2022 Regional Transmission Plan

Executive Summary

The 2022 Regional Transmission Plan (RTP) is the result of a coordinated planning process performed by ERCOT System Planning with extensive review and input by NERC-registered Transmission Planners (TPs), Transmission Owners (TOs), and other stakeholders. The RTP addresses ERCOT System transmission needs for years 2024 through 2028. This report documents the results of the assessment, in part, to comply with the requirements of NERC Reliability Standards, ERCOT Protocols, and the ERCOT Planning Guide.

The reliability analysis was performed over a six-year planning horizon; years one through five representing the near-term horizon and year six representing the long-term horizon. The 2022 RTP assessed ERCOT's steady-state transmission needs under summer peak and off-peak conditions. In addition to the seasonal variations, the RTP also included various sensitivities to address uncertainty involved in the transmission planning process. The reliability analysis in the 2022 RTP included:

- Steady-state contingency analysis to identify criteria violations based on NERC Reliability Standards and ERCOT planning criteria.
- Short-circuit analysis to identify over-dutied circuit breakers in the near-term planning horizon.
- Cascading analysis to identify potential system cascading conditions.

Following the reliability assessment, ERCOT, in collaboration with TPs, developed Corrective Action Plans (CAPs) to address the reliability criteria violations identified in this assessment. These plans included, but were not limited to, upgrades or addition of new transmission facilities and new constraint management plans.

Consistent with the 2021 RTP, ERCOT determined that the demand forecast provided by the IHS Markit study[1] represents the most credible, currently available estimate of future electricity demand in the Permian Basin region for use in the 2022 RTP. Since the completion of the IHS Markit demand forecast in the first quarter of 2020, there have been a significant number of customer-specific requests for new electric service in the Permian Basin region, including in and around the Stanton Loop area. The requests in this area include new operations as well as electrification of existing "off-grid" operations. Transmission Service Providers (TSP) in the region discussed these additional load requests with ERCOT after the 2022 RTP load assumptions were finalized. Time and resource constraints prevented ERCOT from reviewing this additional information and engaging all Far West TSPs and other Market Participants for the needed discussions to determine any appropriate updates to load assumptions for the 2022 RTP. As a result, these additional demand requests in the Permian Basin region, totaling 1,268 MW as of May 2022, were not considered in the 2022 RTP. Further load additions in the Far West weather zone could be reviewed and considered, when appropriate, as part

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

of the ERCOT independent review of project proposals to address additional system needs in the Permian Basin area.

During the 2022 RTP load review process, ERCOT received substantial large load interconnection requests and performed load review based on the established process. The load review process concluded with approximately 8.6 GW of large load being added, and more than 3 GW of those large load are in the Delaware Basin area where significant growth of oil and gas load were forecast by the IHS Markit study. The growth in oil and gas load and the addition of the large load brought the total projected load in the Far West weather zone to more than 12 GW under summer peak conditions by 2028, which has brought significant transmission challenges. Many major transmission projects identified in previous ERCOT special studies, i.e., the Delaware Basin Load Integration Study[2] and Permian Basin Load Interconnection Study,[3] were found to be needed to support the interconnection of the large loads, new oil and gas load, and the forecasted load growth in the area. Besides the Far West Texas region, major transmission enhancements were also identified to facilitate the interconnection of the large load in other areas.

The majority of planned improvements identified in the 2022 RTP are 138-kV and 345-kV system upgrades. The projects identified as 345-kV upgrades consist of new substations, line additions, line upgrades and rebuilds, new 345/138-kV transformers, 345/138-kV transformer upgrades, and reactor additions.

ERCOT identified the following noteworthy reliability projects in the 2022 RTP:

- Faraday to Lamesa to Clearfork to Riverton 345-kV double-circuit line addition in Borden, Dawson, Andrews, Winkler, Loving and Reeves Counties. This project was also identified as the Stage 5 transmission enhancement in the ERCOT Delaware Basin Load Integration Study. The 2022 RTP identified the need for this project starting in summer 2024 to resolve observed reliability violations. The Delaware Basin load was around 6,500 MW in 2024 under summer peak conditions, which had exceeded the load triggering point of 5,972 MW for stage 5 project identified in the Delaware Basin Load Integration Study.
- Midland County Northwest to Midland East to Falcon Seaboard to Morgan Creek to Tonkawa Switch 345-kV existing circuit rebuild and second circuit addition in Midland, Howard, Mitchell, and Scurry Counties. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.

[2] https://www.ercot.com/files/docs/2019/12/23/ERCOT_Delaware_Basin_Load_Integration_Study_Public_Version.zip

[3] https://www.ercot.com/files/docs/2021/12/08/ERCOT_Permian_Basin_Load_Interconnection_Study_Public.zip

- Morgan Creek to Longshore to Consavvy to Midessa South to Odessa 345-kV double circuit line upgrade in Mitchell, Howard, Midland, and Ector Counties. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.
- Quail East 345-kV substation addition, Reiter 345/138-kV substation and 345/138-kV transformer additions, and 345-kV double circuit line addition from Reiter to Quail East in Midland County. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.
- Cedarvale 345/138-kV substation expansion and 345/138-kV transformer additions, and 345-kV double circuit line addition from Cedarvale to Sand Lake in Upton and Ward Counties. This project serves as a placeholder project to address the reliability needs in the area.
- Cholla 345/138-kV substation expansion and 345/138-kV transformer additions with the Wolf Switch to Quarry Field 345-kV double circuit looping into the expanded Cholla substation, and 345-kV double circuit line addition from Cholla to Cedarvale in Ward and Loving Counties. This project serves as a placeholder project to address the reliability needs in the area.
- Consavvy South 345/138-kV substation and 345/138-kV transformer additions, and 345-kV line addition from Consavvy South to Consavvy in Midland County.
- Reactive power support device additions (more than 2000 MVAr), including dynamic devices in the Far West weather zone. This serves as a placeholder project to facilitate the interconnection of the large load in the area.
- Midessa South 345/138-kV transformer upgrade and second 345/138-kV transformer addition in Midland County.
- International Airport 345/138-kV substation expansion and 345/138-kV transformer addition, and 345-kV line addition from International Airport to Liggett Switch in Dallas County.
- Tin Roof 345/138-kV substation expansion and 345/138-kV transformer additions with the Temple Switch to Bell County East Switch 345-kV double circuit line looping into the expanded Tin Roof substation in Bell County. This project serves as a placeholder project to address the reliability needs in the area.
- Beck Road 345/138-kV substation expansion and 345/138-kV transformer additions, and Howard Road to San Miguel 345-kV double-circuit line addition in Bexar and Atascosa counties. This project serves as a placeholder for the remaining reliability needs identified. ERCOT and TSPs will continue to evaluate additional project options. Additional RPG submittals for projects to meet the remaining reliability needs are expected. The “Howard Road 345/138 kV Switching Station Project” submitted by CPS Energy was endorsed by the ERCOT Regional Planning Group (RPG) in December 2021 will also address the reliability needs in the area.
- Lytton 345/138-kV transformer addition in Caldwell County.

