Annual Renewable Energy Constraint and Curtailment Report 2021

August 2022

Contents

Disclaimer

Please note that the historical data contained in this report is indicative and the best available data at the time of writing. While every effort has been made in the compilation of this report to ensure that the information herein is correct, the TSOs do not accept liability for any loss or damage arising from the use of this document or any reliance on the information it contains. Use of this document and the information it contains is at the user's sole risk.

Executive Summary

EirGrid and SONI have prepared this report for the regulatory authorities to outline the levels of dispatch-down of renewable energy in 2021, as required under European[1] and Member State[2] legislation.

Both Ireland and Northern Ireland have been set renewable energy targets for 2030. The Climate Action Plan 2019 set a target of 70% RES-E in Ireland by 2030 and The Northern Ireland Energy Strategy set a target of at least 70% RES-E in Northern Ireland by 2030 Both of these targets were subsequently revised to 80% with the Climate Action Plan 2021 setting a target of 80% RES-E in Ireland by 2030 and the Climate Change No. 2 Bill received Royal Assent on June 6th 2020 and set a target of 80% RES-E in NI by 2030.

Both Ireland and Northern Ireland exceeded previous 40% renewable electricity targets for 2020, with Ireland recording 42.1% and N. Ireland 43.8% in 2020. This is a significant accomplishment to integrate this level of renewable generation while ensuring the electricity system remains stable and the supply secure. The TSOs will continue to do our part in delivering higher levels of renewables on the system.

In Ireland and Northern Ireland, renewable energy is predominantly sourced from wind, although solar energy has grown in size and significance in Northern Ireland in recent years. Other sources include hydroelectricity, biomass, biogas and waste. The main focus of this report is the dispatch down of solar and wind as they are the main sources of renewable electricity on the island.

Dispatch-down of renewable energy refers to the amount of renewable energy that is available but cannot be used by the system. This is because of broad power system limitations, known as curtailments, or local network limitations, known as constraints.

In 2021, the total wind energy generated in Ireland and Northern Ireland was 11,695 GWh, while 938 GWh of wind energy was dispatched down. This represents 7.4% of the total available wind energy in 2021.

In Ireland, the dispatch-down energy from wind resources was 752 GWh. This is equivalent to 7.3% of the total available wind energy.

[1] Article 16C of the 2009 Renewable Energy Directive (2009/28/EC) states: "If significant measures are taken to curtail the renewable energy sources in order to guarantee the security of the national electricity system and security of energy supply, Members States shall ensure that the responsible system operators report to the competent regulatory authority on those measures and indicate which corrective measures they intend to take in order to prevent inappropriate curtailments."

[2] Article 4.4 of Statutory Instrument 147 of 2011 states: "If significant measures are taken to curtail the renewable energy sources in order to guarantee the security of the electricity system and security of energy supply, the transmission system operator shall report to CRU on those measures and indicate which corrective measures it is intended to take in order to prevent inappropriate curtailments."

In Northern Ireland, the dispatch-down energy from wind resources was 185 GWh. This is equivalent to 7.8% of the total available wind energy. The dispatch-down energy from solar resources however was 4 GWh which represented 2.9% of the total available solar energy.

When all renewable sources of electricity are taken into account, the dispatch down level of all renewables on the island in 2021 was 6.4% (6.4% in Ireland and 6.6% in Northern Ireland). See table 6 in appendix A for the full breakdown of all renewable energy sources generation and dispatch down.

Overall, the dispatch-down of energy from wind resources decreased from 12.1% in 2020 to 7.4% in 2021. The level of dispatch-down is affected by a number of factors which vary from year to year, such as the amount of wind and solar installed on the system, and the capacity factor of the renewable generation. For 2020, Covid-19 had the effect of reducing the demand across the first lockdown period which resulted in increased levels of dispatch-down.

Figure 1 below provides an all island view of wind generation and dispatch down. EirGrid and SONI publish renewable data regularly across the year and the reader can find the full data set[3] to answer any specific queries not directly covered in this report.

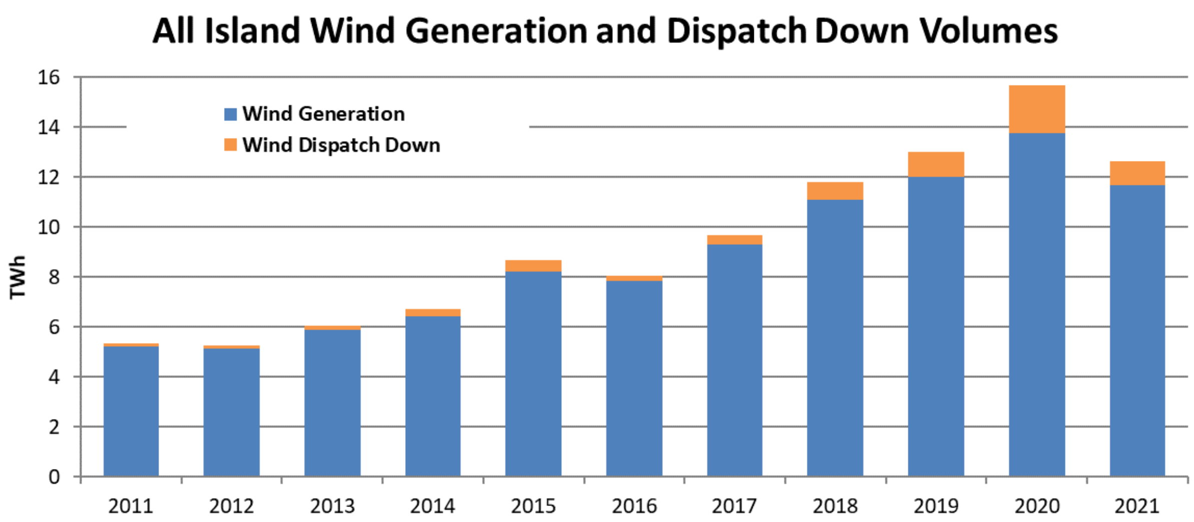

Figure 1: All Island Annual Wind Generation and Dispatch Down Volumes

[3] http://www.eirgridgroup.com/how-the-grid-works/renewables/
http://www.soni.ltd.uk/how-the-grid-works/renewables/

1 Introduction

1.1 Context

The 2009 European Renewable Energy Directive (2009/28/EC) requires that the TSOs report to the regulatory authorities, Commission for Regulation of Utilities (CRU) in Ireland and the Utility Regulator (UR) in Northern Ireland. This report must detail why renewable energy was dispatched-down and what measures are being taken to prevent inappropriate curtailment.

This Directive was put into law in Ireland as S.I. No. 147 of 2011 and in Northern Ireland through the Electricity (Priority Dispatch) Regulations No. 385 of 2012. The Single Electricity Market (SEM) Committee, in its scheduling and dispatch decision paper SEM-11-062, requires that the TSOs report on this as appropriate to CRU and the UR, respectively. This report represents EirGrid and SONI's response to the obligations required through National Law and through the SEM Committee requirement.

1.2 Reasons for Dispatch-Down

Renewable generation receives priority within the scheduling and dispatch algorithms in the Control Centres. However, there will be times when it is not possible to accommodate all priority dispatch generation while maintaining the safe, secure operation of the power system. Security-based limits must be imposed due to both local network and system-wide security issues. It is necessary to reduce the output of renewable generators below their maximum available level when these security limits are reached. This reduction is referred to in this report as 'dispatch-down' of renewable generation and is consistent with the principle of priority dispatch as per SEM-11-062.

There are two reasons for the dispatch-down of wind and solar energy: constraint and curtailment. **Constraint** refers to the dispatch-down of wind and solar generation for localised network reasons (where only a subset of wind/solar generators can contribute to alleviating the problem). **Curtailment** refers to the dispatch-down of wind/solar for system-wide reasons (where the reduction of any or all wind/solar generators would alleviate the problem). The SEM Committee approved the difference between constraint and curtailment in their SEM-13-011 paper. However recent clarification with respect to the Articles 12 and 13 of the Regulation 2019/943 will need consideration in future reporting.

1.3 Reporting Methodology

All controllable wind and solar farms are issued with detailed constraint and curtailment reports each month.

The reports include clear categorisation between constraint and curtailment and clear reasons for why a curtailment or constraint was applied called a 'reason code'. All wind and solar farms also have access to dispatch instructions and wind and solar farm data with each dispatch instruction time-stamped with the instruction time.

A detailed wind and solar aggregate constraint and curtailment report is also published online every month to coincide with the individual wind and solar farm reports. This report is accompanied by a separate user guide, which contains a detailed description of the methodology, worked examples and a Frequently Asked Questions (FAQs) section. Both the aggregate report and the user guide can be found at:
http://www.eirgridgroup.com/how-the-grid-works/renewables/
http://www.soni.ltd.uk/how-the-grid-works/renewables/

Note: Any reduction in the output of renewable generators whilst responding to system frequency is not assessed in these reports. When operating in frequency response mode the wind/solar farm output varies in real time based on the current system conditions and not in response to a dispatch instruction from the wind dispatch tool.

2 Level of Dispatch-Down Energy in 2021

The following provides a summary of the dispatch-down of wind and solar energy in 2021 for Ireland and Northern Ireland. (**Note:** The values are based on the best available data at the time of writing.) More details and figures are provided in Appendix A.

2.1 All-Island

In 2021, the share of electricity demand[4] from renewable sources in Ireland and Northern Ireland was 35.4% (Figure 2). This is broken down as follows:

- 30.6% provided by wind;
- 0.4% provided by solar;
- 1.9% provided by hydro; and
- 2.5% provided by other[4] renewable energy sources.

The total wind energy generated was 11,695 GWh in Ireland and Northern Ireland. There was an estimated total of 938 GWh of dispatch-down energy from wind farms.
This level of dispatch-down of wind represents 7.4% of total available energy from wind resources in Ireland and Northern Ireland.

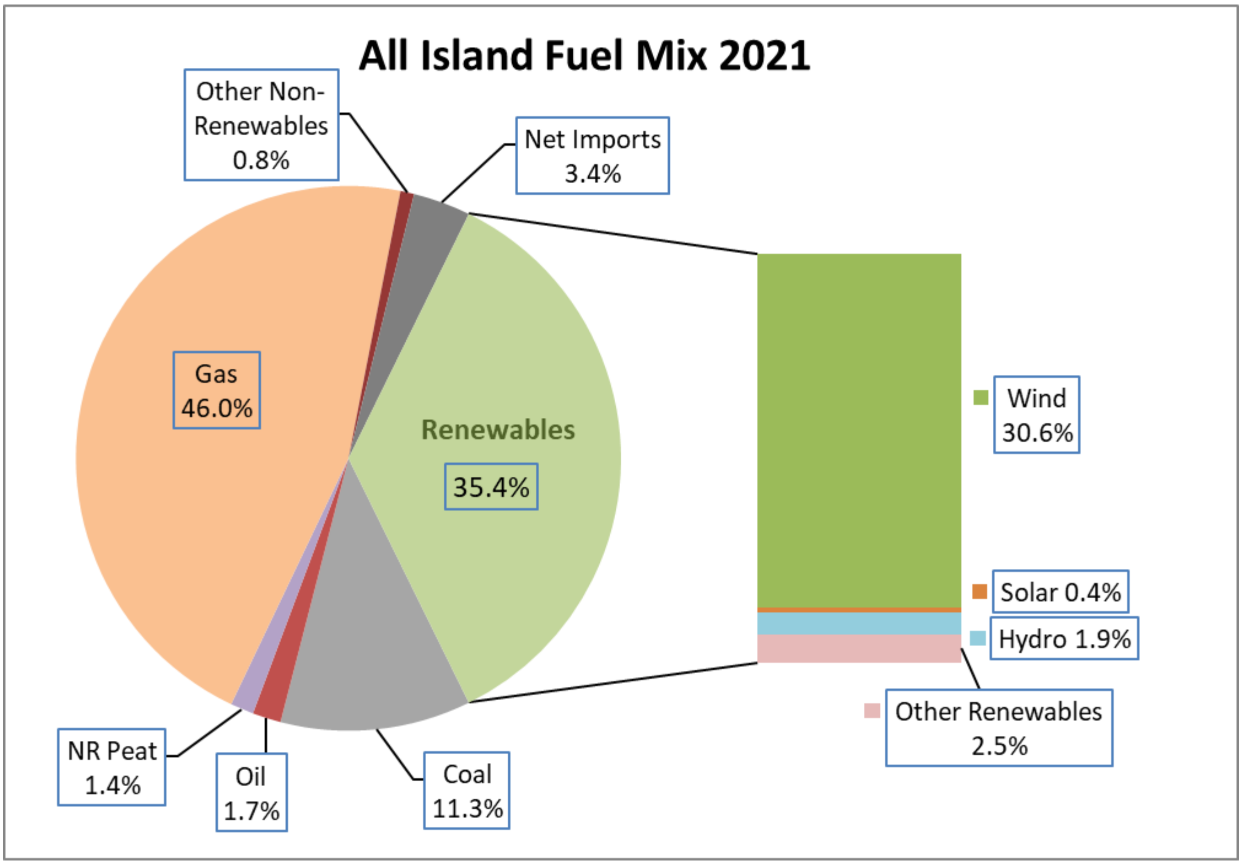

Figure 2: All-Island Fuel Mix for 2021 as Percentage of Demand

[4] Note that since the percentage figures are presented for centrally dispatched generation (based on metered data), they do not account for non-dispatchable embedded renewable generation, which includes biomass, land-fill gas and small-scale hydro.
[4] Other renewable energy sources include CHP, bioenergy and ocean energy.

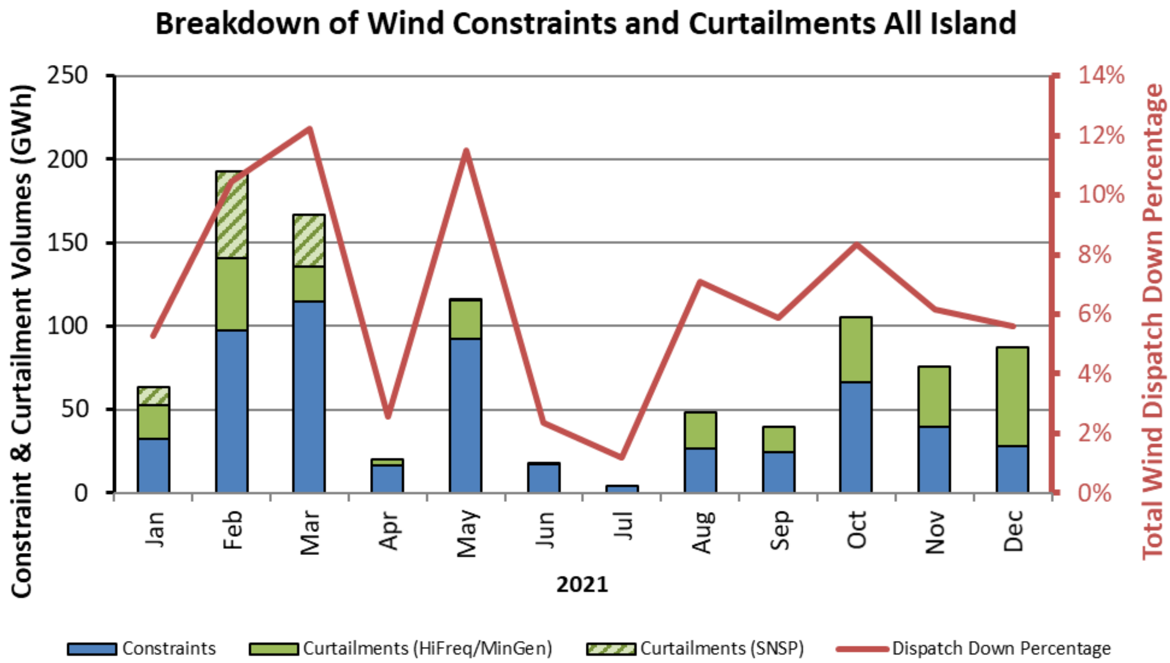

Figure 3: Monthly breakdown of the main wind dispatch-down categories on the island in 2021

2.2 Northern Ireland

In 2021, the total dispatch-down energy from wind generation in Northern Ireland was 185 GWh. This is equivalent to 7.8% of total available wind energy in that jurisdiction.

