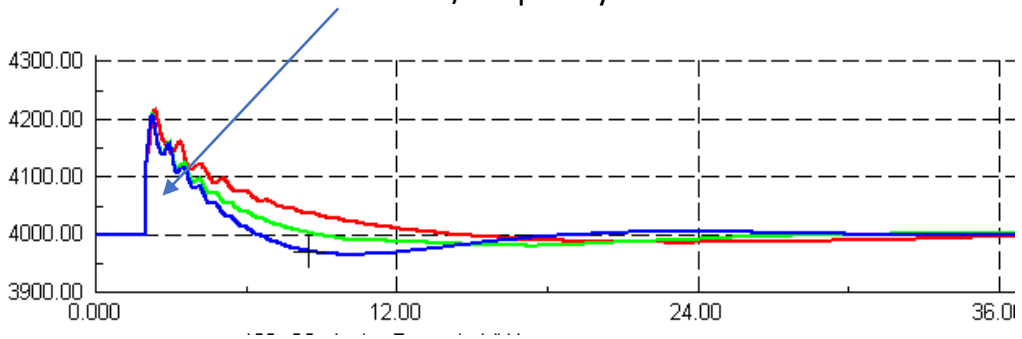
GB Grid Forming

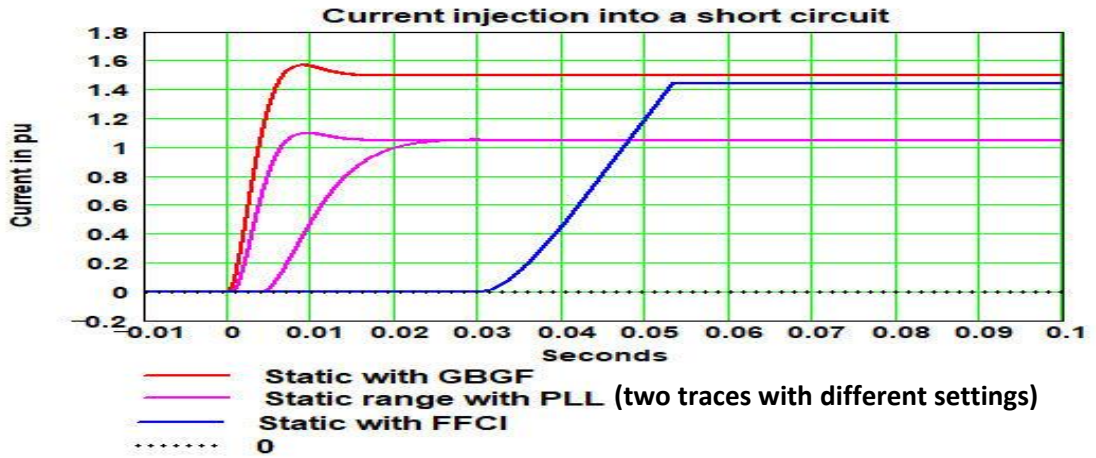
Antony Johnson and Dr Dechao Kong– National Grid ESO
ESIG Conference – Denver Colorado
7 June 2022

Characteristics of Synchronous Plant compared with Power Electronic Converters

- Key Features
  - Synchronous Generators are frequency and phase sensitive and respond instantaneously to system phase changes.
  - Synchronous Plant will supply significant fault current (2 – 4pu at the connection point) upon fault inception – Traditional Converter based plant will supply little more fault current than its plant rating
  - Synchronous plant contributes to inertia, short circuit level and synchronising torque whereas these features are not inherently provided by PLL converter based plant
  - Whilst Traditional Converter control strategies can provide fast fault current injection, they are based upon measurement and calculation resulting in a delayed response.

