.3	9.3	14.1	13.3
Great Island 110 kV	6.8	15.0	13.9	7.6	18.9	18.3	7.0	12.8	11.9	7.9	16.3	15.8
Great Island 220 kV	12.5	14.9	13.8	12.9	18.4	17.8	11.3	11.8	10.8	12.8	13.8	13.3
Great Island 400 kV	17.4	7.4	7.0	10.7	6.5	6.4	-	-	-	-	-	-
Griffinrath A 110 kV	6.6	11.6	10.8	7.1	11.3	11.0	6.9	9.6	9.0	7.3	9.7	9.5
Griffinrath B 110 kV	7.7	12.5	11.6	8.0	12.7	12.4	8.0	10.2	9.6	8.2	10.9	10.6
Harolds 110 kV	10.6	14.1	12.6	4.7	16.1	15.4	10.6	11.9	10.9	4.9	14.1	13.6
Hartnett's Cross 110 kV	4.1	9.9	9.2	5.1	7.9	7.8	4.3	9.3	8.5	5.3	7.5	7.3
Heuston 110 kV	13.9	14.0	12.8	7.8	16.8	16.2	13.4	11.6	10.7	7.9	14.3	13.8
Huntstown A 220 kV	16.2	27.2	22.6	12.8	31.3	29.0	11.1	13.5	11.6	10.4	17.5	16.3
Huntstown B 220 kV	15.0	25.0	21.4	10.2	28.2	26.5	11.1	13.1	11.4	9.4	16.6	15.6
Ikerrin 110 kV	5.9	5.7	5.1	6.6	3.8	3.7	5.7	5.0	4.5	6.4	3.5	3.4
Inchicore 220 kV	13.9	28.4	23.4	9.5	32.4	29.9	12.4	18.8	15.4	9.7	23.1	21.2
Inchicore A 110 kV	31.1	15.5	14.1	26.4	19.1	18.3	25.3	12.7	11.7	22.9	16.0	15.4
Inchicore B 110 kV	51.1	15.9	13.6	36.8	19.7	18.4	35.8	13.0	11.3	29.6	16.5	15.5
Inniscarra 110 kV	5.2	10.8	9.9	6.6	9.4	9.2	5.3	9.7	8.8	6.7	8.8	8.5
Irishtown 220 kV	15.3	26.2	21.7	11.3	30.7	28.4	13.2	17.6	14.6	11.0	22.1	20.3
Kellis 110 kV	5.9	11.1	10.3	7.0	12.5	12.1	6.3	9.2	8.7	7.3	10.7	10.4
Kellis 220 kV	7.9	9.0	8.6	9.7	7.4	7.3	8.2	7.7	7.3	9.8	6.6	6.5
Kilbarry 110 kV	7.7	24.0	20.5	8.5	23.3	22.1	7.4	18.4	16.2	8.2	19.2	18.3
Kildonan 110 kV	8.6	20.9	19.3	6.1	16.9	16.5	8.0	15.8	14.2	6.1	14.1	13.7
Kilgarvan 110 kV	7.3	3.3	3.1	8.0	3.6	3.5	7.3	3.1	2.9	8.0	3.3	3.3
Kilkenny 110 kV	4.9	10.3	9.7	5.7	10.7	10.5	3.7	6.9	6.6	4.2	7.9	7.7
Kill Hill 110 kV	6.3	7.8	6.8	7.3	6.3	6.0	5.8	6.7	5.9	6.8	5.6	5.4
Killonan 110 kV	7.2	21.5	19.0	7.9	14.2	13.8	7.5	18.6	16.5	8.1	13.1	12.7
Killonan 220 kV	7.9	12.0	11.0	10.6	9.8	9.5	8.1	10.3	9.3	10.7	8.8	8.5
Killoteran 110 kV	5.6	12.7	11.7	4.9	13.4	13.0	5.8	10.9	10.2	5.0	11.8	11.5
Kilmahud 110 kV	18.1	14.2	12.2	8.9	16.1	15.2	16.9	11.7	10.3	9.0	13.8	13.1
Kilmore 110 kV	17.6	18.0	15.8	11.6	19.2	18.3	14.2	12.9	11.6	10.9	14.9	14.3

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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 110 kV	13.0	19.4	17.5	13.6	23.2	22.2	12.3	16.8	15.1	12.9	20.4	19.5
Kilpaddoge 220 kV	16.2	23.7	20.1	14.2	28.6	26.6	13.9	17.2	14.5	12.9	21.9	20.3
Kilteel 110 kV	4.2	8.5	7.9	5.3	7.4	7.2	4.3	7.1	6.6	5.3	6.5	6.4
Kinnegad 110 kV	4.5	9.1	8.6	6.1	7.6	7.5	4.4	7.1	6.8	5.7	6.6	6.5
Knockacummer 110 kV	6.5	6.0	5.2	6.5	6.2	5.9	6.6	5.7	4.9	6.6	5.9	5.6
Knockavanna 110 kV	3.0	5.4	4.6	4.4	4.6	4.4	3.1	4.9	4.2	4.4	4.2	4.0
Knockearagh 110 kV	5.4	6.0	5.5	7.3	4.9	4.8	5.5	5.5	5.1	7.4	4.6	4.5
Knocknagoshel 110 kV	7.0	7.9	6.4	7.6	8.3	7.7	7.1	7.5	5.9	7.7	8.0	7.3
Knocknagreenan 110 kV	6.0	12.7	11.6	7.1	12.2	11.8	6.4	11.8	10.6	7.5	11.5	11.1
Knockraha A 110 kV	8.4	24.9	21.9	9.3	23.3	22.3	8.3	19.5	17.3	9.0	19.1	18.4
Knockraha A 220 kV	11.6	19.4	17.1	11.4	19.8	18.9	10.6	15.2	13.1	10.6	16.0	15.1
Knockraha B 110 kV	8.4	24.9	21.9	9.3	23.3	22.3	8.3	19.5	17.3	9.0	19.1	18.4
Knockraha B 220 kV	9.9	11.9	10.9	10.7	11.0	10.7	10.6	15.2	13.1	10.6	16.0	15.1
Knockraha 400 kV	18.6	6.4	6.1	13.7	6.3	6.2	-	-	-	-	-	-
Knockumber 110 kV	3.6	8.9	8.3	4.5	6.4	6.3	3.8	7.9	7.4	4.6	6.0	5.9
Lanesboro 110 kV	3.6	11.8	10.6	4.7	12.0	11.6	3.4	9.3	8.4	4.2	10.2	9.8
Laois 110 kV	6.0	14.8	14.0	6.4	18.2	17.7	6.3	12.2	11.4	6.7	15.2	14.8
Laois 400 kV	13.9	9.0	8.4	9.5	8.0	7.9	13.7	6.8	6.2	10.1	6.6	6.4
Letterkenny110 kV	4.6	7.1	5.3	5.6	7.3	6.6	4.9	6.0	4.4	5.8	6.4	5.6
Liberty A 110 kV	6.3	20.3	17.7	5.1	21.2	20.1	6.1	15.6	14.0	5.1	17.4	16.7
Liberty B 110 kV	6.1	20.3	17.7	4.9	21.1	20.0	6.0	15.6	14.0	5.0	17.4	16.6
Limerick 110 kV	5.3	18.2	16.1	6.8	14.0	13.5	5.6	15.9	14.3	7.0	12.8	12.4
Lisdrum 110 kV	2.7	5.4	5.0	4.1	4.4	4.3	2.8	5.0	4.7	4.1	4.3	4.2
Lisheen 110 kV	5.1	5.3	4.4	5.1	7.9	7.2	5.0	4.8	4.0	5.1	7.2	6.6
Lodgewood 110 kV	8.8	9.5	8.9	9.0	11.2	10.9	9.0	8.6	8.0	9.1	10.2	9.9
Lodgewood 220 kV	8.8	8.5	7.9	10.0	7.8	7.6	9.1	7.4	6.9	10.2	6.9	6.8
Longpoint 220 kV	14.4	19.3	16.6	13.4	21.1	19.9	11.9	13.5	11.7	12.0	16.1	15.2
Louth 220 kV	11.0	22.3	20.1	12.4	25.9	24.9	9.9	15.2	13.2	10.9	18.6	17.5
Louth A 110 kV	6.8	14.3	13.2	7.9	16.8	16.2	6.8	12.3	11.1	7.8	14.7	14.1
Louth B 110 kV	7.4	15.5	14.3	8.4	18.7	18.1	7.3	13.0	11.9	8.2	16.1	15.5
Macetown 110 kV	7.2	20.4	18.7	7.1	18.9	18.3	7.0	15.5	14.0	7.0	15.6	15.0
Macroom 110 kV	6.3	14.1	12.7	7.2	13.5	13.1	6.8	13.1	11.6	7.6	12.8	12.3
Mallow 110 kV	5.1	7.2	6.7	7.0	5.7	5.6	5.2	6.4	6.1	7.0	5.2	5.2
Marina 110 kV	8.1	23.1	19.8	9.2	24.1	22.8	7.3	17.3	15.3	8.3	19.4	18.5
Maynooth A 110 kV	10.3	14.7	13.7	11.0	17.6	17.0	10.3	11.8	11.0	11.0	14.5	14.1
Maynooth A 220 kV	9.6	20.6	18.4	9.4	18.3	17.7	10.0	15.4	13.2	9.7	14.9	14.1

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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 B 110 kV	7.5	19.1	17.7	9.4	17.5	17.1	7.9	15.3	13.9	9.6	14.9	14.5
Maynooth B 220 kV	9.8	24.3	21.4	9.5	21.3	20.5	10.0	17.0	14.4	9.7	16.6	15.7
McDermott 110 kV	16.5	14.0	12.4	5.7	15.6	14.9	14.0	9.9	9.2	6.2	11.9	11.5
Meath Hill 110 kV	3.8	9.7	9.0	5.1	7.7	7.5	3.9	8.4	7.8	5.1	7.0	6.9
Meentycat 110 kV	4.3	5.8	4.6	5.4	5.1	4.8	4.5	5.1	3.9	5.6	4.8	4.3
Midleton 110 kV	3.5	11.7	10.8	4.6	8.7	8.6	3.7	10.0	9.3	4.7	7.9	7.7
Milltown A 110 kV	14.9	15.3	13.6	6.5	17.9	17.1	14.4	12.9	11.7	6.7	15.5	14.9
Milltown B 110 kV	8.7	12.3	11.3	4.0	14.4	13.9	8.8	10.3	9.6	4.2	12.4	12.0
Misery Hill 110 kV	13.3	14.9	13.3	7.2	17.6	16.8	12.9	12.6	11.4	7.4	15.3	14.7
Moneteen 110 kV	5.5	12.2	11.2	6.6	8.3	8.1	5.6	11.1	10.2	6.7	7.8	7.6
Moneypoint 110 kV	15.7	10.1	9.6	18.4	9.8	9.6	15.2	9.1	8.6	17.9	9.0	8.8
Moneypoint 220 kV	16.6	23.4	19.9	14.2	28.2	26.4	14.4	17.2	14.6	13.4	21.9	20.4
Moneypoint G1 400 kV	22.8	11.8	10.7	23.5	12.4	12.0	20.6	11.6	10.0	21.7	13.5	12.7
Moneypoint G2 400 kV	54.7	5.0	4.6	50.6	5.7	5.5	20.6	11.6	10.0	21.7	13.5	12.7
Moneypoint G3 400 kV	22.8	11.8	10.7	23.5	12.4	12.0	20.6	11.6	10.0	21.7	13.5	12.7
Monread 110 kV	3.9	8.5	7.9	4.8	8.1	7.9	4.0	7.0	6.6	4.8	7.0	6.9
Mount Lucas 110 kV	4.4	8.6	7.9	5.8	7.2	7.0	4.0	6.0	5.7	5.1	5.7	5.6
Moy 110 kV	4.6	7.4	6.3	5.8	7.1	6.7	3.7	5.6	4.8	4.6	5.8	5.5
Mullagharlin 110 kV	3.5	9.7	9.0	4.6	9.0	8.8	3.7	8.5	7.9	4.7	8.1	7.9
Mullingar 110 kV	3.4	7.7	7.2	4.9	7.0	6.9	3.4	6.5	6.2	4.7	6.2	6.1
Mulreavy 110 kV	5.6	8.9	6.8	4.6	10.8	9.5	5.4	7.0	5.0	5.7	7.7	6.7
Mungret A 110 kV	5.1	11.5	10.6	6.2	7.7	7.6	5.3	10.5	9.7	6.3	7.2	7.1
Mungret B 110 kV	5.1	11.6	10.6	6.2	7.7	7.6	5.2	10.5	9.7	6.3	7.2	7.1
Nangor 110 kV	15.4	13.9	12.0	7.7	16.0	15.0	14.7	11.6	10.1	7.8	13.7	13.0
Navan 110 kV	5.2	13.9	12.7	6.1	13.1	12.7	5.5	11.8	10.8	6.3	11.5	11.2
Nenagh 110 kV	2.7	3.9	3.6	4.0	2.0	2.0	2.7	3.6	3.4	4.0	1.9	1.9
Newbridge 110 kV	4.0	12.5	11.4	4.8	11.7	11.4	4.0	9.2	8.6	4.7	9.5	9.3
Newbury 110 kV	14.8	17.5	15.4	7.2	18.2	17.4	12.7	12.6	11.4	7.4	14.2	13.7
Nore 110 kV	4.8	9.7	9.2	6.1	10.4	10.2	3.5	6.4	6.1	4.2	7.5	7.3
North Kerry 220 kV	14.2	19.7	16.9	7.7	23.6	22.1	13.1	15.2	12.9	7.9	19.0	17.7
North Kerry A 110 kV	24.6	15.2	12.7	16.6	16.1	15.0	22.0	13.7	11.2	15.8	14.8	13.7
North Kerry B 110 kV	4.8	9.1	8.4	5.8	7.2	7.0	4.9	8.3	7.7	5.8	6.7	6.5
North Quays 110 kV	18.7	15.6	13.9	6.1	17.9	17.1	17.4	13.2	11.9	6.3	15.5	14.9
North Wall 220 kV	15.7	25.6	21.4	8.2	25.9	24.3	11.2	13.0	11.2	8.3	15.6	14.7
Oldcourt A 110 kV	3.8	11.9	11.1	4.6	8.8	8.6	4.0	10.1	9.5	4.7	7.9	7.7
Oldcourt B 110 kV	3.9	12.0	11.1	4.6	8.9	8.7	4.1	10.2	9.5	4.7	8.0	7.8