- Samsung 345/138-kV station and 345/138-kV transformer additions, and 345-kV line addition from Samsung to Hutto Switch in Williamson County. This project serves as a placeholder project to address the reliability needs in the area.
- Sandow 345/138-kV transformer additions in Milam County. This project serves as a placeholder project to address the reliability needs in the area

The 2022 RTP also included an economic assessment of the ERCOT transmission system for years 2024 and 2027. Through this assessment, ERCOT identified projected transmission constraints and lines recommended for dynamic rating. At the time of the analysis, ERCOT's economic criteria[4] for project evaluation were pending,[5] and potential economically driven transmission improvements were not evaluated in the 2022 RTP.

The estimated project completion years provided in the 2022 RTP report were chosen to address reliability needs in a timely manner. The TOs are expected to meet these project completion dates, but lead-times necessary to implement projects based on factors such as availability of construction clearances, the time required to receive regulatory or governmental approvals, equipment availability, land acquisition, and resource constraints may result in different actual project completion dates.

The projects identified in the RTP do not represent ERCOT's endorsement of the projects. Instead, they represent suggested CAPs for the reliability criteria violations identified under the system conditions studied in the RTP. The scope of projects identified in the RTP may change based on further analysis by ERCOT or the TPs that indicate better alternatives or a need to modify the projects due to changes in expected generation, load forecasts, or other system conditions. TPs should perform studies to confirm the need with the latest system conditions and develop applicable reliability projects to resolve any reliability criteria violations.

For projects that are subject to ERCOT Protocols Section 3.11.4, Regional Planning Group Project Review Process, a review shall be conducted in accordance with the process described therein. For a project that is under Regional Planning Group (RPG) review when the RTP is developed, a placeholder project will be used if the need is identified. Projects requiring RPG endorsement will be reviewed in future assessments (where sufficient lead-time exists), such as future RTPs, to ensure the identified system facilities are still needed.

The TOs will provide ERCOT with additional details on project scope, project cost, and an implementation schedule with completion date(s) for each identified project. This information from the TOs may be provided through further RPG review and/or Transmission Project Information Tracking (TPIT) updates in accordance with ERCOT Planning Guide Section 6.4.1.

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[4] https://capitol.texas.gov/billlookup/text.aspx?LegSess=87R&Bill=SB1281

[5] https://interchange.puc.texas.gov/search/filings/?UtilityType=A&ControlNumber=53403&ItemMatch=Equal&DocumentType=ALL&SortOrder=Ascending

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1. 2022 Regional Transmission Plan

This report documents the 2022 Regional Transmission Plan (RTP) assessment performed by ERCOT System Planning. It is intended, in part, to satisfy ERCOT's requirements under NERC Reliability Standards, ERCOT Protocols Section 3.11, and ERCOT Planning Guide Sections 3 and 4.

The RTP study is conducted annually for the entire ERCOT System. The 2022 RTP's near-term and long-term planning horizon analysis evaluated the reliability needs of the ERCOT transmission system for the years 2024, 2025, 2027, and 2028. As required by NERC Reliability Standard TPL-001-5.1, the 2022 RTP included a steady-state analysis of summer peak conditions for years 2024 (year 2), 2025 (year 3), and 2027 (year 5); and off-peak conditions for 2025 (year 3); and a short-circuit analysis of summer peak conditions for 2025 (year 3). The 2022 RTP also included steady-state analysis of summer peak conditions for 2028 (year 6), representing the long-term planning horizon. Year six, or 2028, was selected based on the rationale that most of ERCOT transmission upgrades can be completed within five to six years from the date when the need is identified. In addition to analyzing the reliability needs of the system, the 2022 RTP also evaluated projected congestion on the ERCOT system for years 2024 and 2027.

1.1. Stakeholder Involvement

The development of the RTP is a collaborative process. ERCOT worked with NERC-registered TPs, TOs, and other stakeholders to develop the input assumptions and the scope of technical studies that define the RTP. These assumptions are described in the RTP Scope and Process document and were presented to the stakeholder community at Regional Planning Group (RPG) meetings. The RTP Scope and Process document and input assumptions can be found in Appendices A, B, C, and D. Stakeholders were provided with routine updates on the input assumptions and supporting analysis performed for the 2022 RTP in RPG meetings. Feedback and comments from the RPG were incorporated into the RTP Scope and Process document.

The RPG is responsible for reviewing and providing comments on proposed transmission projects in the ERCOT Region. Under ERCOT Protocols Section 3.11.3, participation in the RPG is required of all Transmission Service Providers and is open to all Market Participants, consumers, other stakeholders, and Public Utility Commission of Texas (PUCT) Staff.

ERCOT worked with TPs, TOs, and other stakeholders to study the existing system and to identify system upgrades and new transmission projects to ensure continued system reliability.

1.2. Standards and Regulations

The RTP assessment was conducted based on requirements in NERC Reliability Standards, ERCOT Protocols, and the ERCOT Planning Guide.

