Annual Renewable Energy Constraint and Curtailment Report 2019

September 2020

EIRGRID SONI

Contents

Disclaimer

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Executive Summary

EirGrid and SONI have prepared this report for the regulatory authorities to outline the levels of dispatch-down of renewable energy in 2019, as required under European[1] and Member State[2] legislation.

The EU Renewable Energy Directive (2009/28/EC) sets a target for Ireland to meet 16% of the country's total energy consumption from renewable energy sources by 2020 including a 40% renewable electricity target. Similarly in Northern Ireland, the Department for the Economy published the Strategic Energy Framework (SEF) in September 2010 that set out a 40% renewable electricity target to be reached by 2020. The Transmission System Operators (TSOs) for Ireland and Northern Ireland, EirGrid and SONI respectively, are working towards achieving the governments' renewable electricity targets.

EU Renewable Energy legislation provides for all existing renewable generation to have priority dispatch. This requires the TSOs to prioritise renewable energy generation in dispatch. Sometimes measures are taken to turn-off or dispatch-down renewable energy for system security reasons. In these circumstances, the TSOs must report this to the regulatory authorities. They must also indicate the corrective measures they plan to take to prevent inappropriate dispatching-down.

In Ireland and Northern Ireland, renewable energy is predominantly sourced from wind. Other sources include solar, hydroelectricity, biomass, and waste. This report is concerned with the dispatch down of wind and, for the first time, solar energy, which has recently grown to significant levels in Northern Ireland. The remaining sources are excluded from this report due to their small overall contribution to renewable energy.

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 2019, the total wind energy generated in Ireland and Northern Ireland was 11,994 GWh, while 1,008 GWh of wind energy was dispatched-down. This represents 7.7% of the total available wind energy in 2019, and is an increase of 301 GWh on the 2018 value.

In Ireland, the dispatch-down energy from wind resources was 711 GWh. This is equivalent to 6.9% of the total available wind energy.

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[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 297 GWh. This is equivalent to 10.7% of the total available wind energy. The dispatch-down energy from solar resources however was 5.6 GWh which represented 4.2% of the total available solar energy.

Overall, the dispatch-down of energy from wind resources increased from 6% in 2018 to 7.7% in 2019. However, during 2019 an additional 918 GWh of wind energy was generated compared to 2018. The level of dispatch-down is affected by a number of factors which vary from year to year, such as the amount of wind installed on the system, and the capacity factor of the wind generation. The total capacity of wind generation on the island rose by 467 MW in 2018 while the average wind capacity factor increased by 1% to 27% in 2019.

Government policy in Ireland and the UK has already set ambitious targets that will affect how electricity is generated. In Ireland, the Climate Action Plan 2019 states that 70% of electricity will be generated from renewable sources by 2030. In the UK, the government is pursuing net zero carbon emissions by 2050. Both of these targets will require us to break new ground in the amount of renewable electricity we manage on the electricity system.

In real terms, we will need to connect over 10,000 megawatts of additional renewable generation to the electricity system. There are many technical challenges when integrating renewable energy to an electricity system. The objective is to integrate this energy while ensuring the electricity system is stable and supply is secure. Currently we operate the power system with up to 65% of renewable power, including onshore wind and solar. This is a pioneering engineering achievement for a synchronous area. By 2030, we must have the ability to manage up to 95% in real time and higher.

In addition this will require improvements to infrastructure to make the grid stronger, and more flexible. We will aim to achieve this by using innovative solutions as well as proven technologies. Our goal will be to achieve the required increase in renewables while minimising the addition of new infrastructure. And as always, we will pursue these changes without impacting on the reliability of the electricity system.

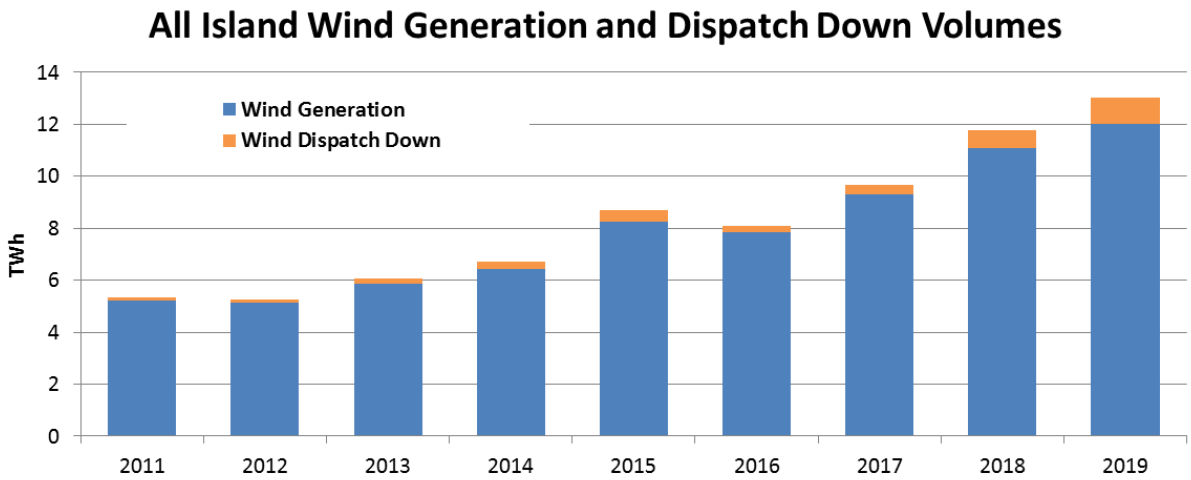


Figure 1: All Island Annual Wind Generation and Dispatch Down Volumes

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 have to 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

In late 2014, two new wind dispatch tools were deployed in the control centres of Ireland and Northern Ireland. This has resulted in a number of system operation improvements. These include:

- clear categorisation between constraint and curtailment
- clear reasons for why a curtailment or constraint was applied called a 'reason code'
- easier access to dispatch instructions and solar and wind farm data
- each instruction is time-stamped with the instruction time

These improvements led to an investigation of whether a more accurate report could be issued to all controllable wind farms, removing the need to estimate the curtailment and constraint levels applied to wind farms. As a result, a new methodology was developed to calculate curtailment and constraint levels. It involves making extensive use of one minute SCADA MW signals received from the wind farms and using time-stamped dispatch instructions from the control centres in Ireland and Northern Ireland. The new approach was more accurate than the previous methodology which made use of average half hourly market data for controllable wind farms only. The new approach was published for industry to provide feedback to the TSOs.

Feedback from industry was incorporated into the calculation methodology. From 2016 all controllable wind farms were issued with new, detailed constraint and curtailment reports each quarter. A detailed wind aggregate constraint and curtailment report was also published online each quarter to coincide with the individual wind farm reports. This report is accompanied by a separate user guide, which contains a detailed description of the new 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/

From 2019 solar farms have been included in this process and solar reports will continue to be issued with detailed reports on a quarterly basis similar to windfarms.

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 2019

The following provides a summary of the dispatch-down of wind and solar energy in 2019 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 2019, the share of electricity demand[3] from renewable sources in Ireland and Northern Ireland was 36.8% (Figure 2). This is broken down as follows:

- 31.2% provided by wind;
- 2.3% provided by hydro; and
- 3.3% provided by other[4] renewable energy sources.

The total wind energy generated was 11,994 GWh in Ireland and Northern Ireland. There was an estimated total of 1,008 GWh of dispatch-down energy from wind farms, which is an increase of about 301 GWh compared to 2018. The level of dispatch-down of wind represents 7.7% of total available energy from wind resources in Ireland and Northern Ireland.

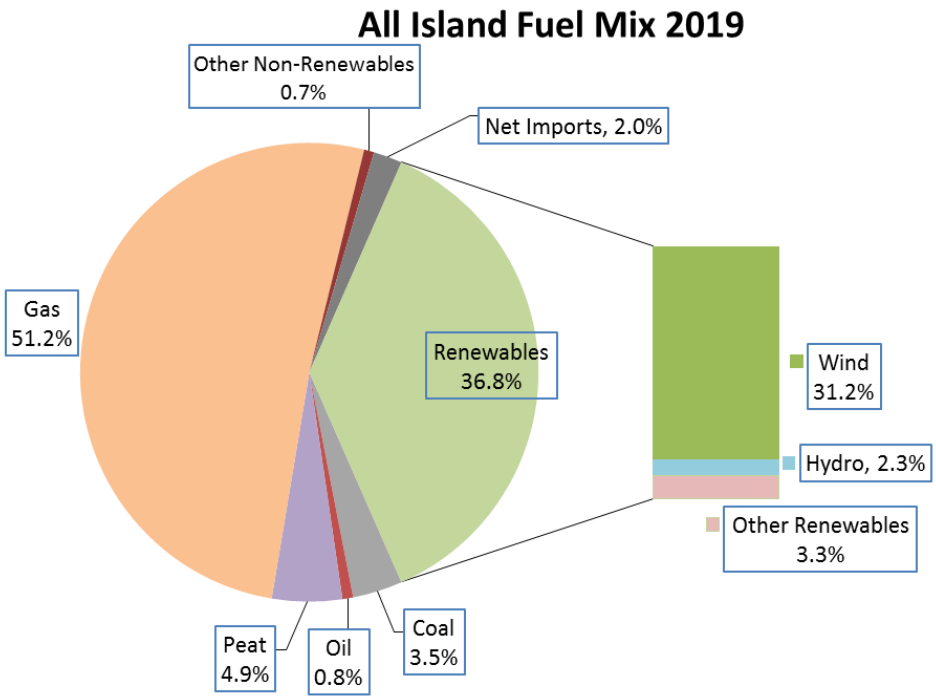


Figure 2: All-Island Fuel Mix for 2019 as Percentage of Demand

[3] 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, solar and ocean energy.

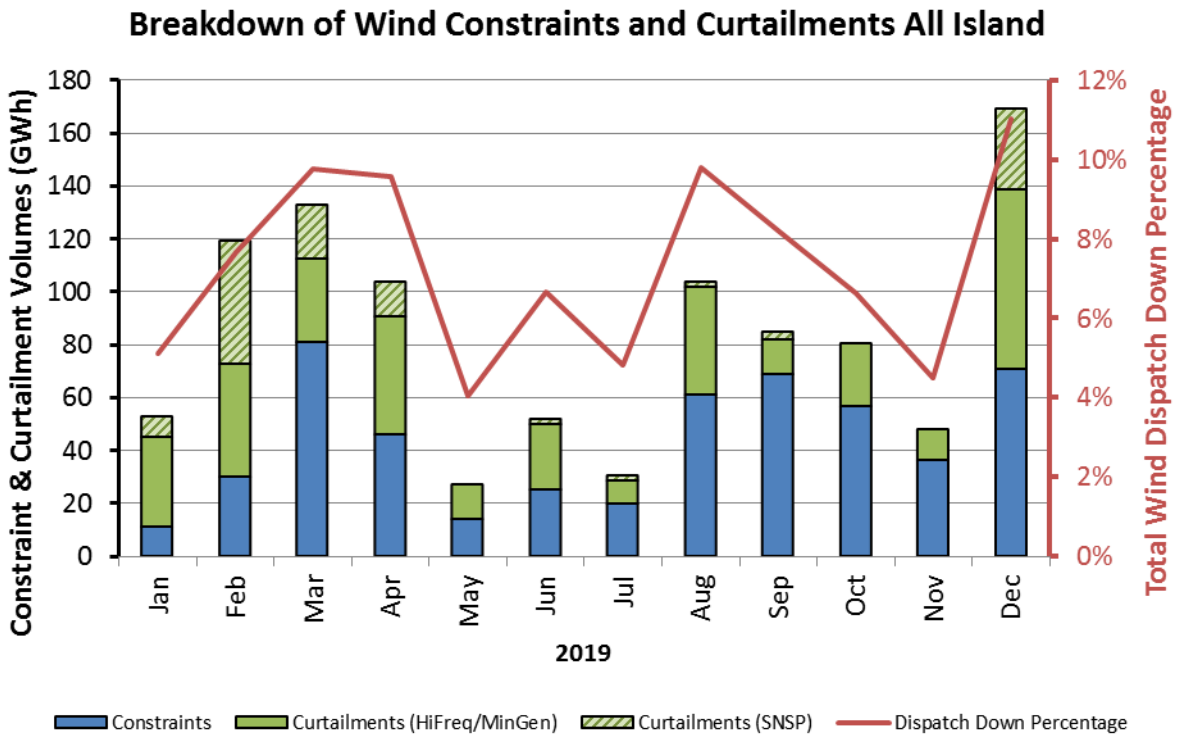


Figure 3: Monthly breakdown of the main wind dispatch-down categories on the island in 2019

2.2 Northern Ireland

In 2019, the total dispatch-down energy from wind generation in Northern Ireland was 297 GWh. This is equivalent to 10.7% of total available wind energy in that jurisdiction. This is a total overall increase of about 47 GWh in dispatch-down energy from wind generation compared to 2018.

