Item 7.2.1: Inverter-Based Resource and Large Load Ride Through Events: Background and Mitigation

Dan Woodfin
Vice President, System Operations

Reliability and Markets Committee Meeting

ERCOT Public
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Overview

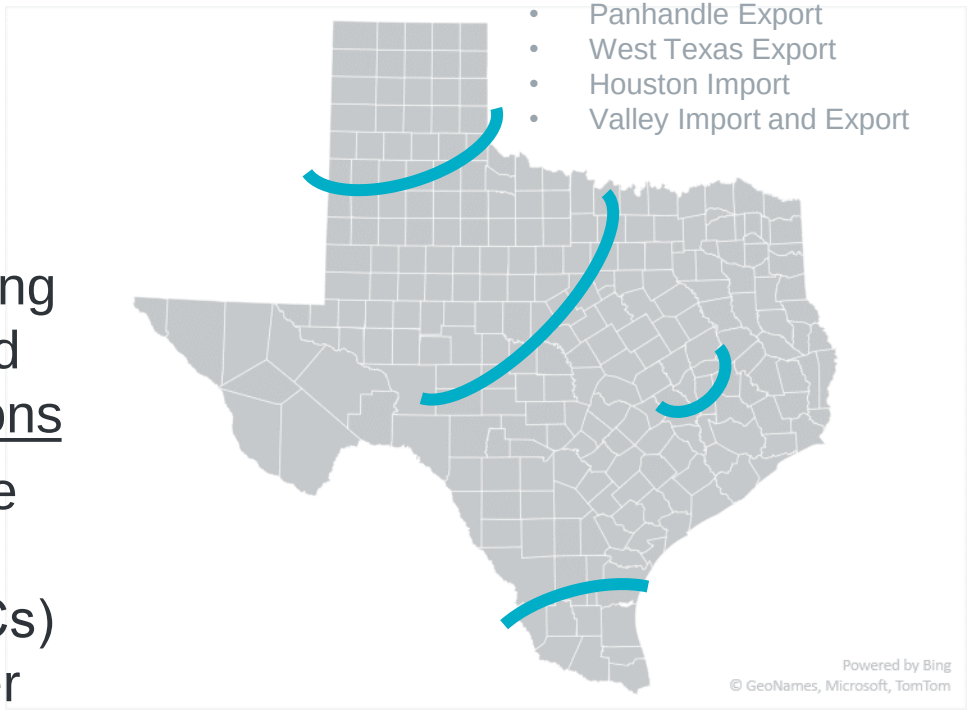
- **Purpose**
  Provide educational background on reliability events that will require policy considerations by Board over next several months

- **Voting Items / Requests**
  No action is requested of the R&M Committee or Board; for discussion only

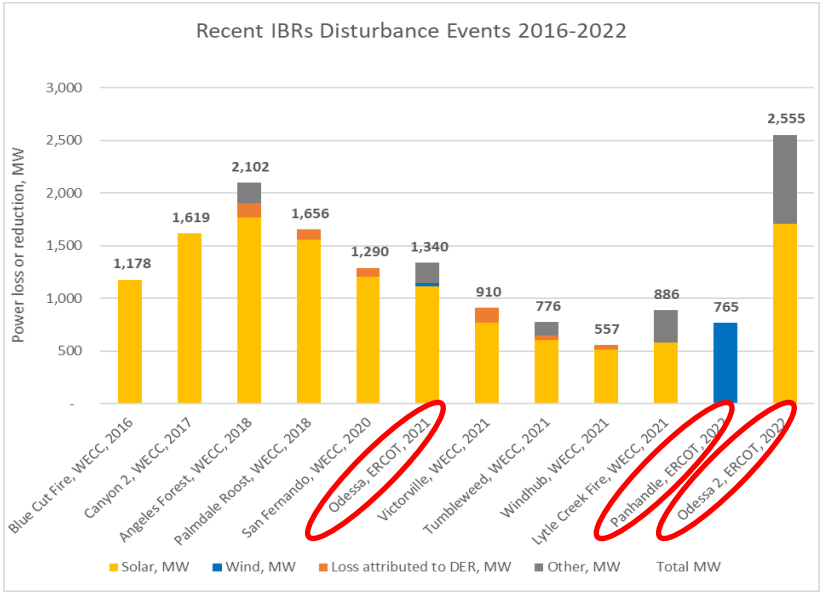
- **Key Takeaways**
  - ERCOT performs complex studies of the dynamic nature of the grid and limits transfers where necessary to maintain reliability
  - There have been several events where resources (primarily inverter-based) or large loads have not ridden-through faults on the system due to behavior that is not modeled in dynamic studies. Improvements by generators, to their actual technical behavior and to reflect the accurate modelling of it, are needed
  - ERCOT is proposing solutions for these ride-through issues which will come before the Board over the remaining meetings this year

