



Item 11: Far West Regional Planning Group Projects

Jeff Billo

Senior Manager, Transmission Planning

Board of Directors Meeting

ERCOT Public

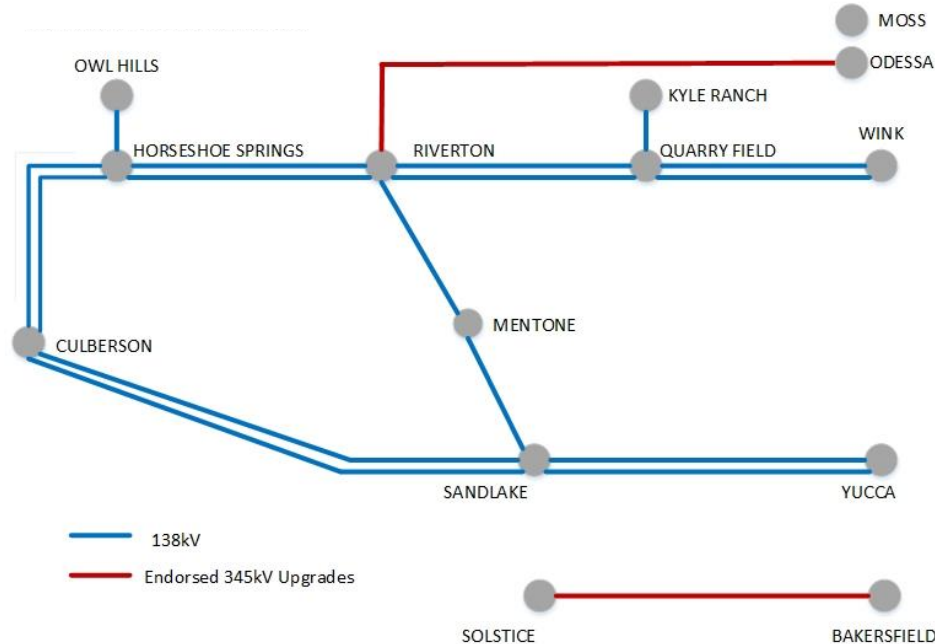
June 12, 2018

Action

- At the conclusion of this presentation the Board of Directors will be asked to:
 1. Endorse the Far West Regional Planning Group (RPG) Projects based on NERC and ERCOT planning reliability criteria; and
 2. Designate the following as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D):
 - Riverton – Sand Lake 345 kV line
 - Sand Lake – Solstice 345 kV line
 - Solstice – Bakersfield 345 kV line

Far West Texas Project

- In June 2017 the Board endorsed the Far West Texas Project which included:
 - Odessa EHV – Riverton 345 kV line
 - Bakersfield – Solstice 345 kV line
- In February 2018 the Board designated the Odessa EHV-Riverton 345 kV line as critical to the reliability of the ERCOT System

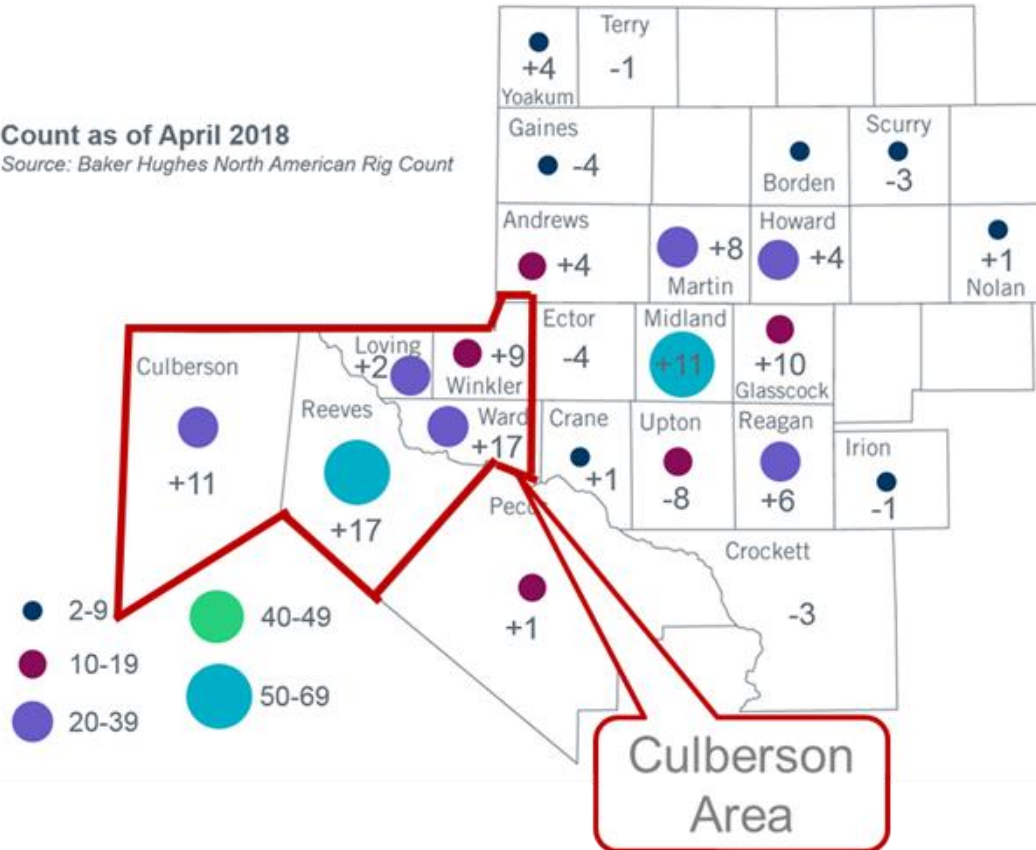


Culberson Loop: Growing Expectations

Permian Basin Rig Count

Count as of April 2018

Source: Baker Hughes North American Rig Count



Culberson Loop Load Forecast

Year/ Vintage	Committed Load
2021 as Studied in 2017	553 MW
Latest 2019 Forecast	880 MW
Latest 2022 Forecast	1013 MW

+/- indicates change between April 2017 and April 2018

New Transmission Proposals to Meet the Growing Demand

- December 2017: Oncor submitted the Far West Texas Dynamic Reactive Device Project for RPG review
- February 2018: Oncor submitted the Far West Texas 2 Project for RPG review
- ERCOT performed a single, combined independent review for these project proposals

Project Need

- ERCOT's independent review indicated voltage criteria violations were the most limiting factors
- The 2017 Far West Texas Project will help, but additional voltage support is needed to meet reliability criteria

Steady State Voltage Stability Assessment

Scenario	Load (MW)	Assumed Transmission Upgrades	Results
1	880	None	Pre-contingency Voltage Collapse
2	880	FWTP*	Post-contingency Voltage Violation Post-contingency Voltage Collapse

*The Far West Texas Project (FWTP) endorsed by ERCOT Board of Directors in June 2017.

