ALL-ISLAND TRANSMISSION SYSTEM PERFORMANCE REPORT

2014

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1. Introduction

1 INTRODUCTION

EirGrid and SONI, as Transmission System Operators (TSOs) for Ireland and Northern Ireland respectively, are pleased to present the annual Transmission System Performance Report for 2014. This report contains transmission system data and performance statistics for the transmission system in Ireland and Northern Ireland for the year 2014 (1st January 2014 – 31st December 2014). The report includes both transmission system performance statistics and a number of high level transmission system characteristics, many of which are published elsewhere, but have been collated into one single source for the benefit of industry and external observers.

EirGrid is required to publish an annual report on the performance of the TSO business in accordance with Condition 18 of the Transmission System Operator Licence granted to EirGrid by the Commission for Energy Regulation (CER). Similarly, SONI is required to produce an annual report on the performance of the TSO in accordance with Condition 20 of the Licence to participate in the Transmission of Electricity granted to SONI Ltd by the Department of Enterprise Trade and Investment.

This report is structured as follows:

- Section 2 outlines all island system data, generation availability and outages
- Section 3 sets out the performance of the EirGrid TSO Business during 2014 against the criteria approved by the CER.
- Section 4 set out the performance of SONI TSO during 2014 against the criteria approved by the Northern Ireland Authority for Utility Regulation (NIAUR)

Appendices which provide further detail on the data, results and methodology of relevance are included at the end of this report.

2. Executive Summary

2 EXECUTIVE SUMMARY

The annual Transmission System Performance Report for 2014 is a comprehensive review of the transmission system through which EirGrid and SONI make available key, all-island system operating data from the previous year. This report contains high level transmission system characteristics and a detailed breakdown of key figures along with an explanation of what these figures mean for the all-island transmission system in the coming year and into the future. Through comparison with previous reports, this provides a useful resource through which possible trends can be identified.

Key statistics detailed in this report include:

- All-island total exported energy
- Winter and summer peak demand
- Maximum all-island wind generation level

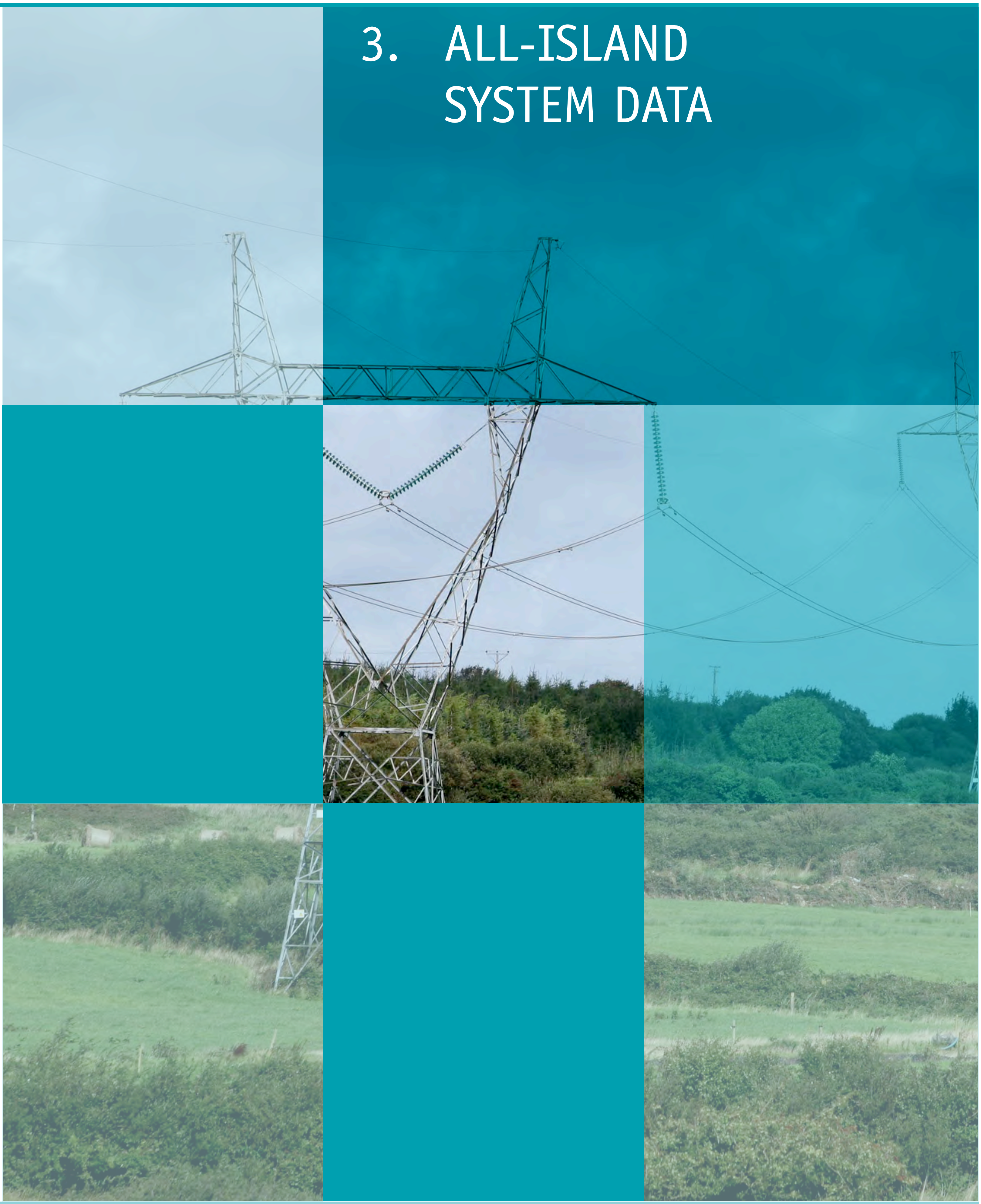
Showing a slight increase of 0.35% on the 2013 figure, 34,960GWh of energy was exported from the island of Ireland in 2014. This figure coincides with the first full year of operation for the East West Interconnector, which registered availability of 97.05% in 2014.

All-island peak demand in the winter of 2014 was also up, reaching 6310 MW on Monday, December 8th, a 1.3% increase on the previous record. Most crucially however, in 2014, 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. Good progress was also made on a number of Grid25 transmission development projects during 2014 resulting in the uprating of over 140km of lines.

The installed wind capacity continues to increase year-on-year, enabling Ireland and Northern Ireland to progress towards the target of having 40% of our electricity produced by renewable sources by 2020. In 2014 a maximum all-island wind generation level of 2314 MW was achieved on Sunday 21st December.

3. ALL-ISLAND SYSTEM DATA



3 ALL-ISLAND SYSTEM DATA

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 also comprises of high voltage stations, where the electricity voltage is reduced for local distribution (at 38 kV, 20 kV and 10 kV in Ireland, and 33 kV, 11kV and 6.6 kV in Northern Ireland). Some large industrial customers 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.

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.

	2013	2014
All-Island Total Exported Energy [GWh]	34,837	34,960
ROI Total Exported Energy [GWh]	25,957	26,195
NI Total Exported Energy [GWh]	8,881	8,765

Table 3.1: Total Exported Energy 2013 & 2014

The All-Island total exported energy in 2014 increased by 0.35% from the 2013 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 transmission system in Ireland and Northern Ireland is a winter peaking system as a result of greater heating and lighting requirements during the winter months and this is illustrated in Figure 3.2. The all-island winter peak in 2014 was 6310 MW and occurred at 17:30 on Monday 8th December. This peak demand of 6310 MW is an increase on the peak demand of 6229 MW in 2013 (+1.3%).

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 2014 a minimum all-island demand of 2191 MW was recorded at 05:45 on Sunday 6th July.

The installed wind capacity continues to increase year-on-year, enabling Ireland and Northern Ireland to progress towards the target of having 40% of our electricity produced by renewable sources by 2020. In 2014 a maximum all-island wind generation level of 2314 MW was achieved on Sunday 21st December.
Table 3.2 provides a summary of the system records for 2013 and 2014.

	2013	2014
Winter Peak Demand [MW]	6,229	6,310
Minimum Summer Night Valley [MW]	2,217	2,191
Maximum Wind Generation [MW]	2,275	2,314

Table 3.2: System Records 2013 & 2014

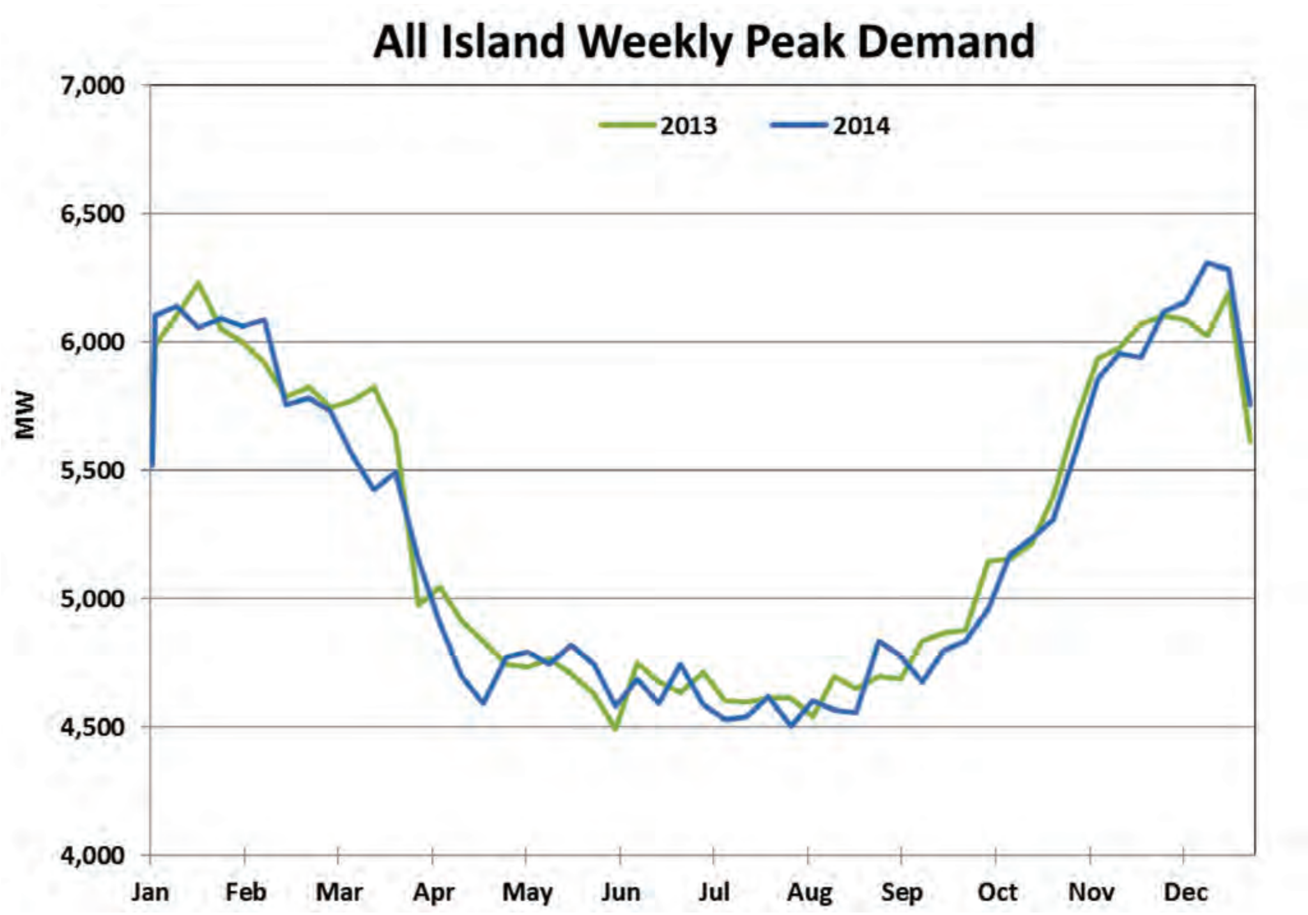


Figure 3.2: Weekly System Demand Peaks for 2013 & 2014

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 All-Island installed capacity of conventional, dispatchable generation in December 2014 was 9351 MW (6968 MW in Ireland and 2383 MW in Northern Ireland). This does not include any import capacity from the Moyle Interconnector or the East West Interconnector.

The All-island installed capacity of wind generation in December 2014 was 2825 MW (2211 MW in Ireland and 614 MW in Northern Ireland)[2].

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

3.4 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 2014.

Generation system availability is calculated on a daily and 365-day rolling average basis[3]. Figure 3.4 shows the daily and 365-day rolling average availability for 2014.

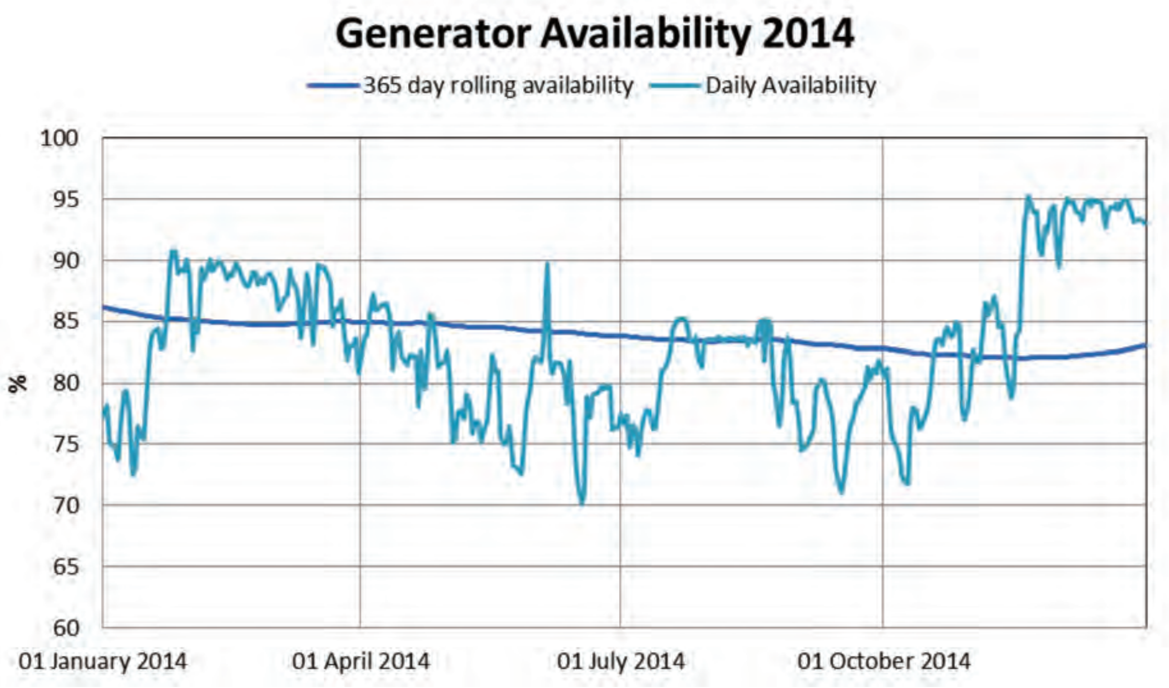


Figure 3.4: Generation System Availability 2014

1 Fully operational generator capacity is given by the Maximum Export Capacity (MEC) of the generator
2 Values from the "All Island Wind and Fuel Mix Report (December 2014)"
3 365-day rolling average is a capacity weighted average availability over the previous 365 days

- The average daily generation system availability in 2014 was 83.03%
- The maximum daily generation system availability in 2014 was 95.29%, occurring on the 20th November 2014
- The minimum daily generation system availability in 2014 was 70.14%, occurring on the 17th June 2014.

3.5 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 3.5

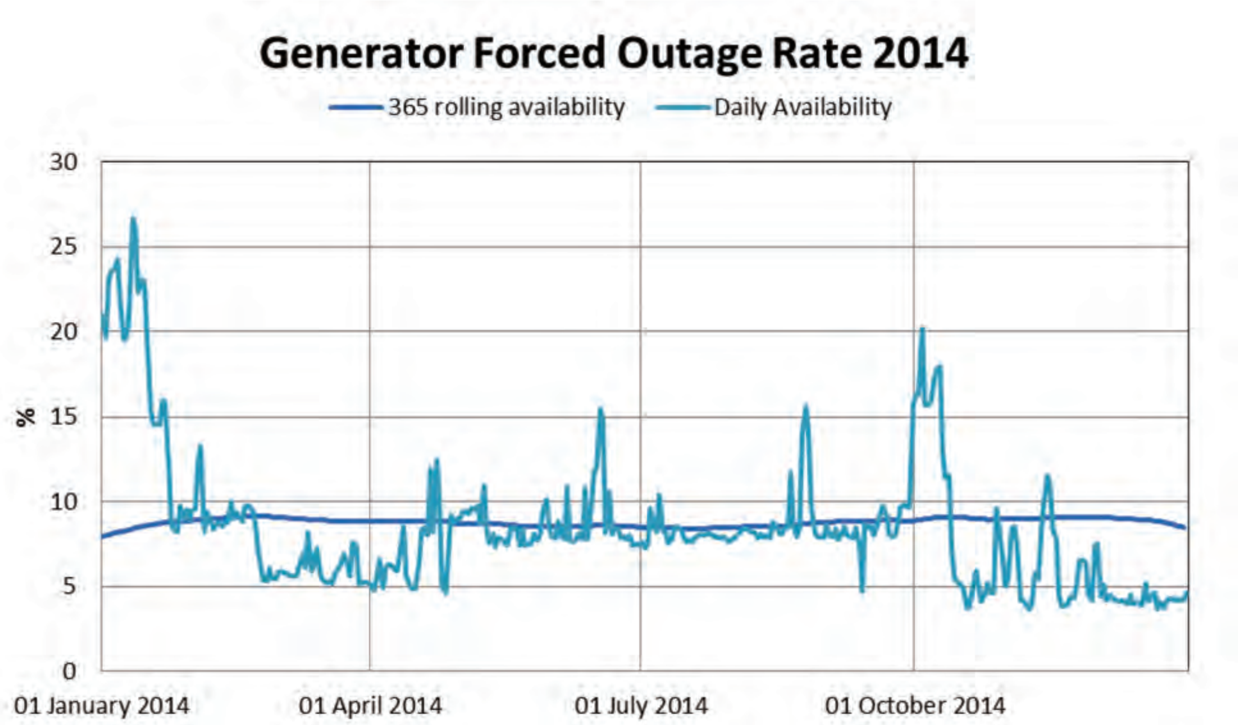


Figure 3.5: Generation System Forced Outage Rate 2014

- The average daily generation system forced outage rate in 2014 was 8.49%.
- The maximum daily generation system forced outage rate in 2014 was 26.69%, occurring on the 11th January 2014. On this date the following units were on forced outage: Whitegate WG1, Aghada AD1 & AT14, Ardnacrusha AA4, Erne ER1, Tarbert TB3, Poolbeg PBC and Moneypoint MP1
- The minimum daily generation system forced outage rate in 2014 was 3.63%.

3.6 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 3.6.

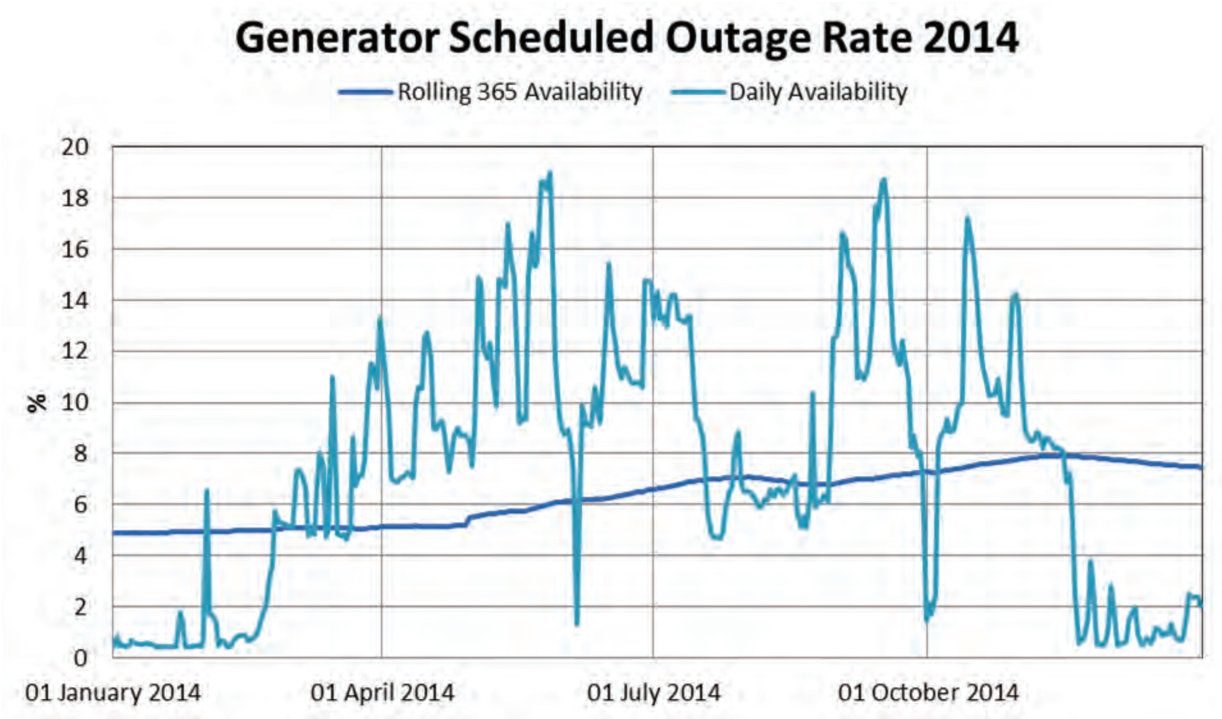


Figure 3.6: Generation System Forced Outage Rate 2014

- The average daily generation system scheduled outage rate in 2014 was 7.47%.
- The maximum daily generation system scheduled outage rate in 2014 was 18.97%, occurring on the 27th May 2014. On this date there were scheduled outages of the following units: Ardnacrusha AA1/AA2/AA4, Erne ER2, Lee LE1/LE2, Liffey LI1/2/4, Lough Ree LR4, Huntstown HN2, Moneypoint MP3 and Whitegate WG1.
- The minimum daily generation system scheduled outage rate in 2014 was 0.41%

EirGrid Transmission System Performance

4 EIRGRID TRANSMISSION SYSTEM PERFORMANCE

This section relates to the performance of EirGrid TSO and the transmission system in Ireland only, unless explicitly stated otherwise. This data has been prepared by EirGrid in accordance with the requirements of Part 5 of Condition 18 of its Transmission System Operator Licence.

4.1 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 The total number of system minutes lost (SM) on the ROI Transmission System in 2014 was 2.881 SM (0.29 SM of this figure was due to load shedding of Normal Tariff customers). All of the 2.881 SM figure was due to Transmission System faults.

Extensive maintenance of the transmission system was carried out throughout the year, including 8,677.53km of overhead line patrols.

One of the key measures of transmission system performance is availability: the average daily generation system availability in 2014 was 83.03%

4.2 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 4.2 provides a summary of transmission system infrastructure for 2014 and 2013

	2014		2013	
Plant Type	No. of Items	Circuit Length [km]	No. of Items	Circuit Length [km]
110 kV Circuits	199	4,268	197	4,200
220 kV Circuits	55	1,917	55	1,917
275 kV Circuits	2	97	2	97
400 kV Circuits	4	439	4	439
Circuit Total	260	6,721	258	6,653
Plant Type	No. of Items	Transformer Capacity [MVA]	No. of Items	Transformer Capacity [MVA]
220/110 kV Transformers	46	8,739	46	8,739
275/220 kV Transformers	3	1,200	3	1,200
400/220 kV Transformers	7	3,550	6	3,050
Transformer Total	56	13,489	55	12,989
Total No. of sub-stations	153		152	

Table 4.2: Transmission System Infrastructure 2014 & 2013

4.3 Grid Development and Maintenance

This section provides an overview of grid development activities in 2014. 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.

4.3.1 Grid 25

Good progress was made on a number of Grid25 projects during 2014 resulting in the uprating over 140km of existing lines. This included the completion of the Cullenagh to Great Island 220kV line in June and the completion of the Cunghill to Glenree 110kV line in July. We also completed the uprating of the 110kV lines from Cathaleen's Fall to Srananagh (No. 2 line) and Kilbarry to Knockraha (No. 1 line) in October.

Bruckana Windfarm was connected to the system via a new 110/38kV DSO transformer in Lisheen 110kV station and was energised on the 29th April. We added 65km of new 110kV line to the transmission system with the energisation of the Binbane to Letterkenny 110kV line in May 2014, and we completed the refurbishment of Navan 110kV station in June 2014.

Planning applications were submitted for five proposed projects during 2014. These included an application for reactive support at Poolbeg 220kV Station which was submitted in June; an application for the uprating of the Bellacorick to Castlebar 110kV line which was submitted in August and an application for the refurbishment of Louth 220kV Station which was submitted in September 2014.

Planning permission was granted for seven projects in 2014 including permission for the Aghada 220kV busbar reconfiguration project, a new 400kV station for the Laois to Kilkenny reinforcement project and the refurbishment of the Tarbert 220kV station.

Over the course of 2014 the following customer connection projects were completed:

- Connection of Kill Hill 110kV station;
- Connection of Bruckana Windfarm into Lisheen 110kV station;

Station and circuit upratings were completed for the following existing transmission assets:

- Cullenagh - Great Island 220kV Line Refurbishment and Uprate
- Louth - Woodland 220kV Line Refurbishment
- Prospect - Tarbert 220kV Line Uprate
- Cathaleen's Fall - Srananagh No. 2 110kV Line Uprate
- Moneypoint - Prospect 220kV Line Refurbishment
- Cashla - Prospect 220kV Line Resagging
- Kilbarry - Knockraha 110kV No. 1 Line Uprate
- Cunghill - Glenree 110kV Line Uprate
- Cahir - Thurles 110kV Line Uprate
- Binbane - Letterkenny 110kV Line - New Line
- Marina 110kV Station Replacement
- Woodland 400kV Station - 3rd 400/220 500MVA Transformer
- Navan 110kV Station Refurbishment
- Sligo 110kV Station Busbar Uprate

4.3.2 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 4.3.2 details the number of connection offers made by EirGrid in 2014.

	Demand	Generation
New Connection Offers Issued in 2014 [No.][4]	1	0
New Connection Offers Issued in 2014 [Capacity]	35 MVA	0 MW

Table 4.3.2: Demand & Generation Connection Offers Issued 2014

4.3.3 Connection Offers Accepted

In order to connect to the transmission system, all demand and generation customers must execute a Connection Agreement with EirGrid. Table 4.3.3 summarises the total number of executed Connection Agreements in 2014 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 2014 [No.]	1	0
Executed Connection Offer Agreements in 2014 [Capacity]	35 MVA	0 MW

Table 4.3.3: Executed Demand & Generation Connection Agreements in 2014

4.3.4 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 4.3.4 provides an overview of the number of new connections to the transmission system commissioned in 2014.

	Demand	Generation
Connections Energised in 2014 [No.]	0	2
Connections Energised in 2014 [Capacity]	0 MVA	251 MW

Table 4.3.4: Demand & Generation Connections Energised in 2014

4 These figures do not include non-capacity connection offers

4.3.5 Customers Certified Operational

Table 4.3.5 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. Note that demand customers are not currently certified by EirGrid and are therefore not included in the table.

	2014		System Total	
	Generation	**Interconnector**	**Generation**	**Interconnector**
Customers Certified Operational [Total No. of sites]	6	0	71	1
Customers Certified Operational [Capacity]	108	0	7,298	530

Table 4.3.5: Customers Certified Operational in 2014

There were 5 new Demand Side Units (DSUs) certified as operational in 2014 and 2 DSUs were recertified for increased capacity.

11 transmission connected windfarms totalling 432 MWs were certified in 2014 which included 1 new windfarm connection. On the distribution system 18 windfarms were certified operational and this accounted for 205 MWs of capacity.

4.3.6 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), preventative 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 4.3.6).

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. Maintenance works are carried out by the Transmission Asset Owner (TAO), ESB Networks.

