ERCOT Permian Basin Load Interconnection Study

Final

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Document Revisions

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Executive Summary

ERCOT, with extensive review and input by the affected Transmission Service Providers (TSPs) and stakeholders, performed the Permian Basin Load Interconnection Study and identified transmission upgrades, especially long lead time transmission upgrades, necessary to reliably serve the existing and projected oil and gas loads in the Permian Basin area. This report describes the identified potential reliability needs and details of the transmission upgrades to meet the electric demand driven by the oil and natural gas industry and the associated economic expansion in the Permian Basin area. The Permian Basin area includes the Delaware Basin, Midland Basin, and Central Basin Platforms which covers most of the counties in the Far West Weather Zone plus five adjacent counties in the West Weather Zone.

The Far West Weather Zone has experienced an average annual peak demand growth rate of approximately 12% from 2016 to 2021 due to significant growth in oil and natural gas industry demand. This growth rate is the highest of any weather zone in the ERCOT region. Due to the short-term planning horizons of the oil and gas industry resulting in lack of long-term load commitments, ensuring that necessary transmission improvements are in place in time to accommodate the rapid oil and gas development continues to be a challenge. As part of the efforts to address the challenge, several transmission upgrades, including the Far West Texas Project (FWTP), the Far West Texas Dynamic Reactive Devices (DRD) Project, and the Far West Texas Project 2 (FWTP2) have been completed in recent years. In addition, ERCOT completed the Delaware Basin Load Integration Study[1] in December 2019 and developed the roadmap involving major new 345-kV lines to improve load serving capability to import power into the Delaware Basin area. The Stage 1 upgrade in the roadmap was endorsed in June 2021 and is expected to be complete in 2023.

Given the challenges associated with the rapid load growth in the Permian Basin area, TSPs serving the Permian Basin area have also made significant efforts to better understand the underlying dynamics of oil and gas development throughout the region. This effort led to the completion of a customer demand study by IHS Markit, which provides an in-depth analysis of the oil and gas industry and provides more granular and detailed electricity demand forecast in the Permian Basin area through 2030. According to the IHS Markit study report[2] published in April 2020, the electricity needs of the Permian Basin is projected to be nearly double by 2030 compared to 2019, based on a detailed examination of the key drivers underlying power demand associated with recent and ongoing growth of oil and gas activities in the Midland Basin, Delaware Basin, Central Basin Platform, and Fringe regions of the Permian Basin. ERCOT and the TSPs relevant to the area reviewed the demand forecast from the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used for the local transmission/load interconnection study of the Permian Basin area.

As a result, ERCOT with significant support from the relevant TSPs performed steady state analyses utilizing the demand forecast through 2030 (8,450 MW in 2025 and 9,970 MW in 2030) and identified a set of transmission improvements to connect and reliably serve the projected oil and gas loads in the Permian Basin area. As summarized in Section 5 of this report, ERCOT identified both preferred and placeholder transmission upgrades. If the preferred upgrades identified in this study are submitted to Regional Planning Group (RPG) for review, ERCOT may use this study report as part of ERCOT Independent Review. The placeholder projects may require further review. Table E.1 lists the details of the preferred upgrades identified in this study. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion. Capital cost estimates of each transmission upgrade

[1] https://www.ercot.com/gridinfo/planning

[2] https://www.ercot.com/files/docs/2020/11/27/27706_ERCOT_Letter_to_Commissioners_-_Follow-up_Status_Update_on_Permian....pdf

were provided by the TSPs relevant to each upgrade. ERCOT used the cost estimates provided by the TSPs to calculate total project cost estimates for various projects.

Table E.1 Preferred Reliability Upgrades

Project ID	Preferred Transmission Upgrades (Note: Assumed ratings can be found in Section 6)	Year of Study Case with Reliability Need Starting to Appear	Approximate Cost Estimate ($M)
1	Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	100.58
2	Rebuild existing Midland East – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	196.47
2	Rebuild existing Morgan Creek – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	2030	
2	Rebuild existing Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	
3	Upgrade existing Morgan Creek – Longshore 345-kV line	2030	393.88
3	Upgrade existing Morgan Creek – Longshore Fly 345-kV line	2025	
3	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy and upgrade Longshore – Consavvy 345-kV line; Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy	2025	
3	Upgrade Consavvy – Midessa South 345-kV line	2025	
3	Upgrade existing Longshore Fly – Quail 345-kV line	2025	
3	Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	2025	
3	Upgrade existing Midessa South – Odessa EHV 345-kV line	2025	
3	Upgrade existing Quail – Odessa EHV 345-kV line	2025	
3	Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer	2025	
18	Add Verhalen – New Load 90108 138-kV line	2025	6.60
24	Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers	2030	65.55
24	Loop existing Solstice – Sand Lake 345-kV double-circuit line at the new IH20 345-kV Substation	2030	
25	Establish a new 345/138-kV Reiter Substation with two new 345/138-kV transformers; Establish a new 345-kV Quail East Substation; Add a new Quail East – Reiter 345-kV double-circuit line	2025	104.65
31	Add Quarry Field – New Load 90004 138-kV line	2025	80.23
31	Add New Load 90004 – New Load 90007 – New Load 90015 – New Load 90066 – Keystone 138-kV line	2025	
31	Add capacitor bank (90 Mvar) at new load bus 90004	2025	
33	Add ONC90005_TAP – New Load 90005 138-kV line	2025	67.25
33	Add New Load 90005 – New Load 90111 – New Load 90023 - New Load 90012 138-kV line	2025	

33	Add capacitor bank (90 Mvar) at new load bus 90012	2025	
34	Add New Load 90012 – New Load 90021 138-kV line	2030	29.6
35	Add Faulkner – New Load 90038 – New Load 90021 138-kV line	2025	33.8
35	Add capacitor bank (90 Mvar) at new load bus 90021	2030	
36	Add Faulkner – New Load 90108 138-kV line	2030	17.55
42	Add Bearkat – North McCamey 345-kV double-circuit line (Stage 2 upgrade)	2030	392.41
42	Add North McCamey – Sand Lake 345-kV double-circuit line (Stage 2 upgrade)	2030	

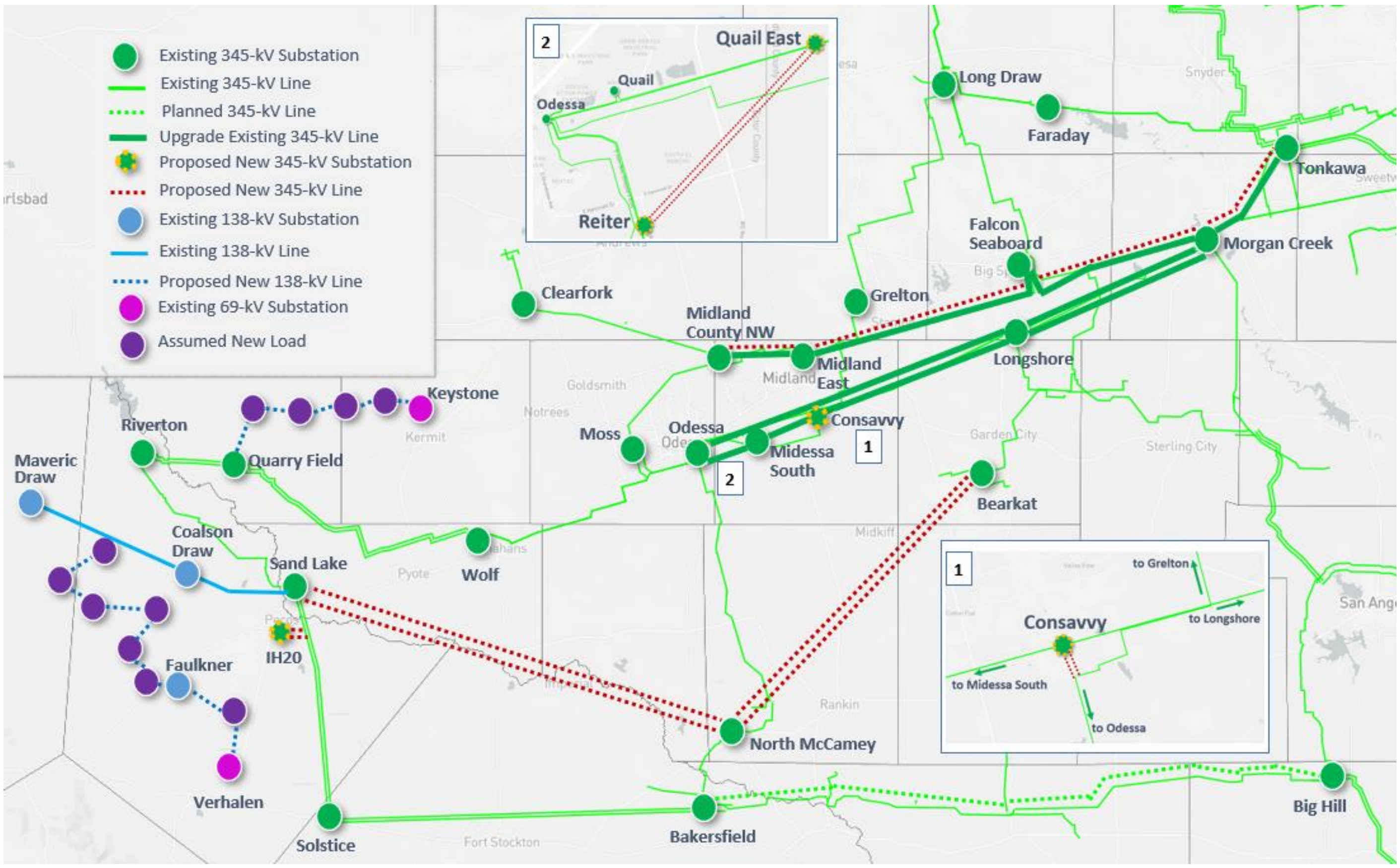

Figure E.1 Preferred Reliability Upgrades for 2030

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1. Introduction

Over the past several years, the Far West Weather Zone, which includes the Delaware Basin, Midland Basin, and Central Basin Platform, has experienced an average annual peak demand growth rate of approximately 12% from 2016 to 2021 due to significant growth in oil and natural gas industry demand. Figure 1.1 shows the primary oil basin resources in the Permian area.

Ensuring that necessary transmission improvements are in place in time to accommodate the rapid oil and gas development in the Permian Basin area has been and will continue to be a significant challenge for both transmission planning and system operations. The challenge originates from fundamental difference in planning horizons between major transmission improvement and oil and gas development. Due to the nature of the oil and gas industry, it is extremely difficult to accurately forecast their electricity demand more than one to two years. On the other hand, transmission improvements, which include planning studies, routing analysis, regulatory approvals, route acquisition, design, and construction, generally can take up to six years. Because of lack of long-term load commitments from the oil and gas industry, transmission planning studies are able to accurately identify system needs only for one to two years in advance, which is not sufficient to plan and construct new transmission improvements for the rapid and significant load growth in the Permian Basin area.

