

All-Island Transmission System Performance Report 2023

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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 2023. This report contains transmission system data and performance statistics for the transmission system in Ireland and Northern Ireland for the year 2023 (1 January 2023 - 31 December 2023).

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 Regulation of Utilities (CRU).

Similarly, SONI is required to produce an annual report on the performance of the TSO business in accordance with Condition 20 of the Licence to participate in the Transmission of Electricity granted to SONI Ltd by the Department for the Economy.

Through comparison with previous reports, this report provides a useful resource through which trends can be identified.

This report is structured as follows:

- Section 3 outlines all-island system data, generation availability and outages,
- Section 4 details the performance of the EirGrid TSO business during 2023 against the criteria approved by the CRU,
- Section 5 details the performance of the SONI TSO business during 2023 against the criteria approved by The Utility Regulator in Northern Ireland.

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

2. Executive Summary

The annual Transmission System Performance Report for 2023 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.

Key statistics detailed in this report include:

- Generation statistics
- Transmission system availability statistics
- Details on system events leading to system minutes lost
- Details of system frequency events

2.1. Key Data

All-island

- All-island peak demand reached 6,836 MW on 5 December 2023 at 17:22. The minimum all-island demand was 2,914 MW and occurred on 2 July 2023 at 05:41.
- The all-island installed capacity of dispatchable generation (including Aggregated Generator Units (AGUs) and excluding batteries) on 31 December 2023 was 7,336 MW.
- In 2023 the system frequency was operated within 49.9 Hz and 50.1 Hz for 98.71% of the time.

Ireland

- In 2023 the availability of the East West Interconnector was 99.1%.
- The weighted-average availability of the Ireland transmission system in 2023 was 95.31%.
- The System Minutes Lost for 2023, attributable to EirGrid, was 4.461.

Northern Ireland

- The availability of the Moyle Interconnector for 2023 was 99.26%.
- The average availability of the Northern Ireland transmission system in 2023 was 97.03%.
- The System Minutes Lost for 2023, attributable to SONI, was 0.669.

3. All-Island System Data

3.1. Overview of the All-Island Electricity System

The transmission system in Ireland and Northern Ireland provides the means to transport energy from generators to demand centres across the island. The transmission system is comprised of high-voltage overhead lines and cables that connect power stations, interconnectors and substations. Transformers link different voltage levels and provide a path for power to flow, typically, from higher to lower voltage networks. The transmission system in Ireland is operated at 400 kV, 220 kV and 110 kV. The transmission system in Northern Ireland is operated at 275 kV and 110 kV.

The 400 kV, 275 kV and 220 kV networks form the backbone of the transmission system. They have higher power carrying capacity and lower losses than the 110 kV networks.

The Ireland and Northern Ireland transmission systems are electrically connected by means of a 275 kV double-circuit. This connection is from Louth station in Co. Louth (IE) to Tandragee station in Co. Armagh (NI).

There are also two 110 kV connections:

- Letterkenny station in Co. Donegal (IE) to Strabane station in Co. Tyrone (NI)
- Corraclassy station in Co. Cavan (IE) to Enniskillen station in Co. Fermanagh (NI)

This section contains basic all-island transmission system data. Further information can be found on the EirGrid website: www.eirgrid.ie and the SONI website: <https://www.soni.ltd.uk/>.

3.2. Total System Production

Total exported energy takes into account energy supplied by all generators that have an export meter, including pumped hydro storage units and batteries. This does not take into account interconnector imports and exports.

Table 1: Total Exported Energy 2020 - 2023

	2020	2021	2022	2023 ¹
All-Island Total Exported Energy [GWh]	39,189	38,479	40,889	36,962
Ireland Total Exported Energy [GWh]	30,738	30,123	32,172	30,018
Northern Ireland Total Exported Energy [GWh]	8,451	8,356	8,716	6,944

3.3. 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 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. The all-island winter peak in 2023 was 6,836 MW and occurred at 17:22 on 5 December.

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 2023 a minimum all-island demand of 2,914 MW was recorded at 05:41 on 2 July.

From the installed wind capacity, a peak all-island wind generation output of 4,653 MW was achieved at 15:56 on 6 December. Table 2 provides a summary of the system records for years 2020 - 2023.

Table 2: System Records 2020 - 2023

	2020	2021	2022	2023
Winter Peak Demand [MW]	6,904	6,826	7,031	6,836
Minimum Summer Night Valley [MW]	2,395	2,765	2,887	2,914
Maximum Wind Generation [MW]	4,246	4,489	4,610	4,653

3.4. Generation Capacity

Generating 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 (excluding small-scale). Table 3 summarises

¹ Provisional figures for 2023

the key categories of all-island generation capacity. This does not include any import capacity from the Moyle Interconnector or the East West Interconnector.

Table 3: All-Island Generation Capacity as of 31 December 2023

	Ireland	Northern Ireland	All-Island
Dispatchable Generation (including AGUs) (MW)	5,906 ²	1,430	7,336
Batteries (MW)	546 (506 MWh)	200 (86 MWh)	746 (592 MWh)
Demand Side Units (MW)	669	124	793
Wind (MW)	4,730	1,364	6,095
Solar (MW)	435	118	553

Appendix 2 provides a list of the dispatchable generating units, including batteries and DSUs, connected to the power system.

² This figure includes 199 MW of temporary emergency generation

3.5. Generation Availability

Generation Availability is a measure of the capability of a generator to deliver power in a given period to the transmission system. In order for EirGrid and SONI to operate a secure and reliable transmission system in an economic and efficient manner, it is necessary for generators to maintain a high rate of availability.

Generation system availability is calculated on a daily and 365-day rolling average basis³. Figure 1 shows the daily and 365-day rolling average availability for 2023. It should be noted that the Kilroot KPS1 and KPS2 units and the Tarbert TB1, TB2, TB3 and TB4 units officially closed on 30 September 2023. These units are excluded from the daily and the 365-day rolling availabilities from that date.

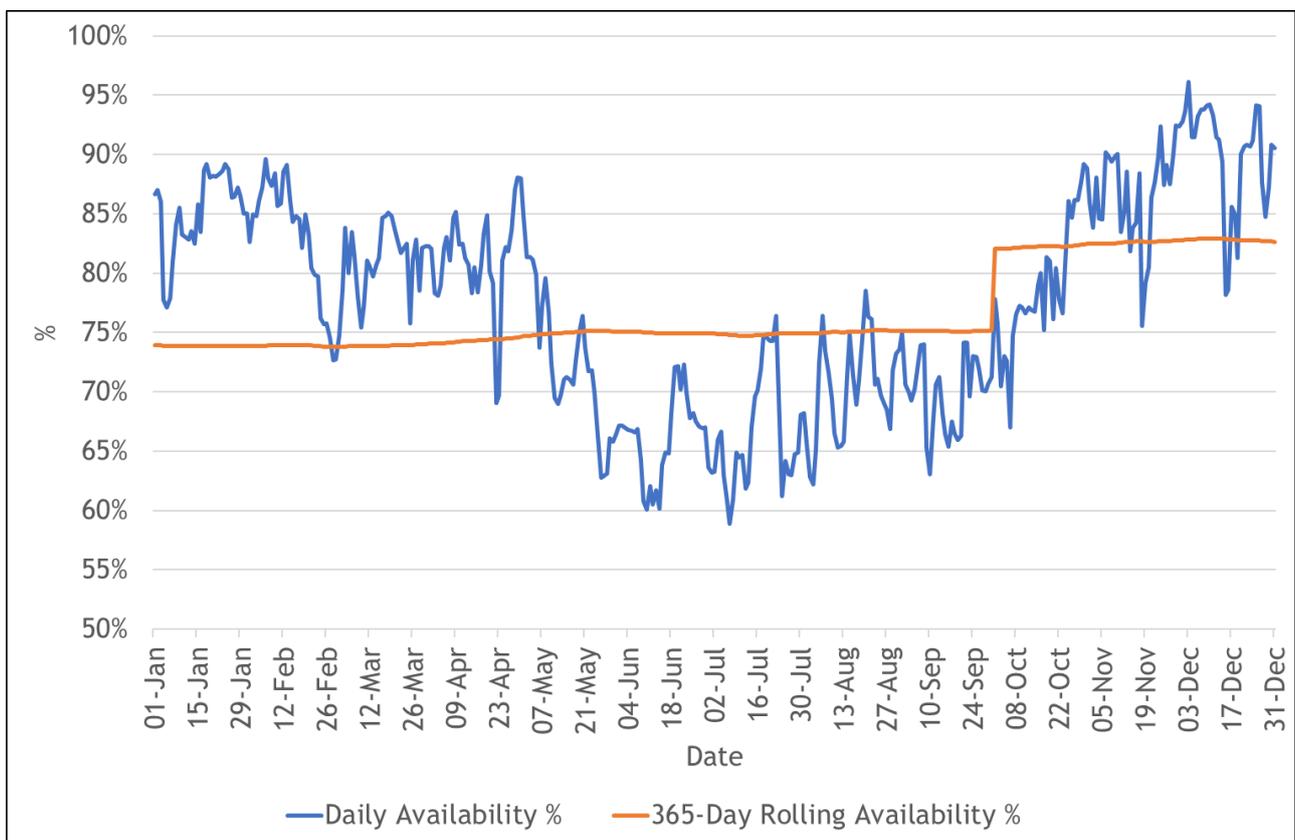


Figure 1: All-Island Dispatchable Conventional Generator (including AGUs) Availability 2023

- The average daily generation availability in 2022 was 77.6%.
- The maximum daily generation availability in 2022 was 96.1%.
- The minimum daily generation availability in 2022 was 58.9%.

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

3.6. Generation Forced Outage %

The generation forced outage % is calculated on a daily and rolling 365-day average basis. The daily forced outage % 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 forced outage % is the average of the daily forced outage % over the previous 365 days. The daily forced outage % and 365-day rolling forced outage % are shown in Figure 2. It should be noted that the Kilroot KPS1 and KPS2 units and the Tarbert TB1, TB2, TB3 and TB4 units officially closed on 30 September 2023. These units are excluded from the daily and 365-day rolling availabilities from that date.

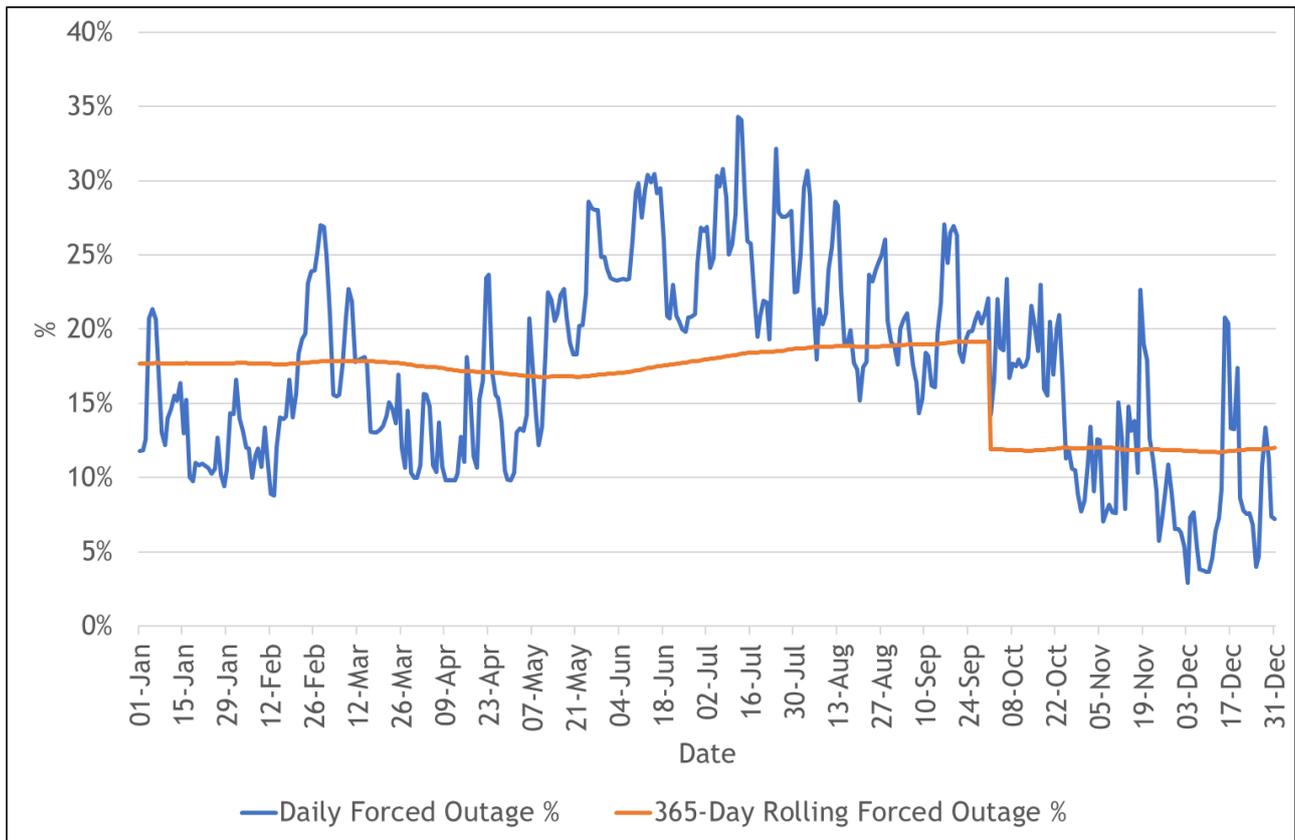


Figure 2: All-Island Dispatchable Conventional Generator (including AGUs) Forced Outage % 2023

- The average daily generation forced outage rate in 2022 was 17.3%.
- The maximum daily generation forced outage rate in 2022 was 34.3%.
- The minimum daily generation forced outage rate in 2022 was 2.9%

3.7. Generation Scheduled Outage %

The generation scheduled outage % can be calculated on a daily and rolling 365-day average basis. The daily scheduled outage % is a capacity weighted percentage of the time during the day that generation units are unavailable due to planned outages. The 365-day rolling scheduled outage % is the average of the daily scheduled outage % over the previous 365 days. The daily scheduled outage % and 365-day rolling scheduled outage % are shown in Figure 3.

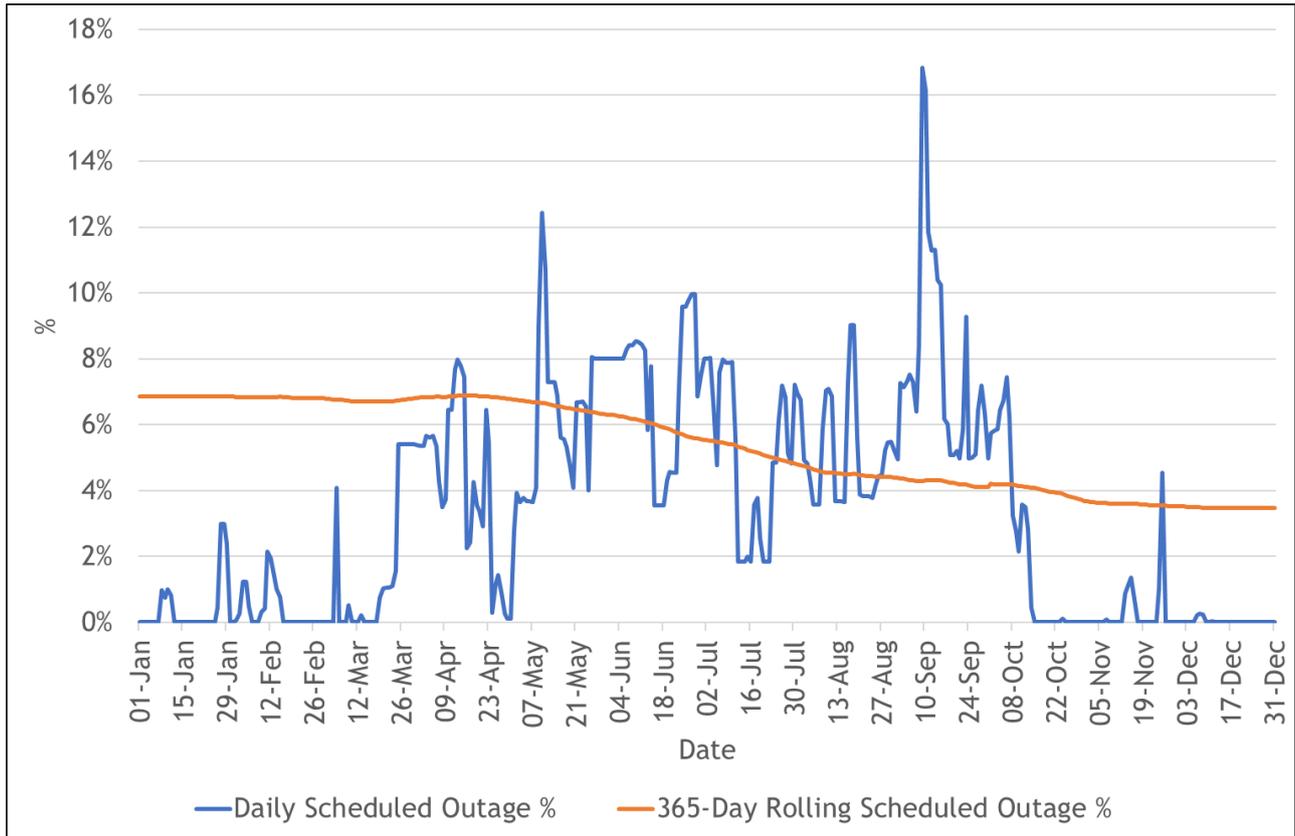


Figure 3: All-Island Dispatchable Conventional Generator (including AGUs) Scheduled Outage Rate 2023

- The average daily generation scheduled outage rate in 2022 was 3.3%.
- The maximum daily generation scheduled outage rate in 2022 was 16.8%.
- The minimum daily generation scheduled outage rate in 2022 was 0%.

3.8. DSU Availability

DSU Availability is a measure of the capability of a Demand Side Unit to deliver demand reduction in a given period to the transmission system. In order for EirGrid and SONI to operate a secure and reliable transmission system in an economic and efficient manner, it is necessary for DSUs to maintain a high rate of availability.

DSU system availability is calculated on a daily and 365-day rolling average basis⁴. Figure 4 shows the daily and 365-day rolling average availability for 2023.

