

All-Island Transmission Forecast Statement **2012-2018**



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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 Transmission Forecast Statement (TFS) 2012-2018, 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 single all-island statement which supersedes the *EirGrid Transmission Forecast Statement 2011-2017* and the *SONI Transmission System Capacity Statement 2011/12-2017/18*, published in April 2011 and September 2011 respectively.

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 TFS 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 seven 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.

A handwritten signature in blue ink that reads "Dermot Byrne". The signature is fluid and cursive, with the first letters of the first and last names being capitalized.

Dermot Byrne

Chief Executive, EirGrid Group

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Executive Summary



EXECUTIVE SUMMARY

The All-Island *Transmission Forecast Statement* 2012-2018 (TFS) describes the development of the transmission system on the island of Ireland over the seven-year period from 2012 to 2018.

This statement has been prepared jointly by EirGrid and SONI and supersedes the EirGrid *Transmission Forecast Statement 2011-2017* and the SONI *Transmission System Capacity Statement 2011/12-2017/18*, published in April 2011 and September 2011 respectively.

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.

The TFS 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 modest growth in the all-island transmission peak demand of 1.2% per year. 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 opportunities for the connection of demand across Northern Ireland. The demand opportunities at 110/33 kV substations 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 2018. The results highlight that new generation connections can be accommodated by the Northern Ireland transmission system at a number of 275 kV nodes without system reinforcement. Conversely the results also show that even with the timely delivery of NIE's planned reinforcements; both the Islandmagee area and the North West region of Northern Ireland cannot accommodate further generation

connections in 2018. 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.

The TFS 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 TFS – 2012, 2015 and 2018. 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 2016/17. This tie line will also increase security of supply, support the development of renewable power generation and provide economic benefits to the all-island transmission system.

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 TFS team. From Left to Right: Raymond Skillen, John O'Higgins, Noel Hanrahan, Richard Crowley, Simon Grimes and Dick Lewis (not pictured).

1 Introduction

- 1.1 Outline of the All-Island 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 Transmission Forecast Statement and Transmission System Capacity Statement separately. The *All-Island Transmission Forecast Statement 2012-2018* is a joint EirGrid / SONI statement that combines the two.

The *All-Island Transmission Forecast Statement 2012-2018* (TFS) 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 information to carry out their own power flow analysis, if desired.

EirGrid and SONI published the *All-island Generation Capacity Statement 2012-2021* (GCS) in December 2011. That document assesses the generation adequacy situation over the ten-year period to 2021. Insofar as possible the TFS complements the demand information presented in the GCS.

EirGrid issued its *Transmission Development Plan 2010-2015* to CER in July 2011. The plan provides details of the transmission system developments expected to be progressed in the five-year period to 2015. NIE have submitted their latest plans SONI in September 2011 as part of the TIA, NIE's plans are also being considered by UREGNI at the time of writing, the information contained in the TFS is representative of these plans.

1.1 OUTLINE OF THE ALL-ISLAND TRANSMISSION FORECAST STATEMENT

The format of the *All-Island Transmission Forecast Statement 2012-2018* is as follows:

- Chapter 2 provides a brief overview of the governing 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 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 demand frequently represent challenging conditions for the TSOs to manage. Table 1-1 shows the forecasts of peak transmission demand for the years 2012 to 2018 covered in this TFS. These are equivalent to projections of total system peak exported generation requirements. Appendix C presents forecasts of demand at each transmission station. Forecasts of transmission flows at peak take account of non-wind embedded generation. Due to its size and variability, transmission and distribution-connected wind generation is modelled explicitly in the analyses.

In overall terms, the TSOs expect that the all-island peak demand will increase by an average of approximately 1.2% each year over the period of the TFS, as outlined in the *All-Island Generation Capacity Statement 2012-2021*; corresponding to an average increase of 1.45% in Northern Ireland and 1.2% in Ireland. The forecasts take into account present difficult economic conditions.

Table 1-1 Forecast of Peak Transmission Demand

Year	Ireland Peak Demand (MW)	Northern Ireland Peak Demand (MW)
2012	4,653	1,731
2013	4,726	1,753
2014	4,799	1,779
2015	4,863	1,806
2016	4,918	1,833
2017	4,959	1,861
2018	5,002	1,889

1.2.2 Generation

The TFS provides information on connected, committed and retiring generation in both Northern Ireland and Ireland.

Northern Ireland

In Northern Ireland, at the beginning of 2012, some 3,196 MW of generation capacity was installed, of which 2,764 MW was connected to the transmission system and 432 MW to the distribution system.

It has been assumed that 741 MW of renewable generation will connect in Northern Ireland over the seven year period covered by the TFS. No thermal generation plant is planned to connect to the Northern Ireland transmission system over this seven 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 2018/19 the total Northern Ireland installed capacity will be circa 3,427 MW, however it should be noted that 1,173 MW of this is variable wind 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 Generation Connections

Type of Generation	Connected to	Number	MW
Offshore Wind	Transmission	1	50
Biomass	Distribution	1	15
Onshore Wind	Distribution	38	676
Total		40	741

It should be noted that a renewable generation target level of 40% is being considered for the year 2020 in Northern Ireland based on consumption. In order for Northern Ireland to meet this target approximately 1,600 MW of installed renewable generation capacity would be

required. This represents a considerable challenge for SONI to manage, and this is discussed in more detail in Chapter 5.

Ireland

At the data freeze date (July 2011), some 8,893 MW of generation capacity was installed in Ireland, of which 7,953 MW is connected to the transmission system and 940 MW to the distribution system. Table 1-3 summarises the planned connections as at the data freeze date.

Table 1-3 Summary of Generators with Signed Connection Agreements (July 2011)

Type of Generation	Connected to	Number	MW
Thermal	Transmission	5	797
Pumped Storage	Transmission	1	70
Wind Farm	Transmission	10	533
Thermal	Distribution	14	102
Hydro	Distribution	3	1
Wind Farm	Distribution	69	731
Total		102	2,233

Taking account of these committed connections, expected unit de-ratings and unit closures, the installed generating capacity would be 11,125 MW by the end of 2018, of which 9,352 MW will be transmission-connected¹.

In the period 2010-2011, 3,990 MW of wind generation (on-shore and off-shore), 91 MW of renewable generation and 1,345 MW of non-renewable/hybrid generation received offers under Gate 3, in Ireland.

1.2.3 Opportunities for New Demand

The transmission system is planned and developed to meet forecast demand growth across the island. The TFS 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 additional to those already forecast. As a general rule, opportunity at a particular node tends to reduce over the period of the seven years 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 A connection agreement was executed on November 5th 2011 between Endesa and EirGrid for a 431 MW CCGT plant at Great Island, Co. Wexford. This will result in the retirement of the current Great Island units.

1.2.4 Opportunities for New Generation

The TFS 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 400 MW without requiring significant transmission system reinforcement. Other nodes, such as Kells and Magherafelt, would also be capable of connecting a generator of significant size. However, the analysis also highlights several areas where there is no capacity, for example the Islandmagee area (Ballylumford and Moyle), Tamnamore and Coolkeeragh. For Ireland, 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. 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 2012, 2015 and 2018.

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 400 kV tie line, transmission system reinforcements and increasing renewable generation levels. In Northern Ireland these short circuit issues have been flagged to NIE and work is planned to resolve these issues. In Ireland these short circuit issues are being resolved by EirGrid. In the interim 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 as plant capability margins are considerably reduced. Figure 1-1 presents the short circuit results for the winter peak 2012 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.

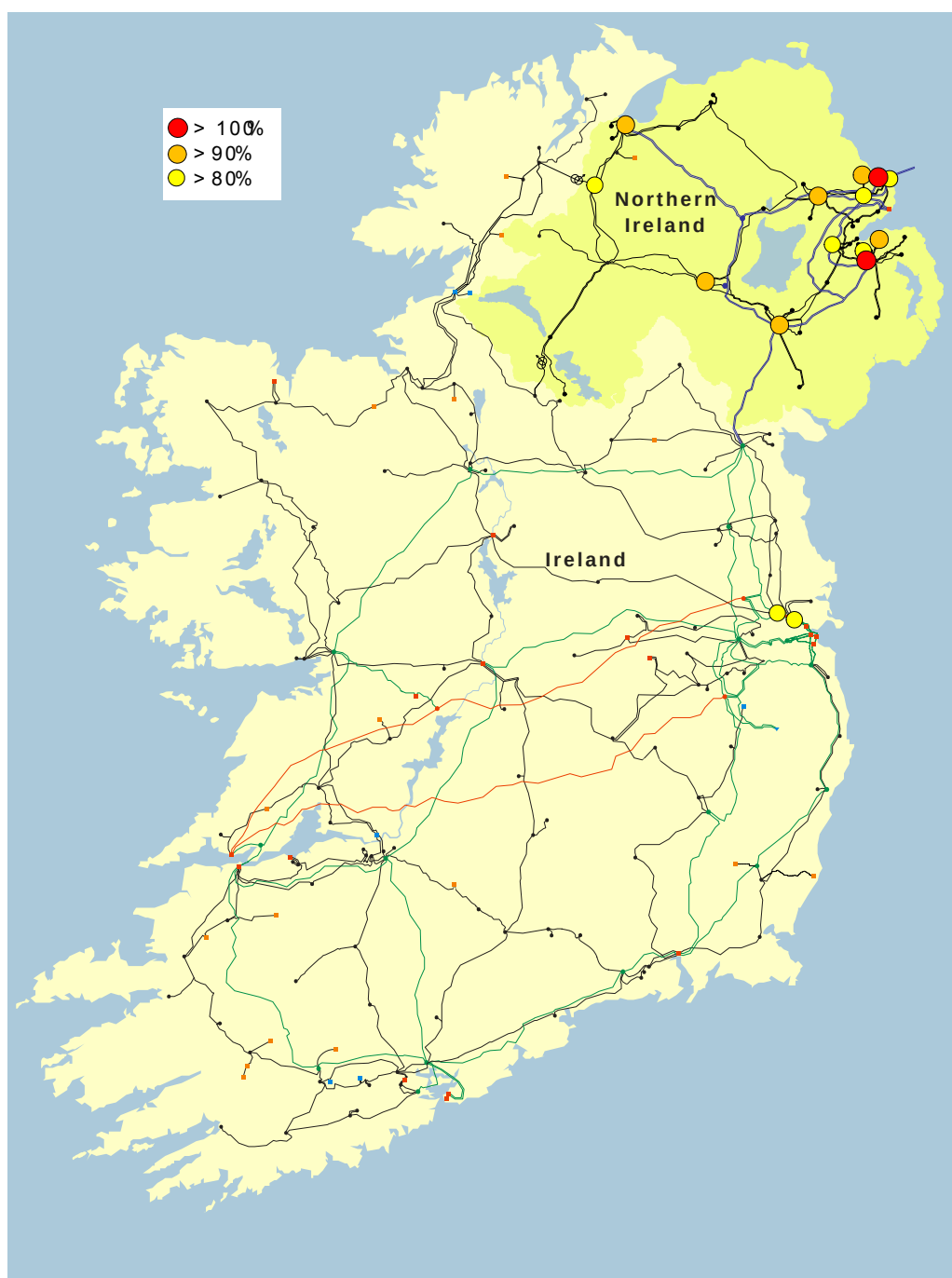


Figure 1-1 Fault Levels for Winter Peak 2012

1.3 OTHER INFORMATION

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

- SONI Grid Code²
- EirGrid Grid Code³

² <http://www.soni.ltd.uk/searchresults.asp>

- Northern Ireland Licence Standards – Transmission and Distribution System Security and Planning Standards⁴
- EirGrid Transmission Planning Criteria⁵ and Operating Security Standards⁶
- SONI Transmission Connection Charging Methodology Statement⁷
- EirGrid Transmission Connection Charging Methodology Statement 2008⁸
- Statement of Charges for Use of the NIE Transmission and Distribution System 2011⁹
- EirGrid Statement of Charges 2011/2012¹⁰
- SONI Transmission System Capacity Statement 2011/12-2017/18¹¹
- EirGrid Transmission Forecast Statement 2011-2017¹²
- All-Island Generation Capacity Statement 2012-2021¹³
- SONI Transmission System Performance Report¹⁴
- EirGrid Transmission System Performance Report¹⁵

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 TFS, EirGrid and SONI froze all data relating to demand, generation and the transmission systems at the beginning of July 2011 and November 2011 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:

- Upgrading of the Carrigadrohid-Macroon 110 kV line;
- Upgrading of the Inniscarra-Macroon 110 kV line;
- Upgrading of the Cahir-Tipperary-Cauteen-Killonan 110 kV line;

³ <http://www.eirgrid.com/operations/gridcode/>

⁴ <http://www.soni.ltd.uk/searchresults.asp>

⁵ <http://www.eirgrid.com/media/Transmission%20Planning%20Criteria.pdf>

⁶ <http://www.eirgrid.com/media/Operating%20Security%20Standards%20December%202011.pdf>

⁷ [http://www.soni.ltd.uk/upload/SEM-08-029%20SONI%20Charging%20%20Statement\[1\].pdf](http://www.soni.ltd.uk/upload/SEM-08-029%20SONI%20Charging%20%20Statement[1].pdf)

⁸ <http://www.eirgrid.com/media/Connection%20Charging%20Statement.pdf>

⁹ <http://www.niegetconnected.co.uk/publications.php>

¹⁰ [http://www.eirgrid.com/media/2011-2012%20Statement%20of%20Charges%20\(11.10.11\)%20v2.0.pdf](http://www.eirgrid.com/media/2011-2012%20Statement%20of%20Charges%20(11.10.11)%20v2.0.pdf)

¹¹ http://www.soni.ltd.uk/upload/2011_TSCS_PRINT_VERSION.pdf

¹² <http://www.eirgrid.com/aboutus/publications/transmissionforecaststatement2011-2017/>

¹³ <http://www.eirgrid.com/media/All-Island%20GCS%202012-2021.pdf>

¹⁴ http://www.soni.ltd.uk/newsstory.asp?news_id=101

¹⁵ <http://www.eirgrid.com/aboutus/publications/>

- Uprating of the Clashavoon-Knockraha 220 kV line;
- Uprating of the Clashavoon-Tarbert 220 kV line;
- Uprating of the Raffeen-Trabeg no.1 110 kV line;
- Uprating of the Charleville-Mallow 110 kV line;
- Uprating of the Cathaleen's Fall-Drumkeen 110 kV line;
- Uprating of the Cathaleen's Fall-Srananagh no.2 110 kV line;
- Uprating of the Cunghill-Sligo 110 kV line;
- Uprating of the Bellacorick-Castlebar 110 kV line;

1.5 PUBLICATION

This TFS 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 Standards

2.1 Governing Arrangements

2.1.1 System Operator Agreement

2.1.2 Single Electricity Market

2.1.3 Roles and Responsibilities'

2.2 Main Technical Requirements of the Transmission System

2.2.1 Security and Planning Standards

2.2.2 Electricity Supply Regulations

2.2.3 Grid Code Requirements

2.3 System Reliability, Stability and Quality

2.4 Increased Renewable Generation Levels



2 GOVERNANCE AND STANDARDS

2.1 GOVERNING ARRANGEMENTS

2.1.1 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 the TFS.

2.1.2 Single Electricity Market

A Single Electricity Market (SEM) has been operating on the island of Ireland, since 2007. The all-island wholesale electricity market allows 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. Down (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)

EirGrid and Northern Ireland Electricity (NIE) are planning a new 400 kV cross-border circuit, which is due to be installed by the end of 2016. Together with other reinforcements, the new circuit will facilitate a greater degree of flexibility in the single electricity market. In the context of the SEM, all cross-border circuits are essentially internal circuits in the market.

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. As such, flows of power across cross-border circuits were permitted in the short circuit and power flow analyses for this TFS.

2.1.3 Roles and Responsibilities (Governance)

Following the introduction of the SEM, both SONI's and NIE's licences were modified to reflect the new structure of the electricity supply industry. SONI has a licence obligation to operate, co-ordinate and direct the flow of electricity onto and over the Northern Ireland transmission system, while NIE has a licence obligation to plan, develop and maintain the Northern Ireland transmission system. In doing so, both SONI and NIE must comply with both the Transmission and Distribution System Security and Planning Standards and the SONI Grid Code. SONI is required to cooperate and assist the Transmission System Owner, 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 TFS forms part of the transmission planning process described in Section C of the TIA.

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.

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 Chapter 9 of this TFS, 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 they meet the requirements of 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 eventuality 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 wide spread 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 and Transmission Planning Criteria and Operating Security Standards for Ireland.

FREQUENCY

The declared frequency of the all-island transmission system is 50 Hz, and is normally controlled within the range 49.8 Hz to 50.2 Hz.

The TSO's 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 the all-island system frequency to fall below 49.3 Hz. In Ireland, 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 respectively.

The synchronous connection of the two transmission systems, currently via the 275 kV double circuit between Louth and Tandragee stations and the two 'power flow controlled' 110 kV circuits increases the inertia of the all-island transmission system, reducing the impact of the loss of a large infeed anywhere on the all-island transmission system.

The all-island transmission system carries reserves on centrally dispatched generating units, the Moyle Interconnector and contracted demand customers (the Short Term Active Response (STAR) scheme) to cover the loss of the largest infeed tripping off the system. This reserve is allocated on an economic basis. In 2012 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 425 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. It is expected that similar arrangements will be in place on the EirGrid East West Interconnector when it becomes operational in Q3 2012. Discussions between EirGrid, National Grid Electricity Transmission (NGET) and EirGrid Interconnector Limited are ongoing to develop these services.

VOLTAGE

The voltage variation permitted by the Electricity Supply Regulations (NI) 1991 on the Northern Ireland transmission system is $\pm 10\%$. 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, the tap position of each generator/system transformer, the electrical characteristics of the system, the level of system load and its power factor.

Voltage control is affected by providing automatic voltage control on generators, altering transformer tap positions and the switching of shunt reactors or capacitors. These operational measures do not compromise the security standards imposed by the Transmission System Operators licence.

2.2.3 GRID CODE REQUIREMENTS

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

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

2.3 SYSTEM RELIABILITY, STABILITY AND QUALITY

The operation of the transmission systems of Northern Ireland and Ireland are planned in accordance with the Transmission and Distribution Security and Planning Standards and 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
- Cascading voltages

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.

2.4 INCREASED RENEWABLE GENERATION LEVELS

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

- The connection of renewable generation to the transmission and distribution networks which displace 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 ‘Ensuring a Secure, Reliable and Efficient Power System in a Changing Environment’¹ report building on the ‘Facilitation of Renewables (FoR)’² 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 instability 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.

An all-island programme of work entitled ‘Delivering a Secure Sustainable Electricity System’ (DS3)³ has been developed by EirGrid and SONI to resolve the operational challenges (outlined above) associated with having up to 75% of generation from non-synchronous sources. The key objectives of the all-island DS3 programme are as follows:

- 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.

¹ http://www.eirgrid.com/media/Ensuring_a_Secure_Reliable_and_Efficient_Power_System_Report.pdf

² <http://www.eirgrid.com/media/FacilitationRenewablesFinalStudyReport.pdf>

³ <http://www.eirgrid.com/operations/ds3/>

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. This includes enhancing existing performance monitoring processes, ensuring Grid Code compliance and reviewing system services arrangements.
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.

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
- 3.8 Connection of New Interface Stations
- 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. Down (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 due to be installed by the end of 2016. 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 kV¹ 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 limited circumstances, such as in the city centres of Belfast, Cork and Dublin, where some limited underground cables are used. Table 3-1 presents the total lengths of overhead lines² 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 July 01st 2011

Voltage Level	Total Line Lengths (km)	Total Cable Lengths (km)
400 kV	439	0
275 kV	772	0
220 kV	1,731	117
110 kV	5,340	295

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 July 01st 2011³

Voltage Level	Capacity (MVA)	Number of transformers
400/220 kV	2,550	5
275/220 kV	1,200	3
275/110 kV	3,600	15
220/110 kV	9,739	50

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.

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 July 01st 2011⁴

Voltage Level	Type	Capacity (Mvar)	Number of Devices
400 kV	Line Shunt Reactor	160	2
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 ganged⁵ 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.

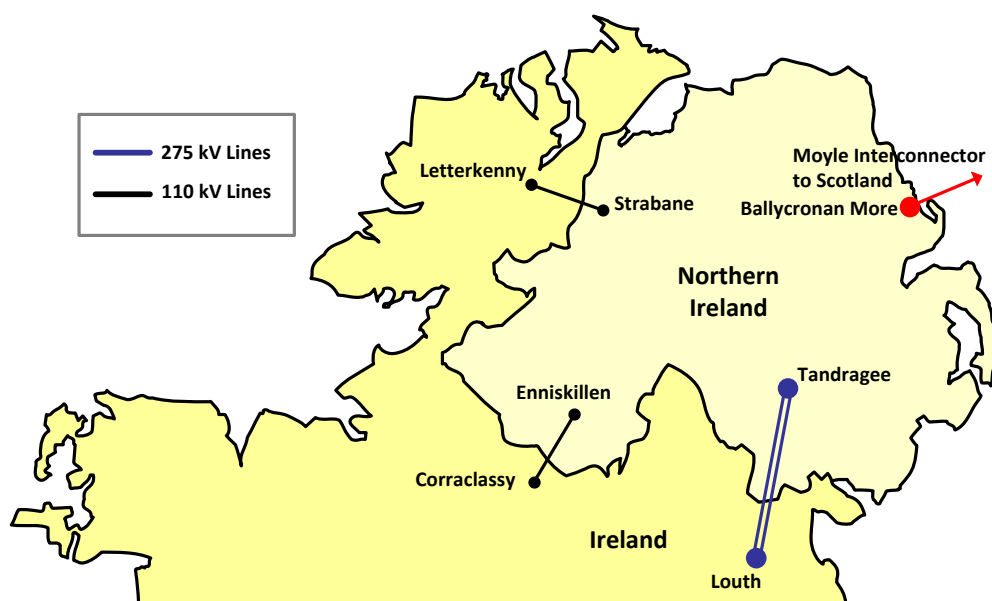


Figure 3-1 Existing Cross-Border Circuits

3.3 INTERCONNECTION WITH GREAT BRITAIN

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 undersea cables from Ballycronan More in Islandmagee, Northern Ireland to Auchencrosh in Ayrshire, Scotland. The link has a physical installed capacity of 500 MW; however, this is restricted due to certain network limitations on both sides of the link. An emergency flow of up to 75 MW is available should the frequency in Northern Ireland 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.

With large imports of power from Great Britain across the Moyle Interconnector and the future EirGrid East-West Interconnector, conventional generation is displaced by this non-synchronous source of generation. This reduces the transmission system inertia; which is also reduced by the increased wind penetration. The Moyle Interconnector increases the dynamic reactive support required by the transmission system; as the link does not have dynamic reactive power export capability, but the EirGrid East West Interconnector will have dynamic reactive power export capability. In Northern Ireland; the capacity of the Moyle Interconnector is auctioned by SONI⁶ on behalf of Moyle Interconnector Limited (MIL). This capacity is purchased by market participants. Figure 3-1 shows the location of the Moyle interconnector.

The amount of power that is permitted to be exported from Northern Ireland to Great Britain across the Moyle Interconnector is 300 MW all year. Table 3-4 below details the available capacity of the Moyle interconnector.

EirGrid is currently constructing a 500 MW HVDC interconnector from Ireland to Wales, this project is discussed in more detail in Section 3.4.

Table 3-4 Total Existing Constraints on the Moyle Interconnector

Direction	Summer	Winter
GB – NI	410 MW	450 MW
NI – GB	300 MW	300 MW

3.4 IRELAND TRANSMISSION SYSTEM DEVELOPMENTS

EirGrid, the TSO for Ireland, issued its *Transmission Development Plan 2010* to the CER in July 2011. The report details the transmission system development projects that have been initiated by EirGrid in addition to a discussion of further developments that may arise in the period of the plan.

The transmission system development plans include projects 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. All information presented on transmission system transfer capabilities and opportunities is contingent on the completion of these development projects in the assumed timeframe.

⁶http://www.mutual-energy.com/The_Moyle_Interconnector/Role_in_the_Electricity_Market.php

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 following is an overview of the major transmission system developments planned for the transmission system of Ireland at the beginning of July 2011, when data was frozen in order to facilitate the completion of the TFS. The Transmission Development Plan 2010 includes details of these and of significant 110 kV reinforcement projects planned for the transmission system. The planned developments are illustrated on a map and on the schematic network diagrams in Appendix A. New generation connections and new transmission interface stations are described in Sections 3.7 and 3.8 respectively.

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

Flagford-Srananagh 220 kV Development

Srananagh 220 kV station, east of Sligo town, will be connected to the 220 kV network by an overhead line from Flagford, near Carrick-on-Shannon, thus extending the 220 kV network into the north-west. A number of 110 kV lines will be connected into the new station, making Srananagh a new hub for power flows into the north-west of Ireland. The Flagford-Srananagh 220/110 kV project is needed to reinforce the network in this area of growing demand, and to reduce the risk of loss of supply at winter peak and during maintenance outages. The project will also contribute to facilitating the growing number of renewables in the North West. The 110 kV elements of this project were completed in 2009. At the time of the data freeze, it was assumed that the 220 kV elements of the project would be due for completion in 2011.

Glanagow-Raffeen 220 kV Circuit

The planned new 220 kV circuit from Glanagow to Raffeen in Co. Cork will be part submarine cable, part underground cable. At the time of the data freeze, it was expected to be completed in 2011.

East-West Interconnector

A new 500 MW interconnector is currently being constructed between Ireland and Wales. Once completed this interconnector will connect Woodland 400 kV station in Co. Meath to Deeside 400 kV station in North Wales via two HVDC cables. The EirGrid East-West Interconnector is scheduled to be operational in the latter part of 2012. The interconnector will be capable of importing and exporting 500MW of electricity.

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 is due for completion in 2015.

Balgriffin 220 kV Development

Balgriffin 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 Balgriffin 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 2014. This station has been renamed Belcamp 220 kV station, but for the purposes of this statement will be referred to as Balgriffin, as the name change occurred after the data freeze date.

Kilpaddoge 220 kV Development

Kilpaddoge 220 kV station, in north Co. Kerry, will be connected into the existing Clashavoon-Tarbert and Killonan-Tarbert 220 kV lines. A number of 110 kV lines will be connected into the new station, making Kilpaddoge a new hub for power flows into the south-west. Kilpaddoge 220/110 kV project is needed to accommodate the planned generation in the south-west and the refurbishment of the existing Tarbert 220 kV station. This project is due for completion in 2013.

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 2013.

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 two new 110 kV overhead lines. Ballyvouskill 220/110 kV project is needed to accommodate the planned generation in the south-west. This project is due for completion in 2014.

Knockanure 220 kV Development

Knockanure 220 kV station will be looped into the existing Clashavoon-Tarbert 220 kV line. The station will be looped into the existing Trien-Tarbert 110 kV circuit and the planned Trien-Athea 110 kV circuit. Knockanure 220/110 kV project is needed to accommodate the planned generation in the south-west. This project is due for completion in 2014.

Kishkeam 220 kV Development

Kishkeam 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. Kishkeam 220/110 kV project is needed to accommodate the planned generation in the south-west. This project is due for completion in 2014. This station has been renamed Ballynahulla 220 kV station, but for the purposes of this statement will be referred to as Kishkeam, as the name change occurred after the data freeze date.

400 kV station near Portlaoise

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, Kildare, Wicklow, Kilkenny, ensure security of supply to Kilkenny and will also increase capacity to the region. This project is due for completion in 2015.

Finglas 110 kV Redevelopment

Replacement of the existing Finglas 110kV station with a new 110kV 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 110kV expansion.

Moneypoint Redevelopment

A new 220 kV substation featuring a 220 kV busbar will be developed at Moneypoint. This will accommodate the planned 220/110 kV transformer which will connect Moneypoint 220 kV and 110 kV voltage levels and is required to reinforce the network in Co. Clare. It will also accommodate the planned Moneypoint-Kilpaddoge 220 kV circuit. The new 220 kV substation and 220/110 kV transformer are due to be completed in 2014.

A newly constructed 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 2015.

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 seven 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 the date the project is included in the TFS study files. In order to create TFS 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 Approved Network Developments

Dungannon-Omagh 110 kV Circuits – Phase 2

Phase 1 works have reconducted the sheltered sections of both Dungannon-Omagh circuits. The remaining lengths of the Dungannon-Omagh 110 kV circuits will be reconducted with Invar conductor. The cable on circuit 2 will also be replaced. Phase 2 works will enable each circuit to have a minimum rating of 186 MVA. Please note that the circuits will be limited to 150 MVA until switchgear at Dungannon is replaced. This work is due to be completed by winter 2011/12.

Ballymena Main Mesh

Two 45 MVA transformers at Ballymena Mesh are to be replaced by two 90 MVA transformers which are assumed to be installed and commissioned by winter 2011/12.

Hannahstown 3rd 275/110 kV IBTX

A third 240 MVA interbus transformer (IBTX) is to be installed at Hannahstown. The demand at Hannahstown will require all supplies to be maintained for the maintenance of one 275/110 kV IBTX coinciding with a forced outage of the other IBTX. Approval is in place for the 3rd IBTX at Hannahstown and the project first appears in the TFS study files in summer 2012.

Magherakeel 110/33 kV Cluster

A new 110/33 kV substation with two 90 MVA transformers is currently being constructed at Magherakeel. The cluster substation is located approximately 38 km west of Omagh Main. A single 110 kV overhead line circuit is under construction to connect the new cluster node into the existing 110 kV mesh at Omagh Main. The conductor is Upas, strung for 75°C; this circuit will be limited to a rating of 144 MVA due to cable connection into the Omagh Main. Magherakeel first appears in the TFS study files in summer 2012.

Killymallaght 110/33 kV Cluster

A new 110/33 kV substation is currently under construction, the substation will comprise of one 60 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 autumn 2012.

Carnmoney Main

One 60 MVA and two 30 MVA transformers at Carnmoney Main will be replaced by two 90 MVA transformers. This asset replacement first appears in the TFS files during winter 2012/13.

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 2012/13. Donegall North will then have two 90 MVA transformers in operation.

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. Approval has been obtained for a fourth transformer at Castlereagh; the project first appears in the TFS study files during winter 2012/13.

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 2012/13.

3.5.2 Unapproved Network Developments***Hannahstown 275/110 kV IBTX***

The interbus transformer IBTX 1 at Hannahstown 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 2012/13.

Ballylumford - Eden - Carnmoney 110 kV Circuit

The conductor on the Ballylumford-Eden-Carmmoney 110 kV circuit is to be replaced. Up-rating is required because the loss of the Hannahstown-Ballylumford / Moyle 275 kV double circuit tower line results in significant overload of the circuit, also single circuit outages can also cause the remaining circuit to be overloaded under normal dispatch levels. It is planned to reconductor the existing double circuit tower line with a GAP conductor, which will allow the up-rating of each circuit to a minimum of 186 MVA. The Ballylumford-Eden portion of the circuit is uprated in the TFS files in winter 2012/13. The Eden-Carmmoney section of the circuit is uprated in the TFS files one year later in winter 2013/14.

Coleraine-Kells 110 kV Circuit Upgrade

It is proposed to uprate the 110 kV circuit between Coleraine and Kells. The tower section of the circuit between Terrygowan and Kells is to be strung with GAP conductor. The Terrygowan-Coleraine 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. This network reinforcement first appears in the TFS study files in winter 2012/13.

Enniskillen-Omagh 110 kV Circuits

It is proposed to re-tension both sides of the double circuit tower line and operate at 75°C to cope with the wind generation being connected in Co. Fermanagh. The works when complete will allow the uprating of each circuit to a minimum of 109 MVA. This network reinforcement first appears in the TFS study files in winter 2012/13.

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 TFS files each substation has two fixed 25 Mvar capacitors working in conjunction with a static var compensator (SVC) with a range of ± 50 Mvar. These schemes first appear in the TFS study files in winter 2013/14.

North West Reactive Compensation

Reactive support at Coolkeeragh 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. It is

proposed that the reactive compensation scheme will be a combination of fixed and dynamic reactive support. In the TFS files there are two fixed 25 Mvar capacitors working in conjunction with a static var compensator (SVC) with a range of ± 50 Mvar. The North West reactive compensation scheme first appears in the TFS study files in winter 2013/14.

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.

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 2013/14. It is assumed that after this work takes place both interbus transformers at Ballylumford can be in service.

Castlereagh-Rosebank 110 kV Circuits

It is proposed to replace the two existing cable circuits which will allow increase the rating of each circuit to a minimum of 144 MVA. This network reinforcement is planned to be completed by winter 2013/14.

Enniskillen Main

It is proposed to replace two 45 MVA transformers and one 60 MVA transformer at Enniskillen Main with two 90 MVA transformers. The asset replacement is planned to be installed and commissioned by winter 2013/14.

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. It is proposed to divert the remaining 275 kV Magherafelt-Tandragee circuit into the substation. The network reinforcement first appears in the TFS study files during winter 2014/15.

Omagh-Tamnamore New 110 kV Circuit

It is proposed to construct a 3rd Omagh-Tamnamore 110 kV single circuit during winter 2014/15, 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 45 km in length on Portal construction and conductored with Zebra strung for 75°C. The circuit will also be looped in to connect with the proposed Fallaghearn cluster substation. The network reinforcement first appears in the TFS study files during winter 2014/15.

Fallaghearn 110/33 kV Cluster

It is proposed to construct a 110/33 kV substation with one 60 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. Fallaghearn cluster first appears in the TFS study files in winter 2014/15.

Pomeroy 110/33 kV Cluster

The proposed establishment of a 110/33 kV substation with one 60 MVA transformer at a site adjacent to the existing 110 kV Omagh-Dungannon circuit '2' following Tamnamore Phase 2 works this circuit will be re-named 'Omagh-Tamnamore', approximately 21 km east of Omagh Main and 18 km west of Tamnamore Main. The existing circuit will be looped into this new cluster substation. Pomeroy cluster first appears in the TFS study files in winter 2014/15.

Mid-Antrim 110/33 kV Cluster

The construction of a 110/33 kV substation with one 60 MVA transformer at a site 6 km from 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 via the construction of two portal 110 kV circuits of 6 km in length each. The conductor is assumed to be Invar, strung for 200°C. This cluster first appears in the TFS study files in winter 2014/15.

Altahullion 110/33 kV Cluster

A new 110/33 kV substation is to be constructed with one 60 MVA transformer. The Altahullion Cluster is to be located approximately 13 km southwest of Limavady Main. A single 110 kV overhead line circuit will be constructed (AP1 construction) to connect the new cluster hub into the existing 110 kV mesh at Limavady Main. The conductor is likely to be Upas; strung for 75°C the circuit is limited to a rating of 144 MVA because of cable connection into Limavady Main. This cluster first appears in the TFS study files in winter 2014/15.

Hannahstown 275/110 kV IBTX 2

The interbus transformer IBTX2 at Hannahstown is to be replaced. The replacement transformer will have a 60 MVA tertiary winding. The asset replacement first appears in the study files during winter 2014/15.

Cregagh Main

It is proposed to replace two 75 MVA transformers at Cregagh Main with two 90 MVA transformers. The asset replacement first appears in the TFS study files during winter 2014/15.

Ballymena Main (switchboard)

It is proposed to replace two 60 MVA transformers at Ballymena switchboard with two 90 MVA transformers. The asset replacement first appears in the TFS study files during winter 2014/15.

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 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. The existing Donegall to PSW 110 kV feeders will be turned in and connected to the proposed new 110/33 kV transformers, the residual sections of 110kV circuits to PSW will be decommissioned. This project first appears in the TFS study files in winter 2015/16.

Cam 110/33 kV Cluster

A new 110/33 kV substation is to be constructed with one 60 MVA transformer. The Cam cluster is to be located approximately 13 km south of Coleraine Main. A single 110 kV overhead line circuit will be constructed to connect the new cluster hub into Coleraine Main. The conductor is likely to be Upas, strung for 65°C. This project is expected to be completed by winter 2015/16.

Coolkeeragh-Limavady-Coleraine 110 kV Circuits

It is proposed to replace the existing Coolkeeragh-Limavady 110 kV circuit as well as the Coleraine-Limavady 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 to a mixture of Invar and GAP conductors. When works are complete the circuits will be up rated to a minimum of 186 MVA. This network reinforcement first appears in the study files in winter 2015/16.

Donegall Main (South)

It is proposed to replace two 60 MVA transformers at Donegall South with two 90 MVA transformers. The asset replacement first appears in the TFS study files during winter 2015/16.

Coolkeeragh-Magherafelt 275 kV Circuits

It is proposed to change the conductor on the existing double circuit tower line. The proposed new conductor has yet to be selected but may be Rubus 500 mm² 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 TFS study files during winter 2015/16.

Hannahstown-Lisburn 110 kV Circuits

The conductors on the Hannahstown-Lisburn '1' and '2' 110 kV single circuits are to be replaced. 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 2016/17.

Drumquin 110/33 kV Cluster

A new 110/33 kV substation is to be constructed with one 60 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.

Limavady Main Extension

It is proposed to extend the busbar at Limavady Main to accommodate turning in the existing Coolkeeragh-Coleraine 110 kV circuit. The conductor on the turned in circuits will then be replaced with a mixture of Invar and GAP conductor with a minimum rating of 186 MVA. This network reinforcement first appears in the study files in 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 TFS 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. 110 kV cables will be laid from the Dee Street terminal tower direct to the transformer end boxes. It is proposed that the existing Rosebank to Dee Street tower line will be connected to the 110 kV network at Rosebank in a tee off

arrangement. This will take place after the Castlereagh-Rosebank 110 kV cables are replaced. Airport Road first appears in the TFS study files during winter 2017/18.

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 base 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 in principle Regulatory and NIE Executive 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 TFS study files during winter 2016/17. 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 TFS. Table 3-5 shows the connection method for the future generators.

Table 3-5 Planned Connection Methods of Future Generators

Generator	Planned Connection Method
Altahullion 1, 2 & 3	Connected to the future Altahullion 110 kV substation, itself radially-connected to Limavady 110 kV substation
Altamuskin	Connected to a new Fallaghearn 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Altgolan (Extension)	Connected to the future Magherakeel 110 kV substation, itself radially-connected to Limavady 110 kV substation
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
Ballyreagh Tempo	Connected into the existing Enniskillen 110 kV substation
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 the existing Limavady 110 kV substation
Cam	Connected into the future Cam 110 kV substation, itself radially-connected into Coleraine 110 kV substation
Carn Hill	Connected into the existing Carnmoney 110 kV substation
Carrickataine	Connected into the existing Killymallaght 110 kV substation
Castlecraig	Connected into the future Drumquin 110 kV substation, itself radially-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
Churchhill	Connected into the future Magherakeel 110 kV substation, itself radially-connected into Omagh 110 kV substation
Cloghboola	Connected to a new Knocknagashel 110 kV substation; itself tailed into Trien 110 kV substation
Cloonty	Connected into the existing Coleraine 110 kV substation

Table 3-5 Planned Connection Methods of Future Generators (continued)

Generator	Planned Connection Method
Clunahill	Connected into the future Drumquin 110 kV substation, itself radially-connected into Omagh South 110 kV substation
Corby Knowe	Connected into the existing Antrim 110 kV substation
Cornavarrow	Connected into the future Drumquin 110 kV substation, itself radially-connected into Omagh South 110 kV substation
Creagh Concrete	Connected into the existing Ballymena 110 kV substation
Cregganconroe	Connected to a new Pomeroy 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Crigshane	Connected into the future Magherakeel 110 kV substation, itself radially-connected into Omagh 110 kV substation
Crockagarron (Extension)	Connected into the existing Dungannon 110 kV substation
Crockbrack	Connected to a new Pomeroy 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Crockdun	Connected to a new Pomeroy 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Cuilleen	Connected to a new Cuilleen 110 kV substation, itself tail-connected into Athlone 110 kV substation
Drumadarragh	Connected into the existing Larne 110 kV substation
Drumquin	Connected into the new Drumquin 110 kV substation, itself radially-connected into Omagh South 110 kV substation
Dunbeg	Connected into the new Cam 110 kV substation, itself radially - connected into Coleraine 110 kV substation
Dunmore	Connected into the future Cam 110 kV substation, itself radially - connected into Coleraine 110 kV substation
East Coast Offshore	Connected into the existing Tandragee 110 kV substation
Eglish	Connected into the existing Killymallaght 110 kV substation
Eshmore	Connected to a new Fallaghearn 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Glanlee Wind Farm (Extension)	Connected into the existing Glanlee 110 kV substation
Glenbuck 1 & 2	Connected into the future Mid-Antrim 110 kV substation looped into the Coleraine-Kells 110 kV circuit
Glenconway	Connected into the existing Killymallaght 110 kV substation

Table 3-5 Planned Connection Methods of Future Generators (continued)

Generator	Planned Connection Method
Gortfinbar	Connected to a new Pomeroy 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Glanlee Wind Farm (Extension)	Connected into the existing Glanlee 110 kV substation
Innishative	Connected to a new Pomeroy 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Keelderry	New Knockavanna 110 kV substation looped into the Agannygal-Derrybrien 110 kV circuit
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
Magherakeel	Connected into the future Magherakeel 110 kV substation, itself radially-connected into Omagh 110 kV substation
Maydown Biomass	Connected into the existing Coolkeeragh 110 kV substation
Meenakeeran	Connected into the future Magherakeel 110 kV substation, itself radially-connected into Omagh 110 kV substation
Mid-Antrim	Connected into the future Mid-Antrim 110 kV substation, itself looped into the Coleraine-Kells 110 kV circuit
Moneypoint	Connected into existing Moneypoint substation at 110 kV
Mullynaveagh	Connected into the existing Drumnakelly 110 kV substation
Mulreavy	New Mulreavy 110 kV substation tail-connected into Cathaleen's Fall 110 kV substation
Nore Power	Connected to a new Nore 110 kV substation, itself tail-connected into Kilkenny 110 kV substation
Ora Moore	Connected into the existing Enniskillen 110 kV substation
Pigeon Top	Connected into the future Drumquin 110 kV substation, itself radially-connected into Omagh South 110 kV substation
Seegronan	Connected into the future Magherakeel 110 kV substation, itself tail-connected into Omagh 110 kV substation
Slatbeg	Connected to a new Fallaghearn 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Slieve Divena 2	Connected to a new Fallaghearn 110 kV substation, itself looped into the future Omagh-Tamnamore 110 kV circuit
Smulgedon	Connected into the existing Limavady 110 kV substation

Table 3-5 Planned Connection Methods of Future Generators (continued)

Generator	Planned Connection Method
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 substation, itself radially -connected into Omagh 110 kV substation
Tievnamenta	Connected into the future Magherakeel 110 kV substation, itself radially -connected into Omagh 110 kV substation
Tullynageer	Connected into the existing Newry 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 3-6 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 3-6 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 Doirí Beaga	Donegal
Ballycummin	BCM	Raheen	Limerick
Ballyragget	BGT	Ballyragget	Kilkenny
Banoge	BOG	Gorey	Wexford
Belfast North Main	BNM	Belfast	Antrim
Bracklone	BRA	Portarlinton	Laois
Cherrywood	CHE	Loughlinstown	Dublin
Hartnett's Cross	HTS	Macroon	Cork
Heuston	HEU	Heuston Station	Dublin
Nenagh	NEN	Nenagh	Tipperary
Knockmullen	KNM	New Ross	Wexford
Ralapanne	RAL	Ralapanne	Kerry
Screeb	SCR	Camus Íochtar	Galway
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 July 2011. 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 2018, including the planned developments. The schematic network diagrams in Appendix A show snapshots of the existing and planned transmission developments at the end of 2011, 2012, 2015 and 2018. The diagrams indicate stations, circuits, transformers, generation, reactive devices and phase shifting transformers.

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

- Tables B-13 to B-17 contain data for new lines and cables and planned changes to existing line and cable data on an annual basis. These tables include a column to indicate whether each listed item of plant is being added, amended or deleted. Changes relating to a particular development project are grouped together and headed by a project description which includes the Capital Project (CP) number with respect to Ireland and a SONI description heading for Northern Ireland.
- Tables B-18 to B-22 list the details of the planned network transformers.
- Tables B-23 to B-24 include the Mvar capacity data for planned reactive compensation devices.
- Tables B-25 to B-26 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 preliminary. Electrical characteristics will be reviewed when the plant is commissioned.

4 Demand

- 4.1 Forecast 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 2012-2021*, published by the EirGrid and SONI in December 2011) contains forecasts of future energy consumption and demand for the ten-year period to 2021.

4.1 FORECASTS OF TRANSMISSION PEAKS

Table 4-1 presents the median winter peak forecasts of transmission demand for the seven years 2012 to 2018, 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 1.2% over the period 2012 to 2018. This is approximately 0.5% less than that predicted in the All-Island Generation Capacity Statement 2011-2020, which forecast 1.7% average annual increase in winter peak demand.

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

	2012	2013	2014	2015	2015	2016	2018
GCS 2012-2021 (MW)	6,348	6,441	6,540	6,630	6,711	6,780	6,851
GCS 2011-2020 (MW)	6,363	6,494	6,631	6,757	6,864	6,957	7,052
Difference (MW)	-15	-53	-91	-127	-153	-177	-201

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)
	Irl	NI	Irl	NI	Irl	NI	NI
2012	6,384		5,086		2,172		1,489
	4,653	1,731	3,722	1,364	1,675	497	
2013	6,441		5,162		2,204		1,508
	4,726	1,753	3,781	1,381	1,701	503	
2014	6,540		5,241		2,238		1,530
	4,799	1,779	3,839	1,402	1,728	511	
2015	6,630		5,314		2,269		1,553
	4,863	1,806	3,890	1,423	1,751	518	
2016	6,711		5,379		2,297		1,576
	4,918	1,833	3,934	1,444	1,770	526	
2017	6,780		5,434		2,319		1,600
	4,959	1,861	3,967	1,466	1,785	534	
2018	6,851		5,490		2,343		1,625
	5,002	1,889	4,002	1,489	1,801	542	

Northern Ireland Transmission Peaks

The winter peak figures 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 2012 forecast of 1,731 MW is the maximum demand projected to occur in winter 2012/13.

The summer peak refers to the average peak value between May and August. This is typically 21.2% lower than the winter 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 summer minimum is referred to as the summer valley in this TFS. 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. The forecasts of summer valley demands in Table 4-2 assume a figure of 28.7% 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 figures represent the expected annual peak demands that are forecast to occur in the October to February winter period of each year e.g., the 2012 forecast of 4,653 MW is the maximum demand projected to occur in winter 2012/13.

The summer peak refers to the average peak value between March and September. This is typically 20% lower than the winter 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 in this TFS. Summer valley cases examine the impact of less demand and less 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. The forecasts of summer valley demands in Table 4-2 assume a figure of 36% 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 2010/11. It is quite unusual that the peak demand of Northern Ireland and Ireland occurred on the same day and at the same time; historically this has not been the case. In this instance, this occurrence may be attributable to the very cold temperatures experienced across the entire island at this time.

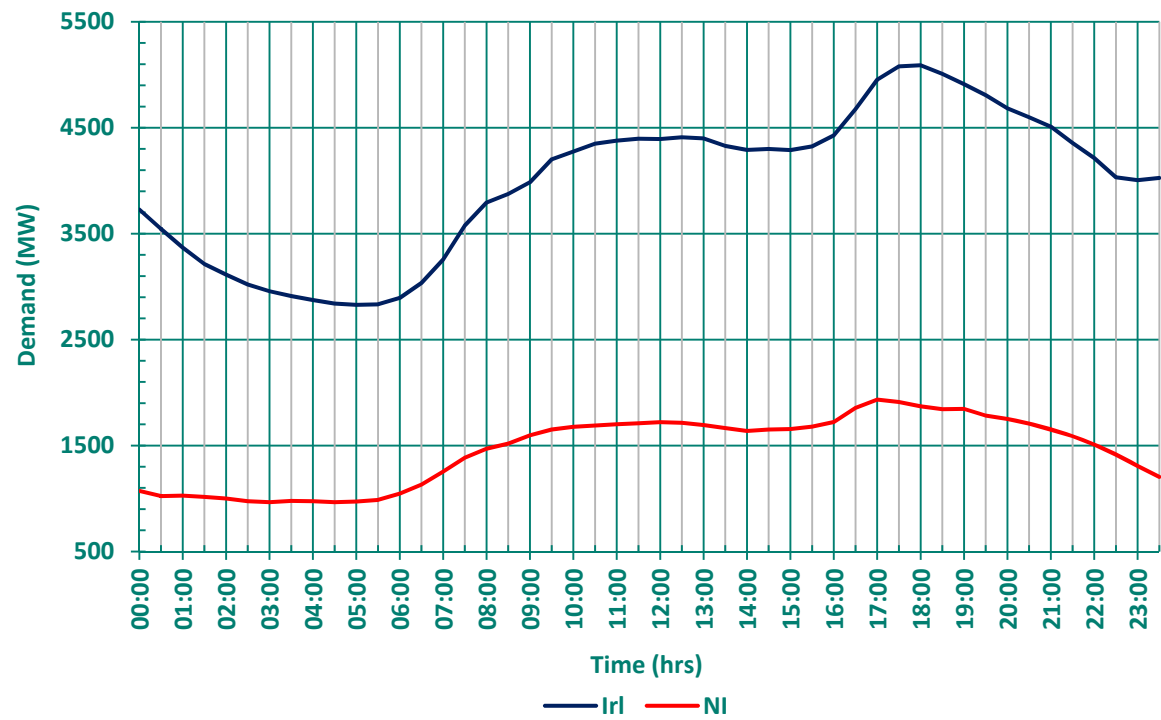


Figure 4-1 Generated Peak Demand Profiles for 2010/11

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.

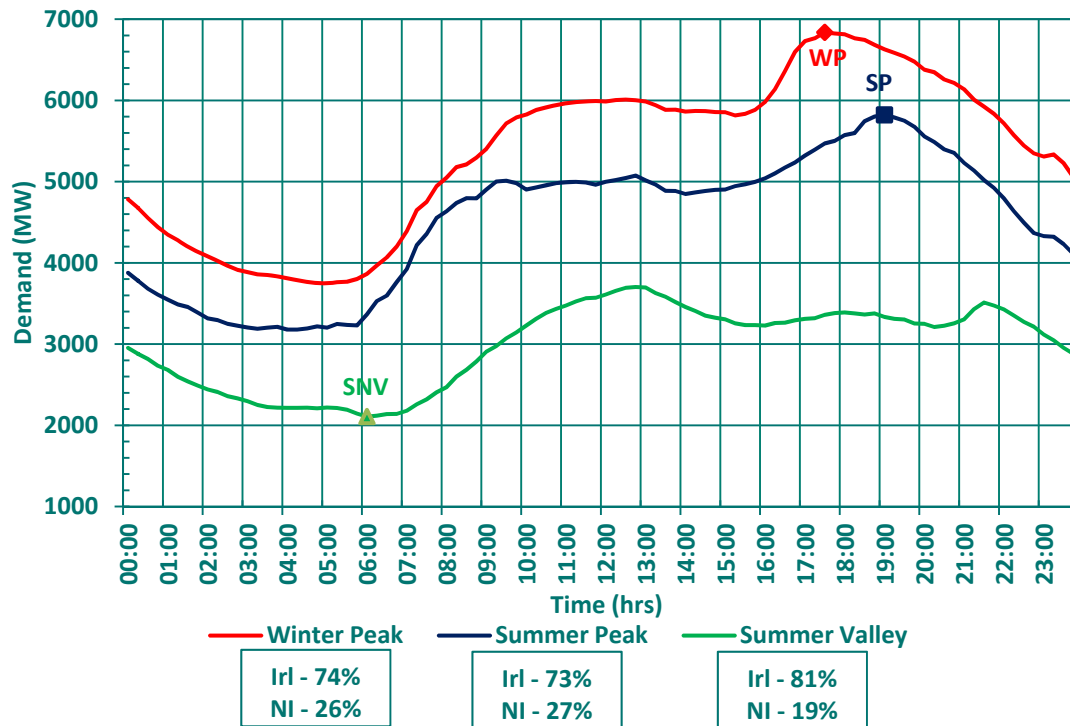


Figure 4-2 All-Island Daily Demand Profiles for Year 2010

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 2010.

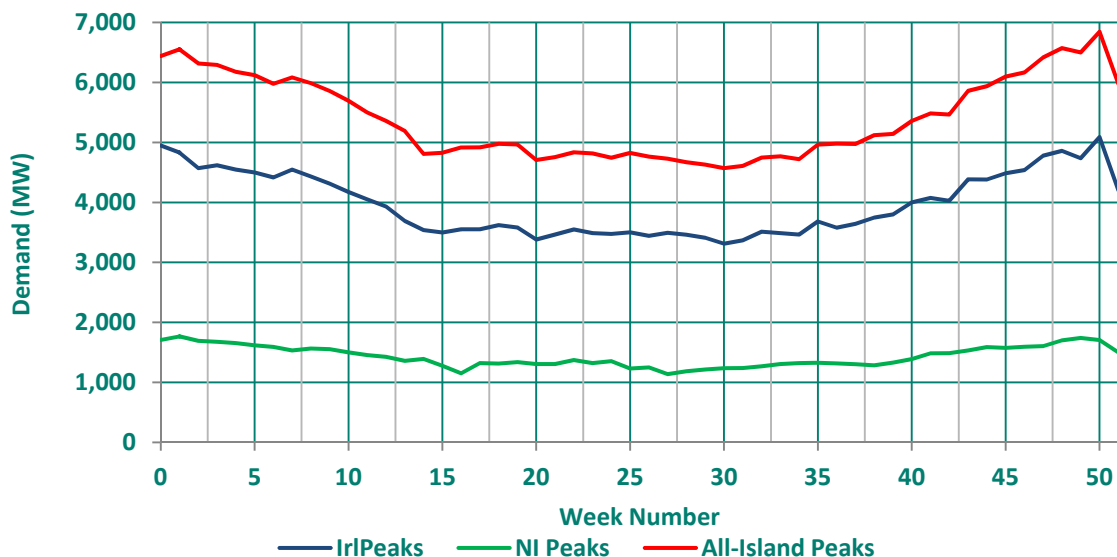


Figure 4-3 Weekly Peak Values for Year 2010

4.3 NORTHERN IRELAND LOAD DURATION CURVE

Figure 4-4 shows the Northern Ireland load duration curve for 2011/12. 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.

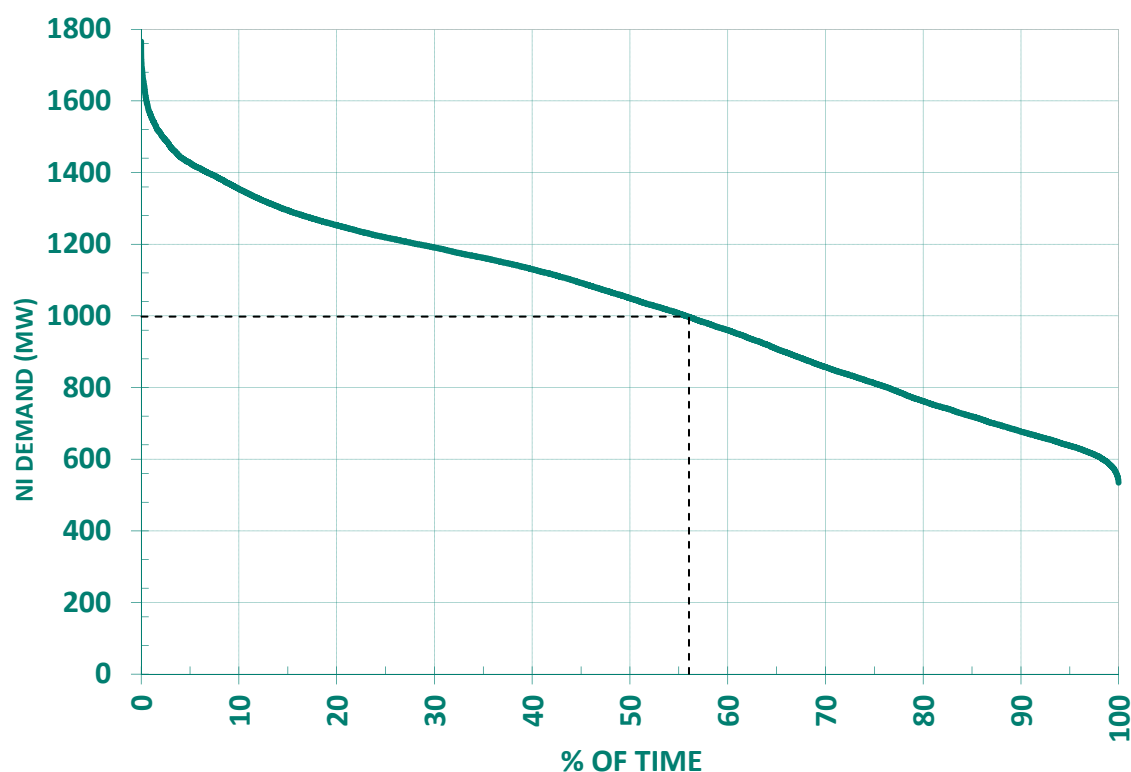


Figure 4-4: Northern Ireland Load Duration Curve 2011/12

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 2012 to 2018. 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 DSO. 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 are expected to 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 Planned Retirement/Divestiture of Generation Plant

5.1.3 Embedded Generation

5.1.4 Wind Generation

5.2 Northern Ireland

5.2.1 Existing and Planned Transmission-Connected Conventional Generation

5.2.2 Planned Retirement/Divestiture of 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 seven years to 2018. 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.

On the 01st of July 2011 (Ireland) and 01st of November (Northern Ireland), when data was frozen in order to permit TFS analyses to be carried out, some 8,893 MW of generation capacity was installed in Ireland and 2,746 MW of generation capacity was installed in Northern Ireland.

5.1 IRELAND

5.1.1 Existing and Planned Transmission-Connected Generation

Of this 8,893 MW of generation capacity, 7,953 MW is connected to the transmission system and 940 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 TFS.

The 7,953 MW figure for transmission system-connected generation capacity includes generators that connected to the transmission system in 2010/2011, namely the Edenderry Peakers in Co. Offaly (116 MW), and Castledockrill Wind Farm in Co. Wexford (41.4 MW).

Currently in Ireland, 19 connection agreements have been executed for a total generation capacity of 1,889 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 July 01st 2011

Generator	Description	Expected Connection Date
Glanlee Wind Farm (Extension)	6 MW wind farm extension in Co. Cork	Aug-11
Nore Power	98 MW OCGT in Co. Kilkenny	Nov-11
Bindoo Wind Farm (Extension)	22 MW wind farm extension in Co. Cavan	Dec-11
EirGrid East West Interconnector	500 MW interconnector	Sep-12
Booltiagh Wind Farm (Extension)	12 MW wind farm extension in Co. Clare	Sep-12
Moneypoint Wind Farm	21.9 MW wind farm located at Moneypoint coal-fired power station in Co. Clare	Sep-12

Table 5-1 Planned Transmission-Connected Generation as at July 01st 2011 (continued)

Generator	Description	Expected Connection Date
Suir	98 MW OCGT in Co. Tipperary	Dec-12
Cuilleen	98.4 MW OCGT in Co. West Meath	Dec-12
Mountlucas	79.2 MW wind farm in Co. Offaly	Mar-13
Mulreavy	82 MW wind farm in Co. Donegal	Apr-13
Kill Hill	62.5 MW wind farm in Co. Tipperary	Jun-13
Athea Wind Farm (Extension)	22 MW wind farm extension in Co. Limerick	Sep-13
Ballakelly	445 MW CCGT in Co. Louth	Nov-13
Keelderry	29.8 MW wind farm in Co. Galway	Nov-13
Cloghboola	46 MW wind farm in Co. Kerry	Feb-14
Caulstown	58 MW OCGT in Co. Meath	May-14
Knockacummer	87 MW wind farm in Co. Cork	Jul-14
Athea	51 MW wind farm in Co. Limerick	Sep-14
Knocknagreenan	70 MW pumped storage unit in Co. Cork	Nov-15

5.1.2 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.

A connection agreement was executed on the 5th of November 2011 between Endesa and EirGrid for a 431 MW CCGT plant at Great Island, Co. Wexford. This will result in the retirement of the current Great Island units.

5.1.3 Embedded Generation

On the 01st of July 2011, there was approximately 940 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-3 in Appendix D provides details of the existing embedded wind farms and their capacities.

Table 5-2 Existing Embedded Generation as at July 01st 2011

	Wind	Small Hydro	Biomass/LFG	CHP	Industrial	Peaking	TOTAL
Net Capacity (MW)	684	25	59	58	9	104	940

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 generators¹. The *All-Island Generation Capacity Statement 2012-2021 (GCS)* estimates biomass CHP to grow steadily to 150 MW capacity by 2020, while conventional CHP capacity is estimated to not change significantly during this period.

As at the 01st of July 2011, one 72 MW generator has an executed connection agreement and is committed to connecting to the distribution system over the next few years. Table 5-3 shows the total amount of generation capacity connected or committed to the distribution system.

Table 5-3 Connected and Committed Embedded Generation as at July 01st 2011, MW

Generator	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

5.1.4 Wind Generation

Over the past two decades wind power generation in Ireland has increased from 6 MW (one wind farm) to 1,520 MW (123 wind farms) at the beginning of July 2011. Figure 5-1 shows the existing and planned transmission-connected, distribution-connected and the total connected wind power capacity at year end from 1992 to 2018.

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 TFS analyses.

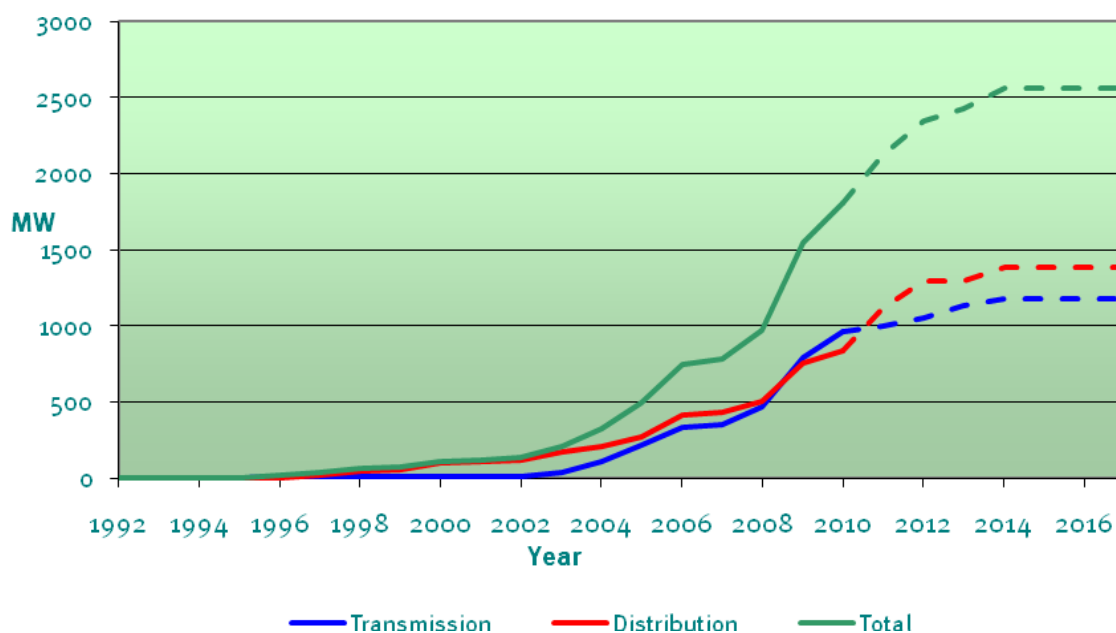


Figure 5-1 Growth in Wind Capacity, 1992 to 2018

As at the 01st of July 2011, 72 wind farms totalling 1,042 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 2011 to 2018. The individual wind farm details are included in Appendix D.

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

Connection	2011	2012	2012	2013	2015	2015	2016	2018
Transmission	788	987	1,250	1,321	1,321	1,321	1,321	1,321
Distribution	1,041	1,214	1,228	1,351	1,351	1,375	1,375	1,415
Total	1,829	2,201	2,478	2,672	2,672	2,696	2,696	2,736

Currently, there are a total of 363 applications totalling 21,187 MW in the applications queue, including 13 (3,041 MW) non-Group Processing Approach applications to the TSO.

In the period 2010-2011 3,990 MW of wind generation (on-shore and off-shore), 91 MW of renewable generation and 1,345 MW of non-renewable/hybrid generation received offers under Gate 3. Figure 5-2 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)	279
B (Mid North West)	1,118
C (Midlands)	223
D (Mid West)	121
E (South West)	1,114
F (South West)	97
G (North East)	186
H1 (Midlands-South West)	506
H2 (South East)	679
I (South)	22
J (Mid East)	1,049
K (South)	62

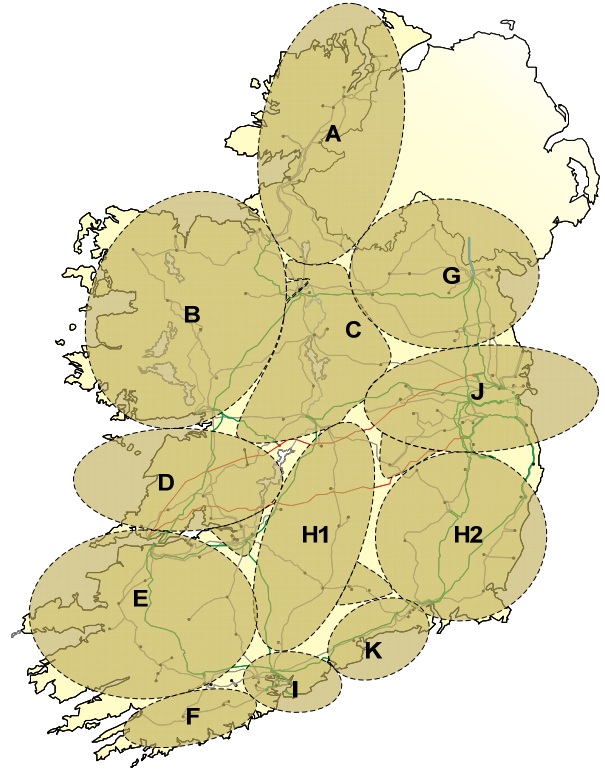


Figure 5-2 Gate 3 Wind Generation Areas

5.2 NORTHERN IRELAND

There is 2,764 MW of generation capacity connected to the Northern Ireland transmission system. Of that 2,764 MW the Moyle Interconnector has an import capacity of 450 MW; Slieve Kirk Wind Farm has a capacity of 26.7 MW and there is 2,286 MW of conventional thermal generation.

