Generator Connection Process

ITC Methodology to determine FAQs & Generator Output Reductions Analysis

Consultation Paper

October 2011

Executive Summary

SONI is the independent Transmission System Operator (TSO) in Northern Ireland (NI). Northern Ireland Electricity (NIE) is the Distribution System Operator (DSO) and is also the Transmission asset owner (TO). This paper has been prepared by SONI, in consultation and agreement with NIE, in order to provide interested parties with a comprehensive overview of revised connection processes to be employed for transmission and distribution generator connections. In particular, this document outlines how the connection process shall be developed in order to provide potential generators with essential information, at an early stage of the connection process, on available transmission system access and also on possible levels of future generator output reductions at each node on the NI transmission system. This information will allow connecting generators to make an informed decision about their connection options.

SONI explains why, given the generator connection charging policy in place and the limited available transmission access that exists in some parts of the transmission system, the implementation of a policy allocating firm and non firm access to the transmission system consistent with that applied in ROI, is essential for NI. An Incremental Transfer Capability (ITC) methodology to calculate a transmission Firm Access Quantity (FAQ) for each generator connecting to the transmission or distribution system is described in detail. This document also sets out how potential developers will be provided with an estimate of the likely incidences of generator output reductions at each node over a number of years.

This paper relates to generator connections to the transmission system and distribution connections, where the total Maximum Export Capacity (MEC) at the connection point is 5MW or above. It is anticipated that the proposals set out in this paper will apply to all applications currently in the connection process as well as future applications for a new connection or modification to an existing connection. This consultation document provides interested parties with an opportunity to communicate their views on the ITC methodology and the Generator Output Reductions analysis procedures which SONI proposes to introduce.

Abbreviations

Abbreviation	Definition
FAQ	Firm Access Quantity
MEC	Maximum Export Capacity
NI	Northern Ireland
TO	Transmission Owner
NIE	Northern Ireland Electricity
SONI	System Operator for Northern Ireland
TSO	Transmission System Operator
DSO	Distribution System Operator
TIP	Transmission Investment Plan
NW	North West (Region of the N.I. Network)
SPS	Special Protection Scheme
RA	Regulatory Authority (NIAUR in NI and CER in ROI)

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1 Introduction

This paper has been prepared by SONI, in conjunction with NIE, and provides an overview of the generator connection process. More importantly, this paper sets out a number of critical issues which exist in relation to the current connection process. The current and future availability of transmission network capacity, the possible output reduction levels on the generator and the timing of planned transmission reinforcements are not currently covered by the generator connection process. This paper addresses these issues and sets out proposals for how they can be encompassed into both SONI and NIE connection processes.

In Northern Ireland (NI) any generator wishing to connect to the electricity transmission system must submit an application to SONI, the Transmission System Operator (TSO). Similarly a generator wishing to connect to the distribution system must submit an application to NIE, the Distribution System Operator (DSO). It has become accepted practice that a Party applying for a connection must have planning permission in place. Generators connecting to the transmission or distribution system require information about the availability of transmission capacity to meet their export needs. If there is insufficient transfer capability available on the transmission system, it is essential to put in place a procedure that will assess all generator connection applications, both transmission and distribution, and determine what level of transmission access is available for each generator. If the transmission network has inadequate capacity to facilitate export from a new generator connection then it is important to communicate this to the potential generator and to identify what needs to be done in order to provide the required access. In the meantime, if a connection is made before the associated transmission reinforcements are complete, the generator may be able to use the network to export, if the circumstances allow. Limited access of this nature will be on a non-firm basis. This paper discusses in detail the following two discrete topics;

1. Calculation of Firm Access Quantity (FAQ) for all generators based on a policy of firm and non-firm transmission access.

SONI has developed a methodology which will assess each node on the transmission system to provide data on the amount of transmission system access that is available, both in the current year and going forward, as network developments occur. For each generator connection to the transmission and distribution system the methodology will calculate the FAQ that can be allocated. The methodology is known as the Incremental Transfer Capability (ITC) methodology and is very similar to that presently used by EirGrid in ROI. At present there is no such mechanism in place in NI to determine transmission access on an individual connection basis. Given that SONI is responsible for connection to and use of the transmission system it is incumbent on SONI to calculate and allocate firm access quantities for all generators using the transmission system. The FAQ's would then be communicated to the connecting generator by the relevant system operator.

2. Provision of data on likely incidents of Generator Output Reductions.

SONI have developed a model which could be used to analyse the likelihood of generator output reductions, under various scenarios of demand and generation, as described in detail in Section 7 of this document. It is proposed that, as the network develops, annual analysis will be carried out and the results made available for each 110kV node on the transmission system. This will provide existing and connecting generators with an indication of likely output reductions in various parts of the network. These forecasts will be made available for the current year and the future six years.

The proposed revisions to the connection process will bring about a number of benefits. These steps will provide connecting generators with important information, at the connection offer stage of the process, regarding the FAQ that is being offered at the transmission connection point and the expected generation output reductions at that node. Given that in NI connecting generators obtain planning approval prior to submitting a connection application publishing regular updated data on available transmission access and analysis of generator output reductions at each transmission node will allow any interested party to make better informed locational decisions. The allocation of firm and non-firm access in NI will be aligned with that in ROI to ensure consistency on an all-island basis going forward. Finally, adoption of these processes will also ensure that SONI will be in a position to enter into a Transmission Use of System (TUoS) agreement with each connecting generator.

It is anticipated that the proposals set out in this paper will apply to all generator connection applications in the connection process at the implementation date as well as future applications for a new connection or modification to an existing connection. For the purpose of the indicative studies it has been assumed that all existing connected generators have a FAQ equal to their Maximum Export Capacity (MEC) as stated in their TUoS agreement. The terms used in this paper are defined in the SONI Grid Code and/or the Transmission Interface Arrangements (TIA) document at www.soni.ltd.uk Please note that in the event of any inconsistencies between this paper and any transmission or distribution Connection Agreement, the Connection Agreement will take precedence. SONI and NIE can accept no responsibility for any loss attributed to the use of data contained in this paper.

2 Background

SONI is the TSO in NI and is responsible for the safe, secure and efficient operation of the Northern Ireland transmission network. Under Condition 25 of SONI's TSO licence it is obliged, on application by any person, to offer to enter into a connection agreement, or modify an existing agreement, for connection to the transmission network. The transmission system in NI is defined as assets that operate at 110kV or above.

NIE is the Transmission Owner in NI and is responsible for the planning, development, construction and maintenance of the transmission system in accordance with NIE's transmission licence. NIE is also the Distribution System Operator (DSO) in NI and is responsible for the operation of the distribution network. The NI electricity distribution network covers all voltage levels at 33kV and below and includes equipment such as transformers, cables, overhead lines, switchgear etc. NIE, the Transmission owner, is referred to as 'TO' throughout this paper. NIE in its role as Distribution System Operator will be referred to as 'DSO' throughout the document.

In March 2010 NIE published a consultation paper entitled "Charges for Connecting Groups of Generators to the Northern Ireland Distribution System".[1] This paper set out charging proposals for connecting groups of generation projects, known as 'Clusters', to the distribution system. Following this consultation NIE prepared and issued a consultation report highlighting that its preferred method of distribution connection charging was a hybrid model which may result in some connection asset costs being repaid via distribution Use of System (UoS) charges. This proposal was subsequently approved by the Utility Regulator on 21st April 2011[2].

In November 2010 the Utility Regulator began a consultation process on the "Electricity Connection policy to the NI distribution system". The purpose of this consultation was to identify areas of the current Statement of Charges for connection to the NI Distribution system which may need to be reviewed. Issues discussed included whether it is appropriate to subsidise connection charges for

[1] This paper is available on NIE's website:
http://www.niegetconnected.co.uk/downloads/Generator_Connection_Charges_Consultation_Paper.pdf

[2] This paper is available on UREGNI's website:
http://www.uregni.gov.uk/uploads/publications/Decision_Paper_on_Charges_for_Connecting_Groups_of_Generators.pdf

micro generators and if the definition of distribution connection assets should be amended to reduce connection charges for distribution connections and encourage the connection of renewable generation. The change in definition proposed by the Utility Regulator would effectively introduce a "semi-shallow" distribution connection charging policy. Following this consultation the Utility Regulator issued a decision paper in May 2011 stating that the consultation showed that changing the definition of distribution connection assets would be welcomed by most respondents. Both the consultation paper and decision paper is available on the Utility Regulator's website[3].

It is essential that the availability of transmission capacity is considered when a distribution connection offer is being made. This is even more significant given the recently approved change to distribution connection charging methodology in relation to clusters of wind generators (see footnote 3 below) which may encourage increased levels of distribution connected generation. SONI considers that a policy of firm and non-firm transmission access rights should be implemented immediately in NI to reflect available access to the transmission system for all generator connections.

The need for allocating FAQ's is confirmed in the recently published consultation paper entitled "Treatment of Price Taking Generation in Tie Breaks in Dispatch in the Single Electricity Market and Associated Issues" (SEM-11-063). This paper states that "The SEM Committee notes the need for approaches to the allocation of FAQs that are compatible with the SEM High Level Design in Ireland and Northern Ireland to facilitate the appropriate operation of the above proposals". The proposal referred to in this quote relate to the dispatch rules whereby, in the event of a tie break situation for price taking generators, those with non-firm access are dispatched down prior to those with firm access. Obviously these dispatch rules can only be applied consistently when all generators in the market are identified as having firm or non-firm access.

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3 http://www.uregni.gov.uk/uploads/publications/Next_Steps_Paper_on_Electricity_Connections_to_the_NI_Dist_System_V_final.pdf
http://www.uregni.gov.uk/uploads/publications/Consultation_on_Electricity_Connections_to_the_NI_Dist_System_Vfinal.pdf

2.1 TSO Obligations

SONI has a number of licence conditions designed to achieve the objectives of the Single Electricity Market (SEM). To comply with these conditions, SONI is obliged to act in conjunction with EirGrid, who is the TSO in ROI. The detailed arrangements are set out in The System Operator Agreement (SOA) between the TSOs. In addition SONI must also have in place and comply with arrangements between the TSO and the Transmission Owner (TO). These details are outlined in The Transmission Interface Arrangements (TIA) document between the TSO and the TO at www.soni.ltd.uk

The TIA sets out arrangements between the TO and TSO to enable the TSO to co-ordinate and direct the flow of electricity onto and over the Transmission System in accordance with technical limits and Licence Standards. Section D of the document deals with arrangements between the TSO and TO in relation to Construction Projects and deals with the process by which the TSO and TO enter into a bilateral Construction Agreement for the construction of a New Connection, a Modification or a System Construction.

2.2 Objectives of this consultation paper

In relation to generator connections, SONI's objective is to achieve a transparent connection process, whereby up to date information that is relevant to a connection is available at an early stage of the connection process. This information includes the transmission FAQ for the generator connection based on studies of incremental transfer capabilities and the likely incidences of generation output reductions at the node. This paper aims to address the following:

- Clearly set out, for information purposes, the roles and relationships between NIE and SONI when applying connection processes for both transmission and distribution generator connections.
- Outline the methodology whereby SONI will perform full contingency analysis to determine the incremental transfer capability (ITC) at each node on the transmission system. This will be used for the calculation of the firm access quantity (FAQ) that can be offered to new connection applications or connection modifications on the transmission or distribution system.
- Describe the analysis which shall be conducted annually in order to provide existing and potential developers with an estimate of the likely incidences of generator output reductions at each transmission node, across a number of years.

This consultation paper gives interested parties the opportunity to express their views on a number of issues as detailed in Section 8. In particular, views are sought on the assumptions to be applied in the ITC methodology and the assumptions to be used for analysis of possible generator output reductions. Importantly the paper also seeks views on use of the date of planning permission as the criterion that should be applied to interactive connection applications when considering access.

2.3 Structure of this paper

This paper is structured as follows; Section 3 discusses the connection charging regime in NI and the need for a policy on firm and non-firm access. An overview of the connection process for generator connections to the transmission system is also provided. Section 4 describes the connection process for generators seeking to connect to the distribution system and the issues which must be addressed in relation to this. Section 5 explains how SONI propose to calculate the FAQ for all new generation projects using the ITC methodology and how this data will be made available to connecting generators. Section 6 discusses topics relating to generator output reductions. Section 7 describes the analysis that will be conducted to assess possible generator output reductions at each transmission node. Section 8 sets out the next steps to be taken in order to put in place the new processes which are essential to address the issues of firmness of access to the transmission system and provision of data on likely generator output reductions so that the connection process better meets the needs of all generators in NI.

This paper also contains indicative results for two years, 2012 and 2016 for both ITC studies and analysis of Generator output reduction. At this stage, before approval of the methodologies, it was deemed inappropriate to perform the analysis for a larger number of years. It should be noted that once the methodologies have been agreed, SONI shall endeavor to provide results for a seven year horizon.

2.4 Responding to this paper

SONI welcomes comments from all interested parties on the issues set out in this paper. Responses should be submitted as outlined in Section 8. SONI will hold an open workshop in relation to the ITC methodology and analysis of generator output reductions during the consultation phase, at which SONI will present their proposals, followed by a questions and answers session. The arrangements for this meeting will be notified separately. Those wishing to attend the workshop should contact Gareth McLoughlin at SONI, by email to gareth.mcloughlin@soni.ltd.uk

3 Generator Connection Process

3.1 Connection Charging Policy

Transmission connection charging for generator connections in NI has been based on a shallow connection charging policy since the introduction of the SEM in November 2007. This is consistent with transmission generator connection charging in ROI. This policy means that generator connections pay for sole use assets required for their connection and all remaining transmission reinforcements are recovered via use of system charges levied on generators and suppliers. Further details can be found in the “Transmission Connection Charging Methodology Statement” available on SONI’s website. Prior to the introduction of the all-island market generators in NI were required to pay for “deep” connection assets which included the transmission reinforcements that were required to facilitate their MEC to be exported on the transmission system. When generator connections only pay for the shallow connection assets it is important that a process is in place to ensure that the necessary deep transmission reinforcements are provided. Should the generator complete the connection assets and connect to the network before completion of transmission reinforcements the generator should be aware that the network may not be available to export their full MEC at all times. If a connection is made before the required transmission reinforcements are complete then this introduces the need for firm and non-firm access arrangements. This type of access is currently used by EirGrid in the connection process in ROI and is explained in more detail in Section 3.2 below.

Connection charging policy for clustered generator connections to the distribution system has recently been revised by the Utility Regulator (see footnote 3). A distribution connection may have a firm connection to the distribution system but due to inadequate transmission capacity being available the transmission access may be non-firm. For this reason it is extremely important that the availability of transmission capacity is considered when a distribution connection is being made. Similar to transmission connections, SONI needs to assess the transmission access available for each distribution connection, above an agreed threshold, and determine the level of transmission access that can be offered to each generator. This will ensure that SONI will be in a position to offer a TUoS agreement to the connecting generator. Given that a distribution connected generator may have connected to the system prior to the completion of the necessary transmission reinforcements, putting in place a policy for the allocation of firm and non-firm transmission access is also essential for distribution generator connections.

3.2 Firm and non-firm access

A generator with firm access to the transmission system may experience generation output reductions however it is financially compensated in these instances via constraints payments from the Market, providing that the generator is not classed as an Autonomous unit in the market[4]. Full details of the rules relating to the Single Electricity Market (SEM) including scheduling and dispatch, constraint and curtailment, etc are available at www.sem-o.com

In some cases when a new generator connection application is received it may be that transmission reinforcements are not required and the system at present can facilitate the full export capacity securely of the new connection without the need for works, in this case the connecting generator will have firm access to the system once connected. However, in many cases the connection of additional generation to the transmission or distribution systems creates the need for additional transmission infrastructure and the new connection should not be granted firm access to the transmission system until this is complete.

