VSM FFCI Expert Group Update

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Agenda

- Recap: Background, and Context to Group formation.
- Workgroup activities and progress to date
- Engagement overview.
- Summary of Stakeholder feedback from Questionnaire
- Summary of Stakeholder feedback on the proposed Technical Specification
- Common Themes and Conclusions
- Next Steps.

Background, and Context to Group formation

- GC0100 consultation on EU Requirements For Generation and HVDC code adoption-
  - by Jan 2021, there is a requirement for an option providing immediate response equivalent to that of a voltage source behind an impedance. This is required to maintain compliance with EU code defined Voltage against time profiles for a transmission fault.
  - GC0100 consultation agreed that should more limited, currently available technology options be taken forward in the short term, an Expert Working Group would need to be formed. This would define, clarify and propose a suitable proposal for security of supply across fault ride through for all Transmission and Distribution connected users beyond Jan 2021.
- An Expert Working Group on Fast Fault Current Injection, and on potential Virtual Synchronous Machine approaches to its delivery, was set up in March 2018 to take forward this work. The group will report back to GCDF in October 2018.
- This is the first of two stages of investigation work ahead of code implementation. Stage 2 including CBA work will be informed by stage 1 investigation.

Work Activities, and progress to date

- Meetings held on 19/04/2018, and 23rd May 2018
- Meeting 3 was on 12th July 2018
- Bilateral meetings with developers and manufacturers have been held across July and August.
- Intention to formally report to GCDF in October
- Key outputs:-
  - Outline Code Specification, and Industry Questionnaire.
  - Provision of system data supporting developer design investigations
  - Receipt of responses to specification. Receipt of update on related initiatives and developments, including trial projects supporting analysis.
- Project remains on track
- There may be further value in the group continuing to support development of specification

Engagement Overview

- Workgroup currently includes 51 individuals, from 36 different organisations; including:
  - European convertor technology manufacturers
  - Developers and owners across synchronous and non-synchronous technologies, both below and above 1MW scale
  - Transmission & Distribution Network Owners
  - ENTSOe and other international institutions.
  - Universities & Academics
- First meeting had 18 physical attendees, 9 remote. Second meeting had 21 physical attendees,11 remote.
- Meeting space presents a challenge, but a good challenge to have!

Summary of Stakeholder Feedback Response – Questionnaire & Specification

- Responses received from:-
  - Siemens
  - Wester Power Distribution (WPD)
  - Enercon
  - Senvion
  - Turbo Power Systems
  - Enstore
  - National Grid Interconnectors
  - University of Strathclyde
  - Wind Europe
  - Equinor
  - GE
  - Digsilent

General Comments on Questionnaire

Questions	General Response
Type of Plant	Wind turbines (Onshore/Offshore Types 3 and 4),, HVDC, Energy Storage Systems, SVC's/Statcom's/dynamic compensation equipment, solar,
Experience in VSM based control Systems	Involvement in Joint Industry Working groups and research Early development and research Research undertaken and small scale software / hardware developed as proof of concept Research being undertaken and aware of concepts General concepts applied and tested but numerous question arise from the draft NGET specification with more detail required No experience. Published Papers on VSM / VSM0H have been highlighed

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Questionnaire Comments On Specification

Questions	General response
Specification	Numerous detailed comments were received on the specification in addition to the questionnaire – Additional points noted include:- 1) The requirements should be technology neutral, and equally apply to Electricity Storage Systems (GC0096) 2) More information is required on the energy store and damping requirements 3) The nature of the overload conditions need to be further defined to avoid increasing system rating and cost particularly when exporting reactive current 4) Additional short term Reactive capability in the extended zone for 20 seconds requires special mention 5) Comparison to synchronous specification needs to be balanced and demonstrated 6) Rating, and storage design considerations 7) The performance requirements should be specified at the Connection Point to the Transmission or Distribution System

Questionnaire Comments On Next steps

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Questions	General Response
Commercial and Regulatory considerations	The specification will add cost to the equipment and it is not known if this is the most economic or efficient compared with other tools or market arrangements There could be tradeoffs between Onshore and Offshore equipment and how the costs are apportioned between the two. The overall approach should have greater focus on incentivising the additional functionality Concerns over retrospectivity and there needs to be a clear framework for remuneration for developers Concerns over specification not intruding into areas of Intellectual Property & Patent. Concern over how transient term energy storage and its' inherent energy exchange with system might be treated from a Regulatory perspective.