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 NIE 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 NIE via their Power Procurement Business (PPB) under pre-vesting contracts, or contracts negotiated thereafter, totals 1007 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. PPB pays a Transmission Use of System (TUoS) to SONI.

Independent Power Producers

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. Coolkeeragh C30, Kilroot K1, K2, KGT3 and KGT4, the Moyle Interconnector, as well as B5 and B6 at Ballylumford are all Independent Market Participants (IMPs). There is 1802 MW of IMP capacity in Northern Ireland. IMPs pay a Transmission Use of System (TUoS) to SONI.

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.

5.2.2 Planned Retirement/Divestiture of Northern Ireland Generation Plant

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 and will result in a 510 MW reduction of Northern Ireland plant capacity.

5.2.3 Embedded Generation

Existing Embedded Generation

Table 5-6 shows a breakdown of the existing Northern Ireland Embedded Generation. There is a 26 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, these units currently participate in the Single Electricity Market. There is 7 MW of CHP plant connected to the Northern Ireland distribution system; this 7 MW is expected to rise to 14 MW by 2018.

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 11 MW of landfill gas generation; it is assumed that by 2018 biogas generation capacity will increase to 19 MW.

Table 5-6 Northern Ireland Embedded Generation

	Wind	Small Hydro	Biofuels	Gas	Landfill Gas	CHP	AGU	Tidal/Wave	TOTAL
Net Capacity (MW)	373	4	1	9	11	7	26	1	432

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 2010/11 winter, generation of this type is estimated to total 68 MW.

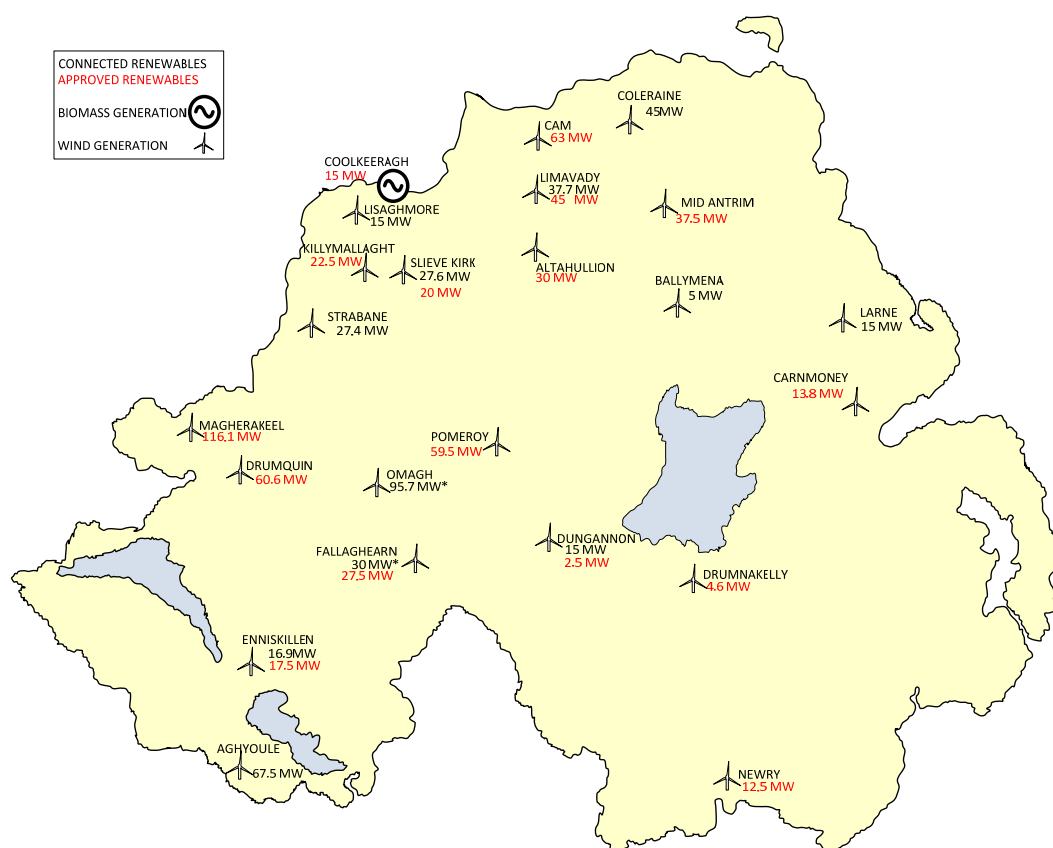
5.2.4 Northern Ireland Renewable Generation

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 5-3. 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 cluster.

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.



*Slieve Divena 1 transferring from Omagh Winter 2014/15

Figure 5-3 Existing and Committed Northern Ireland Renewable Generation

Unapproved Renewable Generation

The Draft 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.

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 TFS study files. Renewable generation that has been included in the TFS 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
Aghyoule	67.5	67.5	67.5	67.5	67.5	67.5	67.5
Altahullion Cluster				30	30	30	30
Antrim					7	7	7
Ballymena (Rural)	5	11	11	11	11	11	11
Cam Cluster				63	63	63	63
Carnmoney		13.8	13.8	13.8	13.8	13.8	13.8
Coleraine	45	45	45	45	45	45	57
Coolkeeragh		15	15	15	15	15	15
Drumnakelly				4.6	4.6	4.6	4.6
Drumquin Cluster					81.7	81.7	96.7
Dungannon	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Enniskillen	16.9	31.9	34.4	34.4	34.4	34.4	34.4
Fallaghearn Cluster				27.5	27.5	27.5	27.5
Killymallaght Cluster	22.5	22.5	22.5	22.5	37.5	37.5	37.5
Larne	15	15	15	25	25	25	25
Limavady	37.7	37.7	37.7	37.7	37.7	82.7	103.7
Lisaghmore	15	15	15	15	15	15	15
Magherakeel Cluster	60.6	116.1	116.1	116.1	134.1	134.1	146.1
Mid-antrim Cluster				37.5	37.5	37.5	37.5
Newry			12.5	12.5	12.5	12.5	12.5
Omagh	125.7	125.7	125.7	125.7	125.7	125.7	125.7
Pomeroy Cluster			59.5	59.5	59.5	65.5	65.5
Slieve Kirk	47.6	47.6	47.6	47.6	47.6	47.6	47.6
Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Tandragee Offshore							50
Totals	503.4	608.7	683.2	855.8	977.5	1028.5	1138.5

Figure 5-4 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 5-4 that the majority of the renewable connections are in the Northern and Western regions of the province. This coincides with some of the weakest areas of the existing transmission system. It can be concluded that for Northern Ireland to meet renewable targets, improvements will have to be made to the transmission network in these areas.

The Renewable Integration Development Project (RIDP)² 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 5-4 Northern Ireland Renewable Generation in 2020

Offshore Renewable Generation

The Crown Estates have launched offshore wind and tidal stream leasing rounds to select developers to take forward up to 800 MW of projects in Northern Ireland waters. SONI is in contact with these developers regarding the connection of off-shore renewable generation; most of the interest is in region off the east coast of the province. SONI's assumptions regarding the 2020 levels and location of offshore generation have been altered accordingly.

5.2.5 Northern Ireland Generation Mix

The chart in Figure 5-5 shows all existing and planned generation over the seven year period covered by this TFS. Superimposed onto the chart is the median demand forecast from the *All-Island Generation Capacity Statement 2012-2021*.

² www.ridp2020.com

³ www.thecrownestate.co.uk

Figure 5-5 shows a surplus of generation in relation to the demand. 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 B4, B5 and B6 in 2016 means that Northern Ireland Generation capacity is reduced by 510 MW for the last two years of study. This reduction in GAS/HFO generation capacity means that if the Moyle HVDC link and wind generation are removed from the stack for example, Northern Ireland would have a generation deficit and would be depending on energy from Ireland to meet the peak demand. The chart also shows the large increases in wind generation expected over the next seven years.

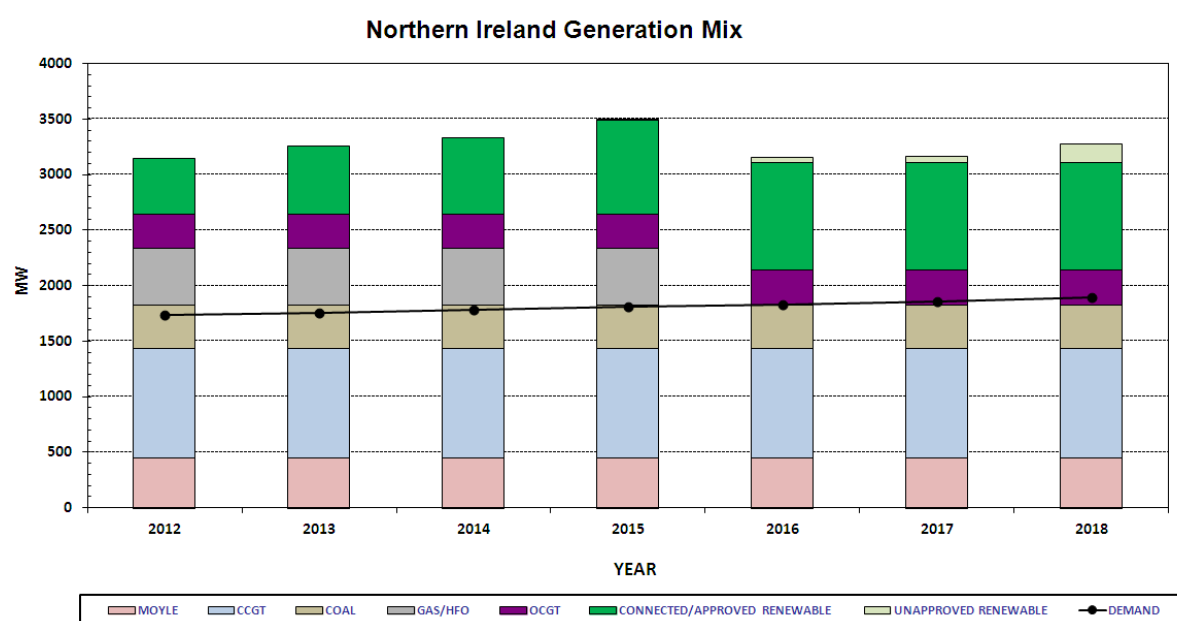


Figure 5-5 Northern Ireland Generation Mix

6 Transmission System Performance

- 6.1.1 Forecast Power Flows
- 6.1.2 Compliance with Planning Standards
- 6.1.3 Short Circuit Currents



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 TFS 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 July 2011 and November 2011 and Ireland and Northern Ireland respectively.

6.1 FORECAST POWER FLOWS

The power flow at any given time depends on transmission system configuration, demand levels and the output from each generator. There are many possible combinations of generator outputs (i.e. dispatches) that can meet the transmission system demand requirements at any given time and many possible demand scenarios. One of the main factors causing changes to network power flows 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 2.1.2 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 for 2012, 2015 and 2018 included imports and exports of power across the existing Moyle and planned East-West interconnector from Great Britain to Ireland.

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 seven year period; power flows on the circuits from the North West of Northern Ireland to larger load centres in the East of Northern Ireland. These increased power flows are most pronounced at times of minimum demand and high renewable generation output. Figure I-2 shows approximately 250 MW of power flowing from the North West of Northern Ireland in Summer Night Valley 2012; it can be seen in Figure I-8 that this power flow increases to circa 390 MW by summer night valley 2018.

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 2012/13 290 Mvars of reactive support was in service in Northern Ireland, this

figure increases to 400 Mvars by Winter 2018/19. 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 in.

Northern Ireland

This TFS 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 seven year period of this TFS. 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) 2010 to the CER for approval in July 2011. The plan indicates the areas of the transmission system likely to be outside thermal, i.e. circuit loading, and voltage standards over the five years to 2015, 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 capitally approved 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 LEVELS¹

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

The short circuit current level is a factor to be considered as the transmission system is developed and in the connection of new generation or demand. The EirGrid Grid Code requires that users connecting to the transmission system design their plant and apparatus to withstand the short circuit current levels 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	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 2012, 2015 and 2018. 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 the summer valley was carried out as the results should indicate the minimum short circuit currents. In reality the minimum short circuit current at each bus could be lower depending

¹ For the purposes of consistency of terminology when combining the Transmission System Capacity Statement and Transmission Forecast Statement, 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 sporadically in both statements.

on the actual generation dispatch and transmission system conditions. Those who require the absolute 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 forced on and dispatched at 0 MW. This measure ensures a high infeed to faults from all generator sources in the studies ensuring that the most onerous, but credible, conditions are considered for the calculation of short circuit current levels at each bus. For the calculations of short circuit current levels at summer valleys, generators that were not dispatched were not connected to the system.

The studies assume that the transmission system is in the normal intact condition (as indicated in the power flow diagrams) and that all circuits connected to a bus contribute to the fault. These results correspond to total busbar short circuit current level. The short circuit current that could flow through each individual circuit breaker may be less than the total busbar short circuit current depending on network conditions.

Assessment of Short Circuit Levels: Ireland

The transmission system in Ireland is designed and operated to maintain short circuit current levels below the standard equipment ratings listed at each voltage level in Table 6-1. In planning the system a 10% margin is applied, so that 220 kV short circuit currents, for example, will be kept below 36 kA.

It should be noted that, the EirGrid Grid Code stipulates that 110 kV equipment at certain designated stations may be designed to 31.5 kA. If necessary, equipment at these stations 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 (future station), 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 (i_p), RMS Break Current (I_B), 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 2018. Figure 6-1 presents the short circuit current level results for the winter peak 2018 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 2012/13, 2015/16 and 2018/19. 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	2012/2013	2015/2016	2018/2019
>100%	BPS 110 kV	BPS 275 kV	BPS 110 kV
	CAS 110 kV	BPS 110 kV	CAS 110 kV
	CDU 110 kV	CAS 110 kV	CDU 110 kV
		CDU 110 kV	CPS 110 kV
		KEL 110 kV	
>90%	CPS 110 kV	BVA 110 kV	BVA 110 kV
	DUN 110 kV	KRA 110 kV ²	KEL 110 kV
	KEL 110 kV	STR 110 kV	KRA 110 kV
	KNO 110 kV		KNO 110 kV
	TAN 110 kV		STR 110 kV

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 2013/14. 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.

Ballylumford 275 kV

The short circuit current level at Ballylumford 275 kV node for single phase faults exceeds the substation ratings in winter 2015/16. With the expected decommissioning of B4, B5 and B6 at Ballylumford after winter 2015/16 the single phase peak make current reduces from 66.86 kA to 54.02 kA by winter 2018/19. As with the Ballylumford 110 kV node SONI will have to manage this risk by operating with one IBTX out of service until the phase 2 plant at Ballylumford is decommissioned.

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 rebuilt with the disconnectors scheduled for replacement with 40 kA equipment by winter 2013/14.

² Knockraha 220 kV station is currently operated with the third transformer in hot-standby to mitigate short circuit current levels exceeding the 90% threshold.

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 2012; 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 2018/19. This is a result of increased renewable generation levels in 2018 and the connection of the new 400 kV Turleenan – Woodland circuit. It is important that NIE put plans in place to address this issue at Coolkeeragh before 2018.

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.

Kells 110 kV

Short circuit current levels at Kells 110 kV substation exceed 100% of the substation assigned rating in 2015/16. Kells 110 kV substation is to be refurbished, with work due to be completed by winter 2016/17. The substation equipment will then have a rating of 40 kA. It is important that in the interim period SONI and NIE develop plans to avoid the risk of exceeding equipment ratings.

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

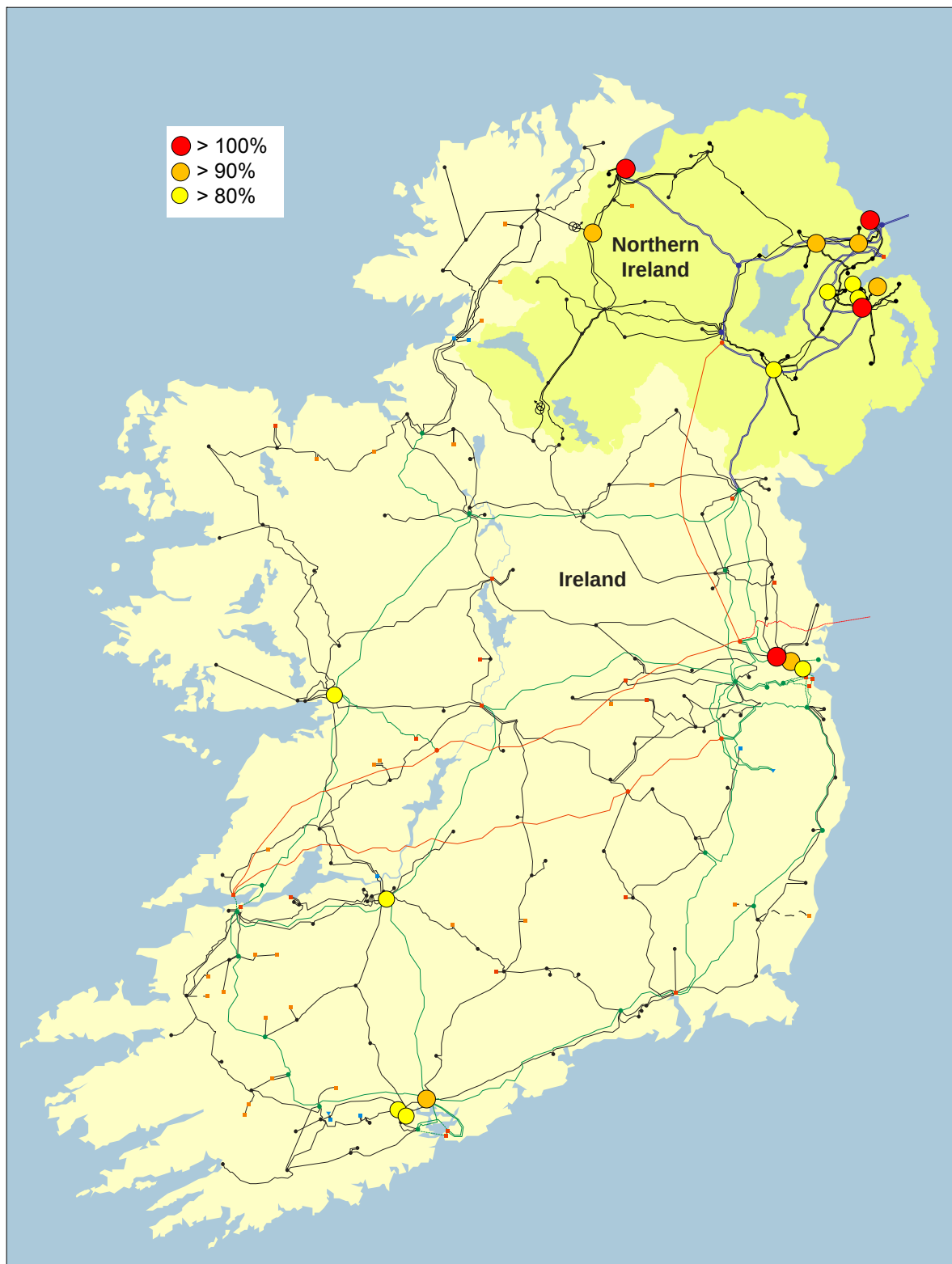


Figure 6-1 Short Circuit Current Levels for Winter Peak 2018

7 Overview of Transmission System Capability Analyses

- 7.1 Generator 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

The manner in which the opportunities were derived for future generator connections was based on EirGrid's GRID25 strategy and analysis undertaken as part of the Gate 3 process.

Three sample years (2012, 2015 and 2018) of results from Firm Access Quantity (FAQ) analysis undertaken for Gates 1, 2 and 3 have been used to form a view of the potential capability of the transmission system to accommodate additional generation capacity over and above that already allocated. EirGrid selected these three years to provide a short, medium and longer term outlook of future possible generation opportunities as transmission system reinforcements are completed.

The qualitative analysis is based on studies completed in December 2011 for Gates 1 & 2 and in January 2010 for Gate 3. In 2012, EirGrid will recalculate FAQs for Gate 3 projects to take into account the latest information on demand forecasts, generation portfolio, delivery timelines for proposed transmission system developments etc.

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 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:

2012: This is the first year of the seven-year period of the All-Island Transmission Forecast Statement (TFS). The information provided for 2012 gives developers a useful indication as to the opportunities that exist in the short-term.

2015: This is the mid-year of the seven-year period. Because of typical lead-times for construction of demand plant, this year represents the more realistic beginning of the period of interest for developers at a pre-feasibility stage wishing to connect to the transmission system.

2018: This covers the final year of the TFS, which extends to winter 2018/19.

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 July 2011. 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 8.1.4.

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 demands 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.

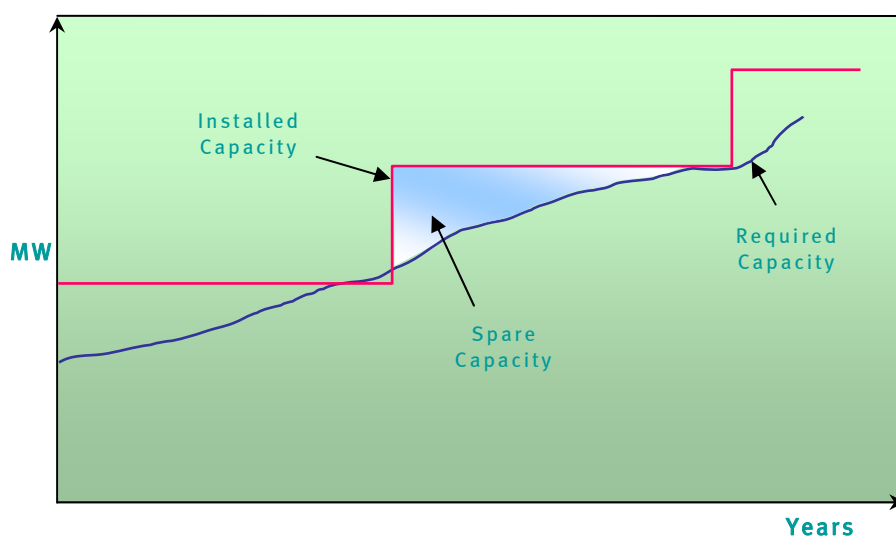


Figure 7-1 Illustration of Typical Step Change in Network Capacity

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.

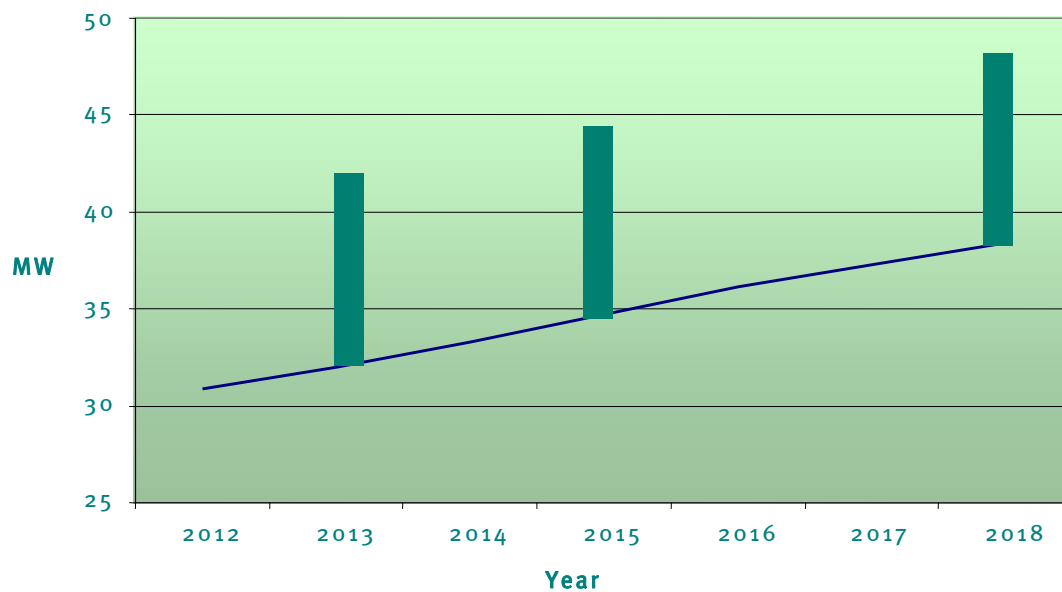


Figure 7-2 Demand Profile at Typical Station

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. Previously 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 30 “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 Continuous Rating (MCR). As wind energy is variable, it cannot be relied upon to

serve demand. As such, local wind generation was switched out in the vicinity of the test node. 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 MCR 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 30 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.

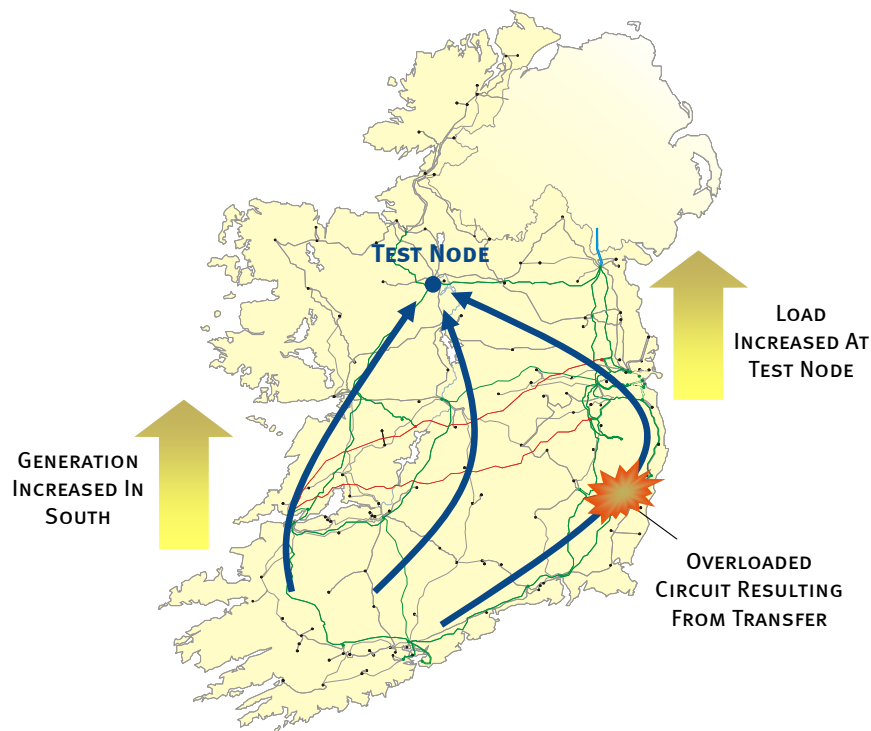


Figure 7-3 Illustration of Incremental Transfer Capability Study Method for Demand

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 2012. 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 2012 using the demand forecasts presented in Table C-2 in Appendix C and the relevant generator dispatch from Table D-5 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 2012.

In assessing opportunities for new demands, 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 2012-2021 (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 TFS is 2018/19, and the connection of new generation has been facilitated by one of three scenarios:

Supplying the Northern Ireland Existing Load

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

Supplying Load in Ireland

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

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 Britain. 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 and n-dc
Autumn	n-m-t
Summer	n-m-t

Maintenance-trip analysis is carried out in summer and autumn. Therefore when a capacity figure is quoted for a transmission node in this TFS, the reader can be sure that this is a firm capacity, 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, where 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 2018 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.

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 any of the 275 kV double circuits between Castlereagh and Ballylumford or the Ballylumford and Kells/Magherafelt double circuit can result in significant overloads on the 110 kV circuits between Ballylumford and Castlereagh, and Ballylumford and Kells. Therefore, in the event of the loss of any of these 275 kV double circuits, the four 110 kV circuits are opened, between Kells and Ballyvallyagh, and Castlereagh and 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.

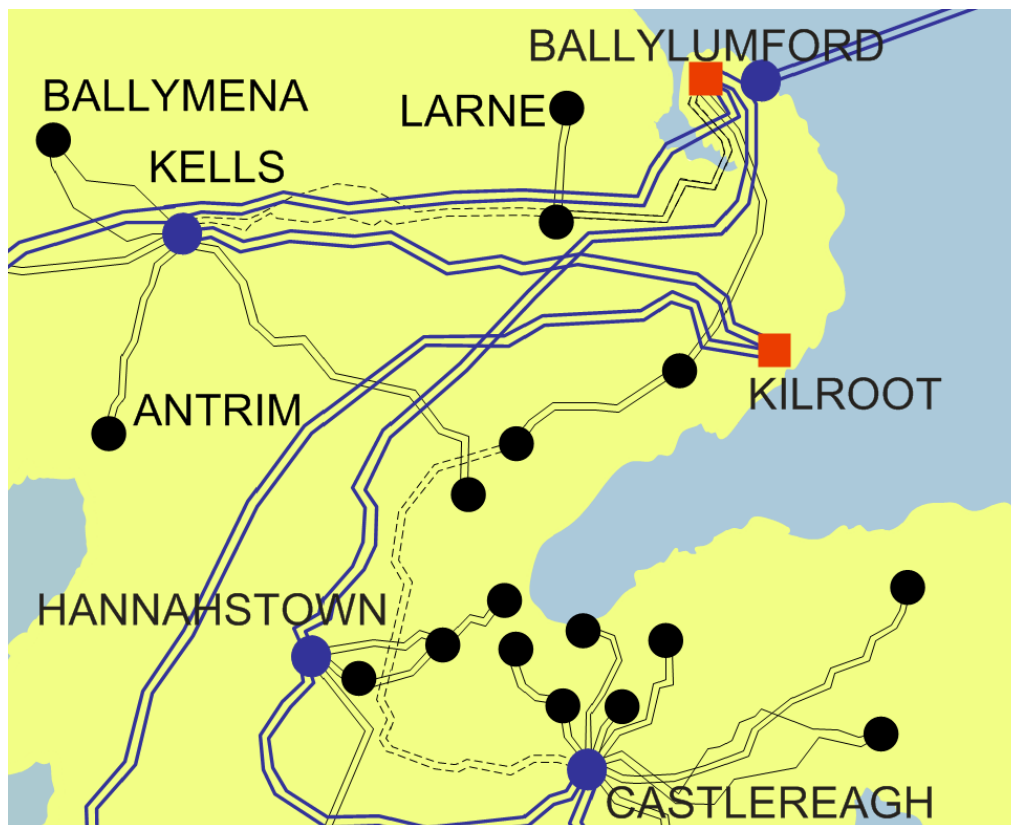


Figure 7-4: Circuits Opened in Ballylumford Protection Scheme

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 2018/19 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 TFS.

8 Transmission System Capability for New Generation

8.1 Network Capability for New Generation in Ireland

8.1.1 GRID25

8.1.2 Gate 3 and Post Gate 3 Generation Applicants

8.1.3 Generation Connection Opportunities created by GRID25

8.1.4 Impact of Gate 3 and Post Gate 3 on Capability for New Generation

8.2 Network Capability for New Generation in Northern Ireland

8.2.1 Generation Opportunities at 275 kV

8.2.2 Generation Opportunities at 110 kV

8.2.3 Generation Opportunities at 33 kV

8.2.4 Northern Ireland Generation Opportunities Conclusions

8 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION

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

8.1 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION IN IRELAND

Indicative information on the opportunities for generator connections based on EirGrid's transmission system development strategy, GRID25, and the Gate 3 group processing scheme for generators, is provided in this section.

8.1.1 GRID25

Over the next 15 to 20 years, major changes are expected to take place in Ireland's electricity needs, in its sources of fuel and in its fleet of power stations. Change will increasingly be driven by issues of energy security, competitiveness, climate change and by the need to move away from imported fuels.

The transmission system is a vital channel for supplying reliable, sustainable and renewable energy and for open competition within the sector. A strong transmission system will bring the energy supplies which will enable Ireland to prosper economically and to provide good quality of life to its people.

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 upgrading 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

The TSO and DSO have received a considerable number of new applications for connection of generation to the transmission system of Ireland. Within the period 2010-2011 3,989 MW

of wind generation (on-shore and off-shore), 91 MW of no-wind renewable generation and 1,345 MW of non-renewable/hybrid generation received offers under Gate 3. Table 4-5 illustrates how Gate 3 generation is distributed across the country. Beyond Gate 3 there are a further 363 applications for connections totalling circa 20,000 MW.

8.1.3 GENERATION CONNECTION OPPORTUNITIES CREATED BY GRID25

8.1.3.1 Opportunities for Gate 3 Generation

On January 29th 2010 EirGrid published the Gate 3 Firm Access Quantities (FAQ), in accordance with the Gate 3 group processing scheme. The publication details the potential levels of firm network access available in the electricity transmission system for each Gate 3 project for each year up to 2023, taking account of the proposed developments outlined in GRID25. Details on Gate 3 FAQs are available on the EirGrid website (www.eirgrid.com).

For the purposes of this All-Island Transmission Forecast Statement, Table 8-1 compiles the Gate 3 Firm Access Quantities (as published 29th January 2010) to illustrate the level of capacity available on the electricity transmission system to accommodate additional generation, for three stages of the seven year period covered by the TFS – 2012, 2015 and 2018. Table 8-1 illustrates that by 2018 the expected developments associated with GRID25 create firm capacity on the transmission system to accommodate almost 3,500 MW of Gate 3 generation. It is important to note that the information (Table 8-1) is derived from analysis undertaken in 2009/10 and the assumptions that prevailed at the time.

Table 8-1 Firm Capacity available for Gate 3 Generation for each area, MW

Area	2012	2015	2018
A	0	0	0
B	8	204	408
C	0	109	223
D	0	121	121
E	0	1	448
F	0	30	60
G	33	186	186
H1	55	339	504
H2	95	454	454
I	0	0	22
J	329	652	1,049
K	0	0	0
Total	520	2,098	3,476

EirGrid is currently recalculating the Gate 3 Firm Access Quantities. The study is re-assessing the potential levels of firm network access available in the electricity transmission system for each Gate 3 project for each year up to the year that firm network access for the full MEC is achieved, taking into account the most up to date information and the latest timelines of proposed developments to the transmission system.

8.1.3.2 Opportunities for Post Gate 3 Generation

Figure 8-1 shows the level of Gate 1, Gate 2 and Gate 3 generation (based on the most recently published FAQs) that is expected to have firm access in each area by 2018, the amount of generation awaiting firm access after this year and the year in which the last Gate 3 applicant is expected to have received firm access for its full MEC.

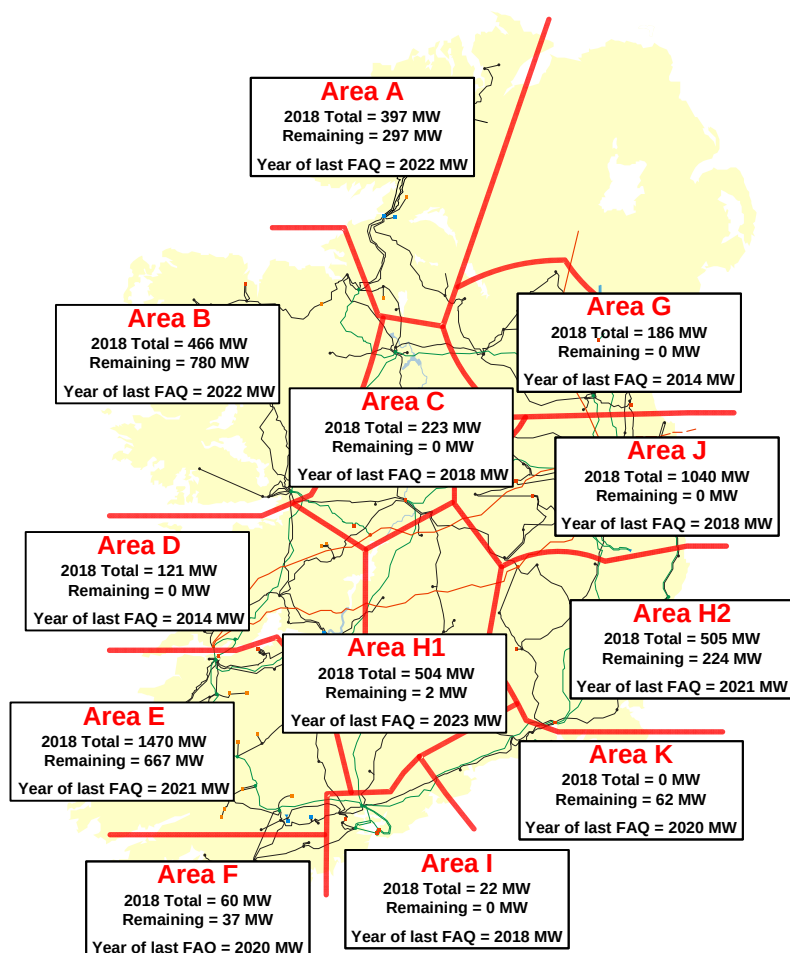


Figure 8-1 Expected Generation per Area

Figure 8-1 could be used to form an opinion on what areas could have additional network capacity in the short to medium-term (i.e. 4-8 years) to accommodate additional generator connections over and above those included in the current gates. For example, in Areas A, B,

E and H2 by 2018 there is a large amount of MWs remaining non-firm, while the last MW does not receive firm access until 2021/22. This would suggest that these areas are awaiting significant network reinforcements to facilitate generator connections. Furthermore, because the required network reinforcements are significant they could, in the more long term, create additional generator opportunities once they are complete. Conversely, all applicants in Areas D and G are due to receive firm access by 2014. This would suggest that Areas D and G are not awaiting major transmission reinforcements and therefore, could potentially be favourable locations for some level of future generator connections in the shorter term.

In addition to the results presented in Figure 8-1, a rudimentary analysis was performed on the GRID25 network assumed for the published Firm Access Quantities, with all of Gate 3 generation connected. The analysis suggests that Areas G, H1, H2, J, and K may have the capability to accommodate further generation capacity. Areas A, B, C, D, E, F and I have limited capability. The potential opportunities for post Gate 3 generation connections are illustrated in Figure 8-2.

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 Gate 3 FAQs published in January 2010 and is subject to change. The generation opportunities are not cumulative. Connection of a large new, non-Gate 3 generator to the transmission system could significantly alter the available opportunities.

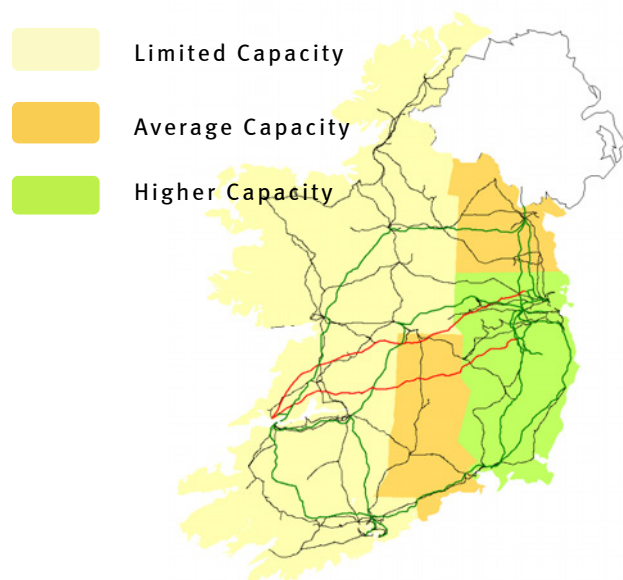


Figure 8-2 Potential Post Gate 3 generation opportunities

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 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.

Section 4.2 contains details of the existing plan for the divestiture or closure of generation plant. In the event that additional generation plants are closed, this is likely to free up some capacity on the network for new generators.

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. Therefore, it is possible that the Dublin region could have the capability to accommodate additional future generation.

8.1.4 Impact of Gate 3 and Post Gate 3 on Capability for New Generation

The transmission system upgrades and reinforcements associated with GRID25 will inherently create significant capacity on the transmission system to accommodate new generation. If new generators sign connection agreements in an area that has received increased transmission system capacity as a result of GRID25 system reinforcements, they will use up some, or perhaps all, of the available capacity in that area.

Given the scale of generator applications, even with the significant network expansion planned, there will not be capacity on the transmission system to provide firm access to all post Gate 3 applications before 2025.

The manner in which post Gate 3 applications will be processed has yet to be decided by the Commission for Energy Regulation (CER).

Up-to-date information on applications, new generation connection agreements and the process for obtaining a formal connection offer are available on www.eirgrid.com. Before making any commercial decisions developers should contact EirGrid for discussions on their proposed developments.

This chapter of the TFS 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.

8.2 TRANSMISSION SYSTEM CAPABILITY FOR NEW GENERATION IN NORTHERN IRELAND

When SONI receives generation related connection enquiries, there are a wide range of technical assessments necessary in advance of offering a connection proposal to the potential transmission system user. Detailed connection studies are required which take into consideration the full impact on short circuit current levels, transient stability and dynamic stability. The development must also meet the technical connection requirements set out in the SONI Grid Code. The potential capacities identified in these capability studies are only indicative. The general information provided in this report may be used as a guide only, and must be followed by 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 2018/19, there are a number of locations on the transmission network where a large 400 MW generator could connect without the need for significant reinforcements.

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 8-3.

The results of the capability analysis in this TFS show that there is spare capacity for the connection of a new large generator at a number of locations on the grid in 2018/19. The Castlereagh, Hannahstown, Kells, Kilroot and Tandragee 275 kV substations, as well as the new 275 kV substation at Turleenan, could all accommodate a 400 MW generator.

Now we 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. The Tamnamore scheme ensures that generation opportunities at the Kells, Magherafelt and Tamnamore 275 kV nodes are significantly increased. This scheme will be needed until the capacity of the transmission system around Tamnamore is improved or there is increased transmission transfer capacity from the North-West of Northern Ireland.

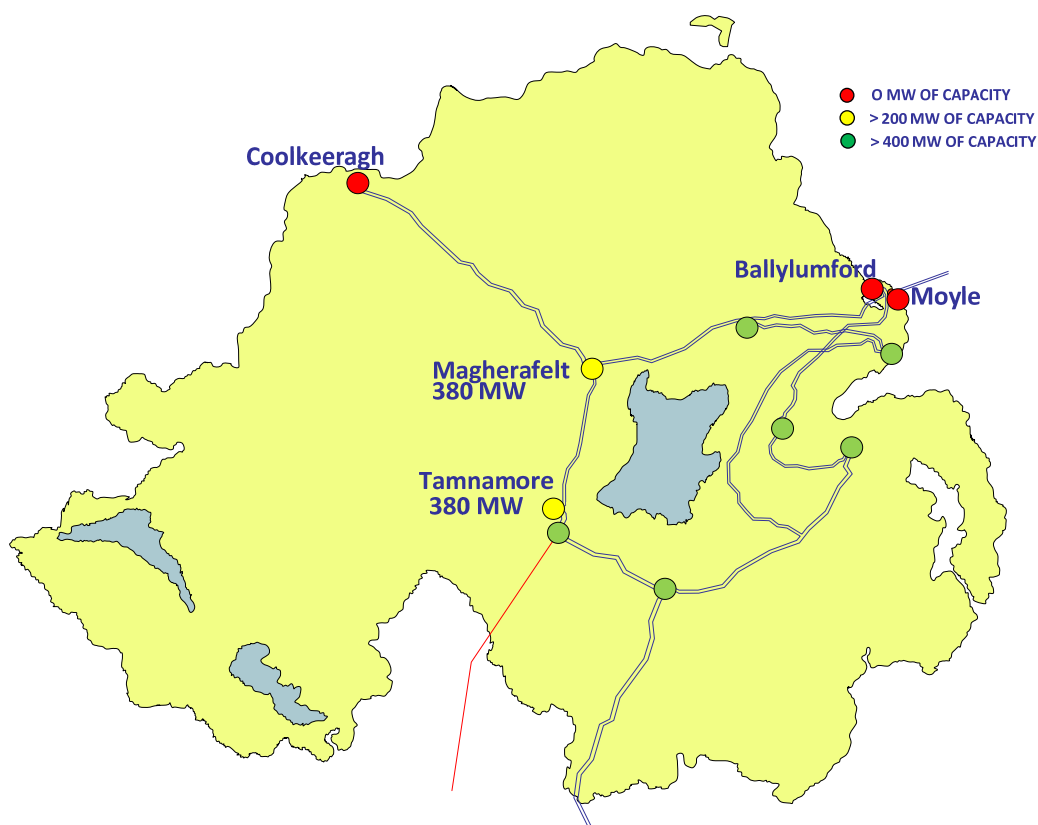


Figure 8-3 Generator Opportunities at 275 kV

The generator opportunity analysis highlights that there is no incremental capacity available at the Ballylumford and Moyle 275 kV substations. This is despite the fact it has been assumed that units B4, B5 and B6 are decommissioned due to the E.U. Heavy Fuel Oil Directive.

The limiting factor for the Islandmagee nodes is the maintenance trip of the Kells IBTXs at Summer Peak conditions which result in overloads on the 110 kV circuits between Ballylumford and Ballyvagh. These 110 kV circuits 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 TFS 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 275 kV node as it is 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 up to 400 MW of generation at each 110 kV node in Northern Ireland is assessed. The results are shown below in Figure 8-4.

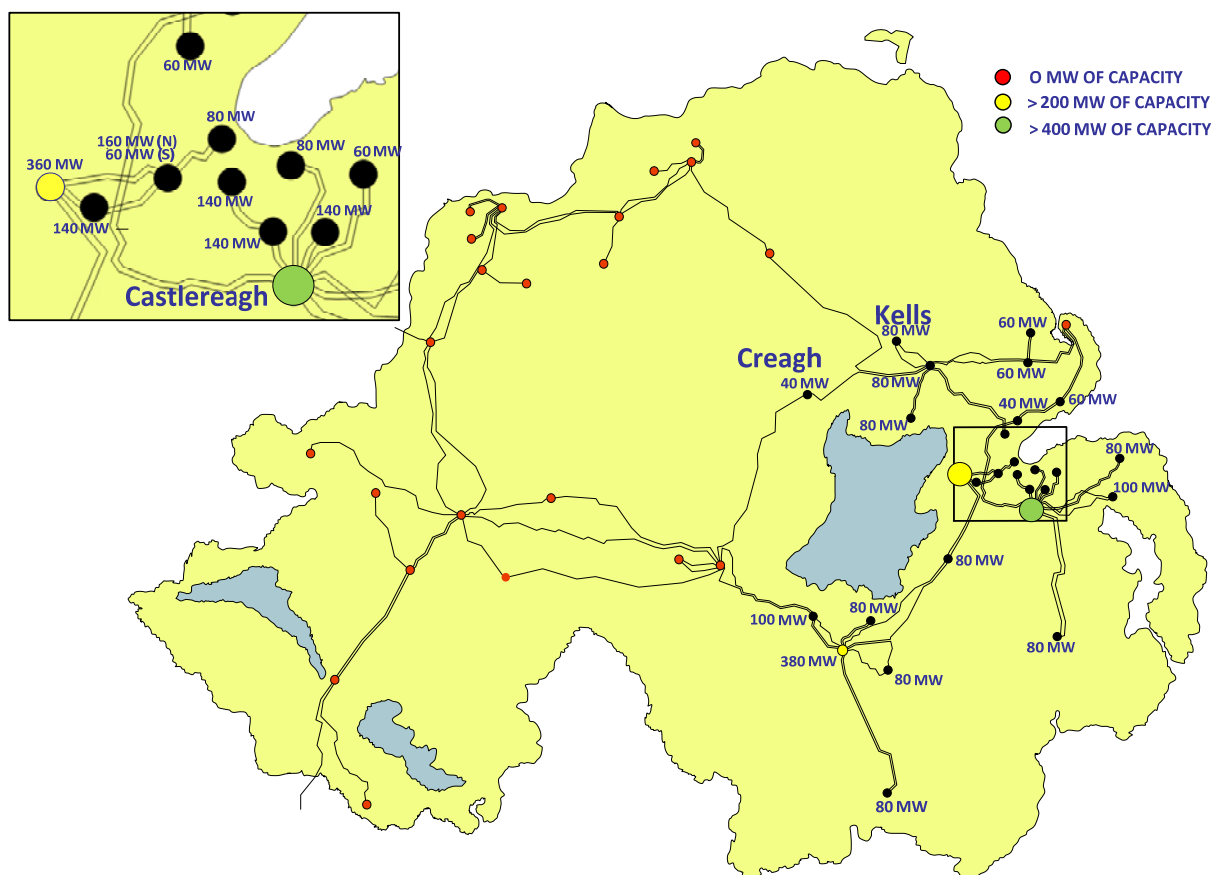


Figure 8-4 Generator Opportunities at 110 kV

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-3.

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 400 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, it is only possible to accommodate 40 MW at Creagh 110 kV substation, while Kells 110 kV can accommodate 80 MW.

The North-West of Northern Ireland is saturated and unable to accommodate the connection of further generation in 2018/19. The predominant power flows driving this saturation 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 8-5.

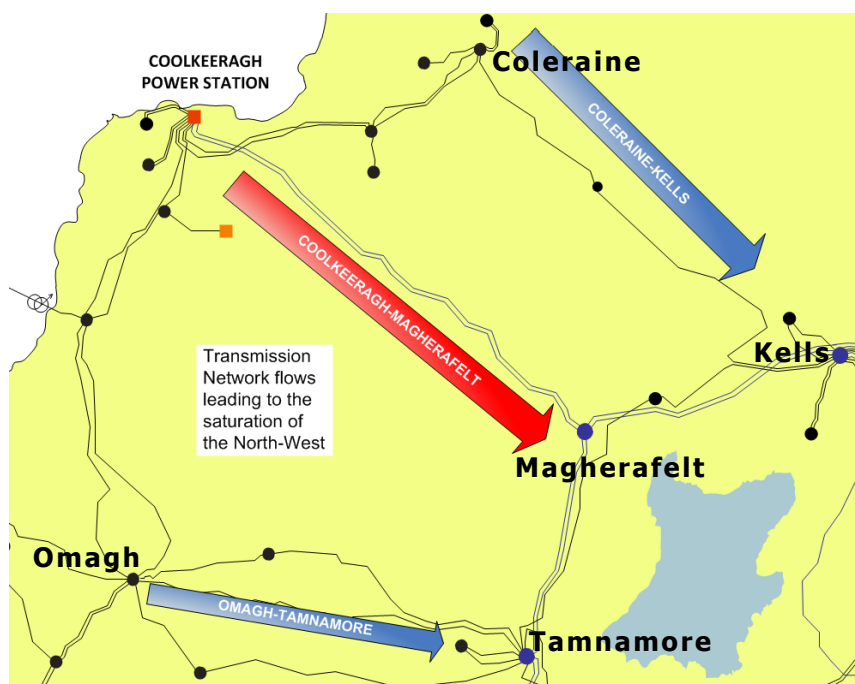


Figure 8-5 Congested Network Corridors

For 2018 summer night valley conditions with circa 1,010 MW of wind connected in Northern Ireland, the loss of the Coolkeeragh-Magherafelt 275 kV double circuit means the power in the North-West must be evacuated via the Omagh-Tamnamore and Coleraine-Kells 110 kV network corridors. This results in thermal overloads on these circuits. The outage of the Omagh-Tamnamore 110 kV circuit results in the overload of the 110 kV circuit between Pomeroy and Tamnamore. 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.

Renewable generation will have to be pre-fault constrained in the future to mitigate the risk of thermal overloads.

By Winter 2018/19 over 1,120 MW of wind generation is connected in the North-West of Northern Ireland. With this amount of renewable generation, the Coolkeeragh-Magherafelt

275 kV double circuit contingency results in voltage collapse. 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 2018, 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 1,120 MW of wind 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.

An implication of these thermal and voltage issues is that the addition of further generation at nodes to the North-West of Northern Ireland will exacerbate the issues associated with the loss of Coolkeeragh–Magherafelt 275 kV double circuit. Nodes in the North-West of Northern Ireland which cannot accept any further generation are marked with the code ‘NW’ in the results tables in Appendix F and red dots in the maps in this Chapter 8.

Without major reinforcement of the transmission system in the North-West of Northern Ireland, there will have to be significant constraints applied on wind generation towards the latter years covered by this statement.

It should be noted that 110 kV generator opportunities presented in this TFS 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 have 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 8-6 and listed in Appendix F, Table F-5.

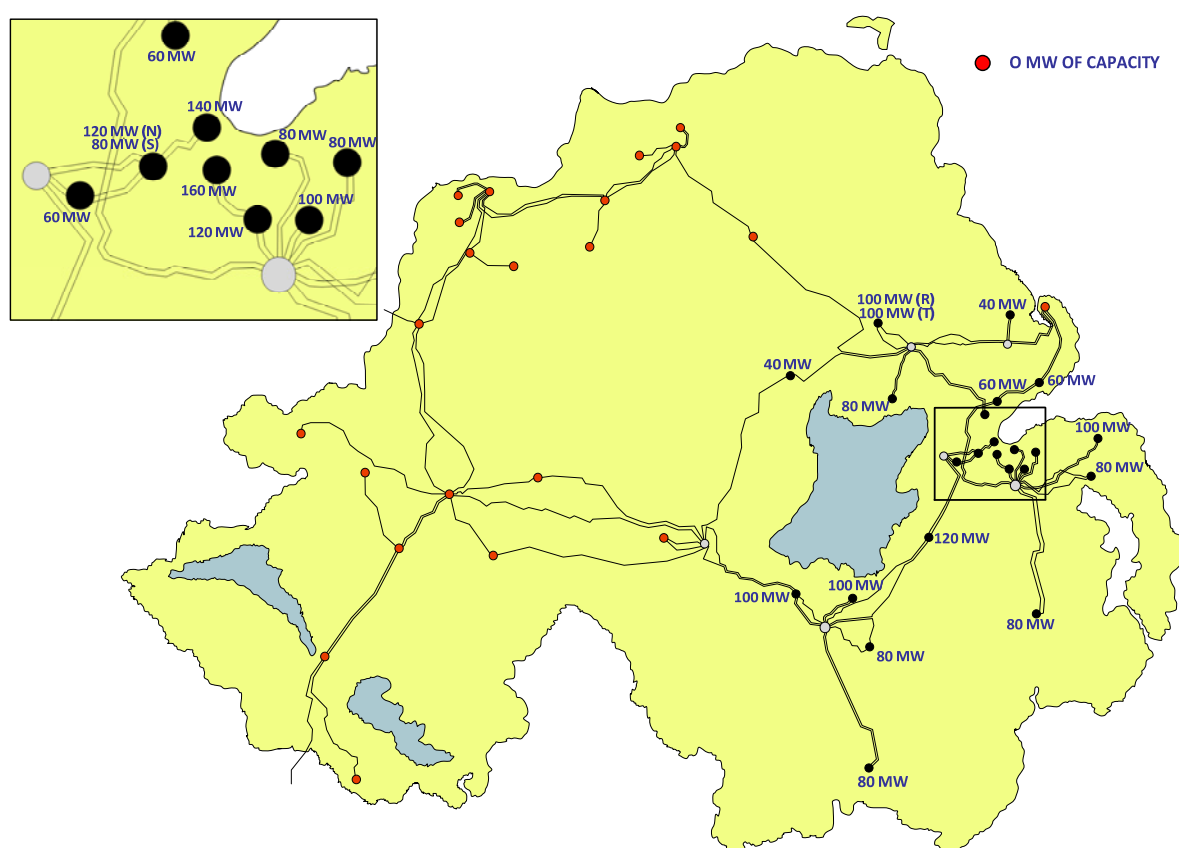


Figure 8-6 Transmission System Capabilities at 33 kV

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 expected renewable generation levels are starting to stress network capability.

It should also be noted that all the capabilities shown are very much dependent on the timely installation of the planned 110 kV reinforcements and the delivery of the network reactive compensation schemes described in Chapter 3 of this TFS.

It can be concluded that the Islandmagee area cannot accept the connection of additional generation without the reinforcement of the 110 kV circuits between Ballylumford and Ballyvagh.

As seen in the results the North-West of Northern Ireland cannot accommodate additional generation beyond the 2018 levels assumed in this TFS. This will be the case until additional 275 kV transmission infrastructure is established in the North-West. This new infrastructure will 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

9.1.1 Bulk Supply Point Where Firm Capacity is Exceeded

9.1.2 Bulk Supply Point Available Capacity

9.1.3 Conclusion

9.2 Transmission System Capability for New Demand in Ireland

9.2.1 Incremental Transfer Capability Results for New Demand

9.2.2 Opportunities for New Demand

9.2.3 Impact of Changes since the Data Freeze

9.2.4 How to Use the Information for Demand



9 TRANSMISSION SYSTEM CAPABILITY FOR NEW DEMAND

The transmission system is being planned to meet anticipated demand growth across the transmission system. Appendix C provides projections of demand at each transmission station. This chapter presents the results of 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 the 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. Table 9-1 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 the seven year period.

Specifically these substations are:

- Strabane
- Waringstown
- Knock

Table 9-2 and Table 9-3 present the demand forecast in MVA under single circuit outage conditions for the next seven years 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 (MVA)	SS (MVA)	WINTER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	
Aghyoule Main	90	29	13.28	13.39	13.53	13.66	13.80	13.94	14.08	5
Antrim Main	90	55.3	44.81	45.35	46.03	46.72	47.42	48.13	48.84	4
Ballymena Mesh (Rural)	90	55.3	51.07	51.70	52.49	37.78	38.59	39.42	40.25	4
Ballymena SWBD (Town)	120	72.8	46.78	47.37	48.12	48.89	49.67	50.46	51.25	4
Ballynahinch Main	180	71.4	64.43	65.24	66.19	67.15	68.13	69.12	70.11	4
Banbridge Main	120	71.4	44.78	45.35	46.03	46.73	47.43	48.14	48.85	4
Coleraine Main	120	71.4	45.93	46.51	47.21	47.92	48.64	49.36	50.09	4
Coolkeeragh Main	180	114	33.47	33.89	34.45	35.03	35.62	36.22	36.82	4
Creagh Main	120	78	26.04	26.32	26.68	42.29	42.65	43.03	43.40	2
Drumnakelly Main	180	111	96.48	97.83	99.56	101.31	103.10	104.92	106.74	4
Dungannon Main	180	114	87.74	88.89	90.38	91.90	93.44	95.01	96.58	4
Eden Main	90	37.4	34.36	34.80	35.29	35.80	36.31	36.83	37.34	4
Enniskillen Main	150	73	50.40	51.04	51.82	52.61	53.42	54.23	55.05	4
Larne Main	90	55.3	44.92	45.53	46.21	46.90	47.60	48.31	49.02	4
Limavady Main	90	40.3	25.12	25.44	25.81	26.20	26.58	26.98	27.37	4
Lisaghmore Main	90	58.5	52.97	53.64	54.45	55.28	56.11	56.96	57.81	2
Lisburn Main	180	100	71.77	72.66	73.81	74.97	76.15	77.35	78.55	3
Loguestown Main	90	58.5	40.44	40.95	41.53	42.12	42.72	43.33	43.93	2
Newry Main	180	103	86.57	87.65	89.02	90.41	91.82	93.26	94.69	3
Newtownards Main	120	78	47.44	48.05	48.74	49.45	50.16	50.88	51.60	2
Omagh Main	120	106	57.65	58.30	59.10	59.92	60.75	61.59	62.43	4
Rathgael Main	180	103	71.49	72.41	73.44	74.48	75.53	76.61	77.67	3

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
			2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	
Rosebank Main	180	111	43.66	44.08	44.55	45.03	45.52	35.72	36.21	4
Springtown Main	180	87.9	33.23	33.65	34.20	34.77	35.34	35.93	36.52	4
Strabane Main	90	33.8	37.34	37.81	38.38	38.95	39.53	40.12	40.70	4
Waringstown Main	180	65.4	68.00	68.70	69.57	70.45	71.34	72.24	73.14	4
Belfast - Airport Road Main	180	103	N/A	N/A	N/A	N/A	N/A	33.16	33.66	3
Belfast Central Main	180	110	68.24	69.07	70.34	71.64	72.95	74.29	75.64	7
Belfast North Main*	180	100	N/A	N/A	N/A	56.41	57.22	58.03	58.85	7
Belfast - PSW	150	100	54.15	54.83	55.62	BSP will be decommissioned				7
Belfast - Carnmoney Main	120	68.6	43.02	43.56	44.24	44.93	45.63	46.34	47.05	4
Belfast - Glengormley Main	60	30.8	16.48	16.70	16.95	17.20	17.47	17.73	18.00	8
Belfast - Cregagh Main	150	78.9	66.80	67.62	68.61	69.61	70.62	58.80	59.83	4
Belfast - Knock Main	120	71	73.65	74.57	75.64	76.73	77.83	68.51	69.62	4
Belfast - Finaghy Main	90	58.5	37.93	38.41	39.01	39.61	40.22	40.85	41.47	2
Belfast - Donegall Main (North)	150	68.5	62.01	62.78	63.70	64.63	65.58	66.54	67.49	4
Belfast - Donegall Main (South)	120	68.5	59.02	59.74	60.59	61.45	62.33	63.21	64.09	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
			2012	2013	2014	2015	2016	2017	2018	
Aghyoule Main	90	29	11.47	11.57	11.69	11.81	11.93	12.01	12.13	5
Antrim Main	90	55.3	40.30	40.78	41.39	42.03	42.66	43.15	43.78	4
Ballymena Mesh (Rural)	90	55.3	47.43	48.02	48.76	35.10	35.86	36.50	37.27	4
Ballymena SWBD (Town)	120	72.8	44.67	45.24	45.96	46.71	47.45	48.04	48.79	4
Ballynahinch Main	180	71.4	53.43	54.10	54.88	55.71	56.52	57.14	57.95	4
Banbridge Main	120	71.4	36.72	37.19	37.75	38.33	38.91	39.35	39.93	4
Coleraine Main	120	71.4	37.43	37.90	38.47	39.06	39.65	40.10	40.69	4
Coolkeeragh Main	180	114	29.57	29.94	30.44	30.96	31.48	31.90	32.43	4
Creagh Main	120	78	22.95	23.20	23.51	37.29	37.61	37.81	38.13	2
Drumnakelly Main	180	111	89.03	90.27	91.87	93.53	95.18	96.51	98.18	4
Dungannon Main	180	114	77.74	78.77	80.08	81.46	82.83	83.92	85.31	4
Eden Main	90	37.4	29.75	30.13	30.56	31.01	31.45	31.79	32.23	4
Enniskillen Main	150	73	46.41	46.99	47.71	48.47	49.21	49.78	50.53	4
Larne Main	90	55.3	39.64	40.18	40.78	41.41	42.03	42.50	43.12	4
Limavady Main	90	40.3	20.57	20.83	21.13	21.46	21.77	22.02	22.34	4
Lisaghmore Main	90	58.5	52.97	43.64	44.19	44.86	45.56	46.24	46.78	2
Lisburn Main	180	93	71.77	59.24	59.97	60.92	61.90	62.88	63.64	3
Loguestown Main	90	58.5	40.44	37.71	38.18	38.73	39.29	39.85	40.28	2

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
			2012	2013	2014	2015	2016	2017	2018	
Newry Main	180	95	73.08	73.99	75.15	76.36	77.55	78.48	79.68	3
Newtownards Main	120	78	39.17	39.67	40.24	40.84	41.43	41.88	42.47	2
Omagh Main	120	106	49.11	49.66	50.34	51.06	51.77	52.30	53.01	4
Rathgael Main	180	95	59.35	60.11	60.96	61.85	62.73	63.39	64.27	3
Rosebank Main	180	111	36.41	36.76	37.15	37.57	37.97	29.70	30.10	4
Springtown Main	180	87.9	29.14	29.51	30.00	30.51	31.01	31.41	31.93	4
Strabane Main	90	33.8	29.92	30.30	30.75	31.22	31.69	32.05	32.52	4
Waringstown Main	180	65.4	60.20	60.82	61.59	62.39	63.18	63.75	64.55	4
Belfast - Airport Road Main	180	95	N/A	N/A	N/A	N/A	N/A	33.87	34.37	3
Belfast Central Main	180	110	59.22	59.95	61.05	62.20	63.34	64.27	65.44	7
Belfast North Main*	180	100	N/A	N/A	N/A	47.94	48.63	49.15	49.84	7
Belfast - PSW	150	100	46.00	46.58	47.25	BSP will be decommissioned				7
Belfast - Carnmoney Main	120	68.6	36.61	37.07	37.65	38.26	38.85	39.32	39.92	4
Belfast - Glengormley Main	60	30.8	16.84	17.06	17.31	17.58	17.85	18.06	18.33	8
Belfast - Cregagh Main	150	78.9	58.85	59.58	60.45	61.35	62.25	51.64	52.55	4
Belfast - Knock Main	120	71	60.23	60.98	61.86	62.78	63.68	55.85	56.76	4
Belfast - Finaghy Main	90	58.5	32.27	32.68	33.19	33.72	34.24	34.65	35.17	2
Belfast - Donegall Main (North)	150	68.5	55.86	56.55	57.38	58.25	59.10	59.75	60.61	4
Belfast - Donegall Main (South)	120	68.5	51.07	51.69	52.43	53.20	53.95	54.53	55.29	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
			2012	2013	2014	2015	2016	2017	2018	
Aghyoule Main	90	29	10.34	10.43	10.53	10.64	10.75	10.80	10.92	5
Antrim Main	90	55.3	39.75	40.22	40.83	41.45	42.07	42.48	43.12	4
Ballymena Mesh (Rural)	90	55.3	43.41	43.95	44.62	32.13	32.82	33.35	34.06	4
Ballymena SWBD (Town)	120	72.8	38.11	38.59	39.21	39.84	40.48	40.91	41.57	4
Ballynahinch Main	180	71.4	46.98	47.57	48.26	48.98	49.69	50.15	50.88	4
Banbridge Main	120	71.4	31.83	32.24	32.72	33.23	33.72	34.05	34.56	4
Coleraine Main	120	71.4	35.58	36.03	36.57	37.14	37.69	38.05	38.63	4
Coolkeeragh Main	180	114	27.18	27.52	27.98	28.46	28.93	29.27	29.76	4
Creagh Main	120	78	21.20	21.43	21.72	34.44	34.74	34.86	35.17	2
Drumnakelly Main	180	111	84.92	86.11	87.63	89.21	90.78	91.90	93.52	4
Dungannon Main	180	114	71.84	72.78	74.00	75.27	76.53	77.41	78.71	4
Eden Main	90	37.4	27.33	27.68	28.07	28.49	28.89	29.15	29.57	4
Enniskillen Main	150	73	44.43	44.99	45.68	46.39	47.10	47.57	48.31	4
Larne Main	90	55.3	35.31	35.78	36.32	36.88	37.43	37.79	38.35	4
Limavady Main	90	40.3	18.65	18.88	19.16	19.45	19.74	19.93	20.22	4

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

BSP Location	TX (MVA)	SS (MVA)	SUMMER BSP FORECAST LOADING SINGLE OUTAGE CONDITIONS (MVA)							Notes
			2012	2013	2014	2015	2016	2017	2018	
Lisaghmore Main	90	58.5	52.97	39.97	40.47	41.09	41.72	42.35	42.77	2
Lisburn Main	180	80	71.77	55.57	56.27	57.15	58.07	58.98	59.60	3
Loguestown Main	90	58.5	40.44	37.36	37.83	38.37	38.92	39.48	39.83	2
Newry Main	180	82	67.19	68.04	69.10	70.20	71.30	72.03	73.16	3
Newtownards Main	120	78	35.76	36.21	36.73	37.28	37.81	38.16	38.71	2
Omagh Main	120	106	45.94	46.46	47.10	47.76	48.42	48.84	49.52	4
Rathgael Main	180	82	51.26	51.91	52.65	53.41	54.17	54.65	55.43	3
Rosebank Main	180	111	32.69	33.01	33.36	33.73	34.10	26.62	26.99	4
Springtown Main	180	87.9	27.55	27.90	28.36	28.83	29.31	29.64	30.13	4
Strabane Main	90	33.8	27.57	27.92	28.34	28.77	29.20	29.48	29.92	4
Waringstown Main	180	65.4	56.46	57.04	57.76	58.51	59.25	59.69	60.45	4
Belfast - Airport Road Main	180	82	N/A	N/A	N/A	N/A	N/A	34.51	34.51	3
Belfast Central Main	180	110	56.96	57.65	58.71	59.81	60.91	61.70	62.84	7
Belfast North Main*	180	100	N/A	N/A	N/A	44.27	44.90	45.31	45.96	7
Belfast - PSW	150	100	42.48	43.02	43.63	BSP will be decommissioned				7
Belfast - Carnmoney Main	120	68.6	36.13	36.59	37.16	37.75	38.34	38.73	39.34	4
Belfast - Glengormley Main	60	30.8	13.45	13.62	13.83	14.04	14.25	14.40	14.62	8
Belfast - Cregagh Main	150	78.9	60.41	61.16	62.05	62.98	63.89	52.92	53.86	4
Belfast - Knock Main	120	71	53.44	54.11	54.89	55.70	56.50	49.47	50.29	4
Belfast - Finaghy Main	90	58.5	29.28	29.65	30.11	30.59	31.06	31.38	31.87	2
Belfast - Donegall Main (North)	150	68.5	50.26	50.88	51.63	52.40	53.17	53.67	54.45	4
Belfast - Donegall Main (South)	120	68.5	48.62	49.22	49.92	50.65	51.36	51.82	52.56	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.

