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PROJECT NO. 55718

RELIABILITY PLAN FOR THE PERMIAN BASIN UNDER PURA § 39.167	**§ § §**	**BEFORE THE PUBLIC UTILITY COMMISSION OF TEXAS**

ONCOR ELECTRIC DELIVERY COMPANY LLC'S SUPPLEMENTAL INFORMATION ON THE COMPARATIVE BENEFITS OF 765 kV

Oncor Electric Delivery Company LLC ("Oncor") respectfully submits the attached report from EEPlus Inc. on the load-serving capabilities of the 765 kilovolt ("kV") and 345 kV alternatives identified in the Permian Basin Reliability Study. At the Public Utility Commission of Texas's ("Commission's") April 3, 2025, open meeting, Commissioner Jackson requested additional information on the comparative benefits of the 765 kV and 345 kV alternatives. Oncor previously filed a response to questions from Commission Staff explaining that the maximum load-serving capabilities of the 765 kV and 345 kV alternatives have not been adequately addressed.[1] Oncor explained that it had retained EEPlus to perform a comparative analysis of the incremental load-serving capabilities of those alternatives, and that initial modeling showed that the 765 kV solution provides 4.4 gigawatts ("GW") of incremental load-serving capability—over 2 GW more than the 345 kV solution.

To further support the Commission's deliberation, Oncor now provides the full report from EEPlus, which confirms the initial modeling results. This report concludes that, "from a load-serving standpoint, 765 kV is a clear superior voltage solution for the long-term service of the Permian Basin." More specifically, the analysis of load levels above the ERCOT Study demonstrates that: (1) the 765 kV alternative provides nearly double the incremental load-serving capability of the 345 kV solution; (2) the 345 kV alternative experiences a high volume of contingency events as it approaches its maximum load-serving capacity, indicating its comparatively "short[er] shelf life"; (3) the load-serving capacity of the 765 kV alternative can be further and more easily increased with future upgrades to the 765 kV system; and (4) at the incremental load levels analyzed by EEPlus, the 345 kV alternative will require significantly more upgrades to reliably serve the Permian Basin.

[1] Docket No. 55718, Oncor's Response to Commission Staff's Questions on EHV Determination at 6-7 (Feb. 14, 2025).

EEPlus's report is included as Attachment 1 hereto. Oncor representatives will be in attendance at the Commission's April 24, 2025, open meeting to answer any questions the Commission may have on the report, its conclusions, and the comparative benefits of the 765 kV alternative.

Respectfully submitted,

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Load Serving Capabilities of the Permian Basin 765-kV and 345-kV Transmission Plans – A Technical Memo

4/17/2025

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1. Executive Summary

Oncor retained EEPlus to study and compare the incremental load serving capability of the 345-kV and the 765-kV Transmission Plans presented by ERCOT in Docket No. 55718. In other words, which transmission plan, 765-kV or 345-kV, is a superior solution from a load-serving standpoint. The assessment was to evaluate differentiators in performance between the 345-kV and 765-kV Transmission Plans if the system load was extended beyond the levels evaluated by ERCOT. Essentially, the analysis was to load the two transmission plans up to their "breaking point" to determine the maximum load-serving capability of the plan. This analysis is instructive to assess the long-term viability of the transmission plans under consideration. EEPlus performed a steady state assessment to determine the incremental Permian Basin region load serving capability afforded by the 345-kV and 765-kV Transmission Plans to evaluate the long-term performance of the two plans.

Based on the analysis documented in this memorandum, the 765-kV Transmission Plan exhibits approximately **double (1.91 times)**, the incremental load serving capability of the 345-kV Transmission Plan. Further, as the 345-kV Transmission Plan reaches its maximum load serving capacity, it experiences a substantial volume of planning contingency events which could lead to the breaking point. The sheer volume of the planning contingency events resulting in the 345-kV Transmission Plan reaching its "breaking point" following the addition of incremental load in the Permian Basin region is indicative of the short shelf life of the 345-kV Transmission Plan in terms of load serving capability beyond typical planning horizons.

