WECC

MVS Update to RAC

March 2, 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

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, under benchmarking
    - GFMDRP_A

Renewable Modeling Updates

- Electrical Control Model
  - REEC_A: the most commonly used model for both wind and PV plants
  - REEC_B: a simplified version of the electrical controls, which was previously used for PV plants but is no accepted and has been disbanded
  - REEC_C: a model intended primarily for use in modeling battery energy storage system
  - REEC_D: the most recent electrical controller model for use with wind, PV and BESS
  - REEC_E *new!* : new features will be added based on REEC_D model

Renewable Modeling Updates

- Power Plant Voltage Droop Control Power Flow Model
  - Implemented in all major software platforms
  - The PPC model, although developed for hybrid plant, can and should be used to model plant voltage droop control for non-hybrid plants as well
  - Test in WECC case with and without PPC power flow models and develop a modeling guideline whitepaper along with the development of repc_c model

Renewable Modeling Updates

- Prioritize the next set of Model Development
  - Grid-Forming Inverter model
  - REEC_E model
  - REPC_D (hybrid plant controller)
  - Multi-Terminal HVDC VSC model
  - SVSMO4 model
  - SCMOV (series capacitor MOV model)

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

- Grid-Forming Control Methods
  - Droop-Based
  - Power Synchronization Loop
  - Voltage Controlled Inverter
  - Virtual Synchronous Machine
  - Virtual Oscillator Control
  - Matching Control
  - PLL-Based Modified Current-Controlled
  - Direct Power Control

