All-Island Ten Year Transmission Forecast Statement 2013

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

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FOREWORD

I am pleased to introduce the All-Island Ten Year Transmission Forecast Statement (TYTFS) 2013, which presents the outlook for opportunities for demand and generation in Ireland and Northern Ireland.

This year, for the first time, EirGrid and SONI, as the Transmission System Operators (TSOs) for Ireland and Northern Ireland respectively, have collaborated to produce a ten year all-island 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 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

Fintan Slye

Chief Executive, EirGrid Group

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Executive Summary

EXECUTIVE SUMMARY

The All-Island *Ten Year Transmission Forecast Statement* 2013 (TYTFS) describes the development of the transmission system on the island of Ireland over the ten-year period from 2013 to 2022.

This statement has been prepared jointly by EirGrid and SONI and supersedes the All-Island *Transmission Forecast Statement 2012-2018*, published in May 2012.

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 developments that have either taken place or are scheduled to be completed over the period covered by the statement.

The transmission system is planned and developed to ensure it meets projected transmission operating conditions while maintaining its performance within defined standards. To continue to meet these standards, in the context of the forecast electricity demand and new generation and demand connections, there is a requirement for ongoing planning and development to reinforce the transmission system.

The TSOs have undertaken a comprehensive review of the existing and planned transmission system topology, existing and projected demand and generation data, with the results presented in the form of maps, diagrams, data tables and network models, which are in electronic format.

This TYTFS contains the results of analyses to determine the likely available capacity, or demand opportunity, at various nodes of the all-island transmission system, assuming a average growth in the all-island transmission peak demand of 1.3% year on year over the period 2013 to 2022. 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 nodes capable of accommodating major industrial loads. There are also opportunities for the connection of demand across Northern Ireland, these demand opportunities depend on the installed transformation capacity and the expected demand growth at the individual substations.

This statement also provides information on the opportunities for generator connections. For 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. Possible opportunities beyond Gate 3 are displayed and discussed. 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 2022. 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 2022. To facilitate the future generation connections in the North West region of Northern Ireland major 275 kV network reinforcements will be required. In addition to this 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 covered by the TYTFS – 2013, 2016 and 2019. 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 the issues and the TSOs will manage the transmission system to avoid the risks highlighted.

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, assumed to be completed by Winter 2017/18. 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 comprehensive information on the transmission system, electricity demand, generation and interconnection with other electricity transmission systems. It is designed to assist prospective customers to identify and evaluate the opportunities available for connecting to or making use of the transmission system. System data, if desired, can be used by prospective customers to undertake their own power flow analyses. 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.

The TYTFS team: From Left to Right: Paul Horan, Dick Lewis, Noel Hanrahan, Yvonne Coughlan and Karen Creighton.

1 Introduction

1.1 Outline of the All-Island Ten Year Transmission Forecast Statement
1.2 Overview of Information
1.3 Other Information
1.4 Data Management
1.5 Publication

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.

EirGrid and SONI, as Transmission System Operators (TSOs) for Ireland and Northern Ireland respectively, previously published the *All-Island Transmission Forecast Statement 2012-2018* as a joint EirGrid / SONI seven year statement. In 2012 the TSOs ran a public consultation outlining several proposals aimed at improving the statement, with one key proposal being to extend the timeframe of the statement from seven to ten years and rename the statement the All-Island Ten Year Transmission Forecast Statement (TYTFS).

The TYTFS *2013* 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 2013-2022* (GCS) in January 2012. That document assesses the generation adequacy situation over the ten-year period to 2022. Insofar as possible the TYTFS complements the demand information presented in the GCS.

EirGrid issued the CER approved *Transmission Development Plan 2012-2022* for Ireland in August 2013. The plan provides details of the transmission system developments expected to be progressed in the period up to 2022. NIE have submitted their latest plans to SONI as part of the Transmission Interface Agreement (TIA). The information contained in the TYTFS is derived from these plans. NIE's plans are also being considered by the Competition Commission (CC) at the time of writing and are subject to the outcome of the CC determination.

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

The format of the All-Island Ten Year *Transmission Forecast Statement* 2013 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' analysis.
- 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. The power flows at peak and minimum demand frequently represent challenging conditions for the TSOs to manage.

Table 1-1 shows the forecasts of peak transmission demand for the years 2013 to 2022 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* 2013-2022, the TSOs expect in overall terms that the all-island peak demand will increase by an average of approximately

1.3% year on year over the period of the TYTFS[1]. This corresponds to an average increase of 1.5% in Northern Ireland and 1.3% in Ireland. For more information on this please see the All-Island *Generation Capacity Statement* 2013-2022[2].

Table 1-1 Forecast of Peak Transmission Demand

Year	Ireland Peak Demand (MW)	Northern Ireland Peak Demand (MW)	All-Island Peak Demand (MW)[3]
2013	4,768	1,733	6,431
2014	4,825	1,747	6,501
2015	4,888	1,773	6,590
2016	4,946	1,800	6,674
2017	4,996	1,828	6,751
2018	5,048	1,856	6,829
2019	5,114	1,885	6,923
2020	5,210	1,915	7,049
2021	5,281	1,946	7,148
2022	5,346	1,977	7,241

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 and Northern Ireland[4]. 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 3,500 - 4,000 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, renewable CHP. This represents a considerable challenge for the industry to manage; this is discussed in more detail in Chapter 5.

Northern Ireland

In Northern Ireland, as of the freeze date of 1st November 2012, some 2,862 MW of generation capacity was installed, of which 2,328 MW was connected to the transmission system and 534 MW to the distribution system.

[1] Note figures quoted in the TYTFS are an average over the ten year period of the statement and growth will vary each year
[2] http://www.eirgrid.com/media/All-Island_GCS_2013-2022.pdf
[3] Please note jurisdictional Peak Demand may occur at a different date and time to the All-Island Peak
[4] http://www.detini.gov.uk/strategic_energy_framework__sef_2010_-3.pdf

It has been assumed that 1461 MW of renewable generation will connect in Northern Ireland over the ten year period covered by the TYTFS. No large thermal generation plant is planned to connect to the Northern Ireland transmission system over this ten year period. The Heavy Fuel Oil Directive is anticipated to result in the decommissioning of some 510 MW of capacity at Ballylumford Power Station by the end of 2015. By the year 2022 the total Northern Ireland installed capacity will be circa 3,813 MW, however it should be noted that 1,855 MW of this is variable renewable generation.

Table 1-2 summarises the Northern Ireland generators included in the analysis. The implications of these developments are discussed in Chapters 8 and 9, which deal with transmission system capability.

Table 1-2 Summary of assumed Northern Ireland Future Generation Connections

Type of Generation	Connected to	Number of Connections	Capacity (MW)
Offshore Wind	Transmission	1	600
Tidal	Transmission	2	200
Biomass	Distribution	2	30
Onshore Wind	Transmission	1	46
Onshore Wind	Distribution	35	585
Total		42	1,461

Ireland

At the data freeze date (December 2012), some 8,747 MW of generation capacity was installed in Ireland, of which 7,531 MW is connected to the transmission system and 1,216 MW to the distribution system. Table 1-3 summarises the planned connections in Ireland as at the data freeze date.

Table 1-3 Summary of Generators with Signed Connection Agreements (December 2012)

Type of Generation	Connected to	Number of Connections	Capacity (MW)
Thermal	Transmission	6	1228
Pumped Storage	Transmission	1	70
Wind Farm	Transmission	24	920
Thermal	Distribution	20	129
Hydro	Distribution	7	12
Wind Farm	Distribution	65	790
Total		123	3,150

Taking account of these committed connections, expected unit de-ratings and unit closures, the installed generating capacity would be 10,820 MW by the end of 2022, of which 9,352 MW will be transmission-connected.

In the period up to the 1st of December 2012 data freeze date, two Gate 3 applicants had connected, a further 43 Gate 3 applicants were contracted to connect, with a further 116 applicants having live Gate 3 offers and a single offer having lapsed.

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 analyses, 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, information is based on EirGrid's transmission system development strategy, GRID25, and analysis undertaken as part of EirGrid's recent re-calculation of Gate 3 Firm Access Quantities (FAQs). 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 2013, 2016 and 2019.

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, other transmission system reinforcements and increasing generation levels. In Northern Ireland these short circuit issues have been highlighted to NIE and work is planned to resolve these issues. In Ireland these short circuit issues are being resolved by EirGrid. 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 means that future connections to the transmission system will require careful analysis. Figure 1-1 presents the short circuit results for the winter peak 2013 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.

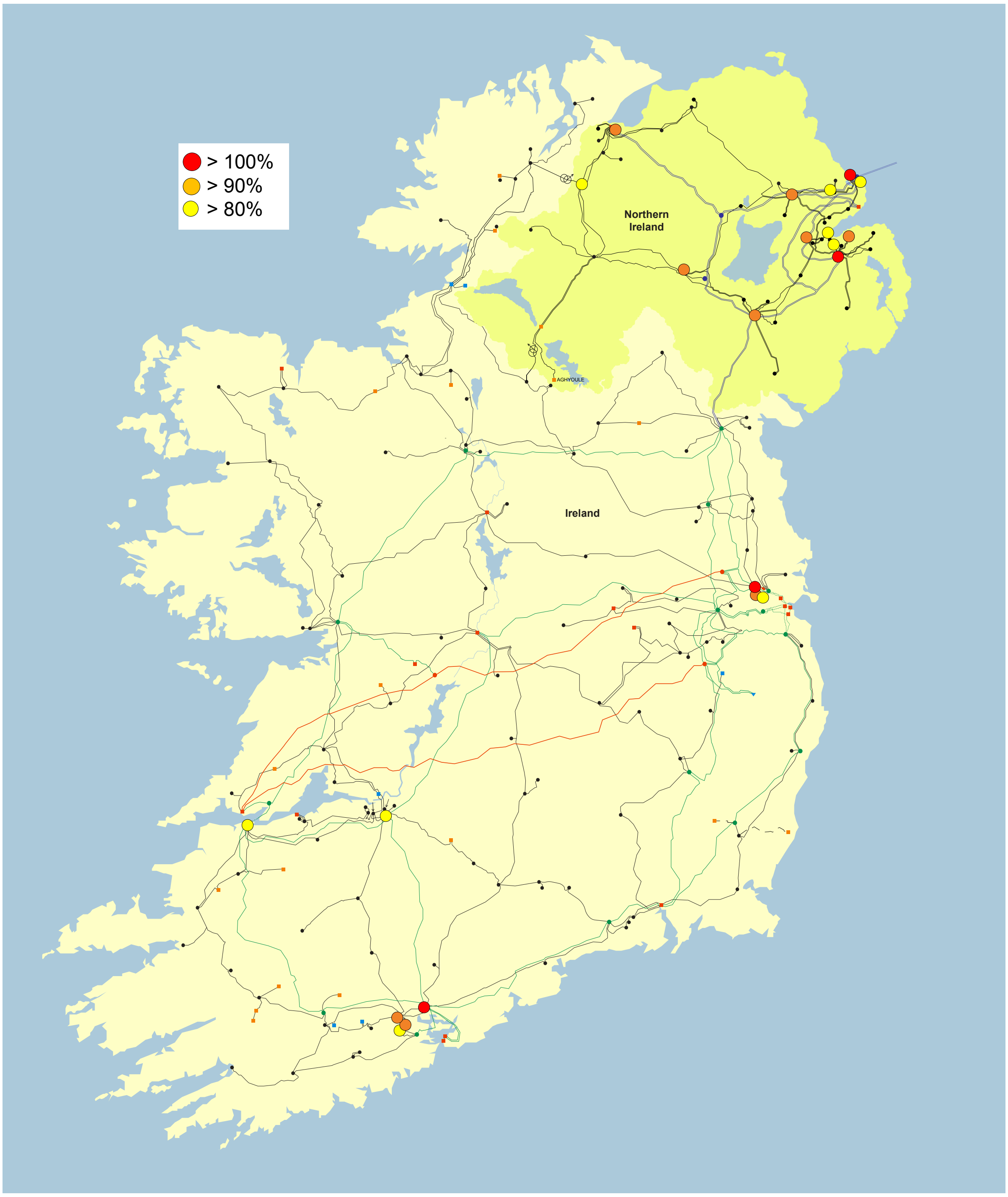

Figure 1-1 Fault Levels for Winter Peak 2013/14

1.3 OTHER INFORMATION

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

- SONI Grid Code[5]
- EirGrid Grid Code[6]
- Northern Ireland Licence Standards – Transmission and Distribution System Security and Planning Standards[7]
- The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[8]
- EirGrid Transmission Planning Criteria[9] and Operating Security Standards[10]
- SONI Transmission Connection Charging Methodology Statement[11]
- EirGrid Transmission Connection Charging Methodology Statement 2008[12]
- Statement of Charges for Use of the NIE Transmission and Distribution System 2011[13]
- EirGrid Statement of Charges 2011/2012[14]
- All-Island Transmission Forecast Statement 2012-2018[15]
- All-Island Generation Capacity Statement 2013-2022[16]
- SONI Transmission System Performance Report[17]
- EirGrid Transmission System Performance Report[18]

[5] http://www.soni.ltd.uk/Operations/GridCodes/
[6] http://www.eirgrid.com/operations/gridcode/
[7] http://www.nie.co.uk/About-NIE/Electricity-industry/Security-planning
[8] http://www.legislation.gov.uk/nisr/2012/381/pdfs/nisr_20120381_en.pdf
[9] http://www.eirgrid.com/media/Transmission%20Planning%20Criteria.pdf
[10] http://www.eirgrid.com/media/Operating%20Security%20Standards%20December%202011.pdf
[11] http://www.soni.ltd.uk/media/documents/Archive/SONI%20Charging%20Methodology%20Statement%20December%202009%20-%20Approved%2022%20December%202010.pdf
[12] http://www.eirgrid.com/media/Connection%20Charging%20Statement.pdf
[13] http://www.niegetconnected.co.uk/publications.php
[14] http://www.eirgrid.com/media/2011-2012%20Statement%20of%20Charges%20(11.10.11)%20v2.0.pdf
[15] http://www.soni.ltd.uk/media/documents/Archive/All-Island%20Transmission%20Forecast%20Statement%202012-2018.pdf
[16] http://www.soni.ltd.uk/media/documents/Operations/CapacityStatements/All%20Island_Generation%20Capacity%20Statement%202013-2022.pdf
[17] http://www.soni.ltd.uk/media/documents/Archive/SONI%20Transmission%20System%20Performance%20Report%202010-11.pdf
[18] http://www.eirgrid.com/aboutus/publications/

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 December 2012 and November 2012 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:

- Uprating of Corduff – Ryebrook 110 kV circuit;
- The new North Connaught 110 kV local network reinforcement;
- The new North West 220 kV Project;

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

- Ardnacrusha 110 kV station refurbishment;
- Inchicore 220 kV GIS station upgrade;
- Dunmanway 110 kV station upgrade and installation of a new coupler;
- The new Moneypoint – North Kerry 400 kV project;
- Uprating of the Bellacorick – Castlebar 110 kV circuit;
- Installation of reactive support at Poolbeg 220 kV station;

The following transmission system developments have been terminated as projects:

- Construction of Brockaghboy cluster;

The following transmission system developments have been completed:

- Replacement of two 45 MVA transformers at Ballymena Main Mesh with two 90 MVA transformers;
- Construction of the Killymallaght 110/33 kV cluster substation and the loop in of the existing Coolkeeragh – Strabane 110 kV circuit '2';
- Replacement of the 60 MVA transformer at Carnmoney Main with a 90 MVA transformer
- Construction of the Cloghran 110 kV station and the loop in of the existing Kildonan – Macetown 110 kV circuit;
- Uprating of the following 110 kV circuits:
  - Ballydine – Doon
  - Butlerstown – Cullenagh
  - Inniscarra – Macroom

- Uprating of the following 110 kV busbars:
  - Ennis
  - Cushaling
- Construction of the following 110 kV stations:
  - Reamore
  - Clonkeen
- Installation of reactive support at the Mullingar 110 kV station;

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

- CP0726 Moneypoint – North Kerry 400 kV project will now be a 220 kV project;
- Brockaghboy WFPS is now assumed to connect into Limavady Main via a 110 kV circuit;
- The location and size of the network reactive compensation in Northern Ireland is subject to change due to ongoing analysis;
- The assumed connection methodology of Fair Head and Torr Head is subject to change as feasibility studies are currently ongoing to determine the optimum connection methodology;

The following transmission system developments are under review:

- Finnstown 220/110 kV transmission development is under review due to the level of demand enquires in the area local to the proposed development;

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.

2 Governance and Planning Strategy

2.1 Governing Arrangements
2.2 Main Technical Requirements of the Transmission System
2.3 System Reliability, Stability and Quality
2.4 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

Following the introduction of the SEM, both SONI's and NIE's (the Transmission System Owner) licences were modified to reflect the new structure of the electricity industry. SONI has licence obligations to operate the Northern Ireland transmission system, while NIE has a licence obligation to plan, develop and maintain the Northern Ireland transmission system[1]. 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. SONI is required to cooperate and assist NIE in meeting its licence obligations regarding the planning and development of the Northern Ireland transmission system. A Transmission Interface Agreement (TIA) exists between SONI and NIE which, amongst other things, sets out the information exchange requirements and timescales to assist each party in meeting its licence obligations. This statement forms part of the transmission planning process described in Section C of the TIA.

Ireland

EirGrid has obligations set out in licence and statute to operate and ensure the maintenance of and develop 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 System Security and Planning Standards 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 in 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 level of quality.

2.2.1 SECURITY AND PLANNING STANDARDS

Northern Ireland

The Northern Ireland transmission system is planned and operated in accordance with the document entitled 'Transmission and Distribution System Security and Planning Standards', which is approved by the Utility Regulator (UREGNI). The relevant standards applicable to the Northern Ireland transmission system are described in Table H-1 of this document.

[1] It should be noted that the Utility Regulator (NI) intends to transfer the investment planning functions to SONI (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 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 is complex but 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. A review of the Planning and Connection Standards is currently being undertaken by SONI and NIE to ensure that they are appropriate for the emerging generation and demand mix in Northern Ireland.

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'.

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 is currently being undertaken to ensure they meet the emerging generation and demand mix in Ireland.

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[2]. This reserve is allocated on an economic all-island basis. In 2013 the maximum reserve provided by the Moyle Interconnector is 75 MW; 50 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 49.5 Hz. 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 49.5 Hz; the amount of reserve available is limited by the difference between the physical flow on the interconnector and the maximum available capacity. The East West Interconnector reduces import by 50 MW when the frequency exceeds 50.4 Hz.

[2] Triggered at 49.3 Hz

VOLTAGE

The voltage variation permitted by The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[3], 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 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.

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

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[4].

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

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

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 displace 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

The all-island network requires significant reinforcement to facilitate the connection of renewable generation and to resolve the challenges outlined above. The 'Ensuring a Secure, Reliable and Efficient Power System in a Changing Environment'[5] report building on the 'Facilitation of Renewables (FoR)'[6] studies examined the hour-to-hour behaviour of the power system in 2010 and compared this with predicted behaviour in 2020. The report highlighted four major areas to be addressed:

- System frequency response will be more important as there will be on average a 25% reduction in on-line synchronous inertia which has significant implications for the rate of change of frequency (RoCoF) and the need for consistent and reliable reserve from the portfolio.
- Ramping requirements will increase as wind power generation increases both the variability and uncertainty in energy sources than has been previously managed on power systems. With increasing volumes of wind there will be an increase in the ramping capability required on the system. This required increase in ramping capability will be influenced in the short to medium term by both the variability of the wind and by the magnitude of the wind forecast error, and new operational policies will be required to maintain security of supply.
- System voltage control will become more challenging as there will be over 25% less synchronous generator reactive capability available. Wind farms can produce reactive power. When these reactive power sources are connected to distribution systems they are less effective than those connected directly to the transmission system for assisting with voltage control and voltage stability on the transmission system, especially during voltage collapse and transient incidents.
- Non-adherence of certain plants to mandated Grid Code requirements combined with unreliable performance when required further increases the challenges to managing an efficient and secure power system in this changing environment.

[5] http://www.eirgrid.com/media/Ensuring_a_Secure_Reliable_and_Efficient_Power_System_Report.pdf
[6] http://www.eirgrid.com/media/FacilitationRenewablesFinalStudyReport.pdf

A multi-year all-island programme of work entitled 'Delivering a Secure Sustainable Electricity System' (DS3)[7] has been developed by EirGrid and SONI to resolve the operational challenges associated with meeting the 2020 renewable targets. This includes allowing for up to 75% penetration of non-synchronous generation. The key objectives of the all-island DS3 programme are:

- To ensure continued security of supply on the island in the context of a changing plant portfolio; and
- To assist in the delivery of the 2020 renewable policy targets, set out in the Renewables Directive 2009/29/EC and detailed in legislation, by minimising curtailment of renewable generation.

There are three main work areas within the programme:

1. System Performance and Incentivisation: Identifying and incentivising the necessary system portfolio capability and performance required to operate a secure power system with increasing penetration of renewables. To this end, a number of modifications regarding Rate of Change of Frequency (RoCoF) and wind farm performance have been brought to the Grid Codes in both Ireland and Northern Ireland and the 'Wind Farm Power Station Settings Schedule'[8] in Northern Ireland. A fundamental review of System Services has also been performed to ensure the required services are available to meet the needs of the system with increasing penetration of renewables and work has begun on implementing an all-island enhanced performance monitoring system to monitor Grid Code and System Services compliance.
2. System Operational Policies: The development and updating of the necessary operational policies to ensure system security primarily in respect of frequency and voltage over various time periods, including but not limited to operating reserves, ramping services, management of uncertainty and TSO-DSO voltage co-ordination.
3. System Tools: The design, development and implementation of enhanced system tools in order to manage the increased operational complexity and provide decision support tools consistent with the changing needs of the power system. These tools include an improved wind forecasting tool, a wind dispatch tool and WSAT (Wind Security Assessment Tool). Furthermore, the continuous update of the EMS (Energy Management System) is central to this work area.

[7] http://www.eirgrid.com/media/DS3%20Programme%20Brochure.pdf
[8] http://www.soni.ltd.uk/media/documents/Operations/Grid-Code/WFPS%20Settings%20Schedule%2021022013.pdf

2.4.2 Smart Grids

Background

Electrical power systems across the world are undergoing a paradigm shift as the imperative to improve the sustainability of the power sector, while maintaining a secure energy supply at competitive prices, is tackled. While the utilisation of increasing levels of renewable energy sources, some of which are less controllable and predictable, is at the heart of this shift, the introduction of energy efficiency measures, demand-side participation and electric vehicles are also expected to be widely deployed in the coming years. This will lead to dramatic changes in how power systems are operated and managed.

The Smart Grid is still a foreign concept for most consumers. However, the overall benefit of a Smart Grid is that it will help minimise the price consumers pay for electricity and help to reduce carbon emissions associated with the electricity they use. Smart Grids have the potential to allow domestic consumers to have access to greater levels of information on their electricity use, which can help facilitate consumer efforts in managing electricity more efficiently and encourage consumers to transfer their electricity usage away from times of the day when demand for electricity is most expensive.

In Ireland and Northern Ireland, due to the relatively small size of our power system coupled with our ambitious targets for incorporating renewable generation, we are at the forefront of identifying, and solving, many of these challenges. No other synchronous system manages the same levels of instantaneous wind penetration levels (50%) seen today, and no other synchronous power system is aiming to safely and securely manage real-time penetration levels of 75% by 2020.

While the term Smart Grid has been used for a variety of concepts, solutions and products for several years, there is no doubt that the power system needs “smart” solutions if TSOs are to effectively manage the system complexity that increased levels of variable renewable generation bring while meeting customer participation expectations.

Many elements of the Smart Grid are already in place on the transmission system; the operational and infrastructural elements of our work are at the heart of what is commonly referred to as the Smart Grid. Nonetheless, it is widely accepted that the difference between today’s grid and a Smart Grid of the future is mainly the grid’s capability to handle more complexity than today in an efficient and effective way.

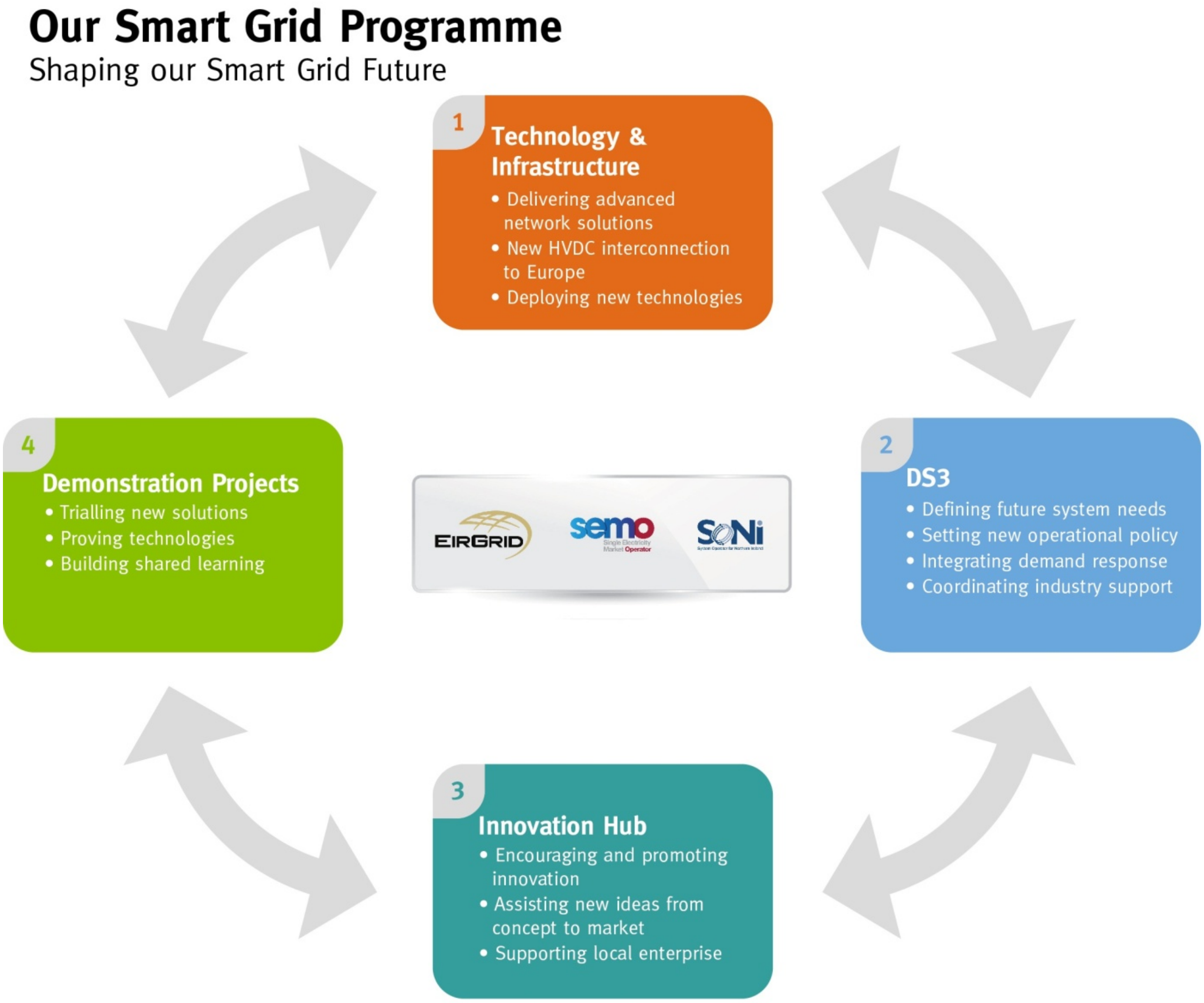

Figure 2-1 Smart Grid Programme Structure

EirGrid and SONI's Smart Grid programme is designed to achieve this goal. At its core, it is a collection of technologies, services, and series of projects to upgrade our current electricity system; to drive innovation and to deliver a low carbon energy future; while continuing to operate and maintain a safe, secure, and reliable system. The programme focuses on the following four key areas:

a) DS3[9]
b) Demonstration Projects[10]
c) Innovation Hub[11]
d) Technology and Infrastructure[12]

[9] http://www.eirgrid.com/operations/ds3/
[10] http://www.eirgrid.com/operations/demonstrationprojects/
[11] http://www.smartgridinnovate.com/
[12] http://www.soni.ltd.uk/Operations/sg/TechnologyandInfrastructure/

3 The Electricity Transmission System

3.1 Overview of the Electricity Transmission System
3.2 Existing Connections Between the Transmission Systems
3.3 Interconnection with Great Britain
3.4 Ireland Transmission System Developments
3.5 Northern Ireland Transmission System Developments
3.6 Joint Northern Ireland and Ireland Approved Transmission System Developments
3.7 Connection of New Generation Stations
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3.9 Detailed Transmission System Information

3 THE ELECTRICITY TRANSMISSION SYSTEM

3.1 OVERVIEW OF THE ELECTRICITY TRANSMISSION SYSTEM

The transmission system plays a vital role in the supply of electricity, providing the means to transport power from generators to demand centres using a system comprising 400 kV, 275 kV, 220 kV and 110 kV 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 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:

- 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. 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, in Ireland. EirGrid and Northern Ireland Electricity (NIE) are planning a new 400 kV cross-border circuit, which is anticipated to be installed by the end of 2017. 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[1] 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.

The transmission system generally comprises 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[2] and cables at the different voltage levels. Revision of individual line lengths “may change” following completion of network development projects.

[1] 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.

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

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	779	<1
220 kV	1,790	122
110 kV	5,745	345

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[3]

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	10,052	52

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.

[3] 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[4]

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	846	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[5] 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.

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

[5] Plant connected in parallel through common switchgear.

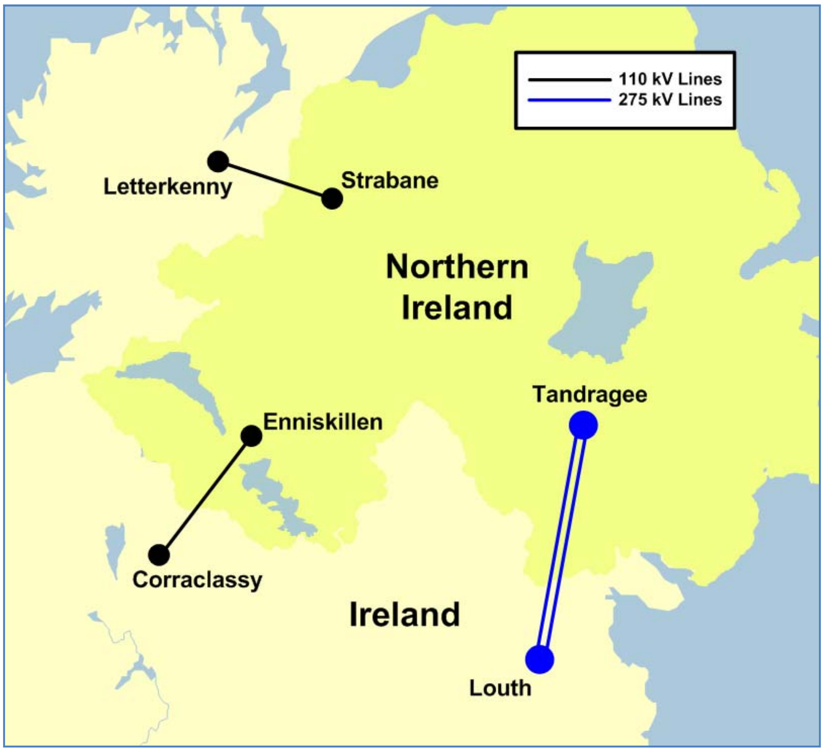


Figure 3-1 Existing Cross-Border Circuits

3.3 INTERCONNECTION WITH GREAT BRITAIN

With large imports of power from Scotland and Wales across the Moyle Interconnector and the EirGrid 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. 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 EirGrid East West Interconnector does have dynamic reactive power export capability. SONI act 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)[6]. The capacity is purchased by market participants and utilised in the SEM. Figure 3-2 shows the location of the Moyle interconnector and EirGrid East-West Interconnector.

[6] 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 be traded between Northern Ireland and Scotland across the Moyle Interconnector is constrained (due to ongoing outage/fault) to 250 MW 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[7]	250 MW	250 MW
	NI – SCO[8]	250MW	250MW
EWIC	WAL – ROI[9]	500 MW	500 MW
	ROI – WAL[9]	500 MW	500 MW

[7] The Moyle Interconnector import capacity increases to 450 MW in all seasons in 2017 due to repair works being completed.

[8] The Moyle Interconnector export capacity decreases to 80 MW in all seasons in 2016 due to network limitations in Scotland.

[9] 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 49.6 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)[10] 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 the interconnector is restored to full capacity in autumn 2017. Therefore, for the purposes of the TYTFS it has been assumed the import capacity of the Moyle Interconnector is restored to 450 MW in 2017. The Moyle Interconnector export capacity is limited to 80 MW from 2016 onwards 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 and is the largest capacity VSC interconnector in operation worldwide. 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

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

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.

3.4 IRELAND TRANSMISSION SYSTEM DEVELOPMENTS

3.4.1 GRID25

Over the next 10 years, major changes to Ireland's electricity requirements are forecast in its fuel mix and in its fleet of power stations. Change will increasingly be driven by issues of energy and system security, competitiveness, climate change and by the desire to move away from imported fossil fuels. The transmission system is a vital channel for supplying reliable, sustainable and renewable energy to Ireland's demand centres while promoting open competition within the sector. Reinforcing and upgrading the transmission system is required in order to maintain a robust electricity transmission system. 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. EirGrid calculates that 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 will need to be doubled by 2025.

In October 2008, EirGrid (the TSO for Ireland) published GRID25, its strategy for the long-term development of the transmission system. GRID25 will provide transmission capacity for increased electricity demand, new conventional generators, increased interconnection and large amounts of renewable generation. Since the GRID25 strategy was developed significant progress has been made in optimising investment plans, in identifying new technical solutions, in building new transmission circuits and in uprating existing circuits. Further details on GRID25 are available on the EirGrid website (www.eirgrid.com).

Appendix B of this TYTFS outlines that EirGrid has capitally approved[11] the uprate of 740 km and the construction of 770 km of circuit. These projects are currently scheduled to be completed by 2022. 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
2008	88	54	2
2009	168	104	7
2010	215	37	5
2011	340	76	3
2012	215	128	2

[11] Approximately

EirGrid published its *Transmission Development Plan 2012-2022* in August 2013. The report 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 in compliance with the Transmission Planning Criteria (TPC).

The planned transmission system developments presented in this statement are based on those projects that have been capitally approved by EirGrid 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 snap shot 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 large point demands could drive further development requirements.

The Transmission Development Plan 2012-2022 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 December 2012, 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. EirGrid's risk management plans and processes seek to identify, analyse, monitor and manage project and programme risks as part of the management and governance of the GRID25 programme. These processes facilitate the management of high risk project dependencies and critical path issues within the context of a changing environment.

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.

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 of Project Constituents

EirGrid has differentiated between moderate and high risk based on project type and project status. Thus line and station busbar uprate projects which are due to be completed by 2016 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 that are due for completion in the near-term are inherently less risky than those that are 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.

All developments included in this section have been capitally approved by EirGrid.

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 wind farm will connect at 110 kV into the new Clogher 110 kV station. This 110 kV transmission station is being built contestably and is due for completion in 2014.

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 West to the 400 kV network. It is expected to be completed in 2015.

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. This project is due for completion in 2015.

Knockanure 220 kV Development[12]

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. This project is due for completion 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 overhead line. Ballynahulla 220/110 kV project is needed to accommodate part of the renewable generation in the south-west. This project is due for completion in 2015. This station was formerly known as Kishkeam but has been renamed.

Poolbeg 220 kV Development

2*50 Mvar reactors will be connected to Poolbeg 220 kV station, in Co. Dublin. The cumulative effect of the number of cable circuits and a reduction in conventional generation in Dublin due to increased wind generation has made it more difficult to control voltage during low demand periods and these reactors will help to alleviate the operational constraint of running generators outside of merit order to adequately control voltages during these low demand periods. 2*50 Mvar blocks will be installed in preference to a single 100 Mvar block to avoid large voltage steps on switching in or out the reactor. The reactors are expected to be completed in the latter half of 2015.

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 busbar. The new busbar will also accommodate a second 400/220 kV transformer. The new 400 kV substation and 400/220 kV transformer are due 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 Moneypoint-Kilpaddoge 220 kV

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

circuit. The new 220 kV substation and 220/110 kV transformer are due to be completed in 2015.

Kilpaddoge 220 kV Development[13]

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. This project is due for completion in 2016.

Inchicore Redevelopment

Replacement of the oldest section of the existing Inchicore 220 kV station 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. This project is due for completion in 2016.

Belcamp 220 kV Development[14]

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. This project is due for completion in 2017 and was formerly known as Belcamp 220 kV Development.

Finglas 220/110 kV Redevelopment

Reconfiguration and redevelopment of the existing Finglas 220 kV and 110 kV busbars 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.

400 kV station near Portlaoise[15]

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-Carlow 110 kV line. The proposed infrastructure will improve quality of supply to Laois, Carlow,

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

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

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

Kildare, Wicklow, Kilkenny, ensure security of supply to Kilkenny and will also increase capacity to the region. This project is due for completion in 2017.

Moneypoint – North Kerry 400 kV Development

A planned new 400 kV circuit from Moneypoint in Co. Clare to north Co. Kerry will create a necessary new path for power out of the South West to the existing 400 kV network. It is expected to be completed in 2017.

Grid West 400 kV Development[16]

A new 400/110 kV station is required in the vicinity of Bellacorick, Co. Mayo, to facilitate the large quantities of renewable generation in the area. This new station will be connected to either Cashla or Flagford 220 kV stations, in Co. Galway and Co. Roscommon respectively, by a 400 kV overhead line circuit and associated station works. The new circuit will create a necessary new path for power out of the Mayo region to the existing meshed 220 kV transmission system. It is expected to be completed in 2019. The location of the 400 kV station sites in Bellacorick and Cashla/Flagford are currently unknown and the 400 kV station locations shown in the geographical maps are only indicative.

Grid Link 400 kV Development[17]

The Grid Link development project comprise a new 400 kV circuit connecting into existing Knockraha 220 kV substation, in Co. Cork and existing Dunstown 400 kV substation, in Co. Kildare, via the existing 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. It will not be necessary to construct a 400 kV substation at Dunstown as there is an existing 400 kV substation located there. 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. The project is due to be completed in 2020.

Finnstown 220 kV Development

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.

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

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

3.5 NORTHERN IRELAND TRANSMISSION SYSTEM DEVELOPMENTS

NIE have provided SONI with 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 planned transmission system projects must receive capital approval from the NIE Executive and UREGNI before work can commence. 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.

3.5.1 NIE Approved Network Developments

The project developments stated below are based on the best information available at the time of the data freeze date (1st November 2012).

Ballymena Main Mesh

Two 45 MVA transformers at Ballymena Main Mesh are to be replaced by two 90 MVA transformers which are assumed to be installed and commissioned by winter 2012/13.

Hannahstown

A third interbus transformer is planned to be installed and commissioned at Hannahstown. The asset first appears in the TYTFS files during winter 2012/13.

Killymallaght 110/33 kV Cluster

A new 110/33 kV substation is currently under construction, the substation will comprise of 90 MVA transformer. The site is adjacent to the Coolkeeragh-Strabane 110 kV circuit ‘2’, approximately 10 km south of Coolkeeragh and 16 km north of Strabane Main. The existing Coolkeeragh-Strabane 110 kV circuit ‘2’ is to be looped into Killymallaght. Installation and commissioning are expected to be complete by winter 2012/13.

Carnmoney Main

One 90 MVA transformer will replace an existing 60 MVA transformer at Carnmoney Main. This asset replacement first appears in the TYTFS files during winter 2012/13.

Coleraine-Kells 110 kV Circuit Upgrade

It is proposed to uprate the 110 kV circuit between Coleraine and Kells. Work has commenced to uprate the portal section of the circuit between Terrygowan and the connection point to the proposed Mid-Antrim cluster is to be strung with Invar conductor. This network reinforcement first appears in the TYTFS in summer 2013. The line between Coleraine and the connection point to the proposed Mid-Antrim cluster section of the circuit is to be uprated with a mixture 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 line. This network reinforcement first appears in the TYTFS study files in winter 2013/14.

Knock Main

Two 60 MVA transformers at Knock Main are to be replaced by two 90 MVA transformers which are planned to be installed and commissioned by winter 2014/15.

Dungannon-Omagh 110 kV Circuits

Following the replacement of the current transformers at Dungannon in winter 2013/14 the rating of these circuits will be 186 MVA. Both Omagh – Dungannon 110 kV circuits will be diverted into Tamnamore Main. The current Omagh – Dungannon 'B' circuit, will by this stage be connected into the Tremoge cluster, will connect directly into Tamnamore. The Omagh – Dungannon 'A' circuit will use a mesh corner at Dungannon Main to connect through to Tamnamore. This design will provide resiliency against N-2 contingencies. This work is due to be completed in winter 2015/16.

Tamnamore Main 275/110 kV Substation – Phase 2

Phase 2 is the completion of the Tamnamore 275/110 kV project. It is proposed to extend the existing 275 kV and 110 kV double busbars at Tamnamore, install a second 275/110 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. The network reinforcement first appears in the TYTFS study files during winter 2015/16.

Belfast North Main

A new 110/33 kV substation at Whitla Street is to be established. This substation will replace the existing 110/33 kV substation at Belfast Power Station West (PSW). This project is required due to the deterioration in condition of the substation assets at PSW. The existing Whitla Street site will be redeveloped for a new 33 kV switchboard and pair of 90 MVA 110/33 kV transformers. This project first appears in the TYTFS study files in winter 2015/16.

3.5.2 NIE Unapproved Network Developments

Donegall Main (North)

One 60 MVA transformer at Donegall North is to be replaced by one 90 MVA transformer which is due to be installed and commissioned by winter 2013/14. Donegall North will then have two 90 MVA transformers in operation.

Castlereagh 275/110 kV IBTX 1

The interbus transformer IBTX 1 at Castlereagh is to be replaced. The replacement transformer will have a 60 MVA tertiary winding. The asset replacement is planned to be installed and commissioned by winter 2013/14.

Tremoge 110/33 kV Cluster

The proposed establishment of a 110/33 kV substation with one 60/90 MVA transformer at a site adjacent to the existing 110 kV Omagh – Dungannon circuit '2', approximately 21 km east of Omagh Main and 25 km west of Tamnamore Main. The existing circuit will be looped into this new cluster substation. Tremoge cluster first appears in the TYTFS study files in winter 2014/15.

Mid-Antrim 110/33 kV Cluster

The construction of a 110/33 kV substation with one 60/90 MVA transformer at a site adjacent to the existing Coleraine – Kells 110 kV circuit, approximately 25 km southeast of Coleraine Main. The existing circuit will be looped into this new cluster substation. This cluster first appears in the TYTFS study files in winter 2014/15.

Castlereagh / Tandragee Reactive Compensation

Reactive support at Castlereagh and Tandragee is to be installed. This reactive compensation is required because the loss of the 275 kV double circuit tower line from Hannahstown-Moyle / Ballylumford has the potential to cause a severe reduction in voltage at Hannahstown and Castlereagh (depending on the demand and dispatch scenario). It is proposed that the reactive compensation schemes will be a combination of fixed and dynamic reactive support. In the TYTFS files each substation has one fixed 30 Mvar capacitor working in conjunction with a static var compensator (SVC) with a range of ± 30 Mvar connected to the 110 kV bus. These schemes first appear in the TYTFS study files in winter 2015/16.

Ballylumford Switchgear

The switchgear at Ballylumford is to be replaced with new indoor GIS switchboard. This will allow both interbus transformers at Ballylumford to be switched in as opposed to only one presently, due to short circuit current level concerns. It is planned to construct a new switch house. A new GIS double busbar 110 kV (40 kA switchboard) will be installed and the 110 kV circuits diverted accordingly. The project is expected to be completed by winter 2015/16. It is assumed that after this work takes place both interbus transformers at Ballylumford can be in service.

Omagh-Tamnamore New 110 kV Circuit

It is proposed to construct a 3rd Omagh – Tamnamore 110 kV single circuit, following on from Tamnamore Phase 2 works where the two Omagh – Dungannon 110 kV circuits were reconfigured to become two Omagh – Tamnamore circuits. This 3rd circuit will be approximately 57 km in length on Portal construction and conductored with Zebra strung for 75^{o}C. The circuit will also be looped in to connect with the proposed Gort cluster substation. The network reinforcement first appears in the TYTFS study files during winter 2015/16.

Gort 110/33 kV Cluster

It is proposed to construct a 110/33 kV substation with one 60/90 MVA transformer at a site adjacent to the proposed new 110 kV Omagh – Tamnamore 3rd circuit approximately 19 km east of Omagh Main and 38 km west of Tamnamore Main. The new circuit would be looped into this new cluster hub. Gort cluster first appears in the TYTFS study files in winter 2015/16.

Omagh / Strabane Reactive Compensation

Reactive support at Omagh and Strabane is to be installed. This reactive support is required because in the event of the Coolkeeragh CCGT not running and a double circuit outage of the 275 kV circuits between Coolkeeragh and Magherafelt, the 110 kV transmission system and the synchronous compensator CGT8 are not capable of supporting the voltage in the North West of Northern Ireland at peak load times. Also under certain wind generation conditions there is the potential for transmission circuit overloads in the North West of Northern Ireland. In the TYTFS files each substation has one static var compensator (SVC) with a range of ± 30 Mvar connected to the 110 kV bus. The reactive compensation scheme at Omagh first appears in the TYTFS study files in winter 2015/16. The reactive compensation scheme at Strabane first appears in the TYTFS study files in winter 2016/17.

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. This network reinforcement is planned to be completed by winter 2016/17.

Brockaghboy 110/33 kV Cluster

The construction of a 110/33 kV substation with one 60/90 MVA transformer at a site approximately 16 km from the closest point from the existing Coleraine – Kells line. It is proposed that the Brockaghboy cluster will be connected to the proposed Mid-Antrim cluster. It is assumed this connection is 16 km of 110 kV in of AP1 construction and UPAS conductor. This cluster first appears in the TYTFS study files in winter 2016/17.

Coolkeeragh-Limavady-Coleraine 110 kV Circuits

It is proposed to uprate the existing Coolkeeragh – Limavady 110 kV circuit as well as the Coleraine-Limavady 110 kV circuit and the Coleraine – Coolkeeragh 110 kV circuit. This uprate is required to accommodate the wind farm clusters expected to connect to the Limavady Main node. It has been assumed that the uprate will be a mixture of Invar and GAP conductors. When works are complete the circuits will be uprated to a minimum of 185 MVA. This network reinforcement first appears in the study files in winter 2016/17.

Drumquin 110/33 kV Cluster

A new 110/33 kV substation is to be constructed with one 60/90 MVA transformer. The Drumquin cluster is to be located approximately 13 km northwest of the existing Enniskillen – Omagh 110 kV circuit. A switching station is to be established at a location provisionally called 'Omagh-South.' This switching station will accommodate a new 110 kV overhead line circuit from the cluster and split the Enniskillen – Omagh circuits into two. The new 110 kV circuit is assumed to be portal with Zebra conductor strung for 75°C. This project is expected to be completed by winter 2016/17.

Coolkeeragh 275/110 IBTX 1

The interbus transformer IBTX 1 at Coolkeeragh is to be replaced with a transformer that will have a 60 MVA tertiary winding. The asset replacement first appears in the TYTFS study files during winter 2016/17.

Airport Road Main

It is planned to construct a new 110/33 kV substation including 2 x 90 MVA transformers and 33 kV switchboard at Airport Road. The substation will be fed as a radial from Castlereagh Main 110 kV. The substation will supply both Airport Road and Queens Road 33/6.6 kV substations which are to be transferred from Creagh Main and Ballymacarrett 33/6.6 kV substation which is to be transferred from Knock Main. Airport Road first appears in the TYTFS study files during winter 2016/17.

Tandragee Main

The interbus transformer IBTX 1 at Tandragee is to be replaced with a transformer that will have a 60 MVA tertiary winding. The asset replacement first appears in the TYTFS study files during winter 2016/17.

Castlereagh 4th 275/110 kV IBTX

A fourth 240 MVA IBTX at Castlereagh is to be installed. The level of demand on Castlereagh requires all supplies to be maintained for the maintenance of one 275/110 kV IBTX coinciding with a forced outage of another Castlereagh IBTX. The project first appears in the TYTFS study files during winter 2017/18.

Coolkeeragh-Magherafelt 275 kV Circuits

It is proposed to change the conductor on the existing double circuit tower line. The proposed new conductor may be Rubus 500 mm^2 AAAC. The new circuits are assumed to have minimum ratings of 761 MVA because of the existing cable element in each circuit. This asset replacement first appears in the TYTFS study files during winter 2017/18.

Hannahstown-Lisburn 110 kV Circuits

The conductors on the Hannahstown – Lisburn ‘1’ and ‘2’ 110 kV single circuits are to be replaced with a UPAS conductor. Several credible contingencies cause the above circuits to be overloaded during high transfers from Northern Ireland to Ireland. With the completion of the 400 kV North-South tie-line the net transfer capability is expected to be increased initially to 1000 MVA. The rating of the Hannahstown – Lisburn circuits however will restrict that. It is planned to change the conductors to match the cable sections, i.e. a rating 144 MVA. The project is expected to be completed by winter 2017/18.

Kells – Mid-Antrim New 110 kV Circuit

It is proposed to construct a second 110 kV circuit between Kells and Mid-Antrim cluster. This additional circuit is required primarily to facilitate the large amounts of wind generation anticipated at the Mid-Antrim and Brockaghboy cluster substations. It is assumed that the construction will be approximately 40 km in length on Portal construction with Zebra conductor strung at 75°C. This circuit will have a minimum rating of 188 MVA. This project is expected to be completed by winter 2017/18.

North Antrim (Tidal)

It is planned to construct a 110/33 kV substation in the North Antrim area to enable the connection of the two tidal schemes at Torr Head and Fair Head. The new North Antrim substation will be connected via 110 kV circuits to Coleraine and Kells. The connection methodology of these tidal schemes is currently under further assessment and is subject to change. This project is included in the TYTFS study files from winter 2019/20.

South Down (Offshore Wind)

It is proposed to construct a 275 kV node in the South Down area to facilitate the connection of 600 MW of off-shore wind generation off the South Down coast. It is assumed this substation will be connected to the Castlereagh 275 kV substation via a 275kV double circuit. It should be noted that this plan is currently under further assessment and subject to change. This project is included in the TYTFS study files from winter 2019/20.

Omagh South – Turleenan 275 kV Circuit

It is proposed to construct a new 275/110 kV node in the Omagh South area to relieve the potential congestion of wind in the west of Northern Ireland and the associated constraint costs. The new line will connect into Turleenan substation; this will be a single 275 kV circuit with a zebra conductor strung on a portal design construction. This project is expected to be completed by winter 2019/20.

3.6 JOINT NORTHERN IRELAND AND IRELAND APPROVED TRANSMISSION SYSTEM DEVELOPMENTS

This section includes transmission system developments which have been approved by both NIE and EirGrid.

A new 400 kV line is currently being progressed by EirGrid and Northern Ireland Electricity (NIE). 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. This project first appears in the TYTFS study files during winter 2017/18. Once this connection is established, the constraints on the existing Tandragee-Louth 275 kV double circuit will be significantly reduced.

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
Athea	New Athea 110 kV substation tail-connected into Trien 110 kV substation
Athea Wind Farm (Extension)	Connected into the planned Athea 110 kV substation
Ballakelly	Connected to a new Ballakelly 220 kV substation, itself tail-connected into Louth 220 kV substation
Beltonanean	Connected to a new Tremoge 110 kV substation, itself looped into the exisiting Omagh – Dungannon 'B' circuit
Bindoo Wind Farm (Extension)	Connected into the existing Ratrussan 110 kV substation
Booltiagh Wind Farm (Extension)	Connected into the existing Booltiagh 110 kV substation
Brockaghboy	Connected into a new Brockaghboy 110 kV cluster substation, itself connected into the furture Mid-Antrim 110 kV substation
Castlecraig	Connected into the future Drumquin 110 kV cluster substation, itself tail-connected into Omagh South 110 kV substation
Caulstown	Connected to a new Caulstown 110 kV substation, itself connected into the existing Platin-Corduff 110 kV line
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
Cornavarrow	Connected into the future Drumquin 110 kV cluster substation, itself tail-connected into Omagh South 110 kV substation
Creggarconroe	Connected to a new Tremoge 110 kV substation, itself looped into the exisiting Omagh – Dungannon 'B' circuit
Crockandun	Connected to a new Tremoge 110 kV substation, itself looped into the exisiting 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 exisiting Omagh – Dungannon 'B' circuit
Crockdun	Connected to a new Tremoge 110 kV substation, itself looped into the exisiting 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

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

Generator	Planned Connection Method
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 exisiting Omagh – Dungannon 'B' circuit
Great Island CCGT	Connected to a new Great Island 220 kV substation
Innishative	Connected to a new Tremoge 110 kV substation, itself looped into the exisiting Omagh – Dungannon 'B' circuit
Keelderry	New Knockavanna 110 kV substation looped into the Agannygal-Derrybrien 110 kV circuit
Kill Hill	Connected to a new Kill Hill 110 kV substation, itself connected into the existing Cahir-Thurles 110 kV line
Knocknagreenan	Connected to a new Knocknagreenan 110 kV substation, itself tail-connected into Carrigadrohid 110 kV substation
Long Mountain	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit
Moneypoint	Connected into existing Moneypoint substation at 110 kV
Mountlucas	Connected to a new Mountlucas 110 kV substation, itself connected into the planned Cushaling-Thornsberry 110 kV line
Mulreavy	New Mulreavy 110 kV substation tail-connected into the planned Clogher 110 kV substation
Nore Power	Connected to a new Nore 110 kV substation, itself tail-connected into Kilkenny 110 kV substation
Off-Shore Wind (South Down)	Connected to a new South Down 275 kV substation, itself connected into Castlereagh 275 kV substation
Pigeon Top	Connected into the future Drumquin 110 kV substation, itself tail-connected into Omagh South 110 kV substation
Seegronan	Connected into the future Magherakeel 110 kV substation, itself tail-connected into Omagh 110 kV substation
Shantavny Scotch	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Slieve Divena 2	Connected to a new Gort 110 kV cluster substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Slieve Kirk (extension)	Connected into the exisiting Slieve Kirk windfarm, itself connected into the Killymallaght 110 kV cluster substation
Smulgedon	Connected into a new Brockaghboy 110 kV cluster substation, itself connected into the furture Mid-Antrim 110 kV substation
Oweninney	Connected to a new Bellacorick 400 kV substation, itself tail-connected into the new Flagford 400 kV substation
Suir	Connected to a new Suir 110 kV substation, itself tail-connected into Cahir 110 kV substation
Thornog	Connected into the future Magherakeel 110 kV cluster substation, itself tail-connected into Omagh 110 kV substation
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

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
Ballyragget	BGT	Ballyragget	Kilkenny
Bancroft	BCT	Tallaght	Dublin
Belfast North Main	BNM	Belfast	Antrim
Blackpool	BLP	Kilbarry	Cork
Bracklone	BRA	Portarlington	Laois
Cherrywood	CHE	Loughlinstown	Dublin
Cloghran	CLG	Ballycoolin	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
Stevenstown	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 December 2012. 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 2022, 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 2012, 2016, 2019 and 2022. 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-19 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-20 to B-22 list the details of the planned network transformers.
- Tables B-23 to B-25 include the Mvar capacity data for planned reactive compensation devices.
- Tables B-26 to B-27 list the details of the planned Northern Ireland interbus transformers on a three winding basis.

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

4.1 Forecasts of Transmission Peaks
4.2 Demand Profiles
4.3 Northern Ireland Load Duration Curve
4.4 Forecast Demand at Transmission Interface Stations
4.5 Northern Ireland Bulk Supply Point 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 2013-2022*, published by EirGrid and SONI in January 2013 contains forecasts of future energy consumption and demand for the ten-year period to 2022.

4.1 FORECASTS OF TRANSMISSION PEAKS

Table 4-1 presents the median winter peak forecasts of transmission demand for the ten years 2013 to 2022, 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 1.3% over the period 2013 to 2022. This is approximately equal to that predicted in the All-Island Generation Capacity Statement 2012-2021, which forecast 1.3% average annual increase in winter peak demand over the period 2012-2021.

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

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
GCS 2013-2022 (MW)	6,431	6,501	6,590	6,674	6,751	6,829	6,923	7,049	7,148	7,241
GCS 2012-2021 (MW)	6,441	6,540	6,630	6,711	6,780	6,851	6,922	7,019	7,128	N/A
Difference (MW)	-10	-39	-40	-37	-29	-22	1	30	20	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, the summer peak, the 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
2013	6,431		5,180		2,189		
	4,768	1,733	3,814	1,366	1,669	520	1,491
2014	6,501		5,237		2,213		
	4,825	1,747	3,860	1,377	1,689	524	1,502
2015	6,590		5,308		2,243		
	4,888	1,773	3,910	1,397	1,711	532	1,525
2016	6,674		5,375		2,271		
	4,946	1,800	3,957	1,418	1,731	540	1,548
2017	6,751		5,437		2,297		
	4,996	1,828	3,997	1,440	1,749	548	1,572
2018	6,829		5,501		2,324		
	5,048	1,856	4,038	1,463	1,767	557	1,596
2019	6,923		5,577		2,355		
	5,114	1,885	4,091	1,485	1,790	566	1,621
2020	7,049		5,677		2,398		
	5,210	1,915	4,168	1,509	1,824	575	1,647
2021	7,148		5,758		2,432		
	5,281	1,946	4,225	1,533	1,848	584	1,673
2022	7,241		5,835		2,464		
	5,346	1,977	4,277	1,558	1,871	593	1,700

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 2013 forecast of 6,431 MW is the maximum demand projected to occur in winter 2013/14. 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 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 represent 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 2013 forecast of 1,733 MW is the maximum demand projected to occur in winter 2013/14.

The summer peak refers to the average peak value between May and August. This is typically 21.2% 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 autumn period, can restrict the transmission system, further reducing its capability to transport power.

Ireland Transmission Peaks

The winter peak represent the expected annual peak demands that are forecast to occur in the October to February winter period of each year e.g. the 2013 forecast of 4,768 MW is the maximum demand projected to occur in winter 2013/14.

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

The forecasts of 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 for the Winter Peak period of 2012. The Ireland and Northern Ireland peaks did not occur on the same day, but both occurred during December 2012.

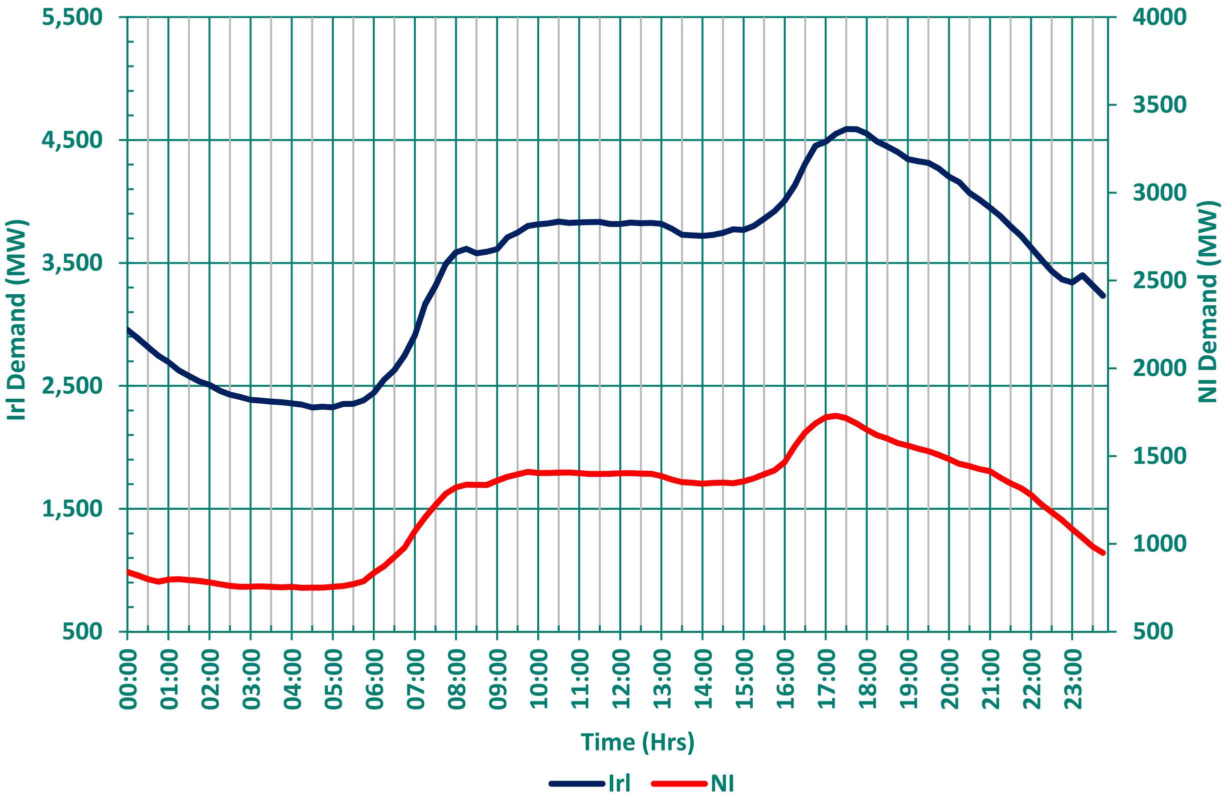


Figure 4-1 Generated Peak Demand Profiles for 2012

All-Island Demand Profiles

Figure 4-2 shows the profiles of Winter Peak, Summer Peak and Summer Valley on an all-island basis and the percentage demand attributable to each jurisdiction during the peak and valley scenarios.

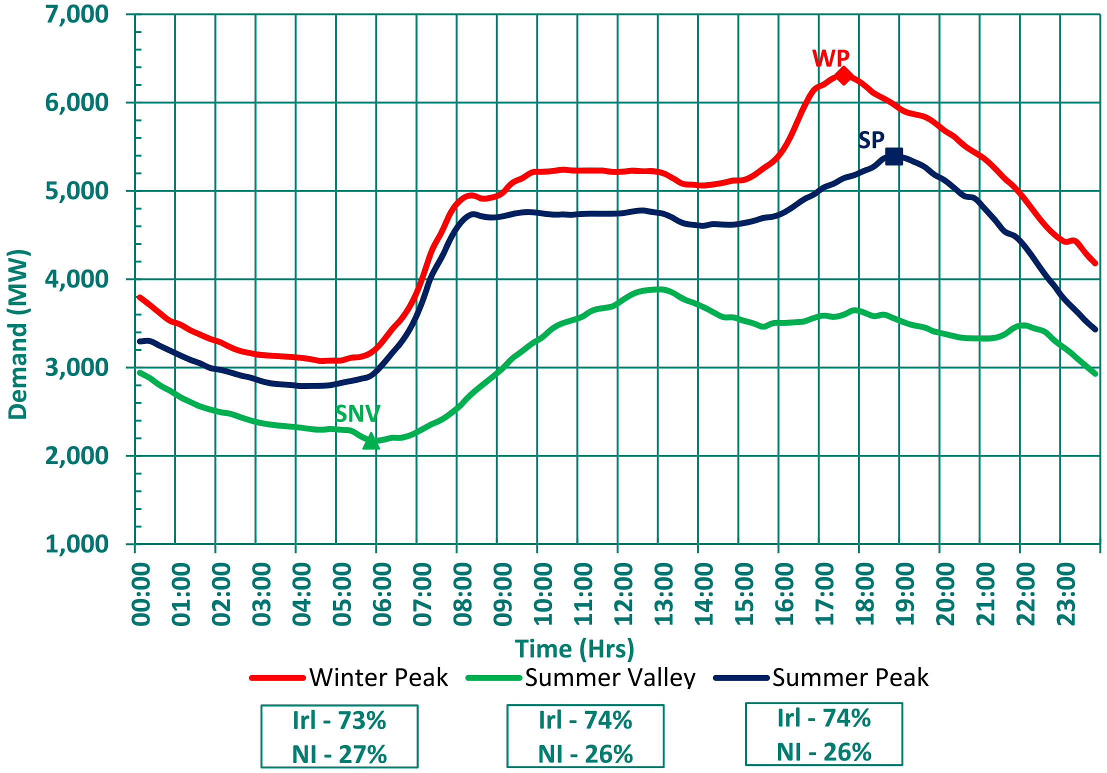


Figure 4-2 All-Island Daily Demand Profiles for Year 2012

All-Island Weekly Demand Peaks

Figure 4-3 below shows the profile for the All-Island, Northern Ireland and Ireland weekly peaks across the year for 2012.

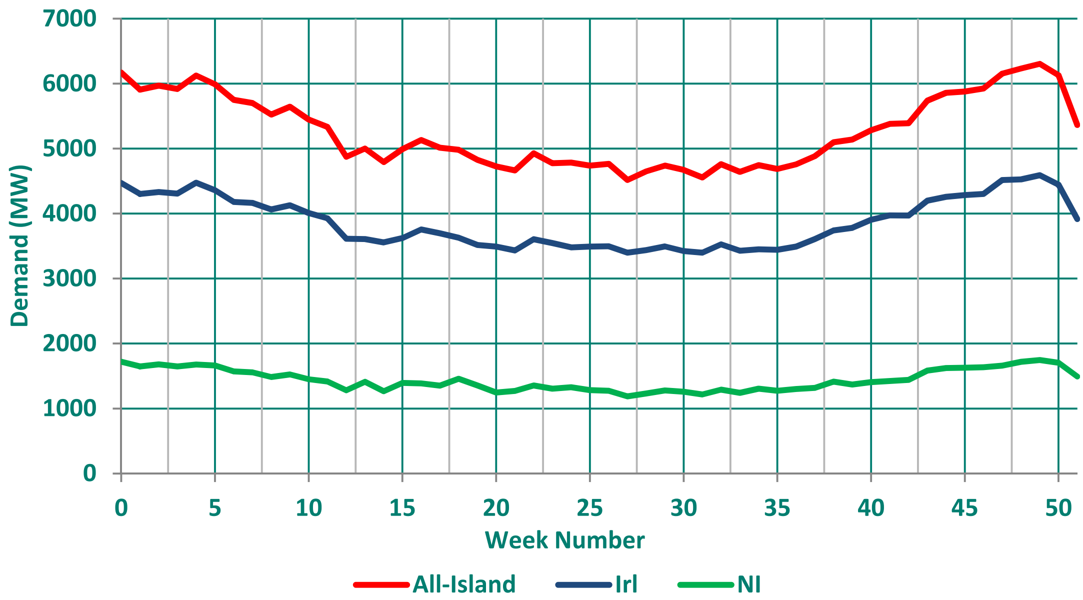


Figure 4-3 Weekly Peak Values for Year 2012

4.3 NORTHERN IRELAND LOAD DURATION CURVE

Figure 4-4 shows the Northern Ireland load duration curve for 2012. 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 more than 55% of the time.

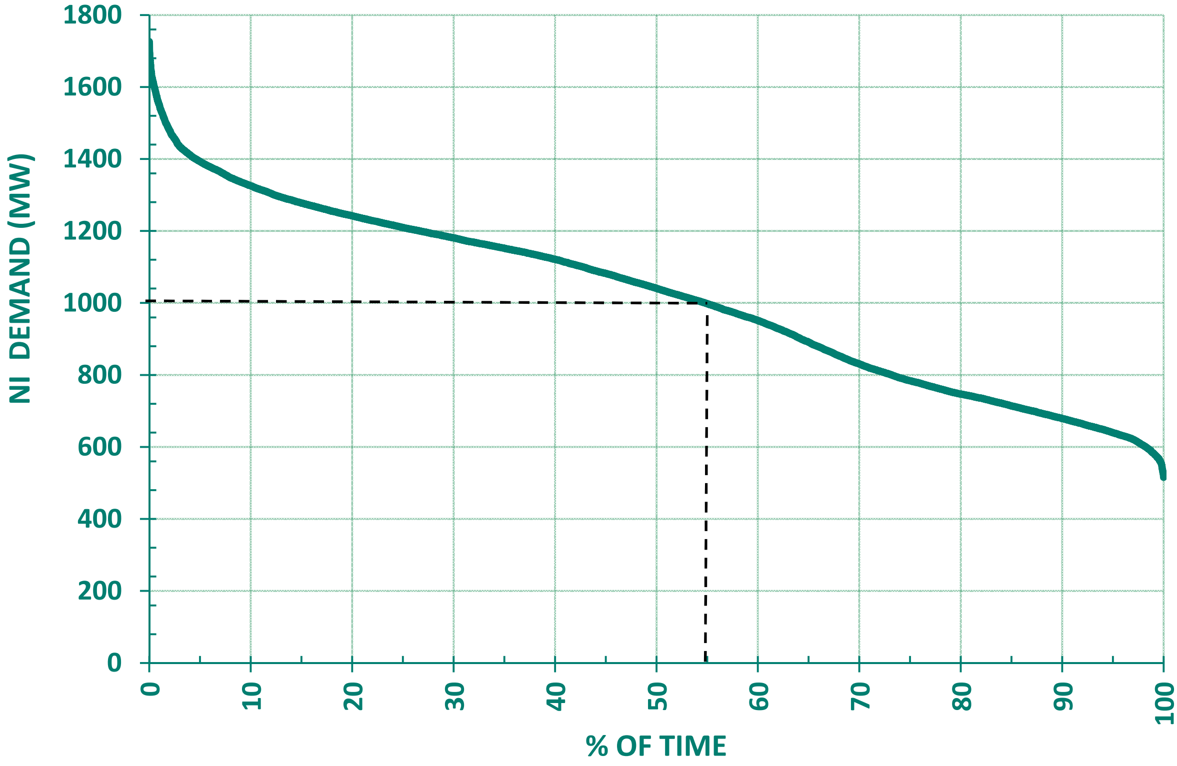


Figure 4-4 Northern Ireland Load Duration Curve 2012

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 2013 to 2022. 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 management schemes 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

5.1 Ireland

5.1.1 Existing and Planned Transmission-Connected Generation

5.1.2 Demand Side Units

5.1.3 Planned Retirement/Divestiture of Generation Plant

5.1.4 Embedded Generation

5.1.5 Wind Generation

5.1.6 Offshore Generation

5.2 Northern Ireland

5.2.1 Existing and Planned Transmission-Connected Conventional Generation

5.2.2 Planned Retirement/Divestiture of Northern Ireland Generation Plant

5.2.3 Embedded Generation

5.2.4 Northern Ireland Renewable Generation

5.2.5 Northern Ireland Generation Mix

5 GENERATION

This chapter gives information about existing generation capacity and future projections for the ten years to 2022. 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 3,500 - 4,000 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, renewable CHP.

The Strategic Energy Framework (SEF) 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 and EirGrid, are planning for this 40% target to be met by the year 2020. This 40% government target translates into approximately 1,600 MW of renewable generation capacity in Northern Ireland.

On the 01st of December 2012 (Ireland) and 01st of November 2012 (Northern Ireland), the data was frozen in order to permit TYTFS analyses to be carried out, some 8,747 MW of generation capacity was installed in Ireland and 2,862 MW of generation capacity was installed in Northern Ireland.

5.1 IRELAND

5.1.1 Existing and Planned Transmission-Connected Generation

Of this 8,747 MW of generation capacity, 7,531 MW is connected to the transmission system and 1,216 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 7,531 MW figure for transmission system-connected generation capacity does not include the East West Interconnector.

On the 01st December 2012, 24 connection agreements have been executed for a total generation capacity of 2,073 MW due to be connected to the transmission system. These planned generators are listed in Table 5-1 with their expected connection dates as at the time of the data freeze.

Table 5-1 Planned Transmission-Connected Generation as at December 01st 2012

Generator	Description	Expected Connection Date
Athea Wind Farm	51 MW wind farm in Co. Limerick	June 2013
Booltiagh Wind Farm (Extension)	12 MW wind farm extension in Co. Clare	June 2013
Great Island CCGT	431 MW CCGT in Co. Wexford	September 2013
Kill Hill Wind Farm	62.5 MW wind farm in Co. Tipperary	September 2013
Mountlucas Wind Farm	79.2 MW wind farm in Co. Offaly	September 2013
Glanlee Wind Farm (Extension)	6 MW wind farm extension in Co. Cork	December 2013
Athea Wind Farm (Extension)	22 wind farm extension in Co. Limerick	September 2014
Mulreavy Wind Farm	89.85 MW wind farm in Co. Donegal	September 2014
Clahane Wind Farm	13.8 MW wind farm in Co. Kerry	November 2014
Caulstown	58 MW OCGT in Co. Meath	April 2015
Seecon Wind Farm	105 MW wind farm in Co. Galway	June 2015
Ugool Wind Farm	64 MW wind farm in Co. Galway	June 2015
Cloghboola Wind Farm	46 MW wind farm in Co. Kerry	September 2015
Moneypoint Wind Farm	21.9 MW wind farm located at Moneypoint coal-fired power station in Co. Clare	December 2015
Oweninney (1) Wind Farm	34 MW wind farm in Co. Mayo	April 2020
Oweninney (2) Wind Farm	48 MW wind farm in Co. Mayo	April 2020
Oweninney (3) Wind Farm	56 MW wind farm in Co. Mayo	April 2020
Oweninney (4) Wind Farm	34 MW wind farm in Co. Mayo	April 2020
Ballakelly CCGT	445 MW CCGT in Co. Louth	December 2022
Cuilleen OCGT	98.4 MW OCGT in Co. West Meath	December 2022
Keelderry Wind Farm	29.75 MW wind farm in Co. Galway	December 2022
Knocknagreenan	70 MW pumped storage in Co. Cork	December 2022
Nore Power	98 MW OCGT in Co. Kilkenny	December 2022
Suir OCGT	98 MW OCGT in Co. Tipperary	December 2022

5.1.2 Demand Side Units

Two Demand Side Units (DSU) have entered the Single Electricity Market with a combined dispatchable capacity of 41 MW. The current Demand Side Management scheme, Winter Peak Demand Reduction Scheme (WPDRS), has been phased out. It is assumed that an increase in DSUs and other measures will result a similar amount of demand reduction.