Apart from the nearly double incremental load serving capability afforded by the 765-kV Transmission Plan, the results demonstrate that even when the 765-kV Transmission Plan reaches its maximum load serving capability, only a small number of planning contingencies are observed to be limiting the plan. This result demonstrates that upgrades to the 765-kV system could unlock additional load serving capacity and is indicative of the long-term benefits of this solution.

Finally, the study results also identified the need for additional upgrades not included in ERCOT's studies to address thermal overloads associated with the incremental load levels evaluated in

this assessment. The 345-kV Transmission Plan required significantly more upgrades to address the thermal issues identified at the higher load levels studied. This is a further indicator of the fact that the 345-kV Transmission Plan is inherently limited in terms of its ability to be a long-term viable solution for the needs of the Permian Basin.

Finally, it is important to note that the results and observations presented in this memorandum are purely based on the steady state assessment. No transient stability and/or dynamic assessment of the two Transmission Plans has been performed as part of this assessment. While the assessment of the dynamic performance of the selected option maybe needed to further fine tune the efficacy of the option, the steady state assessment is appropriate in terms of performing a comparative assessment of the two Transmission Plans, especially from a long-term load serving capability standpoint.

2. Introduction/Background

The Public Utility Commission of Texas (PUCT) unanimously approved a transmission plan to meet the future electricity and reliability needs of the Permian Basin region of Texas on September 26, 2024.[1] PUCT's approval of the Permian Basin Reliability Plan was the culmination of one of the initiatives of House Bill (HB) 5066 enacted by the Texas Legislature, which amongst other things, required the PUCT to direct ERCOT to develop a reliability plan for the Permian Basin region. On December 14th, 2023, the PUCT issued an order in Project No. 55718[2] directing ERCOT to develop a reliability plan for the Permian Basin region with ERCOT being required to submit the plan to the PUCT no later than July 2024. Accordingly, ERCOT submitted their final report associated with the Permian Basin Reliability Plan to the PUCT on July 25, 2024. The report identifies local transmission upgrades of the existing transmission infrastructure deemed necessary to serve the Permian Basin load growth for 2030 and 2038. Second, the report also lays out the additional transmission import paths needed to serve the Permian Basin forecasted load levels in 2030 and 2038. While the import paths associated with the 2030 analysis are limited to 345-kV, the plan includes three (3) import path options for 2038, at 345-kV, 500-kV and 765-kV, to strengthen the region's current and future transmission infrastructure and serve the growing electric demand in the Permian Basin and other surrounding loads in West Texas reliably. The combination of the local transmission upgrades and the import paths are collectively referred to as the "Transmission Plans" going forward in this memorandum.

As directed by HB 5066, ERCOT included the following loads in coming up with the Permian Basin load levels for 2030 and 2038 respectively:

- Load levels forecasted in the 2022 S&P Global Electrifying the Permian Basin study[3];

[1] Public Utility Commission of Texas Approves Reliability Plan for the Permian Basin Region. September 26, 2024. https://ftp.puc.texas.gov/public/puct-info/agency/resources/pubs/news/2024/PUCT_Approves_Reliability_Plan_for_the_Permian_Basin_Region.pdf
[2] ERCOT Letter to the PUCT. January 24, 2025, chrome-https://interchange.puc.texas.gov/Documents/55718_54_1462478.PDF
[3] Electrifying the Permian Basin - Prepared for ERCOT planning committee. S&P Global. March 22, 2023. chrome-https://www.ercot.com/files/docs/2023/03/17/Presentation%20to%20ERCOT%20planning.pdf

- Load currently served by temporary on-site generation not already accounted for in the S&P Global Permian Basin load forecast; and
- Additional load currently seeking interconnection, not included in the two items above, as determined by the electric utility responsible for serving this load and should expressly include demand yet to sign a full interconnection agreement.

Based on the above criteria, ERCOT identified Permian Basin load levels of 23.659 GW in 2030 and 26.4 GW in 2038 for the Permian Basin Reliability Plan study.[4] The load breakdown, by County, for the ERCOT Permian Basin 2038 Study Case ("2038 Study Model") is depicted in Figure 1.

