Consultation regarding charging arrangements for changes to generator protection settings

05/01/2017

1. INTRODUCTION

1.1 The purpose of this consultation is to understand industry's view on what charging arrangements should apply for the potential roll out of generator interface protection amendments.

1.2 For the avoidance of doubt, these amendments will affect all generators connected to the NIE Networks' distribution system who have been connected with interface protection arrangements in line with G59/1/NI.

1.3 Sections 2 and 3 of this report provide rationale and justification for the required settings change whilst sections 4 and 5 provide details on the benefits of these amendments, potential funding mechanisms and next steps.

2. BACKGROUND AND OVERVIEW

2.1 The Facilitation of Renewables (FOR) study, published in 2010 by the TSOs, was a detailed technical study that considered levels of non-synchronous generation (wind and HVDC imports) up to 100% of system demand. The study has shown that during times of high wind generation following the loss of the single largest credible contingency, Rate of Change of Frequency (RoCoF) values of greater than 0.5 Hz/s could be experienced on the island power system. If system separation were to occur RoCoF values up to 2 Hz/s measured over a rolling 500ms could be experienced in Northern Ireland. Simulations show that for a voltage dip induced power imbalance in a system with significant volumes of wind generation, RoCoF values in excess of 2Hz/s can occur over short time periods.

2.2 Accordingly, the main outcome of the FOR study was that wind levels (Non-Synchronous generation) of up to about 75% of demand could be accommodated, but a series of mitigation measures would have to be carried out. One of these measures was the need to address the issue of RoCoF. This issue is the current binding limitation on operating the power system past a system non-synchronous penetration (SNSP) of 55%.

2.3 In order to enable the power system to operate at SNSP levels beyond 55% NIE Networks commissioned Strathclyde University to conduct research to determine the most appropriate interface protection settings. The objectives of this research were to determine settings which ensure power system stability for future system conditions and quantify the increased risks associated with the adoption of these proposed settings.

2.4 The research concluded that the following interface protection settings are necessary to ensure stability for future power system conditions:

G59 Function	Proposed Settings	
	Setting	Time Delay (ms)
RoCoF	1.5Hz/s	300
Vector Shift	12deg	0
Over frequency	52Hz*	1000
Under frequency	48Hz	500
Over Voltage	1.1 pu	500
Under Voltage	Stage 1: 0.85 pu Stage 2: 0.6 pu	3000 2000

TABLE 1

* Some generators may be required to have lower over frequency settings depending on electrical location

3. COST BENEFIT ANALYSIS

Costs

3.1 NIE Networks anticipates that, upon request, all required generators will have the capability to change their current interface protection settings to those proposed within this document. This scenario is referred to as the "Expected Scenario". However, it is possible that some already installed relays may not be able to be amended to the recommended settings and therefore require a new relay to be fitted. To reflect this situation a "Worst Case Scenario" contingency has been included which assumes that 50% of large and small scale generators require a new interface protection relay to be fitted. It is not the intention of this piece of work to retroactively amend G83 protection settings; therefore G83 generators have not been considered in this analysis.

3.2 Following discussions with technical individuals from industry the unit costs for amending generator interface protection settings were determined and the total implementation costs were calculated; the results of which are shown in Table 2.

	Unit Cost		Quantity	"Expected Scenario" Costs	"Worst Case Scenario" Costs	Comments
	Settings Change Only	New Relay Required				
11.04kW – 200kW (G59 connected only)	£450	£1050	322	£144900	£241500	Assumed that generator will be LV connected. Assumed that NVD is not required.
200kW – 750kW (Export Capability)	£450	£2050	389	£175050	£486250	Assumed that generator will be LV connected. Assumed that NVD is required.
200kW – 750kW (Non - Export Capability)	£450	£1050	83	£37350	£62250	Assumed that generator will be LV connected. Assumed that NVD is not required.
750kW – 5MW (Export Capability)	£950	£2550	28	£26600	£49000	Assumed that generator will be HV connected. Assumed that NVD is required. NIE Networks witness testing required.
750kW – 5MW (Non-Export Capability)	£950	£1550	43	£40850	£53750	Assumed that generator will be HV connected. Assumed that NVD is not required. NIE Networks

						witness testing required.
>5MW (Export Capability)	£2000	£13500	37	£74000	£286750	Assumed that generator will be 33kV connected. More expensive relay utilised. Assumed that NVD is required. NIE Networks witness testing required.
Totals			902	£498,750	£1,179,500	[12]

TABLE 2

[1] Accurate as per Q3 2016
[2] Costs are exclusive of NIE Networks' administration costs

Benefits

3.3 It is expected that the cumulative benefits of implementing generator interface protection changes will significantly outweigh the cost of implementation. Based on an expected connected wind generation figure of 4.6GW on the island of Ireland in 2020 it is estimated that the implementation of the new RoCoF standard will have the following benefits in the 2020 calendar year in Ireland (a detailed breakdown of these benefits are provided in Table 3[3]):

- €13m/annum reduction in SEM production costs (i.e. €1445m - €1432m).
- 4.4% reduction in wind curtailment levels (i.e. 15.6% - 11.2%). Under current arrangements only LSG will be subject to curtailment; consequently, LSG will be the main beneficiaries of reduced wind curtailment levels.
- 1.5% contribution towards the renewable energy target (i.e. 36.8% - 35.3%).

