Tesla Comments – NOGRR 282

ERCOT LLWG – 1/22/26

Tesla recommendations on NOGRR 282 phrasing

ERCOT draft, 11/14/25

the LEL shall continue consuming active power from the grid during the low voltage condition. In such cases, the LEL may reduce its active power consumption proportional to the voltage drop but shall return to 90% of its pre-disturbance consumption level from the grid within one second of voltage at the Service Delivery Point or POIB returning to above 0.9 per unit

Tesla recommended addition

For voltage deviations outside the 0.9-1.1pu range and frequency deviations outside of the 58.8 - 61.2 Hz range, ***an internal load-transfer or control stabilization interval of up to 250 millisecond is permitted****.*

For LELs composed of multiple internal devices, one transition will be permitted per disturbance event for each individual device.

Current language

1. "Continue consuming"
   - While not explicit, reads as no "gap" or load draw switching
   - Thus, would require continuous draw from UPS

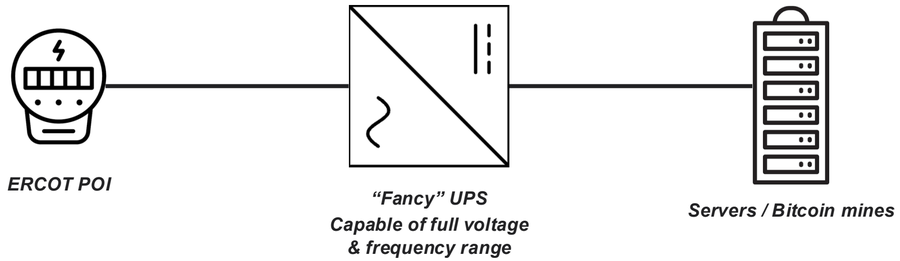
Tesla Recommendation

1. Add <250 millisecond load transfer language
   - Enables ancillary equipment to start drawing current
2. Limit variance frequency
   - "Once per device" to allow for VFDs vs UPS A vs UPS B on a site to have different tripping profiles

Options for Large Loads to provide load stability across voltage & frequency ranges

Optionality should be enabled on solutions, assuming they solve for the technical requirements

Current language: “Fancy” UPS only.
Few options, material concerns from large load developers, hard to retrofit



Clean pathway, but limited options

- Hard to retrofit, challenging to get off SOL/IROL list to avoid curtailment

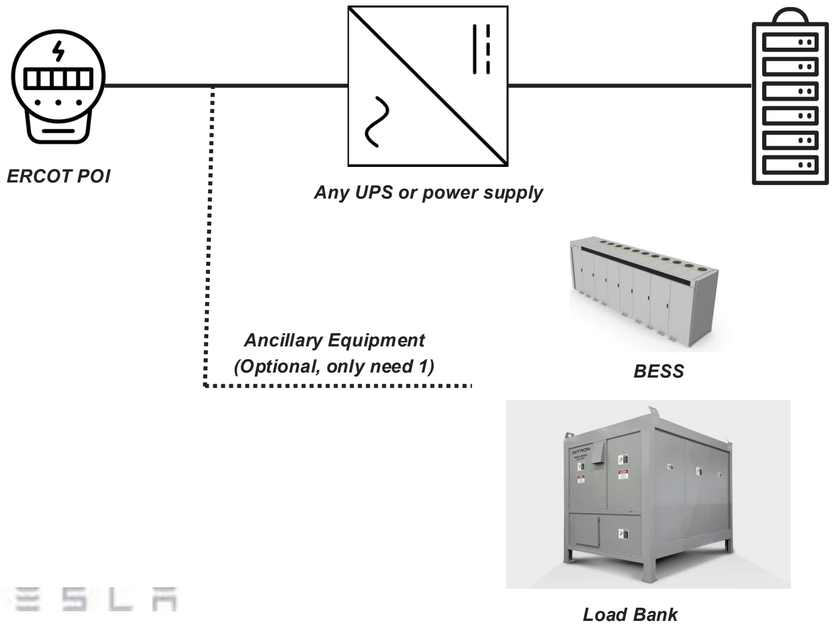
Developers / Operators voiced material concerns

- Data Centers: Concerns on voltage <0.7 and <0.5 voiced

UPS OEMs not capable of this today, may be possible

- VERTIV: Need updates to maybe enable
- Eaton: May be able to meet ERCOT needs, with updates

With proposed tweak: Any UPS, power supply or other power equipment could solve
Technology agnostic, drives innovation, provides load stability to ERCOT



Viable pathway for all sites

- **Technology agnostic:** multiple potential solutions
- **Enables retrofits** to get off SOL/IROL list to avoid curtailment

Ancillary Equipment OEMs – Ready to support!

