



Date: December 12, 2023
To: Board of Directors
From: Bob Flexon, Reliability and Markets (R&M) Committee Chair
Subject: West Texas Synchronous Condenser Regional Planning Group (RPG) Project

Issue for the ERCOT Board of Directors

ERCOT Board of Directors Meeting Date: December 19, 2023

Item No.: 14.2

Issue:

Whether the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) should accept the recommendation of ERCOT staff to endorse the need for the Tier 1 WETT - Synchronous Condensers Regional Planning Group (RPG) Project, Tier 1 LCRA TSC - Bakersfield Dynamic Reactive Substation Upgrade RPG Project and Tier 1 Oncor - West Texas Synchronous Condenser RPG Project, combined and referenced as the West Texas Synchronous Condenser Regional Planning Group (RPG) Project, which ERCOT staff has independently reviewed and which the Technical Advisory Committee (TAC) has voted unanimously to endorse, in order to reduce the reliability risk and strengthen the West Texas system.

Background/History:

ERCOT published the Assessment of Synchronous Condensers to Strengthen the West Texas System in June 2023. WETT, LCRA TSC and Oncor have submitted the three separate Tier 1 Projects, combined referenced as the West Texas Synchronous Condenser Project, that encompasses the ERCOT recommendations stated in the June 2023 report:

- Synchronous condenser installations at six 345-kV substations: Cottonwood, Bearkat, Tonkawa, Long Draw, Reiter, and Bakersfield.
- Approximately 350 MVA capacity at each location.
- Around 3,600 Ampere (A) of three-phase fault current contribution to the 345-kV point of interconnection (POI).
- A combined total inertia of 2,000 MW-seconds (MW-s) or above at each location, incorporating synchronous condenser with flywheel.
- Effective damping control to meet the ERCOT damping criteria in the Planning Guide Section 4.1.1.6.

WETT has proposed the Synchronous Condensers Project, a \$467.7 million, Tier 1 project with an expected in-service date of October 2027, to reduce the reliability risk and strengthen the West Texas system:

- Add two new 175 MVA synchronous condensers at Cottonwood 345-kV substation.



- Add two new 175 MVA synchronous condensers at Bearkat 345-kV substation.
- Add two new 175 MVA synchronous condensers at Long Draw 345-kV substation.
- Each location meets the performance recommendation made by ERCOT.

LCRA TSC has proposed the Bakersfield Dynamic Reactive Substation Upgrade Project, a \$144.5 million, Tier 1 project with an expected in-service date of May 2027, to reduce the reliability risk and strengthen the West Texas system:

- Add two new 175 MVA synchronous condensers at Bakersfield 345-kV substation.
- Meets the performance recommendation made by ERCOT.

Oncor has proposed the West Texas Synchronous Condenser Project, a \$280 million, Tier 1 project with an expected in-service date of May 2027, to reduce the reliability risk and strengthen the West Texas system:

- Add new 350 MVA synchronous condenser capability at Tonkawa 345-kV substation.
- Add new 350 MVA synchronous condenser capability at Reiter 345-kV substation.
- Each location meets the performance recommendation made by ERCOT.

WETT proposed the Synchronous Condensers Project with an initial cost estimate of \$468 million, LCRA TSC proposed the Bakersfield Dynamic Reactive Substation Upgrade Project with an initial cost estimate of \$145 million and Oncor proposed the West Texas Synchronous Condenser Project with an initial cost estimate of \$280 million for RPG review in September 2023. RPG considered project overviews during meetings in October and November 2023. Pursuant to Protocol Section 3.11.4.9(2), ERCOT presented the combined Tier 1 West Texas Synchronous Condenser Project to the Technical Advisory Committee (TAC) for review and comment, and on December 4, 2023, TAC unanimously endorsed the project as recommended by ERCOT.

