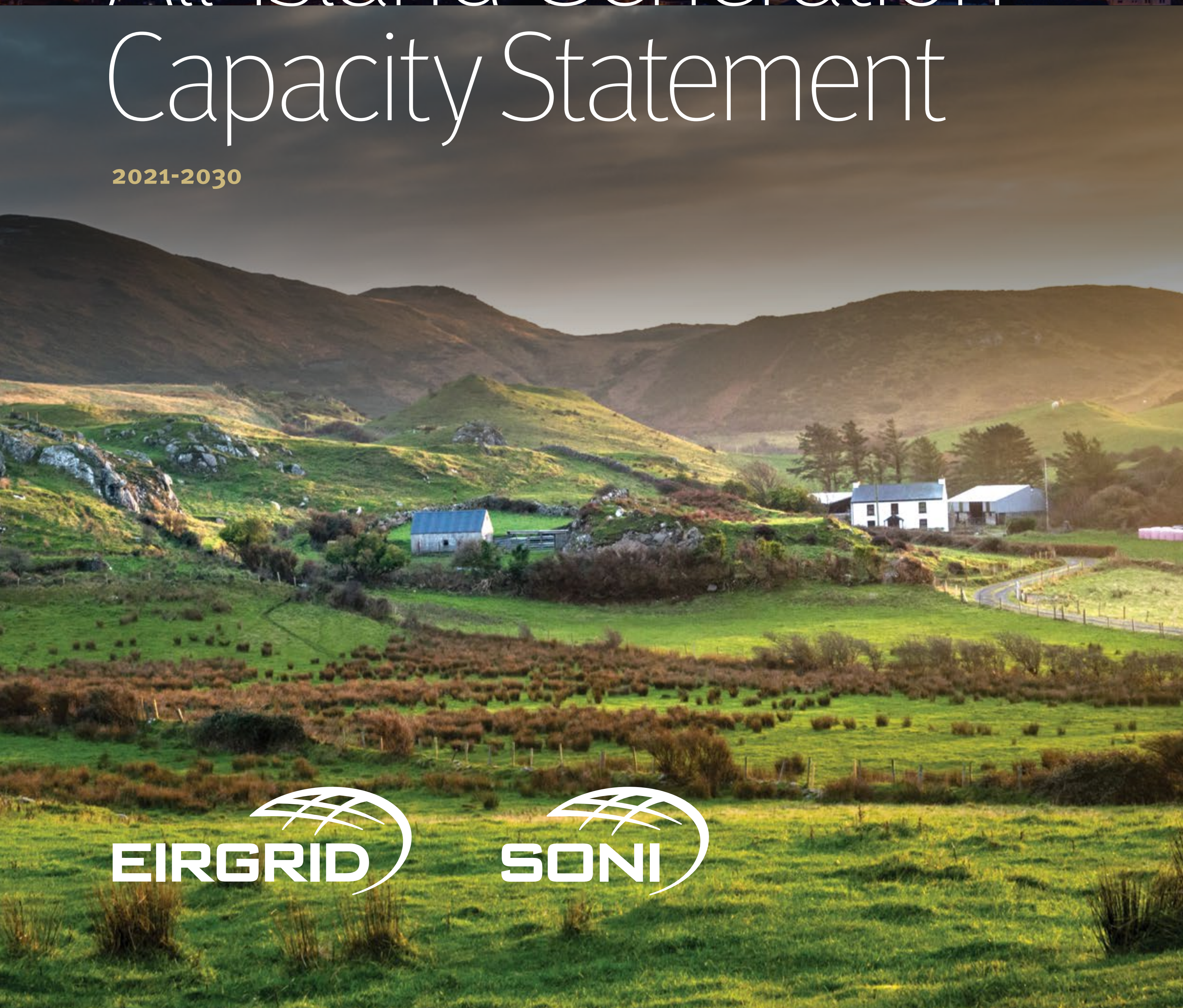
All-Island Generation Capacity Statement

2021-2030



EIRGRID SONI

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This document incorporates the Generation Capacity Report for Ireland and the Generation Capacity Statement for Northern Ireland.

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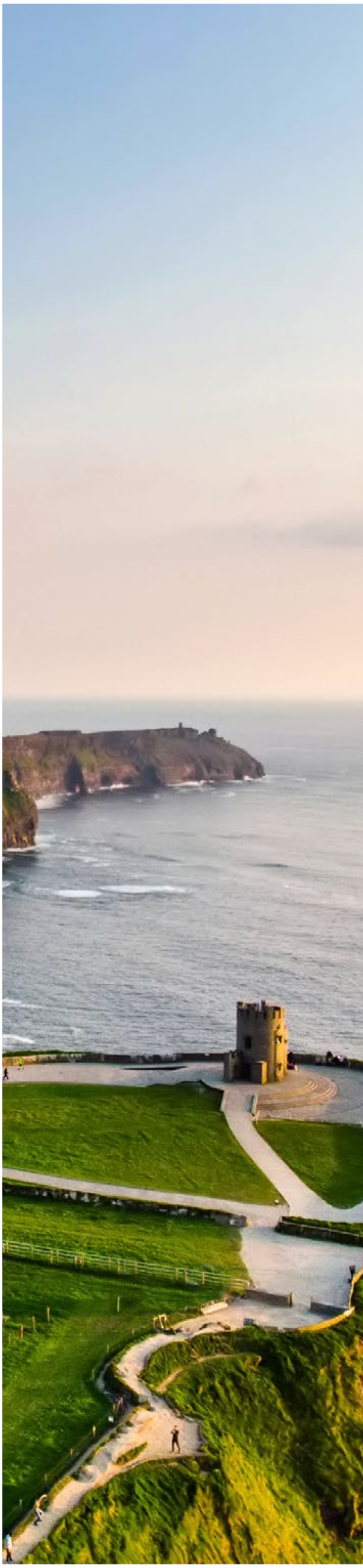


Preface

EirGrid Plc and SONI Ltd, as transmission system operators for Ireland and Northern Ireland respectively, are pleased to present the All-Island Generation Capacity Statement 2021-2030. In this statement, we outline the expected electricity demand and the level of generation capacity that will be required on the island of Ireland over the next ten years. As part of the strategy to support sustainability and decarbonisation, the grid is undergoing a process of modernisation, with greater needs for flexible generation to ensure security of supply. We are working to ensure that everyone has electricity when they need it, at the most economic price possible while preparing the grid to provide at least 70% of our power from renewable sources by 2030.

EirGrid and SONI have carried out generation adequacy studies to assess the balance between supply and demand for a number of realistic scenarios.

There were a number of system alerts in Ireland and Northern Ireland in winter 2020/21 – this is not the first time we have had these on the system. They indicate to industry market participants that capacity margins are tight and a loss of a generator could mean difficulty in meeting demand. This winter we experienced a combination of factors such as zero/low wind, limited interconnector support from Great Britain due to tight capacity margins there also, poor plant performance and a cold snap resulting in record peak electricity demand. We expect the number of system alerts to increase over the coming winters as capacity exits and demand increases.

Low power plant availability for this year continues to be a concern with an expectation that the coming winter period will be challenging. EirGrid and SONI continue to monitor the situation in the short term through the winter outlook forecast.

The capacity auction for the period 01 October 2024 to 30 September 2025 was held at the end of January 2021. The recent withdrawal of previously procured capacity and the failure of the recent auction to clear sufficient capacity mean there is a significant capacity shortfall against security standards for Ireland. We currently forecast capacity deficits in Ireland for the next five winters. The SEM Committee consulted upon the derating approach for emissions-limited plant, noting the emerging risk of some plant being limited in operating hours due to emissions[1]. Eirgrid will investigate any issues that potentially arise from run hour limitations. Margins in Northern Ireland are forecast to remain within standard into the future, however there are risks around when new capacity becomes available and the impact of run hour limitations which could result in deficits appearing. SONI will continue to investigate any issues that potentially arise from run hour limitations. The measures required to resolve the capacity deficits in Ireland are outside the scope of this report. EirGrid is currently engaging with key stakeholders, including the Commission for Regulation of Utilities (CRU) and the Department for the Environment, Climate and Communications (DECC) in relation to these future challenges.

At the end of 2019, EirGrid and SONI launched their respective five-year strategies to transform the electricity systems in both jurisdictions. These strategies focus on the transformation of the power system and electricity market, so that we can make the grid ready to carry at least 70% of electricity from renewable sources in Ireland and Northern Ireland by 2030. The power system will require unprecedented change over the decade. We project that Ireland and Northern Ireland will need upwards of 10 gigawatts (GW) of electricity from clean sources. This will be a fundamental transition for our electricity sector. This means renewable electricity will increasingly replace fossil fuels like coal and oil. Natural gas will still be used to generate electricity when wind and solar power are not available to meet the demand.

1 https://www.semcommittee.com/news-centre/annual-run-hours-limited-de-rating-factor-consultation-t-3-202425-capacity-auction

The electricity industry will have to find new ways to meet the increasing need for energy without relying mainly on burning fossil fuels. Looking out to 2030 our electricity demand is set to increase as consumers find new ways to use electricity. New government policies are expected to help move us away from fossil fuels toward alternative heating methods (such as electric heat pumps) and cleaner modes of transport (such as electric vehicles). This changing demand and generation supply landscape for the island will require coordinated management of new capacity connecting alongside new ways of managing increasing demand to ensure security of supply over this unprecedented period of change.

In Northern Ireland, the Department for Economy is currently developing a new energy strategy. A call for evidence closed in April 2020; the Northern Ireland Energy Strategy policy option consultation[2] opened on 31st March 2021 and ran until 30th June 2021. A final energy strategy is expected to be ready in November 2021 [3]. We are encouraged by the ambition laid out by the former Economy Minister, Diane Dodds MLA, in statements in setting out an expectation for the target to be no less than 70% of electricity from RES by 2030. This vision aligns closely with that of all of Northern Ireland's regional neighbours. The Department for the Economy's Energy Strategy consultation puts forward an option for to achieve a 70% renewables target for 2030; with scope to increase to 80% should it prove feasible [4].

In Ireland, the Irish Government has asked EirGrid to make the power system ready so that at least 70% of Ireland's electricity can come from renewable sources by 2030. To prepare for this change, EirGrid must make the electricity grid stronger and more flexible.

The grids in Ireland and Northern Ireland will need to carry more power, and most of this power will come from renewable generation that varies depending on the weather. Eirgrid and SONI will use the existing grid to meet this goal where possible. However, given the scale of change, there is a need to plan for a great deal of new grid infrastructure – such as underground cables, pylons and substations.

2 https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland
3 https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Energy-strategy-timeline.pdf
4 https://www.economy-ni.gov.uk/sites/default/files/consultations/economy/energy-strategy-for-NI-consultation-on-policy-options.pdf

In March 2021, to support delivery of Ireland's government policy and to gather feedback on proposed approaches to achieving the 2030 targets, EirGrid and the Minister for the Environment, Climate and Communications Eamon Ryan TD launched a nationwide 14-week consultation, Shaping Our Electricity Future[5], In Northern Ireland, SONI also launched an equivalent Shaping Our Electricity Future report for consultation[6] that outlined similar approaches and took cognisance of localised conditions. Based on feedback received, EirGrid and SONI anticipate publicising a plan for Shaping Our Electricity Future before the end of 2021.

The demand forecast outlined within this report is based on up to date economic projections for both Ireland and Northern Ireland which have taken into account the impact of Covid-19. Despite a short-term reduction in demand at the beginning of the measures to mitigate the spread of Covid-19, demand in Ireland is increasing and long-term demand is forecast to increase significantly, due to the expected expansion of many large energy users. In Northern Ireland, demand has been relatively stable and this is forecast to continue, close to previously forecasted levels following a small decrease in 2020 due to Covid-19 lockdown restrictions. With the increase in demand in Ireland, and the decommissioning of generation plant due to decarbonisation targets and emissions standards in both jurisdictions, new capacity will be required.

The North South Interconnector remains critical for security of supply in both jurisdictions. As this report outlines, generation adequacy shifts year-on-year, according to changes in demand. The North-South Interconnector, as with existing interconnection to Great Britain, remains vital for the medium to long-term security of supply on the island of Ireland. Together with the Single Electricity Market (SEM) capacity auctions, this will enable all consumers on the island of Ireland to realise the ambition of maximising the considerable efficiency benefits of an All-Island electricity system and market.

EirGrid and SONI are at the vanguard of delivering a cleaner, affordable and secure supply of electricity for consumers in both jurisdictions. Mapping the island's electricity needs is an important feature of our work; it helps our governments, regulators and industry to prepare for the future. We hope you find the Generation Capacity Statement informative.

Mark Foley
EirGrid Group
Chief Executive

Alan Campbell
SONI
Managing Director

5 https://consult.eirgrid.ie/consultation/public-consultation-shaping-our-electricity-future
6 https://consult.soni.ltd.uk/consultation/public-consultation-shaping-our-electricity-future

Document structure

This document contains a Glossary of Terms section, an Executive Summary, four main sections and four appendices. The structure of the document is as follows:

The **Executive Summary** gives an overview of the main highlights of the document and presents the statement in summary terms.

Section 1 introduces our statutory and legal obligations. The purpose and context of the report is outlined.

Section 2 outlines the demand forecast methodology, and presents estimates of demand over the next ten years.

Section 3 describes the assumptions in relation to electricity generation.

Adequacy assessments are presented in **Section 4**.

Four **Appendices** are included at the end of this report. They provide further detail on the data and methodology used in this study.

Executive Summary

In this Generation Capacity Statement (GCS), the likely balance between electricity demand and supply during the years 2021 to 2030 is examined. This GCS covers both Northern Ireland and Ireland, and is produced jointly between SONI and EirGrid[7].

EirGrid, the transmission system operator (TSO) in Ireland, has a regulatory requirement to publish forecast information about the power system, including an assessment of the balance between supply and demand. SONI, the TSO in Northern Ireland, is required by licence to produce an annual Generation Capacity Statement. To obtain the most relevant information, EirGrid and SONI have consulted widely with industry participants and have used the most up-to-date information at the time of submission to the regulators.

In our adequacy assessment studies, the generation portfolio is modelled against the range of the demand forecast, using the accepted standard of risk. These studies were carried out individually for Ireland and Northern Ireland, and jointly on an All-Island basis. A range of scenarios was prepared to forecast electricity demand over the time horizon of the report.

The scenarios that we use to assess adequacy cover a range of credible risks/uncertainties which have been identified as follows:

- **Demand uncertainty**
  Demand is driven by economic activity, assumptions on energy efficiency and the growth of large energy users and data centres.

- **Decrease in generation availability**
  The availability of a number of existing generators, including those plant expected to decommission in the coming years, has been lower than previous years. Furthermore, some new plant capacity may have run hour restrictions which mean they are not fully available across the entire year.

- **Forecasted new generation failed to materialise**
  New generation that was previously successfully cleared in the capacity market auctions has been withdrawn by the developers.

- **Delay in building new capacity**
  Additional new capacity that was forecasted for delivery in 2022/23 has been delayed because of planning compliance, emissions audits and the global pandemic.

- **Emissions Limits**
  Some fossil fuel generation has been excluded from the capacity market from October 2024 because the plant has advised they will exceed new EU emission limits. In the absence of having a capacity contract, early plant closures will be handled in sensitivity studies.

- Furthermore, there are operational challenges with interconnector trading, capacity reliance on North to South flows, and risks around extended periods of low renewable output.

The transition to low-carbon and renewable energy means that there are assumptions on the retirement of ageing plant due to climate action plan requirements, restrictions from industrial emissions directives and other planning related issues. Over the course of the next 5 years around 1650 MW of generation will retire in Ireland with up to a further 500-600 MW retiring in Northern Ireland. New cleaner gas fired plant will be part of the solution to manage future power system adequacy and security especially at times when the wind and solar output levels are low and for what may be extended periods of time.

7 Where 'we' is used, it refers to both companies, unless otherwise stated.

Furthermore, in order to meet the 8 hour LOLE standard in Ireland, and 4.9 hour LOLE standard in Northern Ireland, we must factor in the realities in the operation of the transmission system. These realities include the need to:

- provide for reserves for when plant is not available,
- manage the power system in the event of a contingency,
- be able to take outages of elements of network equipment, including in particular outages for the connection of new customers.

These operational requirements are in line with the Transmission Planning and System Security Standards and Operating Security Standards as approved by the CRU in Ireland and UR in Northern Ireland, respectively.

The findings, in terms of the overall demand and supply balance, are intended to inform market participants, regulatory agencies and policy makers.

All-Island Key Observations

The transition to low-carbon and renewable energy will have a widespread impact on the power system. There will be major changes in how electricity is generated, and in how it is bought and sold. There will also be major changes in how electricity is used, such as for transport and heat. The electricity system will carry more power than ever before and most of that power will be from renewable sources. Coal, peat and oil-based generation will be phased out in the next decade. These changes will need to be managed in a coordinated and cost-effective way.

The Covid-19 pandemic is having a short-term impact on electricity demand of the Island. The demand forecast outlined within this report is based on up to date economic projections for both Ireland and Northern Ireland which have taken into account the impact of Covid-19.

The SEM Capacity Market is a mechanism designed to ensure that there is enough electricity to power homes, businesses and industry in both jurisdictions up to an accepted Loss of Load Expectation (LOLE) standard of risk. The market takes the form of an auction, held every year, for capacity for a future year.

The amount of generation required in the All-Island Capacity Market is set by the capacity requirement, as calculated by EirGrid and SONI in accordance with the methodology as set out within the Capacity Requirement and De-Rating Factor Methodology Detailed Design Decision Paper[8] and subsequently approved by the Regulatory Authorities (RAs). The demand scenarios outlined in this report are an input to the calculation of the capacity requirement. Operational requirements needed to meet LOLE standards mean that additional capacity is needed for operational reserves and to facilitate transmission outage planning; in line with the standards that we plan and operate the transmission system to.

Under the SEM, only generating units that are successful in the capacity auctions will receive capacity payments. The goal of the auction is to ensure that consumers do not pay for more capacity than is needed. Since 2017, a number of auctions have ran to provide capacity for the years ahead. The outcome of the most recent 2024/2025 T-4 auction has been included in this report. At a high level the market did not respond as required leaving a deficiency of 1500 MW to operate a secure system.

Once the North South Interconnector is completed, the island can be considered to be, for adequacy studies purposes, one electricity system i.e. with all the generation capacity from both jurisdictions available to meet the combined load. One of the advantages of considering an All-Island system is a capacity benefit, i.e. in general, you need less capacity for the combined All-Island system than for the sum of two single-jurisdiction studies.

8 https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-16-082%20CRM%20Capacity%20Requirement%20%20De-rating%20Methodology%20Decision%20Paper.pdf

The North South Interconnector is currently expected to be commissioned during 2025 and become available for its first full year of operation in 2026. This is the earliest expected date. Should the North South Interconnector commissioning be delayed beyond 2025, then the two jurisdictions can be considered, for adequacy study purposes, separately with an allocation for reliance between each region made until such time as the North South Interconnector is operating. Considering the All-Island system in 2026, there is a surplus of plant for the system's 8 hour LOLE security standard as set by the SEM Committee. This surplus is eroded over the following years leading to deficits in certain scenarios. The Low, Median and Median-Low Availability scenarios all remain in surplus out to 2030, but do not take into account operational requirements such as reserve and requirements for transmission outage planning. In contrast, the High, the 8th demand level and 8th demand level with low generator availability scenarios result in All-Island system deficit from 2027, 2030 and 2028 respectively. We believe the latter is the most credible scenario to consider.

On a combined, All-Island basis, the growth in energy demand from 2021 through to 2030 varies between 18% in the low demand scenario, to 43% in the high demand scenario.

Ireland achieved 43.3%, and Northern Ireland achieved 43.8%, of their electricity demand from renewable energy within the calendar year of 2020[9]. EirGrid and SONI are supporting the integration of more intermittent generation sources with initiatives that encourage flexibility such as EU-SysFlex[10], FlexTech[11] and DS3[12].

Northern Ireland Key Observations

The Total Electricity Requirement (TER) in Northern Ireland has remained relatively flat over the last number of years. SONI have observed a reduction in TER for Northern Ireland in 2020 due to the impact of Covid-19. There is an expectation that underlying electricity demand will remain fairly stable in the future, close to previously forecasted levels, following a small decrease in 2020 due to Covid-19 lockdown restrictions. SONI have received some enquiries in relation to possible new data centre demand.

On the supply-side, we have included all capacity currently connected unless providers have notified us that they will not be available. Based on this analysis, in the Median, High and Low demand scenarios, Northern Ireland is within the adequacy standard of 4.9 hours LOLE for the full duration of the studies completed for all scenarios in the report out to 2030. This takes account of both the closure of the Kilroot coal units and generation capacity which was awarded new generation contracts in the SEM T-4 2023/2024 auction in April 2020 and the SEM T-4 2024/25 auction in January 2021. While the recent capacity auction secured enough generation for Northern Ireland to ensure near-term security of supply, the North South Interconnector (as with existing interconnection to Great Britain) remains vital for medium to long-term security. It is noted that there are some uncertainties around new capacity becoming available for a given capacity year, retirement dates for ageing plant and risks around run hour restrictions on new capacity entering the market.

SONI and EirGrid are working towards the delivery of the second North South Interconnector as soon as possible; however, at the earliest, commissioning of the project is expected during 2025 with the first full year of operation by 2026. The project has passed all planning related legal hurdles in Ireland. In Northern Ireland the project received planning approval from the Infrastructure Minister in 2020; SONI hopes that the resulting legal challenge will be processed efficiently and that an outcome will be reached without delay. In the meantime SONI is progressing landowner agreements to facilitate access and construction for Northern Ireland Electricity Networks who will build and maintain the scheme in Northern Ireland.

9 It is important to note that the 2020 calendar year RES-E figure may not be the same figure used for the 2020 RES-E target when calculating 40% RES-E EU target compliance. This will be based upon normalised RES-E where renewable figures will be adjusted using average wind and hydro capacity factors from the last five year and the installed capacities in the final year 2020.
10 https://eu-sysflex.com/
11 https://www.eirgridgroup.com/how-the-grid-works/ds3-programme/flextech-initiative/index.xml
12 http://www.EirGridgroup.com/how-the-grid-works/ds3-programme/

EPUKI has indicated that the coal-fired generators ST1 and ST2 at its Kilroot site will cease operation in 2023. New generation was procured in Northern Ireland via the SEM T-4 2023/2024 auction in April 2020 and the SEM T-4 2024/25 auction in January 2021. New generation procured via the SEM T-4 auctions may have running hour limitations. Run hour limitations will have an impact on security of supply and operational flexibility in modernising the grid. The adequacy position for Northern Ireland will be adversely impacted by any delay in plant delivery or running hour restrictions on new capacity. If a generator leaving the system impacts on system adequacy, the SEM capacity auctions endeavour to procure sufficient generation to meet system needs for the years in question.

The studies presented here are based on the 4.9 hour adequacy standard set by the Utility Regulator and used for Northern Ireland adequacy assessment.

Ireland Key Observations

Long-term system electricity demand in Ireland is increasing and is forecast to increase significantly, due to the expected expansion of many large energy users, in particular data centres. Such rapid increases in demand are unusual; EirGrid acknowledge the challenge and have set out to identify solutions. EirGrid recognises the important role that data centres play in shaping Ireland's economy, and has committed to meeting the challenge of maintaining Ireland's high standards in security of supply while maximising the opportunities presented by these customers. EirGrid are working with ESB Networks, generators, the CRU and Government to identify the appropriate network and generation investments, while meeting our renewable energy goals.

Generator availability performance has been poor and has been trending downwards for the last number of years. Analysis shows that for the Median demand level and low availability scenario, this gives rise to adequacy deficits in 2024[13], meaning that deficits are at least 2 years sooner than previously forecast arising in the capacity year 2023/2024. EirGrid considers this scenario the most credible. The current position is concerning and EirGrid are currently engaging with our key stakeholders to consider the measures required to address these deficits. It is worth noting that adequacy studies assume changes on a calendar year basis (1st January), however deficits may appear sooner if capacity retires at the end of a capacity year (30th September). The studies presented in this report are based on the 8 hour adequacy standard set by CRU for the assessment of Ireland. See Appendix 3 in this report for further explanation of the LOLE Standard.

EirGrid is progressing plans for the proposed Celtic Interconnector between Ireland and France, with a nominal capacity of 700 MW, which has European Project of Common Interest (PCI) status, and has completed an Investment Request with the Commission for Regulation of Utilities (CRU). The Celtic Interconnector project has been awarded a grant from the EU Commission for joint funding of the project to EirGrid and RTE of €530m[14]. The Celtic Interconnector is expected to begin construction in 2022 with commissioning expected in 2026 and becoming available to the market in 2027.

EirGrid is also working with Greenlink Interconnector Limited on its project linking the power markets of Great Britain and Ireland, which is planned for commissioning by the end of 2023. Greenlink is a proposed c190 km electricity interconnector to connect the grids in Ireland and Great Britain, with a nominal capacity of 500 MW. As an EU PCI project, it is an important energy infrastructure project. In Ireland, a Foreshore Licence application was submitted to the Department of Housing, Planning and Local Government (Foreshore Unit) in 2019 and the onshore planning application was submitted to An Bord Pleanála in December 2020.

Key to achieving Ireland's 70% RES-E targets by 2030 will be successful delivery of a series of Renewable Electricity Support Scheme (RESS)[15] auctions across the decade. The initial RESS-1 auction took place in 2020, procuring a total of 1276 MW of new renewable generation.

13 It worth noting that the capacity year starts in October 2023, which means that in capacity year terms the challenges are potentially 3 months ahead of GCS expectations.
14 http://www.EirGridgroup.com/newsroom/celtic-interconnector-fun/index.xml
15 https://www.gov.ie/en/publication/36d8d2-renewable-electricity-support-scheme/

Demand Forecast

The long-term demand forecast in Ireland continues to be heavily influenced by the expected growth of large energy users, primarily data centres. EirGrid's analysis shows that demand from data centres could account for 23% of all demand in Ireland by 2030 in our Median demand scenario*. Furthermore, by 2030 there will be some new additional load from the heat and transport sectors as they move towards electrification.

In Ireland, the forecasted growth in electricity demand between 2021 and 2030 is between 28% in the median demand scenario and 43% in the high demand scenario as shown below in Figure 1.

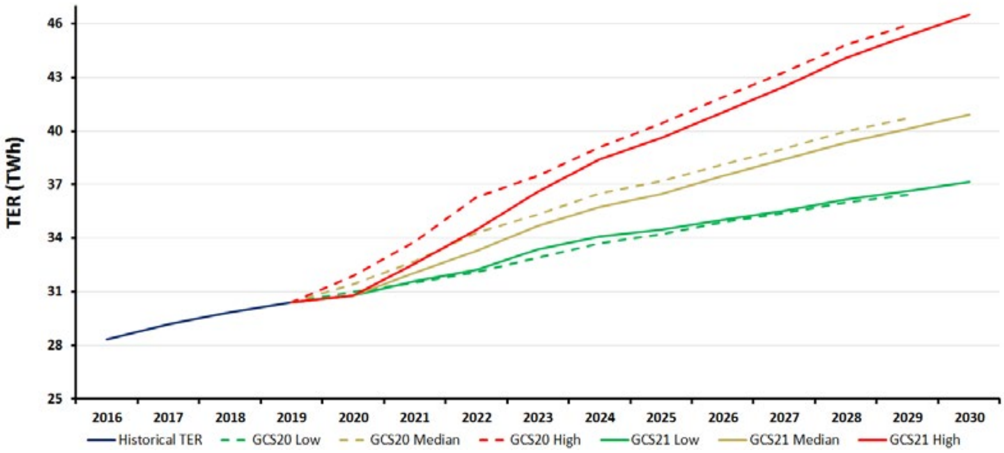


Figure 1 - Ireland Total Electricity Forecast GCS 2021 – 2030

The Median Forecast is generally aligned with EirGrid's Tomorrow's Energy Scenario Centralised Energy which predicts an overall Energy Requirement for Ireland of approximately 41 TWh by 2030. This is in line with the ENTSO-E TYNDP[16] 2020 National Trends Scenario forecast.

TER in Northern Ireland has been relatively flat apart from a reduction of 4% in 2020 due to the impact of Covid-19. The Median scenario shows demand rising by 5% over the next 10 years driven by post Covid-19 recovery and some data centre growth from 2023 (Figure 2). Our low demand scenario shows demand rising by 1%, over the ten year study period while in the high demand scenario demand would rise by 15%. The Northern Ireland overall energy requirement is in line with ENTSO-E TYNDP 2020 forecasts[16].

The SEM Capacity Auctions are in place to ensure enough capacity is procured in Northern Ireland in the short-to-medium term. However, the North South Interconnector remains critical for Northern Ireland's long term electricity security, along with interconnection to Great Britain.

