TRANSMISSION SYSTEM PERFORMANCE REPORT 2009

System Data and Performance Statistics

TRANSMISSION SYSTEM PERFORMANCE REPORT 2009

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01 / INTRODUCTION

EirGrid, as the Transmission System Operator (TSO) for the Republic of Ireland, is pleased to present the annual Transmission System Performance Report for 2009. This report contains transmission system data and performance statistics for the transmission system in the Republic of Ireland for the year 2009.

EirGrid holds licences as the independent electricity Transmission System Operator (TSO) and Market Operator (MO) in the wholesale trading system in the Republic of Ireland. In 2009, EirGrid acquired the System Operator Northern Ireland (SONI Ltd) business, which is the licenced TSO and MO in Northern Ireland. The Single Electricity Market Operator (SEMO) is part of the EirGrid Group, and operates the Single Electricity Market on the island of Ireland.

EirGrid's role, as the TSO in the Republic of Ireland, is to deliver quality connection, transmission and market services to customers and to develop the grid infrastructure required to support the development of Ireland's economy.

The objective is underpinned by a legislative requirement to develop, maintain and operate a safe, secure, reliable, economical and efficient transmission system. As TSO, EirGrid is regulated by the Commission for Energy Regulation (CER).

During the year, the key points of note were as follows:

- The system was operated at all times within acceptable international standards for safety, security and reliability of customer supplies;
- The number of system minutes lost due to transmission system faults was 0.006 minutes;
- A peak demand for the year of 4,890 megawatts (MW)[1] was recorded by the power system on 7th January 2009 at 17:45;
- A new record wind generation level of 1,064 MW was recorded by the power system on 24th October 2009 at 13:52;
- Generator connections were provided for Aghada and Whitegate Combined Cycle Gas Turbines (CCGTs) in Co. Cork and for a number of windfarms throughout Ireland; and
- Extensive maintenance of the transmission system was carried out throughout the year, including 8,684 km of overhead line patrols.

1 Since the introduction of the Single Electricity Market, peak demand records moved from a gross/generated basis to a net/exported basis.

02 / BACKGROUND

EirGrid, the Transmission System Operator, is required to publish the Transmission System Performance Report annually for the previous year[2].

The report includes both transmission system performance statistics and a number of high level transmission system characteristics, many of which are published elsewhere, but which we believe will facilitate the industry and external observers by collating them in one single source.

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 (275kV) and 400,000 volts (400 kV) – and fed into the transmission system, commonly known as the "national grid". The transmission system is made up of approximately 6,458 km of high voltage overhead lines and underground cables and 152 high voltage stations. This is the backbone of the electricity system in this country.

In some of the transmission stations the electricity voltage is reduced for onward, local distribution at 38,000, 20,000 and 10,000 volts. Some large industrial customers can also take their power supply directly from the transmission system. The distribution system, which is separately managed by the Distribution System Operator (ESB Networks Ltd.), brings power from these stations to smaller business units, farms and households.

2 Licence Condition 18 of the Transmission System Operator Licence.

03 / BASIC SYSTEM DATA

This section contains basic transmission system data. Further information can be found on the EirGrid website www.eirgrid.com.

3.1 / Total System Production

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

Table 3.1: Total Exported Energy 2008 & 2009

	2008	2009
Total Exported Energy [GWh]	28,341	26,752

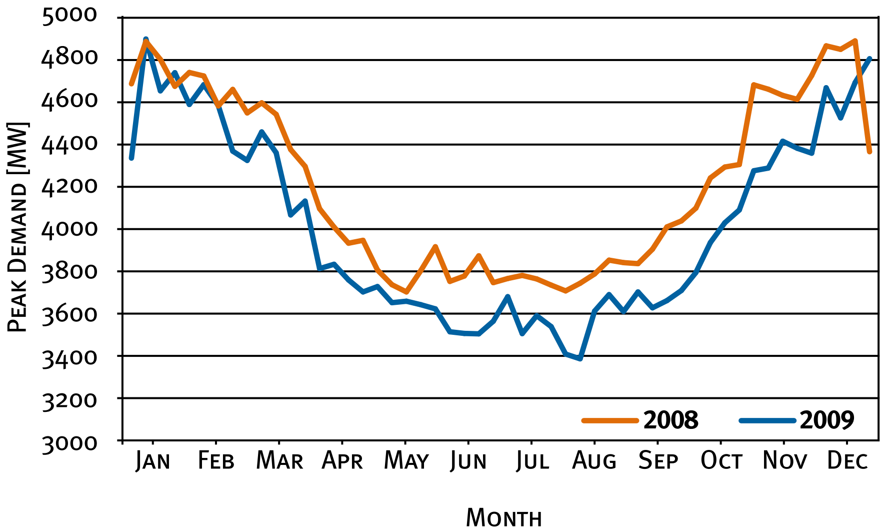
Since 2008 there has been a dramatic change in the economic climate and this has been reflected in a reduction in electricity demand, with the total decrease in exported energy from 2008 to 2009 being 5.61%[3]. The Generation Adequacy Report 2010 – 2016[4] forecasts that demand will not return to 2008 levels until 2013.

3.2 / System Records

Peak demand is a measure of the maximum demand on the transmission system over a particular period (e.g. annual or seasonal) and it is a key measurement for any power system. The Irish system is a winter peaking system because of the greater need for heating and lighting requirements during winter months and this is illustrated in Figure 3.1. The winter peak in 2009 occurred on 7th January 2009 at 17:45.

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 2009 this occurred on 2nd August 2009 at 06:15.

Figure 3.1: Weekly System Demand Peaks 2008 & 2009



The installed wind capacity continues to rise year-on-year enabling Ireland to progress towards the target of having 40% of our electricity consumption being generated from renewable sources by 2020. In 2009 a new record wind generation level was achieved on 24th October 2009 at 13:52.

3 If the 2008 figure is normalised to 365 days to take into account the leap year, then the total decrease in energy exported in 2009 over 2008 was 5.35%.
4 This report is available at www.eirgrid.com.

Table 3.2: System Records 2008 & 2009

	2008	2009
Winter Peak Demand [MW]	4,878	4,890
Minimum Summer Night Valley [MW]	1,786	1,632
Maximum Wind Generation [MW]	892	1,064

3.3 / Operational Generation Capacity

Generation plant is connected to both the transmission and distribution systems. All generation contributes to EirGrid's operation of the transmission system. The total generation capacity is calculated as the sum of all fully operational generator capacities connected to both systems. The distribution data is provided by ESB Networks Ltd. who is the Distribution System Operator (DSO).

Table 3.3: Total Operational Generation Capacity

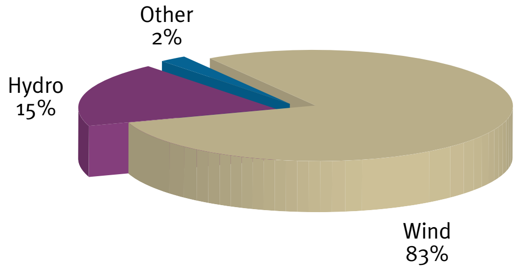
	Dispatchable	Capacity [MW]	% of Total Capacity
Transmission System	Fully	6,213[5]	80%
	Non/Partially	685	9%
Distribution System	Fully	104	1%
	Non/Partially	754	10%
Total Operational Capacity = 7,756 MW			

Dispatchable generation capacity is significant to EirGrid's ability to operate the transmission system. Generation can be fully, partially or non dispatchable. Small scale distributed generation (known as embedded generation) is an example of non-dispatchable generation. Large scale wind farms are examples of partially dispatchable generation. Appendix 1 provides a list of the fully dispatchable generating units connected to the transmission and distribution systems.

3.4 / Renewable Plant Capacity

Renewable plant in Ireland is defined as generation plant whose primary fuel source is renewable (e.g. wind, hydro, biomass, biogas, etc). Renewable plant does not include pump storage.

