SONI

Winter Outlook 2023/24

October 2023

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Introduction

SONI operates the electricity transmission system in Northern Ireland.

We are responsible for the planning and operation of a safe, secure, reliable, economic and efficient electricity transmission system to ensure all reasonable demands for electricity are met. SONI works in partnership with government, the Utility Regulator and industry to ensure Northern Ireland consumers receive a high quality and increasingly clean energy supply, while also managing an increasingly complex supply and demand dynamic.

There are inherent challenges and risks in all complex power systems. Electricity transmission operators around the world face a wide range of demands and challenges, from geo-political pressures, the weather (including very cold spells and storms), delays in new generation development, to outages at power stations and on interconnectors. We utilise our deep technical expertise to assess the impact of these factors and develop mitigation plans, however a confluence of these pressures, which can be heightened in winter, at any one point can create an imbalance on the system which could lead to the system operating outside of our preferred security standards, power shortages or, in rare cases, localised loss of supply.

SONI does not generate electricity, deliver demand response, or control market flows on interconnectors. As a transmission system operator, we plan and manage the electricity grid with the generation that is made available to us by the providers who secure contracts through the all-island capacity market for electricity. We rely on others to have this power available to us when it is needed.

These are the issues that our team of expert and experienced engineers manage every second of every day on behalf of local communities, businesses and farms across the country.

The annual All-Island Generation Capacity Statement published by SONI presents information on generation adequacy studies that assess the balance between supply and demand over the subsequent ten years.

This Winter Outlook presents a more detailed view, focusing on the upcoming winter. This document helps inform the electricity industry and supports preparation for the coming months. We study the expected generation capacity and the forecast demand to determine if there is adequate generation capacity margin. We identify periods where the margin between generation capacity and forecast peak demand is low, and the security of supply of the electricity system may be at risk.

The Winter Outlook for 2023/24 covers the period from 30 October 2023 to 31 March 2024. The data-freeze date for the outlook was 25 September 2023.

Key technical terms

Here we explain some of the key technical terms used in the report. A full glossary of other terms can be found in the following section.

Loss of Load Expectation (LOLE) is a mathematical formula, based on studies, of the number of hours in a period (typically a year[1]) during which the available generation plant will be inadequate to meet the instantaneous demand. The higher this number is, the greater the risk that there will be insufficient generation available to meet the demand at all times. The Department for the Economy sets the LOLE standard which acts as a maximum level of risk that it has judged the system should be operated at. The LOLE standard is 4.9 hours per year.

Expected Unserved Energy (EUE) is the expected amount of energy, based on the same LOLE studies, not supplied during a period (typically a year) due to insufficient generation being available.

Alert state is when a single event on the electricity power system would give rise to a reasonable possibility of one or more operational security limits being violated, e.g., failure to meet the demand.

Emergency state is when one or more operational security limits on the electricity power system are violated, e.g., failure to meet the demand.

De-rated generation capacity is the capacity of generation that can be expected to contribute to capacity adequacy. It is typically based on the historical performance of each generator on the system. A generator that has performed poorly in the past, by being unavailable for extended periods (e.g., due to breakdowns), will have a lower de-rated capacity, as its contribution to capacity adequacy is deemed to be less.

De-rated margin is the sum of the de-rated generation capacity from all available generating units and interconnectors, less the forecast demand and reserve requirement.

1 For Winter Outlook 2023/24, LOLE is assessed over the period 30 October 2023 to 31 March 2024.

Glossary

Capacity
The rated continuous power output of a generator.

Capacity/generation adequacy
When there is sufficient generation capacity to meet the demand and reserve requirements.

Capacity market auction
The Capacity Market is a mechanism designed to ensure that Ireland and Northern Ireland has enough electricity to power homes, businesses and industry. The market takes the form of an auction, held every year, for capacity for the future.

Combined Cycle Gas Turbine (CCGT)
A type of thermal generator that typically uses natural gas as a fuel source. It is a collection of gas and steam turbines where waste heat from the gas turbine(s) is passed through a heat recovery boiler to generate steam for the steam turbine(s).

Conventional generating unit
The general term applied to generating units that produce electricity from coal, oil or natural gas.

Demand
The amount of electrical power consumed by the power system.

Demand Side Unit (DSU)
A unit consisting of one or more individual demand sites that can be dispatched by the TSO to reduce demand.

De-rating factor
The percentage of a generating unit's capacity that reliably contributes to capacity adequacy. It is typically based on forced outage rates.

Dispatchable generating unit/generation
Sources of electricity that can be used on demand and dispatched at the request of the TSOs. Does not include wind and solar generation which are non-dispatchable generation.

Moyle Interconnector (Moyle)
A 500 MW Interconnector that connects the electricity transmission systems of Northern Ireland and Great Britain.

Forced outage
An event where a generator is unavailable for electricity production for a period of time due to unforeseen/unplanned reasons.