Table 4.3.6 provides, in volume terms, a summary of transmission maintenance requirements, maintenance programmed and maintenance completed in 2014 for overhead lines, underground cables and transmission stations.[5]

5 Further information on EirGrid Transmission Equipment Maintenace can be found on the EirGrid website, www.eirgrid.com

Volume of Transmission Maintenance by Activity	Maintenance Requirements	Maintenance Programmed[2]	Maintenance Completed
		Year End	
Overhead Line Maintenance			
Patrols (incl. Helicopter, climbing, infrared & Bolt)	10,108.39	10,007.46	8,677.53
Timber Cutting [km]	71.44	71.592	67.742
Structure & Hardware Replacement [Number]	102	135	126
Insulator & Hardware Replacement [Number]	205	215	20
Underground Cables Maintenance			
Check/Alarms [Number]	599	601	554
Station Maintenance			
Ordinary Service [Number]	336	325	255
Operational Tests [Number]	1025	1028	875
Condition Assessment of Switchgear [Number]	148	148	113
Tap Changer Inspection [Number]	14	13	7
Corrective Maintenance Tasks [No. of Tasks]	422	735	430

Table 4.3.6: Transmission System Maintenance 2014

4.4 Transmission System Availability & Outages

4.4.1 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 3.1. Figure 4.4.1 shows the percentage of the total number of maintenance outages which occurred in each month for 2013 and 2014.

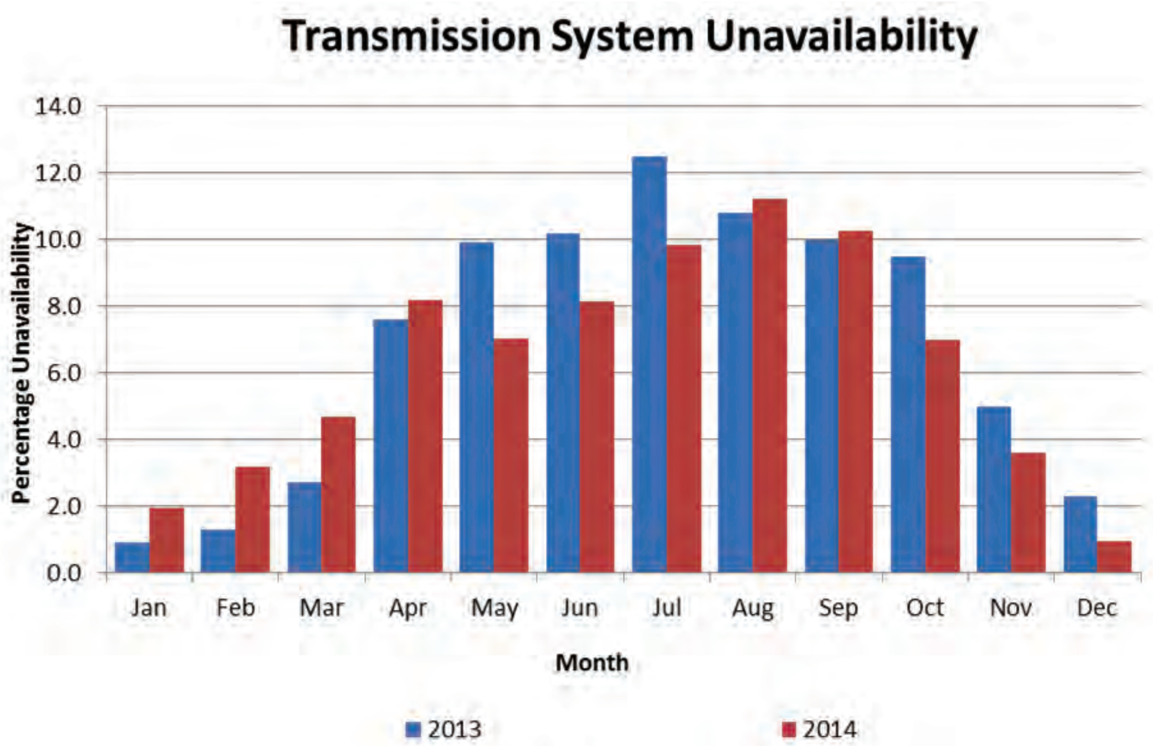


Figure 4.4.1: Monthly Variations of System Unavailability 2013 & 2014

4.4.2 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 3.1.

Table 4.4.2 provides a detailed breakdown of all plant availability figures for 2014 and 2013.

Plant type	Circuit length (km)	Number of Outages	Availability [%] 2014	Availability [%] 2014
110 kV Circuits	4,268	508	92.63	92.88
220 kV Circuits	1,917	96	95.8	93.41
275 kV Circuits	97	9	95.89	96.08
400 kV Circuits	439	3	97.17	90.58
Plant Type	**Transformer Capacity [MVA]**	**Number of Outages**	**Availability 2014 [%]**	**Availability 2013 [%]**
220-110kV Transformers	8,739	114	95.26	93.77
275-220kV Transformers	1,200	3	98.7	85.91
400-220kV Transformers	3,550	21	92.98	93.41
Total	6,721 kM 13,489 MVA	754	95.49	92.29

Table 4.4.2: Transmission System Plant Availability 2013 & 2014

In 2014:

- The average plant availability was 94.17%;
- The maximum availability by plant type was 97.17%, which occurred on the 275kV tie lines; and
- The minimum availability by plant type was 86%, which occurred on the 220/110kV Transformers.

The increase in plant availability from 92.29% in 2013 to 95.49% in 2014 can in part be attributed to the increase in availability of the 275/220kV transformers and the 400kV lines.

4.4.3 Cause of Transmission Plant Unavailability

Transmission plant unavailability is classified into the categories outlined in Table 4.4.3.

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: A) Fault & Reclose B) Fault & Forced C) Forced (No Tripping) 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. **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. **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 4.4.3 Transmission System Plant Unavailability Categories

4.4.4 110 kV Plant Unavailability

Figure 4.4.4 provides a breakdown of the causes of unavailability on the 110 kV network in 2014.

The largest contributor to unavailability (40%) on the 110 kV network in 2014 were outages for the purpose of Corrective and Preventive Maintenance. This type of maintenance includes, amongst others, Ordinary Services, Condition Assessments, wood-pole replacement/straightening and general line maintenance. The most significant of these outages was the refurbishment of the Derryiron-Kinnegad 110kV Circuit, which lasted 108 days.

A further 40% of unavailability on the 110 kV network was attributable to the “New Works” category. This category is for outages to install new equipment or uprate existing circuits. The most significant of these was the outage of Cathleens Falls- Srananagh Two 110 kV line to facilitate the upgrade of the busbar in Cathleens Falls 110kV station. This outage lasted 169 days.

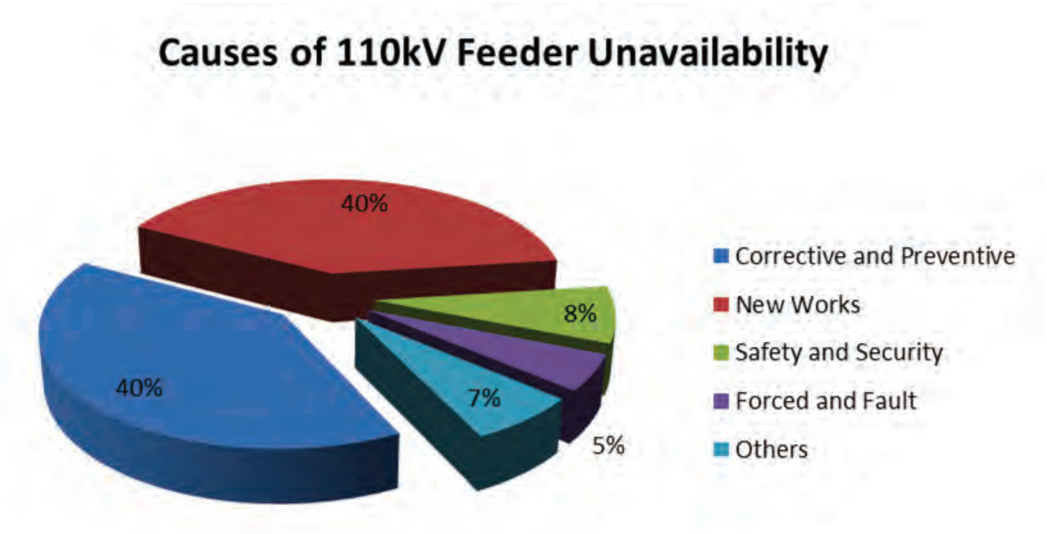


Figure 4.4.4: Causes of Unavailability on the 110kV System in 2014

4.4.5 220 kV Plant Unavailability

Figure 4.4.5 provides a breakdown of the causes of unavailability on the 220 kV network in 2014.

The largest contributor to unavailability (58%) on the 220 kV network in 2014 were also outages for the purpose of Corrective and Preventive Maintenance. The most significant of these was for the refurbishment of the Dunstown – Turlough Hill 220kV Line which lasted for 145 days.

Approximately 24% of unavailability on the 220 kV network was attributable to New Works. The most significant of these outages included the uprating of the Cullenagh-Great Island 220 kV line with HTLS conductor which lasted 106 days.

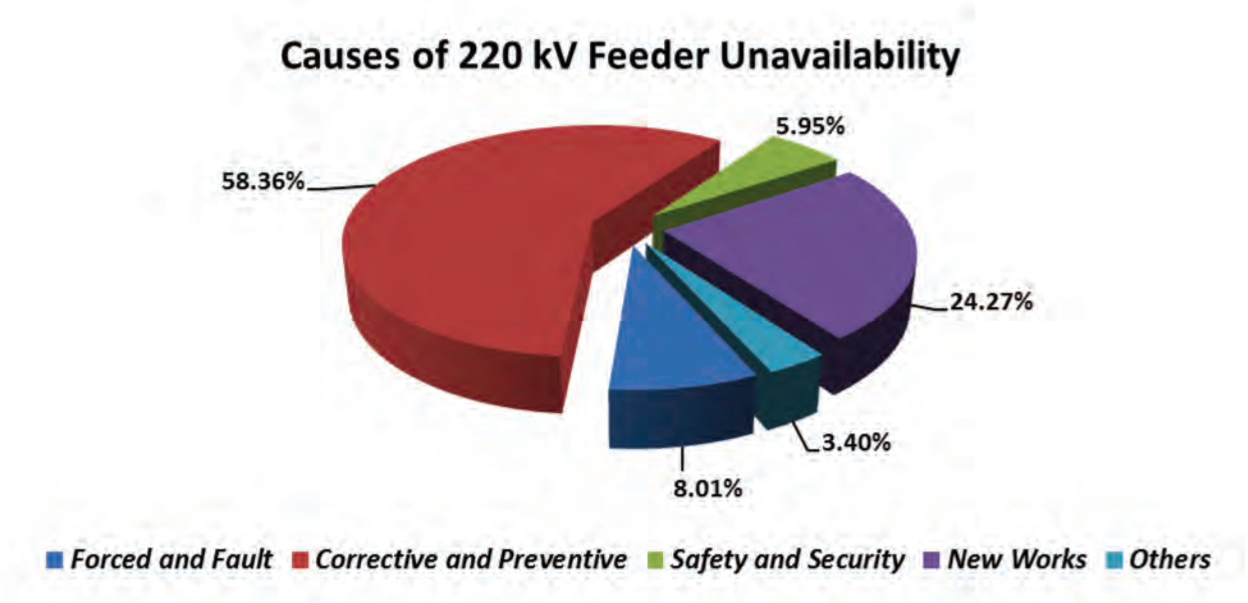


Figure 4.4.5: Causes of Unavailability on the 220kV System in 2014

4.4.6 275 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 2014 there were only 2 outages of 275 kV tie-lines, all of which were for corrective and preventative maintenance. The longest of these was a 20 day outage of Louth - Tandragee 1 (ONE) 275 kV Line to facilitate maintenance.

4.4.7 400 kV Plant Unavailability

Figure 4.4.7. provides a breakdown of the causes of unavailability on the 400 kV network in 2014.

The largest contributor to unavailability (79%) on the 400 kV network in 2014 were corrective and preventative outages. The most significant of these was a maintenance outage of the Oldstreet - Woodland 400kV line which as a result remained on forced outage for 13 days.

The second largest portion (13%) of unavailability on the 400kV Network in 2014 was attributable to forced outages. The most significant of these outages was the refurbishment of the Moneypoint – Oldstreet 400kV Circuit which lasted 16 days.

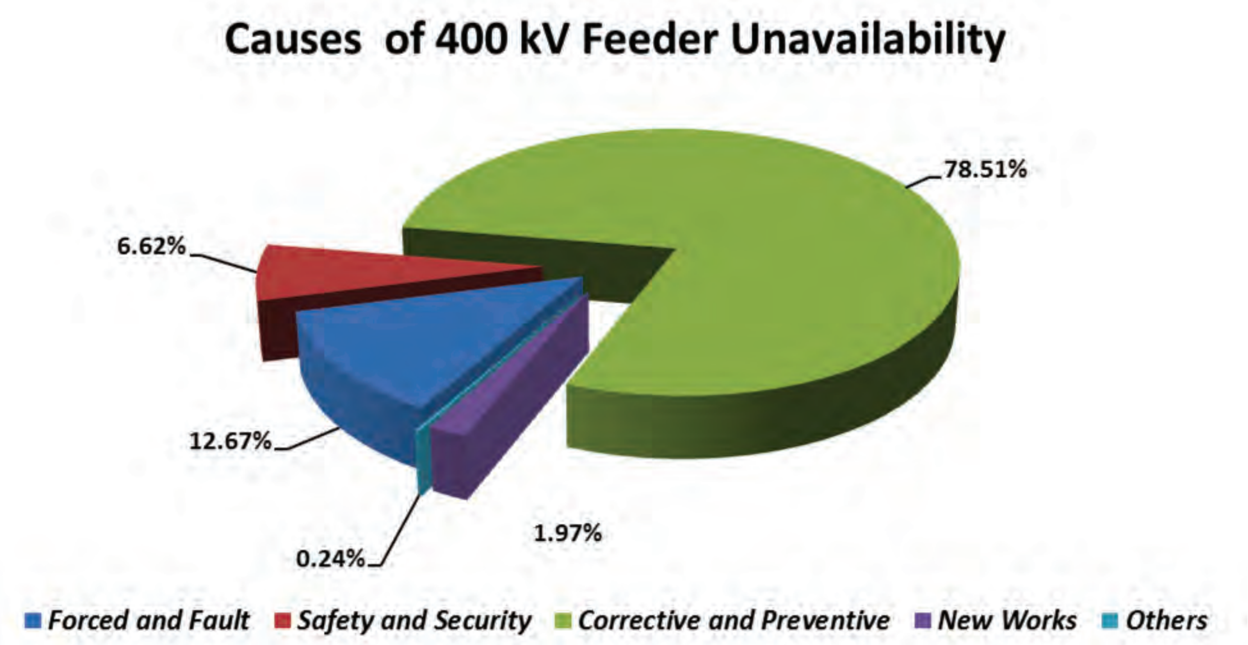


Figure 4.4.7: Causes of Unavailability on the 400kV System in 2014

Table 4.4.7 provides a breakdown of the transmission system outages that occurred in 2014 by plant type.

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	199	4,268	42	34	66	305	61	508
220 kV Circuits	55	1,917	13	6	9	62	6	96
275 kV Tie-lines	2	97	0	0	0	2	0	2
400 kV Circuits	4	439	1	2	2	3	1	9
Total	**260**	**6,721**	**56**	**42**	**77**	**372**	**68**	**615**
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	8,739	10	6	16	69	12	113
275 / 220 kV Transformers	3	1,200	1	0	0	2	0	3
400 / 220 kV Transformers	7	3,550	3	0	2	11	4	20
Total	**56**	**13,489**	**14**	**6**	**18**	**82**	**16**	**136**

Table 4.4.7: Transmission System Plant Outage 2014

4.4.8 East West Interconnector Unavailability

During its first full year of operation, the availability of the East West Interconnector in 2014 was 97.05%. Of the outages contributing to EWIC unavailability, Corrective & Preventative maintenance represented the largest portion (57%), the longest of which was a five day outage to perform annual maintenance. Forced and Fault outages accounted for 42% of all outages.

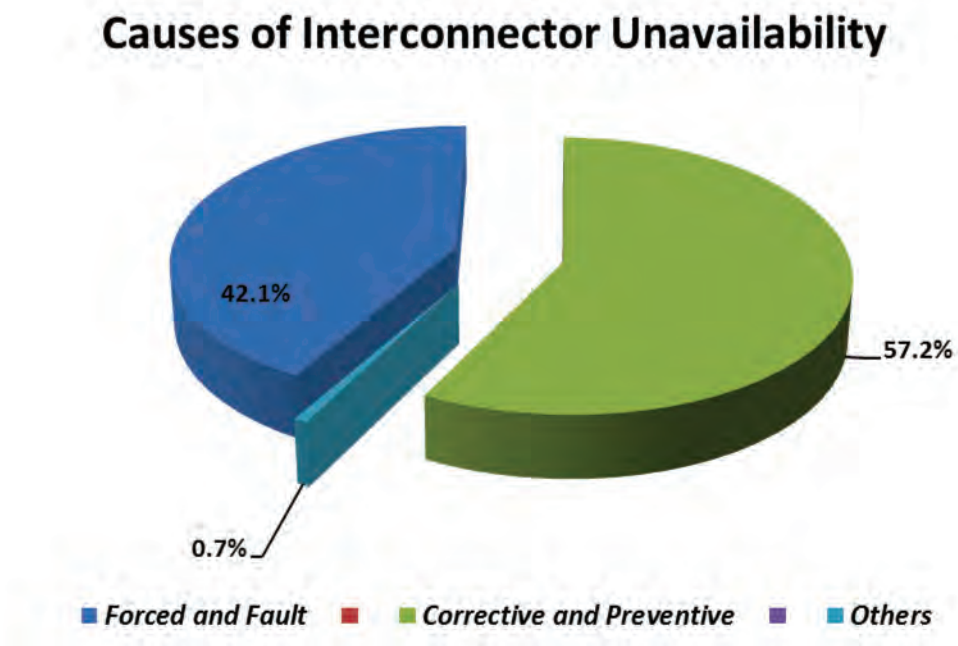


Figure 4.4.8: Causes of East West Interconnector Unavailability in 2014

4.4.9 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

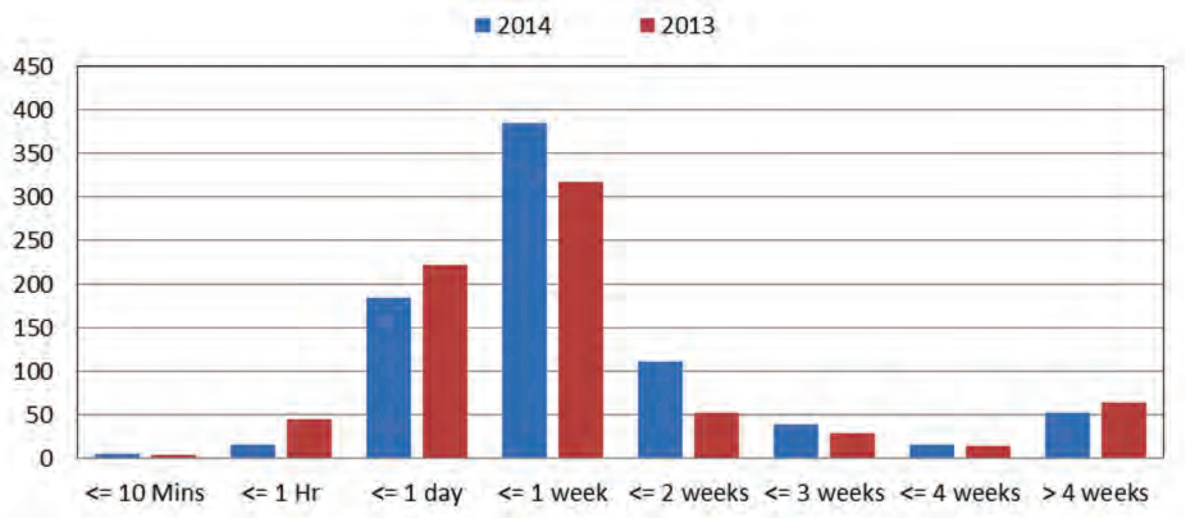


Figure 4.4.9: Duration of Outages in 2013 & 2014

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 thereby reduce the impact on the system, while one week outages for annual maintenance are commonplace during the Outage Season.

4.4.10 Timing of Transmission Outages

Transmission outages are scheduled, where possible, during periods of low load in the summertime (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 apparent in Figure 4.4.10.1 which shows the percentage of the total number of maintenance outages which occurred in each month. The March-October period (known as the Outage Season) sees the highest rates of unavailability during the year, when decreased system load is taken advantage of to carry out extensive maintenance outages such as the 145 day outage to refurbish the Dunstown-Turlough Hill 220kV Line and the 106 day outage for the uprating of the Cullenagh-Great Island 220kV Line.

The high volume of work undertaken in 2014 is highlighted by a similar unavailability level to 2013 which saw unprecedented numbers of outages being completed. Figure 4.4.10.2 also highlights this, showing similar average duration of outages in most months of 2014 compared to 2013.

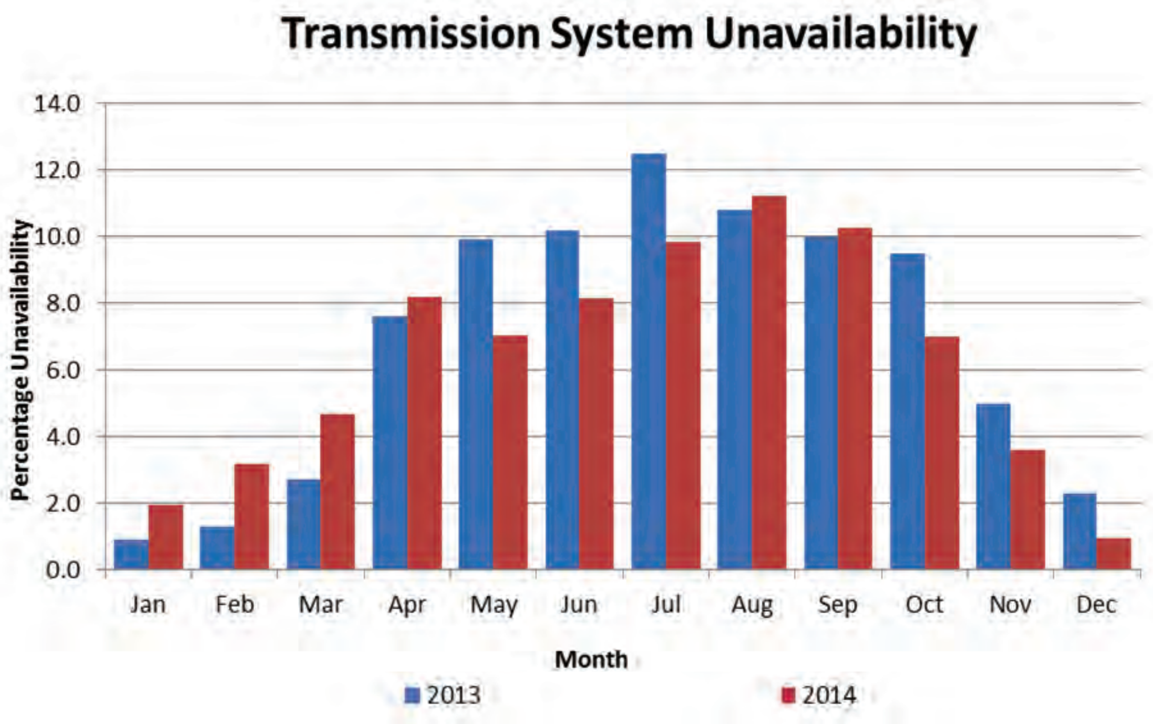


Figure 4.4.10.1: Percentage unavailability in each month of 2013 & 2014

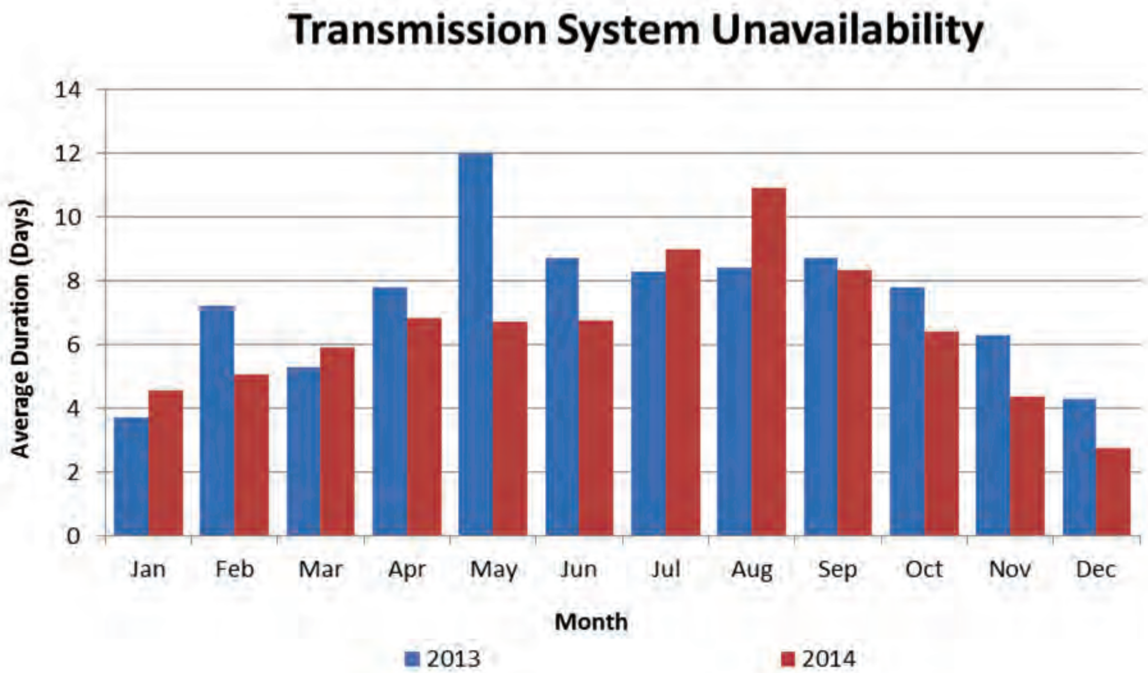


Figure 4.4.10.2: Average duration of outages 2013 & 2014

4.4.11 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.

4.4.11.1 Forced Outages per km

The measure used for analysing the forced outages of lines and cables is the number of forced outages per kilometre of feeder. This is shown in Figure 4.4.11.1 Fault & Reclose forced outages are excluded due to their relatively low level of disruption. The large level of Forced Outages per km on the 400kV network in 2013 due to several forced outages for minor issues (such as SF6 gas leaks and low coolant levels) was reduced for 2014.

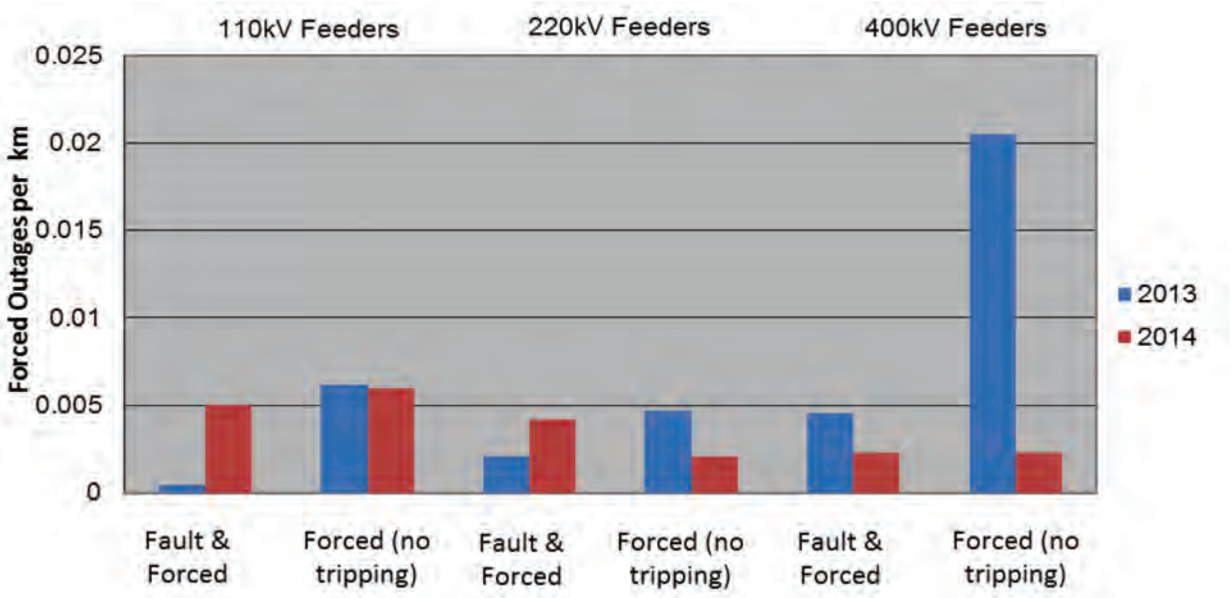


Figure 4.4.11.1: Nature of Feeder Forced Outages 2013 & 2014

4.4.11.2 Forced Outages per MVA

The measure used for analysing the forced outages of transformers is the number of forced outages per MVA capacity, which can be seen in Figure 4.4.11.2.