In 2019, the total dispatch-down energy from solar generation in Northern Ireland was 5.6 GWh. This is equivalent to 4.2% of total available solar energy in that jurisdiction

2.3 Ireland

In 2019, the total dispatch-down energy from wind generation in Ireland was 711 GWh. This is equivalent to 6.9% of total available wind energy in Ireland. This is a total overall increase of about 254 GWh in dispatch-down energy from wind generation compared to 2018.

3 Contributory Factors for Dispatch-Down of Wind

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.

At the beginning of January 2019, the total installed capacity of wind generation on the island was 4,936 MW. By year-end, the figure had risen to 5,389 MW (4,113MW in Ireland and 1,276 MW in Northern Ireland). Table 1 shows the end of year wind capacities on the island from 2009 to 2019.

In 2019, 453 MW was added to the wind installed capacity on the island, which is slightly lower than the 477 MW added in the previous year. Approximately 2.4 GW of wind generation has been added to the all-island system in the past five years. In order to achieve ambitious targets that have been set by recent government policy in Ireland and the UK it is expected that we will need to connect up to 10,000 megawatts of additional renewable generation to the electricity system by 2030.

	Wind Installed Capacities (MW)								
	Ireland			Northern Ireland			All Island		
Year End	TSO	DSO	Total	TSO	DSO	Total	TSO	DSO	Total
2009	668.8	575.8	**1,244.5**	0.0	348.7	**348.7**	668.8	924.5	**1,593.2**
2010	727.8	655.8	**1,383.6**	0.0	392.2	**392.2**	727.8	1,048.0	**1,775.8**
2011	769.2	808.6	**1,577.8**	73.6	438.8	**512.4**	842.8	1,247.4	**2,090.2**
2012	769.2	927.5	**1,696.7**	73.6	526.0	**599.6**	842.8	1,453.5	**2,296.3**
2013	845.2	1,071.3	**1,916.5**	73.6	566.4	**640.0**	918.8	1,637.6	**2,556.4**
2014	1,046.6	1,213.1	**2,259.6**	73.6	655.5	**729.1**	1,120.2	1,868.6	**2,988.8**
2015	1,152.6	1,287.9	**2,440.5**	73.6	677.4	**751.0**	1,226.2	1,965.3	**3,191.5**
2016	1,371.3	1,416.7	**2,788.0**	73.6	869.0	**942.6**	1,444.9	2,285.7	**3,730.6**
2017	1,591.5	1,714.0	**3,305.5**	121.1	1,032.6	**1,153.7**	1,712.6	2,746.6	**4,459.2**
2018	1,774.5	1,885.8	**3,660.2**	121.1	1,155.2	**1,276.3**	1,895.6	3,040.9	**4,936.5**
2019	1,932.5	2,180.4	**4,112.8**	121.1	1,155.2	**1,276.3**	2,053.6	3,335.5	**5,389.1**

Updated 19-May-2020

Table 1: Installed wind capacities on the island from 2009 to 2019

Over the year, the capacity factor[4] of wind farms was 27% which is similar to the levels experienced in the previous three years (26%, 26% and 27% in 2016, 2017 and 2018 respectively). The seasonal variation in the capacity factor is evident in Figure 4.

[4] 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.

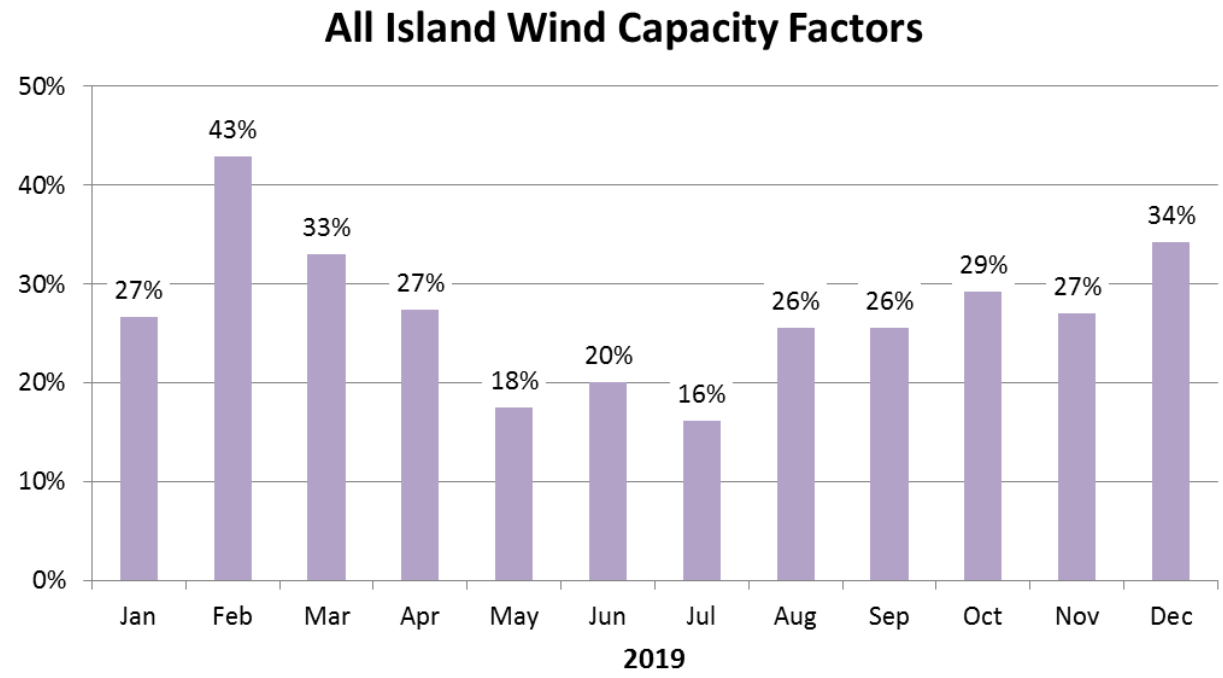


Figure 4: All-Island Monthly Wind Capacity Factors in 2019

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

3.2 Generation Outages in 2019

The main generator outages that may have affected dispatch-down are summarised below;

- All Turlough units were unavailable for pumping for 4 weeks in May/June. The average number of days of outages across of the four units was 38 days each in 2019. Outages of Turlough Hill may result in higher curtailment during these periods.
- EWIC was on outage on a number of occasions in 2019 totalling 13 days and Moyle interconnector was on outage for 8 days in June 2019. There were some periods of high wind during the outages but given the relatively short duration in total this should not have added significantly to dispatch down levels.

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 2018, the all island demand based on metered data was 37.2 TWh. In 2019 the all island demand increased by 0.3% to 37.3 TWh, and so it would not be expected to impact significantly on dispatch-down 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[5] before Autonomous Price Taker Generation[6] units. This policy was implemented in 2008. Its purpose was to:

- 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.

There have been no changes to Operational Policies related to wind dispatch-down since ISEM go-live in October 2018. However the Regulation 2019/943 has significant impact for future operational policies and is currently the subject of a SEMC consultation. It is likely outcomes from this will significantly change operational policy.

[5] 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.

[6] Autonomous Price Taker Generators (APTGs) which are paid based on their actual output at all times as outlined in Table 5.1 of the Trading & Settlement Code found at www.sem-o.com

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

[8] Wind Farm Controllability Categorisation Policy, 5 March 2012

4 Breakdown of Wind Dispatch-Down – Constraints vs Curtailments

In Northern Ireland, the breakdown of wind dispatch-down levels in 2019 between constraints and curtailments was 4.7% and 6% respectively (total 10.7%).

In Ireland, the breakdown of wind dispatch-down levels in 2019 between constraints and curtailments was 3.8% and 3.1% respectively (total 6.9%).

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

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

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

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 raised from 50% to 55% in March 2016, then to 60% in March 2017, and to 65% in April 2018.

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

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).

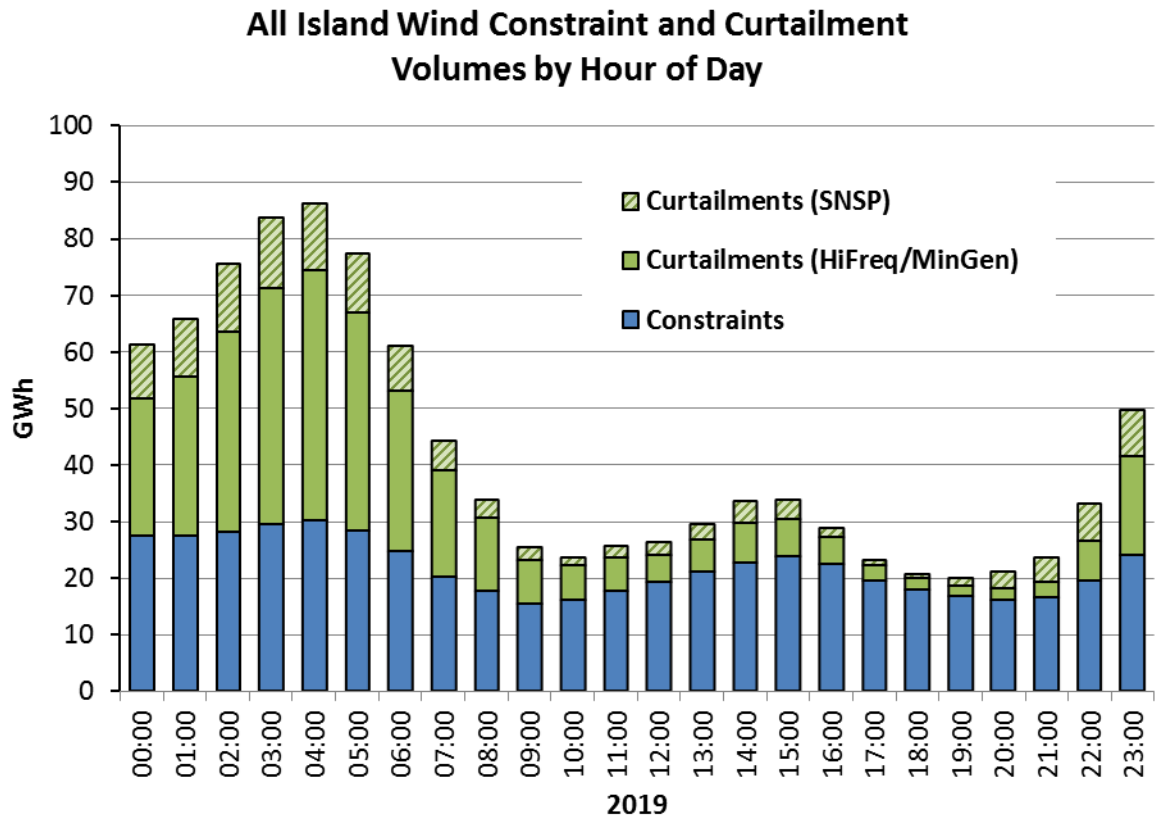


Figure 5: All-Island breakdown of wind constraints and curtailments in 2019 by hour of day

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% in 2019. This was due partly to an increase in installed wind generation but more significantly due to the transmission outages in 2019. Many of these outages were to facilitate the upgrading and uprating of the transmission system. The TSOs make every effort to limit the number and duration of outages that will impact on dispatch down of renewable generation as far as practical.