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 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 01st of December 2012, there was approximately 1,216 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 December 01st 2012, MW

	Wind	Small Hydro	Biomass/ LFG	CHP	Peaking	TOTAL
Net Capacity (MW)	951	26	67	59	114	1,216

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[1]. The *All-Island Generation Capacity Statement 2012-2021 (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 of the 01st of December 2012, five generators have executed connection agreements committing to connecting to the distribution system over the next few years. 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 December 01st 2012

Station	Description	(Expected) 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
Ringsend	72 MW Waste to Energy generator in Co. Dublin	Jun-13
Navan	13 MW Biogas generator in Co. Meath	Aug-14
Tawnaghmore	49 MW Biomass generator in Co. Mayo	Dec-15
Bellacorick	10 MW Wave Energy generator in Co. Mayo	Dec-22
Derryiron	14.49 MW Biomass generator in Co. Offaly	Dec-22

[1] 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.

5.1.5 Wind Generation

Over the past two decades wind power generation in Ireland has increased from 6 MW (one wind farm) to 1,773 MW (159 wind farms) at the beginning of December 2012. Figure 5-1 shows the existing and planned transmission-connected, distribution-connected and the total connected wind power capacity at year end from 2012 to 2022.

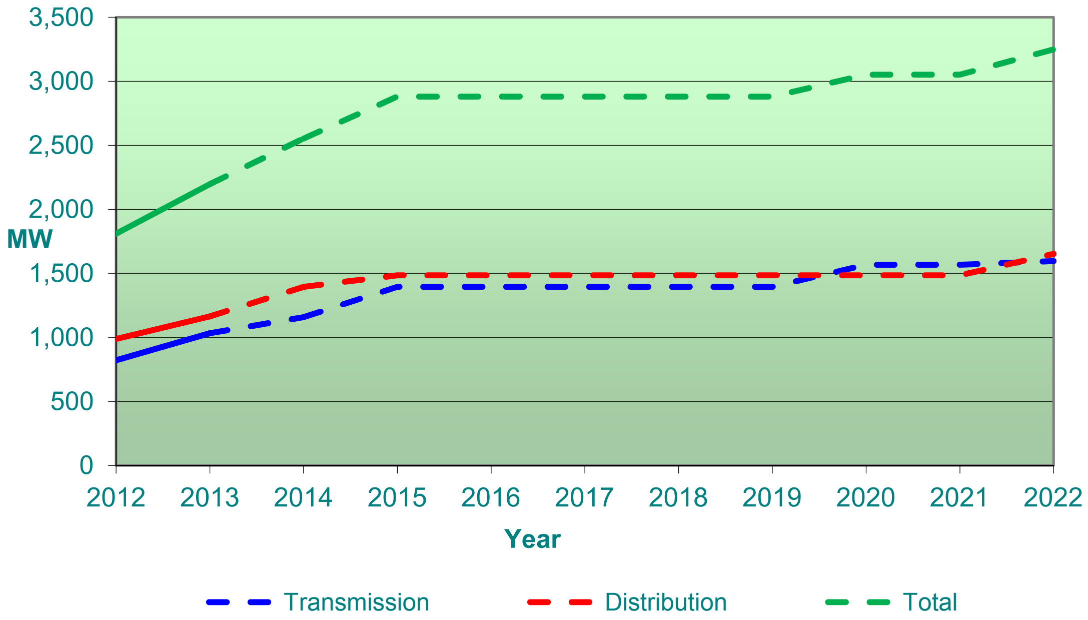


Figure 5-1 Growth in Wind Capacity, 2012 to 2022

As at the 01st of December 2012, 82 wind farms totalling 1,477 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 2012 to 2022. The individual wind farm details are included in Appendix D.

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

Connection	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Transmission	822	1,032	1,158	1,395	1,395	1,395	1,395	1,395	1,567	1,567	1,597
Distribution	988	1,164	1,395	1,485	1,485	1,485	1,485	1,485	1,485	1,485	1,652
Total	**1,809**	**2,197**	**2,553**	**2,880**	**2,880**	**2,880**	**2,880**	**2,880**	**3,052**	**3,052**	**3,249**

Currently, there are a total of 396 applications totalling 22,922 MW in the applications queue, including 42 (3,193 MW) non-Group Processing Approach applications to the TSO and DSO. Since the SEM Tie Break decision was made in March 2013 the amount of contracted wind has increased significantly and it is expected that there will be sufficient renewable generation contracted to connect to the system to meet the 2020 renewable target.

In the period up to the 1st of December 2012 data freeze date, two Gate 3 applicants had connected, a further 43 Gate 3 applicants were contracted to connect, with a further 116 applicants having live Gate 3 offers and a single offer having lapsed. The MWs associated with these offers and the separation between TSO and DSO are shown in Figure 5-2. Following the issuance of a Constraint Report to an applicant, the applicant has 50 Business Days to accept their Offer unless an official dispute is lodged with the CER.

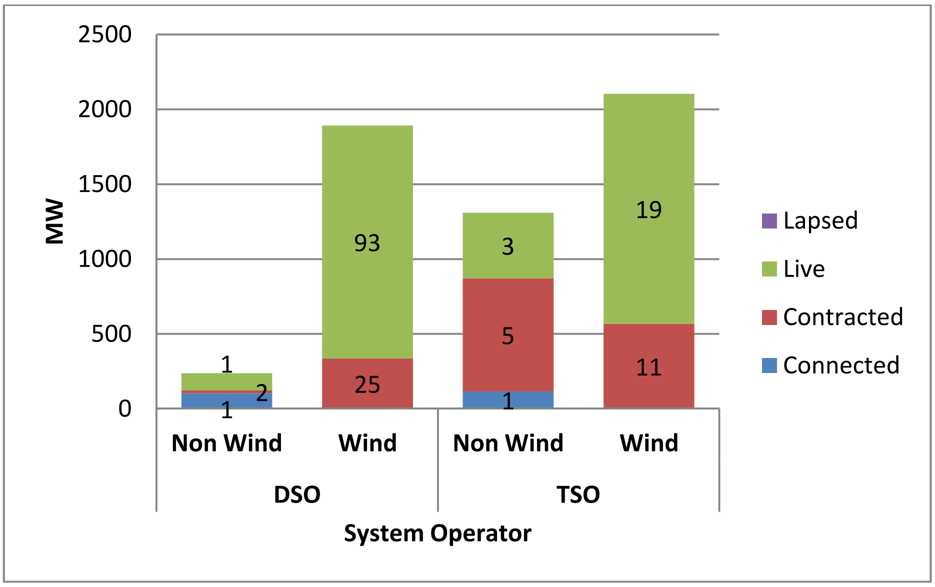


Figure 5-2 Gate 3 Offer Status

Figure 5-3 and Table 5-5 illustrate how Gate 3 generation is distributed across the country.

Table 5-5 Gate 3 Generation Area Totals

Gate 3 Area	Total Generation (MW)
A (North West)	307
B (Mid North West)	1188
C (Midlands)	470
D (Mid West)	121
E (South West)	834
F (South West)	167
G (North East)	186
H1 (Midlands-South West)	591
H2 (South East)	309
I (South)	22
J (Mid East)	1144
K (South)	62

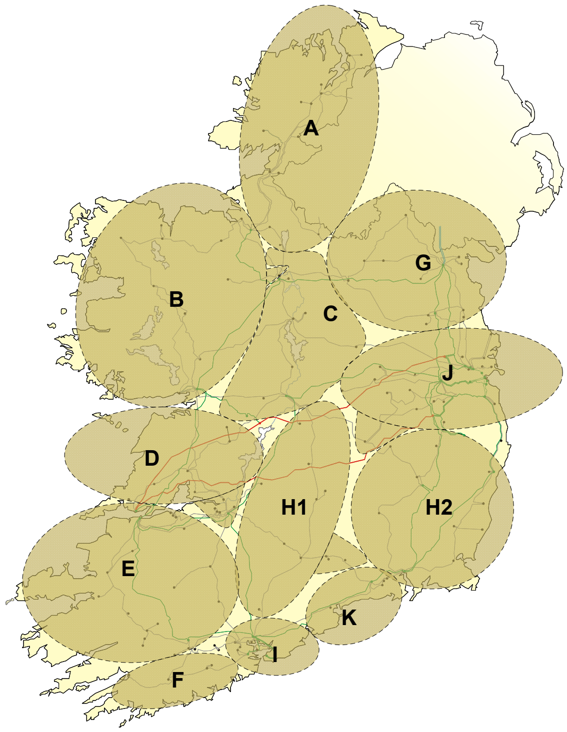


Figure 5-3 Gate 3 Wind Generation Areas

5.1.6 Offshore Generation

In 2012 the Irish Government took the policy decision not to introduce a REFIT support mechanism for offshore wind generation and instead decided to promote the development of offshore wind generation as an export opportunity to UK and North West Europe, provided this is economically beneficial to the state . To help realise this objective the Irish and British Governments signed a Memorandum of Understanding which has triggered detailed analysis of how Irish renewable energy resources might be developed and exported. The Irish Government has also underlined its commitment to the offshore sector in various recent policy documents such as the integrated national marine plan: 'Our Ocean Wealth' and the Department of Communications, Energy and Natural Resources statement on energy priorities to 2020. In the past year the Government also introduced a legislative Bill to modernise the system of foreshore consenting - i.e. licensing developers to explore possible offshore sites - which should make it easier for the development of offshore wind generation in Ireland.

5.2 NORTHERN IRELAND

Of the 2,862 MW, 2,328 MW of generation capacity is connected to the Northern Ireland transmission system and 534 MW is connected to the Northern Ireland distribution system.

The 2,328 MW of transmission connected generation capacity does not take into account the Moyle Interconnector capacity, and is made up of Slieve Kirk windfarm with a capacity of 27.6 MW and 2,300 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-8 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, 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-3. 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. On 30th April 2012 UREGNI published a decision to instruct the cancellation of the GUAs for Ballylumford GT1 and GT2, Coolkeeragh GT8 and Kilroot GT1 and GT2 with effect from 1st November 2012[2]. There is 1714 MW of IMP capacity in Northern Ireland.

Planned Connections of Conventional Generation Plant

There is no new conventional generation currently planned to connect to the transmission system in Northern Ireland over the next 10 years.

[2] http://www.uregni.gov.uk/publications/gua_decision_paper

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:

Ballylumford Gas/HFO ST4, ST5 and ST6 are to be decommissioned by 2016. This is due to environmental constraints introduced by the Large Combustion Plant Directive (LCPD)[3] and will result in a reduction of 510 MW in Northern Ireland plant capacity.

The generation output of Kilroot ST1 and ST2 is anticipated to be severely restricted due to the Industrial Emissions Directive (IED)[4]. 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 5-6 shows a breakdown of the existing Northern Ireland Embedded Generation. There is a 47 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 2022.

There are 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 2022 biogas generation capacity will increase to 25 MW.

[3] http://ec.europa.eu/environment/air/pollutants/stationary/lcp/legislation.htm

[4] http://ec.europa.eu/environment/air/pollutants/stationary/ied/legislation.htm

Table 5-6 Northern Ireland Embedded Generation

Generation	Net Capacity
Large Scale Wind	423
Small Scale Wind	15
Small ScaleBiogass	2
Small Scale Biomass	5
Small Scale Solar	2
Small Scale Hydro	4
Biofuels	1
Landfill Gas	13
CHP	21
AGU	47
Tidal/Wave	1
Total	534

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 the 2011/12 winter, generation of this type is estimated to total 40 MW.

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 5-4. The map indicates the various 110/33 kV Bulk Supply Points (BSPs) and WFPS clusters substations renewable generation is connected to or are assumed to connect to.

In Autumn 2011 the first transmission connected WFPS in Northern Ireland was connected at 110 kV. Slieve Kirk has a capacity of 27.6 MW connected to the backbone network at the Killymallaght substation.

NIE are developing 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.

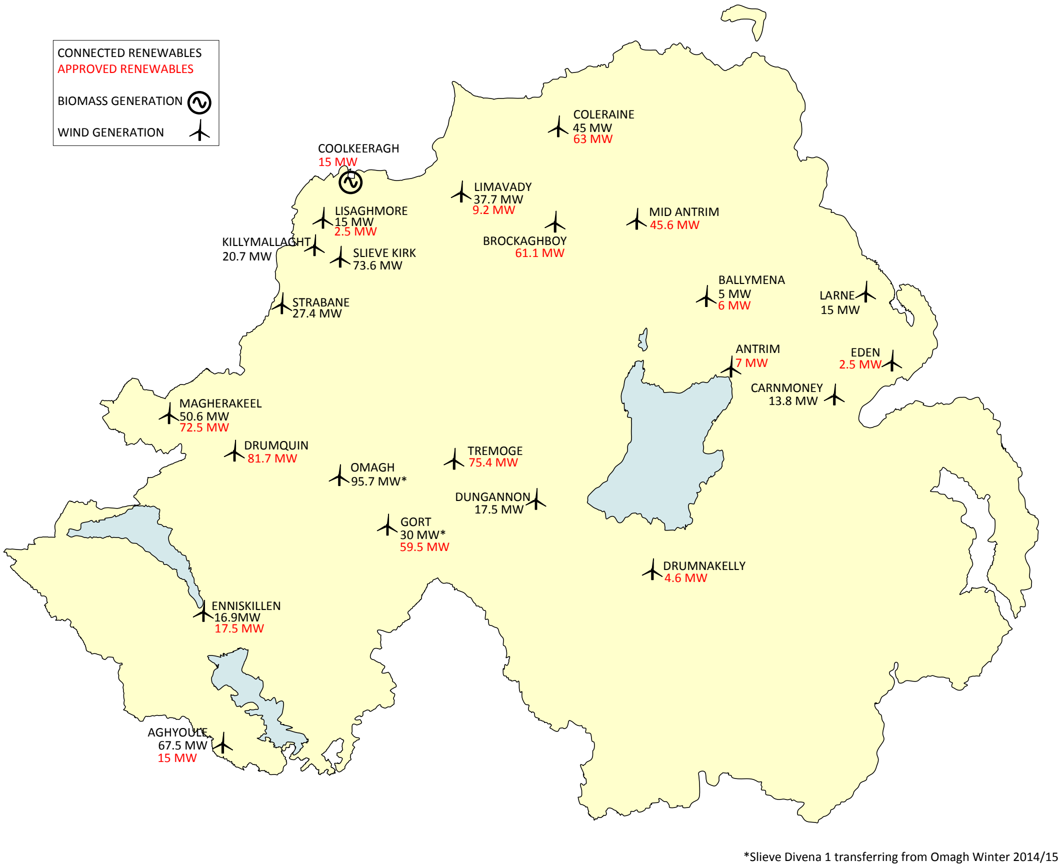


Figure 5-4 Existing and Committed Northern Ireland Renewable Generation

Unapproved Renewable Generation

In order to ensure that this statement is representative of the future Northern Ireland transmission system; renewable projects that were not approved by NIE at the time of the data freeze, but are expected to connect to the Northern Ireland Transmission System over the next seven years have been modelled in the TYTFS study files. Renewable generation that has been included in the TYTFS study files are detailed in Table 5-7.

Table 5-7 Capacity and Location of Renewable Generation by Year End

Transmission Node	Northern Ireland Renewable Capacity (MW)										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Aghyoule	67.5	67.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
Antrim	-	-	-	7	7	7	7	7	7	7	7
Ballymena (Rural)	5	5	11	11	11	11	11	11	11	11	11
Belfast North Main	-	-	-	-	-	15	15	15	15	15	15
Brockaghboy	-	-	-	-	45	45	45	61.1	61.1	61.1	61.1
Carnmoney	-	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
Coleraine	45	45	108	108	108	108	108	108	108	108	108
Coolkeeragh	-	15	15	15	15	15	15	15	15	15	15
Drumnakelly	-	-	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Drumquin	-	-	-	-	-	81.7	81.7	81.7	81.7	81.7	81.7
Dungannon	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Eden	-	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Enniskillen	16.9	16.9	31.9	31.9	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Fair Head	-	-	-	-	-	-	20	40	80	100	100
Gort	-	-	30	30	82.6	82.6	89.5	89.5	89.5	89.5	89.5
Killymallaght	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7
Larne	15	15	15	15	15	15	15	15	15	15	15
Limavady	37.7	37.7	37.7	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Lisaghmore	15	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Magherakeel	50.6	85.1	123	123	123	123	123	123	123	123	123
Mid Antrim	-	-	-	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
Off-Shore Wind	-	-	-	-	-	-	-	-	200	600	600
Omagh	125.7	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
Slieve Kirk	27.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Torr Head	-	-	-	-	-	-	20	40	80	100	100
Tremoge	-	-	-	55.1	57.4	57.4	57.4	57.4	75.4	75.4	75.4
Totals	472	586	728	844	947	1044	1090	1147	1445	1885	1885

Figure 5-5 below 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 5-5 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. For more information on network reinforcements in these areas please see chapter 3.

The Renewable Integration Development Project (RIDP)[5] is currently identifying 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.

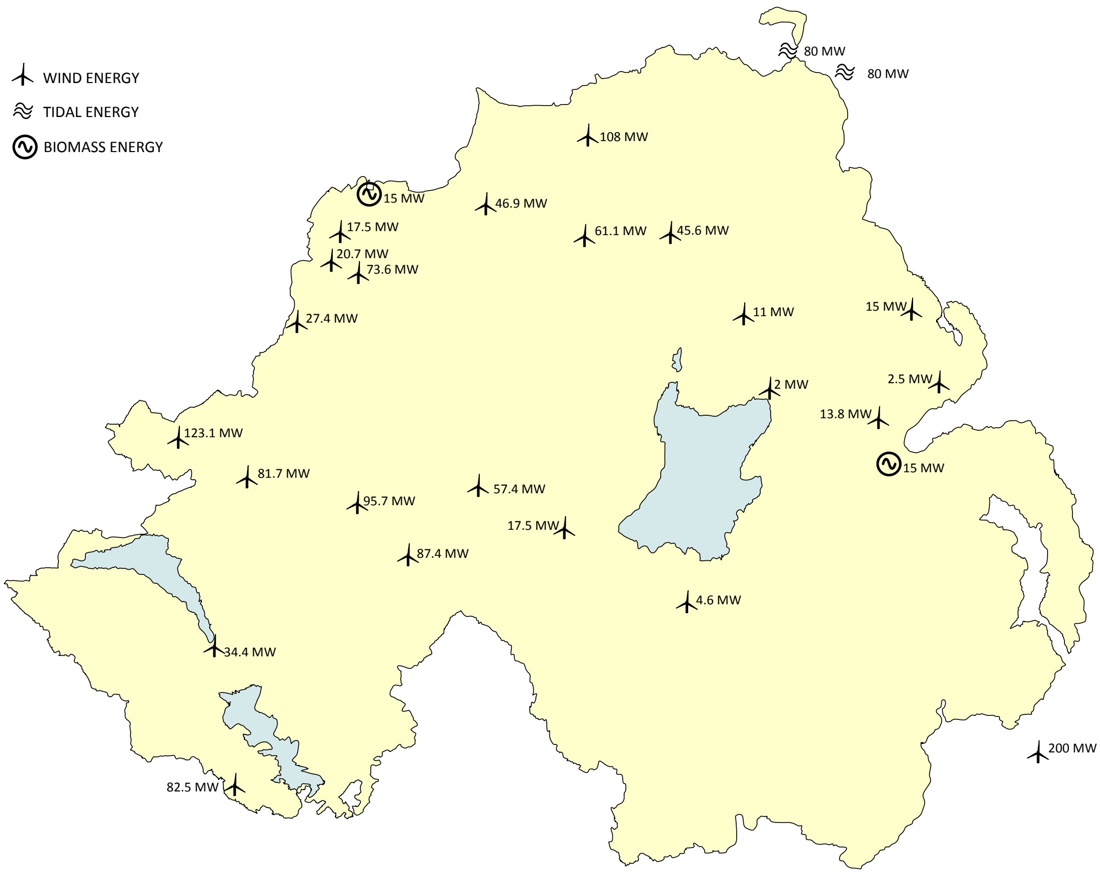


Figure 5-5 Northern Ireland Renewable Generation in 2020

Offshore Renewable Generation

On the 11th October 2012 the Crown Estates[6] announced the award of development rights for a 600 MW off-shore windfarm off the coast of County Down in Northern Ireland waters. 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 have to be altered accordingly.

5.2.5 Northern Ireland Generation Mix

The chart in Figure 5-6 shows all existing and planned generation over the ten year period covered by this TYTFS. Superimposed onto the chart is the median demand forecast form the *All-Island Generation Capacity Statement 2013-2022.*

[5] www.ridp2020.com

[6] www.thecrownestate.co.uk

Figure 5-6 shows a surplus of generation in relation to the demand from a deterministic point of view. However, factors such as economic dispatch, wind variability, reserve requirements and actual HVDC interconnector flows are not taken into account.

The assumed retirement of Ballylumford ST4, ST5 and ST6 at the end of 2015 means that Northern Ireland Generation capacity is reduced by 510 MW for the last seven years of study. The chart also shows the large increases in wind generation expected over the next ten years.

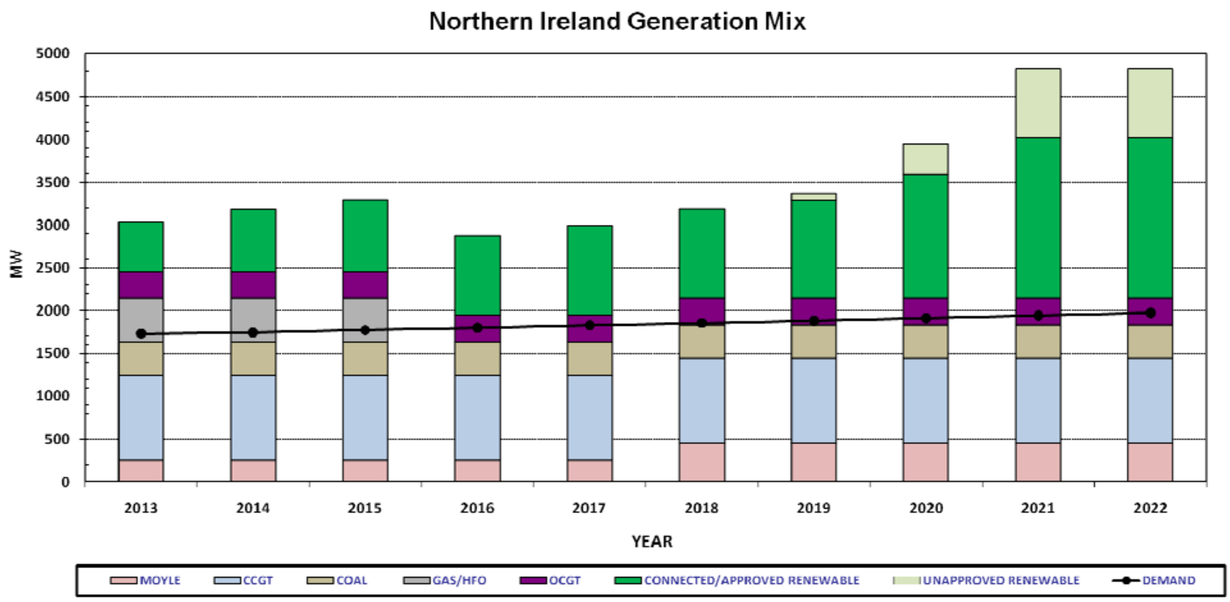


Figure 5-6 Northern Ireland Generation Mix

6 Transmission System Performance

6.1 Forecast Power Flows
6.2 Compliance with Planning Standards
6.3 Short Circuit Current Levels

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 November and December 2012 for Northern Ireland and 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 system in Ireland and Northern Ireland. These increased penetrations are 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. Figure I-2 shows approximately 266 MW of power flowing from the North West of Northern Ireland in Summer Night Valley 2013; it can be seen in Figure I-11 that this power flow increases to circa 392 MW by summer night valley 2022. The reconfiguration of the network at Tamnamore eases the congestion of power flow from the North West to the East in times of minimum demand and high renewable generation.

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 Winter Peak 2013/14 298 Mvars of reactive support was in service in Northern Ireland, this figure increases to 458 Mvars by Winter 2022/23. 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.

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.

Ireland

EirGrid issued its Transmission Development Plan (TDP) 2012-2022 in August 2013. The plan indicates the areas of the transmission system likely to be outside thermal, i.e. circuit loading, and voltage standards over the years up to 2022, 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 been given capital approval by EirGrid 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 standard. Similarly, other developments such as the connection of a new large generator or demand may put areas of the transmission system outside standard. In such cases, further investment may be required.

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.

[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.

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 at the transmission connection point set out in Table 6-1. Current NIE equipment specifications require new users connecting to the Northern Ireland transmission system design their plant and apparatus to withstand the short circuit current levels set out in Table 6-1. Changes to the transmission system or the addition of generation can increase in 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 2013, 2016 and 2019. A description of the calculation methods used and the results are given in Appendix E as well as an explanation of the terms used.

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 peaks, 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.

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

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. In planning the Northern Ireland transmission system short circuit current levels that exceed 80% of the equipment rating should serve as a trigger for NIE to carry out further detailed analysis.

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 level 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 2019. Figure 6-1 presents the short circuit current level results for the winter peak 2019 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 ratings have 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 below provides a list of transmission nodes where the short circuit current level is approaching or would exceed the rating for the years 2013/14, 2016/17 and 2019/20. Where plans are in place to uprate equipment or mitigate the risk these are discussed below, at the time of publishing this was the best information available. 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	2013/2014	2016/2017	2019/2020
>100%	BPS 110 kV	BPS 110 kV	BPS 110 kV
	CAS 110 kV	CDU 110 kV	CDU 110 kV
	CDU 110 kV	KNO (I) 110 kV	CPS 110 kV
	KNO (I) 110 kV[3]		KNO (I) 110 kV
>90%	BPS 275 kV	COL (I) 110 kV	BVG 110 kV
	COL (I) 110 kV[4]	CPS 110 kV	CAS 110 kV
	CPS 110 kV	HAN 110 kV	COL (I) 110 kV
	DUN 110 kV	KBY 110 kV	HAN 110 kV
	HAN 110 kV	KNO (N) 110 kV	KBY 110 kV
	KBY 110 kV[4]	MR 110 kV	KNO (N) 110 kV
	KEL 110 kV	STR (N) 110 kV	MR 110 kV
	KNO (N) 110 kV	TBG 110 kV[4]	STR (N) 110 kV
	MR 110 kV[4]		TAN 110 kV
	TAN 110 kV		TBG 110 kV

[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.

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 due to be completed by Winter 2015/16. 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 at Ballylumford after winter 2015/16 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 110 kV substation is presently being refurbished with the switchgear being rated at 40 kA and is due to be completed by winter 2014/15. However, following the refurbishment the substation will be limited to 31.5 kA by the AEG circuit breakers.

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 2018; its primary purpose is to facilitate outages on 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 2019/20. 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 2019.

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. Tables E-3, E-5 and E-7 show this is not an issue over the period covered by this TYTFS.

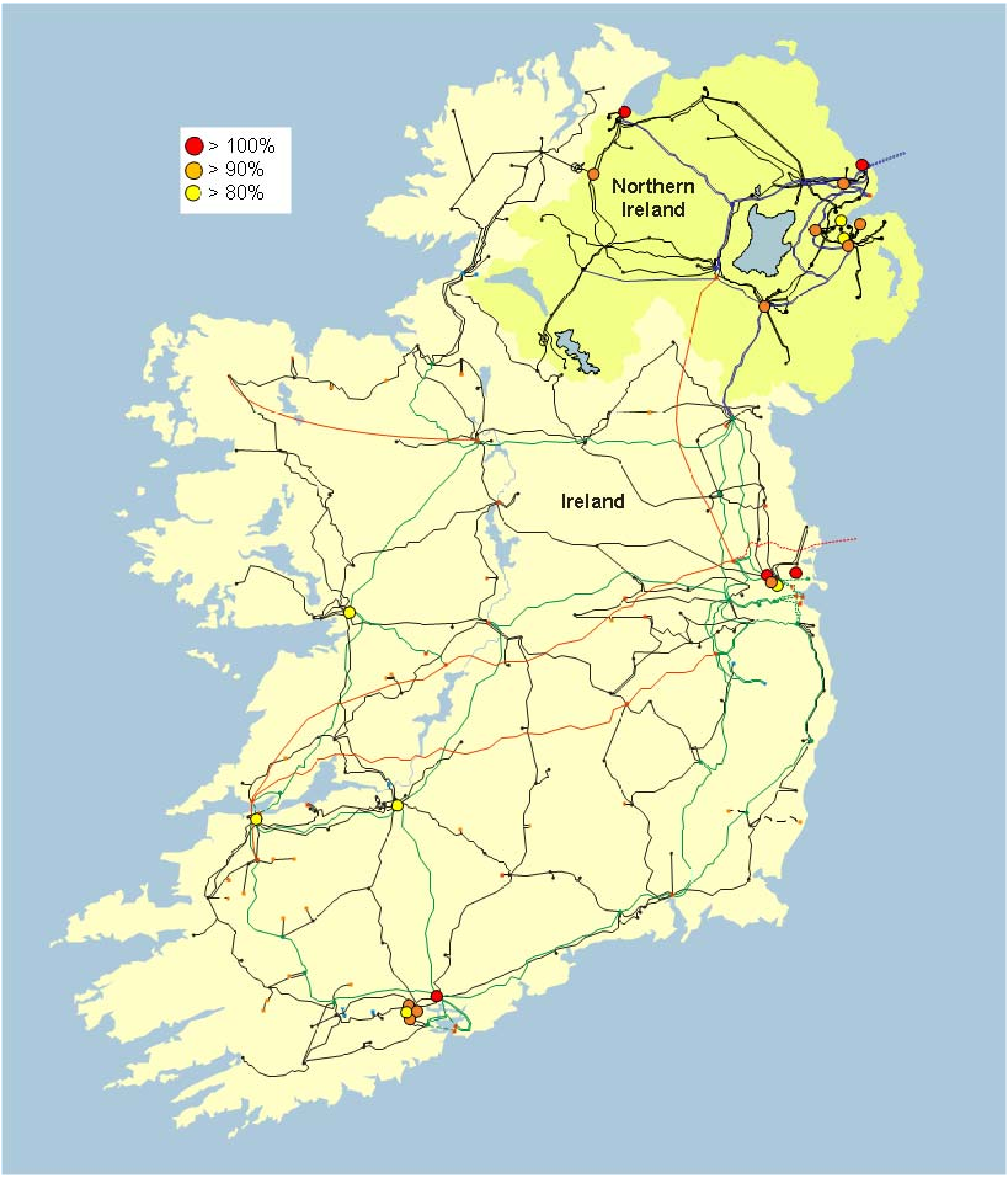


Figure 6-1 Short Circuit Current Levels for Winter Peak 2019/20

7 Overview of Transmission System Capability Analyses

7.1 Generation Opportunity Analysis in Ireland

7.2 Demand Opportunity Analysis in Ireland

7.3 Generator Opportunity Analysis in Northern Ireland

7.4 Demand Opportunity Analysis in Northern Ireland

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 analyses, together with information in other chapters, act as a guide to provide the basis for the statements of opportunity in Chapter 8.

The analyses were 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 chapter 8 and appendix F-1. This analysis provides developers with additional information aiding commercial opportunities of advancing, divesting of or accumulating generation projects. This quantitative analysis is based on studies completed in 2012/13 for recalculating the Gate 1, 2 and 3 Firm Access Quatities (FAQs).

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 recalculation 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 in relation to capacity for demand opportunities) 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 of that year using information describing the existing and planned transmission system as per the 2012 ITC FAQ analysis[1]. The locations analysed are 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 are dependent on the assumptions made about generation[2] and demand, and on the completion dates of transmission system development projects as described in previous chapters. 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 are designed to create credible power flows along identified transmission network corridors. They are designed such that the main transmission corridors out of a group processing area are 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 generation 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 transmission corridors out of the group processing area of the test node with the result presented in section 8.1.4 being the lowest amount that could be accommodated following each of the tests.

7.2 DEMAND OPPORTUNITY ANALYSIS IN IRELAND

This section describes the analyses carried out to determine the capability of the transmission system of Ireland to accommodate additional demand at various parts of the

1 Transmission network reinforcement assumed study dates as per the 2012 ITC FAQ analysis can be found in Table F-1 in Appendix F.

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

3 Test nodes are identified in Table 8-2 in chapter 8.

transmission system. The results of these analyses, together with information in other chapters, provide the basis for the statements of opportunity in Chapter 9.

The analyses were carried out for three specific years:

2013: This is the first year of the period of the TYTFS. The information provided for 2013 gives developers a useful indication as to the opportunities that exist in the short-term.

2016: 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.

2019: 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. The base case generation dispatch scenarios used for the studies are presented in Table D-5 in Appendix D.

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 as described in previous chapters. Factors that may influence the results are discussed in Section 7.2.4.

7.2.1 Transfer Capability Analyses 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 such 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.

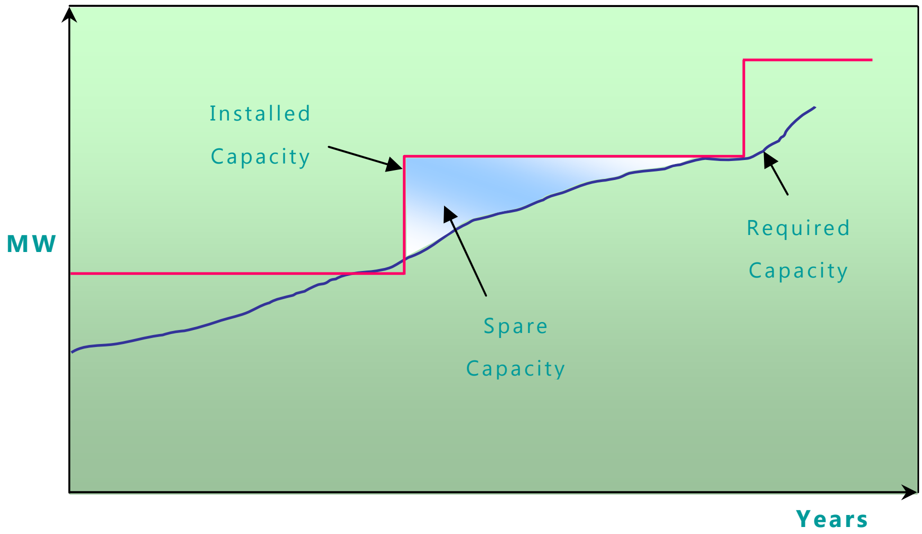


Figure 7-1 Illustration of Typical Step Change in Network Capacity

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 TFS 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.

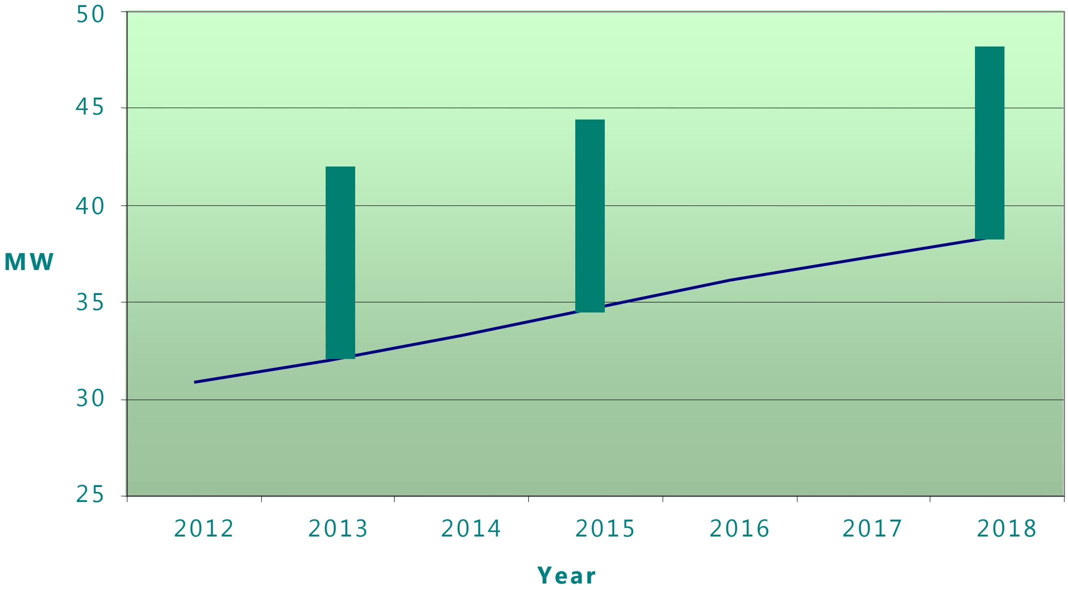


Figure 7-2 Demand Profile at Typical Station

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.

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 and 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. 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 9.2 of Chapter 9.

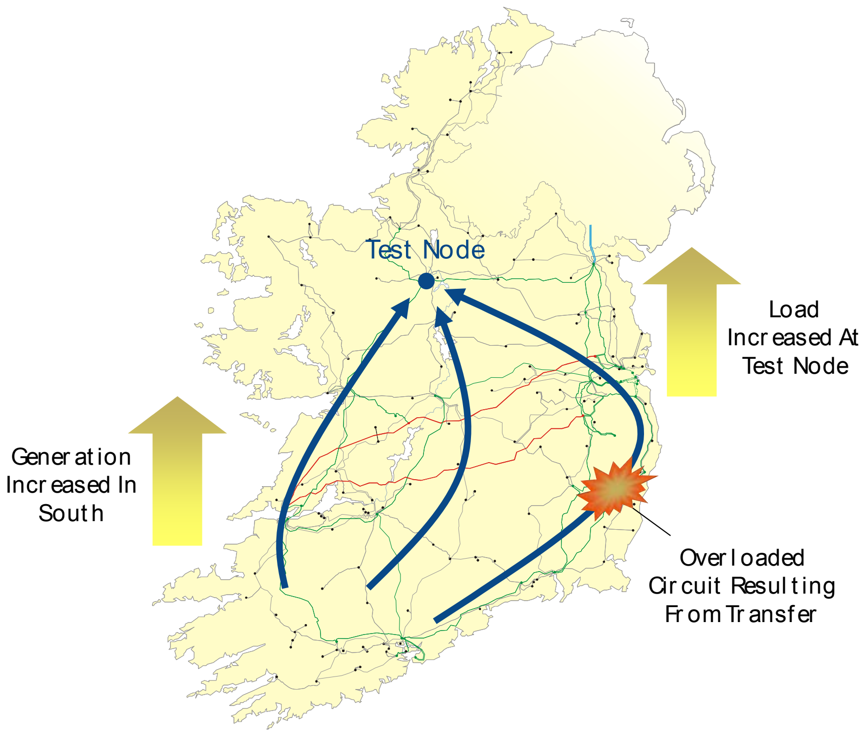


Figure 7-3 Illustration of Incremental Transfer Capability Study Method for Demand

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 2013. 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 2013 using the demand forecasts presented in Table C-2 in Appendix C and the relevant generator dispatch from Table D-4 in Appendix D.

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 2013.

In assessing opportunities for new demand, the TFS 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 2013-2022 (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 - the Gate 3 process has resulted in connection offers for 5,500 MW of conventional and wind generation being issued;

- delays in connection of committed new generation;
- 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

The 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 2022/23, 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 Norther 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 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. Generation opportunities are also analysed at 33 kV nodes at 110/33 kV Bulk Supply Points (BSP) and cluster substations. This is necessary because of the increasing amounts of renewable generation connecting at 33 kV or at lower voltage levels. Though connected at distribution level it is causing circuit thermal limits on the transmission system to be exceeded and constraints are necessary at certain times. Therefore it is important to study the effects of further connections at distribution level moving forward.

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 carryout 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, were possible, that 'under voltage' did not limit the capacity of the network. The amount of reactive support that was used in the study files is considerable by 2022 and in some cases could be as high as 590 Mvar.

It is essential that NIE's Transmission Investment Plan provides adequate reactive power support to maintain stable operation and voltage control on the Northern Ireland transmission system.

[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

7.3.4 Operating and Protection Schemes

During certain outages, protection schemes have been included in the analysis. These are detailed below.

Tamnamore

The Tamnamore Phase 2 project involves the installation of a second 275/110 kV Interbus Transformer (IBTX). SONI are assuming that the completion of Tamnamore Phase 2 will result in the two 110 kV circuits between Tamnamore and Drumnakelly being normally run open. For maintenance of one IBTX at Tamnamore, the circuits will be closed for system security purposes. It is recognised that this will result in system constraints until NIE construct 275 kV transmission corridors from the North-West of Northern Ireland.

For the loss of one Tamnamore to Turleenan 275 kV circuit the remaining intact Tamnamore to Turleenan circuit is susceptible to overloads under certain generation scenarios. In this analysis it is assumed that following an n-1 contingency between Tamnamore and Turleenan the other circuit is tripped automatically.

In addition to this issue analysis has shown that the loss of the 275 kV double circuit between Tamnamore and Turleenan can result in significant overloads on the 110 kV circuit between Creagh and Tamnamore. This overload is being driven by large power exports to Ireland, therefore, in the event of the loss of the 275 kV double circuit, the 110 kV circuit between Tamnamore and Creagh is opened. This scheme forces power to flow on the 275 kV network, preventing overloads on the 110 kV network. This is an interim measure until NIE can increase the 275 kV transmission capacity from the North-West of Northern Ireland.

Ballylumford

The loss of any of the 275 kV double circuits between Castlereagh – Ballylumford or the Ballylumford – Kells/Magherafelt double circuit can result in significant overloads on the 110 kV circuits between Ballylumford – Castlereagh and Ballylumford – Kells. Therefore, in the event of the loss of any of these 275 kV circuits, the four 110 kV circuits are opened, between Kells – Ballyvallagh and Castlereagh – Carnmoney, as shown in Figure 7-4 below (circuits opened are shown as dashed in black). These 110 kV circuits are sensitive to contingencies on the 275 kV network. Without this tripping scheme, there would be little or no incremental capacity at many 275 kV nodes. This is an interim measure until NIE can increase transmission capacity on the 110 kV circuits out of Ballylumford.

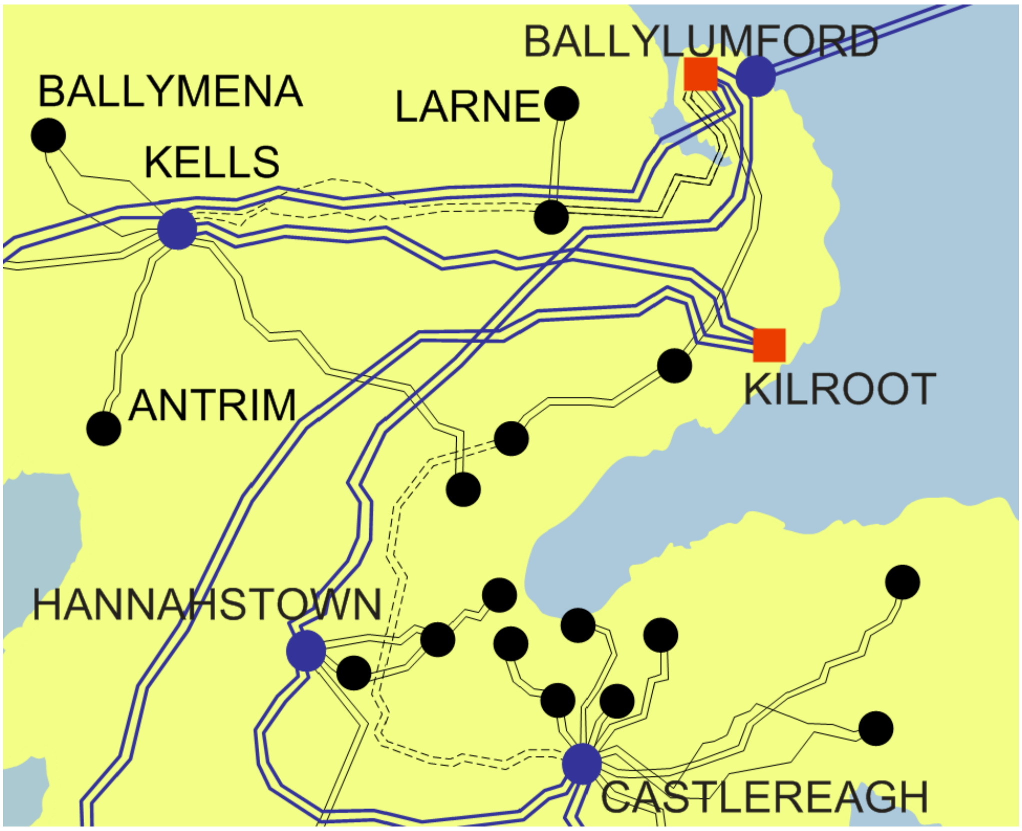


Figure 7-4: Circuits Opened in Ballylumford Protection Scheme

Coolkeeragh

Under high generation scenarios in the North-West, the loss of the 275 kV double circuit between Coolkeeragh and Magherafelt can lead to large overloads on the 110 kV circuits in the area. Following the loss of the 275 kV double circuit, the CCGT at Coolkeeragh is automatically curtailed to 160 MW. As SONI has not received detailed SPS operating schemes for the year 2022/23 it has been assumed that the loss of this 275 kV double circuit will not cause any wind generation to trip via Special Protection Scheme.

7.4 DEMAND OPPORTUNITY ANALYSIS IN NORTHERN IRELAND

This section describes the analyses carried out to determine the capability of the Northern Ireland Bulk Supply Point (BSP) substations to accommodate additional demand. The results of these analyses, together with information in other chapters, provide the basis for the statements of opportunity in 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.

The demand forecasts for Winter Peak, Summer Peak and Autumn 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 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

8.1 Transmission System Capability for New Generation – Ireland
8.2 Transmission System Capability for New Generation – Northern Ireland

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 – IRELAND

This section gives indicative information on:

- The provision of firm access for new generation under GRID25.
- 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 GRID25

Over the next 10 years, major changes to Ireland's electricity requirements are forecast in its fuel mix and in its fleet of power stations. Change will increasingly be driven by issues of energy and system security, competitiveness, climate change and by the desire to move away from imported fossil fuels. The transmission system is a vital channel for supplying reliable, sustainable and renewable energy to Ireland's demand centres while promoting open competition within the sector. Reinforcing and upgrading the transmission system is required in order to maintain a robust electricity transmission system. 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. EirGrid calculates that 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 will need to be doubled by 2025.

In October 2008, EirGrid published GRID25, its strategy for the long-term development of the transmission system. GRID25 will provide transmission capacity for increased electricity demand, new conventional generators, increased interconnection and large amounts of renewable generation. Since the GRID25 strategy was developed significant progress has been made in optimising investment plans, in identifying new technical solutions, in building new transmission circuits and in uprating existing circuits. Further details on GRID25 are available on the EirGrid website (www.eirgrid.com).

8.1.2 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 of the 1st of December 2012 (TYTFS data freeze date) forty five Gate 3 applicants totalling 1,897 MW had accepted their connection offers and all other offers remain live. These offers were permitted to remain live until the publication of the Single Electricity Market (SEM) decision paper (SEM-13-010[1]) *"Treatment of Curtailment in Tie-Break Situations"* (published in March 2013) and the subsequent issuance of Gate 3 constraint reports. Allowing for a fifty business day period from the receipt of the constraint reports the offer validity period for each of these offers expires in the period August – October 2013. Table 5-5 illustrates how Gate 3 generation is distributed across the country.

As of the 1st of December 2012 (TYTFS data freeze date) there are a further 396 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).

8.1.3 Generation Connection Opportunities Created By GRID25

Figure 8-1 gives an indication of the capacity created for new generation in the form of firm access under GRID25 from EirGrid's recent re-calculation of Firm Access Quantities (FAQs) for Gate 1, 2 and 3 generation. 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 recent 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[2]. 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.

[1] SEM-13-010 Decision Paper

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

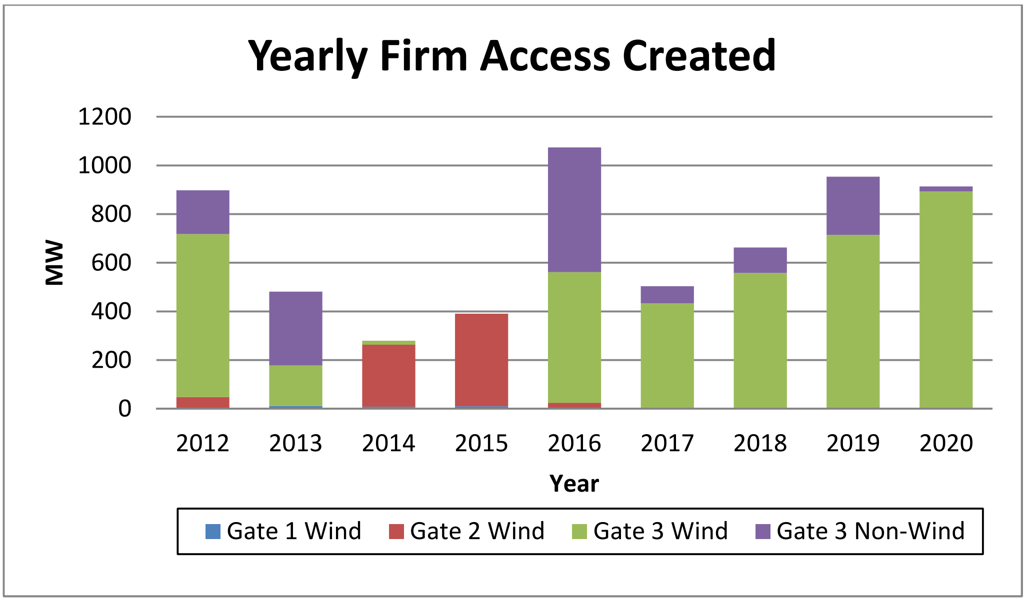


Figure 8-1 Graphical View of Yearly Firm Access Created

While firm access is a useful indicator of 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.

Transmission Reinforcements and Rewarded Firm Access

Table 8-1 presents the results of EirGrid's recent re-calculation of FAQs for all Gates on an area by area basis. Please note only Gate 1 and 2 applicants with a previous FAQ date of post 2012 were re-studied.

Table 8-1 Yearly Firm Access Created

Yearly Firm Access Created, MW										
Area	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gate 1 Wind										
A	19.6	0.0	11.5	8.1	0.0	0.0	0.0	0.0	0.0	0.0
E	10.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0
Totals	29.6	0.0	11.5	8.1	10.0	0.0	0.0	0.0	0.0	0.0
Gate 2 Wind										
A	198.6	48.5	0.0	115.1	25.6	9.5	0.0	0.0	0.0	0.0
E	510.2	0.0	0.0	139.9	355.3	15.1	0.0	0.0	0.0	0.0
Totals	708.8	48.5	0.0	255.0	380.8	24.5	0.0	0.0	0.0	0.0
Gate 3 Wind										
A	307.2	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	272.2
B	1083.8	2.0	0.0	0.0	0.0	221.5	238.7	523.6	0.0	98.0
C	74.1	11.9	0.0	0.0	0.0	30.3	32.0	0.0	0.0	0.0
D	121.4	1.4	0.0	0.0	0.0	120.0	0.0	0.0	0.0	0.0
E	689.5	0.0	0.0	0.0	0.0	21.5	79.1	0.0	261.3	327.6
F	97.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.8	9.2
G	112.7	74.5	0.0	16.6	0.0	0.0	21.6	0.0	0.0	0.0
H1	492.9	0.0	0.0	0.0	0.0	8.0	0.0	0.0	363.8	121.2
H2	89.8	89.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I	21.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	19.6
J	837.4	489.5	166.4	0.0	0.0	136.0	0.0	0.0	0.0	45.5
K	62.3	0.0	0.0	0.0	0.0	0.0	62.3	0.0	0.0	0.0
Totals	3989.8	669.2	166.4	16.6	0.0	537.2	433.7	558.6	714.9	893.4
Gate 3 Non-Wind										
A	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5
B	104.0	0.0	0.0	0.0	0.0	0.0	0.0	104.0	0.0	0.0
C	396.3	99.1	0.0	0.0	0.0	297.2	0.0	0.0	0.0	0.0
E	144.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	141.0	3.0
F	70.0	0.0	0.0	0.0	0.0	0.0	70.0	0.0	0.0	0.0
G	73.0	73.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H1	98.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	98.0	0.0
H2	219.4	4.4	0.0	0.0	0.0	215.0	0.0	0.0	0.0	0.0
I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
J	306.5	3.3	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	1429.4	180.5	303.2	0.0	0.0	512.2	70.0	104.0	239.0	20.5

The following points in relation to the outcome of EirGrid's recent re-calculation of FAQs should be noted:

- Firm access is predominantly awarded to Gate 2 applicants located in the Donegal and Cork/Kerry regions for the years 2014 and 2015 and this coincides with the upgrading of the existing transmission system in these areas.

- A significant quantity of firm access is expected to be awarded in the year 2016 and it is predominantly awarded to Gate 3 applicants. This firm access is coupled to the cumulative effect of upgrading parts of the existing transmission system in the west and south east and the delivery of transmission new builds in the south west.
- The scheduled delivery of significant individual transmission new build projects under GRID25 in the period 2017 – 2020 creates firm access for the areas of Ireland yet to receive full firm access.

Table F-1 in Appendix F gives the complete list of individual transmission reinforcements assumed for EirGrid's recent re-calculation of FAQs and the cumulative resultant FAQs created by these reinforcements. 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 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.

8.1.4 Opportunities for Additional Generation beyond Gate 3

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 recently published Gate 3 FAQs and is subject to change based on Gate 3 offer acceptance. The final uptake on all 116 live Gate 3 connection offers totalling 3,645 MW will not be known until October 2013, therefore if all offers are not accepted there may be additional opportunities on top of those indicated in Table 8-2.

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 recent 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 ITC FAQ analysis. More information on the method of analysis used is described in Chapter 7. The results of the wind generation opportunity analyses are presented in Table 8-2. 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 8-2 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 8-2 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 the respective 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 – 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.

Opportunity is largely based upon the size and location of the connecting generation plant. The results of the generator opportunity analysis indicate that, for 2022/23, there are a number of locations on the transmission network where a 160 MW generator could connect without the need for significant reinforcements. In comparison to the results from last year's publication it can be seen that generation opportunities at a number of nodes has reduced. This is due to expected higher penetration levels of onshore wind and the anticipated connections of the 600 MW offshore wind farm[3] and the 200 MW tidal generation post 2020.

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 this TYTFS 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 a 160 MW generator. As can be seen from the results the Kilroot node has the greatest generation opportunity with a spare capacity of 400 MW.

We also consider the generator opportunities at the Magherafelt and Tamnamore 275 kV nodes and in particular NIE's plans to divert four 275 kV circuits into Tamnamore 275 kV substation. The analysis shows that the lines between Tamnamore and Turleenan are sensitive to overloads for n-1 contingencies. If the Tamnamore operating scheme described in chapter 7 is implemented, overloads on the transmission lines around Tamnamore are prevented, and generation opportunities at the Kells and Tamnamore 275 kV nodes are significantly increased as a result. Such a scheme would be needed until the capacity of the

[3] No contracts are in place and the connection arrangements are undecided pending regulatory policy decisions and completion of the connection application/acceptance process.

transmission system around Tamnamore is improved or there is increased transmission transfer capacity from the North-West of Northern Ireland.

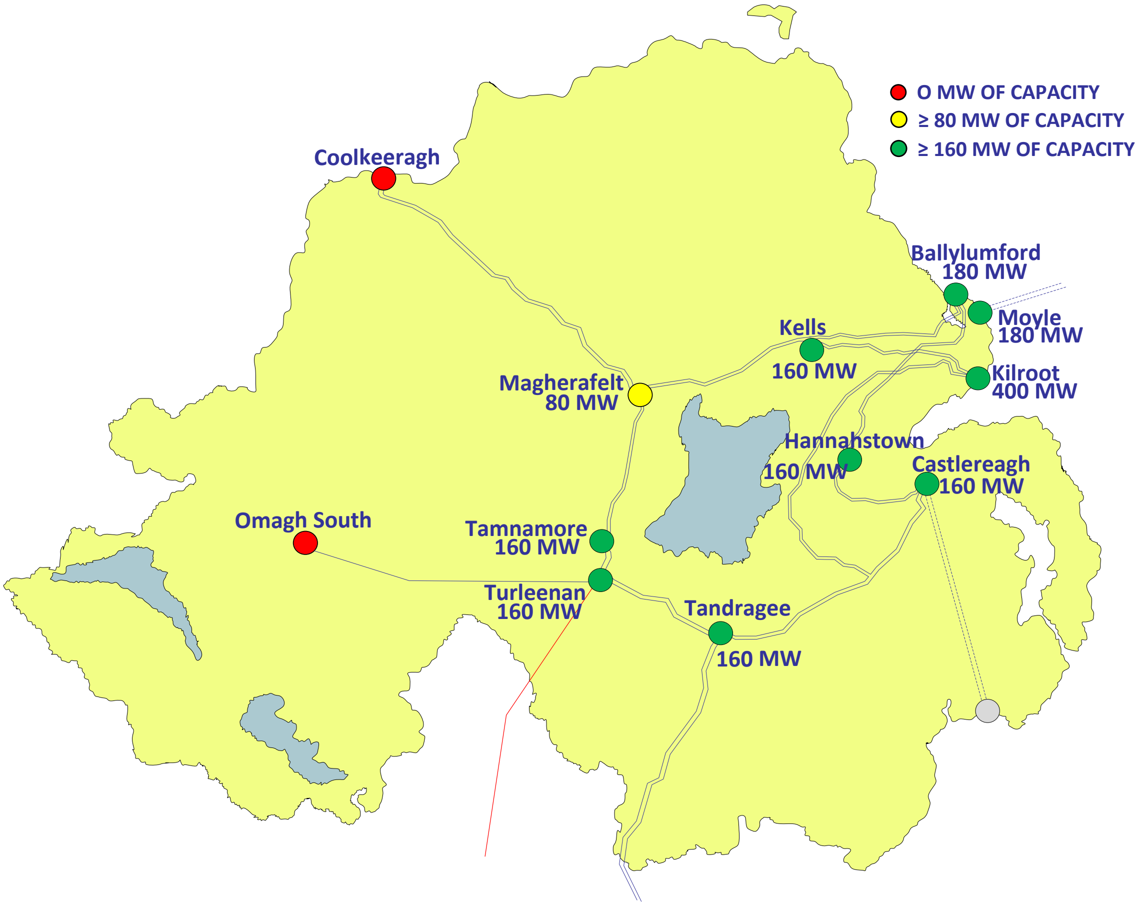


Figure 8-2 Generator Opportunities at 275 kV

The generator opportunity analysis highlights that there is incremental capacity of 180 MW available at the Ballylumford and Moyle 275 kV substations. The limiting factor for the Islandmagee nodes is the loss of the 275 kV lines in the East of the province and particularly the 275 kV Ballylumford - Magherafelt and Ballylumford - Kells double circuits at Winter Peak conditions. This results in overloads on the 110 kV circuits between and Ballylumford - Ballyvallagh and Ballylumford - Eden. To mitigate against the risk of overloads, the Ballylumford operating scheme described in chapter 7 was implemented. Without this tripping scheme, there would be little or no incremental capacity at many 275 kV nodes. The 110 kV circuits would need to be upgraded to facilitate generation opportunities in this area of the Northern Ireland transmission system.

SONI is concerned that a number of critical contingencies on circuits out of the Ballylumford node may cause voltage instability on the Northern Ireland transmission system. SONI believe the Northern Ireland transmission system is close to the margin of voltage collapse for these critical outages. There are a number of operational scenarios that cause these issues including interconnector flows, renewable generation levels and generation dispatches. The 300 Mvar of additional network reactive compensation included in this TYTFS generator opportunity analysis has enabled SONI to identify the thermal capability issues. It is important that full priority is given to these key reactive compensation projects as NIE develop the Northern Ireland transmission system.

There is no spare generator opportunity at the Coolkeeragh and Omagh South 275 kV nodes as they are behind the North-West constraint, described in detail in Section 8.2.2 below.

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 is assessed. The results are shown below in Figure 8-3.

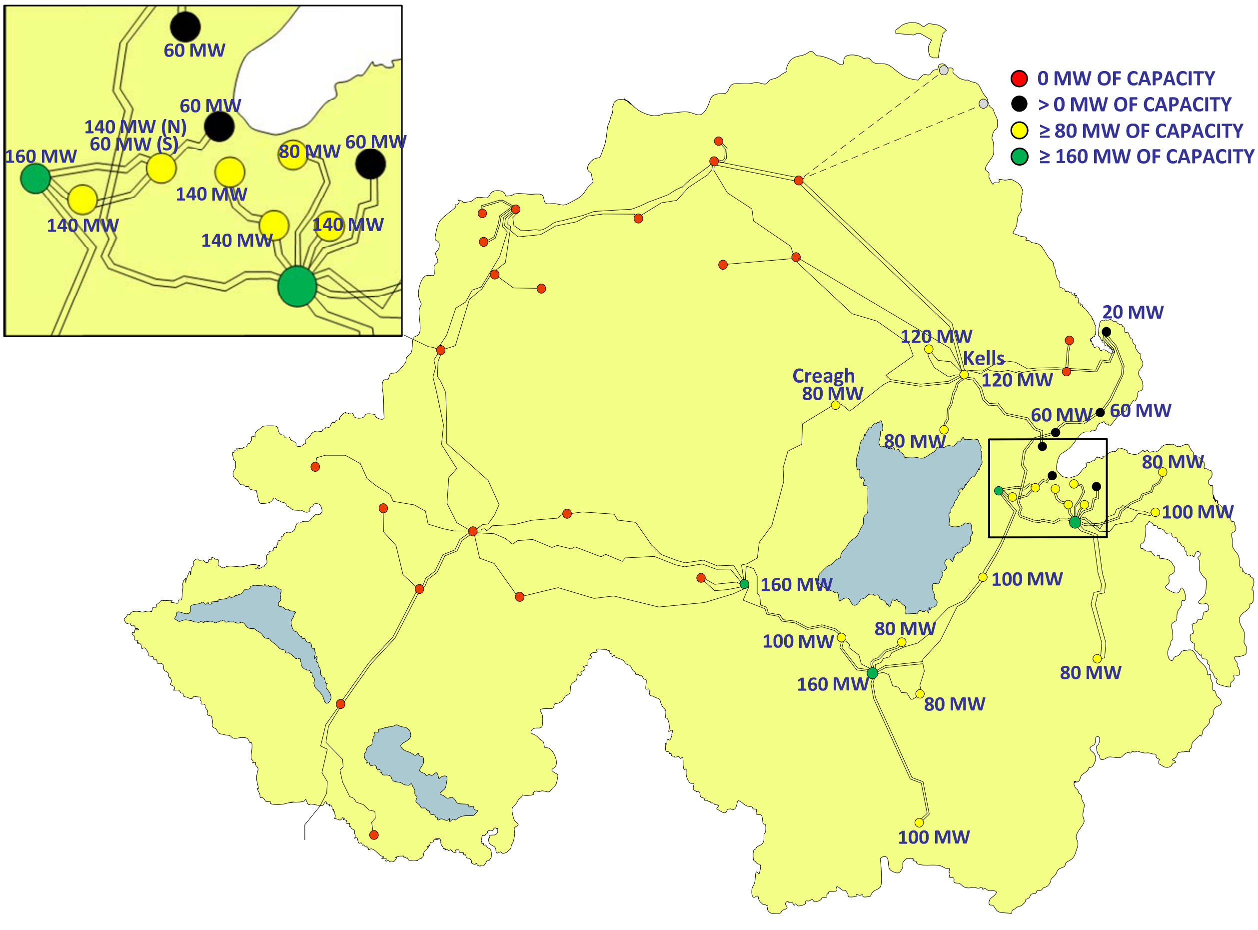


Figure 8-3 Generator Opportunities at 110 kV

Each 110 kV node is 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.

Towards the East of Northern Ireland, opportunities for generation become more substantial. In particular, Castlereagh 110 kV node is shown to be able to accept generation above 160 MW in size. The magnitude of generation opportunity varies depending on the local load, the number of circuits at the node and the rating of the transmission circuit equipment. For example, as indicated in Figure 8-3, it is only possible to accommodate 80 MW at Creagh 110 kV substation, while Kells 110 kV can accommodate 120 MW.

The network in the North-West of Northern Ireland can become heavily loaded in 2022/23. The predominant power flows driving this congestion are from Coleraine, Coolkeeragh and Omagh in the North-West to Kells, Magherafelt and Tamnamore in the East. These congested corridors can be seen in Figure 8-4.

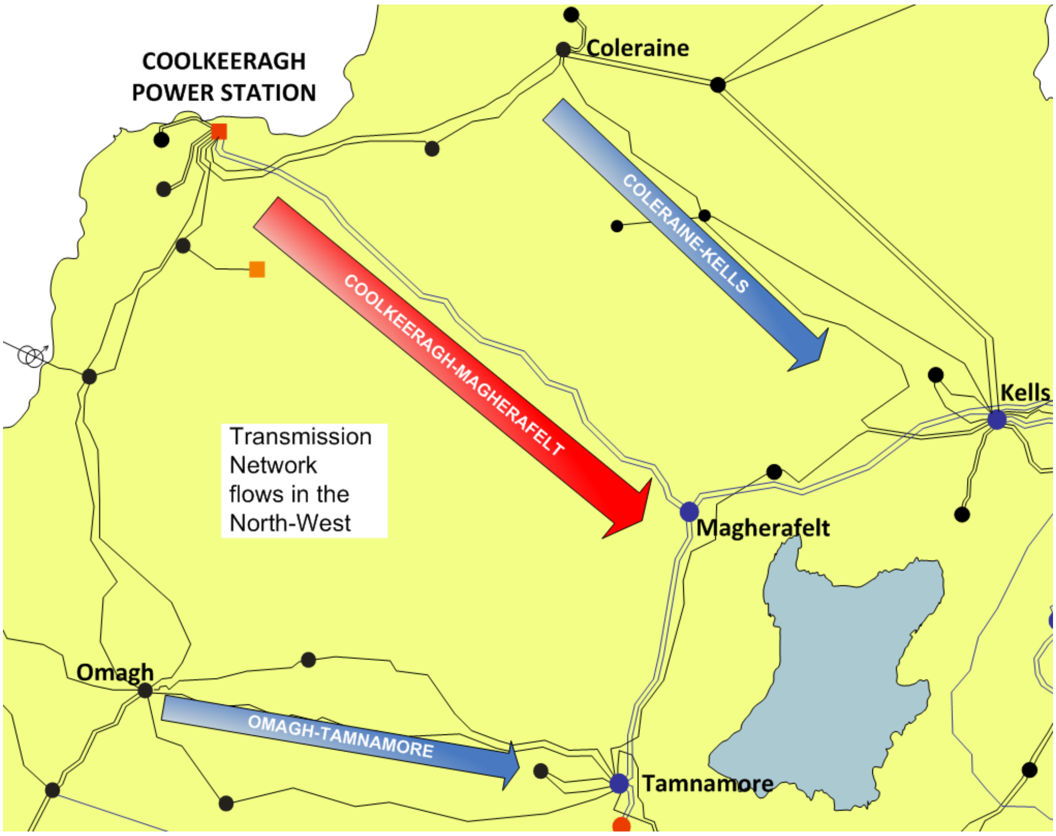


Figure 8-4 Congested Network Corridors

For 2022 summer night valley conditions with circa 1,055 MW of onshore wind connected in Northern Ireland, the loss of the Coolkeeragh-Magherafelt 275 kV double circuit can lead to voltage collapse. Also N-M-1 conditions on the 110 kV network can cause thermal overloads on the remaining 110 kV circuits in the area shown in figure 8-5. These issues are observed despite the fact that:

- the Coolkeeragh Run-Back Scheme is modelled (see Chapter 7.2.4),
- Network reactive compensation is modelled in the North-West, and
- The planned network reinforcements described in Chapter 3 are included.

With the levels of renewable generation assumed in this TYTFS, pre-faults constraints will be required in the future to mitigate the risk of thermal overloads.

By Winter 2022/23 over 1,885 MW of renewable generation is connected in Northern Ireland. With this amount of renewable generation, the Coolkeeragh-Magherafelt 275 kV double circuit contingency results in voltage collapse under certain generation conditions. These voltage stability issues will require careful investigation by NIE to ensure that SONI can operate the transmission system in a stable and secure manner in line with Security and Planning standards.

SONI also has concerns that any contingency which results in the separation of the nodes in the North-West of Northern Ireland from the reactive power sources at Coolkeeragh can cause voltage instability. If the transmission system is to accommodate the levels of renewable generation expected in 2022, it is important that future transmission corridor reinforcements take into consideration operability issues. Plans should either consider linking nodes in the North-West of Northern Ireland with Coolkeeragh or the installation of considerable dynamic reactive capability, in the form of statcom devices, across the region. These measures are necessary to ensure that SONI can control and operate the Northern Ireland transmission system within statutory limits.

Because of these issues it is clear that 1,885 MW of renewable generation cannot be accommodated without major reinforcement beyond the network developments described in Chapter 3. Specifically there is a need for additional 275 kV circuits in the North-West of Northern Ireland to enable power to be transferred out of the region and to secure the Coolkeeragh generation node.

It should be noted that 110 kV generator opportunities presented in this TYTFS are not cumulative, and if a new generator agrees to connect at a particular node, then it will have an impact on the capabilities of many other nodes on the transmission system.

8.2.3 Generation Opportunities at 33 kV

To date the majority of renewable generation has connected to the 33 kV network and at lower distribution voltage levels in Northern Ireland. SONI has analysed the capability of the transmission system to accept new generation at 33 kV level to ensure that the capacity of 110/33 kV transformers are considered. The results are presented in Figure 8-5 and listed in Appendix F, Table F-6.

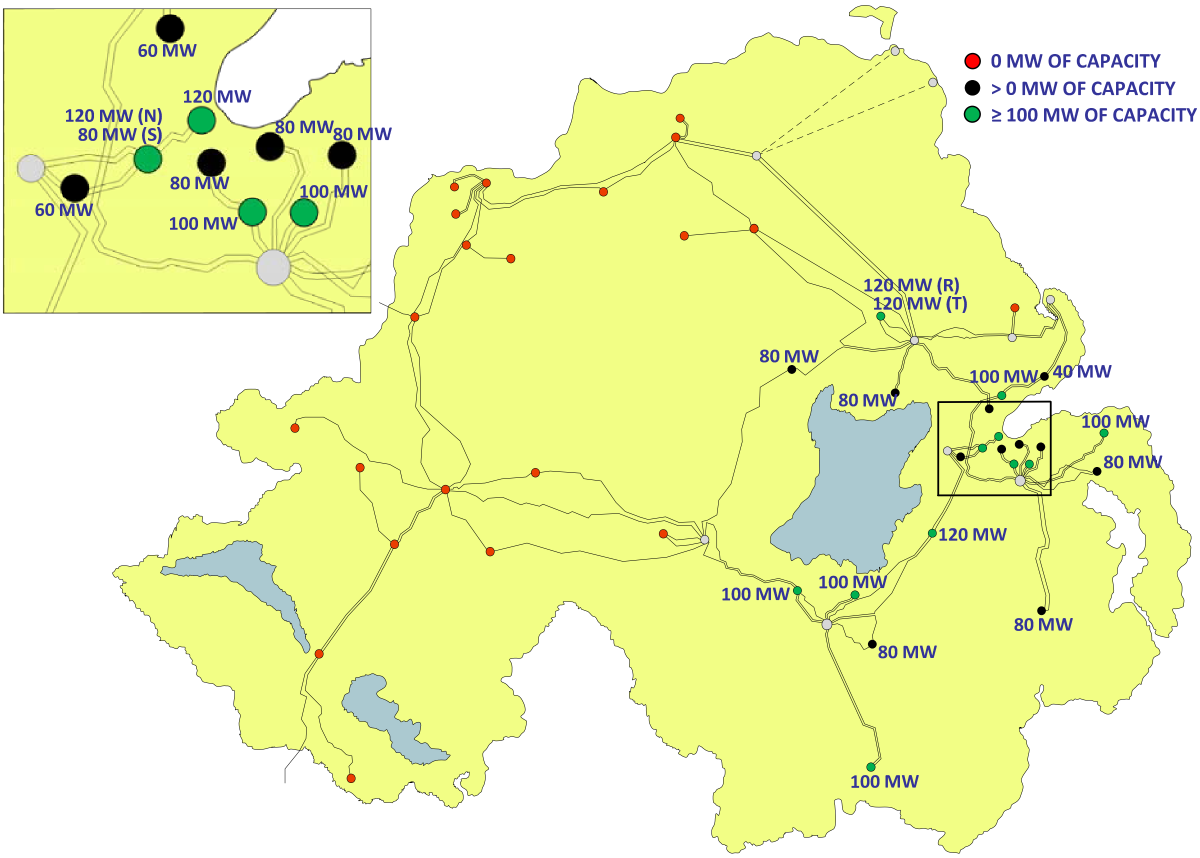


Figure 8-5 Generator Opportunities at 33 kV

8.2.4 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.