There was an overall reduction in forced outages per MVA for 2014.The long term outage of Louth AT1 275/220kV transformer continued in 2014 for 330 days. Overall in 2014 the trend was a reduction of forced outages per MVA compared to 2013.

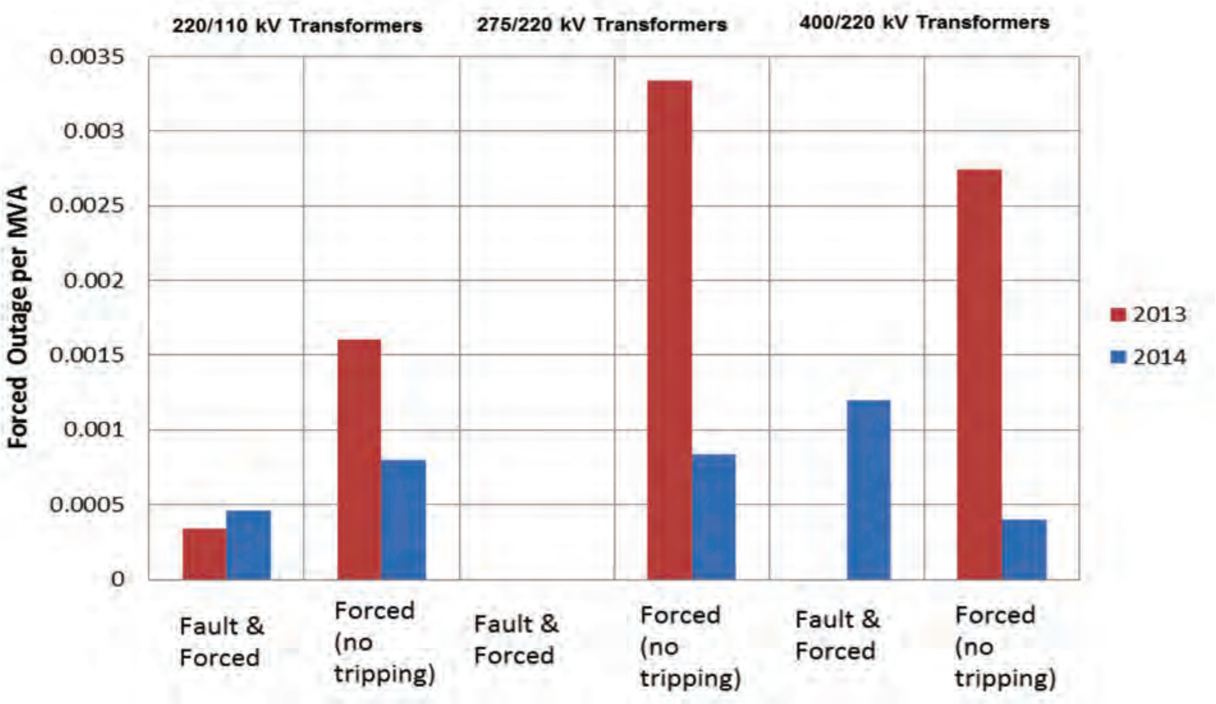


Figure 4.4.11.2: Nature of Transformer Forced Outages 2013 & 2014

4.5. General System Performance

4.5.1. System Frequency and Frequency Deviation

EirGrid and the National Control Centre aims to maintain the system frequency within the stretching target operating range of 50 ±0.1 Hz[6]. The frequency, however, may deviate outside the normal operating range under fault or abnormal operating conditions.

In 2014, the frequency was maintained within the target operating limits of 50 ±0.1 Hz for 99.2% of the time.

Mean Frequency (Hz)	50
Minimum Frequency (Hz)	48.851
Maximum Frequency (Hz)	50.338

Table 4.5.1: System Frequency & Frequency Deviation 2014

The overall performance belies the significant challenges that EirGrid has faced in recent years in terms of the increase in the penetration of variable renewable generation and the resultant decrease in overall system inertia. A power system with a high penetration of variable non-synchronous wind generation poses significant challenges for frequency control over a number of time frames. EirGrid recognises this and seeks to meet many of these challenges through the DS3 Frequency Control and Rate-of- Change-of-Frequency (RoCoF) work streams.

4.5.2. 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;

6 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 4.5.2 shows the number of major alerts on the system over the past five years.

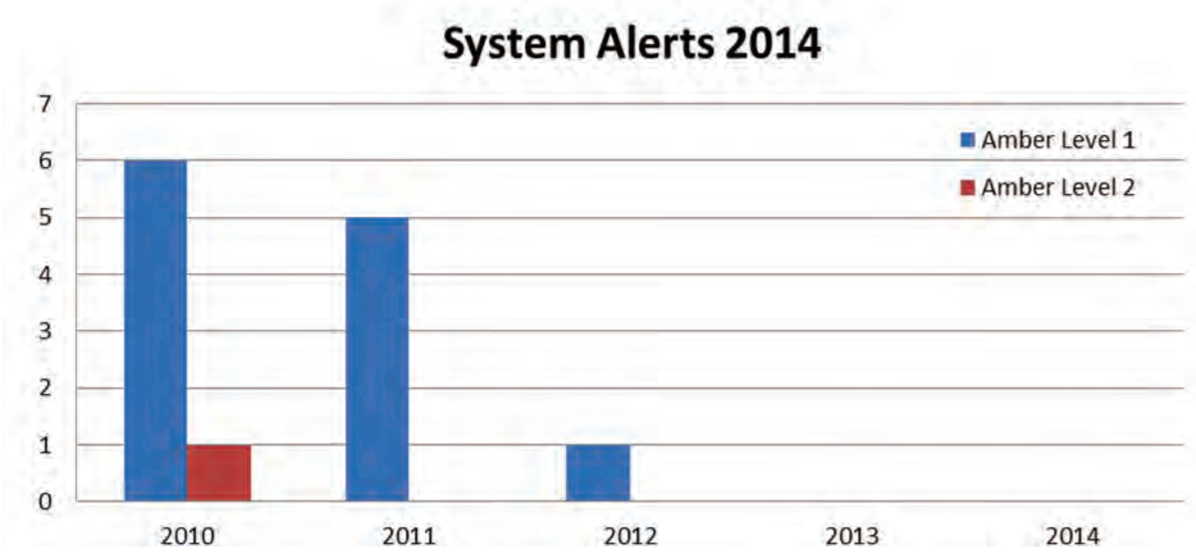


Figure 4.5.2: Number of Alerts in the National Control Centre from 2010 – 2014

4.5.3. System Frequency and Frequency Deviation

There was one Under Frequency Load Shedding (UFLS) disturbance in 2014 which resulted in shedding of Normal Tariff load customers. Short Term Active Response (STAR) interruptible load customers were disconnected during this incident and on one other occasion. Both UFLS disturbances were due to large generator trips.

Table 4.5.3.1 provides a summary of each UFLS event. The relays to disconnect Normal Tariff customer load are only activated once the system frequency drops to 48.85 Hz. The time to recover to 49.9 Hz starts from 49.3 Hz, the point at which the STAR under frequency relays are activated.

The lowest system frequency in 2014 was 48.85 Hz; during the first UFLS disturbance.

SDR No.	Date	Cause	Frequency Nadir, Hz	Minutes to Recover to 49.9 Hz	MVA Minutes	STAR SM	Normal Tariff SM
T029/2014	22/04/2014	Gen. tripped from 377 MW	48.85	7.2	2075	0.063799	0.289904
T031/2013	27/04/2014	Gen. tripped from 370 MW	49.07	5.8	62	0.010540	0

Table 4.5.3.1: Summary of UFLS disturbances in 2014

The target for activation of STAR schemes is 16 events or lower for the year. The number of STAR events each year since 2004 is presented in Figure 1. The average over this period was 2.8 ± 1.7 events per year. System Minutes lost due to activation of the STAR scheme are not attributable to EirGrid due to STAR being a pre-existing contractual arrangement with the customers.

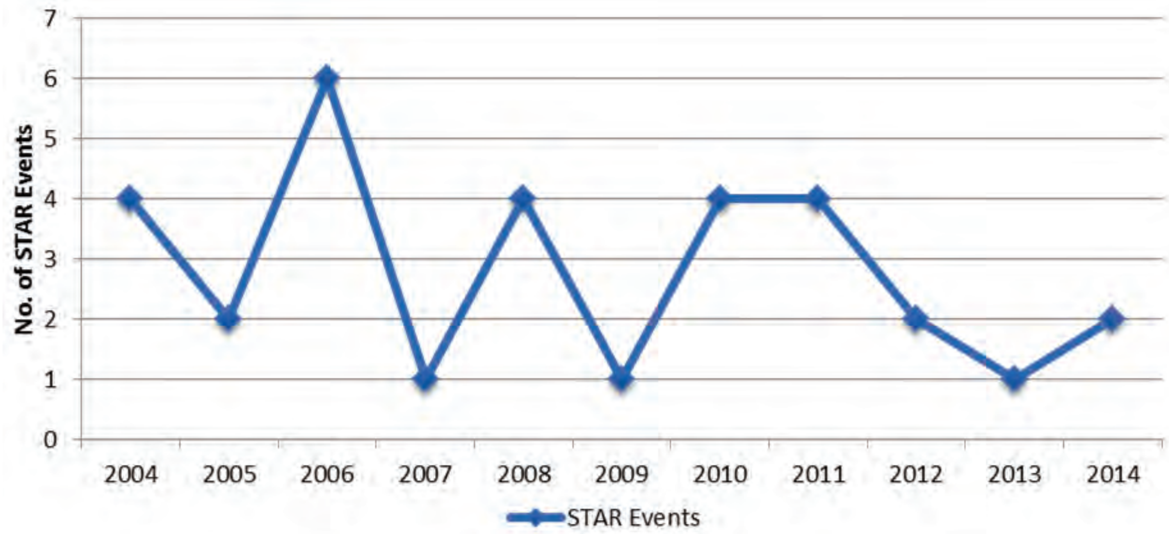


Figure 4.5.3.1: Number of STAR events 2004 – 2014

4.5.3.2 Undervoltage Load Shedding

There was no incident of Under Voltage Load Shedding (UVLS) in 2014.

4.5.4 System Minutes Lost

The international benchmark for transmission 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. When this index has a value equal or greater than one System Minute Lost, the incident is classified as 'major' using the CIRGE definition. System Minutes may be incurred due to faults on the transmission system or due to under-frequency load-shedding events. The formula for calculating System Minute is given in Appendix 3.2.

The total System Minutes lost for 2014, attributable to EirGrid, was 2.881.

The System Minutes lost as a result of faults on the Main System was 2.591 in 2014. For the UFLS disturbance on 22 April 2014, 0.290 System Minutes were lost due to the disconnection of Normal Tariff load customers. The single largest driver for System Minutes lost was Strom Darwin; between 11:36 hours and 16:21 hours on Wednesday 12 February 2014, 1.440 SM were lost to normal tariff customers. Further details on this and other contributory faults are set out in Section 4.5.6.

EirGrid has maintained downward pressure on System Minutes Lost through frequency management, developments in the area of generator performance incentivisation and monitoring and through the transmission system protection upgrade programme.

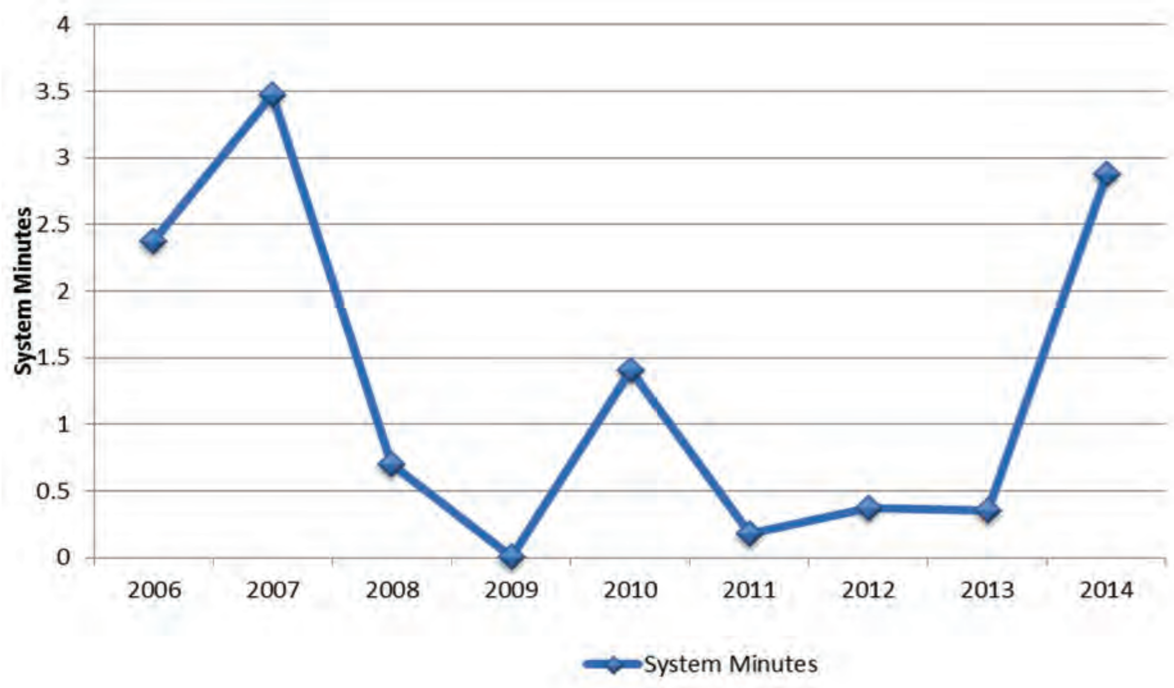


Figure 4.5.4: System Minutes attributable to EirGrid 2006 - 2014

4.5.5 Zone Clearance Ratio

The Zone Clearance Ratio (ZCR) is defined as the ratio of the number of short circuit, system faults, not cleared in Zone 1 to the total number of short circuit faults per year cleared by Main System protection. See Appendix 3.3 for further definition of Zones and ZCR.

In 2014, the ZCR was 0.114. The ZCR trend since 2004 is shown in Figure 4.5.5.

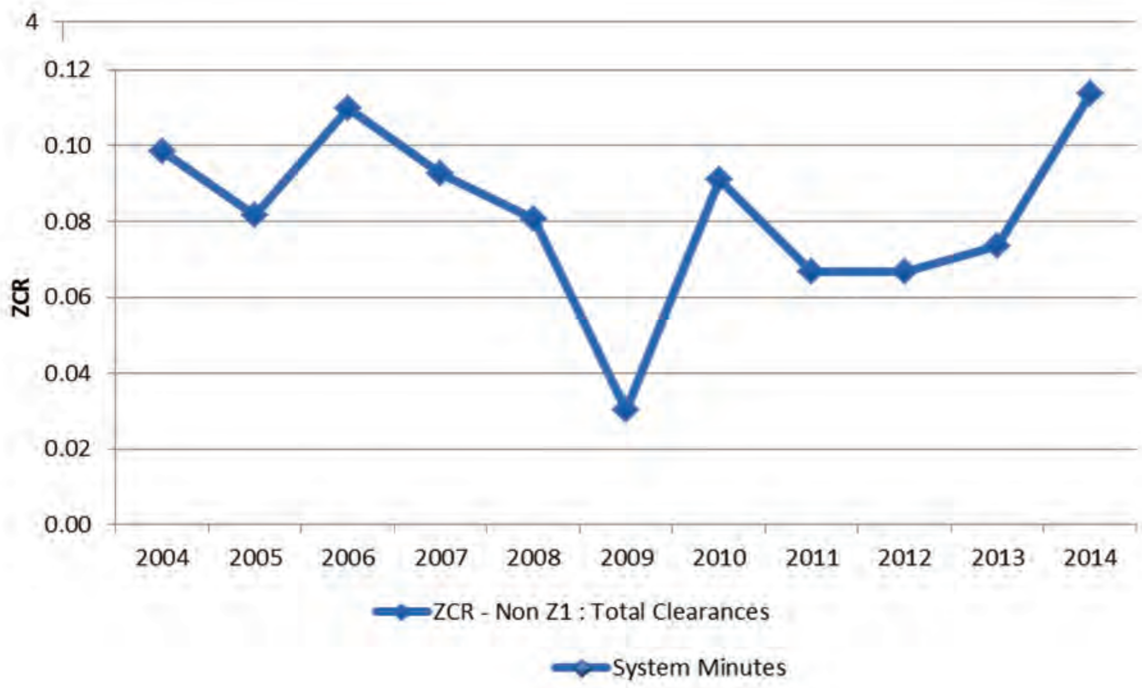


Figure 4.5.5: Zone Clearance Ratio 2004 - 2014

The number of Zone 1, non Zone 1 and Zone 2 clearances for each year are presented in Table 4.5.5. There were 123 short circuit faults cleared by protection on the Main System, an increase of 81 % year on year. This figure is made up of 119 Main System short circuits faults and four Non Main System faults.

Of the 123 short circuit faults cleared by Main System protection, 109 were cleared in Zone 1 and 14 were cleared in Zone 2.

Clearance	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Zone 1	64	45	73	49	57	32	20	28	28	63	109
Non Zone 1	7	4	9	5	5	1	2	2	2	5	14
Zone 2	7	2	6	5	2	1	2	2	2	4	14

Table 4.5.5: Number of Zone 1 and non Zone 1 clearances 2004 - 2014

12 of the 14 Zone 2 clearances occurred on four 110 kV lines during Storm Darwin on 12 February 2014. The slow clearances were all due to the failure of permissive teleprotection signals to reach the associated remote end relays to allow accelerated tripping. There were four Zone 2 clearances on the Coolroe - Kilbarry 110 kV line, three on the Knockearagh - Oughtragh - Tralee 110 kV line, one on the Carrigadrohid - Kilbarry 110 kV line and four on the Cullenagh - Dungarvan 110 kV line.

One Zone 2 clearance, for a fault on the Cushaling - Newbridge 110 kV line, was due to the failure of the Cushaling 110 kV CB in Newbridge to open, due to an issue with the CB mechanism, after receiving trip commands from its associated impedance relays. The REB500 buszone / circuit breaker fail (CBF) protection in Newbridge issued a Stage 1 CBF trip command, 120 ms after fault inception, after which the Cushaling 110 kV CB also failed to open. A Stage 2 CBF trip command was issued to the circuit breakers of all feeders on the Newbridge 110 kV busbar, 244 ms after fault inception. The fault clearance time was 313 ms.

The final Zone 2 clearance, for a fault on the Carlow - Pollaphuca - Stratford 110 kV line, was an expected operation for a fault close to the Pollaphuca end as there is no teleprotection to facilitate accelerated tripping. The fault clearance time was 420 ms.

4.5.6 Summary of Significant Disturbances

4.5.6.1 Loss of Load

T23/2014: Bellacorick and Moy

At 17:19 hours on Monday 31 March 2014, the Moy - Tawnaghmore 2 (two) 110 kV line tripped for a three phase fault. The Bellacorick 110 kV CB in Castlebar was incorrectly tripped in response to the fault on the Moy - Tawnaghmore 2 (two) 110 kV line. The Cunghill - Glenree 110 kV line was out of service, therefore supply was interrupted to Bellacorick, Moy, Tawnaghmore and Glenree which were tail fed from Castlebar. 3 MW of load was disconnected at Bellacorick for up to 32 minutes. 18.9 MW of load was disconnected at Moy for up to 110 minutes. 0.382531 System Minutes were lost to Normal Tariff customers.

T30/2014: Dallow

At 16:17 hours on Wednesday 23 April 2014, the Dallow - Portlaoise - Shannonbridge 110 kV line tripped and reclosed for a three phase fault. The cause of the fault was lightning. 15.6 MW of load fed from Dallow, which is Tee connected between Portlaoise and Shannonbridge, was disconnected for the auto-reclose deadtime of 603 ms. 0.000030 System Minutes were lost to Normal Tariff customers.

T46/2014: Newbridge

At 19:27 hours on Saturday 19 July 2014, the 110 kV busbar in Newbridge 110 kV station was stripped by its circuit breaker fail protection to clear a phase to phase fault (RS) on the Cushaling - Newbridge 110 kV line. The Cushaling 110 kV CB in Newbridge had initially failed to open due to an issue with the CB mechanism. The REB500 buszone / CBF protection in Newbridge issued a Stage 1 CBF trip command, 120 ms after fault inception, after which the Cushaling 110 kV CB also failed to open. A Stage 2 CBF trip command was issued to the circuit breakers of all feeders on the Newbridge 110 kV busbar, 244 ms after fault inception. The fault clearance time was 313 ms. 25.5 MW of load was disconnected at Newbridge for between 6 minutes and 45 minutes. 0.092133 System Minutes were lost to Normal Tariff customers.

T49/2014: Barrymore

At 16:10 hours on Thursday 24 July 2014, the Barrymore - Cahir - Knockraha 110 kV line tripped and reclosed for a three phase fault. The cause of the fault was lightning. 19.3 MW of load fed from Barrymore, which is Tee connected between Cahir and Knockraha, was disconnected for the auto-reclose deadtime of 590 ms. 0.000036 System Minutes were lost to Normal Tariff customers.

T56/2014: Stratford

At 16:12 hours on Saturday 09 August 2014, there was a three phase fault on the Carlow - Pollaphuca - Stratford 110 kV line. The Pollaphuca/Stratford 110 kV CB in Carlow tripped to clear the fault. The cause of the fault was lightning. 10.9 MW of load fed from Stratford, which is Tee connected between Carlow and Pollaphuca, was disconnected for between 37 minutes and 67 minutes. 0.108928 System Minutes were lost to Normal Tariff customers.

T62/2014: Charleville, Glenlara and Mallow
At 10:05 hours on Friday 19 September 2014, the Charleville - Killonan 110 kV line tripped for a three phase to ground fault. The cause of the fault was lightning. 42.4 MW of load was dropped from Charleville, Glenlara and Mallow 110 kV stations for between 10 and 19 minutes. The wind farms at Glenlara and Knockacummer were disconnected. The stations were tail fed from Killonan 220 kV station due to the outage of the Kilbarry - Mallow 110 kV line. 0.110531 System Minutes were lost to Normal Tariff customers.

T63/2014: Bellacorick, Carrowbeg, Castlebar and Moy At 12:16 hours on Monday 29 September 2014, the T phase pole of the T101/SVC 110 kV CB in Castlebar failed to open on command from the NCC. Several unsuccessful attempts were made to open the circuit breaker. Both CB trip coils burned out hence Castlebar 110 kV station had to be de-energised to allow the circuit breaker to be isolated and opened. 51.1 MW of load was disconnected for between 23 minutes and 51 minutes at Bellacorick, Carrowbeg, Castlebar and Moy 110 kV stations. The stations were tail fed from Castlebar due to the outage of the Cunghill - Sligo 110 kV line. 0.350216 System Minutes were lost to Normal Tariff customers.

T67/2014: Kinnegad
At 14:09 hours on Wednesday 15 October 2014, the Derryiron 110 kV CB in Kinnegad was inadvertently tripped while work was in progress for a new buszone protection scheme. Kinnegad was tail fed from Derryiron 110 kV station as the A2 110 kV busbar was on outage. The Industrial Customer load was being supplied via the A1 busbar and T101 in Kinnegad. 9.2 MW of load was disconnected for 61 minutes. 0.106424 System Minutes were lost to an Industrial Customer.

4.5.6.2 Under Frequency Load Shedding

T29/2014: Tynagh CCGT
At 17:31 hours on Tuesday 22 April 2014, Tynagh CCGT tripped from 377 MW. System frequency dropped from 49.95 Hz to 48.85 Hz at its nadir. The frequency recovered to 49.9 Hz within approximately seven minutes. The STAR scheme was activated during this incident, which resulted in the disconnection of 38.2 MW of interruptible Industrial Customer load for 8 minutes 49 seconds. 0.063799 STAR System Minutes were lost. This incident also resulted in the loss of 0.289904 System Minutes due to the temporary disconnection of Normal Tariff load customers by automatic under frequency relays.

T31/2014: Huntstown CCGT
At 21:40 hours on Sunday 27 April 2014, Huntstown HN2 CCGT tripped from 382 MW. System frequency dropped from 49.96 Hz to 49.03 Hz at its nadir. The frequency recovered to 49.9 Hz within approximately six minutes. The STAR scheme was activated during this incident, which resulted in the disconnection of 7.8 MW of interruptible Industrial Customer load for 7 minutes 8 seconds. 0.010540 STAR System Minutes were lost. The System Minutes lost during this incident relate entirely to contracted STAR customers.

4.5.6.2 Other

T12/2014: Storm Darwin

Between 11:36 hours and 16:21 hours on Wednesday 12 February 2014, there was a total of 71 faults on the 110 kV system, caused primarily by storm force winds. There were 64 short circuit faults cleared successfully from the 110 kV system; 52 Zone 1 clearances and 12 Zone 2 clearances. T141 110 kV CB in Limerick was tripped by DSO controlled protection for a fault on the Distribution System. There were six non system faults during the disturbance: T141 110 kV CB in Ennis tripped for a fault on the Drumline - Ennis 110 kV line, 100CAP2 110 kV CB in Drumline tripped for a fault on the same line on a separate occasion, and the Killoteran 110 kV CB in Waterford tripped on four occasions for faults on the Cullenagh - Dungarvan 110 kV line.

There was extensive damage to polesets of 110 kV lines. Eleven 110 kV lines, one cable and one capacitor bank were forced out of service on the day of the fault. Four 110 kV lines were subsequently forced after foot and heli patrols identified damage requiring immediate repair.

Supply was lost to seven 110 kV stations for periods of between 200 ms and 3 hours 35 minutes. The stations affected were: Ballylickey (DSO), Charleville, Dunmanway, Glenlara (DSO), Mallow, Oughtragh and Tullabrack. Loads of between 1.5 MW and 27.2 MW were disconnected on 10 occasions at the seven stations. 1.440353 System Minutes were lost to normal tariff customers.

SONI Transmission System Performance

5 SONI Transmission System Performance

This section relates to the performance of SONI TSO and the transmission system in Northern Ireland only, unless explicitly stated otherwise. This data has been prepared by SONI in accordance with the requirements of Part 11 of Condition 20 of the 'Licence to Participate in the Transmission of Electricity'.

5.1 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 for the 12 month period of this report 2014 was 97.35%. This represents a slight fall when compared with the figure in the previous report for 2013 (97.99%). Most of this decrease was due to planned outages for a wide range of project work across Northern Ireland. There was a higher winter availability of 98.67%, reflecting that planned work on circuits is minimised over the winter months.

The capacity of the Moyle interconnector continues to be an issue, having an annual availability of 41.29%. This all-time low figure was caused mainly by the ongoing cable faults the interconnector has suffered in recent years. There was also planned reconfiguration testing carried out in July and August 2015 which reduced the capacity to 0MW's for a period.

The North-South 275kV Tie Line's availability was 97.23% in 2014 which falls within the operational norms for the 275kV tie line circuit and is a slight increase of availability on previous yearly report and remains well ahead of the record low figure of 2008/09 (94.58%.) The two 110kV Tie Lines had an annual availability of 92.5%, which is low in comparison with previous years this was due to planned maintenance outages taking place in February – April and July – August 2014.

Another key measure of performance is system security, which is captured by reporting on incidents resulting in loss of supplies to customers as defined under Schedule 4 paragraph 35 of the Electricity Supply Regulations (Northern Ireland) 1991. There were no reportable interruptions of supplies to customers within 2014.
Quality of service is measured by the number of voltage and frequency excursions over the year which fall outside statutory limits. There were no voltage excursions within 2014 outside the statutory limits.

The number of frequency excursions below 49.6Hz within 2014 has fallen slightly to 13 incidents in 2014, compared to 16 incidents in 2013.

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 continued to suffer from lengthy unplanned outages.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.

5.2 System Availability

5.2.1 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[7].

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:

System Availability =	**The sum of all circuit hours actually available x 100%**
	(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 busbars are located in transmission substations; the busbars, circuits and network configuration are described in the current All-Island Ten year Transmission Forecast 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 andtaken immediately upon request or planned at less than seven days notice.