ERCOT performed its steady-state reliability assessment in accordance with NERC Reliability Standard TPL-001-5.1, Transmission System Planning Performance Requirements. A portion of the RTP assessment also addressed some requirements in NERC Reliability Standards FAC-002[6] and IRO-017.[7]

ERCOT Protocols Section 3.10.8.4(3) requires ERCOT to identify additional Transmission Elements that have a high probability of providing significant added economic efficiency to the ERCOT market through the use of Dynamic Ratings and request such Dynamic Ratings from the associated ERCOT Transmission Service Provider (TSP). This report identifies such Transmission Elements as part of its economic analysis.

The RTP assessment adheres to ERCOT Planning Guide Section 3.1.1.2, which provides guidelines regarding completion of the RTP. This section requires that ERCOT complete and publish the final RTP report no later than December 31 each year. Additionally, ERCOT Planning Guide Section 4 and ERCOT Protocols Section 3.11.2 specify the transmission planning criteria to be used in the RTP assessment.

1.3. Confidentiality and Report Posting

The RTP report is shared with internal and external stakeholders. One redacted version of the RTP is created by removing, at a minimum, any confidential data such as the list of long lead-time equipment. This report is shared with ERCOT stakeholders via the MIS Secure area. A public version of the RTP report is also created by removing, at a minimum, any confidential data and ERCOT Critical Energy Infrastructure Information (ECEII). This report is posted to the ERCOT website.

[6] FAC-002, Requirement R4
[7] IRO-017, Requirements R3 and R4

2. 2022 Regional Transmission Plan Process

The RTP study process is described in Figure 1. The initial start cases to be used in the reliability analysis were prepared in the case conditioning stage. The case conditioning step in the 2022 RTP also included the use of the “bounded-higher-of” methodology to determine appropriate weather zone load levels for the RTP study. The details of this methodology can be found in ERCOT Planning Guide Section 3.1.7. In the 2022 RTP, the Permian Basin load forecast from the IHS Markit study was utilized for the West and Far West weather zones. Following case conditioning, a reliability analysis was conducted on the base case to determine the CAPs needed to meet ERCOT and NERC reliability requirements. In addition to the base case, the 2022 RTP also included sensitivity cases, a short-circuit analysis, a cascade analysis, a known outages study, and a multiple element outage analysis as required by NERC Reliability Standard TPL-001-5.1. An economic analysis was also conducted to identify projected congestion and lines recommended for Dynamic Rating. The detailed scope, process, and input assumptions used in conducting both reliability and economic analyses are available in Appendices A, B, C, and D.

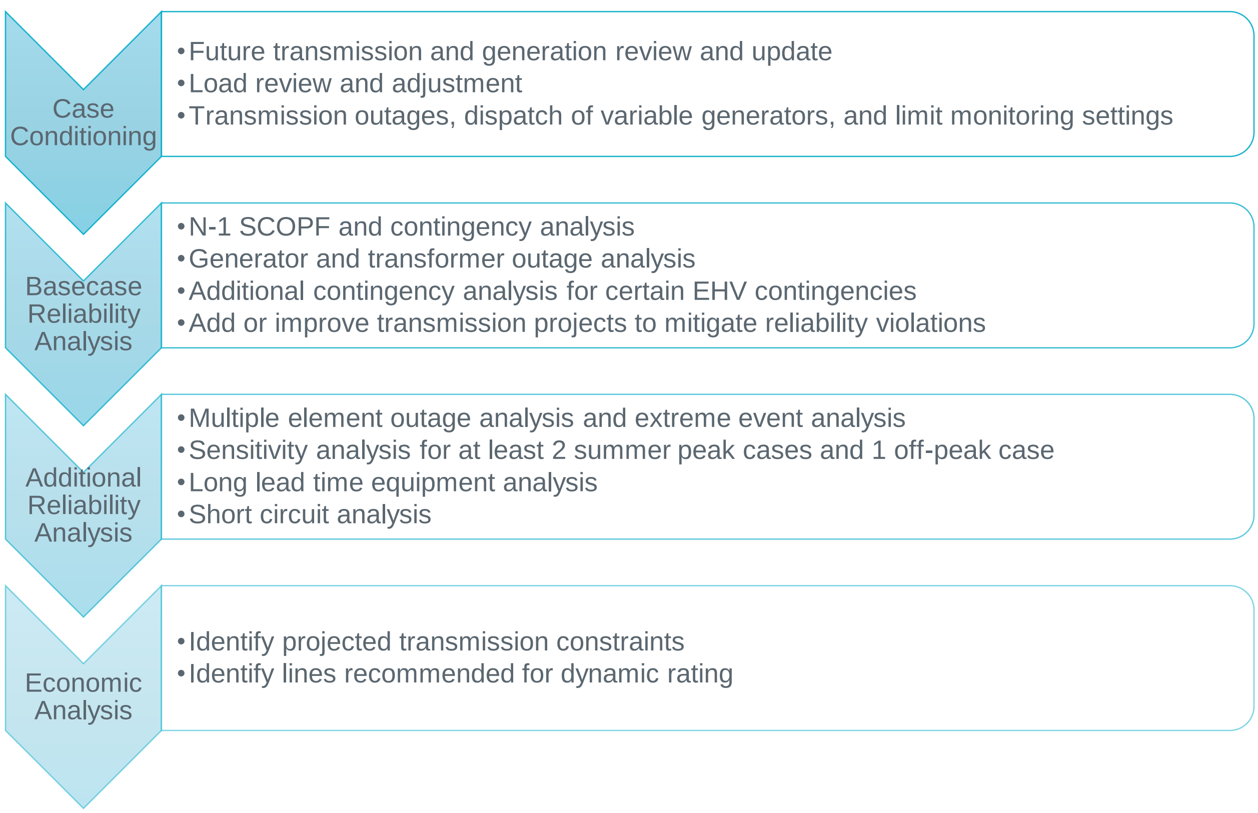


Figure 1: 2022 RTP Transmission Planning Process

ERCOT utilized the following software tools while performing the 2022 RTP:

- PSS/E version 35 was used to develop the conditioned cases.
- PowerWorld version 22 with Security Constrained Optimal Power Flow (SCOPF) and its SIMAUTO functionality were used to perform AC SCOPF analysis and to run generator and transformer outage analysis.
- PowerWorld version 22 was used to screen critical contingencies while evaluating P3 (generator outage) and P6-2 (transformer outage) planning events.
- PowerWorld version 22 and POM application suite version 2021 including POM suite – Optimal Mitigation Measures (OPM) and Potential Cascading Modes (PCM) were used to perform multiple element outage analysis and cascade analysis.
- UPLAN version 11.4 was used to perform security-constrained economic analysis.

