Annual Renewable Energy Constraint and Curtailment Report 2014

07/12/2015

EIRGRID SONI

Contents

Executive Summary

EirGrid and SONI have prepared this report for the Regulatory Authorities to outline the levels of dispatch-down of renewable energy in 2014, 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. In order to achieve this target, the Government set a 10% renewable transport target, a 12% renewable heat target and a 40% renewable electricity target. Similarly in Northern Ireland, the Department of Enterprise, Trade and Investment (DETI) 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 actively working towards facilitating the governments' renewable electricity targets.

The Renewable Energy Directive requires the TSOs to prioritise renewable energy generation. Sometimes measures are taken to turn-off or dispatch-down renewable energy for system security reasons. In these circumstances TSOs must report this to the regulatory authorities. They must also indicate which corrective measures they intend to take in order to prevent inappropriate dispatching-down. Reducing the level of renewable dispatch down helps bring both environmental and economic benefits to consumers in Ireland and Northern Ireland.

In Ireland and Northern Ireland renewable energy is predominately sourced from wind. Other sources include hydroelectricity, solar photovoltaic, biomass and waste. These latter sources of energy are generally maximised in dispatch. Due to their small overall contribution to renewable energy these are excluded from the report.

Dispatch-down of wind energy refers to the amount of wind energy that is available but cannot be produced. This is because of power system limitations, known as curtailment, or network limitations, known as constraints.

In 2014, the total wind energy generated in Ireland and Northern Ireland was 6,436 GWh, while an estimated 277 GWh of wind energy was dispatched-down. This represents 4.1% of the total available wind energy in 2014, and is an increase of about 81 GWh on the 2013 figure.

[1] Article 16. C of the 2009 renewables 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 CER on those measures and indicate which corrective measures it is intended to take in order to prevent inappropriate curtailments.*

In Ireland, the dispatch-down energy from wind resources was 236 GWh: this is equivalent to 4.4% of the total available wind energy. The dispatch-down energy from variable price-taking generation (VPTG) was 165 GWh, and from autonomous generation was 71 GWh. In Northern Ireland, the dispatch-down energy from wind resources was 41 GWh. This is equivalent to 2.8% of the total available wind energy. The dispatch-down energy from variable price-taking generation (VPTG) was 27 GWh, and from autonomous generation was 14 GWh. A high level summary of the above for the last four years can be found in Appendix C.

The level of dispatch-down is affected by a number of factors which vary from year to year. The amount of wind installed on the system and the capacity factor of the wind generation will have an impact on the levels of dispatch-down. The total capacity of wind generation rose by 374 MW in 2014 while the average capacity factor was 28.5%. In 2013 the average capacity factor was 30.6%.

The level of demand is another important factor which can vary from year to year. However, the year-on-year changes are negligible. Average demand in Ireland in 2014 just 0.5% higher than in 2013 and in Northern Ireland it was 1.3% lower than in 2013.

The principal benefits of the Moyle and East West interconnectors are:

- reducing the price of electricity in Single Electricity Market ;
- improving security of supply.

However, they can also facilitate the reduction of wind curtailment. This is done through the use of System Operator trades directly with National Grid Electricity Transmission or through the TSOs' trading partner in Great Britain.

The fundamental issues which give rise to curtailment are being addressed by EirGrid's DS3 programme (Delivering a Secure, Sustainable Electricity System). This programme has been specifically designed to cater for the increased levels of renewable generation which the system now needs to accommodate. This is necessary to ensure that the power system can be operated securely and efficiently and also to address other system wide limitations. This programme of work is based on the published Facilitation of Renewables studies.

In order to address the network limitations which give rise to constraint of wind energy, the Draft Grid Development strategy was developed in Ireland and a similar programme is under development in Northern Ireland. The reinforcement of the network will increase the capacity of wind generation which can be accommodated. However, it should be noted that temporary outages of transmission equipment can be required for:

- network improvement works;
- Connections of new wind-farms to the network.

These works can lead to reduced network capacity and consequentially increased levels of dispatch-down in the short-term.

1. Introduction

1.1 Context

The 2009 European Renewable Directive (2009/28/EC) requires that the TSOs report to the Regulatory Authorities, CER and URegNI. This report must detail why renewable energy was dispatched down and what measures are being taken to prevent inappropriate curtailment.

This Directive was transposed 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 CER and URegNI, 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 has priority dispatch. 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 therefore necessary to reduce the output of renewable generators below their maximum available level on occasions 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.

There are two reasons for the dispatch-down of wind energy, curtailment and constraint. Curtailment refers to the dispatch-down of wind for system-wide reasons (where the reduction of any or all wind generators would alleviate the problem). Constraint refers to the dispatch-down of wind generation for more localised network reasons (where only a subset of wind generators can contribute to alleviating the problem). The SEM Committee approved in SEM-13-011 the difference between constraint and curtailment.

1.3 Data Gathering

The SEM is the preferred source of data due to the reliability and accessibility of the data by all stakeholders. This adds to the transparency of the calculations as they can be readily verified. However, this source is only available for windfarms that are registered in the market as Variable Price Taking Generators (VPTGs).

There is no appropriate SEM data to calculate dispatch-down of autonomous generation. This had to be estimated manually using aggregate SCADA data (which is less accurate than the data for VPTGs). It was estimated that the dispatch-down energy from autonomous windfarms in Ireland and Northern Ireland was approximately 85 GWh for 2014.

Furthermore, due to the differences in the IT systems used in Ireland and Northern Ireland, it was not possible to log all of the categories for the reasons for constraint or curtailment of wind energy in both jurisdictions. This capability has become available in the new All-Island Wind Dispatch Tool which went live in Quarter 2, 2014 in Ireland and Quarter 3, 2014 in Northern Ireland. The TSOs are currently working with Industry on the new

reporting templates and calculation methodology and expect to start using this new reporting in 2016. In the meantime the TSOs intend to provide information based on estimates from the data available.

2. Level of Dispatch-Down Energy in 2014

The following provides a summary of the dispatch-down of wind energy in 2014 for Ireland and Northern Ireland. More details and figures are provided in Appendix A.

2.1 All Island

In the calendar year 2014, the share of centrally dispatched generation[3] from renewable sources in Ireland and Northern Ireland was 21.4%. This is broken down as follows: 17.8% provided by wind, 2% by hydro and 1.7% by other renewable energy sources. The total wind energy generated was 6,436 GWh in Ireland and Northern Ireland. There was an estimated total of 277 GWh of dispatch-down energy of windfarms, which is an increase of approximately 81 GWh compared to 2013. The level of dispatch-down of wind represents 4.1% of total available energy from wind resources in Ireland and Northern Ireland. Details of the calculation methodology are provided in Appendix B.

