Status Update – Assessment of Synchronous Condensers to Strengthen West Texas System

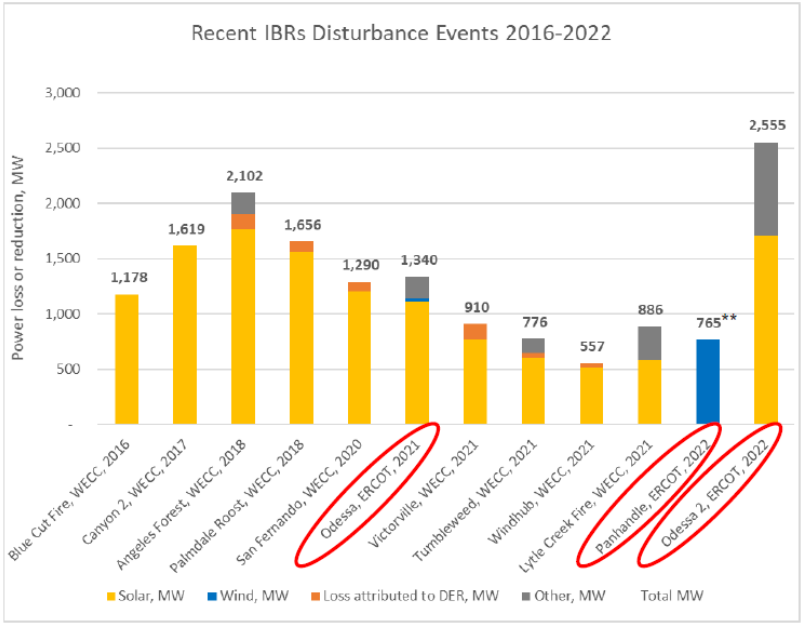
Christian Danielson
Dynamic Studies, ERCOT

Regional Planning Group Meeting
May 16, 2023

Recap

- Increasing and significant reliability risk due to potential unexpected loss of generation and/or load during disturbance(s).

- At the Feb RPG meeting, ERCOT Operation presented the operational challenges, recommending synchronous condensers (each 350 Mvar, total 2,100 Mvar) in six locations in West Texas (west side of FTX GTC Interface).



2023 Feb RPG meeting: RPG Event Details (ercot.com)

- ERCOT presented the study scope at the March RPG meeting, and is currently conducting a study for the potential synchronous condensers in West Texas.

