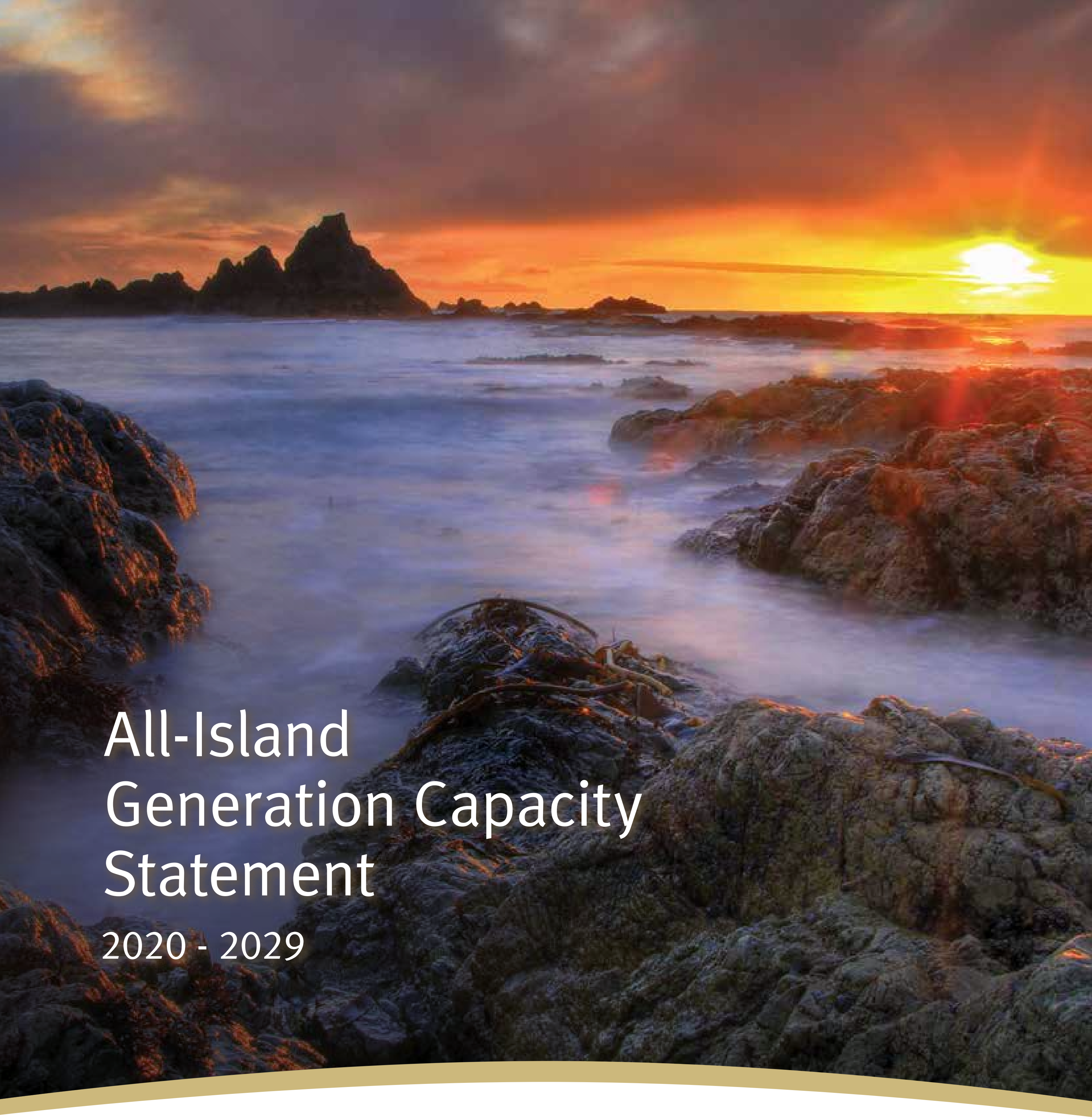

All-Island Generation Capacity Statement

2020 - 2029

EIRGRID

SONI

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EirGrid and SONI have followed accepted industry practice in the collection and analysis of data available. While all reasonable care has been taken in the preparation of this data, EirGrid and SONI are not responsible for any loss that may be attributed to the use of this information. Prior to taking business decisions, interested parties are advised to seek separate and independent opinion in relation to the matters covered by this report and should not rely solely upon data and information contained herein. Information in this document does not amount to a recommendation in respect of any possible investment. This document does not purport to contain all the information that a prospective investor or participant in the Single Electricity Market may need.

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

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Table of Contents

Foreword

EirGrid and SONI, as transmission system operator for Ireland and Northern Ireland respectively, are pleased to present the All-Island Generation Capacity Statement 2020-2029.

In this statement we outline the expected electricity demand and the level of generation capacity that will be required on the island over the next ten years. EirGrid and SONI carried out generation adequacy studies to assess the balance between supply and demand for a number of realistic scenarios.

New market arrangements for the All-Island Single Electricity Market came into operation on 1st October 2018 under the Integrated-Single Electricity Market project. A number of Capacity Market auctions have been successfully held which are central to generation adequacy. New types of capacity such as batteries and flexible generators have entered the market as a result.

The COVID-19 pandemic has had a significant real-time impact on electricity demand of the Island to date and while there have been signs that impact may be short term only it is still too early to determine the actual impacts and how long impacts of COVID-19 may be felt. Once there is a clear view of the long-term effects of COVID-19 on electricity demand and both economies, the demand forecast will be updated to reflect this and published in the GCS 2021-2030; the next version of this report.

Long-term demand in Ireland is increasing and is forecast to increase significantly, due to the expected expansion of many large energy users. With this increase in demand, and the expected decommissioning of generation plant due to decarbonisation targets and emissions standards, it is expected that new capacity will be required. Total Electricity Requirement in Northern Ireland has been relatively stable which is expected to continue.

The European Union has set ambitious targets for decarbonisation and for renewable energy for the electricity sector in 2030. It is imperative that each country individually does what it can to limit and reduce its climate impact.

EirGrid and SONI recently published their 2020 to 2025 strategies, confirming its purpose is to “transform the power system for future generations”, with a primary goal to “lead the electricity sector on sustainability and decarbonisation”. These strategies are consistent with both the Ireland Climate Action Plan 2019 (stating that 70% of electricity will be generated from renewable sources by 2030) and the UK government target for net zero carbon emissions by 2050.

Ireland

In June 2019, the Minister of Communications, Climate Action and Environment for Ireland committed to raise the amount of electricity generated from renewable sources to 70% by 2030 with no generation from peat and coal in the Climate Action Plan 2019. This ambition is needed to honour the Paris Agreement. It represents a significant change for the electricity industry and for EirGrid. It is an opportunity to create a sustainable electricity system that will meet the needs for the next generation. EirGrid awaits the publication of the Government’s National Energy and Climate Plan which is expected in 2020.

The document is expected to set out further details of how the Government envisions achieving the country’s 2030 targets. EirGrid is committed to doing its part in supporting and delivering on the ambitions of Government energy policy.

To support the development of more renewable generation post 2020, the “Renewable Electricity Support Scheme” (RESS) will be a series of auctions to deliver the Renewable Electricity (RES-E) target over the next decade. EirGrid, working with the Department of Communications, Climate Action and Environment (DCCAE), the Commission for Regulation of Utilities (CRU) and industry participants, completed the inaugural RESS auction in August 2020 to enable the delivery of renewable generation projects in order to meet EirGrid’s RES-E trajectory to 2030.

Northern Ireland

For Northern Ireland, the United Kingdom’s Committee on Climate Change recently advised that it is necessary, feasible and cost-effective for the UK to set a target of net-zero Green House Gas (GHG) emissions by 2050. The Climate Change Act 2008 (2050 Target Amendment) Order 2019 came into effect on the 27 June 2019. The revised legally binding target towards net zero emissions covers all sectors of the economy. This update to the Order demonstrates the UK’s and Northern Ireland’s commitment to targeting a challenging ambition in line with the requirements of the Paris Agreement.

Energy Policy is a devolved matter for Northern Ireland and the Department for the Economy (DfE) is progressing the development of an Energy Strategy for Northern Ireland, having already conducted a call for evidence. SONI is providing input to this important work which will inform future renewable targets and the approach to facilitating growth in renewable electricity generation. In acknowledging that there is no single pathway to a low carbon economy SONI has used scenario planning as a means to create a range of possible energy futures and will shortly publish its ‘Tomorrow’s Energy Scenarios’. This document provides a range of plausible scenarios on how the Northern Ireland energy system might develop.

All-Island

The North South Interconnector remains critically needed for security of supply in both jurisdictions. As this report outlines, generation adequacy shifts year-on-year, according to demand. While the recent Single Electricity Market’s (SEM) Capacity Auction process saw enough capacity secured to ensure near-term security of supply, the North South Interconnector, as with existing interconnection to Great Britain remains absolutely vital for the medium to long-term. Together with the new SEM, this will enable all consumers on the island of Ireland to realise the ambition of maximising the considerable benefits of an All-Island electricity system and market.

We hope you find this document informative. This is your grid and energy market. We very much welcome feedback from you on how we can improve this document and make it more useful.

Mark Foley
EirGrid Group
Chief Executive

Jo Aston
SONI
Managing Director

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 **Glossary of Terms** explains some technical terms used in the document.

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.

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=42,000 GWh, Peak = 7.3 GW (Median forecast for All-Island system in 2020) $$\text{ALF} = \frac{42{,}000/8{,}760}{7.33} = 66\%$$ where 8,760 = 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 CO_2 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 achieving these 2020 renewable electricity targets.
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 4000MW of renewable energy to the Irish power system
GWh	Gigawatt Hour	Unit of energy 1 gigawatt hour = 1000000 kilowatt hours = 3.6 x 1012 joules

Acronym/ Abbreviation	Term	Explanation
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.
IED	Industrial Emissions Directive	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.
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.
MEDTSO		MEDTSO is the Association of Mediterranean Transmission System Operators for electricity, operating the High Voltage Transmission Networks of 18 Mediterranean countries.
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
	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.
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.

Acronym/ Abbreviation	Term	Explanation
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[1].
	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 Electricity 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).
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
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

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

Acronym/ Abbreviation	Term	Explanation
TRAPUNTA	Temperature Regression and Load Projection with Uncertainty Analysis	A software tool that allows electric load prediction starting from data analysis of the historical time series (electric load, temperature, other climatic variables) and evaluation of the future evolution of the market (e. g., penetration of heat pump, electric vehicles, batteries, population and industrial growth).
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.
UK Committee on Climate Change		The Committee on Climate Change (CCC) is an independent, statutory body established under the Climate Change Act 2008. It advises the UK and devolved governments on emissions targets and reports to Parliament on progress made in reducing greenhouse gas emissions and preparing for and adapting to the impacts of climate change.

Executive Summary

Executive Summary

In this Generation Capacity Statement (GCS), the likely balance between electricity demand and supply during the years 2020 to 2029 is examined. This GCS covers both Northern Ireland and Ireland and is produced jointly between SONI and EirGrid[2].

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 consulted widely with industry participants and have used the most up-to-date information at the time of submission to regulators.

A range of scenarios was prepared to forecast electricity demand over the time horizon of the report.

In our adequacy assessment studies, the generation portfolio is modelled against the demand forecast, using the accepted standard of risk. These studies were carried out separately for Ireland and Northern Ireland, and jointly on an All-Island basis.

The findings, in terms of the overall demand and supply balance, should be useful to market participants, regulatory agencies and policy makers.

Key Messages

The All-Island demand is increasing and is forecast to increase significantly, largely due to the continued expansion of large energy users such as data centres, albeit as a slightly slower rate than previously forecasted and the Median forecast remains within the bounds of previous forecasts. The long term demand forecast remains on a similar trajectory.

Since restrictions to our daily lives have been applied by both governments due to COVID-19, electricity consumption has been affected significantly. EirGrid and SONI are tracking the impact of this electricity reduction and the potential impacts this may have on the demand forecast for Ireland and Northern Ireland.

Given the uncertainty around COVID-19 and when social distancing may end, it is not yet possible to undertake traditional adequacy analysis. Currently, we do not have enough information to change the main demand forecast in this report. The next publication of the Generation Capacity Statement will cover 2021 – 2030 with more detailed studies and longer term economic impact information are expected to be available to update the demand forecast taking further account of COVID-19 impacts.

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

Under the Single Electricity Market (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 year ahead (T-1 auctions), two years ahead (T-2 auction) or four years ahead (T-4 auctions). The latest auction is a T-4 auction in that it secures capacity for delivery four years ahead of the delivery period (October 2023-September 2024), the outcome of which has been included in this report. Like all of the SEM capacity auctions, it is designed to meet system capacity needs at an economical cost.

2 Where ‘we’ is used, it refers to both companies, unless otherwise stated.

The SEM Capacity Market is designed to procure sufficient capacity to meet the adequacy standard. The recent SEM T-1 2020/2021[3] and T-2 2021/2022[4] auctions were successfully held and secured 7.6 GW and 7.5 GW of de-rated capacity respectively for the All-Island system. The SEM T-4 2023/2024 auction was held in April 2020 and procured 7.3 GW of de-rated capacity for the island[5]. The amount of generation required in the All-Island Capacity Market is set by the capacity requirement, as calculated by EirGrid/SONI in accordance with the methodology as set out within the Capacity Requirement and De-Rating Factor Methodology Detailed Design Decision Paper[6] and subsequently approved by the regulatory authorities. The demand scenarios outlined in the report influence the calculation of the capacity requirement.

While the capacity auctions ensure provision of adequacy in the near to medium term, the second North South Interconnector remains essential to ensuring long term security of supply across the island. EirGrid and SONI are working towards the delivery of the second North South Interconnector as soon as possible; however, this is not likely to be before 2024 as planning has not yet been finalised in Northern Ireland. Planning permission for this interconnector has been granted in Ireland and all legal planning challenges have been overcome. This means the project has passed all planning related legal hurdles in Ireland. SONI is working to resolve the planning challenges in Northern Ireland and will be endeavouring to bring this critical project to fruition as quickly as possible.

In addition to providing long term security of supply, the North South Interconnector is critical to support the decarbonisation of the power system. Much progress has been made towards meeting our targets for renewable energy in both jurisdictions, and this is set to continue. 2019 saw the publication of the Irish Governments Climate Action Plan 2019 and 2020 should see the publication of the National Energy Climate Plan 2021-2029 to outline delivery of the targets. Northern Ireland has met its 40% renewables target – a target which a number of initiatives across SONI have been key in facilitating. The Department for the Economy (DfE) are currently developing an Energy Strategy to contribute to the UK's commitment to deliver net zero carbon by 2050.

EirGrid and SONI are supporting the integration of more intermittent generation sources with initiatives that encourage flexibility such as EU-SysFlex, FlexTech initiative and DS3[7]. Renewables generation performance across 2020 will also determine if Ireland achieves its 40% EU RES-E target – a target which a number of initiatives across EirGrid have been key in facilitating. Ireland achieved 35.7% RES-E for 2019. The percentage achieved across 2020 will be dependent upon a number of factors including renewable and conventional generation performance, and system demand.

Kilroot has indicated that the coal-fired generators ST1 and ST2 will cease operation in 2023. New generation was procured in Northern Ireland via the SEM T-4 2023/2024 auction in April 2020. For any generator leaving the system, if this impacts system adequacy then the SEM capacity auctions will procure sufficient generation to meet system needs for the years in question. EirGrid has also completed the adequacy studies within this report without Moneypoint available from October 2025, in line with SEM Capacity Market timelines and considering guidance from the European Union Clean Energy Package to exclude generation emitting more than 550g/kWh from Capacity Markets such as SEM and also, set out in the Irish Government Climate Action Plan 2019. For clarity EirGrid has not received any closure notice from Moneypoint and it will be a matter for ESB to advise on the future of the plant. The assumption made above is for study purposes only.

3 https://www.sem-o.com/documents/general-publications/T-1-2020-2021-Final-Capacity-Auction-Results-Report.pdf
4 https://www.sem-o.com/documents/general-publications/T-2-2021-2022-Capacity-Market-Auction-Overview_Final.pdf
5 https://www.sem-o.com/documents/general-publications/T-4-2023-2024-Final-Capacity-Auction-Results-Report.pdf
6 https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-16-082%20CRM%20Capacity%20Requirement%20%20De-rating%20Methodology%20Decision%20Paper.pdf
7 http://www.EirGridgroup.com/how-the-grid-works/ds3-programme/

Considering the All-Island system today, there is a surplus of plant currently for the system's 8 hour LOLE security standard as set by the SEM Committee. This surplus is eroded over the next ten years however both the Median and the Low scenario remain in surplus out to 2029. The 8th and High demand scenarios that the All-Island system goes into deficit from 2028 or 2026 respectively. Also, poor availability of the generation fleet due to outages, as seen in 2018 and 2019, could give rise to deficits from 2026.

On a combined, All-Island basis, the growth in energy demand for the next ten years varies between 17% in the low demand scenario, to 41% in the high demand scenario. At the time of publishing, there is uncertainty regarding the effects that Brexit and the COVID-19 virus will have on the islands' demand and economic growth forecasts. Therefore no changes have been made to the adequacy methodology to reflect these atypical events.

The All-Island studies presented here are based on an 8 hour adequacy standard.

Northern Ireland

The Total Electricity Requirement (TER) in Northern Ireland has been relatively flat over the last number of years. There is an expectation that underlying electricity demand will remain fairly stable in the future. There have been some enquiries related 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 scenario, Northern Ireland is within the adequacy standard for the full duration of the studies completed for all scenarios in the report out to 2029. This is due to taking account of both the closure of the Kilroot coal units and new generation which was awarded new generation contracts in the SEM T-4 2023/2024 SEM auction in April 2020. While this capacity auction secured enough Northern Ireland based generation 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.

On completion of the second North South Interconnector we can consider the All-Island system to be capable of operating electrically as one, 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.

The studies presented here are based on the 4.9 hour adequacy standard used in Northern Ireland.

Ireland

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. This will be subject to a review once the full impacts of COVID19 are known later in the year.

Analysis shows that for the Median demand level there may not be adequate generation capacity to meet demand from 2026 for Ireland should Moneypoint close and long term demand continue to rise. Should any other plant of equivalent capacity close then this could also give rise to earlier deficits. Also, poor availability of the generation fleet, as seen in 2018 and 2019, could give rise to adequacy deficits in 2025.

EirGrid is progressing plans for the proposed Celtic Interconnector between Ireland and France and has completed an Investment Request with the Commission for Regulation of Utilities (CRU). A public consultation took place and CRU responded in support of the project in April 2019. 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[8]. The project progressed to public consultation between November 2019 and February 2020 for proposed landing sites[9]. Celtic is expected to begin construction in 2022 and energisation in 2026/2027.

EirGrid is also working with Greenlink Interconnector Limited on its Greenlink 500MW interconnector linking the power markets of Great Britain and Ireland, which is planned for commissioning in 2023. As an EU Project of Common Interest (PCI), it is an important energy infrastructure project. The onshore components of the project are in the pre-planning phase, with planning submissions anticipated soon. The applications for the marine components have been submitted. The project will require planning permission in Ireland and Wales. Further information can be found on the website: www.greenlink.ie/.

Demand Forecast

Long-term system demand in Ireland is increasing and is forecast to increase significantly, due to the expected expansion of many large energy users. This will be subject to a review once the full impacts of COVID19 are known later in the year.

The long-term demand forecast in Ireland continues to be heavily influenced by the expected growth of large energy users, primarily Data Centres. These need a lot of power and can require the same amount of energy as a large town. EirGrid's analysis shows that demand from data centres could account for 27% of all demand in Ireland by 2029 in our Median demand scenario.

In Ireland, the growth in electricity demand for the next ten years varies between 33% in the median demand scenario, to 50% in the high scenario as shown below in Figure 1.