Forced outage rate
The proportion of time that a generation unit is expected to be unavailable for electricity production due to unforeseen/unplanned outages.

Forecast demand
The amount of electrical power that is expected to be consumed by the power system in a time period.

Forecast peak demand
The maximum amount of electricity that is forecast to be consumed by the power system on a daily, weekly or annual basis.

Generating unit
Any apparatus which produces electrical energy.

Generation Capacity Statement
Statement produced by EirGrid and SONI outlining the expected electricity demand and the level of generation capacity that will be required on the island of Ireland over the next ten years.

Interconnector
An electrical link that connects two systems.

Megawatt (MW)
Unit of power: 1 Megawatt = 1,000,000 Watts.

North-South Tie Lines
The electrical link that connects the transmission system of Ireland to the transmission system of Northern Ireland.

Open Cycle Gas Turbine (OCGT)
A type of thermal generator that typically use kerosene or natural gas as a fuel source. It is similar to a CCGT but less efficient, as waste heat from the primary turbine(s) is not recovered.

Outage
A partial or total reduction in the availability of a generating unit such that the generating unit is unavailable to achieve its maximum capacity.

Peaker plant
A dispatchable generating unit that is typically used to meet evening peak demand.

Renewable
A natural resource or source of energy, such as wind, solar and hydro.

Reserve requirement
The additional generation capacity that is required to be available to meet demand in the event that the forecasted supply of power is disrupted.

Scheduled outage
Outage where a generator is unavailable for electricity production due to planned reasons, e.g., for maintenance.

Security of supply
The electricity system's capability to ensure uninterrupted availability of electricity at a reasonable cost.

Security standards generation margin
SONI aims to operate the transmission system in accordance with security standards which are important to ensure security of supply. It is important to maintain margins to allow these standards to be met, and to provide insurance against unexpected events.

System constraints
Congestion at one or more parts of the transmission network that prevent power being transmitted to the location of demand.

Thermal generating unit
Generating units that produce electricity from coal, oil or natural gas, using steam to power a turbine(s).

REMIT
Regulation on Wholesale Energy Markets Integrity and Transparency (REMIT) is an EU Regulation which establishes a framework for the integrity and monitoring of the wholesale energy market. Under REMIT, market participants are obliged to fulfil the obligations that "Market participants shall publicly disclose in an effective and timely manner inside information which they possess…".

Executive summary

This assessment highlights that, whilst there is an increased risk of operating outside of existing security standards for generation margin due to a reduction in conventional generation capacity, there should be sufficient generation this winter to meet expected demand in normal operating conditions.

The Loss of Load Expectation (LOLE) in Northern Ireland for the five months of the winter period being studied has increased from 1.5 hours (last winter) to 1.95 hours. This remains within the level of risk that is set by the Department for the Economy.

There is a risk that the system could enter the Alert State at times, most likely at periods of low wind and low interconnector imports. The risk of the system entering the Emergency State due to insufficient generation being available to meet the demand is low. The Expected Unserved Energy (EUE) figure suggests that, on average, electricity consumers could potentially be without supply for a minimal period of time (less than 10 minutes) over the winter period. LOLE is a metric used to measure the risk or likelihood of such an event happening. This does not necessarily mean that electricity consumers will be without supply for any period.

Based on information at the time of the data freeze, late November is expected to be the most onerous period from a capacity margin perspective. There is no risk of a system-wide “blackout” (a total loss of control of the electricity system) solely due to insufficient generation under any circumstances this winter. Other conditions would have to be present or multiple and significant failures occur to cause a system wide blackout. A key assumption underpinning the Winter Outlook analysis, based on best information available at the time of writing, is that there will be uninterrupted reserves of natural gas from both the Moffat terminal and the Corrib gas field, with no shortage issues.

The increase in LOLE this year is largely due to the retirement of existing generation and delays in the connection and energisation of new generation capacity.

It is important to note that this assessment highlights that whilst a reduction in conventional generation capacity could pose a challenge to maintaining existing security standards for generation margin, good availability of renewable generation and/or imports, improves the generation margin. Furthermore, if consumer demand is lower than the median demand scenario considered in this analysis, the generation margin also improves.

Whilst we expect there to be sufficient generation to meet consumer demand in normal operating conditions, it is important to be clear that our assessments point to a small increase in risk in comparison to the last few years.

Our team of expert engineers are always managing a degree of risk in operating the transmission system and we have tried and tested mitigation and contingency plans in place in the event any challenges arise.

These plans include:

- Maximising all other available generation on the system
- Maximising imports from Great Britain and Ireland
- Reconfiguration of the planned outage schedule
- Acceleration of any new generation due to come onto the system and
- Use of small, more responsive generation, such as Open Cycle Gas Turbines and other technologies such as batteries.