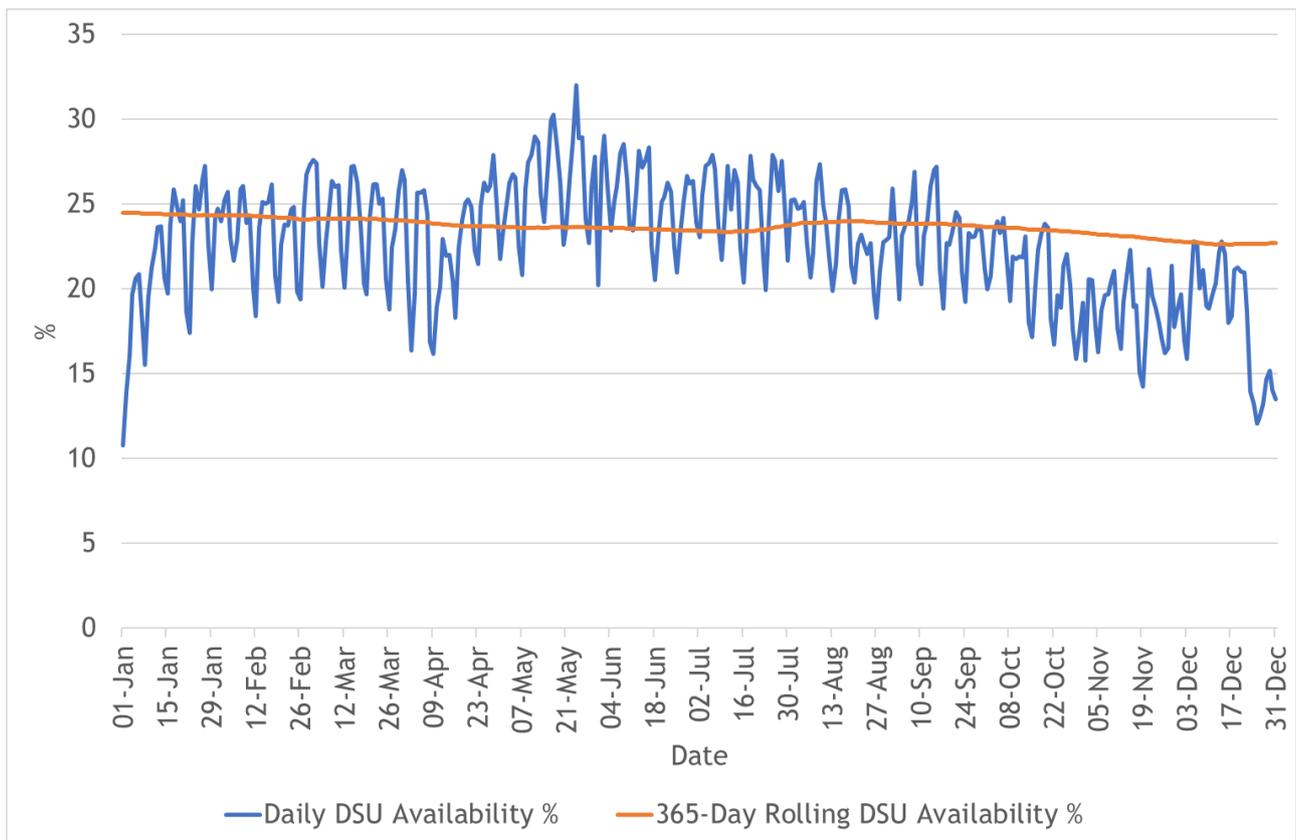


Figure 4: All-Island DSU Availability 2023

- The average daily DSU availability in 2022 was 22.7%.
- The maximum daily DSU availability in 2022 was 32.0%.
- The minimum daily DSU availability in 2022 was 10.8%.

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

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

There was one major incident in 2023. A major incident is one which results in the loss of greater than or equal to one system minute as a result of a single system disturbance.

The system minutes lost as a result of faults on the main system was 4.461 in 2023. No system minutes were lost due to the disconnection of normal tariff load customers during Under Frequency Load Shedding (UFLS) disturbances.

EirGrid have a target to operate the system frequency within the range 49.9 Hz to 50.1 Hz for 98% of the time. In 2023, the system frequency was within the agreed limits 98.71% of the time.

4.2. Grid Development and Maintenance

This section provides an overview of grid development activities in 2023.

4.2.1. Completed Capital Projects

- Corduff - Ryebrook 110 kV line uprate
- Thornsberry 110 kV station
- Moneypoint - Oldstreet 400 kV line refurbishment
- Oldstreet - Woodland 400 kV line refurbishment
- Ballynahulla 220/110 kV station STATCOM
- Ballyvouskill 220/110 kV station STATCOM
- Blundelstown 110 kV station
- Kellystown 220 kV station
- Oweninny Power 2
- Bracetown 220 kV station
- Tullabeg 110 kV station
- Profile Park 110 kV station

- Oldbridge 110 kV station
- New Moneypoint 400/220 kV transformer
- Buffy 110 kV station
- Poolbeg BESS
- Irishtown FlexGen/BESS
- Lenalea 110 kV station
- Garballagh 110 kV station
- Northwall Temporary Emergency Generation
- Maynooth - Shannonbridge 220 kV line diversion
- Raffeen - Trabeg - 2 110 kV line diversion

4.2.2. New Connection Offers

Parties seeking a new connection to the transmission system must apply to EirGrid for a connection offer. EirGrid operates within a regulatory approved process for providing connection offers to generators and demand customers seeking direct connection to the transmission system. The process for issuing generation offers was consulted on in 2017 resulting in the Enduring Connection Policy (ECP) which has led to a significant increase in the number of new generation capacity offers issuing between 2019 and 2023. Applications for ECP-2.4 opened in October 2023 and will begin to be processed in Q2 2024.

In order to connect to the transmission system, all demand and generation customers must execute a connection agreement with EirGrid. Table 4: New Capacity Executed Demand & Generation Connection Agreements summarises the total number of new capacity connection agreements executed in 2023 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.

Table 4: New Capacity Executed Demand & Generation Connection Agreements

	Demand	Generation	Autoproducer	Interconnector
Executed Connection Agreements in 2023 [No.]	0	23	0	0
Executed Connection Agreements in 2023 [Capacity]	0.0 MVA	2,830.2 MW	0.0 MW MEC 0.0 MVA MIC	0.0 MW

In addition to issuing connection offers for new generation and demand capacity, EirGrid facilitates existing contracted customers in modifying existing connection agreements.

4.2.3. Connections Energised

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

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

Table 5: Demand & Generation Transmission Connections Energised in 2023 provides an overview of the number of new connections to the transmission system commissioned in 2023.

Table 5: Demand & Generation Transmission Connections Energised in 2023

	Demand	Conventional Generation	PPM ⁵	Battery
Connections Energised in 2023 [No.]	2	3	6	2
Connections Energised in 2023 [Capacity]	137 MVA	327 MW	367.1 MW	105 MW

4.2.4. Customers Certified Operational

Table 6 provides an overview of customers connected to the transmission system who have been deemed fully operational. It shows customer connections which have completed the testing phase and have received an operational certificate from EirGrid. This includes generators connected to the distribution network. Note that demand customers are not currently certified by EirGrid and are therefore not included in the table.

Following energisation, the unit is required to complete Grid Code Compliance testing, following which Operational Certificates⁶ are issued.

⁵ PPM: Power Park Modules.

⁶ EirGrid issues Operational Certificate Justifications for distribution-connected generation. These are the included in the figures shown.

Table 6: Customers Certified Operational in 2023

	Total number of new units certified operational in 2023	Total new capacity certified operational in 2023 (MW)
PPM	1	17.3
Conventional	1	199.0
Battery	7	274.8
DSU including existing with change in capacity	24	28.0
Synchronous Condenser	1	N/A

4.3. General System Performance

4.3.1. Under-Frequency Load Shedding

There were no UFLS disturbances in 2023 which resulted in shedding of normal tariff load customers.

The relays to disconnect normal tariff customer load are only activated once the system frequency drops to 48.85 Hz. The lowest system frequency in 2023 was 49.71 Hz.

Figure 5 provides a trend of the number of disturbances since 2014 that involved operation of under-frequency relays to disconnect interruptible and normal tariff end-users. No normal tariff customers have been disconnected due to an under-frequency disturbance since 2014.

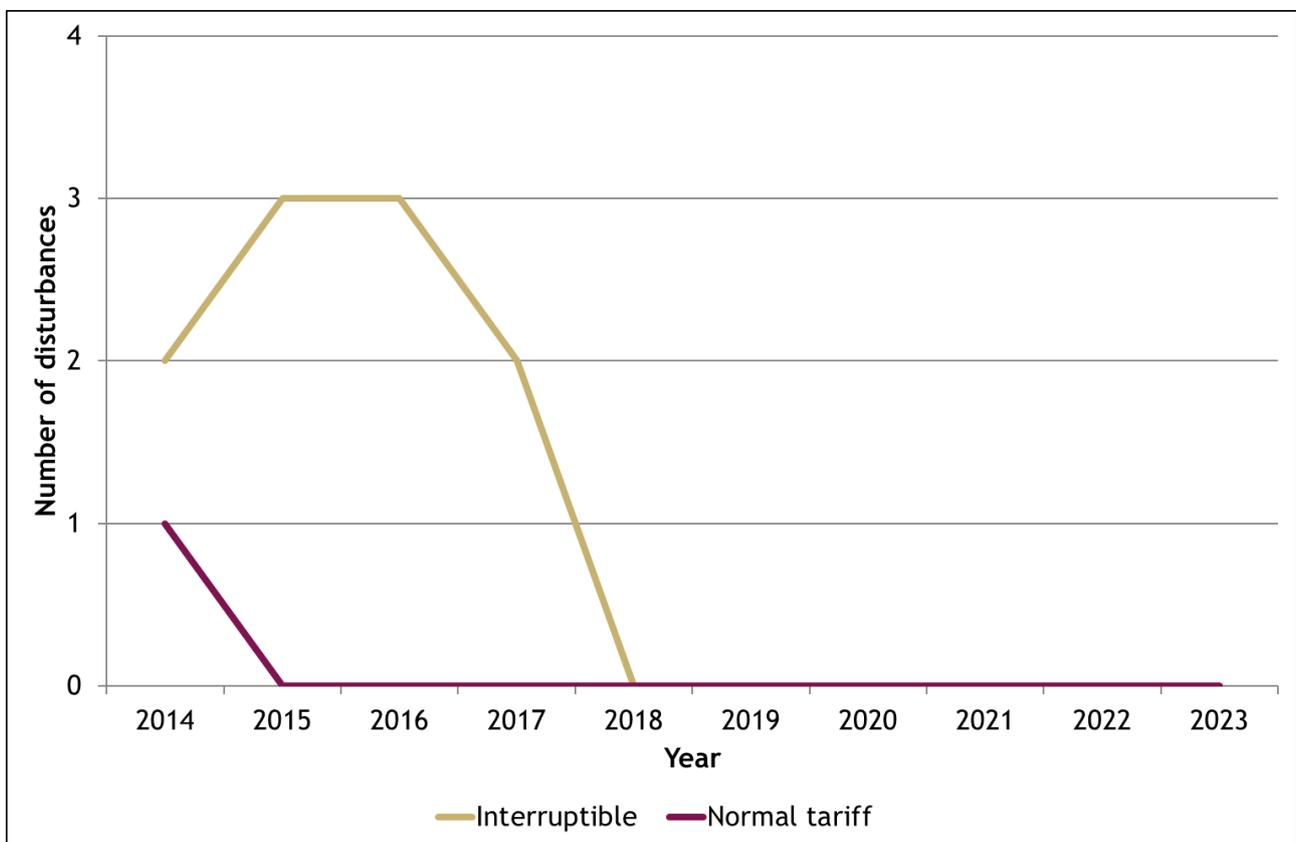


Figure 5: Under frequency disturbances 2014-2023

Figure 6 provides a trend of the lowest system frequency by year since 2014.

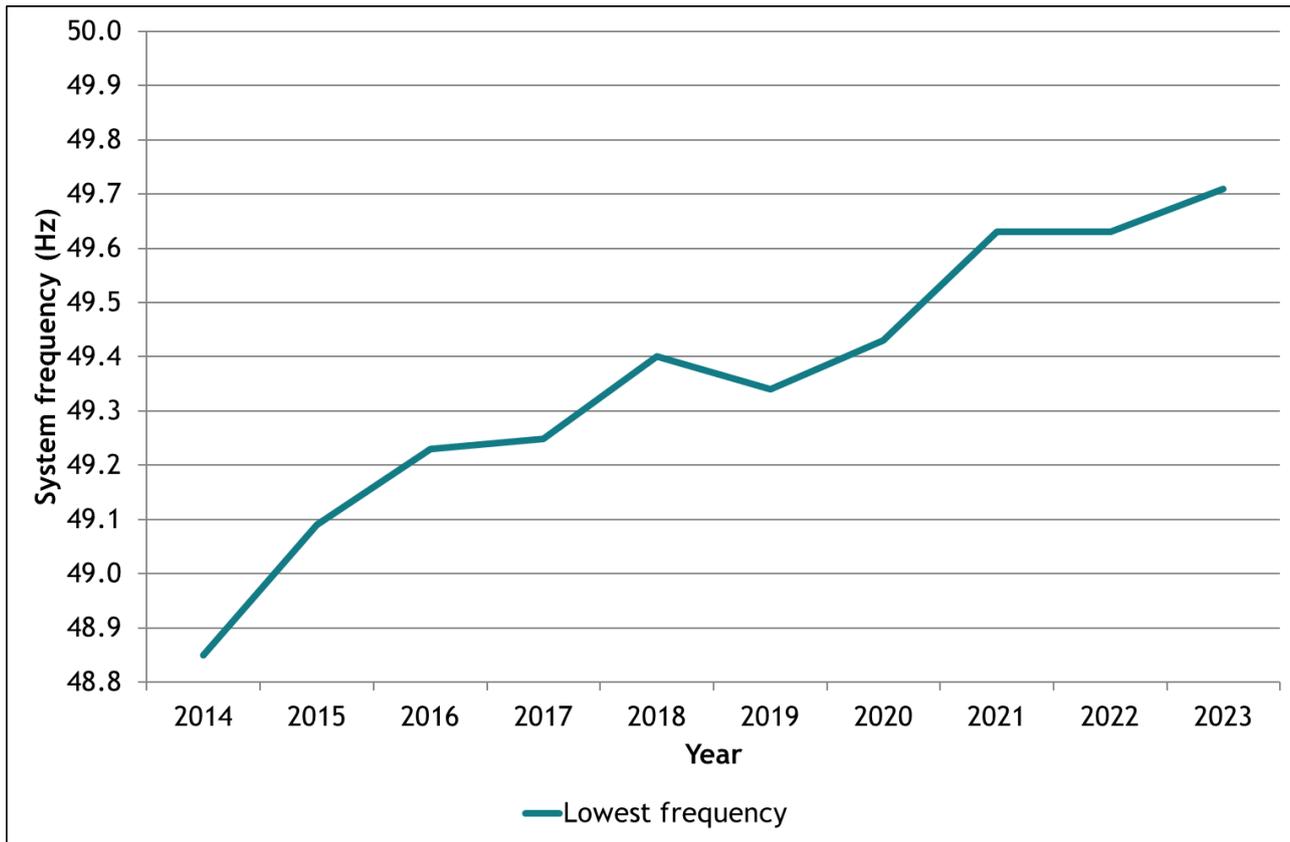


Figure 6: Lowest system frequency 2014-2023

4.3.2. Under-Voltage Load Shedding

There was no incident of Under-Voltage Load Shedding in 2023.

4.4. System Minutes Lost

This section provides information for system minutes lost (SML) attributable to the transmission system operator.

SML is a measure of the energy not supplied for a disturbance. The metric takes account of the load lost (MW), duration of disconnection (minutes) and peak system demand (MW), to allow for historical comparison. For example, if 300 MW were lost for 10 minutes and the system peak was 3000 MW, this would represent one system minute.

$$\text{System minutes} = \frac{(\text{load} \times \text{duration})}{(\text{system peak})} = \frac{(300 \times 10)}{(3000)} = 1$$

The total SML as a result of faults on the main system for 2023, attributable to EirGrid, was 4.461. There were no under frequency load shedding disturbances which resulted in the disconnection of normal tariff load customers.

The trend of SML since 2013 is shown in Figure 7, with incentive / penalty limits and deadbands as provided by the Commission for Regulation of Utilities. The central target provided until 2020 was replaced in 2021 with a deadband between 0.75 and 2.5 SML, where there is neither penalty nor incentive. One fifth of the incentive amount is awarded for every 0.1 SML below 0.75, down to 0.25 SML. One fifth of the incentive amount is penalised for every 0.1 SML above 2.5, up to 3.0 SML.

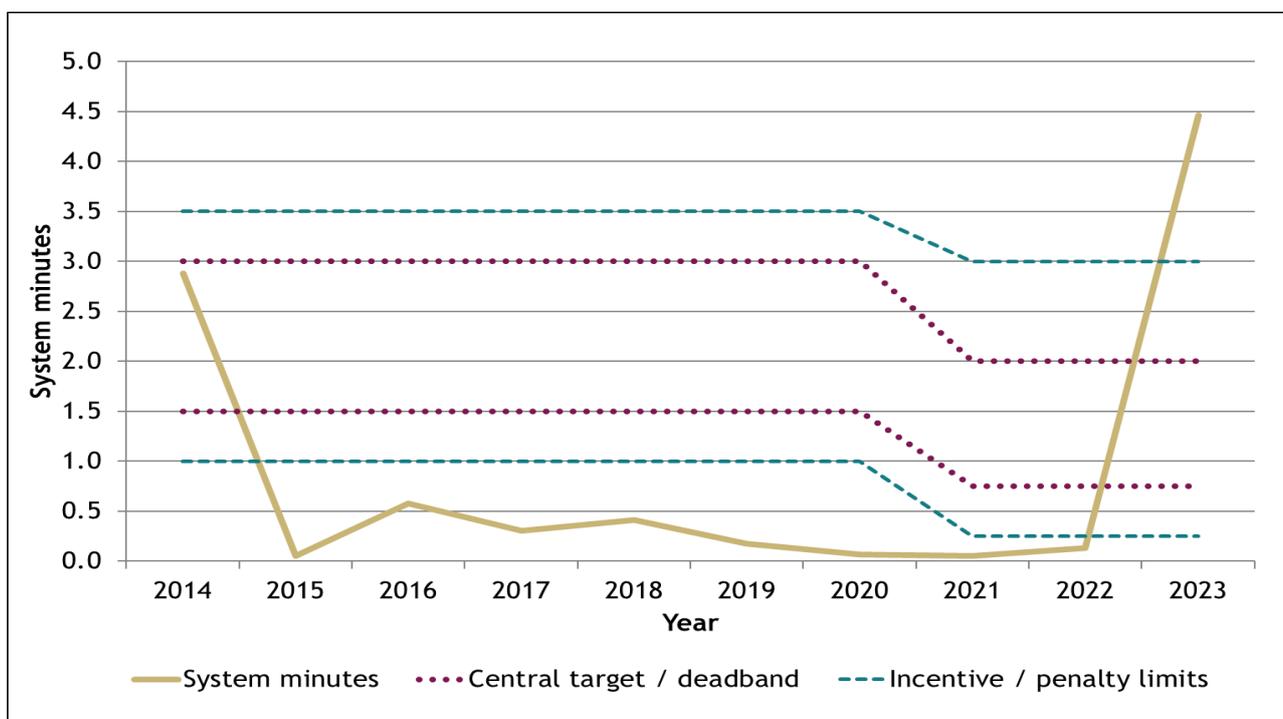


Figure 7: System minutes lost and associated targets: EirGrid 2014-2023

4.5. Zone Clearance Ratio

This section provides details of the short circuit faults on the main system and outside the main system for which main system protection is expected to operate without delay.

Zone clearance ratio (ZCR) is defined as the ratio of the number of short circuit faults, not cleared in zone 1 to the total number of short circuit faults per year cleared by main system protection. See Appendix 1 Glossary, for further definition of Zones and ZCR.

Of the 51 short circuit faults in 2023, the main system protection was expected to operate without delay for 45 of those short circuit faults on the main system. All these 45 faults had zone 1 clearances, giving a zone clearance ratio of 0.118. The ZCR trend since 2014 is shown in Figure 8.