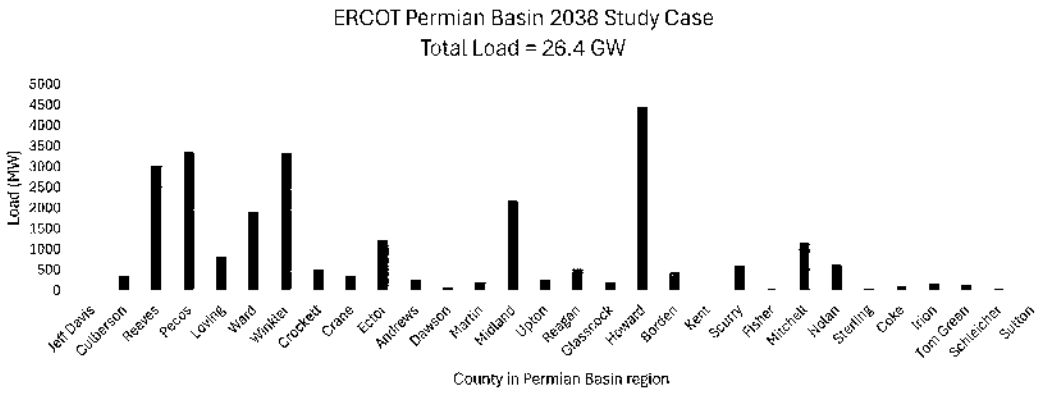

Figure 1. County-wise Load Breakdown, 2038, Permian Basin Reliability Plan Study

Based on the reliability plan study filed with the PUCT, ERCOT developed three Transmission Plans for additional import paths into the Permian Basin for the year 2038, details of which are summarized in Table 1 below. It is important to note that the import paths outlined below were in addition to the local upgrades identified by ERCOT across 2030 and 2038 which were observed to be more or less consistent across the three import path options considered by ERCOT.

[4] ERCOT Reliability Plan for the Permian Basin Region. June 25, 2024.
https://www.ercot.com/files/docs/2024/06/28/Reliability-Plan-For-The-Permian-Basin-Region.pdf

	345-kV Transmission Plan	500-kV Transmission Plan	765-kV Transmission Plan
Number of Paths	5	4	3
New ROW Required	1,676 miles	1,370 miles	1,255 miles
Total Cost	$12.98 Bil	$15.32 Bil	$13.77 Bil

Table 1. Comparison of 345-kV, 500-kV, and 765-kV Transmission Plans in 2038, ERCOT Permian Basin Reliability Plan Study

The ERCOT Permian Basin Reliability Plan study report also compared the performance of the three (3) Transmission Plans across various factors including (but not limited to) meeting ERCOT/NERC reliability criteria while serving the forecasted load, incremental transfer capacity, transmission system losses, operational flexibility, new ROW considerations, number of import paths needed, and cost associated with the paths.

ERCOT determined the 500-kV Transmission Plan was more expensive than the 765-kV Transmission Plan while the incremental transfer capability of the 765-kV plan was higher than all options.[5] As a result, the PUCT directed Transmission Service Providers (TSPs) to prepare CCN applications for five 345-kV import paths and three 765-kV import paths.

Figures 2 and 3 depict the import paths associated with 345-kV and 765-kV Transmission Plans, as recommended by ERCOT in their reliability plan study report respectively.

[5] ERCOT Reliability Plan for the Permian Basin Region. July 25, 2024.
https://www.ercot.com/files/docs/2024/06/28/Reliability-Plan-For-The-Permian-Basin-Region.pdf