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 2019 were Northern Ireland, 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 of 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 2019, the following transmission outages may be worth noting as having the potential to specifically increase constraints, if they coincided with times of high renewable generation on the system (these have been noted because they are critical pieces of infrastructure in accommodating renewables on the system and/or where on outage for an 'extended' period of time:

- The Louth-Tandragee 2 circuit was on outage for 24 days over September/October 2019.
- The Coolkeeragh-Magherafelt A circuit was forced out for a 52 days between September and November 2019.
- Coleraine-Rasharkin circuit was on outage for 21 days in August/September 2019.

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. Increasing and in particular during 2019 complex operational switching has been performed to maximise renewable output wherever possible across the transmission system.

North West (NW)

There is limited connectivity between Donegal / North West and the rest of the system, and any outages for maintenance or uprates can lead to significant constraints. In the Donegal region in 2019, Binbane-Letterkenny 110 kV was out of service from February to May to facilitate the loop-in of the new Tievebrack 110 kV station. In Mayo, the Bellacorick-Moy 110kV circuit was on outage from April to October. Both of these outages would have led to additional constraints of wind in the North West.

South West (SW) and West (W)

The most significant impact on wind constraints in the South West and West regions was the forced outage of Moneypoint T4201 which occurred in January 2019. This, coupled with the transfer of Moneypoint T4202 to the new 400 kV GIS station in Moneypoint which finished in November, meant there was no direct link between the 220 kV network in the South West and the 400 kV network for most of the year. This was a key driver for the constraints of windfarms in the South West in 2019.

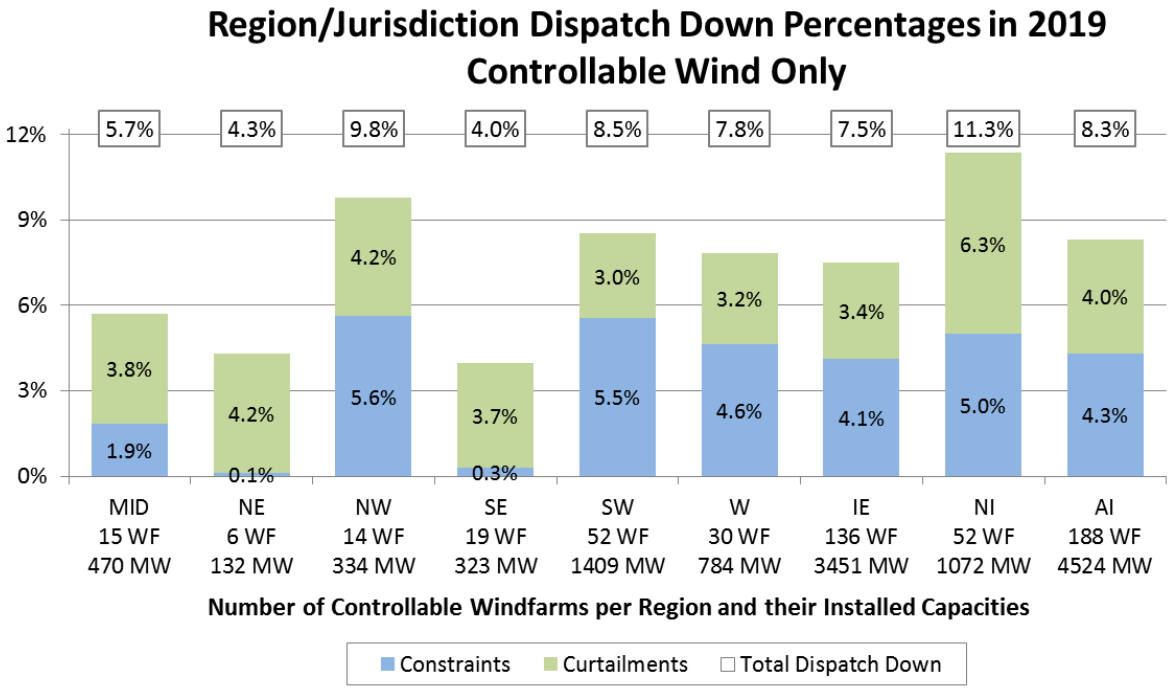


Figure 6: Regional/Jurisdictional Controllable Wind Dispatch-Down Percentages in 2019

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.

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 65% on a permanent basis in April 2018.

The EWIC export limit is 500 MW, but the Moyle export limit is dependent on system conditions in Scotland and can change daily. The firm export capacity on Moyle is 80 MW, but this can be increased to 380 MW since July 2019 in day-ahead market runs, however it is still limited by system conditions in GB.

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

5.2 Operational Policy – Interconnector Countertrading[13]

At the introduction of ISEM (October 2018), countertrading capability for priority dispatch purposes was not actively used by the TSOs in order to let the new market bed-in. The flows on the East West Interconnector and Moyle are driven by price differentials between GB and the all-island system, and the consensus was that the market would get the flows correct i.e. high wind conditions (with corresponding low market prices in ISEM) generally would lead to high exports on the Interconnectors, and vice-versa.

While this has proven to be the case, there remained occasions when countertrading could have been used to reduce curtailment of priority dispatch generation in SEM. In Q3 2019 the TSOs did reintroduce the policy of countertrading for priority dispatch purposes in order to reduce curtailment in SEM.

The approach to countertrading was different to that pre I-SEM given the changes to market design and the introduction of the principle of trades being coordinated (i.e. 'agreed') with the other TSO (i.e. National Grid).

Following the receipt of firm interconnector schedules in the ISEM market at intraday 1 and intraday 2 gate closures, trading can be attempted by the TSOs during these market firm periods as per the schedule outlined below;

Auction	Publication Time	Delivery Period Start	Delivery Period End	Market Firm Until
DAM	11:54 on D-1	23:00 on D-1	23:00 on D	23:00 on D-1 (no change)
IDA1	18:10 on D-1	23:00 on D-1	23:00 on D	11:00 on D
IDA2	08:40 on D	11:00 on D	23:00 on D	23:00 on D

Countertrading on Interconnectors can be facilitated directly between TSOs (EirGrid/SONI and National Grid) or through a third party in the wholesale electricity market in Great Britain. Trading in order to minimise the dispatch down of priority generation is done via the co-ordinated third party trading process.

Given that all co-ordinated third party countertrades must also be agreed between the TSOs, on occasions it has not been 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

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

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 quarterly wind and solar dispatch-down reports for 2019. Our quarterly report user guide provides a detailed description of the dispatch-down categories and the methodology used. Both the quarterly 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

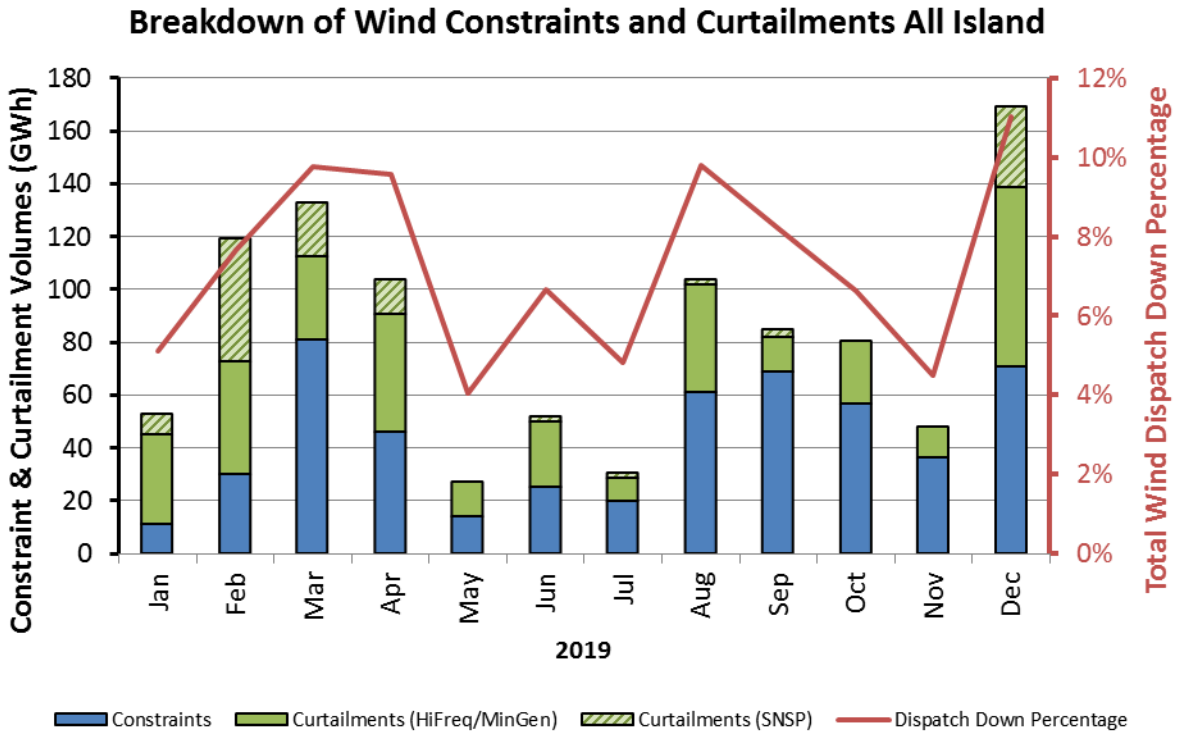
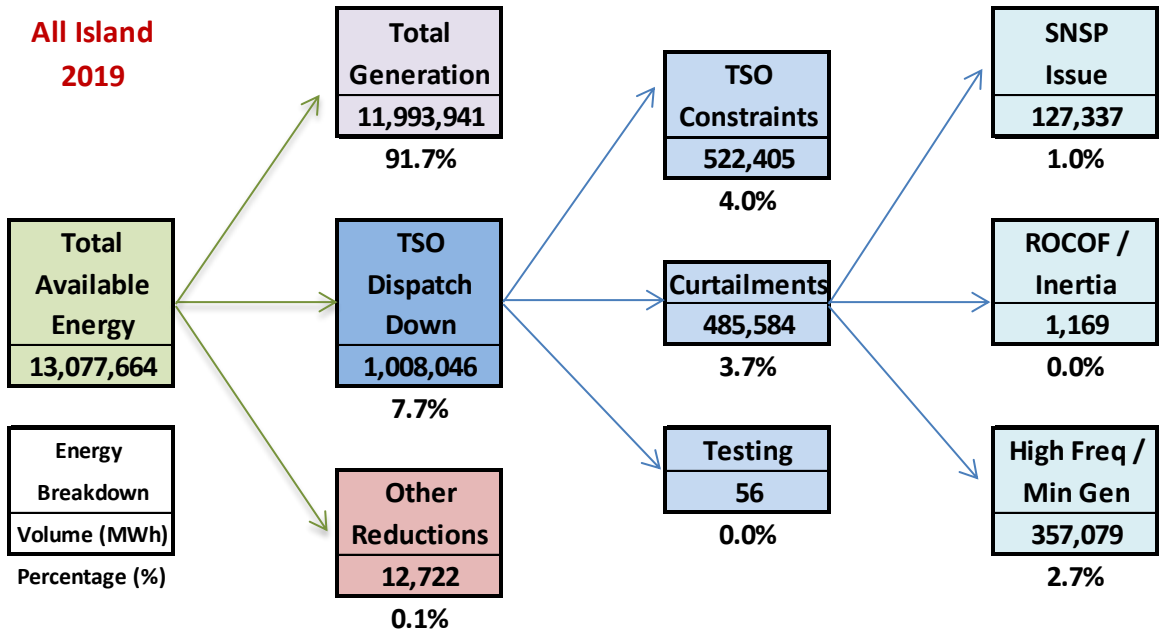