In 2021, the total dispatch-down energy from solar generation in Northern Ireland was 4 GWh. This is equivalent to 2.9% of total available solar energy in that jurisdiction.

2.3 Ireland

In 2021, the total dispatch-down energy from wind generation in Ireland was 752 GWh. This is equivalent to 7.3% of total available wind energy in Ireland.

3 Contributory Factors for Dispatch-Down of Wind and Solar

3.1 Installed Wind and Capacity Factor

As explained in section 1.2, it is sometimes necessary to limit the maximum level of wind generation on the system for security or safety reasons. The impact of these limits on the level of dispatch-down will depend on two factors: the amount of wind generation installed on the system; and the capacity factor of the wind generation.

In 2021, 107 MW was added to the wind installed capacity on the island. The breakdown of wind installed capacities between Ireland and N. Ireland is shown below.

	Wind Installed Capacities (MW)								
	Ireland			Northern Ireland			All Island		
Year End	TSO	DSO	Total	TSO	DSO	Total	TSO	DSO	Total
2010	727.8	662.6	**1,390.4**	0.0	392.2	**392.2**	727.8	1,054.8	**1,782.6**
2011	769.2	815.4	**1,584.6**	73.6	438.8	**512.4**	842.8	1,254.2	**2,097.0**
2012	769.2	934.3	**1,703.5**	73.6	526.0	**599.6**	842.8	1,460.3	**2,303.1**
2013	845.2	1,078.1	**1,923.3**	73.6	566.4	**640.0**	918.8	1,644.4	**2,563.2**
2014	1,046.6	1,219.9	**2,266.4**	73.6	655.5	**729.1**	1,120.2	1,875.4	**2,995.6**
2015	1,152.6	1,294.7	**2,447.3**	73.6	677.4	**751.0**	1,226.2	1,972.1	**3,198.3**
2016	1,371.3	1,423.5	**2,794.8**	73.6	869.0	**942.6**	1,444.9	2,292.5	**3,737.4**
2017	1,591.5	1,720.8	**3,312.3**	121.1	1,032.6	**1,153.7**	1,712.6	2,753.4	**4,466.0**
2018	1,774.5	1,892.6	**3,667.0**	121.1	1,155.2	**1,276.3**	1,895.6	3,047.7	**4,943.3**
2019	1,932.5	2,187.2	**4,119.6**	121.1	1,155.2	**1,276.3**	2,053.6	3,342.3	**5,395.9**
2020	2,064.8	2,235.1	**4,299.8**	121.1	1,155.2	**1,276.3**	2,185.9	3,390.2	**5,576.1**
2021	2,074.1	2,258.4	**4,332.5**	121.1	1,229.5	**1,350.6**	2,195.2	3,487.9	**5,683.1**

Updated Feb 2022

Table 1: Installed wind capacities on the island from 2010 to 2021

Over the year, the capacity factor[5] of wind farms was 24% which was lower than the levels experienced in the previous three years (27%, 26% and 29% in 2018, 2019 and 2020 respectively). The seasonal variation in the capacity factor is evident in Figure 4.

[5] The capacity factor is the amount of energy produced (MW output) relative to the theoretical maximum that could have been produced if the wind generation operated at full capacity. Therefore, it represents the average output of the wind generation. This capacity factor is indicative and based on real-time SCADA data.

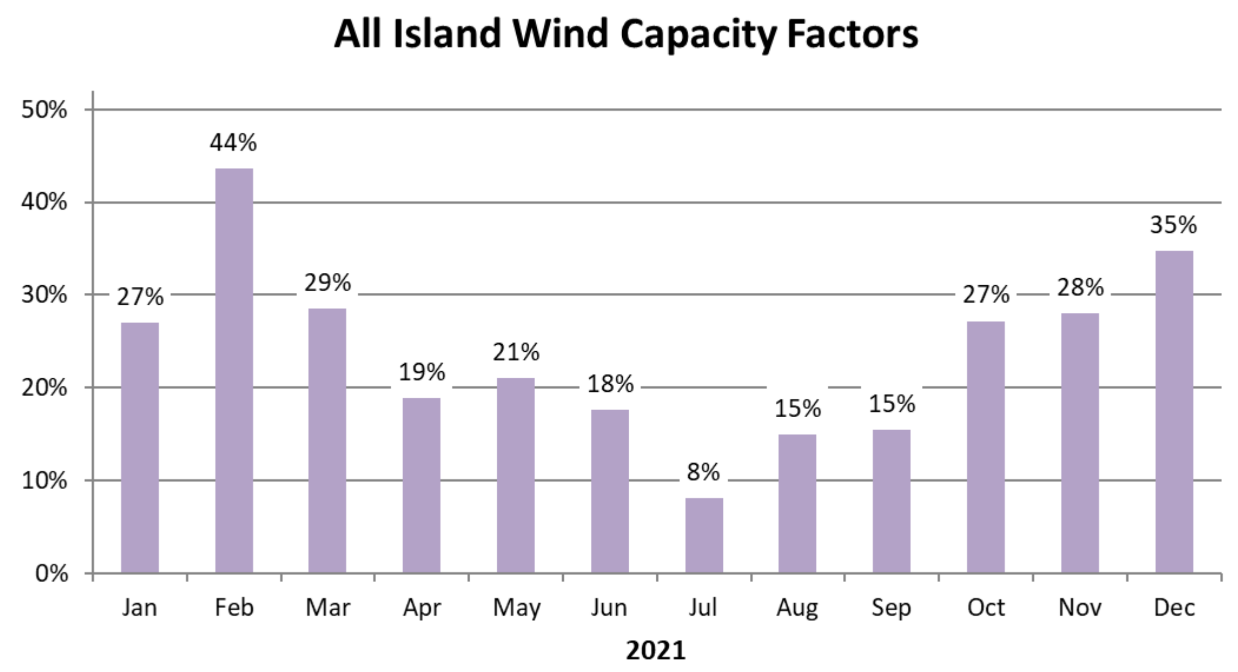

Figure 4: All-Island Monthly Wind Capacity Factors in 2021

Monthly wind capacity factors for Ireland and monthly wind and solar capacity factors for Northern Ireland are included in the Appendix.

3.2 Generation and Transmission System Outages in 2021

Across the year, generators and interconnectors will take planned outages at various times. There will also be transmission system outages. These outages may affect dispatch down figures. However, there were no significant outages noted in 2021 above what TSOs would expect in any year.

3.3 Demand Level

The level of demand is another important factor which may affect the dispatch-down of renewable generation. Increased demand generally enables greater levels of wind and solar to be accommodated on the system.

In 2021 demand levels have recovered to higher than pre-Covid-19 pandemic levels.

3.4 Changes to Operational Dispatch Policy

Before the SEM-11-062 decision paper, the operational policy in use was to dispatch-down Variable Price Taking Generation[6] before Autonomous Price Taker Generation units. This policy was implemented in 2008. Its purpose was to:

[6] Variable Price Taker Generators (now called Controllable Windfarms in ISEM) which:
- when not constrained/curtailed are scheduled and paid based on their actual output;
- when constrained/curtailed are scheduled based on their actual availability.

- provide clarity on operational practice; and
- reflect the more onerous commercial implications of dispatch-down for autonomous units.

Since the introduction of SEM-11-062, there is a requirement to dispatch-down wind and solar generators based on their controllability. This is defined under the Grid Codes and is verified through performance monitoring and testing. The implementation of this is described in the policy document "Policy for Implementing Scheduling and Dispatch Decisions SEM-11-062" [7] and the associated addendum. To meet the controllability definition, the operational policy[8] requires a wind farm to achieve operational certificate status 12 months after energisation. This process was implemented in December 2014 and a number of wind farms were moved to category 1 for this reason. If a wind farm is in category 1, it means that it will be dispatched down ahead of other wind farms.

During 2021 there were two Operational Policy Changes that had a direct impact in helping to reduce the dispatch down of renewable generation:

- Increasing the SNSP Limit from 70% to 75% from the 15 April 2021.
- Reducing to 0MW the requirement for minimum negative ramping reserve held on conventional generation in Ireland.

4 Breakdown of Wind Dispatch-Down – Constraints vs Curtailments

Table 2 shows the aggregate breakdown[9] of wind dispatch-down on the island over the last eleven years.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Dispatch Down Levels	2.2%	2.1%	3.2%	4.1%	5.1%	2.9%	4.0%	6.0%	7.7%	12.1%	7.4%
Constraints	0.4%	0.8%	0.9%	1.4%	1.8%	1.4%	1.2%	2.2%	4.0%	6.2%	4.4%
Curtailments	1.8%	1.3%	2.3%	2.6%	3.3%	1.5%	2.7%	3.8%	3.7%	5.9%	3.0%

Table 2: All-Island Yearly Breakdown of Wind Dispatch-Down Levels into Constraints and Curtailments

Individual breakdowns for Ireland and N. Ireland can be found in the Appendix.

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[7] http://www.eirgridgroup.com/library/index.xml
[8] Wind Farm Controllability Categorisation Policy, 5 March 2012
[9] A more accurate methodology for calculating wind dispatch down was implemented from 2016. Figures from previous years are best estimates.

4.1 Curtailment

Curtailment refers to the dispatch-down of wind / solar for system-wide reasons. There are different types of system security limits that necessitate curtailment:

1. System stability requirements (synchronous inertia, dynamic and transient stability),
2. Operating reserve requirements, including negative reserve,
3. Voltage control requirements,
4. System Non-Synchronous Penetration (SNSP[10]) limit.

In order to securely operate the system these limits result in minimum generation requirements on the conventional (synchronous) generation portfolio. The implementation of these security limits is described in detail in the Operational Constraints Update paper. This document is published[11] on the EirGrid Group website.

SNSP is a system security metric that has been established from the results of the DS3 programme. These studies initially identified 50% as the maximum permissible level. Due to works undertaken by the TSOs under the DS3 programme, the SNSP level was reassessed and the limit was gradually raised over the years to:

- 55% in March 2016
- 60% in March 2017
- 65% in April 2018
- 70 % in April 2021
- 75% in April 2022

The above limits can reduce the ability to accommodate wind and solar generation, particularly during lower demand periods.

The impact of curtailment can be seen in Figure 5, which shows the total annual all-island dispatch-down of energy by hour of day. There are more curtailments in the night hours (11pm to 7am) when compared to constraints because the demand is lower (Figure 5 is essentially the mirror image of the demand curve).

[10] SNSP is the ratio of non-synchronous generation (wind and HVDC imports) to demand plus HVDC exports

[11] http://www.eirgridgroup.com/library/index.xml

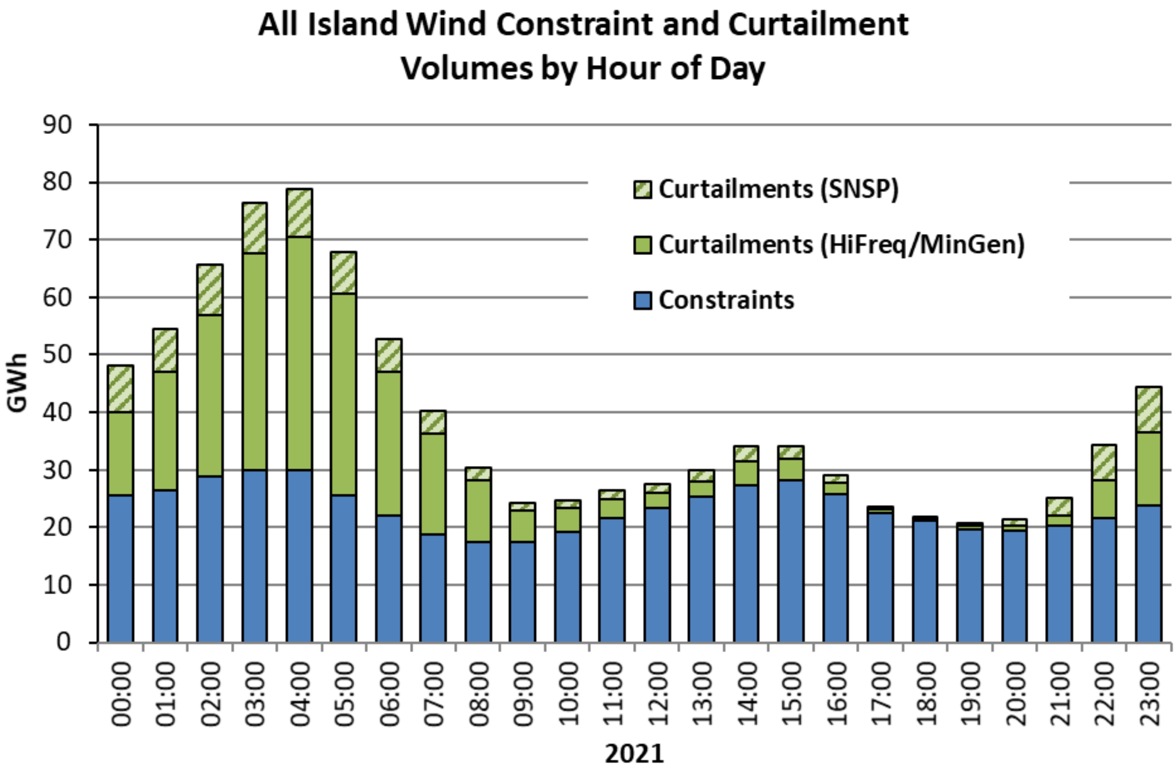


Figure 5: All-Island breakdown of wind constraints and curtailments in 2021 by hour of day

Due to the nature of solar, constraints and curtailments are experienced during daylight hours with the highest level of dispatch down between 10am and 4pm as shown in Figure 18 in the Appendix.

4.2 Constraints

The dispatch-down of wind for network reasons is referred to as a constraint.

Constraint of wind and solar can occur for two main reasons:

- more wind generation than the localised carrying capacity of the network; or
- during outages for maintenance, upgrade works or faults.

In order to reinforce the network to facilitate more wind and solar generation, a number of major capital works projects are scheduled during the transmission outage season each year. These outages may reduce the renewable generation capacity of the network for the duration of any works. In the short term, this leads to a rise in the levels of constraint in these areas. However, in the long term, this reinforcement of the network increases its capacity. This enables the accommodation of more generation in that area.

The level of all-island dispatch-down attributable to constraints (rather than curtailment) was 4.4% in 2021, which was lower than 6.2% constraint levels experienced in 2020. This was partly due to the slight increase in installed wind capacity, but mainly due to the combined impact of significantly higher demand levels, significant reduction in wind capacity factors and a higher SNSP limit.

However, it is possible to experience constraints on the transmission system during intact conditions when there is more renewable generation available than the localised carrying capacity of the network.

4.3 Wind Dispatch-Down by Region

The areas with the highest levels of wind dispatch-down (constraints and curtailment) in 2021 were the West, North West and South West of Ireland (Figure 6). The following are the main factors for high wind dispatch-down in these regions:

Northern Ireland:

In general, wind constraints are trending upwards in Northern Ireland due to the amount of wind on the Northern Ireland system relative to its size. At times there is no option but to constrain wind (and solar) if all the online conventional units are at minimum generation, while also managing the potential loss of the tie-line. The loss of the tie-line is flagged as a Northern Ireland constraint as opposed to curtailment, as it does not affect wind in Ireland, i.e. it's a local Northern Ireland issue. A dedicated constraint group was implemented as a change to the wind dispatch tool in Northern Ireland in December 2019 that enabled the TSO to select all wind and solar farms as a single constraint group. Prior to establishing this group dispatch down for the loss of tie-line may have been labelled as curtailment on some occasions.