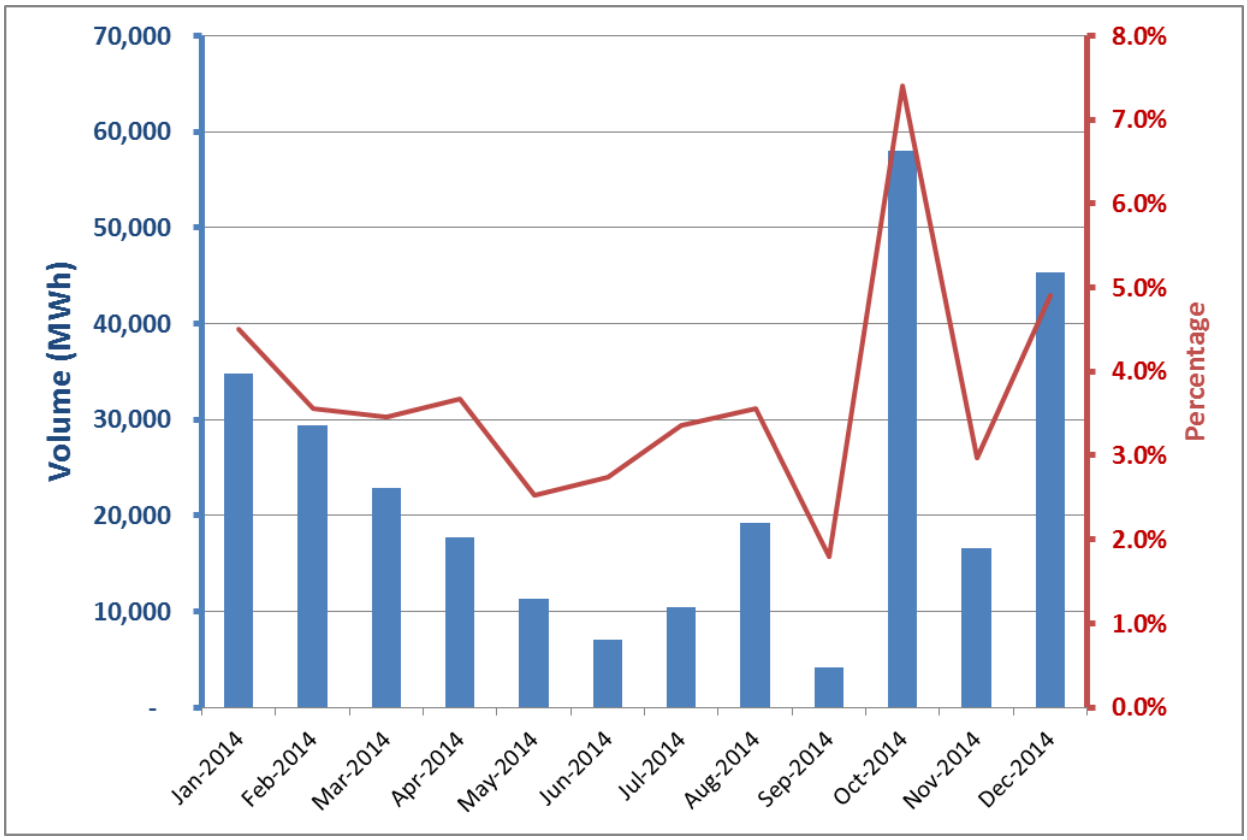

Figure 1: Monthly Variations in Wind Dispatch-Down Levels in 2014

[3] Note that since the percentage figures are presented for centrally dispatched generation (based on SCADA data), they do not account for non-dispatchable embedded renewable generation, which includes biomass, land-fill gas and small-scale hydro.

2.2 Northern Ireland

In 2014 the total dispatch-down energy from wind generation in Northern Ireland was 41 GWh; this is equivalent to 2.8% of total available wind energy in that jurisdiction. This is a total overall increase of approximately 17 GWh in dispatch-down energy from wind generation compared to 2013.

This dispatch-down was spread across variable price taking wind generation (VPTG) and autonomous generation. The dispatch-down energy from VPTG was 27 GWh in Northern Ireland. This represents 2.6% of the available energy from these generators in this period. In addition, there was an estimated 14 GWh of dispatch-down from other controllable wind generation.

At end of 2014, VPTGs constituted approximately 70% of all wind capacity in Northern Ireland. The dispatch-down of VPTGs occurred across 16 windfarms which had a total registered capacity of approximately 374 MW by the end of 2014.

2.3 Ireland

In 2014, the total dispatch-down energy from wind generation in Ireland was 236 GWh; this is equivalent to 4.4% of total available wind energy in Ireland. This is a total overall increase of approximately 65 GWh in dispatch-down energy from wind generation compared to 2013.

This dispatch-down was spread across variable price taking wind generation (VPTG) and autonomous generation. The dispatch-down energy from VPTG was 165 GWh in Ireland. This represents 5.4% of the available energy from these generators in this period. In addition, there was an estimated 71 GWh of dispatch-down from other controllable wind generation. At end of 2014, VPTGs constituted approximately 55% of all wind capacity in Ireland.

The dispatch-down of VPTGs occurred across 41 windfarms which had a total registered capacity of approximately 1,179 MW by the end of 2014.

It is difficult to assign dispatch-down to local network ("constraint") and system-wide ("curtailment") reasons distinctly and unequivocally. However two major constraint areas are identifiable: the north-west and the south-west of Ireland. In addition, curtailment is seen to arise mainly during the night time hours (between 11pm and 9am) due to the low overall system demand.

3 Contributory Factors for Dispatch-Down of Wind

3.1 Changes to Operational Dispatch Policy

Prior to the SEM-11-062 decision paper, the operational policy in use was to dispatch-down variable price-taking generation[4] before autonomous[5] units. This policy was implemented in 2008. The purpose of it is twofold:

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

Since the introduction of SEM-11-062, there is a requirement to dispatch wind generators down based on their controllability. This is defined under Grid Code and is verified through performance monitoring and testing. The implementation of this is described in an operational policy document entitled "Policy for Implementing Scheduling and Dispatch Decisions SEM-11-062" and the associated addendum. To meet the controllability definition, the operational policy[6] requires a wind farm to achieve Operational Certificate status 12 months after energisation. This process was implemented in December 2014 and a number of windfarms were moved to category (i) for this reason. If a wind farm is in category (i) it means that it will be dispatched down ahead of other wind farms.

As a result of this SEM-11-062 decision paper, this report accounts for the dispatch-down of both variable price taking wind generation (VPTG) and autonomous wind generation. In the SEM, VPTG units have availability values that are distinct from dispatch quantities and actual output. This allows the dispatch-down of these units to be calculated. In contrast, autonomous units have their dispatch and availability quantities set to the metered outputs. There is no mechanism from SEM data to calculate the dispatch-down of these windfarms. Some estimation for Ireland generators has been provided in this report and this broad area is being examined.

3.2 Level of Wind

As explained in section 1.2, it is necessary, at times, 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. These are the amount of wind generation installed and the capacity factor of the wind generation.

At the beginning of January 2014, the total installed capacity of wind generation on the island was 2,451 MW. By year-end, the figure had risen to 2,825 MW (2,211 MW in Ireland and 614 MW in Northern Ireland). Figure 2 shows the end of year wind capacities on the island from 2000 to 2014. Of this total capacity, almost 1,596 MW was registered in the SEM as Variable Price Taker Generators (VPTG).

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[4] Variable Price Taker Generators (VPTGs) which are:
- When not constrained/curtailed are scheduled and paid based on their actual output
- When constrained/curtailed are scheduled based on their actual availability

[5] 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

[6] Wind Farm Controllability Categorisation Policy; 5th March 2012

Over the year the capacity factors[7] of windfarms was 28.5%. For comparison the annual capacity factor in 2013 was 30.6% and in 2012 it was 28.5%. The seasonal variation in the capacity factor is evident in figure 3.