Active Power injection of Synchronous Plant during a fault/frequency fall





Deficit of rapid injection of Power (as per a synchronous machines) results in significant issues for post fault frequency, post fault voltage profile , high risk of generator tripping and increased vector shift

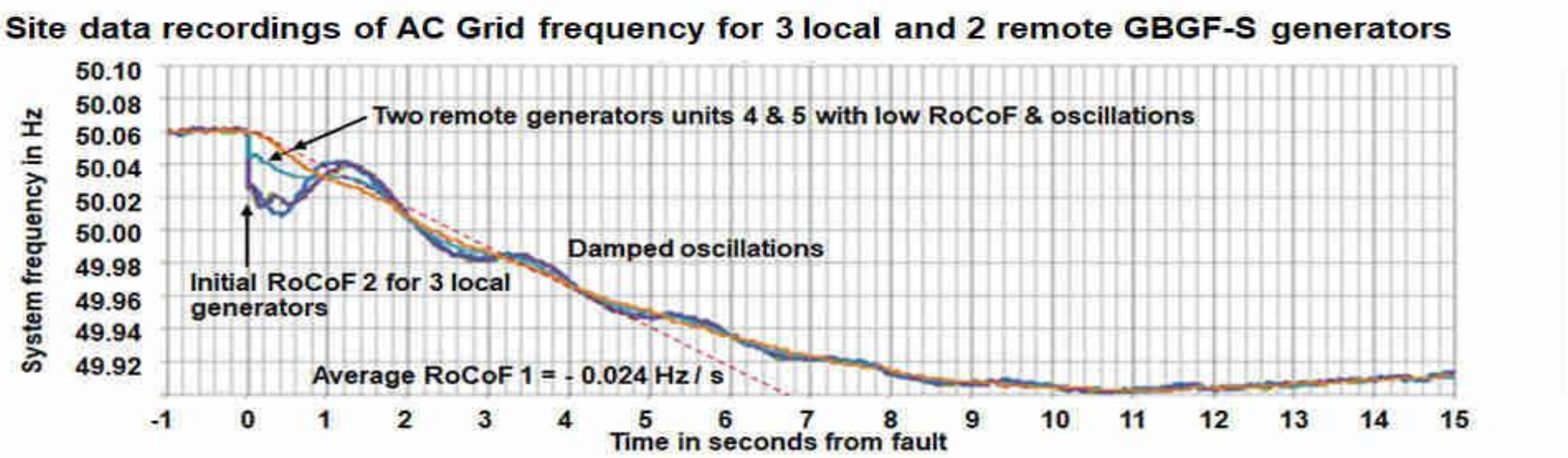
Aims of the GC0137 Workgroup

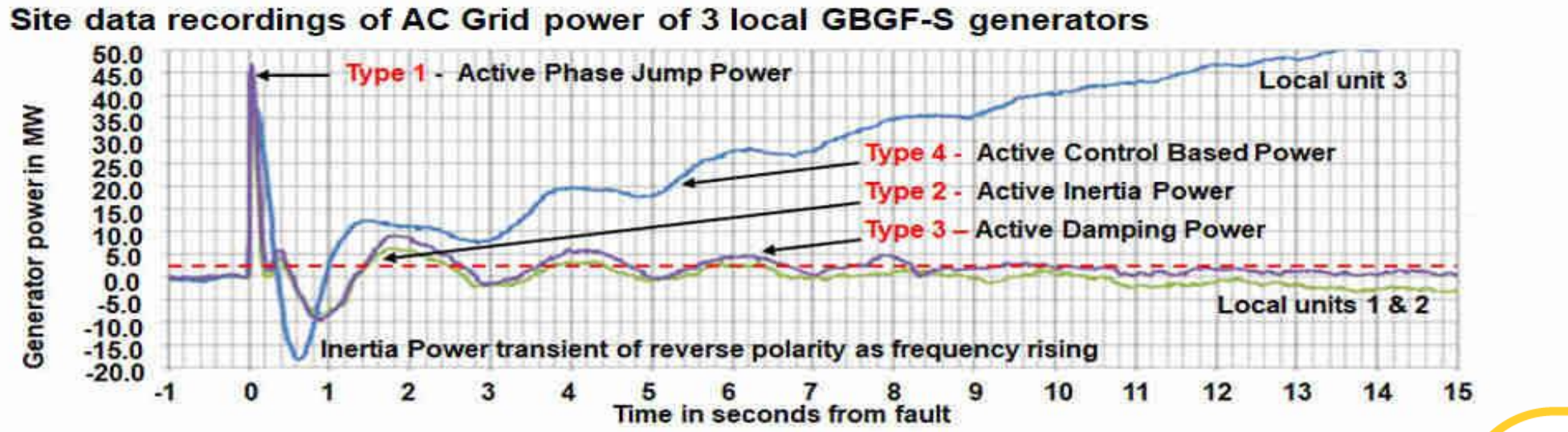
- Provide a high level overview of Grid Forming and the Transmission System Need
- Develop a high level flexible specification which would be Non-Mandatory and provide the necessary framework so the specification can be used in a future market
  - Technical Specification of Plant Requirements
  - Submission of data and models
  - Compliance Simulation and Tests
- Ensure consistency with the Stability Pathfinder Work
- Put measures in place so more detailed work can take place outside of the GC0137 Workgroup
  - Establish a separate Expert Group to develop a GB Grid Forming Best Practice Guide (Ongoing)
    - Eg Basic operation, worked examples, simulations, testing, monitoring techniques, performance, analysis, performance, interaction techniques etc
  - Develop Stability Markets (Ongoing)
- The GC0137 Minimum Specification is NOT as detailed Technical Specification

