RoCoF Alternative & Complementary Solutions Project

Phase 2 Responses

8th of April 2016

EIRGRID SONI

Introduction

On the 22nd December 2015, the EirGrid Group published the “RoCoF Alternative & Complementary Solutions Project Phase 2 Study Report” along with a summary document “DS3 RoCoF Alternative Solutions Project Report Overview”. The report determined the volume of synchronous and/or synthetic inertia required to maintain Rate of Change of Frequency (RoCoF) at 0.5 Hz/s (measured over 500 ms) while allowing System Non-Synchronous Penetration (SNSP) levels to reach 75%. The report concludes that there are credible alternative solutions to the moving the RoCoF standard to 1 Hz/s (measured over 500 ms). Each solution has its own challenges and benefits.

Summary of Phase 2 responses

We received eleven responses from industry in relation to the report. Each response has been reviewed by the Transmission System Operators (TSOs). The report was well received by the majority of respondents. The revised report was updated to correct a third party reference in the original report.

Further studies and market investment signals

Several respondents expressed the view that the TSOs should continue to explore RoCoF alternative sources, particularly synthetic inertia functionality both before and after 2020. Respondents also suggest that associated market investment signals are provided for modification of existing and emerging technologies. As mentioned in the report, we believe that further analysis on alternative solutions to the RoCoF issue should only be performed if results from the primary RoCoF projects indicate that alternatives are required. However, through the Smart Grid Programme the TSOs are continuing to support a number of demonstration projects, some of which have the ability to provide synthetic inertia functionality. Further information on demonstration projects can be found on the EirGrid Group website. As mentioned, the analysis carried out as part of the RoCoF Alternatives Study should not be perceived as the commencement of a procurement process for synchronous or synthetic devices. Investment signals for existing industry participants and new technology developers will be delivered through the DS3 System Services project.

Additional specific industrial comments

This section provides specific industry comments relevant to the RoCoF Alternative Phase 2 project. Some of the comments have been reworded to combine a collection of comments with similar themes.

Industry comment: The studies within the report examine System Non Synchronous Penetration (SNSP) at 75%. Can the TSO confirm if this figure accounts for non-synchronous Small Scale Generation (SSG) and micro generation connected to the network?

TSO response: The techno-economic studies used to generate the study cases do consider small-scale generation in the SNSP metric.

Industry comment: Does the TSO believe that synchronous and/or synthetic inertia devices will be connected to the distribution system as part of the RoCoF alternatives project?

TSO response: At this early stage the TSO has not analysed the optimal geographical location for inertia devices and so cannot speculate on their point of connection.

Industry comment: The studies examine the required levels of inertia to maintain system RoCoF within 0.5Hz/s calculated over 500ms for 99% of the cases analysed. Have the studies examined the required levels of inertia to maintain system RoCoF within 0.5Hz/s calculated over 500ms in Northern Ireland in the case of system separation where it has been calculated that, in the absence of additional inertia, RoCoF may increase to 2Hz/s?

TSO response: The study assumes the second North-South Tie Line is installed and available, therefore, RoCoF will be maintained within 1 Hz/s (measured over 500 ms) on the all-island system. The study does not consider a 2 Hz/s RoCoF event on the island.

Industry comment: With regards to the last paragraph in section 2.4, if it is deemed that an inertial device causes an adverse effect on the distribution system then the Distribution System Operator DSO should have the right to amend the response of the device.

TSO response: At this early stage the TSO has not analysed the effect these devices would have on the distribution system.

Industry comment: How is the TSO planning to ensure that the droop settings are appropriate to avoid undesirable injection / absorption of active power following small frequency excursions on the electricity network?

TSO response: The report highlights some of the challenges with controlling the response of synthetic inertia devices. We believe that a TSO-lead project would be required to mitigate these risks if the alternative solutions were implemented. As part of a TSO-lead project the optimal injection / absorption of individual active power devices would need to be investigated in detail. As noted in the report a large penetration of devices with different droop characteristics may have system stability implications.

Industry comment: What assumptions have been made in the report?

TSO response: Section 3 of the report describes in detail the study assumptions and methodology.

Industry comment: Why have Moyle and EWIC been modelled without reflecting their static reserve responses?

TSO response: As discussed in section 3.2.7.1 the interconnector static reserve responses are disabled in the power system technical simulations. This assumption is based on the fact that the static responses could be within the synthetic inertia period and, therefore, could distort the system volume requirement proposed in the study. The volume of synthetic inertia obtained from the study therefore includes any static response that may be obtained from interconnectors.