Comparison of Project Options

- ERCOT short-listed three options
 - All options include the 345 kV double circuit loop buildout that was contemplated in the 2017 Far West Texas Project
- The primary differences between the options were the type and location of the reactive support

Description	Option 1	Option 2	Option 3
Load Serving Voltage Stability Limit	1608	1568	1688
Load Serving Voltage Stability Limit Prior to New Transmission Lines (Including Only Reactive Devices)	801	821	1001
Estimated Capital Cost (\$M)	\$300.0	\$292.5	\$327.5

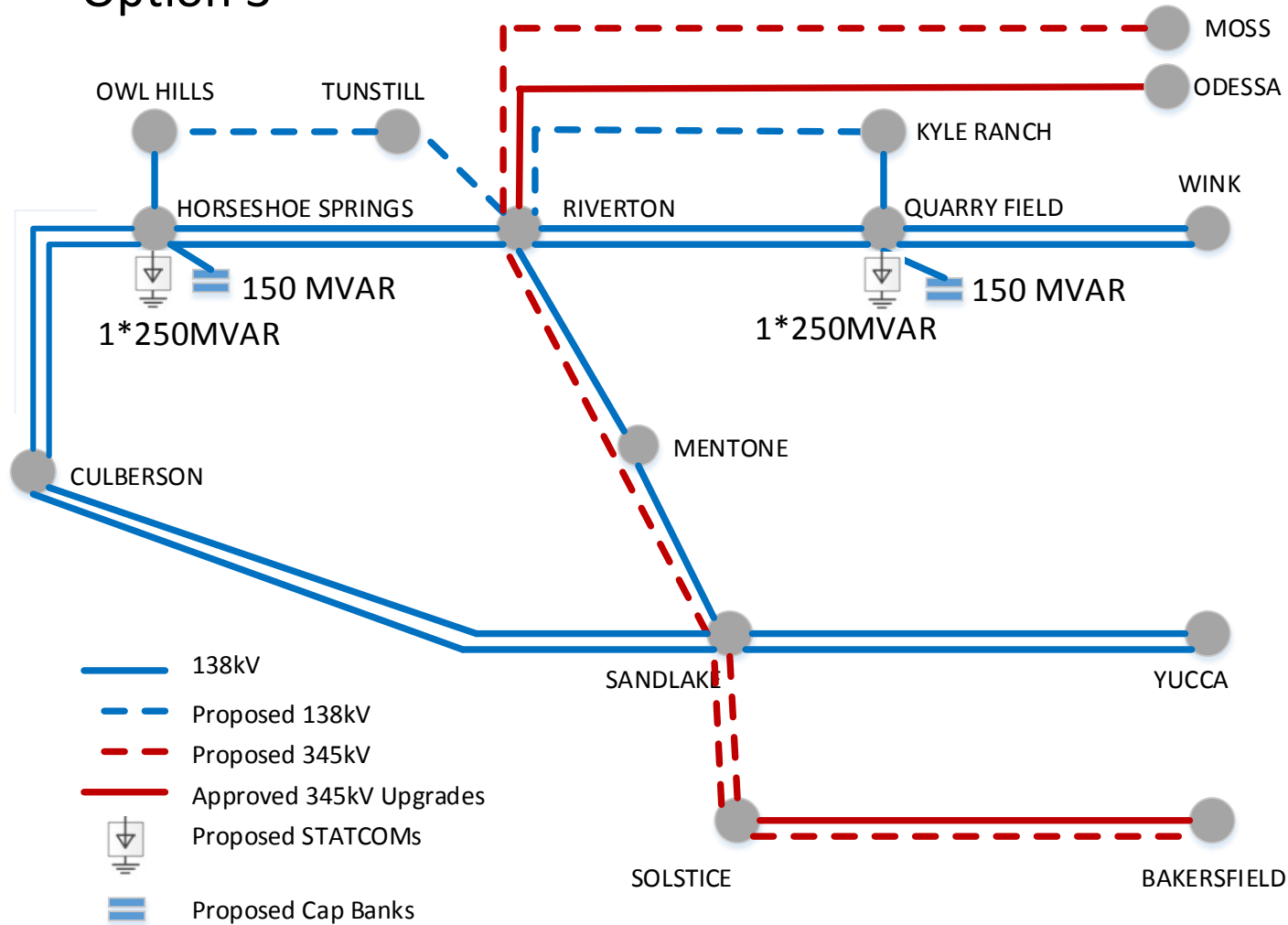
ERCOT Recommendation: Option 3

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice 345 kV Switch Station – Bakersfield 345 kV Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

The estimated capital cost for the Far West RPG Projects is \$327.5 million

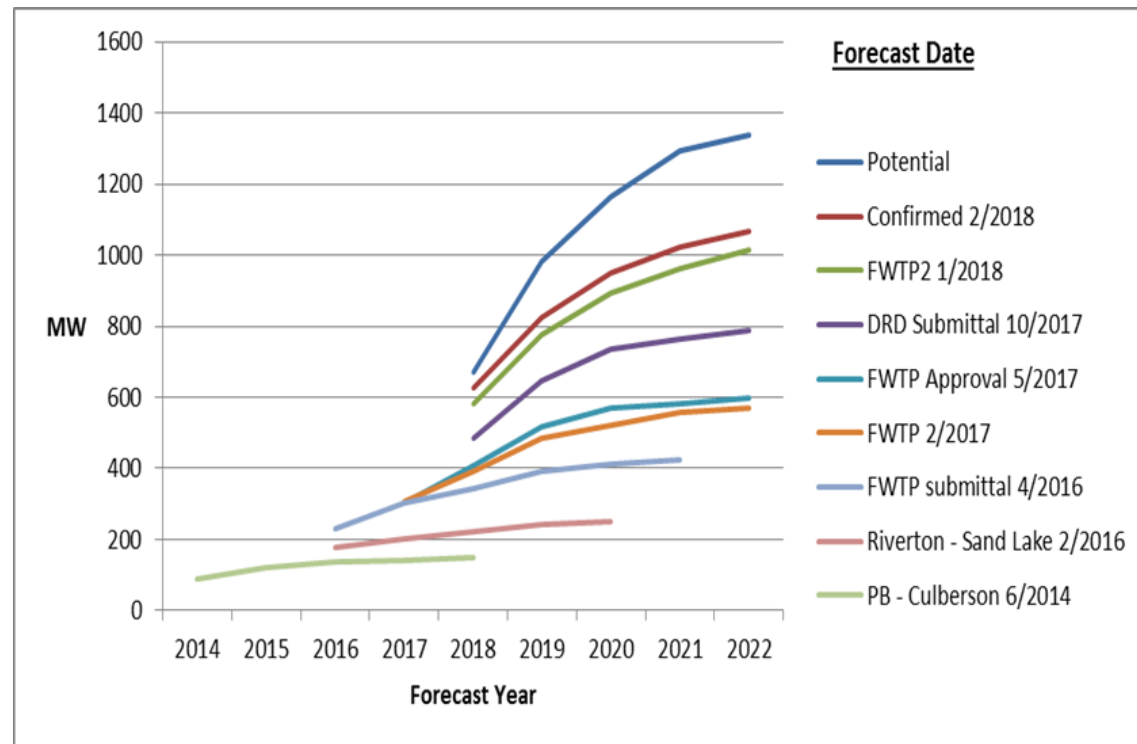
Option 3 One-Line Diagram

Option 3



Critical Infrastructure

- The 345 kV infrastructure will be critical for maintaining reliability for the area
- The load forecast for the Culberson Loop has rapidly increased:



Tier 1 Project Requirements

- Pursuant to Protocol Section 3.11.4.7 (*Tier 1*)
 - Projects with an estimated capital cost of \$50 million or greater are Tier 1 Projects
 - Tier 1 Projects require ERCOT independent review
 - Whether proposed project is needed
 - Whether the proposed project is the preferred solution to the identified system performance deficiency that the projects is intended to resolve
 - Tier 1 Projects require Board endorsement

Basis for Board Endorsement

- Pursuant to Planning Guide Section 3.1.3.1 (*Definitions of Reliability-Driven and Economic-Driven Projects*)
 - Proposed transmission projects are categorized for evaluation into two types:
 - Reliability-driven projects; and
 - Economic-driven projects
- ERCOT recommends the Far West RPG Projects to meet the reliability criteria in the ERCOT System in the Culberson Loop area, based on ERCOT and NERC planning reliability criteria. The Far West RPG Projects were found to be the most cost-effective solution for meeting the near-term and long-term reliability criteria.

PUCT Substantive Rule 25.101(b)(3)(D)

Projects deemed critical to reliability. Applications for transmission lines which have been formally designated by a PURA §39.151 organization as critical to the reliability of the system shall be considered by the commission on an expedited basis. The commission shall render a decision approving or denying an application for a certificate under this subparagraph within 180 days of the date of filing a complete application for such a certificate unless good cause is shown for extending that period.

Request for Board Vote

- ERCOT staff requests and recommends that the Board of Directors vote to endorse the need for the Far West RPG Projects (Option 3) based on NERC and ERCOT planning reliability criteria
- ERCOT staff requests and recommends that the Board of Directors designate the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D)



Date: June 5, 2018
To: Board of Directors
From: Jeff Billo, Sr. Manager, Transmission Planning
Subject: Far West Regional Planning Group Projects

Issue for the ERCOT Board of Directors

ERCOT Board of Directors Meeting Date: June 12, 2018

Item No.: 11

Issue:

Whether the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) should accept the recommendation of ERCOT staff to: (1) endorse the need for the Far West Regional Planning Group (RPG) Projects in order to meet the reliability requirements for the ERCOT System, which ERCOT staff has independently reviewed and which the Technical Advisory Committee (TAC) has voted unanimously to endorse, and (2) designate the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to Public Utility Commission of Texas (PUCT) Substantive Rule 25.101(b)(3)(D).

Background/History:

The Culberson Loop area, located in Far West Texas, has experienced substantial load growth due to the addition of oil and natural gas-related facilities. This significant load growth is forecasted to continue through at least 2022. Oncor Electric Delivery Company (Oncor) submitted two project proposals to meet the near-term and long-term needs for the area: Oncor Far West Texas Project 2 and Dynamic Reactive Devices (collectively, the Far West RPG Projects).

ERCOT performed a single, combined independent review of the two project proposals and confirmed the reliability need for transmission system improvements based on North American Electric Reliability Corporation (NERC) and ERCOT planning reliability criteria. ERCOT short-listed three options and determined that the following set of improvements (Option 3) represents the most cost-effective solution to meet both the near-term and long-term reliability needs for the area:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station;
- Add two new 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures;
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit);
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton

double circuit 138 kV line;

- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station;
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station;
- Install the second 345 kV circuit on the planned Solstice 345 kV Switch Station – Bakersfield 345 kV Switch Station double circuit structures;
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station;
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station;
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station; and
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station.

The estimated cost for these improvements is \$327.5 million.

Due to the rapidly increasing load forecast, the 345 kV infrastructure is critically needed to maintain reliable transmission service for the area. Therefore, ERCOT recommends that the following facilities included in Option 3 be designated as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D):

- Riverton Switch Station – Sand Lake Switch Station 345 kV line;
- Sand Lake Switch Station – Solstice Switch Station 345 kV line; and
- Solstice Switch Station – Bakersfield Switch Station 345 kV line.

The report describing the ERCOT Independent Review of Oncor Far West Texas Project 2 and Dynamic Reactive Devices, including ERCOT staff's recommendation for Option 3, is attached as **Attachment A**.

Key Factors Influencing Issue:

1. Transmission system improvements are needed to meet the reliability criteria in the ERCOT System in the Culberson Loop area.
2. The recommended set of improvements was found to be the most cost-effective solution for meeting the near-term and long-term reliability criteria.
3. Protocol Section 3.11.4.7 requires Board endorsement of a transmission project with an estimated capital cost of \$50 million or greater.
4. TAC voted unanimously to endorse the Far West RPG Projects at the May 24, 2018 TAC meeting.
5. Due to the rapidly increasing load forecast, the 345 kV infrastructure is critically needed to maintain reliable transmission service for the area.
6. If the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines are designated as critical to the reliability of the ERCOT System, the review process at the PUCT will be expedited pursuant to Substantive Rule

25.101(b)(3)(D).

Conclusion/Recommendation:

ERCOT staff recommends that the Board: (1) endorse the need for the Far West RPG Projects (Option 3), which ERCOT staff has independently reviewed and which TAC voted unanimously to endorse, based on NERC and ERCOT planning reliability criteria, and (2) designate the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D).



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

WHEREAS, after due consideration of the alternatives, the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) deems it desirable and in the best interest of ERCOT to accept ERCOT staff's recommendation to (1) endorse the need for the Far West Regional Planning Group (RPG) Projects (Option 3), which ERCOT staff has independently reviewed and which the Technical Advisory Committee (TAC) has voted unanimously to endorse, based on North American Electric Reliability Corporation (NERC) and ERCOT planning reliability criteria, and (2) designate the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to Public Utility Commission of Texas (PUCT) Substantive Rule 25.101(b)(3)(D);

THEREFORE, BE IT RESOLVED, that the ERCOT Board hereby (1) endorses the need for the Far West RPG Projects (Option 3), which ERCOT staff has independently reviewed and which TAC has voted unanimously to endorse, based on NERC and ERCOT planning reliability criteria, and (2) designates the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D).

CORPORATE SECRETARY'S CERTIFICATE

I, Vickie G. Leady, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its June 12, 2018 meeting, the ERCOT Board passed a motion approving the above Resolution by _____.

IN WITNESS WHEREOF, I have hereunto set my hand this ____ day of June, 2018.