Voltage and Stability Limits

- Power flows between two points or areas on the grid may need to be limited due to potential line overloads, or due to voltage or stability issues
- Identifying the need for voltage and stability limits, and quantifying those limits, requires special and complex modeling and simulations
- Once calculated, these limits are then included as “Generic Transmission Constraints” (GTCs) in the dispatch algorithm in order optimize the efficient use of the generation while avoiding voltage and stability issues

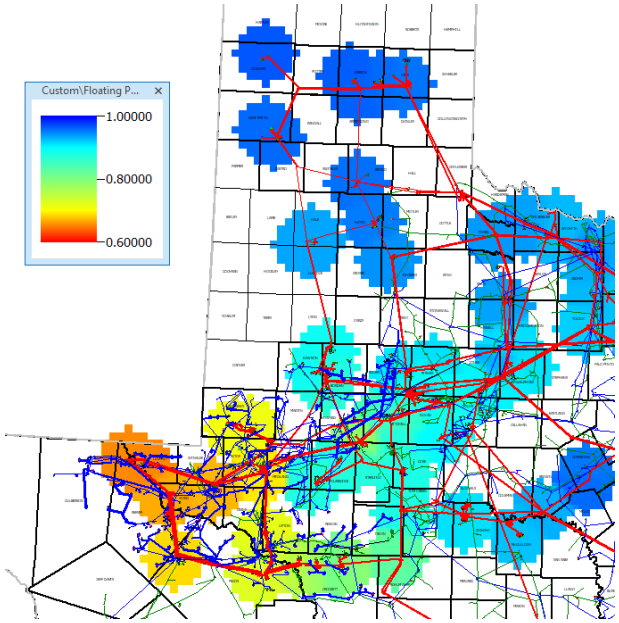


Recent Lack-of-Ride-Through Events



- There have been several significant events (see graph) across the United States where Inverter-Based Resources (IBRs) failed to ride through a fault on the system, including several in ERCOT, as well as numerous smaller events
- There have also been 5 smaller events in ERCOT since October 2022 where large loads in west Texas (data centers and oil/gas) failed to ride through faults
- The control system behavior causing these IBR or large load trip events is not represented in the dynamic simulations; these ride-through events are not generally preventable by reducing transfers across GTCs

What is Ride-Through?

