Northern Ireland Constraints Report

Solar and Wind

Version 1.0
Q3 2023

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At this time, we do not consider the Climate Change Act target of 80% renewables by 2030 or the impact of the emerging carbon budget. In the future SONI will endeavour to update the analysis to consider evolving policy and regulatory considerations. For future editions of this report, we will actively engage with relevant stakeholders, across government departments, the Utility Regulator and industry.

Also to note: inclusion of a particular wind or solar farm in this analysis does not indicate or confirm any right of that developer to connect to or use the network.

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Document History

Version	Date	Comment
1.0	07/2023	

Table of Contents

Document Structure

This document contains six main sections, and three Appendices with an Abbreviations and Terms section at the end.

The structure of the document is as listed below.

Much of this document describes study assumptions and methodology. For customers wishing to see the estimated Total Dispatch Down for Northern Ireland, please proceed to both Section 6 and Appendix C.

Section 1: Introduction and Summary: presents the purpose of the report and a general overview of the study.

Section 2: Study Scenarios: introduces the study areas, the study years and the generation scenarios. Together, these comprise the study scenarios.

Section 3: Study Input Assumptions: describes the study assumptions as they relate to network, demand, interconnection, generation and system operational limits.

Section 4: Study Methodology: provides an overview of the software used and how the model is put together. A description of how Total Dispatch Down results are apportioned is also provided.

Section 5: Results: Overall and by Constraint Area: provides an overview of the reduction in renewable generation forecasted by this study at system level for Northern Ireland as well as the more detailed results for the four constraint areas.

Appendix A: Network Reinforcements: lists the reinforcements that are included in the study for each study scenario. These reinforcements have a material impact on the resulting constraints. This section also lists the representative transmission outage scheduled included within the analysis.

Appendix B: Generator Details: provides an overview of the generation. It also provides a comprehensive list of the individual generators included in the study.

Appendix C: NI Node Results: provides a table of results for every node in the area. This table documents the installed capacity, available energy, surplus, curtailment and constraint for every node in NI.

Appendix D: Contingencies and Lines Overloading: provides for the two study years with 100% capacity, the number of hours of network lines which were binding with respect to particular N-1 contingency.

Appendix E: List of Nodes in the Constraint Areas details a table of the nodes assumed in each of the constraint areas.

Appendix F: Reference to Ireland ECP 2.2 Study: references where the Ireland ECP 2.2 study sits in context of this Northern Ireland constraints study.

The **Abbreviations and Terms** provide a list of the abbreviations and terms used in the document.

With the final chapter on **References**.

Important Note

This NI constraints report presents an estimate of the reduction in available solar and wind generation based on the study assumptions described. In this report we split the reduction in available generation into three categories: surplus, curtailment and constraint.

The implementation of Articles 12 and 13 of the EU Regulation 2019/943[1] will determine the commercial treatment of renewable generation under these three categories of generation.

Following the SEMC decision on the 22nd of March 2022[2] (SEM-22-009 Decision Paper on Dispatch, Redispatch and Compensation Pursuant to Regulation EU 2019/943), the detailed design of Articles 12 and 13 implementation has yet to be determined by SONI and may differ from the pro-rata implementation for constraints used in this study. Therefore this report assumes an interpretation of the likely design as detailed later in this report.

This report uses the term "Total Dispatch Down" to refer to the total reduction in available solar and wind generation i.e., the sum of surplus, curtailment and constraint is considered as the key indicator for the results. However, the term "dispatch down" is more correctly applicable only to TSO instructions to reduce generation output from a market position, as is the case for curtailment and constraint. It is not necessarily applicable to a generator reducing its own output from its availability to a market position so that supply and demand are balanced, as is the case for surplus.

We use the terms "non-priority" and "not-priority" generators synonymously in the report.

The results presented in this report are based on the simulation and modelling assumptions described. The findings are indicative only and this report should in no way be read as a guarantee as to future levels of surplus, curtailment and constraint.

The constraints analysis performed for this report is informed by the generation portfolio in the original Shaping Our Electricity Future v1.0 roadmap. Shaping Our Electricity Future v1.0 explores how the Northern Ireland Energy Strategy, which included a target of 70% RES-E by 2030, could be achieved. It is important to note that current policies for 80% renewables by 2030, and carbon budgets are not included.

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=NL

[2] https://www.semcommittee.com/sites/semc/files/media-files/SEM-22-009%20Decision%20Paper%20on%20Dispatch%2C%20Redispatch%20and%20Compensation%20Pursuant%20to%20Regulation%20EU%202019943.pdf

1 Introduction and Summary

1.1 Objective

The purpose of this work is to assess the possible total dispatch down levels for existing and new generation connections in Northern Ireland for the years 2025 and 2030. Five study scenarios in total have been assessed, comprising different quantities of new generation capacity in the two study years. This study builds on the Northern Ireland Constraints Report 2016[3], which covered the period from 2016 – 2024.

Northern Ireland's aim to deliver 40% of electricity from renewable generation (RES-E) by 2020 led to a significant number of new renewable generation connections; assessing the impact of these was a major driver for the 2016 constraints report. In a similar fashion, meeting the Northern Ireland Assembly's target of 80% RES-E by 2030 will require a significant increase in renewable generation capacity from today, and this report looks at the resulting impact on generation dispatch down.

SONI's Transmission Development Plan Northern Ireland (TDPNI) 2021 outlines planned network investments required across the next decade; many of these are necessary to accommodate the volume of renewable generation required to deliver the 2030 target. SONI's Shaping Our Electricity Future (SOEF) roadmap published in November 2021 details the generation portfolio required to deliver a target of 70% RES-E by 2030. This Northern Ireland constraint study makes use of both the TDPNI 2021 and the Shaping Our Electricity Future 1.0 roadmap to assess the likely levels of total dispatch down.

SONI recently published an update to its SOEF roadmap which details the generation portfolio required to deliver 80% RES-E by 2030, in line with an updated target set in the Climate Change Act (Northern Ireland). The impact of this will be assessed in a future Northern Ireland constraints study.

In Ireland, EirGrid recently published 12 regional constraints reports for ECP 2.2 wind and solar projects. The all-island PLEXOS market model developed for the ECP 2.2 analysis was used for this Northern Ireland constraints analysis report, ensuring consistency of assumptions. Some changes have been made to reflect latest developments in Northern Ireland; where any differences arise, they are summarised in this report.

This Northern Ireland constraints report presents results for a range of generation scenarios and indicate the levels of Total Dispatch Down that solar and wind generation might experience in the future.

The surplus renewable generation, curtailment and constraint results for Northern Ireland are included in Chapter 5 and in Appendix C.

1.2 Northern Ireland Policy Context

Across the last decade, the successful integration of renewable generation allowed Northern Ireland to meet and exceed a target of 40% RES-E by 2020. Several targets have subsequently been set following the achievement of this target:

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[3] https://www.soni.ltd.uk/media/documents/Operations/SONI%20Northern%20Ireland%20Constraints%20May%202016.pdf

- In December 2021, the Northern Ireland Executive published its Energy Strategy, which included a target of 70% RES-E by 2030. How such a target could be delivered was explored in detail in SOEF v1.0.
- In June 2022, the Climate Change Act (Northern Ireland) set a revised target into law of 80% RES-E by 2030. SOEF v1.1 explores what additional changes are required to deliver this on top of those already published in the original SOEF roadmap.

As SOEF v1.1 was only published in July 2023, the full impacts of the generation portfolio outlined in that roadmap are not considered in this report. The constraints analysis performed for this report is heavily informed by the generation portfolio described in the original SOEF v1.0 roadmap. The assessment of the generation portfolio in SOEF v1.1 will be considered in a future iteration of the NI constraints analysis.

1.3 Study Cases Overview

SONI studied five study scenarios in this work. The five scenarios are a product of generation scenarios and study years. There are two generation scenarios, an initial and 100% generation capacity case. When each of these capacity cases is studied in each study year of 2025 and 2030, that yields the four core study scenarios. A fifth scenario, known as the offshore study case, also studies 2030 year and a 100% capacity case with the inclusion of 500 MW of offshore. The purpose of alternating testing different capacity cases in different study years is to illustrate the effect of changes in demand, network and interconnection between study years. This is described in more detail in Chapter 2.

1.4 Assumptions Summary

The evaluation of Total Dispatch Down is impacted by a range of assumptions including generation, demand, interconnection, network and operational limits. Chapter 3 expands in more detail on the numbers and sources for these assumptions. In this opening chapter, Table 1-1 presents a summary of the assumptions used in this study including generation, demand, network and operational constraints. Where relevant, assumption sources are noted in the table.

Feature	Assumptions
Study period	The study horizons are 2025, & 2030
Demand	The TER demand is from the Generation Capacity Statement (GCS) 2022 – 2031, median demand scenario.
Generation	Total renewable generation capacity installed between initial and 2030 in the NI study is 1.3 GW. Total generation capacity (Wind and Solar) considered in the fifth study case is 3.6 GW which is inclusive of 0.5 GW offshore.
Network developments	The network development is based on the Ten Year Transmission Forecast Statement 2021, the Transmission Development Plan for Northern Ireland 2021 – 2030 (TDPNI), and Shaping Our Electricity Future 1.0 (SOEF).
Security constraints	System Non-Synchronous Penetration, Inertia, RoCoF limit and Min. These are discussed in more detail in Section 3.11.
Core NI Constraints scenarios	2025: Initial and 100% of all offers up to and including all known new connections and offers being considered in SOEF 1.0 2030: Initial and 100% of all offers up to and including all known new connections and offers being considered in SOEF 1.0
Sensitivities	Offshore Grid: 100% capacity case based on SOEF 1.0 with the addition of 500 MW offshore as fifth sensitivity test case.

Table 1-1 Summary of Assumptions

1.5 Definition of and Types of Dispatch Down

Total Dispatch Down is defined as follows:

Total Dispatch Down[4] = Surplus + Curtailment + Constraint

[4] For the purposes of this report, the term "Total Dispatch Down" includes Surplus Renewable Generation. Note however that "dispatch down" more correctly refers to dispatch away from a market position and as such, includes curtailment and constraint but not necessarily surplus renewable generation.

Figure 1-1 Total Dispatch Down Equation

The distinction between these components of dispatch down is shown in Figure 1-2 highlighting the generation type and spatial region over which they have an effect. These definitions and how they are apportioned in the results are discussed in more detail in Section 4.5.

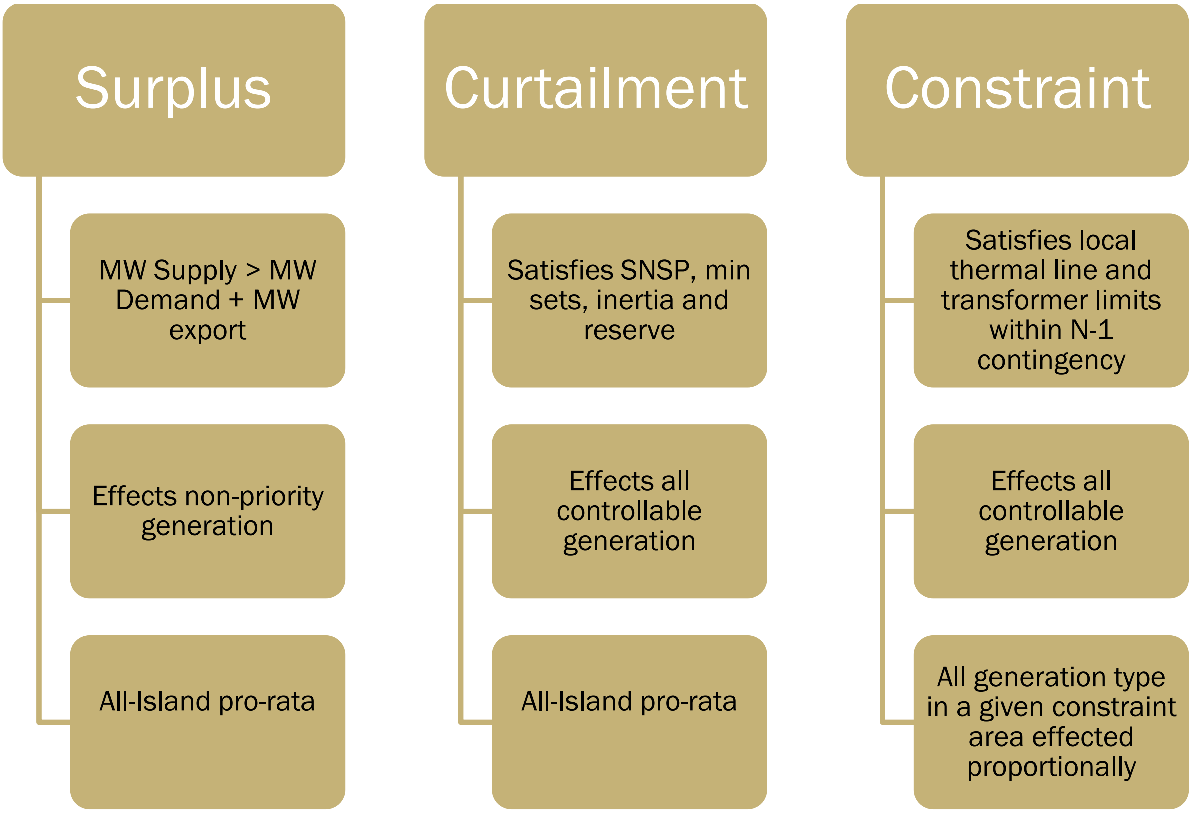

Figure 1-2: Overview and distinction between the different types of dispatch down

1.5.1 Historical Perspective on Dispatch Down

From a historical perspective, as the installed capacity of renewable generation has increased over the last decade, dispatch down has tended to increase accordingly, as demonstrated in Figure 1-3. With onshore wind being the dominant renewable generation technology in Northern Ireland, Figure 1-3 focuses on this technology only. Historically, there was a lack of dispatch down due to surplus renewable generation, which plays a more prominent role in the results in this report. The chart also shows the impact of wind availability on the total dispatch down. For example there was reduction in dispatch down from 2020 to 2021, despite an increase in installed wind generation capacity.

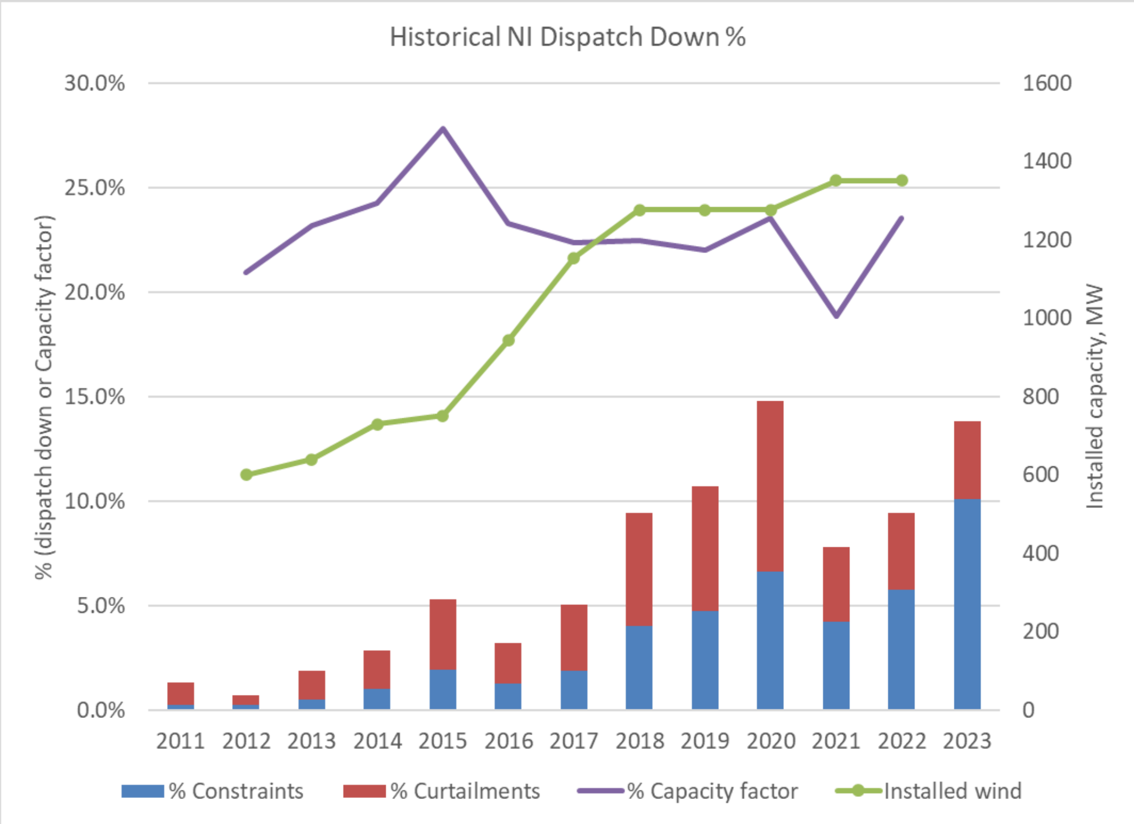

Figure 1-3: Reflection on historic install rate of onshore wind, historic capacity factor and historic % dispatch down components for Northern Ireland.

1.6 Methodology Summary

The Northern Ireland constraints analysis uses SONI's consistent methodology for assessing dispatch down and its contributory components. Plexos Market Simulation software is used deploying an All-Island model. An All-island model is used to get an accurate reflection of generation reduction levels given that surplus and curtailment dispatch down are All-Island issues. The reciprocal Ireland study is discussed in Appendix F.

In this study, SONI conducted five study scenarios. For a given study scenario three sequential model runs are performed to assess the contributory components of surplus, curtailment and constraint dispatch down. Results processing apportions the dispatch down components pro-rata across the generation according to the dispatch down type. The methodology is elaborated in further detail in Chapter 4.

1.7 Results Summary

As a summary conclusion, this study assesses estimates for total dispatch down for Northern Ireland based on SOEF 1.0 generation and TDPNI 2021 network. It examines the effect of generation, effect of network and effect of offshore as illustrated in Figure 1-4. In the scenario where 500MW of offshore wind is connected by 2030, the modelling shows that 18.3% of renewable generation would be dispatched down. This is made up of 14.1% oversupply, 2.9% curtailment and 1.1% constraint.

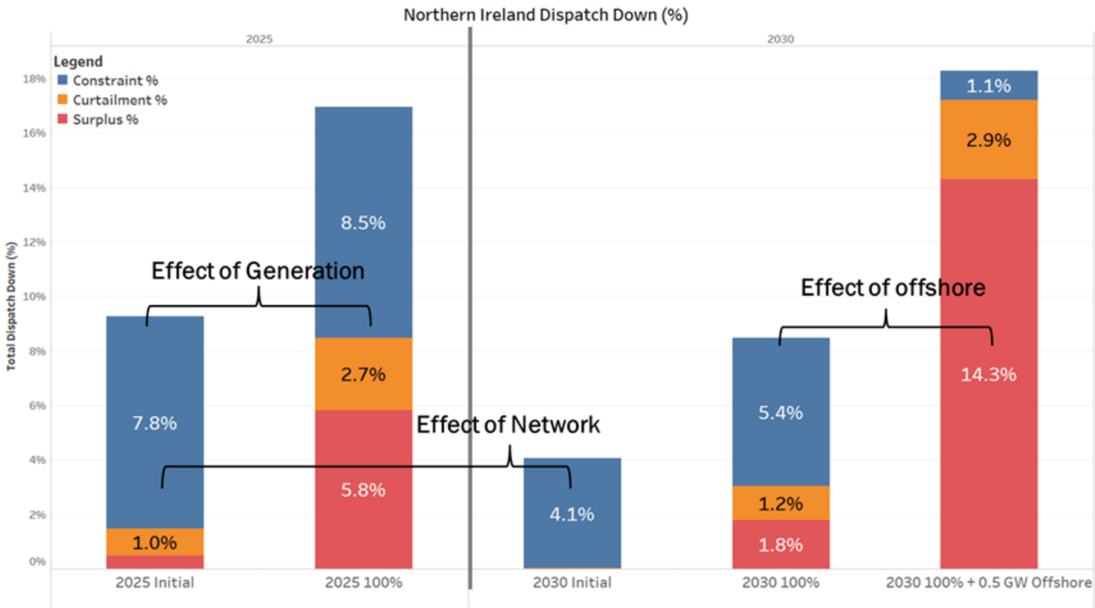

Figure 1-4: Summary chart of the percentage dispatch down results across the studies

2 Study Scenarios

This chapter describes the study scenarios upon which the modelling and results are based. These study scenarios are a produce of study year, generation, network, interconnection and demand among other assumptions. These are briefly introduced here in the context of the study scenario matrix. Further detail on these assumptions is described in chapter 3.

2.1 Study Area

SONI studied four constraint areas in this work. This report documents the outcome across Northern Ireland and each of those constraint areas in one document, across the study cases. The constraint areas are discussed in more detail in Section 4.8.

2.2 Study Scenarios

Studies were carried out for a number of scenario years with different network assumptions, and generation scenarios. The study scenarios are a product of:

- Renewable generation scenario, where the renewable generation scenario examines initial and 100% renewable capacity cases, discussed more in Section 2.2.1
  And
- Study year scenarios, assess two study years, 2025 and 2030, reflecting the demand and network assumptions for each of those years respectively. This is discussed more in Section 2.2.2

An overview of the Northern Ireland study scenarios can be seen in Figure 2-1 and an overview of the reciprocal ECP 2.2 study scenarios for Ireland can be seen in Appendix F.

There are four core Northern Ireland Constraints study scenarios as highlighted and grouped in Figure 2-1, covering the years 2025 and 2030. The core 2025 studies include the Moyle and North-South 1 interconnector while the core 2030 study include the addition of North-South 2.

We also run a fifth scenario looking at a sensitivity including 500 MW of offshore, referred to as the offshore study case. Please note, this does not represent SONI's view on the policy timescales or deliverability. This is a sensitivity and has been included for methodological consistency with studies undertaken in Ireland. We acknowledge that within in the DfE Energy Strategy there are ambitions to reach 1 GW of offshore wind in Northern Ireland from 2030. The impact of this can be assessed in a future Northern Ireland constraints study.

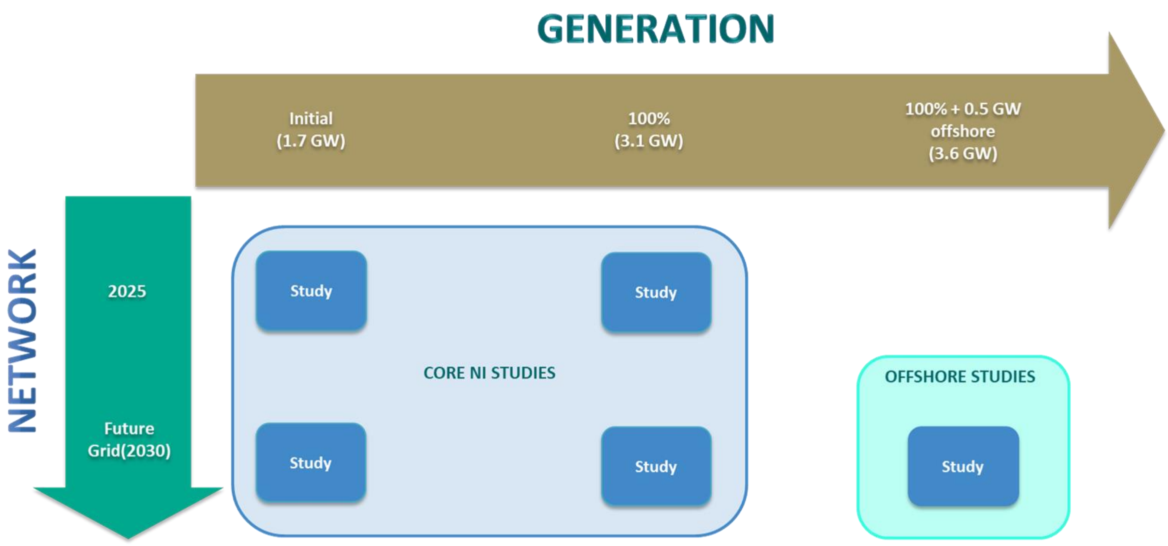

Figure 2-1 NI Study Scenarios: Matrix of Generation and Network Scenarios

A description of the generation scenarios and study year scenarios are provided below in Section 2.2.1 and Section 2.2.2 respectively.

2.2.1 Renewable Generation Scenarios

Three renewable generation scenarios are assessed for input to the Study Scenarios. These include:

- The "Initial" case includes all renewable generation currently expected to be connected before the end of 2024.
    - The initial scenario is assessed for the years 2025 and 2030
- The "100% capacity" case includes all renewable generation currently connected plus capacity aligned with SOEF 1.0.
    - The 100% capacity case is also assessed for the years 2025 and 2030
    - Note the 100% capacity case in 2030 includes some additional capacity attributed to replant and future onshore wind clusters.
- As mentioned above there is a sensitivity scenario looking at offshore, which includes 500 MW of offshore. The offshore study includes the same demand, generation and network portfolio as the 100% 2030 study, with the inclusion of 500 MW of offshore in Area - IV.

A variety of renewable generation scenarios are included to take account of the possibility that not all generators will ultimately connect, and to give a view on the Total Dispatch Down seen under various renewable generation build out rates.

This single report publishes the results of total dispatch down for each of the four areas together in one report.

The installed capacities for the renewable generation scenarios are detailed in section 3.4 of Chapter 3.

2.2.2 Study Year Cases

Network	Total Electricity Requirement (TWh)		
Year	Ireland	Northern Ireland	All – Island
2025	38.5	9.3	47.8
2030	45.1	10.2	55.2

Table 2-1 Total Electricity Requirement (TER) (TWh) from All-Island Generation Capacity Statement 2022-2031

The renewable generation scenarios discussed above are then combined with the study year scenarios to form the five study scenarios. The years 2025 and 2030 are chosen as the study years. These are chosen to capture expected progress over the short to medium term with regard to predicted operational limitation improvements, transmission reinforcements and forecast demand increase. The initial and 100% renewable generation cases are each tested in the years 2025 and 2030, while the offshore renewable generation case is studied in the year 2030 only. This forms the five study scenarios.

The median demand forecast from EirGrid and SONI's All-Island Generation Capacity Statement 2022-2031[5] was used. The 2030 scenario is aligned with Shaping Our Electricity Future (SOEF) Roadmap 1.0. As such, it has the network and operational constraint assumptions that are aligned with the SOEF Roadmap study. It also includes network reinforcements that have received capital approval since the publication of the SOEF Roadmap 1.0.

This study is not intended as an assurance to individual generators that their Total Dispatch Down will change to the estimated levels. Rather, it is a consideration of the potential impact of the SOEF 1.0 reinforcement portfolio on the dispatch down of wind and solar generators. This study is not intended to be exhaustive, and it is not intended to remove all transmission constraints.

[5] https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_SONI_Ireland_Capacity_Outlook_2022-2031.pdf

3 Study Input Assumptions

This section provides a detailed overview of the input assumptions for the surplus, curtailment and constraint modelling.

3.1 Valid for these Generation Assumptions

The estimated surplus, curtailment and constraint levels in this report are valid for the generation assumptions used in these studies.

3.2 All-Island Model

The Plexos market dispatch model used for the Northern Ireland constraints analysis is an All-Island model. It is the same All-Island model that was used for the ECP 2.2 constraints analysis (published December 2022). For both studies the All-island system including Northern Ireland and Ireland has been modelled in Plexos. This is necessary to provide a more accurate estimate of generation reduction levels, given that both surplus and curtailment are All-island issues.

3.3 Data Freeze

The data freeze for the input assumptions for this analysis was July 2022 for the 2025 and 2030 study years. As a result, there may be some recent developments within the electricity network that are not included. The most notable example is the publication of the SOEF 1.1 Roadmap as mentioned in Section 1.2.

3.4 Renewable Installed Capacity

A variety of renewable generation scenarios are included to take account of the possibility that not all generators will ultimately connect, and to give a view on the Total Dispatch Down seen under various renewable generation build out rates. The renewable generation portfolio is based on the Shaping Our Electricity Future v1.0 roadmap with the addition of an offshore sensitivity. Note inclusion of a particular wind or solar farm in this analysis does not indicate or confirm any right of that developer to connect to or use the network.

A detailed system level overview of the renewable generation scenarios used in these studies is given in Section 2. The distribution of generation in each scenario based on technology, area and node is given in Appendix B. The levels of installed solar and wind generation included in each generation scenario are shown in Table 3-1 for Northern Ireland.

The Initial scenario includes currently connected renewable generation plus all renewable generation expected to be connected by the end of 2024. The “NI All Study” or 2030 100% capacity scenario includes all currently connected renewable generation plus all renewable generation expected to connect by 2030. This aligns with the renewable generation levels in Northern Ireland within SOEF 1.0.

	NI Constraints Study Breakdown of NI Generation Capacity (MW)			
Generator	Initial Study	100% (MW)	NI All Study or 2030 100% inc. replant and clusters	100% + 0.5 GW offshore (MW)
Solar	262	619	619	619
Wind	1,484	2,146	2,470	2,470
Wind Offshore	0	0	0	500
Totals	1,956	2,765	3,089	3,589

Table 3-1 Connected and Contracted Solar and Wind Quantities in Northern Ireland for the Study Scenarios

Looking across the constraint areas, the installed wind and solar generation for across Northern Ireland in the “100%” scenario is given in Table 3-2

Type		Initial (MW)	100% (MW)	2030 100% inc. replant and clusters	100% + 0.5 GW offshore (MW)
Offshore wind	NI Area - IV	0	0	0	500
	Total	**0**	**0**	**0**	**500**
Solar PV	NI Area - I	48	167	167	167
	NI Area - II	10	15	15	15
	NI Area - III	6	9	9	9
	NI Area - IV	199	428	428	428
	Total	**262**	**619**	**619**	**619**
Onshore wind	NI Area - I	437	668	798	798
	NI Area - II	669	858	1012	1012
	NI Area - III	128	128	144	144
	NI Area - IV	250	492	516	516
	Total	**1484**	**2146**	**2470**	**2470**
Grand Total		1746	2765	3089	3589

Table 3-2 Wind and Solar Installed Capacity Summary for Northern Ireland Scenarios

For further detail, Table 3-3 and Table 3-4 present the fraction of total wind and solar capacity, from Table 3-2 which is controllable. It also includes the associated available GWh energy output across Northern Ireland for that controllable capacity. Controllable refers to the large-scale renewable generation that incurs dispatch down i.e. where uncontrollable refers to small scale wind and solar which is not controllable and does not incur dispatch down. The purpose of these tables is to present the capacity cases examined across the study years of 2025 and 2030. Whereby the same capacity cases are tested among the study years with a different network and demand varying between the study years. The exception to this is where the 100 % in 2025 differs to that in 2030. This differs as the 2030 horizon includes replanted wind sites and additional onshore wind clusters. The available energy for each capacity case is also included in these tables. The resulting dispatch down applied to that available energy yields the generation output whereby the generation output is then different between study years for a given capacity case.

Solar	Initial	100 %	2030 100%	2030 100% + 0.5 GW offshore
Installed NI (MW)	262	619	619	619
Installed Controllable NI (MW)	134	414	414	414
Available Controllable NI (GWh)	140	431	431	431

Table 3-3 Installed MW and Available GWh for NI – Solar

Wind	Initial	100 %	2030 100%	2030 100% + 0.5 GW offshore
Installed NI (MW)	1484	2,146	2470	2970
Installed Controllable NI (MW)	1240	1,899	2223	2723
Available Controllable NI (GWh)	3230	4,948	5792	7761

Table 3-4 Installed MW and Available GWh for NI – Wind

3.5 Renewable Availability profiles

The amount of electrical energy output from renewable generation is generally described in terms of capacity factor. The capacity factor relates to the amount of energy that may be achieved from a renewable technology over the period of one calendar year. Generally solar PV has a lower capacity factor than wind generators. One factor in the energy yield difference is that solar PV does not produce electrical energy at night, but the wind can blow at any time of the day or night.

The values used in this study for solar and wind are listed in the following sections.

3.5.1 Solar

On average, solar profiles tend to have a fairly predictable shape.. The capacity factor for solar PV is largely dependent on latitude – the closer to the equator the higher the annual capacity factor. The solar capacity factor for a country like Spain will have a value of around 20%, i.e., approximately double the output of Northern Ireland.

Figure 3-1 shows the average max, average and min profiles over a 24 period in the months of January and July. The lowest intensity of solar electrical output is in the four winter months November through to February with hourly values on average not exceeding 20% of the PV panels max output, as illustrated here for the month of January. As expected, the solar electrical energy output is highest in the summer months with average hourly solar electrical output peaking in the 50-60% range.

The main point is that solar available energy is fairly predictable with a peak typically around mid-day. In summer solar is only ramping up and ramping down around peak demand times of day. This is not the case around winter peak demand which cannot be met by solar.

Additionally, solar energy output may be reduced if it is located on a part of the network that has constraint issues.

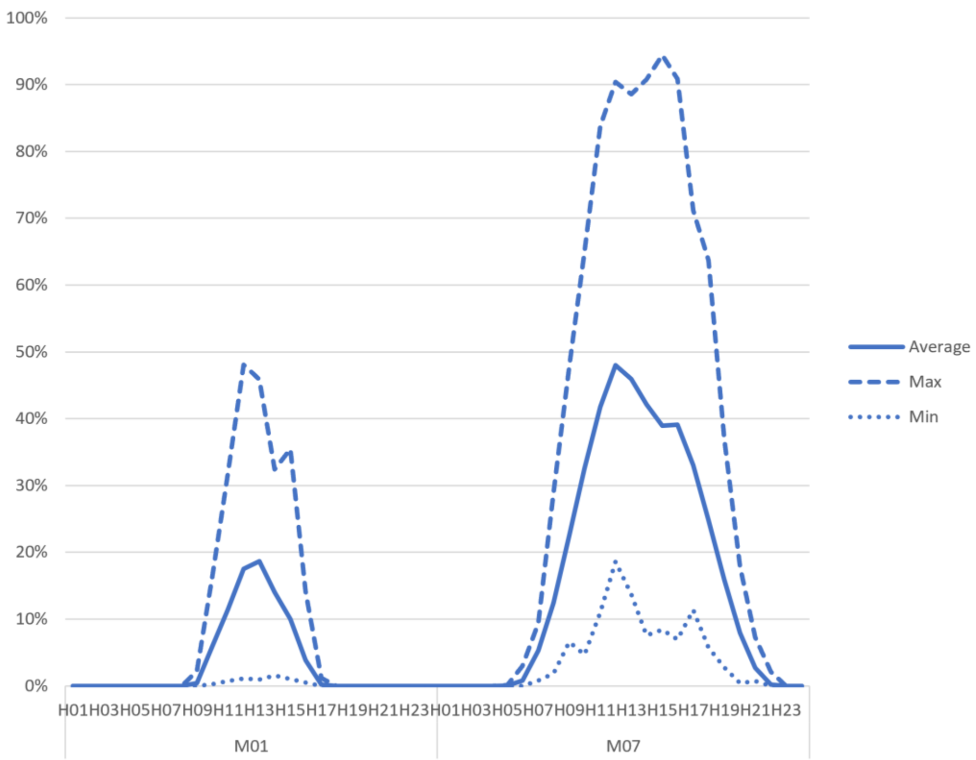

Figure 3-1 Representative Solar Energy Profile from Ballinderry for distribution of hours across January and July

3.5.1.1 Solar Profiles

Solar generation is modelled in the analysis using an hourly solar power series at every transmission node where solar generation is connected.

Solar output varies by latitude. Due to the size and shape of Northern Ireland, it is appropriate to use a single solar profile for these latitudes. This profile is based on a representative solar farm chosen for Northern Ireland. The recorded solar availability per hour (MW) for the year 2020 is then used to create a normalised solar profile. This profile is then used to model all solar generation in Northern Ireland.

For Irelands solar generation, modelling of profiles for solar is split into three regions, North, Middle and South illustrated in Figure 3-2 and their corresponding capacity factors shown in Table 3-5. This approach was done to capture the average behaviour of solar on the island. Solar North covers the same latitude bands as Northern Ireland.

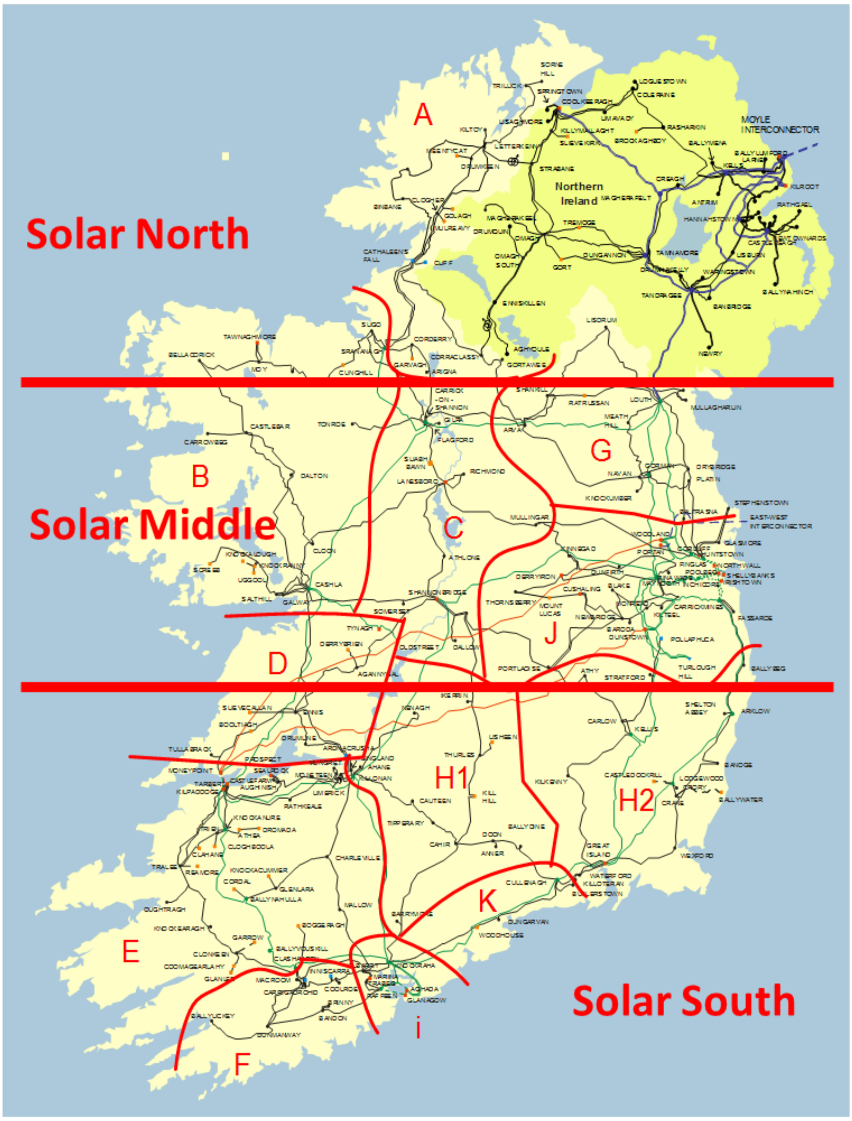

Figure 3-2 Groupings Used for Ireland for Solar Profiles in the All-Island Model.

Solar Region	Capacity Factor (%)
Northern Ireland	11.9
Solar North	11.9
Solar Middle	12.1
Solar South	12.7

Table 3-5 Capacity Factor of Solar Profiles across Ireland and Northern Ireland

3.5.2 Wind

This section details how wind generation in the All-Island model is modelled in Plexos.

Wind generation is modelled using an hourly wind power series at every transmission node where wind generation is connected. Similar to the solar profile, a single onshore wind profile is selected as represented for the wind farm generators in Northern Ireland. The profile is based on a historical wind profile. In this study for Northern Ireland, the weather year 2020, was used. This 2020 wind data aligns with the 2020 solar data. This provides alignment and consistency with the ECP 2.2 Ireland study. The capacity factors of these wind profiles are shown in Figure 3-3.

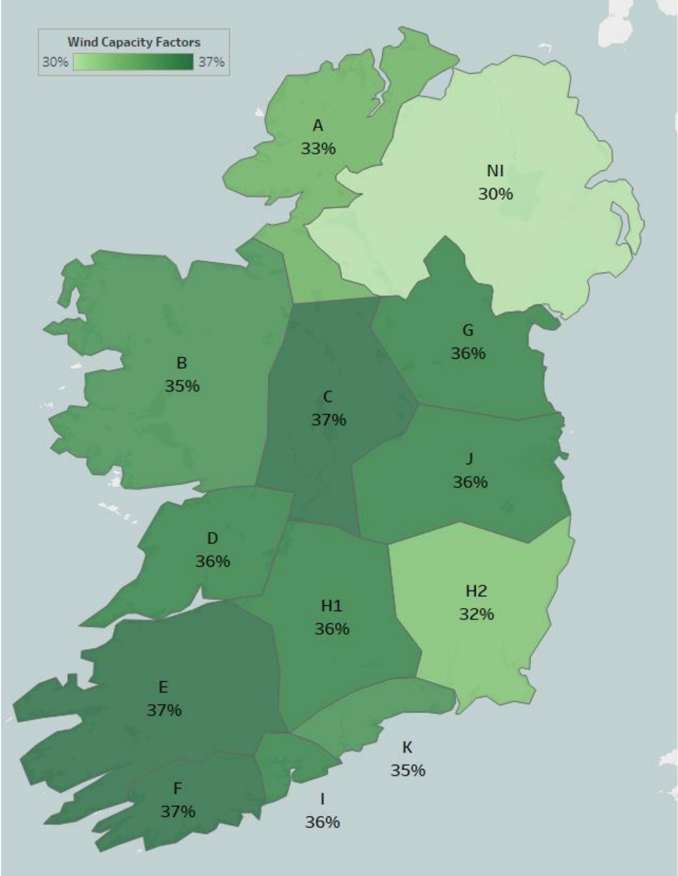

Figure 3-3 2020 Capacity Factor by Area for Wind

3.5.3 Offshore Wind

The offshore wind profile is determined by using the onshore wind profile and scaling it to have a 45% capacity factor.

3.5.4 Generation Controllability

Historically smaller (and some older) wind farms and solar generators are not controllable. The study methodology takes into account all uncontrollable wind and solar generation but does not include these generators in any output reduction calculations.

Generally, apart from some older windfarms, it is assumed that all wind farms are controllable if their maximum export capacity (MEC) is greater than or equal to 5 MW (for generators which received a connection offer before 2015) or if their MEC is greater than or equal to 1 MW (after 2015). All solar farms with an MEC greater than or equal to 5 MW are assumed to be controllable.

3.5.5 Perfect Foresight - Wind Forecast

Building an economic power market model will always require input assumptions. One of those assumptions is that historical data is used to represent the climatic weather year. The use of historical data means that the power market model will create generation commitment and dispatch decisions based on the perfect foresight of wind and solar output. In real-time operation of the power system, this is not the case and there will be forecast errors associated with variable renewables and demand. Perfect foresight may mean that power market models show lower levels of curtailment since it may choose to de-commit units based on what it knows will happen. In reality, wind or demand forecast errors may mean that a different schedule of generators may be required than that modelled with perfect foresight.

3.5.6 Benefit of Capacity Factor

A single load profile is used for each of wind and solar generation in this study for Northern Ireland. In practice, a specific windfarm, may have a higher capacity factor in comparison to an adjacent wind farm that does not have similar technical properties. These technical properties can include location at a site with higher wind speeds or may have a better performing type of wind turbine installed. The windfarm with the higher capacity factor may see lower percentage surplus, curtailment or constraint levels than the adjacent windfarm with a lower capacity factor. This is because at times of medium or low wind speed, the high-capacity factor windfarm can generate power when the low-capacity factor windfarm cannot. However as in this study SONI used a single profile each for solar and wind, this report doesn't reflect localised diversity between wind farm sites.

3.6 Network

3.6.1 Current Transmission Network

This section details the modelling assumptions used in this study for the transmission network.

The transmission system in Northern Ireland is a meshed network with voltage levels at 275 kV and 110 kV. It is characterised by a central East 275 kV ring with radial connections including 275 kV line Northwest to Coolkeeragh. Further, 110 kV network West to Omagh as well as interconnectors (Moyle to the UK and North South to Ireland). All the 110 kV network in the west converges in Omagh with radial 110 kV lines radiating out from Omagh. The network is necessary to allow bulk power to be transported over long distances from power stations and renewable generation sites in west to the load centres and cities in East of Northern Ireland. A diagram of the Northern Ireland transmission system in 2021 can be seen in Figure 3-4. This map is aligned with that published in the TYTFS 2021.

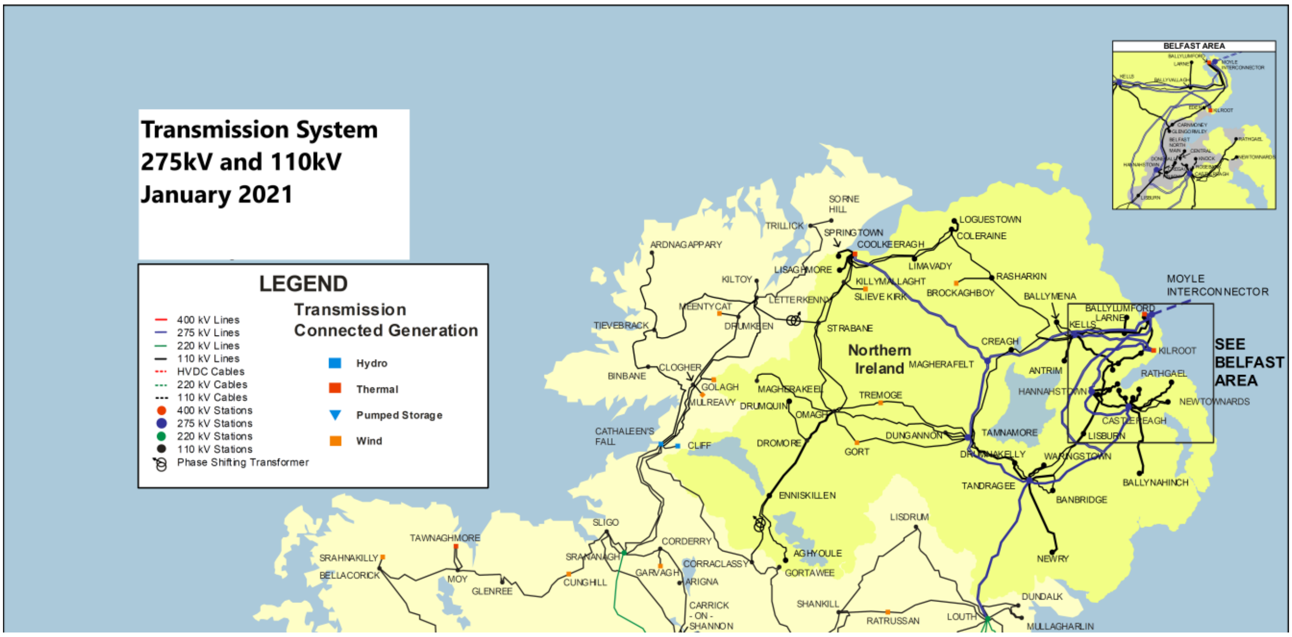

Figure 3-4 Northern Ireland Transmission Network 2021

3.6.2 Distribution System

For the purposes of the constraints modelling, a simplified representation of the distribution system is used whereby all load and generation is assumed to be aggregated to the nearest 33 kV or 110 kV transmission node.

Hence, this report does not account for the impact of constraints (if any) on the distribution network.

3.6.3 Ratings and Overload Ratings

The Northern Ireland transmission system is operated to safely accommodate a single transmission asset loss (N-1 contingency). While formulating an optimum dispatch, system operation takes account of potential overloads that could be caused by certain N-1 contingencies on the transmission system. For planning purposes, when determining if the post-contingency flows are within limits, SONI uses the thermal rating of the apparatus or plant for all contingency analysis.

The statutory framework in Ireland allows operation both with in thermal ratings and overload ratings of lines. Overload rating is typically higher than the normal rating but is only allowed in emergency conditions and for short periods of time. The overload ratings are equipment specific. In Northern Ireland, the overloads are maintained within the single thermal ratings only.

The all-island Plexos model therefore applies different approaches for the two jurisdictions. The Plexos model used for Northern Ireland constraint reporting includes N-1 contingency monitoring against thermal line rating only.

3.6.4 Transmission Reinforcements

In addition to the current transmission network, for each study year (2025 and 2030) a number of transmission reinforcements are added to the model. These additional transmission reinforcements include overhead lines (OHL) and cable uprates as well as new build OHLs, cables and transformers. The network reinforcement assumptions used in the 2025 and 2030 scenarios are aligned with projects outlined in the TDPNI 2021. This is inclusive of reinforcement projects identified in the SOEF 1.0 Roadmap. Additional reinforcements that have achieved Control Point 1 approval since the release of the SOEF 1.0 Roadmap and some projects at an advanced stage with a known preferred option have also been included. A list of the network reinforcements used in the study is provided in Appendix A.

Figure 3-5 shows the 2030 Northern Ireland transmission network. The indicative locations of new stations have been included in Figure 3-5.

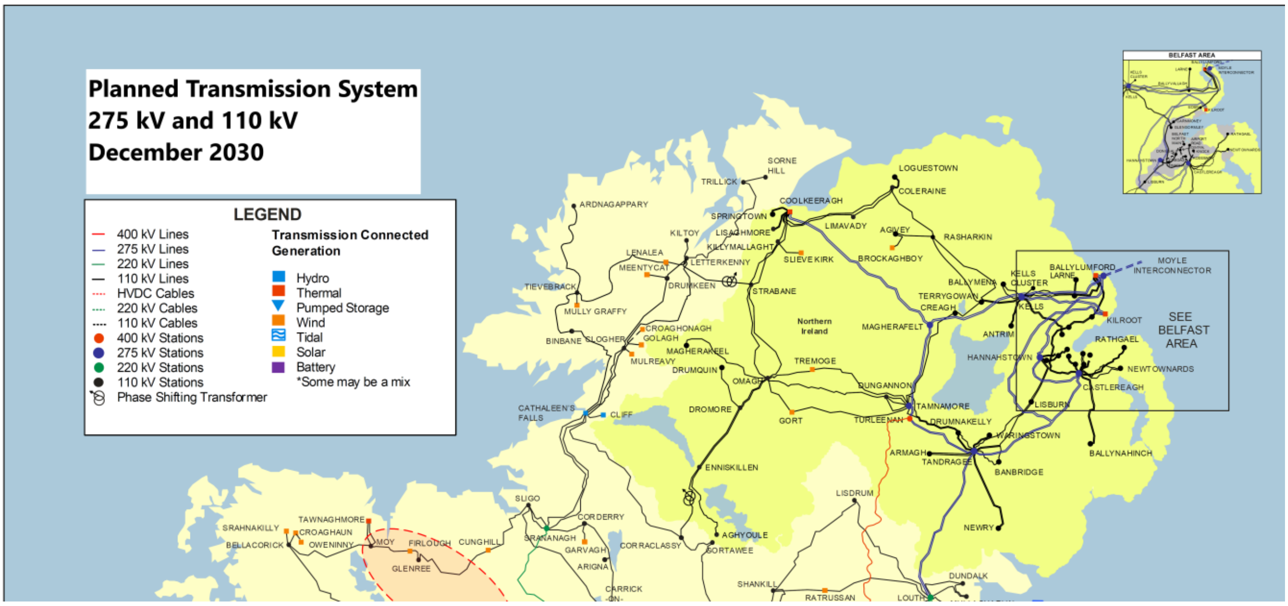

Figure 3-5 Northern Ireland Transmission Network Showing Assumed Future Network Reinforcements

Customers should recognise that the reinforcements listed will be subject to a full analysis and optimisation process under SONI's Grid Development process before a decision is made to proceed with them. Inclusion of transmission reinforcement projects in this report is not confirmation that they will proceed, and other projects may be selected in their place. For the avoidance of doubt, any party making a decision based on this list should recognise that these are modelling assumptions only and should not be considered as a basis in fact. Additional information about reinforcements is available on the SONI website[6].

3.6.5 Transmission Network Outage Programme

SONI plans and manages an annual Transmission Outage Programme. Transmission outages involve planned times when transmission infrastructure (lines, cables and substations etc.) will undergo maintenance and are therefore not in service. Transmission outages may be due to

[6] https://www.soni.ltd.uk/the-grid/projects/

scheduled maintenance, forced outages, to facilitate new connections or for reinforcement reasons (e.g. circuit/busbar uprates).

As well as impacting the availability of a line for transporting power, the outage of a circuit also has an impact on the power flows on neighbouring circuits. The inclusion of transmission outages in the modelling will therefore ultimately impact the results of the constraint analysis.

For this study, following engagement with the outage planning team and a retrospective look back at historical outage frequency on the Northern Ireland grid, a representative transmission outage schedule was included. The outage representation selected was based on that used for SOEF 1.0. It includes 4 lines outages per month over a 6-month period. Outages were selected on the basis that they were geographically distributed across the areas in Northern Ireland and across the different transmission components from 275 kV lines, 110 kV lines and transformers. The aim was to give a representation of a transmission outage programme. The transmission outage schedule used in this analysis is given in Appendix A Table A-6-3. However, at times, there are longer duration outages which may be required for certain connections, reinforcement works or forced outages, and these are not considered in this study. Such outages may result in higher wind and solar constraints.

The all-island model also reflects a similar transmission outage schedule for Ireland with a frequency of nine outages per month over 9 months. These outages represented a geographical spread of circuit outages across areas in the system and across system components i.e. 220/275 kV lines, 110 kV lines, and transformers. This ensures consistent modelling of both parts of the all-island system.

3.7 Battery assumptions

3.7.1 Battery Installed Capacity in Northern Ireland

The assumed installed battery capacity in Northern Ireland is shown in Table 3-6. These are aligned to those from SOEF 1.0. Also shown is the spatial distribution across constraint area with all battery storage assumed in constraint area IV. The battery durations assumed range from 30-minute batteries to 2 hour duration technology. The model was free to optimise if they cycled for arbitrage or if provided provision for reserve.

