# ALL-ISLAND TRANSMISSION SYSTEM PERFORMANCE REPORT 2012

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# ALL-ISLAND TRANSMISSION SYSTEM PERFORMANCE REPORT 2012

# TABLE OF CONTENTS

# 1. Introduction

# 1 INTRODUCTION

EirGrid Group is pleased to present the annual Transmission System Performance Report for 2012. This report contains transmission system data and performance statistics for the transmission system in Ireland for the year 2012 (1st January 2012 – 31st December 2012). The report has been prepared jointly by EirGrid and SONI TSOs. This is the first year that EirGrid and SONI TSO's deliver a combined Transmission System Performance Report. This is also the first year that SONI is reporting on a calendar year basis rather than a financial year basis

EirGrid Group comprises EirGrid as Transmission System Operator in Ireland, SONI as Transmission System Operator in Northern Ireland, SEMO as the all-island Single Electricity Market Operator and the operation and ownership of the East West Interconnector (EWIC).

EirGrid and SONI's role, as the TSOs of Ireland and Northern Ireland is to deliver quality connection, transmission and market services to customers and develop the grid infrastructure required to support the development of Ireland's economy. These objectives are underpinned by a legislative requirement to develop, maintain and operate a safe, secure, reliable, economical and efficient transmission system. EirGrid is regulated by the Commission for Energy Regulation (CER). SONI is regulated by the Northern Ireland Authority for Utility Regulation (NIAUR).

EirGrid and SONI are required to publish the Transmission System Performance Report annually. The report includes both transmission system performance statistics and a number of high level transmission system characteristics, many of which are published elsewhere, but which we believe will facilitate the industry and external observers by collating them in one single source.

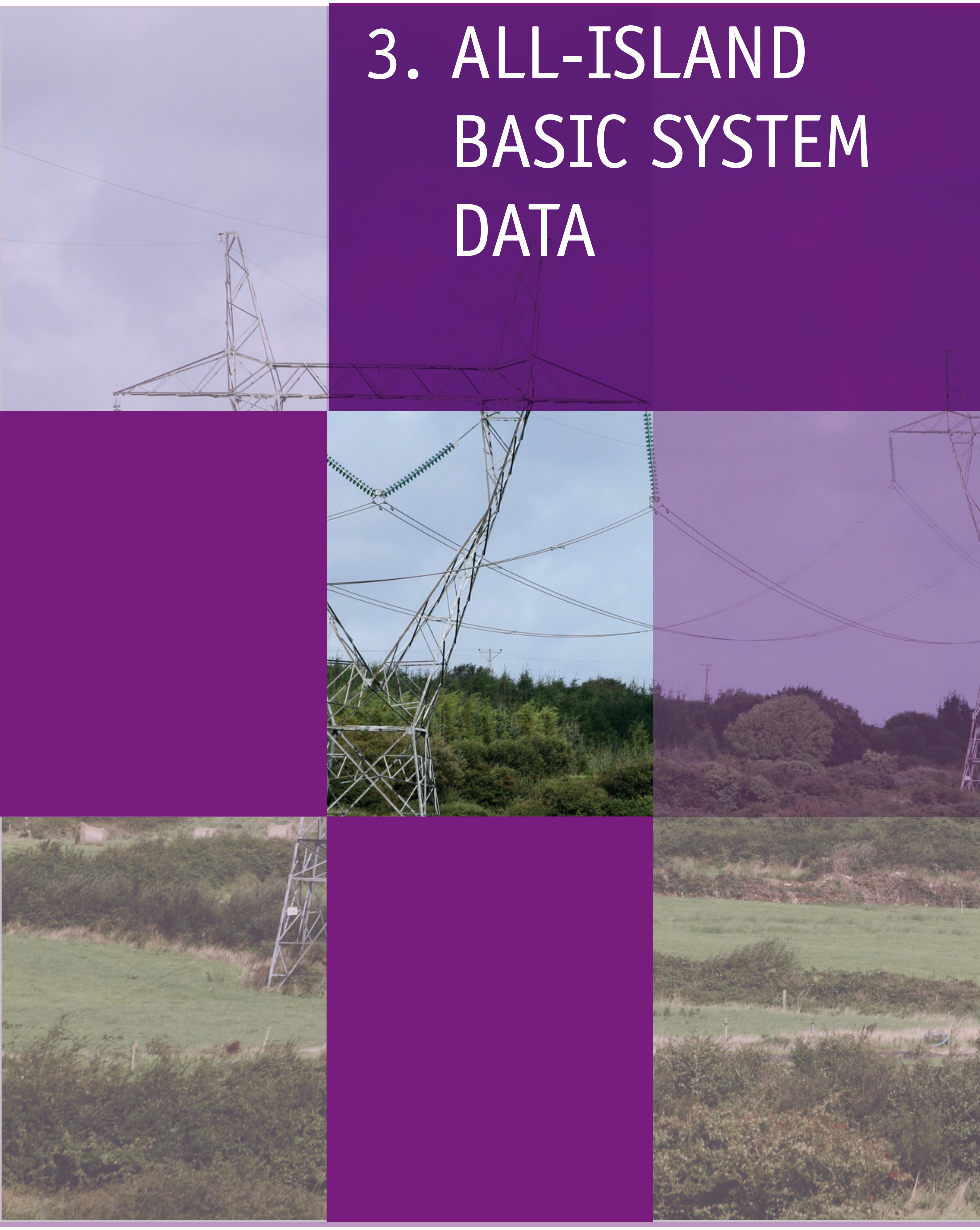
# 2. Background

# 2 BACKGROUND

The transmission system is a meshed network of high voltage lines and cables for the transmission of bulk electricity supplies around Ireland. Electricity generated in power plants is transformed to higher voltage levels – 110,000 volts (110 kV); 220,000 volts (220 kV); 275,000 volts (275 kV) and 400,000 volts (400 kV) – and fed into the transmission system, commonly known as the “national grid”. The transmission system is the backbone of the electricity system in this country. The transmission system also comprises of high voltage stations, where the electricity voltage is reduced for onward, local distribution (at 38,000 (38 kV), 20,000 (20 kV) and 10,000 (10 kV) volts in Ireland, and 33,000 (33 kV), 11,000 (11 kV) and 6,600 (6.6 kV) in Northern Ireland). Some large industrial customers can also take their power supply directly from the transmission system.

The distribution systems in Ireland and Northern Ireland are separately managed by Distribution System Operators (DSOs). The DSO for Ireland is ESB Networks Ltd, and the DSO for Northern Ireland is Northern Ireland Electricity (NIE). These bodies operate the distribution systems and bring power from transmission stations to smaller business units, farms and households.

# 3. ALL-ISLAND BASIC SYSTEM DATA



# 3 ALL-ISLAND BASIC SYSTEM DATA

This section contains basic all-island transmission system data. Further information can be found on the EirGrid and SONI websites: www.eirgrid.com and www.soni.ltd.uk

## 3.1 Total System Production

The total exported energy includes large and small-scale generation and also includes pumped storage units.

| | 2011 | 2012 |
|---|---|---|
| **All-Island Total Exported Energy [GWh]** | 35,144 | 34,637 |
| **ROI Total Exported Energy [GWh]** | 26,126 | 25,724 |
| **NI Total Exported Energy [GWh]** | 9,018 | 8,913 |

**Table 3-1 Total Exported Energy 2011 - 2012**

The total exported energy decreased by 1.4% from the all-island 2011 figure.

## 3.2 System Records

Peak demand is a measure of the maximum demand on the transmission system over a particular period (e.g. annual or seasonal) and it is a key measurement for any power system. The Irish system is a winter peaking system because of the greater need for heating and lighting requirements during the winter months and this is illustrated in Figure 3.1. The all-island winter peak in 2012 occurred at 17:30 on 10th December. This peak demand of 6,305 MW is down from a peak demand of 6,437 MW in 2011.

In summer, the reduced need for heating and lighting results in a lower demand for electricity. The minimum demand is known as the 'minimum summer night valley' and in 2012 a minimum all-island demand of 2,173 MW was recorded at 05:45 on 29th July.

The installed wind capacity continues to rise year-on-year enabling Ireland to progress towards the target of having 40% of our electricity produced by renewable sources by 2020. In 2012 a maximum all-island wind generation level of 1,864 MW was achieved.

Table 3-2 provides a summary of the system records for 2011 and 2012.

| | 2011 | 2012 |
|---|---|---|
| **Winter Peak Demand [MW]** | 6,383 | 6,305 |
| **Minimum Summer Night Valley [MW]** | 2,202 | 2,176 |
| **Maximum Wind Generation [MW]** | 1,839 | 1,864 |

**Table 3-2 System Records 2011 – 2012**

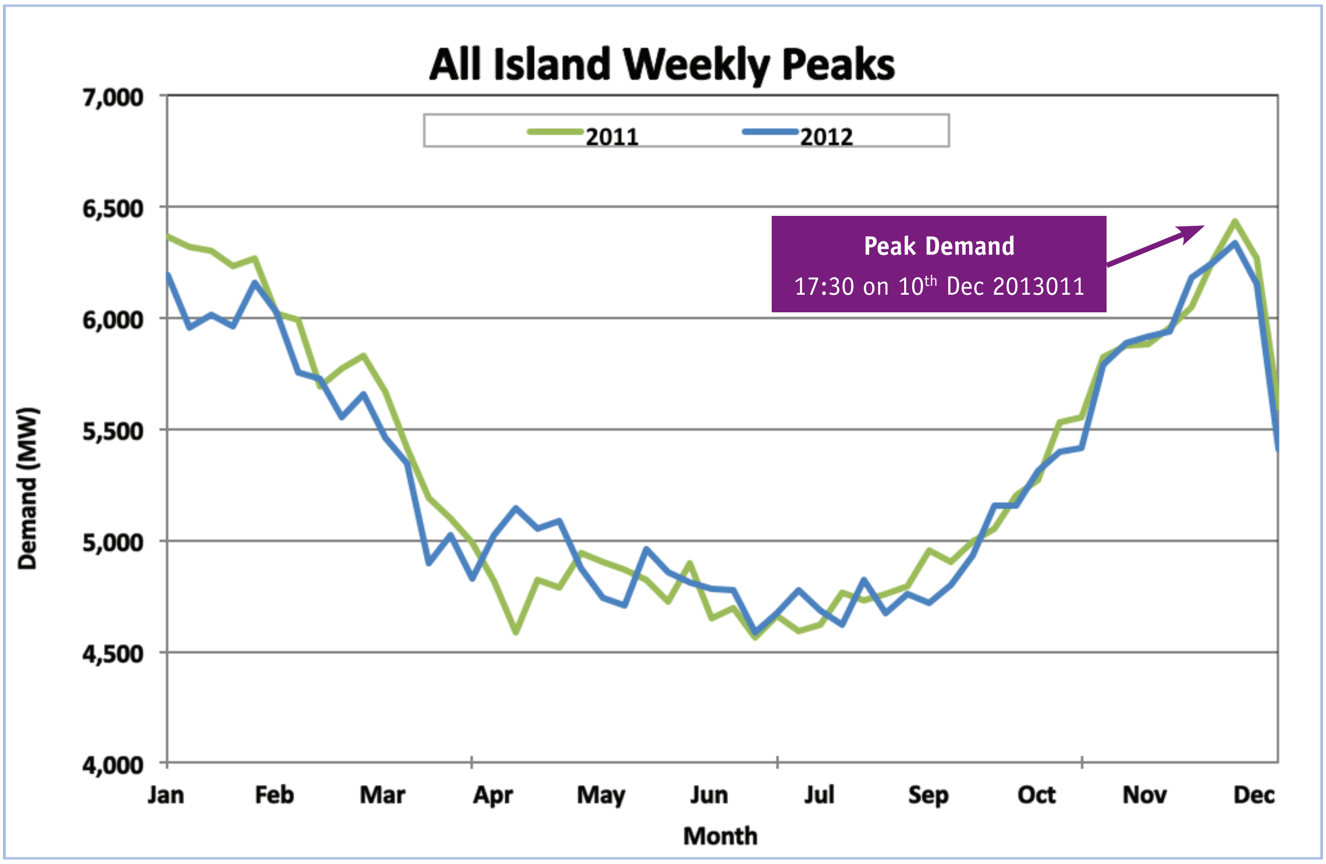



**Figure 3-1 Daily System Demand Peaks 2011 – 2012**

## 3.3 Operational Generation Capacity

Generation plant is connected to both the transmission and distribution systems. All generation contributes to meeting system demand. The total generation capacity is calculated as the sum of all fully-operational generator capacities connected to both systems[1]. The distribution data is provided by the DSO.

The All-Island installed capacity of conventional, dispatchable generation in December 2012 was 9,130 MW (6,794 MW in Ireland and 2,336 MW in Northern Ireland). This does not include any potential import contribution from the Moyle Interconnector or the new East West Interconnector

The All-island installed capacity of renewable generation in December 2012 was 2,497 MW (2,006 MW in Ireland and 491 MW in Northern Ireland), with in excess of 2,100 MW of installed wind generation.

Appendix 1 provides a list of the fully-dispatchable generating units connected to the transmission system.

# 4 ALL-ISLAND GENERATION AVAILABILITY & OUTAGES

## 4.1 Generation Availability

Generation Availability is a measure of the capability of generators to deliver power to the transmission system. In order for EirGrid to operate a secure and reliable transmission system in an economic, efficient manner, it is necessary for generators to maintain a high rate of availability. Appendix 1 provides a breakdown of availability of fully-dispatchable generation units for 2012.

The EirGrid Monthly Availability Report is published on the EirGrid website (www.eirgrid.com) on a unit-by-unit monthly basis. The availability is broken down into scheduled outages, forced outages and ambient conditions. The report also contains a 3-month outlook of unit availability.

Generation system availability is calculated on a daily and 365-day rolling average basis[2]. Figure 4-1 shows the daily and 365-day rolling average availability for 2012.

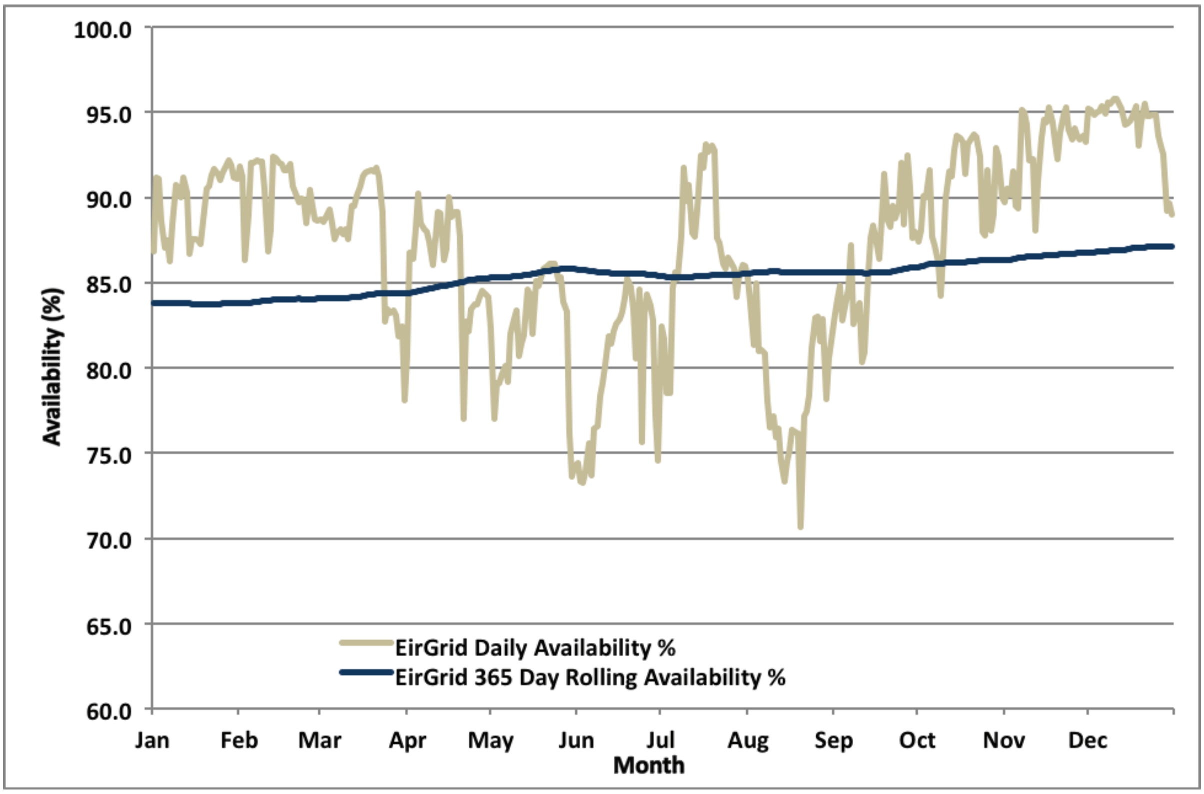



**Figure 4-1 Generation System Availability 2012**

- The average daily generation system availability in 2012 was 87.14%.
- The maximum daily generation system availability in 2012 was 95.79%, occurring on the 11th December 2012.
- The minimum daily generation system availability in 2012 was 70.61%, occurring on the 20th August 2012. On this date there were outages at Aghada AD1, Ardnacrusha AA1 & AA4, Dublin Bay DB1, Edenderry ED1, Erne ER3, Liffey LI5 and Moneypoint MP1 & MP2.

2 365-day rolling average is a capacity weighted average availability over the previous 365 days

## 4.2 Generation System Forced Outage Rate

The generation system forced outage rate (FOR) is calculated on a daily and rolling 365-day average basis. The daily FOR is a capacity weighted percentage of the time during the day that generation units are unavailable due to unforeseen/unplanned outages. The 365-day rolling FOR is the average of the daily FOR over the previous 365 days.

The daily FOR and 365-day rolling FOR are shown in Figure 4-2.

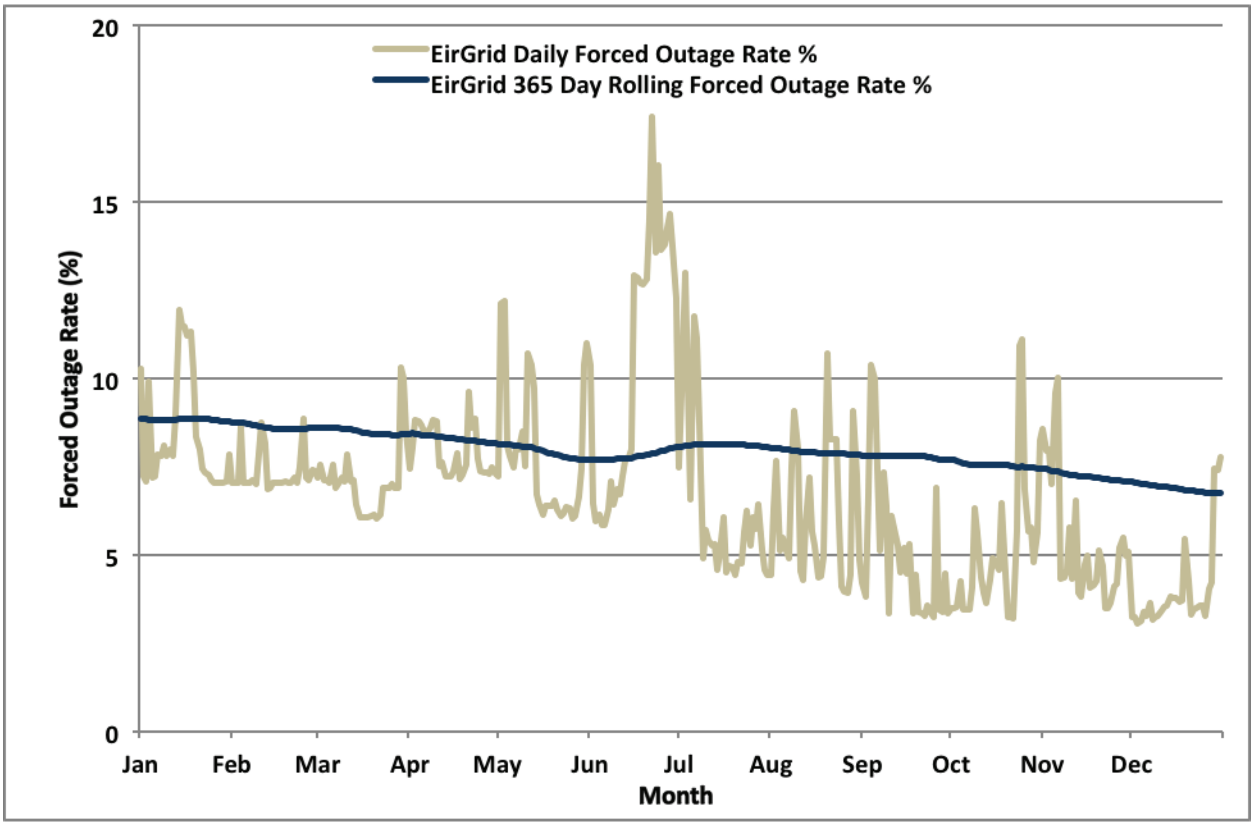



**Figure 4-2 Generation System Forced Outage Rate 2012**

- The average daily generation system forced outage rate in 2012 was 6.74%.
- The maximum daily generation system forced outage rate in 2012 was 17.43%, occurring on the 22nd June 2012. On this date there were forced outages of Erne ER3, North Wall NW5, Moneypoint MP3, Turlough Hill TH3 & TH4 and Tynagh TYC.
- The minimum daily generation system forced outage rate in 2012 was 3.08%, occurring on the 3rd December 2012.

## 4.3 Generation System Scheduled Outage Rate

The generation system scheduled outage rate (SOR) can be calculated on a daily and rolling 365-day average basis. The daily SOR is a capacity weighted percentage of the time during the day that generation units are unavailable due to planned outages. The 365-day rolling SOR is the average of the weekly SOR over the previous 365 days.

The daily SOR and 365-day rolling SOR are shown in Figure 4-3.

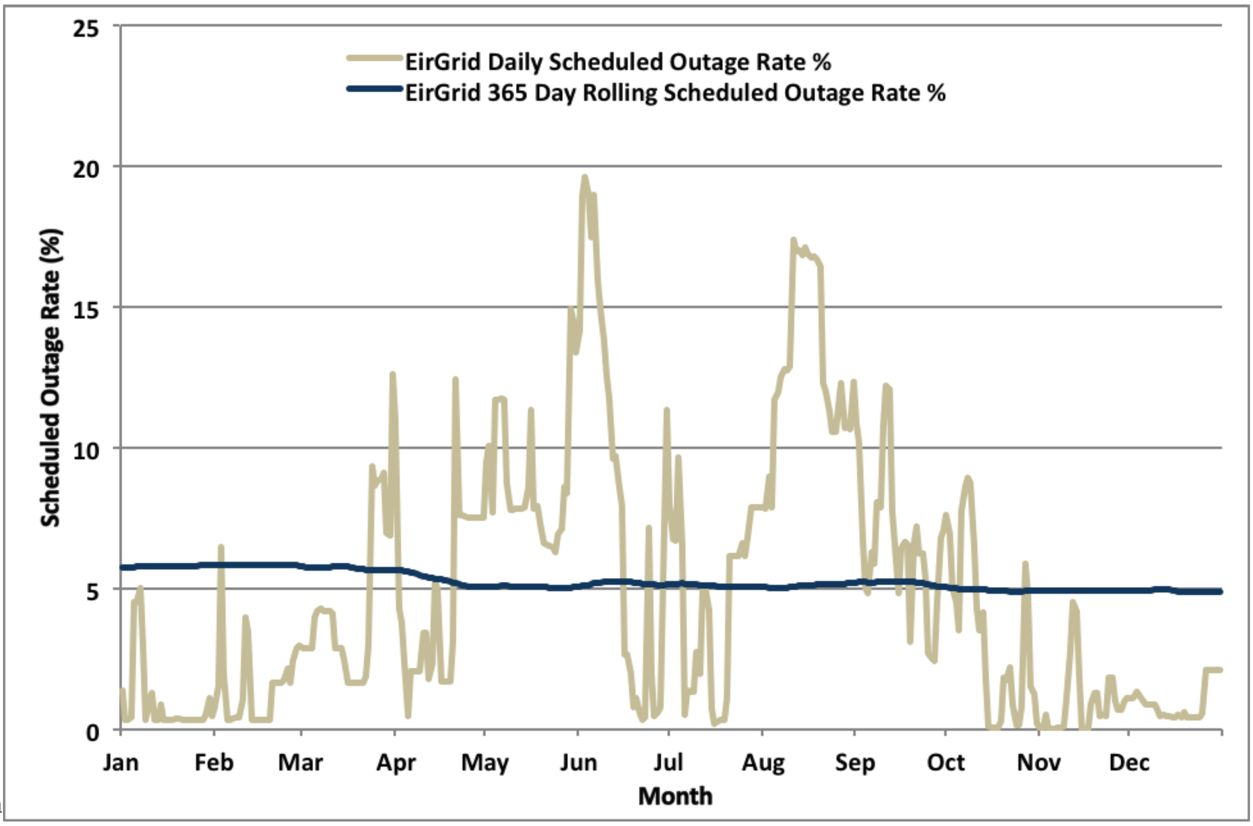



**Figure 4-3 Generation System Scheduled Outage Rate 2012**

- The average daily generation system scheduled outage rate in 2012 was 4.88%.
- The maximum daily generation system scheduled outage rate in 2012 was 19.62%, occurring on the 3rd June 2012. On this date there were scheduled outages of Ardnacrusha station, Erne ER3, Moneypoint MP3, Turlough Hill TH1 & TH2, Tynagh TYC and Whitegate WG1.
- The minimum daily generation system scheduled outage rate in 2012 was 0.00%, occurring on 13 occasions throughout the year.

# EirGrid TSO Transmission System Performance

# 5 EIRGRID SUMMARY

- The system was operated at all times within acceptable international standards for safety, security and reliability of customer supplies. All security of supply Key Performance Indicators (KPIs) were achieved throughout the year
- One 220kV circuit, five 110kV circuits and one new 110kV station were completed in 2012
- The total number of system minutes lost on the ROI Transmission System in 2012 was 0.271 minutes, 0.162 minutes of which were due to Transmission System faults
- There were no new conventional Generator connections provided in 2012 but there were a number of wind farms connected throughout the year
- East West Interconnector was commissioned and tested
- Extensive maintenance of the transmission system was carried out throughout the year, including 9,346 km of overhead line patrols
- One of the key measures of performance is availability,
- From January 2012 to December 2012, the number of 'System Minutes Lost' which occur when supply to customers is disrupted due to transmission system or generating plant failure was 0.3718 in Ireland

## 5.1 Transmission Infrastructure

The transmission system is a meshed network of high voltage lines and cables (110 kV, 220 kV, 275 kV and 400 kV) for the transmission of bulk electricity supplies around Ireland. This excludes the Dublin 110 kV network and some other specific 110 kV circuits which are treated as part of the distribution system. Table 5-1 provides a summary of transmission system infrastructure for 2011 and 2012.

| | 2011 | | 2012 | |
|---|---|---|---|---|
| **Plant Type** | No. of Items | Circuit Length [km] | No. of Items | Circuit Length [km] |
| 110 kV Circuits | 188 | 4,035 | 193 | 4,152 |
| 220 kV Circuits | 56 | 1,862 | 57 | 1,918 |
| 275 kV Tie-lines | 2 | 97 | 2 | 97 |
| 400 kV Circuits | 3 | 439 | 4 | 439 |
| **Circuit Total** | 249 | 6,433 | 256 | 6,606 |
| | | | | |
| **Plant Type** | No. of Items | Transformer Capacity [MVA] | No. of Items | Transformer Capacity [MVA] |
| 220/110 kV Transformers | 44 | 8,239 | 46 | 8,864 |
| 275/220 kV Transformers | 3 | 1,200 | 3 | 1,200 |
| 400/220 kV Transformers | 5 | 2,500 | 5 | 2,500 |
| **Transformer Total** | 52 | 11,939 | 54 | 12,439 |
| | | | | |
| **Total No. of sub-stations** | 156 | | 158 | |

**Table 5-1 Transmission System Infrastructure 2011 & 2012**

## 5.2 Grid Development and Maintenance

This section provides an overview of grid development activities in 2012. Grid development includes new or amended customer connection offers issued, offers accepted and connections energised at year end. This section also provides an overview of the total connected transmission system generating capacity and the level of maintenance activities carried out throughout the year.

### 5.2.1 Grid 25

Grid25 is EirGrid's programme for the long-term development of Ireland's transmission system. This includes the construction of 800km of new circuit at various high voltages and the upgrading of over 2000km of existing transmission circuits using new and existing conductor technologies.

In 2012 significant progress was made in a number of areas with the uprating of 215km of existing transmission circuits and the construction and energisation of 130km of new transmission circuits completed during the period.