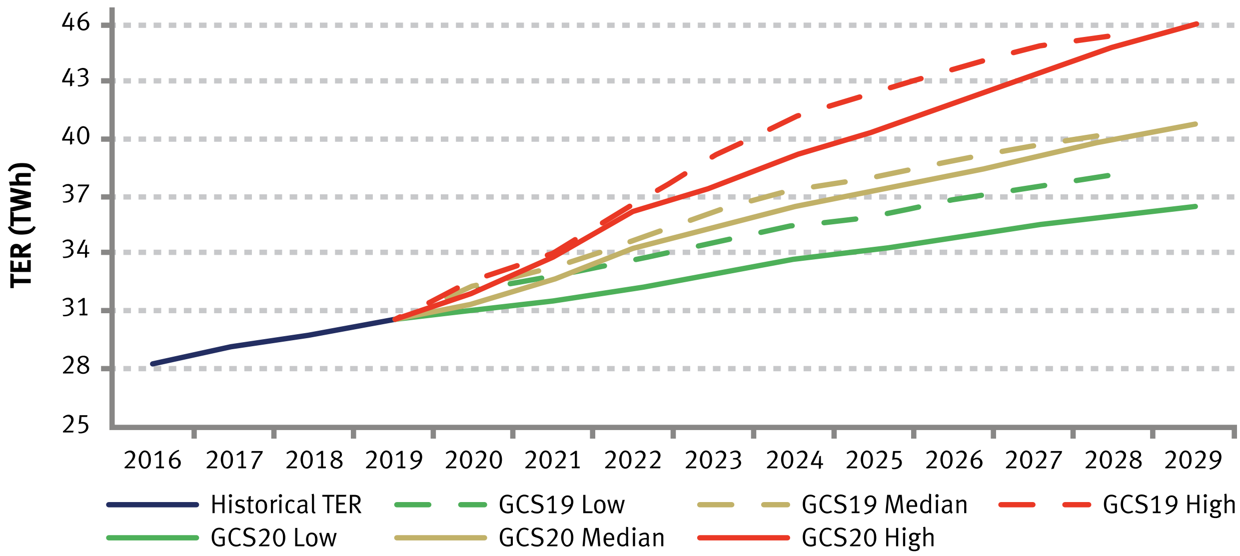


Figure 1: Ireland Total Electricity Forecast GCS 2020 - 2029

The Median Forecast is generally aligned with EirGrid's Tomorrow Energy Scenarios which predict an overall Energy Requirement for Ireland of approximately 41TWh by 2030. This is in line with the ENTSO-E TYNDP[10] 2020 National Trends Scenario forecast.

8 http://www.EirGridgroup.com/newsroom/celtic-interconnector-fun/index.xml
9 http://www.EirGridgroup.com/site-files/library/EirGrid/EirGrid-Celtic-Interconnector-Project-Update-4-Proof-07-DOWNLOAD.pdf
10 ENTSO-E Ten Year National Development Plan 2020: https://consultations.entsoe.eu/tyndp/2020-scenario-storylines/

TER in Northern Ireland is relatively flat, and is expected to continue in this manner in the median scenario up until 2023 when the connection of some data centre load drives demand growth (Figure 2). The median scenario shows demand rising by 4% over the next 10 years. Low demand scenario shows demand falling by 3%, while in the high demand scenario demand would rise by 12%. The Northern Ireland overall energy requirement is in line with ENTSO-E TYNDP 2020 forecasts.

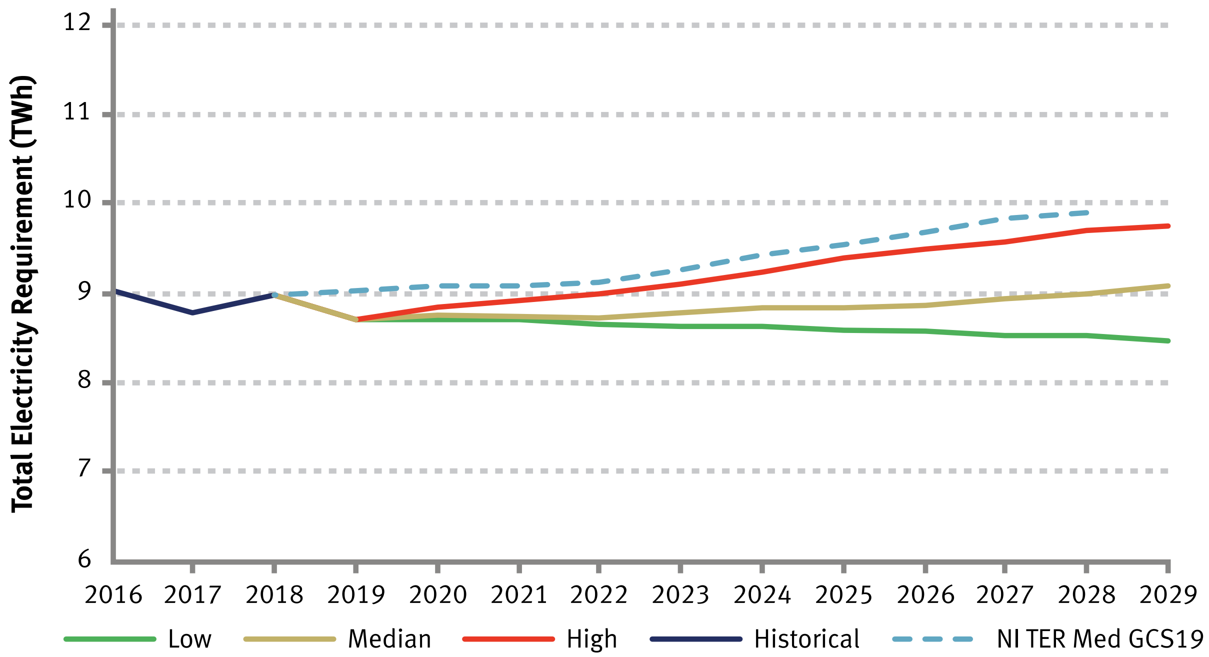


Figure 2: Demand forecast for Northern Ireland, showing the spread from low to high scenarios

Dispatchable Generation and Interconnection

Figure 3 shows the dispatchable generation contracted and connected on the island from the start of 2020. This information was gathered from interested parties in the industry. Some generators have indicated that they will be unavailable in the latter half of the decade. Kilroot has indicated that it will cease operation in 2023. In addition, from guidance in the European Union Clean Energy Package decision to exclude generation emitting more than 550g/kWh from Capacity Markets such as SEM, EirGrid has modelled that Moneypoint coal-fired generation are not available from October 2025. As noted previously no closure notice has been received and a decision on the future of the plant is a matter for ESB.

We have included in the models the new generation that was successful in the previous CY2022/23 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.

We have also included in the models the new generation that was successful in the CY2023/24 T-4 capacity auction from the start of 2024.

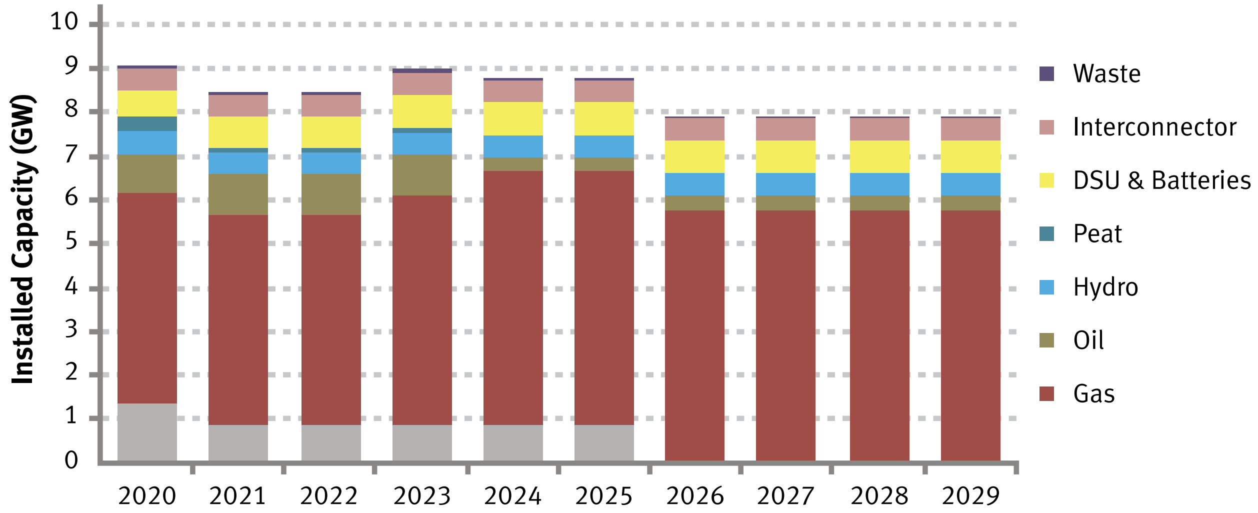


Figure 3: All-Island portfolio of de-rated dispatchable generation and interconnection capacity, as assumed in our central All-Island study

In Ireland and Northern Ireland there has been continued deterioration of unit availability from 2018 into 2019. In particular, the decline of the conventional plant unit availability in both Ireland and Northern Ireland was observed across 2019 as highlighted in Figure 4. 2019 has now become the basis for the low availability year adequacy scenario which is presented later in this report.

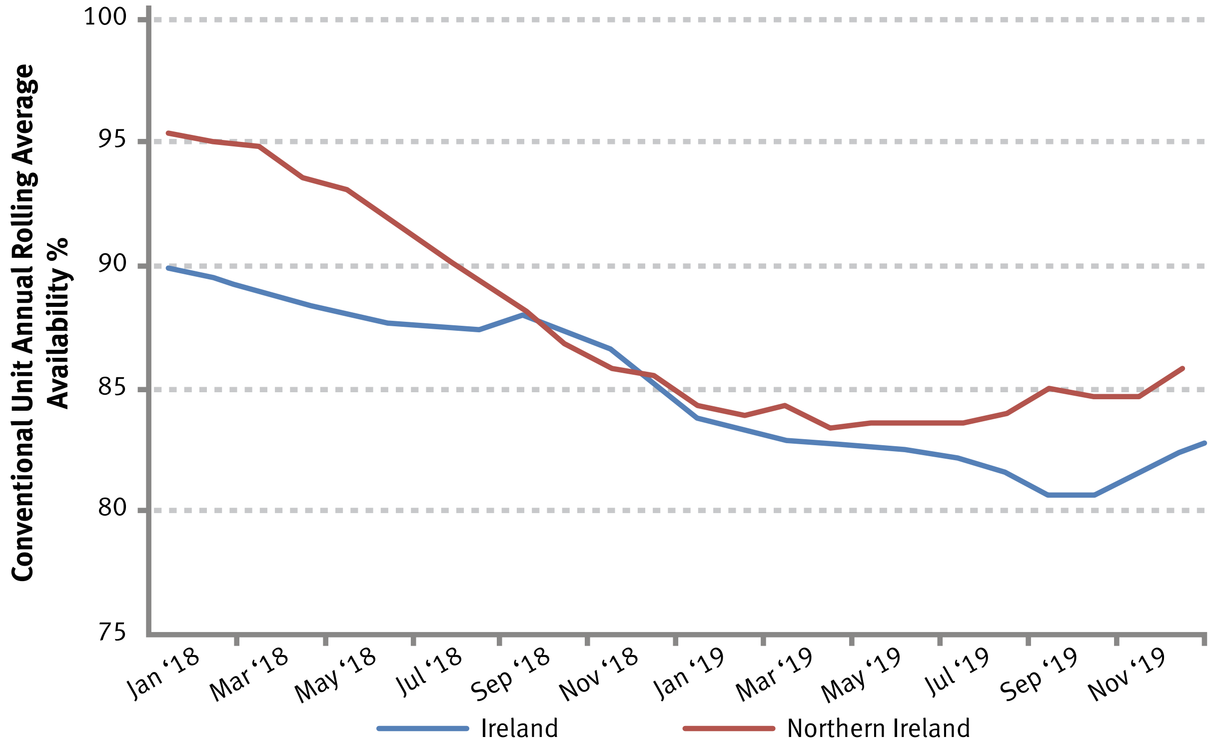


Figure 4: Ireland and Northern Ireland Conventional Unit Availability

Renewable Energy Sources (RES)

Ireland

New wind farms commissioned in Ireland in 2019 brought the total wind capacity to 4,127 MW[11], contributing to the increase in overall RES-E percentage to 35.7%. Other sources of RES-E include biomass, hydro, solar PV and renewable waste. Achievement of the 40% RES-E target will depend on a number of different factors in 2020 including demand levels, renewables generation and system dispatched generation. EirGrid is targeting a RES-E target of 70% for 2030.

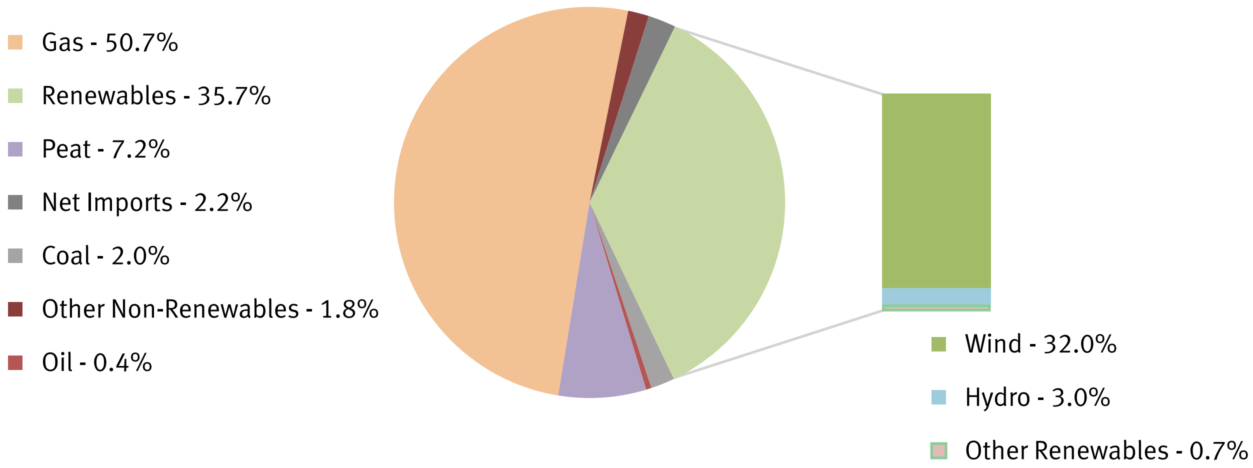


Figure 5: Ireland Fuel Mix 2019

Northern Ireland

The 2010-20 Strategic Energy Framework includes a target to achieve 40% of electricity consumption from renewable sources by 2020. More than 1280 MW of wind is currently installed in Northern Ireland and this is set to grow to almost 1400 MW by 2024. 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 is likely to be met again in 2020 but will be dependent on actual demand and wind levels in 2020.

The Department for the Economy (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 intention is to have a policy options paper for consultation in Winter 2020/21. Through its technical expertise, SONI is supporting the DfE energy strategy development process as appropriate.

DfE's Energy Strategy will set a new target for Northern Ireland supporting the pathway to lower carbon energy. Ireland and Wales have both set targets of 70% by 2030, with Scotland aiming for 100% by 2030. In the Call for Evidence, DfE stated that their starting point was a consideration of a range of pathways, including one the same as Ireland and Wales (70%), one below (60%) and one above (80%).

11 http://www.EirGridgroup.com/site-files/library/EirGrid/Wind20Installed20Capacities.png

As part of this exercise, DfE requested input on what would constitute *'a stretching but achievable ambition for an NI target to 2030, taking into account the level of investment required and potential costs and benefits to consumers'.*

Figure 6 below is based upon metered data from NIE Networks and SONI covering the full 12 months of 2019 and shows Northern Ireland achieved 38.9% RES-E[12].

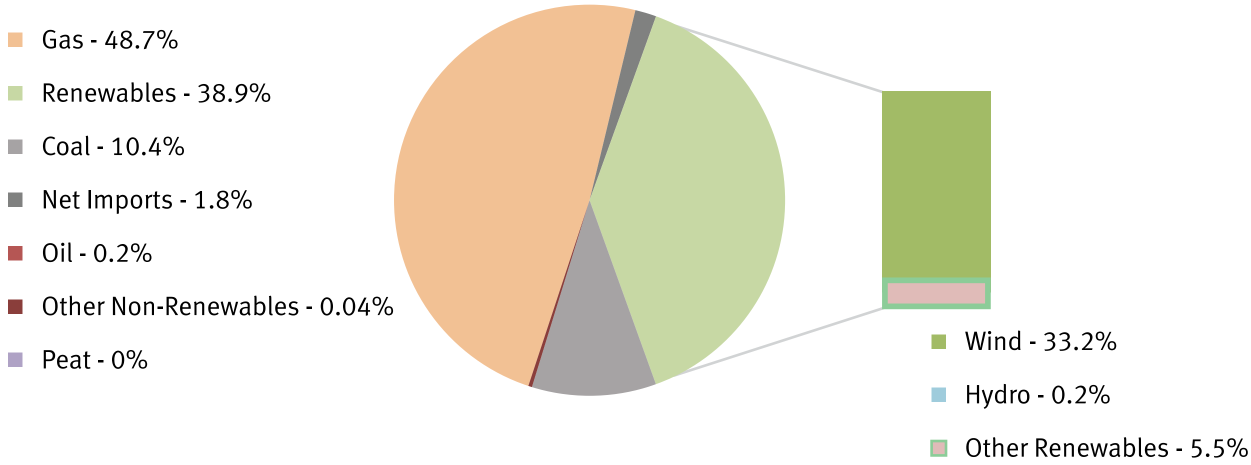


Figure 6: Fuel mix in Northern Ireland in 2019

Adequacy Analysis

We 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 available from 2024, and therefore studies were carried out on an All-Island basis from 2024 to 2029.

In the Capacity Requirement calculations for SEM Capacity Auctions, ten different demand levels were examined, equally spaced from Low to High demand. Then, a Least Worst Regrets analysis was carried out to choose the optimal case. This has resulted in the Capacity Requirement being chosen for demand level 7 or 8, i.e. between the Median and the High demands. We have shown a scenario for the 8th level demand forecast to show as the possible Least-Worst Regret optimal option to procure for.

Single-jurisdictional studies beyond 2024 have been completed, in the event that the second North South Interconnector is delayed.

For the purposes of adequacy studies, we continue to include plant which has been unsuccessful in SEM Capacity Auctions unless formal closure notices have been received or has been directly discussed with the relevant generator owner.

12 The DfE announced in October 2019 that Northern Ireland had achieved its target of 40% RES-E which is accurate when considering electricity consumption on a 12-month rolling bases for the periods ending July, August, September and October 2019. However, as wind was unusually low for November 2019, the 12-month rolling RES-E% reverted back to less than 40% in the 12-month periods ending November and December of 2019. Therefore this has resulted in the final RES-E figure of 38.9% for the calendar year of 2019.

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 the current limited interconnection.

Ireland starts in a position of significant generation surplus in 2020. 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. The High demand scenario goes into deficit in 2025. Only the Low demand scenario remains in surplus for the full duration of the studies. Adequacy studies results for Ireland are listed in Table 1.

With a low availability scenario, 2019 availability statistics was the worst year in the last 5 years, the analysis shows that there would be a deficit of plant by 2025.

The Reduced Coal Capacity scenario represents an adequacy study should one Moneypoint coal unit be unavailable for 2024/2025. The study shows there is a reduced surplus for these years versus the Median Scenario however both scenarios remain in surplus for all of 2024 and 2025.

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
High Demand	1,100	700	490	800	290	**-48**	**-570**	**-670**	**-770**	**-860**
Demand level 8	1,130	770	610	940	450	135	**-360**	**-430**	**-510**	**-580**
Median Demand	1,150	850	720	1,050	580	311	**-170**	**-210**	**-260**	**-320**
Low Demand	1,220	1,020	1,030	1,420	1,020	781	380	390	380	380
Low availability, Median Demand	710	400	270	610	110	**-118**	**-400**	**-440**	**-490**	**-550**
Reduced Coal Capacity, Median Demand	1,150	850	720	1,050	370	189	**-170**	**-210**	**-260**	**-320**

Table 1: Results of adequacy studies for Ireland, given in MW of surplus plant (+) or deficit (-)

Northern Ireland, without the second North South Interconnector

When Northern Ireland is assessed on its own, SONI assume a continued ability to rely on 200 MW from Ireland.

The median demand scenario is shown to be in surplus of, on average, 290 MW for the full duration of the studies. As noted throughout this document, adequacy 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.

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Median Demand	320	280	280	270	330	320	300	280	270	260
Low Demand	340	310	310	310	380	380	380	380	380	380
High Demand	310	270	240	230	280	240	230	210	180	170

Table 2: Results of adequacy studies for Northern Ireland, given in MW of surplus plant (+) or deficit (-)

All-Island, with the second North South Interconnector

The second North South Interconnector is assumed to be available from 2024. 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.

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. Adequacy studies results for the All-Island system are listed in Table 3.

The All-Island system starts to see deficits from 2026 in certain scenarios and from 2028 there are deficits in all scenarios except the Low and Median Scenario.

The Low and Median scenarios remain in surplus for the full duration of the studies out to 2029.

Scenario	2024	2025	2026	2027	2028	2029
High Demand	1120	560	**-180**	**-290**	**-420**	**-520**
Demand level 8	1310	780	80	0	**-100**	**-180**
Median Demand	1460	990	310	250	190	120
Low Demand	1980	1560	980	990	990	980
Low Availability - Median Demand	910	420	**-30**	**-90**	**-160**	**-220**

Table 3: Results of adequacy studies for the All-Island system

Introduction 1

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 2029[13].

Generation adequacy is a measure of the capability of the electricity supply to meet the electricity demand on the system. 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 Generation Capacity Statement (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 Generation Capacity Statement covers the years 2020-2029 for both Northern Ireland and Ireland, and is produced jointly between SONI and EirGrid. 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 2019-2028, published in 2019.

Input data assumptions have been reviewed and updated.

Since restrictions to our daily lives have been applied by both governments due to COVID-19, electricity consumption has been affected significantly. EirGrid and SONI are tracking the impact of this electricity reduction and the potential impacts this may have on the demand forecast for Ireland and Northern Ireland.