16 ENTSO-E Ten Year National Development Plan 2020: https://consultations.entsoe.eu/tyndp/2020-scenario-storylines/

*The original version of the GCS noted 25% and this has been corrected to 23%

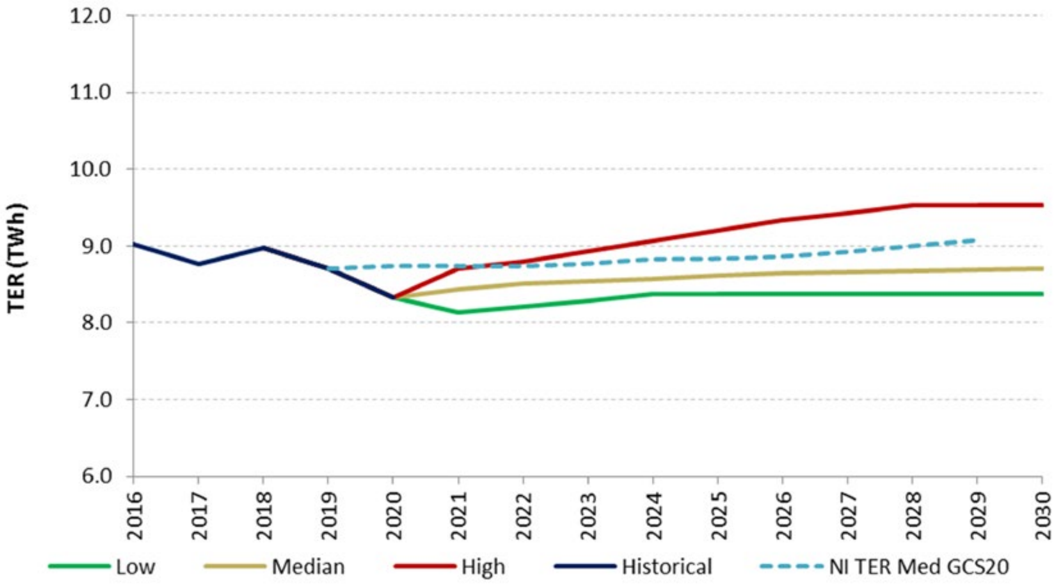


Figure 2 - Demand forecast for Northern Ireland, showing the spread from low to high scenarios

Dispatchable Generation and Interconnection

Across the next ten years, there are a number of generators due to close with new generation units planned to connect. Figure 3 shows the balance between generation units leaving and joining the electricity system in Ireland. In addition, based on the European Union Clean Energy Package decision to exclude generation emitting more than 550g/kWh from Capacity Markets, for the purposes of adequacy assessment we have assumed that Moneypoint coal-fired generation will not be available from October 2025. No closure notice has been received and a decision on the future of the plant is a matter for ESB.

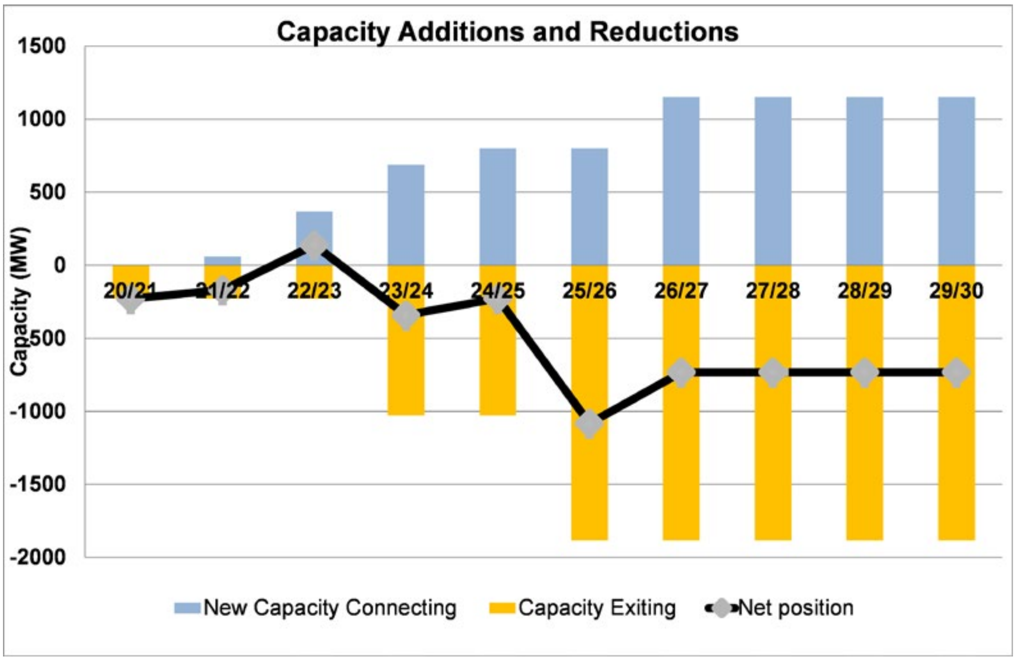


Figure 3 - Balance between generation units leaving and joining the electricity system in Ireland

In addition, EPUKI has indicated that the coal units at its Kilroot site will cease operation in 2023.

In the models we have included new generation that was successful in the previous 2022/23 T-4 capacity auction from the start of 2023. It should be noted that, at time of publication, not all of these units have signed connection agreements in place. Units that have been issued with Termination Notices have been excluded from adequacy studies. Please see Table 6 for a list of these units.

Also included in the models is new generation that was successful in the 2023/24 T-4 capacity auction from the start of 2024 and the generation that was successful in the 2024/25 T-4 capacity auction from the start of 2025.

In Ireland and Northern Ireland there has been continued deterioration of generator availability from 2018 into 2020. In particular, the decline of the conventional plant unit availability in both Ireland and Northern Ireland was observed across 2019 and 2020 as highlighted in Figure 4. 2019 remains the basis for the low availability year adequacy scenario which is presented later in this report. This is due to 2019 resulting in lower adequacy results versus using 2018 and 2020 availability statistics.

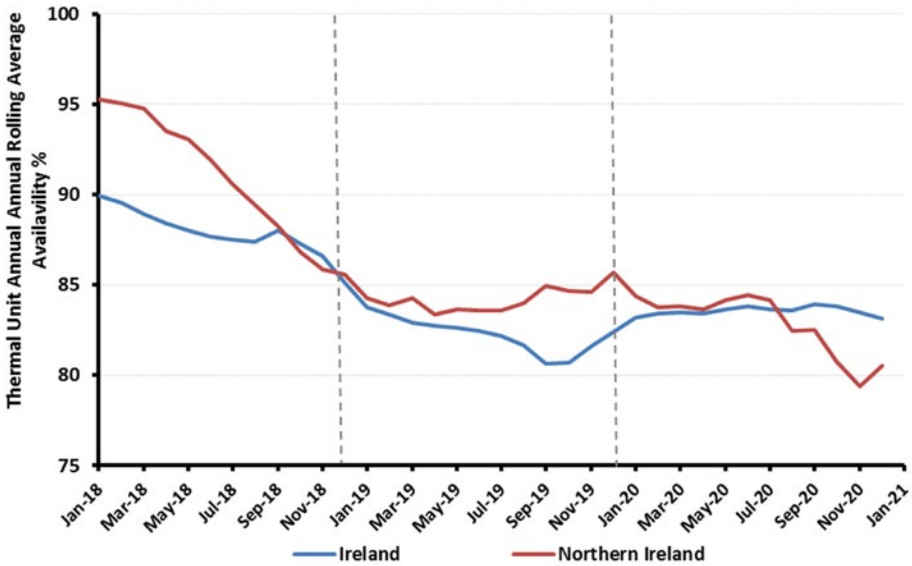


Figure 4 - Ireland and Northern Ireland Conventional Unit Availability

Renewable Energy Sources (RES)

Ireland

New wind farms commissioned in Ireland in 2020 brought the total wind capacity to 4,300 MW[17], contributing to the increase in overall RES percentage to 43.3%. Other sources of RES include biomass, hydro, solar PV and renewable waste. EirGrid is planning for a RES-E target of at least 70% for 2030.

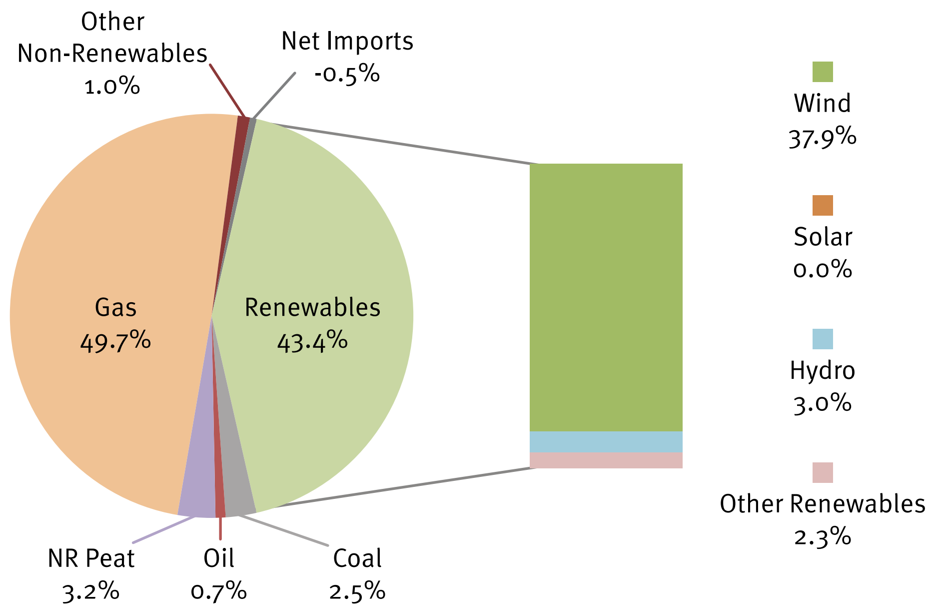


Figure 5 - Fuel mix in Ireland in 2020

Northern Ireland

Close to 1300 MW of wind is currently installed in Northern Ireland, and this is set to grow to almost 1600 MW by 2025. Solar Photovoltaic (PV) generation has seen rapid growth in Northern Ireland in recent years. A number of large-scale projects commissioned in 2017 and 2018 brought the total capacity of solar PV to around 250 MW. The DfE announced in October 2019 that Northern Ireland had achieved its target of 40% RES-E. This target was achieved again in 2020.

The DfE has been considering how to advance proposals for an energy strategy that will enable new and challenging decarbonisation targets. A public engagement process to inform and shape those proposals is underway. The DfE launched the Northern Ireland Energy Strategy policy option consultation[18] on 31st March 2021 and will run until 30th June 2021. The former Minister for the Economy stated that the ambition for the new Energy Strategy for Northern Ireland includes a RES target of no less than 70% by 2030. The new Energy Strategy is expected to be finalised in late 2021, and will set out policy measures that will contribute towards delivery of Northern Ireland's portion of the UK's net zero commitment. Figure 6 below is based upon metered data from NIE Networks and SONI covering the full 12 months of 2020 and shows Northern Ireland achieved 43.8% RES-E.

17 http://www.EirGridgroup.com/site-files/library/EirGrid/Wind20Installed20Capacities.png
18 https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland

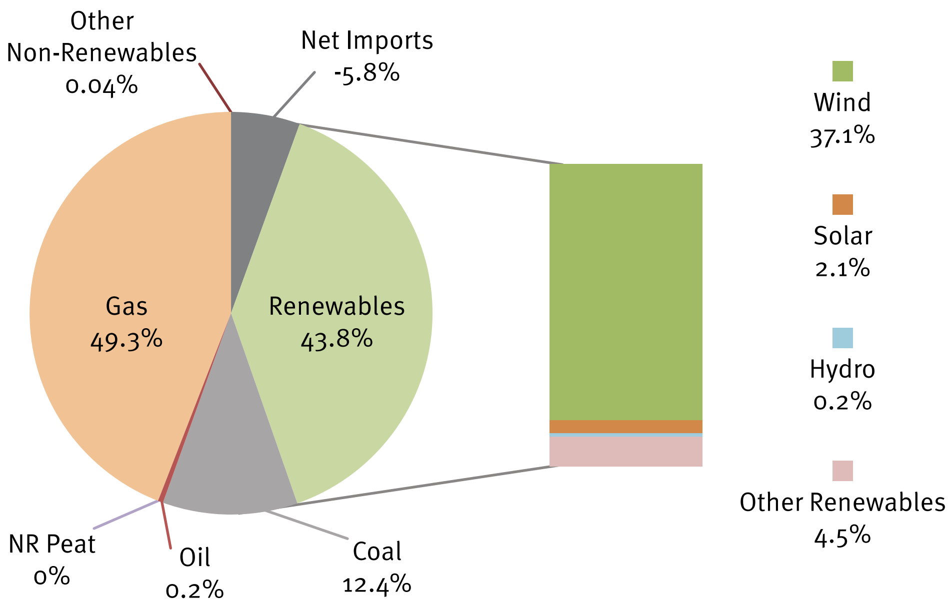


Figure 6 - Fuel mix in Northern Ireland in 2020

Adequacy Analysis

SONI and Eirgrid use the information gathered and the assumptions made in order to model the balance between supply and demand of electricity. Here we present a summary of our generation adequacy studies. We assume the second North South Interconnector will be commissioned during 2025 and become fully operational by 2026, and therefore studies were carried out on an All-Island basis from 2026 to 2030.

In the Capacity Requirement calculations for the SEM Capacity Auctions, ten different demand levels are examined, equally spaced from Low to High demand. A Least Worst Regrets analysis is then carried out to choose the optimal case. To date, the Least Worst Regrets analysis has resulted in the Capacity Requirement being chosen based on demand level 7 or 8, i.e. typically between the Median and the High demands. Therefore we have shown a scenario for the 8th level demand forecast to show this Least-Worst Regret optimal option to procure for.

Single-jurisdictional studies are presented for the 10 year horizon to highlight adequacy position, in the event that the second North South Interconnector is further delayed.

Ireland, without the second North South Interconnector

In the absence of the second North South Interconnector, Ireland is assumed to continue to be able to rely on Northern Ireland for 100 MW across current interconnection. This assumes that there is sufficient capacity from Northern Ireland to facilitate this exchange.

The studies presented in this report are based on the 8 hour adequacy standard set by CRU for assessment of Ireland.

Ireland starts in a position of generation surplus in 2021[19]. Thereafter, some generation plant is assumed to shut down because of emissions restrictions and the EU Commissions' Clean Energy Package. By 2026, all scenarios except the Low demand scenario are below the security standard for the region leading to deficits. Only the Low demand scenario remains in surplus for the full duration of the studies. Adequacy studies results for Ireland are listed in Table 17.

With a low availability, median demand scenario there would be a deficit of plant by 2024. This sensitivity has been highlighted in Table 17. Further analysis of the security of supply risks in Ireland are considered within this report.

A winter 2021 sensitivity study is included; median demand, low availability plus unavailability of two large units for the current calendar year 2021, in this case there is a deficit of 280 MW for winter 2021. For the next winter period 2021, EirGrid will provide further information on Ireland's security of supply status through the Winter Outlook report.

A security of supply study has been included and the results are summarised in Table 18. EirGrid has highlighted that operational requirements should be included in the security of supply assessment; this includes 375 MW to cater for reserves and a further 350 MW to facilitate transmission outage planning.

Over the course of the current capacity year 20/21 a number of transmission outages have been cancelled due to very low generation margins. Table 18 shows a small deficit for the 20/21 capacity year, reflecting the tight margins of the past winter.

Table 18 provides an overview of the various security of supply studies carried out to understand the capacity requirement for the capacity years 22/23, 23/24 and 24/25. The sensitivities cover the various uncertainties and risks such as non-delivery of the expected new capacity; uncertainty in demand, and present/future power plant performance.

19 This assumes an availability of plant from a historical year. There are known issues with two power stations which may create a deficit position in Winter 2021. Eirgrid's winter outlook will provide further information with respect to this unfolding situation.

EirGrid continually monitors supply and demand and factors that may affect the balance between these going forward. Subsequent to the work undertaken in preparing the Generation Capacity Statement, EirGrid has undertaken further Security of Supply studies. These considered the potential impact if not all the conventional generation arriving within the timeframes indicated by the auctions. This means that at times when wind generation is low, there is a higher risk that supply cannot meet demand in the short-term (2022 to 2025). Our studies show that without measures to mitigate this, the additional generation capacity required in Ireland is 260 MW of by October 2022, increasing to 1050 MW by October 2023 and 1850 MW of by October 2024[20].

EirGrid is working with the Regulator (CRU) and the Department of Environment, Climate and Communications (DECC) to address the measures required.

Northern Ireland, without the second North South Interconnector
When Northern Ireland is assessed on its own, SONI assumes a capacity allowance from Ireland of 200 MW. This assumes that there is sufficient capacity from Ireland to facilitate this exchange.

The median demand scenario is shown to be in surplus of, on average, over 400 MW for the full duration of the studies. This is based on the timely delivery of the new generation that was successful in the 2023/24 T-4 capacity auction from the start of 2024 and the generation that was successful in the 2024/25 T-4 capacity auction from the start of 2025. It is also based on full availability of the new generation. Kilroot ST1 and ST2 did not qualify for inclusion in the T-4 2023/24 auction in April 2020 and have indicated these units will cease operation in 2023.

Furthermore, SONI has completed a range of adequacy sensitivity studies to assess the risk to security of supply in Northern Ireland. The studies presented provide an indication of Northern Ireland's adequacy position based on a range of credible risks, low plant availability, delay to contracted capacity, loss of interconnection support, an outage of Coolkeeragh C30 and a sensitivity that considers a run hour limit on the new capacity at Kilroot.

For all studies presented below, unless otherwise stated, assume a 4.9hrs LOLE Adequacy Standard, Median demand and five year system availability averages.

As noted throughout this document, adequacy position shifts year-on-year. The North South Interconnector remains critically needed for medium to long-term security in Northern Ireland. It will also remove costly system constraints and is vital for the facilitation of renewable generation in both jurisdictions.

All-Island, with the second North South Interconnector
The second North South Interconnector is assumed to be commissioned during 2025; and for the purposes of adequacy assessment become fully available from 2026. After the North South Interconnector is completed, the All-Island system is capable of operating electrically as one i.e. with all the generation capacity from both jurisdictions to meet the combined load. Adequacy studies results for the All-Island system are listed in Table 21.

The All-Island system remains in surplus to 2030 in all scenarios apart from the high demand scenario, a low availability with 8th level demand scenario, and the demand level 8 scenario. In these scenarios, deficits occur from 2027, 2028, and 2030 respectively.

The last sensitivity shows that when the Celtic interconnector between Ireland and France is connected from 2027, and if available from 2027 onwards, the All-Island surplus position is further improved.

20 The numbers quoted here represent de-rated generation capacity, which is the expected capacity available to the system after planned and unplanned outages.

1. Introduction

1. Introduction

This report seeks to inform market participants, regulatory agencies and policy makers of the likely generation capacity required to achieve an adequate supply and demand balance for electricity for the period up to 2030.

Generation adequacy is a measure of the capability of the electricity supply to meet the electricity demand on the system. Adequacy is determined using the LOLE standard, which is 8 hours in Ireland and 4.9 hours in Northern Ireland. This means that we are planning the system with the standard assumption that there will be insufficient generation to meet the system demand for 8 hours each year in Ireland, and 4.9 hours each year in Northern Ireland. The development, planning and connection of new generation capacity to the transmission or distribution systems can involve long lead times and high capital investment. Consequently, this report provides information covering a ten-year timeframe.

EirGrid, the transmission system operator (TSO) in Ireland, is required to publish forecast information about the power system, as set out in Section 38 of the Electricity Regulation Act 1999 and Part 10 of S.I. No. 60 of 2005 European Communities (Internal Market in Electricity) Regulations.

SONI, the TSO in Northern Ireland, is required to produce an annual GCS, in accordance with Condition 35 of the Licence to participate in the Transmission of Electricity granted to SONI by the Department for the Economy (DfE).

This GCS covers the years 2021-2030 for both Northern Ireland and Ireland, and is produced jointly between SONI ltd and EirGrid Plc. Where 'we' is used, it refers to both companies, unless otherwise stated. This report supersedes the joint EirGrid and SONI All-Island Generation Capacity Statement 2020-2029, published in 2020. Input data assumptions have been reviewed and updated.

The GCS involves a detailed process completed over a period of approximately eight months. Steps in this process are outlined in Figure 7 and detail of the methodology used is outlined in Appendix 3. We will continue to work with the RAs and other stakeholders to ensure that this document and the underlying methodologies remain relevant and useful.

In predicting the future of electricity generation supply in Ireland and Northern Ireland, we have endeavoured to use the most up-to-date information available at the time of the data freeze for this report (February 2021).

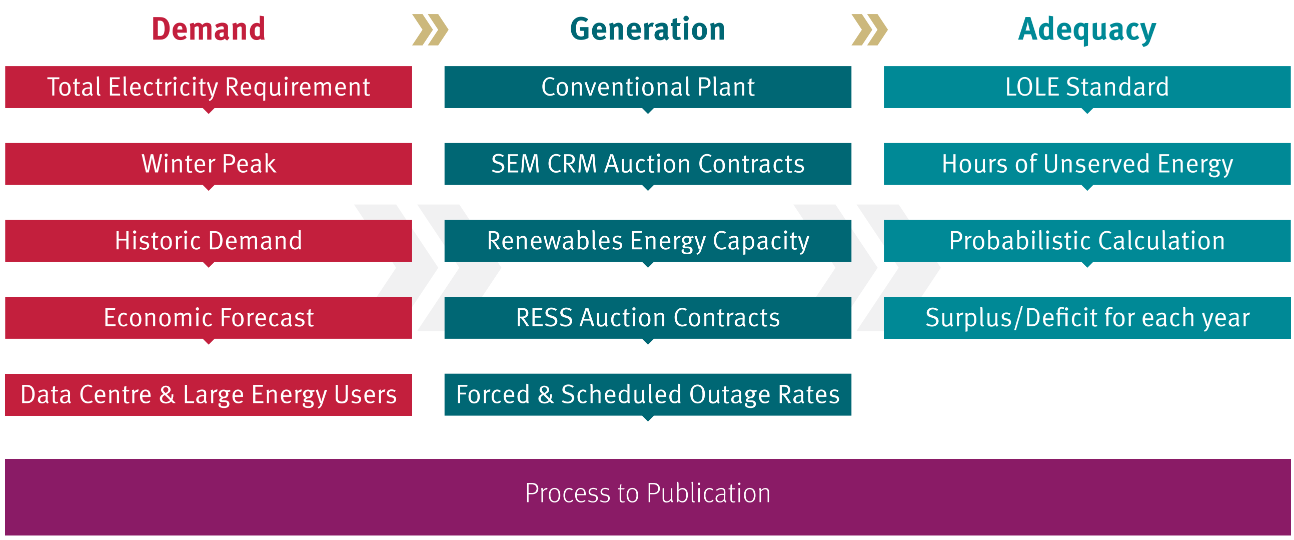


Figure 7 - GCS Development Process

2. Demand Forecast

2. Demand Forecast

2.1. Introduction

Making a prediction of what the electricity demand will be in the future is a multi-layered task. The demand forecast is developed for each jurisdiction separately, and then added together for All-Island studies.

For each jurisdiction, we initially analyse the historical demand data. Part of this process involves the exploration of weather effects on demand, e.g. the correction of a high peak demand on a particularly cold day for an average weather year.

Another aspect of historical analysis is the calculation of the amount of self-consumption, i.e. electricity that is generated and used on-site, without being transmitted to the grid or metered. Examples would be a self-consuming CHP unit, or a domestic solar PV panel.

We also examine other factors affecting demand, such as economic activity and any particular sectors that are experiencing strong growth.

The demand forecast outlined within this report is based on up to date economic projections for both Ireland and Northern Ireland which have taken into account the impact of Covid-19.

This GCS demand forecast is used in the calculation of the Capacity Requirement in the SEM Capacity Market auctions. In order to cover a range of possible futures, the GCS demand forecast is provided as three scenarios: Low, Median and High demand.

2.2. Demand Forecast for Ireland

2.2.1. Methodology

The electricity forecast model for Ireland is a multiple linear regression model which predicts electricity demand based on changes in economic parameters. Particular attention is paid to the effects of new, large energy users, electric vehicles and heat pumps. A spread of electricity forecasts is produced covering the next ten years.

EirGrid has sought the advice of the Economic and Social Research Institute (ESRI) which has expertise in modelling the Irish economy[21]. They advised us to focus on the economic parameters of Real Adjusted Gross National Income (Real GNI*) and Personal Consumption[22].

The demand forecast incorporates some reduction due to the effect of installation of smart meters, which could reduce peak demand from domestic users by up to 8%[23].

2.2.2. Historical data

Historical records of electricity generated and electricity sales are gathered from various sources such as ESB Networks, SEAI (Sustainable Energy Authority of Ireland) and EirGrid. Transporting electricity from the generator to the customer invariably leads to electrical losses. Based on the comparison of historical sales to exported energy over 2008 - 2018, we have estimated that between 7 to 8% of power produced is lost as it passes through the electricity transmission and distribution systems.

Historical weather data is obtained from Met Éireann, Ireland's National Meteorological Service.

21 http://www.esri.ie/irish-economy/
22 Personal Consumption of Goods and Services (PCGS) measures consumer spending on goods and services, including such items as food, drink, cars, holidays, etc.
23 https://www.cru.ie/wp-content/uploads/2011/07/cer11080ai.pdf

2.2.3. Forecasting causal inputs

In order for the energy model to make future predictions, we require forecasts of Real Modified Gross National Income (Real GNI*)[24]. Modified GNI is designed to exclude globalisation effects that are disproportionally impacting the measurement of the size of the Irish economy. GNI* influences the forecast of Commercial and Industrial electricity demand, while Personal Consumption figures influence the forecast of residential electricity demand. These forecasts are provided by the ESRI in their Quarterly Economic Commentary. Longer-term trends arise out of the ESRI's Median Term Review.

As a cross-check, the ESRI forecasts were compared with predictions from other institutions such as the Central Bank of Ireland and the figures listed in Table 1 were used for GCS studies.

Table 1 - Average annual growths for macroeconomic parameters, as advised by the ESRI

	2021-2023	2024-2030
Real GNI*	5.5%	3.0%
Personal Consumption	4.0%	2.5%

24 https://www.cso.ie/en/releasesandpublications/ep/p-nie/nie2019/mgni/

2.2.4. Forecast Scenarios and new Large Energy Users in Ireland

A key driver for electricity demand in Ireland for the next number of years is the connection of new large energy users, such as data centres.

In Ireland, there is currently approximately 1700 MVA of demand capacity that is contracted to data centres and other large energy users that are already connected. These customers are connected to the transmission system or to the distribution system. The average load currently drawn by these customers is approximately 30% of the overall contracted Maximum Import Capacity. Demand from large energy users is expected to continue to rise as these customers build out to their full potential. A significant proportion of this extra load is contracted to materialise in the Dublin region.

There are many projects for large energy users in the connection process, or that have made material enquiries. EirGrid has examined the status of these proposed projects and has made assumptions concerning the demand load expected from these customers in the future. EirGrid has taken into account various different factors including the existence of other completed projects by the same company, financial close, planning permission, etc. This has formed the differences between our low, median and high scenarios.

In forecasting future demand, EirGrid assumes data centres have a flat demand profile. This has been observed in real time data.

Since the GCS 2020-2029, EirGrid has received more detailed demand build-out estimates from the data centres and large energy users across the country. When compared to GCS20, the demand forecast for this sector has remained steady and performed within expectations for 2020.

From the result of this process: Table 2 gives the breakdown of data centre and large energy users demand forecasted by 2030; Figure 8 shows forecasted build out per scenario out to 2030; Figure 9 shows Ireland's Total Energy Requirement (TER) forecast; and Figure 10 shows, for the Median scenario, the energy breakdown forecast per sector.

Table 2 - Forecasted data centre and new large energy users demand by 2030

Forecast Scenario	Addition to 520 MW of currently built data centres and new large energy users	Overall 2030 Demand in MW
Low	390	910
Median	770	1,290
High	1,360	1,880

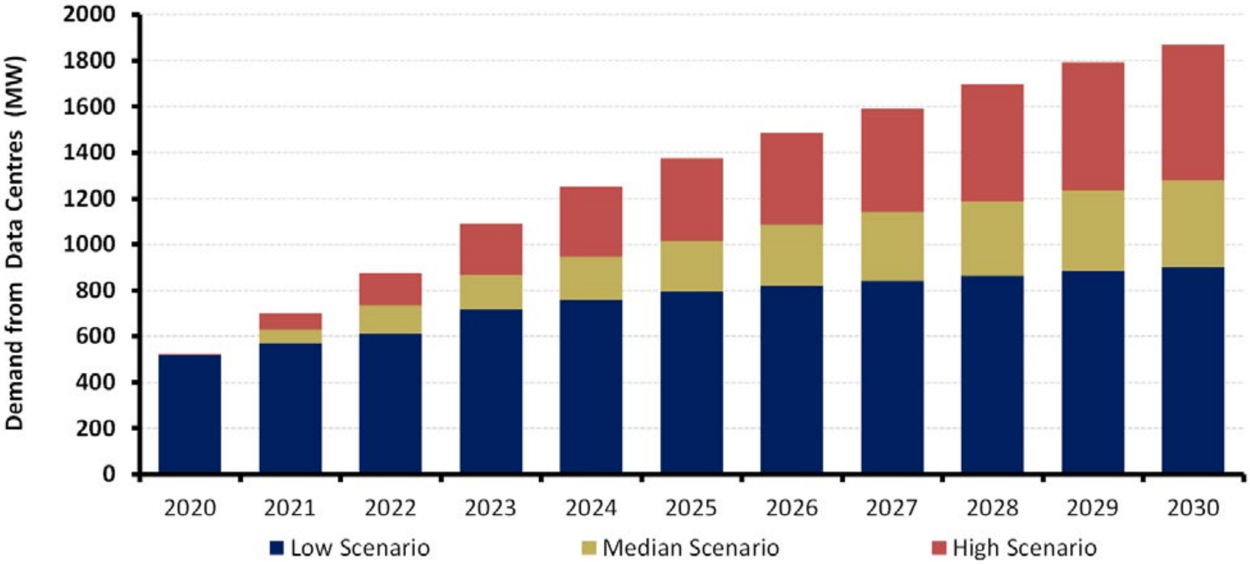


Figure 8 - Ireland demand expected from assumed build-out of large energy users EirGrid divide this demand into the Low, Median and High Demand forecast scenarios for 2030

In line with ENTSO-E TYNDP modelling for the National Trends Scenario, the GCS has included a forecast for electric vehicle and heat pump growth in Ireland over the next ten years. The GCS 2021 – 2030 takes account of the relevant targets from the Irish Governments Climate Action Plan 2019. EirGrid will track how the uptake of EVs and Heat Pumps rolls out over the next ten years to see how take up is following targets and forecast forward appropriately.