Year End	Northern Ireland	Ireland	All-Island
2000	36.8	119.4	156.2
2001	36.8	125.8	162.6
2002	36.8	138.5	175.3
2003	76.0	214.0	290.0
2004	89.1	341.6	430.7
2005	108.6	517.2	625.8
2006	131.6	749.0	880.6
2007	214.0	797.6	1,011.6
2008	230.7	1,030.4	1,261.2
2009	301.1	1,265.5	1,566.6
2010	340.9	1,373.8	1,714.7
2011	405.1	1,631.0	2,036.1
2012	488.5	1,763.5	2,252.0
2013	554.3	1,896.2	2,450.5
2014	614.0	2,211.0	2,825.0

Figure 2: Wind Capacities on the island from 2000 to 2014

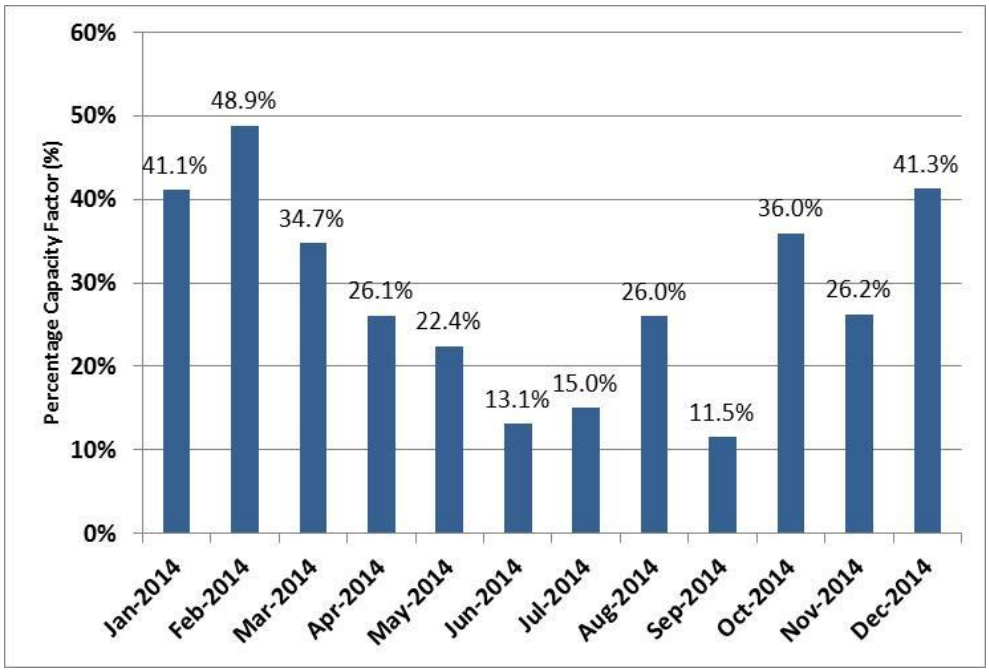

Figure 3: All-Island Monthly Wind Capacity Factors in 2014

[7] 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. It therefore represents the average output of the wind generation. This capacity factor is based on SCADA data.

3.3 Demand Level

The level of demand is another important factor which affects the dispatch-down of wind. Increased demand generally enables greater levels of wind to be accommodated on the system.

In 2014 wind installed capacities on the island increased significantly while wind capacity factors reduced slightly. While total demand remained relatively unchanged, wind generation recorded a 9.6% increase in 2014 from 2013 levels.

3.4 Breakdown of Wind Dispatch-down – Curtailment vs. Constraint

In Northern Ireland, the breakdown of wind dispatch-down volumes in 2014 between constraints and curtailments is estimated to be 8% and 92% respectively.

In Ireland it is currently not possible to categorically distinguish between constraint and curtailment. This is due to the interaction and overlap of curtailment and constraint and the limitations of the systems used for part of 2014 to dispatch wind generation. As a result, the breakdown of dispatch-down energy between constraint and curtailment can only be estimated using the available VPTG wind dispatch-down figures. As a rule of thumb, for any given half-hour, if dispatch-down occurred in five or more regions (of seven in total), this was attributed to curtailment. Conversely, if there was dispatch-down in four or less regions, this was attributed to constraint. Using that methodology, it is estimated that curtailment accounts for approximately 61% of the dispatch-down, while constraint accounts for 39%. For comparison purposes and using the same estimation methodology for 2013 data, we can see that for dispatch-down:

- approximately 44% was attributed to curtailment;
- approximately 56% was attributed to constraints.

All-Island: The following table shows the aggregate estimated breakdown of wind dispatch-down on the island in the last 4 years.

Estimated Breakdown of Dispatch-down of Wind on the Island	2011	2012	2013	2014
Constraints	20%	38%	28%	35%
Curtailments	80%	62%	72%	65%

Table 1: Yearly Breakdown of Dispatch-down Energy into Constraints and Curtailments

3.5 Curtailment

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

i) System stability requirements (synchronous inertia, dynamic and transient stability)
ii) Operating reserve requirements, including negative reserve
iii) Voltage control requirements
iv) Morning load rise requirements

v) System Non-Synchronous Penetration (SNSP[8]) limit (currently 50%)

The first four of these limits tend to impose minimum generation requirements on the conventional (synchronous) generation portfolio. This in turn can limit the "room" for wind generation, particularly overnight during the lower demand hours. The current implementation of these security limits are described in the Operational Constraints Update paper. This paper superseded the Transmission Constraint Groups document. Both documents are published[9] on the EirGrid website.

SNSP is a system security metric that has been established from the results of the Facilitation of Renewables studies. These studies identified 50% as the current maximum permissible level. In 2014 there were some instances of curtailment to ensure this level was not breached. However, the SNSP limit is often superseded by the other minimum generation limits described above. This is most likely during low demand periods with high wind.

The impact of curtailment can be seen in figure 4, which shows the total annual all-island dispatch-down energy by hour of day. The predominance of curtailment in the night hours 23:00 – 09:00 over local constraints (which arise throughout the day) is evident.

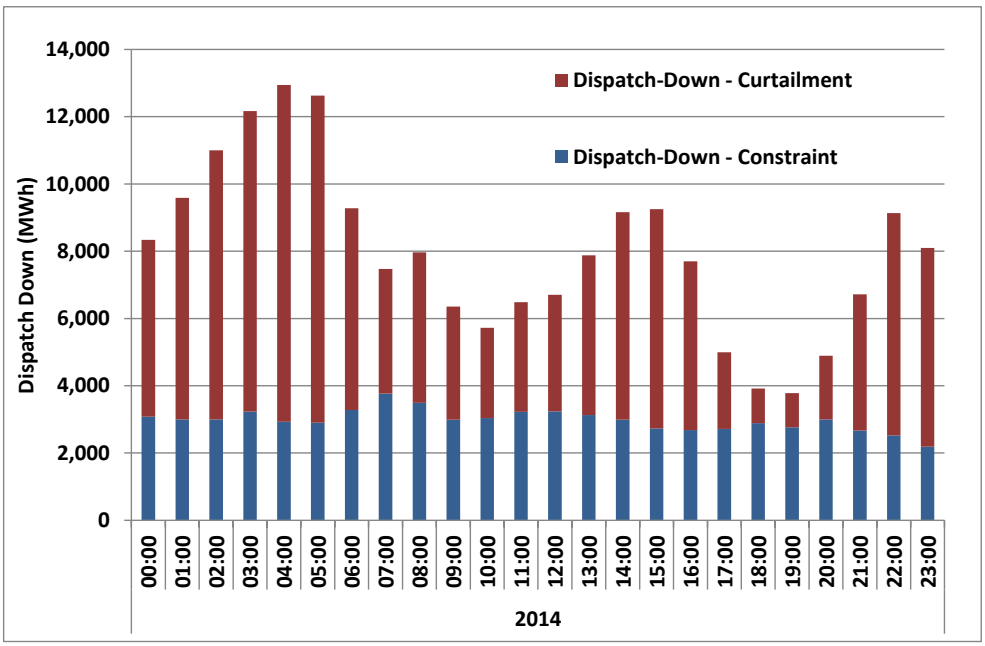

Figure 4: Estimated Breakdown of VPTG Dispatch-down Volumes on the Island in 2014

3.6 Constraints

The dispatch-down of wind for network reasons is referred to as constraint. Constraint of wind can occur for intact network conditions. This can be for two main reasons:

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

[8] SNSP is the ratio of non-synchronous generation (wind and HVDC imports) to demand plus HVDC exports
[9] http://www.eirgrid.com/aboutus/publications/

The draft grid development strategy, Your Grid, Your Views, Your Tomorrow, and associated programmes directly address these issues in Ireland. The strategy allows for strengthening the network in critical/constrained areas. Similar programmes are being envisioned in Northern Ireland which will address these limitations in that jurisdiction.