Winter 2022/23 review

Generation adequacy remained very tight across the winter period at times of low wind generation. Daily engagement and reciprocal support arrangements with transmission system operators in Ireland and Great Britain were key to keeping the system out of the Alert and Emergency States during these periods. As a result, no System Alerts or System Emergencies[2] were experienced on the Northern Ireland power system during winter 2022/23.

Winter 2022/23 had a prolonged period of cold weather in December, and a shorter period in January. The sent-out peak demand over winter 2022/23 was 1,511 MW, which was below our median forecast from last year's Winter Outlook, however this was likely due to the impact of high electricity prices over last winter.

The forced outage rate of dispatchable generation (excluding DSUs) over the winter period was 18.5%. This was higher than our assumption of 11%, predominantly due to the reduced output capabilities of older generating units.

Wind generation output over the winter period was consistent with recent winters, supplying 40% of the electricity demand. However, wind generation output varied from 0 MW to 1,051 MW over the period. In terms of wind generation's contribution to capacity adequacy, we apply a capacity credit to account for its contribution to reliability.

Solar generation output is typically reduced throughout the winter period due to shorter, colder days. With the winter peak demand typically occurring after sunset, the installed solar capacity has been assigned a capacity credit of zero.

During the ten periods with the tightest generation margin, the average import from Ireland was 17 MW on the North-South Tie-Lines and 261 MW from Great Britain on the Moyle Interconnector.

2 There were 42 days during the winter period where we were reliant on wind generation and/or interconnection from Ireland and Great Britain to keep the system out of the Alert (24 days) and Emergency (18 days) States.

Winter outlook

Demand

As can be seen in Figure 1, the transmission peak electricity demand over the winter period in Northern Ireland has been relatively flat over the last number of years. The 2022/23 sent-out transmission peak demand (not temperature corrected) was 1,511 MW, which occurred on 13 December 2022 at 17:00.

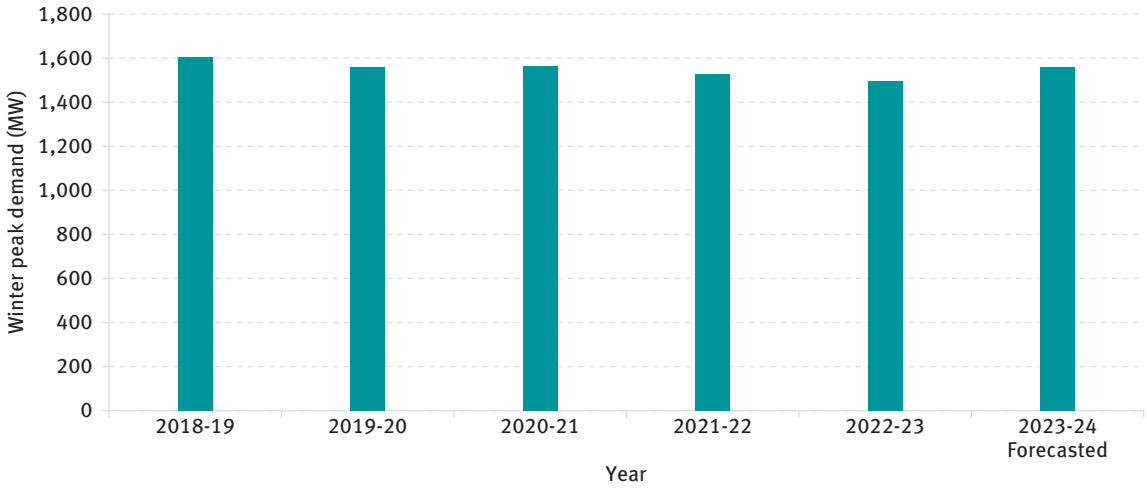

Figure 1: Northern Ireland historical annual peak demand

We anticipate a sent out peak demand of between 1,490 MW and 1,640 MW in Northern Ireland this winter. Figure 2 compares the weekly peak demand for the 2021/22 and 2022/23 winter periods, to the median forecast weekly peak demand for the 2023/24 winter period.