Industry comment: The modelling needs to replicate the system as accurately as possible and that requires that all constraints should be included.

TSO response: The study uses a detailed power system model for dynamic simulations. This model has been validated against real system events. A techno-economic dispatch is used to provide the generation profile for the studies. The purpose of the paper is to investigate the use of different sources of inertia to restrict RoCoF in a system with high levels of SNSP. The inclusion of all existing system constraints as they are defined today would not allow for analysis of future scenarios with a higher SNSP and a lower system inertia.

Industry comment: The report highlights that there are 9% of cases which don't solve and that some of these are due to voltage levels outside limits. This is a serious concern but we assume that part of the reason is because the modelling does not reflect all the constraints and additional DS3 products. Attention should be drawn to the need to examine these cases in more detail.

TSO response: As detailed in section 3.2.5, the main factors for non-convergence include:

- Voltage issues due to the low number of generators dispatched and the geographic dispersion of generators.

- Several of the failed cases were due to wind approaching the limit of installed capacity. It should be noted that this study does not include all planned transmission reinforcements which would have resulted in convergence issues in some cases.

The study approach focuses on determining the system inertia necessary to maintain RoCoF at or below 0.5 Hz/s. The requirements for other system constraints are beyond the scope of the study.

When considering the unsolved cases it must be noted that the cases are created automatically based on a tool which creates an economic market dispatch. The market dispatch is imported into the technical model and solved automatically using existing voltage control mechanisms. In some of the cases convergence issues were observed. In reality the system is operated by highly trained specialised system operators in conjunction with a range of control tools. It should also be noted that the model does not contain all transmission reinforcements that are due to be in place by 2020 which would cause voltage and power flow convergence issues in some of the cases.

Over 8,000 cases, representing a variety of different dispatches, are analysed as part of this study. This provides sufficient cases with which to perform the analysis.

Industry comment: The report fails to quantify the additional synchronous inertia that would be required with the operational constraints that are currently in place on the system.

TSO response: A techno-economic dispatch is used to provide the generation profile for the studies. The current operational constraints restrict RoCoF to 0.5 Hz/s. The purpose of the paper is to investigate the use of different sources of inertia for restricting RoCoF in a system with high levels of SNSP. The inclusion of all existing system constraints would restrict RoCoF to 0.5 Hz/s (measured over 500 ms), therefore there would be no change from today's network. There is a current operational constraint for inertia of 20,000 MW.s. The studies highlighted that this overall volume of inertia would be required to restrict RoCoF to 0.5 Hz/s in the cases analysed. The results from the studies supported the current operational policy.

Industry comment: We consider that there should also be an investigation into a scenario where there is a double event e.g. where a second unit trips due to the initial drop in frequency following the loss of generation.

TSO response: EirGrid and SONI currently operate the system in line with the TSOs' security standards. These standards require us to operate the system in a safe and secure manner. The current operational policy is to operate the system for the loss of a single generator or circuit (N-1). The European network codes also require that the power system is operated securely for N-1 conditions. The study considered these operational policies and therefore sympathetic tripping is not considered.

Industry comment: Before a decision to implement the revised RoCoF standard is taken, a comparison of the risks and costs that would result from either solution. As the report has concluded that synchronous inertia provides a solution, to increasing SNSP to 75% and maintaining the current RoCoF standard, the decision on whether to implement the revised RoCoF standard should include a comparison of these two options in terms of the risks and costs that would result from either solution. It is suggested the additional analysis outlined would be fundamental to drawing this comparison.

TSO response: The RoCoF project has three elements to it, which are the generator studies project, the TSO-DSO project and the alternative solutions project. The generator studies project is currently progressing and is assessing the ability of the existing generation fleet to meet the proposed 1 Hz/s standard. Similarly, the TSO-DSO project is focussed on changing DSO protection to allow for the system to securely operate at higher RoCoF levels. Both of these workstreams are being assessed and monitored as they progress. At this stage, we believe that further analysis on alternative solutions to the RoCoF issue should only be performed if results from the primary RoCoF projects indicate that alternatives are required.

Industry comment: What is the progress of the primary RoCoF projects?

TSO response: The RoCoF project has three elements to it, which are the generator studies project, the TSO-DSO project and the alternative solutions project. The generator studies project is currently progressing and is assessing the ability of the existing generation fleet to meet the proposed 1 Hz/s standard. Similarly, the TSO-DSO project is focussed on changing DSO protection to allow for the system to securely operate at higher RoCoF levels. Quarterly reports on the progress of these RoCoF workstreams are provided by CER and SONI for Ireland and Northern Ireland, respectively. In addition to this, updates on the project are given at various industry stakeholder forums.