Figure 7: Monthly breakdown of all-island wind constraints and curtailments in 2019



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 2019

Ireland Wind

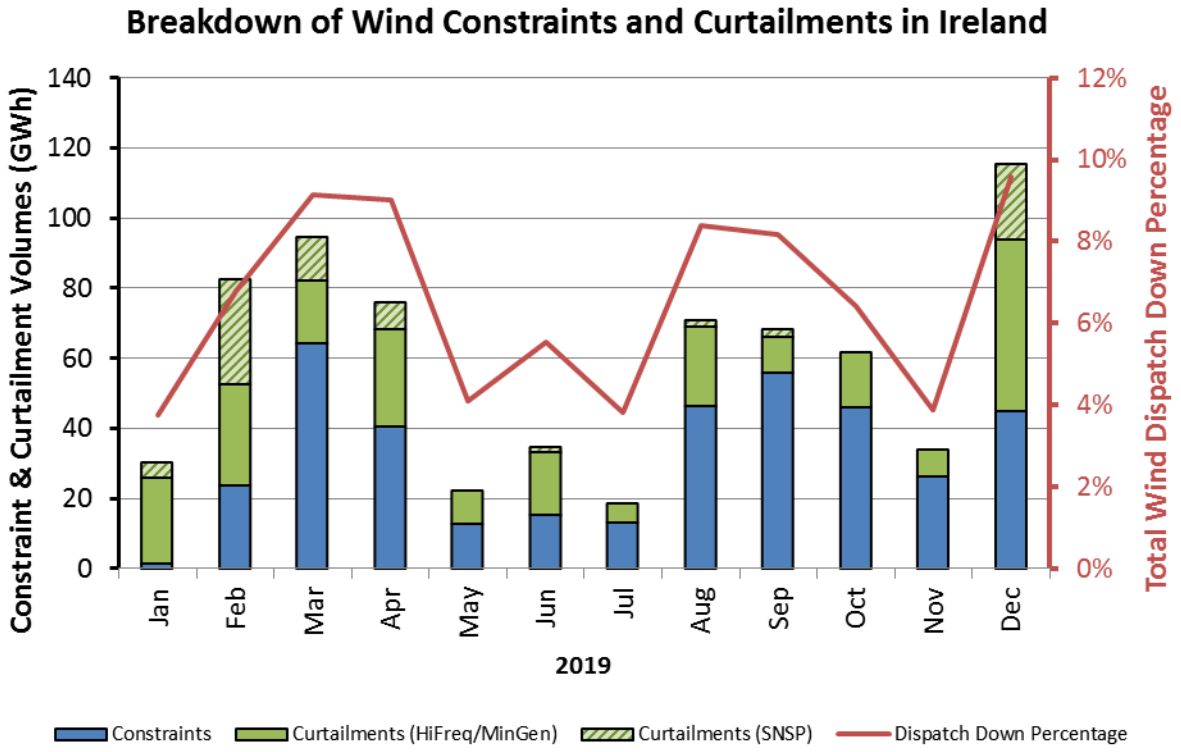
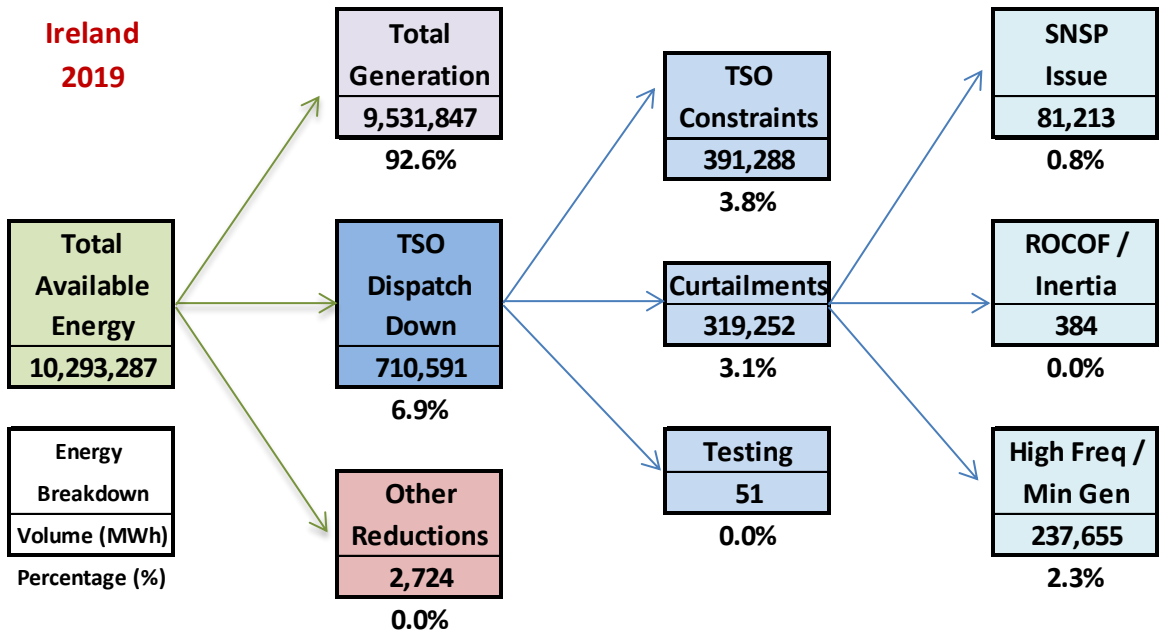


Figure 9: Monthly breakdown of the main wind dispatch-down categories in Ireland in 2019



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 2019

Northern Ireland Wind

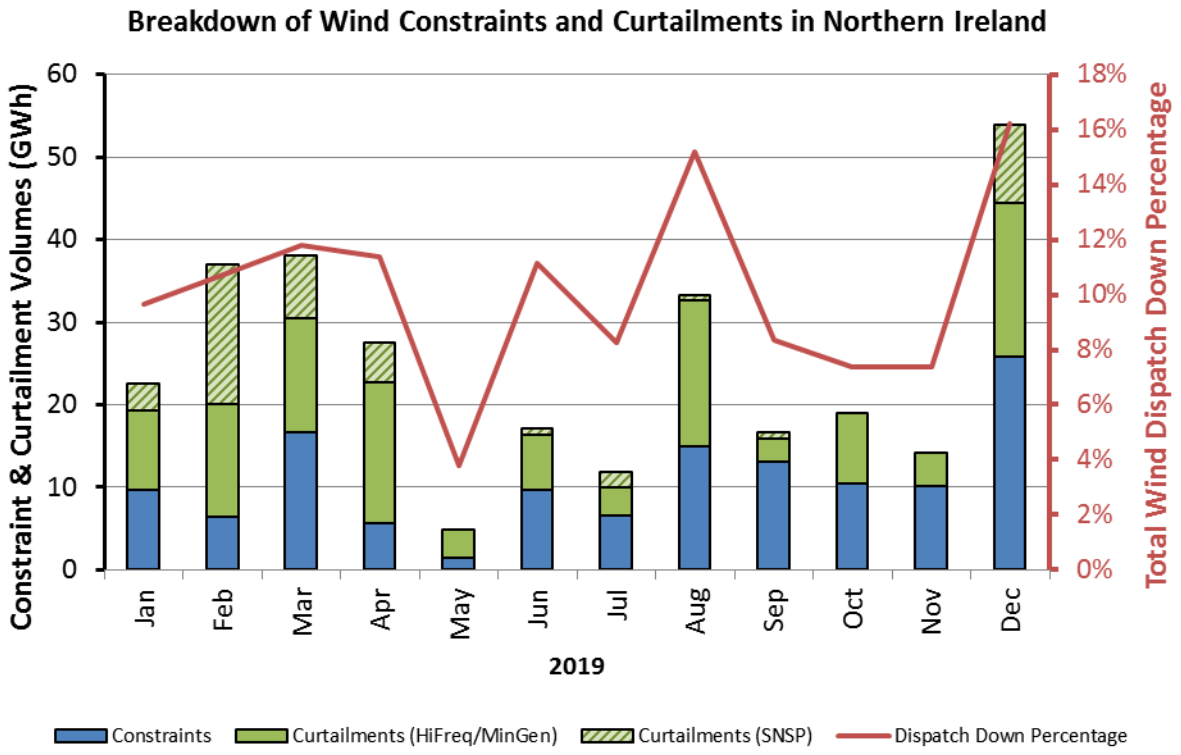
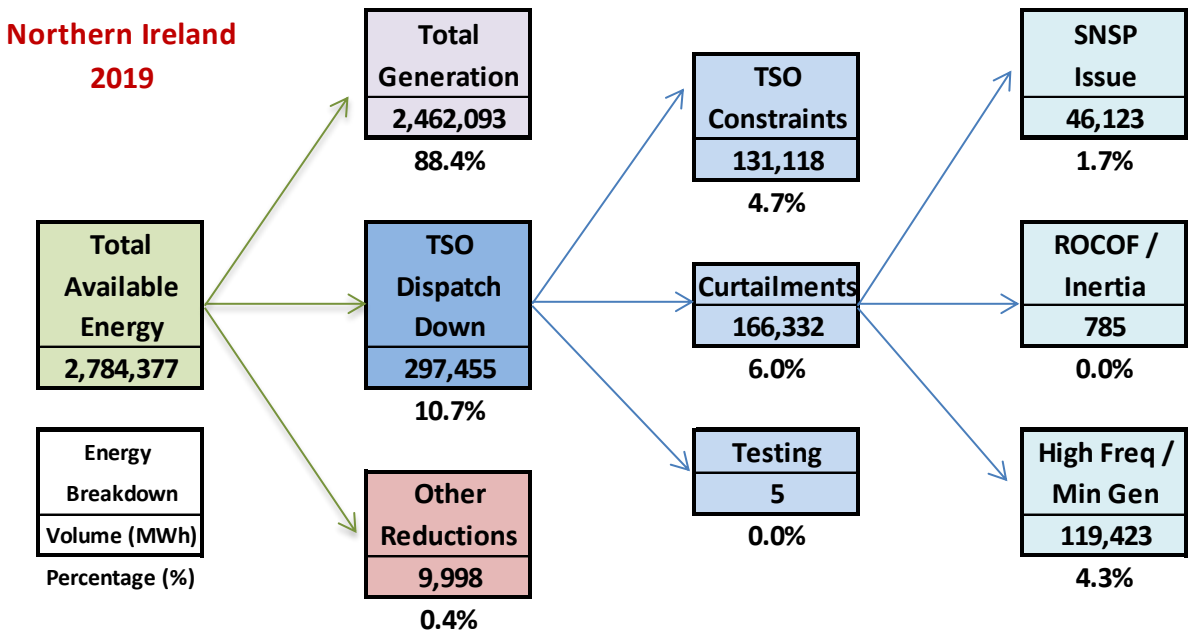