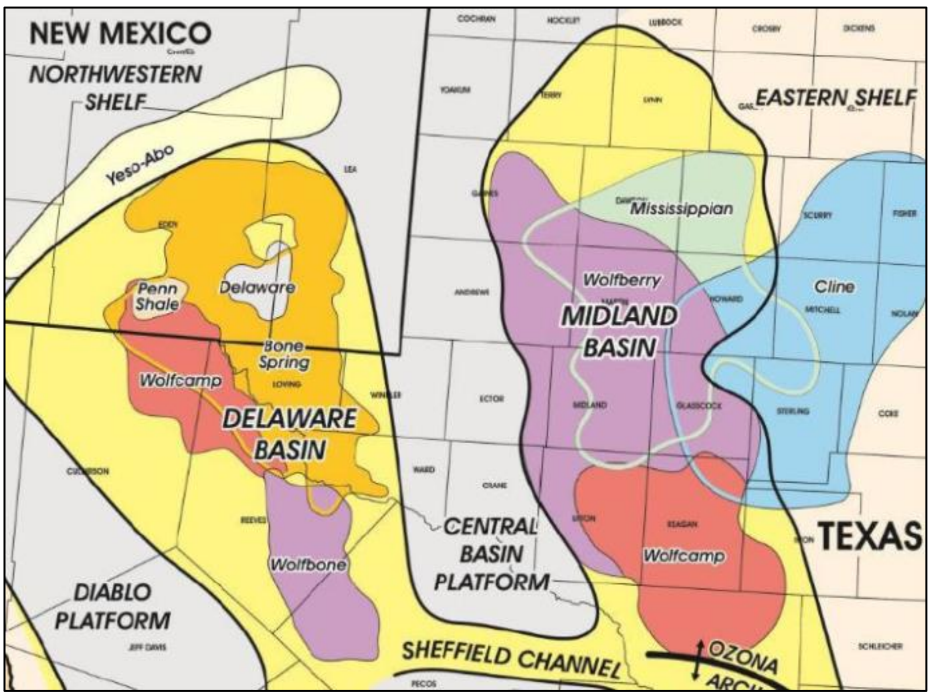

Figure 1.1 Map of Tectonic Subdivision of the Permian Basin[3]

As part of the efforts to address the challenge, several transmission upgrades, including the Far West Texas Project (FWTP), the Far West Texas Dynamic Reactive Devices (DRD) Project, and the Far West Texas Project 2 (FWTP2) have been completed in recent years to accommodate the significant and rapid load growth and address the transmission needs in the Delaware Basin area. In December 2019, ERCOT completed the Delaware Basin Load Integration Study to identify potential long lead

[3] https://www.oilandgas360.com/ngl-energy-partners-adds-water-sources-for-oil-gas-operators-in-the-permian/

time transmission improvements (i.e., new 345-kV transmission lines) to accommodate the rapid oil and gas development. The study developed a roadmap involving major new 345-kV lines to improve the capability to import power into the Delaware Basin area using a higher-than-forecasted (i.e. conceptual plus planned) load growth in the Delaware Basin area. The conceptual loads assumed in the Delaware Basin Load Integration Study were provided by the TSPs in the area based on the surveys of their high-use oil and gas customers. The Stage 1 upgrade in the roadmap was endorsed in June 2021 and is expected to be complete in 2023.

The TSPs serving the load in the Permian Basin area have also made significant efforts to better understand the underlying dynamics of oil and gas development throughout the region. This effort led to the completion of a customer demand study by IHS Markit, which provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian area through 2030. According to the IHS Markit study report, the demand forecast was based on geology and resource assessment, industry intelligence, oil and gas expertise, commercial considerations, translations of historical and forecasted oil and gas activities into electric load demands in every single square mile in the Permian Basin area.

ERCOT and the TSPs relevant to the area reviewed the demand forecast projected in the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used for the local transmission/load interconnection study of the Permian Basin area. More details of the projected demand forecast from the IHS Markit study can be found in Section 2.2 of this report. ERCOT with significant support from the relevant TSPs completed this Permian Basin Load Interconnection Study in 2021 utilizing the demand forecast from the IHS Markit study to identify the reliability challenges and a set of transmission improvements to connect and reliably serve the existing and projected oil and gas loads in the Permian Basin. This report describes the study assumptions, methodology and the results of ERCOT's assessment.

ERCOT also reviewed the historical oil and gas activities and load growth in the Far West region. As shown in Figure 1.2, the oil rig count data showed that the oil and gas drilling activities in the Permian Basin area have been increasing since July 2020 although the activities temporarily declined in early 2020 due to COVID-19 and international oil markets. Figure 1.3 shows the historical peak demand in the Far West Weather Zone which also indicates the resumed rapid load growth in the area.

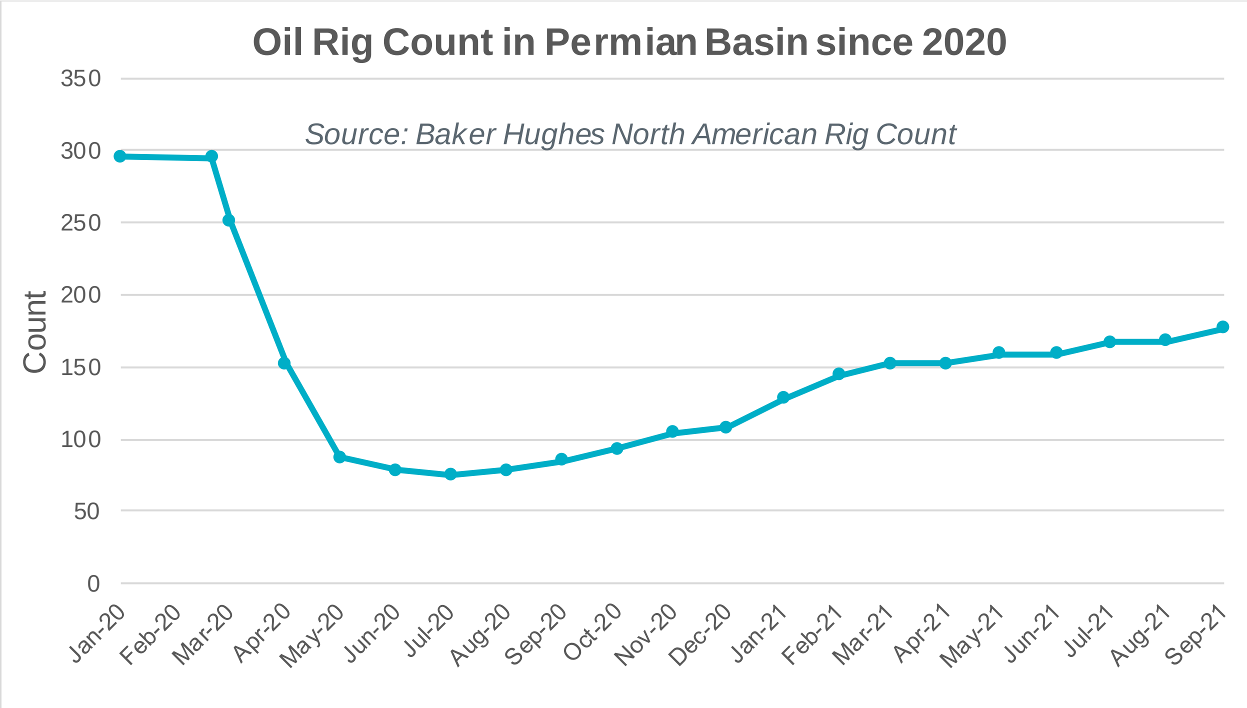

Figure 1.2 Oil Rig Counts in Permian Basin

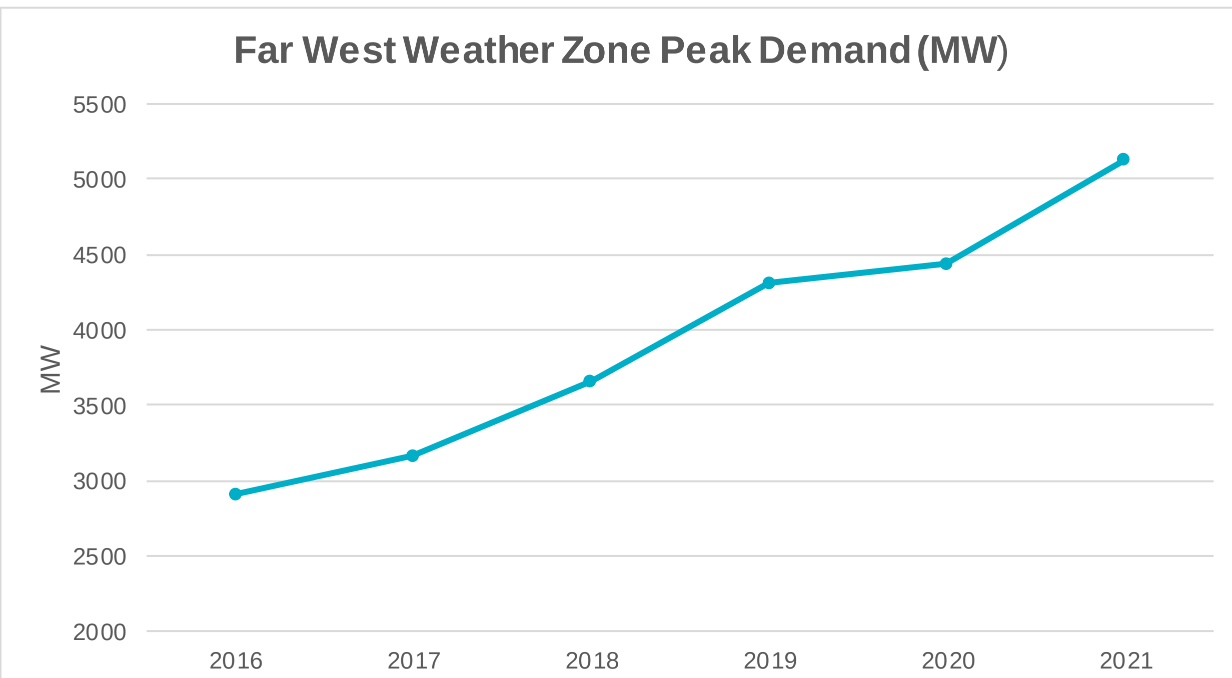

Figure 1.3 Far West Weather Zone Historical Peak Demand

2. Study Assumptions and Methodology

This section describes study assumptions and methodology employed in the Permian Basin Load Interconnection Study.

2.1. Study Area

The Permian Basin area spans most of the counties in the Far West Weather Zone plus five adjacent counties in the West Weather Zone. Table 2.1 shows the counties included in the study area in this study.

Table 2.1 Counties in the Study Area

County	Weather Zone
Andrews	Far West
Borden	Far West
Crane	Far West
Crockett	Far West
Culberson	Far West
Dawson	Far West
Ector	Far West
Glasscock	Far West
Howard	Far West
Irion	West
Loving	Far West
Martin	Far West
Midland	Far West
Mitchell	West
Pecos	Far West
Reagan	Far West
Reeves	Far West
Schleicher	West
Scurry	West
Sterling	West
Upton	Far West
Ward	Far West
Winkler	Far West

2.2. Study Assumption

2.2.1. Reliability Case

The following starting case was used to develop study cases for year 2025 and 2030 in the study:

- The 2025 West/Far West (WFW) summer peak case[4] from the 2020 RTP (posted in October 2020 in the ERCOT MIS site)

[4] https://mis.ercot.com/secure/data-products/grid/regional-planning?id=PG7-173-M

2.2.2. Study Case Loads

The IHS Markit study provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian Basin area through 2030.

As described in Section 1, ERCOT and the TSPs relevant to the area reviewed the demand forecast from the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used in this study. The TSPs made a joint effort and mapped the granular load forecast data to the substation level. The substation level load includes the load connecting to the existing substations and the projected new loads that require new interconnections to the existing transmission grid. Figure 2.1 and Figure 2.2 show the geographic locations of the projected new loads for the year 2025 and 2030.