7 The Grid Code for Northern Ireland is available on SONI's website – www.soni.ltd.uk

5.2.2 Results

5.2.2.1 Annual System Availability

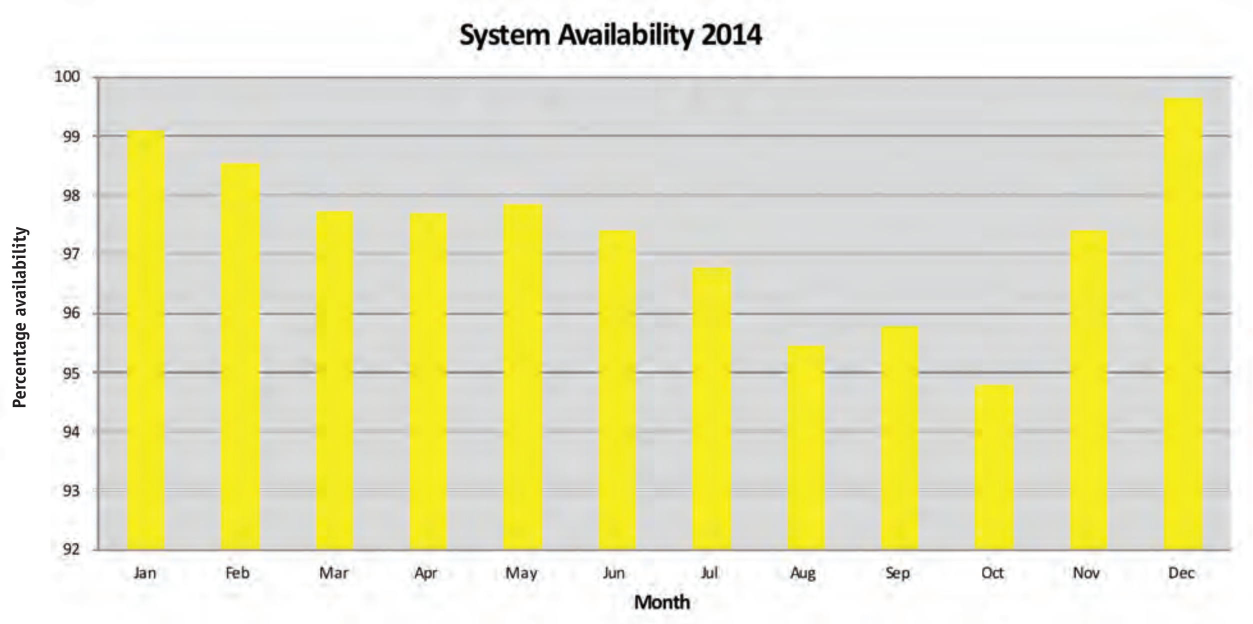
For 2014, the Average Annual Availability of the Northern Ireland Transmission System was 97.35%

5.2.2.2 Summer and winter Availability

The Winter Peak System Availability (average system availability for the winter months Jan, Feb, Nov and Dec 2014) has decreased to 98.67% from 99.12% in the 2013 report.

5.2.2.3 Monthly Variation

Figure 5.2.2.3 below shows the month by month variation in system availability in respect of the transmission network in Northern Ireland.



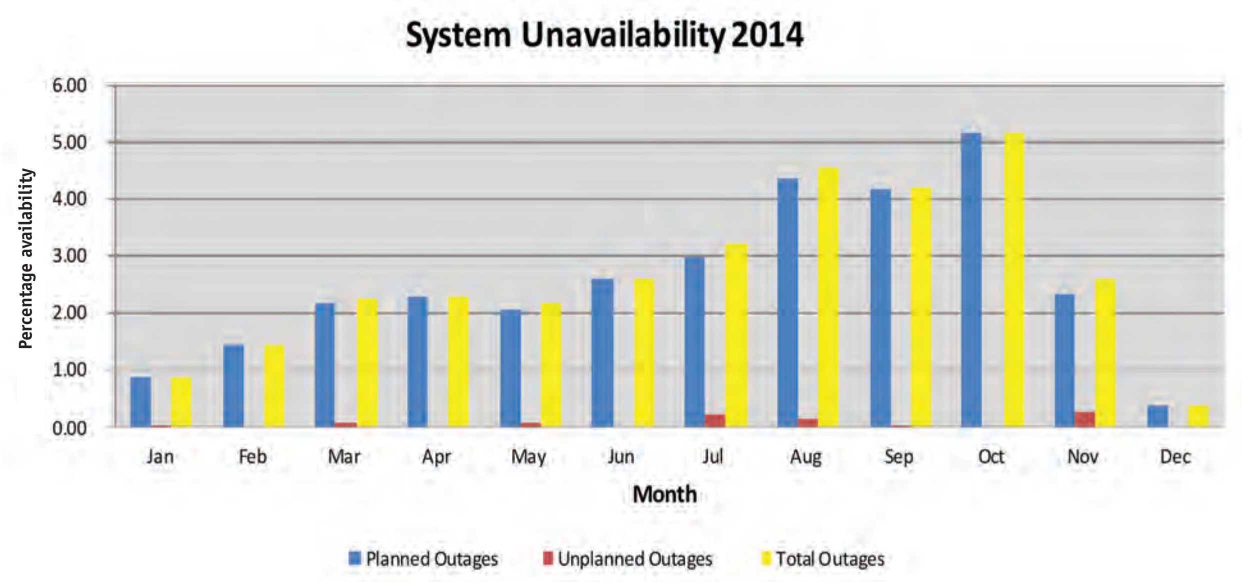
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99.10	98.53	97.73	97.69	97.84	97.40	96.79	95.46	95.79	94.82	97.40	99.63

Figure 5.2.2.3 : System Availability 2014

Overall, the availability of the system is high, particularly over the winter months, with an average of 98.67% for January, February, November and December 2014. 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.

5.2.3 System Unavailability

Figure 5.2.3 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	0.87	1.47	2.19	2.31	2.08	2.60	2.99	4.37	4.18	5.17	2.32	0.37
Unplanned	0.03	0.00	0.08	0.00	0.09	0.00	0.22	0.17	0.03	0.00	0.27	0.00
Total Unavailability	0.90	1.47	2.27	2.31	2.16	2.60	3.21	4.54	4.21	5.18	2.60	0.37

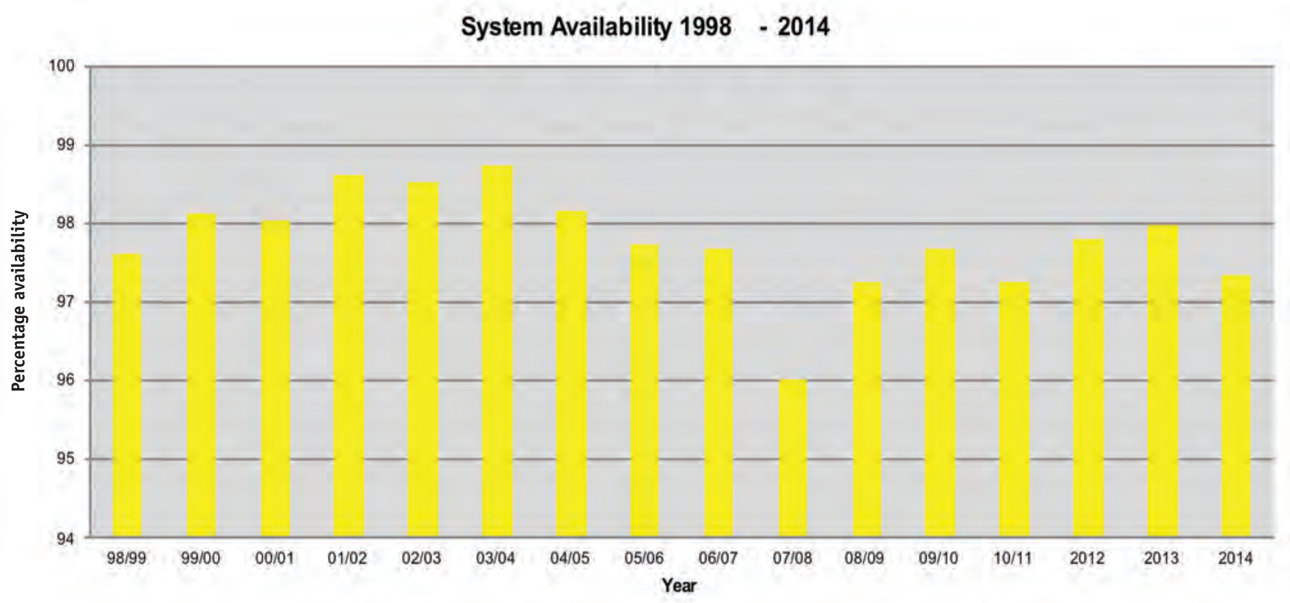
Figure 5.2.3: System Unavailability 2014

Total unavailability varied between 0.37% and 5.18% throughout the year, with the highest occurrence being in October 2014.

Figure 9.3 above shows that the majority of outages occurred during the months of May – Oct 2014. Unplanned outages shown in red remained at a low level throughout 2014.

5.2.3.1 System Historic Availability Performance

Figure 5.2.3.1 below shows the historic variation in system availability from 1998 to 2014 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	2013	2014
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	97.99	97.35

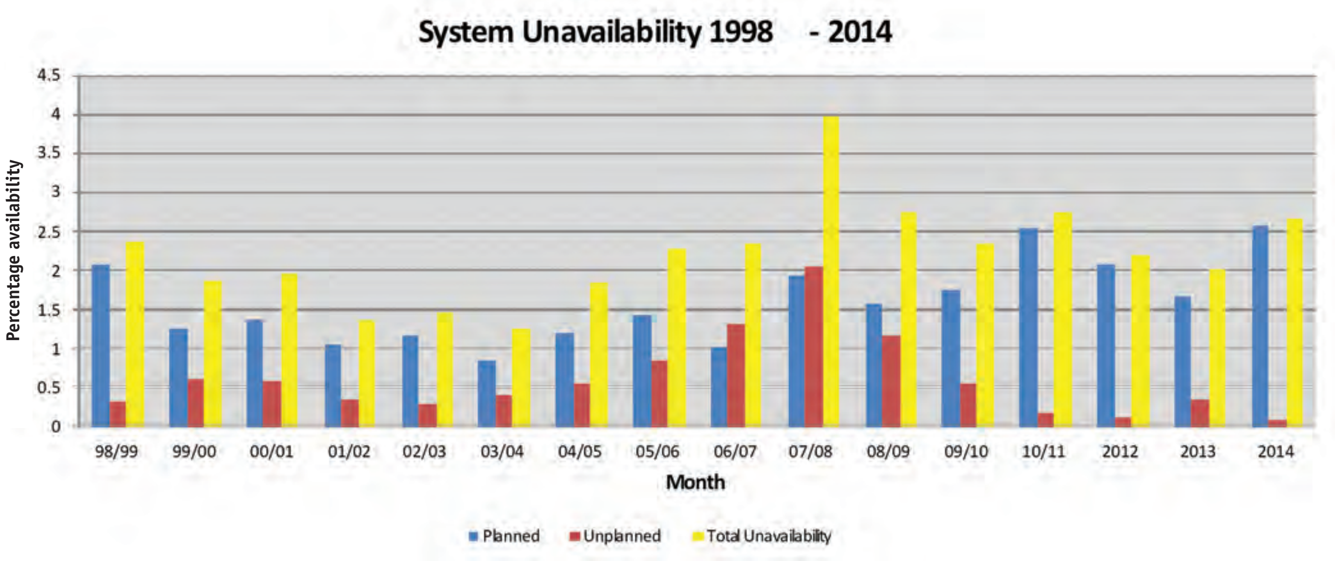
Figure 5.2.3.1: Historic System Availability 1998 – 2014

The Transmission System Performance report up until 2012 aligned to cover the financial year rather than a calendar year. From 2012 onwards SONI have aligned with the calendar year (Jan-Dec) to a line with EirGrid TSO to produce an all Island report. This we believe makes 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 2014 (97.35) shows a slight decrease on the previous year. This is not surprising as there has been an increase in project work in 2014 which has included Busbar replacement projects at Castlereagh, Tandragee and Kells substation.

5.2.3.2 System Historic Unavailability Performance

Figure 5.2.3.2 below shows the breakdown of the system unavailability from 1997/98 to 2014.



	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	2013	2014
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	1.67	2.58
Unplanned	0.31	0.6	0.58	0.34	0.3	0.41	0.56	0.85	1.32	2.05	1.17	0.56	0.18	0.12	0.34	0.08
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	2.01	2.65

Figure 5.2.3.1: Historic System Availability 1998 – 2014

The annual system unavailability figure for 2014 shows a slight increase when compared to the 2013 figure which is due to the large amount of project work at a number of major transmission substation across Northern Ireland. Unplanned outages continue to remain at historically low levels.

5.3 Moyle Interconnector and Tie-Line Availability

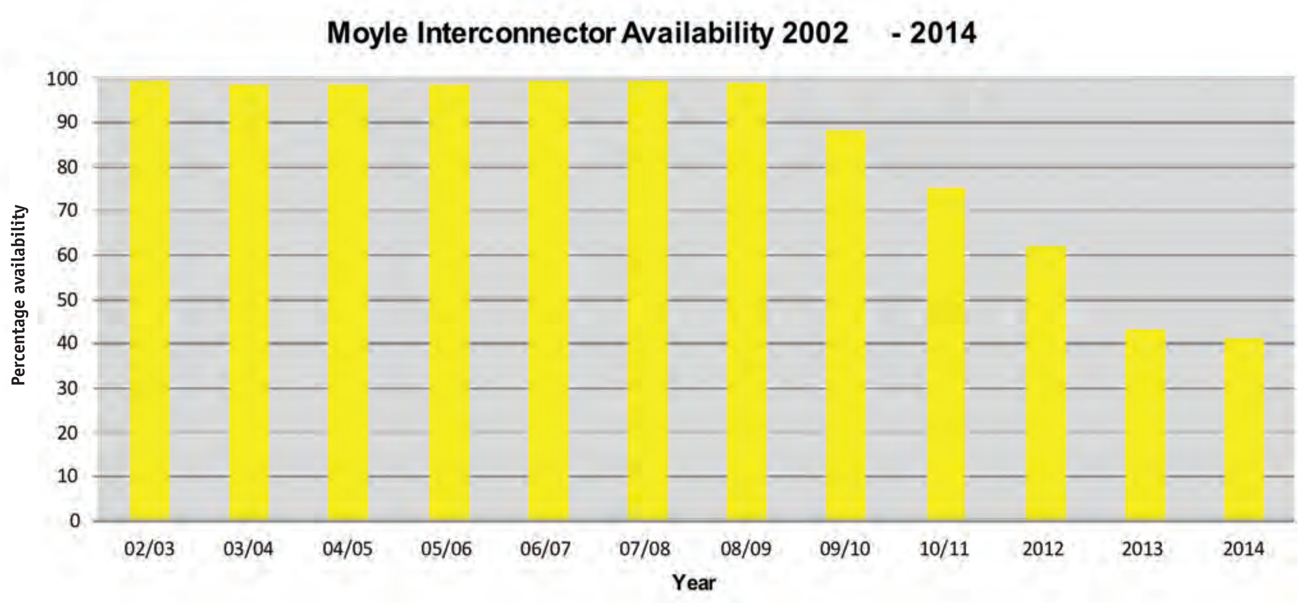
5.3.1 Northern Ireland Interconnection with GB

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.

5.3.1.1 Moyle Interconnector Historic Availability

The Annual Availability of the Moyle Interconnector for 2014 was 41.29%

Figure 5.3.1.1: The steep drop of in availability from 2011 onward has been mainly due to the ongoing cable sheath faults.



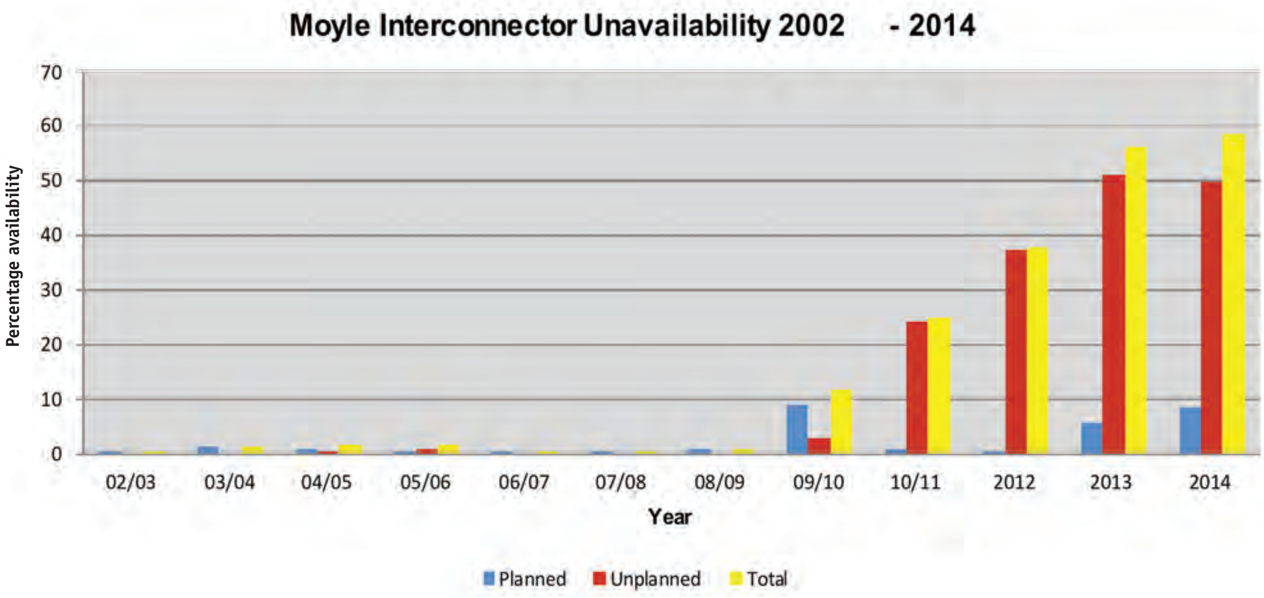
02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
99.40	98.77	98.43	98.34	99.35	99.46	99.09	88.18	75.16	62.02	43.50	41.29

Figure 5.3.1.1: Historic Moyle Interconnector Availability 2002/03 – 2014

The Moyle Interconnector Annual Availability of 41.29% for 2014 is a historic low. The ongoing cable sheath problems have reduced the interconnector's availability by half. Other outages which reduced the interconnector availability further in 2014 are detailed in Appendix 4 of this report.

5.3.1.2 Moyle Interconnector Historic Unavailability

The 2014 Annual Unavailability of the Moyle Interconnector was 58.71%. Figure 5.3.1.2 below shows the historic annual variation in the Moyle Interconnector unavailability from 2002 to 2014.



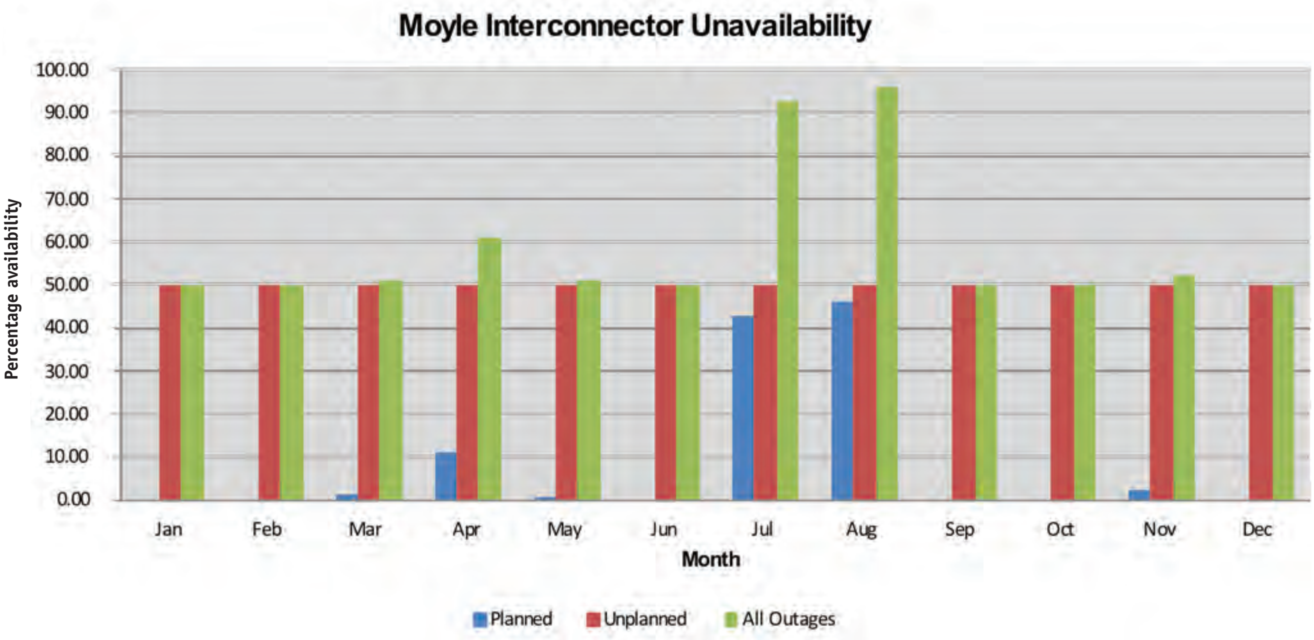
	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
Planned	0.47	1.16	1.00	0.65	0.60	0.50	0.74	8.80	0.67	0.35	5.55	8.70
Unplanned	0.13	0.07	0.57	1.02	0.05	0.05	0.17	3.01	24.17	37.63	50.95	50.01
Total	0.60	1.23	1.57	1.66	0.65	0.54	0.91	11.82	24.84	37.98	56.50	58.71

Figure 5.3.1.2: Historic Moyle Interconnector Unvailability 2002 – 2014

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 Unavailability in recent years, caused almost entirely by the ongoing cable faults. Unavailability of the interconnector has risen slightly between 2013 and 2014; this was due to an increase in the planned outages shown in blue within the above graph.

5.3.1.3 Moyle Interconnector Monthly Unavailability

Figure 5.3.1.3 below shows the month by month variation of unavailability of the interconnector. The graph indicates the breakdown between planned and unplanned outages for each month of 2014.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planned	0.00	0.00	1.14	11.04	0.78	0.00	43.01	46.15	0.00	0.00	2.30	0.00
Unplanned	50.00	50.00	50.00	50.00	50.16	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total	50.00	50.00	51.14	61.04	50.94	50.00	93.01	96.14	50.00	50.00	52.30	50.00

Figure 5.3.1.3: Moyle Interconnector Unavailability 2014

The increase in unavailability in the months of July and August 2014 was due to planned outages for reconfiguration testing of the interconnector. The reconfiguration testing was carried out to ensure the interconnector is capable of continuing to provide 50 per cent capacity even in the event of additional cable faults on the low voltage conductor.

5.3.2. Tie-Line with ROI

5.3.2.1 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.

5.3.2.2 110kV Tie Lines

110kV connections with RoI are as follows:

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

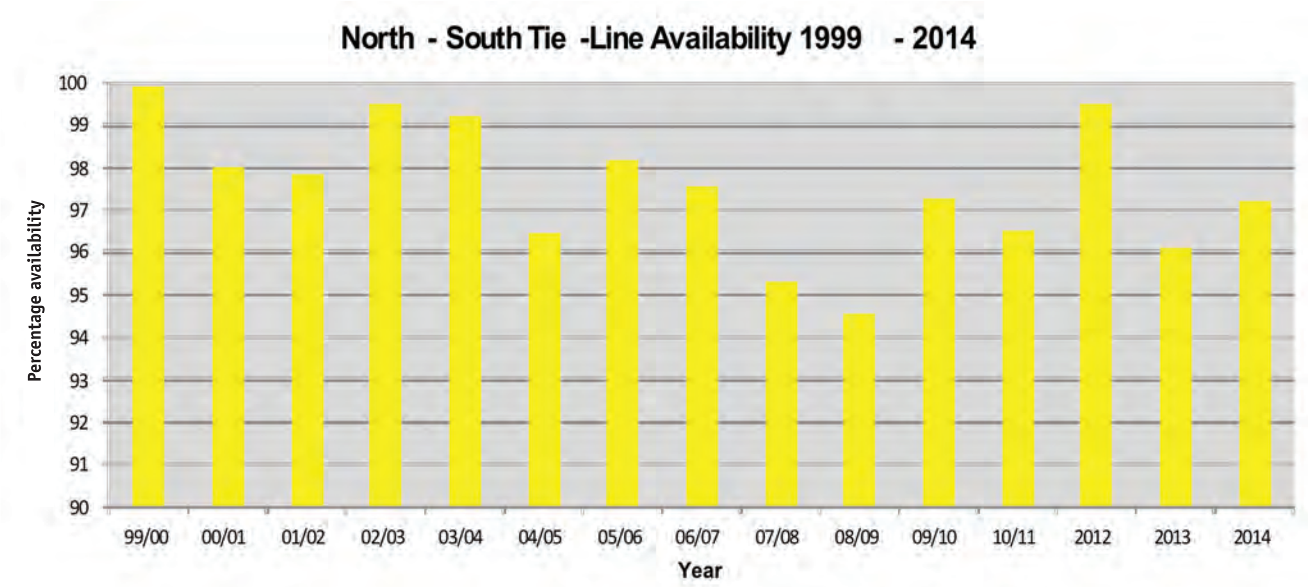
Until 2001, both circuits operated in a standby mode, but were then converted into permanent connections by the deployment of power flow controllers, rated at 125MW. The power flow controllers are normally adjusted to maintain a 0MW transfer, but can be set to any desired value to support either system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

5.3.2.3 275kV North-South Tie Line Annual Availability

The annual availability of the 275kV North-South Tie Line was 97.23%. Figure 5.3.2.3 below shows the annual variation in the availability of the Tie Line from 1999 to 2014.



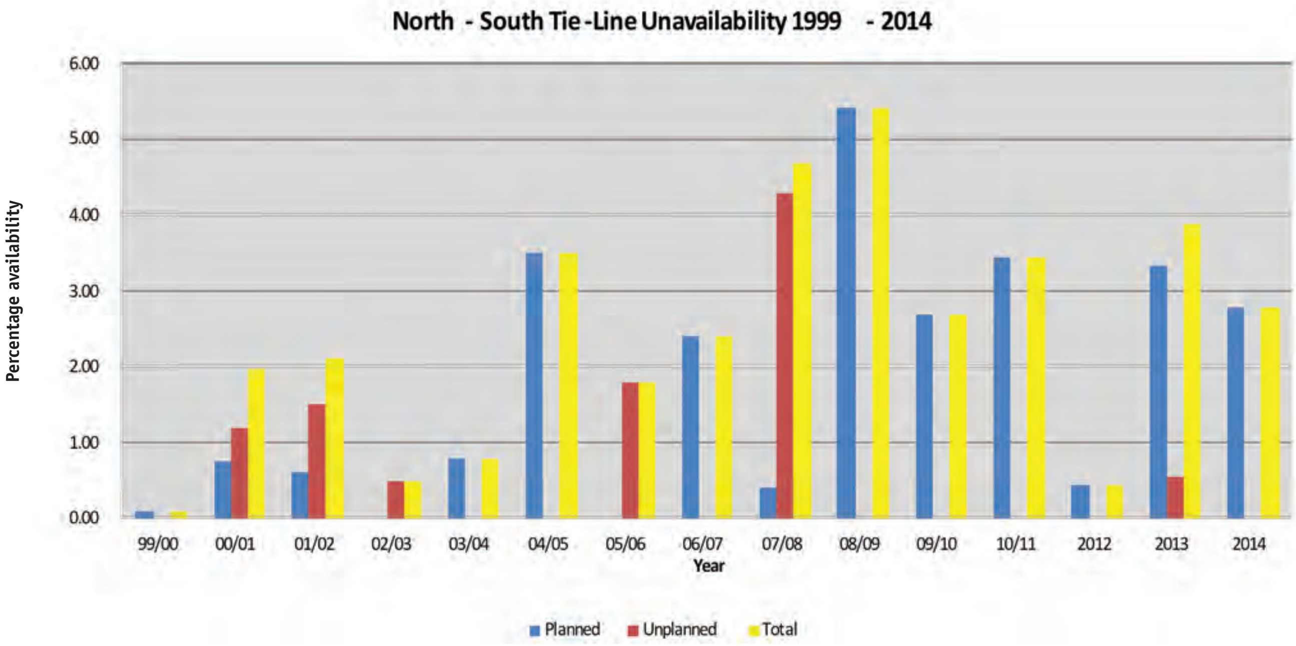
	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
Availability	99.91	98.04	97.87	99.51	99.22	96.49	98.21	97.60	95.31	94.58	97.31	96.54	99.55	96.11	97.23

Figure 5.3.2.3 : Historic North-South Tie Line Availability 1999 – 2014

The 2014 availability figure of 97.23% is an increase on last year's reporting period figure of 96.11% and falls within the operational norms for these two tie line circuits.

5.3.2.4 275kV North-South Tie Line Annual Unavailability

Figure 5.3.2.4 below shows how the total unavailability for the years 1999 to 2014 is split between planned and unplanned outages.