Grid Forming - Key Technical Features of a GBGF Converter

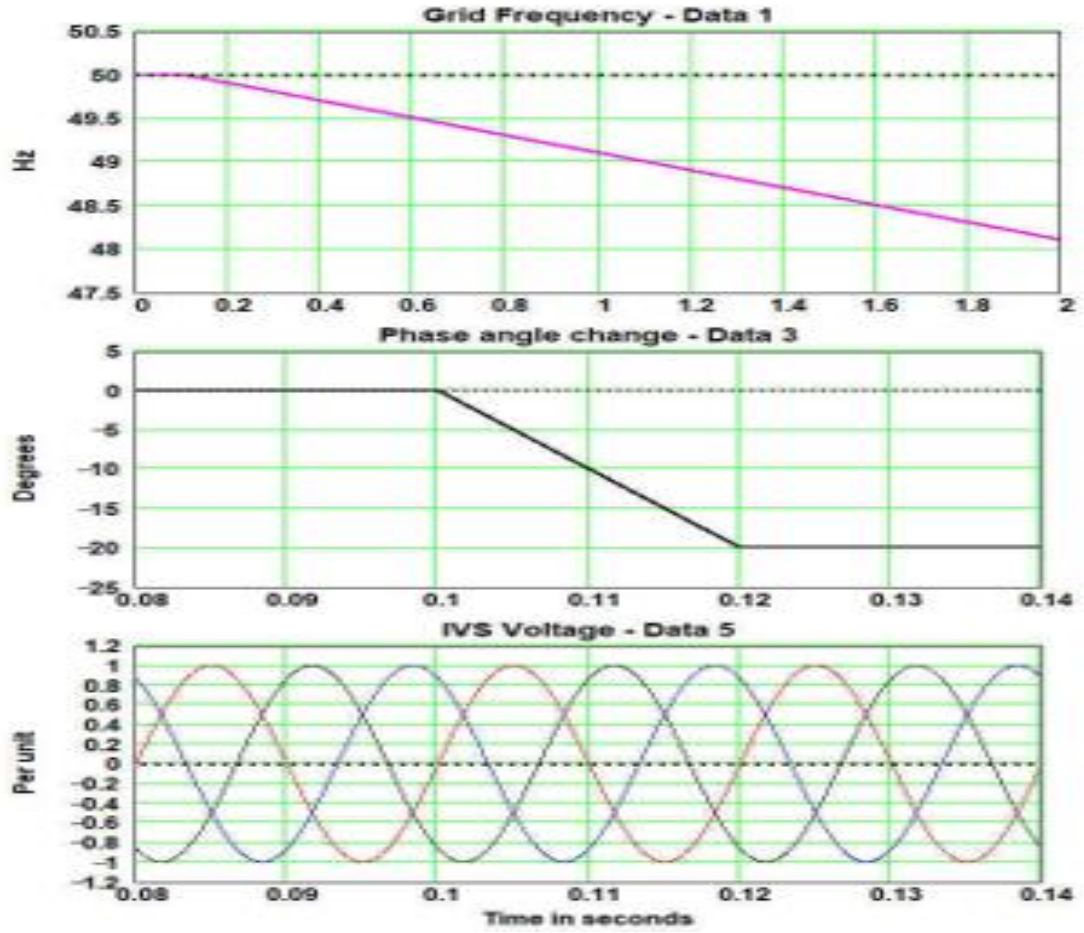
- Comprises a synchronous internal voltage Source behind an impedance (similar to a Synchronous Generator) operating over the range DC to 1KHz
- Capable of contributing to:-
  - Transient Impedance of the AC Grid that is not provided by PLL based Traditional Converters.
  - Phase Jump Power (Instantaneous contribution to System Disturbances – eg synchronising torque)
  - Inertia Power (ie Contribution to System Inertia)
  - Damping Power (Contribution to Damping)