2.1. Permian Basin Load Forecast and Large Load Additions

West Texas has experienced rapid load growth in the past several years due to significant growth of oil and gas production in the area. The average annual load growth rate was observed to be approximately 11% from 2016 through 2022. The rapid load growth coupled with the short lead time of oil and gas load interconnection requests has imposed significant challenges in transmission planning to reliably integrate the growing oil and gas load. Both ERCOT and TSPs serving West Texas oil and gas load have been working diligently to better understand oil and gas activities and growth, and to better prepare for potential long lead time transmission enhancements needed to reliably serve the fast-growing loads.

ERCOT completed the Delaware Basin Load Integration Study with extensive input from TSPs in 2019 and identified a five-stage transmission upgrade road map to reliably serve different levels of Delaware Basin load. In addition, both ERCOT and TSPs have also evaluated West Texas oil and gas load growth at a more granular level. In April 2020, a TSP-sponsored IHS Markit study report for Permian Basin load forecast was published, which was based on an in-depth analysis of the oil and gas activities in the Permian Basin, and provided the load forecast with more granularity. The Permian Basin load forecasted in the IHS Markit study was reviewed by ERCOT and TSPs serving the load within the Permian Basin area and was determined to be appropriate for use in the 2021 RTP. Consistent with the 2021 RTP, ERCOT determined that the demand forecast provided by the IHS Markit study represents the most credible, currently available estimate of future electricity demand in the Permian Basin region for use in the 2022 RTP.

The Permian Basin load forecast from the IHS Markit study included all but four counties in the Far West weather zone and five adjacent counties in the West weather zone. The counties and load forecast from 2022 to 2030 associated with the Permian Basin area can be found in Table 1 and Figure 2, respectively.

Table 1: Permian Basin Counties

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

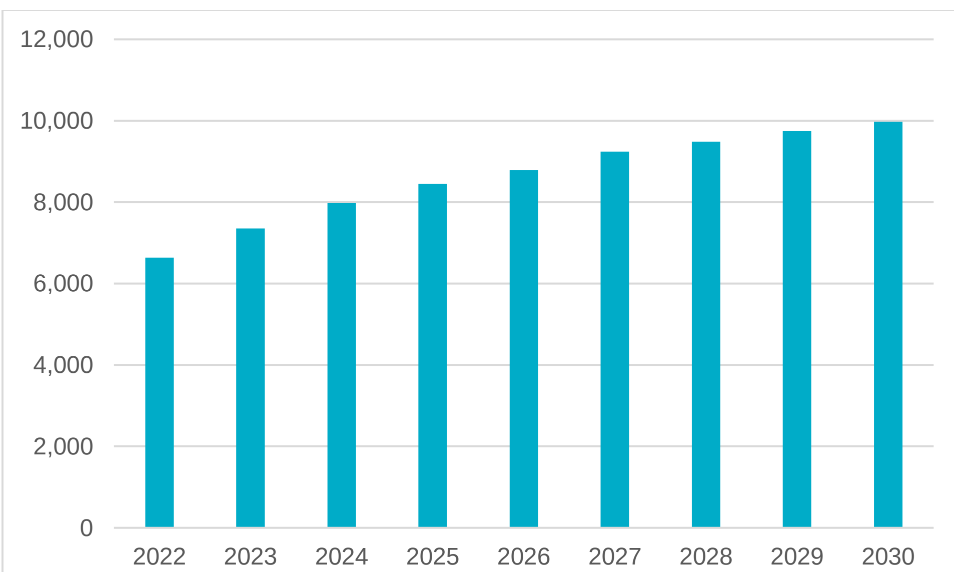


Figure 2: IHS Markit Study Permian Basin Summer Peak Load Forecast (MW)

While a large portion of the Permian Basin loads can be served from existing or planned substations, there are also projected new loads that require new interconnections to the existing transmission system. Similar to the 2021 RTP, the new load interconnection was assumed to be consistent with the ERCOT Permian Basin Load Interconnection Study in the 2022 RTP. The new load-serving stations and their connections to the existing transmission system can be found in Appendix C.

In 2022, ERCOT also received a significant amount of large load interconnection requests during the load review process. ERCOT worked with TSPs and considered signed contracts and public announcements for the large loads to determine the appropriate load to be included in the analysis. Figure 3 below shows the MW amount of the large load included in each study year. The large loads include cryptocurrency load, data center load, and manufacturing load.

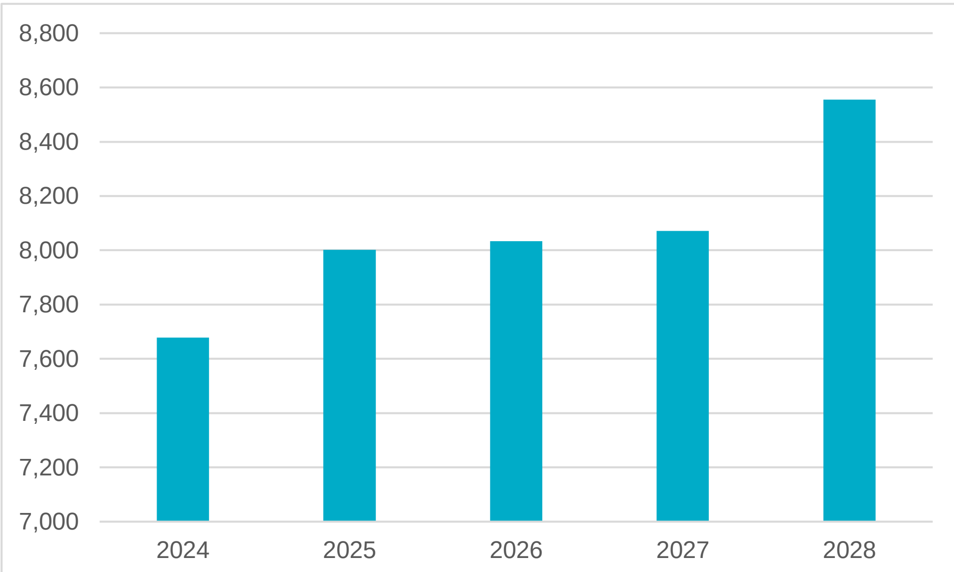


Figure 3: Large Load Addition in 2022 RTP (MW)