Given the uncertainty around COVID-19 and when social distancing may end, it isn't possible to incorporate the impact of the mitigation measures within our traditional adequacy analysis at this time. Currently, we do not have enough trend data to change the main demand forecast in this report in a robust and reliable manner. The next publication of the Generation Capacity Statement will cover 2021 – 2030. Longer term economic impact information are expected to be available to update the main demand forecast taking further account of COVID-19 impacts for the GCS 2021-2030.

The Generation Capacity Statement is evolving to support the SEM Capacity Market and other requirements of a changing electricity system. These changes will be reflected across a longer horizon by the energy scenarios being produced by SONI and EirGrid. We will continue to work with the Regulatory Authorities and other stakeholders to ensure that this document and the underlying methodologies remain relevant and useful.

13 EirGrid and SONI also publish a Winter Outlook Report which is focused on the following winter period, thus concentrating on the known, short-term plant position rather than the long-term outlook presented in the Generation Capacity Statement.
http://www.EirGridgroup.com/site-files/library/EirGrid/Winter-Outlook-2018-19.pdf

2 Demand Forecast

2. Demand Forecast

2.1. Introduction

The COVID-19 pandemic has had a significant real-time impact on electricity demand of the Island. It is not known how long impacts of COVID-19 may be felt. Once there is a clear view of the long-term effects of COVID-19 on electricity demand and both economies, the demand forecast will be updated to reflect this and will be published in the Generation Capacity Statement 2021-2030.

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 to provide a suitable starting point. 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 to what it would have been had the weather been average.

Another aspect of historical analysis is the calculation of the amount of self-consumption, i.e. energy that is created 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. As this sector is growing, it is necessary to track it and the influence that it has on the total metered demand.

We also examine other factors affecting demand, such as economic activity and any particular sectors that are experiencing strong growth. When forecasting demand, we need to take into account the expected growth in these areas.

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 energy efficiency measures and large, new industrial users. 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[14]. They advised us to focus on the economic parameters of Gross Value Added (GVA)[15], Personal Consumption[16] and Gross National Product (GNP)[17].

The demand forecast incorporates some reduction due to energy efficiency measures, in line with the EU energy efficiency targets for 2030. This includes the effect of the installation of smart meters, which could reduce peak demand from domestic users by up to 8%[18].

14 http://www.esri.ie/irish-economy/
15 Gross Value Added at basic prices of non-foreign owned Multinational Enterprises
16 Personal Consumption of Goods and Services (PCGS) measures consumer spending on goods and services, including such items as food, drink, cars, holidays, etc.
17 Gross National Product (GNP) is the total value of goods and services produced in a country, discounting the net amount of incomes sent to or received from abroad. It is modified for the effect of re-domiciled companies, i.e. foreign companies which hold substantial investments overseas but have established a legal presence in Ireland.
18 https://www.cru.ie/wp-content/uploads/2011/07/cer11080ai.pdf

2.2.2. Advances in Demand Profile Modelling

TRAPUNTA (Temperature Regression and loAd Projection with UNcertainty Analysis) is the next step in electricity load forecasting. This tool is a software that allows electric load prediction starting from data analysis of the historical time series (electric load, temperature, other climatic variables) and evaluation of the future evolution of the market (e. g., penetration of heat pump, electric vehicles, batteries, population and industrial growth).

It has been developed by Milano Multiphysics for ENTSO-E. TRAPUNTA is based on an innovative methodology for the electric load projection analysis based on regression, model order reduction and uncertainty propagation.

Using TRAPUNTA to forecast demand profiles is becoming standard across Europe TSOs and modelling groups through ENTSO-E TYNDP Scenarios and MEDTSO adopting this demand modelling tool.

The use of TRAPUNTA will be increasingly useful as EVs and heat pumps become more a part of the system which advances in demand modelling will support. This is because EVs and Heat Pumps do not have a flat demand profile and can have changing effects on the daily demand profile depending on numerous factors including time of year, ambient temperature, technology types and user profiles. TRAPUNTA has not been used for demand profiling in this GCS 2020 – 2029 publication however as EVs and Heat Pumps increase in numbers, TRAPUNTA may be used if deemed appropriate to better model electricity use.

2.2.3. Historical data

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

Past economic data is sourced from the most recent Quarterly National Accounts of the Central Statistics Office[19]. We analyse the data to capture the most recent trends relating the economic parameters to demand patterns.

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

2.2.4. Forecasting causal inputs

In order for the energy model to make future predictions, we require forecasts of Gross Value Added (GVA), Gross National Product (GNP) and Personal Consumption. GVA and GNP are combined to influence the forecast of Commercial and Industrial electricity demand. 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 4 were used for GCS studies.

	2021-2022	2023-2029
GVA / GNP	3.5%	3.1%
Personal Consumption	2.9%	2.2%

Table 4: Average annual growths for macroeconomic parameters, as advised by the ESRI pre-COVID19

19 https://www.esri.ie/publications/quarterly-economic-commentary-spring-2019

2.2.5. Forecast Scenarios and 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 presently approximately 1100 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 typical load currently drawn by these customers is approximately 40% of their contracted Maximum Input Capacity. This is expected 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 also takes account of data centres normally having a flat demand profile.

Since the GCS 2019-2028, EirGrid has received more detailed demand build out estimates from the data centres and large energy users across the country. When compared to GCS19, this has resulted in a reduction of the overall level of peak demand to be reduced by c. 150MW in 2022-2024.

From the result of this process, Table 5 gives the breakdown of Data Centre and Large Industrial Users demand forecasted by 2029, Figure 7 shows to forecasted build out per scenario out to 2029, Figure 8 shows Irelands total energy requirement forecast and Figure 9 shows, for the Median scenario, the energy breakdown forecast per sector.

Demand forecasted from Data Centres and Large Energy Users is not expected to be impacted significantly by COVID-19.

Forecast Scenario	Addition to 450 MVA of currently built Data Centres and large energy users	Overall 2029 Demand in MVA
Low	340	790
Median	800	1,250
High	1,320	1,770

Table 5: Forecasted Data Centre and Large Industrial User Demand by 2029

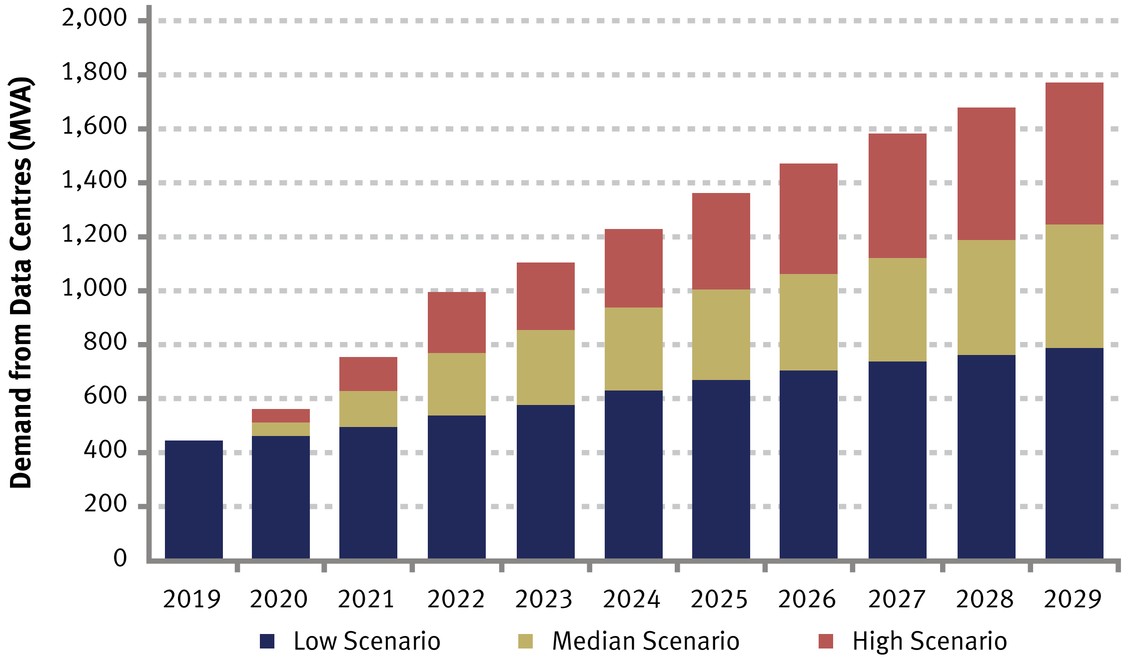


Figure 7: Ireland demand expected from assumed build-out of large energy users, divided into 3 different categories. Also illustrated is how EirGrid assume to divide out this demand into the Low, Median and High Demand forecast scenarios for 2029

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 2020 – 2029 has been updated to take 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. Though the high demand forecast is, for a time, slower to grow than that for GCS19, it is forecasted to reach the same level by 2029.

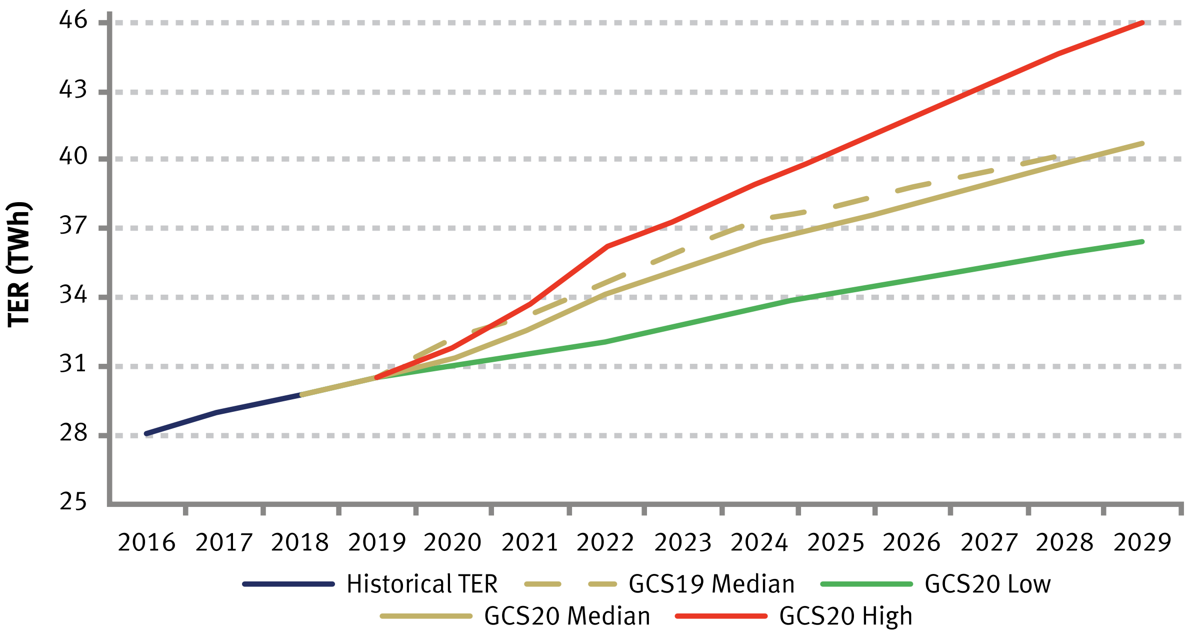


Figure 8: Total Electricity Requirement forecast for Ireland 2020 - 2029

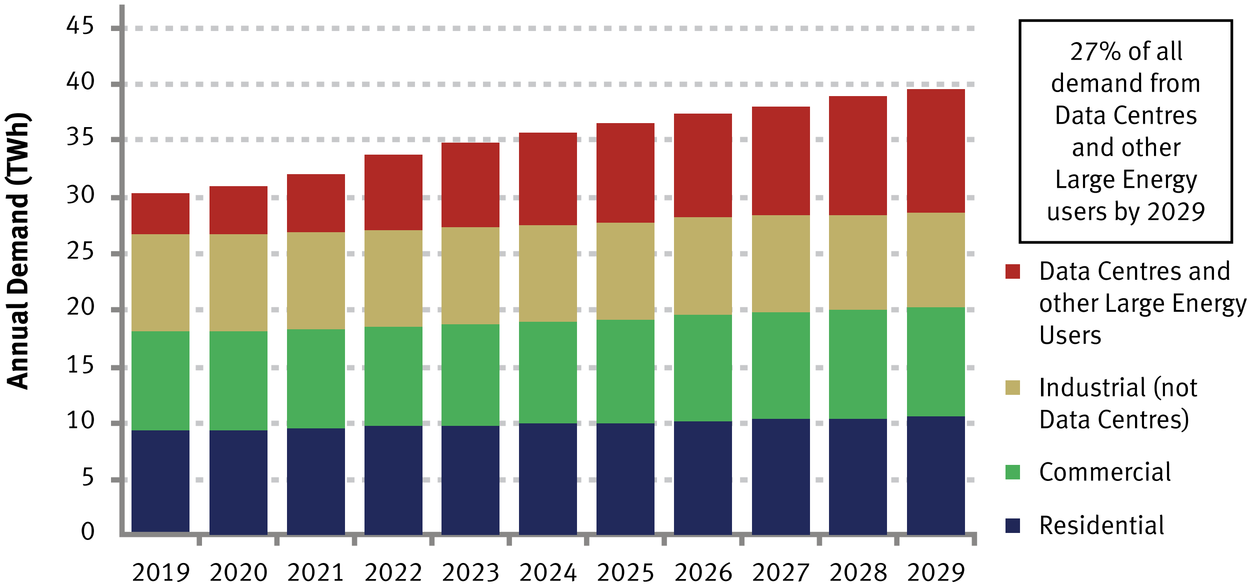


Figure 9: For the Ireland Median Demand scenario, this illustrates the approximate split into different sectors. EirGrid estimate that 27% of total demand will come from data centres by 2029

2.2.6. 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 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 10. 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.

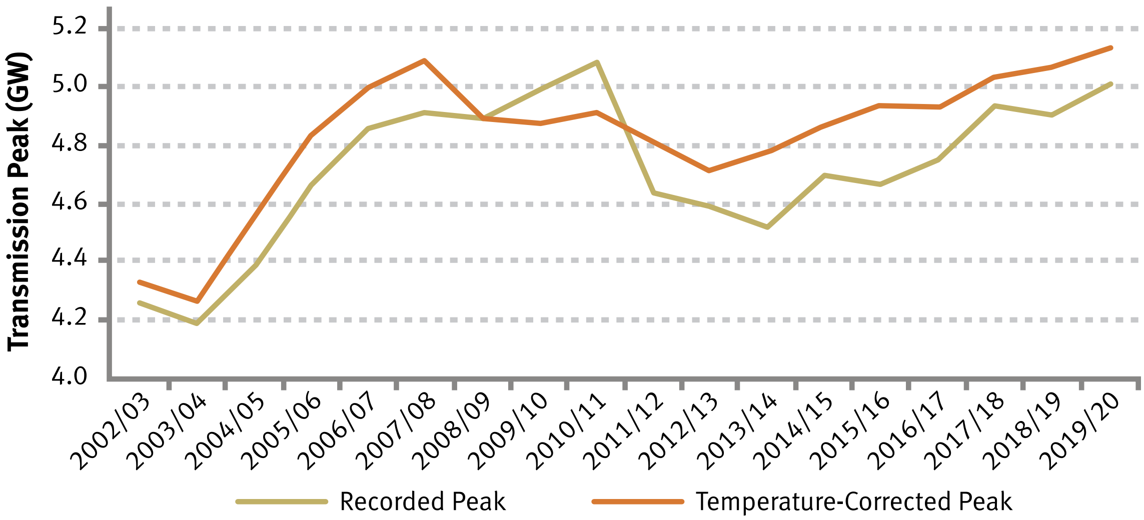


Figure 10: Past values of recorded maximum demand in Ireland, and the ACS temperature-corrected values

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[20] from the start of their roll-out in 2019/2020. The smart meter roll out has been impacted by the COVID19 restrictions. 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%.

In the early years of the forecast, EirGrid has allowed for more variation, i.e. for the low peak forecast, and considered that there might be a slower than forecasted roll-out of smart meters. For the high scenario, EirGrid have considered the possibility that the winter might be severely cold and thus result in higher peaks. This effect is swamped by the larger effects of data centre load variation in the later years of the forecast.

While EirGrid does not expect an extremely warm or extremely cold winter every year, this range of scenarios is within the bounds of probability for the immediate winter. Therefore, it is included in our forecast to be provided for the Least Worst Regret analysis of the Capacity Requirement in the Capacity Market.

The main difference between the forecasts of low, median and high peaks is the differing amounts of load assumed from data centres and other large energy users. While the growth patterns are slightly different from GCS19, the overall trend is quite similar, reflecting the steady progress of the demand projects.

The GCS20 forecasted peaks have changed since GCS19 due to a different ramp out rate of demand of data centres and large energy users across Ireland. This has been informed by information directly from the specific demand customers.

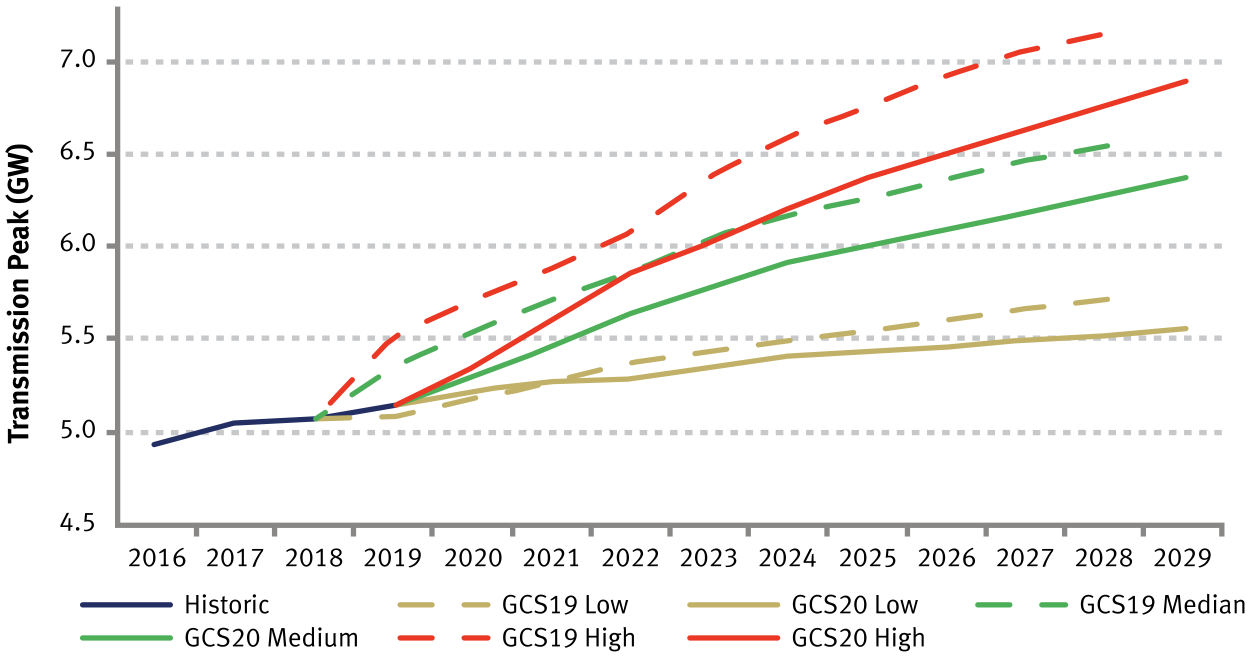


Figure 11: Transmission peak forecast for Ireland

20 https://www.cru.ie/wp-content/uploads/2011/07/cer11080ai.pdf

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 Total Electricity Requirement (TER) forecast is carried out with reference to economic parameters, primarily Gross Value Added (GVA). The consensus amongst economists is that there will be growth in Northern Ireland's economy, although some uncertainty surrounds the pace of growth. For the purposes of the studies we have assumed a steady economic growth of around one percent annually.

The Strategic Energy Framework for Northern Ireland sets 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 DfE intends to have a draft policy options paper for consultation in Winter 2020/21. Through its technical expertise, SONI is supporting the DfE energy strategy development as appropriate.

2.3.2. Demand Scenarios

Given the degree of future economic uncertainty, 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 median, high and low demand forecasts to be formulated.

The median demand forecast is based on an average temperature year, including energy efficiency with the central economic 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 energy efficiency and the pessimistic economic factor being applied. Conversely, the high demand forecast is based on a relatively low temperature year, with lower 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 contains potential load that has made a material enquiry, modified by an estimated connection probability, from 2025. These three scenarios give an appropriate view of the range of possible demand growths. These categories match the approach for the demand scenarios in Ireland.

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)[21] to establish the amount of embedded generation that is currently connected on the system and 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 Total Electricity Requirement (TER)[22].

2.3.4. TER Forecast

It can be seen that the new TER forecast (Figure 12) is slightly reduced compared to the forecast published in the Generation Capacity Statement 2019-2028. This is due to both the review of assumptions surrounding potential new large industrial load and its reduced impact on TER as well as the slight reduction in TER from 2018 to 2019. The Median TER forecast from GCS19 is higher than all three scenarios in this year's report. This reflects the impact of the review of these two factors. The range difference between median and high demand is primarily based on new large industrial load build-out scenarios.

