Workgroup Consultation Response Proforma

GC0137: Minimum Specification Required for Provision of GB Grid Forming (GBGF) Capability (formerly Virtual Synchronous Machine/VSM Capability)

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 to grid.code@nationalgrideso.com by 5pm on **30 April 2021**. Please note that any responses received after the deadline or sent to a different email address may not receive due consideration by the Workgroup.

If you have any queries on the content of this consultation, please contact Kavita Patel Kavita.patel@nationalgrideso.com or grid.code@nationalgrideso.com

Respondent details	Please enter your details
Respondent name:	Dr. Isaac Gutierrez
Company name:	ScottishPower Renewables
Email address:	IGutierrez2@scottishpower.com
Phone number:	07761693652

For reference the Applicable Grid Code Objectives are:

a) *To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity*
b) *Facilitating effective competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);*
c) *Subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole;*
d) *To efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency; and*
e) *To promote efficiency in the implementation and administration of the Grid Code arrangements*

Please express your views regarding the Workgroup Consultation in the right-hand side of the table below, including your rationale.

Standard Workgroup Consultation questions

1	Do you believe that the GC0137 Original Proposal better facilitates the Applicable Objectives?	SPR believe GC0137 better facilitates Grid Code objectives a) b) c) and d), with neutral impact on objective e). On objective a), the specification will allow for the operation of an efficient, coordinated and economical system for the transmission electricity network by unlocking essential capabilities in the technologies that are supposed to be the backbone of the electricity generation at the end of this decade. This will certainly support the SO into operating the system and facing future challenges, reducing the system operation costs. On objective b), GB GF capabilities being incentivised in GB will increase the competition for stability services, reducing the need that out of merit dispatch in other markets by the SO. On Objective c) GB GF represents an essential capability for converter technologies in order to ensure the system remains secure and stable. The future is highly likely to be heavily populated with converters, making the incentive of these features even more relevant for promoting the security and efficiency of the electricity generation. On objective d) the proposal will enable ESO to continue discharging its licensing obligations to maintain the frequency of the grid within the required parameters.
2	Do you support the proposed implementation approach?	Yes, SPR do support implementation in October 2021. We believe the sooner the implementation is, the better as this Minimum specification will be critical into enabling converter-based technology capabilities for achieving zero carbon operation of the electricity system by 2025.
3	Do you have any other comments?	Please see below annex. SPR will also support any comments made by SGRE in their submitted technical responses.
4	Do you wish to raise a Workgroup Consultation Alternative Request for the Workgroup to consider?	No.
Modification Specific Workgroup Consultation questions		
5	Do you believe it is appropriate specify GB Grid Forming as a non-mandatory requirement in the Grid Code and be	Yes, SPR do believe it's appropriate to have a GB Grid Forming as a non-mandatory requirement, supported by a market mechanism that provides investment signals for new and existing projects.

	accessed by future market arrangements rather than as a mandatory requirement?	These capabilities are not standard in the products available to developers from suppliers, and always come with additional costs. In the current heavily competitive environment, it's not affordable for developers to participate in competitive processes, such as CfDs, and include additional costs that may compromise their ability to secure CfD contracts. Given the challenges the industry is facing and targets such as the zero carbon system operation by 2025, and the deployment of significant converter capacity for 2030 (including 40GW of offshore wind); it would be sensible to incentivise these capabilities via remuneration mechanisms which are not to compromise the speed of decarbonisation. A non-mandatory requirement will encourage providers/manufacturers to develop effective solutions in favour of competition.
6	Do you believe the current proposal is sufficiently flexible and facilitates a range of technologies? If not, please state why you feel this to be the case and what type of technologies have been excluded?	SPR do believe the proposal is flexible enough for providers and facilitate a range of technologies. However, SPR support technical views of convertor-based technology providers are highlighting on this matter, particularly SGRE. SPR would also like to highlight that GB GF provides a number of benefits for the system operation that go beyond the usual recognised inertia capabilities. In order to incentivise the participation of a wider range of technologies, the remuneration incentive around GB GF should be flexible and remunerate each of these capabilities. Avoiding a black and white approach that may push back providers that are unable to fulfil the full extent of the specification will be critical for the success of the roll-out of GB GF. However, SPR understand these considerations may not be part of the scope of this proposal.
7	Do you believe the proposal will result in excessive equipment costs? This excludes development costs whilst recognising plant can be also be de-loaded?	At the moment, SPR is still to understand the extent of the additional costs although that's certainly subject to the time in which developers and technology providers decide to enable the capabilities (i.e. early stage of design, retrofit, etc.). SPR do think that any additional costs out of enabling the grid forming capabilities should be remunerated through market mechanisms that provide a signal and incentive to developers to