An offer of non-firm access would allow a generator to connect and subsequently export onto the system before all transmission reinforcements are completed, providing the associated connection works, distribution reinforcements, and other necessary works, including control systems have been completed in full. Prior to transmission reinforcement works being complete, the generator will be considered non-firm in the SEM, which has implications for the generators constraints payments and may in some situations affect dispatch quantities, given the recent SEM consultation paper relating to principles of dispatch in the SEM in a tie break situation (SEM-11-063). Non-firm access means the generator may be dispatched if the transmission system can accommodate the generator's output but no compensation is paid in the event that it cannot. The generator will be given full firm access only when the required transmission infrastructure has been completed in full. In some cases it may be that limited transmission access is available and in this case the generator will have partially firm access, that is, some firm access and some non-firm assess. In this situation when output is reduced the generator will receive constraints payments in relation to firm access quantity only.

In recent years NIE has provided access to generators by installing, in lieu of transmission system reinforcement, fast acting control schemes that will reduce the generators output under certain

[4] Definitions of classes of generator units can be found in Trading and Settlement Code

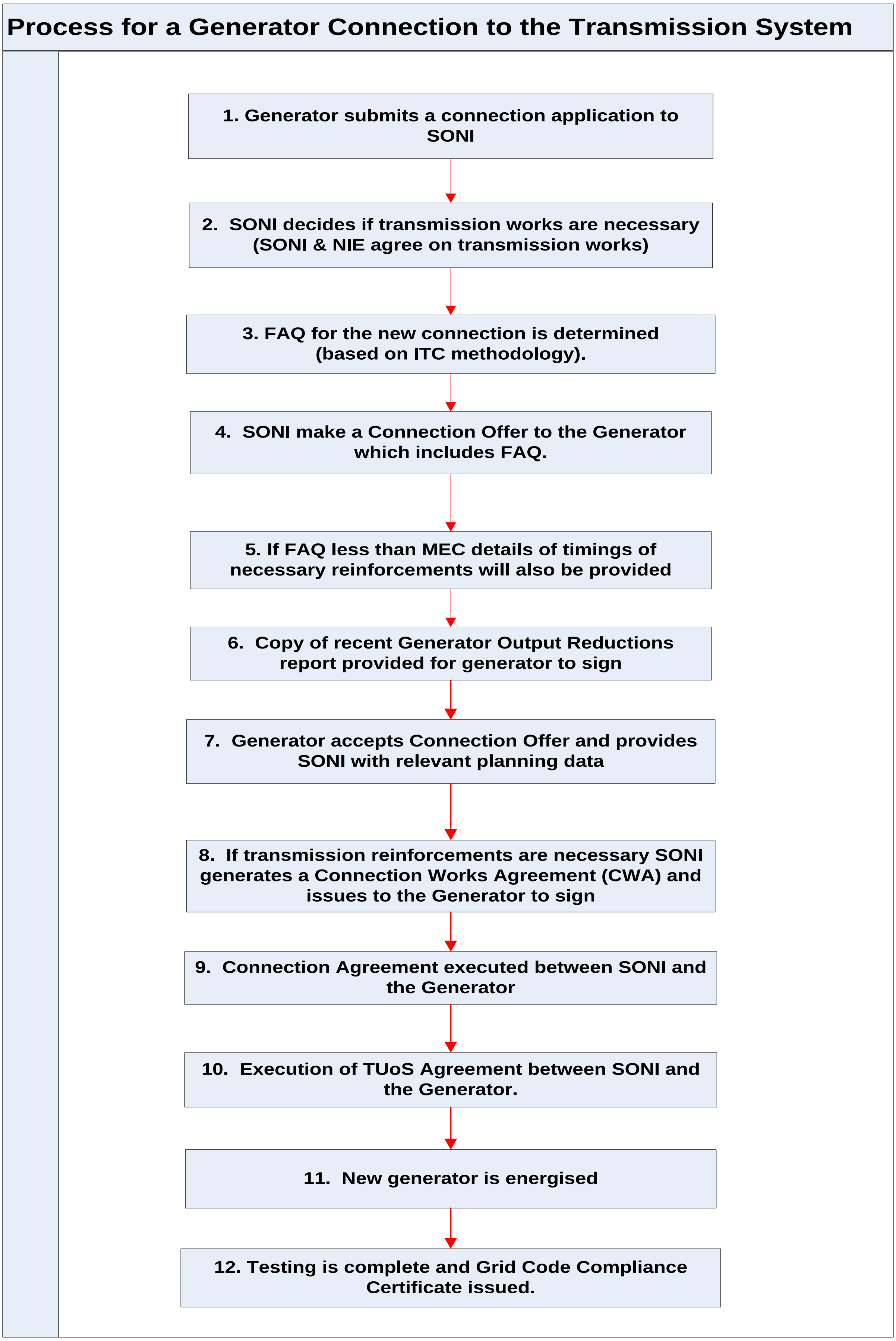
transmission system conditions. These schemes are known as Special Protection Schemes (SPS's) and their presence on the network has not been considered as affecting the generator's firmness. SONI believes that, going forward, all applications for generator connections must be assessed in relation to the availability of transfer capacity on the transmission system and the resulting FAQ that can be provided and this process is discussed in detail in Section 5 of this document. This section also examines the possibility of facilitating non-firm connections on the basis that connections could be made to the transmission and distribution system before all the required transmission infrastructure is in place, but generation output would be reduced when necessary without increasing constraints cost in the market.

3.3 Transmission Generator Connection Process

Currently in Northern Ireland (NI) any generator who wishes to connect to the electricity transmission system must on receipt of full planning permission submit an application to SONI. Similarly a generator wishing to connect to the distribution system must submit an application to NIE, the Distribution System Operator (DSO). Figure 1 illustrates, at a high level, the key steps in the connection process for a new connection, or modification to an existing connection, to the transmission system. Obviously when it is possible that the transmission system can securely facilitate a new generator, or a modification to an existing connection, without the requirement for additional transmission works the process is much simpler. Further details on the connection process can be found in the TIA document available on SONI's website at www.soni.ltd.uk

Taking account of the issue discussed above, this section outlines the process that SONI would like to put in place for future generator connections to the transmission system, this involves the inclusion of two additional elements. For most part the proposed process is the same as that in place at present with the exception that the ITC program shall be implemented to calculate the FAQ that can be offered to all new connections and also analysis shall be undertaken to assess likely generator output reductions at each node and the results will be provided to connecting generators. The flowchart below in Figure 1 shows how the additional steps will fit into the overall connection process and result in better provision of relevant information to the generator at an early stage of the connection process.

Figure 1: Key steps in Transmission Generator Connection process



The ITC methodology calculates the incremental transfer capability at each transmission node then this is used to determine the FAQ that can be offered to an individual generator connection on the transmission system. The Connection Offer, made between SONI and the Generator, will specify the amount of access that can be offered on a firm basis, i.e. the FAQ. The FAQ shall also be detailed in a separate schedule, which will be referenced in the Connection Agreement so as to facilitate a simple amendment should the FAQ change in future. The separate schedule, known as the "FAQ schedule", will be published on SONI's website and updated as necessary. SONI will aim to offer any remaining capacity, that is, the MEC less the FAQ, on a non-firm access basis until such times as the transmission system is reinforced and can facilitate more capacity. SONI will also make known to the generator details of the specify transmission reinforcements that need to be complete and when (according to NIE plans as represented in the SONI Seven Year Transmission Capacity Statement) these are expected to be complete, in order to provide this connecting generator with full firm access for all of its MEC. This detail will be provided in a formal letter of notification. For many reasons the completion times of transmission reinforcements may be delayed, so FAQs will only be amended when the reinforcements have been completed. SONI shall inform generators whenever a transmission reinforcement has been completed which will allow the FAQ for a generator to be amended. The generator will then be responsible for informing the market that its FAQ has changed. In some situations FAQs may be revised upwards a number of times, as reinforcements are completed, before a generator is granted full firm access. Unless otherwise directed, SONI will issue non-firm offers, which in turn, will become firm, or partially firm once the transmission reinforcements associated with the connection have been completed in full. Prior to offer acceptance connecting generators can then decide whether their connection is to proceed on a non-firm basis or whether they wish to wait until firm access is available before connecting. Further details and an illustration of the ITC methodology can be found in Section 5 of this document.

As well as providing each individual connecting generator with a FAQ, information shall also be provided relating to the possibility of generator output reductions. SONI shall study the likelihood of generator output reductions at each node on the transmission system, under a range of scenarios, and provide this information to connecting generators in order to allow the generator to consider all relevant factors before entering into a Connection Agreement. The generator will sign this report, to acknowledge receipt of it, as part of the connection process. This information will be of particular importance to a generator who may connect to the transmission or distribution system with non-firm transmission access and hence will not receive constraints payments if the unit is required to reduce its output for system security reasons. The analysis of generator output reductions is discussed in more detail in Section 6 and 7 of this document.

4 Distribution Generator Connection Process

It is important to acknowledge that connections to the distribution system can have a direct impact on the transmission system, given the need to flow energy on the transmission system to serve demand customers that are not local to the generation. There are a number of issues which exist with the current process for distribution generator connections which SONI seeks to address in this paper. Firstly a generator connecting to the distribution system should have an understanding of the available transmission capacity that exists to absorb the proposed export. In addition, the generator should be aware of the reinforcements that may be required to the transmission system to facilitate the generator's MEC. The generator will also benefit from information on the likely generator output reductions at the transmission node, so that, like any transmission connecting generator, it can fully assess its connection options.

The risk at present is that a generator connecting to the distribution system assumes that the transmission system has available transfer capacity, when in fact, transmission access in the area may be very restricted, due to network constraints. In order to avoid this situation SONI needs to be able to allocate transmission FAQs to both transmission and distribution connected generation to reflect the access that exists. If a generator is connecting in an area where constraints exist then the generator will be given this information in the connection offer, via the FAQ, and will have non-firm or partially firm access to the transmission system until such time as the necessary reinforcements are complete and full firm access can be allocated. It is SONIs view at this point in time that to consider every distribution generator connection application is impractical and therefore a suggested threshold is those applications where the total MEC at a connection point is 5MW or more. It is assumed that this threshold would capture a high percentage of distribution connections and those below this threshold would not have as significant an impact on the transmission system. This threshold is consistent with the level that is proposed by both System Operators (SONI & EirGrid) in relation to All-island TUoS charging for distribution connected generators (SEM-11-018). If it becomes necessary in future or if circumstances require, this threshold can be amended.

4.1 *Future Distribution Generator Connection Process*

There are clear benefits in distribution connections receiving information, concerning levels of firm access and possible generator output reductions, as part of the connection offer process. In order to make the information available it is necessary that SONI is involved in the connection offer process. SONI believes that a process such as the one in place for transmission connections, outlined in Section 3.3 above, should be established for distribution generator connections. The flowchart in Figure 3 illustrates the process that SONI feels would achieve a more optimal outcome in the connection of distribution generation. Many of these steps are similar to those described for transmission connections. In order for the process to operate successfully, it is essential that data is shared between the TSO, DSO and the TO. Corresponding with the process illustrated in the flowchart, Figure 2 below depicts the flow of communication between the relevant parties.

Figure 2: Flow of information for distribution connecting generator DSO, TSO and TO

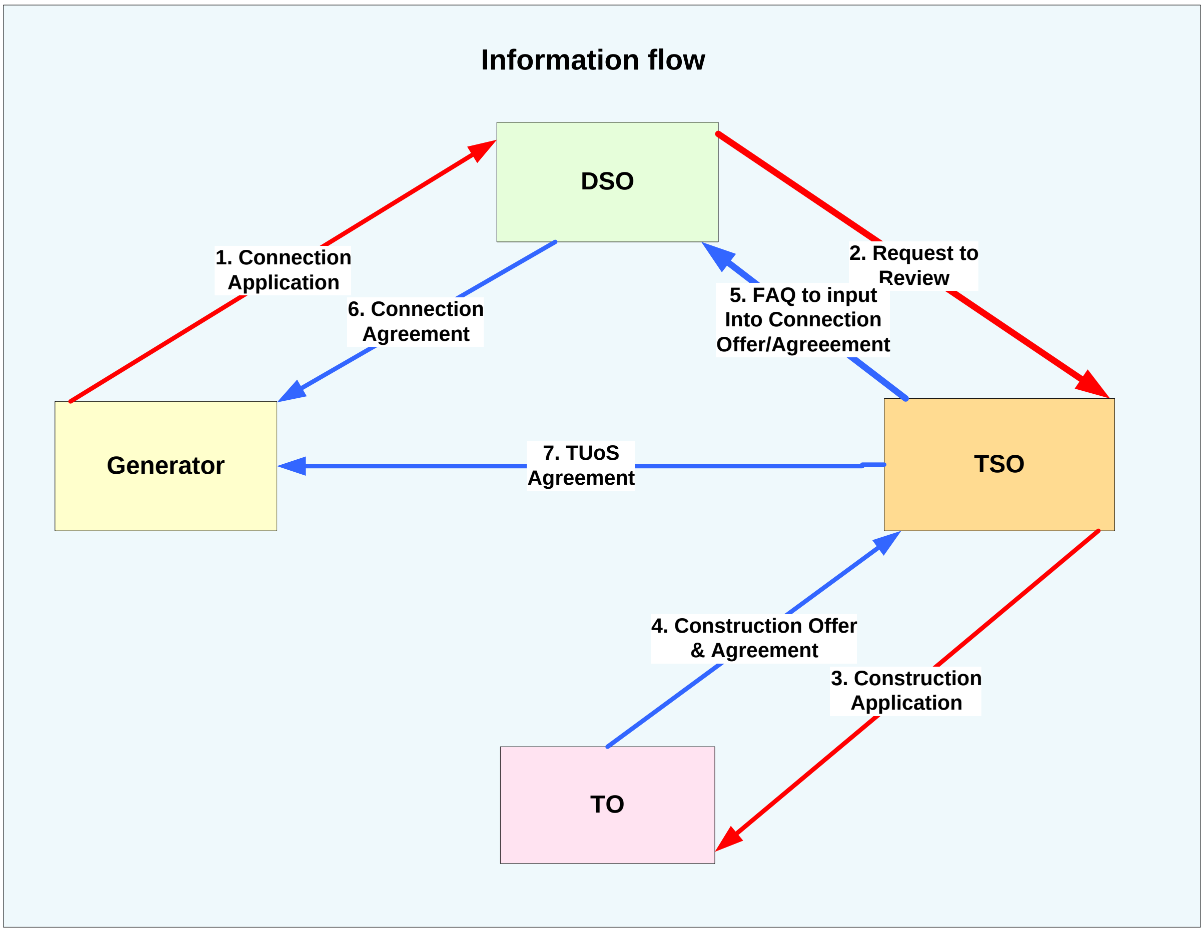
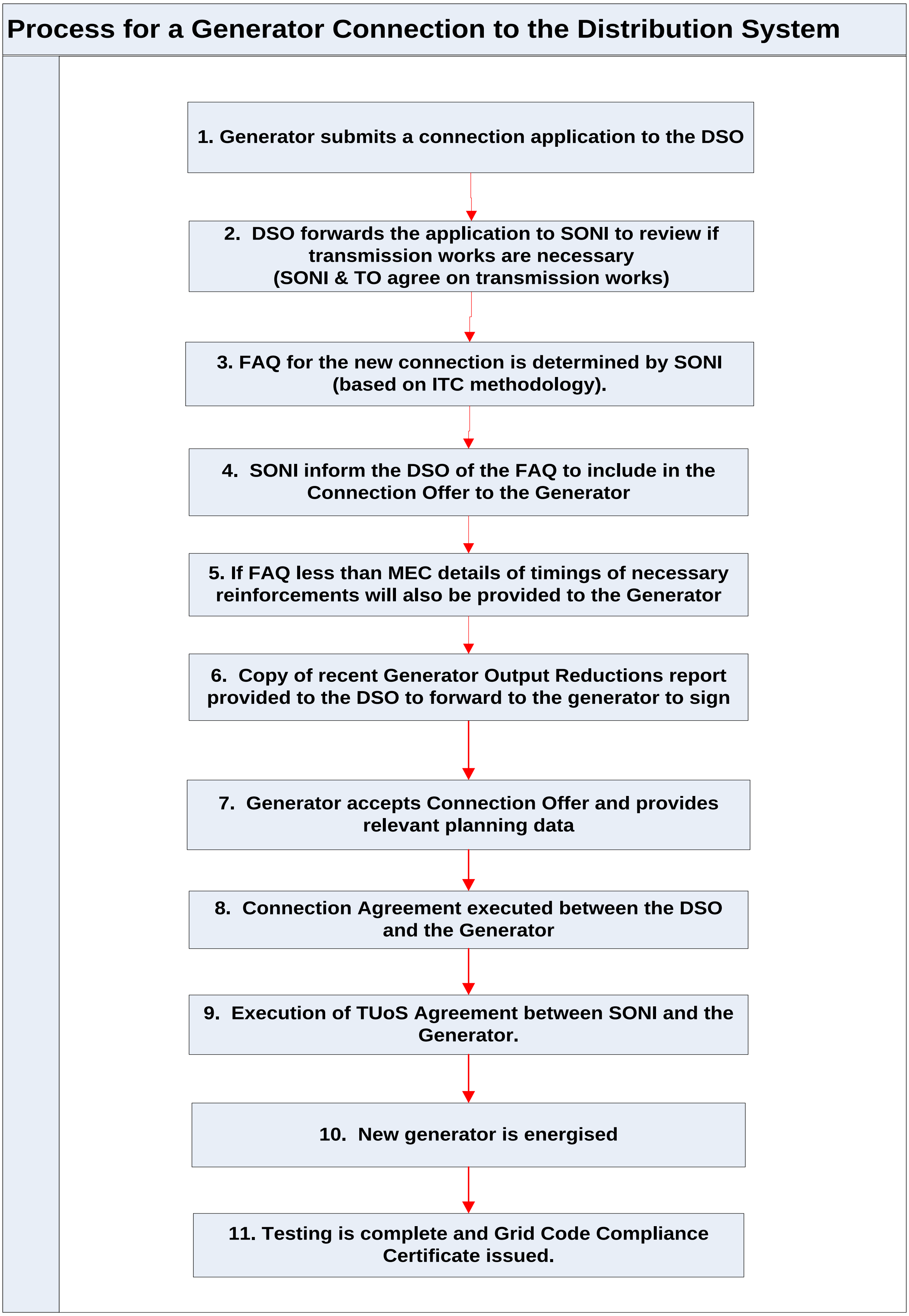