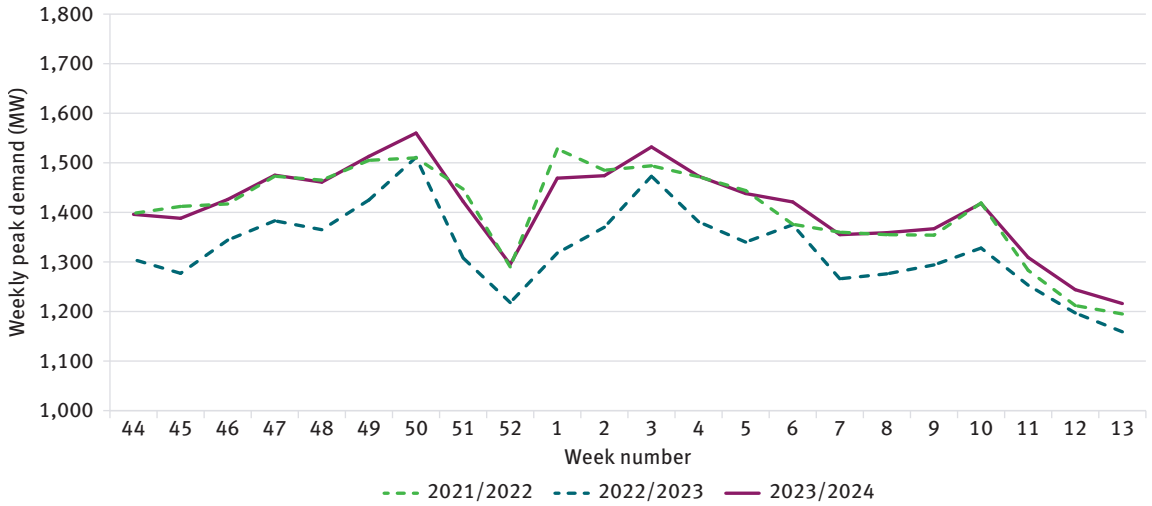

Figure 2: Northern Ireland weekly peak demand for 2021/22 and 2022/23 winter periods versus forecast median weekly peak demand for 2023/24 winter period

Generation capacity versus forecast demand

The total generation capacity in Northern Ireland is made up of a variety of different types of generating units: combined cycle gas turbines (CCGTs), thermal generation plant (coal, heavy fuel oil, biomass), open cycle gas turbines (OCGTs), peaker plant (typically gas and distillate), renewables (mostly wind and solar), demand side units (DSUs), aggregated generating units (AGUs) and a small volume of other technologies. There are two interconnectors: the 500 MW Moyle interconnector connecting Northern Ireland and Scotland: and the North-South Tie-Lines which connect Northern Ireland and Ireland.

We apply de-rating factors to the generation capacity to reflect the contribution of each generator to capacity adequacy to calculate a de-rated generation capacity. For conventional dispatchable generating units, the de-rating factor is based on forced outage rates in a rolling three-year period. For wind generation and interconnection, the de-rating factors are based on those used in the Generation Capacity Statement. Support from Ireland across the North-South Tie-Lines has been assumed at 100 MW, based on tight winter margins expected in Ireland.

The de-rated margin is the sum of the de-rated generation capacity from all available generating units and interconnectors, less the forecast demand and the reserve requirement. The more positive the de-rated margin is, the greater the likelihood that we will have sufficient capacity to meet demand, while a negative de-rated margin indicates there may be a shortage of generation capacity.

Figure 3 shows the total generation capacity on the system, the de-rated generation capacity, and the forecast demand plus reserve for the day with the highest peak demand/ lowest capacity margin, across the upcoming winter period.