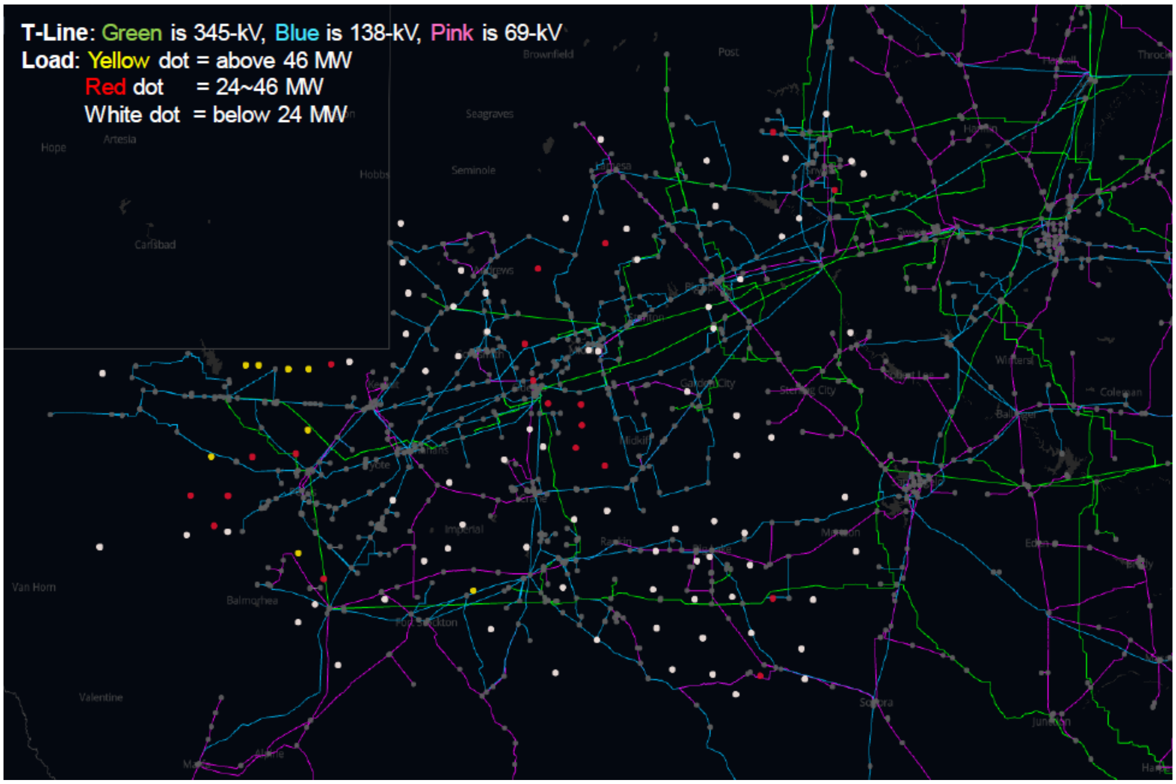

Figure 2.1 Approximate Locations of Projected New Loads for Year 2025

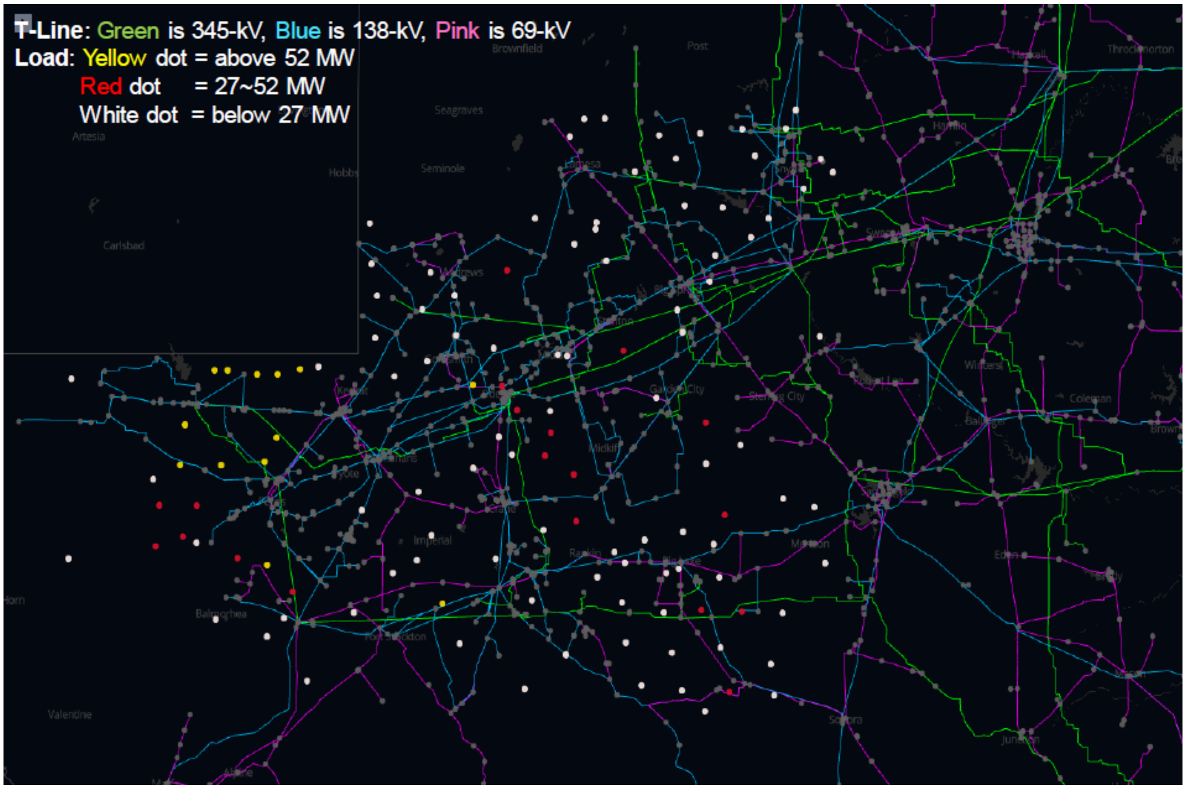

Figure 2.2 Approximate Locations of Projected New Loads for Year 2030

The load in the Permian Basin area in the starting case was updated with the substation level load derived from the demand forecast in the IHS Markit study to develop the study base case. Certain placeholder transmission interconnection projects were assumed to connect the projected new loads into the study base case. Table 2.2 summarizes the load level modeled in this Permian Basin Load Interconnection Study compared to the load in the 2020 RTP case.

Table 2.2 Permian Basin Load Projection for Year 2025 and 2030 in the Study

Permian Basin Load	IHS Load Forecast (MW)		2020 RTP (MW)
	2025 Load	2030 Load	2025 Load
Total Load at Existing Substations	6,601	7,402	8,343
Total Load Requiring New Transmission Interconnections	1,850	2,568	n/a
Total Load	**8,450**	**9,970**	**8,343**

Table 2.3 shows the load projection by the locations in the study base cases.

Table 2.3 IHS Load Projection by Locations for Year 2025 and 2030

Area	2025 Load (MW)	2030 Load (MW)
Delaware Basin	3,789	4,898
Far West (Excluded Delaware Basin)	4,128	4,533
West (Included Five Counties)	532	539
Total	**8,450**	**9,970**

The reactive consumption of the projected new oil and gas load was assumed based on historical operational performance of existing oil and gas load in the Permian Basin area. Based on the review of the historical performance and inputs from the relevant TSPs, 0.97 power factor was used in this study for the projected new oil and gas loads. For the loads at the existing substations, the power factors were assumed the same as in the 2020 RTP case.

2.2.3. Transmission Topology

All RPG-approved Tier 1, 2, and 3 and all Tier 4 transmission projects expected to be in-service within the study area by the respective years were added to the corresponding study base cases based on the review of the ERCOT Transmission Project Information and Tracking (TPIT) report posted in October 2020. During the study, additional transmission projects expected to be in-service within the study area were also added to the study base cases based on the review of the June 2021 TPIT report. Table 2.4 lists the transmission projects added to the study base cases.

Table 2.4 Transmission Additions for Year 2025 and 2030

ERCOT Project #	Project Title	Projected In-Service Date (Month/Year)	Planning Charter Tier
54255	Rebuild Rio Pecos – Lynx Ckt 2 (1926 ACSS)	Dec-20	Tier 4
55372	Conversion of TNMP Gomez to 138-kV service.	Dec-20	Tier 4
57173	TNMP Soaptree Switching Station	Dec-20	Tier 4
52311	Add Gardendale 345-kV Switch	Dec-20	Tier 4
52295	Natural Dam 138-kV Switch	May-21	Tier 4
57797	Athey: Build 138-kV Station	Sep-21	Tier 4
55367	Wolfcamp: Build 138-kV box bay	Nov-21	Tier 4
52322	Establish Courtney Creek Switch	Dec-21	Tier 4
58540	Rebuild 16th St – Soaptree	Dec-21	Tier 4
6719	Twelvemile Substation Addition	Sep-22	Tier 4
55470	Bison to Ozona: Rebuild 69-kV line	Nov-22	Tier 4
51788	Amos Creek Circuit Breaker Addition	Nov-20	Tier 4
52464	Alamito Creek to Ft. Davis: Rebuild 69-kV line	May-23	Tier 4
60489	Adds Leon Creek Switching Station and Tarbush Tie	Sep-21	Tier 4
60491	Rebuild 16th Street-Airport with 1926 ACSS	Mar-22	Tier 4
59402	Add Midland East Switch 345/138-kV Autotransformer #2	Dec-22	Tier 3
62728	Wink – Shifting Sands 69-kV Line Conversion to 138-kV	May-22	Tier 4
63491, 63493, 63495, 63497	Bakersfield to Big Hill 345-kV Second Circuit Addition Project	Summer 2023	Tier 2

ERCOT also included the Stage 2 upgrade (adding a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line) identified in the Delaware Basin Load Integration Study in the 2030 study case since the load level in the Delaware Base area in the 2030 study case exceeded the trigger point of the Stage 2 upgrade as shown in Table 2.5. It indicates the need of a new transmission import path to the Delaware Basin area in the 2030 study case. More details about the Stage 2 upgrade were described in Section 4.3.

Table 2.5 Delaware Basin Transmission Upgrade Roadmap

Stage	Estimated Delaware Basin Load Level (MW)	Upgrade Element	Trigger
1	3,052	Add a second circuit on the existing Big Hill – Bakersfield 345-kV line	Import Needs
2	4,022	A new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line	Import Needs
3	4,582	A new Riverton – Owl Hills 345-kV single-circuit line	Culberson Loop Needs
4	5,032	Riverton – Sand Lake 138-kV to 345-kV conversion and a new Riverton - Sand Lake 138-kV line	Culberson Loop Needs
5	5,422	A new Faraday – Lamesa – Clearfork – Riverton 345-kV double-circuit line	Import Needs

2.2.4. Generation

Planned generators in the West and Far West Weather Zones that met Planning Guide Section 6.9(1) requirements for inclusion in the base cases were added to the study cases based on the 2020 December Generation Interconnection Status (GIS) report posted on January 4, 2021. The added generators are listed in Table 2.6.

