

Modification proposal:	<b>Grid Code GC0075: Hybrid STATCOMs/SVCs</b>		
Decision:	The Authority <sup>1</sup> has decided to approve <sup>2</sup> this modification		
Target audience:	National Grid Electricity Transmission plc (NGET), the Grid Code Review Panel, Grid Code users and other interested parties		
Date of publication:	10 May 2016	Implementation date:	24 May 2016

## Background

National Grid Electricity Transmission plc (NGET) is the System Operator (SO) for the National Electricity Transmission System (NETS). NGET is responsible for ensuring the stable and secure operation of the whole of the NETS. The Grid Code specifies the technical requirements for users connecting to, and using, the NETS.

The Connection Conditions (CC) of the Grid Code CC.6.3.6 (b) require various parties (including all generators) to provide 'continuous voltage control', which is further described in CC.A.7.2.3.1 such as that 90% of relevant reactive capability must be provided within 1 second of a sufficiently large step change in voltage. The requirements surrounding the term 'continuous voltage control' have been interpreted differently, especially in the case of Power Park Modules (PPMs), which typically would require the installation of additional dynamic reactive compensation equipment to provide the full range of required capability. There is likely to be a large increase in the volume of PPMs in the future, displacing conventional synchronous generators whose technical characteristics contain greater inherent dynamic reactive capability. Application of different interpretations to PPMs could lead to insufficient voltage control available to the SO, or inefficiency in the overall solution, resulting in undue costs either on the transmission system or for generators.

Where additional reactive compensation equipment is required for PPMs, a number of options are available. These include dynamic reactive compensation equipment such as Static Compensators (STATCOMs) or Static VAR Compensators (SVCs), and static reactive compensation equipment such as capacitors and reactors and Hybrid STATCOMs/SVCs. These options provide different abilities for providing voltage control at different costs. Hybrid STATCOMs/SVCs are proposed as a cost effective solution for PPMs. However, this solution cannot provide fully continuous voltage control, mainly due to mechanical issues. Therefore, a workgroup carried out a review to identify clear requirements that would strike a balance between the need for stable and secure operation of the NETS and the cost impact on relevant parties, whilst remaining technologically neutral so as to facilitate the deployment of cost effective Hybrid STATCOMs/SVCs.

CC.6.3.15.1 and CC.6.3.15.2 of the Grid Code define 'fault ride through' requirements for generators, ie to remain connected to the system during faults and voltage dips. These do not explicitly cover reactive compensation equipment. They have been interpreted such that the reactive compensation equipment installed at PPMs does not have to remain connected during a fault. This would reduce the voltage control available to the SO for post-fault recovery and pose a risk of voltage drop spreading across the network.

In response to these issues, Grid Code modification GC0075 proposes to:

<sup>1</sup> References to the "Authority", "Ofgem", "we" and "our" are used interchangeably in this document. The Authority refers to GEMA, the Gas and Electricity Markets Authority. The Office of Gas and Electricity Markets (Ofgem) supports GEMA in its day to day work. This decision is made by or on behalf of GEMA.

<sup>2</sup> This document is notice of the reasons for this decision as required by section 49A of the Electricity Act 1989.

- Clarify the requirements surrounding 'continuous voltage control' to strike a balance between performance and costs, taking into account the voltage control abilities of PPMs with current technological abilities and system requirements, including facilitating the use of Hybrid STATCOMs/SVCs to provide voltage control for PPMs; and
- Redefine the 'fault ride through' requirements, to remove uncertainty by referring explicitly to the requirements for 'plant and apparatus' under which PPMs' reactive compensation equipment is classed.

### **The modification proposal**

GC0075 arose from an issue regarding 'continuous voltage control' first raised by a wind farm developer at the Grid Code Review Panel (GCRP) in May 2010. The issue was discussed by the GCRP, which concluded that a Grid Code modification was required to clarify the meaning of 'continuous voltage control'. At a workshop in September 2013, manufacturers put forward a case for the use of Hybrid STATCOMs/SVCs on cost and capability grounds. The GCRP decided to establish a workgroup to consider this in detail.

To determine the appropriate level of voltage control capability to ensure the robustness and integrity of the NETS, the GC0075 Workgroup considered a variety of studies and statistical analysis of weather events. This was to determine the level of repeatability required to respond to a sequence of events, requiring large changes in reactive power over a short time period. This included a review of historical data related to lightning strikes and winter storms. It also included a discussion on Delayed Auto Reclose (DAR) schemes, how they operate, and what effect they have on system voltage. It was found that, with the use of DAR, following response to an event, a maximum of 15 seconds should be allowed prior to responding to a subsequent event.