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Oldstreet 220 kV	15.5	11.8	10.9	12.4	12.3	12.0	13.4	8.3	7.7	11.6	9.4	9.2
Oldstreet 400 kV	15.7	9.4	8.8	9.8	8.2	8.1	13.7	7.7	7.0	9.4	7.2	7.0
Oughtragh 110 kV	3.6	4.9	4.5	4.8	3.0	3.0	3.7	4.5	4.2	4.8	2.9	2.8
Pelletstown 110 kV	13.7	13.0	11.7	7.5	13.4	12.9	12.6	9.5	8.8	7.8	10.5	10.2
Platin 110 kV	4.7	13.6	12.6	5.5	9.8	9.6	4.9	11.4	10.5	5.6	8.8	8.6
Pollaphuca 110 kV	3.2	3.2	3.1	4.6	2.7	2.6	3.3	3.0	2.9	4.7	2.5	2.5
Poolbeg A 110 kV	28.9	16.4	14.5	22.4	19.9	18.9	24.6	13.7	12.4	20.4	17.1	16.4
Poolbeg A 220 kV	16.3	25.6	21.4	6.8	24.2	22.7	11.7	13.1	11.3	7.5	14.9	14.1
Poolbeg B 110 kV	28.9	16.3	14.5	22.3	19.9	18.9	24.6	13.7	12.4	20.4	17.0	16.3
Poolbeg B 220 kV	13.5	26.1	21.8	9.3	27.6	25.8	12.1	17.6	14.6	9.4	20.3	18.8
Poolbeg C 110 kV	21.5	16.0	14.2	7.1	18.4	17.5	19.5	13.4	12.1	7.3	15.9	15.3
Poppintree 110 kV	13.9	17.4	15.4	8.0	18.5	17.7	12.2	12.6	11.3	8.1	14.4	13.9
Portan 260 kV	55.3	7.1	6.9	-	-	-	40.5	6.4	6.1	-	-	-
Portan 400 kV	18.2	12.1	11.2	-	-	-	15.6	8.9	8.0	-	-	-
Portlaoise 110 kV	4.2	13.7	12.7	5.3	12.2	11.9	4.6	11.2	10.3	5.5	10.6	10.4
Pottery 110 kV	17.6	12.9	11.5	5.6	12.6	12.1	16.5	10.6	9.7	5.7	10.9	10.6
Prospect 220 kV	13.0	19.0	16.7	8.5	18.8	18.0	12.2	14.4	12.5	8.7	15.4	14.6
Raffeen 220 kV	14.1	20.1	17.2	12.7	22.5	21.1	12.0	14.3	12.3	11.7	17.2	16.1
Raffeen A 110 kV	7.6	17.5	15.8	8.5	19.7	18.9	7.5	14.2	12.9	8.3	16.5	15.9
Raffeen B 110 kV	9.0	16.8	15.2	9.9	18.8	18.1	8.5	13.8	12.5	9.4	16.0	15.4
Rathkeale 110 kV	3.5	8.0	7.4	4.9	6.0	5.9	3.5	7.2	6.7	4.8	5.6	5.5
Ratrussan 110 kV	3.8	8.3	6.8	4.9	8.5	7.9	3.9	7.8	6.3	5.1	8.3	7.6
Reamore 110 kV	4.3	7.3	6.7	3.4	6.2	6.0	4.4	6.7	6.2	3.5	5.8	5.7
Richmond A 110 kV	3.0	7.7	7.1	4.1	6.8	6.6	2.9	6.4	6.0	3.9	6.0	5.9
Richmond B 110 kV	3.0	7.7	7.1	4.1	6.8	6.6	2.9	6.4	6.0	3.9	6.0	5.9
Rinawade 110 kV	4.7	11.7	11.1	5.8	8.1	8.0	4.9	9.9	9.3	6.0	7.3	7.2
Ringaskiddy 110 kV	5.8	13.6	12.5	6.2	12.5	12.2	5.9	11.5	10.6	6.2	11.0	10.7
Ringsend 110 kV	29.5	16.5	14.6	23.7	20.1	19.1	25.0	13.8	12.5	21.4	17.2	16.5
Ryebrook 110 kV	5.0	15.9	14.6	6.5	12.9	12.6	5.3	13.0	11.7	6.6	11.4	11.0
Salthill 110 kV	4.3	13.6	11.8	3.8	13.3	12.7	4.5	11.7	10.3	3.9	11.9	11.4
Screeb 110 kV	3.8	3.2	3.0	4.8	1.8	1.8	3.9	2.9	2.8	4.8	1.7	1.7
Seal Rock A 110 kV	7.9	10.5	9.3	9.7	10.9	10.5	8.1	10.0	8.9	9.9	10.7	10.2
Seal Rock B 110 kV	8.0	10.5	9.3	9.7	10.9	10.5	8.2	10.0	8.9	9.9	10.7	10.2
Shankill 110 kV	3.5	9.1	7.8	4.7	7.9	7.5	3.6	8.5	7.4	4.8	7.4	7.1
Shannonbridge 110 kV	6.2	18.4	16.4	7.9	19.8	18.9	4.8	12.4	11.3	5.8	14.7	14.2
Shannonbridge 220 kV	7.3	7.8	7.4	10.0	6.5	6.4	6.5	6.5	6.1	8.9	5.8	5.7

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Shellybanks A 220 kV	15.9	25.6	21.4	6.6	28.1	26.2	11.5	13.1	11.3	7.4	16.4	15.4
Shellybanks B 220 kV	14.7	25.2	21.0	9.6	29.0	26.9	12.7	16.9	14.1	9.7	20.9	19.3
Shelton Abbey 110 kV	7.4	8.4	7.9	7.4	8.6	8.4	7.5	7.6	7.1	7.5	7.8	7.7
Singland 110 kV	6.8	17.4	15.7	8.1	13.3	13.0	7.0	15.4	13.9	8.3	12.4	12.0
Sligo 110 kV	3.9	10.5	8.9	4.6	9.3	8.9	3.9	9.6	8.3	4.6	8.7	8.3
Somerset 110 kV	2.9	8.3	7.8	4.0	5.1	5.1	2.9	6.9	6.5	3.9	4.6	4.5
Sorne Hill 110 kV	3.5	3.1	2.6	4.2	3.2	3.0	3.7	2.9	2.4	4.4	3.0	2.8
Srananagh 110 kV	5.1	12.3	10.1	6.0	12.8	11.9	5.0	11.3	9.5	5.9	11.8	11.0
Srananagh 220 kV	7.9	6.2	5.3	9.2	5.1	4.9	7.9	4.9	4.4	9.6	4.0	3.8
Stevenstown 110 kV	4.0	6.8	6.3	4.7	4.2	4.1	4.3	5.7	5.4	4.8	3.8	3.8
Stratford 110 kV	3.2	4.8	4.5	4.3	3.5	3.4	3.4	4.3	4.1	4.4	3.2	3.2
Suir 110 kV	5.9	11.4	10.0	7.3	11.6	11.1	4.5	8.1	7.4	5.5	9.2	8.9
Taney 110 kV	8.7	11.0	9.9	3.2	10.4	10.0	8.8	9.2	8.5	3.3	9.1	8.9
Tarbert 110 kV	34.9	16.8	15.4	35.8	16.0	15.5	25.1	12.1	11.4	27.8	12.9	12.6
Tarbert 220 kV	15.7	22.8	19.4	14.7	26.8	25.1	12.9	16.2	13.8	12.7	20.2	18.9
Tawnaghmore A 110 kV	3.9	5.5	4.9	5.3	4.8	4.6	3.2	4.2	3.8	4.2	4.0	3.9
Tawnaghmore B 110 kV	4.0	5.6	5.0	5.4	5.0	4.8	3.2	4.2	3.8	4.2	4.2	4.0
Thornsberry 110 kV	3.7	7.5	6.9	5.1	6.6	6.4	3.7	5.5	5.3	4.8	5.3	5.2
Thurles 110 kV	6.4	6.8	5.7	6.7	6.9	6.5	6.2	6.0	5.1	6.5	6.3	5.9
Tievebrack 110 kV	3.8	4.3	3.6	5.1	2.9	2.8	3.9	3.9	3.2	5.1	2.8	2.6
Tipperary 110 kV	5.7	8.5	7.8	6.6	5.4	5.3	5.2	7.1	6.6	6.2	4.9	4.8
Tonroe 110 kV	2.6	3.5	3.3	3.8	2.1	2.1	2.7	3.3	3.1	3.8	2.0	2.0
Trabeg 110 kV	8.1	22.8	19.6	9.0	23.5	22.2	7.4	17.2	15.3	8.3	19.1	18.2
Tralee 110 kV	5.0	9.7	8.7	6.0	8.0	7.7	5.1	8.8	7.9	6.1	7.4	7.2
Trien A 110 kV	4.5	8.4	7.7	5.7	7.2	7.0	4.6	7.7	7.1	5.8	6.7	6.5
Trien B 110 kV	12.0	11.1	9.2	9.1	10.3	9.7	11.9	10.3	8.3	9.1	9.7	9.0
Trillick 110 kV	3.6	3.4	2.8	4.4	3.2	3.0	3.8	3.1	2.5	4.5	3.0	2.8
Trinity 110 kV	11.6	14.5	12.9	6.0	17.0	16.2	11.5	12.3	11.1	6.2	14.7	14.2
Tullabrack 110 kV	6.7	7.6	7.2	7.4	5.7	5.6	6.7	6.9	6.5	7.4	5.3	5.2
Turlough 220 kV	10.6	13.7	12.4	12.0	11.7	11.4	11.2	11.6	10.1	12.4	10.5	10.0
Tynagh 220 kV	14.8	13.2	11.8	16.5	14.1	13.5	10.4	7.9	7.4	11.6	9.6	9.3
Uggool 110 kV	7.7	8.4	6.7	8.7	9.4	8.6	7.9	8.0	6.3	8.9	9.1	8.2
Waterford 110 kV	6.6	14.1	12.9	6.9	14.9	14.4	6.8	12.0	11.2	7.1	13.0	12.7
West Galway A 110 kV	4.7	6.4	5.9	5.0	4.3	4.3	4.8	5.8	5.4	5.1	4.1	4.0
West Galway B 110 kV	6.4	9.3	7.8	7.0	8.3	7.8	6.6	8.6	7.2	7.1	7.8	7.4
Wexford 110 kV	4.0	7.3	6.5	5.3	6.5	6.3	4.1	6.7	6.0	5.4	6.0	5.8

Table E-4 Short Circuit Currents for Maximum and Minimum Demand in 2020 (continued)

Bus	Winter Peak 2020						Summer Valley 2020					
	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]
Whitegate 110 kV	4.3	11.0	10.3	5.2	10.8	10.6	4.5	9.4	8.8	5.3	9.6	9.4
Wolfe Tone 110 kV	14.3	13.6	12.2	5.2	15.0	14.4	12.8	9.7	9.0	5.7	11.5	11.2
Woodhouse 110 kV	5.9	6.6	6.1	7.3	4.7	4.6	6.0	5.9	5.6	7.4	4.3	4.3
Woodland 220 kV	12.9	27.4	24.0	12.1	26.9	25.7	12.3	16.9	14.4	11.7	18.7	17.7
Woodland 400 kV	18.3	12.3	11.4	15.7	11.4	11.1	15.6	9.0	8.0	14.3	8.9	8.6

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	18.4 kA – 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 2014, 2017 and 2020:

- **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 2014

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV											
Ballylumford	26.5	66.3	35.65	8.78	21.74	7.74	8.89	10.54	26.29	9.74	11.40
Castlereagh	31.5	79	35.65	8.8	21.65	7.74	8.76	10.43	25.76	9.62	10.94
Coolkeeragh	31.5	79	35.3	8.77	21.66	7.83	9.15	9.61	24.02	9.03	10.76
Hannahstown	31.5	79	35.65	8.56	21.07	7.55	8.53	10.08	24.91	9.32	10.62
Kells	31.5	79	35.65	9.54	23.72	8.37	9.75	11.02	27.39	10.18	11.80
Kilroot	31.5	79	45.3	9.38	23.44	8.23	9.76	10.10	25.15	9.41	11.00
Magherafelt	31.5	79	35.65	10.24	25.45	8.96	10.38	10.54	25.61	9.81	10.55
Moyle	31.5	79	35.65	8.69	21.53	7.68	8.80	10.45	26.09	9.67	11.32
Tandragee	26.5	66.3	35.65	10.83	26.73	9.44	10.75	12.28	30.15	11.31	12.77
Tamnamore	31.5	79	57.3	9.16	22.65	8.12	9.13	9.15	22.26	8.59	9.27
110kV											
Aghyoule	25	62.5		3.87	8.10	3.65	3.75	3.94	8.75	3.79	4.03
Antrim	18.4	46.8		8.11	17.52	7.66	7.78	8.53	18.60	8.26	8.57
Ballylumford*	21.9	55	25.88	14.72	36.06	13.41	16.19				
	26.2	65	29.7					18.04	44.75	17.00	20.90
Ballymena	18.4	46.8		7.83	17.05	7.40	7.56	8.43	18.80	8.15	8.61
Banbridge	18.4	46.8		6.02	12.68	5.77	5.82	6.12	13.53	5.98	6.21
Ballyvallagh	18.4	46.8	23	11.88	26.40	10.96	11.06	11.96	26.22	11.45	11.55
Ballynahinch	18.4	46.8		5.18	10.98	4.95	5.01	5.35	11.79	5.22	5.43
Carnmoney	26.2	65	44.9	7.36	15.43	6.98	7.04	7.63	16.50	7.41	7.63
Castlereagh	26.2	65	33.5	13.73	34.01	12.40	14.76	18.16	45.29	16.86	20.14
Belfast Central	31.5	79		11.58	27.75	10.60	11.49	14.47	32.32	13.62	14.66
Coleraine	31.5	79	42.5	7.48	15.65	6.96	6.97	8.64	18.72	8.23	8.30
Coolkeeragh	31.5	80	33.5	17.14	42.07	15.31	18.59	21.29	52.64	19.81	24.15
Creagh	31.5	80	33.5	6.98	14.22	6.65	6.65	7.54	16.12	7.33	7.38
Cregagh	26.2	65		12.65	30.72	11.50	12.86	16.22	38.13	15.16	16.67
Donegall North	31.5	79	33.5	11.98	28.62	10.98	12.00	15.35	34.73	14.44	15.23
Donegall South				9.76	22.24	9.08	9.33	11.15	24.60	10.65	11.00
Drumnakelly	31.5	79	42.5	15.37	36.31	13.90	15.00	17.48	41.38	16.42	17.92
Dungannon	18.4	46.8	23	13.68	30.87	12.49	13.01	13.92	32.07	13.21	14.21
Eden	25	62.5	45	8.05	17.01	7.62	7.68	8.31	17.99	8.07	8.27
Enniskillen	25	62.5	33.5	7.63	15.83	7.07	7.08	9.10	19.73	8.61	8.66