Type		Initial (MW)	100% (MW)	2030 100% inc. replant and clusters	100% + 0.5 GW offshore (MW)
Battery	NI Area - I	0	0	0	0
	NI Area - II	0	0	0	0
	NI Area - III	0	0	0	0
	NI Area - IV	210	226	226	226
	Total	**210**	**226**	**226**	**226**

Table 3-6: Distribution of the battery installed capacity across constraint area

3.7.2 Battery Archetype Representation in All-Island Model

For this analysis batteries have been modelled using the battery class within Plexos. They have been modelled using the general assumptions shown in Table 3-7.

General Battery Modelling Assumptions	
Max. State of Charge	95%
Min. State of Charge	5%
Charge Efficiency	90%
Discharge Efficiency	90%
Max Cycles per Day	1

Table 3-7 General Battery Modelling Assumptions

The battery capacity (MWh) and max power (MW) has also been entered into the model and were specific to each battery.

For this analysis, the shorter duration batteries (batteries with a storage duration of <= 2 hours), were modelled to supply reserve in the form of Primary Operating Reserve (POR), Secondary Operating Reserve (SOR), Tertiary Operating Reserve 1 (TOR1) & Tertiary Operating Reserve 2 (TOR2). The residual shorter duration batteries were also used for energy arbitrage when the reserve requirements were met. The reserve requirements used in the analysis is given in Section 3.12.2.4 (Table 3-12).

Longer duration batteries assumed in the All-Island model (batteries with a storage duration of > 2 hours) were used within the model for energy arbitrage. The cycling of these batteries is decided by the Plexos optimisation algorithm. Plexos identifies the optimal charge and discharge times to maximise returns.

This approach means that the longer duration batteries charge during times of high renewable generation when the system price is lower, therefore, integrating more solar and wind generation on the system. Note the batteries in the model are reacting to system wide prices and are not responding to local issues. In general, this approach means batteries do not export power to the system during times of high wind and solar generation.

3.8 Demand

For the Northern Ireland constraints analysis, we make use of the median demand forecast from the Generation Capacity Statement (GCS) 2022 - 2031[7] to determine the demand for 2025 and 2030. Growth in demand is forecast across the decade, some of which is driven by the electrification of heat and transport.

The demand profile shapes for Northern Ireland are based on the 2019 historical demand profiles. The historical profiles are adjusted to reflect a future winter peak (Transmission Winter Peak) and Total Energy Requirement (TER) based on the All-Island Generation Capacity Statement 2022 – 2031 median demand for the 2025 and 2030 years. The values used are shown in Table 3-8.

	TER (TWh)			Transmission Winter Peak (GW)		
Year	Ireland	Northern Ireland	All-Island	Ireland	Northern Ireland	All-Island
2025	38.5	9.27	47.8	6.4	1.7	8.07
2030	45.1	10.17	55.2	6.87	1.83	8.67

Table 3-8 Forecast Demand and Peak for Study Years 2025 and 2030 (GCS 2022)

The nodal distribution of the load used in the constraints modelling is consistent with the "All-Island Ten Year Transmission Forecast Statement 2021[8]". This is reported on in Chapter 6 in terms of influence of network flows.

3.9 Interconnection

Existing interconnection on the island consists of a tie line between Northern Ireland and Ireland plus two High Voltage Direct Current (HVDC) interconnectors to Great Britain (GB), referred to as the Moyle Interconnector and the East-West Interconnector (EWIC). This section describes the

[7] https://www.soni.ltd.uk/media/documents/EirGrid_SONI_2022_Generation_Capacity_Statement_2022-2031.pdf

[8] https://www.eirgridgroup.com/site-files/library/EirGrid/All-Island-Ten-Year-Transmission-Forecast-Statement-TYTFS-2021.pdf

assumptions and modelling methodology used for interconnection in these studies across the All-Island model. The results chapter reflects the net import and export flows from the Northern Ireland Network as a whole, before discussing internal network flows across the areas.

3.9.1 North-South Tie Line

The connection of Northern Ireland's power system to Ireland is achieved via a double circuit 275 kV line running from Louth to Tandragee. In addition to the main 275 kV double circuit, there are two 110 kV connections: one between Letterkenny in Co. Donegal and Strabane in Co. Tyrone, and the other between Corraclassy in Co. Cavan and Enniskillen in Co. Fermanagh.

The purpose of these 110 kV circuits is to provide support to either transmission system for certain conditions or in the event of an unexpected circuit outage. Phase shifting transformers in Strabane and Enniskillen are used to control the power flow under normal conditions.

It is assumed that the Letterkenny - Strabane and Corraclassy - Enniskillen 110 kV connections are not used to transfer power between the two control areas for the purposes of this modelling exercise.

EirGrid and SONI are also currently developing a 400 kV North-South Interconnector between Woodland in Ireland and Turleenan in Northern Ireland. The new North-South Interconnector is assumed to be in place for the 2030 scenarios.

Prior to the 400 kV North-South Interconnector being built, the existing Louth - Tandragee Interconnector is limited. The flows are limited to 300 MW from South to North and 300 MW from North to South. When the 400 kV second North-South Interconnector is in place, this limitation will be raised to 1000 MW inter-area flow.

3.9.2 Moyle Interconnector

The Moyle Interconnector, which went into commercial operation in 2002, connects the electricity grids of Northern Ireland and Great Britain between Ballycronan More (Islandmagee) and Auchencrosh (Ayrshire). It has a transfer capacity of 500 MW, however, due to constraints on the transmission networks at either end this capacity can be reduced.

For the purposes of this study the Moyle Interconnector is assumed to have a 400 MW export capacity and a 450 MW import capacity for 2025 and 500 MW in either direction in 2030.

A second HVDC interconnector between Northern Ireland and Great Britain is planned; at the time of the analysis in this report it had not progressed sufficiently to be included in the studies.

3.9.3 East-West Interconnector (EWIC)

The East-West Interconnector links the electricity grids of Ireland and Great Britain, from convertor stations at Portan in Ireland to Shotton in Wales. It began commercial operation in December 2012.

The EWIC Interconnector is modelled for all study years with a maximum capacity of 500 MW.

3.9.4 Greenlink Interconnector

The Greenlink Interconnector is due to be commissioned in 2024 and will connect the electricity grids of Ireland and Wales between Great Island (Co. Wexford) and Pembroke (Co. Pembrokeshire). The Greenlink Interconnector is assumed to be connected for all study years with an import/export capacity of 500 MW.

3.9.5 Celtic Interconnector

The Celtic interconnector connecting Ireland with France is modelled in the 2030 study year. This subsea HVDC (High Voltage Direct Current) cable is expected to be commissioned in 2026 and will have an import/export capacity of 700 MW.

An overview of the interconnector capacities can be seen in Table 3-9.

3.9.6 Interconnector Capacities

The interconnector rated capacities used in the model are shown in Table 3-9

Interconnector	Maximum Export/Import	2025	2030
Moyle Capacity (MW)	Export	400	500
	Import	450	500
EWIC Capacity (MW)	Export	500	500
	Import	500	500
Celtic Capacity (MW)	Export	-	700
	Import	-	700
Greenlink Capacity (MW)	Export	500	500
	Import	500	500
N-S Capacity (MW)	Export	300	1000
	Import	300	1000

Table 3-9 Interconnection Rated Capacities

It is a study assumption that interconnectors can be used to export renewable energy, with the provision that, when calculating an annual average behaviour, it would be optimistic to assume that maximum interconnector export will always be available when required.

The method used to model interconnection in this analysis is consistent with that used in the ECP 2.2 Constraints Analysis. This was based on historical flow analysis for the existing interconnectors and also from TYNDP modelling for prospective interconnectors such as Celtic.

3.10 Conventional Generation

The renewable generation capacity is discussed above in Section 3.4 and 3.5. This section focuses on the conventional generation assumed in the model.

3.10.1 Conventional Generation

The All-Island model includes a portfolio of the thermal conventional generation in both Northern Ireland and Ireland. The installed conventional generation in Northern Ireland assumed in the model is shown in Table 3-10. The operating characteristics of the existing conventional generation employed in the modelling are principally based on the SEM Generator Dataset. In some instances, minor changes to the dataset are made due to additional information becoming available to the TSOs.

The technical dataset includes the following information:

1. Fuel type (e.g. gas, wind, coal etc.) including emissions rates;
2. Maximum and minimum operating output (MW). This is inclusive of grid code derogations;
3. Capacity state and heat rates (used to determine how much fuel is burnt to produce 1 MW of output power);
4. Ramp rates (important to determine how quickly a machine can change its power output);
5. Minimum up-time and downtime.

This technical data allows the Plexos software to calculate the cost of generating a megawatt of electrical energy for each generator in the model. Note that each generator has a different cost.

Other factors that influence the generation dispatch over an extended study horizon are:

- Generation commissioning and decommissioning.
- Generation outages.
- Generation emissions restrictions.

Fuel	Generator name	Installed Capacity (MW)
NI GAS	B10	101
	B31	247
	B32	247
	C30	425
	CGA	12
	KGT6	350
	KGT7	350
	Total	**1,732**
NI GAS TURBINE	BGT1	58
	BGT2	58
	CGT8	53
	KGT1	29
	KGT2	29
	KGT3	42
	KGT4	42
	Total	**310**
NI Biomass	LPS	18

Table 3-10: Overview of assumed installed conventional generation by generation type in Northern Ireland

3.10.2 Conventional Generation Outages

Scheduled and forced conventional generator outages are modelled in Plexos using Scheduled Outage Durations (SODs) and Forced Outage Probabilities (FOPs). For this study, only the Forced Outage Probabilities are used. The FOPs employed are those used for the Dispatch Balancing Costs (DBC) 2020 – 2021 Forecast. Plexos generates forced outage patterns from the FOP and the mean time to repair data. This provides a deterministic outage pattern against which the model dispatches generation against demand.

3.10.3 Network Requirement for Conventional Generation

For conventional generation, the dispatch is primarily economic in nature. As such, the software only runs the relatively expensive conventional generators infrequently in the simulation.

Hence, the model generally does not dispatch peaking generators at times of high solar and wind generation output. For this analysis, these assumptions are reasonable.

3.11 System Operation

3.11.1 Safe Operation (Security Constrained N-1)

The basic principle of N-1 security in network planning states that if a component, such as a transformer or circuit, should fail in a network, then the network security must still be guaranteed, and the remaining network resources must not be overloaded or exceed the short-term overload capability of the equipment. System voltage must also remain within permitted limits although Plexos, as a DC load flow analysis tool, does not monitor system voltage as part of this study.

SONI operates the Northern Ireland transmission network to be N-1 secure. This Plexos study also monitors N-1 contingencies to ensure the results are valid for an N-1 secure network.

3.11.2 Operational Constraint Rules

This section presents the all-island operational constraints, which feed into the Plexos economic dispatch tool for the curtailment and constraint studies. The operational constraints cover System Non-Synchronous Penetration (SNSP), inertia limit, operating reserve requirements and minimum number of synchronous units required.

The purpose of this section is to define the set of operational constraints, and how these constraints may evolve over the proposed study horizons. Operational constraints are important as they define system limits that may require reductions in renewable generation, resulting in curtailment. In general, it is expected that certain operational constraints may be relaxed over time, as the system evolves.

Under the SOEF 1.0 Roadmap, the System Operation workstream sets out a plan for further developing EirGrid and SONI's operation capability to facilitate increases in wind and solar generation levels. The operational limits in this study have remained unchanged from the ECP 2.2 published constraints study for Ireland. As this was complete before the publication of the operational roadmap for 2030, assumptions from the operational roadmap will be reflected in the next iteration of Northern Ireland constraints analysis.

3.11.2.1 System-Wide Operational Constraints

There are several system-wide operational constraints which ensure that the system operators can operate the system securely and within stability limits.

This study uses the operational constraints listed in Table 3-11. The RoCoF limit was not monitored in the Plexos study because the inertia constraint is necessary and sufficient for the RoCoF limit to be satisfied but is included in Table 3-11 for information.

Relating to reserve, the contribution of dispatched down wind to reserve requirements is outside this assessment. By 2030 the FASS programme should provide revenue streams for renewables beyond the delivery of active power.

Active System Wide Operational Constraints (SNSP, Inertia & Minimum Sets)		
Limit	Operational Constraint Rule	Limit Across the Study Years
Non-Synchronous Generation	There is a requirement to limit the instantaneous penetration of asynchronous generation connected to the All-Island system.	2025 – 85% 2030 – 95%
Operational Limit for RoCoF	There is a requirement to limit the RoCoF on the All-Island system.	2025 – 1 Hz/sec 2030 – 1 Hz/sec
Operational Limit for Inertia	There is a requirement to have a minimum level of inertia on the All-Island system.	2025 – 20,000 MWs 2030 – 17,500 MWs
Minimum Sets (IE, NI)	There is a requirement to have a minimum number of conventional generators in Ireland and Northern Ireland.	2025 – 4, 2 2030 – 2, 2
Reserve (IE, NI)	The amount of spare capacity in the system to manage any system disturbance.	POR, SOR, TOR I, and TOR II

Table 3-11 Active System Wide Operational Constraints (SNSP, Inertia & Minimum Sets)

3.11.2.2 System Non-Synchronous Penetration (SNSP)

There is a system need to limit the amount of 'non-synchronous' generation at any point in time. The limit ensures that the power system operates within a stable zone. Wind and solar are typically considered non-synchronous generators.

A mathematical expression describing the SNSP rule is as follows:

$$\frac{All\ Island\ Asynchronous\ Generation + Interconnector\ Imports}{All\ Island\ Demand + Interconnector\ Exports} \leq SNSP\ Limit$$

An increase in the SNSP limit will allow more 'non-synchronous' generation to be accepted onto the system.

3.11.2.3 Minimum Number of Synchronous Generators

There is a requirement to have a minimum number of conventional generators synchronised at all times to provide inertia to the power system, ensure voltage stability, dynamic stability and to ensure that network limitations (line loading and system voltages) are respected. The minimum number of units in each study horizon is given in Table 3-11 above.

3.11.2.4 Operating Reserve

Operating reserve is surplus operating capacity that can instantly respond to a sudden increase in load or decrease in generation output. Operating reserve provides a safety margin that helps ensure reliable electricity supply despite variability in the load and generation. To provide reserve, some generators are part-loaded i.e. are operated below their maximum output capacity to provide a fast-acting source of reserve. Reserve can also be provided by non-conventional sources such as batteries, storage, interconnectors and demand response. In the future, it is expected that a greater share of reserve may be maintained by such non-conventional sources.

The operating reserve requirements modelled in the analysis can be seen in Table 3-12 below.

Operating Reserve Requirements			
Limit	All-Island Requirement % of Largest In-Feed	Ireland Minimum (MW)	Northern Ireland Minimum (MW)
Primary Operating Reserve (POR)	75%	155	50
Regulating Sources of Primary Operating Reserve (POR*)	-	75	50
Secondary Operating Reserve (SOR)	75%	155	50
Tertiary Operating Reserve 1 (TOR1)	100%	155	50
Tertiary Operating Reserve 2 (TOR2)	100%	155	50

Table 3-12 Active Operating Reserve Requirements

*Regulating Sources of Primary Operating Reserve must be provided by conventional generation, this is included in the requirements in the row above.

4 Study Methodology

This section provides an overview of the modelling methodology employed to determine the potential surplus, curtailment and constraint levels for renewable generation in this study.

The methodology of production cost modelling is utilised to conduct the studies for this report. This section includes a detailed description of production cost modelling, and an overview of Plexos (the modelling tool employed) is also provided. In addition, there is a description of the surplus, curtailment and constraint modelling methodology.

This methodology is consistent with that used in the published ECP 2.2 Constraints forecast Analysis for Ireland.

4.1 Production Cost Modelling

In general terms, production cost models utilise optimisation algorithms with the objective of minimising the cost of generating power to meet demand in a region while satisfying operational, security and environmental constraints.

Production cost models may require:

- Specification of individual generator capabilities including capacity, start-up energy, annual forced outage rate, annual scheduled outage duration, reserve provision capabilities, emission rates and heat rates (fuel input requirement per unit output generation).
- Specification of the hourly demand profile for the region.
- Specification of the fuel price for each type of fuel. In the model, wind and solar generation are variable sources with zero production cost. Hydro generation also has zero production cost but is energy limited.
- Specification of the transmission network (required for studies where transmission constraint information is the desired output).
- Specification of contingencies.
- System security constraints such as the requirement for reserve.
- Generator operational constraints such as maximum and minimum operational levels, ramp rates, minimum run times and downtimes etc.
- Environmental considerations such as the cost of CO_2.

Together these variables are used for each generator and for each hour to compute a marginal cost of generation. The sum of the marginal costs of generation and GWh generation of each dispatched generator makes up total system cost. In production cost modelling, the aim is to minimise total system costs. The marginal costs of generation are made up primarily of Short Run Marginal Cost (SRMC) in €/MWh (driven by fuel price and Emission Trading Sector (ETS) price), start/stop costs, O&M costs among others. Chronological production cost models optimise generator commitment and dispatch scheduling for every hour of a study period (typically one-year duration). This is done using the information on marginal cost as well as with the technical properties of generators such as ramp rate, capacity rating and min stable level to determine whether a generator is called to dispatch. Generators with zero or low SRMC are dispatched first and then further generators are dispatched in ascending SRMC until demand is satisfied. This reflects Day-Ahead Market modelling. The regional price in the model is set by the last generator to dispatch. The combination of technical and financial properties typically results in the following modelling outcomes:

- Baseload operation will be met by the most efficient and low-cost plant which usually does not cycle because of high start and shutdown costs. This will include steam boiler units with low-cost fuel and large CCGTs.
- Mid merit operation will be met by flexible generation such as gas units which have lower start and shutdown costs than baseload units.
- Peaking operating will be met by the most flexible plant that has the lowest start and shutdown costs. They will have fast ramp up and ramp down rates and can respond to imbalances and demand peaks. These are, however, the most expensive generators to operate on a continuous basis.
- Non-flexible generation – like renewables will be dispatched subject to Article 12 considerations and subject satisfying operational and local constraints, as discussed in Chapter 3.

4.2 The Software: Plexos Integrated Energy Model

Plexos is a detailed generation and transmission analysis program that has been widely used in the electricity industry for many years. SONI have extensive experience in using this simulation tool to model the power system in Northern Ireland. It is a production cost modelling simulation program, used to determine power system performance and cost. It is a complex and powerful tool for power system analysis, with separate commitment and dispatch algorithms.

4.2.1 Commitment and Dispatch

The commitment process refers to the selection of a number of generators, from the total generation portfolio, that are available to meet customer demand. The decision as to when these generators should be on or off-line is part of the commitment process. For example, additional generation is committed on Monday mornings to meet the higher weekday demand compared to the lower weekend demand where less generation is required.

The dispatch process refers to the decisions taken on the loading of individual generation units. Thus, the contribution from each online or committed unit towards meeting customer demand is determined by the dispatch decision.

While the SEM is operated at half hour intervals, Plexos simulation is solved at hourly increments.

4.2.2 Generator, Demand and Network

Inputs to the Plexos model include full technical performance characteristics and operational cost details of each generation unit on the system. An hourly system demand profile is also required. Additionally, in this study, the transmission system is modelled.

The program output provides complete details of the operation of each generation unit. These are aggregated into system totals. Flows on transmission lines can be monitored and potential constraints on the system can be identified.

4.2.3 DC Loadflow

In addition to being a production cost simulation tool, Plexos also has DC load flow simulation functionality. As it is a DC load flow tool, it only models real power flows and does not consider voltage. While transmission plant and line ratings are MVA rated, for the purposes of modelling the DC load flow MW ratings are used for the circuits. The model assumes a conversion factor of 0.95 in Northern Ireland and 0.9 in Ireland to convert from MVA to MW.

The conversion factor allows the necessary spare capacity for reactive power on the circuits and it allows for post-contingency low voltage.

The Plexos model, as constructed, does not account for network losses. However, losses are accounted for within the Total Electricity Requirement (TER) demand figures.

4.3 System Model

The Plexos model dispatches Northern Ireland and Ireland as a single system, in line with both Grid Codes and the market design. The production cost model solves for an optimal minimum cost commitment and dispatch. Generators are dispatched based on their short-run marginal costs (which include the costs of fuel and CO_2 emissions) and in accordance with the dispatch assumptions outlined below.

Solar and wind powered generators are modelled at 110 kV node level. In other words, if several windfarms are fed from a 110 kV node, the model represents them as a single windfarm at that node. The same is true for solar farms.

4.4 Software Determination of Surplus, Curtailment and Constraint

For this report, wind and solar generators are assumed to be Grid Code compliant and it is assumed that controllable wind and solar generators can be instructed to reduce their output if required. It is worth noting that there are a small number of older wind turbine sites that are uncontrollable, as mentioned in Section 3.4. Assumed small scale generation is also uncontrollable and is explicitly modelled.

SONI has used the Plexos model to calculate surplus, curtailment and constraint. We then use a number of supplementary studies to properly apportion each of these three types of reduction in generator output.

In the simulation, generators are committed and dispatched in the most economical manner while satisfying operational and security constraints, detailed in section 3.11.

The simulation is a security constrained N-1 study. This means that the network flows are constantly monitored to ensure the system is secure against the possible loss of any item of transmission equipment.

The total reduction in energy for each renewable generator is calculated by comparing the renewable energy output from the simulation to the available renewable energy.

4.5 Definition and apportioning of Renewable Generation Surplus, Curtailment and Constraint

4.5.1 Surplus

The reduction of available renewable generation for surplus reasons is necessary when the total available generation exceeds system demand plus interconnector export flows. In this study, generation reduction for surplus is applied prior to curtailment and constraint. Hereafter in this report it is referred to as surplus.

Under the EU's Clean Energy Package, it has been mandated that priority dispatch of renewable generation will continue to apply only to generators which connected prior to July 4th 2019 (Article 12). This will create a new type of generator for consideration in the dispatch process – the non-priority dispatch renewable generator, connected post July 4th 2019.

For this study it has been decided to use the current operational interim arrangement, which is the same approach used within the published ECP 2.2 constraints analysis for Ireland, as the implementation of Article 12 post 2026 is yet to be finalised and will be determined through a separate workstream. This approach is detailed in Section 4.6.

In summary, in this study, during generation reduction owing to surplus, there is a distinction made between the treatment of priority and non-priority renewable generators where non-priority generators are reduced ahead of priority generators. Within these two categories of generation, surplus is applied pro-rata across the all-island system for all renewable generators in this category.

For any hour of the study the surplus level will depend on system demand and interconnector flow capacity. In general, surplus is expected to increase with increasing installed renewable capacity.

4.5.2 Curtailment

In order to operate a safe and secure electricity system, SONI must operate the system within certain operational limits. These limits are discussed in Section 3.11. Curtailment is applied to reduce the output of renewable generators to ensure that operational limits are not breached, and the system can remain secure and stable. Curtailment is applied to all renewable generators across the island where all controllable wind and solar generators share the reduction in output energy arising from curtailment in proportion to their available energy in that hour i.e. on a pro-rata basis. For curtailment, there is no distinction made between the treatment of priority and non-priority generators. This means that changes to curtailment are shared system wide.

Between technology types, solar generation has different reported levels of curtailment compared to wind due to different capacity factors and annual profile shapes.

Across the constraint areas, the applied curtailment is broadly constant across the system. Between the constraint areas, for a given technology type, the percentage curtailment will not differ because a single solar or wind profile is used for each technology type across Northern Ireland. The exception to this will be in Area – IV for the offshore study case where 500 MW of offshore is included at the Ballylumford node. It is designated as wind not priority along with the onshore wind. Note that the offshore wind of course has a different capacity factor which feeds into the pro-rata curtailment calculation.

4.5.3 Constraint

Generators may also need to be dispatched down due to transmission network limitations and, in particular, to ensure that the thermal overload limits of transmission circuits and transformers are not breached. Transmission equipment may become overloaded in an intact network or in the case of a network contingency, where a line may become overloaded if another line were to trip. In order to avoid this, renewable generation may be dispatched down.

Changes in generator output for this reason are referred to as a 'constraint'. The constraining of generation is location-specific and can be reduced, for example, by transmission network reinforcements. The model accounts for N-1 contingencies, this means that the system will be dispatched in such a way that any single contingency will not cause overloads.

In Plexos, when a transmission constraint occurs, Plexos will attempt to alleviate the constraint in the most cost-effective manner. If a transmission constraint causes wind or solar generation to be constrained down, Plexos' internal dispatch logic may choose one generator to constrain down out of several that have the same cost impact on the constraint (due to the fact that, in the constraints model, all wind and solar generators are modelled with zero cost of production).

This report studies the connection of very large amounts of generation to the network. As such, there are some areas where the levels of transmission constraints are both large and frequent. There are also areas where there are, at times, several overlapping operational and transmission constraints. This makes it more difficult to apportion curtailment and constraints to individual nodes.

Post-processing of the results is required to ensure study results are more representative of the application of a constraint instruction. The process involves sharing the constraint volume proportionally or on a pro-rata basis across renewable generators in Northern Ireland which are effective in managing a particular network limitation. There is no distinction made between the treatment of priority and non-priority generators for constraint dispatch down. Constraints are applied to a collection of generators within four areas in Northern Ireland. These are discussed in the Section 4.8. Each generator type observes the same percentage of constraints within an area.

4.6 Priority Dispatch for Wind and Solar Generation

4.6.1 Priority Dispatch for Renewable Generation Connecting after July 2019

EU regulation 2019/943 published in June 2019 introduced a clause in relation to the priority dispatch status of renewable generation connected after the 4th July 2019.

The relevant clause (Article 12) is as follows:

REGULATION (EU) 2019/943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 on the internal market for electricity[9]

Article 12 (6)

Without prejudice to contracts concluded before 4 July 2019, power-generating facilities that use renewable energy sources or high-efficiency cogeneration and were commissioned before 4 July 2019 and, when commissioned, were subject to priority dispatch under Article 15(5) of Directive 2012/27/EU or Article 16(2) of Directive 2009/28/EC of the European Parliament and of the

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN

Council (20) shall continue to benefit from priority dispatch. Priority dispatch shall no longer apply to such power-generating facilities from the date on which the power-generating facility becomes subject to significant modifications, which shall be deemed to be the case at least where a new connection agreement is required or where the generation capacity of the power-generating facility is increased.

Under Article 12, renewable generation connected before the 4th of July 2019 will still hold priority dispatch status, while generation connected after this date will not. This will create a new type of generator for consideration in the dispatch process – the non-priority dispatch renewable generator, connected post July 4th 2019.

The SEMC published a decision paper in relation to Article 12 and 13 of the EU 2019/943 on the 22nd of March 2022[10] (SEM-22-009 Decision Paper on Dispatch, Redispatch and Compensation Pursuant to Regulation EU 2019/943). The detailed design of the interim and enduring solutions to Articles 12 and 13 implementation are yet to be finalised and may differ from the pro-rata implementation for dispatch down used in this study. Therefore, an assumed interpretation has been included in this study consistent with ECP 2.2 constraint forecast based on the SEM-22-009 interim solution. This interpretation has been outlined below.

- During generation reduction for surplus reasons, a distinction is made between the treatment of priority and non-priority renewable generators, with non-priority generators being dispatched down ahead of priority generators. Within, these two categories of generation, surplus is applied pro-rata across the all-island system for all generators in the category.
- During curtailment or constraint of renewable generation, no distinction is made between priority and non-priority generators, and dispatch down is applied pro-rata across either the all-island system (in the case of curtailment), or across the relevant transmission nodes (in the case of constraint).

4.6.2 Modelling Approach for Priority Dispatch

The priority dispatch status of renewable generation is only applicable for generators connected before the 4th July 2019.

For this study, when applying generation reduction for surplus reasons, priority generators are given a negative offer price in the model to ensure their priority in the dispatch. During generation re-dispatch for curtailment and constraint reasons, the renewable generators are all given a zero-offer price without a distinction being made between priority and non-priority generators[11]. As Plexos seeks to provide the most economical solution while satisfying all system constraints it consequently will run as much wind and solar generation as is possible.

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[10] https://www.semcommittee.com/sites/semc/files/media-files/SEM-22-009%20Decision%20Paper%20on%20Dispatch%2C%20Redispatch%20and%20Compensation%20Pursuant%20to%20Regulation%20EU%202019943.pdf

[11] These generator price assumptions have been applied for the purposes of modelling in this study only. The design of the implementation of Articles 12 and 13 in EU Regulation 2019/943, has yet to be agreed by the relevant industry stakeholders and may differ from the implementation used in this study.

4.7 Modelling Running Sequence

The study process is depicted in Figure 4-1. The steps can be summarised as follows:

- During the surplus run, inputs include renewable availability profiles and the generation installed capacity. The model is run unconstrained for the surplus step producing a generation dispatch for each hour across the year. Within that run Plexos dispatches down across the generators. Post processing re-distributes the surplus pro-rata across the generators subject to priority and non-priority rules. The renewable availability profiles are updated accordingly.
- For the curtailed run, the updated renewable profiles from the surplus model are input to the curtailed model along with the operational constraints. The curtailed run produces a generation dispatch again and the redistribution of the curtailed dispatch down is undertaken again to the profiles.
- For the constrained run, the profiles from the curtailed model run are again an input, this time with network rules active to run the constraint study. This produces the final generation dispatch. There is some final processing to redistribute the constrained dispatch down across generators according to constraint areas.
- This modelling run sequence is repeated for each study scenario.

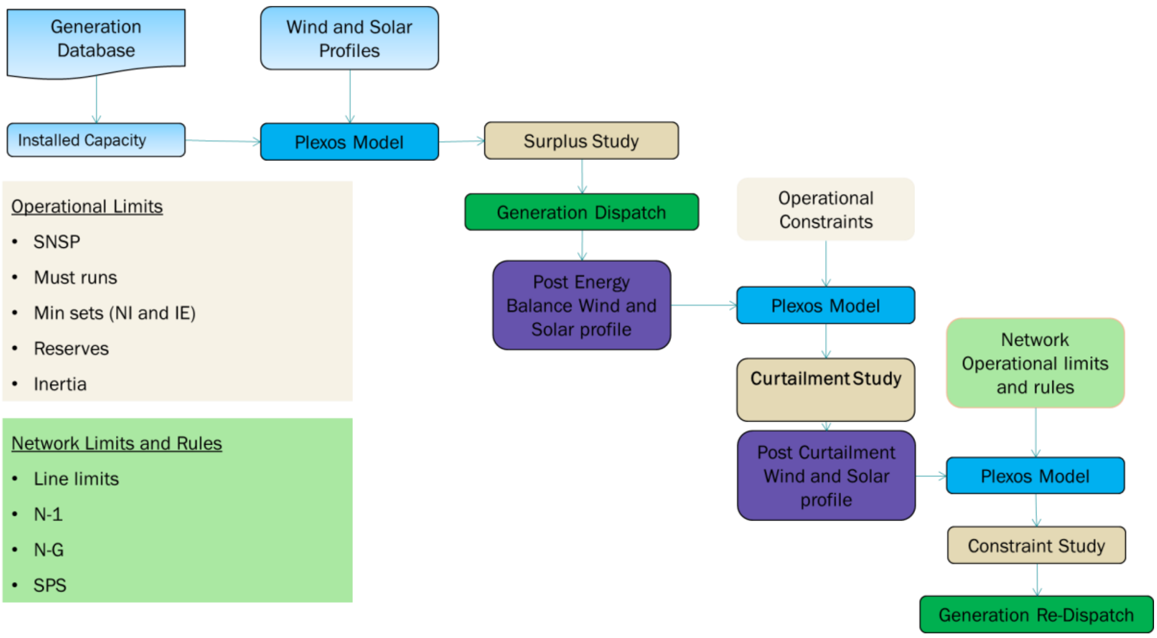

Figure 4-1: Overview of the sequence of model running and results processing

4.8 Northern Ireland Constraint Areas

4.8.1 Reflection on Control Centre Constraint Subgroups

Constraints result from power flow limitations due to the topology and characteristics of the transmission network. Constraints are applied locally and can arise in both an intact network, in the case of an N-1 contingency or due to planned line outages. In order to manage these constraints, wind/solar farms are grouped together according to their effectiveness to alleviate constraints. The effectiveness is a measure of the change in wind/solar farm output relative to the change in the level of the 'base case' or 'N-1" constraint, whereby the effectiveness is a function of the topology of the transmission network. SONI's Control Centre manages wind/solar constraints in real time operation of the power system subject to these constraint subgroups, which are published by the regulator. The Control Centre constraint subgroups are shown in Figure 4-2, which are nested in nature.

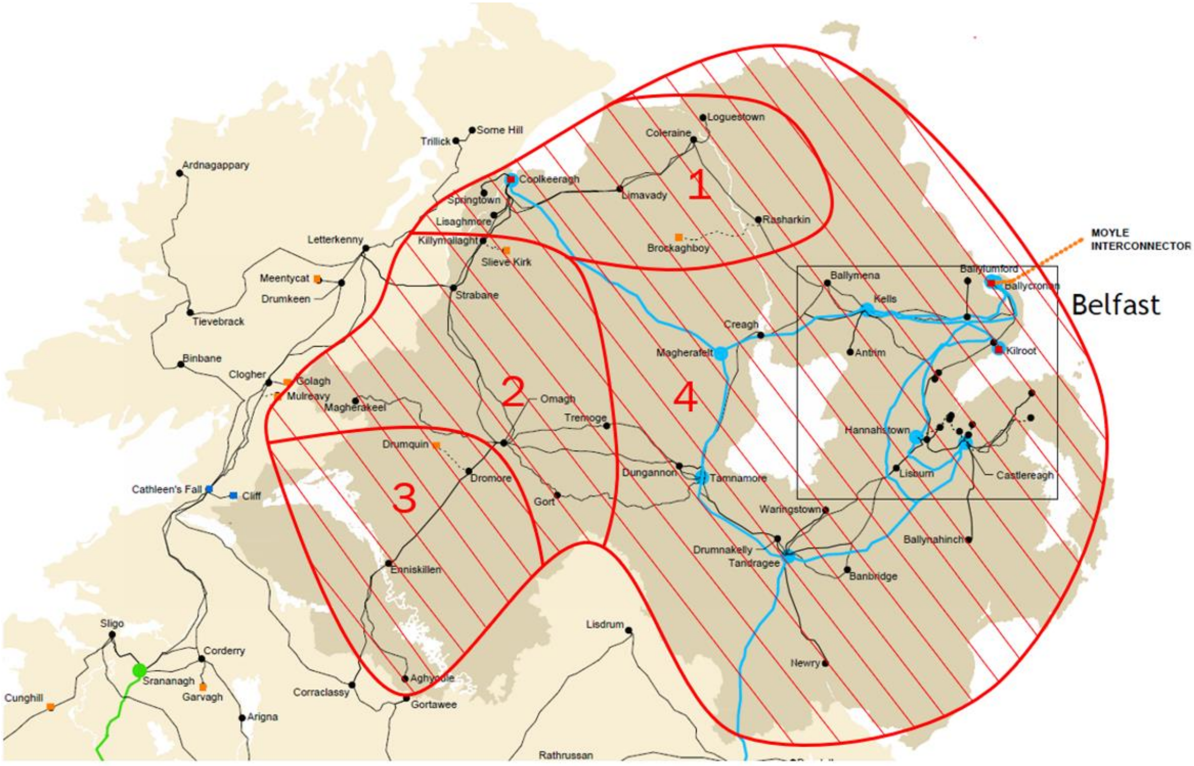

Figure 4-2 Northern Ireland nested subgroups as they exist today operated by the SONI Control Centre.

SONI's Control Centre constraint subgroups are determined from in hour assessment of local generation to mitigate a contingency. They are nested subgroups. In this study, SONI used the Control Centre subgroups as input but an exact mirroring is purposely not replicated. This is described in more detail in the next section and follows the ECP 2-2 modelling methodology. The rational for not mirroring the control centre constraint subgroups is:

- To share the constraints between generators that are associated to bottlenecks in an area.
- To take account of distinction in formulation of a constraint subgroup allocation between control centre and ECP associated studies (discussed below)
- To also take cognisance that constraint subgroups active today may be different in future years so exact replication is not warranted.
- To maintain consistency between study years, the same constraint subgroups have been used in both study years.

4.8.2 Constraint Areas in this Study: Note on Plexos Constraint Post-Processing Reallocation

The constraint forecast study performed using Plexos software applies mathematical optimisation to find the lowest cost generator dispatch schedule to meet demand, subject to a number of system and transmission level constraints. To ensure the model is impartial, the assumptions on the marginal cost of renewable generators remain the same, irrespective of technology or location, and are always less than that of conventional plant. This ensures renewable generators are given priority in the Plexos optimisation. However, due to network congestion caused by line limits and N-1 contingency security checks, the power flows in certain lines are limited causing dispatch down in RES generators. This may affect one generator or multiple generators chosen by Plexos' internal logic. Previously it was observed that Plexos may repeatedly choose the same generator(s) to dispatch down to manage an issue in a region shared by multiple generators.

For that reason, there is a post-processing step between the Plexos simulation and this report to ensure a fair allocation of constraints from Plexos among generators sharing the bottlenecks across the Northern Ireland constraint areas discussed below. The Northern Ireland constraints study maintains consistency with ECP Constraints in application of constraint areas. Whereby the constraint areas group generators that share a common transmission bottleneck, or they are electrically close to a congested area within the network. Therefore, in turn, they are expected to experience similar constraint levels i.e. the post-processing of results re-apportions the percentage constraint evenly across priority and non-priority by generation type across individual areas. The contingencies and overloaded lines associated with a constraint area are included in Appendix D.

The visualisation of the constraint areas is shown in Figure 4-3 below. The detailed list of the nodes associated with those areas are shown in Appendix E. The constraints are shared on a pro-rata basis amongst the generators in an area. The individual node level dispatch down is given in Appendix C. These areas are similar geographically with those from the control centre. Where they differ is that they are considered discreetly as opposed to nested. The motivation for maintaining the same geographic coverage in the study constraint areas is:

- As per described above
- The N-1 contingency binding lines in Appendix D are occurring in these respective constraint areas
- The narrative of representation of renewables and demand in each area whereby
    - Area - I is high in RES with mid demand
    - Area - II is similar to area I.
    - Area - III is low in RES and demand
    - Area - IV with high solar and high demand.

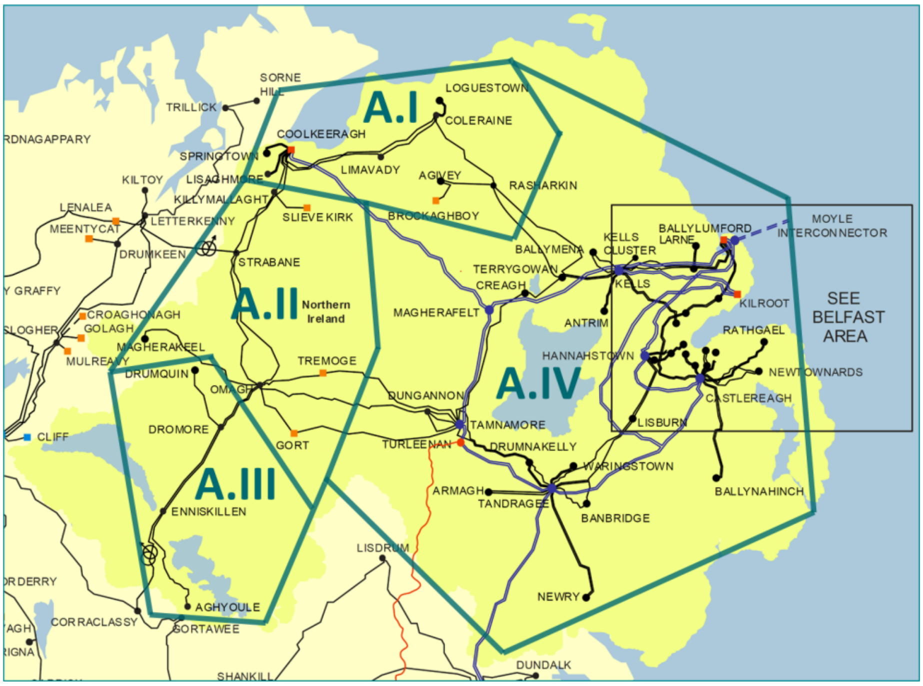

Figure 4-3 Illustration of constraint areas in NI constraints study

5 Results: Overall and by Constraint Area

This chapter discusses the main results from this constraints study, first covering the overall results across Northern Ireland and then providing detailed results at constraint area level. This is illustrated in Figure 5-1, showing the categorization of the results.

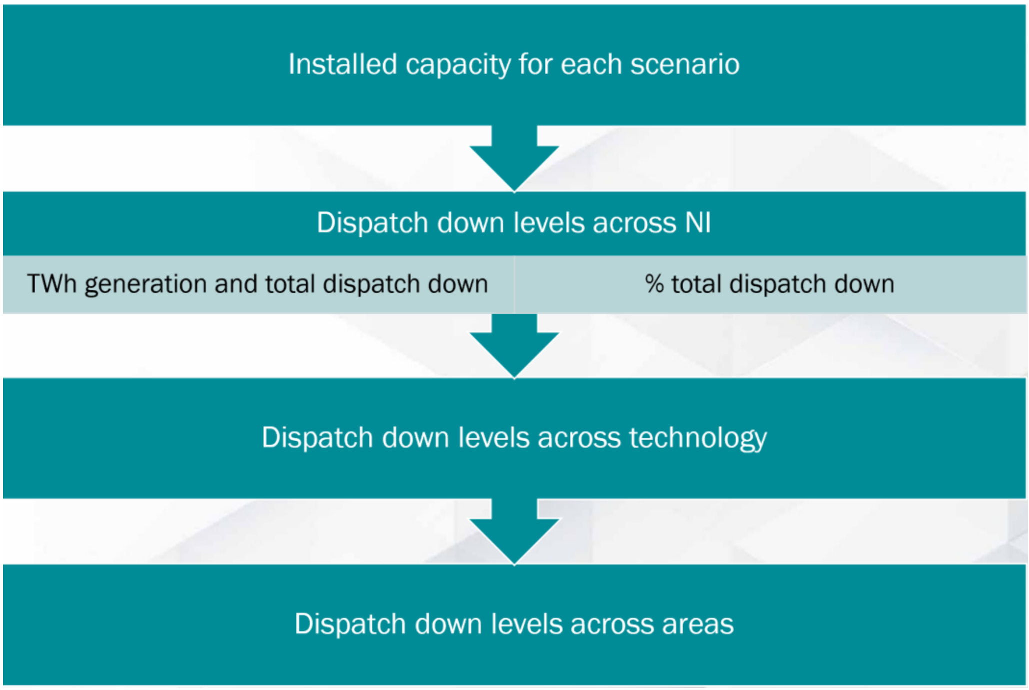

Figure 5-1 Overview of granularity of results for Northern Ireland discussed across Chapter 5

5.1 Overall Results

The following sections provide a summary of the Total Dispatch Down levels estimated at a system level for Northern Ireland. It explores in comparative chart form, the following indicators:

- The total installed capacity in each scenario
- The total dispatch down in TWh and in percentage for each scenario
- The dispatch down results across technology category.

Results are provided for each of the five study scenarios which include:

- Initial and 100% renewable generation scenarios for the year 2025; and
- Initial, 100% and 100% plus 500 MW offshore renewable generation scenarios for the year 2030.

5.1.1 Scenario Installed Capacity Visualisation

Figure 5-2 introduces the installed capacity across the five study scenarios. It is categorized across solar and wind, priority, non-priority, and uncontrollable. The main difference in installed capacity between scenario arises from the wind non-priority, which is the pink colour in the middle and the solar non-priority, which is the green colour on the top. This is because the majority of priority generation would be considered as connected by the qualification date of the end of 2024 for the initial capacity scenario. The following observations can be made on the relative installed capacity between the scenarios:

- Compared with initial, the 100% capacity case has new wind non-priority and solar non-priority.
- 2030 100% case is larger than 2025 100%, due to the addition of extra replant and wind not-priority clusters from SOEF 1.0.
- In the offshore case, 500MW offshore wind is regarded as additional non-priority wind.

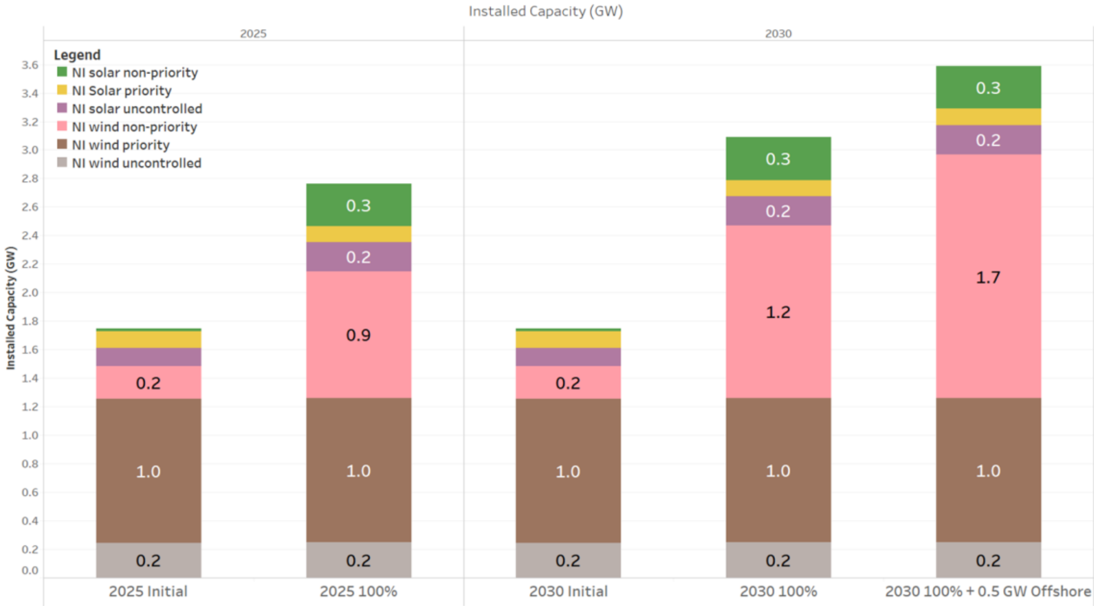

Figure 5-2 Installed capacity in the five study scenarios for Northern Ireland.

5.1.2 TWh Dispatch Down and Constrained Generation

Figure 5-3 compares dispatch down and its constituent components across the scenarios. It shows the constrained generation in TWh along with each of the dispatch down components. Relative to installed capacity in the previous chart, the volume of dispatch down is following same profile shape as that for installed capacity.

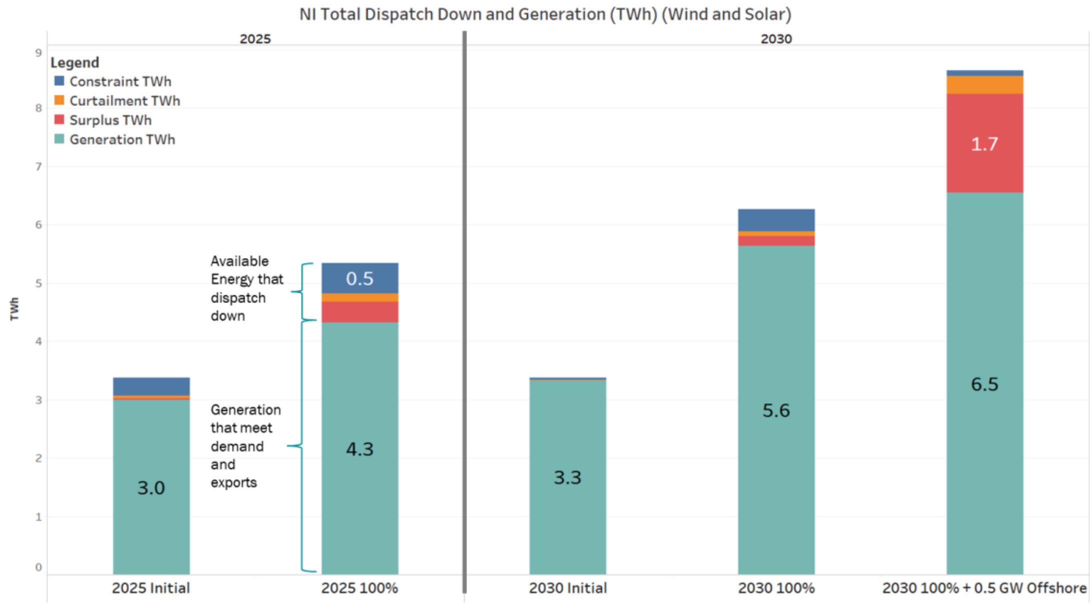

Figure 5-3 Total Dispatch Down and Generation (Wind and Solar) TWh in Northern Ireland

5.1.3 Percentage Total Dispatch Down

The previous chart shows the total dispatch down in absolute TWh terms. Then in relative terms as a percentage of available energy, Figure 5-4 shows the percentage total dispatch down broken into its constituent components across the scenarios. Three influencing drivers or effects on total dispatch down are portrayed from this chart. These include:

- Effect of generation increase: For a given study year, increasing installed capacity drives up the total dispatch down when comparing the initial and 100% renewable generation scenarios,
- Effect of network improvement, improvements in operational limits, new interconnection and demand increase: total dispatch down is lower in 2030 than in 2025 due to the delivery of network reinforcements, additional interconnection capacity, the relaxation of operational constraints and increased demand levels.
- Effect of offshore: the inclusion of 500 MW of offshore wind into the 100% renewable generation scenario in 2030 results in the highest levels of dispatch down, driven mainly by an increase in surplus.

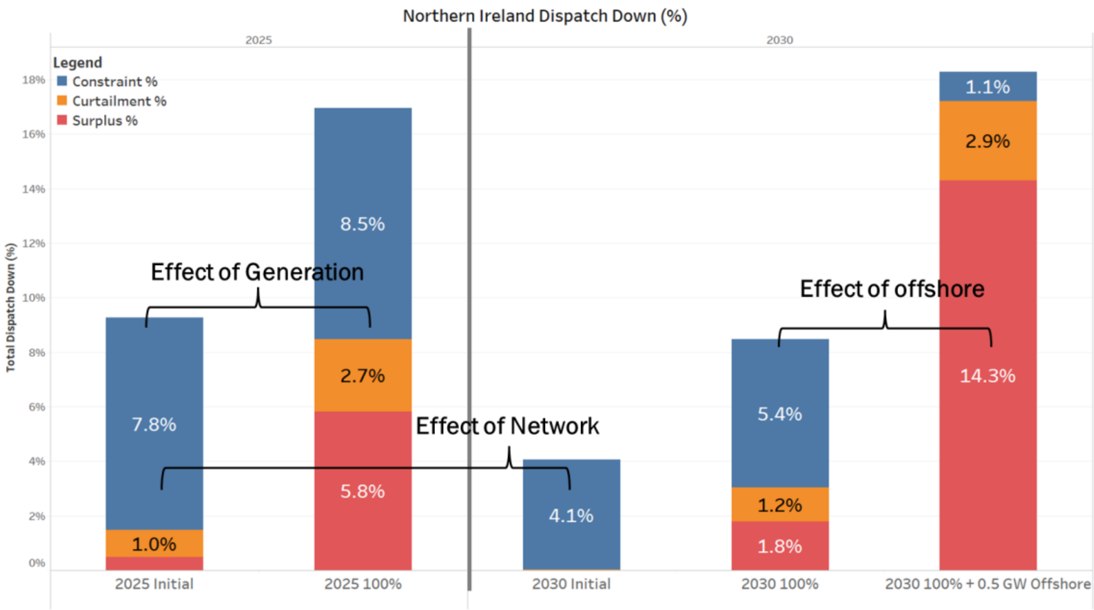

Figure 5-4 Percentage System Total Dispatch Down in Northern Ireland

5.1.4 Percentage Dispatch Down by Technology

Figure 5-5 shows the breakdown of total dispatch down across technology category, focusing on solar and wind, priority and non-priority. The results shown here are for controllable only because the uncontrollable is not allocated dispatch down in the model. There are three key observations:

- Surplus becomes the dominant driver of dispatch down in the offshore study case for wind not priority. This aligns with observations from SOEF.
- In the initial capacity cases, constraint dominates the dispatch down.
- For a particular renewable generation category, the level of % constraint is equal within a constraint area, even when considering priority and non-priority generation.
- The level of % surplus for each renewable generation category is equal across Northern Ireland for a given scenario.
- Solar generation tends to have a lower % total dispatch down when compared with wind generation as it has a more concurrent supply compared with demand.

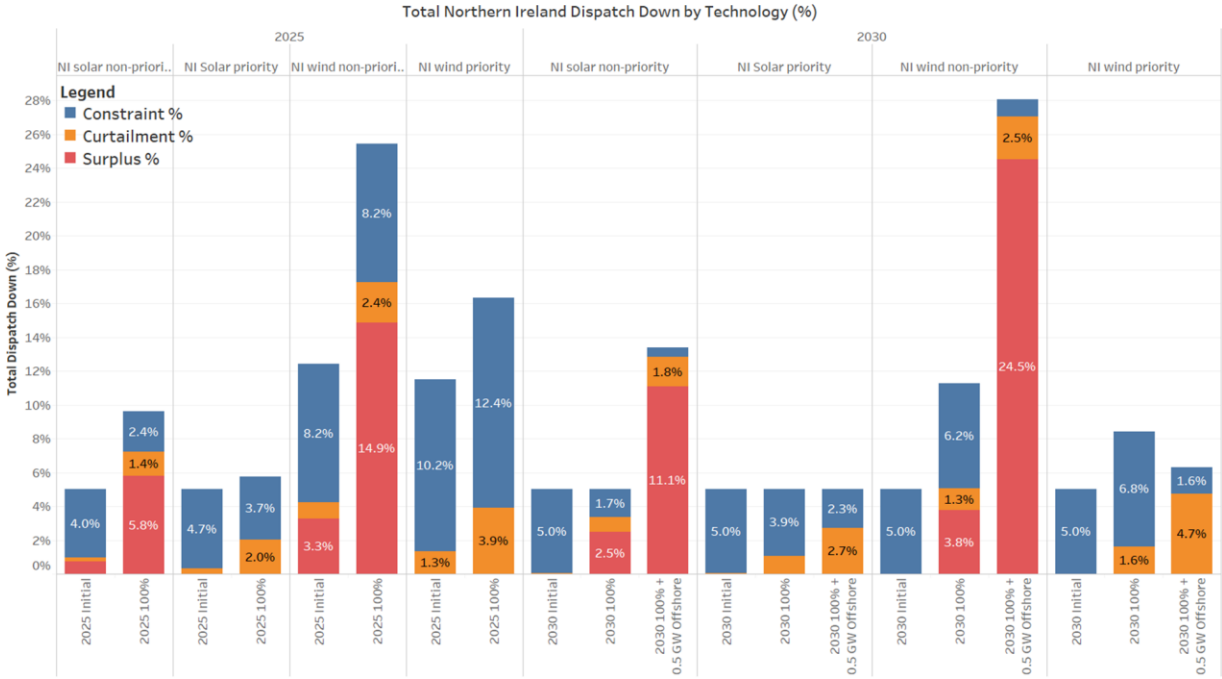

Figure 5-5 Percentage total dispatch down by technology category for Northern Ireland

5.2 Northern Ireland Overview of Overall Flows

Flows into the Northern Ireland grid depend on the study year, the installed capacity and the demand/supply adequacy both within Northern Ireland and with neighbouring interconnected regions. From this study the following observations have been found:

- In the 2025 initial capacity case, there are net flows from the UK into Northern Ireland then into Ireland driven, in part by generation adequacy and demand growth in Ireland. This is amplified in the initial capacity case in 2030 where the capacity is the same but the demand is larger and there is also the inclusion of the North South 2 interconnector.
- In the 2025 100% capacity case, Northern Ireland switches to being a net exporter due to higher renewable energy available
- In the offshore study case, the flow direction observed in the initial 2025 case reverses, with net import from Ireland into Northern Ireland driven by the 5 GW offshore in Ireland, followed by net export over Moyle from Northern Ireland into the UK added to by the 500 MW offshore in Northern Ireland.