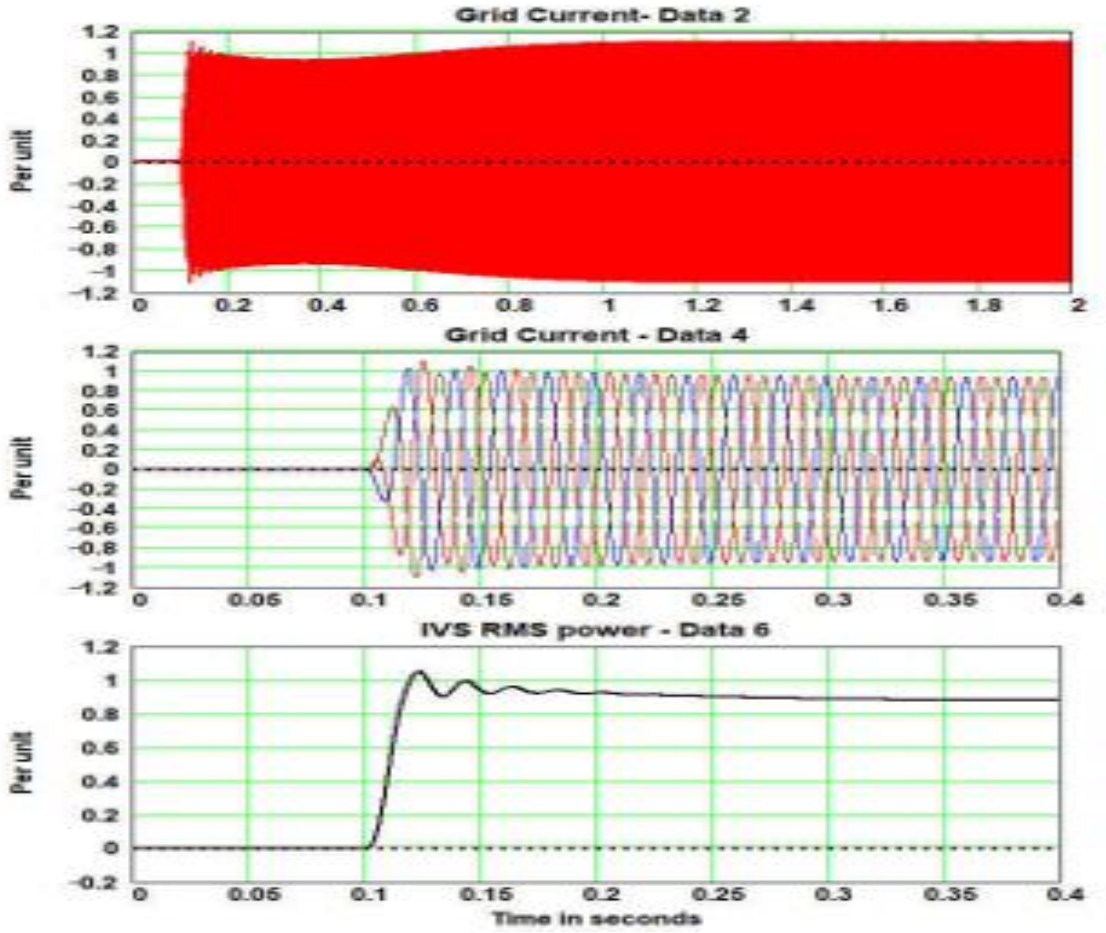
Grid Forming Characteristics - Key Features





