Proposed Constraint Groups

arising

from

SEM-11-105

23rd July 2012

Document identifier:	Information Note	Authored by:	John Ging
Document version:	Version 1.0	Checked by:	Eimear O' Flaherty
Document updated:		Checked by	Ken McDonnell
Date of current issue:	23rd July 2012	Approved by:	Philip O'Donnell, Dick Lewis

Contents

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1 Executive Summary

This document fulfils the task arising from Section 4.2 of the SEM 11-105 decision paper; the identification of up to three constraint groups within which the tie-break dispatch rule-set for constraints will apply. The TSOs have identified proposed constraint groups that meet the criteria outlined in SEM-11-105. This report describes the constraint groups that the TSOs propose to implement.

These constraint groups are identified on a nodal basis, which are binding for a specific set of contingencies relatively local to the area in question. These electrical boundaries were envisaged to be nominally large at formation and to diminish over time as network build out would be completed, thereby delivering some level of certainty to firm generators.

The emergence of any constraint group is dependent on a number of factors, including but not limited to the following; network build out, the quantity of wind connecting and the evolution of Special Protection Schemes. This analysis assumes a realistic take-up of offers on the part of wind, culminating with 30% of Gate 3 projects being installed in Ireland by 2020, bringing renewable energy to be sufficient to meet the 40% target. The installed capacity in Northern Ireland is assumed to be that which is currently connected or has an approved connection agreement. Each proposed constraint group was tested under several conditions, including the potential for all wind offers being accepted and installing their maximum capacities on a non-firm basis in each of the high constraint areas.

The TSOs have developed a methodology to identify the constraint groups that best meet the criteria set out in SEM-11-105. Based on the Gate 3 constraints modelling, a detailed analysis of the power system was conducted, covering a number of years and scenarios in order to identify transmission congestion tie-break events. This led to a number of candidate constraint groups that were analysed on a time-line basis. A set of prospective constraint groups that were significant in size, magnitude, and frequency of occurrence as well as being consistent in geographical area was derived from the time-line analysis. Sensitivity studies were then performed to confirm that the prospective constraint groups were robust and likely to be enduring over a range of scenarios. The evolution of the constraint groups was also determined from the timeline analysis. The modelling methodology was designed to ensure that curtailment does not impact on the determination of the constraint groups.

In summary, and based on the assumptions employed in the analysis, EirGrid and SONI find that:

1. There is a constraint group today in Donegal. This constraint group will evolve depending on the level of wind and network build out. It will ultimately be resolved through the Renewable Integration Development Project (RIDP).

2. While there are pockets of constraints in the South West today, a well defined constraint group based on the occurrences of tie-breaks only emerges once the Gate 2 wind is connected to the 220kV system. This group will eventually encompass about 1GW of installed wind capacity provided all Pre-Gate 3 and Gate 3 wind is connected. Additional network reinforcements, including new build at 400kV, are required to resolve this constraint group.

3. The situation in Northern Ireland is also complex and is subject to significant uncertainty. There does not appear to be significant near-term constraints arising because the Special Protection Schemes that are in place alleviate most transmission congestion events by disconnecting certain connected generation following a fault. Although certain areas are susceptible to localised transmission congestion, they do not appear to be sufficient to warrant the creation of a constraint group in the region. The situation of a constraint group comprising Northern Ireland as a whole was also considered, but was discounted on the basis of it only being applicable in certain dispatch regimes which do not align with the long term strategy for the integration of renewables.

The TSOs propose to implement the constraint group in Donegal when the EMS changes are completed; this is expected to take 12 months following the decision to proceed.

2 Background

2.1 Characteristics of constraint groups

The SEM papers (namely SEM-11-062 and SEM-11-105) concerning the principles of dispatch of priority dispatch plant and their subsequent treatment in the event of tie-breaks arising within the dispatch were published in 2011. From Section 3.3 of SEM-11-105, there shall be a maximum of three constraint groups, residing in the areas susceptible to congestion on the transmission system. These constraint groups should be "conservative" with respect to their size, "sufficiently large" and with "flexibility at their borders". The constraint groups are determined in line with the following characteristics as stipulated in SEM-11-105:

(1) The maximum size of the constraint groups will be fixed in Year 1 and will incorporate a fixed geographical size and electrical boundary.
(2) The constraint groups will only be binding for both a specific set of contingencies in the relative vicinity of the area in question and due to a tie-break situation.
(3) Over time, the size of the constraint groups will decrease on a geographical basis as transmission reinforcements leads to generators becoming excluded from them.
(4) The resulting alleviation of constraints for generators within a constraint group will lead to the effective disappearance of that group once sufficient network reinforcements have occurred.
(5) Finally, constraint groups will not be developed just to maintain the original number of them.

2.2 Dispatch rule-set applying for constraints within a constraint group

The papers stipulated that a hierarchy for turning off plant should be employed based on the dispatchability of the units in question as depicted in Figure 1, i.e.

(1) Firstly, that plant which is not controllable (but should be controllable),
(2) Next, controllable plant,
(3) Finally, autonomous plant which is not controllable or has derogations from this requirement.

A further level in the dispatch hierarchy applies to those units in a constraint group that reside within Category 2, leading to a total of seven possible levels in Ireland and four in Northern Ireland.

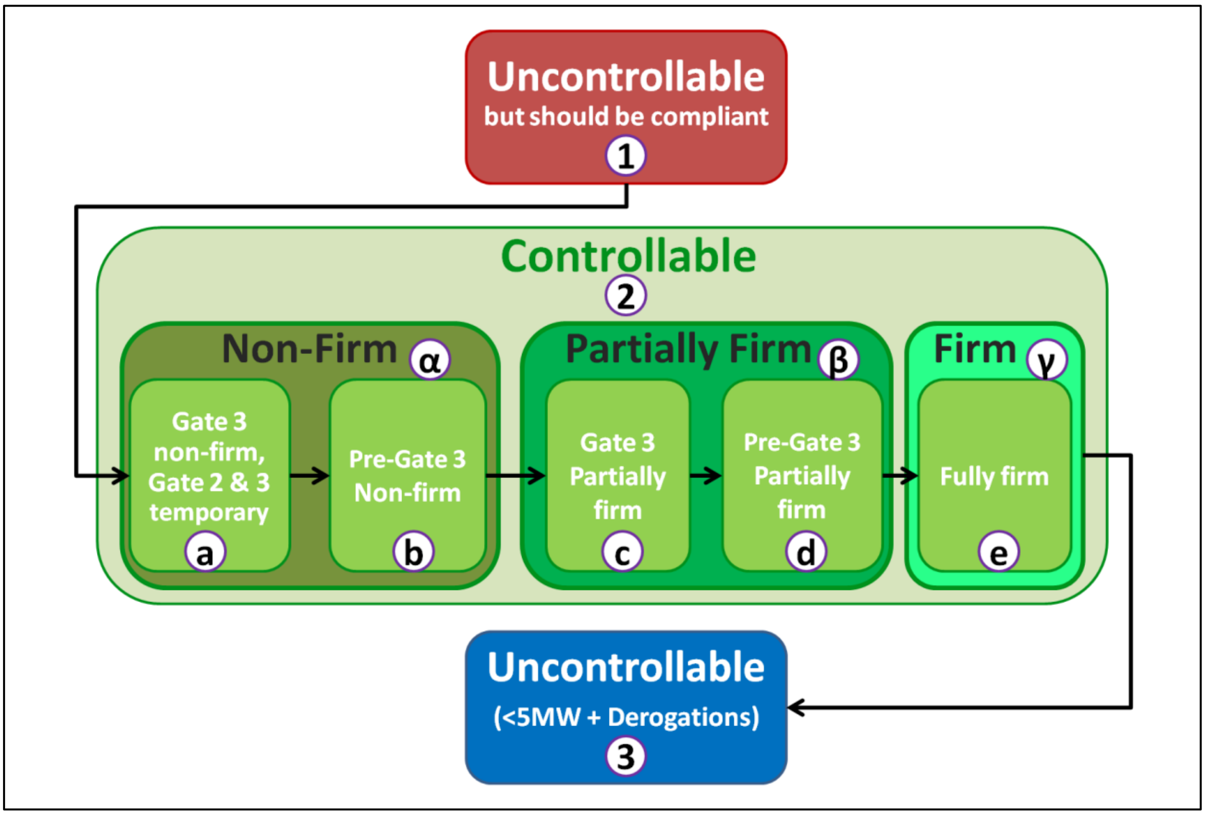

Figure 1: The Dispatch Hierarchy for Priority Plant on the Island of Ireland.

The second category (controllable wind) is subdivided to account for firm access during tie-breaks as follows:

(i) In Ireland, controllable wind in constraint groups is reduced in the order of a – e.
(ii) Constraint groups in Northern Ireland are turned down using the Greek alphabet order of α – γ. (i.e. controllable non-firm wind first, followed by controllable partially firm and finally controllable firm wind)

(iii) Wind farms are turned down on a pro rata basis within levels.

2.3 Definitions

It is worthwhile defining some of the key concepts at this point. These terms are discussed in turn below.

The term **Curtailment** is assigned to any reduction of generator output for system integrity purposes. This includes, but is not limited to, maintaining a secure power system through providing for reserve or inertial support, ensuring that the maximum non-synchronous penetration limitation is not breached and respecting generator ramping capabilities. Other contributing factors may include maintaining mandatory priority dispatch for certain classes of units. Excessive generation events in the market, whereby wind availability exceeds system demand are also considered to be curtailment events. The modelling approach ensured that the treatment of curtailment does not impact on the determination of the constraint groups.

The term **Constraint** is designated to any generator output reduction as a direct consequence of alleviating transmission congestion. This may occur for a set of one or more simultaneous binding constraints. A binding constraint is defined as the most onerous transmission constraint possible, for which a reduction in generation output cannot be avoided, at a given time. In other words, there are often a number of other less arduous, non-binding constraints that exist behind the binding constraint and one of these would become binding if the original binding constraint is removed. An example of this is the upgrading of a transmission line which may cause the binding constraint to migrate to another congestion site upstream of that line.

