DS3 Joint Grid Code Working Group Position Paper on RoCoF
September 2012

1 Purpose

This document sets out the current position as understood by EirGrid and SONI in relation to the rate of change of frequency (RoCoF) levels that may need to be managed in the future operation of the All-Island Power System. The potential RoCoF levels expected are based on the results of the Facilitation of Renewables (FOR)[1] report published in 2010 and are also available in the previous RoCoF discussion paper presented to the Advisory Council at the February 2012 meeting.

2 Background

EirGrid and SONI, the Transmission System Operators (TSOs) in Ireland and Northern Ireland have a responsibility to operate the power system in a secure, safe and reliable manner. Detailed technical studies have indicated that, during times of high wind generation following the loss of the single largest credible contingency, (RoCoF) values of greater than 0.5Hz/s could be experienced on the island power system. In addition, studies have shown that RoCoF values in excess of 2 Hz/s could be experienced in Northern Ireland if system separation were to occur on the island. Simulations show that for a voltage dip induced power imbalance in a system with significant volumes of windfarms, RoCoF values far in excess of 2Hz/s can occur.

The current RoCoF capability required of all units in Ireland is 0.5 Hz/s and is set out in the Irish Grid Code clause CC7.3.1.1 (d). There is a RoCoF requirement of up to 1.5 Hz/s on all transmission connected plant in Northern Ireland which has connected since 2001. This requirement is set out in the minimum functional specification which is provided to all plant at the connection offer stage.

With increasing penetrations of wind generation, it is essential to ensure that the power system can operate securely following the largest credible single contingencies. Therefore, either all units should materially ride through RoCoF in the range of 1 – 2 Hz/s or other means must be found to ensure RoCoF does not exceed 0.5 Hz/s with increasing levels of non synchronous generation. The latter could be achieved by retaining sufficient synchronous inertia connected to the system. It is possible that the solution may require elements of both approaches combined with improvements in system operator tools to manage the increased risks to the system.

3 Increasing the RoCoF Standard

Higher levels of non synchronous generation will result in increased RoCoF values on the power system. To ensure the secure operation of the power system at these higher non synchronous generation levels, the TSOs in conjunction with industry are investigating the possibility of setting a higher RoCoF standard in the Grid Codes and Distribution Codes.
To that end, to ensure the necessary input, the TSOs have established industry, Grid Code and TSO-DSO working groups. There have been several meetings over the past few months and this has resulted in the following positions being established:

[1] "Facilitation of Renewables", EirGrid-SONI June 2010

3.1 Conventional Plant

Owners of conventional plant have performed a high level desktop analysis of is the work required to determine if their generation could ride through higher RoCoF levels. The generator owners have expressed the following concerns/positions:

- Some generator owners on the Island have stated that they cannot support any changes to the Grid Code in relation to higher RoCoF values until a detailed review has been performed on their plant. For example, one particular concern is the risk of a potential catastrophic failure of plant leading to issues for site safety.

- Generators have identified two categories of risk as the potential consequences of increasing the RoCoF levels:
    - The first category may be described as operational consequences where a unit either fails to deliver the required response during a RoCoF event or trips, leading to loss of further electrical power from the system. This has the potential to initiate further cascade tripping events, leading to load shedding, system islanding or system blackouts.
    - The second category can be described as mechanical integrity issues. RoCoF events have the potential to result in reduced component life, decreased overhaul intervals, increased inspection requirements or in the worst case catestrophic failure. This can result as a consequence of either a single event or cumulative damage caused by a series of such events. Potential exists for consequental machinery damage, plant forced outages and ultimately personnel injury. Likelihood and probability of such plant events cannot be determined without further analysis; it is noted that this is a function of the nature of the RoCoF events and the regularity of their occurrence.

- In order to determine how each of the risks detailed above will apply to specific plant, a detailed review and analysis, followed by validation and testing will need to be carried out for each plant. This review would need to cover the control, instrumentation, mechanical and electrical impacts. This is likely to require in the range 5-10 months to complete per generator. For some generator owners with large portfolios, there is a working assumption that this process will take up to 24 months to complete. Preliminary results might be achievable in 10 months if prioritization of generators for RoCoF investigation occurs.

- It is prudent that this review takes place in order to determine the impact (if any) of the higher RoCoF limits on the operation and integrity of each individual unit.

- There is no guarantee that units will be able to manage higher RoCoF values following this review and there may be a requirement for further investment at that stage.

- The cost of this analysis is significant and before proceeding, the generator owners would need clarity on the cost recovery mechanism for this work. Estimates range from EUR120K to EUR250K per unit and will take approximately ten months to complete (although this will extend to 24 months for a large plant portfolio).

Generator owners require substantial resources to investigate the RoCoF issue and until such time as this review is completed, the generator owners would not support any changes to the Grid Codes. This could take up to 24 months to complete following a cost recovery mechanism approval.

