WECC STUDY PROGRAM 2023

GRID FORMING INVERTERS

PODCAST REPORT

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OBJECTIVES

Building on a 2021 WECC study looking at grid-following (GFL) inverters, WECC studied the potential effects of grid-forming (GFM) inverter-based resources (IBR) on the system's ability to maintain system frequency during a large disturbance. The study answered two questions:

- How do GFM IBRs respond to a major loss of generation?
- How much generation is needed from GFM inverters to maintain system frequency and avoid load shedding during a major event?

GRID-FOLLOWING	vs.	GRID-FORMING
Synchronize output with the system; maintain consistent voltage and frequency to react to or "follow" changes on the system		Actively provide voltage and frequency support to help manage or "form" the system, especially during disturbances

APPROACH

WECC used the newly created first-generation generic grid-forming inverter model to complete this assessment. The model is the first of its kind, capable of simulating droop-based GFM IBRs. WECC simulated the replacement of almost 37 GW of synchronous generation with IBRs, then applied two types of system disturbance: a double Palo Verde generating unit outage and a 20% generation imbalance. WECC applied these disturbances to two scenarios—spring early morning and spring mid-afternoon—to compare the frequency response capability of GFL and GFM IBRs.

FINDINGS & RECOMMENDATIONS

The increase in IBRs on the grid will likely decrease system inertia and increase the Rate of Change of Frequency during a generation outage, indicating more load is at risk due to frequency response issues.
GFL IBRs respond more slowly than GFM IBRs, which means it takes more GFL IBRs to provide immediate response to system disturbances. Based on our modeling assumptions, it took four times as many GFL IBRs to compensate for the Palo Verde outage as it did the GFM IBRs.
The change from GFL to GFM technology results in a significant improvement in interconnection-wide frequency response.

- Recommendation: Planning Coordinators should strongly consider GFM technology when replacing synchronous generators with IBRs. They should be designed to provide reliable and robust performance that supports high IBR penetration in the Western Interconnection.

In the imbalance scenario, up to an additional 10% of generation tripped offline due to protection settings, causing a loss of synchronization with the grid.

- Recommendation: The Underfrequency Load Shedding Work Group should look at the Underfrequency Load Shedding methodology considering these results to determine how to evaluate the additional generation loss.

INVERTERS AT A GLANCE

- An inverter connects the electric grid to generating resources such as solar, wind, and energy storage.
- An inverter is a power device that converts direct current (DC) electricity to alternating current (AC) electricity.
- Grid-forming inverters provide immediate response to grid changes and maintain stability during a disturbance or outage.

WECC