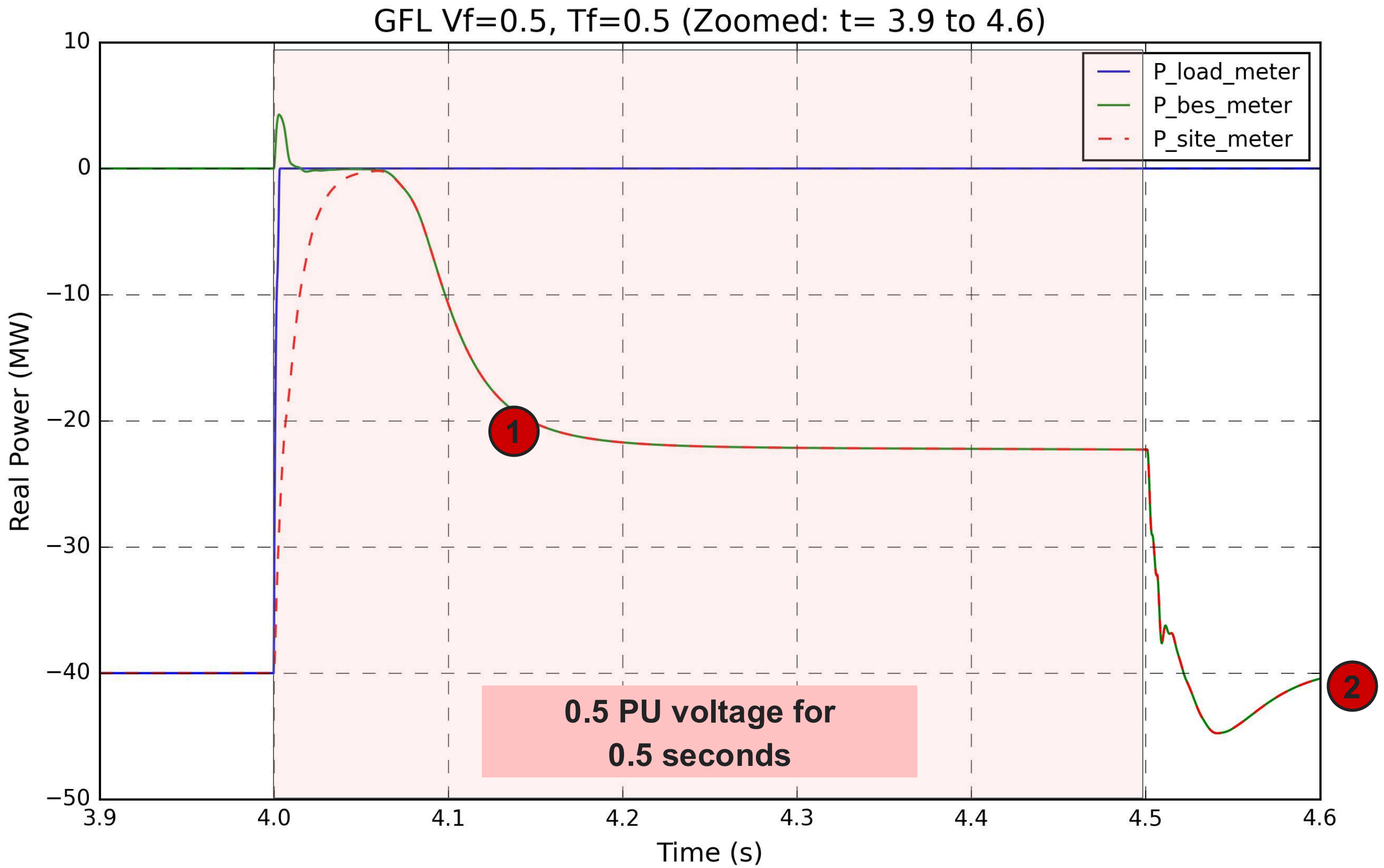
What is ERCOTs “Need” on VRT – why 250 ms is acceptable?