A number of major new transmission reinforcements were completed including:

- Flagford Srananagh 220kV circuit,

Five new 110kV circuits;

- Tarbert Tralee II 110kV circuit,
- Gorman Navan III 110kV circuit,
- Dalton Galway Loop into Cashla 220kV station,
- Gorman Meath Hill 110kV circuit,
- Arva Shankill II 110kV circuit.

The new Banoge 110kV station was also completed in Co. Wexford in early 2012.

As part of the Grid25 programme, planning applications were submitted to the Strategic Infrastructure Division of An Bord Pleanála for the development of the following proposed projects:

- Dublin North Fringe 220kV station project
- North Kerry 220kV station project
- Clashavoon Dunmanway 110kV new circuit
- Kinnegad Mullingar 110kV new circuit
- East Kerry North West Cork 220kV station project

Planning applications were submitted to Limerick County Council for the Killonan 220kV station refurbishment project and to Clare County Council for the refurbishment of the Ardnacrusha 110kV station.

Public consultation began on EirGrid's largest Grid25 projects, the Grid West and the Grid Link projects following their respective launches during 2012. EirGrid also engaged with stakeholders and the public on a number of station and new circuit project proposals across the country.

EirGrid is conducting a number of evidence-based studies on the effects on the environment of substations and high voltage transmission lines ranging from 110kV to 400kV. These robust, peer-reviewed evidence-based studies are aimed at determining the actual impacts of the construction and existence of high voltage electricity transmission projects on the environment. The cultural heritage study was completed in 2012 and it is expected that the remaining studies will be completed in 2013.

## 5.3 Connection Offers Issued

Parties seeking a new connection to the transmission system or to amend an existing Connection Agreement must apply to EirGrid for a connection offer. EirGrid operates a standard regulatory approved process for providing Connection Offers to generators and demand customers seeking direct connection to the transmission system. Table 5-2 details the number of connection offers made by EirGrid in 2012[1].

| | Demand | Generation |
|---|---|---|
| New Connection Offers Issued in 2012 [No.][1] | 1 | 0 |
| New Connection Offers Issued in 2012 [Capacity] | 22 MVA | 0 MW |

**Table 5-2 Demand & Generation Connection Offers Issued in 2012**

## 5.4 Connection Offers Accepted

In order to connect to the transmission system, all demand and generation customers must execute a Connection Agreement with EirGrid. Table 4-2 summarises the total number of executed Connection Agreements in 2012 and their associated load or generation capacities. A connection offer which is accepted in one year is unlikely to impact on connected generation capacity in the same year given the lead times associated with construction.

| | Demand | Generation |
|---|---|---|
| Executed Connection Offer Agreements in 2012 [No.] | 1 | 5 |
| Executed Connection Offer Agreements in 2012 [Capacity] | -25 MVA | 185.8 MW |

**Table 5-3 Executed Demand & Generation Connection Agreements in 2012**

## 5.5 Connections Energised

When a Connection Agreement is executed for a new connection, it typically takes a number of years before the demand or generation is connected to the transmission system. This period includes project development, time taken to obtain consents and to construct the connection.

When the transmission connection is energised, it then takes a number of months for the generator to reach commercial operation. This period is generally much shorter for demand customers.

Table 5-4 provides an overview of the number of new connections to the transmission system commissioned in 2012.

1 These figures do not include non-capacity connection offers

| | Demand | Generation |
|---|---|---|
| Connections Energised in 2012 [No.] | 0 | 1 |
| Connections Energised in 2011 [Capacity] | 0 MVA | 500 MW |

**Table 5-4 Demand & Generation Connections Energised in 2012**

During 2012, there were no new demand customers energised. One new generation connection was energised in 2012. This was the connection of the East-West Interconnector to the system

## 5.6 Customers Certified Operational

Table 5-5 provides an overview of customers connected to the transmission system who have been deemed fully operational. It shows customer connections which have completed the testing phase and have received an operational certificate from EirGrid. This table shows the aggregate position over the entire transmission system at year end for 2011 & 2012.

| | 2011 | | 2012 | |
|---|---|---|---|---|
| | Demand | Generation | Demand | Generation |
| Customers Certified Operational [Total No. of sites] | 19 | 33 | 19 | 35 |
| Customers Certified Operational [Capacity] | 388 MVA | 7,111 MW | 388 MVA | 7,653 MW |

**Table 5-5 Demand & Generation Connections Certified Operational at year end 2011 – 2012**

## 5.7 Maintenance Works Completed

Transmission maintenance is undertaken in accordance with EirGrid's maintenance policy to ensure that the transmission system can operate in a safe, secure and reliable manner. The policy comprises continuous and cyclical condition monitoring (on-line and off-line), preventive maintenance on critical items of plant and the implementation of corrective maintenance tasks. The maintenance policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice. On an annual basis, transmission maintenance activities dictated by policy, work identified from analysis of plant condition and work carried over from previous years provide the total volume of maintenance requirements for the year (refer to Table 5-6).

During the year, due to a variety of reasons not anticipated at the start of the year (including resource limitations, outage restrictions, etc.), it may be necessary to reschedule or defer programmed maintenance activities. While a degree of this is appropriate and in accordance with good practice, the deferrals are kept under close review. Any increase in backlog could have a negative impact on the reliability and performance of the transmission system. Actual maintenance works are carried out by the Transmission Asset Owner (TAO), ESB Networks.

Table 5-6 provides, in volume terms, a summary of transmission maintenance requirements, maintenance programmed and maintenance completed in 2012 for overhead lines, underground cables and transmission stations.

| Volume of Transmission Maintenance by Activity | Maintenance Requirements | Maintenance Programmed[2] | Maintenance Completed |
|---|---|---|---|
| | | Year End | |
| **Overhead Line Maintenance** | | | |
| Patrols (incl. helicopter, climbing & bolt) [km] | 9134.689 | 8853.289 | 7946.289 |
| Timber Cutting [km] | 43 | 43 | 41 |
| Structure Painting [Number] | 3 | 0 | 0 |
| Structure & Hardware Replacement [Number] | 87 | 81 | 67 |
| Insulator & Hardware Replacement [Number] | 147 | 78 | 73 |
| **Underground Cables Maintenance** | | | |
| Check/Alarms [Number] | 671 | 671 | 634 |
| **Station Maintenance** | | | |
| Detailed Service [Number] | 1 | 0 | 0 |
| Ordinary Service [Number] | 386 | 294 | 236 |
| Operational Tests [Number] | 867 | 923 | 855 |
| Tap changes inspection [Number] | 15 | 10 | 7 |
| Corrective Maintenance [Number] | 560 | 475 | 326 |
| Condition Assessment of switchgear [Number] | 200 | 88 | 75 |

**Table 5-6 Transmission System Maintenance 2012**

Appendix 3 provides a full explanation of the main terms and activities in the asset maintenance policy as operated by EirGrid.
The year 2012 saw a significant increase in maintenance completions over 2011.
The year 2011 saw a slight increase in maintenance completions over 2010.
The decrease in the requirements for ordinary services reflects a change in reporting; an ordinary service on a coupler cubicle now includes the ordinary services on the associated sectionalising disconnects. This decrease does not imply a decrease in the backlog of ordinary services.

# 6 TRANSMISSION SYSTEM AVAILABILITY & OUTAGES

## 6.1 Transmission System Availability

When considering transmission system availability, it is the convention to analyse it in terms of transmission system unavailability. The formula for calculating transmission system unavailability is given in Appendix 4. Figure 6-1 shows a monthly breakdown of transmission system unavailability for 2011 and 2012.

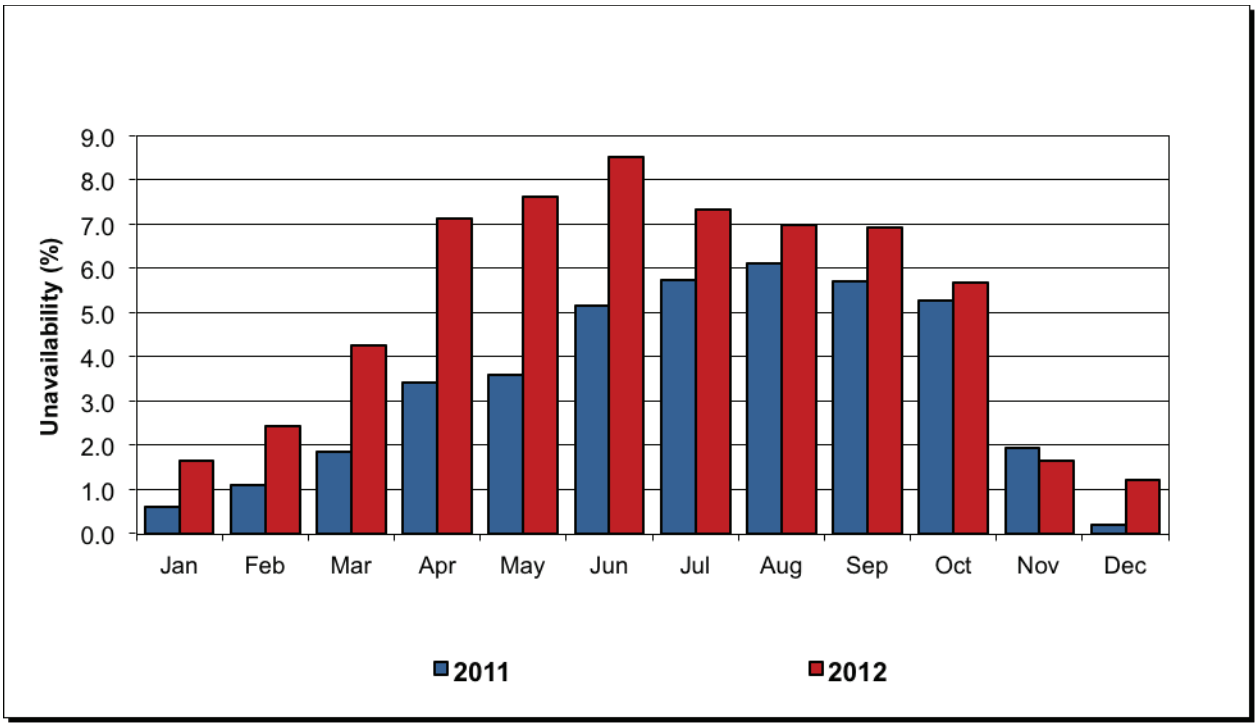



**Figure 6-1 Monthly Variation of System Unavailability 2011 & 2012**

## 6.2 Transmission Plant Availability

The measure of plant availability is the kilometre-day for feeders and the MVA-day for transformers. The availability figures vary between the different categories of plant. The formulae for calculating transmission plant availability are provided in Appendix 4.

Table 6-1 provides a detailed breakdown of all plant availability figures for 2011 and 2012.

| Plant type | Number of items | Circuit length (km) | Number of outages | Availability [%] 2012 | Availability [%] 2011 |
|---|---|---|---|---|---|
| *110kV Feeders* | 193 | 4152 | 463 | 96.17 | 95.40 |
| *220kV Feeders* | 57 | 1918 | 122 | 94.07 | 94.13 |
| *400kV Feeders* | 4 | 439 | 21 | 98.13 | 96.26 |
| *275kV Tie-Lines* | 2 | 97 | 3 | 99.55 | 96.86 |
| **Plant Type** | **Number of items** | **Transformer Capacity [MVA]** | **Number of Outages** | **Availability 2012 [%]** | **Availability 2011 [%]** |
| *220-110kV Transformers* | 46 | 8864 | 84 | 96.15 | 97.96 |
| *275-220kV Transformers* | 3 | 1200 | 8 | 98.43 | 96.92 |
| *400-220kV Transformers* | 5 | 2500 | 6 | 98.12 | 87.44 |
| *Total* | 310 | 6606 kM<br>12564 MVA | 705 | 96.96 | 95.15 |

**Table 6-1 Transmission System Plant Availability 2011 & 2012**

In 2012:
- The average plant availability was 96.96%;
- The maximum availability by plant type was 99.55%, which occurred on the
- 275kV tie lines; and
- The minimum availability by plant type was 94.07%, which occurred on the
- 220kV circuits.

The increase in the average plant availability from 95.15% in 2011 to 96.96% in 2012 can in part be attributed to the increase in availability of the 400/220 kV transformers and the 110kV circuits. These increases were offset, however, by a reduction in the availability of the 220/110 kV transformers and the 220 kV circuits.

There is no direct link between system availability/unavailability and lost load. An increase in system unavailability can be due to an increase in outages which may be planned and hence lost load may not be a direct result. Maintenance outages are normally scheduled to occur between March and October, and particularly during the July - August holiday season when the demand is at a minimum.

## 6.3 Cause of Transmission Plant Unavailability

Transmission plant unavailability is classified into the categories outlined in Table 6-2.

| Category | Description |
|---|---|
| **Forced & Fault** | Refers to unplanned outages. An item of plant trips or is urgently removed from service. Usually caused by imminent plant failure. There are three types of forced outage:<br>A) Fault & Reclose<br>B) Fault & Forced<br>C) Forced (No Tripping)<br>The above forced outages are explained in detail in Section 5.6 |
| **Safety & System Security** | **Safety:** Refers to transmission plant outages which are necessary to allow for the safe operation of work to be carried out.<br><br>**System Security:** Refers to outages which are necessary to avoid the possibility of cascade tripping or voltage collapse as a result of a single contingency. When a line is out for maintenance it may be necessary to take out additional lines for this reason. |
| **New Works** | An outage to install new equipment or uprate existing circuits. |
| **Corrective & Preventative Maintenance** | **Corrective Maintenance:** Is carried out to repair damaged plant. Repairs are not as urgent as in the case of a forced outage.<br><br>**Preventative Maintenance:** Is carried out in order to prevent equipment degradation which could lead to plant being forced out over time. Includes line inspections, tests and routine replacements. |
| **Other Reasons** | A number of other reasons may be attributed to plant unavailability, such as testing, protection testing and third party work. |

**Table 6-2 Transmission System Plant Unavailability Categories**

### 6.3.1 110 kV Plant Unavailability

Figure 6-2 provides a breakdown of the causes of unavailability on the 110 kV network in 2012.

The largest portion of unavailability (49%) on the 110 kV network was attributable to New Works. The most significant of these was for the outage of the Cathaleens Fall - Srananagh 1 110 kV line, for the uprating and diversion of the line. This outage lasted approximately 27 weeks.

Approximately 38% of the unavailability on the 110 kV network was attributable to Corrective and Preventative Maintenance. This type of maintenance includes Ordinary Service, Condition Assessments, wood-pole replacement/straightening and general line maintenance. The most significant of these outages was for the refurbishment the Lisdrum - Shankill 110kV Line which was carried out over a period of 10 weeks.

Forced & Fault accounted for 3% of the unavailability on the 110 kV network, the most significant of which was the forced outage of the Clahane – Trien 110kV Line for the repair of a circuit breaker operating mechanism. This outage took place in April 2012 and lasted in excess of 7 weeks.

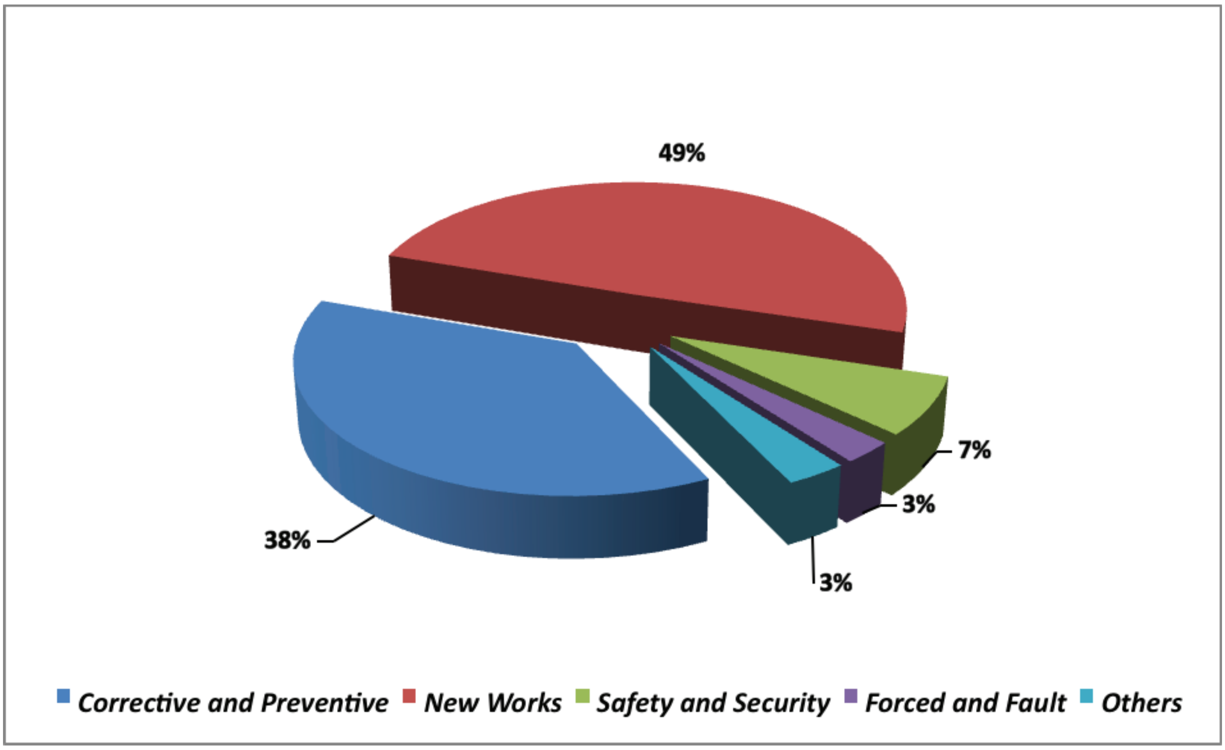



**Figure 6-2 Causes of Unavailability on the 110 kV system in 2012**

### 6.3.2 220 kV Plant Unavailability

The largest portion of unavailability (53%) on the 220 kV network was attributable to corrective and preventative maintenance. This type of maintenance includes, amongst others, Ordinary Service, Condition Assessments, wood-pole replacement/straightening and general line maintenance. The most significant of these was for the refurbishment of the Kilonan - Tarbert 220kv Line which lasted for approximately 11 weeks.

Approximately 33% of unavailability on the 220 kV network was attributable to New Works. The most significant of these outages included the uprating of Inchincore - Maynooth One and Two 220 kV lines. These outages were carried out simultaneously and lasted 14 weeks.

A further 9% of unavailability on the 220 kV network fell into the “other reasons” category. This category consists mainly of outages for protection testing and various inspections. Figure 6-3 provides a breakdown of the causes of unavailability on the 220 kV network in 2012.

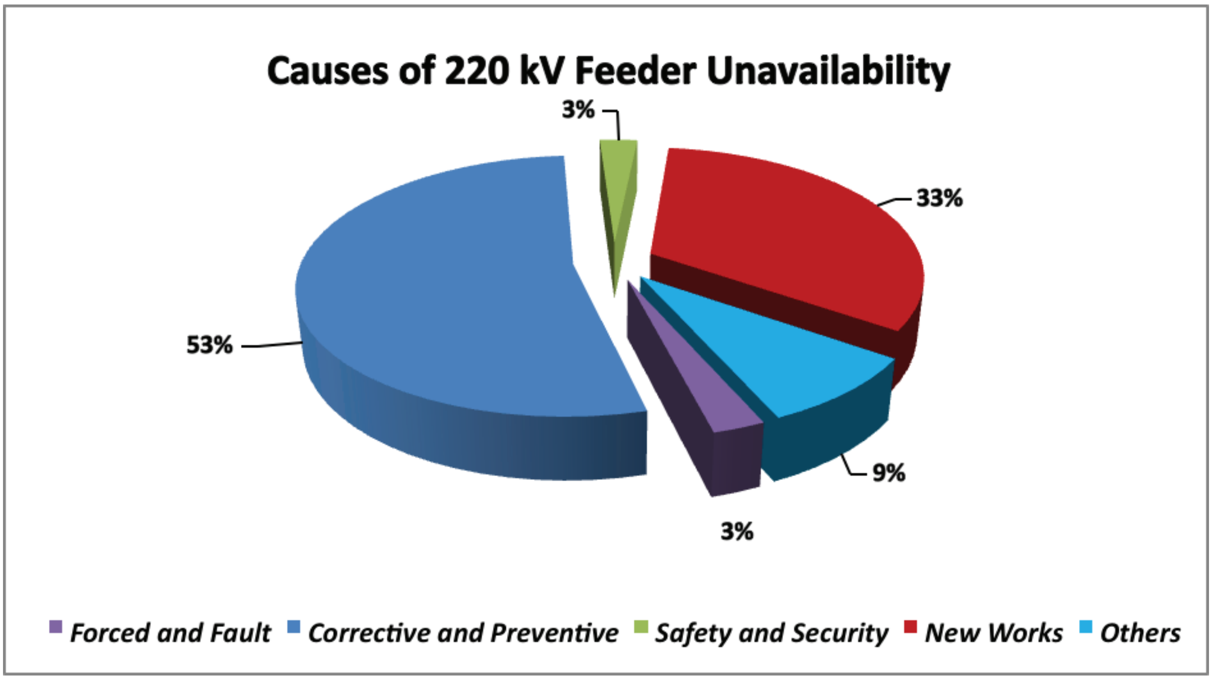



**Figure 6-3 Causes of Unavailability on the 220 kV system in 2012**

### 6.3.3 275 kV Plant Unavailability

The 275 kV tie-line consists of 48.5 km of 275 kV double circuit between Louth station and Tandragee station which is situated in County Armagh. In 2012 there was only one outage of a Louth-Tandragee tie-line. This was an outage of Louth – Tandragee (1) 275 kV line to facilitate a sag inspection and climbing patrol. Operational testing and corrective maintenance of the associated transformers was also carried out during this outage. The outage took place in September 2012 and lasted for a total of 3 days. There were no outages of the Louth – Tandragee (2) 275kV line in 2012.

### 6.3.2 400 kV Plant Unavailability

Figure 6-4 provides a breakdown of the causes of unavailability on the 400 kV network in 2012.

On the 400 kV network, there were a total of 21 outages in 2012. These outages included 12 outages of the Portan - Woodland 400 kV line to facilitate the connection and testing of EWIC. There were also 4 outages each of the Dunstown - Moneypoint and Oldstreet - Woodland 400kV lines. There was one outage of the Moneypoint - Oldstreet 400 kV line in 2012.

The largest portion (51%) of unavailability on the 400 kV network in 2012 was due to corrective and preventative maintenance. The most substantial of these outages was a 10 day outage of the Dunstown - Moneypoint 400kV line in May 2012.

The second largest portion of unavailability on the 400kV Network in 2012 is attributable to "other reasons" and accounts for approximately 34% of the total unavailability. This category is made up mostly of outages relating to the installation, testing and commissioning of the East West Interconnector.

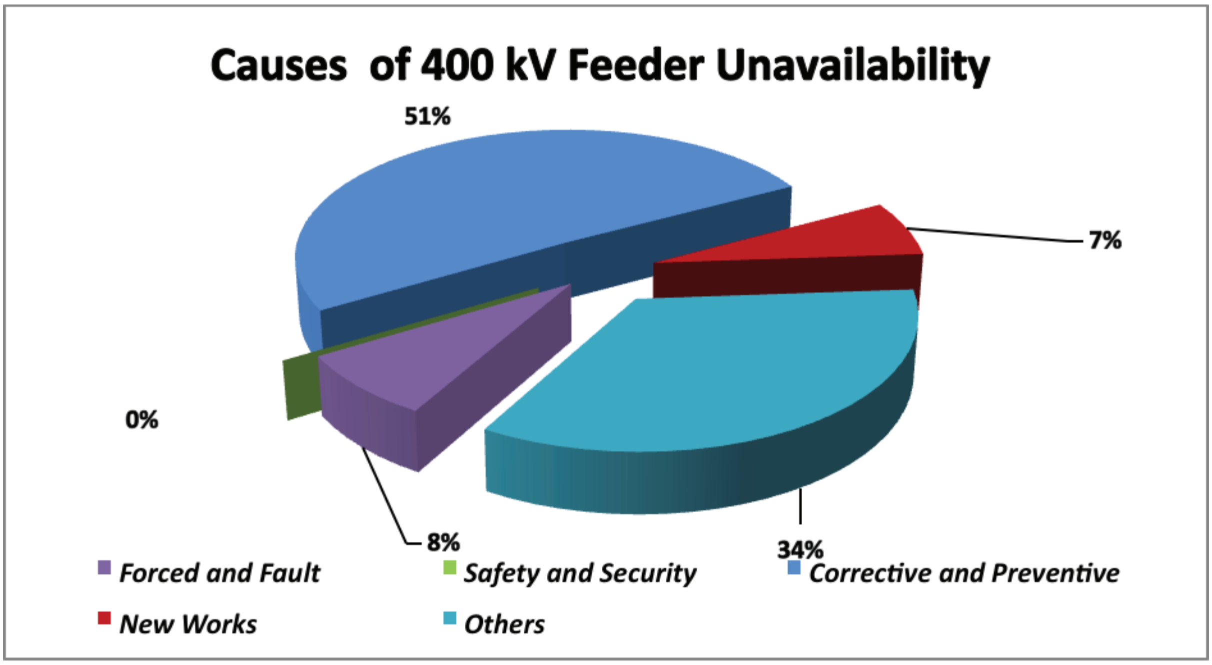



**Figure 6-4 Causes of Unavailability on the 400 kV system in 2012**

Table 6-3 provides a breakdown of the transmission system outages that occurred in 2012 by plant type.

| | | | Type of Outage | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Plant Type** | **Number of Items** | **Circuit Length [km]** | **Forced & Fault** | **Safety & System Security** | **New Works** | **Corrective & Preventative Maintenance** | **Other** | **Total Number of Outages[3]** |
| 110 kV Circuits | 193 | 4,152 | 25 | 57 | 111 | 218 | 52 | 463 |
| 220 kV Circuits | 57 | 1,918 | 8 | 15 | 17 | 69 | 13 | 122 |
| 275 kV Tie-lines | 2 | 97 | 0 | 0 | 1 | 1 | 0 | 2 |
| 400 kV Circuits | 4 | 439 | 1 | 0 | 1 | 2 | 17 | 21 |
| **Total** | **256** | **6,606** | **34** | **72** | **130** | **322** | **28** | **608** |
| **Plant Type** | **Number of Items** | **Transformer Capacity [MVA]** | **Forced & Fault** | **Safety & System Security** | **New Works** | **Corrective & Preventative Maintenance** | **Other** | **Total Number of Outages** |
| 220 /110 kV Transformers | 46 | 8,864 | 10 | 6 | 11 | 27 | 30 | 84 |
| 275 / 220 kV Transformers | 3 | 1,200 | 0 | 3 | 1 | 3 | 1 | 8 |
| 400 / 220 kV Transformers | 5 | 2,500 | 1 | 0 | 0 | 2 | 3 | 6 |
| **Total** | **54** | **12,439** | **11** | **9** | **12** | **32** | **34** | **98** |

**Table 6-3 Transmission System Plant Outages 2012**

## 6.4 Transmission Outage Duration

The duration of transmission outages is useful for assessing transmission system performance. Transmission outages are broken into eight time classifications ranging from less than 10 minutes to greater than four weeks. The total number of outages in each time classification is shown in Figure 6-5.

