

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Greg Middleton</i>
<b>Company Name:</b>	<i>AMPS</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### 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	The original proposal better facilitates the objectives.

	facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	Yes
3	Do you have any other comments?	See comments elsewhere in this document about Uret.
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No

### 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?	AMPS support the view that the requirements must not be more stringent than the RfG, but the existing Grid Codes should also be observed where the RfG is silent.
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	No Comment
	<b>Fast Fault Current Injection questions</b>	
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?	No Comment
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No

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 context of product development timescales?	No Comment
6	Do you have any evidence to support your views?	No Comment
7	Do you have any views on the specific costs related to the additional requirements?	No Comment
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	No Comment
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	The different banding proposals don't have any direct impact on small synchronous generators, except they must support the Uret of 0.3.  Refer to evidence that has already been submitted to GC0048 on the economic impact on small synchronous generators with a lower value of Uret
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	See 9 above
11	Can you provide any feedback/comments on the associated legal text?	No Comment
	<b>Fault Ride Through</b>	
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?	Yes, if Uret remains at 0.3
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	AMPS supports this
	<b>Other questions</b>	

14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	G98 drafts need considerable further work before they can be consulted on
15	Do you have any information based on the proposed solution in respect of implementation costs?	Refer to costings previously supplied to GC0048

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<b>Respondent:</b>	<i>Tom Chevalier, Consultant</i> 01525 862870 <a href="mailto:AMO@PowerDataAssociates.com">AMO@PowerDataAssociates.com</a>
<b>Company Name:</b>	<i>Association of Meter Operators</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b> <b>(Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any	<i>No comment</i>

	potential alternatives for change that you wish to suggest, better facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	<i>No comment</i>
3	Do you have any other comments?	<p>I have some comments on the drafting. I have briefly reviewed the text and have the following comments:</p> <p>G98-2, figure 1 – the export and import meters are shown as separate devices. In practice they are normally a single device which measures the import &amp; export energy. So suggest show as a single meter with text to describe as an import/export meter. It should be noted that this applies to SMETS2 and existing HH meters.</p> <p>G98-2, figure 2 and Figure 3 – after the metering equipment there is a CB or switch fuse shown. This will typically also break the neutral, so single phase would be double pole isolator.</p> <p>G89-2, appendix 2 Note – Rather than just ‘inform’ the meter operator I would suggest the text should prompt the installer/customer to “...to confirm appropriate metering with the Meter Operator...”</p> <p>Similar points to above in respect of G98-1</p>
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>No</i>

### 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	<i>No comment</i>

	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 EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?	<i>No comment</i>
	<b>Fast Fault Current Injection questions</b>	
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?	<i>No comment</i>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	<i>No comment</i>
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 context of product development timescales?	<i>No comment</i>
6	Do you have any evidence to support your views?	<i>No comment</i>
7	Do you have any views on the specific costs related to the additional requirements?	<i>No comment</i>
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	<i>No comment</i>
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	<i>No comment</i>
10	Do you have any views on the banding thresholds for the original and those suggest for the	<i>No comment</i>

	possible alternative?	
11	Can you provide any feedback/comments on the associated legal text?	<i>No comment</i>
	<b>Fault Ride Through</b>	
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?	<i>No comment</i>
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	<i>No comment</i>
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	<i>No comment</i>
15	Do you have any information based on the proposed solution in respect of implementation costs?	<i>No comment</i>



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<b>Respondent:</b>	<i>Please insert your name and contact details (phone number or email address)</i>
<b>Company Name:</b>	<i>Please insert Company Name</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b>  <b>(Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any potential alternatives for change	We believe GC0100 Original Proposal facilitates the Grid Code and discharges the requirement of national implementation of RfG. However, as has

	that you wish to suggest, better facilitates the Grid Code Objectives?	been pointed out in many workgroup meetings, the requirement of FFCI Option 1 and Option 2 are very onerous on the developers. Please see below for further explanation.
2	Do you support the proposed implementation approach?	Yes, we fully support the implementation approach and efforts by the proposer to keep the industry informed.
3	Do you have any other comments?	No
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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?	<p>Although I am not fully aware of legal reasoning provided by alternative proposer, we believe any requirements that are existing in the current Grid Code and planned to taken forward with RfG should be thoroughly reviewed and CBA is conducted to verify this.</p> <p>From an Offshore Wind perspective, this is applicable for all the requirements planned to be taken forward for OTSDUW equipment. It is important to note that in an AC connected Offshore Wind Farm, OTSDUW equipment mainly consists of underground and submarine cables, transformers, harmonic filters, STATCOMs etc. Except STATCOMs, all the other equipment are passive equipment and hence their response will be a natural physical response and not a controlled response. In the context of FRT requirement, we are not entirely sure on whether or not this requirement will be applicable for all the transmission system such as TO equipment of overhead lines, transformers, underground cables built by NGET, SP, SSE etc. In addition, it is important to note that the mandate as per RfG (Requirements for Generators) and HVDC covers the requirements for generators and HVDC and not OTSDUW equipment. This is also not</p>

		<p>covered in Workgroup Terms of Reference.</p> <p>As already mentioned in the workgroup report by the Proposer, due to the way RfG is drafted, Offshore Wind Industry is losing options of where compliance for FRT can be proven, and more stringent requirements are applied than what they are now. In addition, if all the OTSDUW requirements are carried, it will be onerous for offshore wind developers in terms of compliance.</p>
2	<p>Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?</p>	<p>At the high level, both these definitions seem interchangeable. However, further investigation may be needed while other EU Network Codes are developing.</p>
	<p><b>Fast Fault Current Injection questions</b></p>	
3	<p>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?</p>	<p>We believe that the issue of <i>fault current injection</i> has not been sufficiently assessed in order to rush for implementing the changes for the ongoing revision of the grid codes.</p> <p>The proposed reactive current injection requirements would exceed today’s industry standards, leading to additional costs related to increasing the current hardware capabilities, R&amp;D, certification, testing and validation 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. We believe that imposing requirements exceeding the industry standards and current technology capabilities must be based on a comprehensive Cost Benefit Analysis. It is critical to have a common understanding of system needs for scenarios today and in the future. European discussions on power system needs with high renewable penetration levels of variable renewable energy sources and power electronics levels have been focusing on aspects with a time horizon beyond May 2018 to prepare necessary frameworks allowing national TSOs to specify minimum technical requirements. This is currently addressed in the ENTSO-E expert group on fast fault current.</p> <p>To avoid unnecessary system costs, the specification of future system requirements must be based on transparent system studies and firmly established system design criteria. It has already been requested in the workgroup meetings that the simulation models</p>

		<p>used for VSM, Option 2 and Option 3 to be shared with the workgroup so that any realistic behaviour from Power Park Units can be incorporated. This will result in a common rationale and technical background for new requirements. The result will also be that potential later adjustments will have a much more robust starting point. In general, a more transparent common rationale will also result in a clearer signal to the industry in order to understand what longer-term developments are needed to support future system security while efficiently integrating renewables.</p> <p>Scientific system studies modelling the behaviour of network and connected equipment are essential to define proper connection &amp; operation requirements. However, system studies need to be complemented by simulations and real tests to fully understand the potential behaviour of different technologies under all situations (normal, during and after faults). Not doing so risks an under/over estimation of technology performance during times of system stress.</p> <p>In addition, cost of this additional development leads to higher costs of the equipment which may be higher than additional costs for system operation without this facility and hence will be cascaded to higher energy prices for end consumers.</p> <p>We believe Option 3 is the best choice in terms of national implementation of RfG and as NGET recommends an expert group should be formed to look into details of this requirement going forward. In addition, we would like to highlight the FFCl in case of offshore wind farms are provided by each wind turbine based on the voltage seen at its individual terminals. Due to the transient nature of this requirement needing a quick response, and due to the time delay between instructions from park controller and wind turbines, we believe the requirements should be applied with an option to meet at Grid Entry Point or at each WTG terminals.</p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	Please see above in relation to applicability of FFCl requirement either at the Grid Entry Point or at each Power Park Unit terminals.
5	In considering the three Fast Fault Current Injection options 1, 2 and 3 in paragraph 4.4 do you	Unfortunately, we are unable to provide any details regarding technology readiness, costs etc for the development of VSM type technology.

	have any comments in relation to technology readiness, cost implications, and can they be implemented date within the context of product development timescales?	However, we believe the R&D, implementation, & testing etc of VSM type technology may be significant. In addition, the additional energy storage requirement that comes along with VSM may be prohibitive cost for Offshore wind installation. Similarly, Option 2 will need a bigger power electronic converter to be installed inside the wind turbine. This leads to higher cost not just in terms of electrical equipment but also the civil structure. We believe Option 3, is a more viable option at this stage in terms of costs. Although, there is still a need for R&D, this may be considered to be most economically viable option and supporting the transmission system needs at the same time.
6	Do you have any evidence to support your views?	No. We are not able to provide any evidence at this stage.
7	Do you have any views on the specific costs related to the additional requirements?	Please see above.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	In case of DC Connected Power Park Modules, we believe the requirement for FRT is applicable. However, the requirement for FFCI doesn't seem to be valid as any reactive current produced by Power park units behind HVDC station will be masked by the HVDC providing the reactive current. On the contrary, the reactive current produced by power park units may raise the voltage and hence trigger unwanted control from HVDC. Hence, we believe it is important that simulations and analysis is required to prove the concept before implementation can be done.
	<b>Banding questions</b>	
9	What are the specific costs related to the additional 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?	
	<b>Fault Ride Through</b>	
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	We support the FRT voltage time curves proposed for various kinds of generation.

	justification for any alternative?	
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	
15	Do you have any information based on the proposed solution in respect of implementation costs?	

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<b>Respondent:</b>	<i>Paul.youngman@drax.com</i>
<b>Company Name:</b>	<i>Drax power limited</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.  (Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ol style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ol>

### 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	GC0100 satisfies objective (iv) to the extent that it introduces into the Grid code EU Regulation 2016/631. The modification can also be seen as enabling aspects of Objective (i) and (iii) relating to

	facilitates the Grid Code Objectives?	the efficient maintenance and operation of the system and enhancing aspects of security of supply. It is not clear that the provisions and method of implementation will satisfy and enhance competition (ii) or that the chosen option of a wider implementation scope, rather than a narrow minimum implementation meets the efficiency criteria in section (v)
2	Do you support the proposed implementation approach?	<p>We offer qualified support of the proposals. From workgroup discussion it is clear that the proposer has included all changes mandated by the regulation to ensure compliance, and also defined additional requirements that are not mandated.</p> <p>We feel it may have been more efficient to implement an enabling mod that would implement the EU requirements, and then separately define elements that need to be enhanced in the national codes.</p>
3	Do you have any other comments?	No
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<p><i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website,</i></p> <p><a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></p>

### 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	There is general agreement that the proposals introduce more stringent arrangements. The proposer provided information, consultants studies and explanations to outline the merit of these 'more stringent' requirements. As a general rule minimum implementation of EU law into national codes is the preferred method of adoption. It is also clear that there is divergence between the proposer and others workgroup members regarding interpretation and compatibility of introducing more stringent arrangements, and the existing commitments made within the EU codes and regulation.



	are considering the topic in due course?	
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?	Yes
	<b>Fast Fault Current Injection questions</b>	
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?	The proposer highlights option 1 as their preferred option, highlighting that options 2 and 3 would need further development through an expert working group. We support the proposer on the basis that this would not preclude future development of options 2 and 3 by industry parties.
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No
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 context of product development timescales?	No
6	Do you have any evidence to support your views?	N/A
7	Do you have any views on the specific costs related to the additional requirements?	N/A
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	N/A
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	We have no further information on specific costs other than to note that developers and operators will face additional costs due to any additional equipment and processes required to ensure compliance.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	No

11	Can you provide any feedback/comments on the associated legal text?	N/A
	<b>Fault Ride Through</b>	
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?	Yes, and we would expect that this would minimise impacts to the underlying resilience of the network. We would also reasonably expect that significant changes to network characteristics would be notified to relevant parties.
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	It is currently unclear, given that the legal text is yet to be finalised, that the text reflects the intent of all the aspects of the modification.
15	Do you have any information based on the proposed solution in respect of implementation costs?	No

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<b>Respondent:</b>	<i>Konstantinos Pierros</i> <a href="mailto:Konstantinos.pierros@enercon.de">Konstantinos.pierros@enercon.de</a> Phone: +44 131 314 0157
<b>Company Name:</b>	<i>ENERCON GmbH</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b> <b>(Please include any issues, suggestions or queries)</b>	<i>ENERCON do not believe that the issue of Fast Fault Current Injection (FFCI) has been sufficiently assessed in order to rush for implementing the changes for the ongoing revision of the Grid Code and relevant documents.</i> <i>To avoid unnecessary system costs, the specification of future system requirements must be based on transparent system studies and firmly established system design criteria. Scientific system studies modelling the behaviour of network and connected equipment are essential to define proper connection &amp; operation requirements. However, system studies need to be complemented by simulations and real tests to fully understand the potential behaviour of different technologies under all situations (normal, during and after faults). Not doing so risks an under/over estimation of technology performance during times of system stress.</i>  <i>As it currently stands, we do not believe that we can support any of the three Options, but if we had to, it would be Option 3. Please see below for rationale.</i>

### 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?	<i>Please see the answers to the questions with respect to FFCI below.</i>
2	Do you support the proposed	<i>We could not find a clear implementation approach.</i>

	implementation approach?	<i>Perhaps include it in a separate section?</i>
3	Do you have any other comments?	<p><i>Physical quantities (voltage, current) and the grid-event related terminology (incident that leads to a certain response, fault inception, fault clearance, blocking, etc) must be clearly defined and must not be left open to interpretation. The base of the pu system should be clearly defined and explained through examples.</i></p> <p><i>There are minor typos in the report that should be corrected before the Workgroup issues the report.</i></p>
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<p><i>We are unsure if we should raise a WG Consultation Alternative Request. We you like to see modelled the following, however:</i></p> <ul style="list-style-type: none"> <li><i>- FRT voltage against time curves for Type B, C and D (below 110kV) with <math>U_{ret}</math> of 0.05pu and possibly below</i></li> <li><i>- minimum FFCI in line with or similar to the German VDE AR-N-4120 TAR Hochspannung - a rise time of &lt;30ms and a settling time of &lt;60ms</i></li> <li><i>- different characteristics for superior FFCI defined by NGET through remunerated FRT System Service</i></li> </ul>

### 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?	<i>"More stringent" needs to be clearly defined. It seems to stem from legal interpretation of terminology. It seems unreasonable to expect that technical requirements will remain unchanged forever, regardless of the changing technical requirement.</i>
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered	<i>We are happy with the proposal.</i>

	Capacity”?	
	<b>Fast Fault Current Injection questions</b>	
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?	<p><i>At different points throughout, the Workgroup Consultation appears to be actively promoting the alleged capabilities of Virtual Synchronous Machines (Option 1 – VSMS). We do not understand how NGET can be proposing an immature technology, since, to our knowledge, equipment carrying such capability (similar really, because there is not consensus about what is meant with the term VSM) have been only tested in controlled conditions, at very small prototype scale, and their performance has not been observed in a real grid. We would also welcome NGET to include in the Workgroup Report references to strict peer-reviewed publications about VSM.</i></p> <p><i>We believe that NGET should focus on breaking down the necessary characteristics and developing a framework for defining future requirements. Minimum technical specification must be technology neutral. It must not be translated into specific and/or preferred technical solutions like e.g. VSMS. The development of specific technical solutions must be left open for the industry. NGET cannot be in the position to prescribe how a certain performance is to be implemented.</i></p> <p><i>The alternatives to Options 1 are either currently not easily feasible (Option 2, if we consider that the base of the “pu” is the current corresponding to the rated MVA, we also note that the RfG does not require setting reactive current value beyond 1pu) or outdated (Option 3, the German VDE AR-N-4120 TAR Hochspannung currently requires a rise time &lt;30ms and a settling time of &lt;60ms, making it much faster than Option 3).</i></p> <p><i>As it currently stands, we do not believe that we can support any of the three Options, but if we had to, it would be Option 3.</i></p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	<p><i>Yes. Three-pronged:</i></p> <ul style="list-style-type: none"> <li><i>- FRT voltage against time curves for Type B,C and D (below 110kV) with <math>U_{ret}</math> of 0.05pu and below</i></li> <li><i>- minimum FFCI in line with or similar to the German VDE AR-N-4120 TAR Hochspannung - a rise time of</i></li> </ul>

