Study Scope
- Assessment of Synchronous Condensers to Improve System Strength in West Texas Region

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
3/20/2023	1.0	Scope	Christian Danielson, Sun Wook Kang, Prabhu Gnanam

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1. Objectives

Several events (e.g., single line to ground fault) resulting in unexpected significant MW reduction of inverter-based resources (IBRs) in the West Texas (WTX) region were observed in the past two years, i.e., the 2021 and 2022 Odessa events. The impact is likely to increase as more IBRs are expected in the WTX region.

Various efforts are currently in progress to minimize such unexpected issues, which include event analysis, ongoing model review with the owners of the affected facilities, and NOGRR 245 submitted to enhance the ride-through requirements. In addition to the efforts to improve model quality and process, ERCOT Operations recently performed an assessment to strengthen the system in the WTX region and to minimize the unexpected real-time operation challenges. The results were presented at the RPG meeting in February 2023, which include a recommendation of six new synchronous condensers (each 350 MVar) at Cottonwood, Clear Crossing, Tonkawa, Long Draw, Odessa, and Bakersfield.

This document describes a study scope for further review of the operations findings in the planning horizon. The objectives of this special study are:

- to assess the potential synchronous condensers in the planning horizon, and
- to make a recommendation such that the impacted TSP(s) can submit their RPG project(s).

2. Study Assumptions

The study area will be the transmission system in the WTX area, and the following sixteen 345 kV transmission lines will define the study area boundary:

1. Riley – Krum West Switch DCKT 345 kV
2. Jacksboro Switching – Willow Creek Switch and Jacksboro Switching – Henderson Ranch Switch DCKT 345 kV
3. Graham SES – Parker Switch DCKT 345 kV
4. Thomas Price Switch – Willow Creek Switch and Tecumseh Creek Switch – Willow Creek Switch DCKT 345 kV
5. West Shackelford Station – Sam Switch and Aspire – Navarro DCKT 345 kV
6. Russell Gap Switch– Killeen Switch and Buckhorn Switch – Killeen Switch DCKT 345 kV
7. Big Hill – Kendall DCKT 345 kV
8. Jacksboro Switching – Krum West Switch SCKT 345 kV
9. Comanche Switch (ONCOR) – Comanche Peak SES SCKT 345 kV

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2.1. Study Base Case

The following Dynamics Working Group (DWG) case from January 2022 will be used to develop a study base case:

- Near-Term Off-Peak: Year 2025 High Wind Low Load (HWLL)

2.1.1. Generation Updates

The list of generators in Table 1 that met Planning Guide Section 6.9(1) and (2) for inclusion in the planning models at the time of the study are added to the study area based on the January 2023 Generation Interconnection Status (GIS) report published in February 2023:

http://mis.ercot.com/misapp/GetReports.do?reportTypeId=15933&reportTitle=GIS%20Report&showHTMLView=&mimicKey

Table 1: List of New Generation Based on GIS Published in February 2023

GINR	Project Name	Fuel Type	Projected COD	Capacity (MW)
20INR0120	Vortex Wind	Wind	2/23/2023	350
20INR0249	Appaloosa Run Wind	Wind	4/29/2023	175
20INR0268	Pyron BESS II	Battery	3/15/2023	30
20INR0269	Texas Solar Nova 2	Solar	12/29/2023	201
21INR0401	Young Wind	Wind	4/1/2023	499
21INR0473	Vortex BESS	Battery	3/14/2023	122
22INR0326	Inertia Wind	Wind	4/28/2023	301
22INR0328	Inertia BESS	Battery	10/31/2023	13
22INR0360	Jade Solar	Solar	6/30/2023	327
22INR0363	Hayhurst Texas Solar	Solar	11/1/2023	25
22INR0372	BRP Hydra BESS	Battery	8/1/2023	202
22INR0384	BRP Pavo BESS	Battery	8/1/2023	177
22INR0412	Andromeda Solar	Solar	6/30/2023	327
22INR0485	House Mountain	Battery	5/31/2023	63
23INR0371	Rodeo Ranch Energy Storage	Battery	7/17/2023	307

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Generation in the study area will be dispatched according to Table 2. All synchronous generation in the WTX region will be turned off to be consistent with Operation's assessment. The dispatch level of IBRs in the WTX region will be determined based on the following dynamic stability analysis:

- Increase the output from the IBRs in the WTX uniformly and stress the WTX interface (power transfer from West to the rest) until the system goes unstable under critical P1 or P7 events associated with the West Texas GTC Interface.
- The critical dispatch level (maximum stable dispatch) will be modeled as the initial IBR dispatch level in the study base case.

Table 2: Study Area Generation Dispatch

Fuel Type	Dispatch
Solar	TBD - based on maximum stable dispatch
Wind	TBD - based on maximum stable dispatch
Energy Storage	TBD - based on maximum stable dispatch
Conventional	Offline

2.1.2. Transmission

Transmission system topology will be consistent with the DWG case. Any major transmission upgrades (scheduled for 2025) in the study area that are identified in the 2022 RTP will be modeled to address potential steady-state issues (e.g., thermal and voltage) if they are not already modeled in the DWG case.

As shown in Table 3, the placeholder reactive power support devices identified in the 2022 RTP will also be modeled in the study base case to address the potential steady-state voltage issues in the local areas of the Far West Texas region. If some of placeholder reactive devices in Table 3 are relatively close to the locations of the synchronous condensers identified in the ERCOT Operations assessment, the placeholder reactive device(s) will be relocated to the location of the synchronous condenser(s) and modeled as synchronous condenser(s) to accommodate the common reactive power support need between 2022 RTP and ERCOT Operations assessment.