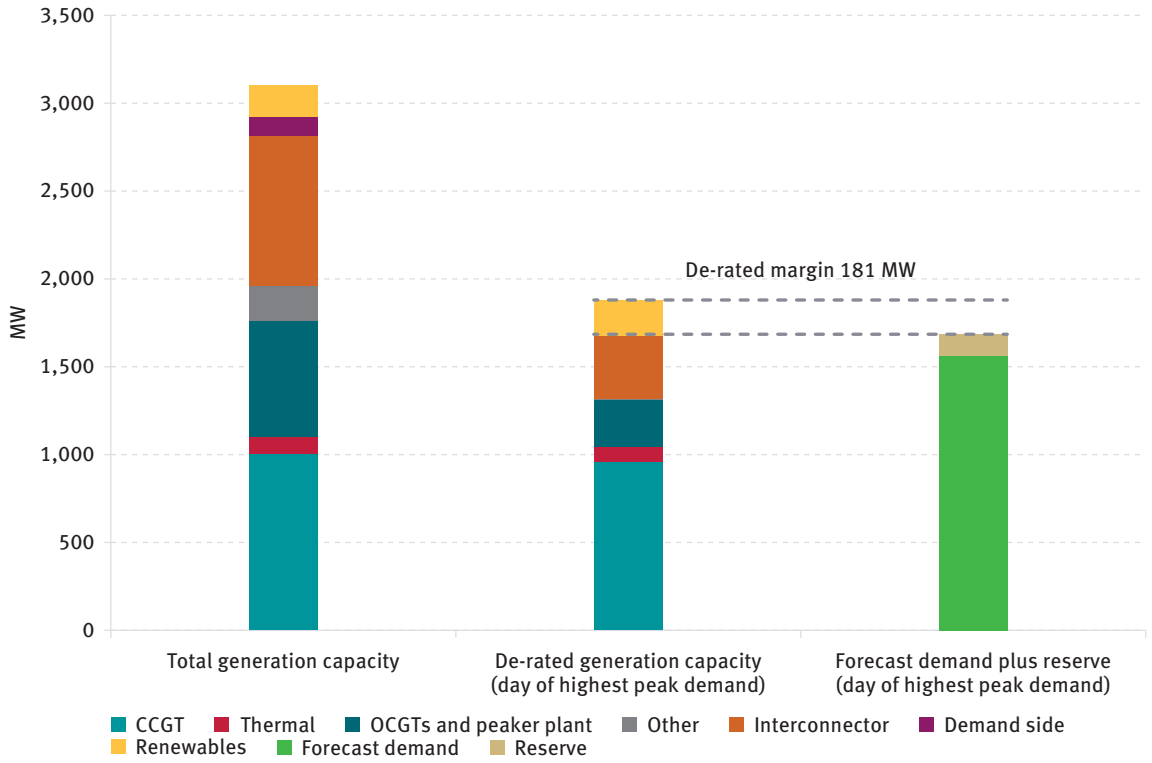

Figure 3: Northern Ireland week containing lowest de-rated capacity margin

LOLE and de-rated margin

The Loss of Load Expectation (LOLE) for Northern Ireland for the five months of the winter period being studied is 1.95 hours. For reference, the annual LOLE standard is 4.9 hours, as set by the Department for the Economy. The minimum de-rated margin over the winter period is expected to be in the range of 61 MW to 291 MW. The results suggest that with the loss of a single large unit in Northern Ireland, there is risk of the system entering the Alert State, most likely at periods of low wind and low interconnector imports. The risk of the system entering the Emergency State, due to insufficient available generation, is low. Any risk is reduced with increased availability of wind and imports, or when demand is less than expected. The Expected Unserved Energy (EUE) figure suggests that, on average, electricity consumers could potentially be without supply for a minimal period of time (less than 10 minutes) over the winter period. LOLE is a metric used to measure the risk or likelihood of such an event happening. This does not necessarily mean that electricity consumers will be without supply for any period.

Figure 4 shows the de-rated margin, as a percentage of demand plus reserve, for the day with the lowest capacity margin across the winter period for three demand scenarios. An approximate figure for the de-rated margin associated with an LOLE of 4.9 hours per year is shown below.

Table 1: Northern Ireland key metrics for median demand level

	2023/24 base case
Loss of Load Expectation (LOLE)	1.95 hours
Expected Unserved Energy (EUE)	169 MWh
Minimum de-rated margin (MW) over winter period	181 MW
Minimum de-rated margin (%) over winter period	10.7%

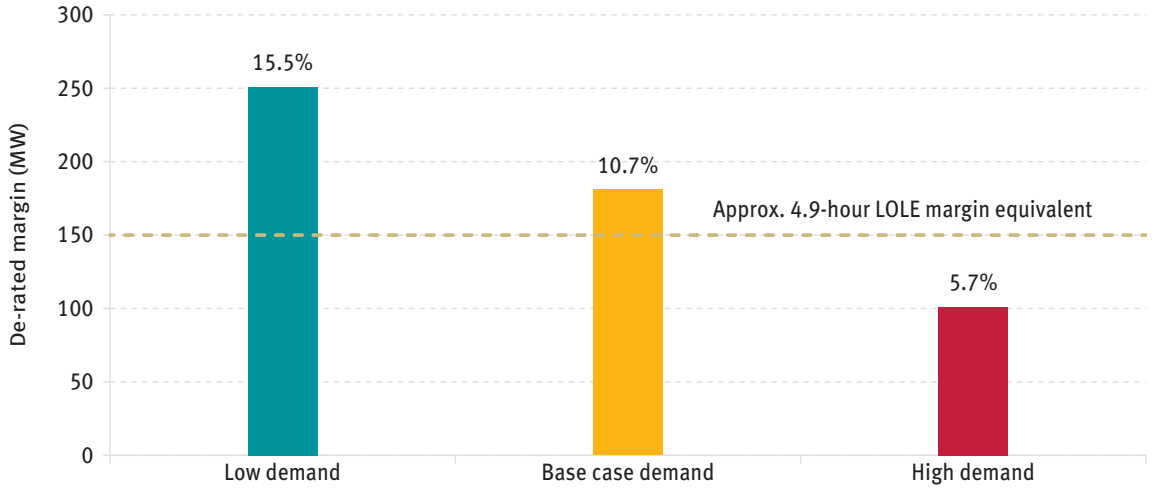

Figure 4: Northern Ireland week containing lowest de-rated capacity margin per demand scenario

Weekly analysis

We study the expected de-rated generation capacity and the forecast demand for each week across the winter period. This allows us to identify weeks when the de-rated margin is low and when the system is at risk of entering the Alert and Emergency states. We look at three interconnector (Moyle Interconnector and North-South Tie-Lines) import scenarios: low (0 MW); median (358 MW); and high (850 MW) imports. It should be noted that our studies also include probabilistic analysis of forced outages, which can have a more significant impact than outlined below.