The major capital works associated with these types of projects may reduce the capacity of the network for the duration of the work. 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. Several circuits were upgraded during 2014 allowing more wind generation to be exported from the region and thus reducing wind constraints.

From a network perspective, the west, north-west and south-west of the Irish system have the greatest level of restrictions for the export of wind. See "VPTG Wind Dispatch-Down by Region in 2014" Chart in Appendix A. Previously there were often restrictions in Donegal, even when there was a fully intact network. This resulted in high levels of constraint of wind in this area. A new circuit was energised in 2014 to help reduce the level of wind constraints in this region.

There is also evidence that other areas on the system have at times seen restrictions but these are generally associated with transmission outages.

The proportion of dispatch-down attributable to constraint (rather than curtailment) is estimated to be 35% in 2014. This is due partly to an increase in installed wind generation but more significantly to the transmission outages in 2014. Many of which are to facilitate the upgrading and uprating of the transmission system. To illustrate, some of the transmission outages that resulted in significant constraint of wind generation are described below.

North West: The SEM-13-011 decision paper defined the Donegal region as a defined constraint group. High constraints on wind farms north of Srananagh 220 kV station can largely be attributed to outages that were required:

- to facilitate the uprate of Cathaleen's Fall 110 kV busbars, most notably the outage of Cathaleen's Fall-Srananagh 2 (two) 110 kV line from May to October 2014.

This resulted in high loading of the parallel Cathaleen's Fall-Srananagh 1 (one) 110 kV line during high wind conditions. There was also a parallel outage of Cathaleen's Falls – Golagh 110 kV line from May to October 2014. This which resulted in high loading of the parallel Cathaleen's Fall-Drumkeen 110 kV line during high wind conditions.

South West: The SEM-13-011 decision paper defined the South-West region as a defined constraint group. The Clashavoon - Knockraha 220 kV line was forced out of service from April to November 2014. This would have restricted the amount of wind generation that could be exported out of the South West region during high wind periods.

Storm Darwin: On 12th February 2014 a severe storm hit Ireland with severe winds and gusts up to 177 km per hour. Approximately 280,000 electricity customers were disconnected due to damage caused to the electricity network. The storm also caused a

number of lines to windfarms in the South West to be disconnected, thus effectively constraining the output of these windfarms. These outages in the South West resulted in the output of other windfarms being constrained to manage overloading lines. Due to the inclement weather and difficult working conditions certain lines were not returned to service for several days after the initial storm.

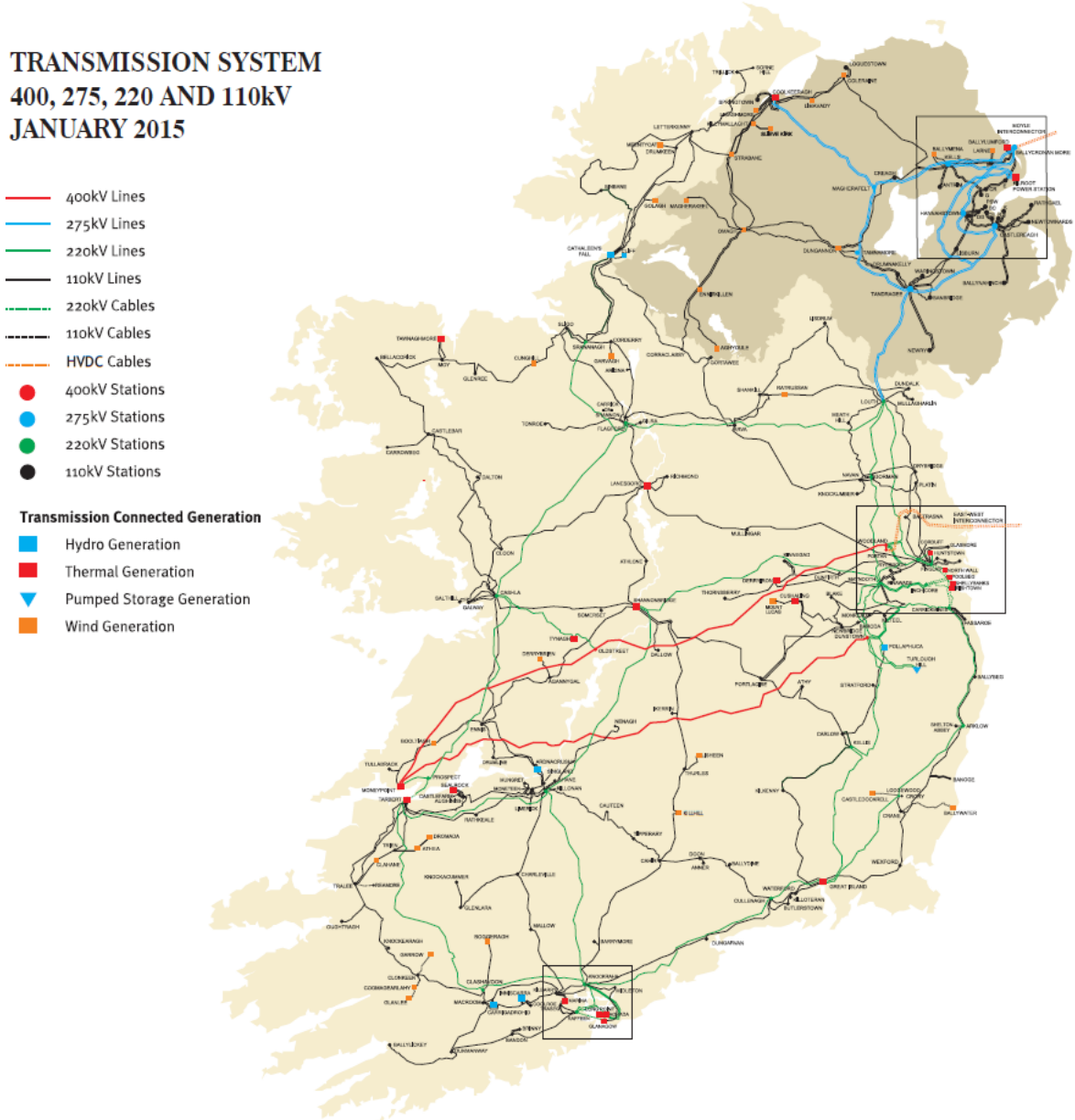

Figure 5: Transmission System Map

3.7 Wind Dispatch Down by Region

The greatest percentage of wind dispatch down was observed in the NW, SE, SW and W as shown in Figure 5. The following are the main drivers for higher than average wind dispatch down in these regions:

North West (NW) – The dispatch down of wind in the region is predominately due to transmission constraints as described in Section 3.6.

South East (SE) – This is mainly due to one windfarm in this region which was in the Controllability Category (i) for most of 2014. This windfarm would be dispatched down for curtailment or constraint reasons ahead of other windfarms.

South West (SW) – The dispatch down of wind in the region is predominately due to transmission constraints as described in Section 3.6.