These three scenarios give an appropriate view of the range of possible demand growths facing Ireland.

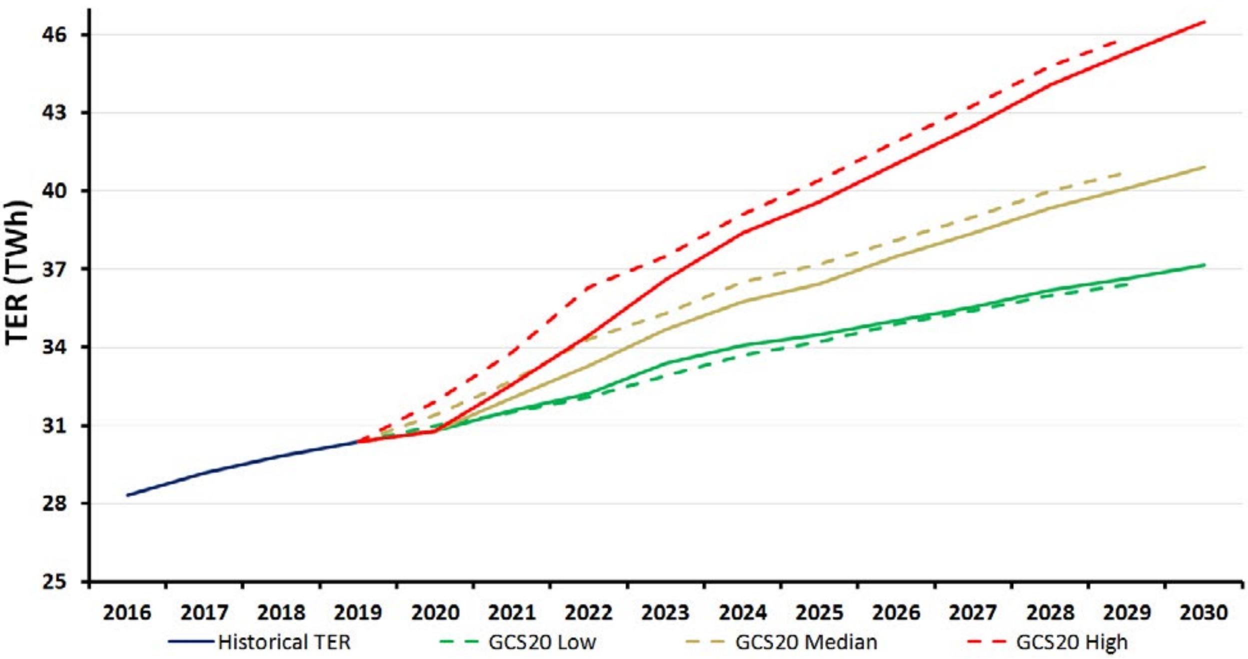


Figure 9 - Total Electricity Requirement forecast for Ireland 2021 – 2030

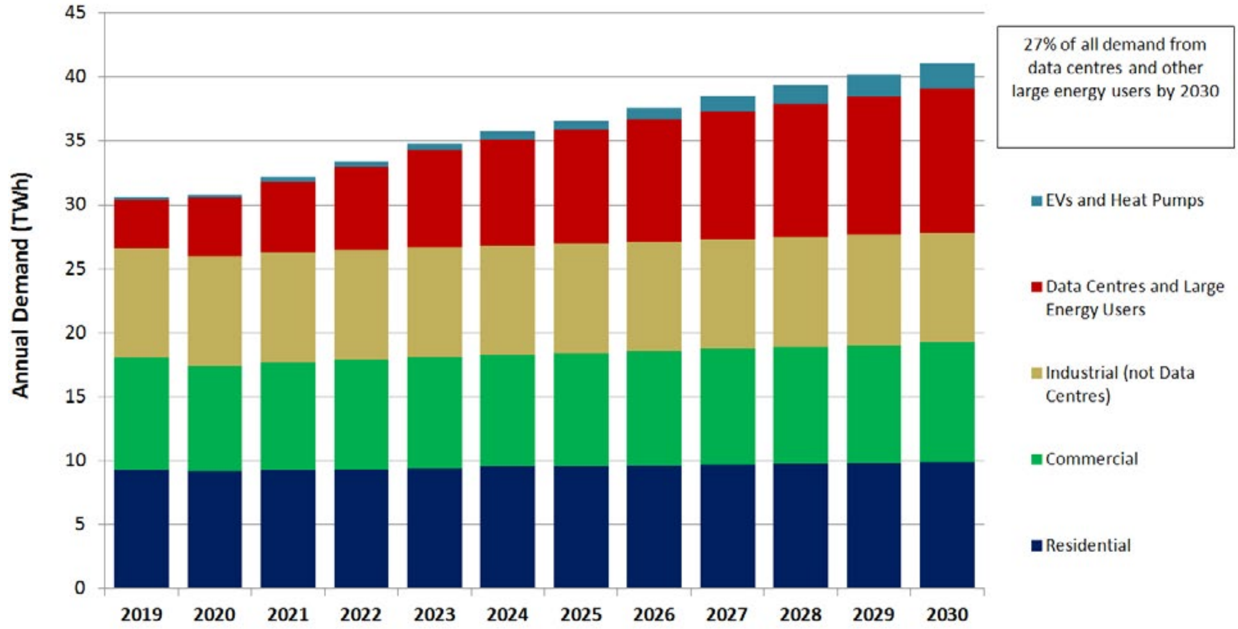


Figure 10 - For the Ireland Median Demand scenario, this illustrates the approximate split into different sectors. EirGrid estimate that 27% of total demand will come from data centres and large energy users by 2030

2.2.5. Peak Demand Forecasting

The peak demand model is based on the historical relationship between the annual electricity consumption and winter peak demand. This relationship is defined by the Annual Load Factor (ALF), which is simply the average load divided by the peak load.

Temperature has a significant effect on electricity demand, particularly on the peak demand. This was particularly evident over the two severe winters of 2010 and 2011, when temperatures decreased dramatically and demand increased to then record levels. Average Cold Spell (ACS) correction has the effect of 'smoothing out' the demand curve so that economic factors are the predominant remaining influences - see Figure 11. The temperature-corrected peak curve is used in the ALF model, which can then be modelled for the future using the previously-determined energy forecasts.

To reflect different segments of demand, additional forecasts of industrial and data-centre type demand is grown separately using a profile appropriate to its expected usage i.e. flat demand profile. Remaining additional demand is grown proportionally using historical demand profiles.

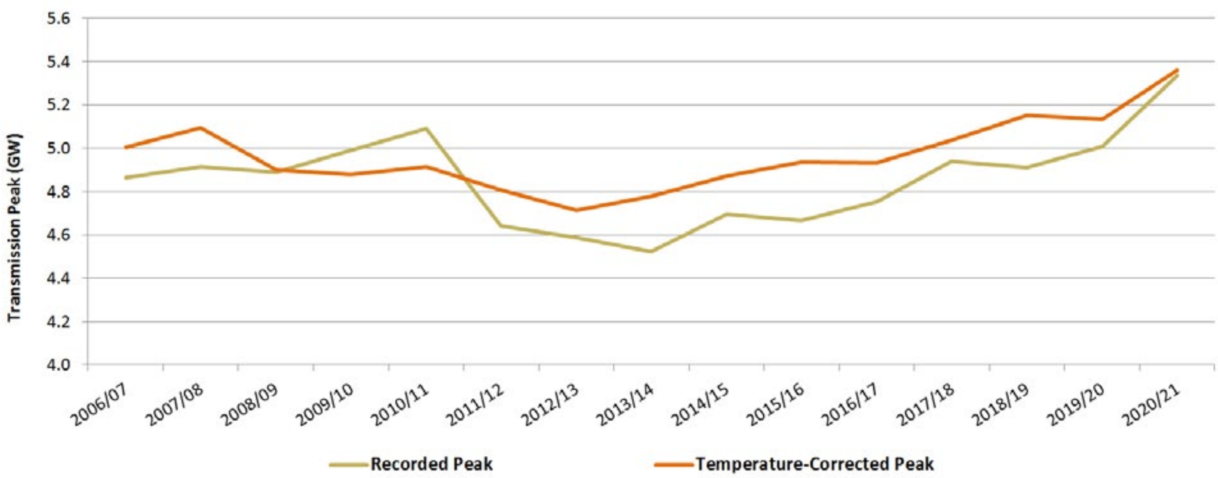


Figure 11 - Past values of recorded maximum demand in Ireland, and the ACS temperature-corrected values

This forecast is then tempered with estimates of energy efficiency savings, particularly to allow for the effect of smart meters. EirGrid assume that smart meters could cause the peak to decrease by up to 8% for domestic users[25] from the start of their roll-out in 2019/2020. At peak demand time, residential demand is c. 50% of electricity demand. Therefore, the smart meter roll out has the potential to reduce peak demand overall by 4%.

For the high scenario, EirGrid have considered the possibility that the winter might be severely cold and thus result in higher peaks. There is a much greater impact from the load growth of data centres and other new large energy users in the later years of the forecast.

An assumption on the variation of EV uptake across the demand scenarios is made to represent the range of possible rates of EV adoption. As quantities of electric vehicles grow, they will have an increasing impact on the electricity grid and on electricity markets. The scale of this impact will depend on a wide range of factors such as the quantity and types of electric vehicle, vehicle usage, types and locations of vehicle chargers and the charging patterns of vehicle owners. Vehicle charger technology has the potential to minimise the potential impact of electric vehicle demand on the electricity system, and on electricity markets. It is assumed that charger technology will evolve over time from simple chargers and patterns that are readily available today, to smart chargers with features such as programmable charge start times to smarter charging technology that optimises vehicle charging in line with dynamic electricity price signals.

In scenarios with a high uptake of electric vehicles, optimisation of charging demand is required to ensure that need for grid development and additional generation capacity is minimised. Figure 12 shows the effect of vehicle charger profiles on system peak demand in EirGrid's Tomorrows Energy Scenarios report for the Coordinated Action scenario by 2030. The use of smart to smarter charger technologies reduces system peak demand by between 0.17 GW and 0.48 GW respectively, compared to simple. The average size of CCGTs is approximately 0.35 GW. Considering this helps to frame the potential benefits associated with vehicle charging technology.

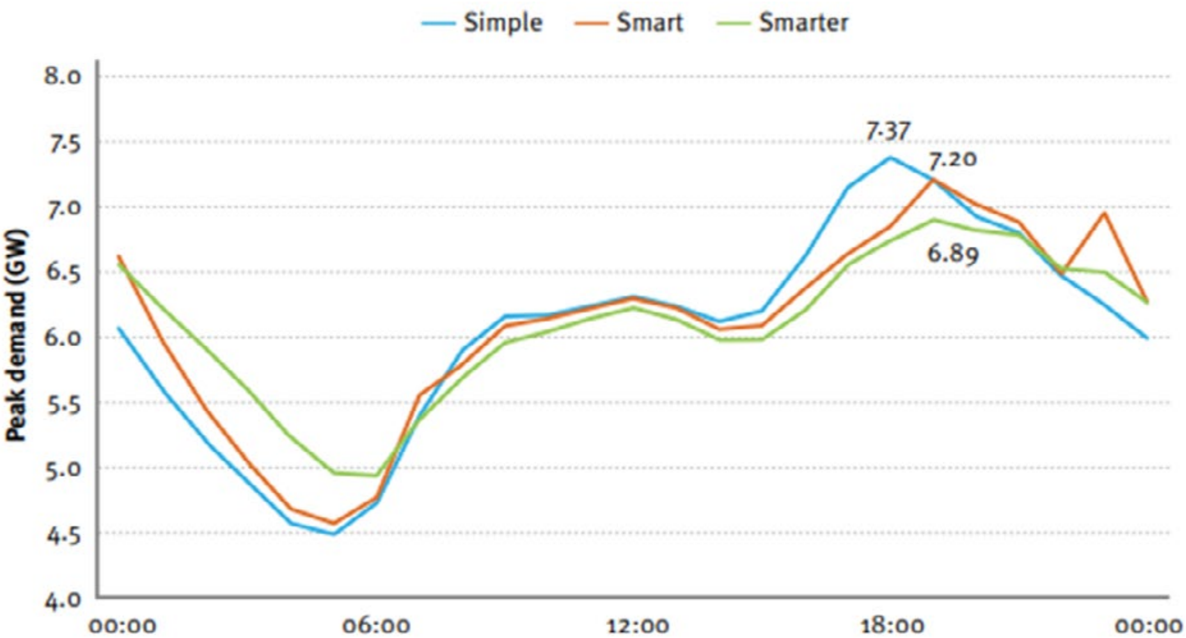


Figure 12 - The impact of electric vehicle charging on the daily profile of winter peak demand in EirGrid's Tomorrows Energy Scenarios 2019 report in the Coordinated Action scenario by 2030[26]

25 https://www.cru.ie/wp-content/uploads/2011/07/cer11080ai.pdf
26 http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-TES-2019-Report.pdf

The GCS21 forecasted short term peaks (2021 – 2023) have changed since GCS20 due to the effects of the high demand peak experienced in early December 2020. The December 2020 peak was in line with the high peak forecast from the GCS 2020 report. The reasons for this high peak is expected to be due to the effect of Covid-19 work from home restrictions combined with a short cold snap plus the easing of Level 5 restrictions in the run up to Christmas. It is unclear if this high winter peak is a longer-term trend.

Therefore the overall peak methodology has not changed due to the demand behaviours of 2020 alone.

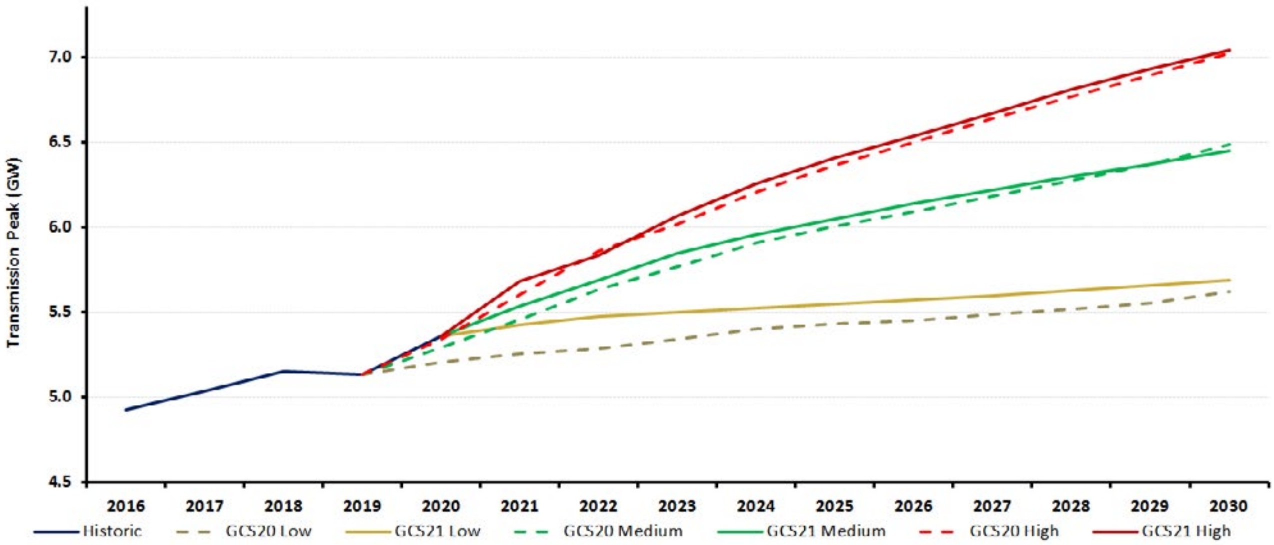


Figure 13 - Transmission peak forecast for Ireland

2.3. Demand Forecast for Northern Ireland

2.3.1. Methodology

The electricity forecast model is a multiple linear regression model which predicts electricity demand based on changes in economic parameters. Particular attention is paid to the effects of energy efficiency measures and large, new industrial users. A spread of electricity forecasts is produced, covering the next ten years.

The TER forecast is carried out with reference to economic parameters, primarily Gross Value Added (GVA). The Northern Ireland economy has been impacted significantly by Covid-19 reducing GVA in 2020 by around 10%. The consensus amongst economists is that there will be strong growth in Northern Ireland's economy in the coming years as Covid-19 restrictions are lifted and normality returns, although some uncertainty remains around the future pace of growth.

The Strategic Energy Framework for Northern Ireland set out the Northern Ireland contribution to the 1% year-on-year energy efficiency target for the UK to 2020. Energy efficiency has also been incorporated in the demand forecast. The Department for the Economy (DfE) has been considering how to advance proposals for an energy strategy that enables new and challenging decarbonisation targets in line with the UK commitment to net zero emissions by 2050. A public engagement process to inform and shape those proposals is underway. The Department for Economy launched their Northern Ireland Energy Strategy policy option consultation[27] on 31st March 2021 and closed on 30th June 2021. The Department for Economy intend to finalise their Energy Strategy by November 2021[28]. Through its technical expertise and data, SONI is supporting the DfE energy strategy development as appropriate. The Energy Strategy will have the potential to increase demand from the heat and transport sectors should heat pumps and electric vehicles form part of the Department for Economy's energy policy for Northern Ireland.

2.3.2. Demand Scenarios

Given the degree of economic uncertainty in the future, SONI believes it prudent to consider three alternative scenarios for the economy, each of which can then be considered to derive an estimate of energy production. Combining temperature and economic scenarios, as well as energy efficiency allows for the formulation of median, high and low demand forecasts.

The median demand forecast is based on an average temperature year. It includes assumptions on future energy efficiency in the electricity system, along with a central economic growth rate factor being applied. This is our best estimate of what might happen in the future.

The low demand forecast is based on a relatively high temperature year, with higher levels of energy efficiency and the pessimistic economic factor being applied. Conversely, the high demand forecast is based on a relatively low temperature year, with lower levels of energy efficiency and the more optimistic economic factor being applied.

There have been some enquiries from new large industrial users, including data centres, seeking to connect in Northern Ireland. In order to capture the impact of new large industrial users, SONI has based the demand forecast scenarios on different build-out scenarios. The low demand scenario assumes no new large industrial load. The median demand scenario includes some data centre load from 2023. In addition to this, the high demand scenario contains potential additional load that may connect to the system from 2023. These three scenarios give an appropriate view of the range of possible demand growths. These categories are similar to the approach for the demand scenarios in Ireland.

27 https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland
28 https://www.economy-ni.gov.uk/articles/energy-strategy-timeline

2.3.3. Self-Consumption

SONI has been working with Northern Ireland Electricity Networks (NIE Networks) and referencing the Renewable Obligation Certificate Register (ROC Register)[29] to establish the amount of embedded generation that is currently connected on the system and to predict what amounts will be connecting in the future.

This has enabled SONI to make an informed estimate of the amount of energy contributed to the total demand by self-consumption, which is then added to the energy which must be exported by generators to meet all demand, resulting in the TER[30].

2.3.4. TER Forecast

It can be seen that the new TER forecast (Figure 14) is reduced compared to the forecast published in the Generation Capacity Statement 2020-2029. This is primarily due to the impact of Covid-19, as well as the review of assumptions surrounding potential new large industrial load and its impact on TER. The range difference between median and high demand is primarily based on new large industrial load build-out scenarios.

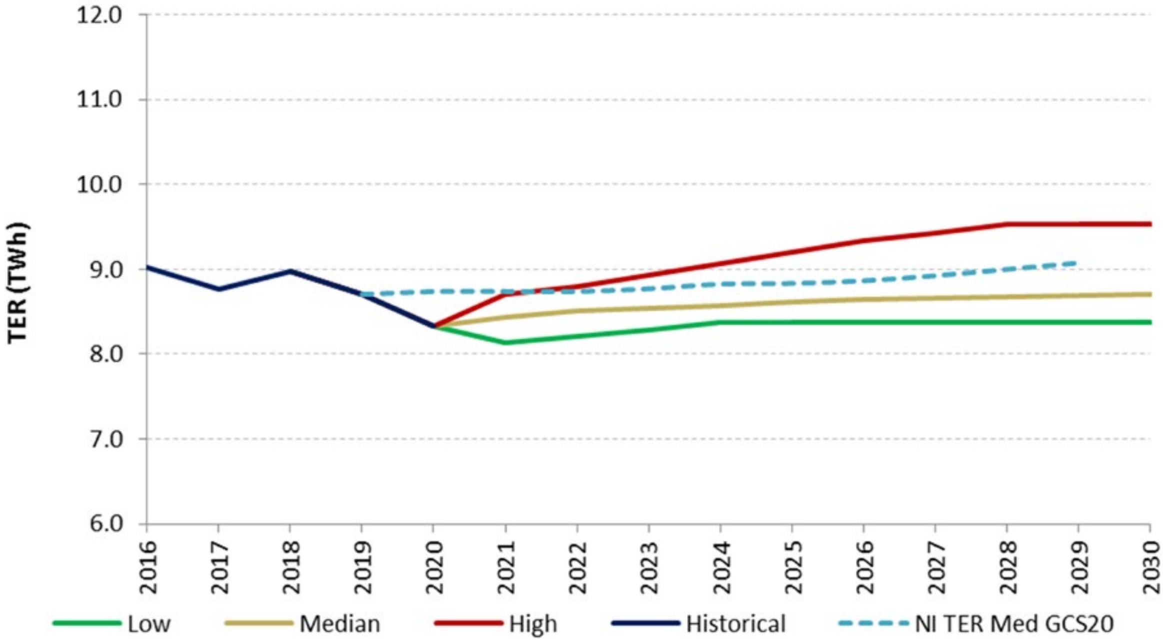


Figure 14 - Northern Ireland TER Forecast

29 https://www.renewablesandchp.ofgem.gov.uk/

30 Self-consumption in Northern Ireland currently represents approximately 3% of TER. This has grown over more than ten years with the installation of small scale generation.

2.3.5. Peak Demand Forecasting

The peak demand model is based on the historical relationship between the annual electricity consumption and winter peak demand. This relationship is defined by the Annual Load Factor (ALF), which is simply the average load divided by the peak load.

Temperature has a significant effect on electricity demand, particularly on Peak demand. This was particularly evident over the two severe winters of 2010 and 2011, when temperatures decreased dramatically and demand increased to record levels. Average Cold Spell (ACS) correction has the effect of 'smoothing out' the demand curve so that economic factors are the predominant remaining influences. The temperature-corrected peak curve is used in the ALF model, which can then be modelled for the future using the previously-determined energy forecasts.

The Northern Ireland 2019/20 sent out peak of 1574 MW occurred on Wednesday 18th December 2019 at 17:30.

When ACS temperature correction is applied the Peak becomes 1626 MW.

As with the annual electricity demand forecast outlined in section 2.2(d), three peak forecast scenarios have been built. These consist of a pessimistic, realistic and optimistic view with adjustments that take account of current economic outlook predictions.

In the early years of the ten year peak demand forecast presented in this report, SONI used temperature variation to give a plausible range between the low and high peak forecasts, i.e. the low peak forecast is based on a mild winter, and the high scenario is based on a very cold winter. This has been based on historical records over the last ten years. While SONI do not expect an extremely warm or extremely cold winter every year, this range of scenarios is within the bounds of probability for the immediate years.

In later years of the ten year peak demand forecast, variations caused by economic projections and in particular new demand types such as data centres are more significant and are used instead.

The main difference between the forecasts of low, median and high peaks is the amount of load assumed from new large industrial load users. This forecast employs a similar methodology as that used in the TER forecast. Figure 15 shows the Transmission Peak forecast for Northern Ireland. It can be seen that the resulting forecast is reduced compared to the GCS 2020-2029 Median scenario.

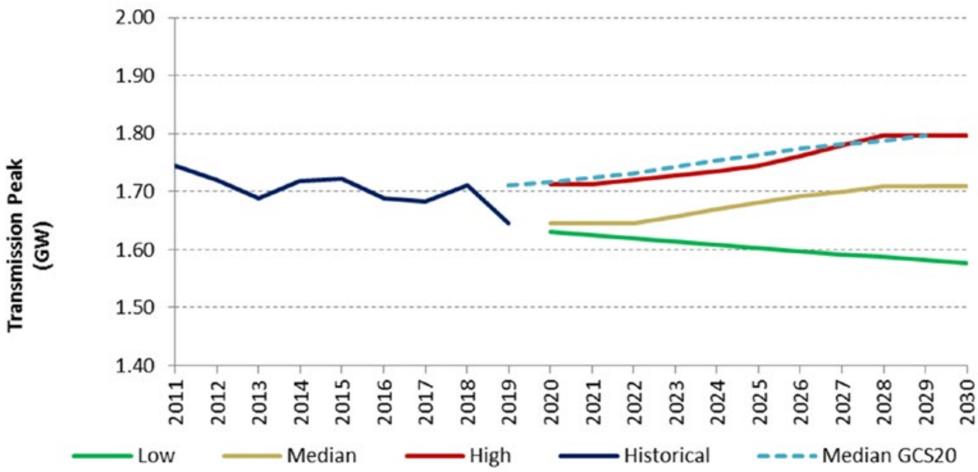


Figure 15 - ACS Transmission Peak forecasts for Northern Ireland

Appendix 1 lists the detailed energy and peak data out to 2030 including growth rates. It also includes the All-Island demand. While demand growth in Northern Ireland is subdued, the demand growth in Ireland is significant which can be seen in the All-Island demand growth.

2.4. The Combined All-Island Forecast

In order to carry out combined studies for the All-Island system, we simply add the two jurisdictional forecasts together for the TER on a half-hourly basis to produce the new All-Island TER and Peak figures as shown in Figure 16 and Figure 17 below.

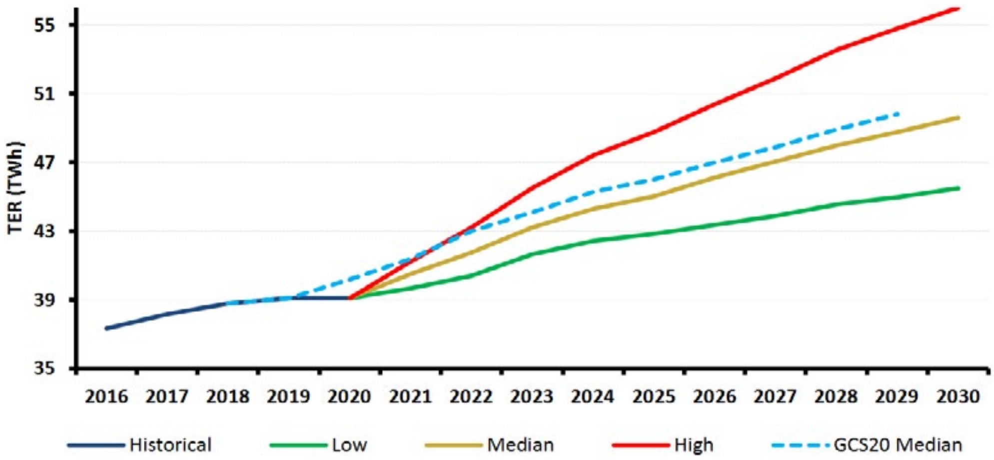


Figure 16 - Combined TER forecast for the All-Island system

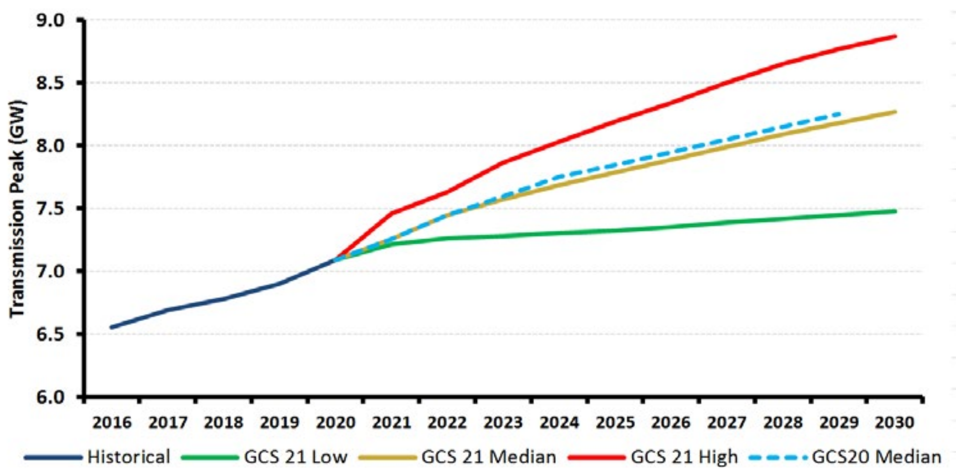


Figure 17 - Transmission Peak forecast for the combined All-Island forecast

2.5. Covid-19 Demand Impact in 2020

Since restrictions to our daily lives have been applied by both governments, electricity consumption has been affected. EirGrid and SONI have tracked the impact of societal restrictions on electricity consumption and the potential impacts this may have on the demand forecast for Ireland and Northern Ireland.

From demand data, the weekly effect of Covid-19 on demand across March to December 2020 is shown in Figure 18 for Ireland and Figure 19 for Northern Ireland.

