Reliability and Security Assessment: Performance, Models, and Tools in ERCOT

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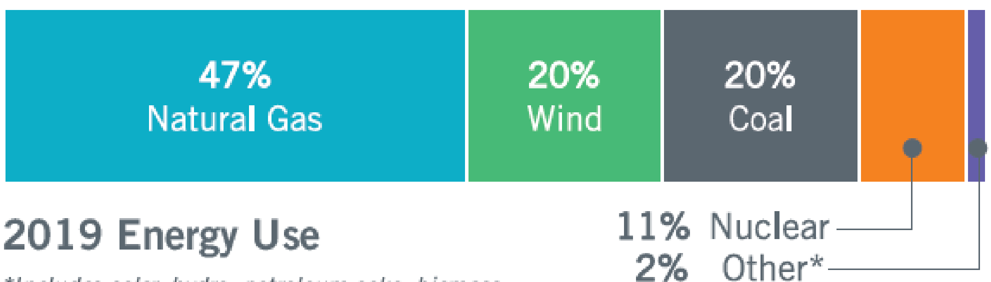
ESIG Webinar
Session 10: Challenges with High Inverter-Based Resource Penetration
April 28, 2020

Quick Facts

- Peak Demand Record: 74,820 MW (August 12, 2019)
- Wind Generation Record: (instantaneous)
  - Output: 20,066 MW Jan. 8, 2020
  - Penetration (load served): 57.88% Nov. 26, 2019

    Total MW served by wind = 18,084 MW



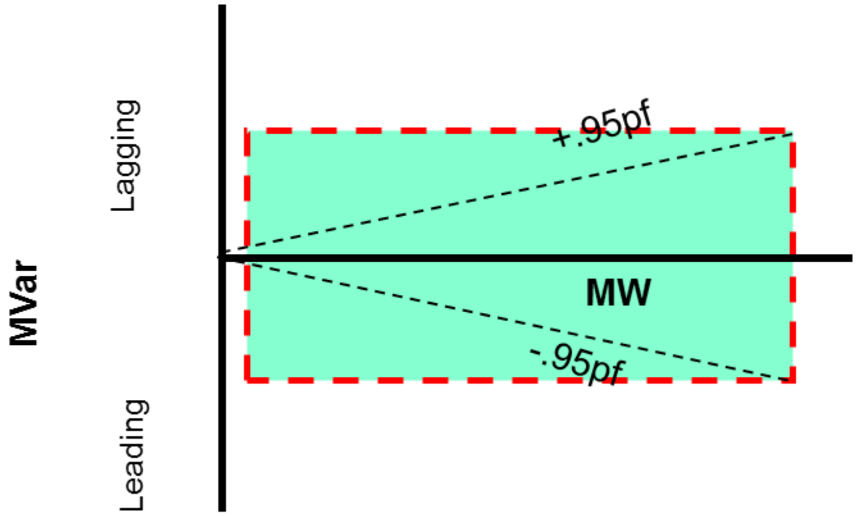
2019 Energy Use

**Includes solar, hydro, petroleum coke, biomass, landfill gas, distillate fuel oil, net DC-tie and Block Load Transfer imports/exports and an adjustment for wholesale storage load*

384 billion kilowatt-hours of energy were used in 2019, a 2 percent increase compared to 2018.

