WECC

MVS Update to RAC

June 27, 2023

Song Wang, MVS Chair

MVS

- Committee Purpose:
  - The purpose of the MVS is to review, recommend, develop, and validate system models used to support reliability assessments and other modeling tools that advance the mission of WECC
- Items for Approval and Discussion:
  - None

Recent and Upcoming Activities

- Recent Activities:
  - GENQEC model workshop
  - Edited and approved WECC Composite Load Model Specification
  - Approved WECC white paper—use of the REPC model
  - Approved renewable modules—REPC_C, WGO, IBFFR, WTGP_B, WTGT_B
  - Approved generator model GENTPJ retirement plan
- Upcoming Activities:
  - Converting IPP DC line model to generic model
  - GENTPJ model retirement
  - Grid-Forming Inverter model development
  - Developing guideline for modeling offshore wind plants
  - Developing a new Renewable Power Plant model – REPC_D

Three-Year Work Plan Status

Title	Reliability Risk Priority	Status	Target Date
Model development—GFM inverter model	2: Changing Resource Mix		12/31/2023
Wind model improvement	2: Changing Resource Mix		12/31/2023
Specifications and guidelines related to power flow, dynamic stability, and EMT models	2: Changing Resource Mix		12/31/2023

 Proceeding  Ongoing  Attention  Assistance  Complete

Load Modeling Updates

- Collaborate with NERC LMWG
  - EV Work
    - EV Model development, testing
    - Refinement of “grid friendly” EV performance
  - Large Load Modeling (data center)
    - NERC Reliability Standards applicability issue
    - Collecting data for large load customers
    - Developing models for large load customer

Power Plant Modeling Updates

- Generator model
  - Continue to promote GENQEC model
- Excitation system model
  - IEEE 421.5-2016 model implementation: MVS is working with four software vendors to complete the new exciter models implementations
- Turbine-governor system model
  - Plan to have a workshop at next MVS meeting
  - Advance Pumped Storage Hydro model development

Power Plant Modeling Updates

- GENTPJ retirement plan
  - Reports and model parameters revalidated in GENTPJ model will be accepted until December 31, 2023
  - No new report with GENTPJ model will be accepted as of the MOD-026 submittal starting January 1, 2024
  - Since GENTPF is the same as GENTPJ without the accuracy improvement of the field current, GENTPF will follow the same retirement plan
- genopz model
  - genopz model a simplified linear generator model with GENTPJ's saturation concept

Active Transmission System Modeling

- Generic simple point-to-point LCC-HVDC model has been done
  - PDCI has been converted to chvdc2 for WECC basecase development and cross-platform conversions
  - IPP – in dialogue with LADWP to see if they can do the same
- Generic simple point-to-point VSC-HVDC model has been done
  - MVS has contacted to Transbay Cable owner to look at developing a parameterized version of vhvdc1
  - Trans Bay Cable contacted the MVS in August stating that they are working on it and intend to compare their final parameterization with the UDM and PSCAD model and will respond as soon as possible

Active Transmission System Modeling

- Next steps:
  - Need to continue work on IPP -> chvdc2
  - Transbay Cable -> vhvdc1
  - Continued work on multi-terminal VSC-HVDC
  - Need to put SVSMO4 on the list of modeling priorities, then implementation, testing and approval

Renewable Modeling Updates

- Approved documents:
  - Model specification of droop-controlled grid forming inverters
  - Clarification on proper use of REPC model
  - Summary of all second-generation generic renewable energy system dynamic models
  - White paper on modeling hybrid power plants
  - White paper on converting REEC models
  - Proposal for new features for the renewable energy system generic models
  - Solar PV plant modeling and validation guideline

Renewable Modeling Updates

- Approved dynamic models
  - Approved
    - REGC_B, REEC_D, REPC_C, WGO, WTGP_B, WTGT_B, IBFFR
  - Under discussion
    - REGC_C
  - Model specification approved, finished benchmarking
    - GFMDRP_A

Renewable Modeling Updates

- Work in Progress
  - REPC_D model
  - Generic models for grid-forming inverters
    - Model specification is being developed
    - Simple structure that can be expanded later
    - Models for different control strategies
    - Models are needed before more GFM inverters are installed in the system
    - Spec will be approved after prototype test on both small test system and WECC full-loop system
  - Collaborate with ATSMWG to develop offshore wind model guide

Renewable Modeling Updates

- Planned Work
  - EMT model for area control interaction study and subsynchronous oscillation study
  - Collaboration with other working groups and industry forum

Grid-Forming Inverter Modeling

- There are mainly three types of grid-forming controls: droop control, virtual synchronous machine control, and virtual oscillator control.