Concern	Need return by	Comments
Frequency	1,000 ms (1s)	• Frequency generally stable for ~0.5s, then starts to increase • At ~1 to 1.2s, crosses 60.4 hz in analysis
Voltage	~500ms (0.5s)	• >1.2 pu for >0.5s is concern, need to return voltage to nominal via load draw faster than this

- LLWG 5/16 session had great details in Luis Hinojosa’s presentation on ERCOT systems needs
- Overall, they show that concerns start to arise if load, across a number of data center facilities, reduces for >500 milliseconds

Load return with BESS – Detailed Grid Following example

0.5 pu voltage for 0.5 seconds, grid following BESS



1. **Current matches pre-fault in ~150 ms**
   - Settles at ~1.2 PU current, ~50% power of pre-fault
   - Matches 2.14.2.d language to not exceed 125% max electric current consumption during disturbance

2. **Power returns to nominal ~100 ms post fault**
   - Faster than 1 second prescribed in 2.14.2.b

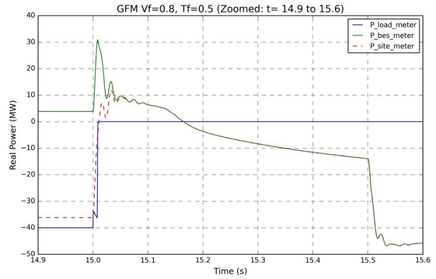
- **Improved ride through capabilities**
  - NOGRR 282 specifies 0.5s for 0.5 pu, meaning at end of simulated fault load full load permitted to reduce to 0
  - Megapack can ride through at 0.5 PU for 25s

Questions?

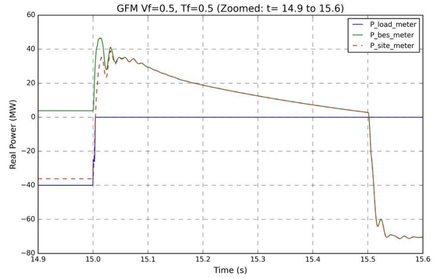
Load return or mimicking with BESS – Tesla Megapack simulations

Grid Forming

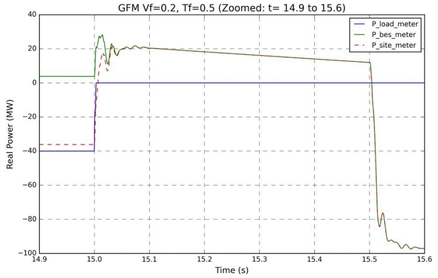
0.8 pu voltage dip



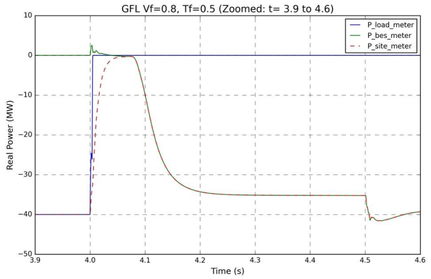
0.5 pu voltage dip

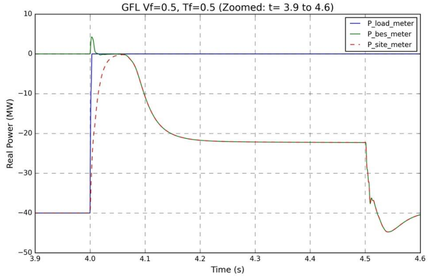


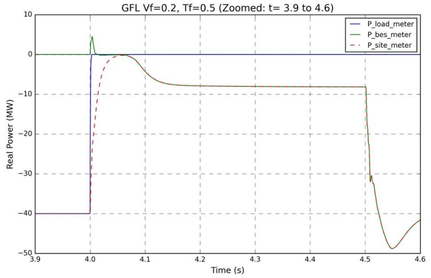
0.2 pu voltage



Grid Following







Analysis

- Varied voltage dips: 0.8, 0.5, 0.2 PU
- 0.5 second fault assumed
- Grid Forming & Grid Following inverter control modes