Waringstown

The demand forecast is based on a 33/11 kV substation load at Carn Central being transferred to Waringstown in Winter 2012/13. Since the firm capacity of the substation is exceeded, the load transfer will not take place until capacity issues have been managed by replacing the 33 kV switchboard.

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. It is important that in the interim period SONI and NIE develop plans to mitigate the risk of overloading equipment.

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 years. 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.

A detailed map of Ireland illustrating the railway network. Major stations are marked with black dots and labeled: Letterkenny, Sligo, Castlebar, Sranagh, Carrick-on-Shannon, Mullaghlin, Drybridge, Mullingar, Athlone, Thornsberry, Cloghan, Carricklines, Galway, Casha, Shannochbridge, Killeel, Portlaoise, Carlow, Arklow, Ennis, Limerick, Kilkenny, Cahir, Wexford, Tralee, Waterford, Middleton, and Trillick. The map shows a dense network of lines, with red lines indicating the main trunk routes and green lines indicating secondary routes. The map also shows the coastline and major bodies of water.

9.2.1 Incremental Transfer Capability Results for New Demand

9-7

Table 9-4 Capability for Additional Demand at 220 kV and 110 kV Stations, MW

Region	Station	2012	2015	2018
North-east	Drybridge	90	100	80
	Mullagharlin	50	40	30
North-west	Carrick-on-Shannon	30	60	50
	Castlebar	<10	<10	10
	Letterkenny	10	<10	<10
	Sligo	40	30	40
	Srananagh (220 kV)	40	50	30
East	Carrickmines	100	110	100
	College Park	20	20	20
	Corduff (220 kV)	110	320	320
	Kilteel	50	30	30
	Mullingar	20	40	50
	Portlaoise	80	10	50
	Thornberry	30	30	50
West	Athlone	10	20	50
	Cashla	50	110	130
	Ennis	60	140	130
	Galway	50	50	50
	Shannonbridge (220 kV)	80	200	200
South-east	Arklow	70	70	70
	Carlow	<10	10	20
	Kellis (220 kV)	20	20	30
	Kilkenny	<10	30	80
	Waterford	90 ^{P1}	120	130
	Wexford	70	60	60
South-west	Cahir	<10	100	70
	Limerick	110	100	110
	Midleton	70	60	50
	Trabeg	10	60	80
	Tralee	<10	50	60

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 years covered by the TFS 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 2012 there will be opportunities for an additional large demand at 20 of the 26 110 kV stations examined and in 2018 there will be opportunities at 24 of the 26 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 TFS includes an assessment of four 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 2015 and 2018. The graphics show that there will be significant demand opportunities in most parts of Ireland throughout the seven-year period to 2018.

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.

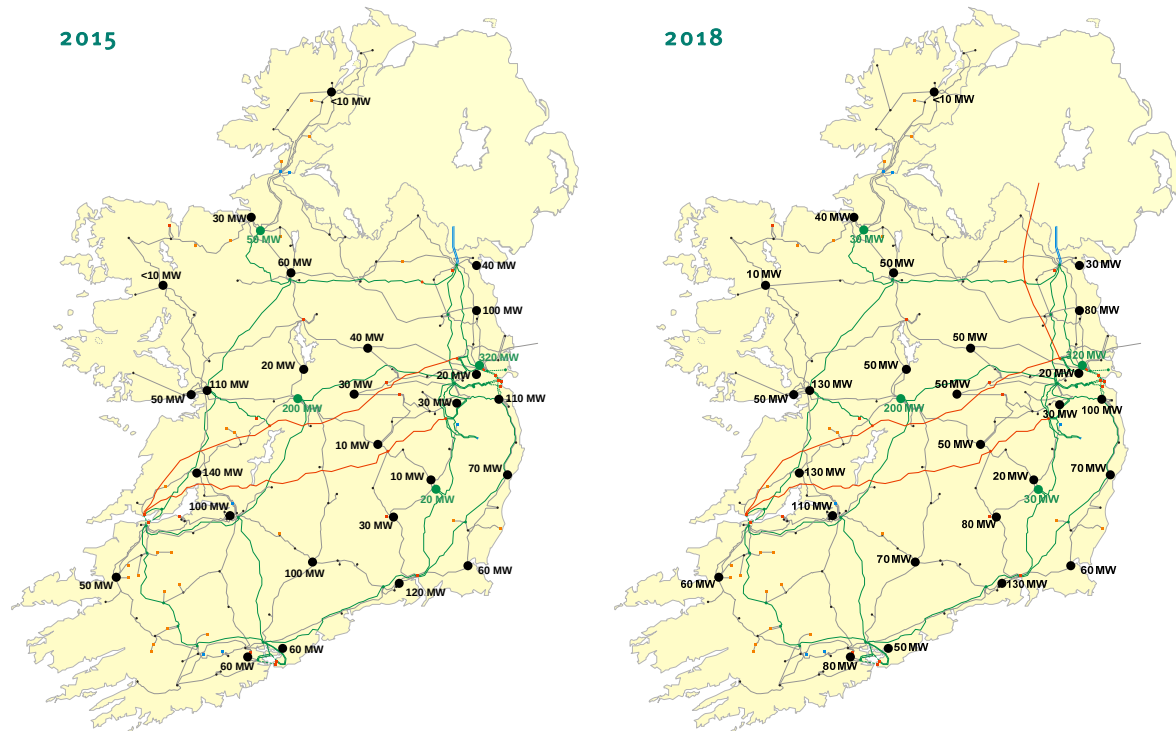


Figure 9-2 Capability for New Demand in 2015 and 2018

9.2.3 Impact of Changes since the Data Freeze

Since the beginning of July 2011, a number of developments have occurred that could impact on the results in Table 9-4. Projects selected and planned since July 2011 are listed in Section 1.4. Of these projects the planned uprating of Raffeen – Trabeg 110 kV circuit 1 in Cork should improve demand opportunities at Trabeg. Also, a connection agreement was executed on the 23rd of February 2012 (post the July 2011 data freeze date) between EirGrid and Hexagon Co-ownership for a 25 MVA demand connection near College Park in North West 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 Waterford city in 2013/14 might use the TFS. The maps in Appendix A show that the nearest 110 kV station is Waterford station. Appendix C shows that the demand at Waterford 110 kV station will be about 73.7 MW at winter peak 2012/13. This is forecast to grow by 3.0 MW between 2012 and 2015 i.e. by 1 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 Waterford i.e. the type of increase that is the subject of the transfer capability analysis presented in this chapter.

The results for Waterford in Table 9-4 show that the opportunity for increased demand is less than 90 MW or less in 2012. The table directs the potential developer to constraint P1 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 Cullenagh-Waterford 110 kV line is responsible for limiting the opportunity. The overload occurs under summer peak maintenance-trip conditions. Capital project CP0558, which entails an uprate of the existing Cullenagh-Waterford 110 kV line, has been initiated by the TSO to relieve the constraint. Detailed information on capital project CP0558 can be found in Appendix B. Following completion of this project towards the end of 2012 the opportunity at Waterford increases to 120 MW in 2015. This indicates that the transmission system is likely to be capable of connecting and supplying the proposed demand once capital project CP0558 has been fully implemented.

A Maps and Schematic Diagrams

- A.1 Transmission System Maps
- A.2 Short Bus Codes
- A.3 Schematic Diagrams of Ireland



APPENDIX A MAPS AND SCHEMATIC DIAGRAMS

Appendix A contains geographical maps of the all-island transmission system and schematic diagrams of the transmission system of Ireland. Geographical maps are presented illustrating the all-island transmission system as it exists at the beginning July of 2011 and as planned for 2018. These maps are also included in A3 format in Appendix J for greater legibility. The schematic diagrams represent the transmission system of Ireland as planned at the end of 2011, 2012, 2015 and 2018.

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 July 01st 2011;
- Figure A-2 is a map of the existing transmission system including planned transmission system developments as at December 31st 2018.

Figure A - 1

Transmission System

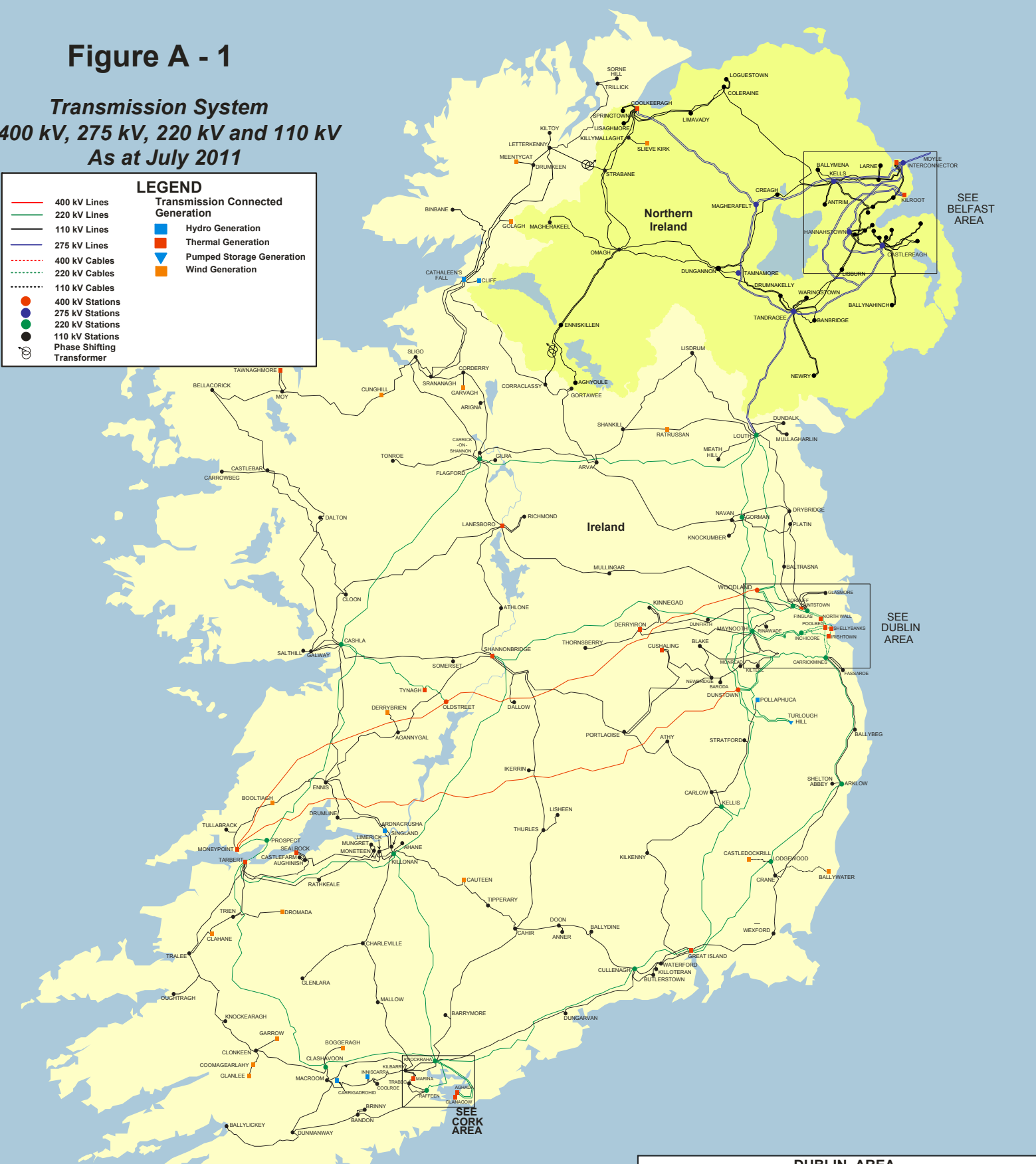
400 kV, 275 kV, 220 kV and 110 kV
As at July 2011

LEGEND

Transmission Connected Generation

- Hydro Generation
- Thermal Generation
- ▲ Pumped Storage Generation
- Wind Generation

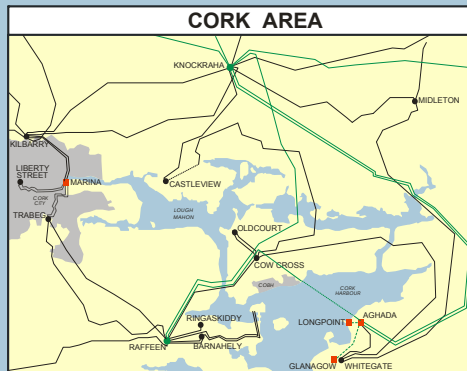
- 400 kV Lines
- 220 kV Lines
- 110 kV Lines
- 275 kV Lines
- - - 400 kV Cables
- - - 220 kV Cables
- - - 110 kV Cables
- 400 kV Stations
- 275 kV Stations
- 220 kV Stations
- 110 kV Stations
- Phase Shifting Transformer



BELFAST AREA



CORK AREA



DUBLIN AREA

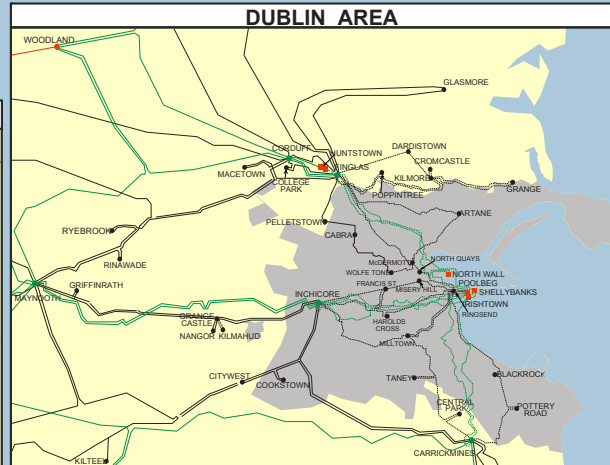
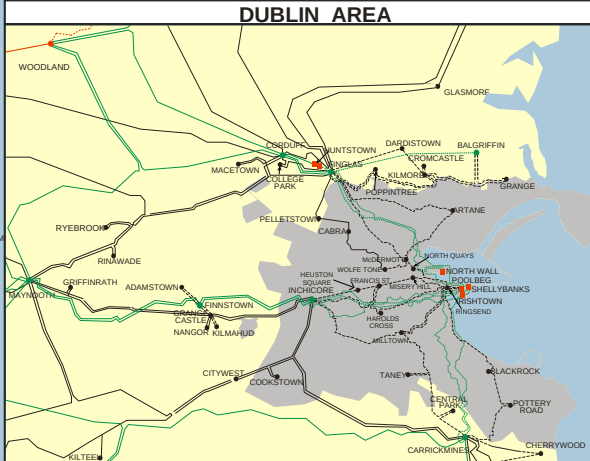
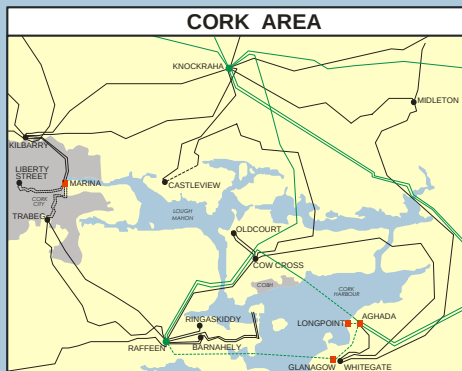
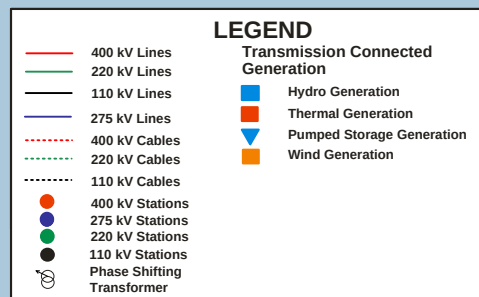


Figure A - 2

Planned Transmission System 400 kV, 275 kV, 220 kV and 110 kV As at December 2018



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	DDK	Dundalk	MAG	Magherafelt
AD	Aghada	DER	Derryiron	MAL	Mallow
ADM	Adamstown	DFR	Dunfirth	MAN	Mid Antrim
AGH	Aghyoule Main	DGN	Dungarvan	MAY	Maynooth
AGL	Agannygal	DLN	Derrylyn	MCE	Macetown
AGY	Ardnagappary	DLT	Dalton	MEE	Meentycat
AHA	Ahane	DMY	Dunmanway	MID	Midleton
AHN	Altahullion	DON	Belfast - Donegall Main (North)	MKL	Magherakeel
AIR	Belfast - Airport Road Main	DON	Belfast - Donegall Main (South)	MLC	Mountlucas
ANR	Anner	DOO	Doon	MLN	Mullagharlin
ANT	Antrim Main	DQN	Drumquin Cluster	MON	Monread
ARI	Arigna	DRM	Drumkeen	MOY	Moy
ARK	Arklow	DRO	Dromada	MP	Moneypoint
ARV	Arva	DRU (I)	Drumline	MR	Marina
ATE	Athea	DRU (N)	Drumnakelly Main	MRY	Mulreavy
ATH	Athlone	DRY	Drybridge	MTH	Meath Hill
ATY	Athy	DSN	Dunstown	MTN	Moneteen
AUG	Aughinish	DUN	Dungannon Main	MUL	Mullingar
BAL	Baltrasna	DYN	Derrybrien	MUN	Mungret
BAN (N)	Banbridge Main	EDE	Eden Main	NAN	Nangor
BAN (I)	Bandon	ENN (N)	Enniskillen Main	NAR	Newtownards Main
BAR	Barrymore	ENN (I)	Ennis	NAV	Navan
BCM	Ballycummin	FAS	Fassaroe	NEN	Nenagh
BDA	Baroda	FIN (N)	Belfast - Finaghy Main	NEW (N)	Newry Main
BDN	Ballydine	FIN (I)	Finglas	NEW (I)	Newbridge
BEG	Ballybeg	FLA	Flagford	NO	Nore
BGF	Balgriffin	KKM	Kishkeam	NW	North Wall
BGH	Boggeragh	KKY	Kilkenny	OLD	Oldcourt
BGT	Ballyragget	FLN	Fallaghearn	OMA	Omagh Main
BIN	Binbane	FNT	Finnstown	OMS	Omagh South
BK	Bellacorick	GAE	Glanlee	OST	Oldstreet
BLI	Ballylickey	GAL	Galway	OUG	Oughtragh
BLK	Blake	GAR	Garvagh	PA	Pollaphuca

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name	Short Bus Code	Full Name	Short Bus Code	Full Name
BLP	Blackpool	GCA	Grange Castle	PB	Poolbeg
BMA	Ballymena Mesh (Rural)	GGO	Glanagow	PLA	Platin
BMA	Ballymena SWBD (Town)	GI	Great Island	PLS	Portlaoise
BNH	Ballynahinch Main	GIL	Gilra	PMR	Pomeroy
BNM	BELFAST - Belfast North Main	GLA	Glasmore	PRO	Prospect
BOG	Banoge	GLE (N)	Belfast - Glengormley Main	PSW	Belfast - PSW
BOL	Booltiagh	GLE (I)	Glenlara	RAF	Raffeen
BPS	Ballylumford Power Station	GLR	Glenree	RAL	Ralapanne
BRA	Bracklone	GOL	Golagh	RAT (N)	Rathgael Main
BRI	Brinny	GOR	Gorman	RAT (I)	Rathkeale
BRY	Barnahely	GRA	Grange	REM	Reamore
BUT	Butlerstown	GRI	Griffinrath	RIC	Richmond
BVG	Ballyvallah	GRO	Garrow	RNW	Rinawade
BVK	Ballyvouskill	GWE	Gortawee	ROS	Rosebank Main
BWR	Ballywater	HAN	Hannastown	RRU	Ratrussan
BY	Ballakelly	HN	Huntstown	RSY	Ringaskiddy
BYC	Ballycronan More (Moyle)	HTS	Hartnett's Cross	RYB	Ryebrook
CA	Caulstown	IA	Inniscarra	SAL	Salthill
CAH	Cahir	IKE	Ikerrin	SBN	Strabane
CAM	Cam Cluster	INC	Inchicore	SCR	Screeb
CAR	Belfast - Carnmoney Main	ISH	Irishtown	SH	Shannonbridge
CAS	Castlereagh	KBY	Kilbarry	SHE	Shelton Abbey
CBG	Carrowbeg	KCR	Knockacummer	SHL	Shellybanks
CBR	Castlebar	KNV	Knockavanna	SK	Sealrock
CD	Carrigadrohid	KEL	Kells	SKL	Shankill
CDK	Castledockrill	KER	Knockearagh	SLI	Sligo
CDL	Cordal	KGN	Knocknagreenan	SNG	Singland
CDU	Corduff	KHL	Kill Hill	SOM	Somerset
CDY	Corderry	KIN	Kinnegad	SOR	Sorne Hill
CEN	Belfast - Belfast Central Main	KLM	Kilmore	SPR	Springtown Main
CF	Cathaleen's Fall	KLN	Killonan	SRA	Srananagh
CFM	Castlefarm	KLS	Kellis	STR (I)	Stratford
CGL	Coomagearlahy	KMT	Killymallaght	STR (N)	Strabane Main
CHA	Charleville	KNG	Knocknagashel	SUR	Suir
CHE	Cherrywood	KNM	Knockmullen	SVN	Stevenstown
CKM	Carrickmines	KNO	Belfast - Knock Main	TAN	Tandragee
CKN	Clonkeen	KNR	Knockanure	TAW	Tawnaghmore
CL	Cliff	KPG	Kilpaddoge	TB	Tarbert

Table A-1 Short Bus Codes (continued)

Short Bus Code	Full Name
CLA	Clashavoon
CLH	Clahane
CLN	Cloon
CLW	Carlow
COL (N)	Coleraine Main
COL (I)	College Park
COR	Corraclassy
COS	Carrick-on-Shannon
COW	Cow Cross
CPS	Coolkeeragh Main
CRA	Crane
CRE	Belfast - Cregagh Main
CRG	Creagh Main
CRO	Coolroe
CSH	Cashla
CTN	Cauteen
CUI	Cuilleen
CUL	Cullenagh
CUN	Cunghill
CUS	Cushaling
CVW	Castleview
DAL	Dallow

Short Bus Code	Full Name
KPS	Kilroot Power Station
KRA	Knockraha
KTL	Kilteel
KTN	Killoteran
KUD	Kilmahud
KUR	Knockumber
LA	Lanesboro
LAR	Larne Main
LET	Letterkenny
LIB	Liberty Street
LIM (N)	Limavady Main
LIM (I)	Limerick
LIS (I)	Lisdrum
LIS (N)	Lisburn Main
LMR	Lisaghmore Main
LOG	Loguestown Main
LOU	Louth
LPT	Longpoint
LSE	Laois
LSN	Lisheen
LWD	Lodgewood
MAC	Macroon

Short Bus Code	Full Name
TBG	Trabeg
TBK	Tullabrack
TH	Turlough Hill
THU	Thurles
TIP	Tipperary
TIV	Tievebrack
TLE	Turleenan
TLK	Trillick
TMN	Tamnamore
TON	Tonroe
TRI	Trien
TRL	Tralee
TSB	Thornsberry
TYN	Tynagh
WAR	Waringstown Main
WAT	Waterford
WEX	Wexford
WHI	Whitegate
WOO	Woodland

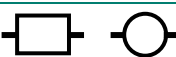
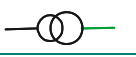
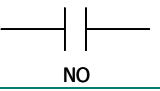
A.3 SCHEMATIC DIAGRAMS OF THE TRANSMISSION SYSTEM OF IRELAND

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 2011 highlights the developments due to be completed in 2011. The diagram for 2012 displays developments due for completion in 2012. The 2015 diagram highlights developments expected to be completed between 2012 and the end of 2015 while the 2018 diagram highlights developments due to be completed between 2015 and the end of 2018.

In all diagrams **blue shading** represents a new development, **pink shading** denotes a circuit uprating, **yellow shading** indicates the locations of conventional generators and **orange shading** indicates the locations of wind generators.

Table A-2 Schematic Legend

Symbol	Network Element Represented
	400 kV circuit
	275 kV circuit
	220 kV circuit
	110 kV circuit
	Busbar
	Busbar with thermal generation
	Busbar with wind generation
	Busbar with thermal and wind generation
	Busbar with hydro generation
	Capacitor
	Static var compensator (SVC)
	Reactor
	Auto-transformer
	Double-wound transformer
	Phase shifting transformer
	Split-busbar
	Normally open point

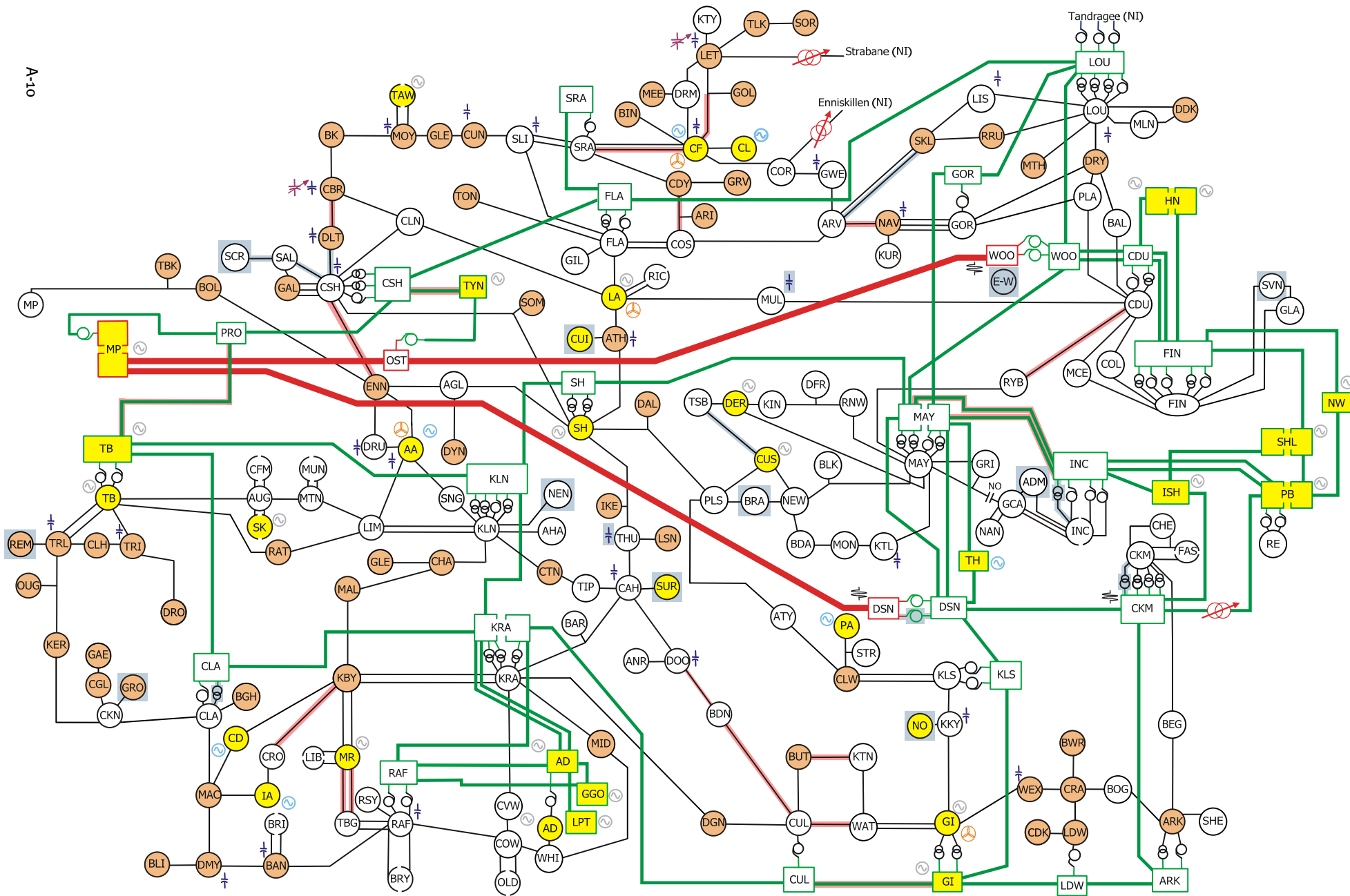


Figure A-4 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2012

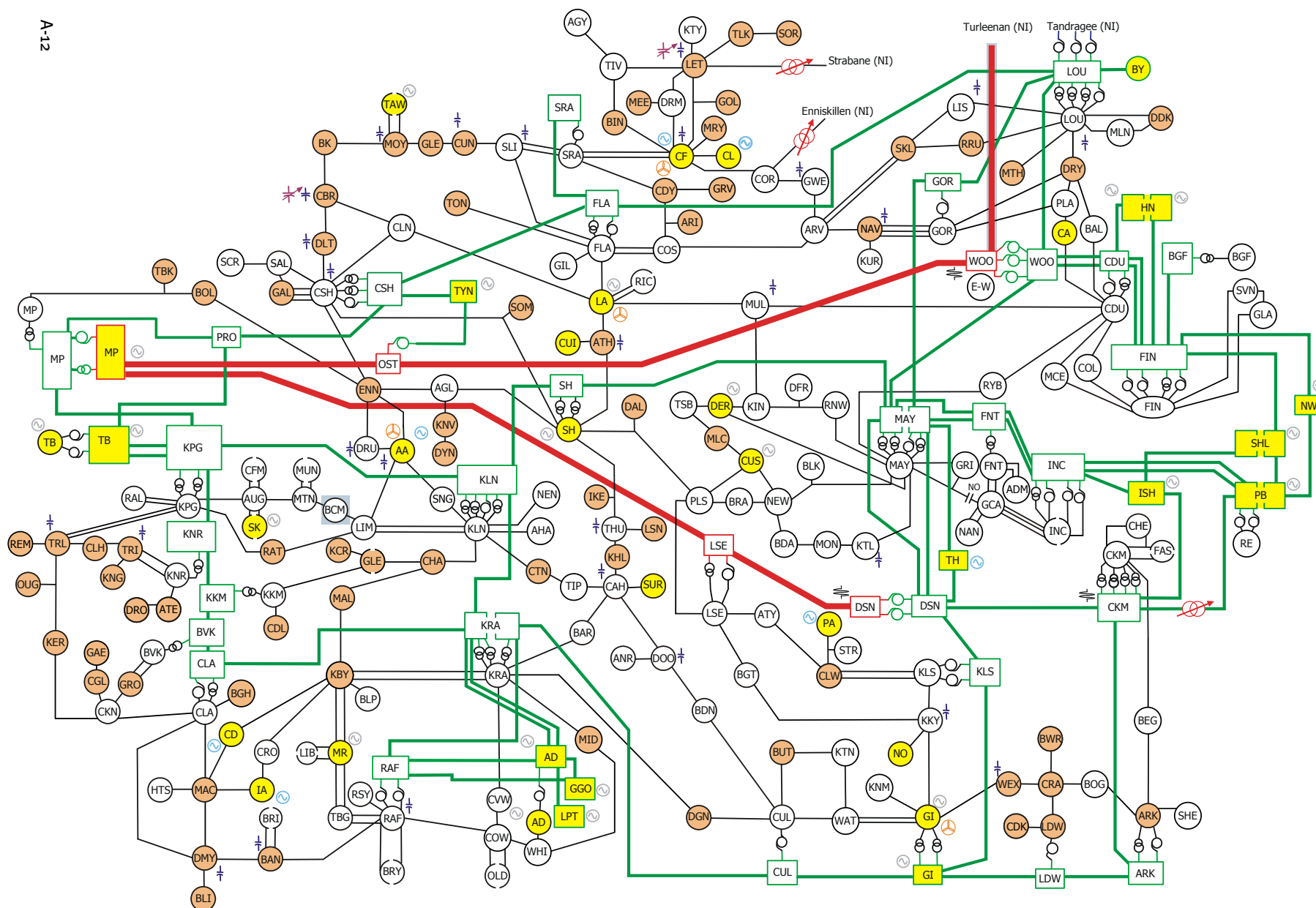


Figure A-6 Schematic Diagram of the Existing and Planned Ireland Transmission System at End of 2018

B Transmission System Characteristics

B.1 Characteristics of the Existing Transmission System

B.2 Changes in Transmission System Characteristics



APPENDIX B TRANSMISSION SYSTEM CHARACTERISTICS

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

The planned developments include transmission system reinforcement projects that have been selected by the TSOs, and developments necessary to connect new generation and demands to the transmission system as at the beginning of July and November 2011.

Readers should refer to Section 1.4 in Chapter 1 of the main text to obtain information on projects approved since July 2011.

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 July 01st 2011

Table B-14 Changes in Circuit Characteristics Expected in 2012

Table B-15 Changes in Circuit Characteristics Expected in 2013

Table B-16 Changes in Circuit Characteristics Expected in 2014

Table B-17 Changes in Circuit Characteristics Expected Beyond 2014

Table B-18 Characteristics of Transformers Expected in 2011

Table B-19 Characteristics of Transformers Expected in 2012

Table B-20 Characteristics of Transformers Expected in 2013

Table B-21 Characteristics of Transformers Expected in 2014

Table B-22 Characteristics of Transformers Expected Beyond 2014

Table B-23 Characteristics of Reactive Compensation Expected in 2011

Table B-24 Characteristics of Reactive Compensation Expected in 2012

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			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
DSN	MP	1	208.5	0.004	0.047	1.049	1424	1713
MP	OST	1	105.0	0.002	0.023	0.530	1424	1713
OST	WOO	1	125.0	0.002	0.028	0.631	1424	1713

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

275 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
LOU	TAN	1	49.81	0.003	0.021	0.127	710	881	881
LOU	TAN	2	49.81	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
CAC02A	CPS	1	0.2	0.000	0.000	0.023	761	761	837
CAC02A	MAG	1	56	0.007	0.025	0.150	412	477	513
CAC02B	CPS	1	0.17	0.000	0.000	0.019	761	761	837
CAC02B	MAG	1	56	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	0.002	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	0.002	0.013	0.077	710	820	881
KEL	KIL	2	29	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			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
AD	GGO	1	3.8	0.000	0.002	0.104	593	593
AD	KRA	2	25.6	0.003	0.022	0.034	431	518
AD	RAF	1	15.2	0.001	0.008	0.261	431	518
AD	KRA	1	25.6	0.003	0.022	0.034	431	518
AD	LPT	1	1.0	0.000	0.000	0.027	593	593
ARK	CKM	1	53.3	0.006	0.046	0.070	431	518
ARK	LWD	1	39.0	0.005	0.034	0.051	431	435
CLA	KRA	1	45.0	0.005	0.039	0.059	431	518
CLA	TB	1	97.3	0.011	0.084	0.127	431	518
CSH	FLA	1	88.1	0.010	0.076	0.115	405	405
CSH	PRO	1	88.5	0.010	0.077	0.116	431	436
CSH	TY	1	33.8	0.004	0.029	0.044	431	436
CKM	DSN	1	41.6	0.005	0.036	0.054	431	518
CKM	ISH	1	11.5	0.000	0.005	0.320	593	593
CUL	GI	1	23.0	0.003	0.020	0.030	229	438
CUL	KRA	1	86.0	0.010	0.075	0.113	431	832
CDU	FIN (I)	1	3.7	0.001	0.003	0.005	431	518
CDU	FIN (I)	2	3.7	0.001	0.003	0.005	431	518
CDU	HN	1	4.5	0.000	0.002	0.123	593	593
CDU	WOO	1	18.4	0.002	0.016	0.024	431	518
CDU	WOO	2	17.8	0.002	0.016	0.023	431	518
DSN	KLS	1	59.3	0.007	0.051	0.077	431	518
DSN	MAY	1	36.3	0.004	0.032	0.048	431	518
DSN	MAY	2	30.6	0.004	0.027	0.040	431	518
DSN	TH	1	26.6	0.003	0.022	0.144	351	351
FLA	LOU	1	110.1	0.013	0.095	0.144	431	476
FIN (I)	HN	1	1.4	0.000	0.001	0.038	570	570
FIN (I)	NW	1	11.9	0.001	0.004	0.680	332	332
FIN (I)	SHL	1	13.4	0.001	0.005	0.367	590	590
GI	KLS	1	69.3	0.008	0.060	0.091	431	518
GI	LWD	1	47.9	0.006	0.042	0.063	431	435
GOR	LOU	1	32.4	0.004	0.028	0.042	431	518
GOR	MAY	1	42.2	0.005	0.037	0.055	431	518
INC	ISH	1	12.1	0.000	0.005	0.330	593	593
INC	MAY	2	19.1	0.002	0.017	0.025	323	389
ISH	SHL	1	1.3	0.000	0.001	0.030	548	548
KRA	KLN	1	82.4	0.055	0.091	0.000	512	565
KRA	RAF	1	23.4	0.003	0.020	0.031	431	518
KLN	SH	1	89.7	0.014	0.080	0.115	286	366
KLN	TB	1	70.6	0.008	0.061	0.092	431	518
LOU	WOO	1	61.2	0.007	0.053	0.080	431	518
MAY	TH	1	53.1	0.006	0.044	0.184	351	351
MAY	INC	1	19.1	0.002	0.017	0.025	323	389
MAY	SH	1	105.6	0.017	0.094	0.135	286	370
MAY	WOO	1	22.3	0.003	0.020	0.030	431	518
MP	PRO	1	12.7	0.001	0.009	0.021	700	700
NW	PB	1	4.5	0.000	0.001	0.261	332	332

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

220 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)	
From	To	No.		R	X	B	Summer	Winter
OST	TY	1	14.5	0.002	0.013	0.019	431	518
PB	SHL	1	0.1	0.000	0.000	0.003	570	570
PB	CKM	1	14.5	0.001	0.005	0.618	267	267
PB	INC	1	12.5	0.001	0.004	0.504	267	267
PB	INC	2	11.3	0.001	0.003	0.722	351	351
PRO	TB	1	10.3	0.001	0.007	0.173	381	381

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
AA	DRU (I)	1	18.4	0.029	0.067	0.006	107	N/A	126
AA	ENN (I)	1	33.0	0.051	0.117	0.011	107	N/A	126
AA	LIM (I)	1	11.7	0.007	0.037	0.012	187	N/A	223
AA	SNG	1	5.6	0.004	0.018	0.003	187	N/A	223
AD	WHI	1	3.1	0.005	0.011	0.001	107	N/A	126
AGH	EKN	1	30.1	0.040	0.095	0.020	109	119	124
AGL	DYN	1	8.0	0.013	0.028	0.003	107	N/A	126
AGL	ENN (I)	1	38.2	0.059	0.131	0.012	107	N/A	126
AGL	SH	1	46.2	0.072	0.159	0.015	107	N/A	126
AHA	KLN	1	3.8	0.004	0.012	0.004	115	N/A	115
ANR	DOO	1	2.0	0.003	0.007	0.001	107	N/A	126
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	90	N/A	95
ARK	BEG	1	22.0	0.010	0.079	0.007	137	N/A	164
ARK	CRA	1	41.8	0.064	0.144	0.013	107	N/A	126
ARK	SHE	2	2.5	0.004	0.009	0.001	72	N/A	95
ART	FIN (I)	1	9.0	0.005	0.010	0.055	108	N/A	115
ART	MCD	1	4.9	0.003	0.006	0.030	108	N/A	115
ARV	COS	1	41.4	0.064	0.142	0.013	107	N/A	126
ARV	GWE	1	30.6	0.019	0.099	0.011	187	N/A	223
ARV	NAV	1	60.6	0.038	0.197	0.021	187	N/A	223
ARV	SKL	1	18.6	0.029	0.065	0.006	86	N/A	111
ATE	DRO	1	7.0	0.005	0.011	0.070	140	N/A	140
ATE	TRI	1	11.0	0.007	0.036	0.004	187	N/A	223
ATH	LA	1	35.8	0.054	0.123	0.012	107	N/A	126
ATH	SH	1	21.6	0.014	0.070	0.016	93	N/A	131
ATY	CLW	1	25.0	0.039	0.086	0.008	107	N/A	126
ATY	PLS	1	26.6	0.041	0.092	0.009	107	N/A	126
AUG	CFM	1	0.7	0.001	0.002	0.001	96	N/A	96
AUG	MTN	1	27.5	0.017	0.089	0.010	187	N/A	223
AUG	SK	3	1.0	0.001	0.001	0.006	120	N/A	120
AUG	SK	4	1.0	0.001	0.001	0.006	120	N/A	120
AUG	TB	1	34.0	0.021	0.111	0.012	187	N/A	223
AUG	CFM	2	0.7	0.001	0.002	0.001	96	N/A	96

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
BAL	CDU	1	16.8	0.011	0.055	0.006	187	N/A	223
BAL	DRY	1	20.0	0.013	0.065	0.007	187	N/A	223
BAN (I)	BRI	1	2.6	0.004	0.009	0.001	107	N/A	126
BAN (I)	DMY	1	25.9	0.040	0.089	0.008	107	N/A	126
BAN (I)	RAF	1	26.9	0.041	0.091	0.012	107	N/A	126
BAN (I)	BRI	2	2.5	0.004	0.009	0.001	107	N/A	126
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	0.001	0.001	0.000	107	N/A	126
BDA	MON	1	12.5	0.012	0.036	0.020	120	N/A	128
BDA	NEW (I)	1	7.9	0.007	0.020	0.019	120	N/A	128
BDN	CUL	1	21.8	0.014	0.071	0.008	107	N/A	126
BDN	DOO	1	11.3	0.007	0.037	0.004	107	N/A	126
BEG	CKM	1	32.3	0.015	0.116	0.010	137	N/A	164
BGH	CLA	1	13.5	0.008	0.040	0.039	187	N/A	223
BIN	CF	1	34.3	0.053	0.118	0.011	107	N/A	126
BK	CBR	1	37.3	0.058	0.128	0.013	99	N/A	120
BK	MOY	1	27.0	0.042	0.093	0.009	99	N/A	126
BLA	POT	1	5.2	0.002	0.004	0.092	109	N/A	115
BLA	RE	1	7.7	0.003	0.006	0.136	109	N/A	115
BLI	DMY	1	27.6	0.043	0.094	0.010	107	N/A	126
BLK	BLK T	1	0.5	0.001	0.002	0.000	137	N/A	164
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
BOL	ENN (I)	1	24.0	0.037	0.083	0.008	107	N/A	126
BOL	TBK T	1	19.6	0.031	0.067	0.006	107	N/A	126
BPS	BVG	1	17.4	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	15.2	0.009	0.051	0.005	69	80	193
BPS	EDE	1	15.2	0.009	0.051	0.005	70	81	193
BRY	RAF	1	1.7	0.003	0.006	0.001	72	N/A	103
BRY	RAF	2	1.8	0.002	0.006	0.001	107	N/A	126
BUT	CUL	1	11.6	0.018	0.040	0.004	107	N/A	126
BUT	KTN	1	2.7	0.002	0.009	0.001	107	N/A	126
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	0.003	79	96	113
BVG	LAR	1	7.1	0.007	0.023	0.003	79	96	113
BWR	CRA	1	21.9	0.011	0.030	0.137	116	N/A	116
CAB	PTN	1	2.7	0.002	0.007	0.005	124	N/A	133
CAB	WOL	1	4.7	0.003	0.005	0.029	108	N/A	115
CAH	DOO	1	15.7	0.010	0.051	0.006	187	N/A	223
CAH	THU	1	39.0	0.041	0.130	0.013	93	N/A	131
CAH	TIP	1	18.1	0.028	0.063	0.006	107	N/A	126
CAH	BAR T	1	44.2	0.066	0.152	0.014	107	N/A	126

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
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	0.060	132	132	145
CAS	CRE	1	3.0	0.001	0.004	0.060	132	132	145
CAS	KNO	1	4.6	0.005	0.004	0.045	66	66	73
CAS	KNO	1	4.5	0.005	0.004	0.045	66	66	73
CAS	NAR	1	18.0	0.015	0.040	0.071	109	119	124
CAS	NAR	1	19.8	0.018	0.046	0.070	109	119	124
CAS	RAT (N)	1	18.9	0.025	0.064	0.006	82	95	103
CAS	RAT (N)	1	18.9	0.025	0.064	0.006	82	95	103
CAS	ROS	1	1.9	0.001	0.002	0.024	117	117	128
CAS	ROS	1	1.9	0.001	0.002	0.024	117	117	128
CBR	CLN	1	57.5	0.089	0.198	0.020	99	N/A	120
CBR	CBG	1	26.5	0.036	0.081	0.056	99	N/A	125
CBR	DLT	1	27.8	0.043	0.096	0.009	74	N/A	94
CD	KBY	1	32.1	0.020	0.104	0.011	187	N/A	223
CD	MAC	1	2.4	0.004	0.008	0.001	107	N/A	126
CDK	LWD	1	6.6	0.003	0.009	0.041	116	N/A	116
CDU	MUL	1	73.3	0.088	0.237	0.041	107	N/A	126
CDU	PLA	1	37.0	0.023	0.120	0.013	187	N/A	223
CDU	RYB	1	13.0	0.012	0.040	0.021	93	N/A	125
CDY	GRV	1	7.3	0.005	0.024	0.003	187	N/A	223
CDY	SRA	1	12.7	0.020	0.044	0.004	107	N/A	126
CDY	ARI T	1	13.7	0.014	0.046	0.005	120	N/A	128
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	137	N/A	164
CF	COR	1	61.3	0.039	0.199	0.022	187	N/A	223
CF	DRM	1	51.3	0.077	0.176	0.017	107	N/A	126
CF	SRA	1	53.3	0.033	0.172	0.027	107	N/A	126
CF	SRA	2	49.2	0.062	0.166	0.016	107	N/A	126
CF	GOL T	1	25.5	0.016	0.083	0.009	107	N/A	126
CGL	GAE	1	2.0	0.001	0.003	0.015	140	N/A	143
CHA	GLE (I)	1	30.0	0.047	0.103	0.010	107	N/A	126
CHA	KLN	1	36.9	0.039	0.123	0.013	137	N/A	164
CHA	MAL	1	22.5	0.035	0.077	0.007	72	N/A	103
CKM	CPK	1	3.4	0.002	0.004	0.025	100	N/A	107
CKM	POT	1	3.2	0.001	0.003	0.057	109	N/A	115
CKM	COO	1	18.0	0.017	0.053	0.024	111	N/A	138
CKM	FAS T	1	2.9	0.005	0.010	0.001	107	N/A	126
CKN	GRO	1	15.6	0.008	0.015	0.154	125	N/A	125
CKN	KER	1	20.3	0.013	0.066	0.007	187	N/A	223
CLA	CKN	1	29.8	0.019	0.097	0.011	187	N/A	223
CLA	MAC	1	5.7	0.004	0.018	0.002	187	N/A	223
CLH	TRI	1	9.0	0.014	0.031	0.003	107	N/A	126

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
CLH	TRL	1	13.5	0.020	0.045	0.025	107	N/A	126
CLN	LA	1	65.0	0.095	0.226	0.021	93	N/A	126
CLW	KLS	1	5.4	0.008	0.019	0.002	107	N/A	126
CLW	KLS	2	5.3	0.008	0.019	0.002	107	N/A	126
CLW	STR (I)	1	17.6	0.027	0.061	0.006	107	N/A	126
COL (I)	KLD	1	5.1	0.003	0.014	0.016	99	N/A	124
COL (I)	CDU	1	2.7	0.001	0.004	0.020	143	N/A	143
COL (I)	CPS	1	46.6	0.061	0.161	0.015	82	95	103
COL (N)	KEL	1	58.9	0.070	0.201	0.020	109	119	124
COL (N)	LIM (N)	1	18.6	0.024	0.064	0.006	82	95	103
COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
COL (N)	LOG	1	8.1	0.011	0.027	0.003	82	95	103
COO	CTY	1	2.9	0.004	0.010	0.001	111	N/A	143
COO	INC	1	6.1	0.006	0.015	0.028	137	N/A	140
COR	GWE	1	10.9	0.007	0.036	0.004	187	N/A	223
COR	EKN	1	27.5	0.043	0.095	0.009	107	N/A	126
COS	FLA	1	3.4	0.005	0.012	0.001	107	N/A	126
COS	FLA	2	3.3	0.005	0.011	0.001	107	N/A	126
COS	ARI T	1	20.7	0.022	0.069	0.007	120	N/A	128
COW	CVW	1	17.2	0.025	0.054	0.018	107	N/A	126
COW	OLD	1	2.3	0.004	0.008	0.001	107	N/A	126
COW	OLD	2	2.2	0.003	0.008	0.001	107	N/A	126
COW	RAF	1	6.9	0.010	0.024	0.003	107	N/A	126
COW	WHI	1	17.8	0.027	0.062	0.006	107	N/A	126
CPK	TNY	1	5.6	0.003	0.006	0.073	108	N/A	115
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	9.3	0.011	0.029	0.012	82	95	103
CPS	SPR	1	9.3	0.011	0.029	0.012	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	187	N/A	223
CRA	WEX	1	21.3	0.022	0.071	0.007	137	N/A	164
CRG	CRG	1	N/A	0.000	0.001	0.006	144	144	144
CRG	CRG	1	N/A	0.000	0.001	0.006	144	144	144
CRG	KEL	1	23.1	0.029	0.076	0.008	82	95	103
CRG	DUN	1	73.0	0.047	0.124	0.012	82	95	103
CRM	KLM	2	1.4	0.001	0.002	0.014	124	N/A	133
CRM	KLM	1	1.4	0.001	0.002	0.014	124	N/A	133
CRO	IA	1	2.7	0.002	0.009	0.001	107	N/A	126
CRO	KBY	1	14.3	0.009	0.047	0.005	107	N/A	126
CSH	CLN	1	22.8	0.014	0.074	0.008	187	N/A	223
CSH	DLT	1	52.0	0.081	0.179	0.017	107	N/A	126
CSH	ENN (I)	1	53.5	0.034	0.174	0.019	107	N/A	126
CSH	GAL	1	13.8	0.022	0.048	0.005	107	N/A	126
CSH	GAL	2	11.3	0.018	0.039	0.004	107	N/A	126

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
CSH	GAL	3	11.3	0.018	0.039	0.004	107	N/A	126
CSH	SOM T	1	44.9	0.070	0.154	0.014	107	N/A	126
CTN	TIP	1	13.2	0.021	0.046	0.004	107	N/A	126
CTY	INC	1	8.9	0.011	0.030	0.003	111	N/A	143
CUL	DGN	1	34.3	0.053	0.116	0.016	107	N/A	126
CUL	WAT	1	12.5	0.008	0.040	0.006	107	N/A	126
CUN	MOY	1	40.7	0.063	0.140	0.013	107	N/A	126
CUN	SLI	1	20.0	0.031	0.069	0.006	99	N/A	126
CUS	NEW (I)	1	31.2	0.033	0.104	0.011	137	N/A	164
CUS	PLS	1	41.8	0.044	0.140	0.014	137	N/A	164
CVW	KRA	1	7.6	0.012	0.026	0.004	107	N/A	126
DAL	DAL T	1	12.2	0.019	0.042	0.004	107	N/A	126
DDK	MLN	1	7.5	0.012	0.026	0.003	107	N/A	126
DDK	LOU	2	16.8	0.026	0.058	0.005	107	N/A	126
DER	KIN	1	15.1	0.012	0.050	0.005	120	N/A	128
DER	MAY	1	43.0	0.027	0.139	0.018	90	N/A	95
DER	TSB	1	19.7	0.031	0.068	0.006	107	N/A	126
DFR	DFR T	1	0.1	0.000	0.000	0.000	107	N/A	126
DGN	KRA	1	53.7	0.034	0.175	0.019	178	N/A	218
DLT	GAL	1	55.1	0.086	0.190	0.018	107	N/A	126
DMY	MAC	1	26.2	0.017	0.085	0.009	107	N/A	126
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	HAN	1	6.1	0.002	0.005	0.140	144	144	158
DON	PSW	1	5.8	0.006	0.006	0.066	75	75	82
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	0.008	69	80	86
DRM	LET	1	8.0	0.013	0.028	0.003	107	N/A	126
DRM	MEE	1	5.0	0.008	0.017	0.002	107	N/A	126
DRU (I)	ENN (N)	1	17.4	0.027	0.060	0.006	107	N/A	126
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	0.005	0.015	0.002	79	96	113
DRU (N)	TAN	2	4.4	0.005	0.015	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	107	N/A	126
DRY	LOU	1	31.9	0.020	0.104	0.011	187	N/A	223
DRY	PLA	1	5.3	0.008	0.018	0.002	107	N/A	126
DTN	FIN (I)	1	9.2	0.002	0.014	0.066	137	N/A	146
DTN	KLM	1	3.2	0.002	0.005	0.032	124	N/A	151
DUN	OMA	1	36.1	0.043	0.125	0.012	150	150	150
DUN	OMA	2	78.8	0.047	0.136	0.013	150	150	150
DUN	TMN	1	5.9	0.004	0.016	0.002	144	144	144
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	N/A	126
FAS	CKM	1	7.5	0.011	0.026	0.003	107	N/A	126

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
FAS	CKM	2	7.5	0.012	0.026	0.002	107	N/A	126
FIN (I)	MCD	1	7.9	0.003	0.007	0.141	141	N/A	150
FIN (I)	PTN	1	3.5	0.003	0.010	0.006	109	N/A	116
FIN (I)	GLA	1	14.0	0.022	0.048	0.005	107	N/A	115
FIN (I)	GLA	2	14.2	0.022	0.049	0.005	107	N/A	115
FIN (I)	GRA	1	13.2	0.005	0.012	0.236	101	N/A	125
FIN (I)	POP	1	4.3	0.002	0.005	0.026	109	N/A	116
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	107	N/A	126
FLA	LA	1	30.6	0.048	0.105	0.010	107	N/A	126
FLA	SLI	1	50.5	0.079	0.174	0.016	107	N/A	126
FLA	TON	1	32.3	0.050	0.112	0.010	99	N/A	126
FRA	HAR	1	2.3	0.002	0.004	0.030	107	N/A	114
FRA	MHL	1	4.2	0.003	0.006	0.042	124	N/A	151
FRA	INC	1	5.6	0.004	0.010	0.073	107	N/A	114
GAL	SAL	1	6.5	0.002	0.007	0.072	125	N/A	123
GCA	INC	1	8.1	0.008	0.025	0.009	108	N/A	115
GCA	INC	2	8.1	0.008	0.025	0.009	108	N/A	115
GCA	KUD	1	2.1	0.002	0.003	0.021	124	N/A	151
GCA	KUD	2	2.1	0.002	0.003	0.021	124	N/A	151
GCA	NAN	1	1.8	0.001	0.002	0.011	92	N/A	98
GCA	NAN	2	1.7	0.001	0.002	0.011	92	N/A	98
GCA	GRI T	1	8.9	0.009	0.029	0.006	107	N/A	115
GI	KKY	1	49.2	0.077	0.169	0.016	107	N/A	126
GI	WAT	1	11.7	0.007	0.038	0.004	187	N/A	223
GI	WAT	2	12.9	0.008	0.042	0.005	187	N/A	223
GI	WEX	1	34.5	0.054	0.119	0.011	107	N/A	126
GLE (N)	KEL	1	21.4	0.027	0.068	0.029	82	82	90
GLE (N)	KEL	1	21.4	0.027	0.068	0.029	82	82	90
GOL	GOL T	1	3.9	0.006	0.014	0.001	107	N/A	126
GOR	NAV	1	5.3	0.008	0.019	0.002	107	N/A	126
GOR	NAV	2	6.3	0.009	0.022	0.002	107	N/A	126
GOR	PLA	1	19.7	0.030	0.068	0.006	107	N/A	126
GRA	KLM	1	5.9	0.003	0.007	0.036	109	N/A	116
GRI	GRI T	1	1.0	0.002	0.004	0.000	107	N/A	115
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	N/A	114
IA	MAC	1	18.1	0.028	0.063	0.006	107	N/A	126
IKE	IKE T	1	0.2	0.000	0.001	0.000	93	N/A	131
INC	MIL	1	8.4	0.004	0.009	0.051	130	N/A	138
KBY	MR	1	4.0	0.004	0.013	0.003	111	N/A	140
KBY	MR	2	4.0	0.004	0.013	0.003	111	N/A	128
KBY	MAL	1	29.1	0.030	0.097	0.010	137	N/A	164
KER	OUG T	1	22.6	0.014	0.074	0.008	187	N/A	223
KIN	DFR T	1	29.3	0.021	0.096	0.010	120	N/A	164

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
KKY	KLS	1	34.3	0.053	0.118	0.011	107	N/A	126
KLM	POP	1	6.0	0.003	0.007	0.037	109	N/A	116
KLN	LIM (I)	1	9.0	0.014	0.031	0.003	107	N/A	126
KLN	LIM (I)	2	11.7	0.018	0.040	0.009	107	N/A	126
KLN	SNG	1	4.1	0.003	0.013	0.003	187	N/A	223
KLN	CTN	1	28.1	0.044	0.098	0.009	107	N/A	126
KMT	SLK	1	6	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	KBY	1	11.9	0.014	0.040	0.004	107	N/A	126
KRA	KBY	2	12.5	0.018	0.043	0.004	107	N/A	126
KRA	MID	1	10.7	0.017	0.037	0.004	107	N/A	126
KRA	BAR T	1	19.4	0.020	0.065	0.007	137	N/A	164
KTL	MAY	1	21.4	0.022	0.072	0.007	99	N/A	125
KTL	MON	1	8.9	0.009	0.030	0.003	120	N/A	128
KTN	WAT	1	5.0	0.004	0.008	0.050	140	N/A	140
KUR	NAV	1	6.1	0.010	0.021	0.002	107	N/A	126
LA	MUL	1	46.3	0.072	0.160	0.015	107	N/A	126
LA	RIC	1	15.7	0.024	0.054	0.007	107	N/A	126
LA	RIC	2	12.6	0.019	0.043	0.005	107	N/A	125
LET	TLK	1	34.7	0.054	0.119	0.011	107	N/A	126
LET	GOL T	1	38.4	0.058	0.132	0.012	107	N/A	126
LET	SBN	1	22.3	0.037	0.083	0.008	107	N/A	126
LIB	MR	1	2.7	0.001	0.003	0.017	100	N/A	100
LIB	MR	2	2.7	0.002	0.003	0.017	120	N/A	120
LIM (I)	MTN	1	7.5	0.005	0.024	0.002	137	N/A	164
LIM (I)	RAT (I)	1	29.1	0.044	0.101	0.012	107	N/A	126
LIS (I)	SKL	1	39.3	0.061	0.135	0.013	107	N/A	126
LIS (I)	LOU	1	40.4	0.063	0.139	0.013	107	N/A	126
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	107	N/A	126
LOU	RRU	1	37.5	0.058	0.129	0.012	107	N/A	126
LSN	THU	1	10.4	0.016	0.036	0.003	107	N/A	126
MAY	GRI T	1	2.2	0.002	0.007	0.002	107	N/A	115
MAY	GRI	1	2.2	0.003	0.009	0.001	107	N/A	115
MAY	RYB	1	8.9	0.009	0.030	0.003	99	N/A	125
MAY	RNW	1	7.1	0.008	0.024	0.002	107	N/A	126
MAY	BLK T	1	30.9	0.032	0.103	0.011	137	N/A	164
MCD	NQS	1	2.0	0.001	0.002	0.036	141	N/A	150
MCD	WOL	1	1.4	0.001	0.002	0.009	108	N/A	115
MCE	CDU	1	4.1	0.003	0.010	0.016	99	N/A	126
MHL	RE	1	3.0	0.002	0.005	0.030	143	N/A	152
MID	WHI	1	20.0	0.030	0.069	0.007	107	N/A	126
MIL	RE	1	4.9	0.003	0.005	0.075	100	N/A	107
MIL	RE	2	5.6	0.003	0.006	0.034	100	N/A	107
MIL	TNY	1	5.6	0.003	0.006	0.070	100	N/A	107
MKL	OMA	1	38.0	0.029	0.108	0.015	139	150	157

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

110 kV Circuits			Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
From	To	No.		R	X	B	Summer	Autumn	Winter
MOY	TAW	1	8.4	0.013	0.029	0.003	107	N/A	126
MOY	TAW	1	8.3	0.013	0.029	0.003	107	N/A	126
MP	TBK T	1	6.6	0.010	0.023	0.002	107	N/A	126
MR	TBG	1	3.3	0.001	0.005	0.033	79	N/A	79
MR	TBG	2	2.9	0.000	0.004	0.027	79	N/A	79
MTH	LOU	1	15.1	0.024	0.052	0.005	107	N/A	126
MTN	MUN	1	0.7	0.001	0.003	0.000	107	N/A	126
MTN	MUN	2	0.7	0.001	0.002	0.000	107	N/A	126
NEW (I)	PLS	1	43.0	0.055	0.146	0.014	107	N/A	126
NEW (I)	BLK T	1	12.2	0.013	0.041	0.004	137	N/A	164
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	141	N/A	150
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	107	N/A	126
PA	STR (I)	1	22.4	0.035	0.077	0.007	72	N/A	103
PB	RE	3	1.4	0.000	0.002	0.046	238	N/A	254
PB	RE	4	1.4	0.000	0.002	0.046	242	N/A	258
PLS	DAL T	1	54.7	0.034	0.178	0.019	178	N/A	218
RAF	TBG	1	10.6	0.016	0.036	0.005	107	N/A	126
RAF	RSY	1	2.1	0.003	0.007	0.001	72	N/A	103
RAF	TBG	2	9.5	0.006	0.031	0.005	187	N/A	223
RAT (I)	TB	1	33.6	0.035	0.112	0.012	137	N/A	164
RE	PB	1	1.2	0.001	0.001	0.016	115	N/A	123
RNW	DFR T	1	25.9	0.020	0.085	0.009	107	N/A	126
RRU	SKL	1	14.5	0.023	0.050	0.005	107	N/A	126
SH	DAL T	1	12.0	0.008	0.039	0.007	187	N/A	223
SH	IKE T	1	53.7	0.034	0.175	0.019	187	N/A	223
SH	SOM T	1	13.8	0.021	0.047	0.006	107	N/A	126
SLI	SRA	1	11.1	0.017	0.038	0.004	107	N/A	126
SLI	SRA	2	12.0	0.019	0.041	0.004	107	N/A	126
SOM	SOM T	1	2.0	0.003	0.007	0.001	107	N/A	126
SOR	TLK	1	4.4	0.007	0.015	0.002	107	N/A	126
STR (I)	STR T	1	2.0	0.003	0.007	0.001	107	N/A	126
TAN	WAR	1	12.9	0.013	0.042	0.004	79	96	113
TAN	WAR	1	12.9	0.013	0.042	0.004	79	96	113
TB	TRI	1	20.5	0.021	0.069	0.007	120	N/A	128
TB	TRL	1	42.0	0.063	0.147	0.014	107	N/A	126
TBK	TBK T	1	2.9	0.005	0.010	0.001	107	N/A	126
THU	IKE T	1	25.9	0.027	0.087	0.009	93	N/A	131
TRL	OUG T	1	11.3	0.007	0.037	0.004	187	N/A	223