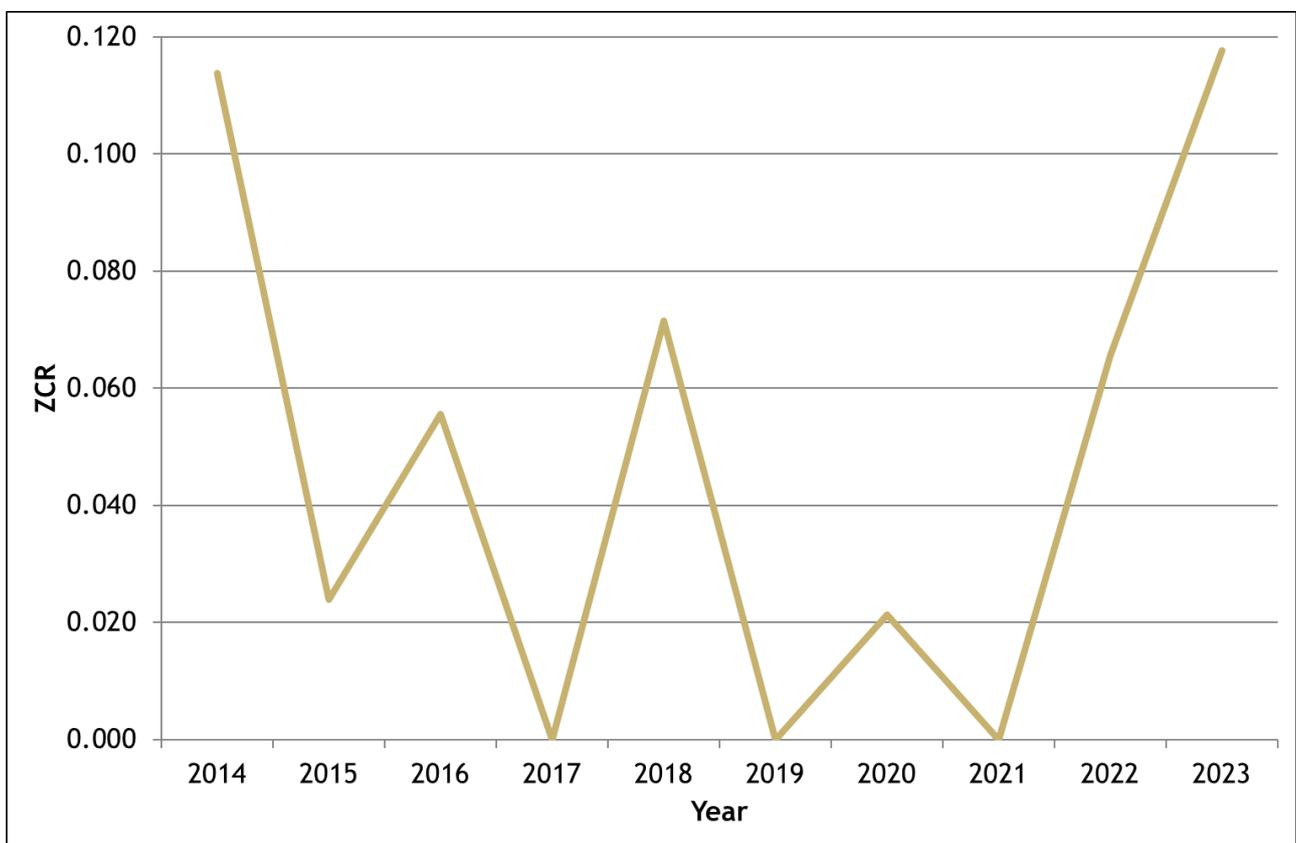


Figure 8: Zone clearance ratio: EirGrid 2014-2023

4.5.1. Frequency Control

In 2023 the system frequency was operated between 49.9 Hz to 50.1 Hz for 98.71% of the time.

4.6. Summary of key disturbances

4.6.1. Loss of load

On 5 May 2023 at 18:59, Blake - Maynooth - Newbridge 110 kV circuit tripped for a three-phase fault (RST). The cause of the fault was lightning, and a thunderstorm weather warning was in place at the time of the disturbance. The circuit's impedance and differential protection operated to clear the fault in 69 ms. An interruption to end-users occurred, resulting in 0.00004 system minutes lost.

On 17 June 2023 at 15:23, Booltiagh - Moneypoint - Tullabrack 110 kV circuit tripped and reclosed for a three-phase to ground fault (RSTE). The fault clearance time was approximately 49 ms. The fault was caused by lightning and a yellow weather warning was in place at the time of the disturbance. An interruption to end-users occurred, resulting in 0.000024 system minutes lost.

On 17 June 2023 at 19:27, Ikerrin - Shannonbridge - Thurles 110 kV circuit tripped for a single-phase to ground fault (RE) and reclosed with the Ikerrin tee remaining out. The fault clearance time was approximately 51 ms. The fault was caused by lightning and a yellow weather warning was in place at the time of the disturbance. An interruption to end-users occurred, resulting in 0.000042 system minutes lost.

On 19 June 2023 at 16:37, Ikerrin - Shannonbridge - Thurles 110 kV circuit tripped for three-phase to earth fault (RSTE). The fault clearance time was approximately 110 ms. The fault was caused by lightning and a yellow weather warning was in place at the time of the disturbance. At 16:56, the Ikerrin - Thurles 110 kV circuit was re-energised. An interruption to end-users occurred, resulting in 0.065589 system minutes lost.

Between 25 November 2023 at 23:50 and 26 November 2023 at 02:51, there were four trips on the transmission network due to a fault on the Sligo 110 kV cubicle at Cunghill 110 kV station. On investigation it was found that the 'T' phase of the busbar disconnect (DA) was damaged. This led to a major incident (i.e. one which results in the loss of greater than or equal to one system minute as a result of a single system disturbance) resulting in the loss of supply to a significant number of customers in the region on 26 November. Following the repair of the damaged DA, the Cunghill - Sligo 110 kV circuit was returned to service on 26 November at approximately 18:00. During the outage the DSO was able to back-feed some of the load via the 38 kV network. 4.39565 system minutes lost were attributed to the incident.

4.6.2. Under-Frequency Load Shedding

There were no under frequency load shedding disturbances in 2023.

4.6.3. Storms Resulting in Trippings

On 13 November 2023 at 05:40, Athlone - Lanesboro 110 kV circuit tripped, reclosed, and tripped for a single-phase to ground fault (RE). The fault clearance time was approximately 64 ms. The fault was caused by heavy wind and a red weather warning was in place due to Storm Debi. No interruptions to end-users occurred.

4.7. Transmission System Availability & Outages

4.7.1. 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 Formulae. Figure 9 shows the percentage Transmission System Unavailability in each month for 2023.

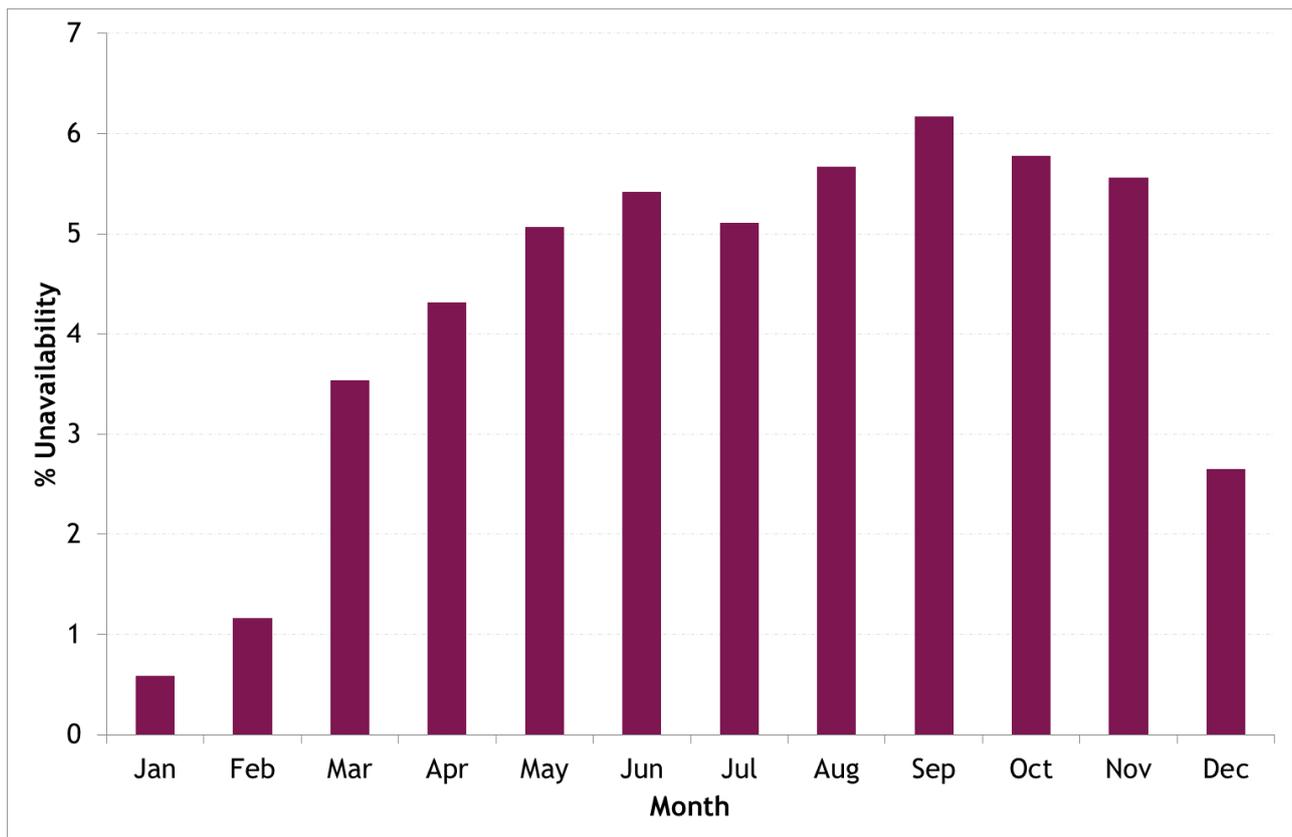


Figure 9: Monthly Variations of Transmission System Unavailability 2023

4.7.2. Transmission Plant Availability

The measure of plant availability is the kilometre-day for feeders and the MVA (megavolt ampere)-day for transformers. The availability figures vary between the different categories of plant. The formulae for calculating transmission plant availability are provided in Appendix 1 Glossary.

Table 7 provides a detailed breakdown of all plant availability figures for 2023.

Table 7: Transmission System Plant Availability 2023

Plant Type	Circuit Length [km]	Number of Outages	Availability (%) 2023
110 kV Circuits	4,673	298	94.55
220 kV Circuits	1,981	90	97.46
275 kV Circuits	97	6	97.68
400 kV Circuits	439	7	95.95
Plant Type	Transformer Capacity [MVA]	Number of Outages	Availability (%) 2023
220 / 110 kV Transformers	11,614	57	96.13
275 / 220 kV Transformers	1,200	10	97.68
400 / 220 kV Transformers	4,050	11	93.14
Total	7,191 km	479	Weighted Average (%)
	16,864 MVA		95.31

4.7.3. Cause of Transmission Plant Unavailability

Transmission plant unavailability is classified into the categories outlined in Table 8.

Table 8: 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)
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.

4.7.4. 110 kV Circuit Unavailability

Figure 10 provides a breakdown of the causes of unavailability on the 110 kV network in 2023.

The largest contributor to unavailability (45%) 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.

A further 40% of unavailability on the 110 kV network in 2023 were outages for the purpose of "Corrective and Preventative" maintenance. This type of maintenance includes, amongst others, ordinary services, condition assessments, wood-pole replacement/straightening and general line maintenance.

11% of unavailability was due to forced outages.

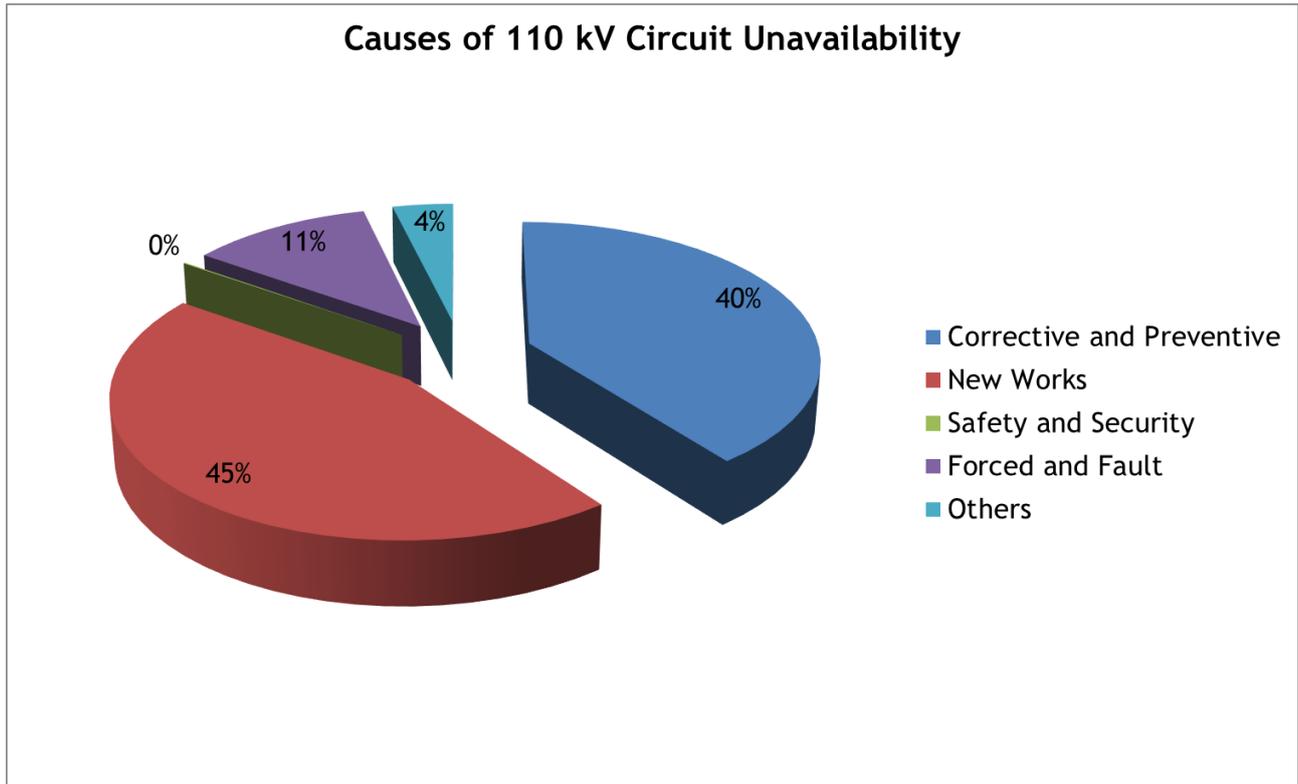


Figure 10: Causes of Unavailability on the 110 kV System in 2023

4.7.5. 220 kV Circuit Unavailability

Figure 11 provides a breakdown of the causes of unavailability on the 220 kV network in 2023. The largest contributor to unavailability (54%) on the 220 kV network in 2023 were outages for "New Works" purposes. A further 24% of unavailability on the 220 kV network was attributable to forced outages. The forced outage of Prospect - Tarbert 220 kV circuit which was out of service for all of 2023 accounted for 20 % of the overall unavailability on the 220 kV system. Approximately 17% of unavailability on the 220 kV network was attributable to "Corrective and Preventative" maintenance.

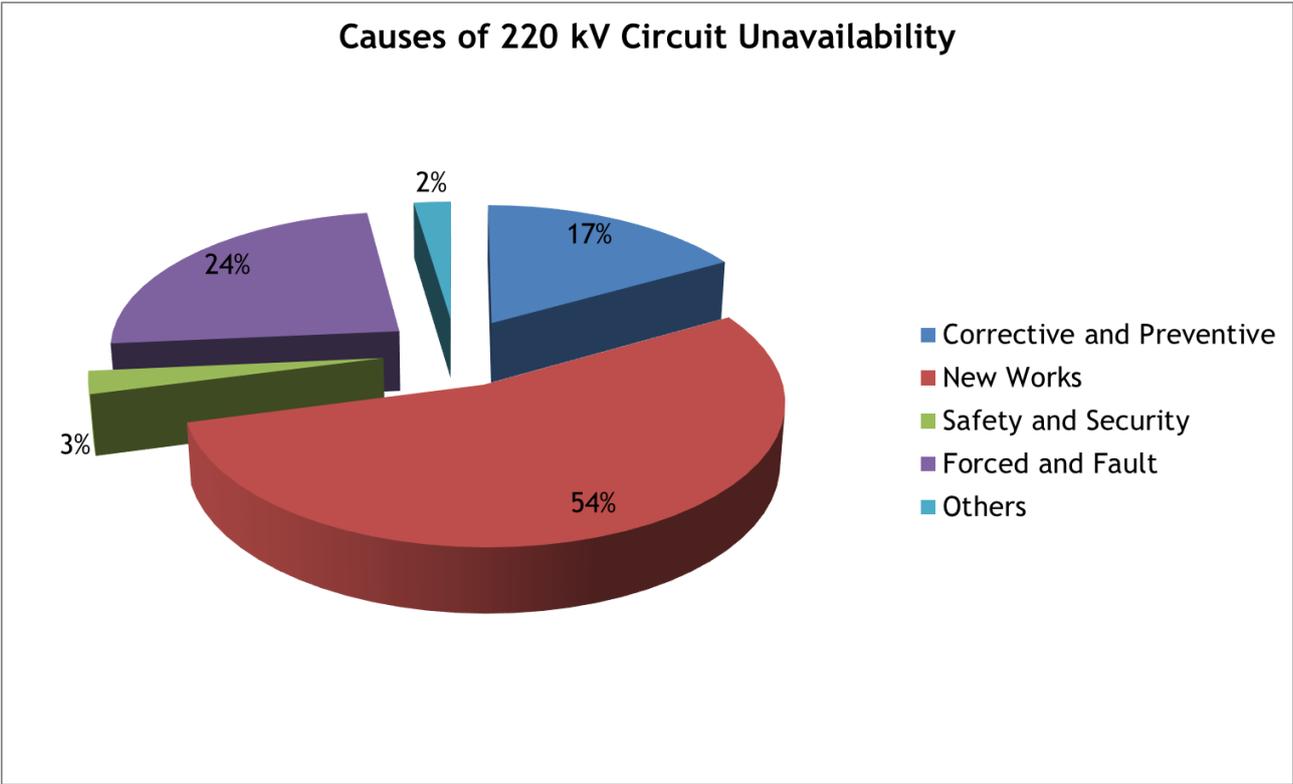


Figure 11: Causes of Unavailability on the 220 kV System in 2023

4.7.6. 275 kV Circuit 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. The largest contributor to unavailability (87%) on the 275 kV network in 2023 was “Corrective and Preventative” maintenance.