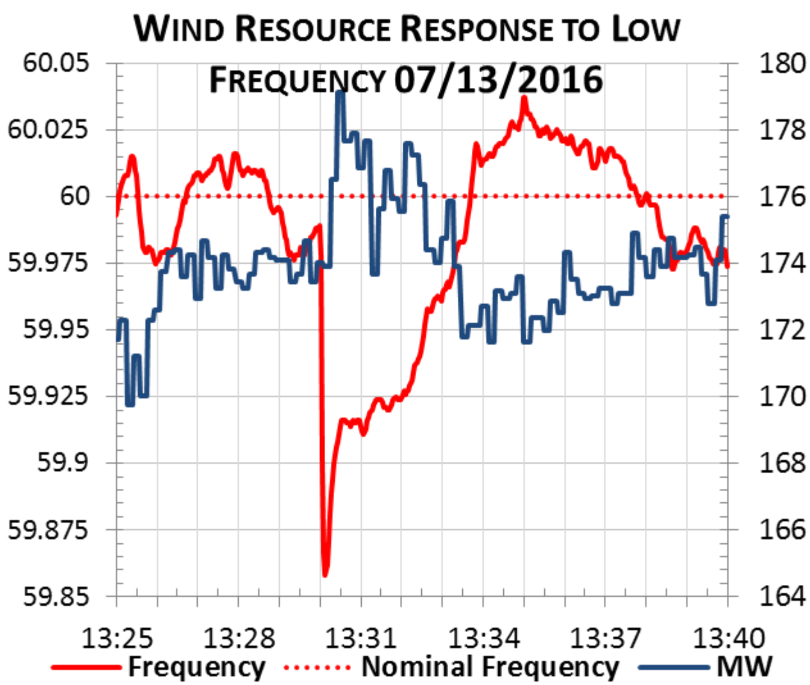
Notable Requirements: Voltage Support

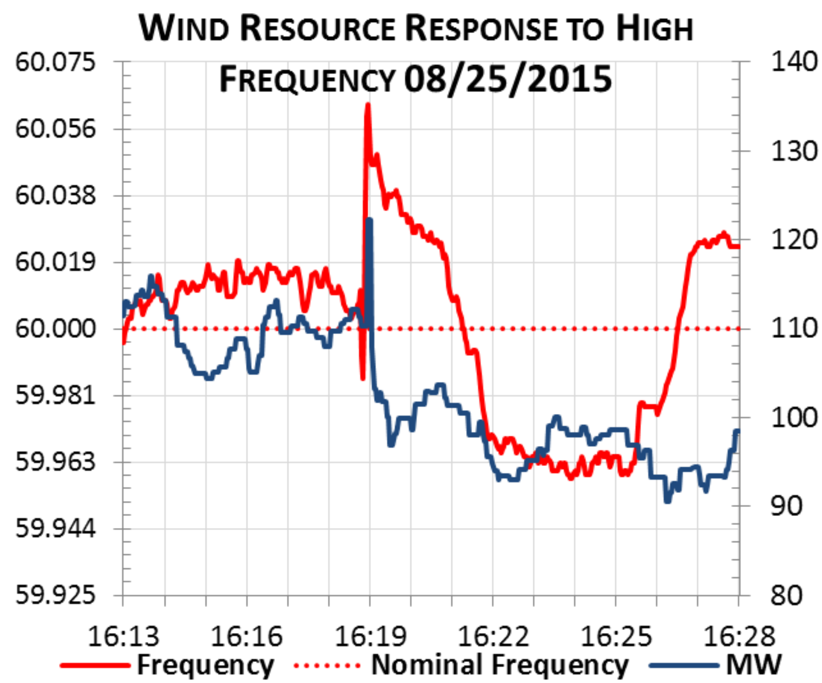
- IBRs are required to provide reactive power
  - 0.95 power factor, leading and lagging, at Point of Interconnection (POI)
  - Provide the capability anytime output is at least 10% of capacity, energy storage is required from 100% charging to discharging
  - Reactive power capability must be **dynamic**