Figure 3.2: Total Connected Renewable Generation Capacity 2009



Total Connected Renewable Generation Capacity = 1,526 MW

5 This figure includes Poolbeg Unit 3 (242 MW) which is on long-term outage and excludes the new Aghada and Whitegate Combined Cycle Gas Turbines (CCGTs) in Co. Cork, since these have not yet completed commissioning testing.

Renewable connected generation represents 20% of the total connected generation capacity, 59% of which is connected to the transmission system.

3.5 / 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 3.4: Transmission System Infrastructure Details 2008 & 2009[6]

	2008		2009	
Plant Type	**No. of Items**	**Circuit Length [km]**	**No. of Items**	**Circuit Length [km]**
110 kV Circuits	174	3,903	183	4,087
220 kV Circuits	51	1,830	53	1,835
275 kV Tie-lines[7]	2	97	2	97
400 kV Circuits	3	439	3	439
Circuit Total	**230**	**6,269**	**241**	**6,458**
Plant Type	**No. of Items**	**Transformer Capacity [MVA]**	**No. of Items**	**Transformer Capacity [MVA]**
220/110 kV Transformers	39	7,064	39	7,064
275/220 kV Transformers	3	1,200	3	1,200
400/220 kV Transformers	5	2,550	5	2,500
Transformer Total	**47**	**10,814**	**47**	**10,764**
Circuit Total	**145**		**152**	

In 2009 a number of new 110 kV line and 220 kV cable projects were completed and a number of new stations were energised. These are listed in Appendix 2 of this report.

6 Distribution plant and third party plant have been excluded.
7 The portion of the 275 kV tie-line which is situated in the Republic of Ireland is 19.4 km.

04 / GRID DEVELOPMENT & MAINTENANCE

This section provides an overview of grid development activities in 2009. 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 transmission connections certified operational and the level of maintenance activities carried out throughout the year.

4.1 / Grid**25**

Grid**25** is a long term strategy for the development of the transmission network to put in place a safe, secure and affordable electricity supply throughout Ireland. This strategy will support economic growth and provide the infrastructure to enable Ireland to realise its renewable potential and achieve the 2020 target of having 40% of our electricity consumption being generated from renewable sources.

Considerable work is being carried out on a number of work streams on the plan for implementing the Grid**25** strategy. For example progress is being made in relation to policy, regulatory, stakeholder engagement and environmental issues. Input is being made to Regional Planning Guidelines and County Development Plans and a Strategic Environmental Assessment (SEA) is presently being carried out on the Grid**25** Implementation Plan. EirGrid has also revised its internal organisational structure for the efficient delivery of Grid**25**.

The capital cost of all ongoing approved network development projects i.e. currently in the public planning or construction phase, amounts to €900 million. Further work is progressing to identify potential solutions to a number of other major regional projects.

4.2 / 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 4.1 details the number of connection offers made by EirGrid in 2009.

Table 4.1: Demand & Generation Connection Offers Issued in 2009

	Demand	Generation
New Connection Offers Issued in 2009 [No.][8]	4	10
New Connection Offers Issued in 2009 [Capacity]	48 MVA	777 MW

4.3 / Connection Offers Accepted

In order to connect to the transmission system, all demand and generation customers must execute a Connection Agreement with EirGrid. Table 4.2 summarises the total number of executed Connection Agreements in 2009 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.

8 This figure includes offers made to new connections and existing connections seeking an amendment to the Maximum Export Capacity (MEC) or Maximum Import Capacity (MIC) of an existing Connection Agreement.

Table 4.2: Executed Demand & Generation Connection Agreements in 2009

	Demand	Generation
Executed Connection Offer Agreements in 2009 [No.]	2	10
Executed Connection Offer Agreements in 2009 [Capacity]	8 MVA	1,035 MW

4.4 / 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 much shorter for demand customers.

Table 4.3 provides an overview of the number of new connections to the transmission system commissioned in 2009.

Table 4.3: Demand & Generation Connections Energised in 2009

	Demand	Generation
Connections Energised in 2009 [No.]	3	8
Connections Energised in 2009 [Capacity]	7 MVA	1,105 MW

During 2009, three existing demand customers increased their maximum import capacity (MIC) by 7 MVA. Eight new generation connections were energised in 2009 and these consisted of six windfarms with a total combined capacity of 228.5 MW and two new combined cycle gas turbines (CCGTs), situated in Aghada and Whitegate Co. Cork, with a capacity of 431 MW and 445 MW respectively.

4.5 / Customers Certified Operational

Table 4.4 provides an overview of customers connected to the transmission system which have been deemed fully operational. It shows customer connections which have completed the testing phase and have received an operational certificate from EirGrid. This table shows the aggregate position over the entire transmission system at year end.

Table 4.4: Demand & Generation Connections Certified Operational at year end

	Demand	Generation
Customers Certified Operational [Total No. of sites]	19	29
Customers Certified Operational [Capacity]	420 MVA	6,441 MW

There were no new demand connections certified operational in 2009, however there were a number of changes to the maximum import capacity (MIC) of existing sites. Four windfarms located in Booltiagh, Derrybrien, Meentycat and Ratrussan, with a combined capacity of 198 MW, were certified operational in 2009. The new ESB Power Generation owned 431 MW combined cycle gas turbine (CCGT) in Aghada, Co. Cork commenced its commissioning testing in September 2009. This unit in addition to the new Bord Gáis owned unit in Whitegate, Co. Cork are expected to be in commercial operation in 2010, therefore they are not included in Table 4.4.

4.6 / Maintenance Works Completed

Transmission maintenance is undertaken in accordance with a formal maintenance policy to ensure that the transmission system can operate in a safe, secure and reliable manner. The policy comprises continuous and cyclical condition monitoring (on-line and off-line), preventive maintenance on critical items of plant and the implementation of corrective maintenance tasks. The maintenance policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice. On an annual basis, transmission maintenance activities dictated by policy, work identified from analysis of plant condition and work carried over from previous years provide the total volume of maintenance requirements for the year (refer to Table 4.5).

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

Table 4.5 provides, in volume terms, a summary of transmission maintenance requirements, maintenance programmed and maintenance completed in 2009 for overhead lines, underground cables and transmission stations.

Table 4.5: Transmission System Maintenance 2009

Volume of Transmission Maintenance by Activity	Maintenance Requirements	Maintenance Programmed	Maintenance Completed
Transmission System Maintenance			
Overhead Line Maintenance			
Patrols (incl. helicopter, climbing & bolt) [km]	9,295	9,220	8,684
Timber Cutting [km]	42	42	37
Structure Painting [Number]	38	17	15
Structure & Hardware Replacement [Number]	112	109	90
Insulator & Hardware Replacement [Number]	114	108	75
Underground Cables Maintenance			
Check/Alarms [Number]	675	667	428
Station Maintenance			
Detailed Service [Number]	2	0	0
Ordinary Service [Number]	528	470	297
Operational Tests [Number]	688	654	547
Tap Changer Inspection [Number]	3	3	3
Corrective Maintenance [Number]	1,067	1,061	757
Condition Assessment of Switchgear [Number]	95	102	66

Appendix 3 provides a full explanation of the main terms and activities in the asset maintenance policy as operated by EirGrid.

The year 2009 saw an improvement in maintenance completions over 2008. The decrease in condition assessment requirements is a reflection of the change in transmission asset maintenance policy. While the improved completion rate of operational tests and ordinary services is a positive step, there is still a significant backlog in ordinary services and condition assessments, despite a change of policy.

Patrols of transmission lines increased in 2009 on 2008 figures due to improved reporting of infra-red patrols.