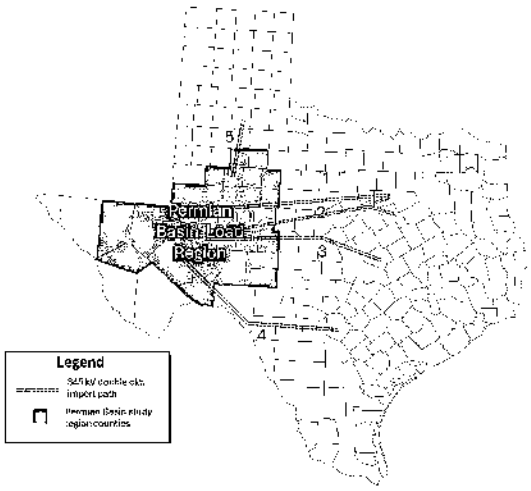

Figure 2. Import Paths, 345-kV Transmission Plan

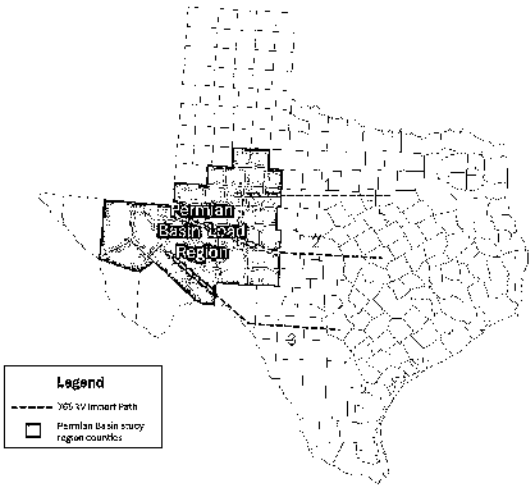

Figure 3. Import Paths, 765-kV Transmission Plan

As part of its on-going engagement with EEPlus to assist with strategic transmission planning efforts, Oncor requested EEPlus to study and compare the incremental load serving capability, above the 26.4 GW in the ERCOT 2038 model, between the 345-kV and the 765-kV Transmission Plans presented by ERCOT to the PUCT in Docket 55718. In other words, what is the maximum load that each Transmission Plan can serve prior to reaching their "breaking point".

EEPlus performed a steady state assessment to assess the incremental Permian Basin region load serving capability afforded by the 345-kV and 765-kV Transmission Plans to further inform Oncor about the long-term performance of the two plans. Details associated with the modeling assumptions, study methodology, results and key inferences drawn from the assessment have been summarized in ensuing sections of this technical memorandum.

3. Study Assumptions & Methodology

a. Transmission Model

Since the focus of the assessment was a comparison between the 345-kV and 765-kV Transmission Plans, EEPlus utilized the ERCOT Permian Basin Reliability Plan study 2038 model ("2038 Study Model") as the starting point to perform power flow studies on incremental load additions in the Permian Basin region. Two versions of the 2038 Study Model, one each for the 345-kV and 765-kV Transmission Plans as posted by ERCOT, were utilized. No other transmission system topology changes were made to these models for the purposes of this assessment. Details associated with the specific transmission models utilized have been provided in Appendix A.

b. Generation & Load Additions

Approximately 3 GWs of new firm "flat-loads" (i.e. loads with high load factor) that were included in the latest ERCOT Steady State Work Group (SSWG) Future Year (FY) 2031 model were added to the 2038 Study Model to evaluate the performance of the 345-kV and the 765-kV Transmission Plans under higher load levels in the Permian Basin region. Additionally, the non-flat load in Permian Basin region was also scaled proportionately as part of the load deliverability assessment. Figure 4 depicts the counties that comprise the Permian Basin study region within which the load additions and scaling was performed as part of the assessment.

In order to maintain the load generation balance in the wake of new load additions, new generation resources meeting Section 6.9 requirements of the ERCOT Planning Guide including solar, wind and conventional generation units, that are far/remote to the study region (i.e. North Central, Southern and Coastal regions), were incrementally modeled and dispatched consistent with the 2038 Study Model. The latest ERCOT Generation Interconnection Status (GIS) report

available at the time of the assessment (January 2025), was utilized to identify the incremental generation resource additions meeting Section 6.9 requirements of the ERCOT Planning Guide.[6]