A **tie-break** situation occurs when a number of equally priced generators exhibit a similar impact on relieving a transmission constraint. The group of generators behind, and contributing to, a tie-break could potentially be a constraint group.

A **constraint group** is then defined as containing a fixed group of generators that will be dispatched down according to the SEM Committee rules for the occurrence of a particular binding constraint(s).

Firm Access Quantity (FAQ) refers to the level of firm financial access available for a generator connecting to the transmission network. Firm financial access means that a generator is eligible for compensation in the manner set out in the Trading & Settlement Code if it is constrained on or off in the dispatch. Each generator's level of FAQ is calculated by the TSOs using an Incremental Transfer Capability (ITC) Program. All Pre-Gate 3 ITC analysis have been completed and were published by EirGrid in December 2011, but the Gate 3 studies are on-going. Therefore, an indication of the previous FAQ levels based on past ITC allocations has been included in *Appendix A* for each of the constraint group areas.

3 Determination of the Constraint Groups

The System Operators have developed a robust methodology to identify the most prominent and likely constraint groups. A small number of candidates consistently emerged after compiling numerous studies across a broad range of scenarios and time horizons. The simulations were executed in a manner analogous to the procedure employed to determine the constraint and curtailment levels in previous reports published by EirGrid.

3.1 Methodology

A full 8760 hour Security Constrained Optimal Powerflow was derived using the PROMOD IV power system simulator. This program outputs an annual chronological unit commitment and dispatch schedule with associated line loadings for each scenario. The dispatch is obtained on an economic basis with provisions for the loss of any individual meshed network element. This N-1 level dispatch is the system standard within the SEM jurisdictions. In some cases, the loss of a double circuit line can be treated as a single contingency in Northern Ireland.

In order to derive the proposed constraint groups, each study year was individually evaluated using the power system modelling engine. At this point, system curtailment and transmission constraints are identified. Several iterations may be required to isolate the potential impact of any underlying constraints. The individual transmission congestion tie-break situations should then be considered to identify those sharing similar binding constraints. It may be possible that overlapping nodal groups emerge. For example, in an arbitrary hour, two nodes may exert an influence on a particular binding constraint, but there may be a different set of nodes contributing to the same binding constraint in another hour.

Every constraint within a year is analysed and categorised in accordance with the period it occurs in. Any binding constraint occurring in an area during a transmission outage period may not fulfil the criteria of being significant and long lasting. However, if that binding constraint occurred before or after the outage was due to take place and appeared in previous or subsequent annual studies, it may be a viable binding constraint for deliberation in the tie-break analysis. All non-feasible binding constraints should be excluded from further consideration before proceeding.

The nodal bands contributing to tie-break situations are then assessed so that the most pertinent are ranked highest. These form the candidate constraint groups. This requires an analysis of the frequency and magnitude of the output reductions due to transmission congestion in each region. These candidate constraint groups were found to correspond to those areas exhibiting relatively high congestion.

Although each study year and its associated scenarios are individually simulated with the power system simulator, the candidate constraint groups arising across several years must be compared against each other. This is achieved through a timeline analysis. This trend assessment identifies constraint groups that are persistent over a number of years. The mechanism by which each node may exit a constraint group is also determined through this multi-year analysis.

The size of each candidate is then examined, since the electrical boundary of each constraint group should be both contiguous and reasonably large in geographical area[1]. Location is then considered since only three constraint groups are permitted, with one in Northern Ireland and two in Ireland. A small number of prospective constraint groups consistently emerged after compiling numerous studies across the range of years and scenarios.

A number of sensitivity tests were also carried out to ensure the robustness of the prospective groups so that the proposed constraint groups reported herein would remain valid with wind portfolios outside of those considered in the reference “Realistic” take-up scenario (see section 4.2.1). These tests included maximising the expected wind in the constraint group areas to assess their impact.

[1] SEM-11-105 on Tie Break Constraints - Groups (Section 3.3)

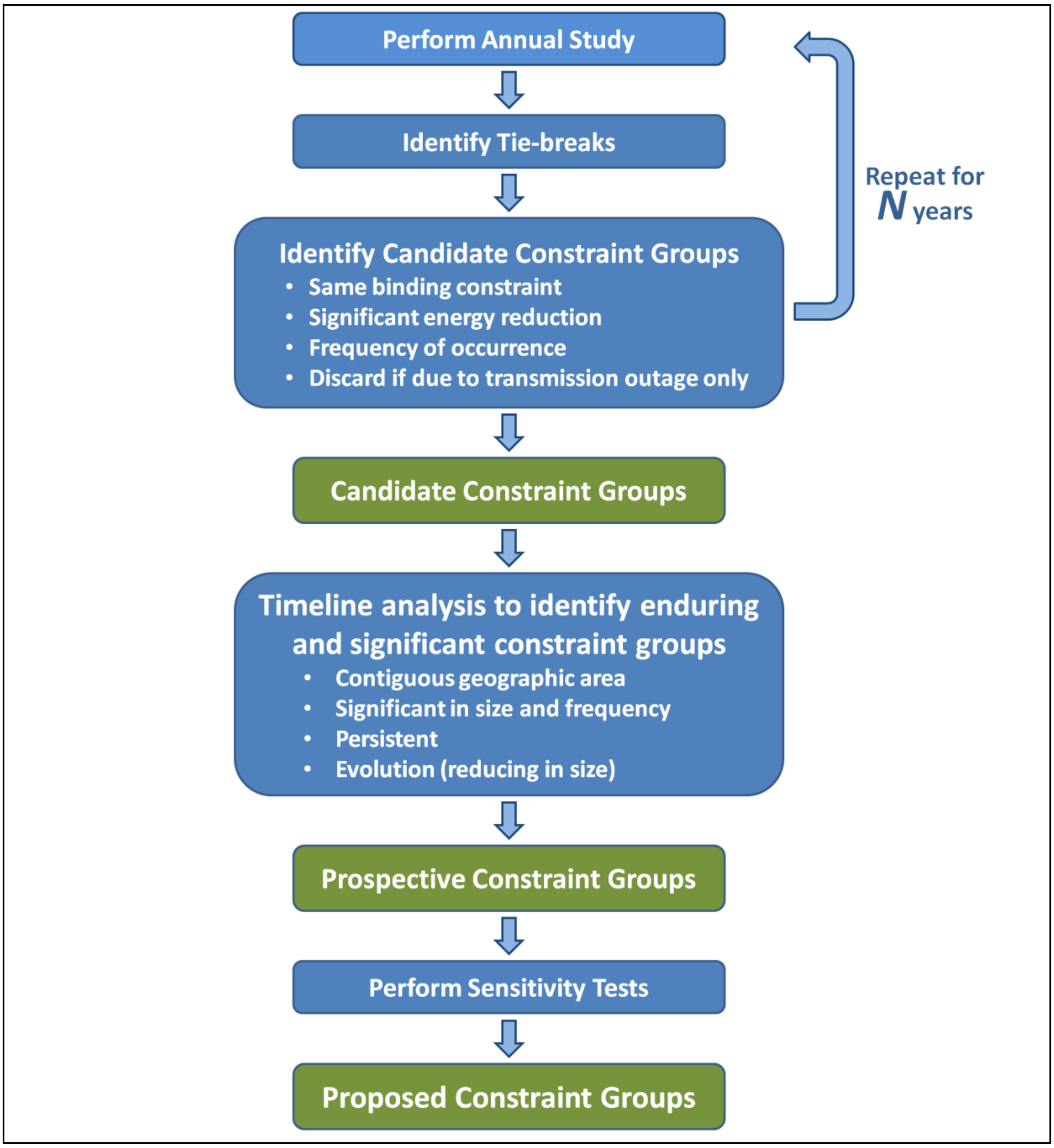

Figure 2: Flowchart describing the algorithm used to establish the constraint groups.

3.2 Modelling Assumptions

A series of studies were compiled for every second year in the period spanning 2012 – 2018. This captures the impact of introducing expected network reinforcements as well as the consequences arising from connecting additional amounts of wind. The conventional generation portfolio was adjusted in line with the joint TSO's All-Island Generation Capacity Statement 2012-2021[2], with Gate 3 conventional generators included as per their target shallow connection dates. The forecasted total electricity requirement peak and median energy demand assumptions employed in the model are also obtained from the same report. The assumed growth of the renewable portfolio was established by means of a survey of all prospective Gate 3 developments carried out by EirGrid in November 2011 and data supplied by SONI pertaining to expected Northern Ireland wind farms throughout the period of study. The devised realistic take-up scenario accounts for the availability of a shallow grid connection, planning status and other site issues such as location within Special Protection Areas. It is assumed that results obtained through this scenario could produce more realistic constraint groups

[2] All-Island Generation Capacity Statement 2012-2021, as released in December 2011 on the EirGrid website.

since the magnitude of connected wind in each area has a considerable influence on the constraint level in that area.

3.2.1 Ireland

The assumed wind generation portfolio for Ireland is depicted in Figure 3. As at the beginning of 2012, there is 1636 MW of wind generation connected and operational. There is currently 930 MW of Pre-Gate 3 generation contracted to connect. EirGrid has assumed that all of the contracted Pre-Gate and Gate 1 wind will be operational by 2014. In addition to this, it is assumed that all the contracted Gate 2 windfarms will be operational by 2014 provided that they are fully firm by 2014[3] and they are not linked to the 220kV transmission projects in the South West (Area E). By 2016, it is estimated that the remaining contracted Gate 2 wind will have connected.

