VSM Expert Group

Meeting 3

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Agenda

- General Specification Issues
- Specification development
- Specification Issues
- Study Considerations
- Plant Mix
- Variation in VSM Specification
- Next Steps

General Specification Issues

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- Storage Capacity requires definition and sizing- CBA to define further
- Frequency Operating Range- CBA will provide clarity of range of conditions the VSM may be expected to operate over and the time evolution
- Equipment rating is unclear Ongoing Bilateral liaison
- Technology Neutrality where hybrid solutions should be permitted
- Bandwidth requirements initial proposals unchanged but may be modified under CBA work
- Clarification on damping requirements to be provided through CBA case study illustration
- Clarity required on terminology and base quantities comments captured and will be reflected in redraft
- Clarification required on the impedance values comments captured and will be reflected in redraft- further options for clarification within bilateral meetings
- Interaction with other Grid Code requirements interactions with storage specification, and ongoing areas of broader code change captured.
- Rate of change of Frequency CBA to define further, iterative with specification
- Market Solutions vs Mandatory requirements CBA to define further
- Storage Plant would be in the scope of these requirements
- Definitive requirements will be difficult until more information is known about commercially available technology and its cost CBA work to define further

Specification Development

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- Detailed studies and justification will be an essential element of this work
- The parameters cannot be finalised until this study work has been completed.
- The CBA and scenario's run will have a significant bearing on the requirements
- All operational conditions need to be considered – both normal and abnormal but credible
- Any specification that is developed must be achievable and the costs being a function of the CBA when the studies have been completed
- There are a number of trade offs than can be made in the specification development process

Specification Issues (1)

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- Storage Capacity requires definition and sizing - (Study dependent)
- Frequency Range – (Study dependent)
- Equipment rating is unclear - (Study dependent)
- Technology Neutrality where hybrid solutions should be permitted – (Flexibility to be permitted in specification – the requirement would be with respect to the Power Park Module or HVDC System – not the Unit or converters enabling developers / manufacturers to design solutions within the Power Park Module or HVDC System)
- Bandwidth requirements (Study dependent but an initial starting point would be 0 – 5Hz).

Specification Issues (2)

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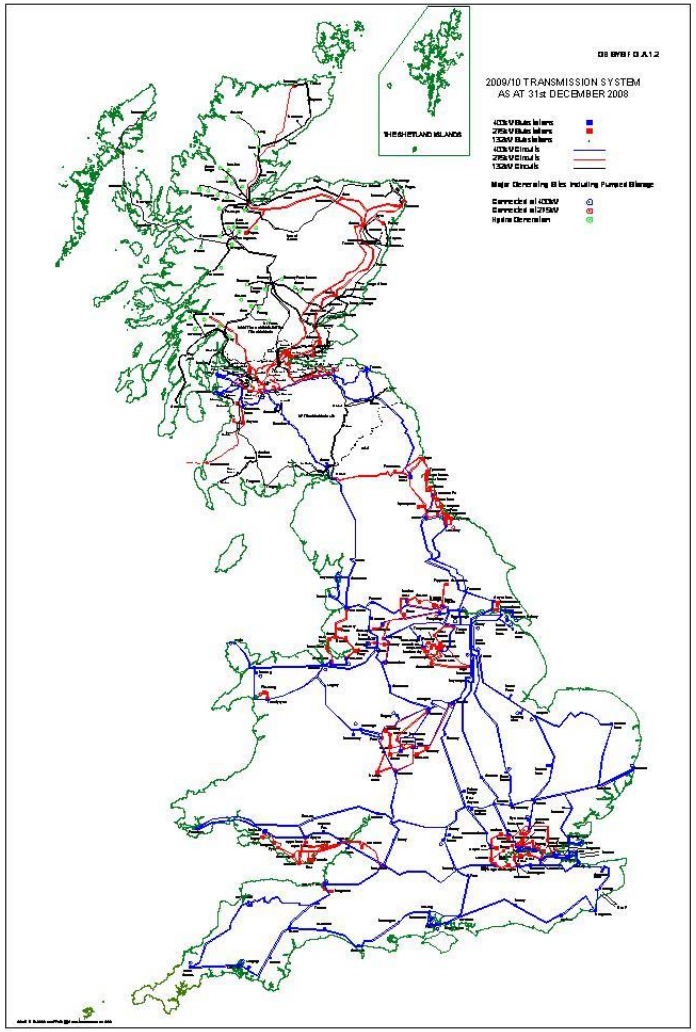
- Clarification on damping requirements (Study dependent but an initial starting point would be consistent with existing Grid Code (ECC.A.6.2.5, ECC.6.2.6) and SQSS (definition of System Instability) requirements.
- Clarity required on terminology and base quantities – (Also being addressed through GC0111 work)
- Clarification required on the impedance values – (Study dependent)
- Interaction with other Grid Code requirements – Assessment required following derivation of specification
- Rate of change of Frequency – (Set at 1Hz/s consistent with RfG requirements - consideration to be given to maximum average ROCOF values – The ROCOF rate will vary with distance from the fault)
- Symmetrical Operation over frequency range – (Performance and Storage requirements will vary greatly over the frequency range (ie a greater storage requirement will be required over 47-52Hz than 49 – 51Hz).
- Market Solutions vs Mandatory requirements