Figure 11: Monthly breakdown of wind dispatch-down categories in Northern Ireland in 2019



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 2019

Northern Ireland Solar

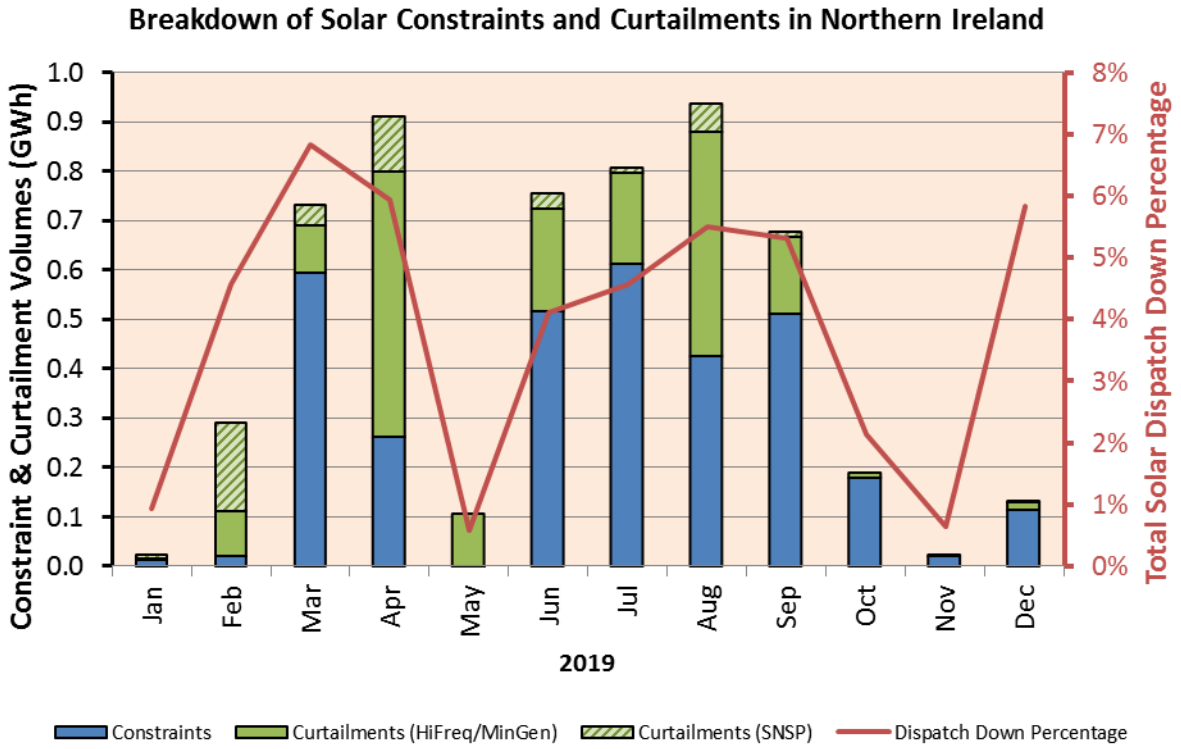


Figure 13: Monthly breakdown of solar dispatch-down categories in Northern Ireland in 2019

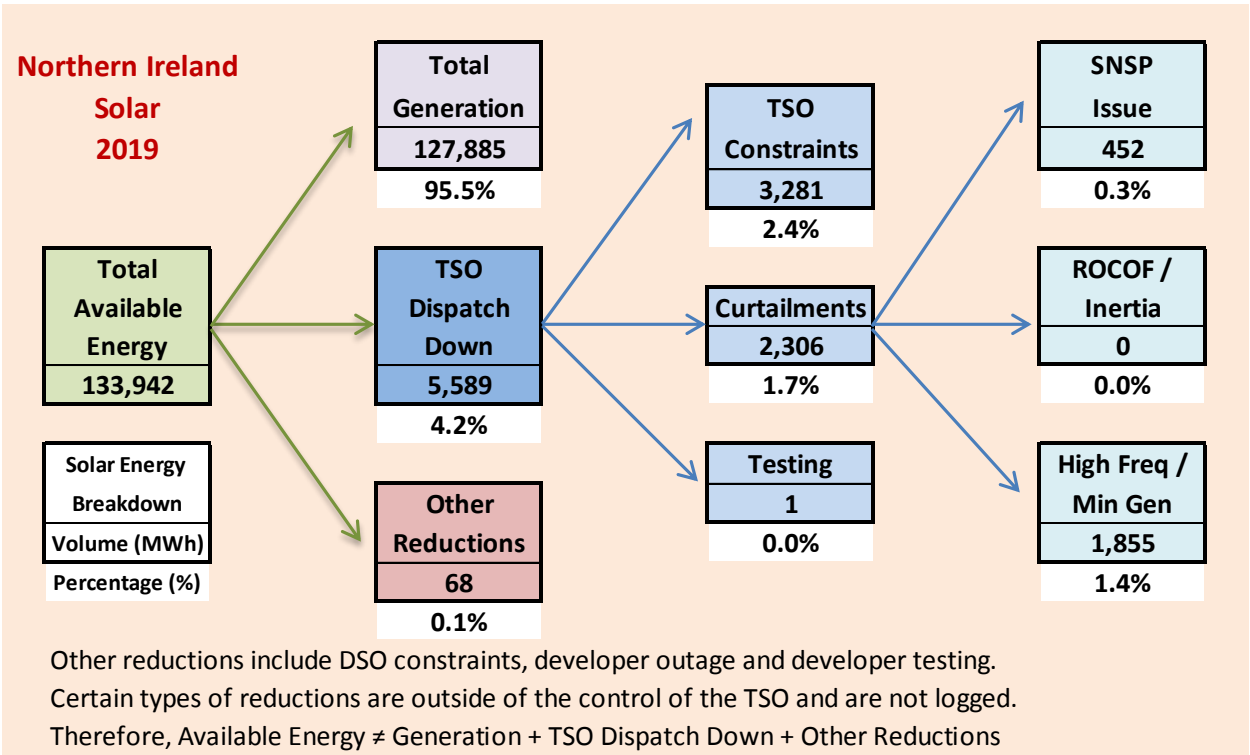


Figure 14: Graphical representation of Northern Ireland solar dispatch-down categories in 2019

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

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

	2011			2012			2013			2014			2015			2016			2017			2018			2019		
Month	**NI**	**IE**	**AI**	**NI**	**IE**	**AI**	**NI**	**IE**	**AI**	**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%	2.4%	1.9%	2.0%	5.7%	3.5%	3.9%	9.7%	3.8%	5.1%
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%	2.0%	1.7%	1.7%	2.9%	2.0%	2.2%	10.7%	6.8%	7.7%
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%	3.0%	3.4%	3.3%	5.9%	4.4%	4.7%	11.8%	9.2%	9.8%
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%**	**2.4%**	**2.3%**	**2.4%**	**4.9%**	**3.3%**	**3.6%**	**10.8%**	**6.8%**	**7.7%**
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%	4.2%	3.5%	3.6%	19.2%	7.4%	9.8%	11.4%	9.0%	9.6%
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%	3.6%	3.5%	3.5%	6.1%	4.7%	5.0%	3.8%	4.1%	4.0%
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%	4.7%	3.9%	4.1%	11.0%	8.0%	8.6%	11.2%	5.6%	6.7%
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%**	**4.2%**	**3.7%**	**3.8%**	**13.0%**	**6.6%**	**8.0%**	**9.4%**	**6.6%**	**7.2%**
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%	4.4%	2.8%	3.2%	2.1%	1.9%	2.0%	8.2%	3.8%	4.8%
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%	3.1%	2.8%	2.9%	5.8%	2.2%	3.0%	15.2%	8.4%	9.8%
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%	4.2%	5.4%	5.1%	13.1%	5.5%	7.4%	8.4%	8.2%	8.2%
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%**	**3.9%**	**3.9%**	**3.9%**	**8.7%**	**3.6%**	**4.8%**	**11.0%**	**7.3%**	**8.0%**
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%	14.6%	9.2%	10.6%	10.2%	6.9%	7.7%	7.4%	6.4%	6.6%
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%	3.2%	2.5%	2.6%	10.2%	5.2%	6.4%	7.4%	3.9%	4.5%
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%	5.3%	2.5%	3.1%	14.9%	7.2%	8.9%	16.2%	9.6%	11.0%
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%**	**8.5%**	**4.9%**	**5.7%**	**11.7%**	**6.4%**	**7.7%**	**11.1%**	**6.9%**	**7.8%**
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%**	**5.0%**	**3.7%**	**4.0%**	**9.4%**	**5.0%**	**6.0%**	**10.7%**	**6.9%**	**7.7%**
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%	1.9%	1.0%	1.2%	4.0%	1.7%	2.2%	4.7%	3.8%	4.0%
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%	3.1%	2.6%	2.7%	5.4%	3.3%	3.8%	6.0%	3.1%	3.7%
Wind Installed Capacity (MW)	512	1,578	2,090	600	1,697	2,296	640	1,917	2,556	729	2,260	2,989	751	2,441	3,192	943	2,788	3,731	1,154	3,306	4,459	1,276	3,660	4,937	1,276	4,113	5,389
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	2,051	7,229	9,280	2,391	8,685	11,076	2,462	9,532	11,994
Wind Capacity Factors	21%	31%	28%	21%	29%	27%	23%	29%	28%	24%	28%	27%	28%	32%	31%	23%	27%	26%	22%	27%	26%	22%	28%	27%	22%	28%	27%
SNSP Limit	50%			50%			50%			50%			55% Trial from Oct			55% Perm from Mar 60% Trial from Nov			60% Perm from Mar 65% Trial from Nov			65% Perm from Apr			65%		

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 annual and quarterly dispatch down reports on : http://www.eirgridgroup.com/how-the-grid-works/renewables/

Wind Dispatch Down Percentages and Breakdown per Region (Controllable Windfarms only)
Curtailments + Constraints + Testing = 100% of Dispatch Down (Testing very small % - not shown in table)