It is assumed that an amount of Gate 3 wind will be operational by the end of 2016 based on the Gate 3 projects which have signed their connection offer, have been granted planning permission, are due to be fully firm by 2016 and are not linked to the "Big 6" Grid25 projects[4] i.e. North-South interconnector, Gridlink, Gridwest, Dublin 400kV ring, Kerry and RIDP. By 2018, it is assumed that more Gate 3 wind will be connected. This is made up of Gate 3 projects which have not yet signed their connection offer, but have been granted planning permission, are not linked to the Big 6 and would be fully firm. Overall, it is possible that 30% of Gate 3 wind is connected by 2020 under this assumed scenario. The figure of 2738 MW shown for 2022 is the remaining Gate 3 wind generation.

A number of scenarios with differing installed regional Gate 3 wind capacities was used in the modelling to evaluate the impact of any wind farms connecting in advance of receiving their full FAQ. These scenarios maintained the same Gate 3 installed wind capacity as assumed in the realistic take up, with the exception that it is pro-rated across all applicable regions. An indication of the installed wind capacities assumed in both constraint group regions is available in *Appendix A*. Sensitivity tests were also performed whereby the assumed installed wind portfolio was maximised in regions exhibiting high constraint levels. It is worth noting that only the wind scheduled to connect at the Bellacorick 110kV node was accommodated in these scenarios.

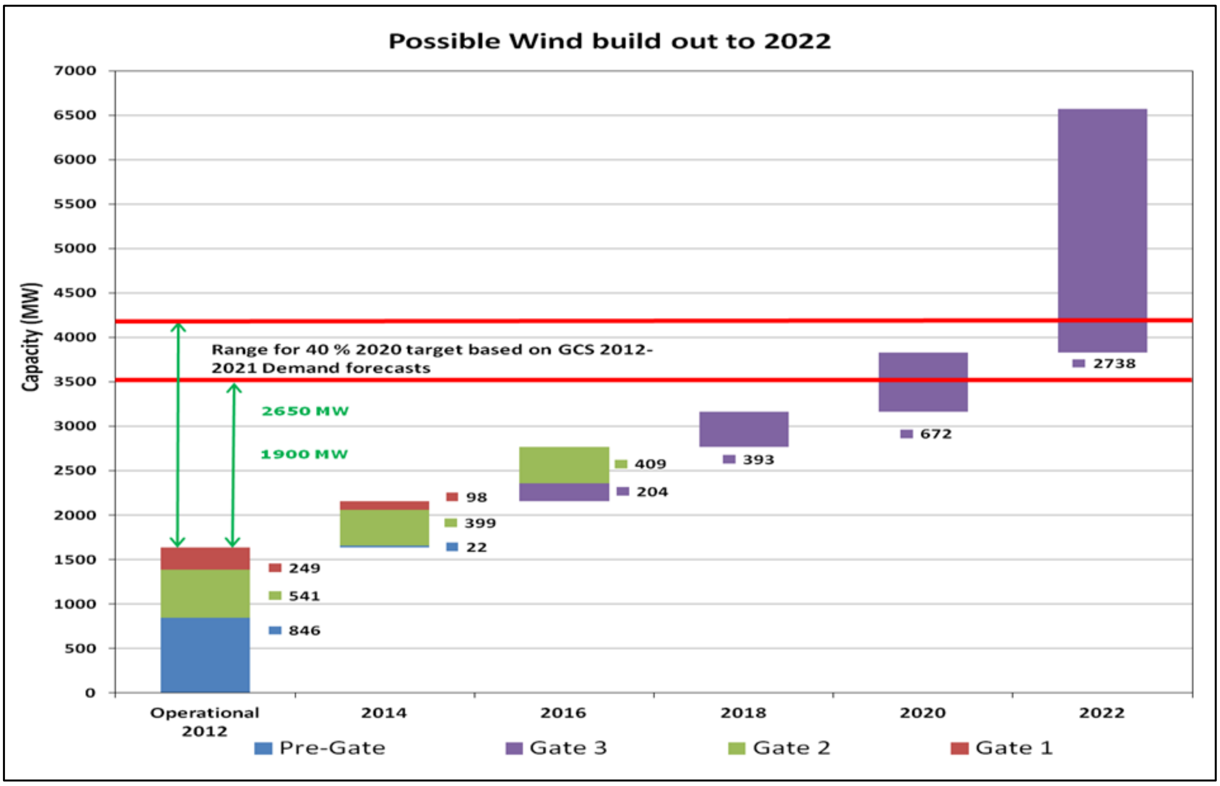

Figure 3: Assumed Wind Generation in Ireland for Constraint Group Analysis.
The 40% target range highlighted between the red lines is indicative of the uncertainty surrounding the uptake of other renewables such as Biomass and relevant CHP plant as well as accounting for possible fluctuations in energy demand or wind output in the event of a lower or higher capacity factor than the 31.6% yearly average.

[3] This is based on the published FAQs for Gates 1 and 2, as released in December 2011 on the EirGrid website.
[4] A list of Grid25 projects is available at http://www.eirgridprojects.com/projects/

3.2.2 Northern Ireland

As at the beginning of 2012, there is 403 MW of wind generation connected and operational in Northern Ireland. SONI have made suggestions with respect to the expected build of wind generation and the changes to the existing transmission network out to 2020 in line with the latest seven year transmission forecast statement[5]. For the years of the study, it has been assumed that all of the wind generation expected to connect by the year of the study has connected. For the avoidance of doubt, the second North-South tie line was not included in any of the studies of the Northern Ireland constraint group, this being consistent with the studies of the constraint groups in Ireland. A range of interconnector flow scenarios were studied for Moyle covering both import cases and cases exporting excess renewable generation.

3.2.3 Other assumptions

Key modelling assumptions include the target delivery dates for network reinforcements and the contribution of Delivery Secure Sustainable Electricity System (DS3)-related issues. Assumptions are made around the capacity available on Moyle and EWIC for export and import. Fuel price assumptions are not considered important for the purposes of this study other than to the extent that they influence the overall dispatch. This is reflected in the merit order of coal and gas units.

A System Non-Synchronous Penetration (SNSP) limit is a significant input assumption as this sets an upper bound for the maximum instantaneous wind that can be accepted on the system. This limit is gradually incremented in line with DS3 programme milestones over the study period from a 50% maximum penetration at present to a 75% upper limit from 2019 onwards. It was also assumed that any surplus wind that would otherwise be curtailed could be exported provided there is sufficient interconnector capacity available and it is possible to move the power to the interconnectors.

The PROMOD IV simulation tool aims to minimise overall production cost, which includes the maximisation of accepted renewable wind generation. In doing so, constraints will typically be treated before curtailment, since any constrained energy which the transmission system cannot accommodate can offset the requirement for further curtailment. However, there may be instances where curtailment is treated first as a global pro rated reduction that may be sufficient to maximise wind whilst avoiding any transmission overloads, even during an N-1 contingency event. Multiple iterations are performed to derive and account for the extent of any underlying transmission constraints occurring with instances of curtailment. The hourly curtailment should be isolated before determining any potential constraint groups, since the application of curtailment whether using a pro-rata or a grandfathered mechanism does not impact on the results.

The current operational and contracted Special Protection Schemes (SPS) were modelled as they have a significant potential to impact on constraint levels. These schemes enable some windfarms to export energy onto the system in advance of the required network reinforcements, but will trip selected generators when certain contingencies occur. However, there is an upper limit to the total amount of generation that can be associated with SPS while maintaining safe, secure system operation with appropriate reserve provisions. In addition, due to the uncertainty surrounding wind generation build out and transmission network development, it is difficult to predict which SPS would still be valid in later years. SONI have assumed that only the Coolkeeragh run-back SPS be included for the study years 2014 and beyond. This is due to some of the current SPS potentially being no longer applicable after future transmission development. In the Donegal region of Ireland, the proposed Mulreavy SPS was included for all applicable study years.

[5] All-Island Transmission Forecast Statement 2012-2018

4 Results

The studies have indicated that only one constraint group is currently required on the All-Island system; this resides in the North West of Ireland. As the level of connected wind is still relatively low compared to planned levels of wind, there is normally insufficient wind to cause high levels of transmission congestion. Hence, significant tie-break situations in the remainder of the All-Island system do not occur unless network maintenance outages are taking place. This North West group is expected to decrease in size as network upgrades are delivered to the region.

A second constraint group materialises once the 220kV infrastructure necessary for Gate 3 shallow connections is installed in the South West of Ireland. It must be noted that the grid topology itself is not causing the formation of this group but instead it is the significant influx of additional wind and the subsequent tie-break situations that arise with this wind.

A similar situation emerges in Northern Ireland whereby no constraint group is required today and one would only be required if the installed capacity exceeded a threshold value and caused the emergence of new local binding constraints. This is found not to occur during the study period, implying that there is no need for a Northern Ireland constraint group. Each of the identified constraint groups will be discussed in greater detail below.

4.1 Constraint Group 1 (Area A: Donegal)

4.1.1 2012 – 2014

Currently, this is a region of relatively high constraints on the transmission system. All generators connecting into Cathaleens Fall busbar, whether directly or from other nodes further north, are to be included in this constraint group. There are three binding constraints (namely Cathaleens Fall – Srananagh 1 & 2 and Cathaleens Fall – Corraclassy) associated with this constraint group and EirGrid are currently undertaking works to alleviate any associated congestion. These works include the uprate of the Cathaleens Fall busbar and the completion of both line uprates from Cathaleens Fall – Srananagh 1 & 2. Each of the defined binding constraints is attributed to events where one line of the trio may trip, thereby causing overloads on one or both of the remaining lines. Figure 4 portrays the current topology of the region with the Maximum Export Capacity (MEC) of the windfarms at each transmission node.