Figure 3: Key steps in Generator Connection process



The connecting generator will submit a connection application to the DSO, as is currently the procedure. For all connection points with an MEC of 5MW or above the DSO shall submit a request to SONI to review the application and consider if transmission reinforcements are required. SONI will assess the expected level of available system capacity that exists and using ITC analysis the FAQ for the connection shall be calculated, as described in Section 5. If the required capacity exists to facilitate the new connection then full firm access can be given. If only some capacity exists then SONI will advise the DSO to offer this as a firm access quantity and the remaining capacity on a non-firm basis until the transmission reinforcements are built, at which time the full required capacity can be offered on a firm access basis. Given that the connection is to the distribution system the Connection Offer shall be made by the DSO. In all cases, whether transmission reinforcements are deemed necessary or not, SONI will advise the DSO on the quantity of firm transmission access that can be offered to the connecting generator. The DSO shall include the amount of the FAQ in the Connection offer.

In the case that the FAQ is less than the MEC then SONI will provide details of the reinforcement works that are necessary to accommodate the increased FAQ and when these are expected to be complete. This information will be forwarded to the connection generator by the DSO. As highlighted in Section 3.3, the completion times of reinforcements may be delayed and FAQs will only be amended when the reinforcements have been complete. If generator output reductions occur, constraints payments would not be made in respect of the non-firm access quantity. FAQ's will be assessed annually for the developed transmission network and all updated FAQs shall be published on the SONI website on the "FAQ schedule". The generator shall receive formal notification whenever a transmission reinforcement has been complete which will allow the FAQ for this generator to be amended. A number of revisions to the FAQ may occur before full firm access is granted. The generator will then be responsible for informing the market that its FAQ has changed. Unless otherwise directed, non-firm offers will be issued, which in turn, will become firm once the transmission reinforcements associated with the connection have been completed in full. Connecting generators can decide whether they wish to proceed on a non-firm basis prior to offer acceptance. Further details and an illustration of the ITC methodology can be found in Section 5 of this document.

SONI will provide a copy of the most recent report detailing the analysis of possible generator output reductions. This shall be forwarded by SONI to the DSO to be included with the generator's Connection Offer. The generator must sign this report and return to SONI, to acknowledge receipt of it. This information will be of particular importance to a generator who may connect without firm transmission access and hence will not receive constraints payments if the unit is forced to reduce its output due to curtailment or network constraints. The availability of this information will allow a potential generator to decide if expected generator output reductions are low enough to still make a project financially viable until such time as firm access might be available. The analysis of generator output reductions is discussed in more detail in Section 6 and 7 of this document. The connecting generator will enter into a Connection Agreement with the DSO and a Transmission Use of System Agreement (TUoS) with SONI.

4.2 Generators connecting as part of a "Cluster"

The Utility Regulator has approved the concept of wind farm clustering. This means that rather than connecting wind farms by individual overhead power lines that in some cases wind farms will be connected via shorter connections to a shared node and common, higher-voltage line. Where a cluster has been established FAQs shall be allocated to each individually connected wind farm using the same rules as for any generator. Generators shall be placed on the list, which is used in the ITC studies, depending on their planning approval date. In the situation where the available FAQ is less than the sum of the MEC's of all generators connecting at a particular node, then FAQs shall be allocated based on planning approval date order of each of the generators. If more than one generator connection has received planning approval on the same date then a pro-rata allocation of the available FAQ shall be calculated, based on MEC of each of the generators.

5 Incremental Transfer Capability (ITC) Methodology

The increasing penetration of renewable generator connections in NI has resulted in potential thermal overloads on key transmission circuits in the North and West (NW) region. This generally occurs when system demands are low, and renewable generation is high, meaning that there is insufficient local load to absorb the generation, and exports on to the transmission system are high as a result. In the short term, the DSO has dealt with this problem by using Special Protection Schemes (SPS) that reduce wind output when required. Medium to longer term plans involve upgrading of transmission circuits in the necessary areas, and construction of additional circuits.

At discussed earlier, at present new generators connect to the NI electricity network without any information on possible network constraints on the transmission system. Some generators are connecting in areas of the network where high levels of local generation exist and hence these units need to export onto the transmission system in order to meet demand. This is not a problem when capacity exists on the transmission system to facilitate these flows, however when the flows on the transmission system are already near full capacity the generation output will undoubtedly be constrained down.

Where studies illustrate that transmission capacity does not exist to facilitate a new connecting generator then transmission access will only be offered on a non-firm basis. This will form part of the generators Connection Offer with SONI, for transmission connections, or Connection Offer with the DSO, for distribution connections. Generators that decide to connect to the transmission or distribution system with non-firm transmission access will not be eligible for constraint payments until such time as the necessary reinforcements are in place to permit firm access.

In order to calculate FAQ’s for each connecting generator SONI are introducing Incremental Transfer Capability (ITC) analysis, the methodology of which is described below. A very similar methodology is already used by EirGrid in ROI. The main purpose of the ITC analysis is to provide clear information to generators wishing to connect to the system of likely network constraints, and the timings of network investment projects to be carried out by the TO that will remove constraints. The ITC analysis will:

- Assess the existing capacity available for new generation at all transmission nodes on the transmission system using the MEC of existing generation, this will be used to determine the

Firm Access Quantity (FAQ) for all new connection applications to connect to the transmission and distribution system.

- Take into account all planned transmission network investment projects and assess how they impact on the FAQ for all generators. FAQs will be increased where possible for generators as necessary transmission reinforcements are complete.
- Provide information on the available FAQs at each node on the NI transmission system on an annual basis.

The proposed assumptions to be applied in conducting the ITC studies and a detailed description of the ITC methodology are provided in the next section. The ITC analysis will be conducted annually and if the results show that the FAQ can be increased for any existing generator, which is currently awaiting firm access, then the generator will receive formal written notification from SONI detailing the revised FAQ. The FAQ for each generator shall be published on the "FAQ schedule", which will be available on SONI's website; this schedule will be updated when it is possible to increase any FAQ. For some generators, FAQs may be revised a number of times before the generator is allocated firm access equal to its MEC.

SONI has conducted ITC analysis using two sets of data, 2012 and 2016. The indicative results are presented in Appendix E of this document. These indicative results indicate areas of the network where transmission capacity is very limited and other nodes where transmission capacity exists and hence an amount of firm access could be facilitated.

5.1 ITC Assumptions

In order to calculate the FAQs assumptions must be made with regards to the level of demand at each node on the NI system. Assumptions must also be made about the generation that will be dispatched to meet demand on the island, the flows on the interconnectors with ROI and GB must be accounted for and most importantly the transmission network must be modeled. It is essential that each of these elements is established with the highest accuracy possible. Each of the main inputs into the ITC model are detailed below, on approval of the ITC methodology these assumptions will be used to provide results for the next seven years. These assumptions have been used to prepared indicative results for 2012 and 2016 and it is intended that going forward these assumptions will be adapted, as appropriate, to perform the annual ITC analysis for future years.

The assumed starting point of the indicative ITC analysis is that all existing generators, connected to the NI transmission and distribution system, have a FAQ equal to its MEC, as referenced in the TUoS agreement under “Basis of TUoS Charging”. A list of all existing generators and their FAQ is shown in Appendix A (Table A.1 & A.2). Going forward generators will be added to this ITC list based on the planning approval date for their connection and assessed in turn using the methodology outlined. It is customary in NI for connecting generators to have obtained planning permission from the Department of Environment (or DETI if relevant) prior to submitting a connection application to the relevant system operator. Only generators that have submitted a connection application, which is deemed to be complete and has been accompanied by the necessary user application fee, will be included in the ITC studies. If more than one generator connection has received planning approval on the same date then a pro-rata allocation of the available FAQ shall be calculated, based on MEC of each of the generators.

5.2 Demand Assumptions

In order to fully assess all likely incidents of system constraints SONI will consider a range of system demand conditions consistent with those used for planning the network. Below are the four scenarios which SONI use to represent, in aggregate, the spectrum of operating conditions used in transmission system analysis. It is important to consider this range of demand scenarios to fully investigate if and when constraints are likely to occur at any node. All the dispatch scenarios are based on a full intact network, that is, one with no outages. Demand levels used in each scenario will be based upon the most recent SONI average cold spell (ACS) corrected demand forecast initially the 2011-2020 forecast will be used). This demand forecast has been used in the latest All-

Island Generation Forecast Statement, and is also used in the forthcoming 2011/12 - 2017/18 SONI Transmission Seven Year Capacity Statement. These forecasts are agreed with the Utility Regulator in advance of publication.

The four scenarios are:

- Winter maximum: This scenario refers to demand at the highest level which is recorded in a weekday between the months November to February, at peak hours, which are 4pm – 7pm. This scenario is representative of the system's ability to accommodate flows at peak demand.
- Autumn maximum: This scenario refers to levels of demand found during September and October months.
- Summer maximum: The Summer Peak refers to the average week-day peak value, between May and August inclusive, which is typically 20% lower than the winter peak. This demand level is of interest because although the overall grid power flow may be lower in summer than in winter, this may not be the case for flows on all circuits. In addition, the capacity of overhead lines is lower because of higher ambient temperatures.
- Summer minimum: The Summer Valley is the annual minimum which generally occurs in August. Annual minimum demand is typically 36% of the annual maximum demand. Analysis of summer valley cases is concerned with the impact of low demand and high levels of generation. This minimum condition is of particular interest when assessing the capability to connect new generation. With local demand at a minimum, the connecting generator must export more of its power across the grid than at peak times. A high level of wind penetration represents testing conditions for the export of wind power from geographically remote regions with limited demand.

5.3 Generation Assumptions

Conventional generation will be dispatched on a merit order basis. In order to maintain system stability and reflecting current operational practice, a minimum of three machines will be dispatched at all times in NI. It is assumed that this will change in 2016/17, with the commissioning of the new 400kV tie-line between Turleenan and Woodland, which will allow the minimum number of conventional machines required to be running in NI to reduce to two.

At present there is no new conventional generation planned to connect to the NI transmission system over the next seven years. It is assumed that, due to environmental constraints imposed by E.U. emissions legislation, the Phase 2 Units (4, 5 and 6) at Ballylumford will have to be decommissioned. This is assumed to occur in December 2015, and so will impact studies from winter 2015/16 onwards.

All existing wind generation will be dispatched at full MEC in all scenarios. In order to assess available capacity for new generators the existing generators must be at full MEC otherwise studies may indicate the presence of available capacity on the transmission system when in fact this does not exist. A summary of existing wind generation is shown in Figure 4 below, summarised per 110kV node, a breakdown is provided in Table A.1 in Appendix A. Wind generation will be operating with a power factor of 0.98 leading in all studies, a figure agreed with NIE under the TIA investment planning panel. A list of all other existing generation is included in Table A.2 in Appendix A. A full list of all generators currently connected to the distribution system in NI, as of February 2011, is provided in Appendix A (Table A.3).

110kV NODE	MW
AGHYOULE	67.5
BALLYMENA	5
COLERAINE	45
DUNGANNON	15
ENNISKILLEN	16.9
LARNE	15
LIMAVADY	37.7
OMAGH	125.7
STRABANE	27.4
LISAMORE	15.0
KILLYMALLAGHT	27.6
TOTAL	**397.8**

Figure 4: Current wind generation in NI by 110kV node

Consideration has been given to the treatment of “Other” generation in the ITC studies, this includes biomass, offshore wind and storage.

Two sites with potential for offshore wind have been identified in a recent DETI Strategic Environmental Assessment. They are at Tunes Plateau, off the North coast of NI, and also at a site off the East coast of NI. Based on recent information, the East coast site is more likely to be developed. Hence, it is assumed that, by 2019, there will be 400MW of offshore wind operating off the East coast.

No significant projects for biomass, offshore wind or compressed air storage will form part of the indicative studies included in this paper, due to a lack of firm connection information. As this becomes available the generation shall be included as appropriate in studies for coming years.

The Moyle interconnector will initially be dispatched to reflect typical current transfers to and from GB. However, as levels of renewables increase, transfers on Moyle may have to be varied to ensure all renewable generation can be accommodated, as well as observing system security rules in relation to the use of conventional generation. Figure 6 below shows the current Moyle import and export limits.