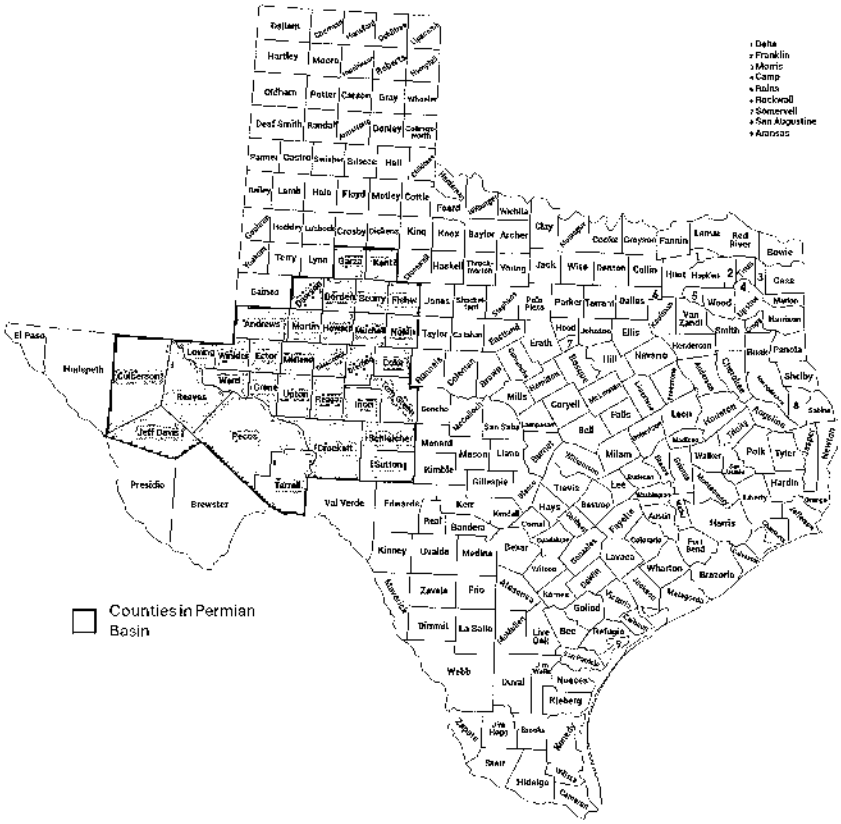

Figure 4. Study region considered for scaling the loads to determine the incremental load serving capability

c. Study Conditions & Scenarios

Consistent with the ERCOT methodology employed for the incremental transfer capacity analysis for the import path options, power flow contingency analysis was performed for North American Electric Reliability (NERC) Category P1, P2.1 and P7[7] events based on the contingency events

[6] ERCOT Generator Interconnection Status (GIS) Report..GIS_Report_January2025. https://www.ercot.com/misdownload/servlets/mirDownload?doclookupId=1074695716

[7] As defined in Table 1 of NERC's TPL-001-5 Transmission System Planning Performance Requirements. https://www.nerc.com/pa/Stand/Reliability%20Standards/TPL-001-5.pdf

posted by ERCOT (refer Appendix A). All ERCOT 345-kV and 765-kV systems were considered for monitoring purposes (i.e. lower voltage systems' impacts were not the focus of the assessment with the exception of low voltage issues leading to a "breaking point" as explained later in the memorandum). Three (3) study scenarios were studied by increasing Permian Basin loads, namely:

- Study Scenario 1 with 2.3 GW of additional load added in the Permian Basin region.
- Study Scenario 2 with 3.9 GW of additional load added in the Permian Basin region.
- Study Scenario 3 with 4.8 GW of additional load added in the Permian Basin region.

