ERCOT Experience with Synchronous Condenser Application

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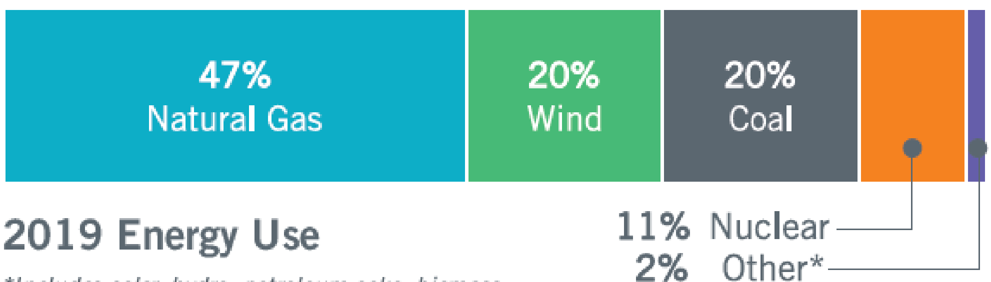
ESIG Webinar
March 26, 2020

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



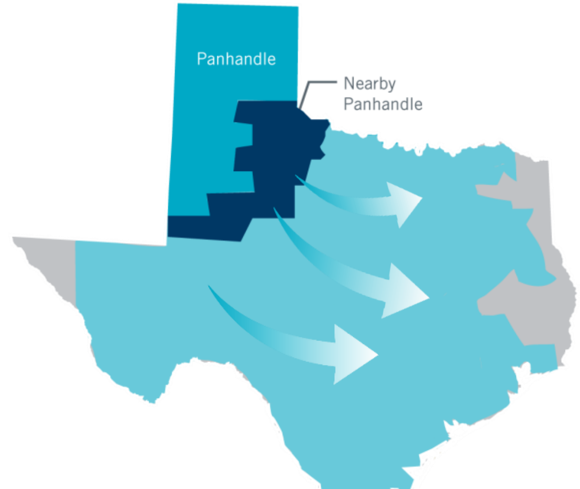
Includes solar, hydro, petroleum coke, biomass, landfill gas, distillate fuel oil, net DC-tie and Block Load Transfer imports/exports and an adjustment for wholesale storage load

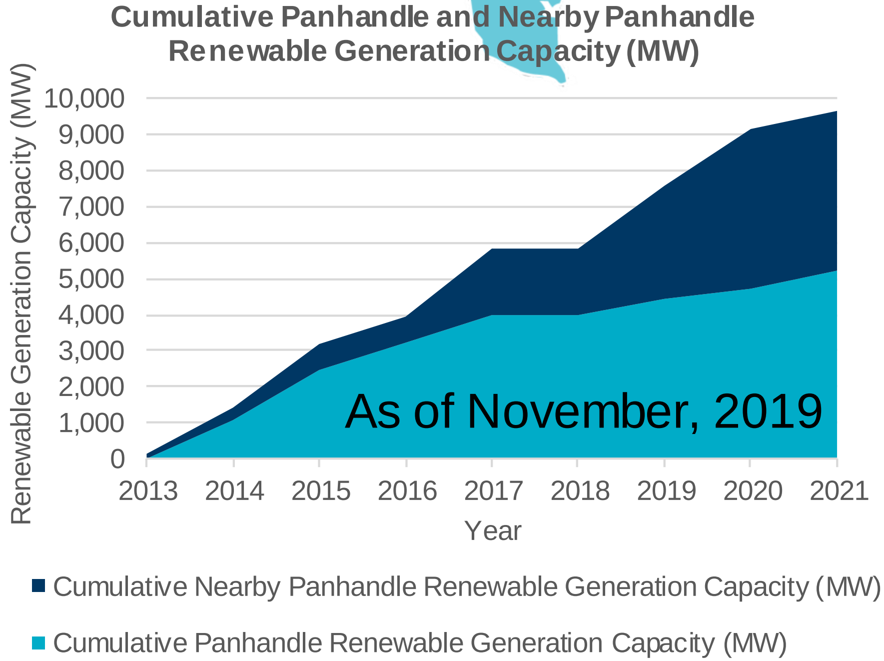
384 billion kilowatt-hours of energy were used in 2019, a 2 percent increase compared to 2018.