Table 3: Placeholder Reactive Power Support Upgrades Modeled in 2022 RTP

Weather Zone	MVar
Far West	2,237.6

The Stage 2 upgrade (i.e., the Bearkat – North McCamey – Sand Lake 345-kV Transmission Line Addition) is expected to be in service in 2026. Therefore, the major transmission upgrade will not be modeled in the study case.

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2.1.3. Load

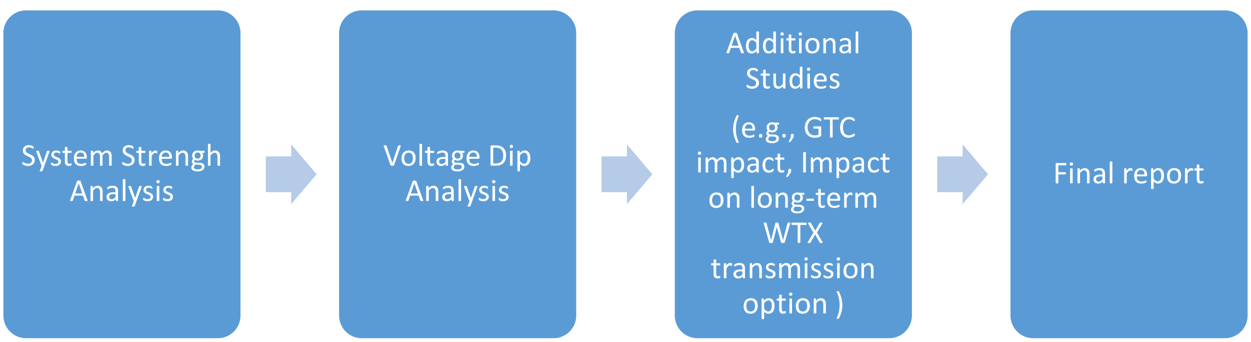
Large Loads in the study area will be further adjusted to be consistent with the latest Large Flexible Load projection. Load updates are needed for the following key locations:

Table 4: Large Loads to be Modeled in the Study Area

Weather Zone	Load (MW)
Far West	2,529
North	2,400
West	200

3. Study Methodology

ERCOT will utilize the study case developed based on the assumptions in Section 2 and conduct various analyses primarily to review operational needs and benefits of the potential synchronous condensers in the transmission planning horizons based on the following high-level process.



3.1. System Strength Analysis

A system strength analysis will be performed with the goal of confirming the locations of the synchronous condensers identified in the Operations assessment based on ERCOT's Weighted Short-Circuit Ratio (WSCR). The locations of the synchronous condensers may be adjusted, as needed. The general steps for performing the system strength analysis are to:

1. Apply a three-phase fault and record system strength at all individual WTX 345 kV buses in the study base case using the WSCR
2. Add a synchronous condenser at each bus on all major WTX 345 kV buses and record system strength. Repeat the step for all individual 345 kV buses
3. Confirm and adjust locations of synchronous condensers identified in the ERCOT Operations assessment

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3.2. Voltage Dip Analysis

Voltage dip analysis will be performed using the System Protection Working Group (SPWG) case built for the year 2025 in addition to the study base case. The goal is to confirm the locations of the synchronous condensers identified in the Operations assessment, which will be supplemental to the system strength analysis. The latest SPWG case(s) will be used to assess voltage dip via short circuit analysis to assess voltage profiles after a fault. The study base case (DWG case) will also be used to assess voltage dip via dynamic stability analysis by applying a fault at either Odessa or Quail. All synchronous generators will be turned off. The synchronous condensers identified in the system strength study will be modeled. All WTX IBRs are assumed to provide negligible short circuit contributions. The general steps for performing the voltage dip analysis are to:

1. Apply a SLG fault on all major WTX 345 kV buses (e.g., Odessa) with and without the synchronous condensers modeled
2. Review 345 kV and 138 kV bus voltages in WTX
3. Check for any buses less than 85% as this is the assumed VRT trigger point
4. Identify if there is a need for additional synchronous condensers, or if adding more condensers would provide a significant benefit
5. Perform a dynamic stability analysis by testing a critical 345 kV SLG event at Odessa or Quail with and without synchronous condensers to further assess the benefit

3.3. Additional Studies

The following additional studies may be considered to assess the potential impact of the synchronous condensers:

1. Potential impact on the existing GTCs (e.g., VSAT power transfer analysis)
2. Potential Impact on the long-term WTX transmission improvement option (e.g., Dynamic stability analysis with and without synchronous condensers)

3.4. Other Considerations

1. Additional sensitivity analysis may be considered: Stage 2 upgrade (endorsed in 2022) and Stage 5 upgrade identified in Delaware Basin Integration Study
    a. Bearkat - North McCamey - Sand Lake 345-kV Transmission Line Addition Project)
    b. Stage 5 upgrade (Faraday - Lamesa - Clearfork - Riverton 345-kV double circuit line addition
2. Sub-synchronous Resonance (SSR) study will need to be performed by TSP(s) based on Nodal Protocol Section 3.22 prior to energization of synchronous condensers.

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4. Tentative Timeline

ERCOT will attempt to complete this study by Q2 2023. Upon completion of the study, a final report will be posted such that affected TSP(s) can submit RPG project(s) to implement.

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