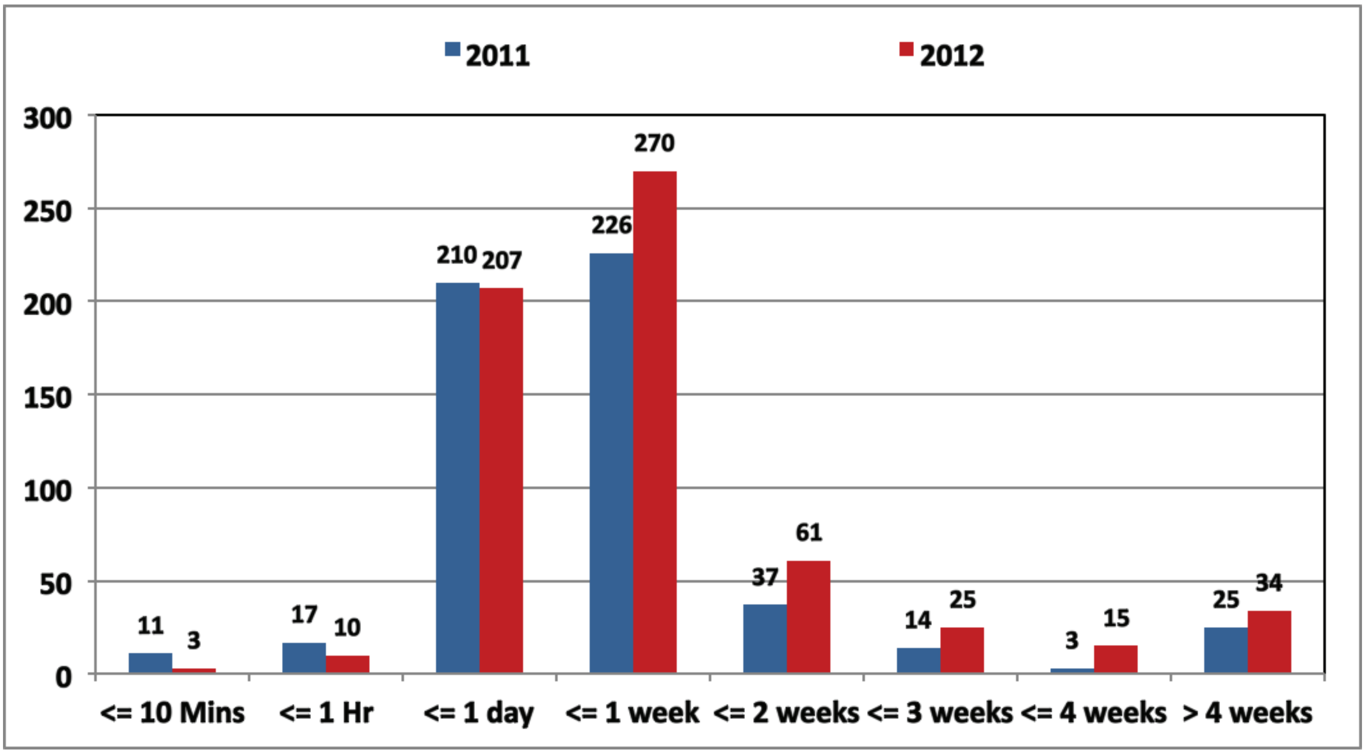



**Figure 6-5 Duration of Outages in 2011 & 2012**

The two most frequent transmission system outage periods occur between one hour and one day and between one day and one week. In the category of one hour to one day, outages can be arranged to avoid peak load times, and their effect on the system can be significantly reduced.

## 6.5 Timing of Transmission Outages

Transmission outages are scheduled, where possible, during periods of low load in the summer period. However, this can be limited by a number of factors such as personnel availability and shortage of hydro-power support in some areas. The seasonal nature of transmission outages is examined by giving the percentage of the total number of maintenance outages which occurred in each month shown in Figure 6-6 and also the average duration of these outages shown in Figure 6-7. In 2012, there were a number of prolonged maintenance outages between May and October. These outages were scheduled to complete, amongst other work, Cullenagh - Waterford 110 kV line uprate and protection upgrade, Killonan – Tarbert 220kV line refurbishment, Coolroe – Kilbarry 110kV line uprate and Ballydine – Cullenagh 110kV line uprate and Ballydine 110kV busbar uprate.

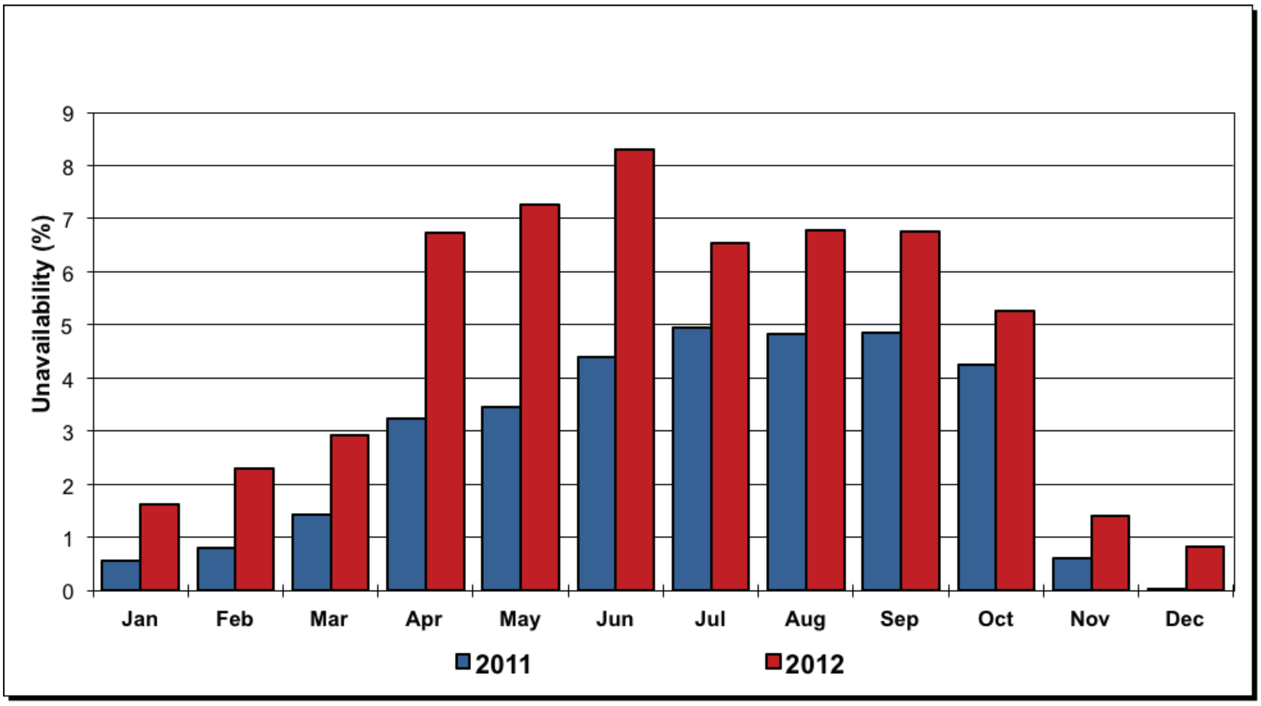



**Figure 6-6 Analyses of Maintenance Outages in 2011 & 2012**

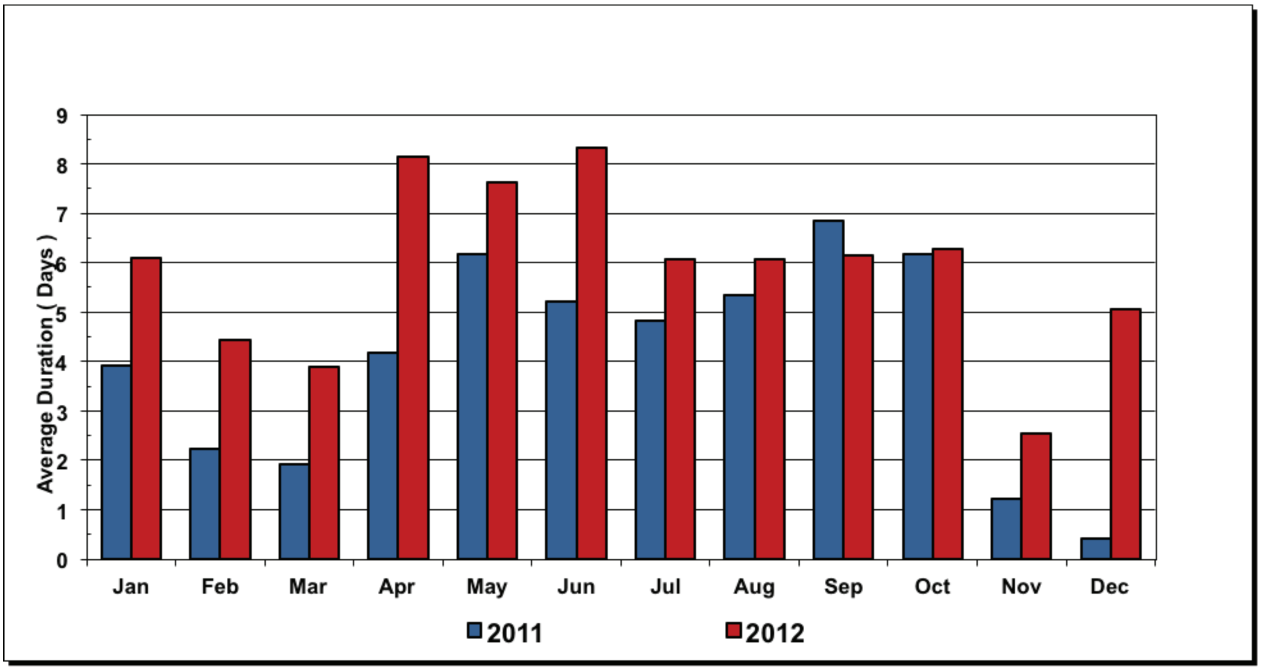



**Figure 6-7 Average Duration of Maintenance Outages 2011 & 2012**

## 6.6 Forced Outages

There are two main outage classifications, voluntary outages and forced outages. The majority of outages are voluntary outages that are scheduled by EirGrid. Forced outages are not scheduled and cause the most disruption to the transmission system. Due to their disruptive nature, forced outages merit further analysis.
There are three types of forced outages.

### A) Fault & Reclose

This type of outage occurs when a fault is detected by the protection equipment; the transmission plant is disconnected and successfully reconnected immediately, thus re-energising the circuit. These represent temporary faults, which, in general, do not cause major disruption to the system or customer. Lightning is a typical cause of this type of outage.

### B) Fault & Forced

This occurs when an item of plant is tripped by protection and does not return to service within ten minutes. This typically signifies plant damage, which requires maintenance.

### C) Forced (No Tripping)

This type of outage occurs when an item of plant is not tripped by protection, but is removed from the system urgently (i.e. there is no opportunity for scheduling). This may be necessary to avoid imminent failure or danger to plant and/or personnel. A typical cause of this outage would be the discovery of a fault during a maintenance inspection which is deemed to be sufficiently severe as to warrant the removal of the plant from service until the plant can be repaired or replaced.

The measure used for analysing the forced outages is the number of forced outages per kilometre of feeder. This is shown in Figure 6-8. Fault & Reclose forced outages are excluded due to their relatively low level of disruption.

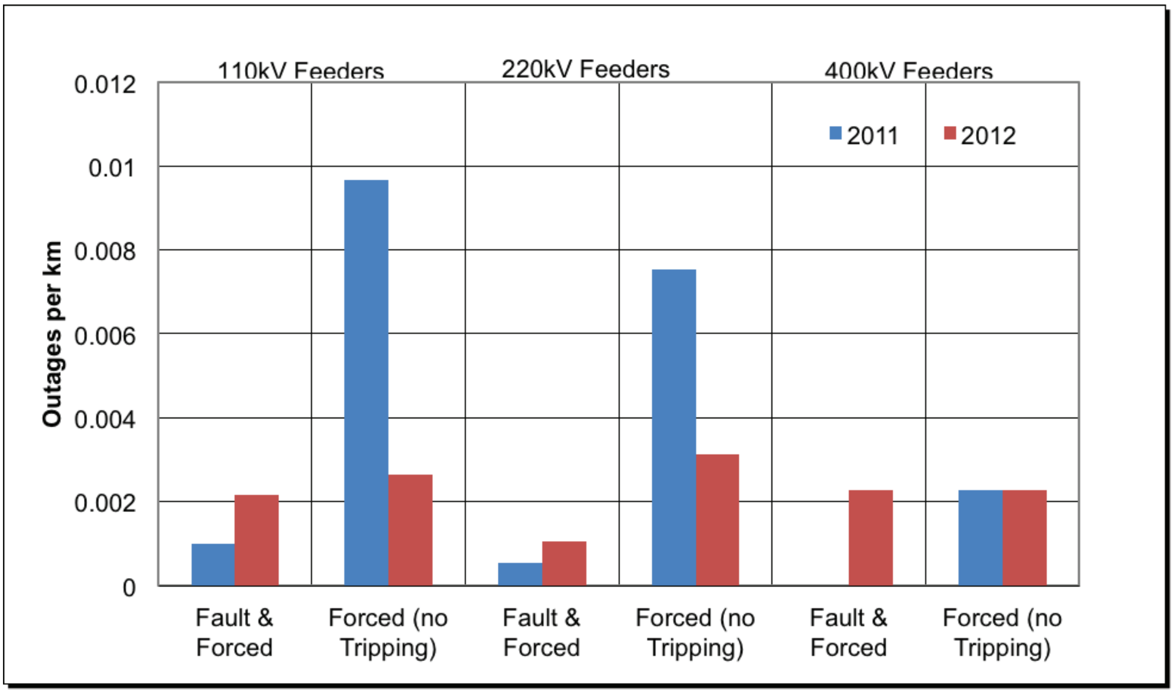



**Figure 6-8 The Nature of Feeder Forced Outages in 2011 & 2012**

There were eleven transformer forced outages in 2012. Of these outages, ten were of 220/110 kV transformers, the longest of which was of Louth T2102 220/110 kV Transformer which was on a forced outage for 123 days following the failure of an oil level test. There was one forced outage of a 400/220 kV transformer in 2012. The outage of T4201 in Woodland 400 kV station was to investigate a low SF6 alarm on the 400kv circuit breaker. There were no forced outages of any 275/220 kV transformers in 2012. Figure 6-9 below illustrates the number of forced outages in 2012 as a fraction of MVA capacity for each voltage level.

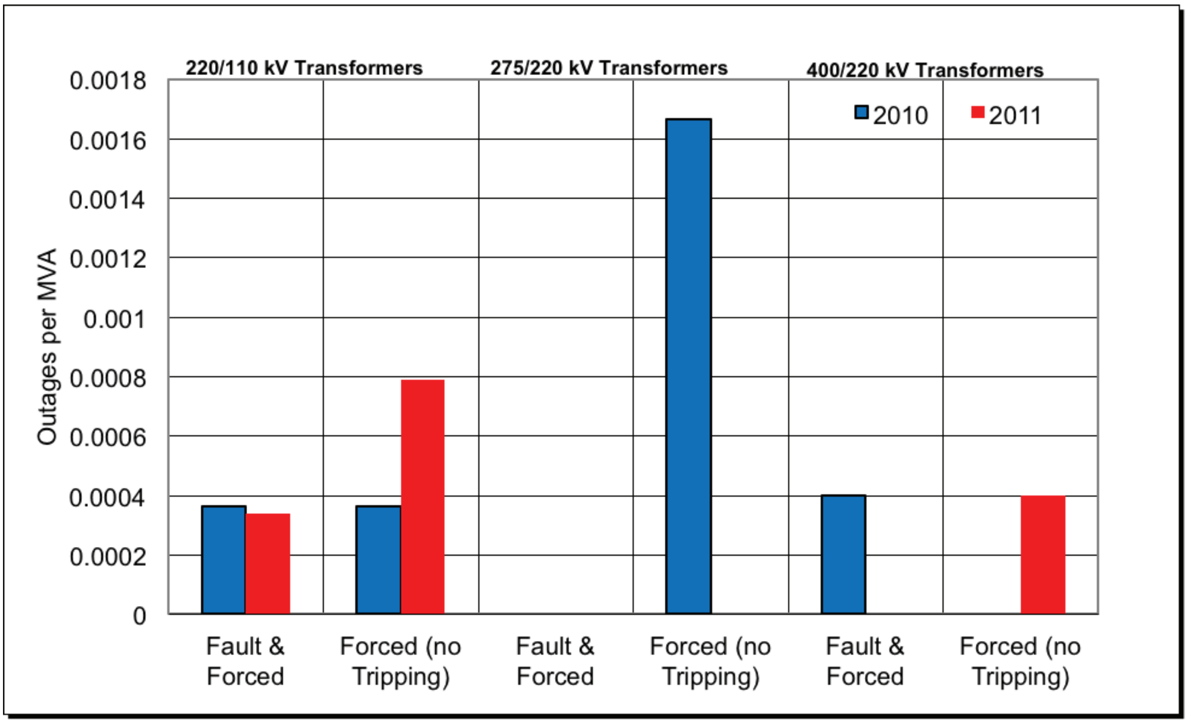



**Figure 6-9 Number of Forced Outages per MVA**

# 7 GENERAL SYSTEM PERFORMANCE

## 7.1 System Minutes Lost

The international benchmark for system performance and reliability is the system minute.

The system minute is an index that measures the severity of each system disturbance relative to the size of the system. It is determined by calculating the ratio of unsupplied energy during an outage to the energy that would be supplied during one minute, if the supplied energy was at its peak value. The formula used for calculating the system minutes lost can be found in Appendix 4.2. When this index for a specific incident is greater than one minute, that incident is classified as "major" using the CIGRÉ definition.

In 2012, the System Minutes lost as a result of faults on the Main System was 0.271. However, of these 0.271 System Minutes, 0.109 are attributable to the DSO.

For the UFLS disturbance on 20 August 2012, 0.211 System Minutes were lost due to the disconnection of Normal Tariff load customers. This figure is also included in the total System Minutes lost for the CER.

The total System Minutes lost for 2012, attributable to EirGrid, was 0.372.

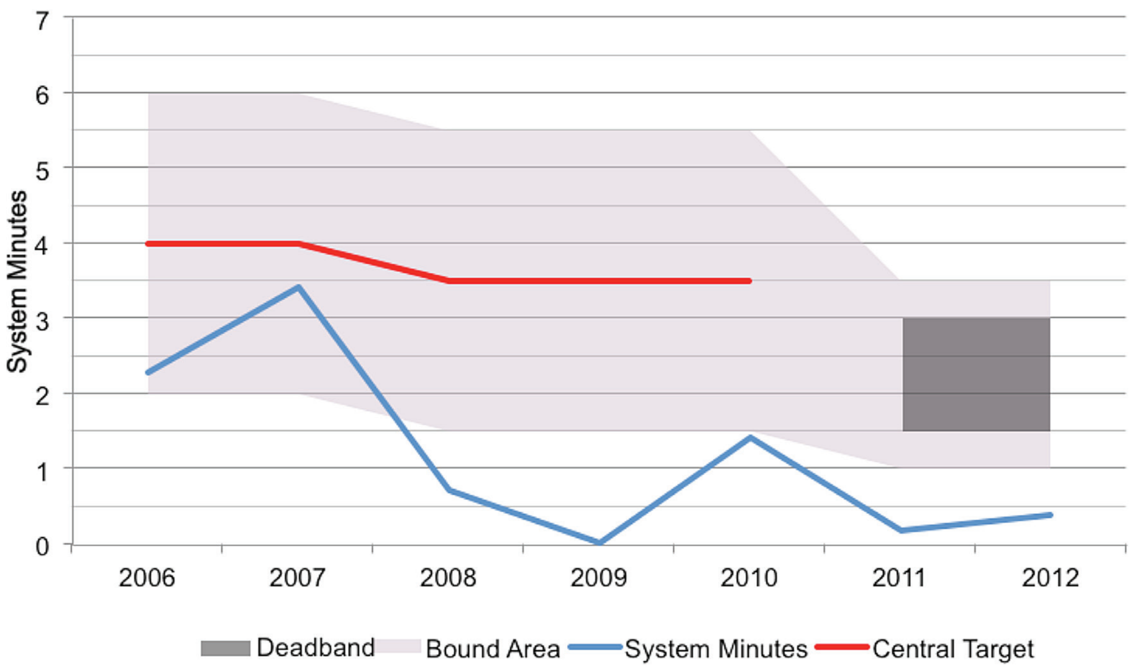



**Figure 7.1: System Minutes attributable to EirGrid 2006 - 2012**

In 2012, system minutes were lost on the Transmission System as a result of a number of transmission system faults and also following an under-frequency event. During the year, system minutes were lost as a result of the following Transmission System faults:

### 3rd January 2012 - Booltiagh - Moneypoint - Tullabrack 110 kV line

At 16:08 hours on Tuesday 03 January 2012, a three phase fault (RST) occurred on the Booltiagh - Moneypoint - Tullabrack 110 kV line. The cause of the fault was lightning. The circuit breaker at Booltiagh tripped to clear the fault and automatically reclosed. The load at Tullabrack, which is Tee connected between Booltiagh and Moneypoint, was disconnected for the autoreclose deadtime of 602 ms. 0.000019 system minutes were lost to Normal Tariff load customers.

### 8th August 2012: Carlow - Pollaphuca - Stratford 110 kV line

At 11:17 hours on Wednesday 08 August 2012, the Kellis 2 (two) 110 kV CB in Carlow 110 kV station was opened in error, disconnecting Pollaphuca and Stratford 110 kV stations. The load at Stratford, which is Tee connected between Carlow and Pollaphuca, was disconnected for 4 minutes 39 seconds. 0.00458 system minutes were lost to Normal Tariff load customers.

### 2nd October 2012 - Booltiagh - Ennis 110 kV line

At 12:42 hours on Tuesday 02 October 2012, a single phase to ground fault (SE) occurred on the Booltiagh - Ennis 110 kV line. The cause of the fault was lightning. The circuit breakers at Booltiagh and Ennis tripped to clear the fault and automatically reclosed. The load at Tullabrack, which is Tee connected between Booltiagh and Moneypoint, was disconnected for the autoreclose deadtime of 800 ms because Booltiagh is tail fed from Ennis. 0.000046 system minutes were lost to Normal Tariff load customers.

### 9th October 2012 - Shankill 110 kV station

At 11:18 hours on Tuesday 09 October 2012, Shankill 110 kV station was disconnected after a busbar fault occurred at Arva 110 kV station. 0.156308 System Minutes were lost to Normal Tariff load customers.

The notable incidents are summarised in Table 7-1.

| Date | Location of Fault | Station Disconnected | Cause | System Minutes |
|---|---|---|---|---|
| 3rd January 2012 | Booltiagh - Moneypoint - Tullabrack 110 kV line | Tullabrack | Lightning | <0.00002 |
| 8th August 2012 | Carlow - Pollaphuca - Stratford 110 kV line | Stratford | Human Error | 0.00458 |
| 2nd October 2012 | Booltiagh – Ennis 110kV line | Tullabrack | Lightening | <0.00005 |
| 9th October 2012 | Arva 110kV Station | Shankill | Human Error | 0.156308 |

**Table 7-1 Summary of system incidents in 2012**

## 7.2 System Frequency and Frequency Deviation

The National Control Centre aims to maintain the frequency within a target operating range of 50 ±0.1 Hz[2]. The frequency, however, may deviate outside the normal operating range under fault or abnormal operating conditions. In 2012, the frequency was maintained within the target operating limits of 50 ±0.1 Hz for 99.3% of the time.

| | |
|---|---|
| **Mean Frequency (Hz)** | 50.0 |
| **Minimum Frequency (Hz)** | 48.83 |
| **Maximum Frequency (Hz)** | 50.11 |

**Table 7-2 System Frequency & Frequency Deviation 2012**

## 7.3 System Alerts

The system may enter an alert state at any time and the number of occasions that this occurs is recorded by the number of amber or red alerts issued by the National Control Centre.

Red alerts are generally issued when:

1. The system frequency deviates significantly from normal i.e. < 49.3Hz for a sustained period of time; and/or
2. System voltages have deviated significantly from normal i.e. a group of stations have 110kV voltages less than 95kV; and/or
3. Significant consumer load has been shed; and/or
4. In the period immediately ahead there is a high risk of failing to meet System Demand or maintaining normal Voltage and Frequency;

Amber alerts are generally issued when:

1. The system margin is such as the tripping of the largest infeed (generator or Interconnector), would give rise to a reasonable possibility of:

   (a) Failure to meet the System Demand; and/or
   (b) Frequency or voltage departing significantly from normal;
   and/or
2. When multiple contingencies are probable because of thunderstorm or high wind activity;

Figure 7-2 shows the number of major alerts on the system over the past 10 years.

2 The Grid Code defines the normal operating range as 50 ±0.2 Hz. The Grid Code can be found on the EirGrid website (www.eirgrid.com).

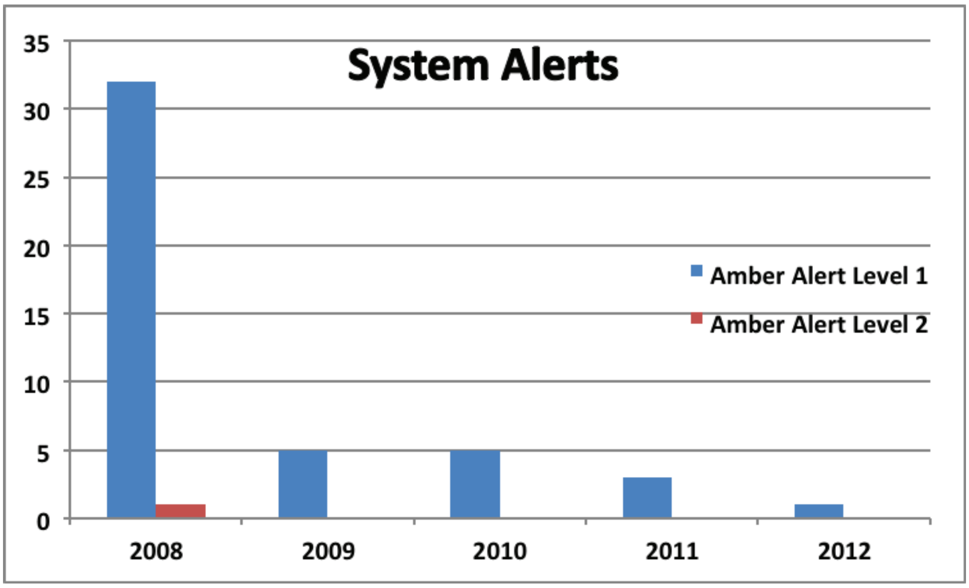



**Figure 7-2 Number of Alerts in the National Control Centre from 2008 - 2012**

## 7.4 Zone Clearance Ratio

The zone clearance ratio is a measure of the performance of protection installed on the transmission system. Protection includes main relays, transmission system circuit breakers and associated equipment, e.g. small wiring, MCBs, auxiliary relays. A measure of the performance of the protection system is the ratio of the number of short circuit faults which were not cleared in Zone 1 to the total number of short circuit faults cleared in all zones during the year.

*See Appendix for an explanation of Zones of Protection.*

In 2012, the ZCR was 0.067. The ZCR since 2004 is shown in Figure 7.3.

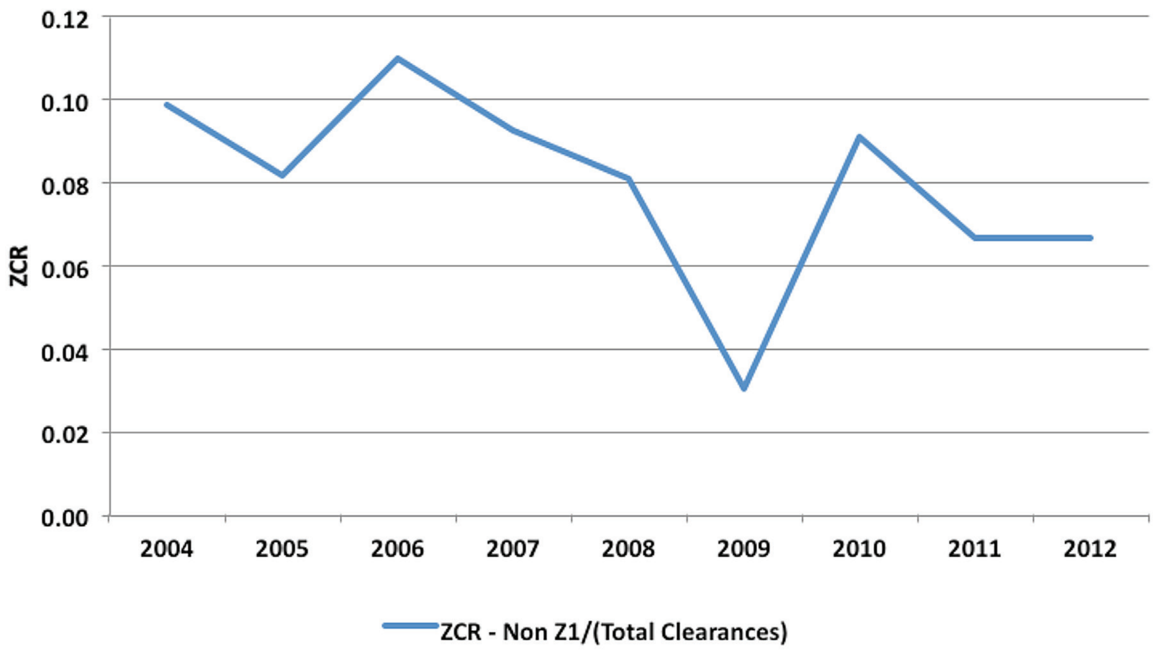



**Figure 7-3: Zone Clearance Ratio 2004 - 2012**

High performance of the protection system is indicated by a low fault clearance rate. The number of Zone 1 and non Zone 1 clearances for each year are presented in Table 7-3. Both the ZCR and number of clearances were the same in 2011 and 2012.

| Year | 2010 | 2011 | 2012 |
|---|---|---|---|
| Zone 1 Clearances | 20 | 28 | 28 |
| Non Zone 1 Clearances | 2 | 2 | 2 |
| Non Zone 1 clearances to total clearances | 2/22 = 0.09 | 2/28 = 0.071 | 2/28 = 0.071 |
| % of Zone Clearance Ratio | 9.09% | 6.67% | 6.67% |

**Table 7-3 Zone Clearance Ratios 2010 - 2012**

System Operator for Northern Ireland

# SONI Transmission System Performance

## 8 SONI SUMMARY

- One of the key measures of performance is availability, both of the overall Northern Ireland transmission system, and interconnection to the system. System availability is calculated as a percentage of actual circuit hours available in relation to total possible circuit hours available. Circuit outages that result from both planned and unplanned unavailability are taken into account.
- The annual system availability was 97.79%, with a higher winter availability of 99.0%, reflecting that planned work on circuits is minimised over the winter months.
- The performance of the Moyle interconnector continues to vary, having an annual availability of 62.02%. This all time low figure was caused by the ongoing cable faults the interconnector has suffered in recent years.
- Both poles of the Moyle were unavailable at the beginning of 2012 due to cable fault events in 2011 (26 June and 24 August 2011). Pole 1 (Cable 1) came back into service 18 January 2012 with an import capacity 250MW. Pole 2 (Cable 2) came back into service 19 February 2012 bringing the interconnector back to full capacity. Pole 2 (Cable 2) of the Moyle tripped 23 June 2012 due to a cable fault. This event reduced the import capacity again to 250MW. The import capacity of the interconnector remained at 250MW running on a single pole for the remainder of 2012.
- On 27-28 November 2012 Moyle conducted a within market test. This was carried out to test the newly designed cable reconfiguration which maintains a capacity of 250MW without relying on the cable sheaths as return paths. The test was successful and gives increased confidence in maintaining the Moyle capacity of 250MW as a minimum in the future.
- The tested reconfiguration of the cables can maintain the 250MW capacity without the requirement to use the incident prone elements of the cable, (i.e. cable sheath/return path). In the case of a further return path faults on Pole 1 the reconfiguration tested could be put into service within a short period of time.
- The North-South 275kV Tie Line's availability was 99.55%. The two 110kV Tie Lines had an annual availability of 94.73%, both figures fall well within the operational norms for these circuits.
- Another key measure of performance is system security, which is captured by reporting on any incidents resulting in loss of supplies to customers. In 2012 there were two reported incidents.
- Quality of service is measured by the number of voltage and frequency excursions over the year, that fall outside statutory limits. There were no voltage excursions over the year. When we consider frequency excursions on the same basis as previous years, using 49.5Hz as a threshold, the number of incidents has decreased from 12 within the 2010/11 report to 4 in 2012 report.
- With the exception of the Moyle Interconnector HVDC link all system availabilities have generally remained at the same level of performance when compared to previous year's reports. Unfortunately during the period of this report the Moyle interconnector suffered from lengthy unplanned outages.