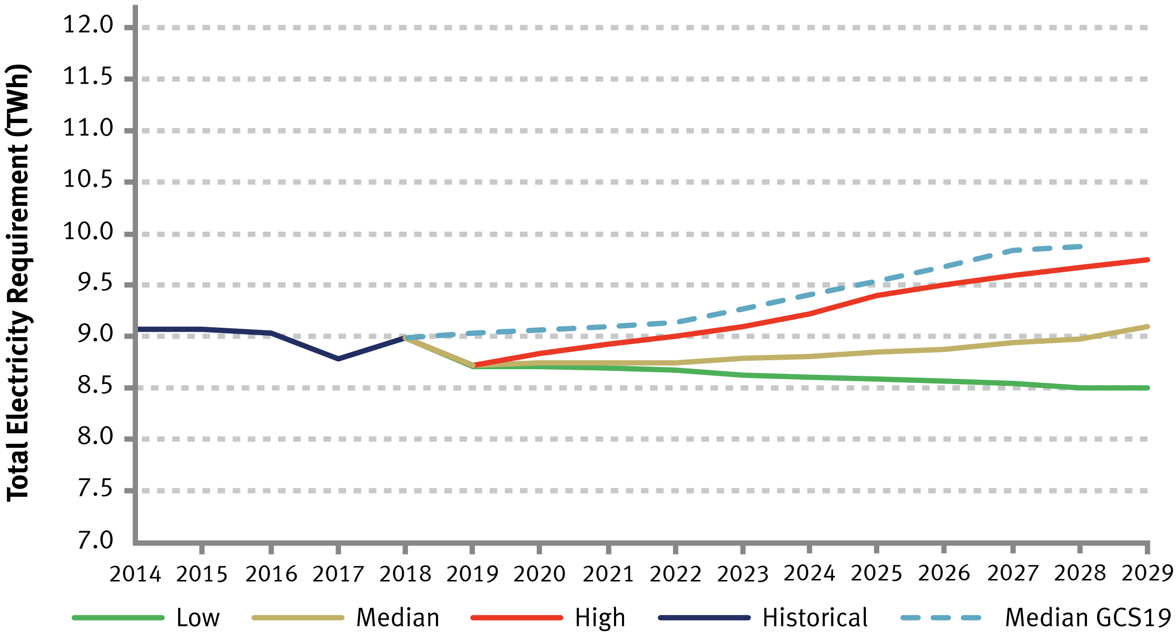


Figure 12: Northern Ireland TER Forecast

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.

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

22 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.

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 2018/19 sent out peak of 1,689 MW occurred on Thursday 31st January 2019 at 18:00.

When ACS temperature correction is applied the Peak becomes 1,639 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 13 shows the Transmission Peak forecast for Northern Ireland. It can be seen that the resulting forecast is slightly reduced compared to the GCS 2019-2028. The main difference is caused by the review of assumptions surrounding potential new large industrial load and its reduced impact on the peak.

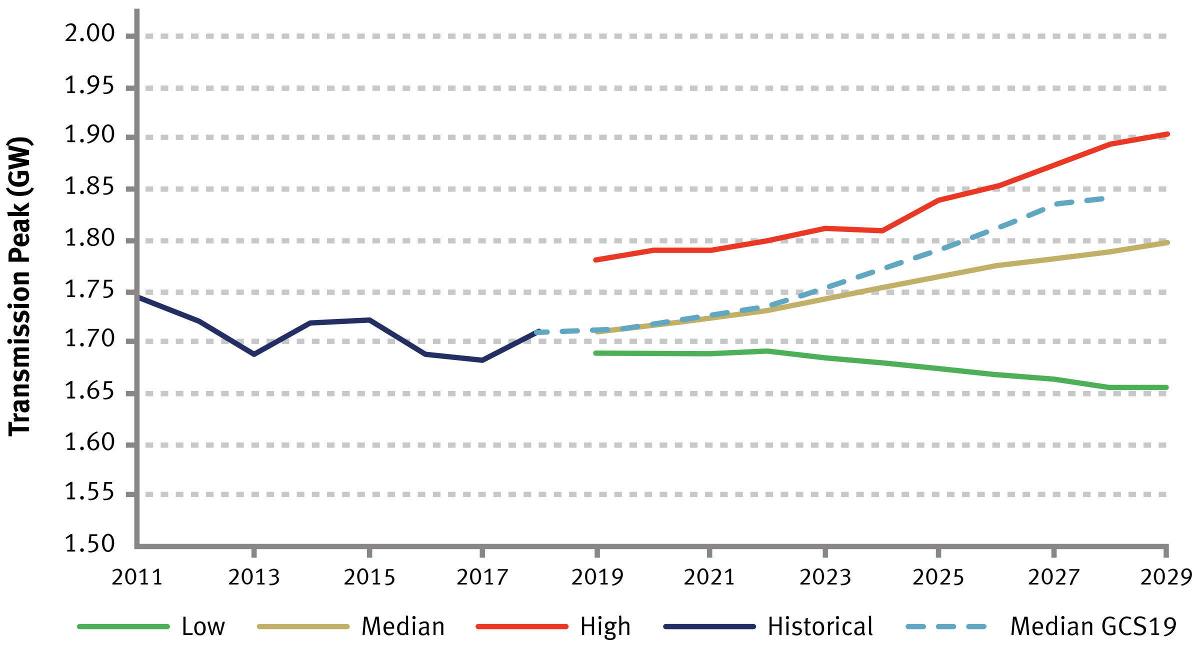


Figure 13: ACS Transmission Peak forecasts for Northern Ireland

Appendix 1 lists the detailed energy and peak data out to 2029 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, see Figure 14. The All-Island peak forecast is shown in Figure 15.

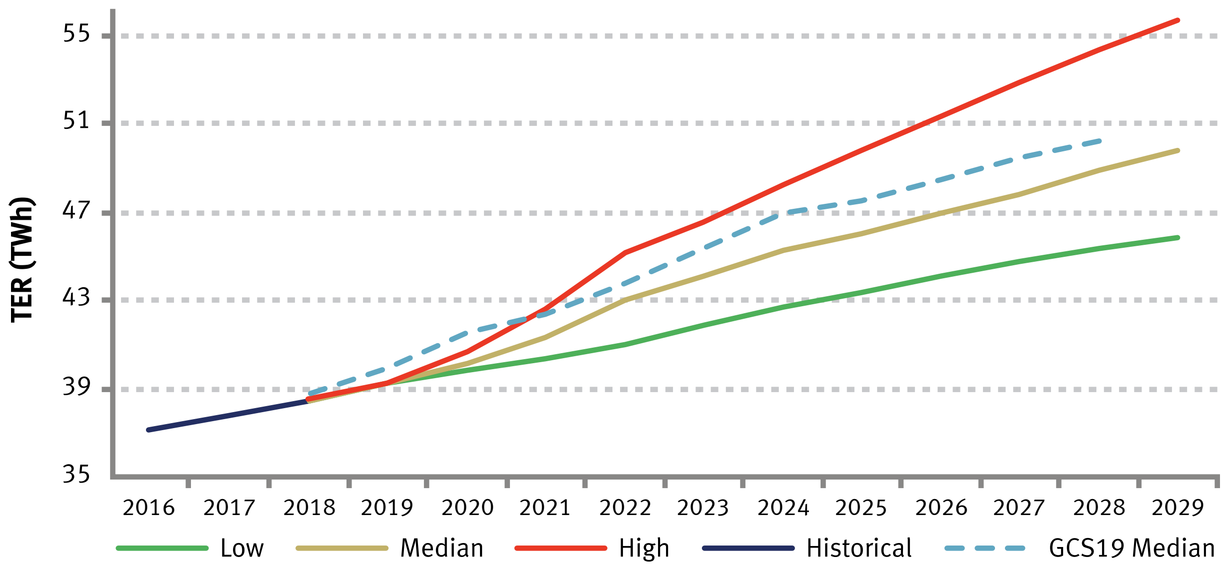


Figure 14: Combined TER forecast for the All-Island system

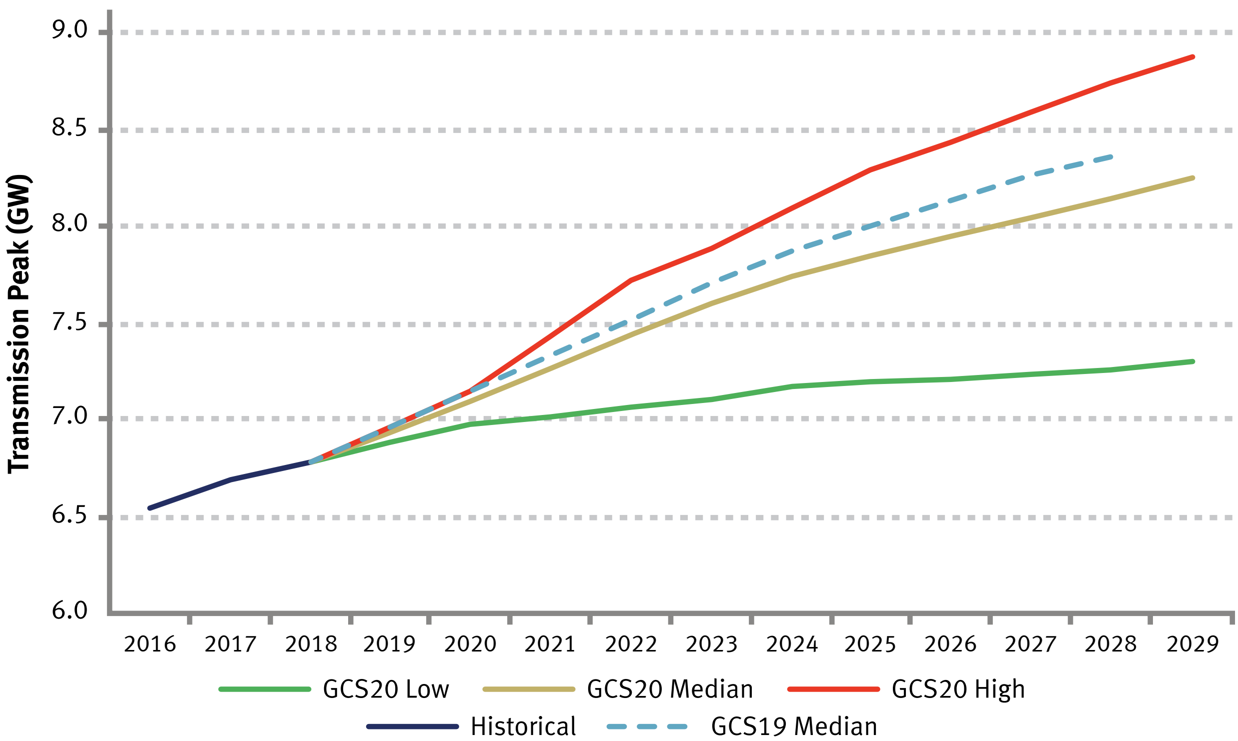


Figure 15: Transmission Peak forecast for the combined All-Island forecast

2.5. COVID-19 Demand Impact

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

Given the uncertainty around COVID-19, it is not possible to undertake traditional adequacy analysis yet. Currently, we do not have enough information to change the demand forecast in this report. As the end of social distancing measures is not known, it is currently unwise to change the main ten year forecast based on only a short period of data.

The next publication of this Generation Capacity Statement will cover 2021 – 2030 and additional published data should be available to enable us to cover more detailed studies and the longer term economic impact information to further update the demand forecast taking better account of COVID-19 impacts.

The year currently expected to mainly be impacted is 2020. As of the end of June 2020, since the start of lockdown real time network data has shown an average reduction in market demand of 7% in Ireland and 15% in Northern Ireland. As of yet, the impact of COVID-19 on system winter peak consumption is not yet known.

We do not know yet how long this suppression of weekly electricity consumption will continue for and to what extent this will change as lockdown restrictions ease across 2020.

2.6. Annual Load Shape and Demand Profiles

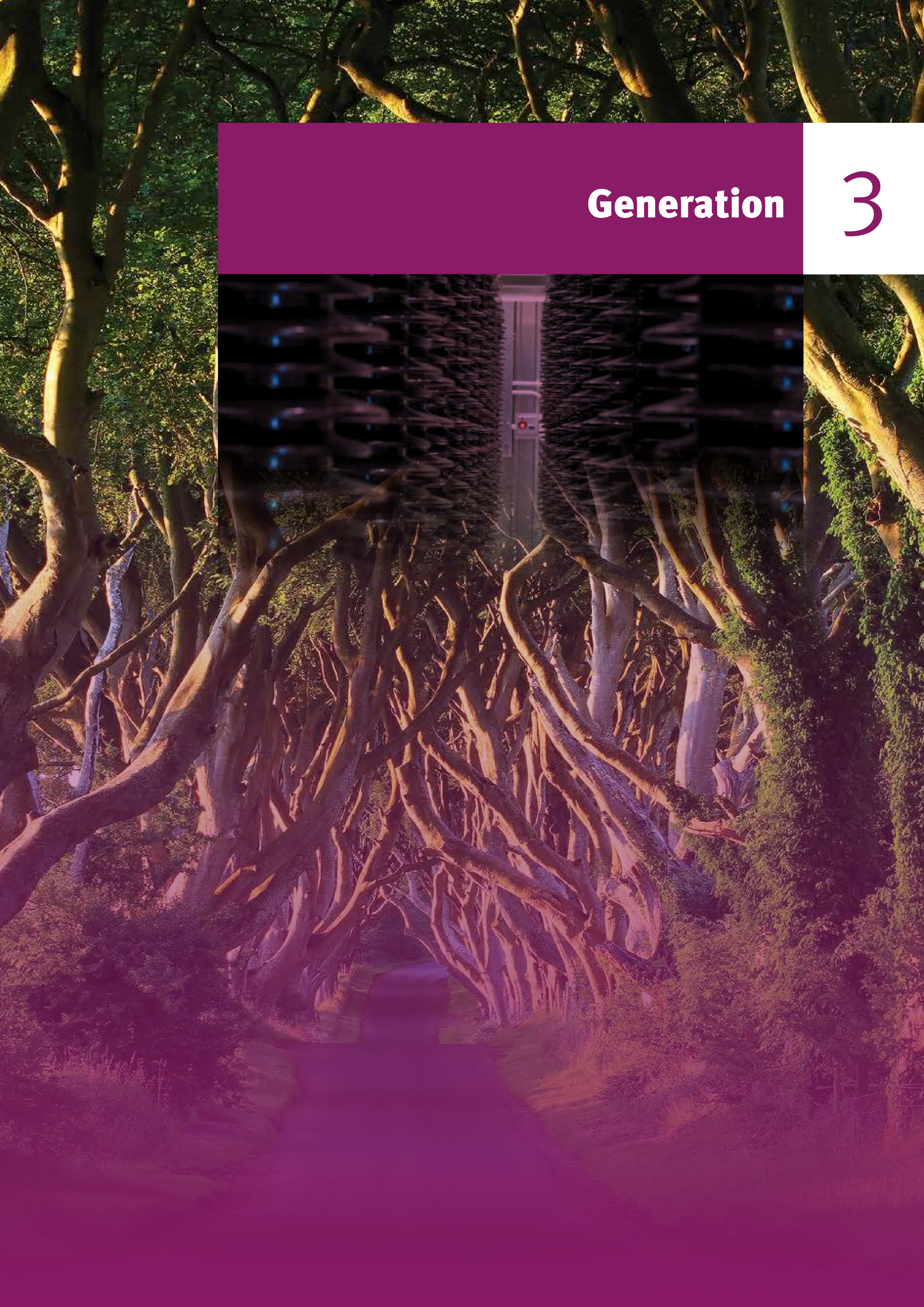
To create future demand profiles for the adequacy studies for both Ireland and Northern Ireland, it is necessary to use an appropriate base year profile which provides a representative demand profile. This profile is then progressively scaled up using forecasts of energy peak and demand. Similar to the 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, and customer demand management.

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 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 16 below illustrates the age of the dispatchable plant on the island with DSUs incorporated.

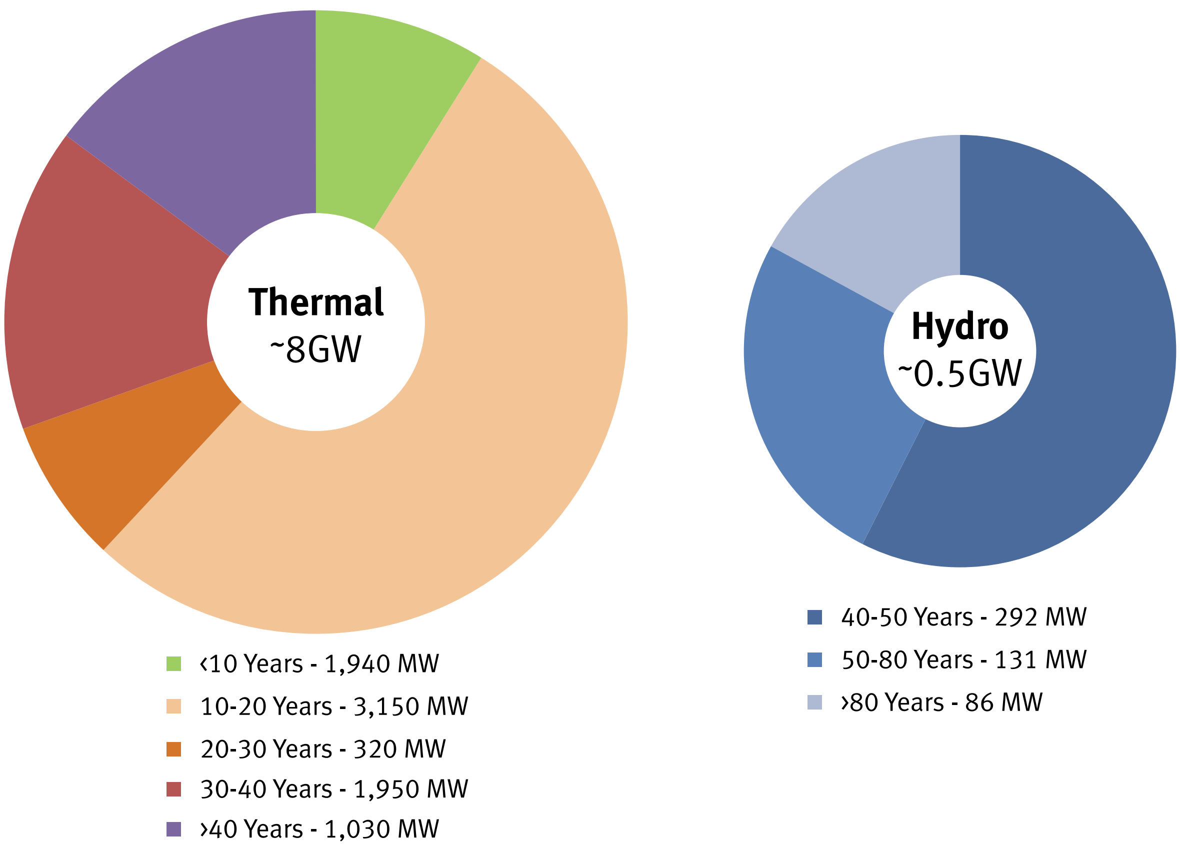


Figure 16: Age breakdown of dispatchable plant on the All-Island system

This amounts to 7 GW of de-rated dispatchable plant on the island of Ireland for 2020. A total of 7.6 GW of de-rated capacity cleared in the T-1 2020/2021 All-Island capacity auction[23] held in November 2019, as shown in Figure 17. For the purposes of adequacy studies, we continue to include unsuccessful plant unless formal closure notices have been received.