From a Northern Ireland perspective, there will always be occasions throughout the year when outages required to maintain the network can increase constraints.
In 2021 there were no significant outages beyond what would be expected each year.

Ireland:

In recent years significant capital works have been undertaken to upgrade the transmission system to allow more wind generation to be exported from wind farms on the system particularly in the North West and South West regions of Ireland. These areas have previously experienced the greatest level of restrictions for the export of wind. Every year a range of planned transmission outages are undertaken which at times will increase constraints. Increasing complex operational switching has been performed in 2021 to maximise renewable output wherever possible across the transmission system.

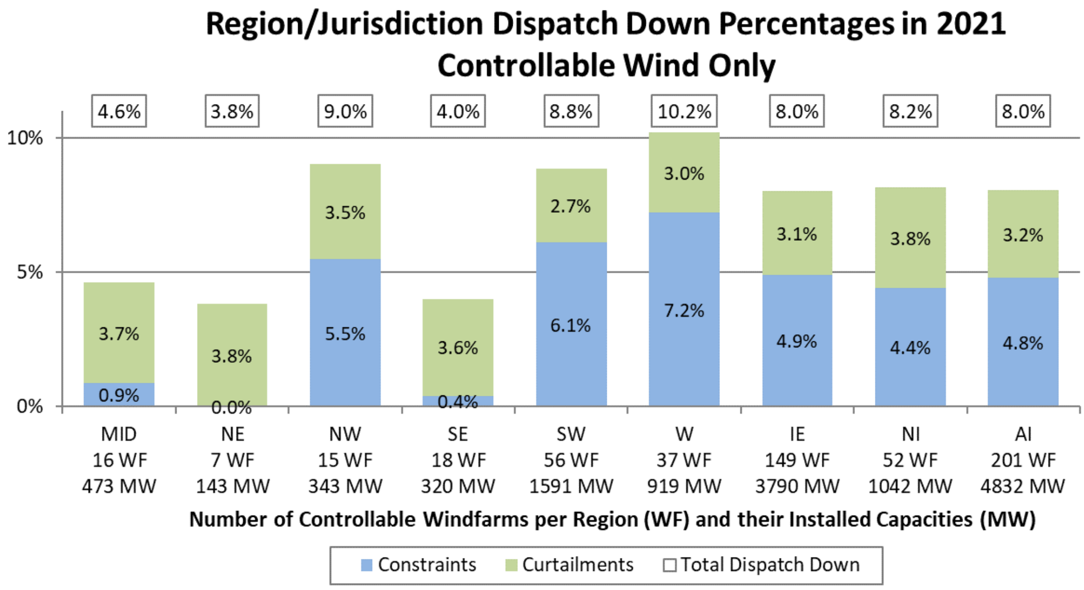


Figure 6: Regional/Jurisdictional Controllable Wind Dispatch-Down Percentages in 2021

Notes:

- Installed capacities are indicative end of year figures and do not reflect capacity changes throughout the year.
- This chart reflects the dispatch down levels and breakdowns for controllable windfarms only which are different from the levels for all windfarms quoted elsewhere in this report.

5 Mitigation Measures

5.1 Operational Policy and the DS3 Programme

The fundamental issues that give rise to curtailment are outlined in Section 4.1. Some of these issues are being addressed by EirGrid and SONI's Delivering a Secure Sustainable Electricity System (DS3) programme[12].

This is a multi-stakeholder, multi-year programme of work designed specifically to securely and efficiently increase the capability of the power system. The DS3 programme was formally launched in August 2011 and is designed to facilitate increased levels of renewables penetration in order to meet public policy objectives. However, the success of the programme depends on appropriate and positive engagement from all industry stakeholders. This includes conventional and renewable generators, the regulatory authorities, transmission system operators and distribution system operators in both Ireland and Northern Ireland.

There are operational policy studies which have been completed with the aim to minimise curtailment. These studies were followed by trials, which are either ongoing or have been completed.

[12] http://www.eirgridgroup.com/how-the-grid-works/ds3-programme/

SNSP (System Non-Synchronous Penetration) is the sum of non-synchronous generation (such as wind, solar and HVDC imports) as a percentage of total demand and exports. When the SNSP limit is raised, a trial period takes place before it becomes permanent. During the trial period, the system is operated at this increased SNSP limit except during adverse system events or during system testing.

The SNSP level was increased to 70% on a permanent basis in April 2021.

The EWIC export limit is 500 MW, but the Moyle export limit through 2021 was dependent on system conditions in Scotland and could change daily. The firm export capacity on Moyle was 80 MW but from 1st December 2020 to 30th September 2021 it increased to 250 MW and from 1st October 2021 to 31st March 2022 it increased again to 270 MW. The positive impact of this change can be seen in the monthly breakdown for 2021.

In 2022 EirGrid and SONI TSOs have:

- Carried out a trial to increase SNSP to 75% which will allow more renewables onto the all island power system. This trial completed in April 2022 and the power system is now operating at 75% SNSP.
- A Negative Reserve trial to reduce the volume of MW held on conventional generation and hence increase the volume of MW from renewable sources was held in Ireland in two phases:
  - Phase 1 ran for 20 days from the 28th of October 2020 to the 16th of November 2020. The requirement for minimum negative ramping reserve on conventional generation in Ireland was reduced from 100MW to 50MW. No trial related issues were flagged.
  - Phase 2 ran for 60 days from the 16th of November 2020 to the 14th of January 2021. The requirement for minimum negative ramping reserve on conventional generation in Ireland was reduced to 0MW. No trial related issues were flagged. This reduction allows for additional wind generation headroom and is estimated to have reduced the curtailment of wind by 10% over the period of the trail.
- The Negative Reserve in Northern Ireland is 50MW and this remains in place.
- Implementation of large-scale batteries on the power system in Ireland and N. Ireland.

The TSOs expect to see the impact of these operational changes through dispatch down reporting in 2022.

5.2 Operational Policy – Interconnector Countertrading[13]

Trades are carried out by the TSOs to minimise the dispatch down of priority generation The approach to countertrading in the SEM is carried out on the principle of trades being coordinated (i.e. 'agreed') with the other TSO (i.e. National Grid Electricity System Operator (NGESO)).

[13] http://www.eirgridgroup.com/site-files/library/EirGrid/InformationNoteExtensionofTSOcounter-tradingfacilitiesforDBCmanagement.pdf

Given that all co-ordinated third-party countertrades must be agreed by NGESO, on occasions it is not always possible to countertrade due to similar congestion issues arising in GB.

5.3 Controllability of Wind and Solar Generators

Wind and solar farm controllability is the ability of the TSO control centres to dispatch a wind/solar farm's output to a specific level. Uncontrollable wind farms (legacy wind farms connected before April 2005) are dispatched directly by opening circuit breakers. This results in full disconnection rather than a gradual dispatch-down. Controllability enables fairness of dispatch-down between wind farms on a pro-rata basis. To ensure increasing and appropriate levels of controllability, EirGrid and SONI have sought, where possible, to standardise testing procedures and rigorously enforce controllability requirements on all wind farms.

Appendix A – Detailed Results

The following charts provide a breakdown of the wind and solar dispatch-down categories both in volumes and in percentage of available energy.

More detailed monthly and regional figures are available in our final monthly wind and solar dispatch-down reports for 2021. Our user guide provides a detailed description of the dispatch-down categories and the methodology used. Both the monthly report and the user guide are available on our website:
http://www.eirgridgroup.com/how-the-grid-works/renewables/
http://www.soni.ltd.uk/how-the-grid-works/renewables/

Reason Codes

This is a list of all the reason codes used when constraining and curtailing wind and solar:

- Transmission (TSO) Constraints: Used to resolve a local network issue.
- Testing (TSO): Used when wind/solar farm testing is carried out by the TSO, e.g. for commissioning and monitoring.
- Curtailments:
    - High Frequency/Minimum generation: Used when attempting to alleviate an emergency high frequency event or in order to facilitate the minimum level of conventional generation on the system to satisfy reserve requirements, priority dispatch or to provide ramping capabilities.
    - SNSP Issue: Used to reduce the System Non-Synchronous Penetration.
    - ROCOF/Inertia: Used when the Rate of Change of Frequency (ROCOF) value for the loss of the largest single infeed is unacceptably high and wind/solar must be dispatched down as a result or when the system inertia is too low.
- Other Reductions:
    - DSO/DNO Constraints: Used when a dispatch is carried out as a result of a request from the Distribution System Operator or the Distribution Network Operator.
    - Developer Outage: Used when a wind/solar farm must reduce output mainly to carry out software upgrades.
    - Developer Testing: Used when testing is carried out by a wind/solar farm developer.

All-Island Wind

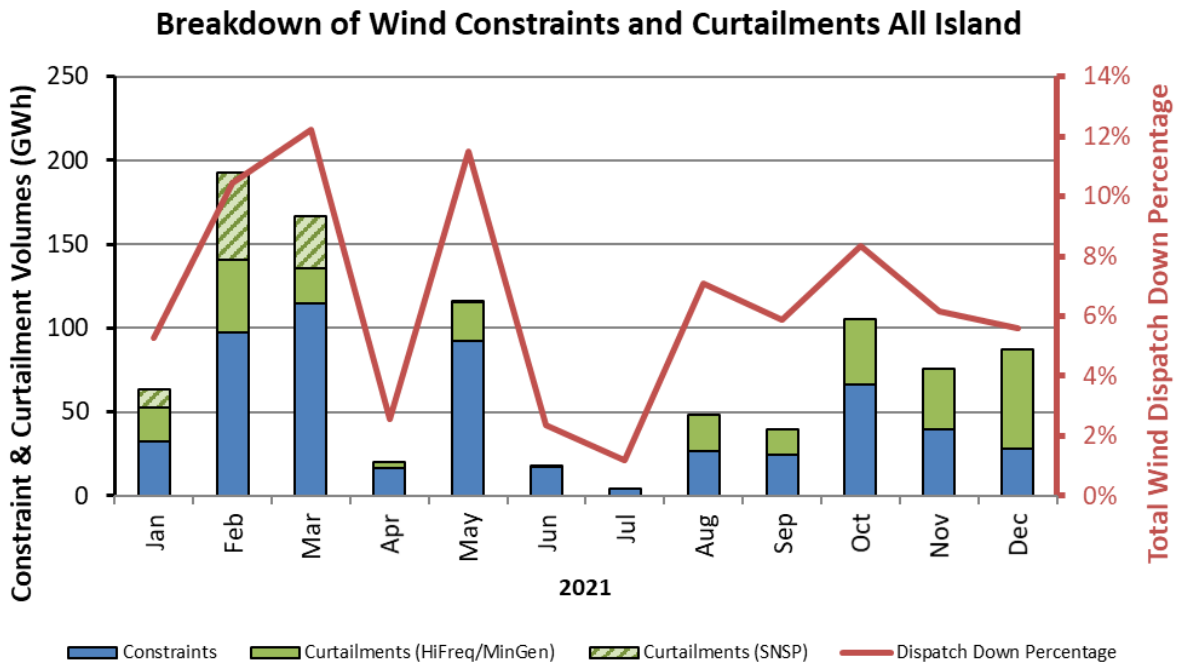
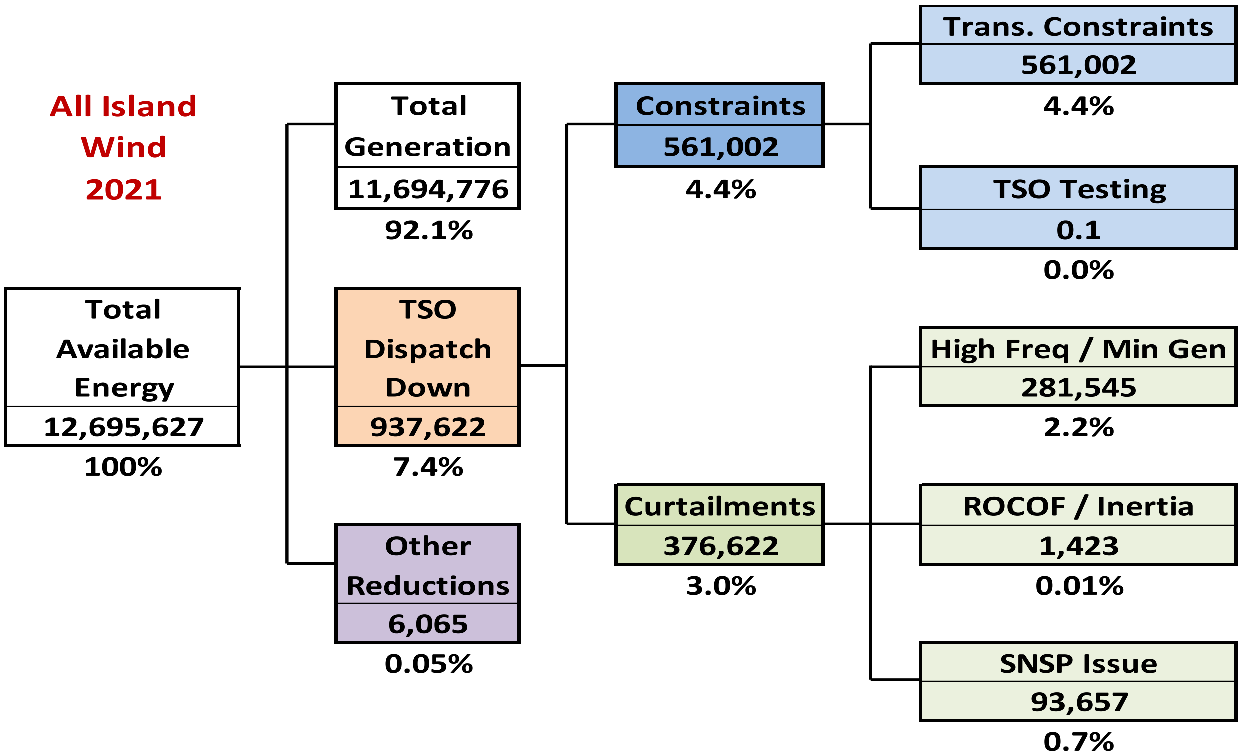


Figure 7: Monthly breakdown of all-island wind constraints and curtailments in 2021



Wind energy breakdowns: Volumes (MWh) and percentages.
Other reductions include DSO constraints, developer outage and developer testing.
Certain types of reductions are outside of the control of the TSO and are not logged.
Therefore, Available Energy ≠ Generation + TSO Dispatch Down + Other Reductions

Figure 8: Graphical representation of all-island wind dispatch-down categories in 2021