In further sections of this chapter, the results over the four Northern Ireland constraint areas are discussed as well as the nature of net generation or net demand driving flows between areas.

5.3 Dispatch Down Results by Constraint Area

The following remaining sections of this results chapter discuss the dispatch down results by constraint area for each technology. It discusses the generation and demand share perspective for each area, and how this influences the net flows in each area. The chapter then finishes with conclusions from the results.

As an overall summary of the constraint area results, Figure 5-6 shows the breakdown of percentage dispatch down for each technology across each of the constraint areas in Northern Ireland. Here, each of the lines presents the trend in dispatch down between the initial and 100% capacity case. The following is illustrated:

- Areas I and II with the most installed wind, observes a high degree of dispatch down.
- Area IV with more demand concentration, observes less dispatch down.
- Area III has the least installed capacity, but still experiences high dispatch down but just on a percentage basis, it’s still low on an energy basis.

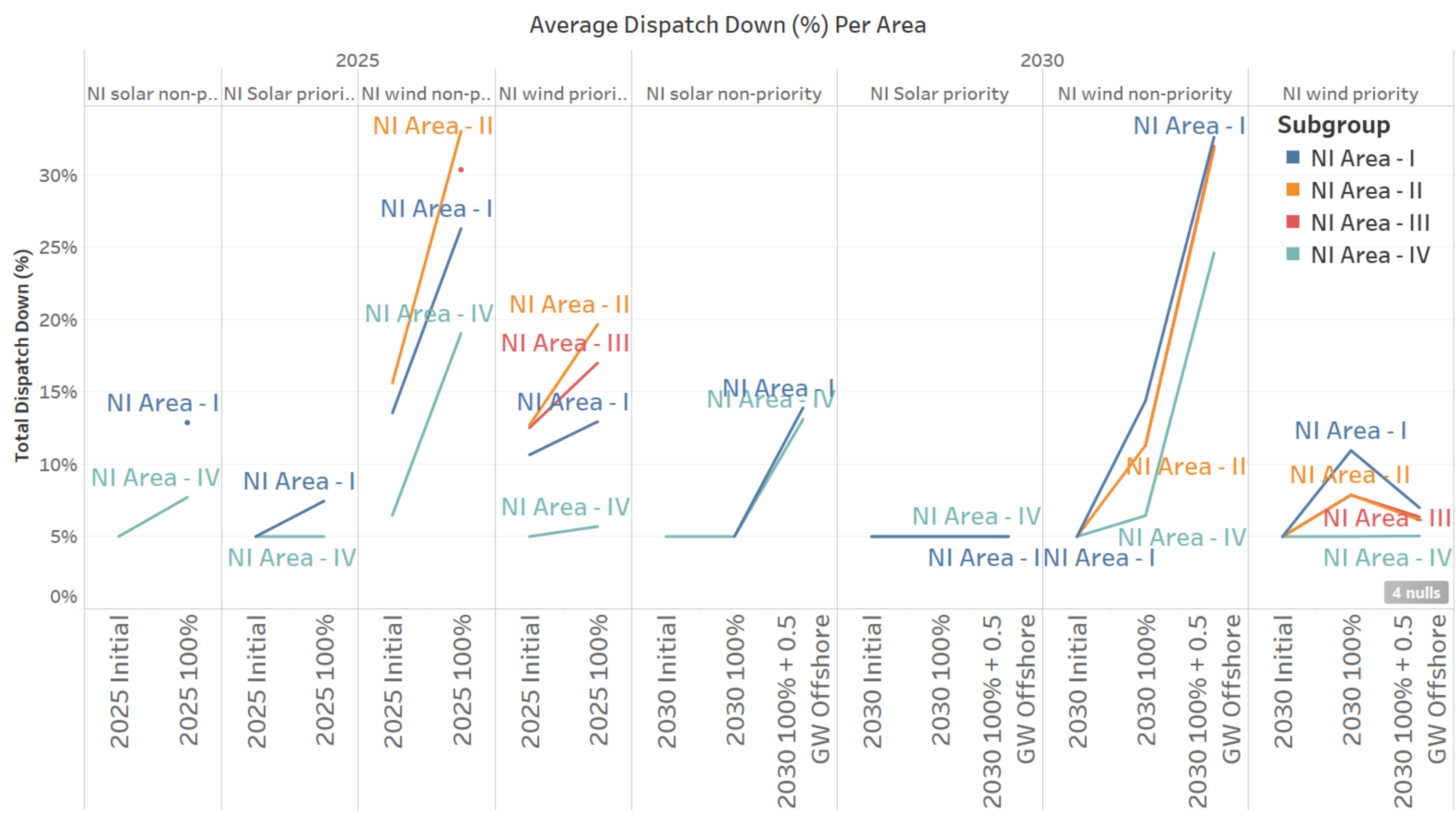

Figure 5-6 Total Dispatch Down % per Area by Technology for Northern Ireland

5.4 Area - I Results

5.4.1 Area - I Generation and Demand Overview

Area - I is the region with the second highest onshore installed capacity across Northern Ireland. The installed renewable capacity is illustrated in Table 5-1. This includes solar and onshore wind, priority and non-priority, as well as uncontrollable solar and onshore wind. The generation capacity is concentrated within regions around the Limavady, Agivey, Rasharkin and Feeney part of the network. Note that the uncontrollable wind and solar, by its name, is not dispatched down and so is not reported in the results.

Node	Solar (MW)			Wind (MW)			Grand Total (MW)
	solar not priority	solar priority	solar uncontrolled	wind not priority	wind priority	wind uncontrolled	
Grand Total	111.0	35.0	21.3	490.8	253.2	53.7	965.0

Table 5-1 Overview of generation by type in Area -I

In terms of demand distribution, Area I accounts for 16% of the total Northern Ireland demand as shown in Table 5-2. This is concentrated at load centres nodes at Coleraine and Coolkeeragh.

Row Labels	Node	Demand share
Area I	Total share	16%

Table 5-2 Demand distribution across Area - I

5.4.2 Area - I Network and Flows Overview

The network in Area - I is illustrated in Figure 5-7. The 275 kV circuit from Coolkeeragh to Magharafelt facilitates flows from the renewable resource rich region to the large load centres in Area - IV. Noting the observations on spatial demand and generation in Area - I above, the Plexos market dispatches were analysed examining the ratio of generation to demand within the Area. The results show, for the 2030 study case in the absence of offshore, that the annual electricity generation is approximately 2.5 times the TWh demand in Area – I. Therefore, at times of high renewable generation, there is a net export of power from Area – I and the dominant power flows tend to be from Area – I towards the load centres in Area – IV and the interconnectors. There are flows to the load centres in Coolkeeragh and Coleraine, but predominantly there is net renewable flow leaving the region towards Area – IV in the East. These flow patterns are relevant when seeking to understand constraint apportionment in the simulation.

Constraints in Area – I can be caused both by local and wider system issues. Constraints in the model are optimised on a system-wide basis so, in theory, an increase in the installed generation in another area can increase constraints in Area- I.

Also, the power flowing out of Area – I meets and joins with power flows from other constraint areas, as the power flows towards the demand centres and interconnectors.

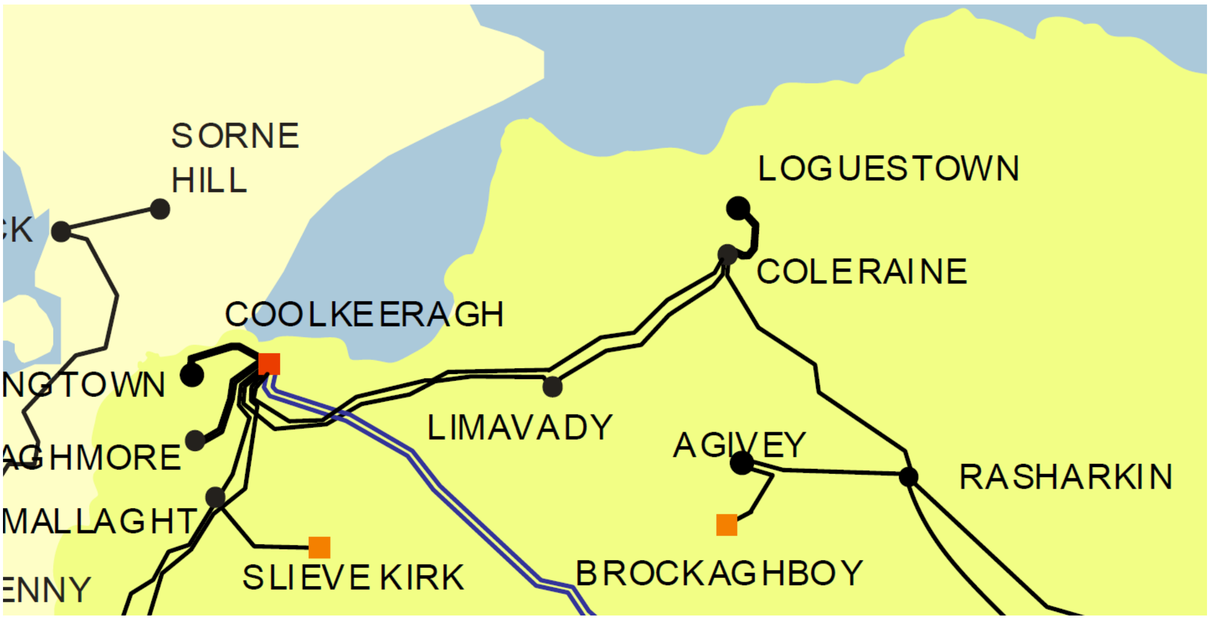

Figure 5-7 Overview of the network in Area – I

5.4.3 Area – I Average Results

The Total Dispatch Down results for Area – I are provided below in Table 5-3 to Table 5-6 and Figure 5-8 to Figure 5-11. These include:

- Breakdown between surplus, curtailment and constraint.
- Percentage Total Dispatch Down relative to the total available energy. The Total Dispatch Down is the sum of surplus, curtailment and constraint.
- Total installed capacity in MW
- Total available energy in GWh
- Total generation in GWh, after dispatch down.

Detailed conclusions that apply across the constraint areas are discussed in the conclusions section of this chapter.

The node level breakdown of surplus, curtailment and constraint are given in Appendix C.

5.4.3.1 Solar Not Priority generation report

NI (NI Area - I)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		111	
Installed Capacity (MW)	2030		111	111
Available Energy (GWh)	2025		116	
Available Energy (GWh)	2030		116	116
Generation (GWh)	2025		101	
Generation (GWh)	2030		110	99
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		5 %	
Constraint (%)	2030		2 %	1 %
Total Dispatch Down (%)	2025		13 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table 5-3 Surplus, Curtailment and Constraint for solar not priority NI (NI Area - I)

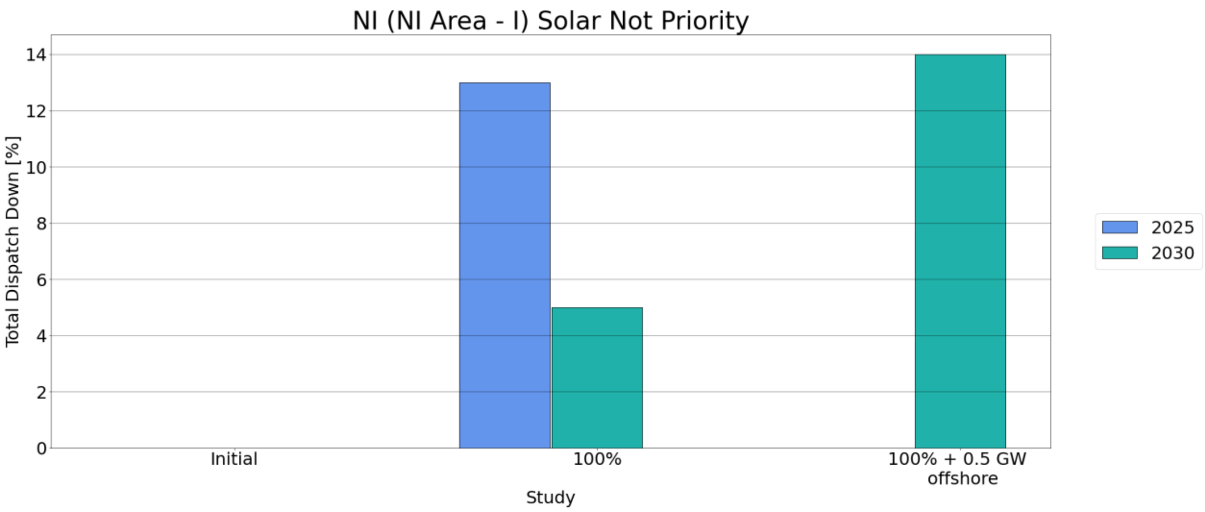

Figure 5-8 Results solar not priority NI (NI Area - I)

5.4.3.2 Wind Not Priority generation report

The wind not priority data is given in the following table.

NI (NI Area - I)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	130	361	
Installed Capacity (MW)	2030	130	491	491
Available Energy (GWh)	2025	340	941	
Available Energy (GWh)	2030	340	1279	1279
Generation (GWh)	2025	294	693	
Generation (GWh)	2030	323	1095	862
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	14 %	26 %	
Total Dispatch Down (%)	2030	5 %	14 %	33 %

Table 5-4 Surplus, Curtailment and Constraint for wind not priority NI (NI Area - I)

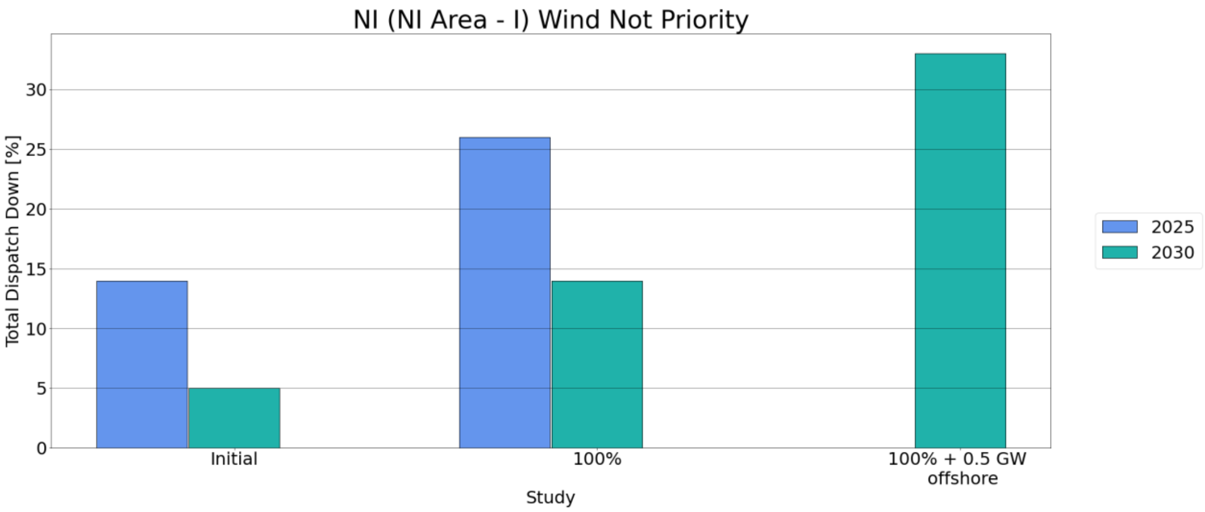

Figure 5-9 Results wind not priority NI (NI Area - I)

5.4.3.3 Solar Priority generation report

The solar priority data is given in the following table.

NI (NI Area - I)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	35	35	
Installed Capacity (MW)	2030	35	35	35
Available Energy (GWh)	2025	36	36	
Available Energy (GWh)	2030	36	36	36
Generation (GWh)	2025	35	34	
Generation (GWh)	2030	35	35	35
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	5 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	7 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table 5-5 Surplus, Curtailment and Constraint for solar priority NI (NI Area - I)

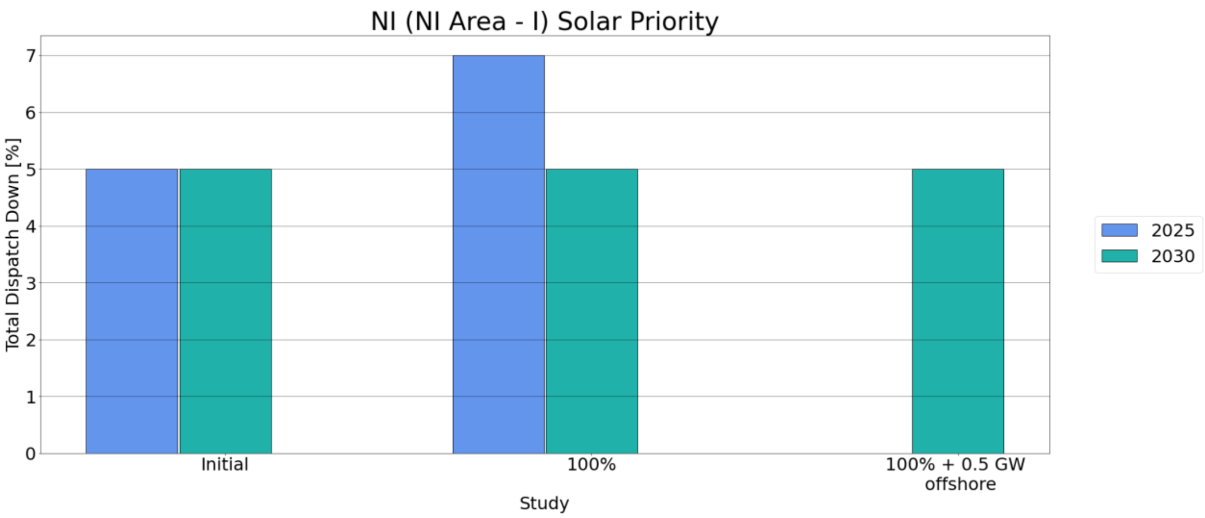

Figure 5-10 Results solar priority NI (NI Area - I)

5.4.3.4 Wind Priority generation report

The wind priority data is given in the following table.

NI (NI Area - I)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	253	253	
Installed Capacity (MW)	2030	253	253	253
Available Energy (GWh)	2025	660	660	
Available Energy (GWh)	2030	660	660	660
Generation (GWh)	2025	589	574	
Generation (GWh)	2030	627	587	614
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table 5-6 Surplus, Curtailment and Constraint for wind priority NI (NI Area - I)

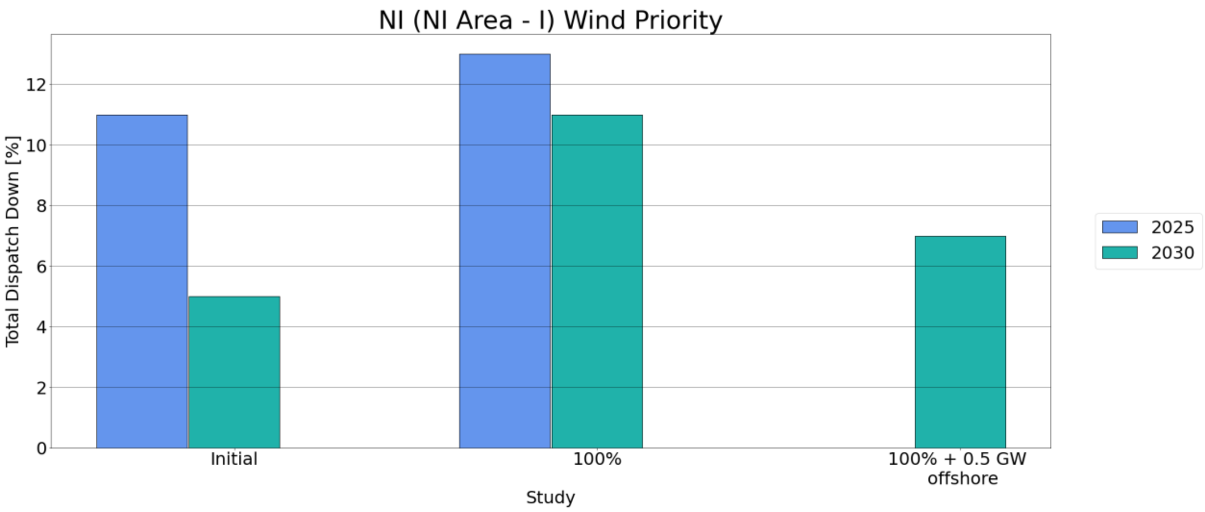

Figure 5-11 Results wind priority NI (NI Area - I)

5.5 Area II Results

5.5.1 Area - II Generation and Demand Overview

Area - II is the region with the highest onshore wind capacity across Northern Ireland. The installed renewable capacity is illustrated in Table 5-7. The generation in Area - II is primarily controllable wind, both priority and not priority. The remainder is some small scale uncontrollable solar and wind. This solar generation capacity is concentrated on the southern end of Area - II near nodes at Omagh, Magherakeel, and Tremoge.

Node	Solar (MW)	Wind (MW)			Grand Total (MW)
	solar uncontrolled	wind not priority	wind priority	wind uncontrolled	
Grand Total	15.4	392.3	570.5	49.8	1027.9

Table 5-7 Overview of generation by type in Area - II

In terms of demand distribution, Area - II accounts for 7% share of Northern Ireland demand as shown in Table 5-8.

Row Labels	Node	Demand Share
Area - II	Total share	7%

Table 5-8 Demand distribution across Area - II.

The next section will discuss how the generation and demand spatial distribution and relative ratio impact the flow topography on the network in Area - II.

5.5.2 Area - II Network and Flows Overview

The network in Area - II is illustrated in Figure 5-12. Noting the observations on spatial demand and generation in Area - II above, the Plexos market dispatches were analysed examining the ratio of generation to demand within the area. The results show for the 2030 study case in the absence of offshore, the annual electricity generation is approximately three times greater than the TWh demand in Area - II. Therefore the dominant flow is a net export of power from Area - II towards the load centres in Area - IV and the interconnectors.

Figure 5-12 Overview of the network in Area - II (excluding Drumquin and Dromore which are part of Area - III)

5.5.3 Area - II Average Results

The Total Dispatch Down results for Area - II are provided below in Table 5-9 to Table 5-10 and Figure 5-13 to Figure 5-14. These include:

- Breakdown between surplus, curtailment and constraint.
- Percentage Total Dispatch Down relative to the total available energy. The Total Dispatch Down is the sum of surplus, curtailment and constraint.
- Total installed capacity in MW
- Total available energy in GWh
- Total generation in GWh, after dispatch down.

Detailed conclusions that apply across the constraint areas are discussed in the conclusions section of this chapter.

The node level breakdown of surplus, curtailment and constraint are given in Appendix C.

5.5.3.1 Wind Not Priority generation report

The wind not priority data is given in the following table.

NI (NI Area - II)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	48	144	
Installed Capacity (MW)	2030	48	298	298
Available Energy (GWh)	2025	126	376	
Available Energy (GWh)	2030	126	777	777
Generation (GWh)	2025	106	252	
Generation (GWh)	2030	120	689	530
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	16 %	33 %	
Total Dispatch Down (%)	2030	5 %	11 %	32 %

Table 5-9 Surplus, Curtailment and Constraint for wind not priority NI (NI Area - II)

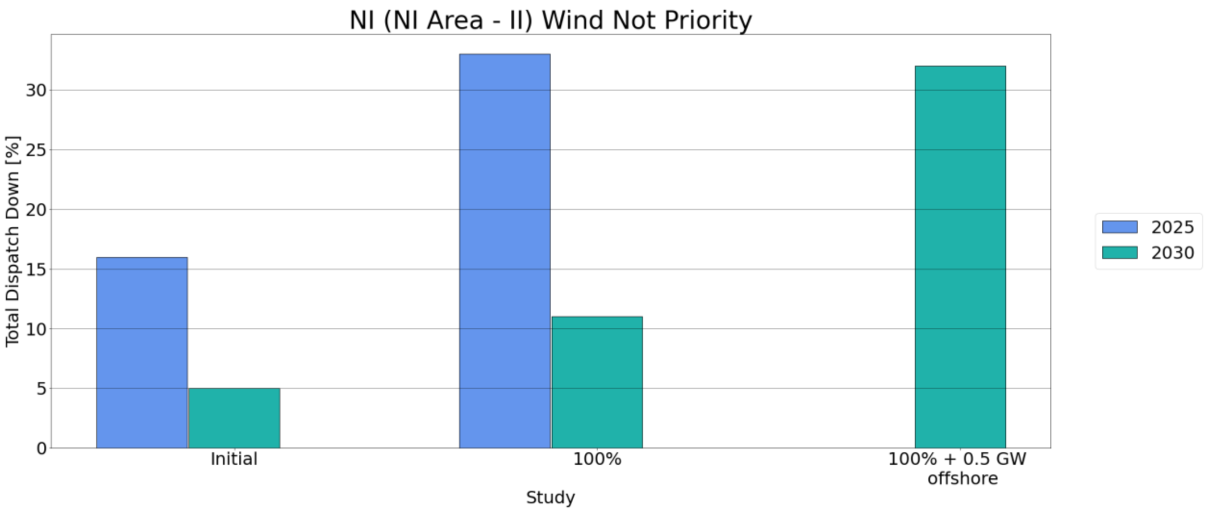

Figure 5-13- Results wind not priority NI (NI Area - II)

5.5.3.2 Wind Priority generation report

The wind priority data is given in the following table.

NI (NI Area - II)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	503	503	
Installed Capacity (MW)	2030	503	503	503
Available Energy (GWh)	2025	1309	1309	
Available Energy (GWh)	2030	1309	1309	1309
Generation (GWh)	2025	1143	1052	
Generation (GWh)	2030	1244	1206	1229
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table 5-10 - Surplus, Curtailment and Constraint for wind priority NI (NI Area - II)

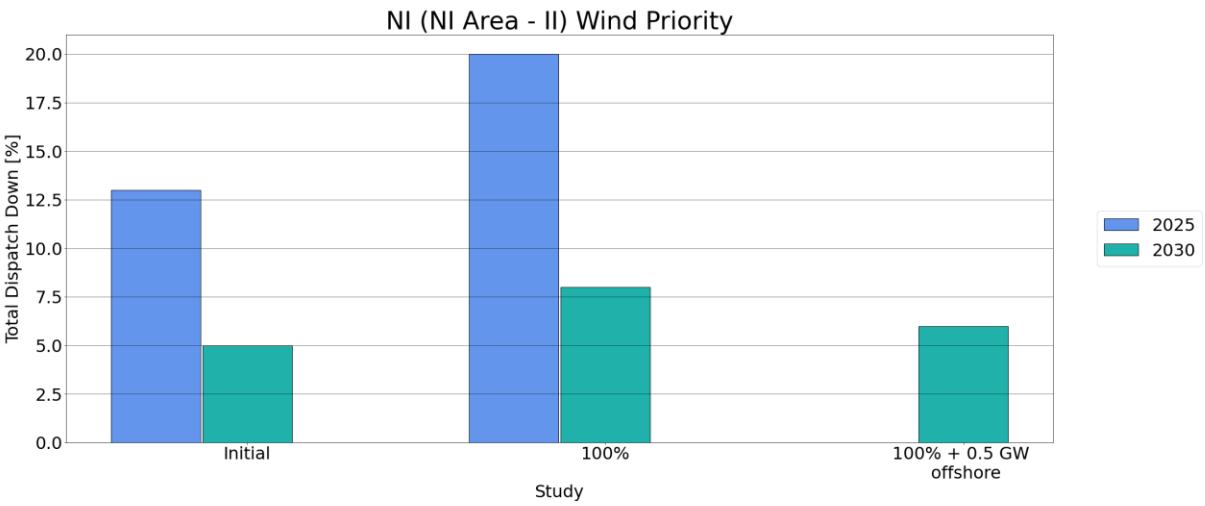

Figure 5-14- Results wind priority NI (NI Area - II)

5.6 Area – III Results

5.6.1 Area - III Generation and Demand Overview

Area - III is the region with the lowest installed renewable capacity across Northern Ireland, as illustrated in Table 5-11. This includes solar uncontrolled and onshore wind, priority and non-priority, as well as uncontrollable onshore wind. This generation capacity is concentrated at Aghyoule and Enniskillen. Note the uncontrollable, by its name, is not dispatched down and so is not reported in the results.

Node	Solar (MW)	Wind (MW)			Grand Total (MW)
	solar uncontrolled	wind not priority	wind priority	wind uncontrolled	
Grand Total	9	16	101	27	153

Table 5-11 Overview of generation by type in Area - III

In terms of demand distribution, Area - III, as well as having the smallest share of renewables, also has the smallest demand concentration of the four areas, accounting for a 5% share of Northern Ireland demand as shown below in Table 5-12.

The next section will discuss how the generation and demand spatial distribution and relative ratio impact the flow demographic on the network in Area - III.

Row Labels	Node	Demand share
Area - III	Total share	5%

Table 5-12 Demand distribution across Area - III

5.6.2 Area - III Network and Flows Overview

The network in Area - III is illustrated in Figure 5-15. Noting the observations on spatial demand and generation in Area - III above, the Plexos market dispatch were analysed examining the ratio of generation to demand within the area. The results show for the 2030 study case in the absence of offshore, the annual electricity generation is approximately 0.8 times the TWh demand in Area - II. Therefore there is a net load in Area - III. Predominant flows will then be in towards this area.

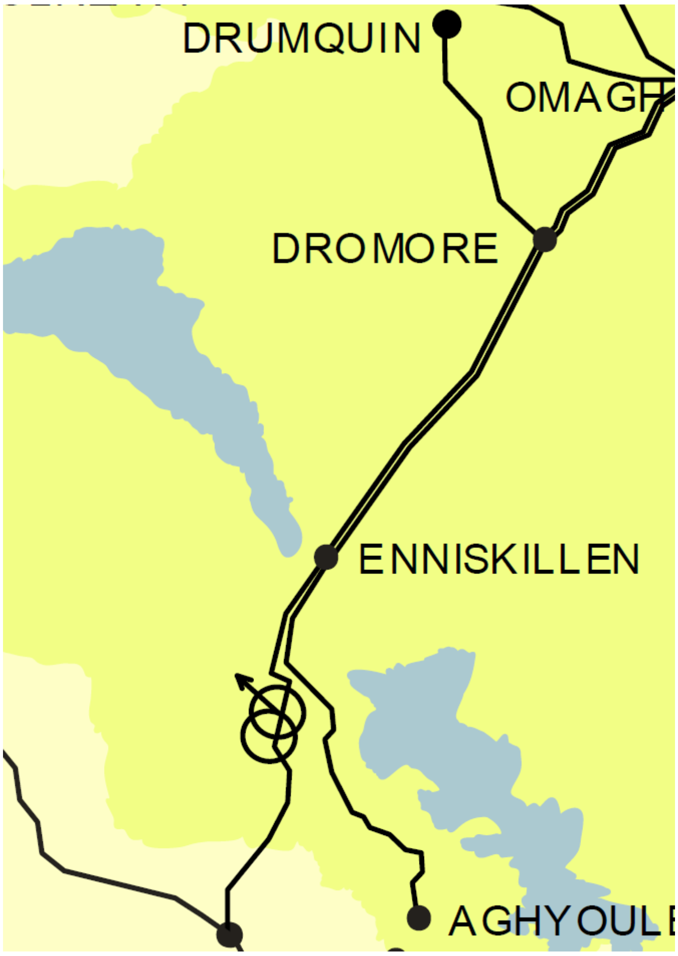

Figure 5-15 Overview of the network in Area - III

5.6.3 Area - III Average Results

The Total Dispatch Down results for Area - III are provided below in Table 5-13 to Table 5-14 and Figure 5-16 to Figure 5-17. These include:

- Breakdown between surplus, curtailment and constraint.
- Percentage Total Dispatch Down relative to the total available energy. The Total Dispatch Down is the sum of surplus, curtailment and constraint.
- Total installed capacity in MW
- Total available energy in GWh
- Total generation in GWh, after dispatch down.

Detailed conclusions that apply across the areas are discussed in the conclusions section of this chapter.

The node level breakdown of surplus, curtailment and constraint are given in Appendix C.

5.6.3.1 Wind Not Priority generation report

The wind not priority data is given in the following table.

NI (NI Area - III)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		94	
Installed Capacity (MW)	2030		110	110
Available Energy (GWh)	2025		245	
Available Energy (GWh)	2030		286	286
Generation (GWh)	2025		170	
Generation (GWh)	2030		254	195
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		13 %	
Constraint (%)	2030		6 %	2 %
Total Dispatch Down (%)	2025		30 %	
Total Dispatch Down (%)	2030		11 %	32 %

Table 5-13 Surplus, Curtailment and Constraint for wind not priority NI (NI Area - III)

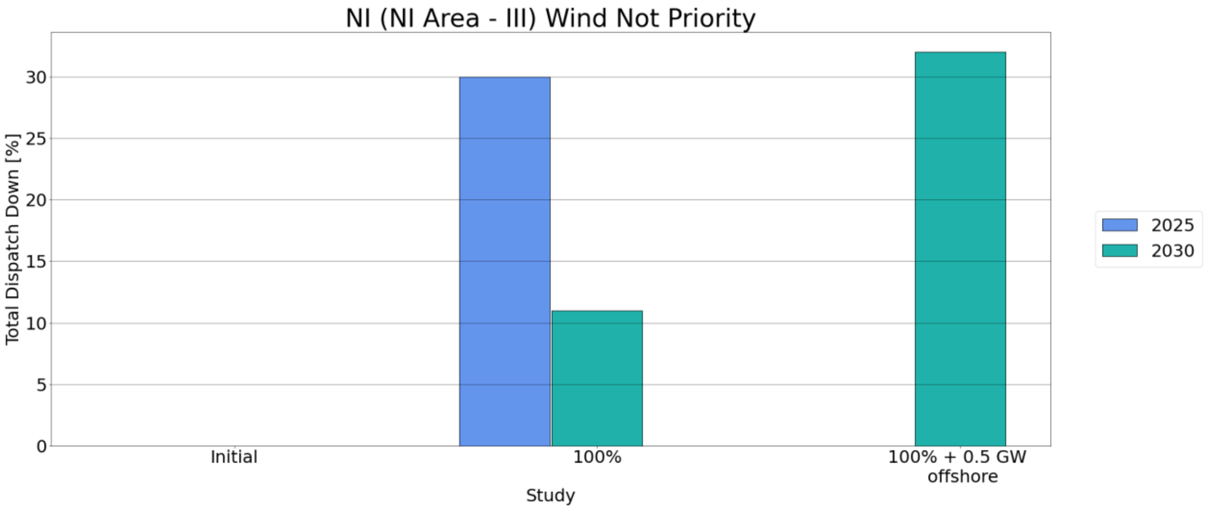

Figure 5-16- Results wind not priority NI (NI Area - III)

5.6.3.2 Wind Priority generation report

The wind priority data is given in the following table.

NI (NI Area - III)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	169	169	
Installed Capacity (MW)	2030	169	169	169
Available Energy (GWh)	2025	440	440	
Available Energy (GWh)	2030	440	440	440
Generation (GWh)	2025	385	365	
Generation (GWh)	2030	418	405	412
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	13 %	
Constraint (%)	2030	5 %	6 %	2 %
Total Dispatch Down (%)	2025	13 %	17 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table 5-14 Surplus, Curtailment and Constraint for wind priority NI (NI Area - III)

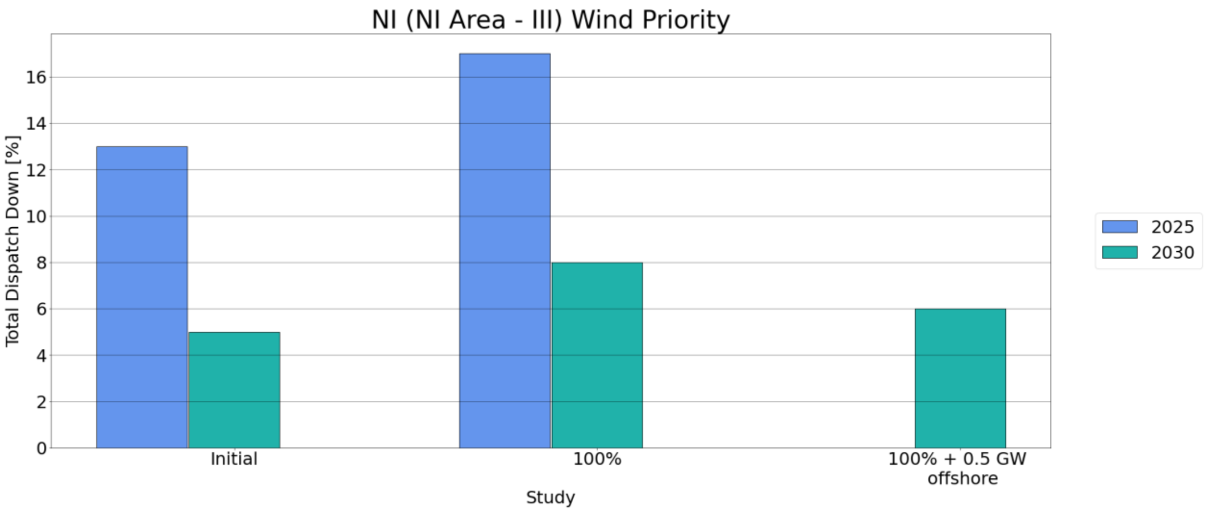

Figure 5-17 Results wind priority NI (NI Area - III)

5.7 Area IV Results

5.7.1 Area - IV Generation and Demand Overview

Area - IV is the region with the third highest onshore installed renewable capacity across Northern Ireland, as illustrated in Table 5-15, or highest total installed renewable capacity when offshore turbines are included.

Node	Battery (MW)	offshore wind (MW)	Solar (MW)			Wind (MW)			Grand Total (MW)
	battery	wind not priority	solar not priority	solar priority	solar uncontrolled	wind not priority	wind priority	wind uncontrolled	
Grand Total	226	500	189	79	159	314	85	117	1670

Table 5-15: Overview of generation by type in Area - IV

In terms of demand distribution, Area - IV accounts for a 73% share of Northern Ireland demand as below shown in Table 5-16. The next section will discuss how the generation and demand spatial distribution and relative ratio impact the flow demographic on the network in Area - II.

Row Labels	Node	Demand share
Area - IV	Total demand share	73%

Table 5-16 Demand distribution across Area - IV

5.7.2 Area - IV Network and Flows Overview

The network in Area - IV illustrated in Figure 5-18 characterised by the large 275 kV double ring. Noting the observations on spatial demand and generation in Area - IV above, the Plexos market dispatch were analysed examining the ratio of generation to demand within the area. The results show for the 2030 study case, in the absence of offshore, the annual electricity generation is approximately 65% of the TWh demand in Area - IV. Therefore Area - IV in the 2030 study case, in the absence of offshore, is net importer of power to meet the area demand.

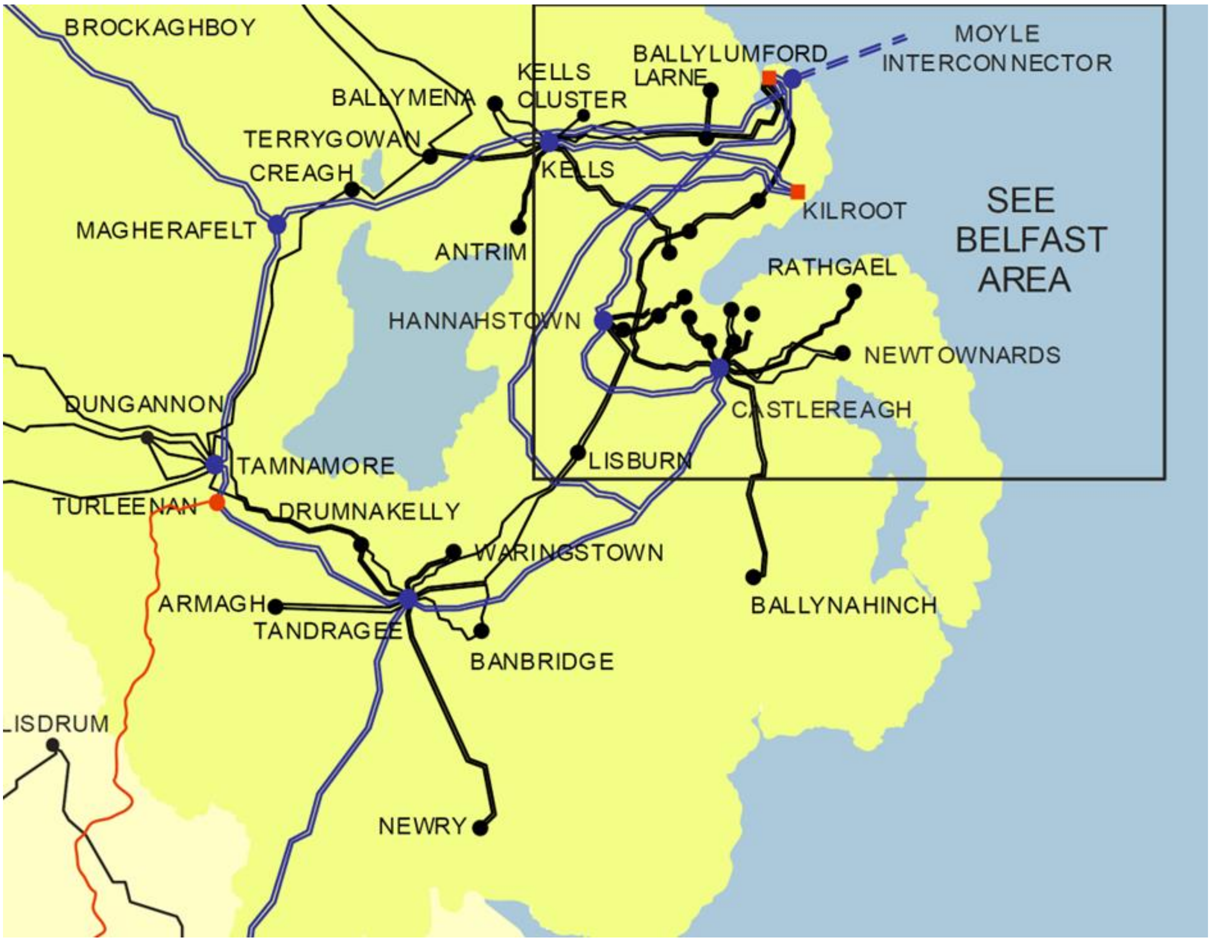

Figure 5-18 Overview of the network in Area - IV

5.7.3 Area - IV Average Results

The Total Dispatch Down results for Area - IV are provided below in Table 5-17 to Table 5-20 and Figure 5-19 to Figure 5-22. These include:

- Breakdown between surplus, curtailment and constraint.
- Percentage Total Dispatch Down relative to the total available energy. The Total Dispatch Down is the sum of surplus, curtailment and constraint.
- Total installed capacity in MW
- Total available energy in GWh
- Total generation in GWh, after dispatch down.

Detailed conclusions that apply across the constraint areas are discussed in the conclusions section of this chapter.

The node level breakdown of surplus, curtailment and constraint are given in Appendix C.

5.7.3.1 Solar Not Priority generation report

The solar not priority data is given in the following table.

NI (NI Area - IV)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	20	189	
Installed Capacity (MW)	2030	20	189	189
Available Energy (GWh)	2025	21	197	
Available Energy (GWh)	2030	21	197	197
Generation (GWh)	2025	20	182	
Generation (GWh)	2030	20	187	171
Surplus (%)	2025	1 %	5 %	
Surplus (%)	2030	0 %	2 %	10 %
Curtailment (%)	2025	0 %	1 %	
Curtailment (%)	2030	0 %	1 %	2 %
Constraint (%)	2025	4 %	1 %	
Constraint (%)	2030	5 %	2 %	1 %
Total Dispatch Down (%)	2025	5 %	7 %	
Total Dispatch Down (%)	2030	5 %	5 %	12 %

Table 5-17- Surplus, Curtailment and Constraint for solar not priority NI (NI Area - IV)

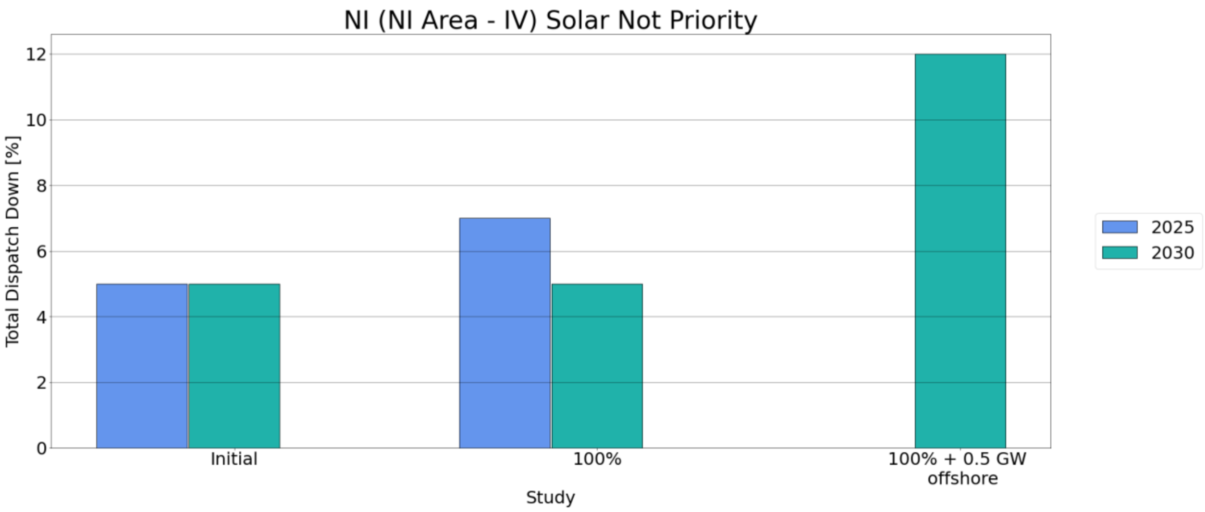

Figure 5-19 Results solar not priority NI (NI Area - IV)

5.7.3.2 Wind Not Priority generation report

The wind not priority data is given in the following table.

NI (NI Area - IV)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	51	290	
Installed Capacity (MW)	2030	51	314	814
Available Energy (GWh)	2025	132	755	
Available Energy (GWh)	2030	132	818	2787
Generation (GWh)	2025	124	611	
Generation (GWh)	2030	125	765	2102
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	26 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	2 %	2 %	
Constraint (%)	2030	5 %	1 %	0 %
Total Dispatch Down (%)	2025	6 %	19 %	
Total Dispatch Down (%)	2030	5 %	6 %	29 %

Table 5-18 Surplus, Curtailment and Constraint for wind not priority NI (NI Area - IV)

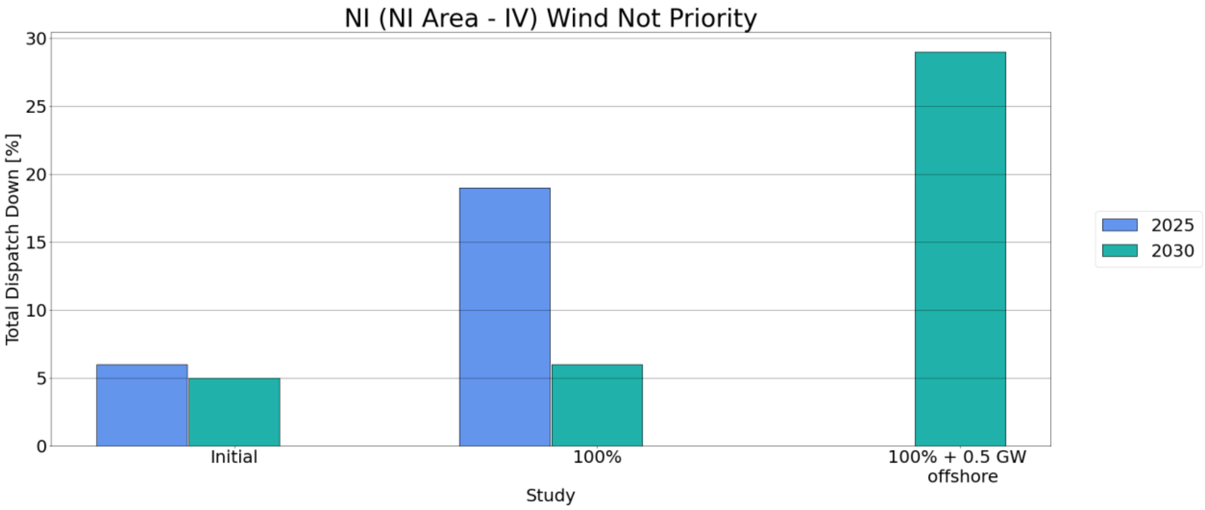

Figure 5-20 Results wind not priority NI (NI Area - IV)

5.7.3.3 Solar Priority generation report

The solar priority data is given in the following table.

NI (NI Area - IV)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	79	79	
Installed Capacity (MW)	2030	79	79	79
Available Energy (GWh)	2025	82	82	
Available Energy (GWh)	2030	82	82	82
Generation (GWh)	2025	78	78	
Generation (GWh)	2030	78	78	78
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	3 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	5 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table 5-19 Surplus, Curtailment and Constraint for solar priority NI (NI Area - IV)

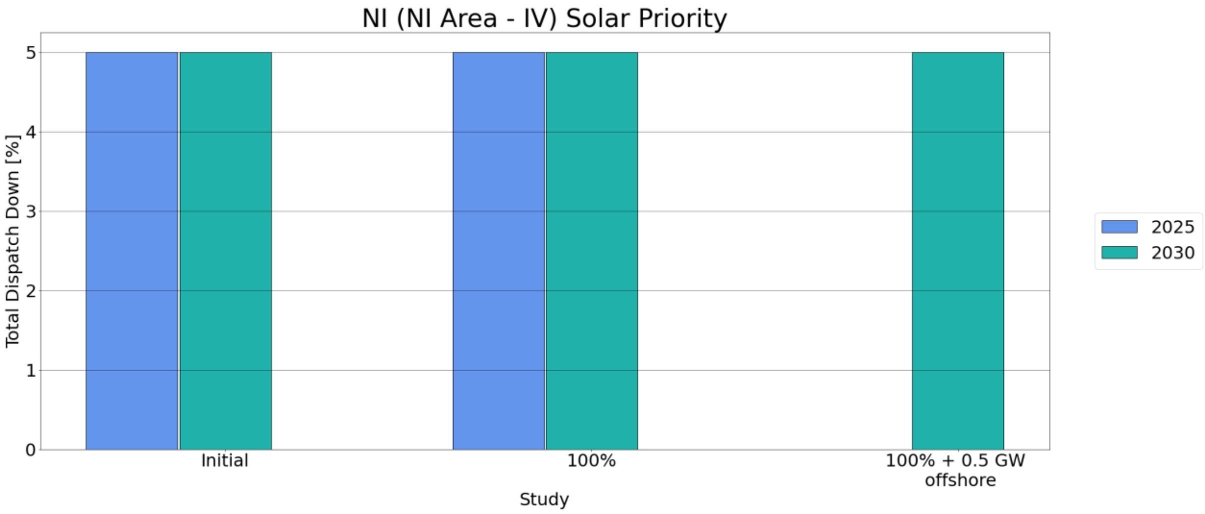

Figure 5-21 Results solar priority NI (NI Area - IV)

5.7.3.4 Wind Priority generation report

The wind priority data is given in the following table.

NI (NI Area - IV)	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	85	85	
Installed Capacity (MW)	2030	85	85	85
Available Energy (GWh)	2025	223	223	
Available Energy (GWh)	2030	223	223	223
Generation (GWh)	2025	212	210	
Generation (GWh)	2030	212	212	211
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	4 %	2 %	
Constraint (%)	2030	5 %	3 %	0 %
Total Dispatch Down (%)	2025	5 %	6 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table 5-20 Surplus, Curtailment and Constraint for wind priority NI (NI Area - IV)

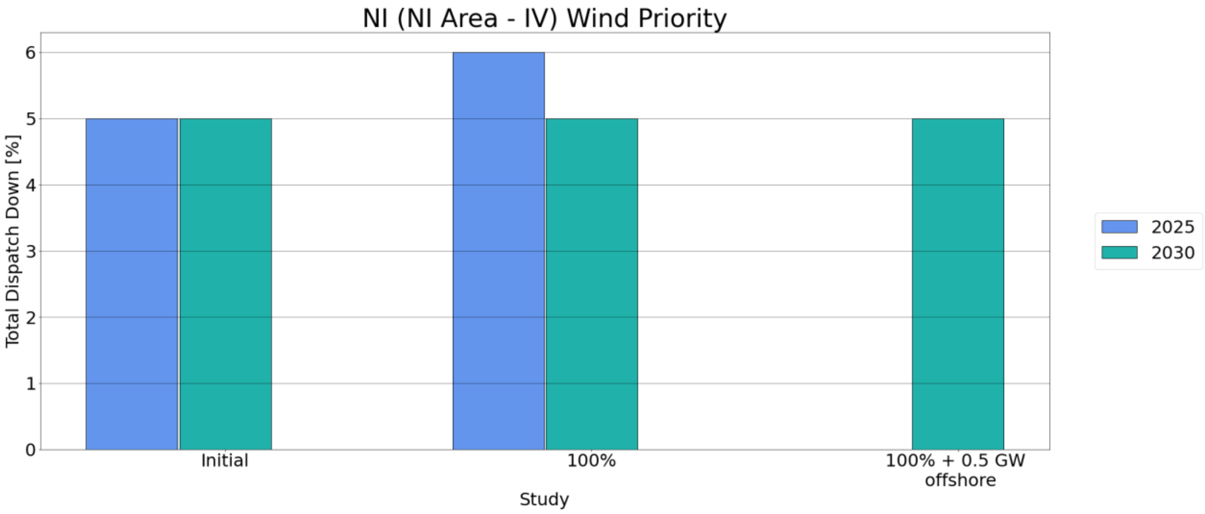

Figure 5-22 Results wind priority NI (NI Area - IV)

5.8 Conclusion – Results for Northern Ireland

To conclude, chapter 5 has provided an overview of the estimated surplus, curtailment and constraint values for Northern Ireland. This was for a range of scenarios based on a number of installed generation assumptions (generation scenarios) and the study year (network and demand assumptions). The results highly depend on the study assumptions, which were described earlier in this report.