West (W) – This is mainly due to one windfarm in this region which was in the Controllability Category (i) for most of 2014. This windfarm would be dispatched down for curtailment or constraint reasons ahead of other windfarms

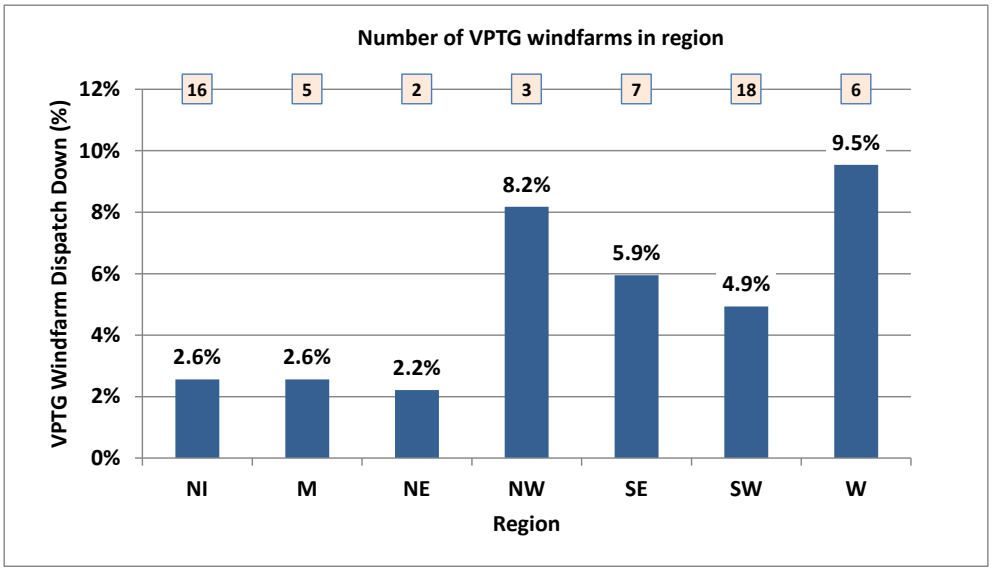

Figure 6: VPTG Wind Dispatch-Down by Region in 2014

4 Mitigation Measures

4.1 Network Reinforcements:

The draft grid development strategy as well as the programmes being developed in Northern Ireland are the primary methods of addressing network capacity issues in the coming years. The outages necessary to deliver the network upgrades may result in additional constraints in the short term. However, in the long run constraints on wind generation will be reduced. In addition, consideration will be given to the use and deployment of new technologies including dynamic line rating and special protection schemes.

4.2 Operational Policy and the DS3 Programme

The fundamental issues that give rise to curtailment have been identified in section 2.5 above. These issues will be addressed by EirGrid and SONI's Delivering a Secure Sustainable Electricity System (DS3) programme[10]. This is a multi-stakeholder, multi-year programme of work designed specifically to securely and efficiently increase the capability of the power system. It will cover operation from a maximum of 50% System Non-Synchronous Penetration (SNSP) level to a maximum of 75% and also address the other limits identified in section 2.5.

The DS3 programme was formally launched in August 2011 and is designed to reduce curtailment. However, the success of the programme is dependent 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.

As part of the DS3 programme of work there are studies underway to investigate the optimisation of operational policy and to minimise curtailment. The System Services procurement project is also underway which is also aiming to help minimise curtailment.

4.3 Operational Policy – Interconnection

Interconnector Status Updates

The East West Interconnector (EWIC) went into partial commercial operation in December 2012 and full commercial operation in May 2013.

The Moyle Interconnector was operating at 250 MW of its 500 MW capacity during 2014.

[10] http://www.eirgrid.com/operations/ds3/

System Operator Interconnector Countertrading[11]

Following gate closure in the SEM, the TSOs may seek to initiate changes to the interconnector flows. The reasons for this would be for system security or to facilitate priority dispatch generation (as directed in SEM Committee Decision paper SEM-11-062). These changes would be through countertrading[12] between SOs or through a third party in the wholesale electricity market in Great Britain.

- Countertrading is carried out in accordance with: commercial parameters approved by the Regulatory Authorities; any relevant system limitations; and the availability of a counter party to give effect to any potential trade.

Countertrading arrangements were used on a regular basis throughout the year to alleviate curtailment of priority dispatch generation and also for reserve co-optimisation. This countertrading is predominately carried out using the services of a third party trading partner. As the tool used by the TSOs optimises the generation schedule based on numerous variables it is not possible to differentiate whether the countertrading was for priority dispatch or for economic reasons.

4.4 Controllability of Wind Generators

Windfarm controllability is the ability of the TSO control centres to dispatch a windfarm's output to a specific level. Uncontrollable windfarms 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 windfarms 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 windfarms.

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11 http://www.eirgrid.com/media/Information%20Note%20on%20SOInterconnectorCountertrading12July2013.pdf

12 Once the SEM market has closed the TSOs may initiate changes to the interconnector schedules via SO countertrading for reasons of system security or to facilitate priority dispatch generation (as directed in SEM Committee Decision paper SEM-11-062).

Appendix A – Detailed Results

The following tables provide a detailed summary of the dispatch-down of wind (in MWh and in terms of percentage of available energy). The data is provided for Northern Ireland and Ireland individually and in aggregate.

All-Island:

Month	All Wind Generation (MWh)	All Wind Dispatch Down Vol (MWh)	All Wind Dispatch Down (%)	VPTG Dispatch-Down Vol (MWh)	Non-VPTG Dispatch-Down Vol (MWh)
Jan-2014	729,901	34,760	4.5%	23,999	10,761
Feb-2014	791,661	29,426	3.6%	24,206	5,220
Mar-2014	632,784	22,891	3.5%	14,380	8,511
Apr-2014	466,635	17,723	3.7%	16,949	774
May-2014	423,520	11,277	2.5%	7,218	4,060
Jun-2014	243,669	7,082	2.7%	2,484	4,598
Jul-2014	292,683	10,475	3.4%	5,912	4,564
Aug-2014	509,715	19,185	3.6%	11,004	8,182
Sep-2014	221,464	4,195	1.8%	1,710	2,484
Oct-2014	719,796	57,994	7.4%	43,449	14,545
Nov-2014	530,649	16,581	3.0%	8,534	8,047
Dec-2014	873,396	45,316	4.9%	32,314	13,003
2014 Total	**6,435,875**	**276,905**	**4.1%**	**192,157**	**84,748**