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

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA		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		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	Parameters 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	0.1325	240	240	30	1.15	0.85	19
Ballylumford IBTx 2	0.0018	0.0641	0.0018	0.2059	0.0	0.128	240	240	30	1.15	0.85	19
Castlereagh IBTx 1	0.0018	0.0641	0.0018	0.2092	0.0	0.1325	240	240	30	1.15	0.85	19
Castlereagh IBTx 2	0.0014	0.0639	0.0018	0.2236	0.0	0.1449	240	240	30	1.15	0.85	19
Castlereagh IBTx 3	0.0018	0.0656	0.0018	0.2375	0.0	0.1593	240	240	30	1.15	0.85	19
Coolkeeragh IBTx 1	0.0018	0.0609	0.0018	0.1273	0.0	0.057	240	240	30	1.15	0.85	19
Coolkeeragh IBTx 2	0.0014	0.0639	0.0018	0.2236	0.0	0.1449	240	240	30	1.15	0.85	19
Hannahstown IBTx 1	0.0018	0.0591	0.0018	0.1261	0.0	0.056	240	240	30	1.15	0.85	19
Hannahstown IBTx 2	0.0018	0.0591	0.0018	0.1261	0.0	0.056	240	240	30	1.15	0.85	19
Hannahstown IBTx 3	0.0014	0.0639	0.0018	0.2236	0.0	0.1449	240	240	60	1.15	0.85	19
Kells IBTx 1	0.0018	0.0609	0.0018	0.1273	0.0	0.057	240	240	30	1.15	0.85	19
Kells IBTx 2	0.0018	0.0607	0.0018	0.1317	0.0	0.057	240	240	30	1.15	0.85	19
Tandragee IBTx 1	0.0018	0.0641	0.0018	0.2092	0.0	0.1325	240	240	60	1.15	0.85	19
Tandragee IBTx 2	0.0018	0.0641	0.0018	0.2092	0.0	0.1325	240	240	30	1.15	0.85	19

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

Substation/ Transformer	Parameters p.u. on 100 MVA base						Rating (MVA)			Off Nominal Ratio (PU)		No. of Taps
	W1-2		W2-3		W3-1							
	R	X	R	X	R	X	W1	W2	W3	Upper	Lower	
Kilroot IBTx 1	0.0027	0.304	0.0027	0.574	0.0027	0.304	110	55	55	1.15	0.94	18

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

Transformer	Rating (MVA)	Impedance p.u. on 100 MVA		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%
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	0.064	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%
Great Island T2101	125	0.003	0.133	9%	18%
Great Island 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 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%
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%

¹ Transformer capacity 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		Voltage Ratio Tapping Range	
		R	X	+	-
Louth T2104	250	0.001	0.064	9%	17%
Maynooth T2101	125	0.002	0.134	22%	18%
Maynooth T2102 ¹	250	0.001	0.064	9%	17%
Maynooth T2103	125	0.002	0.132	22%	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 ¹	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	250 ²	0.001	0.055	9%	17%
Tarbert T2102	250 ²	0.001	0.055	9%	17%
Total	8,989				

Table B-11 Characteristics of Existing Power Flow Controllers

Station	Rating (MVA)	Circuit	Impedance p.u. on 100 MVA		Phase Angle Range (electrical degrees)	
			R	X	+	-
Carrickmines	350	CKM-PB 220 kV	0.000	0.029	15.3	15.3
Enniskillen	125	ENNK - COR 110 kV	0.000	0.0213	1.2	0.8
Strabane	125	STRA - LET 110 kV	0.000	0.0213	1.2	0.8

Table B-12 Characteristics of Existing Reactive Compensation

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
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	

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

Table B-12 Characteristics of Existing Reactive Compensation (continued)

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
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 Reactor (2 x 30)		60
Kells	KEL 22	2 Shunt Reactor (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	2 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	236	
Navan	NAV 110	1 Capacitor (1 Mobile)	30	
Portlaoise	PLS 110	1 Capacitor (1 Mobile)	30	
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 Reactor (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			1,326	480

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 July 01st 2011

Change	Volt	From	To	No.	Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP659 Arva-Navan 110 kV Line Uprate											
Amend	110	ARV	NAV	1	60.6	0.038	0.197	0.021	187	N/A	223
CP620 Arva - Gortawee 110kV Line Uprate											
Amend	110	ARV	GWE	1	30.6	0.019	0.099	0.011	187	N/A	223
CP537 Limerick-Moneteen 110 kV Line Uprate											
Amend	110	LIM (I)	MTN	1	7.5	0.005	0.024	0.002	187	N/A	223
CP218 Construction of Gorman-Navan 3rd 110 kV Line											
Add	110	GOR	NAV	3	6.5	0.007	0.022	0.002	137	N/A	164
CP664 Cullenagh-Knockraha 220 kV Line Uprate											
Amend	220	CUL	KRA	1	86.0	0.010	0.076	0.113	793	N/A	832
CP587 Construction of Glanagow-Rafeen 220 kV Circuit											
Add	220	GGO	RAF	1	9.5	0.000	0.003	0.318	570	N/A	570
CP687 Dunmanway-Macroon 110 kV Line Uprate											
Amend	110	DMY	MAC	1	26.2	0.017	0.085	0.009	187	N/A	223
CP518 Coolroe-Inniscarra 110 kV Line Uprate											
Amend	110	CRO	IA	1	2.7	0.002	0.009	0.001	187	N/A	223
CP552 Athlone-Shannonbridge 110 kV Line Uprate											
Amend	110	SH	ATH	1	21.6	0.014	0.070	0.016	187	N/A	223
CP246 Construction of 2nd Tralee-Tarbert 110 kV Line											
Add	110	TB	TRL	2	47.0	0.030	0.153	0.017	187	N/A	223
CP197 Construction of Cushaling-Thornsberry 110 kV Line											
Add	110	CUS	TSB	1	30.932	0.0322	0.103	0.012	124	N/A	124
CP173 Connection of Banoge 110 kV Station											
Add	110	ARK	BOG	1	22.6	0.035	0.078	0.007	107	N/A	126
Add	110	BOG	CRA	1	26.9	0.042	0.093	0.009	107	N/A	126

Table B-13 Changes in Circuit Characteristics Expected After July 01st 2011 (continued)

Change	Volt	From	To	No.	Length (km)	Impedance p.u. on 100 MVA			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Delete	110	ARK	CRA	1	...	...	...	...	...	...	...
CP211 Construction of Srananagh 220 kV Station and Line											
Add	220	FLA	SRA	1	55	0.006	0.048	0.072	431	N/A	518
Add	220/110	SRA	SRA	2	...	0.001	0.064	...	250	N/A	250
CP615 Construction of Glenree 110 kV Station and Lines											
Add	110	CUN	GLR	1	27.9	0.043	0.096	0.009	99	N/A	126
Add	110	MOY	GLR	1	14.2	0.022	0.049	0.005	99	N/A	126
Delete	110	CUN	MOY	1	...	...	...	...	...	...	...
Tamnamore - Phase 1: Construction of Tamnamore 275/110 kV Station and Line (Approved)											
Add	275	TMN	TAN	1	25.9	0.001	0.011	0.069	710	820	881
Add	275	MAG	TMN	1	25.6	0.001	0.011	0.068	710	820	881
Delete	275	TAN	MAG	1	...	...	...	...	...	...	...
Add	110	TMN	DUN	1	5.9	0.004	0.016	0.002	144	144	144
Antrim 110/33 kV: Replacement of transformers (Approved)											
Add	110/33	ANT	ANT	1	...	0.004	0.246	...	90	90	90
Add	110/33	ANT	ANT	2	...	0.004	0.247	...	90	90	90
Delete	110/33	ANT	ANT	1	...	...	...	...	22.5	22.5	22.5
Delete	110/33	ANT	ANT	2	...	...	...	...	22.5	22.5	22.5
Delete	110/33	ANT	ANT	3	...	...	...	...	22.5	22.5	22.5
Delete	110/33	ANT	ANT	4	...	...	...	...	22.5	22.5	22.5
Omagh 110/33 kV: Replacement of transformers (Approved)											
Add	110/33	OMA	OMA	1	...	0.004	0.245	...	90	90	90
Add	110/33	OMA	OMA	2	...	0.004	0.245	...	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
Dungannon-Omagh 110 kV - Phase 2: Circuit Upgrades (Approved)											
Amend	110	DUN	OMA	A	36.1	0.043	0.125	0.012	150	150	150
Amend	110	DUN	OMA	B	39.3	0.047	0.136	0.013	150	150	150
Ballymena 110/33 kV: Replacement of transformers (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	0.245	...	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

Table B-14 Changes in Circuit Characteristics Expected in 2012

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP254 Cashla Loop-in of Dalton-Galway 110 kV Line											
Add	110	CSH	DLT	1	52	0.081	0.179	0.017	107	N/A	126
Add	110	CSH	SAL	1	24.6	0.030	0.070	0.073	107	N/A	124
Delete	110	DLT	GAL	1	...	...	...	...	...	...	...
CP374 Construction of 2nd Arva-Shankill 110 kV Line											
Add	110	ARV	SKL	2	18.0	0.011	0.059	0.006	187	N/A	223
CP218 Construction of Gorman-Navan 3rd 110 kV Line											
Add	110	GOR	NAV	3	6.5	0.007	0.022	0.002	137	N/A	164
CP228 Kilbarry-Marina 110 kV Line Uprating											
Amend	110	KBY	MR	1	3.99	0.0041	0.0132	0.0029	111	N/A	140
Amend	110	KBY	MR	2	3.99	0.0041	0.0132	0.0029	111	N/A	140
CP371 Ballydine-Doon 110 kV Line Uprate											
Amend	110	BDN	DOO	1	11.3	0.007	0.037	0.004	187	N/A	223
CP558 Ballydine-Cullenagh 110 kV Line Uprate											
Amend	110	BDN	CUL	1	21.8	0.014	0.071	0.008	187	N/A	223
CP560 Cullenagh-Waterford 110 kV Line Uprate											
Amend	110	CUL	WAT	1	12.5	0.008	0.040	0.006	187	N/A	223
CP635 Corderry-Arigna-Carrick-on-Shannon 110 kV Line Uprate											
Amend	110	AG T	CDY	1	13.7	0.014	0.046	0.005	137	N/A	164
Amend	110	AG T	COS	1	20.7	0.022	0.069	0.007	137	N/A	164
CP661 Cashla-Tynagh 220 kV Line Uprate											
Amend	220	CSH	TY	1	33.8	0.004	0.030	0.044	793	N/A	832
CP660 Cashla-Ennis 110 kV Line Uprate											
Amend	110	CSH	ENN (I)	1	53.5	0.034	0.174	0.019	187	N/A	223
CP704 Cathaleen's Fall-Golagh Tee 110 kV Line Uprate											
Amend	110	CF	GL T	1	25.5	0.016	0.083	0.009	187	N/A	223
CP699 Cathaleen's Fall-Srananagh 110 kV Line Uprate											
Amend	110	CF	SRA	1	53.3	0.033	0.172	0.027	187	N/A	223
CP265 Great Island-Cullenagh 220 kV Line Uprate											
Amend	220	GI	CUL	1	23.0	0.003	0.020	0.030	793	N/A	832
CP559 Butlerstown-Kiloteran 110 kV Line Uprate											
Amend	110	BUT	KTN	1	2.7	0.002	0.009	0.001	187	N/A	223
CP517 Coolroe-Kilbarry 110 kV Line Uprate											
Amend	110	CRO	KBY	1	14.3	0.009	0.047	0.005	187	N/A	223

Table B-14 Changes in Circuit Characteristics Expected in 2012 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP644 Construction of Bracklone 110kV Station and Lines											
Add	110	PLS	BRA	1	19.26	0.030	0.067	0.006	107	N/A	126
Add	110	NEW (I)	BRA	1	22.96	0.024	0.077	0.008	107	N/A	126
Delete	110	NEW (I)	PLS	1	...	...	...	...	...	...	...
CP696 Marina-Trabeg 110 kV Lines Uprate											
Amend	110	MR	TBG	1	3.3	0.001	0.005	0.033	209	N/A	223
Amend	110	MR	TBG	2	2.9	0.000	0.004	0.027	209	N/A	223
CP667 Inichiore-Maynooth 220 kV Lines Uprate											
Amend	220	INC	MAY	1	19.1	0.004	0.017	0.025	793	N/A	832
Amend	220	INC	MAY	2	19.1	0.004	0.017	0.025	793	N/A	832
CP668 Corduff-Ryebrook and Maynooth-Ryebrook 110 kV Line Uprates											
Amend	110	CDU	RYB	1	13.0	0.012	0.040	0.021	130	N/A	130
Amend	110	MAY	RYB	1	8.9	0.009	0.030	0.003	137	N/A	164
CP698 Prospect-Tarbert 220 kV Line Uprate											
Amend	220	PRO	TB	1	10.3	0.002	0.009	0.014	431	N/A	518
Construction of Reamore 110 kV Station											
Add	110	TRL	REM	1	14.0	0.007	0.013	0.138	106	N/A	106
CP641 Construction of Nore 110kV Station and Lines											
Add	110	KKY	NO	1	3.6	0.0019	0.0041	0.022	140	N/A	143
Connection of Cuilleen Generator into the new Cuilleen 220 kV Station											
Add	110	CUI	ATH	1	2.25	0.0016	0.0033	0.023	140	N/A	140
Connection of Suir Generator into the new Suir 110 kV Station											
Add	110	SUR	CAH	1	3.9	0.002	0.004	0.024	140	N/A	140
CP652 Construction of Portan 400 kV Station and Line											
Add	380	PRN	WOO	1	0.0	0.000	0.000	0.000	1424	N/A	1713
CP138 Connection of Nenagh 110 kV Station											
Add	110	KLN	NEN	1	33.6	0.052	0.116	0.011	107	N/A	126
Carnmoney 110/33 kV: Replacement of transformers (Approved)											
Add	110/33	CAR	CAR	1	...	0.004	0.245	...	90	90	90
Add	110/33	CAR	CAR	2	...	0.004	0.245	...	90	90	90
Delete	110/33	CAR	CAR	A	...	0.011	0.285	...	60	60	60
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
Donegall North 110/33 kV: Replacement of transformer (Approved)											
Add	110/33	DON_N	DON_N	B	...	0.004	0.245	...	90	90	90
Delete	110/33	DON_N	DON_N	B	...	0.012	0.366	...	60	60	60

Table B-14 Changes in Circuit Characteristics Expected in 2012 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Knock 110/33 kV: Replacement of transformers (Approved)											
Add	110/33	KNO	KNO	1	...	0.004	0.245	...	90	90	90
Add	110/33	KNO	KNO	2	...	0.004	0.245	...	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
Ballylumford-Eden 110 kV circuit upgrade (Unapproved)											
Amend	110	BPS	EDE	1	15.2	0.009	0.051	0.005	186	191	193
Amend	110	BPS	EDE	2	15.2	0.009	0.051	0.005	186	191	193
Coleraine-Kells 110 kV circuit upgrade (Unapproved)											
Amend	110	COL (N)	KEL	1	58.9	0.063	0.202	0.020	186	191	193
Enniskillen-Omagh 110 kV circuit upgrade (Unapproved)											
Amend	110	ENN (N)	OMA	1	33.7	0.044	0.113	0.011	109	119	124
Amend	110	ENN (N)	OMA	2	33.7	0.044	0.113	0.011	109	119	124
Magherakeel Wind Farm Cluster (Approved)											
Add	110	MAG	OMA	1	38.0	0.029	0.108	0.015	139	150	157
Killymallaght Wind Farm Cluster (Approved)											
Delete	110	STR (N)	CPS	2		0.020	0.085	0.009	143	158	166
Add	110	KMT	STR (N)	1	11.0	0.008	0.037	0.004	143	158	166
Add	110	CPS	KMT	1	14.6	0.011	0.048	0.005	143	158	166

Table B-15 Changes in Circuit Characteristics Expected in 2013

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Construction of Kilpaddoge - Moneypoint 220 kV cable											
Add	220	KPG	MP	1	5.5	0.000	0.001	0.184	570	N/A	570
CP647 Construction of a new Kilpaddoge 220/110 kV Station											
Add	220	KPG	TB	1	3.3	0.000	0.003	0.004	431	N/A	518
Add	220	KPG	TB	2	3.3	0.000	0.003	0.004	431	N/A	518
Add	220	KPG	KLN	1	68.0	0.008	0.059	0.089	431	N/A	518
Add	220	KPG	CLA	1	94.7	0.011	0.082	0.124	431	N/A	518
Add	110	KPG	AUG	1	32.8	0.021	0.107	0.012	187	N/A	223
Add	110	KPG	RAT (I)	1	32.2	0.033	0.108	0.011	137	N/A	164
Add	110	KPG	TRI	1	19.4	0.020	0.065	0.007	120	N/A	128
Add	110	KPG	TRL	1	39.4	0.060	0.135	0.013	107	N/A	126
Add	110	KPG	TRL	2	44.4	0.028	0.144	0.016	187	N/A	223
Delete	220	TB	KLN	1	...	...	...	...	...	...	...

Table B-15 Changes in Circuit Characteristics Expected in 2013 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Delete	220	TB	CLA	1	...	...	...	...	...	...	...
Delete	110	TB	AUG	1	...	...	...	...	...	...	...
Delete	110	TB	RAT (I)	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	187	N/A	223
Add	110	RAL	KPG	2	3.4	0.002	0.011	0.001	187	N/A	223
CP421 Construction of Binbane-Letterkenny 110 kV Line											
Add	110	BIN	TIV	1	22	0.023	0.073	0.008	137	N/A	164
Add	110	LET	TIV	1	47	0.049	0.157	0.016	137	N/A	164
CP656 Arklow-Banoge-Crane 110 kV Line Uprate											
Amend	110	ARK	BOG	1	22.6	0.014	0.074	0.008	187	N/A	223
Amend	110	BOG	CRA	1	26.9	0.017	0.087	0.010	187	N/A	223
CP657 Ikerrin Tee-Thurles 110 kV Line Uprate											
Amend	110	IK T	THU	1	25.9	0.016	0.084	0.009	187	N/A	223
CP701 Cullenagh-Dungarvan 110 kV Line Uprate											
Amend	110	CUL	DGN	1	34.3	0.021	0.110	0.021	187	N/A	223
CP702 Butlerstown-Cullenagh 110 kV Line Uprate											
Amend	110	BUT	CUL	1	11.6	0.007	0.038	0.004	187	N/A	223
Construction of new Mountlucas 110 kV station											
Add	110	CUS	MLC	1	16.6	0.011	0.054	0.006	187	N/A	223
Add	110	MLC	TSB	1	16.6	0.011	0.054	0.006	187	N/A	223
Delete	110	CUS	TSB	1	...	...	...	...	...	...	...
CP603 Construction of Mulreavy 110 kV Station											
Add	110	MRY	CF	1	31.3	0.020	0.102	0.011	187	N/A	223
Construction of new Kill Hill 110 kV station											
Add	110	CAH	KHL	1	22.4	0.021	0.070	0.036	137	N/A	164
Add	110	KHL	THU	1	22.4	0.021	0.070	0.036	137	N/A	164
Delete	110	CAH	THU	1	...	...	...	...	...	...	...
Connection of Ballakelly Generator into the new Ballakelly 220 kV Station											
Add	220	BY	LOU	1	1.5	0.000	0.001	0.050	570	N/A	570
CP602 Connection of Keelderry Wind Farm and Loop into Derrybrien-Agannygal 110 kV Circuit at Knockavanna											
Add	110	KNV	DYN	1	2.0	0.003	0.007	0.001	107	N/A	126
Add	110	KNV	AGL	1	6.0	0.009	0.021	0.002	107	N/A	126
Delete	110	AGL	DYN	1	...	...	...	...	...	...	...

Table B-15 Changes in Circuit Characteristics Expected in 2013 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP713 Construction of new Blackpool 110 kV station											
Add	110	BLP	KBY	1	0.2	0.000	0.000	0.004	123	N/A	123
CP707 Looping of Barrymore 110 kV station											
Add	110	BAR	CAH	1	44.5	0.066	0.153	0.014	107	N/A	126
Add	110	BAR	KRA	1	19.7	0.020	0.066	0.007	137	N/A	164
Delete	110	KRA	CAH	1	...	...	...	...	...	...	...
CP644 Construction of Bracklone 110kV Station and Lines											
Add	110	PLS	BRA	1	19.26	0.030	0.067	0.006	107	N/A	126
Add	110	NEW (I)	BRA	1	22.96	0.024	0.077	0.008	107	N/A	126
Delete	110	NEW (I)	PLS	1	...	...	...	...	...	...	...
CPo41 Construction of Hartnett's Cross 110 kV station											
Add	110	HTS	MAC	1	4.5	0.007	0.016	0.002	107	N/A	126
Carnmoney-Eden 110 kV circuit upgrade (Unapproved)											
Amend	110	EDE	CAR	1	12.4	0.007	0.042	0.004	186	191	193
Amend	110	EDE	CAR	2	12.4	0.007	0.042	0.004	186	191	193
Castlereagh-Rosebank 110 kV circuit upgrade (Unapproved)											
Amend	110	CAS	ROS	1	1.9	0.001	0.002	0.014	144	144	144
Amend	110	CAS	ROS	2	1.9	0.001	0.002	0.014	144	144	144
Enniskillen 110/33 kV: Replacement of transformers (Unapproved)											
Add	110/33	ENN (N)	ENN (N)	1	...	0.004	0.245	...	90	90	90
Add	110/33	ENN (N)	ENN (N)	2	...	0.004	0.245	...	90	90	90
Delete	110/33	ENN (N)	ENN (N)	1	...	0.013	0.272	...	45	45	45
Delete	110/33	ENN (N)	ENN (N)	2	...	0.013	0.273	...	45	45	45
Delete	110/33	ENN (N)	ENN (N)	3	...	0.008	0.251	...	60	60	60

Table B-16 Changes in Circuit Characteristics Expected in 2014

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP501 Construction of Clashavoon-Dunmanway 110 kV Line											
Add	110	CLA	DMY	1	35.0	0.022	0.114	0.012	187	N/A	223
CP479 Connection of Athea Wind Farm into Dromada 110 kV Station											
Add	110	ATE	DRO	1	7.0	0.005	0.0105	0.0703	140	N/A	140
CP608 Construction of Knocknagashel 110 kV Station											
Add	110	KNG	TRI	1	13.1	0.008	0.043	0.005	187	N/A	223
CP597 Moneypoint - Tullabrack T - Booltiagh Line Uprate											
Amend	110	MP	TK T	1	6.6	0.004	0.022	0.002	187	N/A	223
Amend	110	TK T	BOL	1	19.6	0.012	0.064	0.007	187	N/A	223
CP500, CP650 & CP651 Construction of Knockanure, Ballyvouskill and Kishkeam 220/110 kV Stations											
Add	220	BVK	CLA	1	18.4	0.002	0.016	0.024	431	N/A	518
Add	220	BVK	KKM	1	14.5	0.002	0.013	0.019	431	N/A	518
Add	220	KKM	KNR	1	47.0	0.006	0.041	0.062	431	N/A	518
Add	220	KNR	KPG	1	17.4	0.002	0.015	0.023	431	N/A	518
Delete	220	CLA	KPG	1	...	...	...	...	...	...	...
Add	110	BVK	GRO	1	4.0	0.003	0.013	0.002	187	N/A	223
Add	110	BVK	GRO	2	4.0	0.003	0.013	0.002	187	N/A	223
Add	110	KKM	GLE (I)	1	12.5	0.008	0.041	0.004	187	N/A	223
Add	110	KNR	TRI	1	4.4	0.005	0.017	0.002	120	N/A	128
Add	110	KNR	TRI	2	5.7	0.004	0.019	0.002	187	N/A	223
Add	110	KNR	KPG	1	15.0	0.015	0.050	0.005	137	N/A	164
Add	110	ATE	KNR	1	9.5	0.006	0.031	0.003	187	N/A	223
Delete	110	ATE	TRI	1	...	...	...	...	...	...	...
Delete	110	KPG	TRI	1	...	...	...	...	...	...	...
Construction of Cordal 110 kV Station											
Add	110	KKM	CDL	1	8.2	0.005	0.027	0.003	187	N/A	223
Connection of Caulstown 110 kV Station and Lines											
Add	110	CA	PLA	1	0.9	0.001	0.003	0.000	187	N/A	223
Add	110	CA	CDU	1	36.9	0.023	0.120	0.013	187	N/A	223
Add	110	CDU	PLA	1	...	...	...	...	...	N/A	...
CP054 Ardnacrusha-Limerick 110 kV Line Uprate											
Amend	110	AA	LIM (I)	1	11.7	0.007	0.037	0.012	187	N/A	223
CP437 Connection of Balgriffin 220 kV Station											
Add	220	BGF	FIN (I)	1	17.0	0.001	0.007	0.569	570	N/A	570
Add	220/110	BGR	BGR	1	...	0.001	0.065	...	250	N/A	250

Table B-16 Changes in Circuit Characteristics Expected in 2014 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP421b Construction of Ardnagappary 110 kV Station											
Add	110	AGY	TIV	1	35.0	0.054	0.120	0.011	107	N/A	126
Tamnamore - Phase 2: Tamnamore 275/110 kV Station and Line (Unapproved)											
Add	275	TAN	TLE	1	20.5	0.001	0.009	0.051	710	820	881
Delete	275	TAN	TMN	1	...	...	...	...	...	...	...
Add	275	MAG	TMN	2	25.6	0.001	0.011	0.068	710	820	881
Add	275	TMN	TLE	2	5.4	0.000	0.002	0.014	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	0.016	82	95	103
Delete	110	CRG	DUN	1	...	...	...	...	...	...	...
Add	110	DRU (N)	TMN	1	22.2	0.028	0.074	0.012	82	95	103
Add	110	DRU (N)	TMN	2	22.5	0.029	0.075	0.008	82	95	103
Delete	110	DRU (N)	DUN	1	...	...	...	...	...	...	...
Delete	110	DRU (N)	DUN	2	...	...	...	...	...	...	...
Construction of Tamnamore-Omagh 110 kV circuit (Unapproved)											
Add	110	OMA	TMN	1	42.7	0.049	0.143	0.030	190	200	210
Pomeroy Wind Farm Cluster (Unapproved)											
Delete	110	DUN	OMA	2	...	...	...	...	...	...	...
Add	110	OMA	PMR	1	21.3	0.027	0.074	0.007	190	200	210
Add	110	PMR	TMN	1	24.6	0.026	0.080	0.024	190	200	210
Fallaghearn Wind Farm Cluster (Unapproved)											
Delete	110	DUN	OMA	3	...	...	...	...	...		...
Add	110	FLN	OMA	1	19.0	0.010	0.066	0.006	188	204	213
Add	110	FLN	TMN	1	38.0	0.020	0.131	0.013	188	204	213
Cregagh 110/33 kV: Replacement of transformers (Unapproved)											
Add	110/33	CRE	CRE	1	...	0.004	0.245	...	90	90	90
Add	110/33	CRE	CRE	2	...	0.004	0.245	...	90	90	90
Delete	110/33	CRE	CRE	A	...	0.009	0.195	...	75	75	75
Delete	110/33	CRE	CRE	B	...	0.009	0.197	...	75	75	75
Ballymena 110/33 kV: Replacement of transformers (Unapproved)											
Add	110/33	BMA_URB	BMA_URB	3	...	0.004	0.245	...	90	90	90
Add	110/33	BMA_URB	BMA_URB	4	...	0.004	0.245	...	90	90	90
Delete	110/33	BMA_URB	BMA_URB	3	...	0.007	0.289	...	60	60	60
Delete	110/33	BMA_URB	BMA_URB	4	...	0.007	0.287	...	60	60	60
Mid-Antrim Wind Farm Cluster (Unapproved)											
Delete	110	COL (N)	KEL	1					...	...	...

Table B-16 Changes in Circuit Characteristics Expected in 2014 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Add	110	COL (N)	MAN	1	26.0	0.031	0.090	0.009	186	191	193
Add	110	KEL	MAN	1	44.9	0.046	0.154	0.015	186	191	193
CP421b Construction of Ardnagappary 110 kV Station											
Add	110	AGY	TIV	1	35.0	0.054	0.120	0.011	107	N/A	126

Table B-17 Changes in Circuit Characteristics Expected beyond 2014

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP506 Construction of Finnstown 220 kV Station											
Add	220	INC	FNT	1	10.6	0.002	0.010	0.014	793	N/A	832
Add	220	INC	FNT	2	10.6	0.002	0.010	0.014	793	N/A	832
Add	220	MAY	FNT	1	9.7	0.002	0.009	0.013	793	N/A	832
Add	220	MAY	FNT	2	9.7	0.002	0.009	0.013	793	N/A	832
Delete	220	INC	MAY	1	...	...	...	...	...	...	...
Delete	220	INC	MAY	2	...	...	...	...	...	...	...
Add	220/110	FNT	FNT	1	...	0.001	0.065	...	250	N/A	250
Add	110	INC	GCA	3	7.7	0.006	0.012	0.080	140	N/A	140
Add	110	FNT	GCA	1	0.9	0.001	0.001	0.009	140	N/A	140
Add	110	FNT	GCA	2	0.9	0.001	0.001	0.009	140	N/A	140
Add	110	FNT	ADM	1	1.6	0.001	0.002	0.016	140	N/A	140
Add	110	FNT	ADM	2	1.6	0.001	0.002	0.016	140	N/A	140
Delete	110	INC	ADM	1	...	...	...	...	...	...	...
Delete	110	ADM	GCA	1	...	...	...	...	...	...	...
CP585 Construction of a new Laois 400 kV											
Add	380	DSN	LSE	1	44.8	0.001	0.010	0.226	1424	N/A	1713
Add	380	MP	LSE	1	170.0	0.003	0.038	0.858	1424	N/A	1713
Add	400/110	LSE	LSE	1	...	0.001	0.027	...	250	N/A	250
Add	400/110	LSE	LSE	2	...	0.001	0.027	...	250	N/A	250
Add	110	PLS	LSE	1	9.7	0.015	0.033	0.003	107	N/A	126
Add	110	ATY	LSE	1	21.9	0.034	0.076	0.007	107	N/A	126
Delete	400	DSN	MP	1	...	...	...	...	...	...	...
Delete	110	ATY	PLS	1	...	...	...	...	...	...	...
Connection of Ballyragget 110 kV Station											
Add	110	LSE	BGT	1	28.0	0.018	0.091	0.010	187	N/A	223
Add	110	KKY	BGT	1	22.0	0.034	0.076	0.007	107	N/A	126
CP596 Construction of Mullingar - Kinnegad 110kV line											
Add	110	MUL	KIN	1	27.0	0.017	0.088	0.010	187	N/A	223

Table B-17 Changes in Circuit Characteristics Expected beyond 2014 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
CP673 Connection of Knocknagreenan 110 kV Station											
Add	110	KGN	CD	1	2	0.0015	0.003	0.020	140	N/A	140
CP490 Connection of Knockmullen 110 kV Station											
Add	110	GI	KNM	1	15	0.015615	0.05004	0.005	137	N/A	164
CP466 & CP469 Construction of Woodland-Turleenan 400kV line											
Add	380	TLE	WOO	1	140.0	0.003	0.031	0.707	1424	N/A	1713
CP075 Construction of Ballycummin 110 kV station											
Add	110	BCM	MTN	1	4.6	0.003	0.015	0.002	187	N/A	223
Add	110	LIM (I)	BCM	1	3.7	0.003	0.012	0.001	137	N/A	164
Delete	110	LIM (I)	MTN	1	...	...	...	...	...		...
Convert Whitla Street into a 110 kV station - Belfast North Main (Approved)											
Add	110	DON_N	BNM	1	5.1	0.005	0.005	0.053	75	75	82
Add	110	DON_N	BNM	2	5.1	0.005	0.005	0.053	75	75	82
Add	110/33	BNM	BNM	1	...	0.004	0.245	...	90	90	90
Add	110/33	BNM	BNM	2	...	0.004	0.245	...	90	90	90
Coleraine-Limavady Circuit Uprate (Unapproved)											
Amend	110	COL (N)	LIM (N)	1	18.6	0.022	0.064	0.006	186	191	193
Coolkeeragh-Limavady Circuit Uprate (Unapproved)											
Amend	110	CPS	LIM (N)	1	29.5	0.032	0.101	0.010	186	191	193
Donegall South 110/33 kV: Replacement of transformers (Unapproved)											
Add	110/33	DON_S	DON_S	A	...	0.004	0.245	...	90	90	90
Add	110/33	DON_S	DON_S	D	...	0.004	0.245	...	90	90	90
Delete	110/33	DON_S	DON_S	A	...	0.012	0.361	...	60	60	60
Delete	110/33	DON_S	DON_S	D	...	0.012	0.366	...	60	60	60
Coolkeeragh-Magherafelt Circuit Uprate (Unapproved)											
Amend	275	CPS	CACO	1	0.2	0.000	0.000	0.023	761	761	837
Amend	275	CPS	CACO	2	56.0	0.000	0.000	0.019	761	761	837
Amend	275	CACO	MAG	1	0.2	0.002	0.024	0.140	761	761	837
Amend	275	CACO	MAG	2	56.0	0.002	0.024	0.140	761	761	837
Looping of Limavady 110 station into the 2nd Coleraine-Coolkeeragh 110 kV circuit and circuit upgrades (Unapproved)											
Add	110	COL (N)	LIM (N)	1	19.0	0.023	0.066	0.006	186	191	193
Add	110	CPS	LIM (N)	2	27.8	0.031	0.096	0.009	186	191	193
Delete	110	COL (N)	CPS	1	...	...	...	...	...	...	...
Hannahstown-Lisburn 110 kV Circuit Upgrades (Unapproved)											
Amend	110	HAN	LIS (N)	1	9.2	0.006	0.026	0.018	144	144	144
Amend	110	HAN	LIS (N)	2	9.2	0.006	0.026	0.018	144	144	144

Table B-17 Changes in Circuit Characteristics Expected beyond 2014 (continued)

Change	Volt	From	To	No.	Length	Impedance p.u. on 100			Rating (MVA)		
						R	X	B	Summer	Autumn	Winter
Cam Wind Farm Cluster (Unapproved)											
Add	110	CAM	COL (N)	1	12.9	0.009	0.033	0.023	126	139	144
Drumquin Wind Farm Cluster (Unapproved)											
Add	110	OMS	DQN	1	13.0	0.007	0.045	0.004	167	180	188
Delete	110	ENN (N)	OMA	1	...	...	...	...	...		...
Delete	110	EKN	OMA	2	...	...	...	...	...		...
Add	110	OMS	ENN (N)	1	N/A	0.026	0.066	0.007	109	119	124
Add	110	OMS	ENN (N)	2	N/A	0.026	0.066	0.007	109	119	124
Add	110	OMS	OMA	1	N/A	0.018	0.047	0.005	109	119	124
Add	110	OMS	OMA	2	N/A	0.018	0.047	0.005	109	119	124

Table B-18 Characteristics of Transformers Expected in 2011

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA		Voltage Ratio Tapping Range	
			R	X	+	-
CP586						
Knockraha T2103	250	220/110	0.001	0.065	9%	17%
CP513						
Carrickmines T2103	250	220/110	0.001	0.064	9%	17%
Tamnamore – Phase 1						
Tamnamore T2101	240	275/110	0.001	0.064	9%	15%

Table B-19 Characteristics of Transformers Expected in 2012

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA		Voltage Ratio Tapping Range	
			R	X	+	-
CP523						
Inchicore T2103	250	220/110	0.000	0.060	9%	18%
CP211						
Srananagh T2101	250	220/110	0.001	0.064	9%	18%
CP683						
Dunstown	500	400/220	0.000	0.032	1%	15%
CP675						
Clashavoon T2102	250	220/110	0.000	0.065	9%	17%
CP483						
Carrickmines T2104	250	220/110	0.001	0.065	9%	17%

Table B-19 Characteristics of Transformers Expected in 2012 (continued)

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA		Voltage Ratio Tapping Range	
			R	X	+	-
Hannahstown						
Hannahstown T2103	240	275/110	0.001	0.064	9%	15%
Castlereagh						
Castlereagh T2104	240	275/110	0.001	0.064	15%	15%

Table B-20 Characteristics of Transformers Expected in 2013

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA		Voltage Ratio Tapping Range	
			R	X	+	-
CP682						
Woodland	500	400/220	0.000	0.032	1%	15%
CP647						
Kilpaddoge T2101	250	220/110	0.001	0.065	9%	17%
Kilpaddoge T2102	250	220/110	0.001	0.065	9%	17%
CP688						
Moneypoint T2101	250	220/110	0.001	0.065	9%	0%

Table B-21 Characteristics of Transformers Expected in 2014

Station / Transformer	Rating (MVA)	HV/LV (kV)	Impedance p.u. on 100 MVA		Voltage Ratio Tapping Range	
			R	X	+	-
CP646 - removal of the temporary fifth transformer						
Finglas	250	220/110				
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						
Kishkeam T2101	250	220/110	0.001	0.064	9%	17%
Tamnamore - Phase 2						
Tamnamore T2102	240	275/110	0.001	0.064	9%	15%

Table B-22 Characteristics of Transformers Expected beyond 2014

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

Table B-23 Characteristics of Reactive Compensation Expected in 2011

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
CP515				
Ardnacrusha	AA 110	1 Capacitor	30	-

Table B-24 Characteristics of Reactive Compensation Expected in 2012

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
CP529				
Thurles	THU 110	1 Capacitor	15	-
CP488				
Mullingar	MUL 110	2 Capacitors (2 x 15)	30	-

Table B-25 Characteristics of Reactive Compensation Expected in 2013

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Castlereagh				
Castlereagh	CAS 110	1 SVC	50	50
Castlereagh	CAS 110	2 Capacitors (2 x 25)	50	-
Coolkeeragh				
Coolkeeragh	CPS 110	1 SVC	50	50
Coolkeeragh	CPS 110	2 Capacitors (2 x 25)	50	-

Table B-25 Characteristics of Reactive Compensation Expected in 2013 (continued)

Station	Bus	Plant	Mvar Capability	
			Generate	Absorb
Tandragee				
Tandragee	TAN 110	1 SVC	50	50
Tandragee	TAN 110	2 Capacitor (2 x 25)	50	-

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

Substation / Transformer	Parameters 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 2012/13 Interbus Transformers Added												
Castlereagh IBTx 4	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Hannahstown IBTx 1	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2012/13 Interbus Transformers Deleted												
Hannahstown IBTx 1	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	30	1.15	0.85	19
Winter 2013/14 Interbus Transformers Added												
Castlereagh IBTx 1	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2013/14 Interbus Transformers Deleted												
Castlereagh IBTx 1	0.0018	0.0641	0.0018	0.2092	0	0.1325	240	240	30	1.15	0.85	19
Winter 2014/15 Interbus Transformers Added												
Tamnamore IBTx 2	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Hannahstown IBTx 2	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2014/15 Interbus Transformers Deleted												
Hannahstown IBTx 2	0.0018	0.0591	0.0018	0.1261	0	0.056	240	240	30	1.15	0.85	19
Winter 2016/17 Interbus Transformers Added												
Coolkeeragh IBTx 1	0.0014	0.0639	0.0018	0.2236	0	0.1449	240	240	60	1.15	0.85	19
Winter 2016/17 Interbus Transformers Deleted												
Coolkeeragh IBTx 1	0.0018	0.0609	0.0018	0.1273	0	0.057	240	240	30	1.15	0.85	19

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

Substation / Transformer	Parameters 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 2016/17 Interbus Transformers add												
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 Station



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. Tables C-1 to C-4 list the demand forecasts at each Transmission Interface Station and Bulk Supply Point for each of the seven years to 2018 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 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)						
			2012	2013	2014	2015	2016	2017	2018
AA	ARDNACRUSHA	0.98	41.8	42.1	43.3	44.6	45.4	46.3	47.2
AD	AGHADA	0.87	0.6	0.6	0.6	0.7	0.7	0.7	0.7
AGH	AGHYOULE MAIN	0.98	12.8	12.9	13.0	13.1	13.3	13.4	13.6
AGY	ARDNAGAPPARY	0.95	0.0	0.0	13.5	13.9	14.2	14.5	14.8
AHA	AHANE	0.98	6.6	6.6	6.8	7.0	7.1	7.3	7.4
AIR	BELFAST - AIRPORT ROAD MAIN	0.98	-	-	-	-	-	31.9	32.4
ANR	ANNER	0.94	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.98	42.8	43.3	44.0	44.6	45.3	46.0	46.6
ARI	ARIGNA	0.93	3.9	3.9	4.0	4.1	4.2	4.3	4.4
ARK	ARKLOW	0.98	25.8	26.0	26.7	27.5	28.0	28.5	29.1
ATH	ATHLONE	0.94	62.5	63.0	64.8	66.7	68.0	69.3	70.6
ATY	ATHY	0.98	23.6	23.8	24.5	25.2	25.7	26.2	26.7
BAL	BALTRASNA	0.99	17.1	17.2	17.5	17.8	18.1	18.3	18.5
BAN - NI	BANDBRIDGE MAIN	0.98	42.9	43.5	44.1	44.8	45.4	46.1	46.8
BAN - I	BANDON	0.95	39.4	39.7	40.9	42.0	42.8	43.7	44.5

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
BAR	BARRYMORE	0.96	24.9	25.1	25.8	26.5	27.1	27.6	28.1
BCM	BALLYCUMMIN	-	-	-	-	-	-	9.7	9.9
BDA	BARODA	0.95	9.5	20.6	20.9	21.2	21.4	21.7	21.9
BDN	BALLYDINE	0.96	17.7	17.8	18.1	18.5	18.7	19.0	19.3
BEG	BALLYBEG	0.99	13.4	13.5	13.9	14.3	14.5	14.8	15.1
BGT	BALLYRAGGET	0.96	-	-	-	22.9	23.3	23.8	24.2
BIN	BINBANE	0.77	21.5	21.7	13.2	13.6	13.9	14.2	14.4
BK	BELLACORICK	0.95	6.8	6.9	7.1	7.3	7.4	7.6	7.7
BLI	BALLYLICKEY	1.00	10.0	10.1	10.4	10.7	10.9	11.1	11.3
BLK	BLAKE	1.00	22.0	10.6	10.9	11.2	11.5	11.7	11.9
BMA	BALLYMENA MESH (RURAL)	0.98	48.5	49.1	49.8	35.9	36.6	37.4	38.2
BMA	BALLYMENA SWBD (TOWN)	0.98	44.4	45.0	45.7	46.4	47.2	47.9	48.7
BNH	BALLYNAHINCH MAIN	0.98	60.3	61.1	62.0	62.9	63.8	64.7	65.6
BNM	BELFAST - BELFAST NORTH MAIN	0.98	-	-	-	54.4	55.2	56.0	56.8
BOG	BANOGE	0.95	13.8	13.9	14.3	14.7	15.0	15.3	15.6
BRA	BRACKLONE	0.97	0.0	11.5	11.8	12.2	12.4	12.7	12.9
BRI	BRINNY	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.97	16.2	16.4	16.8	17.3	17.7	18.0	18.3
BUT	BUTLERSTOWN	0.98	38.7	39.0	40.2	41.3	42.1	42.9	43.7
CAH	CAHIR	0.98	23.5	23.6	24.3	25.0	25.5	26.0	26.5
CAR	BELFAST - CARNMONEY MAIN	0.98	41.4	41.9	42.5	43.2	43.9	44.6	45.2
CBG	CARROWBEG	0.96	19.3	19.5	20.0	20.6	21.0	21.4	21.8
CBR	CASTLEBAR	0.96	32.5	32.7	33.7	34.6	35.3	36.0	36.7
CDY	CORDERRY	0.95	9.9	9.9	10.2	10.5	10.7	10.9	11.1
CEN	BELFAST - BELFAST CENTRAL MAIN	0.98	60.3	61.0	62.1	63.3	64.5	65.6	66.8
CF	CATHALEEN'S FALL	0.95	17.3	17.4	17.9	18.4	18.8	19.1	19.5
CFM	CASTLEFARM	0.95	49.0	49.0	49.0	49.0	49.0	49.0	49.0
CHA	CHARLEVILLE	0.96	17.6	17.7	18.2	18.7	19.1	19.4	19.8
CKM	CARRICKMINES	0.98	316.1	318.4	327.0	335.8	341.9	348.1	354.5
CLN	CLOON	0.96	29.4	29.6	30.5	31.4	32.0	32.6	33.2
CLW	CARLOW	0.96	61.4	61.8	63.2	64.6	65.6	66.6	67.6
COL - NI	COLERAINE MAIN	0.98	43.8	44.4	45.0	45.7	46.4	47.1	47.8

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
COL - I	COLLEGE PARK	0.97	47.3	47.5	48.0	48.7	49.1	49.5	49.9
COS	CARICKONSHANNON	0.98	29.6	29.8	30.7	31.5	32.2	32.8	33.4
COW	COW CROSS	0.99	12.5	12.6	12.9	13.3	13.6	13.8	14.1
CPS	COOLKEERAGH MAIN	0.98	32.2	32.6	33.1	33.7	34.3	34.8	35.4
CRA	CRANE	0.96	33.0	33.3	34.2	35.2	35.9	36.6	37.3
CRE	BELFAST - CREGAGH MAIN	0.98	63.8	64.6	65.6	66.5	67.5	56.2	57.2
CRG	CREAGH MAIN	0.98	25.2	25.4	25.8	40.9	41.2	41.6	41.9
CRO	COOLROE	1.00	10.8	10.9	11.2	11.6	11.8	12.0	12.2
CVW	CASTLEVIEW	0.97	22.2	22.4	23.0	23.7	24.2	24.6	25.1
DAL	DALLOW	0.97	21.3	21.5	22.1	22.7	23.2	23.6	24.1
DDK	DUNDALK	0.98	63.1	42.6	43.8	45.0	45.9	46.8	47.7
DFR	DUNFIRTH	1.00	8.0	8.0	8.3	8.5	8.7	8.8	9.0
DGN	DUNGARVAN	0.98	40.9	41.2	42.4	43.6	44.4	45.3	46.2
DLT	DALTON	0.97	23.2	23.3	24.0	24.7	25.2	25.7	26.2
DMY	DUNMANWAY	0.97	30.8	31.0	31.9	32.8	33.4	34.1	34.8
DON	BELFAST - DONEGALL MAIN (NORTH)	0.98	58.6	59.3	60.2	61.1	62.0	62.9	63.8
DON	BELFAST - DONEGALL MAIN (SOUTH)	0.98	54.9	55.5	56.3	57.1	57.9	58.8	59.6
DOO	DOON	0.97	31.8	32.0	32.8	33.7	34.2	34.8	35.4
DRU - NI	DRUMNAKELLY MAIN	0.98	89.1	90.4	92.0	93.6	95.3	96.9	98.6
DRU - I	DRUMLINE	0.95	25.4	35.6	36.3	37.1	37.6	38.1	38.7
DRY	DRYBRIDGE	0.97	81.8	77.4	79.6	81.9	83.5	85.1	86.8
DUN	DUNGANNON MAIN	0.98	81.4	82.5	83.9	85.3	86.7	88.2	89.6
EDE	EDEN MAIN	0.98	33.0	33.4	33.9	34.4	34.9	35.4	35.9
ENN - NI	ENNISKILLEN MAIN	0.98	49.4	50.0	50.8	51.5	52.3	53.1	53.9
ENN - I	ENNIS	0.98	61.1	61.5	63.3	65.1	66.4	67.6	69.0
FIN - NI	BELFAST - FINAGHY MAIN	0.98	36.4	36.9	37.4	38.0	38.6	39.2	39.8
FIN - I	FINGLAS	0.97	391.9	394.7	405.1	415.8	423.3	430.8	438.5
GAL	GALWAY	0.96	69.6	70.1	72.1	74.2	75.7	77.1	78.6
GI	GREAT ISLAND	0.94	13.9	14.0	14.5	5.5	5.6	5.7	5.8
GIL	GILRA	0.95	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE - NI	BELFAST - GLENGORMLEY MAIN	0.98	16.2	16.4	16.6	16.9	17.1	17.4	17.6
GLE - I	GLENLARA	0.92	17.9	18.0	18.5	19.0	19.4	19.8	20.2

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
GRI	GRIFFINRATH	0.98	57.6	58.1	59.7	61.4	62.6	63.8	65.1
GWE	GORTAWEE	0.95	32.2	32.3	32.6	33.0	33.2	33.4	33.7
HTS	HARNETTS CROSS	0.96	-	7.5	7.7	7.9	8.1	8.2	8.4
IKE	IKERRIN	0.96	27.2	27.4	28.2	29.0	29.6	30.1	30.7
INC	INCHICORE	0.95	369.6	372.0	381.0	390.2	396.6	403.1	409.7
KBY	KILBARRY	0.98	86.5	87.2	89.7	92.2	94.0	95.8	97.7
KER	KNOCKERAGH	0.97	31.4	31.6	32.5	33.4	34.1	34.7	35.4
KIN	KINNEGAD	0.95	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	KILKENNY	0.97	60.3	60.8	62.6	54.3	55.4	56.4	57.5
KNM	KNOCKMULLEN	0.96	-	-	-	9.4	9.6	9.7	9.9
KNO	BELFAST - KNOCK MAIN	0.98	69.3	70.2	71.2	72.2	73.3	64.5	65.5
CTL	KILTEEL	0.93	27.7	27.9	28.7	29.5	30.1	30.7	31.3
KTN	KILLOTERAN	0.97	13.4	13.5	13.9	14.3	14.6	14.8	15.1
KUR	KNOCKUMBER	0.95	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.95	15.5	15.6	16.0	16.5	16.8	17.1	17.5
LAR	LARNE MAIN	0.98	42.8	43.4	44.1	44.7	45.4	46.1	46.7
LET	LETTERKENNY	0.94	63.0	63.5	60.9	62.6	63.8	65.0	66.3
LIB	LIBERTY	0.97	21.5	21.6	22.3	22.9	23.4	23.8	24.3
LIM - NI	LIMAVADY MAIN	0.98	24.3	24.6	25.0	25.3	25.7	26.1	26.5
LIM - I	LIMERICK	0.99	78.1	78.7	81.0	83.3	84.9	76.8	78.3
LIS - NI	LISBURN MAIN	0.98	67.2	68.1	69.1	70.2	71.3	72.4	73.6
LIS - I	LISDRUM	0.97	25.9	26.1	26.9	27.7	28.2	28.7	29.3
LMR	LISAGHMORE MAIN	0.98	50.4	51.0	51.8	52.6	53.4	54.2	55.0
LOG	LOGUESTOWN MAIN	0.98	38.6	39.1	39.6	40.2	40.8	41.4	41.9
LSN	LISHEEN	0.95	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	1.00	13.4	6.0	6.2	6.3	6.5	6.6	6.7
MAL	MALLOW	0.97	22.2	22.4	23.0	23.7	24.1	24.6	25.1
MCE	MACETOWN	0.98	32.1	32.4	33.1	33.9	34.5	35.1	35.7
MID	MIDLETON	0.98	30.6	30.9	31.7	32.6	33.3	33.9	34.6
MLN	MULLAGHARLIN	0.95	5.2	31.3	32.0	32.8	33.3	33.9	34.4
MON	MONREAD	0.97	22.8	22.9	23.2	23.6	23.9	24.1	24.4
MOY	MOY	0.98	22.2	22.4	23.1	23.7	24.2	24.6	25.1
MR	MARINA	0.96	15.8	15.9	16.4	16.8	17.2	17.5	17.8
MTH	MEATH HILL	0.93	45.0	45.3	46.6	47.9	48.9	49.8	50.8

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
MUL	MULLINGAR	0.97	46.1	46.5	47.8	49.1	50.1	51.1	52.1
MUN	MUNGRET	0.95	22.0	22.0	22.0	22.0	22.0	22.0	22.0
NAR	NEWTOWNARDS MAIN	0.98	45.3	45.8	46.5	47.2	47.8	48.5	49.2
NAV	NAVAN	0.97	56.4	56.9	58.5	60.2	61.3	62.5	63.7
NEN	NENAGH	0.95	25.0	25.2	26.0	26.7	27.2	27.8	28.3
NEW - NI	NEWRY MAIN	0.98	79.3	80.3	81.6	82.8	84.1	85.5	86.8
NEW - I	NEWBRIDGE	0.98	36.0	25.2	25.9	26.7	27.2	27.7	28.3
OLD	OLDCOURT	0.94	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	OMAGH MAIN	0.98	54.8	55.4	56.2	57.0	57.8	58.6	59.4
OUG	OUGHTRAGH	0.98	24.4	24.6	25.3	26.1	26.6	27.1	27.6
PB	POOLBEG	0.96	197.5	210.2	215.9	221.8	225.9	230.0	234.2
PLA	PLATIN	0.95	29.0	29.0	29.0	29.0	29.0	29.0	29.0
PLS	PORTLAOISE	0.96	43.9	44.2	45.5	33.9	34.6	35.3	36.0
PSW	BELFAST - PSW	0.98	52.2	52.9	53.7	-	-	-	-
RAL	RALAPPANE	0.95	-	61.0	61.0	61.0	61.0	61.0	61.0
RAT - NI	RATHGAEL MAIN	0.98	66.4	67.3	68.2	69.2	70.2	71.2	72.2
RAT - I	RATHKEALE	0.96	27.3	27.5	28.3	29.1	29.6	30.2	30.8
RIC	RICHMOND	0.97	31.6	31.9	32.8	33.7	34.4	35.0	35.7
RNW	RINAWADE	0.95	15.2	15.2	15.2	15.2	15.2	15.2	15.2
ROS	ROSEBANK MAIN	0.98	41.7	42.1	42.6	43.0	43.5	34.1	34.6
RSY	RINGASKIDDY	0.97	4.0	4.1	4.2	4.3	4.4	4.5	4.6
RYB	RYEBROOK	0.95	102.6	102.6	102.6	102.6	102.6	102.6	102.6
SAL	SALTHILL	0.97	67.7	68.1	69.9	71.8	73.1	74.3	75.7
SCR	SCREEB	0.98	12.3	12.4	12.8	13.1	13.4	13.6	13.9
SHE	SHELTON ABBEY	0.94	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.96	55.5	55.9	57.5	59.2	60.3	61.5	62.7
SLI	SLIGO	0.98	51.5	51.9	53.4	55.0	56.0	57.1	58.2
SNG	SINGLAND	0.99	16.5	16.7	17.1	17.6	18.0	18.3	18.7
SOM	SOMERSET	0.97	19.5	19.7	20.2	20.8	21.2	21.6	22.0
SOR	SORNE HILL	0.95	7.9	7.9	8.1	8.4	8.5	8.7	8.9
SPR	SPRINGTOWN MAIN	0.98	32.0	32.4	32.9	33.5	34.0	34.6	35.2
STR - NI	STRABANE MAIN	0.98	35.8	36.3	36.8	37.3	37.9	38.5	39.0
STR - I	STRATFORD	0.97	22.3	22.4	23.1	23.7	24.2	24.7	25.1
TBG	TRABEG	0.98	77.6	78.2	80.4	82.7	84.4	86.0	87.6

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
TBK	TULLABRACK	0.95	11.4	11.5	11.8	12.2	12.4	12.7	12.9
THU	THURLES	0.95	37.6	37.9	39.0	40.1	40.9	41.6	42.4
TIP	TIPPERARY	0.96	22.2	22.4	23.0	23.7	24.2	24.6	25.1
TLK	TRILICK	0.95	28.1	28.4	29.2	30.0	30.6	31.2	31.8
TON	TONROE	0.95	14.8	14.9	15.4	15.8	16.1	16.4	16.7
TRI	TRIEN	0.97	36.0	36.3	37.3	38.4	39.1	39.9	40.6
TRL	TRALEE	0.97	47.5	47.9	49.2	50.6	51.6	52.6	53.6
TSB	THORNSBERRY	0.98	29.8	30.0	30.9	31.7	32.4	33.0	33.6
WAR	WARINGSTOWN MAIN	0.98	63.6	64.3	65.1	65.9	66.7	67.6	68.4
WAT	WATERFORD	0.97	73.7	74.0	75.4	76.7	77.7	78.6	79.6
WEX	WEXFORD	0.97	51.7	52.1	53.6	55.1	56.2	57.3	58.4
WHI	WHITEGATE	0.95	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Total			6,277	6,412	6,555	6,700	6,810	6,921	7,035

Table C-2 Demand Forecasts at Time of Summer Peak

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
AA	ARDNACRUSHA	0.95	32.4	31.9	32.9	33.9	34.6	35.2	35.9
AD	AGHADA	1.00	1.2	1.1	1.2	1.2	1.2	1.3	1.3
AGH	AGHYOULE MAIN	0.96	10.2	10.3	10.4	10.5	10.6	10.6	10.7
AGY	ARDNAGAPPARY	0.95	-	-	-	12.2	12.4	12.6	12.9
AHA	AHANE	0.98	3.7	3.6	3.8	3.9	3.9	4.0	4.1
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	-	-	-	-	-	32.5	32.5
ANR	ANNER	0.94	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.96	37.1	37.6	38.1	38.7	39.3	39.7	40.3
ARI	ARIGNA	0.97	4.3	4.2	4.4	4.5	4.6	4.7	4.8
ARK	ARKLOW	0.98	23.1	22.8	23.5	24.2	24.7	25.2	25.7
ATH	ATHLONE	0.96	48.9	44.5	45.8	47.2	48.2	49.1	50.1
ATY	ATHY	0.96	12.2	12.1	12.4	12.8	13.1	13.3	13.6
BAL	BALTRASNA	0.97	10.9	10.8	10.9	11.1	11.2	11.3	11.4
BAN - NI	BANDBRIDGE MAIN	0.96	30.0	30.4	30.8	31.3	31.8	32.1	32.6
BAN - I	BANDON	0.94	23.0	30.3	31.2	32.2	32.8	33.5	34.2
BAR	BARRYMORE	0.98	21.4	21.1	21.7	22.4	22.8	23.3	23.8
BCM	BALLYCUMMIN	-	-	-	-	-	-	-	8.7
BDA	BARODA	0.95	9.5	9.5	19.4	19.7	19.9	20.1	20.3
BDN	BALLYDINE	0.94	14.9	14.8	15.1	15.4	15.6	15.8	16.0
BEG	BALLYBEG	0.97	9.6	9.5	9.8	10.1	10.3	10.5	10.7
BGT	BALLYRAGGET	-	-	-	-	-	20.4	20.8	21.2
BIN	BINBANE	0.95	14.4	14.1	14.6	6.8	7.0	7.1	7.3
BK	BELLACORICK	0.93	5.1	5.1	5.2	5.4	5.5	5.6	5.7
BLI	BALLYLICKEY	0.98	11.9	11.7	12.1	12.5	12.7	13.0	13.2
BLK	BLAKE	0.95	22.7	12.3	12.7	13.1	13.3	13.6	13.9
BMA	BALLYMENA MESH (RURAL)	0.96	40.4	40.9	41.5	29.9	30.5	31.0	31.7
BMA	BALLYMENA SWBD (TOWN)	0.96	35.4	35.8	36.4	37.0	37.6	38.0	38.6
BNH	BALLYNAHINCH MAIN	0.96	43.5	44.1	44.7	45.4	46.0	46.5	47.2
BNM	BELFAST - BELFAST NORTH MAIN	0.96	-	-	-	42.7	43.3	43.7	44.3
BOG	BANOGE	0.95	12.3	12.1	12.5	12.8	13.1	13.4	13.6
BRA	BRACKLONE	0.97	-	10.0	10.3	10.6	10.8	11.1	11.3
BRI	BRINNY	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.96	32.0	31.5	32.5	33.4	34.1	34.8	35.5

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
BUT	BUTLERSTOWN	0.98	24.5	24.2	24.9	25.6	26.1	26.7	27.2
CAH	CAHIR	0.96	19.6	19.3	19.9	20.5	20.9	21.3	21.7
CAR	BELFAST - CARNMONEY MAIN	0.96	34.1	34.5	35.1	35.6	36.2	36.6	37.1
CBG	CARROWBEG	0.96	17.2	17.0	17.5	18.0	18.4	18.7	19.1
CBR	CASTLEBAR	0.97	25.1	24.7	25.5	26.2	26.7	27.3	27.8
CDY	CORDERRY	0.95	2.6	2.6	2.7	2.8	2.8	2.9	2.9
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	48.0	48.6	49.5	50.4	51.4	52.0	53.0
CF	CATHALEEN'S FALL	0.95	14.5	14.3	14.7	15.2	15.5	15.8	16.1
CFM	CASTLEFARM	0.95	49.0	49.0	49.0	49.0	49.0	49.0	49.0
CHA	CHARLEVILLE	0.91	16.0	15.8	16.3	16.8	17.1	17.4	17.8
CKM	CARRICKMINES	0.97	235.3	250.9	257.8	264.9	269.9	274.8	280.0
CLN	CLOON	0.94	18.3	21.7	22.3	23.0	23.5	23.9	24.4
CLW	CARLOW	0.96	54.5	53.9	55.1	56.3	57.2	58.1	59.0
COL - NI	COLERAINE MAIN	0.96	33.4	33.8	34.4	34.9	35.4	35.7	36.3
COL - I	COLLEGE PARK	0.96	49.0	48.7	49.3	50.0	50.5	50.9	51.4
COS	CARICKONSHANNON	0.98	18.6	18.4	18.9	19.5	19.9	20.3	20.7
COW	COW CROSS	0.99	14.9	14.7	15.2	15.6	15.9	16.2	16.6
CPS	COOLKEERAGH MAIN	0.96	25.6	26.0	26.4	26.8	27.3	27.6	28.1
CRA	CRANE	0.96	21.2	20.9	21.5	22.2	22.6	23.1	23.5
CRE	BELFAST - CREGAGH MAIN	0.96	56.5	57.2	58.0	58.9	59.7	49.5	50.4
CRG	CREAGH MAIN	0.96	20.0	20.3	20.5	32.6	32.8	33.0	33.3
CRO	COOLROE	0.99	11.2	11.1	11.4	11.7	12.0	12.2	12.4
CVW	CASTLEVIEW	0.98	23.5	23.2	23.9	24.6	25.1	25.6	26.1
DAL	DALLOW	0.96	12.5	12.3	12.7	13.1	13.3	13.6	13.9
DDK	DUNDALK	0.96	45.9	45.3	27.8	28.6	29.2	29.7	30.3
DFR	DUNFIRTH	0.96	3.6	3.5	3.6	3.7	3.8	3.9	4.0
DGN	DUNGARVAN	0.97	30.5	30.1	31.0	31.9	32.5	33.2	33.8
DLT	DALTON	0.96	20.5	20.2	20.8	21.5	21.9	22.3	22.8
DMY	DUNMANWAY	0.95	25.6	21.7	22.4	23.0	23.5	24.0	24.4
DON	BELFAST - DONEGALL MAIN (NORTH)	0.96	46.7	47.3	48.0	48.7	49.4	49.9	50.6
DON	BELFAST - DONEGALL MAIN (SOUTH)	0.96	44.4	44.9	45.5	46.2	46.9	47.3	48.0
DOO	DOON	0.96	25.6	25.2	25.9	26.5	27.0	27.4	27.9