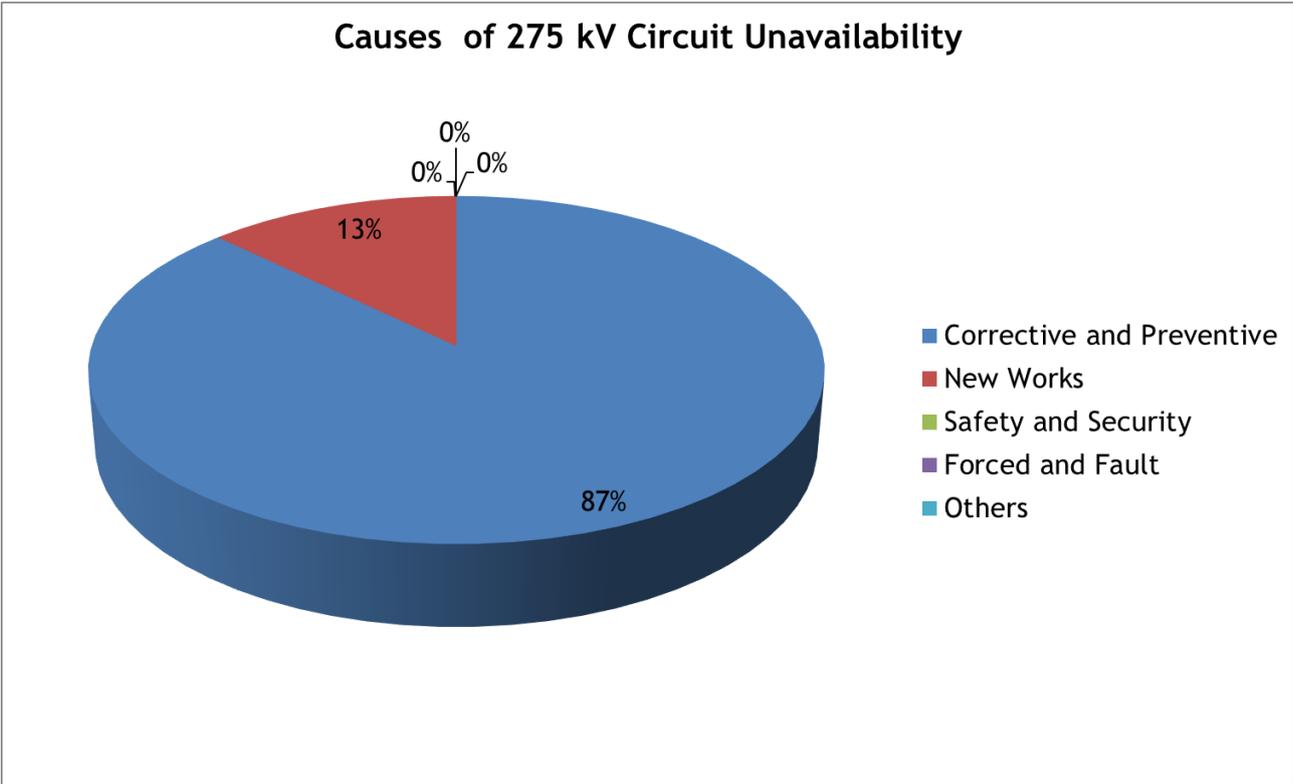


Figure 12: Causes of Unavailability on the 275 kV System in 2023

4.7.7. 400 kV Circuit Unavailability

Figure 13 provides a breakdown of the causes of unavailability on the 400 kV network in 2023. There were 60 days of outages on the 400 kV network in 2023 with the largest contributors being “Corrective and Preventive” maintenance and “New Works”.

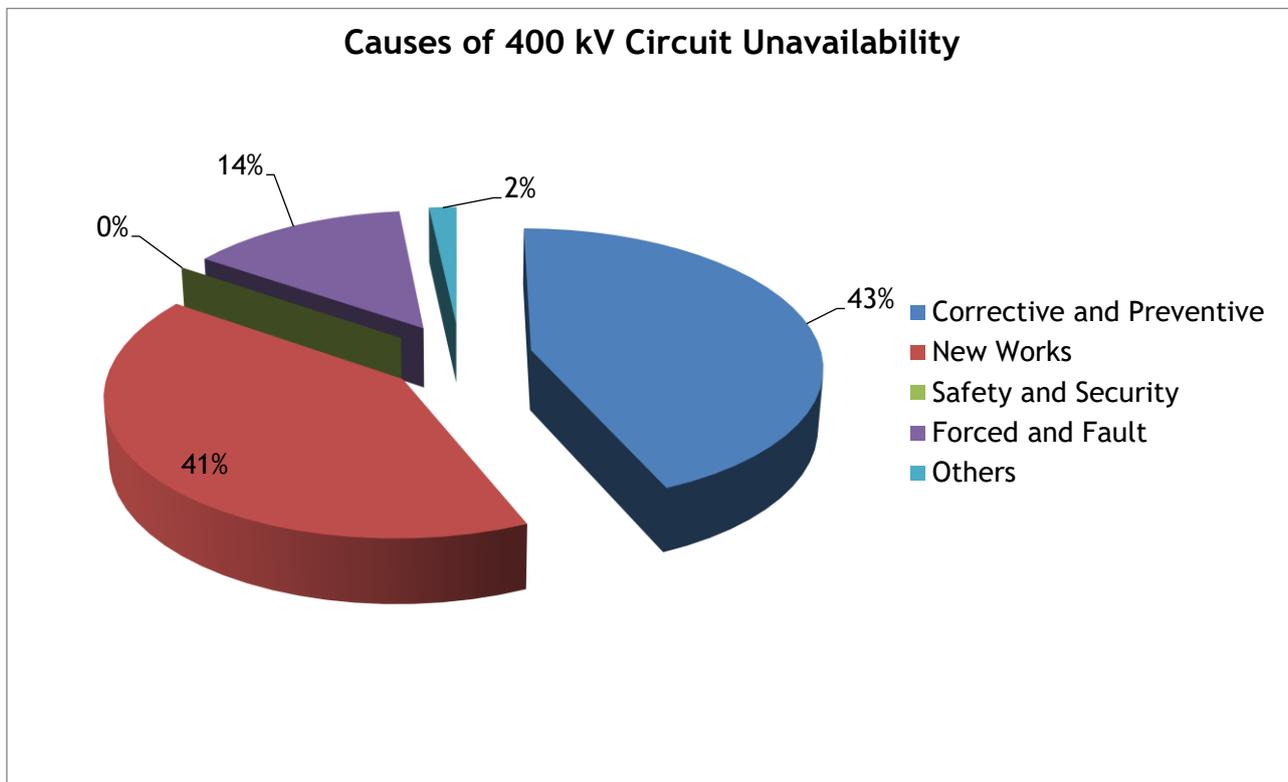


Figure 13: Causes of Unavailability on the 400kV System in 2023

Table 9 provides a breakdown of the transmission system outages that occurred in 2023 by plant type.

Table 9: Transmission System Plant Outage 2023

Plant Type	No. of Items	Circuit Length	Forced & Fault	Safety & System Security	New Works	Corrective & Preventive Maintenance	Other	Total No. of Outages
110 kV Circuits	263	4,673	25	3	66	174	30	298
220 kV Circuits	72	1,981	12	4	38	29	7	90
275 kV Circuits	2	97	0	0	4	2	0	6
400 kV Circuits	4	439	2	0	1	2	2	7
Total	341	7,191	39	7	109	207	39	401
Plant Type	No. of Items	Transformer Capacity	Forced & Fault	Safety & System Security	New Works	Corrective & Preventive Maintenance	Other	Total No. of Outages
220 / 110 kV Trafos	57	11,614	6	2	15	31	3	57
275 / 220 kV Trafos	3	1,200	0	0	5	4	1	10
400 / 220 kV Trafos	8	4,050	1	0	2	5	3	11
Total	68	16,864	7	2	22	40	7	78

4.7.8. East West Interconnector

The East West Interconnector (EWIC) is a high-voltage direct current (HVDC) scheme which links the power systems of Ireland and Great Britain. It has a power rating of 500 MW. EWIC is a fully regulated interconnector which was developed and is owned by EirGrid Interconnector DAC (EIDAC) which is part of the EirGrid Group. The scheme consists of two Converter Stations located in Meath, Ireland and Deeside, Wales connected by 264 km of HV cable, 185 km of which is submarine.

4.7.9. East West Interconnector Availability

In 2023 the availability of the East West Interconnector (EWIC) was 99.1%. EWIC unavailability was as a result of a single planned maintenance outage.

4.7.10. 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 14.

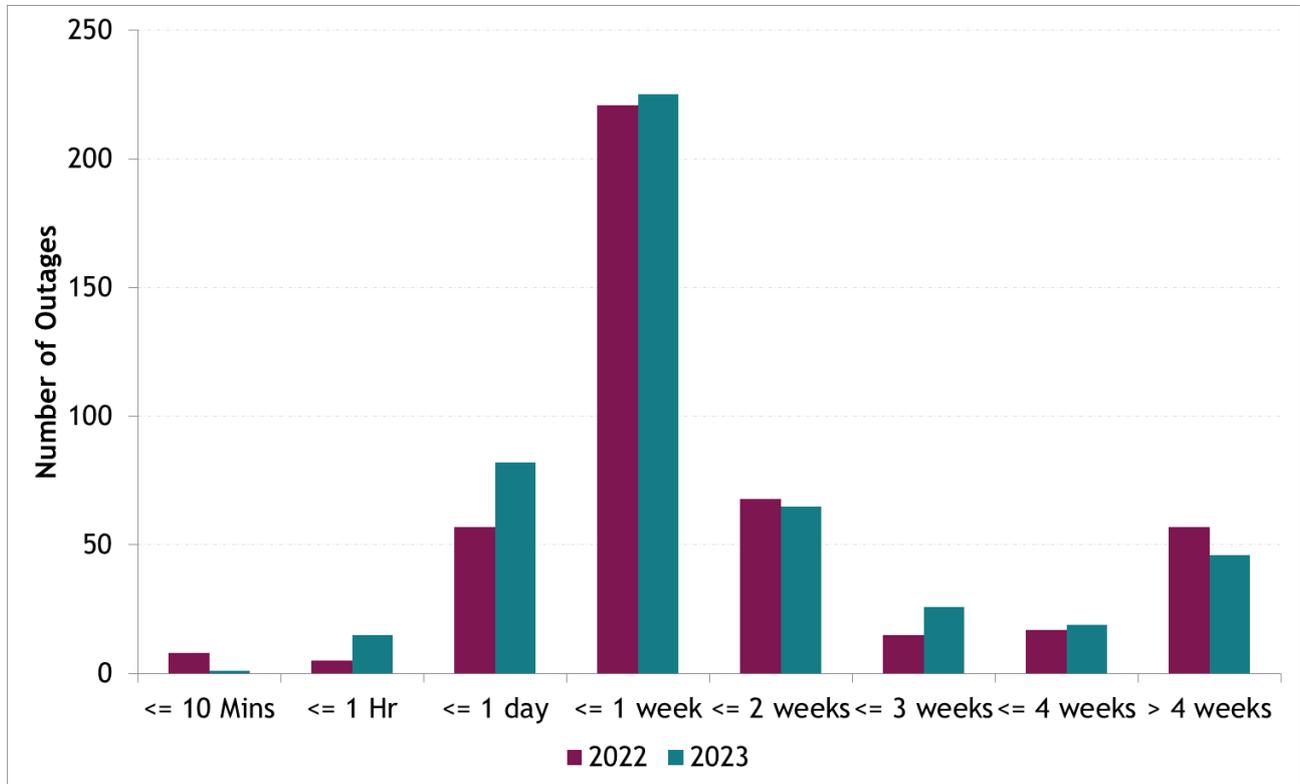


Figure 14: Duration of Outages in 2022 & 2023

The majority of the outage durations are concentrated between one day and 2 weeks with the peak occurring between one day and 1 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.

4.7.11. Timing of Transmission Outages

Figure 15 shows the percentage unavailability of the transmission system in each month. The March-November period sees the highest rates of unavailability during the year, when decreased system load is taken advantage of to carry out extensive maintenance outages. Figure 16 shows the average duration in days of the transmission outages in each month in 2023.

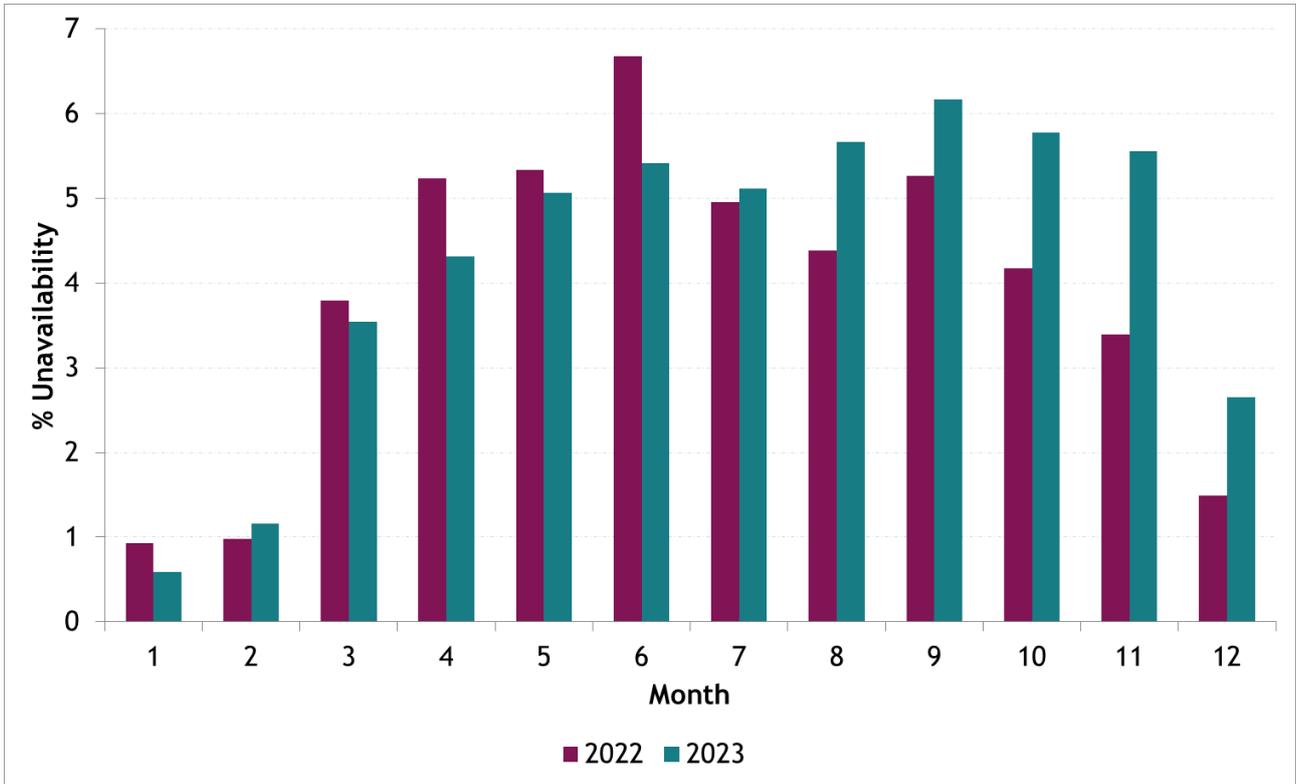


Figure 15: Percentage unavailability in each month of 2022 & 2023

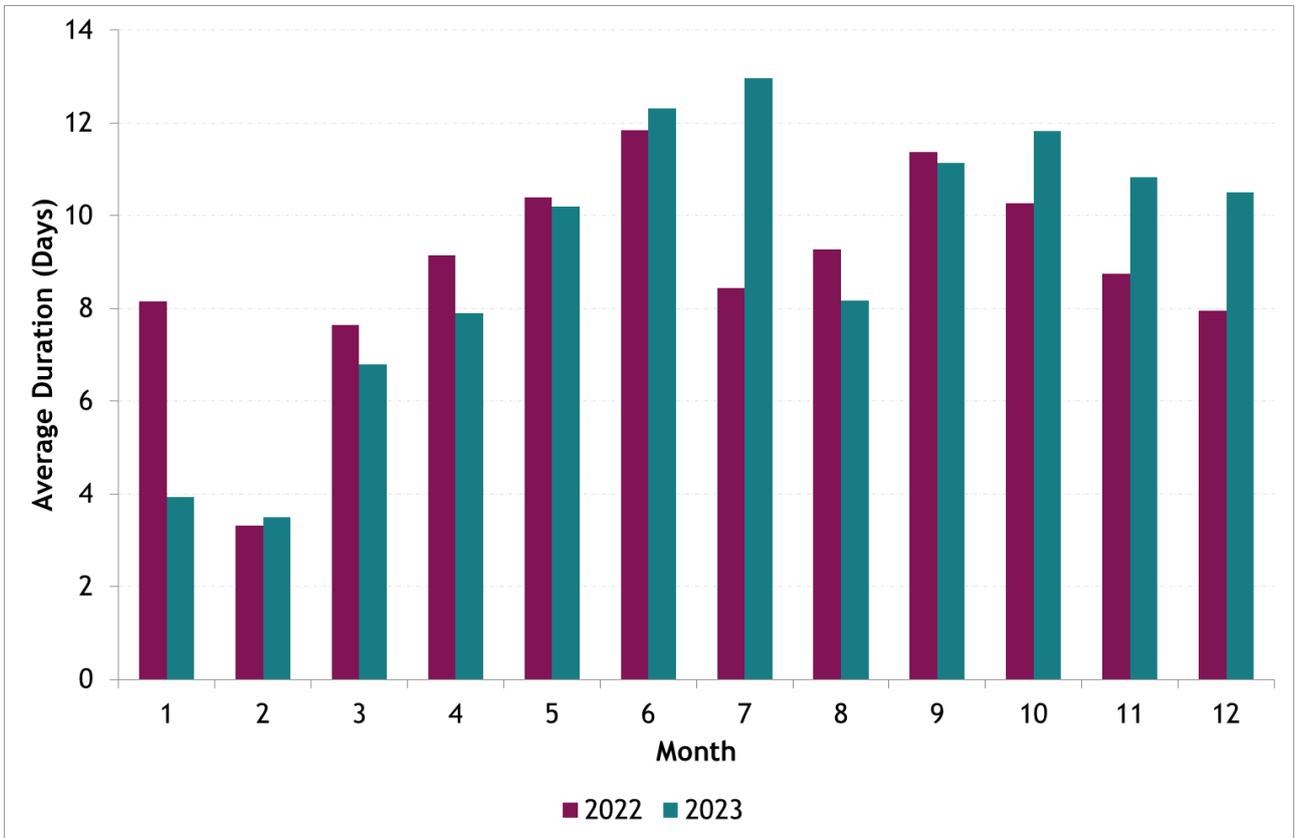


Figure 16: Average duration of outages 2022 & 2023

4.7.12. 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.

4.7.13. 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 and is shown in Figure 17.