Table E-6 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2014 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV											
Finaghy	31.5	79		12.25	29.65	11.22	12.58	16.06	37.33	15.07	16.24
Glengormley	18.4	46.8		4.98	10.02	4.79	4.79	5.03	10.62	4.92	4.97
Hannahstown	31.5	80	33.5	13.21	32.38	12.03	14.07	17.63	43.44	16.45	19.39
Kells*	21.9	55.9	27.4	14.57	35.15	13.24	15.57				
	26.2	65	29.7					18.85	45.85	17.63	20.90
Killymallaght	40	100		10.97	25.14	10.17	10.47	10.89	24.62	10.48	11.05
Knock	18.4	46.8		12.08	26.66	11.03	11.21	13.28	26.48	12.58	13.36
Larne	18.4	46.8	42.5	7.96	17.12	7.50	7.53	7.96	17.65	7.71	7.89
Limavady	18.4	46.8	23	6.89	14.31	6.47	6.48	7.47	16.15	7.18	7.26
Lisburn	18.4	46.8	23	9.73	21.64	9.07	9.22	10.26	22.48	9.85	10.21
Lisaghmore	18.4	46.8		8.91	19.22	8.35	8.46	8.90	19.50	8.61	8.95
Loguestown	18.4	46.8		5.43	11.08	5.15	5.16	5.96	12.64	5.76	5.80
Magherakeel	40	100		3.64	7.87	3.55	3.58	4.07	9.11	4.00	4.04
Newtownards	40	100		6.93	15.05	6.56	6.64	6.88	15.53	6.67	6.94
Newry	18.4	46.8	23	5.12	10.68	4.92	4.97	5.20	11.37	5.08	5.27
Omagh	40	100	42.5	11.92	25.58	10.85	10.92	12.11	26.78	11.45	11.75
PSW	18.4	46.8		10.54	23.04	9.75	9.98	11.31	23.52	10.81	11.79
Rathgael	18.4	46.8		5.52	11.72	5.27	5.32	5.66	12.45	5.51	5.72
Rosebank	40	100		13.09	31.77	11.87	13.29	17.04	41.18	15.88	17.62
Slieve Kirk	40	100		8.14	17.71	7.69	7.78	7.76	17.44	7.55	7.84
Springtown	31.5	79	33.6	9.05	19.68	8.49	8.62	9.22	20.32	8.92	9.27
Strabane	18.4	46.8	23	13.36	29.60	12.13	12.28	14.67	33.32	13.87	14.42
Tandragee	31.5	79	33.6	16.55	40.23	14.89	17.42	20.54	50.42	19.11	22.67
Tamnamore	40	100	45	11.93	28.09	11.05	12.66	11.22	27.02	10.79	12.68
Waringstown	18.4	46.8		7.44	16.39	7.06	7.18	7.42	16.75	7.21	7.56

Table E-7 Northern Ireland Short Circuit Current Levels for Winter Peak 2014

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV											
Ballylumford	26.5	66.3	35.65	21.65	56.09	19.02	25.56	25.3	65.9	23.5	31.45
Castlereagh	31.5	79	35.65	16.86	41.97	14.92	17.12	17.28	42.94	16.06	18.45
Coolkeeragh	31.5	79	35.3	12.55	30.41	11.55	12.87	12.54	31.06	12.04	13.90
Hannahstown	31.5	79	35.65	16.91	42.25	14.99	17.38	17.47	43.6	16.32	19.14
Kells	31.5	79	35.65	19.24	48.82	17.07	20.58	19.5	48.74	18.35	21.16
Kilroot	31.5	79	45.3	18.9	48.45	16.74	21.07	22.46	58.13	20.95	26.92
Magherafelt	31.5	79	35.65	18.59	46.76	16.62	19.21	15.69	37.81	14.94	15.66
Moyle	31.5	79	35.65	21.08	54.48	18.57	24.57	24.32	63.08	22.65	29.56
Tandragee	26.5	66.3	35.65	19.07	47.31	16.93	19.04	18.59	45.61	17.49	19.53
Tamnamore	31.5	79	57.3	14.75	36.61	13.43	14.81	12.42	30.07	11.92	12.64
110kV											
Aghyoule	25	62.5		3.99	8.33	3.74	3.84	4.03	8.95	3.86	4.11
Antrim	18.4	46.8		9.77	20.66	9.32	9.42	9.70	20.86	9.43	9.75
Ballylumford*	21.9	55	25.88	23.85	59.48	22.33	29.17				
	26.2	65	29.7					28.01	70.80	27.21	35.86
Ballymena	18.4	46.8		9.44	20.17	8.97	9.11	9.67	21.37	9.37	9.86
Banbridge	18.4	46.8		6.82	14.13	6.55	6.59	6.68	14.65	6.50	6.73
Ballyvallagh	18.4	46.8	23	16.39	35.41	15.37	15.42	14.83	31.84	14.34	14.40
Ballynahinch	18.4	46.8		5.98	12.46	5.70	5.75	5.93	12.95	5.75	5.98
Carnmoney	26.2	65	44.9	9.02	18.43	8.60	8.65	8.81	18.80	8.57	8.80
Castlereagh	26.2	65	33.5	20.73	51.20	18.43	22.75	26.14	65.11	23.86	29.41
Belfast Central	31.5	79		16.17	38.25	14.71	15.82	19.00	41.31	17.74	19.07
Coleraine	31.5	79	42.5	8.87	18.57	8.19	8.23	9.90	21.53	9.35	9.50
Coolkeeragh	31.5	80	33.5	22.61	55.42	20.35	24.71	27.14	67.18	25.35	30.98
Creagh	31.5	80	33.5	8.11	16.14	7.73	7.73	8.45	17.85	8.20	8.24
Cregagh	26.2	65		18.37	44.15	16.51	18.47	22.23	51.34	20.52	22.56
Donegall North	31.5	79	33.5	18.58	44.22	17.04	18.41	22.39	49.26	21.05	21.92
Donegall South				13.77	30.76	12.88	13.08	14.47	31.20	13.88	14.24
Drumnakelly	31.5	79	42.5	21.41	49.69	19.46	20.70	22.46	52.54	21.16	22.95
Dungannon	18.4	46.8	23	17.32	38.20	15.97	16.44	16.37	37.31	15.64	16.72
Eden	25	62.5	45	10.14	20.85	9.68	9.72	9.76	20.79	9.51	9.71
Enniskillen	25	62.5	33.5	8.36	17.17	7.69	7.70	9.83	21.20	9.23	9.29

Table E-7 Northern Ireland Short Circuit Current Levels for Winter Peak 2014 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Finaghy	31.5	79		19.27	46.79	17.63	19.81	24.01	54.83	22.50	23.99
Glengormley	18.4	46.8		5.60	11.06	5.40	5.40	5.44	11.39	5.31	5.35
Hannahstown	31.5	80	33.5	21.72	53.88	19.70	23.97	27.72	69.13	25.77	31.60
Kells*	21.9	55.9	27.4	20.90	50.23	19.23	23.08				
	26.2	65	29.7					25.81	62.69	24.34	29.44
Killymallaght	40	100		12.48	28.16	11.74	11.96	10.81	24.34	10.49	11.16
Knock	18.4	46.8		17.08	36.14	15.45	15.58	16.75	32.20	15.78	16.76
Larne	18.4	46.8	42.5	9.77	20.55	9.31	9.33	9.16	20.10	8.91	9.08
Limavady	18.4	46.8	23	7.73	15.85	7.25	7.26	8.13	17.48	7.80	7.89
Lisburn	18.4	46.8	23	13.16	28.49	12.35	12.45	12.66	27.22	12.20	12.59
Lisaghmore	18.4	46.8		10.19	21.63	9.64	9.73	9.75	21.16	9.46	9.79
Loguestown	18.4	46.8		6.13	12.47	5.77	5.78	6.54	13.88	6.27	6.33
Magherakeel	40	100		3.89	8.42	3.76	3.80	4.31	9.72	4.20	4.26
Newtownards	40	100		8.35	17.72	7.90	7.96	7.79	17.43	7.55	7.83
Newry	18.4	46.8	23	5.78	11.93	5.52	5.56	5.70	12.43	5.53	5.73
Omagh	40	100	42.5	13.62	28.68	12.47	12.52	13.31	29.17	12.58	12.89
PSW	18.4	46.8		15.25	32.06	14.16	14.33	14.51	29.31	13.93	15.10
Rathgael	18.4	46.8		6.41	13.36	6.10	6.14	6.28	13.69	6.09	6.31
Rosebank	40	100		19.29	46.29	17.27	19.33	23.82	56.99	21.89	24.28
Slieve Kirk	40	100		8.91	19.03	8.53	8.58	5.49	10.59	5.42	5.42
Springtown	31.5	79	33.6	10.37	22.20	9.83	9.94	10.12	22.07	9.84	10.18
Strabane	18.4	46.8	23	15.51	33.61	14.26	14.35	16.30	36.61	15.49	15.96
Tandragee	31.5	79	33.6	23.87	57.45	21.55	25.41	27.80	67.90	25.93	31.09
Tamnamore	40	100	45	14.63	34.07	13.77	15.75	12.71	30.50	12.33	14.53
Waringstown	18.4	46.8		8.73	18.90	8.30	8.41	8.28	18.56	8.03	8.40

Table E-8 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2017

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
275kV											
Ballylumford	26.5	66.3	35.65	9.44	23.51	8.37	9.63	11.20	28.06	10.37	12.18
Castlereagh	31.5	79	35.65	9.43	23.36	8.33	9.49	11.06	27.45	10.22	11.66
Coolkeeragh	31.5	79	35.3	9.54	23.62	8.57	10.00	10.36	26.01	9.76	11.69
Hannahstown	31.5	79	35.65	9.18	22.72	8.13	9.24	10.88	27.05	10.05	11.56
Kells	31.5	79	35.65	10.25	25.68	9.04	10.59	11.65	29.13	10.80	12.55
Kilroot	31.5	79	45.3	10.04	25.26	8.86	10.57	10.69	26.73	9.97	11.72
Magherafelt	31.5	79	35.65	11.23	28.05	9.87	11.44	11.15	27.17	10.42	11.19
Moyle	31.5	79	35.65	9.35	23.26	8.29	9.52	11.11	27.83	10.29	12.09
Tandragee	26.5	66.3	35.65	11.67	28.97	10.24	11.69	13.00	32.10	12.02	13.63
Tamnamore	31.5	79	57.3	11.24	27.95	9.89	11.31	10.96	26.85	10.24	11.30
110 kV											
Aghyoule	25	62.5		4.16	8.83	3.95	4.13	4.16	9.37	4.03	4.40
Antrim	18.4	46.8		7.76	16.65	7.33	7.47	8.25	17.91	7.97	8.29
Ballylumford*	21.9	55	25.88	15.35	37.70	14.03	16.99				
	26.2	65	29.7					18.69	46.46	17.63	21.77
Ballymena	18.4	46.8		7.52	16.30	8.42	7.10	8.18	18.17	7.88	8.37
Banbridge	18.4	46.8		5.87	12.51	6.55	5.65	6.01	13.39	5.88	6.12
Ballyvallagh	18.4	46.8	23	11.95	26.46	6.54	11.05	11.99	26.23	11.48	11.58
Ballynahinch	18.4	46.8		5.26	11.14	6.89	5.05	5.41	11.91	5.28	5.49
Belfast Central	31.5	79		12.12	29.15	12.38	11.12	15.12	33.72	14.23	15.38
Belfast North	18.4	46.8		12.11	26.80	8.25	11.20	12.85	25.75	12.27	13.37
Carnmoney	26.2	65	44.9	7.55	15.80	6.55	7.18	7.79	16.83	7.56	7.79
Castlereagh	26.2	65	33.5	14.44	35.94	18.39	13.07	19.14	47.91	17.75	21.35
Coleraine	31.5	79	42.5	8.74	19.10	7.15	8.05	9.84	22.11	9.30	9.60
Coolkeeragh	31.5	80	33.5	19.90	49.06	18.77	17.80	24.87	61.86	23.14	28.26
Creagh	31.5	80	33.5	7.13	14.53	4.15	6.80	7.69	16.44	7.48	7.54
Cregagh	26.2	65		13.27	32.36	14.23	12.09	17.00	40.00	15.89	17.52
Donegall north	31.5	79	33.5	13.62	32.89	12.54	12.48	17.21	38.86	16.18	17.07
Donegall south				10.82	24.70	7.98	10.08	12.11	26.64	11.58	11.92
Drumnakelly	31.5	79	42.5	13.61	33.01	12.70	12.53	15.56	37.71	14.75	16.35
Dungannon	18.4	46.8	23	10.92	25.13	9.10	10.20	11.42	26.88	10.96	11.76

Table E-8 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2017 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Eden	25	62.5	45	8.26	17.40	6.19	7.83	8.46	18.28	8.21	8.41
Enniskillen	25	62.5	33.5	8.55	18.05	5.98	7.94	10.00	22.09	9.49	9.65
Finaghy	31.5	79		13.96	34.23	14.14	12.78	18.16	42.39	17.03	18.25
Glengormley	18.4	46.8		4.83	9.70	4.10	4.65	4.92	10.36	4.81	4.86
Gort Cluster	40	100		7.75	18.09	8.65	7.31	7.28	16.95	7.04	7.70
Hannahstown	31.5	80	33.5	15.22	37.94	17.51	13.83	20.19	50.59	18.81	22.44
Kells*	21.9	55.9	27.4	13.42	31.68	16.22	12.27				
	26.2	65	29.7					17.53	41.80	16.39	19.17
Killymallaght	40	100		12.05	27.52	8.06	11.22	10.61	24.05	10.26	10.98
Knock	18.4	46.8		12.63	27.81	7.38	11.56	13.77	27.37	13.05	13.90
Larne	18.4	46.8	42.5	7.97	17.11	5.51	7.54	7.96	17.63	7.71	7.89
Limavady	18.4	46.8	23	7.55	16.13	5.25	7.09	7.98	17.65	7.67	7.83
Lisburn	18.4	46.8	23	10.43	23.23	7.05	9.75	10.79	23.64	10.38	10.74
Lisaghmore	18.4	46.8		9.57	20.49	6.76	9.02	9.37	20.41	9.10	9.43
Loguestown	18.4	46.8		6.13	12.87	6.02	5.77	6.52	14.16	6.27	6.40
Magherakeel	40	100		4.46	10.06	10.28	4.26	4.83	11.35	4.67	5.04
Newtownards	40	100		6.85	14.76	7.25	6.41	6.72	14.83	6.45	6.79
Newry	40	100		7.10	15.38	6.80	6.73	6.99	15.76	6.79	7.06
Omagh	18.4	46.8	23	7.19	15.21	4.92	6.83	7.49	16.72	7.26	7.46
PSW	40	100	42.5	14.13	31.51	7.58	12.87	14.46	32.67	13.64	14.33
Rathgael	18.4	46.8		5.62	11.92	6.61	5.37	5.72	12.58	5.58	5.79
Rosebank	40	100		13.54	33.29	15.50	12.32	17.62	43.78	16.43	19.18
Slieve Kirk	40	100		8.68	18.75	6.43	8.24	5.42	10.50	5.33	5.33
Springtown	31.5	79	33.6	9.75	21.03	6.98	9.19	9.74	21.33	9.45	9.79
Strabane	18.4	46.8	23	14.87	32.77	6.34	13.58	15.86	35.98	15.07	15.60
Tandragee	31.5	79	33.5	15.41	38.59	18.89	14.07	19.27	48.61	18.08	22.07
Tamnamore	40	100	45	15.55	38.10	17.41	14.26	16.35	40.34	15.52	18.43
Tremoge Cluster	40	100		8.60	18.67	7.34	8.11	7.99	17.73	7.74	8.18
Waringstown	18.4	46.8		7.21	16.10	7.74	6.88	7.25	16.54	7.07	7.43