This data has been prepared by the System Operator for Northern Ireland Ltd. (SONI) in accordance with the requirements of Part 11 of Condition 20 of the 'Licence to Participate in the Transmission of Electricity'.

SONI is responsible for the safe, secure, efficient and reliable operation of the Northern Ireland transmission network. The transmission network is operated at 275kV and 110kV. Its primary purpose is to transport power via overhead lines and cables from generators and interconnectors to Distribution Bulk Supply Points. The power is then transformed to lower voltages (33, 11 and 6.6kV) and distributed to customers.

Reporting is carried out in accordance with the definitions and principles of the National Fault and Interruption Reporting Scheme (NAFIRS), (Engineering Recommendation G43/2). The effects of national / regional emergencies and disputes are excluded.

This report covers the 12 month period from 1st January – 31st December 2012. The 3 month period 1st October - 31st December 2011 is not reported on here, however is available on request.

# 9 SYSTEM AVAILABILITY

## 9.1 Calculation Methodology

System Performance is monitored by reporting monthly variations in system availability, winter peak and average annual system availability, together with planned and unplanned system availability.

Availability is reduced whenever a circuit is taken out of operation, either for planned purposes e.g. maintenance work, or as the result of a fault, caused, e.g., by lightning strikes, high winds, equipment failure etc.

SONI is required under its licence to operate the transmission system in accordance with the Transmission and Distribution System Security and Planning Standards and the Grid Code.

Planned work is necessary to facilitate new user connections, network development and the maintenance of network assets necessary to deliver acceptable levels of system security and reliability.

The outages of transmission circuits either planned outages or faults resulting in forced outages have the net effect of reducing system availability to less than 100%. System availability is defined by the formula:

$$\textbf{System Availability} = \frac{\textbf{The sum of all circuit hours actually available x 100\%}}{\textbf{(Total No. of circuits) x (Total No. of hours in one year)}}$$

A circuit is defined as the overhead line, cable, transformer or any combination of these that connects two system bus bars together or connects the system to a User's busbar. Network bus bars are located in transmission substations; the bus bars, circuits and network configuration are described in the current SONI Transmission Seven Year Statement.

There are approximately 150 transmission (275kV and 110kV) circuits in the Northern Ireland transmission system, covering a total length of circa 2130km in the form of transmission overhead lines and cable circuits.

Planned unavailability - is defined as outages that are required to maintain transmission network assets. These are planned in excess of seven days prior to the outage. This also includes outages to facilitate user connections (generators etc.) and also general network maintenance that benefits all users.

Unplanned unavailability - is due to an outage which occurs as a result of breakdown, i.e. outages required and taken immediately upon request or planned at less than seven days notice.

## 9.2 Results

### 9.2.1 Annual System Availability

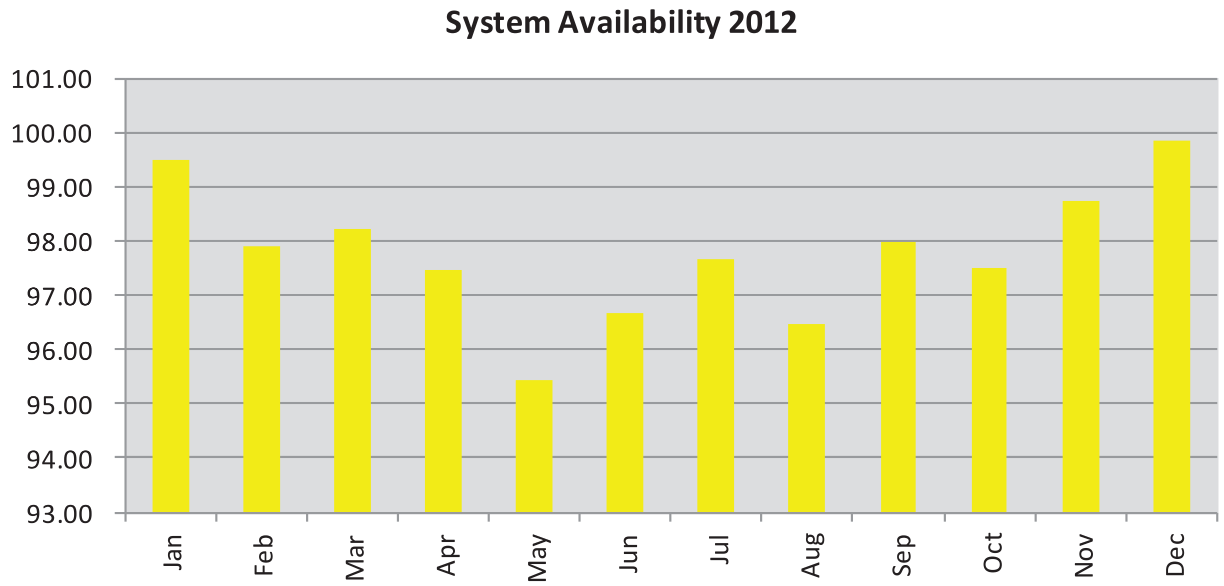
For 2012, the Average Annual Availability of the Northern Ireland Transmission System was 97.79%

### 9.2.2 Summer and winter Availability

The Winter Peak System Availability (average system availability for the winter months Jan, Feb, Nov and Dec 2012) has increased to 99.00% from 98.45% in the 2010/11 report.

### 9.2.3 Monthly Availability

Figure 9.1 below shows the month by month variation in system availability in respect of the transmission network in Northern Ireland.



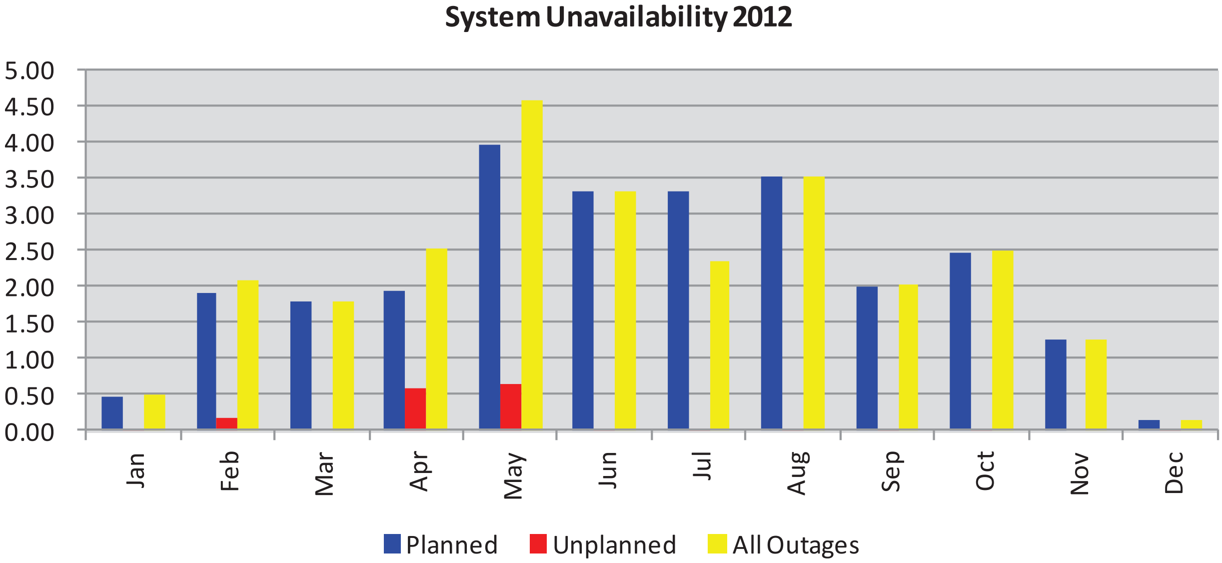

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 99.51 | 97.91 | 98.21 | 97.48 | 95.41 | 96.68 | 97.65 | 96.48 | 97.99 | 97.52 | 98.74 | 99.85 |

**Figure 9.1: System Availability 2012**

Overall, the availability of the system is high, particularly over the winter months, with an average of 99.0% for January, February, November and December 2012. The higher availability over the winter months is because planned outages are usually scheduled to take place over the summer months when network loading is generally lower. From May to August the availability is 96.56%; over 2.0% lower than winter value.

## 9.2.4 System Unavailability

Figure 9.2 below shows the month by month variation in planned, unplanned and total system unavailability.




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 0.46 | 1.91 | 1.79 | 1.93 | 3.96 | 3.32 | 3.32 | 3.52 | 2.01 | 2.47 | 1.26 | 0.13 |
| **Unplanned** | 0.02 | 0.18 | 0.00 | 0.60 | 0.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 |
| **All Outages** | 0.49 | 2.09 | 1.79 | 2.52 | 4.59 | 3.32 | 2.35 | 3.52 | 2.01 | 2.48 | 1.26 | 0.15 |

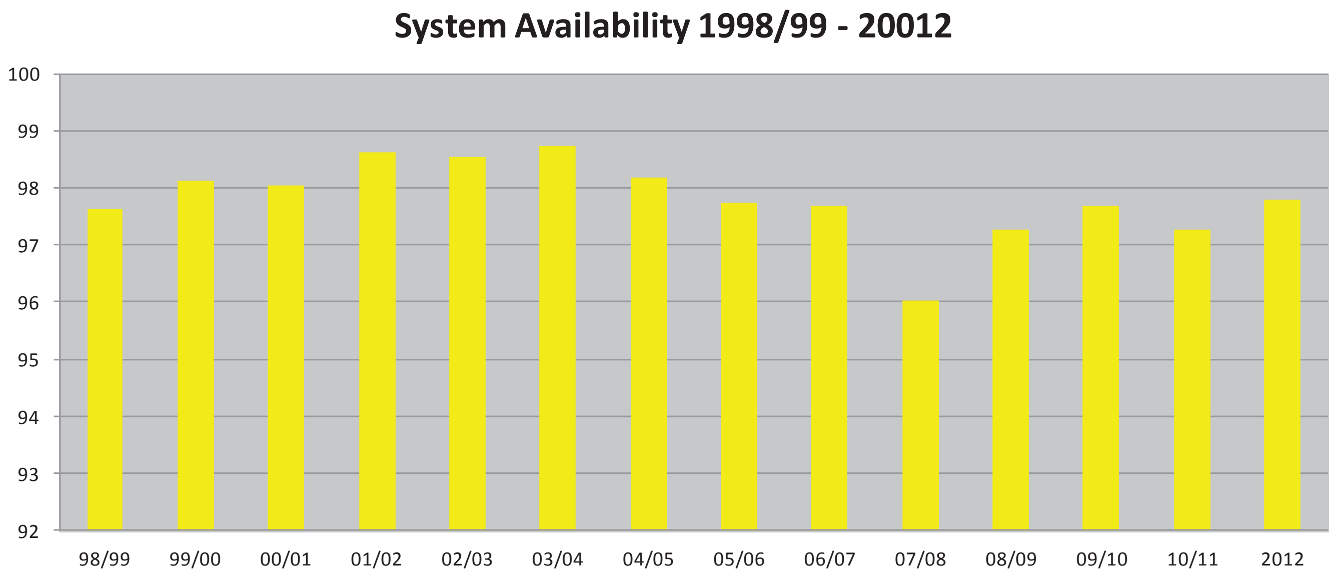
**Figure 9.2: System Unavailability 2012**

Total unavailability varied between 0.15% and 4.59% throughout the year, with the highest occurrence being in May 2012.

Figure 9.2 above shows that the majority of planned outages occurred during the summer months of May – August 2012. These four months have an average value of 3.44% for planned outages. The graph shows that planned outages far outweighed unplanned outages during the period of this report. The low unplanned outage average figure of 0.12% demonstrates how well the transmission system performed.

### 9.2.5 System Historic Availability Performance

Figure 9.3 below shows the historic variation in system availability from 1998/99 to 2012 in respect of the transmission network in Northern Ireland.




| 98/99 | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 97.62 | 98.13 | 98.05 | 98.62 | 98.53 | 98.73 | 98.17 | 97.73 | 97.67 | 96.01 | 97.26 | 97.67 | 97.26 | 97.79 |

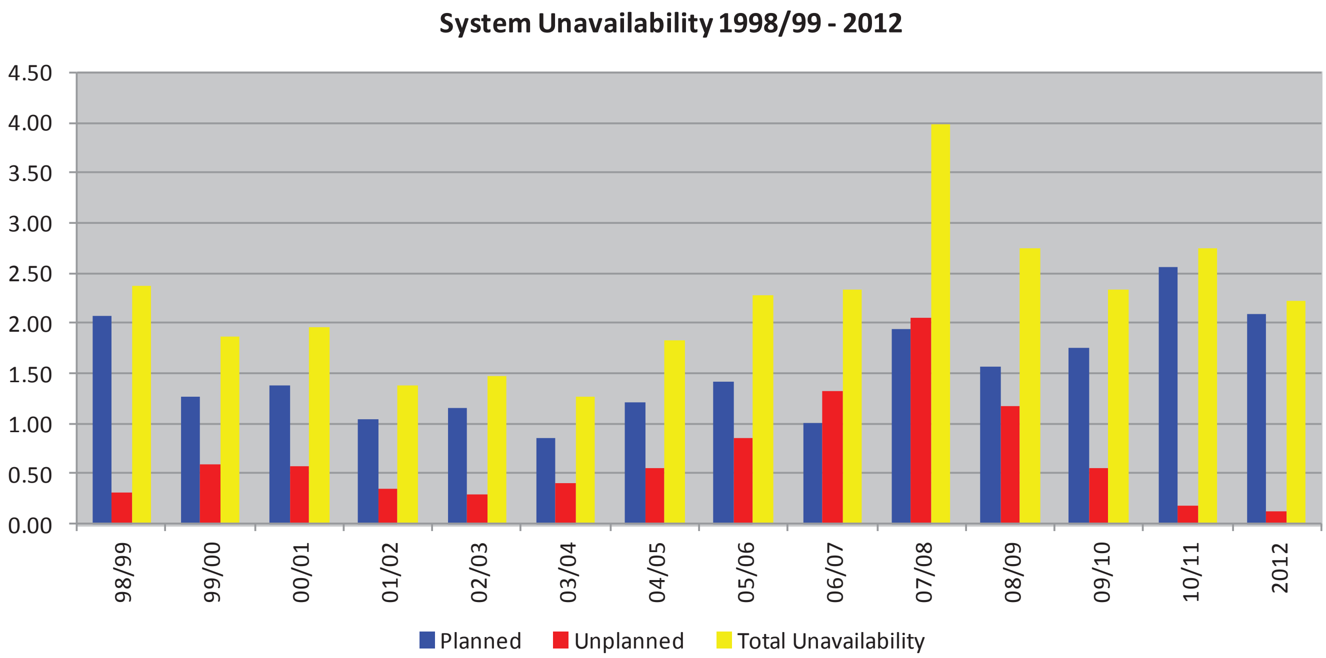
**Figure 9.3: Historic System Availability 1997/98 – 2012**

The Transmission System Performance report for previous years aligned to cover the financial years rather than calendar years. For 2012 SONI have aligned with the calendar year (Jan-Dec) as the first step towards a combined report with our EirGrid colleagues. This we believe make sense as the Networks within both regions are interconnect via AC transmission lines at 275kV and 110kV making one synchronous area, therefore a single network event can have adverse effect on each TSO's regional area.

The percentage figure of system availability for 2012 shows a slight increase on the previous year, and remains ahead of the system low figure of 96.01% in 2006.07. The annual average over the period of the above graph is 97.80%. The figure of 97.79% for 2012 therefore is comparable with this average.

## 9.2.6 System Historic Unavailability Performance

Figure 9.4 below shows the breakdown of the system unavailability from 1997/98 to 2012.




| | 98/99 | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 2.07 | 1.27 | 1.37 | 1.04 | 1.16 | 0.86 | 1.21 | 1.42 | 1.01 | 1.94 | 1.57 | 1.76 | 2.56 | 2.09 |
| **Unplanned** | 0.31 | 0.60 | 0.58 | 0.34 | 0.30 | 0.41 | 0.56 | 0.85 | 1.32 | 2.05 | 1.17 | 0.56 | 0.18 | 0.12 |
| **Total Unavailability** | 2.38 | 1.87 | 1.95 | 1.38 | 1.47 | 1.27 | 1.83 | 2.27 | 2.33 | 3.99 | 2.74 | 2.33 | 2.74 | 2.21 |

**Figure 9.4: Historic System Unavailability 1997/98 – 2012**

figure 2.4; The annual system unavailability figure for 2012 shows a slight decrease when compared to the 2010/11 figure, the trend of reducing unplanned outages continues. The unplanned outages figure reduced from 0.18% to a new low of 0.12%.

Using the data from the above graph the overall annual average percentage for system unavailability is 2.20%. The unavailability percentage for 2012 (2.21%) falls close to the average percentage figure over the entire data period of from 1998 – 2012.

# 10 INTERCONNECTOR and TIE-LINE AVAILABILITY

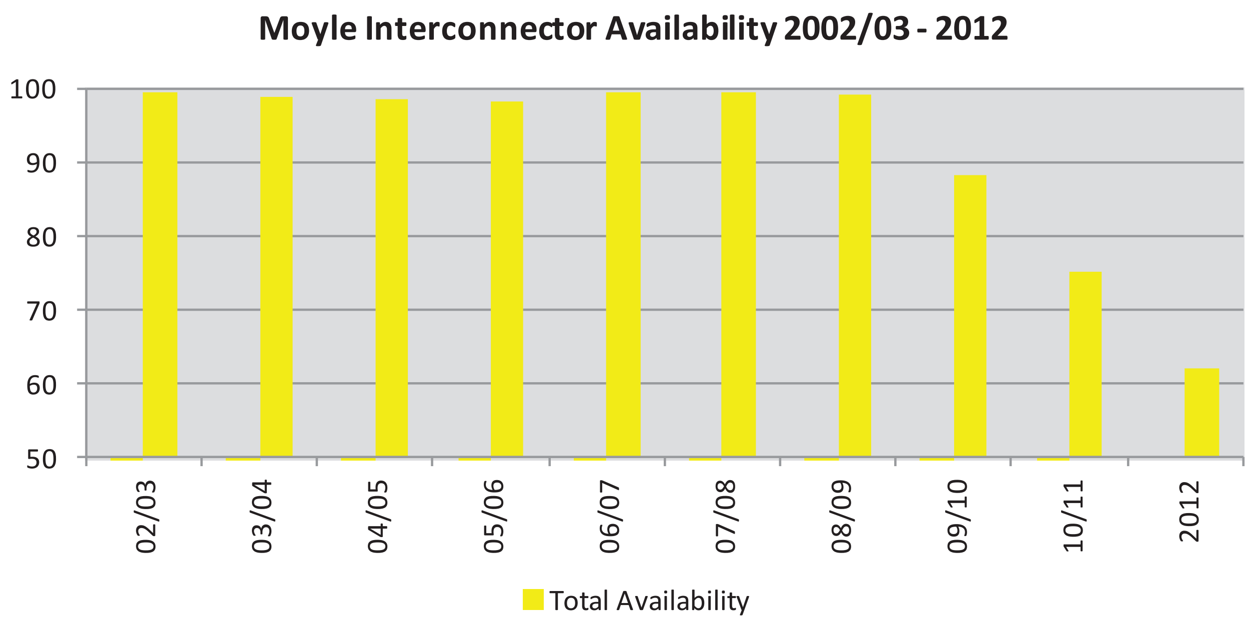
## 10.1 Interconnection with GB

The Moyle interconnector, NI-GB, commenced commercial operation in 2002 and is constructed as a dual monopole HVDC link with two coaxial undersea cables from Ballycronan More, Islandmagee to Auchencrosh, Ayrshire, Scotland. The 500MW link is operated by SONI, and the performance of this link falls under the scope of this report.

## 10.2 Moyle Interconnector Historic Availability

The 2012 Annual Availability of the Moyle Interconnector was significantly reduced to an all time historic low of 62.02%.

Figure 10.1 below shows the historic annual variation in the Moyle Interconnector availability from 2002/03 – 2012. With the exception of the past three years the availability of the Moyle interconnector has remained high since its introduction in 2002, with 2007/08 remaining the highest on record.




| 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|
| 99.40 | 98.77 | 98.43 | 98.34 | 99.35 | 99.46 | 99.09 | 88.18 | 75.16 | 62.02 |

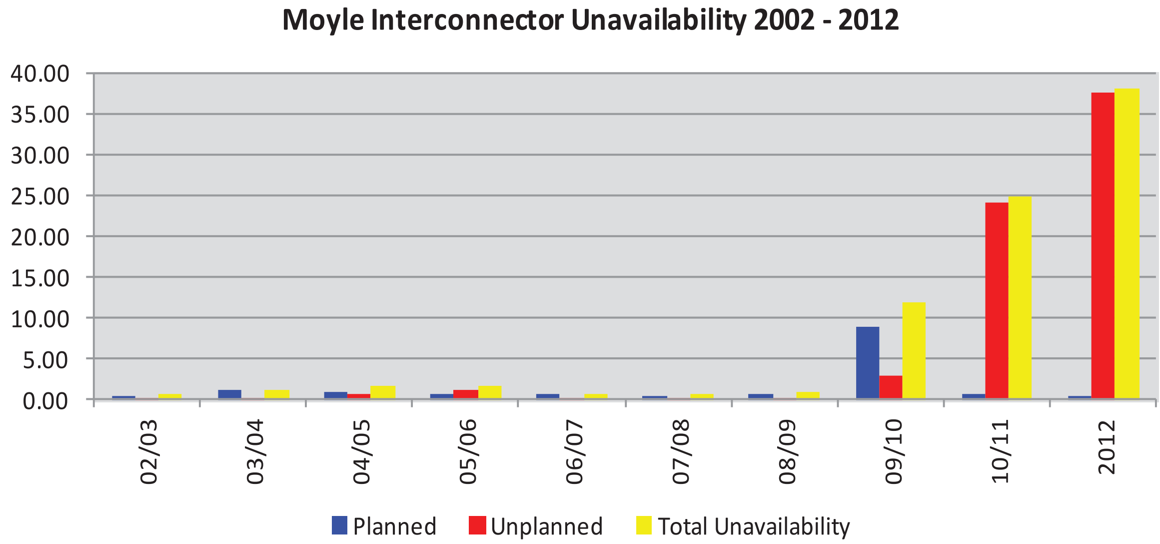
**Figure 10.1: Historic Moyle Interconnector Availability 2002/03 – 2012**

The considerable reduction of availability in 2012 on the Moyle Interconnector was caused by a number of significant unplanned outages.

### 10.2.1 Moyle Interconnector Historic Unavailability

The 2012 Annual Unavailability of the Moyle Interconnector was 37.98%.

Figure 10.2 below shows the historic annual variation in the Moyle Interconnector unavailability from 2002/03 to 2012.




| | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 0.47 | 1.16 | 1.00 | 0.65 | 0.60 | 0.50 | 0.74 | 8.80 | 0.67 | 0.35 |
| **Unplanned** | 0.13 | 0.07 | 0.57 | 1.02 | 0.05 | 0.05 | 0.17 | 3.01 | 24.17 | 37.63 |
| **Total** | 0.60 | 1.23 | 1.57 | 1.66 | 0.65 | 0.54 | 0.91 | 11.82 | 24.84 | 37.98 |

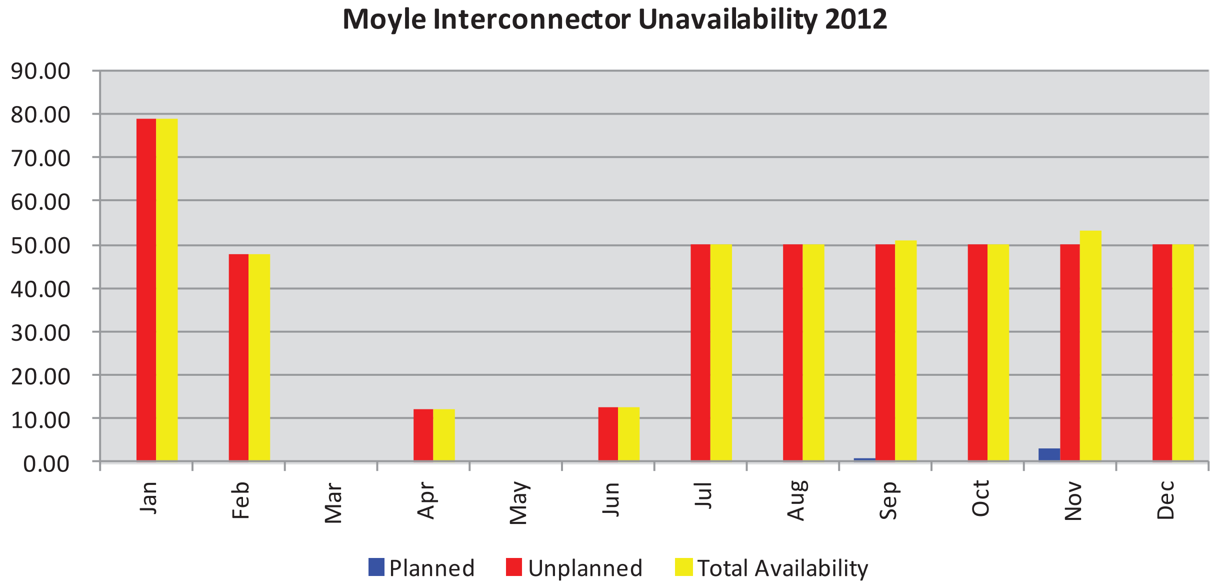
**Figure 10.2: Historic Moyle Interconnector Unvailability 2002/03 – 2012**

Until 2008/09 the average unavailability performance of the interconnector was 1.02%. Minimal outages had resulted in the low unavailability figures. However as can be seen in the graph above there is a sizable increase in the value of percentage Total Unavailability.

The increase in Moyle unavailability for 2012 was caused by a number of unplanned outages on the Interconnector. The first being a continuation of a previous outage covered in previous years reports.

## 10.3 Moyle Interconnector Monthly Unavailability

Figure 10.3 below shows the month by month variation of unavailability of the interconnector. The graph indicates during which months that maintenance has been undertaken by Moyle.