Ireland Wind

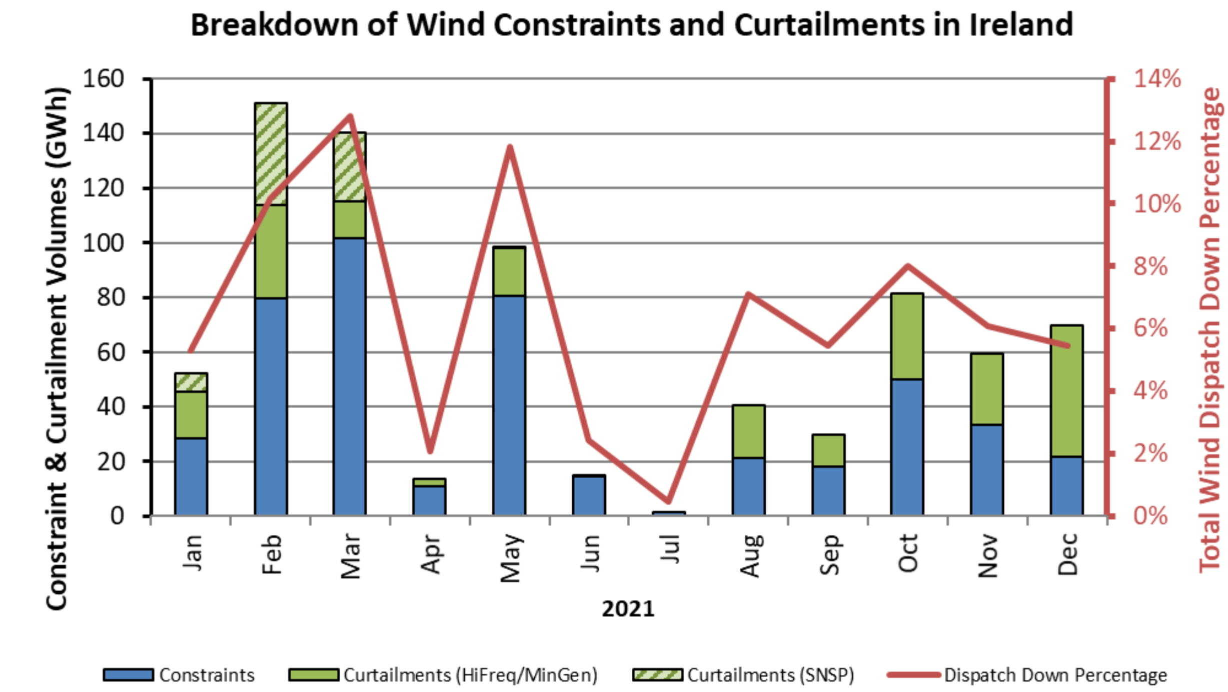
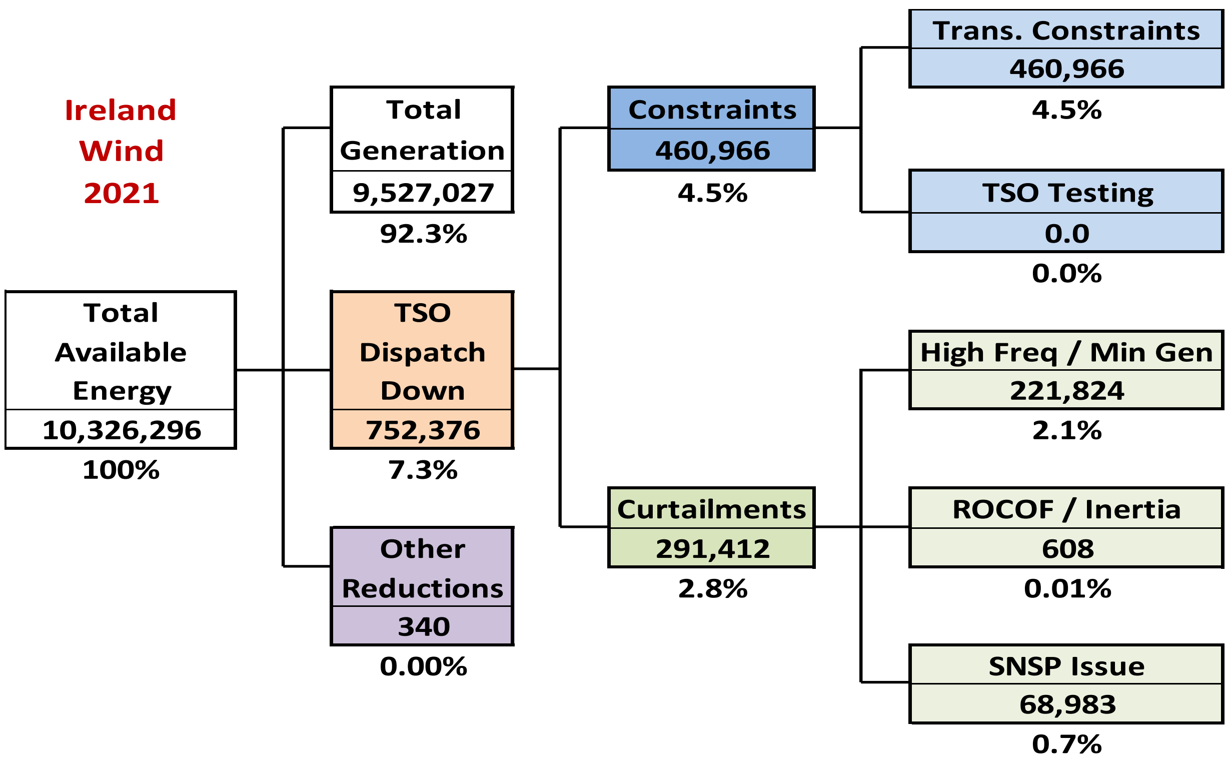


Figure 9: Monthly breakdown of the main wind dispatch-down categories in Ireland in 2021



Wind energy breakdowns: Volumes (MWh) and percentages.
Other reductions include DSO constraints, developer outage and developer testing.
Certain types of reductions are outside of the control of the TSO and are not logged.
Therefore, Available Energy ≠ Generation + TSO Dispatch Down + Other Reductions

Figure 10: Graphical representation of wind dispatch-down categories in Ireland in 2021

Northern Ireland Wind

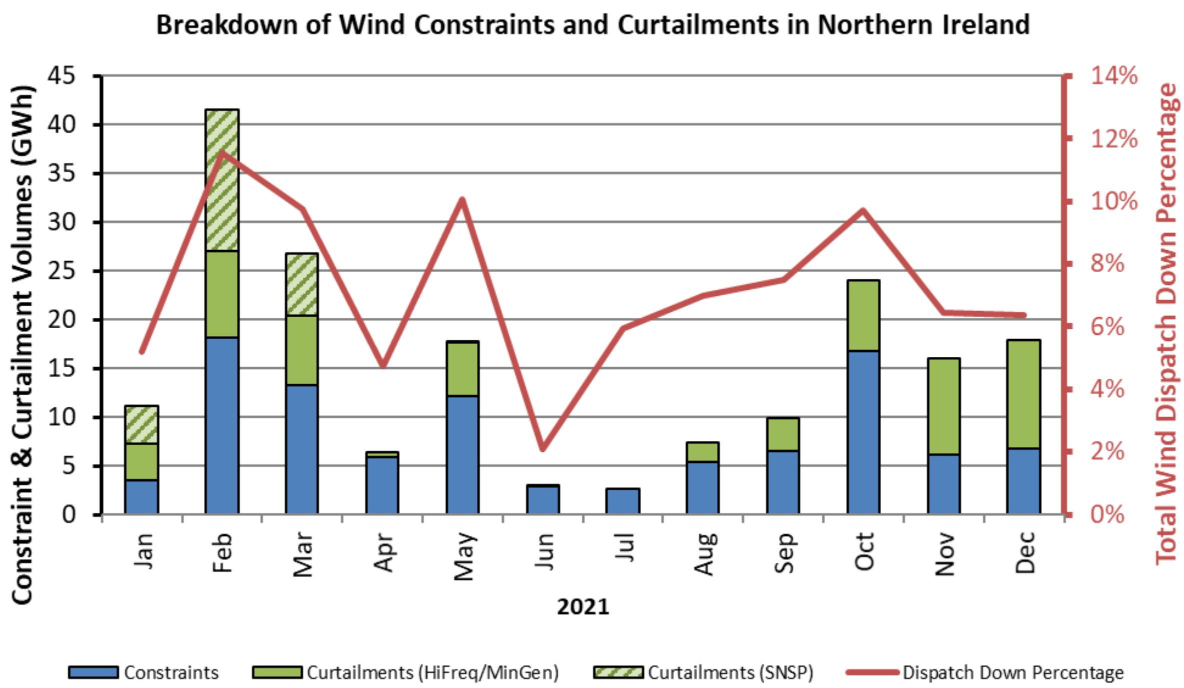
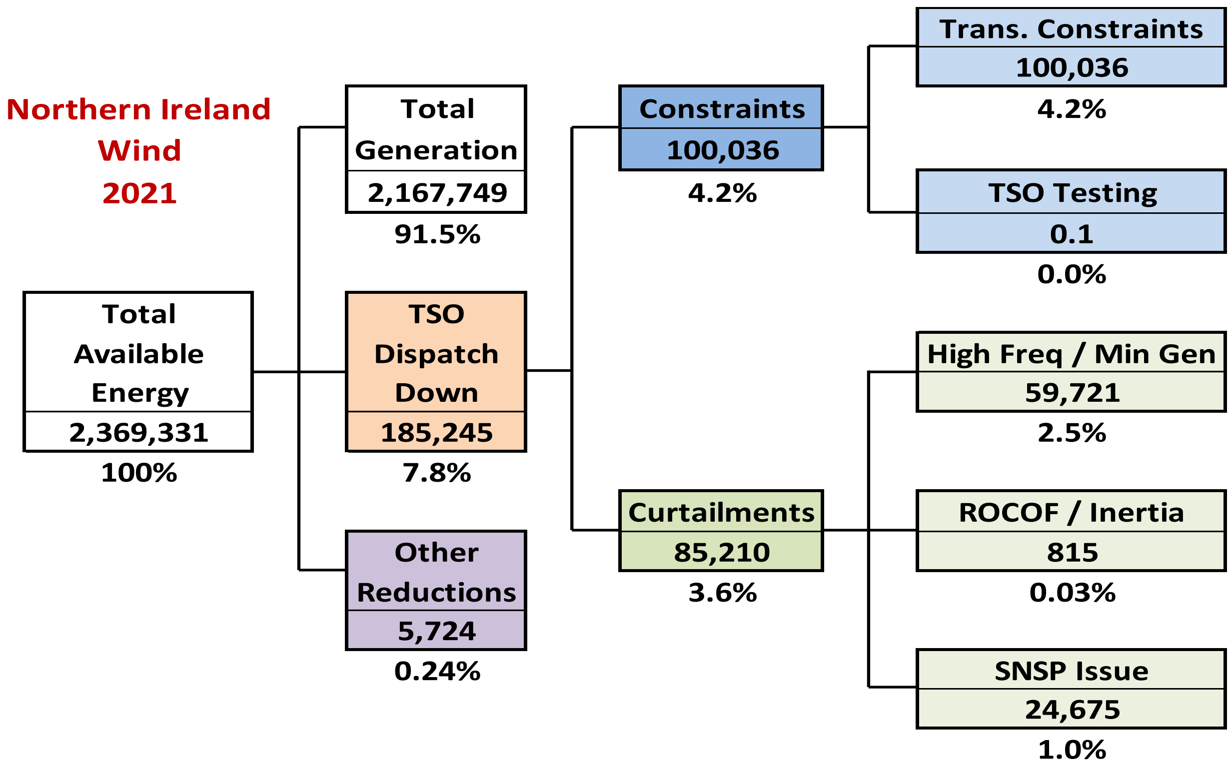


Figure 11: Monthly breakdown of wind dispatch-down categories in Northern Ireland in 2021



Wind energy breakdowns: Volumes (MWh) and percentages.
Other reductions include DSO constraints, developer outage and developer testing.
Certain types of reductions are outside of the control of the TSO and are not logged.
Therefore, Available Energy ≠ Generation + TSO Dispatch Down + Other Reductions

Figure 12: Graphical representation of Northern Ireland wind dispatch-down categories in 2021

Northern Ireland Solar

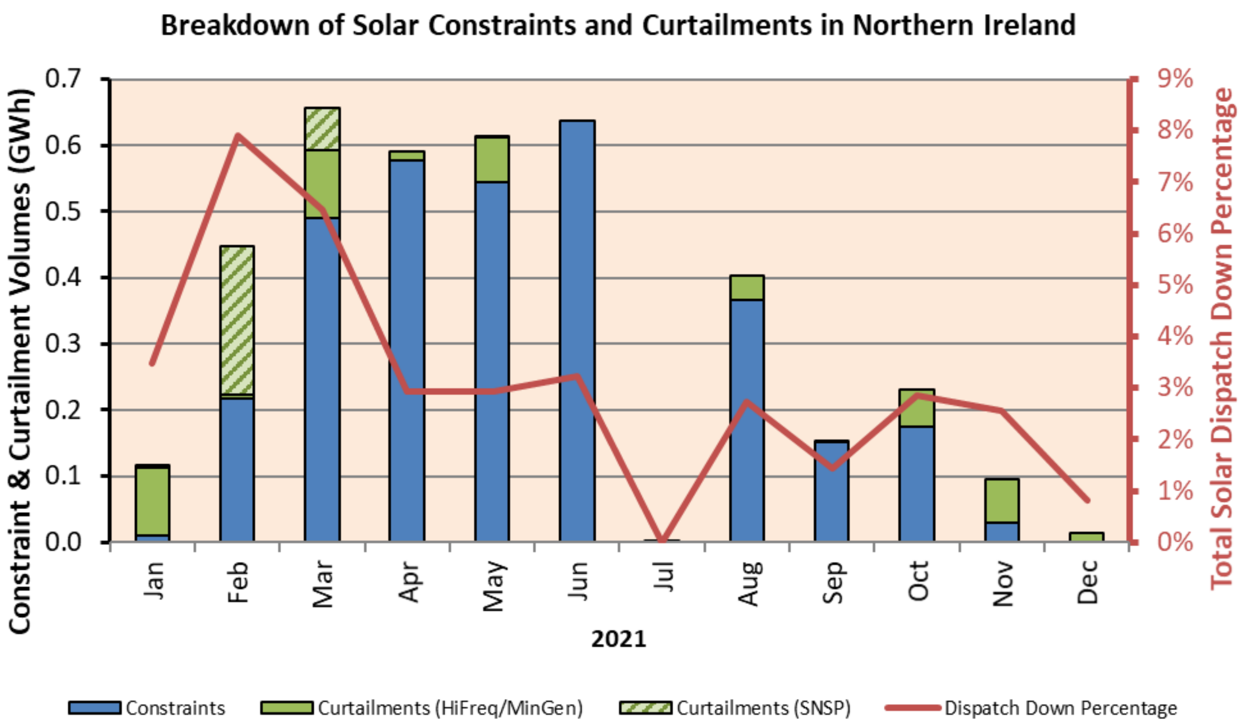


Figure 13: Monthly breakdown of solar dispatch-down categories in Northern Ireland in 2021

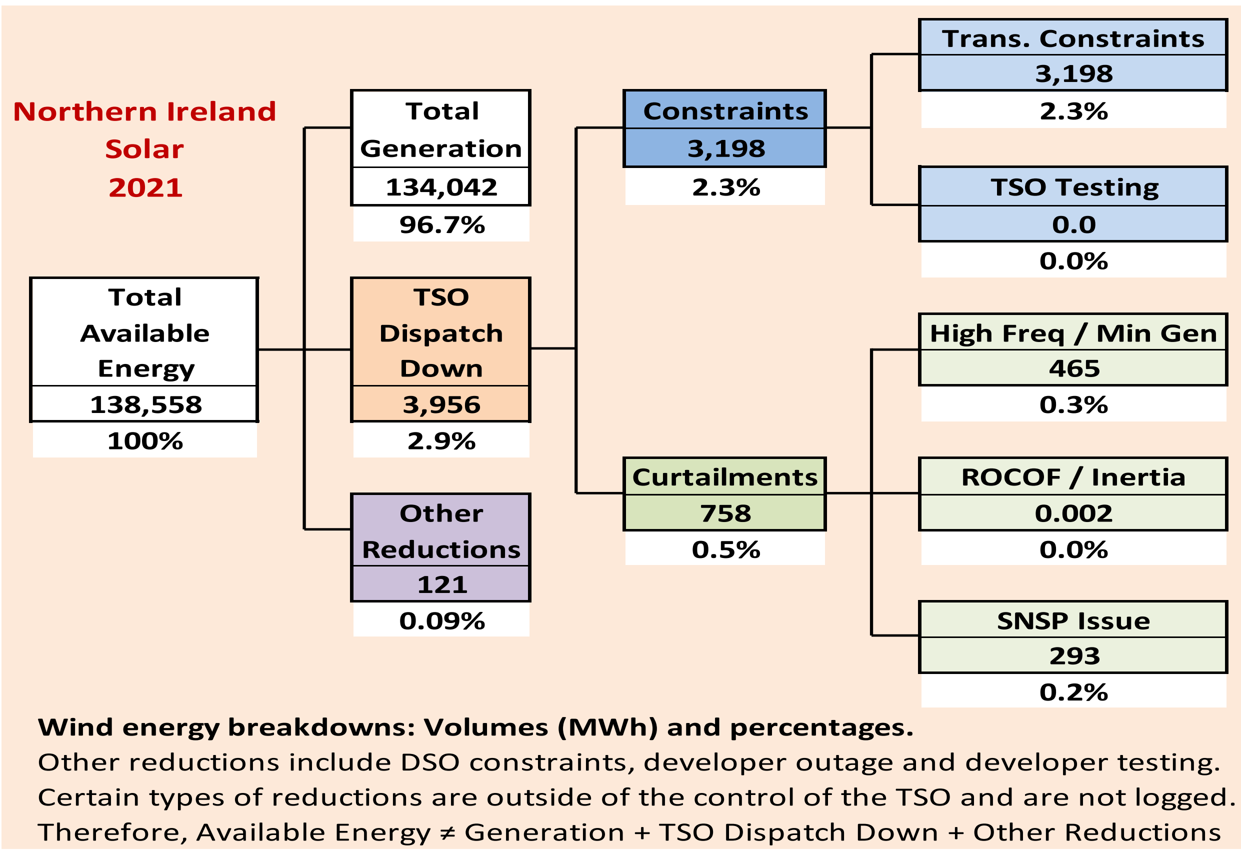


Figure 14: Graphical representation of Northern Ireland solar dispatch-down categories in 2021