		undertake changes in the design of their power plants.
8	Do you believe the proposed Grid Code proposals sit better in the Planning Code, Connection Conditions / European Connection Conditions and Compliance Processes / European Compliance Processes bearing in mind the proposals are non-mandatory or do you think it would be better to have a new standalone section of the Grid Code similar to the Demand Response Services Code? Please state your reasoning.	As the proposal is for a non-mandatory services, SPR believe it would be better to have a new standalone section in the Grid Code similar to the Demand Response Services Code. This would make it consistent as a non-mandatory service and avoid confusions about the responsibilities on generators.
9	Do you support the approach of using the Grid Code to specify the minimum function performance requirements and a GB Grid Forming Best Practice Guide to provide further details? If not please state your reasons for not doing so?	Yes, SPR support this approach and the creation of a Best Practice Guide.
10	The ESO do not believe that it is appropriate for traditional Synchronous Generators (GBGF-S) to meet some of the requirements – for example the submission of NFP Plots on the basis of their already proven features and the higher costs of submitting this data. Do you agree that this is a fair approach on the basis that it will only put costs up if they were mandated to do so? If not please state why you disagree.	SPR understand there are inherent differences between GBGF-S and GBGF-I technologies and agree that some dynamical performance characteristics are already understood for GBGF-S while not so much for GBGF-I. SPR also agree that would be inefficient and not cost effective to mandate testing /analysis to those plants with characteristics that are well understood. However, SPR would encourage NGESO to promote a level playing field between technologies and advocate for removing some preconceptions on GBGF-I technologies that could turn to be disadvantageous for the industry and its participants. SPR hope that NGESO would build the confidence on the performance on this technology along with supporting key technology players.

Annex 1. Further considerations on question 3.

The basic assumption of the document is that the power system is changing due to the connection of converter-based generation and proposes what should be requested to these units to keep "business as usual". As the network moves towards more converter-based generation (and loads) the operation, control and protection methods must change. We would encourage NGESO to promote more work on the below areas:

Difference between grid forming (GF) and virtual synchronous machines (VSM): There is some confusion between GF and VSM. VSM, which is part of the GF family, is based synchronous generator (SG) performance in different degrees depending on the implementation. GF means that the power converter can sustain a voltage at its terminals without any external measurement. VSM, as it is inspired by the SG, can provide inertia and react to frequency disturbances. We should keep in mind that other GF implementations can provide VSM like services.

References to VSM and VSM0H: It has been proved in relevant literature that other current control-based implementation might offer similar or better performance to VSM. In the case of VSM0H, it is the same as the standard grid forming current control with droops extensively used in microgrids. NOTE: grid forming current control configurations have been used very successfully in microgrids.

Complexity of the model: The document uses a very simplified model of the synchronous machine and power converters representing their dynamics below 50Hz. There is the concern of falling into unnecessary simplification and specifying the requirements that might fit an ideal network rather than the real network.

Definition of "Grid forming capability" (GFC): The document defines GFC as "Active Power output is directly proportional to the magnitude and phase of its Internal Voltage Source, the magnitude and phase of the voltage at the Grid Entry Point or User System Entry Point and the sine of the Load Angle." SPR believe this equation represents the active power transferred between any two voltage sources, independently of the used control method. The key point of GF is that the converter can sustain a voltage at its connection terminals. This is not reflected in the document. SPR might argue that all the converters have an "Internal Voltage Source" but in GF, this voltage source might not depend on the network for the fundamental voltage controllability.

We also believe that grid following also is compliant with the following statement: "As a consequence, a Plant which has a Grid Forming Capability is one where the frequency of rotation of the Internal Voltage Source is the same as the System Frequency for normal operation, with only the Load Angle defining the relative position between the two." We are concern that these definitions may not be too accurate.

Time response requirement: the document should specify all the time response requirements. For example, it is established that for the "phase jump active power" the power should be provided in less than 5 ms but there is no mention of the ROCOF time response requirements.

5Hz bandwidth consideration and voltage stability: when comparing to SG, Power converters represent a richer frequency characteristic and can provide a faster response than

SG. Limiting the bandwidth of the outer loop of the converters to 5 Hz might impact the ability of the power convertor to support the network. Simultaneously, the document does not specify the voltage support capabilities that the converter should present, for example, voltage oscillation damping.

Consideration on testing and the converter control gains: Power converters can vary their response by returning the control gains. For example, by changing the H of the controller, more inertia can be provided. This should be understood as an advantage rather than a disadvantage as the converter response can be tailored depending on the grid conditions. The document is based on the approach that parameters will be not changed. The testing should include some kind of sensitivity analysis.

Control interactions: It is suggested that the Network Frequency Perturbation technique should be applied to get the small signal frequency response. This method only provides information about potential interactions when the frequency of the network changes, but the voltage stability is ignored. From a converter control perspective, the converter might likely suffer more from voltage stability issues than active power interactions. Also, it is not clear what should be done to assess the stability of the network using these plots as they only represent the dynamics of a single converter.

Future proofing the system: the specification will unlock converter capabilities to support system stability by aligning their performance to SG in an attempt to maintain system operation as it stands nowadays. Future work from NGESO and working groups should question the operation, control, and protection requirements of the future (and present) power network where SG will represent a small part of the generation units. NGESO, and the industry, need to take on the opportunity to start to define the operation of converter dominated networks in order to try to undertake least regrets decisions that will likely impact the future system costs.

Uncommon terminology: "ROCOF Response Power", "Phase Jump Active Power" are not common terms in electrical engineering. It might be better to specify the power requirements in terms of synchronising and damping power.