FLOW DIRECTION	SUMMER	WINTER
GB-NI	410 MW	450 MW
NI-GB	300 MW	300 MW

Figure 5: Current Moyle Import and Export Limits

5.4 Network Assumptions

Initial studies will be performed using network models provided by the TO for the 2011/12 – 2017/18 SONI Transmission Seven Year Statement. These network models are merged with equivalent files from EirGrid to create All-Island files. Network developments included in the models are reflective of NIE's most recent Transmission Investment Plan. A full list of transmission network developments is provided in Table B.1 in Appendix B of this document. Reinforcements are assumed to be implemented at the end of the appropriate year; this is consistent with other analysis carried out by SONI.

Figure 6 below lists the total transfer capacity in MW for flows between NI and RoI. Presently, the flows are restricted on the 275kV double circuit between Tandragee and Louth, due to the potential impact of system separation. Once the new 400kV tie line between Turleenan and Woodland comes into operation from winter 2016/17, it is assumed that the transfer capacity will be increased to 1400MVA. The two 110kV connections between Strabane and Letterkenny, and Enniskillen and Corraclassy, are assumed to operate normally with zero MW transfer, and are only used for security of supply purposes. As a result, these are not considered to provide any transfer capacity in these studies.

DIRECTION	TOTAL TRANSFER CAPACITY	
	BEFORE WINTER 2016	AFTER WINTER 2016
NI-RoI	430 MW	1400 MW
RoI-NI	380 MW	1400 MW

Figure 6: Transfer Capacity to RoI

5.5 Special Protection Schemes (SPS)

In recent years the DSO has installed a number of Special protection schemes (SPS) in conjunction with certain generator connections. SPSs operate during abnormal system conditions and allow continued operation of the network by switching off, or constraining the output of certain generators. For example the loss of the 275kV double circuit between Coolkeeragh and Magherafelt can lead to large overloads on the 110kV circuits in the area. Following the loss of the double circuit, the CCGT at Coolkeeragh is automatically curtailed to 160MW, known as Coolkeeragh Runback scheme. As this forms part of their connection agreement, this will be modeled in the ITC analysis.

The TO has assessed that beyond a value of 251MW, further quantities of renewable generation in the NW region will result in overloads on the existing transmission network under contingency conditions. As a result NIE have found it necessary to connect some generators with SPSs. These generators and their capacities are listed in Table A.5 in Appendix A. The available Firm Access Quantity (FAQ) for new connections in the NW region is therefore presently zero. The ITC analysis will highlight when additional firm access is likely to become available in future years, given the planned transmission reinforcements.

Figure 7 below highlights how the present constraint level has come about and why the SPS are necessary. The diagram shows the NW section of the NI transmission network. The 110kV 'B' circuit between Omagh and Dungannon is out on maintenance, followed by a loss of the 275kV double circuit between Coolkeeragh and Magherafelt. The loss of the double circuit as a single contingency is credible, as this has occurred in the last five years. Following the double circuit trip, the CCGT at Coolkeeragh is run back to 160MW. Studies have then shown that the maximum amount of wind that can be connected in the NW region is 251MW. Of the present 251.2MW connected without SPS, 246.2MW is located in the NW region. Hence the need for five wind farms to be connected via SPS, as they are all located in the NW area. In terms of the ITC model and allocation of FAQs, generators connected via SPS are treated no differently to any other generator.

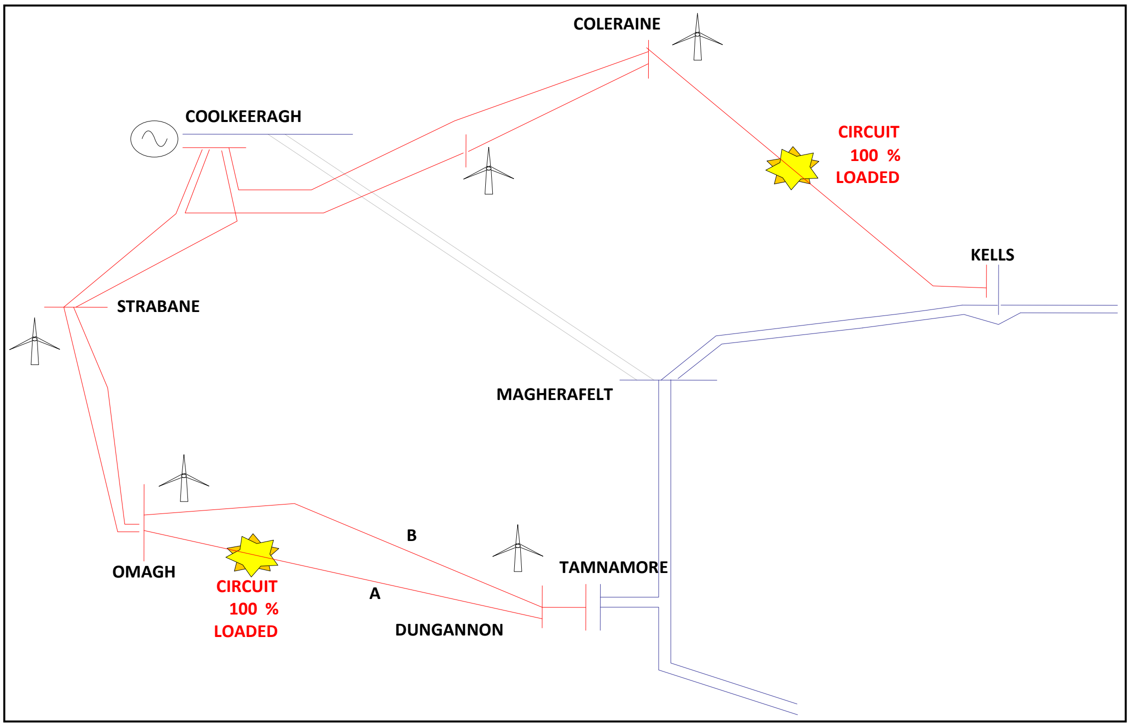


Figure 7: NW Network Map Showing Cause of Constraints

5.6 Process steps

The proposed ITC methodology is demonstrated in a simplified diagram in Figure 8 below. The process shall be conducted on an annual basis so as to reassess FAQs taking account of network developments, this way all data available to potential new generators will be up to date and will reflect current network limitations.

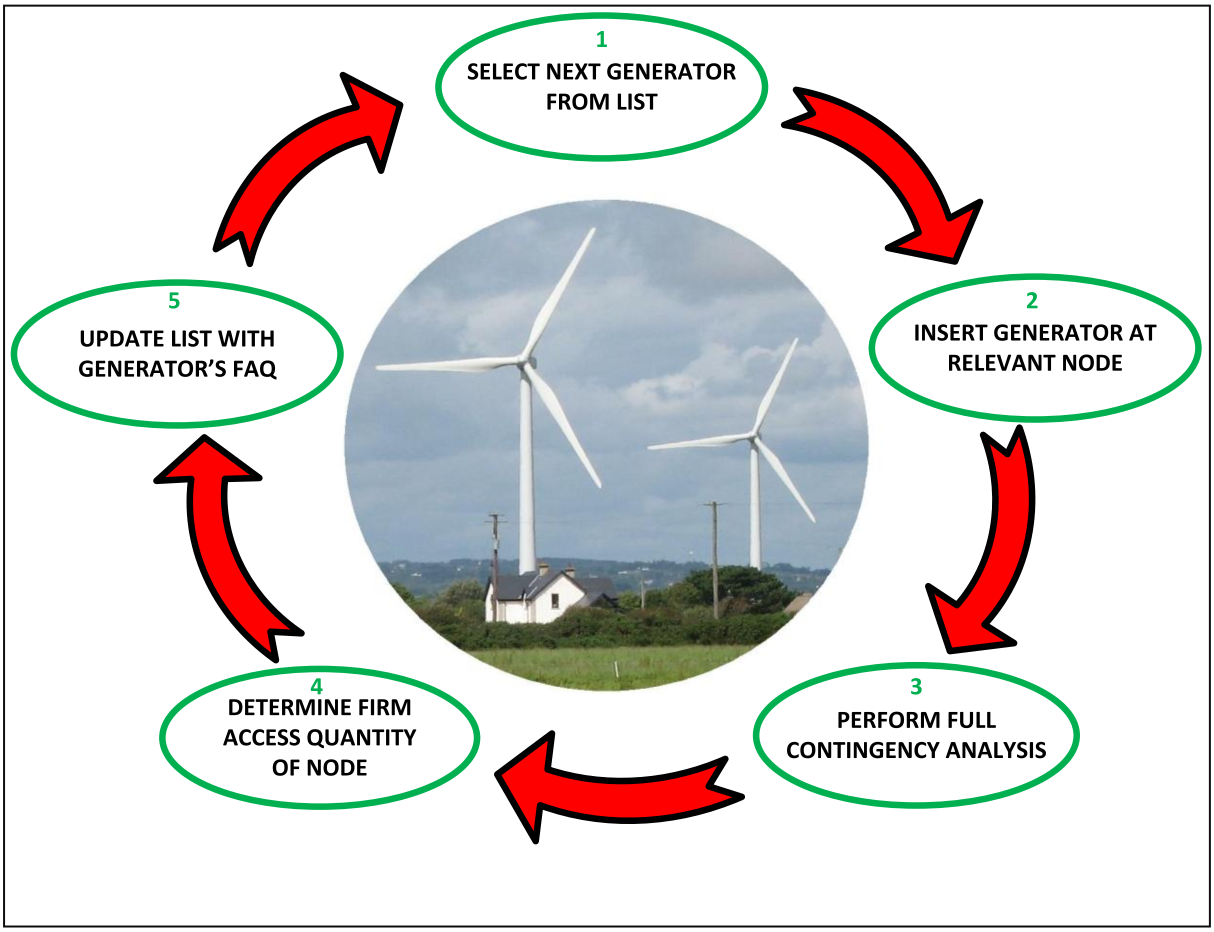


Figure 8: Simplified Methodology Flow Chart

At a very simplistic level, the ITC process looks at each generator in turn, based on a list of existing generators, that have not yet been allocated FAQ equal to MEC, and connecting generators that have submitted a connection application upon receiving planning approval. The list is prepared on a set date known as the "Freeze date", all generator connections for which a complete connection application has been received, by this date will be included on the list. The list includes both transmission and distribution connected generators. The list of generators is arranged in the order of the date that planning approval was granted. This is consistent with how applications are assessed for connection to the electricity system and it is considered to be a fair and transparent method to apply. For each generator the FAQ at the node of connection is assessed using rigorous contingency analysis. The ITC analysis will be performed using PSS/E, via use of an automation program already tested and used for SONI's Transmission Seven Year Statement. The model will look at a range of credible demand and generation scenarios in each of the seasons. The model will produce a quantity of access that can be facilitated at each node. The generator is then allocated a FAQ, which may be less than or equal to the MEC. The network models are then updated accordingly to include this new generator, and its assigned FAQ. As the years progress, network infrastructure is provided, allowing extra network capacity. Any generator with a FAQ less than their MEC will have their FAQ reassigned as capacity becomes available. If there is no generator on the list for a particular node a 'Test' generator will be used to derive a FAQ for this node. Generators are made aware of the FAQ in their connection offer and this information will also be published on the "FAQ schedule" which SONI shall update on an annual basis.

For illustrative purposes, this section provides a worked example of how the ITC methodology will work in practice. The ITC analysis is conducted in year 1 and produces FAQs for a two year period, Year 1 & Year 2, based on the small scale network shown.

Worked Example of the ITC Methodology

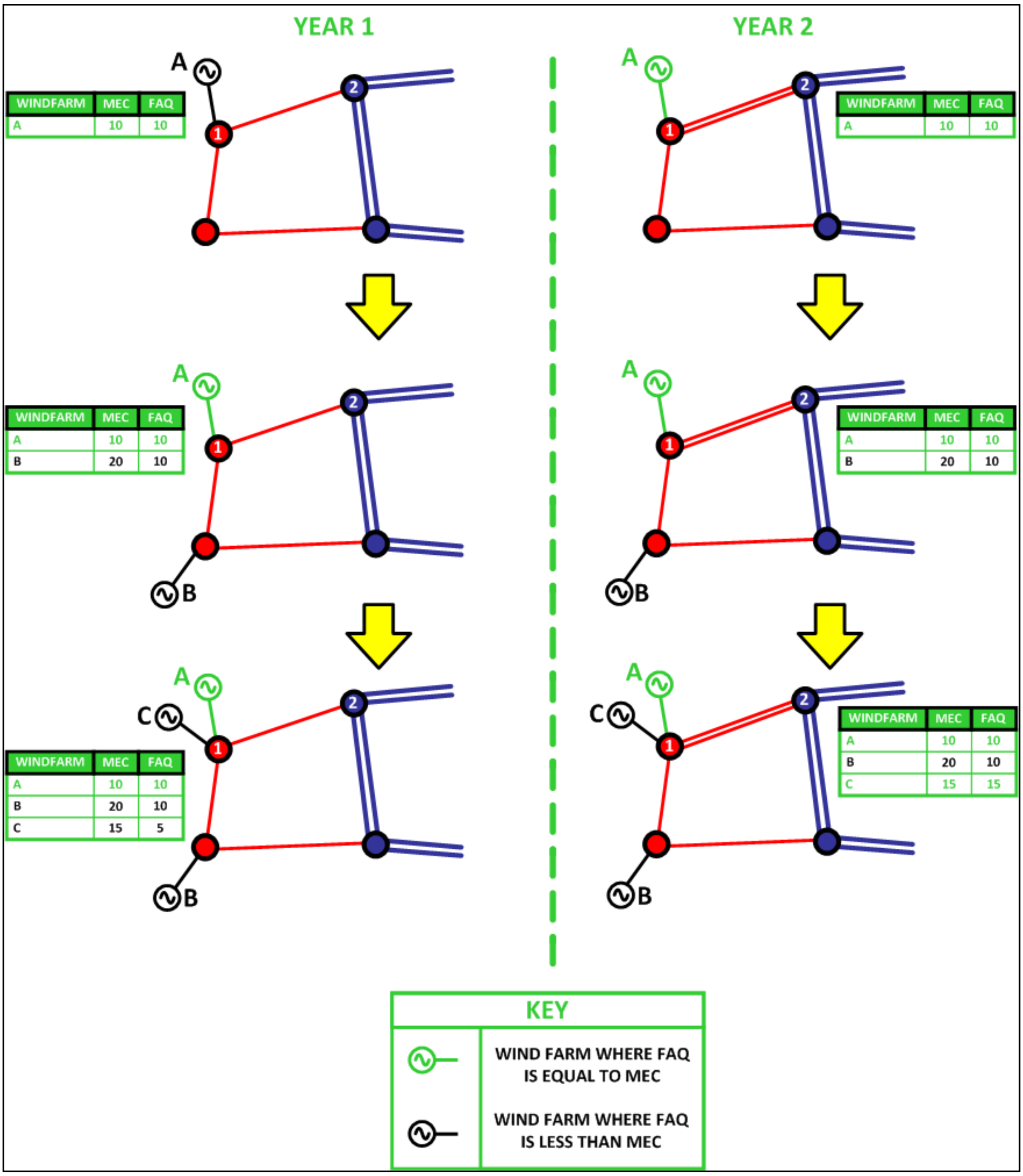


Figure 9: Detailed Methodology Flow Chart

Figure 9 above shows the ITC process for a small example of a transmission network. This illustrates the ITC process being done in Year 1 for a two year horizon, Year 1 and 2. At the data freeze date, Generators A, B and C have obtained planning permission to connect to the system and have submitted connection applications. In year two an additional circuit has been built on the network as shown by the second red line from node 1-2.