2.2. Adoption of the ERCOT Rooftop Solar Growth Forecast

The ERCOT region is experiencing rapid growth in Distributed Generation (DG), especially in the solar photovoltaic less than 1 MW category, which includes rooftop solar and community solar. The total DG at the end of 2021 is estimated to be more than 2,900 MW, as shown in Figure 4.

It is projected that the installed capacity for rooftop solar may reach 7,519 MW by 2030 for the aggressive scenario, or 4,477 MW for the conservative scenario, and 5,861 MW for the moderate scenario. Neither ERCOT nor the TSPs' load forecasts included the potential growth of the rooftop solar PV in the past to account for the rapid adoption of rooftop solar in the ERCOT region. In an effort to address this gap, ERCOT developed a rooftop solar growth forecast for the 2022 Long-Term load forecast. The impacts of the projected rooftop solar growth were incorporated as load reductions at the bus level in the 2022 RTP.

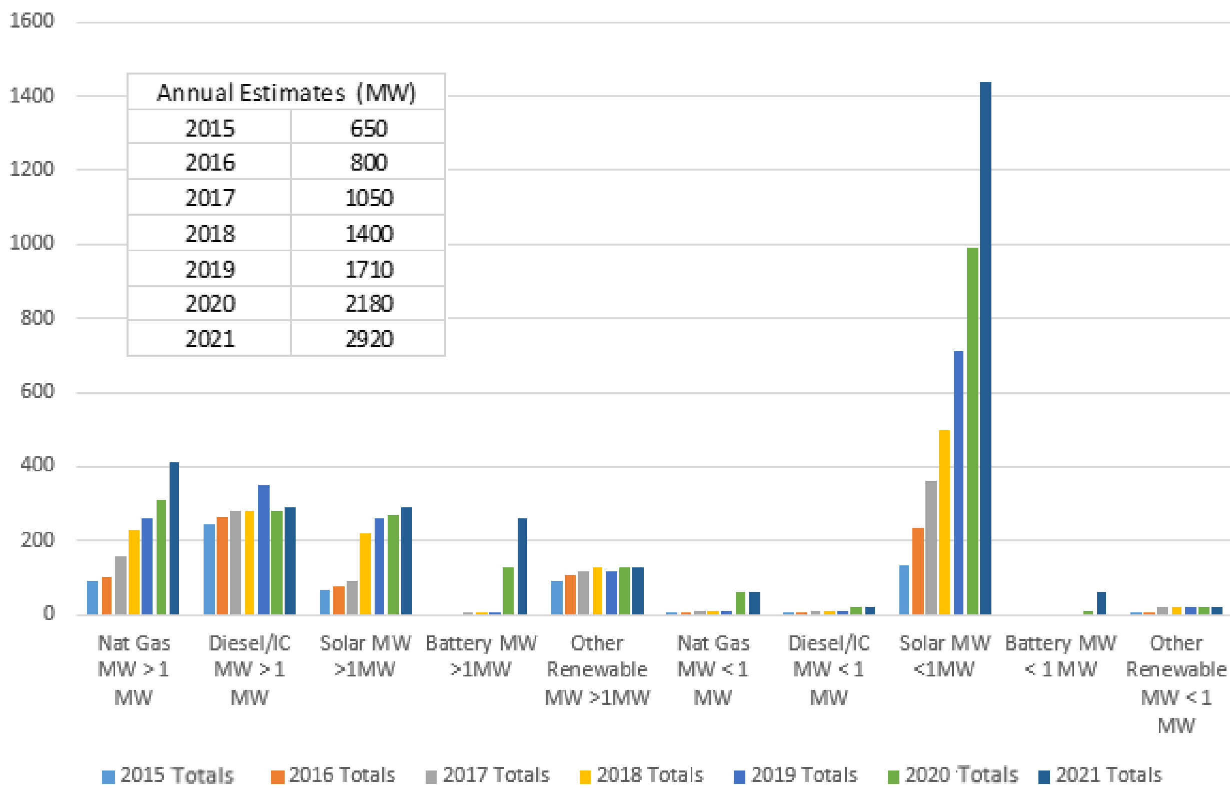


Figure 4: ERCOT Estimated Total DG Growth from 2015 to 2021 (MW)

2.3. Reliability Analysis

The reliability analysis in the 2022 RTP was focused on the steady-state portion requirements of NERC Reliability Standard TPL-001-5.1 and the ERCOT Planning Guide. The purpose of reliability analysis was to identify potential criteria violations and CAPs that may be used to resolve them. The RTP analysis included Security Constrained Optimal Power Flow (SCOPF) to identify unresolvable constraints. Loading and voltage levels at Bulk Electric System (BES) elements were monitored for all NERC planning events, including extreme events. ERCOT staff developed CAPs in collaboration with TPs to mitigate criteria violations in accordance with the NERC and ERCOT performance requirements.

The 2022 RTP reliability analysis included the following studies:

- SCOPF: Security Constrained Optimal Power Flow (SCOPF) was used to perform basic power flow and Contingency Analysis for P0, P1, P2-1, and P7 planning events. SCOPF used generation cost data and other system constraints to give an optimal generation dispatch and unit commitment while maintaining the reliability of the system. In this analysis, the software simulated the removal of all elements of the Protection System and other automatic controls following the contingency event.
- Contingency Analysis: Basic contingency analysis routines in the power flow software were used to test P2-2, P2-3, P2-4, P4, and P5 planning events and extreme events.