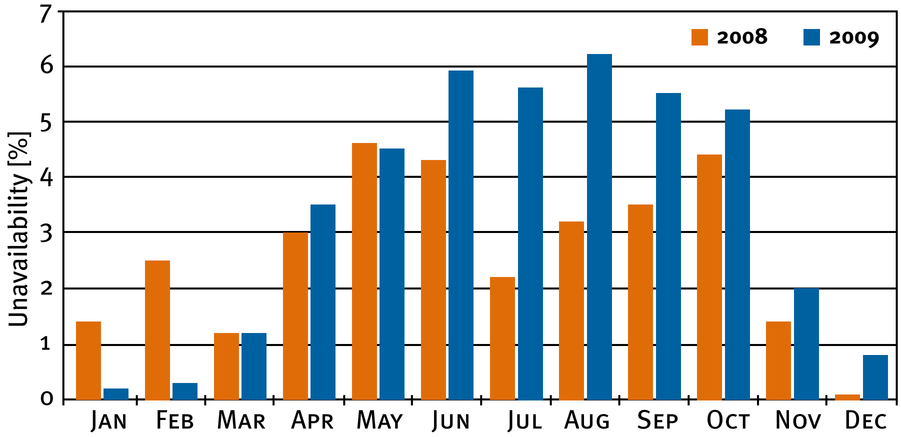
The decrease in the number of cable checks and inspections reflects a change in reporting; there are now reports on 8 monthly inspections, 4 quarterly inspections and 1 annual inspection for oil filled cables.

05 / TRANSMISSION SYSTEM AVAILABILITY & OUTAGES

5.1 / Transmission System Availability

When considering transmission system availability, it is the convention to analyse it in terms of transmission system unavailability. The formula for calculating transmission system unavailability is given in Appendix 4.1. Figure 5.1 shows a monthly breakdown of transmission system unavailability for 2008 and 2009.

Figure 5.1: Monthly Variation of System Unavailability 2008 & 2009



5.2 / Transmission Plant Availability

The measure of plant availability is the kilometre-day for feeders and MVA-day for transformers. These measures weight the availability of plant according to their importance to the transmission system.

The availability figures vary between the different categories of plant. The formulae for calculating transmission plant availability are provided in Appendix 4.1.

Table 5.1 provides a detailed breakdown of all plant availability figures for 2008 and 2009.

Table 5.1: Transmission System Plant Availability 2008 & 2009

Plant Type	Number of items in 2009	Circuit Length in 2009 [km]	Availability 2008 [%]	Availability 2009 [%]
110 kV Circuits	183	4,087	97.57	96.78
220 kV Circuits	53	1,835	95.78	95.47
275 kV Tie-lines	2	439	95.38	94.80
400 kV Circuits	3	97	98.63	97.17
Total	**241**	**6,458**		
Plant Type	**Number of items in 2009**	**Transformer Capacity in 2009 [MVA]**	**Availability 2008 [%]**	**Availability 2009 [%]**
220/110 kV Transformers	39	7,064	98.19	95.96
275/220 kV Transformers	3	1,200	98.76	92.27
400/220 kV Transformers	5	2,500	96.22	87.20
Total	**47**	**10,764**		

In 2009:

- The average plant availability was 94.24%;
- The maximum availability by plant type was 97.17%, which occurred on the 400 kV circuits; and
- The minimum availability by plant type was 87.20%, which occurred on the 400/220 kV transformers.

The small reduction in the average plant availability from 97.22% in 2008 to 94.24% in 2009 can in part be attributed to the long outage of one of the 400/220 kV transformers in Woodland station. This transformer was on outage from the 10th June 2009 and remained on outage at the end of 2009. The reduction in the average plant availability from 2008 to 2009 was also affected by the availability of the 275/220 kV transformers which was due to the forced outage of one of the transformers in Louth station which lasted for 36 days.

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

5.3 / Cause of Transmission Plant Unavailability

Transmission system unavailability is classified into the categories outlined in Table 5.2.

Table 5.2: Transmission System Plant Unavailability Categories

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.
Corrective & Preventive Maintenance	**Corrective Maintenance:** Is carried out to repair damaged plant. Repairs are not as urgent as in the case of a forced outage. **Preventive 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.

1) 110 kV Plant Unavailability

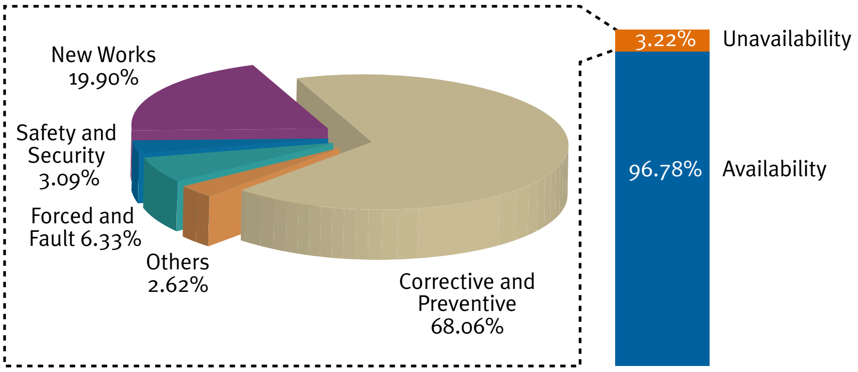
Figure 5.2 provides a breakdown of causes of unavailability on the 110 kV network.

The largest amount of unavailability on the 110 kV system, which was 68%, was due to corrective and preventative maintenance. This type of maintenance includes, amongst others, ordinary service, condition assessments, wood-pole replacement/straightening and general line maintenance. The most significant of the outages was for the refurbishments of the Kilbarry - Mallow 110 kV line and the Dungarvan - Knockraha 110 kV line with both outages lasting 17 and 24 weeks respectively. The refurbishment included uprating and restringing[9] of the conductors.

Approximately 20% of the unavailability on the 110 kV network was due to new works, which included new stations and associated 110 kV lines that were being commissioned during 2009, the most significant of which was 110 kV line works in advance of commissioning of Srananagh 220 kV station.

Forced and Fault issues contributes to 6% of the overall unavailability on the 110 kV system. This figure includes the outage of the Ardnacrusha - Singland 110 kV line, caused by a damaged cable sealing end in Singland 110 kV station, with this outage lasting approximately seven weeks.

Figure 5.2: Causes of Unavailability on the 110 kV system in 2009



2) 220 kV Plant Unavailability

Figure 5.3 provides a breakdown of the causes of unavailability on the 220 kV network.

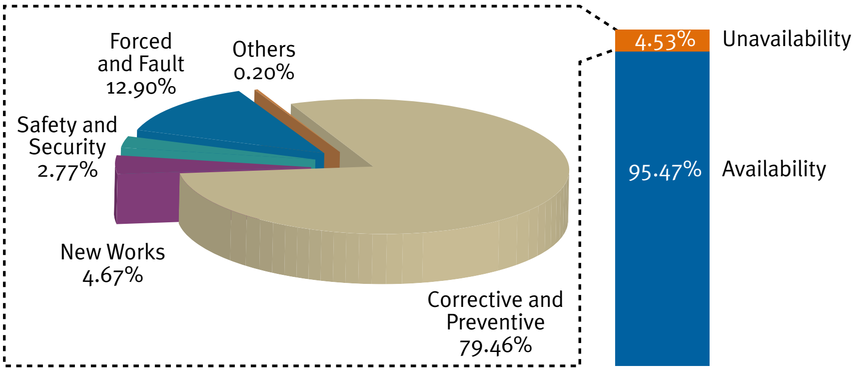
Similar to the 110 kV network the largest portion of unavailability on the 220 kV network, which was 79%, was due to corrective and preventative maintenance. The most significant of these outages was the replacement of the Poolbeg - Shellybanks 220 kV cable which took approximately 13 weeks to complete.

13% of the unavailability on the 220kV network was attributable to forced and fault outages. This was mostly due to the forced outage of the Inchicore - Poolbeg No. 2 220 kV cable which was caused by a fault on the cable sealing end in Poolbeg 220 kV station. This outage commenced on the 17th April 2009 and remained forced out until the end of December 2009.

Approximately 5% of the unavailability on the 220kV network was due to new works being carried out. This was mainly due to outages associated with the commissioning of the new Aghada - Longpoint 220 kV cable and the Aghada - Glanagow 220 kV cable to facilitate the connection of the new Combined Cycle Gas Turbines (CCGTs) in Aghada and Whitegate respectively.

9 Restringing and resagging lines are terms used to commonly describe the work carried out to increase the current carrying capacity of the line.