Vickie G. Leady
Assistant Corporate Secretary



ERCOT Independent Review of Oncor Far West Texas Project 2 and Dynamic Reactive Devices

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
05/21/2018	1.0	Final Report	Xiaoyu Wang, Ying Li, Priya Ramasubbu
		Reviewed by	Prabhu Gnanam, Shun Hsien (Fred) Huang, Jeff Billo

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1. Executive Summary

In June 2017, the ERCOT Board of Directors endorsed the Far West Texas Project (FWTP), a Tier 1 transmission project to address the transmission needs both in the Culberson Loop area and the Barilla Junction area that could reliably serve the Culberson Loop load up to 717 MW. Since the approval of the FWTP project in 2017, Oncor has confirmed that the Culberson Loop has contractually-confirmed load levels that surpass ERCOT's indicated 717 MW limit for the approved Far West Texas Project. Therefore, the endorsed FWTP project was assumed to be in-service in 2020 for the purpose of this study.

In December, 2017, Oncor submitted the Far West Texas Dynamic Reactive Devices (DRD) Project to the Regional Planning Group (RPG) to meet the summer 2019 Culberson Loop load need. The proposed DRD project was estimated to cost \$86 million and was classified as Tier 1 project. At the time the DRD project was proposed, the Culberson Loop was projected to have 650 MW by 2019 and 790 MW by 2022 with the inclusion of the existing and confirmed load requests in the area.

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected contractually-confirmed load level in the Culberson Loop. The proposed FWTP2 project was estimated to cost \$194 million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop was projected to have 775 MW by 2019 and 1013 MW by 2022 with the inclusion of the existing and confirmed load requests in the area.

As of April, 2018, Oncor has confirmed that the Culberson Loop now has contractually-confirmed load levels of 880 MW for 2019 and 1013 MW for 2022. Oncor has also indicated that additional, known potential (not yet contractually-confirmed) load increases in the Culberson Loop may push the total to 1339 MW.

Based on the DRD and FWTP2 proposals, ERCOT completed the combined independent review for both projects together to determine the system needs for both near-term and long-term in a cost effective manner while providing flexibility to meet potential load growth in this region.

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of several project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost effective manner while providing flexibility to accommodate near-term and future load growth in the area of study. Option 3 is estimated to cost \$327.5 million and is described as follows:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake Switch Station to Solstice Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line

- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Switch Station to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station.
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

Reactive support components, including the STATCOMs and capacitors, should be implemented by 2019 if feasible to accommodate the projected 880 MW Culberson Loop demand. Remedial operational schemes may be required in the Culberson Loop area to mitigate post-contingency voltage violations in the near-term until all of the recommended transmission upgrades can be put in-service to meet the Culberson Loop area load growth.

2. Introduction

Over the past several years the Far West Texas Weather Zone has experienced high load growth. Between 2010 and 2016 the average annual growth rate was roughly 8%. This strong growth rate was primarily driven by increases in oil and natural gas related demand. Figure 2.1 shows the total projected load (MW) served from the Culberson Loop as indicated in the Oncor's Far West Texas Project 2 (FWTP2) RPG proposal.

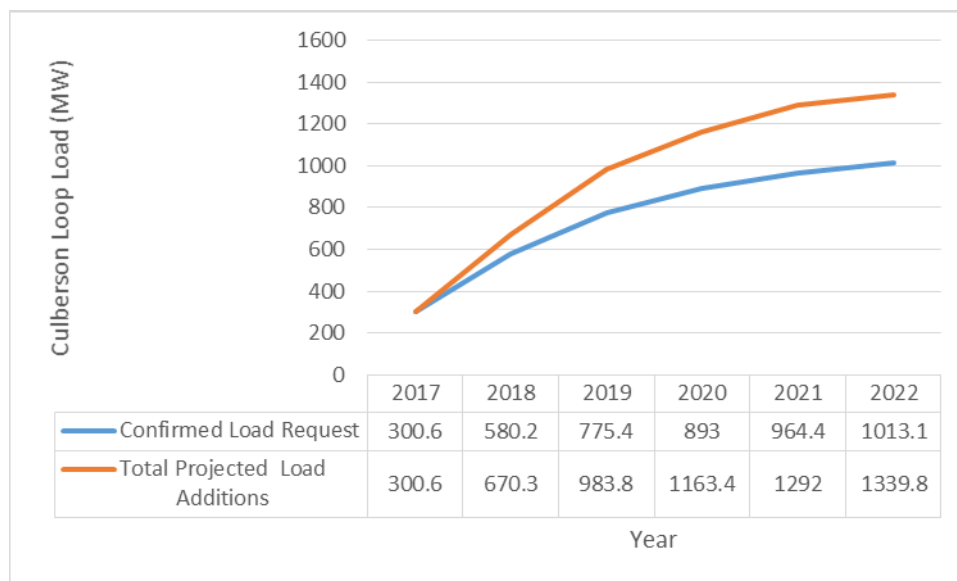


Figure 2.1: Total Projected Load (MW) in the Culberson Loop

Load growth along the Culberson Loop has led to several transmission improvements in the area, including the Far West Texas Project (FWTP) which was endorsed by the ERCOT Board of Directors in June, 2017. The FWTP is expected to be implemented by 2020 and will be able to serve up to 717 MW of Culberson Loop load. Significant new load requests to connect to the Culberson Loop have been observed since the approval of FWTP in 2017 due to growth in the oil and gas activity. As of April, 2018, the Permian Basin oil and natural gas rig count addition by county, as shown in Figure 2.2, has increased by 28% compared to April, 2017. Also, more than 70% of newly added rigs since April, 2017 are located in the counties served by the Culberson Loop transmission system (Culberson, Reeves, Ward, Crane, Loving, and Winkler Counties).

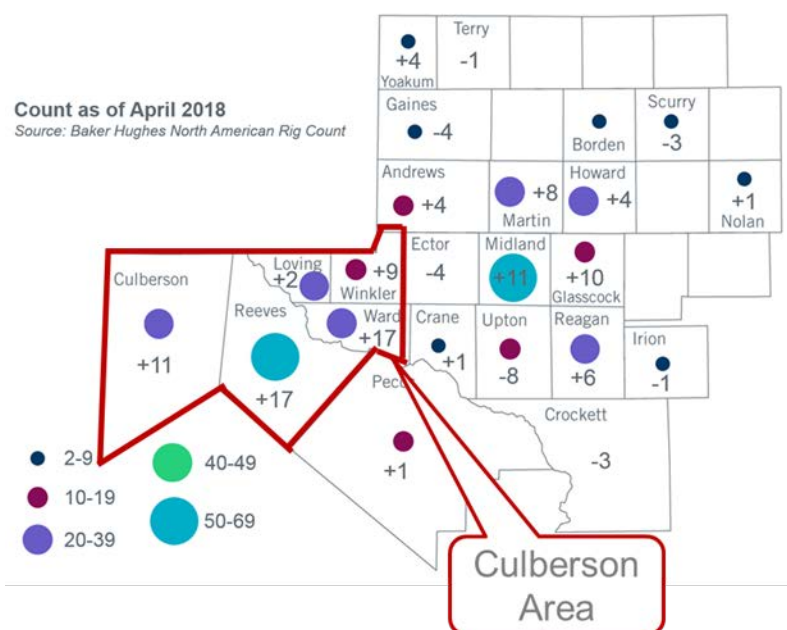


Figure 2.2 Permian Basin Oil and Natural Gas Rig Count Addition since April, 2017