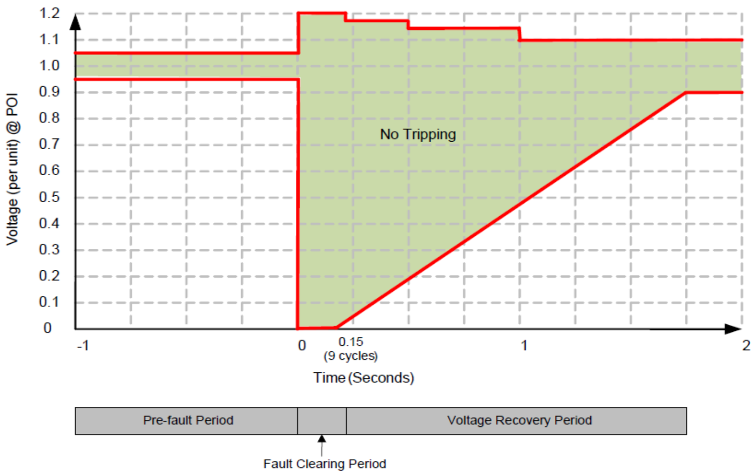
Frequency Support

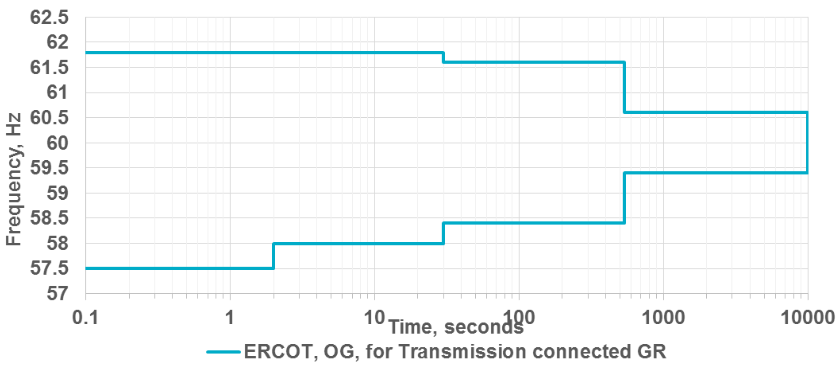
- IBRs are required to assist in ERCOT’s frequency control and provide a “governor-like” response (Primary Frequency Response) to frequency deviations.



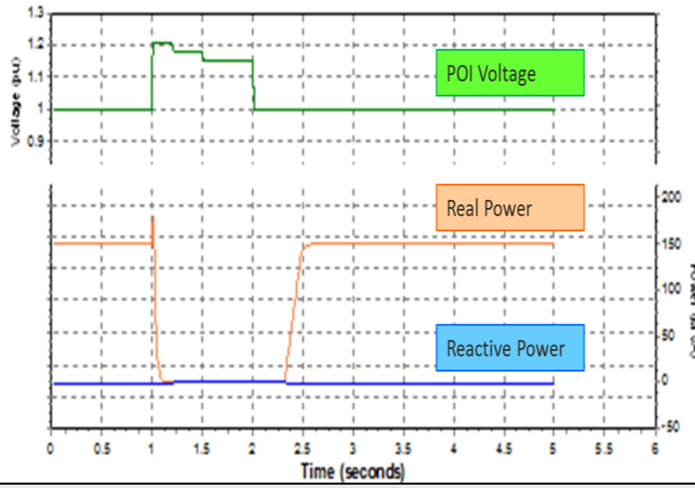


Voltage/Frequency Ride Through





- Generation Resource shall not, during and following a transient voltage disturbance, cease providing real or reactive power except to the extent needed to provide frequency support or aid in voltage recovery.