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 | 0.00 | 3.33 | 0.00 |
| **Unplanned** | 78.68 | 47.93 | 0.00 | 12.22 | 0.00 | 12.62 | 50.00 | 50.10 | 50.00 | 50.05 | 50.00 | 50.00 |
| **Total** | 78.68 | 47.93 | 0.00 | 12.22 | 0.00 | 12.62 | 50.00 | 50.10 | 50.85 | 50.05 | 53.33 | 50.00 |

**Figure 10.3: Moyle Interconnector Unavailability 2012**

Figure 3.3 above clearly shows how the Moyle Interconnector has been affected by the significant increases in unplanned outages.

The ongoing unplanned outage caused by faults on the underwater cable began in July 2011 and has unfortunately continued beyond the period of this report.

## 10.4 Tie-Lines with ROI

### 10.4.1 275kV Tie Line

The synchronous interconnection is via the double circuit 275kV North-South Tie Line between Tandragee and Louth. Since the introduction of the Single Electricity Market (SEM) the circuit is treated as a Tie Line.

Outages are planned between the connected parties to allow work to be undertaken in an efficient manner.

### 10.4.2 110kV Tie Line

110kV connections with RoI are as follows:

- Strabane – Letterkenny 110kV circuit.
- Enniskillen – Corraclassy 110kV circuit

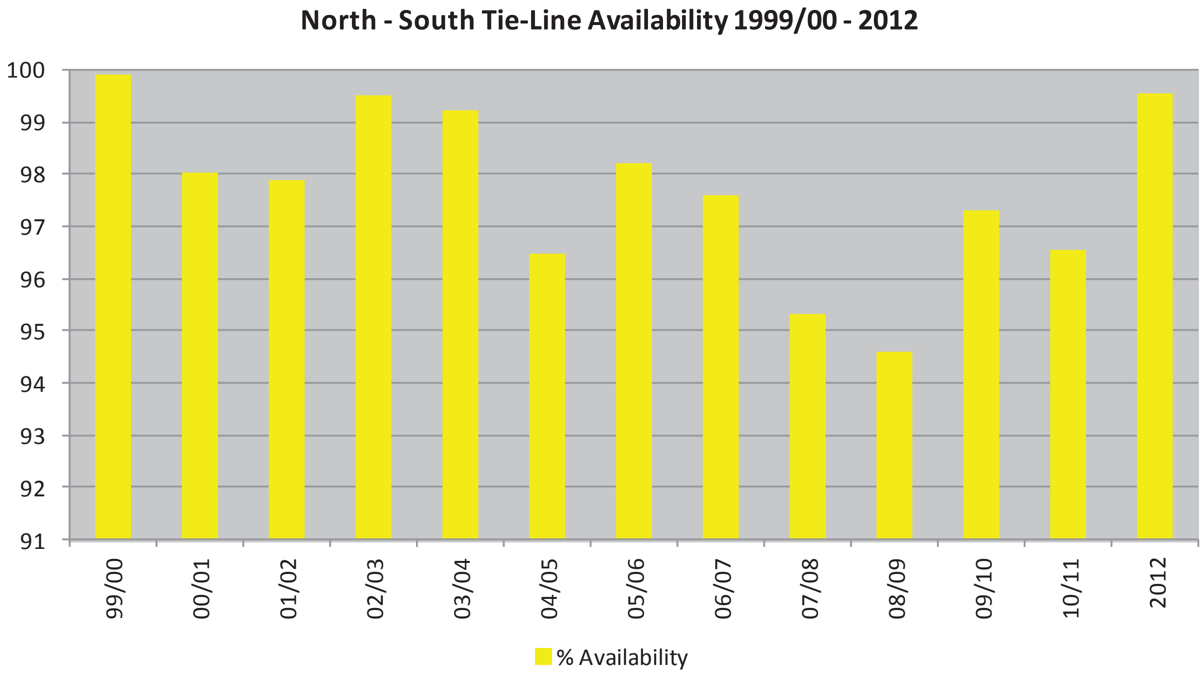
Until 2001, both circuits operated in a standby mode, but were then converted into permanent connections by the deployment of power flow controllers, rated at 125MW. The power flow controllers are normally adjusted to maintain a 0MW transfer, but can be set to any desired value to support either system during abnormal operating conditions. Since the introduction of SEM, the circuits are treated as Tie Lines.

The two circuits are automatically taken out of service during the outage of both 275kV circuits on the North-South Tie Line. This is to ensure that the all-Island network operates in a stable manner.

The Strabane – Letterkenny Tie Line is now also used to import excess wind from Donegal on a regular basis.

### 10.4.3 275kV North-South Tie Line Annual Availability

The annual availability of the 275kV North-South Tie Line was 99.55%. Figure 10.4 below shows the annual variation in the availability of the Tie Line from 1999/2000 to 2012.



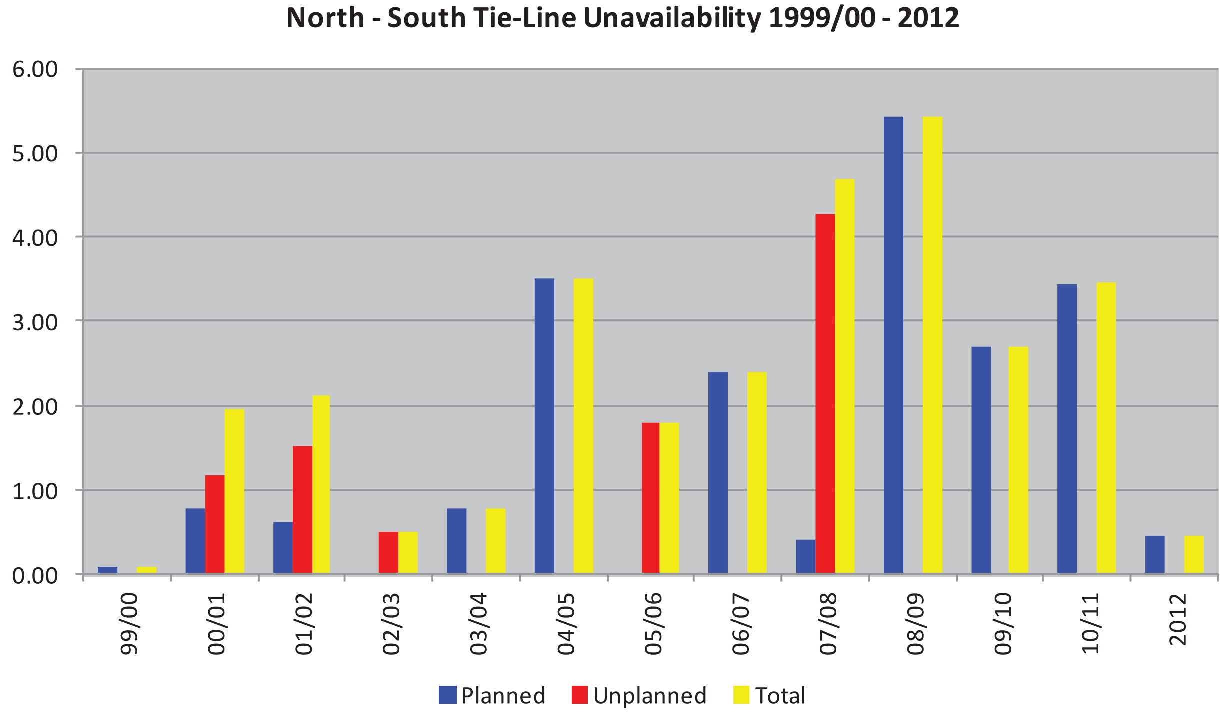

| | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Availability** | 99.91 | 98.04 | 97.87 | 99.51 | 99.22 | 96.49 | 98.21 | 97.60 | 95.31 | 94.58 | 97.31 | 96.54 | 99.55 |

**Figure 10.4: Historic North-South Tie Line Availability 1999/00 – 2012**

The 2012 availability figure of 99.55% is an increase on last year's report and is one of the highest availability figures on record for the North-South tie line in its history. For the fourth successive year there were no unplanned outages on the North – South tie line. The 13 year average for the 275kV Tie Line is 97.70% and the table above shows that the 2012 figure of 99.55% is a high level of availability in comparison.

## 10.4.4 275kV North-South Tie Line Annual Unavailability

Figure 10.5 below shows how the total unavailability for the years 1999/00 to 2012 is split between planned and unplanned outages.



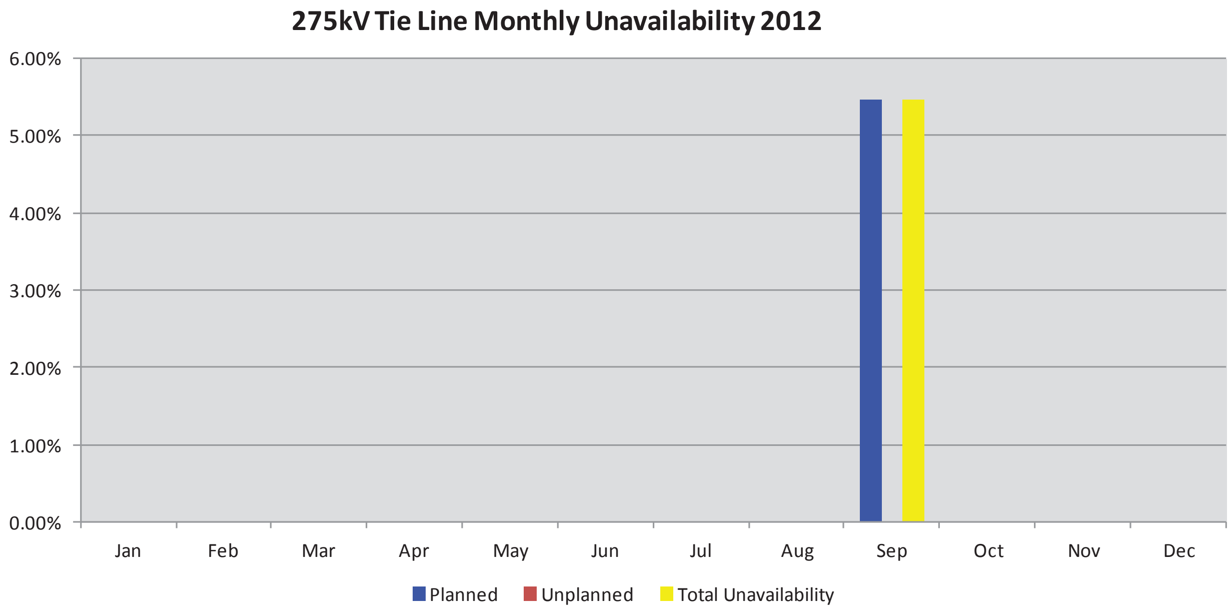

| | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Planned | 0.09 | 0.77 | 0.62 | 0.00 | 0.78 | 3.51 | 0.00 | 2.40 | 0.41 | 5.42 | 2.69 | 3.45 | 0.45 |
| Unplanned | 0.00 | 1.18 | 1.51 | 0.49 | 0.00 | 0.00 | 1.79 | 0.00 | 4.28 | 0.00 | 0.00 | 0.01 | 0.00 |
| Total | 0.09 | 1.96 | 2.13 | 0.49 | 0.78 | 3.51 | 1.79 | 2.40 | 4.69 | 5.42 | 2.69 | 3.46 | 0.45 |

**Figure 10.5: Historic North-South Tie Line Unavailability 1999/00 – 2012**

The level of unavailability for the North – South tie line for 2012 was 0.45%, which is considerably lower than resent years.

## 10.4.5 275kv NORTH-SOUTH TIE LINE MONTHLY UNAVAILABILITY

Figure 10.6 below shows the month by month variation of unavailability of the North-South Tie Line.



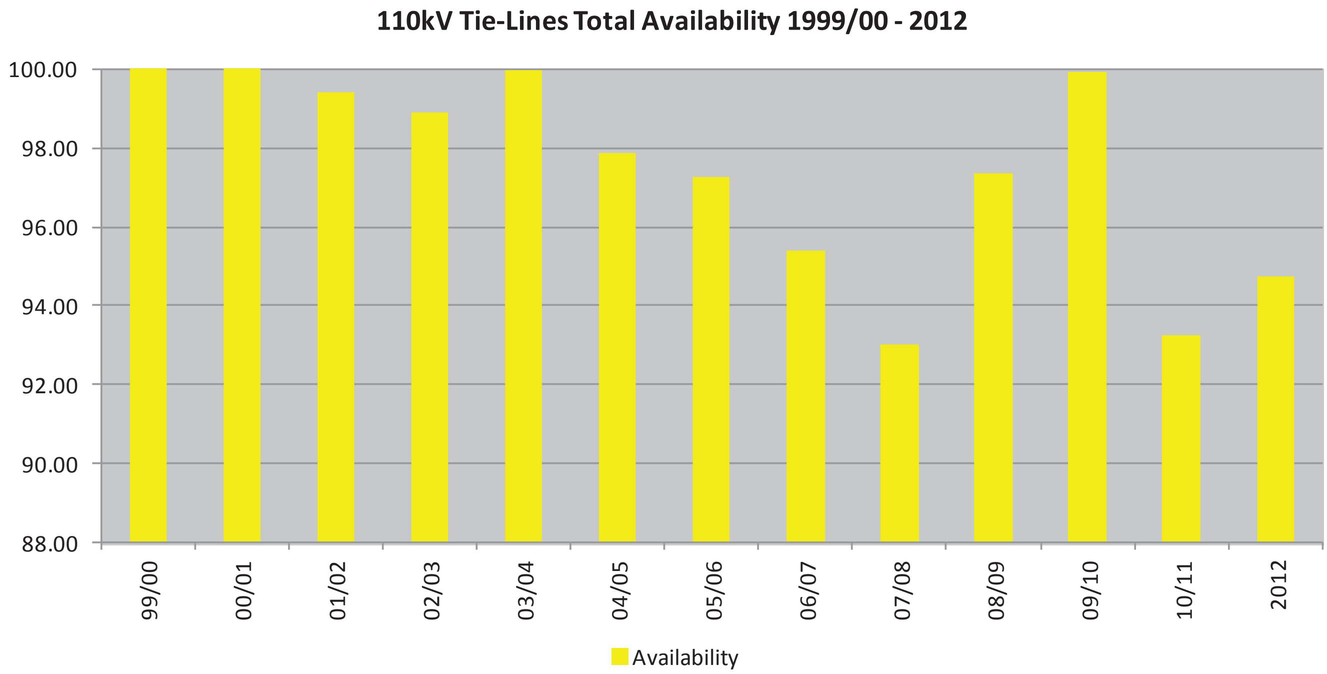

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Planned | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.45 | 0.00 | 0.00 | 0.00 |
| Unplanned | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.45 | 0.00 | 0.00 | 0.00 |

**Figure 10.6: North-South Tie Line Monthly Unavailability 2012**

Figure 10.6 highlights that the total percentage unavailability on the 275kV Tie Line for the period January 2012 – December 2012 was due almost entirely to a planned outage carried out in September 2012

## 10.4.6 110kv TIE LINES ANNUAL AVAILABILITY

The availability of the 110kV Tie Lines was 94.72% for the period January 2012 to December 2012. Figure 10.7 below shows the annual variation in the availability of the Tie Lines from 1999/00 to 2012.



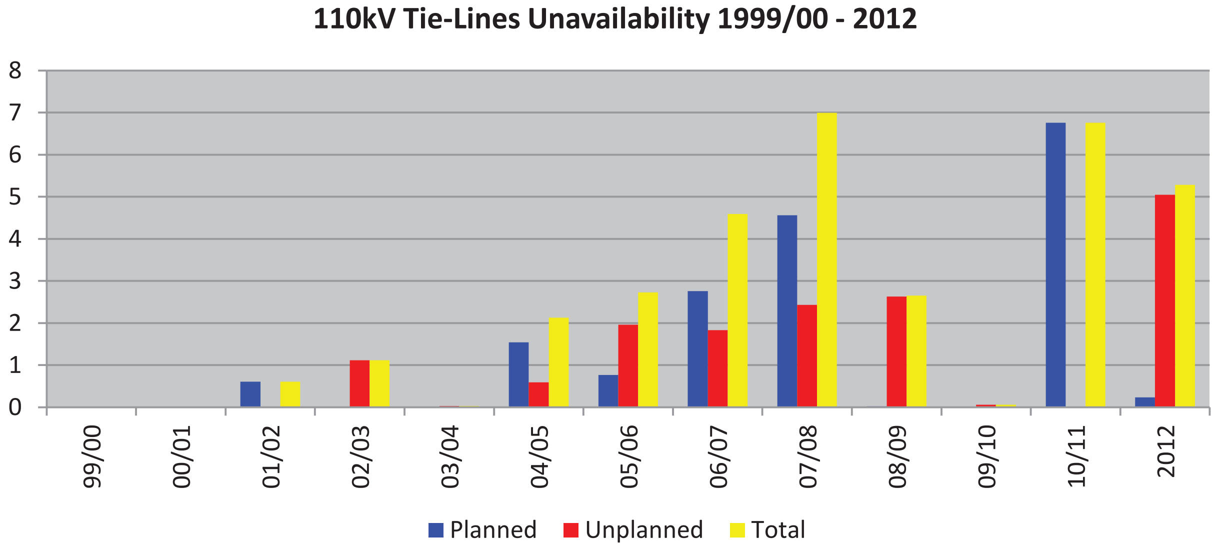

| | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Availability | 100.00 | 100.00 | 99.39 | 98.88 | 99.97 | 97.87 | 97.27 | 95.41 | 93.01 | 97.35 | 99.94 | 93.24 | 94.72 |

**Figure 10.7: Historic 110kV Tie Line Availability 1999/00 – 2012**

The figures for 2012 shows a slight increase of on the previous reporting period 2010/11.

## 10.4.7 110kv TIE LINES ANNUAL UNAVAILABILITY

The unavailability of the 110kV Tie Lines was 5.27% for the period January 2012 to December 2012. Figure 10.8 below shows the annual variation in the unavailability of the Tie Lines from 1999/00 – 2012.



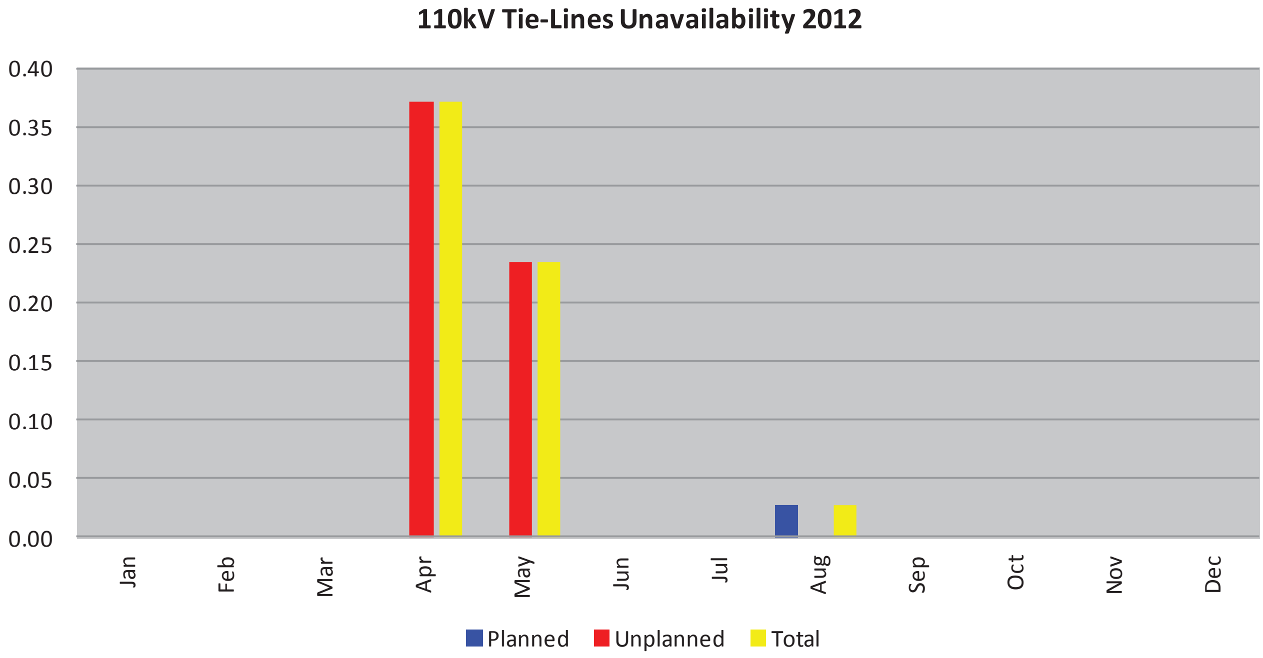

| | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Planned | 0.00 | 0.00 | 0.61 | 0.00 | 0.00 | 1.54 | 0.77 | 2.76 | 4.56 | 0.02 | 0.00 | 6.76 | 0.23 |
| Unplanned | 0.00 | 0.00 | 0.00 | 1.12 | 0.03 | 0.59 | 1.96 | 1.83 | 2.43 | 2.63 | 0.06 | 0.00 | 5.05 |
| Total | 0.00 | 0.00 | 0.61 | 1.12 | 0.03 | 2.13 | 2.73 | 4.59 | 6.99 | 2.65 | 0.06 | 6.76 | 5.27 |

**Figure 10.8: Historic 110kV Tie Line Unavailability 1999/00 – 2012**

As can be seen in figure 10.8 above, total unavailability figure for the 110kV tie-lines was 5.27 the majority of this figure was due to an unplanned outage on the Strabane-Letterkenny circuit during April-May.

## 10.4.8 110kv TIE LINES MONTHLY UNAVAILABILITY

Figure 10.9 below shows the month by month variation of unavailability of the 110kV Tie Lines.




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Unplanned** | 0.00 | 0.00 | 0.00 | 0.37 | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 0.00 | 0.00 | 0.00 | 0.37 | 0.23 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |

**Figure 10.9: 110kV Tie Line Unavailability 2012**

Figure 10.9 above shows the extent of outages on the 110kV Tie Lines during January 2012 to December 2012.

# 11 SYSTEM SECURITY

All Transmission System related events that occurred in Northern Ireland that resulted in a loss of supplies are reported individually, giving information concerning the nature and cause of the incident and location, duration and an estimate of energy unsupplied.

An incident is defined as any system event that results in a single or multiple loss of supply.

## 11.1 Number Of Incidents And Estimated Unsupplied Energy

Within the Northern Ireland system there were two events that resulted in a loss of supply.

The unsupplied energy from the Northern Ireland system during 2012 was estimated to be 12.15 MWh.

## 11.2 Incidents For 2012

Table 11.1 below lists the incidents that are required to be included in this report.

| Incident Date, Time and Location | MW Lost | Mins | MWh Unsupplied | Customers affected |
|---|---|---|---|---|
| **13/06/12**<br>**Ballynahinch and surrounding area**<br>**Reason:**<br>**Reason: Mal-operation of a relay during testing of the protection systems at Ballynahich Main 110/33kV substation.** | Approx. 35 | 3 | 1.75 | 33,710 |
| **20/08/12**<br>**Finaghy, Ballgowan, Ards, Comber, Knock and surrounding areas.**<br>**Reason: Significant loss of generation** | Approx. 48 | Multiple restoration times Approx. 13 | Approx. 10.4 | 46,234 |

**Table 11.1: Transmission System Incidents 2012**

The criterion for reporting incidents is specified in Schedule 4, paragraph 35, of the Electricity Supply Regulations (Northern Ireland) 1991. An incident shall be reported if there has been:

- Any single interruption of supply to one or more consumers of 20MW or more for a period of one minute or longer; or
- Any single interruption of supply to one or more consumers of 5MW or more for a period of one hour or longer; or
- Any single interruption of supply to 5,000 or more consumers for a period of one hour or longer.

## 11.2.1 System Security - Incident Analysis

Figure 11.1 below shows the number of incidents which occurred historically in Northern Ireland. The red bars on the graph below represent the number of incidents each year, whist the blue line is the average duration of each incident.

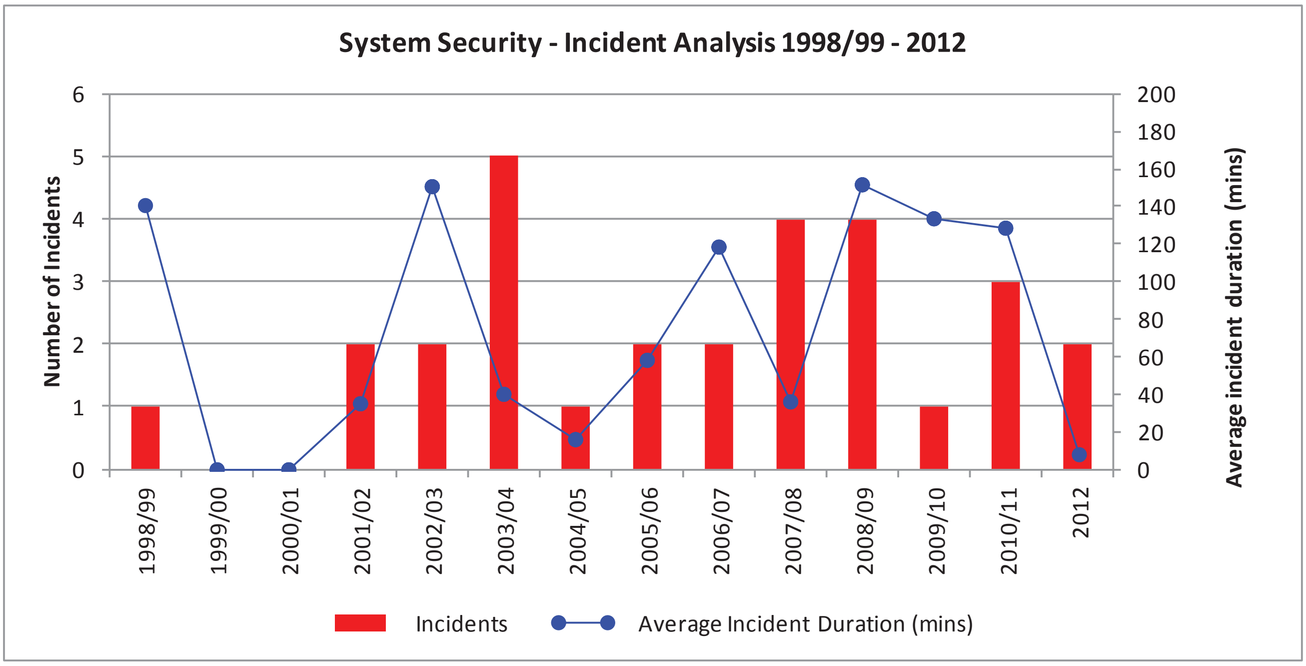



**Figure 11.1: Historic System Security 1998/99 – 2012**

As seen in Figure 11.1 above, the number of incidents has decreased to two, from the previous year's three incidents. The average incident time for 2012 reduced significantly on the previous years.

### 11.2.2 System Security - Unsupplied Energy

Figure 11.2 below shows the historic amount of unsupplied energy to Northern Ireland customers. The red bars are the total for each year in MWh and the blue line is the average amount of unsupplied energy per incident.

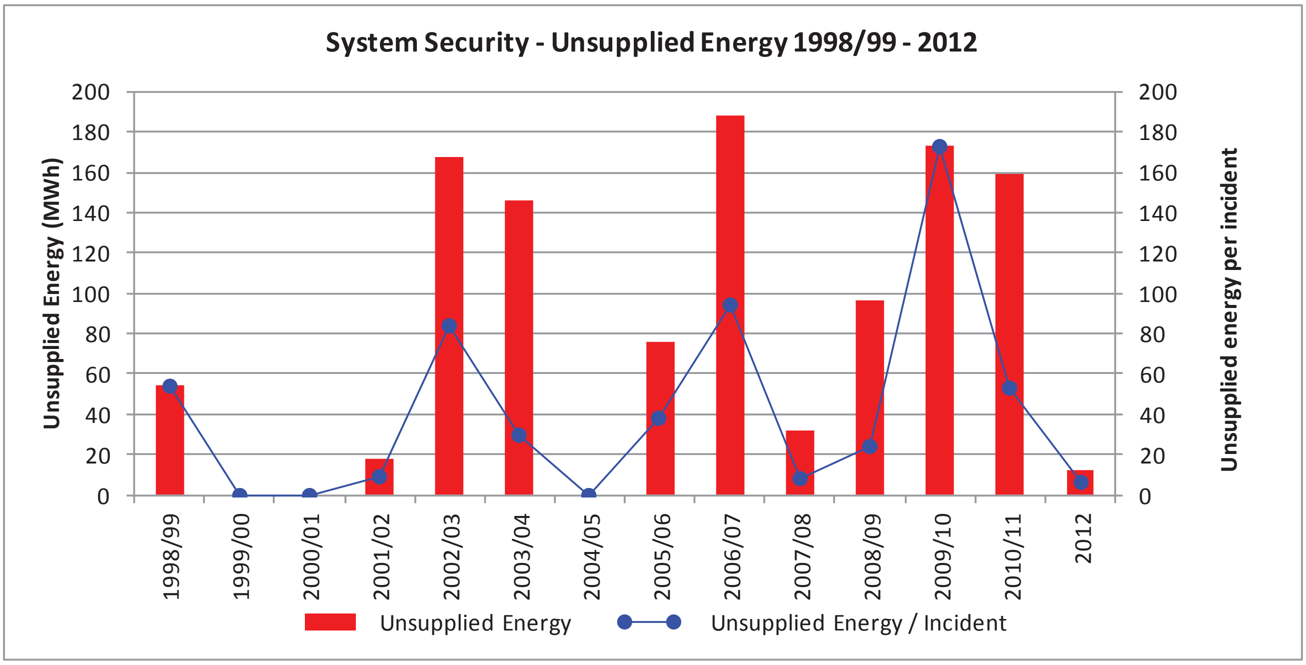



**Figure 11.2: Historic Unsupplied Energy 1998/99 – 2012**

# 12 QUALITY OF SERVICE

Quality of service is measured with reference to system voltage and frequency.