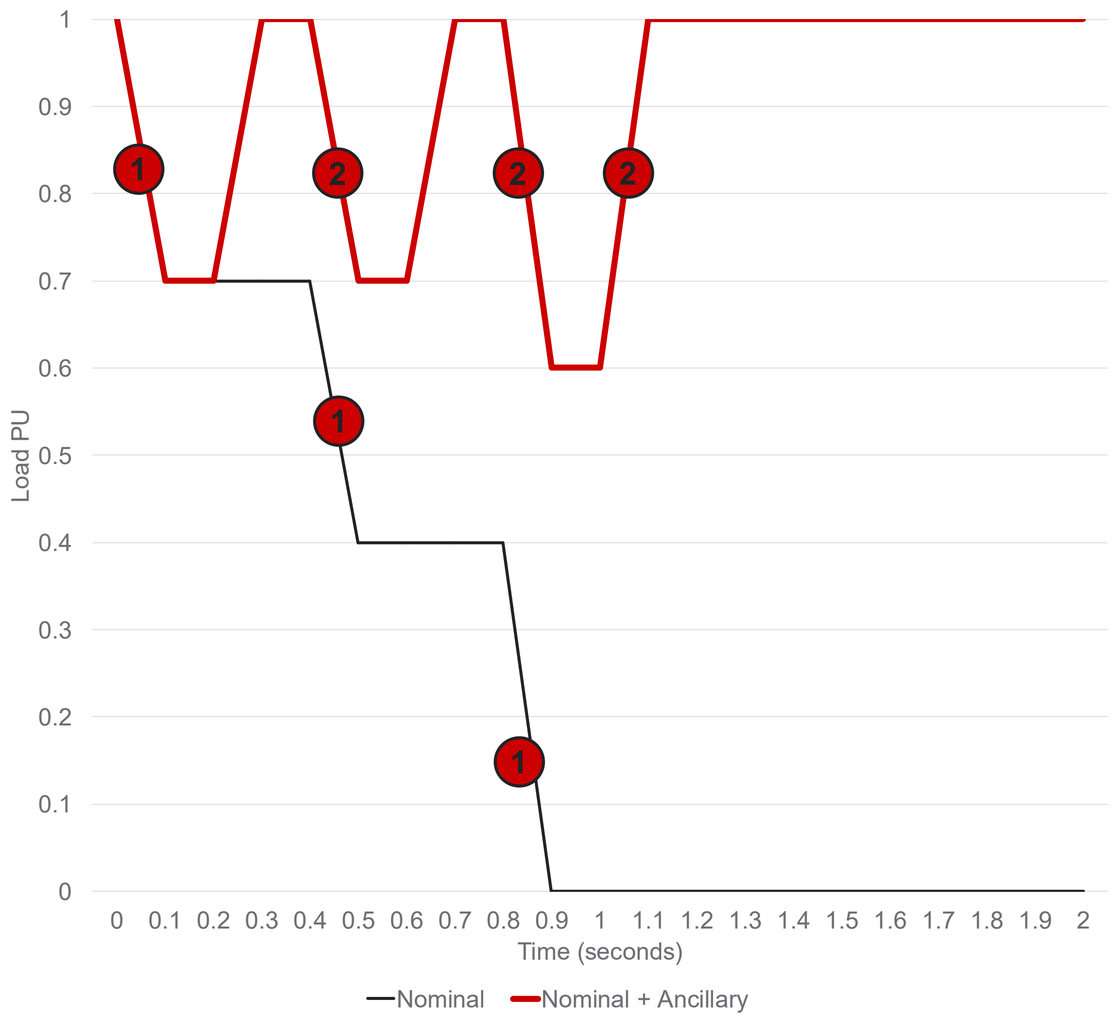
Takeaway: BESS mimics load in < 250ms
Faster than 500 ms “need”

In summary

- Grid following (recommendation)
  - ~150ms current returns to pre-fault
    - Includes during continued fault
    - Likely see derated power for deep sags
  - ~100 ms post fault, power returns to pre-fault

- Grid forming:
  - During fault: focuses on voltage support – injects Q
    - Do not see current draw return as quickly
  - ~100 ms post fault power returns to nominal

Example of “once per device” language intent



Nominal loads may trip at varying times

- VFDs vs UPS may have different characteristics
- Different UPS systems may have different capabilities, with a mix installed on site

1 Example shows 3 discreet load drops

Example shows 200 ms ancillary load transition

2 Quickly picks up load as it drops

Proposed language

For LELs composed of multiple internal devices, one transition will be permitted per disturbance event for each device.