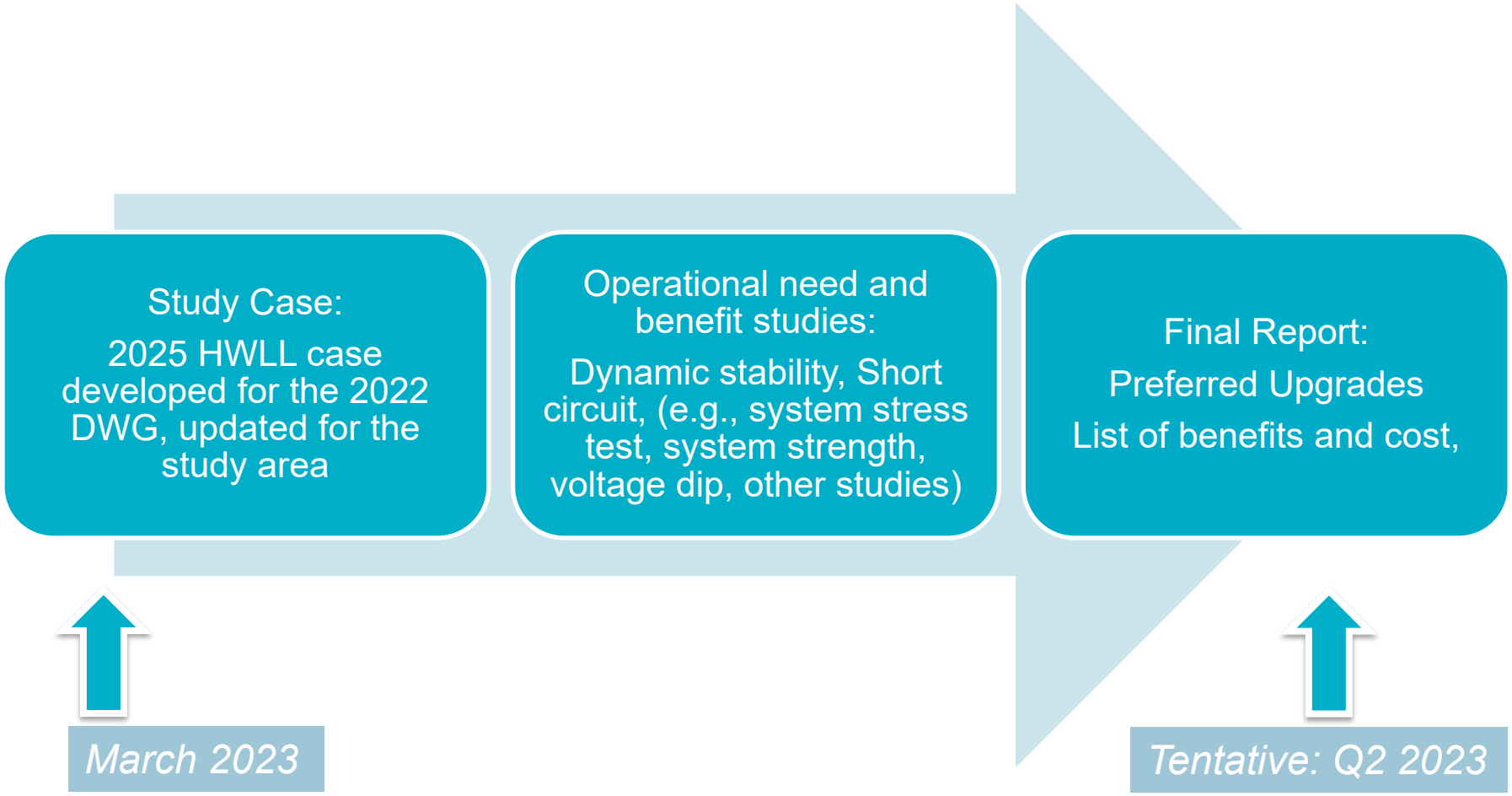
Objectives

- Conduct an ad-hoc study and assess operational challenges, while considering the 2022 RTP reactive power support need.

- Study reliability benefits of the potential synchronous condensers and adjust the reactive power support, if necessary.

- Confirm operational benefits and make recommendation such that TSPs can submit RPG projects.

High Level Overview – Process and Tentative Schedules



Status

- Based on the scope, the DWG and SPWG cases were developed for 2025 case conditions.

- Various analyses including system strength test, voltage dip, dynamic stability simulations, and certain sensitivities analysis have been conducted.

Study Case Development

- Study area is defined as the transmission system behind the West Texas Generic Transmission Constraint (WTX GTC).

- The study base cases assumed a 350 Mvar synchronous condenser at the Reiter 345 kV substation to meet the common reactive power support need between the 2022 RTP and ERCOT Operations assessment. It was based on the TSP feedback and the identification of reactive power support devices in the 2022 RTP, and the proximity to the Odessa location.

Study Case Development (DWG 2025 HWLL)

- Added PG 6.9 generation in WTX based on the January 2023 Generation Interconnection Status (GIS) report published in February 2023.
- Added Large Loads consistent with the 2022 RTP, and modeled transmission upgrades identified in the 2022 RTP.
- Synchronous generators in WTX are offline.
- All IBRs (Battery, Solar, Wind) in WTX are online and dispatched to stress the WTX interface.
  - System may become unstable under certain critical P1 or P7 if the system is more stressed

Study Case Development (SPWG 2025)

- Added PG 6.9 generation in WTX based on the January 2023 Generation Interconnection Status (GIS) report published in February 2023.
- Modeled transmission upgrades identified in the 2022 RTP.
- Synchronous generators in WTX are offline.
- All IBRs (Battery, Solar, Wind) in WTX are online.

Overview of Conducted Studies

- Weighted Short Circuit MVA (WSCMVA) (DWG study case):
  - Evaluate the impact on system strength by adding a synchronous condenser at each bus on all major WTX 345 kV buses. Repeating this step for all individual 345 kV buses and ranking those buses in terms of highest WSCMVA.
  - Sensitivity confirmed synchronous condenser locations with the endorsed Stage 2 upgrade (Bearkat - North McCamey - Sand Lake 345-kV Transmission Line Addition Project) in place.