## 12.1 Voltage

The Electricity Supply Regulations (Northern Ireland) 1991 permit variations of voltage not exceeding 10% for voltages of 110 kV and higher (Regulation 31.2B).

SONI must keep the voltage within these limits, apart from under abnormal conditions e.g. a system fault. The Northern Ireland Transmission & Distribution Security and Planning Standards state that the voltage should not vary by more than 6% following a single contingency event.

For the purpose of this report the 6% limit is used.

## 12.2 Voltage Excursions

During 2012, there were no voltage excursions exceeding these limits.

## 12.3 Frequency

The Electricity Supply Regulation (Northern Ireland) 1991 permit variations in frequency not exceeding 2.5% above and below 50Hz, a range of 48.75Hz to 51.25Hz (Regulation 31.2A).

The SONI Grid Code (CC5.3) imposes a more arduous criterion to within 1% of 50Hz, a range of 49.5Hz to 50.5Hz. In previous reports the SONI Grid Code limits are used when reporting excursions.

For the purposes of this report SONI have decided that they will report on any frequency excursions that impact below a 49.6 Hz or greater than 50.5 Hz threshold. This will increase the number of reportable events providing more information. It was felt that this information would be useful in the light of the changing generation plant portfolio and the introduction of Harmonised Ancillary Services agreements with generators on 1 February 2010.

Table 1.1 provides detailed information for each frequency excursion including maximum rate of change of frequency, minimum frequency reached and time below 49.6 Hz.

As both the NI and RoI transmission networks are connected with 275kV and 110kV Tie Lines to form a synchronous network. Poor generation reliability in either jurisdiction will have a negative impact on its neighbour

The individual frequency event graphs appear in Appendix in this report.

## 12.3.1 Frequency Excursions

In accordance with SONI's decision to report on any frequency excursion in excess of 49.6 Hz, there were 10 reportable frequency excursions during 2012. Table 12.1 below details these excursions.

| Cause of Incident | Date | Generator Capacity MW | Pre-incident Frequency Hz | Minimum Frequency - Entire Event Hz | Minimum Frequency - POR Hz | Maximum Rate of Change of Frequency | | t< 49.6 Hz (secs) | System Load | | | Wind | | | N - S Tie-Line Flow (MW) | Moyle Interconnection Flow (MW) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max df/dt Hz/sec | Average df/dt Hz/sec | | RoI | NI | Total | RoI | NI | Total | | |
| **Whitegate Unit 1 trip** | **04/01/12** | 445 | 50.029 | **49.582 Hz** | 49.596 | -0.3 | -0.226 | 2.7 | 3153 | 1056 | 4209 | 1183 | 246.09 | 1429.09 | -134.40 | -15 |
| **Dublin Bay Unit 1 trip** | **29/03/12** | 403 | 49.989 | **49.581 Hz** | 49.647 | -0.2 | -0.162 | 1.7 | 3236 | 1155 | 4391 | 154 | 103.28 | 257.28 | 8.783 | 450 |
| **Aghada Unit 2 trip** | **20/08/12** | 432 | 50.003 | **48.816 Hz** | 49.073 | -0.41 | -0.268 | 254.4 | 3210 | 1008 | 4218 | 415 | 313.35 | 728.35 | 274.981 | 250 |
| **Whitegate Unit 1 trip** | **03/09/12** | 445 | 49.976 | **49.241 Hz** | 49.402 | -0.24 | -0.174 | 115 | 1808 | 515 | 2323 | 105 | 62.86 | 167.86 | 250.838 | 244 |
| **Moneypoint Unit 1 & Coolkeeragh C30 trips** | **04/09/12** | 402 | 50.018 | **49.529 Hz** | 49.638 | -0.22 | -0.188 | 28.3 | 3259 | 1033 | 4292 | 440 | 144.83 | 584.83 | -48.358 | 250 |
| **Huntstown Unit 2 trip** | **12/09/12** | 400 | 49.968 | **49.543 Hz** | 49.627 | -0.27 | -0.206 | 3.2 | 3110 | 1145 | 4255 | 330 | 95.91 | 425.91 | 84.924 | 149 |
| **East West IC trip** | **26/09/12** | 500 | 50.078 | **49.335 Hz** | 49.571 | -0.39 | -0.32 | 4.6 | 3500 | 982 | 4482 | 1225 | 298.82 | 1523.82 | -39.075 | 134 |
| **Huntstown Unit 2 & TYC trips** | **10/10/12** | 400 | 50.037 | **49.559 Hz** | 49.764 | -0.28 | -0.11 | 6.5 | 3475 | 1035 | 4510 | 474 | 115.27 | 589.27 | -102.509 | 109 |
| **Whitegate trip** | **06/11/12** | 445 | 49.924 | **49.118 Hz** | 49.118 | -0.31 | -0.25 | 257.5 | 3956 | 1279 | 5235 | 685 | 31.56 | 716.56 | -13.519 | 250 |
| **Coolkeeragh C30 trip** | **31/12/12** | 402 | 50.014 | **49.545 Hz** | 49.550 | -0.27 | -0.136 | 4 | 3275 | 1029 | 4304 | 760 | 164.58 | 924.58 | 208.327 | 250 |

**Table 12.1: Frequency Excursions in NI in 2012**

- **Note 1: NS and Interconnection flows, VE+ represents an import to Northern Ireland**
- **Note 2: The System Load figures are in generated metered terms**

**Event Definitions.**

| | | |
|---|---|---|
| Time 0 seconds | - | Considered to be when the frequency falls through 49.8 Hz |
| Pre Incident frequency | - | Average system frequency between t - 60seconds and t -30 seconds |
| Minimum Frequency (Entire Event) | - | Minimum system frequency from t 0 to t + 6 minutes |
| Minimum Frequency (POR) | - | Minimum frequency during POR period from t + 5 seconds to t + 15 seconds |
| Maximum Rate of Change of Frequency | - | Maximum negative rate of change of frequency during the period t – 5 seconds to t + 30 seconds (This is calculated from a five point moving average with a sample rate of 100 milliseconds) |
| Average Rate of Change of Frequency | - | This is the rate of change of frequency observed between two points in time. The first point being when the frequency passes through 49.8 Hz and the second when the frequency nadir is observed between t + 5 seconds and t + 15 sceonds (See HAS agreement) |

## 12.3.2 Annual Frequency Excursions

Figure 12.1 below shows the number of frequency excursions from 1998/99 to 2012. The significant increase to 29 incidents is due the decision to change the criteria for reporting frequency excursions to any incident under 49.6 Hz. To compare against previous years criteria of only including frequency excursions below 49.5Hz, there would have been 4 incidents in the 2012 period.

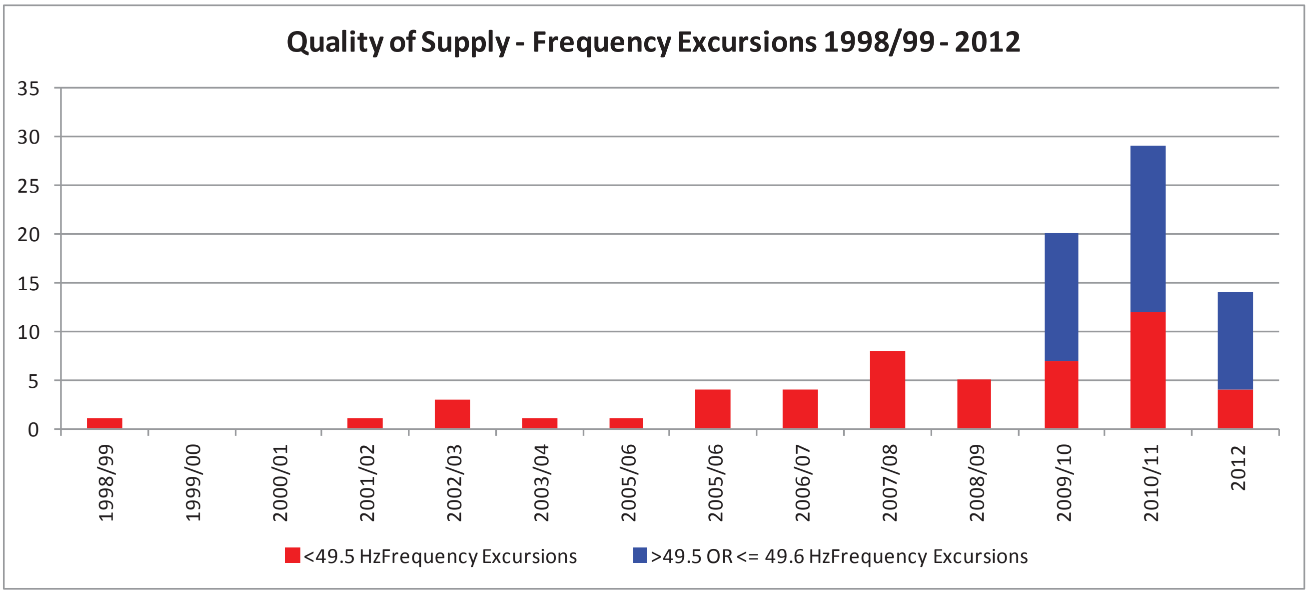



**Figure 12.1: Historic Frequency Excursions 1998/99 – 2012**

In recent years, a number of large combined cycle gas turbine (CCGT) units have been commissioned on the island of Ireland. These units tend to be base load, higher efficiency plant, generating for a high proportion of the time. As the all-island generating plant portfolio tends towards a smaller number of larger units, there is an increased possibility that frequency excursions will occur. However, during 2012 there were no incidents where the Electricity Supply Regulations (Northern Ireland) 1991 statutory limit of 2.5% was exceeded. It should be noted that, during 2009/10, two new CCGTs were commissioned in the Republic of Ireland - at Aghada and Whitegate. The required testing of these new machines led to a number of frequency excursions in Northern Ireland, as demonstrated in resent year's data.

## 13 SONI CONCLUSIONS

- The annual system availability for the 12 month period of this report 2012 (97.79%) has risen slightly when compared with the figure in the previous report for 2010/11 (97.26%)
- The considerable reduction of availability in 2012 on the Moyle Interconnector was caused significant unplanned outages. The Moyle availability value was further affected by the ongoing cable faults that first occurred in June 2011 and have continued beyond the period of this report.
- The 2012 availability figure of 99.55% for the 275kV tie-line is a slight increase of availability on previous yearly report and remains well ahead of the record low figure of 2008/09 which was 94.58%. This was due to planned refurbishment.
- Of the two incidents which caused reportable interruptions of supplies to customers, The cause of the first incident which took place in Ballynahinch Main substation was the mal-operation of a relay during protection testing, the second incident was due to a trip of generating unit Agada unit 2 (20/08/13)
- The number of frequency excursions below 49.6Hz has reduced significantly when compared to the 2010/2011 figure.

## APPENDIX 1 – ALL-ISLAND FULLY DISPATCHABLE GENERATION PLANT

| Company | Unit | Capacity | Fuel | 365-day Rolling Availability % |
|---|---|---|---|---|
| Activation Energy | AEDSU – AE1 | 27 | Demand Side Unit | 68.0 |
| AES | Ballylumford Unit 10 | 98.4 | Gas/Distillate Oil | 69.14 |
| | Ballylumford Unit 31 | 239.5 | Gas/Distillate Oil | 84.17 |
| | Ballylumford Unit 32 | 239.5 | Gas/Distillate Oil | 53.21 |
| | Ballylumford GT1 | 58 | Distillate Oil | 91.63 |
| | Ballylumford GT2 | 58 | Distillate Oil | 90.06 |
| | Ballylumford Unit 4 | 170 | Gas/HFO | 94.62 |
| | Ballylumford Unit 5 | 170 | Gas/HFO | 99.56 |
| | Ballylumford Unit 6 | 170 | Gas/HFO | 79.48 |
| | Kilroot GT1 | 29 | Gas/Distillate Oil | 98.09 |
| | Kilroot GT2 | 29 | Gas/Distillate Oil | 98.46 |
| | Kilroot GT3 | 42 | Gas/Distillate Oil | 99.98 |
| | Kilroot GT4 | 42 | Gas/Distillate Oil | 98.98 |
| | Kilroot Unit 1 | 240 | Coal/HFO | 91.38 |
| | Kilroot Unit 2 | 240 | Coal/HFO | 94.33 |
| Aughinish Alumina Ltd | Seal Rock - SK3 | 85 | Gas / Distillate Oil | 89.5 |
| | Seal Rock - SK4 | 85 | Gas / Distillate Oil | 86.8 |
| Bord Gáis | Whitegate – WG1 | 444 | Gas / Distillate Oil | 89.6 |
| Contour Global | Contour Global 3 | 3 | Gas | 98.23 |
| | Contour Global 4 | 3 | Gas | 98.87 |
| | Contour Global 5 | 3 | Gas | 98.87 |
| Coolkeeragh ESB | Coolkeeragh Unit 30 | 413 | Gas/Distillate Oil | 89.58 |
| | Coolkeeragh GT8 | 53 | Distillate Oil | 96.36 |
| Dalkia Alternative Energy Ltd | DAE VPP – DP1 | 22 | Demand Side Unit | 11.0 |
| Edenderry Power Ltd | Edenderry - ED1 | 118 | Peat | 79.1 |
| | Edenderry – ED3 | 58 | Gas / Distillate Oil | 99.6 |
| | Edenderry – ED5 | 58 | Gas / Distillate Oil | 99.9 |
| Endesa Ireland | Great Island - GI1 | 54 | Heavy Fuel Oil | 98.9 |
| | Great Island - GI2 | 54 | Heavy Fuel Oil | 90.2 |
| | Great Island - GI3 | 109 | Heavy Fuel Oil | 98.9 |
| | Rhode – RP1 | 52 | Distillate Oil | 98.0 |
| | Rhode – RP2 | 52 | Distillate Oil | 98.3 |
| | Tarbert – TB1 | 54 | Heavy Fuel Oil | 99.9 |
| | Tarbert – TB2 | 54 | Heavy Fuel Oil | 99.7 |
| | Tarbert – TB3 | 243 | Heavy Fuel Oil | 99.5 |
| | Tarbert – TB4 | 243 | Heavy Fuel Oil | 99.7 |
| | Tawnaghmore - TP1 | 52 | Distillate Oil | 96.4 |
| | Tawnaghmore - TP3 | 52 | Distillate Oil | 97.9 |

| | | | | |
|---|---|---|---|---|
| ESB Power Generation | Aghada - AD1 | 258 | Gas | 98.0 |
| | Aghada - AD2 | 432 | Gas / Distillate Oil | 95.9 |
| | Aghada - AT1 | 90 | Gas / Distillate Oil | 96.5 |
| | Aghada - AT2 | 90 | Gas / Distillate Oil | 85.2 |
| | Aghada - AT4 | 90 | Gas / Distillate Oil | 88.8 |
| ESB Power Generation | Ardnacrusha - AA1 | 21 | Hydro | 90.4 |
| | Ardnacrusha - AA2 | 22 | Hydro | 91.4 |
| | Ardnacrusha - AA3 | 19 | Hydro | 88.9 |
| | Ardnacrusha - AA4 | 24 | Hydro | 91.1 |
| | Erne - ER1 | 10 | Hydro | 99.5 |
| | Erne - ER2 | 10 | Hydro | 98.6 |
| | Erne - ER3 | 23 | Hydro | 0.0 |
| | Erne - ER4 | 23 | Hydro | 97.6 |
| | Lee - LE1 | 15 | Hydro | 94.8 |
| | Lee - LE2 | 4 | Hydro | 94.9 |
| | Lee - LE3 | 8 | Hydro | 73.9 |
| | Liffey - LI1 | 15 | Hydro | 94.1 |
| | Liffey - LI2 | 15 | Hydro | 94.0 |
| | Liffey - LI4 | 4 | Hydro | 93.9 |
| | Liffey - LI5 | 4 | Hydro | 61.0 |
| | Lough Ree Power - LR4 | 91 | Peat | 92.0 |
| | Marina - MRC | 123 | Gas / Distillate Oil | 76.2 |
| | Moneypoint - MP1 | 285 | Coal / Heavy Fuel Oil | 91.6 |
| | Moneypoint - MP2 | 285 | Coal / Heavy Fuel Oil | 84.5 |
| | Moneypoint - MP3 | 285 | Coal / Heavy Fuel Oil | 96.4 |
| | North Wall - NW5 | 108 | Gas / Distillate Oil | 87.1 |
| | North Wall – NWC | 154 | Gas / Distillate Oil | 0.0 |
| | Poolbeg - PB4 | 158 | Gas / Distillate Oil | 96.7 |
| | Poolbeg - PB5 | 154 | Gas / Distillate Oil | 97.0 |
| | Poolbeg - PB6 | 182 | Gas / Distillate Oil | 95.1 |
| | Turlough Hill - TH1 | 73 | Hydro - Pumped Storage | 58.5 |
| | Turlough Hill - TH2 | 73 | Hydro - Pumped Storage | 69.0 |
| | Turlough Hill - TH3 | 73 | Hydro - Pumped Storage | 34.0 |
| | Turlough Hill - TH4 | 73 | Hydro - Pumped Storage | 45.0 |
| | West Offaly Power - WO4 | 135 | Peat | 90.3 |
| Indaver | Indaver – IW1 | 17 | Waste | 65.4 |
| iPower | I Power AGU | 46 | Distiallate Unit | 99.24 |
| Synergen | Dublin Bay - DB1 | 405 | Gas / Distillate Oil | 80.6 |
| Tynagh Energy Ltd | Tynagh – TYC | 404 | Gas / Distillate Oil | 75.3 |
| Viridian Power & Energy | Huntstown - HN2 | 408 | Gas / Distillate Oil | 93.8 |
| | Huntstown - HNC | 344 | Gas / Distillate Oil | 94.8 |

# APPENDIX 2 – SIGNIFICANT EIRGRID TSO CAPITAL PROJECTS COMPLETED IN 2012

| Circuit Uprates and Refurbishments | CP.No |
|---|---|
| Lisdrum - Shankill 110kV line refubishment | CP0383 |
| Coolroe - Kilbarry 110kV line uprate | CP0517 |
| Cahir - Doon 110kV line uprate inclusive of busbar uprates | CP0551 |
| Ballydine - Cullenagh 110kV line uprate | CP0558 |
| Cullenagh - Waterford 110kV line uprate | CP0560 |
| Limerick - Rathkeale 110kV line refurbishment | CP0571 |
| Arklow - Crane 110kV line uprate inclusive of busbar uprates | CP0656 |
| Cashla - Tynagh 220kV line uprate | CP0661 |
| Cullenagh - Knockraha 220kV line uprate | CP0664 |
| Dunstown - Maynooth 220kV No.1 line refurbishment | CP0665 |
| Killonan - Tarbert 220kV line refurbishment | CP0695 |
| Cathaleen's Fall - Srananagh 110kV No.1 line uprate | CP0699 |
| Cathaleen's Fall - Golagh T 110kV line uprate | CP0704 |
| Corduff - Ryebrook 110kV circuit uprate | CP0766 |

| Connections for DSO | CP.No |
|---|---|
| Salthill 110kV station | CP0125 |
| Shelton Abbey 110kV Station | CP0508 |
| Salthill 110kV Station | CP0543 |
| Lodgewood 220kV station - New 110kV transformer bay | CP0544 |
| Binbane 110kV station - Installation of 63 MVA 110/38 kV transformers | CP0074 |
| Banoge 110kV Station - New Station | CP0173 |

| New Circuits | CP.No |
|---|---|
| Flagford - Srananagh 220kV line | CP0211 |
| Gorman-Navan No.3 110kV line | CP0218 |
| Dalton Galway 110kV line - 110kV Line loop in to Cashla 220kV & Salthill stations | CP0254 |
| Gorman-Meath Hill 110kV line | CP0292 |
| Arva-Shankill No.2 110kV line | CP0374 |

| Transmission Customer Connections | CP.No |
|---|---|
| Portan 110kV Station | CP0652 |
| Clashavoon 220kV station extension | CP0675 |

| Station Uprates and Refurbishments | CP.No |
|---|---|
| Garrow 110kV station extension | CP0648 |
| Inchicore 220kV Station - 4th 250MVA 220/110kV transformer | CP0523 |
| Corderry 110kV station busbar uprate | CP0635 |
| Portlaoise 110kV station busbar uprate | CP0637 |
| Tralee 110kV station new coupler | CP0674 |

## APPENDIX 3 – MAINTENANCE POLICY TERMS

### Appendix 3.1 – Transmission System Maintenance Policy Terms

The following summarises the main terms and activities in the asset maintenance policy as operated by EirGrid. The need to ensure that equipment continues to operate in a safe, secure, economic and reliable manner, while minimising life cycle costs, underlies the principles behind this asset maintenance policy. Effective maintenance management balances the costs of repair, replacement and refurbishment against the consequences of asset failure.

There are three primary maintenance categories:

1. **Preventive:** This includes condition monitoring, both on and offline, inspections and routine servicing. It is usually cyclical and can be planned in advance.
2. **Corrective:** These include actions arising from condition assessments, defective or faulty plant due to age, material or design deficiencies, necessitating modification or replacement programmes.
3. **Fault:** These are unplanned activities arising from plant failure in service and are disruptive.

**Stations:**

Preventive maintenance is carried out at routine intervals on all station assets regardless of age. The following summarises the primary routine preventative maintenance tasks on station equipment:

1. **Operational tests:** These involve, among other activities, opening and closing the breakers and disconnects locally and remotely, carrying out tripping checks on the breakers and checking of interlocking. These tests are designed to ensure that equipment will operate correctly when called upon to do so.
2. **Ordinary services:** Every four years, or five years (depending on the voltage and location of the circuit in the system), more detailed inspection and measurements are taken. All measurements and test values are checked for conformity with standards or other norms established by best industry practice or experience. They are compared to those of previous measurements and tests. Any significant changes or trends are noted and investigated.
3. **Condition assessment:** This non-invasive procedure combines an evaluation of the asset's operational, maintenance and fault histories with a detailed site inspection and site and laboratory tests. The condition assessment evaluates the asset's present condition and residual life and provides data for life management decisions i.e. required corrective maintenance, further monitoring, future operation (i.e. loading/ over-loading restriction, refurbishment, replacement, etc.). The EirGrid policy is to carry out condition assessments at eight-year or ten-year intervals depending on the voltage and location of the circuit in the system.
4. **Tap changer inspections:** These are detailed inspections of the transformer tap changers and a programme of tests to ensure that the tap changer works correctly, that there is no undue arcing, and that remote operation of the tap changer is effective. Where necessary, the tap changer oil is replaced. These tests are programmed every eight years if filters are not fitted to the diverter switch compartment. If filters are fitted, the interval can be extended to 20 years.

5. **Detailed services:** These are a comprehensive overhaul requiring dismantling and replacement of worn or deteriorating parts. The frequency is determined by manufacturer recommendations, condition assessments carried out and previous experience, service life and plant history. It is EirGrid's aim to minimise the level of detailed services carried out, without affecting the reliable and safe operation of the system: consequently prior to the overhaul, a condition assessment is carried out to identify degradation. The extent of the detailed service may be curtailed depending on the results of the condition assessment/condition of the phase first overhauled, and on the circuit breaker fault interrupting history. The interval of detailed service will vary depending on the circuit breaker make, type and condition assessment results. In general these vary from 12 to 24 years.

**Overhead Lines:**
Overhead line maintenance is largely condition based, with the result that routine line maintenance activities are inspections and/or condition assessments. These include helicopter patrols, climbing patrols, ground patrols, bolt patrols, sag checks, infrared thermography patrols, pole rot surveys, conductor corrosion surveys and line condition surveys. Planned maintenance of overhead lines implements requirements for preventative maintenance, corrective maintenance, and repairs, which are identified by inspections and condition assessments.

**Examples include:**

- Tower painting;
- Timber cutting;
- Elimination of type faults (e.g. removal of insulator types, the metal parts of which have been discovered to be prone to rapid corrosion);
- Replacement of corroded conductors or rotten wood poles;
- Replacement of items damaged by flashovers;
- Repair of tower damage; and
- General line refurbishment.

Although age may be a factor contributing to increased corrective maintenance requirements there are other factors which significantly affect required maintenance that are not age independent. These include location (heavily fertilised farmland/polluted industrial environment/coastal areas), damage by livestock/farm machinery, local climate (damp environment conducive to corrosion), timber growth, vandalism, damage by birds, loading of lines and events described as acts of God.

**Cables:**
Inspections are carried out at monthly, quarterly and annual intervals for oil filled cables and at annual intervals for cross-linked polyethylene (XLPE) cables. The principal cause of cable faults is third party damage. Cable routes are patrolled continuously and all third party excavations near transmission cables are monitored to ensure the ongoing integrity of the cables.

## APPENDIX 4 – DEFINITIONS & FORMULAE

Appendix 4.1 – Availability & Unavailability Formula

The availability of 110kV, 220 kV, 275 kV and 400 kV lines is calculated using
Equation 4-1:
System Availability=1- i=1i=n Duration of Outage i * Length of Line (i)j=1j=mLength of Line j * Days in a Year

Equation 4-1

Where n = The total number of lines (at that voltage level) for which outages occurred
m = The total number of lines at that voltage level

The Availability of 220 kV/110 kV, 275 kV/220 kV and 400 kV/220 kV transformers is calculated using Equation 4-2:

System Availability=1- i=1i=n Duration of Outage i * MVA of Transformer (i)j=1j=m MVA of Transformer j * Days in a Year

Equation 4-2

Where: n = The total number of transformers (at that voltage level) for which outages occurred
m = The total number of transformers at that voltage level

System Unavailability, for any period, is calculated using equation 4-3. Equation 4-3 is the same as that used by OFGEM (The Office Of Gas And Electricity Markets) in the UK.

System Unavailability=1- Hours each Circuit is AvailableNumber of Circuits * Hours in Period

Equation 4-3

### Appendix 4.2 – System Minute Formula

The international benchmark for system performance and reliability is the System Minute.
This index measures the severity of each system disturbance. It is determined by calculating the ratio of unsupplied energy during an outage to the energy that would be supplied during one minute, if the supplied energy was at its peak value. When this index is greater than one minute the incident is classified as “major”.

System Minutes= Energy not supplied MW MinutesPower at System Peak

Equation 4-4

= MVA Minutes * (Power Factor)System Peak to Date

Equation 4-5

Where: Power factor = 0.9

Appendix 4.3 – Protection Zones

Zone 1 on a distance relay is the primary protection zone and in the case of an overhead line is set to 70-85 % of the circuit length depending on the location of the circuit in the transmission network. There is no time delay for the relay to pick up when a fault occurs within the zone 1 reach. Typical Zone 1 clearance times are 50 to 150 ms.

Zone 2 on a distance relay is used as the backup protection zone and is set to 100 % of the circuit length plus 20 – 50 % of the length of the shortest feeder at the remote end of the protected circuit. A delay of approximately 400 ms is applied in zone 2 settings and so typical zone 2 fault clearance times are 450 to 550 ms.

Zone 3 on a distance relay is used as the backup protection zone and is the first reverse zone. It is set to 20 – 50 % of the length of the shortest feeder in the reverse direction. A delay of approximately 500 ms is applied in Zone 3 settings and so typical zone 3 fault clearance times are 550 to 650 milliseconds.

Zone 4 is the third forward step of a distance scheme (time delay 900 ms)

Zone 5 is the second reverse step of a distance protection scheme (time delay of 1 second)

Zone 4 and 5 trips are very rarely executed due to the in built time delays.

The more faults cleared in Zone 1, the quicker the fault is taken off the power system which reduces the risk of system instability, plant damage and injury to personnel.