Table 2: Details of Monthly Dispatch-down Energy on the Island

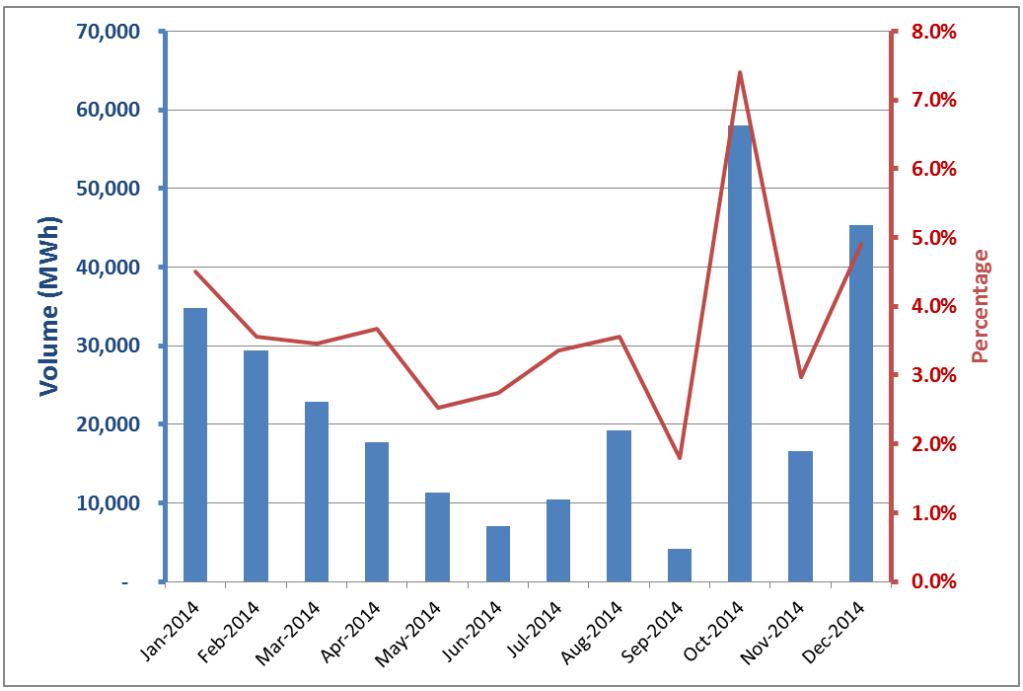

Figure 7: All-Island Wind Dispatch-Down Monthly Volumes and Percentages in 2014

Ireland:

Month	All Wind Generation (MWh)	All Wind Dispatch Down Vol (MWh)	All Wind Dispatch Down (%)	VPTG Dispatch-Down Vol (MWh)	Non-VPTG Dispatch-Down Vol (MWh)
Jan-2014	576,369	30,071	4.9%	20,917	9,154
Feb-2014	621,882	23,668	3.7%	20,690	2,978
Mar-2014	481,032	20,144	4.0%	12,710	7,434
Apr-2014	355,608	15,607	4.2%	15,607	-
May-2014	342,998	10,012	2.8%	6,291	3,722
Jun-2014	196,557	6,773	3.3%	2,306	4,467
Jul-2014	227,767	9,380	3.9%	5,043	4,337
Aug-2014	399,218	14,797	3.5%	8,385	6,412
Sep-2014	179,355	4,151	2.2%	1,710	2,441
Oct-2014	560,210	50,413	8.2%	36,647	13,766
Nov-2014	420,942	14,328	3.2%	7,452	6,875
Dec-2014	696,386	36,871	5.0%	27,719	9,152
2014 Total	**5,058,325**	**236,214**	**4.4%**	**165,477**	**70,738**

Table 3: Details of Monthly Dispatch-down Energy in Ireland

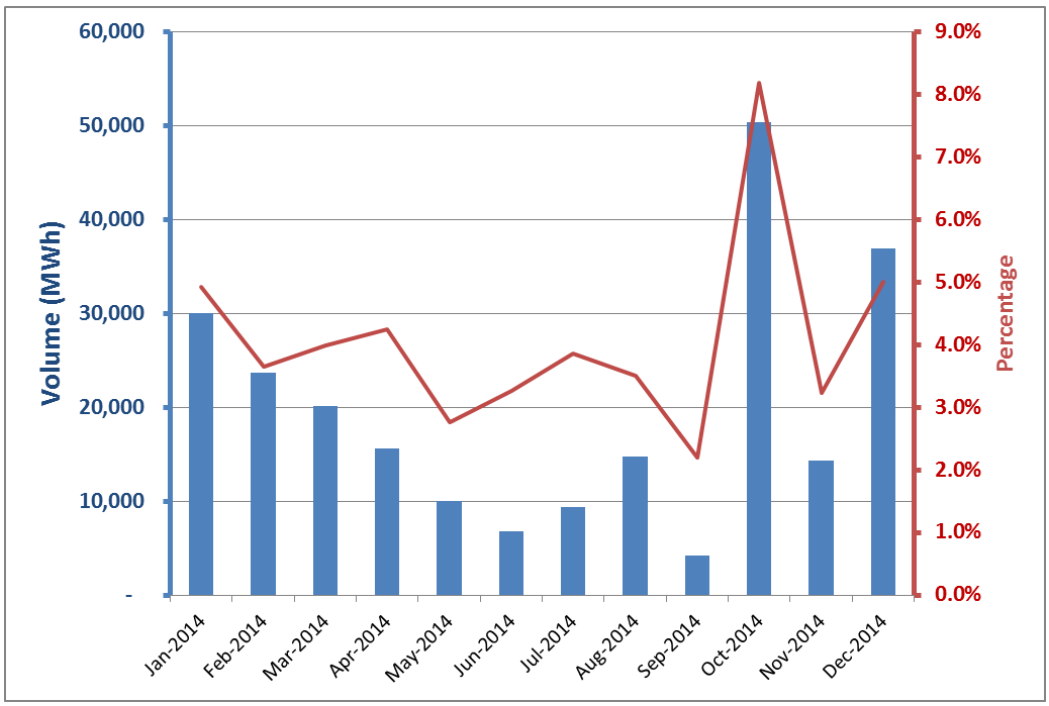

Figure 8: Ireland Wind Dispatch-Down Monthly Volumes and Percentages in 2014

Northern Ireland:

Month	All Wind Generation (MWh)	All Wind Dispatch Down Vol (MWh)	All Wind Dispatch Down (%)	VPTG Dispatch-Down Vol (MWh)	Non-VPTG Dispatch-Down Vol (MWh)
Jan-2014	153,532	4,689	2.9%	3,082	1,607
Feb-2014	169,779	5,758	3.2%	3,516	2,242
Mar-2014	151,753	2,748	1.8%	1,670	1,077
Apr-2014	111,027	2,116	1.8%	1,342	774
May-2014	80,522	1,265	1.5%	927	338
Jun-2014	47,113	309	0.6%	178	131
Jul-2014	64,916	1,095	1.6%	868	227
Aug-2014	110,497	4,389	3.8%	2,618	1,770
Sep-2014	42,109	43	0.1%	-	43
Oct-2014	159,586	7,580	4.5%	6,802	778
Nov-2014	109,706	2,253	2.0%	1,081	1,172
Dec-2014	177,009	8,445	4.5%	4,594	3,850
2014 Total	**1,377,550**	**40,690**	**2.8%**	**26,680**	**14,010**

Table 4: Details of Monthly Dispatch-down Energy in Northern Ireland

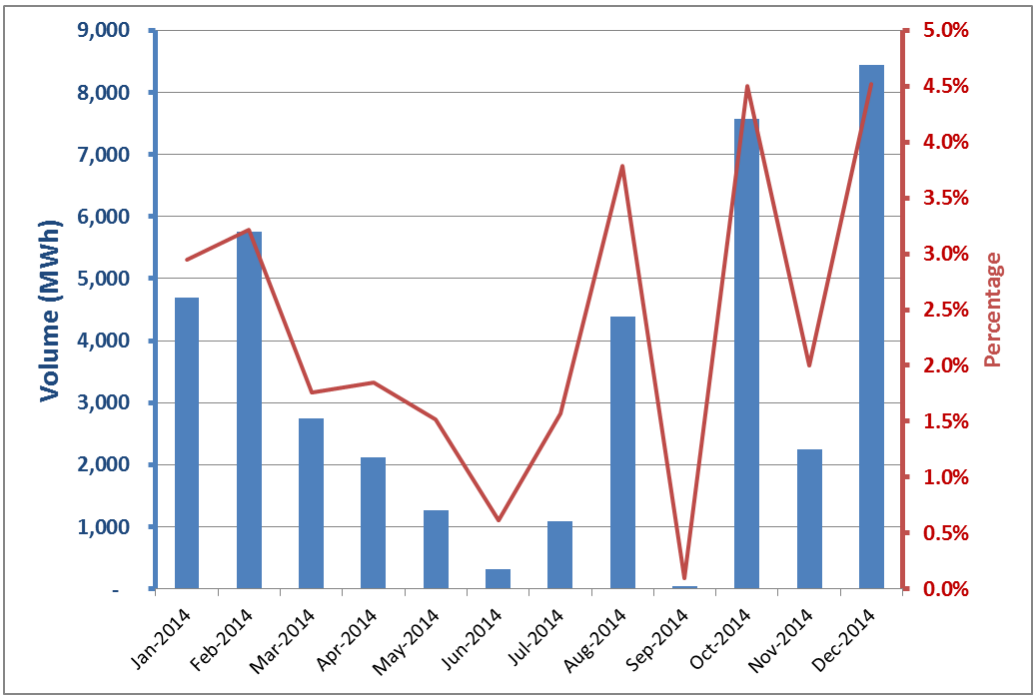

Figure 9: Northern Ireland Wind Dispatch-Down Monthly Volumes and Percentages in 2014

A breakdown of wind dispatch-down figures is provided in this section for Northern Ireland.