		<p>&lt;30ms and a settling time of &lt;60ms</p> <p>- different characteristics for superior FFCl defined by NGET through remunerated FRT System Service</p>
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 context of product development timescales?	<p>Option 1 – far from readiness, severe cost implications throughout the product chain, far from implementation</p> <p>Option 2 – might require additional (spare) capacity through oversized dedicated converters and/or through ones for energy storage, moderate to high cost, possibility to be implemented within the context of product development timescales</p> <p>Option 3 – we are already beyond that point.</p>
6	Do you have any evidence to support your views?	We are a wind turbine manufacturer with an in-house production of inverters that are the key component of the vast majority of the 46GW of our worldwide installed capacity.
7	Do you have any views on the specific costs related to the additional requirements?	Might be able to provide feedback confidentially.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	N/A
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	We can provide feedback confidentially.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	We suppose that the “original” proposal is the one contained in the RfG and “alternative” contained in page 7. We are happy with the alternative proposal.
11	Can you provide any feedback/comments on the associated legal text?	We are happy, but we would like to see the limits with more significant digits and not rounded (0.999MW and not 1MW).
	<b>Fault Ride Through</b>	
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?	<p>Support with one exception: NGET should model as well a curve for Type B,C and D (below 110kV) with <math>U_{ret}</math> of 0.05pu and possibly below.</p> <p>Justification: technology readiness</p>
13	Do you have any specific views	We are happy with the proposal. Facilitation of FRT

	about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	<i>should be a priority and DNOs must adhere to this.</i>
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	<p><i>Annex 2: It appears to be quite convoluted for the time being! Hard to go through it with all the changes. Perhaps introduce a clean version of it for people to comment from scratch.</i></p> <p><i>We note that a few points appear to be contradictory (not exhaustive);</i></p> <ul style="list-style-type: none"> <li>- <i>voltage against time curve for Type B, C and D Power Park Modules under ECC.6.3.15.5 have a <math>U_{ret}</math> of 0.15 and then ECC.6.3.15.9 (b) shows a curve with zero retained voltage for 0.140s?</i></li> <li>- <i>voltage against time curves for voltage at different nodes (supergrid vs Grid/User System Entry Point)</i></li> </ul>
15	Do you have any information based on the proposed solution in respect of implementation costs?	<i>Depending on the option chosen, we might be able to provide feedback confidentially.</i>

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	Alastair Frew
<b>Company Name:</b>	ScottishPower Generation Ltd
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any potential alternatives for change	Yes as it implements European Law.



	that you wish to suggest, better facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	Yes
3	Do you have any other comments?	No
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No

### 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?	<p>Looking at the third package it consists of a number of directives and regulations, with the two key pieces of legislation relating to requirements on electricity providers being “Directive 2009/72/EC common rules for the internal market in electricity ...” and “Regulation 714/2009 on conditions for access to the network for cross-border exchanges in electricity ...”.</p> <p>These two pieces of legislation seem to split requirements into two with 2009/72/EC dealing with the safety and minimum technical requirements, whilst 714/2009 deals with setting cross-border rules on trade, energy flows and charging.</p> <p>In terms of 2009/72/EC this was introduced in 2012 with GB responding indicating its minimum technical requirements were as follows “Article 5: Electricity Safety, Quality and Continuity Regulations 2002, Electricity Transmission Licence, Electricity Distribution Licence, Electricity Interconnector Licence attached. Technical codes including the Grid and Distribution Codes may be found at <a href="http://www.ofgem.gov.uk/Licensing/ElecCodes/Pages/ElecCode.aspx">http://www.ofgem.gov.uk/Licensing/ElecCodes/Pages/ElecCode.aspx</a> “</p> <p>Currently this consultation is dealing with the “Regulation 2016/631 Requirements for grid connection of generators” which has been produced as a deliverable from 714/2009. Given the scope of 714/2009 it is surprising that such a technically detailed version of 2016/631(RFG) has been produced on the bases of a three word title in Article 8 paragraph 6 (b) “network connection rules;”, however we are where we are.</p> <p>Specifically dealing with no more stringent requirements, this seems to be based on a premise that any technical requirements not included in the connection codes 2016/631(RFG), 2016/1388(DCC) or 2016/1447(HVDC) are more stringent, and hence is not permissible. As previously stated minimum technical requirements are detailed within 2009/72/EC and not 714/2009 which defines the criteria for 2016/631(RFG). This is further emphasized in the opening whereas section of 2016/431(RFG) where item (2) second sentence states “..... In addition Article 5 of Directive 2009/72/EC of</p>

		<p>the European Parliament and of the Council (2) requires that Member States or, where Member States have so provided, regulatory authorities ensure, inter alia, that objective technical rules are developed which establish minimum technical design and operational requirements for the connection to the system. ...” . This indicates that 2016/631(RFG) is an addition to any rules set by 2009/72/EC. Moreover it is clear that it was not the indention for the new network codes to remove existing national codes as 714/2009 which defines the requirements for drafting the network codes has in Whereas (7) third sentence “The network codes prepared by the ENTSO for Electricity are not intended to replace the necessary national network codes for non-cross-border issues.” Given the above there does not seem to be any justification for the premise that technical requirements not included in the network codes are more severe and should not be allowed.</p> <p>In summary in GB the current accepted minimum technical standards appear to be the Electricity Safety, Quality and Continuity Regulations 2002, Electricity Transmission Licence, Electricity Distribution Licence, Electricity Interconnector Licence, the Grid and Distribution Codes with additional requirements of the network codes being added as they are enacted. The only issue which may exist is which version of the various documents is currently the approved version. Following the initial submission in 2012 there does not appear to be any clear evidence that the modification process in “Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations” has been followed.</p>
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?	Yes
	<b>Fast Fault Current Injection questions</b>	
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?	<p>Option 1 appears to be a desire from NGET to introduce a Voltage Source Response, however this appears to be based on simulations and assumption of equipment capabilities. NGET indicated during the workgroup that the requested values were based on what they thought they wanted and not on the ability of equipment to achieve these requirements and hence a subsequent workgroup would be required to reset the values. On the bases that the values will need to be reset it is difficult to see the justification to code option 1 into legal text as insufficient work has been done to date and could end up leaving potential new generators with an unachievable requirement.</p> <p>In terms of the other options the preferred option would be option 3.</p>
4	Do you have any alternative fast fault current injection	No

	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 context of product development timescales?	No
6	Do you have any evidence to support your views?	No
7	Do you have any views on the specific costs related to the additional requirements?	No
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	<p>All new generators down to 10MW will now have additional cost for simulations to prove they are capable of fault ride through.</p> <p>In terms new generators connecting at 11kV to meet the fault ride through requirements, whilst currently would be provided without a generator transformer, going forward to demonstrate all auxiliaries will still function a</p>

		<p>generator transformer will be required to ensure the station auxiliary busbars remain suitably above zero volts.</p> <p>There are also various other potential costs.</p>
10	<p>Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?</p>	<p><b><u>General Intension</u></b></p> <p>The proposer’s banding levels appears to be based on a perceived local issue related to local system faults and not cross-border trade issues, which is the propose of 2016/631(RFG). The original intension of 714/2009 is to improve network access and remove obstacles reducing cost. Given this the proposer’s banding proposal is reducing the banding levels from highest possible on the bases of a local issue and not a cross-border issue it is going against the original intension of the third package, by forcing smaller parties to increase their investment costs to cover the additional requirements . It is the view of this respondent that adopting the alternative proposal for the high option will not add additional cost to lower level participants and hence better address the original objectives by increasing access and reducing obstacles.</p> <p><b><u>Harmonisation</u></b></p> <p>The proposer’s justification for this reduced banding level states in section 3.2 fourth paragraph “The majority of European TSOs for Member States in Continental Europe are proposing generator banding levels lower than the maximum permitted under RfG, many of which, if not being comparable with the proposed GB levels, are lower than that proposed for GB. The proposer therefore believes there is a greater likelihood of harmonisation with Continental European neighbours with a lesser banding level than the maximum (noting that NRA approval is required to set these levels).” This justification is based on potential harmonisation across Europe which is similarly against the intensions of 714/2009 which states in whereas (29) “In particular, the Commission should be empowered to establish or adopt the Guidelines necessary for providing the minimum degree of harmonisation required to achieve the aims of this Regulation.” Again it is the view of this respondent that adopting the alternative proposal for the high option will not add additional cost to lower level participants and hence better address the original objectives by increasing access and reducing obstacles.</p> <p><b><u>Frequency Response</u></b></p> <p>The proposer’s justification then moves on in section 3.2 paragraph 6 to state “Threshold of 10MW for GB would provide a greater proportion of Generation inherently capable of contributing to frequency response, noting that commercial facilitation is not in the scope of RfG to consider, but a factor when it comes to cost.” Whilst it is accepted that if a lower banding level is used by default this must result in more frequency response capacity, however the real question is, will this not just be added to the current large amounts of unused frequency response capacity at additional cost to the generator? This view has been previously stated by this respondent in the previous banding consultation in April 2016 and a revised version using the proposer’s latest banding options is repeated below but due to the short timescales is still based on the late 2015 data, but this is still believed to be relevant.</p>

This analysis initially reviews the existing generation and proposed generation in 5 years' time using data available in the TEC Register dated 16 November 2015, Embedded Register dated 16 November 2015 and 2015 week 24 data plus DNO ED1 allows comparisons between existing and future capacity. Summary tables 1a & b and 2a & b of this data which are referred to are given at the end of this section of text.

Looking at the available frequency response if the proposed banding were to be applied to the current generation mix it can be seen in tables 1a & b both options would result in a range of the approximately 77 to 88 GW of plant available to provide response. The difference between the high and proposer's banding options only offers 11% increase or 10,000MW of generating capacity. The additional capacity then only equates to potentially 10% additional frequency response capacity of 1000MW comparing proposed banding to the highest banding option.

Similarly looking forward at the potentially available frequency response if the proposed banding were to be applied to the end of 2021 generation mix it can be seen in tables 2a & b both options would result in a range of the approximately 127 to 139 GW of plant available to provide response. The difference between the high and proposed banding options only offers a 7% increase or 12,000MW of generating capacity. The additional capacity then only equates to potentially 10% additional frequency response capacity of 1,200MW comparing proposed banding to the highest banding option. It should also be noted that this has been applied to all generation and not just the generation connected after 2018 and in practice the proposer's banding option may only pick up an additional 2,000MW of generating capacity and not the 17,000MW.

Based on the current frequency response average usage levels of Primary 657MW, Secondary 448MW and High 708MW (based on the average hourly usage volumes from December 2013 to September 2015) less than 7.5% of the current total available capacity is being utilised. If the proposer's banding option was to be in place today the potential changes would be to reduce the current frequency response capacity usage to 6.6% of the available total. Looking forward 5 years assuming the infeed loss has not changed then the current response requirements should still be applicable in this scenario. Given that the available generation to provide response increases by just approximately 50GW from current levels under the high option with 70% of plant still providing response there should be in 6 years' time still adequate response margins, with utilisation levels even lower.

Whilst still agreeing the proposer's banding option would result in an increase in frequency response capacity, its usage this is likely to be limited and is not clear what benefit this would provide. The high option would appear to suffice in terms of response requirements as there appear to be no detrimental cost implications.

Tables 1a & b below summaries the data for current generation available volumes based on the TEC Register dated 16 November 2015, Embedded Register dated 16 November 2015 and DNO week 24 data 2015.

Total Generating capacity in MW in each band from each source				
Data source	Generator size band (MW)			
	0.8kW - 1MW	1 to 49.9	50 to 74.9	>75MW
DNO ED1	2880	14585	7199	0
TEC Register		1380.43	887.85	67702.9
Embedded Resister		1269.77	233.1	75
Total	2880	17235.2	8319.95	67777.9
Generator Banding				
Type A		2880		
Type B		15854.77		
Type C		7432.1		
Type D		70046.18		
Total		96213.05		
Total C + D		77478.28	Percentage	80.5

Table 1a – Analysis of current generating levels against high banding option.

Total Generating capacity in MW in each band from each source				
Data source	Generator size band (MW)			
	0.8kW - 1MW	1 to 9.9	10 to 49.9	>50MW
DNO ED1	2880	5226	9359	7199
TEC Register		0	1380.43	68590.75
Embedded Resister		119.15	1150.62	308.1
Total	2880	5345.15	11890.05	76097.75
Generator Banding				
Type A		2880		
Type B		5345.15		
Type C		10509.62		
Type D		77478.18		
Total		96213.05		
Total C + D		87987.8	Percentage	91.4

Table 1b – Analysis of current generating levels against proposed banding option.

Tables 2a & b below summaries the data for predicted generation available volumes in years' time (i.e. end of 2021) based on the TEC Register dated 16 November 2015, Embedded Register dated 16 November 2015 and DNO week 24 data 2015.

Total Generating capacity in MW in each band from each source				
Data source	Generator size band (MW)			
	0.8kW - 1MW	1 to 49.9	50 to 74.9	>75MW
DNO ED1	25062.4	21378.29	7199	750
TEC Register		3352.13	2669.15	112750.1
Embedded Resister		2336.57	283.1	75
Total	25062.4	27066.99	10151.25	113575.1
Generator Banding				
Type A		25062.4		
Type B		23714.86		
Type C		7482.1		
Type D		119596.4		
Total		175855.7		
Total C + D		127078.5	Percentage	72.2

Table 2a – Analysis of current generating levels against high banding option.

Total Generating capacity in MW in each band from each source				
Data source	Generator size band (MW)			
	0.8kW - 1MW	1 to 9.9	10 to 49.9	>50MW
DNO ED1	25062.4	11150.96	10227.33	7949
TEC Register		43.8	3308.28	115419.3
Embedded Resister		617.5	1719.07	358.1
Total	25062.4	11812.26	15254.68	123726.4
Generator Banding				
Type A		25062.4		
Type B		11768.46		
Type C		11946.4		
Type D		127078.48		
Total		175855.7		
Total C + D		139024.88	Percentage	79.1

Table 2b – Analysis of current generating levels against high banding option.

		<p><b><u>Fault Ride Through</u></b></p> <p>The proposer justification in section 3.2 paragraph 7 then moves on to fault ride through with a vague statement “There is also a cost of tripping synchronous generation in a higher band (10MW – 50MW) which could result in a potential increase in holding additional reserve costs alone of £9 million / annum”. As previously stated the perceived issue the proposer is trying to deal with relates to a need for generators down to 10MW to be capable of withstanding local network faults by providing new fault ride through capabilities which are not a current requirement. The argument seems to be based on the principle if there is a transmission system fault which results in a large 1800MW generator tripping off then the TSO cannot be expected to cover for any other generators tripping off. Given these fault ride through requirements are new it would have been thought that existing generators which currently are without these facilities would be tripping off due to network faults and currently causing issues. To monitor system issues NGET have been producing the Significant System Events Report since 1998 with the most recent version produced in January 2016 (note a 2017 version has not been produced yet). Within this report the largest consequential loss recorded is 400MW in 2011 due to an island being formed in the north of Scotland which then collapsed, equally there is no evidence of significant volumes of secondary generation being disconnected due system events, nor is there any evidence of an increase in this consequential losses as the generation mix has been changing with time. On the bases there appears to be no current issues from generation not having fault ride through capability adopting the high banding option as opposed to the proposer’s option would again not impose further cost increases to smaller new generators.</p> <p><b><u>Other Issues</u></b></p> <p>Although the RFG limits the banding levels to only new entrants other Network codes such as the 2017/1485 Transmission System Operation Guidelines (TSOG) have adopted these banding levels and are applying them to both new and existing generators. Hence the actual full the cost implications of these banding levels will not be clear until exact implementation details of the other codes are developed the possible retrospective application to existing generators may require a sudden increase in communication links with unknown costs and other unknowns.</p> <p><b><u>Summary</u></b></p> <p>On the bases that for the next 5 years the high option suffices and as some potential costs implications will not be known until all the Network Codes are complete, applying the high option and then carrying out a further review if required in 3 years’ time when all codes are complete appears to be the most pragmatic solution.</p>
11	Can you provide any	Section ECC.3.7 defines existing users, but in sub-section ECC.3.7.2 for demand facilities paragraphs (a), (b) & (c) contain the word “not” which



	feedback/comments on the associated legal text?	means it is actually defining new users so the word “not” needs to be removed from these 3 sentences. The legal text as written appears to be fine for the ECC generation section with possible alternatives just changing the MW levels. An addition section will also be required for the CC section to say it only applies to existing users potentially as follows:- “CC.3.6 The requirements set out in these <b>Connection Conditions</b> shall only apply to <b>Existing Users</b> as defined in ECC.3.7 all other users should refer to the [ <b>European Connection Conditions</b> ]. “
	<b>Fault Ride Through</b>	
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?	Yes
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	Seem ok
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	Yes, only question about the legal text changes is the text change in ECC.A.4A.2 paragraph 3 which appears to be just a clarification of existing text, should also be applied to CC.A.4A.2 paragraph 3?  Looking at the EXXAX2.2 & 3 figures for all 3 options the time axis is not always titled and there are no units, similar for the voltage & current axis. On the example graphs for options 2 & 3 it might be useful if the requirement trace stopped at the point of fault clearance so as not to show parts where the response curve is less than the requirement curve.
15	Do you have any information based on the proposed solution in respect of implementation costs?	No

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Andy Vaudin</i> <i>andrew.vaudin@edfenergy.com</i>
<b>Company Name:</b>	<i>EDF ENERGY</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b> <b>(Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any potential alternatives for change	Yes, we agree that GC0100 Original proposal facilitates the Grid Code objectives.

	that you wish to suggest, better facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	We support the proposed implementation approach of amending the existing Grid Code and Distribution Code.
3	Do you have any other comments?	No.
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No.