Industry comment: We disagree that synthetic inertia is more complex to implement than synchronous inertia. Either alternative RoCoF solution should be TSO-led irrespective of technology.

TSO response: The TSOs note that both synchronous and non-synchronous devices may have the potential to provide responses that could prevent high RoCoF events. Synchronous inertia provided by conventional generators is an established method of providing inertia in electrical power systems. This technology is currently the most proven technology for preventing high RoCoF occurrences. In the case of synthetic inertia, there were some areas that need to be investigated in more detail. In particular, the TSOs view RoCoF detection methodology and response time as being an area that needs to be explored further. The phase 2 studies also highlight some operational challenges relating to the triggering of these devices that will need further investigation. The TSOs would envisage that a project with industry engagement would be required to develop any system-wide synthetic inertia scheme, if this approach was to be taken.

We agree that there is complexity in implementation of synchronous and synthetic inertia.

Industry comment: We propose the TSOs analyse new synthetic inertia control strategies. For example a simple continuous and proportional controller using frequency and RoCoF measures as input variable.

TSO response: EirGrid and SONI performed a number of sensitivities in the phase 2 studies to investigate how various synthetic inertia responses could be employed to prevent high RoCoF events. We recognise that these sensitivities were not exhaustive and that other control methods could be employed. We believe that engagement with industry on synthetic inertia control strategies would be required should further analysis of synthetic inertia solutions be carried out in the future.

Industry comment: Has there been any review of whether load on the system would be adversely affected by RoCoF levels of up to 1 Hz/s (measured over 500 ms)?

TSO response: The Commission for Energy Regulation (CER) and Utility Regulator (UR) have requested that the TSOs investigate the impact that high RoCoF events would have on demand customers in Ireland and Northern Ireland. The TSOs are currently investigating this through engagement with large demand customers and with the DSOs. The TSOs are also performing study analysis to investigate any potential impacts on demand sites.

Industry comment: The results from the techno-economic analysis indicated that reduction of minimum generation, in itself, would not result in material change in the inertia levels deployed.

TSO response: The reduction of minimum generation refers to a reduction in the minimum stable output of a conventional generator. The results from the techno-economic analysis indicated that reduction of minimum generation, in itself, would not result in material change in the inertia levels deployed. One of the reasons behind this finding was due to wind generation replacing conventional generation in the techno-economic solution. Conventional generators that were in merit would have been dispatched above their minimum generation level and therefore reducing this parameter had little impact on the techno-economic results. This result does not discount the benefit associated with further reductions in minimum generation levels. It should be noted that the reduction of minimum generation levels could act as a solution for introducing supplementary synchronous inertia to the system.

Industry comment: Include additional explanation on how RoCoF exceeded 0.5 Hz/s between 200 and 500 milliseconds after the system event”

TSO response: RoCoF is calculated in the study over 500 ms. The calculation begins at the moment of the event and is done on a rolling calculation at 25 ms intervals. For RoCoF to exceed 0.5 Hz/s at 200 ms after the event, the system frequency would need to fall by more than 0.25 Hz in the first 200 ms. The frequency was seen to fall at these very rapid rates in a number of study cases.

Conclusion

On 22nd December 2015, the EirGrid Group published the "RoCoF Alternative & Complementary Solutions Project Phase 2 Study Report" and a summary document "DS3 RoCoF Alternative Solutions Project Report Overview". Eleven responses were received from industry. We welcome the engagement from industry on the report and the feedback received.

Each response was reviewed by the TSOs. The report was well received by the majority of respondents. This document summarises the general themes and some of the direct questions submitted by industry and summarises the TSOs views. Based on the feedback received on the report, we have made some minor changes to the original report. Following consideration of the industrial responses the TSOs do not consider any major modifications are necessary to either the report or the analysis. The overall findings from the report have not been altered from the original report.

We have completed the second phase of the RoCoF alternatives project with the publication of this report. We believe that the project has demonstrated that alternative solutions are available to resolve the RoCoF issue. At this stage, we believe that we have fulfilled the regulatory requirements to investigate and identify alternative solutions to the RoCoF issue. Further analysis on alternative solutions to the RoCoF issue should only be performed if results from the primary RoCoF projects indicate that alternatives are required.