The GB Electricity Transmission System (2016)



- National Grid operate the entire GB Transmission System and own the assets in England and Wales only
- The Scottish Transmission Licensee's (Scottish Hydro Electricity Transmission and Scottish Power Transmission) own the Transmission Assets in the North and South of Scotland respectively
- Peak Demand ~ 61 GW
- Minimum Demand ~ 15.7 GW

Study Options

- There are a number of Study options that could be used for assessment of this issue
  - Full GB Network with detailed representation of 1 DNO network (as per GC0100)
  - 36 Node Model equivalent network with simplified DNO network representation
  - Single busbar equivalent model
- Whilst the full GB model could be used, it is complex with numerous interactions between models and will have a high number of state variables. There are also a considerable number of study scenarios to be run (see next slide).
- The single busbar equivalent will give indicative results but considered too simplistic
- A combination of full GB and 36 node model simulations will be conducted. DNO system will be included in the analysis.

Study Considerations (1)

- The Transmission Network is designed to satisfy the requirements of the SQSS
- Operation over Maximum Demand and Minimum Demand made up of with a combination of different Generating technologies
- Frequency Range (ECC.6.1.2)
  - Normal Operating range
    - 49.8 – 50.2 Hz Operational
    - 49.5 – 50.5 Hz Statutory
  - Abnormal
    - 47 – 52 Hz
- Voltage Range (ECC.6.1.4)
    - 400kV +5% to +10% - 15 minutes
    - 275 kV and 132kV ±10%
    - Below 110kV ±6%

Study Considerations (2)

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- Under abnormal conditions operation of the low frequency demand disconnection scheme will operate as a last line of defence to protect the Transmission System from a complete Blackout or partial Blackout.
- It is essential that all measures currently employed continue to contribute to overall system robustness and reliability
- There is always nervousness around high frequency events then followed by low frequency events
- The studies run as part of this work will need to consider these issues under both normal and abnormal system operating conditions
- In addition extreme conditions such as a system split will also need to be examined

Study Scenario's

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- Study 1 - Apply VSM capability to all Power Park Modules and HVDC Converter equipment and observe results to a range of Transmission System faults
- Study 2 – Repeat study 1 without VSM applied to any Power Park Module or HVDC Converter Plant (ie standard converter models)
- Study 3 – Repeat Study 1 without VSM applied to sub 1MW plant
- Study 4 – Repeat Study 1 with VSM applied to all plant but all plant de-loaded prefault based on operational conditions (eg high wind and interconnectors de-loaded (this assumes there is no storage requirement built into the Power Park Modules or HVDC plant)
- Study 5 – Repeat Study 1 with VSM applied to all Battery Storage and solar plant with wind generation and HVDC de-loaded by 5% prefault
- Study 6 – Repeat Study 2 with Synchronous Compensators installed at strategic points across the network
- Feed costs into CBA analysis and assess