Appendix C contains the detailed results at a nodal level consisting of energy (GWh), percentage surplus, curtailment and constraint values for both solar and wind in Northern Ireland.

5.8.1 Key Messages

The key messages, are:

- Total dispatch down compares well with historical Northern Ireland total dispatch down
- Percentage total dispatch down in the offshore study case is estimated at 18.3%, which is dominated by surplus renewable generation.
- Flows follow the logic relative to input assumptions, whereby high renewable generation in Area - I and Area - II create flows from the West to the East where there is the largest demand concentration.
- **Effect of increasing capacity:** the system level Total Dispatch Down increases with additional installed capacity with a significant increase in surplus. This is evident within each study year, as capacity is increased from the 'Initial' capacity case to the '100%' capacity case. From an installed capacity perspective, Area - III observes some of the lowest TWh volumes of total dispatch down.
- **Effect of additional demand, network and interconnection:** between study years, for a given capacity case, the Total Dispatch Down reduces when comparing 2025 study cases with their respective counterpart capacity cases in the year 2030. This is due to increased demand, network reinforcements, relaxed system level constraints and additional interconnection in the 2030 study year.
- **Comparison between wind and solar:** Solar, with a lower capacity factor, compared to wind, observes lower dispatch down than wind.
- **Effect of offshore:** Increases in offshore wind generation in Northern Ireland, as seen in the offshore wind scenarios, result in rising surplus levels, causing an increase in Total Dispatch Down levels.

5.8.2 General Principles

The observations on some of the underlying principles related to percentage total dispatch down and its components

- **Percentage curtailment is the same across constraint areas for a given generator type.** Across the areas, the percentage curtailment is the same for each respective generation type, distinguished by wind and solar. For example, the non-priority wind in Area - I observes a percentage curtailment of 1 % in the 2030 100% capacity case. The non-priority wind in Area - II, and the other areas, observes the same percentage curtailment for the same study and capacity case. The reason for this is because curtailment is pro-rata across the region.
- **Correspondingly, percentage surplus is the same across constraint areas for a given generator type.** In terms of percentage surplus, the non-priority wind from Area - I observes

the same percentage surplus as the non-priority wind from Area - II and the other areas. For the same reason as the percentage curtailment, this is because percentage surplus is pro-rata across the Island.

- **Within an area, percentage curtailment is different between priority and non-priority**: Between priority wind and non-priority wind in Area - II, the percentage curtailment will be different. The reason is because in the case of the non-priority wind some of the available energy is already dispatched down due to surplus. Whereas in the case of priority wind a higher proportion of the available energy is available to be dispatched around the grid and so it observes more dispatch down due to curtailment.
- **Priority and non-priority generation, by type, experience the same percentage constraint within an area.**

5.8.3 Effect of Offshore

Finally, in relation to the addition of offshore

- **Effect of offshore:** Comparing the 2030 100% capacity case with and without offshore shows a marked increase in percentage total dispatch down, in particular due to surplus.
- **Redistribution of dominant share of dispatch down:** In the case of non-priority wind for example, there is a notable redistribution of percentage share of dispatch down across the types of dispatch down. In particular, percentage surplus increases while percentage constraint reduces. This is observed for three reasons.
    i. There is a redistribution of the available energy dispatched down from surplus at the expense of constraints
    ii. Scale of reduction in percentage share not reflective of scale in change in absolute share: In the offshore study case, the percentage constraint has reduced. However, it is worth noting that the scale reflected in the reduction of the percentage, is not reflective of the scale of the reduction in TWh terms because of the higher available energy in the denominator.

5.8.4 Dominant Contingency

Appendix D shows the number of hours a line is the binding congested line with respect to N-1 contingencies, across the constraint areas. The dominant contingency in Northern Ireland is the loss of Coolkeeragh Magherafelt to cater for flows from the wind rich regions of Area - I and Area - II moving flows from West to the load centres, East in Area - IV. Potential re-routing of flows, contingent on the potential loss of Coolkeeragh Magherafelt 275 kV line, is driving binding lines in the other areas corresponding to the re-routing options. These contingency re-routing options include:

- Pathway 1 is from Area - I east from Coolkeeragh to Coleraine then down South into Rasharkin and Kells. This corresponds with the binding lines observed in Area - I including Limavady to Cam.
- Pathway 2 is then from Area - I from Coolkeeragh down to Strabane through to Omagh in Area - II and then East from Omagh and through Gort and Tremoge to Tamnamore. This, in turn corresponds, with the binding lines attributed to this contingency in Area - II including Gort to Tamnamore and Tremoge to Tamnamore.

6 Appendix A - Network Reinforcement & Maintenance

6.1 A.1 Reinforcements in 2025

The table below lists the reinforcements, additional to the current network, that are included in the 2025 study scenario.

Project Type	Project	Year
New Build	Airport road - Rosebank 110 kV (circuit 1)	2025
New Build	Airport road - Rosebank 110 kV (circuit 2)	2025
Uprate	Ballylumford - Eden 110 kV (circuit 1)	2025
Uprate	Ballylumford - Eden 110 kV (circuit 2)	2025
Uprate	Coolkeeragh - Magherafelt 275 kV (circuit 1)	2025
Uprate	Coolkeeragh - Magherafelt 275 kV (circuit 2)	2025
Uprate	Coolkeeragh - Coolkeeragh 275 kV (circuit 1)	2025
Uprate	Dromore - Omagh 110 kV (circuit 1)	2025
Uprate	Dromore - Omagh 110 kV (circuit 2)	2025
Uprate	Glengormley 110 -33 kV station (circuit 1)	2025

Table A-6-1 Reinforcements included in the 2025 study

6.2 A.2 Reinforcements in 2030

The table below lists the reinforcements, additional to the current network, that are included in the 2030 study scenario.

Project Type	Project	Year
Uprate	Ballymena 110 -33 kV station (circuit 4)	2030
Uprate	Banbridge 110 -33 kV station (circuit 1)	2030
Uprate	Banbridge 110 -33 kV station (circuit 2)	2030
New Build	Belfast Central - Belfast North 110 kV (circuit 1)	2030
New Build	Belfast Central - Belfast North 110 kV (circuit 2)	2030
New Build	Belfast Central A - Belfast Central B 110 kV (circuit 1)	2030
New Build	Belfast North - Donegall 110 kV 1 (circuit 1)	2030
New Build	Belfast North - Donegall 110 kV 1 (circuit 2)	2030
New Build	Belfast North A - Belfast North B 110 kV (circuit 1)	2030
Loop in	Cam - Coleraine 110 kV (circuit 1)	2030
Loop in	Cam - Coleraine 110 kV (circuit 2)	2030
New Build	Cam - Rasharkin 110 kV	2030
Uprate	Carnmoney - Eden 110 kV (circuit 1)	2030
Uprate	Carnmoney - Eden 110 kV (circuit 2)	2030
New Build	Coolkeeragh - Limavady 110 kV	2030
Loop in	Coolkeeragh - Cam 110 kV	2030
Uprate	Coolkeeragh - Killymallaght 110 kV (circuit 1)	2030
Uprate	Coolkeeragh - Limavady 110 kV (circuit 1)	2030
Uprate	Coolkeeragh - Strabane 110 kV (circuit 1)	2030
Uprate	Cregagh 110 - 33 kV station (circuit 1)	2030
Uprate	Cregagh 110 - 33 kV station (circuit 2)	2030
Uprate	Donegall 110 - 33 kV station (circuit 4)	2030
New Build	Dromore - Tamnamore 110 kV	2030
Uprate	Drumnakelly - Tamnamore 110 kV (circuit 1)	2030
Uprate	Drumnakelly - Tamnamore 110 kV (circuit 2)	2030
Uprate	Glengormley 110 - 33 kV station (circuit 2)	2030
New Build	Kells - Terrygowan 110 kV (circuit 1)	2030
Uprate	Killymallaght - Strabane 110 kV (circuit 1)	2030
Uprate	Larne 110 - 33 kV station (circuit 1)	2030
Uprate	Larne 110 - 33 kV station (circuit 2)	2030
Loop in	Limavady - Cam 110 kV	2030
Uprate	Limavady 110 - 33 kV station (circuit 1)	2030
Uprate	Limavady 110 - 33 kV station (circuit 2)	2030
New Build	Magherafelt 275 - 110 kV station	2030
New Build	Magherafelt - Feeney 110 kV	2030
DLR	Magherakeel - Omagh 110 kV (circuit 1)	2030
Uprate	Omagh - Strabane 110 kV (circuit 1)	2030
Uprate	Omagh - Strabane 110 kV (circuit 2)	2030
Loop in	Tamnamore - Turleenan 275 kV (circuit 1)	2030
Loop in	Tamnamore - Turleenan 275 kV (circuit 2)	2030
Loop in	Tandragee -Turleenan 275 kV (circuit 1)	2030
Loop in	Tandragee -Turleenan 275 kV (circuit 2)	2030

New Build	Terrygowan - Rasharkin 110 kV	2030
New Build	Turleenan 275 - 380 kV station (circuit 1)	2030
New Build	Turleenan 275 - 380 kV station (circuit 2)	2030
New Build	Ballylumford -Moyle 275 kV (circuit 1)	2030
New Build	Ballylumford -Moyle 275 kV (circuit 2)	2030

Table A-6-2 Reinforcements included in the 2030 study

6.3 A.3 Maintenance within the Plexos Modelling

The table below outlines the representative transmission outage schedule applied within the Plexos model for this study.

Line	Timeslice	Area
Ballylumford - Kells 275 kV	M4-5	NI Area - IV
Coleraine - Coolkeeragh 110 kV	M4-5	NI Area - I
Dungannon – Omagh 110 kV (circuit 1)	M4-5	NI Area - II
Magherafelt - Tamnamore 275 kV (circuit 1)	M4-5	NI Area - IV
Tandragee 110 kV - 275 kV station (circuit 2)	M6-7	NI Area - IV
Cam Coleraine 110 kV (circuit 1)	M6-7	NI Area - I
Kells – Magherafelt 275 kV (circuit 1)	M6-7	NI Area - IV
Omagh – Strabane 110 kV (circuit 1)	M6-7	NI Area - II
Kells 110 kV - 275 kV station (circuit 1)	M8-9	NI Area - IV
Castlereagh - Kilroot 275 kV	M8-9	NI Area - IV
Aghyoule - Enniskillen 110 kV	M8-9	NI Area - III
Coolkeeragh – Strabane 110 kV (circuit 1)	M8-9	NI Area - I

Table A-6-3 Representative Transmission Outage Schedule for Northern Ireland

7 Appendix B - Generator

The following generator information is included in this Appendix:

- Generator Type for each Generation Scenario
- Generator Type by Area for each Generation Scenario

A full list of generators included in the study is published separately on the SONI constraint forecast webpage[12]

Note: the tables in the following section include Northern Ireland generation only. The Ireland generation is as per the equivalent Appendix B in the published ECP 2.2 Constraints report for Ireland.

7.1 B.1 Generation Type for each Generator Scenario

The table below shows existing and expected wind, wind offshore, solar, battery and other technologies (other technologies include: biomass, biogas, CHP, LFG and Anaerobic Digester (AD) plants) in Northern Ireland, which were included in this analysis.

Type	Initial (MW)	100% (MW)	2030 100% inc. replant and clusters	100% + 0.5 GW offshore (MW)
battery	210	226	226	226
offshore wind	0	0	0	500
solar	262	619	619	619
wave	0	0	0	0
Onshore wind	1484	2146	2470	2470
Grand Total	1956	2991	3315	3815

Table B-7-1 Total Generation per Generation Type

[12] https://www.soni.ltd.uk/customer-and-industry/general-customer-information/

7.2 B.2 Generation Type by Area for each Generator Scenario

On an area basis, the table below shows existing and expected wind, wind offshore, solar, battery and other technologies (other technologies include: biomass, biogas, CHP, LFG and AD plants) in Northern Ireland, which were included in this analysis.

Type	Initial (MW)	100% (MW)	2030 100% inc. replant and clusters	100% + 0.5 GW offshore (MW)
battery	210	226	226	226
NI Area - I	0	0	0	0
NI Area - II	0	0	0	0
NI Area - III	0	0	0	0
NI Area - IV	210	226	226	226
offshore wind	0	0	0	500
NI Area - IV	0	0	0	500
solar	262	619	619	619
NI Area - I	48	167	167	167
NI Area - II	10	15	15	15
NI Area - III	6	9	9	9
NI Area - IV	199	428	428	428
Onshore wind	1484	2146	2470	2470
NI Area - I	437	668	798	798
NI Area - II	669	858	1012	1012
NI Area - III	128	128	144	144
NI Area - IV	250	492	516	516
Grand Total	1956	2991	3315	3815

Table B-7-2 Generation Type by Area for each Generator Scenario

7.3 B.3 Generation List by Type, Node and Name

A full list of generators included in the study is published separately on SONI webpage[13] which includes existing and expected wind, wind offshore, solar, wave, battery and other technologies (other technologies include: biomass, biogas, CHP, LFG and AD plants) in Northern Ireland which were included in this analysis. They are sorted by area and generation type and then alphabetically.

Note that the year of connection is rounded from the build-out rate date or target connection date.

These are in addition to the new large generators, which are listed in EirGrid and SONI's All-Island Generation Capacity Statement 2022 - 2031.

[13] https://www.soni.ltd.uk/customer-and-industry/general-customer-information/

8 Appendix C Node Results

This appendix presents the results of the modelling analysis for Northern Ireland. The levels of surplus, curtailment and constraint that controllable solar and wind generators in Northern Ireland might expect to experience are reported on a nodal basis for the study scenarios. Details on the generation capacity at each node are also provided along with the assumed amount of controllable generation.

This appendix also presents a list for each node of those generators that are included in the study.

Figure C-0-1 - NI Area

8.1 Aghyoule

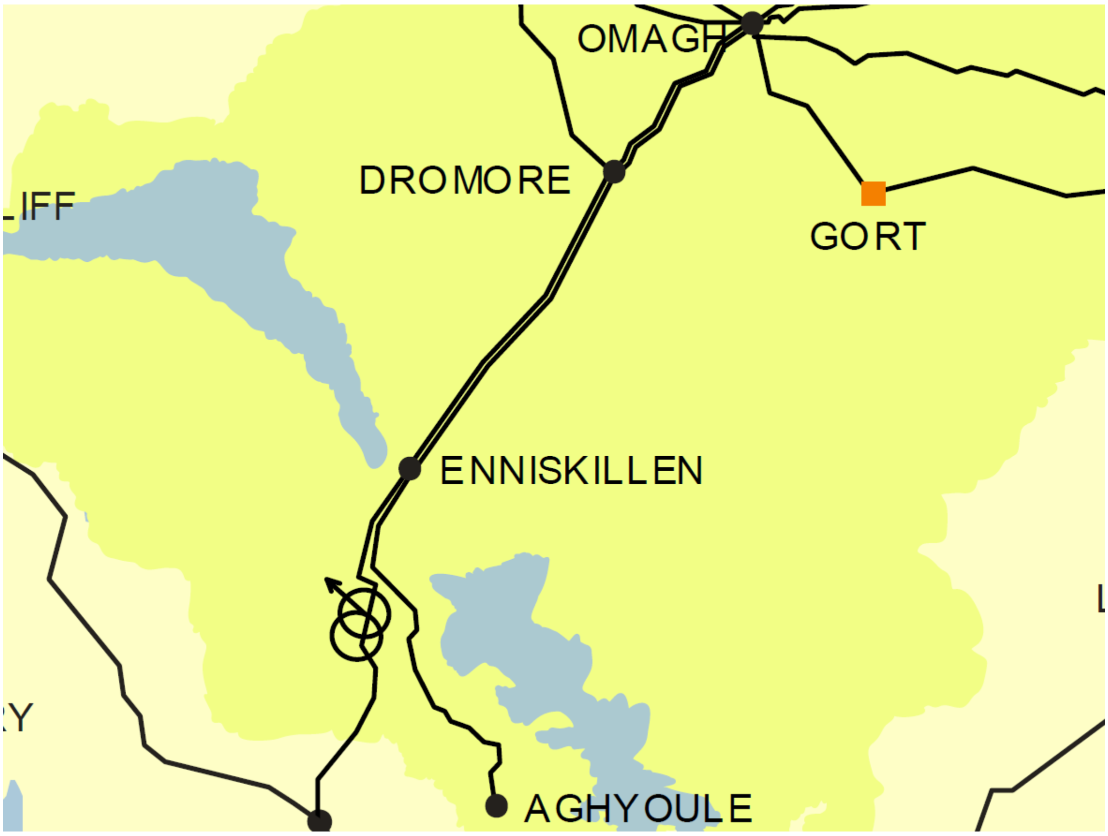

Figure C-1 - Location of node Aghyoule

Generator	SO	Capacity	Type	Status
Molly Mountain	DSO	15.0	wind priority	connected
Slieve Rushen	DSO	54.0	wind priority	connected
Snugborough - replant extra for SOEF 1.1	DSO	15.9	wind not priority	Proposed

Table C-1 - Generation Included in Study for Node Aghyoule

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025			
Installed Capacity (MW)	2030		16	16
Available Energy (GWh)	2025			
Available Energy (GWh)	2030		41	41
Generation (GWh)	2025			
Generation (GWh)	2030		37	28
Surplus (%)	2025			
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025			
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025			
Constraint (%)	2030		6 %	2 %
Total Dispatch Down (%)	2025			
Total Dispatch Down (%)	2030		11 %	32 %

Table C-2 - Surplus, Curtailment and Constraint for wind not priority NI - Node Aghyoule

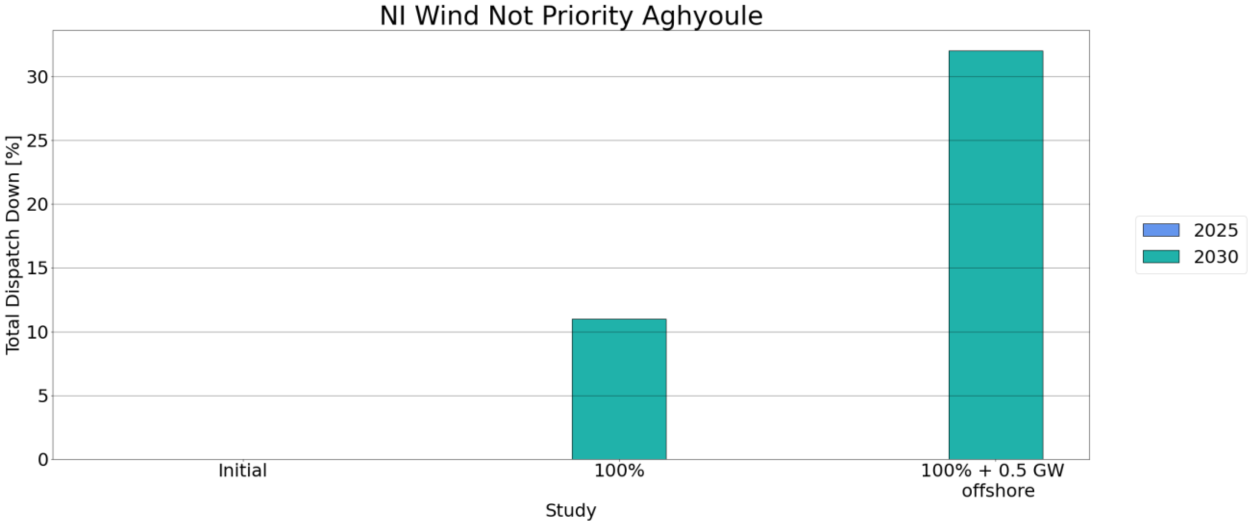

Figure C-2 - Total Dispatch Down for wind not priority - Node Aghyoule

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	69	69	
Installed Capacity (MW)	2030	69	69	69
Available Energy (GWh)	2025	180	180	
Available Energy (GWh)	2030	180	180	180
Generation (GWh)	2025	157	149	
Generation (GWh)	2030	171	166	168
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	13 %	
Constraint (%)	2030	5 %	6 %	2 %
Total Dispatch Down (%)	2025	13 %	17 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-3 - Surplus, Curtailment and Constraint for wind priority NI - Node Aghyoule

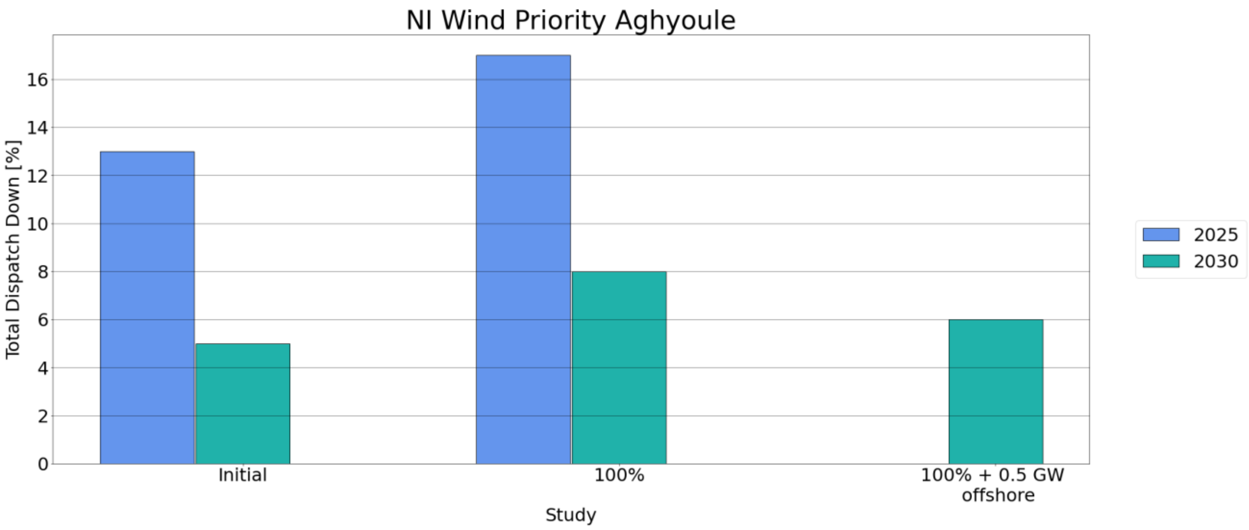

Figure C-3 - Total Dispatch Down for wind priority - Node Aghyoule

8.2 Agivey (Garvagh)

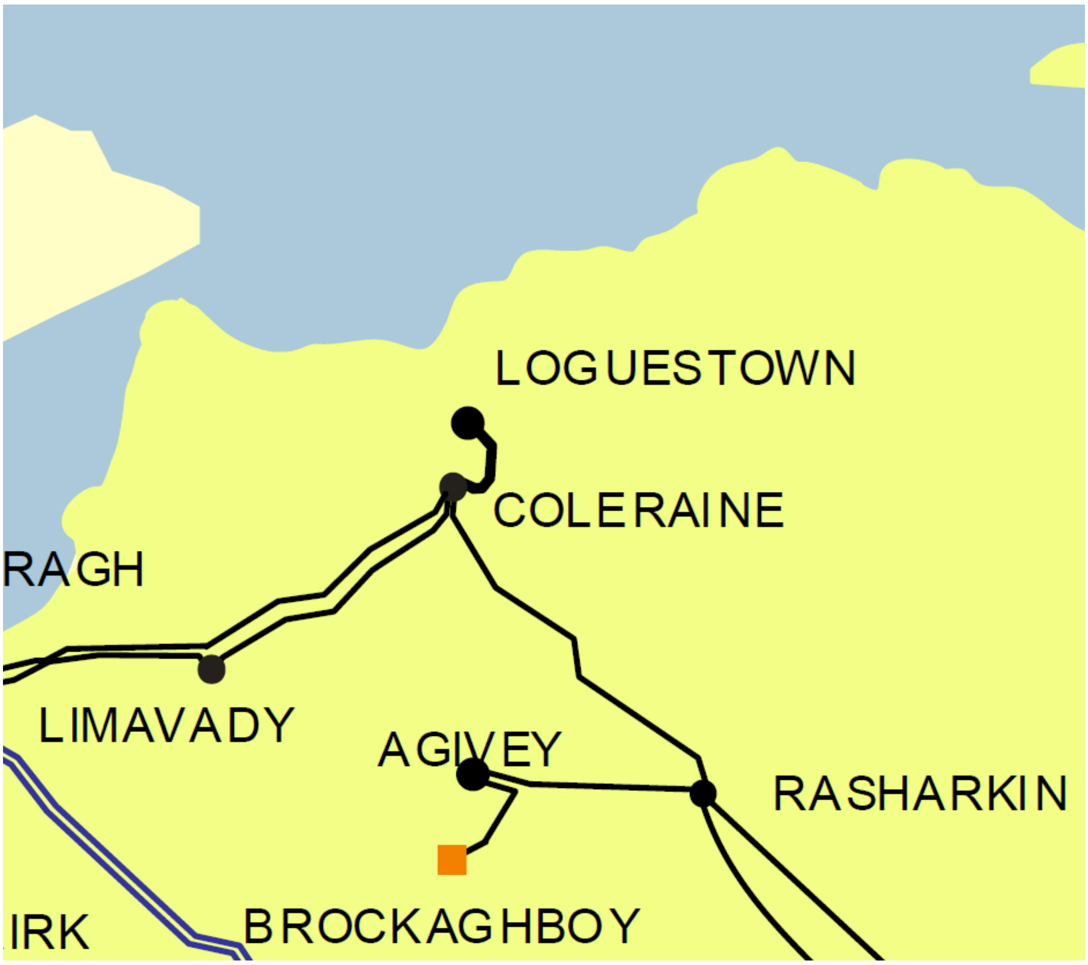

Figure C-4 - Location of node Agivey (note Agivey is now call Garvagh)

Generator	SO	Capacity	Type	Status
Craiggore	DSO	23.5	wind not priority	connected
Evishagarren	DSO	47.0	wind not priority	connected
Evishagarren Inc MEC	DSO	6.9	wind not priority	connected
Smulgedon	DSO	16.1	wind not priority	connected
Corlackey Hill	DSO	47.3	wind not priority	Proposed
Brishey	DSO	28.8	wind not priority	Proposed

Table C-4 - Generation Included in Study for Node Agivey (note Agivey is now call Garvagh)

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	94	170	
Installed Capacity (MW)	2030	94	170	170
Available Energy (GWh)	2025	244	442	
Available Energy (GWh)	2030	244	442	442
Generation (GWh)	2025	211	326	
Generation (GWh)	2030	231	378	298
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	14 %	26 %	
Total Dispatch Down (%)	2030	5 %	14 %	33 %

Table C-5 - Surplus, Curtailment and Constraint for wind not priority NI - Node Agivey (note Agivey is now call Garvagh)

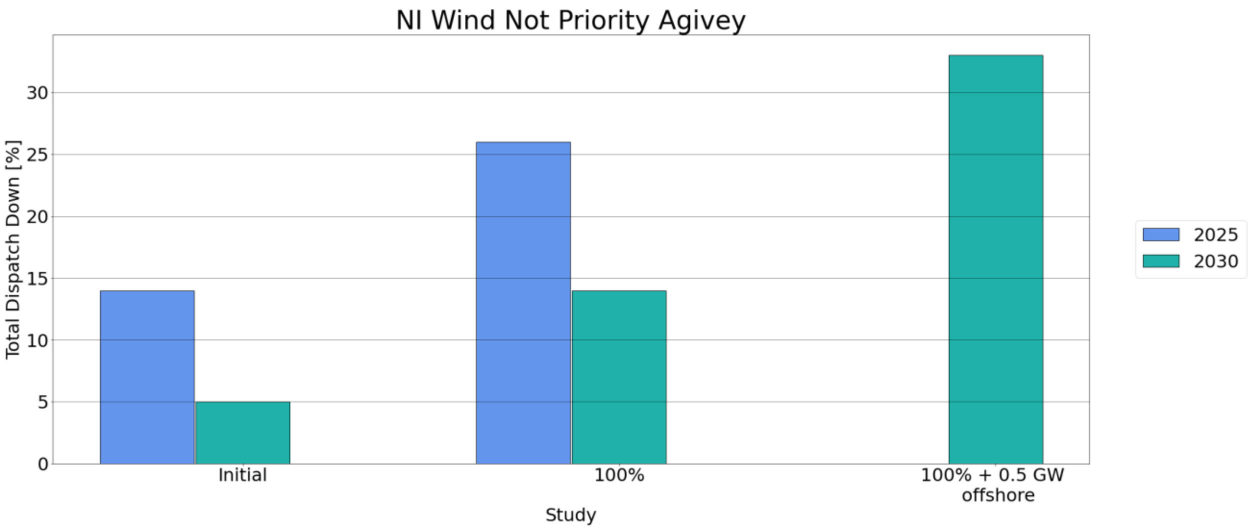

Figure C-5 - Total Dispatch Down for wind not priority - Node Agivey (note Agivey is now call Garvagh)

8.3 Antrim

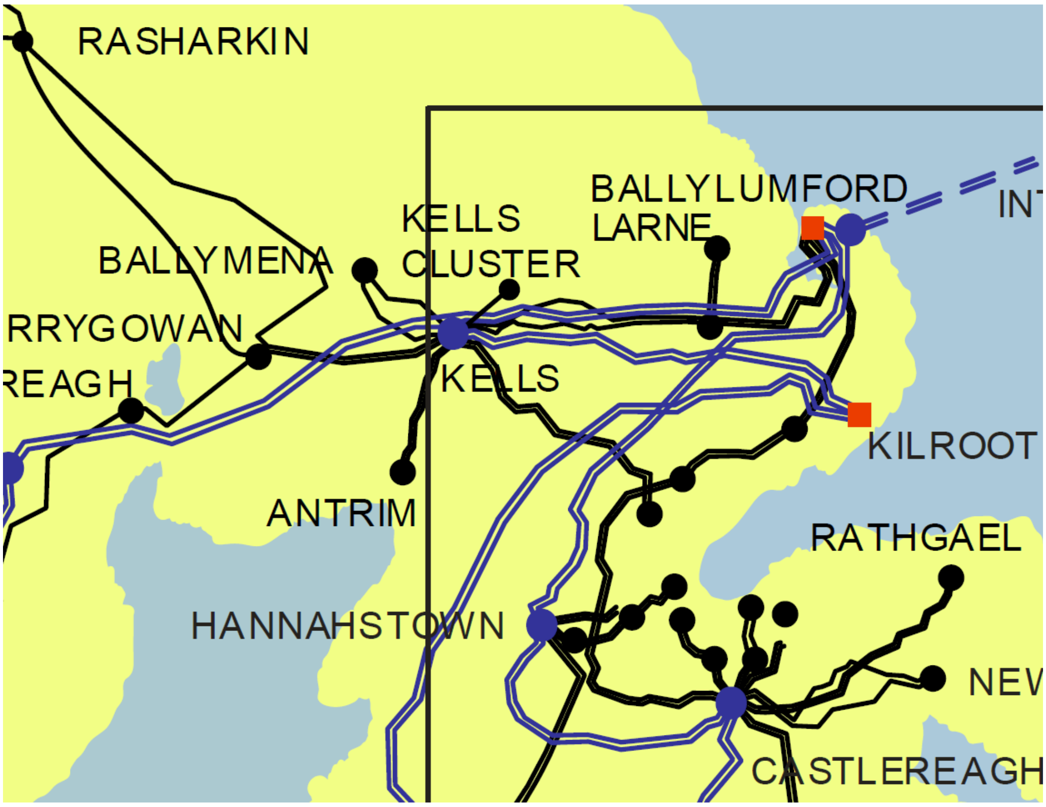

Figure C-6 - Location of node Antrim

Generator	SO	Capacity	Type	Status
Dunore Point solar PV Farm	DSO	0.0	solar priority	connected
Millar Farm	DSO	6.27	solar priority	connected
Assumed solar not priority	DSO	10.2	solar not priority	Proposed

Table C-6 - Generation Included in Study for Node Antrim

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		10	
Installed Capacity (MW)	2030		10	10
Available Energy (GWh)	2025		11	
Available Energy (GWh)	2030		11	11
Generation (GWh)	2025		10	
Generation (GWh)	2030		10	10
Surplus (%)	2025		0 %	
Surplus (%)	2030		0 %	0 %
Curtailment (%)	2025		0 %	
Curtailment (%)	2030		0 %	0 %
Constraint (%)	2025		5 %	
Constraint (%)	2030		5 %	5 %
Total Dispatch Down (%)	2025		5 %	
Total Dispatch Down (%)	2030		5 %	5 %

Table C-7 - Surplus, Curtailment and Constraint for solar not priority NI - Node Antrim

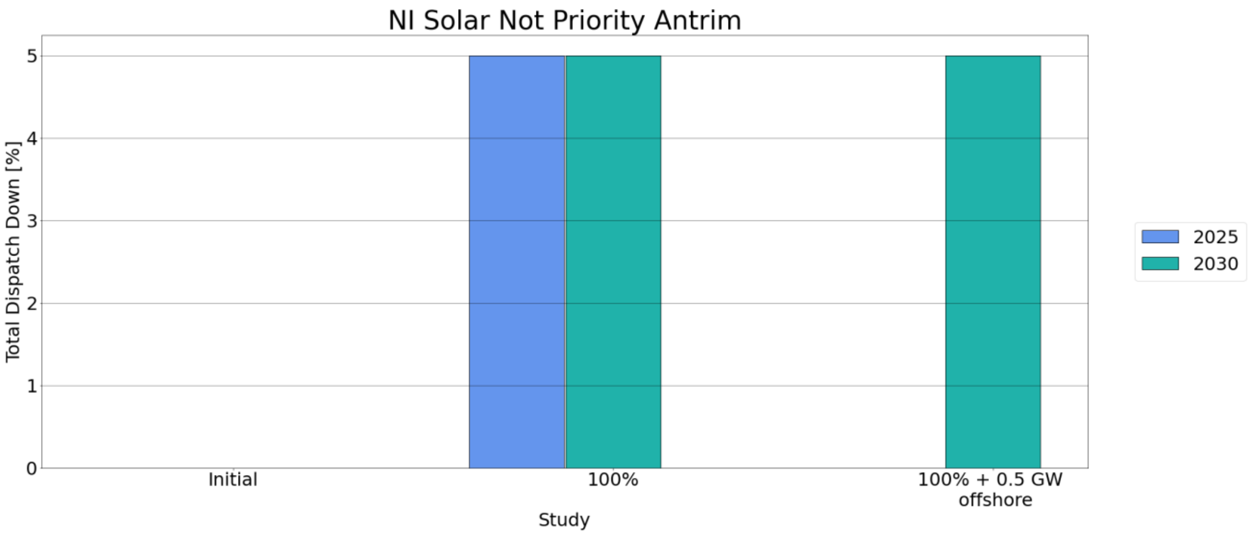

Figure C-7 - Total Dispatch Down for solar not priority - Node Antrim

The solar priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	6	6	
Installed Capacity (MW)	2030	6	6	6
Available Energy (GWh)	2025	7	7	
Available Energy (GWh)	2030	7	7	7
Generation (GWh)	2025	6	6	
Generation (GWh)	2030	6	6	6
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	3 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	5 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-8 - Surplus, Curtailment and Constraint for solar priority NI - Node Antrim

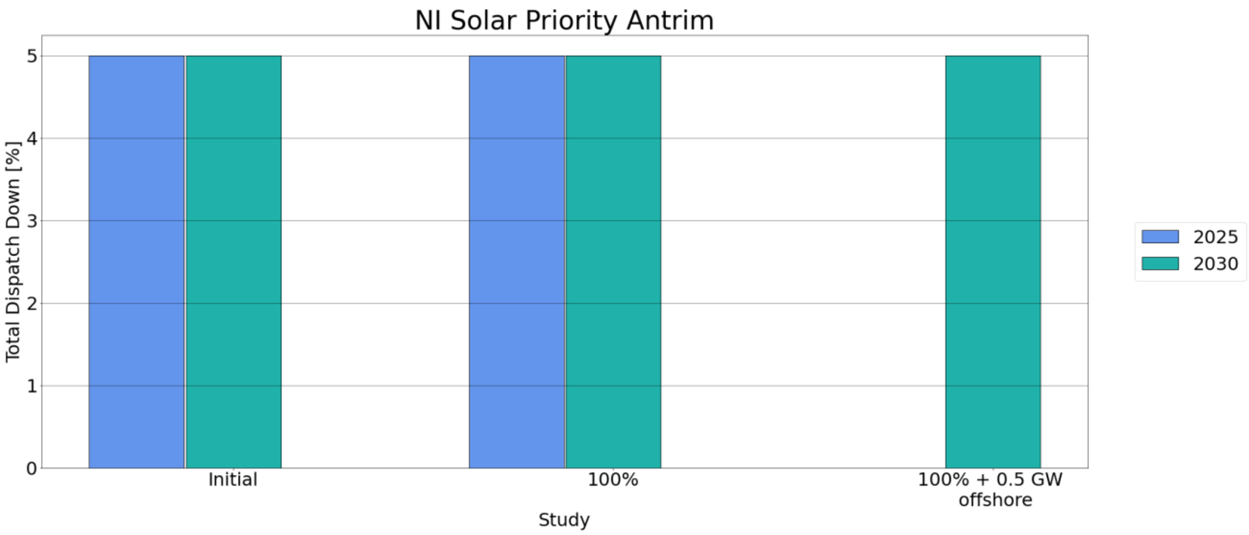

Figure C-8 - Total Dispatch Down for solar priority - Node Antrim

8.4 Ballylumford

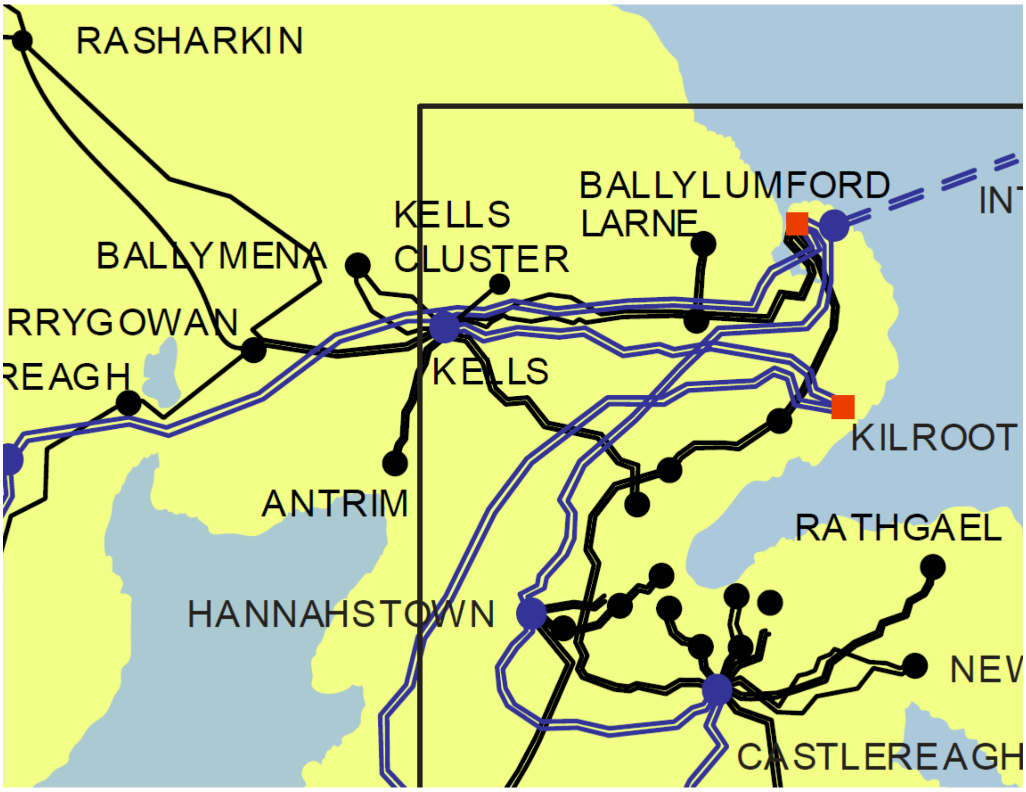

Figure C-9 - Location of node Ballylumford

Generator	SO	Capacity	Type	Status
North Channel Wind	TSO	500.0	wind not priority	Proposed

Table C-9 - Generation Included in Study for Node Ballylumford

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025			
Installed Capacity (MW)	2030			500
Available Energy (GWh)	2025			
Available Energy (GWh)	2030			1969
Generation (GWh)	2025			
Generation (GWh)	2030			1535
Surplus (%)	2025			
Surplus (%)	2030			20 %
Curtailment (%)	2025			
Curtailment (%)	2030			2 %
Constraint (%)	2025			
Constraint (%)	2030			0 %
Total Dispatch Down (%)	2025			
Total Dispatch Down (%)	2030			22 %

Table C-10 - Surplus, Curtailment and Constraint for wind not priority NI - Node Ballylumford

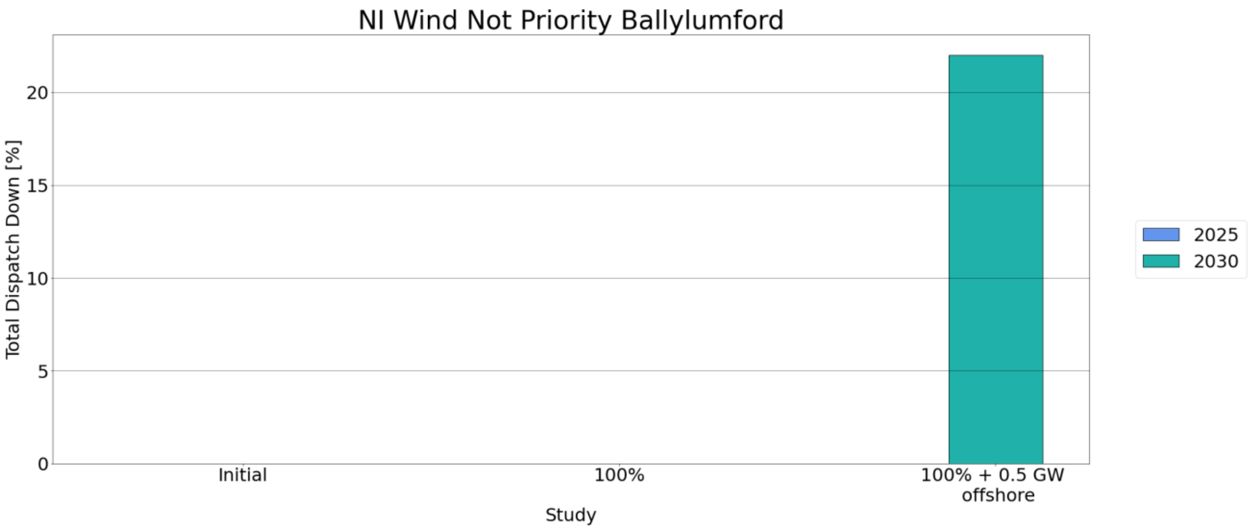

Figure C-10 - Total Dispatch Down for wind not priority - Node Ballylumford

8.5 Ballymena

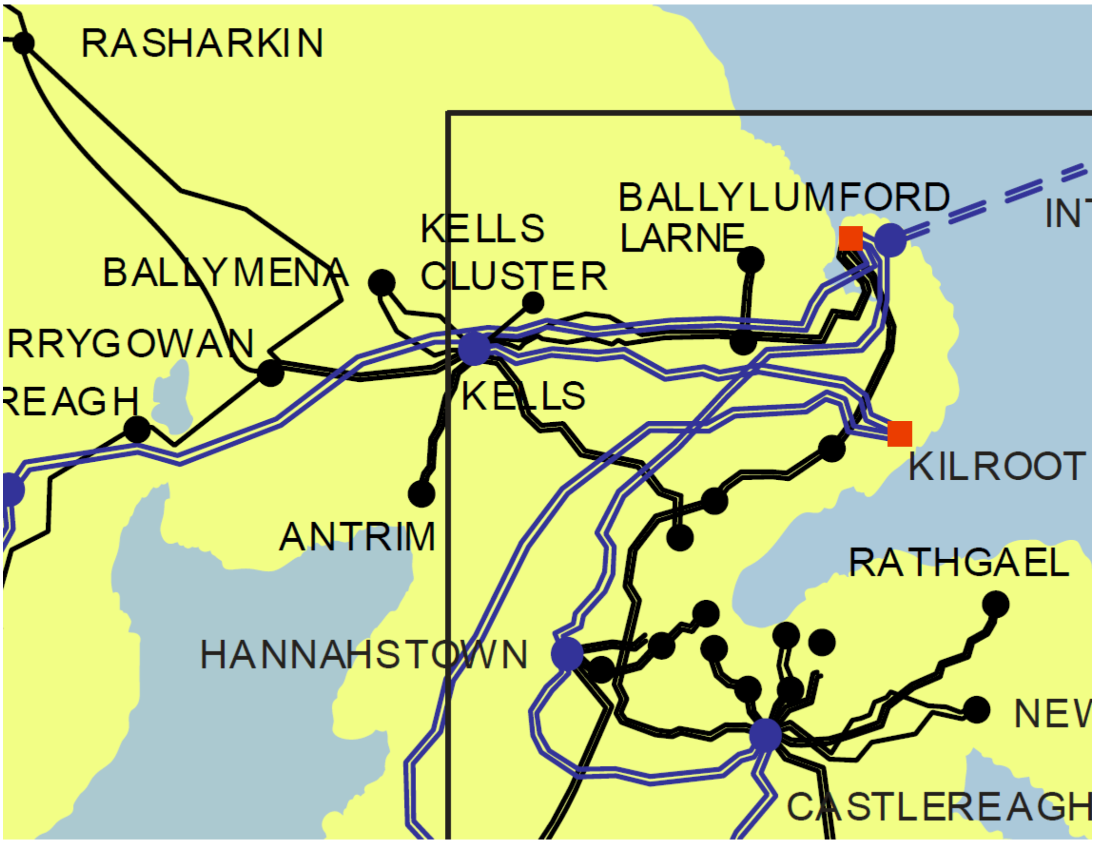

Figure C-11 - Location of node Ballymena

Generator	SO	Capacity	Type	Status
Ballygarvey Road, Project 703	DSO	6.0	solar priority	connected
Elginny Hill	DSO	23.0	wind priority	connected
Rathsherry	DSO	21.15	wind priority	connected
Carnbuck	TSO	50.0	wind not priority	Proposed

Table C-11 - Generation Included in Study for Node Ballymena

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		50	
Installed Capacity (MW)	2030		50	50
Available Energy (GWh)	2025		130	
Available Energy (GWh)	2030		130	130
Generation (GWh)	2025		105	
Generation (GWh)	2030		122	90
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		2 %	
Constraint (%)	2030		1 %	0 %
Total Dispatch Down (%)	2025		19 %	
Total Dispatch Down (%)	2030		6 %	31 %

Table C-12 - Surplus, Curtailment and Constraint for wind not priority NI - Node Ballymena

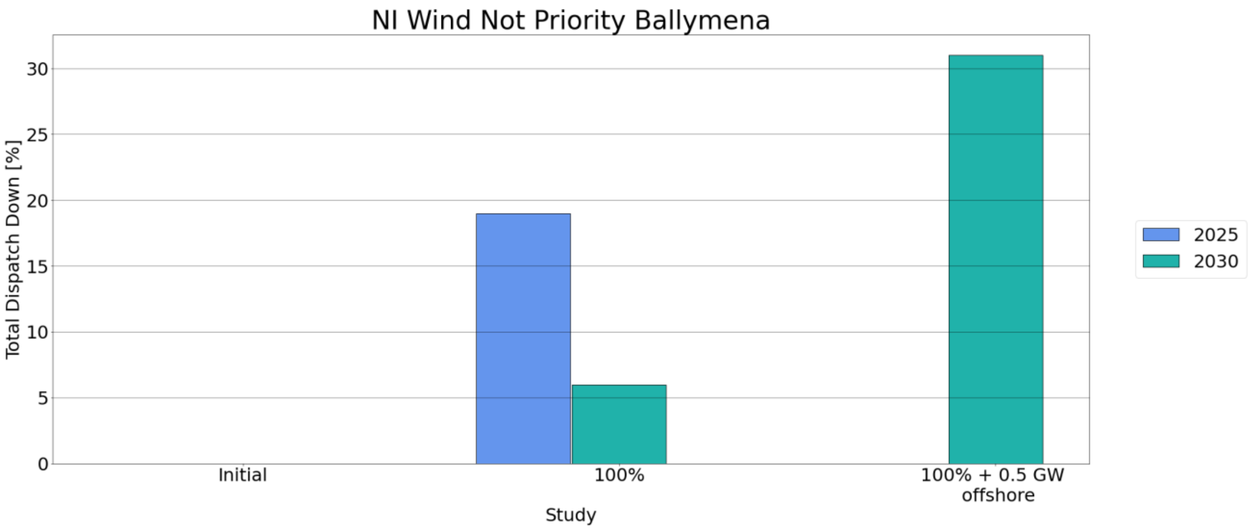

Figure C-12 - Total Dispatch Down for wind not priority - Node Ballymena

The solar priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	6	6	
Installed Capacity (MW)	2030	6	6	6
Available Energy (GWh)	2025	6	6	
Available Energy (GWh)	2030	6	6	6
Generation (GWh)	2025	6	6	
Generation (GWh)	2030	6	6	6
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	3 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	5 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-13 - Surplus, Curtailment and Constraint for solar priority NI - Node Ballymena

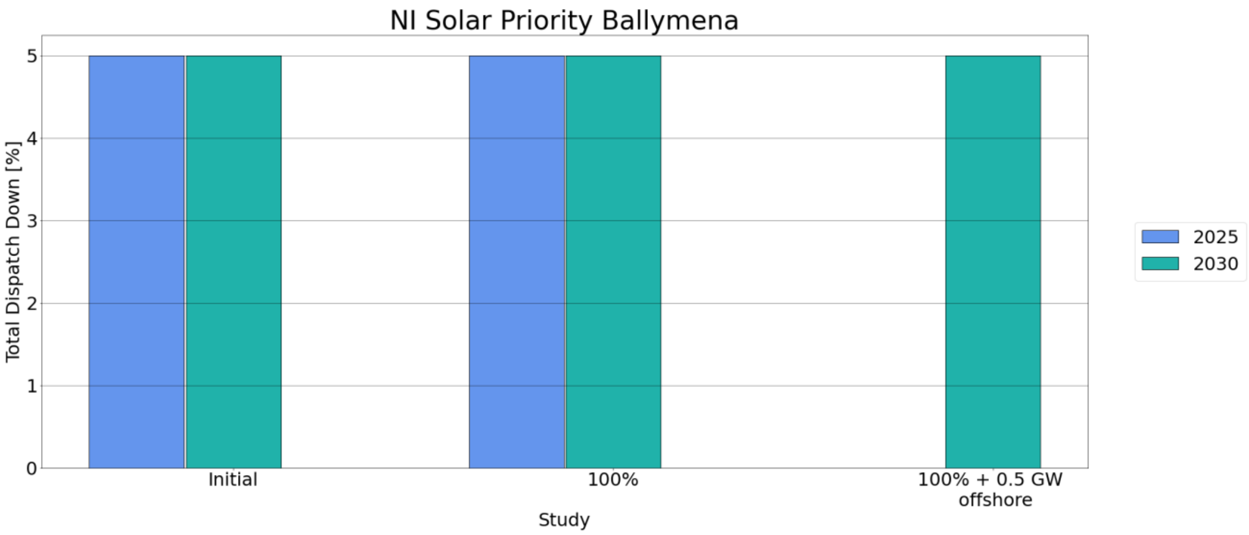

Figure C-13 - Total Dispatch Down for solar priority - Node Ballymena

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	44	44	
Installed Capacity (MW)	2030	44	44	44
Available Energy (GWh)	2025	115	115	
Available Energy (GWh)	2030	115	115	115
Generation (GWh)	2025	109	108	
Generation (GWh)	2030	109	109	109
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	4 %	2 %	
Constraint (%)	2030	5 %	3 %	0 %
Total Dispatch Down (%)	2025	5 %	6 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-14 - Surplus, Curtailment and Constraint for wind priority NI - Node Ballymena