Table E-9 Northern Ireland Short Circuit Current Levels for Winter Peak 2017

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
400 kV											
Turleenan				10.54	26.85	16.16	11.29	10.81	26.95	10.37	11.60
275kV											
Ballylumford	26.5	66.3	35.65	18.6	47.60	16.47	20.71	20.85	53.68	19.43	24.77
Castlereagh	31.5	79	35.65	16.37	40.81	14.47	16.61	16.97	42.26	15.79	18.16
Coolkeeragh	31.5	79	35.3	13.05	33.39	12.02	14.37	12.85	33.01	12.32	15.14
Hannahstown	31.5	79	35.65	16.06	40.12	14.23	16.42	16.76	41.91	15.62	18.27
Kells	31.5	79	35.65	18.84	47.89	16.72	20.20	19.13	47.89	17.95	20.79
Kilroot	31.5	79	45.3	18.71	48.05	16.57	20.92	22.26	57.69	20.74	26.73
Magherafelt	31.5	79	35.65	19.46	49.39	17.38	20.64	16.16	39.17	15.35	16.23
Moyle	31.5	79	35.65	18.2	46.52	16.15	20.12	20.31	52.18	18.95	23.87
Tandragee	26.5	66.3	35.65	20.2	50.48	17.89	20.45	19.65	48.42	18.40	20.76
Tamnamore	31.5	79	57.3	19.92	50.12	17.78	20.57	16.96	41.40	16.07	17.70
Turleenan				20.2	50.79	15.63	20.82	17.44	42.54	16.51	18.15
110 kV											
Aghyoule	25	62.5		4.18	8.82	3.96	4.13	4.15	9.30	4.01	4.37
Airport Road	40	100		11.18	24.34	10.42	10.56	11.29	24.88	10.81	11.23
Antrim	18.4	46.8		9.85	20.83	9.38	9.49	9.73	20.95	9.46	9.78
Ballylumford*	21.9	55	25.88	23.53	58.50	21.58	27.95				
	26.2	65	29.7					27.62	69.63	26.23	34.37
Ballymena	18.4	46.8		9.53	20.42	7.61	9.19	9.73	21.55	9.42	9.95
Banbridge	18.4	46.8		6.6	13.84	6.19	6.38	6.51	14.39	6.36	6.60
Ballyvallagh	18.4	46.8	23	16.29	35.15	5.34	15.26	14.74	31.62	14.24	14.30
Ballynahinch	18.4	46.8		5.99	12.49	6.63	5.74	5.94	12.99	5.76	5.99
Belfast Central	31.5	79		16.24	38.51	11.82	15.94	19.17	41.66	17.84	19.28
Belfast North	18.4	46.8		15.75	33.82	7.34	14.80	15.24	29.60	14.56	15.78
Carnmoney	26.2	65	44.9	8.96	18.32	6.11	8.59	8.77	18.74	8.54	8.77
Castlereagh	26.2	65	33.5	20.75	51.31	20.18	22.80	26.40	65.80	24.04	29.67
Coleraine	31.5	79	42.5	9.45	20.49	6.86	8.77	10.49	23.44	9.86	10.16
Coolkeeragh	31.5	80	33.5	23.21	58.32	23.18	26.73	27.67	69.93	25.80	32.96
Creagh	31.5	80	33.5	8.34	16.69	3.65	7.97	8.64	18.31	8.40	8.44
Cregagh	26.2	65		18.41	44.34	14.04	18.57	22.43	51.76	20.65	22.75

Table E-9 Northern Ireland Short Circuit Current Levels for Winter Peak 2017 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Donegall North	31.5	79	33.5	18.48	44.25	12.02	18.33	22.15	48.89	20.77	21.78
Donegall South				13.71	30.72	7.23	12.98	14.39	31.12	13.78	14.13
Drumnakelly	31.5	79	42.5	17.98	43.10	11.94	17.82	19.25	46.27	18.16	20.04
Dungannon	18.4	46.8	23	14.4	33.46	9.82	14.08	13.91	33.10	13.37	14.63
Eden	25	62.5	45	10.05	20.66	5.60	9.62	9.70	20.67	9.45	9.65
Enniskillen	25	62.5	33.5	8.99	18.84	5.83	8.38	10.41	22.90	9.85	10.00
Finaghy	31.5	79		19.14	46.74	14.16	19.62	23.80	54.69	22.24	23.69
Glengormley	18.4	46.8		5.61	11.09	3.55	5.42	5.43	11.37	5.32	5.36
Gort Cluster	40	100		8.36	19.53	9.04	8.20	7.60	17.70	7.37	8.12
Hannahstown	31.5	80	33.5	21.55	53.84	19.27	23.72	27.42	68.95	25.42	31.18
Kells*	21.9	55.9	27.4	21.16	50.95	18.63	23.27				
	26.2	65	29.7					25.97	63.21	24.39	29.55
Killymallaght	40	100		12.31	28.05	7.78	11.84	10.60	24.08	10.29	11.00
Knock	18.4	46.8		17.08	36.15	6.48	15.56	16.80	32.20	15.78	16.79
Larne	18.4	46.8	42.5	9.71	20.41	4.82	9.28	9.12	20.00	8.89	9.06
Limavady	18.4	46.8	23	7.99	16.94	5.02	7.51	8.32	18.34	7.97	8.12
Lisburn	18.4	46.8	23	13.26	30.34	8.17	12.71	12.40	28.30	11.95	12.52
Lisaghmore	18.4	46.8		10.33	22.07	6.60	9.86	9.85	21.47	9.56	9.90
Loguestown	18.4	46.8		6.46	13.47	5.87	6.08	6.79	14.69	6.50	6.62
Magherakeel	40	100		4.49	10.11	10.17	4.51	4.85	11.37	4.69	5.05
Mid-Antrim	40	100		7.38	15.73	6.86	7.02	7.06	15.50	6.80	7.13
Newtownards	40	100		8.35	17.73	6.37	7.95	7.81	17.45	7.56	7.84
Newry	18.4	46.8	23	5.66	11.82	6.75	5.47	5.60	12.29	5.44	5.66
Omagh	40	100	42.5	15.26	33.74	7.35	14.25	15.18	34.17	14.37	15.08
Rathgael	18.4	46.8		6.41	13.37	6.30	6.14	6.29	13.71	6.10	6.32
Rosebank	40	100		18.92	46.07	15.74	19.59	23.58	58.27	21.66	25.60
Slieve Kirk	40	100		8.82	18.98	6.18	8.51	5.43	10.53	5.35	5.35
Springtown	31.5	79	33.6	10.77	23.41	7.60	10.36	10.36	22.85	10.05	10.51
Strabane	18.4	46.8	23	14.19	31.00	6.02	13.31	13.86	30.98	13.31	13.81
Tandragee	31.5	79	33.5	21.16	52.81	20.10	23.57	25.14	63.35	23.42	29.14
Tamnamore	40	100	45	19.16	47.16	19.51	21.54	19.10	47.34	18.26	22.20
Tremoge Cluster	40	100		9.14	19.65	7.02	8.82	8.29	18.30	8.06	8.49
Waringstown	18.4	46.8		8.36	18.40	7.35	8.08	8.05	18.21	7.81	8.19

Table E-10 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2020

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
400 kV											
Turleenan				8.62	21.89	7.77	9.12	9.40	23.45	8.83	10.05
275kV											
Ballylumford	26.5	66.3	35.65	11.86	30.05	10.65	12.72	13.68	34.76	12.77	15.53
Castlereagh	31.5	79	35.65	11.11	27.77	9.95	11.41	12.60	31.49	11.75	13.50
Coolkeeragh	31.5	79	35.3	10.12	25.66	9.21	10.82	10.45	26.58	9.90	11.92
Hannahstown	31.5	79	35.65	10.9	27.27	9.79	11.23	12.44	31.17	11.61	13.50
Kells	31.5	79	35.65	12.33	31.19	10.99	13.06	13.37	33.64	12.49	14.66
Kilroot	31.5	79	45.3	11.74	29.80	10.50	12.57	11.84	29.71	11.15	13.10
Magherafelt	31.5	79	35.65	13.46	34.09	11.95	14.23	12.69	31.05	11.92	12.84
Moyle	31.5	79	35.65	11.7	29.62	10.52	12.51	13.50	34.29	12.61	15.30
Tandragee	26.5	66.3	35.65	13.96	35.05	12.32	14.33	15.05	37.34	13.96	15.96
Tamnamore	31.5	79	57.3	14.02	35.35	12.40	14.59	13.61	33.53	12.72	14.30
Turleenan	31.5	79	35.65	14.18	35.77	12.53	14.75	13.98	34.46	13.05	14.70
110 kV											
Aghyoule	25	62.5		4.2	8.93	3.96	4.14	4.19	9.45	4.03	4.41
Airport Road	40	100		9.6	21.36	9.11	9.26	10.14	22.66	9.82	10.21
Antrim	18.4	46.8		8.98	19.26	8.55	8.66	9.13	19.83	8.87	9.19
Ballylumford*	21.9	55	25.88	17.12	42.23	15.88	19.64				
	26.2	65	29.7					20.43	51.05	19.46	24.57
Ballymena	18.4	46.8		8.65	18.74	8.23	8.39	9.03	20.13	8.76	9.26
Banbridge	18.4	46.8		6.08	12.92	5.89	5.94	6.13	13.62	6.02	6.26
Ballyvallagh	18.4	46.8	23	13.5	29.73	12.63	12.71	13.00	28.30	12.53	12.61
Ballynahinch	18.4	46.8		5.43	11.43	5.25	5.30	5.50	12.07	5.40	5.61
Belfast central	31.5	79		13.01	31.34	12.12	13.12	16.03	35.56	15.25	16.38
Belfast North Main	18.4	46.8		13.02	28.63	12.21	12.45	13.50	26.77	13.01	14.09
Garvagh Cluster	40	100		4.89	11.19	4.69	4.81	4.91	11.43	4.77	5.12
Carnmoney	26.2	65	44.9	7.92	16.49	7.61	7.67	8.05	17.35	7.86	8.08
Castlereagh	26.2	65	33.5	15.77	39.50	14.50	17.57	20.67	52.06	19.40	23.54
Coleraine	31.5	80	33.5	9.34	20.58	8.66	8.77	10.42	23.52	9.87	10.18
Coolkeeragh	31.5	80	33.5	16.67	40.93	15.26	18.18	20.05	49.56	18.77	22.72
Creagh	31.5	80	33.5	7.68	15.57	7.39	7.39	8.12	17.32	7.93	7.98

Table E-10 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2020 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Cregagh	26.2	65		14.37	35.15	13.30	14.91	18.19	42.74	17.18	18.87
Donegall North	31.5	79	42.5	14.8	35.85	13.77	14.98	18.43	41.50	17.51	18.41
Donegall South				11.58	26.41	10.93	11.14	12.72	27.93	12.27	12.61
Drumnakelly	31.5	79	42.5	14.81	36.07	13.77	15.09	16.58	40.30	15.82	17.56
Drumquin Cluster	40	100		6.37	14.46	6.03	6.24	6.07	13.99	5.86	6.41
Dungannon	18.4	46.8	23	12.95	30.45	12.15	12.81	12.87	30.78	12.38	13.62
Eden	25	62.5	45	8.72	18.27	8.36	8.41	8.77	18.91	8.57	8.77
Enniskillen	25	62.5		8.94	19.03	8.28	8.35	10.50	23.28	9.92	10.13
Finaghy	31.5	79		15.23	37.55	14.15	15.89	19.55	45.68	18.52	19.80
Glengormley	18.4	46.8		8.13	19.16	7.67	7.98	7.52	17.60	7.26	8.06
Gort Cluster	40	100		5.28	10.55	5.12	5.12	5.20	10.94	5.11	5.15
Hannahstown	31.5	80	33.5	16.73	42.05	15.45	18.47	21.90	55.31	20.62	24.87
Kells*	21.9	55.9	27.4	17.5	42.63	16.06	19.14				
	26.2	65	29.7					22.03	54.05	20.68	24.88
Killymallaght	40	100		10.68	24.52	10.06	10.35	10.59	24.04	10.20	10.78
Knock	18.4	46.8		13.65	29.89	12.68	12.84	14.55	28.59	13.92	14.76
Larne	18.4	46.8	42.5	8.63	18.42	8.24	8.26	8.39	18.54	8.18	8.36
Limavady	18.4	46.8	23	7.51	16.09	7.09	7.11	7.92	17.56	7.62	7.78
Lisburn	18.4	46.8	23	11.3	26.25	10.69	11.00	11.15	25.70	10.81	11.35
Lisaghmore	18.4	46.8		8.74	18.89	8.31	8.42	8.71	19.14	8.44	8.77
Loguestown	18.4	46.8		6.41	13.49	6.06	6.09	6.75	14.69	6.50	6.62
Magherakeel	40	100		4.48	10.14	4.28	4.50	4.86	11.45	4.70	5.08
Mid-Antrim	40	100		9.15	20.61	8.55	8.81	9.22	20.83	8.83	9.35
Newtownards	40	100		7.42	16.02	7.11	7.18	7.20	16.21	7.03	7.30
Newry	18.4	46.8	23	5.21	10.98	5.06	5.12	5.25	11.57	5.16	5.37
Omagh	40	100	42.5	14.67	33.13	13.40	13.75	15.18	34.56	14.28	15.09
Omagh South	40	100	1000	11.22	24.29	10.38	10.52	11.10	23.98	10.56	10.66
Rathgael	18.4	46.8	1000	5.82	12.30	5.61	5.66	5.86	12.87	5.74	5.95
Rosebank	40	100		14.7	36.33	13.58	15.63	18.92	47.22	17.84	20.90
Slieve Kirk	40	100		7.97	17.38	7.62	7.71	7.62	17.16	7.42	7.71
Springtown	31.5	79	33.6	9.14	20.10	8.66	8.87	9.19	20.46	8.89	9.35
Strabane	18.4	46.8	23	12.31	27.22	11.48	11.60	12.63	28.35	12.07	12.59