It can be concluded that the Islandmagee area cannot accept the connection of a large generator without the reinforcement of the 110 kV circuits between Ballylumford – Ballyvallagh and Ballylumford – Eden. The generation capacity at Castlereagh, Hannahstown and Tandragee 275 kV nodes has been significantly reduced by the connection of the proposed 600 MW offshore wind farm at South Down.

As can be seen in the results the North-West of Northern Ireland cannot accommodate additional generation beyond the 2022 levels assumed in this TYTFS. The grid is being stressed beyond its capability and is unable to transfer further levels of renewable generation from the region. As a result renewable generation will have to be constrained to mitigate the risk of overloads. These constraints will remain until 275 kV transmission infrastructure is established in the North-West, in addition to the timely completion of the new 400 kV North-South tie-line. This new infrastructure should secure the Coolkeeragh generation node and increase the transfer capability from the region. Further generation in the North-West will also require the installation of additional reactive compensation to ensure system voltage stability is maintained.

It should, of course, be noted that the results presented are merely indicative. Other factors that would affect the overall capability of a node to accept new generation include:

- Existing short circuit current levels at the node;
- Possible delays in system reinforcements;
- Changes in demand profile due to economic conditions and customer behaviour;
- Delays in the connection of planned generation.

9 Transmission System Capability for New Demand

9.1 Transmission System Capability for New Demand in Northern Ireland

9.2 Transmission System Capability for New Demand in Ireland

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 analyses 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 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, autumn and summer peak conditions for a seven 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.

The highest demand will be seen at the BSPs 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 higher Mvar flow and thus gives a true picture of when improvements are required on the Northern Ireland transmission system.

The BSP total installed transformer capacity, substation firm capacity and predicted demands, in MVA, are given in Table 9-1, Table 9-2 and Table 9-3 presents the winter peak demand forecast, in MVA, at each substation, based on a single circuit outage.

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. Table 9-1 highlights a number of BSPs where the firm capacity has been, or will be, exceeded over a seven year period.

Specifically these substations are:

- Strabane
- Knock

Table 9-2 and Table 9-3 present the demand forecast in MVA under single circuit outage conditions over the seven year study period for autumn peak and summer peak.

Notes Relating To the Tables

The tables below contain a column headed notes. 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 9-1 Winter BSP Peak Demand: Single Circuit Outage Conditions

BSP Location	TX[1] (MVA)	SS[2] (MVA)	WINTER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	
Aghyoule Main	90	29.0	17.14	17.26	17.43	17.62	17.83	18.03	18.25	5
Antrim Main	180	55.3	47.34	47.69	48.37	49.06	49.77	50.49	51.23	4
Ballymena Mesh (Rural)	180	55.3	49.21	49.63	37.43	38.21	39.01	39.83	40.66	4
Ballymena SWBD (Town)	120	72.8	51.85	52.53	53.53	54.52	55.52	56.54	57.59	4
Ballynahinch Main	180	71.4	61.70	62.01	62.79	63.60	64.44	65.32	66.22	4
Banbridge Main	120	71.4	41.74	41.97	42.51	43.08	43.66	44.27	44.90	4
Coleraine Main	120	71.4	48.11	48.43	49.14	49.87	50.61	51.38	52.17	4
Coolkeeragh Main	180	114.0	32.52	32.97	33.56	34.14	34.72	35.32	35.93	4
Creagh Main	120	78.0	25.04	25.25	38.18	38.63	39.09	39.56	40.04	2
Drumnakelly Main	180	111.0	96.75	97.69	99.27	100.89	102.53	104.23	105.96	4
Dungannon Main	180	114.0	95.86	96.91	98.55	100.21	101.89	103.62	105.39	4
Eden Main	90	37.4	33.59	33.80	34.23	34.69	35.15	35.64	36.13	4
Enniskillen Main	150	73.0	53.98	54.39	55.21	56.06	56.92	57.81	58.72	4
Larne Main	90	55.3	47.55	47.82	48.45	49.11	49.79	50.50	51.22	4
Limavady Main	90	40.3	26.45	26.65	27.06	27.48	27.90	28.34	28.79	4
Lisaghmore Main	90	58.5	52.22	52.62	53.43	54.26	55.09	55.96	56.85	2
Lisburn Main	180	100.0	69.53	70.05	71.09	72.16	73.24	74.36	75.52	3
Loguestown Main	90	58.5	42.61	42.93	43.53	44.14	44.77	45.42	46.08	2
Newry Main	180	103.0	84.73	85.42	86.76	88.11	89.49	90.91	92.37	3
Newtownards Main	120	78.0	45.93	46.24	46.91	47.60	48.30	49.03	49.78	2
Omagh Main	180	106.0	62.53	63.08	64.11	65.15	66.21	67.30	68.42	4
Rathgael Main	180	103.0	70.09	70.56	71.55	72.57	73.62	74.70	75.82	3
Rosebank Main	180	111.0	33.61	33.80	34.25	34.72	35.19	35.69	36.20	4
Springtown Main	180	87.9	32.28	32.55	32.98	33.42	33.87	34.34	34.82	4
Strabane Main	90	33.8	39.17	39.39	39.91	40.45	41.00	41.57	42.16	4
Waringstown Main	180	117	67.73	68.04	68.75	69.49	70.25	71.05	71.87	2
Belfast - Airport Road Main	180	103.0	N/A	N/A	N/A	23.01	23.36	23.72	24.09	3
Belfast Central Main	180	110.0	64.88	66.34	68.40	70.40	72.38	74.39	76.46	7
Belfast North Main*	180	100.0	N/A	N/A	54.04	54.75	55.48	56.24	57.02	7
Belfast - PSW	150	100.0	53.08	53.36	BSP will be decommissioned					7

[1] Installed transformer capacity

[2] Substation firm capacity

Table 9-1 Winter BSP Peak Demand: Single Circuit Outage Conditions (continued)

BSP Location	TX (MVA)	SS (MVA)	WINTER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	
Belfast - Carnmoney Main	180	68.6	42.89	43.27	43.92	44.59	45.26	45.96	46.67	4
Belfast - Glengormley Main	60	30.8	15.28	15.41	15.64	15.86	16.10	16.34	16.59	8
Belfast - Cregagh Main	150	78.9	70.26	70.77	71.73	58.45	59.42	60.42	61.45	4
Belfast - Knock Main	120	71.0	73.45	73.89	74.89	66.59	67.61	68.68	69.78	4
Belfast - Finaghy Main	90	58.5	34.33	34.57	35.02	35.48	35.95	36.45	36.95	2
Belfast - Donegall Main (North)	150	68.5	62.77	63.07	63.83	64.61	65.41	66.24	67.10	4
Belfast - Donegall Main (South)	120	68.5	54.43	54.73	55.43	56.16	56.91	57.69	58.50	4

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

BSP Location	TX (MVA)	SS (MVA)	AUTUMN BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2013	2014	2015	2016	2017	2018	2019	
Aghyoule Main	90	29.0	16.48	16.59	16.75	16.94	17.13	17.33	17.53	5
Antrim Main	180	55.3	39.76	40.02	40.58	41.17	41.77	42.36	42.98	4
Ballymena Mesh (Rural)	180	55.3	42.14	42.46	32.01	32.69	33.38	34.06	34.78	4
Ballymena SWBD (Town)	120	72.8	48.47	49.07	49.99	50.93	51.87	52.80	53.77	4
Ballynahinch Main	180	71.4	50.41	50.62	51.24	51.92	52.61	53.31	54.03	4
Banbridge Main	120	71.4	34.06	34.22	34.65	35.13	35.61	36.09	36.60	4
Coleraine Main	120	71.4	38.19	38.42	38.97	39.56	40.16	40.75	41.37	4
Coolkeeragh Main	180	114.0	32.33	32.75	33.32	33.91	34.49	35.07	35.68	4
Creagh Main	120	78.0	23.47	23.65	35.75	36.18	36.61	37.04	37.49	2
Drumnakelly Main	180	111.0	84.99	85.75	87.11	88.55	90.01	91.46	92.97	4
Dungannon Main	180	114.0	91.62	92.55	94.09	95.70	97.32	98.93	100.61	4
Eden Main	90	37.4	28.56	28.71	29.07	29.47	29.87	30.27	30.69	4
Enniskillen Main	150	73.0	49.07	49.40	50.13	50.92	51.70	52.49	53.32	4
Larne Main	90	55.3	41.74	41.95	42.49	43.08	43.68	44.29	44.92	4
Limavady Main	90	40.3	21.12	21.26	21.58	21.92	22.26	22.61	22.96	4
Lisaghmore Main	90	58.5	44.67	44.98	45.66	46.38	47.10	47.82	48.58	2
Lisburn Main	180	93.0	57.15	57.53	58.37	59.26	60.16	61.06	62.00	3
Loguestown Main	90	58.5	36.41	36.65	37.16	37.69	38.23	38.76	39.33	2
Newry Main	180	95.0	71.51	72.04	73.14	74.30	75.47	76.64	77.86	3
Newtownards Main	120	78.0	38.45	38.68	39.23	39.82	40.41	41.01	41.63	2
Omagh Main	180	106.0	54.10	54.53	55.41	56.32	57.24	58.16	59.12	4
Rathgael Main	180	95.0	54.81	55.14	55.90	56.71	57.53	58.36	59.22	3
Rosebank Main	180	111.0	25.86	25.99	26.32	26.69	27.06	27.43	27.82	4
Springtown Main	180	87.9	29.15	29.37	29.75	30.16	30.57	30.98	31.41	4
Strabane Main	90	33.8	31.83	31.99	32.40	32.84	33.30	33.75	34.22	4
Waringstown Main	180	117	59.96	60.19	60.80	61.48	62.16	62.84	63.55	2
Belfast - Airport Road Main	180	95.0	N/A	N/A	N/A	20.08	20.39	20.70	21.02	3
Belfast Central Main	180	110.0	64.17	65.56	67.58	69.57	71.54	73.50	75.54	7
Belfast North Main*	180	100.0	N/A	N/A	45.26	45.87	46.48	47.10	47.75	7
Belfast - PSW	150	100.0	44.50	44.70	BSP will be decommissioned					7

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

BSP Location	TX (MVA)	SS (MVA)	AUTUMN BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2013	2014	2015	2016	2017	2018	2019	
Belfast - Carnmoney Main	180	68.6	37.19	37.49	38.04	38.63	39.22	39.80	40.42	4
Belfast - Glengormley Main	60	30.8	13.67	13.78	13.98	14.19	14.40	14.61	14.83	8
Belfast - Cregagh Main	150	78.9	65.70	66.13	67.01	54.62	55.53	56.45	57.40	4
Belfast - Knock Main	120	71.0	60.78	61.09	61.90	55.06	55.91	56.78	57.67	4
Belfast - Finaghy Main	90	58.5	30.47	30.66	31.04	31.46	31.88	32.31	32.75	2
Belfast - Donegall Main (North)	150	68.5	54.06	54.28	54.92	55.60	56.30	56.99	57.72	4
Belfast - Donegall Main (South)	120	68.5	46.95	47.17	47.76	48.41	49.06	49.71	50.40	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)							Notes
			2013	2014	2015	2016	2017	2018	2019	
Aghyoule Main	90	29.0	16.88	17.00	17.15	17.34	17.54	17.75	17.96	5
Antrim Main	180	55.3	35.18	35.43	35.89	36.41	36.94	37.49	38.04	4
Ballymena Mesh (Rural)	180	55.3	37.07	37.38	28.15	28.75	29.35	29.98	30.60	4
Ballymena SWBD (Town)	120	72.8	46.33	46.93	47.76	48.67	49.56	50.49	51.41	4
Ballynahinch Main	180	71.4	45.54	45.76	46.27	46.89	47.51	48.18	48.83	4
Banbridge Main	120	71.4	29.97	30.13	30.48	30.90	31.33	31.77	32.22	4
Coleraine Main	120	71.4	34.98	35.22	35.68	36.22	36.77	37.34	37.91	4
Coolkeeragh Main	180	114.0	32.47	32.91	33.45	34.05	34.63	35.24	35.84	4
Creagh Main	120	78.0	21.51	21.69	32.76	33.15	33.55	33.96	34.38	2
Drumnakelly Main	180	111.0	83.02	83.82	85.06	86.48	87.90	89.38	90.86	4
Dungannon Main	180	114.0	86.20	87.12	88.48	90.00	91.52	93.10	94.69	4
Eden Main	90	37.4	25.95	26.11	26.41	26.77	27.13	27.51	27.89	4
Enniskillen Main	150	73.0	46.00	46.35	46.98	47.72	48.46	49.23	50.01	4
Larne Main	90	55.3	37.57	37.79	38.23	38.77	39.31	39.88	40.45	4
Limavady Main	90	40.3	19.67	19.82	20.09	20.41	20.73	21.06	21.39	4
Lisaghmore Main	90	58.5	40.25	40.55	41.12	41.77	42.43	43.11	43.79	2
Lisburn Main	180	80.0	50.52	50.89	51.58	52.37	53.16	53.99	54.82	3
Loguestown Main	90	58.5	36.00	36.26	36.72	37.25	37.78	38.34	38.89	2
Newry Main	180	82.0	64.45	64.96	65.89	66.94	68.00	69.10	70.20	3
Newtownards Main	120	78.0	34.71	34.95	35.41	35.94	36.47	37.04	37.60	2
Omagh Main	180	106.0	49.78	50.21	50.96	51.81	52.66	53.54	54.42	4
Rathgael Main	180	82.0	49.49	49.81	50.44	51.18	51.93	52.71	53.49	3
Rosebank Main	180	111.0	24.47	24.61	24.90	25.25	25.60	25.97	26.33	4
Springtown Main	180	87.9	27.27	27.49	27.82	28.20	28.59	28.99	29.39	4
Strabane Main	90	33.8	29.35	29.52	29.86	30.28	30.69	31.13	31.57	4
Waringstown Main	180	117	56.51	56.76	57.28	57.92	58.56	59.24	59.92	2
Belfast - Airport Road Main	180	82.0	N/A	N/A	N/A	18.51	18.79	19.09	19.38	3
Belfast Central Main	180	110.0	62.57	63.97	65.87	67.82	69.74	71.70	73.69	7
Belfast North Main*	180	100.0	N/A	N/A	41.65	42.22	42.78	43.38	43.98	7
Belfast - PSW	150	100.0	40.97	41.18	BSP will be decommissioned					7

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)							Notes
			2013	2014	2015	2016	2017	2018	2019	
Belfast - Carnmoney Main	180	68.6	33.99	34.29	34.76	35.30	35.83	36.40	36.96	4
Belfast - Glengormley Main	60	30.8	12.63	12.74	12.91	13.10	13.29	13.50	13.70	8
Belfast - Cregagh Main	150	78.9	63.32	63.78	64.55	52.62	53.50	54.42	55.34	4
Belfast - Knock Main	120	71.0	53.51	53.82	54.48	48.46	49.21	50.00	50.79	4
Belfast - Finaghy Main	90	58.5	27.09	27.28	27.59	27.97	28.34	28.74	29.13	2
Belfast - Donegall Main (North)	150	68.5	50.74	50.98	51.52	52.17	52.82	53.51	54.20	4
Belfast - Donegall Main (South)	120	68.5	42.17	42.39	42.88	43.46	44.05	44.67	45.28	4

9.1.1 Bulk Supply Points Where Firm Capacity is Exceeded

In the tables above, any instance when a BSP is loaded above its firm capacity is highlighted in red. These instances are discussed below.

Strabane

NIE have confirmed that the overloads at Strabane will be addressed by up rating the cables that limit the substation capacity as part of the mesh refurbishment.

Knock

The overload is currently managed by a load transfer scheme. The Ballymacarrett load is scheduled to be transferred from Knock to Airport Road in Winter 2017/18. In the interim period a proportion of the load can be fed via Creagh Main if required.

9.1.2 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 seven year 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.

9.1.3 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 operate the Northern Ireland transmission system so any generation/demand scenario can be catered for.

Large bulk transmission 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 the additional reactive power support to ensure voltage stability for critical 275 kV contingencies.

9.2 TRANSMISSION SYSTEM CAPABILITY FOR NEW DEMAND IN IRELAND

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.

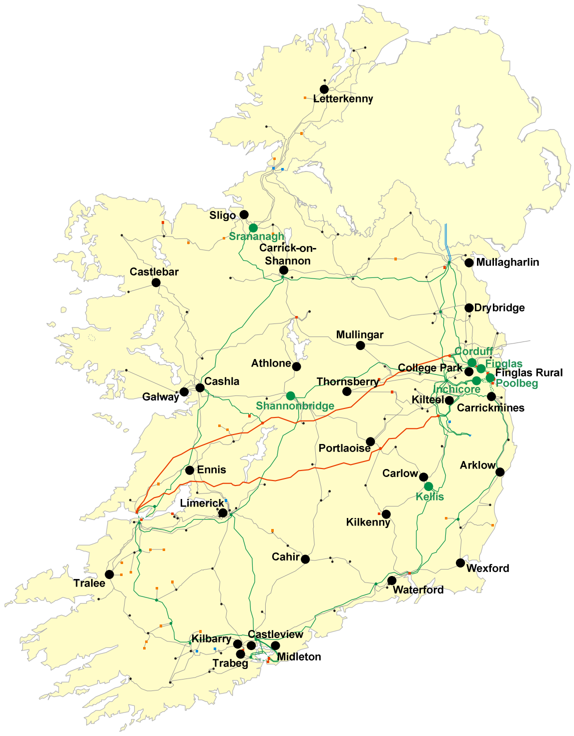


Figure 9-1 110 kV and 220 kV Stations Studied for Demand Opportunities

9.2.1 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 analyses are presented in Table 9-4. These 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 9-4 Capability for Additional Demand at 220 kV and 110 kV Stations, MW

Region	Station	2013	2016	2019
Dublin	Carrickmines	120	100	90
	College Park	30	40	40
	Corduff 220 kV	230	280	230
	Finglas 220 kV	240	190	90
	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 9-4 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.

9.2.2 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 seven year 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 2013 there will be opportunities for an additional large demand[3] at 23 of the 29 110 kV stations examined and in 2019 there will be opportunities at 24 of the 29 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 2016 and 2019. The graphics show that there will be significant demand opportunities in most parts of Ireland throughout the seven-year study period to 2019.

[3] 10 MW or more

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.

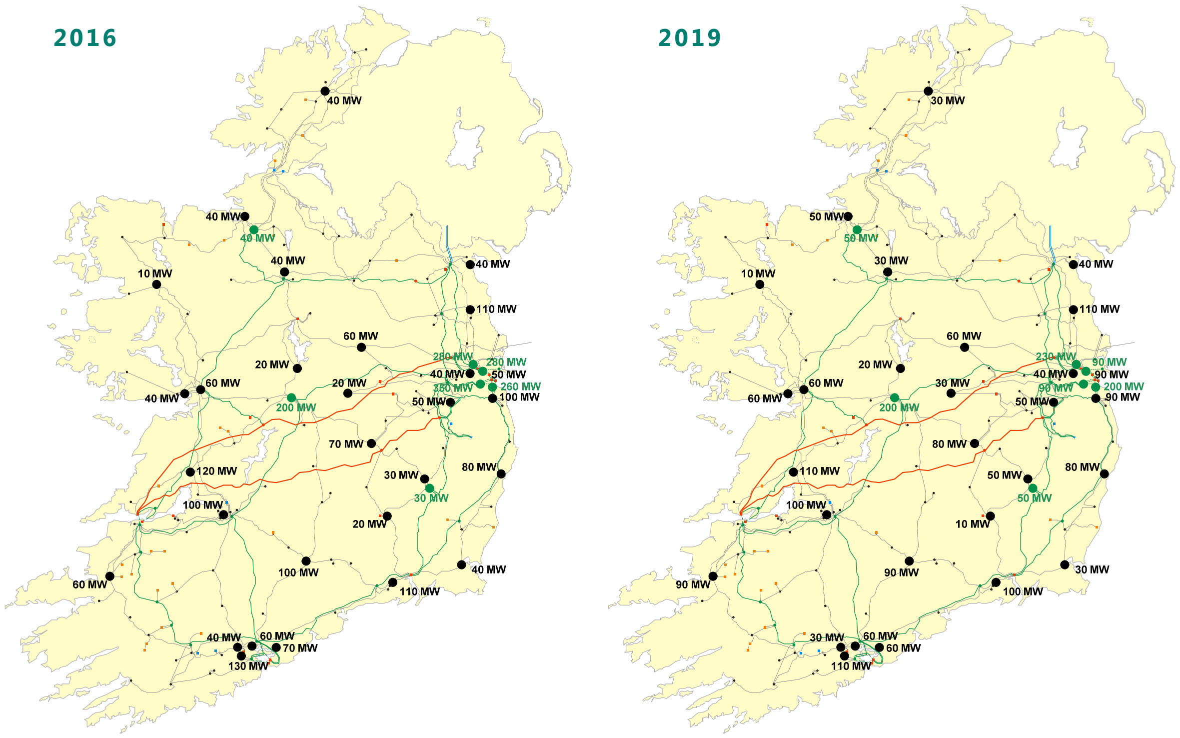


Figure 9-2 Capability for New Demand in 2016 and 2019

9.2.3 Impact of Changes since the Data Freeze

Since the end of 2012, a number of developments have occurred that could impact on the results in Table 9-4. Projects selected and planned since December 2012 are listed in Section 1.4. Of these projects the planned uprating of Raffeen – Trabeg 110 kV circuit 1 in Cork should improve demand opportunites at Trabeg. Also, a connection agreement was executed on the 25th of June 2013 (post the December 2012 data freeze date) between EirGrid and ESB Networks (Distribution System Operator) for a 40 MVA demand connection near Clonshaugh in North East Co. Dublin.

9.2.4 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 9-4 in this chapter. The potential developer should then check the assumptions in Chapters 3 to 5 on which these results are based, and 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 2016/17 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 58.6 MW at winter peak 2013/14. This is forecast to grow by 6.5 MW between 2013 and 2022 i.e. by 0.65 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 9-4 show that the opportunity for increased demand is less than 100 MW or less in 2013. 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. Detailed information on capital project CP0688 can be found in Appendix B. Following completion of this project towards the end of 2015 the opportunity at Ennis increases to 120 MW in 2016. 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.

A Maps and Schematic Diagrams

A.1 Network Maps

A.2 Short Bus Codes

A.3 Schematic Diagrams of the Transmission System of Ireland

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 December of 2012 and as planned for 2022. 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 December 01^{st} 2012;
- Figure A-2 is a map of the existing transmission system including planned transmission system developments as at December 31^{st} 2022.

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, between Flagford and Cashla nodes. Flagford node was chosen to be shown as the meshed point in geographical maps of the all-island transmission system on the basis of a coin toss.

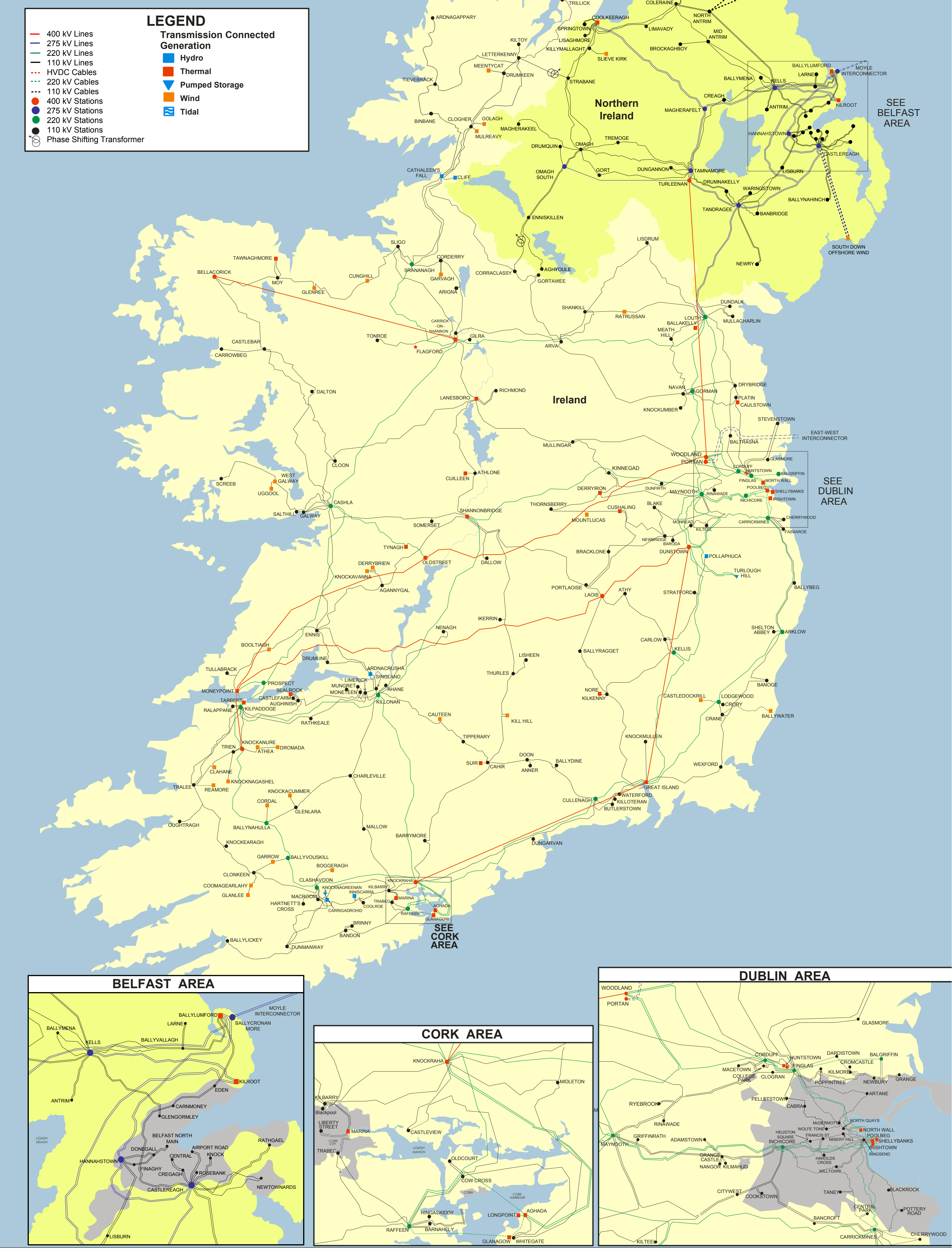
Note 2: The location of Great Island and Knockraha 400/220 kV stations are currently unknown but shown at Great Island and Knockraha existing 220 kV stations in the geographical maps of the all-island transmission system for simplicity.

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 December 2012

Figure A - 2
Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at December 2022



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 December of 2012 and as planned for 2022. These maps are also included in A3 format in Appendix J for greater legibility.

A.1 NETWORK MAPS

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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.

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. Names and codes for future stations, highlighted in yellow, are tentative and may change. 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	Short Bus Code	Full Name	Short Bus Code	Full Name
AA	Ardnacrusha	DAL	Dallow	MAG	Magherafelt
AD	Aghada	DDK	Dundalk	MAL	Mallow
ADM	Adamstown	DER	Derryiron	MAN	Mid Antrim
AGH	Aghyoule Main	DFR	Dunfirth	MAY	Maynooth
AGL	Agannygal	DGN	Dungarvan	MCE	Macetown
AGY	Ardnagappary	DLN	Derrylyn	MEE	Meentycat
AHA	Ahane	DLT	Dalton	MID	Midleton
AIR	Belfast - Airport Road Main	DMY	Dunmanway	MKL	Magherakeel
ANR	Anner	DON	Belfast - Donegall Main (North)	MLC	Mountlucas
ANT	Antrim Main	DON	Belfast - Donegall Main (South)	MLN	Mullagharlin
ARI	Arigna	DOO	Doon	MON	Monread
ARK	Arklow	DQN	Drumquin Cluster	MOY	Moy
ARV	Arva	DRM	Drumkeen	MP	Moneypoint
ATE	Athea	DRO	Dromada	MR	Marina
ATH	Athlone	DRU (I)	Drumline	MRY	Mulreavy
ATY	Athy	DRU (N)	Drumnakelly Main	MTH	Meath Hill
AUG	Aughinish	DRY	Drybridge	MTN	Moneteen
BAL	Baltrasna	DSN	Dunstown	MUL	Mullingar
BAN (I)	Bandon	DUN	Dungannon Main	MUN	Mungret
BAN (N)	Banbridge Main	DYN	Derrybrien	NAN (I)	Nangor
BAR	Barrymore	EDE	Eden Main	NAN (N)	North Antrim
BCM	Ballycummin	ENN (I)	Ennis	NAR	Newtownards Main
BCT	Bancroft	ENN (N)	Enniskillen Main	NAV	Navan
BDA	Baroda	FAI	Fair Head	NBY	Newbury
BDN	Ballydine	FAS	Fassaroe	NEN	Nenagh
BEG	Ballybeg	FIN (I)	Finglas	NEW (I)	Newbridge
BGH	Boggeragh	FIN (N)	Belfast - Finaghy Main	NEW (N)	Newry Main
BGT	Ballyragget	FLA	Flagford	NO	Nore

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
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
CA	Caulstown
CAH	Cahir
CAR	Belfast - Carnmoney Main
CAS	Castlereagh
CBG	Carrowbeg
CBR	Castlebar
CD	Carrigadrohid
CDK	Castledockrill
CDL	Cordal
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
INC	Inchicore
ISH	Irishtown
KBY	Kilbarry
KCR	Knockacummer
KEL	Kells
KER	Knockearagh
KGN	Knocknagreenan
KHL	Kill Hill
KIN	Kinnegad
NW	North Wall
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
RAL	Ralapanne
RAT (I)	Rathkeale
RAT (N)	Rathgael Main
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

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name	Short Bus Code	Full Name	Short Bus Code	Full Name
CDU	Corduff	KKY	Kilkenny	SNG	Singland
CDY	Corderry	KLM	Kilmore	SOM	Somerset
CEN	Belfast - Belfast Central Main	KLN	Killonan	SOR	Sorne Hill
CF	Cathaleen's Fall	KLS	Kellis	SPR	Springtown Main
CFM	Castlefarm	KMT	Killymallaght	SRA	Srananagh
CGL	Coomagearlahy	KNG	Knocknagashel	STR (I)	Stratford
CHA	Charleville	KNM	Knockmullen	STR (N)	Strabane Main
CHE	Cherrywood	KNO	Belfast - Knock Main	SUR	Suir
CKM	Carrickmines	KNR	Knockanure	SVN	Stevenstown
CKN	Clonkeen	KNV	Knockavanna	TAN	Tandragee
CL	Cliff	KNY	West Galway	TAW	Tawnaghmore
CLA	Clashavoon	KPG	Kilpaddoge	TB	Tarbert
CLG	Cloghran	KPS	Kilroot Power Station	TBG	Trabeg
CLH	Clahane	KRA	Knockraha	TBK	Tullabrack
CLN	Cloon	KTL	Kilteel	TH	Turlough Hill
CLO	Clogher	KTN	Killoteran	THU	Thurles
CLW	Carlow	KUD	Kilmahud	TIP	Tipperary
COL (I)	College Park	KUR	Knockumber	TIV	Tievebrack
COL (N)	Coleraine Main	LA	Lanesboro	TLE	Turleenan
COR	Corraclassy	LAR	Larne Main	TLK	Trillick
COS	Carrick-on-Shannon	LET	Letterkenny	TMN	Tamnamore
COW	Cow Cross	LIB	Liberty Street	TON	Tonroe
CPS	Coolkeeragh Main	LIM (I)	Limerick	TOR	Torr Head
CRA	Crane	LIM (N)	Limavady Main	TRE	Tremoge
CRE	Belfast - Cregagh Main	LIS (I)	Lisdrum	TRI	Trien
CRG	Creagh Main	LIS (N)	Lisburn Main	TRL	Tralee
CRO	Coolroe	LMR	Lisaghmore Main	TSB	Thornsberry
CSH	Cashla	LOG	Loguestown Main	TYN	Tynagh
CTN	Cauteen	LOU	Louth	UGL	Uggool
CUI	Cuilleen	LPT	Longpoint	WAR	Waringstown Main
CUL	Cullenagh	LSE	Laois	WAT	Waterford
CUN	Cunghill	LSN	Lisheen	WEX	Wexford
CUS	Cushaling	LWD	Lodgewood	WHI	Whitegate
CVW	Castleview	MAC	Macroom	WOO	Woodland

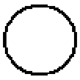
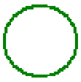
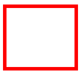
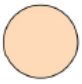
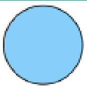
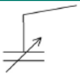
A.3 SCHEMATIC DIAGRAMS OF THE TRANSMISSION SYSTEM OF IRELAND

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 2012 highlights the developments due to be completed in 2012. The diagram for 2013 displays developments due for completion in 2013. The 2016 diagram highlights developments expected to be completed between 2013 and the end of 2016. The 2019 diagram highlights developments expected to be completed between 2016 and the end of 2019 while the 2022 diagram highlights developments due to be completed between 2019 and the end of 2022.

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
	400 kV circuit
	System Link
	110 kV Busbar
	220 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

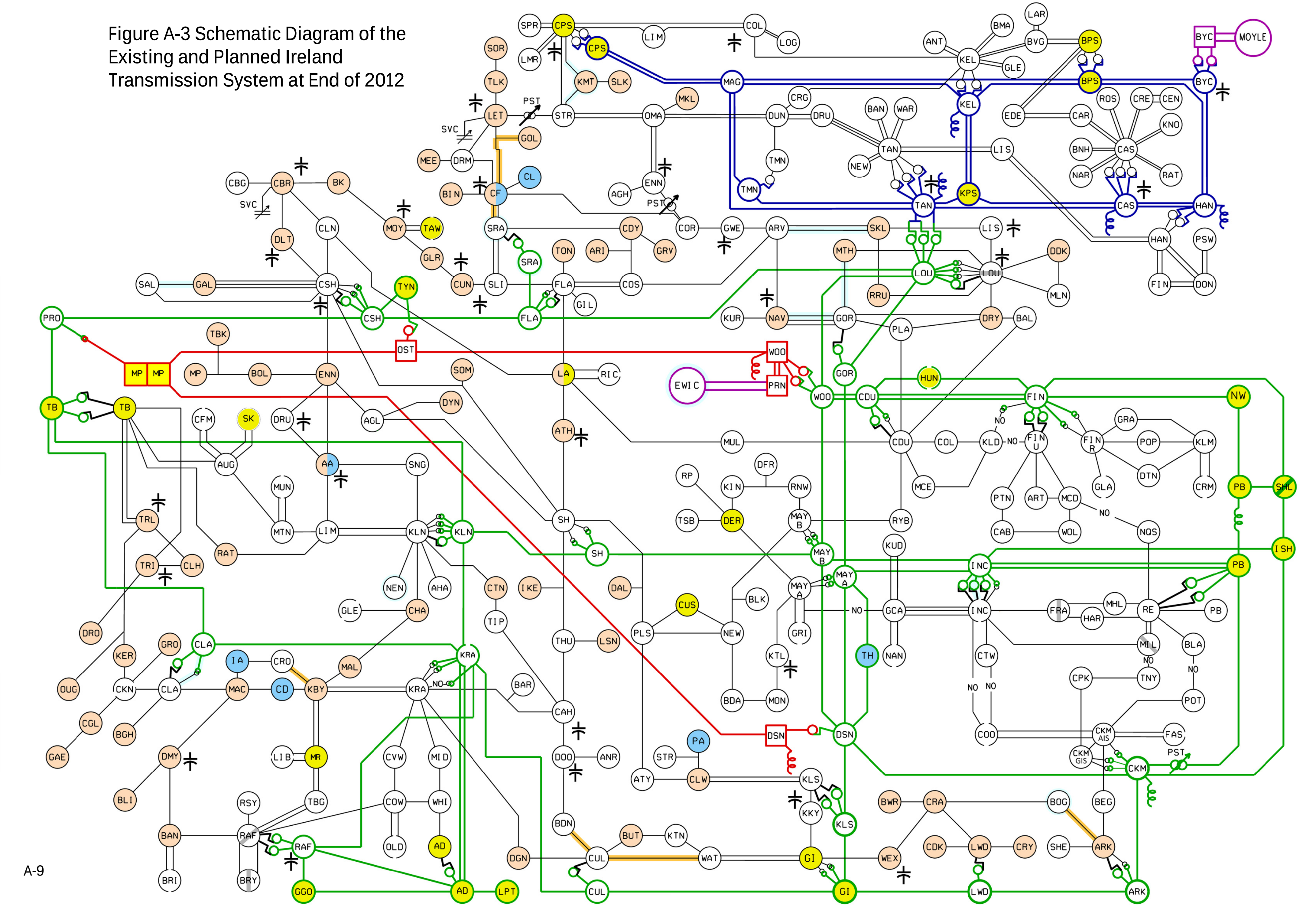


Figure A-3 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2012

Figure A-4 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2013

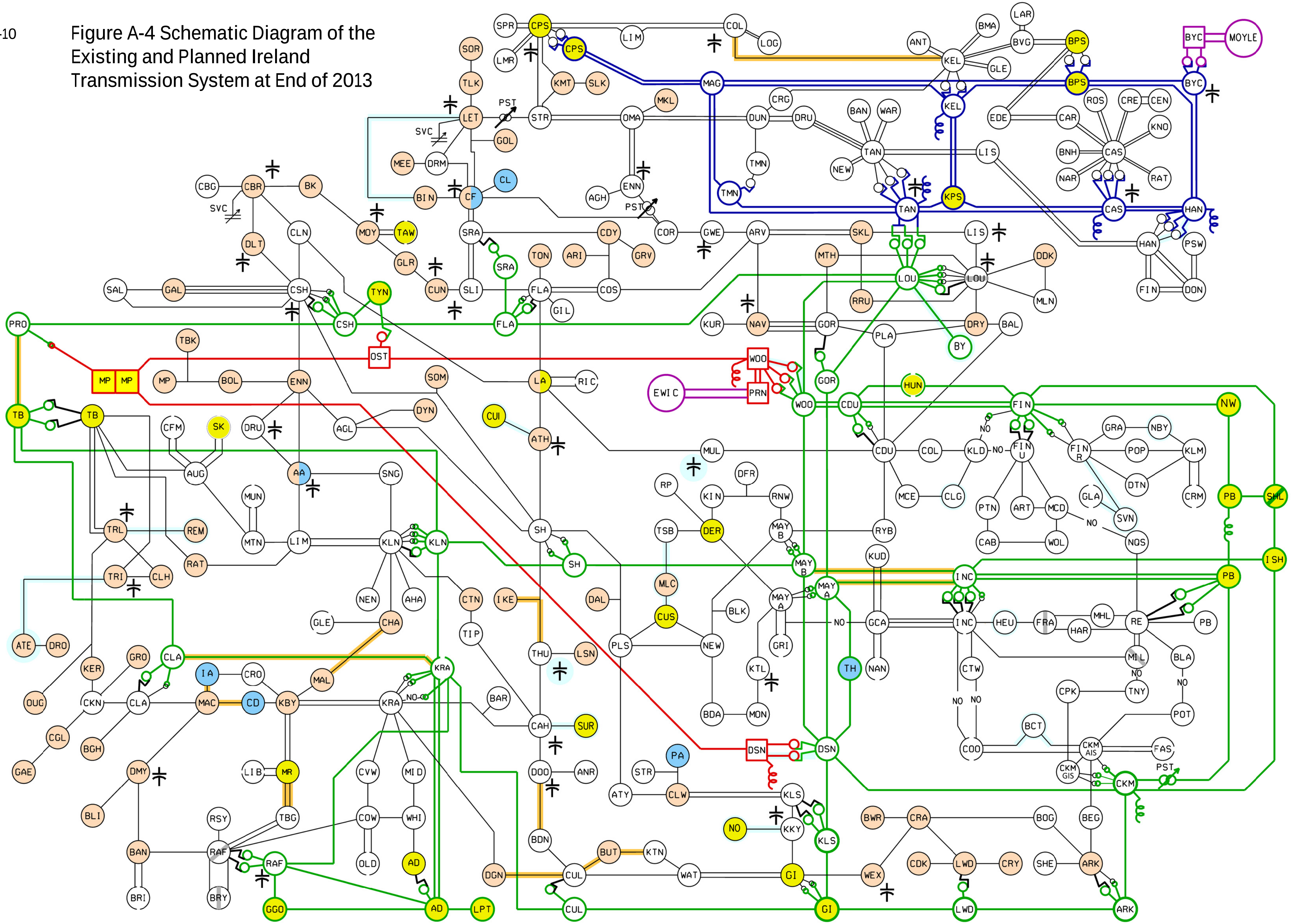


Figure A-5 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2016

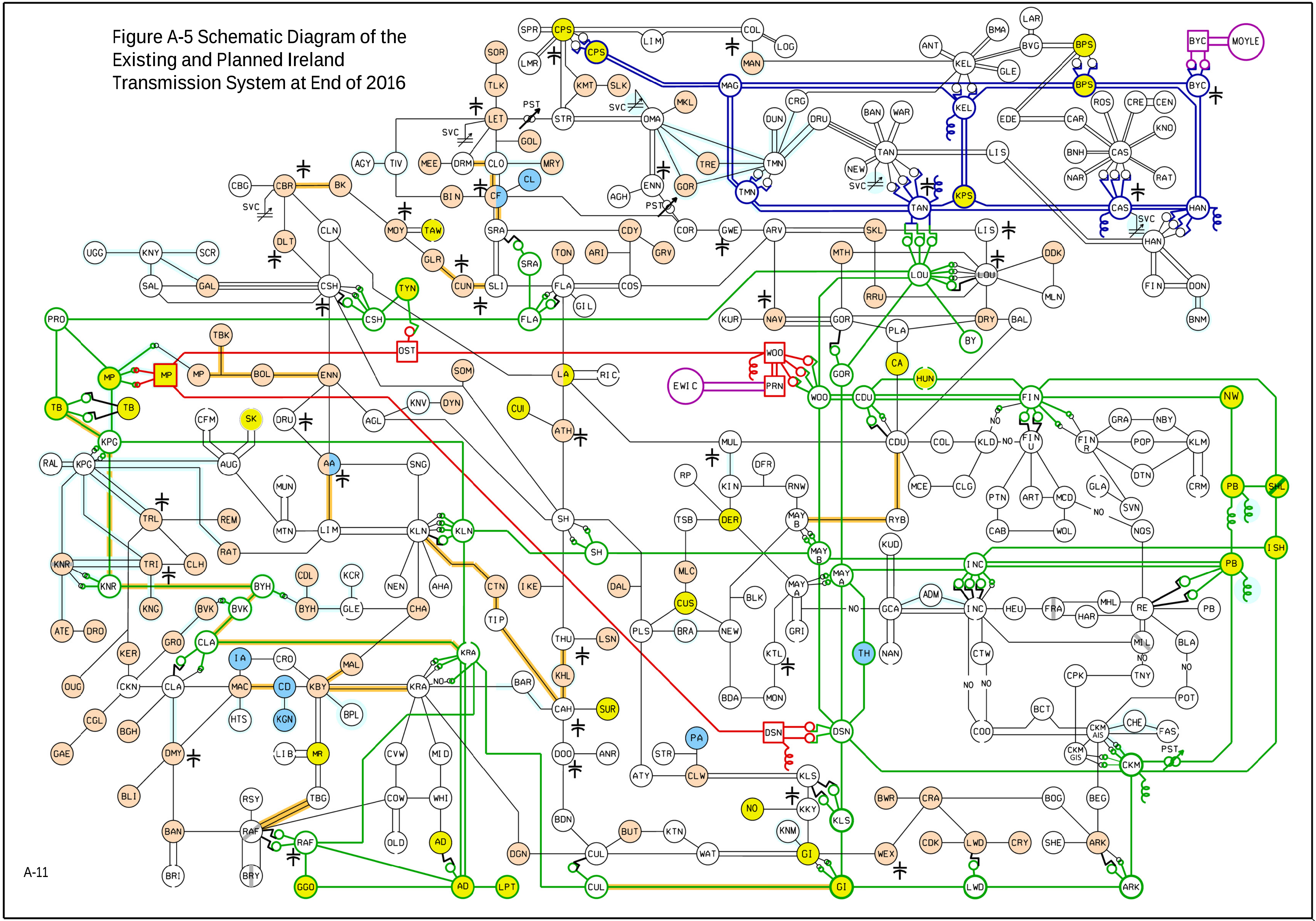
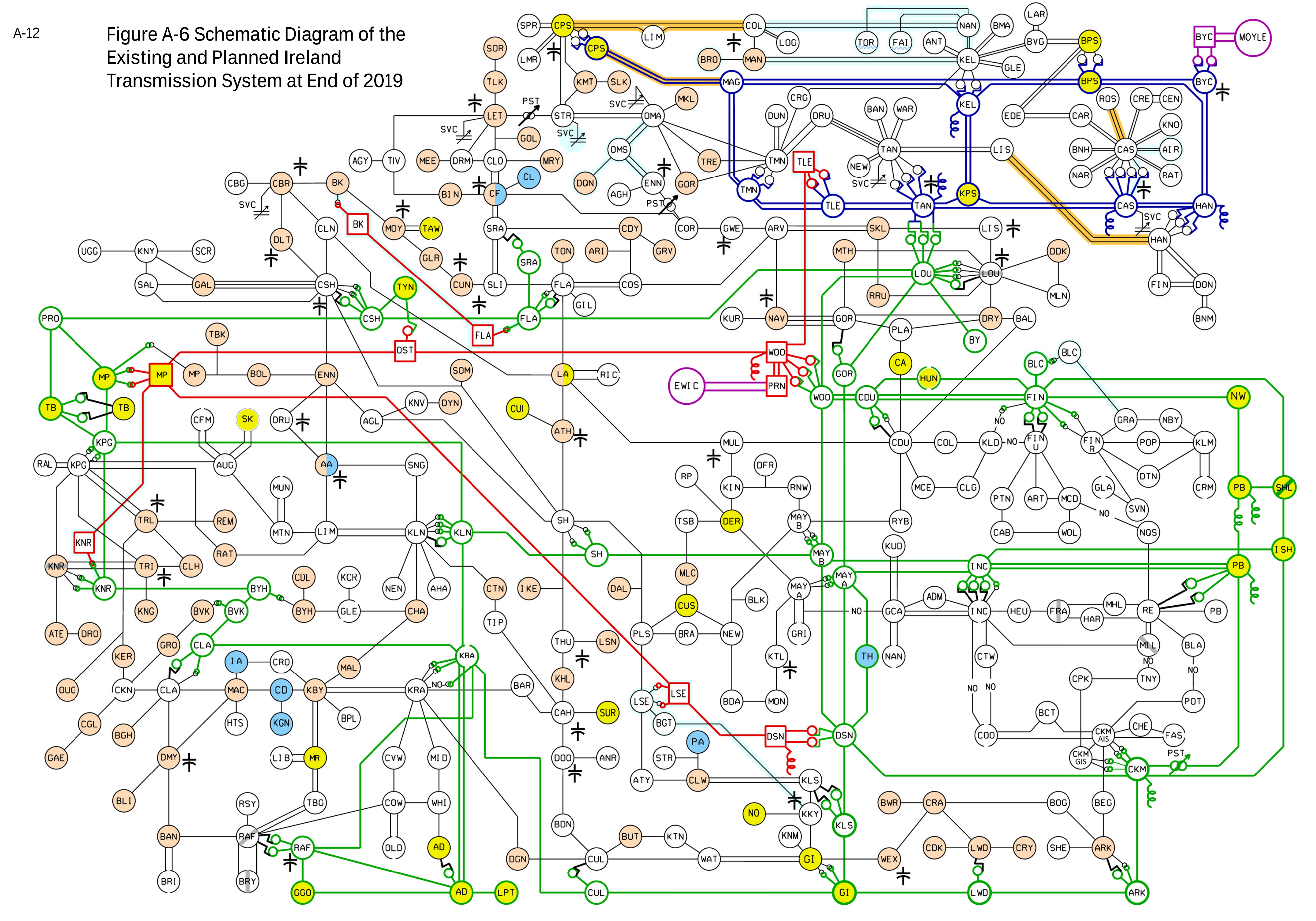


Figure A-6 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2019



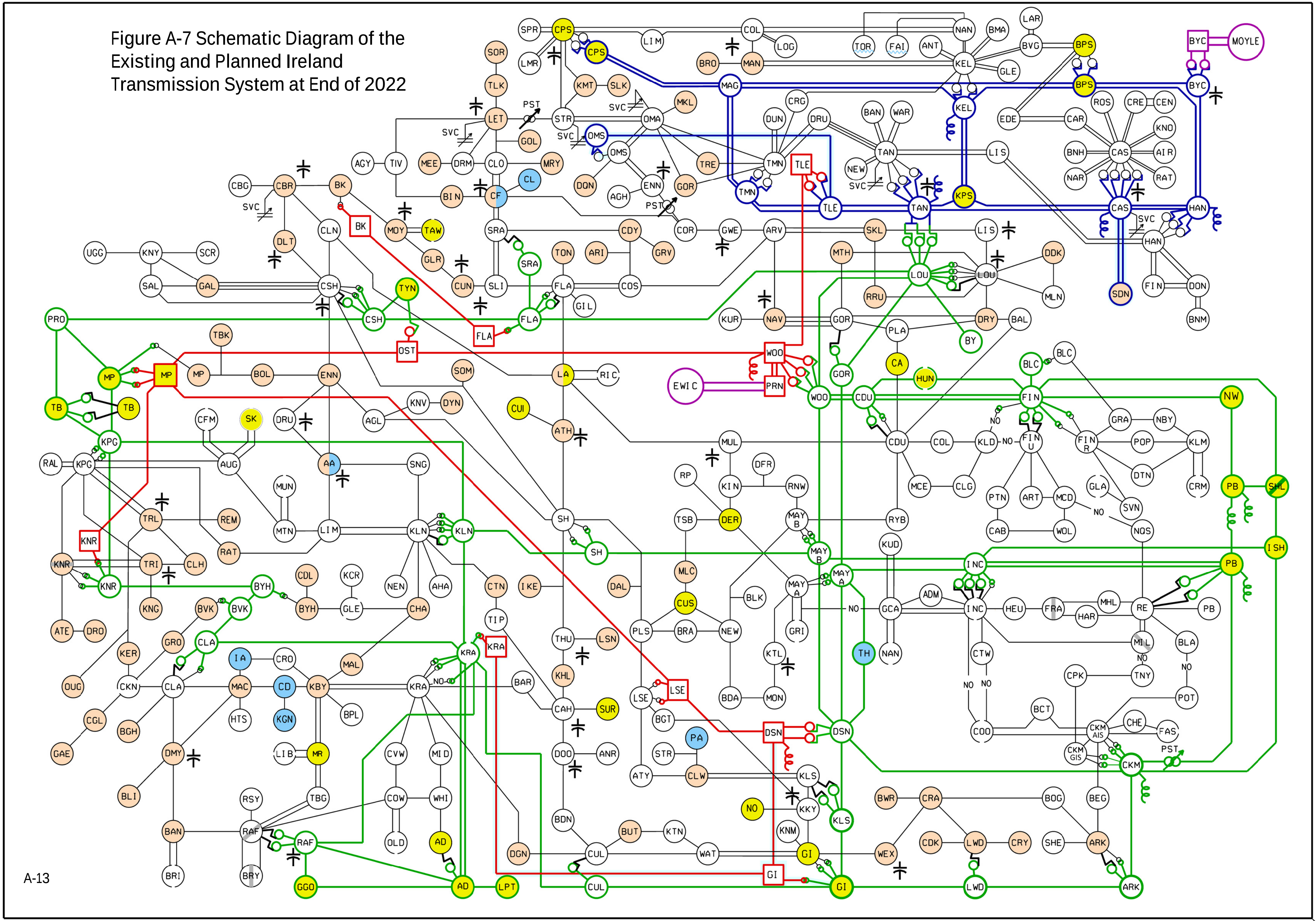


Figure A-7 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2022

B Transmission System Characteristics

B.1 Characteristics of the Existing Transmission System

B.2 Changes in Transmission System Characteristics

B Transmission System

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 November and December 2012.

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:

Table B-2 Characteristics of Existing 400 kV Lines

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

Table B-4 Characteristics of Existing 220 kV Lines and Cables

Table B-5 Characteristics of Existing 110 kV Lines and Cables

Table B-6 Characteristics of Existing 400/220 kV Transformers

Table B-7 Characteristics of Existing 275/220 kV Transformers

Table B-8 Characteristics of Existing 275/110 kV Transformers

Table B-9 Characteristics of Existing 275/11.5 kV Generator Transformers

Table B-10 Characteristics of Existing 220/110 kV Transformers

Table B-11 Characteristics of Existing Power Flow Controllers

Table B-12 Characteristics of Existing Reactive Compensation

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

Table B-13 Changes in Circuit Characteristics Expected After November 01st 2012

Table B-14 Changes in Circuit Characteristics Expected in 2013

Table B-15 Changes in Circuit Characteristics Expected in 2014

Table B-16 Changes in Circuit Characteristics Expected in 2015

Table B-17 Changes in Circuit Characteristics Expected in 2016

Table B-18 Changes in Circuit Characteristics Expected in 2017

Table B-19 Changes in Circuit Characteristics Beyond 2017

Table B-20 Characteristics of Transformers Expected in 2013

Table B-21 Characteristics of Transformers Expected in 2015

Table B-22 Characteristics of Transformers Expected Beyond 2015

Table B-23 Characteristics of Reactive Compensation Expected in 2013

Table B-24 Characteristics of Reactive Compensation Expected in 2015

Table B-25 Characteristics of Reactive Compensation Expected in 2017

Table B-26 Detailed Characteristics of future NI 275/110 kV Interbus Transformers

Table B-27 Detailed Characteristics of future NI 400/275 kV Interbus Transformers

Tables B-2 to B-5 and Tables B-12 to B-16 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	0.003	0.021	0.127	710	881	881
LOU	TAN	2	49.8	0.003	0.021	0.127	710	881	881
BPS	HAN	2	45.5	0.002	0.020	0.127	710	820	881
BPS	KEL	1	34.5	0.002	0.015	0.090	710	820	881
BPS	MAG	1	65.5	0.003	0.029	0.172	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	0.023	761	761	837
CACO2A	MAG	1	56.0	0.007	0.025	0.150	412	477	513
CACO2B	CPS	1	0.2	0.000	0.000	0.019	761	761	837
CACO2B	MAG	1	56.0	0.007	0.025	0.150	412	477	513
CAS	HAN	1	18.4	0.001	0.008	0.051	710	820	881
CAS	HAN	2	18.4	0.001	0.008	0.051	710	820	881
CAS	KPS	1	66.8	0.003	0.029	0.178	710	820	881
CAS	TAN	1	0.0	0.002	0.019	0.124	710	820	881
HAN	BYC	1	44.6	0.002	0.019	0.112	710	820	881
KEL	KPS	1	29.0	0.002	0.013	0.077	710	820	881
KEL	KIL	2	29.0	0.002	0.013	0.077	710	820	881
KEL	MAG	1	31.1	0.002	0.014	0.081	710	820	881
KPS	TAN	1	80.8	0.004	0.035	0.215	710	820	881
MAG	TAN	1	51.5	0.002	0.022	0.136	710	820	881
MAG	TMN	1	25.6	0.001	0.011	0.068	710	820	881
TAN	TMN	1	25.9	0.001	0.011	0.069	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	0.0012	0.008	0.259	434	534
AD	LPT	1	1.0	0.0001	0.000	0.027	593	593
AD	GGO	1	3.8	0.0002	0.002	0.104	593	593
AD	KRA	2	25.6	0.003	0.022	0.034	434	534
ARK	CKM	1	53.3	0.0062	0.046	0.070	434	534
ARK	LWD	1	39.0	0.0046	0.034	0.051	434	534
CLA	KRA	1	45.0	0.0053	0.039	0.059	434	534
CLA	TB	1	97.3	0.0113	0.084	0.127	434	534
CSH	FLA	1	88.1	0.0103	0.076	0.115	405	405
CSH	PRO	1	88.5	0.0103	0.077	0.116	434	436
CSH	TYN	1	33.8	0.0046	0.029	0.046	761	804
CKM	DSN	1	41.6	0.0049	0.036	0.054	434	534
CKM	ISH	1	11.5	0.0004	0.005	0.315	593	593
CUL	GI	1	23.0	0.0027	0.020	0.030	248	414
CUL	KRA	1	86.0	0.0117	0.074	0.117	434	804
CDU	FIN	1	3.7	0.0005	0.003	0.005	434	534
CDU	HN	1	4.5	0.0002	0.002	0.123	593	593
CDU	WOO	1	18.4	0.0022	0.016	0.024	434	534
CDU	FIN	2	3.7	0.0005	0.003	0.005	434	534
CDU	WOO	2	17.8	0.0021	0.016	0.023	434	534
DSN	KLS	1	59.3	0.0069	0.051	0.077	434	534
DSN	MAY	1	36.3	0.0043	0.032	0.048	434	534
DSN	MAY	2	30.6	0.0036	0.027	0.040	434	534
DSN	TH	1	26.6	0.003	0.022	0.144	351	351
FLA	LOU	1	110.1	0.0128	0.095	0.144	434	534
FLA	SRA	1	55.0	0.0064	0.048	0.072	-	534
FIN	HN	1	1.4	0.0001	0.001	0.038	593	593
FIN	SHL	1	13.4	0.0005	0.005	0.367	593	593
FIN	NW	1	11.9	0.0006	0.004	0.680	332	332
GI	KLS	1	69.3	0.0081	0.060	0.091	434	534
GI	LWD	1	47.9	0.0056	0.042	0.063	434	534
GOR	LOU	1	32.4	0.0038	0.028	0.042	434	534
GOR	MAY	1	42.2	0.0049	0.037	0.055	434	534
GGO	RAF	1	9.5	0.000305	0.005	0.414	593	593
INC	ISH	1	12.1	0.0004	0.005	0.330	593	593
INC	MAY	2	19.1	0.0023	0.017	0.025	323	389
ISH	SHL	1	1.3	0.0001	0.001	0.036	593	593
KRA	KLN	1	82.4	0.0145	0.073	0.107	512	565
KRA	RAF	1	23.4	0.0028	0.020	0.031	434	534
KLN	SH	1	89.7	0.0144	0.080	0.115	269	377
KLN	TB	1	70.6	0.0082	0.061	0.092	434	534
LOU	WOO	1	61.2	0.0071	0.053	0.080	434	534
MAY	TH	1	53.1	0.0058	0.044	0.184	351	351
MAY	INC	1	19.1	0.0023	0.017	0.025	323	389

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
MAY	SH	1	105.6	0.0169	0.094	0.135	269	377
MAY	WOO	1	22.3	0.0027	0.020	0.030	434	534
MP	PRO	1	12.7	0.0007	0.009	0.021	825	992
NW	PB	1	4.5	0.0003	0.001	0.261	332	332
OST	TYN	1	14.5	0.0017	0.013	0.019	434	534
PB	SHL	1	0.1	0.0001	0.000	0.003	593	593
PB	CKM	1	14.5	0.0012	0.005	0.618	267	267
PB	INC	1	12.5	0.001	0.004	0.504	267	267
PB	INC	2	11.3	0.0005	0.003	0.722	351	351
PRO	TB	1	10.3	0.0011	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	105		128
AA	ENN (I)	1	33.0	0.051	0.117	0.011	105		128
AA	LIM (I)	1	11.7	0.007	0.037	0.012	99		125
AD	WH	1	3.1	0.005	0.011	0.001	105		128
AGH	EKN	1	31.2	0.039	0.095	0.019	109	119	124
AGL	DYN	1	8.0	0.013	0.028	0.003	105		128
AGL	ENN (I)	1	38.2	0.059	0.131	0.012	105		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	105		219
ARK	SHE	2	2.2	0.004	0.008	0.001	34		57
ART	FIN (I)	1	9.0	0.005	0.010	0.055	120		131
ART	MCD	1	4.9	0.003	0.006	0.030	120		131
ARV	COS	1	41.4	0.064	0.142	0.013	105		128
ARV	GWE	1	30.6	0.019	0.099	0.011	178		219
ARV	NAV	1	60.6	0.038	0.197	0.021	120		128
ARV	SKL	1	18.6	0.029	0.065	0.006	80		110
ARV	SKL	2	23.6	0.015	0.076	0.010	#N/A		219
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

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
ATY	CLW	1	25.0	0.039	0.086	0.008	105		128
ATY	PLS	1	26.6	0.041	0.092	0.009	105		128
AUG	CFM	1	0.7	0.001	0.002	0.001	96		96
AUG	SK	3	1.0	0.001	0.001	0.006	120		131
AUG	SK	4	1.0	0.001	0.001	0.006	120		131
AUG	CFM	2	0.7	0.001	0.002	0.001	96		96
AUG	TB	1	34.0	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	0.013	0.065	0.007	178		219
BAN (I)	BRI	1	2.6	0.004	0.009	0.001	105		128
BAN (I)	DMY	1	25.9	0.040	0.089	0.008	105		128
BAN (I)	RAF	1	26.9	0.041	0.091	0.012	105		128
BAN (I)	BRI	2	2.5	0.004	0.009	0.001	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
BAR	BAR T	1	0.3	0.000	0.001	0.000	136		166
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	107		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
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	105		128
BK	MOY	1	27.0	0.042	0.093	0.009	99		114
BLA	POT	1	5.2	0.002	0.004	0.092	119		119
BLA	RE	1	7.7	0.003	0.006	0.136	119		119
BLI	DMY	1	27.6	0.043	0.094	0.010	105		128
BLK	BLK T	1	0.5	0.001	0.002	0.000	136		166
BMA	KEL	1	10.0	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	105		219
BOL	ENN (I)	1	24.0	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	193
BPS	EDE	1	15.1	0.023	0.053	0.005	70	81	193

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
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	0.040	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	DOO	1	15.7	0.010	0.051	0.006	178		219
CAH	THU	1	39.0	0.041	0.130	0.013	136		166
CAH	TIP	1	18.1	0.028	0.063	0.006	105		128
CAH	BAR T	1	43.7	0.065	0.150	0.014	105		128
CAR	CAS	1	24.7	0.037	0.088	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	0.001	0.004	0.061	132	132	145
CAS	CRE	1	3.0	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	0.015	0.040	0.071	109	119	124
CAS	NAR	1	19.9	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	CLN	1	57.5	0.089	0.198	0.020	105		128
CBR	CBG	1	26.5	0.038	0.083	0.052	99		124
CBR	DLT	1	27.8	0.043	0.096	0.009	90		128
CD	MAC	1	2.4	0.004	0.008	0.001	105		128
CD	KBY	1	32.1	0.020	0.104	0.011	178		219
CDK	LWD	1	6.6	0.003	0.009	0.041	116		116
CDU	MUL	1	73.3	0.088	0.237	0.041	105		128
CDU	PLA	1	37.0	0.023	0.120	0.013	178		219
CDU	RYB	1	13.0	0.012	0.039	0.021	103		130
CDY	GAR	1	7.3	0.005	0.024	0.003	178		219
CDY	SRA	1	12.7	0.020	0.044	0.004	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
CDY	ARI T	1	13.7	0.014	0.046	0.005	136		166
CEN	CRE	1	3.2	0.001	0.004	0.030	144	144	144
CEN	CRE	1	3.2	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	103		128
CF	SRA	1	53.0	0.065	0.179	0.021	107		221
CF	GOL T	1	25.5	0.036	0.093	0.009	105		222
CGL	GAE	1	2.0	0.001	0.003	0.015	130		130
CGL	CKN	1	6.3	0.004	0.021	0.002	178		219
CHA	GLE (I)	1	30.0	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	POT	1	3.2	0.001	0.003	0.057	119		119
CKM	CPK_T	1	0.1	0.000	0.000	0.000	136		166
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	178		219
CLH	TRI	1	9.0	0.014	0.031	0.003	105		128
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		126
CLW	KLS	1	5.4	0.008	0.019	0.002	105		128
CLW	KLS	2	5.3	0.008	0.019	0.002	105		128
CLW	STR (I)	1	17.6	0.027	0.061	0.006	105		128
COL (I)	KLD	1	5.1	0.003	0.013	0.038	99		124
COL (I)	CDU	1	2.7	0.001	0.004	0.020	130		130
COL (I)	CPS	1	46.6	0.061	0.161	0.015	82	95	103
COL (N)	KEL	1	58.9	0.067	0.201	0.020	109	119	124
COL (N)	LIM (N)	1	18.6	0.024	0.064	0.006	82	95	103
COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
COO	CKM	1	15.0	0.014	0.045	0.026	#N/A		130
COO	CKM	2	16.0	0.013	0.042	0.060	130		130
COR	GWE	1	10.9	0.007	0.036	0.004	178		219
COR	EKN	1	27.5	0.043	0.095	0.009	107		126
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
COS	ARI T	1	20.7	0.022	0.069	0.007	120		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	CVW	1	17.2	0.025	0.054	0.018	105		128
COW	OLD	1	2.3	0.004	0.008	0.001	105		128
COW	OLD	2	2.2	0.003	0.008	0.001	105		128
COW	RAF	1	6.9	0.010	0.024	0.003	105		128
COW	WH	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	14.6	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	0.012	0.030	0.003	82	95	103
CPS	LMR	1	9.0	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	26.8	0.018	0.053	0.017	143	158	166
CRA	LWD	1	8.0	0.005	0.026	0.003	178		219
CRA	WEX	1	21.3	0.022	0.071	0.007	136		166
CRG	DUN	1	36.9	0.047	0.125	0.017	82	95	103
CRG	KEL	1	23.1	0.029	0.077	0.013	82	95	103
CRM	KLM	2	1.4	0.001	0.002	0.014	140		140
CRM	KLM	1	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	107		219
CSH	CLN	1	22.8	0.014	0.074	0.008	161		196
CSH	DLT	1	52.0	0.081	0.179	0.017	105		128
CSH	ENN (I)	1	53.5	0.034	0.174	0.019	120		120
CSH	GAL	1	13.8	0.021	0.047	0.004	105		128
CSH	GAL	2	11.3	0.018	0.039	0.004	105		128
CSH	GAL	3	11.3	0.018	0.039	0.004	105		128
CSH	SAL	1	24.6	0.033	0.073	0.067	105		105
CSH	SOM T	1	44.9	0.070	0.154	0.014	105		128
CTN	TIP	1	13.2	0.021	0.046	0.004	105		128
CTN	KLN	1	28.1	0.044	0.098	0.009	105		128
CTY	INC	1	8.9	0.011	0.030	0.003	103		128
CTY	COO	1	2.9	0.004	0.010	0.001	#N/A		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	107		219
CUN	GLR	1	25.9	0.040	0.089	0.008	99		125
CUN	SLI	1	20.0	0.031	0.069	0.006	99		126
CUS	NEW (I)	1	31.2	0.033	0.104	0.011	136		166
CUS	PLS	1	42.1	0.044	0.140	0.014	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
CVW	KRA	1	7.6	0.012	0.026	0.004	105		128
DAL	DAL T	1	12.2	0.019	0.042	0.004	105		128
DDK	MLN	1	7.5	0.012	0.026	0.003	105		128
DDK	LOU	1	16.8	0.026	0.058	0.005	105		128
DER	KIN	1	15.1	0.012	0.050	0.005	120		128
DER	MAY	1	43.0	0.027	0.139	0.018	90		95
DER	TSB	1	19.7	0.031	0.068	0.006	105		128
DFR	DFR T	1	0.1	0.000	0.000	0.000	105		128
DGN	KRA	1	53.7	0.034	0.175	0.019	178		219
DMY	MAC	1	26.2	0.037	0.096	0.009	120		128
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	6.1	0.002	0.005	0.140	144	144	158
DON	HAN	1	6.1	0.002	0.005	0.140	144	144	158
DON	PSW	1	6.0	0.006	0.006	0.066	75	75	82
DON	PSW	1	5.8	0.006	0.006	0.066	75	75	82
DRM	LET	1	8.0	0.013	0.028	0.003	105		128
DRM	MEE	1	5.0	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	105		128
DRU (N)	DUN	1	25.5	0.033	0.087	0.009	82	95	103
DRU (N)	DUN	2	28.1	0.037	0.095	0.010	82	95	103
DRU (N)	TAN	1	4.4	0.004	0.014	0.002	79	96	113
DRU (N)	TAN	2	4.4	0.004	0.014	0.002	79	96	113
DRU (N)	TAN	3	4.1	0.005	0.014	0.001	96	106	119
DRY	GOR	1	19.4	0.029	0.067	0.006	105		128
DRY	LOU	1	31.9	0.020	0.104	0.011	178		219
DRY	PLA	1	5.3	0.008	0.018	0.002	105		128
DTN	FIN (I)	1	9.2	0.002	0.014	0.111	140		140
DTN	KLM	1	3.2	0.002	0.005	0.032	140		140
DUN	OMA	1	36.1	0.042	0.124	0.012	150	150	150
DUN	OMA	2	39.5	0.047	0.135	0.013	150	150	150
DUN	TMN	1	5.9	0.004	0.017	0.005	139	144	152
ENN (N)	OMA	1	33.7	0.044	0.113	0.011	82	95	124
ENN (N)	OMA	2	33.7	0.044	0.113	0.011	82	95	124
FAS	FAS T	1	5.0	0.008	0.017	0.002	107		126
FAS	CKM	1	7.5	0.011	0.026	0.003	103		128
FAS	CKM	1	7.5	0.011	0.026	0.003	103		128
FIN (I)	MCD	1	7.9	0.003	0.007	0.141	119		119
FIN (I)	PTN	1	3.5	0.003	0.010	0.006	80		129

Table B-5 Characteristics of Existing 110 kV Lines and Cables (continued)

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
FIN (I)	GLA	1	14.0	0.022	0.048	0.005	105		128
FIN (I)	GLA	2	14.2	0.022	0.049	0.005	107		115
FIN (I)	GRA	1	13.2	0.005	0.012	0.236	119		119
FIN (I)	POP	1	4.3	0.002	0.005	0.026	120		131
FIN (N)	HAN	1	3.0	0.001	0.003	0.022	144	144	144
FIN (N)	HAN	1	3.2	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	105		128
FLA	SLI	1	50.5	0.079	0.174	0.016	105		128
FLA	TON	1	32.3	0.050	0.111	0.010	99		126
FRA	HAR	1	2.3	0.002	0.004	0.030	107		107
FRA	MHL	1	4.2	0.003	0.006	0.042	140		140
FRA	INC	1	5.6	0.004	0.010	0.073	107		107
GAL	SAL	1	6.5	0.005	0.010	0.065	105		105
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	105		128
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	105		128
GLE (N)	KEL	1	21.4	0.027	0.068	0.027	82	82	90
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	#N/A		166
GOR	NAV	1	5.3	0.008	0.019	0.002	105		128
GOR	NAV	2	6.3	0.009	0.022	0.002	105		128
GOR	NAV	3	6.5	0.007	0.022	0.002	136		166
GOR	PLA	1	19.7	0.030	0.068	0.006	105		128
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

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
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	MIL	1	8.4	0.004	0.009	0.051	120		131
INC	COO	1	6.2	0.006	0.016	0.029	136		140
KBY	MR	2	4.0	0.004	0.013	0.003	103		128
KBY	MAL	1	29.1	0.030	0.097	0.010	136		166
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	104		166
KKY	KLS	1	34.3	0.053	0.118	0.011	105		128
KLD	MCE	1	7.6	0.008	0.025	0.007	120		128
KLM	POP	1	6.0	0.003	0.007	0.037	120		131
KLN	LIM (I)	1	9.0	0.014	0.031	0.003	105		128
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	6.0	0.011	0.022	0.000	98	108	113
KMT	STR (N)	1	11.0	0.008	0.037	0.004	143	158	166
KRA	BAR T	1	19.5	0.020	0.065	0.007	136		166
KRA	KBY	1	11.9	0.014	0.040	0.004	105		128
KRA	KBY	2	12.5	0.018	0.043	0.004	105		128
KRA	MID	1	10.7	0.017	0.037	0.004	105		128
KTL	MAY	1	21.4	0.022	0.072	0.007	99		125
KTL	MON	1	8.9	0.009	0.030	0.003	136		166
KTN	WAT	1	5.0	0.004	0.008	0.050	140		140
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	TLK	1	34.9	0.054	0.120	0.013	105		128
LET	GOL T	1	38.4	0.058	0.132	0.012	103		128
LET	SBN	1	22.3	0.037	0.083	0.008	107		126
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	103		128
LIS (I)	SKL	1	39.3	0.061	0.135	0.013	105		128
LIS (I)	LOU	1	40.4	0.063	0.139	0.013	105		128
LIS (N)	TAN	1	31.0	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	0.020	0.045	0.004	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
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
MAY	GRI T	1	2.2	0.002	0.007	0.002	103		143
MAY	GRI	1	2.2	0.003	0.009	0.001	105		128
MAY	RYB	1	8.9	0.009	0.030	0.003	136		166
MAY	RNW	1	7.1	0.008	0.024	0.002	103		128
MAY	BLK T	1	30.9	0.032	0.103	0.011	136		166
MCD	NQS	1	2.0	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	0.002	0.005	0.030	140		140
MID	WH	1	20.0	0.030	0.069	0.007	105		128
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
MKL	OMA	1	37.5	0.028	0.113	0.015	139	150	157
MOY	GLR	1	14.0	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	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
MR	KBY	1	4.0	0.004	0.013	0.003	103		128
MTH	LOU	1	15.1	0.024	0.052	0.005	105		128
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)	PLS	1	43.0	0.055	0.146	0.014	105		128
NEW (I)	BLK T	1	12.2	0.013	0.041	0.004	136		166
NEW (N)	TAN	1	24.1	0.031	0.080	0.008	82	95	103
NEW (N)	TAN	1	24.0	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	0.040	0.179	0.019	187		223
RAF	TBG	1	10.6	0.016	0.036	0.005	105		128
RAF	RSY	1	2.1	0.003	0.007	0.001	63		99