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
DRU - NI	DRUMNAKELLY MAIN	0.96	75.9	77.0	78.3	79.7	81.1	82.1	83.6
DRU - I	DRUMLINE	0.94	25.1	34.8	35.5	36.3	36.8	37.3	37.9
DRY	DRYBRIDGE	0.97	57.1	56.2	53.4	55.0	56.1	57.2	58.3
DUN	DUNGANNON MAIN	0.96	64.9	65.7	66.8	68.0	69.1	69.9	71.1
EDE	EDEN MAIN	0.96	25.7	26.0	26.4	26.8	27.2	27.4	27.8
ENN - NI	ENNISKILLEN MAIN	0.96	44.4	45.0	45.7	46.4	47.1	47.6	48.3
ENN - I	ENNIS	0.96	44.1	43.4	44.7	46.0	47.0	47.9	48.9
FIN - NI	BELFAST - FINAGHY MAIN	0.96	27.6	27.9	28.4	28.8	29.3	29.6	30.0
FIN - I	FINGLAS	0.92	324.0	319.7	328.3	337.2	343.4	349.5	355.9
GAL	GALWAY	0.98	72.0	70.9	73.1	75.2	76.7	78.3	79.8
GI	GREAT ISLAND	0.95	7.7	7.6	7.8	8.0	0.2	0.2	0.2
GIL	GILRA	0.95	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE - NI	BELFAST - GLENGORMLEY MAIN	0.96	12.9	13.1	13.3	13.5	13.7	13.8	14.0
GLE - ROI	GLENLARA	0.93	10.3	10.1	10.4	10.7	11.0	11.2	11.4
GRI	GRIFFINRATH	0.98	36.0	34.3	35.3	36.3	37.1	37.8	38.6
GWE	GORTAWEE	0.95	28.2	28.1	28.3	28.5	28.6	28.8	29.0
HTS	HARNETTS CROSS	0.96	-	-	6.7	6.9	7.1	7.2	7.3
IKE	IKERRIN	0.94	24.6	24.2	24.9	25.7	26.2	26.7	27.3
INC	INCHICORE	0.96	324.4	331.0	339.1	347.5	353.3	359.1	365.2
KBY	KILBARRY	0.97	58.3	57.4	59.2	60.9	62.2	63.4	64.7
KER	KNOCKERAGH	0.96	33.4	32.9	33.9	34.9	35.6	36.3	37.0
KIN	KINNEGAD	0.95	10.2	10.2	10.2	10.2	10.2	10.2	10.2
KKY	KILKENNY	0.95	49.8	49.0	50.5	52.0	44.1	45.0	45.9
KNM	KNOCKMULLEN	-	-	-	-	-	8.0	8.2	8.3
KNO	BELFAST - KNOCK MAIN	0.96	49.5	50.1	50.8	51.6	52.3	45.8	46.6
KTL	KILTEEL	0.91	21.1	28.5	29.4	30.2	30.8	31.5	32.1
KTN	KILLOTERAN	0.96	15.2	15.0	15.4	15.9	16.2	16.5	16.9
KUR	KNOCKUMBER	0.95	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.96	10.6	10.5	10.8	11.1	11.3	11.5	11.8
LAR	LARNE MAIN	0.96	33.0	33.5	34.0	34.5	35.0	35.4	35.9
LET	LETTERKENNY	0.94	42.2	41.6	42.8	40.1	40.9	41.7	42.6
LIB	LIBERTY	0.95	18.3	18.1	18.6	19.2	19.5	19.9	20.3
LIM - NI	LIMAVADY MAIN	0.96	17.7	17.9	18.2	18.4	18.7	18.9	19.2
LIM - I	LIMERICK	0.98	71.7	70.7	72.8	74.9	76.5	69.5	70.9

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
LIS - NI	LISBURN MAIN	0.96	51.0	51.6	52.4	53.2	54.1	54.7	55.5
LIS - I	LISDRUM	0.95	21.9	21.6	22.2	22.9	23.4	23.8	24.3
LMR	LISAGHMORE MAIN	0.96	37.3	37.7	38.3	38.9	39.5	39.9	40.5
LOG	LOGUESTOWN MAIN	0.96	34.8	35.3	35.8	36.3	36.8	37.1	37.7
LSN	LISHEEN	0.95	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	1.00	14.3	9.9	3.5	3.6	3.7	3.8	3.8
MAL	MALLOW	0.94	14.2	14.0	14.4	14.8	15.1	15.4	15.7
MCE	MACETOWN	0.98	25.0	24.8	25.3	25.9	26.4	26.8	27.2
MID	MIDLETON	0.97	23.2	22.9	23.6	24.3	24.8	25.3	25.8
MLN	MULLAGHARLIN	0.95	5.2	5.2	28.6	29.3	29.7	30.2	30.7
MON	MONREAD	0.96	20.7	20.6	20.9	21.2	21.5	21.7	21.9
MOY	MOY	0.98	17.9	17.7	18.2	18.8	19.1	19.5	19.9
MR	MARINA	0.98	17.9	17.6	18.1	18.7	19.1	19.4	19.8
MTH	MEATH HILL	0.91	31.6	31.2	32.1	33.0	33.7	34.4	35.1
MUL	MULLINGAR	0.95	30.8	30.4	31.3	32.2	32.8	33.5	34.2
MUN	MUNGRET	0.95	22.0	22.0	22.0	22.0	22.0	22.0	22.0
NAR	NEWTOWNARDS MAIN	0.96	33.5	33.9	34.4	34.9	35.4	35.7	36.3
NAV	NAVAN	0.96	46.1	45.5	46.8	48.2	49.2	50.2	51.2
NEN	NENAGH	0.95	22.3	22.0	22.6	23.3	23.8	24.2	24.7
NEW - NI	NEWRY MAIN	0.96	60.8	61.5	62.5	63.5	64.5	65.1	66.1
NEW - I	NEWBRIDGE	0.96	29.0	20.9	11.6	11.9	12.2	12.4	12.7
OLD	OLDCOURT	0.94	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	OMAGH MAIN	0.96	43.0	43.5	44.1	44.7	45.3	45.7	46.3
OUG	OUGHTRAGH	0.98	19.0	18.7	19.3	19.8	20.2	20.6	21.1
PB	POOLBEG	0.98	176.5	185.1	190.3	195.7	199.4	203.2	207.0
PLA	PLATIN	0.95	29.0	29.0	29.0	29.0	29.0	29.0	29.0
PLS	PORTLAOISE	0.95	41.7	41.1	42.3	43.5	33.0	33.7	34.3
PSW	BELFAST - PSW	0.96	41.0	41.5	42.1	-	-	-	-
RAL	RALAPPANE	0.95	-	61.0	61.0	61.0	61.0	61.0	61.0
RAT - NI	RATHGAEL MAIN	0.96	47.2	47.8	48.5	49.2	49.9	50.3	51.1
RAT - I	RATHKEALE	0.93	20.0	19.7	20.3	20.9	21.3	21.7	22.2
RIC	RICHMOND	0.95	26.1	25.7	26.5	27.2	27.8	28.3	28.9
RNW	RINAWADE	0.95	15.2	15.2	15.2	15.2	15.2	15.2	15.2
ROS	ROSEBANK MAIN	0.96	30.7	31.0	31.4	31.7	32.0	25.0	25.4
RSY	RINGASKIDDY	0.99	1.9	1.8	1.9	2.0	2.0	2.0	2.1

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
RYB	RYEBROOK	0.95	81.0	102.6	102.6	102.6	102.6	102.6	102.6
SAL	SALTHILL	0.96	58.1	46.5	47.7	49.0	49.8	50.7	51.6
SCR	SCREEB	0.98	0.0	10.8	11.1	11.4	11.7	11.9	12.2
SHE	SHELTON ABBEY	0.94	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.94	49.6	48.9	50.3	51.8	52.9	53.9	55.0
SLI	SLIGO	0.97	39.3	38.7	39.8	41.0	41.9	42.7	43.5
SNG	SINGLAND	0.95	9.7	9.5	9.8	10.1	10.3	10.5	10.7
SOM	SOMERSET	0.95	16.8	16.5	17.0	17.5	17.9	18.3	18.6
SOR	SORNE HILL	0.95	2.2	2.2	2.2	2.3	2.4	2.4	2.4
SPR	SPRINGTOWN MAIN	0.96	26.0	26.3	26.7	27.2	27.6	27.9	28.4
STR - NI	STRABANE MAIN	0.96	26.0	26.3	26.7	27.1	27.5	27.8	28.2
STR - I	STRATFORD	0.95	7.7	7.6	7.8	8.1	8.2	8.4	8.6
TBG	TRABEG	0.98	50.9	50.2	51.7	53.2	54.3	55.4	56.5
TBK	TULLABRACK	0.94	7.4	7.3	7.5	7.7	7.9	8.0	8.2
THU	THURLES	0.95	22.3	21.9	22.6	23.3	23.7	24.2	24.7
TIP	TIPPERARY	0.95	12.1	12.0	12.3	12.7	12.9	13.2	13.5
TLK	TRILICK	0.99	8.8	8.6	8.9	9.1	9.3	9.5	9.7
TON	TONROE	0.93	8.5	8.3	8.6	8.8	9.0	9.2	9.4
TRI	TRIEN	0.95	22.2	21.8	22.5	23.2	23.6	24.1	24.6
TRL	TRALEE	0.99	35.1	34.6	35.6	36.7	37.4	38.2	38.9
TSB	THORNSBERRY	0.95	25.9	25.5	26.2	27.0	27.6	28.1	28.7
WAR	WARINGSTOWN MAIN	0.96	52.4	52.9	53.6	54.3	55.0	55.4	56.1
WAT	WATERFORD	0.96	37.1	64.1	65.1	66.3	67.1	67.8	68.6
WEX	WEXFORD	0.96	33.5	33.0	34.0	35.0	35.7	36.4	37.1
WHI	WHITEGATE	0.95	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Total			4,992	5,122	5,236	5,352	5,441	5,521	5,621

Table C-3 Demand Forecasts at Time of Summer Valley

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
AA	ARDNACRUSHA	0.96	16.9	15.6	16.2	16.8	17.2	17.6	18.0
AD	AGHADA	0.71	0.6	0.6	0.6	0.6	0.7	0.7	0.7
AGH	AGHYOULE MAIN	0.96	3.7	3.7	3.8	3.8	3.8	3.9	3.9
AGY	ARDNAGAPPARY	0.95	0.0	0.0	0.0	4.1	4.2	4.3	4.4
AHA	AHANE	0.99	0.7	0.7	0.7	0.7	0.7	0.7	0.7
AIR	BELFAST - AIRPORT ROAD MAIN	0.96	-	-	-	-	-	8.8	8.8
ANR	ANNER	0.94	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ANT	ANTRIM MAIN	0.96	16.5	16.7	16.9	17.2	17.4	17.7	17.9
ARI	ARIGNA	1.00	1.6	1.5	1.5	1.6	1.6	1.7	1.7
ARK	ARKLOW	1.00	8.5	7.9	8.2	8.5	8.7	8.9	9.1
ATH	ATHLONE	0.98	8.7	6.8	7.1	7.3	7.5	7.7	7.9
ATY	ATHY	0.98	4.3	4.0	4.1	4.2	4.3	4.5	4.6
BAL	BALTRASNA	0.96	3.6	3.5	3.5	3.6	3.6	3.7	3.7
BAN - NI	BANDBRIDGE MAIN	0.96	10.4	10.5	10.7	10.8	11.0	11.1	11.3
BAN - I	BANDON	0.96	11.2	12.9	13.4	13.9	14.2	14.6	14.9
BAR	BARRYMORE	0.94	9.1	8.5	8.8	9.1	9.3	9.5	9.7
BCM	BALLYCUMMIN	-	-	-	-	-	-	-	3.0
BDA	BARODA	0.95	9.5	9.5	12.8	12.9	13.0	13.1	13.2
BDN	BALLYDINE	0.96	5.5	5.3	5.4	5.5	5.5	5.6	5.7
BEG	BALLYBEG	0.97	3.4	3.2	3.3	3.4	3.5	3.6	3.6
BGT	BALLYRAGGET	-	-	-	-	-	6.9	7.1	7.2
BIN	BINBANE	1.00	6.9	6.4	6.6	4.1	4.2	4.3	4.4
BK	BELLACORICK	0.89	2.2	2.0	2.1	2.2	2.2	2.3	2.3
BLI	BALLYLICKY	0.94	4.0	3.7	3.8	3.9	4.0	4.1	4.2
BLK	BLAKE	1.00	8.2	4.2	4.3	4.5	4.6	4.7	4.8
BMA	BALLYMENA MESH (RURAL)	0.96	11.7	11.9	12.1	8.7	8.8	9.0	9.2
BMA	BALLYMENA SWBD (TOWN)	0.96	12.8	13.0	13.2	13.4	13.6	13.8	14.0
BNH	BALLYNAHINCH MAIN	0.96	14.8	15.0	15.2	15.4	15.7	15.9	16.1
BNM	BELFAST - BELFAST NORTH MAIN	0.96	-	-	-	18.6	18.9	19.1	19.4
BOG	BANOGE	0.95	4.4	4.0	4.2	4.3	4.4	4.5	4.7
BRA	BRACKLONE	0.97	0.0	3.3	3.5	3.6	3.7	3.8	3.9
BRI	BRINNY	0.95	4.6	4.6	4.6	4.6	4.6	4.6	4.6
BRY	BARNAHELY	0.98	21.1	19.5	20.2	20.9	21.4	22.0	22.5

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
BUT	BUTLERSTOWN	0.99	10.1	9.3	9.6	10.0	10.2	10.5	10.7
CAH	CAHIR	0.99	8.6	7.9	8.2	8.5	8.7	8.9	9.1
CAR	BELFAST - CARNMONEY MAIN	0.96	13.4	13.5	13.7	13.9	14.1	14.4	14.6
CBG	CARROWBEG	0.96	6.1	5.7	5.9	6.1	6.2	6.4	6.5
CBR	CASTLEBAR	1.00	14.0	13.0	13.4	13.9	14.3	14.6	15.0
CDY	CORDERRY	0.94	0.5	0.5	0.5	0.5	0.5	0.5	0.6
CEN	BELFAST - BELFAST CENTRAL MAIN	0.96	17.4	17.6	17.9	18.2	18.6	18.9	19.2
CF	CATHALEEN'S FALL	0.94	7.4	6.8	7.0	7.3	7.5	7.7	7.8
CFM	CASTLEFARM	0.95	44.0	44.0	44.0	44.0	44.0	44.0	44.0
CHA	CHARLEVILLE	0.90	9.1	8.4	8.7	9.0	9.2	9.5	9.7
CKM	CARRICKMINES	0.97	91.5	103.5	106.6	109.8	112.0	114.2	116.5
CLN	CLOON	0.97	6.3	7.0	7.3	7.6	7.7	7.9	8.1
CLW	CARLOW	0.98	25.2	24.3	24.7	25.1	25.4	25.7	26.0
COL - NI	COLERAINE MAIN	0.96	11.8	11.9	12.1	12.2	12.4	12.6	12.8
COL - I	COLLEGE PARK	0.96	36.4	35.6	36.0	36.3	36.5	36.7	37.0
COS	CARICKONSHANNON	1.00	7.9	7.3	7.6	7.9	8.0	8.2	8.4
COW	COW CROSS	1.00	9.1	8.4	8.8	9.1	9.3	9.5	9.7
CPS	COOLKEERAGH MAIN	0.96	9.3	9.4	9.6	9.7	9.9	10.0	10.2
CRA	CRANE	0.99	8.5	7.9	8.2	8.5	8.7	8.9	9.1
CRE	BELFAST - CREGAGH MAIN	0.96	18.4	18.6	18.9	19.1	19.4	16.2	16.5
CRG	CREAGH MAIN	0.96	7.3	7.3	7.4	11.8	11.9	12.0	12.1
CRO	COOLROE	1.00	5.5	5.0	5.2	5.4	5.5	5.7	5.8
CVW	CASTLEVIEW	0.99	8.7	8.1	8.3	8.6	8.9	9.1	9.3
DAL	DALLOW	0.99	1.4	1.3	1.3	1.4	1.4	1.4	1.5
DDK	DUNDALK	1.00	15.9	14.7	8.9	9.2	9.4	9.7	9.9
DFR	DUNFIRTH	1.00	1.5	1.4	1.4	1.5	1.5	1.6	1.6
DGN	DUNGARVAN	0.99	11.1	10.3	10.6	11.0	11.3	11.6	11.8
DLT	DALTON	0.99	15.5	14.3	14.8	15.4	15.7	16.1	16.5
DMY	DUNMANWAY	0.99	10.4	8.5	8.8	9.1	9.3	9.5	9.8
DON	BELFAST - DONEGALL MAIN (NORTH)	0.96	19.0	19.2	19.5	19.8	20.0	20.3	20.6
DON	BELFAST - DONEGALL MAIN (SOUTH)	0.96	15.8	16.0	16.2	16.4	16.7	16.9	17.1
DOO	DOON	0.98	11.3	10.7	11.0	11.2	11.4	11.6	11.8
DRU - NI	DRUMNAKELLY MAIN	0.96	24.2	24.5	25.0	25.4	25.8	26.3	26.7

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
DRU - I	DRUMLINE	0.96	9.9	19.2	19.5	19.8	20.1	20.3	20.6
DRY	DRYBRIDGE	1.00	22.4	20.6	19.9	20.6	21.1	21.6	22.1
DUN	DUNGANNON MAIN	0.96	23.5	23.8	24.2	24.6	25.0	25.4	25.8
EDE	EDEN MAIN	0.96	11.8	11.9	12.1	12.3	12.4	12.6	12.8
ENN - NI	ENNISKILLEN MAIN	0.96	14.9	15.1	15.4	15.6	15.8	16.1	16.3
ENN - I	ENNIS	0.99	18.5	17.1	17.7	18.3	18.8	19.2	19.7
FIN - NI	BELFAST - FINAGHY MAIN	0.96	12.3	12.4	12.6	12.8	13.0	13.2	13.4
FIN - I	FINGLAS	0.97	150.1	140.7	144.8	149.1	152.1	155.1	158.2
GAL	GALWAY	1.00	31.8	29.4	30.4	31.5	32.3	33.1	33.9
GI	GREAT ISLAND	0.97	4.1	3.8	4.0	4.1	1.4	1.4	1.4
GIL	GILRA	0.95	10.4	10.4	10.4	10.4	10.4	10.4	10.4
GLE - NI	BELFAST - GLENGORMLEY MAIN	0.96	2.6	2.7	2.7	2.7	2.8	2.8	2.9
GLE - I	GLENLARA	0.97	5.3	4.9	5.1	5.3	5.4	5.5	5.7
GRI	GRIFFINRATH	1.00	13.6	12.2	12.6	13.0	13.4	13.7	14.0
GWE	GORTAWE	0.96	19.6	19.4	19.4	19.5	19.6	19.7	19.7
HTS	HARNETTS CROSS	0.96	-	-	2.3	2.3	2.4	2.4	2.5
IKE	IKERRIN	0.98	8.4	7.7	8.0	8.3	8.5	8.7	8.9
INC	INCHICORE	0.96	151.6	152.6	156.5	160.6	163.4	166.2	169.2
KBY	KILBARRY	1.00	22.3	20.6	21.4	22.1	22.7	23.2	23.8
KER	KNOCKERAGH	1.00	12.2	11.3	11.7	12.1	12.4	12.7	13.0
KIN	KINNEGAD	0.95	4.0	4.0	4.0	4.0	4.0	4.0	4.0
KKY	KILKENNY	0.99	14.5	13.4	13.9	14.4	11.7	12.0	12.3
KNM	KNOCKMULLEN	-	-	-	-	-	2.8	2.9	3.0
KNO	BELFAST - KNOCK MAIN	0.96	19.6	19.8	20.1	20.3	20.6	18.2	18.5
KTL	KILTEEL	0.27	13.0	14.6	15.1	15.7	16.0	16.4	16.8
KTN	KILLOTERAN	0.97	5.3	4.9	5.1	5.3	5.4	5.5	5.7
KUR	KNOCKUMBER	0.95	23.0	23.0	23.0	23.0	23.0	23.0	23.0
LA	LANESBORO	0.98	4.2	3.9	4.0	4.1	4.2	4.3	4.5
LAR	LARNE MAIN	0.96	10.5	10.7	10.8	11.0	11.1	11.3	11.5
LET	LETTERKENNY	0.99	17.7	16.3	16.9	16.2	16.6	17.0	17.4
LIB	LIBERTY	0.95	6.1	5.7	5.9	6.1	6.2	6.4	6.5
LIM - NI	LIMAVADY MAIN	0.96	6.0	6.1	6.2	6.2	6.3	6.4	6.5
LIM - I	LIMERICK	1.00	28.9	26.7	27.7	28.7	29.4	27.2	27.8
LIS - NI	LISBURN MAIN	0.96	16.3	16.5	16.7	17.0	17.2	17.5	17.8

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
LIS - I	LISDRUM	0.98	8.0	7.4	7.7	7.9	8.1	8.3	8.5
LMR	LISAGHMORE MAIN	0.96	14.8	15.0	15.2	15.4	15.7	15.9	16.1
LOG	LOGUESTOWN MAIN	0.96	13.8	14.0	14.2	14.4	14.6	14.8	15.0
LSN	LISHEEN	0.95	16.6	16.6	16.6	16.6	16.6	16.6	16.6
MAC	MACROOM	0.83	5.2	3.4	1.3	1.3	1.4	1.4	1.4
MAL	MALLOW	0.94	1.7	1.6	1.6	1.7	1.7	1.8	1.8
MCE	MACETOWN	0.99	14.4	13.7	14.0	14.3	14.6	14.8	15.0
MID	MIDLETON	0.98	10.4	9.6	10.0	10.4	10.6	10.9	11.1
MLN	MULLAGHARLIN	0.95	2.0	2.0	9.8	10.1	10.3	10.5	10.7
MON	MONREAD	0.96	13.4	13.1	13.2	13.3	13.4	13.5	13.6
MOY	MOY	1.00	7.7	7.1	7.4	7.6	7.8	8.0	8.2
MR	MARINA	0.99	5.2	4.8	5.0	5.1	5.3	5.4	5.5
MTH	MEATH HILL	0.93	10.2	9.4	9.7	10.1	10.3	10.6	10.8
MUL	MULLINGAR	1.00	10.8	10.0	10.3	10.7	11.0	11.2	11.5
MUN	MUNGRET	0.95	15.0	15.0	15.0	15.0	15.0	15.0	15.0
NAR	NEWTOWNARDS MAIN	0.96	10.9	11.0	11.2	11.3	11.5	11.7	11.8
NAV	NAVAN	0.99	15.2	14.0	14.5	15.1	15.4	15.8	16.2
NEN	NENAGH	0.95	7.9	7.3	7.6	7.9	8.0	8.2	8.4
NEW - NI	NEWRY MAIN	0.96	23.6	23.9	24.3	24.7	25.0	25.4	25.8
NEW - I	NEWBRIDGE	0.90	8.0	4.8	1.7	1.7	1.8	1.8	1.9
OLD	OLDCOURT	0.94	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OMA	OMAGH MAIN	0.96	14.8	14.9	15.1	15.3	15.5	15.7	16.0
OUG	OUGHTRAGH	1.00	8.8	8.1	8.4	8.7	8.9	9.1	9.3
PB	POOLBEG	0.98	66.4	72.6	74.8	77.1	78.7	80.3	82.0
PLA	PLATIN	0.95	21.0	21.0	21.0	21.0	21.0	21.0	21.0
PLS	PORTLAOISE	1.00	16.7	15.5	16.0	16.6	13.1	13.5	13.8
PSW	BELFAST - PSW	0.96	17.9	18.1	18.4	-	-	-	-
RAL	RALAPPANE	0.95	-	61.0	61.0	61.0	61.0	61.0	61.0
RAT - NI	RATHGAEL MAIN	0.96	15.6	15.8	16.0	16.2	16.5	16.7	16.9
RAT - I	RATHKEALE	0.96	7.6	7.0	7.3	7.5	7.7	7.9	8.1
RIC	RICHMOND	0.99	8.6	7.9	8.2	8.5	8.7	8.9	9.1
RNW	RINAWADE	0.95	7.6	7.6	7.6	7.6	7.6	7.6	7.6
ROS	ROSEBANK MAIN	0.96	10.4	10.5	10.6	10.7	10.8	8.5	8.6
RSY	RINGASKIDDY	1.00	1.0	0.9	0.9	1.0	1.0	1.0	1.0
RYB	RYEBROOK	0.95	65.0	82.3	82.3	82.3	82.3	82.3	82.3

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
SAL	SALTHILL	0.96	28.0	22.7	23.3	23.9	24.4	24.8	25.3
SCR	SCREEB	0.98	-	3.6	3.7	3.9	4.0	4.1	4.1
SHE	SHELTON ABBEY	0.94	2.3	2.3	2.3	2.3	2.3	2.3	2.3
SKL	SHANKILL	0.98	16.5	15.3	15.8	16.4	16.8	17.2	17.6
SLI	SLIGO	1.00	13.3	12.3	12.7	13.2	13.5	13.8	14.1
SNG	SINGLAND	0.97	2.1	1.9	2.0	2.1	2.1	2.2	2.2
SOM	SOMERSET	1.00	6.4	5.9	6.1	6.3	6.5	6.6	6.8
SOR	SORNE HILL	0.95	0.7	0.7	0.7	0.7	0.7	0.7	0.8
SPR	SPRINGTOWN MAIN	0.96	13.5	13.7	13.9	14.1	14.4	14.6	14.8
STR - NI	STRABANE MAIN	0.96	9.7	9.8	10.0	10.1	10.3	10.4	10.6
STR - I	STRATFORD	1.00	5.2	4.8	5.0	5.1	5.3	5.4	5.5
TBG	TRABEG	0.99	21.4	19.8	20.5	21.2	21.7	22.3	22.8
TBK	TULLABRACK	0.95	3.6	3.3	3.4	3.6	3.6	3.7	3.8
THU	THURLES	0.99	9.3	8.6	8.9	9.2	9.4	9.7	9.9
TIP	TIPPERARY	0.98	4.9	4.5	4.7	4.8	5.0	5.1	5.2
TLK	TRILICK	0.99	7.3	6.8	7.0	7.3	7.5	7.6	7.8
TON	TONROE	0.97	4.9	4.5	4.7	4.8	4.9	5.1	5.2
TRI	TRIEN	0.96	10.7	9.9	10.3	10.7	10.9	11.2	11.4
TRL	TRALEE	1.00	15.5	14.3	14.8	15.3	15.7	16.1	16.5
TSB	THORNSBERRY	0.98	8.2	7.6	7.9	8.2	8.4	8.6	8.8
WAR	WARINGSTOWN MAIN	0.96	19.5	19.7	19.9	20.2	20.4	20.7	20.9
WAT	WATERFORD	0.96	13.8	40.3	40.7	41.2	41.5	41.9	42.2
WEX	WEXFORD	1.00	11.4	10.6	11.0	11.4	11.6	11.9	12.2
WHI	WHITEGATE	0.95	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total			2139	2204	2254	2305	2344	2379	2422

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
AGH	AGHYOULE MAIN	0.97	11.1	11.2	11.3	11.5	11.6	11.7	11.8
AIR	BELFAST - AIRPORT ROAD MAIN	0.97	-	-	-	-	-	32.3	32.7
ANT	ANTRIM MAIN	0.97	38.1	38.5	39.1	39.7	40.3	40.8	41.4
BAN - NI	BANDBRIDGE MAIN	0.97	34.9	35.4	35.9	36.5	37.0	37.4	38.0
BMA	BALLYMENA MESH (RURAL)	0.97	44.6	45.2	45.9	33.0	33.7	34.3	35.1
BMA	BALLYMENA SWBD (TOWN)	0.97	41.9	42.4	43.1	43.8	44.5	45.1	45.8
BNH	BALLYNAHINCH MAIN	0.97	49.9	50.5	51.3	52.0	52.8	53.4	54.1
BNM	BELFAST - BELFAST NORTH MAIN	0.97	-	-	-	46.3	46.9	47.4	48.1
CAR	BELFAST - CARNMONEY MAIN	0.97	35.7	36.1	36.7	37.3	37.8	38.3	38.9
CEN	BELFAST - BELFAST CENTRAL MAIN	0.97	52.5	53.2	54.2	55.2	56.2	57.0	58.1
COL - NI	COLERAINE MAIN	0.97	35.5	36.0	36.5	37.1	37.6	38.1	38.6
CPS	COOLKEERAGH MAIN	0.97	28.1	28.4	28.9	29.4	29.9	30.3	30.8
CRE	BELFAST - CREGAGH MAIN	0.97	55.6	56.3	57.1	58.0	58.8	48.8	49.7
CRG	CREAGH MAIN	0.97	21.9	22.2	22.5	35.6	35.9	36.1	36.4
DON	BELFAST - DONEGALL MAIN (NORTH)	0.97	51.1	51.7	52.5	53.3	54.1	54.7	55.5
DON	BELFAST - DONEGALL MAIN (SOUTH)	0.97	47.2	47.7	48.4	49.1	49.8	50.4	51.1
DRU	DRUMNAKELLY MAIN	0.97	80.4	81.5	83.0	84.5	86.0	87.2	88.7
DUN	DUNGANNON MAIN	0.97	71.0	71.9	73.1	74.4	75.6	76.6	77.9
EDE	EDEN MAIN	0.97	28.3	28.6	29.0	29.5	29.9	30.2	30.6
ENN - NI	ENNISKILLEN MAIN	0.97	46.3	46.9	47.6	48.4	49.1	49.7	50.5
FIN - NI	BELFAST - FINAGHY MAIN	0.97	30.7	31.1	31.6	32.1	32.6	33.0	33.5
GLE - NI	BELFAST - GLENGORMLEY MAIN	0.97	16.3	16.5	16.8	17.0	17.3	17.5	17.8
KNO	BELFAST - KNOCK MAIN	0.97	56.3	57.0	57.8	58.6	59.5	52.2	53.0
LAR	LARNE MAIN	0.97	37.4	37.9	38.5	39.1	39.7	40.1	40.7
LIM - NI	LIMAVADY MAIN	0.97	19.7	20.0	20.3	20.6	20.9	21.1	21.4
LIS - NI	LISBURN MAIN	0.97	55.0	55.6	56.5	57.4	58.3	59.0	60.0
LMR	LISAGHMORE MAIN	0.97	41.1	41.6	42.2	42.9	43.5	44.0	44.7
LOG	LOGUESTOWN MAIN	0.97	35.6	36.0	36.5	37.1	37.6	38.0	38.5
NAR	NEWTOWNARDS MAIN	0.97	37.1	37.6	38.1	38.7	39.2	39.7	40.2
NEW - NI	NEWRY MAIN	0.97	66.7	67.5	68.6	69.7	70.8	71.6	72.7
OMA	OMAGH MAIN	0.97	46.3	46.8	47.5	48.2	48.8	49.3	50.0

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

Bus Code	Bus Name	Power Factor	Demand Forecast (MW)						
			2012	2013	2014	2015	2016	2017	2018
PSW	BELFAST - PSW	0.97	44.4	44.9	45.6	-	-	-	-
RAT - NI	RATHGAEL MAIN	0.97	55.1	55.8	56.6	57.4	58.2	58.8	59.6
ROS	ROSEBANK MAIN	0.97	34.5	34.8	35.2	35.6	36.0	28.1	28.5
SPR	SPRINGTOWN MAIN	0.97	27.8	28.2	28.6	29.1	29.6	30.0	30.5
STR - NI	STRABANE MAIN	0.97	28.5	28.9	29.3	29.7	30.2	30.5	31.0
WAR	WARINGSTOWN MAIN	0.97	56.4	57.0	57.7	58.5	59.2	59.7	60.5
Total			1463	1481	1503	1526	1549	1572	1596

D Generation Capacity and Dispatch Details

- D.1 Generation Connected to the Transmission System
- D.2 Generation Connected to the Distribution System
- D.3 Generation Dispatch Details



APPENDIX D GENERATION CAPACITY AND DISPATCH DETAILS

D.1 GENERATION CONNECTED TO THE TRANSMISSION SYSTEM

Table D-1 lists existing and committed future generation and the contracted maximum export capacity (MEC) of each unit. Table D-2 presents the maximum continuous rating (MCR) of each unit at year end for each year up to 2018. All generation capacity figures in Table D-1 and Table D-2 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-1 Maximum Export Capacities of Existing and Committed Transmission-Connected Generation

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)
Dublin	Dublin Bay Power	DB1	Irishtown	220 kV	Gas/DO	415
	EWIC	EW1	Woodland	400 kV	N/A	500
	Huntstown	HNC	Huntstown	220 kV	Gas/DO	352
	Huntstown	HN2	Corduff	220 kV	Gas/DO	412
	Mountlucas	-	Mountlucas	110 kV	Wind	79.2
	North Wall	NW4	North Wall	220 kV	Gas/DO	163
	North Wall	NW5	North Wall	220 kV	Gas/DO	109
	Poolbeg	PB1	Poolbeg	220 kV	Gas/HFO	109.5
	Poolbeg	PB2	Poolbeg	220 kV	Gas/HFO	109.5
	Poolbeg	PBC	Shellybanks	220 kV	Gas/DO	460
	Turlough Hill	TH1	Turlough Hill	220 kV	Hydro	73
	Turlough Hill	TH2	Turlough Hill	220 kV	Hydro	73
	Turlough Hill	TH3	Turlough Hill	220 kV	Hydro	73
	Turlough Hill	TH4	Turlough Hill	220 kV	Hydro	73
Dublin Area Total						3001.2
South-West	Aghada	AD1	Aghada	220 kV	Gas	258
	Aghada	AT1	Aghada	220 kV	Gas/DO	90
	Aghada	AT2	Aghada	220 kV	Gas/DO	90
	Aghada	AT4	Aghada	220 kV	Gas/DO	90
	Aghada CCGT	ADC	Longpoint	220 kV	Gas/DO	431
	Athea	-	Athea	110 kV	Wind	51
	Athea Extension	-	Athea	110 kV	Wind	22
	Aughinish	SK3	Sealrock	110 kV	Gas/DO	65
	Aughinish	SK4	Sealrock	110 kV	Gas/DO	65
	Boggeragh	-	Boggeragh	110 kV	Wind	57
	Clahane	-	Clahane	110 kV	Wind	37.8
	Cloghboola	-	Knocknagashel	110 kV	Wind	46
	Coomacheo	-	Garrow	110 kV	Wind	41.2
	Coomacheo Extension	-	Garrow	110 kV	Wind	18
	Coomagearlahy	-	Coomagearlahy	110 kV	Wind	42.5
	Coomagearlahy Extension	-	Coomagearlahy	110 kV	Wind	38.5
	Dromada	-	Dromada	110 kV	Wind	46
	Glanlee	-	Glanlee	110 kV	Wind	29.8
	Glanlee Extension	-	Glanlee	110 kV	Wind	6
	Knockacummer	-	Knockacummer	110 kV	Wind	87
	Knocknagreenan		Carrigadrohid	110 kV	Hydro	70
	Lee Hydro	LE1	Inniscarra	110 kV	Hydro	15
	Lee Hydro	LE2	Inniscarra	111 kV	Hydro	4
	Lee Hydro	LE3	Carrigadrohid	110 kV	Hydro	8
	Marina	MRT	Marina	110 kV	Gas	85
	Moneypoint	MP2	Moneypoint	380 kV	Coal/HFO	287.5

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

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)
South-West (Cont.)	Moneypoint	-	Moneypoint	110 kV	Wind	21.9
	Suir	SUR	Cahir	110 kV	Gas	98
	Tarbert	TB1	Tarbert	110 kV	HFO	54
	Tarbert	TB2	Tarbert	110 kV	HFO	54
	Tarbert	TB3	Tarbert	220 kV	HFO	240.7
	Tarbert	TB4	Tarbert	220 kV	HFO	240.7
	Whitegate CCGT	WG	Glanagow	220 kV	Gas/DO	445
South-West Area Total						3235.6
Mid-West	Ardnacrusha	AA1,2,3,4	Ardnacrusha	110 kV	Hydro	86
	Booltiagh	-	Booltiagh	110 kV	Wind	19.5
	Booltiagh Extension	-	Booltiagh	110 kV	Wind	12
	Derrybrien	DBW	Derrybrien	110 kV	Wind	59.5
	Keelderry	-	Knockavanna	110 kV	Wind	29.8
	Moneypoint	MP1	Moneypoint	400 kV	Coal/HFO	287.5
	Moneypoint	MP3	Moneypoint	400 kV	Coal/HFO	287.5
	Tynagh	TY	Tynagh	220 kV	Gas/DO	404
Mid-West Area Total						1185.8
South-East	Ballywater	BWW	Ballywater	110 kV	Wind	42
	Castledockrill	-	Castledockrill	110 kV	Wind	41.4
	Great Island	GI1	Great Island	110 kV	HFO	54
	Great Island	GI2	Great Island	110 kV	HFO	54
	Great Island	GI3	Great Island	220 kV	HFO	108
	Liffey	LI1	Pollaphuca	110 kV	Hydro	15
	Liffey	LI2	Pollaphuca	110 kV	Hydro	15
	Liffey	LI4	Pollaphuca	110 kV	Hydro	4
	Nore Power	NO1	Nore	110 kV	Gas/DO	98
South-East Area Total						431.4
Midlands	Cuilleen	-	Athlone	110 kV	Gas/DO	98.4
	Edenderry Power	ED1	Cushaling	110 kV	Peat	121.5
	Edenderry PCP	ED3	Cushaling	110 kV	DO	58
	Edenderry PCP	ED5	Cushaling	110 kV	DO	58
	Kill Hill	-	Kill Hill	110 kV	Wind	62.5
	Lisheen	-	Lisheen	110 kV	Wind	55
	Rhode PCP	RP1	Derryiron	110 kV	DO	51.8
	Rhode PCP	RP2	Derryiron	110 kV	DO	51.8
	West Offaly Power	WO4	Shannonbridge	110 kV	Peat	141
Midlands Area Total						698
North-West	Erne	ER3	Cathaleen's Fall	110 kV	Hydro	22.5
	Erne	ER4	Cathaleen's Fall	110 kV	Hydro	22.5
	Erne	ER1	Cliff	110 kV	Hydro	10
	Erne	ER2	Cliff	110 kV	Hydro	10

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

Area	Generation Station	Unit ID	Connected At		Fuel Type	Maximum Export Capacity (MW)
North-West (Cont.)	Golagh	GOL	Golagh	110 kV	Wind	15
	Garvagh	-	Garvagh	110 kV	Wind	58.2
	Kingsmountain	-	Cunghill	110 kV	Wind	34.8
	Lough Ree Power	LR4	Lanesboro	110 kV	Peat	94
	Meentycat	-	Meentycat	110 kV	Wind	85
	Mulreavy	-	Mulreavy	110 kV	Wind	82
North-West Area Total						434
North-East	Ballakelly	BY	Ballakelly	220 kV	Gas/DO	445
	Bindoo	-	Ratrussan	110 kV	Wind	70
	Caulstown	-	Platin	110 kV	Gas/DO	58
	Mountain Lodge	-	Ratrussan	110 kV	Wind	30.6
North-East Area Total						603.6
Northern Ireland	Ballylumford CCGT 10	B10	Ballylumford	110 kV	Gas/Gasoil	100
	Ballylumford CCGT 20	B20	Ballylumford	275 kV	Steam	180
	Ballylumford CCGT 21	B21	Ballylumford	275 kV	Gas/Gasoil	160
	Ballylumford CCGT 22	B22	Ballylumford	275 kV	Gas/Gasoil	160
	Ballylumford GT 7	BGT1	Ballylumford	110 kV	Gasoil	58
	Ballylumford GT 8	BGT2	Ballylumford	110 kV	Gasoil	58
	Ballylumford ST4	B4	Ballylumford	275 kV	Gas/HFO	180
	Ballylumford ST5	B5	Ballylumford	275 kV	Gas/HFO	180
	Ballylumford ST6	B6	Ballylumford	275 kV	Gas/HFO	180
	Coolkeeragh CCGT	C30	Coolkeeragh	275 & 110 kV	Gas/Gasoil	430
	Coolkeeragh GT 8	CGT8	Coolkeeragh	275 kV	Gasoil	53
	Kilroot GT 1	KGT1	Kilroot	275 kV	Gasoil	29
	Kilroot GT 2	KGT2	Kilroot	275 kV	Gasoil	29
	Kilroot GT 3	KGT3	Kilroot	275 kV	Gasoil	42
	Kilroot GT 4	KGT4	Kilroot	275 kV	Gasoil	42
	Kilroot ST 1	K1	Kilroot	275 kV	Coal/Oil	260
	Kilroot ST 2	K2	Kilroot	275 kV	Coal/Oil	260
	Moyle	-	Ballycronan More	275 kV	N/A	450
	Slieve Kirk	SLK	Killyamallaght	110 kV	Wind	27.6
Northern Ireland Total						2878.6

Where dual fuel capability exists, the fuel type highlighted in **red** is utilised to meet peak demand.

Table D-2 Maximum Continuous Rating of Existing and Committed Transmission-Connected Generation

Area	Generation Station	Unit ID	Maximum Continuous Rating (Exported MW)						
			2012	2013	2014	2015	2016	2017	2018
	Dublin Bay Power	DB1	403	403	403	403	403	403	403
	EWIC	EW1	500	500	500	500	500	500	500
	Huntstown	HNC	343	343	343	343	343	343	343
	Huntstown	HN2	400	400	400	400	400	400	400
	Mountlucas	-	-	79.2	79.2	79.2	79.2	79.2	79.2
	North Wall	NW4	163	163	163	163	163	163	163
	North Wall	NW5	109	109	109	109	109	109	109
	Poolbeg	PBC	460	460	460	460	460	460	460
	Turlough Hill	TH1	73	73	73	73	73	73	73
	Turlough Hill	TH2	73	73	73	73	73	73	73
	Turlough Hill	TH3	73	73	73	73	73	73	73
	Turlough Hill	TH4	73	73	73	73	73	73	73
Dublin Area Total			2670	2749.2	2749.2	2749.2	2749.2	2749.2	2749.2
South-West	Aghada	AD1	258	258	258	258	258	258	258
	Aghada	AT1	90	90	90	90	90	90	90
	Aghada	AT2	90	90	90	90	90	90	90
	Aghada	AT4	90	90	90	90	90	90	90
	Aghada CCGT	ADC	431	431	431	431	431	431	431
	Athea	-	38	48	51	51	51	51	51
	Athea Extension	-			22	22	22	22	22
	Aughinish	SK3	80.4	80.4	80.4	80.4	80.4	80.4	80.4
	Aughinish	SK4	80.4	80.4	80.4	80.4	80.4	80.4	80.4
	Boggeragh	-	57	57	57	57	57	57	57
	Clahane	-	37.8	37.8	37.8	37.8	37.8	37.8	37.8
	Cloghboola	-	-	-	46	46	46	46	46
	Coomacheo	-	41.2	41.2	41.2	41.2	41.2	41.2	41.2
	Coomacheo Extension	-	18	18	18	18	18	18	18
	Coomagearlahy	-	42.5	42.5	42.5	42.5	42.5	42.5	42.5
	Coomagearlahy Extension	-	38.5	38.5	38.5	38.5	38.5	38.5	38.5
	Dromada	-	46	46	46	46	46	46	46
	Glanlee	-	29.8	29.8	29.8	29.8	29.8	29.8	29.8
	Glanlee Extension	-	6	6	6	6	6	6	6
	Knockacummer	-	87	87	87	87	87	87	87
	Knocknagreenan	-	-	-	-	70	70	70	70
	Lee Hydro	LE1	15	15	15	15	15	15	15
	Lee Hydro	LE2	4	4	4	4	4	4	4
	Lee Hydro	LE3	8	8	8	8	8	8	8
	Marina	MRT	85	85	85	85	85	85	85
	Moneypoint	MP2	281.5	281.5	281.5	281.5	281.5	281.5	281.5
	Moneypoint	-	21.9	21.9	21.9	21.9	21.9	21.9	21.9
	Suir OCGT	-	98	98	98	98	98	98	98
	Tarbert	TB1	54	54	54	54	54	54	54
	Tarbert	TB2	54	54	54	54	54	54	54
	Tarbert	TB3	240.7	240.7	240.7	240.7	240.7	240.7	240.7
	Tarbert	TB4	240.7	240.7	240.7	240.7	240.7	240.7	240.7
	Whitegen CCGT	WG	440.6	440.6	440.6	440.6	440.6	440.6	440.6
South-West Area Total			3105	3115	3186	3256	3256	3256	3256

Table D-2 Maximum Continuous Rating of Existing and Committed Transmission-Connected Generation

Area	Generation Station	Unit ID	Maximum Continuous Rating (Exported MW)						
			2012	2013	2014	2015	2016	2017	2018
Mid-West	Ardnacrusa	AA1,2,3,4	86	86	86	86	86	86	86
	Booltiagh	-	19.5	19.5	19.5	19.5	19.5	19.5	19.5
	Booltiagh Extension	-	12	12	12	12	12	12	12
	Derrybrien	-	59.5	59.5	59.5	59.5	59.5	59.5	59.5
	Keelderry	-	-	29.8	29.8	29.8	29.8	29.8	29.8
	Moneypoint	MP1	281.5	281.5	281.5	281.5	281.5	281.5	281.5
	Moneypoint	MP3	281.5	281.5	281.5	281.5	281.5	281.5	281.5
	Tynagh	TY	382	382	382	382	382	382	382
Mid-West Area Total			1122	1151.8	1151.8	1151.8	1151.8	1151.8	1151.8
South-East	Ballywater	BWW	42	42	42	42	42	42	42
	Castledockrill	-	41.4	41.4	41.4	41.4	41.4	41.4	41.4
	Great Island	GI1	54	54	54	54	54	54	54
	Great Island	GI2	54	54	54	54	54	54	54
	Great Island	GI3	108	108	108	108	108	108	108
	Liffey Hydro	LI1	15	15	15	15	15	15	15
	Liffey Hydro	LI2	15	15	15	15	15	15	15
	Liffey Hydro	LI4	4	4	4	4	4	4	4
	Nore Power	NO1	98	98	98	98	98	98	98
South-East Area Total			431.4	431.4	431.4	431.4	431.4	431.4	431.4
North-East	Ballakelly	BY	-	445	445	445	445	445	445
	Bindoo	-	70	70	70	70	70	70	70
	Caulstown OCGT	-	-	-	58	58	58	58	58
	Mountain Lodge	MLW	30.6	30.6	30.6	30.6	30.6	30.6	30.6
North-East Area Total			100.6	545.6	603.6	603.6	603.6	603.6	603.6
Midlands	Cuilleen OCGT		98.4	98.4	98.4	98.4	98.4	98.4	98.4
	Edenderry Power	ED1	118.3	118.3	118.3	118.3	118.3	118.3	118.3
	Edenderry PCP	ED3	58	58	58	58	58	58	58
	Edenderry PCP	ED5	58	58	58	58	58	58	58
	Kill Hill	-	-	62.5	62.5	62.5	62.5	62.5	62.5
	Lisheen	-	55	55	55	55	55	55	55
	Rhode PCP	RP1	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	Rhode PCP	RP2	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	West Offaly Power	WO4	137	137	137	137	137	137	137
Midlands Area Total			628.3	690.8	690.8	690.8	690.8	690.8	690.8
North-West	Erne	ER3	22.5	22.5	22.5	22.5	22.5	22.5	22.5
	Erne	ER4	22.5	22.5	22.5	22.5	22.5	22.5	22.5
	Erne	ER1	10	10	10	10	10	10	10
	Erne	ER2	10	10	10	10	10	10	10
	Golagh	-	15	15	15	15	15	15	15
	Garvagh	-	58.2	58.2	58.2	58.2	58.2	58.2	58.2
	Kingsmountain	-	34.8	34.8	34.8	34.8	34.8	34.8	34.8
	Lough Ree Power	LR4	91	91	91	91	91	91	91
	Meentycat	-	85	85	85	85	85	85	85
	Mulreavy	-	-	82	82	82	82	82	82
North-West Area Total			349	431	431	431	431	431	431

Table D-2 Maximum Continuous Rating of Existing and Committed Transmission-Connected Generation

Area	Generation Station	Unit ID	Maximum Continuous Rating (Exported MW)						
			2012	2013	2014	2015	2016	2017	2018
Northern Ireland	Ballylumford CCGT 10	B10	100	100	100	100	100	100	100
	Ballylumford CCGT 20	B20	180	180	180	180	180	180	180
	Ballylumford CCGT 21	B21	160	160	160	160	160	160	160
	Ballylumford CCGT 22	B22	160	160	160	160	160	160	160
	Ballylumford GT 7	BGT1	58	58	58	58	58	58	58
	Ballylumford GT 8	BGT2	58	58	58	58	58	58	58
	Ballylumford ST 4	B4	180	180	180	180	-	-	-
	Ballylumford ST 5	B5	180	180	180	180	-	-	-
	Ballylumford ST 6	B6	180	180	180	180	-	-	-
	Coolkeeragh CCGT	C30	430	430	430	430	430	430	430
	Coolkeeragh GT 8	CGT8	53	53	53	53	53	53	53
	Kilroot GT 1	KGT1	29	29	29	29	29	29	29
	Kilroot GT 2	KGT2	29	29	29	29	29	29	29
	Kilroot GT 3	KGT3	42	42	42	42	42	42	42
	Kilroot GT 4	KGT4	42	42	42	42	42	42	42
	Kilroot ST 1	K1	260	260	260	260	260	260	260
	Kilroot ST 2	K2	260	260	260	260	260	260	260
	Moyle		450	450	450	450	450	450	450
	Slieve Kirk	SLK	27.6	27.6	27.6	27.6	27.6	27.6	27.6
Northern Ireland Total			2878.6	2878.6	2878.6	2878.6	2338.6	2338.6	2338.6

D.2 GENERATION CONNECTED TO THE DISTRIBUTION SYSTEM

Table D-3 lists the total capacity of wind generation that currently feeds into each 110 kV transmission station, from the distribution system. Table D-3 also shows the capacity of future wind generation up to 2018, based on the wind farms that currently have signed connection agreements with the DSO (as at the beginning of July 2011).

Table D-3 Existing and Committed Distribution-Connected Wind Farm Capacity

Area	110 kV Station	Wind Farm Capacity (MW)							
		2011	2012	2013	2014	2015	2016	2017	2018
South-West	Athea	-	7.6	7.6	7.6	7.6	7.6	7.6	7.6
	Ballylickey	38.45	38.45	38.45	61.45	61.45	61.45	61.45	61.45
	Bandon	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	Boggeragh	20	43.95	43.95	43.95	43.95	43.95	43.95	43.95
	Cordal	-	11.5	11.5	107.8	107.8	107.8	107.8	107.8
	Dunmanway	25.26	45.31	45.31	45.31	45.31	45.31	45.31	45.31
	Garrow	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99
	Glenlara	53	53	59	59	59	59	59	59

Table D-3 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV Station	Wind Farm Capacity (MW)							
		2011	2012	2013	2014	2015	2016	2017	2018
South-West (Cont.)	Kerry	-	41.3	41.3	41.3	41.3	41.3	41.3	41.3
	Kilbarry	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	Knockearagh	13.85	13.85	13.85	13.85	13.85	13.85	13.85	13.85
	Knocknagashel	2.55	32.55	32.55	32.55	32.55	32.55	32.55	32.55
	Macroom	24	32.75	32.75	32.75	32.75	32.75	32.75	32.75
	Midleton	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Rathkeale	32.49	32.49	32.49	32.49	32.49	32.49	32.49	32.49
	Oughtragh	-	9	9	9	9	9	9	9
	Tralee	62.86	64.56	64.56	64.56	64.56	64.56	64.56	64.56
	Trien	52.7	52.7	52.7	52.7	52.7	52.7	52.7	52.7
South-West Area Total		347.2	501.1	507.1	626.4	626.4	626.4	626.4	626.4
Mid-West	Ardnacruscha	8.35	8.35	8.35	8.35	8.35	8.35	8.35	8.35
	Ennis	-	-	-	-	-	24	24	24
	Galway	4.62	4.62	4.62	4.62	4.62	4.62	4.62	4.62
	Nenagh	8.89	8.89	8.89	9.74	9.74	9.74	9.74	12.29
	Somerset	7.65	7.65	7.65	7.65	7.65	7.65	7.65	7.65
	Tullabrack	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Mid-West Area Total		42.1	42.1	42.1	43.0	43.0	67.0	67.0	69.5
South-East	Arklow	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
	Butlerstown	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Carlow	34.87	34.87	34.87	34.87	34.87	34.87	34.87	34.87
	Crane	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
	Crory	8	8	8	8	8	8	8	8
	Lodgewood	49.35	49.35	49.35	49.35	49.35	49.35	49.35	49.35
	Waterford	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25
	Wexford	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9
South-East Area Total		175.7	175.7	175.7	175.7	175.7	175.7	175.7	175.7
Midlands	Cauteen	86	95	95	95	95	95	95	95
	Dallow	6.8	6.8	11.05	11.05	11.05	11.05	11.05	11.05
	Ikerrin	5.1	5.1	5.1	7.65	7.65	7.65	7.65	7.65
	Lanesboro	3	3	3	3	3	3	3	3
	Tipperary	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Midlands Area Total		105.5	114.5	118.8	121.3	121.3	121.3	121.3	121.3
North-West	Arigna	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6
	Bellacorrick	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45
	Binbane	40.31	46.31	46.31	46.31	46.31	46.31	46.31	46.31
	Castlebar	43.64	43.64	43.64	43.64	43.64	43.64	43.64	43.64
	Cath_Fall	5.4	5.4	5.4	5.4	5.4	5.4	5.4	9.7
	Cloon	-	4.25	4.25	4.25	4.25	4.25	4.25	4.25
	Corderry	41.04	41.04	41.04	41.04	41.04	41.04	41.04	41.04
	Dalton	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55

Table D-3 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV Station	Wind Farm Capacity (MW)							
		2011	2012	2013	2014	2015	2016	2017	2018
North-West (Cont.)	Glenree	34.15	34.15	34.15	34.15	34.15	34.15	34.15	62.15
	Gortawee	3	3	3	3	3	3	3	3
	Letterkenny	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76
	Moy	6	6	6	6	6	6	6	6
	Sorne Hill	61.15	61.15	61.15	61.15	61.15	61.15	61.15	61.15
	Tonroe	5.94	5.94	9.54	9.54	9.54	9.54	9.54	9.54
	Trillick	33.79	33.79	33.79	33.79	33.79	33.79	33.79	33.79
North-West Area Total		339.8	350.0	353.6	353.6	353.6	353.6	353.6	385.9
North-East	Drybridge	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
	Dundalk	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Meath Hill	22.51	22.51	22.51	22.51	22.51	22.51	22.51	22.51
	Navan	-	-	-	-	-	-	-	4.99
	Shankill	3	3	3	3	3	3	3	3
North-East Area Total		30.2	30.2	30.2	30.2	30.2	30.2	30.2	35.2
Dublin	Glasmore	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Griffinrath	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	Grange	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Dublin Area Total		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Northern Ireland	Aghyoule	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5
	Altahullion Cluster	-	-	-	-	30	30	30	30
	Antrim	-	-	-	-	-	7	7	7
	Ballymena (Rural)	5	5	11	11	11	11	11	11
	Cam	-	-	-	-	63	63	63	63
	Carnmoney	-	-	13.8	13.8	13.8	13.8	13.8	13.8
	Coleraine	45	45	45	45	45	45	45	57
	Coolkeeragh	-	-	15	15	15	15	15	15
	Drumquin	-	-	-	-	4.6	86.3	86.3	101.3
	Dungannon	15	17.5	17.5	17.5	17.5	17.5	17.5	17.5
	Enniskillen	16.9	16.9	34.4	34.4	34.4	34.4	34.4	34.4
	Fallaghearn	-	-	-	-	57.5	57.5	57.5	57.5
	Killymallaght	-	22.5	22.5	22.5	22.5	37.5	37.5	37.5
	Larne	15	15	15	15	25	25	25	25
	Limavady	37.7	37.7	37.7	37.7	37.7	37.7	82.7	103.7
	Lisaghmore	15	15	15	15	15	15	15	15
	Magherakeel	-	60.6	116.1	116.1	116.1	134.1	134.1	146.1
	Newry	-	-	-	12.5	12.5	12.5	12.5	12.5
	Mid Antrim	-	-	-	-	37.5	37.5	37.5	37.5
	Omagh	125.7	125.7	125.7	125.7	95.7	95.7	95.7	95.7
	Pomeroy	-	-	-	59.5	59.5	59.5	65.5	65.5
	Strabane	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
	Slieve Kirk	-	20	20	20	20	20	20	20

Table D-3 Existing and Committed Distribution-Connected Wind Farm Capacity (continued)

Area	110 kV Station	Wind Farm Capacity (MW)							
		2011	2012	2013	2014	2015	2016	2017	2018
Northern Ireland Total		370.2	475.8	583.6	655.6	828.2	949.9	1000.9	1060.9
All-island Total		1,412	1,690	1,812	2,007	2,179	2,325	2,376	2,476

Table D-4 lists the existing and committed future distribution generation and their respective MW capacity over the period of the statement, in Ireland.

Table D-4 Existing and Committed Distribution-Connected Conventional Generation

Area	110 kV Station	Wind Farm Capacity (MW)							
		2010	2011	2012	2013	2014	2015	2016	2017
North-West	Tawnaghmore	104	104	104	104	104	104	104	104
North-West Area Total		104	104	104	104	104	104	104	104
North-East	Drybridge	-	17	17	17	17	17	17	17
North-East Area Total		-	17	17	17	17	17	17	17
Dublin	Ringsend	-	-	-	72	72	72	72	72
Dublin Area Total		-	-	-	72	72	72	72	72
Totals		104	121	121	193	193	193	193	193

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.

Since July 2011, the following generators have committed to connecting to the transmission system by executing connection agreements with EirGrid:

- Great Island CCGT 431 MW, in Co. Wexford
- Clahane (2) Wind Farm 13.8 MW, in Co. Kerry
- Oweninney (1) Wind Farm 34 MW, in Co. Mayo
- Oweninney (2) Wind Farm 48 MW, in Co. Mayo
- Oweninney (3) Wind Farm 56 MW, in Co. Mayo
- Oweninney (4) Wind Farm 34 MW, in Co. Mayo
- Seecon (1) Wind Farm 105 MW, in Co. Galway
- Ugool (1) Wind Farm 64 MW, in Co. Galway



D.3 GENERATION DISPATCH DETAILS

Table D-5 through to Table D-7 list generation dispatch profiles used for the purposes of the short circuit current level analyses and capability analyses. 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-5 and Table D-6. 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-5 Dispatch Profiles - Short Circuit and Demand Opportunity Analyses

Area	Generation Station	Unit ID	2012			2015			2018		
			SV	SP	WP	SV	SP	WP	SV	SP	WP
Dublin	Dublin Bay Power	DB1	163	400	400	163	390	400	163	390	400
	EWIC	-	0	0	191	118	0	191	118	0	191
	Huntstown	HN1	0	330	330	138	340	300	138	330	300
	Huntstown	HN2	280	350	390	0	380	390	0	300	400
	North Wall	NW4	0	0	0	0	0	0	0	0	100
	North Wall	NW5	0	0	0	0	0	0	0	0	30
	Poolbeg	PBC	0	0	470	0	0	410	0	0	440
	Turlough Hill	TH1,2,3,4	-280	34	180	-280	26	187	-280	-214	208
	Installed Wind		<1	<1	<1	<1	<1	<1	<1	<1	<1
	Embedded Hydro	-									
Dublin Area Total			163	1114	1961	139	1136	1878	139	806	2069
South-West	Aghada	AD1	0	0	150	0	0	250	0	0	250
	Aghada	AD1	0	0	0	0	0	0	0	0	0
	Aghada	AT1	0	0	0	0	0	0	0	0	0
	Aghada	AT2	0	0	0	0	0	0	0	0	0
	Aghada	AT4	0	0	0	0	0	0	0	0	0
	Aghada CCGT	ADC	0	360	350	0	380	420	0	300	421
	Aughinish	SK3	40	76	83	40	76	81	40	75	81
	Aughinish	SK4	40	76	83	40	76	81	40	75	81
	Knocknagreenan	-	0	0	0	0	0	0	0	0	0
	Lee Hydro	LE1,2	0	0	19	0	0	19	0	0	19
	Lee Hydro	LE3	0	0	8	0	0	8	0	0	8
	Moneypoint	MP2	196	290	300	172	300	295	178	290	293
	Suir OCGT		0	0	0	0	0	0	0	0	0
	Tarbert	TB1	0	0	0	0	0	0	0	0	0
	Tarbert	TB2	0	0	0	0	0	0	0	0	0
	Tarbert	TB3	0	0	0	0	0	0	0	250	256
	Tarbert	TB4	0	0	0	0	0	0	0	100	256
	Whitegate CCGT	WG	110	400	410	111	400	440	111	400	440
	Installed Wind	-	289	96	96	351	117	117	351	117	117
South-West Area Total			675	1298	1499	714	1349	1711	720	1607	2222
Mid-West	Ardnacrusha	AA1,2,3,4	0	0	86	0	0	86	0	0	86
	Booltiagh	-	0	0	0	0	0	0	0	0	0
	Moneypoint	MP1	0	290	300	0	300	295	0	290	293
	Moneypoint	MP3	0	290	300	0	300	295	0	290	293
	Tynagh	TY	0	387	340	0	360	360	0	360	360
	Installed Wind	-	34	11	11	43	14	14	50	17	17
Mid-West Area Total			34	978	1037	43	974	1050	50	957	1049
South-East	Great Island	GI1	0	0	0	0	0	0	0	0	0
	Great Island	GI2	0	0	0	0	0	0	0	0	0
	Great Island	GI3	0	0	0	0	0	0	0	0	0
	Liffey Hydro	LI1,2,4	0	0	14	0	0	14	0	0	14
	Nore Power	NO1	0	0	0	0	0	0	0	0	0
	Installed Wind	-	78	26	26	78	26	26	78	26	26
South-East Area Total			78	26	40	78	26	40	78	26	40

Table D-5 Dispatch Profiles - Short Circuit and Demand Opportunity Analyses (continued)

Area	Generation Station	Unit ID	2012			2015			2018		
			SV	SP	WP	SV	SP	WP	SV	SP	WP
Midlands	Cuilleen	CUI	0	0	0	0	0	0	0	0	0
	Edenderry Power	ED1	100	130	130	60	130	130	60	130	130
	Edenderry PCP	ED3, ED5	0	0	0	0	0	0	0	0	0
	Rhode PCP	RP1, RP2	0	0	0	0	0	0	0	0	0
	West Offaly Power	WO4	120	150	150	120	150	150	120	150	150
	Installed Wind	-	52	17	17	97	32	32	97	33	33
Midlands Area Total			272	297	297	277	312	312	277	313	313
North-West	Erne	ER3,4	0	0	45	0	0	45	0	0	45
	Erne	ER1,2	0	0	20	0	0	20	0	0	20
	Lough Ree Power	LR4	70	100	100	55	100	100	70	100	100
	Installed Wind	-	158	56	56	194	65	65	203	68	68
North-West Area Total			228	156	221	249	165	230	273	168	233
North-East	Ballakelly	BY	0	0	0	0	0	0	0	0	0
	Caulstown OCGT	CA	0	0	0	0	0	0	0	0	0
	Installed Wind	-	39	13	13	39	13	13	41	14	14
North-East Area Total			39	13	13	39	13	13	41	14	14

Table D-6 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-7 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-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 Nature of Short Circuit Currents
- E.3 Duty on 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.
- 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.