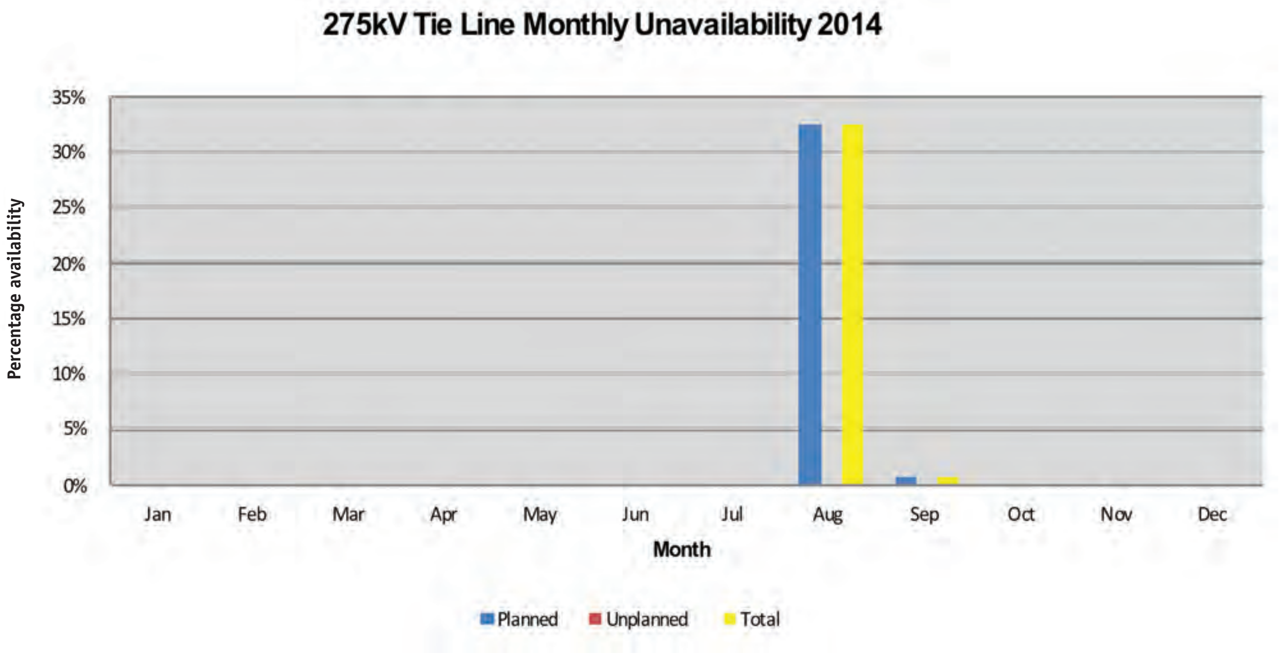
	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
Planned	0.09	0.77	0.62	0.00	0.78	3.51	0.00	2.40	0.41	5.42	2.69	3.45	0.45	3.34	2.77
Unplanned	0.00	1.18	1.51	0.49	0.00	0.00	1.79	0.00	4.28	0.00	0.00	0.01	0.00	0.56	0.00
Total	0.09	1.96	2.13	0.49	0.78	3.51	1.79	2.40	4.69	5.42	2.69	3.46	0.45	3.89	2.77

Figure 5.3.2.4: Historic North-South Tie Line Unavailability 1999 – 2014

The level of unavailability for the North – South tie line for 2014 was 2.77%, which is made up entirely by planned outages on both circuits within August – September.

5.3.2.5 275kV North-South Tie Line Monthly Unavailability

Figure 5.3.2.5 below shows the month by month variation of unavailability of the North-South Tie Line.



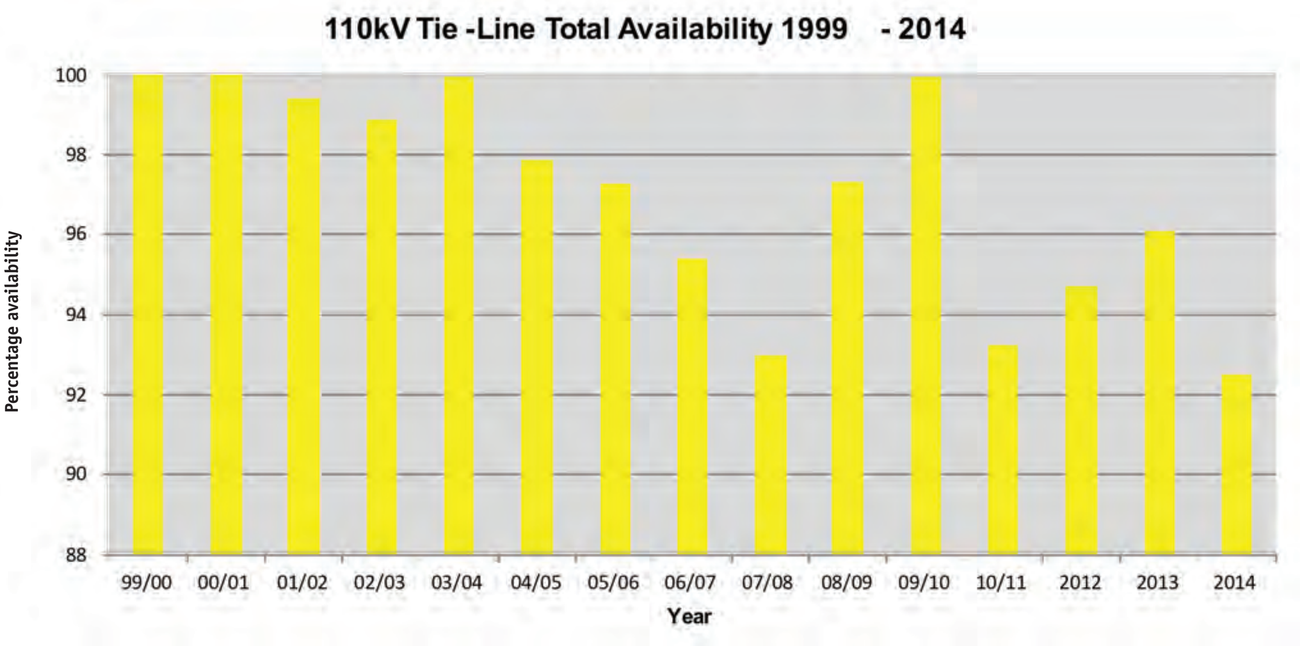
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planned	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.59	0.69	0.00	0.00	0.00
Unplanned	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.59	0.69	0.00	0.00	0.00

Figure 5.3.2.5: North-South Tie Line Monthly Unavailability 2014

Figure 5.3.2.5 highlights the total percentage unavailability on the 275kV Tie Line for the period January – December 2014 was entirely due to planned outages carried out in August – September.

5.3.2.6 110kV Tie Lines Annual Availability

The availability of the 110kV Tie Lines was 92.5% for the period January - December 2014. Figure 5.3.2.6 below shows the annual variation in the availability of the Tie Lines from 1999/00 to 2013.



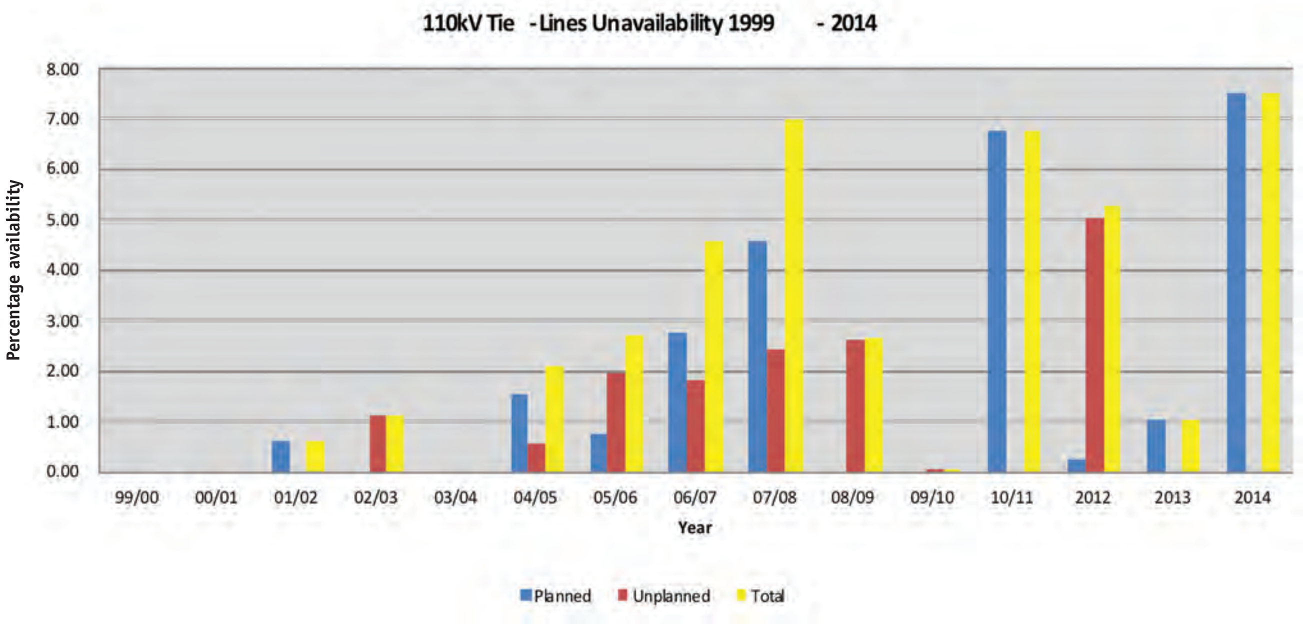
	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
Availability	100	100	99.39	98.88	99.97	97.87	97.27	95.41	93.01	97.35	99.94	93.24	94.72	98.97	92.50

Figure 5.3.2.6: Historic 110kV Tie Line Availability 1999 – 2014

The figures for 2014 show a decrease in 110kV tie-line availability to 92.5% on the previous reporting period. The 2014 figure is the lowest on record and is due to planned outages during February, March, April, July and August for line maintenance work.

5.3.2.7 275kV North-South Tie Line Annual Unavailability

The unavailability of the 110kV Tie Lines was 7.5% for the period January to December 2014. Figure 5.3.2.7 below shows the annual variation in the unavailability of the Tie Lines from 1999–2014 broken down into planned and unplanned outages.



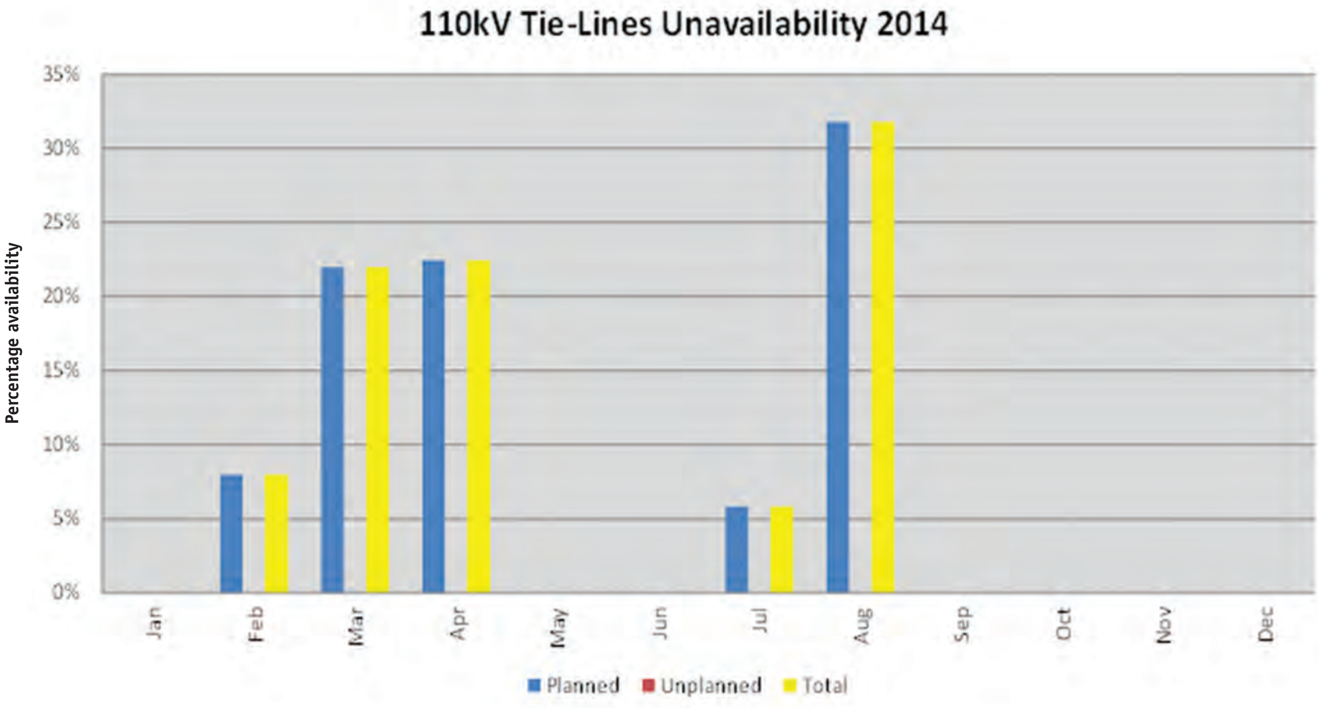
	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	2012	2013	2014
Planned	0.00	0.00	0.61	0.00	0.00	1.54	0.77	2.76	4.56	0.02	0.00	6.76	0.23	1.03	7.50
Unplanned	0.00	0.00	0.00	1.12	0.03	0.59	1.96	1.83	2.43	2.63	0.06	0.00	5.05	0.00	0.00
Total	0.00	0.00	0.61	1.12	0.03	2.13	2.73	4.59	6.99	2.65	0.06	6.76	5.27	1.03	7.50

Figure 5.3.2.7: Historic 110kV Tie Line Unavailability 1999 – 2014

As can be seen in figure 5.3.2.7 above the total unavailability figure for the 110kV tie-lines was 7.5%. All outages in 2014 were planned outages.

5.3.2.8 110kV Tie Lines Monthly Unavailability

Figure 5.3.2.8 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	7.97	21.98	22.43	0.00	0.00	5.85	31.79	0.00	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	7.97	21.98	22.43	0.00	0.00	5.85	31.79	0.00	0.00	0.00	0.00

Figure 5.3.2.8: 110kV Tie Line Unavailability 2014

Figure 5.3.2.8 above shows the extent of outages on the 110kV Tie Lines during January to December 2014. There were no unplanned outages on these circuits within 2014.

5.4 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.

5.4.1 Number of Incidents and Estimated Unsupplied Energy

Within the Northern Ireland system there were no reportable events that resulted in a loss of supply. Therefore there was no reportable unsupplied energy from the Northern Ireland system during 2014.

5.4.2 Incidents for 2014

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.

5.4.2.1 Incident Analysis

Figure 5.4.2.1 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.

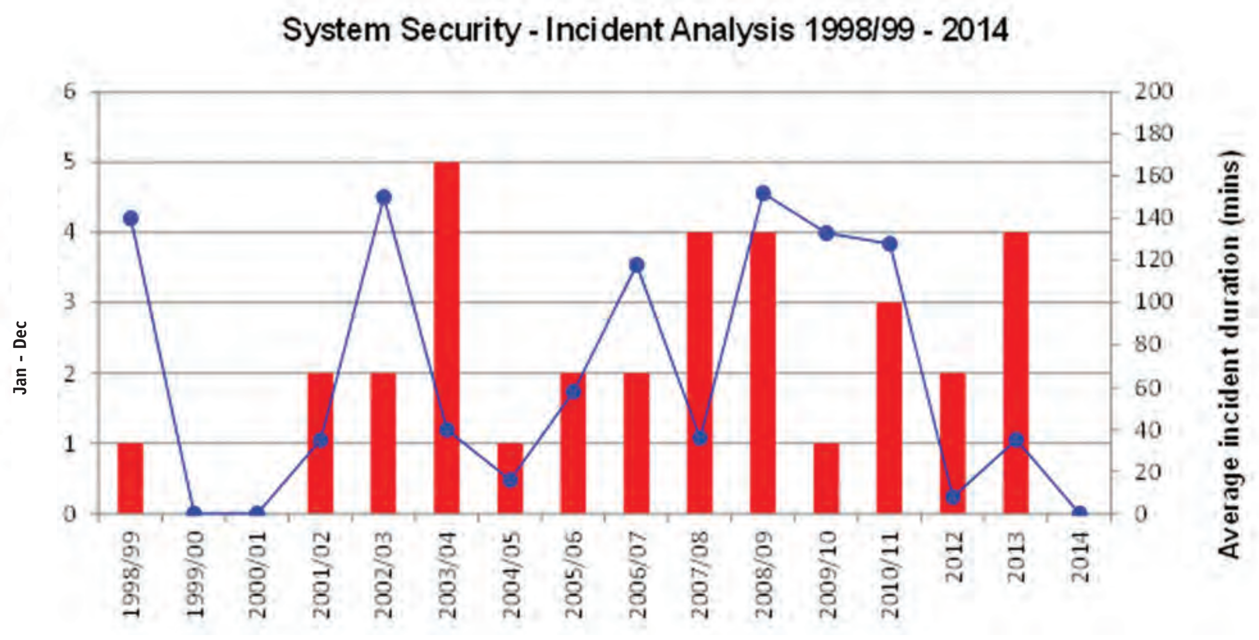


Figure 5.4.2.1: Historic System Security 1998 – 2014

As seen in Figure 5.4.2.1 above, there were no reportable incidents within 2014. This is the first year since 2001 to have no reportable incidents as defined under schedule 4 paragraph 35 of the Electricity Supply Regulations (Northern Ireland) 1991.

5.4.2.2 Unsupplied Energy

Figure 5.4.2.2 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.

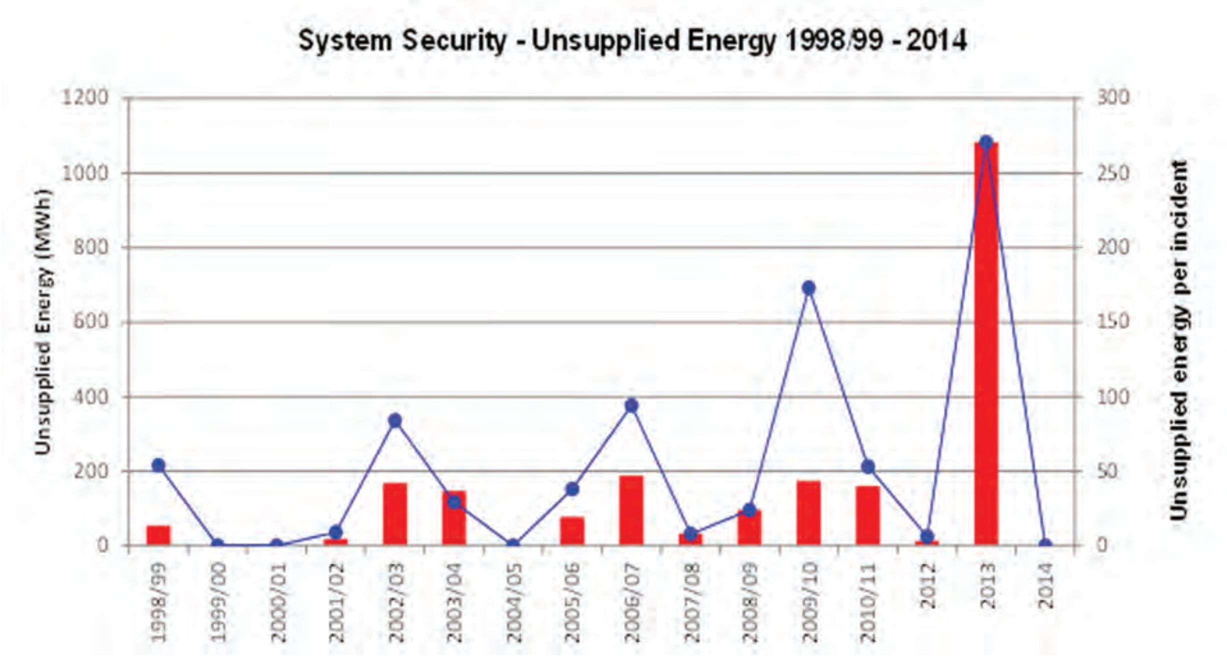


Figure 5.4.2.2: Historic Unsupplied Energy 1998 – 2014

There were no reportable incidents of unsupplied energy in 2014. The large spike in unsupplied energy in 2013 was entirely due to the extreme weather conditions suffered by the transmission network during the ice storm in March 2013.

5.5 Quality of Service

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

5.5.1 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.

5.5.2 Voltage Excursions

During 2014, there were no voltage excursions exceeding these limits.

5.5.3 Frequency

One of the primary responsibilities of SONI as system operator for Northern Ireland is to manage the system frequency in real time in accordance with the Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012[8]. The Electricity Safety, Quality and Continuity Regulations, Article 28(3)(a), permits variations not exceeding 50 ± 0.5 Hz, which is consistent with the normal operating range as defined in the SONI Grid Code section CC5.3.

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 5.5.4 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 5 of this report.

8 http://www.legislation.gov.uk/nisr/2012/381/contents/made. These regulations replaced the Electricity Supply Regulation (N.I.) 1991

5.4.4 Frequency Excursions

In accordance with SONI's decision to report on any frequency excursion in excess of 49.6 Hz, there were 13 reportable frequency excursions during 2014. Table 4.5.4 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		
MONEYPOINT 3	22/01/14	285	49.86	49.475	49.623	-0.25	-0.12	3.1	2431	843	3274	814	104	918	-5	-25
EWIC	20/02/14	500	49.99	49.338	49.373	-0.48	-0.26	7.6	3263	1116	4379	896	326	1223	-19	129
MONEYPOINT 3	21/03/14	285	49.91	49.596	49.576	-0.33	-0.21	0.3	2458	809	3267	937	269	1206	-69	-88
HUNTSTOWN 2	27/04/14	400	49.95	49.040	49.030	-0.51	-0.33	29.7	2750	945	3695	121	50	171	125	235
AGHADA 2	22/05/14	432	50.04	49.599	49.707	-0.33	-0.22	0.4	3243	1111	4354	557	75	631	0	192
MONEYPOINT 2	03/06/14	285	49.90	49.562	49.690	-0.15	-0.13	2	1836	626	2462	260	66	326	-35	-51
MONEYPOINT 2	22/06/14	285	49.94	49.538	49.574	-0.27	-0.22	4.4	2704	894	3598	76	22	99	-168	108
DUBLIN BAY	07/07/14	403	49.99	49.491	49.536	-0.35	-0.26	19.2	3203	1090	4293	58	25	83	-49	1
EWIC	04/09/14	500	49.97	49.347	49.342	-0.61	-0.26	9.6	3374	1101	4474	43	32	75	-13	246
GREAT ISLAND 4	27/09/14	431	50.02	49.447	49.555	-0.59	-0.31	4.6	2880	932	3812	404	210	614	199	246
GREAT ISLAND 4	02/10/14	431	50.02	49.596	49.702	-0.24	-0.19	0.4	3362	1216	4578	1161	408	1569	-77	173
GREAT ISLAND 4	21/10/14	431	50.15	49.391	49.439	-0.47	-0.36	6.3	3835	1345	5180	1130	321	1451	81	218
AGHADA UNIT 2	03/12/14	432	49.99	49.598	49.824	-0.13	-0.11	0.4	4516	1619	6135	29	20	49	22	247

Table 5.5.4: Frequency Excursions in NI in 2014

- **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 - 60 seconds 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)

5.5.5 Annual Frequency Excursions

Figure 5.5.5 below shows the number of frequency excursions from 1998 to 2014. The significant increase to 20 incidents in 2009/10 was due the decision to change the criteria for reporting frequency excursions to incidents less than 49.6 Hz. To compare against previous years criteria of only including frequency excursions below 49.5Hz, there would have been 7 incidents in the 2014 shown in red below.

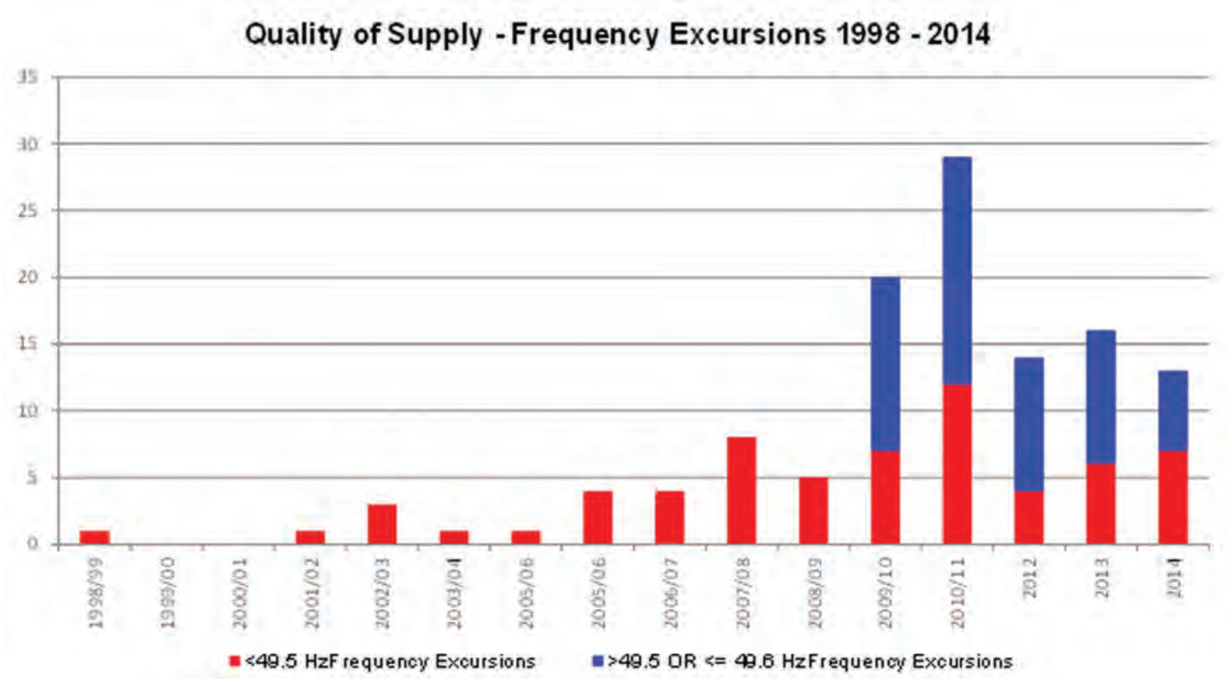


Figure 5.5.5: Historic Frequency Excursions 1998 – 2014

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 trends towards a smaller number of larger units, there is an increased possibility frequency excursions will occur.

During 2014 there were no frequency excursion incidents where the Electricity Supply Regulations (Northern Ireland) 1991 statutory limit of 2.5% was exceeded.