In December, 2017, Oncor submitted to RPG the Far West Texas Dynamic Reactive Devices (DRD) Project, designed to meet the expected summer 2019 Culberson Loop load. The proposed DRD project was estimated to cost \$86 million and was classified as a Tier 1 project. At the time of the DRD project RPG submittal, the Culberson Loop load, with the inclusion of all contractually confirmed load, was projected to be 650 MW by 2019 and 790 MW by 2022. The major components of DRD project proposal were:

- Construct a new Horseshoe Springs 138 kV Switch Station in the Riverton – Culberson 138 kV Double-circuit line
- Install two 250 MVAR, 138 kV Static Synchronous Compensators (STATCOMs) at Horseshoe Spring 138 kV Switch Station

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected load. The proposed FWTP2 project was estimated to cost \$194 million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop area load, again based on contractually confirmed load requests, was projected to serve 775 MW by 2019 and 1013 MW by 2022. Figure 2.3 shows the proposed FWTP2. The major components of the FWTP2 project proposal include:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with one circuit in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)

- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station

As of April, 2018, Oncor has updated the contractually confirmed Culberson area load to be 880 MW by summer 2019 and 1013 MW by 2022. Additional load requests could potentially push the load to more than 1300 MW in the Culberson Loop.

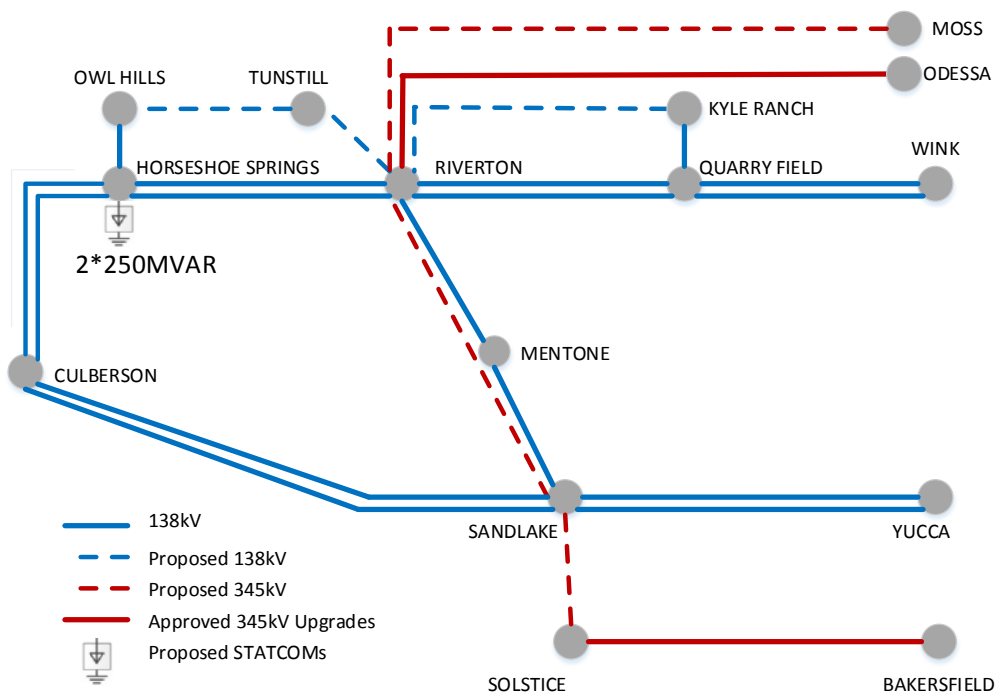


Figure 2.3: Proposed Far West Texas Project 2

Based on both the DRD and the FWTP2 proposals, ERCOT completed this independent review to determine the system needs in the Culberson Loop area and to address those needs in a cost-effective manner while providing the flexibility to meet near-term and potential long-term load growth in this area.

3. Study Assumption and Methodology

ERCOT performed studies under various system conditions to evaluate the system need and identify a cost-effective solution to meet those needs in the area. The assumptions and criteria used for this review are described in this section.

3.1. Study Assumption

The primary focus of this review is the Wink – Culberson – Yucca Drive loop transmission system, referred to as the “Culberson Loop.” Figure 3.1 shows the system map of the study area.

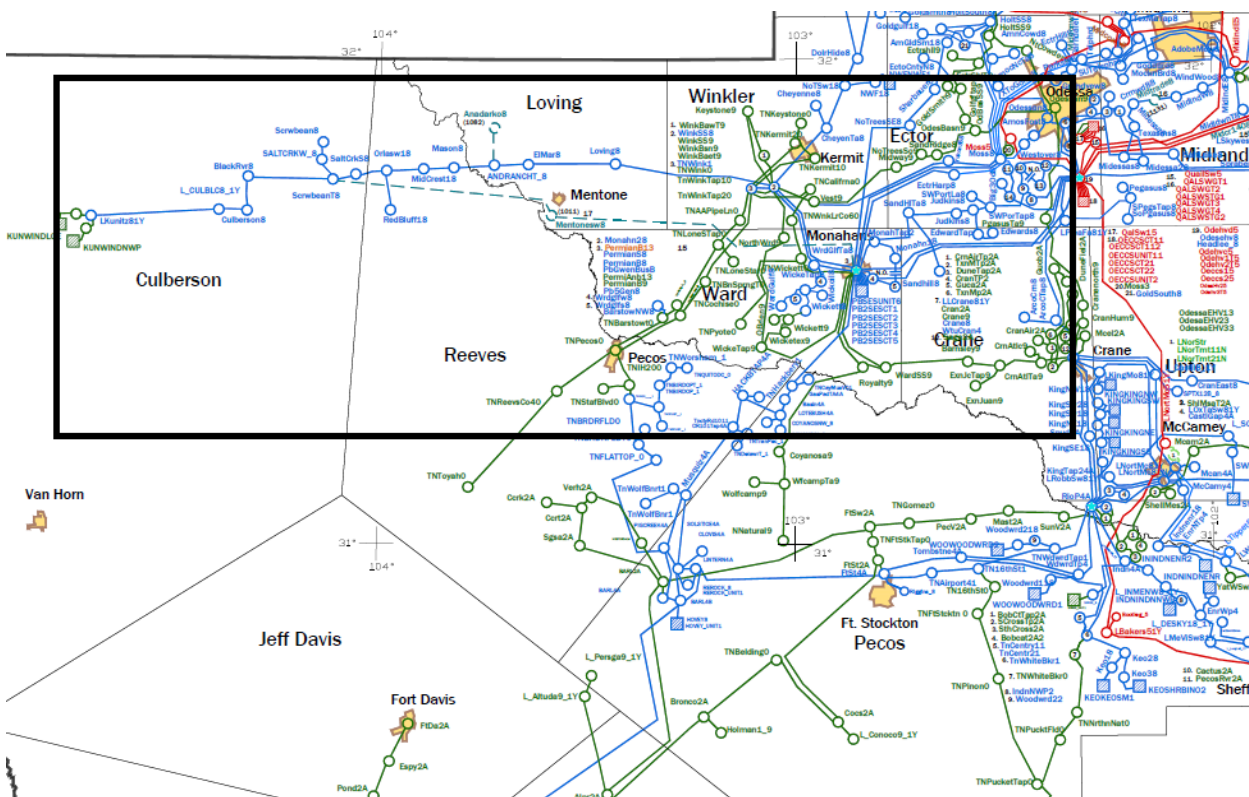


Figure 3.1: Transmission System Map of Study Area

Reliability Cases

The following starting cases were used in the study:

- The 2020 West/Far West (WFW) summer peak case from the 2017 RTP reliability case
- The 2020 Dynamics Working Group summer peak flat start case

Transmission Topology

The starting case was modified based on input from Oncor to include topological changes, switched shunt additions and load additions in the study area for both near-term 2019 summer peak and 2022 summer peak conditions.

Study Case Loads and Potential Loads

Oncor provided data regarding increased load projections in the Culberson Loop area. The most recent Oncor submittal data included 880 MW for 2019 summer peak and 1030 MW for 2022 summer peak in the Culberson Loop area. Oncor met with ERCOT and shared information on the signed customer agreements which confirmed these proposed load additions.

Sensitivity cases were also created to reflect higher potential load projections from Oncor. These cases contained additional customer load requests that did not yet have firm commitment at the time of this independent review. To reflect this “Potential” load growth, the load was increased by 334 MW in the Culberson Loop for 2022 summer peak. The total load in the Potential Load Case was approximately 1347 MW in the Culberson Loop for the Potential Load sensitivity.

Generation

Planned generators in the Far West and West Weather Zones that met Planning Guide Section 6.9 conditions for inclusion in the base cases (according to the 2016 October Generation Interconnection Status report), which were not included in the RTP cases, were added. The added generators are listed in Table 3.1.

Table 3.1 Added Generators That Met Planning Guide Section 6.9 Conditions (2018 April GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Key assumptions applied in this study include the following:

- Wind generation in West and Far West weather zones were set to have a maximum dispatch capability of 2.6% of their rated capacity. This assumption was in accordance with the 2016 Regional Transmission Plan Study Scope and Process document¹.
- Solar generation was set at 70% of their rated capacity in accordance with the 2016 Regional Transmission Plan Study Scope and Process document.
- Considering the oil and gas industry load characteristics (flat load), the most stressed system condition is during the night when solar generation is not available. To study this condition, no solar generation was dispatched in the study base conditions.

Capital Cost Estimates

Capital cost estimates for transmission facilities were provided by Oncor, AEPSC and LCRA TSC. These costs were provided for individual transmission facilities and ERCOT used those values to calculate total project costs for various project options.

3.2. Criteria for Violations

The following criteria were used to identify planning criteria violations.

All 100 kV and above busses, transmission lines, and transformers in the study region were monitored (excluding generator step-up transformers).

- Thermal criteria violations
 - Rate A for Normal Conditions

¹ http://www.ercot.com/content/wcm/key_documents_lists/77730/2016_RTP_Scope_Process_v1.3_clean.pdf

- Rate B for Emergency Conditions
- Voltage violation criteria
 - $0.95 < V_{pu} < 1.05$ Normal
 - $0.90 < V_{pu} < 1.05$ Emergency
 - Post Contingency voltage deviations
 - 8% on non-radial load buses
- Dynamic Stability Analysis
 - NERC TPL-001-4 and ERCOT Planning Guide Section 4

3.3. Study Tools

ERCOT utilized the following software tools for the independent review of the Far West Texas Project:

- PSS/e version 33 was used to perform the dynamic stability analysis and in the initial steady-state case creation to incorporate the TSP idvs files
- PowerWorld Simulator version 20 for SCOPF and steady state contingency analysis
- VSAT version 17 was used for voltage stability analysis
- UPLAN version 10.2.0.19928

4. Project Need

The need for a transmission improvement project was evaluated for the Study Case. Table 4.1 summarized the steady state voltage stability (Power-Voltage) assessment results for the 2019 summer peak. The results showed pre-contingency voltage stability issues with no transmission upgrades. Even with the addition of the ERCOT Board of Directors approved Far West Texas Project (FWTP), as shown in Table 4.1 Scenario 2, the results indicated both voltage violations and voltage collapse under certain contingencies for the projected Culberson Loop 2019 summer peak load. The project need analysis results are consistent with the finding of the 2017 FWTP ERCOT independent review that identified the need for additional upgrades (beyond the FWTP project endorsed in June 2017) to serve loads greater than 717 MW in the Culberson Loop.

Table 4.1 Steady State Voltage Stability Assessment for the Base Case Condition

Scenario	Load (MW)	Transmission Upgrades	Culberson Load Serving Capability	
			NERC P1, P7	NERC P6
1.	880 (2019 Summer Peak)	None	Pre-contingency Voltage Collapse	
2.	880 (2019 Summer Peak)	FWTP ⁽¹⁾	Voltage Violation Voltage Collapse	Voltage Violation Voltage Collapse

(1). The Far West Texas Project (FWTP) endorsed by ERCOT Board of Directors in June, 2017.

5. Project Options

5.1. Options Considerations

The FWTP, which was endorsed by the ERCOT Board of Directors in June 2017, was designed to allow for a number of different expansion options that could accommodate additional load growth. All project alternatives considered in this study align with the expansion options evaluated as part of the ERCOT FWTP independent review.

In addition, project options considered in this study were limited to alternatives that included adding a second 345 kV circuit to the Odessa EHV – Riverton (between Moss and Riverton) and Solstice – Bakersfield 345 kV lines. This limitation was result of the following considerations:

- The Culberson Loop area has experienced a significant rate of load growth. This evaluation focused on contractually committed load with a sensitivity evaluation which includes new customers that have contacted the TSPs with load requests but have not yet finalized a contract to construct. However, it is possible that more, presently unknown, load requests will materialize before the facilities recommended in this evaluation are in service.
- The Odessa EHV – Riverton and Solstice – Bakersfield 345 kV lines have yet to be constructed. If they were constructed with one circuit in place and a second 345 kV circuit was later deemed necessary, the construction outage to add the second circuit would greatly reduce the load serving capability to the Culberson Loop and reduce the operational flexibility during what would likely be a long duration outage.
- It is approximately 50% less expensive to construct the two circuits in place at the initial build than the cost of coming back to install the second circuit at a later time due to reduced access, environmental and mobilization costs, and construction efficiencies.

In addition, the new 138 kV lines proposed in the FWTP2 project are necessary to strengthen the Culberson Loop and provide operational flexibility under normal and outage conditions.