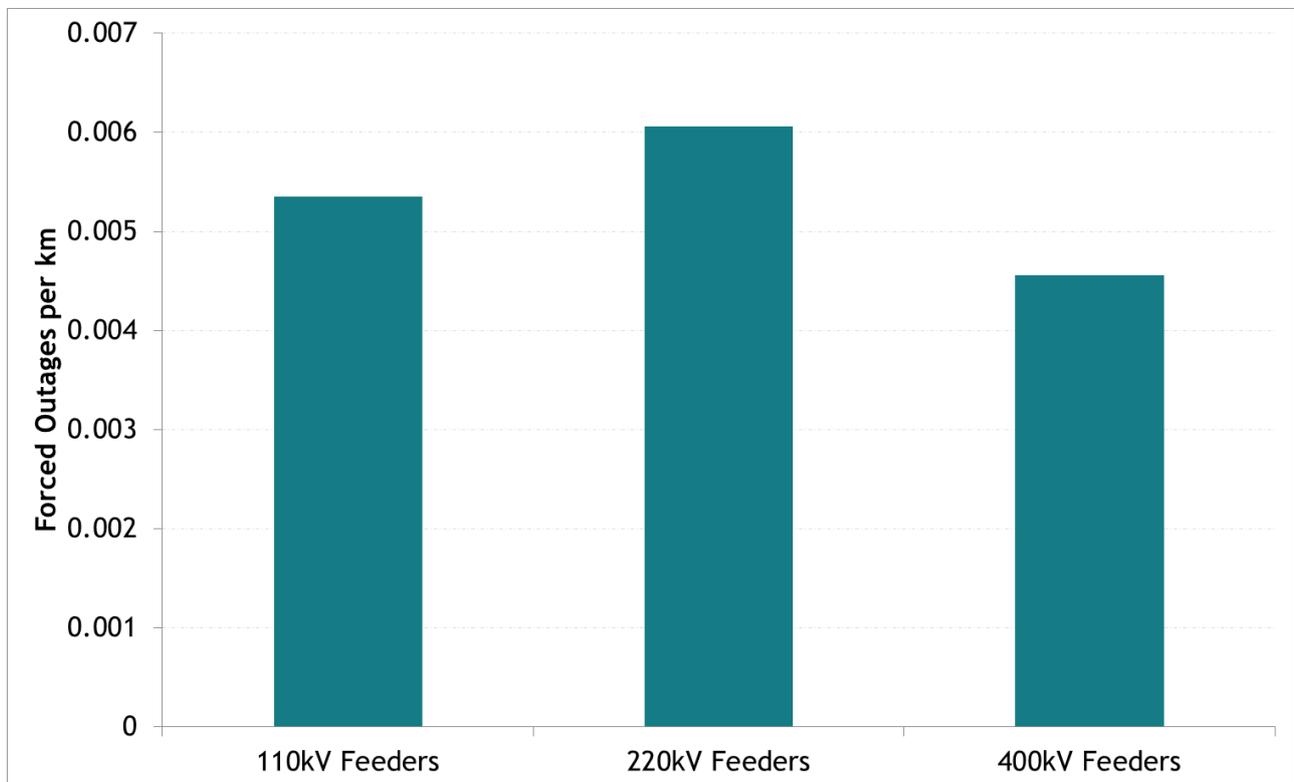


Figure 17: Forced Outages of lines and cables per km in 2023.

4.7.14. 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 18.

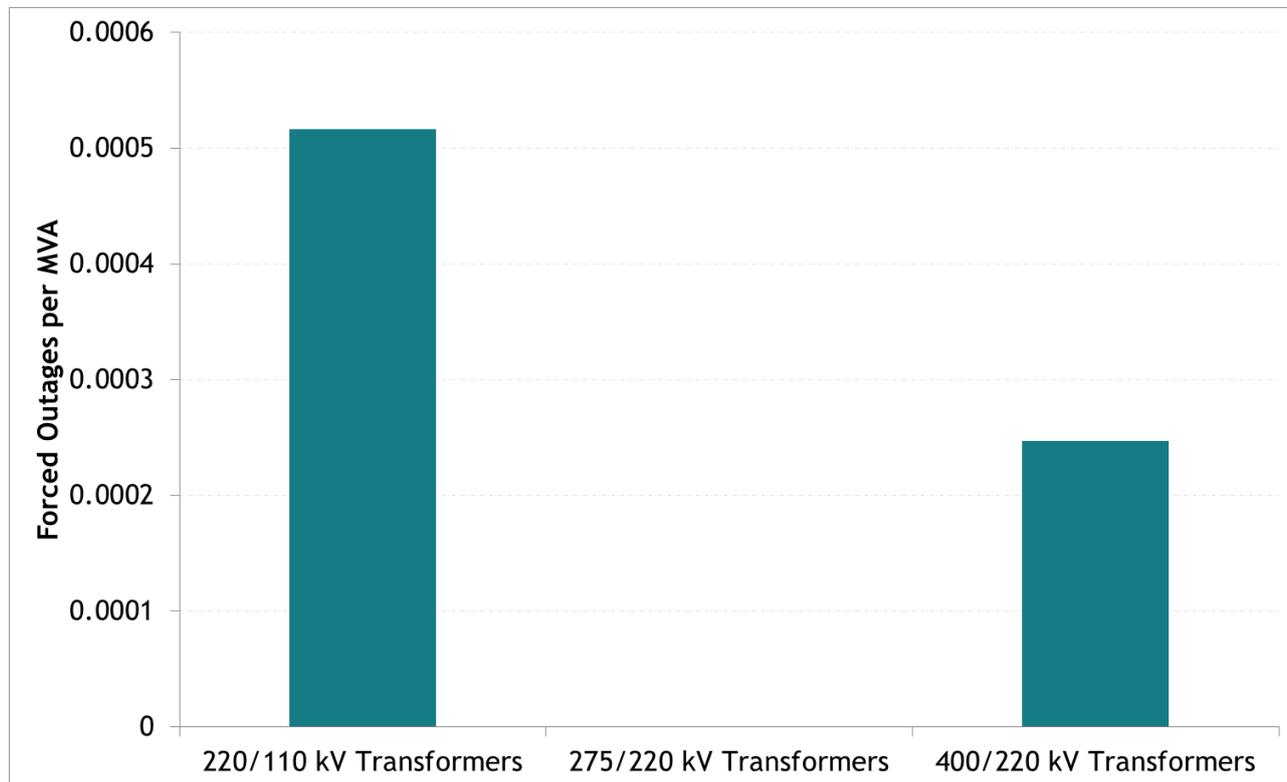


Figure 18: Forced Outage per MVA in 2023

5. SONI Transmission System Performance

This section details the performance of the transmission system in Northern Ireland, unless explicitly stated otherwise. This data has been prepared by SONI in accordance with Condition 20 of the 'Licence to participate in the Transmission of Electricity.

5.1. Summary

SONI is responsible for the safe, secure, efficient and reliable operation of the Northern Ireland transmission network. The transmission network is operated at 275 kV and 110 kV and is made up of 116 circuits covering a total length of approximately 2,311 km. The primary purpose of the transmission system is to transport power from generators and interconnectors to bulk supply points which connect the transmission system to the distribution system.

Availability is a key measure of power system performance. In this report availability refers to the proportion of time a transmission circuit or interconnector was available.

- The annual system availability for 2023 was 97.03%.
- The annual availability of the Moyle Interconnector for 2023 was 99.26%.
- The North-South 275 kV tie line, connecting Louth in Ireland and Tandragee in Northern Ireland had an availability of 97.61% in 2023.
- The annual availability of the Strabane - Letterkenny and Enniskillen - Corraclassy 110 kV tie lines were 84.15% and 88.32%, respectively, in 2023.

The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012 set out the statutory obligations in relation to managing both frequency and voltage for Northern Ireland. Under the regulations SONI is required to report incidents, which have caused interruptions to supply to customers, to the transmission asset owner, NIE Networks. Part 8, paragraph 33 of the regulation contains details of the requirements for the reporting of incidents.

In 2023, there was one transmission incident leading to customers being off supply. This was at 16:44 on 7 September when an incident at Ballymena resulted in the loss of supply to 21,845 customers, equating to a total loss of 20.3 MW. The total system minutes lost for this event was 0.669 minutes.

Quality of service is measured by the number of voltage excursions which fall outside statutory limits. There were no voltage excursions in 2023 outside the statutory limits.

5.2. Transmission System Availability

5.2.1. System Availability

Transmission system availability is the proportion of time a transmission circuit was available during the calendar year. A circuit is defined as the overhead line, cable, transformer or any combination of these that connects two busbars together or connects the transmission system to another system. Transmission system availability is reduced when a circuit is taken out of service, either for planned or unplanned purposes.

Planned outages are necessary to facilitate new user connections, network development and maintenance of network assets necessary to deliver acceptable levels of system security and reliability. These are outages planned with at least seven days' notice.

Unplanned outages can be a result of equipment failure, or a fault caused by adverse weather etc. These are outages required immediately or planned with less than seven days' notice.

System Availability is calculated using the formula:

$$\text{System Availability (\%)} = \frac{\sum \text{Hours each circuit is available}}{(\text{No. of Circuits}) * (\text{Total No. Hours in Period})}$$

In 2023, the analysis of the transmission system availability data has produced the following results:

- The average availability of the Northern Ireland transmission system was in 2023 was 97.03%
- The average winter system availability (for the winter months January, February, November and December 2023) was 98.85%.

Figure 19 below shows the month-by-month variation in Transmission System Availability in Northern Ireland.

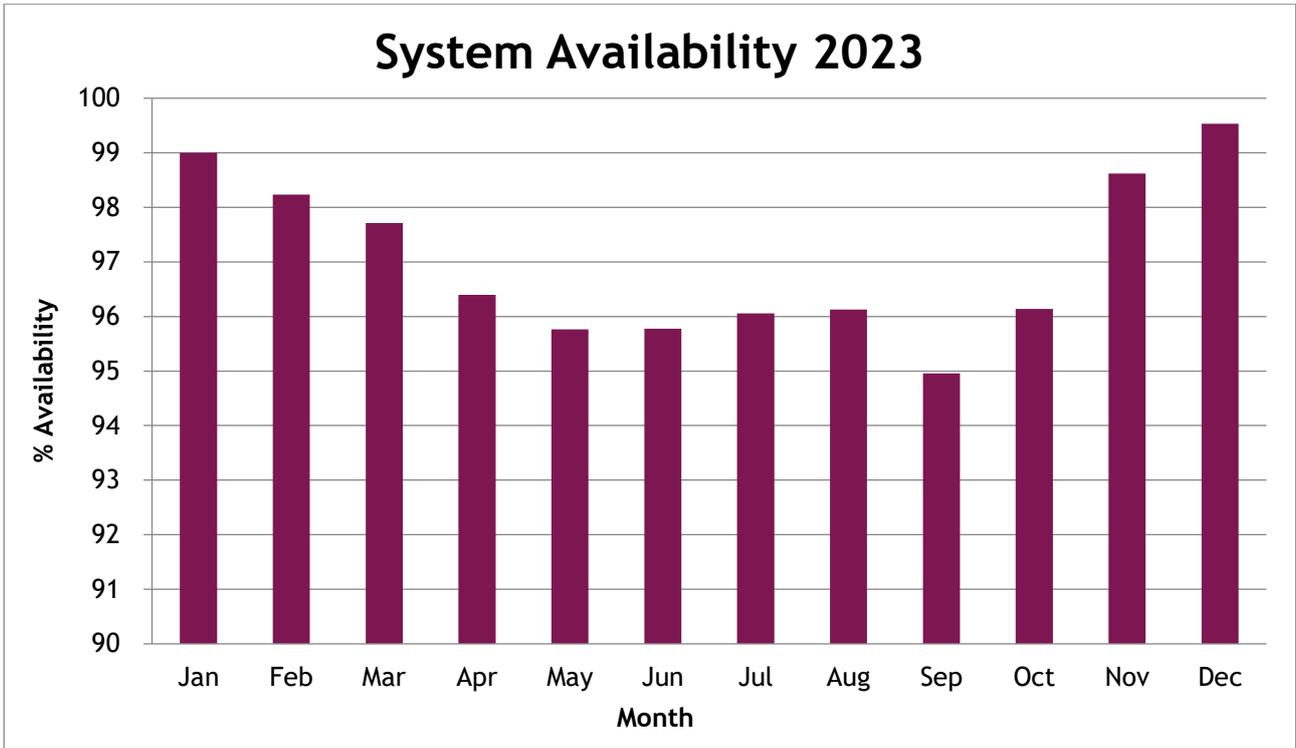


Figure 19: Transmission System Availability 2023

Overall, the availability of the system is high, particularly over the winter months, such as January and December, where maintenance is avoided due to the higher electrical demand and potential adverse weather conditions. The preference is for maintenance to take place over the summer months when network loading is generally lower to mitigate the risk of affecting the supply to customers.

5.2.2. System Unavailability

Figure 20 below shows the month-by-month variation in planned and unplanned system unavailability.

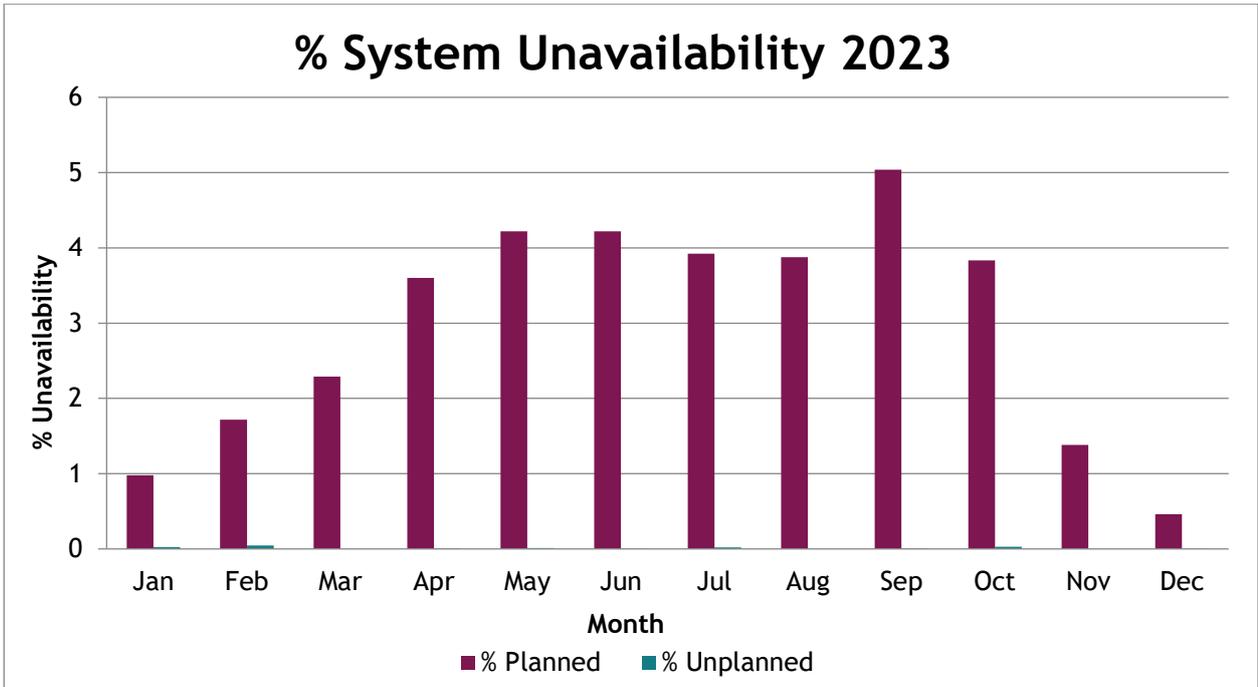


Figure 20: Transmission System Unavailability 2023

Transmission outages are planned during the spring/summer/autumn months where possible. This is to take advantage of periods when the Northern Ireland demand is lower and hence power flows around the transmission system are reduced. During the winter months when demand is higher, only urgent outages or outages that will not reduce the reliability of the transmission system can be accommodated. This is to ensure the resilience of the transmission system is maintained.

5.2.3. System Historical Availability Performance

Figure 21 shows the historic variation in system availability from 2014 to 2023 for the transmission network in Northern Ireland.

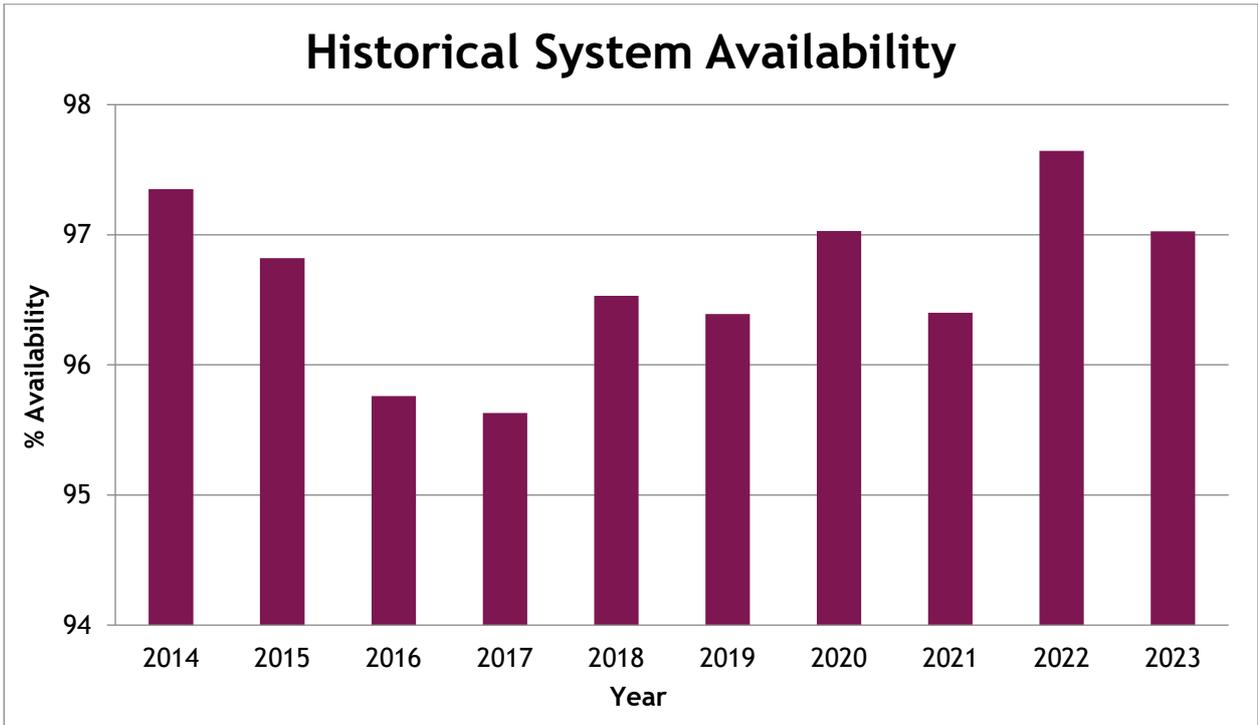


Figure 21: Historical System Availability 2014 to 2023

5.2.4. System Historical Unavailability Performance

Figure 22 below shows the breakdown of the system unavailability from 2014 to 2023.