Table 2.6 Added Generators for Year 2025 and 2030

GINR	Project Name	County	Projected COD	Fuel	Capacity (MW)
17INR0052	Horse13 CallD Repower	Taylor	12/31/2020	WIND	44
17INR0061	Capricorn IV Repower	Sterling	12/31/2020	WIND	9
18INR0079	Woodward I Repower	Pecos	12/31/2020	WIND	0
19INR0121	Galloway Solar	Concho	10/01/2021	SOLAR	250
20INR0046	Maverick Creek II W	Concho	03/23/2021	WIND	118.8
21INR0357	SP TX-12B BESS	Upton	10/31/2021	STORAGE	22.68
21INR0365	Bat Cave Energy Storage	Mason	06/01/2021	STORAGE	100.49
21INR0431	Galloway 2 Solar	Concho	04/01/2022	SOLAR	110
21INR0449	Panther Creek III Repower	Howard	02/02/2021	WIND	15.96

Solar generation in the study area was assumed to be offline to represent a stressed system condition since the oil and natural gas loads are assumed to operate as constant loads throughout the day and night. The dispatch of Energy Storage Resource (ESR) and wind generation as well as solar generation outside of the study area were consistent with the 2020 RTP methodology. Generation retired, indefinitely mothballed, or to be decommissioned was turned off if it was not already offline in the case.

2.2.5. Capital Cost Estimates

Capital cost estimates of each transmission upgrade identified in this study were provided by the TSPs relevant to each upgrade. ERCOT used the cost estimates provided by the TSPs to calculate total project cost estimates for various projects. For new transmission lines requiring new rights of way, ERCOT assumed a routing adder of 20% to the straight distance between two end points.

2.3. Study Methodology

The existing transmission system in some local area was not sufficient to serve the assumed load, especially with the new load interconnections in the Delaware Basin area. In fact, the voltage instability issues were identified in the initial 2025 and 2030 study cases under system intact (i.e., N-0) conditions. The following local transmission upgrade was identified to address the voltage instability issues and applied to the study cases during the case development. This upgrade was assumed in-service during the reliability need analysis.

- Convert existing Barrilla Loop to 138-kV: Barrilla – Hoefs Road – Verhalen – Cherry Creek – Saragosa 69-kV line to 138-kV

ERCOT evaluated various transmission upgrade options and identified a set of transmission upgrades to address the reliability criteria violations in the study area. These transmission upgrades were then categorized as ERCOT preferred upgrades or placeholder upgrades.

Various transmission load interconnection upgrades were considered to connect the projected new loads in Figure 2.3. For example, a radial line from the nearest substation was considered as placeholder to connect the relatively smaller loads (e.g., white dots). For most of the bigger loads (e.g., red and yellow dots), the transmission interconnections were initially modeled based on the inputs from the TSPs as the placeholder. For Area 1, further detailed analysis was performed as described below.

Among the new loads in Figure 2.3, ERCOT and the relevant TSPs focused relatively more on Area 1 in the Delaware Basin area to identify proper local transmission load interconnection projects based on the following considerations:

- A large amount of projected new loads (e.g., red and yellow dots) are concentrated in Area 1 compared to other areas. Area 1 is in the Delaware Basin area which is the most profitable area for the oil and gas development in the Permian Basin according to the IHS Markit study report.
- Compared to other areas in the Permian Basin, Area 1 has limited existing transmission infrastructures.

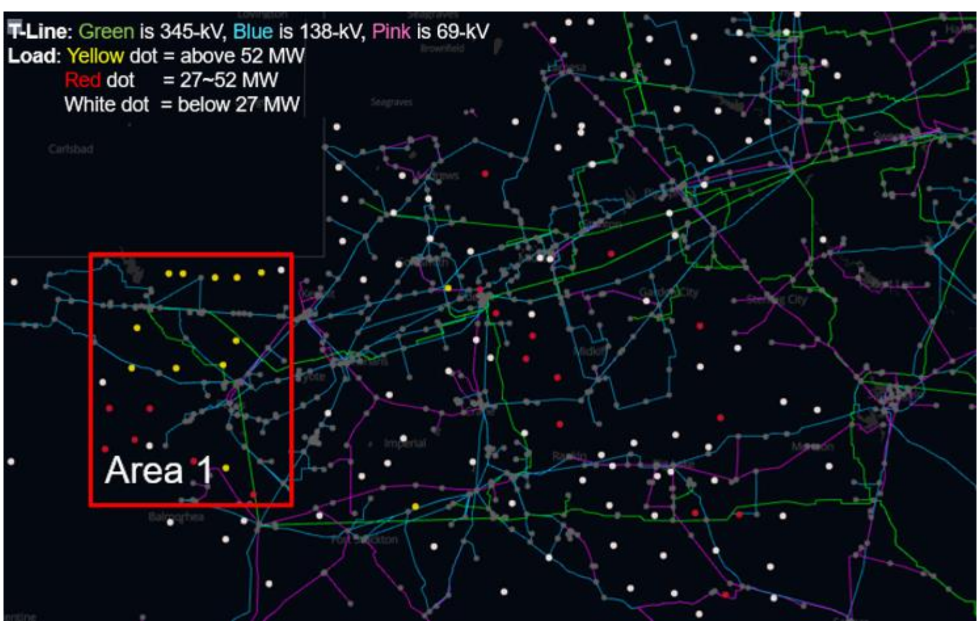

Figure 2.3 Focused Area for New Transmission Interconnection

2.3.1. Tools

ERCOT utilized the following software tool in this study:

- PowerWorld Simulator version 21 was used for SCOPF and steady state contingency and voltage stability analysis

2.3.2. Contingencies

All the NERC P1, P2-1, and P7 contingencies in the West and Far West Weather Zones were evaluated for the AC power flow analyses. ERCOT also evaluated G-1+N-1 and X-1+N-1 contingencies in the study area.

For the G-1+N-1 analyses, the following generator outages were considered to represent the anticipated significant G-1 conditions in the study area:

- Permian Basin all five units (340 MW)
- Odessa Combined Cycle Train 1 (497 MW)

For the X-1+N-1 analyses, the following 345/138-kV transformers were considered to represent the anticipated significant X-1 conditions for the study area:

- Riverton 345/138-kV transformer 1
- Sand Lake 345/138-kV transformer 1
- Wolf 345/138-kV transformer 1
- Quarry Field 345/138-kV transformer 1
- Solstice 345/138-kV transformer 1
- Odessa EHV 345/138-kV transformer 1

2.3.3. Criteria

The reliability assessment was performed based on NERC Reliability Standard TPL-001-4, ERCOT Nodal Protocol and Planning Criteria.

3. Reliability Need

The 2025 and 2030 study base cases were evaluated to determine if system improvements would be necessary to meet the projected demand forecast in the Permian Basin area. The reliability assessment results revealed that both thermal overloads and voltage instability would occur without system improvements. Table 3.1 summarizes the reliability analysis results under N-0, N-1, G-1+N-1, and X-1+N-1 contingencies for the 2025 and 2030 study base cases. No cascading issues were identified in this study. More details of the reliability analysis results were described in the subsequent sections. Transmission upgrades were identified in Section 4 to address these reliability criteria violations.

Table 3.1 Summary of the Reliability Violations

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	2	17
Transmission Line Overloads	~ 196 miles of 345-kV line ~ 347 miles of 138-kV line ~ 127 miles of 69-kV line	~ 269 miles of 345-kV line ~ 366 miles of 138-kV line ~ 177 miles of 69-kV line
Transformer Overloads	Three 345/138-kV transformers Four 138/69-kV transformers	Seven 345/138-kV transformers Six 138/69-kV transformers

3.1. Reliability Needs Inside Delaware Basin Area

The Delaware Basin area mainly includes six counties in Far West Weather Zone: Culberson, Loving, Pecos, Reeves, Ward, and Winkler. The total loads in the Delaware Basin area in the study base cases are 3,789 MW and 4,898 MW in 2025 and 2030 respectively.

Several transmission upgrades, including both the 345-kV and 138-kV upgrades, have been completed in recent years to accommodate the rapid load growth in the Delaware Basin area. The newly built 345-kV lines, Odessa EHV/Moss – Wolf – Quarry Field – Riverton – Sand lake – Solstice – Bakersfield recommended in FWTP and FWTP2, extended the extra high voltage transmission system in the Far West to the Delaware Basin area and formed a loop to serve the underlying system. These 345-kV lines are connected to the 138-kV transmission facilities distributing power flows through the newly added Wolf, Quarry Field, Riverton, Sand Lake, and Solstice 345/138-kV transformers. These 345-kV upgrades together with other 138-kV upgrades such as the Horseshoe Springs Switch – Riverton Switch 138-kV Second Circuit Project and the Ward/Winkler Transmission Improvement Project are sufficient to meet projected near-term load forecast in the Delaware Basin area. However, with the IHS projected load level up to 2030 in this study, the existing transmission system in the Delaware Basin area could experience significant reliability criteria violations without additional transmission upgrades.

The reliability study results showed that there is no unsolvable contingency in the 2025 case, but ten unsolvable contingencies in the 2030 case. Besides the unsolvable consistencies, thermal overloads were also observed in the Delaware Basin area as shown in Table 3.2.

Table 3.2 Summary of the Reliability Violations Inside Delaware Basin Area

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	0	10
Transmission Line Overloads	~ 18 miles of 138-kV line ~ 7 miles of 69-kV line	~ 20 miles of 138-kV line ~ 29 miles of 69-kV line
Transformer Overloads	none	Four 345/138-kV transformers Two 138/69-kV transformers

The following sections describe the details of the thermal violations in those six counties in the Delaware Basin area.

3.1.1. Reliability Needs in Culberson, Loving, and Winkler Counties

The existing transmission overloads in Culberson, Loving, and Winkler Counties were all occurred in the 2030 case as shown in Table 3.3.

Table 3.3 Thermal Overloads in Culberson, Loving, and Winkler Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Wink – California Tnp 69-kV line	Base Case	< 100	123.7
Wink Tnp 138/69-kV transformer 1	Wink Tnp 138/69-kV transformer 2	< 100	106.5
Wink Tnp 138/69-kV transformer 2	Wink Tnp 138/69-kV transformer 1	< 100	106.5
Riverton 345/138-kV transformer 1	Quarry Field 345/138-kV transformer 1 + Riverton 345/138-kV transformer 2	< 100	104.2
Riverton 345/138-kV transformer 2	Quarry Field 345/138-kV transformer 1 + Riverton 345/138-kV transformer 1	< 100	104.0

3.1.2. Reliability Needs in Reeves and Ward Counties

Reeves County has the highest load projection in the study area, 1,430 MW in 2025 and 1,824 MW in 2030. With the projected load level in the 2030 case, both thermal overloads and voltage instability issues were observed in this area. Table 3.4 lists the thermal overloads.

Table 3.4 Thermal Overloads in Reeves and Ward Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Caymus TNP – Gas Pad 138-kV line	Base Case	< 100	130.7
Sand Lake – Cochise TNP 138-kV ckt 1	Sand Lake – Cochise TNP 138-kV ckt 2	< 100	109.7
Sand Lake – Cochise TNP 138-kV ckt 2	Sand Lake – Cochise TNP 138-kV ckt 1	< 100	109.7
Sand Lake 345/138-kV transformer 2	Sand Lake 345/138-kV transformer 1	< 100	105.8
Sand Lake 345/138-kV transformer 1	Sand Lake 345/138-kV transformer 2	< 100	105.5

3.1.3. Reliability Needs in Pecos County

All the identified reliability needs in Pecos County are all related to the thermal overloads of the existing 69-kV and 138-kV lines. Table 3.5 lists the thermal overloads in Pecos County.