Pursuant to Protocol Section 3.11.4.3(1)(a), projects with an estimated capital cost of \$100 million or greater are Tier 1 projects, for which Section 3.11.4.7 requires endorsement by the Board. Section IV(B)(2)(a) requires the R&M Committee to review and make a recommendation to the Board regarding any Tier 1 project. Protocol Section 3.11.4.7 also requires ERCOT to independently review submitted projects. ERCOT verified during independent review of the combined West Texas Synchronous Condenser Project, ERCOT's recommended option reduces the reliability risk and strengthens the West Texas system.

ERCOT conducted a Sub-Synchronous Oscillation (SSO) screening for the potential synchronous condensers, conducted pursuant to Protocol Section 3.22.1.3. The results of the topology check indicated that all the synchronous condenser locations, except at



the Reiter 345-kV substation, are considered to be potentially vulnerable to SSO. Therefore, a detailed SSO assessment is recommended, and the affected TSPs shall coordinate with ERCOT to perform and complete a detailed SSO assessment and provide any SSO Mitigation, if required, prior to energization of synchronous condensers.

No congestion analysis was conducted because synchronous condenser is the sole transmission option and a reactive support device.

The project completion date may change depending on material acquisition, outage coordination, and construction. The cost estimate accounts for the expectation that some construction activities will occur in an energized transmission line corridor. WETT, LCRA TSC and Oncor cooperation with ERCOT could be necessary to develop and implement CMPs based on summer 2027 operational conditions.

The report describing the ERCOT Independent Review of the Tier 1 West Texas Synchronous Condenser Project, including ERCOT staff's recommendation, is attached as **Attachment A**.

Key Factors Influencing Issue:

1. ERCOT System improvements are needed to reduce the reliability risk and strengthen the West Texas system.
2. ERCOT staff found the recommended set of improvements to be the most efficient solution to reduce the reliability risk and strengthen the West Texas system.
3. Protocol Section 3.11.4.7 requires Board endorsement of a Tier 1 project, which is a project with an estimated capital cost of \$100 million or greater pursuant to Section 3.11.4.3(1)(a).
4. TAC voted unanimously to endorse the combined Tier 1 West Texas Synchronous Condenser RPG Project, as recommended by ERCOT, on December 4, 2023.

Conclusion/Recommendation:

ERCOT staff recommends, and the R&M Committee is expected recommend, that the Board endorse the need for the combined Tier 1 West Texas Synchronous Condenser Regional Planning Group (RPG) Project, which ERCOT staff has independently reviewed and which TAC has voted unanimously to endorse, to reduce the reliability risk and strengthen the West Texas system.



ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.
BOARD OF DIRECTORS RESOLUTION

WHEREAS, pursuant to Section 3.11.4.3(1)(a) of the Electric Reliability Council of Texas, Inc. (ERCOT) Protocols, projects with an estimated capital cost of \$100 million or greater are Tier 1 projects, for which Section 3.11.4.7 requires endorsement by the ERCOT Board of Directors (Board); and

WHEREAS, after due consideration of the alternatives, the Board deems it desirable and in the best interest of ERCOT to accept ERCOT staff's recommendation to endorse the need for the Tier 1 WETT - Synchronous Condensers Regional Planning Group (RPG) Project, Tier 1 LCRA TSC - Bakersfield Dynamic Reactive Substation Upgrade RPG Project and Tier 1 Oncor - West Texas Synchronous Condenser RPG Project, combined and referenced as the West Texas Synchronous Condenser RPG Project, which ERCOT staff has independently reviewed and which the Technical Advisory Committee (TAC) and Reliability and Markets (R&M) Committee have voted to endorse, based on North American Electric Reliability Corporation (NERC) and ERCOT reliability planning criteria;

THEREFORE, BE IT RESOLVED, that is the Board hereby endorses the need for the Tier 1 WETT - Synchronous Condensers RPG Project, Tier 1 LCRA TSC - Bakersfield Dynamic Reactive Substation Upgrade RPG Project and Tier 1 Oncor - West Texas Synchronous Condenser RPG Project, combined and referenced as the West Texas Synchronous Condenser Regional Planning Group (RPG) Project, which ERCOT staff has independently reviewed and which TAC and the R&M Committee have voted to endorse, based on NERC and ERCOT reliability planning criteria.