Zone Clearance Ratio= Short circuit faults not cleared in Zone 1Total number of short circuit faults cleared

Equation 4-6

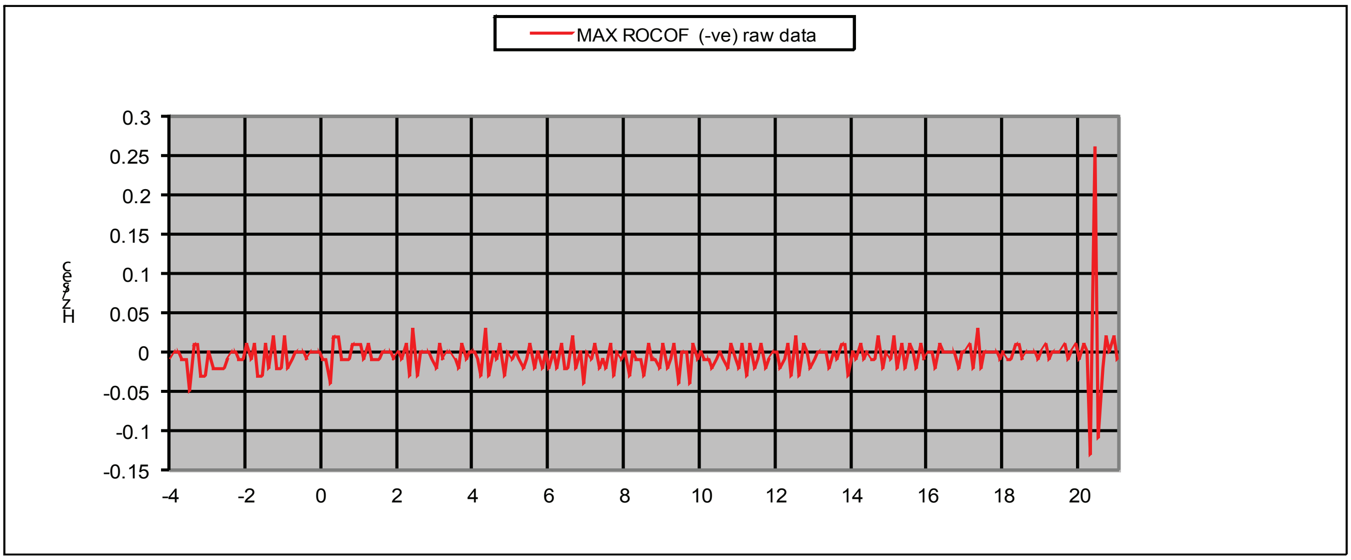
## APPENDIX 5 - FREQUENCY EXCURSION GRAPHS

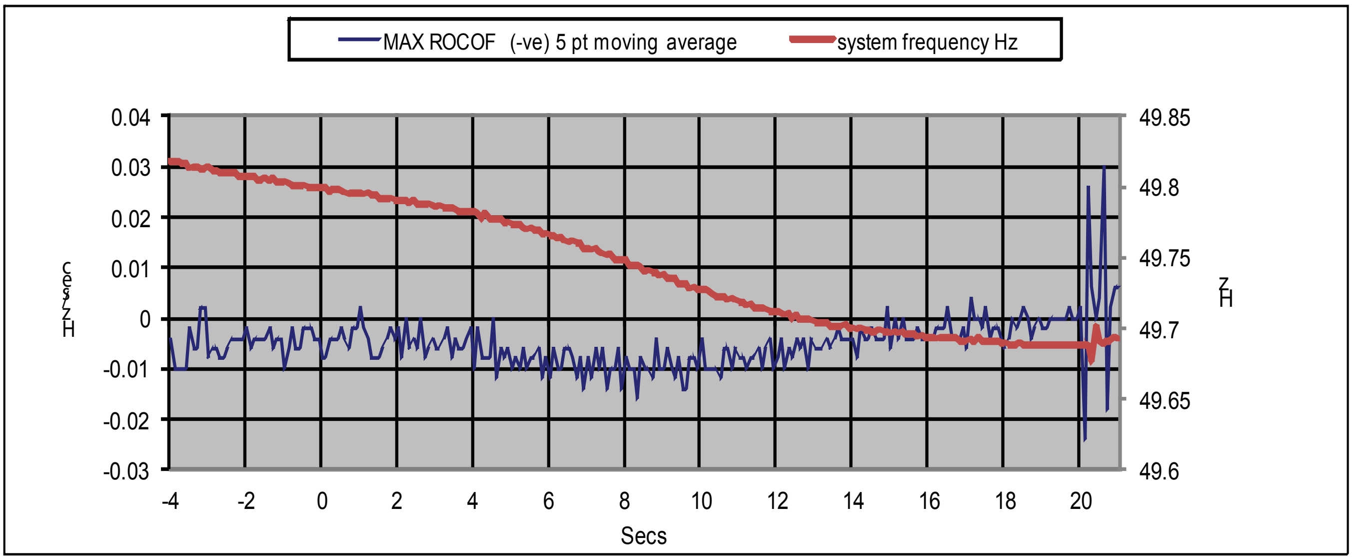
The following is a list of graphs contained in this section.

| | |
|---|---|
| 04/01/2012 | WHITEGATE |
| 29/03/2012 | DUBLIN BAY UNIT 1 |
| 20/08/2012 | AGADA UNIT 2 |
| 03/09/2012 | WHITEGATE UNIT 1 |
| 04/09/2012 | MONEYPOINT UNIT 1 & COOLKEERAGH C30 |
| 12/09/2012 | HUNTSTOWN UNIT 2 |
| 26/09/2012 | EAST WEST IC |
| 10/10/2012 | HUNTSTOWN UNIT 2 & TYNAGH |
| 06/11/2012 | WHITEGATE |
| 31/12/2012 | COOLKEERAGH C30 |

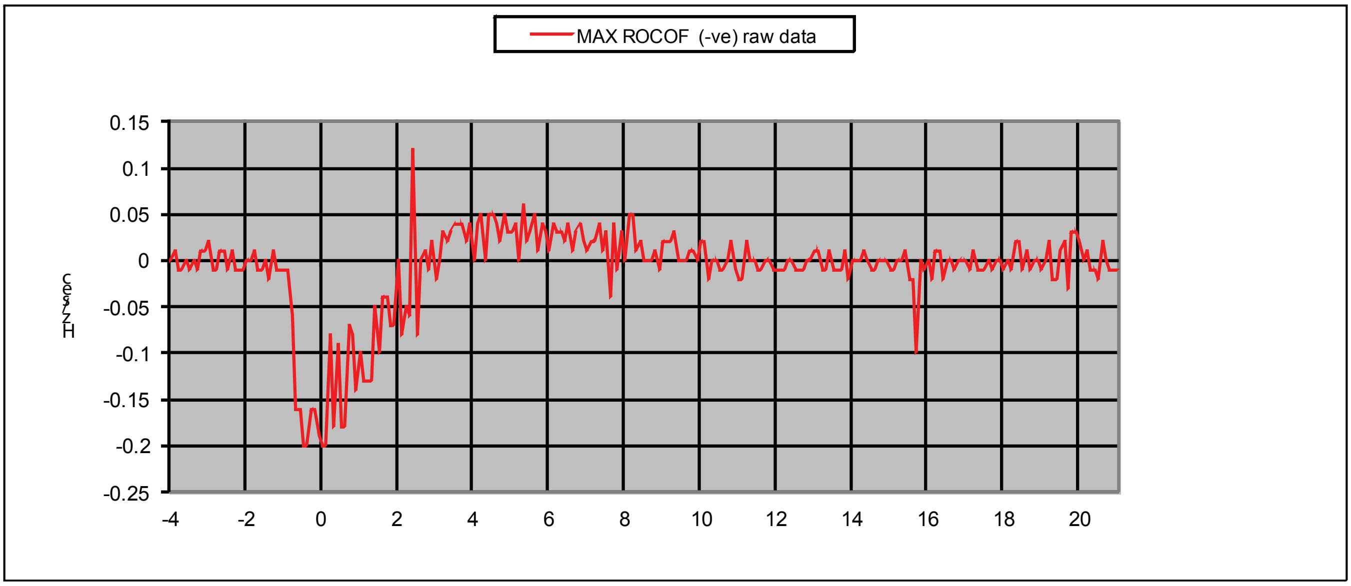
N.B. On all the following graphs the term ROCOF means Rate of Change of Frequency