Table E-10 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2020 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Tandragee	31.5	79	33.5	16.95	42.81	15.64	19.19	20.82	52.90	19.68	24.39
Tamnamore	40	100	45	16.87	41.93	15.62	19.17	17.44	43.49	16.62	20.46
Tremoge Cluster	40	100		8.81	19.14	8.36	8.48	8.12	18.01	7.87	8.31
Waringstown	18.4	46.8		7.54	16.81	7.25	7.37	7.45	16.97	7.29	7.65

Table E-11 Northern Ireland Short Circuit Current Levels for Winter Peak 2020

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
400 kV											
Turleenan				12.19	30.97	11.33	12.94	12.28	30.51	11.79	13.16
275kV											
Ballylumford	26.5	66.3	35.65	21.32	54.71	19.13	23.90	23.54	60.74	22.14	28.11
Castlereagh	31.5	79	35.65	18.41	45.84	16.44	18.59	18.58	46.29	17.42	19.92
Coolkeeragh	31.5	79	35.3	13.56	34.58	12.62	14.87	13.19	33.83	12.74	15.50
Hannahstown	31.5	79	35.65	17.94	44.78	16.09	18.29	18.17	45.41	17.09	19.81
Kells	31.5	79	35.65	20.77	52.84	18.71	22.20	20.53	51.37	19.47	22.28
Kilroot	31.5	79	45.3	20.19	51.81	18.14	22.36	23.66	61.31	22.26	28.21
Magherafelt	31.5	79	35.65	20.96	53.10	18.99	22.12	16.92	40.91	16.21	17.04
Moyle	31.5	79	35.65	20.80	53.27	18.70	23.12	22.81	58.68	21.48	26.89
Tandragee	26.5	66.3	35.65	21.70	54.14	19.46	21.89	20.67	50.87	19.52	21.83
Tamnamore	31.5	79	57.3	21.37	53.65	19.32	21.97	17.84	43.53	17.03	18.72
Turleenan	31.5	79	35.65	21.66	54.36	19.56	22.24	18.40	44.91	17.55	19.30
220 kV											
South Down	40	100		7.83	20.41	7.44	9.09	9.12	24.05	8.80	11.43
110 kV											
Aghyoule	25	62.5		4.26	9.01	4.01	4.19	4.22	9.50	4.06	4.44
Airport Road	40	100		11.49	24.95	10.79	10.92	11.51	25.33	11.08	11.49
Antrim	18.4	46.8		10.61	22.20	10.20	10.28	10.24	21.87	10.01	10.30
Ballylumford*	21.9	55	25.88	24.88	61.60	23.08	29.69				
	26.2	65	29.7					28.94	72.74	27.70	36.14

Table E-11 Northern Ireland Short Circuit Current Levels for Winter Peak 2020 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Ballymena	18.4	46.8		10.23	21.67	9.77	9.90	10.20	22.44	9.93	10.42
Banbridge	18.4	46.8		6.71	14.04	6.47	6.51	6.62	14.62	6.48	6.71
Ballyvallagh	18.4	46.8	23	17.4	37.13	16.41	16.45	15.40	32.81	14.96	15.01
Ballynahinch	18.4	46.8		6.08	12.66	5.81	5.86	6.01	13.13	5.85	6.08
Belfast central	31.5	79		16.85	39.89	15.42	16.58	19.75	42.76	18.51	19.90
Belfast North Main	18.4	46.8		16.19	34.69	15.10	15.33	15.58	30.22	14.97	16.21
Garvagh Cluster	40	100		5.3	12.01	5.14	5.24	5.19	12.03	5.10	5.44
Carnmoney	26.2	65	44.9	9.16	18.67	8.79	8.84	8.92	19.00	8.71	8.94
Castlereagh	26.2	65	33.5	21.75	53.85	19.48	24.04	27.51	68.66	25.23	31.10
Coleraine	31.5	80	33.5	14.99	33.57	14.06	14.26	15.44	35.06	14.81	15.42
Coolkeeragh	31.5	80	33.5	24.9	62.03	22.72	28.60	29.42	73.81	27.72	35.00
Creagh	31.5	80	33.5	8.68	17.27	8.35	8.35	8.92	18.83	8.70	8.74
Cregagh	26.2	65		19.2	46.20	17.38	19.43	23.22	53.50	21.55	23.64
Donegall North	31.5	79	42.5	19.03	45.49	17.57	18.97	22.67	49.96	21.40	22.37
Donegall South				14.07	31.47	13.23	13.41	14.71	31.77	14.15	14.49
Drumnakelly	31.5	79	42.5	18.79	45.02	17.33	18.63	19.97	47.97	18.93	20.80
Drumquin Cluster	40	100		6.55	14.78	6.23	6.43	6.19	14.21	5.99	6.54
Dungannon	18.4	46.8	23	14.88	34.59	14.00	14.65	14.25	33.91	13.74	15.06
Eden	25	62.5	45	10.31	21.09	9.89	9.93	9.88	21.00	9.66	9.85
Enniskillen	25	62.5		9.38	19.78	8.68	8.75	10.93	24.05	10.30	10.51
Finaghy	31.5	79		19.71	48.08	18.17	20.29	24.37	55.91	22.92	24.34
Glengormley	18.4	46.8		5.9	11.56	5.72	5.72	5.64	11.76	5.54	5.58
Gort Cluster	40	100		8.52	19.92	8.11	8.39	7.71	17.94	7.49	8.26
Hannahstown	31.5	80	33.5	22.24	55.48	20.33	24.53	28.08	70.56	26.23	31.98
Kells*	21.9	55.9	27.4	24.71	59.10	22.84	26.48				
	26.2	65	29.7					29.57	71.52	27.97	32.88
Killymallaght	40	100		12.59	28.55	11.97	12.19	11.81	26.56	11.49	12.04
Knock	18.4	46.8		17.77	37.43	16.19	16.32	17.27	32.95	16.33	17.34
Larne	18.4	46.8	42.5	10.13	21.15	9.74	9.75	9.40	20.54	9.21	9.37
Limavady	18.4	46.8	23	9.29	19.52	8.87	8.88	9.26	20.34	9.01	9.16
Lisburn	18.4	46.8	23	13.61	31.08	12.84	13.13	12.66	28.85	12.25	12.82
Lisaghmore	18.4	46.8		10.57	22.39	10.08	10.16	9.96	21.61	9.72	10.05
Loguestown	18.4	46.8		8.64	18.04	8.28	8.31	8.42	18.25	8.20	8.36
Magherakeel	40	100		4.54	10.25	4.36	4.58	4.92	11.55	4.77	5.14

Table E-11 Northern Ireland Short Circuit Current Levels for Winter Peak 2020 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110 kV											
Mid-Antrim	40	100		10.67	23.54	10.15	10.36	10.24	22.80	9.94	10.42
Newtownards	40	100		8.53	18.06	8.10	8.16	7.92	17.69	7.70	7.98
Newry	18.4	46.8	23	5.74	11.98	5.50	5.55	5.68	12.46	5.53	5.75
North Antrim	40	100		14.22	32.77	13.68	13.91	12.19	25.83	11.94	11.97
Omagh	40	100	42.5	16.04	35.60	14.78	15.08	16.17	36.38	15.31	16.08
Omagh South	40	100	100	11.83	25.26	11.00	11.13	11.52	24.65	10.99	11.08
Rathgael	18.4	46.8		6.52	13.57	6.22	6.26	6.37	13.87	6.19	6.41
Rosebank	40	100		19.75	48.12	17.85	20.54	24.46	60.51	22.64	26.68
Slieve Kirk	40	100		8.92	19.12	8.60	8.66	8.13	18.13	7.97	8.23
Springtown	31.5	79	33.6	11.05	23.85	10.53	10.71	10.55	23.16	10.28	10.75
Strabane	18.4	46.8	23	14.58	31.66	13.71	13.78	14.27	31.68	13.76	14.25
Tandragee	31.5	79	33.5	22.31	55.81	20.39	24.93	26.41	66.70	24.74	30.71
Tamnamore	40	100	45	19.99	49.35	18.71	22.92	19.71	48.96	18.93	23.27
Tidal	40	100		11.02	25.93	10.91	11.08	11.06	20.15	11.01	11.01
Tremoge Cluster	40	100		9.32	20.02	8.92	9.03	8.42	18.54	8.20	8.63
Waringstown	18.4	46.8		8.53	18.74	8.15	8.27	8.18	18.50	7.96	8.35

F Additional Information on Opportunities

APPENDIX F ADDITIONAL INFORMATION ON OPPORTUNITIES

F.1 NORTHERN IRELAND GENERATION OPPORTUNITIES RESULTS

Table F-1: Capability Results for 275 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Ballylumford 275 kV	220	A1	180	A1	220	A1	180
Castlereagh 275 kV	300	A3	>400	-	160	A2	160
Coolkeeragh 275 kV	0	NW	0	NW	0	NW	0
Hannahstown 275 kV	360	A3	>400	-	160	A2	160
Kells 275 kV	>400	-	>400	-	160	A2	160
Kilroot 275 kV	>400	-	>400	-	>400	-	>400
Magherafelt 275 kV	80	A4	80	A4	160	A4	80
Moyle 275 kV	220	A1	180	A1	220	A1	180
Omagh South 275 kV	0	NW	0	NW	0	NW	0
Tamnamore 275 kV	380	A2	180	A2	160	A2	160
Tandragee 275 kV	>400	-	>400	-	160	A2	160
Turleenan 275 kV	>400	-	220	A2	160	A2	160

Table F-2: Contingencies and constraints limiting 275 kV capabilities

Network Constraints for new generation at 275 kV		
ID	Outage	Constraint
A1	Intact	Overload on the 110 kV Ballylumford - Eden double circuit
A2	275 kV circuit from Hannahstown - Moyle	Overload on the 275 kV Ballylumford - Moyle circuit
A3	275 kV circuit from Kilroot - Tandragee	Overload on the 275 kV Castlereagh - Tandragee circuit
A4	275 kV circuit from Magherafelt - Tamnamore	Overload on the 275 kV Magherafelt – Tamnamore circuit 2
NW	1- Gort - Tamnamore 110 kV & Omagh - Tamnamore 110 kV 2- Coolkeeragh-Magherafelt 275 kV n-dc	1- Overload on the Tremoge to Tamnamore 110 kV circuit 2- Low voltage in the North West

Table F-3: Capability Results for 110 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Aghyoule 110 kV	0	NW	0	NW	0	NW	0
Airport Road 110 kV	80	R	80	R	80	R	80
Antrim 110 kV	80	R	80	R	80	R	80
Ballylumford 110 kV	20	B1	20	B1	20	B1	20
Ballymena 110 kV	120	R	120	R	120	R	120
Ballynahinch 110 kV	80	R	80	R	80	R	80

Table F-3: Capability Results for 110 kV (continued)

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Ballyvallagh 110 kV	0	B2	0	B2	0	B2	0
Banbridge 110 kV	80	R	80	R	80	R	80
Belfast Central 110 kV	140	B3	140	B3	140	B3	140
Belfast North Main 110 kV	60	R	60	R	60	R	60
Brockaghboy 110 kV	0	NW	0	NW	0	NW	0
Carnmoney 110 kV	60	B4	60	B4	60	B4	60
Castlereagh 110 kV	360	B5	>400	B5	160	B5	160
Coleraine 110 kV	0	NW	0	NW	0	NW	0
Coolkeeragh 110 kV	0	NW	0	NW	0	NW	0
Creagh 110 kV	80	B6	80	B6	80	B6	80
Cregagh 110 kV	140	B7	140	B7	140	B7	140
Donegall A&D 110 kV	60	R	60	R	60	R	60
Donegall B&C 110 kV	160	B8	160	B8	140	B8	140
Drumnakelly 110 kV	100	B9	100	B9	100	B9	100
Drumquin 110 kV	0	NW	0	NW	0	NW	0
Dungannon 110 kV	0	NW	0	NW	0	NW	0
Eden 110 kV	60	B10	60	B10	80	B10	60
Enniskillen 110 kV	0	NW	0	NW	0	NW	0
Finaghy 110 kV	140	B11	140	B11	140	B11	140
Glengormley 110 kV	60	R	60	R	60	R	60
Gort Cluster 110 kV	0	NW	0	NW	0	NW	0
Hannahstown 110 kV	360	B12	340	B12	160	B5	160
Kells 110 kV	280	B13	140	B13	120	B13	120
Killymallaght 110 kV	0	NW	0	NW	0	NW	0
Knock 110 kV	60	R	60	R	60	R	60
Larne 110 kV	0	B2	0	B2	0	B2	0
Limavady 110 kV	0	NW	0	NW	0	NW	0
Lisaghmore 110 kV	0	R	0	R	0	R	0
Lisburn 110 kV	100	B14	100	B14	100	B14	100
Loguestown 110 kV	0	R	0	R	0	R	0
Magherakeel 110 kV	0	NW	0	NW	0	NW	0
Mid Antrim 110 kV	0	NW	0	NW	0	NW	0
Newry 110 kV	100	R	100	R	100	R	100
Newtownards 110 kV	100	R	100	R	100	R	100
North Antrim 110 kV	0	NW	0	NW	0	NW	0
Omagh 110 kV	0	NW	0	NW	0	NW	0
Omagh South 110 kV	0	NW	0	NW	0	NW	0
Rathgael 110 kV	80	R	80	R	80	R	80
Rosebank 110 kV	140	R	140	R	140	R	140
Springtown 110 kV	0	NW	0	NW	0	NW	0
Strabane 110 kV	0	NW	0	NW	0	NW	0
Tamnamore 110 kV	200	B5	180	B5	160	B5	160
Tandragee 110 kV	360	B5	>400	B15	380	B5	160
Tremoge Cluster 110 kV	0	NW	0	NW	0	NW	0
Waringstown 110 kV	80	R	80	R	80	R	80