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
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
RNW	DFR T	1	25.9	0.020	0.085	0.009	103		128
RRU	SKL	1	14.5	0.023	0.050	0.005	105		128
SH	DAL T	1	12.0	0.008	0.039	0.007	178		219
SH	IKE T	1	53.7	0.034	0.175	0.019	178		219
SH	SOM T	1	13.8	0.021	0.047	0.006	105		128
SLI	SRA	1	11.1	0.017	0.038	0.004	105		128
SLI	SRA	2	12.0	0.019	0.041	0.004	105		128
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	0.063	0.147	0.014	105		128
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	0.0018	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	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	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	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Tamnamore IBTx 1	0.0018	0.0656	0.0018	0.2375	0	0.1575	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	
Tamnamore IBTx 1	0.0018	0.0656	0.0018	0.2375	0	0.1575	240	240	30	1.15	0.85	19

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%
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 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%
Tarbert T2101[2]	250	0.001	0.055	9%	17%
Tarbert T2102[2]	250	0.001	0.055	9%	17%
Total	**10,052**				

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	
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	1 Capacitor	15	
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
Total			**1,501**	**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 after November 01st 2012

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Omagh 110/33 kV: Replacement of transformers (NIE Approved)											
Add	110/33	OMA	OMA	1	...	0.004	0.248	...	90	90	90
Add	110/33	OMA	OMA	2	...	0.004	0.249	...	90	90	90
Delete	110/33	OMA	OMA	A	...	0.007	0.250	...	60	60	60
Delete	110/33	OMA	OMA	B	...	0.007	0.250	...	60	60	60
Ballymena 110/33 kV: Replacement of transformers (NIE Approved)											
Add	110/33	BMA_RUR	BMA_RUR	1	...	0.004	0.245	...	90	90	90
Add	110/33	BMA_RUR	BMA_RUR	2	...	0.004	0.246	...	90	90	90
Delete	110/33	BMA_RUR	BMA_RUR	1	...	...	...	...	45	45	45
Delete	110/33	BMA_RUR	BMA_RUR	2	...	...	...	...	45	45	45
Carnmoney 110/33 kV: Replacement of transformers (NIE Approved)											
Add	110/33	CAR	CAR	1	...	0.004	0.248	...	90	90	90
Delete	110/33	CAR	CAR	B	...	0.031	0.596	...	30	30	30
Delete	110/33	CAR	CAR	C	...	0.031	0.596	...	30	30	30
Killymallaght Wind Farm Cluster (NIE Approved)											
Delete	110	STR	CPS	2		0.020	0.085	0.009	143	158	166
Add	110	KMT	STR	1	11.0	0.008	0.037	0.004	143	158	166
Add	110	CPS	KMT	1	14.6	0.018	0.053	0.017	143	158	166

Table B-14 Changes in Circuit Characteristics Expected in 2013

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
CP371 Ballydine-Doon 110 kV Line Uprate											
Amend	110	BDN	DOO	1	11.3	0.007	0.037	0.004	178		219
CP559 Butlerstown-Kiloteran 110 kV Line Uprate											
Amend	110	BUT	KTN	1	2.7	0.002	0.009	0.001	178		219

Table B-14 Changes in Circuit Characteristics Expected in 2013 (continued)

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
CP696 Marina-Trabeg 110 kV Lines Uprate											
Amend	110	MR	TBG	1	3.3	0.001	0.004	0.036	187		223
Amend	110	MR	TBG	2	2.9	0.001	0.003	0.032	187		223
CP667 Inichiore-Maynooth 220 kV Lines Uprate											
Amend	220	INC	MAY	1	19.1	0.003	0.016	0.026	793		833
Amend	220	INC	MAY	2	19.1	0.003	0.016	0.026	793		833
CP698 Prospect-Tarbert 220 kV Line Uprate											
Amend	220	PRO	TB	1	10.3	0.001	0.007	0.173	461		461
Construction of Reamore 110 kV Station											
Add	110	TRL	REM	1	12.0	0.006	0.018	0.120	106		106
CP641 Construction of Nore 110kV Station and Lines											
Add	110	KKY	NO	1	3.6	0.003	0.005	0.036	140		143
Connection of Cuilleen Generator into the new Cuilleen 110 kV Station											
Add	110	CUI	ATH	1	2.3	0.002	0.003	0.023	140		140
Connection of Suir Generator into the new Suir 110 kV Station											
Add	110	SUR	CAH	1	3.9	0.002	0.005	0.035	118		118
Carnmoney 110/33 kV: Replacement of transformers (NIE Approved)											
Add	110/33	CAR	CAR	2	...	0.004	0.248	...	90	90	90
Delete	110/33	CAR	CAR	A	...	0.012	0.228	...	60	60	60
Coleraine-Kells 110 kV circuit upgrade phase 1 (NIE Approved)											
Amend	110	COL	KEL	1	58.9	0.070	0.201	0.020	109	119	124
CP479 Connection of Athea Wind Farm into Dromada 110 kV Station											
Add	110	ATE	DRO	1	7.0	0.005	0.011	0.070	140		140
Add	110	ATE	TRI	1	11.0	0.007	0.036	0.004	178		219
Delete	110	DRO	TRI	1	...	...	...	...	...		...
CP197 Construction of Cushaling-Thornsberry and CP739 Construction of new Mountlucas 110 kV station											
Add	110	CUS	MLC	1	14.5	0.015	0.048	0.005	136		166
Add	110	MLC	TSB	1	19.2	0.020	0.064	0.007	136		166
CP717 Clashavoon-Knockraha 220 kV Line Uprate											
Amend	220	CLA	KRO	1	45.0	0.006	0.039	0.061	761		804
CP421 Construction of Binbane-Letterkenny 110 kV Line											
Add	110	BIN	LET	1	69.0	0.072	0.230	0.024	136		166
CP657 Ikerrin Tee-Thurles 110 kV Line Uprate											
Amend	110	IK T	THU	1	25.9	0.016	0.084	0.009	178		219
CP701 Cullenagh-Dungarvan 110 kV Line Uprate											
Amend	110	CUL	DGN	1	34.3	0.021	0.110	0.021	178		219
CP702 Butlerstown-Cullenagh 110 kV Line Uprate											
Amend	110	BUT	CUL	1	11.6	0.007	0.038	0.004	178		219
Connection of Ballakelly Generator into the new Ballakelly 220 kV Station											
Add	Add	Add	Add	Add	Add	Add	Add	Add	Add	Add	Add

Table B-15 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
CP728 Construction of new Kill Hill 110 kV station											
Add	110	CAH	KHL	1	21.8	0.021	0.068	0.032	136		166
Add	110	KHL	THU	1	21.8	0.021	0.068	0.032	136		166
Delete	110	CAH	THU	1	...	...	...	...	...		...
CP602 Construction of new Knockavanna 110 kV station											
Add	110	DYN	KNV	1	2.0	0.003	0.007	0.001	105		128
Add	110	AGL	KNV	1	6.0	0.009	0.021	0.002	105		128
Delete	110	AGL	DYN	1	...	...	...	...	...		...
CP265 Great Island-Cullenagh 220 kV Line Uprate											
Amend	220	GI	CUL	1	23.0	0.001	0.015	0.037	868		1070
CP644 Construction of Bracklone 110kV Station and Lines											
Add	110	PLS	BRA	1	19.3	0.030	0.067	0.006	105		128
Add	110	NEW	BRA	1	9.3	0.010	0.031	0.003	136		166
Delete	110	NEW	PLS	1	...	...	...	...	...		...
CP668 Corduff-Ryebrook and Maynooth-Ryebrook 110 kV Line Uprates											
Amend	110	MAY	RYB	1	8.9	0.009	0.030	0.003	136		166
CP731 Bellacorick-Castlebar 110 kV Line Uprate											
Amend	110	BK	CBR	1	37.4	0.024	0.122	0.013	178		219
CP716 Carrigadrohid-Macroom 110 kV Line Uprate											
Amend	110	CD	MAC	1	2.4	0.002	0.008	0.001	178		219
CP791 Cunghill-Glenree 110 kV Line Uprate											
Amend	110	CUN	CUL	1	25.9	0.018	0.091	0.010	178		219
CP783 Kilbarry-Knockraha 110 kV Line Uprate											
Amend	110	KBY	KNA	1	11.9	0.008	0.039	0.004	178		219
CP745 Cathaleen's Fall-Srananagh no.2 110 kV Line Uprate											
Amend	110	CF	SRA	2	49.2	0.031	0.160	0.017	178		219
CP736 Cunghill-Sligo 110 kV Line Uprate											
Amend	110	CUN	SLI	1	20.0	0.013	0.065	0.007	178		219
CP776 Kilbarry-Mallow 110 kV Line Uprate											
Amend	110	KBY	MAL	1	29.2	0.018	0.095	0.010	178		219
CP608 Construction of Knocknagashel 110 kV Station											
Add	110	KNG	TRI	1	13.1	0.008	0.043	0.005	178		219
CP754 Raffeen-Trabeg no.1 110 kV Line Uprate											
Amend	110	RAF	TBG	1	10.6	0.007	0.035	0.004	178		219
CP228 Construction of Marina 110 kV GIS station											
Amend	110	KBY	MR	1	4.0	0.004	0.013	0.003	103		143
Amend	110	KBY	MR	2	4.0	0.004	0.013	0.003	103		143

Table B-16 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
CP501 Construction of Clashavoon-Dunmanway 110 kV Line											
Add	110	CLA	DMY	1	35.0	0.022	0.114	0.012	178		219
CP0763, CP500, CP650 & CP651 Construction of Knockanure, Ballyvouskill and Ballynahulla 220/110 kV Stations											
Add	220	KPG	KNR	1	17.4	0.002	0.015	0.023	434		534
Add	220	KNR	KKM	1	47.0	0.006	0.041	0.062	434		534
Add	220	KKM	BVK	1	14.5	0.002	0.013	0.019	434		534
Add	220	BVK	CLA	1	18.4	0.002	0.016	0.024	434		534
Delete	220	CLA	KPG	1	...	...	...	...	...		...
Add	110	BVK	GRO	1	4.0	0.003	0.013	0.002	178		219
Add	110	BVK	GRO	2	4.0	0.003	0.013	0.002	178		219
Add	110	KKM	GLE	1	12.5	0.008	0.041	0.004	178		219
Add	110	ATE	KNR	1	9.5	0.006	0.031	0.003	178		219
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	KNR	KPG	1	15.0	0.015	0.050	0.005	136		166
Delete	110	ATE	TRI	1	...	...	...	...	...		...
Delete	110	KPG	TRI	1	...	...	...	...	...		...
Construction of Cordal 110 kV Station											
Add	110	BYH	CDL	1	8.2	0.005	0.027	0.003	178		219
Connection of Caulstown 110 kV Station and Lines											
Add	110	CA	PLA	1	0.9	0.001	0.003	0.000	178		219
Add	110	CA	CDU	1	36.9	0.023	0.120	0.013	178		219
Add	110	CDU	PLA	1	...	...	...	...	...		...
Tremoge Wind Farm Cluster (Unapproved)											
Delete	110	DUN	OMA	2	...	...	...	...	...		...
Add	110	OMA	TRE	1	21.3	0.025	0.073	0.007	186	190	193
Add	110	TRE	DUN	1	24.6	0.021	0.062	0.006	185	190	193
Mid-Antrim Wind Farm Cluster (Unapproved)											
Delete	110	COL	KEL	1							
Add	110	COL	MAN	1	26.0	0.024	0.069	0.007	185	190	193
Add	110	KEL	MAN	1	44.9	0.039	0.133	0.013	185	190	193
Knock 110/33 kV: Replacement of transformers (unapproved)											
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
Delete	110/33	KNO	KNO	A	...	0.011	0.271	...	60	60	60
Delete	110/33	KNO	KNO	B	...	0.011	0.272	...	60	60	60
CP125 and CP737 Connection of Screeb, Knockranny and Uggool 110 kV Stations											
Add	110	KNY	SAL	1	16.8	0.009	0.046	0.049	178		219
Add	110	KNY	SCR	1	26.0	0.027	0.087	0.009	136		166
Add	110	GAL	KNY	1	20.9	0.009	0.045	0.121	178		219

Table B-16 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	KNY	UGG	1	7.0	0.004	0.023	0.003	178		219
Construction of Kilpaddoge - Moneypoint 220 kV cable (in before Kilpaddoge 220 kV station)											
Add	220	KPG	MP	1	6.5	0.000	0.003	0.178	593		593
CP421 Construction of Tievebrack and Ardnagappary 110 kV Stations											
Add	110	BIN	TIV	1	22.0	0.023	0.073	0.008	136		166
Add	110	LET	TIV	1	47.0	0.049	0.157	0.016	136		166
Add	110	AGY	TIV	1	35.0	0.054	0.120	0.011	105		128
Delete	110	BIN	LET	2	...	...	...	...	...		...
CP603 & CP764 Construction of Mulreavy and Clogher 110 kV Stations, 110 kV Loop-ins and circuit uprates											
Add	110	MRY	CLO	1	7.4	0.005	0.011	0.074	124		124
Add	110	CF	CLO	1	20.0	0.013	0.065	0.007	178		219
Add	110	CF	CLO	2	20.0	0.029	0.073	0.007	187		222
Add	110	CLO	DRU	1	31.5	0.020	0.102	0.011	178		219
Add	110	CLO	GOL T	1	2.5	0.004	0.009	0.001	187		222
Delete	110	CF	DRU	1	...	...	...	...	...		...
Delete	110	CF	GLO	1	...	...	...	...	...		...
CP707 Looping of Barrymore 110 kV station											
Add	110	BAR	CAH	1	44.5	0.066	0.153	0.014	105		128
Add	110	BAR	KRA	1	19.7	0.020	0.066	0.007	136		166
Delete	110	KRA	CAH	1	...	...	...	...	...		...
CP041 Construction of Hartnett's Cross 110 kV station											
Add	110	HTS	MAC	1	4.5	0.007	0.016	0.002	105		128
CP755 Cauteen-Killonan kV Line Uprate											
Amend	110	CTN	KLN	1	28.0	0.018	0.091	0.010	178		219
CP756 Cauteen-Tipperary 110 kV Line Uprate											
Amend	110	CTN	TIP	1	13.2	0.008	0.043	0.005	178		219
CP744 Cahir-Tipperary 110 kV Line Uprate											
Amend	110	CAH	TIP	1	18.1	0.011	0.059	0.006	178		219
CP490 Connection of Knockmullen 110 kV Station											
Add	110	GI	KNM	1	15.0	0.016	0.050	0.005	136		166
CP596 Construction of Mullingar - Kinnegad 110kV line											
Add	110	MUL	KIN	1	27.0	0.017	0.088	0.010	178		219
CP606 Construction of Glenlara-Knockacummer 110 kV Line											
Add	110	GLE	KCR	1	11.2	0.008	0.017	0.112	140		140
CP811 Cahir-Kill Hill-Thurles 110 kV Line Uprate											
Amend	110	CAH	KHL	1	21.8	0.013	0.066	0.033	178		219
Amend	110	KHL	THU	1	21.8	0.013	0.066	0.033	178		219

Table B-17 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
CP673 Connection of Knocknagreenan 110 kV Station											
Add	110	KGN	CD	1	0.9	0.000	0.000	0.000	190		190
Tamnamore - Phase 2: 275/110 kV Substation and Line (NIE Approved)											
Add	275	MAG	TMN	2	25.6	0.001	0.011	0.065	710	820	881
Add	275	TMN	TAN	2	5.4	0.001	0.011	0.065	710	820	881
Delete	275	MAG	TAN	1	...	...	...	...	...		...
Add	110	TMN	DUN	2	7.0	0.009	0.023	0.002	82	95	103
Add	110	TMN	CRG	1	35.5	0.045	0.119	0.022	109	119	124
Delete	110	CRG	DUN	1	...	...	...	...	...		...
Add	110	DRU	TMN	1	22.2	0.028	0.073	0.012	82	95	103
Add	110	DRU	TMN	2	22.5	0.029	0.075	0.008	82	95	103
Delete	110	DRU	DUN	1	...	...	...	...	...		...
Delete	110	DRU	DUN	2	...	...	...	...	...		...
Omagh - Dungannon 110kV - Phase 2 (Part 2) (NIE Approved)											
Add	110	TRE	TMN	1	25.2	0.025	0.080	0.024	185	190	193
Delete	110	TRE	DUN	1	...	...	...	...	...	...	...
Gort Wind Farm Cluster and lines											
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
Convert Whitla Street into a 110 kV substation - Belfast North Main (NIE Approved)											
Add	110	BNM	DON_N	1	5.1	0.005	0.005	0.053	75	75	82
Add	110	BNM	DON_N	2	5.1	0.005	0.005	0.053	75	75	82
Delete	110	DON_N	PSW			0.006	0.006	0.066	75	75	82
Delete	110	DON_N	PSW			0.006	0.006	0.066	75	75	82
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
Delete	110/33	PSW	PSW	A		0.006	0.167	...	75	75	75
Delete	110/33	PSW	PSW	B		0.006	0.166	...	75	75	75
CP647 Construction of a new Kilpaddoge 220/110 kV Station											
Add	220	KPG	TB	1	2.8	0.000	0.003	0.004	761		802
Add	220	KPG	TB	2	2.8	0.000	0.002	0.004	761		802
Add	220	KPG	KLN	1	70.0	0.008	0.061	0.092	434		534
Add	220	KPG	KNR	1	17.4	0.002	0.015	0.024	761		804
Add	110	KPG	AUG	1	32.8	0.021	0.107	0.012	178		219
Add	110	KPG	RAT	1	32.2	0.033	0.108	0.011	136		166
Add	110	KPG	TRL	1	39.4	0.060	0.135	0.013	105		128
Add	110	KPG	TRL	2	44.4	0.028	0.144	0.016	178		219
Add	110	KPG	KNR	1	15.0	0.015	0.050	0.005	136		166
Delete	220	TB	KLN	1	...	...	...	...	...		...

Table B-17 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
Delete	220	TB	CLA	1	...	...	...	...	...		...
Delete	110	TB	AUG	1	...	...	...	...	...		...
Delete	110	TB	RAT	1	...	...	...	...	...		...
Delete	110	TB	TRI	1	...	...	...	...	...		...
Delete	110	TB	TRL	1	...	...	...	...	...		...
Delete	110	TB	TRL	2	...	...	...	...	...		...
Construction of new Ralappane 110 kV station											
Add	110	RAL	KPG	1	3.4	0.002	0.011	0.001	178		219
Add	110	RAL	KPG	2	3.4	0.002	0.011	0.001	178		219
CP597 Moneypoint - Tullabrack T - Booltiagh Line Uprate											
Amend	110	MP	TK T	1	6.6	0.004	0.022	0.002	178		219
Amend	110	TK T	BOL	1	19.6	0.012	0.064	0.007	178		219
Amend	110	BOL	ENN	1	24.0	0.015	0.078	0.009	178		219
CP054 Refurbishment of Ardnacrusha 110 kV station											
Amend	110	AA	LIM	1	11.7	0.007	0.037	0.012	178		219

Table B-18 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
CP585 Construction of a new Laois 400 kV (2017)											
Add	380	DSN	LSE	1	44.8	0.001	0.010	0.226	1577		1944
Add	380	MP	LSE	1	170.0	0.003	0.038	0.850	1577		1944
Add	400/110	LSE	LSE	1	...	0.001	0.027	...			250
Add	400/110	LSE	LSE	2	...	0.001	0.027	...			250
Add	110	PLS	LSE	1	9.7	0.015	0.033	0.003	105		128
Add	110	ATY	LSE	1	21.9	0.032	0.075	0.007	105		128
Delete	400	DSN	MP	1	...	...	...	...	...		...
Delete	110	ATY	PLS	1	...	...	...	...	...		...
Connection of Ballyragget 110 kV Station (2017)											
Add	110	LSE	BGT	1	28.0	0.018	0.091	0.010	178		219
Add	110	KKY	BGT	1	22.0	0.014	0.071	0.008	178		219
CP437 Connection of Belcamp 220 kV Station (2017)											
Add	220	BLC	FIN	1	17.0	0.001	0.007	0.465	593		593
Add	220/110	BLC	BLC	1	...	0.001	0.065	...	250		250
Coleraine-Limavady Circuit Uprate (Unapproved)											
Amend	110	COL	LIM	1	18.6	0.022	0.064	0.006	185	190	193

Table B-18 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
Coolkeeragh-Limavady Circuit Uprate (Unapproved)											
Amend	110	CPS	LIM	1	29.5	0.032	0.101	0.010	185	190	193
Coleraine - Coolkeeragh Circuit Uprate (Unapproved)											
Amend	110	COL	CPS	1	46.6	0.053	0.160	0.016	185	190	193
Drumquin Wind Farm Cluster (Unapproved)											
Add	110	OMS	DRU	1	13.0	0.007	0.045	0.004	167	180	188
Delete	110	ENN	OMA	1	...	...	...	...	...		...
Delete	110	EKN	OMA	2	...	...	...	...	...		...
Add	110	OMS	ENN	1	19.7	0.026	0.066	0.007	82	95	103
Add	110	OMS	ENN	2	19.7	0.026	0.066	0.007	82	95	103
Add	110	OMS	OMA	1	14.0	0.018	0.047	0.005	82	95	103
Add	110	OMS	OMA	2	14.0	0.018	0.047	0.005	82	95	103
Construction of Airport Road 110/33kV BSP Substation and lines (Unapproved)											
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
Castlereagh-Rosebank 110 kV circuit uprates (Unapproved)											
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
Brockaghboy Wind Farm Cluster (Unapproved)											
Add	110	BRO	MAN	1	16.0	0.012	0.045	0.006	139	150	157
CP466 & CP469 Construction of Woodland-Turleenan 400kV line (2017)											
Add	380	TLE	WOO	1	140.0	0.003	0.021	0.707	1577		1944
Construction of Turlennan 400/275kV substation and lines											
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
Delete	275	TAN	TMN	1	...	...	...	...	...		...
Delete	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
CP726 Construction of Moneypoint-Knockanure 400 kV Line											
Add	400	MP	KNR	1	25.0	0.000	0.006	0.126	1100		1100

Table B-19 Changes in Circuit Characteristics beyond 2017

Change	Voltage (kV)	From	To	No.	Length (km)	Impedance p.u. on 100 MVA base			Rating (MVA)		
						R	X	B	Summer	August	Winter
Construction of Kells - Mid-Antrim 110kV 2nd Circuit (Unapproved)											
Add	110	KEL	MAN	2		0.022	0.134	0.013	188	204	213
Coolkeeragh-Magherafelt Circuit Uprate (Unapproved)											
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
Amend	275	CACO	MAG	1	56.0	0.002	0.024	0.140	1000	1000	1000
Amend	275	CACO	MAG	2	56.0	0.002	0.024	0.140	1000	1000	1000
Hannahstown-Lisburn 110 kV Circuit Uprate (Unapproved)											
Amend	110	HAN	LIS	1	9.2	0.006	0.026	0.018	144	144	144
Amend	110	HAN	LIS	2	9.2	0.006	0.026	0.018	144	144	144
Construction of Omagh South – Turleenan 275 kV Circuit (Unapproved)											
Add	275	OMS	TLE	1	62.5	0.035	0.216	0.021	710	820	881
Construction of North Antrim 110 kV substation and lines (Unapproved)											
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	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	110	FAI	NAN (N)	1		0.028	0.107	0.015	139	150	157
Add	110	TOR	NAN (N)	1		0.028	0.107	0.015	139	150	157
Construction of South Down 275 kV substation and lines (Unapproved)											
Add	110	CAS	SDN	1		0.002	0.018	0.110	710	820	881
Add	110	CAS	SDN	2		0.002	0.018	0.110	710	820	881
CP721 Grid West (2019)											
Add	400	BK	FLA	1	123.0	0.002	0.027	0.621	1577		1944
Add	400/110	BK	BK	1	...	0.000	0.036	...	500		500
Add	400/220	FLA	FLA	1	...	0.000	0.027	...	500		500
CP437 Grid Link (2020)											
Add	400	KRA	GI	1	108.0	0.002	0.024	0.545	1577		1944
Add	400	GI	DUN	1	110.0	0.002	0.025	0.555	1577		1944
Add	400/220	GI	GI	1	...	0.000	0.072	...	500		500
Add	400/220	KRA	KRA	1	...	0.000	0.027	...	500		500
CP506 Construction of Finnstown 220 kV Station (2030)											
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
Delete	220	INC	MAY	1	...	...	...	...	...		...
Delete	220	INC	MAY	2	...	...	...	...	...		...
Add	220/110	FNT	FNT	1	...	0.001	0.065	...	250		250
Add	110	INC	GCA	3	7.7	0.005	0.004	0.004	124		124

Table B-19 Changes in Circuit Characteristics beyond 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	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
Delete	110	INC	ADM	1	...	...	...	...	...		...
Delete	110	ADM	GCA	1	...	...	...	...	...		...

Table B-20 Characteristics of Transformers Expected in 2013

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
			R	X	+	-
CP683						
Dunstown	500	400/220	0.000	0.027	10%	7%
CP682						
Woodland	500	400/220	0.000	0.032	1%	15%

Table B-21 Characteristics of Transformers Expected in 2015

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
			R	X	+	-
CP688						
Moneypoint T2101	250	220/110	0.001	0.064	9%	0%
CP580						
Carrickmines T2104	250	220/110	0.000	0.063	9%	18%
CP500						
Knockanure T2101	250	220/110	0.001	0.064	9%	17%
CP650						
Ballyvouskill T2101	250	220/110	0.001	0.064	9%	17%
CP651						
Ballynahulla T2101	250	220/110	0.001	0.064	9%	17%

Table B-22 Characteristics of Transformers Expected beyond 2015

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
			R	X	+	-
CP506						
Finnstown T2101	250	220/110	0.001	0.064	9%	17%
CP647						
Kilpaddoge T2101	250	220/110	0.001	0.065	9%	17%
Kilpaddoge T2102	250	220/110	0.001	0.065	9%	17%

Table B-22 Characteristics of Transformers Expected beyond 2015 (continued)

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA base		Voltage Ratio Tapping Range	
			R	X	+	-
CP585						
Laois T4101	250	400/110	0.000	0.072	15%	15%
Laois T4102	250	400/110	0.000	0.072	15%	15%
CP399						
Moneypoint T4201	500	400/220	0.000	0.027	10%	7%
CP437						
Belcamp T2101	250	220/110	0.001	0.064	9%	17%
Turleenan						
Turleenan T4201	600	400/275	0.001	0.015	10%	10%
Turleenan T4202	600	400/275	0.001	0.015	10%	10%
Turleenan T4203	600	400/275	0.001	0.015	10%	10%
CP726						
Knockanure T4201	500	400/220	0.000	0.027	10%	7%

Table B-23 Changes in the Characteristics of Reactive Compensation Expected in 2013

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
CP515				
Mullingar	MUL 110	2 Capacitors (2 x 15)	30	-
CP529				
Thurles	THU 110	1 Capacitor	15	-
Slieve Kirk				
Slieve Kirk	SKIR20 20	1 Capacitor	13	-

Table B-24 Changes in the Characteristics of Reactive Compensation Expected in 2015

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
CP760				
Poolbeg	PB 220	2 Reactors (2 x 50)	-	100
Castlereagh				
Castlereagh	CAST1_SVC 110	1 SVC	30	30
Castlereagh	CAST1_FIX1 110	1 Capacitor	30	-
Omagh				
Omagh	OMAH1_SVC 110	1 SVC	50	50
Tandragee				
Tandragee	TAND1_SVC 110	1 SVC	30	30
Tandragee	TAND1_FIX 110	1 Capacitor	30	-

Table B-25 Changes in the Characteristics of Reactive Compensation Expected in 2017

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Strabane				
Strabane	STRA1_SVC 110	1 SVC	50	50

Table B-26 Detailed Characteristics of future NI 275/110 kV Interbus Transformers

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	
Summer 2012/13 Interbus Transformers Added												
Hannahstown IBTx 3	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2013/14 Interbus Transformers Added												
Castlereagh IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2013/14 Interbus Transformers Deleted												
Castlereagh IBTx 1	0.001 8	0.0641	0.001 8	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Winter 2015/16 Interbus Transformers Added												
Tamnamore IBTx 2	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2016/17 Interbus Transformers Added												
Coolkeeragh IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Tandragee IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2016/17 Interbus Transformers Deleted												
Coolkeeragh IBTx 1	0.001 8	0.0609	0.001 8	0.1273	0	0.057	240	240	30	1.15	0.85	19
Tandragee IBTx 1	0.001 8	0.0641	0.001 8	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Winter 2017/18 Interbus Transformers Added												
Castlereagh IBTx 4	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2019/20 Interbus Transformers Added												
Omagh South IBTx 1	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Omagh South IBTx 2	0.0014	0.0639	0.0014	0.2236	0	0.1449	240	240	60	1.15	0.85	19

Table B-27 Detailed Characteristics of future NI 400/275 kV Interbus Transformers

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	
Winter 2017/18 Interbus Transformers Added												
Turleenan IBTx 1	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23
Turleenan IBTx 2	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23
Turleenan IBTx 3	0.0008	0.015	0	0.0001	0	0.0001	600	600	60	1.1	0.9	23

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 2022 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)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
AA	ARDNACRUSHA	0.93	58.4	59.2	59.6	59.6	60.2	61.0	61.8	63.1	64.1	65.0
AD	AGHADA	0.87	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
AGH	AGHYOULE MAIN	0.98	16.8	16.9	17.1	17.3	17.5	17.7	17.9	18.1	18.3	18.5
AGY	ARDNAGAPPARY	0.95	0.0	0.0	14.3	14.3	14.4	14.6	14.8	15.1	15.4	15.6
AHA	AHANE	0.98	5.8	5.9	5.9	5.9	6.0	6.1	6.2	6.3	6.4	6.5
AIR	BELFAST - AIRPORT ROAD MAIN	0.98	n/a	n/a	n/a	22.3	22.7	23.0	23.4	23.8	24.1	24.5
ANR	ANNER	0.88	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.98	45.1	45.5	46.1	46.8	47.4	48.1	48.8	49.6	50.3	51.1
ARI	ARIGNA	0.93	3.4	3.4	3.4	3.4	3.5	3.5	3.6	3.6	3.7	3.7
ARK	ARKLOW	0.95	20.9	21.2	21.4	21.3	21.6	21.8	22.1	22.6	22.9	23.3
ATH	ATHLONE	0.94	66.3	67.1	63.1	63.0	63.7	64.5	65.4	66.8	67.8	68.7
ATY	ATHY	0.99	17.1	17.4	17.5	17.5	17.7	17.9	18.1	18.5	18.8	19.1
BAL	BALTRASNA	1.00	15.7	15.9	16.1	16.0	16.2	16.4	16.7	17.0	17.3	17.5
BAN	BANBRIDGE MAIN	0.98	40.1	40.3	40.8	41.3	41.9	42.5	43.1	43.7	44.3	45.0
BAN	BANDON	0.95	31.0	40.8	41.1	41.1	41.5	42.0	42.6	43.6	44.2	44.8
BAR	BARRYMORE	0.96	24.7	25.0	25.2	25.2	25.5	25.8	26.2	26.7	27.1	27.5
BDA	BARODA	0.95	9.5	9.5	21.5	21.5	21.6	21.8	22.0	22.2	22.4	22.6
BDN	BALLYDINE	0.97	18.3	18.5	18.6	18.6	18.7	18.9	19.1	19.4	19.6	19.8
BEG	BALLYBEG	0.99	13.5	13.6	13.7	13.7	13.9	14.0	14.3	14.5	14.8	15.0
BGT	BALLYRAGGET	0.95	0.0	0.0	0.0	0.0	23.7	24.0	24.3	24.8	25.2	25.6
BIN	BINBANE	0.97	24.6	24.9	15.5	15.5	15.6	15.8	16.0	16.4	16.6	16.9
BK	BELLACORICK	0.95	7.9	8.0	8.1	8.1	8.1	8.2	8.4	8.5	8.7	8.8
BLI	BALLYLICKEY	1.00	12.2	12.4	12.5	12.5	12.6	12.8	13.0	13.2	13.4	13.6

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
BLK	BLAKE	0.95	24.2	24.5	12.2	12.2	12.3	12.5	12.6	12.9	13.1	13.3
BMA	BALLYMENA MESH (RURAL)	0.98	45.9	46.2	34.9	35.6	36.3	37.1	37.9	38.7	39.5	40.3
BMA	BALLYMENA SWBD (TOWN)	0.98	49.0	49.6	50.6	51.5	52.4	53.4	54.4	55.4	56.4	57.5
BNH	BALLYNAHINCH MAIN	0.98	57.9	58.2	58.9	59.7	60.5	61.3	62.2	63.0	63.9	64.8
BNM	BELFAST - BELFAST NORTH MAIN	0.98	n/a	n/a	53.2	53.9	54.6	55.4	56.1	56.9	57.7	58.5
BOG	BANOGE	0.95	14.8	15.0	15.1	15.1	15.3	15.4	15.7	16.0	16.2	16.5
BRA	BRACKLONE	0.95	0.0	0.0	12.5	12.5	12.6	12.8	13.0	13.2	13.4	13.6
BRI	BRINNY	0.94	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.96	32.4	32.8	33.0	33.0	33.4	33.8	34.3	35.0	35.5	36.0
BUT	BUTLERSTOWN	0.98	40.4	40.9	41.2	41.1	41.6	42.1	42.7	43.6	44.3	44.9
CAH	CAHIR	0.98	23.6	23.9	24.0	24.0	24.3	24.6	24.9	25.5	25.8	26.2
CAR	BELFAST - CARNMONEY MAIN	0.98	41.2	41.6	42.2	42.8	43.5	44.1	44.8	45.5	46.2	47.0
CBG	CARROWBEG	0.98	21.7	22.0	22.1	22.1	22.4	22.6	22.9	23.4	23.8	24.1
CBR	CASTLEBAR	0.97	28.0	28.3	28.6	28.5	28.8	29.2	29.6	30.2	30.7	31.1
CEN	BELFAST - BELFAST CENTRAL MAIN	0.98	60.5	61.9	63.8	65.7	67.5	69.4	71.3	73.3	75.4	77.5
CF	CATHALEEN'S FALL	0.95	19.9	20.2	20.3	20.3	20.6	20.8	21.1	21.5	21.9	22.2
CFM	CASTLEFARM	0.96	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
CHA	CHARLEVILLE	0.96	19.1	19.4	19.5	19.5	19.7	20.0	20.3	20.7	21.0	21.3
CKM	CARRICKMINES	0.97	344.5	348.8	370.3	369.9	373.6	377.5	382.3	389.5	394.8	399.6
CLG	CLOGHRAN	0.95	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
CLN	CLOON	0.95	25.6	25.9	30.7	30.7	31.0	31.4	31.8	32.5	33.0	33.4
CLW	CARLOW	0.97	52.3	53.0	53.4	53.3	53.9	54.5	55.3	56.5	57.4	58.1
COL	COLERAINE MAIN	0.98	45.9	46.2	46.9	47.6	48.3	49.0	49.8	50.5	51.3	52.1
COL	COLLEGE PARK	0.98	22.3	22.6	22.8	22.8	23.0	23.3	23.6	24.1	24.5	24.8
COS	CARICKONSHANNON	0.98	30.9	31.3	31.5	31.5	31.8	32.2	32.7	33.4	33.9	34.3

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
COW	COW CROSS	0.97	13.2	13.4	13.5	13.5	13.6	13.8	14.0	14.3	14.5	14.7
CPS	COOLKEERAGH MAIN	0.98	31.3	31.7	32.3	32.8	33.4	34.0	34.5	35.1	35.8	36.4
CRA	CRANE	0.97	33.9	34.4	34.6	34.6	35.0	35.4	35.9	36.6	37.2	37.7
CRE	BELFAST - CREGAGH MAIN	0.98	67.0	67.5	68.4	55.7	56.6	57.6	58.6	59.6	60.6	61.6
CRG	CREAGH MAIN	0.98	24.2	24.4	36.9	37.4	37.8	38.3	38.7	39.2	39.7	40.2
CRO	COOLROE	1.00	10.9	11.1	11.2	11.2	11.3	11.4	11.6	11.8	12.0	12.2
CVW	CASTLEVIEW	0.97	21.9	22.2	22.4	22.4	22.6	22.9	23.2	23.7	24.1	24.4
DAL	DALLOW	0.97	17.3	17.5	17.6	17.6	17.8	18.0	18.3	18.7	19.0	19.2
DDK	DUNDALK	0.99	66.0	66.8	44.5	44.5	45.0	45.5	46.2	47.1	47.9	48.5
DFR	DUNFIRTH	1.00	9.2	9.3	9.4	9.4	9.5	9.6	9.8	10.0	10.1	10.2
DGN	DUNGARVAN	0.98	42.2	42.7	43.0	43.0	43.5	44.0	44.6	45.6	46.3	46.9
DLT	DALTON	0.97	24.2	24.5	24.7	24.7	25.0	25.3	25.6	26.2	26.6	26.9
DMY	DUNMANWAY	0.97	36.0	32.2	32.5	32.4	32.8	33.2	33.7	34.4	34.9	35.4
DON	BELFAST - DONEGALL MAIN(NORTH)	0.98	59.3	59.5	60.3	61.0	61.7	62.5	63.3	64.2	65.0	65.9
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.98	50.8	51.1	51.7	52.4	53.1	53.8	54.6	55.4	56.1	56.9
DOO	DOON	0.97	26.7	27.0	27.2	27.2	27.5	27.8	28.2	28.8	29.3	29.7
DRU	DRUMNAKELLY MAIN	0.98	89.2	90.0	91.5	93.0	94.5	96.0	97.7	99.3	101.0	102.6
DRU	DRUMLINE	0.97	27.0	27.4	27.6	27.6	27.9	28.2	28.6	29.2	29.7	30.1
DRY	DRYBRIDGE	0.97	84.5	85.7	80.8	80.7	81.7	82.6	83.8	85.6	86.9	88.1
DUN	DUNGANNON MAIN	0.98	88.6	89.5	91.0	92.6	94.1	95.7	97.4	99.0	100.7	102.5
EDE	EDEN MAIN	0.98	32.3	32.5	32.9	33.3	33.8	34.2	34.7	35.2	35.7	36.2
ENN	ENNISKILLEN MAIN	0.98	52.8	53.2	54.0	54.8	55.7	56.5	57.4	58.3	59.3	60.2
ENN	ENNIS	0.98	58.6	59.3	59.8	59.7	60.4	61.1	62.0	63.3	64.3	65.1
FIN	BELFAST - FINAGHY MAIN	0.98	33.0	33.2	33.6	34.1	34.5	35.0	35.5	36.0	36.5	37.0

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
FIN	FINGLAS	0.97	477.4	483.4	486.8	486.3	491.5	496.9	503.8	513.7	521.1	527.9
GAL	GALWAY	0.96	85.9	87.0	87.7	87.5	88.5	89.6	90.9	92.8	94.2	95.5
GI	GREAT ISLAND	0.88	17.0	17.3	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0
GIL	GILRA	0.96	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE	BELFAST - GLENGORMLEY MAIN	0.98	14.9	15.0	15.2	15.4	15.6	15.9	16.1	16.4	16.6	16.9
GLE	GLENLARA	0.97	16.5	16.7	16.9	16.9	17.0	17.2	17.5	17.9	18.1	18.4
GRI	GRIFFINRATH	0.95	65.2	66.0	66.5	65.0	65.7	66.5	67.5	68.9	69.9	70.9
GWE	GORTAWEE	0.96	31.8	32.0	32.1	32.1	32.2	32.3	32.5	32.7	32.9	33.1
HTS	HARNETTS CROSS	0.95	0.0	0.0	8.6	8.6	8.7	8.8	8.9	9.1	9.2	9.3
IKE	IKERRIN	0.96	26.1	26.4	26.6	26.6	26.9	27.2	27.6	28.2	28.6	29.0
INC	INCHICORE	0.96	336.3	339.9	351.4	352.5	355.7	358.9	363.1	369.1	373.5	377.6
KBY	KILBARRY	0.98	88.6	89.8	90.5	90.4	91.4	92.5	93.9	95.8	97.3	98.6
KER	KNOCKERAGH	0.97	32.7	33.1	33.4	33.3	33.7	34.1	34.6	35.3	35.9	36.4
KIN	KINNEGAD	0.96	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	KILKENNY	0.93	61.2	62.0	62.5	62.4	52.7	53.3	54.1	55.3	56.1	56.9
KNM	KNOCKMULLEN	0.95	0.0	0.0	15.5	15.5	15.7	15.9	16.1	16.4	16.7	16.9
KNO	BELFAST - KNOCK MAIN	0.98	68.8	69.2	70.2	62.4	63.4	64.4	65.4	66.4	67.5	68.6
KTL	KILTEEL	0.93	32.3	32.7	33.0	32.9	33.3	33.7	34.2	34.9	35.5	35.9
KTN	KILLOTERAN	0.97	12.9	13.0	13.1	13.1	13.3	13.4	13.6	13.9	14.1	14.3
KUR	KNOCKUMBER	0.96	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.94	12.0	12.2	12.2	12.2	12.4	12.5	12.7	13.0	13.2	13.3
LAR	LARNE MAIN	0.98	45.0	45.2	45.8	46.5	47.1	47.8	48.5	49.2	49.9	50.6
LET	LETTERKENNY	0.98	65.9	66.8	62.6	62.5	63.3	64.0	64.9	66.3	67.3	68.2
LIB	LIBERTY	0.97	22.4	22.7	22.9	22.8	23.1	23.4	23.7	24.2	24.6	24.9

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
LIM	LIMAVADY MAIN	0.98	25.6	25.8	26.1	26.6	27.0	27.4	27.8	28.3	28.7	29.2
LIM	LIMERICK	0.98	72.6	73.5	74.1	74.0	74.8	75.7	76.8	78.4	79.6	80.7
LIS	LISBURN MAIN	0.98	65.2	65.7	66.7	67.7	68.7	69.7	70.8	71.9	73.1	74.2
LIS	LISDRUM	0.97	26.8	27.2	27.4	27.3	27.7	28.0	28.4	29.0	29.4	29.8
LMR	LISAGHMORE MAIN	0.98	49.5	49.9	50.7	51.5	52.3	53.1	53.9	54.8	55.7	56.6
LOG	LOGUESTOWN MAIN	0.98	40.6	40.9	41.5	42.0	42.6	43.3	43.9	44.5	45.2	45.9
LSN	LISHEEN	0.98	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	1.00	22.2	17.3	8.9	8.9	9.0	9.1	9.2	9.4	9.5	9.7
MAL	MALLOW	0.97	21.6	21.9	22.0	22.0	22.3	22.5	22.9	23.3	23.7	24.0
MCE	MACETOWN	0.98	30.5	30.8	31.0	31.0	31.3	31.6	32.0	32.5	32.9	33.3
MID	MIDLETON	0.98	33.1	33.5	33.8	33.7	34.1	34.5	35.0	35.8	36.3	36.8
MLN	MULLAGHARLIN	0.95	5.2	5.2	33.5	33.5	33.8	34.1	34.5	35.2	35.6	36.0
MON	MONREAD	0.99	11.9	12.0	12.1	12.1	12.3	12.4	12.6	12.8	13.0	13.2
MOY	MOY	0.98	26.6	26.9	27.2	27.1	27.4	27.8	28.2	28.7	29.2	29.6
MR	MARINA	0.96	16.1	16.3	16.4	16.4	16.6	16.8	17.0	17.4	17.6	17.9
MTH	MEATH HILL	0.93	46.9	47.6	47.9	47.9	48.4	49.0	49.7	50.7	51.5	52.2
MUL	MULLINGAR	0.97	49.3	50.0	50.4	50.3	50.9	51.5	52.2	53.3	54.1	54.9
MUN	MUNGRET	0.96	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
NAR	NEWTOWNARDS MAIN	0.98	43.8	44.2	44.8	45.4	46.1	46.8	47.5	48.3	49.0	49.8
NAV	NAVAN	0.97	66.8	67.7	68.2	68.2	68.9	69.7	70.8	72.3	73.3	74.4
NEN	NENAGH	0.95	26.8	27.2	27.4	27.4	27.7	28.0	28.4	29.0	29.5	29.9
NEW	NEWRY MAIN	0.98	77.7	78.4	79.6	80.8	82.1	83.4	84.7	86.1	87.5	88.9
NEW	NEWBRIDGE	0.98	38.7	39.2	27.5	27.4	27.7	28.1	28.5	29.1	29.5	29.9
OLD	OLDCOURT	0.96	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
OMA	OMAGH MAIN	0.98	59.3	59.8	60.8	61.8	62.8	63.8	64.9	66.0	67.1	68.2

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
OUG	OUGHTRAGH	0.98	25.5	25.9	26.1	26.0	26.3	26.6	27.0	27.6	28.0	28.4
PB	POOLBEG	0.96	184.9	187.3	188.8	188.6	190.7	192.9	195.8	199.9	202.9	205.7
PLA	PLATIN	0.95	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
PLS	PORTLAOISE	0.96	51.5	52.2	52.6	52.5	39.8	40.3	40.9	41.8	42.4	43.0
PSW	BELFAST - PSW	0.98	52.2	52.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAL	RALAPPANE	0.96	0.0	0.0	0.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
RAT	RATHGAEL MAIN	0.98	65.2	65.6	66.5	67.5	68.4	69.4	70.5	71.5	72.6	73.7
RAT	RATHKEALE	0.96	24.0	24.4	24.5	24.5	24.8	25.1	25.4	26.0	26.4	26.7
RIC	RICHMOND	0.96	31.2	31.6	31.8	31.8	32.1	32.5	33.0	33.7	34.2	34.7
RNW	RINAWADE	0.96	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
ROS	ROSEBANK MAIN	0.98	32.3	32.5	32.9	33.4	33.8	34.3	34.8	35.3	35.8	36.3
RSY	RINGASKIDDY	0.97	4.6	4.7	4.7	4.7	4.8	4.8	4.9	5.0	5.1	5.1
RYB	RYEBROOK	0.96	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5
SAL	SALTHILL	0.98	63.2	64.1	51.1	51.0	51.6	52.2	53.0	54.1	54.9	55.7
SCR	SCREEB	0.95	0.0	0.0	13.5	13.4	13.6	13.8	14.0	14.3	14.5	14.7
SHE	SHELTON ABBEY	0.96	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.96	55.3	56.0	56.5	56.4	57.0	57.7	58.6	59.8	60.7	61.5
SLI	SLIGO	0.98	59.2	60.0	60.4	60.3	61.0	61.7	62.6	64.0	64.9	65.8
SNG	SINGLAND	0.99	15.6	15.8	15.9	15.9	16.1	16.3	16.5	16.9	17.1	17.3
SOM	SOMERSET	0.97	21.6	21.9	22.1	22.0	22.3	22.5	22.9	23.4	23.7	24.0
SPR	SPRINGTOWN MAIN	0.98	31.1	31.3	31.8	32.2	32.6	33.1	33.5	34.0	34.5	35.0
STR	STRABANE MAIN	0.98	37.5	37.7	38.2	38.7	39.3	39.8	40.4	41.0	41.6	42.1
STR	STRATFORD	0.98	20.9	21.2	21.4	21.3	21.6	21.8	22.2	22.6	23.0	23.3
TBG	TRABEG	0.97	68.3	69.2	69.7	69.6	70.4	71.2	72.3	73.8	74.9	76.0

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23
TBK	TULLABRACK	0.95	15.6	15.8	15.9	15.9	16.1	16.2	16.5	16.8	17.1	17.3
THU	THURLES	0.97	26.0	26.3	26.5	26.5	26.8	27.1	27.5	28.1	28.5	28.9
TIP	TIPPERARY	0.96	20.7	21.0	21.1	21.1	21.4	21.6	21.9	22.4	22.7	23.0
TLK	TRILLICK	0.94	28.4	28.8	29.0	29.0	29.3	29.6	30.1	30.7	31.2	31.6
TON	TONROE	0.90	14.4	14.6	14.7	14.7	14.9	15.0	15.3	15.6	15.8	16.0
TRI	TRIEN	0.97	26.9	27.3	27.5	27.5	27.8	28.1	28.5	29.1	29.6	30.0
TRL	TRALEE	0.97	45.9	46.5	46.8	46.8	47.3	47.9	48.6	49.6	50.3	51.0
TSB	THORNSBERRY	0.98	34.4	34.8	35.1	35.0	35.4	35.9	36.4	37.1	37.7	38.2
WAR	WARINGSTOWN MAIN	0.98	63.5	63.8	64.4	65.1	65.8	66.6	67.3	68.1	68.9	69.7
WAT	WATERFORD	0.98	41.3	41.8	42.1	42.1	42.6	43.0	43.7	44.6	45.3	45.9
WEX	WEXFORD	0.97	54.8	55.5	56.0	55.9	56.5	57.2	58.0	59.3	60.2	61.0
WHI	WHITEGATE	0.96	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Table C-2 Demand Forecasts at Time of Summer Peak

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AA	ARDNACRUSHA	0.87	25.3	25.6	25.8	26.1	25.9	26.3	26.7	27.2	27.7	28.1
AD	AGHADA	1.00	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4
AGH	AGHYOULE MAIN	0.96	16.2	16.3	16.5	16.7	16.9	17.1	17.3	17.5	17.7	17.9
AGY	ARDNAGAPPARY	0.95	0.0	0.0	0.0	13.4	13.3	13.5	13.7	14.0	14.2	14.4
AHA	AHANE	0.98	4.7	4.8	4.8	4.9	4.8	4.9	5.0	5.1	5.2	5.2
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	n/a	n/a	n/a	17.5	17.8	18.1	18.3	18.6	18.9	19.2
ANR	ANNER	0.88	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.96	32.9	33.2	33.6	34.1	34.6	35.1	35.6	36.1	36.7	37.2
ARI	ARIGNA	0.97	5.1	5.2	5.2	5.3	5.2	5.3	5.4	5.5	5.6	5.7
ARK	ARKLOW	0.95	15.7	15.9	16.0	16.2	16.1	16.3	16.5	16.9	17.1	17.4
ATH	ATHLONE	0.98	54.3	55.1	55.4	51.9	51.5	52.2	53.0	54.1	55.0	55.8
ATY	ATHY	0.97	12.8	13.0	13.1	13.2	13.1	13.3	13.5	13.8	14.0	14.2
BAL	BALTRASNA	0.99	11.3	11.4	11.5	11.7	11.6	11.7	11.9	12.2	12.4	12.5
BAN	BANBRIDGE MAIN	0.96	28.3	28.5	28.8	29.2	29.6	30.0	30.5	30.9	31.3	31.8
BAN	BANDON	0.94	29.8	30.2	39.2	39.8	39.5	40.0	40.6	41.5	42.1	42.7
BAR	BARRYMORE	0.98	20.9	21.2	21.3	21.6	21.5	21.7	22.1	22.6	22.9	23.2
BDA	BARODA	0.95	9.5	9.5	9.5	20.8	20.7	20.9	21.0	21.3	21.5	21.6
BDN	BALLYDINE	0.95	16.3	16.4	16.5	16.6	16.6	16.7	16.9	17.1	17.3	17.5
BEG	BALLYBEG	0.95	10.0	10.2	10.2	10.4	10.3	10.4	10.6	10.8	11.0	11.1
BGT	BALLYRAGGET	0.95	0.0	0.0	0.0	0.0	0.0	22.2	22.5	23.0	23.4	23.7
BIN	BINBANE	0.95	22.8	23.2	23.3	14.6	14.5	14.7	14.9	15.2	15.5	15.7
BK	BELLACORICK	0.93	9.1	9.3	9.3	9.4	9.4	9.5	9.6	9.8	10.0	10.1
BLI	BALLYLICKEY	0.95	3.8	3.8	3.9	3.9	3.9	3.9	4.0	4.1	4.2	4.2
BLK	BLAKE	0.98	18.2	18.5	18.6	7.1	7.0	7.1	7.2	7.4	7.5	7.6

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BMA	BALLYMENA MESH (RURAL)	0.96	34.6	34.9	26.3	26.8	27.4	28.0	28.6	29.2	29.8	30.4
BMA	BALLYMENA SWBD (TOWN)	0.96	42.7	43.3	44.0	44.9	45.7	46.6	47.4	48.3	49.2	50.1
BNH	BALLYNAHINCH MAIN	0.96	42.2	42.4	42.9	43.4	44.0	44.6	45.2	45.8	46.5	47.1
BNM	BELFAST - BELFAST NORTH MAIN	0.96	n/a	n/a	40.8	41.4	41.9	42.5	43.1	43.7	44.3	44.9
BOG	BANOGE	0.95	13.7	13.9	14.0	14.2	14.1	14.3	14.5	14.8	15.0	15.3
BRA	BRACKLONE	0.95	0.0	0.0	0.0	11.8	11.7	11.8	12.0	12.3	12.5	12.6
BRI	BRINNY	0.94	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.96	35.3	35.7	36.0	36.4	36.2	36.6	37.2	38.0	38.6	39.2
BUT	BUTLERSTOWN	0.98	29.9	30.3	30.5	30.9	30.7	31.0	31.5	32.2	32.7	33.2
CAH	CAHIR	0.96	30.0	30.4	30.6	31.0	30.8	31.2	31.7	32.4	32.9	33.4
CAR	BELFAST - CARNMONEY MAIN	0.96	32.3	32.6	33.0	33.6	34.1	34.6	35.1	35.7	36.2	36.8
CBG	CARROWBEG	0.97	22.2	22.5	22.6	22.9	22.8	23.1	23.4	23.9	24.3	24.6
CBR	CASTLEBAR	0.97	28.3	28.6	28.8	29.2	29.0	29.4	29.8	30.5	30.9	31.4
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	53.6	54.8	56.5	58.1	59.8	61.5	63.2	64.9	66.7	68.6
CF	CATHALEEN'S FALL	0.95	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.5	4.6	4.7
CFM	CASTLEFARM	0.96	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
CHA	CHARLEVILLE	0.94	14.6	14.8	14.9	15.1	15.0	15.2	15.4	15.8	16.0	16.3
CKM	CARRICKMINES	0.96	247.6	250.6	271.0	274.2	272.6	275.4	278.9	284.1	287.9	291.3
CLG	CLOGHRAN	0.95	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
CLN	CLOON	0.93	18.7	18.9	19.0	23.6	23.4	23.7	24.1	24.6	25.0	25.3
CLW	CARLOW	0.95	26.6	26.9	27.1	27.5	27.3	27.6	28.0	28.6	29.1	29.5
COL	COLERAINE MAIN	0.96	32.8	33.1	33.5	34.0	34.5	35.0	35.6	36.1	36.7	37.2
COL	COLLEGE PARK	0.98	22.9	23.3	23.4	23.7	23.6	23.8	24.2	24.7	25.1	25.5
COS	CARICKONSHANNON	0.98	24.9	25.3	25.4	25.8	25.6	25.9	26.3	26.9	27.3	27.7

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
COW	COW CROSS	0.98	14.1	14.3	14.4	14.6	14.5	14.7	14.9	15.2	15.5	15.7
CPS	COOLKEERAGH MAIN	0.96	30.4	30.8	31.3	31.9	32.4	33.0	33.6	34.1	34.7	35.3
CRA	CRANE	0.96	24.6	25.0	25.1	25.5	25.3	25.6	26.0	26.6	27.0	27.4
CRE	BELFAST - CREGAGH MAIN	0.96	59.0	59.4	60.1	49.0	49.8	50.7	51.6	52.4	53.3	54.2
CRG	CREAGH MAIN	0.96	20.3	20.5	31.0	31.4	31.7	32.1	32.5	32.9	33.3	33.7
CRO	COOLROE	0.99	13.1	13.3	13.4	13.5	13.5	13.6	13.8	14.1	14.3	14.5
CVW	CASTLEVIEW	0.97	27.2	27.6	27.8	28.2	28.0	28.3	28.7	29.4	29.8	30.2
DAL	DALLOW	0.96	14.8	15.1	15.1	15.3	15.2	15.4	15.7	16.0	16.3	16.5
DDK	DUNDALK	0.98	49.1	49.8	50.1	29.3	29.1	29.5	29.9	30.6	31.1	31.5
DFR	DUNFIRTH	1.00	6.1	6.2	6.2	6.3	6.3	6.4	6.5	6.6	6.7	6.8
DGN	DUNGARVAN	0.98	32.8	33.2	33.4	33.9	33.7	34.1	34.6	35.4	35.9	36.4
DLT	DALTON	0.96	20.4	20.7	20.9	21.1	21.0	21.2	21.6	22.0	22.4	22.7
DMY	DUNMANWAY	0.90	22.9	23.2	19.4	19.6	19.5	19.7	20.0	20.5	20.8	21.1
DON	BELFAST - DONEGALL MAIN(NORTH)	0.96	46.0	46.2	46.7	47.3	47.8	48.5	49.1	49.7	50.3	51.0
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.96	38.7	38.9	39.3	39.9	40.4	41.0	41.5	42.1	42.7	43.3
DOO	DOON	0.95	12.5	12.7	12.8	12.9	12.8	13.0	13.2	13.5	13.7	13.9
DRU	DRUMNAKELLY MAIN	0.96	74.9	75.6	76.7	78.0	79.3	80.6	81.9	83.3	84.7	86.0
DRU	DRUMLINE	0.95	29.1	29.5	29.7	30.1	29.9	30.3	30.7	31.4	31.9	32.4
DRY	DRYBRIDGE	0.97	64.4	65.3	65.7	61.5	61.1	61.8	62.7	64.1	65.1	66.0
DUN	DUNGANNON MAIN	0.96	77.6	78.5	79.7	81.1	82.4	83.8	85.3	86.7	88.2	89.7
EDE	EDEN MAIN	0.96	24.4	24.5	24.8	25.2	25.5	25.9	26.2	26.6	26.9	27.3
ENN	ENNISKILLEN MAIN	0.96	45.6	45.9	46.6	47.3	48.0	48.8	49.6	50.3	51.1	51.9
ENN	ENNIS	0.96	49.1	49.8	50.1	50.8	50.5	51.1	51.8	53.0	53.8	54.6

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
FIN	BELFAST - FINAGHY MAIN	0.96	25.5	25.7	26.0	26.3	26.7	27.0	27.4	27.8	28.2	28.6
FIN	FINGLAS	0.94	345.1	349.3	351.4	355.8	353.6	357.5	362.5	369.8	375.2	380.1
GAL	GALWAY	0.99	66.6	67.5	67.9	68.9	68.4	69.2	70.3	71.8	73.0	74.0
GI	GREAT ISLAND	0.95	15.8	16.0	16.1	1.8	1.8	1.8	1.8	1.8	1.9	1.9
GIL	GILRA	0.96	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE	BELFAST - GLENGORMLEY MAIN	0.96	12.0	12.1	12.3	12.5	12.7	12.8	13.0	13.2	13.4	13.6
GLE	GLENLARA	0.96	12.0	12.2	12.3	12.4	12.4	12.5	12.7	13.0	13.2	13.4
GRI	GRIFFINRATH	0.96	39.9	40.4	40.7	39.9	39.6	40.1	40.7	41.6	42.2	42.8
GWE	GORTAWEE	0.96	33.4	33.5	33.6	33.8	33.7	33.8	34.0	34.3	34.5	34.7
HTS	HARNETTS CROSS	0.95	0.0	0.0	0.0	8.1	8.0	8.1	8.2	8.4	8.5	8.7
IKE	IKERRIN	0.94	32.8	33.2	33.4	33.9	33.7	34.1	34.6	35.3	35.9	36.4
INC	INCHICORE	0.96	283.9	286.9	297.7	302.1	300.6	303.3	306.8	311.8	315.5	318.9
KBY	KILBARRY	0.98	75.5	76.6	77.0	78.1	77.6	78.5	79.7	81.4	82.7	83.9
KER	KNOCKERAGH	0.96	35.4	35.9	36.1	36.6	36.4	36.8	37.4	38.2	38.8	39.3
KIN	KINNEGAD	0.96	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	KILKENNY	0.93	60.6	61.4	61.8	62.6	62.2	53.2	54.0	55.2	56.1	56.9
KNM	KNOCKMULLEN	0.95	0.0	0.0	0.0	14.6	14.5	14.7	14.9	15.2	15.5	15.7
KNO	BELFAST - KNOCK MAIN	0.96	49.5	49.8	50.4	44.8	45.5	46.2	47.0	47.7	48.5	49.2
KTL	KILTEEL	0.93	28.7	29.0	29.2	29.6	29.4	29.8	30.2	30.9	31.4	31.8
KTN	KILLOTERAN	0.96	10.0	10.1	10.2	10.3	10.2	10.4	10.5	10.7	10.9	11.1
KUR	KNOCKUMBER	0.96	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.95	11.6	11.7	11.8	12.0	11.9	12.0	12.2	12.5	12.7	12.9
LAR	LARNE MAIN	0.96	34.9	35.1	35.6	36.1	36.6	37.1	37.6	38.1	38.7	39.2
LET	LETTERKENNY	0.97	42.0	42.6	42.9	39.0	38.8	39.2	39.8	40.7	41.4	41.9
LIB	LIBERTY	0.96	22.8	23.1	23.2	23.5	23.4	23.7	24.0	24.6	24.9	25.3
LIM	LIMAVADY MAIN	0.96	18.7	18.8	19.1	19.4	19.7	20.0	20.3	20.6	20.9	21.3

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
LIM	LIMERICK	0.98	71.3	72.2	72.7	73.7	73.2	74.1	75.2	76.8	78.0	79.1
LIS	LISBURN MAIN	0.96	46.6	46.9	47.6	48.3	49.0	49.8	50.6	51.3	52.1	52.9
LIS	LISDRUM	0.96	24.6	25.0	25.1	25.5	25.3	25.6	26.0	26.6	27.0	27.4
LMR	LISAGHMORE MAIN	0.96	37.5	37.8	38.3	38.9	39.5	40.2	40.8	41.4	42.1	42.8
LOG	LOGUESTOWN MAIN	0.96	33.5	33.8	34.2	34.7	35.2	35.7	36.2	36.8	37.3	37.8
LSN	LISHEEN	0.98	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	1.00	16.6	16.8	12.1	4.2	4.2	4.3	4.3	4.4	4.5	4.5
MAL	MALLOW	0.94	17.8	18.1	18.2	18.4	18.3	18.5	18.8	19.2	19.5	19.8
MCE	MACETOWN	0.98	26.1	26.4	26.5	26.8	26.7	26.9	27.3	27.7	28.1	28.4
MID	MIDLETON	0.97	17.4	17.7	17.8	18.0	17.9	18.1	18.4	18.8	19.1	19.3
MLN	MULLAGHARLIN	0.95	5.2	5.2	5.2	31.8	31.6	31.9	32.4	32.9	33.4	33.8
MON	MONREAD	0.98	8.1	8.2	8.3	8.4	8.3	8.4	8.6	8.7	8.9	9.0
MOY	MOY	0.98	17.8	18.0	18.2	18.4	18.3	18.5	18.8	19.2	19.5	19.8
MR	MARINA	0.98	16.3	16.5	16.6	16.8	16.7	16.9	17.2	17.5	17.8	18.1
MTH	MEATH HILL	0.91	25.4	25.7	25.9	26.2	26.0	26.3	26.7	27.3	27.8	28.2
MUL	MULLINGAR	0.95	37.1	37.6	37.8	38.4	38.1	38.6	39.2	40.0	40.6	41.2
MUN	MUNGRET	0.96	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
NAR	NEWTOWNARDS MAIN	0.96	32.5	32.7	33.2	33.7	34.2	34.7	35.2	35.7	36.3	36.8
NAV	NAVAN	0.97	42.5	43.1	43.4	44.0	43.7	44.2	44.9	45.8	46.6	47.2
NEN	NENAGH	0.95	24.9	25.3	25.4	25.8	25.6	25.9	26.3	26.9	27.3	27.7
NEW	NEWRY MAIN	0.96	58.5	58.9	59.8	60.7	61.7	62.7	63.7	64.7	65.7	66.8
NEW	NEWBRIDGE	0.96	30.2	30.6	30.8	19.9	19.8	20.1	20.4	20.8	21.1	21.4
OLD	OLDCOURT	0.96	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
OMA	OMAGH MAIN	0.96	46.4	46.9	47.6	48.3	49.1	50.0	50.8	51.6	52.5	53.3
OUG	OUGHTRAGH	0.98	20.7	21.0	21.1	21.4	21.3	21.5	21.8	22.3	22.7	23.0

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
PB	POOLBEG	0.97	97.8	99.1	99.7	101.1	100.4	101.6	103.2	105.4	107.1	108.6
PLA	PLATIN	0.95	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
PLS	PORTLAOISE	0.95	50.8	51.5	51.9	52.6	52.2	40.4	41.0	41.9	42.6	43.2
PSW	BELFAST - PSW	0.96	40.2	40.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAL	RALAPPANE	0.96	0.0	0.0	0.0	0.0	61.0	61.0	61.0	61.0	61.0	61.0
RAT	RATHGAEL MAIN	0.96	45.6	45.9	46.4	47.1	47.8	48.5	49.2	50.0	50.7	51.5
RAT	RATHKEALE	0.94	18.1	18.3	18.5	18.7	18.6	18.8	19.1	19.5	19.8	20.1
RIC	RICHMOND	0.93	24.7	25.0	25.2	25.5	25.4	25.7	26.1	26.6	27.1	27.4
RNW	RINAWADE	0.96	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
ROS	ROSEBANK MAIN	0.96	23.1	23.2	23.5	23.8	24.1	24.5	24.8	25.2	25.5	25.9
RSY	RINGASKIDDY	0.99	2.1	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.3	2.3
RYB	RYEBROOK	0.96	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5
SAL	SALTHILL	0.98	49.7	50.4	50.7	38.7	38.5	38.9	39.5	40.4	41.0	41.6
SCR	SCREEB	0.95	0.0	0.0	0.0	12.7	12.6	12.7	12.9	13.2	13.4	13.6
SHE	SHELTON ABBEY	0.96	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.94	48.8	49.5	49.8	50.4	50.1	50.7	51.5	52.6	53.4	54.2
SLI	SLIGO	0.97	45.9	46.6	46.9	47.5	47.2	47.8	48.5	49.5	50.3	51.0
SNG	SINGLAND	0.98	9.5	9.7	9.7	9.9	9.8	9.9	10.1	10.3	10.4	10.6
SOM	SOMERSET	0.95	18.0	18.2	18.3	18.6	18.5	18.7	19.0	19.4	19.7	20.0
SPR	SPRINGTOWN MAIN	0.96	25.7	25.9	26.2	26.5	26.9	27.3	27.7	28.0	28.4	28.8
STR	STRABANE MAIN	0.96	27.5	27.7	28.0	28.4	28.8	29.2	29.6	30.0	30.5	30.9
STR	STRATFORD	0.93	15.6	15.8	15.9	16.2	16.0	16.2	16.5	16.8	17.1	17.4
TBG	TRABEG	0.98	66.0	66.9	67.3	68.2	67.8	68.6	69.6	71.2	72.3	73.3
TBK	TULLABRACK	0.94	4.2	4.3	4.3	4.4	4.3	4.4	4.5	4.6	4.6	4.7
THU	THURLES	0.96	23.4	23.7	23.9	24.2	24.0	24.3	24.7	25.2	25.6	26.0
TIP	TIPPERARY	0.95	16.8	17.0	17.1	17.4	17.2	17.5	17.7	18.1	18.4	18.7

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TLK	TRILLICK	0.98	22.7	23.0	23.2	23.5	23.3	23.6	24.0	24.5	24.9	25.2
TON	TONROE	0.93	11.6	11.8	11.9	12.0	12.0	12.1	12.3	12.6	12.8	12.9
TRI	TRIEN	0.95	25.5	25.8	26.0	26.4	26.2	26.5	26.9	27.5	27.9	28.3
TRL	TRALEE	0.99	32.1	32.5	32.7	33.2	33.0	33.4	33.9	34.6	35.2	35.7
TSB	THORNSBERRY	0.95	26.9	27.3	27.5	27.8	27.7	28.0	28.4	29.0	29.5	29.9
WAR	WARINGSTOWN MAIN	0.96	51.8	52.0	52.5	53.1	53.6	54.3	54.9	55.5	56.1	56.8
WAT	WATERFORD	0.97	51.2	51.9	52.3	53.0	52.6	53.3	54.1	55.2	56.1	56.9
WEX	WEXFORD	0.96	44.2	44.9	45.1	45.7	45.4	46.0	46.7	47.7	48.5	49.1
WHI	WHITEGATE	0.96	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Table C-3 Demand Forecasts at Time of Summer Valley

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AA	ARDNACRUSHA	1.00	13.7	13.9	13.9	14.1	13.6	13.8	14.0	14.4	14.7	14.9
AD	AGHADA	0.98	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
AGH	AGHYOULE MAIN	0.96	9.2	9.2	9.3	9.4	9.5	9.6	9.8	9.9	10.0	10.1
AGY	ARDNAGAPPARY	0.95	0.0	0.0	0.0	4.0	3.9	4.0	4.0	4.1	4.2	4.3
AHA	AHANE	1.00	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	0.0	n/a	n/a	6.8	6.9	7.0	7.1	7.2	7.3	7.4
ANR	ANNER	0.88	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.96	15.7	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.5	17.8
ARI	ARIGNA	1.00	5.2	5.3	5.3	5.3	5.2	5.2	5.3	5.5	5.6	5.7
ARK	ARKLOW	0.95	13.7	13.9	13.9	14.1	13.6	13.8	14.1	14.4	14.7	14.9
ATH	ATHLONE	0.98	18.5	18.8	18.7	17.7	17.1	17.3	17.6	18.1	18.4	18.7
ATY	ATHY	1.00	3.1	3.2	3.2	3.2	3.1	3.2	3.2	3.3	3.4	3.4
BAL	BALTRASNA	0.93	3.4	3.4	3.4	3.5	3.3	3.4	3.5	3.5	3.6	3.7
BAN	BANBRIDGE MAIN	0.96	10.3	10.3	10.5	10.6	10.7	10.9	11.1	11.2	11.4	11.5
BAN	BANDON	0.97	10.2	10.4	13.0	13.2	12.7	12.9	13.1	13.5	13.7	14.0
BAR	BARRYMORE	0.94	7.8	8.0	7.9	8.0	7.8	7.9	8.0	8.2	8.4	8.5
BDA	BARODA	0.96	9.5	9.5	9.5	12.9	12.8	12.8	12.9	13.0	13.0	13.1
BDN	BALLYDINE	0.96	5.5	5.6	5.6	5.6	5.5	5.5	5.6	5.7	5.7	5.8
BEG	BALLYBEG	0.96	2.6	2.6	2.6	2.7	2.6	2.6	2.7	2.7	2.8	2.8
BGT	BALLYRAGGET	0.95	0.0	0.0	0.0	0.0	0.0	6.5	6.6	6.8	6.9	7.0
BIN	BINBANE	0.99	23.7	24.1	24.0	21.6	20.9	21.2	21.6	22.1	22.5	22.9
BK	BELLACORICK	0.94	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7
BLI	BALLYLICKEY	0.94	2.5	2.6	2.6	2.6	2.5	2.6	2.6	2.7	2.7	2.8
BLK	BLAKE	1.00	6.5	6.6	6.6	3.2	3.1	3.1	3.2	3.2	3.3	3.4
BMA	BALLYMENA MESH (RURAL)	0.96	9.2	9.3	7.0	7.1	7.3	7.4	7.6	7.8	7.9	8.1