Due to the differences in the systems used to record the data, it was not possible to log all of the categories for the reasons for constraint or curtailment of wind energy in Ireland. This capability has become available in the new All-Island Wind Dispatch Tool which went live in Quarter 2, 2014 in Ireland and Quarter 3, 2014 in Northern Ireland.

Individual dispatch-down of VPTG windfarms 2014:

Year	Jurisdiction	Region	Unit ID	Unit Name	Capacity (MW)	Dispatch Down Vol (MWh)	Available Energy (MWh)	Dispatch Down %	VPTG Start Date
2014	NI	NI	ALT2	Altahullion 2	11.7	788	25,636	3.1%	
2014	NI	NI	CarnHill	CarnHill	13.8	1,060	34,902	3.0%	
2014	NI	NI	Carrickatane	Carrickatane	20.7	1,404	63,218	2.2%	
2014	NI	NI	Churchill	Churchill	18.4	1,550	41,326	3.8%	
2014	NI	NI	Crighshane	Crighshane	32.2	2,852	65,609	4.3%	
2014	NI	NI	Crockagarron	Crockagarron	17.5	933	46,597	2.0%	06/03/2014
2014	NI	NI	Curryfree	Curryfree	15	1,113	45,244	2.5%	
2014	NI	NI	Dunmore	Dunmore NI	21	485	41,273	1.2%	08/05/2014
2014	NI	NI	GAR	Garves	15	964	39,678	2.4%	
2014	NI	NI	GRU	Gruig	25	1,538	58,777	2.6%	
2014	NI	NI	HUN	Hunters Hill	20	805	42,998	1.9%	13/03/2014
2014	NI	NI	Screggagh	Screggagh	20	1,171	46,832	2.5%	
2014	NI	NI	SD1	Slieve Divena 1	30	1,521	60,656	2.5%	
2014	NI	NI	SLI2	Slieve Rushen 2	54	3,088	173,029	1.8%	
2014	NI	NI	Slieve Kirk	Slieve Kirk	74	5,301	186,694	2.8%	
2014	NI	NI	TAP	Tappaghan	28.5	2,106	69,320	3.0%	
2014	**Northern Ireland**				**416.8**	**26,680**	**1,041,788**	**2.6%**	

Year	Jurisdiction	Region	Unit ID	Unit Name	Capacity (MW)	Dispatch Down Vol (MWh)	Available Energy (MWh)	Dispatch Down %	VPTG Start Date
2014	IRE	M	GE1	Gortahile	20	625	63,554	1.0%	
2014	IRE	M	GM1	Garracummer 1	36.9	1,402	115,882	1.2%	25/03/2014
2014	IRE	M	GU1	Glenough	32.5	1,128	111,923	1.0%	
2014	IRE	M	LS1	Lisheen 1	36	5,129	99,390	5.2%	
2014	IRE	M	LS2	Lisheen 1a	19	3,427	66,852	5.1%	
2014	IRE	NE	BD1	Bindoo	48	1,460	110,682	1.3%	
2014	IRE	NE	ML1	Mountain Lodge 1	31.5	2,676	76,189	3.5%	04/02/2014
2014	IRE	NW	BM1	Beam Hill 1	14	3,489	38,144	9.1%	
2014	IRE	NW	MCT	Meentycat	84.96	15,926	198,720	8.0%	
2014	IRE	NW	SN1	Sornehill	38.9	7,328	90,254	8.1%	
2014	IRE	SE	BW1	Ballywater	42	17,648	89,174	19.8%	
2014	IRE	SE	BX1	Ballymartin 1	6	297	17,361	1.7%	11/02/2014
2014	IRE	SE	BX2	Ballymartin 2	8	464	25,424	1.8%	11/02/2014
2014	IRE	SE	BY1	Ballycadden 1	14.45	468	37,852	1.2%	22/07/2014
2014	IRE	SE	BY2	Ballycadden 2	11.5	149	11,894	1.2%	04/11/2014
2014	IRE	SE	CK1	Castledockrell	41.4	1,228	101,126	1.2%	
2014	IRE	SE	RF1	Richfield	27	850	71,981	1.2%	
2014	IRE	SW	AH1	Athea 1	34.35	6,374	78,620	8.1%	01/04/2014
2014	IRE	SW	BA1	Ballybane	29.9	1,760	74,040	2.4%	
2014	IRE	SW	BCw	Ballincollig Hill	13.3	1,279	33,664	3.8%	
2014	IRE	SW	BG1	Boggeragh	57	6,690	160,369	4.2%	
2014	IRE	SW	BR1	Bawnmore	24	1,231	66,859	1.8%	
2014	IRE	SW	CG1	Coomagearlahy 1	42.5	5,664	100,009	5.7%	
2014	IRE	SW	CG2	Coomagearlahy 2	8.5	1,005	23,663	4.2%	
2014	IRE	SW	CG3	Coomagearlahy 3	32.5	4,115	83,398	4.9%	
2014	IRE	SW	CJ1	Clahane	37.8	4,327	99,984	4.3%	
2014	IRE	SW	CZ1	Coomacheo	59.225	9,261	165,187	5.6%	
2014	IRE	SW	DR1	Dromada	28.5	9,167	77,057	11.9%	
2014	IRE	SW	DV1	Dromdeeveen	27	2,686	84,584	3.2%	
2014	IRE	SW	GLC	Glanlee	29.8	3,672	75,157	4.9%	
2014	IRE	SW	GW1	Grouse Lodge	15	762	44,062	1.7%	
2014	IRE	SW	KW1	Knockawarriga	22.5	3,756	57,499	6.5%	
2014	IRE	SW	RC1	Rathcahill West	12.5	459	42,633	1.1%	
2014	IRE	SW	TN2	Tournafulla	17.2	4,160	47,505	8.8%	
2014	IRE	SW	TR1	Taurbeg	25.3	1,163	54,279	2.1%	13/01/2014
2014	IRE	W	BT1	Booltiagh 1	19.45	4,051	35,659	11.4%	
2014	IRE	W	BT2	Booltiagh 2	12	792	34,937	2.3%	11/02/2014
2014	IRE	W	DY1	Derrybrien	59.5	26,302	118,065	22.3%	
2014	IRE	W	GH1	Garvagh 1	26	1,282	84,039	1.5%	
2014	IRE	W	GH2	Garvagh 2	22	1,142	59,107	1.9%	
2014	IRE	W	KG2	Kingsmountain 2	11.05	683	27,275	2.5%	
2014	**Ireland**				**1,179.0**	**165,477**	**3,054,054**	**5.4%**	
2014	**All Island**				**1,595.8**	**192,157**	**4,095,841**	**4.7%**	

Table 6: Dispatch-down Figures for Each VPTG Windfarm in 2014

Note: VPTG start dates are displayed only for windfarms that became VPTG during 2014.