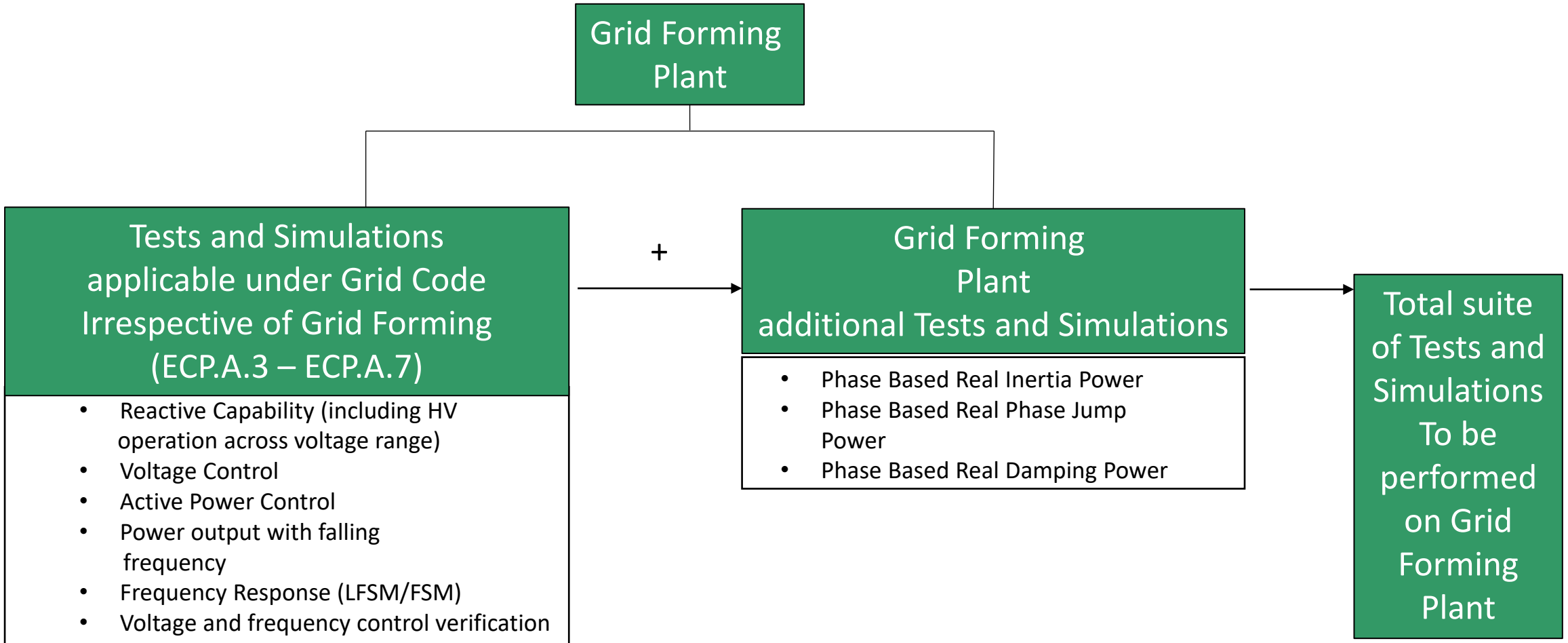
Simulation Results – 20 Degree Phase Jump followed by a Frequency Change of -1Hz/s