3.2 Wind farm Power Stations

Due to the inherent design differences in wind farm power stations (non-synchronous generation), the wind farm owner representatives have confirmed that:

- All wind farms are capable of riding through RoCoF values of at least 1 Hz/s and in some cases as high as 4 Hz/s.
- There are some concerns that a small number of windfarms have certain protection settings which may cause tripping at lower RoCoF values. This needs further investigation but this should not require too much resourcing to resolve.
- The loss of mains protection used in Northern Ireland is predominately vector shift. This may mitigate to some extent the issue of RoCoF protection leading to cascade tripping, but needs further investigation, and will be considered as part of a study into these issues by NIE.

Wind farm owner representatives do not believe there is any fundamental issue with riding through RoCoF values in the range of 1-2 Hz/s and would support such a change. However, an examination of the wind farm internal settings and protection settings is required before implementation.

3.3 Distribution System Operators

The Distribution System Operators (DSOs) of Ireland and Northern Ireland ensure that loss of mains protection is installed on distributed generation in order to protect against islanding. To do this, protection standards have been adopted on all embedded generation in both networks. This raises the following issues:

- The G10 and G59 standards have been set on a consideration of many factors and any changes to these need to be well understood.
- Loss of mains protection can employ either RoCoF or vector shift. The majority of customers in Northern Ireland use vector shift as opposed to RoCoF to detect frequency changes. Customers connected to the distribution network in Ireland primarily use RoCoF relays and these are set to operate at 0.4 Hz/s. The settings of these protection relays will need to be modified to reflect any change to the RoCoF standard in the relevant Code.
- The ownership and responsibility for G59 relays in Northern Ireland is with the distribution connected generator. Future modifications to G59 relays will have to be completed by the generator at the request of the DSO.

- There are different risks to be managed on the distribution system which are dependent on network topology and generator type. All these factors need appropriate consideration before any changes.

The DSOs are producing reports on the status of their Loss of Mains (LoM) protection settings and capabilities. This will clarify the current type and settings of LoM protection used and provide a scope of work required to meet an increased RoCoF capability.

3.4 Transmission System Operators

Following the concerns outlined above by conventional generator owners, and in order to maintain system security and minimise the risks to frequency stability, the TSOs have the following views:

- The TSOs will continue to operate the power system with the current system non-synchronous penetration level of 50%. Other approaches in terms of managing the RoCoF issue will be investigated and are outlined in Section 4.
- EirGrid will proceed with a recommendation to the next Grid Code Review Panel to redefine the current RoCoF standard in the Ireland Grid Code with a view to increasing it from 0.5 Hz/s to 1 Hz/s based on a rolling measurement over 500ms.
- While system separation remains a threat, a standard of 2Hz/s will be sought by the TSOs for Northern Ireland, and remain until such time as further North-South tie-lines are constructed.
- The TSOs are concerned that the current timelines as expressed by the conventional generator owners will have an adverse affect on the wind industry in Ireland and Northern Ireland. The TSOs will continue to engage with industry and the regulatory authorities on this issue.

EirGrid and SONI cannot increase the system non-synchronous penetration level beyond the current level of 50% until either the required RoCoF level beyond 0.5 Hz/s is achievable by all plant or other approaches as outlined in section 4 have been investigated and are in place.

4 Other Approaches

Given the delays outlined above, the TSOs are now investigating the possibility of employing other approaches to help manage the RoCoF issues. This work is concentrated in the area of System Services and Control Centre Tools.

4.1 System Services

- The TSOs are consulting with conventional generator owners to investigate lowering minimum stable generation levels on the existing conventional plant portfolio. This will aid in the provision of the levels of synchronous inertia required on the system.

- As part of the DS3 System Services Review, the TSOs are investigating the development of new types of system services that will value the provision of inertia and the ability to provide fast acting dynamic response to system events.

4.2 Control Centre tools

- An all-island version of the Wind Security Assessment Tool (WSAT) is due to come into operation in September 2012. This will give power system controllers a better indication of potential issues when operating the system at high wind levels.
- It will soon be possible to monitor the inertia and SNSP of the power system in real-time in the Control Centres, by incorporating the calculation of these quantities into the existing Energy Management System (EMS). This will give the power system controllers a clearer picture of the state of the power system and how it behaves as synchronous inertia levels and SNSP change.
- It may be possible in the future to move to a dynamic SNSP calculation, where the allowable SNSP could be varied during different scenarios. This would need a considerable amount of further study before it could be deployed in the Control Centres, and would be unlikely to be in place before the end of 2013. Essentially, this would require a re-run of the Facilitation of Renewables study, but done in far greater detail.

EirGrid and SONI are investigating other options to address the operational challenges associated with RoCoF.

5 Implications for Wind farm Curtailment

It will not be possible to increase the SNSP limit beyond 50% unless the RoCoF capability of all generators can be increased, or an effective method of limiting RoCoF levels can be found. The potential outcome of this is increased curtailment levels on wind generation as more wind generation connects. It should be noted that SNSP is not the only factor affecting curtailment. Wind curtailment is also being affected by flat or declining system demand.