CORPORATE SECRETARY'S CERTIFICATE

I, Jonathan M. Levine, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its December 19, 2023 meeting, the Board passed a motion approving the above Resolution by _____.

IN WITNESS WHEREOF, I have hereunto set my hand this ____ day of December, 2023.

Jonathan M. Levine
Assistant Corporate Secretary



ERCOT Independent Review of West Texas Synchronous Condenser Project

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
November 20, 2023	1.0	Final	Christian Danielson
		Reviewed by	Sun Wook Kang, Prabhu Gnanam

Executive Summary

Inverter-based resources (IBRs) in West Texas have experienced rapid and continued growth. The total capacity of IBRs in West Texas is projected to surpass approximately 42 GW¹ by the end of 2025. The performance of IBRs, such as solar, wind, and energy storage resources, relies heavily on power electronic controls and the strength of the system. In regions like West Texas, where the significant prevalence of IBRs coupled with the absence of conventional synchronous generation resources can result in relatively low levels of short circuit current and synchronizing torque (i.e. weak grid) and increase the likelihood of potential instability issues.

Recent Odessa events in 2021 and in 2022 highlighted this vulnerability as well as IBR performance failures, resulting in a substantial reduction in power output from IBRs triggered by the widespread low voltages during single-line-to-ground (SLG) fault conditions. As the penetration of these IBRs increases, the magnitude of the impact during such occurrences is likely to increase and pose a growing and significant reliability risk to the ERCOT system. Proactively addressing these concerns becomes essential to ensure a reliable and resilient system in West Texas.

To tackle these operational challenges and weak grid issues, ERCOT conducted a comprehensive study to strengthen the system in the West Texas region. In June 2023, ERCOT published the study report titled "[Assessment of Synchronous Condensers to Strengthen the West Texas System](#)," which included the assessment and recommendations for synchronous condenser installations at six 345-kV substations: Cottonwood, Bearkat, Tonkawa, Long Draw, Reiter, and Bakersfield. The study findings indicated that the implementation of synchronous condensers would effectively bolster the reliability of the West Texas system, enhance its resilience to unexpected events, and address the challenges that may arise in real-time operations.

As outlined in Appendix A of the ERCOT Assessment Report titled 'Assessment of Synchronous Condensers to Enhance the West Texas System,' ERCOT made recommendations for specific locations and engineering specifications for the installation of new synchronous condensers:

- Six locations: Cottonwood, Bearkat, Tonkawa, Long Draw, Reiter, and Bakersfield 345-kV substations
- Approximately 350 MVar capacity at each location
- Around 3,600 Ampere (A) of three-phase fault current contribution to the 345-kV point of interconnection (POI)
- A combined total inertia of 2,000 MW-seconds (MW-s) or above at each location, incorporating synchronous condenser with flywheel
- Effective damping control to meet the ERCOT damping criteria in the Planning Guide Section 4.1.1.6.

In September 2023, LCRA TSC, WETT, and Oncor submitted three Regional Planning Group (RPG) proposals for six synchronous condensers with the specifications and at the locations that were recommended in the ERCOT Assessment report. After reviewing the three separate RPG submissions (see Appendices B, C and D), ERCOT concluded that the proposed RPG projects align with the recommendations in the ERCOT Assessment Report (Appendix A). Because the study ERCOT conducted for the ERCOT Assessment Report satisfies the requirements of a study conducted for purposes of an ERCOT Independent Review of these RPG submissions under Section 3.11.4.7 of the ERCOT Protocols, ERCOT will utilize the study conducted for the ERCOT Assessment Report (Appendix A) in lieu of a separate study for this ERCOT Independent Review (EIR). Table E1

¹ West Texas IBRs in operation and meeting Planning Guide 6.9(1) by the end of 2025.

summarizes the expected in-service dates and estimated costs of the synchronous condensers proposed by TSPs. Figure E1 depicts the recommended locations for synchronous condensers in West Texas.