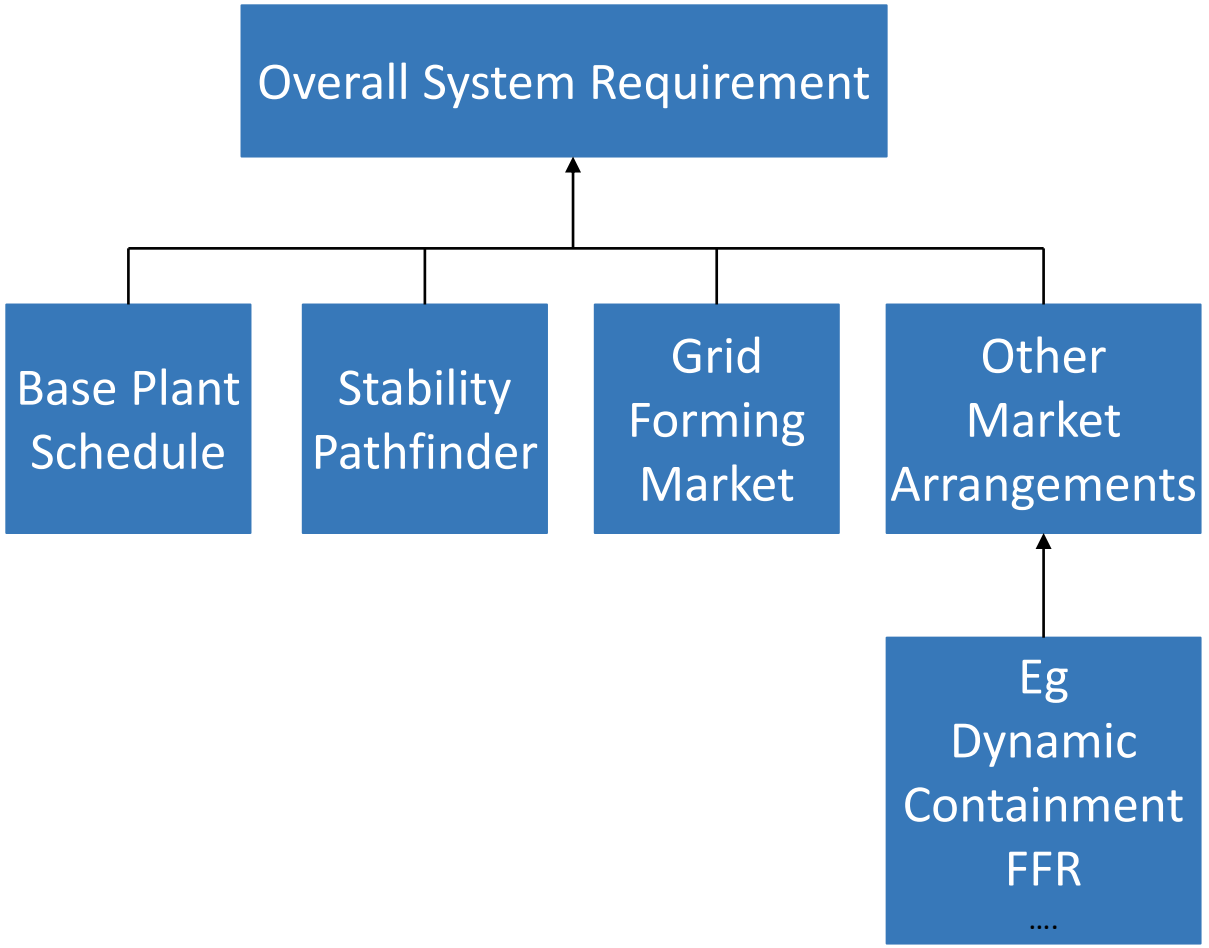


Note: Simulation results kindly supplied by ENSTORE

Compliance – Testing and Simulation - Overview



Interaction with other Initiatives / Markets



Summary

- The GC0137 Specification was approved by our Regulator (Ofgem) in late January 2022 and implemented into the Grid Code in February 2022
- The GC0137 Work is consistent with the National Grid ESO Stability Pathfinder Work
- The final GC0137 Work Group Report is available from:-
  - https://www.nationalgrideso.com/industry-information/codes/grid-code-old/modifications/gc0137-minimum-specification-required (Draft / Final Modification Reports Tab)
- The Expert Group is proceeding on the GB Grid Forming Best Practice Guide and good progress is being made.
- The ESO has been working with partner organisations as part of a Network Innovation Allowance project to explore a potential enduring market design for the procurement of stability services. The primary objective of the stability market is to ensure cost-efficient provision of services needed to maintain system stability and security in the interests of consumers.
  - https://www.nationalgrideso.com/future-energy/projects/stability-market-design --> for detailed project reports, recorded versions of external engagements and slides, and also a 'thought piece' indicating future steps.
- National Grid ESO wishes to acknowledge the help of all those organisations who have been involved in this extensive work in particular Enstore, Siemens Gamesa Renewable Energy and GE