Table 3.5 Thermal Overloads in Pecos County

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Fort Stockton – Leon Creek TNP 138-kV line	Lynx – Tombstone 138-kV line	125.4	125.8
Wolfcamp Tap – Coyanosa 69-kV line	Base Case	101.4	121
Wolfcamp – Coyanosa 69-kV line	Base Case	101.4	121
Wolfcamp Tap – Courtney Creek 69-kV line	Base Case	< 100	119.9
16th Street – Fort Stockton TNP 69-kV line	Base Case	108.1	109.4
Yucca – Royalty 69-kV line	Base Case	< 100	103.8
Lynx – Tombstone 138-kV line	Base Case	100.0	101.1

3.2. Reliability Needs Outside Delaware Basin Area

The reliability needs outside of the Delaware Basin area are mainly divided into the following three regions:

- Dawson, Borden, and Scurry Counties
- Ector, Midland, Howard, and Mitchell Counties
- Upton, Reagan, and Irion Counties.

Table 3.6 summarizes the reliability violations outside of the Delaware Basin area.

Table 3.6 Summary of the Reliability Violations Outside Delaware Basin Area

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	2	7
Transmission Line Overloads	~ 196 miles of 345-kV line ~ 329 miles of 138-kV line ~ 120 miles of 69-kV line	~ 269 miles of 345-kV line ~ 346 miles of 138-kV line ~ 148 miles of 69-kV line
Transformer Overloads	Three 345/138-kV transformers Four 138/69-kV transformers	Three 345/138-kV transformers Four 138/69-kV transformers

The following sections describe the details of thermal violations outside of the Delaware Basin area.

3.2.1. Reliability Needs in Dawson, Borden, and Scurry Counties

The existing 138-kV transmission systems in Dawson, Borden, and Scurry Counties are relatively old and have low normal and emergency ratings. The power flow from the Willow Valley 345-kV source goes through the 138-kV transmission system to serve the load in the area, causing the thermal overloads shown in Table 3.7.

Table 3.7 Thermal Overloads in Dawson, Borden, and Scurry Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line	Vealmoor – Long Draw 345-kV line	110.2	131.0
Scurry – Kndrsacrc – Knapp 138-kV line	Scurry County South – Long Draw/Faraday 345-kV double-circuit line	109.3	124.7
Lamesa – Key Sub – Gail Sub – Willow Valley Switch 138-kV line	Base Case	128.8	117.3
Knapp – Bluff Creek Switch – Exxon Sharon Ridge 138-kV line	Scurry County South – Long Draw/Faraday 345-kV double-circuit line	< 100	109.2
Deep Creek Sub – Sacroc 138-kV line	Odessa Combined Cycle Train 1 + Dermott – Scurry County South 345-kV double-circuit line	< 100	104.9
Howard Switch – Vealmoor 138-kV line	Odessa Combined Cycle Train 1 + Buzzard Draw – Koch Tap 138-kV line	< 100	102.9

3.2.2. Reliability Needs in Ector, Midland, Howard, and Mitchell Counties

The Morgan Creek – Odessa EHV 345-kV path includes the existing Morgan Creek – Longshore – Quail/Odessa EHV 345-kV double-circuit line and the Morgan Creek – Falcon Seaboard – Midland East – Midland County NW 345-kV single-circuit line. The Morgan Creek – Odessa EHV 345-kV path is one of the major backbone transmission systems in the area, and the path is connected to a number of 138-kV transmission facilities distributing power flows through multiple 345/138-kV transformers located along the path. In addition, since the newly built FWTP and FWTP2 extended the 345-kV transmission lines from Moss and Odessa EHV to the Delaware Basin area, more power is expected to flow through the Morgan Creek – Odessa EHV 345-kV path toward the newly built 345-kV lines as the load in the Delaware Basin area continues to grow.

The study results indicated that the existing system can no longer reliably serve the projected demand in the area without upgrading the existing 345-kV lines along the path. Table 3.8 lists the 345-kV level thermal overload issues along the Morgan Creek – Odessa EHV path. Table 3.9 shows the summary of the thermal overloads of the 138-kV and 69-kV systems in the area.

Table 3.8 345-kV Thermal Overloads on the Morgan Creek – Odessa EHV Path

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Morgan Creek – Tonkawa 345-kV line	Morgan Creek – Champion Creek/Bitter Creek 345-kV double-circuit line	115.0	164.2
Consavvy – Midessa South 345-kV line	Quail – Odessa EHV 345-kV line	129.0	127.0
Quail – Odessa EHV 345-kV line	Consavvy – Midessa South 345-kV line	124.8	122.8
Morgan Creek – Longshore 345-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	< 100	122.5
Midland East – Falcon Seaboard 345-kV line	Morgan Creek – Longshore – Consavvy 345-kV double-circuit line	109.3	121.2
Consavvy 345/138-kV transformer	Consavvy – Midessa South/Quail 345-kV double-circuit line	124.2	119.2
Odessa EHV 345/138-kV transformer 2	Odessa EHV – Moss/Wolf 345-kV double-circuit line	112.8	116.1
Morgan Creek – Falcon Seaboard 345-kV line	Morgan Creek – Longshore – Consavvy 345-kV double-circuit line	< 100	106.6
Longshore Fly – Consavvy 345-kV line	Permian Basin Five Units + Big Hill – Schneeman Draw 345-kV double-circuit line	101.4	106.2
Longshore – Consavvy 345-kV line	Odessa Combined Cycle Train 1 + Bakersfield – Cedar Canyon 345-kV double-circuit line	115.5	104.8
Midessa South 345/138-kV transformer	Odessa Combined Cycle Train 1 + Consavvy – Quail & Odessa EHV – Midessa South 345-kV double-circuit line	101.2	104.8
Morgan Creek – Longshore Fly 345-kV line	Odessa Combined Cycle Train 1 + Bakersfield – Cedar Canyon 345-kV double-circuit line (2025); Morgan Creek – Longshore 345-kV line (2030)	105.4	101.8
Midessa South – Odessa EHV 345-kV line	Quail – Odessa EHV 345-kV line	104.0	101.1

Table 3.9 138-kV and 69-kV Thermal Overloads in Ector, Midland, Howard, and Mitchell Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Stanton East – Spraberry 69-kV line	Spraberry 138/69-kV transformer	152.0	165.3
Midkiff 138/69-kV transformer	Spraberry 138/69-kV transformer	117.6	136.3
China Grove – Getty Tap 138-kV line	Vealmoor – Long Draw 345-kV line	105.4	116.4
General Tire Switch – Edwards Tap – Judkins 138-kV line	Permian Basin Five Units + Wolf – Moss/Odessa EHV 345-kV double-circuit line	112.3	110.0
Morgan Creek – McDonald 138-kV line	Base Case	119.6	109.0
Sterling City – Sterling County 69-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	< 100	108.4
Odessa EHV – Yarbrough Sub – Wolf 138-kV line	Permian Basin Five Units + Wolf – Moss/Odessa EHV 345-kV double-circuit line	115.8	107.7
Getty Tap – Big Spring 138-kV line	Vealmoor – Long Draw 345-kV line	< 100	106.7
Odessa North – Odessa 138-kV line	Permian Basin Five Units + Odessa EHV – Moss/Wolf 345-kV double-circuit line	108.0	106.5
Stanton East 138/69-kV transformer	Spraberry 138/69-kV transformer	100.1	106.2
Spraberry 138/69-kV transformer	Midkiff – Reagan Shell Tap 69-kV line	105.9	105.8
Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line	Odessa EHV – Moss/Wolf 345-kV double-circuit line	104.7	105.1

3.2.3. Reliability Needs in Upton, Reagan, and Irion Counties

The study results indicated that some of the existing 69-kV and 138-kV lines are no longer able to reliably serve the projected demand even under the N-0 contingency condition. Table 3.10 summarizes the thermal overloads in this area.

Table 3.10 Thermal Overloads in Upton, Reagan, and Irion Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Big Lake – Barnhart 69-kV line	Barnhart – Cassava 69-kV line	< 100	129.6
Rio Pecos – McCamey – Rankin4 69-kV line	Base Case	116.0	126.4
Cassava – San Angelo Mathis Field 69-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	105.4	120.9
Rio Pecos 138/69-kV transformer 1	Rio Pecos 138/69-kV transformer 2	100.4	110.4
Jerry – Big Lake 138-kV line	Odessa Combined Cycle Train 1 + Big Hill – Schneeman Draw 345-kV double-circuit line	< 100	106.3
Twin Buttes – Hargrove – Pumpjack – Jerry 138-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line (2025); Base Case (2030)	128.5	104.0

4. Project Evaluation

Multiple transmission projects were evaluated in this section to address the reliability violations identified in Section 3.

4.1. Transmission Upgrades Inside Delaware Basin Area

The transmission upgrades inside the Delaware Basin area are divided into the following three areas:

- Culberson, Loving, and Winkler Counties
- Reeves and Ward Counties
- Pecos County

4.1.1. Culberson, Loving, and Winkler Counties

The conversion of the TNMP Wink – California – Wickett 69-kV line to 138-kV was identified to address the overloads of the Wink - California Tnp 69-kV line and Wink Tnp 138/69-kV transformers in the 2030 study case under NERC P0 and P1 contingencies. More details of the reliability needs are available in Table 3.3.

The four new loads #4, #7, #15, and #66 (total of 233 MW in 2030) shown in Figure 4.1 need new connections to the existing transmission grid. ERCOT evaluated the following two options to interconnect these new loads into the system.

- Option A: Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Kyle Ranch Substation
- Option B: Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Quarry Field Substation, and connect new load #66 to Keystone Substation to form a 138-kV loop

Connecting the new load #4 to Kyle Ranch (~ 4 miles) in Option A has a shorter distance compared to connecting it to Quarry Field (~ 10 miles) in Option B. However, Option A is expected to result in negative impact on the loading of the Riverton 345/138-kV transformer 2. The loading on the existing Riverton 345/138-kV transformer 2 is expected to be close to its emergency rating under the critical G-1+N-1 contingency condition in Option A. Therefore, ERCOT recommends Option B, shown in Figure 4.1, as the preferred option to connect the new loads in Loving and Winkler Counties.

According to the June 2021 TPIT report, the existing Keystone 69-kV Substation conversion to 138-kV in Option B is scheduled to be in-service by summer 2022 as part of the Tier 4 project TPIT # 62728: Wink - Shifting Sands (i.e., Keystone) 69-kV line conversion to 138-kV.

In summary, the following two transmission upgrades were identified in Culberson, Loving, and Winkler Counties.