Table F-4: Contingencies and constraints limiting 110 kV capabilities

Network Constraints for new generation at 110 kV		
ID	Outage	Constraint
B1	Intact	Overload on the 110 kV Ballylumford - Eden circuit
B2	110 kV circuit from Ballylumford - Ballyvallagh	Overloads on 110kV Ballylumford - Ballyvallagh circuit 2
B3	Intact System	Overload on the 110 kV circuits from Cregagh to Belfast Central and Castlereagh
B4	110 kV double circuit from Castlereagh - Carnmoney	Overload on the Carnmoney to Eden 110 kV circuit
B5	275 kV circuit from Hannahstown - Moyle	Overload on the 275 kV Ballylumford - Moyle circuit
B6	110 kV circuit from Creagh - Tamnamore	Overload on the 110 kV Creagh - Kells circuit
B7	Intact System	Overload on the 110 kV Castlereagh - Cregagh circuit
B8	Intact System	Overload on the 110 kV Donegall - Hannahstown Circuit
B9	110 kV circuits from Drumnakelly to Tandragee circuits 1 & 2	Overload on the 110 kV Drumnakelly - Tandragee circuit 3
B10	110 kV circuit from Carnmoney - Eden	Overload on the 110 kV Carnmoney - Eden circuit 2
B11	110 kV circuit from Hannahstown - Finaghy	Overload on the 110 kV Hannahstown - Finaghy circuit 2
B12	Intact System	Overload on the 110 kV Lisburn - Tandragee double circuit
B13	Kells Single IBT Outage	Overload on 2nd Kells IBT
B14	110 kV double circuit from Lisburn to Hannahstown	Overload on the 110 kV Lisburn - Tandragee circuit
NW	1- Gort - Tamnamore 110 kV & Omagh - Tamnamore 110 kV 2- Coolkeeragh-Magherafelt 275 kV n-dc	1- Overload on the Tremoge to Tamnamore 110 kV circuit 2- Low voltage in the North West
R	110 kV substation is fed radially; loss of one 110 kV circuit	Overload on the second 110 kV circuit feeding the substation

Table F-5: Capability Results for 33 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Aghyoule 33 kV	0	NW	0	NW	0	NW	0
Airport Road 33 kV	80	T	80	T	80	T	80
Antrim 33kV	80	T	80	T	80	T	80
Ballymena (R) 33kV	120	T	120	T	120	T	120
Ballymena (T) 33kV	120	T	120	T	120	T	120
Ballynahinch 33 kV	80	T	80	T	80	T	80
Banbridge 33 kV	80	T	80	T	80	T	80
Belfast Central 33 kV	80	T	80	T	80	T	80
Belfast North Main 33kV	120	T	120	T	120	T	120
Brockaghboy 33 kV	0	NW	0	NW	0	NW	0
Carnmoney 33 kV	100	T	100	T	100	T	100
Coleraine 33 kV	0	NW	0	NW	0	NW	0
Coolkeeragh 33 kV	0	NW	0	NW	0	NW	0
Creagh 33 kV	80	C1	80	C1	80	C1	80
Cregagh 33kV	100	T	100	T	100	T	100

Table F-5: Capability Results for 33 kV (continued)

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Donegall N 33kV	120	T	120	T	120	T	120
Donegall S 33kV	80	T	80	T	80	T	80
Drumnakelly 33kV	100	C2	100	C2	100	C2	100
Drumquin 33kV	0	NW	0	NW	0	NW	0
Dungannon 33kV	0	NW	0	NW	0	NW	0
Eden 33kV	40	T	40	T	40	T	40
Enniskillen 33kV	0	NW	0	NW	0	NW	0
Finaghy 33kV	60	T	60	T	60	T	60
Glengormley 33kV	61	T	61	T	61	T	60
Gort Cluster 33 kV	0	NW	0	NW	0	NW	0
Killymallaght 33kV	0	NW	0	NW	0	NW	0
Knock 33kV	80	T	80	T	80	T	80
Larne 33kV	0	C3	0	C3	0	C3	0
Limavady 33 kV	0	NW	0	NW	0	NW	0
Lisaghmore 33 kV	0	NW	0	NW	0	NW	0
Lisburn 33 kV	120	T	120	T	120	T	120
Loguestown 33 kV	0	NW	0	NW	0	NW	0
Magherakeel 33 kV	0	NW	0	NW	0	NW	0
Mid Antrim 33 kV	0	NW	0	NW	0	NW	0
Newry 33 kV	100	T	100	T	100	T	100
Newtownards 33 kV	80	T	80	T	80	T	80
Omagh 33 kV	0	NW	0	NW	0	NW	0
Rathgael 33 kV	100	T	100	T	100	T	100
Rosebank 33 kV	100	T	100	T	100	T	100
Springtown 33 kV	0	NW	0	NW	0	NW	0
Strabane 33kV	0	NW	0	NW	0	NW	0
Tremoge Cluster 33 kV	0	NW	0	NW	0	NW	0
Waringstown 33 kV	100	T	100	T	100	T	100

Table F-6: Contingencies and constraints limiting 33 kV capabilities

Network Constraints for new generation at 33 kV		
ID	Outage	Constraint
C1	110 kV circuit from Creagh - Tamnamore	Overload on the 110 kV Creagh - Kells circuit
C2	110 kV circuits from Drumnakelly to Tandragee circuits 1 & 2	Overload on the 110 kV Drumnakelly to Tandragee circuit 3
C3	110 kV circuit from Ballylumford - Ballyvallagh	Overloads on 110kV Ballylumford to Ballyvallagh circuit 2
NW	1- Gort - Tamnamore 110 kV & Omagh - Tamnamore 110 kV 2- Coolkeeragh-Magherafelt 275 kV n-dc	1- Overload on the Tremoge to Tamnamore 110 kV circuit 2- Low voltage in the North West
T	33kV station supplied through 2 Transformers; Loss of Transformer 1.	Overload on second Transformer.

F.2 ADDITIONAL INFORMATION ON DEMAND OPPORTUNITIES IN IRELAND

The transmission system in Ireland is designed to provide a safe, reliable and economic transport service for power from source to demand. In Ireland, the Transmission Planning Criteria (TPC) provides a planning framework by which a balance can be achieved between reliability and economy. Achieving this balance means that under certain circumstances some level of constraints will exist in the system.

EirGrid keeps the performance of the transmission system under review as circumstances change. For example, the connection of new generation or demand to the transmission system, additional to the current forecasts and assumptions, or new interconnection transfers, will alter the expected power flows. Constraints will arise if the new power flows exceed planned transmission system capacity.

In designing out these constraints EirGrid will take account of the following:

- The extent of the constraint;
- The impact on system security;
- The overall economics of the operation of the system;
- The cost of the solution;
- The lead-time of the solution.

The analysis of transfer capabilities described in Chapter 9 identified a number of potential system constraints that could limit power flows arising from new demand connections. Most of these have been identified previously and are being managed by EirGrid.

These potential transmission system constraints are presented in the table below. The first column in each table provides a cross-reference to the results tables in Chapter 9. The second column describes potentially overloaded circuits or names of stations at which low voltages potentially occur following particular outages. The third column lists the circumstances under which the overloads or voltage violations occur, thereby limiting the capacity. For constraints for which projects have already been initiated, the final column provides the reader with the CP number of the capital project designed to relieve the constraint. This can be cross-referenced against the detailed descriptions of the planned projects provided in Section B-2 of Appendix B.

Table F-7 List of Potential System Constraints for which EirGrid has initiated Projects

ID	Potential Overload / Voltage Problem	Circumstances	Comment
C1	Ardnacrusha – Limerick 110 kV line	Overload can occur for loss of Killonan – Singland 110 kV circuit.	Capital project CP688 relieves this constraint.
C2	Voltage violations	Voltage violations can occur for loss of Lanesboro – Mullingar 110 kV circuit.	Capital project CP596 relieves this constraint.
C3	Voltage violations	Voltage violations can occur for loss of Maynooth – Rinawade 110 kV circuit.	Capital project CP197 relieves this constraint.
P1	Voltage violations and Cashla – Dalton 110 kV line	Voltage violations can occur for loss of multiple circuits, overload can occur for loss of Cashla – Dalton 110 kV circuit	Capital project CP816 relieves this constraint.

G Abbreviations and Glossary

APPENDIX G ABBREVIATIONS AND GLOSSARY

G.1 ABBREVIATIONS

AC	Alternating Current
ACS	Average Cold Spell
ATR	Associated Transmission Reinforcement
BSP	Bulk Supply Point
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
p.u.	Per Unit
PST	Phase Shifting Transformer
RES	Renewable Energy Schemes
RMS	Root Mean Square
RP	Review Period
SEM	Single Electricity Market
SONI	System Operator 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
UREGNI	Utility Regulator for Electricity and Gas Northern Ireland
WFPS	Wind Farm Power Station
WP	Winter Peak

G.2 GLOSSARY

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.
Bord Gáis	Bord Gáis Éireann (Bord Gáis) was established in 1976 and is a commercial State body operating in the energy industry. Bord Gáis is responsible for the supply, transmission and distribution of natural gas in Ireland.
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 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 which has been 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. 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
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 colleagues 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	Unswitched connection into existing line between two other stations.
Total Transfer Capability	The total capacity available on cross-border circuits between the 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 losses 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. 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.
UREGNI	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.

H References

APPENDIX H REFERENCES

The following documents are referenced in All-Island Ten Year Transmission Forecast Statement 2014:

- 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, 2014-2023*. EirGrid and SONI issued this report in February 2014. 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 2014 to 2023. 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 H-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.

I Power Flow Diagrams

I.1 Guide to the Power Flow Diagrams

APPENDIX I POWER FLOW DIAGRAMS

This appendix presents power flow diagrams for the following cases:

- Figure I-1 Summer Peak 2014,
- Figure I-2 Summer Valley 2014,
- Figure I-3 Winter Peak 2014,
- Figure I-4 Summer Peak 2023,
- Figure I-5 Summer Valley 2023,
- Figure I-6 Winter Peak 2023,

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.

I.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 connected at each bus is shown beside a 

symbol, with the generation dispatched in MW shown beneath 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. The voltage, in per unit value, is displayed below each bus.