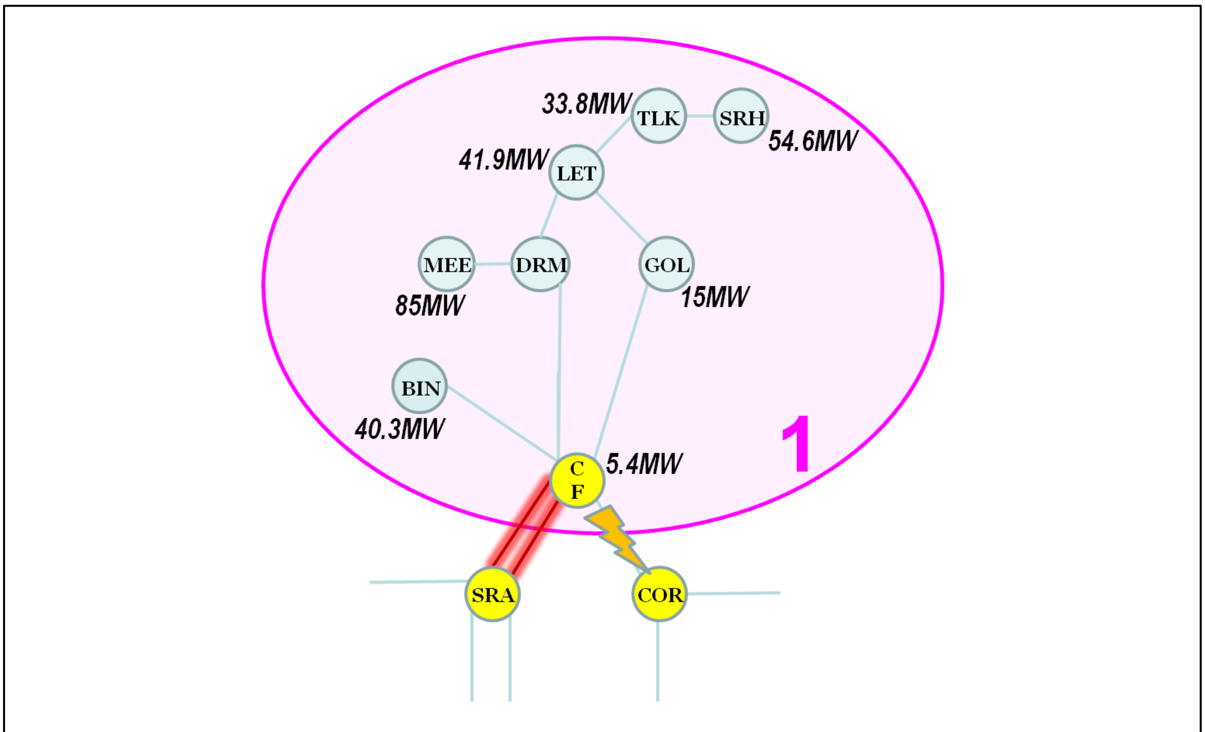

Figure 4: Constraint Group 1 in Donegal at 110kV as required today. As an example, the lines with potential to become overloaded during the loss of the line behind the lightning strike are shown in red. This trio of contingencies is interchangeable.

4.1.2 2014 – 2018

The constraint group is expected to decrease in size after the completion of the uprates described above since there is no longer any impediment to generation on direct tail connections into Cathaleens Fall from exporting their full available capacities southwards. Analysis has indicated that the composition of the constraint group is independent of both (i) further windfarm connections and (ii) the new 110kV network link from Binbane to Letterkenny.

The constraint group will evolve to that shown in Figure 5 with the planned network reinforcements and the level of connected wind. The nodes residing to the North East of Cathaleens Fall become the primary candidates for a constraint group. The level of constraints is further increased with the connection of new wind at the Clogher node, but the group will exist in advance of this event once the forming criteria are satisfied.

This group is then determined through binding constraints on either of the two Cathaleens Fall – Clogher lines. The loss of either line may now potentially overload the remaining line. It is worth noting that this grouping persists whether or not the proposed Mulreavy SPS is included in the model. The application of the SPS requires a differentiated dispatch within the Donegal region.

Although a new 110kV line is scheduled to link Binbane to Letterkenny via Tievebrack, the construction of this line does not alter the composition of the constraint group. There is a tendency for powerflows to favour the Letterkenny – Cathaleens Fall circuits via Clogher due to the relatively lower reactance of these paths. The dominant binding constraint for the area then becomes the loss of either of the two Cathaleens Fall – Clogher lines, which may cause overloads on the remaining line. This situation is valid even with the removal of wind generation through the Mulreavy SPS.

The long term solution for the region is the cross-border Renewables Integration Development Project (RIDP) which will remove the necessity for this constraint group. In the interim, uprating the Cathaleens Fall – Clogher lines even further may somewhat alleviate the constraint level but the constraints and subsequent tie-break situations will still persist.

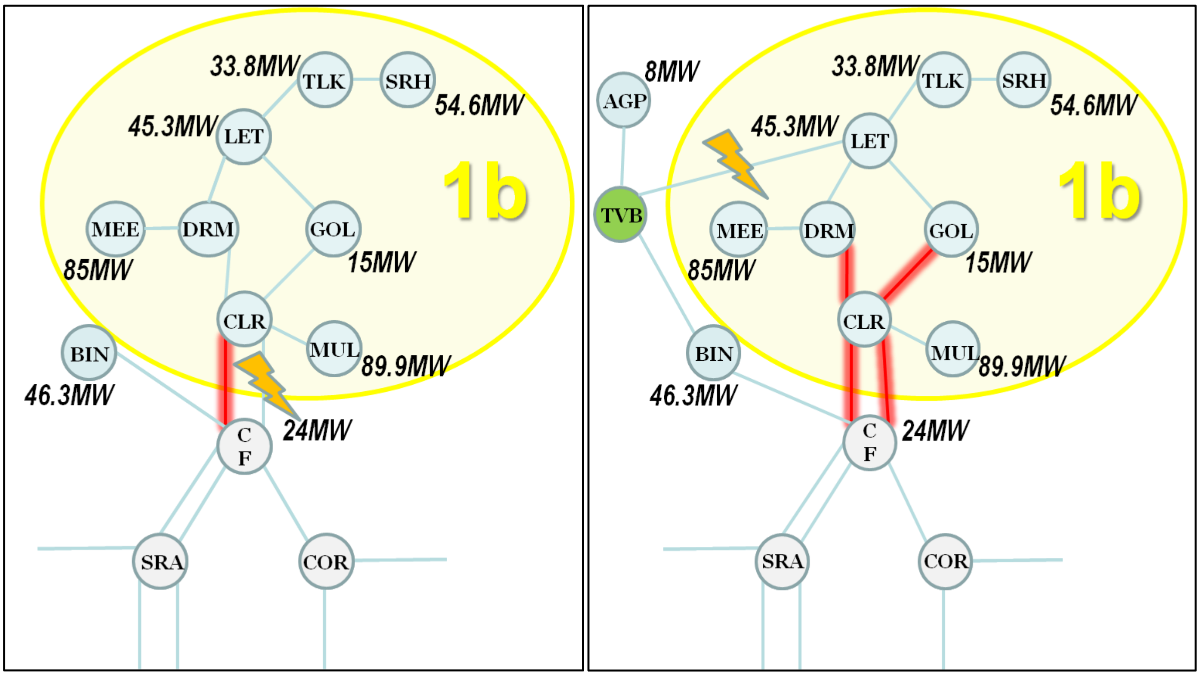

Figure 5: The configuration of Constraint Group 1 in Donegal required for the interim period 2014 – 2016.
The installed capacity at each node has been updated to reflect the expected values for 2016**.**
5(a): The topology on the left is only valid once the uprates are completed at and below Cathaleens Fall.
5(b): The rightmost schematic is valid once the new Binbane – Letterkenny 110kV circuit is completed.

4.1.3 2018 and beyond

The long term evolution of Constraint Group 1 continues to include the same nodes as per the interim period above. Additional wind is expected at many nodes in the area, with a further 105MW expected at the new Croncarkfree node as depicted in Figure 6. This group is also determined through binding constraints on either of the two Cathaleens Falls – Clogher lines. Again, the loss of either line may potentially overload the remaining line. The Binbane – Tievebrack – Letterkenny line can also be considered a binding constraint since its loss can overload the Cathaleens Fall – Clogher lines and vice versa. The long term solution for the constraint group is the proposed cross-border Renewables Integration Development Project (RIDP).