Figure 5.3: Causes of Unavailability on the 220 kV system in 2009



3) 275 kV Plant Unavailability

The 275 kV tie-line consists of 48.5 km of 275 kV double circuit between Louth station and Tandragee station which is situated in County Armagh. In 2009 there were three outages in total on the 275 kV tie line. The Louth – Tandragee No. 1 275 kV line had one outage for routine corrective maintenance which lasted 18 days during June/July. The Louth - Tandragee No. 2 275 kV line had two outages for routine corrective maintenance, one of these outages lasted 19 days in August while the second lasted six hours in July.

4) 400 kV Plant Unavailability

On the 400 kV system, there were four outages in total for the three 400 kV overhead lines. These outages included two outages on the Moneypoint - Oldstreet 400 kV line and two outages on the Dunstown - Moneypoint 400 kV line. All four outages lasted a total of 22 days. One of the outages was a forced outage on the Moneypoint - Oldstreet 400 kV line for eight hours to reset the Oldstreet 400 kV circuit breaker air supply mechanism. The other three outages were conducted for routine maintenance, repairs and inspections.

Table 5.3 provides a breakdown of the transmission system outages that occurred in 2009 by plant type.

Table 5.3: Transmission System Plant Outages 2009

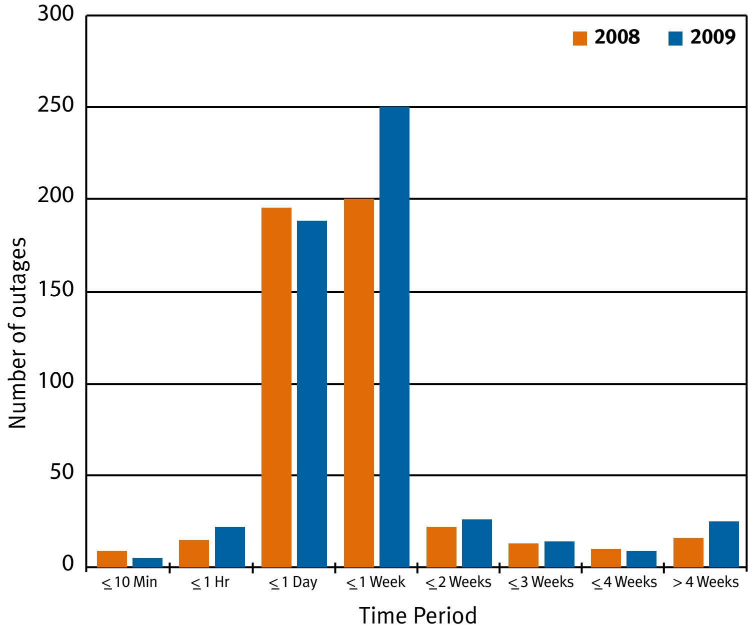
			Type of Outage					
Plant Type	**Number of Items**	**Circuit Length [km]**	**Forced & Fault**	**Safety & System Security**	**New Works**	**Corrective & Preventive Mainten-ance**	**Other**	**Total Number of Outages[10]**
110 kV Circuits	183	4,087	19	81	53	225	44	422
220 kV Circuits	53	1,835	13	17	12	54	16	112
275 kV Tie-lines	2	97	0	0	0	3	0	3
400 kV Circuits	3	439	1	0	0	3	0	4
Total	**241**	**6,458**	**33**	**98**	**65**	**285**	**60**	**541**
Plant Type	**Number of Items**	**Trans-former Capacity [MVA]**	**Forced & Fault**	**Safety & System Security**	**New Works**	**Corrective & Preventive Mainten-ance**	**Other**	**Total Number of Outages[10]**
220/110 kV Transformers	39	7,064	6	10	3	54	5	78
275/220 kV Transformers	3	1,200	2	0	0	4	0	6
400/220 kV Transformers	5	2,500	1	0	0	5	0	6
Total	**47**	**10,764**	**9**	**10**	**3**	**63**	**5**	**90**

5.4 / Transmission Outage Duration

The duration of transmission outages is useful for assessing transmission system performance. Transmission outages are broken into eight time classifications ranging from less than 10 minutes to greater than four weeks. The total number of outages in each time classification is shown in Figure 5.4.

10 A circuit is on outage when any part of the circuit is de-energised. Multiple outages may be recorded for a busbar outage.

Figure 5.4: Duration of Outages in 2009

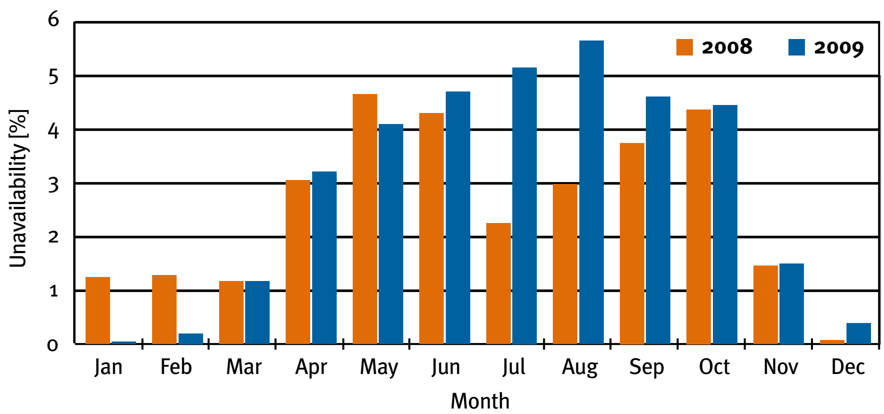


The two most frequent transmission system outage periods occur between one hour and one day and between one day and one week. In the category of one hour to one day, outages can be arranged to avoid peak load times, and their effect on the system can be significantly reduced.

5.5 / Timing of Transmission Outages

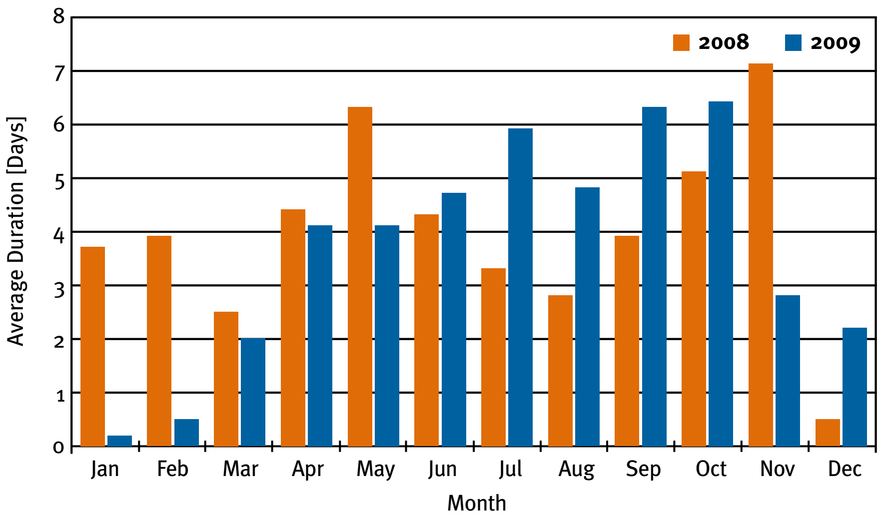
Transmission outages are scheduled, where possible, during periods of low load in the summer period. However this can be limited by a number of factors such as personnel availability and shortage of hydro-power support in some areas. The seasonal nature of transmission outages is examined by giving the percentage of the total number of maintenance outages which occurred in each month shown in Figure 5.5 and also the average duration of these outages shown in Figure 5.6.

Figure 5.5: Maintenance Outages in 2009[11]



11 Maintenance Outages exclude Forced Outages.

Figure 5.6: Average Duration of Maintenance Outages in 2009 [12]



5.6 / Forced Outages

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

There are three types of forced outages.