- Voltage Dip (SPWG study case):
  - Apply a SLG fault on all major WTX 345 kV buses with and without the synchronous condensers modeled to further assess the impact on the voltages at all WTX 345 kV buses and generator terminals.

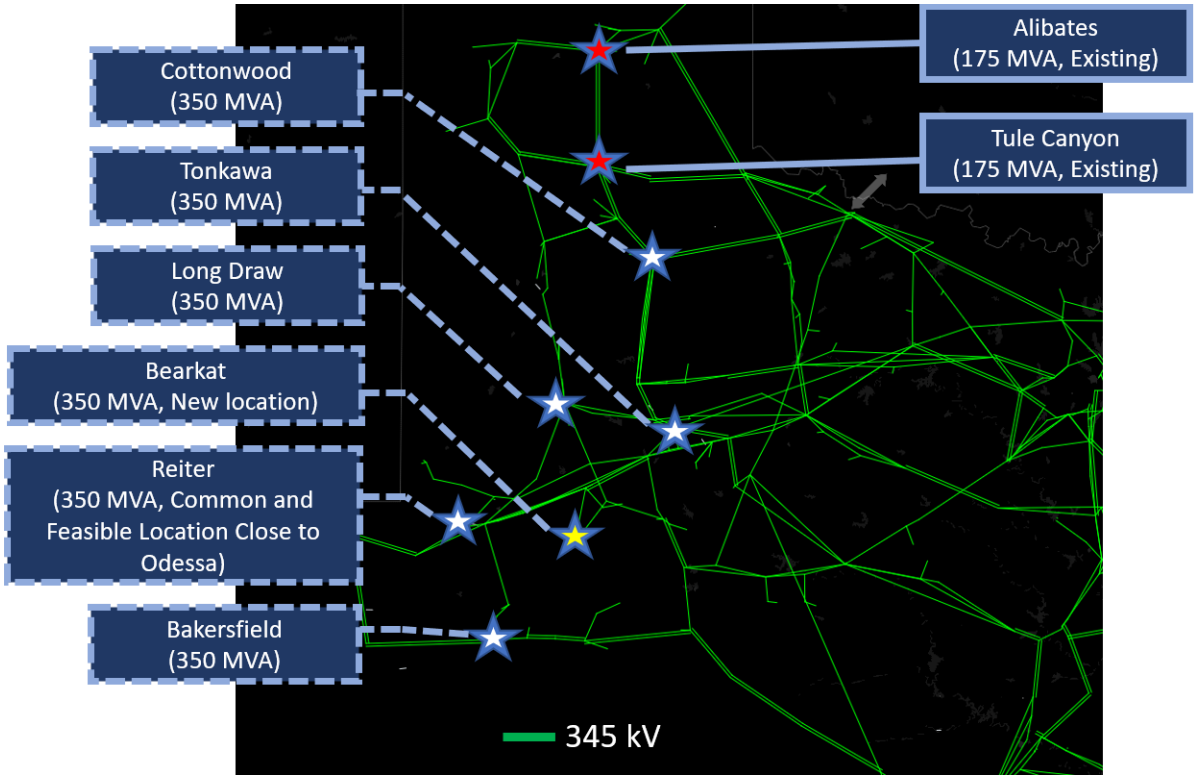
- Dynamic stability simulations:
  - Test SLG events at Odessa and other synchronous condenser locations with and without synchronous condensers to mimic operation events and further assess any potential operational benefit.
  - Test certain critical P1 and P7 events with and without synchronous condensers to further assess any potential reliability benefit.

Synchronous Condenser Location: Key Considerations

- Relative ranking in terms of average WSCMVA.
- Properly spaced apart, avoiding proximity to existing synchronous condensers.
- Number of major transmission outlets at a substation (more connections to the system is better).
- Considered impact of future Bearkat – North McCamey – Sand Lake 345-kV Transmission Addition Project.
- Feasibility of installing Synchronous Condenser at each substation.