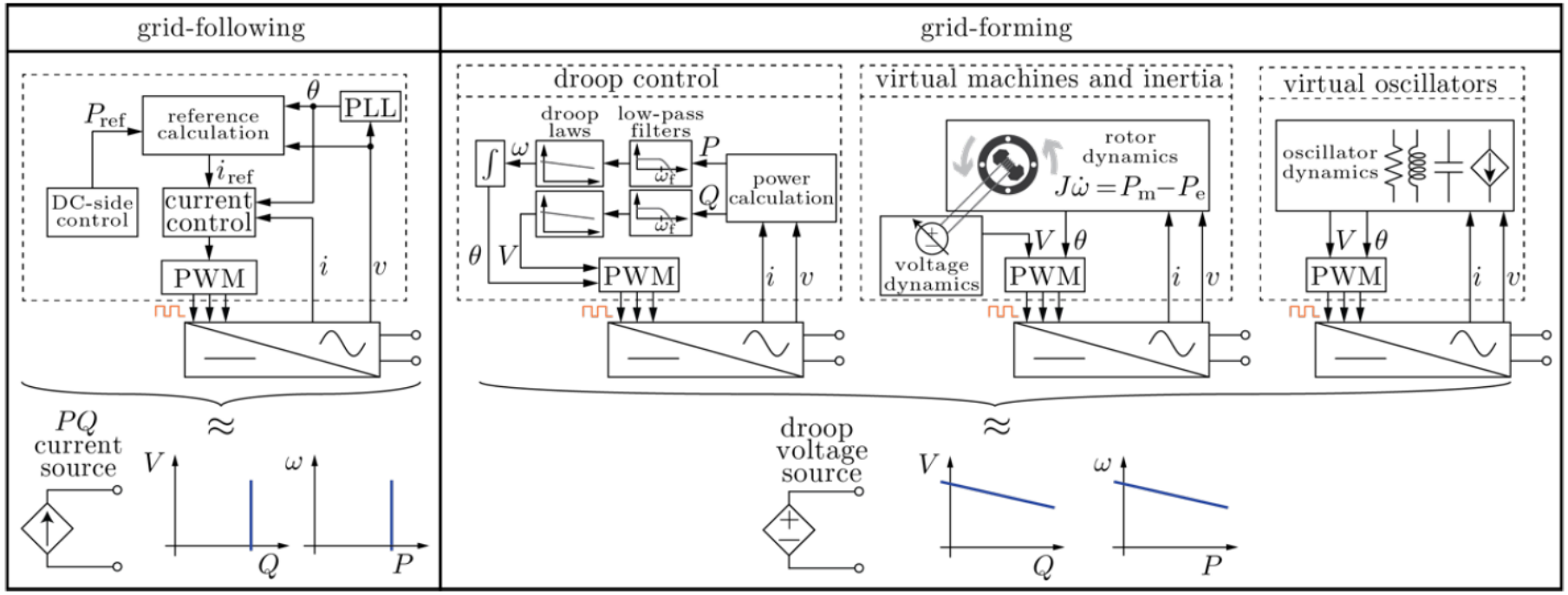


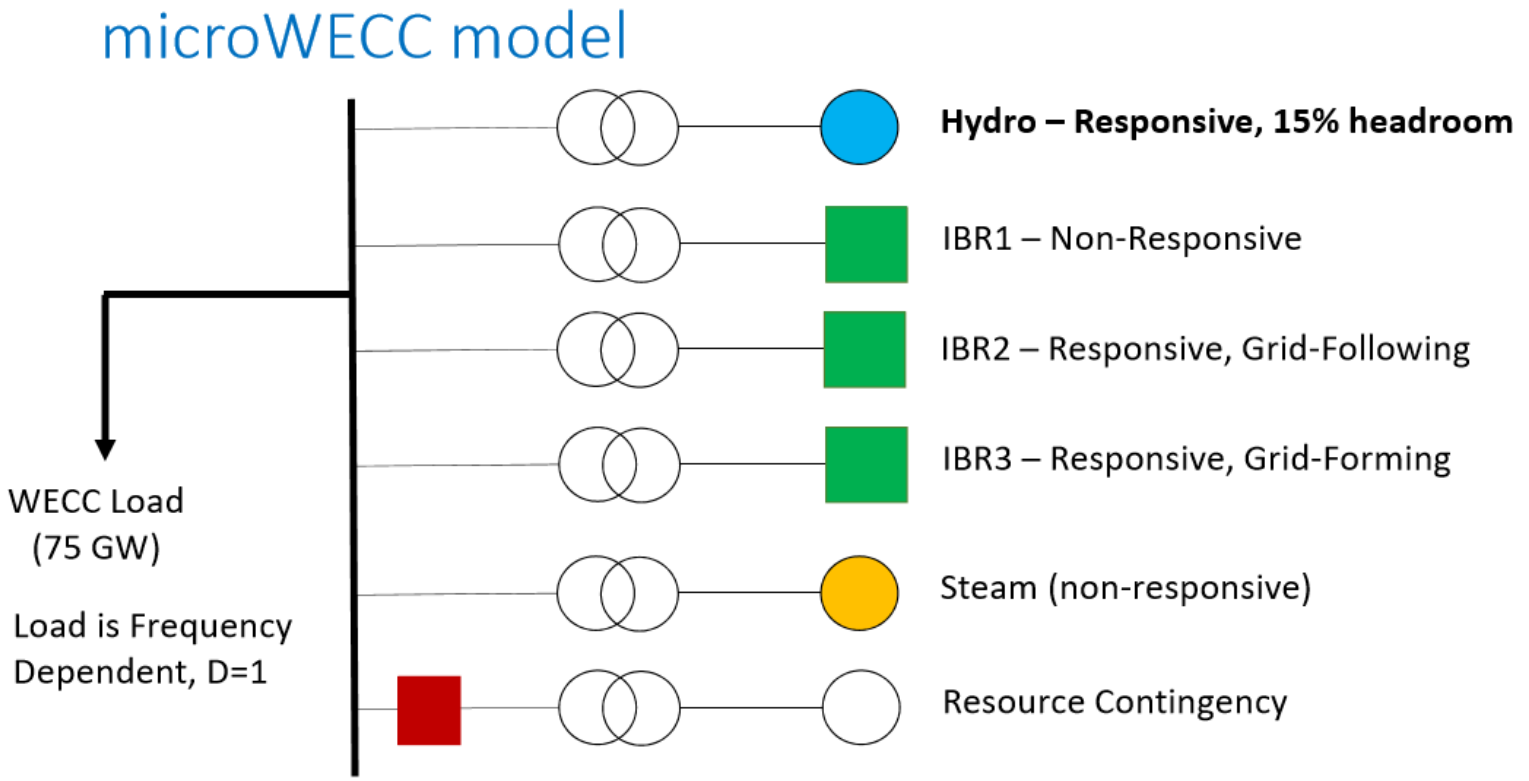
Figure 4. Functional diagrams of grid-following and grid-forming inverters. Grid-following inverters mimic current sources at their output terminals, whereas grid-forming inverters act like voltage sources whose output abides by droop laws.

Grid-Forming Inverter Modeling

- Grid-Forming Control Methods
  - Droop-Based – Specification and benchmarking done.
  - Virtual Synchronous Machine – Under development
  - Power Synchronization Loop
  - Voltage Controlled Inverter
  - Virtual Oscillator Control
  - Matching Control
  - PLL-Based Modified Current-Controlled
  - Direct Power Control