Appendix B – Calculation Methodologies

This appendix outlines the methodologies used to calculate wind dispatch-down in Ireland and Northern Ireland. The methodologies are different due to the different systems used in both jurisdictions in 2014. The new wind dispatch tool went live in quarter 2 of 2014. This will allow the use of the same calculation methodologies in both jurisdictions in the future.

Ireland

Data Used

The following figures were obtained (for VPTG windfarms) from the Single Energy Market settlement system:

DQ (Dispatch Quantities in MW)

AO (Actual Output in MW)

AP (Profiled Availabilities in MW)

TPD (Market Trading Period Duration = 0.5 hr)

Data from other sources (for all windfarms):

Total wind generation: EirGrid & SONI Operations

Total half hourly wind availabilities and generation from SCADA (Ireland only)

Calculation Methodology

Dispatch-down of wind energy is calculated individually for generators that are registered in the SEM as VPTGs. Prior to the SEM-11-062 decision the majority of units dispatched down were VPTGs. Since SEM-11-062 this has changed to the dispatch-down of controllable windfarms, which includes some autonomous generation. Due to the market rules for autonomous generators (APTGs) it is not possible to use validated SEM data to calculate the dispatch-down of APTGs; instead, this is estimated on an aggregate basis using SCADA data.

The calculation steps for dispatch-down of wind are as follows:

Step 1: Dispatch-Down Calculation for VPTG Wind using SEM Data

a) Dispatch-down volume V (MWh) in each trading period:

IF AP = DQ

THEN V = 0

ELSE V = TPD * Max[0, AP-Max(AO,DQ)]

Total dispatch-down volume $R = \sum_{rp} V$

Where ***rp*** is the reporting period – the year 2014 in this case.

b) Dispatch-down level (%):

The dispatch-down levels for a VPTG wind generator are calculated based on the dispatch-down volume R from part (a) above and the wind generator's maximum possible energy generation PE (MWh):

$PE = \sum_{rp}[Max(AO,AP)] * TPD$

(Only during those trading periods where the wind generator is registered as VPTG in SEM)

VPTG dispatch-down level (%) = 100 * R / PE

Step 2: Dispatch-Down Calculation for Autonomous (Non-VPTG) Wind

SCADA data is used to estimate autonomous wind dispatch-down in Ireland only.

a) Estimating all wind dispatch-down in Ireland from SCADA:

The difference between total wind availabilities (Avail) and total wind output (WO) is used as an indicator of the dispatch-down volume of all wind in Ireland. However, the accuracy of SCADA data is not high.

To improve the accuracy, this difference (Avail – WO) is used only during the trading periods where there was a dispatch-down in the market in Ireland (VI ≠ 0). Market dispatch-down volumes in Ireland (VI) can give us a better indication of when there was active dispatching down of wind taking place in Ireland.

Total Dispatch-Down Volume in Ireland DD (MWh) = ΣMax[VI, (Avail-WO)*TPD]

(Note: DD will be zero when VI is zero, i.e. during periods where there was no dispatching down of VPTG wind in Ireland.)

All wind Dispatch-Down % in Ireland = 100 * DD / (DD + $\Sigma(WO_I*TPD)$)

All wind Dispatch-Down % in Northern Ireland = 100 * R_{NI} / (R_{NI} + $\Sigma(WO_{NI}*TPD)$)

Where R is the dispatch-down volume calculated for Northern Ireland in Step 1.

Actual total wind output is used for Northern Ireland (WO).

b) Estimating autonomous dispatch-down of wind in Ireland:

It is calculated by getting the difference between the estimated total wind dispatch-down volume in Ireland and the VPTG dispatch-down in Ireland = DD – RI

Northern Ireland

Data Used

The figures used in these calculations are obtained from the SONI Energy Management System (EMS) in conjunction with dispatch data recorded in EDIL, the control centre tool for dispatching generating plant.

- DIs (Dispatch Instructions in MW from EDIL)
- MW Availability (Minute SCADA MW Availability Data from EMS)
- MW Generation (Minute SCADA MW Generation data from EMS)
- Wind Farm Capacity (MW)
- TP (Time Period, 1 minute)

Calculation Methodology

Dispatch-down of wind energy is calculated individually for each wind farm in Northern Ireland. This is calculated based on Dispatch Instructions logged by SONI Control Engineers in EDIL (date in dd-mm-yy and time in hh:mm) and MW Generation / MW Availability data in the SONI EMS. The resolution of the data used from the EMS is 1 minute.

Where a wind farm's output is reduced by SONI, instructions are logged as a way of determining why a wind farms output has been reduced and as a way of sending instructions to SEMO for market settlement.

Wind Farm Dispatch Instructions recorded in EDIL are classified using the following EDIL reason codes:

LOCL	Local Transmission Constraint
CURL	All Island Curtailment
LOCL T	Local Distribution Constraint
MWOF	MW of Fuel

Step 1: Dispatch-Down Calculation for VPTG Wind using SEM Data

See Ireland calculation methodology section above.

Step 2: Dispatch-down Calculation

1-minute MW Availability and MW Generation SCADA data is downloaded daily from the EMS. This is downloaded for each wind farm installed in Northern Ireland.

Where a wind farm has been dispatched down, the time logged in EDIL is used to calculate the dispatch-down volume for each 1-minute time period. A value in MWhrs and time (hrs) is recorded.

Total Dispatch-down Volume (V) in MWhrs is calculated, using minute SCADA data, in the following way;

IF DI < Wind Farm Capacity

THEN V = (MAX(MW Availability, MW Generation) – DI, 0)

Where V >= 0 MW

Total Dispatch-down time (t) in hrs is calculated, using minute SCADA data, in the following way;

IF DI < Wind Farm Capacity

THEN t = COUNT(TP(DI < Wind Farm Capacity))

Notes

These calculations are applied daily to all wind farms in Northern Ireland. The accuracy of the Dispatch-down Volumes (V) is dependent on the accuracy of MW Availability and MW Generation SCADA data.

The accuracy of the Dispatch-down time (t) is dependent on the accuracy of the instructions entered into EDIL. These are checked daily by SONI staff.

Appendix C – Summary Results

Year	Wind Dispatch-Down (%)		
	Northern Ireland	Ireland	All Island
2011	1.3%	2.4%	2.2%
2012	0.7%	2.5%	2.1%
2013	1.9%	3.5%	3.2%
2014	2.8%	4.4%	4.1%

Year	Wind Dispatch-Down Volume (GWh)		
	Northern Ireland	Ireland	All Island
2011	13	106	119
2012	7	103	110
2013	24	171	196
2014	41	236	277

Year	Wind Capacity (MW) at Year End		
	Northern Ireland	Ireland	All Island
2011	405	1,631	2,036
2012	488	1,763	2,252
2013	554	1,896	2,450
2014	614	2,211	2,825

Year	All Island Estimated Wind Dispatch-down Breakdown	
	Constraints	Curtailment
2011	20%	80%
2012	38%	62%
2013	28%	72%
2014	35%	65%

Appendix D – Abbreviations

CER	Commission for Energy Regulation
DETI	Department of Enterprise, Trade and Investment
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
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
SONI	System Operator Northern Ireland
SW	South West
TSO	Transmission System Operator
URegNI	Utility Regulator Northern Ireland
VPTG	Variable Price Taking Generator
W	West