Figure 5 shows the expected weekly de-rated generation capacity in the medium import scenario. The de-rated generation capacity fluctuates throughout the winter period due to known scheduled outages of generating units occurring and connection of new units.

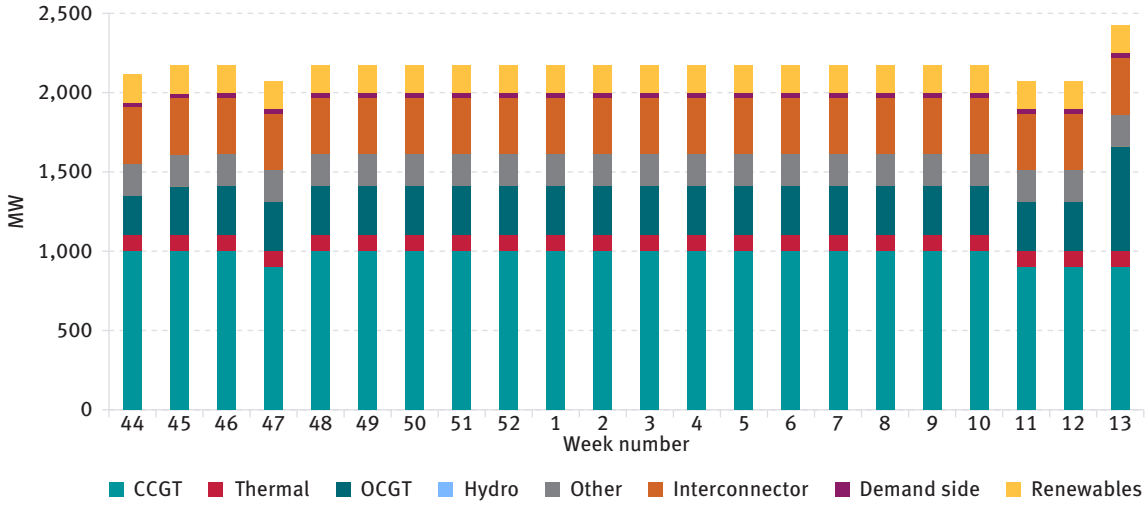

Figure 5: Northern Ireland expected weekly de-rated generation capacity per generator type

Given the small conventional generation portfolio in Northern Ireland and the size of the largest unit relative to the size of the system, it is important to also consider the unavailability of the single largest unit when assessing the winter outlook. Therefore, we assess two scenarios for Northern Ireland: one based on de-rating factors of all units and one based on the largest unit being unavailable (with the remaining conventional units not de-rated).

Figure 6 shows the expected weekly de-rated generation capacity based on de-rating factors for each import scenario versus the forecast demand plus reserve. In the median and high import scenarios, demand plus reserve is met. There are fifteen weeks in the low import scenario where the demand plus reserve requirement exceeds the de-rated capacity. The risk of the system entering the Alert and Emergency states is higher in these weeks.

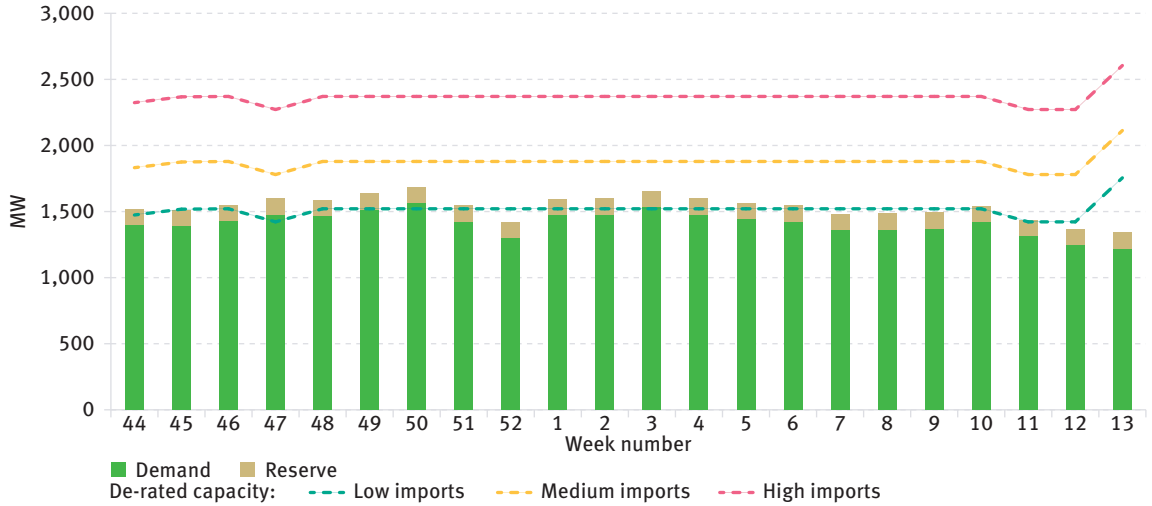

Figure 6: Northern Ireland weekly de-rated generation capacity (dashed lines) for each import scenario versus the forecast demand plus reserve (bars)

Figure 7 shows the weekly expected Northern Ireland de-rated generation capacity based on the largest unit being unavailable for each import scenario versus the forecast demand plus reserve. In the median and high import scenarios, demand plus reserve is met. In the low import scenario, there are twenty-one weeks where the demand plus reserve requirement exceeds the de-rated capacity. The risk of the system entering the Alert and Emergency states is higher in these weeks.