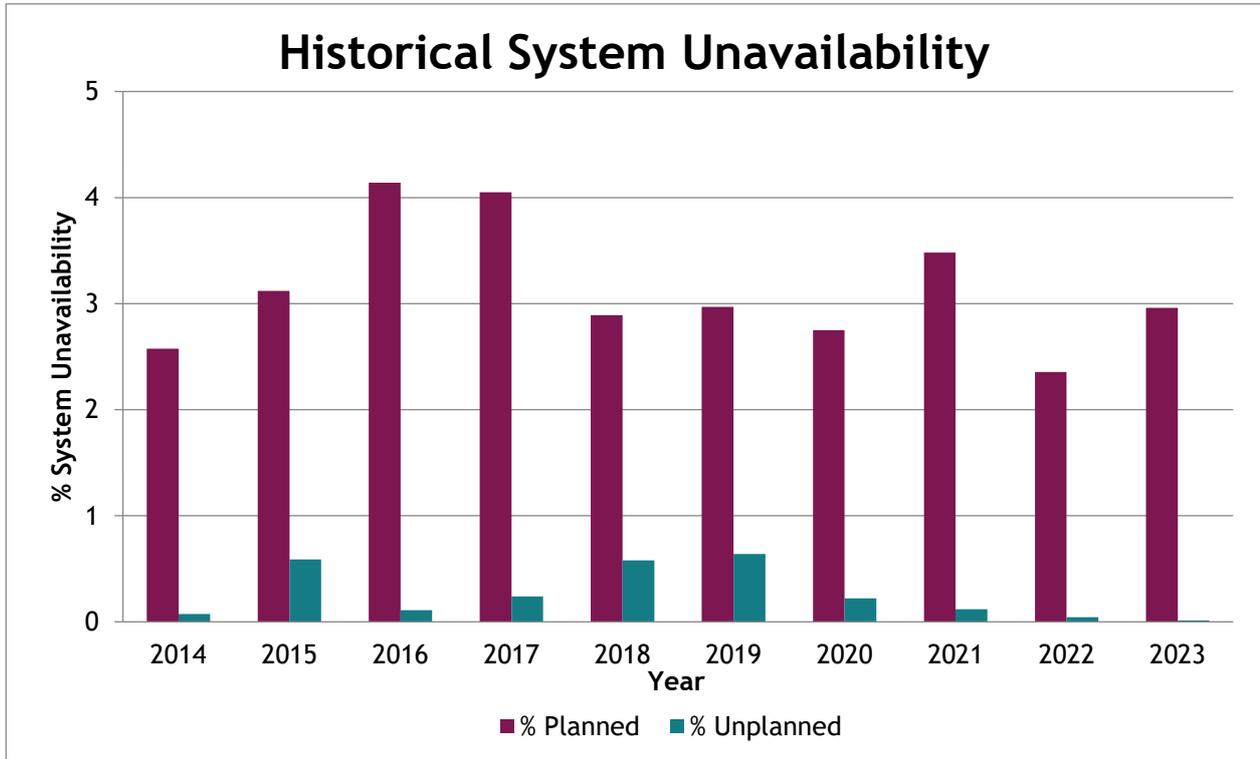


Figure 22: Historical System Unavailability 2014 to 2023

5.2.5. Moyle Interconnector

The Moyle interconnector, owned by Mutual Energy, connects the power systems of Northern Ireland and Scotland. The interconnector is a High Voltage Direct Current (HVDC) system; consisting of two submarine power cables and two HVDC-AC converter stations; one located at Islandmagee in Northern Ireland and the other at Auchencrosh in Scotland.

The interconnector has an operational import capacity of 441 MW and an operational export capacity of a maximum 410 MW (values with reference to the NI system). The interconnector is operated by SONI, and the performance of the interconnector is detailed in this report.

5.2.6. Moyle Interconnector Historical Availability

The Annual Availability of the Moyle Interconnector for 2023 was 99.05%.

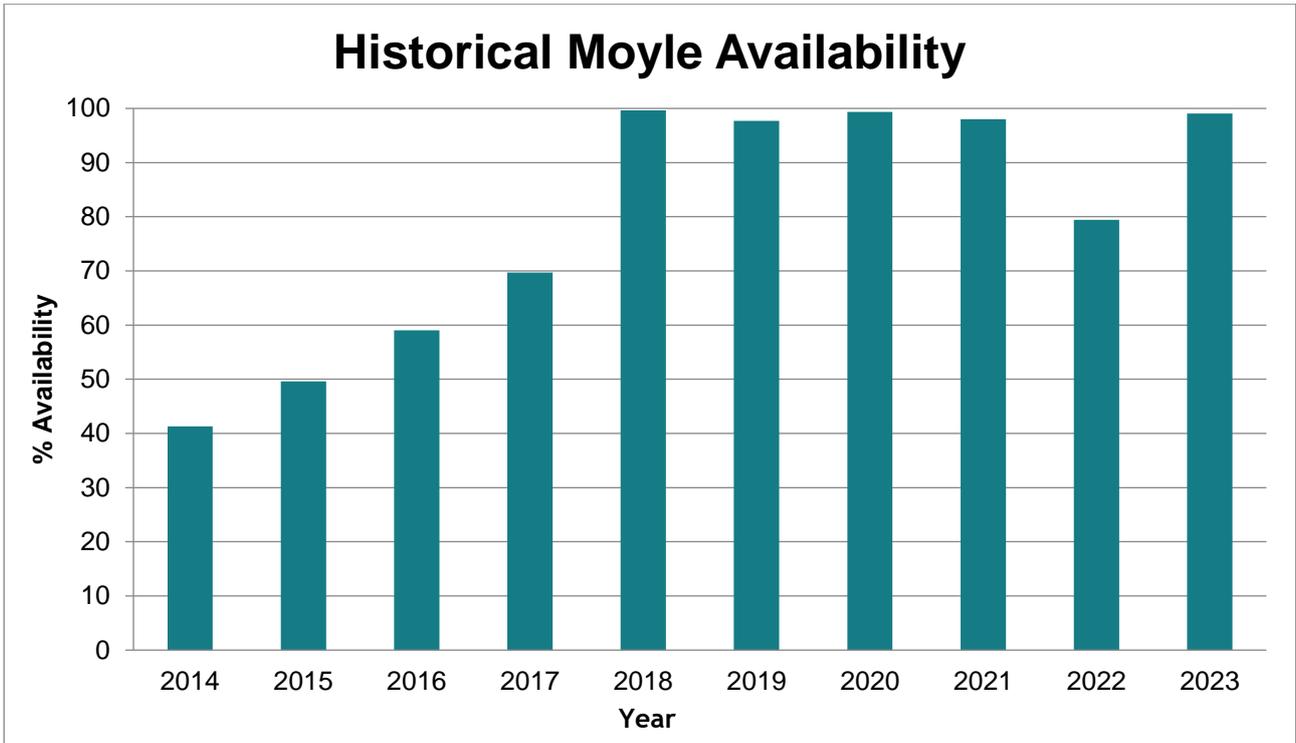


Figure 23: Historical Moyle Interconnector Availability 2014 to 2023

5.2.7. Moyle Interconnector Historical Unavailability

The 2023 Annual Unavailability of the Moyle Interconnector was 0.94%.

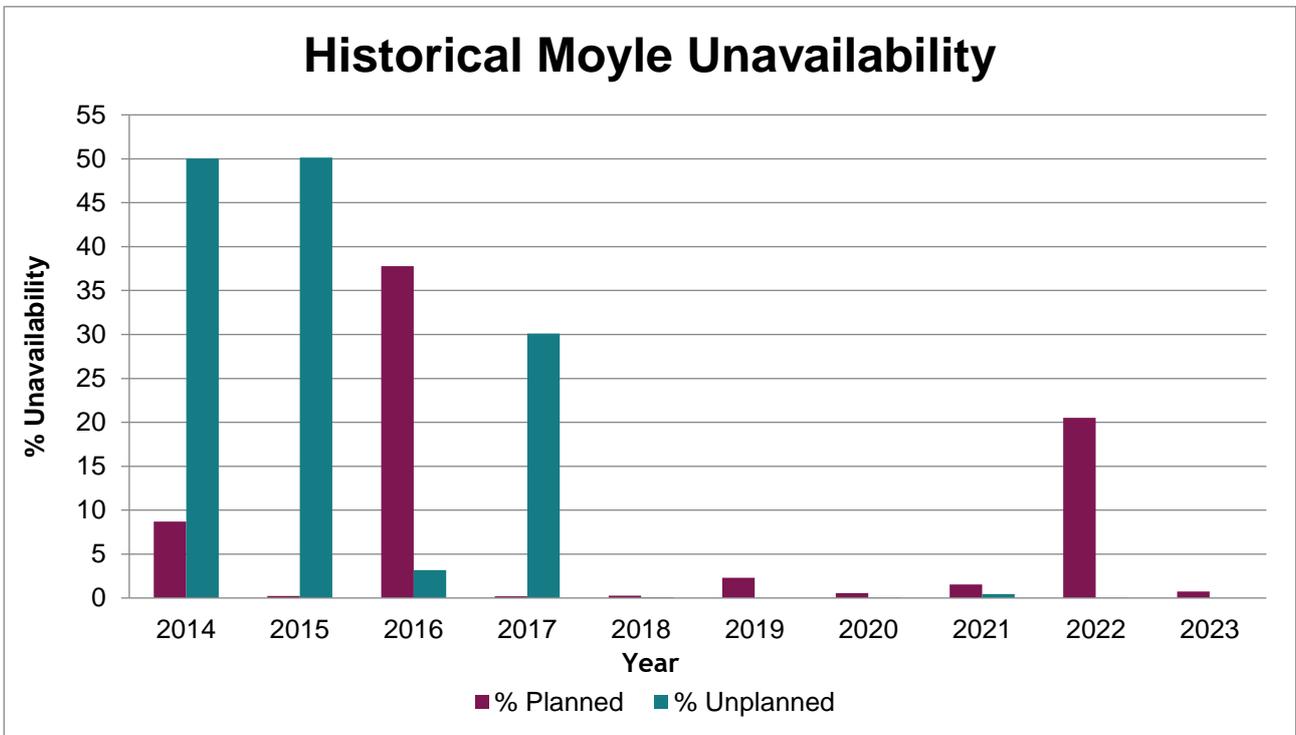


Figure 24: Historical Moyle Interconnector Unavailability 2014 to 2023

5.2.8. Moyle Interconnector Monthly Unavailability

Figure 25 below shows the month-by-month variation of unavailability of the interconnector.

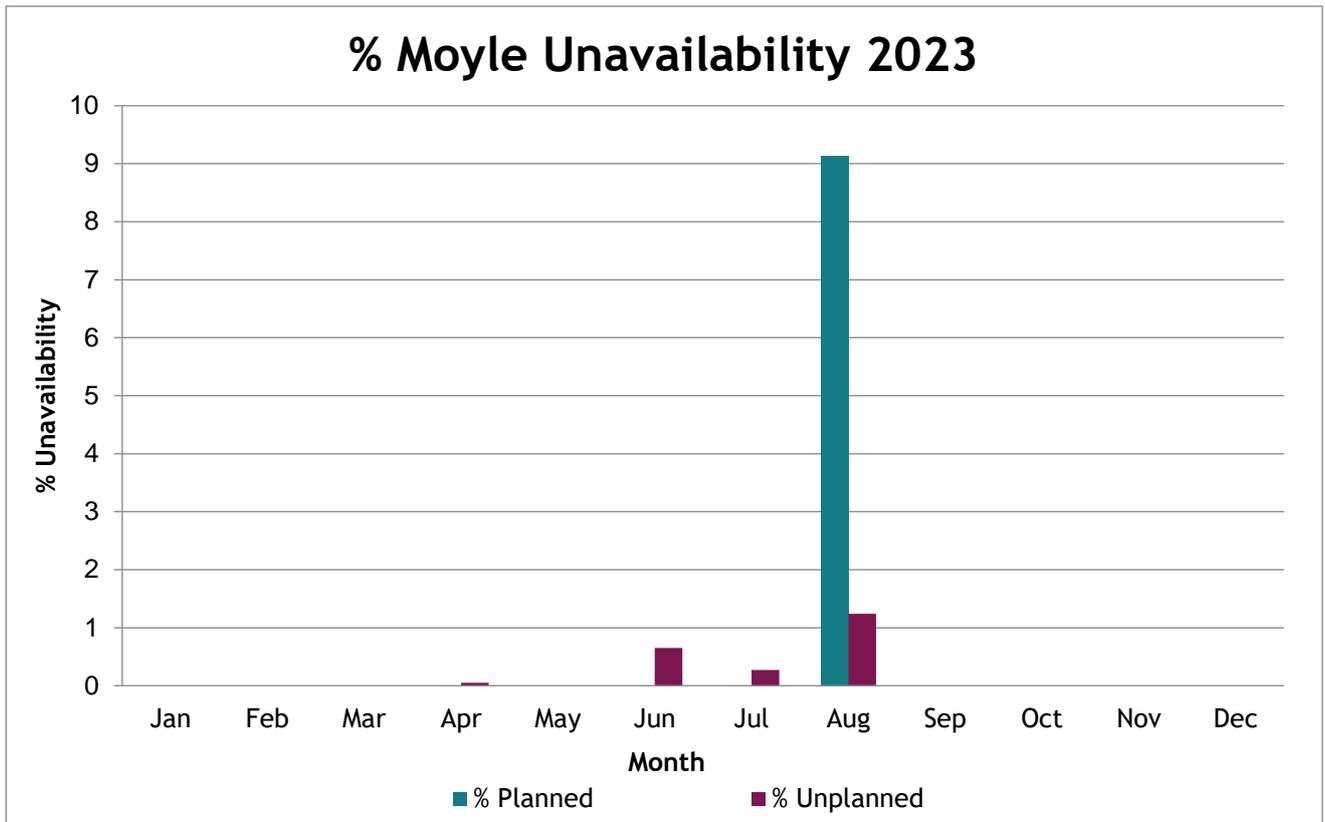


Figure 25: Moyle Interconnector Monthly Unavailability 2023

Figure 25 shows there were scheduled outages of the interconnector throughout August. There were 2 outages, one for each pole. The outages occurred in the same month, with one lasting a single day and the other lasting four days to accommodate annual maintenance of the interconnector. There were forced outages of the interconnector in April, June, July and August 2023.

5.2.9. 275 kV Tie Line

The connections between Ireland and Northern Ireland are referred to as 'Tie Lines'.

The Northern Ireland transmission system is connected to the transmission system in Ireland by means of one 275 kV double-circuit connection from Tandragee 275 kV substation in Co. Armagh to Louth 275 kV substation in Co. Louth.

The 275 kV double-circuit tie line is used as the method for synchronising the Northern Ireland and Ireland power systems together. Energy can flow freely between both jurisdictions, depending on the operating requirements and generating plant being utilised on the all-island power system.

The annual average availability of the 275 kV North-South Tie Line in 2023 was 97.61%.

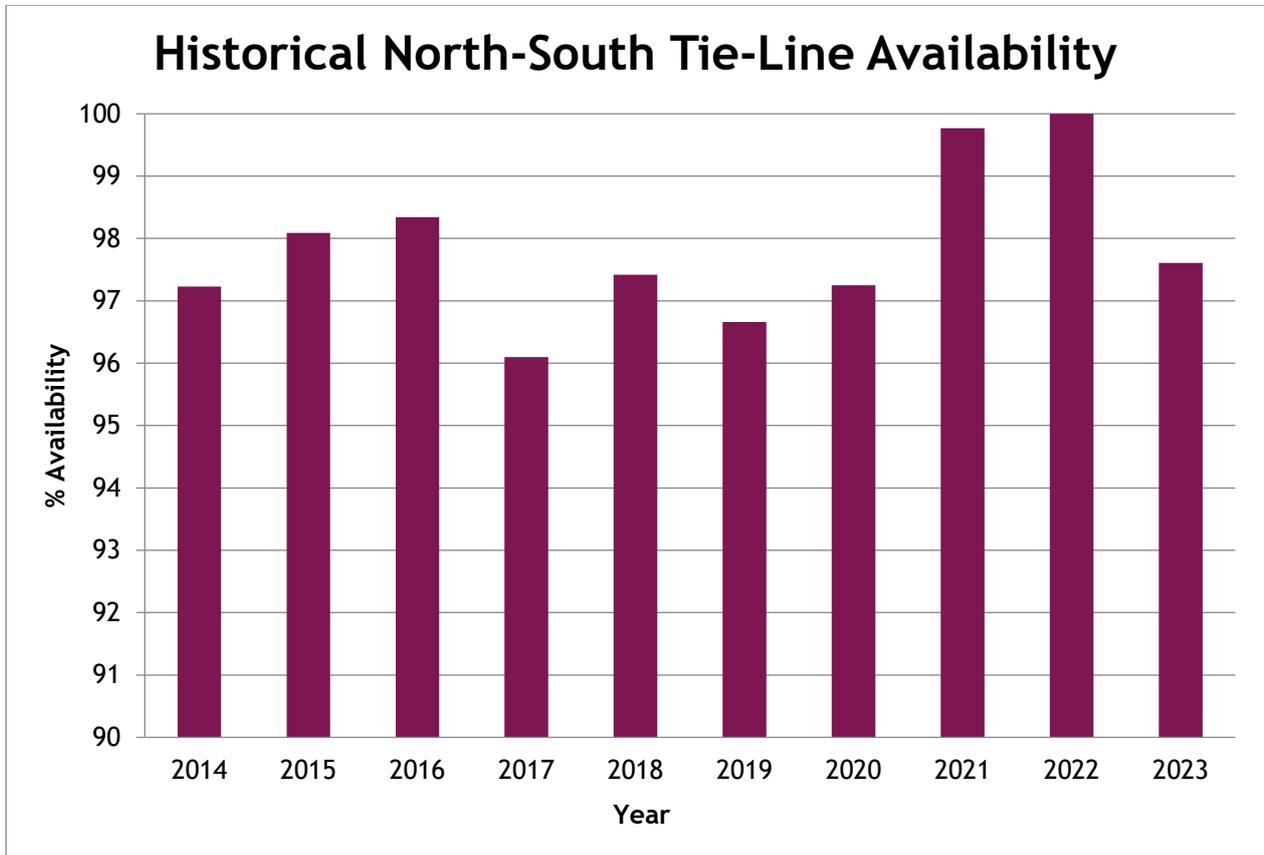


Figure 26: Historical North-South Tie Line Availability 2014 to 2023

A breakdown of 275 kV tie line unavailability is shown in Figure 27 below.

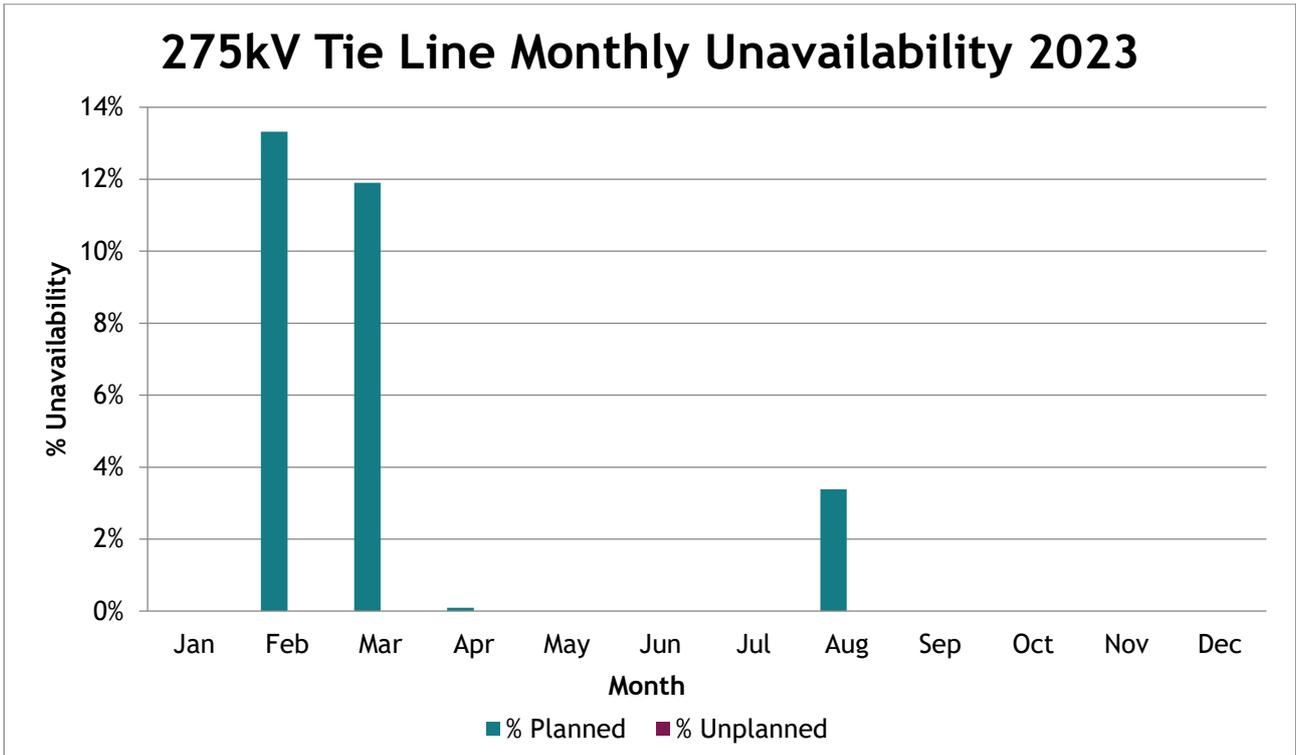


Figure 27: 275kV Tie Line Unavailability 2023

5.2.10. 110 kV Tie lines

There are two 110 kV connections between Ireland and Northern Ireland:

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

These 110 kV tie lines provide an AC connection between the two transmission systems, which allows emergency flows of active and reactive power for frequency and voltage support, increasing system stability.