Variation in VSM Specification

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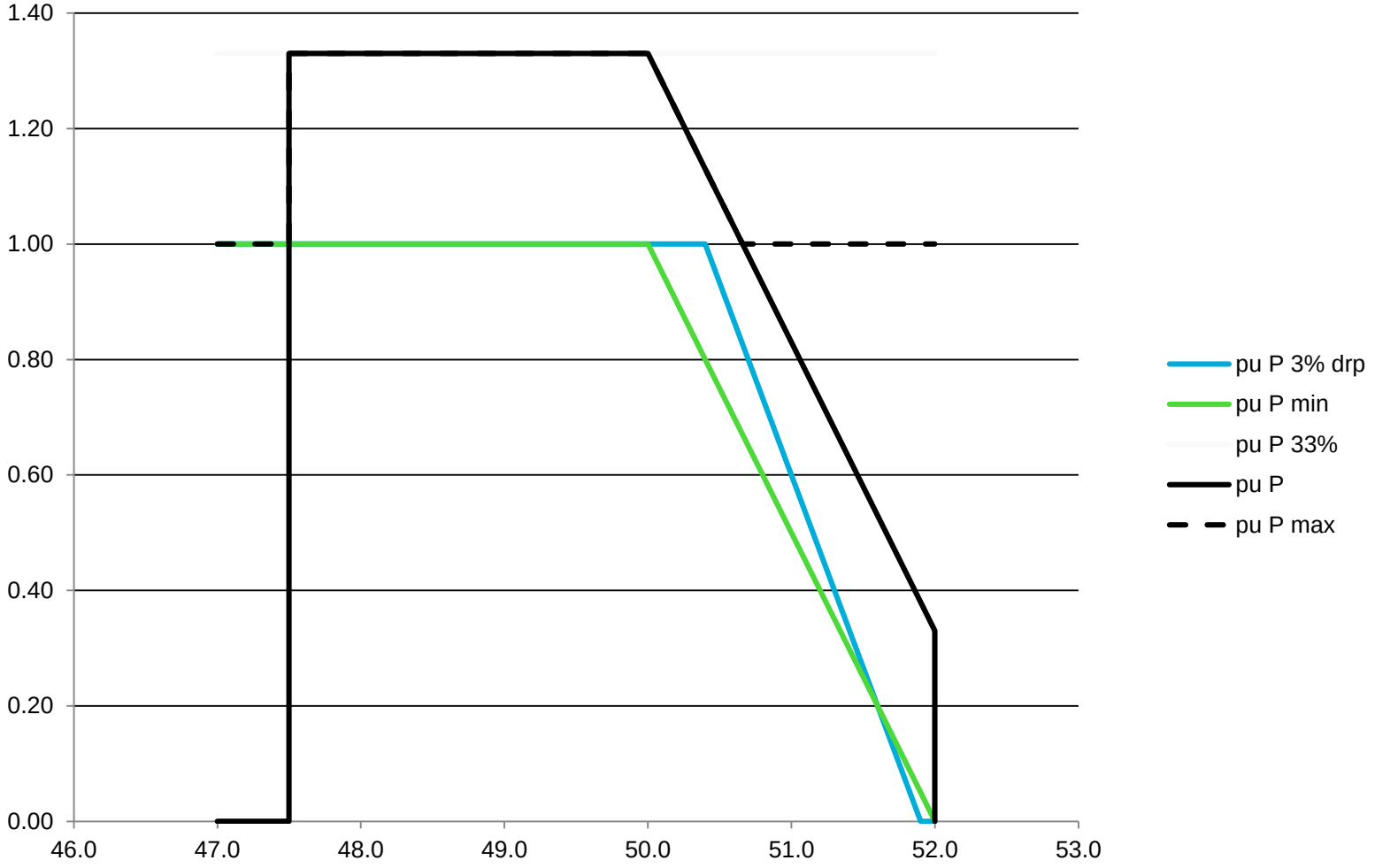
- Repeat of Studies on Slide 10 with the following variation to the VSM Specification
- VSM Specification – Over rated converter (eg 1.5 p.u on MVA base) with operation over 48 – 52Hz, ROCOF limits set at 1Hz/s, symmetric performance for frequency rises and falls with a high equivalent inertia
- VSM Specification – Mid specification – converter rated at 1.25 p.u on MVA base with operation over 49 – 51 Hz, ROCOF limits set to 0.8Hz/s and performance of frequency falls only and a medium equivalent interia
- VSM Specification – Converter rated at 1.0p.u on MVA base operation over 49 – 51Hz. ROCOF Limits set to 0.6Hz/s and performance of frequency falls only. No requirement for storage as all capability is assumed to be achieved by de-loading – ie high wind conditions and part loaded interconnector availability
- Studies will be conducted to look at effectiveness of LFDD scheme.

Illustrative Parameter Specification example



Next Steps

- Prepare and set up National GB Study including DNO Networks
- Prepare different versions of VSM Model
- Assess if the same VSM specification should be applied to different technologies (ie should the same VSM spec be specified for small scale solar / batteries as for large scale interconnectors or Wind Farms)
- Run Studies and feed into Cost Benefit Analysis
- Continue to discuss capabilities with manufacturers and developers