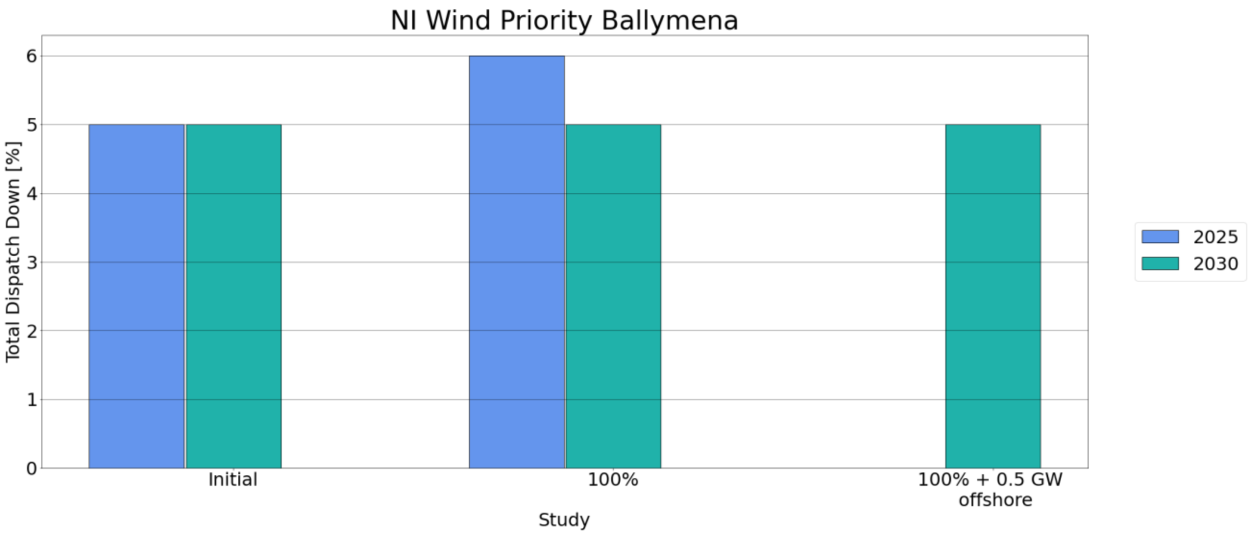

Figure C-14 - Total Dispatch Down for wind priority - Node Ballymena

8.6 Banbridge

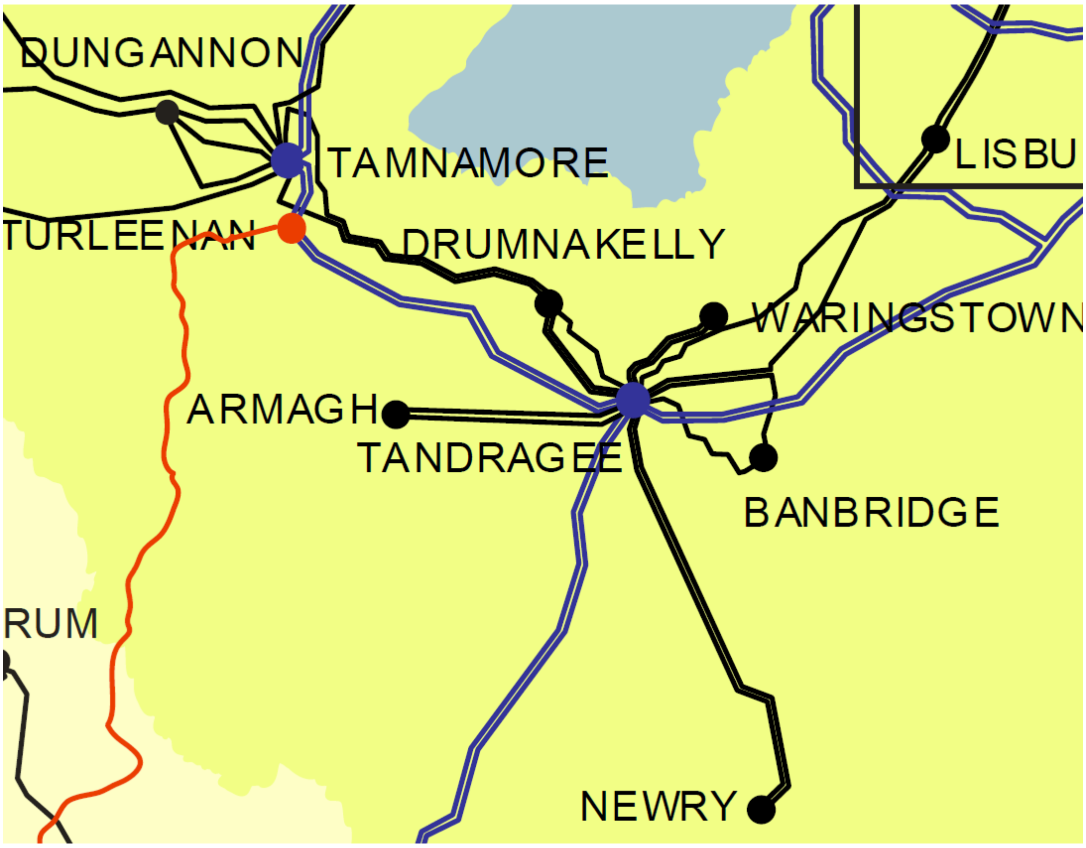

Figure C-15 - Location of node Banbridge

Generator	SO	Capacity	Type	Status
Assumed solar not priority	DSO	8.34	solar not priority	Proposed

Table C-15 - Generation Included in Study for Node Banbridge

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		8	
Installed Capacity (MW)	2030		8	8
Available Energy (GWh)	2025		9	
Available Energy (GWh)	2030		9	9
Generation (GWh)	2025		8	
Generation (GWh)	2030		8	8
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		0 %	
Constraint (%)	2030		2 %	0 %
Total Dispatch Down (%)	2025		8 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-16 - Surplus, Curtailment and Constraint for solar not priority NI - Node Banbridge

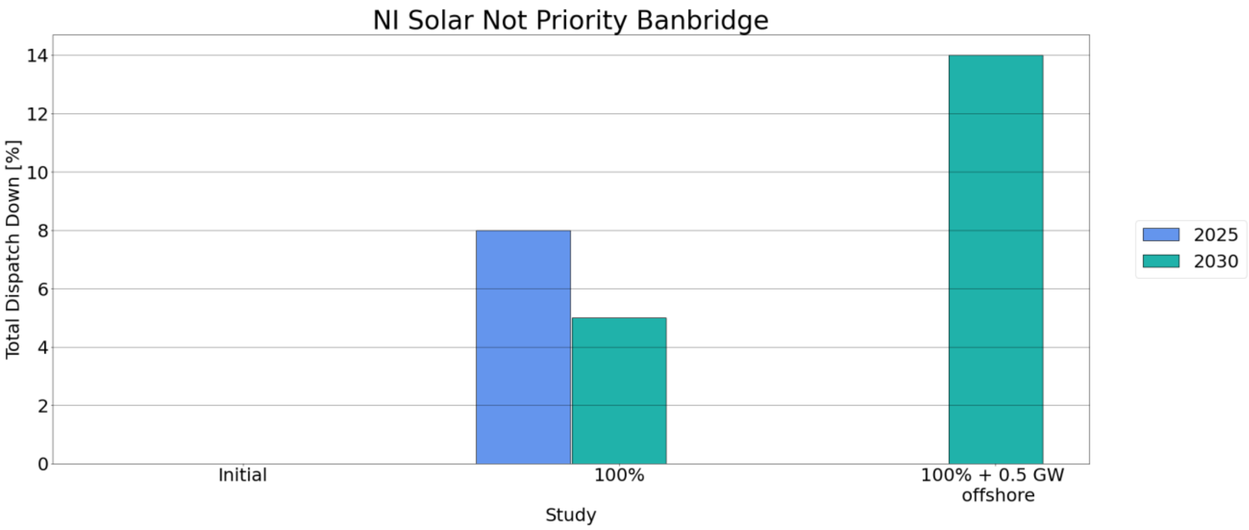

Figure C-16 - Total Dispatch Down for solar not priority - Node Banbridge

8.7 Brockaghboy

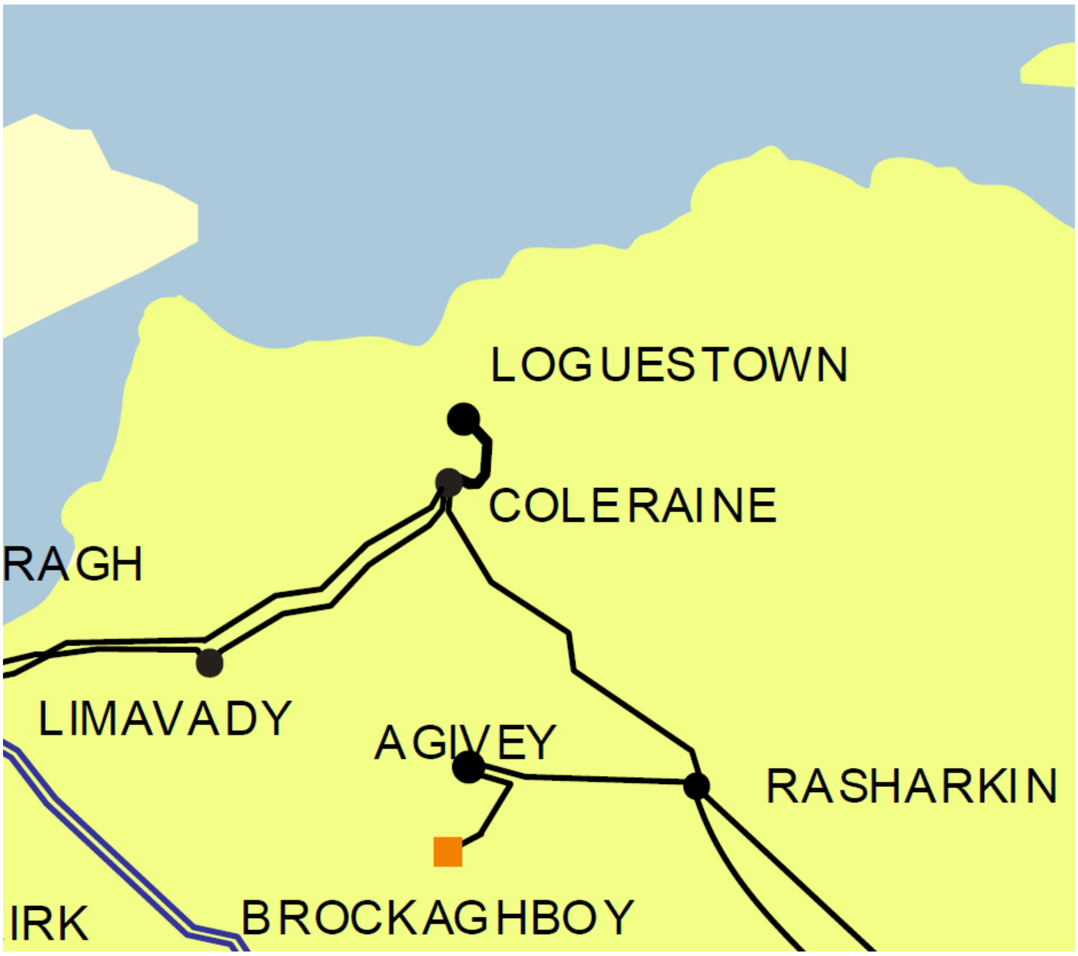

Figure C-17 - Location of node Brockaghboy

Generator	SO	Capacity	Type	Status
Brockaghboy	TSO	47.5	wind priority	connected

Table C-17 - Generation Included in Study for Node Brockaghboy

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	48	48	
Installed Capacity (MW)	2030	48	48	48
Available Energy (GWh)	2025	124	124	
Available Energy (GWh)	2030	124	124	124
Generation (GWh)	2025	111	108	
Generation (GWh)	2030	118	110	115
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-18 - Surplus, Curtailment and Constraint for wind priority NI - Node Brockaghboy

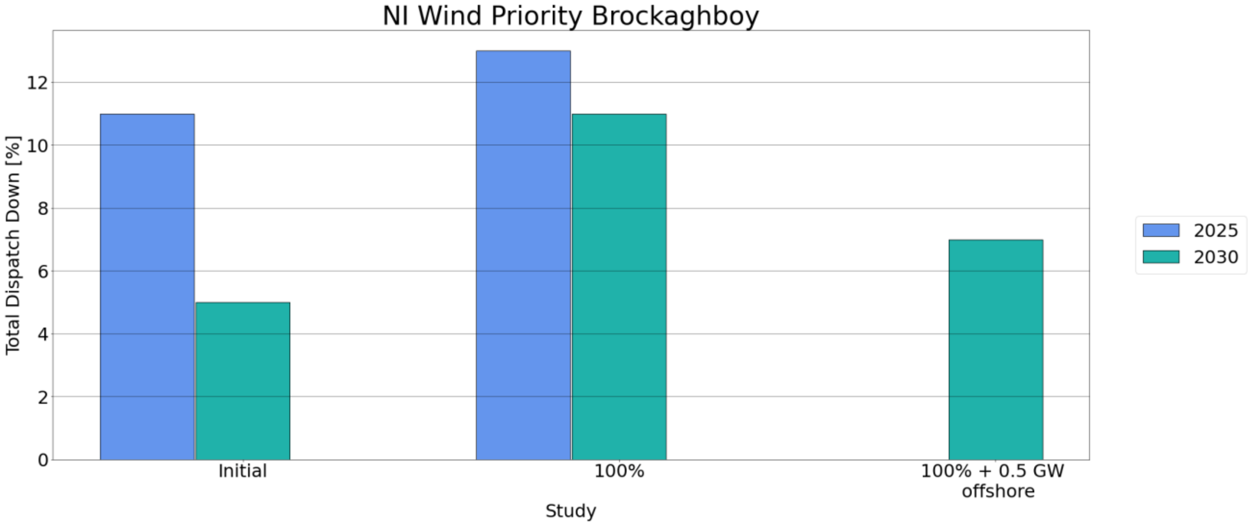

Figure C-18 - Total Dispatch Down for wind priority - Node Brockaghboy

8.8 Cam

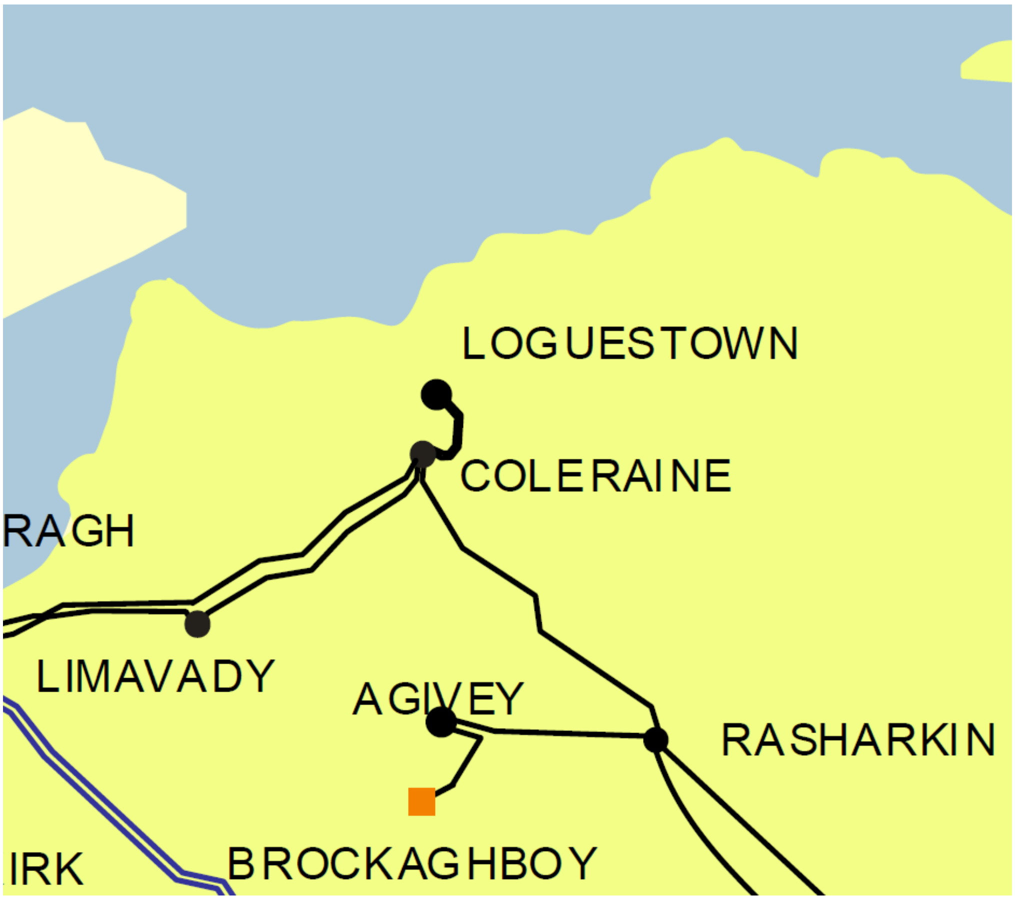

Figure C-19 - Location of node Cam

Generator	SO	Capacity	Type	Status
Rigged Hill - replant extra for SOEF 1.1	DSO	24.4	wind not priority	Proposed
Cam Burn	DSO	13.8	wind not priority	Proposed
Dunbeg Extension	DSO	9.0	wind not priority	Proposed
Dunbeg South	DSO	37.8	wind not priority	Proposed
Dunmore 2	DSO	24.0	wind not priority	Proposed
Bushtown	DSO	25.0	solar not priority	Proposed
Letterloan Road	DSO	29.9	solar not priority	Proposed

Table C-19 - Generation Included in Study for Node Cam

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		55	
Installed Capacity (MW)	2030		55	55
Available Energy (GWh)	2025		57	
Available Energy (GWh)	2030		57	57
Generation (GWh)	2025		50	
Generation (GWh)	2030		54	49
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		5 %	
Constraint (%)	2030		2 %	1 %
Total Dispatch Down (%)	2025		13 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-20 - Surplus, Curtailment and Constraint for solar not priority NI - Node Cam

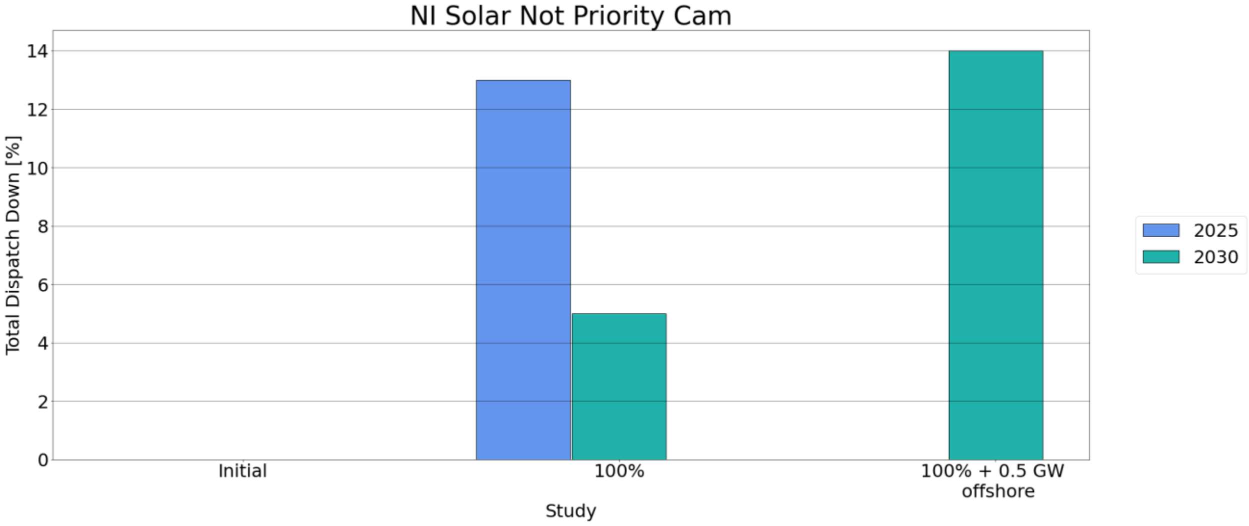

Figure C-20 - Total Dispatch Down for solar not priority - Node Cam

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		85	
Installed Capacity (MW)	2030		109	109
Available Energy (GWh)	2025		220	
Available Energy (GWh)	2030		284	284
Generation (GWh)	2025		162	
Generation (GWh)	2030		243	191
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		9 %	
Constraint (%)	2030		9 %	2 %
Total Dispatch Down (%)	2025		26 %	
Total Dispatch Down (%)	2030		14 %	33 %

Table C-21 - Surplus, Curtailment and Constraint for wind not priority NI - Node Cam

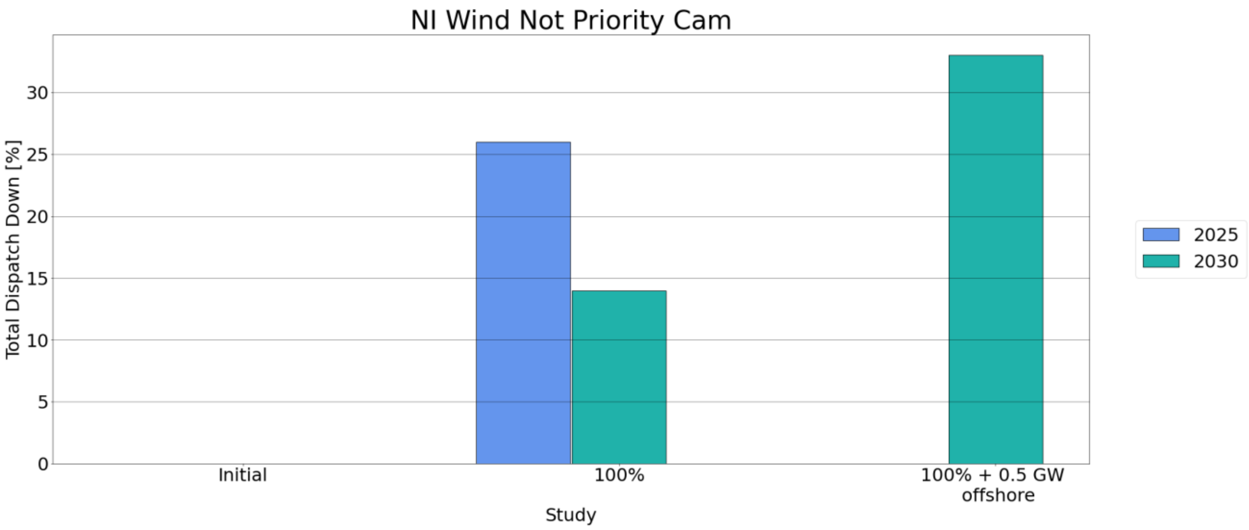

Figure C-21 - Total Dispatch Down for wind not priority - Node Cam

8.9 Carnmoney

Figure C-22 - Location of node Carnmoney

Generator	SO	Capacity	Type	Status
Carn Hill	DSO	13.8	wind priority	connected

Table C-22 - Generation Included in Study for Node Carnmoney

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	14	14	
Installed Capacity (MW)	2030	14	14	14
Available Energy (GWh)	2025	36	36	
Available Energy (GWh)	2030	36	36	36
Generation (GWh)	2025	34	34	
Generation (GWh)	2030	34	34	34
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	4 %	2 %	
Constraint (%)	2030	5 %	3 %	0 %
Total Dispatch Down (%)	2025	5 %	6 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-23 - Surplus, Curtailment and Constraint for wind priority NI - Node Carnmoney

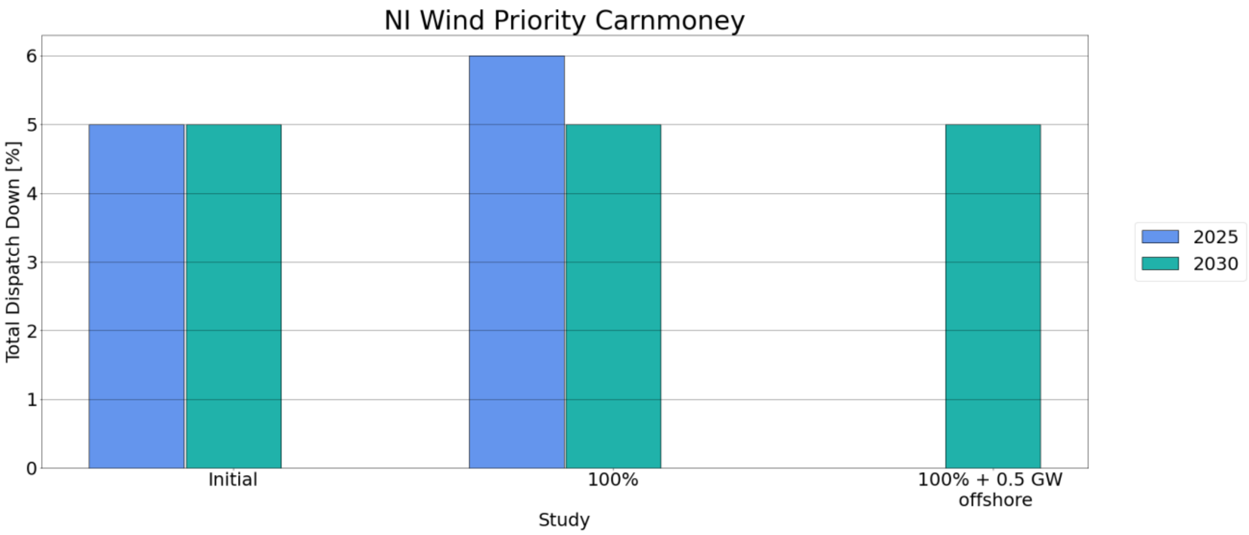

Figure C-23 - Total Dispatch Down for wind priority - Node Carnmoney

8.10 Coleraine

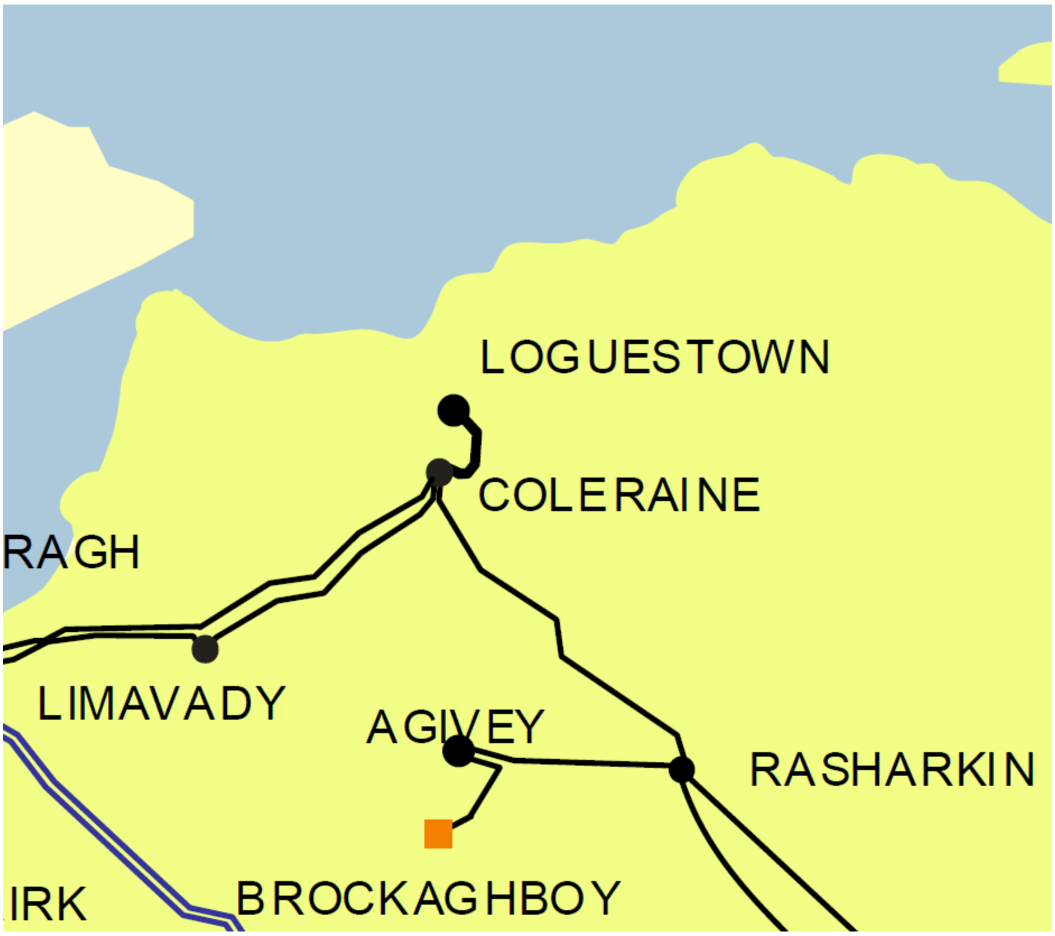

Figure C-24 - Location of node Coleraine

Generator	SO	Capacity	Type	Status
Dunbeg	DSO	42.0	wind priority	connected
Dunmore	DSO	21.0	wind priority	connected
Garves	DSO	15.0	wind priority	connected
Gruig	DSO	25.0	wind priority	connected

Table C-24 - Generation Included in Study for Node Coleraine

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	103	103	
Installed Capacity (MW)	2030	103	103	103
Available Energy (GWh)	2025	268	268	
Available Energy (GWh)	2030	268	268	268
Generation (GWh)	2025	240	234	
Generation (GWh)	2030	255	239	250
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-25 - Surplus, Curtailment and Constraint for wind priority NI - Node Coleraine

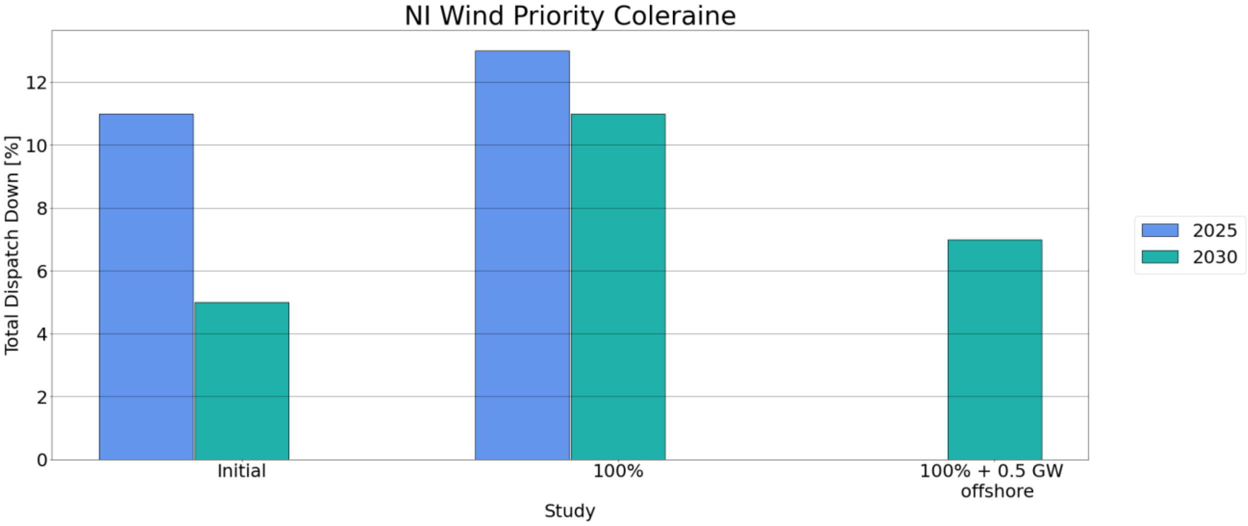

Figure C-25 - Total Dispatch Down for wind priority - Node Coleraine

8.11 Coolkeeragh

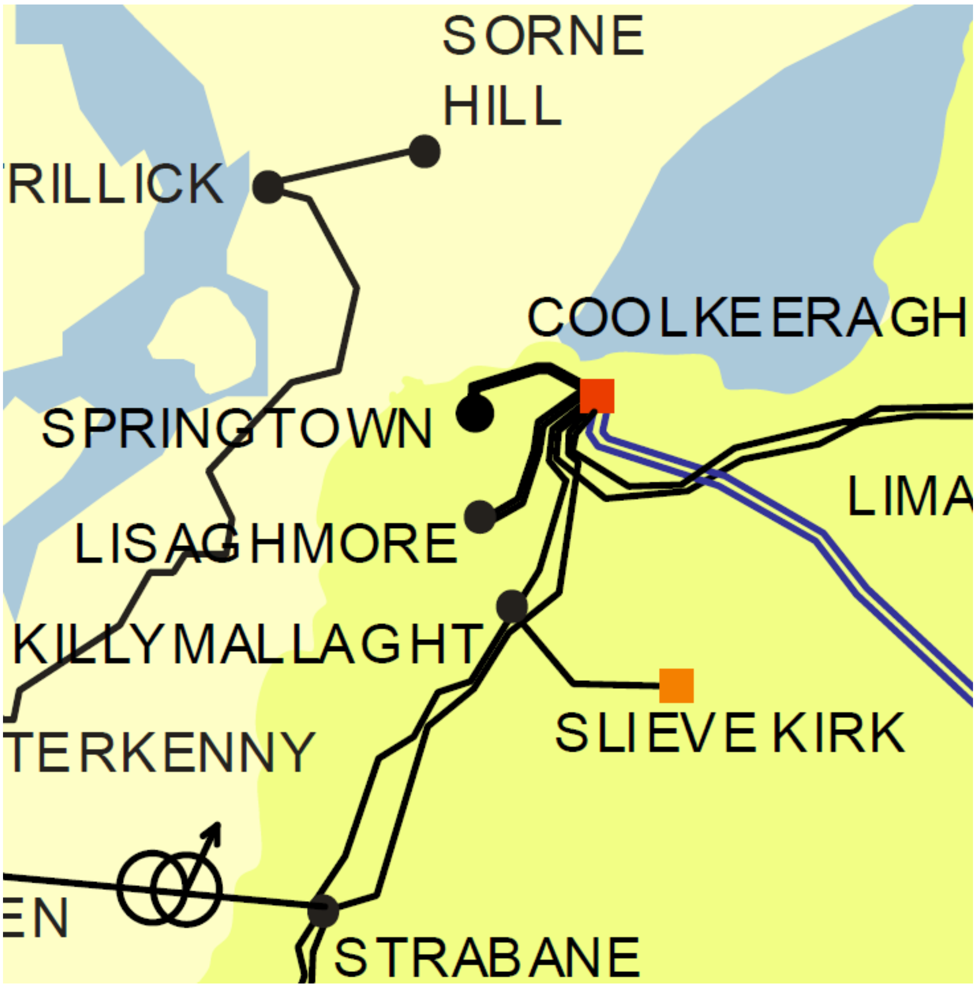

Figure C-26 - Location of node Coolkeeragh

Generator	SO	Capacity	Type	Status
Monnaboy	DSO	12.0	wind priority	connected
Aught Wind Farm	TSO	37.0	wind not priority	connected

Table C-26 - Generation Included in Study for Node Coolkeeragh

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	37	37	
Installed Capacity (MW)	2030	37	37	37
Available Energy (GWh)	2025	96	96	
Available Energy (GWh)	2030	96	96	96
Generation (GWh)	2025	83	71	
Generation (GWh)	2030	92	83	65
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	14 %	26 %	
Total Dispatch Down (%)	2030	5 %	14 %	33 %

Table C-27 - Surplus, Curtailment and Constraint for wind not priority NI - Node Coolkeeragh

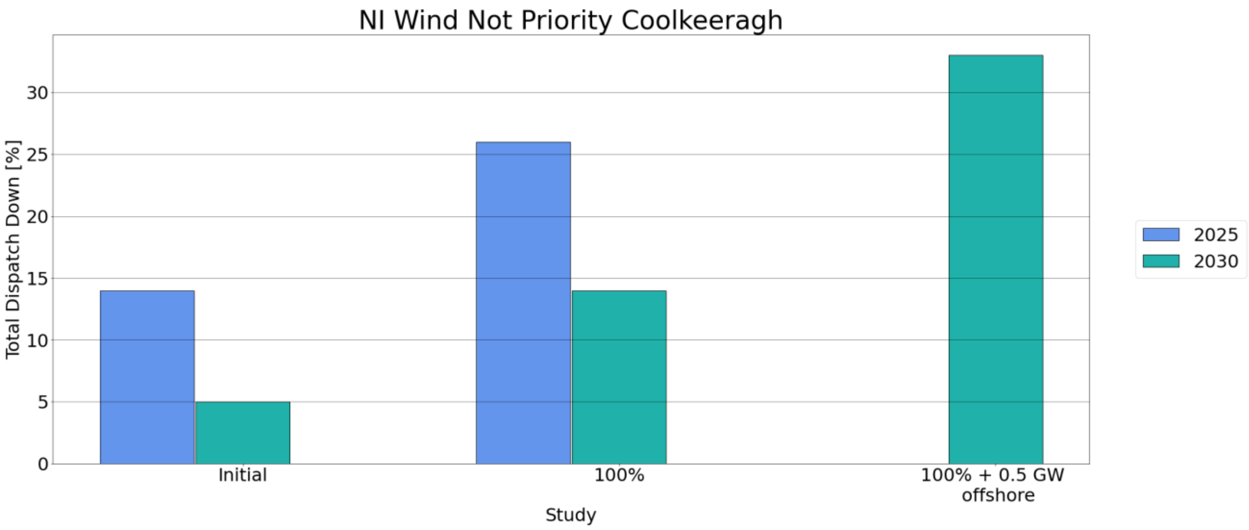

Figure C-27 - Total Dispatch Down for wind not priority - Node Coolkeeragh

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	12	12	
Installed Capacity (MW)	2030	12	12	12
Available Energy (GWh)	2025	31	31	
Available Energy (GWh)	2030	31	31	31
Generation (GWh)	2025	28	27	
Generation (GWh)	2030	30	28	29
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-28 - Surplus, Curtailment and Constraint for wind priority NI - Node Coolkeeragh

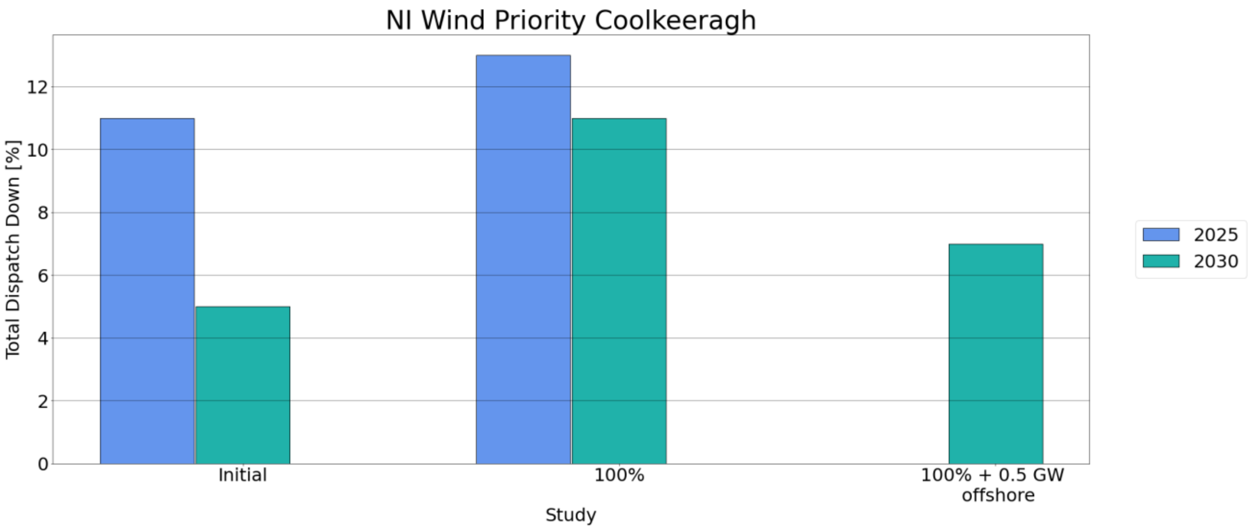

Figure C-28 - Total Dispatch Down for wind priority - Node Coolkeeragh

8.12 Curraghamulkin (Drumquin)

Figure C-29 - Location of node Curraghamulkin (Drumquin)

Generator	SO	Capacity	Type	Status
Castlecraig	DSO	25.0	wind priority	connected
Cornavarrow	DSO	36.0	wind priority	connected
Curraghamulkin Wind Farm	TSO	0.0	wind not priority	Proposed
Pigeon Top	TSO	51.9	wind not priority	Proposed
Slieveglass	DSO	6.9	wind priority	connected
Dooish	TSO	42.0	wind not priority	Proposed

Table C-29 - Generation Included in Study for Node Curraghamulkin (Drumquin)

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		94	
Installed Capacity (MW)	2030		94	94
Available Energy (GWh)	2025		245	
Available Energy (GWh)	2030		245	245
Generation (GWh)	2025		170	
Generation (GWh)	2030		217	166
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		13 %	
Constraint (%)	2030		6 %	2 %
Total Dispatch Down (%)	2025		30 %	
Total Dispatch Down (%)	2030		11 %	32 %

Table C-30 - Surplus, Curtailment and Constraint for wind not priority NI - Node Curraghamulkin (Drumquin)

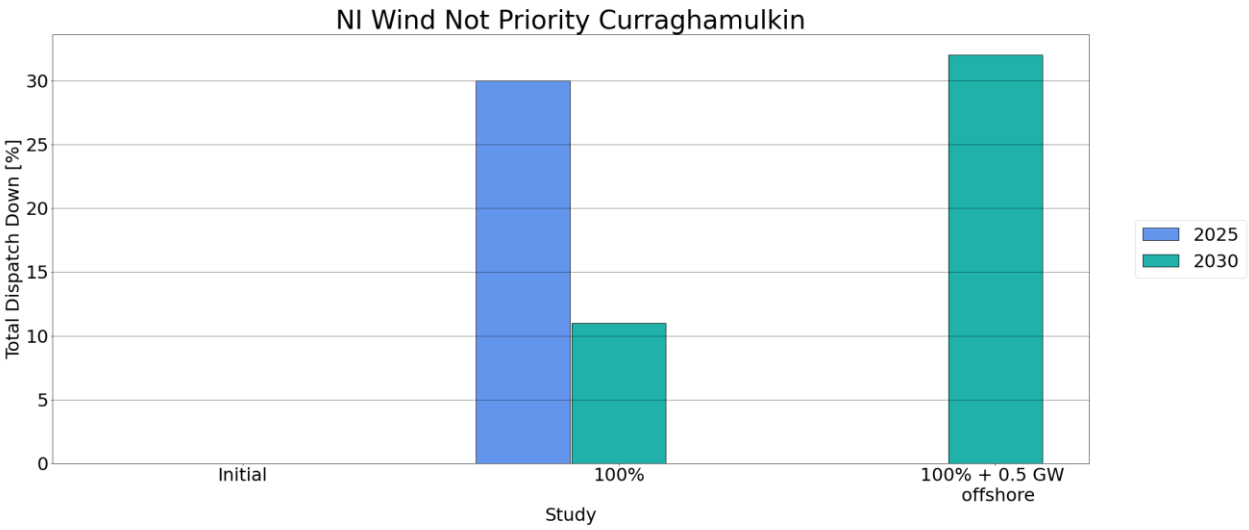

Figure C-30 - Total Dispatch Down for wind not priority - Node Curraghamulkin (Drumquin)

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	68	68	
Installed Capacity (MW)	2030	68	68	68
Available Energy (GWh)	2025	177	177	
Available Energy (GWh)	2030	177	177	177
Generation (GWh)	2025	155	147	
Generation (GWh)	2030	168	163	166
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	13 %	
Constraint (%)	2030	5 %	6 %	2 %
Total Dispatch Down (%)	2025	13 %	17 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-31 - Surplus, Curtailment and Constraint for wind priority NI - Node Curraghamulkin (Drumquin)

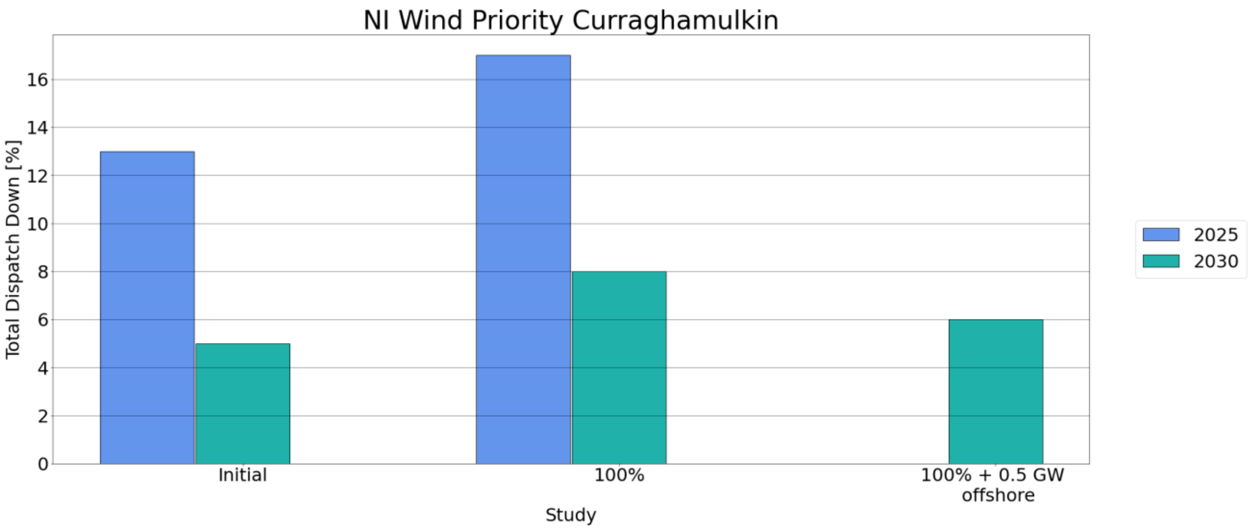

Figure C-31 - Total Dispatch Down for wind priority - Node Curraghamulkin (Drumquin)

8.13 Dungannon

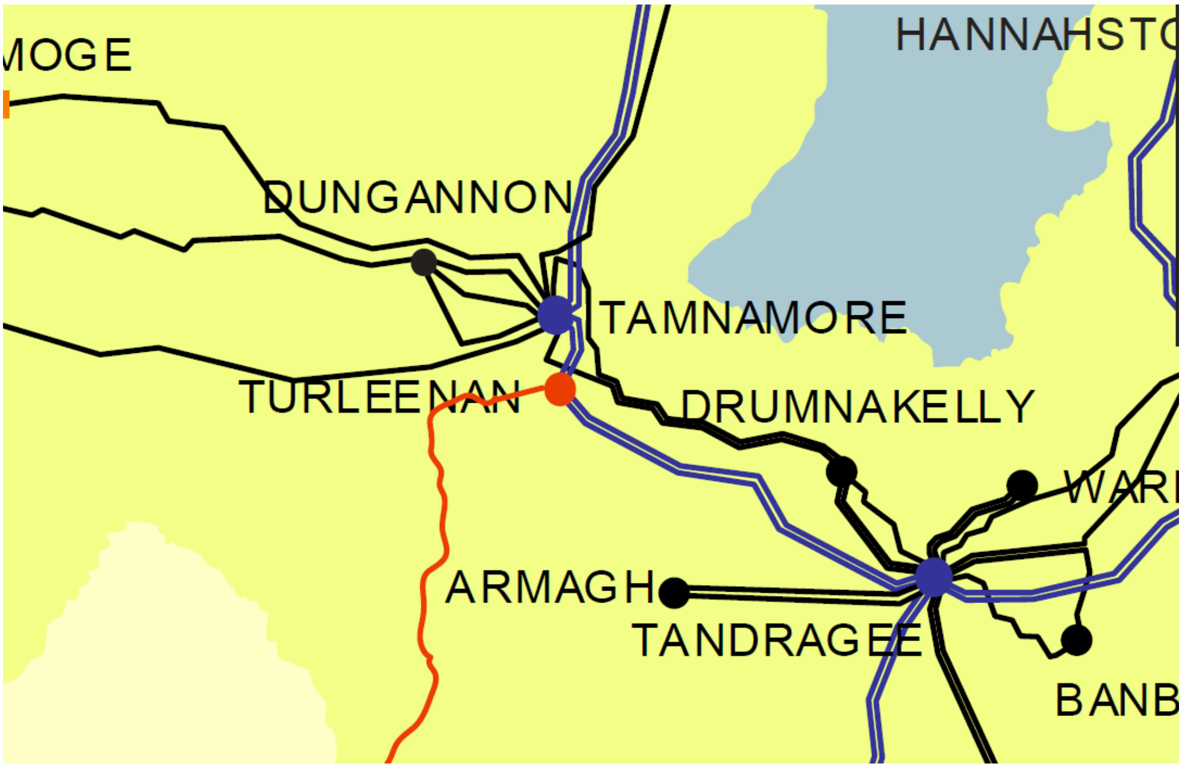

Figure C-32 - Location of node Dungannon

Generator	SO	Capacity	Type	Status
Crockagarran	DSO	17.5	wind priority	connected

Table C-32 - Generation Included in Study for Node Dungannon

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	18	18	
Installed Capacity (MW)	2030	18	18	18
Available Energy (GWh)	2025	46	46	
Available Energy (GWh)	2030	46	46	46
Generation (GWh)	2025	43	43	
Generation (GWh)	2030	43	43	43
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	4 %	2 %	
Constraint (%)	2030	5 %	3 %	0 %
Total Dispatch Down (%)	2025	5 %	6 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-33 - Surplus, Curtailment and Constraint for wind priority NI - Node Dungannon

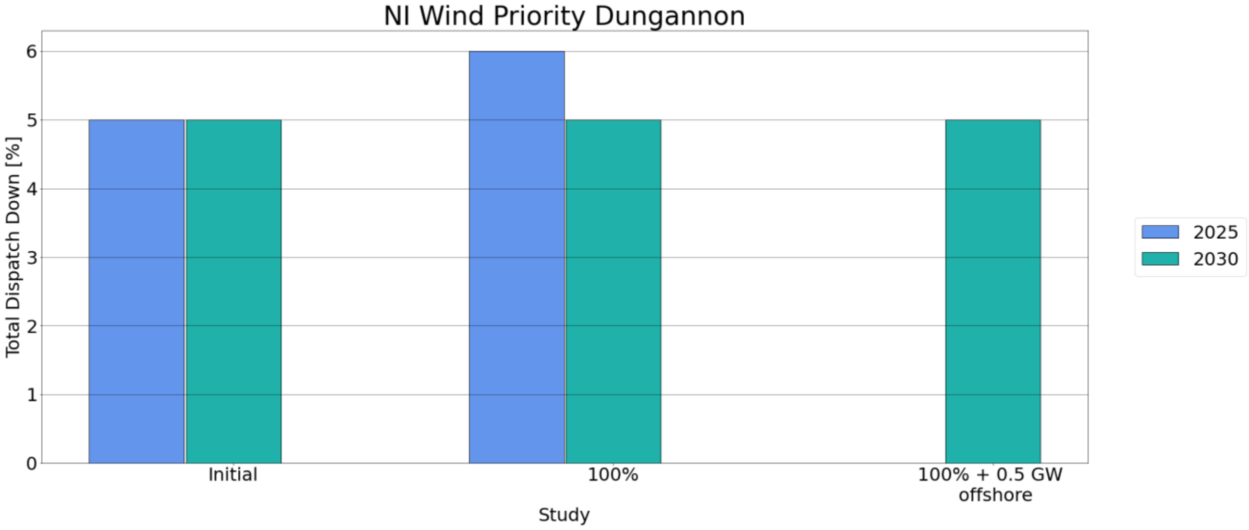

Figure C-33 - Total Dispatch Down for wind priority - Node Dungannon

8.14 Enniskillen

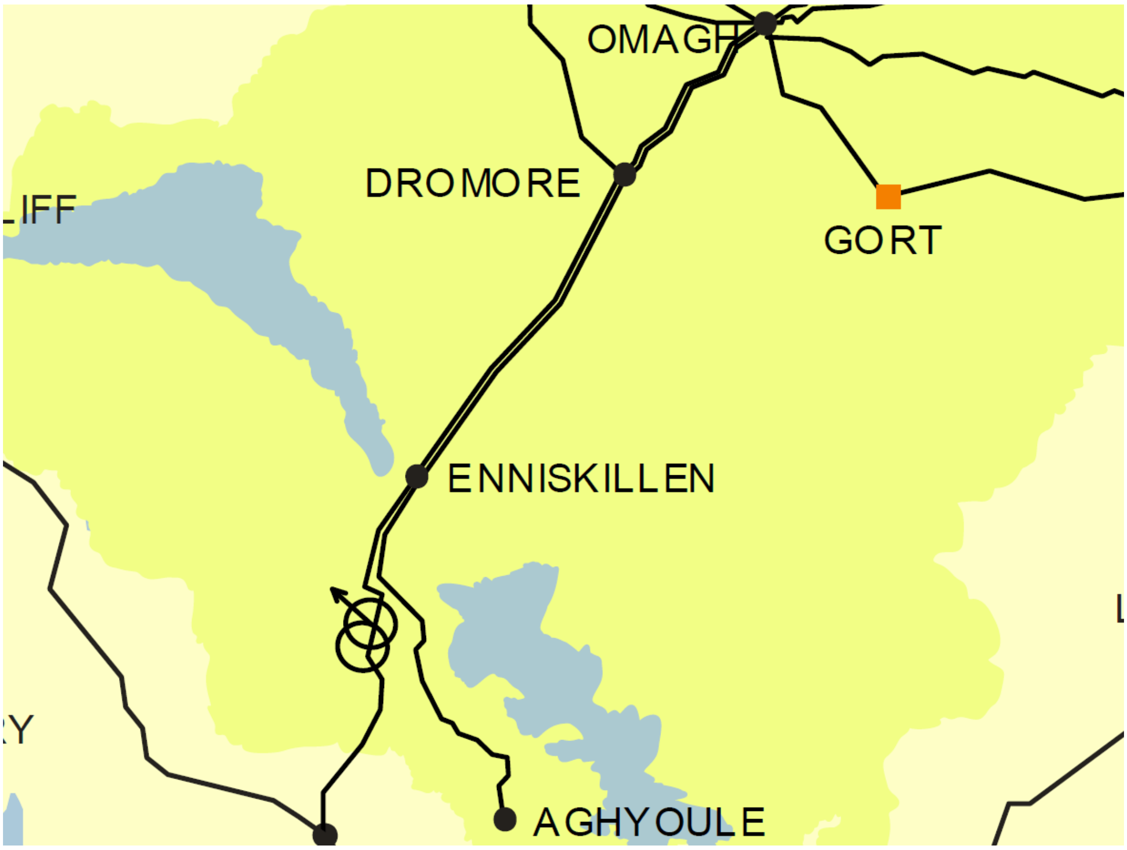

Figure C-34 - Location of node Enniskillen

Generator	SO	Capacity	Type	Status
Callagheen	DSO	16.9	wind priority	connected
Ora More	DSO	15.0	wind priority	connected