5.2. Short-Listed Options

Based on the considerations listed above and the results of preliminary analysis, the following “universal” transmission upgrades were included in all of the short-listed options:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station

- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures

The following three options were studied further for the reactive support in the Culberson Loop. The detailed description of the three short-listed options are provided below and diagrams for these are included in the Appendix.

Option 1

- Universal transmission upgrades
- Install two 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station

The total cost estimate for Option 1 is approximately \$300.0 Million.

Option 2

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station.
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 2 is approximately \$292.5 Million.

Option 3

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Quarry Field 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 3 is approximately \$327.5 Million.

6. Voltage Stability and Dynamic Stability Analysis

A Power-Voltage (PV) analysis was used in the steady state voltage stability assessment for the Culberson Loop area for all short-listed options for the studied scenarios. A Power-Voltage (PV) analysis was used to proportionally increase the load in the Culberson Loop until a voltage collapse identified the maximum load serving capability for the options. Table 7.1 shows the results of this analysis, indicating the maximum loads in the Culberson Loop area that can be reliably served by the three identified project options. A sensitivity analysis was conducted to evaluate the impact of nearby generators to the Culberson Loop load serving capability. All five generators at the Permian Basin (PBSES) generation station were off-line in the study case. The PV results are listed in Table 7.1.

Table 7.1 Voltage and Dynamic Stability Assessment of All Options for Culberson Loop Load Serving Capability

Description	Culberson Loop Load Served (MW)		
	Option 1	Option 2	Option 3
PV Voltage Collapse Results (NERC P1, P6, P7, ERCOT Events)	1608	1568	1688
PV Voltage Collapse Results (without PBSES Units) (NERC P1, P6, P7, ERCOT Events)	1508	1468	1648
Dynamic Stability Result (without PBSES Units) (NERC P1, P6, P7, ERCOT Events) ⁽¹⁾	Acceptable	Acceptable	Acceptable
Estimated Capital Cost (\$M)	300	292.5	327.5

(1). Dynamic stability was conducted at the Culberson Loop load level identified in the PV voltage collapse results.

The majority of the loads in the study area were assumed to be oil and gas customers who employ voltage-sensitive electric equipment in their operations. As specified by Oncor, heavy motor load was assumed to represent the load characteristic in the study area. All three options were tested using time domain dynamic stability simulations including a dynamic load model provided by Oncor to evaluate system stability.

It was assumed that if simulations indicated an acceptable (stable) system response following severe events and/or three-phase faults, the stability response would also be acceptable for the same events with a single-line-to-ground (SLG) fault. If a potential stability issue was observed, the simulation was rerun with SLG faults to ensure a stable system response following a NERC planning event. In this way the analysis demonstrated compliance with NERC planning standards and ERCOT reliability criteria. In these simulations, selected ERCOT transmission buses were monitored for angle and voltage responses.

The dynamic event definitions included the removal of all elements that the protection system and other automatic controls are expected to disconnect for each event. The dynamic simulation results are also listed in Table 7.1.

None of the three options will be fully in-service prior to summer 2019, when the load is projected to reach 880 MW, since the new transmission lines will not be constructed. As a result, a PV analysis was conducted for the 2019 summer condition assuming only the reactive devices in all three options can be implemented to support the Culberson Loop in 2019. The PV analysis results are listed in Table 7.2. The results indicate that for Options 1 and 2 additional operational mitigation measures will be needed to maintain reliability prior to the new transmission lines being put in place. These operational mitigation measures may include (but are not limited to) undervoltage load shed.

Table 7.2 Steady State Voltage Stability Assessment of All Options for Culberson Loop Load Serving Capability with Reactive Devices Only

Description	Culberson Loop Load Served (MW)		
	Option 1	Option 2	Option 3
PV Voltage Collapse Results (reactive devices only) ⁽¹⁾ (NERC P1, P6, P7, ERCOT Events)	801	821	1001
PV Voltage Collapse Results (without PBSES units) (reactive devices only) ⁽¹⁾ (NERC P1, P6, P7, ERCOT Events)	721	741	880 ⁽²⁾

(1). Assuming reactive devices will be in service before new transmission lines.

(2). Oncor indicated that the reactive devices identified to be located at Quarry Field 138 kV Switch Station may not be in service by summer 2019. ERCOT performed a PV analysis considering only the reactive devices located at Horseshoe Springs from Option 3. The results showed that without the Quarry Field reactive devices in service, Option 3 would have a load serving capability of 721 MW.

7. Economic Analysis

Although this RPG project is driven by reliability needs, ERCOT also conducted an economic analysis to identify any potential impact on system congestion related to the addition of the transmission upgrades.

The base case for this economic analysis used the 2023 economic case built for the 2017 RTP as the starting case. The topology changes and generation additions were similar to the steady state base case built. ERCOT modeled each of the three short-listed options and performed production cost simulations for the year 2023. The annual production analysis showed no measurable congestion impact on the ERCOT System with the addition of the transmission upgrades.

8. Subsynchronous Resonance (SSR) Vulnerability Assessment

According to Protocol Section 3.22.1.3(2), ERCOT performed a SSR vulnerability assessment using topology check and the results indicated that all three short-listed options strengthen the transmission network and increase the required transmission circuit outages to have a Generation Resource become radial to series capacitors. The SSR assessment results showed no SSR vulnerability for any existing Generation Resources or Generation Resources satisfying Planning Guide Section 6.9 conditions for inclusion in the planning models at the time of this study.

9. Final Options Comparison

As shown in Table 9.1, a comparison of study results for the three options shows that Option 3, shown in Figure 9.1, met the system reliability criteria under the studied load conditions while providing better load serving capability to accommodate both the near-term and potential future load needs in the Culberson Loop area.

Table 9.1 Options Comparison

Description	Option 1	Option 2	Option 3
Capital cost (\$ Million)	300.0	292.5	327.5
PV Results, Culberson Load Served	1608	1568	1688
PV Results, Culberson Load Served (with only reactive support devices recommended in the options)	801	821	1001
PV Results, Culberson Load Served (without PBSES Units)	1508	1468	1648
PV Results, Culberson Load Served (without PBSES Units) (with only reactive support devices recommended in the options)	721	741	880
Dynamic Stability Results, Culberson Load Served	Acceptable	Acceptable	Acceptable