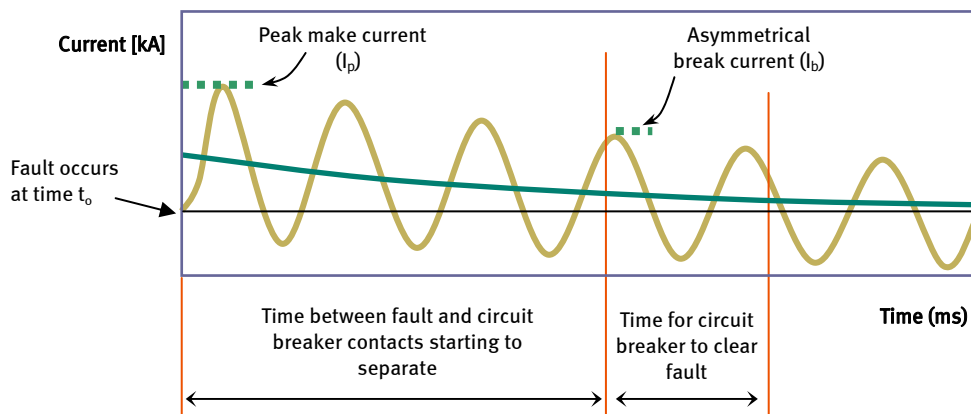


Figure E-1 Typical Short Circuit Current

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 subtransient 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 (I_p) 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, I_b . 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 section¹²). 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 asynchronous 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 (i_p)**

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 (I_B)**

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 2012/13

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	21.27	54.97	18.74	25.07	25	64.98	23.24	30.99
Castlereagh	31.5	79	35.65	16.64	41.19	14.73	16.68	17.17	42.55	16.07	18.30
Coolkeeragh	31.5	79	35.3	12.23	29.3	11.23	12.41	12.55	30.84	12.03	13.77
Hannahstown	31.5	79	35.65	16.7	41.52	14.81	16.98	17.22	42.75	16.12	18.60
Kells	31.5	79	35.65	18.7	47.23	16.64	19.79	19.27	48.05	18.15	20.79
Kilroot	31.5	79	45.3	18.24	46.51	16.23	20.11	21.74	55.99	20.35	25.76
Magherafelt	31.5	79	35.65	18.21	45.62	16.3	18.64	15.64	37.73	14.98	15.72
Moyle	31.5	79	35.65	20.72	53.43	18.3	24.12	24.07	62.3	22.43	29.18
Tandragee	26.5	66.3	35.65	18.8	46.47	16.73	18.66	16.9	41.66	16.82	18.89
Tamnamore	31.5	79	57.3	14.6	36.17	13.31	14.62	12.34	29.97	12.02	12.81
110kV											
Aghyoule	25.0	62.5		3.95	8.24	3.71	3.81	4.00	8.87	3.84	4.09
Antrim	18.4	46.8		9.71	20.53	9.27	9.37	9.65	20.76	9.40	9.71
Ballylumford*	21.9	55	25.88	23.84	59.52	21.85	28.67				
	26.2	65.0	29.7					27.99	70.83	26.61	35.26
Ballymena	18.4	46.8		9.43	20.17	8.95	9.10	9.69	21.43	9.39	9.88
Banbridge	18.4	46.8		6.79	14.07	6.53	6.57	6.66	14.61	6.51	6.74
Ballyvally	18.4	46.8	23	16.33	35.29	15.24	15.29	14.78	31.74	14.29	14.36
Ballynahinch	18.4	46.8		5.95	12.4	5.67	5.72	5.90	12.89	5.73	5.95
Carnmoney	26.2	65	44.9	9.17	19.35	8.74	8.82	8.83	19.27	8.60	8.90
Castlereagh	26.2	65	33.5	20.88	51.47	18.55	22.49	26.39	65.62	24.12	29.31
Belfast Central	31.5	79		16.25	38.38	14.77	15.79	19.12	41.46	17.85	19.13
Coleraine	31.5	79	42.5	8.06	16.47	7.46	7.46	9.22	19.61	8.72	8.75
Coolkeeragh	31.5	80	33.5	22.27	54.22	19.94	23.72	27.55	67.83	25.66	30.83
Creagh	31.5	80	33.5	8.02	15.98	7.69	7.69	8.38	17.67	8.16	8.20
Cregagh	26.2	65		18.50	44.39	16.61	18.41	22.43	51.71	20.73	22.65
Donegall north	31.5	79	33.5	18.14	43.11	16.60	18.00	21.69	47.86	20.37	21.22
Donegall south				13.58	30.35	12.66	12.87	14.25	30.82	13.64	14.01
Drumnakelly	31.5	79	42.5	21.34	49.48	19.39	20.51	22.33	52.22	21.13	22.82
Dungannon	18.4	46.8	23	17.13	37.76	15.83	16.30	16.35	37.15	15.64	16.73
Eden	25.0	62.5	45	10.58	24.03	10.08	10.36	10.00	22.75	9.75	10.39
Enniskillen	25.0	62.5	33.5	8.26	16.96	7.61	7.62	9.67	20.88	9.17	9.22
Finaghy	31.5	79		18.80	45.55	17.17	19.34	23.18	53.02	21.70	23.21
Glengormley	18.4	46.8		5.58	11.02	5.39	5.39	5.43	11.36	5.33	5.37
Hannahstown	31.5	80	33.5	21.10	52.16	19.11	23.23	26.57	66	24.70	30.14
Kells*	21.9	55.9	27.4	20.56	49.25	18.88	22.51				
	26.2	65.0	29.7					25.36	61.46	23.90	28.76

Table E-2 Northern Ireland Short Circuit Current Levels for Winter Peak 2012/13

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]
Killymallaght	40.0	100.0	42.5	12.73	28.77	11.80	12.04	12.44	28.36	11.96	12.40
Knock	18.4	46.8		17.14	36.19	15.49	15.62	16.99	32.86	15.99	17.00
Larne	18.4	46.8	42.5	9.74	20.48	9.29	9.31	9.13	20	8.90	9.07
Limavady	18.4	46.8	23	7.41	15.10	6.93	6.94	7.91	16.92	7.58	7.64
Lisburn	18.4	46.8	23	13.02	28.21	12.19	12.30	12.53	26.96	12.07	12.45
Lisaghmore	18.4	46.8		10.07	21.33	9.49	9.58	9.71	21.03	9.42	9.74
Loguestown	18.4	46.8		5.72	11.46	5.38	5.38	6.22	13.02	5.97	5.99
Magherakeel				3.99	8.52	3.87	3.90	4.45	9.89	4.35	4.40
Newtownards	40.0	100		8.34	17.66	7.88	7.94	7.78	17.38	7.53	7.81
Newry	18.4	46.8	23	5.76	11.89	5.51	5.55	5.68	12.4	5.53	5.73
Omagh	40.0	100	42.5	13.49	28.36	12.34	12.39	13.46	29.29	12.76	13.05
Rathgael	18.4	46.8		6.39	13.31	6.07	6.11	6.26	13.65	6.07	6.29
Rosebank	40.0	100		19.51	46.78	17.44	19.39	24.16	57.89	22.22	24.59
Slieve Kirk	40.0	100.0		8.49	17.74	8.04	8.10	8.03	17.53	7.80	8.02
Springtown	31.5	79	33.6	10.27	21.84	9.70	9.80	10.08	21.87	9.79	10.11
Strabane	18.4	46.8	23	15.59	33.84	14.13	14.23	16.38	36.88	15.64	16.12
Tandragee	31.5	79	33.6	23.91	57.60	21.57	25.26	27.65	67.58	25.96	30.99
Tamnamore	40.0	100	45	14.63	33.87	13.77	15.67	12.82	30.68	12.45	14.63
Waringstown	18.4	46.8		8.76	18.96	8.34	8.45	8.29	18.58	8.07	8.44
PSW	18.4	46.8		14.98	31.57	13.89	14.07	14.31	28.91	13.71	14.88

Table E-3 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2012

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	8.4	20.7	7.4	8.6	10.4	25.8	9.6	11.2
Castlereagh	31.5	79.0	35.65	8.4	20.7	7.4	8.4	10.4	25.5	9.5	10.8
Coolkeeragh	31.5	79.0	35.3	8.3	20.5	7.5	8.7	9.5	23.7	8.9	10.7
Hannahstown	31.5	79.0	35.65	8.2	20.2	7.3	8.2	10.2	25.1	9.4	10.7
Kells	31.5	79.0	35.65	9.1	22.6	8.0	9.4	10.8	26.9	10.0	11.6
Kilroot	31.5	79.0	45.3	8.9	22.3	7.9	9.4	10.0	24.8	9.3	10.9
Magherafelt	31.5	79.0	35.65	9.7	24.1	8.5	10.0	10.4	25.4	9.7	10.5
Moyle	31.5	79.0	35.65	8.3	20.5	7.4	8.5	10.3	25.6	9.5	11.1
Tandragee	26.5	66.3	35.65	10.2	25.1	8.9	10.3	11.8	29.2	10.9	12.5
Tamnamore	31.5	79.0	57.3	8.7	21.6	7.8	8.8	9.1	22.3	8.6	9.3
110kV											
Aghyoule	25.0	62.5		3.8	8.0	3.6	3.7	3.9	8.7	3.8	4.0
Antrim	18.4	46.8		8.0	17.2	7.5	7.6	8.4	18.4	8.2	8.5
Ballylumford*	21.9	55.0	25.9	14.3	34.9	13.0	15.7				
	26.2	65.0	29.7					17.7	43.9	16.7	20.5
Ballymena	18.4	46.8		7.7	16.8	7.3	7.4	8.4	18.7	8.1	8.6

Table E-3 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2012 (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]
Banbridge	18.4	46.8		6.0	12.6	5.7	5.8	6.1	13.5	6.0	6.2
Ballyvallyagh	18.4	46.8	23.0	11.6	25.9	10.7	10.8	11.9	26.1	11.4	11.5
Ballynahinch	18.4	46.8		5.1	10.9	4.9	5.0	5.3	11.8	5.2	5.4
Carnmoney	26.2	65.0	44.9	7.3	15.3	6.9	6.9	7.7	16.7	7.5	7.6
Castlereagh	26.2	65.0	33.5	13.4	33.2	12.1	14.4	18.1	45.0	16.7	19.9
Belfast Central	31.5	79.0		11.4	27.2	10.4	11.3	14.4	32.2	13.6	14.6
Coleraine	31.5	79.0	42.5	7.1	14.7	6.6	6.6	8.4	17.9	8.0	8.0
Coolkeeragh	31.5	80.0	33.5	16.3	40.0	14.6	17.8	21.2	52.4	19.7	24.1
Creagh	31.5	80.0	33.5	6.9	14.1	6.6	6.6	7.5	16.1	7.3	7.4
Cregagh	26.2	65.0		12.4	30.1	11.3	12.6	16.2	38.0	15.1	16.6
Donegall North	31.5	79.0	33.5	12.7	30.2	11.5	12.6	16.4	36.9	15.4	16.1
Donegall South				10.2	23.3	9.5	9.7	11.7	25.8	11.2	11.5
Drumnakelly	31.5	79.0	42.5	15.0	35.6	13.6	14.8	17.5	41.3	16.4	17.9
Dungannon	18.4	46.8	23.0	13.2	29.9	12.1	12.7	13.8	31.9	13.2	14.2
Eden	25.0	62.5	45.0	8.0	16.8	7.5	7.5	8.3	18.0	8.1	8.2
Enniskillen	25.0	62.5	33.5	7.4	15.3	6.9	6.9	9.0	19.4	8.5	8.6
Finaghy	31.5	79.0		13.0	31.4	11.8	13.2	17.2	39.9	16.1	17.3
Glengormley	18.4	46.8		4.9	9.9	4.7	4.7	5.0	10.5	4.9	4.9
Hannahstown	31.5	80.0	33.5	14.0	34.5	12.7	14.9	19.0	46.9	17.7	20.8
Kells*	21.9	55.9	27.4	14.1	33.9	12.8	15.1				
	26.2	65.0	29.7					18.4	44.7	17.2	20.4
Killymallaght	40.0	100.0		10.2	23.2	9.5	9.7	10.1	22.7	9.7	9.9
Knock	18.4	46.8		11.8	26.1	10.8	11.0	13.3	26.6	12.6	13.3
Larne	18.4	46.8	42.5	7.8	16.9	7.4	7.4	7.9	17.6	7.7	7.9
Limavady	18.4	46.8	23.0	6.7	13.9	6.3	6.3	7.3	15.8	7.1	7.1
Lisburn	18.4	46.8	23.0	10.0	22.2	9.3	9.5	10.6	23.1	10.2	10.5
Lisaghmore	18.4	46.8		8.6	18.7	8.1	8.2	8.8	19.3	8.5	8.9
Loguestown	18.4	46.8		5.2	10.6	5.0	5.0	5.8	12.3	5.6	5.7
Magherakeel				3.7	7.9	3.6	3.6	4.2	9.3	4.1	4.1
Newtownards	40.0	100.0		6.9	14.9	6.5	6.6	6.9	15.6	6.7	7.0
Newry	18.4	46.8	23.0	5.1	10.6	4.9	4.9	5.2	11.4	5.1	5.3
Omagh	40.0	100.0	42.5	11.4	24.6	10.4	10.5	12.1	26.7	11.5	11.8
Rathgael	18.4	46.8		5.5	11.6	5.2	5.3	5.6	12.4	5.5	5.7
Rosebank	40.0	100.0		12.9	31.2	11.6	13.1	17.0	41.2	15.8	17.6
Slieve Kirk	40.0	100.0		7.2	15.1	6.8	6.9	7.2	15.7	7.0	7.1
Springtown	31.5	79.0	33.6	8.8	19.1	8.3	8.4	9.1	20.1	8.9	9.2
Strabane	18.4	46.8	23.0	12.3	27.2	11.3	11.4	14.1	32.1	13.4	13.9
Tandragee	31.5	79.0	33.6	16.2	39.5	14.6	17.3	20.6	50.6	19.1	22.9
Tamnamore	40.0	100.0	45	11.7	27.4	10.8	12.4	11.3	27.1	10.8	12.7
Waringstown	18.4	46.8		7.4	16.4	7.1	7.2	7.5	16.9	7.3	7.6
PSW	18.4	46.8		11.1	24.1	10.2	10.4	11.8	24.5	11.3	12.3

Table E-4 Northern Ireland Short Circuit Current Levels for Winter Peak 2015/16

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	21.9	56.85	19.45	25.99	25.63	66.86	23.94	31.92
Castlereagh	31.5	79	35.65	17.15	42.7	15.3	17.35	17.5	43.5	16.41	18.70
Coolkeeragh	31.5	79	35.3	13	33.09	12.05	14.20	13.13	33.64	12.63	15.39
Hannahstown	31.5	79	35.65	17.16	42.89	15.33	17.58	17.36	43.17	16.31	18.65
Kells	31.5	79	35.65	19.39	49.25	17.42	20.80	19.87	49.71	18.79	21.55
Kilroot	31.5	79	45.3	18.79	48.13	16.86	20.90	22.32	57.72	20.99	26.62
Magherafelt	31.5	79	35.65	19.23	48.71	17.39	20.42	16.54	40.1	15.8	16.69
Moyle	31.5	79	35.65	21.31	55.21	18.98	24.97	24.65	64.03	23.08	30.00
Tandragee	26.5	66.3	35.65	19.85	49.65	17.9	20.40	18.97	47.03	17.97	20.44
Tamnamore	31.5	79	57.3	18.66	46.78	16.91	19.30	16	39.03	15.29	16.64
110kV											
Aghyoule	25.0	62.5		4.07	8.49	3.85	3.95	4.06	9.03	3.91	4.17
Altahullion				5.54	11.89	5.23	5.29	5.43	12.32	5.25	5.45
Antrim	18.4	46.8		9.88	20.89	9.17	9.34	9.94	22.05	9.65	10.20
Ballylumford*	21.9	55	25.88	24.58	61.70	26.05	22.65				
Ballylumford*	26.2	65.0	29.7					28.74	73.07	27.39	36.21
Ballymena	18.4	46.8		9.63	20.65	7.75	9.17	9.94	22.05	9.65	10.20
Banbridge	18.4	46.8		6.61	13.85	6.18	6.35	6.54	14.45	6.39	6.63
Ballyvallagh	18.4	46.8	23	16.82	36.43	5.62	15.76	15.08	32.4	14.60	14.67
Ballynahinch	18.4	46.8		6.03	12.56	6.52	5.75	5.96	13.03	5.79	6.02
Belfast North Main	18.4	46.8		15.56	33.50	7.42	14.44	15.01	29.39	14.38	15.60
Cam				6.28	13.57	5.87	5.99	6.17	13.98	5.91	6.22
Carnmoney	26.2	65	44.9	9.56	21.22	8.38	9.11	9.06	20.45	8.83	9.43
Castlereagh	26.2	65	33.5	21.64	53.73	19.24	19.26	27.13	67.91	24.82	30.40
Belfast central	31.5	79		16.75	39.68	11.15	15.24	19.53	42.3	18.25	19.55
Coleraine	31.5	79	42.5	9.12	19.45	6.61	8.36	10.51	23.11	9.86	10.08
Coolkeeragh	31.5	80	33.5	23.63	58.62	21.23	21.38	29.10	72.8	27.23	34.17
Creagh	31.5	80	33.5	8.41	16.84	3.66	8.05	8.71	18.48	8.47	8.51
Cregagh	26.2	65		19.12	46.08	13.29	17.20	22.97	52.94	21.24	23.06
Donegall North	31.5	79	33.5	18.19	43.53	12.43	16.70	21.38	47.44	20.13	21.14
Donegall South				13.66	30.75	7.91	12.77	14.52	31.88	13.91	14.47
Drumnakelly	31.5	79	42.5	18.18	43.50	11.63	16.71	19.47	46.76	18.41	20.25
Dungannon	18.4	46.8	23	12.55	29.00	9.44	11.93	10.83	25.7	10.54	11.37
Eden	25.0	62.5	45	10.89	25.09	9.05	10.39	10.18	23.36	9.93	10.65
Enniskillen	25.0	62.5	33.5	8.89	18.61	5.88	8.28	10.04	22.14	9.53	9.70
Fallaghearn				8.48	19.81	8.57	8.08	7.68	17.85	7.47	8.19
Finaghy	31.5	79		18.84	45.98	14.83	17.27	22.89	52.91	21.48	23.19
Glengormley	18.4	46.8		5.64	11.13	3.55	5.46	5.47	11.43	5.37	5.41
Hannahstown	31.5	80	33.5	21.14	52.69	20.27	19.22	26.11	65.31	24.33	29.77

Table E-4 Northern Ireland Short Circuit Current Levels for Winter Peak 2015/16 (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*	21.9	55.9	27.4	21.19	50.89	18.35	19.57				
Kells*	26.2	65.0	29.7					26.14	63.45	24.71	29.75
Killymallaght				13.10	29.69	12.33	12.56	12.77	29.16	12.34	12.78
Knock	18.4	46.8		17.68	37.26	16.01	16.13	17.35	33.52	16.35	17.38
Larne	18.4	46.8	42.5	9.98	21.04	9.53	9.55	9.28	20.4	9.06	9.27
Limavady	18.4	46.8	23	8.30	17.78	7.73	7.79	8.93	19.78	8.50	8.73
Lisburn	18.4	46.8	23	12.98	28.32	12.19	12.30	12.49	27.03	12.04	12.44
Lisaghmore	18.4	46.8		10.36	21.99	9.83	9.91	9.89	21.42	9.62	9.94
Loguestown	18.4	46.8		6.25	12.83	5.84	5.86	6.70	14.28	6.40	6.49
Magherakeel				5.01	11.29	4.74	5.03	5.33	12.54	5.11	5.62
Mid-Antrim				6.57	13.78	6.27	6.29	6.30	13.75	6.12	6.31
Newtownards	40.0	100		8.48	17.95	8.02	8.08	7.87	17.59	7.62	7.90
Newry	18.4	46.8	23	5.73	12.06	5.48	5.57	5.66	12.51	5.51	5.81
Omagh	40.0	100	42.5	15.74	34.64	14.50	14.70	15.73	35.32	14.93	15.60
Pomeroy				9.39	20.06	8.96	9.06	8.46	18.58	8.24	8.67
Rathgael	18.4	46.8		6.48	13.48	6.16	6.20	6.33	13.8	6.14	6.36
Rosebank	40.0	100		19.77	48.32	17.75	20.34	24.33	60.44	22.44	26.54
Slieve Kirk	40.0	100		8.67	18.10	8.29	8.34	8.17	17.85	7.98	8.20
Springtown	31.5	79	33.6	10.58	22.55	10.06	10.16	10.29	22.35	10.02	10.35
Strabane	18.4	46.8	23	16.12	35.03	15.01	15.10	17.18	38.68	16.44	16.89
Tandragee	31.5	79	33.6	21.51	53.67	19.59	23.91	25.58	64.51	23.90	29.68
Tamnamore	40.0	100	45	19.12	46.97	17.88	21.69	19.06	47.17	18.30	22.28
Waringstown	18.4	46.8		8.44	18.55	8.05	8.17	8.10	18.33	7.88	8.27

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2015

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	9.2	22.7	8.2	9.3	11.1	27.6	10.3	12.0
Castlereagh	31.5	79.0	35.65	9.2	22.6	8.2	9.2	11.0	27.0	10.2	11.4
Coolkeeragh	31.5	79.0	35.3	9.1	22.3	8.2	9.4	10.1	25.2	9.6	11.3
Hannahstown	31.5	79.0	35.65	8.9	22.0	8.0	8.9	10.6	26.2	9.9	11.1
Kells	31.5	79.0	35.65	10.0	24.8	8.9	10.2	11.6	28.9	10.8	12.4
Kilroot	31.5	79.0	45.3	9.7	24.3	8.6	10.2	10.5	26.1	9.8	11.4
Magherafelt	31.5	79.0	35.65	10.8	27.0	9.6	11.1	11.3	27.6	10.6	11.4
Moyle	31.5	79.0	35.65	9.1	22.5	8.1	9.2	11.0	27.4	10.2	11.9
Tandragee	26.5	66.3	35.65	11.3	27.9	10.0	11.4	12.8	31.6	11.9	13.5
Tamnamore	31.5	79.0	57.3	10.9	27.0	9.7	11.0	11.3	27.7	10.6	11.7

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2015 (continued)

Node	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]	I'' [kA]	ip [kA]	IB [kA]	asym B [kA]
110kV											
Aghyoule	25.0	62.5		4.0	8.3	3.8	3.9	4.0	8.9	3.9	4.1
Altahullion				5.2	11.2	4.9	5.0	5.3	11.9	5.1	5.3
Antrim	18.4	46.8		8.3	17.8	7.6	7.8	8.7	19.6	8.5	9.0
Ballylumford*	21.9	55.0	25.9	15.2	37.3	18.3	13.9				
	26.2	65.0	29.7					18.6	46.2	17.6	21.4
Ballymena	18.4	46.8		8.1	17.6	8.3	7.6	8.7	19.6	8.5	9.0
Banbridge	18.4	46.8		5.8	12.4	6.5	5.6	6.0	13.4	5.9	6.1
Ballyvallagh	18.4	46.8	23.0	12.2	27.1	6.4	11.3	12.2	26.8	11.7	11.8
Ballynahinch	18.4	46.8		5.2	11.1	6.8	5.0	5.4	11.8	5.3	5.5
Carnmoney	26.2	65.0	44.9	7.9	17.7	9.0	7.4	8.0	18.1	7.7	8.3
Castlereagh	26.2	65.0	33.5	14.4	35.9	17.2	13.1	19.2	48.0	17.8	21.1
Belfast central	31.5	79.0		12.1	29.0	11.7	11.1	15.1	33.6	14.2	15.3
Coleraine	31.5	79.0	42.5	7.6	15.9	5.0	7.1	8.9	19.2	8.5	8.5
Coolkeeragh	31.5	80.0	33.5	18.2	44.4	17.5	16.4	23.2	57.2	21.7	25.9
Creagh	31.5	80.0	33.5	7.3	14.8	4.1	7.0	7.8	16.8	7.6	7.7
Cregagh	26.2	65.0		13.3	32.3	13.4	12.1	17.0	39.9	15.9	17.3
Donegall North	31.5	79.0	33.5	13.1	31.5	12.3	12.1	16.5	37.3	15.6	16.3
Donegall South				10.5	24.0	8.2	9.8	11.8	26.0	11.3	11.6
Drumakelly	31.5	79.0	42.5	13.6	32.9	12.3	12.6	15.7	37.9	14.9	16.4
Dungannon	18.4	46.8	23.0	10.8	25.1	9.6	10.2	9.9	23.4	9.5	10.3
Eden	25.0	62.5	45.0	8.7	20.1	9.7	8.2	8.7	20.2	8.5	9.1
Enniskillen	25.0	62.5	33.5	8.2	17.4	6.1	7.7	9.5	21.0	9.0	9.2
Fallaghearn	40.0	100		8.0	18.9	9.0	7.6	7.5	17.5	7.2	8.0
Finaghy	31.5	79.0		13.4	32.8	14.0	12.4	17.3	40.4	16.3	17.5
Glengormley	18.4	46.8		5.0	10.1	3.9	4.9	5.0	10.6	5.0	5.0
Hannahstown	31.5	80.0	33.5	14.6	36.2	17.0	13.4	19.2	47.5	17.9	21.1
Kells*	21.9	55.9	27.4	15.1	36.3	16.7	13.8				
	26.2	65.0	29.7					19.6	47.5	18.4	21.6
Killymallaght	40.0	100		11.6	26.6	10.8	11.1	11.9	27.2	11.4	11.9
Knock	18.4	46.8		12.6	27.7	11.6	11.7	13.9	27.8	13.2	14.0
Larne	18.4	46.8	42.5	8.1	17.4	7.7	7.7	8.1	17.9	7.8	8.0
Limavady	18.4	46.8	23.0	7.5	15.9	7.0	7.0	8.6	18.8	8.2	8.3
Lisburn	18.4	46.8	23.0	10.2	22.7	9.6	9.7	10.6	23.3	10.2	10.6
Lisaghmore	18.4	46.8		9.1	19.6	8.6	8.7	9.1	19.9	8.9	9.2
Loguestown	18.4	46.8		5.5	11.2	5.2	5.2	6.1	12.8	5.8	5.9
Magherakeel				5.0	11.2	4.7	5.0	5.3	12.5	5.1	5.6
Mid-Antrim				6.0	12.7	5.7	5.7	5.9	13.0	5.8	5.9
Newtownards	40.0	100		7.1	15.3	6.7	6.8	7.0	15.8	6.8	7.0

Table E-5 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2015 (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]
Newry	18.4	46.8	23.0	5.1	10.9	4.9	5.0	5.2	11.7	5.1	5.4
Omagh	40.0	100	42.5	14.1	31.6	12.9	13.1	14.6	33.2	13.8	14.5
Pomeroy				8.8	19.1	8.3	8.4	8.2	18.1	7.9	8.4
Rathgael	18.4	46.8		5.6	11.8	5.4	5.4	5.7	12.5	5.6	5.8
Rosebank	40.0	100		13.6	33.4	12.4	14.1	17.7	44.1	16.6	19.2
Slieve Kirk	40.0	100		8.1	17.1	7.7	7.7	7.8	17.2	7.6	7.9
Springtown	31.5	79.0	33.6	9.3	20.1	8.8	8.9	9.5	20.7	9.2	9.5
Strabane	18.4	46.8	23.0	14.0	30.9	12.9	13.0	15.6	35.5	14.9	15.4
Tandragee	31.5	79.0	33.6	15.5	38.8	14.2	17.0	19.6	49.4	18.4	22.3
Tamnamore	40.0	100	45.0	15.4	37.9	14.2	16.8	16.5	40.7	15.7	18.7
Waringstown	18.4	46.8		7.2	16.2	6.9	7.0	7.3	16.6	7.1	7.5
PSW	18.4	46.8		11.4	24.8	10.6	10.8	11.9	24.8	11.5	12.4

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2018/19

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				10.64	27.12	10.01	11.54	11.02	27.51	10.65	11.91
275kV											
Ballylumford	26.5	66.3	35.65	18.7	47.67	16.7	20.73	21.05	54.02	19.71	24.85
Castlereagh	31.5	79	35.65	16.5	40.86	14.69	16.54	17.09	42.36	15.97	18.11
Coolkeeragh	31.5	79	35.3	13.21	33.6	12.27	14.41	13.06	33.39	12.58	15.23
Hannahstown	31.5	79	35.65	16.18	40.17	14.44	16.36	16.61	41.19	15.56	17.69
Kells	31.5	79	35.65	18.79	47.51	16.87	20.01	19.36	48.34	18.27	20.92
Kilroot	31.5	79	45.3	18.43	47.08	16.53	20.44	21.99	56.71	20.63	26.1
Magherafelt	31.5	79	35.65	19.76	49.99	17.88	20.99	16.95	41.05	16.18	17.1
Moyle	31.5	79	35.65	18.3	46.58	16.38	20.15	20.51	52.52	19.23	23.97
Tandragee	26.5	66.3	35.65	20.74	51.9	18.69	21.44	19.8	49.05	18.72	21.34
Tamnamore	31.5	79	57.3	20.39	51.26	18.49	21.32	17.59	42.96	16.78	18.45
Turleenan	40	100	42.5	20.68	51.99	18.75	21.63	17.96	43.86	17.13	18.82
110kV											
Aghyoule	25	62.5		3.83	8.67	3.92	4.03	4.13	9.19	3.98	4.25
Airport Road	40	100		11.32	24.59	10.55	10.68	11.41	25.13	10.91	11.33
Altahullion	40	100		7.1	15.54	6.66	6.76	6.48	14.93	6.24	6.59
Antrim	18.4	46.8		9.91	20.99	9.47	9.59	9.82	21.17	9.56	9.92
Ballylumford*	21.9	55	25.88	23.8	59.37	21.86	28				
	26.2	65	29.7				27.85	70.38	26.46	34.35	27.85
Ballymena	18.4	46.8		9.61	20.6	9.13	9.3	9.92	21.99	9.61	10.15

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2018/19 (continued)

NODE	Rating			Three Phase				Single Phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]
Banbridge	18.4	46.8		6.65	13.93	6.39	6.43	6.57	14.51	6.41	6.65
Ballyvallagh	18.4	46.8	23	16.58	35.88	15.49	15.56	14.92	32.06	14.41	14.48
Ballynahinch	18.4	46.8		5.99	12.47	5.7	5.75	5.93	12.94	5.74	5.96
Belfast North Main	18.4	46.8		15.39	33.08	14.23	14.46	14.88	29.13	14.21	15.41
Carnmoney	26.2	65	44.9	9.47	21.01	9	9.23	9.03	20.38	8.78	9.38
Castlereagh	26.2	65	33.5	21.33	52.74	18.89	22.92	27.07	67.51	24.61	29.93
Belfast Central	31.5	79		16.54	39.1	15	16.03	19.43	41.95	18.08	19.35
Cam	40	100		6.65	14.54	6.18	6.34	6.41	14.68	6.13	6.51
Coleraine	31.5	79	42.5	10.02	21.84	9.09	9.27	11.35	25.46	10.56	10.96
Coolkeeragh	31.5	80	33.5	24.29	60.08	21.99	27.15	29	72.31	27.16	33.69
Creagh	31.5	80	33.5	8.42	16.85	8.06	8.06	8.7	18.45	8.46	8.5
Cregagh	26.2	65		18.86	45.32	16.89	18.7	22.87	52.5	21.05	22.8
110kV											
Donegall North	31.5	79	33.5	17.98	42.9	16.45	17.85	21.16	46.9	19.85	20.81
Donegall South				13.53	30.4	12.61	12.87	14.42	31.62	13.77	14.32
Drumnakelly	31.5	79	42.5	18.36	43.98	16.84	18.15	19.65	47.24	18.56	20.43
Drumquin				6.88	15.6	6.54	6.77	4.62	9.69	4.52	4.53
Dungannon	18.4	46.8	23	12.79	29.53	12.18	12.65	10.93	25.92	10.65	11.48
Eden	25	62.5	45	10.75	24.74	10.23	10.58	10.11	23.2	9.85	10.57
Enniskillen	25	62.5	33.5	9.34	19.68	8.68	8.75	10.42	23.13	9.89	10.12
Fallaghearn				8.66	20.27	8.27	8.5	7.77	18.11	7.57	8.31
Finaghy	31.5	79		18.63	45.3	17.01	19.15	22.66	52.28	21.18	22.79
Glengormley	18.4	46.8		5.62	11.09	5.44	5.44	5.45	11.4	5.35	5.39
Hannahstown	31.5	80	33.5	20.87	51.84	18.9	22.93	25.82	64.43	23.97	29.03
Kells*	21.9	55.9	27.4	21.14	50.7	19.48	23.17				
	26.2	65	29.7					26.08	63.23	24.58	29.52
Killymallaght	40.0	100		13.43	30.44	12.63	12.89	12.97	29.64	12.53	13.02
Knock	18.4	46.8		17.43	36.7	15.72	15.84	17.23	33.18	16.17	17.18
Larne	18.4	46.8	42.5	9.88	20.83	9.42	9.44	9.22	20.25	8.98	9.19
Limavady	18.4	46.8	23	12.87	28.91	11.62	12.06	13.24	30.15	12.37	13.27
Lisburn	18.4	46.8	23	13.15	30.03	12.3	12.61	12.29	28.05	11.83	12.43
Lisaghmore	18.4	46.8		10.47	22.17	9.94	10.02	9.93	21.52	9.66	9.99
Loguestown	18.4	46.8		6.65	13.82	6.18	6.21	7.01	15.1	6.67	6.8
Magherakeel				5.38	12.28	5.08	5.51	5.64	13.45	5.4	6.12
Mid-Antrim				6.75	14.19	6.42	6.45	6.43	14.07	6.24	6.44
Newtownards	40.0	100		8.4	17.79	7.93	7.99	7.81	17.43	7.56	7.83
Newry	18.4	46.8	23	5.78	12.15	5.51	5.6	5.71	12.61	5.54	5.84
Omagh	40.0	100	42.5	16.82	37.26	15.49	15.75	16.41	37.05	15.58	16.4
Omagh South				12.17	26.06	11.35	11.48	9.8	20.6	9.44	9.47
Pomeroy				9.62	20.55	9.19	9.3	8.59	18.88	8.38	8.83
Rathgael	18.4	46.8		6.43	13.38	6.1	6.14	6.28	13.67	6.08	6.29
Rosebank	40.0	100		19.5	47.49	17.43	19.9	24.26	60.01	22.25	26.05

Table E-6 Northern Ireland Short Circuit Current Levels for Winter Peak 2018/19 (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]
Slieve Kirk	40.0	100		8.8	18.33	8.41	8.47	8.24	17.97	8.04	8.26
Springtown	31.5	79	33.6	10.71	22.78	10.19	10.29	10.37	22.53	10.09	10.43
Strabane	18.4	46.8	23	16.46	35.69	15.34	15.42	17.44	39.22	16.7	17.16
Tandragee	31.5	79	33.6	21.73	54.35	19.76	24.25	25.86	65.38	24.12	30.1
Tamnamore	40	100	45	19.71	48.47	18.48	22.53	19.49	48.32	18.74	23
Waringstown	18.4	46.8		8.49	18.64	8.09	8.21	8.12	18.35	7.89	8.27

Table E-7 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2018

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				7.7	19.7	7.1	8.4	8.8	22.0	8.3	9.5
275kV											
Ballylumford	26.5	66.3	35.65	10.3	25.7	9.3	10.7	12.2	30.6	11.4	13.4
Castlereagh	31.5	79	35.65	10.3	25.5	9.3	10.4	12.1	29.9	11.2	12.7
Coolkeeragh	31.5	79	35.3	10.3	26.2	9.4	11.3	10.9	27.9	10.4	12.7
Hannahstown	31.5	79	35.65	10.0	24.8	9.0	10.2	11.7	28.9	10.9	12.3
Kells	31.5	79	35.65	11.3	28.5	10.2	11.9	12.8	32.1	12.0	14.0
Kilroot	31.5	79	45.3	10.9	27.4	9.8	11.6	11.5	28.6	10.8	12.6
Magherafelt	31.5	79	35.65	12.8	32.3	11.5	13.7	12.8	31.4	12.1	13.1
Moyle	31.5	79	35.65	10.2	25.5	9.2	10.6	12.1	30.3	11.3	13.3
Tandragee	26.5	66.3	35.65	13.1	32.9	11.7	13.7	14.5	36.1	13.5	15.6
Tamnamore	31.5	79	57.3	13.3	33.4	11.9	14.0	13.5	33.2	12.7	14.2
110kV											
Aghyoule	25	62.5		4.1	8.6	3.9	4.0	4.1	9.1	3.9	4.2
Airport Road	40	100		9.5	21.1	9.0	9.1	10.1	22.6	9.8	10.2
Altahullion	40	100		6.9	15.2	6.5	6.6	6.4	14.8	6.2	6.5
Antrim	18.4	46.8		8.7	18.7	8.3	8.4	8.9	19.4	8.7	9.0
Ballylumford*	21.9	55	25.88	16.3	40.2	15.1	18.2				
	26.2	65	29.7					19.7	49.2	18.7	23.1
Ballymena	18.4	46.8		8.4	18.3	8.0	8.2	9.0	20.1	8.8	9.3
Banbridge	18.4	46.8		6.1	12.9	5.9	5.9	6.2	13.7	6.1	6.3
Ballyvagh	18.4	46.8	23	13.1	29.1	12.3	12.4	12.8	28.1	12.4	12.5
Ballynahinch	18.4	46.8		5.4	11.4	5.2	5.2	5.5	12.1	5.4	5.6
Belfast North Main	18.4	46.8		12.3	27.2	11.6	11.8	13.0	26.0	12.5	13.5
Cam				6.4	14.0	6.0	6.1	6.3	14.4	6.0	6.4
Carnmoney	26.2	65	44.9	8.1	18.3	7.8	8.0	8.2	18.6	8.0	8.5

Table E-7 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2018 (continued)

NODE	Rating			Three phase				Single phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]
Castlereagh	26.2	65	33.5	15.5	38.7	14.2	16.9	20.6	51.7	19.2	23.0
Belfast Central	31.5	79		12.8	30.8	11.9	12.8	15.9	35.3	15.1	16.2
Coleraine	31.5	79	42.5	9.3	20.3	8.5	8.7	10.7	24.1	10.1	10.4
Coolkeeragh	31.5	80	33.5	20.2	50.0	18.3	22.4	24.7	61.5	23.1	28.4
Creagh	31.5	80	33.5	7.6	15.4	7.3	7.3	8.1	17.2	7.9	7.9
Cregagh	26.2	65		14.1	34.5	13.0	14.5	18.1	42.4	17.0	18.5
Donegall North	31.5	79	33.5	13.9	33.5	12.9	14.1	17.3	39.1	16.4	17.3
Donegall South				11.1	25.3	10.4	10.7	12.5	27.8	12.0	12.5
Drumnakelly	31.5	79	42.5	14.7	35.7	13.6	14.9	16.7	40.5	15.9	17.6
Drumquin				6.7	15.2	6.3	6.5	4.6	9.7	4.5	4.5
Dungannon	18.4	46.8	23	11.4	26.6	10.9	11.3	10.2	24.3	9.9	10.7
Eden	25	62.5	45	9.0	20.9	8.6	8.9	9.0	20.7	8.8	9.4
Enniskillen	25	62.5	33.5	8.8	18.6	8.2	8.3	9.9	22.1	9.5	9.7
Fallaghearn				8.3	19.6	7.9	8.2	7.7	17.9	7.4	8.2
Finaghy	31.5	79		14.3	35.0	13.2	14.9	18.2	42.7	17.3	18.6
Glengormley	18.4	46.8		5.2	10.3	5.0	5.0	5.1	10.8	5.1	5.1
Hannahstown	31.5	80	33.5	15.6	38.8	14.4	17.0	20.2	50.5	19.0	22.6
Kells*	21.9	55.9	27.4	16.4	39.7	15.2	17.9				
	26.2	65	29.7					21.0	51.3	19.9	23.6
Killymallaght	40	100		12.4	28.4	11.6	11.9	12.4	28.5	11.9	12.5
Knock	18.4	46.8		13.4	29.4	12.4	12.6	14.6	29.0	13.9	14.8
Larne	18.4	46.8	42.5	8.5	18.4	8.1	8.2	8.4	18.6	8.2	8.4
Limavady	18.4	46.8	23	12.0	27.3	10.9	11.3	12.9	29.6	12.0	13.0
Lisburn	18.4	46.8	23	10.9	25.2	10.3	10.6	10.9	25.1	10.5	11.1
Lisaghmore	18.4	46.8		9.6	20.6	9.1	9.2	9.4	20.4	9.1	9.5
Loguestown	18.4	46.8		6.3	13.2	6.0	6.0	6.8	14.6	6.5	6.6
Magherakeel				5.3	12.2	5.0	5.5	5.6	13.4	5.4	6.1
Mid-Antrim				6.5	13.7	6.2	6.2	6.3	13.8	6.1	6.3
Newtownards	40	100		7.3	15.8	7.0	7.1	7.2	16.2	7.0	7.3
Newry	18.4	46.8	23	5.3	11.2	5.1	5.2	5.3	11.7	5.2	5.5
Omagh	40	100	42.5	15.5	34.8	14.2	14.5	15.6	35.4	14.8	15.6
Omagh South				11.4	24.7	10.7	10.8	9.6	20.3	9.2	9.2
Pomeroy				9.2	19.9	8.7	8.9	8.4	18.6	8.2	8.6
Rathgael	18.4	46.8		5.8	12.2	5.5	5.6	5.8	12.8	5.7	5.9
Rosebank	40	100		14.5	35.8	13.3	15.2	18.9	47.2	17.8	20.6
Slieve Kirk	40	100		8.4	17.7	8.0	8.1	8.1	17.7	7.8	8.1
Springtown	31.5	79	33.6	9.8	21.1	9.3	9.4	9.8	21.4	9.5	9.8
Strabane	18.4	46.8	23	14.9	32.8	13.9	14.0	16.3	37.1	15.6	16.1

Table E-7 Northern Ireland Short Circuit Current Levels for Summer Night Valley 2018
(continued)

NODE	Rating			Three phase				Single phase			
	RMS [kA]	Peak [kA]	Asym [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]	I'' [kA]	I _p [kA]	I _B [kA]	asym B [kA]
Tandragee	31.5	79	33.6	16.8	42.5	15.5	19.0	21.0	53.6	19.9	24.7
Tamnamore	40	100	45	16.8	41.4	15.6	19.0	17.5	43.5	16.8	20.5
Waringstown	18.4	46.8		7.6	16.9	7.3	7.4	7.5	17.1	7.4	7.7

SHORT CIRCUIT CURRENTS IN IRELAND

E.5.4 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 3.4 (released in October 2009) 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	25 kA
	Designated sites	31.5 kA

E.5.5 Analysis

The generation dispatches used in the short circuit analysis are shown in Table D-5 in Appendix D.

The total RMS break current at a busbar is an indication of the short circuit level that one could expect at that point in the transmission system. However, they do not necessarily represent the short circuit current that could flow through each individual breaker, which may be lower.

E.5.6 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)

$$I_p = \sqrt{2} \cdot \left[1.02 + 0.98 \cdot e^{-3 \frac{R}{X}} \right] \cdot I_k''$$

- AC component ($I_{RMS_AC_b}$) of short-circuit current at a selected time of break (t_b)

$$I_{RMS_AC_b} = I_k' + (I_k'' - I_k') \cdot e^{-\frac{t_b}{40ms}}$$

- DC component (I_{DC_b}) of short-circuit current at a selected time of break (t_b)

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

- Break current (I_b) at a selected time of break (t_b)

$$I_b = \sqrt{I_{DC_b}^2 + I_{RMS_AC_b}^2}$$

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012

Bus	Winter Peak 2012						Summer Valley 2012					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	I_k'' [kA]	I_k' [kA]	X/R Ratio	I_k'' [kA]	I_k' [kA]	X/R Ratio	I_k'' [kA]	I_k' [kA]	X/R Ratio	I_k'' [kA]	I_k' [kA]
Adamstown 110 kV	9.6	10.7	9.6	6.9	10.7	10.3	-	-	-	-	-	-
Agannnygal 110 kV	2.9	5.9	5.1	4.2	4.6	4.4	3.0	5.4	4.5	4.2	4.4	4.2
Aghada 110 kV	4.7	9.3	8.8	5.7	10.7	10.5	4.7	7.5	7.0	5.6	9.0	8.7
Aghada A 220 kV	10.4	7.2	6.7	12.4	7.8	7.6	6.6	3.9	3.6	7.6	4.9	4.7
Aghada B 220 kV	15.7	11.6	10.4	15.6	14.2	13.6	11.4	7.8	7.0	11.7	10.2	9.7
Aghada C 220 kV	15.7	11.6	10.4	15.6	14.2	13.6	11.4	7.8	7.0	11.7	10.2	9.7
Aghada D 220 kV	11.4	7.7	7.1	13.6	8.5	8.3	6.6	3.9	3.6	7.5	5.0	4.8
Ahane 110 kV	4.5	13.6	12.6	5.5	10.7	10.4	4.7	10.9	9.8	5.5	9.3	8.9
Anner 110 kV	4.6	7.6	7.1	5.9	4.7	4.6	3.4	5.9	5.5	4.6	4.0	3.9
Ardnacrusha 110 kV	5.6	16.2	14.4	6.9	16.1	15.5	5.0	11.9	10.3	6.1	13.2	12.5

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Arigna 110 kV	3.8	7.8	6.8	5.0	5.5	5.3	4.0	7.0	6.0	5.1	5.1	4.9
Arklow 110 kV	8.3	8.8	8.0	9.2	10.7	10.2	8.6	7.7	6.8	9.4	9.5	9.0
Arklow 220 kV	9.0	8.0	7.3	10.2	7.4	7.2	9.5	6.6	5.8	10.5	6.4	6.2
Artane 110 kV	13.5	12.8	11.7	5.8	15.0	14.4	12.8	9.6	8.8	6.3	11.8	11.4
Arva 110 kV	3.8	9.9	8.8	5.0	7.3	7.1	4.0	8.9	7.8	5.1	6.8	6.6
Athea 110 kV	5.7	6.9	6.0	7.5	6.0	5.8	5.9	5.8	5.0	7.5	5.5	5.2
Athlone 110 kV	5.4	10.2	9.6	6.2	5.7	5.7	4.3	7.1	6.8	5.4	4.8	4.8
Athy 110 kV	3.1	6.5	6.2	4.3	4.7	4.7	3.3	5.5	5.2	4.4	4.2	4.2
Aughinish 110 kV	7.8	10.3	9.3	9.9	10.8	10.4	8.2	9.3	8.2	10.2	10.3	9.8
Ballybeg 110 kV	8.9	6.6	6.2	9.3	7.8	7.6	9.0	5.9	5.5	9.4	7.1	6.9
Ballydine 110 kV	5.5	8.3	7.8	6.9	5.8	5.7	3.4	6.4	5.9	4.6	4.8	4.7
Ballylickey 110 kV	3.2	3.3	3.1	4.4	1.9	1.9	3.3	3.1	2.8	4.4	1.8	1.8
Ballywater 110 kV	4.2	5.9	5.4	3.1	6.0	5.8	4.8	5.7	4.8	3.2	5.7	5.4
Baltrasna 110 kV	6.0	10.7	10.2	7.3	8.1	8.0	6.3	9.3	8.7	7.4	7.5	7.4
Bandon 110 kV	3.3	6.6	6.0	4.7	5.2	5.1	3.5	5.7	5.2	4.8	4.8	4.6
Banoge 110 kV	3.7	6.3	5.8	4.6	5.3	5.2	3.8	5.7	5.1	4.8	4.9	4.7
Barnahealy A 110 kV	4.6	12.6	11.6	5.4	12.8	12.5	4.7	10.0	9.0	5.3	10.7	10.3
Barnahealy B 110 kV	6.5	12.4	11.4	7.3	12.4	12.0	6.3	9.9	8.9	6.9	10.4	10.1
Baroda 110 kV	4.0	8.8	8.2	4.9	9.9	9.6	4.3	7.5	6.9	5.1	8.8	8.5
Barrymore 110 kV	3.6	8.2	7.8	4.9	4.6	4.6	3.7	6.8	6.3	4.8	4.2	4.1
Bellacorick 110 kV	3.1	4.3	3.9	4.2	4.1	3.9	2.9	3.5	3.1	3.7	3.6	3.4
Binbane 110 kV	3.1	3.5	3.0	4.6	3.3	3.1	3.0	3.1	2.6	4.3	3.0	2.9
Blackrock 110 kV	11.0	11.0	10.0	2.9	9.9	9.6	9.7	10.0	9.1	2.8	9.2	9.0
Blake 110 kV	3.9	8.3	7.8	5.0	5.6	5.5	4.2	7.1	6.6	5.1	5.1	5.0
Boggeragh 110 kV	7.4	8.7	7.9	7.7	5.4	5.3	7.5	7.7	6.7	7.7	5.0	4.8
Booltiagh 110 kV	3.4	4.7	4.1	4.8	3.7	3.6	3.4	4.4	3.7	4.7	3.7	3.5
Bracklone 110 kV	3.4	6.9	6.6	4.6	4.6	4.6						
Brinny A 110 kV	3.2	5.9	5.4	4.5	4.4	4.3	3.3	5.2	4.7	4.6	4.1	4.0
Brinny B 110 kV	3.2	5.9	5.4	4.5	4.5	4.4	3.3	5.2	4.7	4.6	4.1	4.0
Butlerstown 110 kV	5.2	11.7	10.6	5.5	11.0	10.6	4.5	8.5	7.7	4.7	8.7	8.4
Cabra 110 kV	12.4	12.4	11.3	4.7	13.3	12.9	12.0	9.3	8.5	5.2	10.7	10.4
Cahir 110 kV	4.7	11.1	10.3	5.9	6.0	5.9	3.5	7.9	7.2	4.7	5.0	4.9
Carrick-on-Shannon 110 kV	4.2	12.3	10.9	5.0	12.8	12.3	4.4	10.7	9.2	5.2	11.5	10.9
Carlow 110 kV	5.3	9.7	9.0	6.0	9.3	9.0	5.4	7.4	6.7	6.0	7.6	7.4
Carrickmines 110 kV	29.6	12.8	11.4	26.1	14.1	13.5	20.1	11.5	10.3	18.5	13.0	12.5
Carrickmines 220 kV	13.5	19.4	16.8	10.2	23.6	22.3	13.6	13.1	11.1	10.4	16.8	15.6
Carrigadrohid 110 kV	5.5	13.2	11.9	6.4	10.2	9.9	5.6	10.7	9.2	6.3	9.0	8.6

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Carrowbeg 110 kV	2.7	3.0	2.7	3.9	2.6	2.5	2.7	2.7	2.4	3.8	2.4	2.4
Cashla 110 kV	6.9	17.1	15.3	7.7	20.8	19.9	6.1	13.2	11.6	6.7	16.7	15.8
Cashla 220 kV	8.2	11.4	10.6	10.3	11.0	10.7	7.8	8.1	7.1	9.3	8.6	8.2
Castlebar 110 kV	3.1	5.5	4.8	4.4	4.6	4.5	3.2	4.7	4.1	4.2	4.7	4.5
Castledockrill 110 kV	6.9	8.3	7.2	4.6	9.9	9.3	7.3	7.5	6.2	4.8	9.0	8.3
Castlefarm A 110 kV	7.1	10.0	9.0	8.7	10.1	9.8	7.5	9.0	7.9	8.9	9.6	9.1
Castlefarm B 110 kV	7.1	9.9	9.0	8.7	10.1	9.7	7.5	9.0	7.9	8.9	9.6	9.1
Castlevew 110 kV	3.8	12.9	11.9	4.6	9.2	9.0	4.0	10.1	9.1	4.6	7.9	7.7
Cathaleen's Fall 110 kV	5.1	9.9	8.1	6.0	9.3	8.7	4.0	7.8	6.2	4.9	8.0	7.4
Cauteen 110 kV	3.3	8.1	7.6	4.4	4.2	4.2	3.4	7.1	6.5	4.4	3.9	3.8
Central 110 kV	14.2	11.6	10.5	7.7	12.5	12.0	11.9	10.5	9.5	7.1	11.6	11.2
Charleville 110 kV	3.6	6.8	6.1	5.0	4.4	4.3	3.8	6.0	5.4	5.1	4.1	4.0
Cherrywood 110 kV	10.2	10.7	9.7	8.5	11.3	10.9	-	-	-	-	-	-
City West 110 kV	9.0	10.5	9.6	7.3	9.6	9.3	9.4	9.1	8.2	7.6	8.7	8.4
Clahane 110 kV	4.4	9.5	7.9	5.9	7.8	7.4	4.8	8.1	6.4	6.2	7.2	6.7
Clashavoon 110 kV	8.5	15.9	13.9	10.1	14.7	14.1	8.1	12.6	10.4	9.4	12.5	11.7
Clashavoon 220 kV	9.6	8.7	8.0	11.2	8.2	8.0	8.8	6.2	5.4	10.1	6.4	6.1
Cliff 110 kV	4.6	7.6	6.5	5.6	6.5	6.2	3.8	6.1	5.1	4.7	5.8	5.5
Clonkeen 110 kV	7.7	8.5	6.2	8.4	8.4	7.5	8.1	7.7	5.2	8.6	7.9	6.8
Cloon 110 kV	4.3	8.1	7.5	5.3	5.3	5.2	4.3	6.9	6.4	5.3	4.9	4.8
College Park 110 kV	8.5	19.5	18.0	6.6	21.3	20.7	8.4	15.3	13.7	6.8	17.8	17.0
Cookstown A 110 kV	10.5	11.1	10.1	7.6	10.8	10.4	10.9	9.5	8.6	8.0	9.7	9.4
Coolroe 110 kV	5.0	10.9	10.0	6.5	9.6	9.3	3.6	8.4	7.6	4.7	8.1	7.8
Coomagearlahy 110 kV	7.7	7.1	5.1	9.0	7.6	6.6	8.1	6.5	4.3	9.3	7.2	6.1
Corderry 110 kV	4.0	8.7	7.3	5.3	7.5	7.1	4.1	7.8	6.3	5.3	7.1	6.6
Corduff 110 kV	9.7	22.6	20.7	11.0	24.6	23.8	9.3	17.3	15.3	10.5	20.1	19.1
Corduff 220 kV	16.6	24.4	21.2	15.6	28.4	26.8	13.3	13.7	11.7	13.5	18.0	16.7
Corraclassy 110 kV	4.3	6.8	6.3	6.4	4.1	4.0	4.3	6.3	5.7	6.3	3.9	3.8
Cow Cross 110 kV	4.2	12.8	11.8	4.8	10.7	10.4	4.4	10.0	9.1	4.8	9.0	8.8
Crane 110 kV	5.7	8.9	7.7	6.0	9.2	8.7	6.4	8.1	6.6	6.4	8.4	7.8
Cromcastle A 110 kV	12.1	11.9	10.6	7.5	12.9	12.4	11.7	9.3	8.5	7.8	10.8	10.4
Cromcastle B 110 kV	12.1	11.9	10.6	7.5	12.9	12.4	11.7	9.3	8.5	7.8	10.8	10.4
Cuilleen 110 kV	5.3	9.8	9.3	5.6	5.6	5.5	-	-	-	-	-	-
Cullenagh 110 kV	7.1	14.0	12.8	8.1	15.4	14.9	5.7	10.2	9.2	6.4	11.9	11.4
Cullenagh 220 kV	9.6	8.6	8.0	11.2	8.0	7.8	8.1	6.4	5.7	9.5	6.5	6.2
Cunghill 110 kV	3.4	6.3	5.6	4.7	5.3	5.1	3.4	5.4	4.7	4.6	4.9	4.7
Cushaling 110 kV	6.3	10.6	9.7	7.6	11.6	11.3	5.7	8.0	7.3	6.9	9.3	9.0
Dallow 110 kV	3.4	5.5	5.3	4.6	3.3	3.3	3.5	4.9	4.7	4.7	3.1	3.1

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Dalton 110 kV	2.8	4.6	4.2	3.9	3.0	2.9	2.8	4.1	3.7	3.9	2.8	2.8
Dardistown 110 kV	15.9	12.1	10.8	14.4	13.6	13.0	14.4	9.4	8.6	13.6	11.2	10.8
Derrybrien 110 kV	3.0	4.7	4.0	4.3	4.2	4.0	3.0	4.4	3.6	4.4	4.0	3.8
Derryiron 110 kV	5.9	8.2	7.9	7.6	8.0	7.9	5.1	5.9	5.6	6.2	6.5	6.3
Doon 110 kV	5.2	8.4	7.8	6.5	5.3	5.2	3.5	6.5	6.0	4.7	4.4	4.3
Dromada 110 kV	5.1	6.2	5.5	5.0	5.5	5.3	5.3	5.4	4.6	5.1	5.0	4.8
Drumkeen 110 kV	4.0	7.2	5.4	5.3	5.9	5.4	4.0	6.6	4.8	5.3	5.6	5.1
Drumline 110 kV	3.2	8.4	7.7	4.3	5.7	5.6	3.2	7.0	6.3	4.2	5.1	5.0
Drybridge 110 kV	5.4	14.4	13.2	6.5	11.6	11.3	5.8	12.3	11.1	6.7	10.5	10.2
Dundalk 110 kV	3.5	9.2	8.5	4.6	7.6	7.5	3.7	8.1	7.5	4.7	7.1	6.9
Dunfirth 110 kV	4.7	6.1	5.9	5.9	4.0	3.9	4.8	5.2	5.0	5.9	3.6	3.6
Dungarvan 110 kV	3.7	6.1	5.7	4.8	3.6	3.5	3.8	5.1	4.8	4.8	3.2	3.2
Dunmanway 110 kV	5.0	7.3	6.5	6.7	5.8	5.6	5.2	6.4	5.7	6.8	5.3	5.1
Dunstown 220 kV	11.5	19.5	17.6	11.3	19.9	19.2	11.9	13.5	11.5	11.2	14.2	13.4
Dunstown 400 kV	18.5	7.3	6.8	17.7	6.6	6.4	19.7	3.9	3.6	15.9	3.7	3.6
Ennis 110 kV	3.8	10.5	9.2	5.1	8.9	8.5	3.4	8.7	7.5	4.6	7.9	7.6
Fassaroe East 110 kV	5.1	8.2	7.7	5.5	5.9	5.8	7.7	8.9	8.1	6.8	6.3	6.1
Fassaroe West 110 kV	5.2	8.4	7.8	5.6	6.1	6.0	5.5	7.3	6.8	5.7	5.7	5.6
Finglas 220 kV	18.0	24.2	20.8	16.9	29.2	27.4	13.0	13.0	11.2	13.3	17.6	16.4
Finglas A 110 kV	35.9	14.1	12.4	31.3	15.3	14.6	24.0	10.6	9.6	24.2	12.4	11.9
Finglas B 110 kV	36.8	14.5	13.1	32.4	17.8	17.1	24.0	10.6	9.6	24.0	13.7	13.1
Flagford 110 kV	4.5	12.8	11.4	5.4	15.0	14.3	4.7	11.1	9.6	5.6	13.3	12.5
Flagford 220 kV	7.4	7.8	7.2	9.7	7.0	6.9	7.7	6.7	5.9	9.8	6.3	6.1
Francis Street A 110 kV	11.4	11.1	10.0	5.9	13.1	12.5	11.8	9.2	8.4	6.2	11.3	10.9
Francis Street B 110 kV	12.4	13.1	12.0	6.5	15.6	15.1	9.2	9.8	9.0	3.7	11.4	11.1
Galway 110 kV	4.5	12.8	11.5	5.2	13.0	12.5	4.5	10.2	9.1	5.1	11.0	10.6
Garrow 110 kV	5.4	7.1	5.3	5.0	7.2	6.5	5.6	6.5	4.5	5.2	6.9	5.9
Garvagh 110 kV	4.5	6.7	5.6	6.1	5.7	5.4	4.6	6.1	4.9	6.2	5.4	5.0
Gilra 110 kV	3.1	6.7	6.3	4.0	5.1	5.0	3.2	6.1	5.6	4.0	4.7	4.6
Glanagow 220 kV	16.0	11.7	10.5	17.0	14.4	13.8	11.8	8.0	7.1	12.5	10.4	9.9
Glanlee 110 kV	7.6	6.8	4.9	8.1	7.3	6.5	7.9	6.3	4.2	8.3	7.0	5.9
Glasmole A 110 kV	5.1	7.4	6.8	5.4	5.0	4.9	4.6	5.5	5.2	5.1	3.9	3.8
Glasmole B 110 kV	4.4	6.4	5.9	5.0	4.1	4.1	4.6	5.5	5.1	5.1	3.8	3.8
Glenlara 110 kV	3.4	3.5	3.0	5.2	2.6	2.5	3.6	3.3	2.8	5.3	2.5	2.4
Glenree 110 kV	3.7	5.2	4.8	4.7	4.1	4.0	3.2	4.1	3.6	4.1	3.5	3.4
Golagh 110 kV	4.0	5.2	4.4	5.1	3.3	3.2	3.1	4.5	3.7	4.1	2.9	2.8
Gorman 110 kV	6.4	15.4	14.1	7.4	16.5	15.9	6.8	13.2	11.8	7.8	14.7	14.1
Gorman 220 kV	8.7	12.0	11.2	10.2	9.4	9.3	9.6	9.7	8.6	10.7	8.4	8.1

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Gortawee 110 kV	4.4	6.6	6.1	6.6	4.7	4.6	4.4	6.1	5.5	6.6	4.5	4.4
Grange 110 kV	12.9	12.2	10.8	5.9	12.9	12.4	12.2	9.5	8.6	6.2	10.7	10.4
Grange Castle 110 kV	10.9	11.1	10.0	10.0	11.3	10.8	11.4	9.4	8.5	10.3	10.1	9.7
Great Island 110 kV	7.7	15.4	13.9	8.6	19.1	18.3	5.7	10.1	8.9	6.3	13.3	12.5
Great Island 220 kV	10.5	10.2	9.3	12.3	10.2	9.9	8.2	7.1	6.2	9.6	7.9	7.6
Griffinrath 110 kV	7.0	10.8	10.2	7.4	10.8	10.6	7.5	9.1	8.4	7.7	9.5	9.2
Harolds 110 kV	11.6	11.2	10.0	5.6	13.0	12.4	11.9	9.2	8.4	5.9	11.3	10.8
Heuston 110 kV	13.4	13.3	12.2	7.8	16.1	15.6	-	-	-	-	-	-
Huntstown A 220 kV	17.1	23.3	20.2	14.2	28.1	26.5	12.6	12.7	10.9	12.1	17.1	15.9
Huntstown B 220 kV	15.7	21.9	19.3	11.8	25.7	24.4	13.4	13.0	11.3	11.7	17.0	16.0
Ikerrin 110 kV	4.8	5.4	5.1	6.3	3.2	3.2	4.8	4.8	4.6	6.3	3.0	3.0
Inchicore 220 kV	11.7	19.3	17.0	7.7	22.9	21.8	13.4	13.1	11.1	9.7	16.6	15.5
Inchicore A 110 kV	27.2	14.7	13.4	24.9	18.3	17.6	25.1	12.0	10.9	23.8	15.3	14.7
Inchicore B 110 kV	40.8	14.4	12.9	34.7	18.2	17.3	34.3	11.9	10.6	31.4	15.5	14.7
Inniscarra 110 kV	4.7	10.6	9.7	6.2	9.0	8.8	3.6	8.3	7.5	4.7	7.8	7.5
Irishtown 220 kV	14.0	20.5	17.8	12.5	25.1	23.6	14.2	13.4	11.4	13.6	17.4	16.2
Kellis 110 kV	6.3	10.4	9.7	7.4	11.6	11.3	6.3	7.8	7.1	7.3	9.2	8.9
Kellis 220 kV	8.1	8.4	7.9	9.9	6.9	6.8	7.9	6.5	5.9	9.6	5.9	5.7
Kilbarry 110 kV	6.2	20.5	17.8	7.7	18.3	17.5	5.9	14.7	12.6	6.5	15.6	14.7
Kildonan 110 kV	6.6	15.2	14.2	5.9	13.5	13.2	6.8	12.4	11.3	6.1	11.8	11.4
Kilkenny 110 kV	4.3	7.9	7.4	5.0	8.6	8.5	3.0	4.6	4.3	4.2	4.3	4.2
Killonan 110 kV	5.5	19.8	17.7	6.9	20.5	19.7	5.6	14.9	12.8	6.8	16.6	15.7
Killonan 220 kV	5.7	10.3	9.6	7.6	9.7	9.5	6.6	7.9	6.9	8.2	8.0	7.7
Killoteran 110 kV	5.4	12.5	11.4	5.2	12.4	12.0	4.8	9.0	8.0	4.7	9.7	9.3
Kilmahud 110 kV	9.8	10.8	9.7	8.5	10.9	10.5	10.2	9.2	8.2	8.8	9.8	9.4
Kilmore 110 kV	15.2	12.5	11.1	10.0	13.7	13.0	13.9	9.7	8.8	10.0	11.3	10.8
Kilteel 110 kV	4.4	8.0	7.5	5.5	7.0	6.8	4.6	7.1	6.4	5.6	6.6	6.4
Kinnegad 110 kV	5.1	6.3	6.1	6.8	5.4	5.4	4.9	5.0	4.8	6.3	4.7	4.6
Knockearagh 110 kV	6.2	7.1	5.8	7.9	5.9	5.6	6.6	6.3	4.9	8.1	5.5	5.1
Knockraha A 110 kV	21.8	6.2	6.0	24.1	6.2	6.2	13.1	4.8	4.6	15.5	5.1	5.0
Knockraha B 110 kV	7.4	21.8	19.4	8.5	20.4	19.6	6.7	15.3	13.3	7.5	15.9	15.1
Knockraha A 220 kV	8.8	10.8	9.9	9.9	11.8	11.4	6.3	5.9	5.3	7.0	7.2	6.9
Knockraha B 220 kV	11.6	9.4	8.7	12.0	9.3	9.1	10.2	7.0	6.3	10.8	7.4	7.2
Knockumber 110 kV	3.7	8.7	8.1	4.6	6.3	6.2	3.9	7.9	7.3	4.7	6.0	5.9
Lanesboro 110 kV	3.6	10.7	9.9	4.9	10.5	10.2	3.9	9.3	8.6	5.1	9.7	9.5
Letterkenny 110 kV	4.4	8.4	6.3	6.0	7.4	6.7	4.4	7.7	5.5	5.9	6.9	6.2
Liberty A 110 kV	5.2	17.2	15.2	5.7	14.3	13.8	5.2	12.8	11.2	4.6	14.0	13.3
Liberty B 110 kV	5.2	17.2	15.2	5.4	14.2	13.7	5.2	12.8	11.2	4.5	14.0	13.3