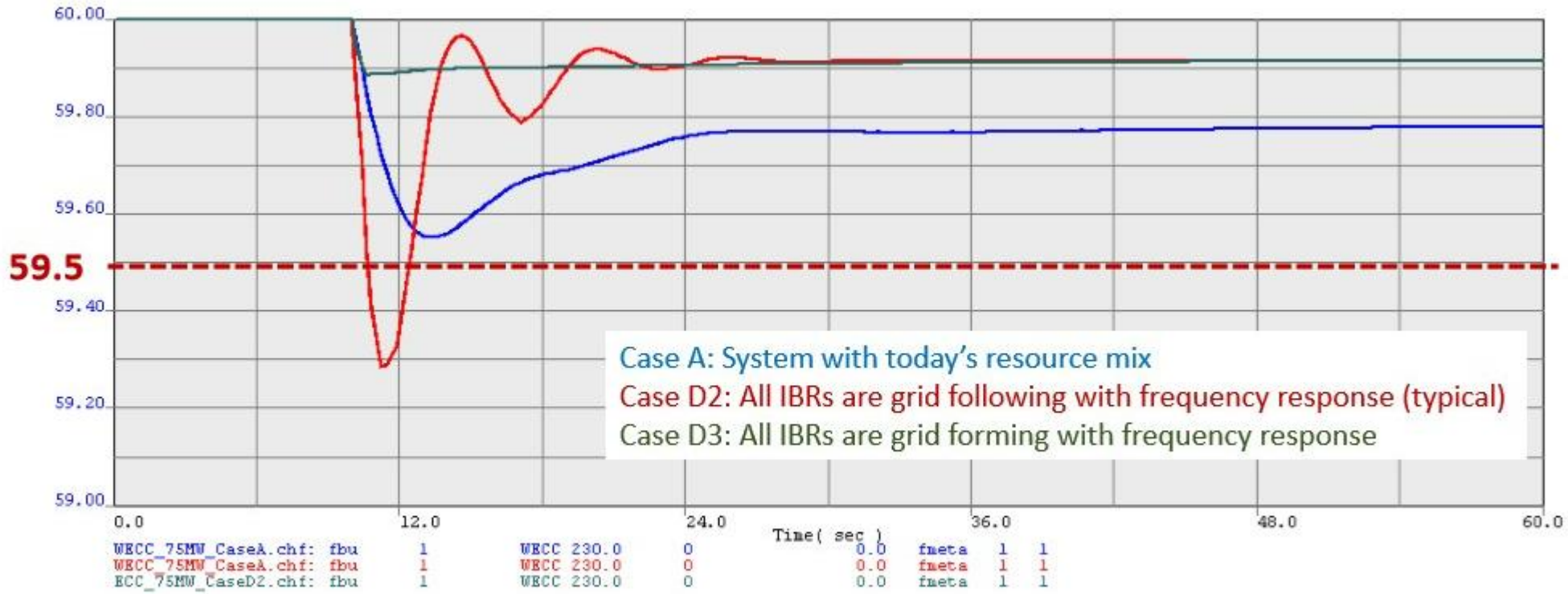
Grid-Forming Inverter Modeling

- IBR grid-forming vs grid following frequency response



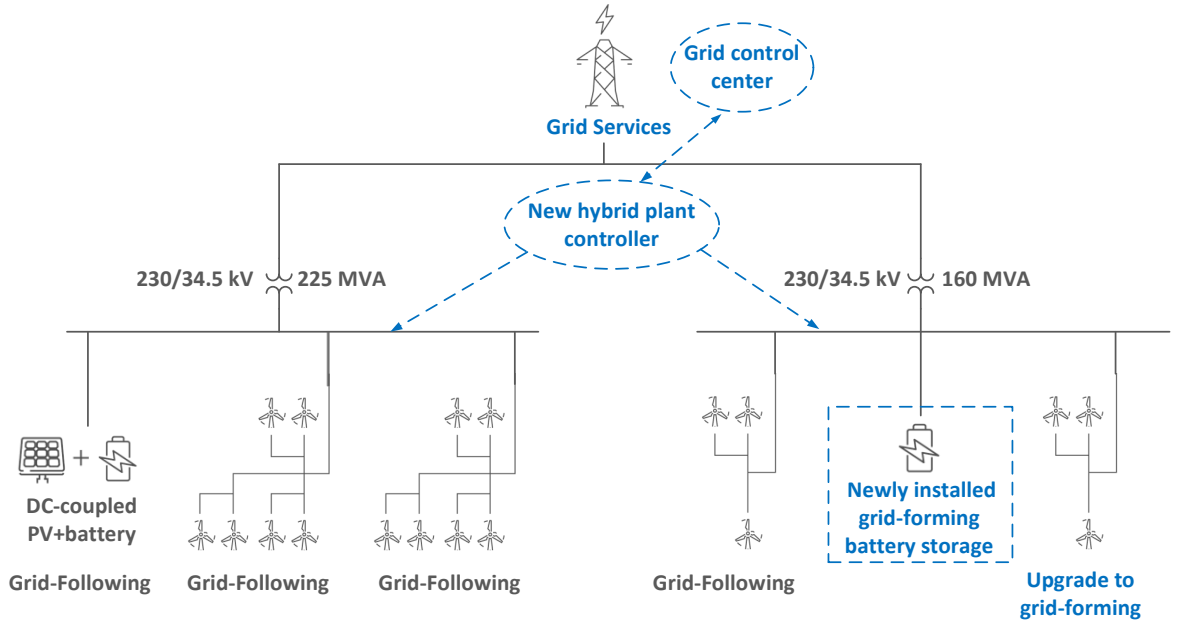
Grid-Forming Inverter Modeling

- IBR grid-forming vs grid following frequency response (BPA)



DE-FOA-2745 Topic 1: Demonstration of Grid Services

- Demonstration Site
  - Wheatridge Renewable Energy Facility is ***North America's first energy center to combine wind, solar, and battery storage in one location***, with 300 MW of wind, 50 MW of solar, and 30 MW of energy storage systems
  - This will be ***the first time that grid-forming IBRs, including both wind and battery storage, are connected to the US bulk power systems,*** and demonstrated at the same site for grid services



DE-FOA-2745 Topic 1: Demonstration of Grid Services

Team Members and Roles

- **PGE**
  - PI: Song Wang
  - Role: Lead on whole project
- **GE Research and GE Renewables**
  - POCs: Phil Hart and Corey Holliday
  - Role: GFM wind, GFM BESS, and hybrid plant controller deployment
- **BPA**
  - POC: Dmitry Kosterev
  - Role: System operation and PMU data collection
- **PNNL**
  - POC: Wei Du
  - Role: Modeling
- **UT-Austin**
  - POC: Alex Huang
  - Role: DC-coupled PV/BESS GFM design and testing at the university's lab
- **PSU**
  - POC: Robert Bass
  - Role: DEIA Engineering internship program

DE-FOA-2745 Topic 1: Demonstration of Grid Services

BP 1

Pre-demonstration Study

- GFM metric definition
- GFM service definition
- Interconnection study
- BESS sizing study
- Initial cost-benefit study