Table E1. Expected In-Service Date and Estimated Cost of Synchronous Condensers Proposed by TSPs

TSP	Substation Name	Expected In-Service Date	Estimated Total Cost (\$ Million)
LCRA TSC	Bakersfield 345-kV	May 2027	144.5
Oncor	Tonkawa 345-kV	May 2027	140.0
Oncor	Reiter 345-kV	May 2027	140.0
WETT	Bearkat 345-kV	October 2027	155.2
WETT	Cottonwood 345-kV	October 2027	155.6
WETT	Long Draw 345-kV	October 2027	156.9

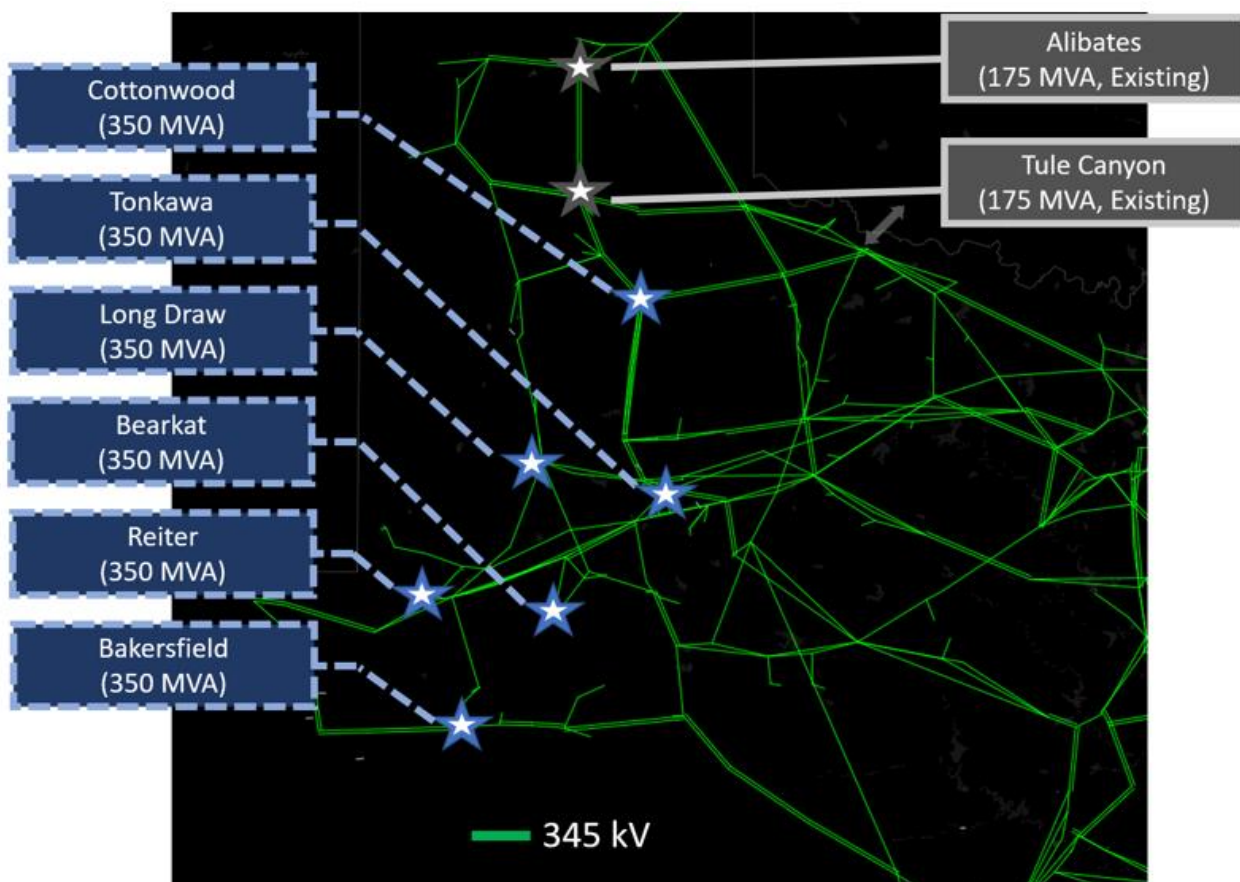


Figure E1. Recommended Locations for Synchronous Condensers in West Texas

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1. Project Need

Over the past seven years, various interconnections across the United States have experienced several system disturbances related to Inverter-Based Resources (IBRs). Among these, three significant events occurred within ERCOT, with two of them taking place in the Odessa area within the West Texas region. These events, known as the Odessa Disturbance events, occurred in May 2021 and June 2022, resulting in substantial generation losses from solar farms. With the remarkable expansion of IBRs, particularly solar generation within ERCOT over the past few years, and the expectation of continued growth, there is a heightened potential for these events to amplify in magnitude, thereby posing significant reliability risks to the system.

In response to the 2021 and 2022 Odessa events, the North American Electric Reliability Corporation (NERC) issued a Level 2 alert in March 2023, identifying them as systemic performance issues that could lead to unexpected losses of Bulk Power System (BPS)-connected generation. NERC recommended addressing performance deficiencies in existing and future generation resources promptly to ensure the reliable operation of the power system.

Following the 2021 Odessa event, ERCOT has intensified efforts to analyze the causes of inverter tripping during such events and to identify corrective measures to enhance the resilience of IBRs and the overall power system. As part of the effort, ERCOT completed a study on June 27, 2023, to strengthen the West Texas region where IBRs are substantially present and conventional synchronous generation resources are lacking. More details of the study can be found in Appendix A.

For this Independent Review of the three combined RPG proposals, ERCOT thoroughly examined and confirmed the validity of the project need described in Section 3 of Appendix A. Additionally, the assumptions and methodology provided in Section 2 of Appendix A were carefully reviewed and found to be comprehensive.