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

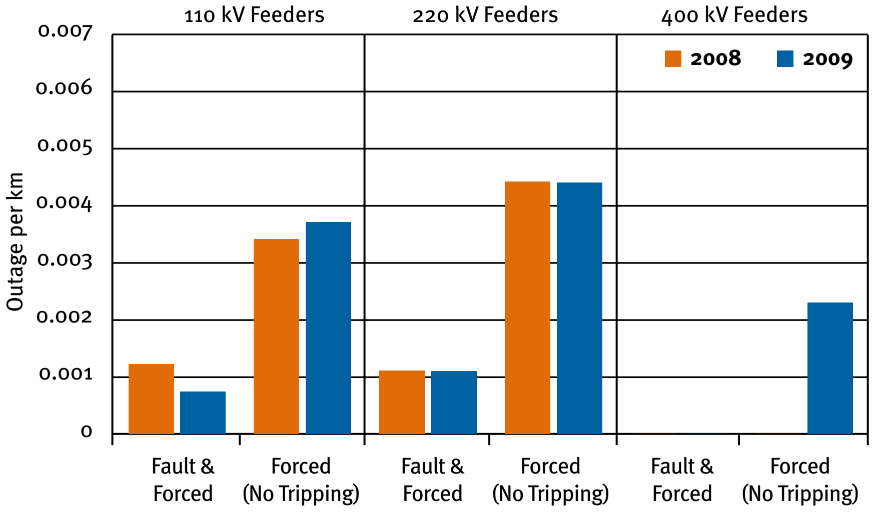
B) Fault & Forced
This occurs when an item of plant is tripped by protection and does not return to service within ten minutes. This typically signifies permanent plant damage, which requires maintenance.

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

The measure used for analysing the forced outages is the number of forced outages per kilometre of feeder. This is shown in Figure 5.7. Fault & Reclose forced outages are excluded due to their relatively low level of disruption.

12 Maintenance Outages exclude Forced Outages.

Figure 5.7: The Nature of Feeder Forced Outages in 2008 & 2009.



There were nine transformer forced outages in 2009. Six of these were on the 220/110 kV transformers, with the forced outage duration ranging from approximately 1 hour to 11 days. The 275 / 220 kV transformers had two forced outages with the longest lasting 36 days. There was one forced outage of a 400/220 kV transformer in 2009. The transformer tripped on the 10th June 2009 due to an oil leakage caused by studs becoming sheared off the main tank. The transformer remained out of service at the end of 2009 and was due to re-energise at the end of January 2010.

06 / GENERATION AVAILABILITY & OUTAGES

6.1 / Generation Availability

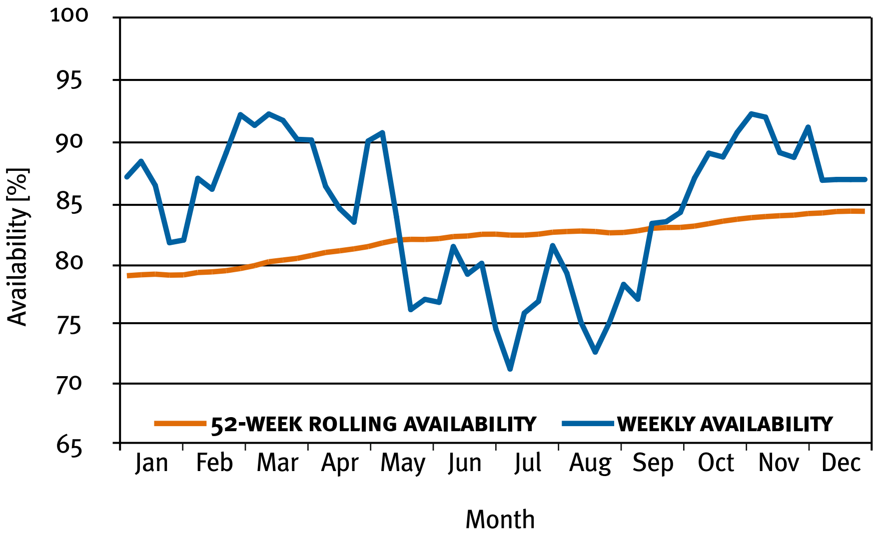
Generation Availability is a measure of the capability of generators to deliver power to the transmission system. In order for EirGrid to operate a secure and reliable transmission system in an economic manner, it is necessary for generators to maintain a high rate of availability. Appendix 1 provides a breakdown of availability of fully dispatchable generating units for 2009.

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

Generation system availability is calculated on a weekly and 52-week[13] rolling average basis. Weekly availability is a capacity weighted percentage of the time from 00:00 Sunday to 00:00 Sunday that generators are available. 52-week rolling availability is the average of the weekly availability over the previous 52 weeks.

Figure 6.1 shows the weekly and 52-week rolling average availability for 2009.

Figure 6.1: Generation System Availability 2009[14]



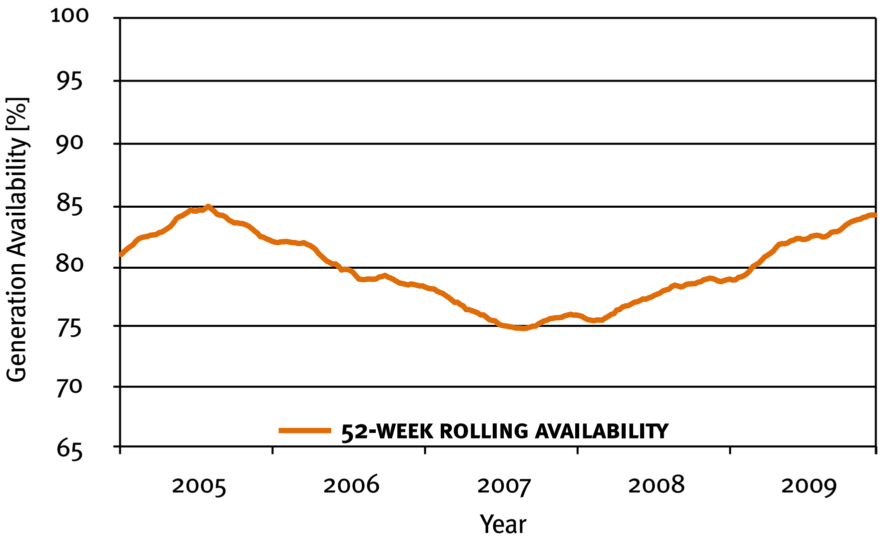
- The average weekly generation system availability in 2009 was 84.35%.
- The maximum weekly generation system availability in 2009 was 92.37%, occurring in week 45.
- The minimum weekly generation system availability in 2009 was 71.20%, occurring in week 28.

Figure 6.2 shows the 52-week rolling average generation system availability trend over the past five years. Generation system availability declined from a high of 85.01% in mid 2005 to a low of 75.03% in 2007. Since then, the average weekly generation system availability has increased to 84.35%.

13 EirGrid use the ISO standard for week numbers, which states that week 1 of a given year is the week which contains the first Thursday of that year.

14 This figure includes the long term outage of PB3 (242 MW).

Figure 6.2: 52-Week Rolling System Availability 2005 - 2009

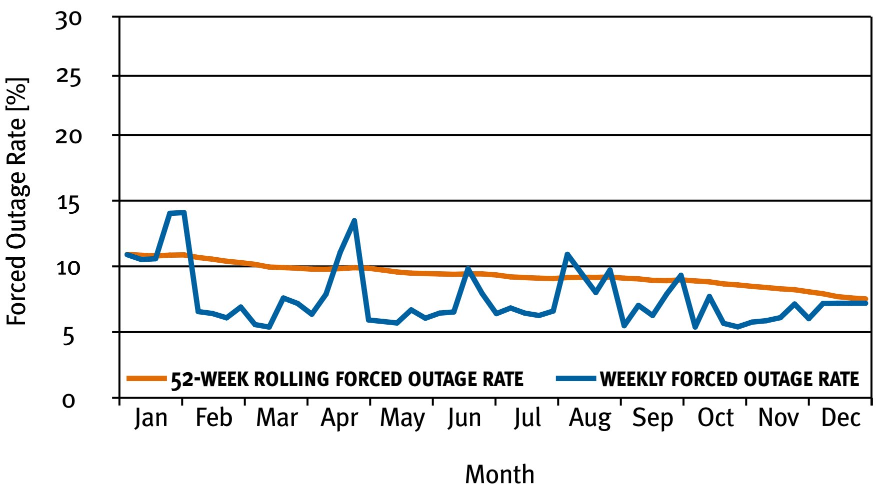


6.2 / Generation System Forced Outage Rate

The generation system forced outage rate is calculated on a weekly and rolling 52-week average basis. The weekly forced outage rate is a capacity weighted percentage of the time from 00:00 Sunday to 00:00 Sunday that generators are unavailable due to unforeseen/unplanned outages. The 52-week rolling forced outage rate is the average of the weekly forced outage rate over the previous 52 weeks.