Before analysis of each individual connection begins, a list of connecting generators to be tested is drawn up. This is comprised of any generator from previous years awaiting full MEC allocation (i.e. their FAQ is less than their MEC) and all generators with planning approval that have submitted a connection application to connect to the system by the time of the freeze date. The list is always ordered in terms of the date of planning approval. This ensures that generators awaiting full MEC allocation are always prioritised ahead of generator connections that received planning approval at a later date, whenever new network capacity becomes available.

Network models for the year under test must also be set up, for all demand scenarios described earlier. These models include any planned network reinforcements, and all generators already connected to the system with full MEC allocation (i.e. their FAQ is equal to their MEC). Below is a brief description of the process shown in Figure 10.

ITC Analysis to produce FAQ's for Year 1

Generator A, B & C have all submitted connection applications. The first generator granted planning permission to connect to the system is **Generator A**, with an application for 10MW of MEC. Following full contingency analysis, the FAQ of Generator A is 10MW, i.e. equal to its MEC. Generator A shall be offered firm access to the transmission system of 10MW; this shall be included in the Connection Offer made to the generator. The network models for year 1 are then updated with generator A, dispatched at its FAQ.

Generator B is next on the ITC list with an application for MEC of 20MW. Following full contingency analysis, the FAQ of Generator B is only 10MW. The files are updated with Generator B, dispatched at its FAQ. Generator B shall be offered firm access to the transmission system of 10MW, and non-firm access of 10MW; this shall be included in the Connection Offer made to the generator. The generator will also be advised on the necessary reinforcements which must be complete to deliver the full FAQ and when these are expected to be complete. In later years when the FAQ is reassessed the FAQ for Generator B may increase.

The final generator to obtain planning permission is **Generator C**. Following full contingency analysis, the FAQ assigned to Generator C is less than the MEC applied for. Generator C has applied to have an MEC of 15MW, it can be offered firm access to the transmission system of 5MW, and non-firm access of 10MW; this shall be included in the Connection offer issued to the generator. In later years when the FAQ is reassessed the FAQ for Generator C may increase.

ITC Analysis to produce FAQ's for Year 2

The network files for the second year are prepared, by updating the year one files with any new network reinforcements that will be complete, consistent with the Transmission Investment Plan. Any generator from the year one analysis which had their full MEC allocated are entered into the files and dispatched at full output. The list of generators to be tested comprises of those without full MEC allocation from year 1 (Generator B and C from the example above).

Following full contingency analysis of each individual generator, starting with the first from the previous year without full MEC access, and proceeding until the last applicant, it can be seen that the network reinforcement has allowed Generator C to have its FAQ reassessed and increased to equal its full MEC. Generator B remains with a FAQ less than its MEC despite Generator B having received planning approval before Generator C.

Development of the transmission network is planned on many factors including demand growth, security of supply, renewable generation connections etc. As a result, generators which received planning approval later than others may benefit from new reinforcements ahead of those with earlier dates of planning approval, as shown with Generators B and C in the example above. This example demonstrates the benefit of providing information on available FAQ's at each node for future years, Generator B may have chosen to locate at Node 1 if it had known in advance that firm access would be available at node 1 and that full firm access would not be available at the node where it has now planned to connect to.

The ITC analysis will include all existing generators and generators who have accepted a connection offer and are expected to connect to the system. It will also include those applicants who currently hold a valid connection offer, that is, a connection offer that is still within 90 days of issue and is assumed will be accepted. In addition, all completed connection applications seeking a connection offer will be included in the analysis. Any generator who has failed to proceed, within the allowed time, after acceptance of a connection offer or whose connection offer has expired will not be included in the ITC analysis.

5.7 *Facilitating the additional generation*

When a node is tested, during modeling, given that demand on the system will remain unchanged, it is necessary to reduce existing generation to allow the new generator under test to be dispatched at full capacity, while still achieving a balance of total generation and demand on the system. In the ITC methodology it is proposed that in order to dispatch the new connecting generator or "Test" generator then this will be done by each of the three methods described below. In total 12 cases are examined, that is, each of the four demand scenarios in each of the 3 situations below. This results in a set of twelve values of available transfer capabilities at each node. The minimum of these values is then identified as the available transfer capability that can be accommodated at that node. It is important to note that when a node is analysed, the existing generation connected at that node is maximised before analysis is performed.

1. Supplying the existing NI Load

In this scenario, a new generator is connected to the appropriate node. As the output of the generator increases, a corresponding amount is scaled off the existing conventional generation in NI. The existing renewable generation in NI remains at full output. In effect, the new generation is supplying the existing NI load.

2. Supplying the Load in ROI

In this scenario, the output of the new generation connecting to the system or the test generator is transferred across the tie lines to ROI. In this case the NI demand remains unchanged as does the output of all other NI generating units. The additional generation is exported to ROI.

3. Reducing imports from GB

In this scenario, as the output of the new generation at the test node increases, the energy transfers across the Moyle interconnector are correspondingly adjusted. In effect, imports are reduced, and can result in power being exported to GB. It is important to note that these studies do not take into consideration any existing or future constraints on the Scottish transmission system.

5.8 *Contingency analysis*

Figure 10 below illustrates the contingency analysis which shall be performed for each scenario. The system shall be designed to withstand the more probable contingencies without widespread system failure and instability, maintaining power quality within specified voltage and frequency fluctuation ranges and maintaining voltage and thermal loadings within operating limits. The more probable contingencies are comprised of single contingency (N-1). The single contingency test N-1 covers the loss of any single item of generation or transmission equipment at any time. N-1 contingency analysis shall be carried out in each season. In winter N-DC contingency shall also be analysed. The loss of a double circuit is treated as a single contingency. This is a reasonable assumption given that this has occurred on a number of occasions in the last few years.

SEASON	CONTINGENCY ANALYSIS
WINTER	N-1 and N-DC
AUTUMN	N-1
SUMMER	N-1

Figure 10: Range of Contingency Analysis Performed

5.9 ITC Results

Results of the ITC analysis will be published on an annual basis; this will show the FAQs for all new and existing generators. The results will also be presented by 110kV node on the system, to highlight nodes on the system where firm access is and is not available. It is intended to provide results in tables similar to that shown in Figure 11 and Figure 12 below. The results table will indicate, for each generator, what the FAQ is for all years studied, when the FAQ is expected to change, and what network development facilitates this change. As part of the connection process each connecting generator that has been allocated an FAQ less than the requested MEC will have been provided with details of the network reinforcements required in order to provide FAQ equal to its MEC and when these are expected to be complete.

When the ITC studies show that an existing generator can have its current FAQ increased, most likely due to the addition of transmission infrastructure, this generator will receive formal written notification from SONI, for transmission connections, or the DSO for distribution connections, to advise of the revised FAQ and its effective date. The published "FAQ schedule", as referenced in the Connection Agreement, will be revised to reflect the change in FAQ.

Generator	110kV Node	MEC	2011 FAQ	2012 FAQ	2013 FAQ	2014 FAQ	2015 FAQ	2016 FAQ	NOTES
Gen 1	X	20	0	0	20	20	20	20	New circuit provides capacity from 2013
Gen 2	Y	30	-	0	0	0	30	30	Circuit uprate provides capacity from 2015

Figure 11: Example of ITC Results Output for each generator

110kV NODE	MECs of existing Generators	FAQ of existing Generators	Available FAQ
A	52	30	0
B	25	20	0
C	10	10	0
D	10	10	20
E	0	0	20

Figure 12: Results of ITC analysis for each 110kV node

5.10 Indicative Results of 2012 & 2016 ITC studies

Appendix E presents the indicative results from the ITC analysis conducted for 2012 and 2016. The values relate solely to the scheduled firm access available per node for an individual year. These results are indicative and on approval on the final ITC methodology SONI shall perform final studies for these years. Please note that SONI or NIE are not responsible for use of any data contained in this paper.

6 Generator Output Reductions

Generator output reductions occur when a controllable generator is dispatched down to a quantity less than the market schedule dispatch. Different specific circumstances will determine whether a generator's output will be reduced due to network limitations or to maintain system integrity. The fact that a generator may have firm transmission access does not mean that it cannot experience generation output reductions at times.

As discussed earlier in the document, in addition to providing generators with information on available transmission system access, by using the ITC model to calculate FAQs, it is also intended to provide information to new and existing generators on the possible level of generator output reductions at each node, over a number of years. This section of the document outlines why generator output reductions occur on the NI network and how SONI propose that modeling will be conducted to determine the likelihood of these occurring in future years, under a range of demand and generation scenarios.

The production of a report containing analysis of likely generator output reductions will provide potential new generators with an estimate of the network limitations (constraints) and system limitations (curtailment) that they may encounter in future years. SONI shall publish the results of the studies in a report and this report will be revised annually and additional years will be added as appropriate. Where possible the report will follow guidelines that have been published by the SEM committee in "Principles of Dispatch and the Design of the Market Schedule in the Trading and Settlement Code (SEM Committee Decision Paper 26th August 2011 SEM-11-062). The methodology applied to analyse generator output reductions can be found in Section 7 of this document. It should be noted that the analysis undertaken will relate only to transmission restrictions. SONI is not responsible for constraints that may occur due to limitations on the distribution system. The information used to compile the report shall be derived from SONI's own data and from data received from the TO. Whilst every effort will be taken in the preparation of this data to ensure accuracy, SONI or NIE will not be responsible for any loss that may be attributed to the use of this information.

6.1 *Why Generation Output Reductions occur*

When we refer to generator output reductions that can occur we are referring to the possibility that a generator may not be dispatched as per the schedule dispatch but instead actual output is reduced in response to system conditions. For the purposes of this modelling exercise SONI refer to constraints that result from network limitation and curtailment that results from system limitations. For overall reductions these are summed.

In the SEM generators bid into the market and are dispatched in such a way as to provide the most economical dispatch for the island. This dispatch is known as the Market Schedule, it is an unconstrained dispatch and it takes no account of system conditions that must be met. Following the preparation of the merit order list of generators to be dispatched, the TSOs must actually dispatch generators to meet various obligations and operate a safe, secure and reliable electricity system. The obligations include, for example, frequency control, provision of reserve, voltage control and inertia.

When the dispatch of a generator is changed in order to meet these obligations, this is known as 'Curtailment'. The difference between the merit-order dispatch quantity as per the market schedule and the actual dispatch as advised by the System Operator is the curtailment quantity.

Changes to generator output due to transmission network limitations, specifically the overloading of transmission lines, cables and transformers are known as 'Constraints'. In this case the generator may be dispatched from an economical point of view in the market but the network physically cannot facilitate that dispatch and the output of the unit must be reduced. Constraints are location specific and can be reduced by transmission network reinforcements. Some transmission constraints might only exist temporarily due to transmission lines being taken out of service for maintenance or uprating. For the purposes of the studies maintenance outages on any part of the network are not considered and an intact system is utilised so as to identify where long-term network constraints exist.

6.2 *Key drivers on the NI System*

Northern Ireland has a small transmission system with a maximum demand of circa 1900MW and a minimum demand of 500MW. By 2012 NI installed wind capacity will be approximately 400MW. The transmission system in also connected to RoI and Scotland. It is readily apparent that operational difficulties will become more prominent in the forthcoming years as connected generation increases. In theory, a windy summer night could see almost the entire indigenous load met by wind generation. In addition, the NI transmission network is now nearing its operational and capacity limits with multiple generators connected at weaker parts of the network. The transmission system is predominantly strong in the east of NI, where around two thirds of the demand is located. In the less densely populated north and west, the current transmission system was not designed to accommodate the now anticipated levels of generation, and in particular the operating rules that SONI must adopt to ensure safe, secure and economic operation of the system.

The connection of wind generation in the North and West of Northern Ireland has resulted in occasions where wind generation has had to be reduced due to network limitations and also due to operational rules. Generator output reductions will continue to grow if generation connections continue at a faster pace than network development.

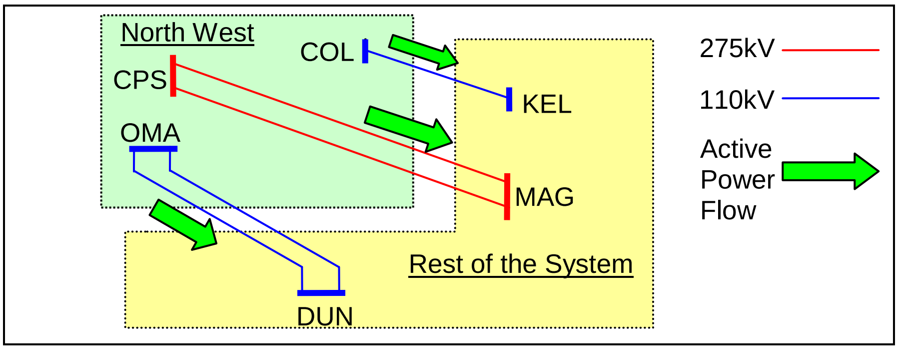


Figure 13: Power Flow from the North West of the NI System.

6.3 Why generation output must be reduced

For an increasing proportion of the time the North and West of the NI system will have excess generation. Figure 13 above highlights the active power flow from the North West of the system through five circuits to the rest of the NI power system. Currently 90% (335MW) of the connected wind generation is located within the North West region of NI. The most severe (N-1) outage contingency for the Northern Ireland system would be the loss of the Coolkeeragh to Magherafelt 275kV double circuit. In the event of the loss of this line along with high wind levels, the remaining 110kVs lines would overload and power supply to the NW of Northern Ireland would be disrupted. It is for this reason that power flows need to be managed prior to an unexpected line outage that could lead to power disruptions. Map C.3 in appendix C shows how the NI Transmission system will be developed by the end of 2011. Major developments over the next number of years will include wind farm clusters being constructed at Killymallaght and Magherakeel. The map shows the locations of connected and proposed wind farms in NI, which is predominantly in the NW.

6.4 Aim of Analysis

The TSO intends to produce an annual report and make it available to all new and existing generators detailing the likely incidents of curtailment and constraints on the NI transmission system, by node. The data will provide estimates of output reductions in the current year and in future years. The provision of this data will allow existing generators and potential connecting generators to see the impact that planned upgrades to the network will have on constraints. An example of this is shown in the results table in Section 7.6, when a transmission reinforcement is completed in 2016 this removes the particular constraint at this node. The TSO proposes that the annual report shall be made available on its website and the most up to date copy shall also be provided to generators connecting to the transmission and distribution system along with their connection offer.

7 Generator Output Reductions Analysis

It is proposed that analysis will be done on a nodal basis to give all connecting generators an indication of likely generation reductions in the area where they are considering connecting.

As with any model, the assumptions on which the analysis is based are extremely important. The generator output analysis requires a number of assumptions to be made and these are discussed in turn below. It is intended that where possible assumptions used in the analysis will be consistent with those applied in ITC analysis, these assumptions are discussed in detail in Section 5 above therefore have not been repeated here.

7.1 Modelling Assumptions

1. Contingency Assumptions

A single contingency, N-1 shall be applied for the studies. N-1 covers the loss of any single item of generation or transmission equipment at any time. The most severe (N-1) outage contingency for the Northern Ireland system would be the loss of the Coolkeeragh to Magherafelt 275kV double circuit. In the event of this outage, and high wind levels, the remaining 110kV lines would overload and power supply to the NW of Northern Ireland would be disrupted.

2. Demand profile

Demand levels will be assumed to be the same as those used in the ITC analysis, these are based on SONI's forecast demand consistent with that used in other TSO studies such as generation capacities studies. It is important that the assumption used in the constraints and curtailment modelling are consistent, where possible, with the ITC modelling as the results will be used simultaneously by connecting generators.