Controllable Wind By Region		2016					2017					2018					2019				
	Cap (MW)	Qtr1	Qtr2	Qtr3	Qtr4	2016	Qtr1	Qtr2	Qtr3	Qtr4	2017	Qtr1	Qtr2	Qtr3	Qtr4	2018	Qtr1	Qtr2	Qtr3	Qtr4	2019
MID	**514**	**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%**	**5.2%**	**4.6%**	**4.9%**	**6.8%**	**5.5%**
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%	0.2%	0.9%	2.4%	3.5%	1.8%
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%	5.1%	3.7%	2.4%	3.3%	3.7%
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%**	**5.0%**	**4.1%**	**2.6%**	**4.8%**	**4.3%**
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%	0.1%	0.0%	0.2%	0.2%	0.1%
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%	4.9%	4.1%	2.4%	4.6%	4.2%
NW	**343**	**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%**	**9.9%**	**8.9%**	**13.7%**	**7.5%**	**9.8%**
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%	4.8%	4.7%	11.7%	2.9%	5.6%
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%	5.2%	4.1%	2.0%	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%**	**4.6%**	**3.5%**	**2.9%**	**4.0%**	**3.9%**
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%	0.1%	0.0%	0.2%	0.6%	0.2%
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%	4.5%	3.5%	2.7%	3.4%	3.6%
SW	**1,498**	**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%**	**9.4%**	**8.6%**	**8.2%**	**8.5%**	**8.7%**
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%	5.6%	5.6%	6.1%	5.6%	5.7%
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%	3.8%	3.0%	2.1%	2.9%	3.0%
W	**846**	**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%**	**6.3%**	**7.6%**	**10.9%**	**7.4%**	**7.8%**
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%	2.2%	3.7%	9.3%	4.3%	4.6%
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%	4.1%	3.8%	1.7%	3.0%	3.2%
Controllable Wind Totals:																					
IE	**3,664**	**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%**	**7.5%**	**7.2%**	**8.0%**	**7.3%**	**7.5%**
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%	3.2%	3.7%	5.8%	4.1%	4.1%
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%	4.3%	3.5%	2.1%	3.3%	3.4%
NI	**1,018**	**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%**	**11.6%**	**10.1%**	**11.6%**	**11.7%**	**11.3%**
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%	3.9%	3.4%	6.4%	6.3%	5.0%
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%	7.7%	6.7%	5.1%	5.4%	6.3%
AI	**4,682**	**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%**	**8.5%**	**7.8%**	**8.7%**	**8.2%**	**8.3%**
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%	3.4%	3.6%	6.0%	4.5%	4.3%
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%	5.1%	4.1%	2.8%	3.7%	4.0%
All Wind (Controllable + Non-Controllable) Totals:																					
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%**	**6.8%**	**6.6%**	**7.3%**	**6.9%**	**6.9%**
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%	2.9%	3.4%	5.3%	3.8%	3.8%
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%	3.9%	3.2%	1.9%	3.1%	3.1%
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%**	**10.8%**	**9.4%**	**11.0%**	**11.1%**	**10.7%**
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%	3.6%	3.2%	6.1%	5.9%	4.7%
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%	7.2%	6.2%	4.9%	5.2%	6.0%
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%**	**7.7%**	**7.2%**	**8.0%**	**7.8%**	**7.7%**
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%	3.1%	3.4%	5.5%	4.3%	4.0%
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%	4.6%	3.8%	2.6%	3.5%	3.7%

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

All Wind (Controllable + Non-Controllable)			Jan	Feb	Mar	Qtr1	Apr	May	Jun	Qtr2	Jul	Aug	Sep	Qtr3	Oct	Nov	Dec	Qtr4	2019
Wind	**AI**	**Dispatch Down**	**5.1%**	**7.7%**	**9.8%**	**7.7%**	**9.6%**	**4.0%**	**6.7%**	**7.2%**	**4.8%**	**9.8%**	**8.2%**	**8.0%**	**6.6%**	**4.5%**	**11.0%**	**7.8%**	**7.7%**
		Constraints	1.1%	1.9%	5.9%	3.1%	4.2%	2.1%	3.2%	3.4%	3.1%	5.7%	6.7%	5.5%	4.6%	3.4%	4.6%	4.3%	4.0%
		Curtailments	4.0%	5.7%	3.8%	4.6%	5.3%	1.9%	3.4%	3.8%	1.7%	4.1%	1.5%	2.6%	2.0%	1.1%	6.4%	3.5%	3.7%
	IE	**Dispatch Down**	**3.8%**	**6.8%**	**9.2%**	**6.8%**	**9.0%**	**4.1%**	**5.6%**	**6.6%**	**3.8%**	**8.4%**	**8.2%**	**7.3%**	**6.4%**	**3.9%**	**9.6%**	**6.9%**	**6.9%**
		Constraints	0.2%	2.0%	6.2%	2.9%	4.8%	2.3%	2.5%	3.4%	2.7%	5.5%	6.7%	5.3%	4.8%	3.0%	3.7%	3.8%	3.8%
		Curtailments	3.6%	4.8%	3.0%	3.9%	4.2%	1.8%	3.1%	3.2%	1.1%	2.9%	1.5%	1.9%	1.6%	0.9%	5.9%	3.1%	3.1%
	NI	**Dispatch Down**	**9.7%**	**10.7%**	**11.8%**	**10.8%**	**11.4%**	**3.8%**	**11.2%**	**9.4%**	**8.2%**	**15.2%**	**8.4%**	**11.0%**	**7.4%**	**7.4%**	**16.2%**	**11.1%**	**10.7%**
		Constraints	4.2%	1.9%	5.2%	3.6%	2.3%	1.2%	6.3%	3.2%	4.6%	6.7%	6.5%	6.1%	4.1%	5.3%	7.8%	5.9%	4.7%
		Curtailments	5.5%	8.9%	6.6%	7.2%	9.1%	2.6%	4.8%	6.2%	3.7%	8.4%	1.8%	4.9%	3.3%	2.1%	8.4%	5.2%	6.0%
Solar	**NI**	**Dispatch Down**	**0.9%**	**4.6%**	**6.8%**	**5.3%**	**5.9%**	**0.6%**	**4.1%**	**3.4%**	**4.6%**	**5.5%**	**5.3%**	**5.1%**	**2.1%**	**0.6%**	**5.8%**	**2.4%**	**4.2%**
		Constraints	0.5%	0.3%	5.6%	3.2%	1.7%	0.0%	2.8%	1.5%	3.5%	2.5%	4.0%	3.3%	2.0%	0.6%	5.1%	2.2%	2.4%
		Curtailments	0.4%	4.2%	1.3%	2.1%	4.2%	0.6%	1.3%	1.9%	1.1%	3.0%	1.3%	1.8%	0.1%	0.0%	0.7%	0.2%	1.7%

Table 5: Wind and solar monthly dispatch down percentages and breakdowns in 2019

Appendix B – Renewable Dispatch Down by Hour of Day

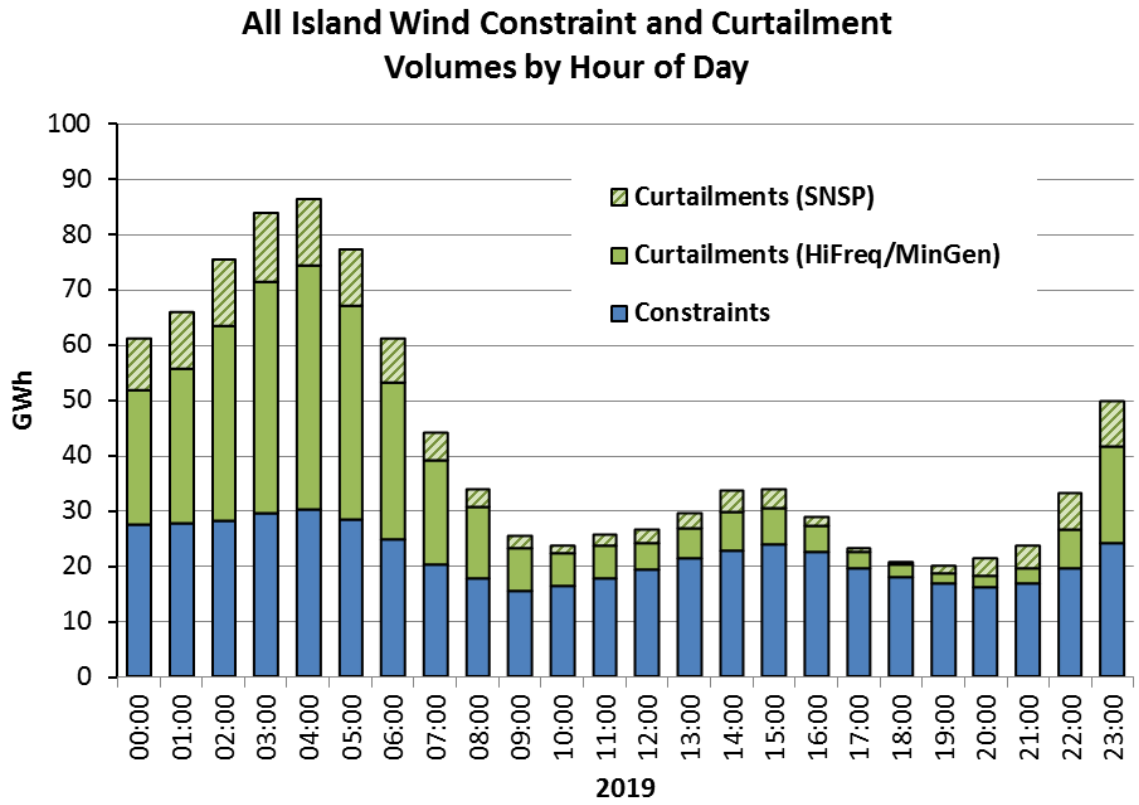


Figure 15: All-Island breakdown of wind constraints and curtailments in 2019 by hour of day

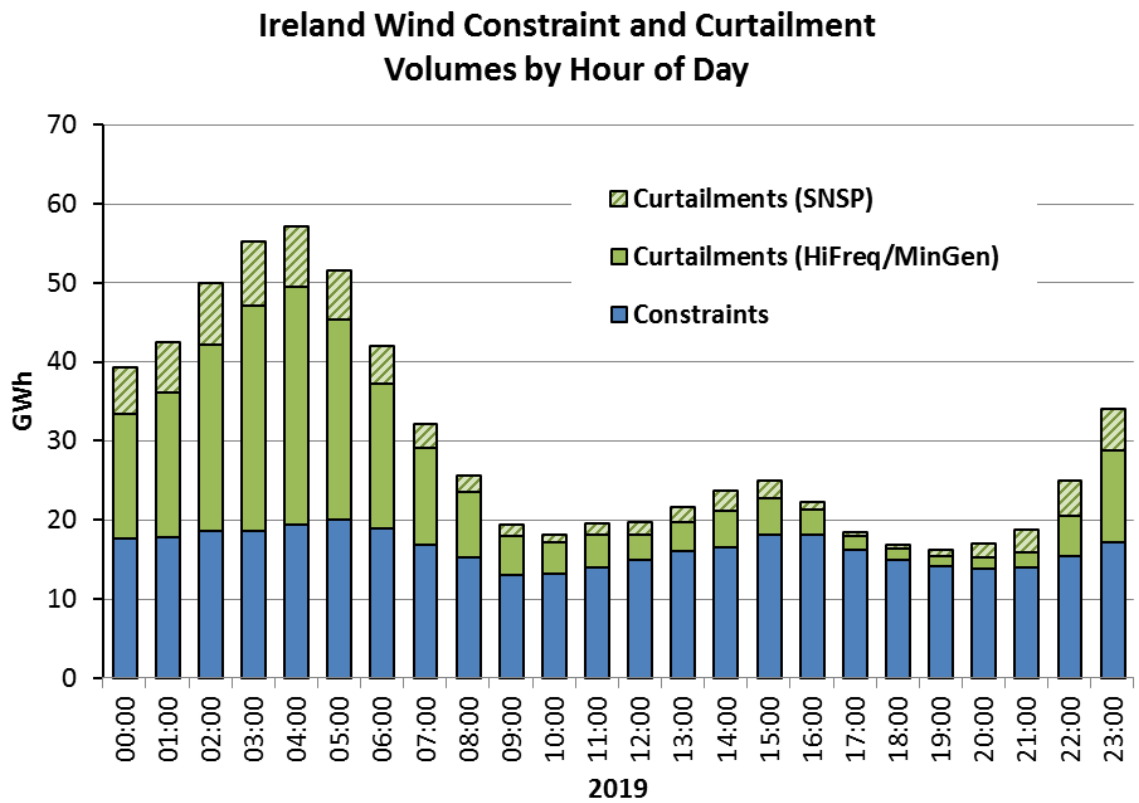


Figure 16: Breakdown of wind constraints and curtailments In Ireland in 2019 by hour of day