2. Conclusion and Recommendation

The findings of the study in Appendix A indicated that new synchronous condensers at the six locations with a total of 2,100 MVA will improve the reliability and resilience of the West Texas system. The 345-kV substations at Cottonwood, Bearkat, Tonkawa, Long Draw, Reiter, and Bakersfield were identified as effective locations for the installation of a synchronous condenser.

The new synchronous condensers at these proposed substations exhibited a high relative ranking compared to other locations in terms of average weighted short-circuit MVA in the West Texas region. Additionally, these locations are strategically spaced apart, avoiding proximity to existing synchronous condensers, which ensures optimal distribution of reactive power support across the West Texas region. These locations provide support for a broad number of faults across the West Texas region and provide a significant improvement in system responses for critical faults even under stressed system conditions, as demonstrated by the results of the voltage dip and stability simulations. Moreover, these substations have a significant number of major transmission connections, indicating their importance as key hubs within the system. Lastly, the feasibility of installing synchronous condensers at each substation was evaluated and determined to have adequate space by the affected TSP(s). 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 system.

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

ERCOT recommends the following locations and engineering specifications for the new synchronous condensers:

- Six locations: Cottonwood, Bearkat, Tonkawa, Long Draw, Reiter, and Bakersfield 345-kV substations
- Approximately 350 MVA capacity at each location
- Around 3,600 Ampere (A) of three-phase fault current contribution to the 345-kV point of interconnection (POI)
- A combined total inertia of 2,000 MW-seconds (MW-s) or above at each location, incorporating synchronous condenser with flywheel
- Effective damping control to meet the ERCOT damping criteria in the Planning Guide Section 4.1.1.6.

ERCOT recommends that the affected TSPs consult with ERCOT if different specifications of the synchronous condensers are considered for implementation.