Historical Wind Dispatch Down (Constraint and Curtailment) Percentages for Ireland (IE), Northern Ireland (NI) and All Island (AI)

	2011			2012			2013			2014			2015			2016		
Month	NI	IE	AI	NI	IE	AI	NI	IE	AI	NI	IE	AI	NI	IE	AI	NI	IE	AI
Jan	0.0%	0.8%	0.6%	0.5%	2.2%	1.9%	0.7%	0.4%	0.5%	2.9%	4.9%	4.5%	4.3%	4.3%	4.3%	3.4%	3.5%	3.5%
Feb	0.0%	0.6%	0.5%	0.2%	2.8%	2.2%	0.3%	0.7%	0.6%	3.2%	3.7%	3.6%	4.6%	4.1%	4.2%	2.3%	3.3%	3.1%
Mar	2.7%	1.8%	2.0%	0.8%	2.4%	2.0%	0.6%	0.3%	0.3%	1.8%	4.0%	3.5%	11.4%	8.0%	8.8%	0.9%	2.4%	2.1%
Qtr1	**0.7%**	**1.0%**	**0.9%**	**0.5%**	**2.4%**	**2.0%**	**0.6%**	**0.4%**	**0.5%**	**2.7%**	**4.2%**	**3.9%**	**6.9%**	**5.4%**	**5.8%**	**2.4%**	**3.2%**	**3.0%**
Apr	1.3%	1.2%	1.3%	0.2%	1.4%	1.2%	2.6%	4.7%	4.3%	1.8%	4.2%	3.7%	2.8%	1.8%	2.0%	0.8%	1.4%	1.3%
May	2.2%	3.5%	3.2%	0.6%	1.6%	1.4%	3.7%	6.1%	5.6%	1.5%	2.8%	2.5%	3.8%	4.5%	4.3%	1.1%	1.2%	1.2%
Jun	0.4%	0.8%	0.7%	0.4%	4.0%	3.3%	1.9%	3.7%	3.4%	0.6%	3.3%	2.7%	4.2%	5.0%	4.8%	0.3%	0.7%	0.7%
Qtr2	**1.6%**	**2.3%**	**2.2%**	**0.4%**	**2.2%**	**1.9%**	**2.9%**	**5.0%**	**4.6%**	**1.5%**	**3.4%**	**3.0%**	**3.7%**	**3.9%**	**3.8%**	**0.8%**	**1.2%**	**1.1%**
Jul	0.2%	3.3%	2.8%	0.5%	1.9%	1.6%	0.8%	4.2%	3.4%	1.6%	3.9%	3.4%	2.8%	3.8%	3.7%	6.2%	2.3%	3.1%
Aug	0.0%	0.7%	0.5%	4.0%	4.2%	4.1%	2.4%	5.4%	4.7%	3.8%	3.5%	3.6%	5.0%	5.8%	5.6%	7.0%	4.6%	5.0%
Sep	2.4%	3.9%	3.7%	0.4%	4.8%	3.7%	0.5%	4.2%	3.3%	0.1%	2.2%	1.8%	1.5%	2.7%	2.5%	5.8%	5.6%	5.6%
Qtr3	**1.5%**	**3.1%**	**2.8%**	**1.5%**	**3.8%**	**3.3%**	**1.3%**	**4.6%**	**3.9%**	**2.4%**	**3.3%**	**3.1%**	**3.1%**	**4.1%**	**3.9%**	**6.3%**	**4.4%**	**4.8%**
Oct	2.4%	4.7%	4.3%	0.0%	0.3%	0.2%	1.6%	5.9%	5.0%	4.5%	8.2%	7.4%	4.2%	3.8%	3.9%	1.9%	1.8%	1.8%
Nov	1.2%	2.3%	2.1%	0.1%	1.0%	0.8%	4.0%	3.0%	3.2%	2.0%	3.2%	3.0%	6.9%	6.8%	6.9%	2.7%	1.0%	1.3%
Dec	0.7%	2.2%	1.9%	0.8%	2.8%	2.5%	2.0%	4.4%	3.8%	4.5%	5.0%	4.9%	6.2%	6.3%	6.3%	3.8%	3.1%	3.3%
Qtr4	**1.4%**	**2.9%**	**2.6%**	**0.4%**	**1.6%**	**1.4%**	**2.4%**	**4.5%**	**4.0%**	**3.9%**	**5.7%**	**5.3%**	**6.1%**	**6.0%**	**6.0%**	**3.0%**	**2.1%**	**2.3%**
Year Total DD	**1.3%**	**2.4%**	**2.2%**	**0.7%**	**2.5%**	**2.1%**	**1.9%**	**3.5%**	**3.2%**	**2.8%**	**4.4%**	**4.1%**	**5.3%**	**5.1%**	**5.1%**	**3.2%**	**2.8%**	**2.9%**
Constraints	0.3%	0.5%	0.4%	0.3%	0.9%	0.8%	0.5%	1.0%	0.9%	1.0%	1.5%	1.4%	1.9%	1.8%	1.8%	1.3%	1.4%	1.4%
Curtailments	1.1%	2.0%	1.8%	0.4%	1.5%	1.3%	1.3%	2.5%	2.3%	1.8%	2.9%	2.6%	3.4%	3.3%	3.3%	1.9%	1.4%	1.5%
Wind Installed Capacity (MW)	512	1,585	2,097	600	1,703	2,303	640	1,923	2,563	729	2,266	2,996	751	2,447	3,198	943	2,795	3,737
Wind Generation (GWh)	943	4,256	5,198	1,020	4,102	5,122	1,259	4,642	5,901	1,453	5,116	6,568	1,803	6,537	8,339	1,725	6,115	7,840
Wind Capacity Factors	21%	31%	28%	21%	28%	27%	23%	29%	28%	24%	28%	27%	28%	32%	31%	23%	27%	26%
SNSP Limit	50%			50%			50%			50%			55% Trial from Oct			55% Perm from Mar 60% Trial from Nov		

	2017			2018			2019			2020			2021		
Month	NI	IE	AI	NI	IE	AI	NI	IE	AI	NI	IE	AI	NI	IE	AI
Jan	2.4%	1.9%	2.0%	5.7%	3.5%	3.9%	9.7%	3.8%	5.1%	12.3%	9.0%	9.8%	5.2%	5.3%	5.3%
Feb	2.0%	1.7%	1.7%	2.9%	2.0%	2.2%	10.7%	6.8%	7.7%	17.4%	12.3%	13.4%	11.5%	10.2%	10.5%
Mar	3.0%	3.4%	3.3%	5.9%	4.4%	4.7%	11.8%	9.2%	9.8%	14.5%	10.7%	11.4%	9.8%	12.8%	12.2%
Qtr1	**2.4%**	**2.3%**	**2.4%**	**4.9%**	**3.3%**	**3.6%**	**10.8%**	**6.8%**	**7.7%**	**14.9%**	**10.9%**	**11.7%**	**9.4%**	**9.7%**	**9.6%**
Apr	4.2%	3.5%	3.6%	19.2%	7.4%	9.8%	11.4%	9.0%	9.6%	21.8%	9.0%	11.8%	4.7%	2.1%	2.5%
May	3.6%	3.5%	3.5%	6.1%	4.7%	5.0%	3.8%	4.1%	4.0%	19.8%	12.6%	13.9%	10.1%	11.8%	11.5%
Jun	4.7%	3.9%	4.1%	11.0%	8.0%	8.6%	11.2%	5.6%	6.7%	26.2%	15.4%	17.5%	2.1%	2.4%	2.4%
Qtr2	**4.2%**	**3.7%**	**3.8%**	**13.0%**	**6.6%**	**8.0%**	**9.4%**	**6.6%**	**7.2%**	**22.7%**	**12.7%**	**14.6%**	**6.0%**	**6.1%**	**6.1%**
Jul	4.4%	2.8%	3.2%	2.1%	1.9%	2.0%	8.2%	3.8%	4.8%	12.4%	9.2%	9.8%	5.9%	0.5%	1.2%
Aug	3.1%	2.8%	2.9%	5.8%	2.2%	3.0%	15.2%	8.4%	9.8%	14.4%	11.4%	11.9%	7.0%	7.1%	7.1%
Sep	4.2%	5.4%	5.1%	13.1%	5.5%	7.4%	8.4%	8.2%	8.2%	9.0%	9.0%	9.0%	7.5%	5.5%	5.9%
Qtr3	**3.9%**	**3.9%**	**3.9%**	**8.7%**	**3.6%**	**4.8%**	**11.0%**	**7.3%**	**8.0%**	**11.6%**	**9.8%**	**10.2%**	**7.1%**	**5.1%**	**5.4%**
Oct	14.6%	9.2%	10.6%	10.2%	6.9%	7.7%	7.4%	6.4%	6.6%	12.4%	13.9%	13.6%	9.7%	8.0%	8.4%
Nov	3.2%	2.5%	2.6%	10.2%	5.2%	6.4%	7.4%	3.9%	4.5%	12.8%	13.4%	13.3%	6.4%	6.1%	6.2%
Dec	5.3%	2.5%	3.1%	14.9%	7.2%	8.9%	16.2%	9.6%	11.0%	9.8%	9.7%	9.7%	6.4%	5.4%	5.6%
Qtr4	**8.5%**	**4.9%**	**5.7%**	**11.7%**	**6.4%**	**7.7%**	**11.1%**	**6.9%**	**7.8%**	**11.6%**	**12.3%**	**12.2%**	**7.5%**	**6.4%**	**6.6%**
Year Total DD	**5.0%**	**3.7%**	**4.0%**	**9.4%**	**5.0%**	**6.0%**	**10.7%**	**6.9%**	**7.7%**	**14.8%**	**11.4%**	**12.1%**	**7.8%**	**7.3%**	**7.4%**
Constraints	1.9%	1.0%	1.2%	4.0%	1.7%	2.2%	4.7%	3.8%	4.0%	6.6%	6.1%	6.2%	4.2%	4.5%	4.4%
Curtailments	3.1%	2.6%	2.7%	5.4%	3.3%	3.8%	6.0%	3.1%	3.7%	8.2%	5.3%	5.9%	3.6%	2.8%	3.0%
Wind Installed Capacity (MW)	1,154	3,312	4,466	1,276	3,667	4,943	1,276	4,120	5,396	1,276	4,300	5,576	1,351	4,332	5,683
Wind Generation (GWh)	2,051	7,229	9,280	2,391	8,685	11,076	2,462	9,532	11,994	2,630	11,138	13,768	2,168	9,527	11,695
Wind Capacity Factors	22%	27%	26%	22%	28%	27%	22%	28%	26%	24%	30%	29%	19%	25%	24%
SNSP Limit	60% Perm from Mar 65% Trial from Nov			65% Perm from Apr			65%			65%			70% Trial from Jan 70% Perm from Apr 75% Trial from Apr		

Notes:

"Dispatch Down" consists of constraints + curtailments. All wind figures included (controllable + non-controllable).

The darker shaded cells indicate higher dispatch-down percentages in order to produce a graphical representation similar to a heat map.

A more accurate methodology for calculating wind dispatch down was implemented from 2016. Figures from previous years are best estimates.

Wind installed capacities, generation and capacity factors are indicative and based on the latest available information.

SNSP (System Non-Synchronous Penetration) is the sum of non-synchronous generation (such as wind, solar and HVDC imports) as a percentage of total demand and exports.

When the SNSP limit is raised, a trial period takes place before it becomes permanent. During the trial period, the system is operated at this increased SNSP limit except in times of extreme system events or during system testing.

For more infomration see our annual and monthly dispatch down reports on: http://www.eirgridgroup.com/how-the-grid-works/renewables/ or: https://www.soni.ltd.uk/how-the-grid-works/renewables/

Table 3: Historical Wind Dispatch-Down Summary in Ireland, Northern Ireland and All-Island

Wind Dispatch Down Percentages and Breakdown per Region (Controllable Windfarms only)