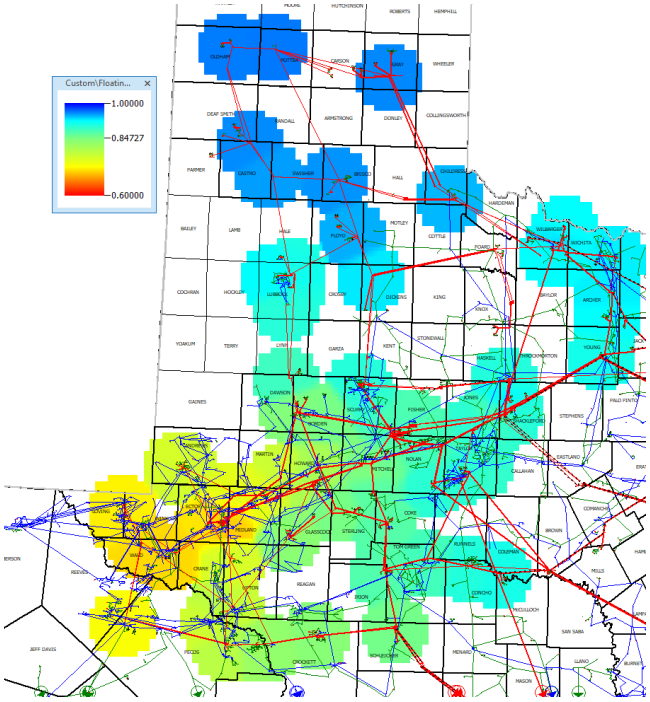
Key Assessment Findings

- Overall, locations are consistent with the operations assessment. With the removal of the 345 kV Clear Crossing location and the addition of the 345 kV Bearkat location.
- A total of six synchronous condensers (2,100 MVA) were identified that will provide effective improvement to WTX.
- Affected TSPs confirmed feasibility of the proposed synchronous condenser locations.