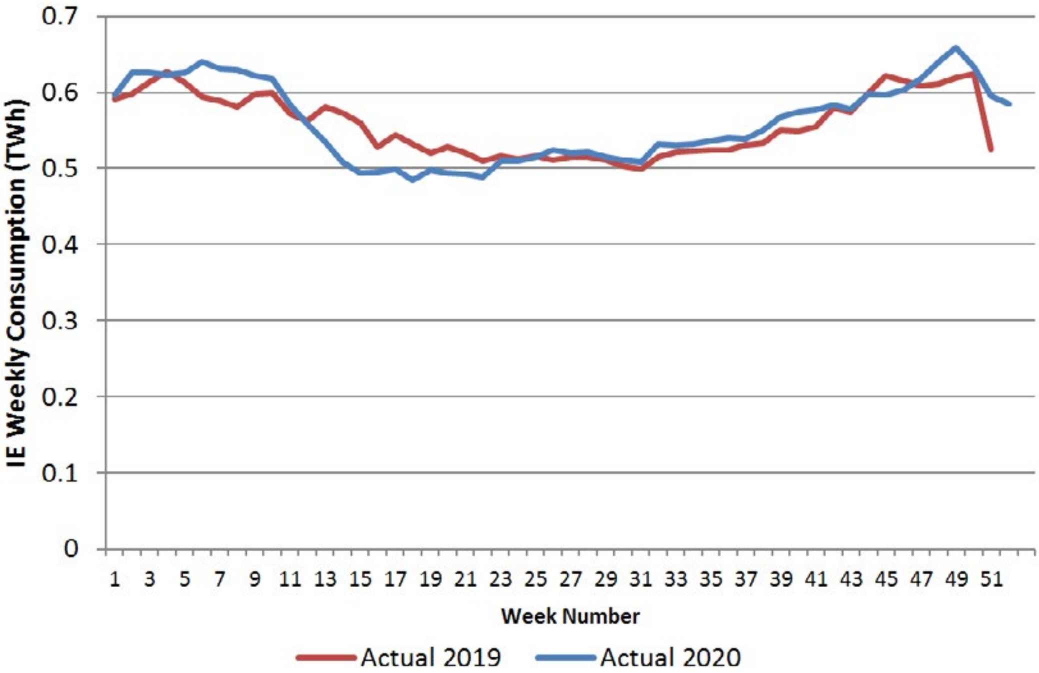


Figure 18 - Ireland Weekly consumption 2019 v 2020

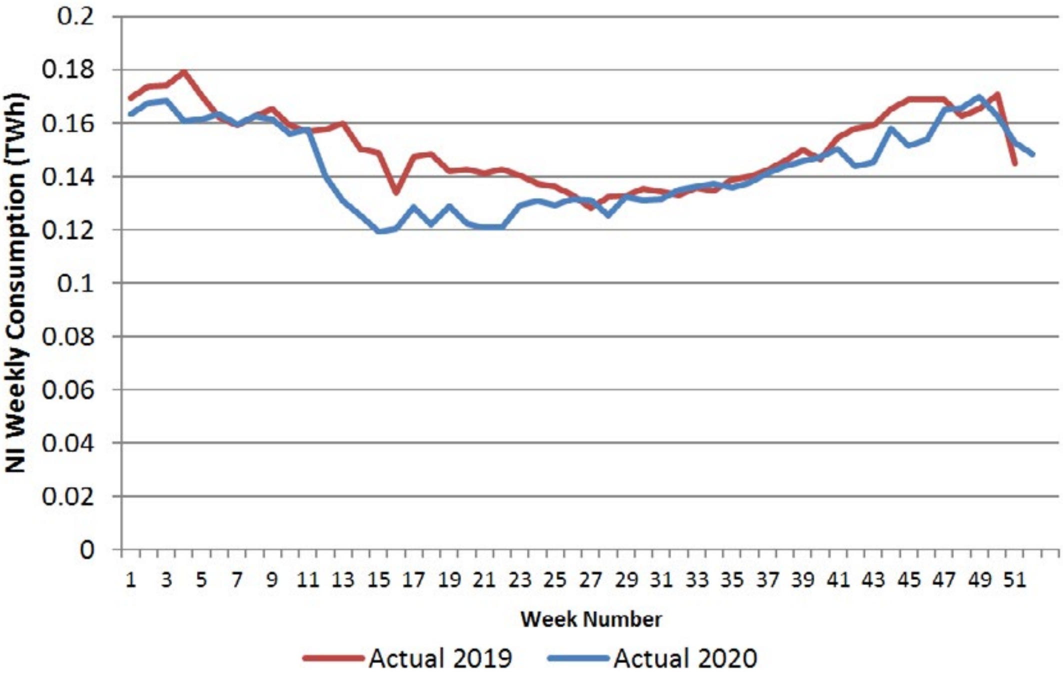


Figure 19 - Northern Ireland Weekly consumption 2019 v 2020

We do not yet know how long electricity consumption will continue to be affected and to what extent this will change as lockdown restrictions ease across 2021, however, we expect underlying economic trends to dominate once the impact of Covid-19 starts to ease. This will be facilitated by stimulus funding from the European Green Deal in Ireland, and the Economic Recovery Action Plan[31] in Northern Ireland.

31 https://www.economy-ni.gov.uk/sites/default/files/publications/economy/dfe-economic-recovery-action-plan.pdf

2.6. Annual Load Shape and Demand Profiles

To create future demand profiles for the adequacy studies for both Ireland and Northern Ireland, it is necessary to use an appropriate base year profile which provides a representative demand profile. This profile is then progressively scaled up using forecasts of energy peak and demand. Similar to the methodology employed in the Capacity Market auction calculations, we have used a number of base year profiles, separately carried out a range of adequacy studies, and then taken an average of the results. The profile year with the closest result to this average was then used for subsequent adequacy studies. This avoids any bias that might ensue if only one, atypical year were used.

To reflect different segments of demand, additional forecast industrial and data-centre type demand is grown separately using a profile appropriate to its expected usage, i.e. flat demand profile. Remaining additional demand is grown proportionally using historical demand profiles.

Electricity usage generally follows relatively predictable patterns. For example, the peak demand occurs during winter weekday evenings while minimum usage occurs during summer weekend night-time hours. Peak demand during summer months occurs much earlier in the day than it does in the winter period.

Many factors impact on this electricity usage pattern throughout the year. Examples include weather, large sporting and social events, holidays, customer demand management, in addition to the uptake of micro generation, electric vehicles and heat pumps.

3. Generation

3. Generation

3.1. Introduction

This section describes all significant sources of electricity generation connected to the systems in Ireland and Northern Ireland known to the system operators. The portfolio changes over time and may change due to the Capacity Market in the SEM. This is because only plant that is successful in the capacity auctions for the relevant years will receive capacity payments and therefore be liable for Reliability Options. Plant that does not receive capacity payments may seek to exit the market. Any changes to the portfolio are particularly significant to the operation of a power system such as ours, which has a high proportion of intermittent renewable generation.

Therefore, we have endeavoured to paint a general picture of how the All-Island portfolio might evolve from the present situation of surplus, to one where the system is adequate to an 8-hour LOLE standard.

For information, Figure 20 below illustrates the age of the dispatchable plant on the island with Demand Side Units (DSUs) incorporated.

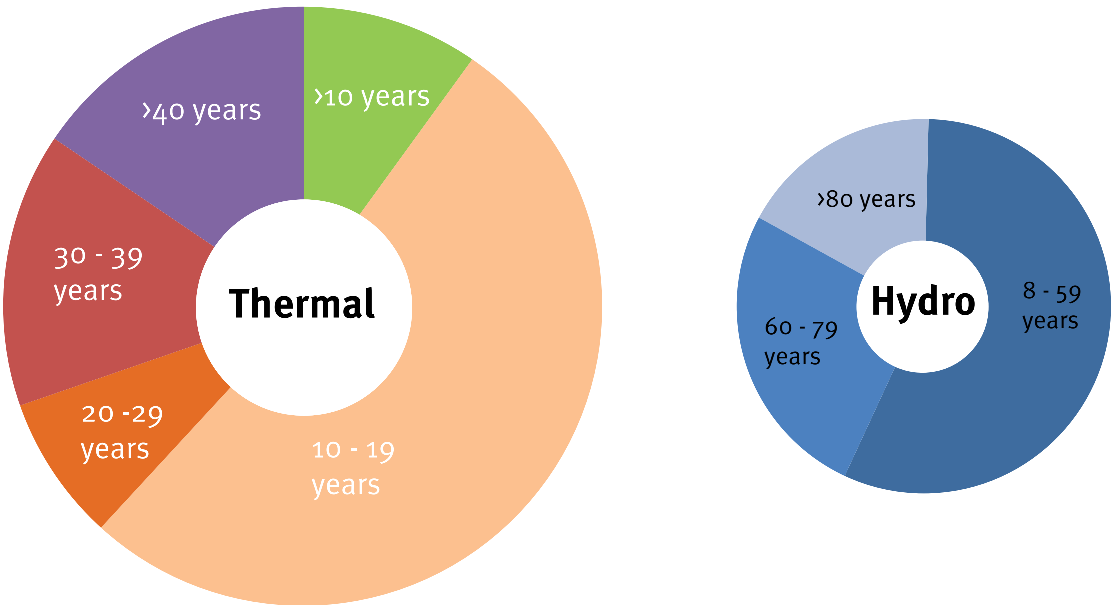


Figure 20 - Age breakdown of dispatchable plant on the All-Island system

This amounts to 9.7 GW of dispatchable plant on the island of Ireland for 2021 – including DSUs/AGUs and Interconnectors, but no small scale generation or RES. A total of 6.1 GW of de-rated capacity cleared in the T-4 2024/2025 All-Island capacity auction[32] held in January 2021, as shown in Figure 21.

32 https://www.sem-o.com/documents/general-publications/T-4-2024-2025-Final-Capacity-Auction-Results-Report.pdf

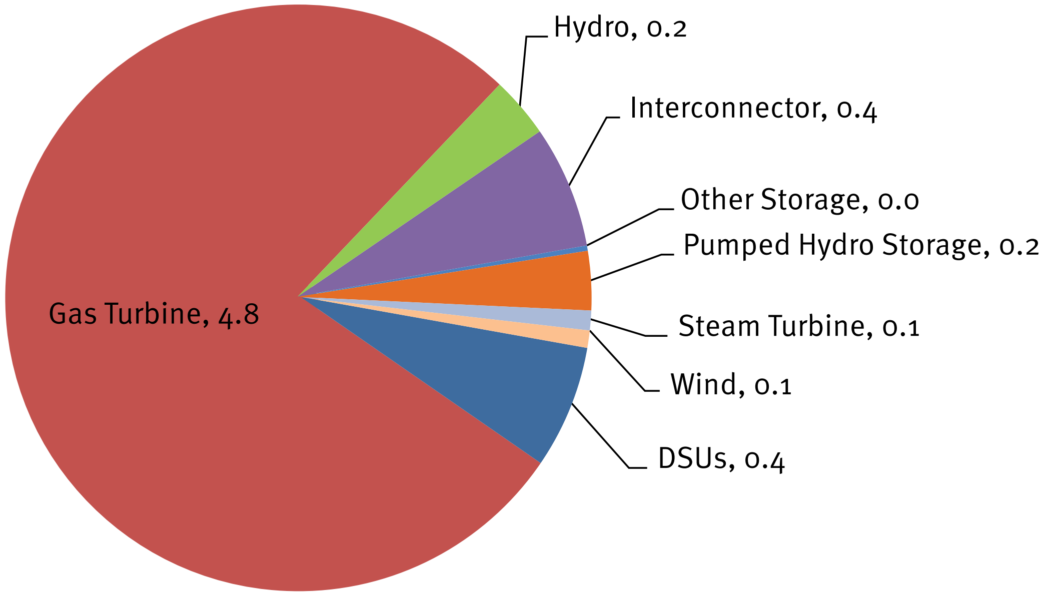


Figure 21 - Total amount of de-rated capacity (GW) that cleared the T-4 2024/2025 All-Island Capacity Market by Technology Category

3.1.1. SEM Capacity Market Auction Results

The Single Electricity Market (SEM) is the wholesale electricity market for the island, established in 2007. It is designed to provide wholesale electricity at the lowest possible cost, ensuring that there is adequate supply to meet demand and to support long-term sustainability. The I-SEM was launched on the 1st of October 2018.

The SEM is designed and regulated by the Single Electricity Market Committee (SEM Committee) which is made up of representatives from regulators in Northern Ireland (the Utility Regulator) and Ireland (the Commission for the Regulation of Utilities) and two independent members.

SONI and EirGrid operate the SEM under the contractual joint venture, the Single Electricity Market Operator (SEMO). The operation of the capacity market is a TSO obligation and is funded through the TSO price controls.

SEM Capacity Auctions
We have included the new entrant generation units in the models that were successful in the SEM CRM 2022/23 T-4 capacity auction from the start of 2023, the CY2023/24 T-4 capacity auction from the start of 2024, and the CY2024/25 T-4 capacity auction from the start of 2025. It should be noted that, at time of publication, not all of these units had signed connection agreements in place. Recent security of supply studies highlight uncertainty of new capacity becoming available on time. Units that have been issued with Termination Notices have been excluded from adequacy studies - please see Table 6 for a list of these units.

To date, most renewable generation has not participated in the Capacity Auctions. Mechanisms like REFIT in Ireland and ROCs in Northern Ireland were specifically designed to encourage investment in renewable energy.

Under the SEM, only generating units that are successful in the capacity auctions will receive capacity payments. The goal of the auction is to ensure that consumers do not pay for more capacity than is needed. Since 2017, a number of auctions have been run to provide capacity for the years ahead. The outcome of the most recent 2024/2025 T-4 auction has been included in the report. To support that the All-Island system adequacy level is maintained, the following auctions have taken place and procured the following volumes for the All-Island system.

Table 3 - 2024/2025 T-4 Auction Results

Auction	Date	Awarded Capacity (De-Rated)
2018/2019 T-1	15/12/2017	7.774 GW[33]
2019/2020 T-1	13/12/2018	8.266 GW[34]
2020/2021 T-1	26/11/2019	7.605 GW[35]
2021/2022 T-2	5/12/2019	7.512 GW[36]
2022/2023 T-4	28/03/2019	7.412 GW[37]
2023/2024 T-4	27/04/2020	7.322 GW[38]
2024/2025 T-4	21/01/2021	6.168 GW[39]
2022/2023 T-1	21/10/2021[40]	TBC
2024/2025 T-3	20/01/2022[41]	TBC

33 https://www.sem-o.com/documents/general-publications/Capacity-Market-Final-Capacity-Auction-Results-Report_FCAR1819T-1.pdf
34 https://www.sem-o.com/documents/general-publications/T-1-2019-2020-Final-Capacity-Auction-Results-Report.pdf
35 https://www.sem-o.com/documents/general-publications/T-1-2020-2021-Final-Capacity-Auction-Results-Report.pdf
36 https://www.sem-o.com/documents/general-publications/T-2-2021-2022-Final-Capacity-Auction-Results-Report.pdf
37 https://www.sem-o.com/documents/general-publications/T-4-2022-2023-Final-Capacity-Auction-Results-Report.pdf
38 https://www.sem-o.com/documents/general-publications/T-4-2023-2024-Final-Capacity-Auction-Results-Report.pdf
39 https://www.sem-o.com/documents/general-publications/T-4-2024-2025-Final-Capacity-Auction-Results-Report.pdf
40 https://www.sem-o.com/documents/general-publications/CAT2223T-1-2022-2023-T-1-Capacity-Auction-Timetable.pdf
41 https://www.sem-o.com/documents/general-publications/CAT2425T-3-2024-2025-T-3-Capacity-Auction-Timetable.pdfhttps://www.sem-o.com/documents/general-publications/CAT2425T-3-2024-2025-T-3-Capacity-Auction-Timetable.pdf

3.2. Changes to Conventional Generation in Ireland

This section describes changes in fully dispatchable-plant capacities in Ireland. Information on known plant additions and closures are documented.

Some of the older generators in Ireland have informed EirGrid of their intention to decommission, as detailed below in Table 4. The main reason for decommissioning is increasing restrictions to emissions.

Table 4 - Assumptions for Plant closures in Ireland

Plant	Export Capacity (MW)	Modelled as closing by the end of:	Comment
Aghada (AT1)	90	2023	IED Limited Life-time Derogation. ESB have provided a closure notice for these units.
Tarbert 1, 2, 3, 4	590	2023	Discussed with SSE. SSE has provided a closure notice for these units.
Moneypoint	885	2025	Moneypoint units did not qualify for the 2024/2025 T-4 Capacity Auction.
Edenderry	118	2023	Current planning expires at end of 2023. Bord na Móna has not provided a closure notice for this and is applying for planning permission extension.
Total	**1,683 MW**		

At the time of publication, planning permission for Edenderry peat plant is due to expire at the end of 2023. However, EirGrid notes that Bord na Mona are in the process of seeking extension to this planning permission. EirGrid will track the developments of this extension and will update our adequacy modelling appropriately when a result of this planning permission extension request is known.

Table 5 lists the successful generation units in previous T-4 auctions at their de-rated capacities. It should be noted that, at time of publication, not all of these units had signed connection agreements in place. Recent security of supply studies highlights the impact on the adequacy position if this new capacity does not become available on time. Failure to deliver on new capacity for a given capacity year could present significant challenges to the adequacy position of the system. Further mitigating measures may be required should new capacity fail to deliver on time for a given capacity year.

Table 5 - Assumptions for new plant capacities for adequacy studies from 2023 to 2025

Plant	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Contract Length (years)	Forecast Available[42]
ESB Ringsend Gas Flexgen	70	64	10	2023
ESB Poolbeg Gas Flexgen	70	64	10	2023
ESB Corduff Gas Flexgen	70	64	10	2023
ESB Poolbeg 2hr Battery Storage	75	22.5	10	2023
ESB Southwall 2hr Battery Storage	30	9	10	2023
ESB Inchicore 2hr Battery Storage	30	9	10	2023
ESB Aghada 1hr Battery Storage	19	5.7	10	2023
Grange Backup Power Limited Gas Turbine	115	104	10	2024
ESB Gas Turbine	13	11	10	2024
Data and Power Hub Services Limited Gas Turbine	116	105	10	2024
Ronaver Gas Turbine	2	2	1	2024
Scottish Power	40	12	10	2024
Winter Winds	9	3	10	2024
Energia	60	18	10	2024
Various Battery project	73	22	1/10	2025
Statkraft Gas Turbine	48	45	10	2025
Gas Turbine	11	10	1	2025
Various DSUs	260	78	1/10	2025
Total	**1,111**	**648**		

Auction Termination Notices

Following certain SEM CRM auctions, a number of awarded contracts have been terminated and are not progressing. The contracts listed below have been issues Termination Notices and have been removed from studies.

42 Availability is assumed from 1st January of the given year

Table 6 - Units issued with Termination Notices

Plant	Technology Type	SEM CRM Auction	Awarded New Capacity Terminated (MW)	Termination issued
ESB North Wall 4	Gas Turbine	T-4 22/23	108[43]	2021
ESB North Wall 5	Gas Turbine	T-4 22/23	108[44]	2021
EnerNoc	DSU		2.6[45]	2021
Ronaver	DSU		4.1[46]	2021
Statkraft	Gas Turbine	T-4 23/24	44[47]	2021
Total			**266**	

It should be noted that, post the data freeze date, a number of units for the 22/23 capacity year have signaled their intention to terminate. This has been captured in subsequent security of supply analysis in this document as shown in table 5.

3.3. Changes to Conventional Generation in Northern Ireland

This section describes changes in fully-dispatchable plant capacities in Northern Ireland. Information on known plant additions and closures are documented in Table 7.

For the purposes of adequacy studies, all existing plant that entered the T-4 2022/23, T-4 2023/24 and T-4 2024/25 auction is included, not just the capacity that was successful in the auction. This amounts to 2.4 GW of de-rated dispatchable plant in Northern Ireland.

Table 7 - Assumptions for plant changes in Northern Ireland

Plant	Export Capacity (MW)	Modelled as closing by the end of:	Comment
Kilroot ST1	238	2023	EPUKI have provided a closure notice for these units. Operation ceases in 2023.
Kilroot ST2	238	2023	EPUKI have provided a closure notice for these units. Operation ceases in 2023.

Kilroot ST1 and ST2 did not qualify for inclusion in the T-4 2023/24 auction in April 2020 and EPUKI subsequently issued a Closure Notice for ST1 and ST2 confirming their intention to close both units on 30th September 2023. Kilroot GT1, GT2, GT3 and GT4 did not qualify for inclusion in the T-4 2024/25 auction in January 2021.

New conventional open cycle peaking generation was contracted in the SEM T-4 23/24 and SEM T-4 24/25 capacity auctions in April 2020 and January 2021. This new generation is listed below in Table 8.

43 https://www.sem-o.com/documents/general-publications/2223T-4-Capacity-Market_Capacity-Termination-Notice_PY_000030-ESB.pdf
44 https://www.sem-o.com/documents/general-publications/2223T-4-Capacity-Market_Capacity-Termination-Notice_PY_000030-ESB.pdf
45 https://www.sem-o.com/documents/general-publications/2021T-1-Capacity-Market_Capacity-Termination-Notice_PY_000088-EnerNoc.pdf
46 https://www.sem-o.com/documents/general-publications/2021T-1-Capacity-Market_Capacity-Termination-Notice_PY_000194-Ronaver.pdf
47 https://www.sem-o.com/documents/general-publications/2223T-4-Capacity-Market_Capacity-Termination-Notice_PY_034058-Statkraft-Ireland.pdf

Table 8 - Assumptions for new conventional plant capacities for adequacy studies

Plant	Rated Capacity[48]	Net De-Rated Capacity (MW)	Contract Length (years)	Forecast Available
EP Kilroot	406	338	10	2024
EP Kilroot	263	219	10	2025

During 2015, investment was made in a Selective Non-Catalytic Reduction system at ST1 and ST2 to reduce NOx emissions. These units were fully available in 2016 through to 2020 with an ability to purchase some additional emission allowances in the UK's NOx trading scheme. From July 2020, emissions restrictions became tighter with the end of Transitional National Plan and the units on oil firing are now limited to a rolling annual average of 1500 stack hours. In 2021, revised Best Available Techniques Reference Document restrictions apply, so emissions limits have tightened further. EPUKI has been working with a supplier that has developed a potential solution to further reduce NOx emissions, though they have indicated that the solution is new technology so there is performance uncertainty until commissioning and calibration tests have been completed. This solution would only apply to the coal fired generation up to the point of unit closure.

Belfast Power Limited (Evermore Energy) is proposing a 480 MW gas fired power station in the Belfast Harbour Estate. The proposed power station will use combined cycle gas turbine (CCGT) technology. For the purposes of this report, this project is not included in the adequacy studies. SONI will continue to monitor the status of this project with a view to incorporating it in future studies as appropriate[49].

3.4. Impact of the Industrial Emissions Directive, Climate Action Plan and Clean Energy Package

It is noted that there are some uncertainties around new capacity becoming available for a given capacity year, retirement dates for ageing plant and risks around run hour restrictions on new capacity entering the market. New generation procured via the SEM T-4 auctions may have run hour limitations due to EU legal requirements in relation to emissions from natural gas peaking units. Without careful management run hour limitations could have an impact on security of supply and operational flexibility in modernising the grid. The adequacy position for Northern Ireland and Ireland could be adversely impacted by any delay in plant delivery or run hour restrictions on new capacity. The European Union has set ambitious targets for decarbonisation and for renewable energy for the electricity sector by 2030. To date, the IED, CEP and the Irish Government Climate Action Plan 2019 are the three main instruments which aim to transform the electricity sector, amongst other sectors, for a cleaner and more sustainable future for all.

In June 2019, the Minister of Communications, Climate Action and Environment committed to eliminating generation from peat and coal while raising the amount of electricity generated from renewable sources to at least 70% by 2030. This ambition is needed to honour the Paris Agreement.

In Ireland, Department of Environment, Climate and Communications launched a set of auctions called the Renewable Electricity Support Scheme (RESS). The RESS 1 auction was the first Renewable Electricity Support Scheme by the Irish Government and was a pivotal component of the Climate Action Plan. Going forward, there will be further RESS auctions to deliver at least 70% renewable electricity target by 2030.

The RESS-1 auction was available to onshore wind and solar technologies. There are also preference categories for solar projects and community funded projects. Similar to REFIT, the RESS payments will be made through the PSO Levy.

48 For the purposes of AdCal modelling, rated capacity is determined based on assumptions made using a de-rating factor

49 Note that the analysis within the report is taken at February 2021, and that the licence for Belfast Power Limited was revoked with effect from 30 July 2021

Directive 2010/75/EU of the European Parliament and the Council on industrial emissions (the Industrial Emissions Directive or IED) is the main EU instrument regulating pollutant emissions from industrial installations. The IED replaces seven existing directives including the Integrated Pollution Prevention and Control Directive 2008/1/EC (IPPC) and the Large Combustion Plant Directive 2001/80/EC (LCPD).

In 2017, the European Commission published a final decision on the Best Available Techniques[50] (BAT) for large combustion plants, which will apply new standards on emissions from August 2021. For combustion plants, Emission Limit Values (ELVs) for Nitrous Oxide (NO_x), Sulphur Dioxide (SO_2) and particulate levels have been tightened.

The Clean Energy Package targets all generation to be under 550g/kWh by 2025 to be eligible to receive payment under a capacity mechanism. This limit will affect certain generation plants in Ireland.

3.5. Interconnection

Interconnection allows the transport of electrical power between two transmission systems. Interconnection with Great Britain over the East-West and Moyle interconnectors provides a significant capacity benefit. It also allows opportunities for direct trading between the system operators, known as counter-trading. Further transmission links between Ireland and Northern Ireland would significantly enhance generation adequacy in both jurisdictions.

3.5.1. North South Interconnector

The second high capacity transmission link between Ireland and Northern Ireland is assumed to be commissioned during 2025, and become fully operational by 2026. It is assumed that all-Island generation adequacy assessments can be carried out from 2026 onwards. This All-Island assessment shows an increase in the security of supply for both jurisdictions, as the demand and generation portfolios for Northern Ireland and Ireland are aggregated to meet to combined demand.

Prior to the completion of this second North South Interconnector project, the existing interconnector arrangement between the two regions creates a physical constraint affecting the level of support that can be provided between jurisdictions. On this basis, each TSO is obliged to help the other in times of capacity shortfall.

With this joint operational approach to capacity shortfalls, the TSOs agreed that the level of capacity reliance would be maintained by modifying interconnector flows. Reductions in reserve would be followed by load shedding by both parties as a final step to maintaining system integrity[51].

Generation adequacy assessments for each region are carried out with an assumed degree of capacity interdependence from the other region. This is an interim arrangement until the second North South Interconnector removes this physical constraint. This is due to the system outages and the region demand peak for each region occurring at different times. Therefore, some allowance for inter-regional supply can be estimated to balance supply across the island. The capacity reliance values used for the adequacy studies are shown in Table 9. This capacity reliance figure assumes that there is sufficient capacity from either jurisdiction to facilitate an exchange of power.

Table 9 - Capacity reliance at present on the existing North South Interconnector

	North to South	South to North
Capacity Reliance	100 MW	200 MW

50 http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1502972300769&uri=CELEX:32017D1442
51 https://www.sem-o.com/documents/general-publications/Information_Note_on_Inter-Area_Flow_Constraints.pdf

During real time operations, flows in excess of the capacity reliance can sometimes take place if required.

As it is within the All-Island market, the interconnection between Ireland and Northern Ireland is treated as an element of the transmission system, rather than an interconnector to facilitate cross-border trading. As such, it is a different case compared to how the East-West (EWIC) and Moyle interconnectors are considered.

3.5.2. Generation Available in Great Britain

When assessing the contribution of an interconnector to generation adequacy, we need to consider the availability of generation at the other side, as well as the availability of the interconnector itself.

In order to improve our understanding of how interconnection can provide benefits, we look to our European neighbours. In collaboration with a number of TSOs, including EirGrid and SONI, ENTSO-E has improved its adequacy assessment methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments. The European Resource Adequacy Assessment (ERAA)[52] uses probabilistic methods to take into account the intermittency of the growing renewable generation sector.

3.5.3. East-West HVDC Interconnection between Ireland and Wales

The East-West interconnector connects the transmission systems of Ireland and Wales with a capacity of 500 MW in either direction. However, it is difficult to predict whether or not imports for the full 500 MW will be available at all times. Informed by the SEM Capacity Market decision, we used a 60% external market de-rating factor, i.e. 300 MW, and appropriate availability statistics.

3.5.4. Moyle Interconnector between Northern Ireland and Scotland

The Moyle Interconnector is a dual monopole HVDC link with two coaxial undersea cables from Ballycronanmore (Islandmagee) to Auchencrosh (Ayrshire). The transfer capacity of the Moyle Interconnector for the trading of electricity between the electricity markets of Ireland and Great Britain varies[53], as is shown in Table 10.

Table 10 - Transfer capacity of the Moyle Interconnector

Direction	Time Period	Available Capacity (MW)	Additional Capacity Potentially Available from National Grid (MW)	Capacity Available to SONI due to Constraint (MW)
West to East	1 December 2020 to 31 October 2021	250	250	400
	1 November 2021 to 31 March 2022	160	340	400
	1 April 2022 Onwards	500	0	400
East to West	1 April to 31 October Annually	450 (may be reduced to 410 under certain system conditions)	N/A	N/A
	1 November to 31 March Annually	450	N/A	N/A

52 https://www.entsoe.eu/outlooks/eraa/
53 http://www.mutual-energy.com/electricity-business/moyle-interconnector/trading-across-the-moyle-interconnector/

It is difficult to predict whether or not imports for the full capacity will be available at all times. This capacity reliance figure assumes that there is sufficient capacity from Great Britain to facilitate an exchange of power.

For the purposes of adequacy studies, we treat the Moyle Interconnector with a 60% external market de-rating factor (270 MW) as used in the SEM Capacity Market and appropriate availability statistics.

3.5.5. Further Interconnection

There are a number of proposed interconnector projects involving Ireland. Table 11 below contains a list of projects that has been assessed as part of the current European Ten Year Network Development Plan[54] Projects of Common Interest. As these projects are at a preliminary stage, EirGrid has not included them in the adequacy assessments in this report. It is expected that once an interconnector project reaches financial close and has an Engineering, Procurement and Construction (EPC) contract it will be included in GCS adequacy studies.