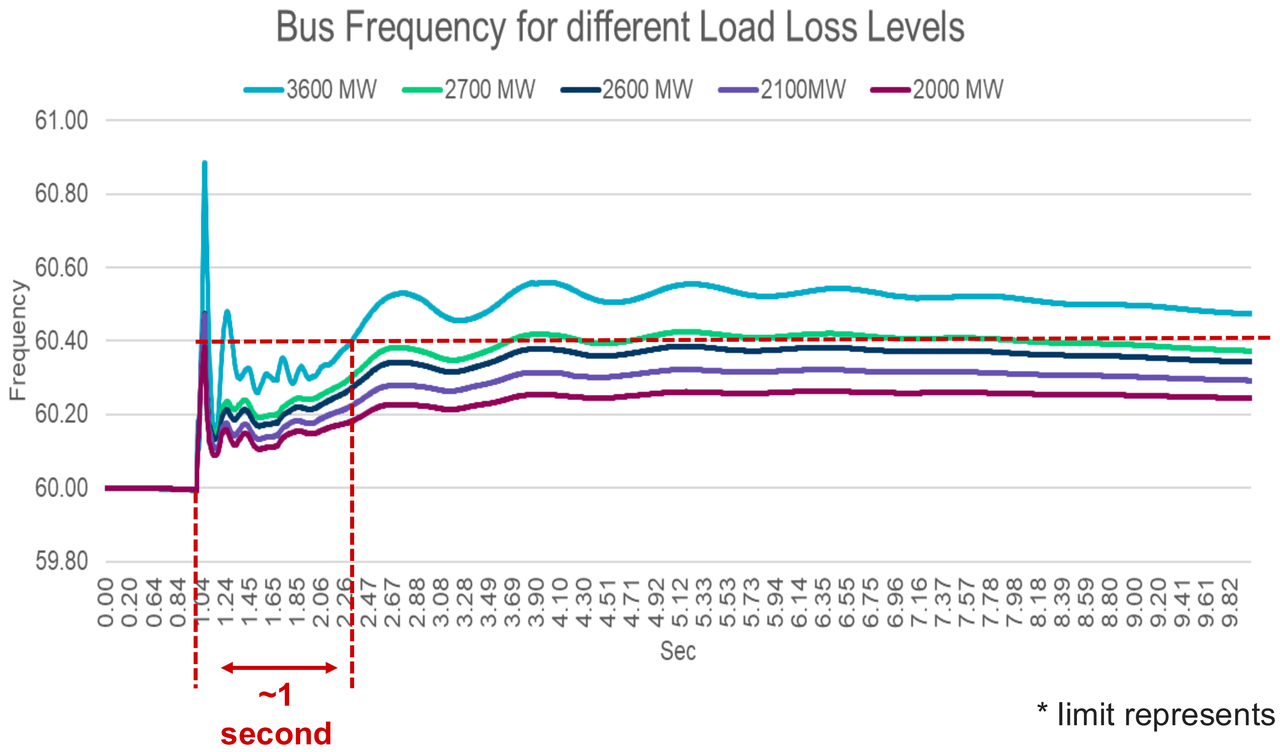
- Intended to add clarity that having differing trip settings on devices is OK
- This would benefit ERCOT stability, as loads get picked up as they drop
  - i.e. in example shows minimum 0.6 pu, which is quickly transferred to ancillary equipment

LEL Ride-Through Studies

- From 6/13/25 workshop
- Initial frequency jump believed to be from software actual vs actual (voiced over in call)

ERCOT has also performed a study of system frequency response to a significant LEL (multiple LELs in same area) trip

– Under certain critical conditions, the loss of more than 2600 MW of LELs* would cause system frequency to increase to a level (60.4Hz) at which conventional generators are concerned that they might not ride through, which may lead to an uncontrolled cascading event