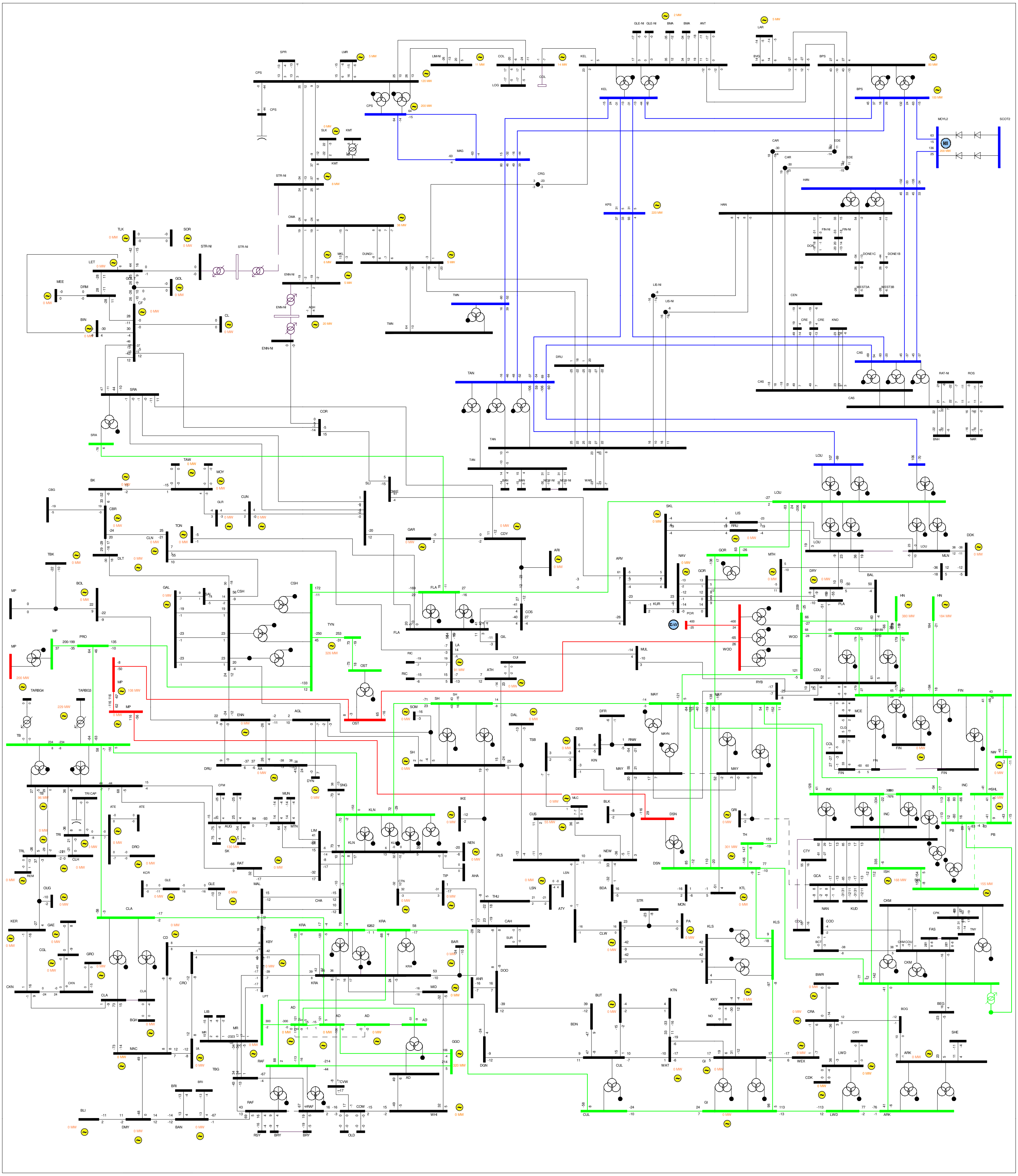


Figure I-01 Power Flow Diagram Summer Peak 2014

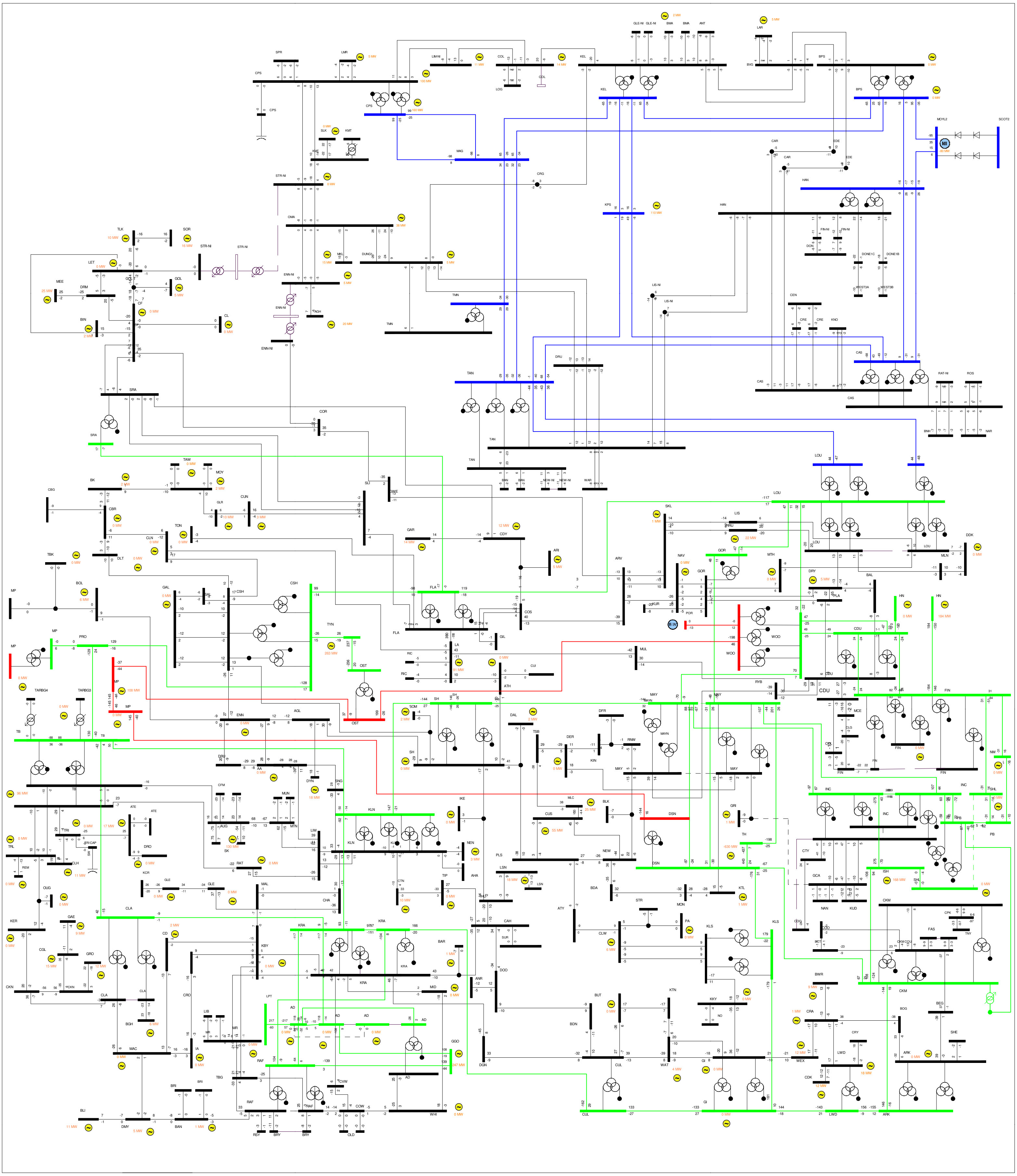


Figure I-02 Power Flow Diagram Summer Night Valley 2014

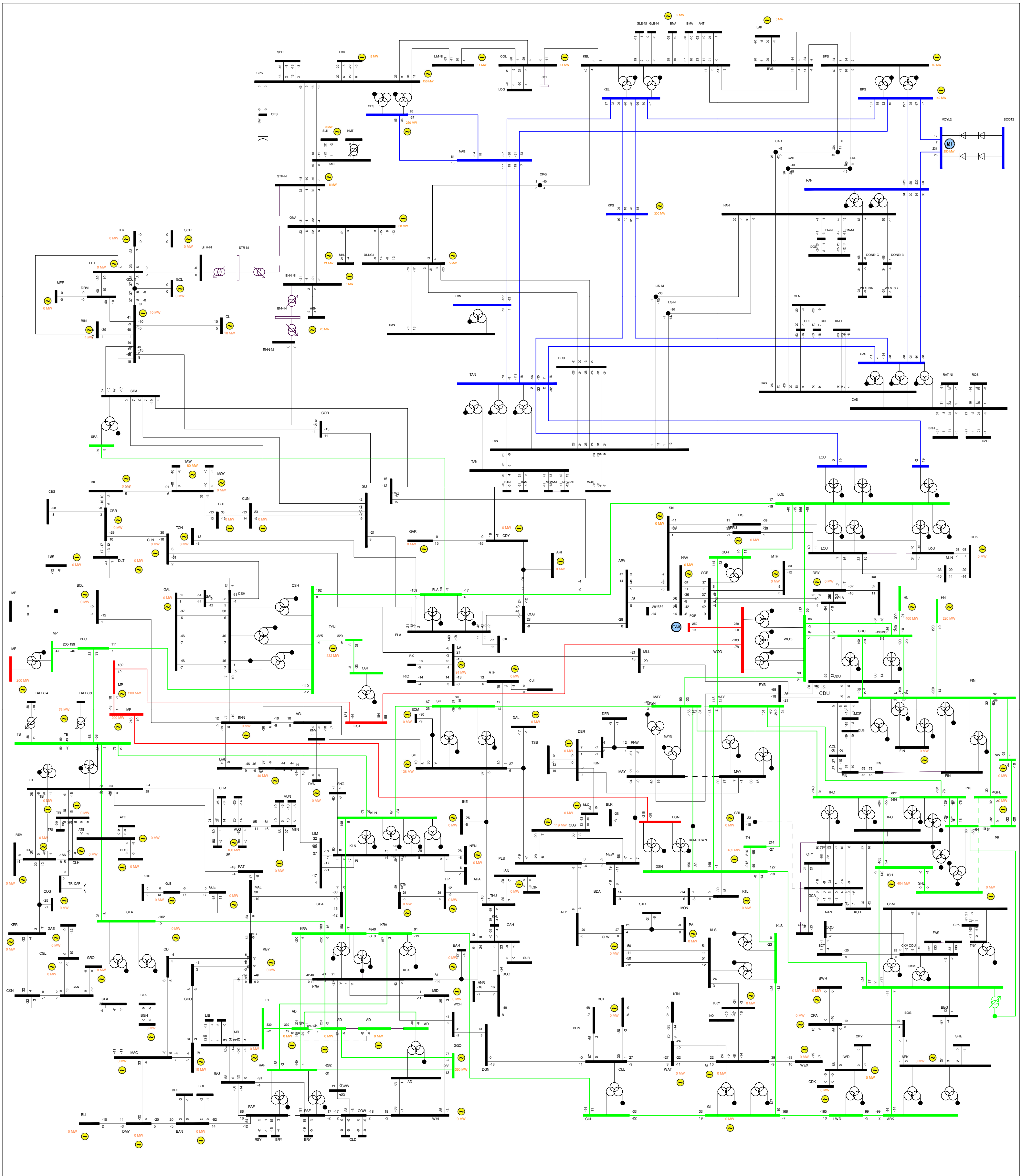


Figure I-03 Power Flow Diagram Winter Peak 2014

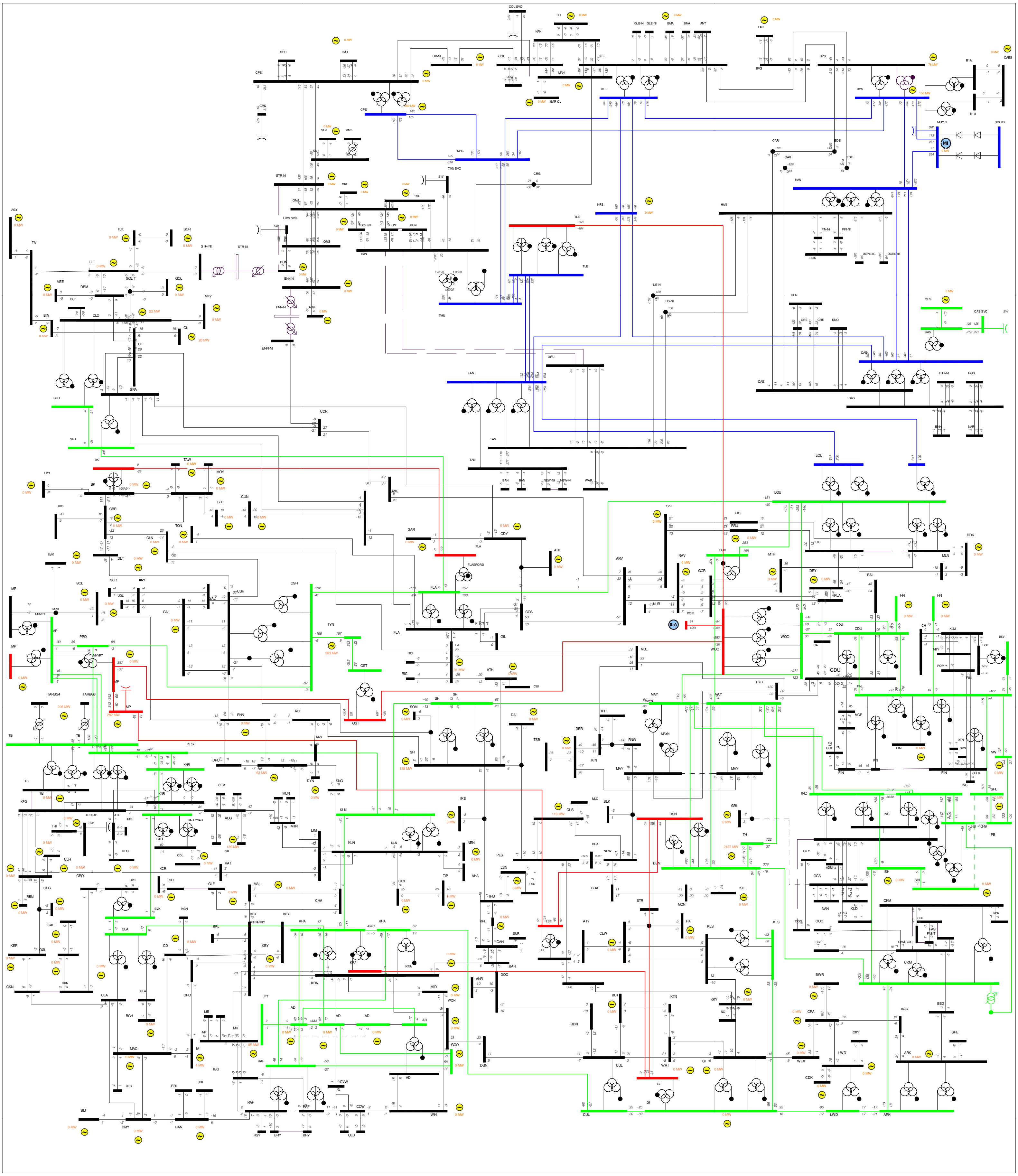


Figure I-04 Power Flow Diagram Summer Peak 2023

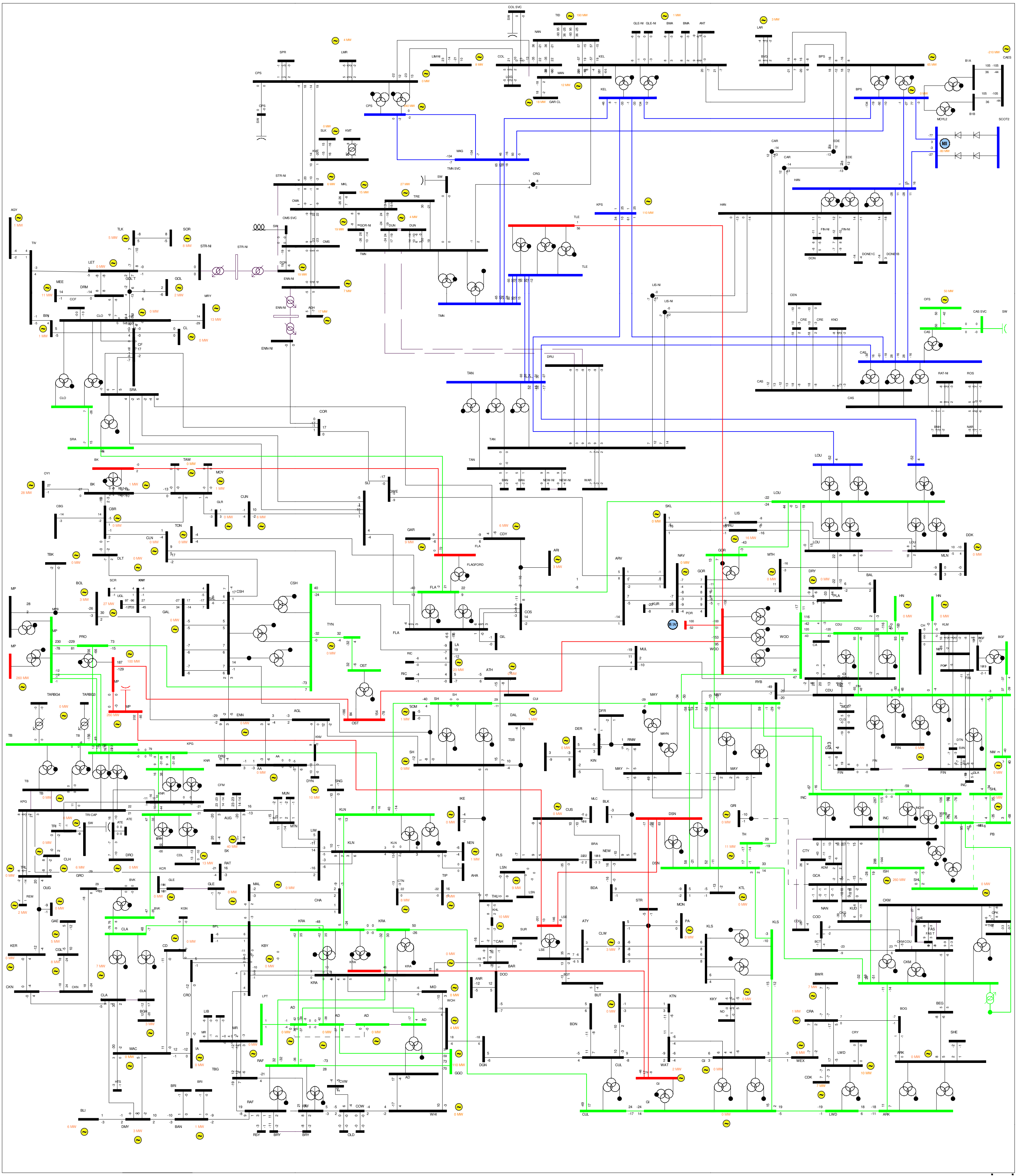


Figure I-05 Power Flow Diagram Summer Night Valley 2023

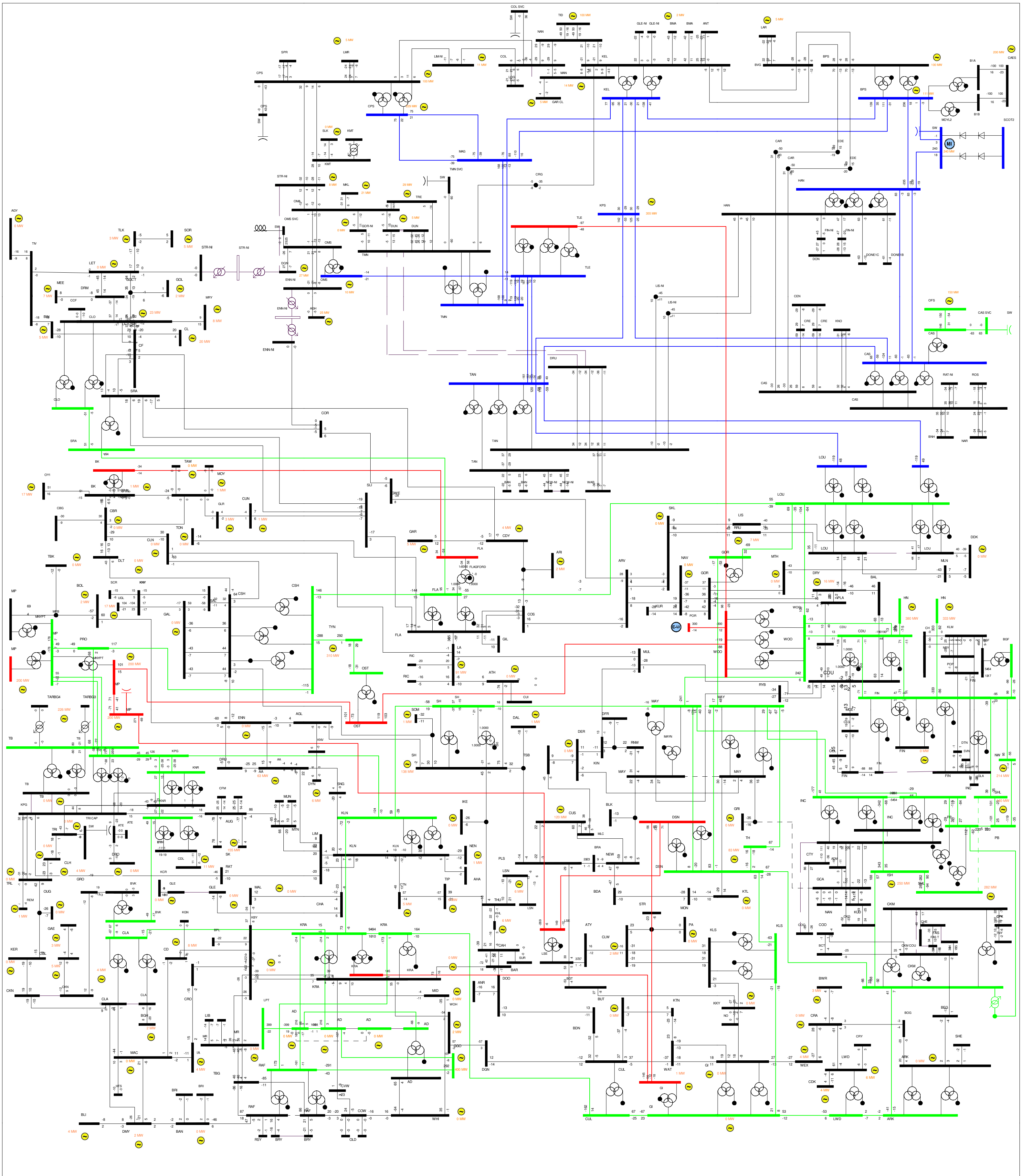


Figure I-06 Power Flow Diagram Winter Peak 2023

J Size A3 Geographical Maps

APPENDIX J SIZE A3 GEOGRAPHICAL MAPS

Appendix J contains geographical maps of the All-Island Transmission System in A3 format. Maps are presented illustrating the All-Island Transmission System as it exists at the beginning of October 2013 and as planned at the end of 2023

Figure J - 1

Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at October 2013

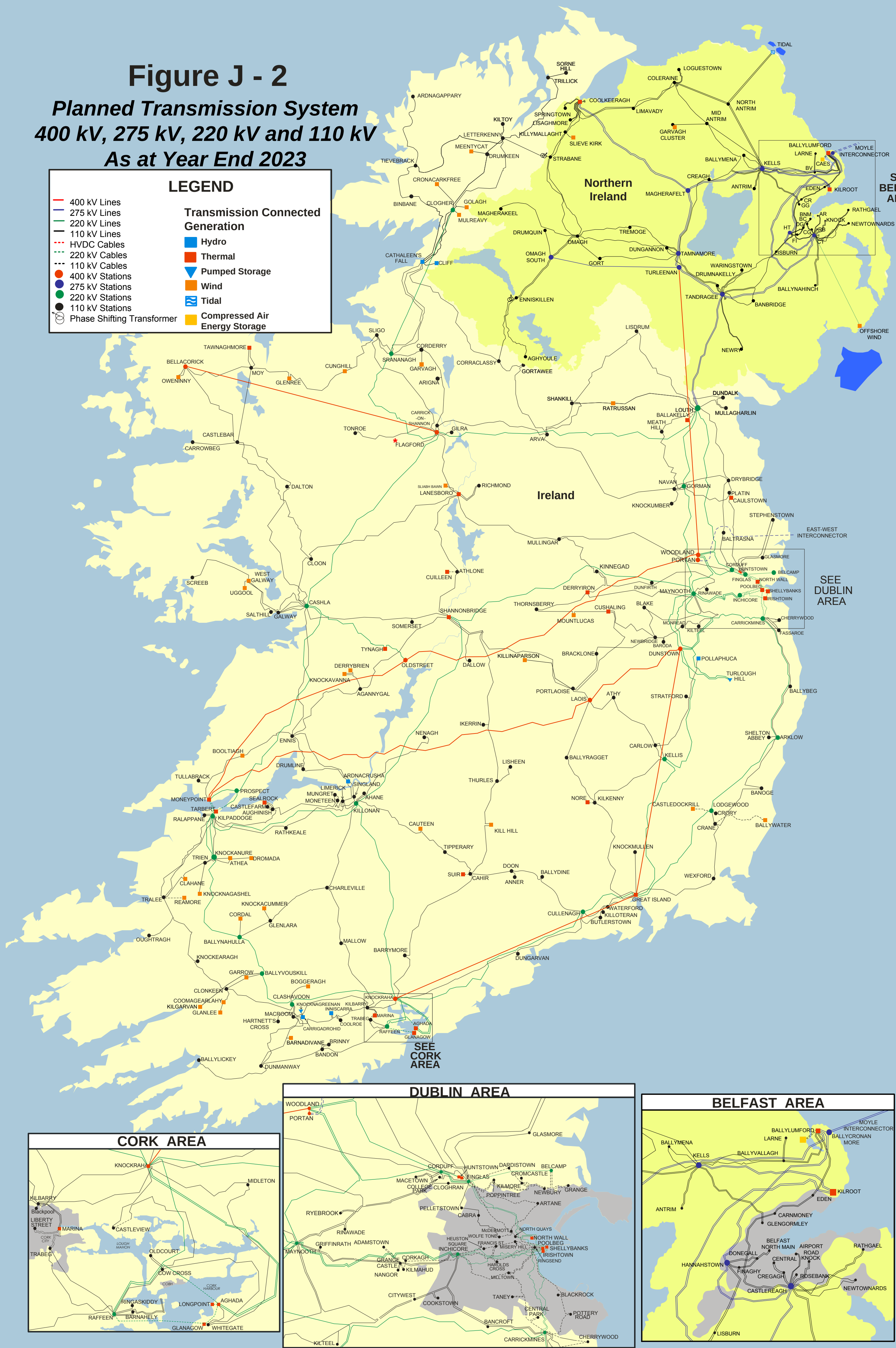


Figure J - 2
Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at Year End 2023
LEGEND
400 kV Lines
275 kV Lines
220 kV Lines
110 kV Lines
HVDC Cables
220 kV Cables
110 kV Cables
400 kV Stations
275 kV Stations
220 kV Stations
110 kV Stations
Phase Shifting Transformer
Transmission Connected Generation
Hydro
Thermal
Pumped Storage
Wind
Tidal
Compressed Air Energy Storage
Northern Ireland
Ireland
SEE BELFAST AREA
SEE DUBLIN AREA
SEE CORK AREA
EAST-WEST INTERCONNECTOR
MOYLE INTERCONNECTOR
OFFSHORE WIND
TIDAL
SORNE HILL
TRILLICK
ARDNAGAPPARY
COOLKEERAGH
COLERAINE
LOGUESTOWN
NORTH ANTRIM
LIMAVADY
SPRINGTOWN
LISAGHMORE
KILTOY
LETTERKENNY
KILLYMALLAGHT
SLIEVE KIRK
MEENTYCAT
DRUMKEEN
STRABANE
GARVAGH CLUSTER
MID ANTRIM
BALLYMENA
KELLS
LARNE
BALLYLUMFORD
TIEVEBRACK
CRONACARKFREE
CREAGH
ANTRIM
MAGHERAFELT
KILROOT
EDEN
RATHGAEL
NEWTOWNARDS
BINBANE
CLOGHER
GOLAGH
MAGHERAKEEL
MULREAVY
DRUMQUIN
OMAGH
TREMOGE
DUNGANNON
TAMNAMORE
OMAGH SOUTH
GORT
TURLEENAN
DRUMNAKELLY
WARINGSTOWN
LISBURN
BALLYNAHINCH
CATHALEEN'S FALL
CLIFF
ENNISKILLEN
TANDRAGEE
BANBRIDGE
NEWRY
SLIGO
CORDERRY
SRANANAGH
GARVAGH
ARIGNA
CORRACLASSY
AGHYOULE
GORTAWEE
LISDRUM
TAWNAGHMORE
BELLACORICK
MOY
CUNGHILL
OWENINNY
GLENREE
SHANKILL
RATRUSSAN
DUNDALK
MULLAGHARLIN
LOUTH
BALLAKELLY