23 https://www.sem-o.com/documents/general-publications/T-1-2020-2021-Capacity-Market-Auction-Overview_Final.pdf

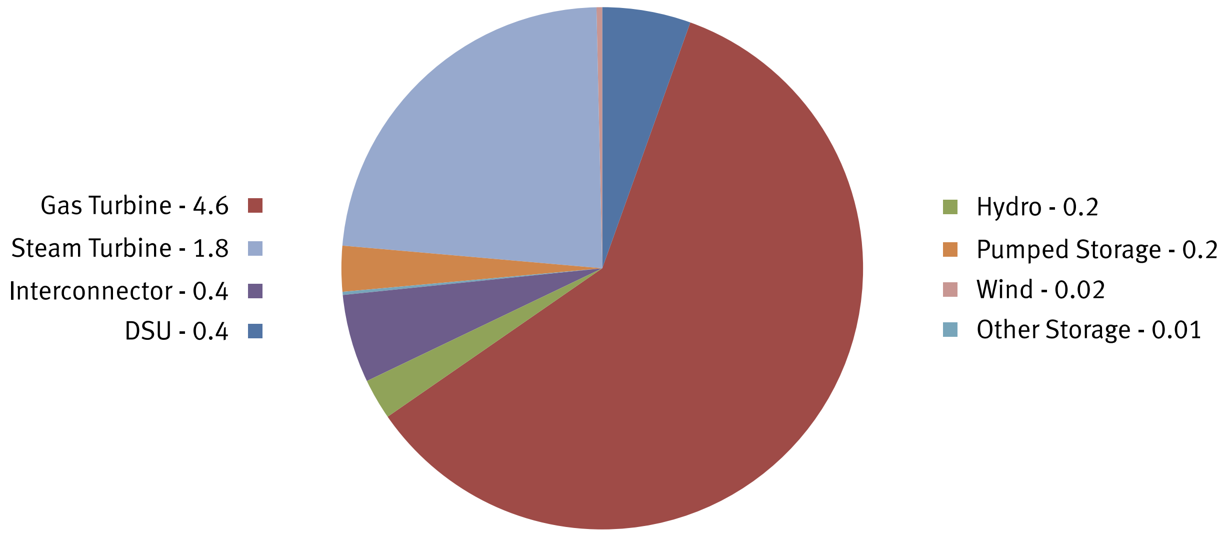


Figure 17: Total amount of de-rated capacity (GW) that cleared the T-1 2020/2021 All-Island Capacity Market by Technology Category

3.1.1. SEM Capacity Market Auction Results

The Single Electricity Market (SEM) is the wholesale electricity market for the island. 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. It was launched on the 1st of October 2018 to increase integration with European markets. This means that consumers here can benefit from low-cost generation from across Europe.

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 joint venture SEMO.

SEM Capacity Auctions

For the purposes of adequacy studies, EirGrid and SONI included all existing plant that have entered the SEM capacity auctions to date, not just the capacity that was successful in the auction.

We have included in the models the new entrant generation units that were successful in the CY2022/23 T-4 capacity auction from the start of 2023 and the CY2023/24 T-4 capacity auction from the start of 2024. It should be noted that, at time of publication, not all of these units had signed connection agreements in place.

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.

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 have informed EirGrid of their intention to decommission, as detailed below in Table 6. The main reason for decommissioning is increasing restrictions to emissions.

Plant	Export Capacity (MW)	Expected to close by the end of year:	Comment
Aghada (AT1)	90	2023	IED Limited Life-time Derogation. ESB has not provided a closure notice for these units.
Tarbert 1, 2, 3, 4	590	2023	Discussed with SSE. SSE has not provided a closure notice for these units.
Moneypoint	885	2025	Due to Moneypoint not being compliant of the Clean Energy Package of 550gCO_2/kWh. ESB has not provided a closure notice for these units. MP2 was not successful in the CY2022/2023 and CY2023/2024 T-4 SEM auctions.
Lough Ree	91	2020	Closing due to planning constraints.
West Offaly	137	2020	Closing due to planning constraints.
Edenderry	118	2023	Current planning expires at end of 2023. BnM has not provided a closure notice for this and are applying for planning permission extension.

Table 6: Assumptions for Plant closures in Ireland

At the time of publication, planning permission for Edenderry peat plant is due to end at the end of 2023. However, EirGrid notes that Bord na Mona are in the process to seek extension of 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 7 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.

Plant	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Forecast Available
ESB North Wall 5 GT	118	108	2023
ESB North Wall 4 GT	118	108	2023
Statkraft Ireland Offshore Project	500	48	2023
ESB Ringsend Gas Flexgen	70	64	2023
ESB Poolbeg Gas Flexgen	70	64	2023
ESB Corduff Gas Flexgen	70	64	2023
ESB Poolbeg 2hr Battery Storage	76	39	2023
ESB Southwall 2hr Battery Storage	30	17	2023
ESB Inchicore 2hr Battery Storage	30	17	2023
ESB Aghada 1hr Battery Storage	19	7	2023
Grange Backup Power Limited	115	104	2024
ESB Gas Turbine	13	11	2024
Data and Power Hub Services Limited	116	105	2024
Energia Battery Storage	23	18	2024
Ronaver Gas Turbine	2	2	2024

Table 7: Assumptions for new plant capacities for adequacy studies from 2023 or 2024

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 8.

For the purposes of adequacy studies, all existing plant that entered the T-4 2022/23 and T-4 2023/24 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.

Plant	Export Capacity (MW)	Expected to close by the end of year:	Comment
Kilroot ST1	238	2024	Did not qualify for T-4 2023/24 SEM Auction. Kilroot has indicated that it will reduce to 199 MW from mid-2020. Operation ceases in 2023.
Kilroot ST2	238	2024	Did not qualify for T-4 2023/24 SEM Auction. Kilroot has indicated that it will reduce to 199 MW from mid-2020. Operation ceases in 2023.

Table 8: Assumptions for plant changes in Northern Ireland

Kilroot ST1 and ST2 did not qualify for inclusion in the T-4 2023/24 auction in April 2020. New conventional generation were contracted in the SEM T-4 23/24 capacity auction in April 2020. This new generation is listed below in Table 9.

Plant	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Forecast Available
EP Kilroot	383	338	2024

Table 9: Assumptions for new conventional plant capacities for adequacy studies from 2024

Investment has been made in a Selective Non-Catalytic Reduction system at ST1 and ST2 to reduce emissions. They have been fully available in 2016, 2017, 2018 and 2019 and have an ability to purchase some additional emission allowances in the UK's NOx trading scheme. Kilroot believes that these units will be fully available under this arrangement until the end of June 2020.

Emission restrictions become tighter from July 2020 when the Transitional National Plan ends and units on oil firing could be limited to a rolling annual average of 1500 stack hours. In 2021 revised Best Available Techniques Reference Document restrictions will apply, so limits will tighten further. EP UK Investments has been working with a supplier that has developed a solution to further reduce NOx emissions though they have indicated that the solution is new technology so there is performance uncertainty until commissioning tests have been completed. This solution would only apply to the coal rating of 398 MW. In the absence of a formal notification of closure, SONI has modelled the units at the reduced capacity of 398 MW without run-hour or emissions restrictions for the purposes of the adequacy studies.

Current UK policy is to end coal-fired generation in Great Britain by 2025. However, EP UK Investments have confirmed that given the impact of the EU Clean Energy Package, and a lack of qualification in capacity auctions, Kilroot ST1 and ST2 units will cease coal operation in 2023.

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.

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

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, to 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 70% by 2030. This ambition is needed to honour the Paris Agreement. EirGrid awaits the publication of the Government's National Energy and Climate Plan which is expected in 2020. The document is expected to set out further details of how the Government envisions achieving the country's 2030 targets.

To promote the generation of electricity from renewable sources, the Irish Government announced a new Renewable Electricity Support Scheme (RESS). Framed within the context of Ireland's Climate Action Plan the RESS-1 auction has provisionally awarded 2,237GWh of contracts in August 2020[24]. This auction result accounts for approximately 10% of the amount forecast to be required to meet the 2030 targets. EirGrid worked closely with DCCAE and the CRU to implement the RESS auction process.

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[25] (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 (NOx), Sulphur Dioxide (SO2) and particulate levels have been tightened.

The Clean Energy Package targets all generation to be under 550g/kWh by 2025 and this limit will affect certain generation plants in Ireland.

In Ireland, some plants are affected by the IED, and have entered into the Ireland TNP (Transitional National Plan). However, it is not anticipated that their running regimes will be curtailed. For example, under the TNP, Moneypoint's availability will be closely linked to the performance of its abatement equipment.

3.5. Interconnection

3.5.1. North South Interconnector

As the second high capacity transmission link between Ireland and Northern Ireland is assumed to be available in 2024, and therefore an All-Island generation adequacy assessment can be carried out from 2024 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 by each system to the other. On this basis each TSO is obliged to help the other in times of 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[26, 27].

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. The capacity reliance values used for the adequacy studies are shown in Table 10.

24 http://www.eirgridgroup.com/site-files/library/EirGrid/RESS-1-Provisional-Auction-Results-(R1PAR).pdf
25 http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1502972300769&uri=CELEX:32017D1442
26 https://www.sem-o.com/documents/general-publications/Information_Note_on_Inter-Area_Flow_Constraints.pdf
27 http://www.EirGridgroup.com/site-files/library/EirGrid/OperationalConstraintsUpdateVersion1_82_May_2019.pdf

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

Table 10: Capacity reliance at present on the existing North South Interconnector

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 recently improved its adequacy assessment methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments. The Mid-Term Adequacy Forecast (MAF[28]) 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 derating 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[29] is shown in Table 11.

28 https://www.entsoe.eu/outlooks/maf/Pages/default.aspx
29 http://www.mutual-energy.com/electricity-business/moyle-interconnector/trading-across-the-moyle-interconnector/

Direction	Dates	Contracted Capacity (MW)	Additional Capacity Potentially Available (MW)	Potential Total Capacity Available (MW)
West to East	10 November 2017 to 30 November 2020	80	420	500
	1 December 2020 to 31 May 2020	307	193	500
	1 June 2020 to 31 October 2021	250	250	500
	1 November 2021 to 31 March 2022	160	340	500
	1 April 2022 Onwards	500	0	500
East to West	Each Year	450	-	450

Table 11: Transfer capacity of the Moyle Interconnector

It is difficult to predict whether or not imports for the full capacity will be available at all times.

For the purposes of adequacy studies, we treat the Moyle interconnector with a 60% external market derating 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 12 below contains a list of projects that has been assessed as part of the current European Ten Year Network Development Plan[30] 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 EPC contract it will be included in GCS adequacy studies.

Project	Description	Project Promoters Target Availability
Celtic Interconnector	Interconnector between Ireland and France (with PCI status[31])	2026/2027
Greenlink	Project providing interconnection to Great Britain (with PCI status[34])	2023/2024

Table 12: Proposed interconnection projects

30 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
31 EC Project of Common Interest, see: https://ec.europa.eu/energy/sites/ener/files/documents/memberstatespci_list_2017.pdf

3.6. Wind Capacity and Renewable Targets

In both Ireland and Northern Ireland, government policies are in place which set targets for the amount of electricity sourced from renewables. 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. Our 'Delivering a Secure Sustainable Electricity System' (DS3) programme aims to meet the challenges of operating the electricity system in a secure manner while achieving the 2020 renewable electricity targets[32].

In Ireland, DCCAE has 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% out to 2030[33].

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 connection schemes to develop renewable generation; Gate 3, Non-GPA and ECP-1. Figure 18 shows the breakdown of connected, contracted and in-process grid connections including ECP-1 wind, solar and battery projects. The graph represents the capacity of connection offers which have been issued however it is not clear yet what level of installed capacity will result from the total capacity offered. EirGrid publishes a list of all Transmission Connected wind generation in Ireland[34], while ESB Networks publishes that which is Distribution Connected[35].

As intermittent RES generation is deployed, challenges related to mismatch between energy generation and consumption become more critical. To help facilitate RES integration, Battery Energy Storage does not contribute directly to each regions RES-E target however it can help facilitate the integration of increased renewable energy capacity. Sufficiently flexible energy storage systems, particularly those connected through fast-response electronic interfaces would ideally complement a varied and disperse generation portfolio. In particular, various energy storage technologies are expected to provide a wide range of advanced services (mostly related to system integrity and stability, for instance synthetic/virtual inertia, frequency containment, frequency restoration and restoration reserves, ramping support, and energy balance; but also energy arbitrage over different time scales, from intra-daily to seasonal).

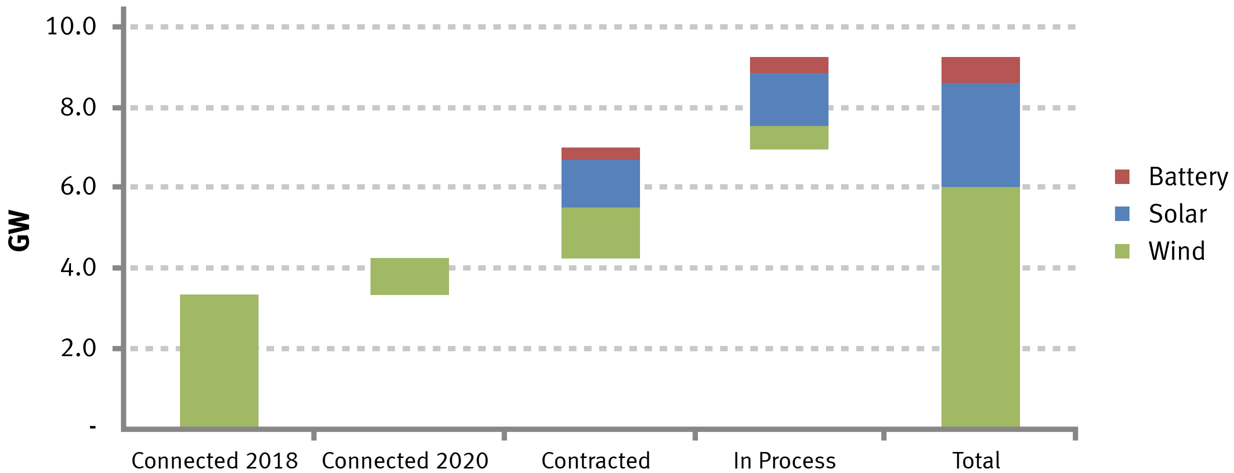


Figure 18: Connected, contracted and in-process grid connections in Ireland including ECP-1 wind, solar and battery projects

32 http://www.EirGridgroup.com/how-the-grid-works/ds3-programme/
33 https://www.dccae.gov.ie/documents/RESS%20Design%20Paper.pdf
34 http://www.EirGridgroup.com/customer-and-industry/general-customer-information/connected-and-contracted-generators/
35 https://www.esbnetworks.ie/new-connections/generator-connections/generator-connection-statistics

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 5MW and under.

	Existing (MW)	Planned (MW)
Northern Ireland TSO	121	0
Northern Ireland DSO	974	245
Total	**1,095**	**245**

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

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[36]. 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
  - Reduce reliance on peat fired plants –
    - Bord na Mona transition away from peat by 2028 – Current planning permission for Edenderry ends 2023 but seeking extension.
    - 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[37].
- 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 meters installation for all homes by 2024
- Revised market structures and grid connection processes to best facilitate the targets.

The GCS 2020 targets a scenario which achieves 70% RES-E as a basis for the GCS 2020 adequacy studies out to 2030. A renewable energy mix which could achieve the 70% RES-E target based on this year's GCS ten-year median demand forecast is shown below in Figure 19.

36 https://assets.gov.ie/10206/d042e174c1654c6ca14f39242fb07d22.pdf
37 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.

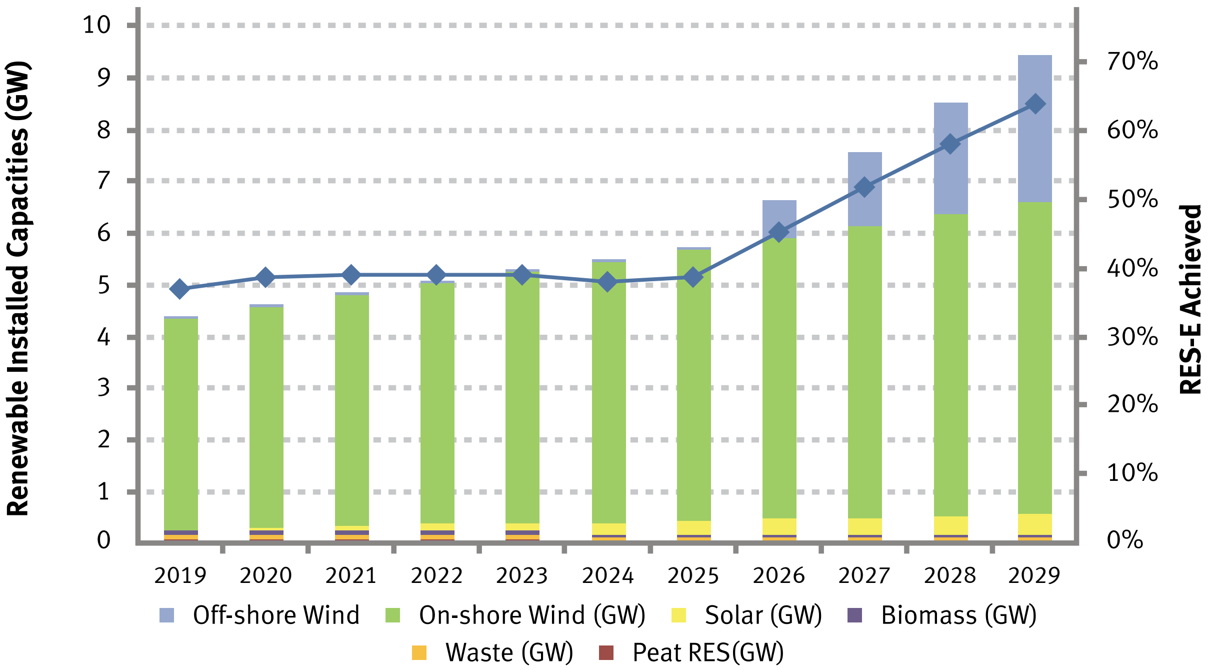


Figure 19: Example renewable energy generation portfolio which could achieve the 2030 70% RES-E target

Renewable electricity deployment takes a centralized pathway. The diversity of the renewables mix increases due to reducing levelised costs and auction designs: large scale onshore wind, offshore wind and solar PV are expected to be most prevalent. Carbon capture and storage could be developed to further decarbonize fossil fuel generation.

To promote the generation of electricity from renewable sources, the Irish Government announced a new Renewable Electricity Support Scheme (RESS). Framed within the context of Ireland's Climate Action Plan the RESS-1 auction has provisionally awarded 2,237GWh of contracts in August 2020[38]. This auction result accounts for approximately 10% of the amount forecast to be required to meet the 2030 targets. EirGrid worked closely with DCCAE and the CRU to implement the RESS auction process.

3.6.2. Wind Power in Ireland

The Irish Government has a target of 40% of electricity to be generated from renewable sources by 2020, as was restated in the 2015 White Paper on Energy[39]. The 40% RES-E target is 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.

Installed capacity of wind generation has increased from 135 MW at the end of 2002 to over 4127 MW at the end of 2019. This value is set to increase this year as Ireland endeavours to meet its renewable target in 2020 and beyond.

38 http://www.eirgridgroup.com/site-files/library/EirGrid/RESS-1-Provisional-Auction-Results-(R1PAR).pdf
39 http://www.dccae.gov.ie/energy/en-ie/Energy-Initiatives/Pages/White-Paper-on-Energy-Policy-in-Ireland-.aspx

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[40]. This is done by applying an average of the past 5 year's capacity factor. This normalised annual energy has grown from 4,200 GWh in 2011 to c. 9,500 GWh in 2019, which accounts for c. 31% of total electricity demand in 2019. The variation in wind capacity factors is displayed in Figure 20[41].

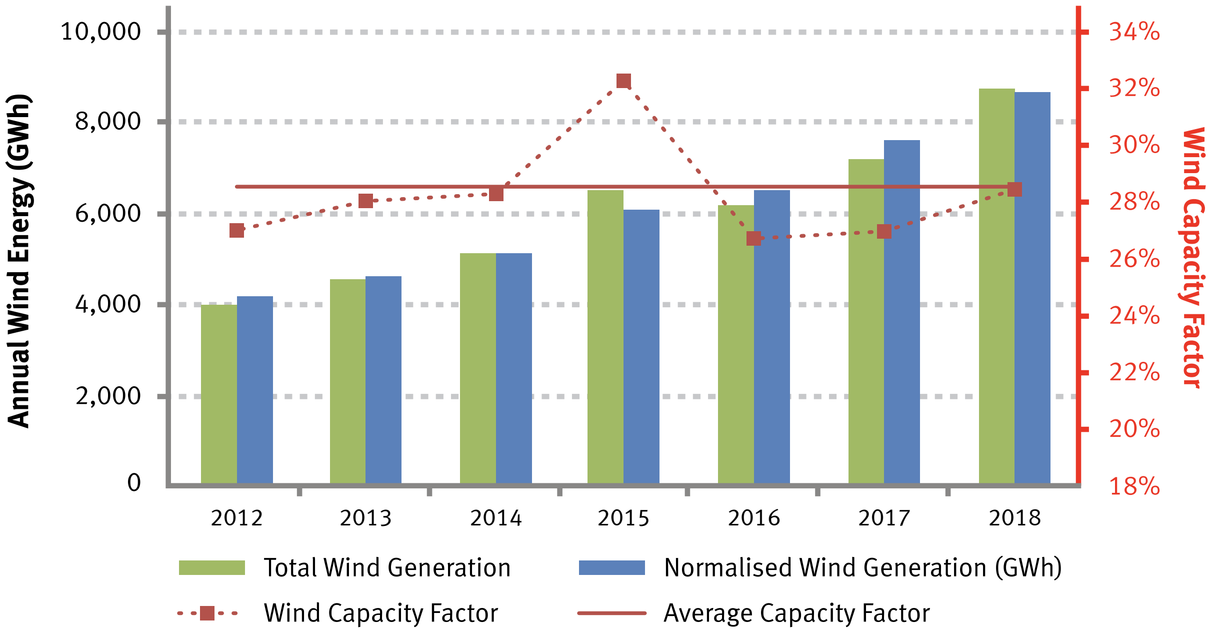


Figure 20: The actual and normalised annual energy produced from wind power in Ireland over the last six years. In red are the figures for annual wind capacity factor, and their average

The actual amount of renewable energy that will be required will depend on the demand in 2020. Also, the assumptions made for other renewable generation will have a bearing on how much wind energy will need to be generated to reach the 40% target. Lastly, a small amount of available energy from wind cannot be used due to transmission constraints or system curtailment. We estimated this to be approximately 6.9% in 2019[42]. This has varied between 2.8% and 6.9% over the past seven years.