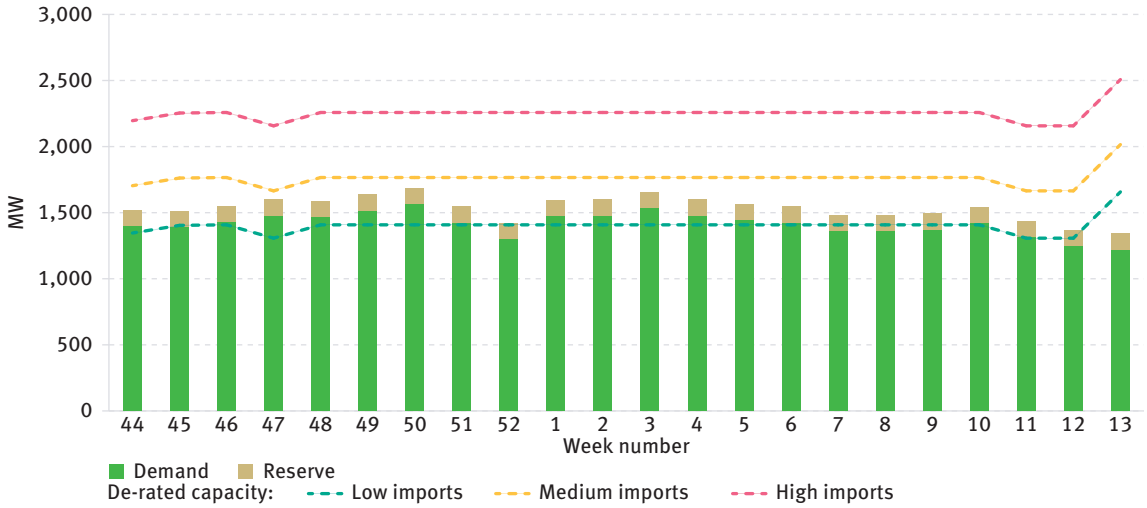

Figure 7: Northern Ireland weekly generation capacity based on the largest unit being unavailable with all other generation not de-rated (dashed lines) for each import scenario versus the forecast demand plus reserve (bars)

Northern Ireland forced outage rates

The dispatchable generation (excluding DSUs) forced outage rate in Northern Ireland has increased significantly over the past five years. For August 2022 to July 2023, it stands at 18.7%. This has led to tight margins in 2023, resulting in the Northern Ireland system entering the Alert state on one occasion during the summer period and has impacted the system's ability to accommodate generator planned outages.

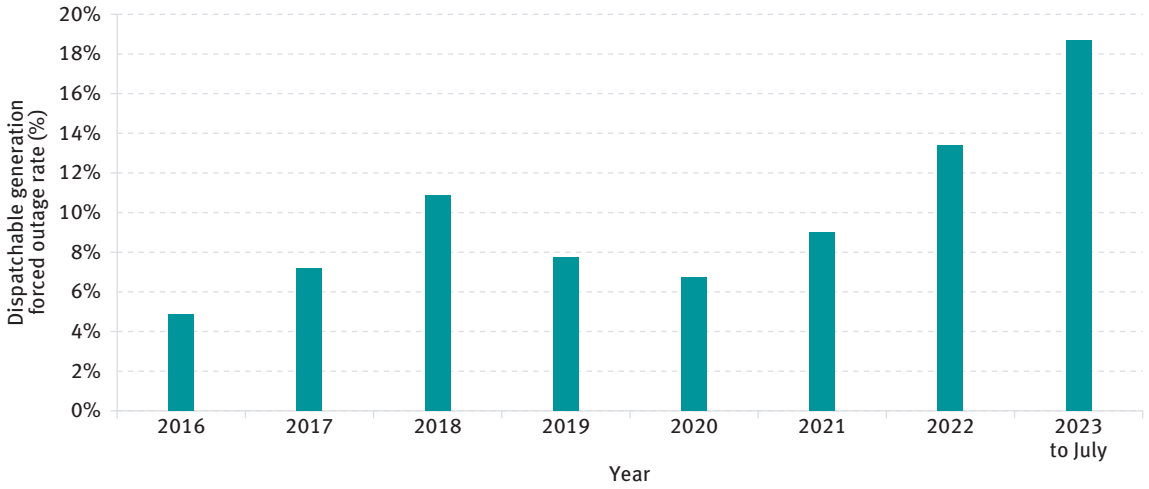

Figure 8: Northern Ireland historical dispatchable generation annual forced outage rates