### 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?	<p>We are not of the view that the Original proposal would apply more stringent requirements than the EU Network Codes allow.</p> <p>We are not clear what form the Grid Code would take under any "removing more stringent requirements" alternative proposal. A concern would be that many important requirements within the existing Grid Code would not be applicable to plant covered by the EU Codes. As an example, it could mean that the recent GC0077 sub-synchronous resonance modification was not applicable to new plant. It is our view that by removing important elements of the Grid Code, the "removing more stringent requirements" alternative proposal would work against Grid Code objectives (i) and (iii).</p> <p>We would expect National Grid to provide clear guidance to the workgroup as to any legal interpretations behind these "more stringent requirements" concerns.</p>
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	We have no objection to using Maximum Capacity, but do not believe that the implications of using this instead of Registered Capacity, if any, have been detailed in the workgroup report.
	<b>Fast Fault Current Injection questions</b>	
3	What are your views on options 1, 2 and 3 as set out in	The National Grid System Operability Framework (SOF) analysis shows low minimum

	paragraph 4.4 for Fast Fault Current Injection and which option (if any) would you prefer?	<p>Short Circuit Level at present, and declines in SCL in the coming decades. We share the National Grid operability concerns regarding falling Short Circuit Levels on the system and the consequent need for plant to be able to provide FFCl as one area of mitigation.</p> <p>However, we note that the VSM technology envisaged by the Proposer could only be regarded as emerging or at the development stage.</p> <p>We would expect National Grid to provide its view to the workgroup on the questions raised in 5 below.</p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No.
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 context of product development timescales?	We do not have this information, but believe that these are important areas for the workgroup to consider.
6	Do you have any evidence to support your views?	See 5
7	Do you have any views on the specific costs related to the additional requirements?	See 5
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	Whilst not being able to predict what future technology developments might be, we do agree that the proposed wording allows a reasonable degree of flexibility.
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	We do not have any details on costs related to lowering the banding thresholds.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	<p>We understand the system security and operability justifications for proposing lower banding thresholds. We note that Continental Europe TSOs have in many cases also proposed lower banding.</p> <p>It does not seem to have been explained why the B banding threshold is proposed at the level of 1MW, when there could potentially be benefits for system security, particularly FRT capability with an amended threshold.</p>

11	Can you provide any feedback/comments on the associated legal text?	We agree with the form of the draft legal text, but note that it will require further workgroup review prior to being sent to Ofgem.
	<b>Fault Ride Through</b>	
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?	We support the FRT proposals in general. However, the report does not include the analysis, which would demonstrate that there will not be system security issues and associated costs to consumers, from setting the band B synchronous generator Uret to 0.3 p.u. rather than aligned with other band B generators at 0.1 p.u.
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	We agree that this is a reasonable approach.
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	We agree with the form of the draft legal text, but note that it will require further workgroup review prior to being sent to Ofgem.
15	Do you have any information based on the proposed solution in respect of implementation costs?	None.

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Athanasios Krontiris &amp; Grant McKay – ABB HVDC</i>
<b>Company Name:</b>	<i>ABB, Power Grids Division, HVDC</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b> <b>(Please include any issues, suggestions or queries)</b>	We are pleased to provide comments below on the questions which relate specifically to the performance or future development of HVDC converter systems. We would welcome the opportunity for further discussions with National Grid in this regard should you require any clarification or further information.

### 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?	
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

## Specific GC0100 questions

Q	Question	Response
1	<p>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?</p>	<p>Requirements in EU network codes are either exhaustive (values or value ranges set within the codes) or non-exhaustive (open for the relevant system operators to further specify). In the former case, more stringent requirements in national implementation than in the original EU network codes is not allowed, since this would undermine the general aim of EU-wide network codes, namely product and system harmonization.</p> <p>In addition to the distinction above, requirements in EU network codes are either mandatory (must be implemented on national level) or non-mandatory (can, but don't have to be implemented on national level). It is not clear if additional requirements further than the non-mandatory requirements stated in the EU network codes can be added in the national implementation. Such further requirements, which may be specific to a particular system such as the UK power system, appear in our opinion to be compatible with EU regulations, as long as they are technically justified and do not constitute unnecessary barriers to an integrated electricity market.</p>
2	<p>Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?</p>	<p>Either term may be used. We recommend a clear definition in the UK grid code, potentially with a note if another term as the one in the original EU network code is used.</p>
	<p><b>Fast Fault Current Injection questions</b></p>	
3	<p>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?</p>	<p>In our view the proposal as well as the underlying studies do not clearly identify the specific system needs; in particular, it is unclear, whether challenges in future operation are related to voltage control or frequency control. Requirements need to fall into one of these categories to be assessed correctly.</p> <p>We believe that fast fault current injection can already be fulfilled with today's technology (current control with PLL). We cannot therefore concur with the statement in section 4.4. (page 35) that "in summary conventional PLL converters are slow to inject reactive current and this in turn will affect the retained voltage at the connection point".</p> <p>Requirements for fault current injection need to cover both control implementation (e.g. performance with</p>

		<p>regards to timing) and rating (maximum fault current needed). The proposal stipulates values for ratings (1.5 pu for option 1, 1.25 pu for option 2), however it is unclear how these requirements are derived from system needs.</p> <p>With respect to (fast) frequency control, a need for provision of synchronising torque and inertia can be expected in the future as the share of non-synchronous generation increases. This need, and any related requirements, should be treated separately from fault current injection, although proposed technical solutions may address both aspects at the same time. A requirement for synchronising torque in the future seems reasonable, but –as studies by National Grid indicate– can be allocated to some generating plants only, or can be regulated by means of ancillary service markets. In our view, a market-based approach is more likely to ensure cost-optimization, since:</p> <ul style="list-style-type: none"><li>i) The requirements for option 1 (VSM) will introduce additional costs, and</li><li>ii) The exact system needs are not known yet</li></ul> <p>Furthermore, a market-based approach could allow utilisation of already existing potential (e.g. in existing HVDC interconnections) potentially at a lower cost.</p> <p>Further comments on the proposed options:</p> <ul style="list-style-type: none"><li>· For option 1 (VSM), several additional features/benefits are indicated on pages 35-36, including contribution to system inertia and rate of change of system frequency (RoCoF), compatibility with synchronous machines, and easy integration into existing grids, thus enabling greater market share for converter derived generator technologies. We would like to highlight that these features are not only specific to VSM, and similar behaviour can be reached by today's current control (option 2 or 3). In particular, for a low share of non-synchronous generation, operating in current control may even be more robust than VSM control.</li><li>· For options 2 and 3, it is not clear from figures 4.4 under which condition blocking is permitted (for instance, is this related to potential over-voltage after fault clearance? Or is blocking due to thermal protection for longer fault clearing times also allowed?)</li></ul>
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		<p>Furthermore, what does temporary blocking imply for the requirement for active power recovery after the fault §ECC.6.3.15.8.vi ?). In addition, the requirements for fault current injection (pu value) for fault clearing times longer than 140 ms are not given. Finally, there is no relation between remaining voltage at the PCC and required fault current injection; a requirement would need to be added defining this relation.</p>
4	<p>Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?</p>	<p>With respect to fault current injection, we believe that current control should be sufficient; please refer to the answer in question 3 above.</p> <p>With respect to the provision of synchronizing torque, several solutions have been proposed for operating converters in a grid-forming matter. Concepts include among others:</p> <ul style="list-style-type: none"> <li>• Power synchronization control, refer to: "Power-Synchronization Control of Grid-Connected Voltage-Source Converters," L. Zhang, L. Harnfors, and H.-P. Nee, IEEE Transactions on Power Systems, vol. 25, pp. 809-820, 2010.</li> <li>• Swing-Equation-Based-Inertial-Response control, refer to: "Virtual synchronous machine", H.-P. Beck and R. Hesse, in 9<sup>th</sup> International Conference on Electrical Power Quality and Utilisation, 2007, pp. 1-6.</li> <li>• Inertia-Less Virtual Synchronous Machine (VSM0H) control, refer to: "Use of an Inertia-less Virtual Synchronous Machine within Future Power Networks with High Penetrations of Converters", M. Yu, A.J. Roscoe, C.D. Booth, A. Dysko, R. Ierna, J. Zhu and H. Urdal, Power System Computation Conference (PSCC) 2016</li> </ul> <p>As mentioned in the proposal, work is ongoing within entso-e. A requirement for the provision of synchronizing torque is not stated in the EU network codes, and therefore would not necessarily need to be included in the UK implementation of the codes at this stage. Instead, we recommend a later introduction of such requirements based on the findings from the entso-e study and other studies specific to the UK power system.</p>
5	<p>In considering the three Fast Fault Current Injection options 1,</p>	<p>Option 3 is state-of-the-art. Option 2 does not introduce any additional R&amp;D</p>

	<p>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 context of product development timescales?</p>	<p>requirements for the control of converters. Therefore, it can be considered as commercially available. However, it may have some cost implications. Raising the fault current contribution to 1.25 pu means that the converter must be overrated. For HVDC converters, the requirement for higher fault current may result in the short-term to a minor increase in investment cost. In the mid-term (3-5 years), this increase in cost may be further reduced by R&amp;D activities and new products.</p> <p>For the assessment of option 1, one needs to differentiate: The requirement for increased fault current stated in the proposal (1.5 pu) will have some cost implications. For HVDC converters, it will result in the short-term to an increase in investment cost. Similar to the discussion for option 2 above, the requirement for higher fault current itself is no new feature and the technology to meet such a requirement is commercially available. On the other hand, the requirement for inertia contribution cannot be covered by the state-of-the-art technology. R&amp;D activities are required to make the proposed VSM control concept commercially available. Additional costs are related to the converter itself and the storage required for the provision of inertia. The former depends on the expanded operating range: an increase by +33% according to Annex 6 will result in higher investment cost. The latter depends mainly on the requirement for inertia support. In the supporting documents in Annex 6 a value in the range of 2-7 MWs/MVA is stated, however there is no figure in the proposal. In particular, for HVDC systems energy storage on the DC side of the converter is unlikely to be technically and/or economically feasible due to the very high voltage; instead, a separate converter with lower voltage and storage facilities on the DC side would be required which has significant implication on investment costs as well as operating losses. It is, however, possible in HVDC systems to compensate for the energy needed for inertia support in the remote terminal, as long as the VSM requirements are not valid for both terminals.</p>
6	<p>Do you have any evidence to support your views?</p>	<p>We are not aware of VSM control being implemented in any commercially available HVDC system offering. Furthermore, HVDC suppliers have not communicated to the market (press releases or publications) plans to incorporate VSM control into HVDC converters in the near future.</p>

7	Do you have any views on the specific costs related to the additional requirements?	Please refer to our answer to question 5 above.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	
	<b>Banding questions</b>	
9	What are the specific costs related to the additional 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?	
	<b>Fault Ride Through</b>	
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?	<p>The fault ride through curve for HVDC converters in Figure 7.3 is in accordance with the EU network code. However, the fault ride through is not related to fault current injection. Setting Ublock equal to zero practically disqualifies line-commutated converters. During drafting of the EU network code for HVDC, great care was taken to avoid such general disqualifications and we suggest that this may be reconsidered.</p> <p>We would like to further highlight that the instance of fault clearance needs a clear definition. The requirements for FRT and subsequent active power recovery up to 90% within 500 ms from fault clearance must be related to the instance the voltage returns in the 0.9-1.1 pu band. Otherwise significant overrating of the converter is necessary. Note that the term “fault clearance” is also used in Figures 4.4 and in section 4.4, however with another interpretation.</p>
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3	

	deliver the intent of the solution outlined in section 3?	
15	Do you have any information based on the proposed solution in respect of implementation costs?	

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	Rob Wilson <a href="mailto:Robert.wilson2@nationalgrid.com">Robert.wilson2@nationalgrid.com</a> 07799 656402
<b>Company Name:</b>	National Grid Electricity Transmission plc
<b>Please express your views regarding the Workgroup Consultation, including rationale.  (Please include any issues, suggestions or queries)</b>	<p>This workgroup consultation represents the end of a very long development process. There is very little time now left to achieve compliance with the national implementation deadlines for the European Connection Codes (of which the first, RfG, is due on 17 May 2018). This work must now be brought to a timely close and hopefully this consultation will help in gathering any further evidence available and then allowing submission of the proposal(s) to the Panel and Authority without further delay.</p> <p>Noting that legal text for the alternatives is not included in this consultation, we would point out that this is not necessary to allow their progressing to Code Administrator consultation and submission to the Authority. Any further development of alternatives is the responsibility of the parties proposing them or, if they so choose, the workgroup. Given that there is very limited time remaining for compliance and that the principles behind the alternative proposals are complete this consultation should be sufficient to gather any further stakeholder views and evidence and allow the work to proceed. In terms of the legal text, the relevant clauses in the code are GR21.5 which states for the Code Administrator consultation that legal text may not be required if Panel and the Authority agree; and GR 22.1&amp;2 regarding the final report which in GR22.2(g) requires an assessment of the changes only.</p> <p><i>GR.21.5 Where the Grid Code Review Panel is of the view that the proposed text to amend the Grid Code for a Grid Code Modification Proposal or Workgroup Alternative Grid Code Modification(s) is not needed in the Grid Code Modification Report, the Grid Code Review Panel shall consult (giving its reasons as to why it is of this view) with the Authority as to whether the Authority would like the Grid Code Modification</i></p>

	<p><i>Report to include the proposed text to amend the Grid Code. If it does not, no text needs to be included. If it does, and no detailed text has yet been prepared, the Code Administrator shall prepare such text to modify the Grid Code in order to give effect to such Grid Code Modification Proposal or Workgroup Alternative Grid Code Modification(s) and shall seek the conclusions of the relevant Workgroup before consulting those identified in GR.21.2.</i></p> <p><i>GR.22.2 The matters to be included in a Grid Code Modification Report shall be the following (in respect of the Grid Code Modification Proposal):</i></p> <p><i>g) an assessment of:</i></p> <p><i>(i) the impact of the Grid Code Modification Proposal and any Workgroup Alternative Grid Code Modification(s) on the Core Industry Documents and the STC;</i></p> <p><i>(ii) the changes which would be required to the Core Industry Documents and the STC in order to give effect to the Grid Code Modification Proposal and any Workgroup Alternative Grid Code Modification(s);</i></p> <p><i>(iii) the mechanism and likely timescale for the making of the changes referred to in (ii);</i></p>
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### 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?	<p>The original proposal for GC0100 better facilitates the Grid Code Objectives.</p> <p>An assessment of the original proposal against the Grid Code objectives is as follows:</p> <p><i>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</i></p> <p>Positive. In developing this code modification the task of the workgroup has been to find a balance between the costs that will be incurred by owners of equipment in complying with a more onerous specification and the benefit to the system in avoiding operational costs that would otherwise be incurred in providing support due to the connection of less capable equipment. This is also the aim of the European Network Codes as stated by</p>

