GC0100 EU Connection Codes GB Implementation – Mod 1

Industry parties are invited to respond to this consultation expressing their views and supplying the rationale for those views, particularly in respect of any specific questions detailed below.

Please send your responses by **5pm** on **2 October 2017** to grid.code@nationalgrid.com. Please note that any responses received after the deadline or sent to a different email address may not receive due consideration by the Workgroup.

Any queries on the content of the consultation should be addressed to Chrissie Brown at Christine.brown1@nationalgrid.com

Respondent:	*Frank Martin (frank.martin@siemens.com)*
Company Name:	*Siemens Gamesa Renewable Energy (SGRE)*
Please express your views regarding the Workgroup Consultation, including rationale. **(Please include any issues, suggestions or queries)**	The workgroup consultation for GC0100 is an essential step for the implementation of EU regulation and adopting the grid code requirements in the UK. The work initially started with GC0048 where technical key aspects of GC0100 have been addressed and developed. In general, an observation of the working group GC0100 / GC0101 is the timeframe given for the developing of a final draft for the grid code consultation was extremely short – as a result several technical key aspects have not sufficiently addressed (e.g. Option 1 in general and in connection to DC connected PPM's, …). These aspects needs much more focus and assessments in dedicated working groups and should not be pushed into grid code changes for national implementation of EU regulation. SGRE views on particular matters within this consultation will be reflected in the answers to the questions below.

Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any potential alternatives for change that you wish to suggest, better facilitates the Grid Code Objectives?	./.
2	Do you support the proposed implementation approach?	./.
3	Do you have any other comments?	VSM is not only fast fault current. Additional technical information is needed for manufacturers to be able to assess the technical requirements and cost impact of providing these services.

		Ideally if any converter connected generator is to provide system services required to support other types of generation, then an incentive scheme should be considered, as all renewable generators are competing to provide energy at the lowest possible cost. SGRE believes that the desire to have a converter connected generation control that can be simulated at the RMS level (GC0100 – Effects of VSM, slide 8) needs to be carefully considered. With a low bandwidth primary controller (5Hz) then an outer loop (fast acting) control will be required to act, under certain system conditions to prevent converter overcurrent (this will be similar to existing fast current limiting control with current control schemes). This presents a non-linear control system which cannot be simulated at the RMS level, and it is arguably during a severe system transient that this control change will take place. Consideration of the point at which such change in controls takes place needs discussed.
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	./.

Specific GC0100 questions

Q	Question	Response
1	Removing More Stringent Requirements' concerns have been expressed by some Workgroup members that applying more stringent requirement on newly connecting parties (that fall within this scope of the EU Network Codes for generation, demand and HVDC systems) maybe incompatible with EU law. Do you have any views on this topic that could assist the Workgroup when they are considering the topic in due course?	
2	Are you comfortable with using	The term "Registered Capacity" is well known in the

	the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?	UK. By introducing a new definition as per EU definition it is important to adopt them consistently among the grid code (definitions, adopt these definitions in the specific parts where grid code requirements are specified).
	Fast Fault Current Injection questions	
3	What are your views on options 1, 2 and 3 as set out in paragraph 4.4 for Fast Fault Current Injection and which option (if any) would you prefer?	As NGET outlines in the consultation document Option 1 falls outside the timescale of EU regulation implementation. These aspects should of course be investigated but should not be done under the umbrella of the RfG implementation – instead a separate WG should investigate these aspects. The document “EU Connection Codes GB Implementation – Mod 1” is describing “Option 1” as a way to deliver Fast Fault Current as specified by the RfG. However, the requirements for “Option 1” as outlined in “GC0100 - Effects of VSM (Option 1)” cover everything from inertial response, response to system imbalances and harmonics, and controller bandwidth limitations. While it is understood for the fast and short term response the focus of GC0100 should not shift to a broad range of aspects as it cannot be covered by this consultation. **Option 1** requirements proposed in “GC0100 - Effects of VSM (Option 1)” represent a fundamental change to how power converters are designed and operated, how they interact with the power system, and the extent by which this is done. But given that grid forming converter control is a new, and compared to current control immature, technology for both the TSOs and for the converter manufacturers, there will be uncertainty in terms of both the performance it might deliver and the cost of a particular performance. The table on page 3 in “GC0100 - Effects of VSM (Option 1)” suggests that National Grid anticipates that grid forming converters will be able to deliver the required system services at a lower cost than the alternatives as e.g. synchronous compensators. The physical characteristics and limitations of the power converter needs to be respected no matter which control algorithm it is running, which means that any capability, or rather any combination of capabilities, that requires additional current carrying capability or dynamical power exchange needs to be designed into the power converter. If all capabilities are required at the same time, their requirements for

		current window and active power need added up and designed into the power converter, whereas an amount of sharing could be achieved if a prioritization is allowed. Furthermore it is not fully clear whether Option 1 is a WTG converter requirement or if it applies at PPM level. Also for offshore connected PPM it is important for the decision if capability is offered onshore or offshore. It is not clear what is driving the requirement for a 33% overproduction of active power for 20seconds. It is not clear what is driving the requirement for a 1.5pu overcurrent for 20seconds. **Option 2** with related requirements to supply 1,25 p.u. of reactive current during a fault potentially disqualify existing hardware design. Furthermore it is not fully clear from the draft legal text how Option 2 requirements are understood for e.g. FRT requirements greater than 140 ms in duration where the grid code required provision of Active Power in proportion to the retained balances voltage. This also applies for Option 3. (Option 2 with 1pu current) **Seen from described technical challenges and aspects and the outlined timeline for national implementation Option 3 is seen as the only feasible solution.** From our point of view the NC RfG requirements does not imply any necessary changes to the current reactive current injection requirements of today's UK grid code.
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	./.
5	In considering the three Fast Fault Current Injection options 1, 2 and 3 in paragraph 4.4 do you have any comments in relation to technology readiness, cost implications, and can they be implemented date within the	**Option 1** represents an entirely new converter control and will very likely introduce a host of new stability and control issues that each manufacturer need to deal with and get under control. This will require intensive R&D work for the industry as well as extensive simulations / testing to investigate and understand all effect in all relevant operational