Phase Shifting Transformers (PSTs), designed for energy to flow in two directions, are installed at Strabane and Enniskillen and control the flow of energy between Ireland and Northern Ireland. These PSTs are rated at 125 MW each and are, in normal operation, operated to maintain a 0 MW flow between both jurisdictions.

To negate any potential system abnormalities as a result of transmission outages, either scheduled or unplanned, a controlled flow can be allowed, to support system operation in both jurisdictions. Also, in times of high wind, the Strabane-Letterkenny tie line is used to import excess wind energy being produced in the north-west of Ireland.

The availability of the 110 kV Tie Lines was 86.23% in 2023.

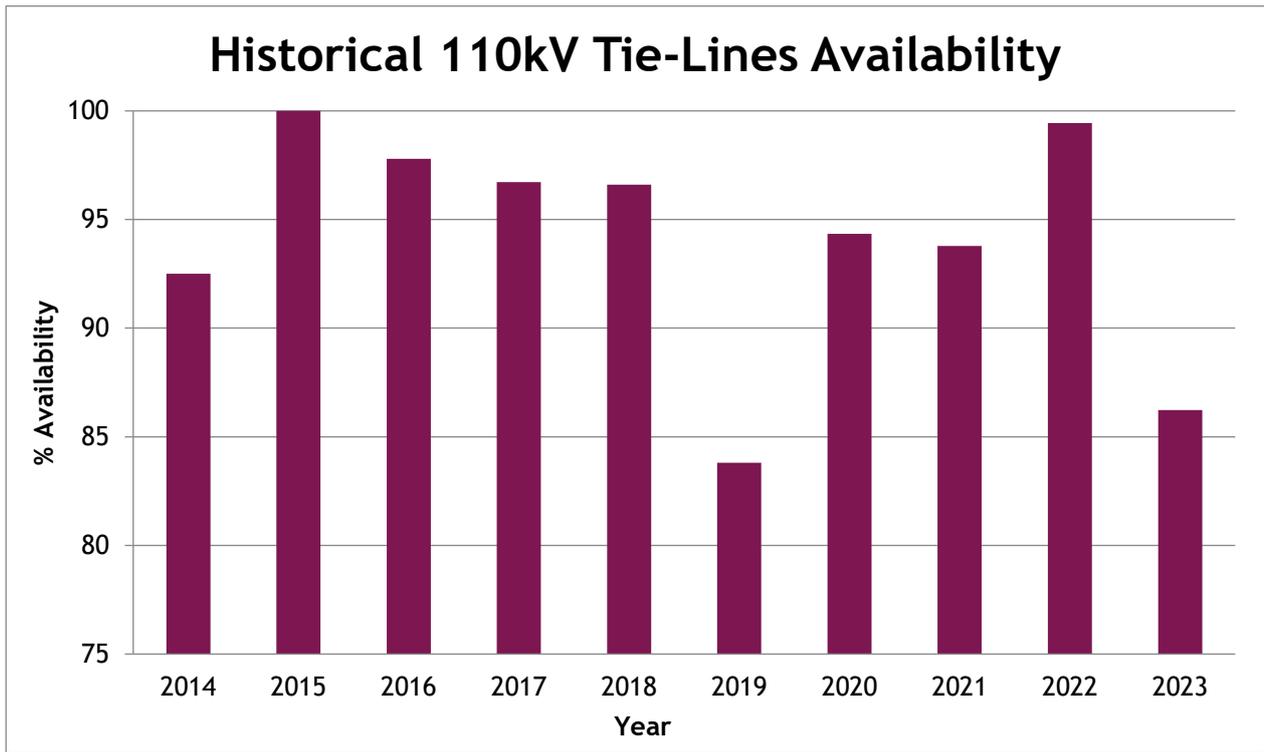


Figure 28: North-South Tie Line Availability 2014 to 2023

A breakdown of 110 kV tie line unavailability is shown in Figure 29 below.

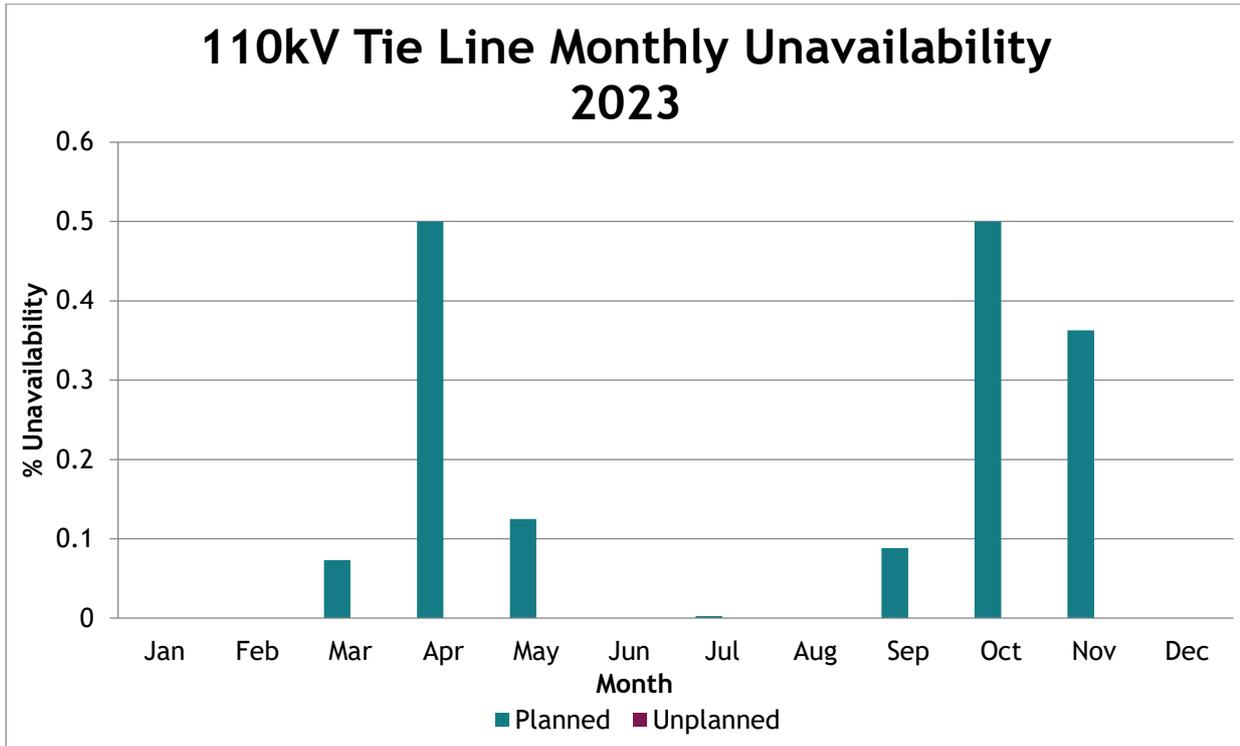


Figure 29: 110kV Tie Line Unavailability 2023

5.3. Transmission System Security

An incident is a system event that results in loss of supply. In this section incidents resulting from issues on the Northern Ireland Transmission system are described individually. The following sections detail the nature, location and duration of the incidents with an estimate of energy unsupplied.

5.3.1. Incidents for 2023

The criterion for the reporting of incidents is specified in Part 8, paragraph 33, of 'The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012'. An incident shall be reported if there has been:

- any single interruption of supply, to any demand of 20 MW or more at the time of the interruption, for a period of three minutes or longer; or
- any single interruption of supply, to any demand of 5 MW or more at the time of the interruption, for a period of one hour or longer; or
- any single interruption of supply to 5,000 or more consumer's installations for a period of one hour or longer.

5.3.2. Number of Incidents and Estimated Unsupplied Energy

In 2023, there was one system event in Northern Ireland that resulted in the loss of supply to customers. Details of this event are given below.

- At 16:44 on 7 September, an incident occurred at Ballymena substation. This event resulted in the loss of supply to 21,845 customers, equating to a total loss of 20.3 MW. All customers were fully restored within 28 minutes of the event happening.

5.3.3. Incident Analysis

Figure 30 details the incidents that have occurred historically in Northern Ireland.

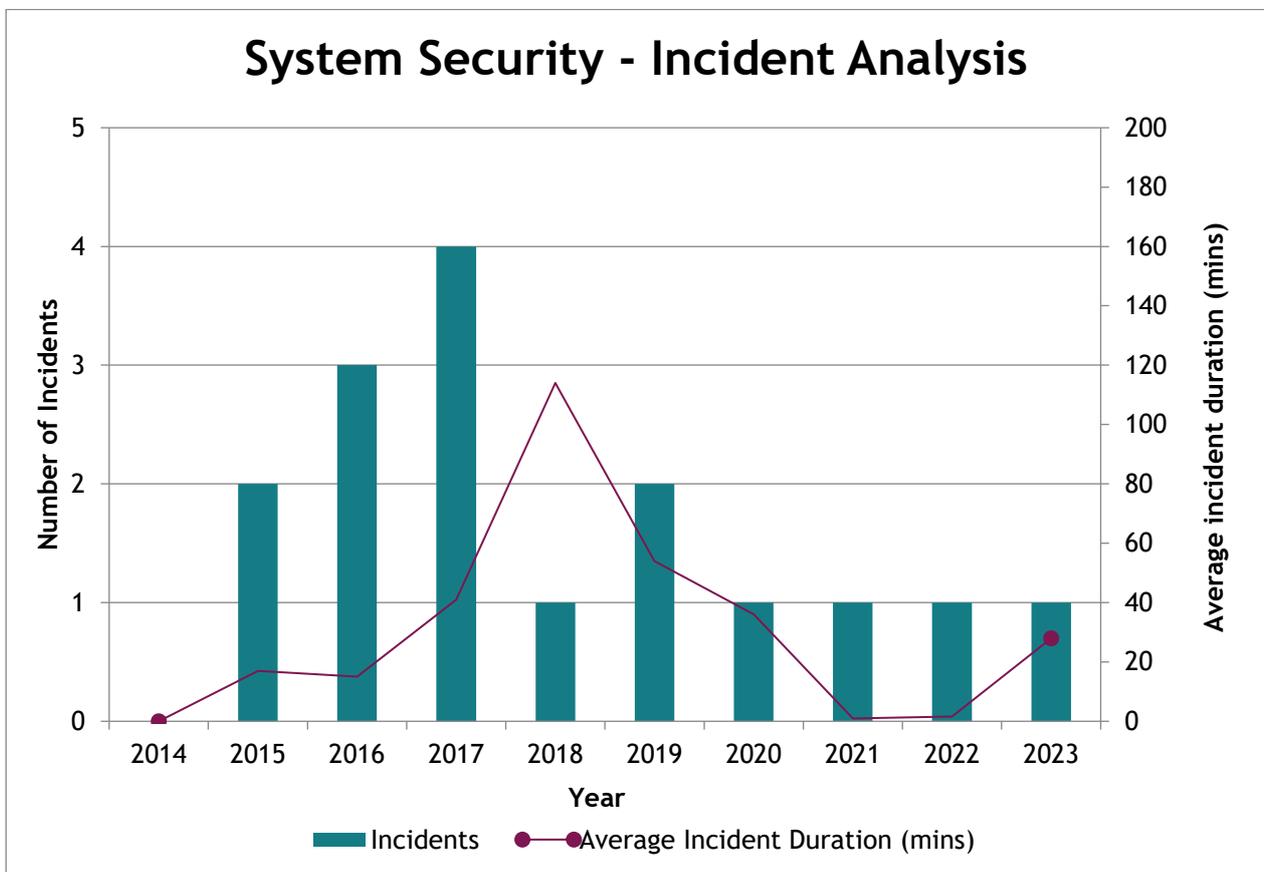


Figure 30: Historical System Security 2014 to 2023

5.3.4. Unsupplied Energy

Figure 31 below shows the historical amount of unsupplied energy to Northern Ireland customers.

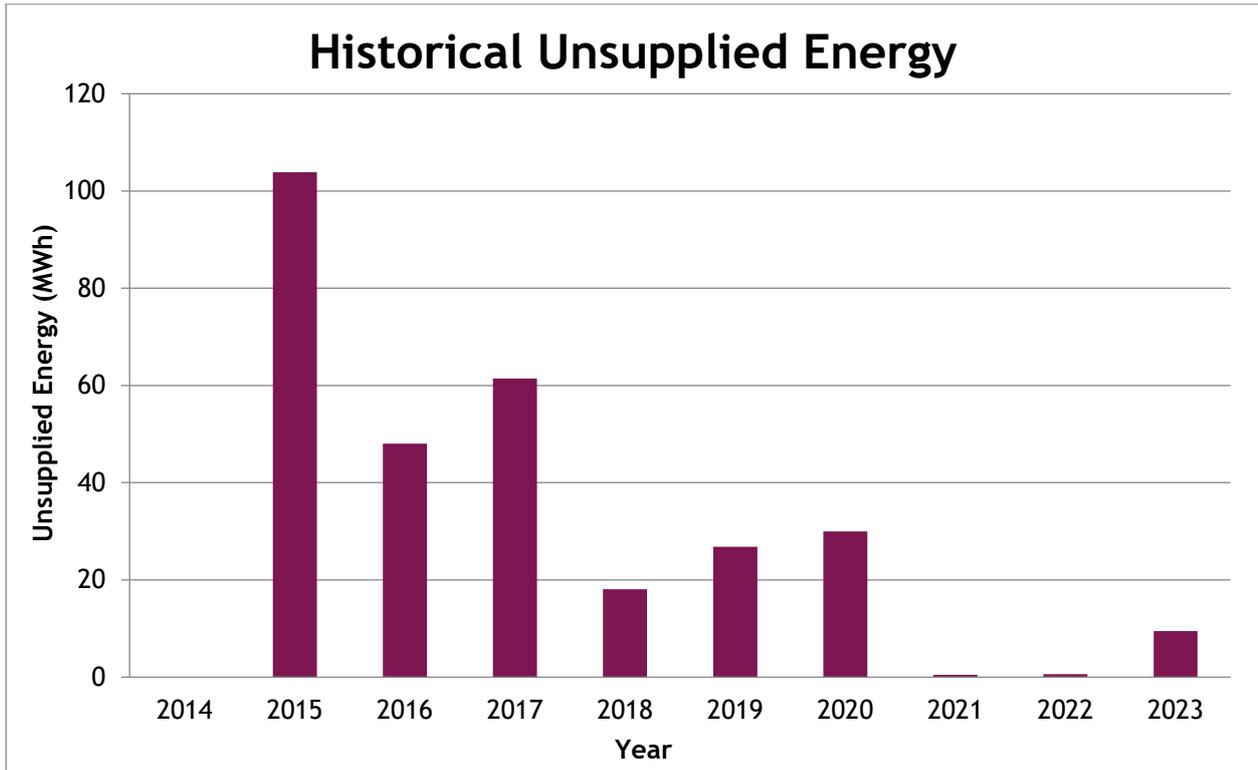


Figure 31: Historical Unsupplied Energy 2014 to 2023

5.3.5. System minutes lost

The total system minutes lost for 2023, attributable to SONI, was 0.669. The trend of system minutes lost since 2014 is shown in Figure 32.



Figure 32: System minutes lost 2014 - 2023

5.3.6. 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 “Zones of Protection” for further definition of Zones and ZCR.

In 2023, the ZCR was 0.047. Of the 21 short circuit faults in 2023, the main system protection was expected to operate without delay for 20 of those short circuit faults on the main system. All these 20 faults had zone 1 clearances, giving a zone clearance ratio of 0.047.

5.4. Quality of Service

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

5.4.1. Voltage

The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012 details the requirements for the management of voltage in Northern Ireland.

Part 7, paragraph 28 permit variations not exceeding 10% for operating voltages of 110 kV or higher. As well as adhering to legislation, SONI also operates the transmission system in such a way as to comply with the Operating Security Standards⁷, acceptable step changes in voltages are detailed in Table 10.

Table 10: Voltage step change limits in operational timescales

Transmission System secured events or switching event	Voltage fall	Voltage rise
Following loss of single circuit	-6%	+6%
Following loss of double circuit overhead line	-10%	+6%

5.4.2. Voltage Excursions

There were no voltage excursions exceeding these limits in 2023.

5.4.3. Frequency

SONI is required to manage the frequency of the power system. Power system frequency is a measure of balance between the electrical demand on the network and the amount of energy being generated. The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012 details the requirements for the management of Frequency in Northern Ireland.

Part 7, paragraph 28 of the regulations permits a frequency variation of up to 0.5 Hz above or below 50 Hz. There were no reportable frequency excursions in Northern Ireland in 2023.

⁷ [SONI Operating Security Standards](#)

5.4.4. Frequency Excursions

There were no reportable frequency excursions in Northern Ireland in 2023.