		<p>ENTSO-E and is particularly important given the development of the system and the shift in the generation portfolio from larger, centrally despatched units to smaller and embedded renewable generation.</p> <p><i>ii. To facilitate 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)</i></p> <p>Positive. Ofgem have made clear during the workgroup proceedings that their decisions will be based on evidence in both directions – ie that where choices are made these are based on a tipping point being reached where the costs of choosing more onerous settings is evidenced to outweigh the operational benefit.</p> <p><i>iii. 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</i></p> <p>Positive, as stated above, in making balanced choices for the overall benefit of the end consumer.</p> <p><i>iv. 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</i></p> <p>Positive. This modification is required to implement elements of the 3 European Connection Codes forming part of the suite of European Network Codes resulting from the EU 3rd Package legislation (EC 714/2009).</p> <p><i>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</i></p> <p>Neutral. Although noting that this is the first comprehensive modification to be taken through Grid Code Open Governance and therefore the first Grid Code modification to go</p>
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		<p>through an official workgroup consultation which will be followed on acceptance of the workgroup report by the Grid Code Panel by a Code Administrator consultation.</p> <p>So as noted above, the GC0100 original proposal better facilitates objectives (i)-(iv) and is neutral against objective (v).</p> <p>Providing that this is evidenced, the alternative proposal for the type or banding thresholds fulfils the same objectives. Currently this alternative is however not evidenced and also lacks a solution to the demarcation needed in determining Uret values as referenced below to allow optimum system support but avoid setting values with which sectors of the generation businesses cannot comply.</p> <p>The 'more stringent' alternative fulfils none of the objectives as summarised below.</p> <p>Assessment of the 'more stringent' alternative against the Grid Code objectives:</p> <ul style="list-style-type: none"> <li><i>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</i></li> </ul> <p>Negative. The 'more stringent' alternative does not embody the minimum solution as required by Ofgem for implementation of the European Network Codes and so does not permit efficient development.</p> <ul style="list-style-type: none"> <li><i>ii. To facilitate 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)</i></li> </ul> <p>Negative. The 'more stringent' alternative is not achievable in the time available and proposes striking out of national code requirements without which system security will be compromised and new connections will be unable to proceed under safety rules and due to a lack of clarity over equipment specifications. Further, due to the time that</p>
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		<p>solving these issues will take the ability of new entrants to meet their European Connection Code obligations will be compromised as the leadtime that they will have prior to compliance being required will be reduced.</p> <p><i>iii. 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</i></p> <p>Negative. The 'more stringent' alternative will prevent secure connection of new entrants and stifle development of efficient solutions.</p> <p><i>iv. 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</i></p> <p>Negative. The 'more stringent' alternative is not a minimum or efficient solution as required by Ofgem.</p> <p><i>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</i></p> <p>Negative' The 'more stringent' alternative will require comprehensive and unnecessary modifications to the existing national codes.</p>
2	Do you support the proposed implementation approach?	Yes.
3	Do you have any other comments?	No.
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No.

### Specific GC0100 questions

Q	Question	Response
1	Removing More Stringent	This argument is not valid, is in contradiction to advice from Ofgem, and its persistent reiteration has wasted a great deal of

<p>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?</p>	<p>time that could have been more profitably employed in completing implementation and giving developers and manufacturers greater leadtime for compliance.</p> <p>The European Connection Network Codes were intended to consider cross-border issues and to seek harmonisation. However, they were never intended to be a complete solution or to overwrite all national legislation.</p> <p>Ofgem has advised industry in their <a href="#">2014 decision</a><sup>1</sup> on how to implement the European Network Codes of the need to adopt a minimum solution; this was explained to mean only bringing forward any new GB Code provisions required by virtue of the EU Connection Codes, and removing any conflicts with existing GB Code provisions. This advice was repeated in <a href="#">Ofgem's decision letter on urgency</a><sup>2</sup> for modification GC0103. In this letter, and in various other correspondence, Ofgem have also urged stakeholders to bring forward specific examples of where existing code provisions impact cross-border trade such that they can be dealt with through the existing code modification processes. No examples have been forthcoming.</p> <p>It is also worthy of note that article 7.3 of RfG (EU 2016/631; HVDC and DCC codes similar) states that: <i>'When applying this Regulation, Member States, competent entities and system operators shall: (d) respect the responsibility assigned to the relevant TSO in order to ensure system security, including as required by national legislation.'</i></p> <p>To remove all national code provisions outside the scope of the European Codes by the 'more stringent' argument, unless it can be proven that cross-border trade is not impacted, would render the GB electricity system inoperable in contravention of this clause and would prevent any parties from connecting new equipment to the system until a full clause-by-clause review could be completed against both EU Connection Code requirements and the further legislation of other member states.</p> <p>None of the other 27 EU member states implementing the European Connection Codes are considering the 'more stringent' argument as valid. All are adopting a similar minimum approach to GB in implementation. Legal advice from ENTSO-E on this subject is that member states are allowed to introduce or maintain more detailed and in certain cases more stringent requirements.</p>
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<sup>1</sup> <https://www.ofgem.gov.uk/ofgem-publications/92240/openletteronimplementationandconsultationonnewdesignations-pdf>

<sup>2</sup> <https://www.ofgem.gov.uk/publications-and-updates/gc0103-introduction-harmonised-applicable-electrical-standards-gb-ensure-compliance-eu-connection-codes-decision-urgency>

This is as follows:

*By virtue of Articles 2 and 4 of the Treaty on the Functioning of the European Union (TFEU), the EU does not have an exclusive but a shared competence on energy matters. According to Article 194 TFEU, Union policy on energy shall aim to ensure notably the functioning of the energy market and promote the interconnection of energy networks. An EU Member State could therefore adopt additional, national legislation to complement the CNCs. Nonetheless, this could only be to complement and render EU law more efficient and, by application of the principles of EU law direct effect and supremacy, could not be in contradiction to EU law, including the CNCs provisions.*

*Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 ("Regulation 714/2009") allows for the adoption of additional provisions at national level under certain conditions:*

- *Article 8(7) Regulation 714/2009 states that "the network codes shall be developed for cross-border network issues and market integration issues and shall be without prejudice to the Member States' right to establish national network codes which do not affect cross-border trade". The notion of "cross-border trade" is however not defined by Regulation 714/2009. The notion appears however to be interpreted in a broad fashion by the Commission in order not to limit the scope and applicability of the network codes.*

- *Article 21 of Regulation 714/2009 allows Member States to maintain or introduce measures that contain more detailed provisions than those set in Regulation 714/2009 also related to cross-border trade issues;*

- *The CNCs, in their whereas parts (Whereas (30) RfG, (22) DCC and (18) HVDC), clarifies that the CNCs form an integral part of Regulation 714/2009, so that Article 21 of this Regulation applies to them.*

*In application of these considerations, a Member State can adopt at national level:*

- *network codes which do not affect cross-border trade and do not contradict EU law. For instance, Article 3(2) RfG enumerates several cases in which the RfG does not apply at national level: in this case Member States are still competent to define requirements applicable at national level. In addition, the RfG does not set rules to determine the voltage level to connection point: it lies within the competence of Member States (see Whereas (10) RfG);*
- *more detailed provisions also related to cross-border trade issues than those established in the CNCs provided that, in*

*accordance with the principle of subsidiarity, it is the most relevant level of intervention and they do not contradict the CNCs requirements in order to complement the EU Regulations.*

*A possible criterion to evaluate the feasibility of national measures in the framework of energy matters could be the TFEU rules. According to the TFEU, it is possible to introduce measures constituting a barrier to trade if these measures are justified on limited grounds such as these foreseen in Articles 36 and 114 of TFEU.*

*Applied to the CNCs, the following cases could be considered:*

- *Extension of CNCs requirements to an additional category of grid user*

*A national measure could apply to type B power generating modules (PGMs) requirements that the RfG only applies to type C PGMs. The RfG harmonises the application of the said requirements to PGMs. The national measure could therefore only be valid provided:*

- *it is demonstrated it provides for a wide range of automated dynamic response with greater resilience to operational events defined by whereas (12) RfG;*
- *it is allowed by the requirement's aims defined in the CNC's whereas and the specific CNC's requirements; and*
- *it is demonstrated it does not affect cross-border trade, unless it is demonstrated the measure at national level merely details requirements of the CNCs.*

*For instance :*

- *Art. 4 RfG implies that type A and B existing power generating modules are not subject to RfG requirements even in case of substantial modifications. However, Member States can decide to extend the scope of application to such generating modules in order to improve CNCs' application provided the above conditions are met;*

- *According to Article 18 of RfG, the U-Q/max profile applies only to type C and D synchronous power generating modules. A national measure can extend its scope of application to type B if compatible with the type B requirements' aims defined in whereas (12) RfG, the requirements' aims (see whereas (24) RfG) and type B requirements relating to voltage stability according to Article 17(2)(a).*

- *Introduction of requirements not covered by the CNCs*  
*The possibility to introduce requirements at national level is feasible in two different cases:*

- *not - cross border issues (most cases). The fact that a requirement is not detailed in a CNC could indicate that it is not affecting cross-border trade but this needs to be assessed on a case-by-case basis ;*

- *in other cases, to complement EU regulations, provided*

		<p><i>that they do not contradict EU law.</i></p> <p><i>In case the measure would constitute a barrier to trade, it could still be valid provided it is justified by either Art. 30 TFEU or is considered as reasonable according to EU case law.</i></p> <p><i>- Wider national ranges of parameters than defined by CNCs</i></p> <p><i>Several CNCs requirements set ranges within which parameters need to be defined at the national level. It could be considered to define nationally parameters outside of the set range.</i></p> <p><i>For some requirements, the CNCs expressly authorise to define national parameters beyond the set ranges (e.g. frequency withstand capability for PGM, under Art. 13(2)(b) RfG). National measures doing so are justified as long as they respect the conditions set in the CNCs relevant provisions.</i></p> <p><i>When the national measures do not respect these conditions or the CNCs do not expressly authorise to define national parameters beyond the set ranges, any deviation would go against the CNCs and is therefore not admissible, unless it is demonstrated the measure does not constitute a trade restriction.</i></p> <p>In summary, and in keeping with Ofgem’s guidance, the proposals for GB implementation of the European Connection Codes are a minimum solution. Stakeholders are not precluded from identifying areas of further work where ‘more stringent’ requirements could be a restriction on cross-border trade but these do not have to be addressed now and are not part of the minimum solution for compliance.</p>
2	<p>Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?</p>	<p>Yes. As long as the final report to the Authority makes clear the development and application of this definition.</p>
	<p><b>Fast Fault Current Injection questions</b></p>	
3	<p>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?</p>	<p>Option 1 sets the longer term direction of travel for equipment. It is valid that it is included to seek views but National Grid do not feel that it can be mandated at the current time. Further development with industry is required with a view to making the necessary code changes to progress this requirement from roughly 2021.</p> <p>Option 2 is in our view potentially the most balanced solution in deriving maximum operational benefit within the bounds of existing technology capability. However, we would welcome submissions from developers and manufacturers on potential costs so these can be taken into account.</p> <p>Option 3 was acknowledged in workgroup discussions to be achievable and represents a baseline.</p>

4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No.
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 context of product development timescales?	Option 2 has been agreed and put in the Bilateral Connection Agreement of a recent interconnector project so is technically achievable. Information on costs would help to finalise the selection of these options.
6	Do you have any evidence to support your views?	Benefits set out against the original proposal, other evidence expected from developers/manufacturers.
7	Do you have any views on the specific costs related to the additional requirements?	Benefits set out against the original proposal, other evidence expected from developers/manufacturers.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	Yes.
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	Benefits set out against the original proposal, other evidence expected from developers/manufacturers. None yet identified other than for market participation which is not a RfG requirement.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	The original proposals represent a good balance between cost and benefit delivering the optimum solution to end consumers. No evidence has been provided by developers or manufacturers of significant costs that are incurred in selecting the thresholds set out in the original proposal rather than the alternative (maximum) figures.

The main contentious aspect of the banding thresholds has been the B/C threshold; this represents a move from a 'product standard' base in types A/B to a more interactive requirement for operational support in types C/D. Harmonisation is one of the stated aims of the European Network Codes. Publicly available positions in other member states are currently as follows:

Member State	Type Threshold Proposals			Status
	A/B	B/C	C/D	
BE	250 kW	25 MW	75 MW (25 MW if >110 kV)	Under discussion
CZ	A1: 11 KW A2: 100 KW	B1: 1 MW B2: 30 MW	75 MW	Under discussion
DE	135 KW	36 MW	45 MW	Under discussion
EE	0.5 MW	5 MW	15 MW	Preliminary proposal
ES	100 KW	5 MW	50 MW	Under discussion
FI	1 MW	10 MW	30 MW	Under discussion
FR	1 MW	18 MW	75 MW	Preliminary proposal
HR	500 kW	5 MW	10 MW	Under discussion
HU	200 KW	5 MW	25 MW	Under discussion
IE	100kW	5MW	10MW	Preliminary proposal
LU	135 KW	36 MW	45 MW	Under discussion
NL	1 MW	50 MW	60 MW	Under discussion
NO	1,5 MW	10 MW	30 MW	Under discussion
PL	1MW	50 MW	75MW	Preliminary proposal
PT	1 MW	10 MW	45 MW	Under discussion
RO	1 MW	5 MW	20 MW	Approved
SI	150 kW	5 MW	25 MW	Preliminary proposal
SK	100 KW	5 MW	20 MW	Under discussion

(only public domain positions included – status included correct at Sept 2017 which is mainly under discussion/in workgroup or equivalent)

The original proposal which has a B/C threshold of 10MW is generally aligned well with these positions. The nearest comparators for GB are probably Spain (5MW) and Norway (10MW) in terms of system size and strength. Proposals in the CE block need to be put into context as part of a much larger interconnected area, although it is notable that France are still proposing a B/C threshold of 18MW.

In RfG the maximums allowable for type thresholds are set by synchronous area in relation to the size of that area – so in the CE block for B/C this is 50MW, the Baltic and Nordic states have 10MW and Ireland 5MW. It should be noted that the GB synchronous area had an original maximum in the ENTSO-E draft of RfG of 10MW for the B/C threshold. GB stakeholders argued successfully that for reasons of harmonisation and to ensure evidence was provided this should be increased to match the CE block figure. A consultation was run through the workgroup in summer 2016 on the banding threshold proposals in GB. No

		<p>evidence of costs was received in complying with the technical capabilities described in RfG in lowering the B/C banding threshold to 10MW. Costs were highlighted in participating in the balancing mechanism, which at the moment in GB would also be required to facilitate provision of frequency response, however this market participation is not mandated in RfG. Note also that generators choosing to participate in the BM also derive further revenue streams which are assumed to be positive since some embedded generators have done this voluntarily.</p> <p>The original proposals represent a coordinated and complete solution with fault ride through and fast fault current injection. In brief, and though explained in the report, system modelling and studies have shown that fast fault current injection is required to help support post-fault voltages. If the FFCI proposal as set out is accepted a retained voltage post-fault of 0.10pu will be achievable; without FFCI this will be 0.05pu which many generators will struggle to achieve leading to increased cascade tripping and further operational costs. A Uret (retained voltage) setting of 0.10pu is therefore required to avoid this. Workgroup discussion has highlighted that smaller reciprocating diesel generators cannot however comply with this and have a minimum Uret achievable of 0.30pu using current technology. This is due to a slower speed of controller response and inherent lack of inertia. To balance these technical limitations and the system need, therefore, a B/C threshold of 10MW enables Uret to be set at 0.10pu in type C and 0.30pu in type B which was generally accepted by the workgroup as a good compromise.</p> <p>In conclusion therefore, we continue to support the original proposal. No evidence has been provided to instead choose the maximum figures as in the alternative. This would in any case leave some difficult choices to be made between an increased risk of cascade tripping and attendant operational costs/system security issues (if Uret was relaxed say to 0.30pu), and codifying a requirement that small generators could not meet (if it was not).</p>
11	Can you provide any feedback/comments on the associated legal text?	The legal text throughout is written to be as helpful and user-friendly to GB stakeholders as possible. A new European Connection Conditions section is proposed to be added to the Grid Code which combines European Connection Code and existing GB provisions such that compliance with this will for users satisfy all GB and EU requirements.
	<b>Fault Ride Through</b>	
12	Do you support the fault ride through voltage against time curves If not please state why you disagree, what	Yes. As noted above the FFCI/FRT/banding threshold proposals represent a complete and coordinated solution achieving the best compromise between equipment costs and operational benefit for end consumers based on the evidence available.



	alternative you would recommend and your justification for any alternative?	
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No.
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	Yes.
15	Do you have any information based on the proposed solution in respect of implementation costs?	No.