Assumptions for wind capacity development post-2020 in this Generation Capacity Statement were developed using the Climate Action Plan 2019 targets.

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 and challenging decarbonisation targets. A public engagement process to inform and shape those proposals is underway. The intention is to have a draft policy options paper for consultation in Winter 2020/21.

The context for energy has changed substantially since the 2010 Strategic Energy Framework (SEF) was published. 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.

The SEF facilitated a significant increase in low carbon electricity with a target of 40% electricity from renewable sources by 2020. DfE proposes a new strategy will set a new target supporting the pathway to lower carbon energy. Ireland and Wales have both set targets of 70% by 2030, with Scotland aiming

40 http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN
41 http://www.eirgridgroup.com/how-the-grid-works/renewables
42 http://www.EirGridgroup.com/site-files/library/EirGrid/2017-Qtr4-Wind-Dispatch-Down-Report.pdf

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.

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 NIRO in 2017 means that there is no support scheme available in Northern Ireland to support 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 the cheapest and 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.

In the absence of an energy strategy approved by the Minister for the Economy we have based the expected growth of wind capacity on volumes of applications to SONI and NIE Networks which have accepted a grid connection offer.

For 2019, 39% of electricity consumption came from renewable sources (based on sent out metering) in Northern Ireland, most of which was from wind power.

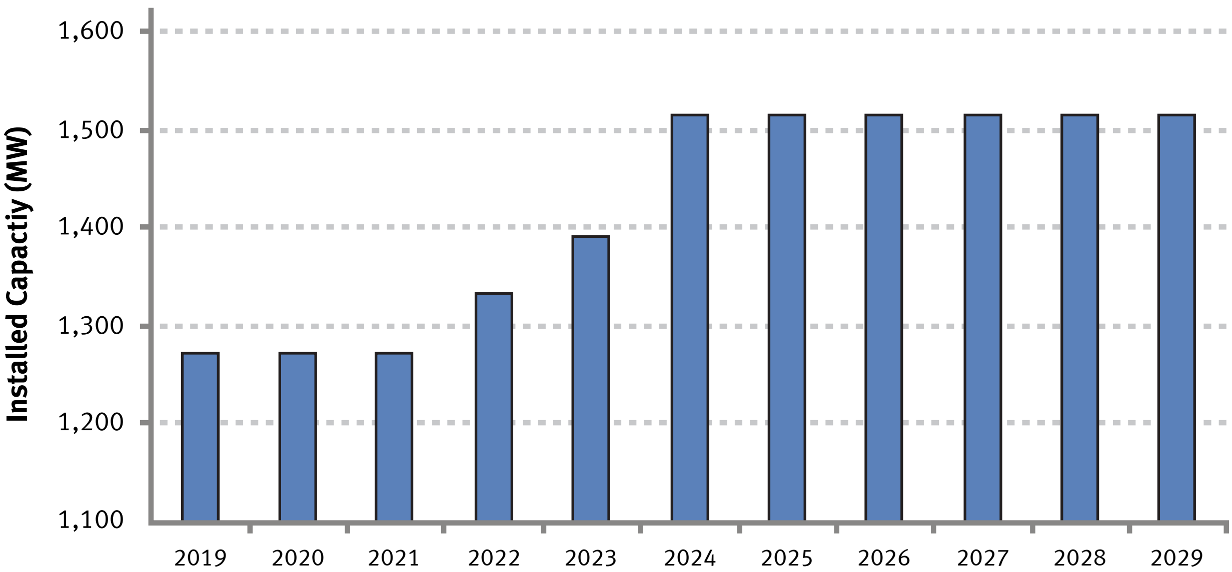


Figure 21: Expected growth of wind capacity installed in Northern Ireland

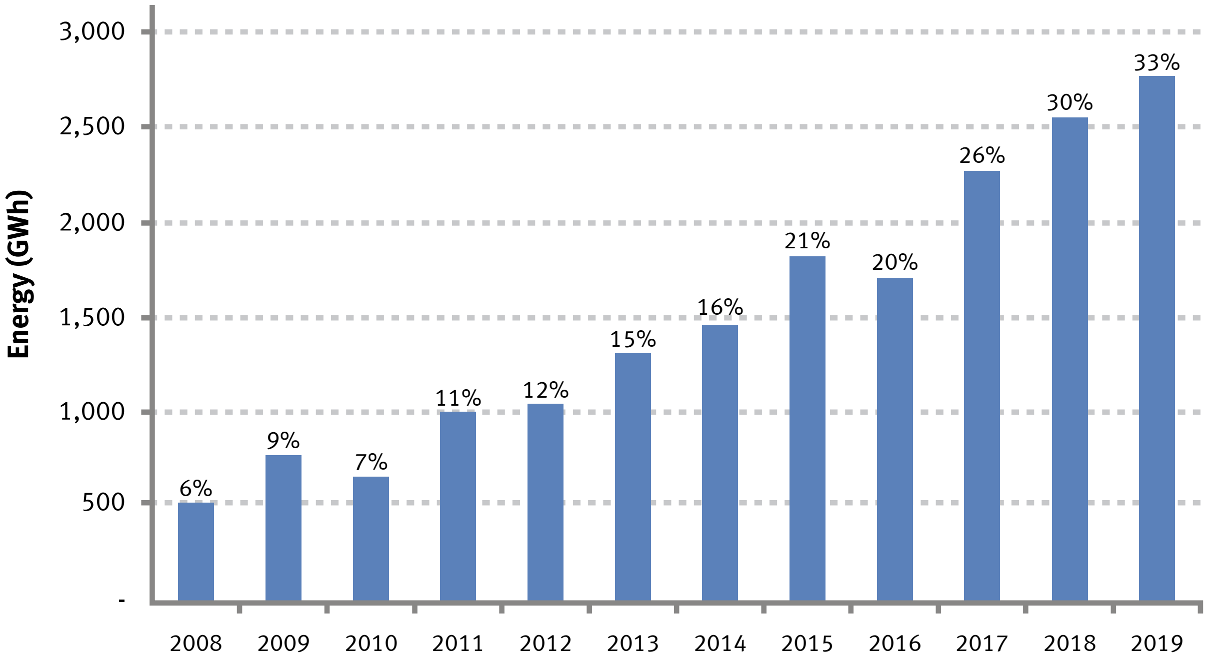


Figure 22: Historical wind generation for Northern Ireland in annual electricity terms

3.6.4. Operational Balancing Challenges and Solutions with Increasing Variable Renewable Generation in Ireland and Northern Ireland

Current operational policy in Ireland and Northern Ireland places limits on System Non-Synchronous Penetration (SNSP, comprising instantaneous variable generation output plus HVDC interconnector imports as a percentage of the system's electricity demand) to a maximum of 65%. This allows up to 90% of consumer demand to be met by renewables in certain periods, if interconnector export flows facilitate these levels of SNSP. This limit necessitates dispatching down of RES generation in certain situations, to preserve electricity system security. EirGrid and SONI are committed to increasing the SNSP limit to 75% by 2021. We recognise that in a 2030 system where variable generation will provide up to 95% of instantaneous demand, interconnection with other systems cannot be the sole answer to the facilitation of greater RES generation.

Variable generation forecast errors pose a unique challenge to operation of the system. The comparatively high installed capacity of variable generation (particularly wind) results in forecast errors that are a significant proportion of system demand. The island of Ireland's location on the edge of Europe and the influence of the jet stream on weather compounds the potential errors.

Figure 23 shows a set of wind power forecasts covering the period of a storm event in October 2018. The bold line is the median power forecast, with each of the other lines being individual forecasts covering the 30 hours within the prediction horizon. The spread of the individual forecasts represents known and unavoidable uncertainty in the procured renewable generation forecast.

One of the most cost effective ways of ensuring sufficient resources are available to cover the uncertainty from forecast errors is to explicitly include forecast error risks in the operational scheduling process. Therefore, EirGrid and SONI are including Ramping Margin (RM) reserve constraints within its operational scheduling tools, with time varying requirements that reflect the forecast uncertainty. A novel methodology has been developed to distil the uncertainty information of the individual forecasts in Figure 23. These characterisations of the forecast uncertainty ultimately translate to time varying RM reserve requirements that reflect the current weather conditions.

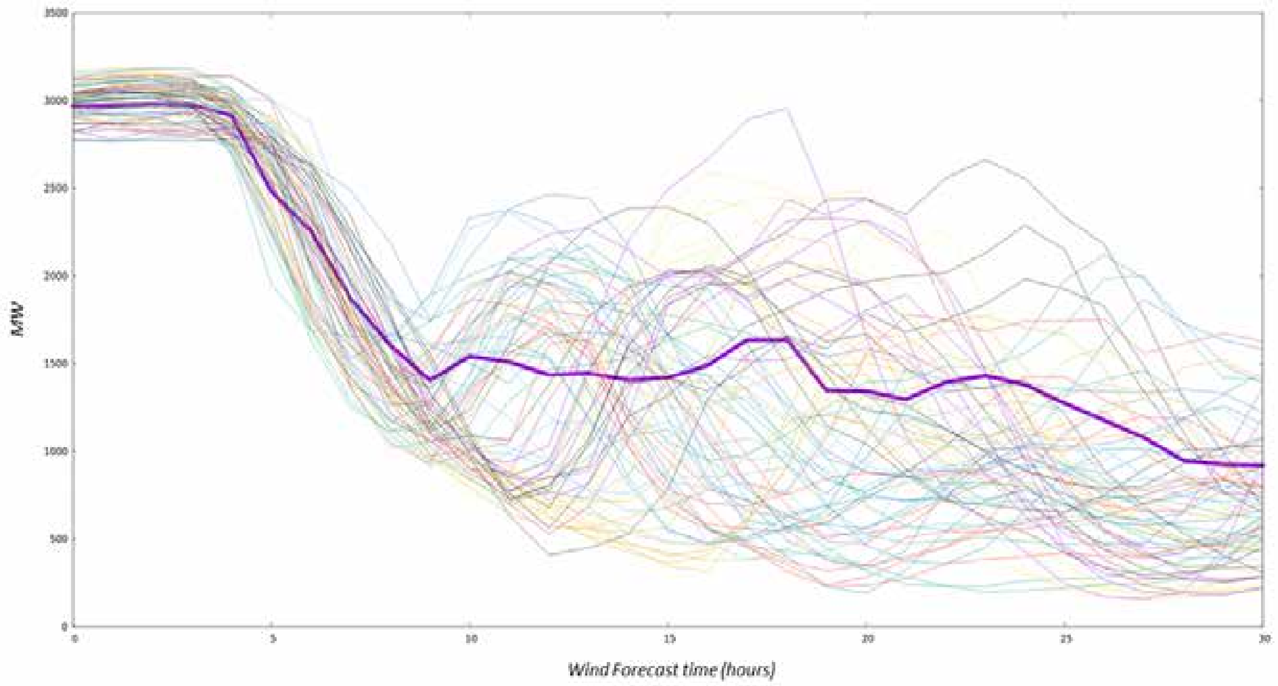


Figure 23: Renewable generation forecast and median values covering period of October 2018 storm event

The implementation of ramping margin reserves in the scheduling optimisation is a key enabler to moving from the current system non-synchronous penetration limit (SNSP) of 65% to 75% from 2020 and further increases in future years, along with "look-ahead" security assessment and voltage trajectory monitoring. The challenge of facilitating increases in non-synchronous generation is not to be underestimated.

3.6.5. Modelling of Wind Power in Adequacy Studies

The modelling of wind power in our adequacy studies matches 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.

Electricity CO_2 Emissions and supply efficiency in Ireland[43]

The EU Council agreed a 2030 Climate and Energy Policy Framework with a binding target of 43% reduction in ETS (Emissions Trading Scheme) sector emissions and a 30% reduction in non-ETS emissions, both compared to 2005. CO_2 emissions from electricity are included in the ETS emissions sector. The use of renewables in electricity generation in 2018 reduced CO_2 emissions by 4 Mt and avoided €430 million in fossil fuel imports.

The carbon intensity of electricity fell from 437 gCO_2/kWh in 2017 to 375 gCO_2/kWh in 2018. This was mainly due to increased wind generation and a 44% reduction in coal use for electricity generation for 2017 versus 2018, which is much less efficient and more carbon intensive than gas or renewables. This large reduction in coal use was due to a technical fault at Moneypoint. Without renewable energy the carbon intensity of electricity generation would have been over 500 gCO_2/kWh in 2018.

43 https://www.seai.ie/publications/Energy-in-Ireland-2019-.pdf - SEAI Energy in Ireland 2019 Report

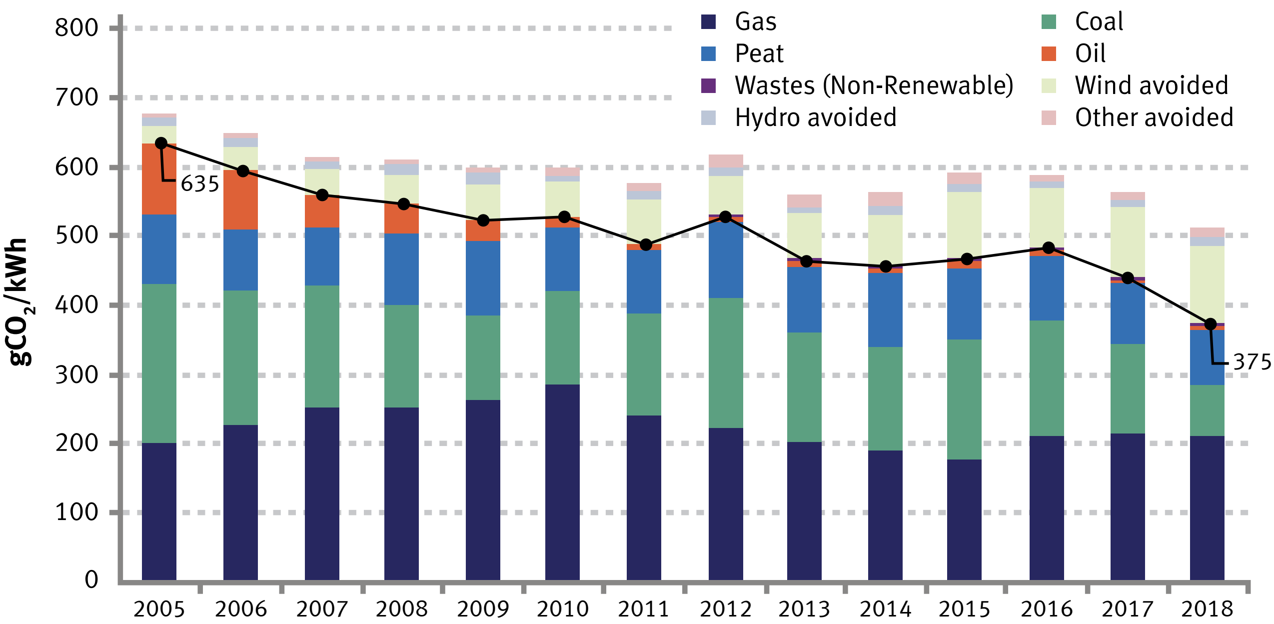


Figure 24: CO_2 emission per kWh of electricity supplied with contribution by fuel

From the mid-1990s onwards the efficiency of the electricity generation began to increase due to the introduction of higher efficiency natural gas plant, the increase in production from renewable sources, the closure of old peat-fired stations, and an increase in electricity imports.

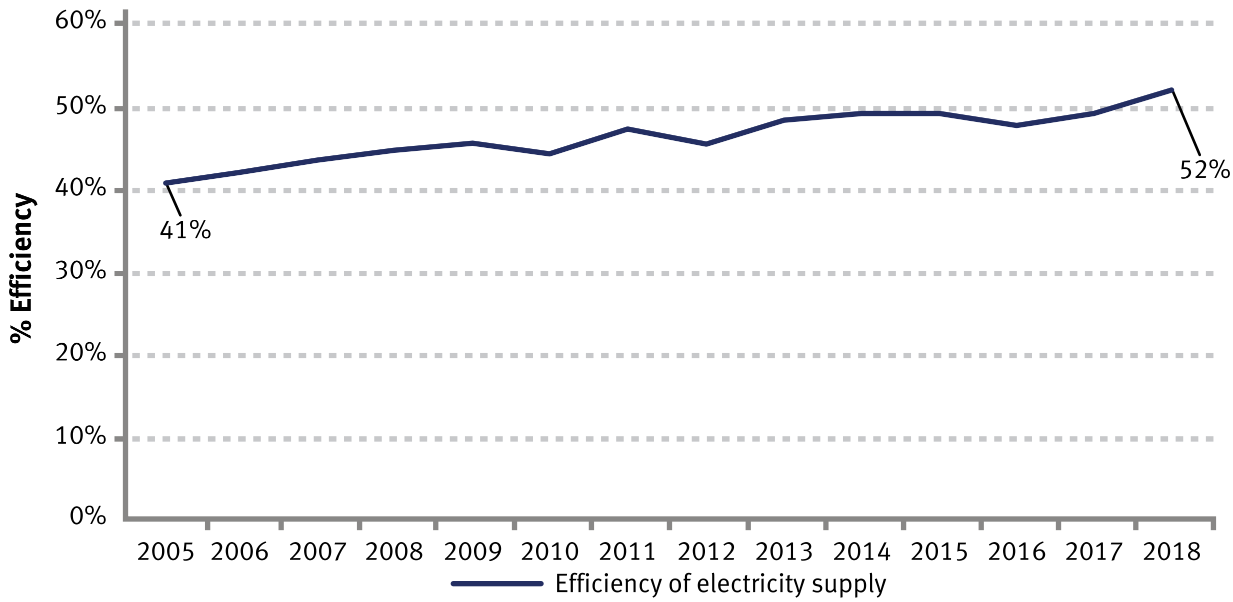


Figure 25: Efficiency of electricity supply[44]

Northern Ireland Greenhouse Gas Emissions

Northern Ireland's contribution to the UK fifth carbon budget requires emissions reductions of at least 35% against 1990 levels by 2030. Greenhouse gas emissions in 2017 were estimated to be 20 million tonnes of CO_2 equivalent, a decrease of 3% compared to 2016. The longer term trend shows a decrease of 18% compared to 2018 (base year).

44 https://www.seai.ie/publications/Energy-in-Ireland-2019-.pdf

The largest sectors in terms of emissions in 2017 were agriculture, transport and energy supply. The largest decreases since 1990 have been in the energy supply, waste management and residential sectors. These were driven by improvements in energy efficiency, fuel switching from coal to natural gas, which became available in the late 1990s, and the introduction of methane capture and oxidation systems in landfill management.

Between 2016 and 2017, emissions from the energy supply sector decreased by 15.1% and accounted for most of the total decrease. This is due to a reduction in coal combustion at power stations in Northern Ireland.

3.7. Other Non-Conventional Generation

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

3.7.1. Demand Side Units

A Demand Side Unit (DSU) consists of one or more individual demand sites that we can dispatch as if it was 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, 571 MW of DSU capacity cleared the T-1 Capacity Market auction held in November 2019 and 620MW successfully cleared the 2022/2023 T-4 Capacity Auction held in March 2019. EirGrid will continue to monitor this relatively new capacity in order to assess its contribution to system adequacy appropriately.

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 available their combined capacity to the market. An AGU capacity of 88 MW and a DSU capacity of 135 MW were successful in the T-1 Capacity Market auction held in November 2019. In the SEM T-4 2023/24 capacity auction, an additional 32MW of DSUs was contracted for Northern Ireland.

3.7.2. Small scale CHP

Combined Heat and Power 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 CO2 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 GCS19. 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.

3.7.3. Biofuel

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

For the previous GCS, EirGrid estimated there to be 54 MW of generation capacity powered by biofuel, biogas or landfill gas in Ireland. This amount has now been lessened to 24MW as an amount of biofuel units have registered as a DSU.

ESB peat units at Lough Ree and West Offaly are due to closed at the end of 2020 due to planning constraints.

Bord Na Monas Edenderry 118MW 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 is applying 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.

3.7.4. 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.

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 Project of Common Interest by the European Union[45]. 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 studies 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.

3.7.5. Waste-to-energy

Ireland has two waste-to-energy plants. The 61 MW Dublin waste-to-energy plant which was commissioned in 2017 and Indaver (17 MW). The GCS assumes a 50% renewable content, thus contributing to our RES-E targets.