- Convert existing TNMP Wink – California – Wickett 69-kV line to 138-kV (identified in 2030 study case)
- Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Quarry Field Substation, and then connect new load #66 to Keystone Substation to form a 138-kV loop (identified in 2025 study case)

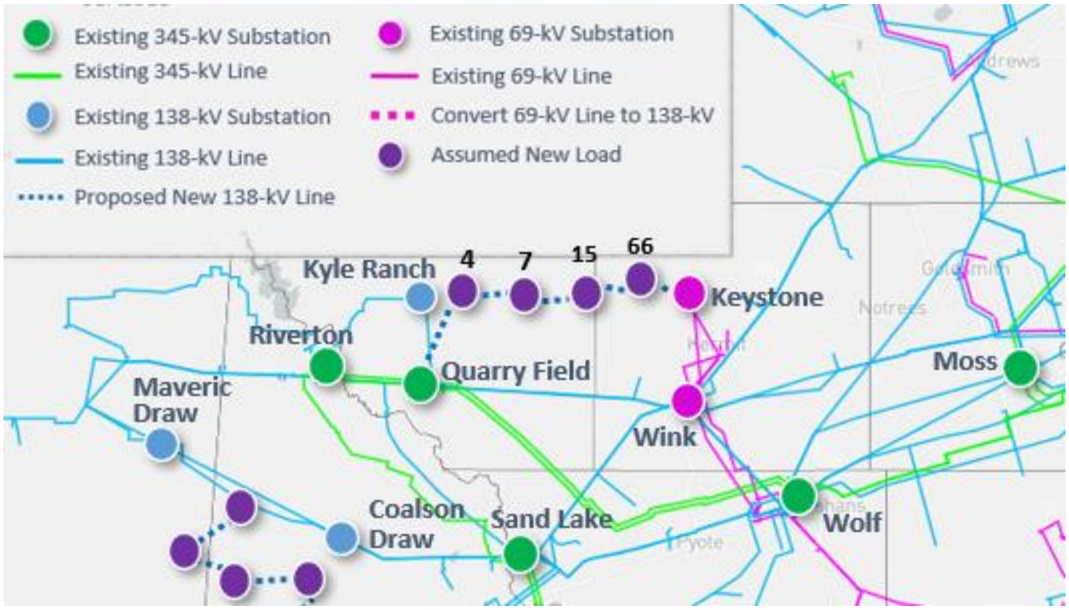

Figure 4.1 Loving and Winkler County Transmission Interconnection

4.1.2. Reeves and Ward Counties

Reeves County has the highest load projection in the study area, 1,430 MW in 2025 and 1,824 MW in 2030. Among these total load projections, 362 MW in 2025 and 566 MW in 2030 are related to new loads requiring new connections to the existing transmission grid. In addition to the new load connection projects, upgrades associated with existing transmission facilities were also identified to address the reliability needs in Reeves and Ward Counties listed in Section 3.1.2.

4.1.2.1 New Load Connection Projects

Figures 4.2 and 4.3 show the transmission interconnections to the new loads in 2025 and 2030. There are seven new loads in Reeves County which need connections to the existing transmission grid in 2030 as shown in Figure 4.3.

Below are the identified new 138-kV transmission lines to interconnect these new loads into the system in 2025:

- Tap a new 138-kV station on existing Coalson Draw – Maveric Draw 138-kV line, about 7.3 miles away from Coalson Draw
- Add new 138-kV lines to connect the new loads #5, #111, #23, and #12 to the new station on the Coalson Draw – Maveric Draw 138-kV line
- Add new 138-kV lines to connect the new loads #38 and #21 to Faulkner Substation

In 2030, the following additional new transmission lines are needed to form a 138-kV loop to reliably serve the projected load in this area:

- Add a new 138-kV line to connect the new load #108 to Verhalen Substation. This new load appears in 2030
- Add a new 138-kV line to connect the new loads #12 and #21 to form a 138-kV loop in 2030
- Add a new 138-kV line to connect the new load #108 to Faulkner to form a 138-kV loop in 2030

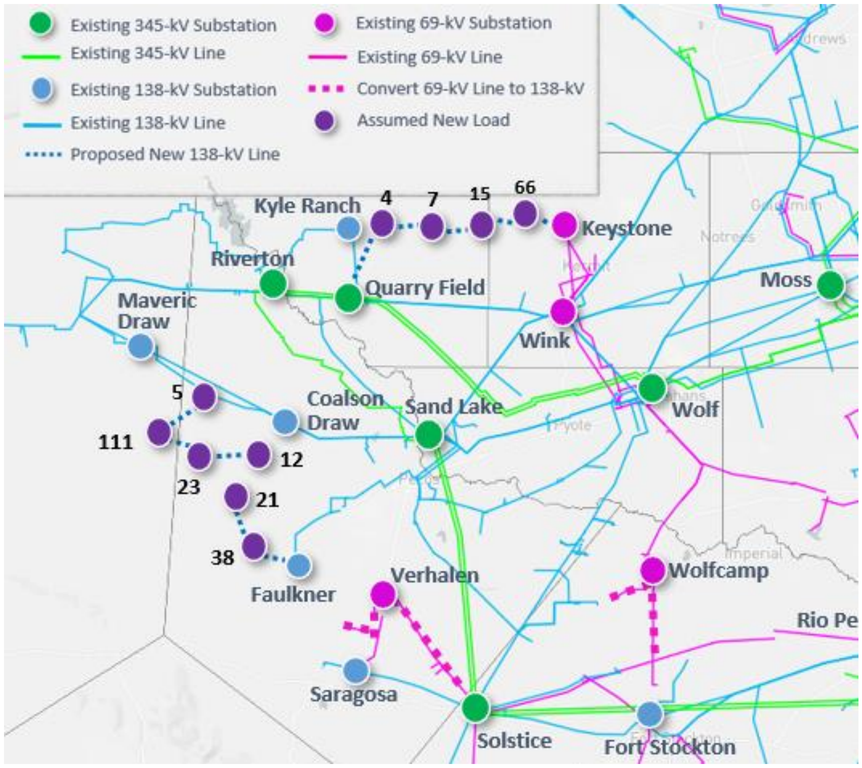

Figure 4.2 Reeves County Transmission Interconnection in 2025

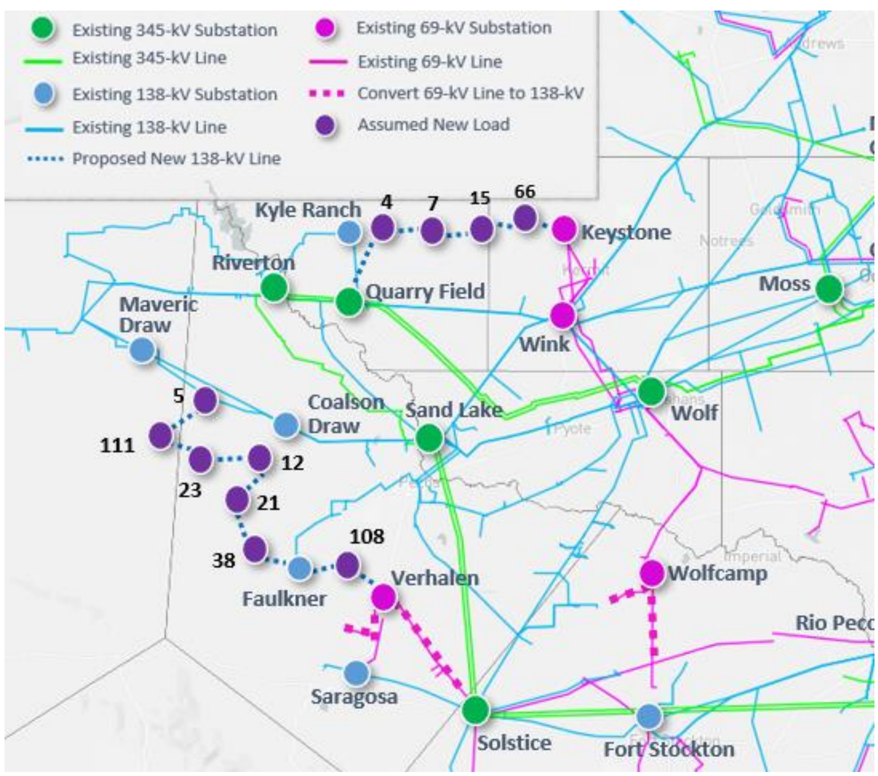

Figure 4.3 Reeves County Transmission Interconnection in 2030

4.1.2.2 Upgrades Associated with Existing Transmission Facilities

The conversion of the Barrilla Loop to 138-kV was identified to address the voltage instability issues in Reeves County.

As shown in Table 3.4 in Section 3, thermal overloads of the Sand Lake 345/138-kV transformers and Sand Lake – Cochise 138-kV double-circuit line were observed in the 2030 case under NERC P1 (N-1) contingencies. The overloads of the Sand Lake 345-kV transformers are substantially higher under the critical X-1+N-1 contingency conditions. This indicates that additional 345/138-kV transformation capacity is needed in this area to serve the projected load. ERCOT tested the following three options that involve looping the existing Solstice – Sand Lake 345-kV line into the 138-kV system with two new 345/138-kV transformers near the existing IH20 138-kV Substation to address the reliability needs.

- Option A: Loop Solstice – Sand Lake 345-kV double-circuit line at IH20 Substation
- Option B: Loop Solstice – Sand Lake 345-kV double-circuit line at Collie Field Substation
- Option C: Loop Solstice – Sand Lake 345-kV double-circuit line at Saddleback Substation

Option A resolves all the violations without any additional upgrades. Option A also has more 138-kV outlets compared to Option B and Option C.

Option B and Option C also resolve the violations but need additional upgrades. Option B needs to upgrade additional 2.95 miles of existing 138-kV line from Collie Field Tap to IH20. Option C needs to upgrade additional 4.88 miles of existing 138-kV line from Saddleback to IH20.

Based on the comparison, ERCOT recommends Option A as the preferred option to address the reliability need in the area.

Details of the identified transmission upgrades associated with the existing transmission facilities in Reeves and Ward Counties are described below:

- Convert existing Barrilla Loop to 138-kV: Barrilla – Hoefs Road – Verhalen – Cherry Creek – Saragosa 69-kV line to 138-kV (identified in 2025 study case)
- Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers and loop the existing Solstice – Sand Lake 345-kV double-circuit line into the new IH20 Substation (identified in 2030 study case)
- Terminal equipment upgrade associated with existing Caymus TNP - Gas Pad 138-kV line (identified in 2030 study case)

4.1.3. Pecos County

All the identified reliability issues in Pecos County are related to the thermal overloads of the existing 69-kV and 138-kV lines. The following transmission upgrades were identified in the 2025 study case to address the reliability needs in Table 3.5:

- Convert existing Yucca – Wolfcamp – Courtney Creek 69-kV line to 138-kV
- Upgrade existing Lynx – Tombstone – Fort Stockton138-kV line
- Upgrade existing Fort Stockton – Leon Creek 138-kV line
- Upgrade existing 16th Street – Fort Stockton TNP 69-kV line

4.2. Transmission Upgrades Outside Delaware Basin Area

The transmission upgrades outside of the Delaware Basin area are mainly in three areas:

- Dawson, Borden, and Scurry Counties

- Ector, Midland, Howard, and Mitchell Counties
- Upton, Reagan, and Irion Counties

4.2.1. Dawson, Borden, and Scurry Counties

As shown in Table 3.7, thermal overloads were observed in Dawson, Borden, and Scurry Counties, and the following transmission upgrades were identified to address the reliability needs:

- Upgrade existing Sacroc – Deep Creek Sub – Snydrs 138-kV line (identified in 2030 study case)
- Upgrade existing Scurry – Kndrsacrc – Knapp 138-kV line (identified in 2025 study case)
- Upgrade existing Knapp – Bluff Creek Switch – Willow Valley Switch 138-kV line (identified in 2030 study case)
- Upgrade existing Lamesa - Key Sub – Gail Sub – Willow Valley Switch 138-kV line (identified in 2025 study case)
- Upgrade existing Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line (identified in 2025 study case)

4.2.2. Ector, Midland, Howard, and Mitchell Counties

Majority of the thermal overloads, especially the 345-kV transmission level, were occurred in Ector, Midland, Howard, and Mitchell Counties. This section describes the details of the transmission upgrades identified to address the reliability needs in this area.

4.2.2.1 345-kV Transmission Upgrades

The following transmission upgrades were identified in 2025 study case and recommended by ERCOT.