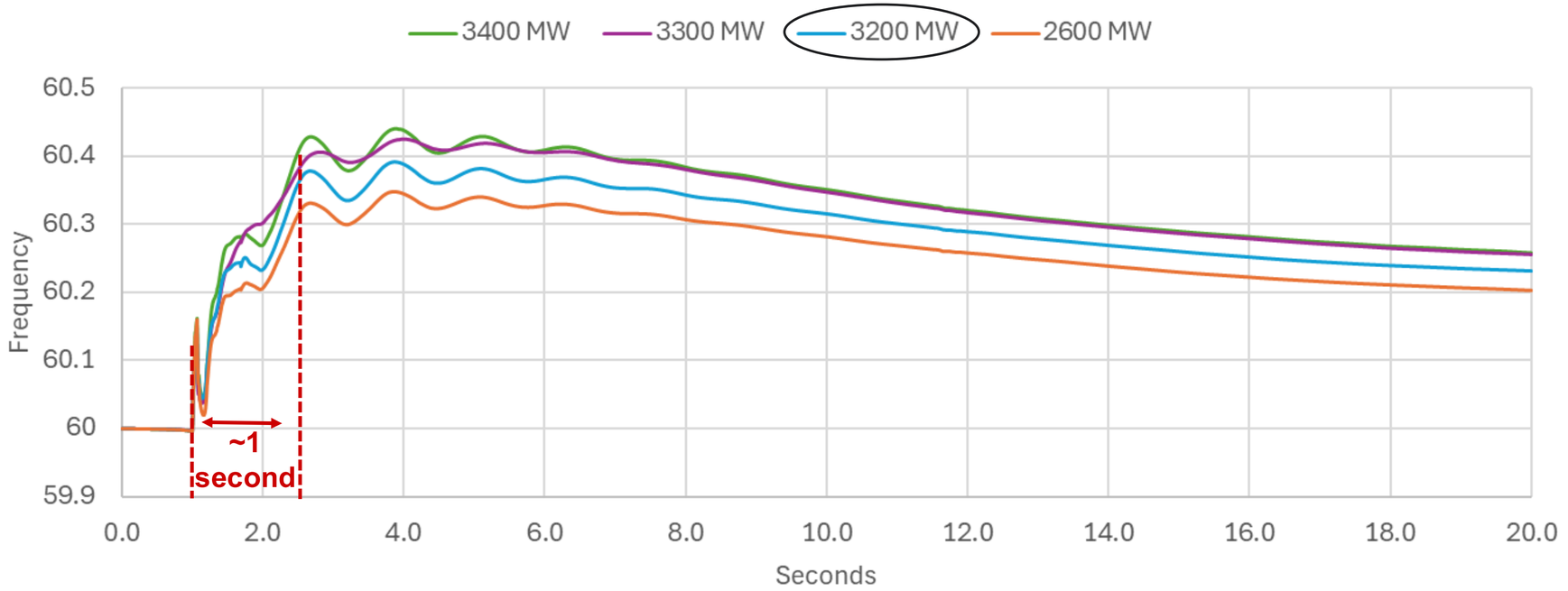
Key Takeaway: If the volume of LELs that cannot ride-through system faults continues to increase, it could result in a major event.

* limit represents combined voltage sensitive, consequential and non-consequential LEL loss

- From 12/11/25 LLWG meeting

Updated Frequency Study Dec 2025 - (3,200 MW)

Bus Frequency for different load loss levels from original study case



MW Load Loss	Frequency Max
~3,400	60.43
~3,300	60.43
~3,200	60.38
~2,600	60.21

Key Takeaway: We validated our cases and identified an issue which limited Primary Frequency Response from units sitting near 0 MW output which limited ESRs from providing PFR in the negative direction when idle. We have updated the logic to allow response as expected and identified a new limit of **3,200 MW**. Additionally, we have done some model validation and are doing outreach for models which responded incorrectly.

From May 16, 2025 LLWG, Large_Load_Loss_Analysis_051625_LLWG

Voltage Sensitivity Analysis – Observation 2

- Following sensitivity analyses are performed using voltage rise criteria 1.2 pu for 0.5 sec as this puts IBRs in a may trip zone.
- The voltage issues become more severe showing a wider area issue around 2,450 MW load loss.

Scenario (Load Loss Level - MW)	Status
~3,600	Insecure - Wide Area Voltage Issues
~2,600	Insecure - Wide Area Voltage Issues
~2,450	Insecure - Wide Area Voltage Issues
~2,100	Insecure - Local Voltage Issues
~2,000	Insecure - Local Voltage Issues
~1,950	Secure

Key Takeaway: In this study, local voltage issues were observed starting at a load loss around ~2,000 MW and wide area voltage issues arose around ~2,450 MW which indicates more severe case conditions around this load loss. Note that, this specific historical case was selected based on the most limiting frequency response characteristics. Potentially, additional analysis is needed to understand this observation better.