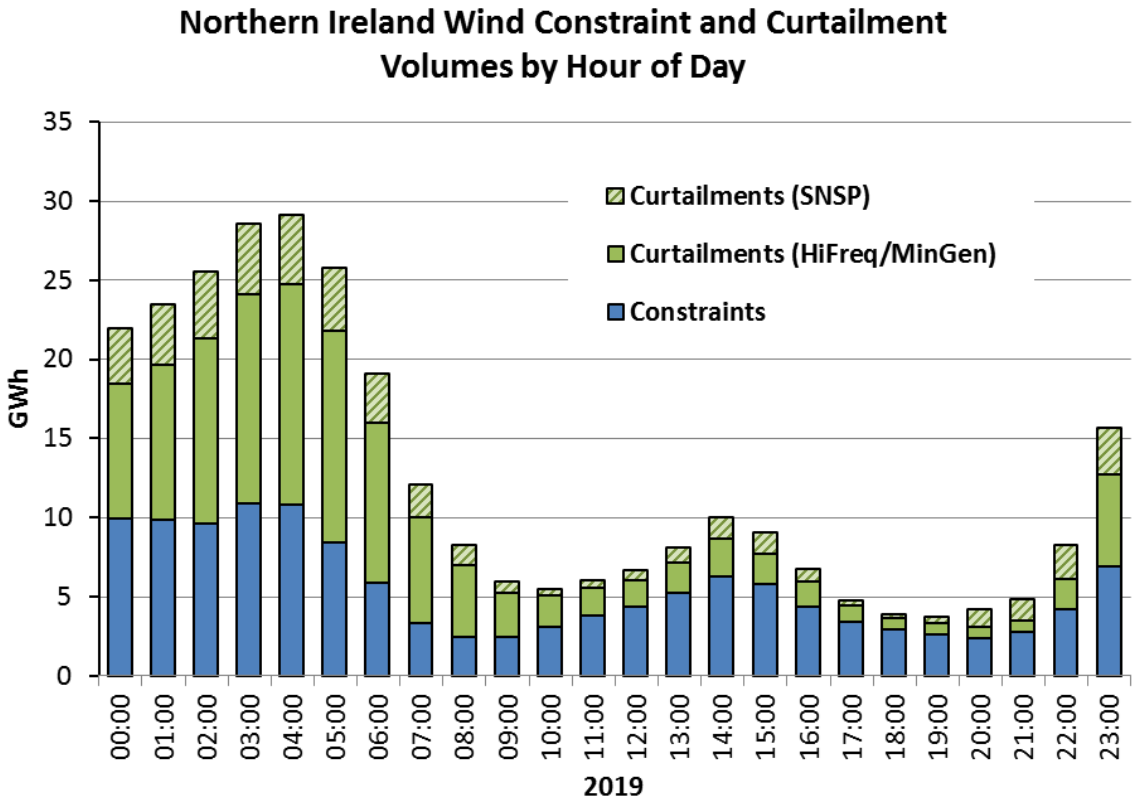


Figure 17: Breakdown of wind constraints and curtailments in NI in2019 by hour of day

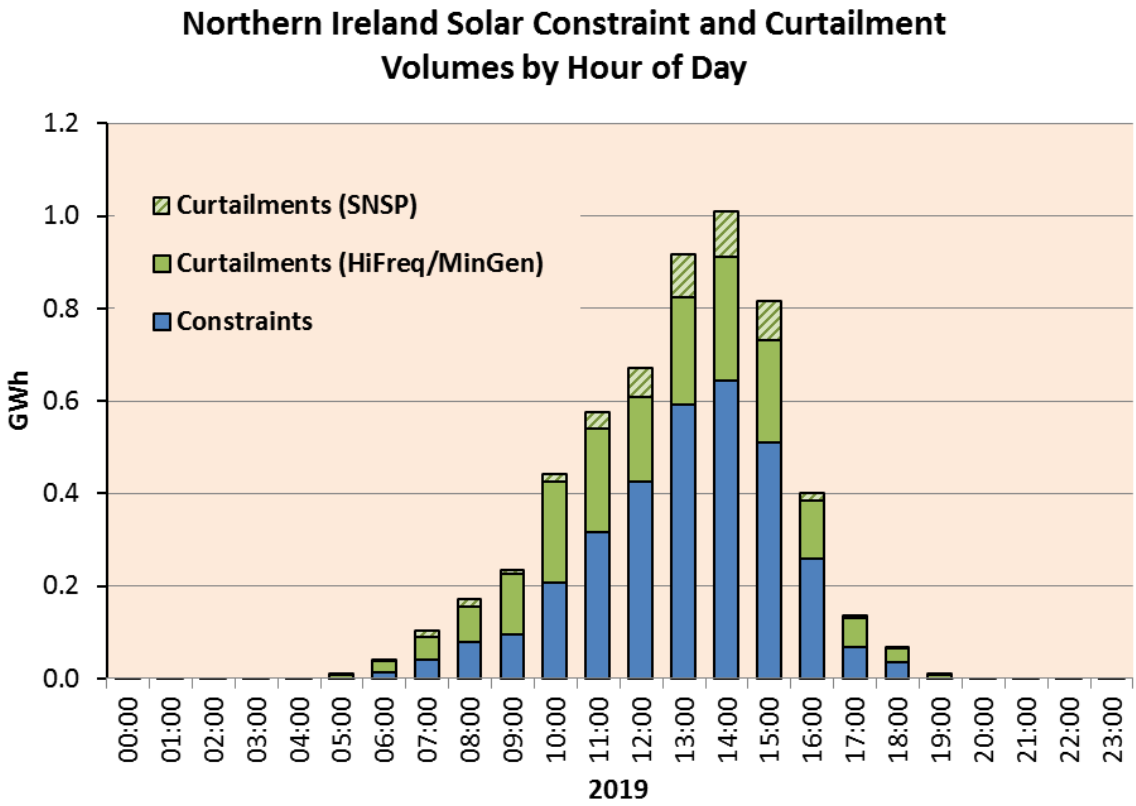


Figure 18: Breakdown of solar constraints and curtailments in NI in 2019 by hour of day