Based on discussions with Oncor and the long-term nature of the assessment, the focus of the analysis was to identify the "breaking point" in terms of incremental load that can be served for the 345-kV and the 765-kV Transmission Plans. The breaking point, for the purposes of this assessment, is determined when the load addition causes an electric "system voltage collapse" (i.e., the point when the system loses its ability to maintain acceptable voltages due to increased load during simulated disturbances) or a "non-convergence" – meaning that the power flow program cannot determine the voltage magnitudes and phase angles at each bus in the power system, nor the power flows on each line, to within an acceptable tolerance. This report will hereon refer to two these conditions as "collapse and/or non-convergence." Low voltage and/or non-convergence results from power flow simulations are often a sign that the limits of the system's load serving capability are being reached. Finally, a "thermal overload" means that the power flow on a transmission element exceeds its designed facility rating (Continuous Rating under normal operating conditions and the 2-Hr Emergency Rating under contingency conditions). However, thermal overloads can often be addressed by upgrading line/terminal equipment, reconductoring, adding transformers, or by other means that do not necessarily involve a new 345-kV or 765-kV path. Consequently, thermal overloads are flagged but are not deemed to limit the load serving capability conclusions.

4. Results Summary

Tables 2(a) and 2(b) provide a comparative analysis of the performance of the 345-kV and 765-kV Transmission Plans across the three (3) study scenarios evaluated for the Permian Basin load serving capability assessment.

The results presented in Tables 2(a) and 2(b) include a performance comparison across the three study scenarios in terms of the following Key Performance Indicators (KPIs):

- Breaking Point (Voltage Collapse/Non-Convergence) observed at studied Permian Basin load level
- Steady state voltage security of the system
- Thermal violations or overloads observed at studied Permian Basin load level

As evident from the results presented in Table 2(b), even with the initial 2.3 GW of incremental load additions in the Permian Basin (Study Scenario 1), the first signs of limitations of the 345-kV Transmission Plan start to reveal themselves in the form of voltage violations. This limitation is further underscored in Study Scenario 2 where the 345-kV Transmission Plan option essentially reaches its breaking point with over 65 planning contingency events resulting in either voltage collapse or non-convergence as shown in Table 2(a). Based on the analysis performed and the study assumptions, the incremental load serving capability of the 345-kV Transmission Plan option is limited to around 2.3 GW.

On the contrary, the 765-kV Transmission Plan performs significantly better in terms of the "breaking point" KPI. The first instances of non-convergence and/or voltage collapse for the 765-kV import path option are observed in Study Scenario 3 with the incremental load additions at 4.8 GW. The incremental load addition in the Permian Basin region was reduced to 4.4 GW to eliminate any such "breaking points" for the 765-kV import path option, thus pegging the incremental load serving capability of the 765-kV option at almost double, 1.91 times, that of its 345-kV counterpart.

Additionally, the 765-kV Transmission Plan option is observed to perform better in terms of the other KPIs (steady state voltage security and thermal overloads) across all the three study scenarios as shown on Table 2(b).

Figures 5 and 6 depict the incremental load growth that could be accommodated by the 345-kV and 765-kV Transmission Plans, by study counties.

It is important to note that the results' summary presented in Tables 2(a) and 2(b) are purely based on the set of P1, P2.1 and P7 events simulated and is limited to steady state assessment. No transient stability and/or dynamic assessment of the two Transmission Plans has been performed as part of this assessment. Moreover, additional fine tuning of the power flow models may be needed for a more precise load serving capability study including the monitoring of lower voltage systems that may require voltage support devices to support increased loads. Finally, additional loads may have been approved to connect in the Permian Basin since the publication of the October 2024 SSWG models used in this study, that may impact the results documented herein.

Study Scenario	Incremental Permian Basin Load Addition (GW)	Total Permian Basin Load (GW)	Contingency Events Resulting in Voltage Collapse or Non-Convergence	
			765-kV Import Path	345-kV Import Path
1	2.3	28.7	None	None
2	3.9	30.3	None	Yes *(65 events)*
3	4.8	31.2	Yes *(12 events. Incremental PB load limited to **4.4 GW** to avoid any "breaking points")*	Yes *(Over 100 events)*

Table 2(a). Performance comparison of the ERCOT 345-kV and 765-kV Transmission Plan – Voltage Collapse/Non-Convergence