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BMA	BALLYMENA SWBD (TOWN)	0.96	14.0	14.1	14.4	14.7	14.9	15.2	15.5	15.8	16.1	16.4
BNH	BALLYNAHINCH MAIN	0.96	15.5	15.5	15.7	15.9	16.1	16.4	16.6	16.8	17.1	17.3
BNM	BELFAST - BELFAST NORTH MAIN	0.96	0.0	n/a	17.6	17.8	18.0	18.3	18.6	18.8	19.1	19.3
BOG	BANOGE	0.95	4.2	4.2	4.2	4.3	4.1	4.2	4.3	4.4	4.4	4.5
BRA	BRACKLONE	0.95	0.0	0.0	0.0	3.5	3.4	3.5	3.5	3.6	3.7	3.7
BRI	BRINNY	0.94	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.97	23.0	23.3	23.2	23.6	22.8	23.1	23.5	24.1	24.6	25.0
BUT	BUTLERSTOWN	0.99	10.1	10.3	10.2	10.4	10.0	10.2	10.4	10.6	10.8	11.0
CAH	CAHIR	0.99	11.4	11.6	11.5	11.7	11.3	11.4	11.6	11.9	12.2	12.4
CAR	BELFAST - CARNMONEY MAIN	0.96	12.5	12.6	12.8	13.0	13.1	13.4	13.6	13.8	14.0	14.2
CBG	CARROWBEG	0.99	7.2	7.3	7.3	7.4	7.1	7.2	7.4	7.6	7.7	7.8
CBR	CASTLEBAR	0.99	9.0	9.2	9.1	9.3	8.9	9.1	9.2	9.5	9.7	9.8
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	19.8	20.2	20.8	21.4	22.0	22.7	23.3	24.0	24.6	25.3
CF	CATHALEEN'S FALL	0.94	3.8	3.9	3.9	3.9	3.8	3.9	3.9	4.0	4.1	4.2
CFM	CASTLEFARM	0.96	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
CHA	CHARLEVILLE	0.96	5.2	5.3	5.3	5.3	5.2	5.2	5.3	5.5	5.6	5.7
CKM	CARRICKMINES	0.96	100.8	102.1	120.6	121.9	119.1	120.2	121.6	123.7	125.2	126.6
CLG	CLOGHRAN	0.95	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
CLN	CLOON	0.98	5.5	5.6	5.6	6.9	6.7	6.8	6.9	7.1	7.2	7.4
CLW	CARLOW	1.00	5.8	5.9	5.9	6.0	5.8	5.9	6.0	6.1	6.3	6.4
COL	COLERAINE MAIN	0.96	13.0	13.1	13.3	13.5	13.7	13.9	14.1	14.3	14.5	14.8
COL	COLLEGE PARK	0.98	11.6	11.8	11.7	11.9	11.5	11.6	11.9	12.2	12.4	12.6
COS	CARICKONSHANNON	1.00	8.0	8.1	8.0	8.2	7.9	8.0	8.1	8.4	8.5	8.7
COW	COW CROSS	0.99	3.2	3.2	3.2	3.2	3.1	3.2	3.2	3.3	3.4	3.4

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CPS	COOLKEERAGH MAIN	0.96	19.7	19.9	20.3	20.6	21.0	21.4	21.7	22.1	22.5	22.9
CRA	CRANE	0.98	8.5	8.6	8.6	8.7	8.4	8.5	8.7	8.9	9.1	9.2
CRE	BELFAST - CREGAGH MAIN	0.96	22.3	22.4	22.7	18.5	18.8	19.2	19.5	19.8	20.2	20.5
CRG	CREAGH MAIN	0.96	5.0	5.0	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3
CRO	COOLROE	0.99	5.8	5.8	5.8	5.9	5.7	5.8	5.9	6.0	6.2	6.3
CVW	CASTLEVIEW	0.99	9.9	10.1	10.0	10.2	9.8	10.0	10.1	10.4	10.6	10.8
DAL	DALLOW	0.99	4.0	4.1	4.1	4.1	4.0	4.0	4.1	4.2	4.3	4.4
DDK	DUNDALK	1.00	16.0	16.2	16.1	9.9	9.6	9.7	9.9	10.2	10.4	10.5
DFR	DUNFIRTH	1.00	2.5	2.6	2.6	2.6	2.5	2.5	2.6	2.7	2.7	2.8
DGN	DUNGARVAN	1.00	10.8	10.9	10.9	11.1	10.7	10.8	11.0	11.3	11.5	11.7
DLT	DALTON	0.99	6.2	6.3	6.3	6.4	6.1	6.2	6.3	6.5	6.6	6.7
DMY	DUNMANWAY	0.99	9.8	9.9	8.7	8.8	8.5	8.6	8.8	9.0	9.2	9.3
DON	BELFAST - DONEGALL MAIN(NORTH)	0.96	19.9	20.0	20.2	20.5	20.7	21.0	21.3	21.6	21.8	22.1
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.96	15.4	15.4	15.6	15.8	16.0	16.3	16.5	16.7	17.0	17.2
DOO	DOON	0.99	4.1	4.1	4.1	4.2	4.0	4.1	4.1	4.3	4.3	4.4
DRU	DRUMNAKELLY MAIN	0.96	24.2	24.5	24.9	25.3	25.7	26.1	26.6	27.0	27.5	27.9
DRU	DRUMLINE	0.99	9.7	9.9	9.8	10.0	9.6	9.8	9.9	10.2	10.4	10.6
DRY	DRYBRIDGE	1.00	19.5	19.8	19.7	18.5	17.8	18.1	18.4	18.9	19.3	19.6
DUN	DUNGANNON MAIN	0.96	29.3	29.6	30.1	30.6	31.1	31.7	32.2	32.8	33.3	33.9
EDE	EDEN MAIN	0.96	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.4	8.5
ENN	ENNISKILLEN MAIN	0.96	15.6	15.7	16.0	16.2	16.5	16.7	17.0	17.3	17.5	17.8
ENN	ENNIS	0.99	16.8	17.1	17.0	17.2	16.6	16.9	17.2	17.6	18.0	18.3
FIN	BELFAST - FINAGHY MAIN	0.96	9.3	9.4	9.5	9.6	9.7	9.9	10.0	10.2	10.3	10.4
FIN	FINGLAS	0.97	155.9	157.9	157.2	159.2	154.7	156.5	158.9	162.2	164.7	167.0
GAL	GALWAY	1.00	29.3	29.8	29.6	30.1	29.1	29.5	30.0	30.8	31.4	31.9

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
GI	GREAT ISLAND	1.00	5.2	5.3	5.3	1.0	0.9	1.0	1.0	1.0	1.0	1.0
GIL	GILRA	0.96	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE	BELFAST - GLENGORMLEY MAIN	0.96	2.8	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.2	3.2
GLE	GLENLARA	0.97	4.6	4.7	4.7	4.8	4.6	4.7	4.7	4.9	5.0	5.0
GRI	GRIFFINRATH	0.97	17.4	17.7	17.6	17.4	16.8	17.1	17.4	17.8	18.2	18.5
GWE	GORTAWEE	0.96	20.2	20.2	20.2	20.2	20.1	20.2	20.2	20.3	20.4	20.4
HTS	HARNETTS CROSS	0.95	0.0	0.0	0.0	2.4	2.3	2.4	2.4	2.5	2.5	2.6
IKE	IKERRIN	0.98	8.2	8.4	8.3	8.5	8.2	8.3	8.4	8.6	8.8	9.0
INC	INCHICORE	0.96	149.7	151.2	160.1	162.1	158.6	160.1	161.8	164.4	166.3	168.1
KBY	KILBARRY	0.99	26.4	26.8	26.7	27.1	26.2	26.6	27.0	27.8	28.3	28.7
KER	KNOCKERAGH	1.00	12.2	12.4	12.3	12.5	12.1	12.2	12.5	12.8	13.0	13.2
KIN	KINNEGAD	0.96	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
KKY	KILKENNY	0.99	15.8	16.0	15.9	16.2	15.6	13.0	13.3	13.6	13.9	14.1
KNM	KNOCKMULLEN	0.95	0.0	0.0	0.0	4.4	4.2	4.3	4.4	4.5	4.6	4.7
KNO	BELFAST - KNOCK MAIN	0.96	20.8	20.9	21.2	18.9	19.2	19.5	19.8	20.1	20.4	20.8
KTL	KILTEEL	0.91	9.2	9.3	9.3	9.4	9.1	9.2	9.4	9.6	9.8	10.0
KTN	KILLOTERAN	0.98	6.4	6.5	6.5	6.6	6.4	6.5	6.6	6.8	6.9	7.0
KUR	KNOCKUMBER	0.96	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.98	2.8	2.9	2.8	2.9	2.8	2.8	2.9	3.0	3.0	3.1
LAR	LARNE MAIN	0.96	13.9	14.0	14.2	14.4	14.6	14.8	15.0	15.2	15.4	15.7
LET	LETTERKENNY	0.95	21.6	21.9	21.8	20.8	20.1	20.4	20.8	21.3	21.7	22.1
LIB	LIBERTY	0.94	7.2	7.4	7.3	7.4	7.2	7.3	7.4	7.6	7.7	7.9
LIM	LIMAVADY MAIN	0.96	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.6	7.7
LIM	LIMERICK	1.00	26.1	26.5	26.4	26.8	25.9	26.3	26.7	27.4	27.9	28.4
LIS	LISBURN MAIN	0.96	15.1	15.2	15.5	15.7	15.9	16.2	16.5	16.7	17.0	17.2

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
LIS	LISDRUM	0.99	7.9	8.0	8.0	8.1	7.8	7.9	8.1	8.3	8.4	8.6
LMR	LISAGHMORE MAIN	0.96	13.8	13.9	14.1	14.3	14.5	14.8	15.0	15.2	15.5	15.7
LOG	LOGUESTOWN MAIN	0.96	14.0	14.1	14.3	14.5	14.7	14.9	15.2	15.4	15.6	15.8
LSN	LISHEEN	0.98	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	0.96	6.3	6.4	5.0	2.6	2.5	2.6	2.6	2.7	2.7	2.8
MAL	MALLOW	0.96	8.9	9.1	9.0	9.1	8.8	9.0	9.1	9.4	9.5	9.7
MCE	MACETOWN	0.99	13.3	13.4	13.4	13.5	13.2	13.3	13.5	13.7	13.9	14.0
MID	MIDLETON	0.98	7.2	7.3	7.2	7.3	7.1	7.2	7.3	7.5	7.7	7.8
MLN	MULLAGHARLIN	0.95	2.0	2.0	2.0	10.0	9.7	9.8	10.0	10.2	10.3	10.5
MON	MONREAD	1.00	3.2	3.2	3.2	3.3	3.2	3.2	3.3	3.3	3.4	3.5
MOY	MOY	0.99	6.8	6.9	6.8	6.9	6.7	6.8	6.9	7.1	7.2	7.4
MR	MARINA	0.99	4.7	4.8	4.7	4.8	4.7	4.7	4.8	4.9	5.0	5.1
MTH	MEATH HILL	0.93	6.7	6.8	6.8	6.9	6.6	6.7	6.8	7.0	7.2	7.3
MUL	MULLINGAR	1.00	11.1	11.3	11.2	11.4	11.0	11.1	11.4	11.6	11.9	12.1
MUN	MUNGRET	0.96	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
NAR	NEWTOWNARDS MAIN	0.96	11.5	11.6	11.8	11.9	12.1	12.3	12.5	12.7	12.9	13.1
NAV	NAVAN	1.00	13.4	13.6	13.5	13.7	13.2	13.4	13.7	14.0	14.3	14.5
NEN	NENAGH	0.95	7.5	7.7	7.6	7.7	7.5	7.6	7.7	7.9	8.1	8.2
NEW	NEWRY MAIN	0.96	20.6	20.8	21.1	21.4	21.7	22.1	22.5	22.8	23.2	23.6
NEW	NEWBRIDGE	0.98	11.7	11.9	11.8	8.6	8.3	8.4	8.6	8.8	8.9	9.1
OLD	OLDCOURT	0.96	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
OMA	OMAGH MAIN	0.96	17.2	17.3	17.6	17.9	18.2	18.5	18.8	19.1	19.4	19.8
OUG	OUGHTRAGH	1.00	9.0	9.1	9.1	9.2	8.9	9.0	9.2	9.4	9.6	9.8
PB	POOLBEG	0.99	70.4	71.5	71.1	72.3	69.8	70.8	72.1	73.9	75.3	76.6
PLA	PLATIN	0.96	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
PLS	PORTLAOISE	1.00	10.7	10.9	10.8	11.0	10.6	7.1	7.3	7.5	7.6	7.7

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
PSW	BELFAST - PSW	0.96	17.3	17.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RAL	RALAPPANE	0.96	0.0	0.0	0.0	0.0	61.0	61.0	61.0	61.0	61.0	61.0
RAT	RATHGAEL MAIN	0.96	17.6	17.7	17.9	18.2	18.5	18.8	19.0	19.3	19.6	19.9
RAT	RATHKEALE	0.96	10.1	10.3	10.2	10.4	10.0	10.1	10.3	10.6	10.8	11.0
RIC	RICHMOND	0.87	7.5	7.6	7.6	7.7	7.4	7.5	7.7	7.9	8.0	8.2
RNW	RINAWADE	0.96	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
ROS	ROSEBANK MAIN	0.96	8.6	8.7	8.8	8.9	9.0	9.2	9.3	9.4	9.6	9.7
RSY	RINGASKIDDY	0.99	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
RYB	RYEBROOK	0.96	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
SAL	SALTHILL	0.98	17.9	18.2	18.1	14.6	14.1	14.3	14.6	14.9	15.2	15.5
SCR	SCREEB	0.95	0.0	0.0	0.0	3.8	3.7	3.7	3.8	3.9	4.0	4.0
SHE	SHELTON ABBEY	0.96	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.97	14.6	14.9	14.8	15.0	14.5	14.7	15.0	15.3	15.6	15.9
SLI	SLIGO	1.00	15.0	15.2	15.1	15.4	14.8	15.1	15.3	15.7	16.0	16.3
SNG	SINGLAND	0.97	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.4	3.5	3.5
SOM	SOMERSET	1.00	6.2	6.3	6.2	6.3	6.1	6.2	6.3	6.5	6.6	6.7
SPR	SPRINGTOWN MAIN	0.96	13.7	13.8	14.0	14.2	14.4	14.6	14.8	15.0	15.3	15.5
STR	STRABANE MAIN	0.96	10.6	10.6	10.8	10.9	11.1	11.2	11.4	11.6	11.7	11.9
STR	STRATFORD	1.00	4.9	5.0	5.0	5.1	4.9	5.0	5.1	5.2	5.3	5.4
TBG	TRABEG	0.99	22.7	23.1	23.0	23.3	22.5	22.9	23.3	23.9	24.3	24.7
TBK	TULLABRACK	0.95	1.1	1.1	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2
THU	THURLES	0.97	11.7	11.9	11.8	12.0	11.6	11.7	12.0	12.3	12.5	12.7
TIP	TIPPERARY	0.98	6.3	6.4	6.4	6.5	6.2	6.3	6.5	6.6	6.7	6.9
TLK	TRILLICK	0.99	5.6	5.7	5.7	5.8	5.6	5.7	5.8	5.9	6.0	6.1
TON	TONROE	0.94	5.6	5.7	5.7	5.8	5.6	5.7	5.8	5.9	6.0	6.1

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TRI	TRIEN	0.96	11.0	11.2	11.1	11.3	10.9	11.1	11.3	11.6	11.8	12.0
TRL	TRALEE	0.99	15.1	15.3	15.2	15.5	15.0	15.2	15.4	15.8	16.1	16.4
TSB	THORNSBERRY	0.99	8.3	8.4	8.3	8.5	8.2	8.3	8.5	8.7	8.8	9.0
WAR	WARINGSTOWN MAIN	0.96	19.6	19.7	19.9	20.2	20.4	20.6	20.9	21.1	21.4	21.6
WAT	WATERFORD	0.98	14.5	14.7	14.7	14.9	14.4	14.6	14.9	15.2	15.5	15.8
WEX	WEXFORD	0.97	13.0	13.2	13.1	13.3	12.9	13.1	13.3	13.7	13.9	14.1
WHI	WHITEGATE	0.96	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AGH	AGHYOULE MAIN	0.97	16.0	16.1	16.3	16.5	16.6	16.8	17.0	17.2	17.4	17.7
ANT	ANTRIM MAIN	0.97	37.6	37.8	38.4	38.9	39.5	40.0	40.6	41.2	41.8	42.5
BMA	BALLYMENA MESH (RURAL)	0.97	39.7	40.0	30.2	30.8	31.5	32.1	32.8	33.5	34.2	34.9
BMA	BALLYMENA SWBD (TOWN)	0.97	45.2	45.8	46.7	47.5	48.4	49.3	50.2	51.1	52.1	53.1
BNH	BALLYNAHINCH MAIN	0.97	47.1	47.3	47.9	48.6	49.2	49.9	50.5	51.2	51.9	52.7
BAN	BANBRIDGE MAIN	0.97	32.5	32.6	33.0	33.5	33.9	34.4	34.9	35.4	35.9	36.4
COL	COLERAINE MAIN	0.97	36.1	36.3	36.8	37.4	38.0	38.5	39.1	39.7	40.3	41.0
CPS	COOLKEERAGH MAIN	0.97	30.6	31.0	31.6	32.1	32.7	33.3	33.8	34.4	35.0	35.6
CRG	CREAGH MAIN	0.97	22.4	22.6	34.2	34.6	35.0	35.4	35.9	36.3	36.8	37.2
DRU	DRUMNAKELLY MAIN	0.97	77.7	78.4	79.6	81.0	82.3	83.6	85.0	86.4	87.9	89.4
DUN	DUNGANNON MAIN	0.97	83.4	84.2	85.6	87.1	88.6	90.0	91.6	93.1	94.7	96.4
EDE	EDEN MAIN	0.97	27.2	27.3	27.7	28.0	28.4	28.8	29.2	29.6	30.0	30.4

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ENN	ENNISKILLEN MAIN	0.97	48.7	49.0	49.7	50.5	51.3	52.1	52.9	53.8	54.6	55.5
LAR	LARNE MAIN	0.97	39.1	39.3	39.8	40.4	41.0	41.5	42.1	42.7	43.3	44.0
LIM	LIMAVADY MAIN	0.97	20.3	20.4	20.7	21.0	21.3	21.7	22.0	22.4	22.7	23.1
LMR	LISAGHMORE MAIN	0.97	42.1	42.4	43.0	43.7	44.4	45.1	45.8	46.5	47.2	48.0
LIS	LISBURN MAIN	0.97	53.2	53.6	54.4	55.2	56.0	56.9	57.7	58.6	59.5	60.5
LOG	LOGUESTOWN MAIN	0.97	34.4	34.6	35.1	35.6	36.1	36.6	37.1	37.7	38.2	38.8
NEW	NEWRY MAIN	0.97	65.4	65.9	66.9	68.0	69.0	70.1	71.2	72.4	73.6	74.8
NAR	NEWTOWNARDS MAIN	0.97	36.4	36.6	37.1	37.7	38.2	38.8	39.4	40.0	40.6	41.2
OMA	OMAGH MAIN	0.97	51.0	51.4	52.2	53.1	53.9	54.8	55.7	56.6	57.6	58.6
RAT	RATHGAEL MAIN	0.97	50.9	51.2	51.9	52.6	53.4	54.1	54.9	55.8	56.6	57.5
ROS	ROSEBANK MAIN	0.97	24.7	24.8	25.1	25.5	25.8	26.2	26.5	26.9	27.3	27.7
SPR	SPRINGTOWN MAIN	0.97	27.8	28.0	28.3	28.7	29.1	29.5	29.9	30.3	30.8	31.2
STR	STRABANE MAIN	0.97	30.1	30.3	30.7	31.1	31.5	32.0	32.4	32.9	33.3	33.8
WAR	WARINGSTOWN MAIN	0.97	55.7	55.9	56.5	57.1	57.8	58.4	59.1	59.7	60.4	61.1
AIR	BELFAST - AIRPORT ROAD MAIN	0.97	n/a	n/a	n/a	19.2	19.5	19.8	20.1	20.4	20.7	21.1
CEN	BELFAST - BELFAST CENTRAL MAIN	0.97	57.0	58.3	60.1	61.8	63.6	65.3	67.2	69.0	71.0	73.0
BNM	BELFAST - BELFAST NORTH MAIN	0.97	n/a	n/a	44.3	44.9	45.5	46.1	46.7	47.4	48.1	48.7
PSW	BELFAST - PSW	0.97	43.6	43.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)									
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAR	BELFAST - CARNMONEY MAIN	0.97	35.4	35.7	36.3	36.8	37.4	37.9	38.5	39.1	39.7	40.4
GLE	BELFAST - GLENGORMLEY MAIN	0.97	13.1	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9
CRE	BELFAST - CREGAGH MAIN	0.97	61.9	62.3	63.2	51.5	52.3	53.2	54.1	55.0	56.0	56.9
KNO	BELFAST - KNOCK MAIN	0.97	56.6	56.9	57.6	51.3	52.1	52.9	53.7	54.6	55.4	56.3
FIN	BELFAST - FINAGHY MAIN	0.97	29.0	29.1	29.5	29.9	30.3	30.7	31.1	31.6	32.0	32.5
DON	BELFAST - DONEGALL MAIN(NORTH)	0.97	49.5	49.7	50.3	50.9	51.6	52.2	52.9	53.6	54.3	55.0
DON	BELFAST - DONEGALL MAIN(SOUTH)	0.97	43.5	43.7	44.2	44.8	45.4	46.0	46.7	47.3	48.0	48.7

D Generation Capacity and Dispatch Details

D.1 Generation 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 2022. 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 2022. Table D-2 is based on the wind farms that currently have signed connection agreements with the DSO (as at the beginning of December 2012).

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

Figure D-1 displays the geographical location of all existing and planned wind farms and the total at each 110 kV station they feed into. MW capacities shaded orange correspond to existing wind farms and blue correspond to committed wind farms.

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)									
						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
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	220 kV	Gas/DO	352	352	352	352	352	352	352	352	352	352
	Huntstown	HN2	Corduff	220 kV	Gas/DO	412	412	412	412	412	412	412	412	412	412
	Mountlucas	-	Mountlucas	110 kV	Wind	79	79	79	79	79	79	79	79	79	79
	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	-	Athlone	110 kV	Gas/DO	98	98	98	98	98	98	98	98	98	98
	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
	Edenderry Power	ED1	Cushaling	110 kV	Peat	122	122	122	122	122	122	122	122	122	122
	Kill Hill	-	Kill Hill	110 kV	Wind	63	63	63	63	63	63	63	63	63	63
	Lisheen	-	Lisheen	110 kV	Wind	55	55	55	55	55	55	55	55	55	55
	Rhode PCP	RP1	Derryiron	110 kV	Distillate	52	52	52	52	52	52	52	52	52	52
	Rhode PCP	RP2	Derryiron	110 kV	Distillate	52	52	52	52	52	52	52	52	52	52
	West Offaly Power	WO4	Shannonbridge	110 kV	Peat	141	141	141	141	141	141	141	141	141	141
Total						698	698	698	698	698	698	698	698	698	698
Mid-West	Ardnacrusha	AA1	Ardnacrusha	110 kV	Hydro	22	22	22	22	22	22	22	22	22	22

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)									
						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mid - West	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	20	20	20	20	20	20	20	20	20	20
	Booltiagh Extension	-	Booltiagh	110 kV	Wind	12	12	12	12	12	12	12	12	12	12
	Derrybrien	DBW	Derrybrien	110 kV	Wind	60	60	60	60	60	60	60	60	60	60
	Keelderry	-	Knockavanna	110 kV	Wind	-	30	30	30	30	30	30	30	30	30
	Moneypoint	MP1	Moneypoint	400 kV	Coal/HFO	288	288	288	288	288	288	288	288	288	288
	Moneypoint	MP3	Moneypoint	400 kV	Coal/HFO	288	288	288	288	288	288	288	288	288	288
	Tynagh	TY	Tynagh	220 kV	Gas/DO	404	404	404	404	404	404	404	404	404	404
Total						1156	1186	1186	1186	1186	1186	1186	1186	1186	1186
North-East	Ballakelly	BY	Ballakelly	220 kV	Gas/DO	445	445	445	445	445	445	445	445	445	445
	Bindoo	-	Ratrussan	110 kV	Wind	70	70	70	70	70	70	70	70	70	70
	Caulstown	-	Platin	110 kV	Gas/DO	-	58	58	58	58	58	58	58	58	58
	Mountain Lodge	-	Ratrussan	110 kV	Wind	31	31	31	31	31	31	31	31	31	31
Total						546	604	604	604	604	604	604	604	604	604
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	170	-	-	-	-	-	-	-
	Ballylumford ST5	B5	Ballylumford	275 kV	Gas/HFO	170	170	170	-	-	-	-	-	-	-
	Ballylumford ST6	B6	Ballylumford	275 kV	Gas/HFO	170	170	170	-	-	-	-	-	-	-
	Coolkeeragh CCGT	C30	Coolkeeragh	275 & 110 kV	Gas/Gasoil	413	413	413	413	413	413	413	413	413	413

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)									
						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Northern Ireland	Coolkeeragh GT 8	CGT8	Coolkeeragh	275 kV	Gasoil	53	53	53	53	53	53	53	53	53	53
	Kilroot GT 1	KGT1	Kilroot	275 kV	Gasoil	29	29	29	29	29	29	29	29	29	29
	Kilroot GT 2	KGT2	Kilroot	275 kV	Gasoil	29	29	29	29	29	29	29	29	29	29
	Kilroot GT 3	KGT3	Kilroot	275 kV	Gasoil	42	42	42	42	42	42	42	42	42	42
	Kilroot GT 4	KGT4	Kilroot	275 kV	Gasoil	42	42	42	42	42	42	42	42	42	42
	Kilroot ST 1	K1	Kilroot	275 kV	Coal/Oil	240	240	240	240	240	240	240	240	240	240
	Kilroot ST 2	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	450	450	450	450	450	450	450	450
	Slieve Kirk	SLK	Killyamallaght	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	2815	2305	2305	2305	2305	2305	2305	2305
North-West	Erne	ER3	Cathaleen's Fall	110 kV	Hydro	23	23	23	23	23	23	23	23	23	23
	Erne	ER4	Cathaleen's Fall	110 kV	Hydro	23	23	23	23	23	23	23	23	23	23
	Erne	ER1	Cliff	110 kV	Hydro	10	10	10	10	10	10	10	10	10	10
	Erne	ER2	Cliff	110 kV	Hydro	10	10	10	10	10	10	10	10	10	10
	Garvagh	-	Garvagh	110 kV	Wind	58	58	58	58	58	58	58	58	58	58
	Golagh	GOL	Golagh	110 kV	Wind	15	15	15	15	15	15	15	15	15	15
	Kingsmountain	-	Cunghill	110 kV	Wind	35	35	35	35	35	35	35	35	35	35
	Lough Ree Power	LR4	Lanesboro	110 kV	Peat	94	94	94	94	94	94	94	94	94	94
	Meentycat	-	Meentycat	110 kV	Wind	85	85	85	85	85	85	85	85	85	85
	Mulreavy	-	Mulreavy	110 kV	Wind	-	-	90	90	90	90	90	90	90	90
	Oweninny	-	Bellacorick	400 kV	Wind	-	-	-	-	34	34	34	34	34	34
	Oweninny	-	Bellacorick	400 kV	Wind	-	-	-	-	48	48	48	48	48	48
	Oweninny	-	Bellacorick	400 kV	Wind	-	-	-	-	56	56	56	56	56	56
	Oweninny	-	Bellacorick	400 kV	Wind	-	-	-	-	34	34	34	34	34	34
	Seecon		Knockranny	110 kV	Wind	-	-	105	105	105	105	105	105	105	105

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)									
						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
North - West	Ugool	-	Knockranny	110 kV	Wind	-	-	64	64	64	64	64	64	64	64
Total						352	352	611	611	783	783	783	783	783	783
South-East	Ballywater	BWW	Ballywater	110 kV	Wind	42	42	42	42	42	42	42	42	42	42
	Castledockrill	-	Castledockrill	110 kV	Wind	41	41	41	41	41	41	41	41	41	41
	Great Island	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	LI1	Pollaphuca	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Liffey	LI2	Pollaphuca	110 kV	Hydro	15	15	15	15	15	15	15	15	15	15
	Liffey	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
Total						862	646	646	646	646	646	646	646	646	646
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/DO	431	431	431	431	431	431	431	431	431	431
	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
	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
	Boggeragh	-	Boggeragh	110 kV	Wind	57	57	57	57	57	57	57	57	57	57
	Clahane	-	Clahane	110 kV	Wind	38	38	38	38	38	38	38	38	38	38

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)									
						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
South - West	Clahane Extension	-	Clahane	110 kV	Wind	-	14	14	14	14	14	14	14	14	14
	Cloghboola	-	Cloghboola	110 kV	Wind	-	46	46	46	46	46	46	46	46	46
	Coomacheo	-	Garrow	110 kV	Wind	41	41	41	41	41	41	41	41	41	41
	Coomacheo Extension	-	Garrow	110 kV	Wind	18	18	18	18	18	18	18	18	18	18
	Coomagearlahy	-	Coomagearlahy	110 kV	Wind	43	43	43	43	43	43	43	43	43	43
	Coomagearlahy Extension	-	Coomagearlahy	110 kV	Wind	39	39	39	39	39	39	39	39	39	39
	Dromada	-	Dromada	110 kV	Wind	46	46	46	46	46	46	46	46	46	46
	Glanlee	-	Glanlee	110 kV	Wind	30	30	30	30	30	30	30	30	30	30
	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
	Knocknagreenan	-	Carrigadrohid	110 kV	Hydro	-	-	-	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	288	288	288	288	288	288	288	288	288	288
	Moneypoint	-	Moneypoint	110 kV	Wind	-	-	22	22	22	22	22	22	22	22
	Suir	SUR	Cahir	110 kV	Gas	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	241	241	241	241	241	241	241	241	241	241
	Tarbert	TB4	Tarbert	220 kV	HFO	241	241	241	241	241	241	241	241	241	241
	Whitegate CCGT	WG	Glanagow	220 kV	Gas/DO	445	445	445	445	445	445	445	445	445	445
Total						2989	3071	3179	3249	3249	3249	3249	3249	3249	3249

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

Area	110 kV station	Wind Farm Capacity (MW)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
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	78.9	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
	Dallow	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
	Ikerrin	5.1	35.1	38.5	38.5	38.5	38.5	38.5	38.5	38.5	41.1
	Lisheen		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	23.2
	Tipperary	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Midlands Area Total		106.9	204.1	207.5	207.5	207.5	207.5	207.5	207.5	207.5	221.8
Mid-West	Ardnacrusha	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	Ennis	-	-	-	-	-	-	-	-	-	24.0
	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		21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	45.0
North-East	Drybridge	4.2	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.7
	Dundalk	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Meath Hill	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
	Navan	-	-	-	-	-	-	-	-	-	5.0
	Shankill	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
North-East Area Total		30.2	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	37.7
North-West	Arigna	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6
	Bellacorick	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0
	Binbane	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3
	Castlebar	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	43.6

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

Area	110 kV station	Wind Farm Capacity (MW)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
North - West	Cathaleen's Fall	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
	Cloon	-	-	-	-	-	-	-	-	-	4.3
	Corderry	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	41.0
	Dalton	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	43.4
	Galway	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
	Glenree	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	64.8
	Gortawee	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	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	45.7
	Moy	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	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
	Somerset	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
	Sorne Hill	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	61.6
	Tonroe	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
	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		397.6	405.3	405.3	405.3	405.3	405.3	405.3	405.3	405.3	499.0
South-east	Arklow	25.2	25.2	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	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9
	Crane	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
	Crory	61.3	61.3	61.3	61.3	61.3	61.3	61.3	61.3	61.3	61.3
	Waterford	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
	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		188.0	188.0	224.5	224.5	224.5	224.5	224.5	224.5	224.5	224.5

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

Area	110 kV station	Wind Farm Capacity (MW)									
		2013	2014	2015	2016	2017	2018	2018	2020	2021	2022
South-West	Athea	-	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
	Ballylickey	48.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
South - West	Bandon	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
	Boggeragh	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	44.0
	Cloghboola			32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	Cordal		89.8	107.8	107.8	107.8	107.8	107.8	107.8	107.8	107.8
	Dunmanway	25.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3
	Garrow	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
	Glenlara	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	59.0
	Kilbarry		0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	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
	Oughtragh	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Rathkeale	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5
	Reamore	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7
	Tralee	47.6	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3
	Trien	51.4	52.7	52.7	52.7	52.7	52.7	52.7	52.7	52.7	52.7
South-West Area Total		419.9	543.2	593.8	593.8	593.8	593.8	593.8	593.8	593.8	623.7
Northern Ireland	Aghyoule	67.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
	Antrim			7	7	7	7	7	7	7	7
	Ballymena (Rural)	5	11	11	11	11	11	11	11	11	11
	Brockaghboy				45	45	45	61.1	61.1	61.1	61.1
	Carnmoney	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
	Coleraine	45	108	108	108	108	108	108	108	108	108
	Drumnakelly		4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6

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

Area	110 kV station	Wind Farm Capacity (MW)									
		2013	2014	2015	2016	2017	2018	2018	2020	2021	2022
Northern Ireland	Drumquin					81.7	81.7	81.7	81.7	81.7	81.7
	Dungannon	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
	Eden	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Enniskillen	16.9	31.9	31.9	34.4	34.4	34.4	34.4	34.4	34.4	34.4
	Gort		30.0	30.0	82.6	82.6	89.5	89.5	89.5	89.5	89.5
	Killymallaght	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7
	Larne	15	15	15	15	15	15	15	15	15	15
	Limavady	37.7	37.7	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
	Lisaghmore	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
	Magherakeel	85.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1	123.1
	Mid Antrim			45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
	Omagh	125.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
	Tremoge			55.1	57.4	57.4	57.4	57.4	75.4	75.4	75.4
	Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Northern Ireland Total		444.0	497.3	638.9	755.8	858.2	946.8	962.9	980.9	980.9	980.9

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

Area	110 kV station	Conventional Capacity (MW)										
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Dublin	Ringsend			72	72	72	72	72	72	72	72	72
	Derryiron											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
	Tawnaghmore	104	104	104	153	153	153	153	153	153	153	153
Total		121	121	206	255	255	255	255	255	255	255	280

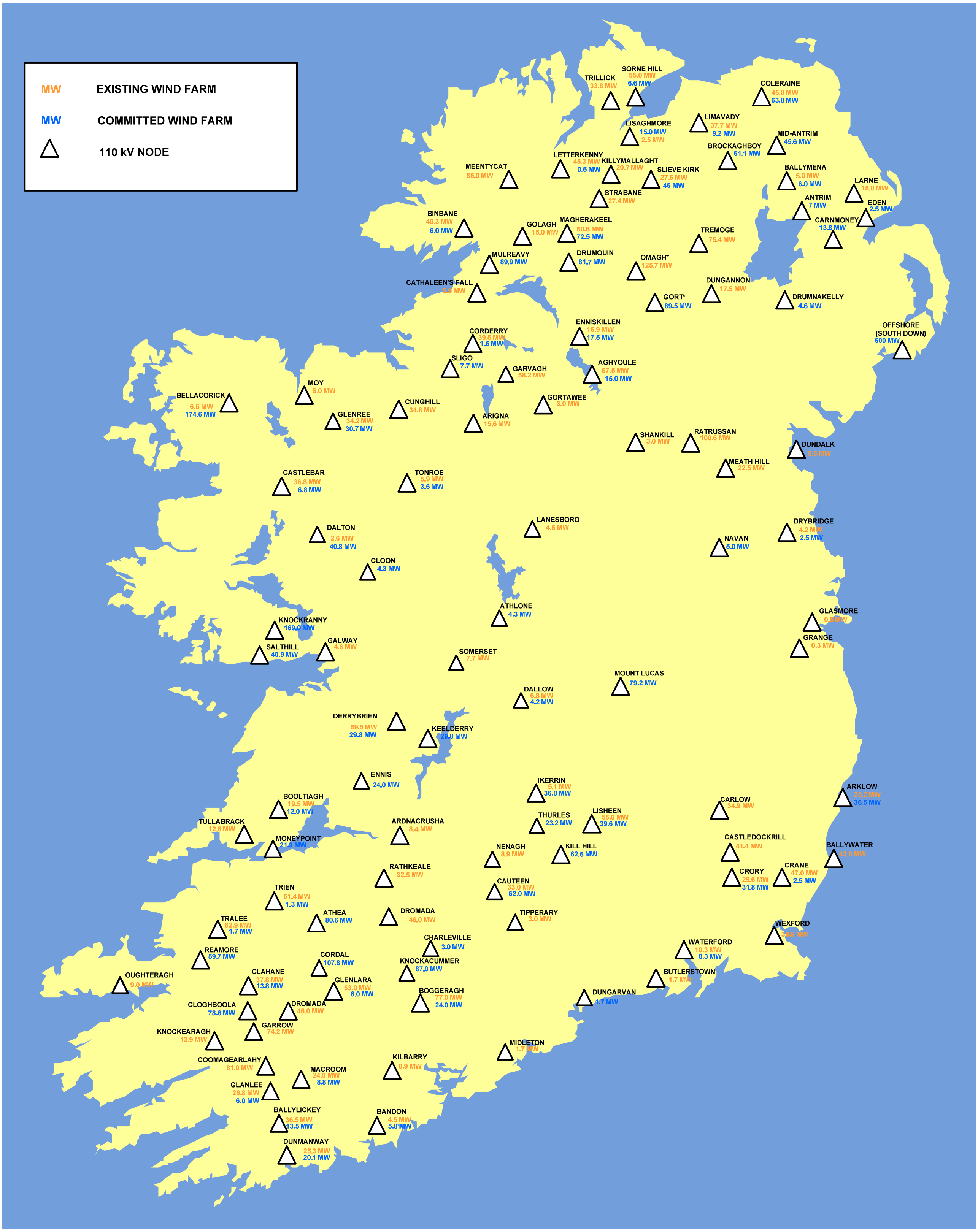


Figure D-1 Geographical Location of Existing and Planned Wind Farms since the end of 2012

D.1 GENERATION DISPATCH DETAILS

Table D-4 through to Table D-7 list generation dispatch profiles used for the purposes of the short circuit current level analyses, capability 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-4 and at 30% in Table D-7. The values shown are in exported terms i.e. they are 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 TFS 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-8 lists the existing and proposed generating plant contract details in Northern Ireland.

Table D-4 Dispatch Profiles – Ireland Short Circuit and Demand Opportunity Analyses

Area	Generation Station	Unit ID	2013			2016			2019			2022		
			SV	SP	WP	SV	SP	WP	SV	SP	WP	SV	SP	WP
Dublin	Dublin Bay Power	DB1	163	300	330	163	300	330	163	400	330	200	-	330
	EWIC	-	180	500	500	-120	350	500	-100	500	500	-300	-	500
	Huntstown	HN1	138	0	330	138	0	238	138	0	330	138	-	330
	Huntstown	HN2	0	300	320	0	300	330	0	350	330	0	-	330
	North Wall	NW4	0	0	0	0	0	0	0	0	0	0	-	0
	North Wall	NW5	0	0	0	0	0	0	0	0	0	0	-	0
	Poolbeg	PBC	130	300	240	130	300	270	130	0	270	130	-	390
	Turlough Hill	TH1,2,3,4	-210	171	140	-210	155	140	-210	118	120	-210	-	154
	Installed Wind		24	8	8	24	8	8	24	8	8	24	-	8
Dublin Area Total			425	1579	1868	125	1413	1816	145	1376	1888	-18	-	2042
South-West	Aghada	AD1	0	0	0	0	0	0	0	0	0	0	-	0
	Aghada	AT1	0	0	0	0	0	0	0	0	0	0	-	0
	Aghada	AT2	0	0	0	0	0	0	0	0	0	0	-	0
	Aghada	AT4	0	0	0	0	0	0	0	0	0	0	-	0
	Aghada CCGT	ADC	0	300	330	0	0	330	0	400	330	0	-	330
	Aughinish	SK3	39	80	80	39	80	80	39	80	80	39	-	80
	Aughinish	SK4	39	80	80	39	80	80	39	80	80	39	-	80
	Knocknagreenan	-	0	0	0	0	0	0	0	0	0	0	-	0
	Lee Hydro	LE1,2	0	0	19	0	0	19	0	0	19	0	-	19
	Lee Hydro	LE3	0	0	8	0	0	8	0	0	8	0	-	8
	Moneypoint	MP2	209	260	280	200	270	290	193	280	290	155	-	290
	Suir OCGT		0	0	0	0	0	0	0	0	0	0	-	0
	Tarbert	TB1	0	0	0	0	0	0	0	0	0	0	-	0
	Tarbert	TB2	0	0	0	0	0	0	0	0	0	0	-	0
	Tarbert	TB3	0	0	0	0	0	0	0	0	0	0	-	0
	Tarbert	TB4	0	0	0	0	0	0	0	0	0	0	-	0

Table D-4 Dispatch Profiles – Ireland Short Circuit and Demand Opportunity Analyses (continued)

Area	Generation Station	Unit ID	2013			2016			2019			2022		
			SV	SP	WP	SV	SP	WP	SV	SP	WP	SV	SP	WP
South - West	Whitegate CCGT	WG	111	300	300	111	300	330	111		330	180	-	330
	Installed Wind	-	236	79	79	343	114	114	343	114	114	352	-	117
South-West Area Total			634	1099	1176	732	844	1251	725	954	1251	765		1254
Mid-West	Ardnacrusha	AA1,2,3,4	0	0	86	0	0	86	0	0	86	0	-	86
	Booltiagh	-	0	0	0	0	0	0	0	0	0	0	-	0
	Moneypoint	MP1	0	260	280	0	270	290	0	280	290	0	-	290
	Moneypoint	MP3	0	260	280	0	270	290	0	280	290	0	-	290
	Tynagh	TY		360	370	0	370	370	0	370	370	0	-	370
	Installed Wind	-	67	22	22	98	33	33	98	33	33	102	-	34
Mid-West Area Total			67	902	1038	98	943	1069	98	963	1069	102		1070
South-East	Great Island	GI1	0	0	0	0	0	0	0	0	0	0	-	0
	Great Island	GI2	0	0	0	0	0	0	0	0	0	0	-	0
	Great Island	GI3	0	0	0	0	0	0	0	0	0	0	-	0
	Great Island	GI4	0	0	0	0	300	330	0	410	330	0	-	330
	Liffey Hydro	LI1,2,4	0	0	34	0	0	34	0	0	34	0	-	34
	Nore Power	NO1	0	0	0	0	0	0	0	0	0	0	-	0
	Installed Wind	-	8	3	3	19	6	6	19	6	6	19	-	6
South-East Area Total			8	3	37	19	306	370	19	416	370	19		370
Midlands	Cuilleen	CUI	0	0	0	0	0	0	0	0	0	0	-	0
	Edenderry Power	ED1	60	130	133	60	130	133	60	130	133	60	-	133
	Edenderry PCP	ED3, ED5	0	0	0	0	0	0	0	0	0	0	-	0
	Rhode PCP	RP1, RP2	0	0	0	0	0	0	0	0	0	0	-	0
	West Offaly Power	WO4	55	150	154	55	150	154	55	150	154	55	-	154
	Installed Wind	-	67	22	22	98	33	33	98	33	33	102	-	34
Midlands Area Total			182	302	309	213	313	320	213	313	320	217		321

Table D-4 Dispatch Profiles – Ireland Short Circuit and Demand Opportunity Analyses (continued)

Area	Generation Station	Unit ID	2013			2016			2019			2022		
			SV	SP	WP	SV	SP	WP	SV	SP	WP	SV	SP	WP
North-West	Erne	ER3,4	0	0	45	0	0	45	0	0	45	0	-	45
	Erne	ER1,2	0	0	20	0	0	20	0	0	20	0	-	20
	Lough Ree Power	LR4	70	100	103	70	100	103	70	100	103	70	-	103
	Installed Wind	-	177	59	59	257	86	86	309	103	103	337	-	112
North-West Area Total			247	159	227	327	186	254	379	203	271	407		280
North-East	Ballakelly	BY	0	0	0	0	0	0	0	0	0	0	-	0
	Caulstown OCGT	CA	0	0	0	0	0	0	0	0	0	0	-	0
	Installed Wind	-	39	13	13	40	13	13	40	13	13	41	-	14
North-East Area Total			39	13	13	40	13	13	40	13	13	41		14

Table D-5 Dispatch Profiles – Northern Ireland Short Circuit Current Level

Area	Generation Station	Unit ID	2012		2015		2018	
			SV	WP	SV	WP	SV	WP
Northern Ireland	Ballylumford CCGT 10	B10	65	65	65	65	65	65
	Ballylumford CCGT 20	B20	0	140	0	140	0	140
	Ballylumford CCGT 21	B21	0	140	0	140	0	120
	Ballylumford CCGT 22	B22	0	140	0	140	0	120
	Ballylumford GT 7	BGT1	0	0	0	0	0	0
	Ballylumford GT 8	BGT2	0	0	0	0	0	0
	Ballylumford ST 4	B4	0	100	0	150	0	0
	Ballylumford ST 5	B5	0	0	0	0	0	0
	Ballylumford ST 6	B6	0	0	0	0	0	0
	Coolkeeragh CCGT	C30	260	400	260	400	260	400
	Coolkeeragh GT 8	CGT8	0	0	0	0	0	0
	Kilroot GT 1	KGT1	0	0	0	0	0	0
	Kilroot GT 2	KGT2	0	0	0	0	0	0
	Kilroot GT 3	KGT3	0	0	0	0	0	0
	Kilroot GT 4	KGT4	0	0	0	0	0	0
	Kilroot ST 1	K1	110	160	110	195	110	120
	Kilroot ST 2	K2	0	160	0	195	0	120
	Moyle (Import)	-	236	190.6	118	190.6	118	190.6
	Wind Generation	-	30%	10%	30%	10%	30%	10%

Table D-6 Dispatch Profiles – Northern Ireland Generator Opportunity Analysis

Area	Generation Station	Unit ID	2018			
			SV	SP	AP	WP
Northern Ireland	Ballylumford CCGT 10	B10	65	65	65	65
	Ballylumford CCGT 20	B20	0	80	60	100
	Ballylumford CCGT 21	B21	0	100	100	120
	Ballylumford CCGT 22	B22	0	0	0	0
	Ballylumford GT 7	BGT1	0	0	0	0
	Ballylumford GT 8	BGT2	0	0	0	0
	Ballylumford ST 4	B4	0	0	0	0
	Ballylumford ST 5	B5	0	0	0	0
	Ballylumford ST 6	B6	0	0	0	0
	Coolkeeragh CCGT	C30	260	400	400	400
	Coolkeeragh GT 8	CGT8	0	0	0	0
	Kilroot GT 1	KGT1	0	0	0	0
	Kilroot GT 2	KGT2	0	0	0	0
	Kilroot GT 3	KGT3	0	0	0	0
	Kilroot GT 4	KGT4	0	0	0	0
	Kilroot ST 1	K1	110	110	110	120
	Kilroot ST 2	K2	0	0	0	0
	Moyle (Import positive)	-	-300	120	168	190.6
	Renewable Generation	-	100%	100%	100%	100%

Table D-7 Dispatch Profiles – Power Flow Diagrams

Please note that the summer valley short circuit and demand opportunity analysis dispatch in Table D-4 was used for the power flow diagrams and as such has not been included in Table D-7.

Area	Generation Station	Unit ID	2013		2016		2019		2022	
			SP	WP	SP	WP	SP	WP	SP	WP
Dublin	Dublin Bay Power	DB1	300	300	300	300	330	300	300	330
	EWIC	-	400	500	400	500	400	500	400	500
	Huntstown	HN1	300	330	138	238	0	330	300	330
	Huntstown	HN2	300	300	194	330	330	300	300	330
	North Wall	NW4	0	0	0	0	0	0	0	0
	North Wall	NW5	0	0	0	0	0	0	0	0
	Poolbeg	PBC	130	130	130	270	0	270	300	390
	Turlough Hill	TH1,2,3,4	140	170	140	180	133	140	140	134
	Installed Wind		24	24	24	24	24	24	24	24
Dublin Area Total			1594	1754	1326	1842	1217	1864	1764	2038
South-West	Aghada	AD1	0	0	0	0	0	0	0	0
	Aghada	AT1	0	0	0	0	0	0	0	0
	Aghada	AT2	0	0	0	0	0	0	0	0
	Aghada	AT4	0	0	0	0	0	0	0	0
	Aghada CCGT	ADC	300	300	0	330	330	330	300	330
	Aughinish	SK3	75	80	70	80	80	60	80	40
	Aughinish	SK4	75	80	70	80	80	60	80	40
	Knocknagreenan	-	0	0	0	0	0	0	0	0
	Lee Hydro	LE1,2	0	19	0	19	0	19	0	19
	Lee Hydro	LE3	0	8	0	8	0	8	0	8
	Moneypoint	MP2	280	230	150	290	180	290	125	270
	Suir OCGT		0	0	0	0	0	0	0	0
	Tarbert	TB1	0	0	0	0	0	0	0	0
	Tarbert	TB2	0	0	0	0	0	0	0	0
	Tarbert	TB3	0	0	0	0	0	0	0	0
	Tarbert	TB4	0	0	0	0	0	0	0	0
	Whitegate CCGT	WG	300	300	300	330	0	330	300	330
	Installed Wind	-	236	236	343	343	343	343	352	352
South-West Area Total			1266	1253	933	1480	1013	1440	1237	1389
Mid-West	Ardnacrusha	AA1,2,3,4	0	86	0	86	0	86	0	86
	Moneypoint	MP1	250	230	150	100	180	100	125	100
	Moneypoint	MP3	250	230	150	100	180	100	125	100
	Tynagh	TY	0	266	300	155	370	0	0	155
	Installed Wind	-	34	34	43	43	43	43	50	50
Mid-West Area Total			534	846	643	484	773	329	300	491
	Great Island	GI1	0	0	0	0	0	0	0	0

Table D-7 Dispatch Profiles – Power Flow Diagrams (continued)

Area	Generation Station	Unit ID	2013		2016		2019		2022	
			SP	WP	SP	WP	SP	WP	SP	WP
South-East	Great Island	GI2	0	0	0	0	0	0	0	0
	Great Island	GI3	0	0	0	0	0	0	0	0
	Great Island	GI4	0	0	300	330	330	330	330	330
	Liffey Hydro	LI1,2,4	0	34	0	34	0	34	0	34
	Nore Power	NO1	0	0	0	0	0	0	0	0
	Installed Wind	-	8	8	19	19	19	19	19	19
South-East Area Total			8	42	319	383	349	383	349	383
Midlands	Cuilleen	CUI	0	0	0	0	0	0	0	0
	Edenderry Power	ED1	120	133	100	133	130	133	130	133
	Edenderry PCP	ED3, ED5	0	0	0	0	0	0	0	0
	Rhode PCP	RP1, RP2	0	0	0	0	0	0	0	0
	West Offaly Power	WO4	120	140	100	154	150	154	150	154
	Installed Wind	-	67	67	98	98	98	98	102	102
Midlands Area Total			307	340	298	385	378	385	382	389
North-West	Erne	ER3,4	0	45	0	45	0	45	0	45
	Erne	ER1,2	0	20	0	20	0	20	0	20
	Lough Ree Power	LR4	80	103	100	103	100	103	100	103
	Installed Wind	-	177	177	257	257	309	309	337	337
North-West Area Total			257	345	357	425	409	477	437	505
North-East	Ballakelly	BY	0	0	0	0	0	0	0	0
	Caulstown OCGT	CA	0	0	0	0	0	0	0	0
	Installed Wind	-	39	39	40	40	40	40	41	41
North-East Area Total			39	39	40	40	40	40	41	41
Northern Ireland	Ballylumford CCGT 10	B10	65	90	65	100	0	100	65	90
	Ballylumford CCGT 20	B20	120	170	120	130	110	90	110	100
	Ballylumford CCGT 21	B21	100	150	100	110	90	80	90	100
	Ballylumford CCGT 22	B22	100	150	100	110	90	80	90	100
	Ballylumford GT 7	BGT1	0	0	0	0	0	0	0	0
	Ballylumford GT 8	BGT2	0	0	0	0	0	0	0	0
	Ballylumford ST 4	B4	0	0	0	0	0	0	0	0
	Ballylumford ST 5	B5	0	0	0	0	0	0	0	0
	Ballylumford ST 6	B6	0	0	0	0	0	0	0	0
	Coolkeeragh CCGT	C30	400	400	400	410	400	400	260	400
	Coolkeeragh GT 8	CGT8	0	0	0	0	0	0	0	0
	Kilroot GT 1	KGT1	0	0	0	0	0	0	0	0
	Kilroot GT 2	KGT2	0	0	0	0	0	0	0	0
	Kilroot GT 3	KGT3	0	0	0	0	0	0	0	0
	Kilroot GT 4	KGT4	0	0	0	0	0	0	0	0

Table D-7 Dispatch Profiles – Power Flow Diagrams (continued)

Area	Generation Station	Unit ID	2013		2016		2019		2022	
			SP	WP	SP	WP	SP	WP	SP	WP
	Kilroot ST 1	K1	120	140	90	120	110	170	110	120
	Kilroot ST 2	K2	0	140	90	120	0	170	0	120
	Moyle (Import)	-	250	250	175	250	250	450	300	450
	Wind Generation	-	160	171	263	280	306	311	496	496
	Tidal Generation	-	0	0	0	0	0	0	40	40
Northern Ireland Total			1315	1661	1403	1630	1356	1851	1561	2016

Table D-8 Existing and Proposed Northern Ireland Generating Plant Contract Details

Centrally Dispatched Generating Unit	Fuel Type	Contract	
		Type	Details
Ballylumford ST 4	GAS/HFO	NIE	See Note 1
Ballylumford ST 5	GAS/HFO	IPP	See Note 2
Ballylumford ST 6	GAS/HFO	IPP	See Note 2
Ballylumford CCGT 21	GAS/GASOIL	NIE	See Note 4
Ballylumford CCGT 22	GAS/GASOIL	NIE	See Note 4
Ballylumford CCGT 20	STEAM	NIE	See Note 4
Ballylumford CCGT 10	GAS/GASOIL	NIE	See Note 4
Ballylumford GT 7	GASOIL	NIE	Contracted until 31/03/2020
Ballylumford GT 8	GASOIL	NIE	Contracted until 31/03/2020
Kilroot ST 1	COAL/OIL	IPP	Contracted until 31/03/2024
Kilroot ST 2	COAL/OIL	IPP	Contracted until 31/03/2024
Kilroot GT 1	GASOIL	NIE	Contracted until 31/03/2024
Kilroot GT 2	GASOIL	NIE	Contracted until 31/03/2024
Kilroot GT 3	GASOIL	IPP	Commenced operation 01/03/2009
Kilroot GT 4	GASOIL	IPP	Commenced operation 01/03/2009
Coolkeeragh GT8	GASOIL	NIE	Contracted until 31/03/2020
Coolkeeragh CCGT	GAS/GASOIL	IPP	Commenced operation 01/04/2005
Moyle	DC LINK		See Note 3

NOTE 1: In a GUA with NIE PPB until 31st March 2012; Due to EU legislation on emissions it is assumed that this generation will be decommissioned beyond 2015.

NOTE 2: This is an Independent Power Producer (IPP); due to EU legislation on emissions it is assumed that this generation will be decommissioned beyond 2015.

NOTE 3: Capacity is auctioned regularly (monthly and annually) to the market participants.

NOTE 4: The contract expiry date is 31 March 2012 (with two five-year extension options exercisable by PPB with two years notice in each case)

E Short Circuit Currents

E.1 Background of Short Circuit Currents
E.2 The Nature of Short Circuit Currents
E.3 Duty of Circuit Breakers
E.4 Short Circuit Current Calculation Methodology
E.5 Short Circuit Currents in Northern Ireland
E.6 Short Circuit Currents in Ireland

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.

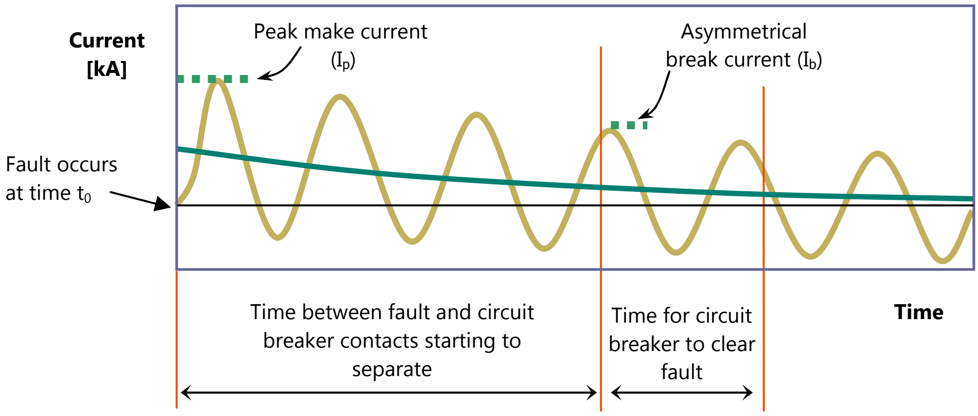


Figure E-1 Typical Short Circuit Current

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 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 NORTHERN IRELAND

E.5.1 Methodology 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-1 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.5.2 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.5.3 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 2012, 2015 and 2018:

- **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-2 Northern Ireland Short Circuit Current Levels for Winter Peak 2013/14

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	21.52	55.75	19.03	25.54	25.23	65.71	23.51	31.42
Castlereagh	31.5	79	35.65	16.83	41.89	14.97	17.17	17.28	42.95	16.19	18.57
Coolkeeragh	31.5	79	35.3	12.42	30.02	11.48	12.71	12.67	31.35	12.18	14.00
Hannahstown	31.5	79	35.65	16.88	42.17	15.04	17.43	17.49	43.65	16.4	19.21
Kells	31.5	79	35.65	19.15	48.6	17.09	20.60	19.47	48.65	18.37	21.18
Kilroot	31.5	79	45.3	18.83	48.27	16.78	21.10	22.39	57.94	20.98	26.92
Magherafelt	31.5	79	35.65	18.46	46.42	16.62	19.20	15.67	37.79	14.97	15.70
Moyle	31.5	79	35.65	20.96	54.16	18.58	24.55	24.26	62.92	22.66	29.55
Tandragee	26.5	66.3	35.65	18.96	47.02	17.02	19.12	18.32	45.12	17.32	19.45
Tamnamore	31.5	79	57.3	14.68	36.46	13.47	14.86	12.39	30.02	11.92	12.65
110kV											
Aghyoule	25.0	62.5		3.94	8.21	3.71	3.81	3.99	8.84	3.83	4.07
Antrim	18.4	46.8		9.75	20.63	9.32	9.43	9.70	20.88	9.46	9.78
Ballylumford*	21.9	55	25.88	24.03	60.02	22.13	29.17				
	26.2	65.0	29.7					28.25	71.52	26.94	35.85
Ballymena	18.4	46.8		9.45	20.20	8.98	9.13	9.68	21.40	9.39	9.89
Banbridge	18.4	46.8		6.80	14.08	6.55	6.59	6.66	14.60	6.52	6.75
Ballyvallagh	18.4	46.8	23	16.37	35.37	15.33	15.38	14.82	31.81	14.35	14.41
Ballynahinch	18.4	46.8		5.95	12.41	5.68	5.73	5.91	12.91	5.74	5.97
Carnmoney	26.2	65	44.9	9.01	18.43	8.61	8.67	8.81	18.82	8.59	8.82
Castlereagh	26.2	65	33.5	20.85	51.47	18.61	22.94	26.29	65.43	24.10	29.65
Belfast Central	31.5	79		16.22	38.33	14.79	15.89	19.03	41.34	17.82	19.16
Coleraine	31.5	79	42.5	8.08	16.52	7.49	7.49	9.25	19.68	8.76	8.79
Coolkeeragh	31.5	80	33.5	22.23	54.34	20.18	24.14	27.58	68.09	25.88	31.29
Creagh	31.5	80	33.5	8.05	16.03	7.73	7.73	8.43	17.78	8.22	8.26
Cregagh	26.2	65		18.45	44.31	16.64	18.60	22.31	51.47	20.67	22.71
Donegall north	31.5	79	33.5	18.50	44.01	17.00	18.40	22.34	49.13	21.02	21.88
Donegall south				13.75	30.73	12.87	13.07	14.48	31.24	13.89	14.26
Drumnakelly	31.5	79	42.5	21.38	49.67	19.54	20.74	22.50	52.66	21.26	22.99
Dungannon	18.4	46.8	23	17.04	37.54	15.84	16.32	16.02	36.52	15.37	16.45
Eden	25.0	62.5	45	10.14	20.85	9.69	9.73	9.77	20.82	9.54	9.74
Enniskillen	25.0	62.5	33.5	8.23	16.89	7.64	7.65	9.75	21.01	9.22	9.27
Finaghy	31.5	79		19.18	46.54	17.59	19.77	23.94	54.65	22.46	23.94
Glengormley	18.4	46.8		5.59	11.04	5.41	5.41	5.43	11.36	5.33	5.37
Hannahstown	31.5	80	33.5	21.60	53.53	19.64	23.87	27.62	68.79	25.72	31.48
Kells*	21.9	55.9	27.4	20.63	49.47	19.00	22.75				
	26.2	65.0	29.7					25.42	61.63	24.00	28.97
Killymallaght				12.40	28.04	11.75	11.99	11.94	26.65	11.60	12.13
Knock	18.4	46.8		17.14	36.22	15.55	15.68	16.75	32.24	15.82	16.82
Larne	18.4	46.8	42.5	9.76	20.54	9.33	9.35	9.16	20.09	8.95	9.12
Limavady	18.4	46.8	23	7.41	15.12	6.96	6.97	7.91	16.92	7.59	7.66

Table E-2 Northern Ireland Short Circuit Current Levels for Winter Peak 2013/14 (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]
Lisburn	18.4	46.8	23	13.13	28.44	12.35	12.45	12.64	27.16	12.21	12.59
Lisaghmore	18.4	46.8		10.07	21.36	9.55	9.64	9.70	21.03	9.44	9.77
Loguestown	18.4	46.8		5.74	11.49	5.40	5.40	6.24	13.07	5.99	6.01
Magherakeel	40.0	100		3.94	8.61	3.85	3.94	4.35	9.90	4.28	4.43
Newtownards	40.0	100		8.33	17.67	7.89	7.95	7.77	17.37	7.54	7.82
Newry	18.4	46.8	23	5.76	11.89	5.53	5.57	5.69	12.40	5.54	5.74
Omagh	40.0	100	42.5	13.47	28.44	12.48	12.55	13.22	29.00	12.60	12.96
PSW	18.4	46.8		15.21	32.00	14.15	14.33	14.51	29.32	13.93	15.11
Rathgael	18.4	46.8		6.39	13.32	6.08	6.12	6.26	13.65	6.08	6.30
Rosebank	40.0	100		19.38	46.48	17.42	19.48	23.92	57.20	22.08	24.46
Slieve Kirk	40.0	100		8.35	17.45	8.05	8.11	8.25	18.10	8.09	8.29
Springtown	31.5	79	33.6	10.25	21.94	9.75	9.86	10.10	22.00	9.84	10.18
Strabane	18.4	46.8	23	15.29	33.18	14.27	14.37	16.32	36.58	15.64	16.13
Tandragee	31.5	79	33.6	23.92	57.67	21.71	25.52	27.97	68.46	26.15	31.36
Tamnamore	40.0	100	45	14.35	33.29	13.58	15.43	12.43	29.73	12.09	14.16
Waringstown	18.4	46.8		8.68	18.80	8.30	8.41	8.22	18.42	8.02	8.38

Table E-3 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2013

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	8.67	21.52	7.73	8.94	10.58	26.41	9.81	11.53
Castlereagh	31.5	79	35.65	8.67	21.38	7.71	8.79	10.5	25.96	9.72	11.08
Coolkeeragh	31.5	79	35.3	8.6	21.23	7.75	9.06	9.67	24.17	9.1	10.86
Hannahstown	31.5	79	35.65	8.47	20.87	7.54	8.58	10.33	25.56	9.56	10.97
Kells	31.5	79	35.65	9.39	23.4	8.33	9.77	11	27.38	10.21	11.87
Kilroot	31.5	79	45.3	9.23	23.13	8.19	9.79	10.1	25.15	9.43	11.06
Magherafelt	31.5	79	35.65	10.02	24.96	8.88	10.36	10.52	25.58	9.83	10.60
Moyle	31.5	79	35.65	8.59	21.31	7.67	8.85	10.5	26.21	9.74	11.45
Tandragee	26.5	66.3	35.65	10.52	26.04	9.33	10.71	12.08	29.79	11.21	12.76
Tamnamore	31.5	79	57.3	8.97	22.23	8.06	9.12	9.11	22.2	8.59	9.30
110kV											
Aghyoule	25.0	62.5		3.84	8.04	3.63	3.73	3.93	8.73	3.79	4.03
Antrim	18.4	46.8		8.03	17.37	7.62	7.74	8.48	18.49	8.22	8.53
Ballylumford*	21.9	55	25.88	14.50	35.48	13.27	16.08				
	26.2	65.0	29.7					17.91	44.35	16.91	20.83
Ballymena	18.4	46.8		7.78	16.96	7.37	7.54	8.43	18.81	8.16	8.62
Banbridge	18.4	46.8		5.99	12.64	5.77	5.82	6.12	13.53	5.99	6.22
Ballyvallagh	18.4	46.8	23	11.76	26.18	10.89	11.01	11.93	26.19	11.44	11.55
Ballynahinch	18.4	46.8		5.17	10.96	4.96	5.02	5.37	11.82	5.24	5.45
Carnmoney	26.2	65	44.9	7.36	15.45	6.99	7.06	7.67	16.62	7.46	7.70
Castlereagh	26.2	65	33.5	13.93	34.59	12.64	15.09	18.64	46.57	17.32	20.73

Table E-3 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2013

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]
Belfast Central	31.5	79		11.70	28.07	10.76	11.66	14.73	32.81	13.88	14.97
Coleraine	31.5	79	42.5	7.18	14.88	6.72	6.73	8.42	18.07	8.05	8.09
Coolkeeragh	31.5	80	33.5	17.12	42.17	15.46	18.74	22.01	54.59	20.55	25.06
Creagh	31.5	80	33.5	6.94	14.16	6.64	6.64	7.56	16.15	7.36	7.41
Cregagh	26.2	65		12.81	31.16	11.70	13.09	16.57	38.91	15.51	17.04
Donegall North	31.5	79	33.5	13.00	31.13	11.94	13.00	16.70	37.59	15.72	16.50
Donegall South				10.44	23.78	9.74	9.98	11.84	26.03	11.33	11.68
Drumnakelly	31.5	79	42.5	15.45	36.62	14.13	15.29	17.76	42.07	16.75	18.28
Dungannon	18.4	46.8	23	13.53	30.57	12.47	13.00	13.81	31.86	13.16	14.18
Eden	25.0	62.5	45	8.03	17.00	7.62	7.68	8.34	18.06	8.09	8.30
Enniskillen	25.0	62.5	33.5	7.47	15.50	6.98	6.99	9.05	19.60	8.60	8.65
Finaghy	31.5	79		13.34	32.42	12.24	13.70	17.59	40.78	16.50	17.69
Glengormley	18.4	46.8		4.95	9.98	4.78	4.78	4.99	10.55	4.90	4.95
Hannahstown	31.5	80	33.5	14.49	35.73	13.21	15.52	19.51	48.29	18.20	21.51
Kells*	21.9	55.9	27.4	14.29	34.45	13.08	15.41				
	26.2	65.0	29.7					18.58	45.15	17.45	20.70
Killymallaght	40.0	100.0		10.90	25.03	10.22	10.53	11.01	24.82	10.62	11.18
Knock	18.4	46.8		12.21	26.90	11.20	11.38	13.46	26.79	12.76	13.59
Larne	18.4	46.8	42.5	7.92	17.06	7.49	7.52	7.96	17.65	7.72	7.91
Limavady	18.4	46.8	23	6.75	13.99	6.36	6.37	7.38	15.91	7.10	7.17
Lisburn	18.4	46.8	23	10.18	22.58	9.53	9.67	10.67	23.32	10.26	10.63
Lisaghmore	18.4	46.8		8.86	19.13	8.36	8.47	8.92	19.51	8.65	8.98
Loguestown	18.4	46.8		5.27	10.68	5.01	5.01	5.86	12.35	5.67	5.70
Magherakeel	40.0	100		3.62	7.83	3.54	3.57	4.19	9.50	4.13	4.21
Newtownards	40.0	100		6.93	15.05	6.58	6.65	6.90	15.58	6.70	6.97
Newry	18.4	46.8	23	5.09	10.64	4.91	4.96	5.19	11.35	5.08	5.27
Omagh	40.0	100	42.5	11.71	25.19	10.78	10.85	12.14	26.92	11.53	11.87
PSW	18.4	46.8		11.29	24.54	10.48	10.69	11.95	24.65	11.44	12.43
Rathgael	18.4	46.8		5.51	11.70	5.27	5.32	5.66	12.46	5.52	5.73
Rosebank	40.0	100		13.26	32.24	12.08	13.52	17.44	42.16	16.27	18.02
Slieve Kirk	40.0	100.0		7.71	16.40	7.36	7.44	7.86	17.41	7.66	7.88
Springtown	31.5	79	33.6	9.01	19.62	8.51	8.64	9.25	20.36	8.97	9.32
Strabane	18.4	46.8	23	13.02	28.89	12.04	12.20	14.59	33.14	13.90	14.45
Tandragee	31.5	79	33.6	16.73	40.81	15.20	17.92	21.03	51.80	19.66	23.48
Tamnamore	40.0	100	45	11.81	27.83	11.03	12.64	11.18	26.95	10.78	12.68
Waringstown	18.4	46.8		7.43	16.39	7.09	7.22	7.44	16.81	7.24	7.60

Table E-4 Northern Ireland Short Circuit Current Levels for Winter Peak 2016/17

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	17.9	45.68	15.82	19.99	20.35	52.27	18.93	24.18
Castlereagh	31.5	79	35.65	15.76	39.15	13.91	16.00	16.6	41.24	15.42	17.73
Coolkeeragh	31.5	79	35.3	12.34	29.94	11.37	12.67	12.44	30.83	11.93	13.77
Hannahstown	31.5	79	35.65	15.49	38.58	13.7	15.84	16.43	40.99	15.29	17.88
Kells	31.5	79	35.65	18.01	45.62	15.97	19.34	18.63	46.58	17.47	20.27
Kilroot	31.5	79	45.3	18.02	46.19	15.94	20.27	21.75	56.25	20.23	26.16
Magherafelt	31.5	79	35.65	17.94	45.09	16.05	18.70	15.25	36.9	14.5	15.32
Moyle	31.5	79	35.65	17.53	44.67	15.52	19.44	19.84	50.84	18.48	23.32
Tandragee	26.5	66.3	35.65	18.9	47.11	16.87	19.36	18.44	45.57	17.35	19.69
Tamnamore	31.5	79	57.3	17.63	43.99	15.82	18.06	14.62	35.71	13.92	15.22
110kV											
Aghyoule	25.0	62.5		4.21	8.87	3.98	4.15	4.17	9.34	4.02	4.37
Airport Road	40	100		11.11	24.17	7.12	10.33	11.26	24.82	10.77	11.19
Antrim	18.4	46.8		9.81	20.75	9.34	9.44	9.72	20.90	9.45	9.76
Ballylumford*	21.9	55	25.88	23.07	57.30	21.10	27.39				
	26.2	65.0	29.7					27.22	68.53	25.79	33.81
Ballymena	18.4	46.8		9.52	20.39	7.65	9.00	9.73	21.52	9.40	9.93
Banbridge	18.4	46.8		6.55	13.75	6.24	6.29	6.48	14.32	6.33	6.57
Ballyvallagh	18.4	46.8	23	16.15	34.93	5.47	15.04	14.73	31.64	14.21	14.28
Ballynahinch	18.4	46.8		5.97	12.45	6.65	5.67	5.94	12.98	5.76	5.99
Belfast central	31.5	79		16.03	37.88	11.63	14.49	18.99	41.20	17.64	19.00
Belfast North Main	18.4	46.8		15.37	33.02	7.37	14.18	15.05	29.31	14.35	15.55
Brockaghboy Cluster	40	100		4.72	10.09	6.92	4.53	4.69	10.61	4.57	4.75
Carnmoney	26.2	65.0	44.9	8.95	18.32	6.19	8.51	8.80	18.80	8.54	8.78
Castlereagh	31.5	79	33.5	20.45	50.36	19.73	18.06	26.14	64.94	23.73	29.18
	31.5	79	42.5	9.34	20.24	7.80	8.59	10.48	23.35	9.87	10.27
Coleraine	31.5	80	33.5	22.94	56.23	18.31	20.84	27.69	68.48	26.02	31.46
Coolkeeragh	31.5	80	33.5	8.36	16.77	3.71	7.99	8.64	18.33	8.40	8.45
Creagh	26.2	65		18.16	43.58	13.83	16.22	22.22	51.16	20.40	22.44
Cregagh	31.5	79	33.5	17.97	42.85	12.06	16.39	21.70	47.86	20.30	21.28
Donegall North				13.47	30.19	7.43	12.53	14.27	30.90	13.64	14.01
Donegall South	31.5	79.0	42.5	17.71	42.41	12.14	16.22	19.07	45.82	18.01	19.92
Drumnakelly	18.4	46.8	23	12.68	29.01	8.99	11.92	12.72	29.88	12.24	13.15
Dungannon	25.0	62.5	45	10.02	20.61	5.65	9.52	9.68	20.64	9.42	9.62
Eden	25.0	62.5	33.5	9.12	19.10	5.82	8.47	10.61	23.34	10.02	10.18
Enniskillen	31.5	79		18.59	45.21	14.20	16.93	23.29	53.39	21.71	23.15
Finaghy	18.4	46.8		5.62	11.11	3.60	5.43	5.43	11.37	5.33	5.37
Glengormley	40.0	100		8.52	19.86	8.75	8.10	7.69	17.85	7.47	8.19
Hannahstown	31.5	80	33.5	20.84	51.73	18.96	18.81	26.72	66.76	24.72	30.17