Controllable Wind By Region	Cap (MW)	2016 Qtr1	2016 Qtr2	2016 Qtr3	2016 Qtr4	2016	2017 Qtr1	2017 Qtr2	2017 Qtr3	2017 Qtr4	2017	2018 Qtr1	2018 Qtr2	2018 Qtr3	2018 Qtr4	2018
MID	473	**1.3%**	**0.4%**	**2.6%**	**1.8%**	**1.5%**	**2.7%**	**4.0%**	**4.2%**	**5.4%**	**4.1%**	**4.9%**	**5.4%**	**2.7%**	**5.6%**	**4.8%**
Constraints		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.0%	1.7%	0.8%	1.3%	0.1%	0.8%	0.2%	0.6%
Curtailments		1.3%	0.4%	2.5%	1.7%	1.5%	2.7%	3.7%	3.1%	3.7%	3.3%	3.6%	5.3%	1.9%	5.4%	4.2%
NE	143	**0.9%**	**0.5%**	**1.9%**	**2.1%**	**1.4%**	**2.7%**	**2.6%**	**2.7%**	**4.7%**	**3.3%**	**3.2%**	**5.3%**	**2.7%**	**5.0%**	**4.1%**
Constraints		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%
Curtailments		0.9%	0.5%	1.9%	2.1%	1.4%	2.7%	2.6%	2.7%	4.7%	3.3%	3.2%	5.3%	2.6%	4.9%	4.1%
NW	354	**2.8%**	**1.8%**	**8.2%**	**2.9%**	**3.8%**	**2.9%**	**5.0%**	**5.1%**	**6.9%**	**4.9%**	**4.9%**	**9.4%**	**11.1%**	**12.9%**	**9.4%**
Constraints		1.3%	1.5%	5.9%	1.2%	2.3%	1.1%	1.5%	2.2%	2.2%	1.7%	0.7%	3.3%	9.4%	8.3%	5.2%
Curtailments		1.5%	0.3%	2.3%	1.6%	1.5%	1.8%	3.4%	2.9%	4.8%	3.2%	4.2%	6.0%	1.7%	4.6%	4.2%
SE	320	**2.4%**	**0.6%**	**2.6%**	**1.8%**	**1.9%**	**2.5%**	**3.2%**	**3.1%**	**4.7%**	**3.4%**	**4.0%**	**5.9%**	**2.6%**	**5.1%**	**4.4%**
Constraints		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.4%	0.0%	0.1%
Curtailments		2.4%	0.6%	2.5%	1.8%	1.9%	2.5%	3.2%	3.0%	4.6%	3.4%	4.0%	5.9%	2.2%	5.1%	4.4%
SW	1,591	**6.2%**	**2.1%**	**6.8%**	**2.9%**	**4.8%**	**3.0%**	**5.3%**	**3.8%**	**5.1%**	**4.2%**	**3.1%**	**8.7%**	**3.1%**	**7.3%**	**5.6%**
Constraints		4.7%	1.7%	4.6%	1.3%	3.3%	0.7%	2.6%	1.2%	1.3%	1.3%	0.3%	5.3%	1.8%	2.8%	2.3%
Curtailments		1.5%	0.4%	2.2%	1.6%	1.5%	2.3%	2.6%	2.6%	3.8%	2.8%	2.8%	3.4%	1.2%	4.5%	3.2%
W	919	**2.0%**	**1.4%**	**4.0%**	**2.5%**	**2.5%**	**2.1%**	**3.1%**	**6.7%**	**6.4%**	**4.8%**	**3.3%**	**7.2%**	**4.0%**	**6.6%**	**5.3%**
Constraints		0.2%	0.5%	0.0%	0.5%	0.3%	0.2%	0.3%	4.4%	2.5%	2.0%	0.2%	2.4%	2.1%	2.0%	1.6%
Curtailments		1.8%	0.9%	4.0%	2.1%	2.2%	1.9%	2.8%	2.3%	3.9%	2.8%	3.2%	4.7%	1.9%	4.6%	3.7%
Controllable Wind Totals:																
AI	4,890	**3.5%**	**1.3%**	**5.6%**	**2.6%**	**3.4%**	**2.7%**	**4.3%**	**4.5%**	**6.3%**	**4.5%**	**4.1%**	**8.9%**	**5.3%**	**8.5%**	**6.7%**
Constraints		1.7%	0.8%	2.9%	0.9%	1.6%	0.4%	1.3%	1.9%	2.1%	1.4%	0.6%	2.8%	3.4%	3.4%	2.5%
Curtailments		1.8%	0.5%	2.7%	1.7%	1.8%	2.3%	3.0%	2.6%	4.2%	3.1%	3.5%	6.1%	1.9%	5.1%	4.2%
IE	3,801	**3.7%**	**1.4%**	**5.2%**	**2.5%**	**3.3%**	**2.7%**	**4.3%**	**4.5%**	**5.6%**	**4.2%**	**3.7%**	**7.5%**	**4.0%**	**7.2%**	**5.6%**
Constraints		2.2%	0.9%	2.6%	0.7%	1.7%	0.4%	1.2%	1.8%	1.5%	1.2%	0.4%	2.9%	2.4%	2.4%	1.9%
Curtailments		1.6%	0.5%	2.5%	1.7%	1.6%	2.3%	3.0%	2.7%	4.0%	3.0%	3.3%	4.6%	1.7%	4.7%	3.7%
NI	1,089	**2.8%**	**0.9%**	**7.0%**	**3.3%**	**3.6%**	**2.6%**	**4.5%**	**4.3%**	**8.7%**	**5.3%**	**5.3%**	**13.8%**	**9.0%**	**12.6%**	**10.0%**
Constraints		0.0%	0.3%	3.8%	1.6%	1.4%	0.2%	1.3%	2.0%	3.8%	2.0%	1.0%	2.5%	6.6%	6.5%	4.3%
Curtailments		2.7%	0.6%	3.2%	1.7%	2.2%	2.4%	3.2%	2.3%	4.8%	3.3%	4.3%	11.3%	2.4%	6.0%	5.7%
All Wind (Controllable + Non-Controllable) Totals:																
AI		**3.2%**	**1.2%**	**4.8%**	**2.3%**	**3.0%**	**2.4%**	**3.8%**	**3.9%**	**5.7%**	**4.0%**	**3.6%**	**8.0%**	**4.8%**	**7.7%**	**6.0%**
Constraints		1.6%	0.7%	2.5%	0.8%	1.4%	0.3%	1.1%	1.6%	1.9%	1.2%	0.5%	2.5%	3.1%	3.1%	2.2%
Curtailments		1.6%	0.5%	2.3%	1.5%	1.6%	2.0%	2.7%	2.3%	3.8%	2.7%	3.1%	5.5%	1.7%	4.6%	3.8%
IE		**3.3%**	**1.2%**	**4.4%**	**2.1%**	**2.9%**	**2.3%**	**3.7%**	**3.9%**	**4.9%**	**3.7%**	**3.3%**	**6.6%**	**3.6%**	**6.4%**	**5.0%**
Constraints		1.9%	0.8%	2.2%	0.6%	1.4%	0.4%	1.1%	1.6%	1.3%	1.0%	0.4%	2.6%	2.1%	2.2%	1.7%
Curtailments		1.4%	0.4%	2.2%	1.5%	1.4%	2.0%	2.6%	2.3%	3.6%	2.6%	2.9%	4.1%	1.5%	4.2%	3.3%
NI		**2.7%**	**0.9%**	**6.3%**	**3.0%**	**3.4%**	**2.4%**	**4.2%**	**3.9%**	**8.5%**	**5.0%**	**4.9%**	**13.0%**	**8.7%**	**11.7%**	**9.4%**
Constraints		0.0%	0.3%	3.4%	1.5%	1.3%	0.2%	1.3%	1.8%	3.7%	1.9%	1.0%	2.3%	6.4%	6.1%	4.0%
Curtailments		2.7%	0.6%	2.9%	1.5%	2.0%	2.2%	3.0%	2.1%	4.8%	3.1%	4.0%	10.7%	2.3%	5.6%	5.4%

Controllable Wind By Region	2019 Qtr1	2019 Qtr2	2019 Qtr3	2019 Qtr4	2019	2020 Qtr1	2020 Qtr2	2020 Qtr3	2020 Qtr4	2020	2021 Qtr1	2021 Qtr2	2021 Qtr3	2021 Qtr4	2021
MID	**5.2%**	**4.6%**	**4.9%**	**6.8%**	**5.5%**	**12.3%**	**12.3%**	**7.4%**	**10.9%**	**11.0%**	**5.5%**	**2.7%**	**4.7%**	**4.8%**	**4.6%**
Constraints	0.2%	0.9%	2.4%	3.5%	1.8%	2.9%	2.6%	4.5%	6.3%	4.2%	0.7%	1.3%	1.2%	0.6%	0.9%
Curtailments	5.1%	3.7%	2.4%	3.3%	3.7%	9.5%	9.7%	2.9%	4.6%	6.9%	4.8%	1.4%	3.4%	4.1%	3.7%
NE	**5.0%**	**4.1%**	**2.6%**	**4.8%**	**4.3%**	**9.2%**	**9.8%**	**3.2%**	**5.6%**	**7.3%**	**5.2%**	**2.3%**	**2.7%**	**3.5%**	**3.8%**
Constraints	0.1%	0.0%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Curtailments	4.9%	4.1%	2.4%	4.6%	4.2%	9.2%	9.8%	3.2%	5.4%	7.2%	5.2%	2.2%	2.6%	3.5%	3.8%
NW	**9.9%**	**8.9%**	**13.7%**	**7.5%**	**9.8%**	**13.9%**	**18.0%**	**17.5%**	**14.7%**	**15.5%**	**10.4%**	**8.9%**	**6.3%**	**8.5%**	**9.0%**
Constraints	4.8%	4.7%	11.7%	2.9%	5.6%	4.8%	9.6%	16.0%	9.2%	8.9%	5.5%	7.7%	4.4%	4.3%	5.5%
Curtailments	5.2%	4.1%	2.0%	4.6%	4.2%	9.1%	8.4%	1.5%	5.6%	6.6%	4.8%	1.2%	1.8%	4.2%	3.5%
SE	**4.6%**	**3.5%**	**2.9%**	**4.0%**	**3.9%**	**9.9%**	**15.5%**	**11.2%**	**6.9%**	**10.2%**	**4.9%**	**3.1%**	**2.9%**	**4.1%**	**4.0%**
Constraints	0.1%	0.0%	0.2%	0.6%	0.2%	0.9%	5.0%	8.8%	1.5%	3.3%	0.3%	1.5%	0.1%	0.0%	0.4%
Curtailments	4.5%	3.5%	2.7%	3.4%	3.6%	9.0%	10.4%	2.4%	5.4%	7.0%	4.6%	1.6%	2.8%	4.1%	3.6%
SW	**9.4%**	**8.6%**	**8.2%**	**8.5%**	**8.7%**	**12.3%**	**13.5%**	**9.7%**	**14.7%**	**12.8%**	**13.2%**	**6.8%**	**4.8%**	**7.3%**	**8.8%**
Constraints	5.6%	5.6%	6.1%	5.6%	5.7%	3.8%	7.2%	7.3%	11.0%	7.3%	9.6%	5.9%	2.8%	4.1%	6.1%
Curtailments	3.8%	3.0%	2.1%	2.9%	3.0%	8.5%	6.3%	2.5%	3.7%	5.5%	3.6%	0.9%	2.0%	3.3%	2.7%
W	**6.3%**	**7.6%**	**10.9%**	**7.4%**	**7.8%**	**10.7%**	**14.4%**	**11.6%**	**15.9%**	**13.1%**	**12.1%**	**9.7%**	**8.7%**	**9.1%**	**10.2%**
Constraints	2.2%	3.7%	9.3%	4.3%	4.6%	4.5%	8.5%	9.9%	11.8%	8.4%	8.2%	8.8%	6.0%	5.8%	7.2%
Curtailments	4.1%	3.8%	1.7%	3.0%	3.2%	6.2%	5.9%	1.7%	4.1%	4.7%	4.0%	0.9%	2.7%	3.3%	3.0%
Controllable Wind Totals:															
AI	**8.5%**	**7.8%**	**8.7%**	**8.2%**	**8.3%**	**12.6%**	**16.0%**	**10.8%**	**13.2%**	**13.1%**	**10.4%**	**6.6%**	**5.9%**	**7.2%**	**8.0%**
Constraints	3.4%	3.6%	6.0%	4.5%	4.3%	3.7%	7.9%	8.3%	8.4%	6.7%	6.0%	5.5%	3.5%	3.6%	4.8%
Curtailments	5.1%	4.1%	2.8%	3.7%	4.0%	8.9%	8.0%	2.5%	4.8%	6.4%	4.4%	1.2%	2.4%	3.6%	3.2%
IE	**7.5%**	**7.2%**	**8.0%**	**7.3%**	**7.5%**	**11.7%**	**14.0%**	**10.5%**	**13.5%**	**12.4%**	**10.6%**	**6.7%**	**5.6%**	**7.1%**	**8.0%**
Constraints	3.2%	3.7%	5.8%	4.1%	4.1%	3.5%	6.6%	8.2%	9.1%	6.6%	6.5%	5.6%	3.1%	3.5%	4.9%
Curtailments	4.3%	3.5%	2.1%	3.3%	3.4%	8.2%	7.4%	2.3%	4.3%	5.8%	4.1%	1.1%	2.5%	3.5%	3.1%
NI	**11.6%**	**10.1%**	**11.6%**	**11.7%**	**11.3%**	**15.7%**	**23.9%**	**12.2%**	**12.2%**	**15.5%**	**9.8%**	**6.2%**	**7.4%**	**7.8%**	**8.2%**
Constraints	3.9%	3.4%	6.4%	6.3%	5.0%	4.3%	13.3%	8.6%	5.3%	6.9%	4.3%	4.8%	5.4%	4.0%	4.4%
Curtailments	7.7%	6.7%	5.1%	5.4%	6.3%	11.3%	10.6%	3.6%	6.9%	8.6%	5.5%	1.4%	2.0%	3.8%	3.8%
All Wind (Controllable + Non-Controllable) Totals:															
AI	**7.7%**	**7.2%**	**8.0%**	**7.8%**	**7.7%**	**11.7%**	**14.6%**	**10.2%**	**12.2%**	**12.1%**	**9.6%**	**6.1%**	**5.4%**	**6.6%**	**7.4%**
Constraints	3.1%	3.4%	5.5%	4.3%	4.0%	3.4%	7.3%	7.8%	7.7%	6.2%	5.5%	5.0%	3.2%	3.3%	4.4%
Curtailments	4.6%	3.8%	2.6%	3.5%	3.7%	8.3%	7.3%	2.4%	4.4%	5.9%	4.1%	1.1%	2.2%	3.3%	3.0%
IE	**6.8%**	**6.6%**	**7.3%**	**6.9%**	**6.9%**	**10.9%**	**12.7%**	**9.8%**	**12.3%**	**11.4%**	**9.7%**	**6.1%**	**5.1%**	**6.4%**	**7.3%**
Constraints	2.9%	3.4%	5.3%	3.8%	3.8%	3.3%	6.0%	7.7%	8.3%	6.1%	5.9%	5.1%	2.9%	3.2%	4.5%
Curtailments	3.9%	3.2%	1.9%	3.1%	3.1%	7.6%	6.7%	2.1%	3.9%	5.3%	3.8%	1.0%	2.2%	3.2%	2.8%
NI	**10.8%**	**9.4%**	**11.0%**	**11.1%**	**10.7%**	**14.9%**	**22.7%**	**11.6%**	**11.6%**	**14.8%**	**9.4%**	**6.0%**	**7.1%**	**7.5%**	**7.8%**
Constraints	3.6%	3.2%	6.1%	5.9%	4.7%	4.1%	12.6%	8.2%	5.0%	6.6%	4.1%	4.6%	5.2%	3.8%	4.2%
Curtailments	7.2%	6.2%	4.9%	5.2%	6.0%	10.8%	10.1%	3.4%	6.6%	8.2%	5.3%	1.3%	1.9%	3.7%	3.6%

Table 4: Historical breakdown of wind dispatch down percentages by region and jurisdiction

			2021 Jan	Feb	Mar	Qtr1	Apr	May	Jun	Qtr2	Jul	Aug	Sep	Qtr3	Oct	Nov	Dec	Qtr4	2021
Wind	**AI**	**Dispatch Down**	**5.3%**	**10.5%**	**12.2%**	**9.6%**	**2.5%**	**11.5%**	**2.4%**	**6.1%**	**1.2%**	**7.1%**	**5.9%**	**5.4%**	**8.4%**	**6.2%**	**5.6%**	**6.6%**	**7.4%**
		Constraints	2.7%	5.3%	8.4%	5.5%	2.1%	9.2%	2.3%	5.0%	1.2%	3.9%	3.6%	3.2%	5.3%	3.2%	1.8%	3.3%	4.4%
		Curtailments	2.6%	5.2%	3.8%	4.1%	0.4%	2.3%	0.0%	1.1%	0.0%	3.2%	2.2%	2.2%	3.1%	2.9%	3.8%	3.3%	3.0%
	IE	**Dispatch Down**	**5.3%**	**10.2%**	**12.8%**	**9.7%**	**2.1%**	**11.8%**	**2.4%**	**6.1%**	**0.5%**	**7.1%**	**5.5%**	**5.1%**	**8.0%**	**6.1%**	**5.4%**	**6.4%**	**7.3%**
		Constraints	2.9%	5.4%	9.3%	5.9%	1.7%	9.7%	2.4%	5.1%	0.5%	3.7%	3.3%	2.9%	4.9%	3.4%	1.7%	3.2%	4.5%
		Curtailments	2.4%	4.8%	3.5%	3.8%	0.4%	2.1%	0.0%	1.0%	0.0%	3.4%	2.2%	2.2%	3.1%	2.7%	3.8%	3.2%	2.8%
	NI	**Dispatch Down**	**5.2%**	**11.5%**	**9.8%**	**9.4%**	**4.7%**	**10.1%**	**2.1%**	**6.0%**	**5.9%**	**7.0%**	**7.5%**	**7.1%**	**9.7%**	**6.4%**	**6.4%**	**7.5%**	**7.8%**
		Constraints	1.6%	4.9%	4.9%	4.1%	4.4%	6.9%	2.0%	4.6%	5.9%	5.1%	4.9%	5.2%	6.8%	2.5%	2.4%	3.8%	4.2%
		Curtailments	3.6%	6.6%	4.9%	5.3%	0.4%	3.2%	0.0%	1.3%	0.0%	1.9%	2.6%	1.9%	3.0%	4.0%	4.0%	3.7%	3.6%
Solar	**NI**	**Dispatch Down**	**3.5%**	**7.9%**	**6.5%**	**6.4%**	**2.9%**	**2.9%**	**3.2%**	**3.0%**	**0.0%**	**2.7%**	**1.4%**	**1.2%**	**2.9%**	**2.6%**	**0.8%**	**2.5%**	**2.9%**
		Constraints	0.3%	3.8%	4.8%	3.7%	2.8%	2.6%	3.2%	2.9%	0.0%	2.5%	1.4%	1.2%	2.2%	0.8%	0.1%	1.5%	2.3%
		Curtailments	3.2%	4.1%	1.6%	2.6%	0.1%	0.3%	0.0%	0.1%	0.0%	0.2%	0.0%	0.1%	0.7%	1.8%	0.7%	1.0%	0.5%