Undesired Performance

IBRs Integration in ERCOT: Reliability and Security Assessment

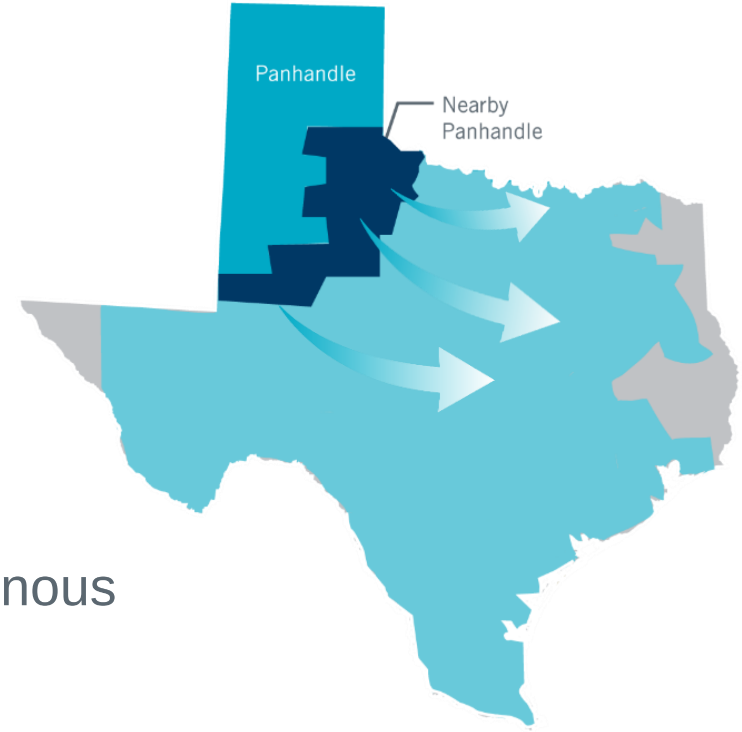
Resource Interconnection	Planning	Operations

• Steady State
• Dynamic Stability
• Short Circuit
• Reactive Power
• Voltage Ride Through
• Subsynchronous Resonance (SSR)
	• Steady State
	  • Power flow
	  • PV analysis
	• Dynamic Stability
	  • PSS/e
	  • PSCAD (mainly in weak grids)
	• SSR
		• Steady State (offline/online)
		  • Power flow
		  • PV analysis
		• Dynamic stability
		  • PSS/e, TSAT (offline)
		  • TSAT (online, to be implemented)

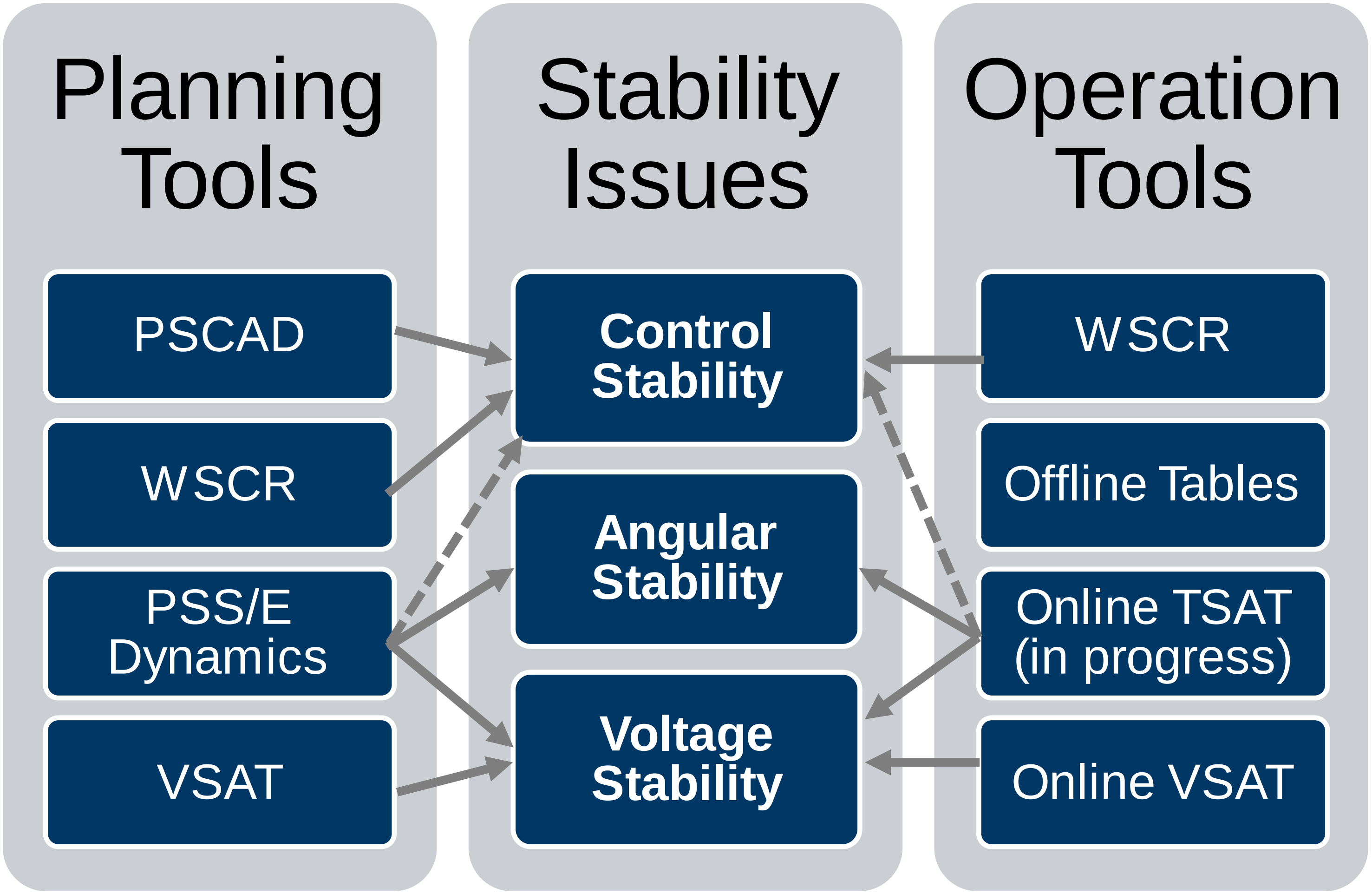
ERCOT Reliability Assessment Example: Panhandle Region