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Please insert your name and contact details (phone number or email address)</i>
<b>Company Name:</b>	<i>Please insert Company Name</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale. (Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"><li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li><li>ii. To facilitate 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)</li><li>iii. 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</li><li>iv. 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</li><li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li></ul>

## 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?	Yes
2	Do you support the proposed implementation approach?	No
3	Do you have any other comments?	The time frame given for the industry consultation is not sufficient to develop a clear alternative proposal. Proposal is given within comments. If the opportunity arises, a more specific proposal can be developed. The consultations, most of them with very short response times and running through the summer, are not helping stakeholders to consolidate their views in the most constructive way.
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

## 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	The EU Network Codes are in most areas flexibly worded to allow individual members to derive national requirements. Of highest importance is the focus on interconnection requirements rather than new more stringent requirements for individual generators. Current grid code review and other existing panels should be used to discuss and derive the requirement based on cost benefit analysis. NGET as network operator and member of ENTSO-e has significant input into the development of the EU Network Codes and should adhere to GB review and acceptance processes. EU Network Codes in its overall framework are not intended to interfere significantly with national matters and to drive higher

	course?	requirements.
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?	<p>No. Registered Capacity should stay. There could be some issues where the number of turbines exceed the available export capacity (sometimes known as overpowering), this is reasonably common with maximum production restricted to a level below the nameplate rating. In this case a PPM could unfairly end up in a higher band because of the nameplate rating of the equipment being used to determine the Maximum Capacity.</p> <p>It is noted that overpowering when considered with respect to dynamic operation, will be beneficial for the overall performance of the PPM and expected to be beneficial for the grid as well.</p> <p>If Maximum Capacity is legally binding for implementation, then Registered Capacity needs to be included additionally and relationship to Maximum Capacity shown.</p>
	<b>Fast Fault Current Injection questions</b>	
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?	<p>Current grid code wording for zero FRT and maximum reactive current infeed as per technology capability are sufficient. It could be extended to include a definition of response timing and minimum amplitude performance of the fast fault current injection with reference to the voltage characteristic. 1 p.u fast reactive current injection (using nominal machine active current as base at 1pu voltage) is possible at present.</p> <p>Option 1 (VSM Concept). It should not be up to the network operator to drive technology development to a particular concept. VSM is a solution to a requirement and as such not a viable preferred option for a grid code. This is currently based on research only. The estimated/ presented benefits may not be real and applicable to the real wind turbine. It seems premature to make this a binding grid code requirement without substantially further and wider (e.g at European/international level) industry discussion. This position is already reflected in the discussion in the workgroup report.</p> <p>To provide more (Option 2) would require a new</p>

		<p>design of hardware components.</p> <p>Flexible wording of PPM rather than PPU performance and acceptance of project specific options would enable the use of additional equipment and enables project specific cost benefit analysis and remuneration as ancillary service.</p> <p>Wind turbines are capable of riding through a 0 p.u voltage fault at the MV terminals. The preference would be to specify a lower retained voltage and reduce the fast reactive current injection requirement. Therefore our preference would be for implementation of option 3.</p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	The use of additional equipment within the PPM should not be ruled out. A STATCOM or inverter interfaced storage device could be used to provide additional/faster current injection.
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 context of product development timescales?	<p>Option 1 (VSM Concept). This is a solution and not a requirement. There are different solutions to the requirement and choosing one concept excludes competitive options and technology development.</p> <p>Option 2 (1.25 p.u fast reactive current) This requirement could be achieved, however requires upgrade and extension of current hardware designs and would need sufficient lead time for the development. Cost consideration to fulfil the requirements include R&amp;D, Certification/Test and Validation.</p> <p>Option 3 (1.0 p.u fast reactive current) This option can be achieved at present, however some R&amp;D effort will be required to adjust to this performance.</p>
6	Do you have any evidence to support your views?	Fault ride through documentation (including tests and models) have been submitted confidentially to NGET for our technology for various projects and for type registration, confirming our technology performance and control.
7	Do you have any views on the specific costs related to the additional requirements?	A Larger LVRT funnel together with fast active power recovery will require additional R&D effort, hardware changes, testing and validation costs. If the time for active power recovery after fault is increased from 0,5s to 1s, as found in the rest of the world, will reduce this unnecessary additional cost for DFIG wind turbines. Full converter technologies will not have issues with the 0,5s. recovery time.
8	Is the current proposed wording for the remote end HVDC and	We require more time to analyse the proposal

	DC Connected Power park modules sufficient to facilitate future new technology?	
	<b>Banding questions</b>	
9	What are the specific costs related to the additional 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?	
	<b>Fault Ride Through</b>	
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?	We support the revised voltage against time curves, however we would comment that this does make the GB fast active power recovery more difficult to achieve. We have commented in the past that achieving this requirement is technically very challenging for larger rotor turbines (e.g. greater than 120m diameter). For DFIG wind turbines this will increase the technology costs.
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	“The converter of each <b>Type B</b> , <b>Type C</b> and <b>Type D Power Park Module...</b> “  Drafting implies that a PPM will only have 1 converter, which is not necessarily the case.
15	Do you have any information based on the proposed solution in respect of implementation costs?	

**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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Frank Martin (frank.martin@siemens.com)</i>
<b>Company Name:</b>	<i>Siemens Gamesa Renewable Energy (SGRE)</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p>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.</p> <p>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.</p> <p>SGRE views on particular matters within this consultation will be reflected in the answers to the questions below.</p>

**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.

		<p>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.</p> <p>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.</p>
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).
	<b>Fast Fault Current Injection questions</b>	
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?	<p>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.</p> <p>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.</p> <p><b>Option 1</b> 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</p>

		<p>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.</p> <p>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.</p> <p>It is not clear what is driving the requirement for a 33% overproduction of active power for 20seconds.</p> <p>It is not clear what is driving the requirement for a 1.5pu overcurrent for 20seconds.</p> <p><b>Option 2</b> 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.</p> <p>This also applies for Option 3. (Option 2 with 1pu current)</p> <p><b>Seen from described technical challenges and aspects and the outlined timeline for national implementation Option 3 is seen as the only feasible solution.</b></p> <p>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.</p>
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	<p><b>Option 1</b> 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&amp;D work for the industry as well as extensive simulations / testing to investigate and understand all effect in all relevant operational</p>

	<p>context of product development timescales?</p>	<p>modes of the WT's and WPP's.</p> <p>In our point of view the technology is not presently commercially ready and it will be very difficult to realize this by January 2021.</p> <p>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:</p> <ol style="list-style-type: none"> <li>1) Let NGET see if the perceived potential of this type control is realized in an actual setting with actual power hardware</li> <li>2) Let the industry get more knowledge and experience about what the proposed converter control will mean in practise for their converter design</li> <li>3) Be able to properly assess the cost vs benefit of grid forming converter to compare against competing technologies such as synchronous condensers</li> </ol> <p>These steps should be followed by a dedicated WG so possible conclusions can be taken be made for future system needs.</p> <p><b>Option 2 / Option 3</b> of the consultation document outlines that these Options would apply for PPM's which have signed "mayor plant items" after 17<sup>th</sup> of May 2018.</p> <p>Even for Option 2 / Option 3 R&amp;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.</p> <p><b>Therefore a transition period of at least 1 year is suggested.</b></p>
6	<p>Do you have any evidence to support your views?</p>	<p>./.</p>
7	<p>Do you have any views on the specific costs related to the additional requirements?</p>	<p>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&amp;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</p>

		<p>operator should consider to incentivise the development of such capabilities under an ancillary services market.</p> <p>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!!</p> <p>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?</p> <p>In order to dimension the converter overload requirements to support a VSM, the maximum RoCoF is required.</p> <p>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.</p> <p>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.</p> <p>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!!</p> <p>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.</p> <p><b>Option 3 is seen as the most cost effective</b></p>
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		<p><b>solution seen from the hardware, design and compliance point of view.</b></p> <p>Imposing requirements exceeding the industry standards and current technology capabilities must be based on a comprehensive Cost Benefit Analysis.</p> <p>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.</p>
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.
	<b>Banding questions</b>	
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?	./.
	<b>Fault Ride Through</b>	
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?	<p>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).</p> <p>It cannot be responsibility of PPM's to provide more capabilities to limit requirements (e.g. voltage time curve) for other types of generation.</p> <p>A well-functioning ancillary services market should</p>

		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?	./.
	<b>Other questions</b>	
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?	./.

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Christian Merchan, <a href="mailto:christian.merchan@ge.com">christian.merchan@ge.com</a></i>
<b>Company Name:</b>	<i>GE Power</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### 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	Yes. Please refer to comments below.

	facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	Please refer to comments below.
3	Do you have any other comments?	N/A
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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?	No comment
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	No comment
	<b>Fast Fault Current Injection questions</b>	
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?	The capacity limiting factor in a power electronic converter, in particular for the large type of converter adopted in HVDC, is the current carrying capability of the available power electronic devices. The operating DC voltage with respect to ground is also



an important determining factor as this influences the cost of the transmission circuit. These two factors then combine to provide the economic power transmission capacity of the transmission link. In general, the larger the indivisible “block” of power transmission (i.e., the larger the MegaWatt rating of the converter) the lower the cost of the converter per MegaWatt). This was true for the older technology of Line-Commutated Converter and remains so for Voltage Source converters. Reference is made to CIGRE Brochure 186, “Economic Assessment of HVDC Links”, Table 4.1.

There is a fundamental difference between the operation of a synchronous machine and a power electronic based source under dynamic conditions. The machine, due to its construction will have a significant current carrying capability under dynamic (fault) conditions. However, a power electronic based source has a limited current capability due to the nature of power electronic devices. In addition, it must be highlighted that these power electronic devices have negligible thermal overload capability, that is, they are not able to operate beyond their rated current. Consequently, the fastest control associated with a converter is that which determines the instantaneous current flowing through the power electronics, and hence, being delivered to the AC system. Any demand of the converter to deliver current to the AC system (either real or reactive) must be regulated by the converter controller in order to protect the power electronics from catastrophic failure resulting in the loss of the plant.

The concept of a VSM relies on the premise that the converter controller attempts to maintain an AC voltage irrespective of the consequential current, fundamentally, the current regulation described in the previous paragraph is omitted in the controller, inherently making the current response of the converter faster in the event of a dip in the AC voltage. Which, as highlighted above, risks the catastrophic loss of the converter.

A solution, to permit the adoption of a VSM controller, would be to rate the converter such that the physical inductance within the converter limits the maximum current to a value within the capability of the power electronics. However, today, typically, the

total linear inductance within the converter will be equivalent to approximately 0.3pu, making the inherent fault current 3.33pu. Hence, an unintentional consequence of the adoption of VSM would be to reduce the capacity of all future HVDC links by approximately one-third; significantly impacting on the return-on-investment of the infrastructure. It should be noted that, whilst it would be possible to increase the linear reactance of the converter, to some extent, this has a direct impact on both the maximum transmission capability of the converter and the losses associated with the AC-DC energy conversion, so, again, having a significant impact on the return-on-investment of the infrastructure.

The operation of the converter as a VSM for remote faults, that is, those not demanding a current above the current rating of the converter is possible but the step of current regulation (to ensure that the current rating is not breached) must be maintained and this will impact on the speed of current injection.

A pro-active approach, on the part of National Grid would be to engage the suppliers of HVDC equipment to establish what is practicable in terms of achieving a Fast Fault Current Injection response and to better define the current response envelope, noting that even a synchronous machines response is limited by its inherent reactance.

Considering **Option 2** it is understood that there is no requirement for active positive phase sequence current flow and hence all of the current carrying capability of the converter is available for reactive power. Under these circumstances it may be possible to achieve 1.25pu reactive current but this would affect the voltage rating of the converter, requiring a steady-state margin in the converter design to cope with this contingency. This margin would translate into a higher steady-state converter current, resulting in reduced maximum capacity and higher converter losses, (possibly more than a 50% increase). It would also increase the size of the converter.

Clarification is sort with respect to the difference between Figure 4.4(a) and Figure 4.4(b), in particular, what is the associated AC voltage? The

		<p>above comments are based on the definition of fault recovery being that the AC voltage has achieved a positive phase sequence rms voltage of 0.9pu or high. It would be beneficial to indicate the corresponding AC voltage characteristic. Also, Figure 4.4(a) should clarify the time of 'Fault Clearance'".</p> <p><b>Option 3</b> limits the maximum reactive current to 1.0pu. This would operate within the capability of today's VSC converter design without increasing capital cost or losses and would also be consistent with the solution being sourced by the global market.</p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	<p>Response times required for <b>Option 2</b> and <b>Option 3</b> would appear to be consistent with today's technology.</p> <p>If this question specifically relates to <b>Option 1</b>, the VSM control of a converter then, as referenced in '3' above, it is suggested that National Grid engage with the supply chain for HVDC converters to establish what is practical. It must be borne in mind, however, that any UK special requirements that are over and above the global HVDC market need may result in an artificial restriction of the supply chain and hence a consequential increase in the capital cost.</p>
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 context of product development timescales?	<p>Please refer to comments under '3'. <b>Option 2</b> and <b>Option 3</b> would, based on the assumptions stated, be practicable in the time frames stated. However, <b>Option 1</b> is a major divergence from the HVDC technology applied to-date and something that the supply chain may not directly address. This would result HVDC converters connected to the UK grid being limited in power transmission capability significantly impacting on the return-on-investment and hence the economic justification for the HVDC link.</p>
6	Do you have any evidence to support your views?	Please refer to above comments.
7	Do you have any views on the specific costs related to the additional requirements?	<b>Option 3</b> , considering the stated assumptions, are not expected to impact on cost. <b>Option 2</b> , will impact on both capital cost and losses. <b>Option 1</b> would have a significant impact on the cost per MegaWatt, roughly increasing the cost by three times (x3).
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	As identified above further clarification is needed.

	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	No comment
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	No comment
11	Can you provide any feedback/comments on the associated legal text?	No comment
	<b>Fault Ride Through</b>	
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?	No comment
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No comment
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	No comment
15	Do you have any information based on the proposed solution in respect of implementation costs?	No comment

## Grid Code Workgroup Consultation Response Proforma

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Any queries on the content of the consultation should be addressed to Chrissie Brown at [Christine.brown1@nationalgrid.com](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Christopher Smith – Christopher.smith3@nationalgrid.com</i>
<b>Company Name:</b>	<i>National Grid Interconnector Holdings Ltd</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### 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	No comments offered

	facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	No comments offered
3	Do you have any other comments?	No comments offered
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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?	No comments offered
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	No comments offered
	<b>Fast Fault Current Injection questions</b>	
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 explained below we believe that options 1 and 2 would have a significant impact on the technology provided and would significantly increase CAPEX cost threatening viability. Therefore National Grid Interconnectors Holdings Ltd would strongly support

		option 3. We would also support the setting up of a separate workgroup to consider a wider range of technical and market based solutions to the technical challenge that is being investigated.
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No comments offered
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 context of product development timescales?	<p>For HVDC systems the power electronics are the limiting technology. The very short thermal timeconstants in the power electronics results in the equipment being sized for the proposed overload capability, as stated in option 1 and option 2 as a full time rating. As a result, the HVDC equipment will need to be oversized for the rated capacity of the project.</p> <p><u>Example 1</u></p> <p>As an example the 1000MW HVDC links are being delivered with dc voltages of <math>\pm 320\text{kV}</math>. Under option 1 to achieve the overload capability the same 1000MW project would be required to delivered with a <math>\pm 500\text{kV}</math>. This has a number of issues for a developer.</p> <ul style="list-style-type: none"> <li>• Underutilised equipment therefore a loss of cost efficiency.</li> <li>• Larger buildings, for example building heights would move from 20m to 24m. This can have a significant effect on the availability of locations and the ability to achieve planning consent.</li> <li>• Reduced supply chain. The higher the operational voltage the smaller the number of suppliers with suitable experience at that voltage for both cables and converters.</li> </ul> <p><u>Example 2</u></p> <p>The supply chain will be required to create a new product design just for the UK. This could possible include the higher rated devices. This has a number of issues for a developer.</p> <ul style="list-style-type: none"> <li>• UK specific designs will attract a premium from the supply chain.</li> <li>• Potential reduction in number of suppliers as they may not chose to produce new products</li> <li>• Ongoing maintenance issues. Higher spares holdings will be required as supplier standard products are not being used.</li> <li>• Higher downtime as Original Equipment Manufacturer only has a small number of staff trained in the UK unique product.</li> </ul>

The use of option 3 allows for a market driven solution and a wider variety of solutions to meet the issues.