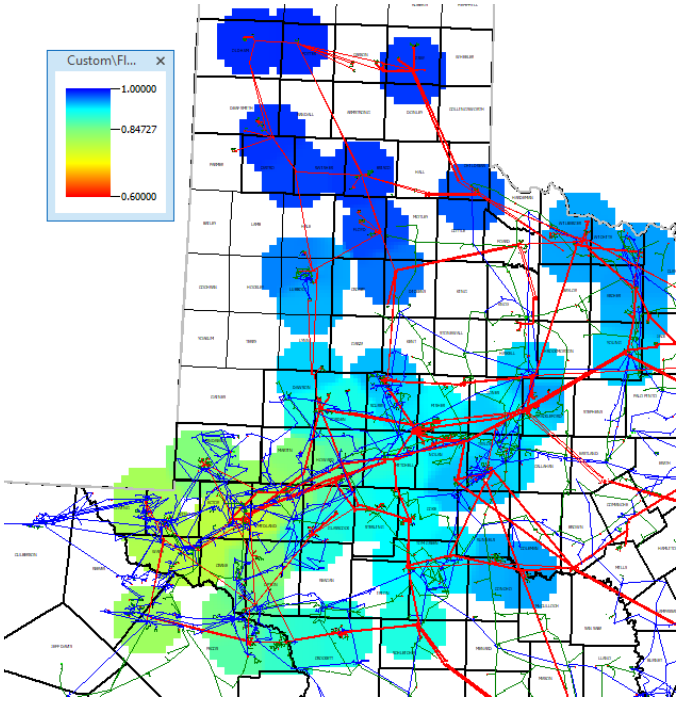


Example Benefit

- Reduces widespread voltage dips and over-voltages across WTX



No New Synchronous Condensers

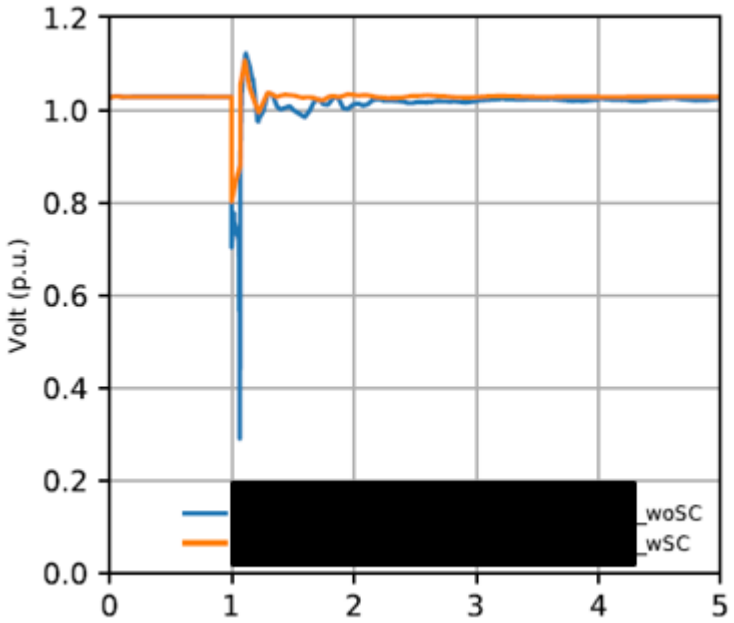


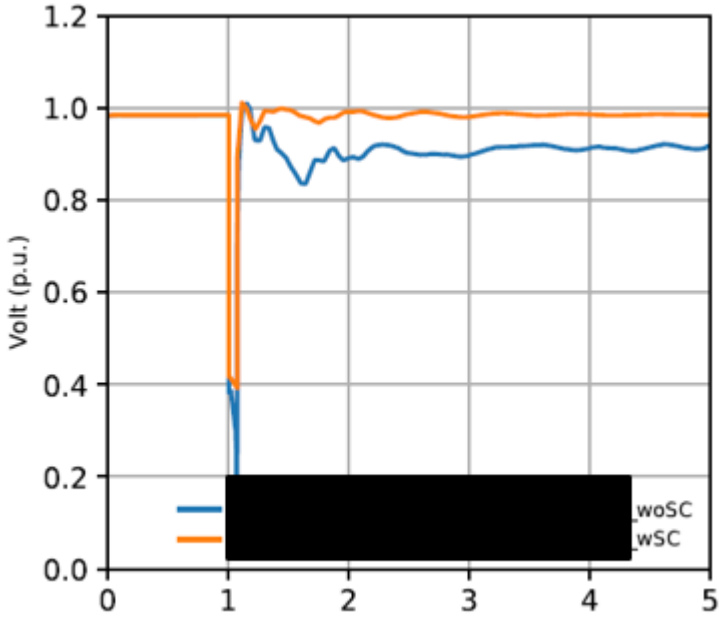
With 6 Synchronous Condensers

345kV WTX bus voltage profile contour with a SLG fault at Odessa-area 345kV bus

Example Benefit (continued)

- Significant reduction in voltage overshoot and improvement in voltages under fault
- Improved system response after a fault event which could result in potential significant reduction in generation tripping when a critical event occurs under stressed system conditions





Potential Impact on McCamey GTC

- ERCOT conducted dynamic stability studies using the latest QSA cases to evaluate the impact on the existing McCamey GTC limit with and without the potential 6 synchronous condensers.

- The McCamey GTC limit is expected to be improved by an average of 15% with the potential synchronous condensers.

Preliminary Results: Summary of Key Benefits

- Reduces widespread impacts from transmission faults across WTX
  - By an average of 21%* reduction in numbers of 345 and 138 kV buses that experience severe voltage dips (less than .85 p.u.) for major WTX transmission faults
  - By an average of 22%* reduction in IBR capacity that experiences severe voltage dip at generator terminals (less than .85 p.u.) for major WTX transmission faults
  - 11%* increases in the system strength (voltage stiffness, measured in the WTX short circuit current level)

*Benefit calculated with 6 proposed synchronous condensers benchmarked against cases without any added synchronous condensers (including 345 kV Reiter)

Preliminary Results: Summary of Benefits (Continued)

- Selection of locations provides support for broad number of faults across the WTX region.

- Provides additional system strength and resilience necessary to addresses operational challenges that may arise during unexpected disturbance conditions.

- Provides significant improvement in system responses for critical faults even under stressed system conditions (e.g., reduction in potential generation tripping, improved voltage recovery).

Conclusions

- Six synchronous condensers would improve the reliability and resilience of the existing system.

- Both these improvements on the transmission system, and continued focus on improving IBRs' capability and performance, are needed to maintain the reliable operation of the ERCOT grid.

- Additional system improvements will be required to support the continued growth of IBRs in the ERCOT grid.

Next Steps

- Other studies in progress (e.g., potential impact on the long-term WTX transmission improvement option, sensitivity analysis)

- Tentative timeline
  - Q2 2023 to complete the special study

Questions?

Comments are welcome to:
Christian Danielson, Christian.Danielson@ercot.com
Sun Wook Kang, Sunwook.Kang@ercot.com