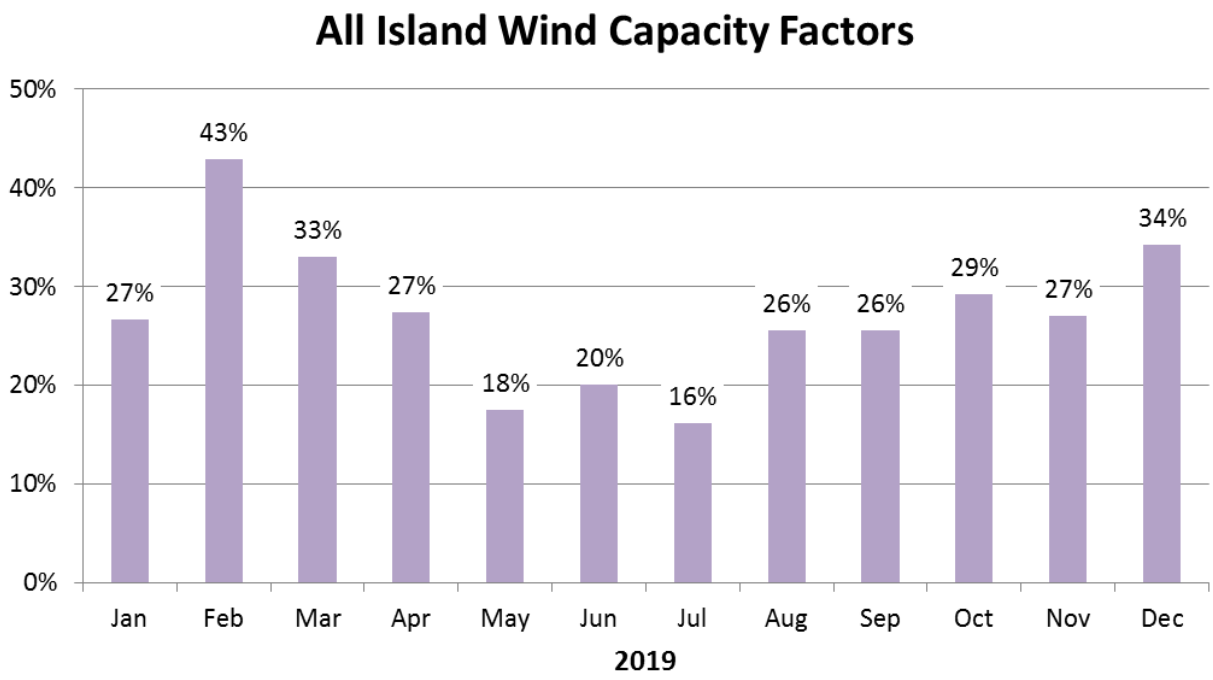


Figure 19: All-Island Monthly Wind Capacity Factors in 2019

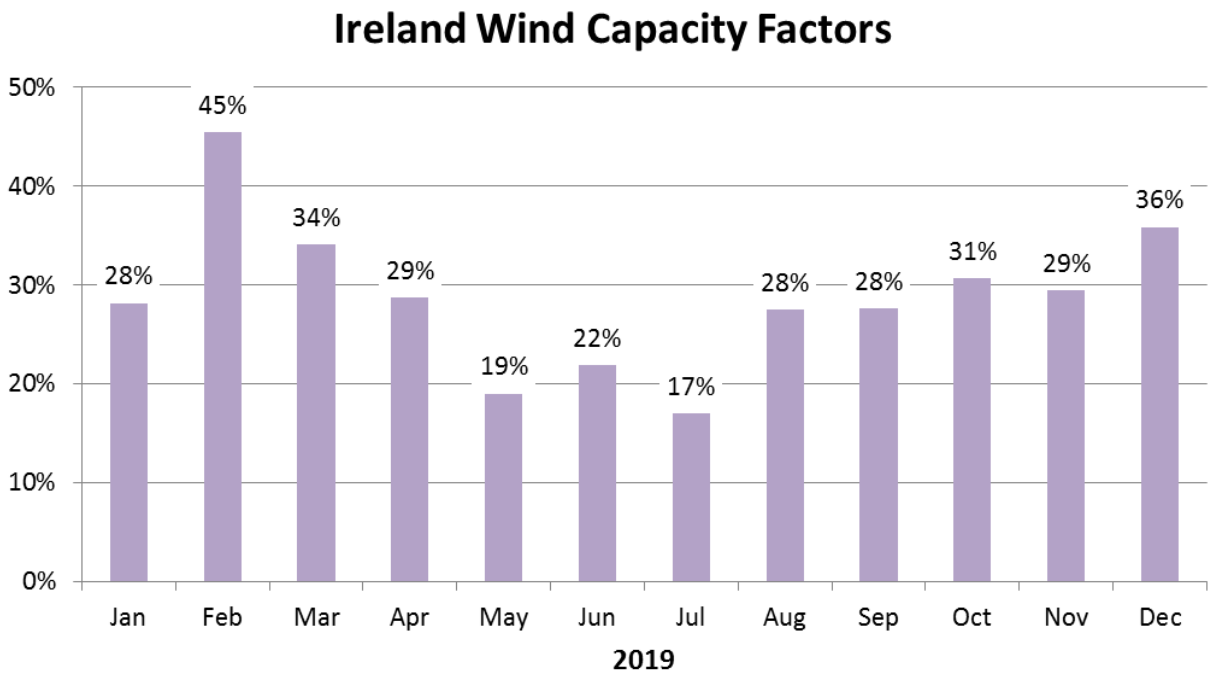


Figure 20: Ireland Monthly Wind Capacity Factors in 2019

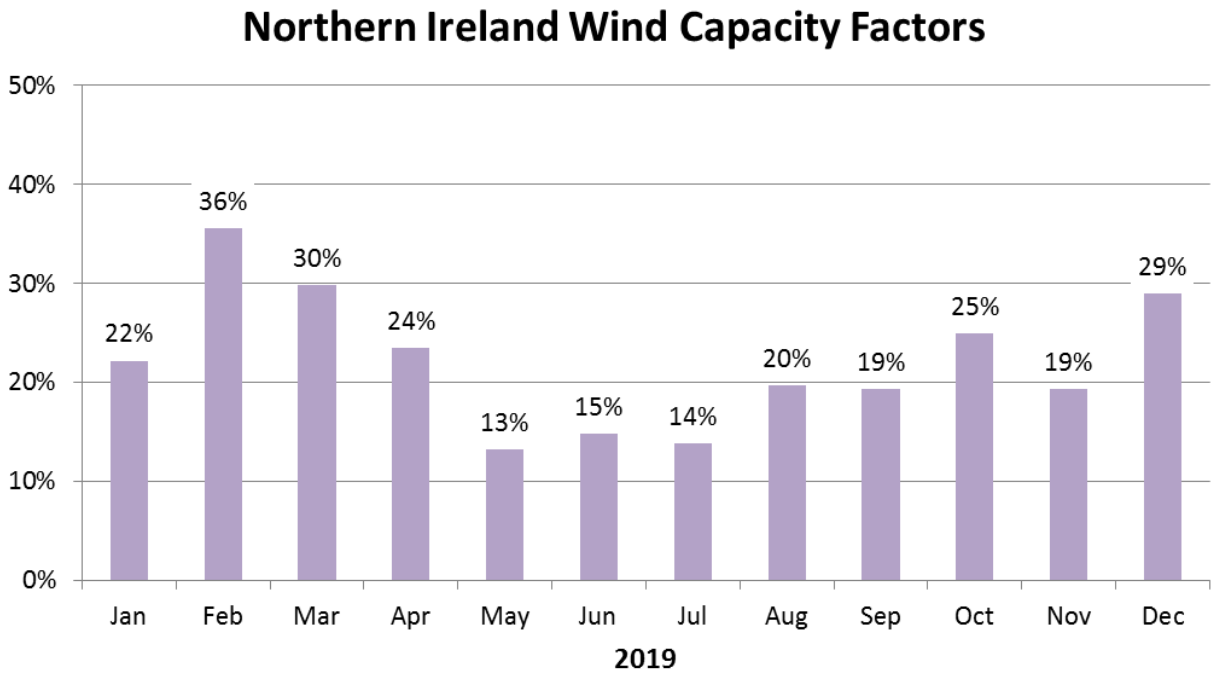


Figure 21: Northern Ireland Monthly Wind Capacity Factors in 2019

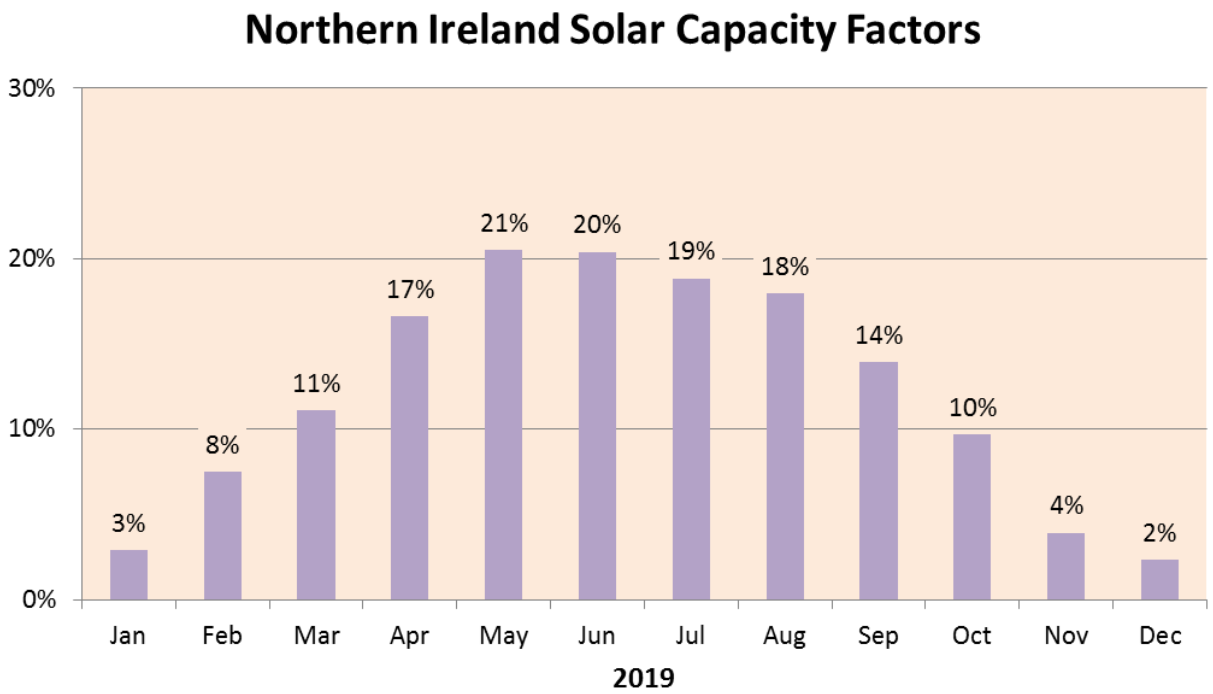


Figure 22: Northern Ireland Monthly Solar Capacity Factors in 2019

Appendix C – Transmission System Map

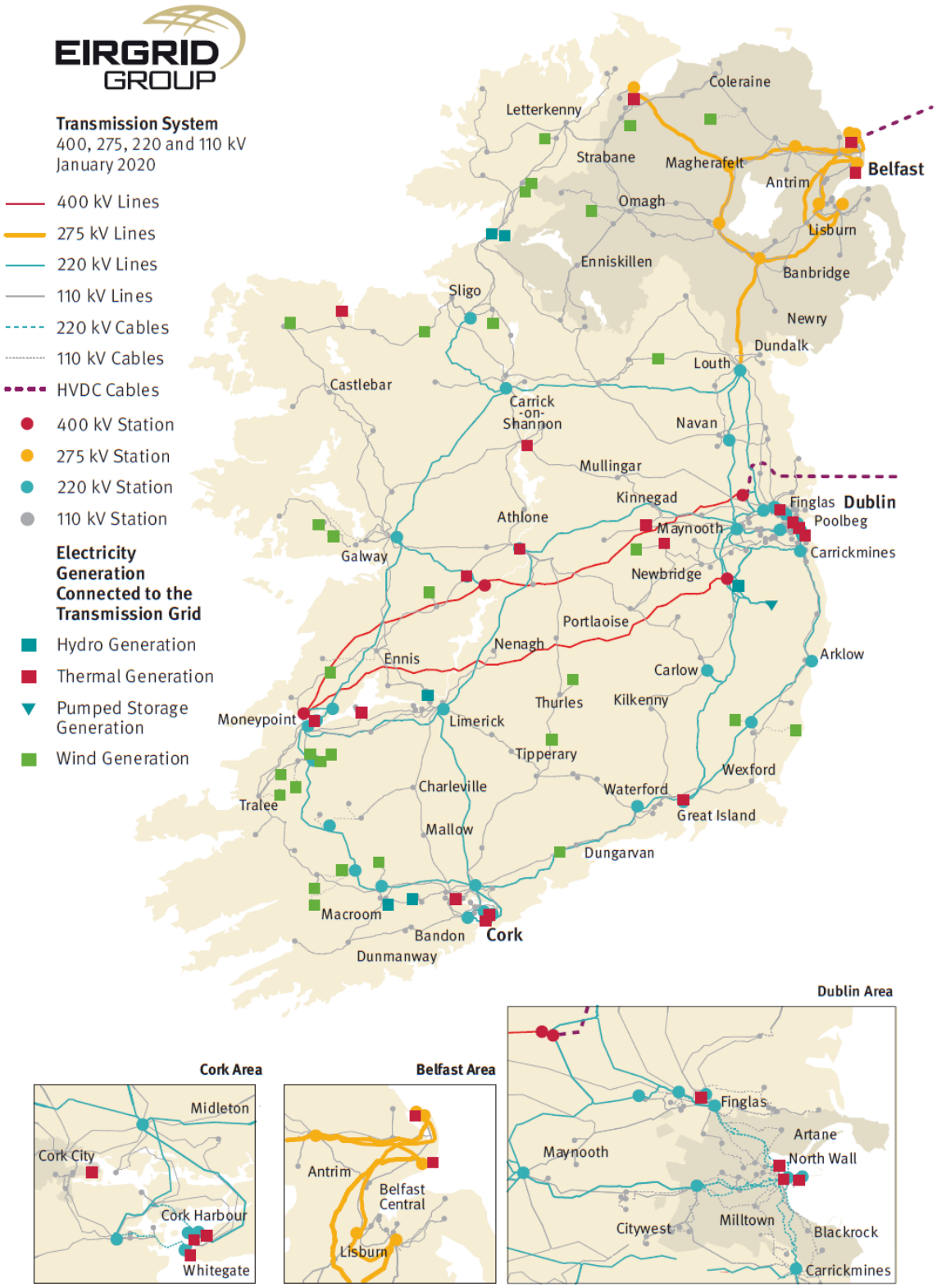


Figure 23: Transmission System Map

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
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
TSO	Transmission System Operator
UR	Utility Regulator Northern Ireland
VPTG	Variable Price Taking Generator
W	West