			Dispatch			
Scenario ID	Wind connected (GW)	Dispatch	SEM Production Cost (€m)	Wind Curtailment (%)	Wind (%)	RES (%)
A_50	3.5	50% (current)	€ 1,557	8.5%	23.1%	29.2%
A_60		60% (RoCoF)	€ 1,575	4.8%	24.0%	30.1%
A_70		70% (Partial)	€ 1,525	1.5%	24.9%	31.0%
A_75		75% (Full)	€ 1,516	0.7%	25.1%	31.2%
B_50	4.6	50% (current)	€ 1,445	15.6%	28.0%	35.3%
B_60		60% (RoCoF)	€ 1,432	11.2%	29.5%	36.8%
B_70		70% (Partial)	€ 1,344	2.8%	32.3%	39.7%
B_75		75% (Full)	€ 1,334	1.4%	32.7%	40.1%
C_50	5.7	50% (current)	€ 1,367	23.0%	31.7%	40.5%
C_60		60% (RoCoF)	€ 1,338	18.8%	33.5%	42.3%
C_70		70% (Partial)	€ 1,194	6.0%	38.7%	47.6%
C_75		75% (Full)	€ 1,176	3.5%	39.7%	48.7%

[4]

TABLE 3

[3] The current figures in Table 3 are based on an SNSP figure of 50%; however, since the publishing of this report the current level of SNSP has been increased to 55%.

[4] Table 4 in the following report: (https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-14-059a%20TSO%20Report%20Demand%20Analysis%20DS3%20System%20Services.pdf).

3.4 NIE Networks is aware that currently under some fault scenarios the interface protection of some generators may operate resulting in the disconnection of the generator from the electricity network. This phenomenon has been referred to as "nuisance tripping" by the industry and results in a small loss of revenue to the generator owner. An additional, non-quantifiable benefit of implementing the proposed interface protection amendments will be that interface protection will be less susceptible to "nuisance tripping" resulting in less interruptions to generator supplies. Statistics on generator "nuisance tripping" are not readily accessible and therefore this benefit cannot be quantified.

3.5 Moreover, amending generator protection settings will allow for higher levels of SNSP, reducing wind energy curtailment by 4.4% in 2020. Because of the higher levels of SNSP and reduced renewable energy curtailment an additional non-quantifiable benefit will be a carbon emissions reduction.

4. FUNDING PROPOSALS

4.1 In order to ascertain industry views on the potential funding approaches associated with generator interface protection NIE Networks have proposed 4 potential funding approaches, outlined in Table 4. In responding, consultees should clearly declare which funding proposal, if any, is their preference.

4.2 The proposed funding proposals distinguish between Large Scale[5] Generation (LSG) and Small Scale[6] Generation (SSG) as the benefits declared in section 3 of this report may not be analogous for both LSG and SSG. For example SSG is not currently subject to curtailment and therefore will not benefit from a reduction in curtailment levels.

Options	**Funding Proposal**	
	LSG Costs	**SSG Costs**
1	LSG Pay for individual costs	SSG Pay for individual costs
2	LSG pay for their individual costs and cover SSG costs	
3	LSG Pay for individual costs	Northern Ireland customer pays for SSG costs
4	Northern Ireland customer pays for all implementation costs	
5	Alternative proposal	

TABLE 4

[5] Generation ≥ 5MW
[6] Generation < 5MW

4.3 From an administrative perspective, Option 1 is straightforward in that each individual generator would make the necessary arrangements to amend their protection settings, and there would be no exchange of monies between generators or NIE Networks. This is the only option that could be implemented without further administrative issues being considered and addressed.

4.4 For Option 2, a formula will need to be considered which determines how much of the total SSG cost is met by each individual LSG. For example costs could be evenly split across all LSGs, or costs could be pro-rated based on the relative size of each LSG. Consultees are asked to consider and respond on this matter, if Option 2 is your preference.

4.5 Option 2 will also require the establishment of a central administrator to take monies from LSGs, and make payments to SSGs.

4.6 Under Options 3 and 4 costs incurred by SSGs (Option 3), or for both SSGs and LSGs (Option 4), would be refunded by NIE Networks. The Utility Regulator would need to approve and implement a mechanism to allow NIE Networks to recover their associated costs.

5. NEXT STEPS

5.1 This consultation will commence on **05/01/17** and will run for a period of 4 weeks. During this period stakeholders are invited to express a view on any aspect of the proposed generator interface protection amendments. In particular, NIE Networks welcomes responses from consultees with regards to the most appropriate method to fund said amendments. Consultees should clearly state which funding proposal outlined within Table 4 is their preference, if any. In responding, consultees should outline their affiliation to the Northern Ireland Electricity system and state the type and size of generating plant, if any, that they have connected to the NIE Networks' distribution system. Responses should be received by NIE Networks **before 03/02/17** and should be addressed to:

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5.2 During the consultation period, should any stakeholder have any specific queries on any aspect of this document they should contact Carl Hashim as set out above.

5.3 Following the end of the consultation period and receipt of responses from consultees, NIE Networks will send a report to the Utility Regulator on the outcome of its review which will include written representations from all electricity stakeholders responses received during the consultation process.