Table E-4 Northern Ireland Short Circuit Current Levels for Winter Peak 2016/17 (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]
Kells*	40.0	100	42.51	20.72	49.74	18.39	18.95	25.61	62.12	24.03	28.99
Killymallaght	40.0	100.0		12.76	28.86	7.69	12.11	12.17	27.14	11.83	12.35
Knock	18.4	46.8		16.87	35.71	6.56	15.16	16.69	32.02	15.64	16.65
Larne	18.4	46.8	42.5	9.71	20.45	4.88	9.25	9.15	20.07	8.91	9.08
Limavady	18.4	46.8	23	7.98	16.92	5.44	7.50	8.33	18.36	8.00	8.17
Lisburn	18.4	46.8	23	12.81	27.93	6.51	11.98	12.46	26.90	11.98	12.36
Lisaghmore	18.4	46.8		10.24	21.70	6.52	9.73	9.80	21.24	9.54	9.86
Loguestown	18.4	46.8		6.36	13.19	5.97	5.96	6.75	14.53	6.47	6.59
Magherakeel	40.0	100		5.62	13.17	15.89	5.26	5.74	14.02	5.48	6.64
Mid-Antrim	40.0	100		7.48	16.04	7.51	7.09	7.60	16.77	7.34	7.65
Newtownards	40.0	100		8.32	17.66	6.40	7.84	7.80	17.43	7.54	7.82
Newry	18.4	46.8	23.0	5.59	11.64	6.54	5.34	5.55	12.16	5.40	5.61
Omagh	40.0	100	42.5	15.91	35.20	7.26	14.63	15.60	35.28	14.79	15.52
Omagh South	40	100		11.24	23.58	5.11	10.51	9.49	19.75	9.14	9.15
Rathgael	18.4	46.8		6.40	13.35	6.32	6.07	6.29	13.71	6.09	6.31
Rosebank	40.0	100		18.67	45.32	15.58	16.65	23.38	57.62	21.41	25.25
Slieve Kirk	40.0	100		8.54	17.83	6.15	8.24	8.40	18.43	8.24	8.43
Springtown	31.5	79.0	33.6	10.41	22.25	6.71	9.92	10.15	22.10	9.89	10.22
Strabane	18.4	46.8	23	16.01	34.83	6.03	14.97	16.92	38.01	16.23	16.73
Tandragee	31.5	79	33.5	20.80	51.80	20.26	18.88	24.86	62.56	23.18	28.89
Tamnamore	40.0	100	45	18.90	46.40	19.72	17.60	18.74	46.41	17.96	21.76
Tremoge Cluster	40.0	100		9.12	19.44	6.13	8.72	8.01	17.79	7.82	8.12
Waringstown	18.4	46.8		8.29	18.25	7.42	7.89	8.00	18.11	7.77	8.16

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2016

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	9.42	23.39	8.49	9.67	11.29	28.18	10.55	12.26
Castlereagh	31.5	79	35.65	9.39	23.15	8.44	9.48	11.15	27.57	10.4	11.72
Coolkeeragh	31.5	79	35.3	9.47	23.41	8.64	10.03	10.39	26.04	9.87	11.75
Hannahstown	31.5	79	35.65	9.14	22.55	8.23	9.23	10.96	27.14	10.22	11.61
Kells	31.5	79	35.65	10.32	25.72	9.25	10.69	11.81	29.4	11.05	12.71
Kilroot	31.5	79	45.3	10.04	25.16	9.01	10.58	10.71	26.67	10.08	11.69
Magherafelt	31.5	79	35.65	11.2	27.93	10.04	11.53	11.25	27.36	10.6	11.34
Moyle	31.5	79	35.65	9.33	23.15	8.42	9.57	11.19	27.95	10.47	12.17
Tandragee	26.5	66.3	35.65	11.67	28.91	10.47	11.84	13.14	32.39	12.28	13.82
Tamnamore	31.5	79	57.3	11.22	27.85	10.08	11.42	11.06	27.05	10.43	11.45

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2016 (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											
Aghyoule	25.0	62.5		4.13	8.75	3.91	4.08	4.14	9.29	3.99	4.34
Antrim	18.4	46.8		8.42	18.13	8.04	8.15	8.75	19.01	8.51	8.81
Ballylumford*	21.9	55	25.88	15.37	37.59	14.21	17.06				
	26.2	65.0	29.7					18.78	46.49	17.84	21.84
Ballymena	18.4	46.8		8.17	17.77	8.02	7.77	8.71	19.44	8.45	8.94
Banbridge	18.4	46.8		5.87	12.49	6.48	5.68	6.02	13.37	5.90	6.13
Ballyvallagh	18.4	46.8	23	12.41	27.46	6.34	11.59	12.37	27.01	11.91	12.00
Ballynahinch	18.4	46.8		5.26	11.12	6.84	5.07	5.41	11.88	5.29	5.50
Belfast central	31.5	79		12.15	29.14	11.89	11.26	15.15	33.70	14.35	15.40
Belfast North Main	18.4	46.8		12.00	26.46	8.00	11.22	12.81	25.63	12.31	13.34
Carnmoney	26.2	65.0	44.9	7.56	15.81	6.58	7.23	7.80	16.86	7.61	7.84
Castlereagh	31.5	79	33.5	14.55	36.15	17.88	13.31	19.28	48.21	18.02	21.49
Coleraine	31.5	79	42.5	9.18	20.29	11.15	8.69	10.24	23.20	9.87	10.74
Coolkeeragh	31.5	80	33.5	19.91	49.15	18.95	18.16	25.15	62.55	23.70	28.85
Creagh	31.5	80	33.5	7.37	15.03	4.01	7.09	7.90	16.89	7.71	7.76
Cregagh	26.2	65		13.34	32.45	13.74	12.28	17.09	40.12	16.08	17.62
Donegall North	31.5	79	33.5	13.51	32.46	12.09	12.53	17.18	38.62	16.27	17.07
Donegall South				10.77	24.53	7.94	10.13	12.11	26.61	11.65	11.99
Drumnakelly	31.5	79.0	42.5	13.79	33.44	12.40	12.85	15.87	38.42	15.15	16.69
Dungannon	18.4	46.8	23	11.04	25.48	9.23	10.41	11.57	27.27	11.15	11.97
Eden	25.0	62.5	45	8.27	17.42	6.21	7.89	8.49	18.34	8.27	8.47
Enniskillen	25.0	62.5	33.5	8.43	17.82	6.01	7.89	9.96	21.99	9.47	9.62
Finaghy	31.5	79		13.86	33.83	13.66	12.84	18.16	42.19	17.15	18.28
Glengormley	18.4	46.8		5.08	10.20	3.85	4.94	5.08	10.70	5.00	5.04
Gort Cluster	40.0	100		7.95	18.64	9.04	7.53	7.39	17.23	7.16	7.87
Hannahstown	31.5	80	33.5	15.11	37.45	16.67	13.91	20.20	50.30	18.97	22.27
Kells*	40.0	100	42.51	15.54	37.50	16.75	14.34	19.99	48.58	18.85	22.18
Killymallaght	40.0	100.0		11.84	27.07	8.12	11.22	11.63	26.10	11.30	11.83
Knock	18.4	46.8		12.70	27.90	7.24	11.74	13.82	27.39	13.17	13.99
Larne	18.4	46.8	42.5	8.20	17.58	5.40	7.80	8.15	18.05	7.93	8.11
Limavady	18.4	46.8	23	7.68	16.13	5.57	7.33	8.10	17.68	7.86	8.03
Lisburn	18.4	46.8	23	10.39	23.10	7.00	9.81	10.80	23.61	10.44	10.79
Lisaghmore	18.4	46.8		9.55	20.44	6.75	9.09	9.37	20.40	9.14	9.46
Loguestown	18.4	46.8		6.27	13.20	7.39	6.03	6.63	14.41	6.47	6.69
Magherakeel	40.0	100		5.27	12.30	14.24	4.96	5.48	13.30	5.25	6.17
Mid-Antrim	40.0	100		6.98	15.01	7.43	6.70	6.80	15.00	6.64	7.00
Newtownards	40.0	100		7.11	15.40	6.76	6.78	7.02	15.84	6.84	7.10
Newry	18.4	46.8	23.0	5.02	10.56	6.68	4.86	5.13	11.30	5.04	5.23
Omagh	40.0	100	42.5	14.3	32.14	7.69	13.18	14.51	33.03	13.75	14.4

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2016 (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]
Rathgael	18.4	46.8		5.61	11.89	6.56	5.40	5.72	12.56	5.59	5.80
Rosebank	40.0	100		13.8	33.61	13.74	12.71	18.01	43.53	16.90	18.6
Slieve Kirk	40.0	100		8.15	17.19	6.37	7.85	8.16	17.98	7.99	8.19
Springtown	31.5	79.0	33.6	9.73	21.00	6.98	9.27	9.74	21.32	9.51	9.85
Strabane	18.4	46.8	23	14.5	32.05	6.47	13.57	15.82	35.82	15.18	15.7
Tandragee	31.5	79	33.5	15.7	39.30	18.54	14.51	19.81	50.00	18.73	22.7
Tamnamore	40.0	100	45	15.8	38.76	18.14	14.63	16.58	41.06	15.83	18.9
Tremoge Cluster	40.0	100		8.50	18.33	6.43	8.10	7.71	17.20	7.50	7.81
Waringstown	18.4	46.8		7.25	16.18	7.72	6.96	7.31	16.67	7.14	7.50

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2019/20

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]
380kV											
Turleenan				10.90	27.76	10.31	11.85	11.43	28.55	11.06	12.37
275kV											
Ballylumford	26.5	66.3	35.65	19.37	49.33	17.41	21.56	21.56	55.28	20.27	25.55
Castlereagh	31.5	79	35.65	16.99	42.13	15.22	17.27	17.46	43.32	16.38	18.67
Coolkeeragh	31.5	79	35.3	13.32	33.86	12.46	14.63	13.07	33.41	12.64	15.31
Hannahstown	31.5	79	35.65	16.65	41.38	14.95	17.04	17.25	42.98	16.2	18.79
Kells	31.5	79	35.65	19.91	50.44	17.98	21.45	19.97	49.86	18.93	21.74
Kilroot	31.5	79	45.3	19.5	49.93	17.55	21.86	23.08	59.66	21.72	27.70
Magherafelt	31.5	79	35.65	20.36	51.46	18.55	21.76	16.74	40.47	16.06	16.90
Moyle	31.5	79	35.65	18.94	48.16	17.06	20.93	20.98	53.69	19.75	24.61
Omagh South	40	100	1000	3.69	8.63	3.56	3.67	4.24	10.04	4.12	4.35
South Down	40	100	1000	21.46	53.85	19.57	22.53	19	46.43	18.15	19.95
Tandragee	26.5	66.3	35.65	21.52	53.79	19.51	22.37	20.71	51.09	19.64	22.14
Tamnamore	31.5	79	57.3	21.07	52.89	19.22	22.12	18.19	44.42	17.4	19.09
Turleenan	31.5	79	35.65	21.46	53.85	19.57	22.53	19	46.43	18.15	19.95
110kV											
Aghyoule	25.0	62.5		4.04	9.15	4.13	4.29	4.27	9.55	4.12	4.47
Airport Road				10.28	24.51	10.57	10.71	11.40	25.07	10.94	11.37
Antrim	18.4	46.8		9.99	21.97	10.15	10.24	10.20	21.73	9.98	10.28
Ballylumford*	21.9	55	25.88	21.62	59.48	22.34	28.65				
	26.2	65.0	29.7					28.17	70.50	26.91	34.97
Ballymena	18.4	46.8		10.21	21.56	9.75	9.89	10.21	22.41	9.92	10.43
Banbridge	18.4	46.8		6.65	13.94	6.41	6.45	6.59	14.55	6.44	6.68
Ballyvallagh	18.4	46.8	23	17.15	36.51	16.16	16.20	15.24	32.41	14.80	14.86
Ballynahinch	18.4	46.8		6.01	12.53	5.73	5.78	5.98	13.07	5.81	6.04

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2019/20 (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]
Belfast Central	31.5	79		16.51	38.92	15.03	16.14	19.43	41.99	18.13	19.51
Belfast North Main	18.4	46.8		15.82	33.87	14.71	14.94	15.32	29.89	14.68	15.92
Brockaghboy Cluster	40.0	100.0		6.31	13.74	6.09	6.23	5.71	13.20	5.60	5.98
Carnmoney	26.2	65	44.9	9.04	18.42	8.64	8.70	8.82	18.80	8.60	8.83
Castlereagh	31.5	79	33.5	21.28	52.37	18.94	23.24	27.07	67.21	24.70	30.24
Coleraine	31.5	79	42.5	15.52	33.63	14.66	14.80	15.49	34.71	14.90	15.40
Coolkeeragh	31.5	80	33.5	24.30	59.52	22.40	27.60	28.90	71.45	27.44	33.99
Creagh	31.5	80	33.5	8.63	17.15	8.31	8.31	8.86	18.70	8.64	8.68
Cregagh	26.2	65		18.80	45.02	16.92	18.86	22.85	52.47	21.09	23.13
110kV											
Donegall North	31.5	79	33.5	18.60	44.29	17.10	18.44	22.30	49.06	20.97	21.93
Donegall South				13.79	30.83	12.93	13.12	14.51	31.34	13.92	14.29
Drumnakelly	31.5	79	42.5	18.35	43.95	16.93	18.34	19.63	47.18	18.61	20.56
Drumquin Cluster	40.0	100		7.04	16.02	6.73	6.92	6.75	15.49	6.56	7.09
Dungannon	18.4	46.8	23	13.03	29.77	12.34	12.75	13.07	30.71	12.60	13.52
Eden	25.0	62.5	45	10.15	20.79	9.72	9.76	9.76	20.76	9.54	9.74
Enniskillen	25.0	62.5	33.5	10.01	21.12	9.35	9.41	11.54	25.45	10.96	11.16
Fair Head	40.0	100.0		6.73	15.07	6.70	6.75	2.66	6.07	2.66	2.73
Finaghy	31.5	79		19.26	46.79	17.69	19.73	23.97	54.82	22.46	23.87
Glengormley	18.4	46.8		5.82	11.38	5.66	5.66	5.59	11.64	5.50	5.54
Gort Cluster				8.78	20.52	8.47	8.73	7.90	18.34	7.73	8.49
Hannahstown	31.5	80	33.5	21.70	53.87	19.76	23.73	27.65	69.10	25.72	31.18
Kells*	40.0	100	42.51	24.82	58.53	22.96	26.63	29.81	71.28	28.19	33.12
Killymallaght				13.02	29.32	12.47	12.67	12.27	27.28	11.99	12.47
Knock	18.4	46.8		17.39	36.58	15.75	15.89	16.98	32.45	15.99	17.02
Larne	18.4	46.8	42.5	10.02	20.89	9.62	9.63	9.32	20.35	9.12	9.28
Limavady	18.4	46.8	23	9.36	19.52	8.97	8.98	9.28	20.28	9.03	9.18
Lisburn	18.4	46.8	23	13.37	30.50	12.58	12.87	12.52	28.53	12.09	12.68
Lisaghmore	18.4	46.8		10.50	22.18	10.05	10.14	9.94	21.52	9.72	10.06
Loguestown	18.4	46.8		8.68	17.74	8.36	8.38	8.41	18.02	8.21	8.33
Magherakeel				5.09	11.69	4.79	5.30	5.33	12.78	5.10	5.91
Mid-Antrim				11.37	24.73	10.88	11.06	10.50	23.48	10.23	10.70
Newtownards	40.0	100		8.41	17.81	7.96	8.02	7.86	17.55	7.62	7.90
Newry	18.4	46.8	23	5.66	11.80	5.43	5.48	5.62	12.33	5.48	5.69
North Antrim	40.0	100.0		14.77	31.70	14.24	14.29	9.78	21.35	9.63	9.71
Omagh	40.0	100	42.5	17.33	38.47	16.06	16.35	17.28	38.93	16.44	17.22
Omagh South	40.0	100		17.33	38.48	16.06	16.35	17.28	0.00	16.44	16.44
Rathgael	18.4	46.8		6.45	13.42	6.14	6.18	6.33	13.79	6.14	6.36
Rosebank	40.0	100		19.34	46.88	17.38	19.95	24.09	59.33	22.18	26.04
Slieve Kirk				8.61	17.86	8.37	8.40	8.39	18.29	8.26	8.39

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2019/20 (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]
Springtown	31.5	79	33.6	10.68	22.76	10.26	10.36	10.31	22.42	10.10	10.44
Strabane	18.4	46.8	23	16.47	35.64	15.54	15.62	17.24	38.58	16.64	17.12
Tandragee	31.5	79	33.5	21.69	54.18	19.85	24.52	25.81	65.13	24.18	30.24
Tamnamore	40.0	100	45	19.72	48.50	18.58	22.76	19.49	48.40	18.77	23.09
Torr Head	40.0	100.0		6.73	15.07	6.70	6.75	2.66	6.07	2.66	2.73
Tremoge Cluster				9.34	19.86	9.00	9.05	8.15	18.04	7.97	8.27
Waringstown	18.4	46.8		8.43	18.54	8.06	8.19	8.12	18.38	7.90	8.30

Table E-7 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2019

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]
380 kV											
Turleenan				7.99	20.34	7.44	8.69	8.87	22.18	8.48	9.58
275kV											
Ballylumford	26.5	66.3	35.65	10.5	26.28	9.56	10.99	12.25	30.79	11.52	13.55
Castlereagh	31.5	79	35.65	10.44	25.94	9.47	10.72	12.11	30.12	11.36	12.90
Coolkeeragh	31.5	79	35.3	10.35	26.46	9.53	11.52	10.88	27.89	10.39	12.79
Hannahstown	31.5	79	35.65	10.14	25.19	9.22	10.41	11.86	29.54	11.13	12.75
Kells	31.5	79	35.65	11.63	29.27	10.52	12.35	12.9	32.32	12.13	14.11
Kilroot	31.5	79	45.3	11.18	28.25	10.13	12.03	11.54	28.88	10.93	12.77
Magherafelt	31.5	79	35.65	12.99	32.87	11.76	13.99	12.51	30.58	11.85	12.76
Moyle	31.5	79	35.65	10.39	25.97	9.46	10.85	12.14	30.51	11.42	13.44
Tandragee	26.5	66.3	35.65	13.53	33.9	12.25	14.15	14.84	36.78	13.94	15.86
Tamnamore	31.5	79	57.3	13.54	34.11	12.27	14.38	13.33	32.77	12.61	14.07
110kV											
Aghyoule	25.0	62.5		4.15	8.77	3.93	4.10	4.13	9.27	3.98	4.34
Airport Road				9.40	20.90	8.93	9.08	10.00	22.34	9.68	10.08
Antrim	18.4	46.8		8.82	18.88	8.45	8.56	9.00	19.51	8.78	9.08
Ballylumford*	21.9	55	25.88	16.22	39.63	15.12	18.25				
	26.2	65.0	29.7					19.52	48.33	18.63	22.96
Ballymena	18.4	46.8		8.53	18.49	8.15	8.31	8.97	19.98	8.72	9.21
Banbridge	18.4	46.8		5.99	12.73	5.82	5.87	6.11	13.59	6.01	6.24
Ballyvallagh	18.4	46.8	23	13.09	28.81	12.31	12.39	12.76	27.75	12.32	12.40
Ballynahinch	18.4	46.8		5.34	11.29	5.17	5.22	5.48	12.04	5.37	5.58
Belfast Central	31.5	79		12.72	30.59	11.88	12.84	15.80	35.00	15.02	16.14
Belfast North Main	18.4	46.8		12.62	27.74	11.88	12.13	13.20	26.36	12.74	13.83
Brockaghboy Cluster	40.0	100.0		5.77	12.72	5.52	5.66	5.40	12.55	5.26	5.65
Carnmoney	26.2	65	44.9	7.74	16.15	7.44	7.51	7.94	17.14	7.76	7.99
Castlereagh	31.5	80	33.5	15.41	38.48	14.21	17.09	20.41	51.23	19.15	23.05

Table E-7 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2019 (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]
Coleraine	31.5	79	42.5	9.63	21.06	9.06	9.23	10.71	24.03	10.21	10.62
Coolkeeragh	31.5	80	33.5	20.33	50.61	18.62	23.28	24.94	62.39	23.55	29.45
Creagh	31.5	80	33.5	7.56	15.33	7.31	7.31	8.04	17.16	7.87	7.92
Cregagh	26.2	65		14.05	34.28	13.03	14.56	17.94	42.06	16.95	18.58
Donegall North	31.5	79	33.5	14.32	34.51	13.39	14.50	18.01	40.43	17.14	17.97
Donegall South				11.23	25.57	10.64	10.85	12.45	27.32	12.03	12.37
Drumnakelly	31.5	79	42.5	14.64	35.64	13.75	14.99	16.58	40.27	15.90	17.59
Drumquin	40.0	100.0		6.35	14.37	6.02	6.21	5.96	13.75	5.77	6.32
Dungannon	18.4	46.8	23	11.47	26.50	10.88	11.29	11.96	28.23	11.52	12.39
Eden	25.0	62.5	45	8.48	17.79	8.14	8.19	8.61	18.55	8.41	8.61
Enniskillen	25.0	62.5	33.5	8.68	18.44	8.11	8.18	10.19	22.59	9.67	9.88
Finaghy	31.5	79		14.72	36.07	13.75	15.30	19.09	44.39	18.13	19.32
Gort Cluster				8.14	19.13	7.73	8.01	7.50	17.51	7.26	8.02
Glengormley	18.4	46.8		5.17	10.32	5.04	5.04	5.13	10.78	5.05	5.09
Hannahstown	31.5	80	33.5	16.16	40.30	15.01	17.64	21.39	53.59	20.20	23.93
Kells	40.0	100	42.51	17.26	41.83	16.00	18.82	21.92	53.48	20.70	24.58
Killymallaght				11.93	27.30	11.34	11.60	11.61	26.12	11.30	11.85
Knock	18.4	46.8		13.33	29.19	12.42	12.59	14.31	28.23	13.70	14.58
Larne	18.4	46.8	42.5	8.44	18.01	8.08	8.10	8.29	18.31	8.09	8.26
Limavady	18.4	46.8	23	7.83	16.71	7.46	7.49	8.20	18.14	7.94	8.11
Lisburn	18.4	46.8	23	10.98	25.43	10.44	10.74	10.94	25.15	10.62	11.15
Lisaghmore	18.4	46.8		9.59	20.58	9.16	9.26	9.35	20.43	9.13	9.47
Loguestown	18.4	46.8		6.45	13.44	6.18	6.21	6.79	14.65	6.57	6.69
Magherakeel				4.50	10.21	4.30	4.57	4.87	11.48	4.70	5.15
Mid-Antrim				9.71	21.58	9.19	9.42	9.47	21.45	9.15	9.65
Newtownards	40.0	100		7.27	15.70	6.97	7.04	7.10	15.99	6.93	7.19
Newry	18.4	46.8	23	5.10	10.73	4.95	5.00	5.20	11.44	5.11	5.30
Omagh	40.0	100	42.5	14.74	33.13	13.59	13.92	14.94	34.02	14.15	14.96
Omagh South	40.0	100.0		14.74	33.14	13.59	13.92	14.94	0.00	14.15	14.15
Rathgael	18.4	46.8		5.71	12.08	5.51	5.56	5.79	12.71	5.67	5.88
Rosebank	40.0	100		14.36	35.41	13.31	15.24	18.67	46.46	17.60	20.50
Slieve Kirk				8.13	17.14	7.85	7.91	8.09	17.83	7.93	8.13
Springtown	31.5	79	33.6	9.77	21.15	9.34	9.46	9.73	21.36	9.49	9.85
Strabane	18.4	46.8	23	14.82	32.72	13.91	14.03	15.97	36.20	15.35	15.88
Tandragee	31.5	79	33.5	16.82	42.49	15.69	19.12	20.97	53.27	19.92	24.54
Tamnamore	40.0	100	45	16.76	41.55	15.69	19.15	17.43	43.42	16.67	20.39
Tremoge Cluster				8.64	18.61	8.26	8.33	7.78	17.37	7.57	7.89
Waringstown	18.4	46.8	1000	7.44	16.60	7.18	7.31	7.44	16.97	7.28	7.66

E.6 SHORT CIRCUIT CURRENTS IN IRELAND

E.6.1 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-8 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.6.2 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.6.3 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)

$$I_{DC\_b} = \sqrt{2} \cdot I_k'' \cdot e^{-2 \cdot \pi \cdot 50 \cdot t_b \cdot \frac{R}{X}}$$

- 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-9 Short Circuit Currents for Maximum and Minimum Demand in 2013

Bus	Winter Peak 2013						Summer Valley 2013					
	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	5.4	4.2	4.8	4.6	3.1	5.6	4.9	4.3	4.4	4.3
Aghada 110 kV	4.6	9.8	9.3	5.6	11.1	10.8	4.8	7.7	7.1	5.7	9.1	8.8
Aghada A 220 kV	14.8	18.4	15.5	15.5	20.5	19.2	9.3	8.8	7.5	10.0	11.4	10.5
Aghada B 220 kV	14.6	17.5	14.8	12.1	19.8	18.5	10.7	9.9	8.2	10.3	12.5	11.5
Aghada C 220 kV	14.0	17.7	15.0	13.1	19.8	18.6	9.2	8.7	7.4	9.5	11.1	10.4
Aghada D 220 kV	14.8	18.4	15.5	15.5	20.5	19.2	9.3	8.8	7.5	10.0	11.4	10.5
Ahane 110 kV	4.7	14.0	12.7	5.7	10.8	10.5	4.9	11.2	9.9	5.7	9.4	9.0
Anner 110 kV	3.9	7.6	6.9	4.5	5.5	5.3	3.4	5.8	5.4	3.9	4.1	4.0
Ardnacrusha 110 kV	5.9	16.7	14.6	7.2	16.5	15.8	5.4	12.2	10.6	6.5	13.3	12.6
Arigna 110 kV	3.8	7.8	7.0	4.9	5.5	5.4	3.9	7.1	6.2	5.0	5.2	5.0
Arklow 110 kV	10.3	9.4	8.7	11.1	11.2	10.9	10.4	8.2	7.5	11.2	9.9	9.5
Arklow 220 kV	8.9	8.6	8.0	10.2	7.7	7.5	9.0	7.0	6.3	10.2	6.6	6.4
Artane 110 kV	13.3	13.3	11.9	5.7	15.3	14.6	13.2	10.1	9.2	6.2	12.2	11.7
Arva 110 kV	3.7	10.2	9.1	4.9	7.3	7.1	3.9	9.1	8.0	5.0	6.8	6.6
Athea 110 kV	5.5	6.9	5.7	6.7	7.1	6.6	-	-	-	-	-	-
Athlone 110 kV	5.0	9.7	8.7	5.8	9.4	9.1	4.3	7.4	6.8	5.4	4.8	4.8
Athy 110 kV	3.0	6.6	6.2	4.3	5.2	5.1	3.3	5.5	5.2	4.4	4.6	4.5
Aughinish 110 kV	7.9	10.7	9.4	10.0	11.1	10.6	8.4	9.6	8.3	10.4	10.4	9.8
Ballybeg 110 kV	9.3	7.1	6.7	9.6	8.2	8.0	9.5	6.4	6.0	9.8	7.4	7.3
Ballydine 110 kV	3.9	8.3	7.6	3.8	6.3	6.1	3.5	6.4	5.9	3.4	5.1	5.0
Ballylickey 110 kV	2.9	3.2	3.0	4.1	1.9	1.8	3.0	3.0	2.8	4.1	1.8	1.7
Ballywater 110 kV	4.6	6.2	5.9	3.2	6.1	6.0	4.8	5.4	5.1	3.3	5.4	5.3
Baltrasna 110 kV	5.9	11.3	10.6	7.2	8.4	8.2	6.2	9.9	9.1	7.3	7.7	7.5
Bancroft 110 kV	10.5	16.3	14.4	5.9	16.9	16.2	11.0	13.9	12.3	6.2	15.0	14.3
Bandon 110 kV	3.0	6.5	5.9	4.4	5.1	4.9	3.2	5.6	5.0	4.5	4.7	4.5
Banoge 110 kV	5.9	6.5	6.1	6.7	5.6	5.5	6.1	5.7	5.4	6.8	5.1	5.0
Barnahealy A 110 kV	4.5	14.0	12.8	5.3	13.7	13.3	4.9	10.3	9.2	5.5	10.9	10.5
Barnahealy B 110 kV	6.7	13.6	12.4	7.4	13.1	12.7	6.5	10.2	9.0	7.1	10.6	10.2
Baroda 110 kV	3.9	9.0	8.3	4.7	10.0	9.7	4.2	7.5	6.9	5.0	8.7	8.5
Barrymore 110 kV	3.6	8.5	8.0	4.7	4.8	4.8	3.7	6.8	6.3	4.8	4.1	4.1
Bellacorick 110 kV	3.0	4.2	3.8	4.0	4.1	3.9	2.7	3.3	3.0	3.5	3.4	3.3
Binbane 110 kV	3.4	4.9	4.3	4.9	4.2	4.0	3.0	3.1	2.7	4.2	3.0	2.9
Blackrock 110 kV	8.2	15.4	13.6	2.2	12.3	11.9	8.6	13.1	11.7	2.3	11.1	10.8
Blake 110 kV	3.8	8.5	7.9	4.9	5.6	5.5	4.1	7.2	6.7	5.1	5.1	5.0
Boggeragh 110 kV	16.6	4.0	3.4	17.4	4.2	4.0	16.9	3.5	3.1	17.6	3.8	3.6
Booltiagh 110 kV	3.1	4.5	3.9	4.4	3.9	3.8	3.2	4.1	3.5	4.4	3.6	3.5

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	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]
Brinny A 110 kV	2.9	5.8	5.4	4.2	4.3	4.2	3.1	5.0	4.6	4.3	4.0	3.9
Brinny B 110 kV	2.9	5.8	5.4	4.2	4.3	4.2	3.1	5.1	4.6	4.3	4.0	3.9
Butlerstown 110 kV	6.1	12.6	11.6	6.2	11.7	11.4	4.5	8.6	7.9	4.6	8.7	8.5
Cabra 110 kV	12.2	12.8	11.4	4.6	13.5	13.0	12.3	9.8	9.0	5.1	11.1	10.7
Cahir 110 kV	4.4	11.2	9.9	5.3	10.5	10.0	3.4	7.6	6.8	4.1	5.1	5.0
Carlow 110 kV	5.1	9.9	9.1	6.0	10.1	9.8	5.3	7.4	6.8	6.0	8.1	7.9
Carrickmines 220 kV	13.7	21.8	18.3	8.4	25.1	23.4	15.0	17.1	13.7	9.6	20.4	18.6
Carrickmines A 110 kV	22.2	18.9	16.5	16.5	19.9	18.9	22.6	15.8	13.8	17.2	17.3	16.5
Carrickmines B 110 kV	22.2	18.9	16.5	16.5	19.9	18.9	22.6	15.8	13.8	17.2	17.3	16.5
Carrick-on-Shannon 110 kV	4.1	12.4	11.0	4.9	12.8	12.3	4.3	10.8	9.5	5.1	11.5	10.9
Carrigadrohid 110 kV	5.6	12.6	11.4	6.5	9.5	9.3	5.5	9.8	8.7	6.3	8.2	7.9
Carrowbeg 110 kV	2.6	2.9	2.6	3.6	2.6	2.5	2.6	2.6	2.4	3.6	2.4	2.3
Cashla 110 kV	6.7	17.4	15.4	7.5	20.9	19.9	6.6	13.4	11.9	7.3	16.8	16.0
Cashla 220 kV	7.8	11.8	10.7	9.4	11.4	11.0	7.9	8.4	7.4	9.2	8.9	8.5
Castlebar 110 kV	3.0	5.3	4.6	4.0	5.2	5.0	3.0	4.5	4.0	3.9	4.6	4.4
Castledockrill 110 kV	6.8	8.3	7.8	4.6	9.5	9.2	6.9	7.1	6.5	4.8	8.2	7.9
Castlefarm A 110 kV	7.1	10.3	9.1	8.7	10.3	9.9	7.5	9.2	8.0	9.0	9.7	9.2
Castlefarm B 110 kV	7.2	10.2	9.1	8.7	10.3	9.9	7.6	9.2	8.0	9.1	9.7	9.2
Castleview 110 kV	3.7	14.1	13.0	4.5	9.6	9.4	4.2	10.3	9.2	4.8	8.0	7.8
Cathaleen's Fall 110 kV	4.6	10.5	8.9	5.5	9.6	9.1	3.9	7.8	6.7	4.7	8.0	7.6
Cauteen 110 kV	3.0	7.7	7.1	4.1	4.5	4.4	3.1	6.6	6.0	4.1	3.8	3.7
Central 110 kV	10.5	16.5	14.6	5.5	16.9	16.1	11.1	14.0	12.4	5.9	14.9	14.3
Charleville 110 kV	4.1	7.6	6.6	5.1	5.2	5.1	3.8	6.1	5.3	5.1	4.2	4.0
City West 110 kV	6.0	8.6	7.5	6.0	6.1	5.9	6.2	7.4	6.8	6.1	5.6	5.5
Clahane 110 kV	4.1	9.1	7.9	5.2	7.7	7.4	4.4	7.4	6.4	5.5	6.5	6.2
Clashavoon 220 kV	8.8	9.3	8.4	9.8	8.6	8.4	9.4	7.1	6.2	10.5	7.0	6.7
Clashavoon A 110 kV	7.8	13.7	12.4	9.0	11.5	11.1	7.5	10.9	9.5	8.7	9.7	9.3
Clashavoon B 110 kV	26.5	4.6	4.1	27.9	5.3	5.1	27.1	4.1	3.6	28.5	4.8	4.6
Cliff 110 kV	4.3	8.0	7.0	5.2	6.7	6.4	3.8	6.1	5.4	4.7	5.8	5.6
Cloghran 110 kV	6.5	18.0	16.5	6.8	15.8	15.4	6.8	14.8	13.2	7.0	13.9	13.4
Clonkeen A 110 kV	6.8	8.3	7.1	7.6	8.3	7.8	7.1	7.3	6.1	7.8	7.5	7.0
Clonkeen B 110 kV	6.9	8.2	7.0	7.6	8.3	7.8	7.1	7.3	6.0	7.8	7.4	7.0
Cloon 110 kV	4.2	8.0	7.4	5.2	5.3	5.2	4.3	6.9	6.4	5.2	4.9	4.8
College Park 110 kV	9.3	23.4	21.1	6.3	24.7	23.8	9.3	18.5	16.1	6.6	20.4	19.4
Cookstown A 110 kV	6.3	10.5	9.7	5.5	8.0	7.8	6.6	9.3	8.6	5.6	7.3	7.2
Cookstown B 110 kV	5.0	7.4	6.6	5.4	5.0	4.8	5.2	6.4	5.9	5.5	4.6	4.5

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	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	6.1	11.3	10.4	7.6	9.9	9.7	4.9	8.5	7.7	6.2	8.2	8.0
Coomagearlahy 110 kV	7.1	7.0	5.9	8.2	7.7	7.1	7.3	6.3	5.2	8.3	7.0	6.4
Corderry 110 kV	3.9	8.9	7.6	5.1	8.0	7.6	4.1	7.9	6.6	5.3	7.4	6.9
Corduff 110 kV	10.2	26.6	23.6	11.4	28.1	27.0	10.0	20.5	17.6	11.1	22.9	21.6
Corduff 220 kV	15.7	26.8	22.1	14.9	29.8	27.7	13.7	16.0	13.0	13.5	19.5	17.8
Corraclassy 110 kV	4.3	7.1	6.7	5.5	5.3	5.2	4.3	6.4	5.8	5.4	4.9	4.8
Cow Cross 110 kV	4.1	14.0	12.9	4.7	11.1	10.9	4.5	10.3	9.2	5.0	9.2	8.8
Crane 110 kV	6.5	9.3	8.5	6.5	9.3	9.0	6.7	7.7	7.0	6.6	8.0	7.7
Cromcastle A 110 kV	11.9	12.4	10.8	7.1	13.2	12.5	12.0	10.0	8.9	7.4	11.2	10.7
Cromcastle B 110 kV	11.9	12.4	10.8	7.1	13.2	12.5	12.0	10.0	8.9	7.4	11.2	10.7
Cuilleen 110 kV	4.8	9.3	8.4	6.1	9.2	8.9	-	-	-	-	-	-
Cullenagh 110 kV	7.6	15.4	14.1	8.3	16.6	16.1	5.9	10.5	9.5	6.7	12.1	11.6
Cullenagh 220 kV	9.6	10.4	9.7	10.5	9.4	9.2	7.4	6.8	6.1	8.6	6.8	6.6
Cunghill 110 kV	3.1	6.0	5.4	4.3	5.0	4.9	3.0	5.0	4.5	4.1	4.5	4.3
Cushaling 110 kV	7.1	11.9	10.5	8.5	12.8	12.2	5.9	7.0	6.1	6.9	8.5	8.1
Dallow 110 kV	3.4	5.7	5.3	4.6	3.4	3.3	3.5	5.1	4.8	4.7	3.1	3.0
Dalton 110 kV	2.7	4.5	4.1	3.9	3.7	3.6	2.8	4.0	3.7	3.9	3.4	3.3
Dardistown 110 kV	15.6	12.6	11.0	11.9	13.8	13.1	15.1	10.1	9.0	12.0	11.6	11.0
Derrybrien 110 kV	3.0	5.0	4.3	4.4	4.4	4.2	3.1	4.6	3.9	4.5	4.1	3.9
Derryiron 110 kV	6.0	8.8	8.0	7.6	8.4	8.2	5.5	4.4	4.2	6.5	5.1	5.0
Doon 110 kV	4.3	8.4	7.7	4.7	6.2	6.1	3.5	6.3	5.8	3.9	4.5	4.4
Dromada 110 kV	4.9	6.2	5.2	4.4	6.3	5.9	4.9	5.1	4.4	5.3	3.6	3.4
Drumkeen 110 kV	3.8	7.5	6.3	4.9	6.3	6.0	3.9	6.6	5.5	5.0	5.8	5.5
Drumline 110 kV	3.2	8.4	7.6	4.2	5.6	5.5	3.4	7.1	6.4	4.3	5.2	5.0
Drybridge 110 kV	5.3	15.0	13.5	6.4	11.9	11.5	5.6	12.7	11.4	6.6	10.7	10.3
Dundalk 110 kV	3.4	9.3	8.6	4.5	8.3	8.1	3.6	8.3	7.6	4.6	7.6	7.4
Dunfirth 110 kV	4.7	6.2	5.9	6.4	4.8	4.7	4.8	5.0	4.8	6.4	4.2	4.2
Dungarvan 110 kV	5.7	6.5	6.1	6.6	3.9	3.8	3.8	5.1	4.8	4.8	3.2	3.2
Dunmanway 110 kV	3.4	6.7	6.0	4.6	5.3	5.2	3.6	5.7	5.1	4.7	4.8	4.6
Dunstown 220 kV	10.8	20.6	18.2	10.8	22.9	21.8	11.3	15.2	12.7	10.9	14.9	14.0
Dunstown 400 kV	17.2	7.5	7.0	20.6	8.0	7.8	19.6	4.1	3.8	15.8	3.8	3.7
Ennis 110 kV	3.7	10.5	9.1	5.0	9.0	8.6	3.9	8.8	7.6	5.1	7.9	7.6
Fassaroe East 110 kV	4.9	10.0	9.2	5.3	6.9	6.8	5.1	8.9	8.2	5.4	6.4	6.3
Fassaroe West 110 kV	4.6	10.0	9.2	5.1	6.9	6.7	4.8	8.8	8.2	5.2	6.4	6.2
Finglas 220 kV	17.1	26.9	21.9	15.8	30.8	28.3	14.4	16.0	12.9	14.2	19.8	18.1
Finglas A 110 kV	35.8	14.8	12.7	30.8	15.8	14.9	28.0	11.5	10.2	26.3	13.0	12.4

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]
Finglas B 110 kV	36.9	15.0	13.4	32.1	18.2	17.3	28.0	11.3	10.2	26.5	14.1	13.5
Flagford 110 kV	4.4	13.0	11.5	5.3	15.0	14.3	4.6	11.3	9.9	5.5	13.3	12.6
Flagford 220 kV	7.2	7.9	7.3	9.4	7.0	6.9	7.4	6.8	6.0	9.5	6.3	6.1
Francis Street A 110 kV	11.0	12.2	11.0	5.5	14.1	13.5	11.3	10.6	9.6	5.7	12.5	12.0
Francis Street B 110 kV	12.7	13.4	12.2	6.5	15.9	15.3	13.2	11.6	10.6	6.8	14.1	13.5
Galway 110 kV	4.4	12.9	11.6	5.1	13.1	12.6	4.6	10.3	9.3	5.2	11.1	10.7
Garrow 110 kV	4.9	6.9	6.0	4.7	7.1	6.7	5.1	6.2	5.3	4.9	6.4	6.1
Garvagh 110 kV	4.4	6.8	5.8	5.9	5.9	5.7	4.5	6.2	5.2	6.0	5.6	5.3
Gilra 110 kV	3.0	6.7	6.3	4.0	5.0	5.0	3.1	6.2	5.7	4.0	4.7	4.6
Glanagow 220 kV	15.3	18.1	15.3	14.2	20.6	19.3	11.0	10.2	8.4	11.2	13.0	11.9
Glanlee 110 kV	6.9	6.8	5.7	7.5	7.4	6.9	7.2	6.1	5.0	7.6	6.8	6.3
Glasmore 110 kV	4.7	7.6	6.8	5.2	5.1	4.9	4.9	6.4	5.9	5.3	4.6	4.5
Glenlara A 110 kV	4.2	4.5	3.5	4.2	4.6	4.2	3.4	3.4	2.8	5.2	2.5	2.4
Glenlara B 110 kV	4.2	4.5	3.5	4.2	4.6	4.2	3.4	3.4	2.8	5.2	2.5	2.4
Glenree 110 kV	3.3	4.9	4.5	4.3	3.9	3.8	2.8	3.7	3.4	3.6	3.2	3.2
Golagh 110 kV	3.1	4.9	4.4	4.1	3.1	3.0	3.2	4.4	3.9	4.1	2.9	2.8
Gorman 110 kV	6.1	15.9	14.3	7.1	16.8	16.2	6.4	13.5	12.0	7.4	14.8	14.2
Gorman 220 kV	8.5	12.4	11.4	9.8	9.7	9.5	9.1	10.3	9.1	10.2	8.6	8.3
Gortawee 110 kV	4.4	6.8	6.3	6.0	5.3	5.2	4.4	6.1	5.6	6.0	5.0	4.9
Grange 110 kV	12.9	12.7	11.1	4.3	12.5	11.9	12.8	10.2	9.1	4.5	10.7	10.2
Grange Castle 110 kV	12.6	14.0	12.1	8.8	17.0	16.0	13.0	11.9	10.5	9.1	14.8	14.0
Great Island 110 kV	8.4	17.3	15.6	9.3	21.0	20.1	5.9	10.3	9.3	6.5	13.4	12.8
Great Island 220 kV	13.3	14.4	13.1	14.8	15.8	15.3	7.6	7.4	6.6	8.9	8.1	7.8
Griffinrath A 110 kV	6.9	11.2	10.4	7.3	11.0	10.7	7.4	9.3	8.6	7.7	9.5	9.3
Griffinrath B 110 kV	7.4	11.6	10.8	7.4	11.0	10.7	8.0	9.5	8.9	7.9	9.5	9.3
Harolds 110 kV	11.1	12.3	11.0	5.2	14.1	13.5	11.5	10.6	9.6	5.4	12.5	12.0
Heuston 110 kV	13.8	13.7	12.4	7.8	16.4	15.8	14.3	11.8	10.8	8.2	14.5	13.9
Huntstown A 220 kV	16.2	25.8	21.1	13.4	29.6	27.3	14.1	15.6	12.6	12.9	19.3	17.6
Huntstown B 220 kV	14.9	23.7	20.0	11.3	26.8	25.1	13.0	14.5	11.9	11.2	17.7	16.3
Ikerrin 110 kV	5.0	5.2	4.7	5.8	3.7	3.6	4.6	4.6	4.1	5.4	3.2	3.1
Inchicore 220 kV	13.6	26.2	21.3	9.8	30.0	27.6	15.2	19.5	15.2	11.2	23.2	20.9
Inchicore A 110 kV	29.8	15.1	13.7	25.9	18.6	17.8	29.4	13.0	11.7	25.9	16.2	15.5
Inchicore B 110 kV	47.3	15.3	13.2	37.1	19.1	17.9	44.5	13.0	11.4	36.2	16.4	15.5
Inniscarra 110 kV	6.1	11.0	10.1	7.5	9.4	9.1	4.7	8.2	7.4	5.9	7.8	7.5
Irishtown 220 kV	15.0	24.6	20.2	11.4	28.8	26.5	16.8	19.5	15.2	13.2	23.5	21.1
Kellis 110 kV	6.1	10.6	9.9	7.2	12.1	11.7	6.1	7.9	7.3	7.1	9.4	9.1

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	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 220 kV	7.9	8.9	8.5	9.8	7.3	7.2	7.5	6.8	6.2	9.3	6.0	5.9
Kilbarry 110 kV	6.6	23.8	20.2	7.5	22.6	21.4	6.1	14.8	12.5	6.8	16.1	15.1
Kildonan 110 kV	8.6	20.6	18.8	5.8	16.4	16.0	8.7	16.5	14.6	6.0	14.3	13.7
Kilkenny 110 kV	4.3	8.0	7.5	5.1	8.8	8.6	3.0	4.6	4.4	4.2	4.3	4.2
Killonan 110 kV	6.1	20.7	18.0	7.5	21.2	20.2	6.1	15.4	13.1	7.4	16.9	15.9
Killonan 220 kV	7.5	11.4	10.4	9.8	10.3	10.0	7.7	8.7	7.6	9.7	8.5	8.1
Killoteran 110 kV	5.9	13.5	12.4	5.4	13.2	12.8	4.9	9.1	8.3	4.7	9.8	9.5
Kilmahud 110 kV	10.8	13.4	11.7	7.0	16.1	15.2	11.2	11.5	10.2	7.3	14.2	13.4
Kilmore 110 kV	15.0	13.0	11.3	9.3	13.9	13.2	14.6	10.4	9.3	9.5	11.7	11.2
Kilteel 110 kV	4.3	8.1	7.5	5.4	7.1	6.9	4.6	7.0	6.6	5.6	6.5	6.3
Kinnegad 110 kV	5.1	6.5	6.1	6.7	5.6	5.5	5.2	4.2	4.0	6.4	4.3	4.2
Knockacummer 110 kV	4.1	4.1	3.2	4.7	4.5	4.1	-	-	-	-	-	-
Knockearagh 110 kV	5.8	6.9	6.1	7.4	5.9	5.6	6.0	6.0	5.3	7.5	5.3	5.1
Knockraha A 110 kV	8.5	26.1	22.8	9.3	24.1	23.1	22.7	5.9	5.6	24.5	6.0	5.9
Knockraha A 220 kV	10.8	16.6	14.4	11.3	16.0	15.3	9.5	10.8	8.9	10.0	12.4	11.5
Knockraha B 110 kV	8.5	26.1	22.8	9.3	24.1	23.1	7.3	15.6	13.3	8.1	16.1	15.2
Knockraha B 220 kV	10.1	11.5	10.5	10.9	10.7	10.4	9.5	10.8	8.9	10.0	12.4	11.5
Knockumber 110 kV	3.6	8.9	8.2	4.5	6.4	6.3	3.8	8.0	7.4	4.6	6.0	5.9
Lanesboro 110 kV	3.7	10.9	9.8	4.9	10.8	10.4	3.9	9.7	8.7	5.2	9.9	9.6
Letterkenny110 kV	4.2	9.1	7.5	5.3	8.7	8.2	4.3	7.5	6.2	5.3	7.5	7.0
Liberty A 110 kV	5.5	19.9	17.3	4.7	20.4	19.4	5.4	12.9	11.1	4.7	14.8	14.0
Liberty B 110 kV	5.4	19.9	17.3	4.6	20.3	19.3	5.3	12.9	11.1	4.6	14.8	13.9
Limerick 110 kV	4.9	17.7	15.5	5.9	15.3	14.7	5.1	13.5	11.6	5.9	12.8	12.2
Lisdrum 110 kV	2.7	5.3	4.9	3.9	3.1	3.0	2.8	4.9	4.6	3.9	3.1	3.0
Lisheen 110 kV	4.0	4.4	3.8	3.4	6.5	6.0	3.8	4.0	3.4	3.3	5.8	5.4
Lodgewood 110 kV	8.7	9.6	8.9	8.9	11.3	10.9	8.6	8.0	7.3	8.8	9.6	9.2
Lodgewood 220 kV	8.9	8.4	7.9	10.1	7.7	7.6	8.4	6.3	5.7	9.6	6.2	6.0
Longpoint 220 kV	14.3	18.1	15.3	13.3	20.0	18.8	9.1	8.7	7.4	9.4	11.2	10.4
Louth 220 kV	9.3	19.0	16.9	10.6	17.7	17.1	9.7	14.1	11.8	10.8	14.4	13.5
Louth A 110 kV	6.6	13.8	12.6	7.6	16.1	15.5	6.8	12.1	10.8	7.9	14.4	13.8
Louth B 110 kV	7.0	14.9	13.6	7.9	17.6	17.0	7.2	12.8	11.5	8.1	15.6	14.9
Macetown 110 kV	7.2	20.0	18.2	7.1	18.8	18.2	7.4	16.2	14.3	7.3	16.1	15.4
Macroom 110 kV	6.6	14.0	12.5	7.5	11.1	10.7	6.3	10.7	9.4	7.0	9.3	8.9
Mallow 110 kV	4.0	7.3	6.6	5.7	5.7	5.5	3.6	6.0	5.4	5.2	4.9	4.8
Marina 110 kV	6.8	22.7	19.3	7.9	23.2	21.9	6.0	14.1	12.0	6.6	16.3	15.3
Maynooth A 110 kV	10.8	14.1	13.0	11.5	16.9	16.4	11.6	11.3	10.4	12.2	13.9	13.4

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik” [kA]	Ik’ [kA]	X/R Ratio	Ik” [kA]	Ik’ [kA]	X/R Ratio	Ik” [kA]	Ik’ [kA]	X/R Ratio	Ik” [kA]	Ik’ [kA]
Maynooth A 220 kV	9.6	19.3	17.0	9.5	17.5	16.8	10.7	14.9	12.4	10.9	13.9	13.1
Maynooth B 110 kV	7.7	18.6	17.1	9.5	17.2	16.8	8.4	15.3	13.7	10.0	14.9	14.4
Maynooth B 220 kV	9.7	22.6	19.7	9.5	20.3	19.4	11.0	16.7	13.7	10.8	15.7	14.7
McDermott 110 kV	16.5	13.8	12.2	5.8	15.4	14.7	15.5	10.4	9.4	6.3	12.3	11.8
Meath Hill 110 kV	3.8	9.6	8.8	5.1	7.6	7.4	4.0	8.5	7.8	5.2	7.0	6.9
Meentycat 110 kV	3.6	6.3	5.4	5.0	5.3	5.1	3.8	5.7	4.8	5.1	4.9	4.7
Midleton 110 kV	3.4	11.6	10.7	4.6	8.6	8.5	3.8	8.7	7.9	4.8	7.3	7.1
Milltown A 110 kV	15.0	13.2	11.8	7.1	15.4	14.7	15.3	11.4	10.2	7.4	13.5	13.0
Milltown B 110 kV	8.7	12.1	11.0	4.0	14.1	13.6	9.1	10.5	9.7	4.2	12.5	12.1
Misery Hill 110 kV	13.5	12.9	11.5	7.7	15.2	14.5	13.9	11.1	10.0	8.0	13.4	12.8
Moneteen 110 kV	5.2	12.1	10.9	6.2	8.6	8.4	5.4	10.1	8.9	6.3	7.7	7.5
Moneypoint 110 kV	2.7	2.5	2.3	3.9	1.7	1.7	2.7	2.4	2.2	3.9	1.6	1.6
Moneypoint 220 kV	12.8	10.3	9.4	10.3	10.0	9.7	11.6	7.7	6.8	10.5	8.1	7.7
Moneypoint G1 400 kV	21.4	7.6	6.9	17.3	7.5	7.2	14.0	3.7	3.5	14.0	4.3	4.2
Moneypoint G2 400 kV	29.4	3.9	3.6	23.8	4.1	4.0	23.3	3.5	3.1	21.6	3.8	3.7
Moneypoint G3 400 kV	21.4	7.6	6.9	17.3	7.5	7.2	14.0	3.7	3.5	14.0	4.3	4.2
Monread 110 kV	4.0	8.0	7.4	4.9	7.7	7.5	-	-	-	-	-	-
Mount Lucas 110 kV	4.8	8.1	7.5	6.0	7.7	7.5	4.2	6.8	6.4	5.1	6.9	6.8
Moy 110 kV	3.8	5.0	4.5	4.9	5.1	4.9	2.7	3.4	3.1	3.3	3.8	3.7
Mullagharlin 110 kV	3.5	9.4	8.7	4.6	8.8	8.6	3.7	8.4	7.8	4.7	8.1	7.9
Mullingar 110 kV	2.7	4.7	4.3	3.7	4.6	4.5	2.8	4.2	4.0	3.8	4.3	4.2
Mungret A 110 kV	4.9	11.4	10.4	5.9	8.0	7.8	5.1	9.6	8.5	6.0	7.2	7.0
Mungret B 110 kV	4.8	11.4	10.4	5.9	8.0	7.8	5.0	9.6	8.5	6.0	7.2	7.0
Nangor 110 kV	11.4	13.6	11.8	7.3	16.4	15.5	11.8	11.7	10.3	7.6	14.4	13.7
Navan 110 kV	5.2	13.9	12.5	6.2	13.0	12.6	5.5	12.0	10.7	6.4	11.7	11.2
Nenagh 110 kV	2.6	3.8	3.6	3.8	2.1	2.1	2.7	3.5	3.2	3.9	2.0	2.0
Newbridge 110 kV	4.1	10.7	9.7	4.9	9.9	9.6	4.4	8.5	7.8	5.1	8.5	8.2
Newbury 110 kV	14.1	12.9	11.2	6.9	13.5	12.8	13.8	10.3	9.2	7.2	11.4	10.9
Nore 110 kV	4.4	7.7	7.3	5.7	8.7	8.5	-	-	-	-	-	-
North Quays 110 kV	18.1	13.4	12.0	6.6	15.4	14.7	18.3	11.5	10.4	6.9	13.5	13.0
North Wall 220 kV	15.9	24.5	20.1	8.5	24.9	23.2	13.7	14.9	12.2	9.2	17.1	15.8
Oldcourt A 110 kV	3.6	11.5	10.7	4.4	8.3	8.2	4.0	8.8	8.0	4.6	7.1	6.9
Oldcourt B 110 kV	3.6	11.6	10.8	4.4	8.4	8.3	4.0	8.9	8.0	4.6	7.2	7.0
Oldstreet 220 kV	15.1	11.0	10.2	12.8	11.6	11.3	11.6	6.7	6.2	11.0	7.9	7.7
Oldstreet 400 kV	17.1	7.8	7.2	12.1	7.2	7.0	13.6	4.8	4.3	11.5	5.1	4.9
Oughtragh 110 kV	3.6	5.2	4.7	4.8	3.2	3.1	3.7	4.5	4.1	4.8	2.9	2.9

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	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]
Pelletstown 110 kV	13.7	12.9	11.5	7.6	13.2	12.7	13.6	9.9	9.0	8.0	10.8	10.5
Platin 110 kV	4.7	13.6	12.4	5.5	9.8	9.5	5.0	11.8	10.6	5.7	8.9	8.7
Pollaphuca 110 kV	3.2	3.2	3.0	4.7	2.6	2.6	2.8	2.4	2.3	4.0	2.2	2.2
Poolbeg A 220 kV	16.3	24.4	20.2	7.0	23.3	21.8	14.6	15.1	12.3	8.0	16.4	15.2
Poolbeg B 220 kV	13.0	24.0	19.9	9.2	25.6	23.8	14.2	18.1	14.3	10.4	20.3	18.5
Poppintree 110 kV	16.1	13.4	11.7	9.5	14.3	13.6	15.4	10.7	9.5	9.7	12.0	11.4
Portan 400 kV	58.3	3.9	3.8	44.8	4.4	4.4	44.6	3.4	3.2	36.6	3.7	3.7
Portlaoise 110 kV	3.7	9.2	8.5	5.2	7.2	7.1	4.0	7.4	6.8	5.4	6.3	6.2
Pottery 110 kV	12.6	17.4	15.3	4.1	16.4	15.7	13.2	14.7	12.9	4.3	14.5	13.9
Prospect 220 kV	11.5	13.3	11.8	10.3	13.1	12.6	10.2	8.9	7.7	10.0	9.5	9.0
Raffeen 220 kV	8.6	16.2	14.5	9.7	18.1	17.4	7.7	11.6	10.1	8.6	13.8	13.1
Raffeen A 110 kV	5.6	16.7	15.1	6.5	18.7	18.0	5.8	11.7	10.3	6.5	14.1	13.3
Raffeen B 110 kV	13.9	18.8	15.9	12.7	21.1	19.8	10.2	10.1	8.3	10.3	12.8	11.7
Rathkeale 110 kV	3.4	7.9	7.3	4.6	4.4	4.3	3.5	6.6	6.1	4.6	4.0	3.9
Ratrussan 110 kV	3.7	8.3	6.8	4.9	8.5	7.9	3.8	7.5	6.1	4.9	8.0	7.4
Reamore 110 kV	4.5	8.2	7.2	3.4	6.6	6.4	-	-	-	-	-	-
Richmond 110 kV	3.0	7.3	6.7	4.2	6.5	6.3	3.2	6.6	6.1	4.4	6.0	5.8
Rinawade 110 kV	4.7	11.3	10.7	5.9	8.0	7.8	5.0	9.6	8.9	6.0	7.2	7.1
Ringaskiddy 110 kV	5.7	13.1	12.0	6.2	12.1	11.7	5.8	9.9	8.8	6.2	9.9	9.5
Ringsend 110 kV	25.6	14.1	12.5	20.3	17.0	16.1	25.3	12.1	10.8	20.5	14.8	14.1
Ryebrook 110 kV	5.2	16.0	14.6	6.5	13.2	12.8	5.6	13.5	12.0	6.8	11.8	11.4
Salthill 110 kV	3.9	11.3	10.2	3.7	11.3	10.9	4.1	9.2	8.4	3.8	9.8	9.4
Seal Rock A 110 kV	7.6	10.5	9.3	9.4	11.0	10.5	8.1	9.4	8.1	9.8	10.3	9.7
Seal Rock B 110 kV	7.6	10.5	9.3	9.4	11.0	10.5	8.1	9.4	8.1	9.8	10.3	9.7
Shankill 110 kV	3.5	9.3	8.0	4.8	7.8	7.5	3.7	8.3	7.2	4.8	7.3	6.9
Shannonbridge 110 kV	6.2	17.9	15.8	7.8	19.3	18.4	6.4	15.6	13.4	8.0	17.3	16.3
Shannonbridge 220 kV	7.3	7.6	7.2	9.5	6.4	6.3	7.8	6.7	6.1	9.9	5.8	5.7
Shellybanks A 220 kV	15.9	24.4	20.1	6.9	26.8	24.9	14.4	15.1	12.3	8.1	18.1	16.6
Shellybanks B 220 kV	14.5	23.7	19.6	9.8	27.3	25.3	16.3	18.9	14.9	11.5	22.6	20.4
Shelton Abbey 110 kV	7.3	8.3	7.7	7.4	8.5	8.3	7.5	7.3	6.7	7.5	7.6	7.4
Singland 110 kV	6.0	16.9	14.9	7.1	15.4	14.8	5.8	12.8	11.1	6.9	12.8	12.2
Sligo 110 kV	3.6	10.0	8.8	4.6	8.9	8.6	3.7	8.4	7.3	4.6	7.9	7.5
Somerset 110 kV	2.9	8.3	7.8	4.0	5.2	5.1	3.1	7.5	6.9	4.1	4.8	4.7
Sorne Hill 110 kV	3.3	3.4	2.9	4.1	3.4	3.3	3.4	3.1	2.7	4.1	3.2	3.0
Srananagh 110 kV	4.4	11.8	10.2	5.4	12.2	11.6	4.5	9.9	8.4	5.4	10.6	10.0
Srananagh 220 kV	7.1	4.9	4.6	9.5	3.8	3.8	7.1	4.4	4.0	9.3	3.6	3.5

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2013 (continued)

Bus	Winter Peak 2013						Summer Valley 2013					
	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]
Stevenstown 110 kV	4.5	6.2	5.7	5.0	3.9	3.9	4.7	5.4	5.0	5.1	3.7	3.6
Stratford 110 kV	3.3	4.7	4.4	4.3	3.4	3.4	3.2	3.7	3.5	4.1	3.0	2.9
Suir 110 kV	4.6	10.6	9.3	5.9	10.7	10.2	-	-	-	-	-	-
Taney 110 kV	6.6	14.0	12.6	2.5	12.7	12.3	7.0	12.1	10.9	2.6	11.5	11.1
Tarbert 110 kV	12.0	22.0	18.8	14.0	20.4	19.4	9.2	14.4	12.3	11.0	15.4	14.5
Tarbert 220 kV	13.9	15.7	13.5	15.5	17.4	16.4	9.9	9.3	8.0	11.1	11.5	10.8
Tawnaghmore A 110 kV	3.7	4.2	3.8	4.9	3.9	3.8	2.6	2.8	2.6	3.3	3.0	2.9
Tawnaghmore B 110 kV	3.8	4.2	3.8	5.0	4.0	3.9	2.6	2.8	2.6	3.3	3.1	3.0
Thornsberry 110 kV	4.1	7.1	6.5	5.4	6.3	6.2	3.6	2.8	2.7	4.5	3.0	2.9
Thurles 110 kV	4.5	5.7	4.9	4.8	6.0	5.7	4.2	4.9	4.3	4.5	5.3	5.0
Tipperary 110 kV	3.0	7.6	7.0	4.0	4.7	4.6	3.0	6.1	5.6	4.0	3.6	3.6
Tonroe 110 kV	2.7	3.5	3.3	3.8	2.1	2.1	2.7	3.2	3.0	3.8	2.0	1.9
Trabeg 110 kV	6.8	22.3	19.1	7.6	22.4	21.2	6.0	13.9	11.9	6.1	16.1	15.1
Tralee 110 kV	5.0	10.9	9.2	6.2	8.5	8.1	5.3	8.6	7.4	6.4	7.4	7.0
Trien A 110 kV	4.8	10.1	8.4	6.1	9.0	8.5	5.0	8.0	6.7	6.3	6.7	6.4
Trien B 110 kV	4.8	10.1	8.4	6.1	9.0	8.5	5.0	8.0	6.7	6.3	6.7	6.4
Trillick 110 kV	3.3	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	1.8	2.8	2.5	2.3	3.9	1.7	1.7
Turlough 220 kV	10.5	13.0	11.7	12.0	11.3	11.0	10.9	10.6	9.1	12.4	9.8	9.4
Tynagh 220 kV	14.6	12.4	11.1	16.5	13.4	12.9	9.7	6.7	6.2	10.7	8.3	8.0
Waterford 110 kV	7.3	15.1	13.7	7.3	14.6	14.1	5.6	9.9	9.0	6.0	10.6	10.2
Wexford 110 kV	3.9	7.5	6.7	5.2	6.2	6.0	4.2	6.2	5.5	5.4	5.6	5.4
Whitegate 110 kV	4.2	10.7	10.0	5.1	10.5	10.3	4.5	8.2	7.5	5.3	8.7	8.4
Wolfe Tone 110 kV	14.4	13.4	12.0	5.3	14.8	14.2	13.9	10.2	9.3	5.8	11.9	11.5
Woodland 220 kV	12.1	24.4	21.1	12.1	24.6	23.4	12.5	16.3	13.5	12.3	17.9	16.7
Woodland 400 kV	20.9	8.9	8.3	21.5	9.0	8.8	18.9	6.2	5.6	19.5	6.7	6.4

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016

Bus	Winter Peak 2016						Summer Valley 2016					
	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	10.5	13.6	11.8	6.5	16.2	15.3	10.7	11.5	10.3	6.7	14.1	13.5
Agannygal 110 kV	3.0	6.5	5.7	4.3	4.9	4.8	3.1	6.0	5.2	4.4	4.6	4.4
Aghada 110 kV	4.6	10.0	9.4	5.7	11.2	11.0	4.8	7.9	7.3	5.8	9.2	9.0
Aghada A 220 kV	14.7	18.7	15.9	15.4	20.8	19.5	9.3	9.2	7.9	10.0	11.8	11.0
Aghada B 220 kV	14.5	17.8	15.2	12.0	20.1	18.9	10.7	10.3	8.6	10.2	12.9	11.9
Aghada C 220 kV	13.9	18.0	15.4	13.0	20.1	18.9	9.2	9.0	7.7	9.4	11.5	10.8
Aghada D 220 kV	14.7	18.7	15.9	15.4	20.8	19.5	9.3	9.2	7.9	10.0	11.8	11.0
Ahane 110 kV	5.0	14.3	13.2	5.9	10.9	10.7	5.1	11.7	10.5	5.9	9.6	9.3
Anner 110 kV	4.3	7.8	7.1	4.8	5.6	5.5	4.2	6.3	5.8	4.6	4.9	4.7
Ardnacrusha 110 kV	6.1	17.5	15.5	7.4	17.4	16.7	5.4	13.0	11.4	6.5	14.1	13.4
Ardnagappary 110 kV	2.8	2.3	2.1	4.1	1.3	1.3	2.8	2.1	1.9	4.1	1.2	1.2
Arigna 110 kV	3.8	8.0	7.2	5.0	5.6	5.4	3.9	7.3	6.4	5.0	5.2	5.1
Arklow 110 kV	10.6	9.6	8.9	11.5	11.5	11.1	10.2	8.1	7.5	10.9	9.9	9.6
Arklow 220 kV	8.9	8.6	8.0	10.2	7.7	7.5	8.9	7.1	6.5	10.1	6.7	6.5
Artane 110 kV	13.3	13.4	12.0	5.7	15.3	14.7	13.1	10.1	9.3	6.2	12.2	11.7
Arva 110 kV	3.7	10.3	9.3	4.9	7.4	7.2	3.8	9.3	8.3	5.0	6.9	6.7
Athea 110 kV	12.9	7.2	5.7	13.0	7.7	7.0	12.6	6.7	5.1	12.9	7.3	6.5
Athlone 110 kV	4.9	9.8	8.9	5.8	9.5	9.2	4.2	7.5	7.0	5.0	8.0	7.8
Athy 110 kV	3.0	6.7	6.3	4.2	5.3	5.2	3.2	5.7	5.4	4.3	4.7	4.7
Aughinish 110 kV	8.2	10.7	9.5	10.2	11.2	10.7	8.4	9.7	8.5	10.4	10.5	10.0
Ballakelly 220 kV	10.8	21.4	19.5	12.2	23.0	22.2	9.4	14.8	12.6	10.5	17.3	16.2
Ballybeg 110 kV	9.8	7.1	6.7	10.1	8.2	8.1	9.4	6.3	6.0	9.7	7.4	7.3
Ballydine 110 kV	4.2	8.4	7.7	3.9	6.3	6.2	4.2	6.8	6.3	3.9	5.6	5.4
Ballylickey 110 kV	3.0	3.7	3.4	4.2	2.1	2.0	3.2	3.3	3.1	4.2	1.9	1.9
Ballynahulla 110 kV	17.7	7.8	6.8	14.1	7.5	7.1	17.1	7.3	6.1	13.9	7.0	6.6
Ballynahulla 220 kV	8.2	9.4	8.5	8.2	9.3	9.0	8.7	7.8	6.5	8.6	8.0	7.6
Ballyvouskill 110 kV	16.5	7.8	6.9	15.1	8.0	7.6	15.9	7.0	6.0	14.7	7.4	6.9
Ballyvouskill 220 kV	8.3	9.7	8.7	9.0	10.3	9.9	8.8	8.0	6.7	9.3	8.9	8.3
Ballywater 110 kV	4.6	6.2	5.8	3.2	6.1	6.0	4.8	5.4	5.1	3.3	5.4	5.3
Baltrasna 110 kV	5.9	11.6	10.9	7.2	8.5	8.4	6.1	9.9	9.3	7.3	7.7	7.5
Bancroft 110 kV	12.2	13.2	12.1	6.8	15.1	14.6	10.9	14.1	12.6	6.1	15.2	14.6
Bandon 110 kV	3.1	7.2	6.6	4.5	5.4	5.3	3.3	6.0	5.5	4.6	5.0	4.8
Banoge 110 kV	5.9	6.6	6.2	6.8	5.6	5.5	6.1	5.7	5.4	6.8	5.1	5.0
Barnahealy A 110 kV	5.4	14.5	13.3	6.1	14.1	13.7	5.7	10.7	9.6	6.3	11.3	10.9
Barnahealy B 110 kV	6.7	14.0	12.8	7.4	13.4	13.0	6.8	10.5	9.4	7.4	10.9	10.5
Baroda 110 kV	3.8	9.4	8.6	4.6	10.7	10.3	4.0	7.9	7.3	4.7	9.3	9.0

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Barrymore 110 kV	3.6	8.8	8.3	5.3	6.5	6.4	3.8	7.0	6.6	5.3	5.7	5.6
Bellacorick 110 kV	3.8	4.7	4.2	5.0	4.4	4.3	3.7	3.7	3.3	4.7	3.7	3.6
Binbane 110 kV	3.4	5.1	4.4	5.0	4.3	4.1	3.5	4.6	4.0	4.9	4.1	3.9
Blackpool 110 kV	7.6	24.2	20.8	7.7	23.4	22.2	7.2	15.2	13.0	7.5	16.7	15.8
Blackrock 110 kV	11.0	11.7	10.5	2.8	10.1	9.7	8.5	13.3	11.9	2.3	11.2	10.9
Blake 110 kV	3.8	8.7	8.2	4.9	5.8	5.7	3.9	7.5	7.0	5.0	5.2	5.2
Boggeragh 110 kV	16.7	4.1	3.5	17.5	4.3	4.0	16.4	3.9	3.3	17.3	4.1	3.8
Booltiagh 110 kV	6.2	8.1	7.4	7.8	6.7	6.5	3.6	6.8	6.0	4.9	5.6	5.4
Bracklone 110 kV	3.6	9.0	8.3	4.6	8.1	7.9	3.7	7.5	7.0	4.7	7.2	7.0
Brinny A 110 kV	3.0	6.4	5.9	4.3	4.6	4.5	3.2	5.4	5.0	4.4	4.2	4.1
Brinny B 110 kV	3.0	6.4	5.9	4.3	4.6	4.5	3.2	5.5	5.0	4.4	4.2	4.1
Butlerstown 110 kV	5.9	11.6	10.7	6.0	11.2	10.9	5.8	9.0	8.3	5.9	9.2	8.9
Cabra 110 kV	12.1	12.9	11.5	4.6	13.6	13.1	12.2	9.8	9.0	5.0	11.0	10.6
Cahir 110 kV	5.8	12.2	10.7	6.5	11.2	10.8	4.8	8.7	7.7	5.5	9.1	8.7
Carlow 110 kV	5.1	9.9	9.2	6.0	10.1	9.8	5.1	7.5	6.9	5.9	8.2	7.9
Carrickmines 220 kV	13.9	22.8	19.2	8.8	26.4	24.7	14.7	17.9	14.6	9.2	21.3	19.6
Carrickmines A 110 kV	31.8	13.6	12.1	25.1	14.4	13.8	22.5	16.1	14.1	17.2	17.7	16.9
Carrickmines B 110 kV	25.3	14.7	13.5	21.0	17.3	16.7	22.5	16.1	14.1	17.2	17.7	16.9
Carrick-on-Shannon 110 kV	4.1	12.8	11.4	4.9	13.1	12.6	4.3	11.3	10.0	5.1	11.9	11.3
Carrigadrohid 110 kV	7.4	14.0	12.6	8.7	12.2	11.9	6.9	10.1	9.0	7.6	8.7	8.4
Carrowbeg 110 kV	2.7	3.0	2.7	3.7	2.7	2.6	2.7	2.7	2.5	3.7	2.5	2.4
Cashla 110 kV	7.1	19.9	17.3	7.9	23.6	22.2	7.0	16.2	14.0	7.7	19.8	18.5
Cashla 220 kV	8.4	12.6	11.4	10.0	12.0	11.6	8.5	9.3	8.3	9.8	9.6	9.2
Castlebar 110 kV	3.3	5.7	4.9	4.4	5.7	5.4	3.3	4.9	4.3	4.3	5.2	4.9
Castledockrill 110 kV	6.9	8.2	7.7	4.7	9.4	9.1	7.0	7.1	6.6	4.8	8.2	7.9
Castlefarm A 110 kV	7.3	10.3	9.2	8.8	10.4	10.0	7.6	9.4	8.2	9.1	9.8	9.3
Castlefarm B 110 kV	7.3	10.3	9.2	8.9	10.4	10.0	7.6	9.4	8.2	9.1	9.8	9.3
Castleview 110 kV	3.8	14.4	13.2	4.5	9.9	9.7	4.2	10.6	9.5	4.8	8.2	8.0
Cathaleen's Fall 110 kV	5.6	11.7	9.4	6.2	10.9	10.2	4.9	9.2	7.5	5.6	9.5	8.8
Caulstown 110 kV	5.1	14.5	13.2	5.8	9.7	9.5	4.9	11.4	10.5	5.6	8.4	8.3
Cauteen 110 kV	5.8	8.7	8.0	6.7	5.3	5.2	5.7	7.5	6.8	6.6	4.8	4.7
Central 110 kV	14.4	12.3	11.0	7.6	12.8	12.3	10.9	14.2	12.7	5.8	15.2	14.5
Charleville 110 kV	4.4	6.7	6.2	5.9	4.6	4.5	4.6	5.9	5.4	5.9	4.2	4.1
Cherrywood 110 kV	10.2	11.4	10.2	7.5	11.1	10.7	8.0	12.8	11.5	5.8	12.7	12.3
City West 110 kV	5.9	8.7	7.7	6.0	6.1	6.0	6.1	7.4	6.8	6.1	5.6	5.5
Clahane 110 kV	4.2	8.5	7.6	5.4	7.2	7.0	4.4	7.5	6.6	5.9	6.2	6.0