- Upgrade #1: Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit
- Upgrade #2: Rebuild existing Morgan Creek – Falcon Seaboard – Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit
- Upgrade #3: Upgrade existing Morgan Creek – Longshore – Odessa EHV 345-kV double-circuit line
- Upgrade #4: Establish a new 345/138-kV substation at Consavvy with two new transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy; Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy
- Upgrade #5: Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer
- Upgrade #6: Establish a new 345/138-kV substation at Reiter (~ 3 miles south of Odessa EHV 345-kV Substation) with two new transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Establish a new 345-kV substation at Quail East (~ 2.5 miles east of Quail 345-kV Substation), and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV line into Quail East; Add a new Quail East - Reiter 345-kV double-circuit line (~ 2.5 miles)

Among the six upgrades, Upgrades #1, #2, #3, and #5 are the upgrades of existing transmission facilities to address some of the reliability needs identified in Table 3.8. Upgrades #4, #5, and #6 are related to adding new transmission facilities to address the remaining reliability needs in Table 3.8. Details of Upgrades #4 and #6 including option evaluations were discussed below.

Upgrade #4 is needed to serve the load in Midland County. As shown in Table 3.8, under certain P7 contingency related to the segment of the Morgan Creek – Longshore – Odessa EHV 345-kV double-circuit line, all the flow from the Morgan Creek to Odessa EHV path redirected to Consavvy resulted in the overload of the Consavvy 345/138-kV transformer. Several options were evaluated to address the reliability need, and the performance of each option was compared in Table 4.1.

Table 4.1 Options to Address Consavvy Transformer Overload

Option	Option Description	Percent Loading	
		2025	2030
Option 1	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy	102.7	89.3
Option 2	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	78.7	76.7
Option 3	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South and Longshore Fly – Quail 345-kV double-circuit line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	92.2	93.3

As shown in Table 4.1, Option 2 adds a new Consavvy 345-kV source to serve the load in Midland County while relieving the overload on the Consavvy transformer under X-1+N-1 contingency condition of one Consavvy 345/138-kV transformer and the related P7 contingency. Based on the study results, ERCOT recommends Option 2 as the preferred solution.

Odessa EHV 345/138-kV transformer 2 is overloaded in both 2025 and 2030 cases. According to the TSP, upgrading the existing Odessa EHV transformer or adding additional transformer at Odessa EHV are not feasible options due to the space constraints and based on TSP's practice. As such, four transmission upgrade options were evaluated to address this overload issue. The details of the options and performance were compared in Table 4.2.

Table 4.2 Options to Address Odessa EHV Transformer 2 Overload

Option	Option Description	Percent Loading	
		2025	2030
Option 1	Add a new Midessa South – Moss 345-kV single-circuit line (~20 miles)	96.1	98.1
Option 2	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Establish a new 345/138-kV substation at Quail East with two new 345/138-kV transformers, and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV double-circuit line into Quail East; Add a new Quail East – Reiter 345-kV double-circuit line (~2.5 miles)	64.8	64.7
Option 3	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter;	80.4	80.6

	Establish a new 345-kV substation at Quail East, and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV double-circuit line into Quail East; Add a new Quail East – Reiter 345-kV double-circuit line (~2.5 miles)		
Option 4	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Add a new Reiter – Midessa South 345-kV double-circuit line (~6 miles)	89.5	91.7

The study results showed that Options 2 and 3 performed better than Options 1 and 4. Option 3 is less costly than Option 2 since Option 3 does not require the new 138-kV Quail East Substation and two new 345/138-kV transformers. As such, ERCOT recommends Option 3 as the preferred upgrade.

4.2.2.2 138-kV and 69-kV Transmission Upgrades

Besides the 345-kV level upgrades, the following 138-kV and 69-kV transmission upgrades were identified to address the reliability needs in Table 3.9:

- Upgrade existing China Grove – Getty Tap 138-kV line (identified in 2025 study case)
- Upgrade existing Getty Tap – Big Spring 138-kV line (identified in 2020 study case)
- Upgrade existing Morgan Creek – McDonald 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line (identified in 2025 study case)
- Upgrade existing Sterling City – Sterling County 69-kV line (identified in 2030 study case)
- Convert existing Spraberry – Midkiff 69-kV line to 138-kV (identified in 2025 study case)
- Upgrade existing Salt Flat – Pronghorn – Consavvy 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Rexall – General Tire Switch – Edwards Tap – Judkins – Sandhills Tap – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Moss – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa North – Odessa 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Yarbrough Sub – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Holt – Scharbauer POI 138-kV line (identified in 2025 study case)

4.2.3. Upton, Reagan, and Irion County Projects

The following transmission upgrades were identified in the 2025 study case to address the reliability needs in Table 3.10.

- Upgrade existing Twin Buttes – Hargrove – Pumpjack – Big Lake 138-kV line
- Convert existing Rio Pecos – Big Lake 69-kV line to 138-kV
- Convert existing Big Lake – San Angelo Concho 69-kV line to 138-kV

Since the new loads in Upton, Reagan, and Irion Counties are relatively smaller and sparse compared to other loads in the Delaware Basin or Midland area, these transmission upgrades are considered as placeholders. Further review of these upgrades will be required if submitted for RPG review.

4.3. Stage 2 Upgrade

ERCOT completed the Delaware Basin Load Integration Study in December 2019 and identified a roadmap of preferred system upgrades to meet future demand growth in the Delaware Basin area and improve the capability to import power into the Delaware Basin area. The roadmap involves five stages of the long lead time 345-kV upgrades as shown in Table 2.5. Among the upgrades, the Stage 1 upgrade which adds a second circuit on the existing Big Hill – Bakersfield 345-kV line was endorsed by ERCOT in June 2021 and is expected to be implemented in 2023.

As described in Section 2.2.3, the load level associated with the Delaware Base area in the 2030 study case is expected to exceed the trigger point of the Stage 2 upgrade (i.e., a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line). Although ERCOT conducted the detailed analysis of the need for the Stage 2 upgrade in the Delaware Basin Load Integration Study, ERCOT performed additional analysis in this Permian Basin Load Interconnection Study to reconfirm the need for the Stage 2 upgrade. The additional analysis was performed using the 2030 study case without the Stage 2 upgrade, and the results showed voltage instability under multiple P7 contingencies (i.e., N-1 conditions).

As described in Sections 4, 5, and 6 of the Delaware Basin Load Integration Study, ERCOT evaluated a number of import path options as alternatives to the Stage 2 upgrade, including a new Faraday – Lamesa – Clearfork – Riverton 345-kV double-circuit line (i.e., the Stage 5 upgrade). Due to more mileages of new rights-of-way and higher project costs of those alternatives, ERCOT proposed the addition of a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line as the Stage 2 upgrade in the Delaware Basin Load Integration Study.

Based on the results of the Delaware Basin Load Integration Study and this Permian Basin Load Interconnection Study, ERCOT recommends the Stage 2 upgrade as a new transmission import path to the Delaware Basin area in the 2030 study case:

- Stage 2 upgrade: add a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line (~164 miles), with the minimum normal and emergency rating of at least 2564 MVA

5. Summary of the Transmission Upgrades

As discussed in Section 4, various transmission upgrades were developed to address the reliability criteria violations identified in the Permian Basin Load Interconnection Study. The long lead time transmission upgrades (e.g., RPG Tier 1 and Tier 2 projects) and the new load connections in the Delaware Basin area which form a 138-kV loop are considered as preferred projects. The remaining transmission upgrades are considered as placeholder projects and may require further review. The placeholder projects include the transmission upgrades that are expected to be potential RPG Tier 3 and Tier 4 projects as well as the transmission upgrades in Upton, Reagan, and Irion Counties which are at the border of the Permian Basin study area. Table 5.1 summarizes the transmission upgrades identified in this study. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion.

Table 5.1 Summary of the Identified Transmission Upgrades in 2025 and 2030

Reliability Upgrades	Unit	Project Consideration
New 345-kV Line	~ 295 miles	Preferred
Existing 345-kV Line Upgrade	~ 211 miles	Preferred
New 345-kV Substation	4	Preferred
New 345/138-kV Transformer	7	Preferred
New 138-kV Line	~ 128 miles	Preferred
Existing 138-kV Line Upgrade	~ 449 miles	Placeholder
69-kV line to 138-kV Conversion	~ 313 miles	Placeholder
Reactive Support Need	~ 400 MVAR	Placeholder

Table 5.2 lists the details of the preferred transmission upgrades identified in this study. Figures 5.1 and 5.2 show the maps of the preferred reliability upgrades identified in the 2025 and 2030 cases.

Table 5.2 List of the Preferred Transmission Upgrades

<table>
<tr><th>Project ID</th><th>Preferred Transmission Upgrades</th><th>Assumed Rate A/B (MVA) in Study Case</th><th>Year of Study Case with Reliability Need Starting to Appear</th><th>Approximate Cost Estimate ($M)</th></tr>
<tr><td>1</td><td>Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit</td><td>2988/2988</td><td>2025</td><td>100.58</td></tr>
<tr><td>2</td><td>Rebuild existing Midland East – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit</td><td>1792/1792</td><td>2025</td><td rowspan="3">196.47</td></tr>
<tr><td>2</td><td>Rebuild existing Morgan Creek – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit</td><td>1792/1792</td><td>2030</td></tr>
<tr><td>2</td><td>Rebuild existing Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit</td><td>1792/1792</td><td>2025</td></tr>
<tr><td>3</td><td>Upgrade existing Morgan Creek – Longshore 345-kV line</td><td>1792/1792</td><td>2030</td><td rowspan="3">393.88</td></tr>
<tr><td>3</td><td>Upgrade existing Morgan Creek – Longshore Fly 345-kV line</td><td>1792/1792</td><td>2025</td></tr>
<tr><td>3</td><td>Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers;
Loop existing Longshore – Midessa South 345-kV line into Consavvy and upgrade Longshore – Consavvy line;</td><td>1792/1792</td><td>2025</td></tr>
</table>

	Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy			
3	Upgrade Consavvy – Midessa South 345-kV line	1792/1792	2025	
3	Upgrade existing Longshore Fly – Quail 345-kV line	1792/1792	2025	
3	Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	1723/1723	2025	
3	Upgrade existing Midessa South – Odessa EHV 345-kV line	1792/1792	2025	
3	Upgrade existing Quail – Odessa EHV 345-kV line	1792/1792	2025	
3	Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer	600/600	2025	
18	Add Verhalen – New Load 90108 138-kV line	483/ 483	2025	6.60
24	Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers	700/750	2030	65.55
24	Loop existing Solstice – Sand Lake 345-kV double-circuit line at the new IH20 345-kV Substation	2988/2988	2030	
25	Establish a new 345/138-kV Reiter Substation with two new 345/138-kV transformers; Establish a new 345-kV Quail East Substation; Add a new Quail East – Reiter 345-kV double-circuit line	2988/2988	2025	104.65
31	Add Quarry Field – New Load 90004 138-kV line	614/614	2025	80.23
31	Add New Load 90004 – New Load 90007 – New Load 90015 – New Load 90066 – Keystone 138-kV line	614/614	2025	
31	Add capacitor bank (90 Mvar) at new load bus 90004		2025	
33	Add ONC90005_TAP – New Load 90005 138-kV line	617/617	2025	67.25
33	Add New Load 90005 – New Load 90111 – New Load 90023 – New Load 90012 138-kV line	614/614	2025	
33	Add capacitor bank (90 Mvar) at new load bus 90012		2025	
34	Add New Load 90012 – New Load 90021 138-kV line	617/617	2030	29.6
35	Add Faulkner – New Load 90038 – New Load 90021 138-kV line	617/617	2025	33.8
35	Add capacitor bank (90 Mvar) at new load bus 90021		2030	
36	Add Faulkner – New Load 90108 138-kV line	617/617	2030	17.55
42	Add Bearkat – North McCamey 345-kV double-circuit line	2564/2564	2030	392.41
42	Add North McCamey – Sand Lake 345-kV double-circuit line	2564/2564	2030	