3. Wind Assumptions

A historic wind profile will be used in the model. SONI shall analyse five years of previous wind levels and select the most suitable profile. For the purposes of the analysis wind generation is operating at 0.98 PF leading.

4. Generation assumptions

Conventional generation will be dispatched in the model based on the most economical dispatch. Coolkeeragh unit is assumed to be dispatched at 160MW as per the SPS which is in place for this generator. Wind is dispatched at various levels to produce a correlation between demand levels and maximum allowed wind levels.

5. Network assumption

The analysis will consider a number of load conditions in Summer, Winter and Autumn, applying the appropriate seasonal line ratings. The rationale for using these various scenarios is discussed in Section 5 of this document. The network models for each year of the study have been agreed with the TO and will be consistent with the network models used in the ITC analysis.

6. Transmission reinforcements

The timings of planned reinforcements and the details will be as per ITC analysis, details are provided in Appendix B. Studies are all based on an intact network, that is, transmission outages are not modelled.

7. Dispatch rules

The dispatch rule-set employed shall be based on the "Principles of Dispatch and the Design of the Market Schedule in the Trading & Settlement Code', published August 2011, (SEM-11-062). It is assumed that all NI wind generators >5MW are controllable and can therefore be instructed to reduce their output if required. When it is necessary to reduce wind generation output in a tie break situation the decision rules as determined by the SEM committee, following consultation of 26th August (SEM -11- 063), shall be applied where possible.

8. Interconnector assumption

Treatment of flows on the Moyle interconnector as well as the North-South tie-line, plus the additional two tie lines between NI and ROI, will be the same as in the ITC studies outlined in Section 5.

7.2 *Methodology for conducting analysis*

SONI has developed a model to conduct analysis of generator reductions (including constraint and curtailment) under various scenarios. This section describes in detail the current methodology which will be applied to provide results for each node on the transmissions system. These studies will be carried out for a number of years. A base year wind profile derived from historic profiles is used to produce future year wind profiles by uniformly scaling to the appropriate forecast installed wind capacity levels. Different specific circumstances will result in whether a generators output will be reduced due to network limitations (constraints) or to maintain system security (curtailment).

Constraint Studies

Load flow studies, using PSSE software are done using network models provided by the TO. These studies are carried out for Summer, Winter and Autumn and for a range of system load conditions for each of these seasons. These studies identify how much generation capacity can be connected in the NI network before a network overload occurs. The results of these studies are then plotted and correlated to determine a linear relationship between maximum renewable output and system load in each season. These equations are then input into the constraints model to calculate how much generation can be accommodated on the transmission network, excluding the Coolkeeragh – Magherafelt double circuit which is assumed unavailable, to export power. This capacity value allows the model to derive, for each half hour, how much renewable generation can be allowed on the system whilst maintaining a secure system.

SPS schemes are described in Section 5 above and the presence of these has allowed additional wind generation to be connected to the system. Using a historic wind profile a forecast of wind generation in each half hour of the entire year. In order to determine when constraints occur, the model examines in which half hour periods forecast wind levels exceeds allowable wind levels. If allowable renewable generation is always higher than forecast renewable generation then we would have a situation of zero constraints. The half hour periods when constraints are present are counted and these are presented in percentage terms. Most importantly the total MWh of constraints is also calculated, this value will allow interested parties to get a fuller picture of the total amount of constraints that can be expected on the system.

Curtailment Studies

Curtailment studies are carried out using the same approach as described above for constraints and using the same historic wind profiles and forecasted demand levels. These studies assume that at least three conventional generators will remain connected for system security reasons as per the TSO's operational rules. A curtailment will occur when forecasted wind output plus generation from the three conventional units, plus flows on the Moyle interconnector and the N-S tie line is higher than demand. As per the Facilitation of Renewables Study at www.eirgrid.com limits on instantaneous wind penetration plus imports are limited to 50% of all-island demand.

When a curtailment and a constraint are found to occur at the same time then the constraint takes precedence. If curtailment is greater than constraints] then wind generation will be reduced further in order to meet the system requirements. In the periods when it is necessary to reduce wind generation a decision has to be made as to which wind generators should have their output reduced. It is assumed in this study that, where possible, all wind generators share the reduction in output energy arising from curtailment on a pro-rata basis. This is based on the rules as set out in the paper "Principles of Dispatch and the Design of the Market Schedule in the Trading & Settlement Code" (SEM-11-062) prepared by the Regulatory Authorities[5]. Any SEM Committee decision following the current consultation on "Treatment of Price Taking generators in tie breaks in Dispatch in the Single Electricity Market and Associated Issues" will be applied to the analysis.

7.3 Generator output reductions report

Going forward SONI shall prepare and publish a report annually which will detail expected levels of constraints and curtailment for each node on the NI transmission system. SONI will provide a copy of the most recent report to all transmission connecting generators as part of their connection process. This report shall be forwarded by SONI to the DSO to be included with the distribution connected generator's Connection Offer. Connecting generators will sign this report as part of the connection process to acknowledge that it has been provided to them. The report shall also be published on the SONI website.

[5] This paper is available on www.allislandproject.org

7.4 Interpreting the results

The report detailing possible generator output reductions is intended to provide interested parties with best available estimates of forecast constraints and curtailment, however actual levels of curtailment and constraint may vary from those forecast in this report. The analysis is based on a large set of input assumptions, such as the amount of new wind generation connecting to the system, demand growth, wind profiles, dispatch rules, roll-out of transmission reinforcements, treatment of interconnection with Great Britain and treatment of ROI generation. As with any model especially one containing a large amount of variables, the actual outturn may differ from the predicted outturn.

7.5 Results of analysis

The generator output reduction report, which the TSO shall prepare and publish annually, will contain all the necessary details around the analysis that has been undertaken. Most importantly it shall set out the assumptions which have been used in the model. For each node a table in the format shown below will be presented to illustrate the findings from the analysis. The table will show for each node, how many units of energy will possibly be constrained and how much might be curtailed. It will identify where there is an overlap in constraints and curtailment. The table will provide data for future years so that it is clear if the constraints and curtailment situation at a particular node is expected to worsen or improve over coming years. The intention is that as the transmission system is reinforced that output reductions will be alleviated and that the percentage of constraints will decrease over time.

7.6 *Example of results table*

The table below shows how results might be presented for each node on the NI transmission system. The energy that must be reduced (GWhs) and the percentage of half hour time periods in which reductions occur are published.

SAMPLE SUBSTATION Generation Node									
Results	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Potential Energy (Gwh)	348	348	348	200	200	200	200	200	200
Constrained Energy (Gwh)	18	18	18	9	0	0	0	0	0
Curtailed Energy (Gwh)	19	19	19	10	10	10	10	10	10
Constrained & curtailed Energy (Gwh)	30	30	30	16	10	10	10	10	10
Curtailment (%)	5	5	5	2	1	1	1	1	1
Constrained (%)	5	5	5	2	0	0	0	0	0
Constraint & Curtailment (%)	9	9	9	4	1	1	1	1	1

Figure 14: Sample of ITC results table

Overlap in Curtailment & Constraints

Development of cluster reduces energy at this node

Network upgrade removes constraint

7.7 Results from indicative studies for 2012 and 2016

Appendix E presents the indicative results from the most recent analysis in Northern Ireland. Levels of Constraints and Curtailment are presented for two years 2012 and 2016. A combined level of total generator output reductions is also presented. Installed levels of generation have been provided by the DSO for Distributed connected generators (see Appendix A table (A.3)). Transmission connected generation levels have been provided by SONI. It was not possible for these indicative studies to use the updated dispatch rules as published by the SEM committee on 26th August 2011, for consultation given that work was almost complete. Therefore these indicative results have been based on the previous dispatch rules as set out in "Principles of Dispatch and the Design of the Market Schedule in the Trading & Settlement Code' (SEM-09-073).

8 Conclusions and Next Steps

Interested parties are invited to respond with comments on this paper outlining their views. In particular respondents should indicate their views on:

1. Whether the assumptions of the ITC methodology, as outlined in Section 5, which shall be applied to calculate a FAQ for each connecting generator are reasonable.
2. If it is reasonable that connecting generators will be added to the ITC analysis list in order of date of obtaining planning permission.
3. If a reasonable threshold for calculating FAQs for distribution generator connections is those connection points with an MEC of 5MW or more. Circumstances may require this to be reduced in future.
4. If the assumptions on which the Generator Output Reductions analysis shall be based are considered to be correct.

Please also include any additional comments or issues that you would like to be considered. We would encourage parties to respond as fully as possible by 5pm on Friday 25 November 2011 at the latest. Responses should be forwarded electronically to Gareth McLoughlin at gareth.mcloughlin@soni.ltd.uk. Please note that TSO intends to publish all responses to this paper on the website at www.soni.ltd.uk. Respondents who wish to have their response remain confidential should highlight this when submitting the response.

The system operators will hold an open workshop in relation to the ITC methodology and Analysis of generator Output reductions, at which SONI will present their paper, followed by a questions and answers session. The arrangements for this meeting will be notified separately.

Appendix A: FAQs of Existing Generators

A.1 FAQ FOR EACH WIND GENERATOR IN NI

WIND FARM	110kV NODE	MEC (MW)	FAQ (MW)
RIGGED HILL	COLERAINE	5	5
CORKEY	BALLYMENA	5	5
ELLIOT'S HILL	LARNE	5	5
BESSEY BELL	OMAGH	5	5
OWENREAGH	STRABANE	5.5	5.5
LENDRUM'S BRIDGE 1	OMAGH	5.94	5.94
LENDRUM'S BRIDGE 2	OMAGH	7.26	7.26
ALTAHULLION	LIMAVADY	26	26
TAPPAGHAN	OMAGH	19.5	19.5
SNUGBOROUGH	AGHYOULE	13.5	13.5
CALLAGHEEN	ENNISKILLEN	16.9	16.9
LOUGH HILL	STRABANE	7.8	7.8
BIN MOUNTAIN	STRABANE	9	9
WOLF BOG	LARNE	10	10
SLIEVE RUSHEN	AGHYOULE	54	54
ALTAHULLION 2	LIMAVADY	11.7	11.7
BESSEY BELL 2	OMAGH	9	9
OWENREAGH 2	STRABANE	5.1	5.1
GARVES	COLERAINE	15	15
GRUIG	COLERAINE	25	250
SLIEVE DIVENA	OMAGH	30	30
TAPPAGHAN 2	OMAGH	9	9
CROCKAGARRON	DUNGANNON	15	15
HUNTER'S HILL	OMAGH	20	20
SCREGGAGH	OMAGH	20	20
CURRYFREE	LISAGHAMORE	15	15
SLIEVE KIRK	KILLYMALLAGHT	27.6	27.6

A.2 FAQ FOR EACH DISPATCHABLE GENERATOR IN NI

CONVENTIONAL GENERATOR UNIT	MEC (MW)	FAQ (MW)
BALLYLUMFORD UNIT 7	53	53
BALLYLUMFORD UNIT 8	53	53
BALLYLUMFORD CCGT 20	479	479
BALLYLUMFORD CCGT 10	98.4	98.4
BALLYLUMFORD UNIT 4	170	170
BALLYLUMFORD UNIT 5	170	170
BALLYLUMFORD UNIT 6	170	170
COOLKEERAGH GT 8	53	53
COOLKEERAGH C30	413	413
KILROOT GENERATING UNIT 1	240	240
KILROOT GENERATING UNIT 2	240	240
KILROOT GT 1	23.6	23.6
KILROOT GT2	23.6	23.6
KILROOT GT 3	42	42
KILROOT GT4	42	42
IPOWER AGU	21.6	21.6
CONTOUR GLOBAL	9	9

A.3 LIST OF GENERATORS CURRENTLY CONNECTED TO THE DISTRIBUTION SYSTEM IN NI

SCHEME NAME	MAXIMUM CAPACITY (MW)	110kV NODE
RIGGED HILL	5	COLERAINE
CORKEY	5	BALLYMENA
ELLIOT'S HILL	5	LARNE
BESSEY BELL	5	OMAGH
OWENREAGH	5.5	STRABANE
LENDRUM'S BRIDGE 1	5.94	OMAGH
LENDRUM'S BRIDGE 2	7.26	OMAGH
ALTAHULLION	26	LIMAVADY
TAPPAGHAN	19.5	OMAGH
SNUGBOROUGH	13.5	AGHYOULE
CALLAGHEEN	16.9	ENNISKILLEN
LOUGH HILL	7.8	STRABANE
BIN MOUNTAIN	9	STRABANE
WOLF BOG	10	LARNE
SLIEVE RUSHEN	54	AGHYOULE
ALTAHULLION 2	11.7	LIMAVADY
BESSEY BELL 2	9	OMAGH
OWENREAGH 2	5.1	STRABANE
GARVES	15	COLERAINE
GRUIG	25	COLERAINE
SLIEVE DIVENA	30	OMAGH
TAPPAGHAN 2	9	OMAGH
CROCKAGARRON	15	DUNGANNON
HUNTER'S HILL	20	OMAGH
SCREGGAGH	20	OMAGH
CURRYFREE	15	LISAGHAMORE
TOTAL	**370.2**	

A.4 LIST OF GENERATORS IN ORDER TO BE INPUT INTO THE ITC MODEL

SCHEME NAME	MAXIMUM CAPACITY (MW)	110kV NODE	DATE OF PLANNING PERMISSION
CRIGHSHANE	32.2	MAGHERAKEEL	02/05/2007
CHURCHILL	18.4	MAGHERAKEEL	02/05/2007
TULLYNAGEER	12.5	NEWRY	13/07/2007*
SLIEVE DIVENA 2	20	FALLAGHEARN	08/10/2007
THORNOG	10	MAGHERAKEEL	13/03/2008
LONG MOUNTAIN	27.6	LONG MOUNTAIN	02/07/2008
ALTAMOOSKIN	7.5	FALLAGHEARN	16/12/2008
CARRICKATANE	22.5	KILLYMALLAGHT	20/03/2009
GORTFINBAR	12.5	CREGGANCONROE	08/05/2009
TIEVENAMEENTA	37.5	MAGHERAKEEL	28/08/2009
GLENCONWAY	20	KILLYMALLAGHT	21/12/2009
CARN HILL	13.8	CARN HILL	12/02/2010
CREGGANCONROE	20.7	CREGGANCONROE	08/09/2010
CROCKDUN	12.5	CREGGANCONROE	13/09/2010
ALTAHULLION 3	30	ALTAHULLION	22/09/2010
DUNMORE	21	CAM	25/10/2010
INISHATIVE	13.8	CREGGANCONROE	12/11/2010
CROCKAGARRON EXT	3	DUNGANNON	08/12/2010
CORNAVARROW	36	DRUMQUIN	13/12/2010
PIGEON TOP	20.7	DRUMQUIN	13/12/2010
SEEGRONAN	18	MAGHERAKEEL	13/01/2011
DUNBEG	42	CAM	27/01/2011
ORA MORE	15	ENNISKILLEN	30/03/2011
CASTLECRAIG	25	DRUMQUIN	01/06/2011

* Planning approval in RoI

A.5 LIST OF GENERATORS WITH SPECIAL PROTECTION SCHEMES (SPS)

WIND FARM	110kV NODE	MEC (MW)	SPS	SPS (MW)
GRUIG	COLERAINE	25	**Y**	25
SLIEVE DIVENA	OMAGH	30	**Y**	30
TAPPAGHAN 2	OMAGH	9	**Y**	9
HUNTER'S HILL	OMAGH	20	**Y**	20
SCREGGAGH	OMAGH	20	**Y**	20
COOLKEERAGH			y	160
TOTALS (MW)		**355.2**		**104.0**

Appendix B: Transmission Reinforcements

B.1 LIST OF TRANSMISSION NETWORK PROJECTS

Table B.1 below lists the transmission network projects anticipated to occur over the next seven years, in line with SONI's Transmission Seven Year Statement. The projects can be seen geographically in map C.2 in Appendix C.