Study Scenario	Incremental Permian Basin Load Addition (GW)	Total Permian Basin Load (GW)	Low Voltage Concerns (below 0.85 per unit)		Thermal Overloads	
			765-kV Import Path	345-kV Import Path	765-kV Import Path	345-kV Import Path
1	2.3	28.7	None	Yes *(Incremental PB load limited to **2.3 GW** to avoid any voltage concerns)*	Yes	Yes *(High number of thermal violations)*
2	3.9	30.3	None	Yes *(Low voltage violations for almost 36 outages)*	Yes	Yes *(High number of thermal violations)*
3	4.8	31.2	None *(Incremental PB load limited to **4.4 GW** to avoid any voltage concerns)*	Yes *(Significant number of low voltage issues)*	Yes	Yes *(High number of thermal violations)*

Table 2(b). Performance comparison of the ERCOT 345-kV and 765-kV Transmission Plan – Voltage Violations and Thermal Overloads

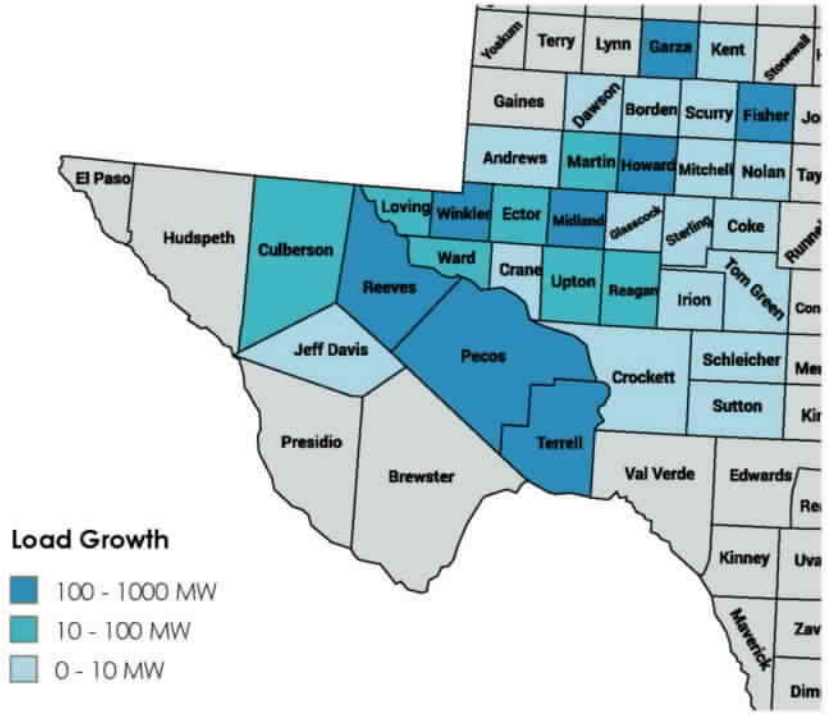

Figure 5. Incremental load growth by Permian Basin County, 345-kV transmission plan