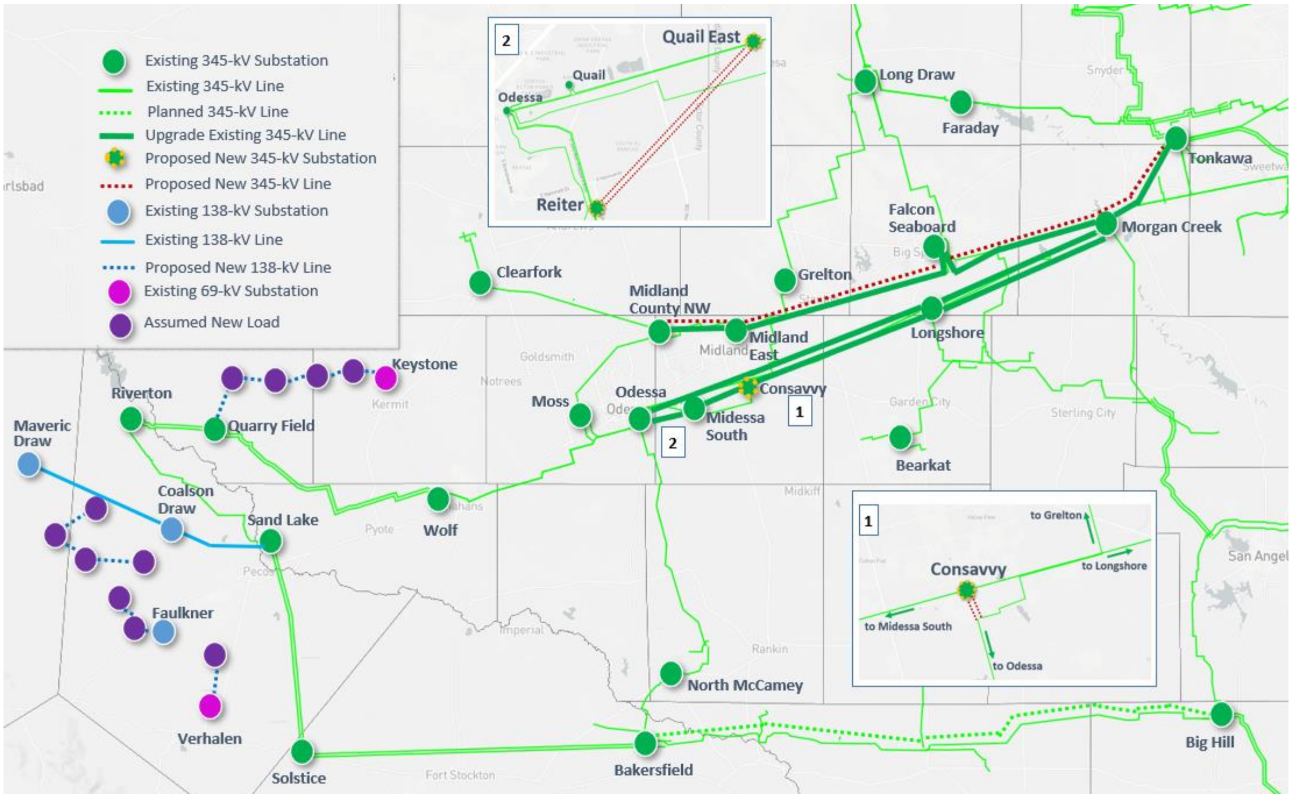

Figure 5.1 Preferred Reliability Upgrades for 2025

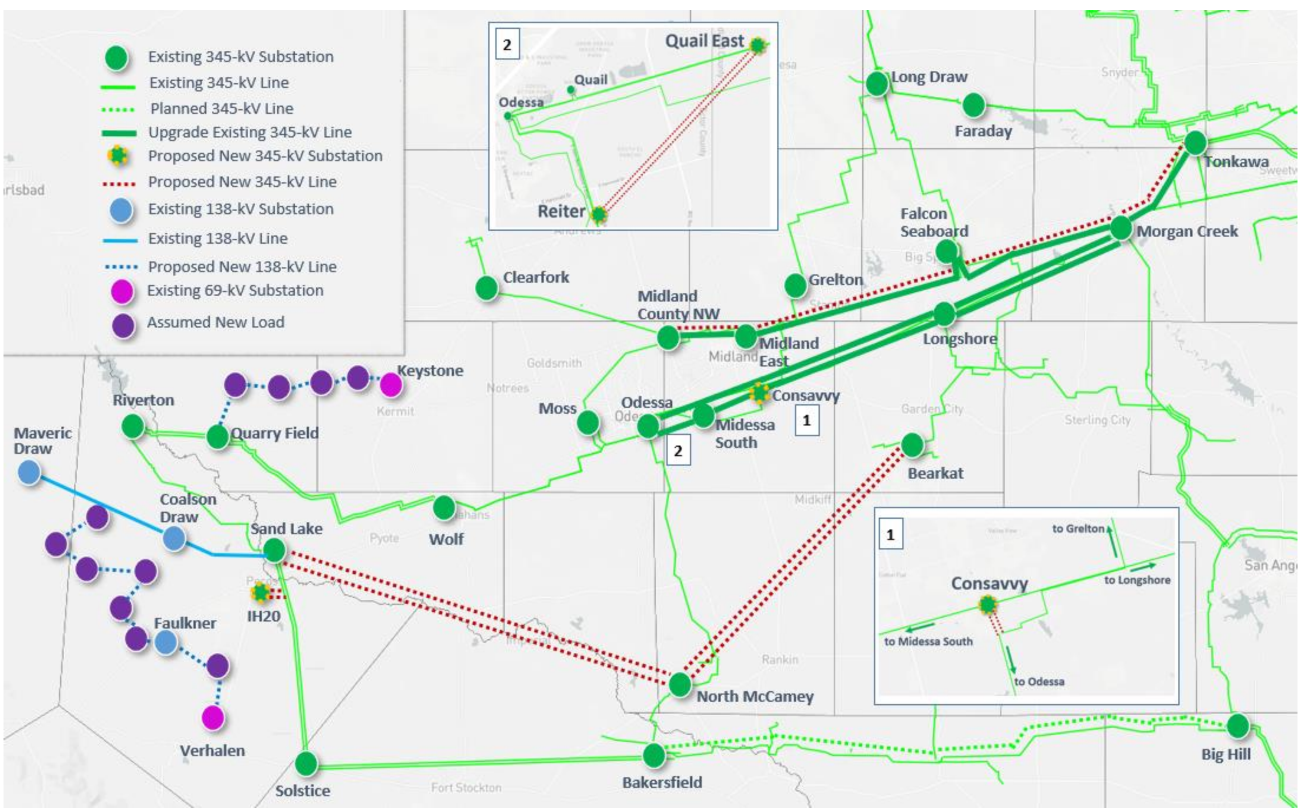

Figure 5.2 Preferred Reliability Upgrades for 2030

Table 5.3 lists the placeholder transmission upgrades identified in this study.

Table 5.3 List of the Placeholder Transmission Upgrades

Project ID	Placeholder Transmission Upgrades	Year of Study Case with Reliability Need Starting to Appear	Approximate Cost Estimate ($M)
4	Upgrade existing Sacroc – Deep Creek Sub – Snydrs 138-kV line	2030	24.23
5	Upgrade existing Scurry – Kndrsacrc – Knapp 138-kV line	2025	19.44
6	Upgrade existing Knapp – Bluff Creek Switch 138-kV line	2030	46.02
6	Upgrade existing Bluff Creek Switch – Willow Valley Switch 138-kV line	2030	
7	Upgrade exisitng Lamesa – Key Sub – Gail Sub – Willow Valley Switch 138-kV line	2025	45.09
8	Upgrade existing Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line	2025	28.98
9	Upgrade existing China Grove – Getty Tap 138-kV line	2025	56.86
10	Upgrade existing Getty Tap – Big Spring 138-kV line	2030	20.63
11	Upgrade existing Morgan Creek – McDonald 138-kV line	2025	46.66
12	Upgrade existing Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line	2025	21.16
13	Upgrade existing Lynx – Tombstone – Fort Stockton 138-kV line	2025	38.60
14	Upgrade existing Fort Stockton – Leon Creek 138-kV line	2025	3.58
15	Upgrade existing Twin Buttes – Hargrove – Pumpjack – Big Lake 138-kV line	2025	65.05
16	Upgrade existing Sterling City – Sterling County 69-kV line	2030	2.48
17	Upgrade existing 16th Street – Fort Stockton TNP 69-kV line	2025	0.75
18	Convert existing Barrilla Loop 69-kV line to 138-kV	2025	46.81
18	Add Verhalen – New Load 90008 138-kV line	2025	
18	Add Hoefs Road – New Load 90026 138-kV line	2025	
18	Add capacitor bank (90 Mvar) at new load bus 90008	2025	
19	Convert existing Yucca – Wolfcamp – Courtney Creek 69-kV line to 138-kV	2025	75.50
20	Convert existing Big Lake – San Angelo Concho 69-kV line to 138-kV	2025	61.24
21	Convert existing Rio Pecos – Big Lake 69-kV line to 138-kV	2025	114.00
22	Convert existing Spraberry – Midkiff 69-kV line to 138-kV	2025	6.84
23	Convert existing TNMP Wink – California – Wickett 69-kV to 138-kV	2030	14.46
26	Upgrade existing Odessa EHV – Rexall – General Tire Switch – Edwards Tap – Judkins – Sandhills Tap – Wolf 138-kV line	2025	62.74
27	Upgrade existing Moss – Wolf 138-kV line	2025	39.30
28	Upgrade existing Odessa North – Odessa 138-kV line	2025	15.76

29	Upgrade existing Odessa EHV – Yarbrough Sub – Wolf 138-kV line	2025	63.11
30	Upgrade existing Holt – Scharbauer POI 138-kV line	2025	10.46
32	Add Kyle Ranch – New Load 90001 – New Load 90006 138-kV line	2025	3.97
35	Add New Load 90021 - New Load 90032 138-kV line	2025	17.0
37	Add ONC90002_TAP – New Load 90002 138-kV line	2025	18.37
37	Add capacitor bank (24 Mvar) at new load bus 90002	2030	
38	Add Three Mile Draw Switch – New Load 90106 138-kV line	2030	13.54
39	Add ONC90009_TAP – New Load 90009 138-kV line	2025	14.53
41	Increase the capacitor bank at bus 1323 to 18.4 Mvar from 9.2 Mvar	2030	0.50
44	Upgrade existing Salt Flat – Pronghorn – Consavvy 138-kV line	2025	15.70
45	Terminal equipment upgrade for existing Caymus TNP – Gas Pad 138-kV line	2030	0.50

6. Conclusion

The purpose of this Permian Basin Load Interconnection Study was to identify transmission upgrades that are necessary to connect projected oil and gas loads in the Permian Basin area.

This study identified a list of the transmission upgrades, including both the preferred and placeholder projects, required by 2025 and 2030 to address the identified reliability criteria violations in the study area.

The preferred projects may be endorsed by ERCOT based on the results of this Permian Basin Load Interconnection Study if they are submitted for RPG review. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion. The placeholder projects are expected to require further analysis if submitted for RPG review.

7. Appendix

Maps of All Transmission Upgrades	Maps of All Transmission Upgra