APPENDIX 1 – ALL-ISLAND FULLY DISPATCHABLE GENERATION PLANT

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
Activation Energy	AEDSU - AE1	84.693	Demand Side Unit	59.96
	AEDSU - AE2	4.952	Demand Side Unit	43.71
	AEDSU - AE3	13.969	Demand Side Unit	96.38
Aughinish Alumina Ltd	Seal Rock SK3	85	Gas / Distillate Oil	85.45
	Seal Rock -SK4	85	Gas / Distillate Oil	85.30
Bord Gáis	Whitegate - WG1	444	Gas / Distillate Oil	70.96
Dalkia Alternative Energy Ltd	DAE VPP - DP1	27	Demand Side Unit	32.98
Endeco Technologies Ltd	Endeco - EC1	4.5	Demand Side Unit	58.31
ESBPG	Aghada - AD1	258	Gas / Distillate Oil	90.67
	Aghada - AD2	431	Gas / Distillate Oil	72.03
	Aghada - AT11	90	Gas / Distillate Oil	98.55
	Aghada - AT12	90	Gas / Distillate Oil	97.27
	Aghada - AT14	90	Gas / Distillate Oil	94.52
	Ardnacrusha - AA1	21	Hydro	51.98
	Ardnacrusha - AA2	22	Hydro	66.29
	Ardnacrusha - AA3	19	Hydro	22.18
	Ardnacrusha - AA4	24	Hydro	55.20
	Erne - ER1	10	Hydro	69.55
	Erne - ER2	10	Hydro	7.16
	Erne - ER3	22	Hydro	88.46
	Erne - ER4	22	Hydro	73.34
	Lee - LE1	15	Hydro	90.93
	Lee - LE2	4	Hydro	94.06
	Lee - LE3	8	Hydro	93.62
	Liffey - LI1	15	Hydro	96.06
	Liffey - LI2	15	Hydro	98.49
	Liffey - LI4	4	Hydro	98.88
	Liffey - LI5	4	Hydro	96.73
	Lough Ree - LR4	91	Peat	87.25
	Marina - MRC	95	Gas / Distillate Oil	59.15
	Moneypoint - MP1	285	Coal / Heavy Fuel Oil	57.85
	Moneypoint - MP2	285	Coal / Heavy Fuel Oil	65.33
	Moneypoint - MP3	285	Coal / Heavy Fuel Oil	86.92
	North Wall - NW5	104	Gas / Distillate Oil	91.98
	North Wall - NWC	154	Gas / Distillate Oil	0.00
	Poolbeg - PB4	154	Gas / Distillate Oil	96.79
	Poolbeg - PB5	154	Gas / Distillate Oil	96.45
	Poolbeg - PB6	182	Gas / Distillate Oil	92.63
	Turlough Hill - TH1	73	Hydro - Pumped Storage	87.62
	Turlough Hill - TH2	73	Hydro - Pumped Storage	88.42

	Turlough Hill - TH3	73	Hydro - Pumped Storage	88.60
	Turlough Hill - TH4	73	Hydro - Pumped Storage	89.26
Company	**Unit**	**Capacity (MW)**	**Fuel**	**365-day Rolling Availability %**
Edenderry Power Ltd	Edenderry - ED1	118	Peat	89.08
	Edenderry - ED3	58	Gas / Distillate Oil	99.90
	Edenderry - ED5	58	Gas / Distillate Oil	99.88
Electricity Exchange Ltd	Electric Ireland - EI1	17.81	Demand Side Unit	44.94
SSE Generation	Great Island - GI1	54	Heavy Fuel Oil	95.47
	Great Island - GI2	54	Heavy Fuel Oil	86.64
	Great Island - GI3	109	Heavy Fuel Oil	93.65
	Rhode - RP1	52	Distillate Oil	99.18
	Rhode - RP2	52	Distillate Oil	99.81
	Tarbert - TB1	54	Heavy Fuel Oil	96.05
	Tarbert - TB2	54	Heavy Fuel Oil	95.59
	Tarbert - TB3	241	Heavy Fuel Oil	97.18
	Tarbert - TB4	243	Heavy Fuel Oil	73.75
	Tawnaghmore - TP1	52	Distillate Oil	96.03
	Tawnaghmore - TP3	52	Distillate Oil	98.71
Indaver	Indaver - IW1	17	Waste	89.73
Synergen	Dublin Bay - DB1	405	Gas / Distillate Oil	94.12
Tynagh Energy Ltd	Tynagh - TYC	384	Gas / Distillate Oil	94.98
Viridian Power and Energy	Huntstown - HN2	400	Gas / Distillate Oil	94.12
	Huntstown - HNC	342	Gas / Distillate Oil	96.33
AES	Ballylumford - B10	94	Gas / Distillate Oil	87.73
	Ballylumford - B21	249	Gas / Distillate Oil	82.75
	Ballylumford - B22	249	Gas / Distillate Oil	83.13
	Ballylumford - BGT1	58	Gas / Distillate Oil	83.02
	Ballylumford - BGT2	58	Gas / Distillate Oil	96.15
	Ballylumford - BPS4	170	Gas / Distillate Oil	92.27
	Ballylumford - BPS5	170	Gas / Distillate Oil	83.49
	Ballylumford - BPS6	170	Gas / Distillate Oil	97.99
	Kilroot - KGT1	29	Gas / Distillate Oil	94.61
	Kilroot - KGT2	29	Gas / Distillate Oil	89.75
	Kilroot - KGT3	42	Gas / Distillate Oil	98.81
	Kilroot - KGT4	42	Gas / Distillate Oil	99.65
	Kilroot - KPS1	238	Coal / Heavy Fuel Oil	91.3
	Kilroot - KPS2	238	Coal / Heavy Fuel Oil	66.42
Contour Global	Contour Global - CG3	3	Gas / Distillate Oil	99.99
	Contour Global - CG4	3	Gas / Distillate Oil	99.83
	Contour Global - CG5	3	Gas / Distillate Oil	99.65
Coolkeeragh ESB	Coolkeeragh - C30	408	Gas / Distillate Oil	77.85
	Coolkeeragh - CG8	53	Gas / Distillate Oil	97.78
Empower	EmpowerAGU - EMP	3	Distillate	100
iPower	iPower AGU	74	Distillate	99.86

Total		9,351 MW		82.82 %

APPENDIX 2 – SIGNIFICANT EIRGRID TSO CAPITAL PROJECTS COMPLETED IN 2014

2014 Transmission System Performance Report - Appendix 2 - Significant Capital Projects

CP No.	CP.No	Project Type
CP0265	Cullenagh - Great Island 220kV Line Refurbishment and Uprate	Circuit Uprates and Refurbishments
CP0691	Louth - Woodland 220kV Line Refurbishment	Circuit Uprates and Refurbishments
CP0698	Prospect - Tarbert 220kV Line Uprate	Circuit Uprates and Refurbishments
CP0745	Cathaleen's Fall - Srananagh No. 2 110kV Line Uprate	Circuit Uprates and Refurbishments
CP0746	Moneypoint - Prospect 220kV Line Refurbishment	Circuit Uprates and Refurbishments
CP0748	Cashla - Prospect 220kV Line Resagging	Circuit Uprates and Refurbishments
CP0783	Kilbarry - Knockraha 110kV No. 1 Line Uprate	Circuit Uprates and Refurbishments
CP0791	Cunghill - Glenree 110kV Line Uprate	Circuit Uprates and Refurbishments
CP0811	Cahir - Thurles 110kV Line Uprate	Circuit Uprates and Refurbishments
CP0728	Kill Hill Wind Farm - 110kV Shallow Connection	Connections for Generators
CP0761	Bruckana Wind Farm - 110kV Shallow Connection	Connections for Generators
CP0421	Binbane - Letterkenny 110kV Line - New Line	New Circuit
CP0228	Marina 110kV Station Replacement	Station Uprates and Refurbishments
CP0682	Woodland 400kV Station - 3rd 400/220 500MVA Transformer	Station Uprates and Refurbishments
CP0708	Navan 110kV Station Refurbishment	Station Uprates and Refurbishments
CP0772	Sligo 110kV Station Busbar Uprate	Station Uprates and Refurbishments

APPENDIX 3 – Definitions & Formulae (ROI Transmission System)

Appendix 3.1 – Availability & Unavailability Formula

The availability of 110kV, 220 kV, 275 kV and 400 kV lines is calculated using Equation 4-1:

$$\text{System Availability} = 1 - \frac{\sum_{i=1}^{i=n} \text{Duration of Outage (i)} * \text{Length of Line (i)}}{\sum_{j=1}^{j=m} \text{Length of Line (j)} * \text{Days in a Year}}$$

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:

$$\text{System Availability} = 1 - \frac{\sum_{i=1}^{i=n} \text{Duration of Outage (i)} * \text{MVA of Transformer (i)}}{\sum_{j=1}^{j=m} \text{MVA of Transformer (j)} * \text{Days in a Year}}$$

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.

$$\text{System Unavailability} = 1 - \frac{\sum \text{Hours each Circuit is Available}}{\text{Number of Circuits} * \text{Hours in Period}}$$

Equation 4-3

Appendix 3.2 – 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".

$$\text{System Minutes} = \frac{\text{Energy not supplied MW Minutes}}{\text{Power at System Peak}}$$

Equation 4-4

$$= \frac{\text{(MVA Minutes)} * \text{(Power Factor)}}{\text{System Peak to Date}}$$

Equation 4-5

Where: Power factor = 0.9

Appendix 3.2 – System Minute Formula

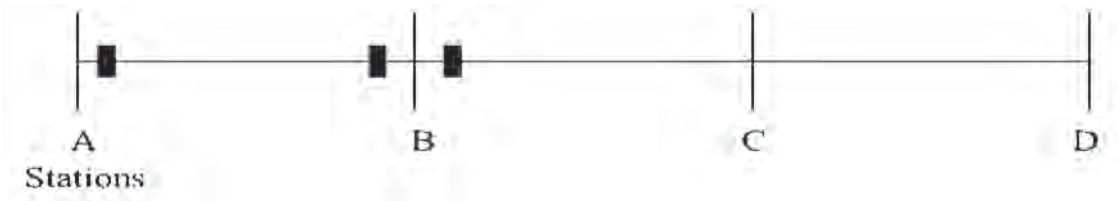
Zone 1 on a distance relay is the primary protection zone and in the case of an overhead line is set to 70-85 % of the circuit length depending on the location of the circuit in the transmission network. There is no time delay for the relay to pick up when a fault occurs within the zone 1 reach. Typical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

$$\text{Zone Clearance Ratio} = \frac{\text{Short circuit faults not cleared in Zone 1}}{\text{Total number of short circuit faults cleared}}$$

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.

Equation 4-6

Appendix 3.3 – Protection Glossary

DISTURBANCE
A system disturbance is defined as one or more related faults and their consequences which occur either simultaneously or over a period of time. These incidents are grouped in a single system disturbance report under the highest voltage involved.

FAULT
Any abnormal event causing or requiring the tripping of a Main System circuit breaker automatically within the Main System. Any abnormal event causing or requiring the closing of a Main System circuit breaker automatically within the Main System. Any abnormal event causing or requiring the tripping of an MV circuit breaker automatically by under frequency relay operation.

MAIN SYSTEM
The main transmission system includes: the 400 kV, 220 kV and 110 kV overhead line (OHL) and underground cable (UGC) network; the 400 kV, 220 kV and 110 kV busbars and couplers, the 400/220 kV and 220/110 kV coupling transformers (with the exception of those feeding the Dublin City 110 kV network). It also includes the 275 kV ESB/NIE interconnector and associated 275/220 kV transformers. The main transmission system does not include the Dublin City 110 kV network or the 220/110 kV coupling transformers at Carrickmines, Inchicore and Poolbeg. The HV circuit breakers of tail connected lines and directly connected transformers (ESB DSO load transformers, directly connected industrial customers load transformers and generator transformers) are part of the Main Transmission System thus faults on these lines and transformers, which cause transmission system circuit breakers to be tripped, are reported.

MVA MINUTE LOST
Amount of Power (Mega Volt-Amp) not supplied during an interruption of one minute.

NON MAIN SYSTEM/ OUTSIDE THE MAIN SYSTEM
All HV plant on the Irish electricity network that does not form part of the Main System: The Dublin 110 kV network which is controlled by the NDCC (the MV system in Ireland is controlled by the ESB SDCC in Wilton and the NDCC in Leopardstown), all DSO and Industrial Customer load transformers, all IPP generator transformers, and all plant on the NIE owned, SONI controlled, HV system in Northern Ireland.

NON SYSTEM FAULT
Any unplanned circuit breaker operation resulting from a cause other than a system fault or incorrect manual operation from a control point.

STAR SCHEME
Short Term Active Response is a scheme operated by EirGrid whereby large electricity consumers voluntarily contract to make their load available for short term interruptions. This service provides EirGrid with approximately 45 MW of static reserve that is utilised in the event of system frequency falling below 49.3 Hz.

SYSTEM FAULT
Any fault or system abnormality which involves, or is the result of failure of primary electrical apparatus and which requires the disconnection of the affected equipment from the system by the automatic tripping of the associated circuit breaker.

APPENDIX 4 - MOYLE INTERCONNECTOR FORCED AND PLANNED OUTAGES 2014

Start Date	Start Time	End Date	End Time	Outage Description
31.03.2014	07:00	07.04.2014	15:59	National Grid outage
12.05.2014	22:00	13.05.2014	06:59	Outage for Moyle reconfiguration testing
14.05.2014	06:00	14.05.2014	08:36	TRIP
18.05.2014	06:00	18.05.2014	13:59	Moyle reconfiguration Testing
29.06.2014	05:24	29.06.2014	17:59	TRIP
05.07.2014	08:00	29.08.2014	16:59	Outage for Moyle reconfiguration testing
03.11.2014	08:00	04.11.2014	16:59	Moyle outage due to a planned National Grid/Scottish Power outage.
04.11.2014	17:00	04.11.2014	20:00	TRIP - Delay in Return to Service following planned outage
08.12.2014	06:36	08.12.2014	09:00	TRIP - Due to weather conditions on the Scottish Power System
10.12.2014	15:36	10.12.2014	16:26	TRIP - Due to weather conditions on the Scottish Power System
11.12.2014	01:37	11.12.2014	03:04	TRIP - Due to weather conditions on the Scottish Power System
12.12.2014	09:30	12.12.2014	11:56	TRIP - Due to weather conditions on the Scottish Power System

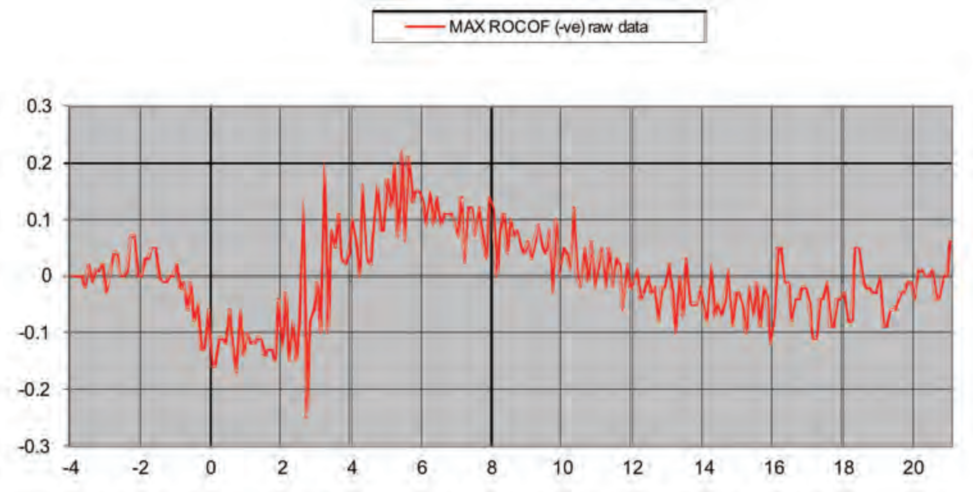
APPENDIX 5 - ALL-ISLAND FREQUENCY EXCURSIONS GRAPHS 2014

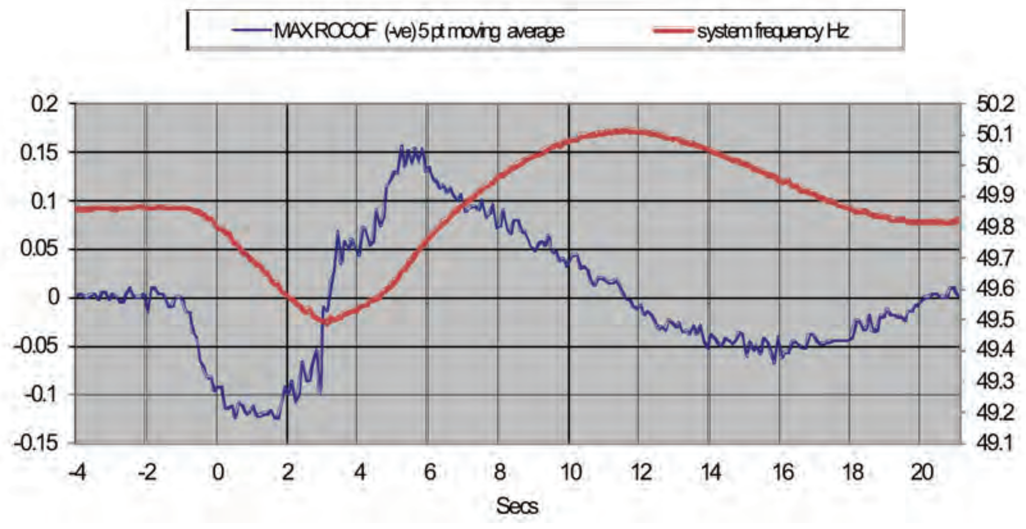
The following is a list of graphs contained in this section.

CAUSE OF INCIDENT	DATE
MONEYPOINT 3	22/01/2014
EWIC	20/02/2014
MONEYPOINT 3	21/03/2014
HUNTSTOWN 2	27/04/2014
AGHADA 2	22/05/2014
MONEYPOINT 2	03/06/2014
MONEYPOINT 2	22/06/2014
DUBLIN BAY	07/07/2014
EWIC	04/09/2014
GREAT ISLAND 4	27/09/2014
GREAT ISLAND 4	02/10/2014
GREAT ISLAND 4	21/10/2014
AGHADA UNIT 2	03/12/2014

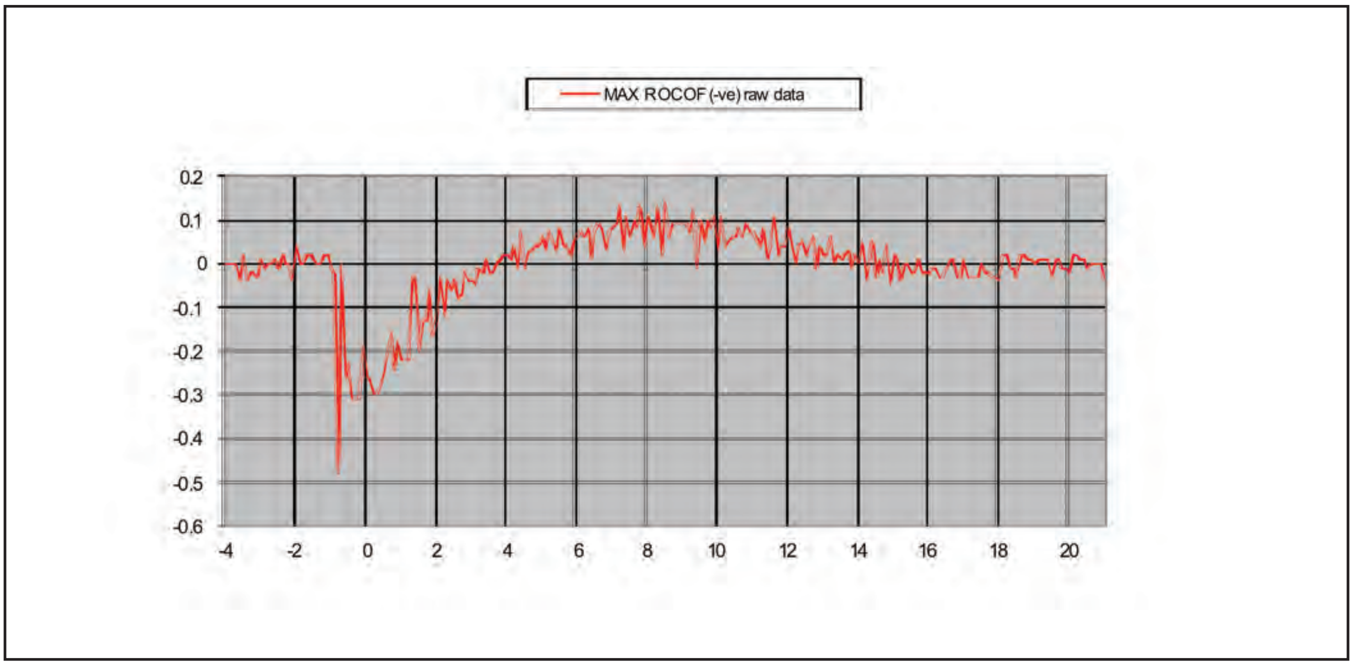
N.B. On all the following graphs the term ROCOF means Rate of Change of Frequency