National Grid Interconnectors Holdings Ltd would also highlight that the consultation discusses Energy Storage. As per the Section 10 of the Electricity Act 1989, all licenced TSOs (which include all owners of interconnectors) must be certified as unbundled from generation or supply activities. This process of certification establishes the facts of the relationship between entities, and precludes TSOs from having control (not simply a >50% share holding) over a relevant producer or supplier.

As per Ofgem's recent announcement that storage will be licenced as a sub-set of generation, all battery storage is classified as generation. While Section 10 of the Electricity Act does allow Ofgem to exercise some discretion (whereby they can approve certification even if they find that the TSO has control of a producer or supplier) the specific prohibition on exercising this discretion found in Section 10F (9) applies:

"(9A) Except where subsection (9B) applies, the Authority may treat one or more of the five tests in this section as passed if...

...(9B) This subsection applies where the applicant, or a person who controls or has a majority shareholding in the applicant, controls or has a majority shareholding in a person ("A") who operates a generating station and—

- (a) A is a relevant producer or supplier; and
- (b) the generating station is directly physically connected to anything that forms part of the applicant's transmission system or electricity interconnector."

This section of the act specifically prohibits Ofgem utilising their discretion to certify where the storage in question is connected to the licensee's interconnector.

Therefore, requiring interconnector owners to install battery storage appears incongruent with the



		regulations.
6	Do you have any evidence to support your views?	See answer to question 5
7	Do you have any views on the specific costs related to the additional requirements?	<p>Whilst National Grid Interconnectors Holdings Ltd cannot provide detailed cost information in the public domain we would highlight the following to the Regulator:</p> <p>The answer Question 5 provided an example 1. The Regulator can use the FPA submissions for IFA2 and NSL to ascertain an order of magnitude increase as follows:</p> <p>Converter Costs: The Converter for a 1000MW IFA2 type link would cost the same as the NSL link.</p> <p>Cable Costs: Whilst more difficult to directly relate a scaled NSL cost for the IFA2 length would provide an approximation.</p> <p>Developers would need to consider if the additional CAPEX would make investment worth while, irrespective of the present Regulatory regimes.</p> <p>National Grid Interconnectors Holdings Ltd would also re-iterate the reference to cost analysis form other TSO's which have indicated that alternative technologies, such as Synchronous Condensers, provide a cost advantage.</p> <p><a href="http://www.eirgridgroup.com/site-files/library/EirGrid/System-Service-Provision-DNV-KEMA-Report-2012.pdf">http://www.eirgridgroup.com/site-files/library/EirGrid/System-Service-Provision-DNV-KEMA-Report-2012.pdf</a></p>
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	It would appear that the requirements offshore may result in innovative solutions, such as DC connected windfarms, not being allowed to be implemented.
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	No comments offered
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	No comments offered

11	Can you provide any feedback/comments on the associated legal text?	No comments offered No comments offered
	<b>Fault Ride Through</b>	
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?	No comments offered
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No comments offered
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	Yes
15	Do you have any information based on the proposed solution in respect of implementation costs?	No comments offered

## Grid Code Workgroup Consultation Response Proforma

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Any queries on the content of the consultation should be addressed to Chrissie Brown at [Christine.brown1@nationalgrid.com](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>PThomas@nordex-online.com</i>
	<b>Nordex Acciona Wind Power</b>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ol style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ol>

### 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?	See below
2	Do you support the proposed implementation approach?	Yes
3	Do you have any other comments?	No
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No

### 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?	No
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	Yes
	<b>Fast Fault Current Injection questions</b>	
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 1 hasn't been considered by Nordex . Options 2&3

	option (if any) would you prefer?	Either Option is technically feasible: see (4)
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	<p>ECC.6.3.16.3.1</p> <ul style="list-style-type: none"> <li>- Zero voltage does not really occur, can it be further specified what is meant by falling to zero (see also FRT)</li> <li>- Reactive current is required to reach at least 1.25 p.u. of the rating of the power park module. We propose to add a definition for this rating as rated active power. In other words to use active current at rated active power and <math>\cos(\phi) = 1</math> as a basis. Considering the current ratings of expected modules used, this addition to the modification is very important to us.</li> <li>- The forbidden zone lies at either 1.0 p.u. or 1.25 p.u reactive current, where 1.25 p.u. is high. It would make sense and help to require the mean current after 120 ms to stay above this forbidden zone but allow the instantaneous current, due to oscillating behaviour, to temporarily be below 1.0 or 1.25 p.u. Or alternatively, to define a deadband below 1.25 p.u.</li> </ul>
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 context of product development timescales?	See (4)
6	Do you have any evidence to support your views?	Confidential
7	Do you have any views on the specific costs related to the additional requirements?	No
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	N/A
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	None
10	Do you have any views on the banding thresholds for the original and those suggest for the	No

	possible alternative?	
11	Can you provide any feedback/comments on the associated legal text?	See (4)
	<b>Fault Ride Through</b>	
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?	<p>General Comment:-</p> <p>For multiple and sequential FRT performance it is very important that PPU's do not face unrealistic requirements. Whilst FRT tests at zero volt are done and passed in a test environment, Nordex have many hundreds of real FRT measurements. These are both single and multiple three phase faults on transmission connected wind farms taken over several years. The retained voltage has been well above zero volt at the PPU.</p> <p>For multiple / repetitive faults, actual FRT performance strongly depends on realistic values being specified for retained voltage.</p> <p>Nordex therefore believe the GCode requirements should distinguish between symmetrical and asymmetrical faults, and assume realistic retained voltage levels at the PPU.</p>
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	N/A
15	Do you have any information based on the proposed solution in respect of implementation costs?	No

## Grid Code Workgroup Consultation Response Proforma

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Please send your responses by **5pm on 2 October 2017** to [grid.code@nationalgrid.com](mailto:grid.code@nationalgrid.com).

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Any queries on the content of the consultation should be addressed to Chrissie Brown at [Christine.brown1@nationalgrid.com](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Alan Creighton</i>
<b>Company Name:</b>	<i>Northern Powergrid</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ol style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ol>

### 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	The original proposal and the potential alternative proposal on banding would both better facilitate the Grid Code and Distribution Code objectives. We are not convinced that the potential alternative related to

	facilitates the Grid Code Objectives?	the 'stringency' concern would better facilitate these objectives.
2	Do you support the proposed implementation approach?	Yes
3	Do you have any other comments?	No
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No <i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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?	We are not convinced by the arguments put forwards, but have no specific comments on the legality of the original proposal. Legal guidance from BEIS and / or Ofgem would probably be beneficial.
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	It is not really clear from the consultation documentation what the definition of Maximum Capacity is and how it differs from that of Registered Capacity. We note that the Distribution documents relate to Registered Capacity; it seems reasonable to continue to use this existing terminology where possible to help make the changes easier for customers to understand..
	<b>Fast Fault Current Injection questions</b>	
3	What are your views on options	Option 2 & 3 seem more realistic at the moment. If



	1, 2 and 3 as set out in paragraph 4.4 for Fast Fault Current Injection and which option (if any) would you prefer?	there is a need to implement option 1, then this would be best properly considered by a separate GCode WG. We understand the concerns about codifying a requirement to implement what is currently a non-proven solution.
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No
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 context of product development timescales?	No
6	Do you have any evidence to support your views?	N/A
7	Do you have any views on the specific costs related to the additional requirements?	No
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	No response
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	No response
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	We have a slight preference for the possible alternative banding threshold on the basis that it probably require less change now, particularly given that NGET can propose different thresholds in 3 years (from EIF) when there may be more experience and evidence of any additional cost. However the original proposal is likely to be more future proof and it would be reasonable to implement this if there is no evidence that it will materially increase costs.
11	Can you provide any feedback/comments on the associated legal text?	We have separately provided comments on the proposed legal text associated with the Distribution Code to the technical authors, in order that these comments could be factored into the legal text that is currently being drafted for GC0102. It is difficult to form a view of the legal text until a complete set of

		<p>legal text, including the definitions, required to implement RfG is available.</p> <p>If any of the potential alternatives are developed, stakeholders will need to have visibility and the opportunity to comment on the legal text required to implement them.</p>
	<b>Fault Ride Through</b>	
12	<p>Do you support the fault ride through voltage against time curves</p> <p>If not please state why you disagree, what alternative you would recommend and your justification for any alternative?</p>	No response
13	<p>Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?</p>	The proposal seems reasonable to help ensure that the ride through capability can be delivered in practice.
	<b>Other questions</b>	
14	<p>Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?</p>	See response to 11
15	<p>Do you have any information based on the proposed solution in respect of implementation costs?</p>	No response

# Grid Code Workgroup Consultation Response Proforma

## 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<p><i>Isaac Gutierrez</i>  <i>Senior Electrical Engineer</i>  <i>Telephone number work: 01416143104</i>  <i>Mobile: 07761693652</i>  <i>Email: igutierrez2@scottishpower.com</i></p>
<b>Company Name:</b>	<i>Scottishpower Renewable Ltd (UK)</i>
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity. <b>Impact of the consultation on this objective is negative specifically with the requirements of FFCI (option 1 and 2) which will not lead to an economical system</b></li> <li>ii. To facilitate 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). <b>Impact of this consultation on this objective is neutral</b></li> <li>iii. 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. <b>Impact of consultation is negative at the moment if FFCI option 1 or 2 are included in the UK Grid Code</b></li> <li>iv. 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 <b>Impact of this consultation on this objective is negative as National Grid in trying to implement more onerous</b></li> </ul>

	<p style="color: red;">requirement is not complying with European Law</p> <p>v. To promote efficiency in the implementation and administration of the Grid Code arrangements. <b>Impact of consultation is positive on this objective</b></p>
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### 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?	<b>Yes, to some extent. Please refer to comments on objectives</b>
2	Do you support the proposed implementation approach?	<b>No, timescale are too short which are not allowing current wind farm tenderers to exactly know what grid code requirements they have to meet. The implementation date of 17 May 2018 does not provide enough room for timely decision making in regards to electrical balance of plant and wind turbines electrical specifications. SPR considers that a grace period should be implemented until December 2018 so any contract signed after December 2018 should comply with the Grid Code changes otherwise the implementation date of 17 May 2018 will highly impact developers in particular the requirements of FFCI as they are specifically for wind turbines frequency converters (requirement that will not only impact wind turbine frequency converter but the turbine system as a whole please refer to answer below in question 3)</b>
3	Do you have any other comments?	<b>No</b>
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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?	Although currently most SPR power generating plant is able to meet the current UK Grid Code requirements, there is certainly opposition from SPR to National Grid applying more stringent requirements than those currently in RfG to new generators as definitively there will be an impact in CAPEX and OPEX. SPR believes that there is incompatibility with European Law as some of the requirements that National Grid is trying to implement are more onerous than those set out in RfG
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	Yes, as long as there is consistency within the UK Grid Code using this definition
	<b>Fast Fault Current Injection questions</b>	
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?	<p><b>Option 1</b> is not viable in the short term neither in the long term as VSM is a new technology concept that is both undeveloped and untested hence it will take a considerable amount of time for the VSM technology to reach maturity and become commercially viable. In continental Europe none of EU members adhering to the RfG is implementing in their grid codes requirements for VSM. In addition, National Grid is not providing adequate substantiation for the need of VSM.</p> <p><b>Option 2</b> is not viable either from the point of view of CAPEX and OPEX as requiring reactive current priority up to a maximum of 1.25 pu for voltage depression below 0.65 pu will certainly increase the cost of the wind turbines due to the fact that bigger frequency converters will be required to meet this requirement. Not only manufacturers will need to look into the size of converters but also all other electrical and mechanical components within the wind turbine that interact to provide FFCL. In addition, it is not clear what amount of active current is required for voltage depression below 0.65 pu., The modification only states the amount of reactive current required and nothing is said in relation to active current. What shall be done with the active current below 0.65 pu voltage depressions, are we</p>

		<p>allowed to inject zero active current?. Additionally in regards to reactive current is the expectation to inject this amount of current for balance and unbalanced faults?. Is National Grid expecting negative sequence current injection? This might not be possible as for example a Y-delta transformer installed in the nacelle of a wind turbine will tend to block the negative sequence current. Also, it is not clear what should be the active current contribution for voltage depression above 0.65 pu against reactive current contribution i.e. proportion of active current and reactive current. <b>Option 3</b> is to certain extent acceptable and this option is preferred by SPR as this will have no impact in CAPEX and OPEX but the requirement will need to be clarified in relation to the amount of active current that is required for voltage depression below 0.65 pu. The modification only states the amount of reactive current required and nothing is said in relation to active current. What shall be done with the active current below 0.65 pu voltage depressions, are we allowed to inject zero active current?. Additionally in regards to reactive current is the expectation to inject this amount of current for balance and unbalanced faults?. Is National Grid expecting negative sequence current injection? This might not be possible as for example a Y-delta transformer installed in the nacelle of a wind turbine will tend to block the negative sequence current. Also, clarifications will be required for active current contribution for voltage depression above 0.65 pu against reactive current contribution i.e. proportion of active current and reactive current.</p>
4	<p>Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?</p>	<p>A solution applied to the converter to meet FFCI will definitely increase both CAPEX and OPEX for windfarms. As mentioned in SPR answer 3, not only manufacturers will need to look into the size of converters but also all other electrical and mechanical components within the wind turbine that interact to provide FFCI. There should be solutions implemented in the transmission system as well in addition to those that National Grid is seeking to implement on Generators. For example SPT's project Phoenix is an industry initiative that should not be ignored, including the outcome of the work related to the Commercial Model Development for new services essential to Grid Operation. (See slide pack attached from latest Stakeholder Engagement from page 23)</p>

		 <p>Phoenix Stakeholder Event 060717 slide d</p>
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 context of product development timescales?	Please refer to comments in question 3. Additionally some manufacturers have intimated to SPR that there will be a negative cost-benefit case for not offering products to the UK market as is not on their interest to meet these new requirements (as their manufacturing cost will increase and the profits will be extremely marginal) which could definitely lead to increased energy cost in the electricity markets due to unavailability of wind turbines options. In this scenario, the developer will be forced to buy (or not) few products available to the UK market as there will not be a choice of wind turbines. This could also push developers to not go ahead with certain projects at all due to the increased investment costs. In absence of financial support from the government on onshore wind for example, wind farm developers are changing their economic/investment models (e.g. subsidies are being replaced for Power Purchase Agreement) on onshore windfarms and technical requirement like FFCI (option 1 and 2) could harm this kind of ventures and definitely affect development of onshore wind.
6	Do you have any evidence to support your views?	SPR had conversation with wind turbines manufactures although exact details cannot be disclosed due to confidentiality issues. SPR prefers this information to be disclosed directly from wind turbine manufacturers to National Grid
7	Do you have any views on the specific costs related to the additional requirements?	Yes, please refer to both answer 3 and 5
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	No, there should be explicit statements mentioning that new technologies can be utilised to meet the requirements
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	Mainly for small generator Type A and B there will be associated cost with meeting FRT requirements
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	New proposed banding will affect connection in the transmission system in Scotland as SSE and SPT have a different approach to small, medium and large generators. For example Type C generator did not

		have to provide any frequency response now with the new requirements; the generators have to provide frequency response. Although SPR understands why frequency response is required at this level of generation, National Grid should make sure that the current ancillary services market is also implemented for the generator under the RfG requirements that are to be included in the UK Grid Code.
11	Can you provide any feedback/comments on the associated legal text?	Legal text seems ok although there are missing comments made during the legal text revision meeting. A second meeting just for legal text review shall be held
	<b>Fault Ride Through</b>	
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?	Yes
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No,
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	No as it is not taking into consideration yet the impact of FFCI. In the consultation document the following is mentioned: <i>“Without FFCI as proposed (does this mean VSM option?), the proposal will need to lower the value of <math>U_{ret}</math> (from 0.1pu to 0.05pu) and even then, this value would only appropriate in the short term before a further review is likely to be required.”</i> . The final legal text will depend on both the consultation responses and defining values like $U_{ref}$ properly under the absence of VSM
15	Do you have any information based on the proposed solution in respect of implementation costs?	No