Table 5: Wind and solar monthly dispatch down percentages and breakdowns in 2021

2021 All RES DD Summary Volumes (MWh) and Percentages	All Island Availability	All Island Generation	All Island Dispatch Down	All Island Dispatch Down	Ireland Availability	Ireland Generation	Ireland Dispatch Down	Ireland Dispatch Down	Northern Ireland Availability	Northern Ireland Generation	Northern Ireland Dispatch Down	Northern Ireland Dispatch Down
Wind	12,695,627	11,694,776	937,622	7.4%	10,326,296	9,527,027	752,376	7.3%	2,369,331	2,167,749	185,245	7.8%
Solar	138,558	134,042	3,956	2.9%	-	-	-	0.0%	138,558	134,042	3,956	2.9%
Waste	309,263	303,052	15,116	4.9%	309,263	303,052	15,116	4.9%	-	-	-	0.0%
Hydro	757,290	757,290	-	0.0%	742,121	742,121	-	0.0%	15,169	15,169	-	0.0%
Other RES	946,362	946,362	-	0.0%	582,251	582,251	-	0.0%	364,111	364,111		0.0%
Total RES	14,847,100	13,835,522	956,694	6.4%	11,959,931	11,154,450	767,492	6.4%	2,887,169	2,681,072	189,202	6.6%

Table 6: All renewable sources dispatch down in 2021

RES: Renewable Energy Sources.

Other RES category consists of generation from Biomass, Biogas and Landfill Gas.

Appendix B – Wind and Solar Dispatch Down by Hour of Day

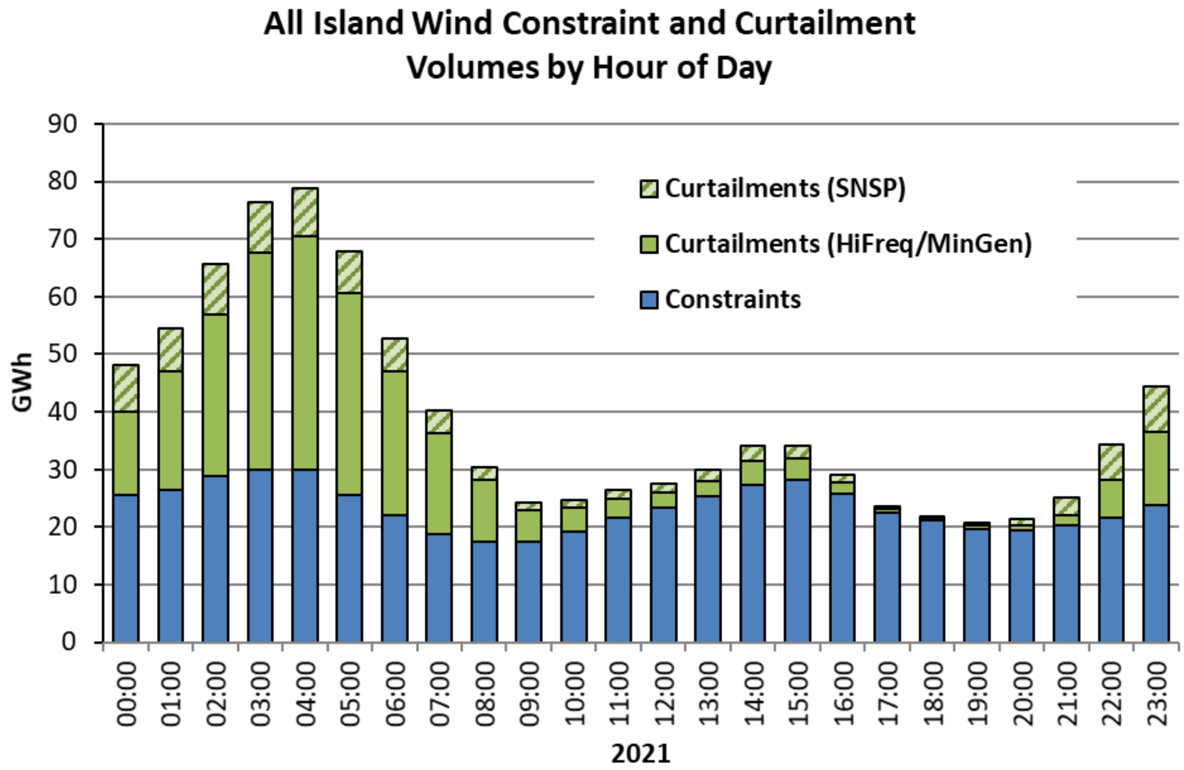


Figure 15: All-Island breakdown of wind constraints and curtailments in 2021 by hour of day

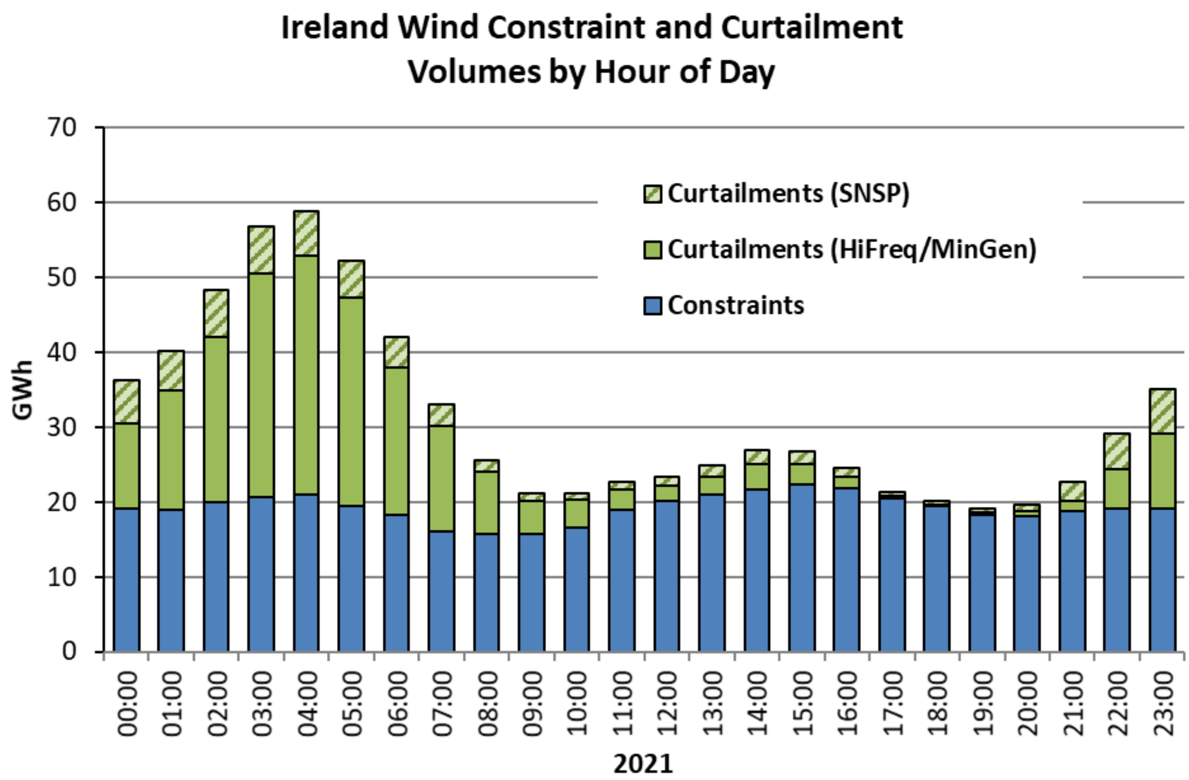


Figure 16: Breakdown of wind constraints and curtailments In Ireland in 2021 by hour of day

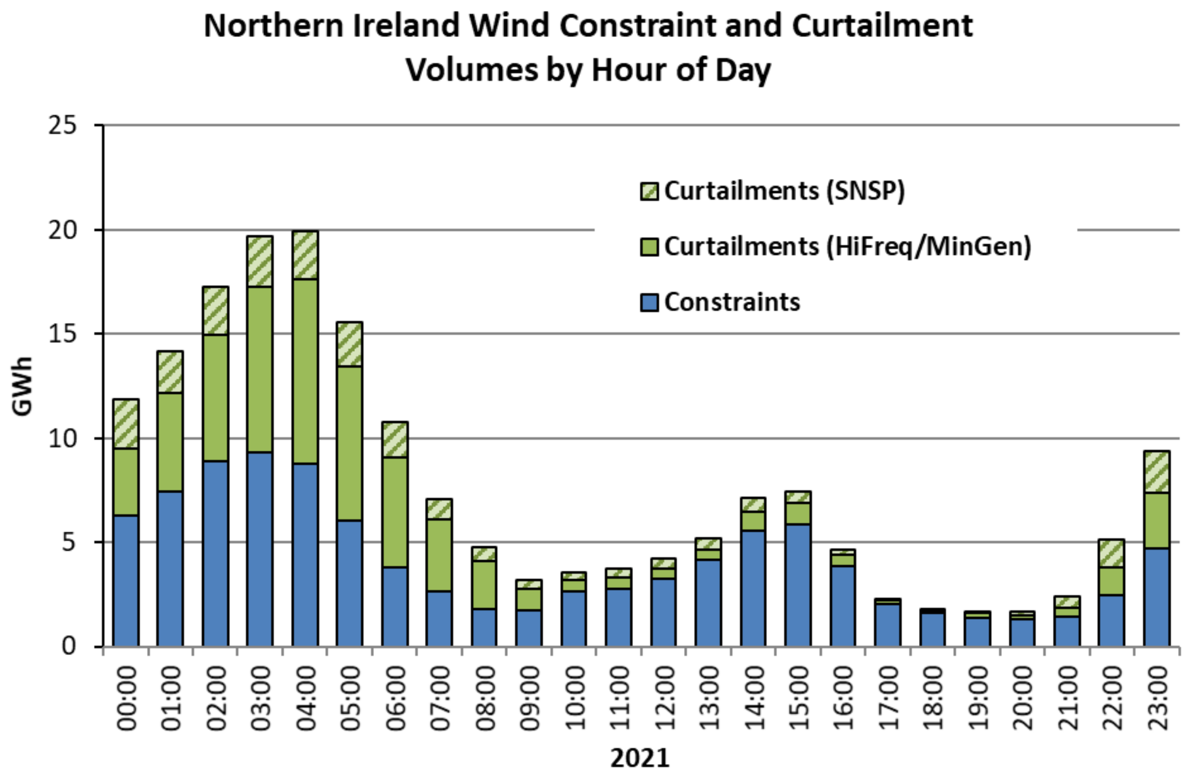


Figure 17: Breakdown of wind constraints and curtailments in NI in 2021 by hour of day

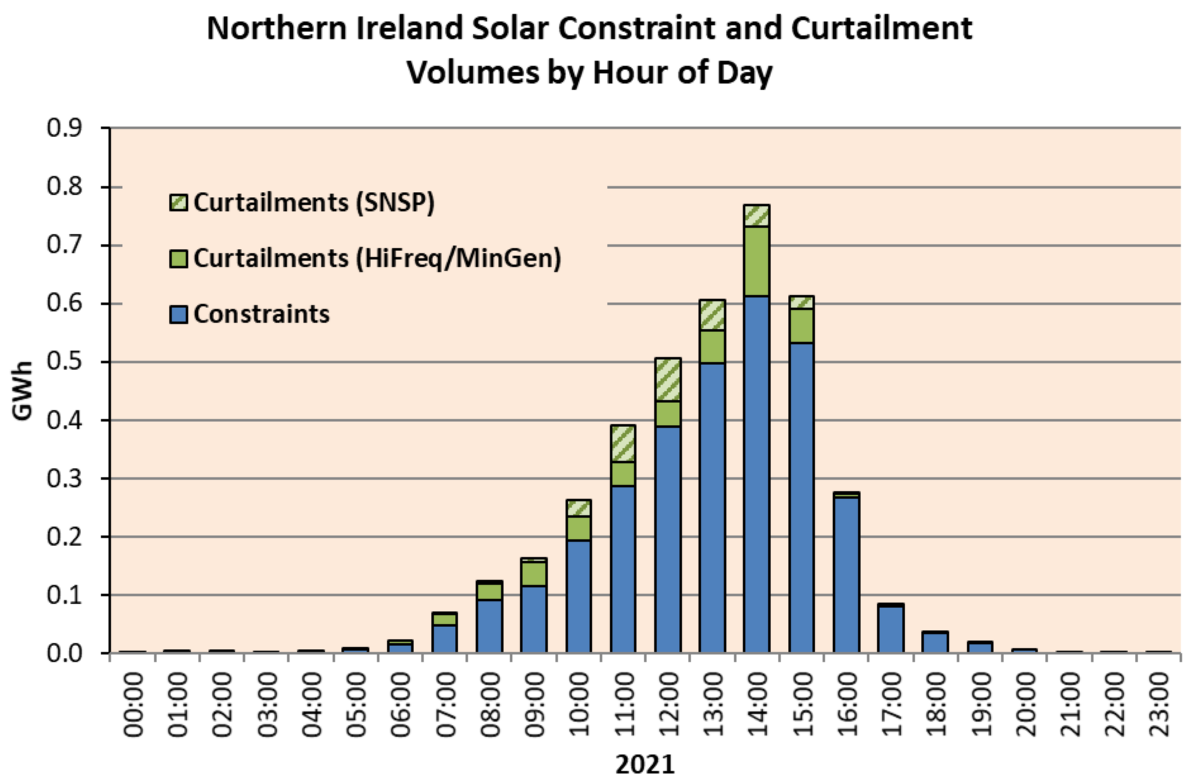


Figure 18: Breakdown of solar constraints and curtailments in NI in 2021 by hour of day