B.1 ASSUMED DATE OF COMMISSION OF TRANSMISSION NETWORK PROJECTS

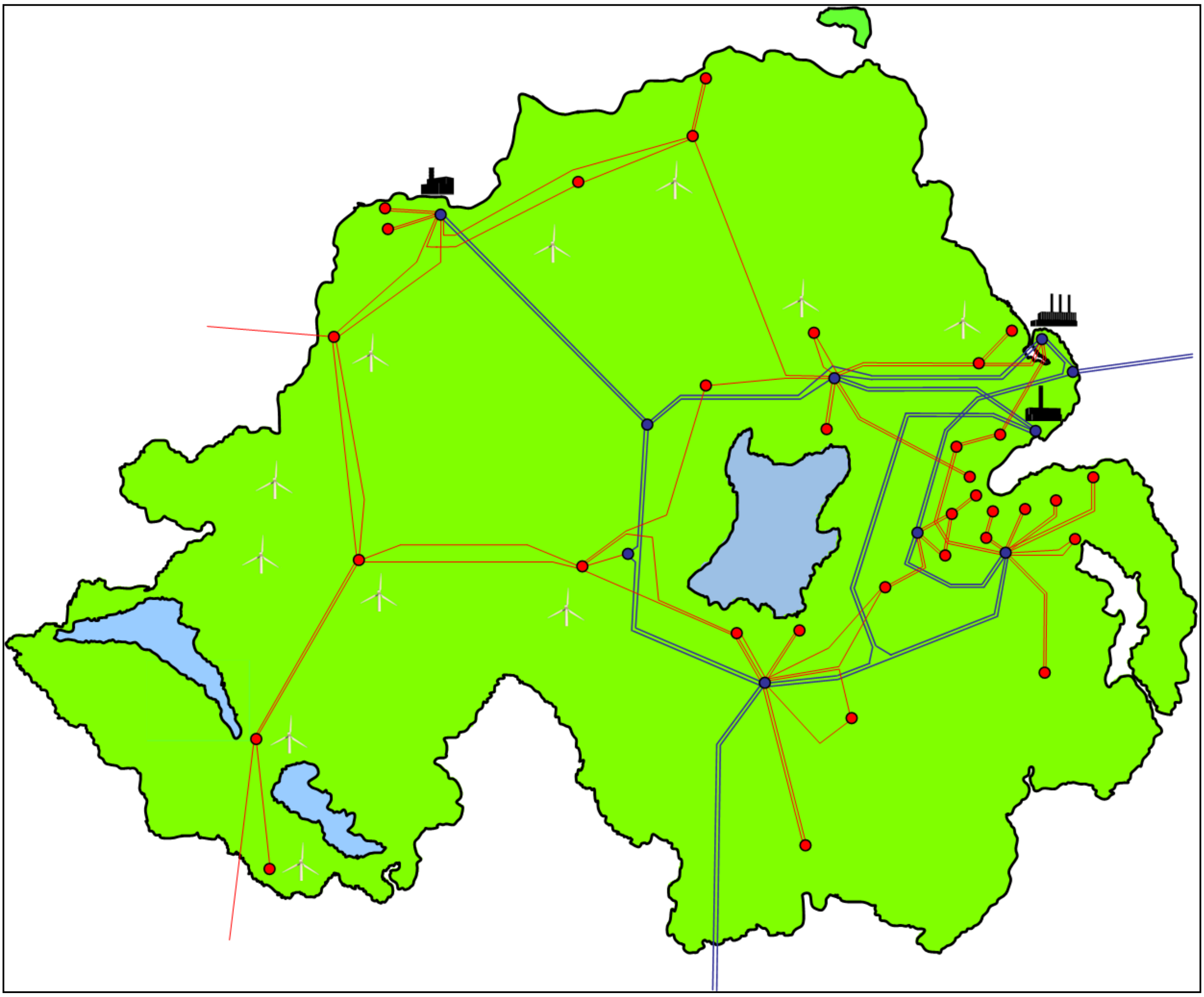
YEAR	NETWORK REINFORCEMENTS	
2011	1	KILLYMALLAGHT WIND FARM CLUSTER
2012	2	MAGHERAKEEL WIND FARM CLUSTER
	3	OMAGH – DUNGANNON 110kV CIRCUITS 1 &2 UPRATE TO 190/210MVA
2013	4	KELLS - COLERAINE 110kV CIRCUIT UPRATE TO 190/210MVA – PHASE 1
	5	BALLYLUMFORD - EDEN 110kV CIRCUITS 1 & 2 UPRATE TO 190/210MVA
	6	REACTIVE COMPENSATION AT CASTLEREAGH, COOLKEERAGH AND TANDRAGEE
2014	7	KELLS - COLERAINE 110kV CIRCUIT UPRATE TO 190/210MVA – PHASE 2
	8	FALLAGHEARN WIND FARM CLUSTER
	9	OMAGH – DUNGANNON 110kV CIRCUIT 3
	10	EDEN - CARNMONEY 110k V CIRCUITS 1 & 2 UPRATE TO 190/210MVA
	11	TAMNAMORE 275/110kV SUBSTATION PHASE 2
	12	CREGGANCONROE WIND FARM CLUSTER
2015	13	ALTAHULLION WIND FARM CLUSTER
	14	LONG MOUNTAIN WIND FARM CLUSTER
2016	15	KELLS - COLERAINE 110kV CIRCUIT UPRATE TO 190/210MVA – PHASE 3
	16	COOLKEERAGH - MAGHERAFELT 275kV DOUBLE CIRCUIT UPRATE TO 1000/1200MVA
	17	COLERAINE - LIMAVADY - COOLKEERAGH 110kV CIRCUIT UPRATE TO 190/210MVA
	18	ENNISKILLEN - OMAGH 110kV DOUBLE CIRCUIT UPRATE TO 109/124MVA
	19	CAM WIND FARM CLUSTER
	20	DRUMQUIN WIND FARM CLUSTER
2017	21	LISBURN - HANNAHSTOWN 110kV CIRCUITS 1 & 2 UPRATE TO 144/166MVA
	22	TURLEENAN - WOODLAND 400kV TIE LINE
2018	23	BROCKABHOY WIND FARM CLUSTER
	24	DERRYGONNOLLEY WIND FARM CLUSTER

Table B.1: Assumed Date of Commission of Transmission Network Projects

Appendix C: NI Network Maps

C.1 EXISTING NORTHERN IRELAND NETWORK

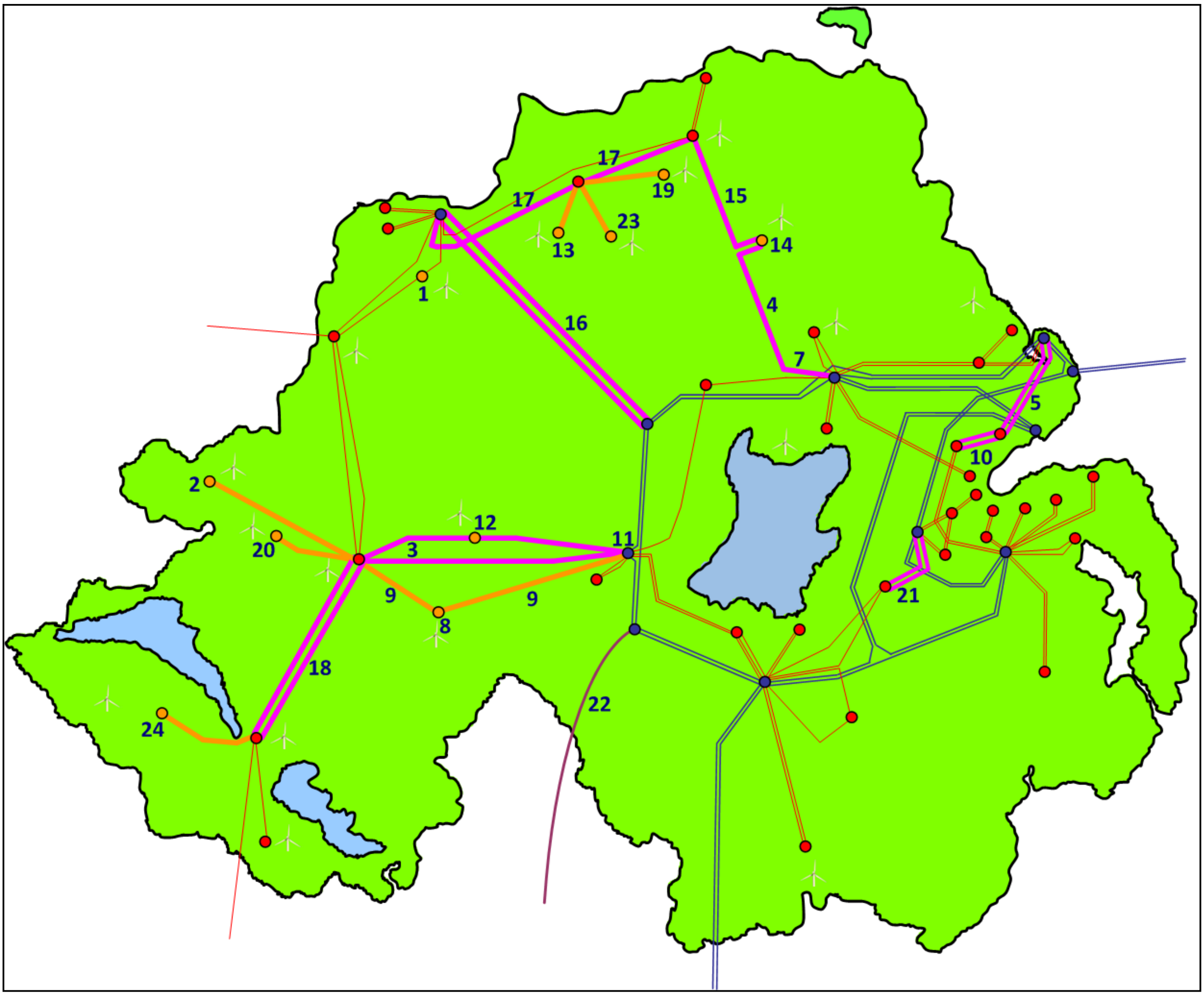
Map C.1 below shows the Northern Ireland transmission network as it exists at the start of 2011.



Map C.1: NI Transmission Network 2011

C.2 NORTHERN IRELAND NETWORK WITH TRANSMISSION NETWORK PROJECTS

Map C.2 below shows what areas of the network are developed over the next seven years, in accordance with NIE's Transmission Investment Plan. The numbers correspond with the projects listed in table B.1 in Appendix B.

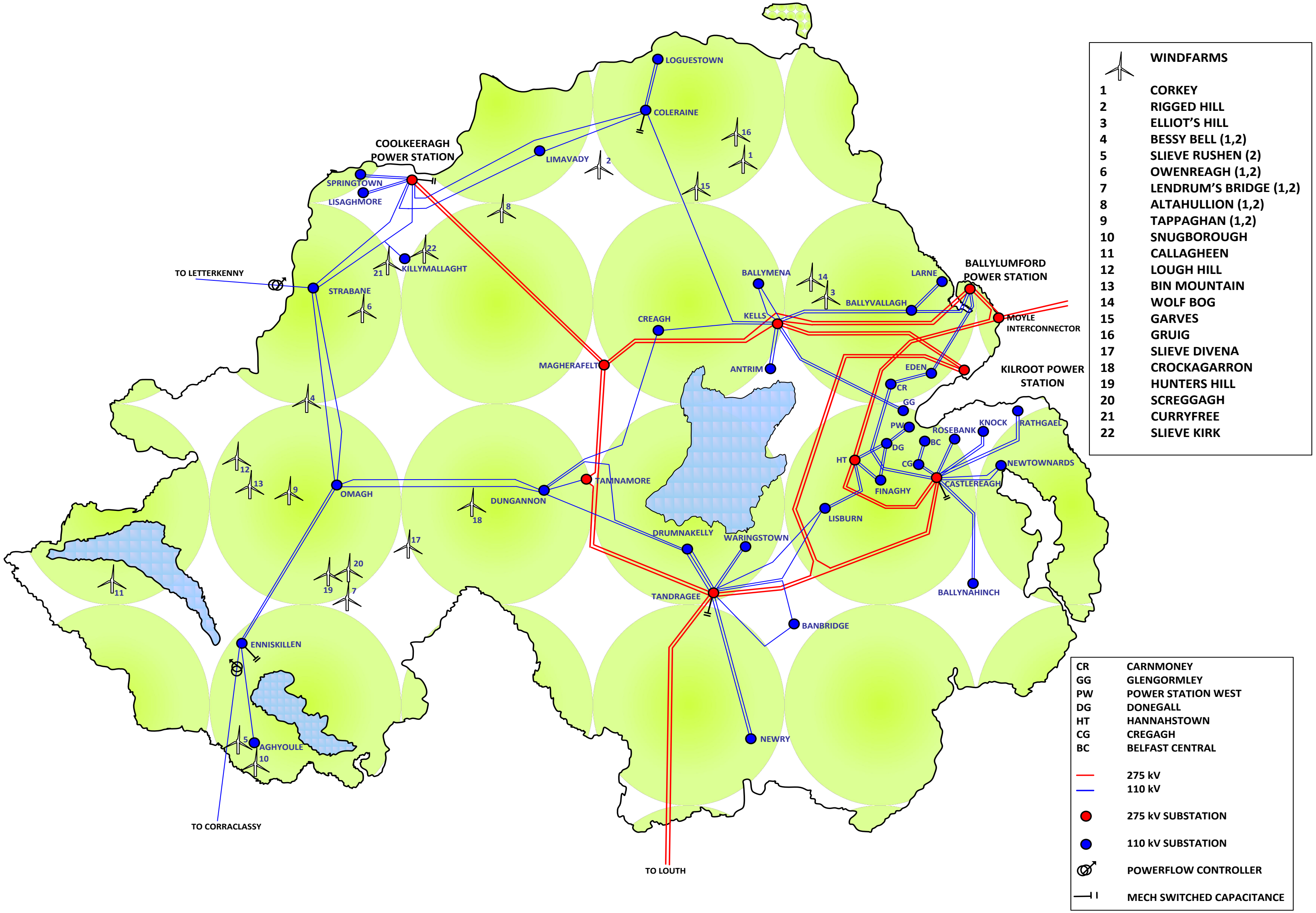


Map C.2: NI Transmission Network Showing Projects

SYMBOL	DESCRIPTION
(orange circle with orange line)	NEW WIND FARM CLUSTER
(pink line)	TRANSMISSION CIRCUIT UPRATING
(purple line)	NEW 400kV NORTH SOUTH TIE LINE