Grid-Forming Inverter Modeling

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

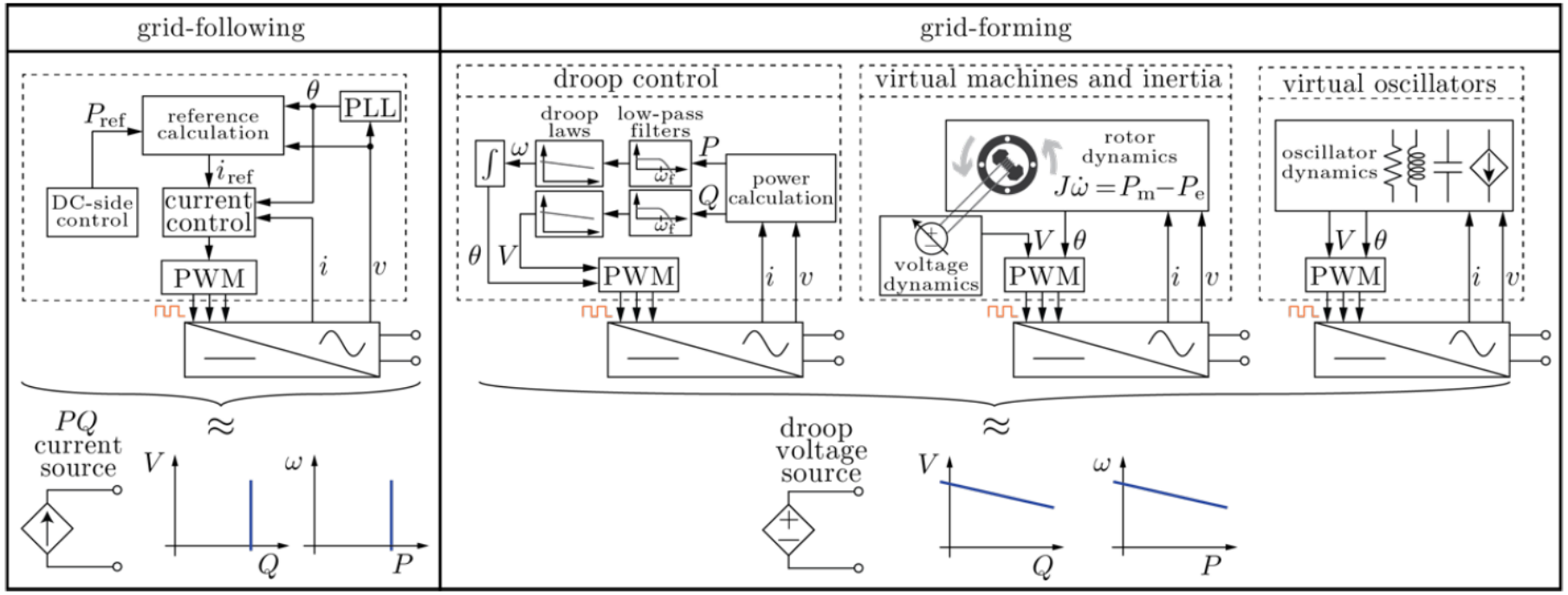
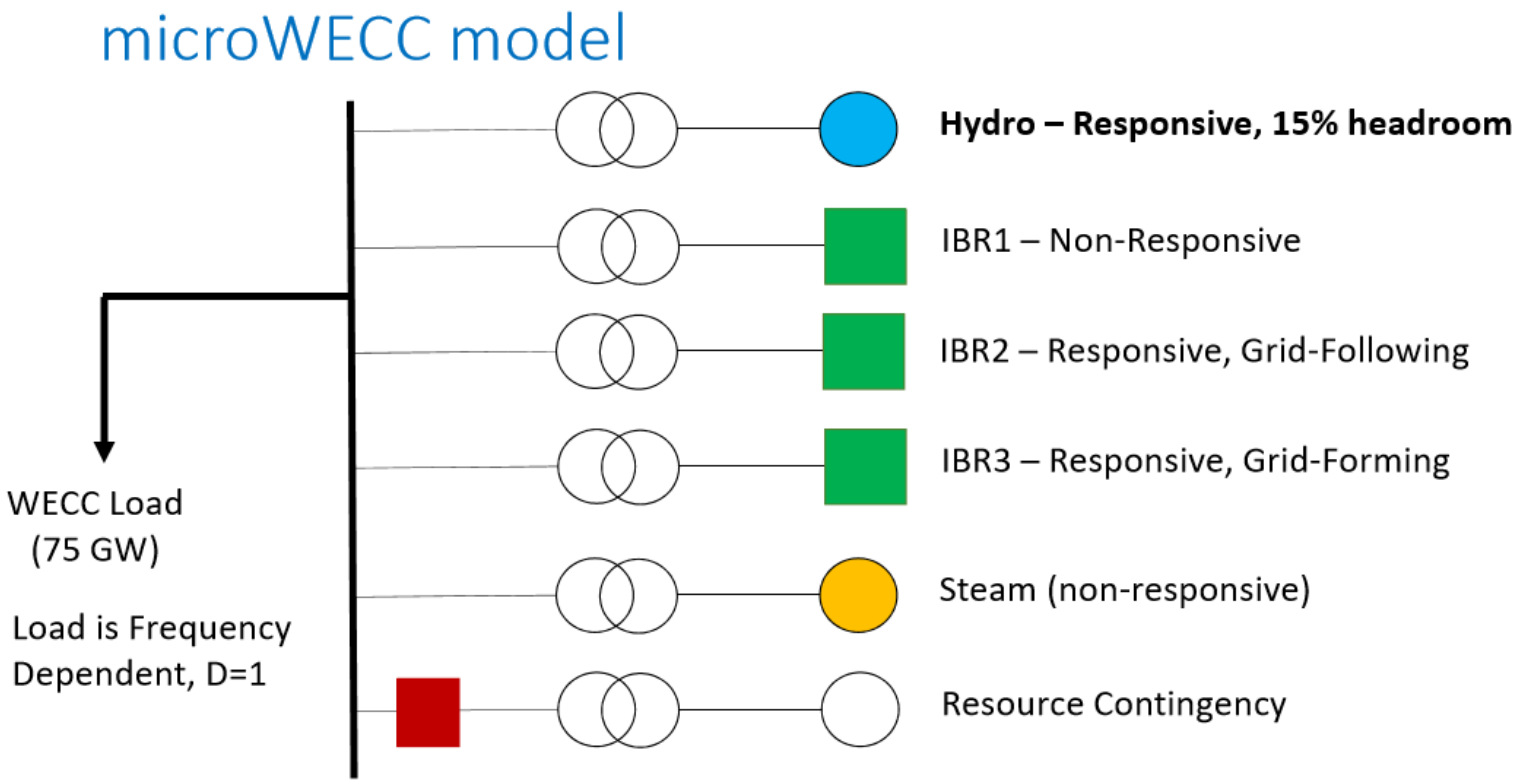


Figure 4. Functional diagrams of grid-following and grid-forming inverters. Grid-following inverters mimic current sources at their output terminals, whereas grid-forming inverters act like voltage sources whose output abides by droop laws.