The Workgroup identified the following factors limiting the speed or frequency response by Hybrid STATCOMs/SVCs:

- The time taken to charge the operating mechanism of the circuit breaker (1-15 seconds for Hybrid STATCOMs/SVCs) due to the use of spring loaded switches;
- The delay whilst the capacitor banks are discharged, to remove residual charge, after being switched out before being switched back into service; and
- The impact on increased maintenance unless the number of switching operations is limited to between 10,000 and 100,000 switches.

Given these limitations, the Workgroup proposed that an appropriate requirement for PPMs should be to respond to a maximum of 5 events in a 5-minute period, and 25 events in a 24-hour period. This would allow response to 96% of events that arise during a winter storm, allow sufficient time for the cooling of capacitor banks between events, and does not overwork switchgear equipment leading to increased maintenance requirements.

The Workgroup also proposed to clarify the definition of an event as one requiring a change in reactive power output from its maximum leading value to its maximum lagging value and back again, or vice versa.

Dynamic reactive control, an essential service to maintain system voltage, can be provided by different parties, generators or transmission licensees. It also interacts with the transmission protection system. In order to ensure that an appropriate balance has been struck between the system requirement and impact on all relevant parties and associated costs, the Workgroup conducted a cost-benefit analysis on a range of options for ensuring required voltage performance against scenarios of increased volume of PPMs being connected to the system. These included: (a) removing requirements from PPMs,

with dynamic reactive control being provided by transmission licensees instead; (b) using an alternative transmission protection system (change from DAR to High Speed Auto Reclose) to reduce the level of dynamic reactive control required; (c) setting more stringent requirements on PPMs than that which would be provided by Hybrid STATCOMs/SVCs; and (d) revising the requirements on PPMs such that they can be met by Hybrid STATCOMs/SVCs.

The cost-benefit analysis showed option (d) to be the most cost effective to ensure the required system voltage performance.

A requirement to upgrade voltage control equipment on existing or under construction PPMs would incur much higher costs than those for new connections. The GCRP recognised that PPMs that are existing or which expect to connect by 1 December 2017 and are unable to provide 'continuous voltage control' are unlikely to cause any operational issues. Therefore, it was concluded that it is appropriate to impose the new requirements only on projects to be connected after 1 December 2017.

Taking the above considerations into account, the Workgroup proposed the following modifications to CC.A.7.2.3.1, and the addition of a new sub-paragraph CC.A.7.2.3.2 to clarify the requirements surrounding the provision of 'continuous voltage control':

- CC.A.7.2.3.1 – 90% of the change in reactive power output following a voltage step change requiring a change in reactive power output from its maximum leading value to its maximum lagging value and back again, or vice versa, is to be provided:
  - within 1 second for all parties, and
  - within 2 seconds for plant and apparatus installed on or after 1 December 2017.
- CC.A.7.2.3.2 – for generators and plant and apparatus installed on or after 1 December 2017, the reactive power output described in CC.A.7.2.3.1 must be achieved once every 15 seconds at least 5 times in any 5-minute period, and at least 25 times in any 24-hour period. NGET must be notified of any subsequent restriction on reactive capability.

On the 'fault ride through' requirement, the Workgroup also found that, for connections made after 1 December 2017, there is significant benefit to ensuring that no shunt capacitors are switched off during faults or voltage dips such that they are available to assist post-fault voltage recovery without undue cost to meeting this requirement. This requirement is made explicit by proposing changes to CC.6.3.15.1 and CC.6.3.15.2, including reference to plant and apparatus which provide this service for PPMs.

The January 2016 industry consultation resulted in six responses, five of which supported the changes. One was marginally supportive, commenting that a non-continuous requirement could impose risk on the SO. However, based on the analysis carried out by the Workgroup, NGET agreed that the proposed changes would be sufficient to ensure the vast majority of severe events will be responded to by generators.

### **NGET's recommendation**

NGET issued its GC0075 Final Report to us on 5 April 2016. The Final Report<sup>3</sup> recommends approval of the legal text changes in Annex 3 of the Report. NGET considers that the proposal provides clarity on the voltage control requirements of generators, in

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<sup>3</sup> Grid Code proposals, final reports and representations can be viewed on NGET's website at: <http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/>. Information about GC0075 appears here: <http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0075/>

particular for PPMs who have interpreted the current requirements differently, which will ensure that voltage control on the transmission system is adequately met in an economical way and maintains system security.

NGET considers that GC0075 will better facilitate the following Grid Code Objectives:

- (i), by minimising operational risk and planning requirements for severe events with minimal cost implications on generators and manufacturers whilst providing clarity of the requirements;
- (ii), by having minimal impact on generators and manufacturers whilst facilitating the deployment of cost effective Hybrid STATCOMs/SVCs. NGET also consider the modified requirements to provide the widest range of switch choices to manufacturers and ensures the majority of events are responded to by PPMs; and
- (iii), by minimising the potential risks of severe weather events thereby minimising the costs and burden of ensuring the system rides through such events, whilst ensuring the majority of events are covered by PPMs.