	context of product development timescales?	modes of the WT's and WPP's. In our point of view the technology is not presently commercially ready and it will be very difficult to realize this by January 2021. An intermediate step that would reduce the risk for all involved parties (TSO, manufacturers) might be to do a demonstration project using existing power hardware to: 1) Let NGET see if the perceived potential of this type control is realized in an actual setting with actual power hardware 2) Let the industry get more knowledge and experience about what the proposed converter control will mean in practise for their converter design 3) Be able to properly assess the cost vs benefit of grid forming converter to compare against competing technologies such as synchronous condensers These steps should be followed by a dedicated WG so possible conclusions can be taken be made for future system needs. **Option 2 / Option 3** of the consultation document outlines that these Options would apply for PPM's which have signed "mayor plant items" after 17th of May 2018. Even for Option 2 / Option 3 R&D work by the industry is required and various compliance aspects need to be worked on (e.g. testing, simulation and studies) which means more time to comply with these requirements is necessary. **Therefore a transition period of at least 1 year is suggested.**
6	Do you have any evidence to support your views?	./.
7	Do you have any views on the specific costs related to the additional requirements?	The proposed reactive current injection requirements (especially Option 1 and 2) would exceed today's industry standards, leading to additional costs related to increasing the current hardware capabilities, R&D, testing, validation and certification costs. It's worth to mention that specific UK only requirements should not force manufacturers to change their hardware for the rest of the markets as well. Therefore the system

		operator should consider to incentivise the development of such capabilities under an ancillary services market. Especially Option 1 will have the highest impact on costs as it represents a fundamental change on power converters. In addition Option 1 requirements will mean an extended capability which means available stored energy!! In order to dimension such additional energy storage capability, across what frequency range it is desired that a VSM with an inertial constant of between 2 and 7 is delivered? In order to dimension the converter overload requirements to support a VSM, the maximum RoCoF is required. Given that the installed converter connected generation capability is spread between banding levels (specifically PV within band A), it seems that loading the requirements to provide system inertia, via VSM, on banding levels B, C, D, penalises certain technologies. If it is desirable that converter connected generation in banding B, C, D provide system services such as FFC and VSM, which will result in additional capital equipment cost, then an incentive scheme should be considered that allows all generation types (Wind, PV..) to compete on equal terms. Why is VSM being considered within the context of fast fault current? VSM places additional requirements on converter connected generation beyond current rating, specifically transient energy requirements. These two aspects will impose significant costs to additional hardware. To develop, test / verify and certify these new control schemes and technologies will impose additional costs which can be characterised with the amount of developing a complete new converter system!! Option 2 may require changes to hardware (assessments necessary) and to controls. In addition to that, costs for verification and compliance needs to be added. **Option 3 is seen as the most cost effective**

		solution seen from the hardware, design and compliance point of view. Imposing requirements exceeding the industry standards and current technology capabilities must be based on a comprehensive Cost Benefit Analysis. The lead times associated with providing Option 1 (beginning of 2021) but also Option 2 (may 2018) needs to be considered. WPP's already sold and in the design process cannot upgrade power hardware in a timescale of less than a year if the existing power hardware does not support the additional fast fault current injection requirement.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	No. Due to the technical aspects of DC connected PPM's it is in our view not sufficiently evaluated and discussed if one of the Options specified is actually needed for such a configuration of DC connected PPM. The 3 Options have been evaluated mainly from the challenges seen in AC systems.
	Banding questions	
9	What are the specific costs related to the additional requirements?	See previous comments on Band A, on the lack of VSM requirements.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	./.
11	Can you provide any feedback/comments on the associated legal text?	./.
	Fault Ride Through	
12	Do you support the fault ride through voltage against time curves If not please state why you disagree, what alternative you would recommend and your justification for any alternative?	The consultation document outlines that there is a close link between the proposed voltage against time curves and the fast fault current injection requirements (e.g. section 3.6). As state of the art WPP's (PPM's) are capable of supporting low retained voltage faults and supplying e.g. reactive current it seems that WPP's (PPM's) will be asked to extend their capabilities with the outlined Options to supply fast fault current injection in order to limit Uret (e.g. Figure 5.7). It cannot be responsibility of PPM's to provide more capabilities to limit requirements (e.g. voltage time curve) for other types of generation. A well-functioning ancillary services market should

		make sure that sufficient amounts of these power system services are available at all times to ensure robust operation of the power system.
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	./.
	Other questions	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	To some extent. As for example the legal draft (annex 2) presents the intended changes. Unfortunately it is not fully clear how the proposed options will be incorporated in the legal draft – e.g. ECC.6.3.15.9.2 b (ii) and fast fault current injection is not clear but is highly relevant for manufacturers.
15	Do you have any information based on the proposed solution in respect of implementation costs?	./.