Table C-34 - Generation Included in Study for Node Enniskillen

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	32	32	
Installed Capacity (MW)	2030	32	32	32
Available Energy (GWh)	2025	83	83	
Available Energy (GWh)	2030	83	83	83
Generation (GWh)	2025	73	69	
Generation (GWh)	2030	79	77	78
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	13 %	
Constraint (%)	2030	5 %	6 %	2 %
Total Dispatch Down (%)	2025	13 %	17 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-35 - Surplus, Curtailment and Constraint for wind priority NI - Node Enniskillen

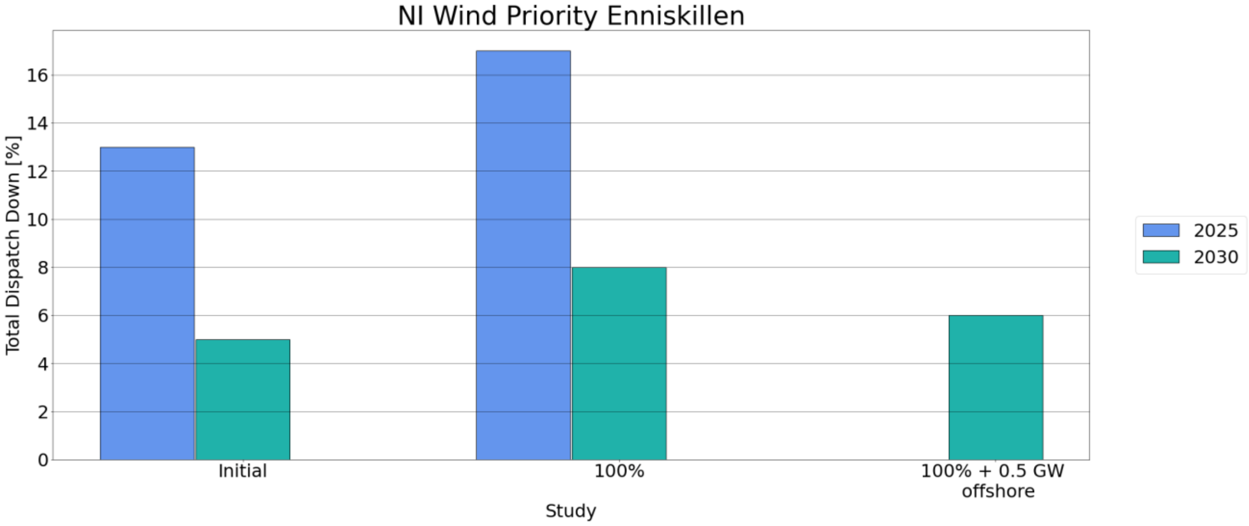

Figure C-35 - Total Dispatch Down for wind priority - Node Enniskillen

8.15 Feeney

Figure C-36 - Location of node Feeney

Generator	SO	Capacity	Type	Status
Altahullion - replant extra for SOEF 1.1	DSO	41.0	wind not priority	Proposed
Ballyhanedin	DSO	24.0	wind not priority	Proposed
Barr Cregg	DSO	24.2	wind not priority	Proposed
Magheramore	DSO	21.6	wind not priority	Proposed

Table C-36 - Generation Included in Study for Node Feeney

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		70	
Installed Capacity (MW)	2030		111	111
Available Energy (GWh)	2025		182	
Available Energy (GWh)	2030		289	289
Generation (GWh)	2025		134	
Generation (GWh)	2030		247	195
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		9 %	
Constraint (%)	2030		9 %	2 %
Total Dispatch Down (%)	2025		26 %	
Total Dispatch Down (%)	2030		14 %	33 %

Table C-37 - Surplus, Curtailment and Constraint for wind not priority NI - Node Feeney

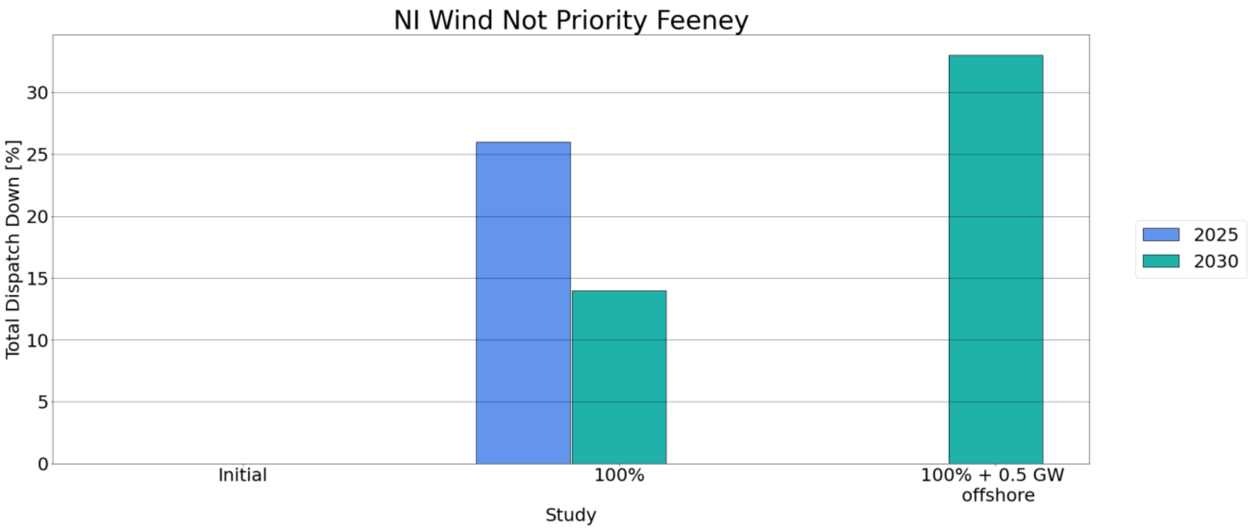

Figure C-37 - Total Dispatch Down for wind not priority - Node Feeney

8.16 Glengormley

Figure C-38 - Location of node Glengormley

Generator	SO	Capacity	Type	Status
Ballyutoagh Wind Farm	DSO	11.5	wind not priority	connected

Table C-38 - Generation Included in Study for Node Glengormley

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	12	12	
Installed Capacity (MW)	2030	12	12	12
Available Energy (GWh)	2025	30	30	
Available Energy (GWh)	2030	30	30	30
Generation (GWh)	2025	28	24	
Generation (GWh)	2030	28	28	21
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	2 %	2 %	
Constraint (%)	2030	5 %	1 %	0 %
Total Dispatch Down (%)	2025	6 %	19 %	
Total Dispatch Down (%)	2030	5 %	6 %	31 %

Table C-39 - Surplus, Curtailment and Constraint for wind not priority NI - Node Glengormley

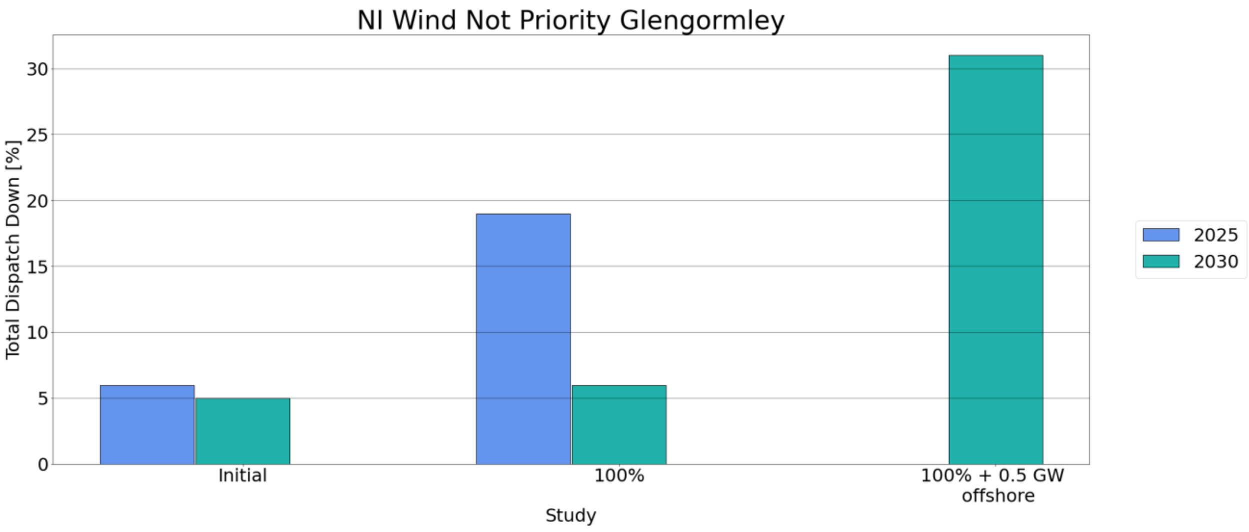

Figure C-39 - Total Dispatch Down for wind not priority - Node Glengormley

8.17 Gort

Figure C-40 - Location of node Gort

Generator	SO	Capacity	Type	Status
Altamuskin	DSO	14.1	wind priority	connected
Crockbaravally	DSO	7.5	wind priority	connected
Murley Mountain	DSO	22.5	wind not priority	connected
Shantavany Scotch	DSO	16.1	wind priority	connected
Slieve Divena 2	DSO	18.8	wind priority	connected
Teiges	DSO	11.0	wind priority	connected
Gort - SOEF 1.1 assumption for NI	TSO	40.0	wind not priority	Proposed
Murley	DSO	22.5	wind not priority	Proposed

Table C-40 - Generation Included in Study for Node Gort

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	22	45	
Installed Capacity (MW)	2030	22	85	85
Available Energy (GWh)	2025	59	117	
Available Energy (GWh)	2030	59	221	221
Generation (GWh)	2025	49	79	
Generation (GWh)	2030	56	196	151
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	16 %	33 %	
Total Dispatch Down (%)	2030	5 %	11 %	32 %

Table C-41 - Surplus, Curtailment and Constraint for wind not priority NI - Node Gort

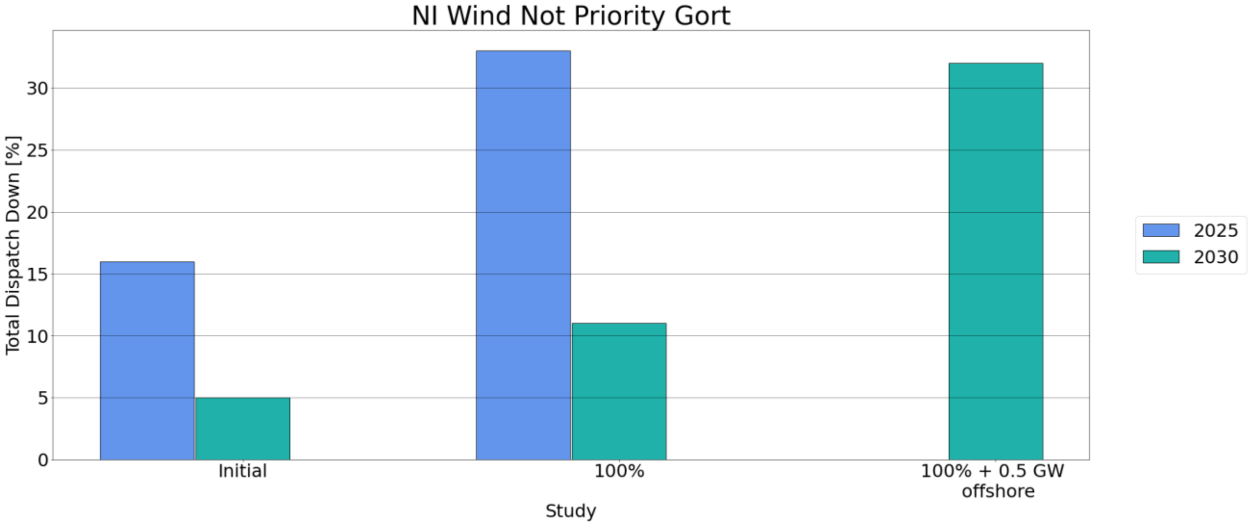

Figure C-41 - Total Dispatch Down for wind not priority - Node Gort

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	68	68	
Installed Capacity (MW)	2030	68	68	68
Available Energy (GWh)	2025	176	176	
Available Energy (GWh)	2030	176	176	176
Generation (GWh)	2025	154	141	
Generation (GWh)	2030	167	162	165
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-42 - Surplus, Curtailment and Constraint for wind priority NI - Node Gort

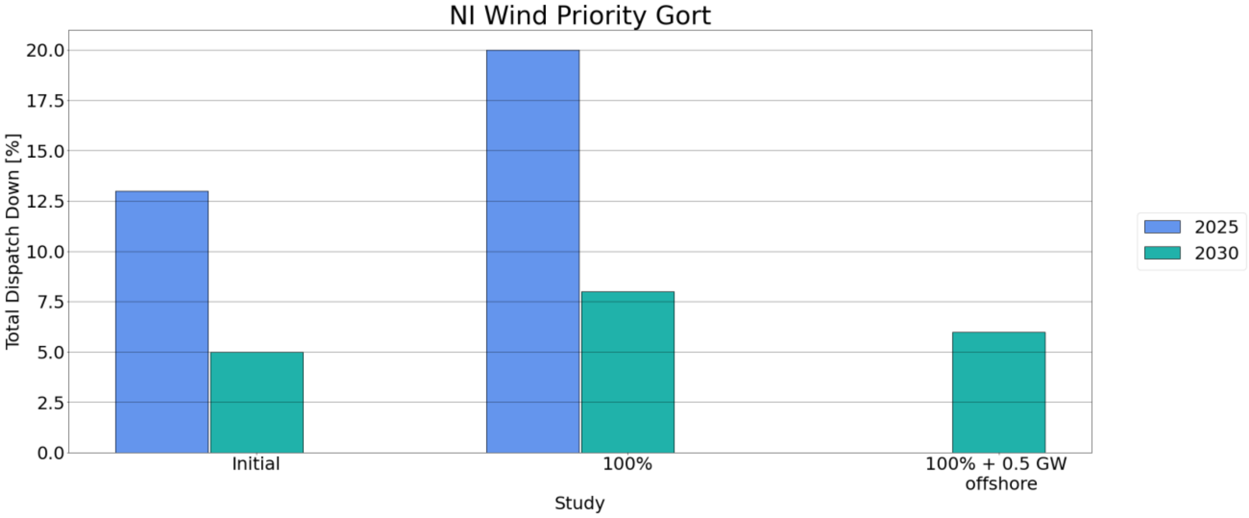

Figure C-42 - Total Dispatch Down for wind priority - Node Gort

8.18 Kells

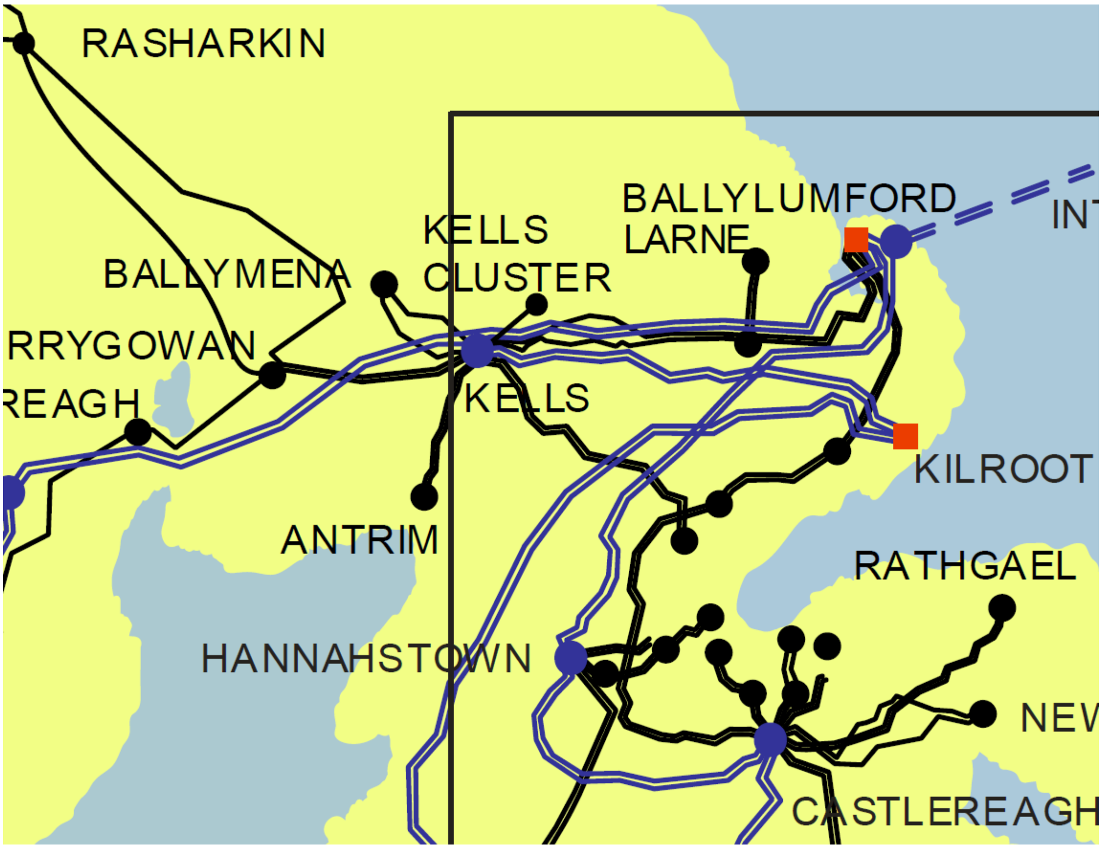

Figure C-43 - Location of node Kells

Generator	SO	Capacity	Type	Status
Castlegore	DSO	23.1	wind not priority	connected
Elliot's Hill - replant extra for SOEF 1.1	DSO	24.4	wind not priority	Proposed
Steeple Road	DSO	20.0	solar not priority	connected
Ballygilbert	DSO	58.8	wind not priority	Proposed
Carnalbanagh	DSO	28.5	wind not priority	Proposed
Ushinagh	DSO	58.8	wind not priority	Proposed
Ballycowan	DSO	29.9	solar not priority	Proposed
Liminary Road	DSO	22.5	solar not priority	Proposed
Kells	DSO	22.5	solar not priority	Proposed

Table C-43 - Generation Included in Study for Node Kells

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	20	95	
Installed Capacity (MW)	2030	20	95	95
Available Energy (GWh)	2025	21	99	
Available Energy (GWh)	2030	21	99	99
Generation (GWh)	2025	20	91	
Generation (GWh)	2030	20	94	85
Surplus (%)	2025	1 %	6 %	
Surplus (%)	2030	0 %	3 %	11 %
Curtailment (%)	2025	0 %	1 %	
Curtailment (%)	2030	0 %	1 %	2 %
Constraint (%)	2025	4 %	0 %	
Constraint (%)	2030	5 %	2 %	0 %
Total Dispatch Down (%)	2025	5 %	8 %	
Total Dispatch Down (%)	2030	5 %	5 %	14 %

Table C-44 - Surplus, Curtailment and Constraint for solar not priority NI - Node Kells

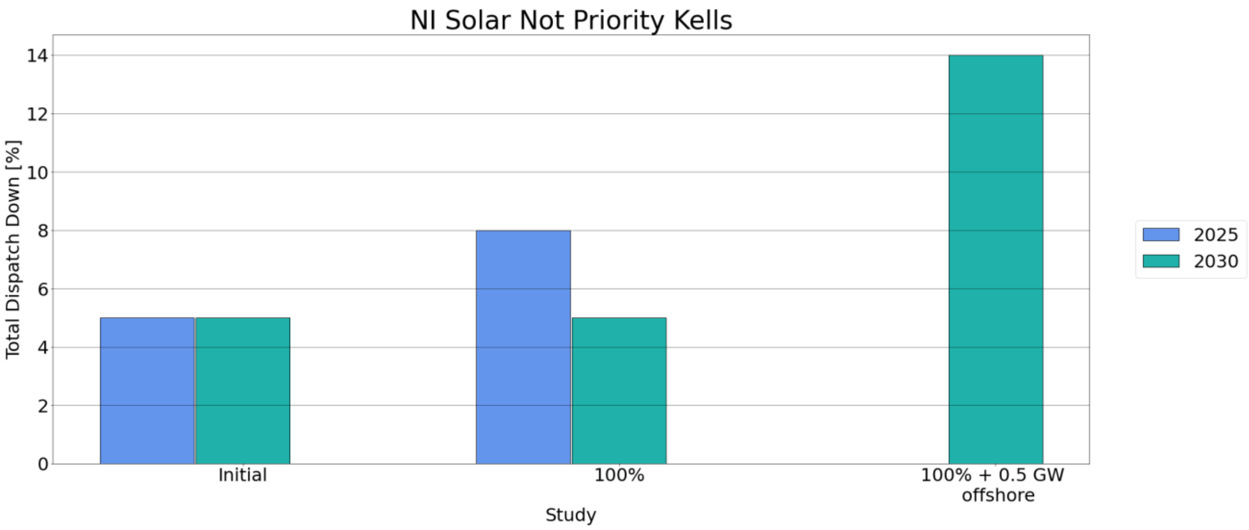

Figure C-44 - Total Dispatch Down for solar not priority - Node Kells

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	23	169	
Installed Capacity (MW)	2030	23	194	194
Available Energy (GWh)	2025	60	441	
Available Energy (GWh)	2030	60	504	504
Generation (GWh)	2025	56	357	
Generation (GWh)	2030	57	472	350
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	2 %	2 %	
Constraint (%)	2030	5 %	1 %	0 %
Total Dispatch Down (%)	2025	6 %	19 %	
Total Dispatch Down (%)	2030	5 %	6 %	31 %

Table C-45 - Surplus, Curtailment and Constraint for wind not priority NI - Node Kells

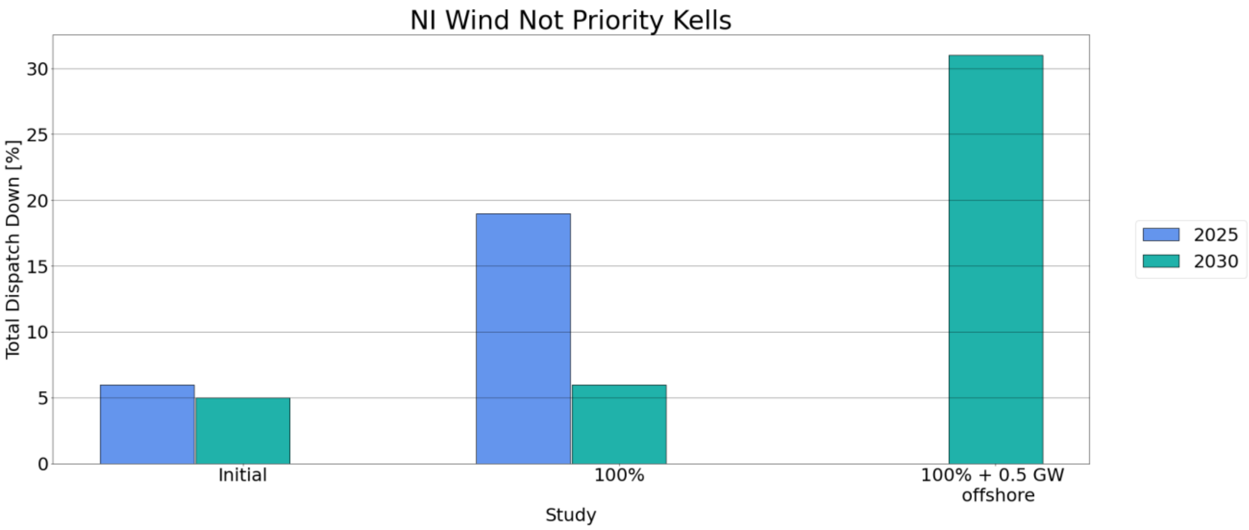

Figure C-45 - Total Dispatch Down for wind not priority - Node Kells

8.19 Kells cluster

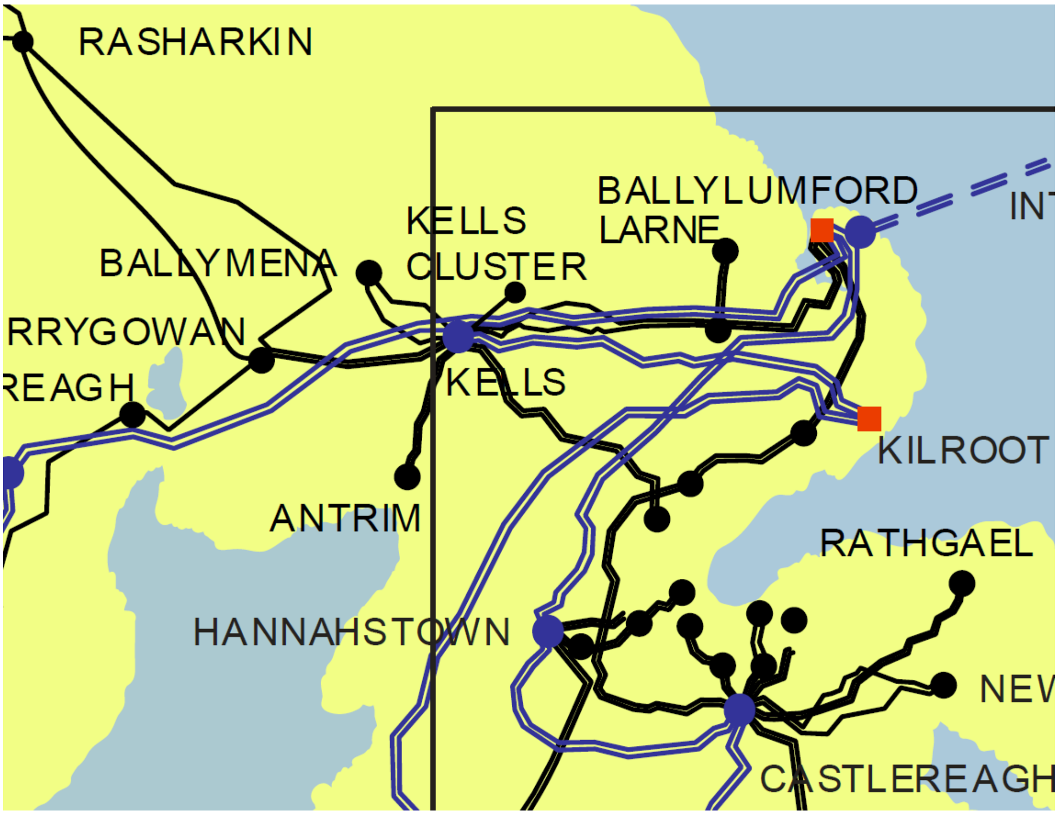

Figure C-46 - Location of node Kells cluster

Generator	SO	Capacity	Type	Status
Whappstown Road	DSO	9.2	wind not priority	Proposed

Table C-46 - Generation Included in Study for Node Kells cluster

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		9	
Installed Capacity (MW)	2030		9	9
Available Energy (GWh)	2025		24	
Available Energy (GWh)	2030		24	24
Generation (GWh)	2025		19	
Generation (GWh)	2030		22	17
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		2 %	
Constraint (%)	2030		1 %	0 %
Total Dispatch Down (%)	2025		19 %	
Total Dispatch Down (%)	2030		6 %	31 %

Table C-47 - Surplus, Curtailment and Constraint for wind not priority NI - Node Kells cluster

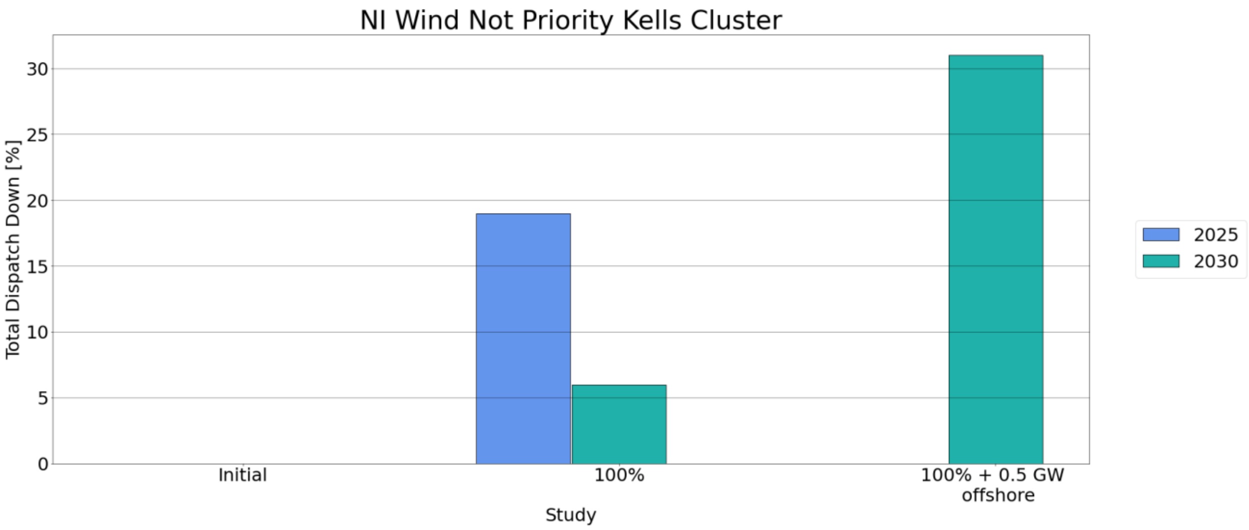

Figure C-47 - Total Dispatch Down for wind not priority - Node Kells cluster

8.20 Killymallaght

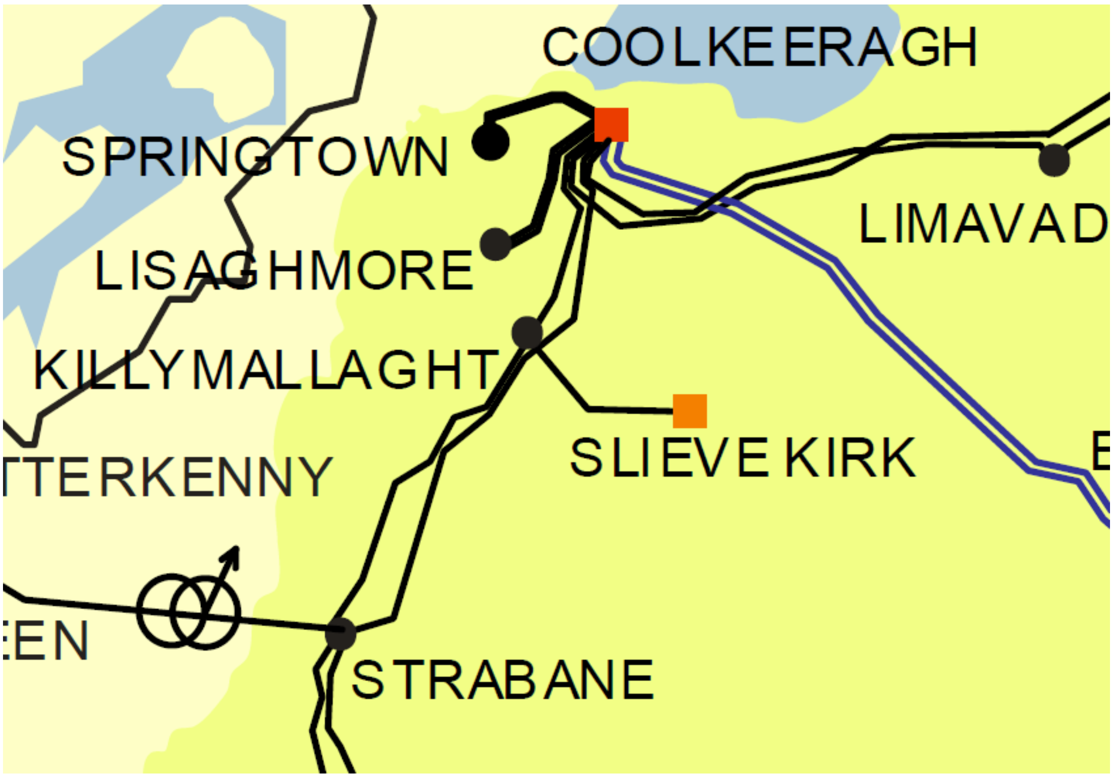

Figure C-48 - Location of node Killymallaght

Generator	SO	Capacity	Type	Status
Carrickatane	DSO	20.7	wind priority	connected
Eglish	DSO	15.0	wind priority	connected
Slieve Kirk	TSO	73.6	wind priority	connected

Table C-48 - Generation Included in Study for Node Killymallaght

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	109	109	
Installed Capacity (MW)	2030	109	109	109
Available Energy (GWh)	2025	285	285	
Available Energy (GWh)	2030	285	285	285
Generation (GWh)	2025	249	229	
Generation (GWh)	2030	271	262	267
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-49 - Surplus, Curtailment and Constraint for wind priority NI - Node Killymallaght

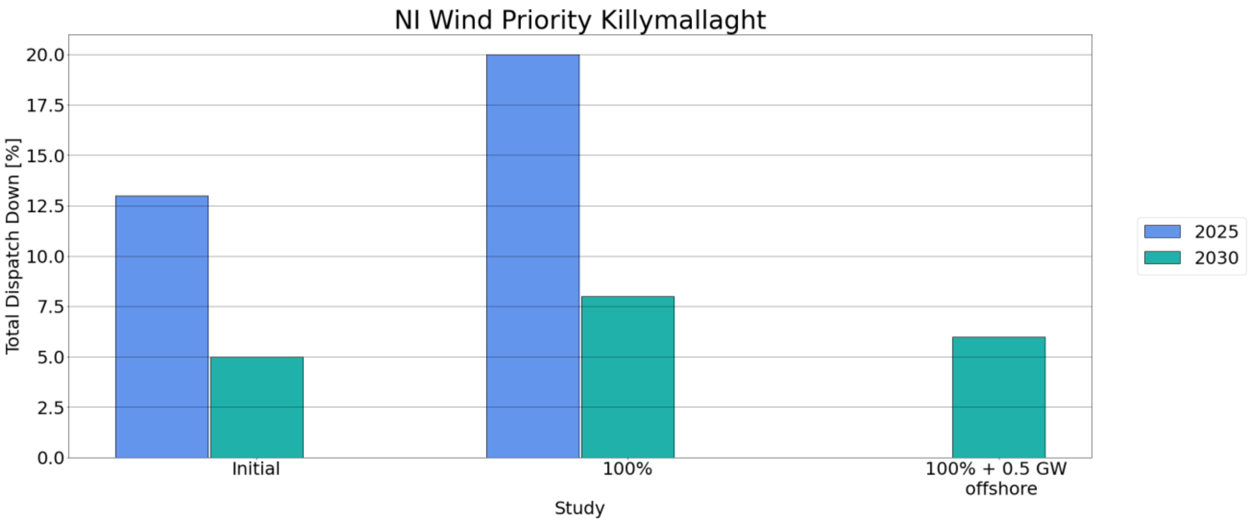

Figure C-49 - Total Dispatch Down for wind priority - Node Killymallaght

8.21 Larne

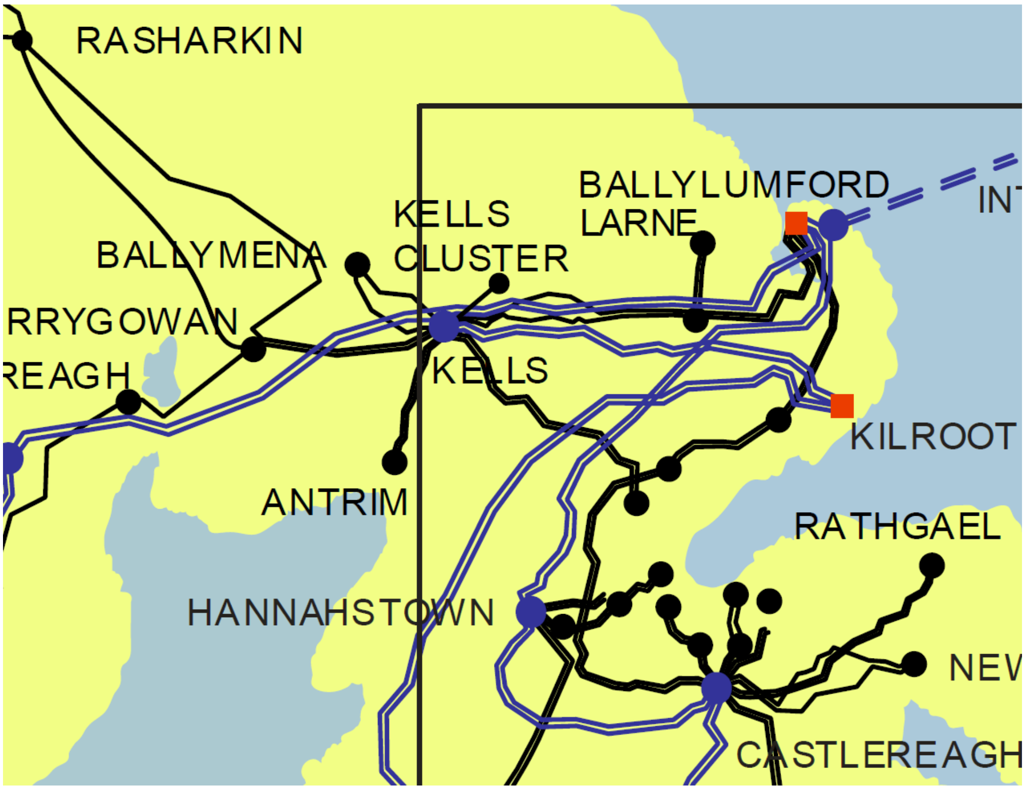

Figure C-50 - Location of node Larne

Generator	SO	Capacity	Type	Status
Ballykeel Wind Farm	DSO	16.1	wind not priority	connected
Wolf Bog	DSO	10.0	wind priority	connected

Table C-50 - Generation Included in Study for Node Larne

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	16	16	
Installed Capacity (MW)	2030	16	16	16
Available Energy (GWh)	2025	42	42	
Available Energy (GWh)	2030	42	42	42
Generation (GWh)	2025	39	34	
Generation (GWh)	2030	40	39	29
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	2 %	2 %	
Constraint (%)	2030	5 %	1 %	0 %
Total Dispatch Down (%)	2025	6 %	19 %	
Total Dispatch Down (%)	2030	5 %	6 %	31 %

Table C-51 - Surplus, Curtailment and Constraint for wind not priority NI - Node Larne

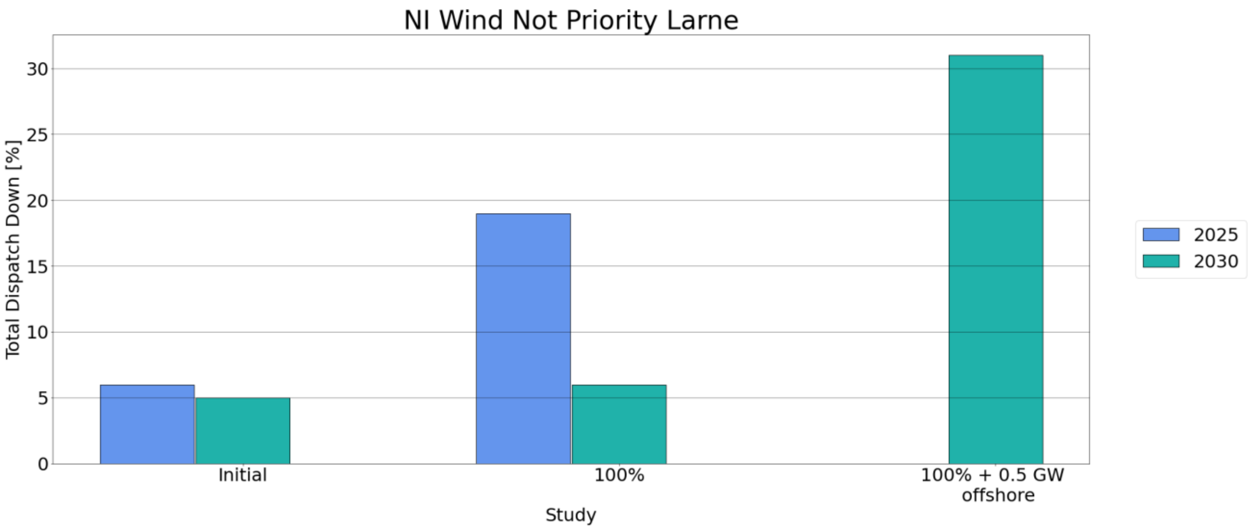

Figure C-51 - Total Dispatch Down for wind not priority - Node Larne

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	10	10	
Installed Capacity (MW)	2030	10	10	10
Available Energy (GWh)	2025	26	26	
Available Energy (GWh)	2030	26	26	26
Generation (GWh)	2025	25	25	
Generation (GWh)	2030	25	25	25
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	4 %	2 %	
Constraint (%)	2030	5 %	3 %	0 %
Total Dispatch Down (%)	2025	5 %	6 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-52 - Surplus, Curtailment and Constraint for wind priority NI - Node Larne

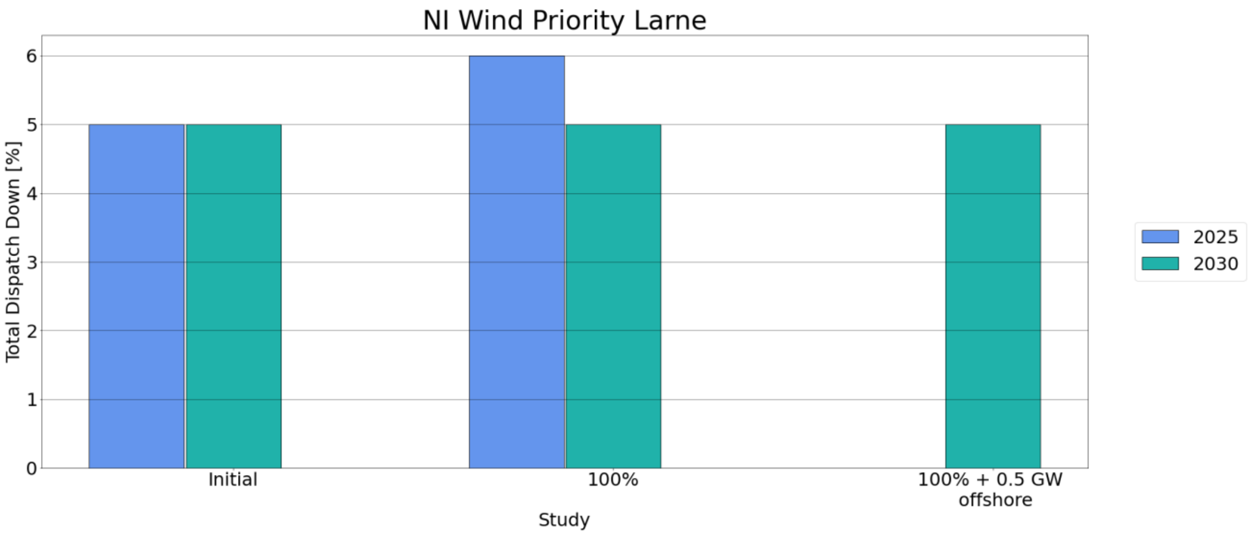

Figure C-52 - Total Dispatch Down for wind priority - Node Larne

8.22 Limavady

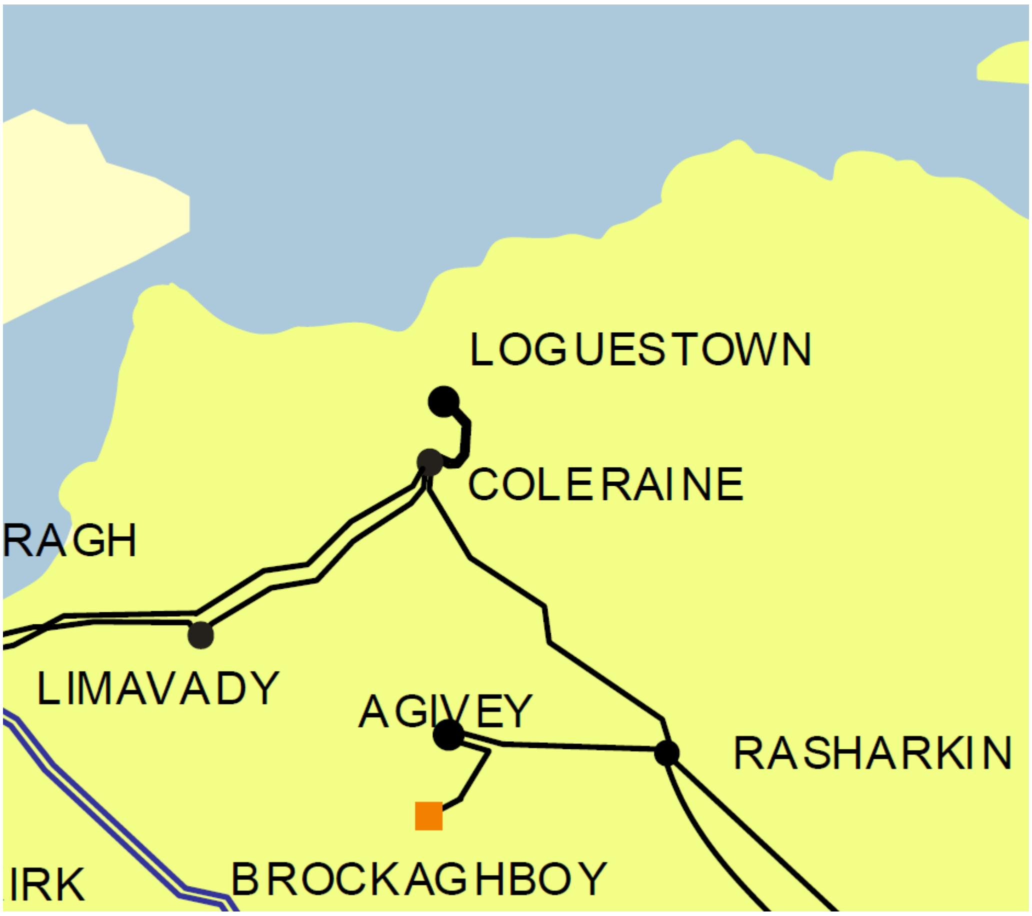

Figure C-53 - Location of node Limavady

Generator	SO	Capacity	Type	Status
Altahullion 2	DSO	11.7	Wind priority	connected

Table C-53 - Generation Included in Study for Node Limavady

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	12	12	
Installed Capacity (MW)	2030	12	12	12
Available Energy (GWh)	2025	30	30	
Available Energy (GWh)	2030	30	30	30
Generation (GWh)	2025	27	27	
Generation (GWh)	2030	29	27	28
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-54 - Surplus, Curtailment and Constraint for wind priority NI - Node Limavady

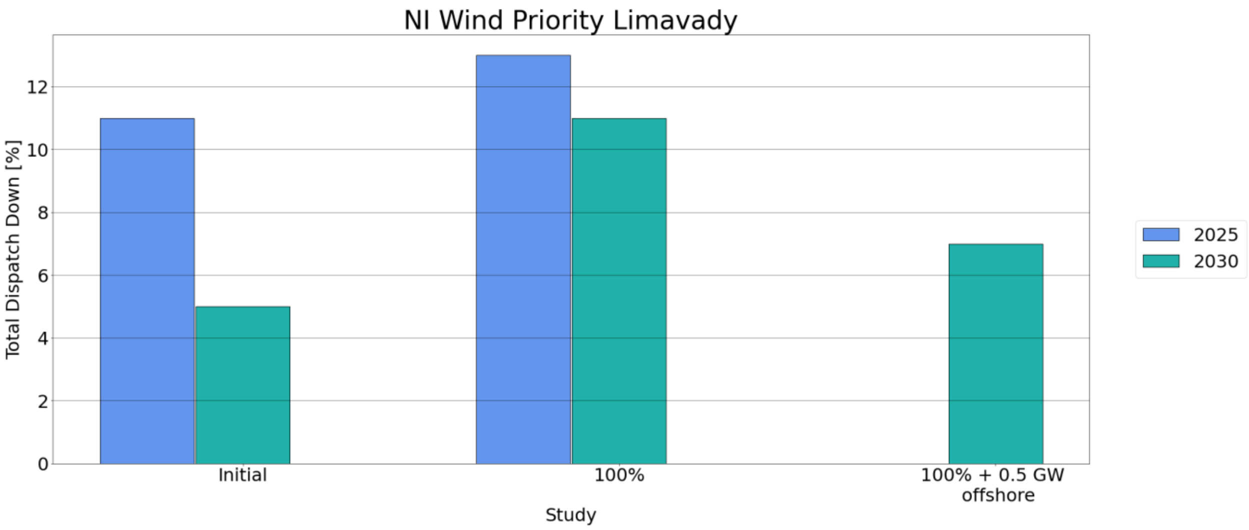

Figure C-54 - Total Dispatch Down for wind priority - Node Limavady

8.23 Lisaghmore

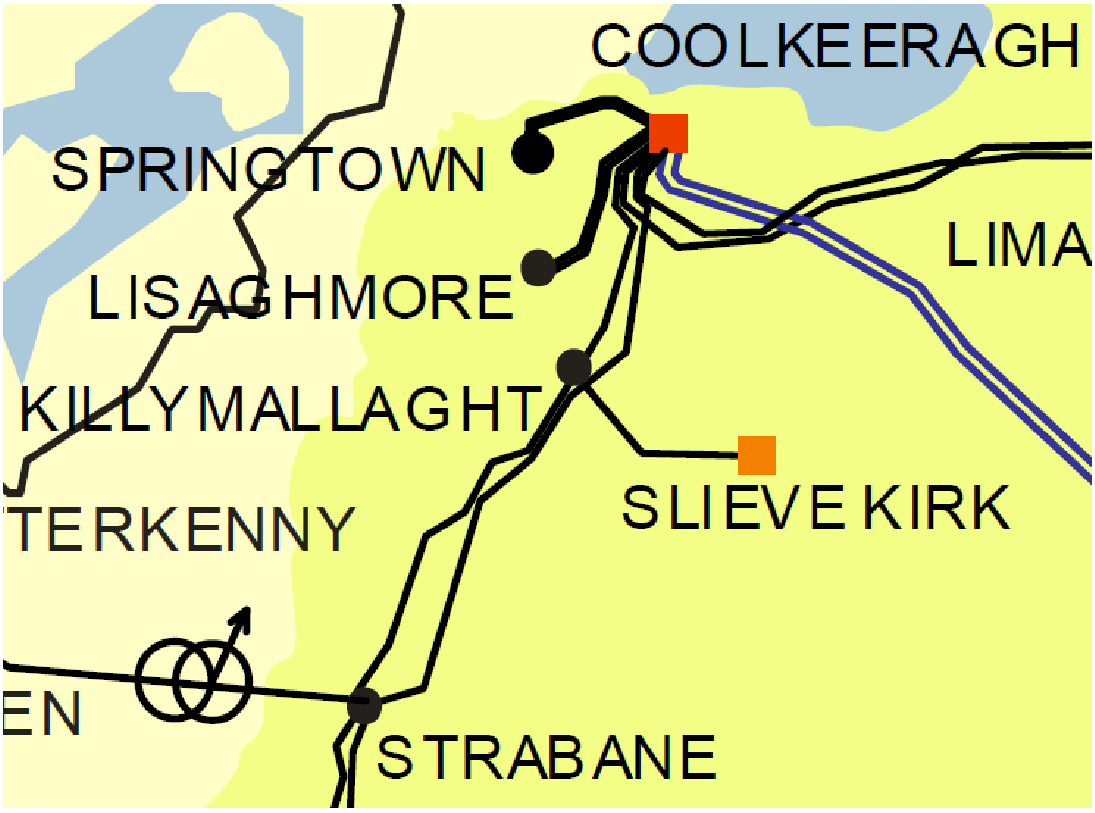

Figure C-55 - Location of node Lisaghmore

Generator	SO	Capacity	Type	Status
Curryfree	DSO	15.0	wind priority	connected

Table C-55 - Generation Included in Study for Node Lisaghmore

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	15	15	
Installed Capacity (MW)	2030	15	15	15
Available Energy (GWh)	2025	39	39	
Available Energy (GWh)	2030	39	39	39
Generation (GWh)	2025	35	34	
Generation (GWh)	2030	37	35	36
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-56 - Surplus, Curtailment and Constraint for wind priority NI - Node Lisaghmore