- Finalize GFM control
- Internal GFM reviews
- Eng., permit & approval
- Demonstration design
- Develop HiL testbed
- Block box model dev.
- Hybrid plant model
- EMT simulation studies
- DC-coupled GFM model

BP 2

Field Deployment and Demonstration

- Install & com. GFM BESS
- Commission GFM wind
- Upgrade plant control
- Commission DAQ sys.
- Install isolation equipment
- Modify BOP control
- Final HiL validation
- Generic pos. seq. model
- Pos. seq. sim. study
- DC-coupled GFM exp.
- GFM/GFL freq. reg demo
- GFM/GFL volt reg demo
- HYB plant control demo
- Data collection
- Preliminary analysis

BP 3

- Model calibration
- Detailed results report
- Final cost-benefit study
- DC coupled storage sizing
- Internship program and project management across all Budget Periods

DE-FOA-2745 Topic 1: Demonstration of Grid Services

- Industry Impacts
  - Help utilities and system operators better understanding the benefits and drawbacks of both GFM and GFL technologies
  - Gain confidence in providing various grid services with both technologies, paving the way for US bulk power systems with extremely high renewable penetration
  - Create a two-way communication channel between grid engineers and inverter vendors so that they can collaborate to understand the real needs of IBR controls to provide better grid services to power grids
  - PGE and BPA are currently considering including requirements for grid-forming capabilities in our own interconnection standards

WECC

Electric Reliability and Security for the West

Contact:

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