MEATH HILL
TONROE
FLAGFORD
GILRA
ARVA
CASTLEBAR
CARROWBEG
DALTON
RICHMOND
LANESBORO
NAVAN
GORMAN
DRYBRIDGE
PLATIN
CAULSTOWN
KNOCKUMBER
STEPHENSTOWN
BALTRASNA
MULLINGAR
WOODLAND
PORTAN
CLOON
ATHLONE
CUILLEEN
KINNEGAD
DERRYIRON
MAYNOOTH
WEST GALWAY
SCREEB
UGGOOL
CASHLA
SALTHILL
GALWAY
SHANNONBRIDGE
THORNSBERRY
CUSHALING
MOUNTLUCAS
BLAKE
SOMERSET
TYNAGH
DERRYBRIEN
OLDSTREET
DALLOW
KILLINAPARSON
BRACKLONE
DUNSTOWN
POLLAPHUCA
TURLOUGH HILL
KNOCKAVANNA
AGANNYGAL
PORTLAOISE
LAOIS
ATHY
STRATFORD
BALLYBEG
NENAGH
IKERRIN
ENNIS
BOOLTIAGH
DRUMLINE
ARDNACRUSHA
SINGLAND
LISHEEN
BALLYRAGGET
CARLOW
KELLIS
SHELTON ABBEY
ARKLOW
TULLABRACK
MONEYPOINT
PROSPECT
SEALROCK
LIMERICK
MUNGRET
MONETEEN
AHANE
KILLONAN
TARBERT
RALAPPANE
KILPADDOGE
CASTLEFARM
AUGHINISH
THURLES
NORE
KILKENNY
CASTLEDOCKRILL
LODGEWOOD
CRORY
CRANE
BANOGE
BALLYWATER
RATHKEALE
CAUTEEN
KILL HILL
TIPPERARY
KNOCKANURE
TRIEN
ATHEA
DROMADA
CLAHANE
KNOCKNAGASHEL
TRALEE
REAMORE
CHARLEVILLE
SUIR
CAHIR
DOON
ANNER
BALLYDINE
KNOCKMULLEN
WEXFORD
GREAT ISLAND
WATERFORD
KILLOTERAN
BUTLERSTOWN
CULLENAGH
KNOCKACUMMER
CORDAL
GLENLARA
OUGHTRAGH
BALLYNAHULLA
MALLOW
BARRYMORE
DUNGARVAN
KNOCKEARAGH
GARROW
BALLYVOUSKILL
BOGGERAGH
CLONKEEN
COOMAGEARLAHY
KILGARVAN
GLANLEE
CLASHAVOON
MACROOM
HARTNETT'S CROSS
BARNADIVANE
BRINNY
BANDON
BALLYLICKEY
DUNMANWAY
CORK AREA
KNOCKRAHA
MIDLETON
KILBARRY
MARINA
LIBERTY STREET
CASTLEVIEW
TRABEG
OLDCOURT
COW CROSS
RINGASKIDDY
LONGPOINT
AGHADA
RAFFEEN
BARNAHELY
GLANAGOW
WHITEGATE
DUBLIN AREA
WOODLAND
PORTAN
GLASMORE
CORDUFF
HUNTSTOWN
DARDISTOWN
BELCAMP
CROMCASTLE
MACETOWN
FINGLAS
KILMORE
COLLEGE PARK
CLOGHRAN
POPPINTREE
NEWBURY
GRANGE
ARTANE
PELLETSTOWN
CABRA
RYEBROOK
RINAWADE
NORTH QUAYS
NORTH WALL
POOLBEG
SHELLYBANKS
IRISHTOWN
RINGSEND
HEUSTON SQUARE
INCHICORE
FRANCIS ST
MISERY HILL
MAYNOOTH
GRIFFINRATH
ADAMSTOWN
CORKAGH
GRANGE CASTLE
KILMAHUD
NANGOR
HAROLDS CROSS
MILLTOWN
CITYWEST
COOKSTOWN
TANEY
BLACKROCK
CENTRAL PARK
POTTERY ROAD
BANCROFT
CARRICKMINES
CHERRYWOOD
KILTEEL
BELFAST AREA
BALLYLUMFORD
MOYLE INTERCONNECTOR
BALLYCRONAN MORE
LARNE
BALLYMENA
KELLS
BALLYVALLAGH
KILROOT
EDEN
ANTRIM
CARNMONEY
GLENGORMLEY
BELFAST NORTH MAIN
AIRPORT ROAD
RATHGAEL
DONEGALL
HANNAHSTOWN
CENTRAL
KNOCK
FINAGHY
CREAGH
ROSEBANK
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