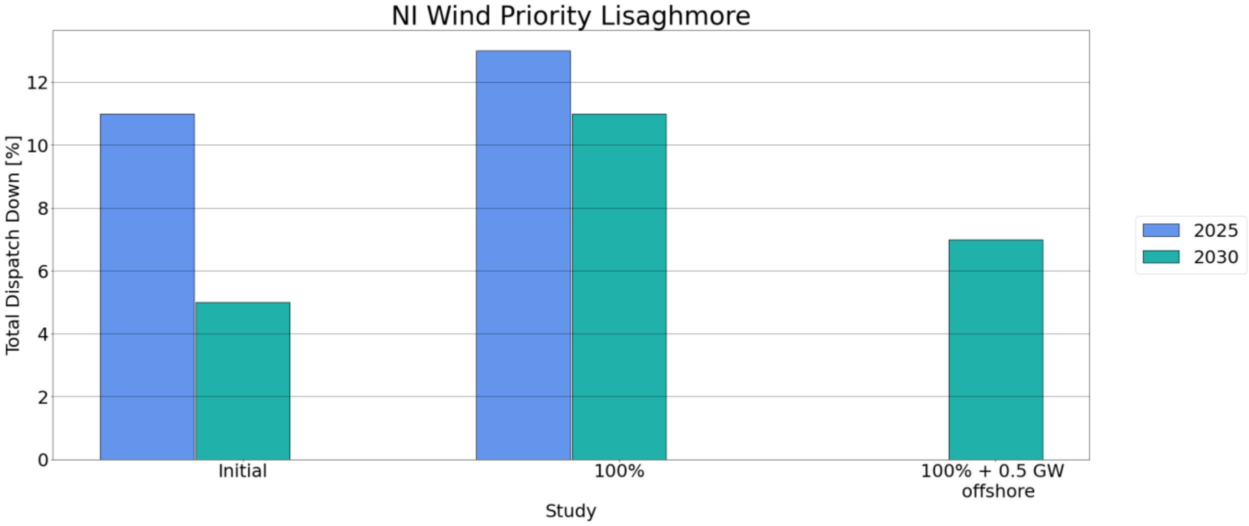

Figure C-56 - Total Dispatch Down for wind priority - Node Lisaghmore

8.24 Lisburn

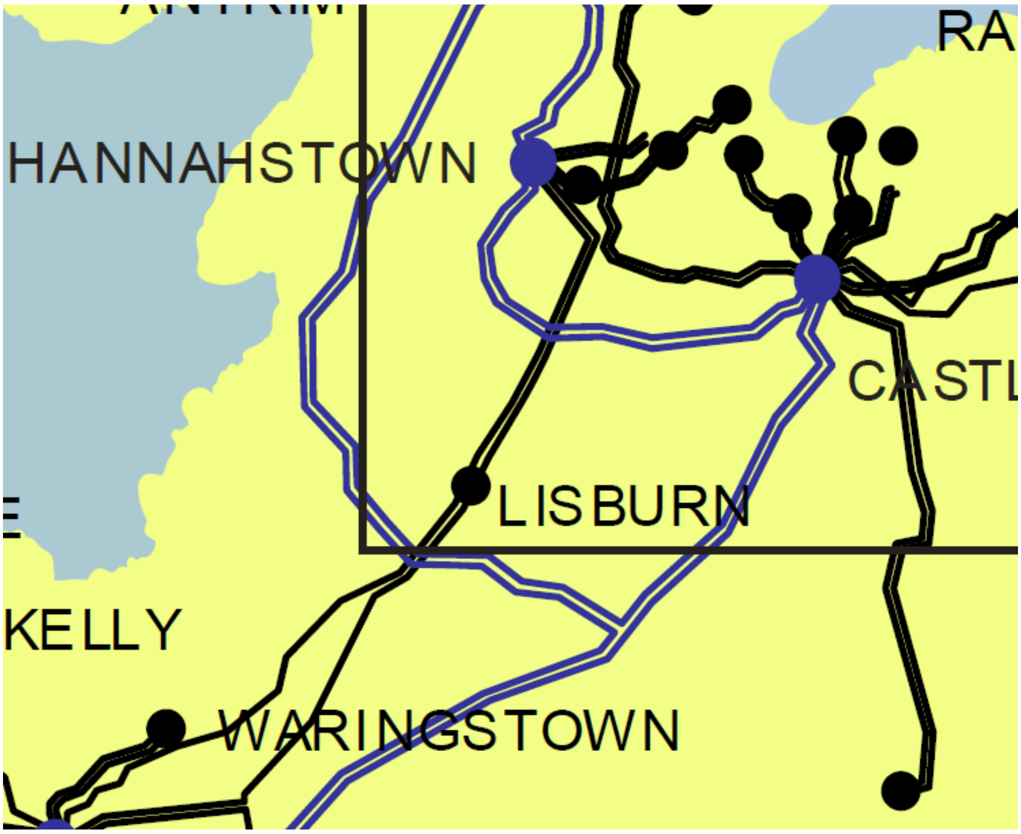

Figure C-57 - Location of node Lisburn

Generator	SO	Capacity	Type	Status
Lisburn PV Park (aka Balinderry Road and Moneybroom Road)	DSO	16.92	solar priority	connected
Lough Road Solar	DSO	21.0	solar priority	connected
Maghaberry Road	DSO	20.43	solar priority	connected
Assumed solar not priority	DSO	31.9	solar not priority	Proposed

Table C-57 - Generation Included in Study for Node Lisburn

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		32	
Installed Capacity (MW)	2030		32	32
Available Energy (GWh)	2025		33	
Available Energy (GWh)	2030		33	33
Generation (GWh)	2025		31	
Generation (GWh)	2030		32	29
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		0 %	
Constraint (%)	2030		2 %	0 %
Total Dispatch Down (%)	2025		8 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-58 - Surplus, Curtailment and Constraint for solar not priority NI - Node Lisburn

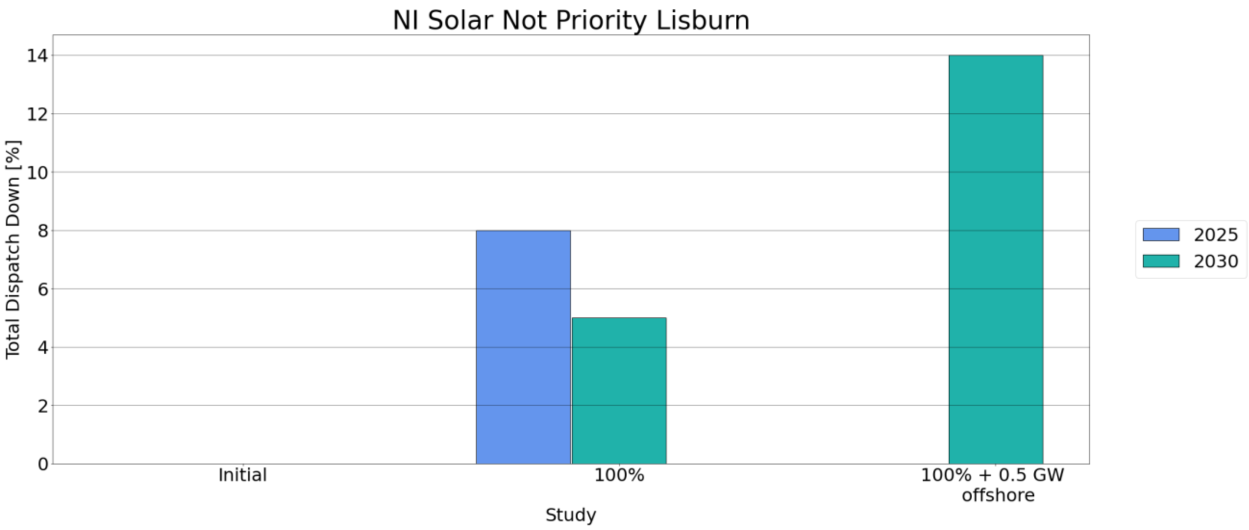

Figure C-58 - Total Dispatch Down for solar not priority - Node Lisburn

The solar priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	58	58	
Installed Capacity (MW)	2030	58	58	58
Available Energy (GWh)	2025	61	61	
Available Energy (GWh)	2030	61	61	61
Generation (GWh)	2025	58	58	
Generation (GWh)	2030	58	58	58
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	3 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	5 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-59 - Surplus, Curtailment and Constraint for solar priority NI - Node Lisburn

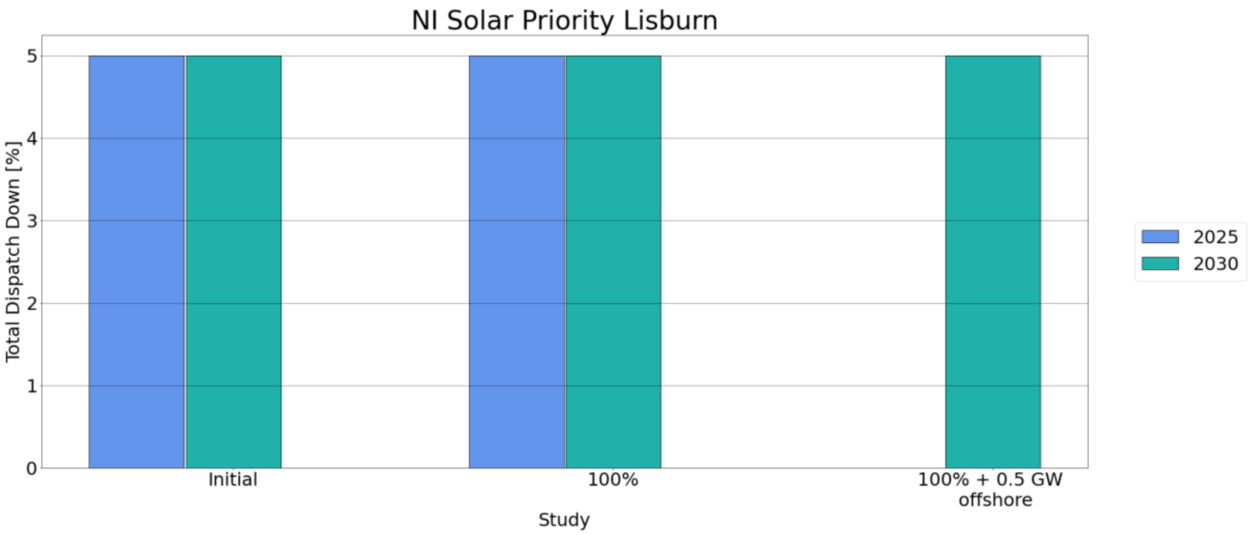

Figure C-59 - Total Dispatch Down for solar priority - Node Lisburn

8.25 Loguestown

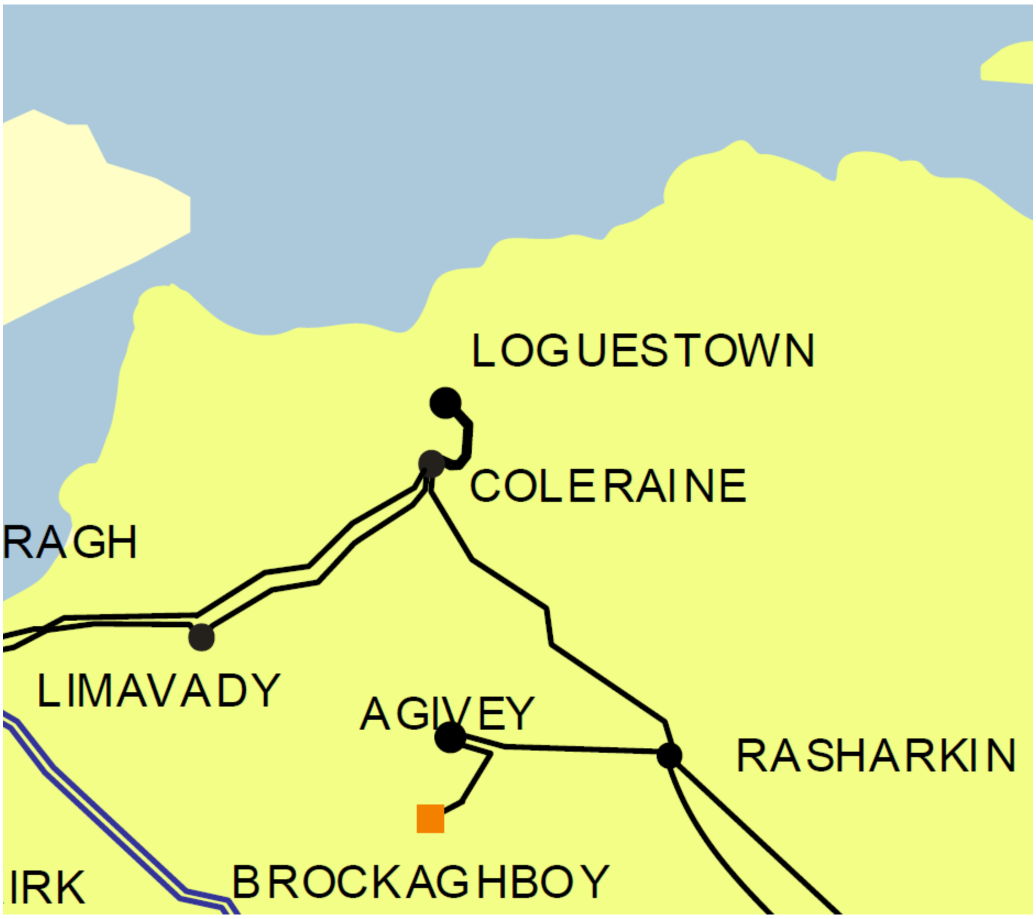

Figure C-60 - Location of node Loguestown

Generator	SO	Capacity	Type	Status
Cloonty	DSO	9.2	wind priority	connected
Ballyrashane	DSO	29.9	solar not priority	Proposed

Table C-60 - Generation Included in Study for Node Loguestown

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		30	
Installed Capacity (MW)	2030		30	30
Available Energy (GWh)	2025		31	
Available Energy (GWh)	2030		31	31
Generation (GWh)	2025		27	
Generation (GWh)	2030		30	27
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		5 %	
Constraint (%)	2030		2 %	1 %
Total Dispatch Down (%)	2025		13 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-61 - Surplus, Curtailment and Constraint for solar not priority NI - Node Loguestown

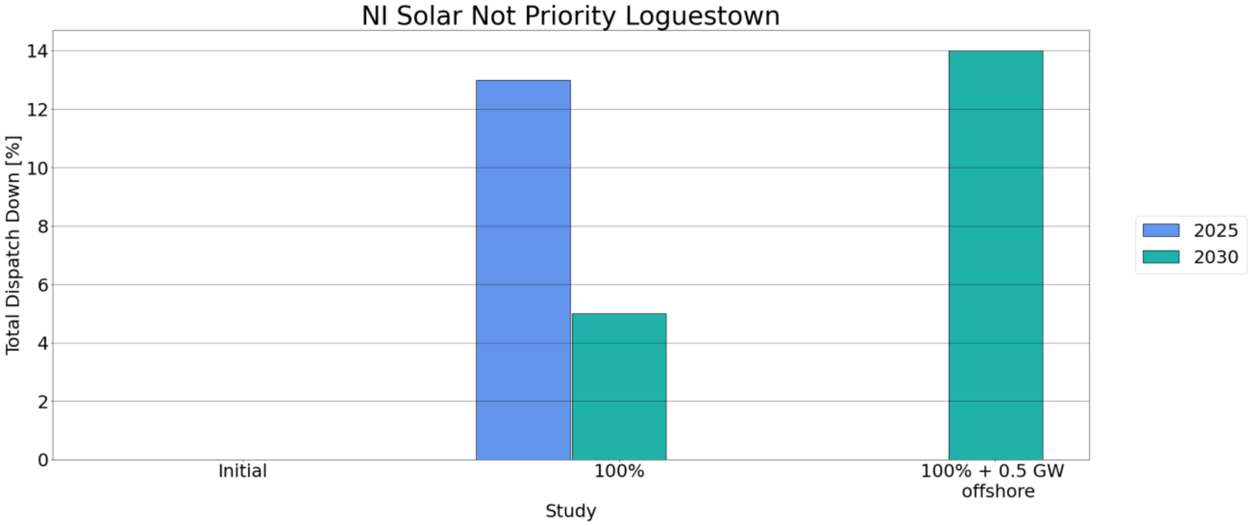

Figure C-61 - Total Dispatch Down for solar not priority - Node Loguestown

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	9	9	
Installed Capacity (MW)	2030	9	9	9
Available Energy (GWh)	2025	24	24	
Available Energy (GWh)	2030	24	24	24
Generation (GWh)	2025	21	21	
Generation (GWh)	2030	23	21	22
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-62 - Surplus, Curtailment and Constraint for wind priority NI - Node Loguestown

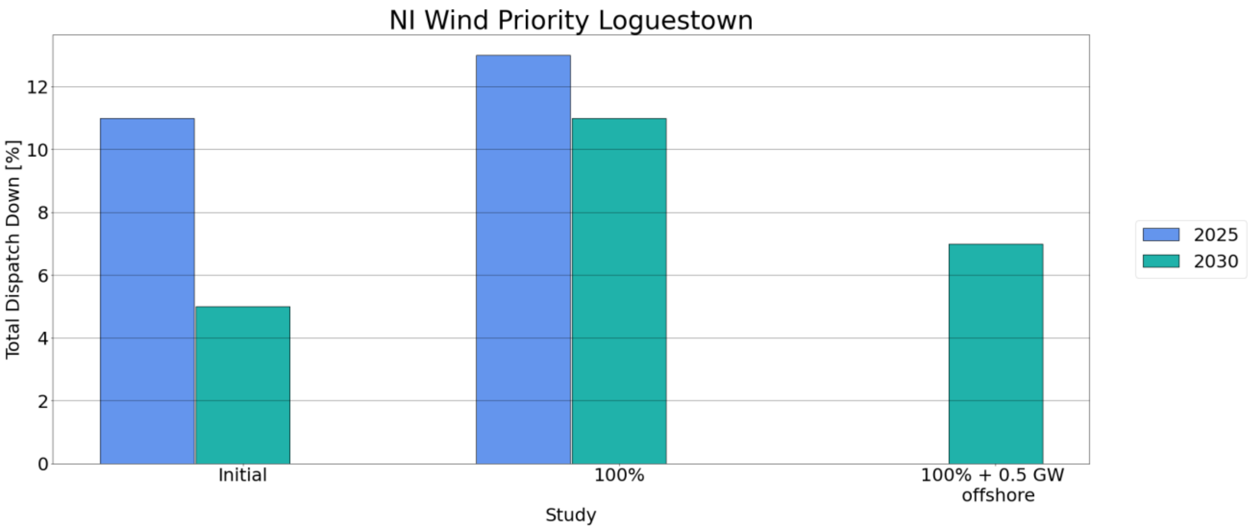

Figure C-62 - Total Dispatch Down for wind priority - Node Loguestown

8.26 Magherakeel

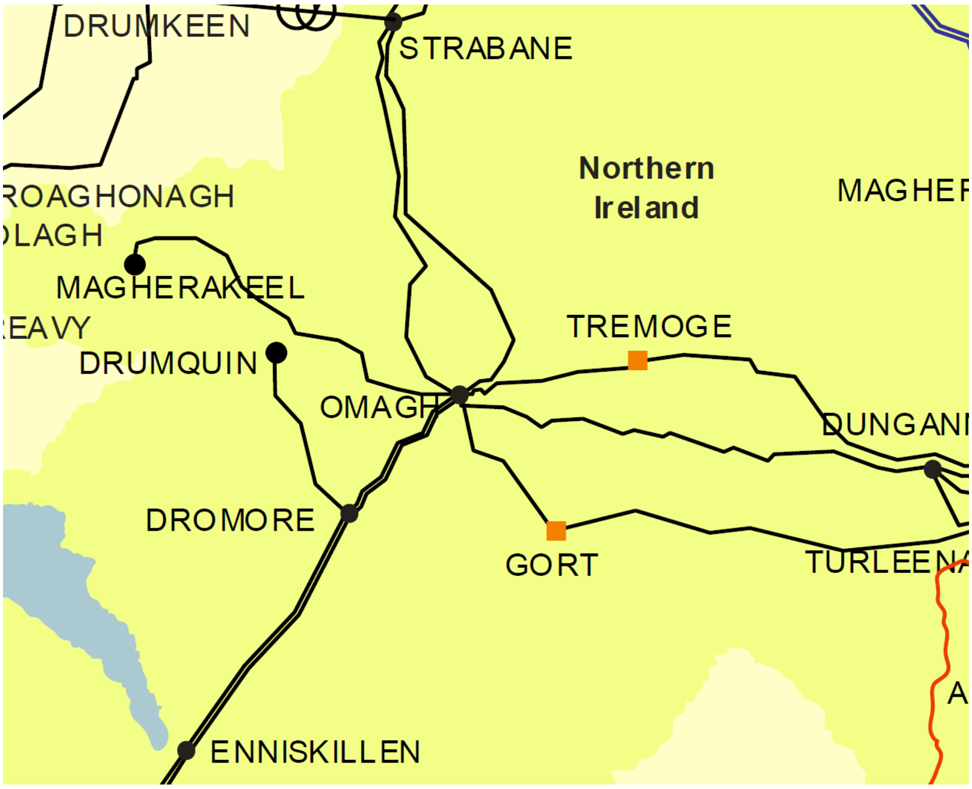

Figure C-63 - Location of node Magherakeel

Generator	SO	Capacity	Type	Status
Church Hill	DSO	18.4	wind priority	connected
Crighshane	DSO	32.2	wind priority	connected
Gronan Wind Farm	DSO	11.75	wind not priority	connected
Seegronan	DSO	14.1	wind priority	connected
Seegronan Extension Wind farm	DSO	7.05	wind not priority	connected
Thornog	DSO	20.0	wind priority	connected
Tievenameenta	DSO	34.5	wind priority	connected
Gronan	DSO	12.0	wind not priority	Proposed
Seegronan Extension	DSO	7.1	wind not priority	Proposed
Magherakeel Wind farm	DSO	7.05	wind not priority	connected

Table C-63 - Generation Included in Study for Node Magherakeel

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	26	45	
Installed Capacity (MW)	2030	26	45	45
Available Energy (GWh)	2025	67	117	
Available Energy (GWh)	2030	67	117	117
Generation (GWh)	2025	57	78	
Generation (GWh)	2030	64	104	80
Surplus (%)	2025	3 %	15 %	
Surplus (%)	2030	0 %	4 %	28 %
Curtailment (%)	2025	1 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	16 %	33 %	
Total Dispatch Down (%)	2030	5 %	11 %	32 %

Table C-64 - Surplus, Curtailment and Constraint for wind not priority NI - Node Magherakeel

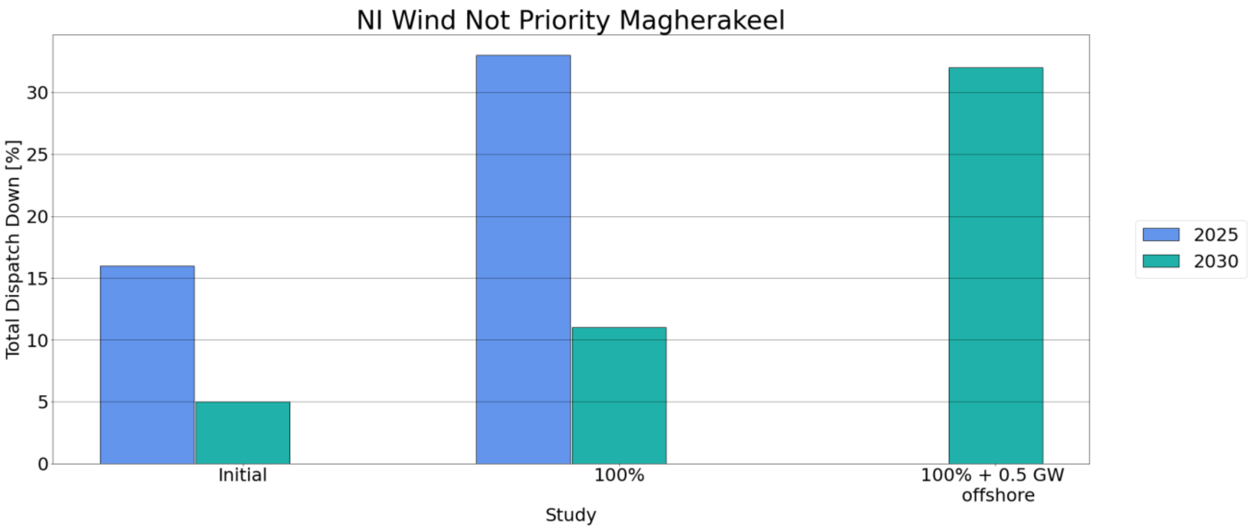

Figure C-64 - Total Dispatch Down for wind not priority - Node Magherakeel

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	119	119	
Installed Capacity (MW)	2030	119	119	119
Available Energy (GWh)	2025	311	311	
Available Energy (GWh)	2030	311	311	311
Generation (GWh)	2025	271	249	
Generation (GWh)	2030	295	286	292
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-65 - Surplus, Curtailment and Constraint for wind priority NI - Node Magherakeel

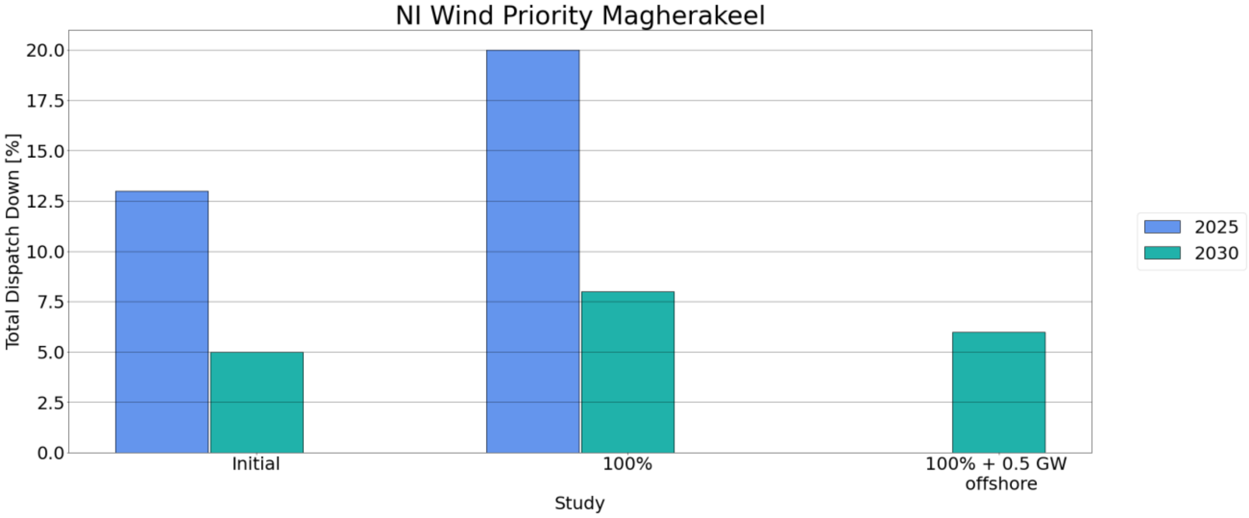

Figure C-65 - Total Dispatch Down for wind priority - Node Magherakeel

8.27 Newry

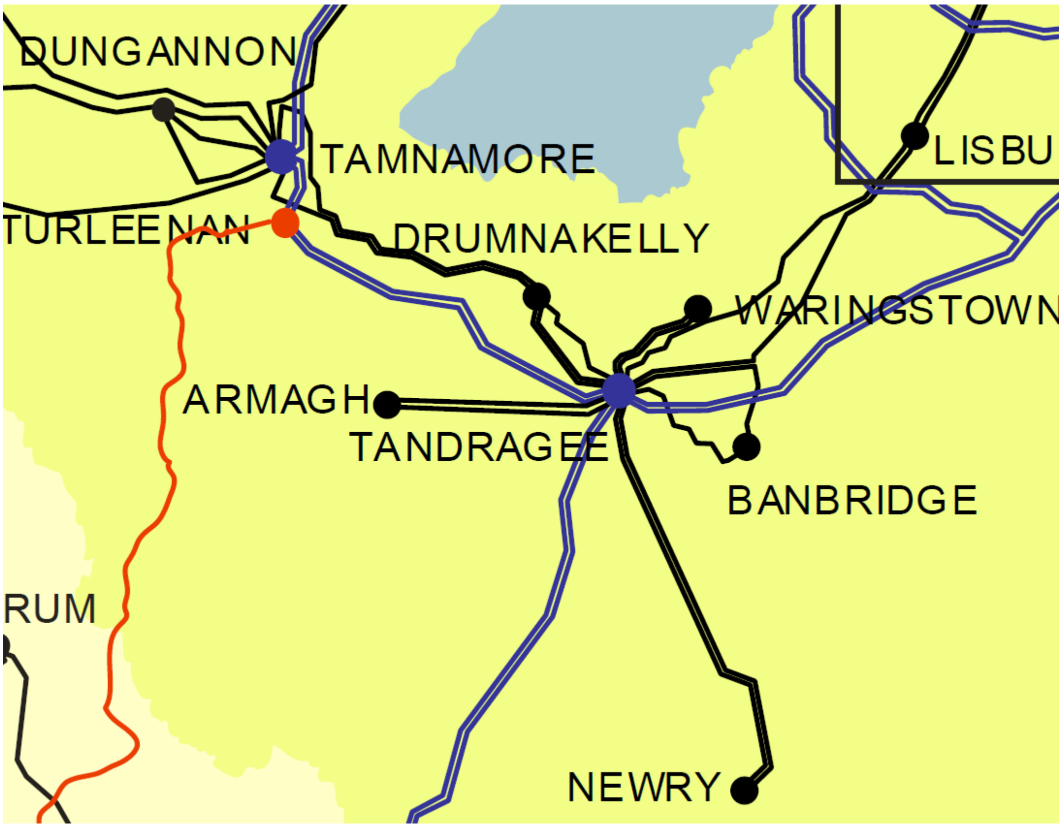

Figure C-66 - Location of node Newry

Generator	SO	Capacity	Type	Status
Gruggandoo	DSO	33.6	wind not priority	Proposed

Table C-66 - Generation Included in Study for Node Newry

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		34	
Installed Capacity (MW)	2030		34	34
Available Energy (GWh)	2025		88	
Available Energy (GWh)	2030		88	88
Generation (GWh)	2025		71	
Generation (GWh)	2030		82	61
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		2 %	
Constraint (%)	2030		1 %	0 %
Total Dispatch Down (%)	2025		19 %	
Total Dispatch Down (%)	2030		6 %	31 %

Table C-67 - Surplus, Curtailment and Constraint for wind not priority NI - Node Newry

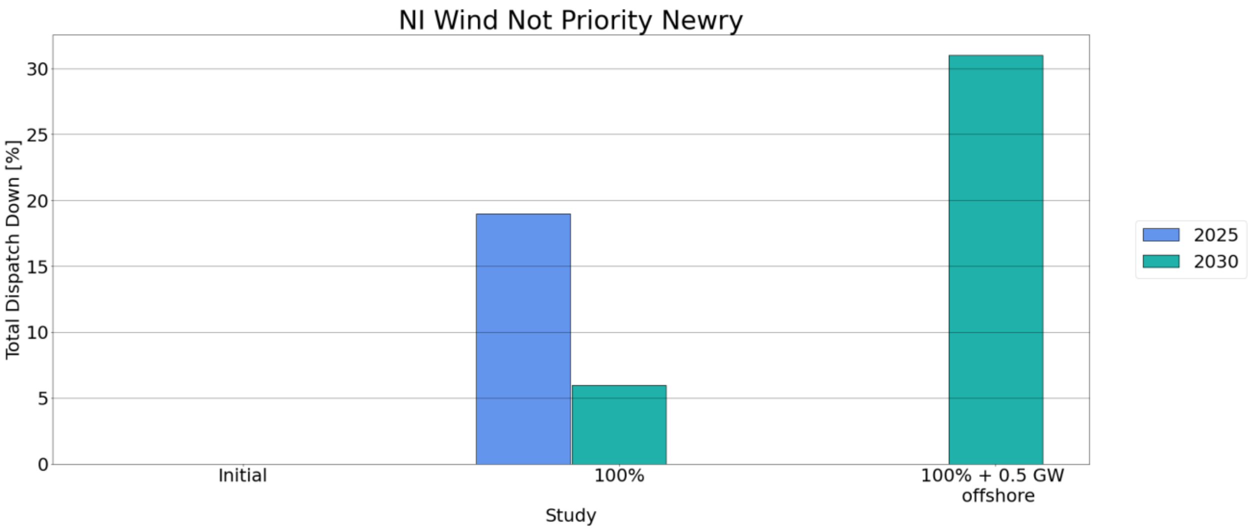

Figure C-67 - Total Dispatch Down for wind not priority - Node Newry

8.28 Newtownards

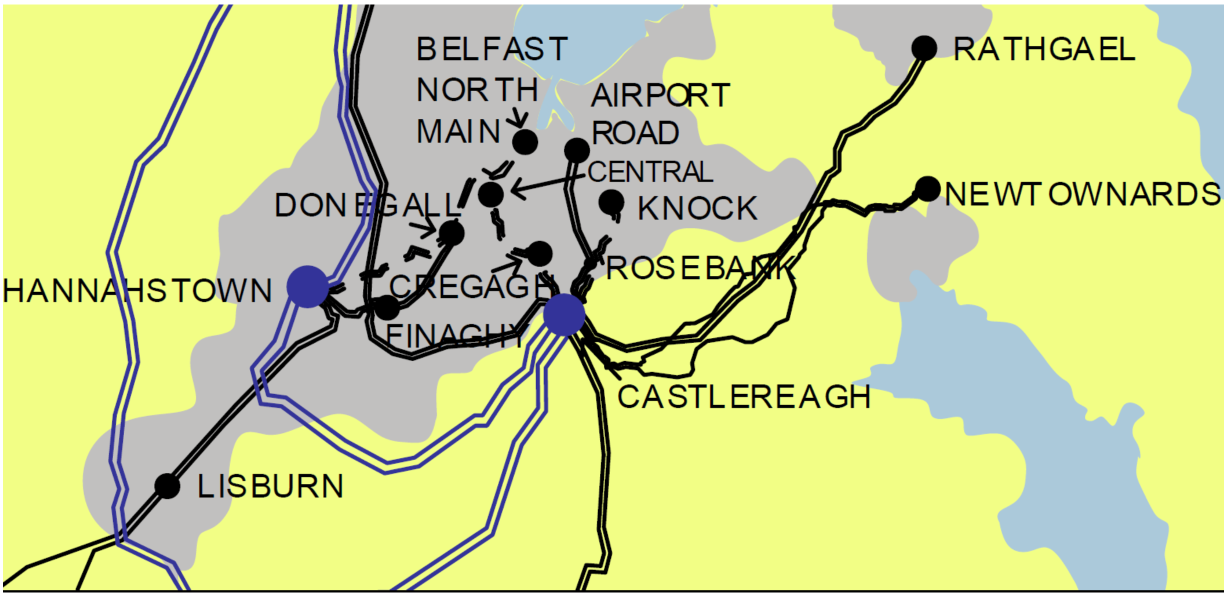

Figure C-68 - Location of node Newtownards

Generator	SO	Capacity	Type	Status
Assumed solar not priority	DSO	12.75	solar not priority	Proposed

Table C-68 - Generation Included in Study for Node Newtownards

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		13	
Installed Capacity (MW)	2030		13	13
Available Energy (GWh)	2025		13	
Available Energy (GWh)	2030		13	13
Generation (GWh)	2025		12	
Generation (GWh)	2030		13	11
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		0 %	
Constraint (%)	2030		2 %	0 %
Total Dispatch Down (%)	2025		8 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-69 - Surplus, Curtailment and Constraint for solar not priority NI - Node Newtownards

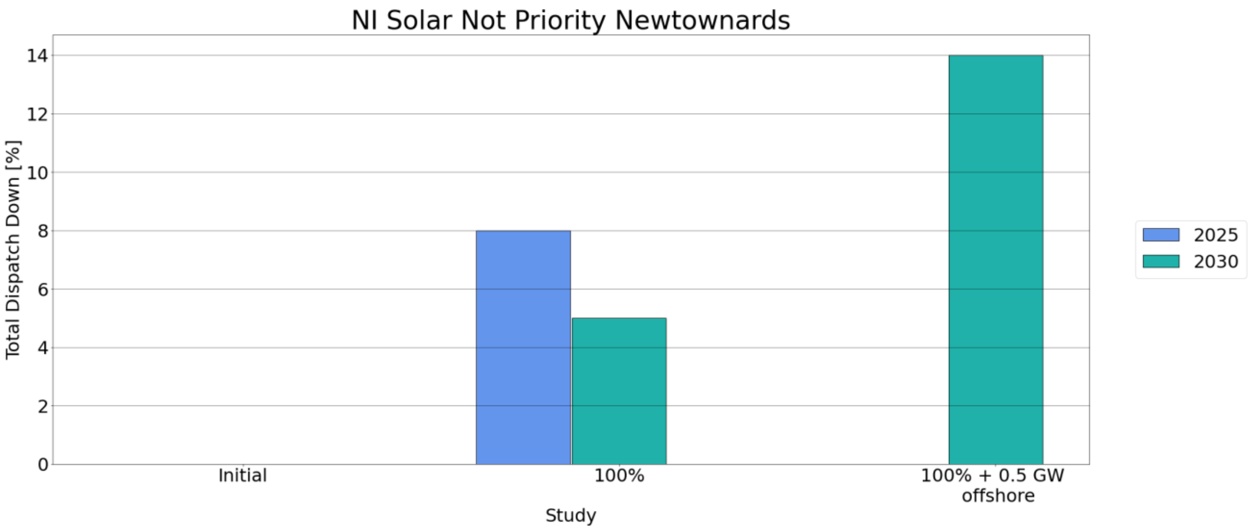

Figure C-69 - Total Dispatch Down for solar not priority - Node Newtownards

8.29 Omagh

Figure C-70 - Location of node Omagh

Generator	SO	Capacity	Type	Status
Bessy Bell - replant extra for SOEF 1.1	DSO	24.4	wind not priority	Proposed
Bessy Bell 2	DSO	9.0	wind priority	connected
Hunter's Hill	DSO	20.0	wind priority	connected
Lendrum's Bridge - replant extra for SOEF 1.1	DSO	25.7	wind not priority	Proposed
Screggagh	DSO	20.0	wind priority	connected
Slieve Divena	DSO	30.0	wind priority	connected
Tappaghan	DSO	28.5	wind priority	connected

Table C-70 - Generation Included in Study for Node Omagh

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025			
Installed Capacity (MW)	2030		50	50
Available Energy (GWh)	2025			
Available Energy (GWh)	2030		131	131
Generation (GWh)	2025			
Generation (GWh)	2030		116	89
Surplus (%)	2025			
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025			
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025			
Constraint (%)	2030		6 %	1 %
Total Dispatch Down (%)	2025			
Total Dispatch Down (%)	2030		11 %	32 %

Table C-71 - Surplus, Curtailment and Constraint for wind not priority NI - Node Omagh

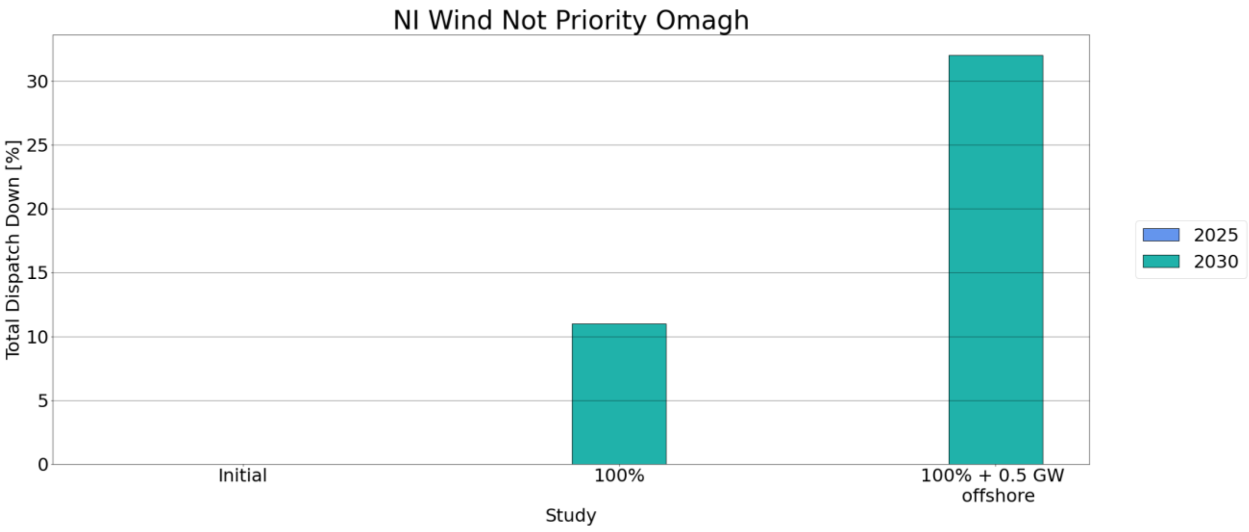

Figure C-71 - Total Dispatch Down for wind not priority - Node Omagh

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	108	108	
Installed Capacity (MW)	2030	108	108	108
Available Energy (GWh)	2025	280	280	
Available Energy (GWh)	2030	280	280	280
Generation (GWh)	2025	245	225	
Generation (GWh)	2030	266	258	263
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-72 - Surplus, Curtailment and Constraint for wind priority NI - Node Omagh

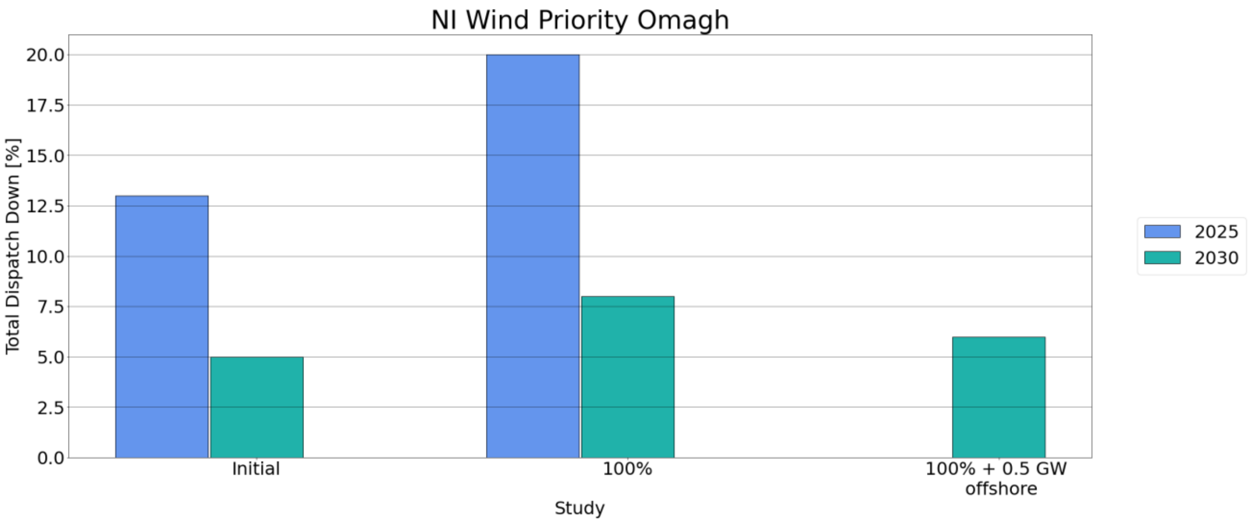

Figure C-72 - Total Dispatch Down for wind priority - Node Omagh

8.30 Rasharkin

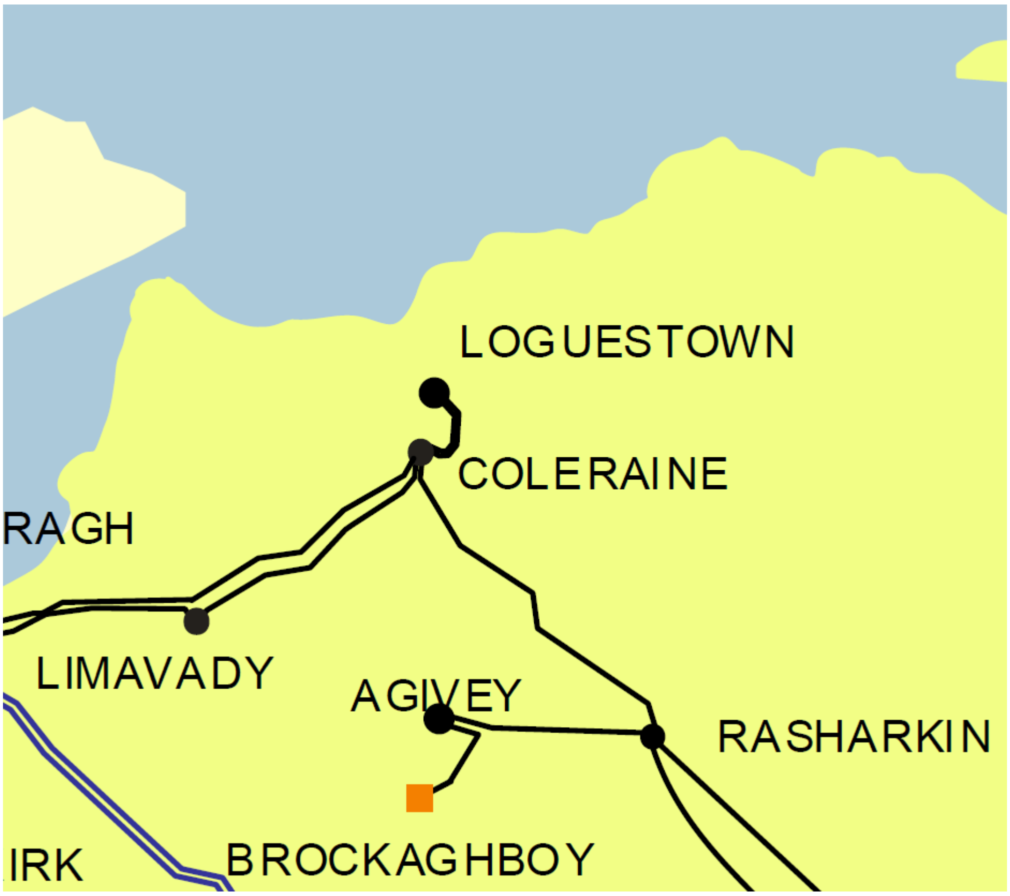

Figure C-73 - Location of node Rasharkin

Generator	SO	Capacity	Type	Status
Altaveedan	DSO	18.0	wind priority	connected
Bann Road PV	DSO	29.81	solar priority	connected
Corkey - replant extra for SOEF 1.1	DSO	24.4	wind not priority	Proposed
Finvoy Road	DSO	5.209	solar priority	connected
Glenbuck	DSO	9.2	wind priority	connected
Long Mountain	DSO	27.6	wind priority	connected
Rasharkin - SOEF 1.1 assumption for NI	TSO	40.0	wind not priority	Proposed
Assumed solar not priority	DSO	26.2	solar not priority	Proposed

Table C-73 - Generation Included in Study for Node Rasharkin

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		26	
Installed Capacity (MW)	2030		26	26
Available Energy (GWh)	2025		27	
Available Energy (GWh)	2030		27	27
Generation (GWh)	2025		24	
Generation (GWh)	2030		26	23
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		5 %	
Constraint (%)	2030		2 %	1 %
Total Dispatch Down (%)	2025		13 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-74 - Surplus, Curtailment and Constraint for solar not priority NI - Node Rasharkin

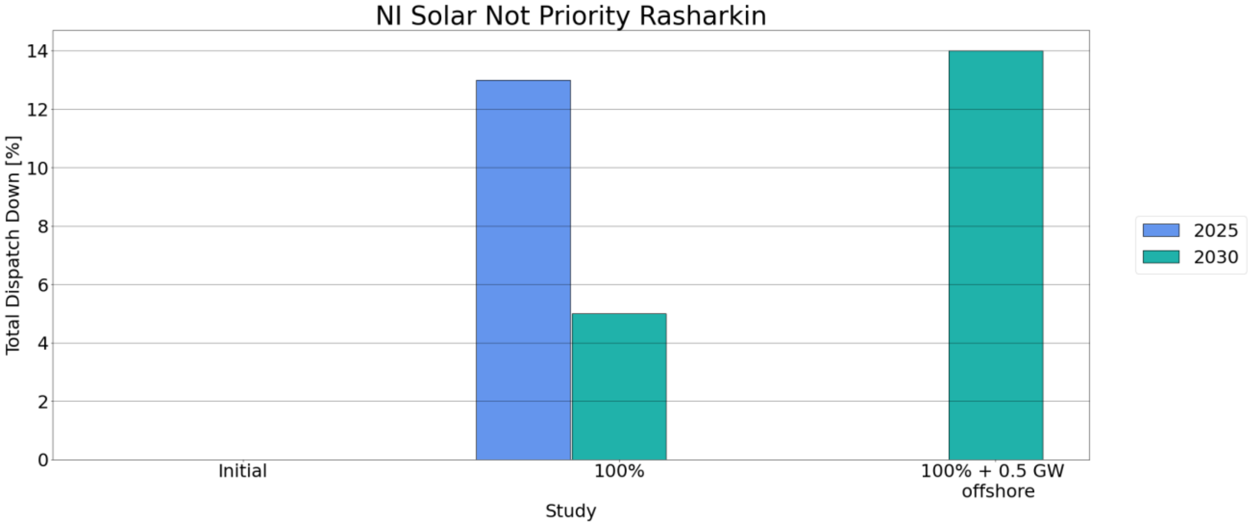

Figure C-74 - Total Dispatch Down for solar not priority - Node Rasharkin

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025			
Installed Capacity (MW)	2030		64	64
Available Energy (GWh)	2025			
Available Energy (GWh)	2030		168	168
Generation (GWh)	2025			
Generation (GWh)	2030		144	113
Surplus (%)	2025			
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025			
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025			
Constraint (%)	2030		9 %	2 %
Total Dispatch Down (%)	2025			
Total Dispatch Down (%)	2030		14 %	33 %

Table C-75 - Surplus, Curtailment and Constraint for wind not priority NI - Node Rasharkin

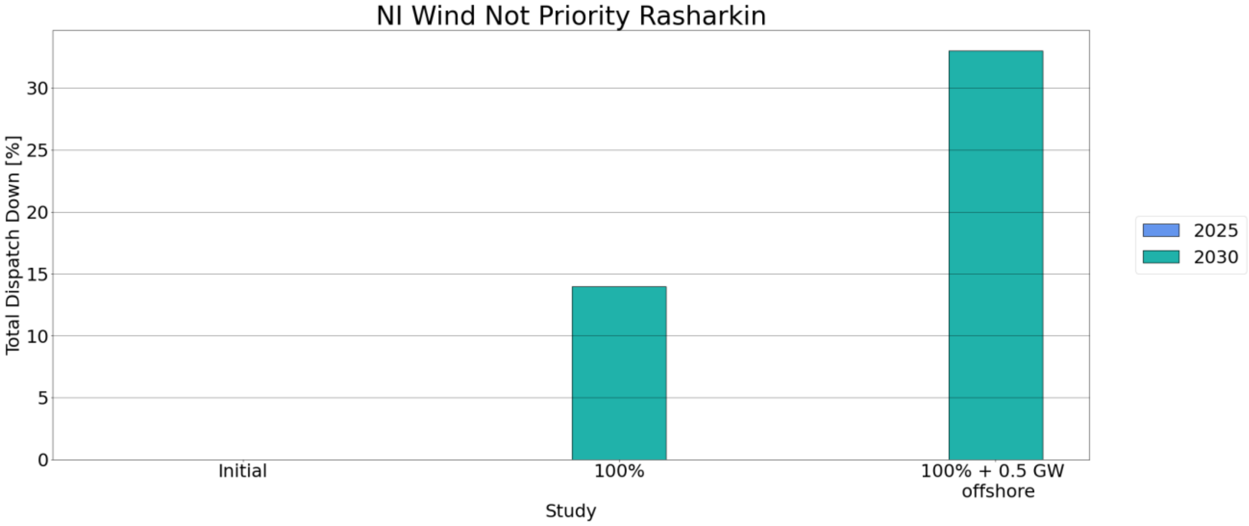

Figure C-75 - Total Dispatch Down for wind not priority - Node Rasharkin

The solar priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	35	35	
Installed Capacity (MW)	2030	35	35	35
Available Energy (GWh)	2025	36	36	
Available Energy (GWh)	2030	36	36	36
Generation (GWh)	2025	35	34	
Generation (GWh)	2030	35	35	35
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	5 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	7 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-76 - Surplus, Curtailment and Constraint for solar priority NI - Node Rasharkin

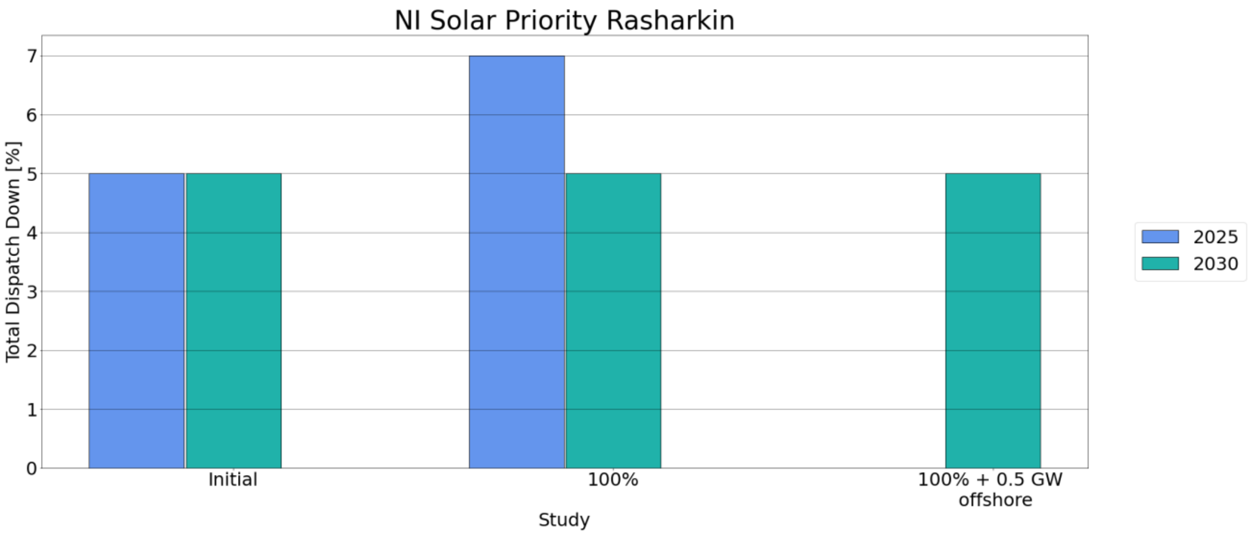

Figure C-76 - Total Dispatch Down for solar priority - Node Rasharkin

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	55	55	
Installed Capacity (MW)	2030	55	55	55
Available Energy (GWh)	2025	143	143	
Available Energy (GWh)	2030	143	143	143
Generation (GWh)	2025	128	124	
Generation (GWh)	2030	136	127	133
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	9 %	9 %	
Constraint (%)	2030	5 %	9 %	2 %
Total Dispatch Down (%)	2025	11 %	13 %	
Total Dispatch Down (%)	2030	5 %	11 %	7 %

Table C-77 - Surplus, Curtailment and Constraint for wind priority NI - Node Rasharkin