- Multiple Element Contingency Analysis: Planning events P3 and P6 involve a first and second level contingency analysis. Such events were tested using multiple element contingency analysis. During this analysis, loss of elements due to the first contingency was followed by acceptable system adjustments before testing the effect of the second contingency event. The list of acceptable system adjustments included system reconfiguration, changes in voltage schedule, and re-dispatch of generation. Other contingency events such as P4 and P5 planning events and extreme events, which involved simultaneous removal of multiple elements, were also analyzed. Extreme events associated with the disruption of gas pipelines were also included.
- Cascading Analysis: Cascading analysis was conducted to test all planning and extreme events where a facility may be loaded above its relay loadability rating before mitigation measures can be taken. In this analysis, the software simulated the removal of all elements of Protection System and other automatic controls following the contingency event. This included tripping of generators and transmission elements which were loaded beyond their relay loadability limits. These contingencies were screened to detect potential cascade events for more detailed analysis.
- Short Circuit Analysis: In accordance with the agreement between ERCOT and TPs in the ERCOT region as required by NERC Reliability Standard TPL-001-5.1, Requirement R7 (revised in May 2020), ERCOT performed the short-circuit analysis in order to determine short-circuit currents for Resource Entity (RE)-owned facilities. The results of the short-circuit analysis included the magnitude of short-circuit current and the source impedance associated with each fault. These results were communicated to the NERC Registered Generator Owners (GOs). GOs completed a review of study results, acknowledged the findings, and provided a list of over-dutied circuit breakers and CAPs. In addition, GOs also confirmed the continued validity and implementation status of the facilities identified in the previous RTP.
- Long Lead Time Equipment Analysis: Under Requirement 2.1.5 of NERC Reliability Standard TPL-001-5.1, the impact of the possible unavailability of major transmission equipment with a lead time of one year or more was studied. The studies were performed with an initial condition of the identified long lead time equipment modeled as out of service, followed by P0, P1, and P2 contingency events. The list of long lead time equipment was developed based on feedback from the TOs. The results of this analysis were communicated to the TOs.
- Sensitivity Analysis: ERCOT selected the summer peak conditions of 2024 and 2027 and off-peak conditions of 2025 for sensitivity analyses as required by Requirement 2.1.3 of NERC Reliability Standard TPL-001-5.1. ERCOT prepared the following sensitivity cases by varying the generation and load input assumptions:

  - Winter peak load conditions for years 2024 and 2027: Identify potential transmission upgrades needed under winter peak load conditions, which may have different challenges compared with summer peak load conditions.

  - High Renewable Light Load condition for the 2025 off-peak case: Identify potential challenges associated with high renewable dispatch. In this sensitivity, no renewable curtailment was utilized and potential solutions to accommodate the assumed level of penetration were identified.

  The sensitivity analyses were performed with all identified reliability solutions from the base case analysis to evaluate the effectiveness and robustness of the base case solutions under the stressed system conditions.

- Known Outages Impact Analysis: Under Requirement 2.1.4 of NERC Reliability Standard TPL-001-5.1, the impact of known outages of generation or transmission facilities planned in the near-term planning horizon was studied. ERCOT issued Market Notices to collect known outages information from both TOs and GOs. TOs were required to provide technical rationales for their known outages selection for each study case included in the 2022 RTP. ERCOT developed the technical rationale[8] for the selection of GO-submitted outages to be included in the corresponding study cases. The known outages from the TOs and the GO outages selected based on ERCOT-developed technical rationale were then used to study their impact on system performance under P0 and P1 contingencies.

2.1.1 CAP Development

Under the ERCOT Planning Guide, reliability projects are those system improvements (projects) that are needed to meet NERC Reliability Standards or ERCOT planning criteria, which could not otherwise be met by simultaneously feasible, security-constrained re-dispatch of existing and planned generation. In order to develop this list of projects, grid simulation software was utilized which included the removal of all protection system elements and other automatic controls following the simulated contingency events. These elements included devices designed to provide steady-state control of electrical system quantities, such as on-load tap-changing transformers, phase-shifting transformers, and switched capacitors and reactors.

A list of potential CAPs, or reliability projects, along with the corresponding limiting elements and contingencies, was communicated to the appropriate TP and/or TO. TPs and TOs reviewed the initial list of reliability-driven projects for their technical feasibility and estimated year of completion (considering necessary lead times). In some cases, the TOs also provided project alternatives. In instances where it is not feasible to construct a project prior to the identified date of need, ERCOT designed Constraint Management Plans (CMP) to mitigate the criteria violations until the permanent CAP can be put in-service. These mitigation actions were developed in collaboration with TPs and further communicated to ERCOT Operations. Intermediate and final results were posted on the ERCOT MIS Secure Area and presented to stakeholders at regularly scheduled RPG meetings in order to solicit comments and suggestions.

[8] https://www.ercot.com/files/docs/2022/03/09/2022_RTP_TPL_001-5_Known_Outages_March_2022_RPG.pdf

2.1.2 System Operating Limit (SOL) Identification

The ERCOT SOL Methodology was used to determine if additional SOLs were needed in the planning horizon. Per the criteria, a new SOL was identified if results of the reliability analysis of the base case resulted in any of the following:

- Voltage instability (resulting in uncontrolled voltage collapse).
- Cascading or uncontrolled separation or islanding.

2.4. Economic Analysis

ERCOT conducted an economic analysis to identify projected congestion and lines recommended for dynamic rating. To conduct this analysis, ERCOT prepared production cost models for years 2024 and 2027. Details on the production cost models developed for the 2022 RTP can be found in Appendix E.

3. Findings from Reliability Analysis

3.1. Reliability Projects and Constraint Management Plans

The primary purpose of the 2022 RTP reliability analysis was to identify reliability criteria violations and potential CAPs to resolve them. Overall, the base reliability analysis identified a need for 89 CAPs. The detailed list of criteria violations and resulting CAPs can be found in Appendix F. Figure 5 illustrates the geographic location of the identified CAPs. The legend linking reliability projects and their associated map indices can be found in Appendix G.