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Limerick 110 kV	4.7	17.2	15.3	5.7	15.1	14.6	4.8	13.2	11.4	5.7	12.7	12.1
Lisdrum 110 kV	2.8	5.3	4.9	3.9	3.2	3.2	2.9	4.9	4.6	3.9	3.1	3.0
Lisheen 110 kV	4.7	5.2	4.6	6.3	3.0	2.9	4.8	4.7	4.2	6.3	2.8	2.8
Lodgewood 110 kV	8.4	9.5	8.2	9.0	11.7	11.0	9.0	8.5	6.9	9.4	10.6	9.7
Lodgewood 220 kV	9.2	7.6	6.9	10.7	7.3	7.1	9.3	6.2	5.4	10.6	6.3	6.0
Longpoint 220 kV	11.5	7.7	7.1	14.0	8.5	8.2	6.6	3.9	3.6	7.5	5.0	4.8
Louth 220 kV	9.6	18.6	16.9	12.7	15.8	15.4	10.2	13.4	11.5	12.7	13.0	12.3
Louth A 110 kV	6.8	13.5	12.4	7.9	15.6	15.1	7.1	11.7	10.5	8.1	14.0	13.4
Louth B 110 kV	7.3	14.7	13.5	8.4	17.2	16.7	7.6	12.6	11.4	8.5	15.3	14.6
Macetown 110 kV	7.0	17.0	15.8	6.9	16.2	15.8	7.1	13.6	12.3	7.1	13.9	13.5
Macroom 110 kV	6.7	15.0	13.3	7.5	12.2	11.8	6.5	11.9	10.1	7.3	10.6	10.0
Mallow 110 kV	3.5	6.8	6.3	5.2	5.3	5.2	3.7	5.9	5.5	5.3	4.9	4.8
Marina 110 kV	6.1	19.2	16.7	8.1	15.5	14.9	5.9	13.9	12.0	6.3	15.3	14.5
Maynooth A 110 kV	10.9	13.6	12.7	11.6	16.4	16.0	11.4	11.1	10.1	11.9	13.9	13.3
Maynooth B 110 kV	8.1	18.0	16.9	9.8	16.5	16.2	8.6	14.4	13.0	10.1	14.1	13.7
Maynooth A 220 kV	9.6	17.0	15.3	10.1	15.4	14.9	11.5	12.5	10.7	11.6	12.5	11.9
Maynooth B 220 kV	9.5	20.8	18.7	9.4	18.6	18.0	11.1	14.1	12.0	10.9	14.4	13.6
McDermott 110 kV	16.7	13.3	12.1	5.9	15.1	14.5	14.7	9.8	9.0	6.4	11.9	11.5
Meath Hill 110 kV	4.0	9.5	8.8	5.3	7.6	7.4	4.3	8.6	7.8	5.5	7.1	6.9
Meentycat 110 kV	3.8	6.1	4.5	5.3	5.1	4.6	3.8	5.7	4.1	5.3	4.9	4.4
Midleton 110 kV	3.6	10.8	10.1	4.7	8.4	8.2	3.8	8.7	7.9	4.7	7.3	7.1
Milltown A 110 kV	15.3	11.9	10.6	7.6	14.1	13.5	15.4	9.8	8.9	8.0	12.1	11.6
Milltown B 110 kV	8.7	11.8	10.8	4.0	13.9	13.4	9.2	9.9	9.1	4.4	12.0	11.6
Misery Hill 110 kV	13.9	11.7	10.4	8.3	14.0	13.3	14.1	9.6	8.8	8.7	12.0	11.5
Moneypoint G1 400 kV	23.6	7.2	6.7	18.5	7.3	7.1	14.3	3.4	3.1	14.3	4.1	4.0
Moneypoint G2 400 kV	29.4	3.8	3.5	24.9	4.0	3.9	25.3	3.4	3.1	22.6	3.7	3.6
Moneypoint G3 400 kV	23.6	7.2	6.7	18.5	7.3	7.1	14.3	3.4	3.1	14.3	4.1	4.0
Moneteen 110 kV	5.2	11.9	10.9	6.2	8.7	8.5	5.3	9.9	8.8	6.3	7.7	7.5
Moneypoint 110 kV	3.2	2.9	2.4	4.5	1.7	1.6	3.2	2.7	2.2	4.5	1.7	1.6
Moneypoint 220 kV	12.7	9.8	9.1	11.0	9.5	9.3	12.4	7.5	6.6	10.9	8.0	7.6
Monread 110 kV	4.1	7.9	7.3	5.0	7.2	7.1	4.3	6.9	6.3	5.2	6.8	6.6
Moy 110 kV	4.1	5.2	4.8	5.3	5.5	5.3	3.0	3.7	3.3	3.7	4.3	4.1
Mullagharlin 110 kV	3.6	9.3	8.6	4.5	7.1	7.0	3.8	8.3	7.6	4.6	6.7	6.5
Mullingar 110 kV	2.7	4.6	4.3	3.8	4.6	4.5	2.8	4.1	3.9	3.8	4.2	4.2
Mungret A 110 kV	4.9	11.3	10.4	5.9	8.0	7.9	5.0	9.4	8.4	6.0	7.2	7.0
Mungret B 110 kV	4.9	11.3	10.4	5.9	8.0	7.9	5.0	9.5	8.4	6.0	7.2	7.0
Nangor 110 kV	10.2	10.9	9.8	8.6	11.0	10.6	10.6	9.2	8.3	8.9	9.9	9.5
Navan 110 kV	5.4	13.5	12.4	6.3	12.8	12.4	5.8	11.7	10.6	6.6	11.6	11.2

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Nenagh 110 kV	2.6	3.8	3.7	3.8	2.1	2.1	2.7	3.4	3.3	3.9	2.0	2.0
Newbridge 110 kV	4.2	10.3	9.5	5.0	9.7	9.5	4.5	8.5	7.8	5.2	8.6	8.3
Nore 110 kV	4.4	7.7	7.3	5.4	8.5	8.3	-	-	-	-	-	-
North Quays 110 kV	18.1	12.1	10.8	7.1	14.1	13.5	17.9	9.9	9.0	7.5	12.1	11.6
North Wall 110 kV	16.6	22.1	19.2	9.8	25.2	23.8	12.4	12.1	10.5	9.8	15.8	14.8
Oldcourt A 110 kV	3.7	10.7	10.0	4.4	8.1	8.0	3.9	8.6	7.9	4.5	7.0	6.9
Oldcourt B 110 kV	3.8	10.8	10.1	4.5	8.2	8.1	4.0	8.7	8.0	4.5	7.1	6.9
Oldstreet 220 kV	15.7	10.4	9.9	13.1	11.3	11.1	11.5	6.2	5.7	11.1	7.5	7.3
Oldstreet 400 kV	18.8	7.1	6.8	12.5	6.9	6.8	14.1	4.0	3.7	12.2	4.6	4.5
Oughtragh 110 kV	3.8	5.4	4.7	4.9	3.3	3.2	4.0	4.8	4.1	5.0	3.0	2.9
Pelletstown 110 kV	13.9	12.5	11.4	7.6	13.0	12.6	13.2	9.4	8.6	8.1	10.6	10.2
Platin 110 kV	4.8	13.1	12.1	5.6	9.6	9.4	5.1	11.3	10.3	5.8	8.8	8.6
Pollaphuca 110 kV	3.2	3.1	3.0	4.7	2.5	2.5	2.8	2.4	2.3	4.0	2.2	2.2
Poolbeg A 110 kV	24.6	12.6	11.3	21.1	15.4	14.7	23.2	10.3	9.3	20.8	13.1	12.5
Poolbeg B 110 kV	24.6	12.6	11.3	21.1	15.4	14.7	23.2	10.3	9.3	20.8	13.0	12.5
Poolbeg A 220 kV	17.0	22.0	19.2	10.7	26.2	24.8	12.8	12.2	10.5	10.5	16.2	15.2
Poolbeg B 220 kV	14.2	16.5	14.5	13.1	18.5	17.6	14.7	11.6	9.9	13.9	14.1	13.2
Poppintree 110 kV	16.3	12.9	11.4	9.7	14.0	13.4	14.6	9.9	9.0	9.7	11.5	11.1
Portan 400 kV	23.2	6.8	6.5	23.4	8.1	8.0	-	-	-	-	-	-
Portlaoise 110 kV	3.8	9.0	8.4	5.3	7.0	6.9	4.1	7.5	7.0	5.5	6.3	6.2
Pottery 110 kV	17.1	12.0	10.8	5.6	12.3	11.8	13.8	10.9	9.8	5.3	11.4	10.9
Prospect 220 kV	11.4	12.4	11.3	10.0	11.6	11.3	11.1	8.6	7.4	10.5	9.4	8.9
Raffeen A 110 kV	5.5	14.7	13.4	6.4	17.0	16.4	5.5	11.3	10.1	6.2	13.7	13.1
Raffeen 220 kV	14.8	11.7	10.5	14.3	14.3	13.6	11.3	8.0	7.1	11.4	10.3	9.8
Raffeen B 110 kV	8.1	14.4	13.1	9.2	16.5	15.9	7.4	11.2	10.0	8.2	13.5	12.9
Rathkeale 110 kV	3.5	7.9	7.4	4.6	4.4	4.4	3.6	6.7	6.1	4.6	4.0	3.9
Ratrussan 110 kV	3.5	7.6	6.3	4.6	8.0	7.5	3.7	7.0	5.7	4.8	7.7	7.1
Reamore 110 kV	4.2	9.2	7.7	3.7	7.4	7.1	4.7	8.0	6.4	3.9	6.8	6.3
Richmond 110 kV	3.0	7.3	6.8	4.2	6.4	6.3	3.2	6.4	6.0	4.4	5.9	5.8
Rinawade 110 kV	4.9	11.1	10.6	5.9	7.6	7.5	5.2	9.4	8.7	6.1	6.9	6.7
Ringaskiddy 110 kV	5.7	12.0	11.0	6.2	11.4	11.1	5.7	9.6	8.7	6.1	9.7	9.4
Ringsend 110 kV	24.5	12.7	11.2	21.0	15.5	14.7	23.2	10.3	9.3	20.7	13.1	12.5
Ryebrook 110 kV	5.5	15.4	14.3	6.0	10.6	10.4	5.8	12.5	11.2	6.2	9.4	9.2
Salthill 110 kV	4.5	11.7	10.5	4.0	11.5	11.1	4.4	9.4	8.5	4.0	9.9	9.5
Screeb 110 kV	3.4	2.6	2.5	4.4	1.5	1.4	-	-	-	-	-	-
Seal Rock A 110 kV	7.6	10.2	9.2	9.3	10.7	10.3	7.9	9.2	8.1	9.6	10.2	9.6
Seal Rock B 110 kV	7.6	10.2	9.2	9.3	10.7	10.3	7.9	9.2	8.1	9.6	10.2	9.6
Shankill 110 kV	3.6	9.0	7.8	4.8	7.8	7.4	3.8	8.1	6.9	4.9	7.2	6.9

Table E-9 Short Circuit Currents for Maximum and Minimum Demand in 2012 (continued)

Bus	Winter Peak 2012						Summer Valley 2012					
	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]
Shannonbridge 110 kV	6.0	16.9	16.0	7.9	18.7	18.3	6.2	14.3	13.3	7.9	16.8	16.3
Shannonbridge 220 kV	7.0	7.4	7.2	9.3	6.3	6.2	7.6	6.4	5.9	9.7	5.7	5.6
Shellybanks A 220 kV	16.6	22.0	19.1	10.6	26.2	24.8	12.6	12.1	10.5	10.4	16.2	15.2
Shellybanks B 220 kV	13.6	19.9	17.4	11.7	24.5	23.1	13.6	13.1	11.1	12.7	17.0	15.8
Shelton Abbey 110 kV	6.2	7.7	7.0	6.5	7.9	7.6	6.5	6.8	6.1	6.7	7.2	6.9
Singland 110 kV	5.6	16.4	14.7	6.7	14.7	14.2	5.4	12.5	10.9	6.4	12.2	11.7
Sligo 110 kV	3.8	10.0	8.7	4.8	9.0	8.6	3.9	8.6	7.2	4.8	8.1	7.6
Somerset 110 kV	3.0	8.2	7.8	4.0	5.2	5.1	3.1	7.2	6.8	4.1	4.8	4.7
Sorne Hill 110 kV	3.8	3.5	2.7	4.1	3.8	3.4	3.9	3.4	2.5	4.2	3.7	3.3
Srananagh 110 kV	4.8	11.6	9.9	5.9	12.2	11.5	4.7	9.9	8.1	5.7	10.7	9.9
Srananagh 220 kV	7.4	4.9	4.5	9.9	3.9	3.8	7.3	4.4	3.9	9.7	3.6	3.4
Stevenstown 110 kV	4.7	6.1	5.6	5.1	3.9	3.9	-	-	-	-	-	-
Stratford 110 kV	3.3	4.7	4.4	4.4	3.3	3.3	3.2	3.7	3.5	4.2	2.9	2.9
Suir 110 kV	4.6	10.5	9.8	5.1	5.8	5.7	-	-	-	-	-	-
Taney 110 kV	6.4	10.4	9.7	2.3	10.9	10.6	6.9	8.9	8.2	2.5	9.7	9.4
Tarbert 110 kV	12.2	21.5	18.6	14.3	20.2	19.3	9.8	14.8	12.1	11.5	16.0	14.8
Tarbert 220 kV	13.9	14.9	13.2	15.7	16.9	16.1	10.9	9.0	7.7	12.0	11.4	10.6
Tawnaghmore A 110 kV	3.9	4.3	4.1	5.3	4.5	4.4	2.9	3.0	2.7	3.6	3.5	3.4
Tawnaghmore B 110 kV	3.8	4.3	4.0	5.2	4.2	4.1	2.9	3.1	2.8	3.6	3.3	3.2
Thornsberry 110 kV	4.0	6.7	6.3	5.3	5.9	5.8	4.1	5.2	4.9	5.3	5.0	4.9
Thurles 110 kV	4.9	6.4	5.7	7.5	4.5	4.4	4.7	5.5	5.0	7.2	4.1	4.1
Tipperary 110 kV	3.2	7.8	7.3	4.4	4.0	4.0	3.1	6.5	6.0	4.3	3.7	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	6.2	18.9	16.5	7.5	15.4	14.8	5.8	13.7	11.9	6.1	15.2	14.4
Tralee 110 kV	5.6	11.5	9.3	6.9	8.9	8.4	6.3	9.7	7.4	7.3	8.0	7.4
Trien A 110 kV	5.1	10.3	8.5	6.6	8.8	8.3	5.5	8.6	6.8	6.9	7.9	7.3
Trillick 110 kV	3.8	3.8	2.8	4.2	3.7	3.3	3.9	3.7	2.7	4.3	3.6	3.2
Tullabrack 110 kV	3.2	3.0	2.6	4.4	1.9	1.8	3.2	2.9	2.4	4.4	1.8	1.7
Turlough 220 kV	11.1	12.4	11.4	12.4	10.9	10.6	12.4	10.1	8.9	13.3	9.5	9.2
Tynagh 220 kV	15.3	11.6	10.9	17.5	12.9	12.6	9.9	6.3	5.8	10.9	8.0	7.7
Waterford 110 kV	6.8	13.8	12.5	7.1	13.6	13.1	5.3	9.6	8.6	5.6	10.4	9.9
Wexford 110 kV	3.9	7.2	6.2	5.2	6.2	5.9	4.2	6.2	5.2	5.3	5.7	5.3
Whitegate 110 kV	4.4	10.1	9.5	5.2	10.2	10.0	4.5	8.1	7.5	5.2	8.6	8.4
Wolfe Tone 110 kV	14.6	13.0	11.8	5.4	14.6	14.0	13.4	9.6	8.8	5.9	11.6	11.1
Woodland A 220 kV	12.4	22.6	20.3	11.9	22.2	21.4	12.0	13.9	11.9	11.7	15.6	14.7
Woodland B 220 kV	33.8	6.6	6.5	25.4	8.2	8.1	24.6	4.9	4.7	20.7	6.3	6.1
Woodland 400 kV	23.2	6.8	6.5	23.4	8.1	8.0	18.2	4.3	3.9	18.8	4.9	4.8

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Adamstown 110 kV	13.2	16.9	15.4	6.5	19.0	18.3	13.3	14.0	12.7	6.8	16.4	15.7
Agannysgal 110 kV	3.0	6.2	5.5	4.3	4.7	4.6	3.2	5.7	4.9	4.4	4.5	4.3
Aghada 110 kV	4.6	9.6	9.1	5.6	10.9	10.7	4.7	7.7	7.2	5.6	9.1	8.8
Aghada A 220 kV	10.2	7.8	7.2	12.2	8.2	7.9	6.6	4.2	3.8	7.6	5.1	4.9
Aghada B 220 kV	15.6	12.0	10.8	15.5	14.7	14.0	11.7	8.0	7.2	12.0	10.4	9.9
Aghada C 220 kV	15.6	12.0	10.8	15.5	14.7	14.0	11.7	8.0	7.2	12.0	10.4	9.9
Aghada D 220 kV	11.1	8.4	7.7	13.4	9.1	8.8	6.6	4.2	3.8	7.5	5.2	5.0
Ahane 110 kV	4.5	13.9	12.9	5.5	10.7	10.5	4.7	11.4	10.3	5.6	9.5	9.2
Anner 110 kV	4.7	7.8	7.2	5.9	4.8	4.7	4.5	6.4	5.9	5.7	4.3	4.2
Ardnacrusha 110 kV	5.5	16.8	15.2	6.8	16.8	16.2	5.2	12.6	11.1	6.2	13.8	13.1
Ardnagappary 110 kV	2.7	2.2	2.0	4.0	1.3	1.2	2.8	2.1	1.9	4.1	1.2	1.2
Arigna 110 kV	3.8	7.8	7.0	5.0	5.5	5.3	4.0	7.2	6.2	5.1	5.2	5.0
Arklow 110 kV	10.7	9.2	8.3	11.6	11.1	10.6	11.1	8.0	7.1	11.8	9.8	9.3
Arklow 220 kV	9.1	8.1	7.5	10.3	7.5	7.3	9.6	6.8	6.0	10.6	6.6	6.3
Artane 110 kV	13.6	13.1	11.9	6.3	13.5	13.0	13.3	10.0	9.2	6.8	11.0	10.6
Arva 110 kV	3.7	10.0	9.0	5.0	7.3	7.1	3.9	9.1	8.1	5.1	6.9	6.7
Athea 110 kV	16.3	7.8	6.5	16.4	6.5	6.1	16.6	7.2	5.8	16.6	6.2	5.8
Athlone 110 kV	5.3	10.4	9.8	6.2	5.8	5.7	4.3	7.2	6.9	5.4	4.8	4.8
Athy 110 kV	3.2	7.6	7.3	4.2	5.6	5.5	3.4	6.4	6.0	4.4	5.0	4.9
Aughinish 110 kV	7.9	10.4	9.4	10.0	10.8	10.5	8.3	9.7	8.5	10.3	10.6	10.1
Balgriffin 110 kV	13.9	15.7	14.2	6.8	18.2	17.5	13.2	12.1	11.0	7.2	14.8	14.2
Balgriffin 220 kV	16.0	16.3	14.8	8.0	19.1	18.4	13.8	10.8	9.5	8.6	13.6	12.9
Ballakelly 220 kV	10.9	21.2	19.5	13.0	16.8	16.4	10.0	14.0	12.4	11.6	13.2	12.7
Ballybeg 110 kV	9.7	6.8	6.4	10.0	8.0	7.8	9.9	6.1	5.7	10.1	7.2	7.0
Ballydine 110 kV	5.7	8.5	7.9	7.0	5.9	5.8	5.4	7.0	6.4	6.7	5.2	5.1
Ballylickey 110 kV	3.2	3.7	3.4	4.3	2.0	2.0	3.3	3.4	3.1	4.4	2.0	1.9
Ballyragget 110 kV	4.2	7.5	7.2	5.1	5.2	5.2	-	-	-	-	-	-
Ballyvouskill 110 kV	23.8	7.8	5.8	18.0	8.3	7.5	22.2	7.1	4.9	17.5	7.7	6.6
Ballyvouskill 220 kV	10.1	9.4	8.2	11.0	9.2	8.8	10.4	7.4	6.1	11.0	7.7	7.2
Ballywater 110 kV	4.6	6.1	5.5	3.2	6.1	5.9	5.3	5.8	4.9	3.3	5.8	5.5
Baltrasna 110 kV	6.0	11.0	10.5	7.3	8.2	8.1	6.2	9.5	9.0	7.3	7.6	7.4
Bandon 110 kV	3.2	7.1	6.5	4.6	5.5	5.4	3.4	6.1	5.6	4.7	5.0	4.9
Banoge 110 kV	6.8	6.7	6.2	7.6	5.8	5.7	7.1	6.1	5.4	7.8	5.4	5.2
Barnahealy A 110 kV	4.4	13.0	12.1	5.2	13.1	12.8	4.8	10.2	9.3	5.4	10.9	10.5
Barnahealy B 110 kV	6.3	12.8	11.8	7.1	12.6	12.3	6.4	10.1	9.2	7.1	10.6	10.2
Baroda 110 kV	3.9	9.4	8.7	4.7	10.4	10.1	4.2	8.1	7.4	5.0	9.3	9.0
Barrymore 110 kV	3.6	8.6	8.2	5.4	6.3	6.2	3.7	7.0	6.6	5.3	5.6	5.5
Bellacorick 110 kV	3.1	4.3	3.9	4.2	4.0	3.9	2.9	3.5	3.2	3.8	3.6	3.4

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Binbane 110 kV	3.5	5.0	4.2	5.1	4.3	4.0	3.5	4.5	3.8	5.1	4.0	3.8
Blackpool 110 kV	6.0	21.7	19.0	7.0	18.9	18.1	6.2	15.0	13.1	7.0	14.8	14.1
Blackrock 110 kV	10.9	11.4	10.3	2.8	10.1	9.8	11.1	9.5	8.8	3.0	9.0	8.8
Blake 110 kV	3.8	8.6	8.2	4.9	5.7	5.6	4.1	7.5	7.0	5.1	5.2	5.1
Boggeragh 110 kV	7.4	8.9	8.2	7.6	5.4	5.3	7.7	7.9	7.1	7.8	5.1	4.9
Booltiagh 110 kV	6.2	8.0	7.5	7.6	6.2	6.1	6.4	7.1	6.6	7.7	5.9	5.8
Bracklone 110 kV	3.3	8.0	7.6	4.4	5.2	5.1	3.6	6.9	6.5	4.5	4.7	4.6
Brinny A 110 kV	3.1	6.3	5.8	4.4	4.6	4.5	3.3	5.5	5.1	4.5	4.3	4.2
Brinny B 110 kV	3.1	6.4	5.9	4.4	4.7	4.6	3.3	5.5	5.1	4.5	4.3	4.2
Butlerstown 110 kV	6.2	12.1	11.0	6.3	11.4	11.0	6.1	9.0	8.1	6.3	9.2	8.9
Cabra 110 kV	12.5	12.6	11.5	5.1	12.1	11.7	12.4	9.7	8.9	5.5	10.1	9.8
Cahir 110 kV	4.9	11.8	10.8	6.0	6.2	6.1	4.2	8.7	7.8	5.3	5.4	5.2
Carrick-on-Shannon 110 kV	4.1	12.5	11.2	4.9	13.0	12.5	4.4	11.0	9.7	5.2	11.7	11.2
Carlow 110 kV	5.1	10.1	9.4	5.8	9.6	9.3	5.3	7.7	7.1	5.9	7.9	7.6
Carrickmines 110 kV	30.1	13.2	11.8	26.1	14.5	13.9	26.3	10.9	9.9	24.0	12.5	12.0
Carrickmines 220 kV	13.5	20.4	17.8	10.0	24.5	23.2	13.2	14.5	12.4	10.5	18.5	17.3
Carrigadrohid 110 kV	6.0	14.3	13.2	6.8	10.6	10.3	5.8	10.9	9.7	6.5	9.1	8.8
Carrowbeg 110 kV	2.7	3.0	2.7	4.0	2.4	2.4	2.7	2.7	2.4	3.8	2.4	2.3
Cashla 110 kV	6.9	17.4	15.7	7.7	21.1	20.2	6.9	13.8	12.3	7.6	17.3	16.4
Cashla 220 kV	8.1	11.8	10.9	10.2	11.2	10.9	8.3	8.6	7.6	9.9	8.9	8.6
Castlebar 110 kV	3.1	5.5	4.9	4.3	3.8	3.7	3.1	4.7	4.2	4.3	4.3	4.1
Castledockrill 110 kV	7.5	8.5	7.4	4.8	10.1	9.5	8.0	7.7	6.3	5.0	9.2	8.4
Castlefarm A 110 kV	7.2	10.0	9.1	8.7	10.1	9.8	7.5	9.3	8.2	9.0	9.9	9.4
Castlefarm B 110 kV	7.2	10.0	9.1	8.7	10.1	9.8	7.5	9.3	8.2	9.0	9.9	9.4
Castlevue 110 kV	3.7	13.7	12.7	4.5	9.6	9.5	4.1	10.3	9.4	4.6	8.0	7.8
Cathaleen's Fall 110 kV	5.5	11.5	9.5	6.5	10.2	9.6	5.0	9.5	7.7	6.1	9.1	8.5
Caulstown 110 kV	5.2	13.7	12.8	5.9	9.4	9.2	5.1	11.2	10.3	5.8	8.4	8.3
Cauteen 110 kV	3.3	8.2	7.7	4.4	4.2	4.2	3.5	7.3	6.7	4.5	4.0	3.9
Central 110 kV	14.3	11.9	10.8	7.7	12.8	12.4	14.1	10.0	9.2	7.9	11.2	10.8
Charleville 110 kV	3.5	6.5	5.9	4.8	4.4	4.2	3.6	5.8	5.2	4.9	4.1	4.0
Cherrywood 110 kV	10.2	11.0	10.0	8.4	11.6	11.2	10.4	9.3	8.6	8.6	10.2	9.9
City West 110 kV	7.1	12.8	11.9	6.2	10.9	10.7	7.5	11.0	10.1	6.4	9.8	9.6
Clahane 110 kV	4.4	8.8	7.3	6.1	7.3	6.9	4.7	7.9	6.3	6.3	6.8	6.4
Clashavoon 110 kV	8.7	16.9	15.3	10.5	15.6	15.1	8.6	13.3	11.5	10.1	13.2	12.6
Clashavoon 220 kV	9.9	10.1	9.1	11.2	9.8	9.4	9.3	7.5	6.3	10.4	7.8	7.3
Cliff 110 kV	4.7	8.5	7.4	5.8	6.9	6.6	4.4	7.0	6.0	5.4	6.3	6.0

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Clonkeen A 110 kV	5.8	6.5	6.1	7.1	4.4	4.3	6.0	5.8	5.3	7.2	4.1	4.0
Clonkeen B 110 kV	10.1	6.6	4.8	7.7	7.3	6.4	10.3	6.1	4.1	7.9	6.9	5.8
Cloon 110 kV	4.2	8.2	7.6	5.3	5.3	5.2	4.4	7.1	6.6	5.4	4.9	4.8
College Park 110 kV	8.4	20.1	18.7	6.5	21.8	21.2	8.3	15.9	14.4	6.7	18.2	17.4
Cookstown 110 kV	8.2	13.6	12.6	6.4	12.5	12.2	8.5	11.6	10.7	6.6	11.1	10.8
Coolroe 110 kV	4.9	11.2	10.4	6.5	9.8	9.5	5.0	8.9	8.1	6.3	8.5	8.3
Coomagearlahy 110 kV	9.8	5.8	4.1	9.7	6.7	5.7	10.1	5.4	3.5	9.9	6.4	5.2
Cordal 110 kV	14.4	6.0	5.7	16.6	6.0	5.9	14.5	5.6	5.2	16.7	5.8	5.6
Corderry 110 kV	3.9	8.8	7.5	5.2	7.6	7.2	4.1	8.1	6.6	5.4	7.2	6.7
Corduff 110 kV	9.7	23.4	21.6	11.1	25.2	24.5	9.2	18.1	16.1	10.3	20.6	19.7
Corduff 220 kV	16.4	25.8	22.6	15.2	29.7	28.2	13.5	14.7	12.6	13.0	18.7	17.4
Corraclassy 110 kV	4.3	7.0	6.6	6.4	4.1	4.1	4.4	6.6	6.1	6.5	4.0	3.9
Cow Cross 110 kV	4.1	13.3	12.4	4.7	10.9	10.7	4.4	10.3	9.4	4.9	9.1	8.9
Crane 110 kV	6.9	9.2	8.1	6.9	9.5	9.0	7.7	8.3	6.9	7.3	8.6	8.0
Cromcastle A 110 kV	11.5	15.2	13.8	6.4	17.9	17.2	11.4	11.8	10.8	6.8	14.6	14.0
Cromcastle B 110 kV	11.5	15.2	13.8	6.4	17.9	17.2	11.4	11.8	10.8	6.8	14.6	14.0
Cuilleen 110 kV	5.2	10.0	9.4	5.5	5.6	5.6	4.1	6.8	6.6	4.9	4.7	4.6
Cullenagh 110 kV	7.8	14.5	13.2	8.8	15.8	15.3	7.3	10.8	9.6	8.2	12.5	11.9
Cullenagh 220 kV	9.7	8.7	8.1	11.3	8.1	7.9	8.6	6.5	5.9	10.1	6.6	6.4
Cunghill 110 kV	3.4	6.3	5.7	4.7	5.4	5.2	3.4	5.5	4.8	4.6	5.0	4.7
Cushaling 110 kV	6.7	12.4	11.1	8.2	13.1	12.5	6.4	9.5	8.4	7.9	10.6	10.1
Dallow 110 kV	3.5	5.7	5.5	4.7	3.4	3.4	3.6	5.1	4.9	4.7	3.1	3.1
Dalton 110 kV	2.8	4.6	4.2	3.9	2.8	2.7	2.8	4.1	3.8	3.9	2.8	2.7
Dardistown 110 kV	14.5	15.4	13.9	12.0	19.0	18.2	13.7	12.0	10.9	11.8	15.3	14.6
Derrybrien 110 kV	3.1	5.0	4.2	4.5	4.3	4.1	3.2	4.6	3.9	4.6	4.1	3.9
Derryiron 110 kV	5.6	10.1	9.6	7.4	9.3	9.1	5.3	6.5	6.0	6.5	6.9	6.7
Doon 110 kV	5.3	8.7	8.0	6.5	5.4	5.3	5.0	7.0	6.4	6.1	4.8	4.6
Dromada 110 kV	9.8	7.0	5.9	6.9	5.9	5.6	10.1	6.5	5.3	7.0	5.6	5.3
Drumkeen 110 kV	3.9	7.7	5.9	5.3	6.2	5.7	4.0	7.1	5.3	5.4	5.9	5.4
Drumline 110 kV	3.2	8.9	8.2	4.3	7.7	7.6	3.4	7.6	6.9	4.4	7.0	6.8
Drybridge 110 kV	5.5	15.3	14.1	6.6	11.9	11.7	5.7	12.6	11.5	6.6	10.6	10.3
Dundalk 110 kV	3.5	9.3	8.6	4.6	7.8	7.7	3.6	8.3	7.7	4.7	7.3	7.1
Dunfirth 110 kV	4.6	6.8	6.6	5.8	4.3	4.2	4.8	5.4	5.2	5.9	3.7	3.6
Dungarvan 110 kV	5.7	6.4	6.1	6.6	3.9	3.8	5.8	5.4	5.1	6.6	3.5	3.5
Dunmanway 110 kV	5.5	9.6	8.7	7.1	7.4	7.2	5.8	8.2	7.3	7.3	6.7	6.5
Dunstown 220 kV	11.4	20.9	18.9	11.3	21.3	20.6	12.7	15.7	13.5	12.1	17.3	16.3

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Dunstown 400 kV	16.2	8.3	7.9	15.5	7.7	7.6	16.8	6.3	5.7	15.0	6.4	6.2
Ennis 110 kV	4.0	12.1	11.0	5.4	10.2	9.9	4.3	10.2	9.1	5.5	9.2	8.9
Fassaroe East 110 kV	5.1	8.4	7.9	5.5	6.0	5.9	5.3	7.3	6.9	5.6	5.5	5.4
Fassaroe West 110 kV	5.2	8.6	8.0	5.6	6.2	6.1	5.5	7.5	7.0	5.7	5.7	5.6
Finglas 220 kV	17.8	25.4	22.0	16.3	30.3	28.6	13.9	14.4	12.3	13.4	18.7	17.4
Finnstown 110 kV	16.5	17.6	16.0	8.0	19.9	19.2	16.0	14.5	13.1	8.4	17.1	16.4
Finnstown 220 kV	9.9	25.3	22.1	8.9	25.5	24.4	11.0	17.5	14.6	9.8	19.4	18.1
Finglas A 110 kV	6.5	15.7	14.8	5.4	13.5	13.3	6.6	13.0	11.9	5.5	11.9	11.6
Finglas B 110 kV	24.2	17.6	15.7	21.3	21.3	20.4	19.4	13.3	12.0	18.1	16.8	16.1
Finglas C 110 kV	39.1	14.8	13.4	31.7	15.7	15.1	27.0	11.1	10.1	25.1	12.5	12.1
Flagford 110 kV	4.4	13.1	11.8	5.3	15.2	14.6	4.7	11.5	10.1	5.6	13.6	12.9
Flagford 220 kV	7.4	7.9	7.4	9.8	7.1	6.9	7.9	6.9	6.2	10.0	6.4	6.2
Francis Street A 110 kV	10.4	13.0	11.7	5.4	14.9	14.3	10.6	11.0	10.1	5.5	13.0	12.5
Francis Street B 110 kV	12.4	13.4	12.3	6.5	16.0	15.5	12.4	11.3	10.4	6.7	13.9	13.4
Galway 110 kV	4.5	13.0	11.7	5.2	13.2	12.7	4.7	10.6	9.5	5.3	11.3	10.8
Garrow 110 kV	21.2	7.5	5.5	15.9	8.1	7.2	20.4	6.8	4.7	15.7	7.6	6.4
Garvagh 110 kV	4.4	6.7	5.7	6.1	5.7	5.4	4.6	6.2	5.1	6.2	5.5	5.1
Gilra 110 kV	3.0	6.8	6.4	4.0	5.1	5.0	3.2	6.2	5.7	4.0	4.7	4.7
Glanagow 220 kV	15.8	12.1	10.9	16.9	14.8	14.2	12.1	8.2	7.3	12.9	10.6	10.1
Glanlee 110 kV	9.5	5.7	4.0	8.8	6.5	5.6	9.8	5.3	3.4	8.9	6.2	5.1
Glasmore A 110 kV	4.4	8.2	7.6	4.8	5.5	5.4	4.7	7.0	6.5	5.0	5.1	5.0
Glasmore B 110 kV	3.9	7.0	6.6	4.5	4.5	4.4	4.1	6.1	5.7	4.7	4.2	4.1
Glenlara A 110 kV	3.0	3.1	2.6	4.5	2.4	2.3	3.0	2.9	2.5	4.6	2.3	2.2
Glenlara B 110 kV	13.3	5.5	5.2	10.9	3.8	3.7	13.5	5.2	4.8	11.0	3.6	3.5
Glenree 110 kV	3.7	5.2	4.8	4.6	4.1	4.0	3.2	4.2	3.7	4.1	3.5	3.4
Golagh 110 kV	4.0	5.4	4.6	5.2	3.4	3.3	4.0	4.9	4.2	5.1	3.2	3.0
Gorman 110 kV	6.3	16.1	14.8	7.4	16.9	16.4	6.7	13.6	12.3	7.7	14.9	14.4
Gorman 220 kV	8.7	12.8	12.1	10.2	9.8	9.6	9.2	10.4	9.4	10.4	8.7	8.4
Gortawee 110 kV	4.4	6.7	6.2	6.7	4.8	4.7	4.5	6.3	5.8	6.7	4.6	4.5
Grange 110 kV	11.1	15.0	13.6	5.5	17.5	16.8	11.0	11.7	10.7	5.9	14.2	13.7
Grange Castle 110 kV	17.0	17.7	16.1	8.5	20.2	19.4	16.5	14.6	13.2	8.8	17.3	16.5
Great Island 110 kV	7.8	15.9	14.4	8.7	19.6	18.8	6.6	10.5	9.3	7.2	13.7	13.0
Great Island 220 kV	10.5	10.4	9.5	12.3	10.4	10.1	8.7	7.3	6.4	10.1	8.1	7.7
Griffinrath A 110 kV	6.7	11.5	10.8	7.1	11.2	11.0	7.2	9.7	9.0	7.5	9.9	9.6
Griffinrath B 110 kV	10.6	13.1	11.7	5.1	14.8	14.2	10.8	11.1	10.2	5.2	13.0	12.5
Harnetts 110 kV	4.2	10.8	10.1	5.2	7.3	7.1	4.5	8.8	8.0	5.3	6.5	6.3

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Heuston 110 kV	13.4	13.7	12.5	7.8	16.5	15.9	13.3	11.5	10.6	8.0	14.2	13.7
Huntstown A 220 kV	16.8	24.4	21.3	13.7	29.2	27.6	13.7	14.1	12.1	12.3	18.3	17.1
Huntstown B 220 kV	15.5	22.9	20.4	11.5	26.7	25.5	12.9	13.4	11.6	10.9	17.1	16.0
Ikerrin 110 kV	5.5	5.6	5.3	7.0	3.4	3.3	5.6	5.1	4.8	7.1	3.2	3.1
Inchicore 220 kV	10.8	21.2	18.6	7.5	24.8	23.5	11.1	15.0	12.8	8.2	18.7	17.5
Inchicore A 110 kV	27.8	15.1	13.8	25.2	18.7	18.0	24.5	12.5	11.5	23.0	15.9	15.3
Inchicore B 110 kV	26.8	18.9	17.1	22.2	23.2	22.3	23.5	15.4	13.9	20.5	19.5	18.6
Inniscarra 110 kV	4.7	10.9	10.1	6.1	9.2	9.0	4.7	8.6	7.9	6.0	8.1	7.8
Irishtown 220 kV	13.5	21.6	18.9	12.0	26.2	24.7	12.8	15.0	12.8	11.9	19.3	18.0
Knockavanna 110 kV	3.1	5.2	4.5	4.5	4.3	4.2	3.2	4.9	4.1	4.6	4.2	4.0
Kellis 110 kV	6.0	10.8	10.1	7.1	12.0	11.7	6.1	8.1	7.5	7.0	9.5	9.2
Kellis 220 kV	8.0	8.5	8.1	9.8	7.0	6.9	8.0	6.8	6.2	9.6	6.0	5.9
Kilbarry 110 kV	6.0	22.1	19.3	7.6	19.2	18.4	6.2	15.2	13.2	7.5	15.0	14.3
Kilkenny 110 kV	4.4	10.1	9.5	5.2	10.6	10.3	3.0	4.6	4.4	3.4	5.7	5.5
Kill Hill 110 kV	5.2	7.9	6.9	6.3	4.2	4.1	5.2	6.9	6.0	6.2	3.9	3.8
Killonan 110 kV	5.5	20.5	18.3	6.9	21.0	20.2	5.8	15.8	13.7	7.0	17.3	16.4
Killonan 220 kV	5.5	10.9	10.2	7.5	10.1	9.9	6.5	8.6	7.6	8.2	8.5	8.1
Killoteran 110 kV	6.0	12.9	11.7	5.6	12.7	12.3	5.9	9.4	8.4	5.6	10.1	9.7
Kilmahud 110 kV	12.9	16.9	15.3	6.6	19.0	18.3	13.0	14.0	12.6	6.9	16.4	15.7
Kilmore 110 kV	15.4	16.2	14.6	9.2	19.4	18.5	14.3	12.4	11.3	9.4	15.5	14.9
Kilpaddoge 110 kV	12.1	20.1	17.3	14.0	19.2	18.2	11.3	16.1	13.1	13.1	16.2	15.0
Kilpaddoge 220 kV	16.4	22.6	19.9	16.8	25.7	24.5	13.2	12.7	10.5	14.0	15.8	14.5
Kilteel 110 kV	4.2	8.3	7.8	5.4	7.1	7.0	4.5	7.4	6.7	5.5	6.8	6.5
Kinnegad 110 kV	4.6	9.0	8.6	6.2	7.4	7.3	4.9	5.3	5.0	6.4	4.9	4.8
Kishkeam 110 kV	24.7	7.6	7.2	23.0	7.2	7.1	23.9	7.0	6.4	22.6	6.8	6.6
Kishkeam 220 kV	10.1	9.2	8.3	11.0	8.5	8.2	10.7	7.4	6.2	11.4	7.3	6.9
Knockacummer 110 kV	8.5	4.9	4.6	6.0	3.4	3.4	8.8	4.6	4.3	6.1	3.3	3.2
Knockanure A 110 kV	27.3	9.9	8.6	22.7	8.5	8.2	25.6	8.9	7.5	22.1	7.9	7.5
Knockanure B 110 kV	5.0	9.7	8.3	6.3	7.3	7.0	5.3	8.6	7.1	6.5	6.7	6.4
Knockanure 220 kV	11.0	13.4	12.2	10.8	11.3	10.9	11.9	9.7	8.2	11.5	9.1	8.6
Knockearagh 110 kV	5.7	6.2	5.6	7.8	5.0	4.9	5.9	5.6	5.0	7.9	4.7	4.5
Knockmullen 110 kV	4.2	6.5	6.2	5.2	4.3	4.2	-	-	-	-	-	-
Knocknagashel 110 kV	11.9	6.0	5.4	9.7	3.4	3.4	12.1	5.6	5.0	9.7	3.2	3.2
Knocknagreenan 110 kV	5.4	13.4	12.4	5.4	10.0	9.8	-	-	-	-	-	-
Knockraha 110 kV	7.9	24.9	22.1	9.1	23.7	22.8	7.0	15.9	13.9	7.9	16.5	15.7
Knockraha A 220 kV	8.7	12.6	11.4	9.7	13.5	13.0	6.3	6.5	5.7	7.0	7.8	7.4

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Knockraha B 220 kV	11.8	9.7	9.0	12.3	9.6	9.4	10.4	7.1	6.5	11.1	7.6	7.3
Knockumber 110 kV	3.6	8.8	8.3	4.5	6.3	6.2	3.8	8.0	7.5	4.7	6.0	5.9
Lanesboro 110 kV	3.6	11.5	10.7	4.9	10.8	10.6	3.8	9.4	8.8	5.1	9.9	9.6
Laois 110 kV	5.8	14.2	13.4	6.2	17.4	17.1	6.3	10.6	9.9	6.7	13.5	13.1
Laois 400 kV	14.2	7.7	7.4	11.1	7.0	6.8	14.6	5.9	5.4	13.6	6.3	6.1
Letterkenny 110 kV	4.5	9.4	7.1	6.1	8.1	7.4	4.7	8.6	6.4	6.2	7.6	6.9
Liberty A 110 kV	5.1	18.1	16.1	5.6	14.8	14.3	5.4	13.2	11.7	5.8	12.1	11.7
Liberty B 110 kV	5.0	18.1	16.1	5.3	14.8	14.3	5.4	13.1	11.6	5.5	12.1	11.6
Limerick 110 kV	4.7	17.6	15.8	5.7	15.3	14.8	4.9	13.9	12.1	5.8	13.1	12.5
Lisdrum 110 kV	2.7	5.3	4.9	3.9	3.2	3.1	2.8	5.0	4.7	3.9	3.1	3.0
Lisheen 110 kV	5.1	5.5	4.8	6.5	3.1	3.0	5.2	5.0	4.4	6.6	2.9	2.9
Lodgewood 110 kV	9.6	9.7	8.4	10.1	12.0	11.3	10.3	8.7	7.1	10.6	10.8	9.9
Lodgewood 220 kV	9.2	7.7	7.1	10.7	7.4	7.2	9.5	6.3	5.5	10.8	6.4	6.1
Longpoint 220 kV	11.2	8.4	7.7	13.7	9.1	8.8	6.6	4.2	3.8	7.5	5.2	5.0
Louth 220 kV	11.1	22.0	20.2	14.6	17.2	16.9	10.2	14.5	12.7	12.7	13.6	13.0
Louth A 110 kV	6.9	13.8	12.8	8.1	15.9	15.5	7.0	12.1	11.0	8.1	14.3	13.7
Louth B 110 kV	7.5	15.1	14.1	8.6	17.6	17.1	7.5	13.0	11.9	8.5	15.6	15.0
Macetown 110 kV	6.9	17.5	16.3	6.8	16.4	16.1	7.0	14.2	12.9	6.9	14.2	13.7
Macroom 110 kV	7.0	16.0	14.5	7.8	12.6	12.3	7.0	12.2	10.7	7.7	10.8	10.3
Mallow 110 kV	3.5	6.8	6.3	5.2	5.3	5.2	3.6	5.9	5.4	5.3	4.9	4.8
Marina 110 kV	5.9	20.4	17.9	7.9	16.1	15.6	6.2	14.3	12.6	7.8	13.0	12.5
Maynooth A 110 kV	10.4	14.6	13.6	11.2	17.5	17.0	11.2	12.0	11.0	11.7	14.8	14.3
Maynooth B 110 kV	7.9	18.8	17.6	9.7	17.0	16.6	8.5	15.3	13.9	10.0	14.7	14.2
Maynooth A 220 kV	8.6	21.1	19.0	9.0	18.9	18.3	9.9	15.7	13.4	9.8	15.4	14.6
Maynooth B 220 kV	9.1	23.8	21.3	9.2	21.4	20.7	10.4	16.8	14.3	10.0	16.9	15.9
McDermott 110 kV	17.0	13.6	12.3	6.4	13.6	13.1	15.5	10.2	9.4	6.9	11.0	10.7
Meath Hill 110 kV	4.0	9.7	8.9	5.3	7.6	7.4	4.2	8.7	8.0	5.4	7.1	7.0
Meentycat 110 kV	3.7	6.4	4.9	5.3	5.3	4.9	3.8	6.0	4.5	5.3	5.1	4.6
Midleton 110 kV	3.5	11.4	10.7	4.6	8.7	8.5	3.8	8.8	8.2	4.7	7.4	7.2
Milltown A 110 kV	14.3	14.1	12.6	6.8	16.3	15.6	14.2	11.9	10.9	7.1	14.1	13.6
Milltown B 110 kV	8.6	12.1	11.1	4.0	14.2	13.7	8.9	10.2	9.5	4.2	12.4	12.0
Misery Hill 110 kV	12.9	13.8	12.4	7.8	16.1	15.4	12.9	11.6	10.6	7.7	13.9	13.4
Moneypoint G1 400 kV	24.3	11.1	10.3	22.5	11.6	11.3	19.3	7.3	6.4	18.9	8.7	8.2
Moneypoint G2 400 kV	55.5	4.9	4.6	54.2	5.5	5.4	19.3	7.3	6.4	18.9	8.7	8.2
Moneypoint G3 400 kV	24.3	11.1	10.3	22.5	11.6	11.3	19.3	7.3	6.4	18.9	8.7	8.2
Moneteen 110 kV	5.2	12.1	11.1	6.3	8.7	8.5	5.4	10.3	9.2	6.3	7.9	7.7

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Moneypoint 110 kV	14.9	10.1	9.4	17.7	9.6	9.4	14.0	8.7	7.7	16.7	8.5	8.1
Moneypoint 220 kV	16.3	22.4	19.8	16.3	25.4	24.2	13.3	12.6	10.5	13.9	15.2	14.0
Monread 110 kV	3.9	8.3	7.7	4.9	7.4	7.3	4.2	7.2	6.6	5.1	6.9	6.7
Mount Lucas 110 kV	6.2	9.5	8.2	7.2	6.5	6.3	6.7	7.6	6.5	7.5	5.7	5.5
Moy 110 kV	4.0	5.2	4.8	5.2	5.5	5.3	3.0	3.7	3.3	3.7	4.3	4.1
Mullagharlin 110 kV	3.6	9.5	8.8	4.6	7.8	7.6	3.7	8.4	7.9	4.7	7.2	7.1
Mullingar 110 kV	3.5	7.7	7.2	4.9	7.0	6.8	2.8	4.1	3.9	3.8	4.3	4.2
Mulreavy 110 kV	7.7	5.3	4.7	7.5	2.6	2.6	7.6	4.8	4.2	7.5	2.5	2.4
Mungret A 110 kV	4.9	11.4	10.5	5.9	8.1	7.9	5.1	9.8	8.8	6.0	7.3	7.1
Mungret B 110 kV	4.9	11.4	10.6	5.9	8.1	7.9	5.1	9.8	8.8	6.0	7.3	7.1
Nangor 110 kV	14.2	17.2	15.6	6.8	19.4	18.7	14.1	14.2	12.8	7.2	16.7	16.0
Navan 110 kV	5.3	14.0	12.9	6.3	13.0	12.7	5.7	12.0	11.0	6.6	11.8	11.4
Nenagh 110 kV	2.6	3.8	3.7	3.8	2.1	2.1	2.7	3.5	3.4	3.9	2.0	2.0
Newbridge 110 kV	4.0	11.2	10.3	4.9	10.2	10.0	4.4	9.4	8.5	5.1	9.1	8.8
Nore 110 kV	4.4	9.7	9.2	5.4	10.3	10.1	2.9	4.5	4.2	3.5	5.5	5.4
North Quays 110 kV	17.4	14.4	12.9	6.4	16.3	15.6	16.8	12.1	11.0	6.6	14.1	13.6
North Wall 110 kV	16.4	23.1	20.2	9.6	26.1	24.7	13.1	13.3	11.5	9.8	16.6	15.6
Oldcourt A 110 kV	3.6	11.1	10.4	4.4	8.3	8.1	3.9	8.8	8.1	4.5	7.1	7.0
Oldcourt B 110 kV	3.7	11.2	10.5	4.4	8.4	8.2	4.0	8.8	8.2	4.5	7.2	7.0
Oldstreet 220 kV	15.9	11.1	10.5	13.0	11.9	11.7	13.5	7.4	6.8	12.1	8.7	8.4
Oldstreet 400 kV	16.8	8.6	8.2	11.0	7.9	7.8	14.9	6.2	5.6	11.0	6.3	6.1
Oughtragh 110 kV	3.8	5.2	4.7	5.0	3.1	3.1	4.0	4.7	4.2	5.1	2.9	2.9
Pelletstown 110 kV	14.0	12.7	11.6	8.2	11.9	11.5	13.7	9.8	9.0	8.6	9.9	9.6
Platin 110 kV	5.1	14.2	13.2	5.8	9.9	9.7	5.0	11.6	10.6	5.7	8.9	8.7
Pollaphuca 110 kV	3.2	3.1	3.1	4.6	2.5	2.5	2.7	2.4	2.3	4.0	2.2	2.2
Poolbeg A 110 kV	24.5	15.0	13.4	20.6	17.9	17.1	22.6	12.6	11.4	19.6	15.4	14.8
Poolbeg B 110 kV	24.5	15.0	13.4	20.6	17.9	17.1	22.6	12.6	11.4	19.6	15.3	14.8
Poolbeg A 220 kV	16.8	23.0	20.2	10.5	27.2	25.8	13.6	13.4	11.5	10.5	17.2	16.1
Poolbeg B 220 kV	11.8	19.6	17.3	11.1	21.3	20.3	11.9	14.1	12.1	11.3	16.5	15.5
Poppintree 110 kV	14.1	16.4	14.8	7.7	19.5	18.7	13.4	12.5	11.4	8.0	15.6	15.0
Portan 400 kV	20.2	9.0	8.5	21.2	10.4	10.2	18.4	6.6	6.0	18.9	8.1	7.8
Portlaoise 110 kV	4.3	12.8	12.1	5.2	10.5	10.3	4.9	10.3	9.6	5.6	9.0	8.8
Pottery 110 kV	17.2	12.4	11.2	5.6	12.6	12.1	16.6	10.3	9.4	5.8	11.0	10.6
Prospect 220 kV	13.2	17.9	16.2	8.1	16.7	16.2	12.0	11.0	9.4	8.9	11.7	11.0
Raffeen A 110 kV	5.3	15.3	14.1	6.2	17.5	17.0	5.6	11.6	10.5	6.3	13.9	13.3
Raffeen 220 kV	14.8	12.2	11.0	14.3	14.7	14.1	11.6	8.2	7.4	11.7	10.6	10.1

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Raffeen B 110 kV	7.7	15.0	13.7	8.9	17.1	16.5	7.6	11.5	10.4	8.5	13.7	13.1
Ralappane 110 kV	9.8	16.8	14.8	10.6	14.2	13.7	9.7	13.8	11.5	10.4	12.3	11.7
Rathkeale 110 kV	3.5	8.0	7.4	4.7	4.5	4.4	3.7	7.0	6.3	4.7	4.1	4.0
Ratrussan 110 kV	3.5	7.6	6.3	4.6	8.0	7.5	3.6	7.1	5.8	4.7	7.8	7.2
Reamore 110 kV	4.4	8.9	7.5	3.8	7.2	6.8	4.7	8.0	6.5	3.9	6.7	6.3
Richmond A 110 kV	3.0	7.6	7.2	4.2	6.5	6.4	3.1	6.5	6.1	4.3	6.0	5.9
Rinawade 110 kV	4.8	11.6	11.1	5.9	7.8	7.7	5.1	9.8	9.1	6.0	7.0	6.9
Ringaskiddy 110 kV	5.5	12.4	11.5	6.1	11.7	11.4	5.7	9.8	9.0	6.1	9.8	9.5
Ringsend 110 kV	24.8	15.2	13.5	20.8	18.1	17.2	22.8	12.7	11.5	19.7	15.4	14.8
Ryebrook 110 kV	5.4	15.7	14.7	6.0	10.7	10.5	5.7	13.1	11.8	6.1	9.6	9.4
Salthill 110 kV	4.5	11.9	10.7	4.0	11.7	11.3	4.6	9.7	8.8	4.1	10.1	9.8
Screeb 110 kV	3.4	2.6	2.5	4.4	1.5	1.4	3.4	2.4	2.3	4.4	1.4	1.4
Seal Rock A 110 kV	7.7	10.2	9.3	9.4	10.7	10.3	8.0	9.5	8.4	9.7	10.5	10.0
Seal Rock B 110 kV	7.7	10.2	9.3	9.4	10.7	10.3	8.0	9.5	8.4	9.7	10.5	10.0
Shankill 110 kV	3.5	9.1	7.9	4.7	7.7	7.4	3.7	8.3	7.2	4.9	7.3	7.0
Shannonbridge 110 kV	6.1	17.5	16.7	8.0	19.3	18.9	6.2	14.8	14.0	8.0	17.3	16.9
Shannonbridge 220 kV	7.0	7.5	7.3	9.3	6.4	6.3	7.4	6.6	6.2	9.6	5.8	5.7
Shellybanks A 220 kV	16.4	23.0	20.2	10.4	27.2	25.8	13.4	13.3	11.5	10.4	17.2	16.1
Shellybanks B 220 kV	13.1	21.1	18.5	11.3	25.5	24.1	12.3	14.5	12.5	11.1	18.8	17.5
Shelton Abbey 110 kV	7.3	8.0	7.3	7.3	8.1	7.9	7.6	7.1	6.3	7.5	7.3	7.1
Singland 110 kV	5.5	16.9	15.3	6.7	15.0	14.5	5.5	13.1	11.6	6.5	12.7	12.2
Sligo 110 kV	3.8	10.3	9.0	4.8	9.2	8.8	4.0	9.0	7.7	4.9	8.3	7.9
Somerset 110 kV	3.0	8.3	7.9	4.0	5.2	5.2	3.1	7.3	7.0	4.1	4.8	4.7
Sorne Hill 110 kV	3.7	3.7	2.8	4.1	4.0	3.5	3.8	3.5	2.6	4.2	3.7	3.4
Srananagh 110 kV	4.7	12.0	10.4	5.9	12.5	11.8	5.0	10.5	8.8	6.1	11.2	10.5
Srananagh 220 kV	7.4	4.9	4.6	10.0	3.9	3.8	7.7	4.5	4.1	10.1	3.6	3.5
Stevenstown 110 kV	4.2	6.6	6.2	4.7	4.2	4.2	4.4	5.8	5.5	4.8	3.9	3.9
Stratford 110 kV	3.2	4.7	4.5	4.3	3.4	3.3	3.1	3.8	3.6	4.1	3.0	2.9
Suir 110 kV	4.8	11.1	10.2	5.1	6.0	5.9	3.9	8.0	7.3	4.5	5.1	5.0
Taney 110 kV	6.4	10.7	9.9	2.3	11.1	10.8	6.6	9.2	8.6	2.4	9.9	9.7
Tarbert 110 kV	34.4	16.3	15.5	37.0	15.7	15.4	22.1	10.7	9.9	25.4	11.8	11.4
Tarbert 220 kV	16.0	21.6	19.1	16.8	24.7	23.6	12.6	12.1	10.1	13.6	15.2	14.0
Tawnaghmore A 110 kV	3.9	4.3	4.1	5.3	4.5	4.4	2.8	3.1	2.8	3.5	3.5	3.4
Tawnaghmore B 110 kV	3.8	4.3	4.0	5.1	4.2	4.1	2.9	3.1	2.8	3.6	3.3	3.2
Thornberry 110 kV	4.6	7.9	7.2	6.1	6.6	6.4	5.2	6.1	5.5	6.5	5.6	5.4
Thurles 110 kV	5.5	6.8	5.9	8.2	4.7	4.5	5.7	6.1	5.4	8.2	4.4	4.3

Table E-10 Short Circuit Currents for Maximum and Minimum Demand in 2015 (continued)

Bus	Winter Peak 2015						Summer Valley 2015					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Tievebrack 110 kV	3.6	4.5	3.8	5.0	3.0	2.9	3.6	4.1	3.5	5.1	2.9	2.7
Tipperary 110 kV	3.1	7.9	7.4	4.4	4.1	4.0	3.3	6.8	6.3	4.4	3.8	3.7
Tonroe 110 kV	2.7	3.6	3.3	3.8	2.1	2.1	2.7	3.3	3.1	3.9	2.0	2.0
Trabeg 110 kV	6.0	20.1	17.7	7.4	15.9	15.4	6.3	14.2	12.5	7.4	12.8	12.3
Tralee 110 kV	5.7	10.9	9.0	7.1	8.5	8.1	6.2	9.6	7.7	7.4	7.9	7.4
Trien A 110 kV	4.8	9.2	7.7	6.5	7.5	7.1	5.1	8.2	6.6	6.7	6.9	6.5
Trien B 110 kV	15.6	8.1	7.1	12.8	5.8	5.6	15.7	7.4	6.4	12.8	5.4	5.2
Trillick 110 kV	3.7	4.0	3.0	4.2	3.8	3.4	3.8	3.8	2.8	4.3	3.6	3.3
Trinity 110 kV	11.5	13.4	12.0	6.6	15.6	14.9	-	-	-	-	-	-
Tullabrack 110 kV	6.5	7.5	7.1	7.3	5.6	5.5	6.8	6.7	6.1	7.5	5.2	5.0
Turlough 220 kV	10.8	13.0	12.0	12.1	11.3	11.0	12.1	11.0	9.8	12.9	10.1	9.7
Tynagh 220 kV	15.1	12.2	11.4	17.3	13.5	13.1	10.8	7.1	6.5	11.9	8.8	8.5
Waterford 110 kV	7.2	14.2	12.8	7.4	13.9	13.4	6.7	10.2	9.0	6.9	10.9	10.4
Wexford 110 kV	4.0	7.3	6.3	5.3	6.3	6.0	4.4	6.3	5.3	5.6	5.7	5.4
Whitegate 110 kV	4.3	10.4	9.8	5.1	10.4	10.2	4.5	8.2	7.7	5.2	8.7	8.5
Wolfe Tone 110 kV	14.7	13.2	12.0	5.8	13.1	12.7	14.0	10.0	9.2	6.3	10.8	10.4
Woodland A 220 kV	12.4	24.5	22.2	12.4	25.8	24.9	12.8	16.0	13.7	12.5	18.5	17.4
Woodland B 220 kV	32.7	7.7	7.5	24.5	9.4	9.3	27.9	6.5	6.1	22.3	8.1	7.9
Woodland 400 kV	20.2	9.0	8.5	21.2	10.4	10.2	18.4	6.6	6.0	18.9	8.1	7.8

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018

Bus	Winter Peak 2018						Summer Valley 2018					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Adamstown 110 kV	13.2	17.0	15.5	6.5	19.1	18.4	13.3	14.2	12.8	6.8	16.5	15.9
Agannnygal 110 kV	3.0	6.1	5.4	4.3	4.7	4.5	3.1	5.8	5.0	4.4	4.5	4.4
Aghada 110 kV	4.6	9.5	9.0	5.6	10.9	10.7	4.7	7.7	7.2	5.6	9.1	8.9
Aghada A 220 kV	10.2	7.7	7.1	12.2	8.1	7.9	6.6	4.2	3.9	7.5	5.1	5.0
Aghada B 220 kV	15.6	11.9	10.7	15.5	14.5	13.9	11.6	8.0	7.2	11.9	10.4	9.9
Aghada C 220 kV	15.6	11.9	10.7	15.5	14.5	13.9	11.6	8.0	7.2	11.9	10.4	9.9
Aghada D 220 kV	11.1	8.3	7.7	13.4	9.0	8.7	6.6	4.2	3.9	7.4	5.3	5.1
Ahane 110 kV	4.5	13.8	12.8	5.5	10.6	10.4	4.7	11.6	10.5	5.6	9.6	9.3
Anner 110 kV	4.7	7.7	7.1	5.9	4.7	4.7	4.5	6.4	5.9	5.7	4.3	4.2
Ardnacrusha 110 kV	5.5	16.8	15.1	6.7	16.8	16.2	5.2	12.9	11.5	6.2	14.1	13.5

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Ardnagappary 110 kV	2.7	2.2	1.9	4.0	1.2	1.2	2.8	2.1	1.9	4.1	1.2	1.2
Arigna 110 kV	3.8	7.8	6.9	5.0	5.4	5.3	3.9	7.2	6.3	5.1	5.2	5.0
Arklow 110 kV	10.7	9.2	8.2	11.5	11.0	10.6	11.0	8.1	7.2	11.8	9.9	9.4
Arklow 220 kV	9.1	8.2	7.5	10.3	7.5	7.3	9.5	6.9	6.1	10.6	6.6	6.4
Artane 110 kV	13.6	13.2	12.0	6.3	13.6	13.1	13.3	10.1	9.3	6.7	11.1	10.7
Arva 110 kV	3.7	9.9	8.9	5.0	7.2	7.0	3.9	9.2	8.1	5.1	6.9	6.7
Athea 110 kV	16.3	7.7	6.4	16.4	6.4	6.1	16.5	7.3	5.9	16.5	6.3	5.9
Athlone 110 kV	5.3	10.3	9.7	6.2	5.7	5.6	4.2	7.2	7.0	5.4	4.9	4.8
Athy 110 kV	3.2	7.5	7.2	4.2	5.6	5.5	3.4	6.5	6.2	4.4	5.1	5.0
Aughinish 110 kV	7.9	10.3	9.3	9.9	10.7	10.3	8.2	9.7	8.5	10.2	10.5	10.0
Balgriffin 110 kV	13.9	15.9	14.3	6.8	18.4	17.7	13.3	12.3	11.2	7.2	15.0	14.4
Balgriffin 220 kV	16.0	16.6	15.1	8.0	19.4	18.7	14.1	11.1	9.8	8.6	13.9	13.2
Ballakelly 220 kV	11.1	21.1	19.3	13.1	16.7	16.3	10.3	14.3	12.6	11.9	13.4	12.8
Ballybeg 110 kV	9.7	6.8	6.4	10.0	8.0	7.8	9.8	6.1	5.7	10.1	7.3	7.0
Ballycummin 110 kV	4.7	14.0	12.7	5.9	11.3	11.0	4.9	11.8	10.5	6.0	10.2	9.9
Ballydine 110 kV	5.7	8.5	7.9	7.0	5.9	5.8	5.4	7.0	6.5	6.7	5.3	5.2
Ballylickey 110 kV	3.2	3.7	3.4	4.3	2.0	2.0	3.3	3.4	3.2	4.4	2.0	1.9
Ballyragget 110 kV	4.2	7.5	7.2	5.1	5.2	5.1	4.2	6.0	5.7	5.0	4.5	4.5
Ballyvouskill 110 kV	23.8	7.7	5.8	18.0	8.2	7.4	22.1	7.1	5.0	17.4	7.7	6.7
Ballyvouskill 220 kV	10.1	9.3	8.2	11.0	9.1	8.7	10.1	7.6	6.2	10.9	7.8	7.3
Ballywater 110 kV	4.6	6.0	5.5	3.2	6.0	5.8	5.2	5.9	5.0	3.3	5.8	5.5
Baltrasna 110 kV	6.0	11.0	10.4	7.3	8.2	8.1	6.2	9.6	9.0	7.3	7.6	7.5
Bandon 110 kV	3.2	7.1	6.5	4.6	5.5	5.4	3.4	6.2	5.6	4.7	5.1	4.9
Banoge 110 kV	6.8	6.7	6.1	7.6	5.8	5.7	7.1	6.1	5.5	7.8	5.4	5.2
Barnahealy A 110 kV	4.4	13.0	12.1	5.2	13.0	12.7	4.7	10.2	9.4	5.4	10.9	10.5
Barnahealy B 110 kV	6.3	12.8	11.8	7.1	12.6	12.2	6.3	10.2	9.3	7.0	10.6	10.3
Baroda 110 kV	3.9	9.4	8.7	4.7	10.4	10.1	4.1	8.2	7.6	4.9	9.5	9.2
Barrymore 110 kV	3.6	8.6	8.1	5.4	6.2	6.2	3.7	7.0	6.6	5.3	5.6	5.5
Bellacorick 110 kV	3.1	4.3	3.9	4.2	4.0	3.9	2.9	3.5	3.2	3.7	3.6	3.4
Binbane 110 kV	3.4	4.9	4.1	5.1	4.3	4.0	3.5	4.6	3.8	5.1	4.0	3.8
Blackpool 110 kV	6.0	21.6	18.9	7.0	18.8	18.0	6.1	15.2	13.2	7.0	14.9	14.2
Blackrock 110 kV	10.9	11.4	10.3	2.8	10.1	9.8	11.1	9.6	8.8	3.0	9.1	8.8
Blake 110 kV	3.8	8.6	8.2	4.9	5.7	5.6	4.0	7.6	7.1	5.0	5.2	5.2
Boggeragh 110 kV	7.4	8.8	8.2	7.6	5.4	5.3	7.6	7.9	7.1	7.7	5.1	4.9
Booltiaigh 110 kV	6.3	7.9	7.5	7.7	6.2	6.1	6.5	7.3	6.8	7.8	6.0	5.9
Bracklone 110 kV	3.3	7.9	7.6	4.4	5.1	5.1	3.5	7.1	6.7	4.5	4.8	4.7