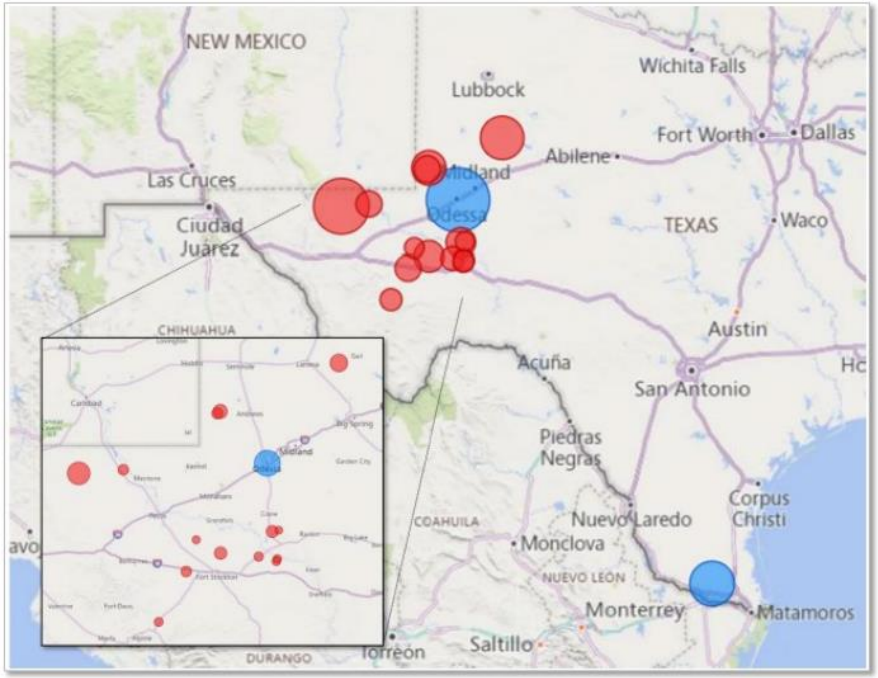


- Following a lightning strike or equipment failure on a transmission line or other equipment, the voltage in the area may be depressed until the protection systems clear the fault
  - The weaker the grid is in the area of the fault, the more widespread the voltage depression will be (see graph)
- Generators and large loads in the area need to “ride-though” this voltage dip and continue to produce power, and support voltage, and stay in sync with the grid frequency
- ERCOT initially implemented ride-through requirements for new generators in 2008; some existing wind farms were exempted

Key Takeaway: If generators or loads do not ride-through an event, it can cause reliability issues from outages in the local area up to system-wide frequency instability. The effects due to a fault are more widespread in a weak grid area

Details on the Largest IBR Event: Odessa 2

- 345 kV single-line-to-ground fault at 12:59 PM on June 4, 2022
- 2,555 MW loss of generation
  - 844 MW loss of synchronous generation
  - 1,711 MW loss of solar generation
- System frequency dropped to 59.7 Hz
  - 2,343 MW of Responsive Reserve Service deployed out of 2,442 MW available at time of event
- Mitigation for units involved is complete except for one unit which is still in-process



Impacted Units
Blue = Synchronous generator
Red = Solar generator
Circle size indicates MW lost

Key Takeaway: The 6/4/22 Odessa Event was the largest of several events in which some IBRs and synchronous generators did not appropriately ride-through a fault

Details on the Largest Load Event: 12/7/2022

- Multiple related faults on 138 kV lines near Odessa, including one three-phase fault due to a breaker failure, at 3:50 AM on December 7, 2022
- Reduction in load of about 1,600 MW
  - Included mix of large loads including data centers, oil/gas load, and other industrial loads
  - Two thermal generators tripped during event, totaling 112 MW
  - Solar units were not impacted since event occurred at night
  - System frequency spiked to 60.235 Hz
  - Returned to 60 Hz in 12 min 30 sec

Key Takeaway: The 12/7/2022 event shows need for improved interconnection process for large loads and improved simulation models of new load types.

Key Takeaways: Mitigation tools that will be coming before the Board soon

- NOGRR245, Improved ride-through requirements for IBRs; anticipated at Board by October
- West Texas Synchronous Condenser Project: to reduce risk of incorrect modeling and tuning and limit the geographic extent of low voltages during a fault; ERCOT recommendation to Regional Planning Group (RPG) in June
- Several new market rules under development; will be filed soon:
  - Supplement current model benchmarking requirements by requiring ERCOT and transmission operator notification before parameter changes are implemented in the field
  - Require interconnection studies and set ride-through standards for large loads
  - Require improved data monitoring equipment necessary for model validation
- 2024-2025 Budget Request at June Board meeting
  - Increased capabilities for system stability studies and model validation
  - Increased capabilities for near-miss and event analysis