The weekly forced outage rates and 52-week rolling forced outage rates are shown in Figure 6.3.

Figure 6.3: Generation System Forced Outage Rate 2009[15]

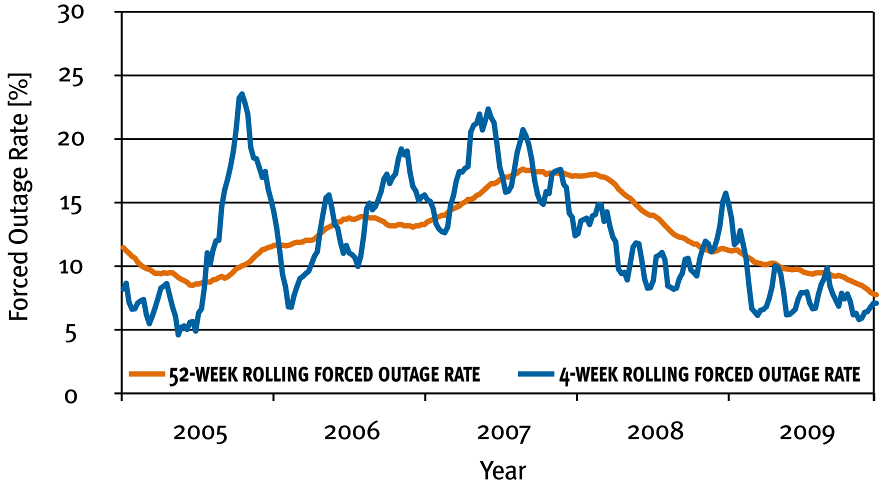


- The average weekly generation system forced outage rate in 2009 was 7.73%.
- The maximum weekly generation system forced outage rate in 2009 was 14.34%, occurring in week 5.
- The minimum weekly generation system forced outage rate in 2009 was 5.49%, occurring in week 11.

15 These figures include the long term outage of PB3 (242 MW). The average weekly generation system forced outage rate in 2009 is 3.76% when PB3 is excluded.

Figure 6.4 shows the generation system forced outage rate over the last five years on a 4-week and 52-week rolling average basis. The 4-week rolling forced outage rate is calculated in a similar way to the 52-week rolling average. The highest 4-week forced outage rate in 2009 was 15.37%.

Figure 6.4: Generation System Forced Outage Rate 2005-2009



07 / GENERAL SYSTEM PERFORMANCE

7.1 / System Minutes Lost

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

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

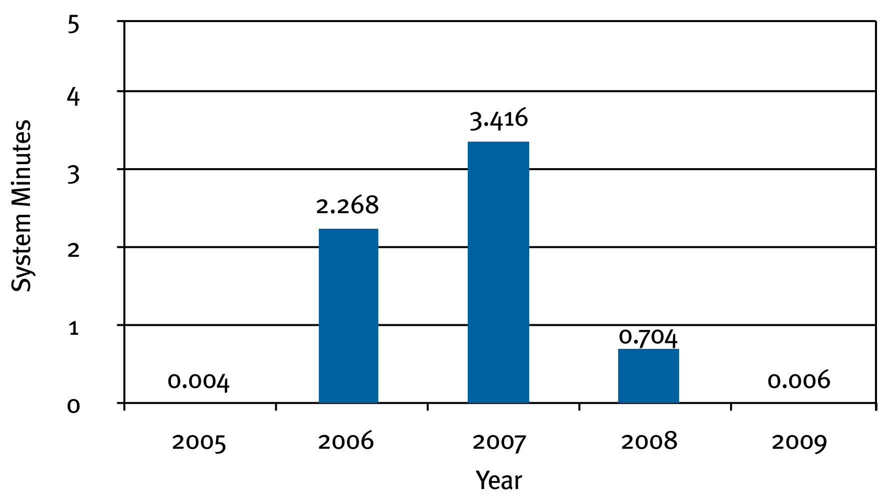
System minutes can be lost for many reasons, however only those associated with transmission system faults are detailed here. Table 7.1 details the system minutes lost in 2009 due to transmission system faults.

Table 7.1: System Minutes Lost due to Transmission Faults in 2009

Date	Location	Cause	MVA Minutes	System Minutes
21 Apr 2009	Gortawee – Arva 110 kV Busbar	Mal Operation	6.705	0.001
23 Jul 2009	Middleton 110 kV Busbar	Undesired Relay Operation	0.279	<0.001
19 Sep 2009	Crane T122 Transformer	Undesired Relay Operation	27.317	0.005
11 Oct 2009	Ryebrook 110 kV A1 Busbar	Mal Operation	1.220	<0.001
Total			**35.521**	**0.006**

The total system minutes lost due to transmission faults in 2009 was 0.006 system minutes, by international standards 0.006 system minutes is very low.

Figure 7.1: System Minutes lost due to Transmission Faults only [2005-2009]



There was one under frequency incident in 2009 which resulted in the loss of 0.033 system minutes. This under frequency incident occurred on 8th June 2009 at 12:52 and was caused by the tripping of a 400 MW generator. The frequency dropped to a minimum of 49.29 Hz and recovered to within the target operating range of 50 ± 0.1 Hz within approximately 9 minutes. The Short Term Active Response (STAR) scheme was activated during this incident. This is a scheme operated by EirGrid whereby large electricity consumers voluntarily contract to make their load available for short term interruptions. The system minutes lost during this incident relate entirely to contracted STAR customers. No non-contracted customers lost supply during this incident.

This incident is summarised in Table 7.2.

Table 7.2: System Minutes Lost due to Under Frequency Events in 2009

Date	Cause	Frequency Nadir [Hz]	MVA Minutes	System Minutes
08 Jun 2009	Generator tripped from 400 MW	49.29	169.648	0.033
Total			**169.648**	**0.033**

7.2 / System Frequency & Frequency Deviation

The National Control Centre aims to maintain the frequency within a target operating range of 50 ±0.1 Hz[16]. The frequency, however, may deviate outside the normal operating range under fault or abnormal operating conditions. In 2009, the frequency was maintained within the target operating limits of 50 ±0.1 Hz for 98% of the time, an improvement over 97% in 2008.

Table 7.3: System Frequency & Frequency Deviation 2009

Mean Frequency:	50.00 Hz
Standard Deviation:	0.04 Hz
Minimum Frequency:	49.29 Hz
Maximum Frequency:	50.30 Hz

7.3 / Zone Clearance Ratio

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

See Appendix 4.3 for an explanation of Zones of Protection.

High performance of the protection system is indicated by a low fault clearance ratio. The fault clearance ratio for 2009 was 3.03%.

16 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).