Figure C.1: Symbols Used in Geographical Map

Map C.3: Approved NI transmission system Winter 2011/2012



Appendix D: Conventional & Other Generation

D.1 EXISTING NORTHERN IRELAND DISPATCHABLE GENERATION

	Capacities (MW Sent out)						
UNIT	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
BALLYLUMFORD ST 4	170	170	170	170	170	N/A	N/A
BALLYLUMFORD ST 5	170	170	170	170	170	N/A	N/A
BALLYLUMFORD ST 6	170	170	170	170	170	N/A	N/A
BALLYLUMFORD CCGT B31	245	245	245	245	245	245	245
BALLYLUMFORD CCGT B32	245	245	245	245	245	245	245
BALLYLUMFORD CCGT 10	97	97	97	97	97	97	97
BALLYLUMFORD GT 7	58	58	58	58	58	58	58
BALLYLUMFORD GT 8	58	58	58	58	58	58	58
KILROOT ST 1	238	238	238	238	238	238	238
KILROOT ST 2	238	238	238	238	238	238	238
KILROOT GT 1	29	29	29	29	29	29	29
KILROOT GT 2	29	29	29	29	29	29	29
KILROOT GT 3	42	42	42	42	42	42	42
KILROOT GT 4	42	42	42	42	42	42	42
COOLKEERAGH GT 8	53	53	53	53	53	53	53
COOLKEERAGH CCGT	402	402	402	402	402	402	402
IPOWER AGU	22	22	22	22	22	22	22
CONTOUR GLOBAL CGC3	3	3	3	3	3	3	3
CONTOUR GLOBAL CGC4	3	3	3	3	3	3	3
CONTOUR GLOBAL CGC5	3	3	3	3	3	3	3

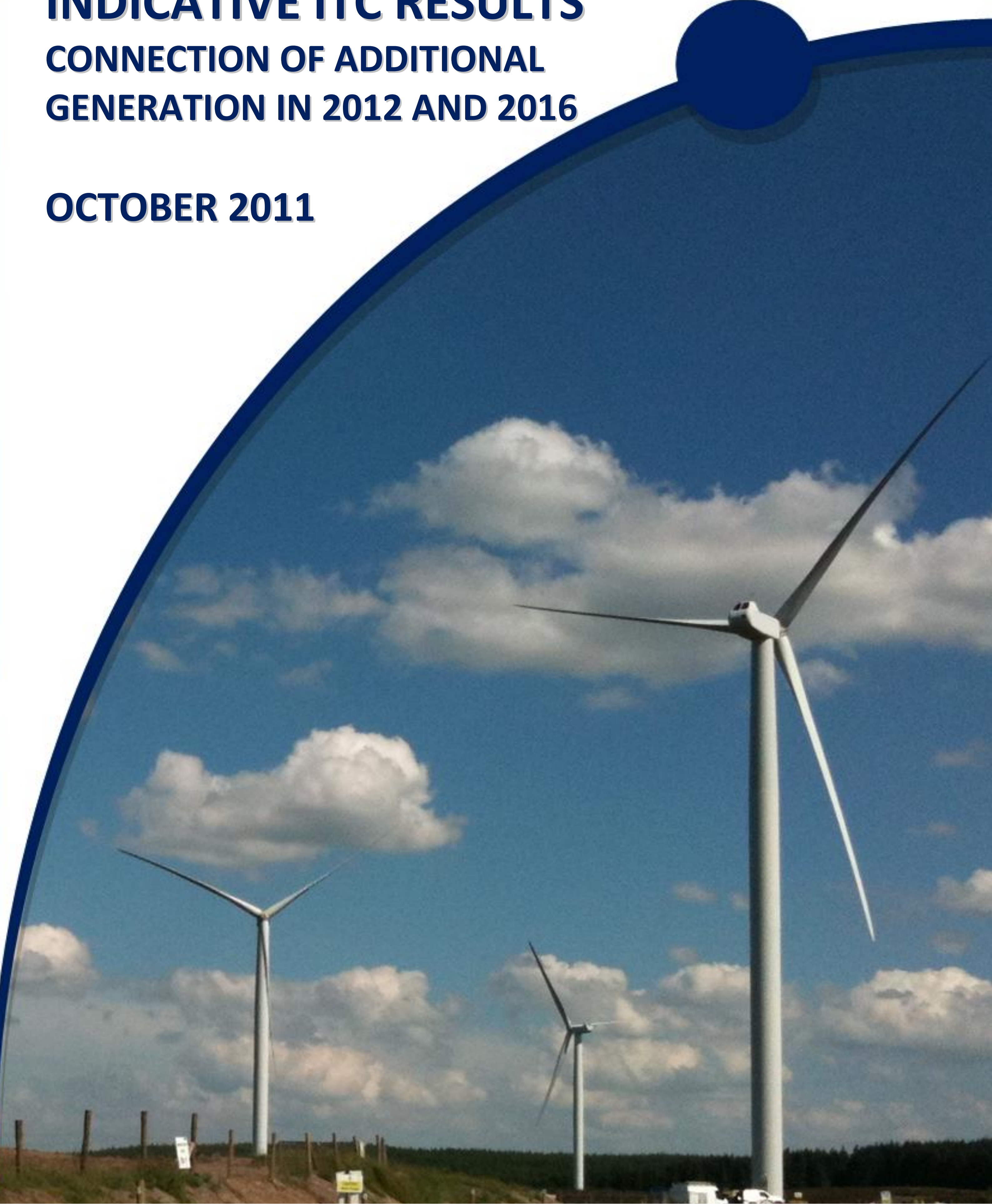
Appendix E: Indicative Results of ITC Analysis for 2012 & 2016

System Operator for Northern Ireland

INDICATIVE ITC RESULTS

CONNECTION OF ADDITIONAL GENERATION IN 2012 AND 2016

OCTOBER 2011



1 2012

1.1 NETWORK DEVELOPMENTS IN 2012

DEVELOPMENT		NOTES
1	MAGHERAKEEL WIND FARM CLUSTER	Wind farm cluster, connecting into 110kV substation at Omagh.
2	OMAGH - DUNGANNON CIRCUITS	Uprating of the existing 110kV A and B circuits between Omagh and Dungannon to 186/193 MVA.[6]

Table 1.1: List of NI Network Reinforcements in 2012

Figure 1.1: Map of NI Network Reinforcements in 2012

[6] These circuits will initially be limited to a continuous rating of 150MVA, due to the rating of switchgear at Dungannon. Once Tamnamore Phase 2 is completed in 2014, these circuits will have this limitation removed.

1.2 RESULTS FOR 2012 ITC RUN

	WIND FARMS	MEC	SUMMER MAX	SUMMER MIN	AUTUMN MAX	WINTER MAX	FAQ
-	GRUIG	25	25	25	25	25	25
-	SLIEVE DIVENA	30	30	30	30	30	30
-	TAPPAGHAN 2	9	9	9	9	9	9
-	HUNTERS HILL	20	20	20	20	20	20
-	SCREGGAGH	20	20	20	20	20	20
-	CURRYFREE	15	15	15	20	20	15
-	SLIEVE KIRK	27.6	27.6	27.6	27.6	27.6	27.6
1	GLENBUCK	3	3	3	3	3	3
2	CRIGHSHANE	32.2	32.2	0	32.2	32.2	0
3	CHURCH HILL	18.4	18.4	0	18.4	18.4	0
4	TULLYNAGEER	12.5	12.5	12.5	12.5	12.5	12.5
5	SLIEVE DIVENA 2	20	20	0	20	20	0
6	THORNOG	10	10	0	10	10	0
7	LONG MOUNTAIN	27.6	27.6	0	27.6	27.6	0
8	ALTAMOOSKIN	7.5	7.5	0	7.5	7.5	0
9	CARRICKATANE	22.5	18	0	22.5	22.5	0
10	GORTFINBAR	12.5	3	0	12.5	12.5	0
11	BALLYREAGH, TEMPO	2.5	2.5	2.5	2.5	2.5	2.5
12	TIEVENAMEENTA	37.5	0	0	15	25	0
13	GLENCONWAY	20	0	0	0	0	0
14	CARN HILL	13.8	13.8	13.8	13.8	13.8	13.8
15	CREGGANCONROE	20.7	0	0	0	0	0
16	CROCKDUN	12.5	0	0	0	0	0
17	ALTAHULLION 3	30	0	0	0	0	0
18	DUNMORE	21	0	0	0	0	0
19	INISHATIVE	13.8	0	0	0	0	0
20	CROCKAGARRAN EXT	3	3	3	3	3	3
21	MULLYNAVEAGH	4.6	4.6	4.6	4.6	4.6	4.6
22	CORNAVARROW	36	0	0	0	0	0
23	PIGEON TOP	20.7	0	0	0	0	0
24	SEEGRONAN	18	0	0	0	0	0
25	DUNBEG	42	0	0	0	0	0
26	ORA MORE	15	0	0	0	0	0
27	CASTLECRAIG	25	0	0	0	0	0
28	GLENBUCK 2	6.9	0	0	0	0	0
TOTAL			573.9	437.2	602.9	612.9	437.2

Table 1.2: ITC Results for 2012

2 2016

2.1 NETWORK DEVELOPMENTS IN 2016

DEVELOPMENT		NOTES
1	COOLKEERAGH-MAGHERAFELT	Uprating of the existing 275kV double circuit between Coolkeeragh and Magherafelt to 1000 MVA.
2	NORTH-WEST 110kV CIRCUITS	Uprating of existing 110kV circuit from Coolkeeragh-Limavady-Coleraine to 190/210 MVA.
3	ENNISKILLEN - OMAGH CIRCUITS	Uprating of the existing 110kV A and B circuits between Enniskillen and Omagh to 109/124 MVA.
4	CAM WIND CLUSTER	Wind farm cluster, connecting into existing 110kV substation at Limavady.
5	DRUMQUIN WIND CLUSTER	Wind farm cluster, connecting into existing 110kV substation at Omagh.

Table 2.1: List of NI Network Reinforcements in 2016

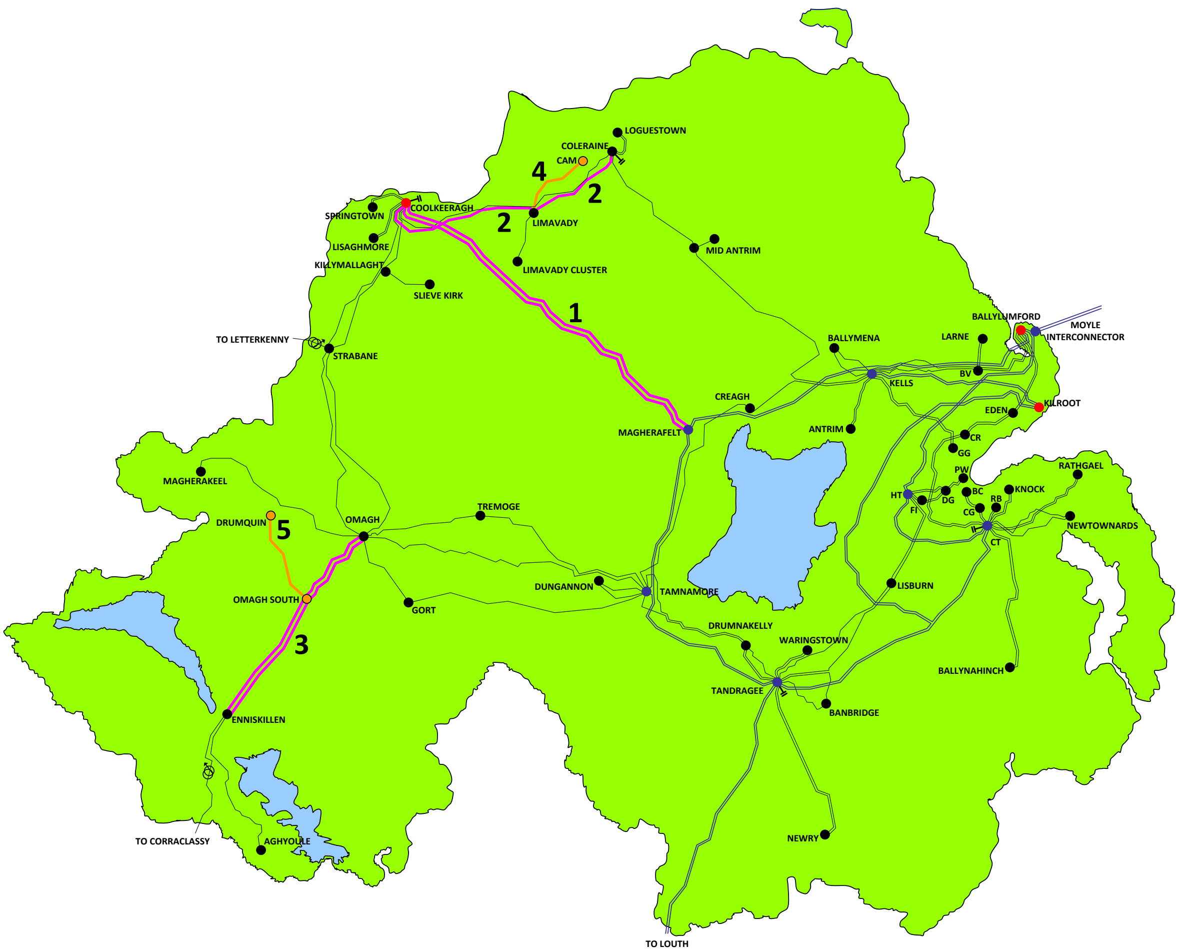


Figure 2.1: Map of NI Network Reinforcements in 2016

2.2 RESULTS FOR 2016 ITC RUN

	WIND FARMS	MEC	SUMMER MAX	SUMMER MIN	AUTUMN MAX	WINTER MAX	FAQ
1	GLENBUCK	3	3	3	3	3	3
2	CRIGHSHANE	32.2	32.2	32.2	32.2	32.2	32.2
3	CHURCH HILL	18.4	18.4	18.4	18.4	18.4	18.4
4	TULLYNAGEER	12.5	12.5	12.5	12.5	12.5	12.5
5	SLIEVE DIVENA 2	20	20	20	20	20	20
6	THORNOG	10	10	10	10	10	10
7	LONG MOUNTAIN	27.6	27.6	27.6	27.6	27.6	27.6
8	ALTAMOOSKIN	7.5	7.5	7.5	7.5	7.5	7.5
9	CARRICKATANE	22.5	22.5	22.5	22.5	22.5	22.5
10	GORTFINBAR	12.5	12.5	12.5	12.5	12.5	12.5
11	BALLYREAGH, TEMPO	2.5	2.5	2.5	2.5	2.5	2.5
12	TIEVENAMEENTA	37.5	37.5	37.5	37.5	37.5	37.5
13	GLENCONWAY	20	20	20	20	20	20
14	CARN HILL	13.8	13.8	13.8	13.8	13.8	13.8
15	CREGGANCONROE	20.7	20.7	20.7	20.7	20.7	20.7
16	CROCKDUN	12.5	12.5	12.5	12.5	12.5	12.5
17	ALTAHULLION 3	30	30	30	30	30	30
18	DUNMORE	21	21	12	12	21	12
19	INISHATIVE	13.8	13.8	0	13.8	13.8	0
20	CROCKAGARRAN EXT	3	3	3	3	3	3
21	MULLYNAVEAGH	4.6	4.6	4.6	4.6	4.6	4.6
22	CORNAVARROW	36	36	0	36	36	0
23	PIGEON TOP	20.7	20.7	0	20.7	20.7	0
24	SEEGRONAN	18	18	0	18	18	0
25	DUNBEG	42	42	0	42	42	0
26	ORA MORE	15	15	0	15	15	0
27	CASTLECRAIG	25	0	0	25	25	0
28	GLENBUCK 2	6.9	6.9	6.9	6.9	6.9	6.9

TOTAL	882	727.5	907	907	727.5

Table 2.2: ITC Results for 2016

Appendix F: Indicative Results of Generator Output Reductions for 2012 & 2016