Table 11 - Proposed interconnection projects

Project	Description	Project Promoters Target Commissioning Date
Celtic Interconnector	Interconnector between Ireland and France (with PCI status[55])	2026
Greenlink Interconnector	Project providing interconnection to Great Britain (with PCI status[53])	2023

There are further connection projects noted in ENTSOE's most recent Ten Year Network Development Plan 2020. In Northern Ireland there is potential for new interconnection (LirIC) to Scotland, with one potential operator receiving an interconnector licence from Ofgem. In Ireland, there is a further interconnector project (MARES Connect) from Ireland to GB, it is part of a wider project that includes a sea water pumped hydro station. Based on the early development status of these projects they are not included within any studies or tables in this report.

3.6. Wind Capacity and Renewable Targets

In Ireland, government policies are in place which set targets for the amount of electricity sourced from renewables. A new Energy Strategy is under development in Northern Ireland and new targets are expected to be set when the strategy is published in November 2021. The integration of more variable renewable forms of generation on the power system means we must consider an additional complex range of demand and supply issues.

In Ireland, DECC (formerly DCCAE) launched a set of auctions called the Renewable Electricity Support Scheme (RESS). The RESS scheme is underpinned by the agreement between the EU Commission, EU Parliament and EU Council to set an EU-wide, binding renewable energy target of 32% by 2030[56].

It can be assumed that Ireland's renewable targets will be achieved largely through the deployment of additional wind powered generation. There have been a number of grid access schemes to develop connection of renewable generation: Gate 3, Non-GPA and ECP-1. The current grid access schemes is called Enduring Connection Process-2 (ECP-2). ECP-2 is currently underway and is due to be completed in 3 annual tranches. EirGrid publishes a list of all Transmission-connected wind generation in Ireland[57], while ESB Networks publishes that which is distribution connected[58].

As intermittent RES generation is deployed, challenges related to mismatch between energy generation and consumption become more critical.

54 TYNDP 2020 is produced by the European Network of Transmission System Operators – Electricity (ENTSO-e), see: https://eepublicdownloads.azureedge.net/tyndp-documents/TYNDP_2020_Joint_Scenario_Report_ENTSOG_ENTSOE_200629_Final.pdf
55 EC Project of Common Interest, see: https://ec.europa.eu/energy/sites/ener/files/documents/memberstatespci_list_2017.pdf
56 https://www.dccae.gov.ie/documents/RESS%20Design%20Paper.pdf
57 http://www.EirGridgroup.com/customer-and-industry/general-customer-information/connected-and-contracted-generators/
58 https://www.esbnetworks.ie/new-connections/generator-connections/generator-connection-statistics

Battery energy storage facilitates integration of renewable energy by shifting curtailed or constrained RES to times where there is greater demand. Sufficiently flexible energy storage systems, particularly those connected through fast-response electronic interfaces, would ideally complement a varied and dispersed generation portfolio. Various energy storage technologies are expected to provide a wide range of advanced services (mostly related to system integrity and stability). These services include synthetic/virtual inertia, frequency containment, frequency restoration, restoration reserves and ramping support, along with energy arbitrage over different time scales, from intra-daily to seasonal.

3.6.1. RESS Auctions Pathway and achieving the Ireland RES-E target of 70%

In 2019, the Irish Government published the Climate Action Plan 2019[59]. In it the Government set out guidelines for how, at a high level, the 70% renewable energy target is reached. This includes:

- Delivering an early and complete phase-out of coal and peat fired electricity generation
  - Moneypoint closure by 2025
  - Reduced reliance on peat fired plants
    - Bord na Mona transition away from peat by 2028. Current planning permission for Edenderry ends in 2023, but an extension to planning is being pursued.
    - ESB Shannonbridge and Lanesbourgh are to close at the end of 2020.
- An increase of electricity from renewable sources to 70% via:
  - At least 3.5 GW of offshore renewable energy,
  - Up to 1.5 GW of grid-scale solar PV energy,
  - Up to 8.2 GW total of increased onshore wind capacity.
- Meeting 15% of electricity demand by renewable sources contracted under corporate PPAs[60].
- Enhanced interconnection is planned, including the Celtic Interconnector to France and the Greenlink Interconnector to the UK.
- Facilitation of small and micro-scale generation at a residential and community level to sell excess generation back to the grid.
- Smart meter installation for all homes by 2024.
- Revised market structures and grid connection processes to best facilitate the targets.

59 https://assets.gov.ie/10206/d042e174c1654c6ca14f39242fb07d22.pdf
60 A corporate PPA refers to a contractual arrangement whereby independent generators (typically renewable) and corporates that are large energy consumers, contract for the sale of power to that consumer.

Furthermore, the 70% RES-E target in Ireland was set prior to the Programme for Government's intention to increase its decarbonisation ambition to achieve a 7% annual reduction in greenhouse gas emissions between 2021 and 2030. This Programme for Government[61] has a number of commitments that aims to build on the Climate Action Plan 2019. These include:

- At least 70% RES-E by 2030,
- 5GW offshore wind by 2030,
- Carbon tax increase to €100 per tonne by 2030,
- 7% per annum reduction in overall GHG emissions by 2030 (51% over the decade to 2030),
- Net zero emissions by 2050,
- Retrofitting 500,000 homes by 2030 (to a B2 energy rating),
- Install 600,000 heat pumps.

The Government has outlined trajectories to 70% RES-E in the National Energy and Climate Plan . This is due to be updated to reflect higher levels of ambition. Furthermore, the Government is currently consulting on the Climate Action Plan 2021 in the context of delivering this new climate ambition.

A renewable energy mix that could achieve the 70% RES-E target based on this year's GCS ten-year median demand forecast is shown below in Figure 22.

The Government has outlined trajectories to 70% RES-E in the National Energy and Climate Plan[62]. This is due to be updated to reflect higher levels of ambition. Furthermore, the Government is currently consulting on the Climate Action Plan 2021 in the context of delivering this new climate ambition.

A renewable energy mix that could achieve the 70% RES-E target based on this year's GCS ten-year median demand forecast is shown below in Figure 22.

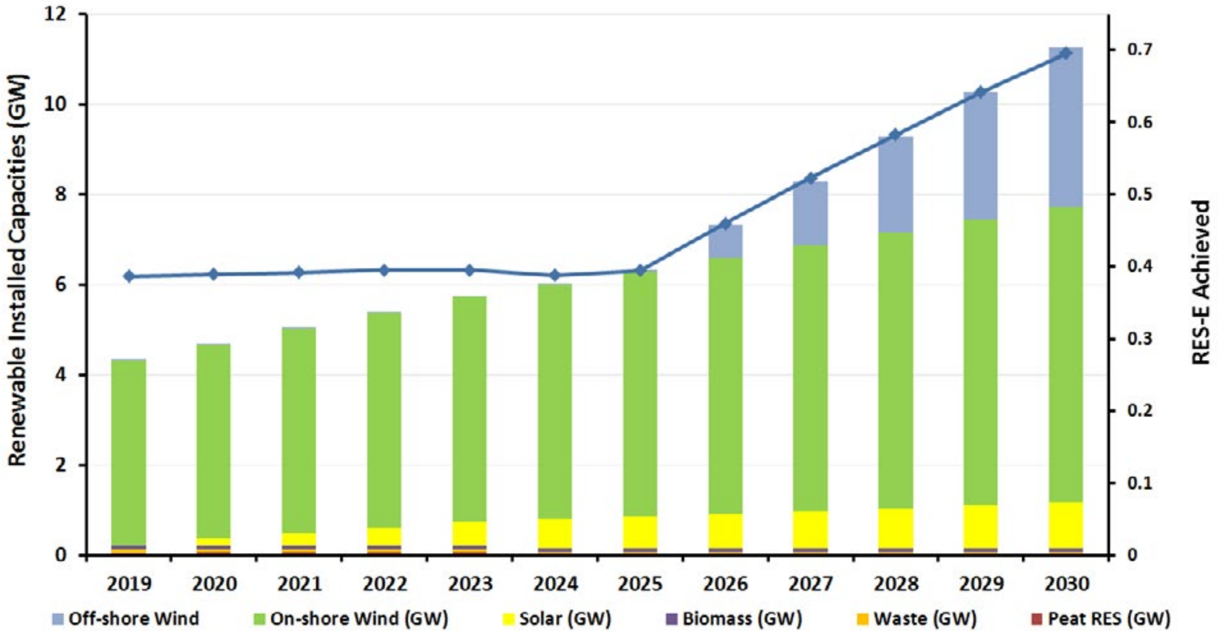


Figure 22 - Example renewable energy generation portfolio which could achieve the 2030 70% RES-E target

61 https://www.gov.ie/en/publication/7e05d-programme-for-government-our-shared-future/
62 https://www.gov.ie/en/publication/0015c-irelands-national-energy-climate-plan-2021-2030/

For the RESS 1 auction, successful projects get support for 15 years with project delivery by 31st December 2023. There were 7 technology categories defined in the terms and conditions of RESS 1 with the Capacity Factors recommended by EirGrid, based on the GCS and Tomorrow's Energy Scenarios studies. These capacity factors are given in the table below:

Table 12 - Capacity Factors

Eligible Technology	Renewable Capacity Factor
Onshore Wind	35%
Offshore Wind	45%
Solar	11%
Hydro	35%
Biomass HECHP	85%
Waste to Energy HECHP	43%
Biogas HECHP	36%

In total, 114 projects applied to participate in RESS 1 qualification. From this a total Offer Quantity (MW) of 1276 MW was successful and a total Offer Quantity (MW) of 283 MW was not successful. Locations for the successful projects are shown in Figure 23.

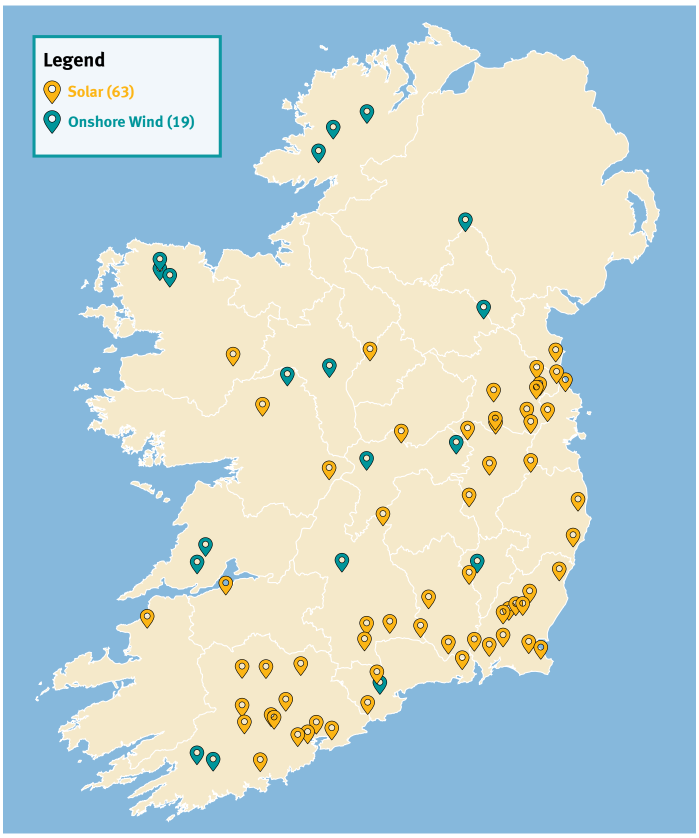


Figure 23 - Location of RESS 1 Successful Projects

3.6.2. Wind Power in Ireland

Installed capacity of wind generation has increased from 135 MW at the end of 2002 to 4300 MW at the end of 2020. This value is set to increase as Ireland endeavours to meet its renewable targets in 2030 and beyond.

The Irish Government had a target of 40% of electricity to be generated from renewable sources by 2020, as was restated in the 2015 White Paper on Energy[63]. The 40% RES-E target was a part of the Government's strategy to meet the overall Irish target to achieve 16% of all energy consumed to come from renewable sources by 2020. Ireland achieved this target in 2020, with 43.3% of electricity generated from renewable energy sources.

In order to comply with the RES Directive (2009/28/EC) guidelines for the 2020 RES target in Ireland, we normalise the annual energy from wind power[64]. This is done by applying an average of the past 5 year's capacity factor. This normalised annual energy has grown from 4200 GWh in 2011 to 11,070 GWh in 2020. The variation in wind capacity factors is displayed in Figure 24[65].

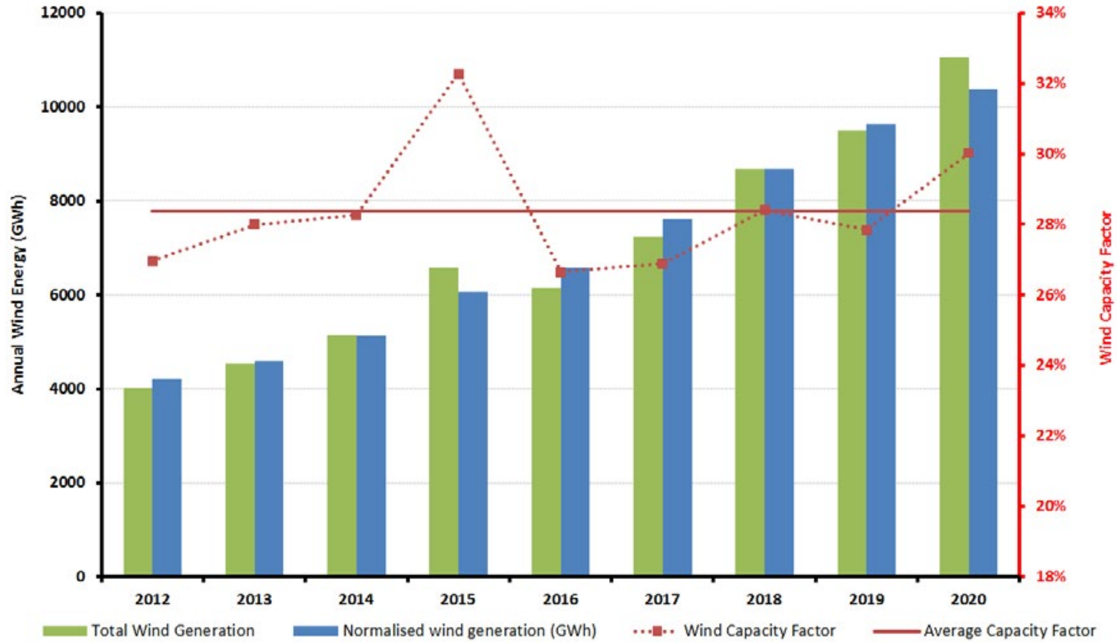


Figure 24 - The actual and normalised annual energy produced from wind power in Ireland over the last eight years

63 http://www.dccae.gov.ie/energy/en-ie/Energy-Initiatives/Pages/White-Paper-on-Energy-Policy-in-Ireland-.aspx
64 http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN
65 http://www.eirgridgroup.com/how-the-grid-works/renewables

3.6.3. Wind Power in Northern Ireland

The Department for the Economy (DfE) has been considering how to advance proposals for an energy strategy that will enable new policy targets that compliment ambition decarbonisation commitments. A public engagement process to inform and shape those proposals is underway and a policy options paper for consultation was published in March 2021 with the final strategy published in late 2021.

The context for climate and energy has changed substantially since the 2010 Strategic Energy Framework (SEF) was published. The SEF facilitated a significant increase in low carbon electricity with a target of 40% electricity from renewable sources by 2020. In June 2019, the UK became the first major economy to commit to a 100% reduction in greenhouse gas emissions by 2050. This 'net zero' target represents a significant step-change in the commitment to addressing the climate crisis.

DfE's proposed new strategy will set new targets to support a pathway to lower carbon energy. Ireland and Wales have both set targets of 70% by 2030, with Scotland aiming for 100% by 2030. While the updated energy policy for Northern Ireland is under consideration, the direction of travel is clear and any target is likely to be similar to those set in other regions of the UK. The most recent consultation paper released by the Department for the Economy on the upcoming Energy Strategy proposes a 70% renewables target for 2030; with scope to increase to 80% should it prove feasible.

Significant investment will be needed in the future to deliver higher levels of low carbon electricity. Whilst the SEM provides revenue streams for power generators, the closure of the Northern Ireland Renewables Obligation (NIRO) in 2017 means that no support scheme is available in Northern Ireland to encourage investment and reduce risk for investors. However, this is set within a context where costs have fallen and some subsidy-free projects are emerging. Both GB and Ireland have auction-style mechanisms in Contracts for Difference (CfD) and the Renewable Electricity Support Scheme (RESS). As part of the strategy development, DfE is consulting on how to bring forward new renewable electricity projects, including whether a support scheme is required, what this might look like and the level of support needed for each technology.

Onshore wind and solar PV may be expected to be less expensive and the most readily deployed technologies for Northern Ireland in the medium term. Offshore renewables may offer a significant opportunity to develop additional large-scale renewable capacity. The latest CfD auction results highlight just how far costs have come down, with the subsidy price for offshore wind cheaper than the costs of either gas or nuclear.

While the energy policy remains in development, SONI has based the expected growth of wind capacity on current grid connection applications to SONI and NIE Networks and that have accepted a grid connection offer.

For 2020, 43.8% of total electricity requirement (TER) came from renewable sources (based on sent out metering) in Northern Ireland, most of which was from wind power.

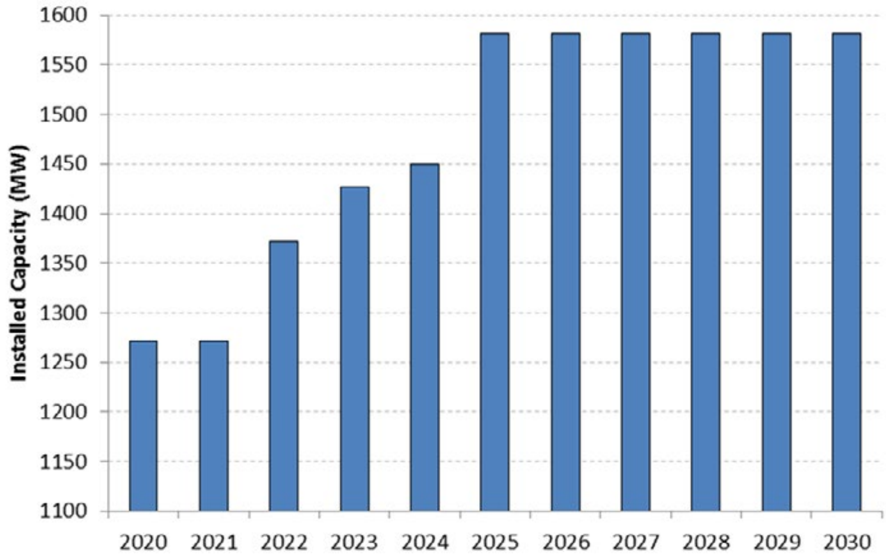


Figure 25 - Expected growth of wind capacity installed in Northern Ireland

Table 13 shows the totals for existing and planned wind generation in Northern Ireland. The figures for Northern Ireland are based on volumes of applications to SONI and NIE Networks which have accepted a grid connection offer and do not include small scale generation of 5 MW and under. Therefore, it does not include any additional 2030 wind generation targets that may be an outcome of the Department for the Economy's upcoming Energy Strategy.

Table 13 - Existing (connected or energised) and planned (contracted or applied) wind farms for Northern Ireland

	Existing (MW)	Planned (MW)
Northern Ireland TSO	121	131
Northern Ireland DSO	974	179
Total	**1,095**	**310**

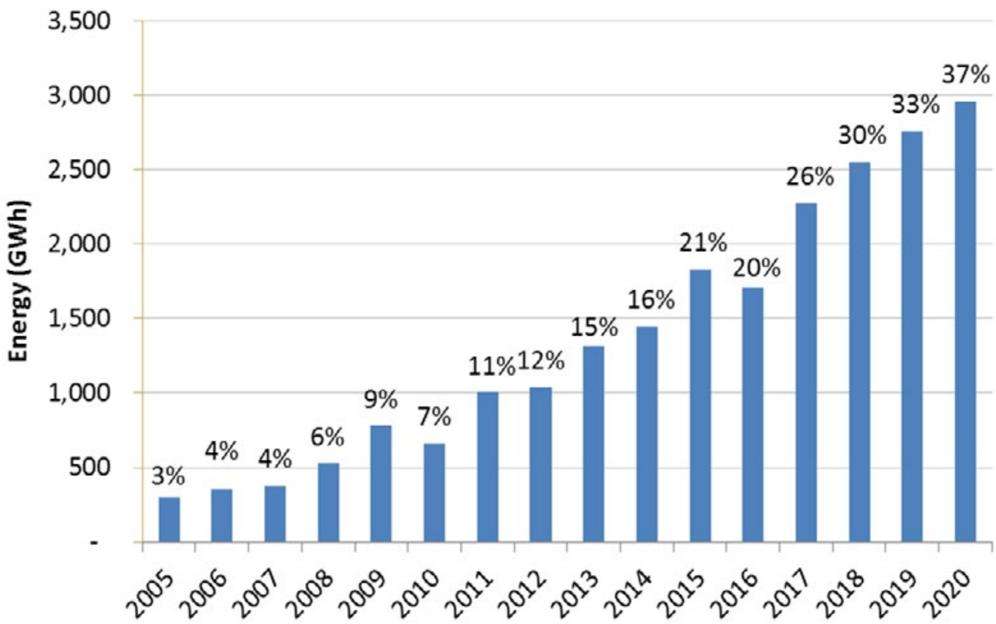


Figure 26 - Historical wind generation for Northern Ireland in annual electricity terms

3.7. Modelling of Non-Conventional Generation in Adequacy Studies

Wind, Solar, Interconnectors, DSU and battery modelling is based on a simplified methodology using de-rated capacity credit equivalent values. The de-rating values used are calculated and published through the SEM CRM auction process. AdCal was developed mainly for conventional plant and Turlough Hill and does not capture the variability of renewable energy sources, DSUs/batteries or Interconnectors.

The final De-Rating Factor for Interconnectors is calculated by multiplying the marginal De-Rating Factor that applies to their size class by the External Market De-Rating Factor. The External Market De-Rating Factor for the T-4 2024/2025 auction will be 0.60 for interconnectors from Great Britain to Ireland or Northern Ireland.

The de-rating values used in AdCal studies are as follows:

Table 14 - De-rating values used in AdCal studies

Technology	De-rating value across 2021 - 2030[66]
Wind	10.3% - 7.3%
Solar	12.7% - 9.7%
Demand Side Units	30%
Battery Energy Storage	30%
Interconnectors	60% External Market De-Rating value Plus the marginal De-Rating Factor that applies to their size class

The modelling of wind power in our adequacy studies differs to the treatment of wind in the Capacity Market calculations. For the Capacity Market, a number of historical wind profiles are grown to match the installed capacity of wind expected in future years. These profiles are then used separately to modify the future demand forecast, where each historical year's profile for wind is matched with the same historical year's demand profile. It is these modified demand forecasts that are subsequently used in the adequacy calculations to obtain the Capacity Requirement for the Capacity Market. A move to a software package such as Energy Exemplars' PLEXOS software would facilitate the study of the variability of wind, solar, DSUs, batteries and interconnectors to a similar or higher level than the SEM Capacity Auction.

66 https://www.sem-o.com/documents/general-publications/Final-Auction-Information-Pack_FAIP2425T-4.pdf

3.8. Other Non-Conventional Generation

The assumed build-out of non-conventional generators is summarised in APPENDIX 2 (Table A-5 and Table A-8).

3.8.1. Demand Side Units (DSUs)

A DSU consists of one or more individual demand sites that can be dispatched as if it were a generator. An individual demand site is typically a medium to large industrial premises. A DSU Aggregator may contract with the individual demand sites and aggregate them together to operate as a single DSU.

In Ireland, 265 MW of de-rated capacity successfully cleared the T-4 2024/25 capacity auction held in January 2021.

Industrial generation refers to generation usually powered by diesel engines, located on industrial or commercial premises, which act as on-site supply during peak demand and emergency periods. The condition and mode of operation of this plant is uncertain, as some of these units fall outside the control of the TSOs. Industrial generation has been ascribed a capacity of 9 MW in Ireland for the purposes of this report.

Dispatchable Aggregated Generating Units (AGU) operate in Northern Ireland, which consist of a number of individual diesel generators grouping together to make their combined capacity available to the market. In Northern Ireland, an AGU capacity of 79 MW and a DSU capacity of 118 MW successfully cleared the T-4 2024/25 capacity auction held in January 2021.

DSUs now form an increasing portion of the generation portfolio and are replacing other units in capacity auctions. EirGrid and SONI will continue to engage with these relatively new capacity units in order to realise their full potential for contributing to system adequacy.

3.8.2. Small scale CHP

Combined Heat and Power (CHP) utilises generation plant to simultaneously create both electricity and useful heat. Due to the high overall efficiency of CHP plant, often in excess of 80%, its operation provides benefits in terms of reducing fossil fuel consumption and CO_2 emissions.

There are approximately 159 MW of CHP units noted in Ireland which are included in the GCS, mostly gas-fired. This is the same as the GCS20. This does not include the 161 MW centrally dispatched CHP plant operated by Aughinish Alumina.

In Northern Ireland, there is currently an estimated 9 MW of small-scale CHP connected to the distribution system (3 MW of which is renewable and 6 MW non-renewable). With little further information available, an assumption has been made that this will not change for the purposes of this statement.

3.8.3. Biofuel

There are a number of different types of biofuel-powered generation plant on the island.

EirGrid estimates there to be 24 MW of generation capacity powered by biofuel, biogas or landfill gas in Ireland, with an additional 30 MW of biofuel units that have registered as a DSU.

Bord Na Mona's Edenderry 118 MW peat unit is assumed to continue operations until at least the end of 2023 when its current planning permission is due to expire. At the time of publication, Bord na Mona has applied to extend the time limit of the current planning permission. EirGrid assumes the Bord Na Mona peat unit uses a biomass percentage of c. 50%. Should this situation be updated we will reflect that in future publications of the GCS.

Currently in Northern Ireland, there is an estimated 46 MW of small-scale generation powered by biofuels, including biomass, biogas and landfill gas. For the purposes of this report, and in the absence of more detailed information, it has been assumed that this capacity will not change.

Lisahally Waste Project became operational in 2015 in Northern Ireland. It is a wood-fueled energy-from-waste/biomass combined heat and power plant with a capacity of approximately 18 MW. The plant is dispatchable and has been granted priority dispatch.

3.8.4. Large and Small-scale Hydro

It is estimated that there is currently 22 MW of small-scale hydro capacity installed in rivers and streams across Ireland. Such plant generates approximately 43 GWh per year, making up 0.2% of total annual generation. While this is a mature technology, the lack of suitable new locations limits increased contribution from this source. It is assumed that there are no further increases in small hydro capacity over the remaining years of the study horizon.

The capacity in Northern Ireland is approximately 6 MW and consists primarily of a large number of small run-of-the-river projects. For the purposes of this report it has been assumed that this capacity will not change.

A large scale hydro project, 360 MW Silvermines in County Tipperary, has been deemed a PCI project by the European Union[67]. This will allow it to apply for EU investment funding to help support linking of the energy systems of the EU and achievement of EU member states energy policy and climate objectives. This project has not been included in adequacy assessments; however, development of this project will be followed and included when appropriate. The project may also have other benefits if it takes part in EirGrid's system services market.

3.8.5. Waste-to-energy

Ireland currently has two waste-to-energy plants:

- A 61 MW Dublin waste-to-energy plant commissioned in 2017;
- and Indaver, a 17 MW waste-to-energy plant.

The GCS assumes a 50% renewable content, thus contributing to our RES targets.

In early 2018, approximately 15 MW of energy-from-waste generation was installed at the Bombardier site in Belfast.

3.8.6. Solar PV

In Ireland, EirGrid has assumed the amount of installed solar will grow linearly from todays 139 MW and will reach 1000 MW by 2030. This is based upon Government targets contained within the Climate Action Plan 2019 report plus ECP-1[68] grid connection offers which have been made.

In Northern Ireland, the capacity of small-scale solar PV has increased rapidly in recent years. Connected capacity is approximately 124 MW. With little further information, an assumption has been made that this will not change for the purposes of this statement.

In Northern Ireland, a number of large-scale PV projects have connected in recent years. Capacity is approximately 144 MW. SONI expects capacity to grow to 165 MW by 2022.

Similar to the treatment of wind power, solar PV capacity is de-rated in our adequacy studies to the de-rating factor used in the 2024/25 T-4 Capacity Market auction, i.e. 0.127[69].

67 https://ec.europa.eu/energy/maps/pci_fiches/PciFiche_2.29.pdf
68 http://www.eirgridgroup.com/site-files/library/EirGrid/2018-Batch-(ECP-1)-Eligible-Applications-Joint-SO-Publication-31.8.18.pdf
69 https://www.sem-o.com/documents/general-publications/Final-Auction-Information-Pack_FAIP2425T-4.pdf

3.8.7. Marine Energy

In Ireland, due the large amount of uncertainty associated with this new technology, EirGrid have taken the prudent approach for now that there will be no commercial marine developments available for adequacy purposes in Ireland before 2030.

The Governments National Energy Climate Plan 2021-2030 forecasts 30 MW of ocean energy developments by 2030.

In Northern Ireland, the Crown Estate has awarded development rights for sites off the North Coast close to Torr Head and Fair Head. At present, there are no connection offers in place for tidal projects. Therefore, for the purposes of this report, SONI have not included any marine capacity within our reference scenario adequacy studies. SONI will continue to monitor its status with a view to incorporating it into future studies.

3.8.8. Energy Storage

A number of battery projects have been contracted via two mechanisms: SEM Capacity Auctions and DS3 Systems Services. These routes offer different but essential services to the power system on the island of Ireland.