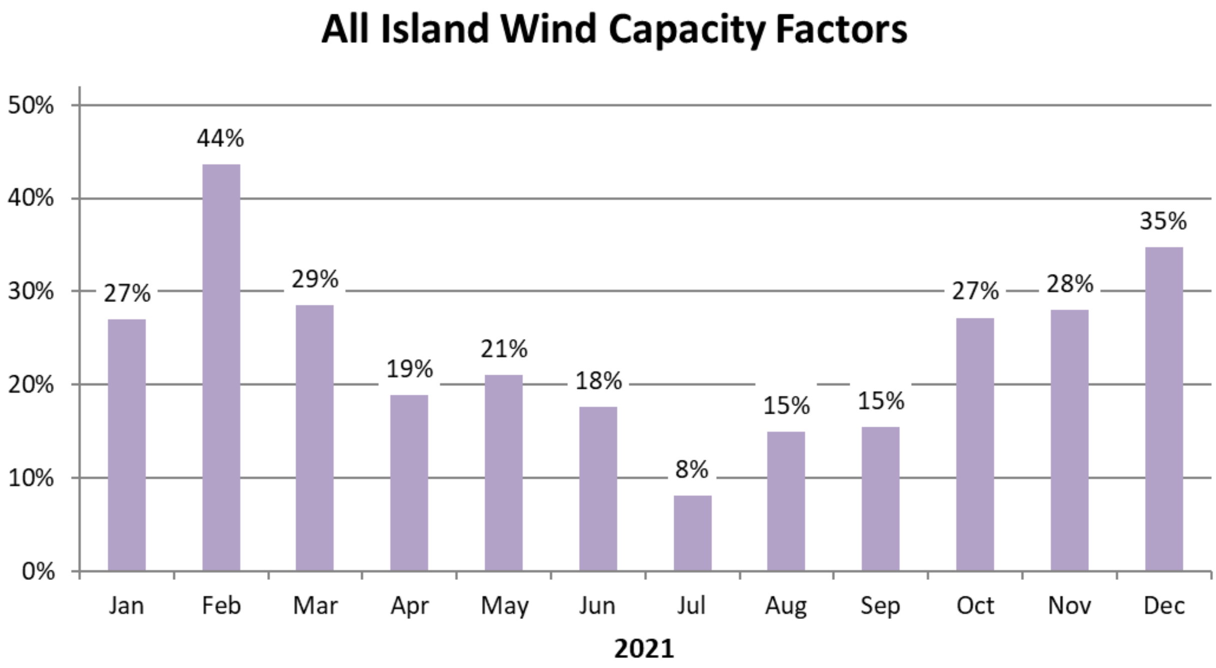


Figure 19: All-Island Monthly Wind Capacity Factors in 2021

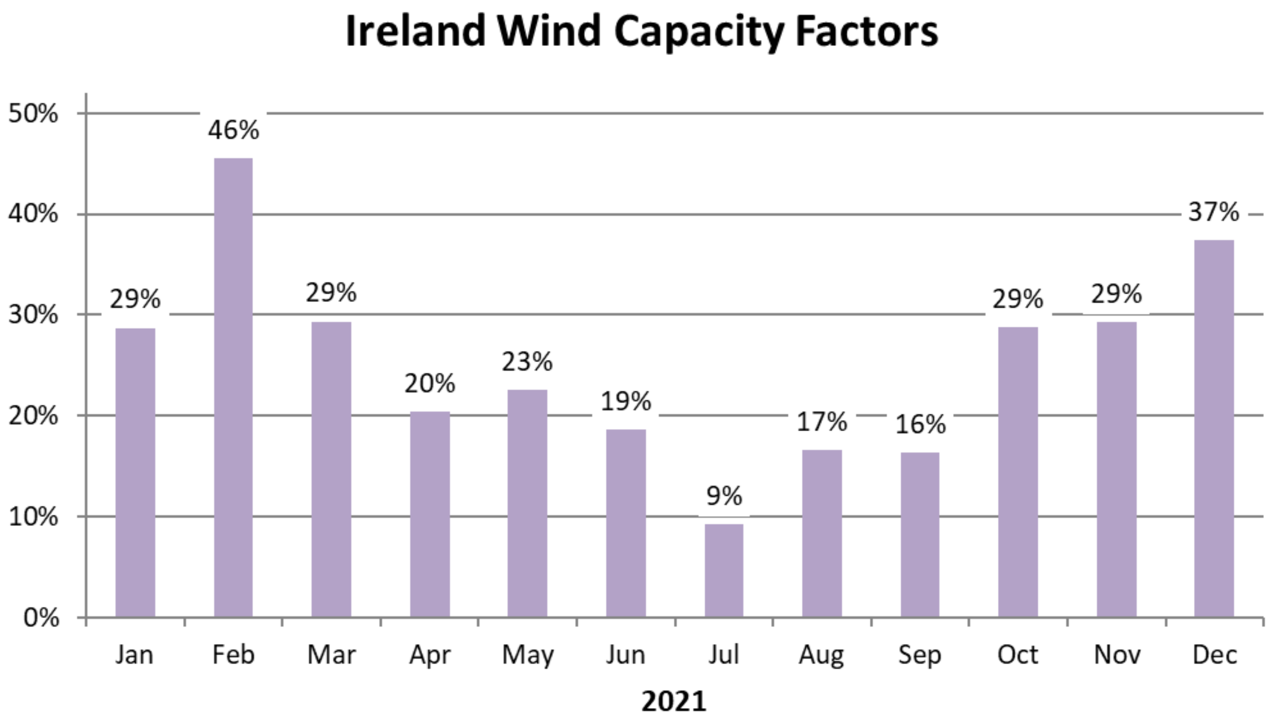


Figure 20: Ireland Monthly Wind Capacity Factors in 2021

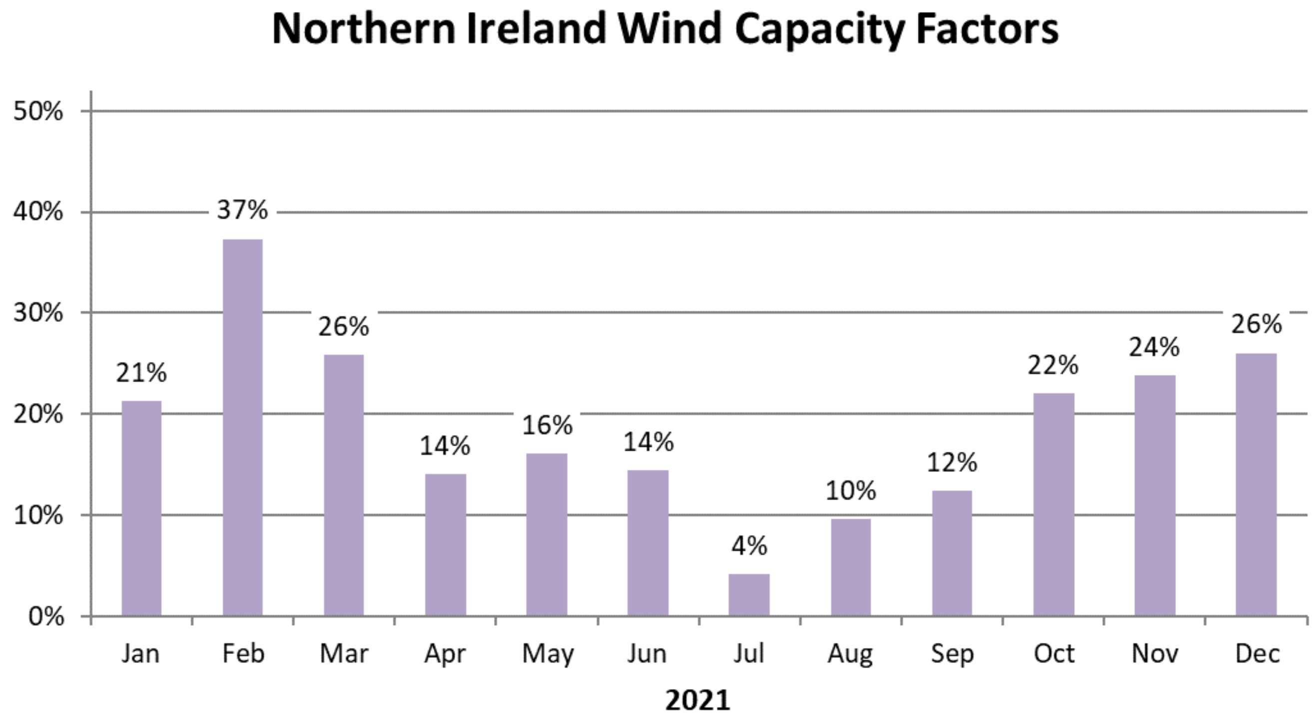


Figure 21: Northern Ireland Monthly Wind Capacity Factors in 2021

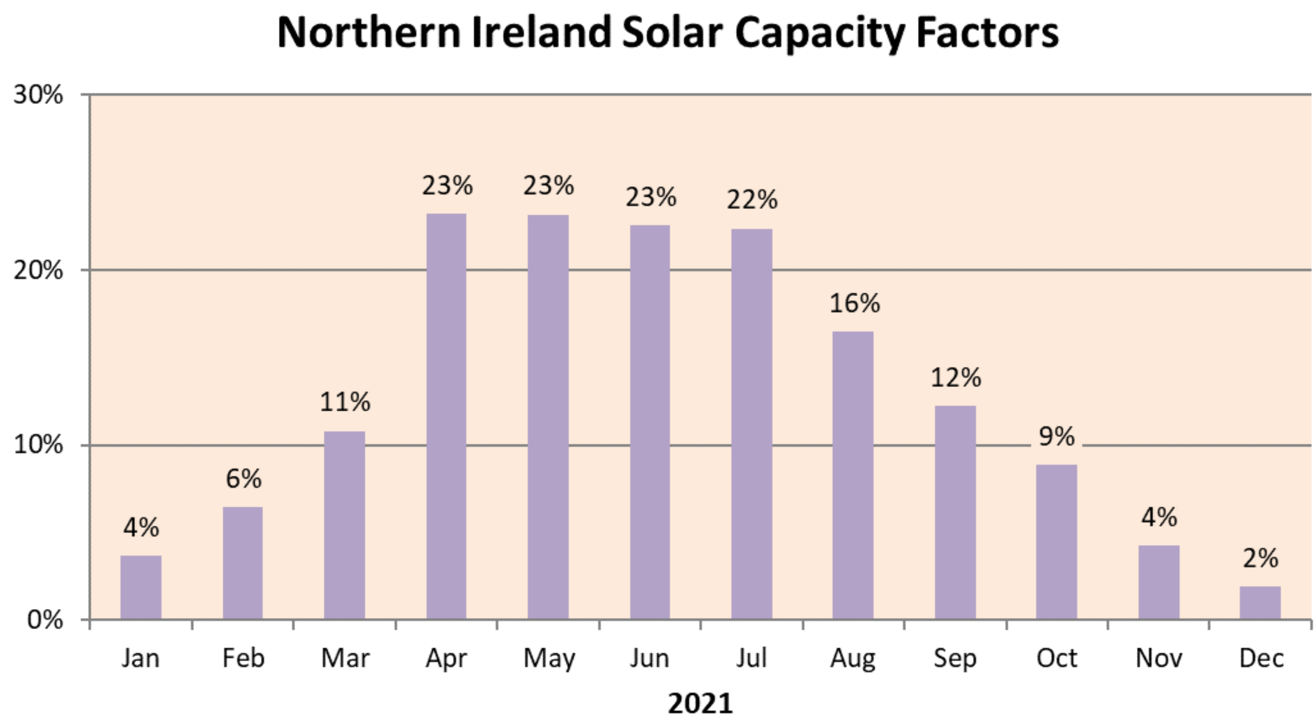


Figure 22: Northern Ireland Monthly Solar Capacity Factors in 2021

Appendix C – Transmission System Map

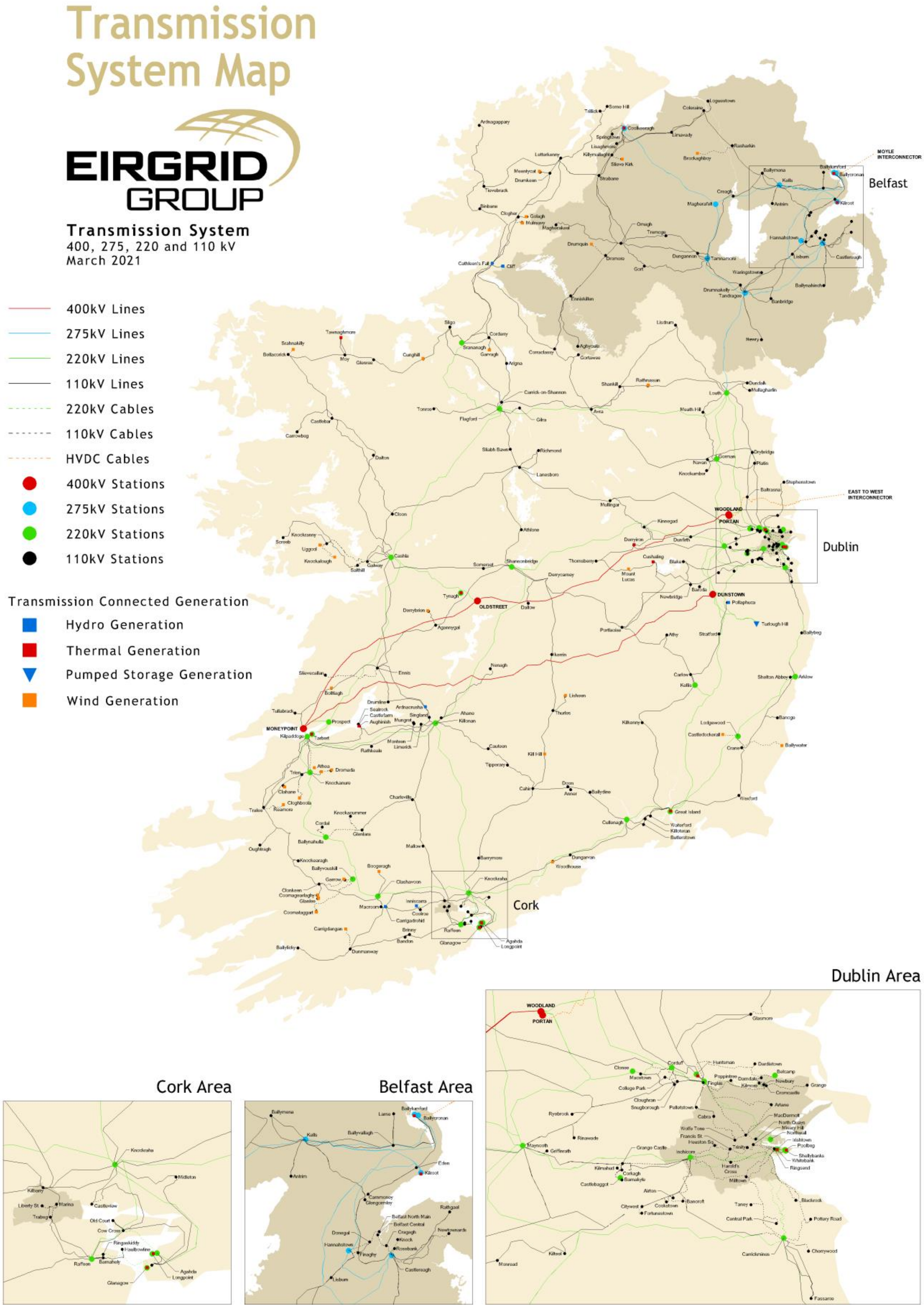


Figure 23: Transmission System Map

Appendix D – Abbreviations

CHP	Combined Heat and Power
CRU	Commission for Regulation of Utilities
DfE	Department for Economy, Northern Ireland
DNO	Distribution Network Operator
DSO	Distribution System Operator
E	East
EWIC	East West Interconnector
GW	Gigawatt
GWh	Gigawatt-hour
HVDC	High Voltage Direct Current
IRE	Ireland
IT	Information Technology
km	Kilometre
kV	Kilovolt
MID	Midlands (region)
MW	Megawatt
MWh	Megawatt-hour
NE	North East
NI	Northern Ireland
NW	North West
RES-E	Renewable Energy Sources (Electricity)
S	South
S.I.	Statutory Instrument
SCADA	Supervisory Control And Data Acquisition
SE	South East
SEF	Strategic Energy Framework
SEM	Single Electricity Market
SNSP	System Non-Synchronous Penetration
SO	System Operator
SONI	System Operator Northern Ireland
SW	South West
TCG	Transmission Constraint Group
TSO	Transmission System Operator
UR	Utility Regulator Northern Ireland
VPTG	Variable Price Taking Generator
W	West