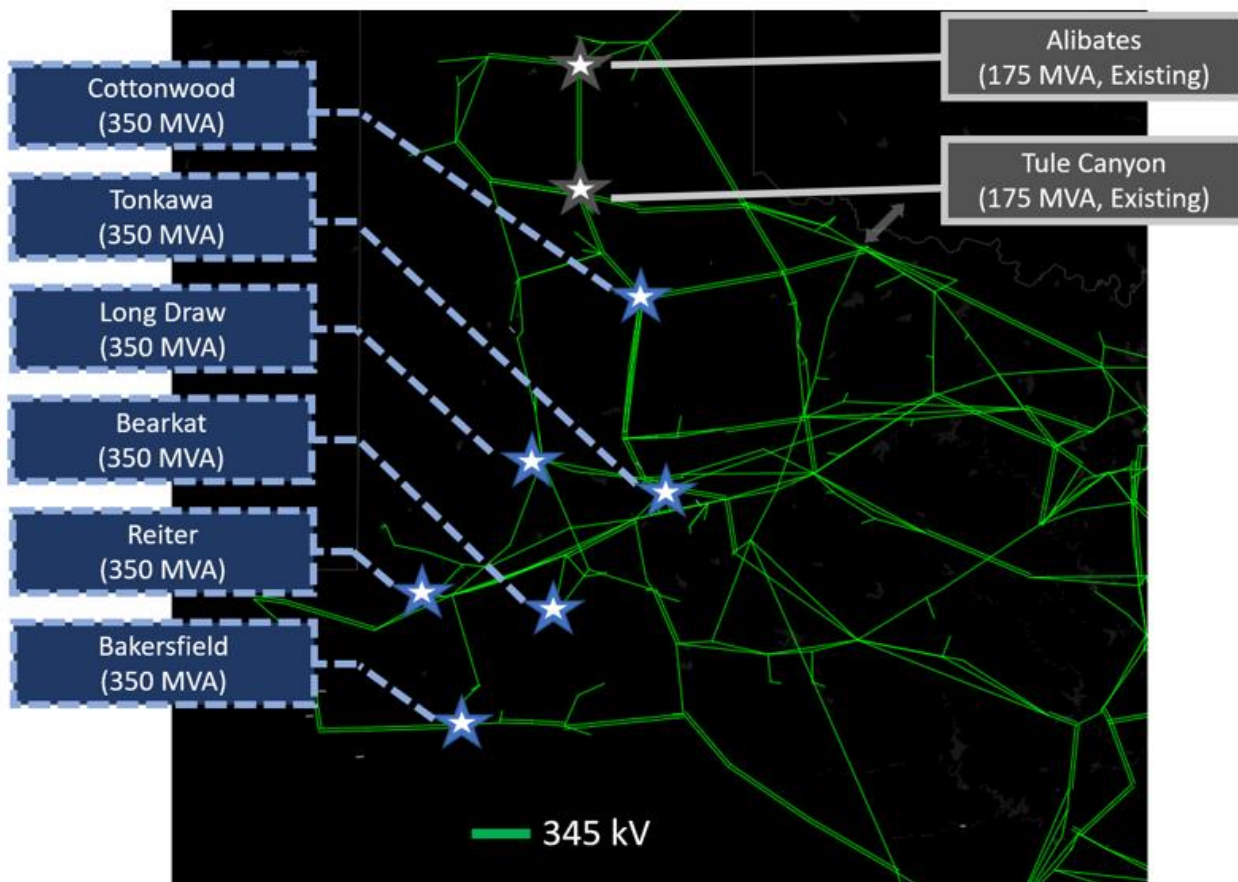






Figure E1. Recommended Locations for Synchronous Condensers in West Texas

3. Appendix

<p>3.1. Appendix A: ERCOT Assessment Report</p>	 Assessment-of-Sync hronous-Condenser
<p>3.2. Appendix B: LCRA TSC RPG Submittal</p>	 Bakersfield Dynamic Reactive Substation
<p>3.3. Appendix C: Oncor RPG Submittal</p>	 RPG_Oncor_WestTe xas_Synchronous_Cc
<p>3.4. Appendix D: WETT RPG Submittal</p>	 WETT Synchronous Condenser RPG Proj