Generic vendor agnostic grid forming inverter models

For positive sequence studies

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A generic grid forming (GFM) model

- Model developed through collaborative work across EPRI, Univ of Illinois (UIUC), University of Washington (UW), and University of Minnesota (UMN).

- Generic model is structured to allow representation of different GFM control methods:
  - Droop based GFM (Type – A Droop)
  - Virtual synchronous machine (VSM) based GFM
  - Dispatchable virtual oscillator (dVOC) based GFM

- Model can be interfaced with existing generic plant controller models (REPC_ *)
  - Model additionally also has power limits included.

- Detailed validation and robustness studies have been presented at prior WECC MVS meetings.
  - Model specifications posted on WECC website (link)

- User defined versions of the model developed in PSLF and PSS/E
  -Benchmarked against each other
  - Extensively tested against OEM blackbox models in EMT domain
  - Successfully tested out on real island networks and in the WECC base case
Structure of generic model for droop based GFM

- Fault current limiting handled at network interface


D. Ramasubramanian, "Differentiating between plant level and inverter level voltage control to bring about operation of 100% inverter-based resource grids," Electric Power Systems Research, vol. 205, no. 107739, Apr 2022 [Link]

Structure of generic model for VSM based GFM

- Fault current limiting handled at network interface


D. Ramasubramanian, “Differentiating between plant level and inverter level voltage control to bring about operation of 100% inverter-based resource grids,” Electric Power Systems Research, vol. 205, no. 107739, Apr 2022 [Link]

Structure of generic model for dVOC based GFM

- Fault current limiting handled at network interface
Application example: Validation of case fidelity with 100% IBRs in a real island power system network

- Events applied
  - Trip synchronous condenser at $t = 2.5s$ to create 100% IBR network
  - Subsequent trip one PV plant at to verify frequency response with grid forming IBRs

Same trend of response across both PSS/E and PSCAD
Application example: Three phase solid to ground fault at end of circuit in a real island power system network

- 2s duration fault is part of system’s planning criteria
  - Fault is at the end of the circuit
- More severe faults with voltage going down to zero have also been satisfactorily tested
- Both PSS/E and PSCAD show similar trend of response
Summary & next steps

- Generic model for grid forming devices has been developed in positive sequence domain

- Model has been tested against EMT blackbox model of at least two OEMs
  - Trend of response is replicated

- Model performance has been satisfactorily tested out for an island network with 100% IBR generation profile.

- Simulation software vendor implementation plan is to be discussed
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