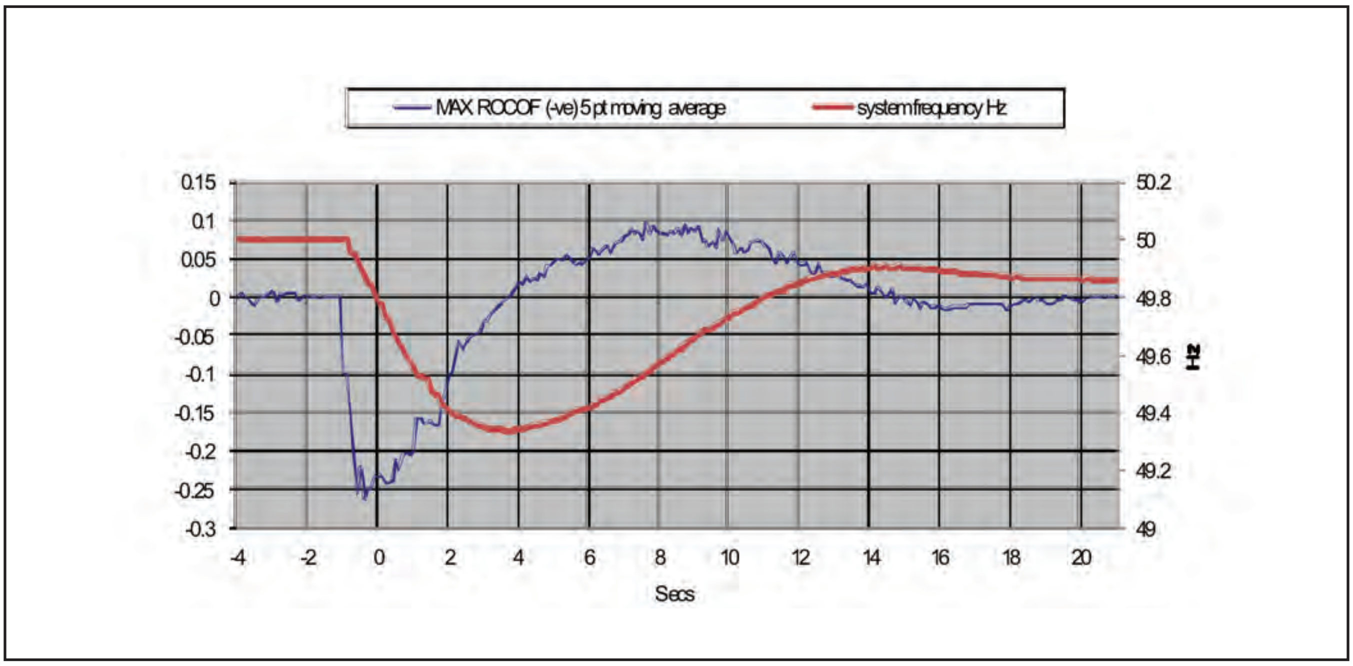
22/01/2014 MONEYPOINT 3



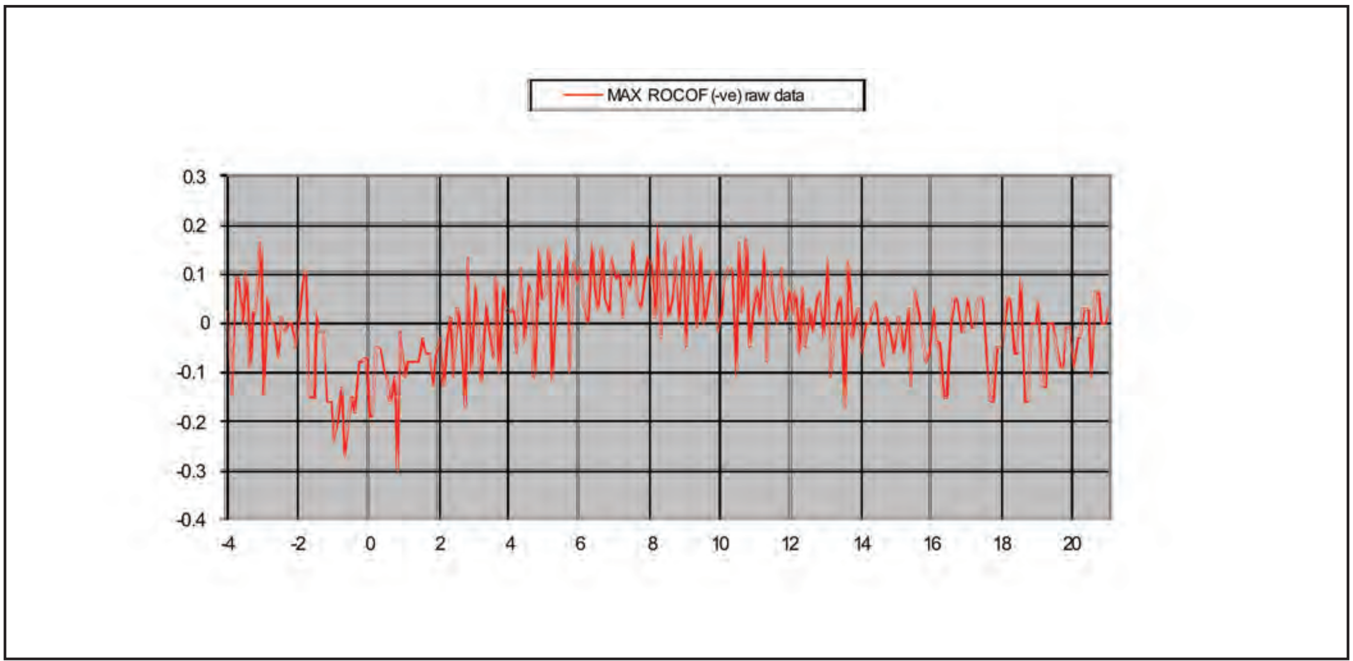


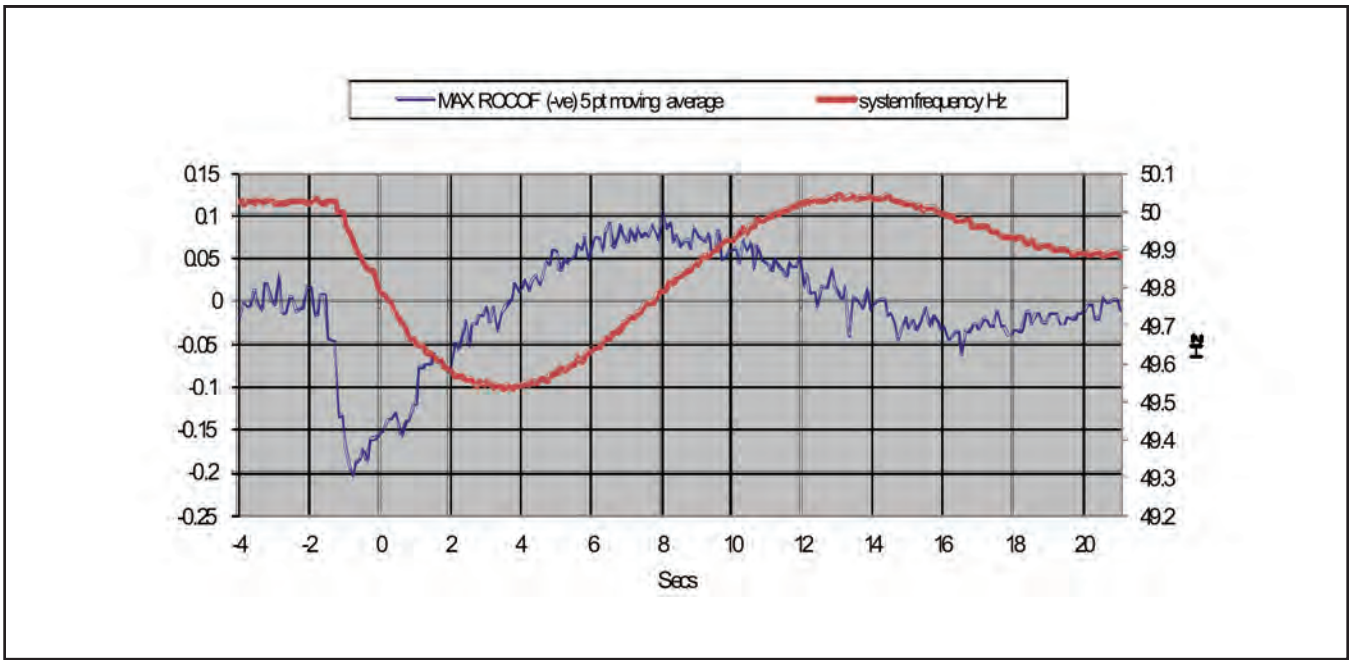
20/02/2014 EWIC



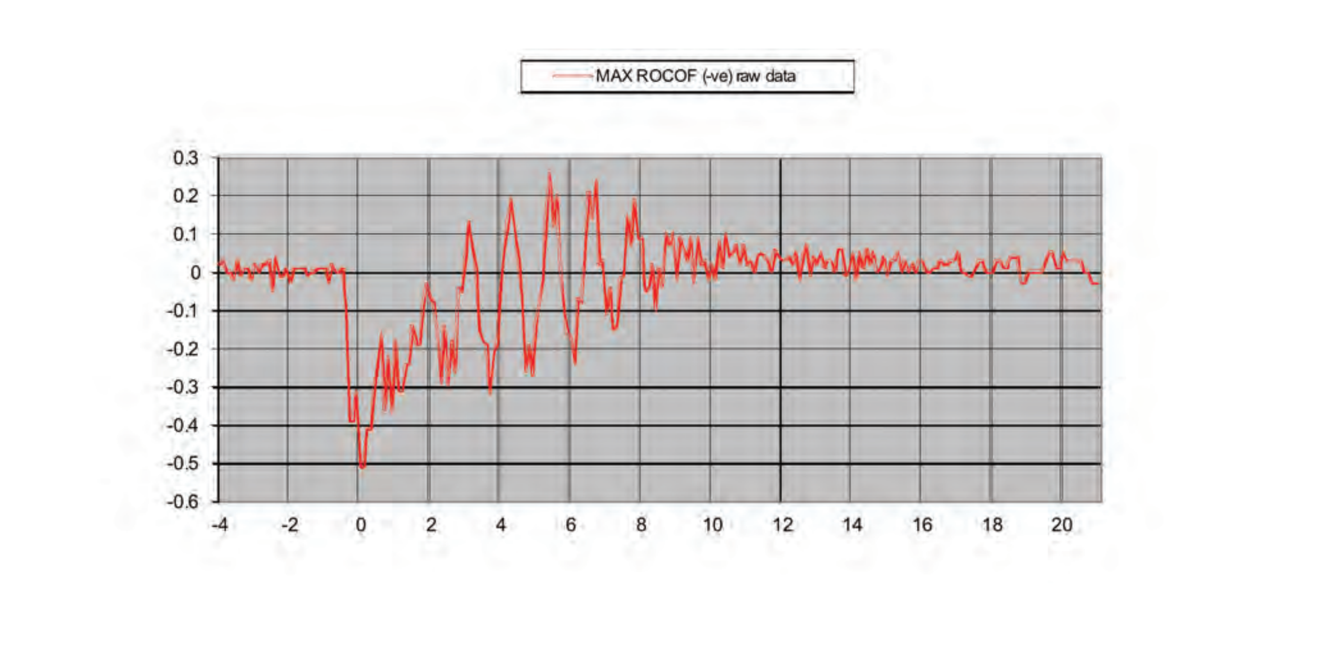


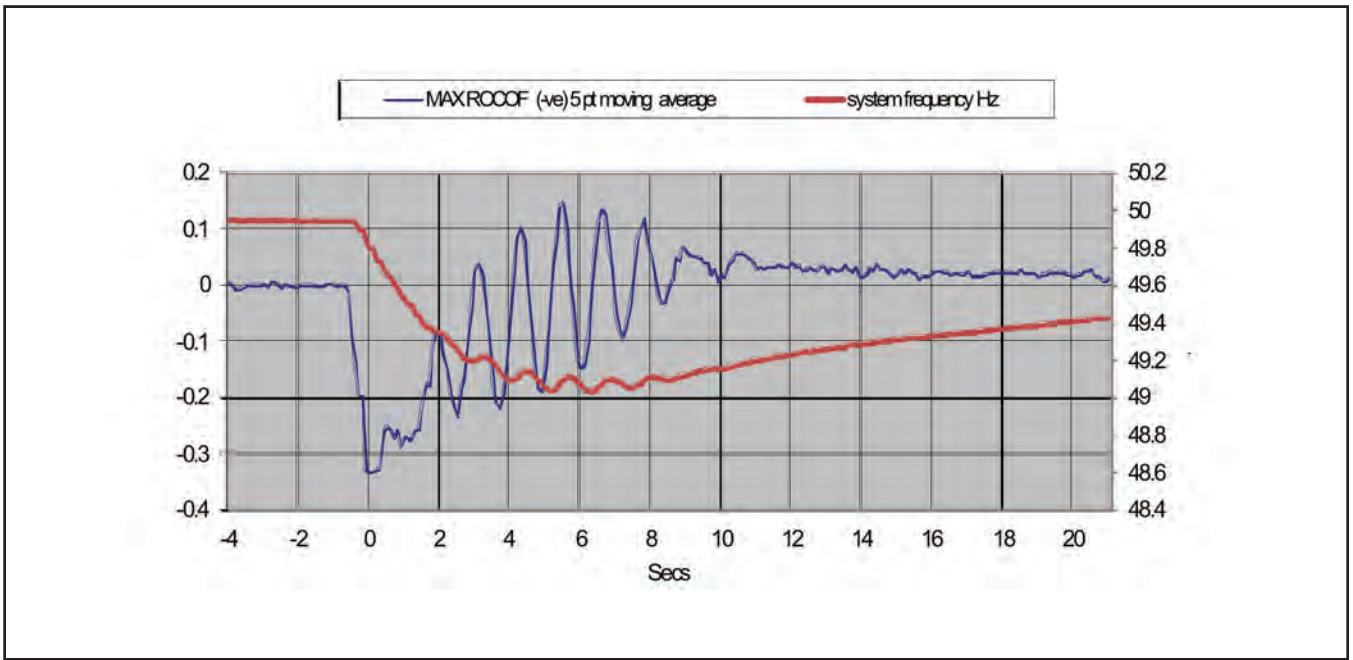
21/03/2014 MONEYPOINT 3



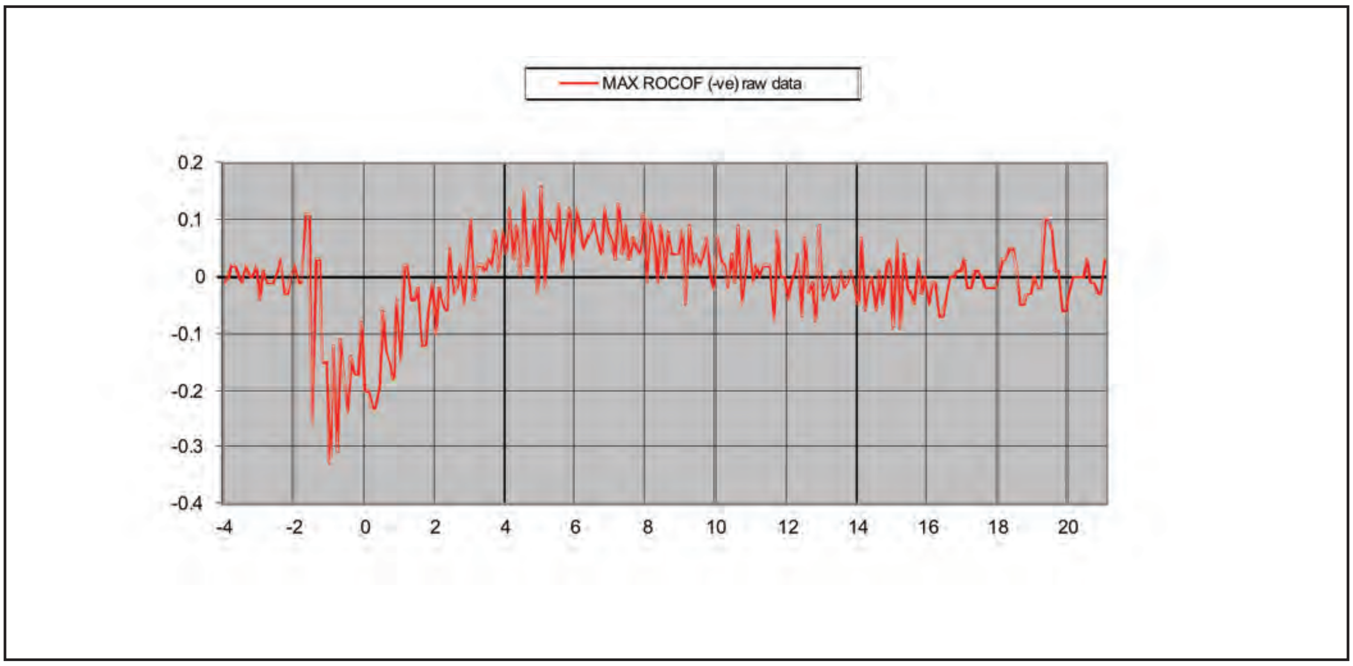


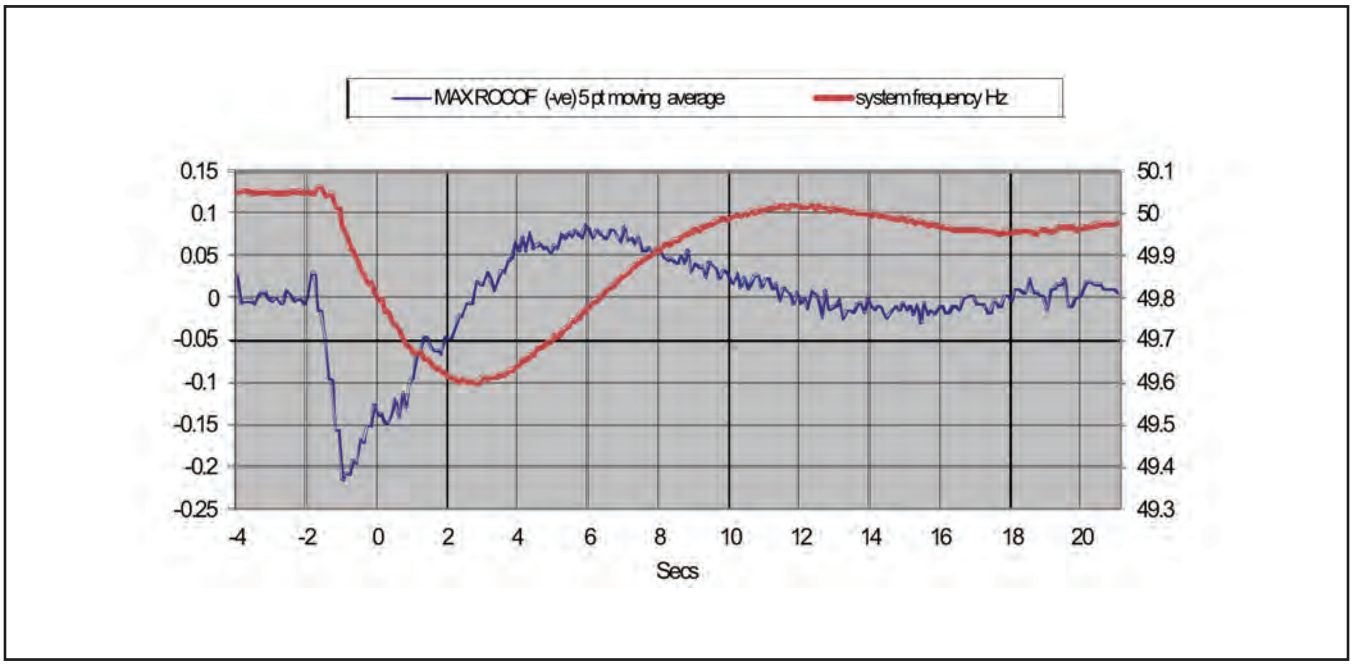
27/04/2014 HUNTSTOWN 2





22/05/2014 AGHADA 2





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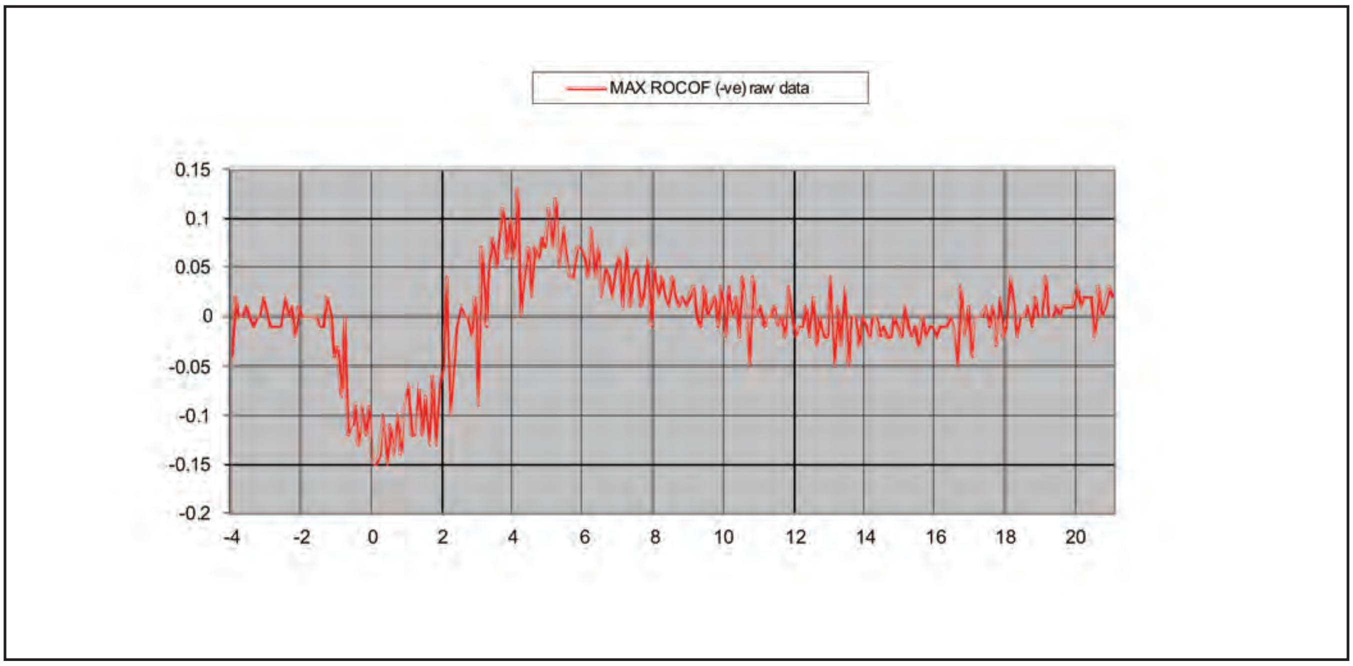

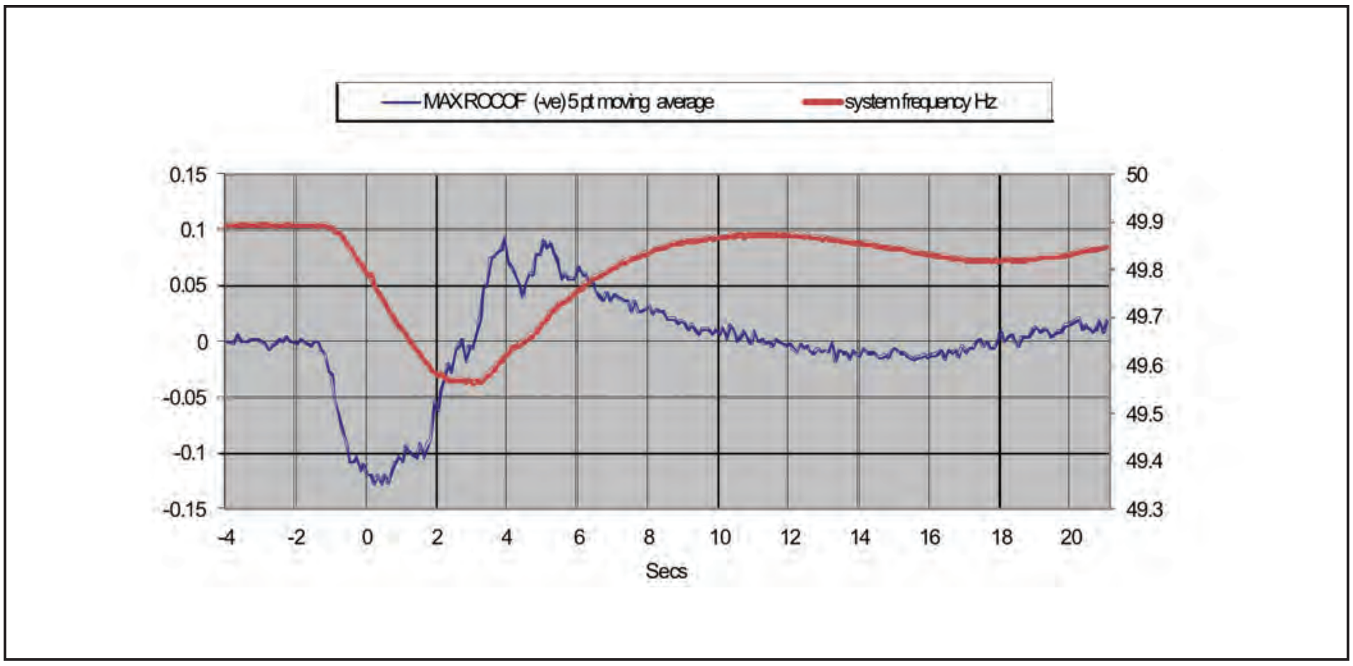

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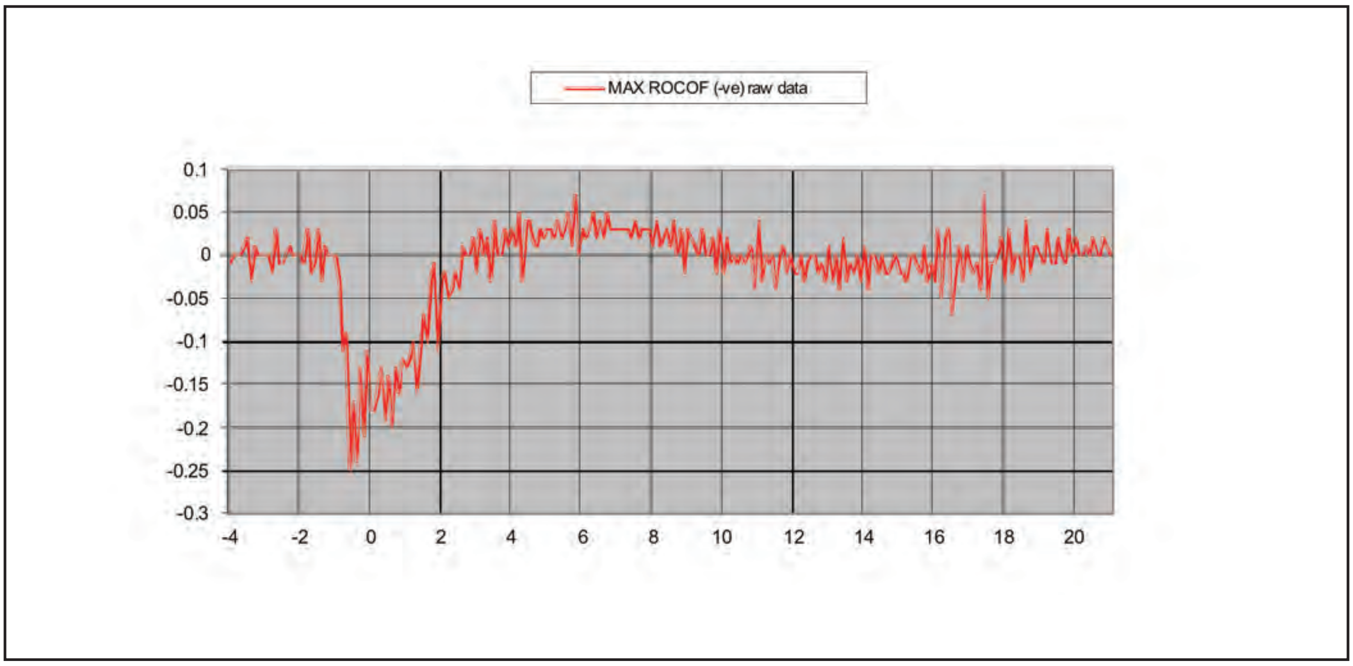