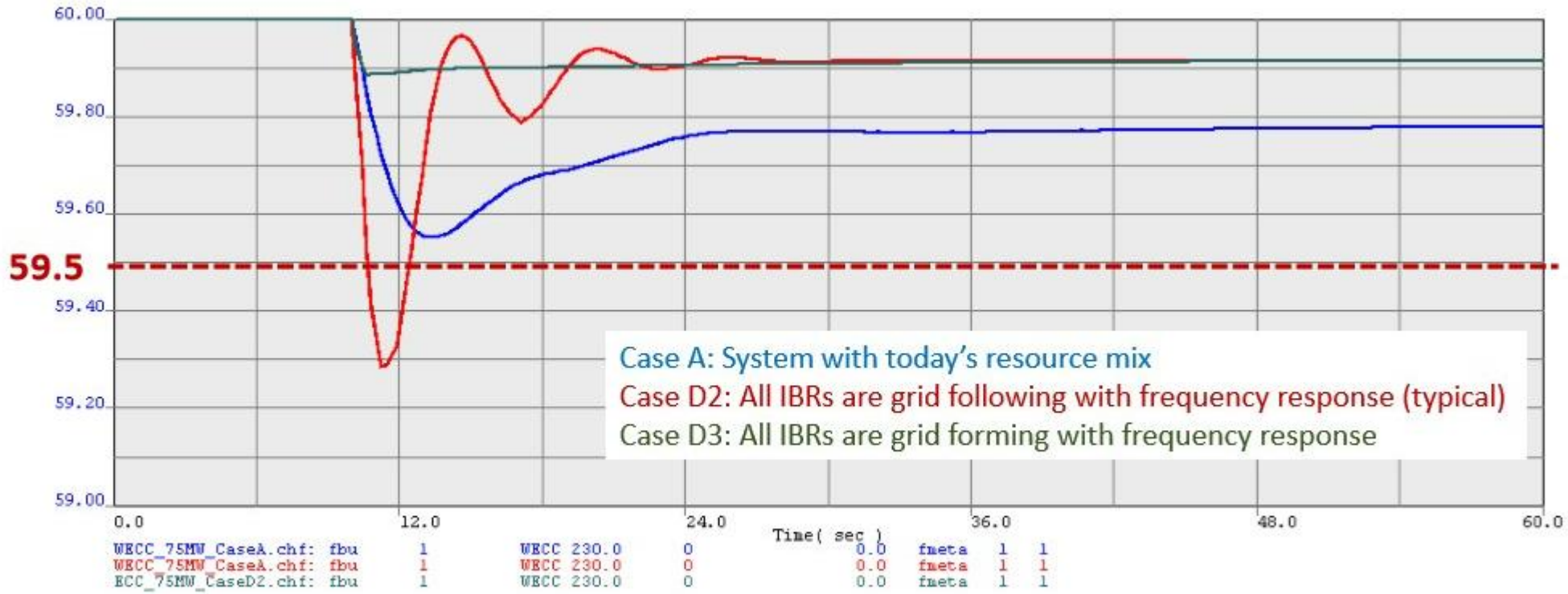
Grid-Forming Inverter Modeling

- IBR grid-forming vs grid following frequency response



Grid-Forming Inverter Modeling

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



Power Plant Modeling Updates

- Generator model
  - Continue 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
  - Hydro power generation model development
  - 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