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

45 https://ec.europa.eu/energy/maps/pci_fiches/PciFiche_2.29.pdf

3.7.6. Solar PV

In Ireland, the uptake of government support in this sector is unclear, and so EirGrid has assumed modest growth, reaching 430 MW by 2030, building linearly from todays 16MW. This is based upon economic studies carried out by McKinsey Consultancy and contained within the Climate Action Plan report.

In Northern Ireland, the capacity of small scale solar PV has increased rapidly in recent years. Connected capacity is approximately 117 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 134 MW. SONI expects capacity to grow to 179 MW by 2022. This projection shows no chance from last year's report.

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 2023/24 T-4 Capacity Market auction, i.e. 0.097[46].

3.7.7. 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 2029.

The Governments National Energy Climate Plan 2021-2030 forecasts 30MW 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.

3.7.8. Energy Storage

A number of battery projects have been contracted for via two mechanisms; SEM Capacity Auctions and DS3 Systems Services. These routes offer different but essential services to the power system on the Island. 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). Whereas 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 and that the regulatory approved generation adequacy standard is satisfied. This design helps to promote the short-term and long term interests of consumers of electricity across Ireland and Northern Ireland with respect to price, quality, reliability and security of supply of electricity.

The Regulated Tariff DS3 arrangements are available to any built generator (including batteries) that passes testing for DS3 service contracts. There are various batteries in different stage of development and are not under Volume Capped or Capacity Market so are open to standard DS3 payments.

There are 18 batteries that received connection offers under ECP-1.

The Regulated Tariff DS3 arrangement is the preferred route for attracting investment going forward.

46 https://www.sem-o.com/documents/general-publications/Initial-Auction-Information-Pack_IAIP2324T-4.pdf

For batteries, clarity on interactions between Volume Capped and the existing I-SEM arrangements has been provided in an information note published on the DS3 Consultations and Publications web page[47].

The battery projects currently contracted and/or under construction in Ireland are:

SEM Capacity Auction	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Assumed Available
ESB Poolbeg 2hr Battery Storage	100	39	2023
ESB Southwall 2hr Battery Storage	30	17	2023
ESB Inchicore 2hr Battery Storage	30	17	2023
ESB Aghada 1hr Battery Storage	19	7	2023
Ronaver	20	5	2024
Scottish Power	53	12	2024
Winter Winds	11	3	2024
Energia	23	18	2024

DS3 System Services Contract	Capacity (MW)	Assumed Available
Scottish Power Renewables (UK) Ltd	50	Sept 2021
Kilmannock Battery Storage	30	Sept 2021
Porterstown Battery Storage Limited	30	Sept 2021

Table 14: Battery projects currently contracted and/or under construction in Ireland

The Kilroot Energy Storage Array located in Kilroot Power Station began operation in 2016 and was the first battery project in Northern Ireland. An additional number of energy storage projects have connection offers with SONI.

The battery projects which were awarded contracts in the SEM T-4 2023/24 capacity auction in Northern Ireland are:

SEM Capacity Auction	Rated Capacity (MW)	Net De-Rated Capacity (MW)	Assumed Available
Drumkee Energy	35	8	2024
Energia	11	8	2024
Mullavilly Energy	35	8	2024

Table 15: Battery projects currently contracted in Northern Ireland

47 http://www.EirGridgroup.com/site-files/library/EirGrid/ISEM-Volume-Capped-interactions.pdf

3.8. 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. These use the 5-year averages per technology class. There are five different technology classes in the Capacity Market, and a system-wide class, see Table 16.

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

Table 16: Availability parameters that were used in the T-4 2023/2024 Capacity Market auction in April 2020

Thermal Plant Availability

In 2019, average system availability continued to decline or remain at a similar level as 2018. In particular, plant outages towards the end of the outage season bringing system availability down to a low of 76% in the month of September 2019.

Figure 26 shows Ireland system wide availability which has been decreasing for the past number of years. This affects generation plant ability to provide maximum adequacy support to demand.

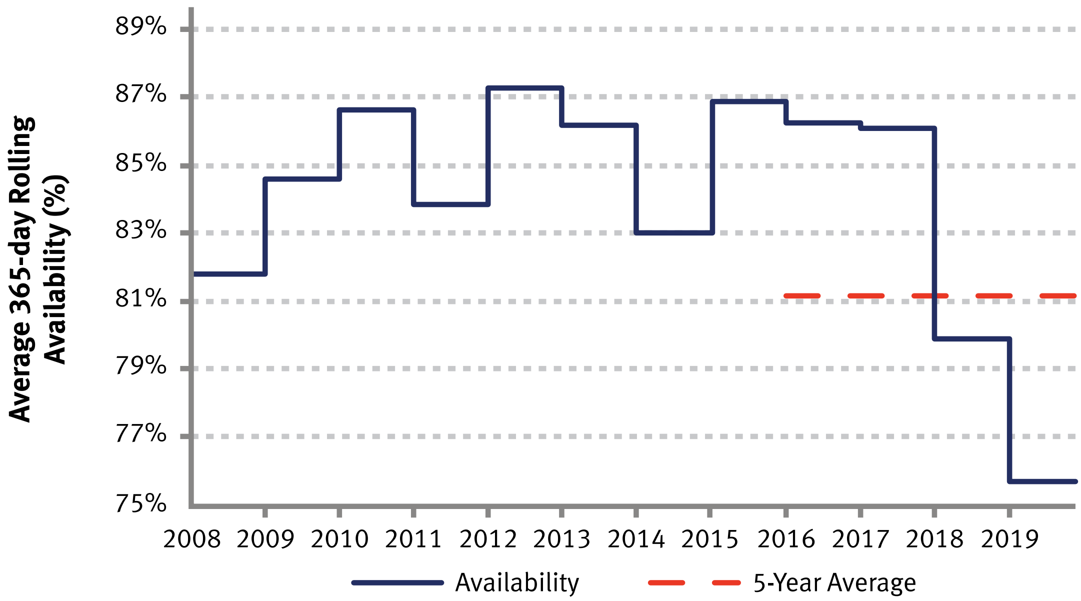


Figure 26: The average 365-day annual system-wide availability in Ireland

Ireland Forced Outage Rates have been increasing over the past number of years, linked to the system availability falling. This is displayed in Figure 27.

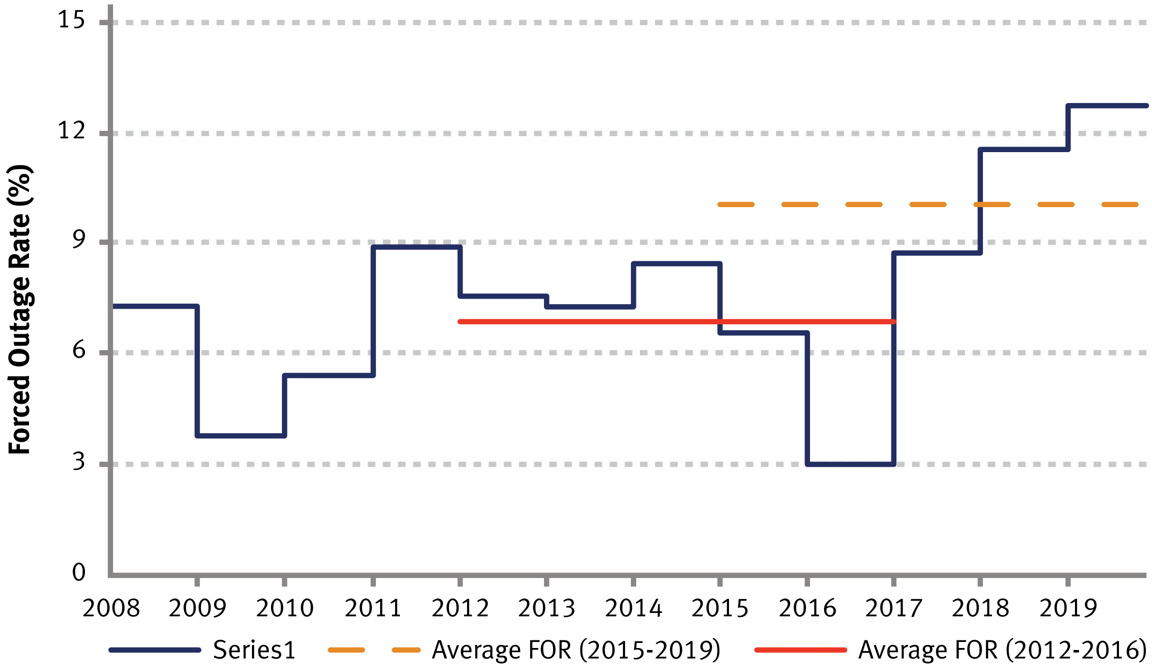


Figure 27: Average annual system-wide Forced Outage Rates in Ireland for each of the past 10 years (solid lines in navy blue), and also across 2014-2018 (Dashed Orange) and 2012-2016 (Solid Red)

For comparison, see the system-wide average FOR in Northern Ireland in Figure 28.

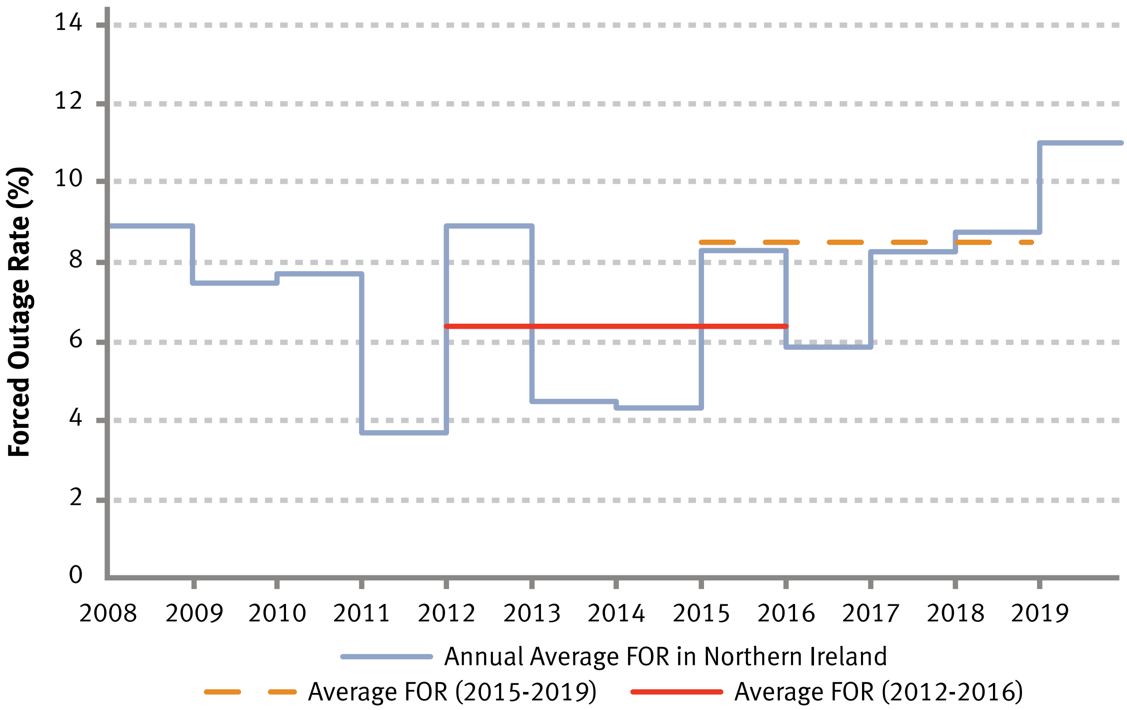


Figure 28: Average annual system-wide FOR in Northern Ireland for each of the past 10 years (solid lines in light blue), and also across 2014-2018 (Dashed Orange) and 2012-2016 (Solid Red)

In Ireland and Northern Ireland there has been a deterioration of unit availability over the past year with recent improvements in November/December 2019. In particular, the continued deterioration of the conventional plant unit availability in both Ireland and Northern Ireland was observed across 2019 as highlighted in Figure 29. This highlights the possibility of a low availability year occurring and we have analysed this in one of our adequacy scenarios.

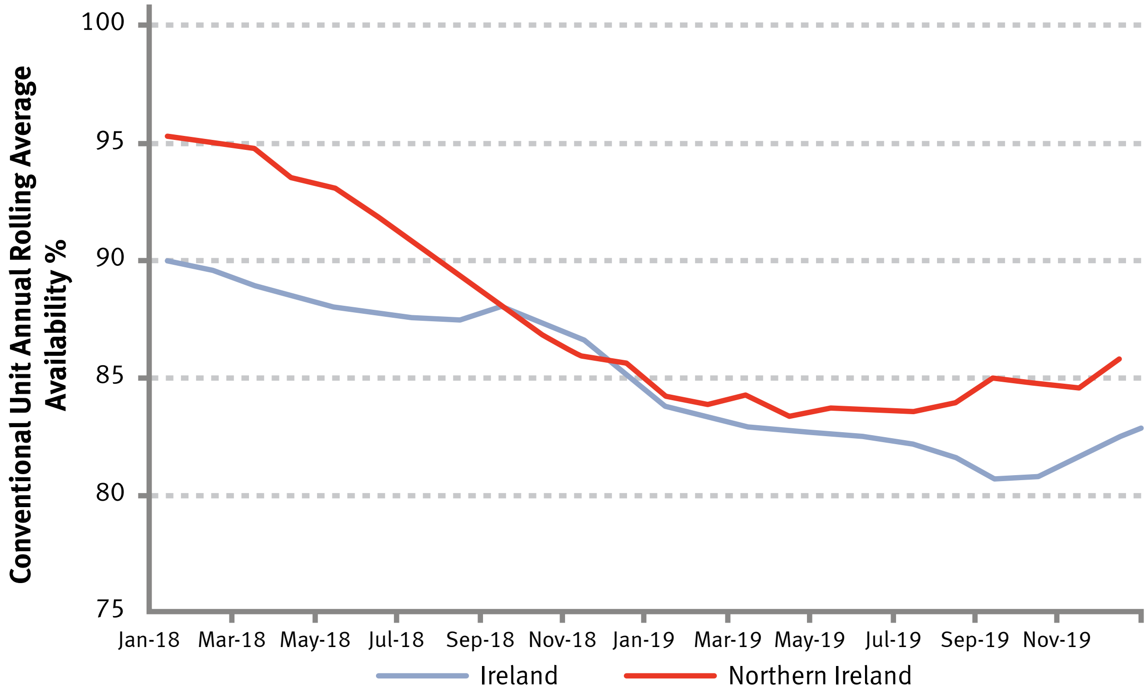


Figure 29: Ireland and Northern Ireland Conventional Unit Availability

4
Adequacy Assessments

4. Adequacy Assessments

4.1. Introduction

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 assessments were carried out for low, median and high demand scenarios. We also include a scenario at the 8th level demand forecast[48] for Ireland (this matches the level of demand chosen by the Least Worst Regrets methodology for the calculation of the Capacity Requirement in the 2023/24 T-4 Capacity Market auction).
- The portfolio excludes generation capacity that has notified us that they will be not available.
- The availability statistics match those used in the Capacity Market auction, i.e. 5-year average values for each technology category.
- The derating factor for the undersea interconnectors EWIC and Moyle was approximately 50%, as determined by the Regulatory Authorities.
- Typical profiles of demand and wind were used in the studies.
- The adequacy standard is set at 8 hours Loss of Load Expectation (LOLE) per year for Ireland and in the All-Island case.
- For Northern Ireland, the standard is 4.9 hours Loss of Load Expectation (LOLE) and assumes a 200 MW capacity reliance on Ireland.
- Ireland assumes a 100 MW capacity reliance on Northern Ireland.

The adequacy results are given in MW as a surplus (+) or deficit (-) of perfect plant (plant that is 100% available).

48 Demand Level 8 was selected in the 2018/19 T-1 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.

4.3. Adequacy Results for Ireland

The Ireland system starts in a position of significant surplus, as shown in Figure 30. 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. If capacity that was unsuccessful in the SEM capacity auctions close sooner than currently expected, then deficits may occur earlier also.

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.

The final scenario that we looked at is one in which if a large coal unit was to become unavailable from 2023 onwards. For this, EirGrid started with the Median demand scenario and then removed one coal unit. This is a study scenario only and EirGrid have not received a notice of closure for such a scenario.

You can see below how the adequacy situation dis-improves over the next ten years in Figure 30. This demonstrates the need for new low-carbon plant to be commissioned from 2026 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 2023/24 capacity auction.

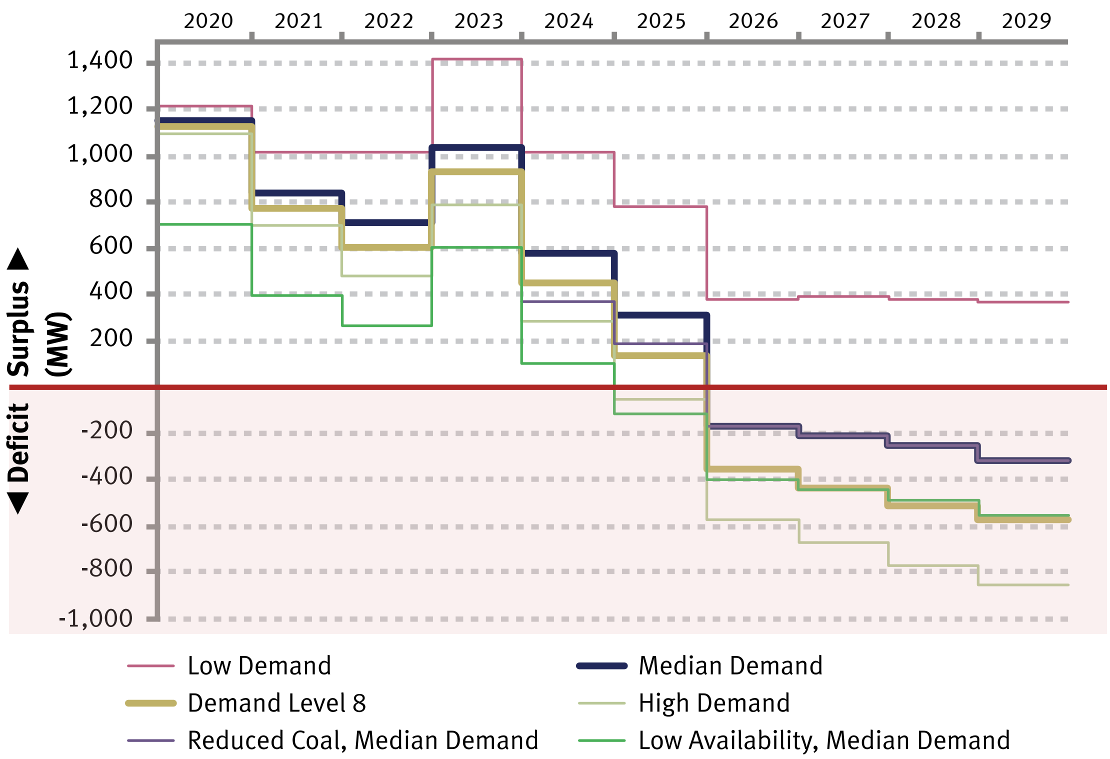


Figure 30: Adequacy results for Ireland, in terms of surplus or deficit of plant

4.4. Adequacy Results for Northern Ireland

Figure 31 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 approximately 290 MW for most years. This reflects the fact that there is no significant change expected in the median demand forecast.

These adequacy results include new generation which were awarded a contract in the SEM T-4 2023/24 capacity auction. This auction 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 absolutely vital for medium to long-term security – something which is critical to business and domestic consumers in Northern Ireland.

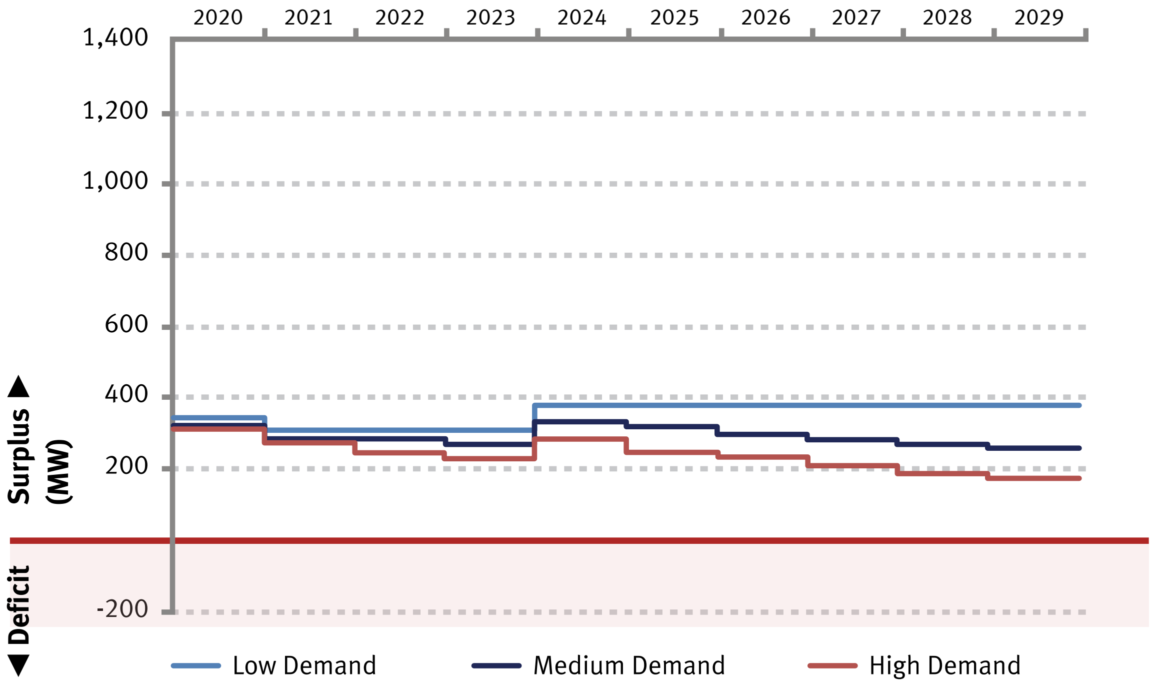


Figure 31: Adequacy results for Northern Ireland, in terms of surplus or deficit of plant. Results are given for the low, median and high demand scenarios.