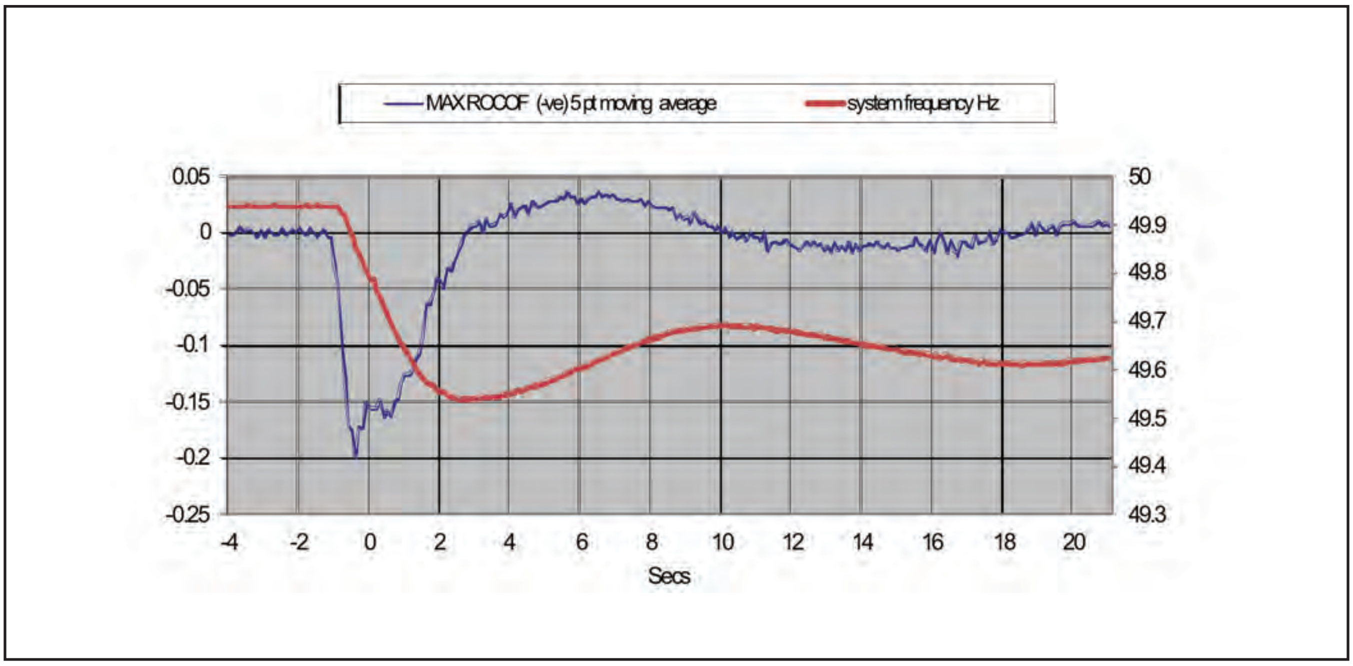

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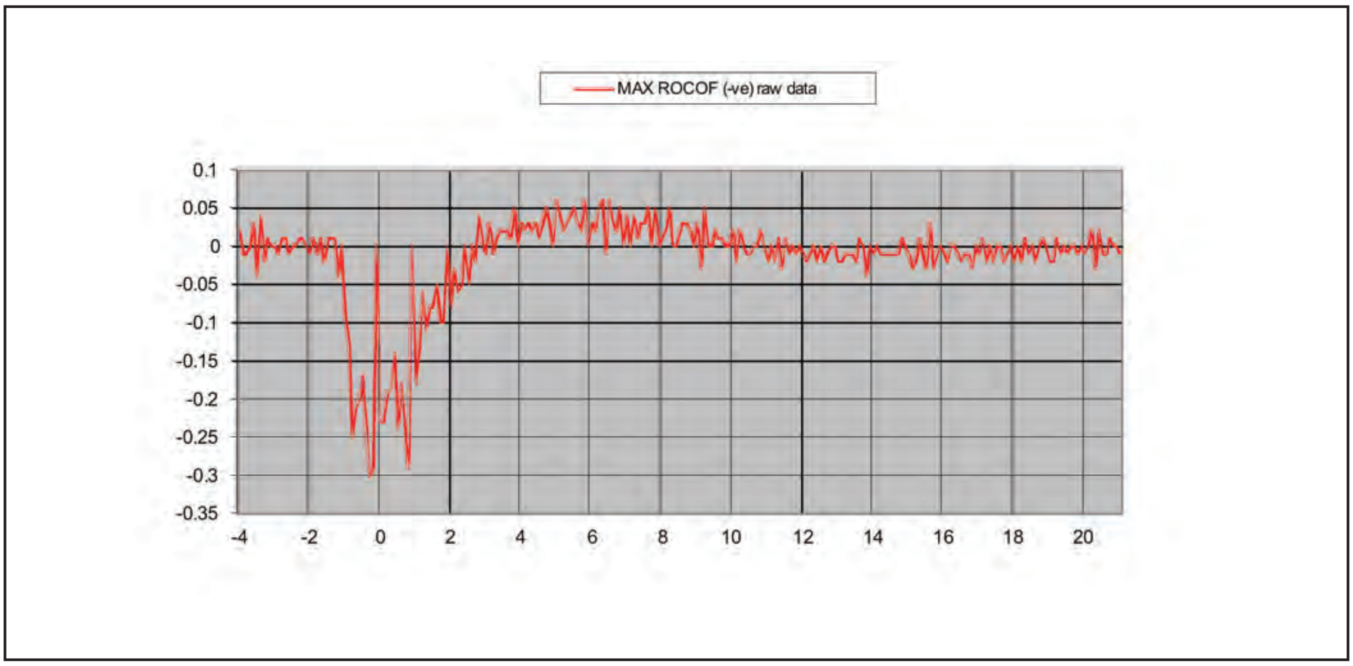
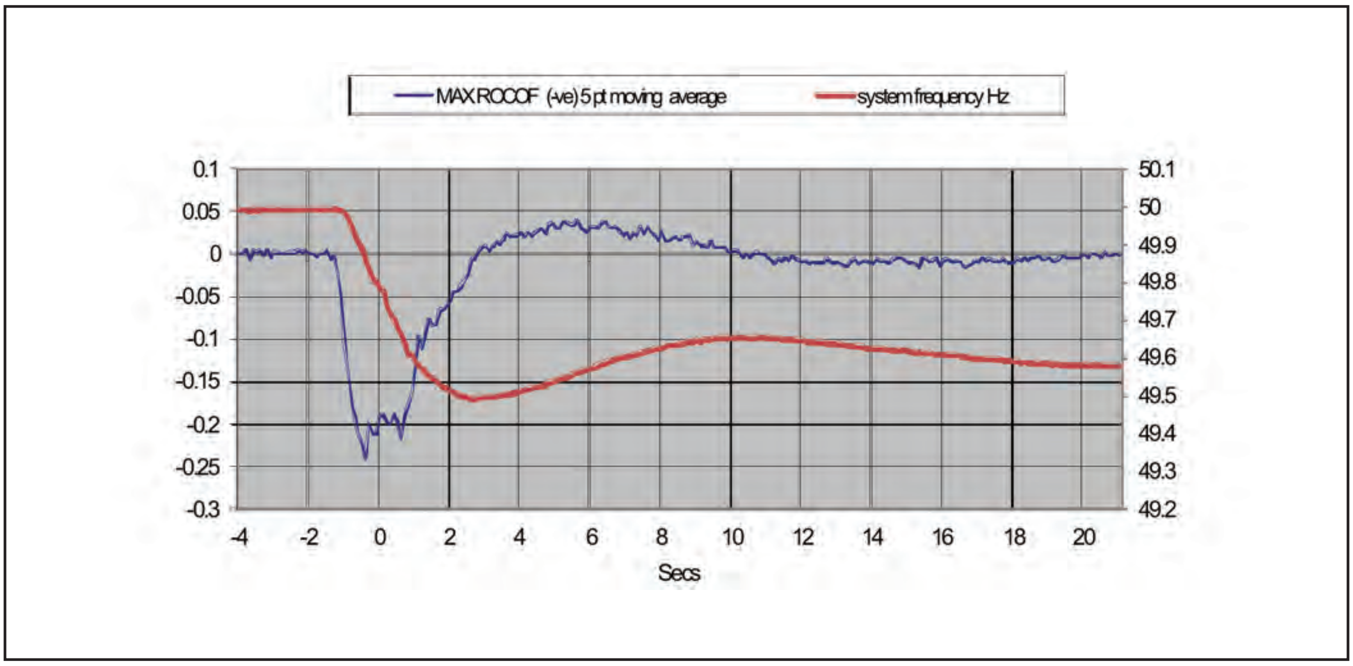
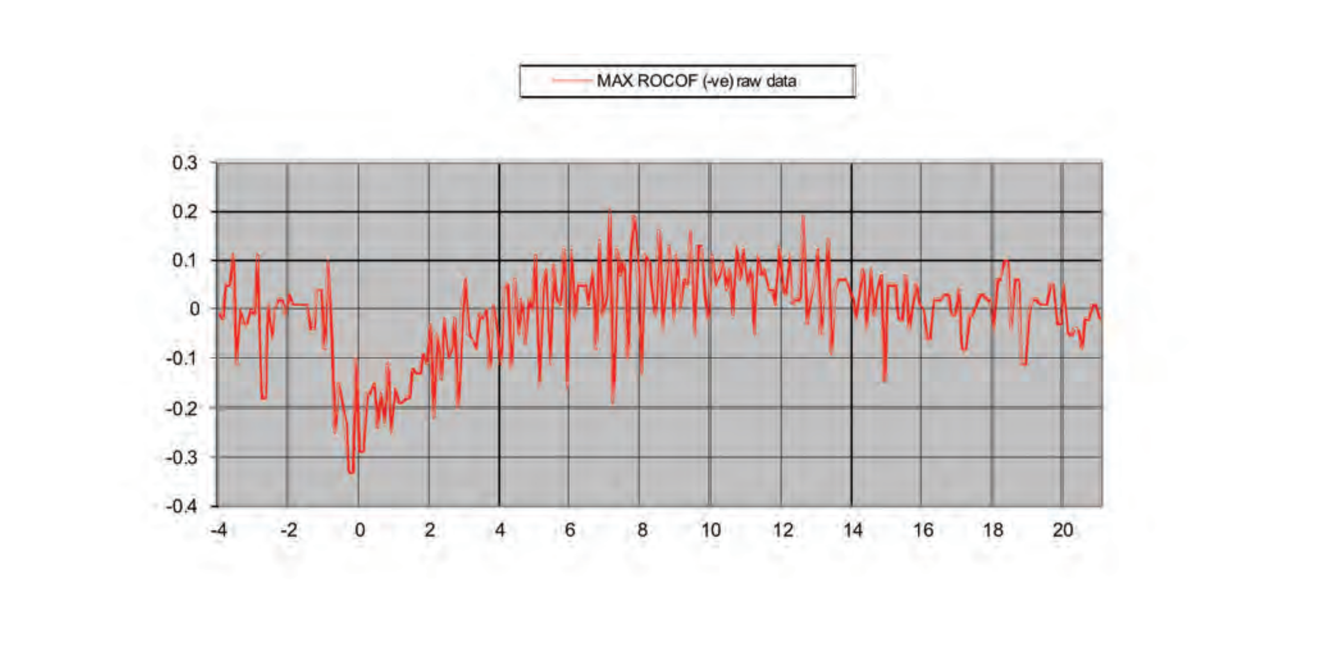
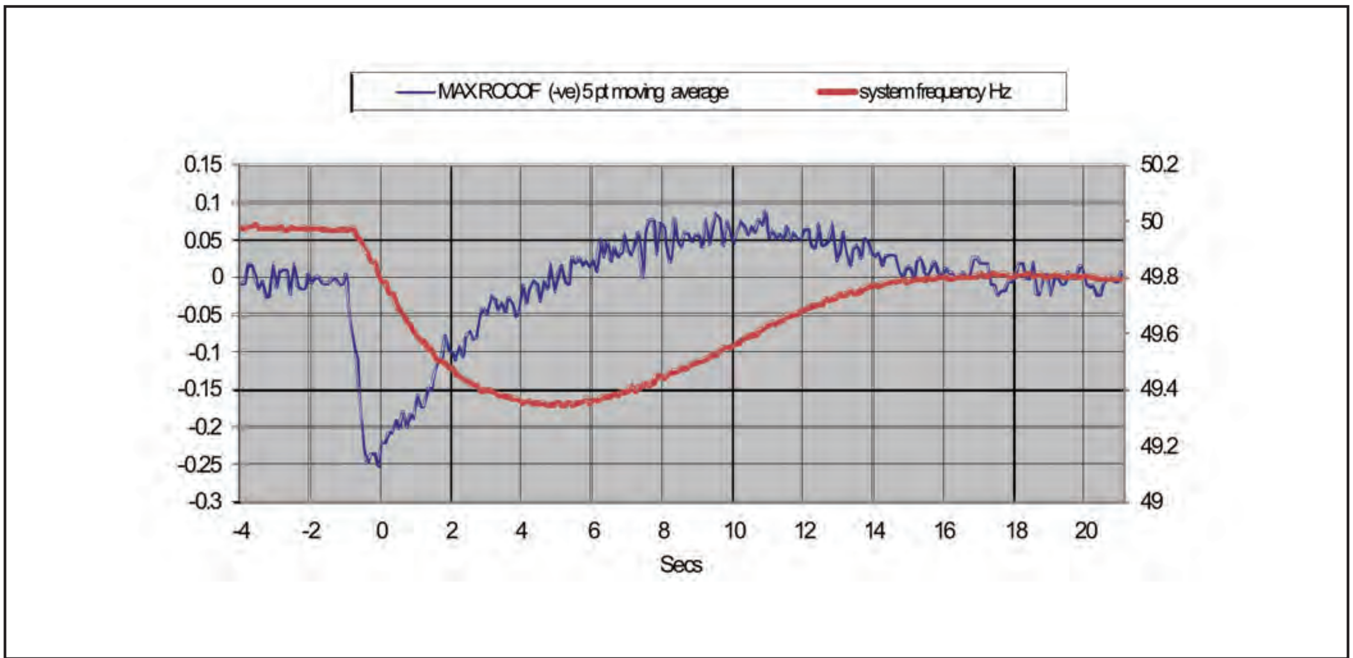
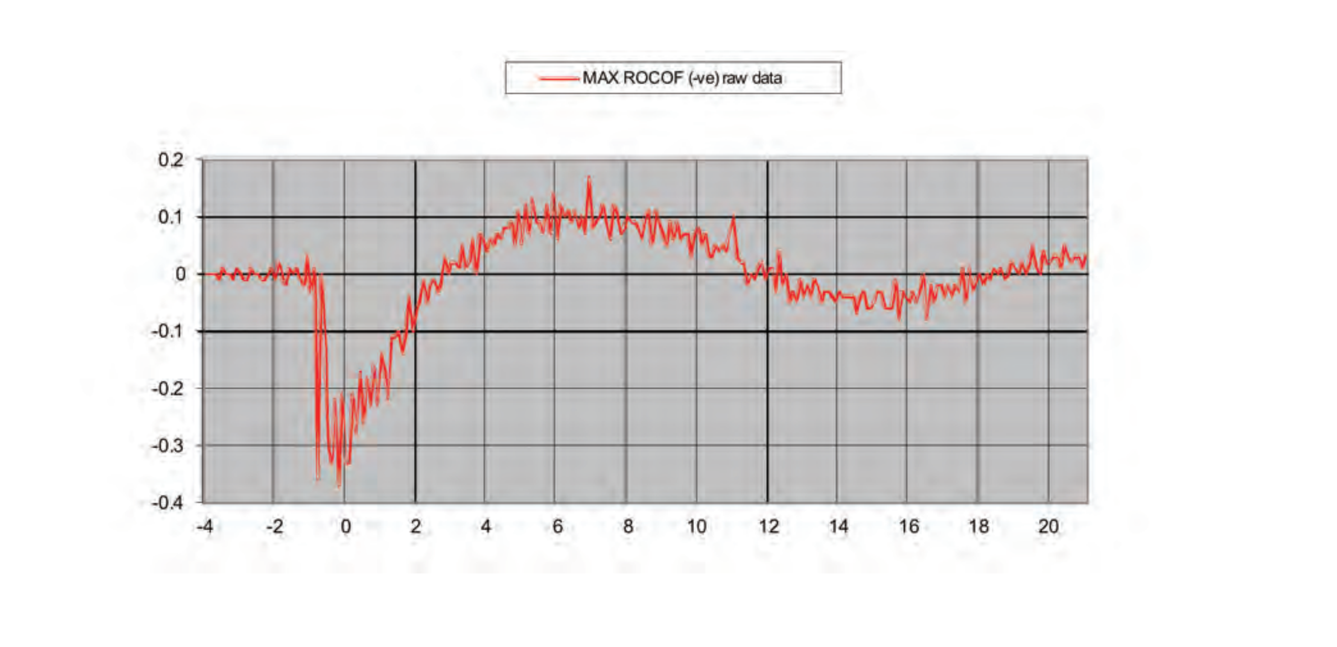




04/09/2014 EWIC



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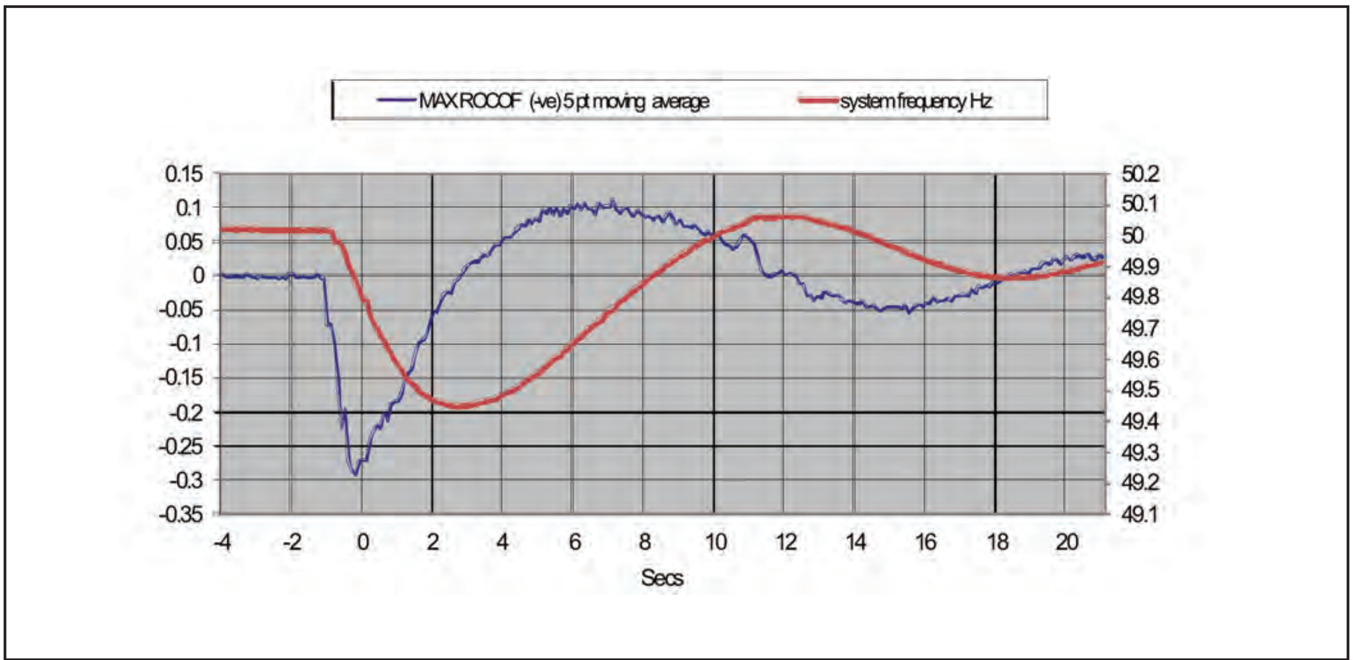
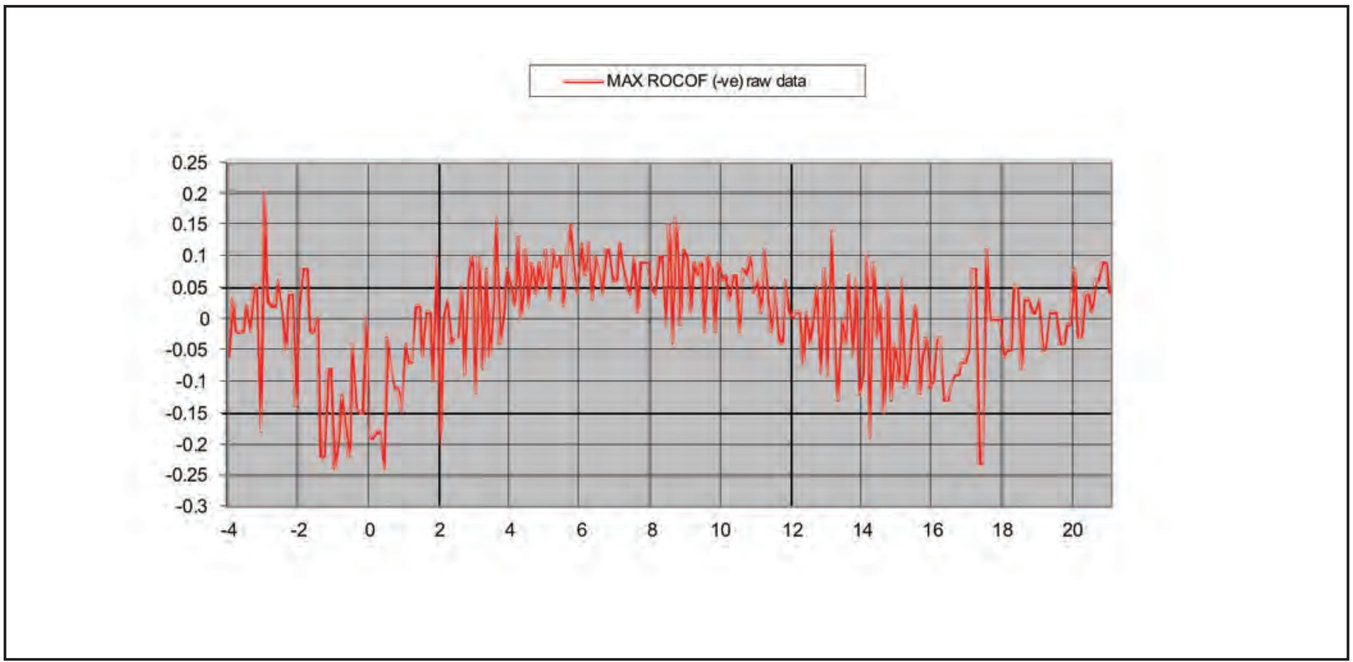
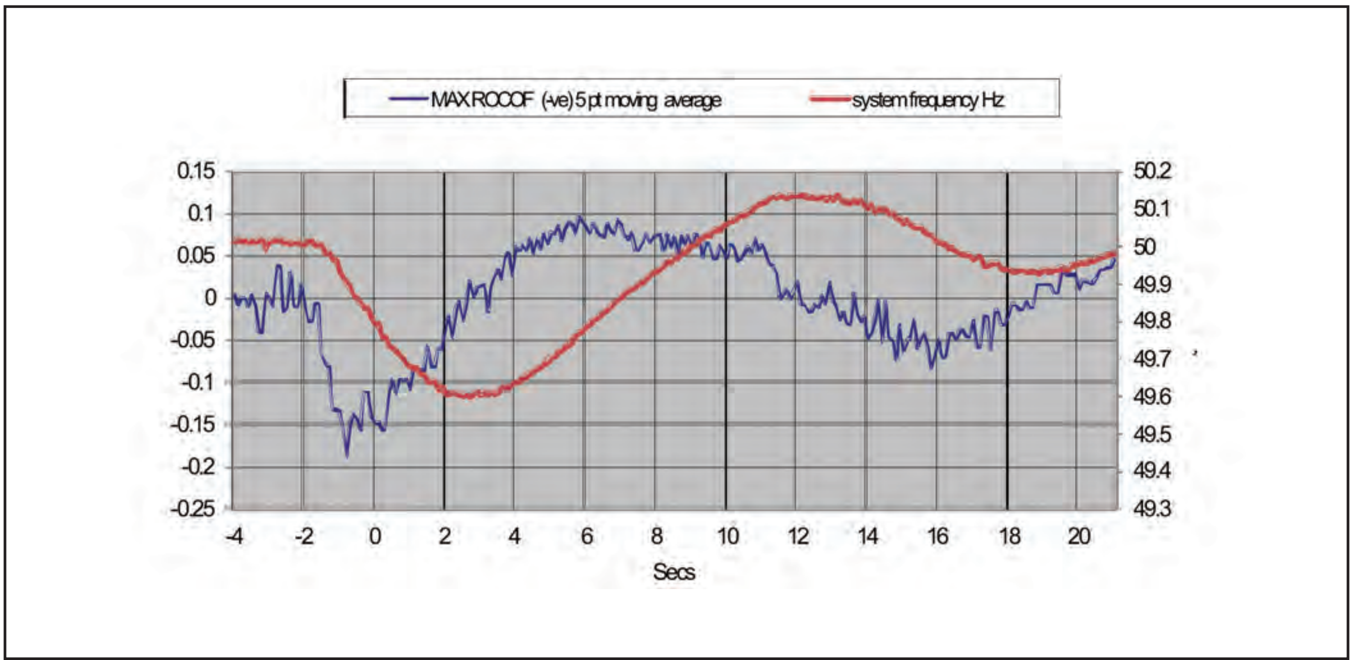
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-4
-2
0
2
4
6
8
10
12
14
16
18
20

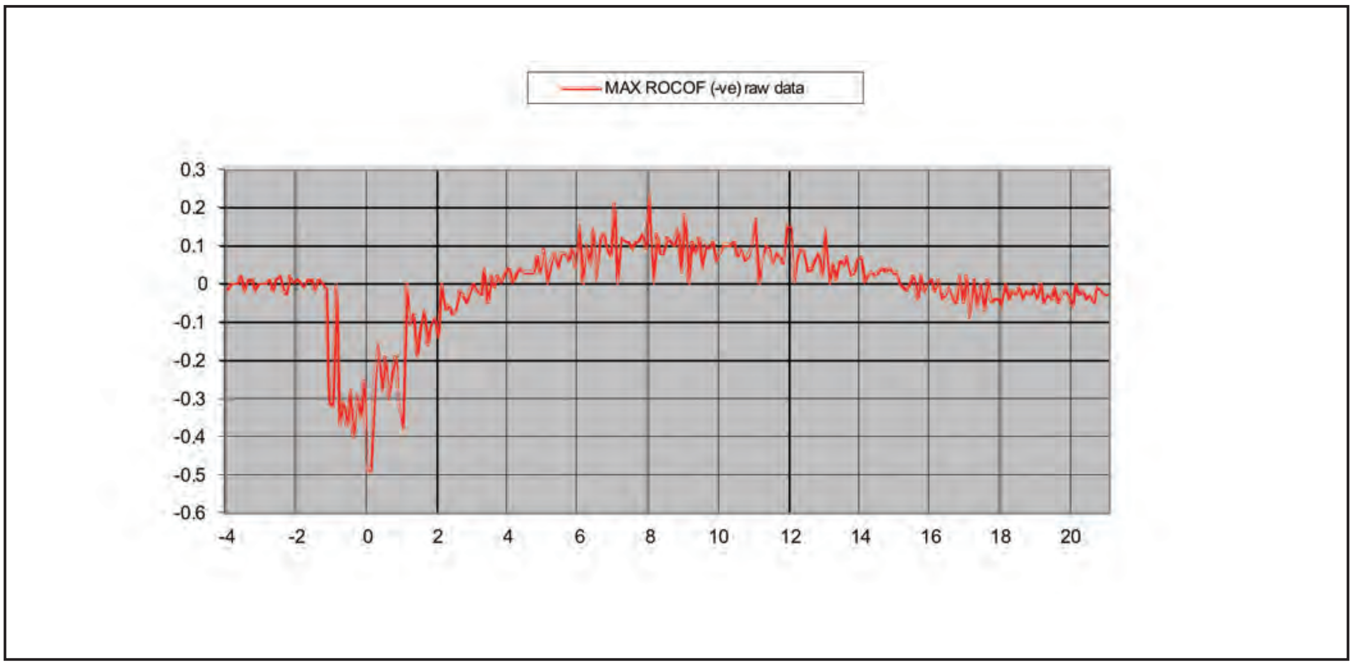

MAX ROCOF (-ve) 5 pt moving average
system frequency Hz
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
50.2
50.1
50
49.9
49.8
49.7
49.6
49.5
49.4
49.3
49.2
49.1
-4
-2
0
2
4
6
8
10
12
14
16
18
20
Secs

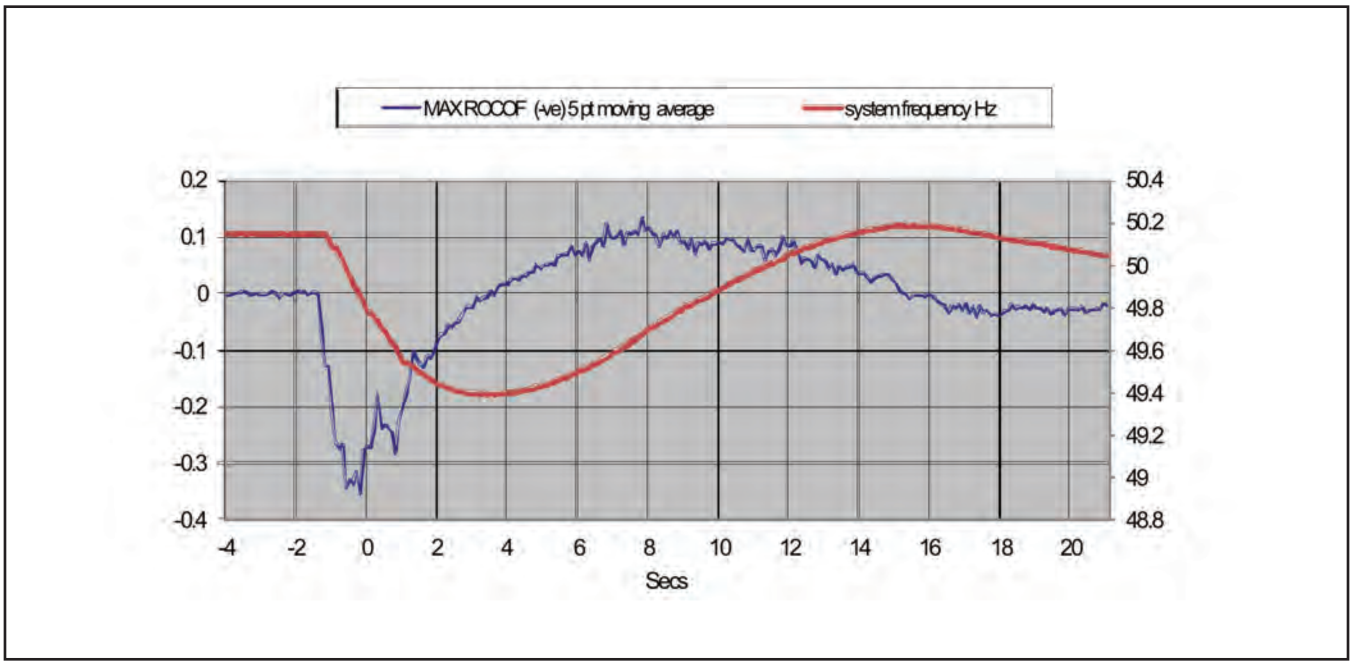
02/10/2014 GREAT ISLAND 4



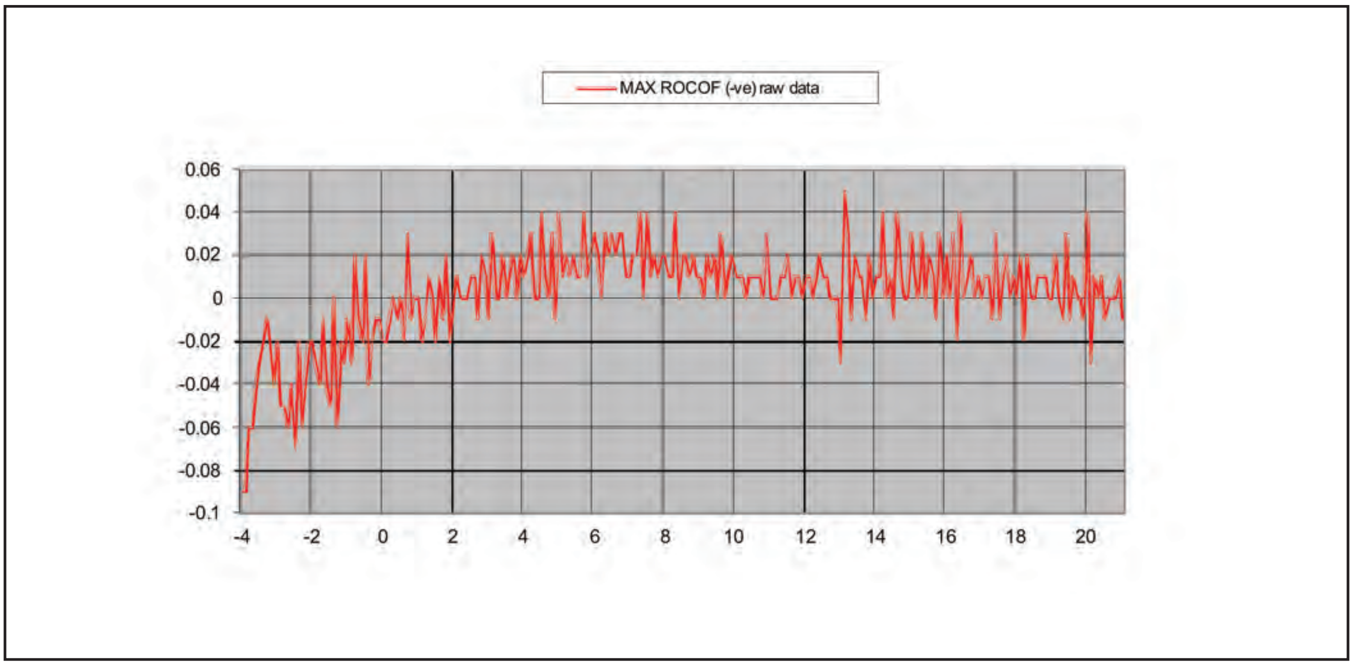


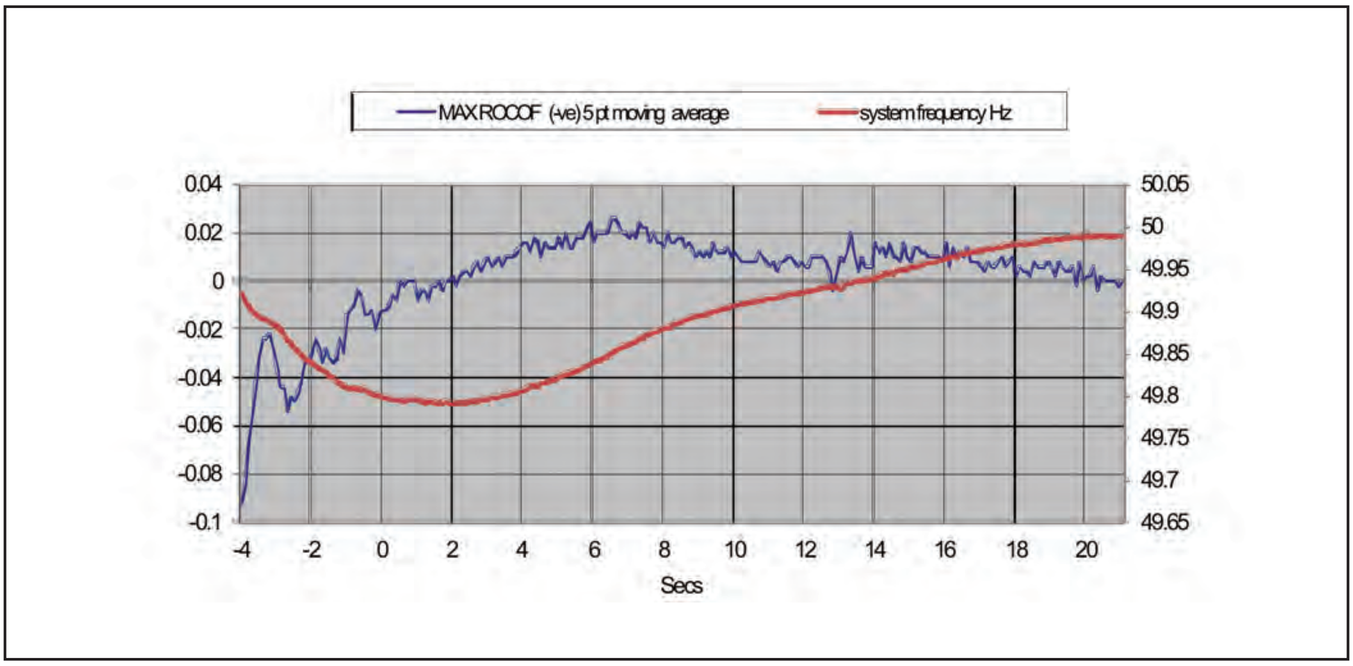
21/10/2014 GREAT ISLAND 4





03/12/2014 AGHADA UNIT 2





EirGrid Plc
The Oval, 160 Shelbourne Road,
Ballsbridge, Dublin 4.
Telephone +353 (0)1 702 6642
Fax +353 (0)1 661 5375
e-mail info@eirgrid.com
www.eirgrid.com

SONI Ltd
Castlereagh House, 12 Manse Road,
Belfast, BT6 9RT.
Telephone +353 (0)28 90794336
Fax +353 (0)28 90709560
e-mail enquiries@soni.ltd.uk
www.soni.ltd.uk

EIRGRID

SONi
System Operator for Northern Ireland

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