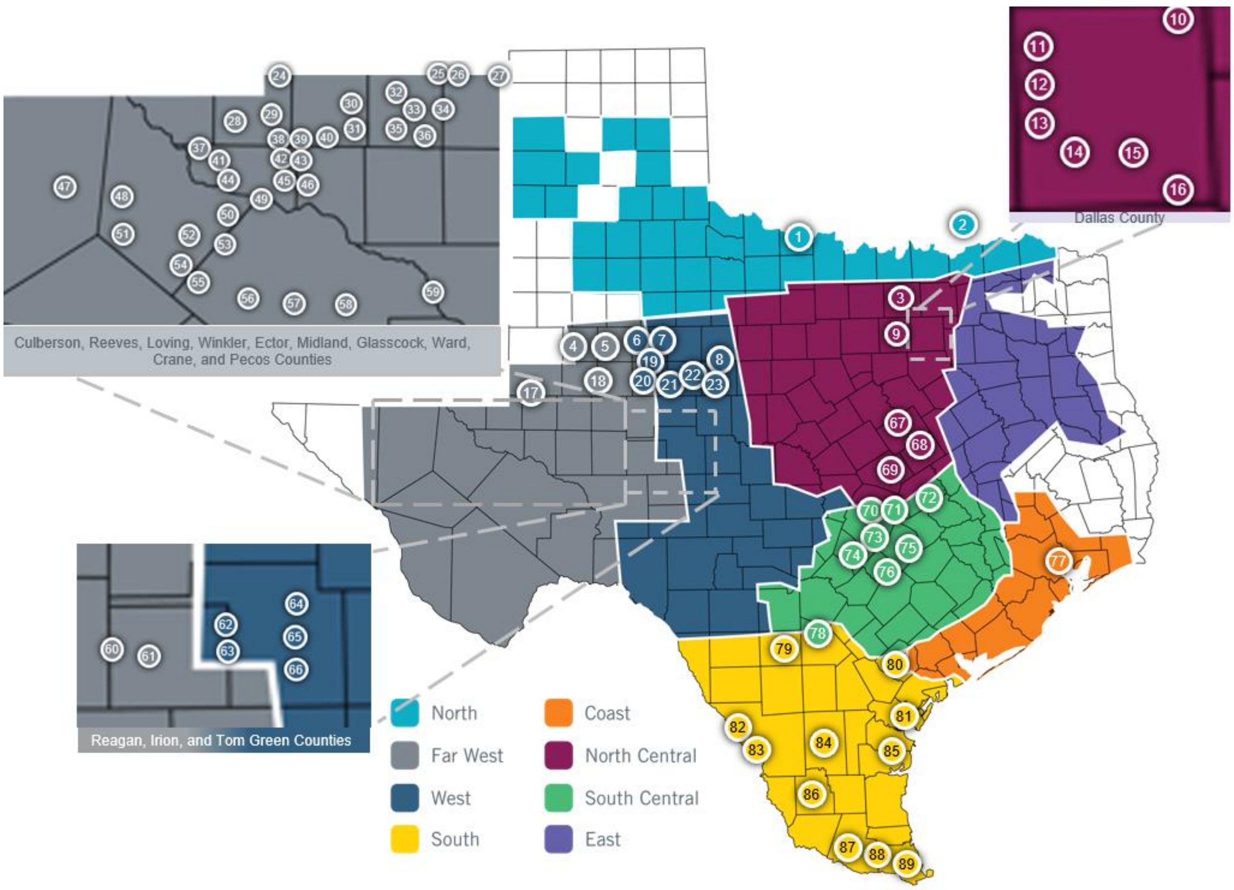


Figure 5: Geographic Locations of CAPs Identified in the 2022 RTP

Figures 6[9] and 7 summarize the types of projects, their geographic locations, and associated voltage levels. Figure 8 distinguishes between projects that were newly identified in the 2022 RTP and projects that were identified in previous ERCOT planning studies or TSP studies.

[9] The 69-kV to 138-kV line conversion was included in the 138-kV category.

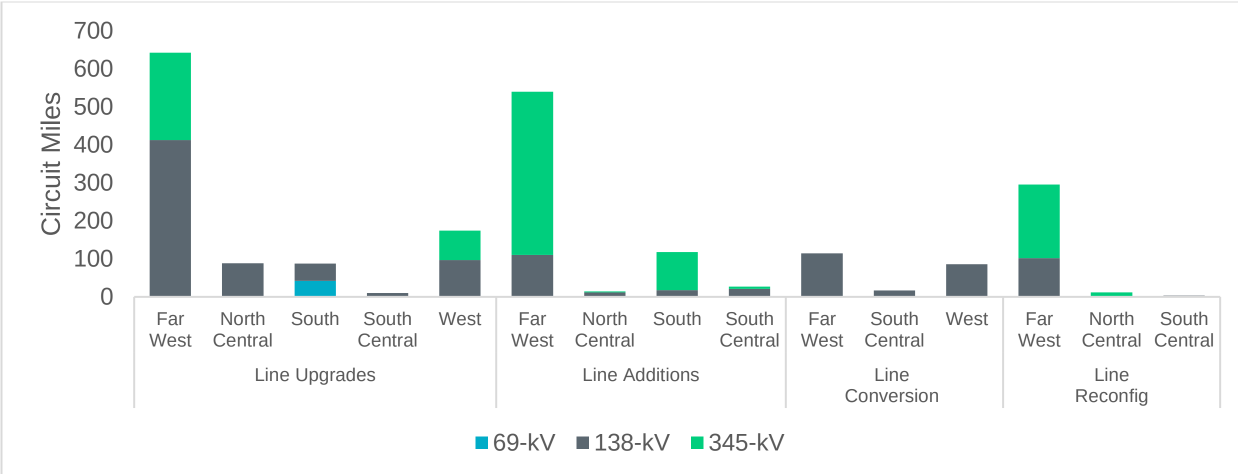


Figure 6: 2022 RTP Transmission Line Project Types by Weather Zone and Voltage Level