The aim of DS3 System Services is to put in place the correct structure, level and type of service in order to ensure that the system can operate securely with higher levels of non-synchronous renewable generation (up to 75% instantaneous penetration). The aim of the SEM Capacity Market is to ensure that the generation capacity in Ireland and Northern Ireland (including Storage, Demand Side Units and Interconnector capacity) is sufficient to meet demand in the short-to-medium term, and that the regulatory-approved power system reliability standard is satisfied. This design helps to promote the interests of consumers of electricity across Ireland and Northern Ireland with respect to price, quality, reliability and security of supply of electricity.

Under the current DS3 System Services arrangements there have been two means for batteries to seek a contract, the Regulated Tariff (or volume uncapped) and the Volume capped tariff. The Regulated Tariff under the current DS3 arrangements is available to any built generator (including batteries) that passes testing for DS3 system services contracts. The Volume Capped tariff procurement process closed in 2019 and resulted in the award of fixed-term contracts to three battery projects totalling 110 MW for specific high availability reserve services. There are various batteries in different stages of development that are not under the Volume Capped or Capacity Market so are open to standard DS3 payments.

The battery projects currently contracted and/or under construction in Ireland via the CRM Capacity auction are:

Table 15 - Battery projects currently contracted and/or under construction in Ireland

SEM Capacity Auction	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Assumed Available
ESB Poolbeg 2hr Battery Storage	75	22.5	2023
ESB Southwall 2hr Battery Storage	30	9	2023
ESB Inchicore 2hr Battery Storage	30	9	2023
ESB Aghada 1hr Battery Storage	19	5.7	2023
Scottish Power	40	12	2024
Winter Winds	9	3	2024
Energia	60	18	2024
SEM CRM T-4 24/25 Auction Battery Storage	73	22	2025

Two Northern Ireland battery storage projects were energised in 2020 totalling 100 MW of capacity. The Drumkee 50 MW battery energised in November 2020 and the Mullavilly battery energised in December 2020. Two further 50 MW battery storage projects are being progressed. The Kells 50 MW battery and the Castlereagh 50 MW battery are both expected to be connected in 2022.

Battery storage capacity is de-rated in our adequacy studies to the de-rating factor used in the 2024/25 T-4 Capacity Market auction - see Table 14.

3.9. Plant Availability

For the purpose of adequacy studies in the GCS, EirGrid and SONI use the plant availability averages from the SEM Capacity Market Requirement. Outage statistics are determined on a technology class level using 5 years of forced outage, scheduled outage and availability data for all technology classes, excluding DSUs (which are given system-wide outage statistics) and pumped storage hydro (based on 10 years of data). These use the 5-year averages per technology class. There are six different technology classes in the Capacity Market - see Table 16.

Table 16 - Availability parameters that were used in the T-4 2024/2025 Capacity Market auction

Technology Category	Mean Forced Outage Probability (%)	Mean Scheduled Outage Rate (weeks)
DSU	7.3%	3
Gas Turbine	4.7%	2
Hydro	3.9%	6
Steam Turbine	12.2%	3
Pumped Storage	5.9%	3
System Wide	7.3%	3

Thermal Plant Availability
In 2020, average All-Island system availability continued to decline, or remained at similar levels to 2019 availability levels. In particular, plant outages towards the end of the outage season brought system availability down to a low of 76% in the month of October 2020.

Figure 27 shows system-wide availability in Ireland which has been decreasing for the past number of years. This affects generation plant ability to provide maximum adequacy support to demand.

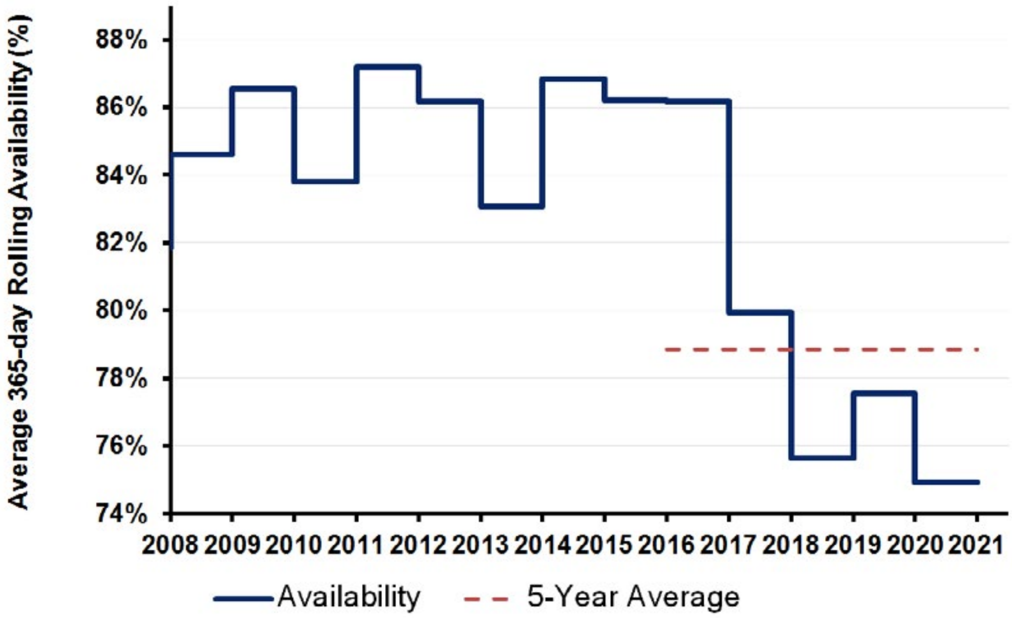


Figure 27 - The average 365-day annual system-wide availability in Ireland

Forced Outage Rates have been increasing over the past number of years, linked to the system availability falling. This is displayed in Figure 28.

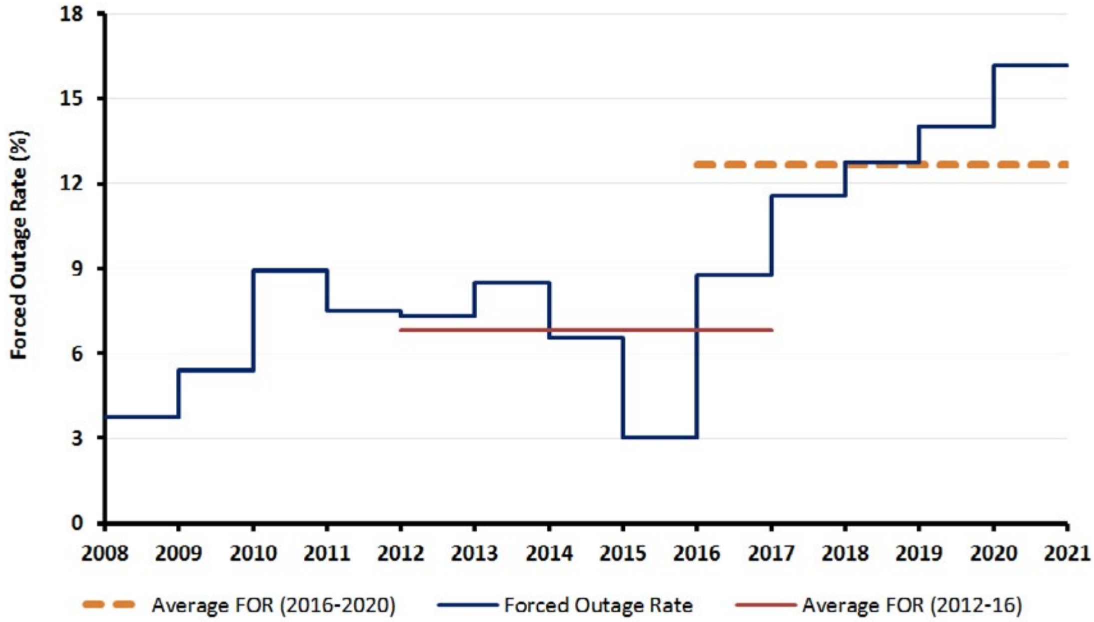


Figure 28 - Average annual system-wide Forced Outage Rates in Ireland for each of the past 12 years (solid lines in navy blue), and also across 2016-2020 (Dashed Orange) and 2012-2016 (Solid Red)

For comparison, see the system-wide average Forced Outage Rates in Northern Ireland in Figure 29.

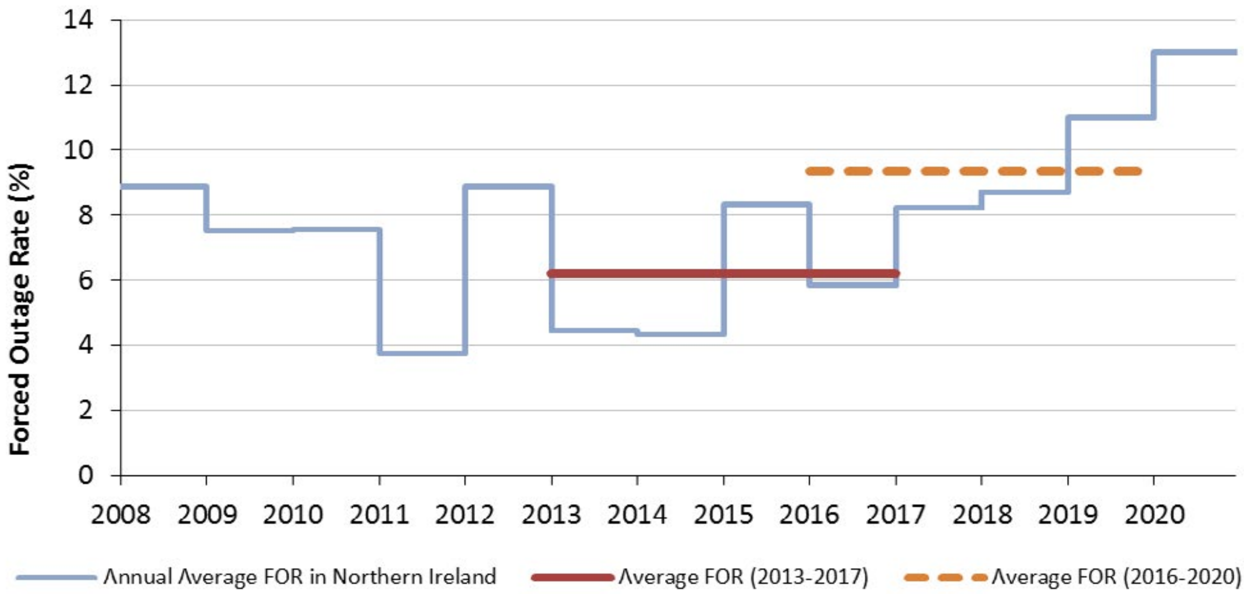


Figure 29 - Average annual system-wide FOR in Northern Ireland for each of the past 10 years (solid lines in light blue), and also across 2016-2020 (Dashed Orange) and 2013-2017 (Solid Red)

In Ireland and Northern Ireland there has been a deterioration of unit availability over the last two years. In particular, the continued deterioration of conventional plant unit availability in both Ireland and Northern Ireland was observed across 2020, as highlighted in Figure 30. This highlights the possibility of a low availability year occurring and we have analysed this in one of our adequacy scenarios.

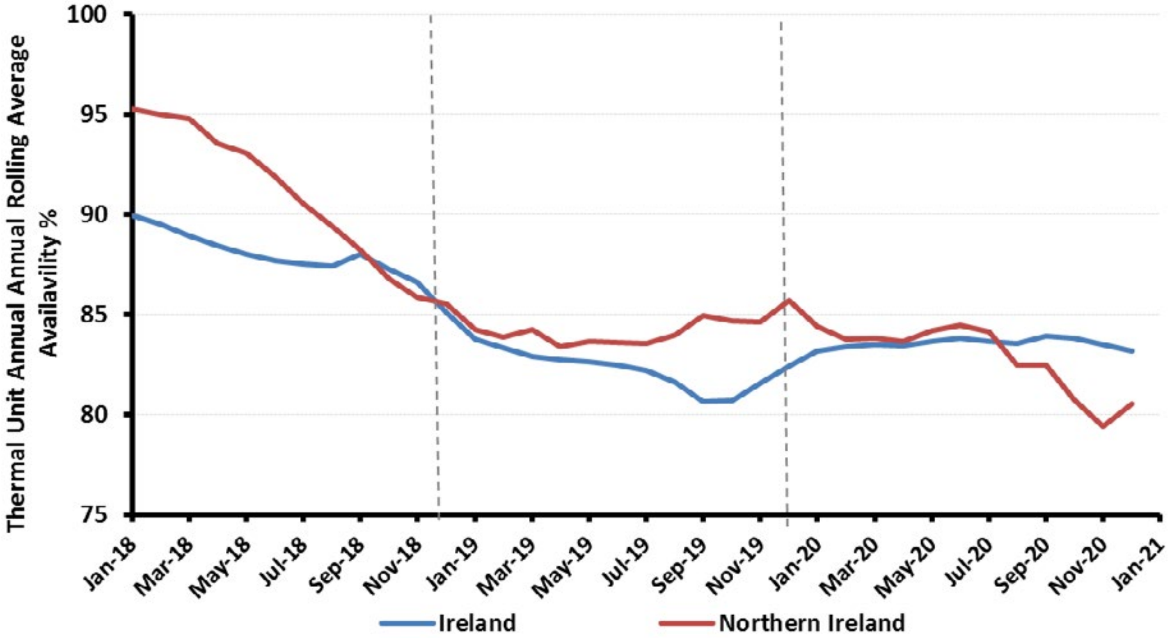
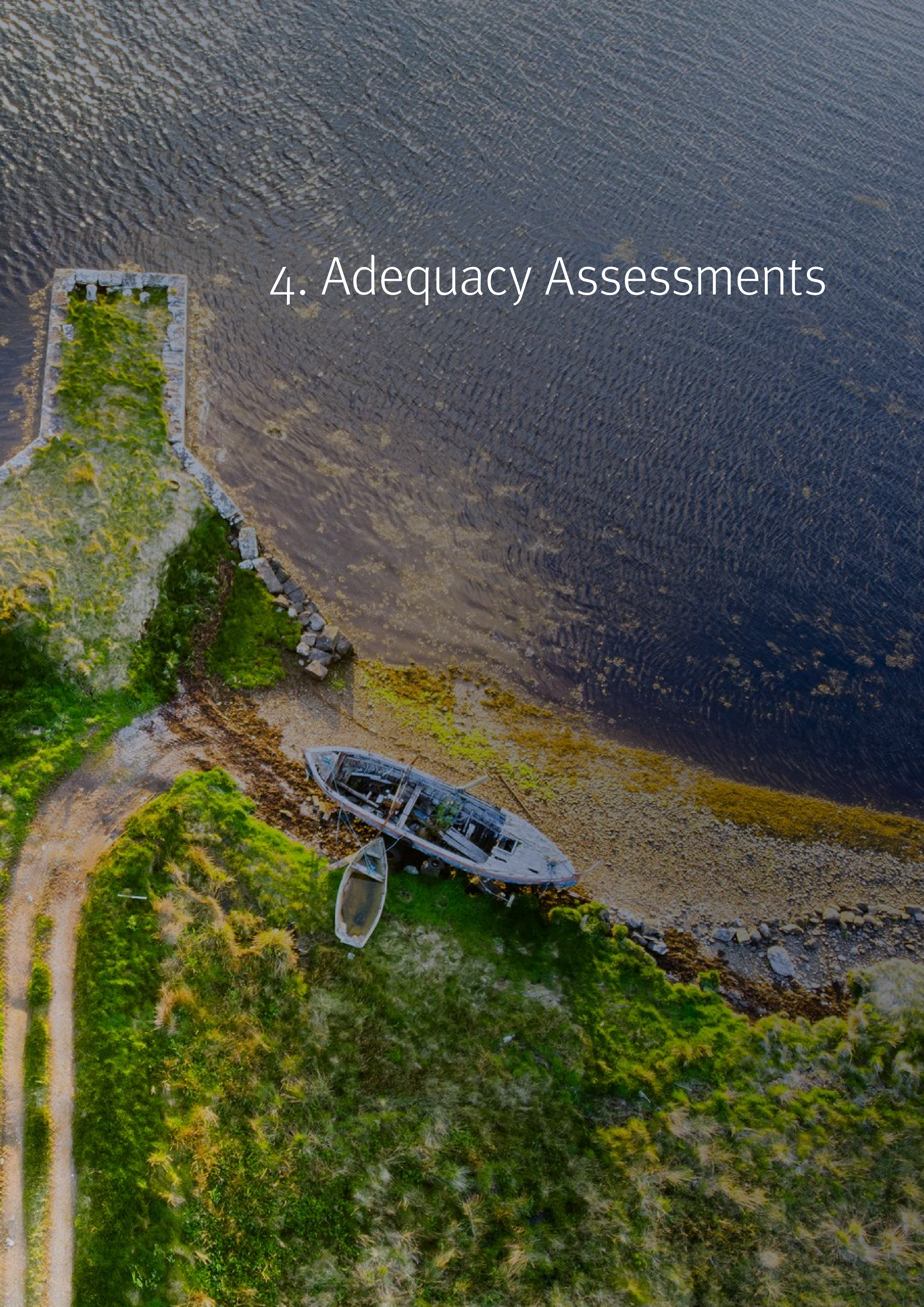


Figure 30 - Ireland and Northern Ireland Conventional Unit Availability

4. Adequacy Assessments



4. Adequacy Assessments

4.1. Introduction

Security of supply is a high priority for EU Member States, National Regulatory Authorities (NRAs) and Transmission System Operators (TSOs). Under current EU legislation[70] there is an obligation on each Member State to monitor the security of electricity supply within their territory over the medium to long-term and each member state is entitled to set and monitor the level of Security of Supply deemed appropriate for its own needs. EU Member states have the responsibility to comply with the requirements of the EU Target Model. In Ireland, the TSO is charged[71] with reporting and advising on security of supply in electricity through adequate planning and operation of transmission capacity.

At present, the generation security standard is evaluated for the SEM as a whole, as well as separately for Ireland and Northern Ireland, using the following security standards:

- SEM: 8 hours LOLE
- Ireland: 8 hours LOLE
- Northern Ireland : 4.9 hours LOLE

We study generation adequacy in order to assess the balance of supply and demand in the future. The assumptions made in the last two chapters for supply and demand are now brought together in our adequacy assessments. Detail on the methodology we employ is given in APPENDIX 3.

Studies are carried out in three different ways:

- for Northern Ireland alone,
- for Ireland alone, and
- for both jurisdictions combined, i.e. on an All-Island basis.

In this section, we describe the setup of each scenario and present the results of the adequacy studies in graphical format. Tables of the results are to be found in APPENDIX 4.

It is important to acknowledge the shifting nature of adequacy year-on-year. As a result this document is updated annually.

4.2. Assumptions

In our adequacy studies, we assume the following:

- The adequacy standard is set at 8 hours LOLE per year for Ireland and in the All-Island case. Ireland only study assumes a 100 MW capacity reliance on Northern Ireland.
- For Northern Ireland, the standard is 4.9 hours LOLE and assumes a 200 MW capacity reliance from Ireland.
- Wind, Solar, Interconnectors, DSU and battery modelling is based on a simplified methodology using de-rated capacity credit equivalent values.
- The portfolio excludes generation capacity that has notified us that they will be not available.
- AdCal was developed mainly for conventional plant and pumped storage units, such as Turlough Hill, and does not capture the variability of renewable energy sources, DSUs/batteries or Interconnectors.

70 Directive 2003/54/EC and EU Directive 2005/89/EC
71 Statutory Instrument 60 of 2005

- Adcal looks at capacity adequacy and does not account for network related issues. i.e. if we only procure capacity to 8 hours LOLE it may not comply with the EirGrid Transmission Planning Standards and Operational Security Standard.
- The assessments were carried out for low, median and high demand scenarios. We also include a scenario at the 8th level demand forecast[72] for Ireland.
- The availability statistics match those used in the Capacity Market auction, i.e. 5-year average values for each technology category unless otherwise stated for sensitivity study purposes.
- The de-rating factor for the undersea interconnectors EWIC and Moyle used a 60% external market de-rating factor plus appropriate forced and scheduled outage statistics from the CRM Capacity Auction process. The adequacy results are given in MW as a surplus (+) or deficit (-) of perfect plant (plant that is 100% available).

4.3. Adequacy Results for Ireland

The Ireland system starts in a position of surplus, as shown in Figure 31. This is eroded as the demand forecast increases with each passing year and some generation plant is assumed to shut. If the 8th demand level is assumed, significant deficits are expected from 2026. Deficits may occur earlier if contracted generation yet to be constructed fails to materialise or if existing contracted generation decommissions earlier than anticipated.

To meet Dublin specific security of supply issues, from the SEM T-4 2022/2023 auction, a Dublin regional location requirement has been included. This is to meet the expected demand growth specific to the Dublin region. Without this locational requirement, EirGrid would see operational constraints and issues on the network due to generation being further away from the concentrated demand.

EirGrid also looks at the effects of the generators having low availability, i.e. five years' of availability data was assessed and the worst availability year identified - the availability of each unit in this year is used for the low availability scenario. 2019 proved to be the year with the lowest availability statistics. This applies to all generation units, except for the DSUs and batteries – for whom availability for adequacy purposes is kept at 30%. The adequacy situation deteriorates when using these low availability statistics with deficits occurring from 2024 with a median demand level.

The final scenario that we looked at is one in which new generation from the SEM CRM auctions are delayed by a one year period in the Median demand scenario.

You can see below how the adequacy situation changes over the next ten years in Figure 31. This demonstrates the need for new low-carbon plant to be commissioned from 2024/2025 with only the low demand scenario remaining in surplus.

These adequacy results include new generation which were awarded a contract in the SEM T-4 2024/25 capacity auction.

Ireland starts in a position of generation surplus in 2021 based on an 8hr LOLE standard. Thereafter, some generation plant is assumed to no longer be available as outlined earlier in this report. By 2025, all scenarios except the Low demand scenario are below the security standard for the region leading to deficits. If the Median demand with 2019 low availability statistics occurred then the system would be in deficit from 2024. Only the Low demand scenario remains in surplus for the full duration of the studies. Adequacy studies results for Ireland are listed in Table 17. A further sensitivity for winter 2021 is included; median demand, low availability plus outage of 2 large units for the current calendar year 2021. Based on this winter 2021 sensitivity there is a deficit of 280 MW. For the next winter period 2021, EirGrid provide further information on Ireland's security of supply status through the Winter Outlook report.

72 Demand Level 8 was selected in the 2024/25 T-4 Capacity Market auction using a Least-Worst Regrets analysis. It is recalculated for each Capacity Market auction, which could result in different demand levels being selected in future.

Table 17 - Results of adequacy studies for Ireland, given in MW of surplus plant (+) or deficit (-)

Core Scenarios	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Low Demand	900	880	1110	700	830	180	220	270	260	210
Median Demand	810	680	860	390	470	**-250**	**-260**	**-260**	**-310**	**-400**
Demand level 8	740	580	760	260	300	**-440**	**-490**	**-510**	**-580**	**-680**
High Demand	700	490	650	130	150	**-620**	**-690**	**-730**	**-820**	**-930**
Sensitivities										
Median Demand, Low Availability	400	270	440	**-60**	40	**-420**	**-430**	**-430**	**-480**	**-570**
Median Demand, Low Availability, Outage of two large units in 2021.	**-280**[73]	270	440	**-60**	40	**-420**	**-430**	**-430**	**-490**	**-570**

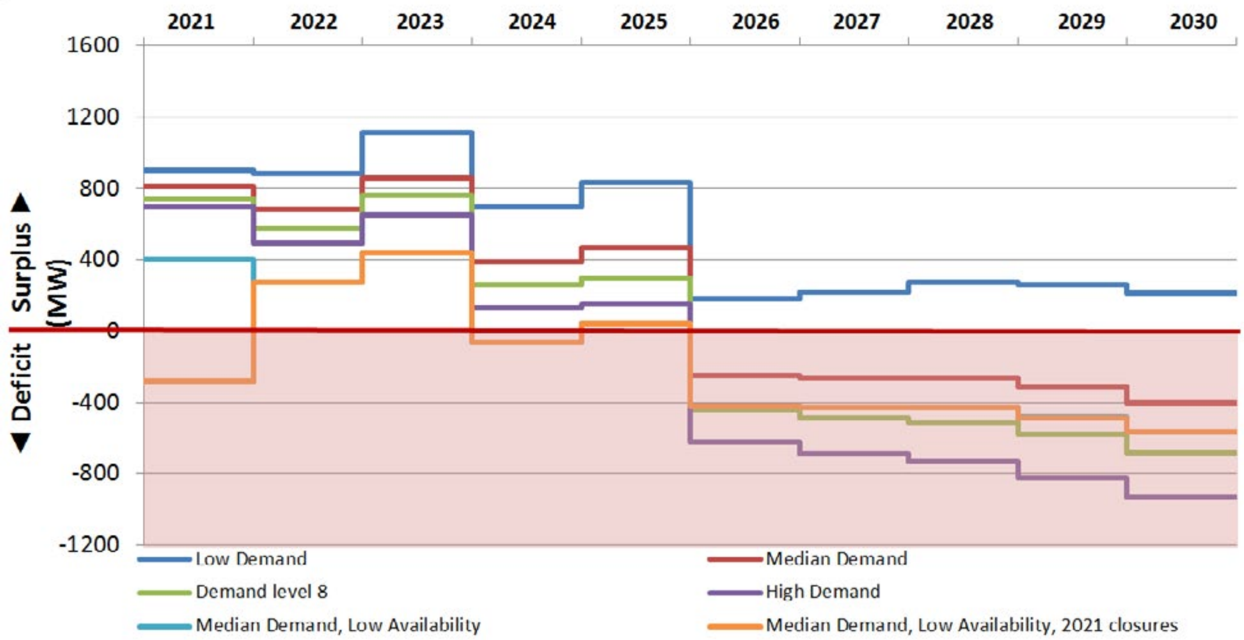


Figure 31 - Adequacy results for Ireland, in terms of surplus or deficit of plant

73 Parameters consistent with 20/21 in Table 20. GCS modelling approximations used for demand and generation Jan to Dec, as relevant for the winter 2021 scenario.

Ireland Only - Security of Supply Risk Studies

Relative to the Generation Capacity Statement 2020-2029, a number of factors have exacerbated the adequacy position in Ireland over the last 12 months:

- **Demand**
  Strong demand growth of around 140 MW/year in median forecast for the 2020 to 2025 periods, primarily due to large energy users such as data centres.

- **Generator Availability**
  The availability of a number of existing generators, including those expected to decommission in the coming years, has been reducing over the past number of years, In addition to this is the low de-rating factor applying to time-limited plant currently. Greater adequacy contribution of time-limited plant could be possible if operational performance improvements are made.

- **Forecasted new generation will no longer be available**
  New generation that had previously cleared in the capacity market auctions has been withdrawn by a developer. In particular 240 MW in the Dublin region which was due to connect in October 2022. Subsequent to the freeze date, an additional 210 MW of capacity has issued termination notices.

- **Uncertainty in new capacity being available on time**
  Additional new capacity projects that were forecasted for delivery by October 2022 have been granted extension to their first delivery milestones, in 2020, due to a number of issues. This means that the final delivery milestone of October 2022 is at risk.

- **Emissions Limits**
  Fossil fuel generation with high CO_2 emissions has been excluded from the capacity market from October 2024 because the plant will exceed EU emission limits. In the absence of having a capacity contract these plant may seek to close earlier than expected.

The capacity auction for the period 01 October 2024 to 30 September 2025 was ran at the end of January 2021. Insufficient capacity was successful in the auction and the recent withdrawal of NW4 and 5 units procured in the T-4 22/23 auction means there is a significant capacity shortfall against security standards for Ireland from 2024/2025.

EirGrid expects the number of system alerts may increase over the coming winters as capacity exits and demand increases. Approximately 1,650 MW of rated capacity is due to exit the market over the coming years (based on the assumption that the Industrial Emission Directive or planning permission conditions closes Tarbert, Edenderry, Moneypoint and an Aghada unit). In parallel with this the total demand is forecasted to grow significantly over the next decade.

Due to these factors, further adequacy studies were carried out to assess a selection of potential scenarios in order to greater understand the security of supply risk to Ireland.

For all studies presented below, unless otherwise stated, assume an 8hrs LOLE Adequacy Standard, median demand with all three Moneypoint units unavailable from October 2024 and 5 year system availability averages. A security of supply sensitivity has been highlighted in Table 18; a low availability (2019 historical values) median demand scenario, this scenario is reflective of an operational position similar to 2020/2021. Further analysis by EirGrid shows that operational requirements should be included in the security of supply assessment; this includes 375 MW to cater for reserves and a further 350 MW to facilitate transmission outage planning.

Over the course of the current capacity year 20/21 a number of transmission outages have been cancelled due to very low generation margins. Table 18 shows a small deficit for the 20/21 capacity year, reflecting the tight margins of the past winter.

Table 18 gives an overview of the various security of supply studies carried out to understand the capacity requirement for the capacity years 22/23, 23/24 and 24/25. The sensitivities cover the various uncertainties and risks such as non-delivery of the expected new capacity; uncertainty in demand, and future power plant performance.