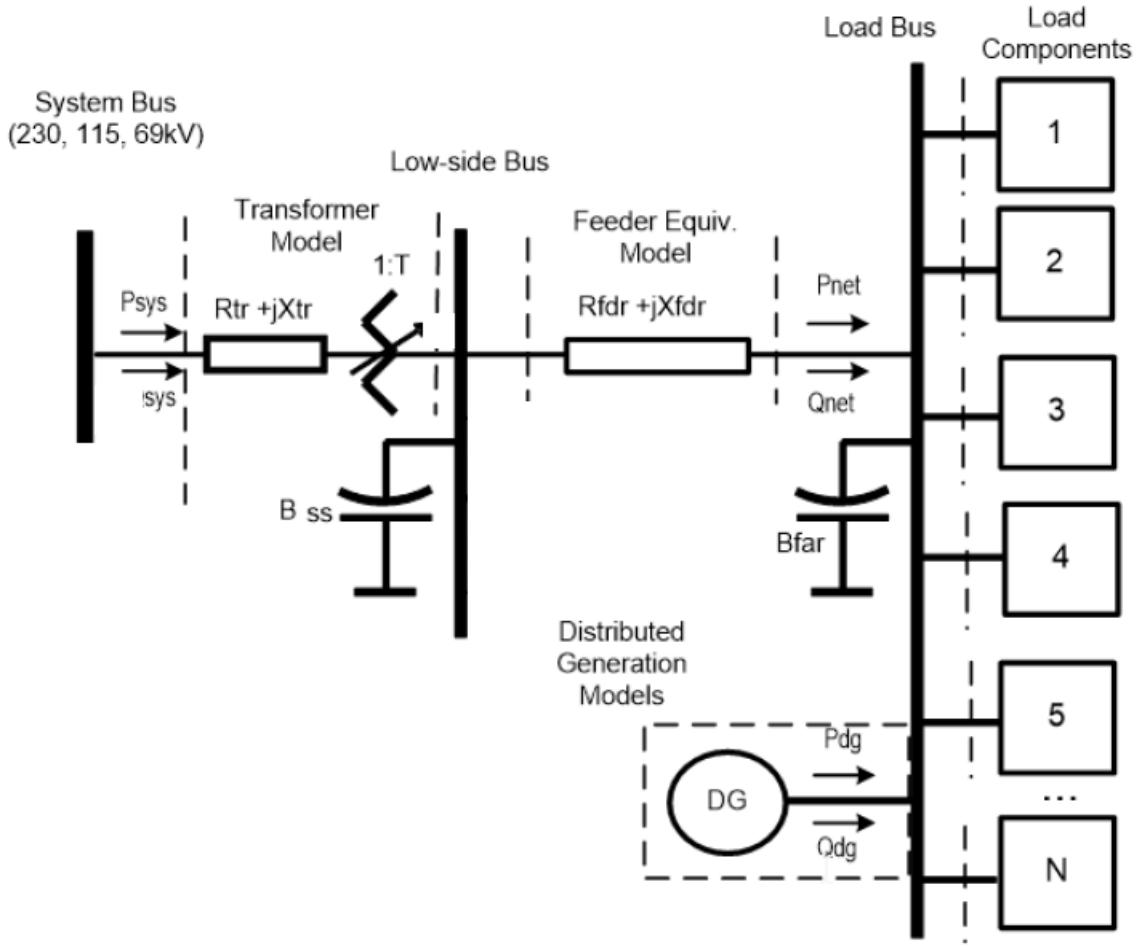
- Next steps
  - Need to continue work on IPP -> chvdc2
  - BPA to provide finalized PDCI parameterization for WECC basecase building
  - Transbay Cable -> vhvdc1
  - Continued work on multi-terminal VSC-HVDC
  - Need to put SVSMO4 on the list of modeling priorities, then implementation, testing and approval

Load Modeling Updates

- Modular models developed/under developing
  - BTM DER data set
  - DER induced oscillation under frequency control
  - Heat pump model
  - Motor C model benchmark
  - EV, VFD, etc
- Industrial loads
  - Data center
- Load modeling process/toll/policy improvement
- TRV document recently published

Load Modeling Updates

- Module based load modeling



WECC

Electric Reliability and Security for the West

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