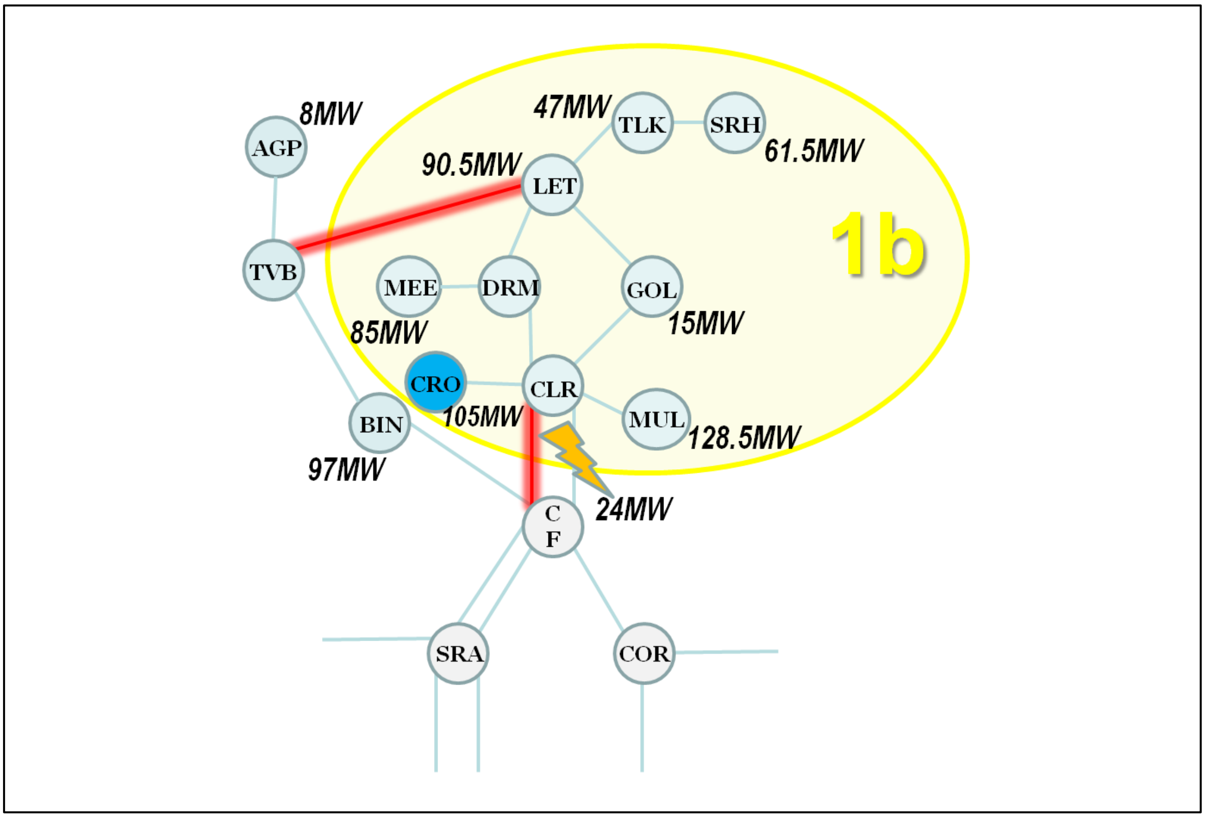

Figure 6: Constraint Group 1 in Donegal as required for the long term period until the completion of RIDP. The MEC denotes the total expected wind capacity for the region.

Time	Nodes	Map code	Forming Criteria	Resolution	Binding Constraints
Today	Ardnagappary Binbane Cathaleens Fall Clogher Croncarkfree Drumkeen Golagh Letterkenny Meentycat Mulreavy Sorne Hill Tievebrack Trillick	AGP* BIN CF CLR* CRO* DRM GOL LET MEE MUL* SRH TVB* TLK	Already required	uprate CF-SRA 1 & 2 uprate CF-COR uprate CF busbar	CF-SRA 1 & 2 CF-COR
From 2014/2015 (b)	Clogher Croncarkfree Drumkeen Golagh Letterkenny Meentycat Mulreavy Sorne Hill Trillick	CLR CRO DRM GOL LET MEE MUL SRH TLK	Complete uprate of CF-SRA 1 & 2 CF-COR CF busbar	RIDP	CF-CLR 1 & 2 LET-TVB

Table 1: Constraint Group 1 (Donegal) as it is assumed to evolve over time with the completion of required network reinforcements. The associated binding constraints and reasons behind the formation and exit of the proposed constraint group are also included. (*) The asterisks denote that these future nodes would form part of the group if they were to pre-build before 2014/15 without the completion of the uprates to the South of Cathaleens Fall.

4.2 Constraint Group 2 (Area E: Cork/Kerry)

4.2.1 2012 – 2014

Our analysis indicates that there is no requirement for a second constraint group in Ireland in the immediate future. Figure 7 below shows a network diagram of the Cork/Kerry region which is applicable up to the construction of the new 220kV stations which are required for most of the outstanding shallow connections. Small levels of localised transmission congestion may exist during certain instances of high wind or transmission maintenance outages in the period up to 2014, particularly around the Clonkeen or Trien clusters, depending on the level of connected wind in the region. These levels are nominally small and the System Operators do not see them as sufficient to warrant the creation of a constraint group because of the following two reasons:

- (i) No Gate 3 wind is expected to connect in this timeframe,
- (ii) The creation of a group in this area may not offer any stability due to the number of impending connections and transmission works expected to occur over the coming years – this is the more critical reason.

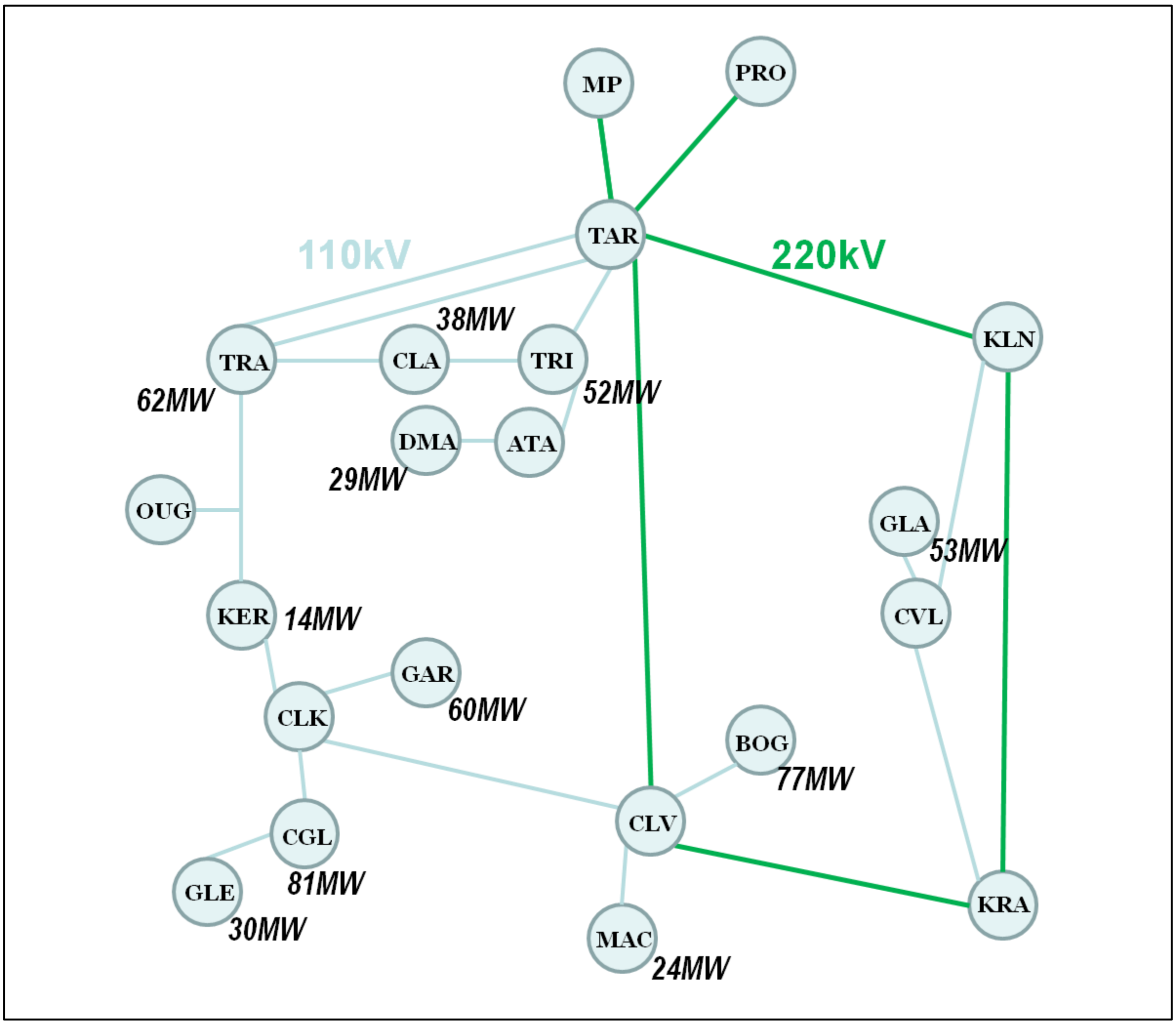

Figure 7: A schematic of the South West region as it is configured at present.

4.2.2 2015/ 2016 and beyond

Once the new 220kV stations are built in the region, a significant quantity of wind (>1.1 GW) is expected to energise, with final connections at these stations (see Figure 8). This includes some existing wind changing from their current temporary connections at the 110kV level to the new stations, thereby diminishing the potential for any issues on the lower voltage network in the region. Although the pre-Gate 3 wind is scheduled to become firm at this point, the inclusion of any additional Gate 3 wind in the model has the potential to cause transmission congestion at the 220kV level and lead to subsequent tie-break situations with pre-Gate 3 wind. This is primarily caused by the occurrence of any of the following three binding constraints:

(a) Moneypoint – Kilpaddogge,
(b) Prospect – Tarbert – Kilpaddoge,
(c) Ballyvouskil – Clashavoon.

The loss of any of these circuits may potentially overload either of the two remaining branches. Therefore, Constraint Group 2 is to include any windfarm with a final connection at any of the Knockanure, Kishkeam or Ballyvouskil 220kV stations once the first Gate 3 windfarm connects at any of these nodes.

Additional network reinforcements, including new build at the 400kV level, are required as a means of removing this constraint group. These required works correlate with the outstanding deep reinforcements associated with the nodes in the constraint group.