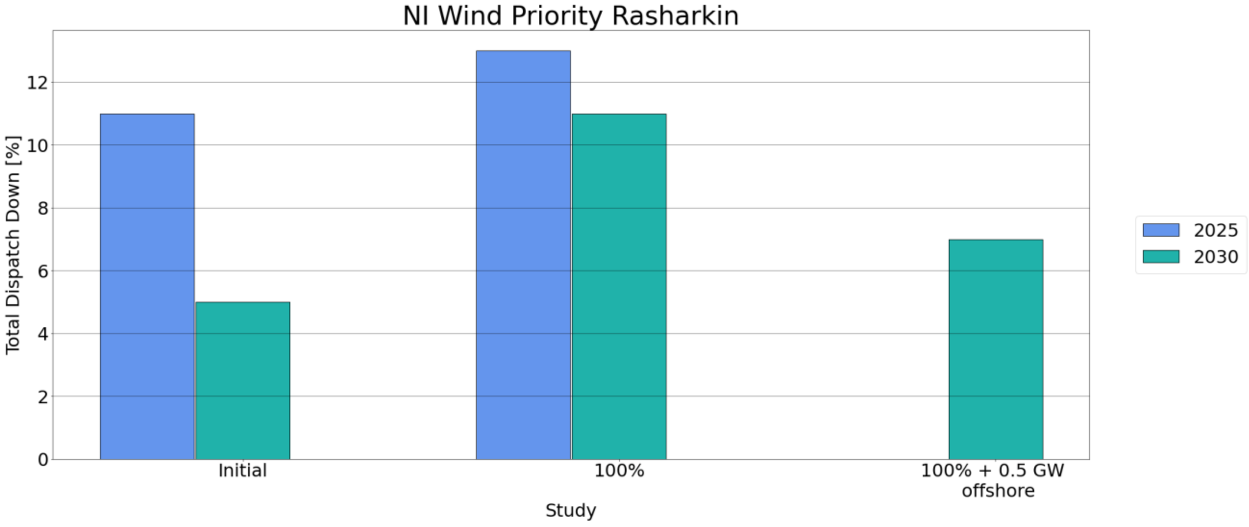

Figure C-77 - Total Dispatch Down for wind priority - Node Rasharkin

8.31 Rathgael

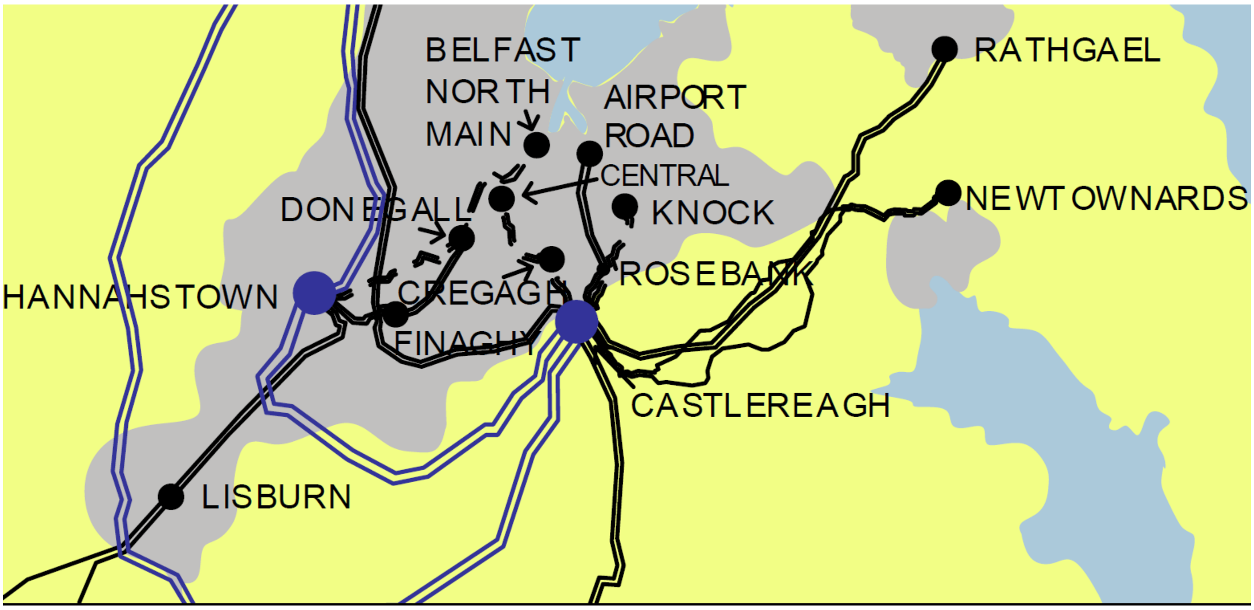

Figure C-78 - Location of node Rathgael

Generator	SO	Capacity	Type	Status
Assumed solar not priority	DSO	12.75	solar not priority	Proposed

Table C-78 - Generation Included in Study for Node Rathgael

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		13	
Installed Capacity (MW)	2030		13	13
Available Energy (GWh)	2025		13	
Available Energy (GWh)	2030		13	13
Generation (GWh)	2025		12	
Generation (GWh)	2030		13	11
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		0 %	
Constraint (%)	2030		2 %	0 %
Total Dispatch Down (%)	2025		8 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-79 - Surplus, Curtailment and Constraint for solar not priority NI - Node Rathgael

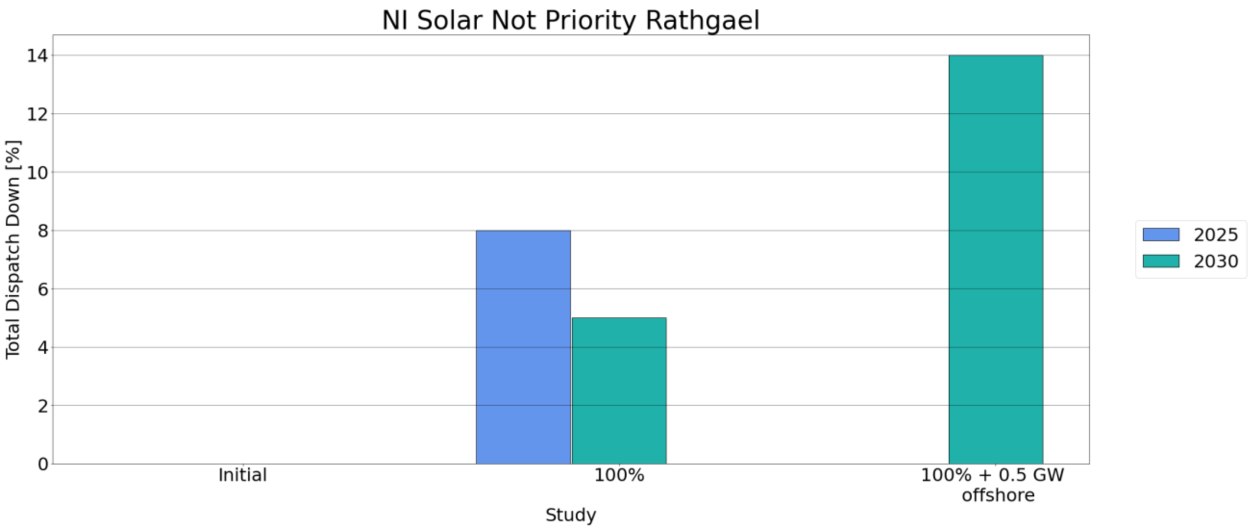

Figure C-79 - Total Dispatch Down for solar not priority - Node Rathgael

8.32 Strabane

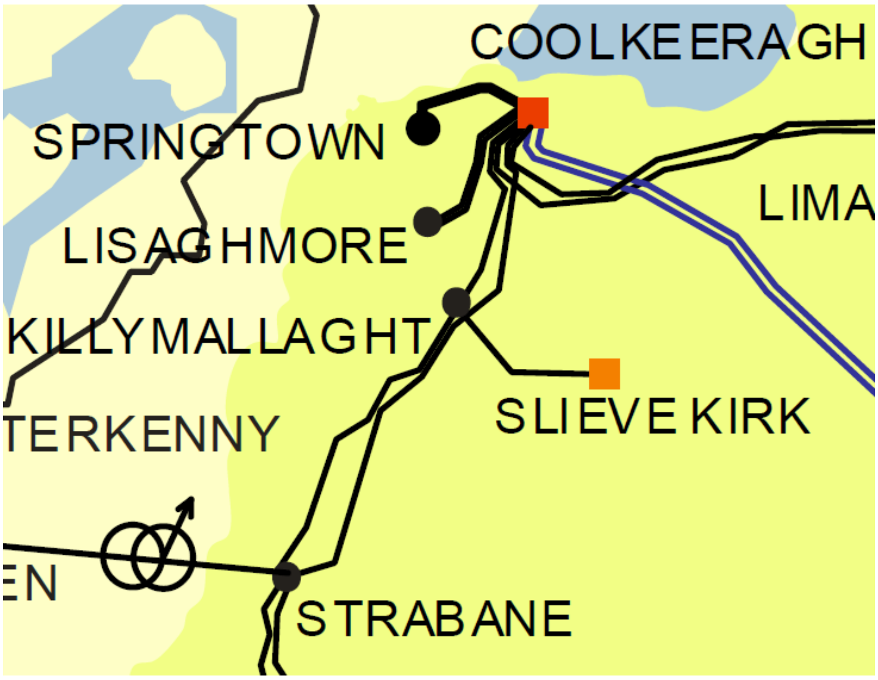

Figure C-80 - Location of node Strabane

Generator	SO	Capacity	Type	Status
Bin Mountain	DSO	9.0	wind priority	connected
Lough Hill	DSO	7.8	wind priority	connected
Owenreagh - replant extra for SOEF 1.1	DSO	23.9	wind not priority	Proposed
Owenreagh 2	DSO	5.1	wind priority	connected
Craignagapple	TSO	37.6	wind not priority	Proposed

Table C-80 - Generation Included in Study for Node Strabane

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		38	
Installed Capacity (MW)	2030		62	62
Available Energy (GWh)	2025		98	
Available Energy (GWh)	2030		160	160
Generation (GWh)	2025		66	
Generation (GWh)	2030		142	109
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		16 %	
Constraint (%)	2030		6 %	1 %
Total Dispatch Down (%)	2025		33 %	
Total Dispatch Down (%)	2030		11 %	32 %

Table C-81 - Surplus, Curtailment and Constraint for wind not priority NI - Node Strabane

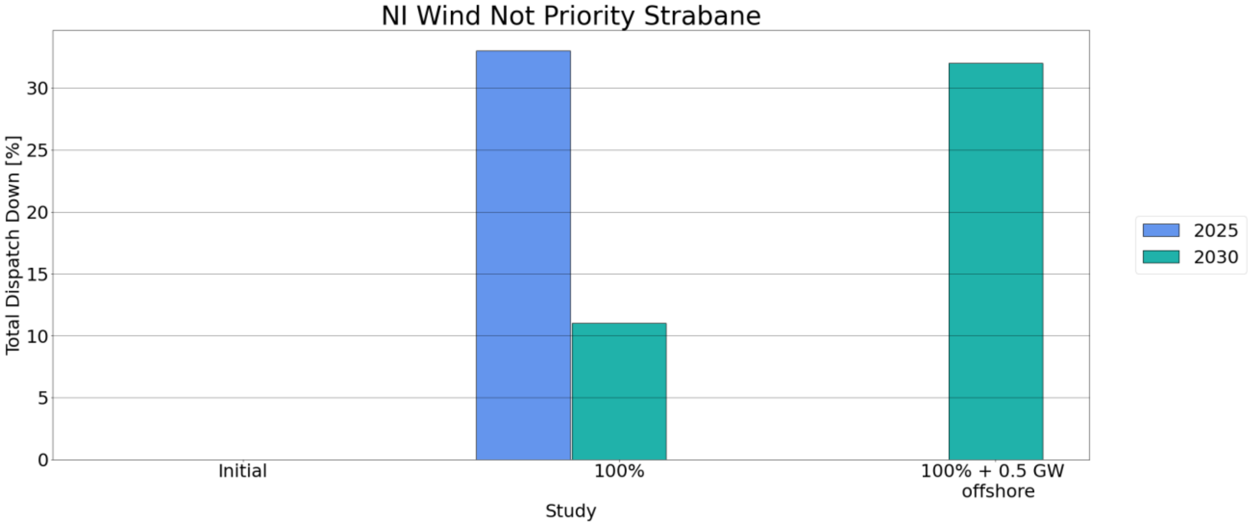

Figure C-81 - Total Dispatch Down for wind not priority - Node Strabane

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	22	22	
Installed Capacity (MW)	2030	22	22	22
Available Energy (GWh)	2025	57	57	
Available Energy (GWh)	2030	57	57	57
Generation (GWh)	2025	50	46	
Generation (GWh)	2030	54	53	54
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-82 - Surplus, Curtailment and Constraint for wind priority NI - Node Strabane

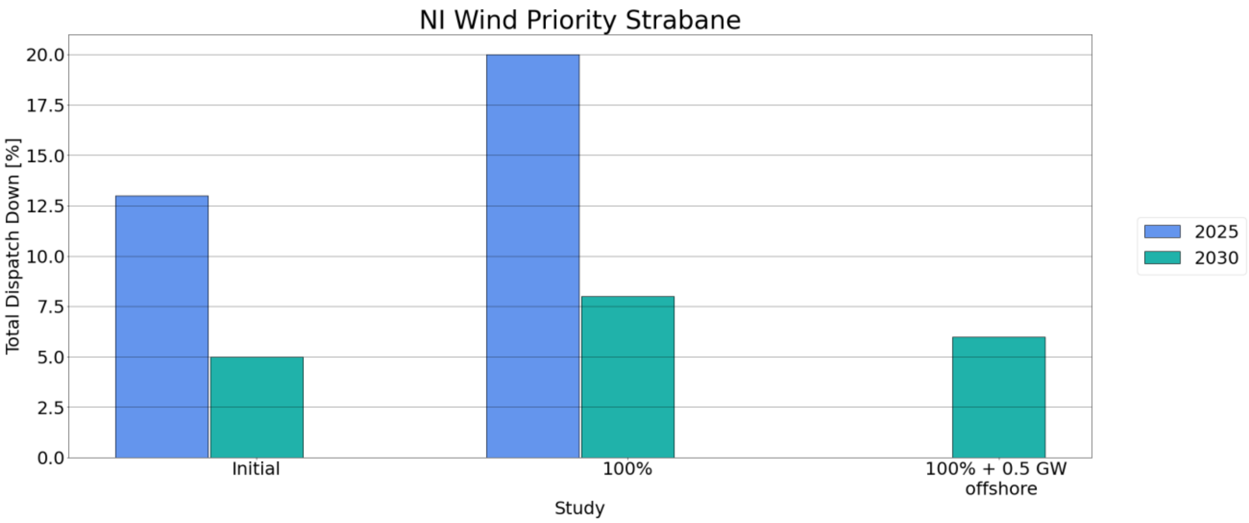

Figure C-82 - Total Dispatch Down for wind priority - Node Strabane

8.33 Tremoge

Figure C-83 - Location of node Tremoge

Generator	SO	Capacity	Type	Status
Cregganconroe	DSO	13.8	wind priority	connected
Crockandun	DSO	15.0	wind priority	connected
Crockdun	DSO	12.5	wind priority	connected
Eshmore	DSO	7.05	wind priority	connected
Gortfinbar	DSO	15.0	wind priority	connected
Inishative	DSO	13.8	wind priority	connected
Tremoge - SOEF 1.1 assumption for NI	TSO	40.0	wind not priority	Proposed
Cullion	DSO	16.8	wind not priority	Proposed

Table C-83 - Generation Included in Study for Node Tremoge

The wind not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		17	
Installed Capacity (MW)	2030		57	57
Available Energy (GWh)	2025		44	
Available Energy (GWh)	2030		148	148
Generation (GWh)	2025		29	
Generation (GWh)	2030		131	101
Surplus (%)	2025		15 %	
Surplus (%)	2030		4 %	28 %
Curtailment (%)	2025		2 %	
Curtailment (%)	2030		1 %	3 %
Constraint (%)	2025		16 %	
Constraint (%)	2030		6 %	1 %
Total Dispatch Down (%)	2025		33 %	
Total Dispatch Down (%)	2030		11 %	32 %

Table C-84 - Surplus, Curtailment and Constraint for wind not priority NI - Node Tremoge

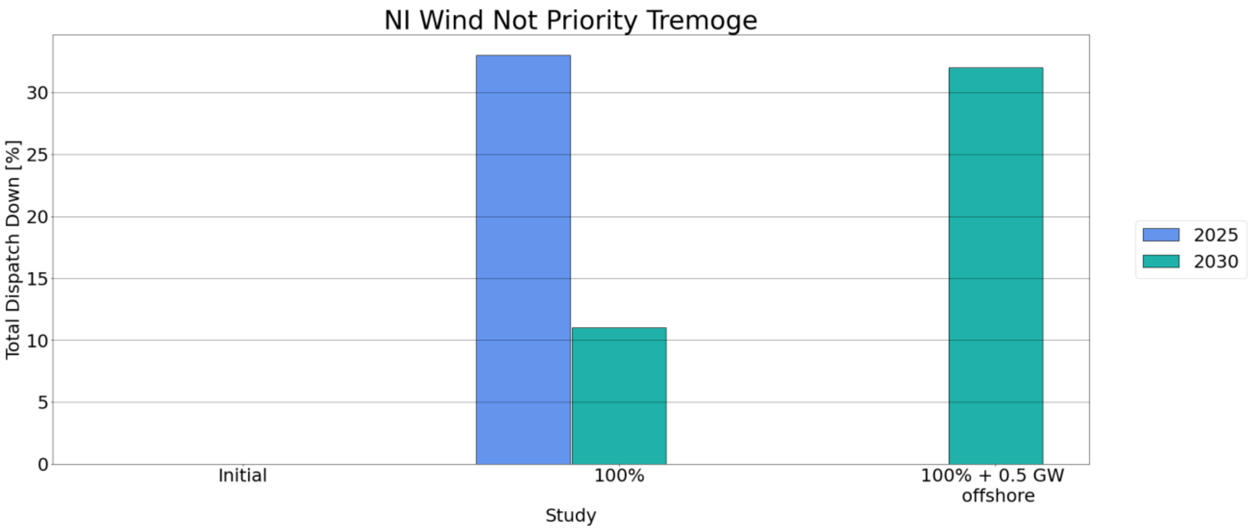

Figure C-84 - Total Dispatch Down for wind not priority - Node Tremoge

The wind priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	77	77	
Installed Capacity (MW)	2030	77	77	77
Available Energy (GWh)	2025	201	201	
Available Energy (GWh)	2030	201	201	201
Generation (GWh)	2025	175	161	
Generation (GWh)	2030	191	185	189
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	1 %	4 %	
Curtailment (%)	2030	0 %	2 %	5 %
Constraint (%)	2025	11 %	16 %	
Constraint (%)	2030	5 %	6 %	1 %
Total Dispatch Down (%)	2025	13 %	20 %	
Total Dispatch Down (%)	2030	5 %	8 %	6 %

Table C-85 - Surplus, Curtailment and Constraint for wind priority NI - Node Tremoge

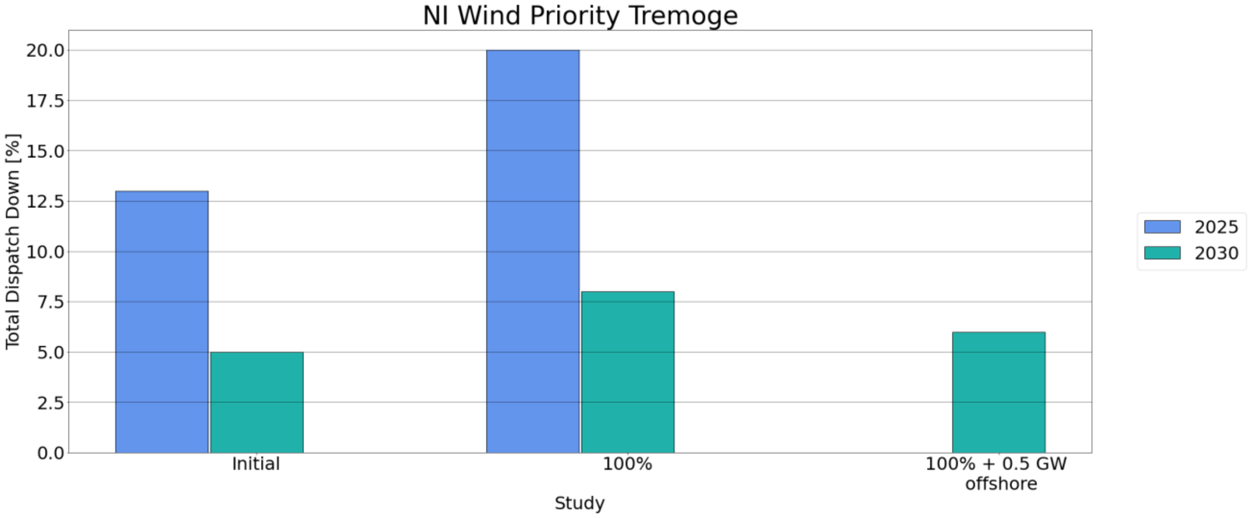

Figure C-85 - Total Dispatch Down for wind priority - Node Tremoge

8.34 Waringstown

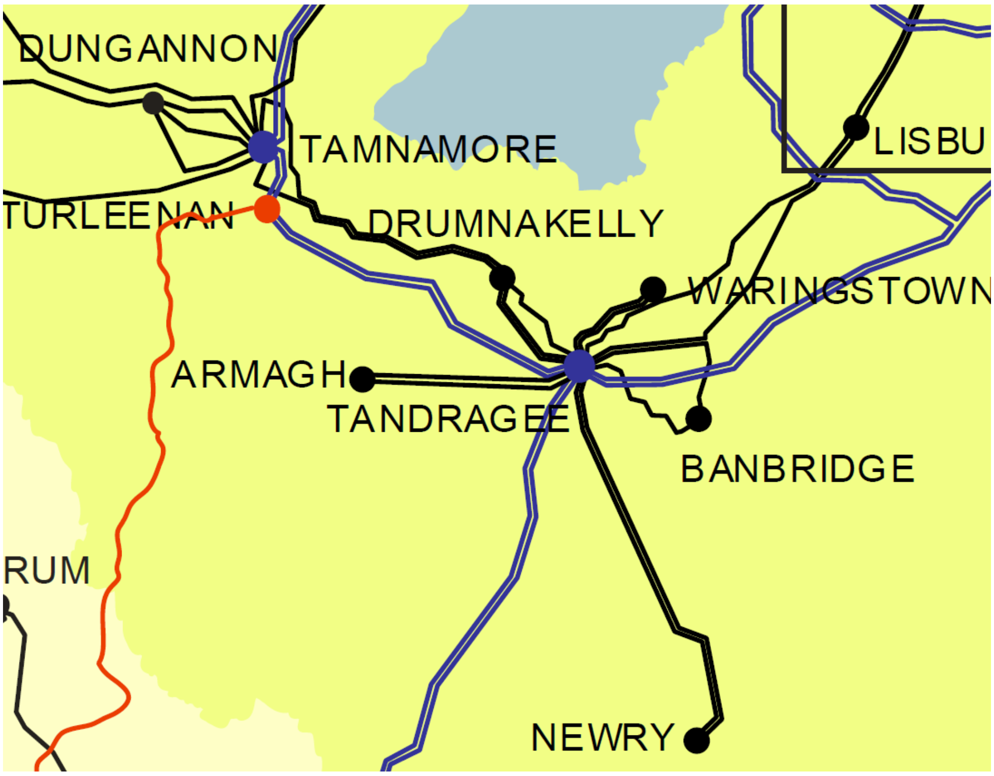

Figure C-86 - Location of node Waringstown

Generator	SO	Capacity	Type	Status
Laurel Hill Road + Overinstall	DSO	8.5	solar priority	connected
Assumed solar not priority	DSO	18.34	solar not priority	Proposed

Table C-86 - Generation Included in Study for Node Waringstown

The solar not priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025		18	
Installed Capacity (MW)	2030		18	18
Available Energy (GWh)	2025		19	
Available Energy (GWh)	2030		19	19
Generation (GWh)	2025		18	
Generation (GWh)	2030		18	16
Surplus (%)	2025		6 %	
Surplus (%)	2030		3 %	11 %
Curtailment (%)	2025		1 %	
Curtailment (%)	2030		1 %	2 %
Constraint (%)	2025		0 %	
Constraint (%)	2030		2 %	0 %
Total Dispatch Down (%)	2025		8 %	
Total Dispatch Down (%)	2030		5 %	14 %

Table C-87 - Surplus, Curtailment and Constraint for solar not priority NI - Node Waringstown

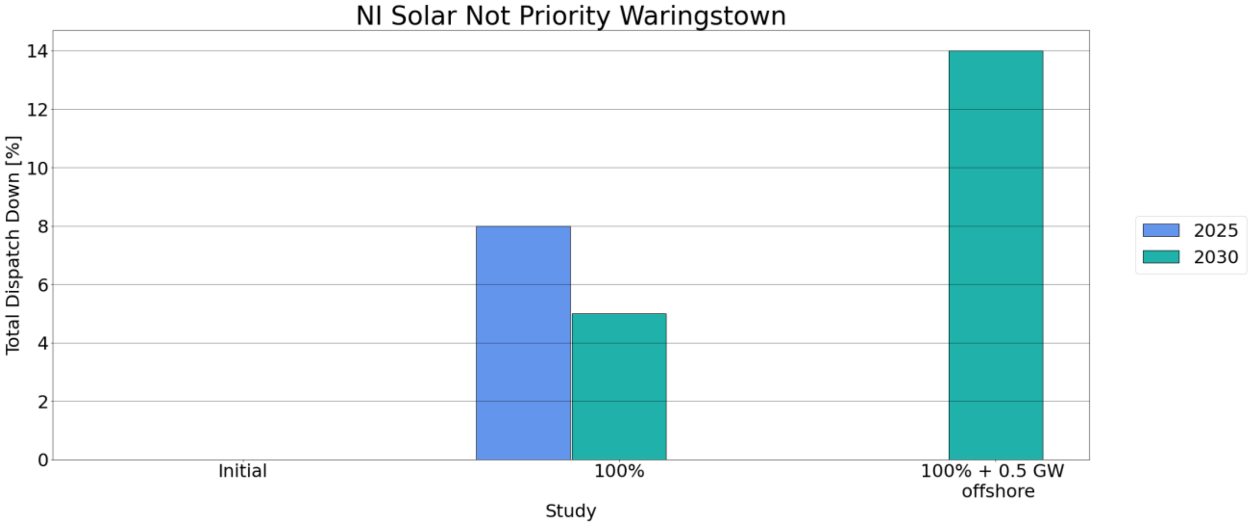

Figure C-87 - Total Dispatch Down for solar not priority - Node Waringstown

The solar priority data is given in the following table.

NI	Year	Initial	100%	100% + 0.5 GW offshore
Installed Capacity (MW)	2025	8	8	
Installed Capacity (MW)	2030	8	8	8
Available Energy (GWh)	2025	9	9	
Available Energy (GWh)	2030	9	9	9
Generation (GWh)	2025	8	8	
Generation (GWh)	2030	8	8	8
Surplus (%)	2025	0 %	0 %	
Surplus (%)	2030	0 %	0 %	0 %
Curtailment (%)	2025	0 %	2 %	
Curtailment (%)	2030	0 %	1 %	3 %
Constraint (%)	2025	5 %	3 %	
Constraint (%)	2030	5 %	4 %	2 %
Total Dispatch Down (%)	2025	5 %	5 %	
Total Dispatch Down (%)	2030	5 %	5 %	5 %

Table C-88 - Surplus, Curtailment and Constraint for solar priority NI - Node Waringstown

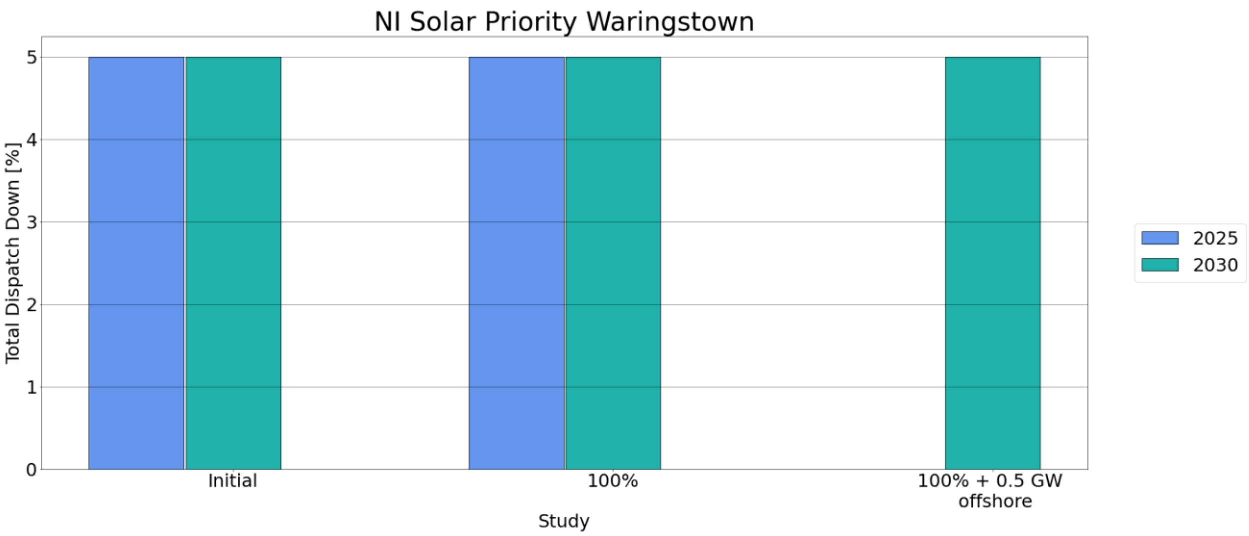

Figure C-88 - Total Dispatch Down for solar priority - Node Waringstown

8.35 Small scale

8.35.1 Small scale wind

Node	Name	SO	Connected	Assumed
Aghyoule	Aghyoule Main Total Wind	DSO	2.5	
	Snugborough	DSO	13.5	
Antrim	Antrim Main Total Wind	DSO	7.2	
Ballymena	Ballymena Main Total Wind	DSO	11.4	
	Corkey	DSO	5.0	
	Michelin	DSO	4.6	
Ballymena	Brackagh Quarry	DSO	5.0	
Ballynahinch	Ballynahinch Main Total Wind	DSO	9.8	
Banbridge	Banbridge Main Total Wind	DSO	7.7	
Coleraine	Coleraine Main Total Wind	DSO	9.6	
	Rigged Hill	DSO	5.0	
Creagh	Creagh Main Total Wind	DSO	7.9	
Drumnakelly	Drumnakelly Main Total Wind	DSO	8.1	
Dungannon	Dungannon Main Total Wind	DSO	9.5	
Eden	Eden Main Total Wind	DSO	3.7	
	Lisglass	DSO	2.3	
Enniskillen	Enniskillen Main Total Wind	DSO	11.2	
Larne	Elliot's Hill	DSO	5.0	
	Larne Main Total Wind	DSO	9.7	
Limavady	Altahullion	DSO	26.0	
	Limavady Main Total Wind	DSO	3.3	
Lisaghmore	Lisaghmore Main Total Wind	DSO	3.7	
Lisburn	Lisburn Main Total Wind	DSO	4.4	
Loguestown	Loguestown Main Total Wind	DSO	6.1	
Magherafelt	Straw Mountain Wind Farm	DSO		2.6
Newry	Newry Main Total Wind	DSO	3.4	
Newtownards	Newtownards Main Total Wind	DSO	5.5	
Omagh	Bessy Bell	DSO	4.3	
	Lendrum's Bridge	DSO	13.2	
	Omagh Main Total Wind	DSO	14.4	
Rathgael	Rathgael Main Total Wind	DSO	1.3	
Rosebank	Rosebank Main Total Wind	DSO	2.7	
Strabane	Owenreagh	DSO	5.5	
	Strabane Main Total Wind	DSO	12.4	

Table C-89 – Connected and assumed uncontrollable small scale wind generation assumed as per SOEF 1.0

8.35.2 Small scale solar

Node	Name	SO	Connected	Assumed
Aghyoule	Aghyoule Main Total PV	DSO	0.1	0.0
Antrim	Antrim Main Total PV	DSO	11.0	6.7
Ballymena	Ballymena Main Total PV	DSO	6.0	3.5
Ballynahinch	Ballynahinch Main Total PV	DSO	6.2	3.8
Banbridge	Banbridge Main Total PV	DSO	3.8	2.3
Belfast	Belfast Central Main Total PV	DSO		0.2
	Belfast North Main Main Total PV	DSO		0.7
Belfast Central	Belfast Central Main Total PV	DSO	0.4	
Belfast North Main	Belfast North Main Main Total PV	DSO	1.2	
Carnmoney	Carnmoney Main Total PV	DSO	1.1	0.7
Coleraine	Coleraine Main Total PV	DSO	3.7	2.3
Coolkeeragh	Coolkeeragh Main Total PV	DSO	1.0	0.6
Creagh	Creagh Main Total PV	DSO	2.6	1.6
Cregagh	Cregagh Main Total PV	DSO	1.3	0.8
Donegall	Donegall North Main Total PV	DSO		0.6
	Donegall South Main Total PV	DSO		0.9
Donegall North	Donegall North Main Total PV	DSO	1.0	
Donegall South	Donegall South Main Total PV	DSO	1.5	
Drumnakelly	Drumnakelly Main Total PV	DSO	8.6	4.1
Dungannon	Dungannon Main Total PV	DSO	11.0	6.7
Eden	Eden Main Total PV	DSO	2.4	1.5
Enniskillen	Enniskillen Main Total PV	DSO	5.5	3.4
Finaghy	Finaghy Main Total PV	DSO	1.0	0.6
Glengormley	Glengormley Main Total PV	DSO	0.6	0.4
Knock	Knock Main Total PV	DSO	1.3	0.8
Larne	Larne Main Total PV	DSO	3.8	2.3
Limavady	Limavady Main Total PV	DSO	2.5	1.5
Lisaghmore	Lisaghmore Main Total PV	DSO	1.7	1.1
Lisburn	Lisburn Main Total PV	DSO	5.0	3.0
Loguestown	Loguestown Main Total PV	DSO	2.6	1.6
Newry	Newry Main Total PV	DSO	5.0	3.1
Newtownards	Newtownards Main Total PV	DSO	8.4	5.2
Omagh	Omagh Main Total PV	DSO	5.2	3.2
Rathgael	Rathgael Main Total PV	DSO	3.5	2.1
Rosebank	Rosebank Main Total PV	DSO	10.3	6.3
Springtown	Springtown Main Total PV	DSO	1.7	1.0
Strabane	Strabane Main Total PV	DSO	4.4	2.7
Waringstown	Waringstown Main Total PV	DSO	2.9	1.8

Table C-90 Connected and assumed uncontrollable small scale solar generation assumed as per SOEF 1.0

9 Appendix D Contingencies and Lines Overloading

For different study scenarios, there were several transmissions boundaries that limit the power flow. Some of the main overload and contingency pairs binding for more than 150 hours for the two study years (2025 100% and 2030 100%) can be seen below. The Plexos model tests contingency for loss of lines in each hour of the year. The model then determines which lines become overloaded and binding hours as results of contingencies. The results below show binding lines for each the contingency and their respective area. Plexos will constrain generation nearby these binding lines. The area analysis reapportions by area.

9.1 D.1 Year 2025

Area of line	Line	Contingency	Hours Range
NI Area - I	Line (Coolkeeragh Limavady_110_1 NI)	Loss of Kells Rasharkin 110 NI	500-750
NI Area - I	Line (Coolkeeragh Strabane_110_1 NI)	Loss of Coolkeeragh Killymallaght 110 NI	250-500
NI Area - I	Line (Coleraine Rasharkin_110_1)	Loss of Kells Rasharkin 110 NI	250-500
NI Area - I	Line (Coolkeeragh Limavady_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	250-500
NI Area - I	Line (Coolkeeragh Limavady_110_1 NI)	Loss of Coleraine Rasharkin 110 NI	<250
NI Area - I	Line (Coolkeeragh Strabane_110_1 NI)	Loss of Tamnamore (or Dungannon) to Tremoge 110 NI	<250
NI Area - I	Line (Coolkeeragh Killymallaght 110 ckt 1 NI)	Loss of Dungannon Omagh 110 NI	<250
NI Area - I	Line (Coolkeeragh_110_75520_CPS_275_1)	loss of coolkeeragh 275 110 ckt 2	<250
NI Area - I	Line (Coolkeeragh_110_75520_CPS_275_2)	loss of coolkeeragh 275 110 ckt 1	<250
NI Area - II	Line (Omagh Strabane_110_2 NI)	Loss of Cool Magh 275 DC - wi SPS	500-750
NI Area - II	Line (Killymallaght Strabane 110 ckt 1 NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - II	Line (Omagh Strabane_110_2 NI)	Loss of Tamnamore (or Dungannon) to Tremoge 110 NI	<250
NI Area - II	Line (Omagh Strabane_110_2 NI)	Loss of Omagh Strabane 110 ckt 1 NI	<250
NI Area - II	Line (Omagh Strabane_110_2 NI)	Loss of Dungannon Omagh 110 NI	<250
NI Area - IV	Line (Drumnakelly Tamnamore_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	1500-1750
NI Area - IV	Line (Kells Rasharkin 110 ckt 1 NI)	Loss of Cool Magh 275 DC - wi SPS	1000-1250
NI Area - IV	Line (Kells Rasharkin 110 ckt 1 NI)	Loss of Coleraine Rasharkin 110 NI	250-500
NI Area - IV	Line (Tamnamore Tremoge_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - IV	Line (Drumnakelly Tamnamore_110_1 NI)	Loss of Coolkeeragh Killymallaght 110 NI	<250
NI Area - IV	Line (Hannahstown Lisburn_110_1 NI)	Loss of CAST TAND 275kV SC	<250
NI Area - IV	Line (Kells_110_81520_KEL_275_2)	loss of Ballylumford 275 110 ckt 1	<250
NI Area - IV	Line (Tamnamore Tremoge_110_1 NI)	Loss of Gort Tamnamore 110 NI	<250

Table D-1 Binding contingency and overloading lines in 2025 NI 100% study

9.2 D.2. Year 2030

Area of line	Line	Contingency	Hours Range
NI Area - I	Line (Limavady Cam 110 new NI)	Loss of Cool Magh 275 DC - wi SPS	500-750
NI Area - I	Line (Coolkeeragh_110_75520_CPS_275_1)	loss of coolkeeragh 275 110 ckt 2	500-750
NI Area - I	Line (Limavady Cam 110 new NI)	Loss of Kells Rasharkin 110 NI	250-500
NI Area - I	Line (Coolkeeragh_110_75520_CPS_275_2)	loss of coolkeeragh 275 110 ckt 1	250-500
NI Area - I	Line (Coolkeeragh Strabane_110_1 NI)	Loss of Coolkeeragh Killymallaght 110 NI	250-500
NI Area - I	Line (Agivey Rasharkin 110 NI)	Base	<250
NI Area - I	Line (Cam Coleraine B 110 new NI)	Loss of Coleraine Rasharkin 110 NI	<250
NI Area - I	Line (Cam Coleraine B 110 new NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - I	Line (Coleraine Rasharkin_110_1)	Loss of Kells Rasharkin 110 NI	<250
NI Area - I	Line (Coolkeeragh Limavady_110_1 NI)	Loss of Kells Rasharkin 110 NI	<250
NI Area - I	Line (Coolkeeragh Killymallaght 110 ckt 1 NI)	Loss of Dungannon Omagh 110 NI	<250
NI Area - I	Line (Coolkeeragh Killymallaght 110 ckt 1 NI)	Loss of Tamnamore (or Dungannon) to Tremoge 110 NI	<250
NI Area - I	Line (Cam Coleraine B 110 new NI)	Loss of Cam Rasharkin 110 NI new	<250
NI Area - I	Line (Cam Coleraine B 110 new NI)	Loss of Kells Rasharkin 110 NI	<250
NI Area - II	Line (Gort Tamnamore_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - II	Line (Magherakeel Omagh 110 ckt 1 NI)	Base	<250
NI Area - III	Line (Dromore Tamnamore 110 NI new)	Loss of Cool Magh 275 DC - wi SPS	750-1000
NI Area - III	Line (Dromore Tamnamore 110 NI new)	Loss of Tamnamore (or Dungannon) to Tremoge 110 NI	<250
NI Area - III	Line (Dromore Tamnamore 110 NI new)	Loss of Dungannon Omagh 110 NI	<250
NI Area - III	Line (Dromore Tamnamore 110 NI new)	Loss of Coolkeeragh Killymallaght 110 NI	<250
NI Area - IV	Line (Tamnamore Tremoge_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	1000-1250
NI Area - IV	Line (Kells Rasharkin 110 ckt 1 NI)	Loss of Cool Magh 275 DC - wi SPS	750-1000
NI Area - IV	Line (Dungannon Omagh_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	250-500
NI Area - IV	Line (Drumnakelly Tamnamore_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - IV	Line (Kells_110_81520_KEL_275_2)	loss of kells 275 110 ckt 1	<250
NI Area - IV	Line (Kells_110_81520_KEL_275_2)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - IV	Line (Tamnamore Turleenan 275 ckt 2 NI future)	loss of TAMN turleenan 275 SC	<250
NI Area - IV	Line (Drumnakelly Tandragee_110_2 NI)	Loss of Cool Magh 275 DC - wi SPS	<250

Area of line	Line	Contingency	Hours Range
NI Area - IV	Line (Drumnakelly Tandragee_110_1 NI)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - IV	Line (Tamnamore Tremoge_110_1 NI)	Loss of Dungannon Omagh 110 NI	<250
NI Area - IV	Line (Creagh Terrygowan 110 ckt 1 NI newish)	loss of kells 275 110 ckt 2	<250
NI Area - IV	Line (Kells Rasharkin 110 ckt 1 NI)	Loss of Coleraine Rasharkin 110 NI	<250
NI Area - IV	Line (Drumnakelly Tandragee_110_1 NI)	loss of Tamnamore 275 110 ckt 1	<250
NI Area - IV	Line (Drumnakelly Tandragee_110_2 NI)	loss of Tamnamore 275 110 ckt 1	<250
NI Area - IV	Line (Hannahstown Lisburn_110_1 NI)	Loss of CAST TAND 275kV SC	<250
NI Area - IV	Line (Drumnakelly Tandragee_110_2 NI)	loss of Tamnamore 275 110 ckt 2	<250
NI Area - IV	Line (Drumnakelly Tandragee_110_1 NI)	loss of Tamnamore 275 110 ckt 2	<250
NI Area - IV	Line (Dungannon Omagh_110_1 NI)	Loss of Tamnamore (or Dungannon) to Tremoge 110 NI	<250
NI Area - IV	Line (Creagh Terrygowan 110 ckt 1 NI newish)	Loss of Cool Magh 275 DC - wi SPS	<250
NI Area - IV	Line (Tamnamore Tremoge_110_1 NI)	Loss of Coolkeeragh Killymallaght 110 NI	<250
NI Area - IV	Line (Hannahstown Lisburn_110_1 NI)	loss of Tamnamore 275 110 ckt 1	<250
NI Area - IV	Line (Hannahstown Lisburn_110_1 NI)	Loss of BAFD BCRM 275kV SC	<250
NI Area - IV	Line (Kells_110_81520_KEL_275_2)	loss of Ballylumford 275 110 ckt 1	<250
NI Area - IV	Line (Tamnamore 110 275 IBT2)	loss of Tamnamore 275 110 ckt 1	<250

Table D-2 Binding contingency and overloading lines in 2030 NI 100% study

10 Appendix E List of Nodes in Constraint Area

The detailed list of the nodes associated with the constraint areas is shown in table below

Constraint area	Node
NI Area - I	Agivey Brockaghboy
	Cam
	Coleraine
	Coolkeeragh
	Limavady
	Lisaghmore
	Loguestown
	Rasharkin
NI Area - II	Gort
	Killymallaght
	Magherakeel
	Omagh
	Strabane
	Tremoge
NI Area - III	Aghyoule
	Drumquin
	Enniskillen
NI Area - IV	Antrim
	Ballylumford
	Ballymena
	Ballynahinch
	Banbridge
	Belfast North
	Carnmoney
	Castlereagh
	Creagh
	Cregagh
	Drumnakelly
	Dungannon
	East Antrim
	Eden
	Glengormley
	Glengormley
	Kells
	Kells Cluster
	Kilroot
	Larne
	Larne
	Lisburn
	Magherafelt
	Newry
	Newtownards
	Rathgael
	Rosebank
	Tamnamore
	Tandragee
	Waringstown

Table 10-1 NI Generator Nodes Within the Study areas of this study.

11 Appendix F Reference to Ireland ECP 2.2 Study

In this Northern Ireland study the assumptions for Ireland are the same as from those published for the Ireland ECP 2.2 study found on the EirGrid website. This report specifically focuses on Northern Ireland and associated specific assumptions. Where initial and 100% capacity cases are explored in the Northern Ireland constraints study cases, these map well to the same capacity cases published already for Ireland. In addition, the Northern Ireland offshore wind study matches with the 5 GW offshore sensitivity from ECP 2.2 constraints.

The reciprocal study cases for Ireland relative to the study cases in this work is shown in the figure below.

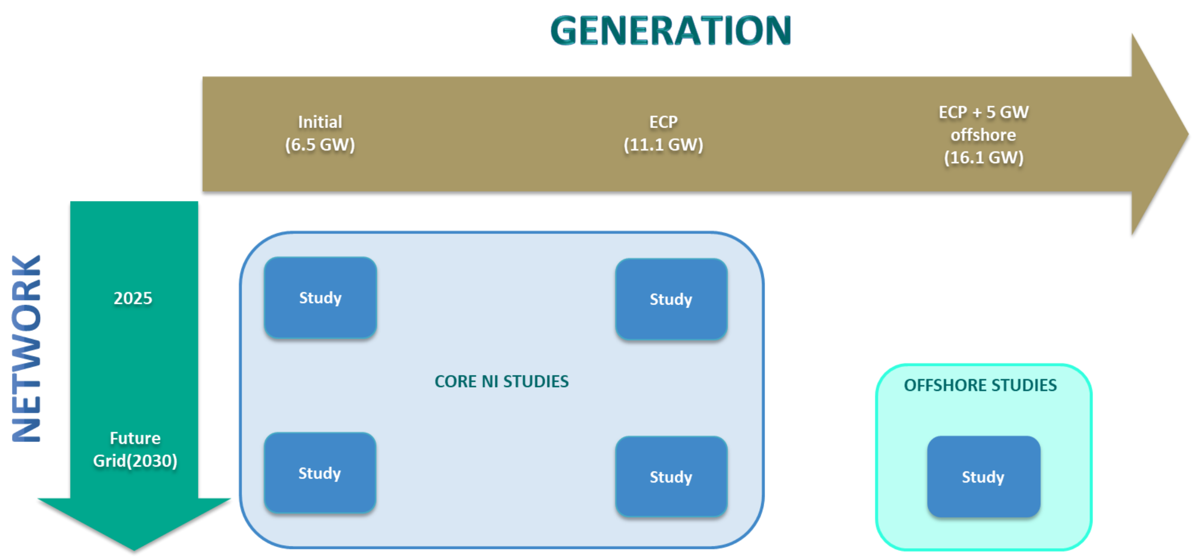

Figure 11-1 Reciprocal ECP 2.2 Study Scenarios: Matrix of Generation and Network Scenarios

The capacities assumed in Ireland are also shown below in Table 11-1, these capacities are taken from the correspond ECP 2.2 constraints analysis studies.

ECP 2.2 Breakdown of IE Generation Capacity (MW)			
	Initial Study	ECP All Study	ECP + 5 GW offshore
Battery	759	1,524	1,524
Solar	1,231	4,744	4,744
Wind	5,059	6,661	6,661
Wind Offshore	-	-	5,000
Totals	7,049	12,929	17,929

Table 11-1 Connected and Contracted Solar and Wind Quantities in Ireland for the Study Scenarios

11.1 Northern Ireland 2030 Scenario Relative to ECP 2.2 Future Grid Scenarios

For this Northern Ireland constraints study, the study year of 2030 matches to the Future Grid scenario from ECP 2.2 constraints for Ireland. The 2030 scenarios uses network assumptions from SOEF 1.0 for the Northern Ireland grid in 2030 same as used for the Future Grid scenarios in ECP 2.2.

12 Abbreviation and Terms

Active Power

The product of voltage and the in-phase component of alternating current measured in Megawatts (MW). When compounded with the flow of 'reactive power', measured in Megavolt-Amperes Reactive (Mvar), the resultant is measured in Megavolt-Amperes (MVA).

Busbar

The common connection point of two or more circuits.

Capacity Factor

The capacity factor of a generator is the ratio of the actual electrical energy output over a given period of time to the maximum possible electrical energy output over that period.

$$Capacity\ Factor = \frac{Energy\ Output}{Hours\ per\ year * Installed\ Capacity}$$

Combined Cycle Gas Turbine (CCGT)

This is 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.

Commission for Regulation of Utilities (CRU)

The CRU is the regulator for the electricity, natural gas and public water sectors in Ireland.

Constraint

The reduction in output of a generator due to network limits. Usually, constraints are local to a transmission bottleneck.

Contingency

The unexpected failure or outage of a system component, such as a generation unit, transmission line, transformer or other electrical element. The transmission network is operated safe against the possible failure or outage of any system component. Hence, contingency usually refers to the possible loss of any system component. A contingency may also include multiple components, when these are subject to common cause outages.

Curtailment

Curtailment is when the transmission system operators EirGrid and SONI ask generation to reduce their output to ensure system security is maintained. Usually, curtailment is shared across the whole system.

Demand

The amount of electrical power that customers consume and which is measured in Megawatts (MW). In a general sense, the amount of power that must be transported from transmission network connected generation stations to meet all customers' electricity requirements.

Dispatch Balancing Costs (DBC)

Dispatch Balancing Costs refers to a number of payments related to the differences between generators' market position and their actual output. They include Constraint Payments, Uninstructed Imbalance Payments and Generator Testing Charges. The Transmission System Operators (TSOs) are responsible for forecasting and managing Dispatch Balancing Costs.

Enduring Connection Policy (ECP)

The Commission for Regulation of Utilities (CRU) has put in place a revised approach to issuing connection offers to generators. This approach is called the Enduring Connection Policy (ECP). With ECP, it is envisaged that batches of generator connection offers will issue on a periodic basis.

Enduring Connection Policy - 2 (ECP-2)

ECP-2 is the second stage of the CRU's development of enduring connection policy in Ireland. In June 2020 the CRU published their decision on ECP-2, this decision set policy for at least three batches of connection offers (ECP-2.1, ECP-2.2 and ECP-2.3).

Forced Outage Probability (FOP)

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 Dispatch

This is the configuration of outputs from the connected generation units.

Interconnector

The electrical link, facilities and equipment that connect the transmission network of one power market to another.

Loadflow

Study carried out to simulate the flow of power on the transmission system given a generation dispatch and system load.

A DC loadflow is a study, which uses simplifying assumptions in relation to voltage and reactive power. DC loadflow studies are used as part of an overarching study. For example, Plexos uses DC loadflow because it is performing studies for every hour of every study year and is performing a large optimisation calculation for each of these.

Maximum Export Capacity (MEC)

The maximum export value (MW) provided in accordance with a generator's connection agreement. The MEC is a contract value that the generator chooses as its maximum output.

Megawatt (MW) and Gigawatt (GW)

Unit of power: 1 megawatt = 1,000 kilowatts = 106 joules / second

1 gigawatt = 1,000 megawatts

Megawatt Hour (MWh), Gigawatt Hour (GWh) and Terawatt Hour (TWh)

Unit of energy: 1 megawatt hour = 1,000 kilowatt hours = 3.6 x 10^9 joules

1 gigawatt hour = 1,000 megawatt hours

1 terawatt hour = 1,000 gigawatt hours

Operational Constraints/Limits

In order to operate a safe, secure and stable electricity system, the TSO must operate the system within certain operational constraints/limits which include; maximum SNSP, maximum RoCoF, minimum level of system inertia, minimum number of conventional units, minimum levels of reserve.

Conventional generator "must run" rules to ensure adequate system voltage and power flow control

Surplus

Reduction of renewable generation to a level below its availability for surplus reasons is necessary when the total available generation exceeds system demand plus interconnector export flows. Surplus is applied through market processes prior to dispatch or balancing actions taken by the transmission system operator such as curtailment and constraint.

Plexos

Plexos is a commercially available power system simulation tool used in this study to evaluate over supply, curtailment and constraint. Plexos is a detailed generation and transmission analysis program that has been widely used in the electricity industry for many years.

Rate of Change of Frequency (RoCoF)

As low inertia non-synchronous generators displace high inertia synchronous generators in system dispatch, then the system gets lighter. Then, for the loss of a large infeed (e.g. trip of an interconnector or generator), the system frequency will change more quickly.

RoCoF is the agreed limit to which the system is agreed to be operated and which generators, demand and system protection schemes are expected to manage. In Ireland, the TSOs are proposing to increase the RoCoF value. This will allow more renewable generation and may require confirmation by participants that they can meet the proposed RoCoF.

Short Run Marginal Cost (SRMC)

The instantaneous variable cost for a power plant to provide an additional unit of electricity, i.e. the cost of each extra MW it could produce excluding its fixed costs. The SRMC reflects the opportunity cost of the electricity produced, which is the economic activity that the generator forgoes to produce electricity. For example, in the case of a generator fueled by gas, the opportunity cost includes the price of gas on the day that it is bidding in because if the generator is not producing electricity it could sell its gas in the open market.

System Non-Synchronous Penetration (SNSP)

The introduction of large quantities of non-synchronous generators such as solar and wind poses challenges to a synchronous power system. For Ireland, a system non-synchronous penetration (SNSP) ratio is defined to help identify the system operational limits. The present allowable ratio is 75% but future system services arrangements and proposed amendments to system operation are expected to allow SNSP to increase in future years.

Total Dispatch Down

For the purpose of this report Total Dispatch Down is equivalent to the sum of surplus (generation self reduction due to market position), plus curtailment (re-dispatch due to system operational constraints), plus constraint (re-dispatch due to network limitations).

Total Electricity Requirement (TER)

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 Peak

The peak demand that is transported on the transmission network. The transmission peak includes an estimate of transmission losses.

Transmission System

The transmission system is a meshed network of high-voltage lines and cables (400 kV, 275 kV, 220 kV and 110 kV) for the transmission of bulk electricity supply around Northern Ireland and Ireland.

Transmission System Operator (TSO)

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 and Large Energy Users connected at the transmission level.

Uprating

A network reinforcement solution whereby an existing circuit's rating can be increased. This is achieved by increasing ground clearances and/or replacing conductor, together with any changes to terminal equipment, support structures and foundations.

Winter Peak

This is the maximum annual system demand. Historically this occurs in the winter period October to February, inclusive in Ireland and in the period November to February in Northern Ireland.

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