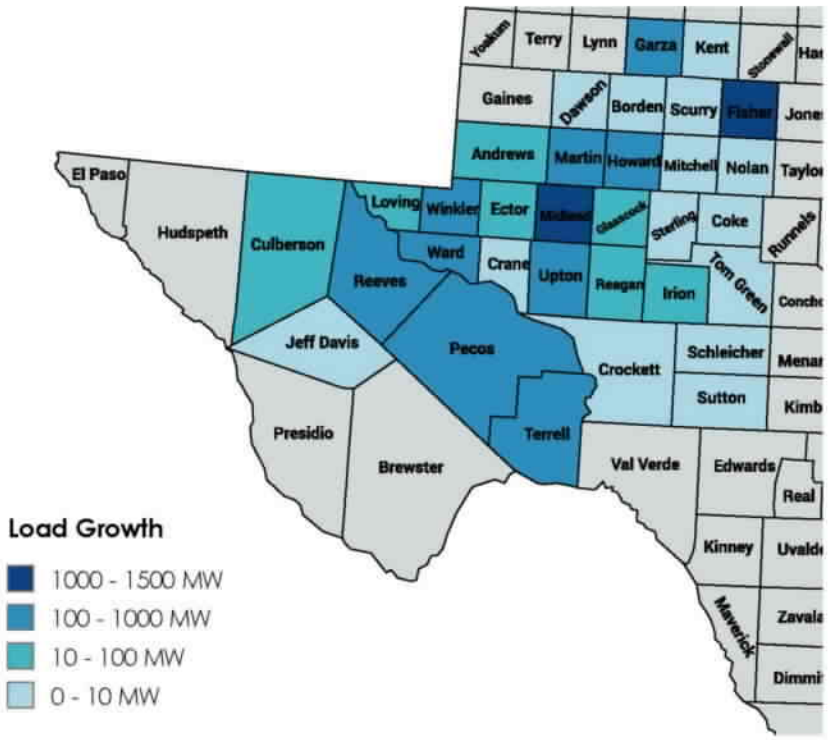

Figure 6. Incremental load growth by Permian Basin County, 765-kV transmission plan

5. Key Observations

Based on the above analysis and results, with the system convergence and voltage security performance criteria, the 765-kV Transmission Plan exhibits the ability of serving an incremental 4.4 GW of additional load while the 345-kV Transmission Plan is limited to around 2.3 GW of incremental load serving capability in the Permian Basin. Thus, from a load serving standpoint, 765-kV is a clear superior voltage solution for the long-term service of the Permian Basin.

Based on the analysis above and summarized in Tables 2(a) and 2(b), the 765-kV Transmission Plan exhibits approximately double, 1.91 times, the incremental load serving capability in comparison to the 345-kV Transmission Plan. More importantly, the sheer volume of the contingency events resulting in the 345-kV Transmission Plan reaching its "breaking point" following the addition of 3.9 GW of incremental load in the Permian Basin region is indicative of the short shelf life of the 345-kV Transmission Plan in terms of load serving capability beyond typical planning horizons. On the other hand, apart from the nearly double incremental load serving capability afforded by the 765-kV Transmission Plan, the results of the analysis are indicative of the 765-kV Transmission Plan having the capability to support a much longer cycle of load growth in the region, obviously with some subsequent enhancements of the system.

Finally, the study results also identified the need for additional upgrades not included in ERCOT's studies to address thermal overloads associated with these incremental load levels, but the 345-kV Transmission Plan identified the need for significantly more upgrades to address these thermal issues. This is a further indicator of the fact that the 345-kV Transmission Plan is inherently limited in terms of its ability to be a long-term viable solution for the needs of the Permian Basin.

6. Appendix A

ERCOT steady state cases/models and .con files utilized for the study:

1. "2038_345-kV Import Paths Case Addendum ImportPath4.raw" case from "Permian_Basin_Reliability_Plan_Study_Final_Cases_and_Contingencies_Addendum_ECEII.zip"[8] has been utilized for the 2038 345kV transmission system study case modeling to begin with.
2. "2038_EHV_765-kV Import Paths Case.raw" case from "Permian_Basin_Reliability_Plan_Study_Final_Cases_and_Contingencies_ECEII.zip" has been utilized for the 2038 765kV transmission system study case modeling to begin with.
3. "24SSWG_2031_SUM1_U1_Final_10142024.raw" case from the "24SSWG_U1_Cases_and_Logs_Final_10142024_ECEII.zip" ERCOT SSWG database has been utilized to refer the newly added flat-loads in the Permian Basin region.
4. "P1P2-1P7 Contingencies in WFW - 2038 345-kV Import Paths Addendum.con" contingency file from "Permian_Basin_Reliability_Plan_Study_Final_Cases_and_Contingencies_Addendum_ECEII.zip" utilized for the contingency events simulated on the 2038 345kV transmission system study case.
5. "P1P2-1P7 Contingencies in WFW - 2038 765-kV Import Paths.con" contingency file from "Permian_Basin_Reliability_Plan_Study_Final_Cases_and_Contingencies_ECEII.zip" utilized for the contingency events simulated on the 2038 765kV transmission system study case.

[8] Regional Planning Postings on ERCOT MIS website – Permian Basin Reliability Plan Study. https://mis.ercot.com/secure/data-products/grid/regional-planning?id=pg3-4098-m

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