



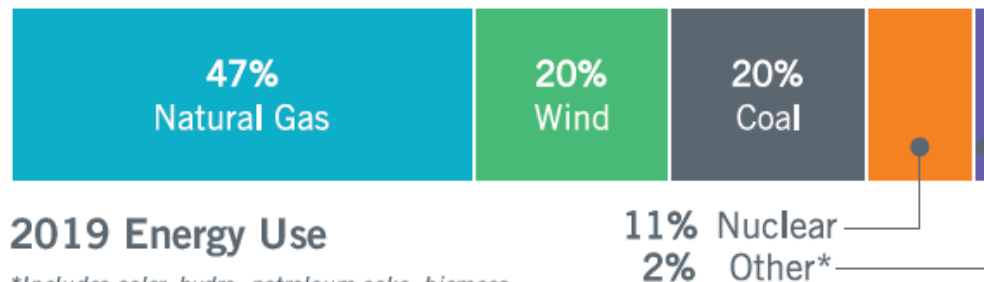
ERCOT Experience with Synchronous Condenser Application

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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

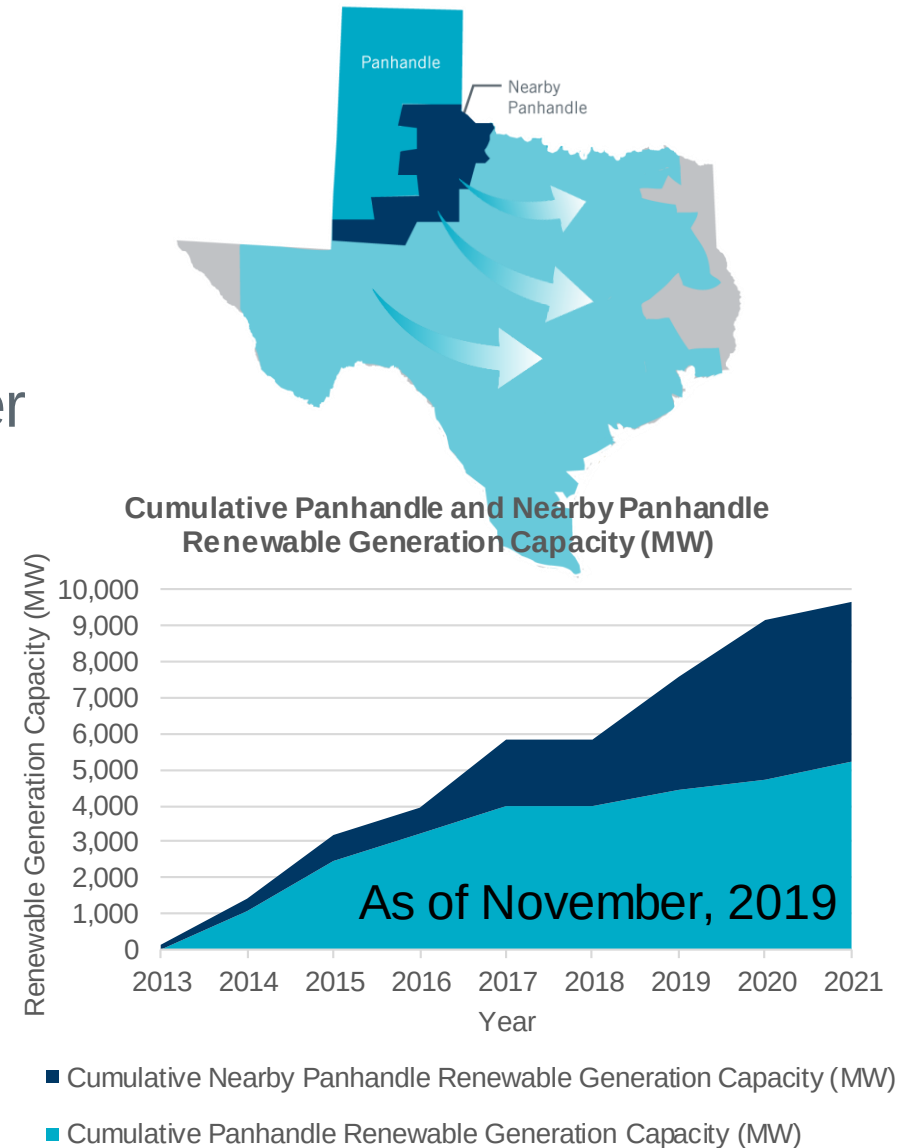
**Includes solar, hydro, petroleum coke, biomass, landfill gas, distillate fuel oil, net DC-tie and Block Load Transfer imports/exports and an adjustment for wholesale storage load*

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



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.

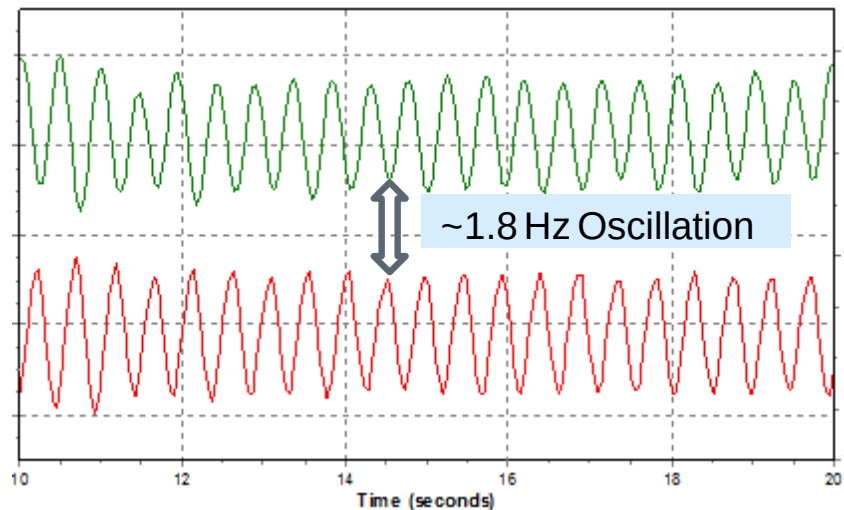
Implementation of Synchronous Condensers

- 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 expense
 - 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

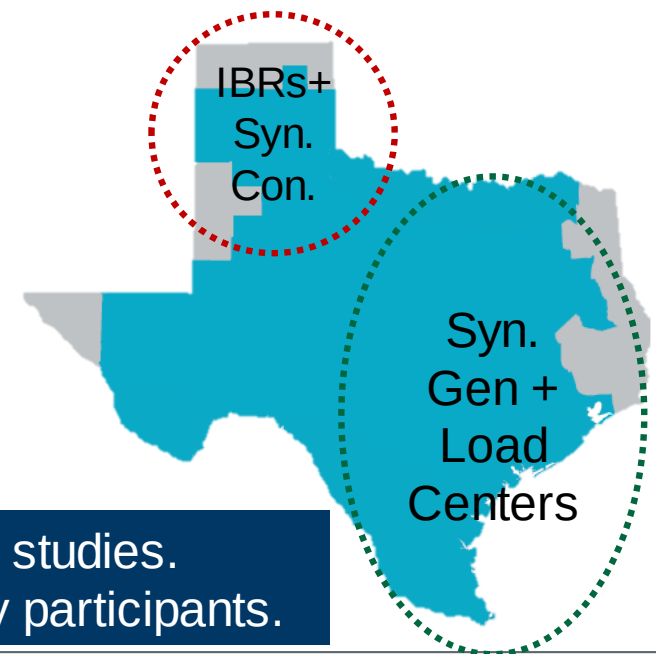


Synchronous Condensers

- 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.