Table 18 - Security of Supply Scenarios - Ireland

SOS STUDIES[74]										
Scenario	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**	**26/27**	**27/28**	**28/29**	**29/30**
Median Demand	800	700	880	340	**-170**	**-230**	**-240**	**-240**	**-290**	**-380**
Median Demand, present low availability	430	310	480	**-60**	**-350**	**-410**	**-420**	**-420**	**-470**	**-560**
8th Demand, present and future low availability	360	200	380	**-190**	**-710**	**-800**	**-840**	**-860**	**-940**	**-1030**
8th demand, low availability, 22/23 Capacity Delay/ Termination	360	200	120	**-450**	**-940**	**-1030**	**-1070**	**-1090**	**-1170**	**-1260**
Operational Reserve Requirement	**-20**	**-180**	**-260**	**-830**	**-1320**	**-1410**	**-1450**	**-1470**	**-1550**	**-1640**
Transmission Outage Planning Requirement	**-20**	**-180**	**-260**	**-1180**	**-1670**	**-1760**	**-1800**	**-1820**	**-1900**	**-1990**

Subsequent to the work undertaken in preparing the Generation Capacity Statement, EirGrid TSO has undertaken further Security of Supply studies that include additional sensitivities related to the risk of termination of new capacity. These studies highlight the need to retain Operating Reserves of 375 MW and plan for 8th decile demand, but delay the provision for Transmission Outage Planning to the 24/25 capacity year. Consequently, Eirgrid TSO recommends making available the following capacity for Ireland over the capacity years 22/23 to 24/25. 260 MW of de-rated capacity is required by October 2022, increasing to 1050 MW of de-rated capacity by October 2023 and to 1850 MW of de-rated capacity by October 2024, so that the power system complies with the 8 Hour LOLE standard and operational requirements in line with the Transmission Planning and System Security Standards and Operating Security Standards. Short term as well as longer-term measures to address this capacity requirement are being considered with the CRU.

74 For the security of supply studies a simplified modelling methodology is employed whereby annual Jan-Dec demand forecasts are assessed against capacity changes on an Oct –to Sept basis. This approach allows the greater proportion of the demand year to be assessed against the available capacity for each year.

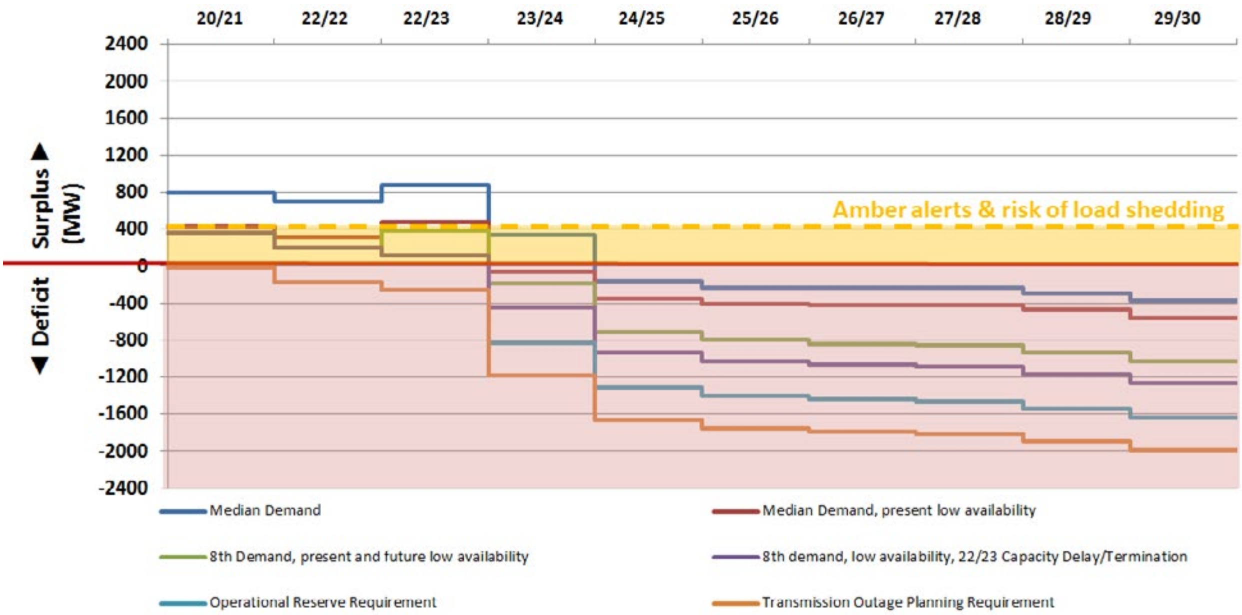


Figure 32 - Sensitivity Study Adequacy results for Ireland, in terms of surplus or deficit of plant

Factors to consider when assessing the management of Security of Supply, Operational requirements and Uncertainties

The transition to low-carbon and renewable energy will have widespread consequences. There will be major changes in how electricity is generated, and in how it is bought and sold. There will also be major changes in how electricity is used, such as for transport and heat. The electricity system will carry more power than ever before and most of that power will be from renewable sources. Coal, peat and oil-based generation will be phased out in the next decade. These changes will need to be managed in a coordinated and cost-effective way. The approaches for grid development are the focus of the recent Shaping our Electricity Future study[75].

EirGrid believes new cleaner, dispatchable plant is required to replace generation exiting the market between now and 2030 in Ireland. In the future, a more diverse portfolio of technologies will be required. Traditionally, there was a reliance on conventional generation to provide the full range of services and capabilities, while in the future, with less conventional generation synchronised at times of high variable RES output, the services must come from other technologies, which typically provide a subset of the required system services. New cleaner gas fired capacity will be part of the solution to manage future power system adequacy and security especially at times when the wind and solar output levels are low and for what may be extended periods of time.

In order to meet the 8 hour LOLE standard the realities in the operation of the transmission system must be factored in. These realities include the need to provide for reserves for when plant is not available,to manage the power system in the event of a contingency and the need to be able to take outages of elements of network equipment, particularly outages for the connection of new customers. These requirements are in line with the Transmission Planning and System Security Standards and Operating Security Standards as approved by the Commission and must be factored in to the overall capacity requirement.

75 https://www.eirgridgroup.com/site-files/library/EirGrid/Full-Technical-Report-on-Shaping-Our-Electricity-Future.pdf

When assessing system adequacy EirGrid needs to consider a wide range of assumptions and uncertainties, they are as follows:

Assumptions on retirement of ageing plant due to climate action plan requirement, restriction from industrial emissions directives and other planning related issues
Between now and 2025 a total of 1655 MW of rated capacity is due to retire.

The level of demand to be forecast out to 2030 – Steady growth of demand driven by large energy users and data centres plus the potential demand impact of electric vehicles and heat pumps on the system
In Ireland, at present there is around 1700 MVA of connected and contracted large energy user and data centres. These customers are connected to the transmission system or to the distribution system. The typical load currently drawn by these customers is approximately 30% of their contracted Maximum Import Capacity (MIC), but each of the users has an expected growth rate projected into the future. The GCS 2021-2030 peak demand forecast predicts an average increase of around 140 MW/year in overall demand between 2020 and 2025.

In addition, the 2030 demand scenario assumes some level of smart charging for EVs will be in place. In scenarios with high uptake of electric vehicles, optimisation of charging demand is required to ensure that the need for grid development and additional generation capacity is minimised. The Tomorrow's Energy Scenarios 2019 report[76] highlights the benefits of smart EV charging technologies; which, if employed, have the potential to supress system peak demand growth by between 170 MW and 480 MW respectively, compared to simple or no smart EV charging. Based on the Tomorrow's Energy Scenarios 2019 analysis, around 500 MW of de-rated capacity is needed if smart EV charging is not developed by 2030. The average size of CCGTs is approximately 400 MW, this insight helps to frame the potential benefits of smart vehicle charging technology.

The core adequacy studies carried out in the GCS are based on median demand forecast but it may be more prudent to plan for a higher level of demand (7^{th} or 8^{th} decile) eventuating consistent with the overall Least-Worst Regrets analysis which underpins the methodology in the Capacity Market[77]. This factor would relate to c. 100 MW-150 MW of additional de-rated plant.

Trends in low power plant availability continue to prevail
In Ireland and Northern Ireland there has been a continued deterioration of unit availability over the past three years. In particular, the considerable deterioration of conventional plant unit availability in both Ireland and Northern Ireland was observed across 2019 and 2020. The core GCS adequacy studies use 5 year average system performance statistics. However, when recent deterioration in system performance is considered, the adequacy position is negatively impacted. Low availability studies show an additional 200 to 450 MW of de-rated plant is required across the study horizon to meet standards. Low availability studies help capture poor performance in respect of a number of units, perhaps most notably Moneypoint. Should the level of availability of the existing generation fleet improve then the adequacy position of the system would improve.

Uncertainty with new capacity becoming available on time
Approximately 650 MW of new de-rated capacity is assumed in our studies to be available by 2024, with a further 110 MW of de-rated capacity by 2025. If this new capacity is not available then the adequacy position would be worse for a given year by the decrease in de-rated capacity.

76 http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-TES-2019-Report.pdf
77 https://www.semcommittee.com/sites/semc/files/media-files/SEM-18-030a%20Appendix%20A%20TSO%20Capacity%20Requirement%20and%20De-rating%20Factors%20Methodology%20June%202018.pdf

Variable RES
Variable RES (mainly wind) is given a credit of c. 500 MW for 2023/24 as part of the overall capacity assessment. If this wind is not available for a lengthy period, then the adequacy standard would not be met.

Interconnection Availability
Interconnection support from GB to Ireland is given a credit of 250 MW for 2023/24 as part of the overall capacity assessment. GB has a similar decarbonisation goal as Ireland with a significant transition of plant. When our system margins are low this typically coincides with the GB having low margins.

NI Reliance
A reliance of 100 MW is assumed from Northern Ireland to Ireland, there is a risk that when system margins are low in Ireland that the same conditions will prevail in Northern Ireland.

The assumptions on power plant retirement and identified uncertainties present credible risks to system adequacy unless mitigating measures are put in place. Failure to deliver on new capacity, or an extended period of low renewable output could present significant challenges. Further mitigating measures may be required should new capacity fail to deliver on time for a given capacity year.

4.4. Adequacy Results for Northern Ireland

Figure 33 shows a graphical representation of the adequacy studies' results for Northern Ireland over the ten years of the study.

There are separate traces for the low, median and high demand scenarios. The median demand scenario is shown to be in surplus of, on average, over 400 MW for the full duration of the studies. This is based on the timely delivery of the new generation that was successful in the 2023/24 T-4 capacity auction from the start of 2024 and the generation that was successful in the 2024/25 T-4 capacity auction from the start of 2025. It is also based on full availability of the new generation. Kilroot ST1 and ST2 did not qualify for inclusion in the T-4 2023/24 auction in April 2020 and EPUKI has indicated these units will cease operation in 2023.

Furthermore, in order to meet the 4.9 hour LOLE standard in Northern Ireland, SONI must factor in the realities in the operation of the transmission system. For Northern Ireland SONI expect a 200 MW surplus to cater for operational requirements such as reserve.

The capacity auctions have secured enough Northern Ireland-based generation to ensure near-term security of supply. However, the second North-South Interconnector, as with existing interconnection to Great Britain, remains vital for medium to long-term security – something which is critical to business and domestic consumers in Northern Ireland.

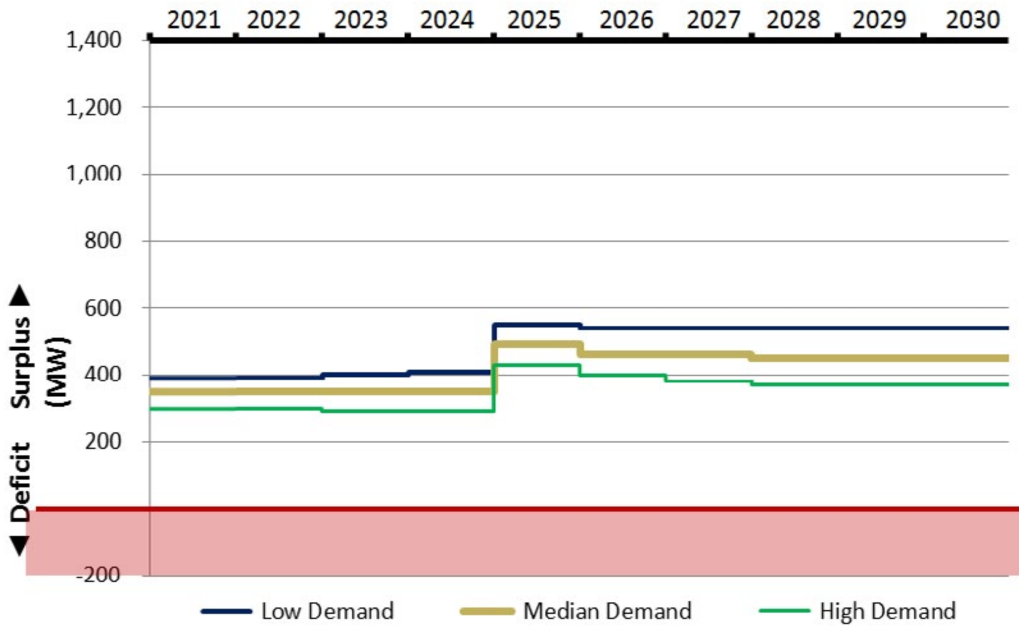


Figure 33 - Adequacy results for Northern Ireland, in terms of surplus or deficit of plant. Results are given for the low, median and high demand scenarios.

Table 19 - Results of adequacy studies for Northern Ireland, given in MW of surplus plant (+) or deficit (-)

Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Median Demand	350	350	350	350	490	460	460	450	450	450
Low Demand	390	390	400	410	550	540	540	540	540	540
High Demand	300	300	290	290	430	400	380	370	370	370

Furthermore SONI has completed a range of adequacy sensitivity studies to assess the risk to security of supply in Northern Ireland. The studies presented provide an indication of Northern Ireland's adequacy position based on a range of credible risk, low plant availability, delay to contracted capacity, loss of interconnection support, an outage of Coolkeeragh (C30) and a sensitivity that considers a run hour limit on the new capacity at Kilroot.

Table 20 shows how individual sensitivities impact Northern Ireland's surplus/deficit position.

- A scenario assuming low availability of the generating units (based on 2019 availabilities) reduces the surplus by 200 – 300 MW across the 10 years compared to the median scenario.
- Interconnection support from Ireland, in this scenario the overall surplus is reduced by 200 MW, this a credible operational risk given the capacity issues highlighted in the Ireland's security of supply studies, further details in section 4.3.
- A scenario that includes a long term outage of a large Northern Ireland unit reduces surplus by 200 – 300 MW across the 10 years.
- An annual 1500 running hour restriction on the new Kilroot gas capacity highlights that capacity surplus reduces below 125 MW by 2024, and go into deficit by 2026 under a scenario where the Kilroot GTs retire (c 142 MW).

For all sensitivity studies presented in Table 20, unless otherwise stated, assume a 4.9hrs LOLE Adequacy Standard, Median demand and five year system availability averages.

Table 20 - Security of Supply Scenarios – Northern Ireland

Sensitivity on Median Demand	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Low System Availability	80	80	80	80	160	140	130	130	130	130
One Year Late Delivery of New Contracted CRM	350	350	350	20	350	460	460	450	450	450
Loss of Ireland Support	150	150	150	150	290	260	260	250	250	250
C30 unavailable one year	90	90	90	90	200	170	170	160	160	160
New Kilroot GTs Running Limitation	350	350	350	110	130	110	100	100	100	100
New Kilroot GTs Running Limitation + KGTs Retire from 2025	350	350	350	110	0	**-30**	**-30**	**-40**	**-40**	**-40**

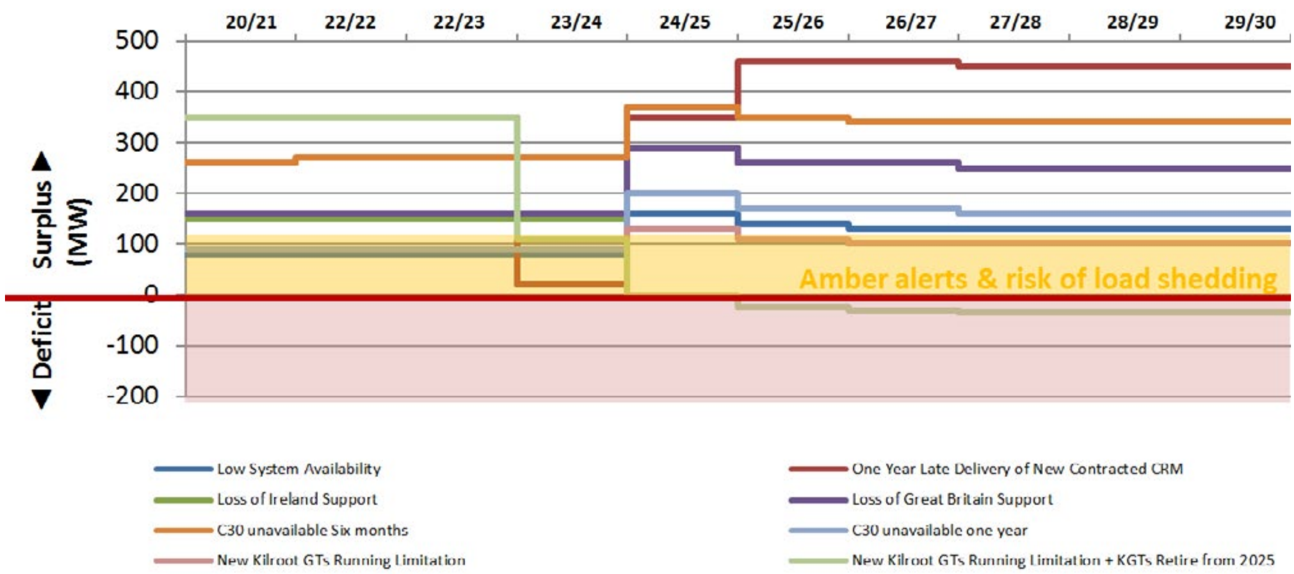


Figure 34 - Security of Supply Adequacy Scenarios – Northern Ireland

4.5. Adequacy Results for the All-Island System

Adequacy studies are carried out on an All-Island basis, which assumes that the second North-South Interconnector is available. The second North South Interconnector is assumed to be commissioned during 2025 and become fully operational by 2026.

In the All-Island case, the surplus for any particular year is greater than the sum of the two separate jurisdictional studies. This capacity benefit demonstrates some of the advantages of the second North-South Interconnector. In addition to long term security of supply the North-South Interconnector will support the decarbonisation of the power system across the island by facilitating 900 MW more of renewable electricity (enough to power 600,000 homes). It will remove constraints on the all-island grid, maximising the benefits of the SEM. This will result in initial savings to consumers across the island of c. €/£20million per year, with those savings rising as more renewable energy is brought onto the system.

Figure 35 shows the All-Island adequacy results for different scenarios. All scenarios see reducing surpluses over time, due to long term demand increasing and assumed plant closures. The High Demand scenario show deficits from 2027, the Demand level 8 with Low Availability scenario shows deficits from 2028, and the Demand level 8 scenario shows deficits from 2030. If capacity is unsuccessful in the future SEM capacity auctions, or any other plant becomes unavailable then further deficits could occur.

The Low and Median Demand Scenarios remain in surplus for the full time period of the study.

These adequacy results include new generation which were awarded a contract in the SEM T-4 2024/25 capacity auction held in January 2021.

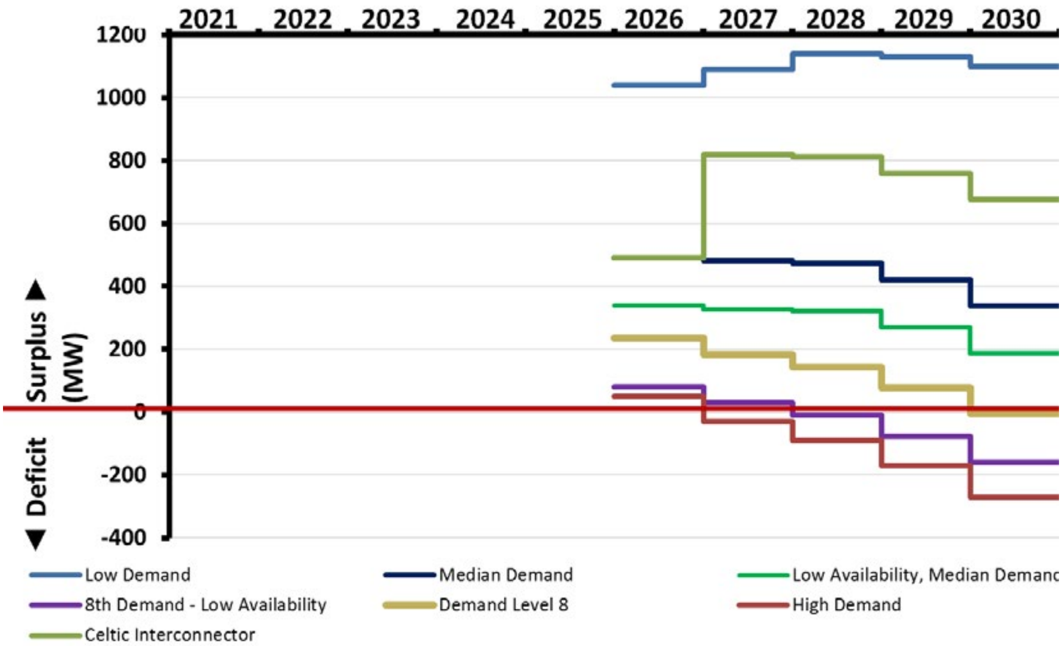
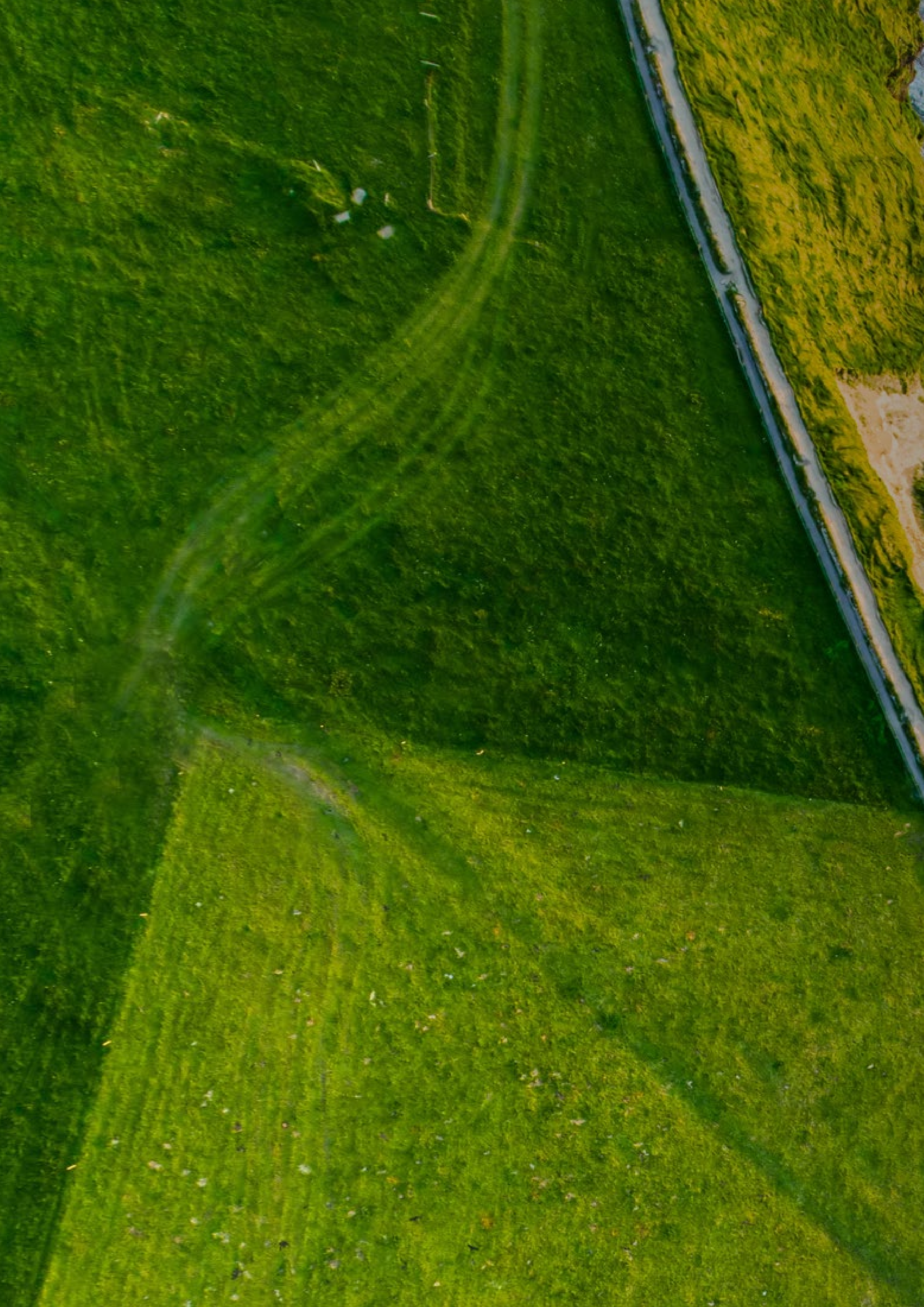


Figure 35 - Adequacy results for the All-Island system

Table 21 - Results of adequacy studies for the All-Island system (MW)

Scenario	2026	2027	2028	2029	2030
High Demand	50	**-30**	**-90**	**-170**	**-270**
Demand level 8	240	180	140	80	**-10**
Median Demand	490	480	480	420	340
Low Demand	1,040	1,090	1,140	1,130	1,100
Low Availability - Median Demand	340	330	320	270	190
Low Availability - 8th Demand	80	30	**-10**	**-80**	**-160**
Celtic Interconnector – Median Demand	490	820	810	760	680



Appendices

Appendix 1 Demand Scenarios

Table A-1 - The Median Demand Forecast, given in Calendar year format (including a correction to 366 days in each Leap year), for Total Electricity Requirement (TER). TER is the total electricity required by the region, i.e. it includes all electricity produced by large-scale, dispatchable generators, all small-scale exporting generators, and an estimate of electricity produced by self-consuming generators. *Figure is provisional

Median	Calendar year TER (TWh)						TER Peak (GW)			Transmission Peak (GW)		
Year	Ireland		Northern Ireland		All-Island		Ireland	Northern Ireland	All-Island	Ireland	Northern Ireland	All-Island
2020	30.8	1.3%	8.3	-4.3%	39.1	0.1%	5.48	1.68	7.10	5.36	1.65	6.98
2021	32.1	4.2%	8.4	1.0%	40.5	3.5%	5.65	1.68	7.26	5.54	1.65	7.14
2022	33.3	3.8%	8.5	0.9%	41.8	3.2%	5.84	1.68	7.45	5.72	1.65	7.33
2023	34.7	4.3%	8.5	0.4%	43.2	3.5%	5.97	1.69	7.57	5.85	1.66	7.45
2024	35.8	3.1%	8.6	0.4%	44.3	2.5%	6.07	1.70	7.69	5.96	1.67	7.57
2025	36.4	1.9%	8.6	0.4%	45.0	1.6%	6.16	1.72	7.79	6.05	1.68	7.67
2026	37.5	2.8%	8.6	0.5%	46.1	2.4%	6.26	1.73	7.89	6.14	1.69	7.77
2027	38.4	2.4%	8.6	0.2%	47.0	2.0%	6.34	1.74	7.99	6.22	1.70	7.87
2028	39.3	2.5%	8.7	0.2%	48.0	2.1%	6.41	1.75	8.09	6.30	1.71	7.97
2029	40.1	1.9%	8.7	0.2%	48.8	1.6%	6.49	1.75	8.18	6.37	1.71	8.06
2030	40.9	2.1%	8.7	0.1%	49.6	1.7%	6.57	1.75	8.27	6.45	1.71	8.15

Table A-2 - Low Demand Forecast

Low	Calendar year TER (TWh)						TER Peak (GW)			Transmission Peak (GW)		
Year	Ireland		Northern Ireland		All-Island		Ireland	Northern Ireland	All-Island	Ireland	Northern Ireland	All-Island
2020	30.8	1.3%	8.3	-4.3%	39.1	0.1%	5.48	1.68	7.10	5.36	1.65	6.98
2021	31.6	2.6%	8.1	-2.7%	39.7	1.5%	5.54	1.64	7.10	5.43	1.60	6.98
2022	32.2	2.0%	8.2	1.0%	40.4	1.8%	5.59	1.63	7.15	5.48	1.60	7.03
2023	33.4	3.6%	8.3	1.0%	41.6	3.1%	5.62	1.63	7.16	5.50	1.59	7.05
2024	34.1	2.1%	8.4	1.0%	42.4	1.9%	5.65	1.62	7.19	5.53	1.59	7.07
2025	34.5	1.1%	8.4	0.0%	42.8	0.9%	5.67	1.62	7.21	5.55	1.58	7.09
2026	35.0	1.6%	8.4	0.0%	43.4	1.3%	5.69	1.62	7.24	5.58	1.58	7.12
2027	35.5	1.5%	8.4	0.0%	43.9	1.2%	5.72	1.62	7.27	5.60	1.58	7.15
2028	36.2	1.8%	8.4	0.0%	44.5	1.5%	5.75	1.62	7.30	5.63	1.58	7.18
2029	36.6	1.2%	8.4	0.0%	45.0	1.0%	5.78	1.62	7.33	5.66	1.58	7.22
2030	37.1	1.4%	8.4	0.0%	45.5	1.1%	5.81	1.62	7.36	5.69	1.58	7.25

Table A-3 - High Demand Forecast

High	Calendar year TER (TWh)						TER Peak (GW)			Transmission Peak (GW)		
Year	Ireland		Northern Ireland		All-Island		Ireland	Northern Ireland	All-Island	Ireland	Northern Ireland	All-Island
2020	30.8	1.3%	8.3	-4.3%	39.1	0.1%	5.48	1.68	7.10	5.36	1.65	6.98
2021	32.6	5.8%	8.7	4.2%	41.3	5.5%	5.80	1.75	7.46	5.68	1.71	7.35
2022	34.4	5.8%	8.8	1.0%	43.2	4.8%	5.95	1.76	7.63	5.84	1.72	7.52
2023	36.6	6.2%	8.9	1.5%	45.5	5.3%	6.19	1.76	7.86	6.07	1.73	7.74
2024	38.4	4.9%	9.0	1.5%	47.4	4.3%	6.38	1.77	8.03	6.26	1.74	7.91
2025	39.6	3.1%	9.2	1.5%	48.8	2.8%	6.53	1.78	8.19	6.41	1.74	8.07
2026	41.0	3.7%	9.3	1.5%	50.4	3.3%	6.66	1.80	8.34	6.54	1.76	8.22
2027	42.5	3.5%	9.4	1.0%	51.9	3.1%	6.79	1.82	8.50	6.67	1.78	8.38
2028	44.1	3.7%	9.5	1.0%	53.6	3.2%	6.93	1.83	8.65	6.81	1.80	8.53
2029	45.3	2.8%	9.5	0.0%	54.8	2.3%	7.05	1.83	8.77	6.93	1.80	8.65
2030	46.5	2.6%	9.5	0.0%	56.0	2.2%	7.16	1.83	8.87	7.04	1.80	8.75