Concluding observations

The assessment contained in this Winter Outlook points to a number of key observations:

- Whilst there is an increased risk of operating outside of existing security standards for generation margin due to a reduction in conventional generation capacity, there should be sufficient generation this winter to meet expected demand in normal operating conditions.
- The assessment of generation margin for this coming winter period indicates that the Northern Ireland power system may, at times, be relying on the availability of imports and renewable generation to maintain security standards for generation margin. This does not necessarily mean there will be any disruption to the electricity supply, however it does mean there is an increased risk, and the system could be operating at tighter margins than accounted for in existing security standards. Where there is standard availability of conventional generation and good availability of imports or renewable generation, existing security standards for generation margin should be maintained as normal.
- The circumstances in which the power system could be operating outside of these standards have arisen due to the retirement of existing generation and delays in the connection and energisation of new generation capacity.
- Until planned new generation connects to the system, there is a risk of the Northern Ireland system entering the Alert and Emergency states, most likely at periods of low wind and low imports.
- With high and median imports, the risk of the Northern Ireland system entering the Alert state is low.
- Actual imports are likely to be around the median levels anticipated, but the on-day availability of such is dependent on the system conditions within Ireland and Great Britain, and it should be noted that it is already anticipated that margins will be tight in Ireland this coming winter. As wind availability increases, it reduces the reliance on median or high imports.
- The study assumes an approximate allocation of wind capacity of 180 MW, aligning with assumptions from the All-Island Generation Capacity Statement however, at times when the actual output of wind generation is higher for a sustained period, the risk of the system entering the Alert and Emergency states is reduced. Wind above this assumed level increases the TSO‘s flexibility, decreases generation margin risk and can reduce the reliance on imports. It is however important to highlight the risk that wind levels could be lower than this assumption.
- Whilst a reduction in conventional generation capacity could pose a challenge to maintaining existing security standards for generation margin, good availability of wind/renewable generation and/or imports, improves generation margin.
- Furthermore, if consumer demand is lower than the median demand scenario considered in this analysis, generation margin also improves.
- Whilst we expect there to be sufficient generation to meet consumer demand in normal operating conditions, it is important to be clear that our assessments point to a small increase in risk in comparison to the last few years.
- Our team of expert engineers are always managing a degree of risk in operating the transmission system and we have tried and tested mitigation and contingency plans in place in the event any challenges arise. These plans include:
    - Maximising all other available generation of the system
    - Maximising imports from Great Britain and Ireland
    - Reconfiguration of the planned outage schedule
    - Acceleration of any new generation due to come onto the system and
    - Use of small, more responsive generation, such as Open Cycle Gas Turbines and other technologies such as batteries.

Assumptions

Availability

- Combined cycle gas turbine (CCGT) and large thermal unit (high- and mid-merit units) de-rating factors are based on forced outage rates over a rolling three-year window
- The de-rating factor for Peaker Plant is 0.9. These are generators that generally run only when there is a high demand or to respond to system events for capacity or to meet security standards
- The availability of Demand Side Units (DSUs), batteries, and wind are based on the All-Island Generation Capacity Statement
- Due to the winter peak typically occurring after sunset, the installed solar capacity has been assigned a capacity credit of zero
- Moyle Interconnector de-rating factor is based on the Generation Capacity Statement,
- North-South Tie-Lines de-rated to 100 MW for median flows from Ireland to Northern Ireland, due to the tight margins expected in Ireland this winter and
- New generation capacity: Connection dates as per current REMIT information (at the time of data freeze). New generation capacity has been de-rated accordingly based on the balance of new equipment against untested reliability.

Forecast demand

Median demand values for the winter period have been assumed as per the All-Island Generation Capacity Statement.

Gas network

There will be uninterrupted reserves of natural gas from the Moffat terminal in Scotland, as well as from the Corrib gas field in Ireland, with no shortage issues.

Import scenarios

This references the amount of electricity the TSO can import via the Moyle Interconnector and the North-South Tie-Lines. For this study, we have included three scenarios: low, median, and high imports. These are defined in Table 2 below:

Table 2: Import scenario breakdown

Import scenario	Moyle Interconnector (imports)	North-South Tie-Line (South to North)	Combined total
Low	0 MW	0 MW	**0 MW**
Median	258 MW	100 MW	**358 MW**
High	450 MW	400 MW	**850 MW**

Network

A fully intact network will be available.

Reserve

Northern Ireland operational reserve requirement has been set at 125 MW in this winter Outlook. These operational measures are used to minimise LOLE.


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