Option 3

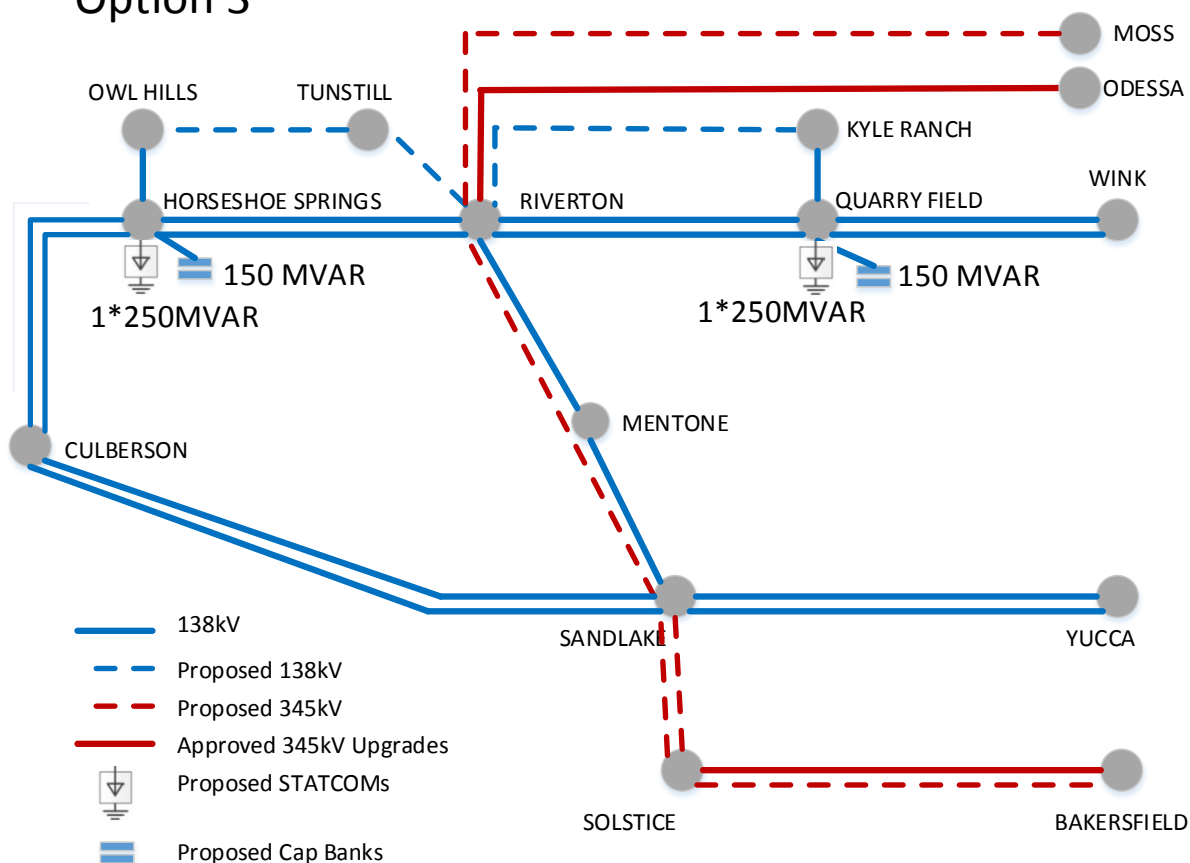


Figure 9.1: Option 3

10. Sensitivity Studies

Sensitivity studies were performed to ensure compliance with Planning Guide requirements.

10.1. Generation Sensitivity Analysis

According to Planning Guide Section 3.1.3(4)(a), the generation sensitivity analysis will evaluate the effect that proposed Generation Resources in or near the study area will have on a recommended transmission project. Based on the 2018 April Generator Interconnection Status report, Table 10.1.1 shows all the generators in the area that met Planning Guide 6.9 and Table 10.1.2 shows all the generators in the area with a signed standard generator interconnection agreement (SGIA) that did not meet Planning Guide 6.9 conditions for inclusion in the planning models. Considering the oil and gas industry load characteristics, the most stressed system condition is during the night when solar generation is not available. No solar generation in the Culberson Loop was assumed available in the study base conditions. Therefore, the proposed Generation Resources in the Culberson Loop area will have no impact on the recommended transmission project.

Table 10.1.1 Generators Met Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Table 10.1.2 Generators with SGIA That Did Not Meet Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
18INR0022	Winkler Solar	150	Solar	Winkler	Far West

10.2. Load Scaling Impact Analysis

Planning Guide Section 3.1.3(4) (b) requires evaluation of the impact of various load scaling on the criteria violations seen in the study cases.

Because the voltage violations were observed at load serving buses inside the Culberson Loop, ERCOT assumed that the load scaling in the outside weather zones did not have a material impact on the observed need.

11. Conclusion

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of the project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost effective manner and provide needed load serving capability to the rapid oil and gas industry load growth in the Culberson Loop area. Option 3 is estimated to cost \$327.5 million and is described as follows:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice 345 kV Switch Station – Bakersfield 345 kV Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

The reactive support components, including STATCOMs and capacitors, recommended in Option 3 should be implemented by 2019 if feasible to accommodate the projected 880 MW Culberson Loop in summer 2019. Additionally, the sizing of capacitor bank stages should take into account operational considerations. Remedial operational schemes may be required to mitigate post-contingency voltage violations in the Culberson Loop area until the recommended transmission upgrades can be built to reliably serve the increasing load.

12. Designated Provider of Transmission Facilities

In accordance with the ERCOT Nodal Protocols Section 3.11.4.8, ERCOT staff is to designate transmission providers for projects reviewed in the RPG. The default providers will be those that own the end points of the new projects. These providers can agree to provide or delegate the new facilities or inform ERCOT if they do not elect to provide them. If different providers own the two ends of the recommended projects, ERCOT will designate them as co-providers and they can decide between themselves what parts of the recommended projects they will each provide.

Oncor owns the Odessa EHV Switch Station, Moss Switch Station and is planning to construct and own the new Riverton Switching Station and therefore is the presumed owner of the Riverton Switching Station. Therefore, ERCOT designates Oncor as the designated provider for the 345 kV Odessa EHV to Riverton and Moss to Riverton transmission facilities along with the two recommended 345/138 kV autotransformers at Riverton.


LCRA TSC owns the Bakersfield Switchyard while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation. Therefore, ERCOT designates AEPSC and LCRA TSC as the designated co-providers for the 345 kV Bakersfield to Solstice transmission facilities but AEPSC as the provider of the two recommended 345/138 kV autotransformers at Solstice.

Oncor is planning to construct and own the new Sand Lake Switching Station and therefore is the presumed owner of the Sand Lake Switching Station, while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation. ERCOT designates Oncor and AEPSC as the designated co-providers for the 345 kV Sand Lake to Solstice transmission facilities and Oncor as the provider of the two recommended 345/138 kV autotransformers at Sand Lake Switch Station.

Oncor owns all the 138 kV Switch Stations listed in the recommended Option 3. Therefore, ERCOT designates Oncor as the designated provider for all the 138 kV transmission facilities along with the proposed STATCOMs and static capacitor banks.

The designated TSPs have requested critical designation status for the Riverton – Sand Lake 345 kV Line, the Sand Lake – Solstice 345 kV Line, and the Bakersfield – Solstice 345 kV line for multiple operational and reliability needs to address the rapid load growth in the Culberson Loop area. ERCOT designates the project critical to reliability per PUCT Substantive Rule 25.101(b)(3)(D).

13. Appendix

Options Diagrams	 Options_OneLine.p ptx
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