NGET considers that GC0075 has no interaction with the Requirement for Generators (RfG) Code, a relevant European Network Code, and therefore considers it to have no impact on Grid Code Objective (iv).

### **Our decision**

We have considered the issues raised by the modification proposal and in the Final Report dated 5 April 2016. We have considered and taken into account the responses to NGET's consultation on the modification proposal which are included in the Final Report. We have concluded that:

- implementation of the modification proposal will better facilitate the achievement of the objectives of the Grid Code<sup>4</sup>; and
- approving the modification is consistent with our principal objective and statutory duties.<sup>5</sup>

### **Reasons for our decision**

We consider this modification proposal will better facilitate Grid Code objectives (i), (ii) and (iii), and has a neutral impact on objective (iv).

#### ***(i) 'to permit the development, maintenance and operation of an efficient, co-ordinated and economical system for the transmission of electricity'***

The Grid Code currently requires generators to provide continuous voltage control. The definition of 'continuous' has been interpreted differently amongst PPMs, resulting in varying voltage control capabilities which undermine the co-ordination of the system and which increases the planning requirement on NGET.

The modification proposal clarifies the voltage control requirements of generators during severe events by defining the required timeframe to provide 90% of the change in reactive power output, and the required repeatability of this including the intervals between repeated events. It also ensures that the equipment that provides this service for PPMs cannot be switched in or out during a fault. This homogenises the availability of all generators connected after 1 December 2017, in particular PPMs, making them all

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<sup>4</sup> As set out in Standard Condition C14(1)(b) of NGET's Transmission Licence, available at: <https://epr.ofgem.gov.uk/>

<sup>5</sup> The Authority's statutory duties are wider than matters which NGET must take into consideration and are detailed mainly in the Electricity Act 1989 as amended.

available to the SO for voltage control. It therefore reduces the operational risk and planning requirements for severe events and so we consider the modification proposal better facilitates this Grid Code objective.

***(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)'***

The Grid Code as written requires generators to provide 'continuous voltage control'. In practice, some PPMs have interpreted the requirements differently, resulting in varying voltage control abilities during severe events, posing potential operational issues for NGET. The lack of clarity could potentially raise costs for certain generators and present undue barriers to their entry to the market. We consider that clarifying the requirements helps to reduce uncertainty and facilitates a level playing ground for all generators.

The clarified requirements in the modification proposal take into account the technical feasibility, cost implications as well as overall system performance impact. By striking an appropriate balance between overall system requirements and costs incurred on all relevant parties to achieve the required performance, the proposed modification would remove undue barriers to entry for generators, while maintaining system performance and costs at an appropriate level to all. These effects would have a positive impact on competition.

The modification proposal will come into force for all generators installed on or after 1 December 2017. This avoids placing undue costs on already existing projects or ones currently under construction without adverse impact on the system as a whole or on other parties.

We consider that the modification proposal better facilitates this Grid Code objective for these reasons.

***(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'***

The modification proposal makes the voltage control requirements clearer by defining the term 'continuous', allowing generators, in particular PPMs, to provide voltage control sufficient to meet the requirements of the majority of severe weather events with minimal cost implications. It also ensures this capability is not switched in or out during a fault by including plant and apparatus, which provide the service for PPMs, in the 'fault ride through' requirements, thereby making it available for post-fault recovery. The Grid Code as currently written permits PPMs' plant and apparatus to be switched in or out during a fault. This directly improves planning during severe events and increases the security of the transmission system.

It also allows this voltage control to be provided by generators, in particular PPMs, at a lower cost than the cost otherwise incurred if the transmission licensee were required to provide it, thereby promoting system efficiency.

We consider that better defined voltage control requirements and inclusion of plant and apparatus in the 'fault ride through' requirements helps ensure future PPMs have sufficient voltage control to meet the requirement for the vast majority of severe events and 96% of winter storms. The modification proposal therefore better facilitates this Grid Code objective.

***(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'***

We agree with the Workgroup's analysis that the modification proposal is consistent with the RfG Code as the RfG does not specify repeatability requirements of reactive power output. We therefore consider that the modification proposal has a neutral impact on this Grid Code objective.

#### **Decision notice**

In accordance with Standard Condition C14 of NGET's Transmission Licence, the Authority hereby approves modification proposal Grid Code GC0075 *'Hybrid STATCOMs/SVCs'*.

We direct that GC0075 is implemented on 24 May 2016.

**Min Zhu**

**Associate Partner – Cost & Outputs and Technical**

Signed on behalf of the Authority and authorised for that purpose