## Grid Code Workgroup Consultation Response Proforma

### 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](mailto:grid.code@nationalgrid.com).

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Any queries on the content of the consultation should be addressed to Chrissie Brown at [Christine.brown1@nationalgrid.com](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	Marko Grizelj, <a href="mailto:marko.grizelj@siemens.com">marko.grizelj@siemens.com</a> , 01614466930
<b>Company Name:</b>	Siemens
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p>In general, the work group consultation was a success with a number of key topics being addressed. Unfortunately, due to the lack of manufacturer presence, particularly for HVDC, a number of topics were not addressed in sufficient detail.</p> <p>Siemens's views on particular matters within this consultation will be reflected in the answers to the questions below.</p> <p><i>For reference, the Grid Code objectives are:</i></p> <ol style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ol>

## 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?	
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

## 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 EU definition of Maximum Capacity instead of the GB definition of "Registered	

	Capacity”?	
	<b>Fast Fault Current Injection questions</b>	
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?	<p>Option 1 bears a heavy impact on the current designs of the converter system, both in terms of hardware and software. Successful implementation of Option 1 would require a coordinated and focused effort from the industry and the TSO to ensure that an economical and effective solution is developed.</p> <p>Option 2 simply bears an impact on the hardware costs. Supplying current over 1.0pu rated current may in some specific cases be possible to a certain degree (taking into consideration various project parameters). However, specifying a blanket 1.25 pu rated current supply will ensure that costs definitely increase and would further limit competitiveness of HVDC technology.</p> <p>Option 3 is the preferred solution given the current status of the technology and market. As mentioned previously, Siemens’s understands that Option 3 on its own will not solve the predicted future issues with the network. Alternative options should be investigated in a dedicated and focused working group with the appropriate representation from the industry.</p>
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	<p>Siemens considers that current options discussed above are applicable to systems connected to the UK main network. The Options should not be forced on to Remote End Converters and DC Connected Power Park Modules, as the particulars of an offshore network and the related control systems are very different to those onshore*.</p> <p>Therefore flexibility should be included to allow an optimal solution for FFCI offshore. This can include wording to ensure that the remote end converter <u>and/or</u> DC Connected Power Park modules can coordinate their contribution according to the implementation of the protection system and the limits of the technology.</p> <p>*AC Protection system for offshore applications can be design according to the implemented short circuit contributions from the respective systems.</p>
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 context of product development timescales?	
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?	With respect to the Remote End Converters, the FFCI requirements would not only drive costs up for Option 1 and 2 and thus make HVDC offshore transmission significantly less competitive than its AC counterpart but it would also eliminate possible technological alternatives. This includes Siemens's offshore diode rectifier solution (SGA-DRU). The SGA-DRU was developed as a result of a focused effort to further reduce the cost of offshore transmission systems whilst still ensuring a reliable connection onshore. The passive nature of SGA-DRU would mean that the current requirements on FFCI would not be met. SGA-DRU would rely on the current contribution from the Power park modules.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	Siemens's view is that in the case of an offshore connection, the offshore system is decoupled from the onshore grid in using a HVDC connection. Therefore requirements as set out for onshore connected HVDC converters should not automatically apply to offshore as this severely limits innovation in the technology and imposes unnecessary costs that are eventually transferred to the end user.  Siemens would ensure that alternative solutions, which still comply with onshore system stability requirements and retain expected reliability figures, should not be discounted due to excessively onerous offshore requirements, particularly when those same requirements can be met by the corresponding power park modules connected to the system.
	<b>Banding questions</b>	
9	What are the specific costs related to the additional 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?	
	<b>Fault Ride Through</b>	
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?	
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	It is not immediately clear that alternative requirements can be agreed for Remote End Converters and DC Connected Power park modules (within the framework of the EU grid code).
15	Do you have any information based on the proposed solution in respect of implementation costs?	

## Grid Code Workgroup Consultation Response Proforma

### 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.

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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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Graeme Vincent</i> <i>Graeme.vincent@spenergynetworks.co.uk</i>
<b>Company Name:</b>	<i>SP Energy Networks</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b> <b>(Please include any issues, suggestions or queries)</b>	<p><i>For reference, the Grid Code objectives are:</i></p> <ul style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ul>

### Standard Workgroup Consultation questions

Q	Question	Response
1	Do you believe that GC0100 Original proposal, or any potential alternatives for change	We believe that the proposals outlined in the GC0100 Original Proposal better facilitate the Grid Code Objectives.

	that you wish to suggest, better facilitates the Grid Code Objectives?	
2	Do you support the proposed implementation approach?	Yes
3	Do you have any other comments?	In general, it would have been helpful to have provided further information (eg summary of results and what on the studies which have been undertaken which have enabled NGET certain conclusions to be reached. Reading through
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No

### 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?	Whilst we have some sympathy with the views being expressed this is not the interpretation that we understand nor the expectation of those involved during the development and drafting process of the network codes at the European level..
2	Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	As long as the definition is made clear and unambiguous and is used in a consistent manner by all parties and all Codes then the use of maximum capacity as a definition should be okay. However, confusion may arise if the terms are used interchangeably and
	<b>Fast Fault Current Injection questions</b>	
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?	No particular comment, though specification of a solution which is not yet commercially or technical proven at this level is perhaps not the ideal solution and we would support the establishment of an interim solution which would allow some further development period to establish a technologically proven solution.

4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	No response.
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 context of product development timescales?	See response to 3 above.
6	Do you have any evidence to support your views?	No response
7	Do you have any views on the specific costs related to the additional requirements?	No response
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	No response
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	No response
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	<p>We agree with the proposed (original) proposal as the proposed thresholds more closely align with the existing requirements in Scotland and therefore continue to ensure the operation of the Electricity system in Scotland. We believe that this reflects the direction of travel required to adapt to the changing system background with an ever increasing penetration of distributed generation connecting to Distribution networks. Adopting a higher set more closely aligned to those of Central Europe does not seem to be an appropriate solution given the relative magnitude of the CE system compared to that in GB. In addition given the evidence that a number of European TSOs are actively trying to establish lower bandings than the maximum values proposed in the RfG, we believe alignment to these higher levels which other European TSOs are seeking to reduce is not an appropriate solution.</p> <p>We do appreciate that lowering these thresholds is likely to have an increase in associated compliance assessment and monitoring costs for other parties</p>



		including DNOs, however, as stated within the document it is likely that exist smaller generators would need to have certain technical requirements to meet the future requirements for the management and operation of the national electricity transmission network.
11	Can you provide any feedback/comments on the associated legal text?	Whilst I appreciate that the track changes are present to assist the reader understand the changes which have been made, we did find it quite difficult to follow what a 'clean' version of the text would look like. Also as we have a limited time to read and review all the associated legal text associated with this modification and that of GC0101 (both distribution and transmission elements.) which has limited us to high level comments only at this stage.
	<b>Fault Ride Through</b>	
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?	No response
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	No we don't have any specific views on this aspect, though acknowledge that changes will be required to align with RfG requirements.
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	Whilst I appreciate that the track changes are present to assist the reader understand the changes which have been made, we did find it quite difficult to follow what a 'clean' version of the text would look like but believe so.
15	Do you have any information based on the proposed solution in respect of implementation costs?	No response

## Grid Code Workgroup Consultation Response Proforma

### 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](mailto: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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Garth Graham (garth.graham@sse.com)</i>
<b>Company Name:</b>	SSE
<p><b>Please express your views regarding the Workgroup Consultation, including rationale.</b></p> <p><b>(Please include any issues, suggestions or queries)</b></p>	<p><i>For reference, the Grid Code objectives are:</i></p> <ol style="list-style-type: none"> <li>i. To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity</li> <li>ii. To facilitate 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)</li> <li>iii. 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</li> <li>iv. 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</li> <li>v. To promote efficiency in the implementation and administration of the Grid Code arrangements</li> </ol>

### 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	<p><b>ORIGINAL</b></p> <p>We do not believe that GC0100 does better facilitate the Grid Code Objectives as it <u>fails to discharge</u> the</p>

	<p>facilitates the Grid Code Objectives?</p>	<p>obligations imposed upon the licensee by its license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.</p> <p>As the National Grid presentation to EnergyUK on 23<sup>rd</sup> May 2017 noted, in respect of the three connection codes (RfG, DCC and HVDC), the aim of these Network Codes is to “<i>Set consistent technical requirements across EU for new connections of user equipment (e.g. generation / interconnectors)</i>”. This accords with the recitals of the RfG, DCC and HVDC Network Codes.</p> <p>However, as both the Proposer’s explanations to the Workgroup and the legal text makes clear there is not even to be a set of consistent technical requirements across GB (let alone with the EU) for new connections as a result of GC0100 as, for example, apparently many of these multiple technical requirements are, instead, to be determined by the network operate alone, in a non-open / non-transparent way, and applied differently to each new connection. This non-harmonised approach is inconsistent with the EU Network Codes.</p> <p>Furthermore, the imposition of additional costs (such as the twelve items listed on pages 59-60 of the Workgroup consultation document) will affect cross border trade between Member States as well as within the Member State (between GB and Northern Ireland) and as such will not be in compliance with Article 8(7) of Regulation 714/2009.</p> <p>In addition to not being better in terms of Objective (iv) the GC0100 Original does better facilitate the Grid Code Objectives (ii), (iii) and (v) as it:</p> <p>fails to facilitate competition in the generation and supply of electricity (by not complying with EU law – see above – and imposing additional costs on GB generation);</p> <p>fails to promote security and efficiency in electricity generation (by not complying with EU law – see above); and</p> <p>fails to promote efficiency in the implementation and administration of the Grid Code arrangements (by not</p>
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complying with EU law – see above).

#### **POTENTIAL ALTERNATIVE (a)**

For the reasons set out above, given that this potential alternative (as described on page 54 of the Workgroup consultation) is based on the Original then it too fails to better facilitate the Grid Code Objectives in terms, primarily, of (iv) but also (i), (iii) and (v).

Nevertheless, in respect of the specific aspect of this potential alternative as regards the level of banding; and taking into account the previous substantial body of evidence provided by Workgroup members and stakeholders as part of the GC048 Workgroup deliberations and consultations; then taken in isolation this aspect would (absent the Original) better facilitate the Grid Code Objectives in terms, primarily, of (ii) competition in the generation and supply of electricity for the reasons provided to the GC048 Workgroup deliberations and consultations.

#### **POTENTIAL ALTERNATIVE (b)**

We do believe that potential alternative (b) (as described on page 55-62) of the Workgroup consultation) does better facilitate the Grid Code Objectives as it ensures the discharging of the obligations imposed upon the licensee by its license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.

As the National Grid presentation to EnergyUK on 23<sup>rd</sup> May 2017 noted, in respect of the three connection codes (RfG, DCC and HVDC), the aim of these Network Codes is to “*Set consistent technical requirements across EU for new connections of user equipment (e.g. generation / interconnectors)*”. This accords with the recitals of the RfG, DCC and HVDC Network Codes.

It is clear that this potential alternative (b) seeks to ensure that only those obligations applicable to newly connecting parties that fall within the scope of the EU Network Codes will be implemented into the GB national network codes (such as, but not limited to, the Grid Code and Distribution Code) as required by

		<p>those EU Network Codes.</p> <p>As detailed on pages 55-62 of the Workgroup consultation document there are clear reasons as to why this is required.</p> <p>In addition to being better in terms of Objective (iv) the potential alternative (b) also better facilitate the Grid Code Objectives (ii), (iii) and (v) as it:</p> <p>as by complying with EU law – see above – and not imposing additional costs (over and above those required by law) on GB generation it facilitates competition in the generation and supply of electricity;</p> <p>as by complying with EU law – see above – and not imposing additional costs (over and above those required by law) on GB generation it promotes security and efficiency in electricity generation; and</p> <p>as by complying with EU law – see above – and not imposing additional costs (over and above those required by law) on GB generation it promotes efficiency in the implementation and administration of the Grid Code arrangements.</p>
2	Do you support the proposed implementation approach?	We note the proposed implementation approach set out in Section 7 and support this.
3	Do you have any other comments?	<p>We note the Workgroup deliberations in respect of the <i>affect on cross border trade</i>.</p> <p>The Workgroup may wish to take due notice of the Commission's guidance in this regard which is available at:</p> <p><a href="http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3A126113">http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3A126113</a></p> <p>It sets out the following:</p> <p><b>"the concept of "trade between EU countries":</b>  <i>the concept of "trade" is not limited to traditional exchanges of goods and services across borders. It is a wider concept, covering all cross-border economic activity including establishment. This interpretation is consistent with the fundamental objective of the Treaty to promote free movement of goods, services, persons and capital. The requirement that there must be an effect on trade "between EU countries" implies that there must be an impact on cross-border economic activity involving at</i></p>

		<p>least two EU countries;</p> <p><b>the notion "may affect":</b> the function of the notion "may affect" is to define the nature of the required impact on trade between EU countries. According to the standard test developed by the Court of Justice, the notion "may affect" implies that it must be possible to foresee with a sufficient degree of probability on the basis of a set of objective factors of law or fact that the agreement or practice may have an influence, direct or indirect, actual or potential, on the pattern of trade between EU countries. In cases where the agreement or practice is liable to affect the competitive structure inside the EU, EU law jurisdiction is established".</p>
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	No.

### 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?	<p>We fully support the concerns set out on pages 55-62 of the Workgroup Consultation as regards the need to remove (from the proposed Original) the more stringent requirements when implementing the EU Network Codes into the GB national network codes (namely the Grid Code and Distribution Code).</p> <p>We note that to date the deliberations within the Workgroup have tended to be focused by those who hold a contrary view on the 'policy' position; namely that those who hold this contrary view (which is primarily network operators) seek to retain the existing status quo obligations set out in both the Grid Code and Distribution Code on new connecting parties who in the future will be encompassed within the scope of the EU Network Codes.</p> <p>However, this is at odds with both the position of BEIS and Ofgem who have both acknowledges that it may be necessary to remove or amend existing GB national network code obligations that conflict with the EU Network Code obligations.</p> <p>This position was most recently reaffirmed by Ofgem in their 30<sup>th</sup> August 2017 letter (in respect of GC0103):</p>

*“To ensure the full and timely implementation of the EU Connection Codes, we are therefore encouraging the Grid Code Panel to focus on:*

*a) bringing forward any new Grid Code provisions made necessary by virtue of the EU Connection Codes; and*

*b) removing or amending any existing Grid Code provisions which may conflict with the EU Connection Codes.” [emphasis added]*

Whilst we can appreciate that some Workgroup members may hold a contrary view from a ‘policy’ perspective, we note that, in our view, this is a matter of ‘law’ (not ‘policy’) and that no counter legal arguments have been forthcoming.

Furthermore, even if such arguments were to come forward we would strongly argue that the Workgroup should, nevertheless, put forward this potential alternative as a formal Alternative so that Ofgem (who are the correct body to consider this matter) are able to determine on this matter of law by choosing between the two (the Original and this potential alternative).

Failure to put forward this as a formal Alternative runs the serious risk that Ofgem will either:

(a) be unable to determine on GC0100 (and have to send it back); or

(b) (depending on the CMP261 deliberations around the legality or otherwise of post send back changes to WACMs) reject the Original proposal, and any other Alternative(s) related to it, as it does not address the ‘more stringent’ matter which is in contravention of EU law.

Either of these necessary additional aspects will, if applicable, delay the implementation of the GC0100 solution which is not in the wider interest of all concerned.