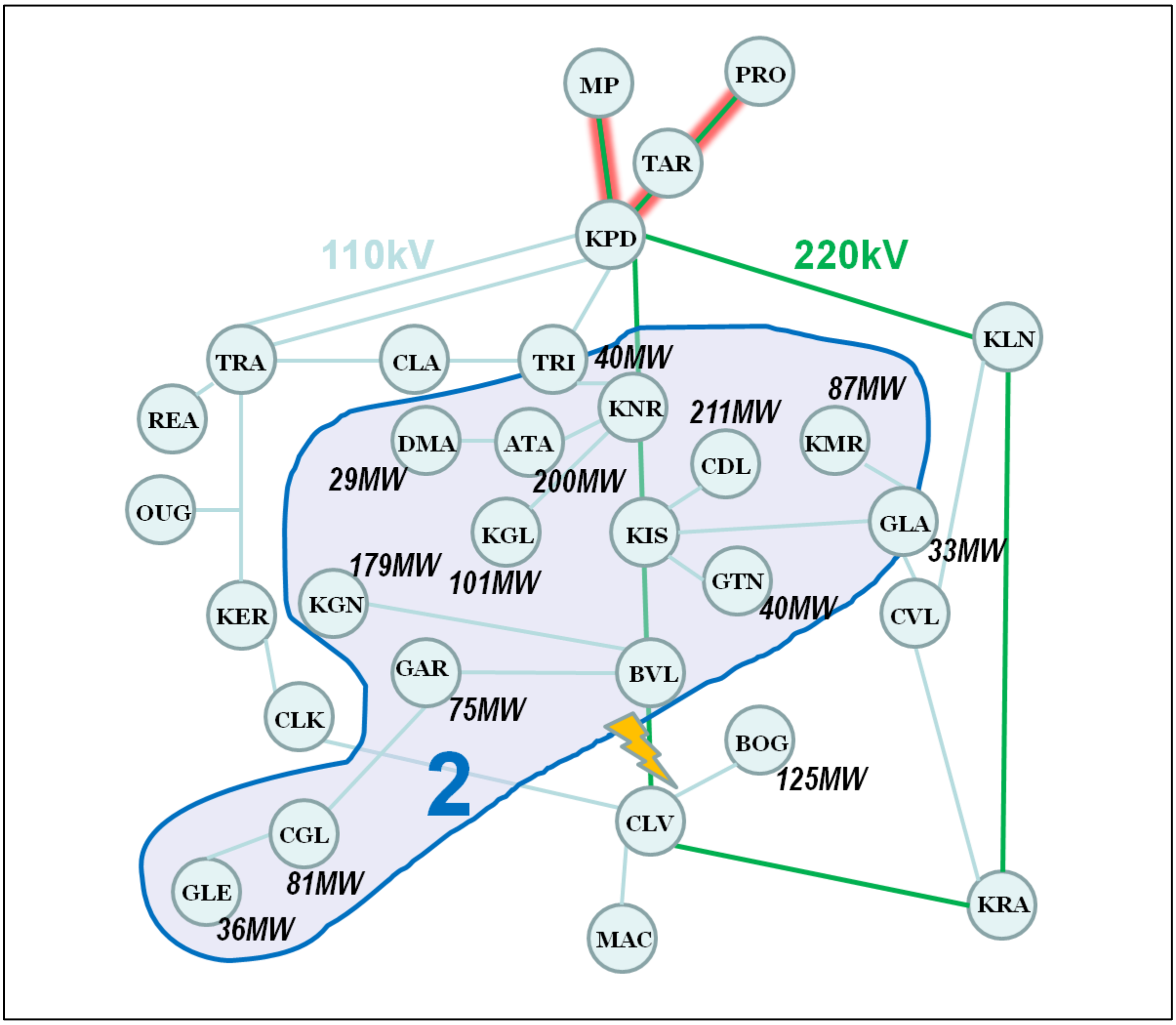

Figure 8: The South West region after the construction of the new 220kV stations.
Note: Trien and Glenlara stations have split busbars, with some wind connecting on each side. Only that which exports onto the 220kV network is included in the proposed constraint group.

Time	Nodes	Map code	Forming Criteria	Resolution	Binding Constraints
Today	N/A				
From 2014/2015	Athea Ballyvouskil Coomagearlahy Cordal Dromada Garrow Glanlee Glenlara* Glentane Kilgarvan Kishkeam Knockacummer Knockanure Knocknagashel Trien*	ATA BVL CGL CDL DMA GAR GLE GLA GTN CGN KIS KMR KNR KGL TRI	New BVL, KIS and KNR 220kV stations	Regional 400kV reinforcement	BVL-CLA KPD-TAR-PRO KPD-MP

Table 2: This shows the expected members of Constraint Group 2 (Cork/Kerry). This group is assumed to apply once the 220kV stations have been built and the first Gate 3 windfarms connect. (*) The asterisks denote that only wind connected at a busbar that links to a 220kV station from these nodes is included in the Constraint Group.

	Nodes	Map code	
	Boggeragh	BOG	
	Clahane	CLA	
	Clonkeen	CLK	
	Clashavoon	CLV	
	Charleville	CVL	
	Knockearagh	KER	
	Killonan	KLN	
	Kilpaddoge	KPD	
	Knockraha	KRA	
	Macroom	MAC	
	Moneypoint	MP	
	Oughtragh	OUG	
	Prospect	PRO	
	Reamore	REA	
	Tarbert	TAR	
	Tralee	TRA	

Table 3: This shows the node names used in the schematics of the South West but not previously listed.

4.3 Constraint Group 3 (Northern Ireland)

The Northern Ireland network is characterised by a relatively strong 275kV double circuit ring from the injection points in the North East, with a 275kV double circuit spur from Magherafelt to Coolkeeragh (see Figure 9). The network in the West and North West of Northern Ireland is such that the majority of the wind is connecting or due to connect at the 110kV level. A programme of works has been proposed for the relatively near term to uprate, supplement and reinforce this network. Longer term plans include the complete strengthening of the network in the north and west of Northern Ireland and the previously mentioned cross-border Renewables Integration Development Project (RIDP).

The situation in respect of renewables connection in Northern Ireland has some similarities to that in Ireland. To date, the management of connections has been based upon receipt of planning permission. At first, distribution connections were provided for individual wind farms but in order to minimise 33kV line build an approach of clustering at the 110kV level is now the preferred connection arrangement. There were no jurisdictional “Gates” applied in Northern Ireland and the 110kV network has over time been “stretched” through the installation and use of Special Protection Schemes (SPS). The use of such schemes enabled more generation to connect subject to inter-tripping arrangements on the loss of certain circuits. It also allowed wind generation to be connected prior to the required 110kV reinforcement being carried out.

The arrangements under SEM for the employment of SPS was discussed in the consultation paper AIP/SEM/72/06 entitled *Single Electricity Market Connections and Transmission Use of System for Generators, A Consultation Paper*, which was dated July 2006. In the subsequent decision paper AIP/SEM/114/06 entitled *Single Electricity Market: Generator Connection Policy*, which was dated September 2006, the decision of the Regulatory Authorities in respect of SPS and associated firmness is set out[6].

The management of the connection queue, a process for the granting of FAQs and the generation of constraint reports, has recently been the subject of a consultation by SONI. Its output and recommendations are currently the subject of discussion between SONI and the Utility Regulator. The outcome of this consultation will have implications for the levels of generation, and its firmness, in Northern Ireland going forward. At the same time, the Utility Regulator is currently consulting on NIE’s investment programme under the next price control (RP5) with a new Price Control to take effect from 1st October 2012. This consultation does not include specific provisions for network development associated with renewables. It is understood that this will be considered separately. All of this means the situation in Northern Ireland is to some extent in a degree of flux. This does not tend to make for straightforward modelling of the constraint groups based upon future expectations of both generators and network build out.

[6] Under position of the Regulatory Authorities:

> *With regards to fast-acting control schemes, in connecting a new user to the system, the transmission companies should consider the most appropriate solution, given their transmission planning processes and the obligations, standards and criteria that apply. These solutions generally require the construction of additional circuits and fast-acting control schemes are typically employed in order to provide non-firm access prior to the construction of deep reinforcements.* (AIP/SEM/72/06: A4)

and under the decision of the Regulatory Authorities:

> *To the extent that any fast-acting control scheme is installed at the behest of a user, the costs or consequences of the scheme should be borne by that user.* (AIP/SEM/72/06: A4)

4.3.1 Present Situation

The use of SPS within the Northern Ireland network, particularly in its Western region, is sufficient to limit the appearance of significant transmission constraints that constitute a tie-break situation in the near term. Therefore it is the System Operators' assessment that no constraint group is required in Northern Ireland at this time.

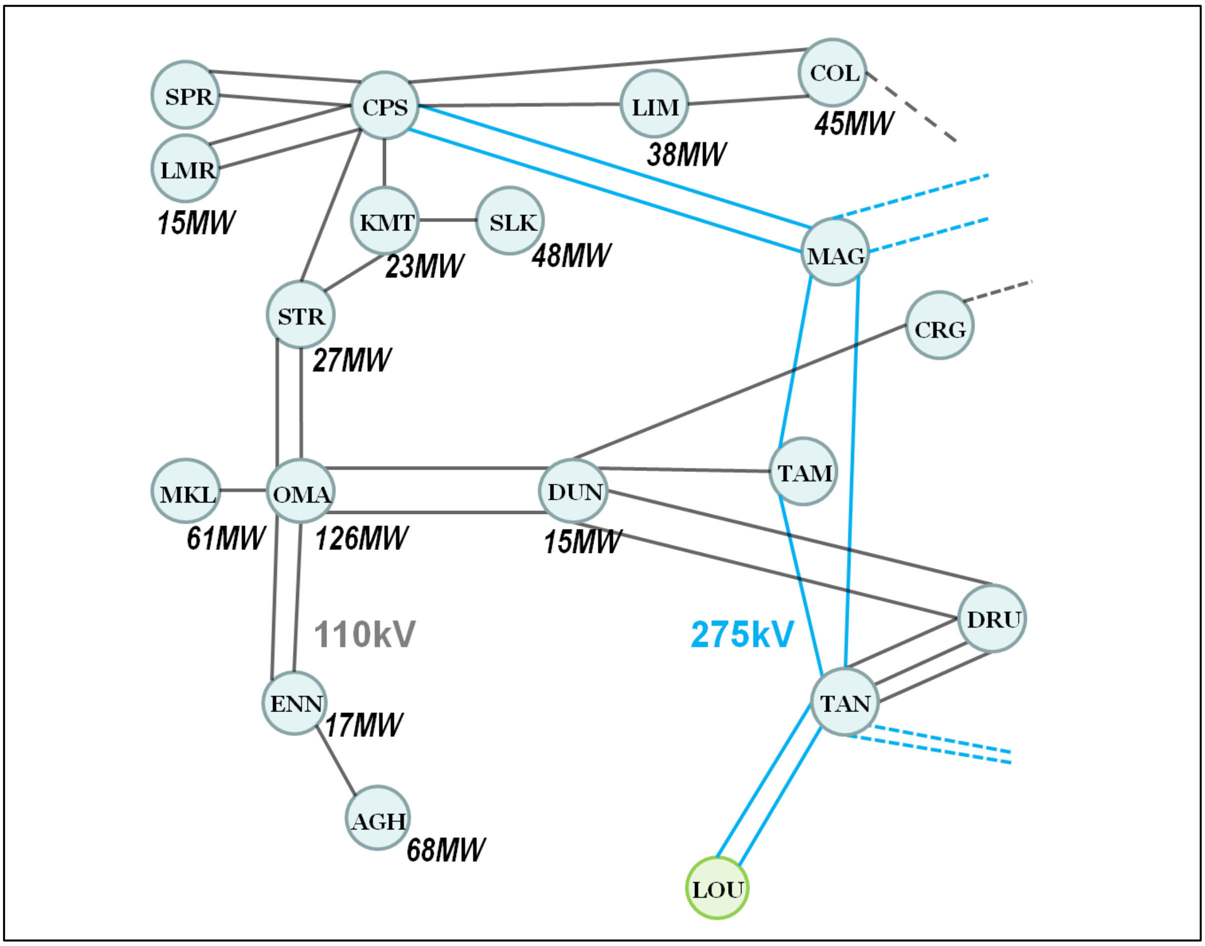

Figure 9: A schematic of the West of Northern Ireland at present.