Appendix 2 Generation Plant Information

Table A-4 - Registered Capacity of dispatchable generation and interconnectors in Ireland in 2021 (MW) DSU: Demand Side Unit; HFO: Heavy Fuel Oil; DO: Distillate Oil

	ID	Fuel Type	Technology Category	2021	Comment
Aghada	AT1	Gas/DO	Gas Turbine	90	To close before end of 2023
	AT2	Gas/DO	Gas Turbine	90	
	AT4	Gas/DO	Gas Turbine	90	
	AD2	Gas/DO	Gas Turbine	431	
All DSU	DSU	DSU	DSU	540	
Ardnacrusha	AA1-4	Hydro	Hydro	86	
Dublin Bay	DB1	Gas/DO	Gas Turbine	415	
Dublin Waste	DW1	Waste	Steam Turbine	61	
Edenderry	ED1	Milled peat/ biomass	Steam Turbine	118	Current Planning Permission runs out at the end of 2023
	ED3	DO	Gas Turbine	58	
	ED5	DO	Gas Turbine	58	
Erne	ER1-4	Hydro	Hydro	65	
EWIC	EW1	DC Interconnector		500	
Great Island CCGT	GI4	Gas/DO	Gas Turbine	464	
Huntstown	HNC	Gas/DO	Gas Turbine	337	
	HN2	Gas/DO	Gas Turbine	408	
Indaver Waste	IW1	Waste	Steam Turbine	21	
Lee	LE1-4	Hydro	Hydro	27	
Liffey	LI1-4	Hydro	Hydro	38	
Moneypoint	MP1	Coal/HFO	Steam Turbine	285	Modelled as not available from October 2025
	MP2	Coal/HFO	Steam Turbine	285	Modelled as not available from October 2025
	MP3	Coal/HFO	Steam Turbine	285	Modelled as not available from October 2025
Poolbeg CC	PBA	Gas/DO	Gas Turbine	234	
	PBB		Gas Turbine	234	
Rhode	RP1	DO	Gas Turbine	52	
	RP2	DO	Gas Turbine	52	
Sealrock	SK3	Gas/DO	Gas Turbine	81	
	SK4	Gas/DO	Gas Turbine	81	
Tarbert	TB1	HFO	Steam Turbine	54	To close by end of 2023
	TB2	HFO	Steam Turbine	54	To close by end of 2023
	TB3	HFO	Steam Turbine	241	To close by end of 2023
	TB4	HFO	Steam Turbine	243	To close by end of 2023

Table A-4 - Registered Capacity of dispatchable generation and interconnectors in Ireland in 2021 (MW) DSU: Demand Side Unit; HFO: Heavy Fuel Oil; DO: Distillate Oil

	ID	Fuel Type	Technology Category	2021	Comment
Tawnaghmore	TP1	DO	Gas Turbine	52	
	TP3	DO	Gas Turbine	52	
Turlough Hill	TH1	Pumped storage	Storage	292	
Tynagh	TYC	Gas/DO	Gas Turbine	389	
Whitegate	WG1	Gas/DO	Gas Turbine	450	
Total Dispatchable including DSU				7,313	

Table A-5 - Partially/Non-Dispatchable plant in Ireland (MW)

At year end:	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Wind Onshore	4,500	4,700	4,900	5,100	5,300	5,420	5,540	5,660	5,780	5,900
Wind Offshore	25	25	25	25	25	395	1445	2745	3345	3500
Small Scale Hydro	26	26	26	26	26	26	26	26	26	26
Biomass and Biogas	24	24	24	24	24	24	24	24	24	24
Biomass CHP	30	30	30	30	30	30	30	30	30	30
Industrial	9	9	9	9	9	9	10	11	11	11
Conventional CHP	129	129	129	129	129	129	129	129	129	129
Solar PV	261	384	507	630	692	753	815	877	938	1,000
Total	**5,004**	**5,327**	**5,650**	**5,973**	**6,235**	**6,786**	**8,019**	**9,502**	**10,283**	**10,620**

Table A-6 - All Renewable energy sources in Ireland (MW). We have assumed that the peat plant at Edenderry will be approximately 40-50% powered by biomass by 2020

At year end:	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
All Wind*	4,525	4,725	4,925	5,125	5,325	5,815	6,985	8,405	9,125	9,400
All Hydro	242	242	242	242	242	242	242	242	242	242
Biomass/LFG (including those units registered in the Capacity Market and Biomass CHP)	24	24	24	24	24	24	24	24	24	24
Waste (Assume 50% renewable)	41	41	41	41	41	41	41	41	41	41
Peat Stations on Biomass	59	59	59	0	0	0	0	0	0	0
Solar	261	384	507	630	692	753	815	877	938	1,000
Total	**5,152**	**5,475**	**5,798**	**6,062**	**6,324**	**6,875**	**8,107**	**9,589**	**10,370**	**10,707**

*The wind forecasts past 2021 are not based on exact projects. When more detailed information of exact wind developments occur, this will be included in the forecast.

Table A-7 - Registered Capacity of dispatchable generation and interconnectors in Northern Ireland in 2021 (MW)

	ID	Fuel Type	Technology Category	2021	Comment
Ballylumford	B31	Gas/Heavy Fuel Oil	Gas Turbine	246	
	B32	Gas/Heavy Fuel Oil	Gas Turbine	246	
	B10	Gas/Heavy Fuel Oil	Gas Turbine	101	
	GT7(GT1)	Distillate Oil	Gas Turbine	58	
	GT8(GT2)	Distillate Oil	Gas Turbine	58	
Kilroot	ST1	Heavy Fuel Oil/ Coal	Steam Turbine	238	Ceases operation in 2023.
	ST2	Heavy Fuel Oil/ Coal	Steam Turbine	238	Ceases operation in 2023.
	KGT1	Distillate Oil	Gas Turbine	29	
	KGT2	Distillate Oil	Gas Turbine	29	
	KGT3	Distillate Oil	Gas Turbine	42	
	KGT4	Distillate Oil	Gas Turbine	42	
Coolkeeragh	GT8	Distillate Oil	Gas Turbine	53	
	C30	Gas/Distillate Oil	Gas Turbine	408	
AGU	AGU	Distillate Oil	Gas Turbine	79	
DSU	DSU	Various	DSU	118	
Lisahally		Biomass		18	Not in Capacity Market, but assumed available for capacity requirement
Contour Global	CGA/CGC	Gas	Gas Turbine	12	
Moyle		DC Interconnector		450	
Total Dispatchable plant:				**2,465**	

Table A-8 - Partially/Non-Dispatchable plant in Northern Ireland (MW)

At year end:	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Large Scale Wind	1,095	1,196	1,251	1,274	1,405	1,405	1,405	1,405	1,405	1,405
Small Scale Wind	176	176	176	176	176	176	176	176	176	176
Large Scale Solar	144	165	165	165	165	165	165	165	165	165
Small Scale Solar	124	124	124	124	124	124	124	124	124	124
Small Scale Biogas	24	24	24	24	24	24	24	24	24	24
Landfill Gas	16	16	16	16	16	16	16	16	16	16
Small Scale Biomass	6	6	6	6	6	6	6	6	6	6
Renewable CHP	3	3	3	3	3	3	3	3	3	3
Other CHP	6	6	6	6	6	6	6	6	6	6
Small Scale Hydro	6	6	6	6	6	6	6	6	6	6
Waste-to-Energy	15	15	15	15	15	15	15	15	15	15
Total	**1,615**	**1,737**	**1,792**	**1,815**	**1,946**	**1,946**	**1,946**	**1,946**	**1,946**	**1,946**

Table A-9 - All Renewable energy sources in Northern Ireland (MW)

At year end:	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
All Wind	1,271	1,372	1,427	1,450	1,581	1,581	1,581	1,581	1,581	1,581
All Solar PV	268	289	289	289	289	289	289	289	289	289
All Biomass/ Biogas/LFGas/ WTE	79	79	79	79	79	79	79	79	79	79
Renewable CHP	3	3	3	3	3	3	3	3	3	3
Hydro	6	6	6	6	6	6	6	6	6	6
Total RES	**1,627**	**1,749**	**1,804**	**1,827**	**1,958**	**1,958**	**1,958**	**1,958**	**1,958**	**1,958**

Appendix 3 Methodology

Generation Adequacy Standard

Generation adequacy is assessed by determining the likelihood of there being sufficient generation to meet customer demand. For these purposes customers include Distribution System Operators such as ESB and NIE and some large users, such as data centres who connect directly to the grid. It does not necessarily take into account any limitations imposed by the transmission system, reserve requirements or the energy markets though often these considerations can be incorporated into adequacy calculations by making modifications to the input data-sets.

In practice, when there is not enough supply to meet load, the load must be reduced. This is achieved by cutting off electricity from customers. In adequacy calculations, if there is predicted to be a supply shortage at any time, there is a LOLE for that period. In reality, load shedding due to generation shortages is a very rare event.

LOLE can be used to set an adequacy standard – it is set by the relevant Regulatory Authority. In Ireland the adequacy standard is 8 hours LOLE per annum and Northern Ireland it is 4.9 hours LOLE per annum. If this is exceeded in either jurisdiction, it indicates the system has a higher than acceptable level of risk. The adequacy standard used for All-Island calculations is 8 hours as agreed by the Regulatory Authorities.

With any generator, there is always a risk that it may suddenly and unexpectedly be unable to generate electricity (due to equipment failure, for example). Such events are called forced outages, and the proportion of time a generator is out of action due to such an event gives its forced outage rate (FOR).

Forced outages mean that the available generation in a system at any future period is never certain. At any particular time, several units may fail simultaneously or there may be no such failures at all. There is therefore a probabilistic aspect to supply and to the LOLE.

The model used for these studies works out the probability of load loss for each half-hour period – it is these that are then summed to get the yearly LOLE, which is then compared to the adequacy standard. It is assumed that forced outages of generators are independent events and that one generator failing does not influence the failure of another.

As well as outages, adequacy calculations should consider other characteristics that restrict the ability of a generator to generate electricity when needed. This is the case for wind and solar generation whose ability to generate is determined by climatic conditions. Generators that are limited in the amount of time they can generate such as storage generators also need to be considered.

Loss of load Expectation

AdCal software is used to calculate LOLE. The probability of supply not meeting demand is calculated for each hour of each study year. The annual LOLE is the sum of the contributions from each hour.

Consider now the simplest case of a single-system study, with a deterministic load model (that is, with only one value used for each load), and no scheduled maintenance, so that there is one generation availability distribution for the entire year.

If

$L_{h,d}$ =load at hour h on day d
G =generation plant available
H =number loads/day to be examined (i.e. 1, 24 or 48)
D =total number of days in year to be examined
Then the annual LOLE is given by

$$LOLE = \sum_{d=1,D} \sum_{h=1,H} Prob.\ (G < L_{h,d})$$

This equation is used in the following practical example.

Simplified Example of LOLE Calculation

Consider a system consisting of just three generation units, as in Table A-10.

Table A-10 - System for LOLE example

	Capacity (MW)	Forced outage probability	Probability of being available
Unit A	10	0.05	0.95
Unit B	20	0.08	0.92
Unit C	50	0.10	0.90
Total	**80**		

If the load to be served in a particular hour is 55 MW, what is the probability of this load being met in this hour? To calculate this, the following steps are followed, see Table A-11:

1. How many different states can the system be in, i.e. if all units are available, if one is forced out, if two are forced out, or all three?
2. How many megawatts are in service for each of these states?
3. What is the probability of each of these states occurring?
4. Add up the probabilities for the states where the load cannot be met.
5. Calculate expectation.

Only states 1, 2 and 3 are providing enough generation to meet the demand of 55 MW. The probabilities for the other five *failing* states are added up to give a total probability of 0.1036. So in this particular hour, there is a chance of approximately 10% that there will not be enough generation to meet the load.

It can be said that this hour is contributing about 6 minutes (10% of 1 hour) to the total LOLE for the year. This is then summed for each hour of the year.

Table A-11 - Probability table

1)	1)	2)	3)	3)	4)	4)
State	**Units in service**	**Capacity in service (MW)**	**Probability for (A*B*C)**	**Probability**	**Ability to meet 55 MW demand**	**Expectation of Failure (LOLE)**
1	A, B, C	80	0.95*0.92*0.90 =	0.7866	Pass	0
2	B, C	70	0.05*0.92*0.90 =	0.0414	Pass	0
3	A, C	60	0.95*0.08*0.90 =	0.0684	Pass	0
4	C	50	0.05*0.08*0.90 =	0.0036	Fail	0.0036
5	A, B	30	0.95*0.92*0.10 =	0.0874	Fail	0.0874
6	B	20	0.05*0.92*0.10 =	0.0046	Fail	0.0046
7	A	10	0.95*0.08*0.10 =	0.0076	Fail	0.0076
8	none	0	0.05*0.08*0.10 =	0.0004	Fail	0.0004
Total				**1.0000**		**0.1036**

Interpretation of Results

While the use of LOLE allows a sophisticated, repeatable and technically accurate assessment of generation adequacy to be undertaken, understanding and interpreting the results may not be completely intuitive. If, for example, in a sample year, the analysis shows that there is a loss of load expectation of 16 hours, this does not mean that all customers will be without supply for 16 hours or that, if there is a supply shortage, it will last for 16 consecutive hours.

It does mean that if the sample year could be replayed many times and each unique outcome averaged, that demand could be expected to exceed supply for an annual average duration of 16 hours. If such circumstances arose, typically only a small number of customers would be affected for a short period. Normal practice would be to maintain supply to industry, and to use a rolling process to ensure that any burden is spread.

In addition, results expressed in LOLE terms do not give an intuitive feel for the scale of the plant shortage or surplus. This effect is accentuated by the fact that the relationship between LOLE and plant shortage/surplus is highly non-linear. In other words, it does not take twice as much plant to return a system to the 8 hour standard from 24 hours LOLE as it would from 16 hours.

The adequacy calculation assumes that forced outages are independent, and that if one generator trips it does not affect the likelihood of another generator tripping. In some situations, it is possible that a generator tripping can cause a system voltage disturbance that in turn could cause another generator to trip. Any such occurrences are a matter for system security, and therefore are outside the scope of these system adequacy studies.

As for common-mode failures, it is possible that more than one generating unit is affected at the same time by, for example, a computer virus or by extreme weather, etc. However, it could be considered the responsibility of each generator to put in place measures to militate against such known risks for their own units.

Surplus & Deficit

In order to assist understanding and interpretation of results, a further calculation is made which indicates the amount of plant required to return the system to standard. This effectively translates the gap between the LOLE projected for a given year and the standard into an equivalent plant capacity (in MW). If the system is in surplus, this value indicates how much plant can be removed from the system without breaching the LOLE standard. Conversely, if the system is in breach of the LOLE standard, the calculation indicates how much plant should be added to the system to maintain security.

The exact amount of plant that could be added or removed would depend on the particular size and availability of any new plant to be added. The amount of surplus or deficit plant is therefore given in terms of Perfect Plant. Perfect Plant may be thought of as a conventional generator with no outages. In reality, no plant is perfect, and the amount of real plant in surplus or deficit will always be higher.

It should be noted that actual loss of load as a result of a supply shortage does not represent a catastrophic failure of the power system[78]. In all probability such shortages, or loss of load, would not result in widespread interruptions to customers. Rather, it would likely take the form of supply outages to a small number of customers for a period in the order of an hour or two. This would be done in a controlled fashion, to ensure that critical services are not affected.

Value of Lost Load

The Value of Lost Load is becoming more and more important in current TSO's activities, especially regarding the generation adequacy issue. The Value of Lost Load can be used within capacity mechanisms and the cost-benefit analysis of system investments.

The Value of Lost Load is the monetary damage arising from the non-supply of a given amount of energy (in MWh for instance) due to a power outage. Costs can be significant as they imply the interruption of productive processes for industrials and businesses or the reduction of leisure activities. VoLL can vary per country depending on how much each country values the factors which affect the cost of lost load.

The revised Electricity Regulation, a part of the Clean Energy Package would require ENTSO-E, pursuant to Article 19.5 and Article 10, to develop a common VoLL methodology. ENTSO-E is working on developing a common VoLL methodology for member TSOs[79].

The time of lost load is also significant. A power interruption during the night for 5 minutes does not have the same consequences as if it occurs during the peak hours for one hour. There is not a unique VoLL which can be applied for all types of outages. The VoLL should be fine-tuned to precisely consider interruptions characteristics and then real costs caused by an outage.

For defining generation adequacy standard, the VoLL should be assessed during peak hours only and should consider a several-hours pre-notification time.

The existing reliability standard is for an average LOLE. Two parameters feed into this reliability standard – the Net Cost of New Entry (CoNE) and the Value of Lost Load (VoLL). In Ireland the LOLE Standard is 8hr and in Northern Ireland the LOLE Standard is 4.9 hours.

In the SEM market, the VoLL and Net CoNE are set for each SEM Capacity Market which is used to calculate the value of contracts awarded to winning generators in each auction.

In essence, VOLL estimates the cost of not having enough supply to serve the load, while CONE evaluates the cost of having over-supply. In order to find the optimal balance between supply and demand, we can use VOLL and CONE to define the most appropriate LOLE standard

78 In line with international practice, some risk of such supply shortages are accepted to avoid the unreasonably high cost associated with reducing this risk to a negligible level.
79 https://www.acer.europa.eu/Events/Workshop-on-the-estimation-of-the-cost-of-disruption-of-gas-supply-CoDG-and-the-value-of-lost-load-in-power-supply-systems-VoLL-in-Europe/Documents/CEPAPresentation_VoLLWorkshop.pdf

The most efficient number of hours of outage to allow (LOLE standard) is a function of the Value of Lost Load (VOLL) and the fixed and variable costs of a peaker (Cost of New Entry (CONE)).

The answer to the question "How many hours of lost load should I allow?" is derived from a straightforward cost analysis: In theory, load should be unserved in hours when the cost of serving it would exceed VOLL[80]. Put algebraically, outage makes sense as long as

VOLL * LOLE standard ‹ CONE

For example:

VOLL ~ [Cost of CONE] / [LOLE standard] = [€80,000/MW year] / [8 hours /year] = €10,000 /MWh

Figure 36 shows the point at which this balance point is found – marked by X between both graphs.

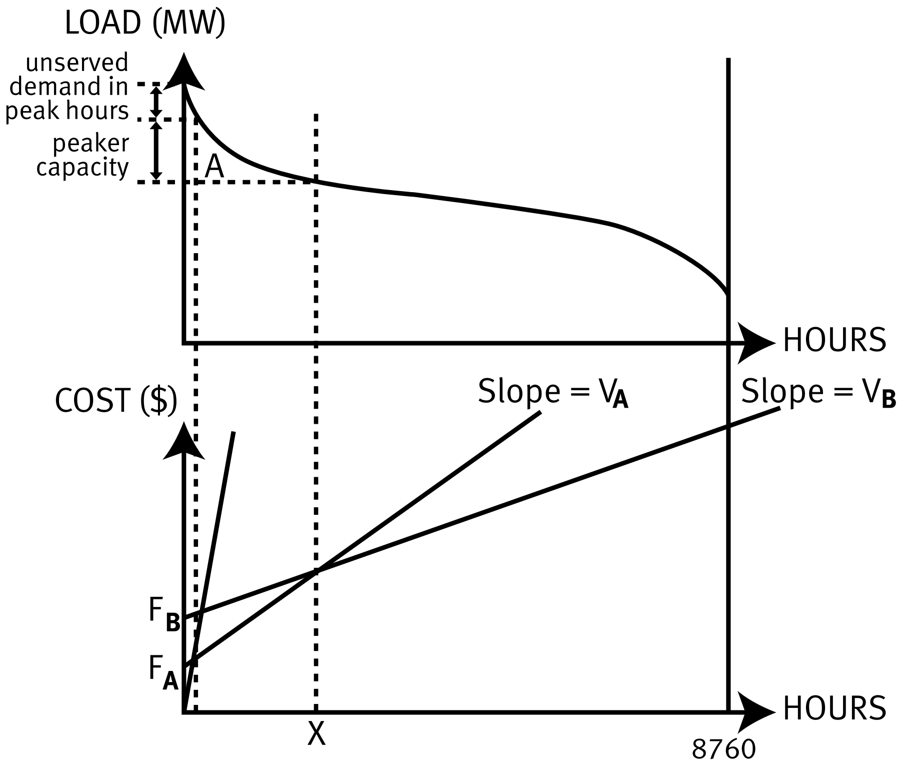


Figure 36 - Balance point between the costs of a new entrant (CONE) to meet demand versus the cost impact of not meeting demand (VoLL) for a certain LOLE[81]

80 http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Hunt_Making_Competition_Work.pdf
81 http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Hunt_Making_Competition_Work.pdf

Appendix 4 Glossary of Terms

Acronym/ Abbreviation	Term	Explanation
ACS	Average Cold Spell	Average Cold Spell (ACS) correction has the effect of 'smoothing out' the demand curve so that economic factors are the predominant remaining influences.
AGU	Aggregated Generator Unit	A number of individual generators grouping together to make available their combined capacity.
ALF	Annual Load Factor	The ALF is the average load divided by the peak load. E.g. TER=42000 GWh, Peak = 7.3 GW (Median forecast for All-Island system in 2020) $$ALF \; \frac{42000/8760}{7.3} = 66\%$$ where 8760 = number of hours per year = 24*365
CF	Capacity Factor	$$\text{Capacity Factor} = \frac{\text{Energy Output}}{\text{Hours per year*Installed Capacity}}$$
CEP	Clean Energy Package	EU Commission package of measures to facilitate the clean energy transition. The EU has committed to cut CO2 emissions by at least 40% by 2030 while modernising the EU's economy.
CCGT	Combined Cycle Gas Turbine	A type of thermal generator that typically uses natural gas as a fuel source. It is a collection of gas turbines and steam units; where waste heat from the gas turbines(s) is passed through a heat recovery boiler to generate steam for the steam turbines.
CHP	Combined Heat and Power	A highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process.
	Demand	The amount of electrical power that is consumed by a customer and is measured in megawatts (MW). In a general sense, the amount of power that must be transported from generation stations to meet all customers' electricity requirements. This includes any losses (line or transformer).
DS3	Delivering a Secure Sustainable Electricity System	In response to binding National and European targets, EirGrid Group began a multi-year programme, "Delivering a Secure, Sustainable Electricity System" (DS3). The aim of the DS3 Programme is to meet the challenges of operating the electricity system in a secure manner while operating with high levels of renewable generation.
DSU	Demand Side Unit	A Demand Side Unit (DSU) consists of one or more Individual Demand Sites that can be dispatched by the Transmission System Operator (TSO) as if it was a generator.

Acronym/ Abbreviation	Term	Explanation
	Dispatchable Generation	Sources of electricity that can be used on demand and dispatched at the request of power grid operators, according to market needs. Does not include wind and solar generation which are non-dispatchable generation
	EU-SysFlex	Aiming to achieve a pan-European system with an efficient coordinated use of flexibilities for the integration of a large share of renewable energy sources. EU-SysFlex will come up with new types of services that will meet the needs of the system with more than 50% of renewable energy sources.
ECP-1	Enduring Connection Policy	A process to provide connection offers to facilitate 2GW of renewable generation in Ireland.
ENTSO-e	European Network of Transmission System Operators – Electricity	ENTSO-E, the European Network of Transmission System Operators, represents 43 electricity transmission system operators from 36 countries across Europe.
ESB Networks	Electricity Supply Board: Networks	A subsidiary within ESB Group, ESB Networks is the licensed operator of the electricity distribution system in the Republic of Ireland and owner of all transmission and distribution network infrastructure.
ESRI	Economic and Social Research Institute	The role of the Economic and Social Research Institute is to advance evidence-based policymaking that supports economic sustainability and social progress in Ireland.
EVs		Electric Vehicles
	FlexTech Initiative	Industry wide consortium to better understand the perspectives and key challenges of players in the electricity sector that if resolved, will deliver significant benefits in terms of meeting Ireland and Northern Ireland's renewable obligations.
FOP	Forced Outage Probability	This is the statistical probability that a generation unit will be unable to produce electricity for non-scheduled reasons due to the failure of either the generation plant or supporting systems. Periods when the unit is on scheduled outage are not included in the determination of forced outage probability.
	Generation Adequacy	The ability of all the generation units connected to the electrical power system to meet the total demand imposed on them at all times. The demand includes transmission and distribution losses in addition to customer demand.
	Gate 3	Generation Connection Policy system of issuing connection offers for 4000 MW of renewable energy to the Irish power system

Acronym/ Abbreviation	Term	Explanation
GWh	Gigawatt Hour	Unit of energy 1 gigawatt hour = 1000000 kilowatt hours = 3.6 x 1012 joules
GNP	Gross National Product	The total value of goods produced and services provided by a country during one year, equal to the gross domestic product plus the net income from foreign investments.
GVA	Gross Value Added	In economics, GVA is the measure of the value of goods and services produced in an area, industry or sector of an economy. In national accounts GVA is output minus intermediate consumption; it is a balancing item of the national accounts' production account.
IC	Interconnector	The electrical link, facilities and equipment that connect the transmission network of one country to another.
HVDC	High Voltage, Direct Current	A HVDC electric power transmission system uses direct current for the bulk transmission of electrical power.
	Economic and Social Research Institute	The role of the Economic and Social Research Institute is to advance evidence-based policymaking that supports economic sustainability and social progress in Ireland.
LOLE	Loss of Load Expectation	The LOLE is the mathematical expectation of the number of hours in the year during which the available generation plant will be inadequate to meet the instantaneous demand.
MEC	Maximum Export Capacity	The maximum export value (MW) provided in accordance with a generator's connection agreement. The MEC is a contract value which the generator chooses as its maximum output and is used in the design of the Transmission System.
MVA	Mega Volt Ampere	Unit of apparent power. MVA ratings are often used for transformers, e.g. for customer connections.
MW	Megawatt	Unit of power
1 megawatt = 1000 kilowatts = 106 joules / second	Gate 3	Generation Connection Policy system of issuing connection offers for 4000 MW of renewable energy to the Irish power system
	Non-GPA	Non-Group Processing Approach
NECP	National Energy and Climate Plan	Regulation on the governance of the energy union and climate action to meet the EU's 2030 energy and climate targets for each member state.
NIE Networks	Northern Ireland Electricity Networks	NIE Networks owns the electricity transmission and distribution network and operates the electricity distribution network which transports electricity to customers in Northern Ireland.

Acronym/ Abbreviation	Term	Explanation
NIRO	Northern Ireland Renewables Obligation	NIRO is the main policy measure for supporting the development of renewable electricity in Northern Ireland. NIRO is closed for applications.
RAs	Regulatory Authorities	Refers to both: Ireland: Commission for Regulation of Utilities (CRU) Northern Ireland: Utility Regulator for Electricity and Gas for Northern Ireland
REFIT 3	Renewable Energy Feed-in Tariff 3	REFIT 3 is a support scheme for renewable energy in Ireland from the Department of Communications, Climate Action and Environment. It is designed to incentivise the addition of 310 MW of renewable electricity capacity to the Irish grid. Of this, 185 MW will be High Efficiency CHP, using both Anaerobic Digestion and the thermo-chemical conversion of solid biomass, while 125 MW will be reserved for biomass combustion and biomass co-firing[82].
	Reliability Options	The SEM CRM Capacity Auctions are a competitive process between qualified capacity providers to be awarded "reliability options" for the provision of capacity to the All-Island system.
RES	Renewable Energy Source	
RES-E		Renewable Electricity
RESS	Renewable Energy Support Scheme	Scheme will provide for a renewable electricity (RES-E) ambition of up to a maximum of 70% by 2030 in Ireland, initially announced via the Government Climate Action Plan 2019. Subject to determining the cost effective level which will be set out in the National Energy and Climate Plan (NECP).
Running Hour Limitation		Restrictions on availability of plant due to external factors for example environmental
SEAI		Sustainable Energy Authority of Ireland
SEF		Strategic Energy Framework 2010 Northern Ireland
SEM	Single Electricity Market	This is the wholesale market for the island of Ireland.
ENTSO-E TYNDP		European Network of Transmission System Operators – Electricity Ten Year National Development Plan
TWh	Terawatt Hour	Unit of energy 1 terawatt hour = 1000000000 kilowatt hours = 3.6 x 1015 joules

82 http://www.dccae.gov.ie/energy/en-ie/Renewable-Energy/Pages/Refit-3-landing-page.aspx

Acronym/ Abbreviation	Term	Explanation
TER	Total Electricity Requirement	TER is the total amount of electricity required by a country. It includes all electricity exported by generating units, as well as that consumed on-site by self-consuming electricity producers, e.g. CHP.
	Transmission Losses	A small proportion of energy is lost as heat or light whilst transporting electricity on the transmission network. These losses are known as transmission losses.
	Transmission Peak	The peak demand that is transported on the transmission network. The transmission peak includes an estimate of transmission losses
TSO	Transmission System Operator	In the electrical power business, a transmission system operator is the licensed entity that is responsible for transmitting electrical power from generation plants to regional or local electricity distribution operators.

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