5.4.5. Historical Frequency Excursions

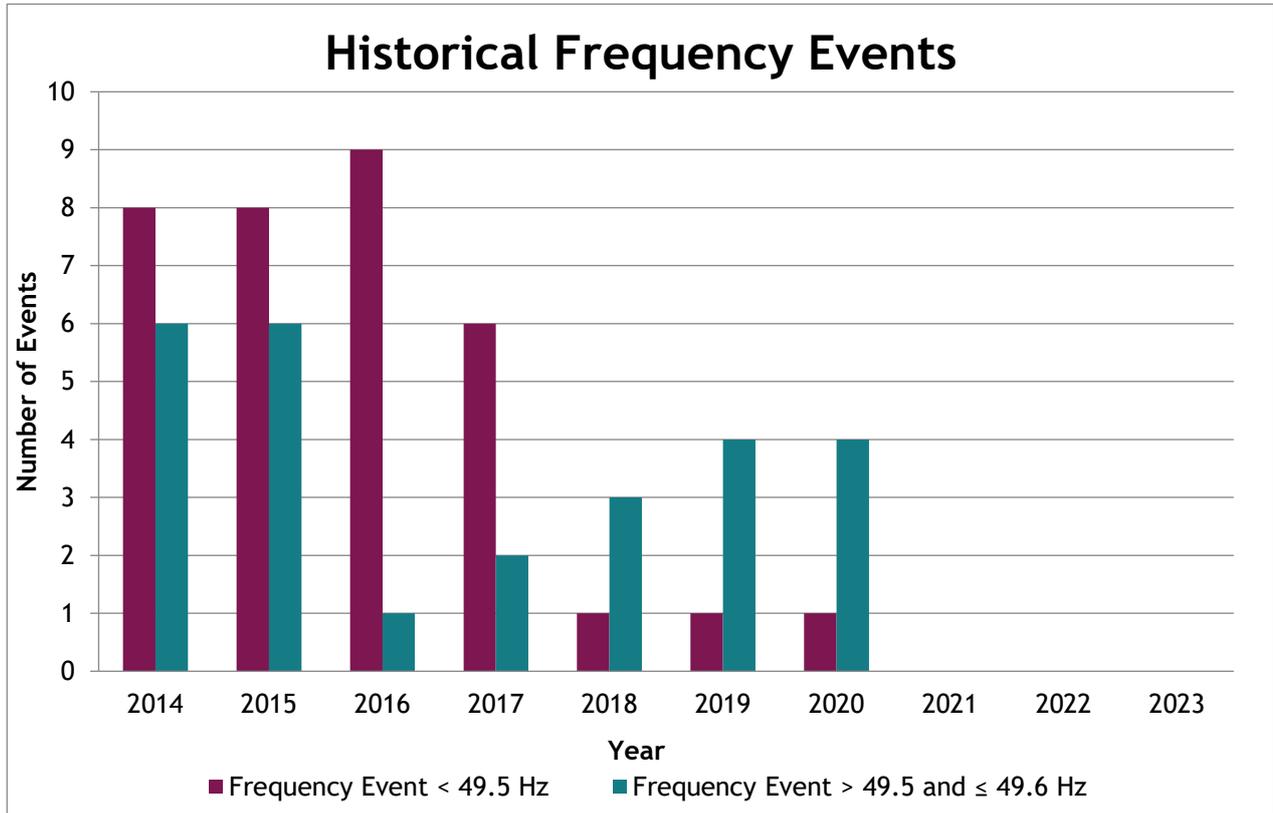


Figure 33: Historic Frequency Excursions 2014-2023

6. Appendix 1 Glossary

6.1. DCEF

Directional comparison earth fault. A teleprotection scheme that allows accelerated tripping by exchanging permit and receive signals for earth faults in a relay's forward direction.

6.2. 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.

6.3. 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.

6.4. Main system: EirGrid

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 Networks interconnector as far as the border with Northern Ireland, and the 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 (DSO load, directly connected industrial customer load, generator and HVDC interconnector 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.

6.5. Main system: SONI

The main transmission system includes: the 275 kV and 110 kV OHL and UGC network, the 275 kV and 110 kV busbars and couplers, the 275/110 kV interbus transformers, and all 110/33 kV transformers (aka main transformers). It also includes the 275 kV ESB/NIE Networks interconnector as far as the border with Ireland. The HV circuit breakers of directly connected transformers (generator and HVDC interconnector transformers) are part of the main transmission system thus faults on these transformers, which cause transmission system circuit breakers to be tripped, are reported.

6.6. Major incident

A major incident is one which results in the loss of greater than or equal to one system minute as a result of a single system disturbance.

6.7. MVA Minute Lost

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

6.8. Non main system/outside the main system: EirGrid

All HV plant on the Irish electricity network that does not form part of the main system: the Dublin 110 kV network (controlled by the DSO at the northern distribution control centre (NDCC). The MV system in Ireland is controlled by the NDCC in Leopardstown), all DSO and industrial customer load transformers, all Independent Power Producer (IPP) generator transformers, and all plant on the NIE Networks owned, SONI controlled, HV system in Northern Ireland.

6.9. Non main system/outside the main system: SONI

All HV plant connected to the Northern Irish electricity network that does not form part of the main system: all IPP generator transformers, HVDC interconnector transformers, and all plant on the ESB owned, EirGrid controlled, HV system in Ireland.

6.10. 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.

6.11. Permanent Fault

A fault is permanent if the component or unit is damaged and cannot be restored to service until repair or replacement is completed. An overhead line trips and stays out of service due to the absence or outage of reclosing facilities; the fault is permanent if maintenance staff must carry out equipment repairs or replacement before the line is returned to service. A protection setting change is required on the piece of plant before or after it is switched in following a fault.

6.12. POTT

Permissive overreach transfer trip. A distance teleprotection scheme that allows accelerated tripping by exchanging permit and receive signals for faults in a relay's zone 2.

6.13. Protection - Correct Operation

The operation is correct if a fault is cleared by the protection (in any time step) such that the correct circuit breakers open and no other circuit breaker opens.

6.14. Protection - Incorrect Operation

The operation is incorrect if, while a fault is being cleared, a circuit breaker is opened which should not have opened or a circuit breaker remains closed which should have opened.

6.15. PUTT

Permissive underreach transfer trip. A distance teleprotection scheme that allows accelerated tripping by receiving a signal for a fault in a relay's forward direction.

6.16. Sustained Interruption

A sustained interruption is one which lasts for more than one minute.

6.17. 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.

6.18. System Minute

A measure of the energy not supplied for a disturbance. The metric takes account of the load lost (MW), duration of disconnection (Minutes) and peak system demand (MW), to allow for historical comparison. For example, if 300 MW were lost for 10 minutes and the system peak was 3000 MW, this would represent one System Minute.

$$\text{System Minutes} = \frac{(\text{Load MW} \times \text{Duration mins})}{(\text{System Peak MW})} = \frac{(300 \times 10)}{3000} = 1$$

6.19. Transient Fault

A fault is transient if the unit or component is undamaged and is restored to service through manual switching operations, or rapid automatic reclosure on overhead lines, without repair being performed, but possibly with on-site inspection.

6.20. Zone Clearance Ratio

The Zone Clearance Ratio is defined as the ratio of the number of short circuit faults not cleared in Zone 1 to the total number of short circuit faults per year. The more faults cleared in Zone 1, the quicker they are taken off the power system which reduces the risk of system instability, plant damage and injury to personnel.

6.21. Zones of Protection

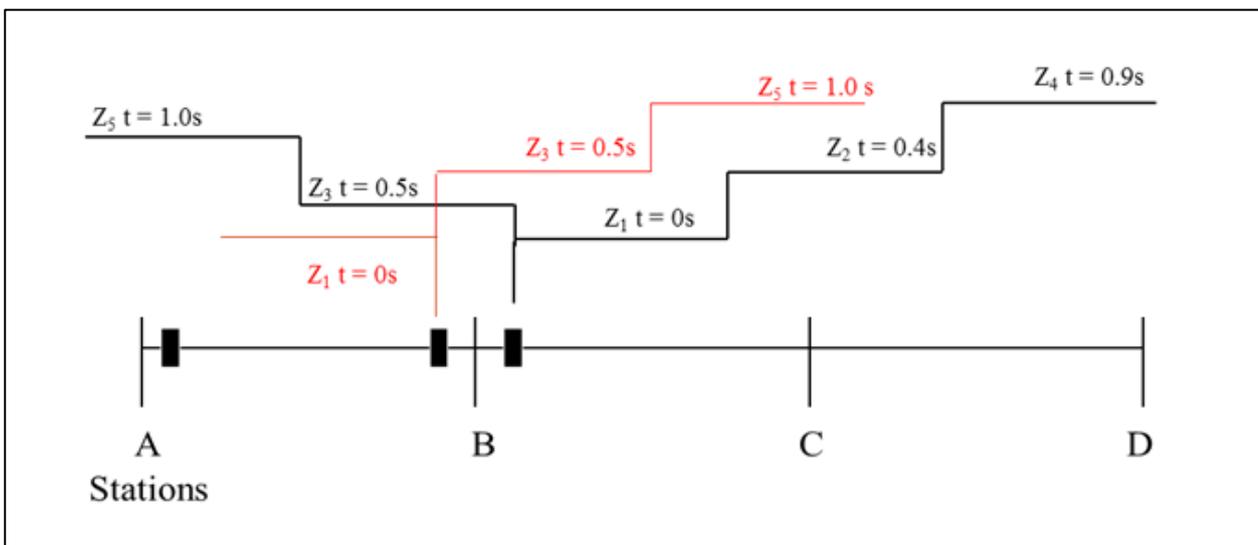


Figure 34: Zones of Protection

Zone 1 on an impedance (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, as shown in Figure 34. Typical Zone 1 clearance times are 50 to 150 ms.

Zone 2 on an impedance relay is used as a 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 an impedance relay is used as a backup protection zone and 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 with a time delay of approximately 900 ms.

Zone 5 is the second reverse step of a distance protection scheme with a time delay of approximately 1.1 seconds.

7. Appendix 2 All Island Dispatchable Generation Plant

Table 11: All Island Dispatchable Generation Plant

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
AC Automation	ACA	7.625	DSU	75.0
Enel X	AE1	85.533	DSU	13.1
	AE2	11.341	DSU	33.0
	AE3	13.969	DSU	28.0
	AE4	15.096	DSU	15.3
	AE5	15.300	DSU	0.0
	EN1	15.451	DSU	12.3
	EN2	16.298	DSU	7.5
	EN3	16.330	DSU	22.6
	EN4	15.700	DSU	24.0
	EN5	5.840	DSU	0.1
	EN6	30.012	DSU	20.0
	EN8	23.350	DSU	32.5
	EN9	15.918	DSU	42.3
	EX1	20.200	DSU	0.0
Activation Energy Ltd (NI)	AEA	2.589	DSU	33.8
EPUK	Ballylumford - B10	101.000	Gas / Distillate Oil	87.9
	Ballylumford - B31	247.000	Gas / Distillate Oil	91.7

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
	Ballylumford - B32	247.000	Gas / Distillate Oil	91.4
	Ballylumford - BGT1	58.000	Distillate Oil	35.8
	Ballylumford - BGT2	58.000	Distillate Oil	95.4
	Kilroot - KGT1	30.000	Distillate Oil	92.9
	Kilroot - KGT2	29.000	Distillate Oil	87.7
	Kilroot - KGT3	42.000	Distillate Oil	85.7
	Kilroot - KGT4	42.000	Distillate Oil	68.3
Aughinish Alumina Ltd	Seal Rock - SK3	83.000	Gas / Distillate Oil	80.8
	Seal Rock - SK4	83.000	Gas / Distillate Oil	84.4
	EB1	25.000	DSU	0.0
Bord Gáis	Whitegate - WG1	444.000	Gas / Distillate Oil	95.2
Contour Global	CGA	12.084	Gas	68.4
Coolkeeragh ESB	Coolkeeragh - C30	425.000	Gas / Distillate Oil	75.2
	Coolkeeragh - CG8	53.000	Distillate Oil	93.6
DAE Virtual Power Plant	DP1	17.967	DSU	43.3
	DP2	19.157	DSU	18.3
	DP3	8.413	DSU	9.8
Dublin Waste to Energy	Dublin Waste - DW1	62.000	Waste	86.5
Edenderry Power Ltd	Edenderry - ED1	118.000	Biomass	49.8
	Edenderry - ED3	58.000	Distillate Oil	99.9
	Edenderry - ED5	58.000	Distillate Oil	99.9
Electricity Exchange NI	VN1	6.671	DSU	2.1

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
Electric Ireland DSU	EI1	13.139	DSU	46.9
VIOTAS	EE1	54.741	DSU	21.4
	EE2	27.289	DSU	16.5
	EE3	10.306	DSU	10.6
	EE4	11.001	DSU	6.7
	EE5	11.211	DSU	56.1
	EE6	13.718	DSU	39.1
	EE7	7.156	DSU	30.4
	EE8	16.801	DSU	42.4
	EE9	10.973	DSU	29.5
	VS1	7.735	DSU	20.8
	VS2	10.110	DSU	27.5
Empower	EMP	12.760	Distillate Oil	99.6
Endeco Technologies	EC1	51.665	DSU	23.6
	EC2	12.750	DSU	31.7
	EC3	5.194	DSU	48.9
	EC4	4.820	DSU	45.4
	EC5	20.082	DSU	22.8
	ECA	24.305	DSU	24.8
	ECB	6.267	DSU	32.4
Energy Trading Ireland	ETB	5.542	DSU	18.7
	ETC	4.039	DSU	0.0
	ETD	6.087	DSU	2.7
	ETE	5.031	DSU	8.5

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
	ETF	5.053	DSU	0.0
	ETR	4.037	DSU	9.3
Evermore Renewable Energy	Lisahally - LPS	18.000	Biomass	79.1
Indaver	IW1	17.000	Waste	95.1
IPOWER	AGU	55.197	Distillate Oil	86.7
	ID1	4.334	DSU	20.0
	ID2	5.400	DSU	29.4
	ID3	9.852	DSU	67.9
Kelwin	KZ3	2.000	Diesel / Ultra-Capacitor	95.3
Powerhouse Generation Ltd.	PG1	9.821	DSU	29.8
Powerhouse Generation Ltd. (NI)	PH1	13.283	DSU	22.4
	PH2	13.578	DSU	32.0
SSE Generation Ireland	Great Island - GI4	464.000	Gas / Distillate Oil	90.2
	Rhode - RP1	52.000	Distillate Oil	97.2
	Rhode - RP2	52.000	Distillate Oil	96.8
	Tawnaghmore - TP1	52.000	Distillate Oil	81.2
	Tawnaghmore - TP3	52.000	Distillate Oil	97.8
Synergen	Dublin Bay - DB1	415.000	Gas / Distillate Oil	82.5
Tynagh Energy Ltd	Tynagh - TYC	404.000	Gas / Distillate Oil	81.7
Viridian Power and Energy	Huntstown - HN2	402.000	Gas / Distillate Oil	90.3

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
	Huntstown - HNC	342.000	Gas / Distillate Oil	90.1
ESB Power Generation	Ardnacrusha - AA1	21.000	Hydro	96.9
	Ardnacrusha - AA2	22.000	Hydro	94.8
	Ardnacrusha - AA3	19.000	Hydro	55.0
	Ardnacrusha - AA4	24.000	Hydro	18.2
	Aghada - AD2	449.000	Gas / Distillate Oil	84.1
	Aghada - AT11	90.000	Gas / Distillate Oil	98.1
	Aghada - AT12	90.000	Gas / Distillate Oil	97.7
	Aghada - AT14	90.000	Gas / Distillate Oil	98.4
	Erne - ER1	10.000	Hydro	98.6
	Erne - ER2	10.000	Hydro	86.5
	Erne - ER3	23.000	Hydro	98.7
	Erne - ER4	23.000	Hydro	92.3
	Lee - LE1	15.000	Hydro	94.0
	Lee - LE2	4.000	Hydro	92.7
	Lee - LE3	8.000	Hydro	95.2
	Liffey - LI1	15.000	Hydro	62.1
	Liffey - LI2	15.000	Hydro	62.4
	Liffey - LI4	4.000	Hydro	74.8
	Liffey - LI5	4.000	Hydro	96.1
	Moneypoint - MP1	285.000	Coal / Heavy Fuel Oil	69.5

Company	Unit	Capacity (MW)	Fuel	365-day Rolling Availability %
	Moneypoint - MP2	285.000	Heavy Fuel Oil	36.6
	Moneypoint - MP3	285.000	Coal / Heavy Fuel Oil	71.5
	Poolbeg - PBA	232.000	Gas / Distillate Oil	76.6
	Poolbeg - PBB	232.000	Gas / Distillate Oil	94.5
	Turlough Hill - TH1	73.000	Hydro - Pumped Storage	94.4
	Turlough Hill - TH2	73.000	Hydro - Pumped Storage	91.7
	Turlough Hill - TH3	73.000	Hydro - Pumped Storage	92.3
	Turlough Hill - TH4	73.000	Hydro - Pumped Storage	93.7
	Northwall Temporary Emergency Generation - NW8	199.000	Gas	95.4
Low Carbon	Drumkee - DK1	50.000 (21.600 MWh)	Battery	97.6
	Mullavilly - MZ1	50.000 (21.600 MWh)	Battery	99.0
	Connor - CSB	50.000 (21.600 MWh)	Battery	57.8
	Lisnabreeny - KEB	50.000 (21.600 MWh)	Battery	72.7
	Porterstown - PN1	30.000 (27.000 MWh)	Battery	98.6
Statkraft	Beenanaspuck and Tobertoreen - XT2	11.000 (5.660 MWh)	Battery	93.5
	Kelwin - KZ4	26.600 (13.400 MWh)	Battery	96.6
Lumcloon Energy	Lumcloon - LU1	50.000 (30.000 MWh)	Battery	N/A

Company	Unit	Capacity (MW) (MWh)	Fuel	365-day Rolling Availability %
	Lumcloon - LU2	50.000 (30.000 MWh)	Battery	N/A
	Shannonbridge - SI1	50.000 (30.000 MWh)	Battery	N/A
	Shannonbridge - SI2	50.000 (30.000 MWh)	Battery	N/A
NTR	Gorey - OD1	9.000 (4.500 MWh)	Battery	97.6
Killala Community Wind Farm	Killala - KF2	10.800 (10.800 MWh)	Battery	90.9
ESB	Aghada - AD3	19.000 (37.100 MWh)	Battery	98.1
	Kylemore - IH1	30.000 (60.000 MWh)	Battery	65.0
	Poolbeg - PB8	75.000 (150.000 MWh)	Battery	40.6
Scottish Power	Gorman - GF1	50.000 (32.200 MWh)	Battery	99.0
Innogy/RWE	Lisdrumdoagh - LF1	60.000 (26.280 MWh)	Battery	0.0
	Gardnershill - GP1	8.500 (9.580 MWh)	Battery	98.0
NTR	Avonbeg - AV1	16.000 (9.22 MWh)	Battery	N/A

8. Appendix 3 EirGrid Maintenance Policy Terms

The following summarises the main terms and activities in the asset maintenance policy as operated by EirGrid⁸. The overall objective of maintenance is to ensure that the assets continue to meet their service and performance requirements including safety, environmental and output parameters⁹. Maintenance activities help to realise expected lifetime of an asset.

There are four primary maintenance categories:

1. Preventative/Routine: Preventive/routine maintenance is planned at predetermined intervals to reduce the likelihood of equipment degradation which could lead to plant failure e.g., condition assessment. This type of maintenance is planned in advance and the frequencies of these activities are pre-determined by the EirGrid Asset Maintenance Policy
2. Corrective: Corrective maintenance may consist of repair, restoration, or replacement of equipment before functional failure. Corrective maintenance requirements are identified through regular inspections. The aim of routine inspections is to identify the potential for failure in time for the solution to be planned and scheduled and then performed during the next available outage.
3. Fault: Fault maintenance includes activities arising from unexpected equipment failure in service.
4. Statutory Maintenance: Maintenance which is carried out to facilitate statutory requirements e.g., Pressure Vessel Inspections, bund inspections.

Please refer to the 'Guide to Transmission Equipment Maintenance' which is published on the EirGrid website for further information¹⁰.

⁸ In Northern Ireland maintenance policy for the transmission system is the responsibility of NIE Networks as licenced Transmission Owner.

⁹ An anatomy of Asset Management - Institute of Asset Management Version 2 (July 2014)

¹⁰ www.eirgridgroup.com/site-files/library/EirGrid/Guide-to-Transmission-Equipment-Maintenance-March-2019.pdf

9. Appendix 4 Formulae

9.1. Ireland Availability & Unavailability Formula

Availability of 110kV, 220 kV, 275 kV and 400 kV lines:

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

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

Availability of 220 kV/110 kV, 275 kV/220 kV and 400 kV/220 kV transformers:

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

Where: n = The total number of transformers for which outages occurred

m = The total number of transformers at that voltage level

System Unavailability:

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

The equation above is the same as that used by OFGEM (The Office of Gas and Electricity Markets) in the UK.

9.2. System Minute Formula

System Minutes:

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

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

Where Power Factor = 0.9.