4.3.2 2014 – 2016 and beyond

Studies have been carried out to look at the situation with respect to constraint groups within Northern Ireland going forward. As outlined above, with an absence of certainty about the timing of both generation build, and particularly new network investment, such studies are dependent upon the assumptions employed. This uncertainty makes it inherently difficult to envisage future SPS and thus, the Coolkeeragh run-back scheme aside, no SPS have been included in the Northern Ireland studies from 2014 onwards. However, under all of the simulations compiled, no candidate nodes satisfied all of the forming criteria to establish a constraint group. That is not to say that instances of localised congestion pockets do not occur, merely that the magnitudes and frequencies of such events are insufficient to merit being designated as a constraint group (see Table 4).

Time	Nodes	Map code	Forming Criteria	Resolution	Binding Constraints
Today	N/A – No Constraint Group for Northern Ireland				
From 2014	N/A – No Constraint Group for Northern Ireland				

Table 4: Possible Constraint Group in Northern Ireland.

	Nodes	Map code	
	Aghyoule	AGH	
	Coleraine	COL	
	Coolkeeragh Power Station	CPS	
	Creagh	CRG	
	Drumnakelly	DRU	
	Dungannon	DUN	
	Enniskillen	ENN	
	Killymallaght	KMT	
	Limavady	LIM	
	Lisaghmore	LMR	
	Louth	LOU	
	Magherafelt	MAG	
	Magherakeel	MKL	
	Omagh	OMA	
	Slieve Kirk	SLK	
	Springtown	SPR	
	Strabane	STR	
	Tamnamore	TAM	
	Tandragee	TAN	

Table 5: This shows the node names used in the schematic of the West of Northern Ireland.

Finally, it is also worth considering whether Northern Ireland as a whole could potentially constitute a constraint group. During occasions of low demand with high levels of wind generation, there exists a potential for transmission constraints to appear in a southerly direction on the North-South tie line. This constraint would be expected to diminish with the completion of the second North-South interconnector. However, when considering the North-South interconnector it has to be recognised that transmission limitations existed between the two jurisdictions prior to the introduction of SEM – yet it was deemed appropriate that generation "connected to SEM" in both jurisdictions be provided with firm access to SEM notwithstanding this. In that sense it was, and still is, accorded somewhat "particular" status and a party connects to a single jurisdictional transmission system but has use of the all island networks. Therefore, the constraint between Northern Ireland and Ireland is not driven primarily by the connection of new additional renewables – as is generally the case in the other studies – but by the wider portfolio and the need to maintain system security conditions within Northern Ireland.

The situation limited by the North-South tie line may be exacerbated if it coincided with a period of significant imports on the Moyle interconnector. Since this is considered to be a constraint event with all wind generation deemed to have a similar contribution to relieving the transmission congestion, a tie-break situation emerges. It should be noted that whilst this is designated to be a transmission constraint as per SEM-11-086[7], further analysis with increased tie line capacity indicates that this may not necessarily always be appropriate since there may also be simultaneous surplus wind generation in Ireland. As there is no additional capacity to accommodate the surplus NI energy at these times, so this would normally constitute a curtailment event. However, the opacity introduced by the tie line limits may therefore prevent such instances from being regarded in such a manner.

There are also a number of other uncertainties in relation to the potential designation of the entirety of Northern Ireland as a constraint group. Firstly, there is the impact on interconnector flows following the introduction of the East-West interconnector which remains uncertain. Secondly, the arrangements for counter trading in order to facilitate output by renewables which was provided for in SEM-11-062 and on which the System Operators have submitted proposals to the Regulatory Authorities remain to be finalised. Thirdly, the consideration as to whether under the scenarios whereby such constraints are prevalent – low demand and high wind – the necessary reduction in wind output is primarily a constraint or a curtailment issue.

For all of these reasons, as well as seeking to interpret the primary underlying intent of the constraint group concept in the SEM-11-063 paper as one to manage incremental renewable connections while protecting both end customers and existing renewable generators, the System Operators believe that the entirety of Northern Ireland should not be designated as a constraint group.

More generally, in relation to more local constraints within Northern Ireland, network studies are continuing and the TSO would not be recommending the introduction of any constraint group pending the completion of these. Indeed, dependent upon the assumptions and the relative speed of generation connection and network build no tie-break constraint group may be seen in Northern Ireland.

[7] SEM-11-086 Treatment of Price Taking Generation in Tie-breaks in Dispatch in the Single Electricity Market and Associated Issues

5 Conclusion

This document fulfils the task arising from Section 4.2 of the SEM 11-105 decision paper; the identification of up to three constraint groups within which the tie-break dispatch rule-set for constraints will apply. The TSOs have identified two constraint groups that meet the criteria outlined in SEM-11-105. This report describes the constraint groups that the TSOs propose to implement.

The TSOs developed a methodology to identify the constraint groups that best meet the criteria set out in SEM-11-105. The methodology is described in Section 3.1. It is worth emphasising that the stress testing and sensitivity element of the methodology is key to ensuring that a realistic and sufficiently large constraint group is defined from the start. This adds to the robust and thorough nature of the resulting constraint groups so that they have the key characteristics of being significant and recurring under different scenarios and years.

In summary, and based on the assumptions employed in the analysis, EirGrid and SONI find that:

1. There is a constraint group today in Donegal. This constraint group will evolve depending on the level of wind and network build out. It will ultimately be resolved through the Renewable Integration Development Project (RIDP).

2. While there are pockets of constraints in the South West today, a well defined constraint group based on the occurrences of tie-breaks only emerges once the Gate 2 wind is connected to the 220kV system. This group will eventually encompass about 1GW of installed wind capacity provided all Pre-Gate 3 and Gate 3 wind is connected. Additional network reinforcements, including new build at 400kV, are required to resolve this constraint group.

3. The situation in Northern Ireland is also complex and is subject to significant uncertainty. There does not appear to be significant near-term constraints arising because the Special Protection Schemes that are in place alleviate most transmission congestion events by disconnecting certain connected generation following a fault. Although certain areas are susceptible to localised transmission congestion, they do not appear to be sufficient to warrant the creation of a constraint group in the region. The situation of a constraint group comprising Northern Ireland as a whole was also considered, but was discounted on the basis of it only being applicable in certain dispatch regimes which do not align with the long term strategy for the integration of renewables.

Figure 10 illustrates the proposed constraint groups described in detail in this report.

It is likely that the constraint groups identified above will have an influence on decision making for prospective projects in their respective areas. Any non-firm generator connecting in these regions will likely be subject to increased constraint levels when compared to a pro-rata situation (again, dependent upon take-up). This is in addition to curtailment whose application by a pro-rata or a grandfathered mechanism does not impact on the presented results. The consequences of this may be that the development of projects in these regions could be put on hold until the necessary transmission reinforcements are delivered.

This makes predicting the constraint groups which may occur difficult, as the choice of group may lead to it not actually occurring, given the actual impact of residing in a constraint group is likely to deter generators from developing prior to receiving their full FAQ.

The arrangements set out in SEM-11-105 provided for up to three constraint groups. There may be periods where one, two or even no constraint groups are required. Further to this, the proposed constraint groups are only valid when the appropriate binding constraints are invoked. Situations where the electrical topology is modified due to prolonged outages in an area may also render any local constraint group temporarily invalid. It is also possible that other constraint groups could potentially be warranted in the event of a significant quantity of non-firm wind deciding to connect in an area without sufficient transmission reinforcements. This may be particularly appropriate in the event of substantial applications for temporary connections or a potential Gate 4 connection process occurring since the studies described in this document only account for known connection methods and expected timelines.

The TSOs propose to implement the constraint group in Donegal when the EMS changes are completed; this is expected to take 12 months following the decision to proceed.