Renewable Generation in Panhandle

- Remote from synchronous generators and load centers
- GW power export
- Hundred miles power transfer
- All inverter-based resources

- Challenges and Needs
  - Weak Grid
  - Voltage Stability





Synchronous Condensers in Panhandle

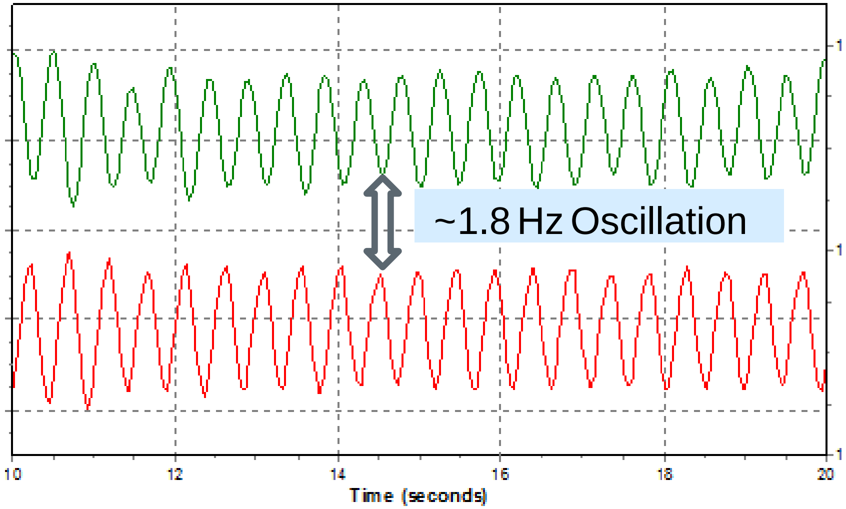
- Both dynamic stability and electromagnetic transient studies were conducted to determine the technology (synchronous condensers, SVC, or STATCOM), location, and spec of these devices.
- Synchronous condensers were selected to improve both system strength and grid stability.
- These synchronous condensers were located to contribute to the short circuit power and dynamic reactive power support.

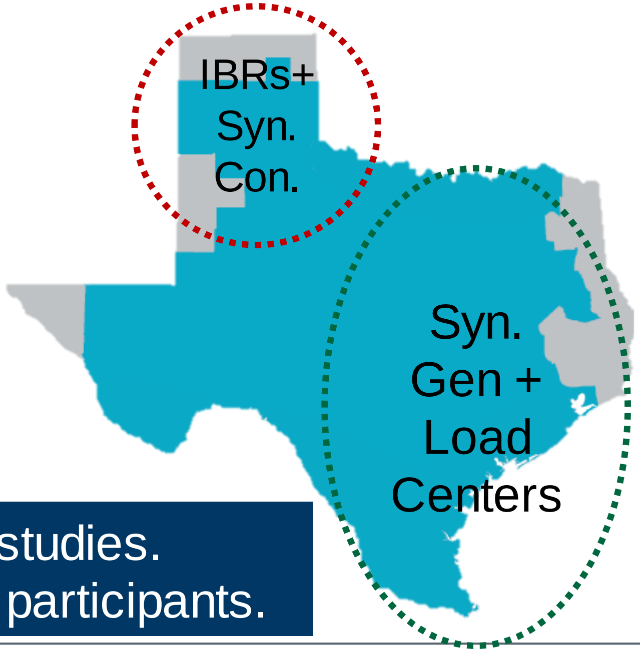
Implementation of Synchronous Condensers

- Consideration of synchronous condensers included but not limited to the following:
  - System benefits (improve stability and reduced renewable curtailment)
  - Capital cost
  - New or retrofit the old synchronous generators
  - Availability, maintenance, losses, and operational expanse
  - Optimal design for the specific system needs (system strength and voltage support)
  - Unstaffed and remote control
- Two synchronous condensers were implemented in 2018 in Panhandle.
  - +175/-125 MVAr,
  - ~1600 kA 3PH fault current

Synchronous Condensers

- Synchronous condensers generally don't have power system stabilizer (PSS).
- Reduced damping support with diminished on-line synchronous generators under high penetration of inverter-based resources (IBRs).
- IBRs generally don't provide PSS-like damping support.





Observed oscillatory responses in the stability studies. Synchronous condensers identified as primary participants.

Takeaways

- Synchronous condensers are susceptible to classical inter-area oscillations and angular separation when there are large power transfers over long distances across the network.

- Should consider synchronous machine stability when recommending synchronous condensers.

- Should explore requirements for system damping support from synchronous condensers, IBRs, and transmission dynamic reactive devices.