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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	3.1	6.3	5.8	4.4	4.6	4.5	3.3	5.5	5.1	4.5	4.3	4.2
Brinny B 110 kV	3.1	6.3	5.8	4.4	4.6	4.5	3.3	5.6	5.1	4.5	4.3	4.2
Butlerstown 110 kV	6.2	12.0	11.0	6.3	11.3	11.0	6.0	9.2	8.4	6.2	9.4	9.1
Cabra 110 kV	12.4	12.7	11.6	5.0	12.2	11.8	12.4	9.8	9.0	5.5	10.1	9.8
Cahir 110 kV	4.9	11.8	10.7	6.0	6.2	6.1	4.1	8.7	7.8	5.3	5.4	5.3
Carrick-on-Shannon 110 kV	4.1	12.4	11.1	5.0	12.8	12.3	4.3	11.1	9.8	5.1	11.8	11.3
Carlow 110 kV	5.1	10.2	9.4	5.8	9.6	9.3	5.3	8.0	7.3	5.9	8.1	7.9
Carrickmines 110 kV	30.1	13.2	11.8	26.1	14.6	13.9	26.4	10.9	10.0	24.1	12.6	12.1
Carrickmines 220 kV	13.5	20.6	18.0	9.9	24.8	23.4	13.2	14.7	12.5	10.4	18.8	17.5
Carrigadrohid 110 kV	6.0	14.3	13.1	6.8	10.5	10.3	5.7	11.0	9.8	6.5	9.1	8.8
Carrowbeg 110 kV	2.7	3.0	2.7	4.0	2.4	2.4	2.7	2.7	2.5	3.8	2.4	2.3
Cashla 110 kV	6.9	17.4	15.6	7.7	21.0	20.1	6.9	14.0	12.5	7.6	17.5	16.7
Cashla 220 kV	8.1	11.7	10.8	10.2	11.1	10.8	8.3	8.7	7.8	9.9	9.1	8.7
Castlebar 110 kV	3.1	5.5	4.8	4.3	3.8	3.7	3.1	4.8	4.2	4.3	4.3	4.1
Castledockrill 110 kV	7.5	8.4	7.3	4.8	10.0	9.4	7.9	7.7	6.4	4.9	9.2	8.6
Castlefarm A 110 kV	7.1	9.9	9.0	8.7	10.0	9.7	7.4	9.3	8.2	8.9	9.8	9.4
Castlefarm B 110 kV	7.2	9.9	9.0	8.7	10.0	9.7	7.4	9.3	8.2	9.0	9.8	9.4
Castlevue 110 kV	3.7	13.6	12.6	4.5	9.6	9.4	4.0	10.4	9.5	4.6	8.1	7.9
Cathaleen's Fall 110 kV	5.5	11.4	9.4	6.5	10.1	9.5	5.0	9.5	7.8	6.0	9.2	8.6
Caulstown 110 kV	5.2	13.7	12.8	5.9	9.3	9.2	5.1	11.2	10.3	5.8	8.4	8.3
Cauteen 110 kV	3.2	8.1	7.6	4.4	4.2	4.1	3.4	7.4	6.8	4.5	4.0	3.9
Central 110 kV	14.2	12.0	10.8	7.7	12.9	12.4	14.1	10.0	9.2	7.9	11.3	10.9
Charleville 110 kV	3.5	6.5	5.8	4.8	4.3	4.2	3.6	5.8	5.2	4.9	4.1	4.0
Cherrywood 110 kV	10.2	11.1	10.0	8.4	11.6	11.2	10.4	9.4	8.6	8.6	10.3	9.9
City West 110 kV	7.1	12.8	11.9	6.2	10.9	10.7	7.4	11.0	10.2	6.4	9.9	9.6
Clahane 110 kV	4.4	8.7	7.2	6.1	7.2	6.8	4.7	8.0	6.5	6.2	6.9	6.5
Clashavoon 110 kV	8.7	16.9	15.2	10.5	15.6	15.0	8.5	13.4	11.7	10.0	13.3	12.7
Clashavoon 220 kV	9.9	10.1	9.0	11.2	9.7	9.3	9.1	7.6	6.4	10.2	7.9	7.4
Cliff 110 kV	4.7	8.4	7.3	5.8	6.9	6.6	4.4	7.1	6.1	5.4	6.4	6.0
Clonkeen A 110 kV	5.8	6.4	6.0	7.1	4.4	4.3	6.0	5.9	5.4	7.2	4.1	4.0
Clonkeen B 110 kV	10.1	6.6	4.8	7.7	7.2	6.4	10.2	6.2	4.1	7.8	6.9	5.8
Cloon 110 kV	4.2	8.1	7.5	5.3	5.2	5.1	4.4	7.1	6.6	5.3	4.9	4.8
College Park 110 kV	8.5	20.2	18.8	6.5	21.9	21.3	8.4	16.2	14.5	6.7	18.4	17.6
Cookstown A 110 kV	8.2	13.7	12.6	6.4	12.5	12.2	8.5	11.7	10.7	6.6	11.2	10.9
Coolroe 110 kV	4.9	11.2	10.4	6.5	9.7	9.5	4.9	8.9	8.2	6.3	8.5	8.3
Coomagearlahy 110 kV	9.8	5.8	4.0	9.7	6.6	5.7	10.0	5.5	3.5	9.9	6.4	5.3

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Cordal 110 kV	14.4	5.9	5.6	16.6	6.0	5.9	14.4	5.7	5.3	16.6	5.8	5.6
Corderry 110 kV	3.9	8.8	7.4	5.2	7.5	7.1	4.1	8.1	6.7	5.4	7.2	6.8
Corduff 110 kV	9.8	23.6	21.7	11.2	25.3	24.6	9.4	18.3	16.3	10.5	20.9	19.9
Corduff 220 kV	16.7	26.7	23.4	15.4	30.6	29.0	13.8	15.3	13.1	13.4	19.3	18.0
Corraclassy 110 kV	4.3	7.0	6.6	6.4	4.1	4.0	4.3	6.7	6.2	6.5	4.0	3.9
Cow Cross 110 kV	4.1	13.3	12.3	4.7	10.9	10.6	4.4	10.3	9.4	4.8	9.2	8.9
Crane 110 kV	6.8	9.2	8.0	6.8	9.4	8.9	7.6	8.4	7.0	7.3	8.7	8.2
Cromcastle A 110 kV	11.5	15.4	13.9	6.4	18.1	17.4	11.4	12.0	10.9	6.8	14.8	14.2
Cromcastle B 110 kV	11.5	15.4	13.9	6.4	18.1	17.4	11.4	12.0	10.9	6.8	14.8	14.2
Cuilleen 110 kV	5.2	9.9	9.3	5.5	5.6	5.5	4.1	6.9	6.6	4.9	4.7	4.7
Cullenagh 110 kV	7.8	14.4	13.2	8.8	15.7	15.2	7.2	11.0	9.9	8.0	12.7	12.1
Cullenagh 220 kV	9.6	8.7	8.1	11.3	8.1	7.9	8.6	6.7	6.0	10.1	6.7	6.4
Cunghill 110 kV	3.4	6.3	5.6	4.7	5.3	5.1	3.4	5.5	4.8	4.6	5.0	4.7
Cushaling A 110 kV	6.7	12.4	11.1	8.2	13.1	12.5	6.1	9.8	8.6	7.6	10.8	10.3
Dallow 110 kV	3.5	5.6	5.4	4.7	3.3	3.3	3.6	5.1	5.0	4.7	3.1	3.1
Dalton 110 kV	2.8	4.6	4.2	3.9	2.7	2.7	2.8	4.2	3.8	3.9	2.8	2.7
Dardistown 110 kV	14.5	15.6	14.1	12.0	19.2	18.4	13.8	12.1	11.1	11.8	15.5	14.8
Derrybrien 110 kV	3.1	4.9	4.2	4.5	4.2	4.0	3.2	4.7	3.9	4.6	4.2	3.9
Derryiron 110 kV	5.6	10.1	9.6	7.4	9.2	9.1	4.9	7.7	7.2	6.3	7.9	7.7
Doon 110 kV	5.3	8.6	7.9	6.5	5.3	5.2	4.9	7.0	6.4	6.1	4.8	4.7
Dromada 110 kV	9.8	6.9	5.9	6.9	5.8	5.5	10.1	6.5	5.4	7.0	5.7	5.3
Drumkeen 110 kV	3.9	7.6	5.8	5.3	6.1	5.7	4.0	7.2	5.4	5.3	5.9	5.4
Drumline 110 kV	3.2	8.9	8.2	4.4	7.7	7.5	3.4	7.8	7.1	4.4	7.1	6.9
Drybridge 110 kV	5.5	15.2	14.0	6.6	11.9	11.6	5.7	12.6	11.5	6.6	10.6	10.4
Dundalk 110 kV	3.5	9.3	8.6	4.6	7.8	7.6	3.6	8.3	7.8	4.7	7.3	7.2
Dunfirth 110 kV	4.6	6.8	6.6	5.8	4.3	4.2	4.7	6.0	5.8	5.8	3.9	3.9
Dungarvan 110 kV	5.7	6.4	6.0	6.6	3.9	3.8	5.8	5.5	5.2	6.6	3.5	3.5
Dunmanway 110 kV	5.5	9.5	8.6	7.1	7.4	7.2	5.8	8.2	7.3	7.2	6.8	6.5
Dunstown 220 kV	11.4	21.0	19.1	11.2	21.6	20.8	12.6	15.9	13.6	12.0	17.5	16.5
Dunstown 400 kV	16.1	8.3	7.9	14.4	7.9	7.8	16.7	6.4	5.7	14.9	6.5	6.2
Ennis 110 kV	4.2	12.3	11.2	5.6	10.3	10.0	4.5	10.7	9.6	5.7	9.5	9.2
Fassaroe East 110 kV	5.1	8.4	7.9	5.5	6.0	5.9	5.3	7.4	6.9	5.6	5.5	5.4
Fassaroe West 110 kV	5.2	8.6	8.0	5.6	6.2	6.1	5.5	7.5	7.1	5.7	5.7	5.6
Finglas 220 kV	17.9	26.2	22.8	16.4	31.2	29.4	14.2	14.9	12.7	13.7	19.3	18.0
Finnstown 110 kV	16.5	17.7	16.0	8.0	20.0	19.2	16.1	14.7	13.2	8.4	17.2	16.5
Finnstown 220 kV	9.8	25.6	22.4	8.9	25.8	24.6	10.9	17.8	14.9	9.8	19.7	18.4

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	Three-Phase			Single-Phase			Three-Phase			Single-Phase		
	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]	X/R Ratio	Ik'' [kA]	Ik' [kA]
Finglas A 110 kV	6.5	15.8	14.8	5.4	13.5	13.3	6.7	13.1	12.0	5.5	12.0	11.7
Finglas B 110 kV	24.4	17.8	15.9	21.4	21.6	20.6	19.8	13.5	12.2	18.4	17.0	16.3
Finglas C 110 kV	39.6	15.0	13.6	32.0	15.8	15.2	27.8	11.2	10.2	25.7	12.6	12.2
Flagford 110 kV	4.4	13.0	11.6	5.3	15.1	14.4	4.7	11.6	10.2	5.5	13.7	13.0
Flagford 220 kV	7.4	7.9	7.3	9.8	7.0	6.8	7.8	7.0	6.3	10.0	6.5	6.2
Francis Street A 110 kV	10.4	13.1	11.7	5.4	15.0	14.3	10.6	11.1	10.2	5.7	13.2	12.7
Francis Street B 110 kV	12.4	13.5	12.3	6.4	16.1	15.5	12.4	11.3	10.5	6.7	13.9	13.5
Galway 110 kV	4.5	12.9	11.6	5.2	13.0	12.5	4.7	10.7	9.7	5.3	11.4	11.0
Garrow 110 kV	21.2	7.4	5.5	15.9	8.0	7.1	20.2	6.9	4.7	15.6	7.6	6.5
Garvagh 110 kV	4.4	6.7	5.6	6.1	5.6	5.4	4.6	6.3	5.1	6.2	5.5	5.1
Gilra 110 kV	3.0	6.7	6.3	4.0	5.0	4.9	3.1	6.3	5.8	4.0	4.8	4.7
Glanagow 220 kV	15.8	12.0	10.8	16.8	14.7	14.0	12.0	8.2	7.4	12.8	10.6	10.2
Glanlee 110 kV	9.5	5.6	4.0	8.8	6.4	5.5	9.7	5.3	3.4	8.9	6.2	5.1
Glasmore A 110 kV	4.4	8.3	7.7	4.8	5.5	5.4	4.7	7.0	6.6	5.0	5.1	5.0
Glasmore B 110 kV	3.8	7.0	6.6	4.5	4.5	4.4	4.1	6.1	5.8	4.7	4.2	4.1
Glenlara A 110 kV	3.0	3.1	2.6	4.5	2.4	2.3	3.0	2.9	2.5	4.6	2.3	2.2
Glenlara B 110 kV	13.3	5.5	5.2	10.9	3.8	3.7	13.5	5.2	4.8	11.0	3.6	3.6
Glenree 110 kV	3.7	5.2	4.8	4.6	4.1	4.0	3.2	4.2	3.7	4.1	3.5	3.4
Golagh 110 kV	4.0	5.3	4.6	5.1	3.3	3.2	4.0	4.9	4.2	5.1	3.2	3.1
Gorman 110 kV	6.3	16.0	14.7	7.4	16.9	16.4	6.7	13.6	12.4	7.7	15.0	14.4
Gorman 220 kV	8.8	12.8	12.0	10.2	9.7	9.6	9.3	10.4	9.4	10.4	8.7	8.5
Gortawee 110 kV	4.4	6.7	6.2	6.7	4.7	4.6	4.5	6.3	5.8	6.7	4.6	4.5
Grange 110 kV	11.0	15.2	13.7	5.4	17.6	16.9	11.1	11.9	10.8	5.9	14.4	13.9
Grange Castle 110 kV	17.0	17.8	16.1	8.5	20.2	19.4	16.5	14.8	13.3	8.8	17.4	16.7
Great Island 110 kV	7.7	15.8	14.3	8.7	19.5	18.7	6.4	11.0	9.7	7.0	14.3	13.5
Great Island 220 kV	10.5	10.3	9.4	12.3	10.3	10.0	8.7	7.4	6.6	10.1	8.3	7.9
Griffinrath 110 kV	6.7	11.5	10.8	7.1	11.2	11.0	7.0	9.9	9.2	7.3	10.0	9.8
Harolds 110 kV	10.6	13.1	11.8	5.1	14.9	14.3	10.8	11.1	10.2	5.3	13.1	12.7
Harnetts 110 kV	4.2	10.7	10.0	5.2	7.2	7.1	4.4	8.9	8.1	5.3	6.5	6.4
Heuston 110 kV	13.4	13.7	12.6	7.8	16.6	16.0	13.3	11.6	10.6	8.0	14.3	13.8
Huntstown A 220 kV	16.9	25.2	22.0	13.7	30.0	28.3	13.9	14.5	12.5	12.5	18.8	17.6
Huntstown B 220 kV	15.6	23.6	21.1	11.5	27.3	26.1	13.2	13.9	12.0	11.1	17.6	16.5
Ikerrin 110 kV	5.5	5.6	5.2	7.0	3.3	3.3	5.6	5.1	4.8	7.0	3.2	3.1
Inchicore 220 kV	10.8	21.5	18.9	7.4	25.1	23.8	11.0	15.2	13.0	8.1	19.0	17.8
Inchicore A 110 kV	27.9	15.2	13.9	25.3	18.8	18.1	24.6	12.6	11.6	23.1	16.0	15.4
Inchicore B 110 kV	26.9	19.0	17.2	22.2	23.3	22.4	23.6	15.6	14.0	20.6	19.7	18.8

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Inniscarra 110 kV	4.7	10.8	10.1	6.1	9.2	9.0	4.7	8.7	8.0	5.9	8.1	7.9
Irishtown 220 kV	13.5	21.9	19.2	12.0	26.5	25.1	12.8	15.2	13.0	11.8	19.6	18.3
Knockavanna 110 kV	3.1	5.2	4.5	4.5	4.3	4.1	3.2	4.9	4.1	4.6	4.2	4.0
Kellis 110 kV	6.0	10.9	10.1	7.1	12.0	11.7	6.1	8.5	7.8	7.1	9.9	9.6
Kellis 220 kV	8.0	8.5	8.1	9.8	7.0	6.9	8.0	6.9	6.3	9.6	6.1	5.9
Kilbarry 110 kV	6.0	22.0	19.2	7.6	19.1	18.3	6.2	15.3	13.4	7.4	15.1	14.4
Kilkenny 110 kV	4.4	10.3	9.7	5.2	10.7	10.5	3.4	6.5	6.1	4.0	7.6	7.4
Kill Hill 110 kV	5.2	7.9	6.8	6.3	4.2	4.0	5.2	6.9	6.0	6.2	3.9	3.8
Killonan 110 kV	5.5	20.4	18.3	6.9	20.9	20.1	5.7	16.1	14.1	6.9	17.7	16.8
Killonan 220 kV	5.5	10.8	10.1	7.5	10.0	9.7	6.4	8.8	7.9	8.2	8.7	8.4
Killoteran 110 kV	6.0	12.8	11.6	5.6	12.7	12.3	5.8	9.7	8.7	5.5	10.3	9.9
Kilmahud 110 kV	12.9	16.9	15.4	6.6	19.1	18.4	13.0	14.1	12.7	6.9	16.5	15.8
Kilmore 110 kV	15.4	16.4	14.8	9.2	19.5	18.7	14.4	12.6	11.5	9.4	15.7	15.1
Kilpaddoge 110 kV	12.1	19.9	17.1	14.0	19.0	18.0	11.7	16.7	13.8	13.4	16.7	15.6
Kilpaddoge 220 kV	16.3	22.6	19.9	16.7	25.7	24.4	13.8	14.3	11.9	14.4	17.8	16.4
Kilteel 110 kV	4.2	8.3	7.8	5.4	7.1	7.0	4.4	7.6	6.8	5.5	6.9	6.7
Kinnegad 110 kV	4.6	9.0	8.6	6.2	7.4	7.3	4.5	7.5	7.0	6.0	6.6	6.5
Kishkeam 110 kV	24.7	7.6	7.1	23.0	7.2	7.0	23.8	7.1	6.5	22.5	6.8	6.6
Kishkeam 220 kV	10.1	9.1	8.2	11.0	8.4	8.1	10.5	7.6	6.4	11.2	7.4	7.0
Knockacummer 110 kV	8.5	4.8	4.6	6.0	3.4	3.4	8.7	4.6	4.3	6.1	3.3	3.2
Knockanure A 110 kV	27.3	9.8	8.5	22.7	8.4	8.0	26.1	9.0	7.6	22.3	8.0	7.5
Knockanure B 110 kV	5.0	9.6	8.2	6.3	7.2	6.9	5.2	8.7	7.3	6.5	6.8	6.5
Knockanure 220 kV	10.9	13.3	12.1	10.8	11.1	10.8	11.8	10.3	8.9	11.3	9.5	9.0
Knockearagh 110 kV	5.7	6.2	5.5	7.8	5.0	4.8	5.9	5.6	5.0	7.9	4.7	4.5
Knockmullen 110 kV	4.2	6.5	6.1	5.2	4.3	4.2	4.3	5.2	4.9	5.2	3.7	3.7
Knocknagashel 110 kV	11.9	5.9	5.3	9.7	3.4	3.3	12.1	5.6	5.0	9.7	3.3	3.2
Knocknagreenan 110 kV	5.4	13.3	12.3	5.4	10.0	9.8	5.2	10.3	9.2	5.3	8.6	8.4
Knockraha 110 kV	7.9	24.8	22.0	9.1	23.5	22.6	6.9	16.1	14.1	7.9	16.6	15.8
Knockraha A 220 kV	8.6	12.5	11.3	9.7	13.4	12.9	6.2	6.5	5.8	6.9	7.9	7.5
Knockraha B 220 kV	11.8	9.7	9.0	12.3	9.6	9.4	10.3	7.2	6.5	11.0	7.6	7.3
Knockumber 110 kV	3.6	8.8	8.3	4.5	6.3	6.2	3.8	8.0	7.5	4.7	6.0	5.9
Lanesboro 110 kV	3.6	11.3	10.5	4.9	10.7	10.4	3.8	10.0	9.3	5.1	10.2	10.0
Laois 110 kV	5.8	14.1	13.4	6.2	17.3	16.9	6.2	11.7	10.9	6.5	14.8	14.3
Laois 400 kV	14.1	7.7	7.3	13.1	7.7	7.5	14.6	6.0	5.4	13.6	6.5	6.2
Letterkenny 110 kV	4.5	9.4	7.0	6.1	8.1	7.4	4.6	8.7	6.5	6.2	7.6	7.0
Liberty A 110 kV	5.1	18.1	16.1	5.6	14.7	14.2	5.4	13.2	11.8	5.7	12.2	11.7

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Liberty B 110 kV	5.0	18.1	16.0	5.3	14.7	14.2	5.3	13.2	11.7	5.5	12.1	11.7
Limerick 110 kV	4.7	17.5	15.7	5.7	15.6	15.1	4.8	14.1	12.4	5.8	13.7	13.1
Lisdrum 110 kV	2.7	5.3	4.9	3.9	3.2	3.1	2.8	5.0	4.7	3.9	3.1	3.0
Lisheen 110 kV	5.1	5.4	4.7	6.5	3.0	3.0	5.2	5.0	4.4	6.6	2.9	2.9
Lodgewood 110 kV	9.6	9.6	8.3	10.0	11.9	11.2	10.2	8.7	7.3	10.5	10.9	10.1
Lodgewood 220 kV	9.2	7.7	7.0	10.7	7.4	7.2	9.4	6.4	5.6	10.7	6.4	6.2
Longpoint 220 kV	11.2	8.3	7.6	13.7	9.0	8.7	6.5	4.2	3.9	7.5	5.2	5.1
Louth 220 kV	11.2	21.9	20.0	14.7	17.2	16.7	10.5	14.8	13.0	13.1	13.7	13.2
Louth A 110 kV	6.9	13.8	12.8	8.1	15.9	15.4	7.0	12.1	11.0	8.1	14.4	13.8
Louth B 110 kV	7.6	15.1	14.0	8.6	17.5	17.0	7.6	13.1	12.0	8.6	15.7	15.1
Macetown 110 kV	6.9	17.5	16.4	6.9	16.5	16.1	7.1	14.3	13.0	7.0	14.3	13.9
Macroom 110 kV	7.0	16.0	14.5	7.8	12.6	12.2	6.9	12.3	10.9	7.6	10.8	10.4
Mallow 110 kV	3.5	6.7	6.2	5.2	5.2	5.1	3.6	5.9	5.5	5.3	4.9	4.8
Marina 110 kV	5.9	20.3	17.8	7.9	16.0	15.5	6.1	14.5	12.7	7.8	13.1	12.6
Maynooth A 110 kV	10.4	14.6	13.7	11.2	17.5	17.0	10.7	12.3	11.3	11.3	15.1	14.6
Maynooth B 110 kV	7.9	18.8	17.7	9.7	17.0	16.6	8.4	15.6	14.2	10.0	14.9	14.4
Maynooth A 220 kV	8.5	21.3	19.1	8.9	18.9	18.3	9.8	15.9	13.6	9.7	15.6	14.8
Maynooth B 220 kV	9.2	24.3	21.8	9.2	21.6	20.9	10.4	17.2	14.6	10.0	17.2	16.2
McDermott 110 kV	17.0	13.7	12.4	6.4	13.7	13.2	15.6	10.4	9.5	6.8	11.1	10.8
Meath Hill 110 kV	4.0	9.6	8.9	5.3	7.6	7.4	4.2	8.7	8.1	5.4	7.2	7.0
Meentycat 110 kV	3.7	6.3	4.8	5.3	5.2	4.8	3.8	6.1	4.5	5.3	5.1	4.6
Midleton 110 kV	3.5	11.3	10.6	4.6	8.7	8.5	3.7	8.9	8.2	4.7	7.4	7.2
Milltown 110 kV	14.3	14.2	12.7	6.8	16.3	15.6	14.2	11.9	10.9	7.0	14.3	13.8
Milltown 110 kV	8.6	12.2	11.2	4.0	14.2	13.7	8.9	10.3	9.6	4.2	12.4	12.1
Misery Hill 110 kV	12.9	13.9	12.4	7.8	16.2	15.4	12.9	11.7	10.7	8.0	14.1	13.6
Moneypoint G1 400 kV	23.5	11.2	10.4	21.7	11.8	11.5	16.6	6.7	6.0	16.9	8.0	7.7
Moneypoint G2 400 kV	55.7	4.9	4.6	54.2	5.5	5.3	38.8	4.3	3.9	40.9	5.0	4.8
Moneypoint G3 400 kV	23.5	11.2	10.4	21.7	11.8	11.5	16.6	6.7	6.0	16.9	8.0	7.7
Moneteen 110 kV	5.1	11.6	10.7	6.2	8.6	8.4	5.2	10.1	9.1	6.3	7.9	7.7
Moneypoint 110 kV	15.0	9.9	9.2	17.9	9.4	9.2	14.6	9.0	8.1	17.3	8.8	8.4
Moneypoint 220 kV	16.2	22.3	19.8	16.3	25.3	24.1	14.1	14.3	11.9	14.4	17.7	16.4
Monread 110 kV	3.9	8.3	7.7	4.9	7.4	7.3	4.1	7.4	6.7	5.0	7.1	6.9
Mount Lucas 110 kV	6.2	9.5	8.2	7.2	6.5	6.3	6.3	8.0	6.8	7.2	5.9	5.6
Moy 110 kV	4.0	5.2	4.8	5.2	5.4	5.3	3.0	3.7	3.3	3.7	4.3	4.1
Mullagharlin 110 kV	3.6	9.4	8.7	4.6	7.8	7.6	3.7	8.5	7.9	4.7	7.3	7.1
Mullingar 110 kV	3.5	7.7	7.2	4.9	7.0	6.8	3.5	6.6	6.3	4.9	6.3	6.2

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Mulreavy 110 kV	7.7	5.2	4.7	7.5	2.6	2.5	7.5	4.8	4.2	7.5	2.5	2.4
Mungret A 110 kV	4.8	11.0	10.1	5.9	7.9	7.8	4.9	9.6	8.7	6.0	7.4	7.2
Mungret B 110 kV	4.8	11.0	10.2	5.9	8.0	7.8	4.9	9.6	8.8	6.0	7.4	7.2
Nangor 110 kV	14.2	17.3	15.7	6.8	19.5	18.7	14.1	14.3	12.9	7.2	16.8	16.1
Navan 110 kV	5.3	13.9	12.8	6.3	13.0	12.6	5.7	12.0	11.0	6.6	11.8	11.4
Nenagh 110 kV	2.6	3.8	3.6	3.8	2.1	2.0	2.7	3.5	3.4	3.9	2.0	2.0
Newbridge 110 kV	4.0	11.2	10.3	4.9	10.2	10.0	4.2	9.6	8.7	5.1	9.3	9.0
Nore 110 kV	4.4	9.9	9.4	5.4	10.4	10.2	3.4	6.2	5.8	4.0	7.3	7.1
North Quays 110 kV	17.4	14.5	12.9	6.4	16.3	15.6	16.9	12.2	11.1	6.6	14.3	13.8
North Wall 110 kV	16.4	23.7	20.8	9.5	26.6	25.3	13.3	13.7	11.8	9.8	17.1	16.1
Oldcourt A 110 kV	3.6	11.0	10.3	4.4	8.2	8.1	3.9	8.8	8.2	4.5	7.1	7.0
Oldcourt B 110 kV	3.7	11.1	10.4	4.4	8.3	8.2	3.9	8.9	8.2	4.5	7.2	7.0
Oldstreet 220 kV	16.0	11.2	10.7	13.0	12.0	11.8	13.3	7.5	7.0	12.0	8.8	8.5
Oldstreet 400 kV	15.9	9.0	8.6	10.6	8.1	8.0	14.1	6.4	5.8	10.7	6.5	6.2
Oughtragh 110 kV	3.8	5.1	4.6	5.0	3.1	3.0	3.9	4.7	4.2	5.1	3.0	2.9
Pelletstown 110 kV	14.0	12.8	11.7	8.2	11.9	11.6	13.8	9.9	9.1	8.6	10.0	9.7
Platin 110 kV	5.1	14.2	13.1	5.8	9.8	9.6	5.0	11.6	10.7	5.7	8.9	8.7
Pollaphuca 110 kV	3.2	3.2	3.1	4.6	2.5	2.5	2.7	2.5	2.4	4.0	2.3	2.3
Poolbeg A 110 kV	24.6	15.1	13.5	20.6	18.0	17.2	22.7	12.6	11.5	19.7	15.6	15.0
Poolbeg B 110 kV	24.5	15.1	13.5	20.6	18.0	17.2	22.7	12.6	11.5	19.7	15.5	14.9
Poolbeg A 220 kV	16.9	23.7	20.8	10.4	27.8	26.3	13.8	13.8	11.9	10.6	17.7	16.6
Poolbeg B 220 kV	11.8	19.8	17.5	11.1	21.5	20.5	11.9	14.4	12.3	11.3	16.7	15.7
Poppintree 110 kV	14.1	16.6	14.9	7.7	19.7	18.8	13.5	12.7	11.6	8.0	15.8	15.2
Portan 400 kV	18.1	11.6	11.0	19.9	12.7	12.5	17.1	8.4	7.5	18.2	9.9	9.4
Portlaoise 110 kV	4.3	12.7	12.0	5.2	10.4	10.2	4.7	10.9	10.1	5.5	9.4	9.2
Pottery 110 kV	17.2	12.5	11.2	5.6	12.6	12.1	16.6	10.4	9.5	5.8	11.1	10.7
Prospect 220 kV	13.2	17.8	16.1	8.1	16.6	16.1	12.4	12.1	10.4	8.6	12.8	12.1
Raffeen A 110 kV	5.3	15.2	14.0	6.2	17.4	16.8	5.5	11.6	10.6	6.3	13.9	13.4
Raffeen 220 kV	14.7	12.1	10.9	14.3	14.6	13.9	11.5	8.2	7.4	11.6	10.6	10.1
Raffeen B 110 kV	7.7	15.0	13.6	8.9	17.0	16.4	7.5	11.6	10.5	8.4	13.8	13.2
Ralappane 110 kV	9.8	16.7	14.6	10.6	14.1	13.5	9.8	14.3	12.0	10.5	12.7	12.0
Rathkeale 110 kV	3.5	7.9	7.3	4.7	4.4	4.4	3.6	7.1	6.5	4.7	4.2	4.1
Ratrussan 110 kV	3.5	7.5	6.3	4.6	7.9	7.4	3.6	7.1	5.8	4.7	7.8	7.2
Reamore 110 kV	4.4	8.8	7.4	3.8	7.1	6.8	4.6	8.1	6.7	3.9	6.8	6.4
Richmond 110 kV	3.0	7.5	7.1	4.2	6.4	6.3	3.1	6.7	6.4	4.3	6.1	6.0
Rinawade 110 kV	4.8	11.6	11.1	5.9	7.8	7.7	5.1	10.1	9.4	6.0	7.2	7.0

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Ringaskiddy 110 kV	5.5	12.4	11.4	6.0	11.6	11.3	5.7	9.9	9.0	6.1	9.9	9.6
Ringsend 110 kV	24.9	15.3	13.6	20.9	18.2	17.3	23.0	12.7	11.6	20.0	15.6	15.0
Ryebrook 110 kV	5.4	15.8	14.7	6.0	10.7	10.5	5.7	13.2	11.9	6.1	9.7	9.4
Salthill 110 kV	4.5	11.8	10.6	4.0	11.6	11.2	4.6	9.9	8.9	4.1	10.2	9.9
Screeb 110 kV	3.4	2.6	2.4	4.4	1.4	1.4	3.4	2.4	2.3	4.4	1.4	1.4
Seal Rock A 110 kV	7.6	10.1	9.2	9.4	10.6	10.2	7.9	9.5	8.4	9.7	10.4	9.9
Seal Rock B 110 kV	7.6	10.1	9.2	9.4	10.6	10.2	7.9	9.5	8.4	9.7	10.4	9.9
Shankill 110 kV	3.5	9.0	7.8	4.7	7.7	7.4	3.7	8.3	7.2	4.9	7.3	7.0
Shannonbridge 110 kV	6.1	17.3	16.5	7.9	19.0	18.6	6.1	14.9	14.0	7.9	17.3	16.9
Shannonbridge 220 kV	7.0	7.5	7.2	9.3	6.3	6.2	7.4	6.6	6.2	9.6	5.9	5.8
Shellybanks A 220 kV	16.4	23.6	20.7	10.3	27.8	26.3	13.6	13.7	11.9	10.5	17.7	16.6
Shellybanks B 220 kV	13.1	21.3	18.7	11.2	25.8	24.4	12.3	14.8	12.7	11.1	19.1	17.8
Shelton Abbey 110 kV	7.3	8.0	7.2	7.3	8.1	7.8	7.5	7.1	6.4	7.5	7.4	7.1
Singland 110 kV	5.5	16.8	15.2	6.7	14.9	14.5	5.5	13.4	11.9	6.5	12.9	12.4
Sligo 110 kV	3.8	10.2	8.9	4.8	9.1	8.7	3.9	9.0	7.7	4.9	8.3	7.9
Somerset 110 kV	2.9	8.2	7.8	4.0	5.1	5.1	3.1	7.4	7.0	4.1	4.8	4.8
Sorne Hill 110 kV	3.7	3.6	2.7	4.1	3.9	3.5	3.8	3.5	2.7	4.2	3.7	3.4
Srananagh 110 kV	4.7	11.9	10.3	5.9	12.3	11.7	4.9	10.6	8.9	6.0	11.2	10.5
Srananagh 220 kV	7.4	4.9	4.6	10.0	3.8	3.7	7.6	4.5	4.1	10.1	3.6	3.5
Stevenstown 110 kV	4.2	6.6	6.2	4.7	4.2	4.2	4.4	5.8	5.5	4.8	4.0	3.9
Stratford 110 kV	3.2	4.8	4.5	4.3	3.4	3.3	3.1	3.8	3.7	4.1	3.0	3.0
Suir 110 kV	4.8	11.0	10.1	5.1	6.0	5.9	3.9	8.1	7.3	4.5	5.1	5.0
Taney 110 kV	6.4	10.7	9.9	2.3	11.1	10.8	6.6	9.2	8.6	2.4	10.0	9.7
Tarbert 110 kV	34.5	16.1	15.3	37.0	15.6	15.3	23.6	11.3	10.5	26.8	12.3	12.0
Tarbert 220 kV	16.0	21.5	19.1	16.8	24.7	23.6	13.1	13.5	11.3	13.9	16.9	15.7
Tawnaghmore A 110 kV	3.9	4.3	4.0	5.3	4.4	4.3	2.8	3.1	2.8	3.5	3.5	3.4
Tawnaghmore B 110 kV	3.8	4.3	4.0	5.1	4.1	4.0	2.8	3.1	2.8	3.6	3.3	3.2
Thornsberry 110 kV	4.6	7.9	7.2	6.1	6.6	6.4	4.8	6.6	6.0	6.1	5.8	5.7
Thurles 110 kV	5.5	6.7	5.9	8.2	4.7	4.5	5.7	6.1	5.4	8.2	4.4	4.3
Tievebrack 110 kV	3.6	4.4	3.8	5.0	2.9	2.8	3.6	4.1	3.6	5.0	2.9	2.8
Tipperary 110 kV	3.1	7.9	7.4	4.4	4.0	4.0	3.2	6.8	6.3	4.4	3.8	3.7
Tonroe 110 kV	2.7	3.5	3.3	3.8	2.1	2.0	2.7	3.3	3.1	3.9	2.0	2.0
Trabeg 110 kV	6.0	20.0	17.6	7.4	15.8	15.3	6.2	14.3	12.6	7.3	12.9	12.4
Tralee 110 kV	5.7	10.8	8.9	7.1	8.5	8.0	6.1	9.8	7.8	7.3	8.0	7.5
Trien A 110 kV	4.8	9.1	7.5	6.5	7.4	7.0	5.0	8.3	6.7	6.6	7.0	6.6
Trien B 110 kV	15.6	8.0	7.1	12.8	5.7	5.6	15.7	7.4	6.5	12.8	5.5	5.3

Table E-11 Short Circuit Currents for Maximum and Minimum Demand in 2018 (continued)

Bus	Winter Peak 2018						Summer Valley 2018					
	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]
Trillick 110 kV	3.7	3.9	2.9	4.2	3.8	3.4	3.8	3.8	2.8	4.3	3.6	3.3
Trinity 110 kV	11.5	13.5	12.1	6.6	15.6	14.9	11.6	11.4	10.4	6.8	13.7	13.2
Tullabrack 110 kV	6.5	7.4	7.0	7.3	5.5	5.4	6.8	6.9	6.3	7.5	5.3	5.1
Turlough 220 kV	10.8	13.0	12.0	12.1	11.3	11.0	12.0	11.1	9.8	12.9	10.1	9.8
Tynagh 220 kV	15.0	12.2	11.4	17.2	13.4	13.1	10.7	7.2	6.7	11.8	8.9	8.6
Waterford 110 kV	7.2	14.2	12.8	7.4	13.9	13.4	6.5	10.5	9.4	6.8	11.1	10.7
Wexford 110 kV	4.0	7.3	6.3	5.3	6.3	6.0	4.3	6.4	5.4	5.5	5.7	5.4
Whitegate 110 kV	4.3	10.4	9.8	5.1	10.4	10.2	4.4	8.2	7.7	5.2	8.7	8.5
Wolfe Tone 110 kV	14.7	13.4	12.1	5.8	13.2	12.8	14.1	10.2	9.3	6.3	10.9	10.5
Woodland A 220 kV	13.2	26.2	23.7	13.0	27.1	26.2	13.6	17.0	14.6	13.2	19.5	18.4
Woodland B 220 kV	32.8	8.7	8.5	24.0	10.4	10.3	28.3	7.4	7.0	22.2	9.1	8.8
Woodland 400 kV	18.1	11.6	11.0	19.9	12.7	12.5	17.1	8.4	7.5	18.2	9.9	9.4

F Additional Information on Opportunities

F.1 Northern Ireland Generation Opportunity Results

F.2 Additional Information on Demand Opportunities in Ireland

APPENDIX F ADDITIONAL INFORMATION ON OPPORTUNITIES

F.1 NORTHERN IRELAND GENERATION OPPORTUNITIES RESULTS

Table F-1: Capability Results for 275 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Ballylumford 275 kV	0	A1	0	A1	0	A1	0
Castlereagh 275 kV	>400	-	>400	-	>400	-	>400
Coolkeeragh 275 kV	0	NW	0	NW	0	NW	0
Hannahstown 275 kV	>400	-	>400	-	>400	-	>400
Kells 275 kV	>400	-	>400	-	>400	-	>400
Kilroot 275 kV	>400	-	>400	-	>400	-	>400
Magherafelt 275 kV	380	A2	>400	-	>400	-	380
Moyle 275 kV	0	A1	0	A1	0	A1	0
Tamnamore 275 kV	380	A2	>400	-	>400	-	380
Tandragee 275 kV	>400	-	>400	-	>400	-	>400
Turleenan 275 kV	>400	-	>400	-	>400	-	>400

Table F-2: Contingencies and constraints limiting 275 kV capabilities

Network Constraints for new generation at 275 kV		
ID	Outage	Constraint
A1	Kells Double IBT Outage	Overloads on 110kV Ballylumford - Ballyvallyagh circuits 1 and 2.
A2	275 kV double circuit from Ballylumford to Hannahstown/Moyle	Overload on the 110 kV Creagh - Tamnamore Circuit
NW	1- Coolkeeragh-Magherafelt 275 kV n-dc 2- Omagh-Tamnamore 110 kV n-1	1- Low voltage in the North West 2- Overload on the Pomeroy - Tamnamore 110 kV circuit

Table F-3: Capability Results for 110 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Aghyoule 110 kV	0	NW	0	NW	0	NW	0
Airport Road 110 kV	80	R	80	R	80	R	80
Altahullion 110 kV	0	NW	0	NW	0	NW	0
Antrim 110 kV	80	R	80	R	80	R	80
Ballylumford 110 kV	0	B1	0	B1	0	B1	0
Ballymena 110 kV	80	R	80	R	80	R	80
Ballynahinch 110 kV	80	R	80	R	80	R	80
Ballyvallyagh 110 kV	60	B1	80	B1	60	B1	60
Banbridge 110 kV	80	R	80	R	80	R	80
Belfast Central 110 kV	140	B2	140	B2	140	B2	140
Belfast North Main 110 kV	80	B3	80	B3	80	B4	80
Cam Cluster 110 kV	0	NW	0	NW	0	NW	0
Carnmoney 110 kV	40	B5	40	B6	40	B7	40

Table F-3: Capability Results for 110 kV (continued)

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Castlereagh 110 kV	>400	-	>400	-	>400	-	>400
Coleraine 110 kV	0	NW	0	NW	0	NW	0
Coolkeeragh 110 kV	0	NW	0	NW	0	NW	0
Creagh 110 kV	40	B8	40	B8	40	B8	40
Cregagh 110 kV	140	B2	140	B2	140	B2	140
Donegall A&D 110 kV	60	R	60	R	60	R	60
Donegall B&C 110 kV	160	B9	160	B9	160	B9	160
Drumnakelly 110 kV	100	B10	100	B10	100	B10	100
Drumquin 110 kV	0	NW	0	NW	0	NW	0
Dungannon 110 kV	0	B14	0	B14	0	B14	0
Eden 110 kV	80	B7	60	B7	80	B7	60
Enniskillen 110 kV	0	NW	0	NW	0	NW	0
Fallaghearn 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
Hannahstown 110 kV	>400	-	360	B12	>400	-	360
Kells 110 kV	80	B1	100	B1	80	B1	80
Killymallaght 110 kV	0	NW	0	NW	0	NW	0
Knock 110 kV	60	R	60	R	60	R	60
Larne 110 kV	60	R	60	R	60	R	60
Limavady 110 kV	0	NW	0	NW	0	NW	0
Lisaghmore 110 kV	0	NW	0	NW	0	NW	0
Lisburn 110 kV	80	B13	80	B13	80	B13	80
Loguestown 110 kV	0	NW	0	NW	0	NW	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	80	R	80	R	80	R	80
Newtownards 110 kV	100	R	100	R	100	R	100
Omagh 110 kV	0	NW	0	NW	0	NW	0
Omagh South 110 kV	0	NW	0	NW	0	NW	0
Pomeroy 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	0	B14	0	B14	0	B14	0
Tandragee 110 kV	>400	-	380	B15	380	B15	380
Waringstown 110 kV	80	R	80	R	80	R	80

Table F-4: Contingencies and constraints limiting 110 kV capabilities

Network Constraints for new generation at 110 kV		
ID	Outage	Constraint
B1	Kells Double IBTX Outage	Overloads on 110kV Ballylumford - Ballyvallyagh circuits 1 and 2
B2	Intact System	Overload on the 110 kV circuits from Cregagh - Belfast Central and Castlereagh
B3	275 kV double circuit from Magherafelt - Tamnamore	Overload on the 110 kV Belfast North Main - Donegal Circuit
B4	275 kV double circuit from Turleenan - Tandragee	Overload on the 110 kV Belfast North Main - Donegal Circuit
B5	275 kV double circuit from Tamnamore - Turleenan	Overloads on 110 kV circuit from Castlereagh - Carnmoney
B6	275 kV double circuit from Magherafelt - Tamnamore	Overloads on 110 kV circuit from Castlereagh - Carnmoney
B7	275 kV double circuit from Ballylumford - Hannahstown/Moyle	Overloads on 110 kV circuit from Castlereagh - Carnmoney
B8	275 kV double circuit from Magherafelt - Ballylumford/Kells	Overload on the 110 kV Creagh - Kells Circuit
B9	Intact System	Overload on the 110 kV Donegal - Hannahstown Circuit
B10	110 kV circuits from Drumnakelly - Tandragee circuits 1 & 2	Overload on the 110 kV Drumnakelly - Tandragee circuit 3
B11	Intact System	Overload on the 110 kV Finaghy - Hannahstown circuit
B12	275 kV double circuit from Tamnamore - Turleenan	Overload on the 110 kV Lisburn - Tandragee circuit
B13	110 kV double circuit from Lisburn - Hannahstown	Overload on the 110 kV Lisburn - Tandragee circuit
B14	Tamnamore Double IBTX Outage	Overload on the Drumnakelly to Tamnamore 110 kV circuits
B15	Tandragee Double IBTX Outage	Overload on the 110 kV Lisburn - Tandragee circuit
NW	1- Coolkeeragh-Magherafelt 275 kV n-dc 2- Omagh-Tamnamore 110 kV n-1	1- Low voltage in the North West 2- Overload on the Pomeroy - Tamnamore 110 kV circuit

Table F-5: Capability Results for 33 kV

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Aghyoule 33 kV	0	NW	0	NW	0	NW	0
Airport Road 33 kV	80	T	80	T	80	T	80
Altahullion 33 kV	0	NW	0	NW	0	NW	0
Antrim 33kV	80	T	80	T	80	T	80
Ballymena (R) 33kV	100	C1	100	C1	100	C1	100
Ballymena (T) 33kV	100	C1	100	C1	100	C1	100
Ballynahinch 33 kV	80	T	80	T	80	T	80
Banbridge 33 kV	80	T	80	T	80	T	80
Belfast Central 33 kV	160	T	160	T	160	T	160
Belfast North Main 33kV	160	C2	140	C2	160	C2	140
Cam Cluster 33 kV	0	NW	0	NW	0	NW	0
Carnmoney 33 kV	80	T	60	T	80	T	60
Coleraine 33 kV	0	NW	0	NW	0	NW	0
Coolkeeragh 33 kV	0	NW	0	NW	0	NW	0
Creagh 33 kV	40	C3	40	C3	40	C3	40
Cregagh 33kV	120	T	120	T	120	T	120
Donegall N 33kV	120	T	120	T	120	T	120
Donegall S 33kV	80	T	80	T	80	T	80
Drumnakelly 33kV	100	C4	100	C4	100	C4	100
Drumquin 33kV	0	NW	0	NW	0	NW	0
Dungannon 33kV	0	C5	0	C5	0	C5	0
Eden 33kV	60	T	60	T	60	T	60
Enniskillen 33kV	0	NW	0	NW	0	NW	0
Fallaghearn 33kV	0	NW	0	NW	0	NW	0
Finaghy 33kV	60	T	60	T	60	T	60
Glengormley 33kV	60	C6	60	C6	60	C6	60
Killymallaght 33kV	0	NW	0	NW	0	NW	0
Knock 33kV	80	T	80	T	80	T	80
Larne 33kV	40	T	40	T	40	T	40
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	80	T	80	T	80	T	80
Newtownards 33 kV	80	T	80	T	80	T	80
Omagh 33 kV	0	NW	0	NW	0	NW	0
Omagh South 33 kV	0	NW	0	NW	0	NW	0
Pomeroy 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

Table F-5: Capability Results for 33 kV (continued)

Substation	Maximum Transfer (in MW) to						Minimum
	Northern Ireland		Ireland		Scotland		
Waringstown 33 kV	100	T	100	T	100	T	100

Table F-6: Contingencies and constraints limiting 33 kV capabilities

Network Constraints for new generation at 33 kV		
ID	Outage	Constraint
C1	Kells Double IBTX Outage	Overloads on 110kV Ballylumford - Ballyvallyagh circuits 1 and 2
C2	Intact System	Overload the 33 kV circuit between Belfast North Main and Belfast Central
C3	275 kV double circuit from Magherafelt - Ballylumford/Kells	Overload on the 110 kV Creagh - Kells Circuit
C4	110 kV circuits from Drumnakelly - Tandragee circuits 1 & 2	Overload on the 110 kV Drumnakelly - Tandragee circuit 3
C5	Tamnamore Double IBTX Outage	Overload on the Drumnakelly - Tamnamore 110 kV circuits
C6	Intact System	Overload on the 110/33 kV Glengomley Transformer
NW	1- Coolkeeragh-Magherafelt 275 kV n-dc 2- Omagh-Tamnamore 110 kV n-1	1- Low voltage in the North West 2- Overload on the Pomeroy - Tamnamore 110 kV circuit
T	33kV station supplied through 2 TXs; Loss of Transformer 1.	Overload on second Transformer.

F.2 ADDITIONAL INFORMATION ON DEMAND OPPORTUNITIES IN IRELAND

The transmission system in Ireland is designed to provide a safe, reliable and economic transport service for power from source to demand. In Ireland, the Transmission Planning Criteria (TPC) provides a planning framework by which a balance can be achieved between reliability and economy. Achieving this balance means that under certain circumstances some level of constraints will exist in the system.

EirGrid keeps the performance of the transmission system under review as circumstances change. For example, the connection of new generation or demand to the transmission system, additional to the current forecasts and assumptions, or new interconnection transfers, will alter the expected power flows. Constraints will arise if the new power flows exceed planned transmission system capacity.

In designing out these constraints EirGrid will take account of the following:

- The extent of the constraint;
- The impact on system security;
- The overall economics of the operation of the system;
- The cost of the solution;
- The lead-time of the solution.

The analysis of transfer capabilities described in Chapter 9 identified a number of potential system constraints that could limit power flows arising from new demand connections. Most of these have been identified previously and are being managed by EirGrid.

These potential transmission system constraints are presented in the table below. The first column in each table provides a cross-reference to the results tables in Chapter 9. The second column describes potentially overloaded circuits or names of stations at which low voltages potentially occur following particular outages. The third column lists the circumstances under which the overloads or voltage violations occur, thereby limiting the capacity. For constraints for which projects have already been initiated, the final column provides the reader with the CP number of the capital project designed to relieve the constraint. This can be cross-referenced against the detailed descriptions of the planned projects provided in Section B-2 of Appendix B.

Table F-7 List of Potential System Constraints for which EirGrid has initiated Projects

ID	Potential Overload / Voltage Problem	Circumstances	Comment
P1	Cullenagh-Waterford 110 kV line	Overload can occur for loss of Butlerstown-Cullenagh 110 kV circuit.	Capital project CP0558 relieves this constraint.
P2	Voltage violations	Voltage violations can occur for loss of Kilkenny-Kellis 110 kV circuit.	Capital project CP0585 relieves this constraint.

G Abbreviations and Glossary



G
Glossary



APPENDIX G ABBREVIATIONS AND GLOSSARY

G.1 ABBREVIATIONS

AC	Alternating Current
ACS	Average Cold Spell
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
GCS	Generation Capacity Statement
GIS	Gas Insulated Switchgear
HFO	Heavy Fuel Oil
HVDC	High Voltage Direct Current
IME	Internal Market for Electricity
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
MVA	MegaVolt-Amperes
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
SV	Summer Valley
TFS	Transmission Forecast Statement
TRM	Transfer Reserve Margin
TSO	Transmission System Operator
TTC	Total Transfer Capacity
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.
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.

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.
Upgrading	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



APPENDIX H REFERENCES

The following documents are referenced in All-Island Transmission Forecast Statement 2012-2018:

- 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, 2012-2021*. EirGrid and SONI issued this report in December 2011. 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 3.5, March 2011. 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.

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 7 th 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 7 th August 1992.
PLM-ST-4	CEGB Criteria for System Transient Stability Studies Issue 1, dated September 1975, and NIE amendment sheet Issue 2, dated 7 th August 1992.
PLM-ST-9	Voltage Criteria for the Design of 400 kV and 275 kV Supergrid System Issue 1, date 1 st December 1985, and NIE amendment sheet Issue 2, dated 7 th August 1992.
ER-P28	Planning Limits for Voltage Fluctuations.
ER-P16	EHV or HV Supplies to Induction Furnaces.
ER-P29	Planning Limits for Voltage Unbalance.
ER-G5/3	Limits for Harmonics (To be replaced by ER-G5/4 following UK practice and in conjunction with a joint review with EirGrid).
EPM-1	Operational Standards of Security and Supply, dated November 2004.

I Power Flow Diagrams

I.1 Guide to the Power Flow Diagrams



APPENDIX I POWER FLOW DIAGRAMS

This appendix presents power flow diagrams for the following cases:

- Figure I-1 Summer Peak 2012,
- Figure I-2 Summer Valley 2012,
- Figure I-3 Winter Peak 2012/13,
- Figure I-4 Summer Peak 2015,
- Figure I-5 Summer Valley 2015,
- Figure I-6 Winter Peak 2015/16,
- Figure I-7 Summer Peak 2018,
- Figure I-8 Summer Valley 2018,
- Figure I-9 Winter Peak 2018/19,

Note that summer cases include all projects expected to be completed by 1st July of the year stated and winter cases include all projects expected by 31st December of the year stated. As such, the layout of the network in the power flow diagrams may not feature all projects listed in Appendix B for a particular year as these are listed on a yearly basis.

I.1 GUIDE TO THE POWER FLOW DIAGRAMS

Different colours represent each of the voltage levels:

- 400 kV red,
- 275 kV blue,
- 220 kV green,
- 110 kV black,

Generation connected at each bus is shown beside a  symbol, with the generation dispatched in MW shown beneath the symbol. Embedded generation is shown at the transmission bus to which it is connected through the distribution system. The East–West interconnector is denoted by a  symbol and the Moyle interconnector is denoted by a  symbol. The magnitude of the power on the interconnectors is given beneath the symbol in MW.

There are two values shown at both ends of each circuit. The value above the line is the MW flow and the value below the line is the Mvar flow. A positive value indicates that the direction of flow is away from the bus; a negative value, towards the bus.

The voltage, in per unit value, is displayed below each bus.





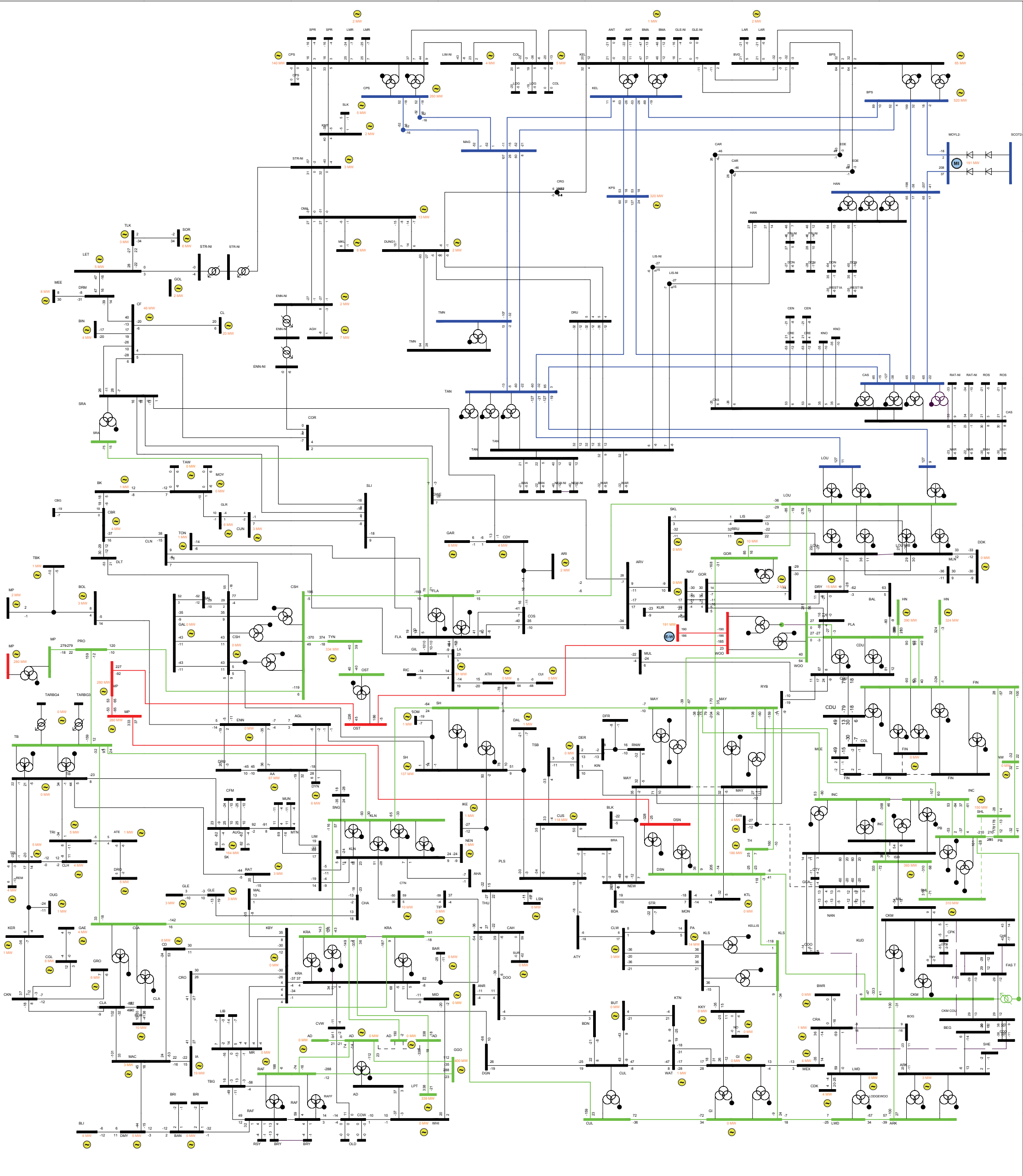


Figure I-03 Power Flow Diagram Winter Peak 2012/13

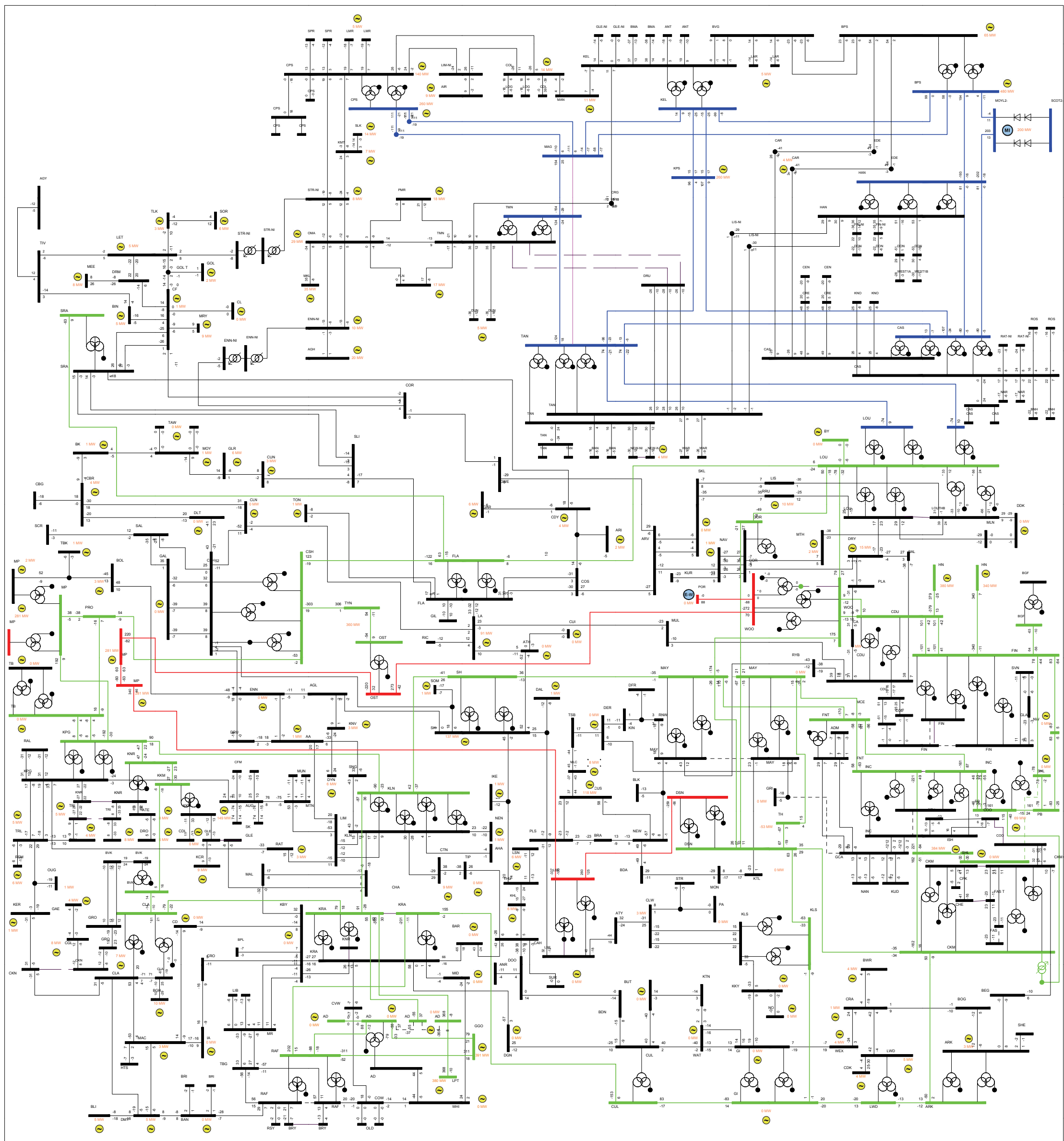
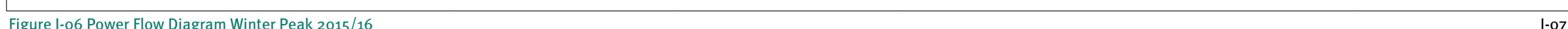


Figure I-04 Power Flow Diagram Summer Peak 2015





1-07

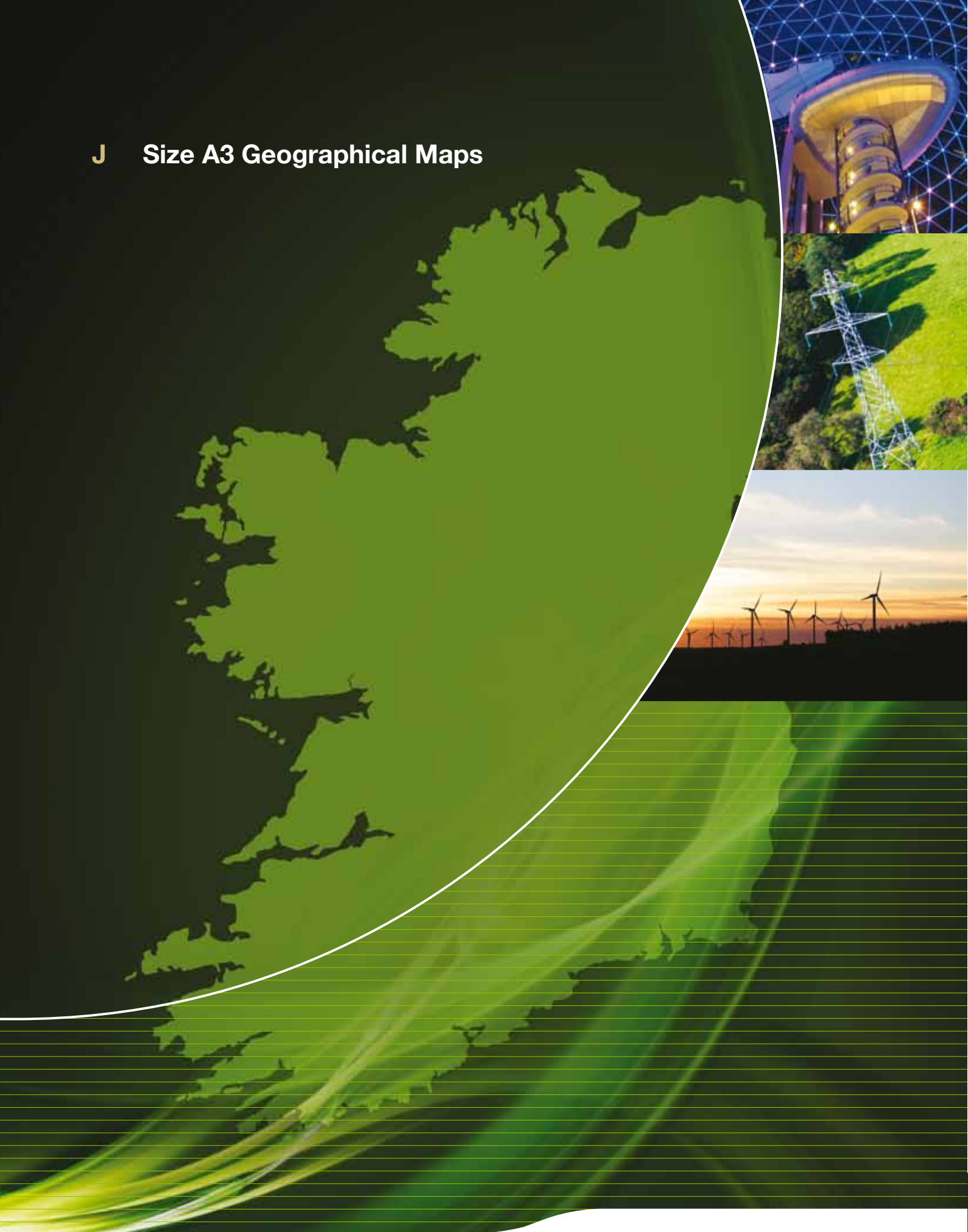




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J Size A3 Geographical Maps



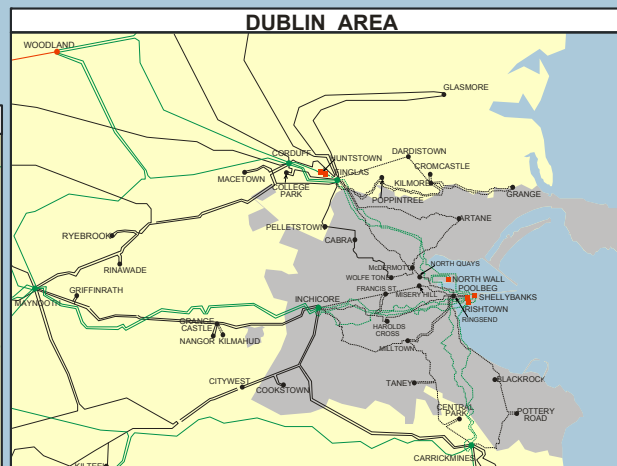
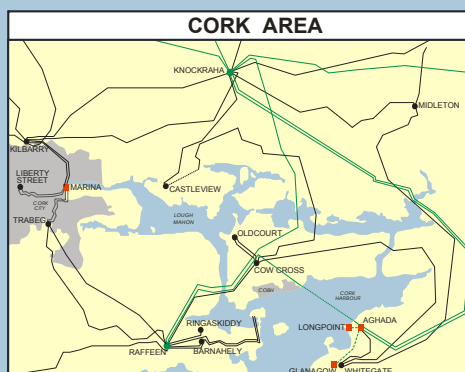
APPENDIX J SIZE A₃ GEOGRAPHICAL MAPS

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 July of 2011 and as planned at the end of 2018.

Figure J - 1

Transmission System

**400 kV, 275 kV, 220 kV and 110 kV
As at July 2011**



**Planned Transmission System
400 kV, 275 kV, 220 kV and 110 kV
As at December 2018**