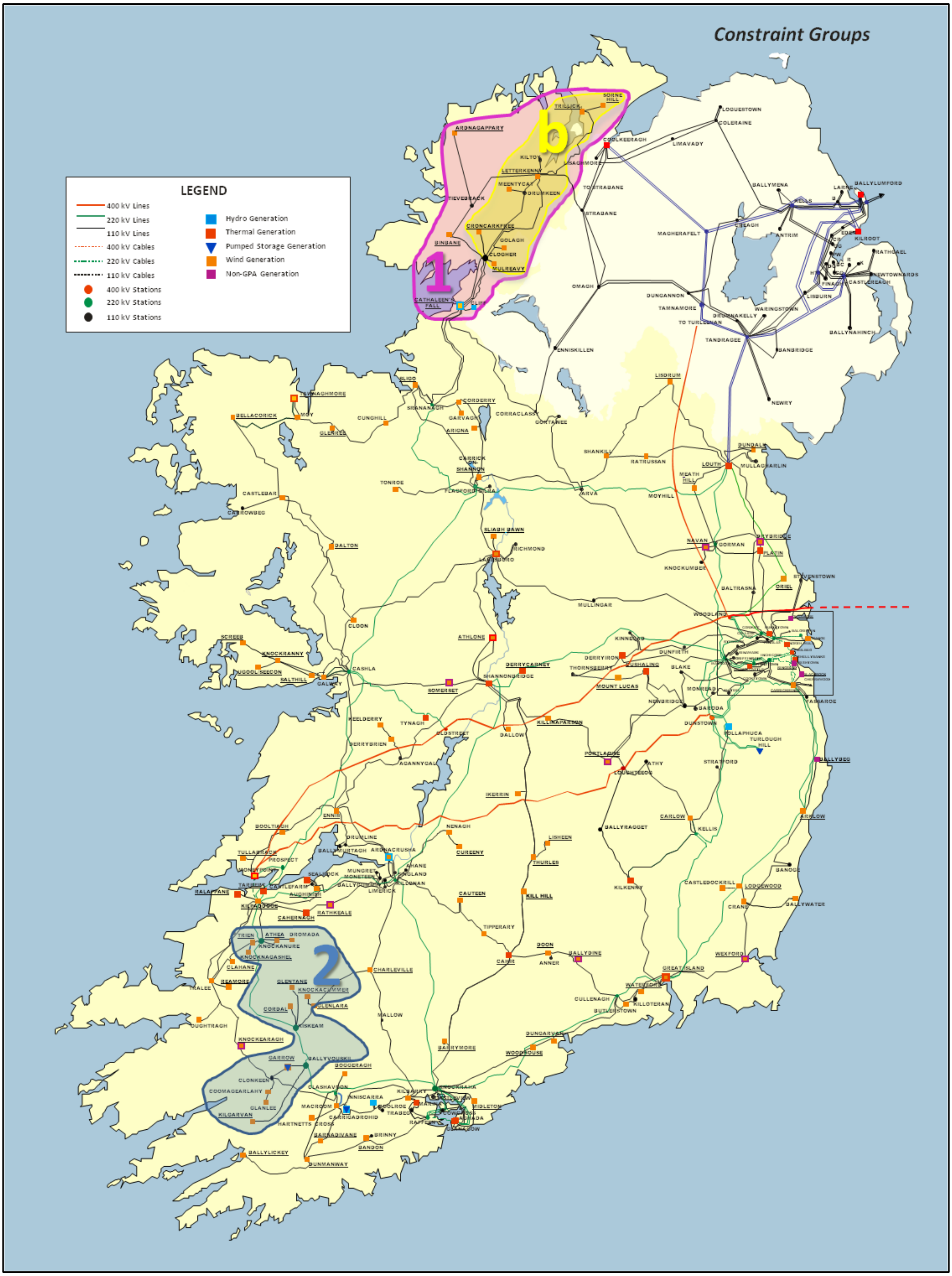

Figure 10: Geographic map of the proposed Constraint Groups on the Island of Ireland.

Appendix A. Assumed FAQ levels and Connected Wind for the IE Constraint Groups

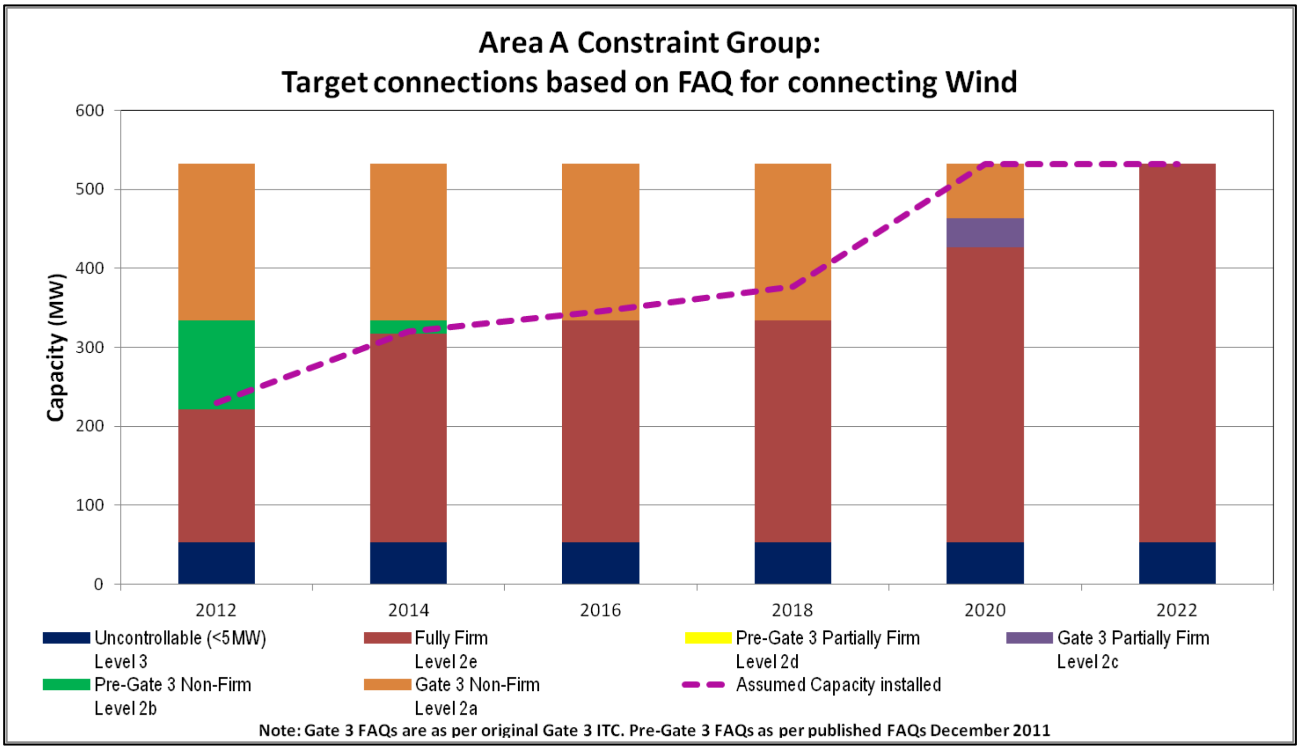

Figure 1: Assumed magnitude of each wind category in Area A connecting in the Constraint Group.

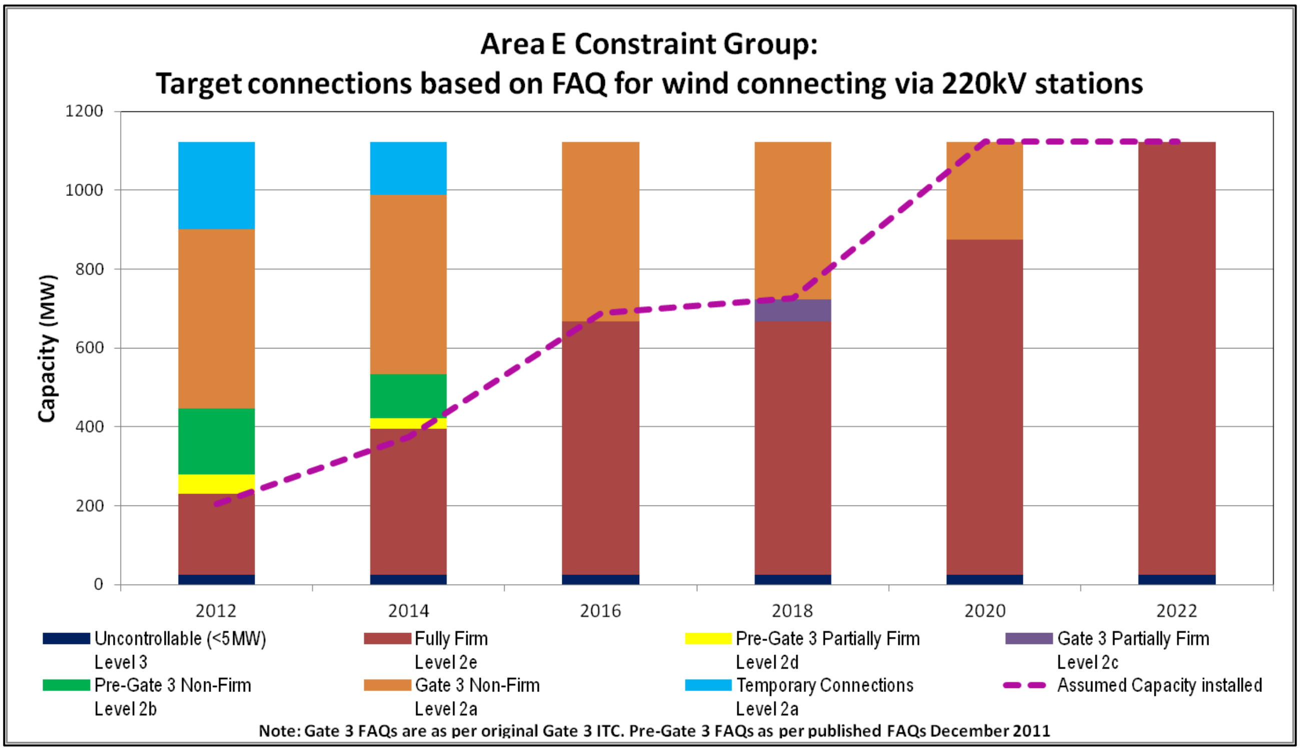

Figure 2: Assumed magnitude of each wind category in the Area E Constraint Group connecting at the designated 220kV stations in the proposed Constraint Group.

Note: The FAQ presented here corresponds to that in the original Gate 3 ITC and the Pre-Gate 3 FAQs published in December 2011.