Table 7.4: Zone Clearance Ratio 2009

	2009
Zone 1 clearance	32
Non Zone 1 clearances	1
Non Zone 1 clearances to total clearances	1/33 = 0.0303
% of Zone Clearance Ratio	3.03%

APPENDIX 1 – FULLY DISPATCHABLE GENERATION PLANT INFORMATION[17]

Company	Unit	Capacity [MW]	Fuel	52-Week Rolling Average Availability %
Aughinish Alumina Ltd	Seal Rock - SK3	80	Gas / Distillate Oil	92.8
	Seal Rock - SK4	80	Gas / Distillate Oil	90.3
Edenderry Power Ltd	Edenderry - ED1	118	Peat	80.4
Endesa [18]	Great Island - GI1	54	Heavy Fuel Oil	95.8
	Great Island - GI2	54	Heavy Fuel Oil	86.9
	Great Island - GI3	109	Heavy Fuel Oil	89.1
	Rhode - RP1	52	Distillate Oil	98
	Rhode - RP2	52	Distillate Oil	98.3
	Tarbert - TB1	54	Heavy Fuel Oil	95.2
	Tarbert - TB2	54	Heavy Fuel Oil	94.6
	Tarbert - TB3	243	Heavy Fuel Oil	95.5
	Tarbert - TB4	243	Heavy Fuel Oil	93
	Tawnaghmore - TP1	52	Distillate Oil	97.2
	Tawnaghmore - TP3	52	Distillate Oil	98.8
ESB Power Generation	Ardnacrusha - AA1	21	Hydro	96.4
	Ardnacrusha - AA2	22	Hydro	90.7
	Ardnacrusha - AA3	19	Hydro	97.5
	Ardnacrusha - AA4	24	Hydro	99
	Aghada - AD1	257	Gas	91.2
	Aghada - AT1	90	Gas / Distillate Oil	69.7
	Aghada - AT2	90	Gas / Distillate Oil	97.6
	Aghada - AT4	90	Gas / Distillate Oil	99.7
	Erne - ER1	10	Hydro	98.6
	Erne - ER2	10	Hydro	98.6
	Erne - ER3	23	Hydro	95.2
	Erne - ER4	23	Hydro	96.8
	Lee - LE1	15	Hydro	86.5
	Lee - LE2	4	Hydro	94.4
	Lee - LE3	8	Hydro	95.8
	Liffey - LI1	15	Hydro	91.9
	Liffey - LI2	15	Hydro	77.7
	Liffey - LI4	4	Hydro	99.7
	Liffey - LI5	4	Hydro	73.7
	Lough Ree Power - LR4	90	Peat	90.8
	Moneypoint - MP1	285	Coal / Heavy Fuel Oil	85.7
	Moneypoint - MP2	285	Coal / Heavy Fuel Oil	87.1
	Moneypoint - MP3	285	Coal / Heavy Fuel Oil	76
	Marina - MRC	123	Gas / Distillate Oil	72.7
	Northwall - NWC	154	Gas / Distillate Oil	75.1
	Northwall - NW5	109	Gas / Distillate Oil	95.4
	Poolbeg - PB1	115	Gas / Heavy Fuel Oil	90.2
	Poolbeg - PB2	115	Gas / Heavy Fuel Oil	86.9
	Poolbeg - PB3	242	Gas / Heavy Fuel Oil	0
	Poolbeg - PB4	154	Gas / Distillate Oil	93.4
	Poolbeg - PB5	150	Gas / Distillate Oil	96
	Poolbeg - PB6	173	Gas / Distillate Oil	90.1
	Turlough Hill - TH1	73	Hydro - Pumped Storage	89.7
	Turlough Hill - TH2	73	Hydro - Pumped Storage	96.4
	Turlough Hill - TH3	73	Hydro - Pumped Storage	98.1
	Turlough Hill - TH4	73	Hydro - Pumped Storage	93.5
	West Offaly Power - WO4	137	Peat	76.2
Synergen	Dublin Bay - DB1	415	Gas / Distillate Oil	80.6
Tynagh Energy Ltd	Tynagh - TYC	400	Gas / Distillate Oil	82.7
Viridian Power & Energy	Huntstown - HNC	344	Gas / Distillate Oil	94.7
	Huntstown - HN2	408	Gas / Distillate Oil	88.2
Total		**6,317**		**84.6**

17 This information is per the EirGrid Monthly Availability Report, December 2009
18 As of 8th January 2009 Endesa took over ownership of these units from ESB Power Generation

APPENDIX 2 – SIGNIFICANT CAPITAL PROJECTS 2009

New Circuits

Ardnacrusha – Singland 110 kV line
Boggeragh – Clashavoon 110 kV line
Cathaleens Fall – Srananagh No.1 & 2 110 kV line
Corderry – Srananagh 110 kV line
Dromada – Trien 110 kV line
Killonan – Singland 110 kV line
Sligo – Srananagh No.1 & 2 110 kV line
Aghada – Longpoint 220 kV cable
Aghada – Glanagow 220 kV cable

Circuit Upratings and Refurbishments

Crane – Wexford 110 kV line uprate
Drybridge – Louth 110 kV line uprate
Dungarvan – Knockraha 110 kV line uprate
Flagford – Lanesboro 110 kV line refurbishment and partial uprate
Flagford – Sligo 110 kV line refurbishment
Kilbarry – Mallow 110 kV line uprate
Aghada – Knockraha No.1 & 2 220 kV line refurbishment
Carrickmines – Dunstown 220 kV line refurbishment
Gorman – Louth 220 kV line refurbishment
Poolbeg – Shellybanks 220 kV cable uprate

New Stations

Athy 110 kV station
Boggeragh 110 kV station
Dromada 110 kV station
Singland 110 kV station
Longpoint 220 kV station
Glanagow 220 kV station
Srananagh 220 kV station

Transmission Stations Refurbishments

Macetown 110 kV station – Installation of surge arrestors
Letterkenny 110 kV station – Installation of surge arrestors
Cashla 220 kV station – Circuit breaker replacement in Prospect Bay
Knockraha 220 kV station refurbishment

New Generator Connections Provided

IPP038FC Meentycat windfarm phase 2 extension
IPP038GC Coomacheo windfarm extension
IPP042B Mountain Lodge windfarm extension
IPP057 Boggeragh windfarm
IPP089 Aghada CCGT
IPP091B Lisheen windfarm
IPP102 Whitegate CCGT
IPP120 Dromada windfarm
Coomagearlahy 110 kV station – IPP windfarm extension works

Other Projects Completed

Underground diversion Stepaside [Carrickmines-Dunstown 220 kV Line]

APPENDIX 3 – MAINTENANCE POLICY TERMS

Appendix 3.1 – Transmission System Maintenance Policy Terms

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

There are three primary maintenance categories:

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

Stations:

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

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

diverter switch compartment. If filters are fitted, the interval can be extended to 20 years.

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

Overhead Lines:

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

Examples include:

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

Although age may be a factor contributing to increased corrective maintenance requirements there are other factors which significantly affect required maintenance that are age independent. These include location (heavily fertilised farmland/polluted industrial environment/coastal areas), damage by livestock/farm machinery, local climate (damp environment conducive to corrosion), timber growth, vandalism, damage by birds, loading of lines and acts of God.

Cables:

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

APPENDIX 4 – DEFINITIONS & FORMULAE

Appendix 4.1 – Availability & Unavailability Formula

The availability of 110kV, 220 kV, 275 kV and 400 kV lines is calculated using equation 4.1

$$Availability = 1 - \frac{\sum_{i=1}^{i=n} Duration\ of\ Outage\ (i) * Length\ of\ line\ (i)}{\sum_{j=1}^{j=m} Length\ of\ Line\ (j) * Days\ of\ Year} \quad (4.1)$$

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 400 kV/220 kV, 275 kV / 220 kV and 220 kV/110 kV transformers is calculated using equation 4.2

$$Availability = 1 - \frac{\sum_{i=1}^{i=n} Duration\ of\ Outage\ (i) * MVA\ of\ transformer\ (i)}{\sum_{j=1}^{j=m} MVA\ of\ transformer\ (j) * Days\ in\ a\ year} \quad (4.2)$$

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

System Unavailability, for any period, is calculated using equation 4.3. Equation 4.3 is the same as that used by OFGEM (The Office Of Gas And Electricity Markets) in the UK.

$$System\ Unavailability = 1 - \frac{\sum Hours\ each\ circuits\ is\ available}{Number\ of\ circuits * Hours\ in\ period} \quad (4.3)$$

Appendix 4.2 – System Minute Formula

The international benchmark for system performance and reliability is the System Minute.