4.5. Adequacy Results for the All-Island System

There are also studies carried out on an All-Island basis, which assume that the second North South Interconnector is available. The second North South Interconnector is assumed to be available in 2024.

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 32 shows the All-Island adequacy results for different scenarios. All scenarios see reducing surpluses over time, due to long term demand increasing and the assumed plant closures. The Low Availability and High Demand Scenarios show deficits from 2026 and the Demand level 8 Scenario shows deficits from 2028. 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 2023/24 capacity auction.

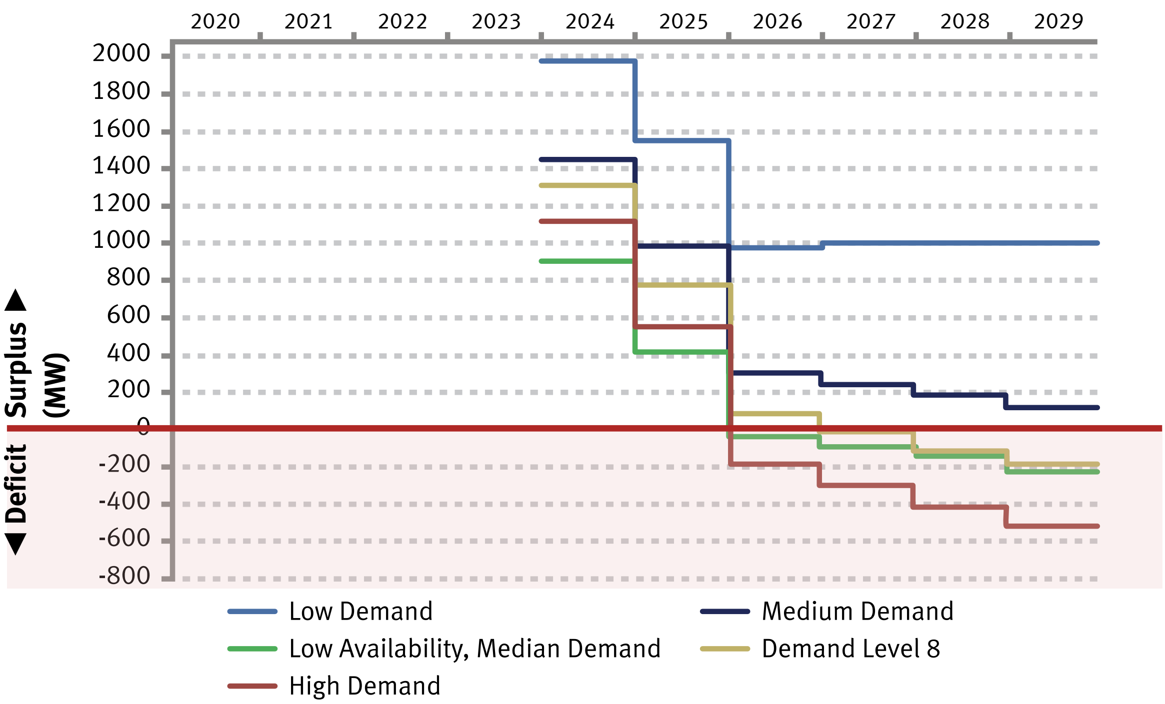


Figure 32: Adequacy results for the All-Island system

Appendices

Appendix 1 Demand Scenarios

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
2019	30.5*		8.7		39.2*		5.24	1.74	6.90	5.14	1.71	6.76
2020	31.4	3.0%	8.8	0.4%	40.2	2.3%	5.41	1.75	7.09	5.32	1.72	6.95
2021	32.7	3.8%	8.7	-0.3%	41.4	3.0%	5.57	1.76	7.26	5.46	1.72	7.11
2022	34.3	5.0%	8.7	0.0%	43.0	3.9%	5.75	1.77	7.45	5.63	1.73	7.29
2023	35.3	3.0%	8.8	0.4%	44.1	2.5%	5.89	1.78	7.60	5.77	1.74	7.44
2024	36.5	3.4%	8.8	0.6%	45.3	2.8%	6.03	1.79	7.75	5.91	1.75	7.59
2025	37.2	2.0%	8.8	0.1%	46.0	1.7%	6.12	1.80	7.85	6.01	1.76	7.69
2026	38.1	2.5%	8.9	0.4%	47.0	2.1%	6.21	1.81	7.95	6.09	1.77	7.79
2027	39.0	2.2%	8.9	0.7%	47.9	1.9%	6.30	1.82	8.05	6.18	1.78	7.89
2028	40.0	2.5%	9.0	0.8%	48.9	2.1%	6.39	1.83	8.15	6.28	1.79	7.99
2029	40.7	1.9%	9.1	0.8%	49.8	1.8%	6.49	1.83	8.25	6.37	1.80	8.09

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

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
2019	30.5*		8.7		39.2*		5.24	1.74	6.90	5.14	1.71	6.76
2020	31.0	1.7%	8.7	0.0%	39.7	1%	5.33	1.72	6.98	5.21	1.69	6.84
2021	31.5	1.5%	8.7	-0.4%	40.2	1%	5.37	1.72	7.02	5.26	1.69	6.88
2022	32.1	2.0%	8.7	-0.3%	40.8	1%	5.40	1.72	7.06	5.29	1.69	6.92
2023	32.9	2.2%	8.6	-0.3%	41.5	2%	5.46	1.72	7.12	5.34	1.69	6.96
2024	33.7	2.5%	8.6	0.0%	42.3	2%	5.52	1.72	7.18	5.40	1.68	7.02
2025	34.2	1.7%	8.6	-0.6%	42.8	1%	5.55	1.71	7.20	5.43	1.67	7.05
2026	34.9	1.8%	8.6	-0.2%	43.4	1%	5.57	1.71	7.22	5.46	1.67	7.07
2027	35.4	1.5%	8.5	-0.4%	43.9	1%	5.60	1.70	7.24	5.49	1.66	7.08
2028	36.0	1.8%	8.5	-0.1%	44.5	1%	5.64	1.69	7.27	5.52	1.66	7.11
2029	36.4	1.2%	8.5	-0.5%	44.9	1%	5.67	1.69	7.30	5.56	1.65	7.14

Table A-2: Low 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
2019	30.5*		8.7		39.2*		5.24	1.74	6.90	5.14	1.71	6.76
2020	31.9	4.5%	8.8	1.6%	40.7	3%	5.46	1.76	7.15	5.34	1.73	7.00
2021	33.8	6.0%	8.9	0.6%	42.7	5%	5.72	1.78	7.43	5.60	1.75	7.28
2022	36.3	7.3%	9.0	0.9%	45.2	6%	5.98	1.81	7.72	5.86	1.77	7.56
2023	37.5	3.4%	9.1	1.2%	46.6	3%	6.14	1.82	7.89	6.02	1.78	7.74
2024	39.1	4.3%	9.2	1.5%	48.3	4%	6.32	1.84	8.09	6.20	1.81	7.94
2025	40.4	3.3%	9.4	1.7%	49.8	3%	6.48	1.88	8.29	6.36	1.84	8.13
2026	41.9	3.7%	9.5	1.2%	51.4	3%	6.61	1.89	8.43	6.49	1.85	8.28
2027	43.3	3.4%	9.6	0.8%	52.9	3%	6.75	1.91	8.59	6.63	1.87	8.43
2028	44.8	3.4%	9.7	1.1%	54.4	3%	6.89	1.93	8.75	6.77	1.89	8.59
2029	45.9	2.5%	9.7	0.6%	55.6	2%	7.01	1.94	8.88	6.89	1.90	8.72

Table A-3: High Demand Forecast

Appendix 2 Generation Plant Information

	ID	Fuel Type	Technology Category	2020	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	571	
Ardnacrusha	AA1-4	Hydro	Hydro	86	
Dublin Bay	DB1	Gas/DO	Gas Turbine	405	
Dublin Waste	DW1	Waste	Steam Turbine	61	
Edenderry	ED1	Milled peat/ biomass	Steam Turbine	118	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	431	
Huntstown	HNC	Gas/DO	Gas Turbine	342	
	HN2	Gas/DO	Gas Turbine	408	
Indaver Waste	IW1	Waste	Steam Turbine	17	
Lee	LE1-4	Hydro	Hydro	27	
Liffey	LI1-4	Hydro	Hydro	38	
Lough Ree	LR4	Peat	Steam Turbine	91	To close at end 2020
Moneypoint	MP1	Coal/HFO	Steam Turbine	285	To close in 2025 due to CEP
	MP2	Coal/HFO	Steam Turbine	285	To close in 2025 due to CEP
	MP3	Coal/HFO	Steam Turbine	285	To close in 2025 due to CEP
Poolbeg CC	PBA	Gas/DO	Gas Turbine	230	
	PBB	Gas/DO	Gas Turbine	230	
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	241	To close by end of 2023

	ID	Fuel Type	Technology Category	2020	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	400	
West Offaly	WO4	Peat	Steam Turbine	137	To close at end 2020
Whitegate	WG1	Gas/DO	Gas Turbine	444	
Total Dispatchable including DSU				**7,525**	

Table A-4: Registered Capacity of dispatchable generation and interconnectors in Ireland in 2020 (MW) DSU: Demand Side Unit; HFO: Heavy Fuel Oil; DO: Distillate Oil

***Some CHP, Biomass and LFG units have registered as Demand Side units in the Capacity Market, and are therefore included in the previous**

At year end:	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Wind Onshore	4300	4500	4700	4900	5100	5300	5420	5540	5660	5780
Wind Offshore	25	25	25	25	25	25	725	1425	2125	2825
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	9	10	11	11
Conventional CHP	129	129	129	129	129	129	129	129	129	129
Solar PV	53	91	129	167	204	242	280	318	355	393
Total	**4596**	**4834**	**5072**	**5310**	**5547**	**5785**	**6643**	**7502**	**8360**	**9218**

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

At year end:	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
All Wind*	4325	4525	4725	4925	5125	5325	6145	6965	7785	8605
All Hydro	242	242	242	242	242	242	242	242	242	242
Biomass/LFG	54	84	84	84	84	84	84	84	84	84
(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	59	0	0	0	0	0	0
Solar	**53**	**91**	**129**	**167**	**204**	**242**	**280**	**318**	**355**	**393**
Total RES	**4744**	**4982**	**5220**	**5458**	**5636**	**5874**	**6732**	**7590**	**8447**	**9305**

Table A-6: All Renewable energy sources in Ireland (MW). We have assumed that the peat plant at Edenderry, Lough Ree and West Offaly will be approximately 30-35% powered by biomass by 2020

***The wind forecasts past 2020 are not based on exact projects. When more detailed information of wind developments is available, this will be included in the forecast.**

	ID	Fuel Type	Technology Category	2020	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	Reduces to 199 MW from mid-2020. Ceases operation in 2023.
	ST2	Heavy Fuel Oil*/ Coal	Steam Turbine	238	Reduces to 199 MW from mid-2020. 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	

	ID	Fuel Type	Technology Category	2020	Comment
AGU	AGU	Distillate Oil	Gas Turbine	88	
DSU	DSU	Various	DSU	135	
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 including DSU	**2,491**	

Table A-7: Registered Capacity of dispatchable generation and interconnectors in Northern Ireland in 2020 (MW).

At year end:	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Large Scale Wind	1095	1095	1095	1157	1215	1340	1340	1340	1340	1340	1340
Small Scale Wind	176	176	176	176	176	176	176	176	176	176	176
Large Scale Solar	134	134	134	179	179	179	179	179	179	179	179
Small Scale Solar	117	117	117	117	117	117	117	117	117	117	117
Small Scale Biogas	24	24	24	24	24	24	24	24	24	24	24
Landfill Gas	16	16	16	16	16	16	16	16	16	16	16
Small Scale Biomass	6	6	6	6	6	6	6	6	6	6	6
Renewable CHP	3	3	3	3	3	3	3	3	3	3	3
Other CHP	6	6	6	6	6	6	6	6	6	6	6
Small Scale Hydro	6	6	6	6	6	6	6	6	6	6	6
Waste-to-Energy	15	15	15	15	15	15	15	15	15	15	15
Total	**1598**	**1598**	**1598**	**1705**	**1763**	**1888**	**1888**	**1888**	**1888**	**1888**	**1888**

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

At year end:	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
All Wind	1271	1271	1271	1333	1391	1516	1516	1516	1516	1516	1516
All Solar PV	251	251	251	296	296	296	296	296	296	296	296
All Biomass/ Biogas/LFGas/ WTE	79	79	79	79	79	79	79	79	79	79	79
Renewable CHP	3	3	3	3	3	3	3	3	3	3	3
Hydro	6	6	6	6	6	6	6	6	6	6	6
Total RES	**1610**	**1610**	**1610**	**1717**	**1775**	**1900**	**1900**	**1900**	**1900**	**1900**	**1900**

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

Appendix 3 Methodology

Generation Adequacy Standard

Generation adequacy is assessed by determining the likelihood of there being sufficient generation to meet customer demand. 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 Loss of Load Expectation (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. In Ireland the adequacy standard is 8 hours and Northern Ireland 4.9 hours LOLE per annum as set by the relevant regulatory authority. 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

Lh,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

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

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.

	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**		

Table A-10: System for LOLE example

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.

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**

Table A-11: Probability table

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[49]. 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.

49 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.

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[50].

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 Loss of Load Expectation (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

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[51]. 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 34 shows the point at which this balance point is found – marked by X between both graphs.

50 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
51 http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Hunt_Making_Competition_Work.pdf

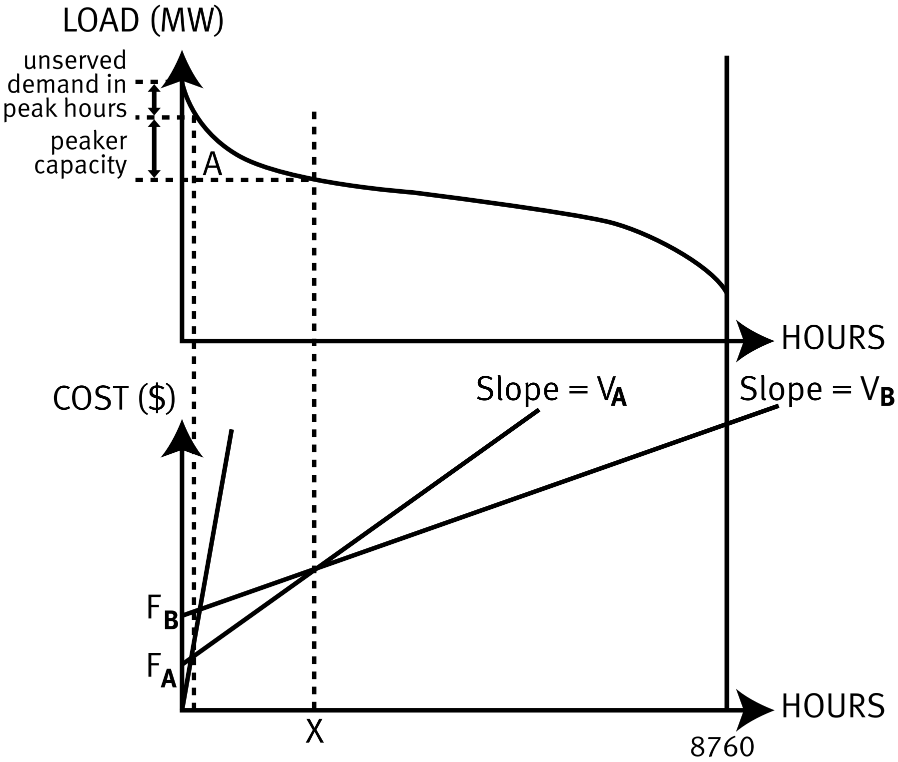


Figure 34: Balance point between the costs of a new entrant (CONE) to meet demand versus the cost impact of not meeting demand (VoLL) for a certain Loss of Load Expectation (LOLE)[52]

Future Developments in System Adequacy Modelling

All adequacy assessments outlined in this report are modelled using Adcal – an EirGrid and SONI in house software based in Excel VBA. AdCal is a probability-based tool used in determining generation adequacy. Adequacy assessment is a fundamental way of measuring whether the generation of electricity in a system meets the expected requirements and energy demand at a certain point in time. The integration of large amounts of renewable energy sources (RES), the completion of the internal electricity market, as well as new storage technologies, demand side response and evolving policies may require revised adequacy assessment methodologies.

AdCal will continue to be the way adequacy assessments are carried out however EirGrid and SONI will carry out studies to investigate if doing adequacy studies via PLEXOS would lead to advantages for this type of market assessment. There are significant advantages for EirGrid and SONI in changing from a convolution based probability calculation (AdCal and the PASA phase) to a Monte-Carlo based simulation. The PLEXOS PASA phase schedules maintenance in a similar way to AdCal, as they are based on convolution probability methods. These include having greater insight into the impact of generator outages on the system, the frequency particular outages and how these outages affect the hours of unserved energy and reserve shortfall, but also the amount of unserved energy and shortage throughout the year. With Plexos, operating reserves, market prices and transmission constraints could be applied and the effects on the system analysed.

Historically, the point with the highest load was chosen to assess generation adequacy, and the same approach was applied to evaluate the associated impacts on security of supply at a pan-European level. However, with the development of the energy generation mix, which means more fluctuating renewables in the system and less conventional fossil fuel generation, critical situations may occur in the future at different times than at peak demand.

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

The Capacity Requirement is the primary driver of the volume of capacity to be purchased by the market through the Capacity Market auction. The intention is that the level of capacity procured should be sufficient to maintain the agreed adequacy standard, i.e. the 8 hour LOLE standard.

EirGrid and SONI are therefore working to improve its existing adequacy methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments.

There are significant advantages in changing from a convolution based probability calculation (AdCal and the PASA phase) to a Monte-Carlo based simulation, in particular such modelling takes consideration of the energy limits of DSUs and battery units. These include having greater insight into the impact of generator outages on the system, the frequency of particular outages and how these outages affect the hours of unserved energy and reserve shortfall, but also the amount of unserved energy and shortage throughout the year.

With Plexos, operating reserves, market prices and transmission constraints could be applied and the effects on the system analysed. Also using the same model and same tool for all adequacy studies has the advantage of greater continuity between studies and associated output results.

Another significant advantage of the Monte Carlo method is that one can pinpoint the precise cause for high or low reliability indices. Outlier samples that may have a large influence on the indices can be easily identified and reported on as required.

Appendix 4 Adequacy Results

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
High Demand	1100	700	490	800	290	**-50**	**-570**	**-670**	**-770**	**-860**
Demand level 8	1130	770	610	940	450	140	**-360**	**-430**	**-510**	**-580**
Median Demand	1150	850	720	1050	580	310	**-170**	**-210**	**-260**	**-320**
Low Demand	1220	1020	1030	1420	1020	780	380	390	380	380
Low availability, Median Demand	710	400	270	610	110	**-120**	**-400**	**-440**	**-490**	**-550**
Reduced Coal Capacity, Median Demand	1150	850	720	1050	370	190	**-170**	**-210**	**-260**	**-320**

Table A-13: Results of adequacy studies for Ireland, given in MW of surplus plant (+) or deficit (-)

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Median Demand	320	280	280	270	330	320	300	280	270	260
Low Demand	340	310	310	310	380	380	380	380	380	380
High Demand	310	270	240	230	280	240	230	210	180	170

Table A-14: Results of adequacy studies for Northern Ireland, given in MW of surplus plant (+) or deficit (-)

Scenario	2024	2025	2026	2027	2028	2029
High Demand	1120	560	**-180**	**-290**	**-420**	**-520**
Demand level 8	1310	780	80	0	**-100**	**-180**
Median Demand	1460	990	310	250	190	120
Low Demand	1980	1560	980	990	990	980
Low Availability - Median Demand	910	420	**-30**	**-90**	**-160**	**-220**

Table A-15: Results of adequacy studies for the All-Island system

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