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	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]
Clashavoon 220 kV	8.7	10.6	9.5	9.3	10.6	10.2	8.8	8.4	7.1	9.3	8.9	8.4
Clashavoon A 110 kV	8.3	14.8	13.4	9.6	13.0	12.6	8.2	11.3	10.0	9.4	10.6	10.1
Clashavoon B 110 kV	27.8	4.7	4.2	29.2	5.5	5.2	25.7	4.5	3.9	27.3	5.1	4.9
Cliff 110 kV	4.8	8.6	7.3	5.7	7.2	6.9	4.3	6.9	5.9	5.2	6.4	6.1
Clogher 110 kV	5.3	9.9	7.9	5.5	9.5	8.8	5.1	8.6	6.7	5.4	8.8	8.0
Cloghran 110 kV	6.5	18.4	17.0	6.7	16.0	15.6	6.7	14.9	13.4	6.8	13.9	13.4
Clonkeen A 110 kV	5.7	6.3	5.9	7.0	4.3	4.3	5.9	5.6	5.2	7.1	4.0	3.9
Clonkeen B 110 kV	8.7	6.2	5.3	7.4	6.8	6.3	8.8	5.8	4.8	7.5	6.4	5.9
Cloon 110 kV	4.2	8.5	7.8	5.8	7.0	6.8	4.3	7.5	6.8	5.8	6.4	6.2
College Park 110 kV	9.2	24.1	21.9	6.3	25.2	24.3	9.0	18.7	16.6	6.5	20.6	19.7
Cookstown A 110 kV	7.1	9.1	8.6	5.9	7.6	7.4	6.5	9.3	8.7	5.6	7.4	7.2
Cookstown B 110 kV	5.0	7.5	6.7	5.4	5.0	4.8	5.1	6.5	6.0	5.4	4.6	4.5
Coolroe 110 kV	6.4	11.7	10.7	7.9	10.3	10.0	6.3	8.8	8.0	7.6	8.5	8.2
Coomagearlahy 110 kV	8.7	5.6	4.6	9.0	6.5	6.0	8.8	5.3	4.3	9.1	6.2	5.6
Cordal 110 kV	11.7	6.0	5.4	9.7	4.6	4.5	11.8	5.7	4.9	9.8	4.4	4.2
Corderry 110 kV	4.0	9.2	7.8	5.3	8.1	7.7	4.2	8.3	6.9	5.4	7.5	7.1
Corduff 110 kV	10.3	27.4	24.6	11.5	28.8	27.7	9.7	20.9	18.2	10.8	23.2	22.0
Corduff 220 kV	15.7	27.8	23.2	14.8	30.7	28.6	13.3	16.7	13.8	13.1	20.2	18.6
Corraclassy 110 kV	4.3	7.2	6.7	5.5	5.3	5.2	4.3	6.6	6.1	5.5	5.0	4.9
Cow Cross 110 kV	4.4	14.4	13.2	5.0	11.7	11.4	4.8	10.6	9.6	5.3	9.7	9.3
Crane 110 kV	6.6	9.2	8.4	6.5	9.2	8.9	6.7	7.8	7.1	6.6	8.0	7.8
Cromcastle A 110 kV	11.9	12.5	10.9	7.1	13.3	12.6	11.8	9.9	8.9	7.4	11.1	10.7
Cromcastle B 110 kV	11.9	12.5	10.9	7.1	13.3	12.6	11.8	9.9	8.9	7.4	11.1	10.7
Cuilleen 110 kV	4.7	9.4	8.6	6.0	9.3	9.0	4.0	7.1	6.7	5.0	7.8	7.6
Cullenagh 110 kV	7.3	14.4	13.3	7.8	16.0	15.5	6.8	10.8	9.9	7.2	12.7	12.2
Cullenagh 220 kV	10.0	10.3	9.6	7.9	9.9	9.7	7.9	7.1	6.5	7.1	7.6	7.3
Cunghill 110 kV	4.7	6.6	5.9	6.4	5.5	5.3	4.5	5.6	4.9	6.0	5.0	4.8
Cushaling 110 kV	6.8	12.1	10.7	8.2	13.0	12.4	5.6	8.7	7.8	6.6	10.4	9.9
Dallow 110 kV	3.4	5.7	5.4	4.6	3.4	3.3	3.5	5.2	4.9	4.7	3.1	3.1
Dalton 110 kV	2.8	4.7	4.3	4.0	3.7	3.6	2.8	4.2	3.9	4.0	3.5	3.4
Dardistown 110 kV	15.6	12.7	11.1	11.9	13.8	13.2	14.9	10.1	9.1	11.9	11.5	11.0
Derrybrien 110 kV	3.1	5.3	4.5	4.6	4.5	4.3	3.2	5.0	4.2	4.7	4.3	4.1
Derryiron 110 kV	5.6	10.5	9.7	7.2	10.0	9.7	4.7	7.4	7.0	5.8	7.9	7.7
Doon 110 kV	4.8	8.7	7.9	5.0	6.4	6.2	4.5	6.9	6.3	4.9	5.5	5.4
Dromada 110 kV	8.8	6.5	5.2	5.8	6.8	6.3	8.8	6.1	4.7	5.9	6.5	5.8
Drumkeen 110 kV	4.6	8.2	6.7	5.6	7.0	6.6	4.6	7.5	6.1	5.6	6.6	6.1

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	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]
Drumline 110 kV	3.3	9.0	8.3	4.4	7.7	7.5	3.3	7.7	7.0	4.3	7.0	6.8
Drybridge 110 kV	5.3	16.0	14.5	6.5	12.3	12.0	5.4	12.9	11.7	6.5	10.7	10.4
Dundalk 110 kV	3.4	9.6	8.9	4.5	8.4	8.3	3.5	8.4	7.7	4.5	7.6	7.4
Dunfirth 110 kV	4.5	6.8	6.6	6.3	5.1	5.1	4.6	6.0	5.7	6.2	4.7	4.7
Dungarvan 110 kV	5.7	6.5	6.1	6.5	3.9	3.9	5.8	5.4	5.1	6.5	3.5	3.5
Dunmanway 110 kV	4.3	9.0	8.1	5.6	7.0	6.8	4.7	7.4	6.6	5.8	6.2	6.0
Dunstown 220 kV	10.9	21.8	19.5	10.8	23.9	22.9	10.9	15.9	13.5	11.0	18.4	17.2
Dunstown 400 kV	16.6	8.2	7.7	19.6	8.6	8.4	16.4	5.7	5.1	19.2	6.4	6.2
Ennis 110 kV	4.2	12.6	11.3	5.5	10.5	10.2	3.9	10.6	9.3	5.1	9.3	8.9
Fassaroe 110 kV	8.2	11.6	10.8	7.4	10.6	10.4	7.4	12.2	11.0	6.8	10.5	10.2
Fassaroe East 110 kV	5.1	8.6	8.1	5.3	6.4	6.3	4.7	8.7	8.1	5.1	6.2	6.1
Fassaroe West 110 kV	5.2	8.8	8.2	5.4	6.6	6.5	4.8	8.9	8.2	5.2	6.4	6.3
Finglas 220 kV	17.1	27.7	22.8	15.7	31.7	29.3	14.0	16.6	13.6	13.8	20.6	18.9
Finglas A 110 kV	36.1	14.9	12.9	30.9	15.9	15.0	27.9	11.5	10.2	26.2	12.9	12.4
Finglas B 110 kV	37.2	15.2	13.5	32.3	18.3	17.4	27.9	11.3	10.3	26.3	14.1	13.6
Flagford 110 kV	4.4	13.4	11.9	5.3	15.4	14.7	4.6	11.8	10.4	5.5	13.8	13.1
Flagford 220 kV	7.4	8.2	7.6	9.7	7.2	7.1	7.6	7.1	6.4	9.8	6.5	6.3
Francis Street A 110 kV	10.5	14.0	12.6	5.0	16.2	15.5	10.7	12.2	11.0	5.2	14.4	13.8
Francis Street B 110 kV	12.7	13.6	12.5	6.4	16.2	15.6	13.0	11.7	10.8	6.7	14.2	13.7
Galway 110 kV	5.0	15.5	13.3	5.6	15.4	14.6	5.2	13.1	11.2	5.8	13.5	12.8
Garrow 110 kV	12.7	6.8	5.9	11.1	7.3	6.9	12.7	6.3	5.2	11.1	6.8	6.4
Garvagh 110 kV	4.5	6.9	5.9	6.0	6.0	5.7	4.6	6.3	5.4	6.1	5.6	5.3
Gilra 110 kV	3.0	6.8	6.4	4.0	5.1	5.0	3.1	6.3	5.8	4.0	4.8	4.7
Glanagow 220 kV	15.2	18.5	15.7	14.1	21.0	19.6	11.1	10.6	8.8	11.2	13.4	12.3
Glanlee 110 kV	8.5	5.5	4.5	8.2	6.3	5.9	8.6	5.2	4.2	8.3	6.0	5.5
Glasmore 110 kV	4.7	7.6	6.8	5.2	5.1	4.9	4.9	6.3	5.8	5.3	4.6	4.5
Glenlara A 110 kV	3.2	3.1	2.8	4.8	2.5	2.4	3.2	2.9	2.6	4.8	2.3	2.3
Glenlara B 110 kV	11.0	5.8	4.9	7.6	5.7	5.4	11.1	5.5	4.5	7.6	5.5	5.2
Glenree 110 kV	5.0	5.5	4.9	6.0	4.2	4.1	4.6	4.3	3.8	5.4	3.6	3.5
Golagh 110 kV	3.9	7.3	6.1	4.5	5.6	5.3	4.0	6.5	5.3	4.5	5.2	4.9
Gorman 110 kV	6.0	16.7	15.2	7.1	17.5	16.9	6.3	13.8	12.4	7.3	15.1	14.5
Gorman 220 kV	8.7	13.1	12.3	9.8	10.2	10.0	8.9	10.7	9.5	9.8	8.9	8.6
Gortawee 110 kV	4.4	6.8	6.3	6.0	5.3	5.2	4.4	6.3	5.8	6.0	5.0	4.9
Grange 110 kV	12.9	12.8	11.2	4.2	12.6	12.0	12.7	10.1	9.1	4.5	10.6	10.2
Grange Castle 110 kV	12.6	14.3	12.4	8.7	17.3	16.3	12.9	12.1	10.7	9.0	15.0	14.2
Great Island 110 kV	6.8	14.3	13.2	7.5	18.1	17.4	6.2	10.5	9.6	6.8	13.7	13.1

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	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]
Great Island 220 kV	11.1	12.8	11.8	12.2	14.7	14.2	7.9	7.6	6.9	8.6	9.6	9.2
Griffinrath A 110 kV	6.7	11.5	10.8	7.1	11.2	11.0	6.9	9.7	9.1	7.3	9.8	9.6
Griffinrath B 110 kV	7.2	11.9	11.1	7.3	11.2	10.9	7.4	10.0	9.4	7.5	9.8	9.6
Harolds 110 kV	10.6	14.1	12.6	4.7	16.2	15.5	10.9	12.2	11.1	4.9	14.3	13.8
Hartnett's Cross 110 kV	4.4	10.4	9.6	5.5	7.9	7.7	4.7	8.1	7.4	5.7	6.5	6.3
Heuston 110 kV	13.9	13.9	12.7	7.8	16.7	16.1	14.1	12.0	11.0	8.1	14.6	14.1
Huntstown A 220 kV	16.2	26.6	22.0	13.3	30.4	28.2	13.7	16.2	13.3	12.5	20.1	18.4
Huntstown B 220 kV	14.9	24.4	20.8	11.2	27.5	25.8	12.7	15.0	12.6	10.8	18.3	17.0
Ikerrin 110 kV	5.9	6.0	5.3	6.5	3.9	3.8	6.0	5.5	4.9	6.5	3.7	3.5
Inchicore 220 kV	13.8	27.8	22.9	9.5	31.8	29.4	14.7	20.8	16.6	10.8	24.9	22.6
Inchicore A 110 kV	30.7	15.4	14.0	26.3	19.0	18.2	29.5	13.1	12.0	25.9	16.4	15.8
Inchicore B 110 kV	50.1	15.7	13.5	38.3	19.5	18.3	45.3	13.1	11.6	36.5	16.6	15.7
Inniscarra 110 kV	6.5	11.4	10.4	7.8	9.7	9.5	6.3	8.5	7.8	7.5	8.1	7.9
Irishtown 220 kV	15.2	25.8	21.3	11.3	30.3	28.0	16.3	20.5	16.3	12.3	24.7	22.4
Kellis 110 kV	6.1	10.6	9.9	7.1	12.1	11.8	6.0	7.9	7.4	6.9	9.5	9.2
Kellis 220 kV	7.9	8.8	8.4	9.7	7.3	7.2	7.4	6.9	6.3	9.1	6.1	6.0
Kilbarry 110 kV	7.7	24.6	21.0	8.5	24.0	22.8	7.3	15.4	13.1	8.0	17.0	16.0
Kildonan 110 kV	8.6	21.0	19.3	5.8	16.6	16.2	8.5	16.7	14.9	5.9	14.3	13.8
Kilkenny 110 kV	4.4	7.9	7.4	5.2	8.8	8.5	2.9	4.6	4.4	3.4	5.7	5.6
Kill Hill 110 kV	6.3	7.9	6.9	7.2	6.2	6.0	5.9	6.7	5.9	6.8	5.6	5.4
Killonan 110 kV	6.9	21.5	19.0	8.4	21.8	20.9	6.7	16.3	14.0	8.0	17.7	16.7
Killonan 220 kV	7.7	12.0	11.0	10.1	10.6	10.4	7.8	9.2	8.1	9.9	8.9	8.5
Killoteran 110 kV	5.7	12.3	11.3	5.3	12.5	12.1	5.6	9.4	8.6	5.3	10.1	9.8
Kilmahud 110 kV	10.8	13.7	11.9	7.0	16.4	15.5	11.0	11.6	10.3	7.2	14.3	13.6
Kilmore 110 kV	15.0	13.1	11.4	9.3	14.0	13.3	14.5	10.4	9.3	9.5	11.6	11.1
Kilpaddoge 110 kV	12.7	20.1	17.8	12.8	24.4	23.2	-	-	-	-	-	-
Kilpaddoge A 220 kV	15.8	23.7	20.3	12.9	28.3	26.5	10.0	11.3	9.4	10.2	13.6	12.6
Kilpaddoge B 220 kV	15.8	23.7	20.3	12.9	28.3	26.5	9.4	10.6	9.0	9.8	12.2	11.4
Kilteel 110 kV	4.2	8.3	7.7	5.3	7.2	7.1	4.3	7.1	6.7	5.4	6.5	6.4
Kinnegad 110 kV	4.6	9.1	8.6	6.1	7.6	7.5	4.4	7.3	6.9	5.8	6.6	6.5
Knockacummer 110 kV	7.8	5.1	4.3	7.6	5.4	5.1	7.9	4.9	4.1	7.7	5.2	4.9
Knockavanna 110 kV	3.1	5.6	4.8	4.6	4.6	4.4	3.2	5.2	4.4	4.6	4.3	4.1
Knockearagh 110 kV	5.5	6.1	5.6	7.5	5.0	4.8	5.6	5.4	4.9	7.6	4.5	4.4
Knockmullen 110 kV	4.2	6.2	5.9	5.1	4.2	4.1	4.2	5.2	4.9	5.1	3.7	3.6
Knocknagoshel 110 kV	10.1	5.9	4.5	11.6	6.5	5.8	10.1	5.6	4.1	11.6	6.2	5.5
Knocknagreenan 110 kV	7.1	13.9	12.6	8.4	12.2	11.8	-	-	-	-	-	-

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]
Knockraha A 110 kV	9.0	26.8	23.5	9.7	25.1	24.1	23.3	6.0	5.7	24.9	6.1	6.0
Knockraha A 220 kV	10.6	17.3	15.0	11.1	16.7	15.9	9.4	11.4	9.5	9.8	13.2	12.2
Knockraha B 110 kV	9.0	26.8	23.5	9.7	25.1	24.1	8.0	16.3	14.0	8.8	17.0	16.1
Knockraha B 220 kV	10.2	11.6	10.6	10.9	10.9	10.6	9.4	11.4	9.5	9.8	13.2	12.2
Knockumber 110 kV	3.5	9.1	8.5	4.5	6.5	6.4	3.7	8.1	7.5	4.6	6.0	5.9
Lanesboro 110 kV	3.6	11.7	10.6	4.8	11.3	10.9	3.8	10.4	9.4	5.0	10.4	10.1
Letterkenny110 kV	4.6	9.8	7.9	5.7	9.3	8.7	4.7	8.8	7.0	5.7	8.6	8.0
Liberty A 110 kV	6.1	20.5	17.9	5.0	21.4	20.3	6.2	13.4	11.7	5.3	15.5	14.7
Liberty B 110 kV	6.0	20.5	17.8	4.8	21.3	20.2	6.1	13.4	11.6	5.1	15.5	14.6
Limerick 110 kV	5.1	18.2	16.1	6.1	15.7	15.1	5.2	14.2	12.3	6.1	13.2	12.6
Lisdrum 110 kV	2.7	5.5	5.1	3.8	3.2	3.1	2.8	5.0	4.7	3.9	3.1	3.0
Lisheen 110 kV	5.0	5.4	4.5	4.0	7.9	7.2	5.1	5.0	4.2	4.1	7.4	6.7
Lodgewood 110 kV	8.8	9.5	8.8	9.0	11.2	10.8	8.7	8.0	7.4	8.9	9.6	9.3
Lodgewood 220 kV	8.8	8.2	7.7	10.0	7.6	7.5	8.4	6.4	5.9	9.5	6.3	6.1
Longpoint 220 kV	14.2	18.4	15.7	13.2	20.3	19.1	9.1	9.1	7.8	9.4	11.5	10.8
Louth 220 kV	10.9	22.2	20.0	12.5	23.6	22.7	9.6	15.3	12.9	10.8	17.8	16.6
Louth A 110 kV	6.7	14.5	13.4	7.8	17.0	16.4	6.7	12.4	11.2	7.7	14.8	14.2
Louth B 110 kV	7.2	15.7	14.5	8.2	18.8	18.2	7.1	13.2	11.9	8.0	16.1	15.5
Macetown 110 kV	7.1	20.5	18.8	7.1	19.0	18.5	7.3	16.4	14.6	7.2	16.2	15.6
Macroom 110 kV	7.5	15.1	13.5	8.6	13.2	12.8	7.1	11.0	9.7	8.0	9.9	9.5
Mallow 110 kV	5.1	7.2	6.7	7.0	5.7	5.6	5.2	6.1	5.7	7.0	5.1	5.0
Marina 110 kV	7.9	23.4	20.0	9.0	24.4	23.1	7.2	14.7	12.6	8.1	17.1	16.1
Maynooth A 110 kV	10.4	14.6	13.5	11.1	17.4	16.9	10.6	12.1	11.2	11.3	14.7	14.3
Maynooth A 220 kV	9.5	20.2	18.0	9.4	18.1	17.5	10.1	15.7	13.3	9.9	15.0	14.2
Maynooth B 110 kV	7.6	19.1	17.7	9.3	17.5	17.1	8.0	15.8	14.3	9.7	15.2	14.7
Maynooth B 220 kV	9.7	23.5	20.8	9.4	20.9	20.1	10.4	17.4	14.6	10.0	16.8	15.8
McDermott 110 kV	16.5	13.9	12.4	5.8	15.5	14.8	15.3	10.4	9.5	6.3	12.2	11.8
Meath Hill 110 kV	3.8	9.9	9.1	5.1	7.8	7.6	3.9	8.6	7.9	5.1	7.1	6.9
Meentycat 110 kV	4.1	6.8	5.7	5.5	5.7	5.4	4.2	6.3	5.2	5.5	5.4	5.1
Midleton 110 kV	3.4	11.7	10.9	4.6	8.7	8.6	3.8	8.9	8.2	4.8	7.4	7.2
Milltown A 110 kV	14.9	15.3	13.7	6.6	17.9	17.1	15.1	13.2	11.9	6.8	15.8	15.2
Milltown B 110 kV	8.7	12.3	11.3	4.0	14.3	13.8	9.0	10.6	9.8	4.1	12.6	12.2
Misery Hill 110 kV	13.2	14.9	13.3	7.2	17.7	16.9	13.5	12.9	11.6	7.5	15.6	14.9
Moneteen 110 kV	5.3	12.3	11.2	6.3	8.7	8.5	5.4	10.4	9.3	6.3	7.8	7.6
Moneypoint 110 kV	15.3	10.2	9.6	17.9	9.9	9.7	8.8	8.2	7.5	10.8	8.1	7.8
Moneypoint 220 kV	16.6	23.1	20.0	14.2	27.8	26.2	10.2	11.0	9.2	10.1	13.3	12.4

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]
Moneypoint G1 400 kV	24.3	13.6	12.1	24.8	15.2	14.6	13.3	4.1	3.8	13.0	4.7	4.6
Moneypoint G2 400 kV	24.3	13.6	12.1	24.8	15.2	14.6	24.9	4.0	3.6	26.2	4.6	4.4
Moneypoint G3 400 kV	24.3	13.6	12.1	24.8	15.2	14.6	13.3	4.1	3.8	13.0	4.7	4.6
Monread 110 kV	3.9	8.2	7.6	4.8	7.9	7.7	4.1	7.0	6.6	4.9	7.1	6.9
Mount Lucas 110 kV	4.5	8.3	7.7	5.9	7.8	7.6	4.5	6.6	6.1	5.6	6.7	6.5
Moy 110 kV	5.2	5.6	4.9	6.6	5.5	5.3	3.9	3.8	3.4	4.8	4.2	4.0
Mullagharlin 110 kV	3.5	9.8	9.1	4.6	9.1	8.9	3.6	8.5	7.9	4.7	8.2	8.0
Mullingar 110 kV	3.4	7.7	7.2	4.9	7.0	6.8	3.5	6.6	6.3	4.8	6.3	6.2
Mulreavy 110 kV	4.7	8.6	6.8	5.3	8.7	8.0	4.7	7.6	5.9	5.2	8.1	7.3
Mungret A 110 kV	5.0	11.6	10.6	6.0	8.0	7.9	5.1	9.8	8.9	6.0	7.3	7.1
Mungret B 110 kV	5.0	11.6	10.6	6.0	8.0	7.9	5.1	9.9	8.9	6.0	7.3	7.1
Nangor 110 kV	11.4	13.9	12.1	7.2	16.8	15.8	11.6	11.8	10.5	7.5	14.5	13.8
Navan 110 kV	5.1	14.5	13.2	6.1	13.4	13.0	5.4	12.2	11.0	6.3	11.8	11.4
Nenagh 110 kV	2.6	3.9	3.6	3.9	2.1	2.1	2.7	3.5	3.3	3.9	2.0	2.0
Newbridge 110 kV	4.0	11.3	10.3	4.7	10.9	10.5	4.2	9.2	8.5	4.9	9.4	9.1
Newbury 110 kV	14.0	13.0	11.3	6.9	13.5	12.9	13.7	10.3	9.2	7.1	11.3	10.8
Nore 110 kV	4.5	7.7	7.2	5.7	8.6	8.4	2.9	4.4	4.2	3.4	5.5	5.4
North Kerry 220 kV	9.2	13.7	12.1	8.5	13.0	12.5	9.2	9.2	7.7	8.9	9.6	9.0
North Kerry A 110 kV	4.8	9.4	8.5	5.8	7.3	7.1	4.3	6.1	5.5	6.2	4.1	4.0
North Kerry B 110 kV	21.1	9.6	7.6	17.4	9.8	9.0	18.5	8.6	6.5	16.3	8.9	8.0
North Quays 110 kV	18.7	15.6	13.9	6.1	17.9	17.1	18.7	13.5	12.1	6.3	15.8	15.2
North Wall 220 kV	15.8	25.1	20.9	8.4	25.5	23.9	13.3	15.5	12.9	9.0	17.6	16.3
Oldcourt A 110 kV	3.8	11.8	11.0	4.6	8.7	8.5	4.2	9.1	8.3	4.8	7.4	7.2
Oldcourt B 110 kV	3.8	11.9	11.0	4.6	8.8	8.6	4.2	9.1	8.3	4.8	7.5	7.3
Oldstreet 220 kV	15.6	11.7	10.8	12.8	12.2	11.9	11.7	7.1	6.6	11.0	8.2	8.0
Oldstreet 400 kV	16.3	9.2	8.6	10.8	8.1	8.0	13.3	5.1	4.6	11.2	5.3	5.1
Oughtragh 110 kV	3.6	5.0	4.6	4.8	3.1	3.0	3.8	4.5	4.1	4.9	2.9	2.8
Pelletstown 110 kV	13.7	13.0	11.6	7.5	13.3	12.8	13.5	9.9	9.1	8.0	10.8	10.4
Platin 110 kV	5.0	14.9	13.6	5.8	10.2	10.0	4.9	11.8	10.8	5.6	8.9	8.7
Pollaphuca 110 kV	3.2	3.2	3.0	4.7	2.6	2.6	2.7	2.4	2.4	4.0	2.2	2.2
Poolbeg A 220 kV	16.3	25.1	21.0	7.0	23.8	22.4	14.2	15.7	13.0	7.9	16.9	15.7
Poolbeg B 220 kV	13.4	25.6	21.4	9.3	27.2	25.4	14.0	19.4	15.7	10.2	21.7	19.9
Poppintree 110 kV	16.1	13.5	11.8	9.5	14.4	13.7	15.3	10.6	9.5	9.6	11.9	11.4
Portan 400 kV	58.4	4.0	3.9	44.4	4.5	4.5	44.5	3.4	3.3	36.4	3.8	3.7
Portlaoise 110 kV	3.6	9.9	9.1	5.0	8.6	8.4	3.9	8.2	7.6	5.1	7.6	7.5
Pottery 110 kV	17.5	12.8	11.4	5.6	12.5	12.0	13.1	14.9	13.2	4.2	14.7	14.1

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	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]
Prospect 220 kV	13.1	19.3	17.0	8.7	19.0	18.2	9.7	10.5	8.9	8.7	11.6	10.8
Raffeen 220 kV	14.0	19.2	16.3	12.7	21.5	20.2	10.2	10.5	8.8	10.3	13.2	12.2
Raffeen A 110 kV	7.4	17.3	15.7	8.4	19.4	18.7	7.3	12.3	10.8	8.1	14.7	14.0
Raffeen B 110 kV	8.8	16.7	15.0	9.9	18.6	17.8	8.2	12.0	10.6	9.1	14.3	13.5
Ralappane 110 kV	10.2	16.8	15.1	9.1	18.1	17.4						
Rathkeale 110 kV	3.5	8.0	7.4	4.6	4.5	4.5	3.5	6.8	6.3	4.6	4.0	4.0
Ratrussan 110 kV	3.7	8.4	6.9	4.9	8.6	8.0	3.9	7.8	6.3	5.1	8.2	7.6
Reamore 110 kV	4.6	7.9	7.0	3.5	6.5	6.2	4.8	7.0	6.2	3.7	5.9	5.7
Richmond 110 kV	3.0	7.7	7.1	4.2	6.6	6.5	3.1	6.9	6.4	4.3	6.1	6.0
Rinawade 110 kV	4.7	11.7	11.1	5.8	8.1	8.0	4.9	10.1	9.5	6.0	7.4	7.2
Ringaskiddy 110 kV	5.8	13.5	12.4	6.2	12.3	12.0	6.0	10.2	9.1	6.3	10.1	9.7
Ringsend 110 kV	29.2	16.5	14.7	23.6	20.0	19.1	28.3	14.2	12.7	23.4	17.5	16.7
Ryebrook 110 kV	5.1	16.3	15.0	6.5	13.3	13.0	5.5	13.7	12.3	6.7	11.8	11.5
Salthill 110 kV	4.1	13.2	11.5	3.6	12.9	12.3	4.3	11.2	9.9	3.8	11.4	10.9
Screeb 110 kV	3.8	3.2	3.0	4.8	1.8	1.8	3.8	2.9	2.8	4.8	1.7	1.7
Seal Rock A 110 kV	7.8	10.5	9.4	9.6	11.0	10.6	8.1	9.6	8.3	9.8	10.4	9.9
Seal Rock B 110 kV	7.9	10.5	9.4	9.6	11.0	10.6	8.1	9.6	8.3	9.8	10.4	9.9
Shankill 110 kV	3.5	9.5	8.2	4.7	7.9	7.6	3.6	8.5	7.4	4.8	7.3	7.0
Shannonbridge 110 kV	6.1	18.5	16.4	7.7	19.9	19.0	6.2	16.3	14.1	7.7	18.0	17.0
Shannonbridge 220 kV	7.3	7.7	7.4	9.5	6.5	6.4	7.6	6.8	6.3	9.7	5.9	5.8
Shellybanks A 220 kV	15.9	25.1	20.9	6.8	27.5	25.6	14.1	15.7	13.0	7.8	18.8	17.3
Shellybanks B 220 kV	14.6	24.8	20.6	9.6	28.7	26.6	15.8	19.9	15.9	10.7	23.7	21.5
Shelton Abbey 110 kV	7.4	8.5	7.9	7.4	8.6	8.4	7.4	7.2	6.7	7.4	7.6	7.4
Singland 110 kV	6.4	17.5	15.7	7.5	15.8	15.3	6.1	13.5	11.8	7.1	13.3	12.7
Sligo 110 kV	4.0	10.6	9.2	5.0	9.3	8.9	4.0	9.1	7.8	5.0	8.4	8.0
Somerset 110 kV	2.9	8.5	8.0	4.0	5.3	5.2	3.0	7.7	7.1	4.0	4.9	4.8
Sorne Hill 110 kV	3.3	3.5	3.0	4.1	3.5	3.4	3.4	3.2	2.8	4.1	3.3	3.1
Sranangh 110 kV	4.9	12.4	10.6	5.9	12.7	12.0	5.0	10.7	9.0	5.9	11.3	10.6
Sranangh 220 kV	7.6	5.1	4.7	10.0	3.9	3.8	7.6	4.5	4.1	9.9	3.6	3.5
Stevenstown 110 kV	4.5	6.2	5.7	5.0	3.9	3.9	4.7	5.3	5.0	5.1	3.6	3.6
Stratford 110 kV	3.3	4.7	4.4	4.3	3.4	3.4	3.1	3.7	3.5	4.1	3.0	2.9
Suir 110 kV	5.9	11.4	10.0	7.3	11.3	10.8	4.7	7.9	7.1	5.6	8.9	8.5
Taney 110 kV	8.7	10.9	9.8	3.2	10.3	10.0	6.9	12.2	11.1	2.5	11.6	11.2
Tarbert 110 kV	34.5	16.8	15.5	35.6	15.9	15.5	9.9	15.4	13.2	12.0	16.0	15.1
Tarbert 220 kV	15.5	22.9	19.7	14.1	26.8	25.2	9.8	11.3	9.4	10.9	14.0	12.9
Tawnaghmore A 110 kV	4.5	4.5	4.1	5.9	4.1	4.0	3.4	3.1	2.8	4.4	3.2	3.1

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2016 (continued)

Bus	Winter Peak 2016						Summer Valley 2016					
	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]
Tawnaghmore B 110 kV	4.6	4.6	4.1	6.0	4.3	4.1	3.4	3.1	2.8	4.4	3.3	3.2
Thornsberry 110 kV	3.9	7.5	7.0	5.2	6.7	6.5	3.8	5.8	5.5	5.0	5.5	5.4
Thurles 110 kV	6.4	6.9	5.8	6.2	6.9	6.5	6.3	6.3	5.3	6.1	6.5	6.1
Tievebrack 110 kV	3.6	4.6	4.0	4.9	3.0	3.0	3.6	4.2	3.7	4.9	2.9	2.8
Tipperary 110 kV	5.7	8.5	7.8	6.5	5.5	5.4	5.3	7.0	6.4	6.2	4.9	4.8
Tonroe 110 kV	2.7	3.6	3.3	3.8	2.1	2.1	2.7	3.3	3.1	3.8	2.0	2.0
Trabeg 110 kV	7.9	23.1	19.8	8.8	23.8	22.5	7.3	14.6	12.5	8.0	16.8	15.8
Tralee 110 kV	5.2	10.4	9.0	6.3	8.2	7.9	5.5	8.9	7.6	6.7	7.4	7.1
Trien A 110 kV	4.5	8.8	7.9	5.8	7.4	7.1	4.5	7.6	6.7	6.7	5.5	5.3
Trien B 110 kV	13.7	8.0	6.3	11.9	7.4	6.8	13.2	7.4	5.5	11.7	6.9	6.3
Trillick 110 kV	3.4	3.8	3.3	4.2	3.5	3.4	3.4	3.5	3.1	4.2	3.3	3.1
Trinity 110 kV	11.6	14.5	13.0	6.0	17.0	16.2	11.9	12.5	11.3	6.2	15.0	14.4
Tullabrack 110 kV	6.6	7.7	7.2	7.3	5.7	5.6	4.5	6.3	5.8	5.3	4.8	4.7
Turlough 220 kV	10.5	13.3	12.1	11.9	11.5	11.2	10.6	10.8	9.5	11.9	10.1	9.6
Tynagh 220 kV	15.0	13.0	11.6	16.7	14.0	13.4	9.9	7.1	6.6	10.9	8.7	8.4
Uggool 110 kV	7.7	8.3	6.6	8.7	9.4	8.6	7.9	7.9	6.2	8.8	9.0	8.1
Waterford 110 kV	6.6	13.5	12.4	6.8	13.6	13.2	6.2	10.2	9.3	6.5	10.9	10.5
West Galway A 110 kV	6.4	9.2	7.7	7.0	8.2	7.8	6.6	8.5	7.0	7.1	7.7	7.3
West Galway B 110 kV	4.6	6.3	5.9	4.9	4.3	4.2	4.7	5.7	5.3	5.0	4.0	3.9
Wexford 110 kV	4.0	7.3	6.5	5.3	6.4	6.2	4.2	6.3	5.6	5.4	5.8	5.6
Whitegate 110 kV	4.3	10.9	10.2	5.1	10.7	10.4	4.6	8.4	7.7	5.3	8.9	8.6
Wolfe Tone 110 kV	14.3	13.5	12.1	5.3	14.9	14.3	13.8	10.2	9.3	5.7	11.9	11.5
Woodland 220 kV	12.1	25.5	22.4	12.1	25.6	24.4	12.0	17.0	14.3	11.9	18.5	17.3
Woodland 400 kV	20.2	9.4	8.8	20.9	9.4	9.2	18.5	6.4	5.8	19.1	6.8	6.6

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019

Bus	Winter Peak 2019						Summer Valley 2019					
	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	10.5	13.6	11.9	6.4	16.3	15.4	10.7	11.7	10.5	6.7	14.3	13.7
Agannygal 110 kV	3.0	6.6	5.7	4.3	4.9	4.8	3.1	6.1	5.3	4.4	4.6	4.4
Aghada 110 kV	4.6	10.0	9.4	5.6	11.2	11.0	4.8	8.0	7.4	5.7	9.3	9.1
Aghada A 220 kV	14.6	18.9	16.0	15.3	21.0	19.7	9.1	9.5	8.2	9.9	12.1	11.3
Aghada B 220 kV	14.4	18.0	15.3	11.9	20.3	19.0	10.6	10.6	9.0	10.1	13.3	12.3
Aghada C 220 kV	13.8	18.2	15.5	12.9	20.3	19.1	9.1	9.3	8.0	9.3	11.8	11.1
Aghada D 220 kV	14.6	18.9	16.0	15.3	21.0	19.7	9.1	9.5	8.2	9.9	12.1	11.3
Ahane 110 kV	5.0	14.4	13.2	6.0	8.5	8.4	5.1	12.0	10.8	6.0	7.8	7.6
Anner 110 kV	4.3	7.8	7.1	4.8	5.6	5.4	4.1	6.3	5.9	4.6	4.9	4.8
Ardnacrusha 110 kV	6.1	17.6	15.6	7.7	16.3	15.7	5.6	13.3	11.8	6.9	13.8	13.2
Ardnagappary 110 kV	2.8	2.3	2.1	4.1	1.3	1.3	2.8	2.1	1.9	4.1	1.2	1.2
Arigna 110 kV	3.8	8.1	7.2	4.9	5.7	5.5	3.9	7.4	6.5	5.0	5.3	5.1
Arklow 110 kV	10.6	9.7	8.9	11.5	11.5	11.1	10.6	8.5	7.8	11.4	10.3	9.9
Arklow 220 kV	8.9	8.6	8.0	10.2	7.7	7.5	9.1	7.3	6.7	10.2	6.8	6.6
Artane 110 kV	13.3	13.5	12.1	5.6	15.5	14.8	13.2	10.3	9.5	6.1	12.4	12.0
Arva 110 kV	3.7	10.4	9.4	4.9	7.4	7.2	3.8	9.4	8.4	5.0	6.9	6.7
Athea 110 kV	13.4	7.4	5.9	13.5	7.9	7.3	13.3	7.1	5.5	13.4	7.6	6.9
Athlone 110 kV	4.9	9.9	9.0	5.8	9.6	9.3	4.2	7.6	7.1	5.0	8.0	7.8
Athy 110 kV	3.3	7.7	7.3	4.4	6.1	6.0	3.4	6.6	6.3	4.5	5.5	5.4
Aughinish 110 kV	8.1	10.7	9.5	10.2	11.2	10.7	8.4	10.0	8.7	10.4	10.8	10.2
Ballakelly 220 kV	10.8	21.9	20.0	12.2	23.6	22.8	9.7	15.4	13.2	10.8	17.9	16.8
Ballybeg 110 kV	9.8	7.1	6.7	10.0	8.2	8.1	9.7	6.3	6.0	9.9	7.4	7.2
Ballydine 110 kV	4.2	8.4	7.7	3.9	6.3	6.2	4.1	6.9	6.4	3.9	5.6	5.5
Ballylickey 110 kV	3.0	3.6	3.4	4.2	2.0	2.0	3.1	3.3	3.1	4.2	1.9	1.9
Ballynahulla 110 kV	18.1	7.9	6.9	14.3	7.5	7.2	18.2	6.8	5.9	14.6	6.7	6.4
Ballynahulla 220 kV	8.3	9.9	9.0	8.3	9.7	9.4	8.6	8.2	7.1	8.5	8.4	8.0
Ballyragget 110 kV	5.4	7.8	7.4	6.3	5.5	5.4	4.8	6.2	5.9	5.8	4.8	4.8
Ballyvouskill 110 kV	16.8	7.8	6.9	15.2	8.0	7.7	16.0	7.2	6.2	14.8	7.4	7.0
Ballyvouskill 220 kV	8.3	10.0	9.0	9.0	10.5	10.1	8.6	8.3	7.2	9.1	9.1	8.6
Ballywater 110 kV	4.6	6.2	5.8	3.2	6.1	5.9	4.7	5.5	5.2	3.3	5.5	5.4
Baltrasna 110 kV	5.9	11.6	11.0	7.2	8.5	8.4	6.0	10.1	9.4	7.3	7.8	7.6
Bancroft 110 kV	12.2	13.2	12.2	6.8	15.1	14.6	12.6	11.7	10.7	7.0	13.6	13.1
Bandon 110 kV	3.1	7.2	6.6	4.5	5.4	5.3	3.3	6.1	5.6	4.6	5.0	4.9
Banoge 110 kV	5.9	6.6	6.1	6.7	5.6	5.5	6.0	5.8	5.5	6.8	5.2	5.1
Barnahealy A 110 kV	5.4	14.5	13.3	6.1	14.1	13.7	5.6	10.9	9.8	6.2	11.5	11.0
Barnahealy B 110 kV	6.7	14.0	12.7	7.4	13.4	13.0	6.7	10.7	9.6	7.3	11.0	10.6

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Baroda 110 kV	3.7	9.8	9.1	4.5	11.0	10.7	3.9	8.3	7.8	4.7	9.7	9.5
Barrymore 110 kV	3.7	9.1	8.5	5.5	6.6	6.5	3.9	7.5	7.0	5.5	5.9	5.8
Belcamp 110 kV	13.7	16.5	14.6	7.7	17.5	16.8	13.4	13.1	11.8	8.0	14.6	14.1
Belcamp 220 kV	14.3	17.6	15.5	6.5	20.8	19.8	13.4	12.6	10.9	7.2	15.7	14.8
Bellacorick 400 kV	16.0	4.5	4.4	15.6	6.4	6.4	-	-	-	-	-	-
Bellacorick A 110 kV	3.9	4.8	4.3	5.1	4.5	4.3	3.8	3.8	3.4	4.8	3.8	3.6
Bellacorick B 110 kV	12.1	1.9	1.8	13.0	2.4	2.3	-	-	-	-	-	-
Binbane 110 kV	3.4	5.1	4.5	5.0	4.3	4.2	3.5	4.6	4.0	4.9	4.1	3.9
Blackpool 110 kV	7.5	24.4	20.9	7.6	23.6	22.4	7.1	15.7	13.5	7.4	17.1	16.2
Blackrock 110 kV	10.9	11.8	10.5	2.8	10.1	9.8	11.2	10.2	9.4	2.9	9.2	8.9
Blake 110 kV	3.7	8.9	8.5	4.9	5.9	5.8	3.9	7.8	7.4	4.9	5.4	5.3
Boggeragh 110 kV	16.7	4.1	3.5	17.5	4.2	4.0	16.4	3.9	3.3	17.3	4.1	3.9
Booltiagh 110 kV	6.2	8.2	7.4	7.6	6.8	6.6	6.3	7.3	6.6	7.7	6.3	6.1
Bracklone 110 kV	3.5	9.9	9.3	4.6	8.6	8.5	3.6	8.5	7.9	4.7	7.8	7.6
Brinny A 110 kV	3.0	6.4	5.9	4.3	4.6	4.5	3.2	5.5	5.1	4.4	4.2	4.1
Brinny B 110 kV	3.0	6.4	5.9	4.3	4.6	4.5	3.2	5.5	5.1	4.4	4.3	4.2
Butlerstown 110 kV	5.8	11.7	10.8	5.9	11.2	10.9	5.7	9.3	8.5	5.8	9.4	9.1
Cabra 110 kV	12.1	13.0	11.7	4.6	13.7	13.2	12.2	10.0	9.3	5.0	11.2	10.9
Cahir 110 kV	5.7	12.3	10.8	6.5	11.2	10.8	4.7	8.8	7.9	5.5	9.2	8.8
Carlow 110 kV	5.0	10.3	9.5	5.9	10.4	10.1	5.1	8.0	7.5	5.9	8.6	8.4
Carrickmines 220 kV	13.8	23.0	19.5	8.7	26.7	24.9	14.9	18.9	15.5	9.6	22.6	20.8
Carrickmines A 110 kV	31.9	13.7	12.1	25.1	14.4	13.8	31.8	11.7	10.7	25.3	12.8	12.3
Carrickmines B 110 kV	25.4	14.8	13.6	21.0	17.4	16.8	25.5	12.9	11.8	21.4	15.4	14.9
Carrick-on-Shannon 110 kV	4.1	12.8	11.5	4.8	13.4	12.9	4.2	11.4	10.1	5.1	11.9	11.4
Carrigadrohid 110 kV	7.4	14.0	12.7	8.7	12.4	12.0	6.8	10.2	9.2	7.9	10.2	9.8
Carrowbeg 110 kV	2.7	3.1	2.8	3.8	2.7	2.6	2.7	2.8	2.6	3.8	2.5	2.5
Cashla 110 kV	7.1	20.3	17.6	7.9	24.0	22.6	7.0	16.7	14.4	7.7	20.2	19.0
Cashla 220 kV	8.4	12.8	11.6	9.9	12.1	11.7	8.6	9.6	8.5	9.9	9.8	9.4
Castlebar 110 kV	3.4	5.9	5.0	4.6	5.9	5.6	3.4	5.2	4.5	4.5	5.4	5.1
Castledockrill 110 kV	6.9	8.2	7.7	4.7	9.4	9.2	6.9	7.2	6.7	4.8	8.3	8.1
Castlefarm A 110 kV	7.3	10.3	9.2	8.9	10.4	10.0	7.6	9.6	8.4	9.1	10.0	9.5
Castlefarm B 110 kV	7.3	10.3	9.2	8.9	10.4	10.0	7.6	9.6	8.4	9.1	10.0	9.5
Castleview 110 kV	3.7	14.4	13.3	4.5	9.8	9.6	4.2	10.8	9.8	4.7	8.3	8.1
Cathaleen's Fall 110 kV	5.6	11.8	9.6	6.2	11.0	10.3	4.9	9.2	7.6	5.6	9.5	8.8
Caulstown 110 kV	5.1	14.5	13.3	5.8	9.6	9.4	4.9	11.6	10.7	5.6	8.5	8.3
Cauteen 110 kV	5.8	8.7	8.0	6.7	5.0	4.9	5.7	7.6	6.9	6.6	4.6	4.5

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Central 110 kV	14.4	12.4	11.1	7.6	12.8	12.3	14.7	10.7	9.8	7.8	11.4	11.1
Charleville 110 kV	4.4	6.7	6.2	5.9	4.5	4.4	4.6	6.0	5.5	6.0	4.2	4.1
Cherrywood 110 kV	10.2	11.4	10.2	7.5	11.2	10.8	10.4	9.9	9.1	7.6	10.0	9.7
City West 110 kV	5.9	8.7	7.7	6.0	6.1	6.0	6.1	7.5	6.9	6.1	5.7	5.5
Clahane 110 kV	4.2	8.5	7.6	5.4	7.2	7.0	4.4	7.7	6.9	5.5	6.7	6.5
Clashavoon 220 kV	8.7	10.8	9.7	9.3	10.8	10.4	8.7	8.7	7.5	9.2	9.2	8.7
Clashavoon A 110 kV	8.3	14.8	13.5	9.6	13.0	12.6	8.1	11.5	10.2	9.3	11.0	10.6
Clashavoon B 110 kV	28.0	4.7	4.2	29.3	5.5	5.2	25.9	4.5	3.9	27.4	5.2	4.9
Cliff 110 kV	4.8	8.6	7.4	5.6	7.2	6.9	4.3	6.9	5.9	5.2	6.4	6.1
Clogher 110 kV	5.3	10.0	8.0	5.5	9.5	8.8	5.1	8.6	6.7	5.4	8.7	8.0
Cloghran 110 kV	6.5	18.5	17.2	6.7	16.1	15.7	6.7	15.3	13.9	6.9	14.2	13.8
Clonkeen A 110 kV	5.7	6.3	5.9	7.0	4.3	4.2	5.8	5.6	5.3	7.0	4.0	3.9
Clonkeen B 110 kV	8.6	6.3	5.3	7.4	6.8	6.4	8.8	5.8	4.8	7.5	6.3	5.9
Cloon 110 kV	4.2	8.6	7.8	5.8	7.0	6.8	4.3	7.6	7.0	5.8	6.4	6.3
College Park 110 kV	9.2	24.3	22.2	6.3	25.4	24.6	9.1	19.4	17.3	6.5	21.3	20.4
Cookstown A 110 kV	7.1	9.1	8.6	5.8	7.6	7.4	7.3	8.2	7.7	6.0	7.0	6.8
Cookstown B 110 kV	5.0	7.6	6.7	5.4	5.0	4.9	5.1	6.5	6.1	5.4	4.6	4.5
Coolroe 110 kV	6.4	11.7	10.7	7.9	10.3	10.0	6.2	8.9	8.2	7.5	8.7	8.4
Coomagearlahy 110 kV	8.7	5.7	4.7	9.0	6.5	6.0	8.8	5.3	4.3	9.1	6.1	5.6
Cordal 110 kV	11.8	6.1	5.4	9.8	4.7	4.5	12.5	5.5	4.8	10.1	4.3	4.2
Corderry 110 kV	4.0	9.2	7.9	5.3	8.2	7.8	4.1	8.3	7.0	5.4	7.5	7.1
Corduff 110 kV	10.3	27.7	25.0	11.5	29.1	28.0	9.9	21.7	19.1	11.0	24.0	22.8
Corduff 220 kV	15.8	28.8	24.1	14.8	31.9	29.7	13.8	18.1	15.0	13.6	21.9	20.3
Corraclassy 110 kV	4.2	7.4	6.9	5.5	5.4	5.3	4.3	6.7	6.2	5.5	5.0	4.9
Cow Cross 110 kV	4.3	14.4	13.2	5.0	11.7	11.4	4.7	10.8	9.8	5.2	9.8	9.5
Crane 110 kV	6.5	9.2	8.4	6.5	9.2	8.9	6.7	7.9	7.2	6.6	8.2	7.9
Cromcastle A 110 kV	11.3	16.0	14.2	6.8	17.1	16.4	11.3	12.7	11.5	7.1	14.3	13.8
Cromcastle B 110 kV	11.3	16.0	14.2	6.8	17.1	16.4	11.3	12.7	11.5	7.1	14.3	13.8
Cuilleen 110 kV	4.7	9.4	8.6	6.0	9.4	9.1	4.0	7.2	6.7	5.0	7.8	7.6
Cullenagh 110 kV	7.2	14.5	13.4	7.7	16.1	15.6	6.7	11.2	10.2	7.2	13.0	12.5
Cullenagh 220 kV	9.9	10.3	9.7	7.9	9.9	9.7	7.9	7.3	6.7	7.1	7.8	7.5
Cunghill 110 kV	4.7	6.6	5.9	6.4	5.5	5.3	4.5	5.7	5.0	6.0	5.0	4.8
Cushaling 110 kV	6.6	12.8	11.4	8.0	13.6	13.0	5.5	9.3	8.3	6.6	10.9	10.5
Dallow 110 kV	3.4	5.8	5.4	4.6	3.4	3.4	3.5	5.3	4.9	4.7	3.2	3.1
Dalton 110 kV	3.1	5.3	4.6	4.4	4.0	3.9	3.1	4.8	4.3	4.4	3.8	3.6
Dardistown 110 kV	14.3	16.2	14.4	10.2	17.7	17.0	13.9	12.9	11.6	10.4	14.8	14.2

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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	3.1	5.3	4.5	4.6	4.5	4.3	3.2	5.0	4.2	4.7	4.3	4.1
Derryiron 110 kV	5.6	10.5	9.7	7.1	10.0	9.8	4.6	7.5	7.1	5.8	8.0	7.8
Doon 110 kV	4.8	8.7	7.9	5.0	6.4	6.2	4.5	7.0	6.4	4.8	5.6	5.5
Dromada 110 kV	8.9	6.7	5.4	5.8	7.0	6.4	9.0	6.4	5.0	5.9	6.7	6.1
Drumkeen 110 kV	4.5	8.2	6.8	5.6	7.0	6.6	4.6	7.5	6.1	5.6	6.6	6.2
Drumline 110 kV	3.2	9.0	8.3	4.4	7.7	7.5	3.4	7.8	7.2	4.5	7.1	6.9
Drybridge 110 kV	5.3	16.1	14.6	6.5	12.3	12.0	5.4	13.1	11.9	6.5	10.8	10.5
Dundalk 110 kV	3.4	9.6	8.9	4.5	8.4	8.2	3.5	8.5	7.9	4.5	7.7	7.5
Dunfirth 110 kV	4.5	6.9	6.6	6.3	5.2	5.1	4.6	6.0	5.8	6.2	4.8	4.7
Dungarvan 110 kV	5.7	6.5	6.1	6.5	3.9	3.8	5.7	5.5	5.2	6.5	3.6	3.5
Dunmanway 110 kV	4.3	9.0	8.1	5.6	7.0	6.8	4.6	7.5	6.7	5.7	6.3	6.1
Dunstown 220 kV	10.9	22.3	19.9	10.9	24.5	23.5	11.5	17.7	15.1	11.5	20.2	18.9
Dunstown 400 kV	15.3	8.8	8.2	17.7	9.3	9.1	15.4	7.1	6.3	17.6	7.8	7.5
Ennis 110 kV	4.1	12.7	11.3	5.5	10.6	10.2	4.4	10.9	9.6	5.7	9.5	9.2
Fassaroe 110 kV	5.0	8.6	8.1	5.3	6.4	6.3	5.2	7.7	7.3	5.4	5.9	5.8
Fassaroe East 110 kV	5.2	8.8	8.2	5.4	6.6	6.5	5.3	7.9	7.4	5.5	6.1	6.0
Fassaroe West 110 kV	8.2	11.7	10.8	7.4	10.6	10.4	8.5	10.3	9.6	7.5	9.7	9.4
Finglas 220 kV	17.1	28.7	23.7	15.7	33.0	30.5	14.5	18.0	14.8	14.2	22.4	20.6
Finglas A 110 kV	24.7	18.6	16.3	17.5	19.9	19.0	21.2	14.4	12.9	16.6	16.3	15.6
Finglas B 110 kV	37.5	15.3	13.7	32.5	18.5	17.6	29.2	11.5	10.6	27.4	14.5	13.9
Flagford 110 kV	4.4	13.5	12.0	5.2	16.0	15.3	4.5	11.9	10.5	5.4	13.9	13.2
Flagford 220 kV	7.4	8.2	7.6	8.3	9.4	9.1	7.6	7.2	6.5	9.8	6.6	6.4
Flagford 400 kV	12.5	2.8	2.7	13.3	3.3	3.2	-	-	-	-	-	-
Francis Street A 110 kV	10.4	14.1	12.6	5.0	16.3	15.6	10.7	12.3	11.2	5.2	14.6	14.0
Francis Street B 110 kV	12.7	13.7	12.5	6.4	16.2	15.7	13.0	11.9	11.0	6.7	14.4	14.0
Galway 110 kV	5.0	15.7	13.5	5.6	15.5	14.7	5.2	13.3	11.5	5.7	13.7	13.0
Galway 110 kV	5.0	15.7	13.5	5.6	15.5	14.7	5.2	13.3	11.5	5.7	13.7	13.0
Garrow 110 kV	12.8	6.9	5.9	11.1	7.3	6.9	12.7	6.3	5.4	11.1	6.8	6.4
Garvagh 110 kV	4.5	7.0	6.0	6.0	6.0	5.8	4.6	6.4	5.4	6.1	5.6	5.3
Gilra 110 kV	3.0	6.9	6.5	3.9	5.2	5.1	3.1	6.3	5.9	4.0	4.8	4.7
Glanagow 220 kV	15.1	18.6	15.8	14.0	21.1	19.8	10.9	11.0	9.2	11.1	13.8	12.8
Glanlee 110 kV	8.5	5.5	4.6	8.2	6.4	5.9	8.6	5.2	4.2	8.3	6.0	5.5
Glasmore 110 kV	4.1	8.4	7.6	4.7	5.4	5.3	4.3	7.1	6.6	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	2.6	4.9	2.3	2.3
Glenlara B 110 kV	11.1	5.8	4.9	7.6	5.8	5.5	10.4	4.8	4.2	7.6	5.0	4.8
Glenree 110 kV	5.0	5.6	5.0	6.0	4.2	4.1	4.6	4.3	3.8	5.5	3.6	3.5

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Golagh 110 kV	3.9	7.3	6.1	4.5	5.6	5.4	3.9	6.5	5.4	4.5	5.2	4.9
Gorman 110 kV	6.0	16.9	15.4	7.1	17.7	17.1	6.3	14.0	12.6	7.3	15.3	14.7
Gorman 220 kV	8.7	13.2	12.3	9.8	10.2	10.0	8.9	11.0	9.8	9.9	9.1	8.8
Gortawee 110 kV	4.4	7.0	6.5	6.0	5.3	5.2	4.4	6.4	5.8	6.0	5.1	4.9
Grange 110 kV	11.1	15.8	14.1	5.3	16.5	15.8	11.2	12.6	11.4	5.6	13.9	13.3
Grange Castle 110 kV	12.6	14.3	12.4	8.7	17.4	16.4	12.9	12.3	10.9	9.0	15.2	14.5
Great Island 110 kV	6.6	14.6	13.4	7.3	18.3	17.7	6.1	11.1	10.1	6.7	14.3	13.8
Great Island 220 kV	11.0	12.9	11.9	12.0	14.7	14.3	7.9	7.9	7.1	8.7	9.9	9.5
Griffinrath A 110 kV	6.6	11.5	10.8	7.1	11.2	11.0	6.9	9.9	9.3	7.3	10.0	9.8
Griffinrath B 110 kV	7.1	11.9	11.2	7.2	11.2	11.0	7.4	10.2	9.6	7.4	9.9	9.7
Harolds 110 kV	10.6	14.1	12.7	4.7	16.2	15.5	10.9	12.4	11.3	4.9	14.5	14.0
Hartnett's Cross 110 kV	4.4	10.4	9.6	5.5	7.9	7.7	4.6	8.3	7.6	5.5	6.9	6.7
Heuston 110 kV	13.8	14.0	12.8	7.8	16.8	16.1	14.2	12.2	11.2	8.0	14.8	14.4
Huntstown A 220 kV	16.1	27.4	22.8	13.1	31.6	29.4	14.1	17.4	14.5	12.7	21.7	20.0
Huntstown B 220 kV	14.9	25.2	21.6	11.1	28.4	26.7	13.0	16.1	13.6	10.9	19.7	18.4
Ikerrin 110 kV	5.9	6.0	5.3	6.5	3.9	3.8	5.9	5.6	4.9	6.5	3.7	3.6
Inchicore 220 kV	13.8	28.2	23.3	9.5	32.2	29.8	15.0	22.2	17.8	10.5	26.4	24.1
Inchicore A 110 kV	30.8	15.5	14.1	26.3	19.0	18.3	30.4	13.4	12.3	26.4	16.7	16.1
Inchicore B 110 kV	50.4	15.7	13.6	38.4	19.5	18.4	47.9	13.3	11.9	37.8	16.9	16.0
Inniscarra 110 kV	6.5	11.4	10.4	7.8	9.7	9.5	6.2	8.7	7.9	7.4	8.3	8.0
Irishtown 220 kV	15.2	26.1	21.6	11.2	30.6	28.3	16.6	21.6	17.3	12.4	26.2	23.8
Kellis 110 kV	5.9	11.0	10.2	7.0	12.4	12.1	6.0	8.6	8.0	7.0	10.1	9.8
Kellis 220 kV	7.9	8.9	8.5	9.7	7.3	7.2	7.6	7.1	6.6	9.3	6.3	6.1
Kilbarry 110 kV	7.7	24.8	21.2	8.5	24.2	22.9	7.2	15.8	13.6	7.9	17.4	16.5
Kildonan 110 kV	8.5	21.2	19.6	5.8	16.7	16.4	8.5	17.2	15.5	5.9	14.6	14.2
Kilkenny 110 kV	4.9	10.2	9.6	5.7	10.7	10.4	3.7	6.6	6.3	4.3	7.7	7.5
Kill Hill 110 kV	6.3	7.9	6.9	7.2	6.2	6.0	5.9	6.8	6.0	6.8	5.7	5.5
Killonan 110 kV	6.9	21.6	19.1	7.6	14.1	13.7	6.8	16.9	14.7	7.5	12.4	12.0
Killonan 220 kV	7.7	11.9	11.1	10.6	9.7	9.5	7.9	9.7	8.6	10.5	8.5	8.2
Killoteran 110 kV	5.6	12.4	11.4	5.2	12.5	12.2	5.5	9.7	8.9	5.2	10.4	10.1
Kilmahud 110 kV	10.8	13.7	12.0	7.0	16.5	15.6	11.0	11.8	10.6	7.2	14.5	13.8
Kilmore 110 kV	15.2	17.1	15.1	9.7	18.4	17.5	14.6	13.4	12.1	9.9	15.2	14.6
Kilpaddoge 110 kV	12.6	20.3	18.0	12.8	24.6	23.4	11.4	16.7	14.4	11.8	20.8	19.5
Kilpaddoge 220 kV	15.3	24.4	21.1	12.6	29.2	27.5	11.9	14.8	12.4	11.1	19.1	17.6
Kilteel 110 kV	4.2	8.4	7.9	5.3	7.3	7.1	4.3	7.3	6.9	5.3	6.6	6.5
Kinnegad 110 kV	4.5	9.2	8.6	6.1	7.7	7.5	4.3	7.4	7.0	5.7	6.7	6.6

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Knockacummer 110 kV	7.8	5.1	4.4	7.6	5.4	5.1	6.9	4.1	3.7	7.0	4.6	4.4
Knockavanna 110 kV	3.1	5.6	4.8	4.6	4.6	4.4	3.2	5.2	4.4	4.6	4.3	4.1
Knockearagh 110 kV	5.5	6.1	5.6	7.5	4.9	4.8	5.6	5.5	5.0	7.5	4.6	4.5
Knockmullen 110 kV	4.1	6.3	6.0	5.1	4.2	4.1	4.2	5.3	5.1	5.1	3.8	3.7
Knocknagoshel 110 kV	10.2	6.0	4.6	11.7	6.6	5.9	10.2	5.8	4.3	11.7	6.4	5.7
Knocknagreenan 110 kV	7.1	14.0	12.6	8.3	12.4	12.0	6.5	10.2	9.2	7.6	10.1	9.8
Knockraha A 110 kV	8.9	27.1	23.7	9.7	25.3	24.2	23.3	6.0	5.8	24.9	6.2	6.1
Knockraha A 220 kV	10.6	17.4	15.2	11.0	16.8	16.0	9.3	11.9	9.9	9.7	13.5	12.6
Knockraha B 110 kV	8.9	27.1	23.7	9.7	25.3	24.2	7.9	16.9	14.6	8.7	17.4	16.5
Knockraha B 220 kV	10.2	11.6	10.6	10.9	10.9	10.5	9.3	11.9	9.9	9.7	13.5	12.6
Knockumber 110 kV	3.5	9.2	8.6	4.5	6.5	6.4	3.7	8.2	7.6	4.6	6.1	6.0
Lanesboro 110 kV	3.6	11.8	10.7	4.8	11.5	11.1	3.8	10.6	9.6	5.0	10.6	10.3
Laois 110 kV	5.9	14.7	13.9	6.3	18.0	17.6	6.1	12.1	11.3	6.5	15.2	14.7
Laois 400 kV	13.5	8.2	7.8	9.8	7.6	7.4	13.6	6.7	6.0	10.1	6.5	6.3
Letterkenny110 kV	4.5	9.8	8.0	5.6	9.3	8.7	4.7	8.8	7.1	5.7	8.7	8.0
Liberty A 110 kV	6.1	20.7	17.9	4.9	21.5	20.4	6.1	13.7	12.0	5.2	15.8	15.0
Liberty B 110 kV	6.0	20.6	17.9	4.8	21.4	20.4	6.0	13.7	12.0	5.0	15.8	15.0
Limerick 110 kV	5.1	18.3	16.2	6.6	13.8	13.3	5.2	14.6	12.8	6.5	12.1	11.6
Lisdrum 110 kV	2.7	5.4	5.1	3.8	3.1	3.0	2.8	5.0	4.7	3.9	3.1	3.0
Lisheen 110 kV	5.0	5.4	4.5	4.0	7.9	7.2	5.1	5.1	4.3	4.0	7.5	6.8
Lodgewood 110 kV	8.8	9.5	8.8	8.9	11.2	10.8	8.7	8.2	7.5	8.8	9.7	9.4
Lodgewood 220 kV	8.7	8.2	7.7	9.9	7.6	7.5	8.5	6.6	6.0	9.6	6.4	6.2
Longpoint 220 kV	14.1	18.6	15.8	13.1	20.5	19.2	9.0	9.3	8.1	9.3	11.8	11.1
Louth 220 kV	10.9	22.7	20.7	12.5	24.2	23.4	9.9	16.0	13.6	11.1	18.4	17.3
Louth A 110 kV	6.7	14.6	13.5	7.8	17.0	16.5	6.8	12.6	11.4	7.8	15.0	14.4
Louth B 110 kV	7.2	15.7	14.6	8.2	18.8	18.3	7.2	13.4	12.2	8.1	16.4	15.8
Macetown 110 kV	7.1	20.7	19.0	7.1	19.2	18.7	7.3	16.9	15.2	7.2	16.6	16.0
Macroom 110 kV	7.5	15.2	13.6	8.5	13.3	12.9	7.1	11.2	9.9	8.0	11.0	10.5
Mallow 110 kV	5.1	7.1	6.6	7.0	5.7	5.6	5.2	6.2	5.7	7.0	5.2	5.1
Marina 110 kV	7.9	23.6	20.2	9.0	24.6	23.2	7.1	15.0	13.0	8.0	17.5	16.5
Maynooth A 110 kV	10.2	14.7	13.6	11.0	17.5	17.0	10.4	12.3	11.4	11.1	15.0	14.6
Maynooth A 220 kV	9.5	20.4	18.2	9.4	18.2	17.6	10.2	16.5	14.1	9.9	15.6	14.8
Maynooth B 110 kV	7.5	19.2	17.9	9.3	17.6	17.2	8.0	16.3	14.8	9.7	15.5	15.1
Maynooth B 220 kV	9.7	24.1	21.3	9.4	21.2	20.4	10.6	18.8	15.9	10.1	17.7	16.8
McDermott 110 kV	16.5	14.0	12.5	5.7	15.6	15.0	15.5	10.6	9.8	6.2	12.5	12.1
Meath Hill 110 kV	3.8	9.9	9.1	5.1	7.8	7.6	3.9	8.7	8.0	5.1	7.2	7.0

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Meentycat 110 kV	4.1	6.8	5.7	5.4	5.6	5.4	4.2	6.3	5.2	5.5	5.4	5.1
Midleton 110 kV	3.4	11.8	10.9	4.6	8.8	8.6	3.8	9.1	8.4	4.8	7.5	7.3
Milltown A 110 kV	14.9	15.3	13.7	6.5	18.0	17.2	15.2	13.4	12.1	6.7	16.0	15.4
Milltown B 110 kV	8.7	12.3	11.3	4.0	14.3	13.9	9.0	10.8	10.0	4.1	12.8	12.4
Misery Hill 110 kV	13.2	15.0	13.4	7.2	17.7	16.9	13.5	13.1	11.9	7.4	15.8	15.2
Moneteen 110 kV	5.3	12.3	11.2	6.5	8.2	8.1	5.4	10.6	9.6	6.5	7.6	7.4
Moneypoint 110 kV	15.1	10.3	9.7	17.1	10.3	10.1	14.0	9.0	8.3	16.0	9.3	9.0
Moneypoint 220 kV	16.0	23.5	20.5	13.7	28.5	26.9	12.5	14.7	12.4	11.9	19.0	17.6
Moneypoint G1 400 kV	21.7	15.0	13.3	21.8	16.9	16.1	15.4	9.3	7.9	16.4	11.5	10.7
Moneypoint G2 400 kV	21.7	15.0	13.3	21.8	16.9	16.1	15.4	9.3	7.9	16.4	11.5	10.7
Moneypoint G3 400 kV	21.7	15.0	13.3	21.8	16.9	16.1	15.4	9.3	7.9	16.4	11.5	10.7
Monread 110 kV	3.8	8.4	7.8	4.8	8.0	7.8	4.0	7.2	6.8	4.9	7.2	7.1
Mount Lucas 110 kV	4.5	8.5	7.9	5.8	8.0	7.8	4.4	6.8	6.4	5.6	6.8	6.6
Moy 110 kV	5.2	5.6	5.0	6.6	5.6	5.4	3.9	3.9	3.5	4.8	4.3	4.1
Mullagharlin 110 kV	3.5	9.8	9.1	4.6	9.1	8.9	3.6	8.7	8.0	4.7	8.3	8.1
Mullingar 110 kV	3.4	7.7	7.2	4.9	7.0	6.8	3.4	6.7	6.4	4.8	6.4	6.3
Mulreavy 110 kV	4.6	8.6	6.9	5.2	8.7	8.0	4.6	7.6	6.0	5.2	8.0	7.3
Mungret A 110 kV	5.0	11.6	10.6	6.2	7.7	7.5	5.1	10.1	9.1	6.2	7.1	6.9
Mungret B 110 kV	5.0	11.6	10.7	6.2	7.7	7.5	5.1	10.1	9.1	6.2	7.1	6.9
Nangor 110 kV	11.4	13.9	12.1	7.2	16.8	15.8	11.6	12.0	10.7	7.5	14.7	14.1
Navan 110 kV	5.1	14.7	13.4	6.1	13.6	13.2	5.4	12.4	11.2	6.3	11.9	11.6
Nenagh 110 kV	2.6	3.9	3.6	3.9	2.0	2.0	2.7	3.5	3.3	4.0	1.9	1.9
Newbridge 110 kV	3.9	12.0	11.0	4.7	11.3	11.0	4.1	10.0	9.2	4.8	9.9	9.7
Newbury 110 kV	13.2	16.6	14.7	6.5	17.4	16.7	13.0	13.2	11.8	6.8	14.6	14.0
Nore 110 kV	4.9	9.6	9.1	6.1	10.3	10.1	3.6	6.2	5.9	4.2	7.3	7.2
North Kerry 220 kV	11.8	17.5	15.5	10.7	18.9	18.1	11.5	12.7	10.7	10.7	14.6	13.7
North Kerry 400 kV	17.6	11.2	10.2	11.6	11.0	10.6	14.7	7.7	6.7	11.5	8.3	7.9
North Kerry A 110 kV	4.8	9.4	8.6	5.8	7.3	7.1	4.9	8.4	7.6	5.9	6.8	6.6
North Kerry B 110 kV	24.9	10.0	8.0	21.2	10.4	9.6	22.7	9.3	7.2	20.1	9.8	8.9
North Quays 110 kV	18.7	15.7	14.0	6.1	18.0	17.2	18.9	13.7	12.4	6.3	16.1	15.4
North Wall 220 kV	15.7	25.8	21.6	8.2	26.1	24.5	13.6	16.6	13.9	8.8	18.8	17.5
Oldcourt A 110 kV	3.8	11.8	11.0	4.5	8.7	8.5	4.1	9.2	8.5	4.7	7.5	7.3
Oldcourt B 110 kV	3.8	11.9	11.1	4.6	8.8	8.6	4.2	9.3	8.5	4.8	7.6	7.4
Oldstreet 220 kV	15.6	11.8	11.0	12.7	12.4	12.0	13.1	8.0	7.4	11.7	9.2	8.9
Oldstreet 400 kV	15.2	9.8	9.2	10.2	8.5	8.3	13.4	7.2	6.5	10.2	6.9	6.7
Oughtragh 110 kV	3.6	5.0	4.6	4.8	3.1	3.0	3.7	4.5	4.2	4.9	2.9	2.9

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	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]
Pelletstown 110 kV	13.6	13.1	11.8	7.5	13.4	12.9	13.6	10.1	9.3	7.9	11.0	10.7
Platin 110 kV	5.0	15.0	13.7	5.7	10.2	10.0	4.8	12.0	11.0	5.6	9.0	8.8
Pollaphuca 110 kV	3.2	3.2	3.1	4.6	2.6	2.6	2.7	2.5	2.4	3.9	2.3	2.3
Poolbeg A 220 kV	16.2	25.8	21.6	6.8	24.3	22.9	14.6	16.8	14.0	7.7	17.9	16.8
Poolbeg B 220 kV	13.4	25.9	21.8	9.3	27.5	25.7	14.3	20.6	16.7	10.1	22.8	21.0
Poppintree 110 kV	14.0	17.3	15.2	7.9	18.4	17.6	13.6	13.6	12.2	8.2	15.3	14.7
Portan 400 kV	62.4	4.3	4.2	39.3	5.0	4.9	51.4	3.9	3.8	35.5	4.4	4.4
Portlaoise 110 kV	4.2	13.6	12.7	5.2	11.9	11.6	4.5	11.3	10.5	5.4	10.5	10.2
Pottery 110 kV	17.5	12.9	11.5	5.6	12.5	12.0	17.8	11.1	10.1	5.7	11.2	10.9
Prospect 220 kV	12.8	19.6	17.4	8.5	19.3	18.6	11.2	12.9	11.1	8.7	14.2	13.4
Raffeen 220 kV	13.9	19.3	16.4	12.6	21.7	20.3	10.1	10.8	9.1	10.2	13.6	12.6
Raffeen A 110 kV	7.3	17.4	15.7	8.3	19.4	18.7	7.2	12.5	11.2	8.0	14.9	14.2
Raffeen B 110 kV	8.8	16.6	14.9	9.9	18.5	17.8	8.1	12.2	10.8	9.0	14.5	13.8
Ralappane 110 kV	10.1	16.9	15.2	9.0	18.2	17.5	9.7	14.3	12.5	8.9	15.9	15.1
Rathkeale 110 kV	3.5	8.0	7.5	4.6	4.5	4.4	3.6	7.0	6.5	4.6	4.1	4.1
Ratrussan 110 kV	3.7	8.4	7.0	4.9	8.6	8.0	3.8	7.9	6.4	5.0	8.3	7.7
Reamore 110 kV	4.6	7.9	7.0	3.5	6.5	6.2	4.8	7.3	6.4	3.6	6.1	5.9
Richmond 110 kV	3.0	7.7	7.1	4.2	6.7	6.5	3.1	7.0	6.5	4.3	6.2	6.1
Rinawade 110 kV	4.7	11.8	11.2	5.8	8.1	8.0	4.9	10.3	9.7	5.9	7.4	7.3
Ringaskiddy 110 kV	5.7	13.5	12.3	6.2	12.3	12.0	5.9	10.3	9.3	6.3	10.2	9.9
Ringsend 110 kV	29.3	16.6	14.7	23.6	20.1	19.1	28.9	14.4	13.0	23.7	17.8	17.0
Ryebrook 110 kV	5.1	16.4	15.1	6.5	13.3	13.0	5.4	14.0	12.7	6.7	12.0	11.7
Salthill 110 kV	4.1	13.3	11.6	3.6	13.0	12.4	4.3	11.4	10.0	3.7	11.6	11.1
Screeb 110 kV	3.8	3.2	3.0	4.8	1.8	1.8	3.8	2.9	2.8	4.8	1.7	1.7
Seal Rock A 110 kV	7.8	10.5	9.4	9.6	11.0	10.6	8.1	9.8	8.6	9.8	10.6	10.1
Seal Rock B 110 kV	7.8	10.5	9.4	9.6	11.0	10.6	8.1	9.8	8.6	9.8	10.6	10.1
Shankill 110 kV	3.5	9.5	8.2	4.7	7.9	7.6	3.6	8.6	7.5	4.8	7.4	7.1
Shannonbridge 110 kV	6.1	18.7	16.6	7.8	20.0	19.2	6.2	16.5	14.3	7.7	18.2	17.2
Shannonbridge 220 kV	7.3	7.8	7.4	9.6	6.5	6.4	7.6	6.9	6.4	9.8	6.0	5.8
Shellybanks A 220 kV	15.8	25.8	21.6	6.6	28.3	26.4	14.4	16.8	14.0	7.6	20.2	18.7
Shellybanks B 220 kV	14.6	25.1	20.9	9.6	28.9	26.9	16.0	20.9	16.9	10.6	25.0	22.8
Shelton Abbey 110 kV	7.4	8.5	7.9	7.4	8.6	8.4	7.5	7.6	7.0	7.5	7.8	7.6
Singland 110 kV	6.4	17.6	15.7	7.7	13.3	12.9	6.2	13.9	12.3	7.4	11.6	11.2
Sligo 110 kV	3.9	10.7	9.3	5.0	9.4	9.0	4.0	9.2	7.9	4.9	8.4	8.0
Somerset 110 kV	2.9	8.5	8.0	3.9	5.3	5.2	2.9	7.7	7.2	4.0	4.9	4.8
Sorne Hill 110 kV	3.3	3.5	3.0	4.1	3.5	3.3	3.4	3.2	2.8	4.1	3.3	3.1

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2019 (continued)

Bus	Winter Peak 2019						Summer Valley 2019					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]	X/R Ratio	Ik" [kA]	Ik' [kA]
Srananagh 110 kV	4.9	12.5	10.8	5.9	12.9	12.2	4.9	10.8	9.1	5.9	11.4	10.7
Srananagh 220 kV	7.6	5.1	4.7	9.4	4.1	4.0	7.6	4.6	4.2	9.9	3.7	3.6
Stevenstown 110 kV	4.1	6.7	6.3	4.7	4.2	4.1	4.2	5.9	5.5	4.7	3.8	3.8
Stratford 110 kV	3.2	4.8	4.5	4.3	3.4	3.4	3.1	3.9	3.7	4.1	3.1	3.0
Suir 110 kV	5.8	11.5	10.1	7.2	11.3	10.8	4.6	8.1	7.3	5.6	9.0	8.7
Taney 110 kV	8.7	10.9	9.9	3.2	10.3	10.0	8.9	9.6	8.8	3.3	9.4	9.1
Tarbert 110 kV	34.2	17.0	15.7	35.4	16.0	15.6	21.6	11.5	10.7	24.5	12.4	12.1
Tarbert 220 kV	15.0	23.6	20.4	13.7	27.5	25.9	11.4	14.2	12.0	11.3	18.0	16.7
Tawnaghmore A 110 kV	4.5	4.5	4.1	5.9	4.1	4.0	3.4	3.2	2.9	4.4	3.3	3.2
Tawnaghmore B 110 kV	4.6	4.6	4.2	6.1	4.3	4.2	3.4	3.2	2.9	4.4	3.4	3.2
Thornsberry 110 kV	3.8	7.6	7.1	5.1	6.7	6.6	3.8	6.0	5.6	4.9	5.6	5.5
Thurles 110 kV	6.4	6.9	5.9	6.2	7.0	6.5	6.3	6.4	5.4	6.1	6.6	6.2
Tievebrack 110 kV	3.6	4.6	4.0	4.9	3.0	3.0	3.6	4.2	3.7	4.9	2.9	2.8
Tipperary 110 kV	5.7	8.5	7.8	6.5	5.3	5.2	5.3	7.1	6.5	6.2	4.8	4.7
Tonroe 110 kV	2.7	3.6	3.3	3.8	2.1	2.1	2.7	3.3	3.1	3.8	2.0	2.0
Trabeg 110 kV	7.9	23.2	19.9	8.7	23.9	22.6	7.2	14.9	12.9	7.9	17.2	16.2
Tralee 110 kV	5.2	10.4	9.0	6.3	8.2	7.9	5.4	9.3	8.0	6.4	7.7	7.4
Trien A 110 kV	4.5	8.8	7.9	5.8	7.4	7.1	4.7	7.9	7.1	5.9	6.8	6.6
Trien B 110 kV	14.6	8.3	6.5	12.5	7.7	7.1	14.3	7.8	6.0	12.4	7.3	6.7
Trillick 110 kV	3.4	3.8	3.3	4.2	3.5	3.3	3.4	3.5	3.1	4.2	3.3	3.1
Trinity 110 kV	11.6	14.5	13.0	6.0	17.0	16.3	11.9	12.7	11.5	6.2	15.2	14.6
Tullabrack 110 kV	6.5	7.7	7.3	7.8	7.0	6.9	6.6	6.9	6.4	7.8	6.5	6.4
Turlough 220 kV	10.4	13.5	12.2	11.9	11.6	11.3	10.6	11.3	10.0	12.0	10.4	10.0
Tynagh 220 kV	14.9	13.1	11.8	16.6	14.0	13.5	10.3	7.7	7.1	11.5	9.4	9.1
Uggool 110 kV	7.6	8.3	6.7	8.7	9.3	8.5	7.8	7.9	6.2	8.8	9.0	8.2
Waterford 110 kV	6.5	13.7	12.5	6.7	13.7	13.3	6.1	10.5	9.6	6.4	11.2	10.9
West Galway A 110 kV	6.4	9.2	7.7	6.9	8.2	7.8	6.5	8.6	7.1	7.0	7.8	7.3
West Galway B 110 kV	4.6	6.3	5.9	4.9	4.3	4.2	4.7	5.7	5.3	5.0	4.0	4.0
Wexford 110 kV	4.0	7.3	6.5	5.3	6.5	6.2	4.2	6.4	5.7	5.4	5.9	5.7
Whitegate 110 kV	4.2	10.9	10.2	5.1	10.7	10.4	4.5	8.6	7.9	5.3	9.0	8.7
Wolfe Tone 110 kV	14.3	13.7	12.2	5.2	15.1	14.4	13.9	10.4	9.6	5.7	12.1	11.7
Woodland 220 kV	12.8	27.5	24.2	12.3	27.2	26.0	13.2	19.5	16.4	12.7	20.8	19.5
Woodland 400 kV	17.9	12.2	11.4	16.4	11.7	11.4	17.2	9.2	8.1	16.2	9.3	8.9

F Additional Information on Opportunities

F.1 Generation Opportunities Created by GRID25 in Ireland

F.2 Northern Ireland Generation Opportunity Results

F.3 Additional Information on Demand Opportunities in Ireland

APPENDIX F ADDITIONAL INFORMATION ON OPPORTUNITIES

F.1 GENERATION OPPORTUNITIES CREATED BY GRID25 IN IRELAND

Figure F-1 lists the following information:

- Date In: the date assumed in the Gate 3 Firm Access Study for the completion of the transmission system reinforcement listed.
- Reinforcement: a transmission system development which has been associated with a particular (or multiple) Gate 1 2 and 3 generation applicants, in their application for firm access.
- Areas Impacted: the areas of the transmission system (shown in Figure 5-5) where firm access quantities have increased as a result of the transmission system development listed.
- Firm Access Associated: a yearly summation of the firm access available to Gate 1 2 and 3 generation applicants in an area(s) as a result of the transmission developments listed and the existing network.
- It should be noted that generally no one transmission reinforcement solely creates access and it is a combination of transmission reinforcements that leads to the delivery of firm access across different areas on a yearly basis. E.g. the new Arva – Shankill 2 and Gorman – Meath Hill 110 kV circuits combine to create 404 MW of access for areas G and J in 2012.
- In general Table 8-1 in chapter 8 and Table F-1 below can be used to estimate the levels of access created by specific ATRs in a given year and area and to also determine which Gate the access has been created for.