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

$$System\ Minutes = \frac{Energy\ not\ supplied\ MW\ minutes}{Power\ at\ System\ Peak} \quad (4.4)$$

$$= \frac{(MVA\ minutes) * (Power\ Factor)}{System\ Peak\ to\ Date} \quad (4.5)$$

Where: Power Factor = 0.9

Appendix 4.3 – Protection Zones

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

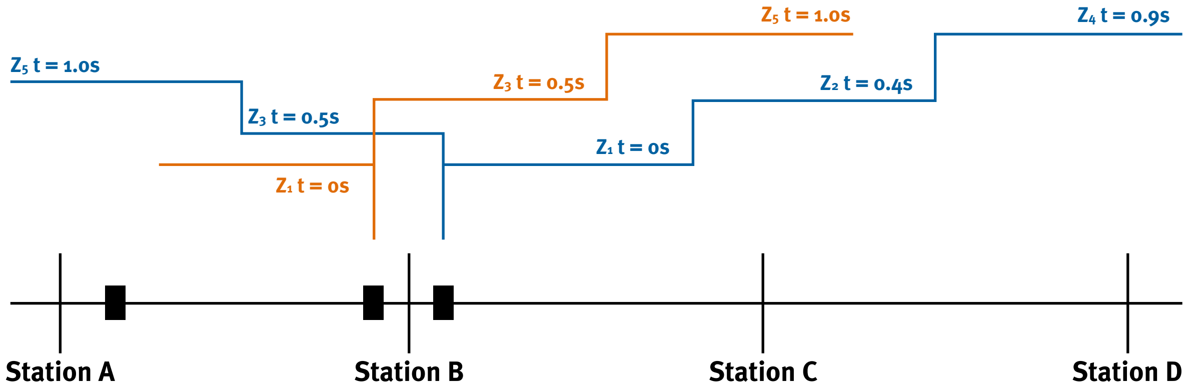
Zone 2 on a distance relay is used as the backup protection zone and is set to 100 % of the circuit length plus 20 – 50 % of the length of the shortest feeder at the remote end of the protected circuit. A delay of approximately 400 ms is applied in zone 2 settings and so typical zone 2 fault clearance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

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

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

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

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



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

$$\textit{Zone Clearance Ratio} = \frac{\textit{Short circuit faults not cleared in Zone 1}}{\textit{Total number of short circuit faults cleared}} \quad (4.6)$$

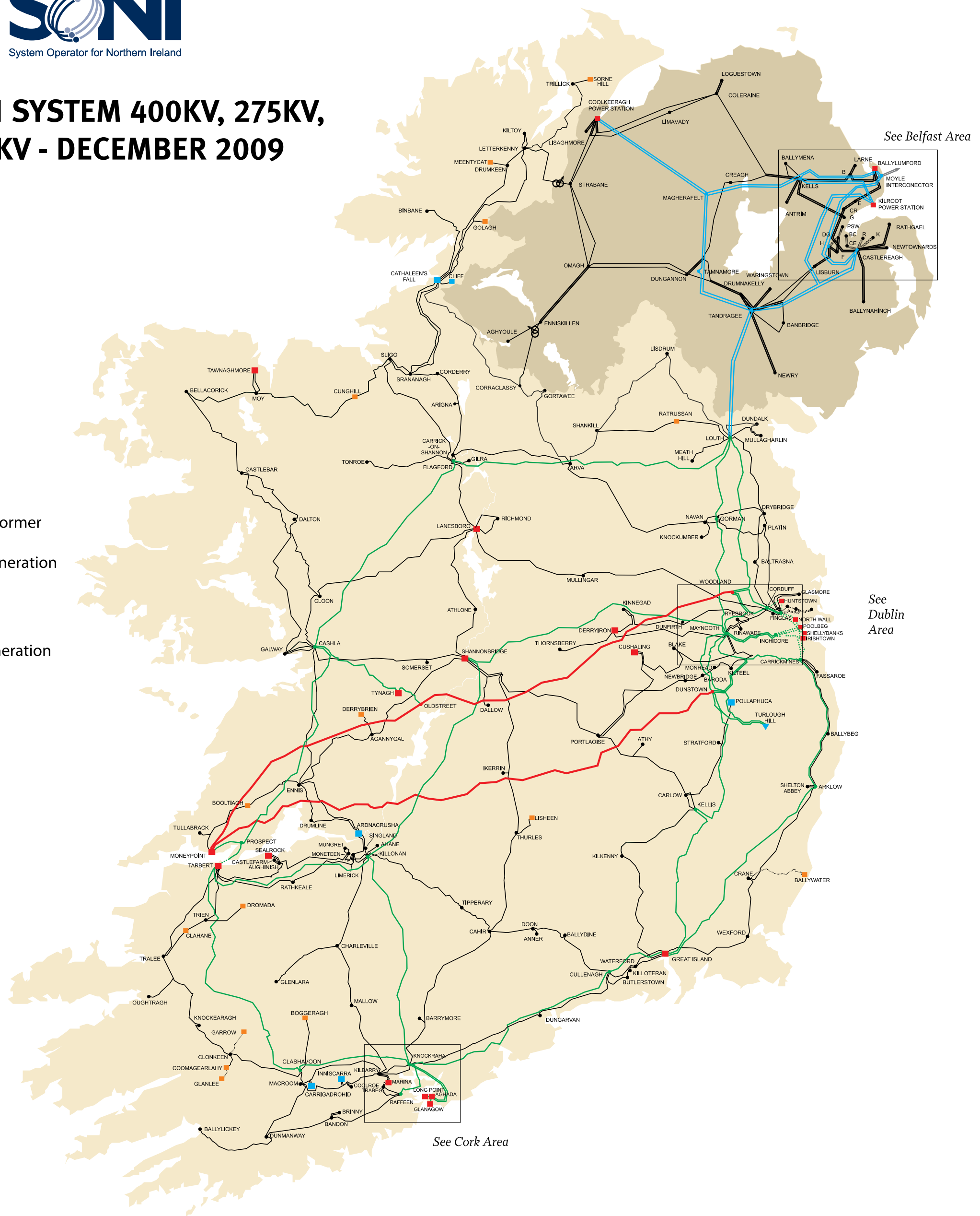
A target for the zone clearance ratio has been agreed with the CER as well as the upper and lower bounds.

TRANSMISSION SYSTEM 400KV, 275KV, 220KV AND 110KV - DECEMBER 2009

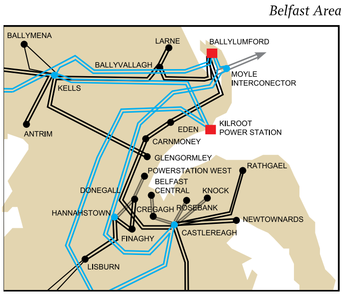
- 400kV Lines
- 275kV Lines
- 220kV Lines
- 110kV Lines
- 220kV Cables
- 110kV Cables
- 400kV Stations
- 275kV Stations
- 220kV Stations
- 110kV Stations
- Phase Shifting Transformer

Transmission Connected Generation

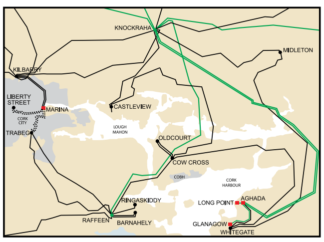
- Hydro Generation
- Thermal Generation
- Pumped Storage Generation
- Wind Generation



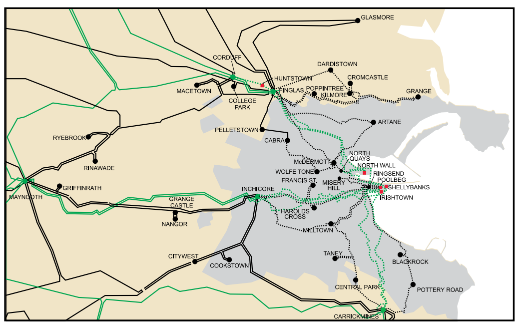
Belfast Area



Cork Area



Dublin Area



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