TSOs' Position Paper on RoCoF
May 2012

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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. These values can go beyond 0.8 Hz/s for the loss of the largest infeed on the island and to even greater levels for a voltage dip induced power imbalance from a system with significant volumes of windfarms. In addition, studies have shown that RoCoF values in the region of 1 - 2 Hz/s could be experienced if system separation were to occur on the island.

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 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[2] 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 potentially by providing system services payments. It is possible that the solution may require elements of both approaches combined with improvements in Control Centre tools to manage the increased risks to the system.

3 Increasing the RoCoF Standard

Higher levels of non-synchronous generation will potentially result in increased RoCoF values on the power system due to reduced system inertia. To ensure the secure operation of the power system at these higher non-synchronous generation levels, the TSOs in

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

[2] The exact RoCoF value is dependent on the time domain of measurement of the rate of change of frequency.

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. Through these groups, there has been substantial engagement over the past few months and this has resulted in the following positions being established:

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.
- This review would need to cover the control, instrumentation, mechanical and electrical impacts. This is likely to require 8-10 months to complete per generator. For some generator owners with large portfolios, there is a working assumption that this process will take up to thirty months to complete. Preliminary results might be achievable in 12-14 months if prioritization of generators for RoCoF investigation occurs.
- While there is no explicit evidence that the generators will experience a catastrophic failure, it is prudent that this review takes place. The generator owners believe it is possible that there may be an impact on generator lifespan and this needs to be quantified.
- 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 are from EUR250,000 per unit up to EUR10million 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 thirty months to complete following a cost recovery mechanism approval.

3.2 Windfarm Power Stations

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

- All windfarms are capable of riding through RoCoF values of at least 1 Hz/s and in some cases as high as 4Hz/s.
- There are some concerns on a small number of windfarms that certain protection settings may cause tripping at lower RoCoF values. This would need investigation but this should not require too much resourcing or time to resolve.

- The loss of mains protection used in Northern Ireland is predominately vector shift which mitigates to a large extent the issue of RoCoF protection leading to cascade tripping. However, the appropriate settings for vector shift to avoid routine network switching leading to tripping of localised wind farms needs further investigation.

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 and positions outlined above, in order to maintain system security and minimise the risks to frequency stability, the TSOs have the following views:

- 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.

- The TSOs will continue to operate the power system with the current system non-synchronous penetration (SNSP) level of 50% until such time as a satisfactory solution is achieved for managing the RoCoF challenge.
- The TSOs are investigating and considering other approaches other than that outlined in Section 3 to assist in managing the RoCoF issue. These other approaches are outlined in Section 4.

The TSOs cannot increase the system non-synchronous penetration level beyond the current level of 50% until a satisfactory solution for managing the RoCoF challenge is achieved.

3.5 Next Steps – Increasing the RoCoF Standard

The TSOs will proceed with a recommendation to the Grid Code Review Panel meetings to define a RoCoF standard in the range of 1 – 2 Hz/s[3].

4 Further Investigation

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 areas 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

[3] The exact RoCoF value to be incorporated in the Grid Codes is dependent on the time domain of measurement.

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 with a greater number of scenarios.

The TSOs are investigating other approaches to assist in addressing 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.