Table F-1: Individual Transmission Reinforcements and Resultant Firm Access Quantities

Date In	Reinforcement	Areas Impacted	Firm Access Associated								
			2012	2013	2014	2015	2016	2017	2018	2019	2020
2012	Arva - Shankill 110kV circuit 2	ABCGJ	404	0	132	26	258	292	663	0	370
2012	Ballydine - Cullenagh 110kV circuit uprate	H1K	0	0	0	0	297	62	0	454	121
2012	Cath's Fall - Golagh T 110kV circuit uprate	A	0	0	90	26	9	0	0	0	0
2012	Cath's Fall - Srananagh 110kV circuit 1 uprate	AG	0	0	106	26	9	22	0	0	0
2012	Coolroe - Kilbarry 110kV circuit uprate	EF	0	0	0	0	0	0	0	0	337
2012	Cullenagh - Knockraha 220kV circuit uprate	EFH1IK	0	0	0	0	30	141	0	847	121
2012	Cullenagh - Waterford 110kV circuit uprate	DEFH1IK	0	0	0	355	165	211	0	945	478
2012	Gorman - Meath Hill 110kV circuit	GJ	404	0	17	0	0	22	0	0	0
2012	Ryebrook 110kV station busbar uprate including line bays	H1J	160	166	0	0	236	0	0	0	46
2013	Ballydine 110kV station busbar uprate	EH1IK	0	0	0	0	297	62	0	557	121
2013	Bellacorick - Castlebar 110kV circuit uprate	B	0	0	0	0	113	6	273	0	0
2013	Bellacorick 110kV station busbar uprate	B	0	0	0	0	116	6	273	0	0
2013	Binbane - Letterkenny 110kV circuit	A	0	11	98	26	9	0	0	0	0
2013	Butlerstown - Cullenagh 110kV circuit uprate	EFH1IK	0	0	0	355	145	211	0	857	121
2013	Butlerstown - Killoteran 110kV circuit uprate	EH1IK	0	0	0	0	108	62	0	716	121
2013	Butlerstown 110kV station busbar uprate	EFH1IK	0	0	0	355	145	211	0	945	150
2013	Cath's Fall 110kV station busbar uprate section A1/B1	A	0	0	98	26	9	0	0	0	261
2013	Charleville - Mallow 110kV circuit uprate	EFIK	0	0	0	0	0	132	0	175	5
2013	Clashavoon - Knockraha 220kV circuit uprate	EFI	0	0	0	355	15	39	0	0	280
2013	Cullenagh - Dungarvan 110kV circuit uprate	EFH1IK	0	0	0	355	23	211	0	390	356
2013	Cullenagh - Great Island 220kV circuit uprate	DEFH1H2IJK	0	0	0	355	516	211	0	945	478
2013	Cushaling 110kV station busbar uprate	J	0	14	0	0	0	0	0	0	0
2013	Dunstown 400/220kV transformer T4202 - second transformer	EFH1I	0	0	0	0	0	0	0	0	478
2013	Ennis 110kV station busbar uprate	DEFH1	0	0	0	355	143	70	0	757	449
2013	Ikerrin T - Thurles 110kV circuit uprate	H1	0	0	0	0	0	0	0	356	121
2013	Inchicore - Maynooth 220kV circuit 1 uprate	H1J	0	166	0	0	136	0	0	0	0
2013	Inchicore - Maynooth 220kV circuit 2 uprate	J	0	115	0	0	136	0	0	0	46

Table F-1: Individual Transmission Reinforcements and Resultant Firm Access Quantities (continued)

Date In	Reinforcement	Areas Impacted	Firm Access Associated								
			2012	2013	2014	2015	2016	2017	2018	2019	2020
2013	Inniscarra - Macroom 110kV circuit uprate	EF	0	0	0	0	0	0	0	0	337
2013	Maynooth - Ryebrook 110kV circuit uprate	H1J	0	166	0	0	136	0	0	0	46
2013	Navan 110kV station busbar uprate	B	0	0	0	0	0	0	628	0	0
2013	Thurles 110kV station busbar uprate	H1	0	0	0	0	0	0	0	454	121
2014	Cahir - Tipperary 110kV circuit uprate	H1	0	0	0	0	0	0	0	37	50
2014	Carrick on Shannon 110kV station busbar uprate	ABCG	0	0	132	26	261	292	663	0	370
2014	Cath's Fall - Clogher 1 (ex Drumkeen) 110kV circuit uprate	A	0	0	90	26	9	0	0	0	0
2014	Cath's Fall - Srananagh 110kV circuit 2 uprate	AG	0	0	115	26	9	22	0	0	0
2014	Cath's Fall 110kV station busbar uprate section A2/B2	A	0	0	98	26	9	0	0	0	261
2014	Cauteen - Killonan 110kV circuit uprate	H1	0	0	0	0	0	0	0	454	121
2014	Cauteen - Tipperary 110kV circuit uprate	H1	0	0	0	0	0	0	0	37	50
2014	Cunghill - Glenree 110kV circuit uprate	B	0	0	0	0	116	6	273	0	0
2014	Cunghill - Sligo 110kV circuit uprate	B	0	0	0	0	116	6	273	0	0
2014	Cunghill 110kV station busbar uprate - busbar sectionaliser only	B	0	0	0	0	116	6	273	0	0
2014	Drumkeen 110kV station busbar uprate - busbar sectionaliser only	A	0	0	90	26	9	0	0	0	0
2014	Dunmanway 110kV station busbar uprate	F	0	0	0	0	0	0	0	88	9
2014	Great Island 220kV - station replacement	H1	0	0	0	0	0	0	0	0	121
2014	Loop in of Clogher 110kV station to Cath's Fall to Drumkeen 110kV circuit	A	0	0	90	26	9	0	0	0	0
2014	Sligo - Srananagh 110kV circuit 2 uprate	A	0	0	0	0	9	0	35	0	272
2014	Sligo 110kV station busbar uprate	AB	0	0	0	0	126	6	307	0	272
2014	Tipperary 110kV station busbar uprate	H1	0	0	0	0	0	0	0	0	50
2014	Corduff - Ryebrook 110kV circuit uprate	J	0	0	0	0	0	0	0	0	46
2015	Ardnacrusha 110kV station refurbishment - busbar uprate	BEFH1I	0	0	0	0	327	111	524	857	219
2015	Arva - Carrick on Shannon 110kV circuit uprate	ABC	0	0	0	0	249	271	663	0	370
2015	Arva - Shankill 110kV circuit 1 uprate	AB	0	0	0	0	218	239	494	0	370
2015	Ballynahulla - Knockanure 220kV circuit uprate	EFH1I	0	0	0	0	0	0	0	804	478
2015	Ballyvouskil - Clashavoon 220kV circuit uprate	E	0	0	0	291	6	39	0	92	203

Table F-1: Individual Transmission Reinforcements and Resultant Firm Access Quantities (continued)

Date In	Reinforcement	Areas Impacted	Firm Access Associated								
			2012	2013	2014	2015	2016	2017	2018	2019	2020
2015	Cahir - Kill Hill - Thurles 110kV circuit uprate	H1	0	0	0	0	0	0	0	0	71
2015	Castlebar - Cloon 110kV circuit uprate	AB	0	0	0	0	0	0	307	0	272
2015	Castlebar 110kV station busbar uprate	AB	0	0	0	0	116	6	307	0	272
2015	Clashavoon - Dunmanway 110kV circuit	EF	0	0	0	0	0	39	0	363	332
2015	Clashavoon 220kV station busbar uprate - busbar coupler only	EF	0	0	0	0	15	39	0	0	260
2015	Clogher - Drumkeen 110kV circuit uprate	A	0	0	0	26	9	0	0	0	0
2015	Great Island - Wexford 110kV circuit uprate	H1	0	0	0	0	0	0	0	356	121
2015	Kilpaddoge - Knockanure 220kV circuit uprate	EFH1IK	0	0	0	291	36	211	0	804	478
2015	Kilpaddoge - Moneypoint 220kV cable	DEFH1I	0	0	0	355	462	149	0	847	478
2015	Moneypoint GIS development (220kV and 110kV)	BDEFH1I	0	0	0	355	386	318	524	804	576
2015	North Kerry 220/110kV Station	E	0	0	0	21	9	0	0	57	0
2015	Sligo - Srananagh 110kV circuit 1 uprate	A	0	0	0	0	9	0	35	0	272
2015	Wexford 110kV station busbar uprate	H1	0	0	0	0	0	0	0	356	121
2016	Arigna T - Carrick on Shannon 110kV circuit uprate	AB	0	0	0	0	218	239	307	0	272
2016	Arigna T - Corderry 110kV circuit uprate	B	0	0	0	0	218	239	169	0	0
2016	Barrymore T - Cahir 110kV circuit uprate	EFIK	0	0	0	0	0	211	0	390	356
2016	Bellacorick - Moy 110kV circuit uprate	B	0	0	0	0	0	0	273	0	0
2016	Booltiagh - Ennis 110kV circuit uprate	D	0	0	0	0	120	0	0	0	0
2016	Carrickmines 220kV GIS development	J	0	0	0	0	136	0	0	0	46
2016	Carrickmines 4th 250MVA 220/110kV transformer	J	0	0	0	0	136	0	0	0	46
2016	Cashla - Salthill 110kV circuit uprate	B	0	0	0	0	0	128	0	0	0
2016	Lanesboro 110kV station busbar uprate	ABC	0	0	0	0	252	271	663	0	370
2016	Letterkenny 110kV station busbar uprate	A	0	0	0	0	9	0	0	0	261
2016	Moneypoint - Tullabrack T 110kV circuit uprate	D	0	0	0	0	120	0	0	0	0
2016	Moneypoint GIS development (400kV)	DEFH1H2IK	0	0	0	0	662	211	0	945	478
2016	Moy 110kV station busbar uprate	AB	0	0	0	0	0	0	307	0	272
2017	Barrymore T - Knockraha 110kV circuit uprate	EFIK	0	0	0	0	0	211	0	262	0

Table F-1: Individual Transmission Reinforcements and Resultant Firm Access Quantities (continued)

Date In	Reinforcement	Areas Impacted	Firm Access Associated								
			2012	2013	2014	2015	2016	2017	2018	2019	2020
2017	Binbane - Cathaleen's Fall 110kV circuit uprate	A	0	0	0	0	0	0	0	0	261
2017	Cashla - Dalton 110kV circuit uprate	AB	0	0	0	0	0	0	307	0	272
2017	Clashavoon - Macroom 110kV circuit 2	E	0	0	0	0	0	39	0	275	323
2017	Dalton 110kV station busbar uprate	AB	0	0	0	0	0	0	307	0	272
2017	Galway 110kV station busbar uprate	B	0	0	0	0	0	233	0	0	0
2017	Lanesboro - Mullingar 110kV circuit uprate	ABC	0	0	0	0	0	271	663	0	370
2017	North - South 400kV project	ABG	0	0	0	0	0	22	524	0	370
2018	Athlone - Lanesboro 110kV circuit uprate	AB	0	0	0	0	0	0	663	0	370
2018	Castlebar - Dalton 110kV circuit uprate	AB	0	0	0	0	0	0	307	0	272
2018	Corderry - Srananagh 110kV circuit uprate	AB	0	0	0	0	0	0	203	0	272
2018	Flagford - Sligo 110kV circuit uprate	AB	0	0	0	0	0	0	203	0	272
2018	North Connaght 110kV local network reinforcement	B	0	0	0	0	0	0	273	0	0
2019	Killonan - Limerick 110kV circuit 1 uprate	H1	0	0	0	0	0	0	0	454	121
2019	Killonan - Limerick 110kV circuit 2 uprate	H1	0	0	0	0	0	0	0	454	121
2019	Moneypoint - North Kerry 400kV circuit	EFH1I	0	0	0	0	0	0	0	945	478
2020	Grid Link 400kV project	EFH1I	0	0	0	0	0	0	0	0	478
2020	High voltage network development in the North West (Renewables Integration Development Project)	AB	0	0	0	0	0	0	0	0	370
2020	Loop Woodland 400/220kV Station into Gorman Maynooth 220kV circuit	J	0	0	0	0	0	0	0	0	46
2020	Maynooth - Woodland 220kV up voltage to 400kV (ex Gorman line)	J	0	0	0	0	0	0	0	0	46
2020	Maynooth 400kV Station - 400/220kV transformer T4201	J	0	0	0	0	0	0	0	0	46

F.2 NORTHERN IRELAND GENERATION OPPORTUNITIES RESULTS

Table F-2: 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-3: 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-4: 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-4: 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-5: 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-6: 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-6: 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-7: 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.3 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-8 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

G.1 Abbreviations

G.2 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
WDRI	Winter Demand Reduction Incentive
WFPS	Wind Farm Power Station
WP	Winter Peak
WPDRS	Winter Peak Demand Reduction Scheme

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 Demand Reduction Incentive Tariff	This scheme, administered by Electric Ireland provides large demand customers with a financial incentive to reduce their demand over weekday peak hours in winter.

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.
Winter Peak Demand Reduction Scheme	This scheme was introduced in winter 2003/04 as an incentive to business customers to reduce consumption during system peak hours (5-7pm) in winter months.

H References

H References

APPENDIX H REFERENCES

The following documents are referenced in All-Island Ten Year Transmission Forecast Statement 2013:

- 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, 2013-2022*. EirGrid and SONI issued this report in January 2012. 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 2012 to 2021. Available on www.eirgrid.com.
- EirGrid Grid Code Version 4.0, December 2012. 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 Power Flow Diagrams

APPENDIX I POWER FLOW DIAGRAMS

This appendix presents power flow diagrams for the following cases:

- Figure I-1 Summer Peak 2013,
- Figure I-2 Summer Valley 2013,
- Figure I-3 Winter Peak 2013/14,
- Figure I-4 Summer Peak 2016,
- Figure I-5 Summer Valley 2016,
- Figure I-6 Winter Peak 2016/17,
- Figure I-7 Summer Peak 2019,
- Figure I-8 Summer Valley 2019,
- Figure I-9 Winter Peak 2019/20,
- Figure I-10 Summer Peak 2022,
- Figure I-11 Summer Valley 2022,
- Figure I-12 Winter Peak 2022/23,

Wind farms were dispatched at 30% of their rated capacity in all the cases.

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.

New summation label 0 MW

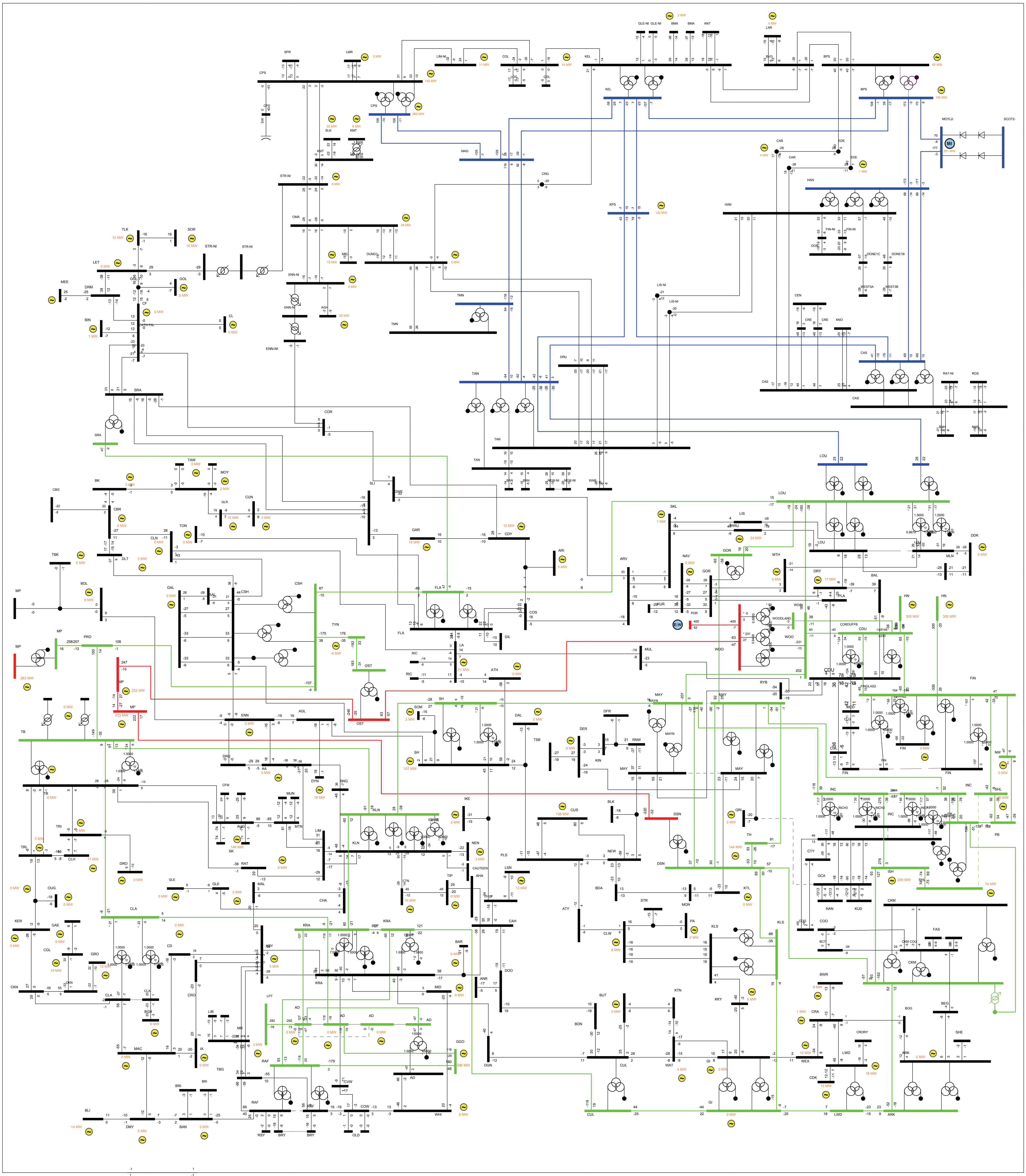


Figure I-01 Power Flow Diagram Summer Peak 2013

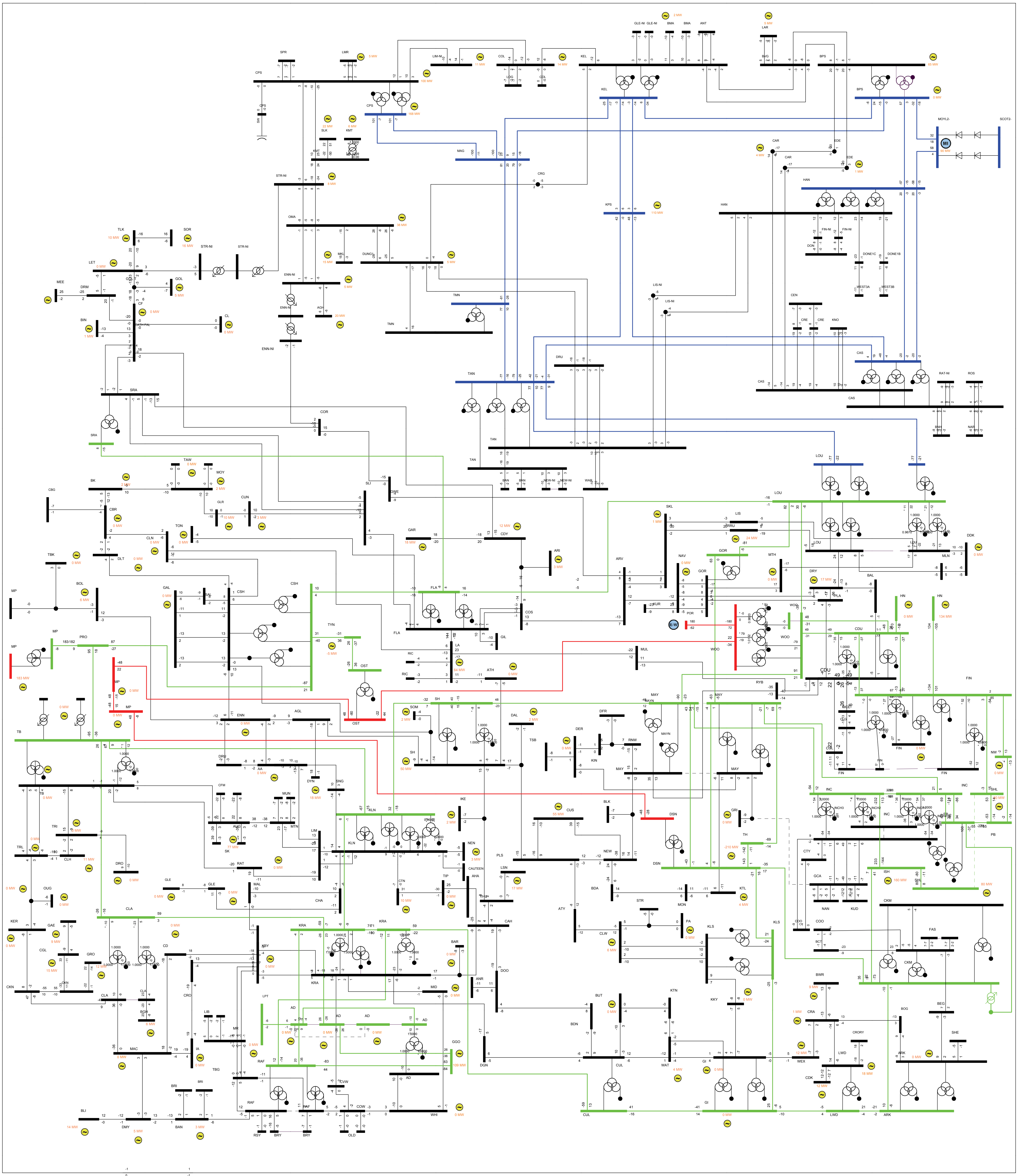


Figure I-02 Power Flow Diagram Summer Night Valley 2013

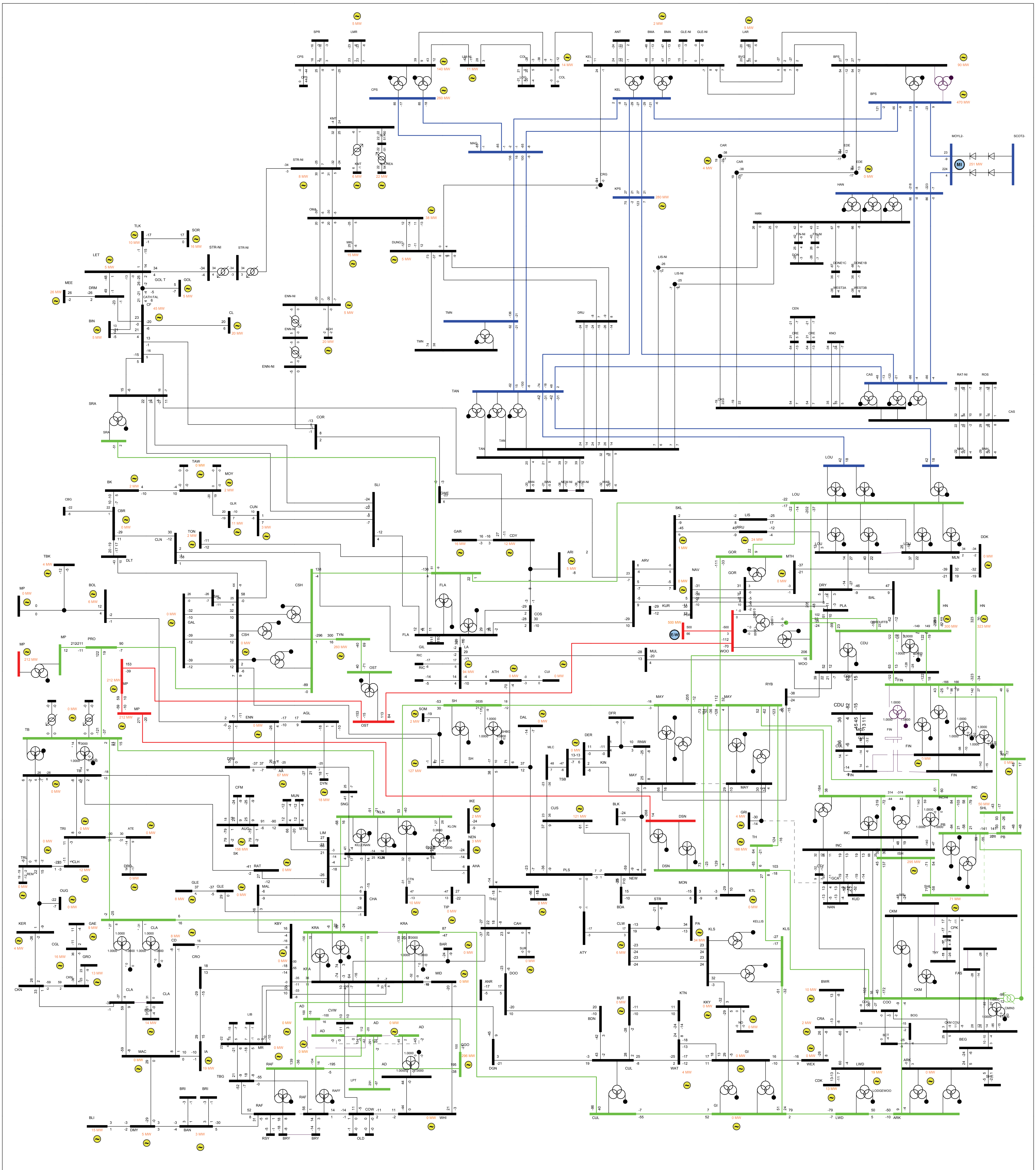


Figure I-03 Power Flow Diagram Winter Peak 2013/14

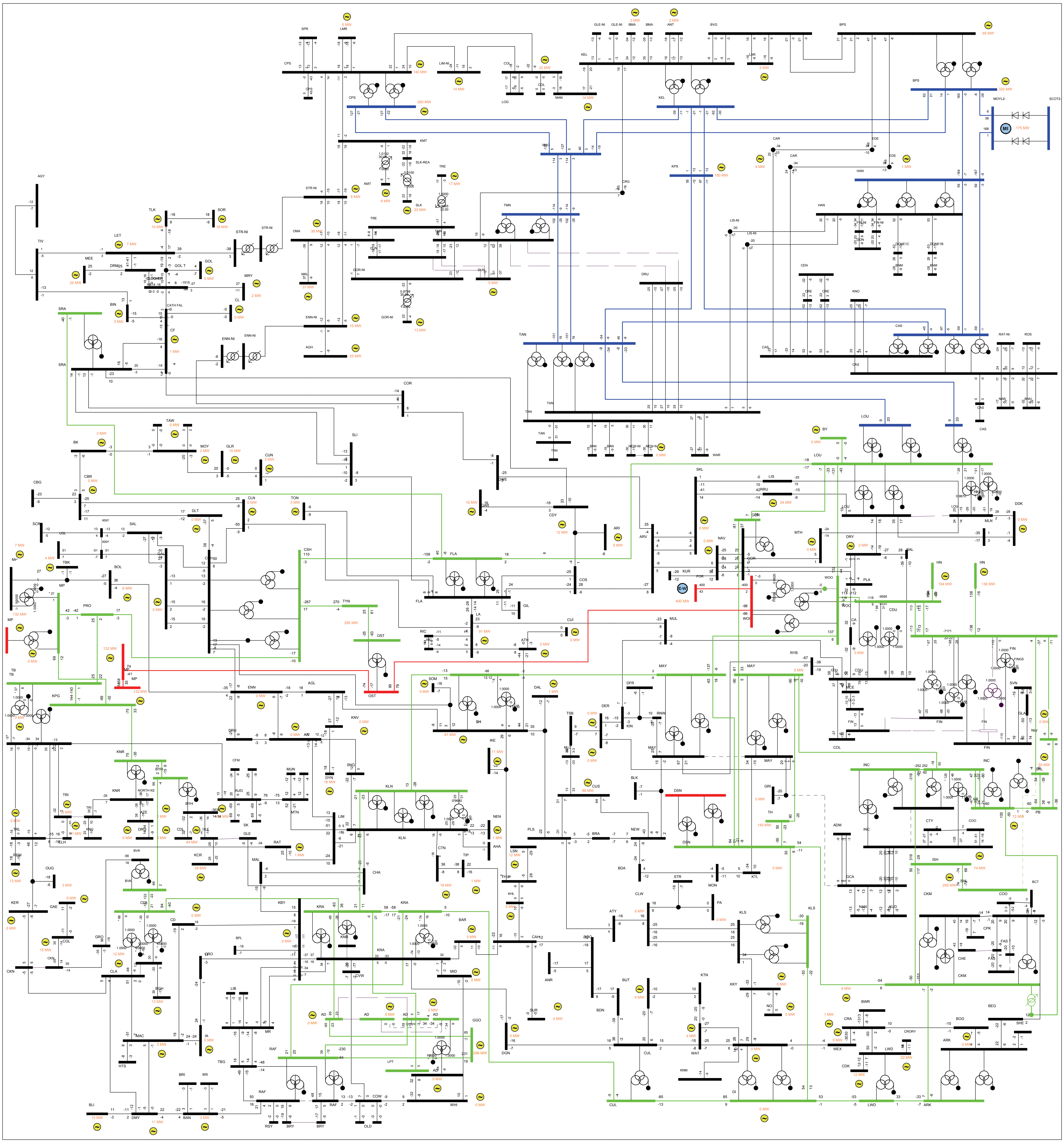


Figure I-04 Power Flow Diagram Summer Peak 2016

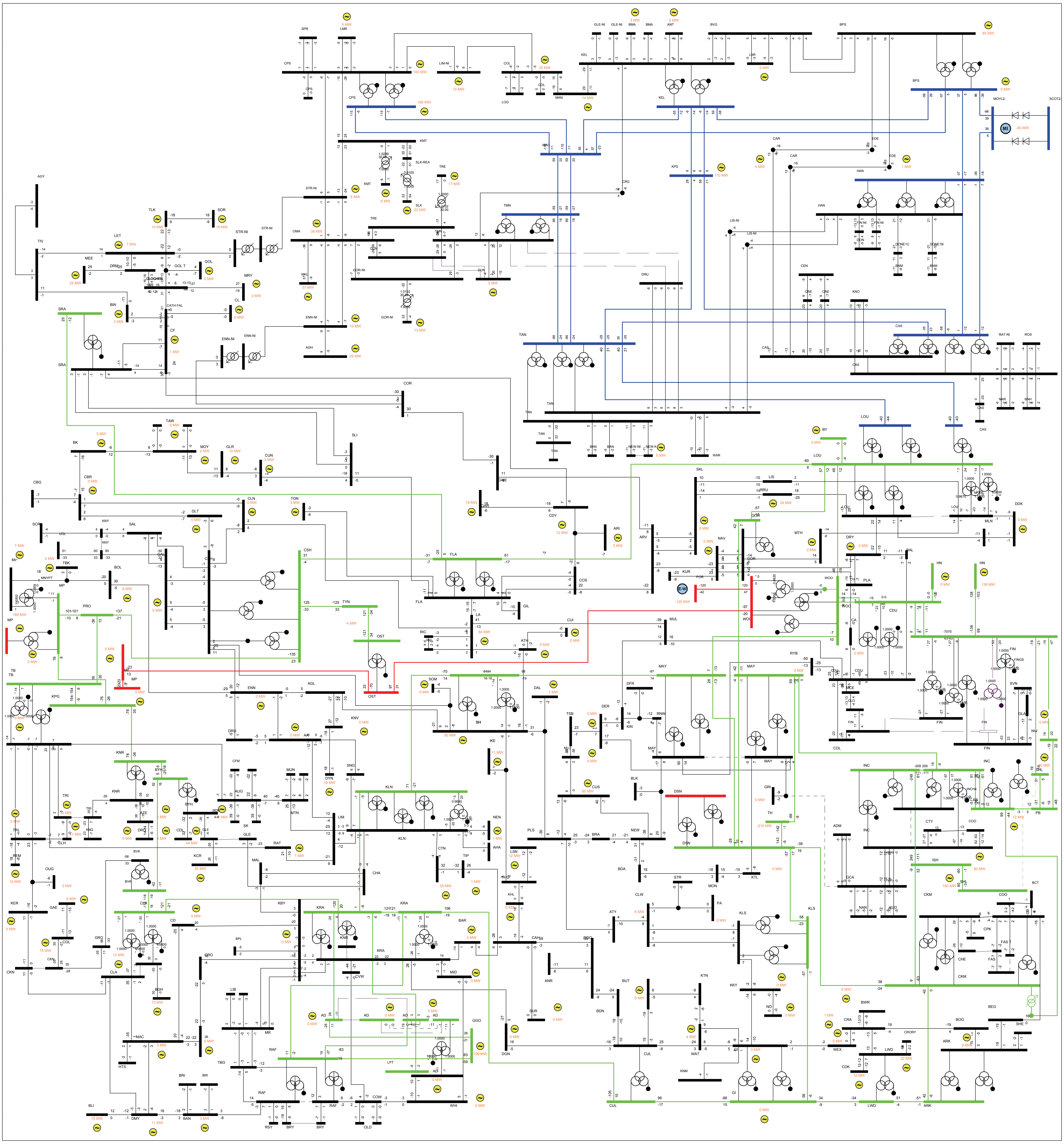


Figure I-05 Power Flow Diagram Summer Night Valley 2016

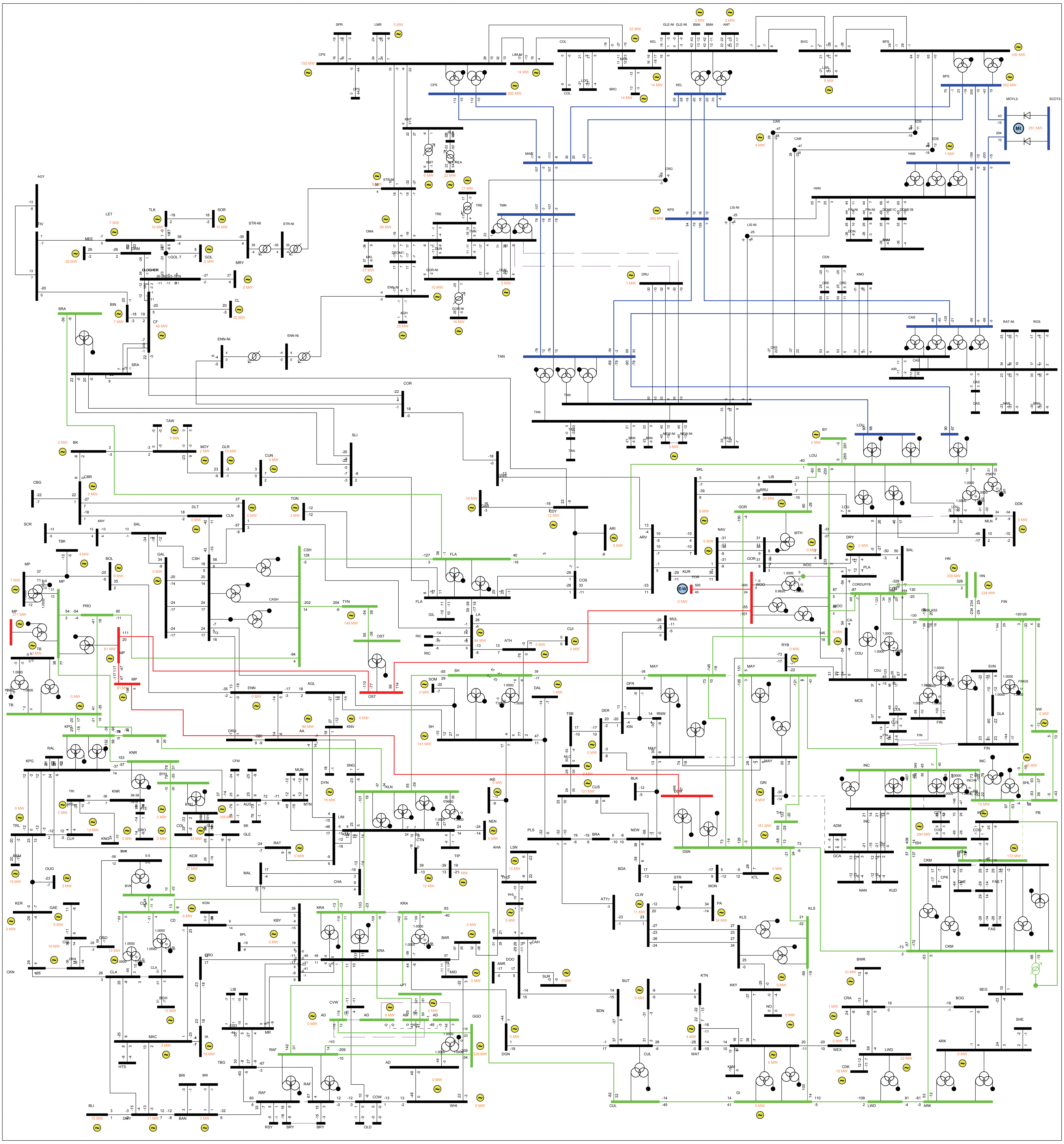


Figure I-06 Power Flow Diagram Winter Peak 2016/17

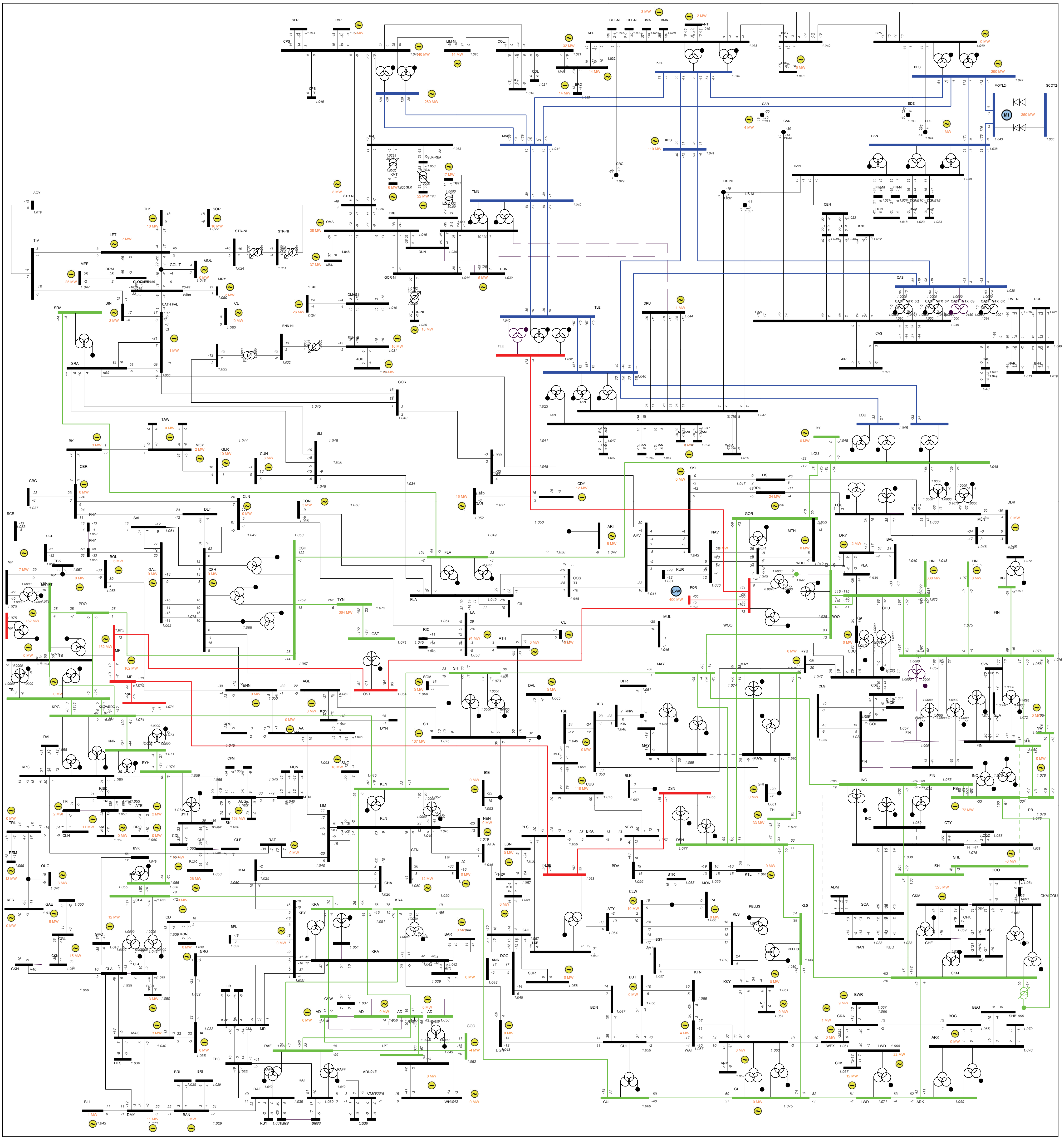


Figure I-07 Power Flow Diagram Summer Peak 2019

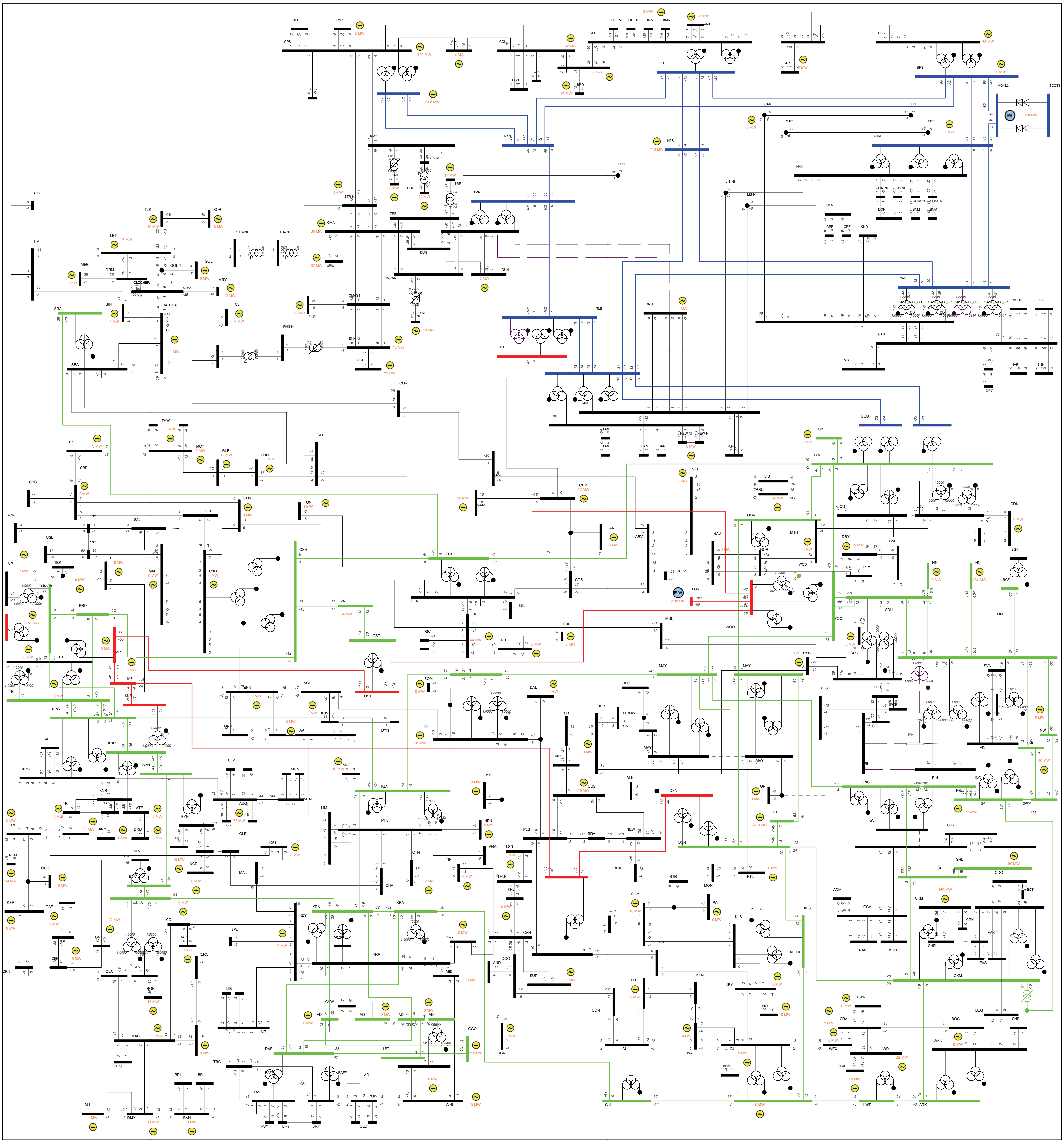


Figure I-08 Power Flow Diagram Summer Night Valley 2019

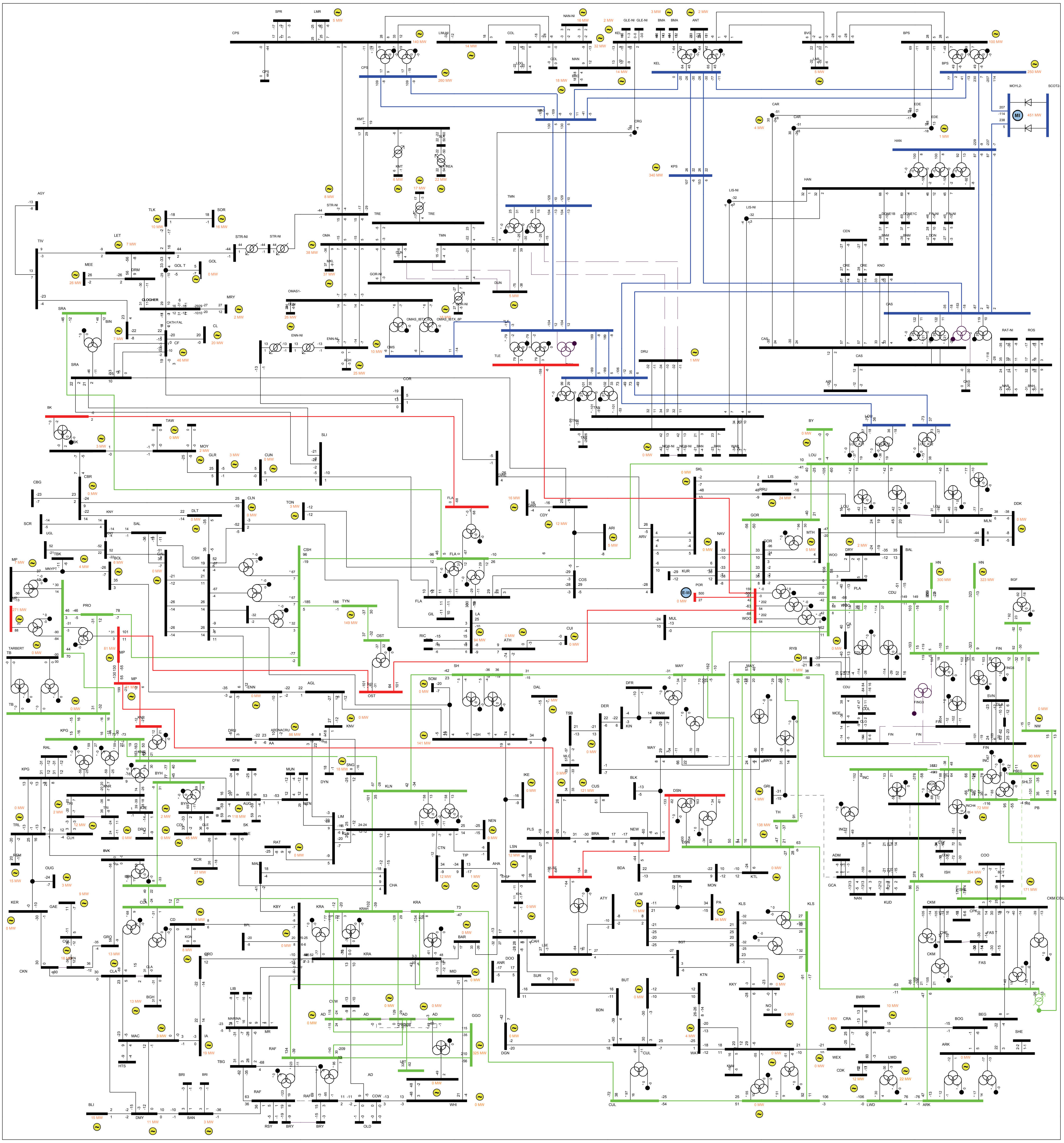


Figure I-09 Power Flow Diagram Winter Peak 2019/20

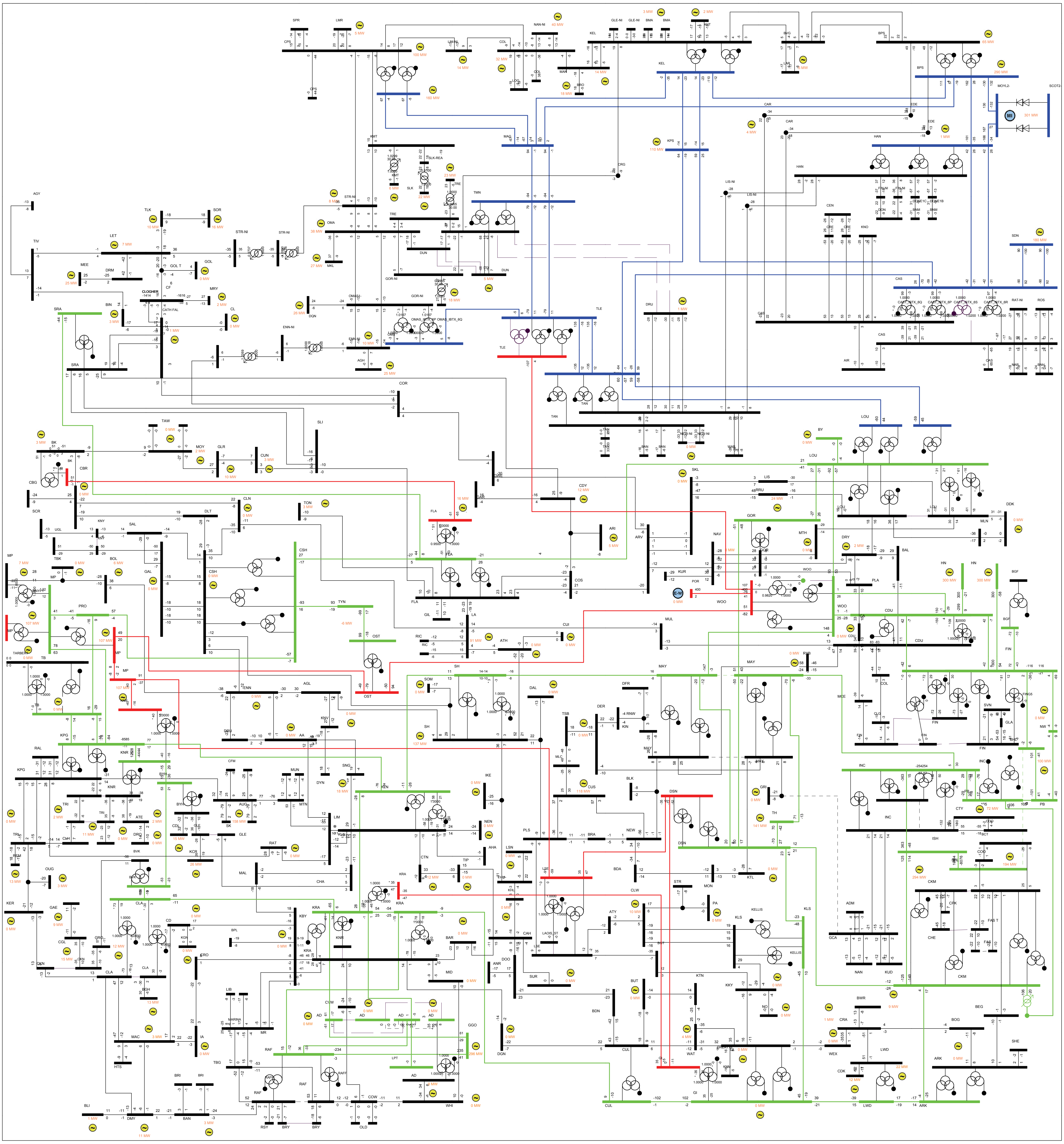


Figure I-10 Power Flow Diagram Summer Peak 2022

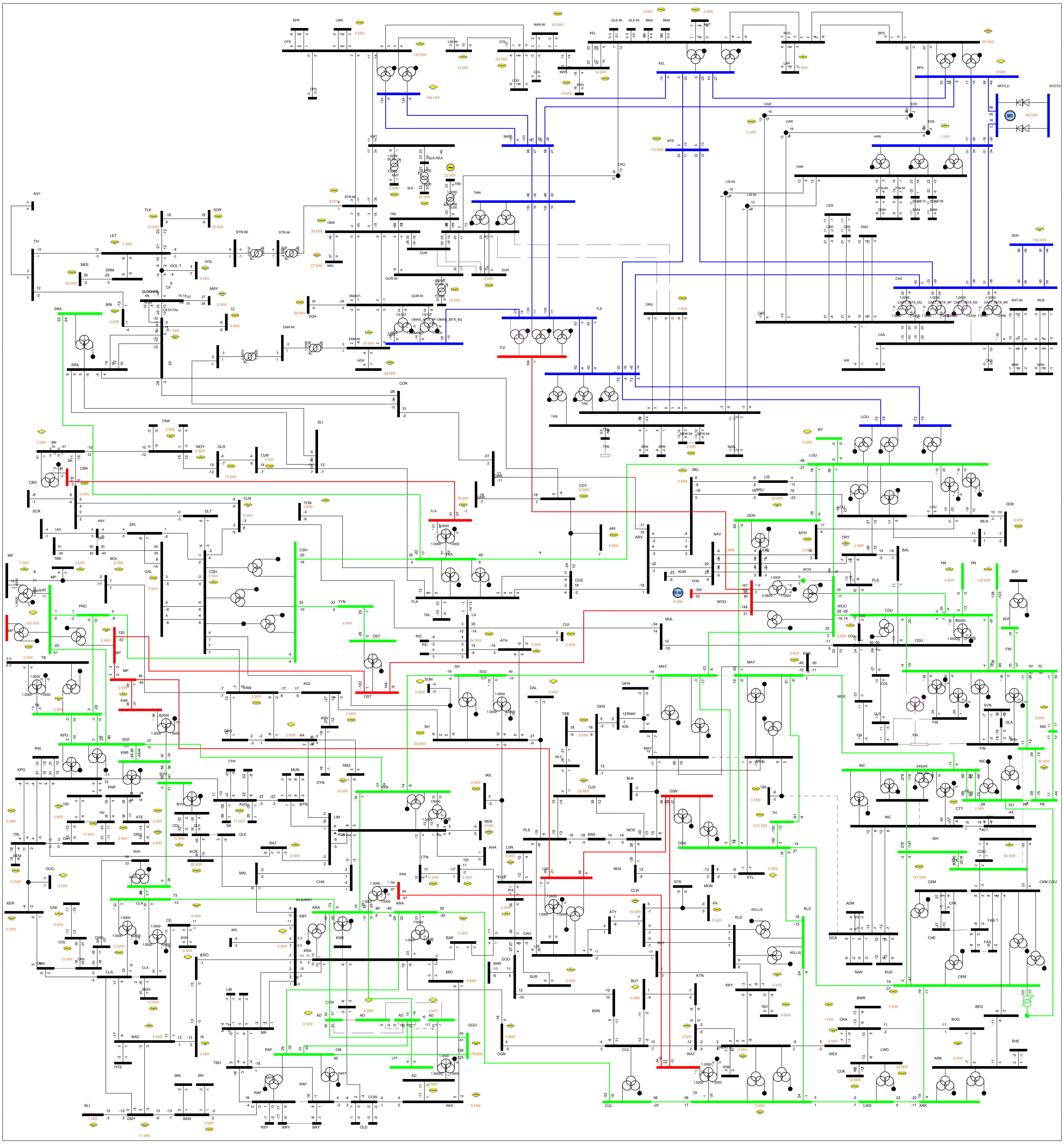


Figure I-11 Power Flow Diagram Summer Night Valley 2022

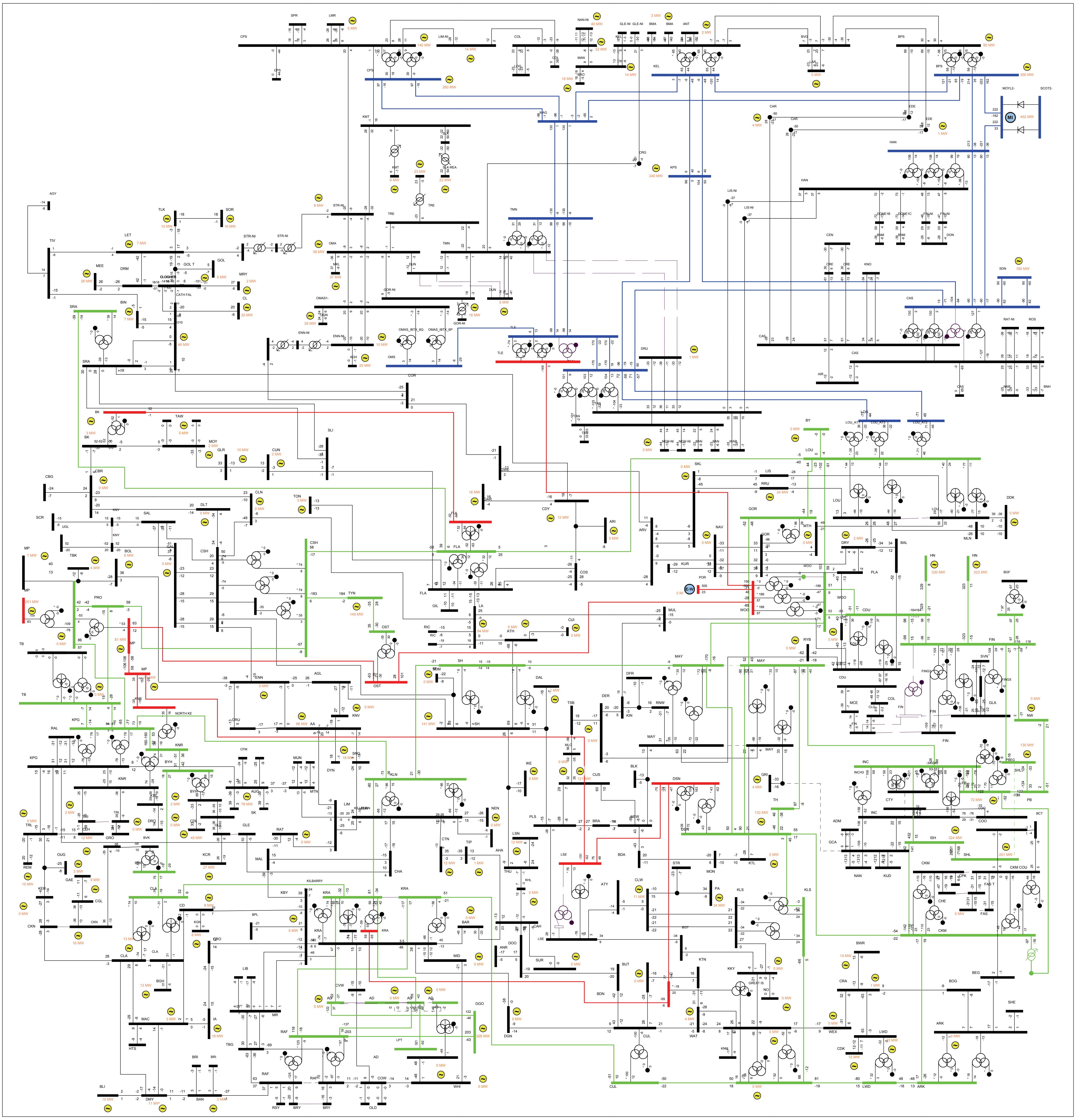


Figure I-12 Power Flow Diagram Winter Peak 2022/23

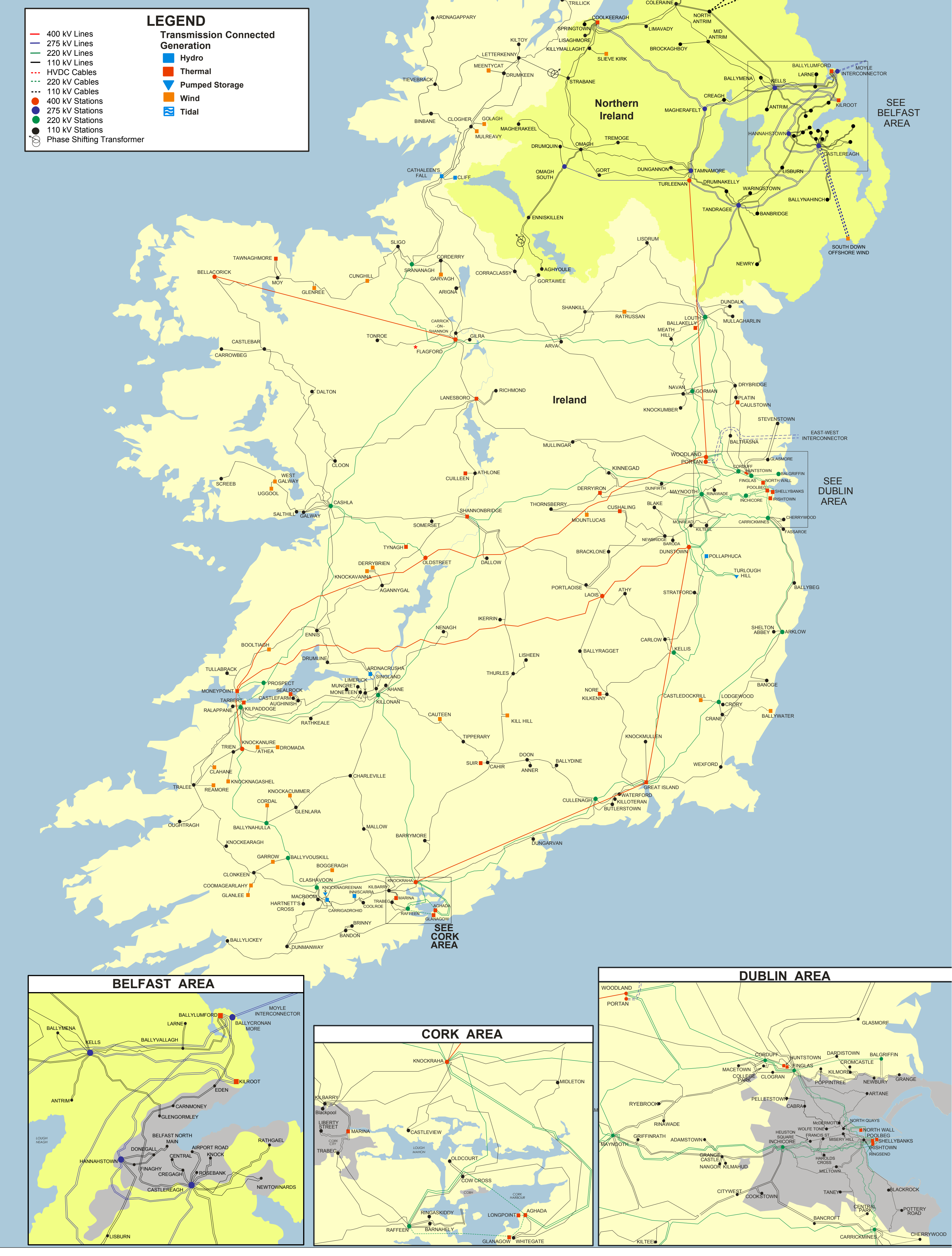
J Size A3 Geographical Maps

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 December of 2012 and as planned at the end of 2022.

Figure J - 1
Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at December 2012

Figure J - 2
Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at December 2022



The Oval,
160 Shelbourne Road,
Ballsbridge,
Dublin 4.

Tel +353 (0)1 677 1700
Fax +353 (0)1 661 5375

info@eirgrid.com
www.eirgrid.com

Castlereagh House,
12 Manse Road,
Belfast,
BT6 9RT.

Tel +44 28 907 94336
Fax +44 28 907 07560

enquiries@soni.ltd.uk
www.soni.ltd.uk