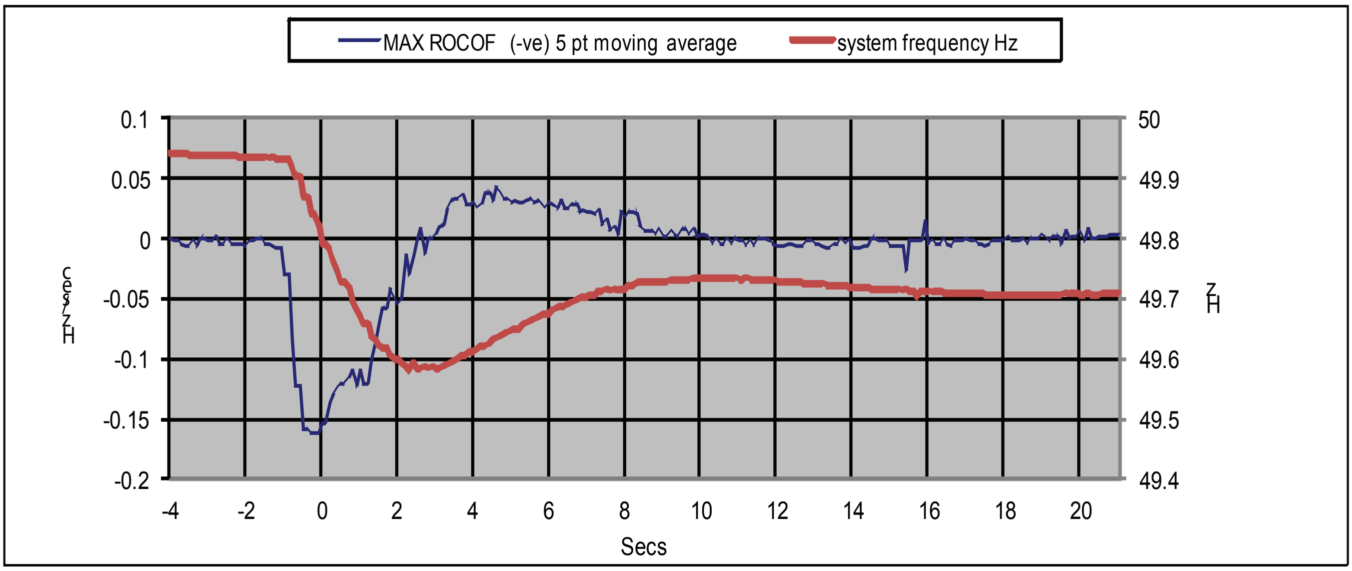
04/01/2012 WHITEGATE



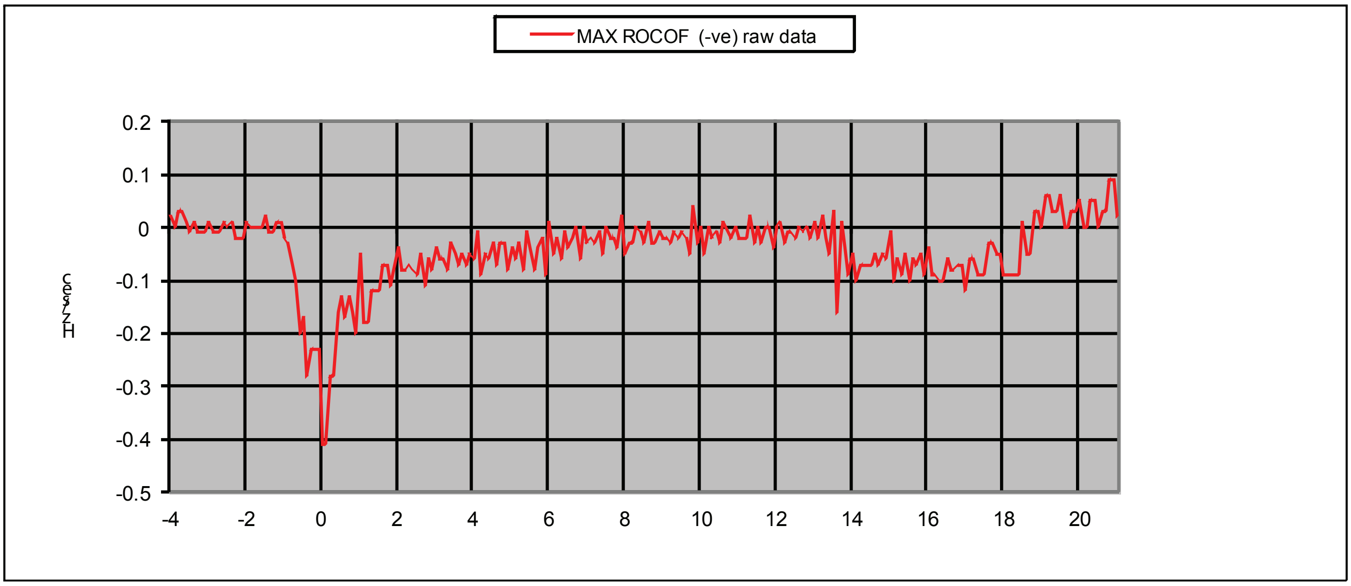



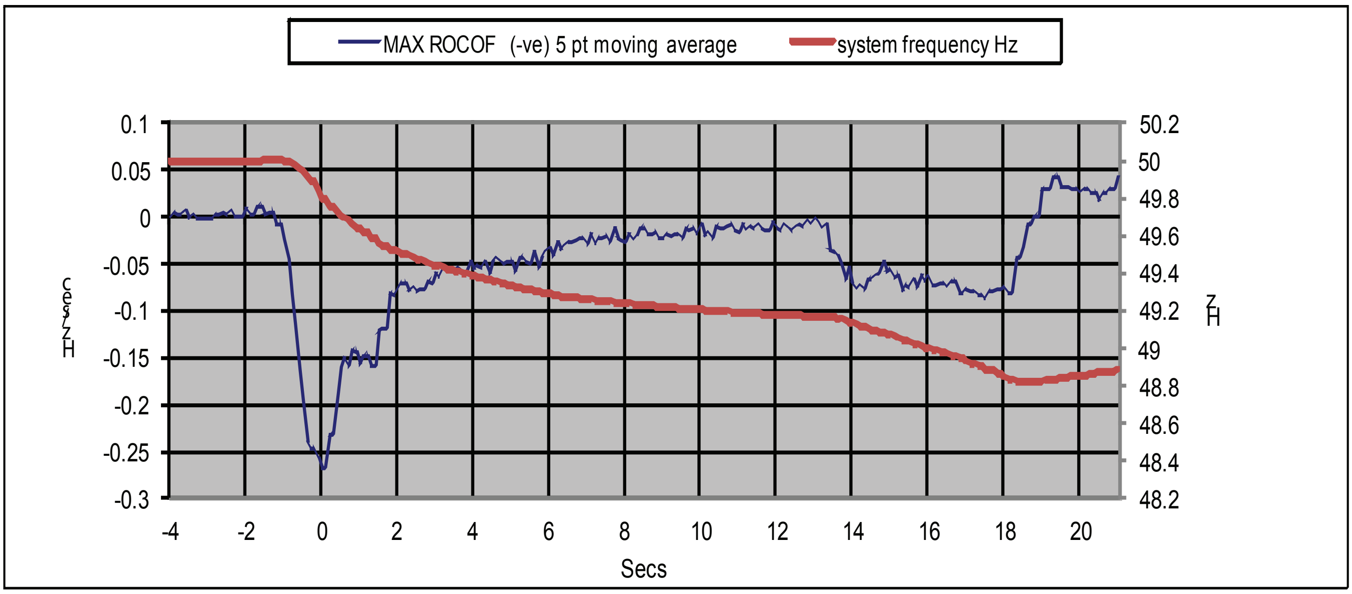
29/03/2012 DUBLIN BAY UNIT 1



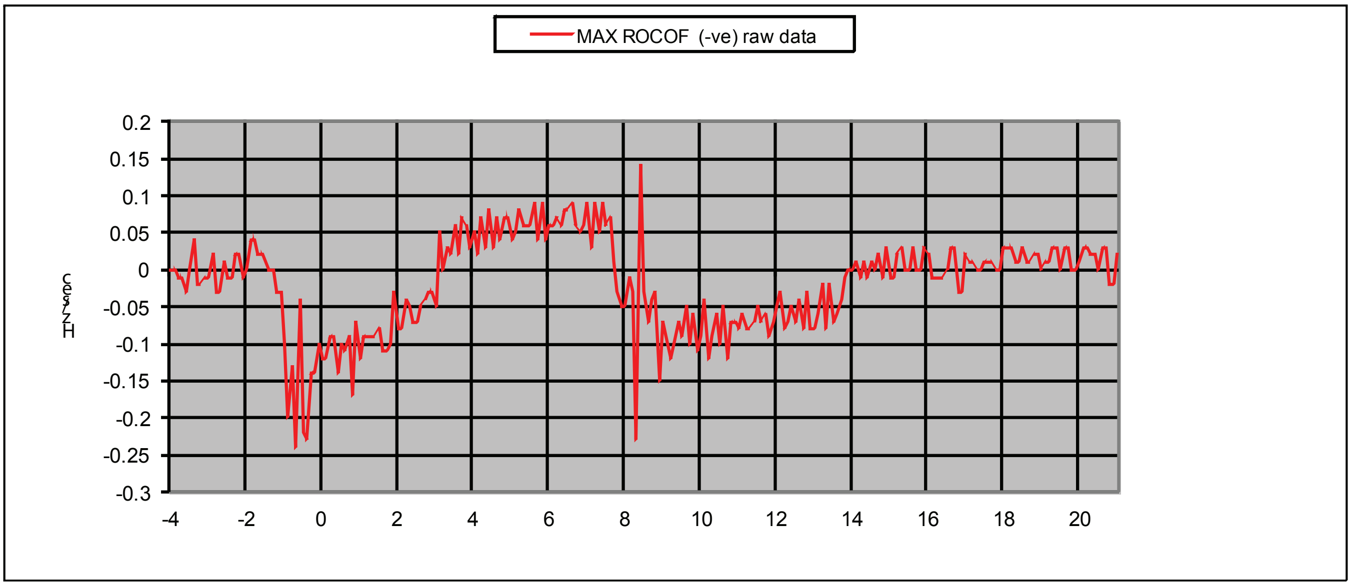



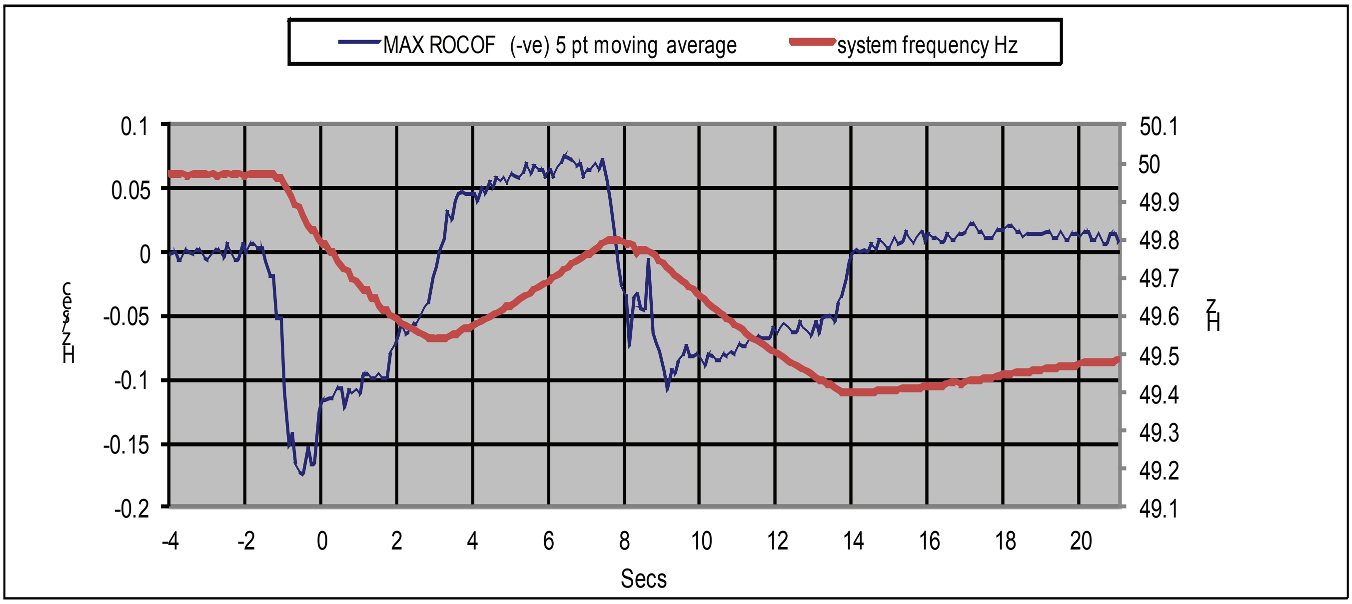
20/08/2012 AGADA UNIT 2

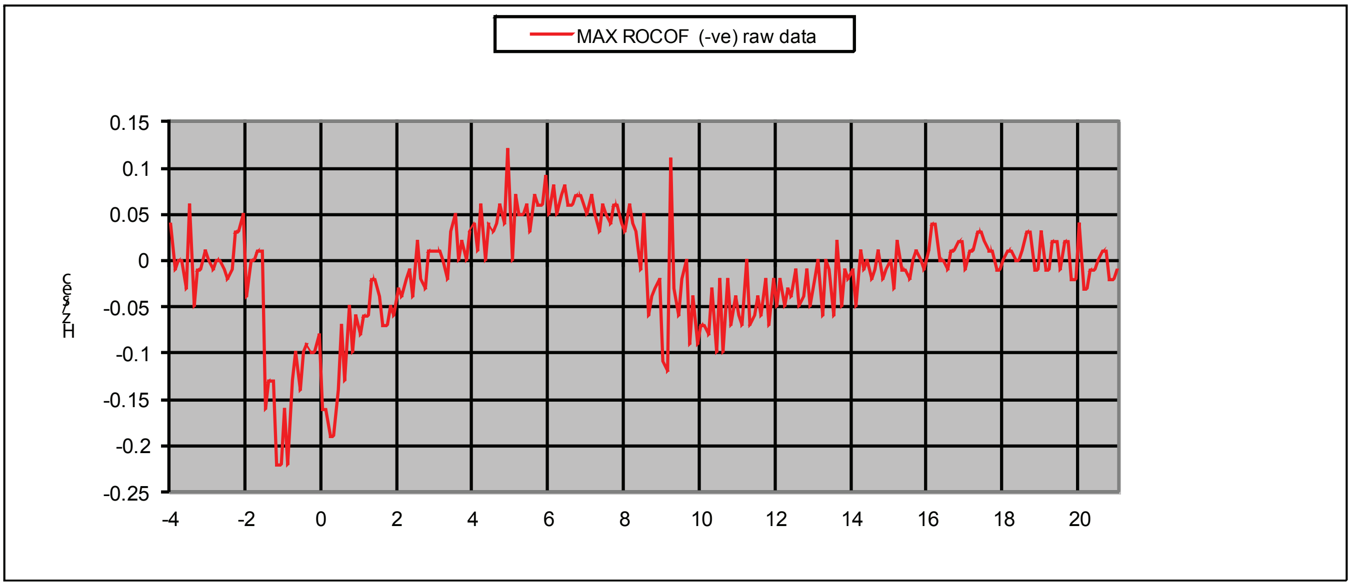


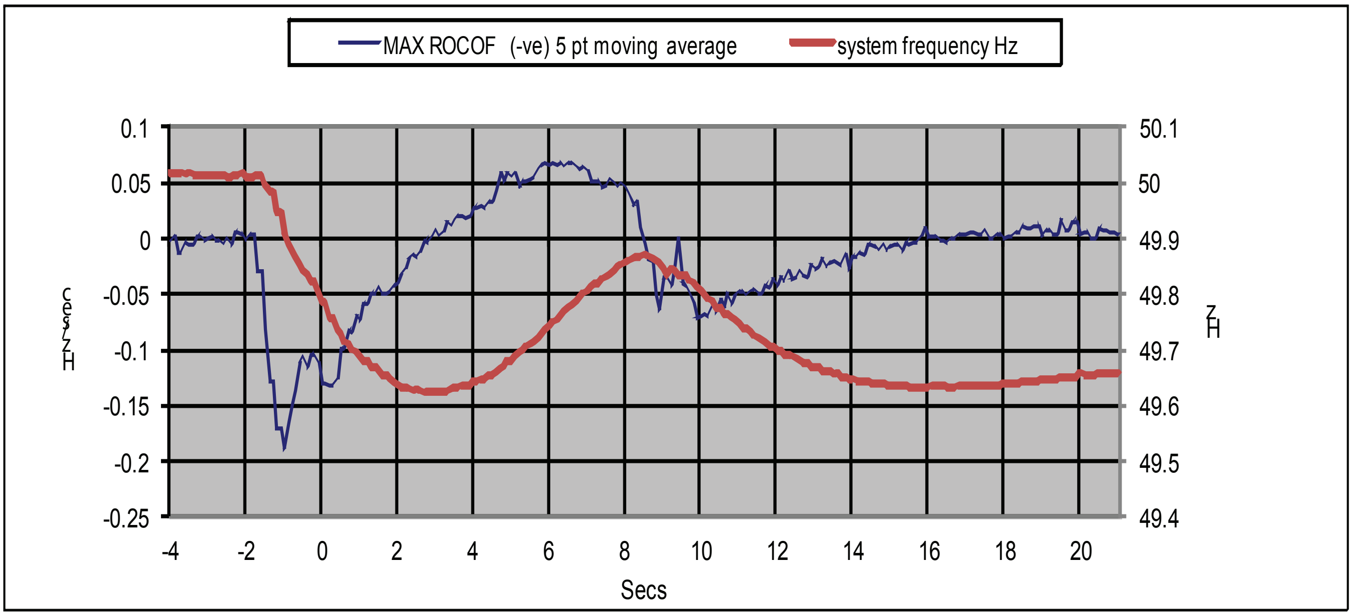



03/09/2012 WHITEGATE UNIT 1

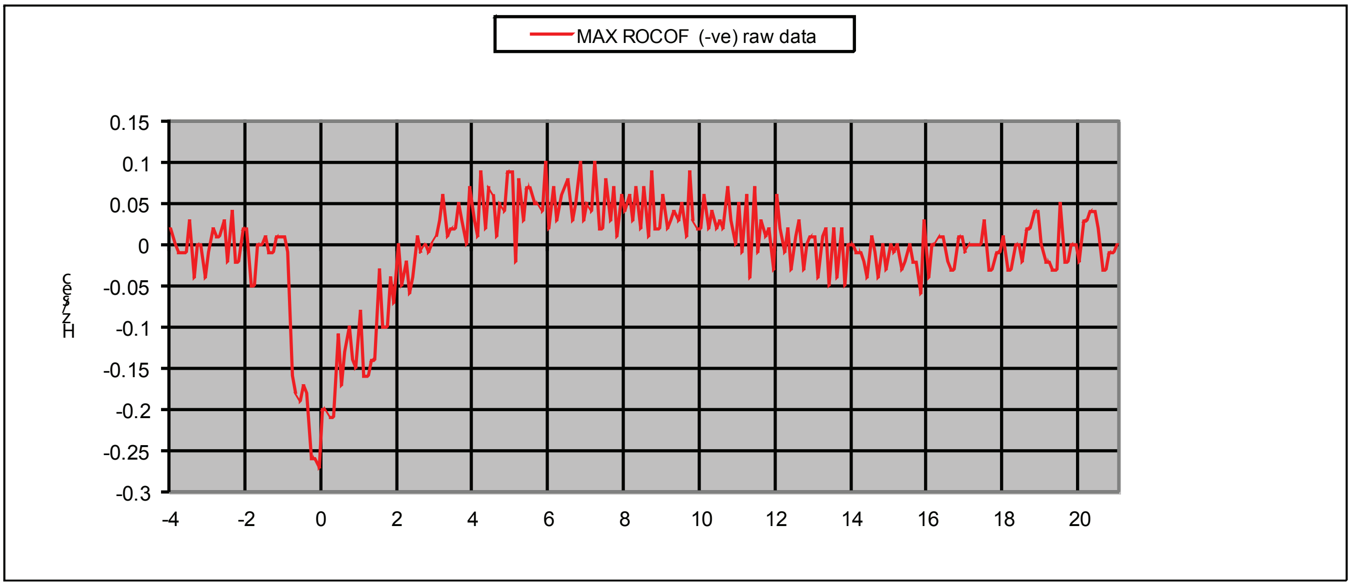


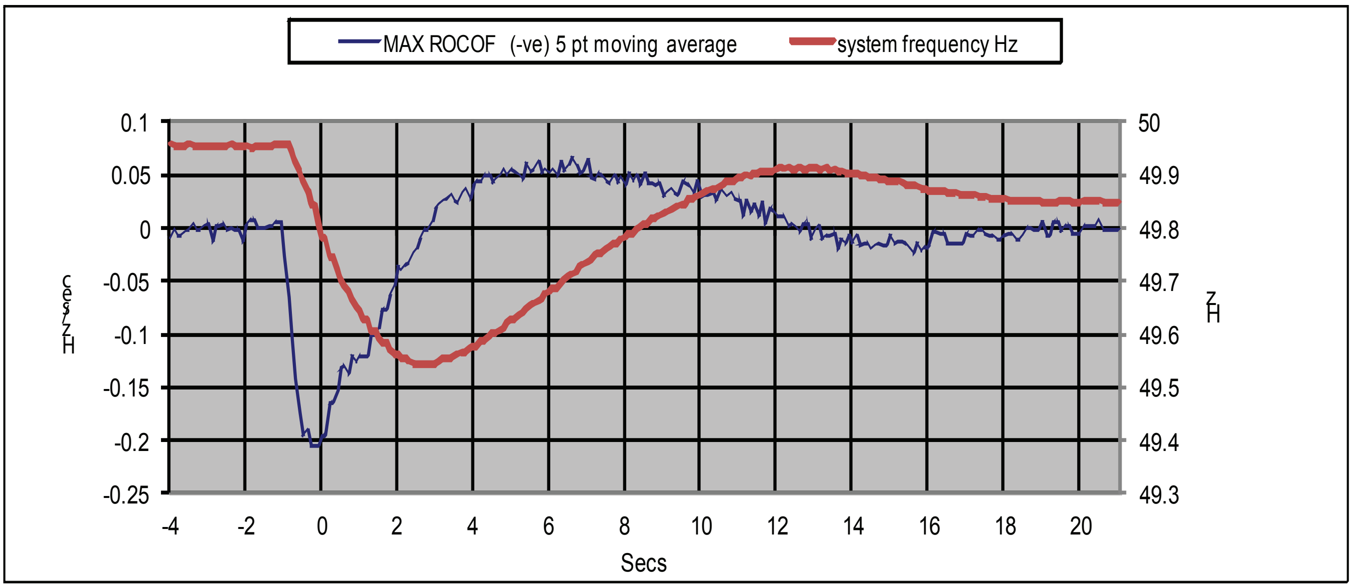



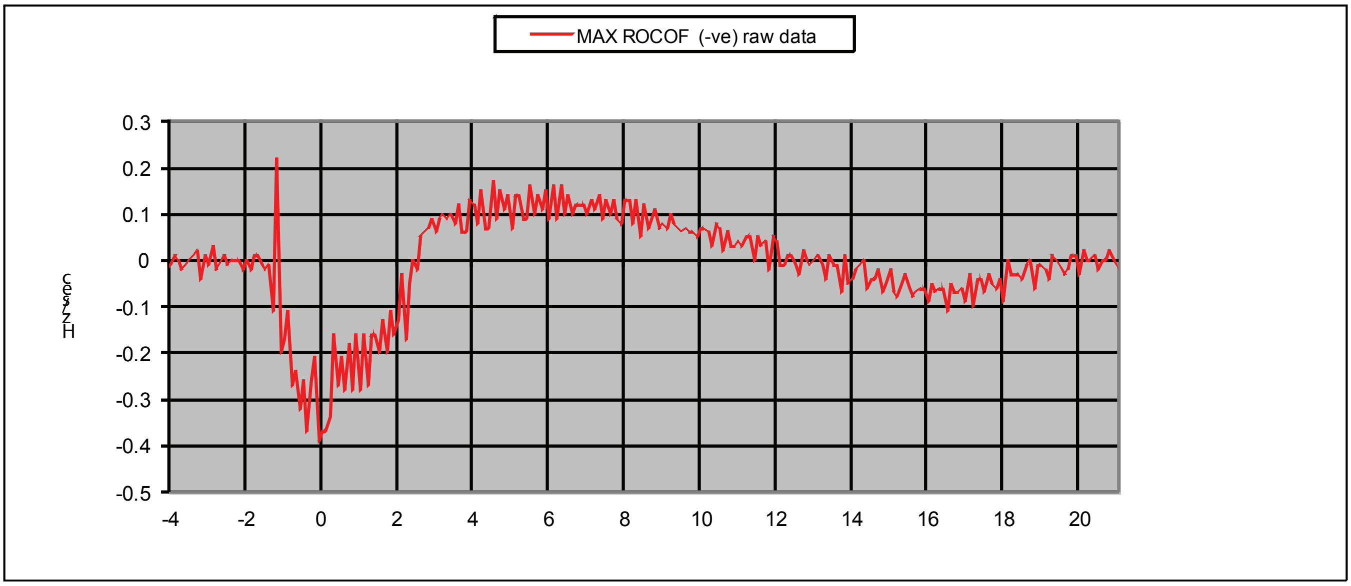

MAX ROCOF (-ve) raw data
Hz/sec
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-4
-2
0
2
4
6
8
10
12
14
16
18
20

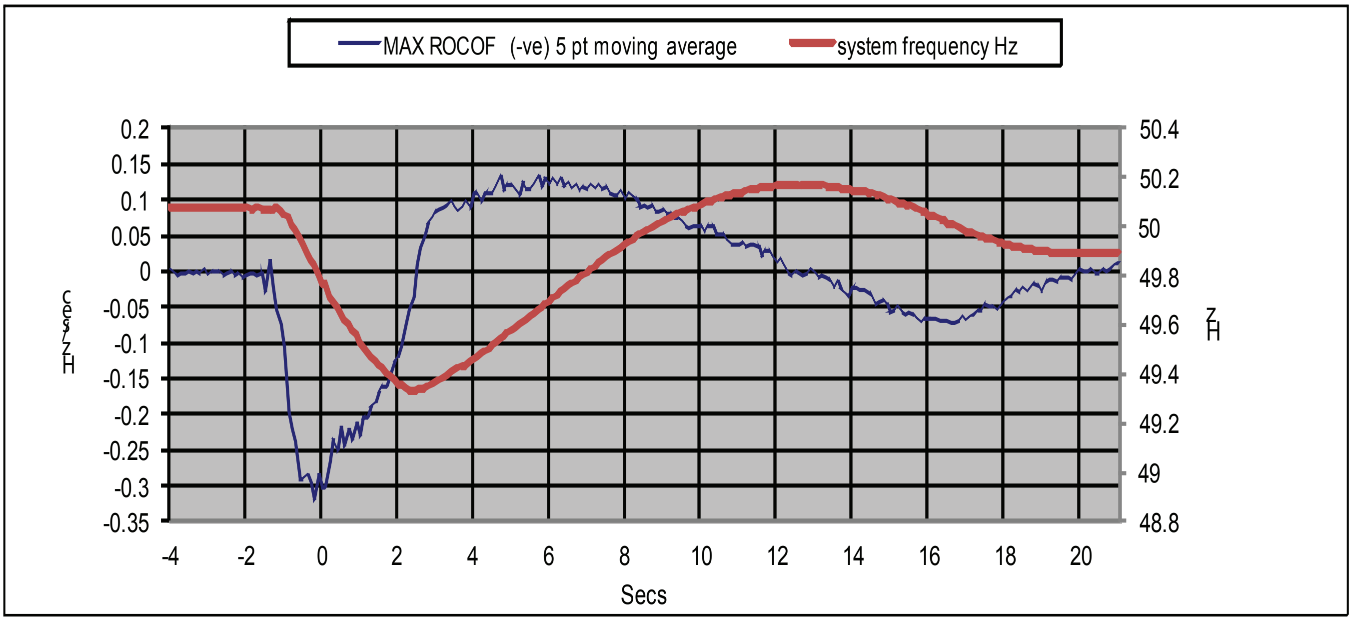

MAX ROCOF (-ve) 5 pt moving average
system frequency Hz
Hz/sec
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
50.1
50
49.9
49.8
49.7
49.6
49.5
49.4
Hz
-4
-2
0
2
4
6
8
10
12
14
16
18
20
Secs

12/09/2012 HUNTSTOWN UNIT 2

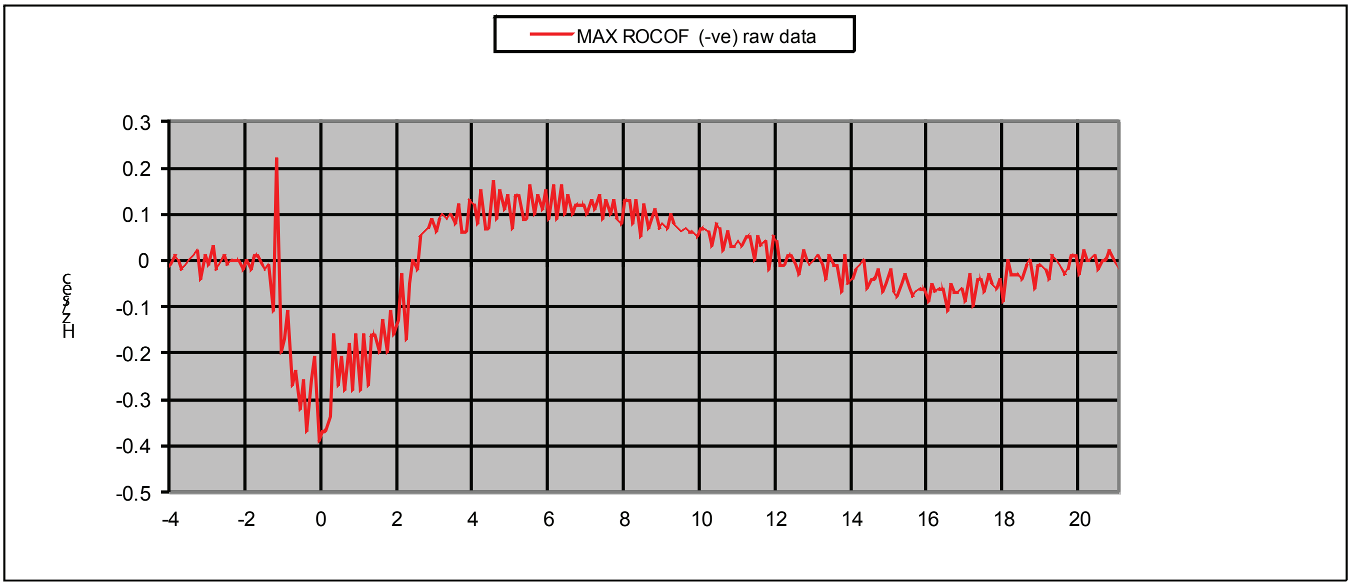


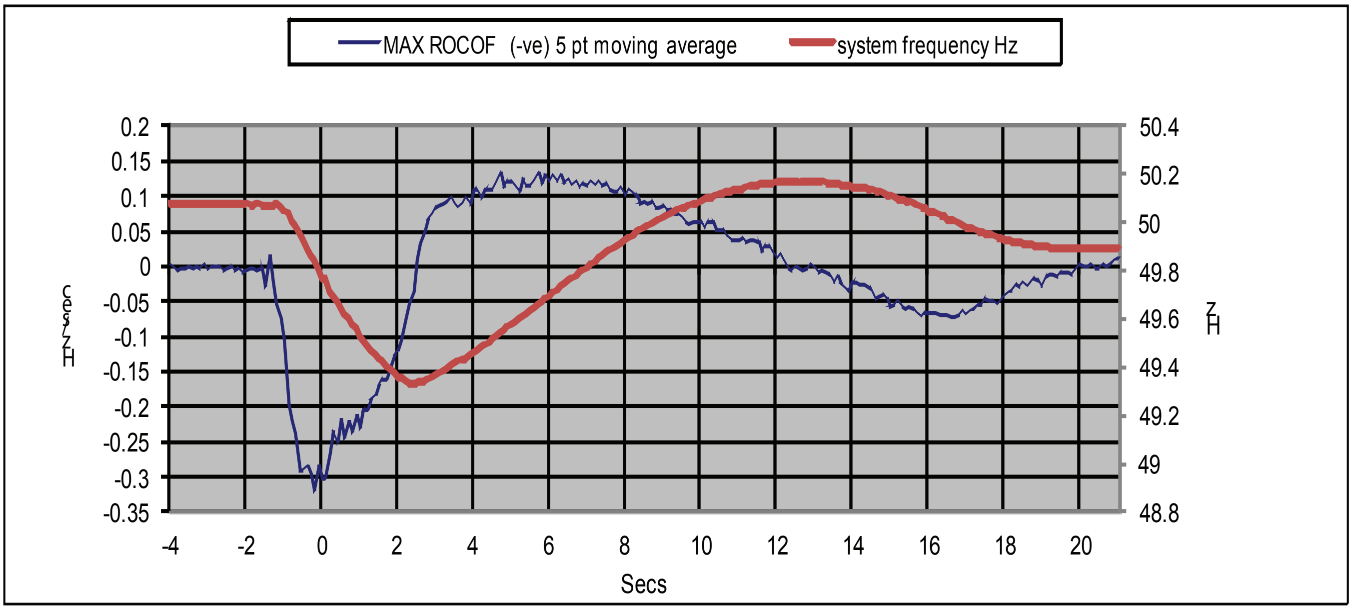




MAX ROCOF (-ve) raw data
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
Hz/sec
-4
-2
0
2
4
6
8
10
12
14
16
18
20

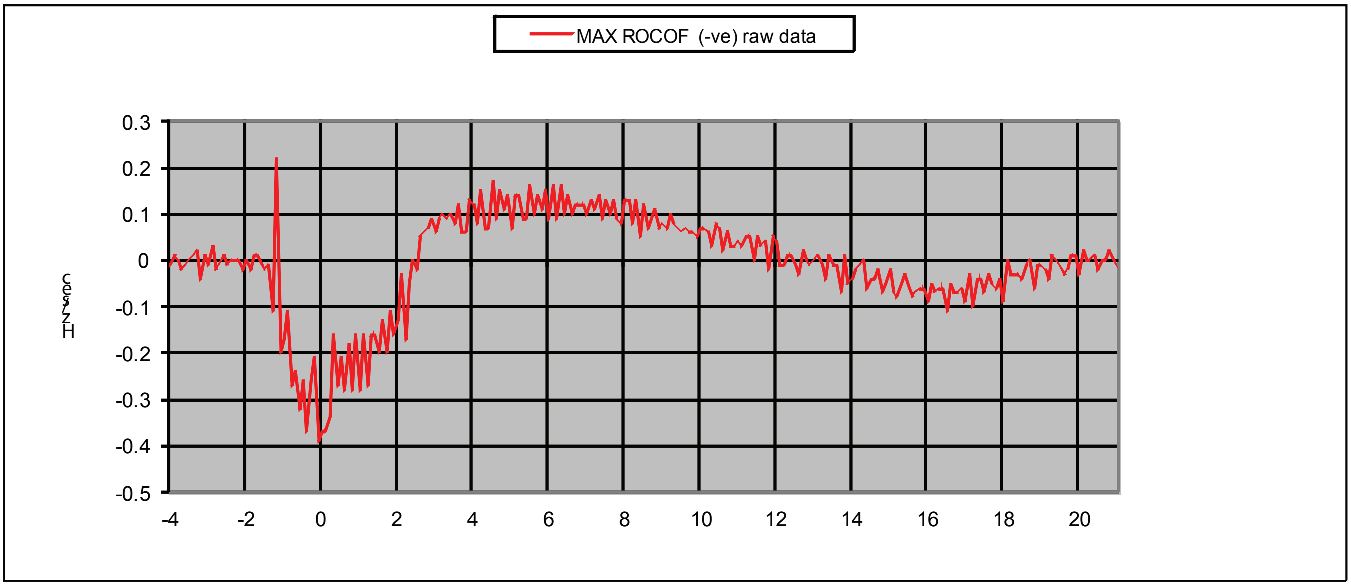

MAX ROCOF (-ve) 5 pt moving average
system frequency Hz
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
Hz/sec
50.4
50.2
50
49.8
49.6
49.4
49.2
49
48.8
Hz
-4
-2
0
2
4
6
8
10
12
14
16
18
20
Secs

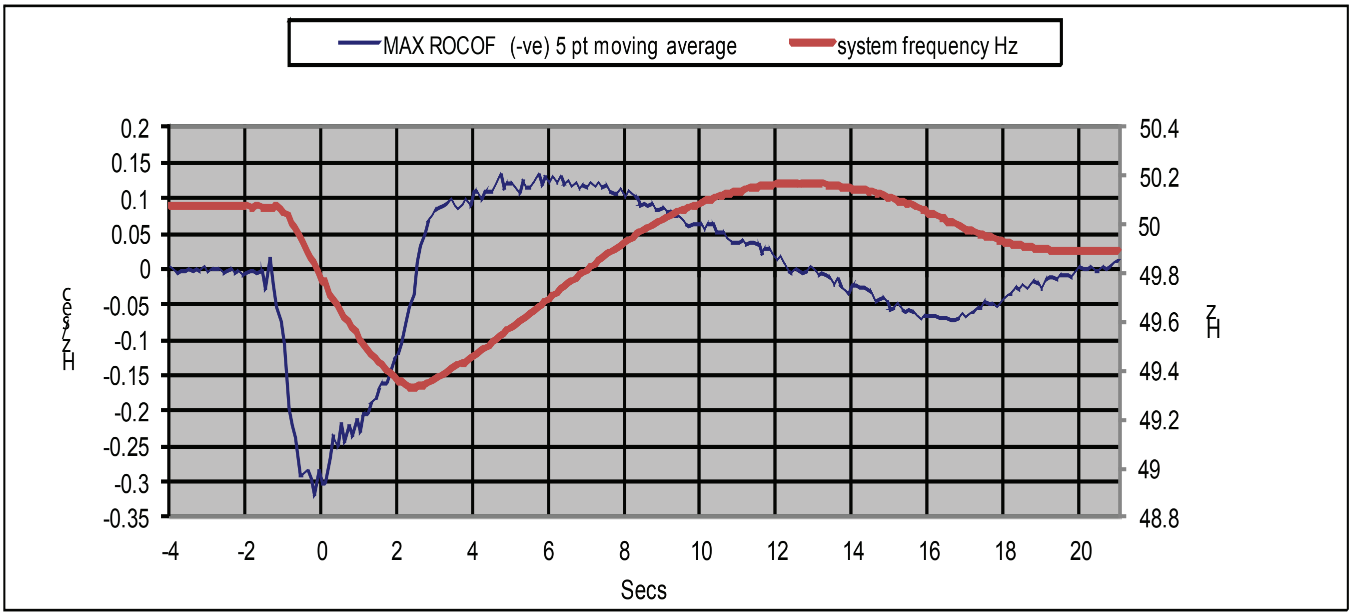
10/10/2012 HUNTSTOWN UNIT 2 & TYNAGH



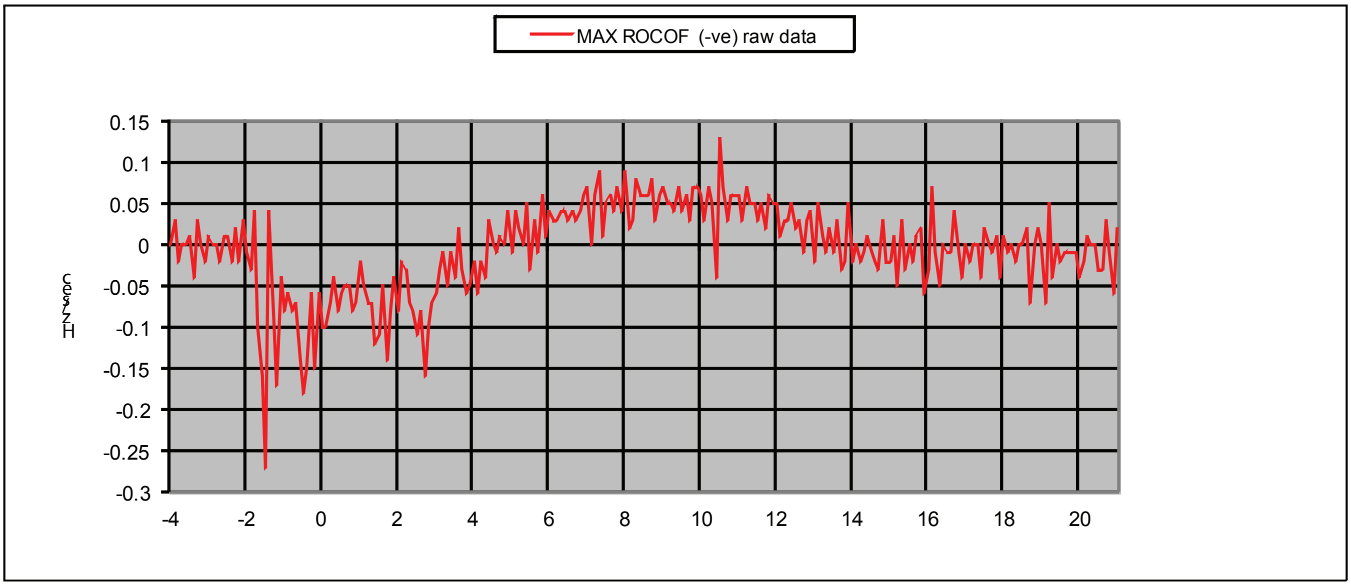



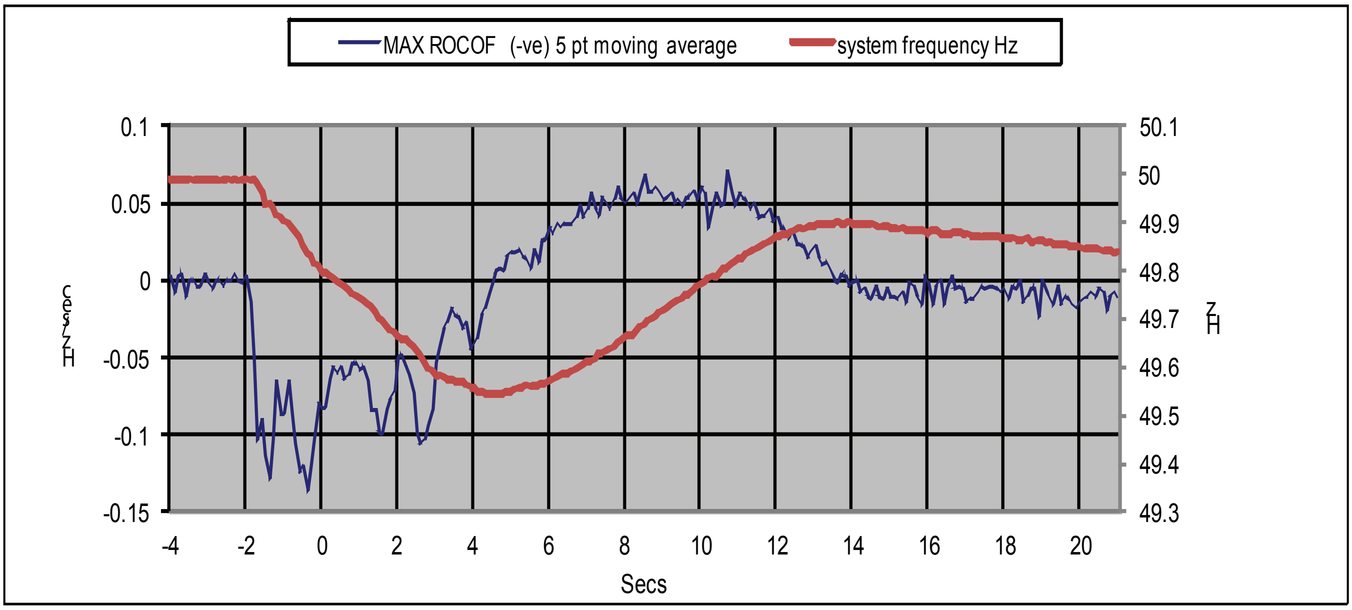
06/11/2012 WHITEGATE



31/12/2012 COOLKEERAGH C30



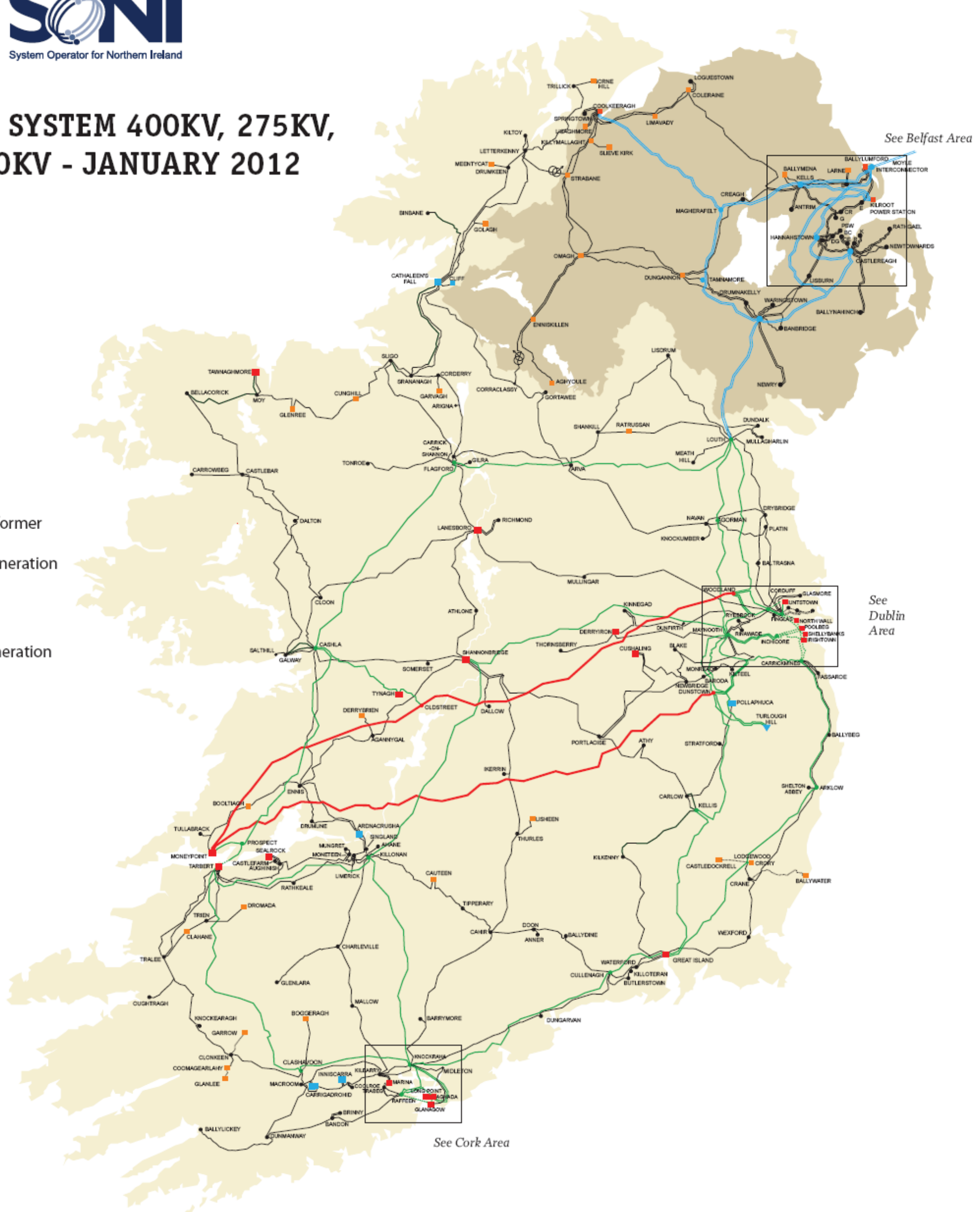



# TRANSMISSION SYSTEM 400KV, 275KV, 220KV AND 110KV - JANUARY 2012

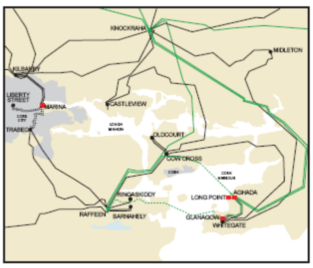
- 400kV Lines
- 275kV Lines
- 220kV Lines
- 110kV Lines
- 220kV Cables
- 110kV Cables
- 400kV Stations
- 275kV Stations
- 220kV Stations
- 110kV Stations
- Phase Shifting Transformer

Transmission Connected Generation

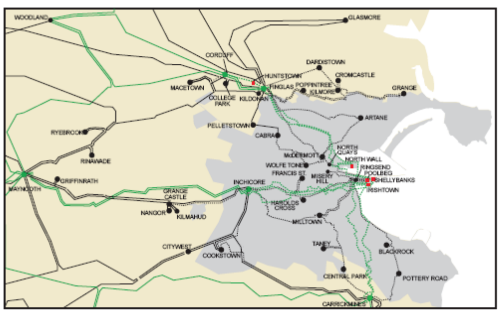
- Hydro Generation
- Thermal Generation
- Pumped Storage Generation
- Wind Generation




Belfast Area



Cork Area



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