- More than 10 GW IBRs
- Remote from synchronous generators and load centers
- Hundred miles power transfer
- All inverter-based resources

- Challenges and Needs
  - Weak Grid
  - Voltage Stability
  - Oscillation (installed two synchronous condensers in Panhandle)



Example: Panhandle Stability and Assessment Tools



- ERCOT has incorporated the described tools in both planning and operation to manage the stability in Panhandle.

Notable Practices and Activities

- IBRs are required to provide PSCAD models.
- Effective on May 1, 2020, Resource Entities provide positive sequence dynamic models will be required to provide dynamic model quality tests.
- ERCOT continues to work with stakeholders to improve dynamic models, including model accuracy and adequacy.

Dynamic Model Quality Tests

- Flat Start
- Small Voltage Disturbance (+/- 3%)
- Large Voltage Disturbance (LVRT/HVRT)
- Frequency Disturbance (0.3 Hz deviation)
- System Strength (SCR from 5 to 1.2)

A tool was developed to facilitate these tests

Notable Practices and Ongoing Activities

- In Panhandle, both PSS/e and PSCAD studies are conducted to evaluate the system dynamic performance
- User defined models are allowed and generally are recommended by vendors for weak grid conditions
  - The improvement of generic models is underway
- Consideration of PSCAD study
  - More accurate for weak grid application
  - Complex and time consuming
  - May not fit the need in operations and real time applications

Panhandle PSCAD Case

- Total of 50 IBR Projects (~10 GW)
- Represented by 62 vendor specific PSCAD models
- 43 threads are used to perform PSCAD simulation
- ~1.5 hours per contingency run

Notable Practices and Activities

- Renewable integration increases variability and complexity in generation dispatch and associated reactive flows exposing the ERCOT Grid to more voltage stability issues, reactive switching, and need for reactive coordination.
- ERCOT is actively working on a project to develop a multi-hour look ahead tool to improve reactive power coordination within the ERCOT region.

Reactive Power Coordination Tool will optimize reactive power controls (shunt devices, Generator Voltage Set Points, Static Var Compensators (SVCs), etc.) across a multi-hour interval to resolve reactive power and voltage-related constraints (voltage limits, temporal constraints, reactive reserves, etc.) under both normal and contingency conditions.

Takeaways

- System characteristic is changing along with the increase of IBRs connect to the grid
- Continuous review and revise the existing performance, model, and tools are important with rapid deployment of IBRs

18-24 Months

Typical time for IBRs from initial planning to physical interconnection

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