Notwithstanding any Ofgem decision on GC0100 it should also be noted that all TSOs, DSO and relevant network operators are bound to comply with the applicable EU law even if this is in contravention of any national law provisions (such as, but not limited to, their respective licences or the national network codes including, but not limited to, the Grid Code or Distribution Code). They cannot, for

		<p>example, rely on any national provisions that place them in contravention of their EU law duties. Newly connecting parties which fall within the scope of the EU Network Codes could, in those circumstances where EU law has been contravened, seek full legal redress against the contravening party or parties in the national and / or EU courts.</p>
2	<p>Are you comfortable with using the EU definition of Maximum Capacity instead of the GB definition of “Registered Capacity”?</p>	<p>As we set out elsewhere in this consultation response, we believe that the EU Network Codes need to be fully implemented into the GB national network codes – which is not what the GC0100 Original does.</p> <p>In this respect we believe that all the definitions within the EU Network Codes (and not just limited to the ‘Maximum Capacity’ definition alone) should be used instead of the GB definitions where both exist.</p>
	<p><b>Fast Fault Current Injection questions</b></p>	
3	<p>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?</p>	<p>We are concerned about proposing technology which is still classified as ‘experimental’ (i.e. ‘VSM’) as a <i>mandatory</i> requirement for generators.</p> <p>We do not feel that the option of synchronous compensators which are proven sources of FFCI has yet been fully explored with accurate costs which reflect making use of <b>existing</b> generators rather than new build synchronous compensators.</p> <p>Intuitively it seems wrong not to investigate how existing large thermal plant and, in particular, embedded thermal rotating plant (that has recently been added to the system to take part in the capacity market) could be incentivised to provide this service when they are otherwise out of merit (e.g by means of retrospectively fitting clutches to enable them to run as synchronous compensators), particularly in light of recent reduction in ‘embedded benefits’.</p> <p>Such a solution is technical demonstrable and if it could be incentivised by competitive tenders with time periods of &gt; 4 years, could provide a cheaper and more certain means of providing FFCI than VSM.</p>
4	<p>Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the</p>	<p>See our answer to Question 3 above.</p>



	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 context of product development timescales?	
6	Do you have any evidence to support your views?	<p>Clutches have been fitted to thermal rotating generators up to 300 MW in size and are routinely fitted to peaking plants in the US as a means of adding value by running as a Synchronous Compensator when out of merit.</p> <p>If there was a commercial market in providing FFCI services then it would incentivise manufacturers to design clutches that could be easily retrofitted.</p>
7	Do you have any views on the specific costs related to the additional requirements?	
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	The specific costs related to requiring GB generators to operate to the lower banding thresholds (such as those proposed with the Original) when compared with the banding values set out in the Table 1 (Article 5) of the RfG have already been provided by us in response to the GC048 consultation response. For the sake of brevity we avoid repeating those detailed costings here as we understand the GC0100 Workgroup is already aware of this costing information.
10	Do you have any views on the banding thresholds for the original and those suggest for the possible alternative?	<p>Notwithstanding our comments under Question 1 (applicable objectives) above, we believe that the application of the banding values set out in the Table 1 (Article 5) of the RfG (and shown in yellow highlight on page 46 of the Workgroup Consultation) for a three year period is the pragmatic way forward.</p> <p>It ensures that newly connecting GB generators are not subject to the sub-optimal solution which would arise if the low banding levels proposed with the Original were to be adopted.</p>

11	Can you provide any feedback/comments on the associated legal text?	
	<b>Fault Ride Through</b>	
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?	We support the proposed FRT curves.
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	We support in principle the proposed change which avoids the risk of tripping of G59 protection, subject to this not being more stringent than the requirements of the EU Network Codes.
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	<p>We <u>do not</u> agree that the draft legal text contained in Annex 2 and 3 delivers the intent of the solution outlined in Section 3.</p> <p>This is because the intent of the GC0100 solution is to ensure that all the requisite applicable articles of the EU Network Codes (RfG, DCC and HVDC) are implemented into the national network codes (namely the Grid Code and Distribution Code).</p> <p>However, there is <u>no evidence</u> provided that clearly maps over each of the EU Network Code obligations (that GC0100 is intended to be implemented into the national network codes) to the draft legal text.</p> <p>It was clear from the August Workgroup review of the draft legal text for GC0100 that multiple gaps and inconsistency existed (at that time) between the draft legal text and the delivery of the intent of the solution outlined in Section 3 of the Workgroup consultation. Our review of the latest draft legal text shows that many gaps and inconsistencies still exist.</p> <p>Absent a clear mapping of the EU Network Code articles to the draft legal text we cannot see how either (a) the Workgroup; or (b) stakeholders; or (c) the requisite Code Panel(s); or (d) Ofgem can say that the draft legal text does deliver the solution outlined in Section 3.</p> <p>Notwithstanding the above, we also note that the draft legal text appears to be in direct contravention</p>

of the EU Network Codes.

By way of example, the suggested use of the existing national definitions, amended in part by the EU Network Code requirements, has the unintended (or possibly intended?) consequence that it will not be clear to existing connected parties that, in fact, they are not actually bound by the EU Network Code amended definitions within the Grid Code (or Distribution Code) as this would be applying those EU Network Codes definitions (and associated obligations) to existing connected parties without either (1) a CBA being undertaken or (2) those parties having substantially modified their respective connection agreement(s) which would be in direct contravention of the RfG, DCC and HVDC Network Codes.

Another, more specific example (one of many) is the suggested wording of ECC2.1:

*“For the purposes of the Grid Code, physical quantities such as current or voltage are not defined terms as their meaning will vary depending upon the context of the obligation. For example, voltage could mean positive phase sequence root means square voltage, instantaneous voltage, phase to phase voltage, phase to earth voltage. The same issue equally applies to current, and it therefore felt that in view of these variations the terms current and voltage should remain undefined with the meaning depending upon the context of the application. The European Connection Codes define requirements of current and voltage but they have not been adopted as part of EU implementation.” [emphasis added]*

As the wording in ECC2.1 acknowledges, there is an EU Network Codes definition for ‘voltage’ (see RfG Article 2 (3)) namely:

*“‘voltage’ means the difference in electrical potential between two points measured as the root-mean-square value of the positive sequence phase-to-phase voltages at fundamental frequency”*

However, despite this, according to ECC2.1 this is not to be adopted for the purposes of GB.

Not only is the entirely without merit and in contravention of the defect (as the objective of GC0100 is to implement the EU Network Codes in their entirety) it also begs a number of questions;

		<p>such as:</p> <p>‘what other parts of the EU Connection Network Codes are also ‘conveniently’ to be ignored (according to the draft legal text) and not adopted as part of GC0100?’;</p> <p>‘what additional parts of the EU Connection Network Codes (not already included in the draft legal text) can also ‘conveniently’ now be ignored and not adopted as part of GC0100?’</p> <p>We were unaware that the implementation of the EU Network Codes within the GB national network codes was to be on the basis of such an ‘a la carte’ approach.</p> <p>This being the case we feel certain that generators, demand facilities and HVDC links newly connecting to the GB network will, likewise, wish to see this ‘a la carte’ approach being applied to other parts of the EU Network Codes when it comes to GB implementation that are ‘convenient’ to them.</p>
15	Do you have any information based on the proposed solution in respect of implementation costs?	Some of the additional implementation costs in respect of the proposed solution are set out on pages 59-60.

## Grid Code Workgroup Consultation Response Proforma

### 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.

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Any queries on the content of the consultation should be addressed to Chrissie Brown at [Christine.brown1@nationalgrid.com](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<b>Kamran Sharifabadi Dr. Eng.</b> Leading Advisor Power Transmission Technologies Mobile: +47 48099053 Email: <a href="mailto:kamsh@statoil.com">kamsh@statoil.com</a>
<b>Company Name:</b>	<b>STATOIL</b>
<b>Please express your views regarding the Workgroup Consultation, including rationale.</b>  <b>(Please include any issues, suggestions or queries)</b>	<ul style="list-style-type: none"> <li>We are convinced that public consultations are important. However, in addition to the meetings, we need to ensure a better platform for exchange of information and consultation. The consultations, most of them with very short response time and running through the summer are not helping stakeholders to consolidate their views in more constructive ways.</li> </ul>

### 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?	<ul style="list-style-type: none"> <li>Statoil believes that the issue of <i>fault current injection</i> has not been sufficiently assessed in order to rush for implementing the changes for the ongoing revision of the grid codes. The <i>Requirements for Generators (RfG)</i> network code does not imply any necessary changes to the current reactive current injection of today's UK grid code. The recently updated IGDs (and the new HPoPIPS) suggest the possible need for technological changes to meet stated requirements. But to face such technology changes, the industry requires a basis of verified data, as a result of system studies and firmly established system design criteria.</li> <li>The proposed reactive current injection requirements would exceed today's industry standards, leading to additional costs related</li> </ul>

		<p>to increasing the current hardware capabilities, R&amp;D, certification, testing and validation 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,</p> <ul style="list-style-type: none"> <li>• Statoil believes that imposing requirements exceeding the industry standards and current technology capabilities must be based on a comprehensive Cost Benefit Analysis.</li> <li>• It is critical to have a common understanding of system needs for scenarios today and in the future. <b>European discussions</b> on power system needs with high renewable penetration levels of variable renewable energy sources and power electronics levels have been focusing on aspects with a <b>time horizon beyond May 2018</b> to prepare necessary frameworks allowing national TSOs to specify minimum technical requirements. This is currently addressed in the <b>ENTSO-E expert group on fast fault current. We do not understand why for National grid is so imperative to include such requirementst in the upcoming revision of the grid code.</b></li> <li>• On the concept of grid forming converter controls, the wind industry believes that TSOs should focus on breaking down the characteristics of being grid forming and developing a framework for defining future requirements. National TSOs should use such frameworks specifying the minimum technical requirements needed at the connection point to maintain system stability. <b>Minimum technical specification should be technology neutral where possible.</b> They should not be translated into specific and/or preferred technical solutions like e.g. Virtual Synchronous Machines. The development of specific technical solutions should be left open for the industry.</li> <li>• To avoid unnecessary system costs, the specification of future <b>system requirements must be based on transparent system studies and firmly established system design criteria.</b> This will result in a common rationale and technical background for new requirements. The result will also be that potential later adjustments will have a much more robust starting point. In general, a more transparent common rationale will also result in a clearer signal to the industry in order to understand what longer-term developments are needed to support future system security</li> </ul>
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		<p>while efficiently integrating renewables.</p> <ul style="list-style-type: none"> <li>Scientific system studies modelling the behaviour of network and connected equipment are essential to define proper connection &amp; operation requirements. However, <b>system studies need to be complemented by simulations and real tests</b> to fully understand the potential behaviour of different technologies under all situations (normal, during and after faults). Not doing so risks an under/over estimation of technology performance during times of system stress.</li> </ul>
2	Do you support the proposed implementation approach?	NO
3	Do you have any other comments?	
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 EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	Yes.
	<b>Fast Fault Current Injection questions</b>	
3	What are your views on options	Option 3

	1, 2 and 3 as set out in paragraph 4.4 for Fast Fault Current Injection and which option (if any) would you prefer?	
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 context of product development timescales?	
6	Do you have any evidence to support your views?	NG should ask the question to Vendors & manufactures of the equipment. We cannot share any of the Vendor material, development plans with a third party e.g. National Grid.
7	Do you have any views on the specific costs related to the additional requirements?	Answer as above (question 6) Statoil, cannot share confidential information.
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park modules sufficient to facilitate future new technology?	NO
	<b>Banding questions</b>	
9	What are the specific costs related to the additional requirements?	NG should ask the question to Vendors & manufactures of the equipment. Statoil cannot share any of the Vendor material, costing or development plans with a third party e.g. National Grid.
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?	
	<b>Fault Ride Through</b>	
12	Do you support the fault ride through voltage against time curves If not please state why you disagree, what alternative you	NO, we don't support the proposal.



	would recommend and your justification for any alternative?	
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	
15	Do you have any information based on the proposed solution in respect of implementation costs?	Yes. But Statoil cannot share any of the Vendor material, CAPEX, development plans with a third party e.g. National Grid.

## Grid Code Workgroup Consultation Response Proforma

### 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.

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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](mailto:Christine.brown1@nationalgrid.com)

<b>Respondent:</b>	<i>Daniel Fraile – Senior Analyst- Grids and Markets Daniel.fraile@windeurope.org</i>
<b>Company Name:</b>	<i>WindEurope, asbl</i>
<b>Please express your views regarding the Workgroup Consultation, including rationale.  (Please include any issues, suggestions or queries)</b>	<p>The consultations, most of them with very short response time and running through the summer are not helping stakeholders to consolidate their views in more constructive ways.</p> <p>We are convinced that concerns expressed in the following answers to the consultation need to be properly addressed by National Grid.</p> <p>Overall WindEurope expects a better platform for exchange</p>

### 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?	<p>In order to avoid unnecessary system costs, the specification of future system requirements must be based on transparent system studies and firmly established system design criteria. This will result in a common rationale and technical background for new requirements. The result will also be that potential later adjustments will have a much more robust starting point.</p> <p>In general, a more transparent common rationale will also result in a clearer signal to the industry in order to understand what longer-term developments are needed to support future system security while efficiently integrating renewables.</p>
2	Do you support the proposed implementation approach?	

3	Do you have any other comments?	
4	Do you wish to raise a WG Consultation Alternative Request for the Workgroup to consider?	<i>If yes, please complete a WG Consultation Alternative Request form, available on National Grid's website, <a href="http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/">http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/modifications/forms-and-guidance/</a> and return to the Grid Code inbox at <a href="mailto:grid.code@nationalgrid.com">grid.code@nationalgrid.com</a></i>

### 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 EU definition of Maximum Capacity instead of the GB definition of "Registered Capacity"?	
	<b>Fast Fault Current Injection questions</b>	
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?	WindEurope believes that the issue of <i>fault current injection</i> has not been sufficiently assessed and has been rushed for the implementation of the changes for the ongoing revision of the grid codes. The <i>Requirements for Generators (RfG)</i> network code does not imply any necessary changes to the current reactive current injection of today's UK grid code. The recently updated IGDs (and the new HPOPIPS) suggest the possible need for technological changes to meet stated requirements. But to face such

		technology changes, the industry requires a basis of verified data, as a result of system studies and firmly established system design criteria
4	Do you have any alternative fast fault current injection solutions noting that the requirement applies to the Converter not the wider Power System?	On the concept of grid forming converter controls, the wind industry believes that TSOs should focus on breaking down the characteristics of being grid forming and developing a framework for defining future requirements. National TSOs should use such frameworks specifying the minimum technical requirements needed at the connection point to maintain system stability. <b>Minimum technical specification should be technology neutral where possible.</b> They should not be translated into specific and/or preferred technical solutions like e.g. Virtual Synchronous Machines. The development of specific technical solutions should be left open for the industry.
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 context of product development timescales?	The proposed reactive current injection requirements would exceed today's industry standards, leading to additional costs-related to increasing the current hardware capabilities, R&D, certification, testing and validation 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,
6	Do you have any evidence to support your views?	WindEurope believes that imposing requirements exceeding the industry standards and current technology capabilities must be based on a comprehensive Cost Benefit Analysis. It is critical to have a common understanding of system needs for scenarios today and in the future. European discussions on power system needs with high renewable penetration levels of variable renewable energy sources and power electronics levels have been focusing on aspects with a time horizon beyond May 2018 to prepare necessary frameworks allowing national TSOs to specify minimum technical requirements. This is currently addressed in the ENTSO-E expert group on fast fault current. We do not understand why for National grid is so imperative to include such requirements in the upcoming revision of the grid code.
7	Do you have any views on the specific costs related to the additional requirements?	
8	Is the current proposed wording for the remote end HVDC and DC Connected Power park	

	modules sufficient to facilitate future new technology?	
	<b>Banding questions</b>	
9	What are the specific costs related to the additional 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?	
	<b>Fault Ride Through</b>	
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?	
13	Do you have any specific views about the proposal to modify the stage 2 under voltage protection for distributed generation interface protection?	
	<b>Other questions</b>	
14	Does the Legal drafting contained in annex 2 and 3 deliver the intent of the solution outlined in section 3?	
15	Do you have any information based on the proposed solution in respect of implementation costs?	