Questionnaire Comments On Technology Readiness

Questions	Specification Comments
Technology readiness	The specification cannot currently be met by existing plants Different control strategies may be different for different types of equipment (eg wind generation, storage etc). The costs , technical and regulatory challenges vary considerably across technologies. VSM type functionality across manufacturers has been previously investigated, with approaches existing since early 1990s. However it was identified not to be commercially attractive. Solutions between Onshore and Offshore may need to be considered separately. Retrofitting to existing plant – particularly wind turbines would need further consideration such as cooling, component design and reliability, but is possible. A hybrid solution could be considered where a mix of energy storage synchronous compensators and other market based solutions are used but the wider aspects of this – eg space would need to be considered Dependent on technology, and a clear specification and driver to do so, a minimum timeframe of between 2-5 years to develop and deploy would be required

Common Themes and Conclusions (1)

- Valuable feedback received from Questionnaire and Specification, generating exceptionally high engagement from Industry.
- VSM and related approaches are well founded across initial manufacturer development and academic publication.
- Some experience has been gained with VSM technology but not yet at a commercial level. Some trials have taken place and others are planned
- VSM is achievable but there are considerations relating to cost, sizing and specification that require further investigation.
- The timescales of the workgroup are challenging and further development of specification requires continued involvement from all industry stakeholders. Ideally a longer development time should be allowed.
- Once a specification has been developed, the lead time is probably in the 2 – 5 year time frame. Retrofitting appears possible.

Common Themes and Conclusions (2)

- Storage Capacity requirements are currently unclear, however some initial estimates have been given
- Equipment rating is unclear as are the costs, sizing and space requirements which would be technology and development specific
- There is appetite for Hybrid solutions, particularly for Offshore Schemes as well as an appetite for commercial mechanisms
- Interaction with other Grid Code requirements
- National Grid are in the process of examining these issues and working with stakeholders in developing a clearer specification. This includes taking forward bilateral conversations in order to manage areas of IP sensitivity.

Common themes and Conclusions

- The main comments and themes have been summarised in earlier slides but the high level issues are noted below.
  - Eg. why have the values specified been chosen: eg. are they max or min values, how fast should the controls operate, voltage ranges, transient overvoltage, harmonics / quality of supply, maximum voltage levels, terminology, base quantities, application to Offshore and typographical comments
  - What is the balance between market code and other asset solutions- does this specification represent the most economic and efficient approach & how would it be implemented / incentivised?

Next Steps:-

- Further Cost Benefit Analysis as Stage 2 work should proceed, to examine appropriate form of code implementation.
- Scope of CBA should not preclude-
  - Retrofitting/ Retrospectivity. Different solutions/ specifications across technologies
  - Balance between Market and Code specification
  - Combinations of Market, code and asset solutions.
  - Implementation across all scales of convertor via use of standardisation where possible.
  - Delivery horizons between 2-5 years from specification.
- A draft TOR is provided for Stage 2 CBA for GCDF to consider;
  - Workgroup participation- enlarged Stage 1 or new representation?
  - Workgroup timeframe- completion by December 2018 still viable?
  - Interaction with other Code activities.

Next Steps

- Refine the specification to address feedback received.
- Examine the hybrid approached that can be used and how various options can be fed into the cost benefit analysis.
- Time and date of next meeting, to finalise reporting.