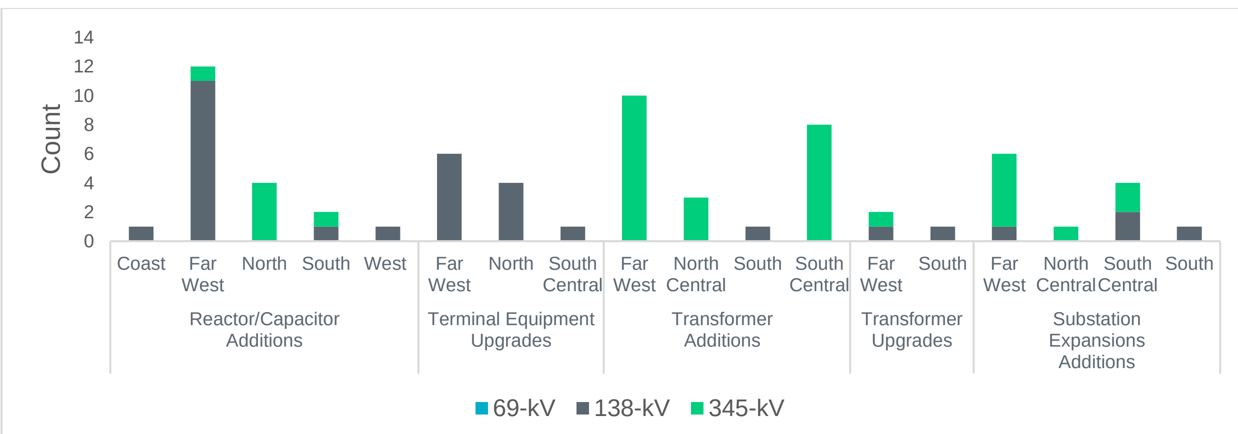


Figure 7: 2022 RTP Other Upgrades and Additions by Weather Zone and Voltage Level

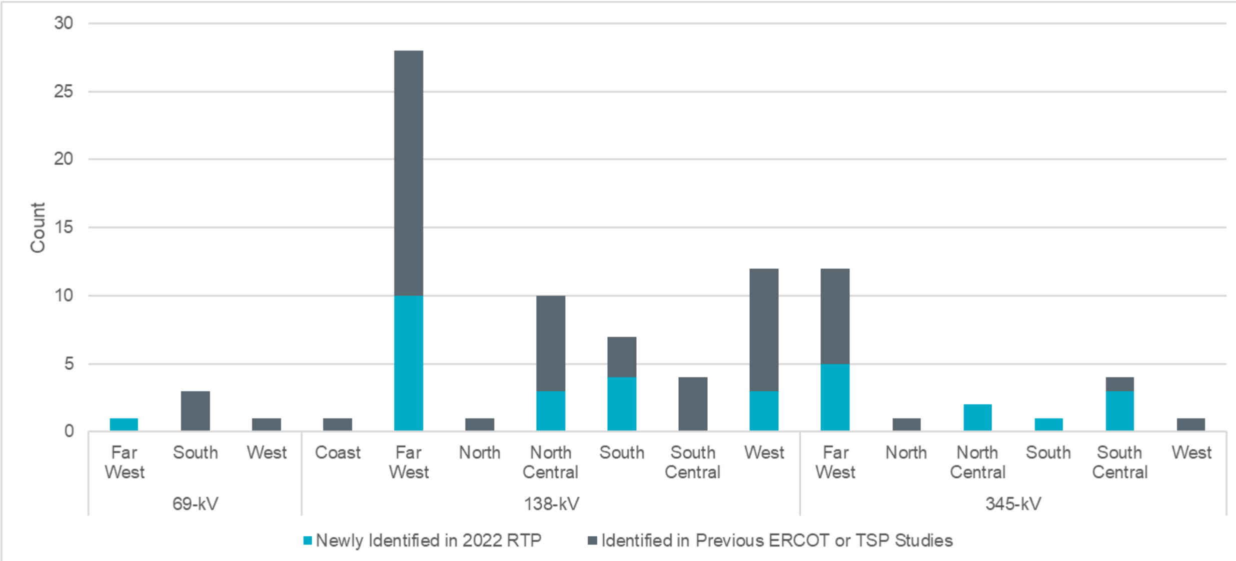


Figure 8: Projects Newly Identified in the 2022 RTP versus Projects Previously Identified

ERCOT, in collaboration with TPs, also identified two potential CMPs as placeholder mitigating actions which will be reviewed in the operations planning horizon by ERCOT and TOs. The list and details of the CMPs identified in the 2022 RTP can be found in Appendix H.

3.1.1 West Texas Study Findings

As described in Section 2.1, the Permian Basin load forecast from the IHS Markit study was adopted in the 2022 RTP similar to the 2021 RTP. Besides the forecasted demand that can be served from the existing and planned substations, there are 120 projected new oil and gas loads served from new stations through new interconnections to the existing transmission grid by year 2028. In the 2022 RTP, those new load serving stations are mostly radially connected to the existing system, which is consistent with the ERCOT Permian Basin Load Interconnection Study. The new load connection information can be found in Appendix C. The focus of the 2022 RTP was on the system impacts from loads served from both existing and planned substations, and the new substations with assumed connections.

Besides the projected oil and gas load, the 2022 RTP also incorporated more than 3 GW of large load in the Far West weather zone based on ERCOT load review results, which brings the total projected load to more than 12 GW under summer peak conditions by 2028 in the Far West weather zone with more than 50% of the 12 GW load located in the Delaware Basin area. Various reliability violations were observed under the loss of part of the existing import paths into the Delaware Basin area and indicated the need for additional import paths into the area. The “Bearkat - North McCamey - Sand Lake 345-kV Transmission Line Addition Project” (stage 2 project from the ERCOT Delaware Basin Load Integration study) submitted by LCRA TSC, Oncor, and WETT was endorsed by ERCOT in 2022 as a first step in addressing the import needs in the area.

The 2022 RTP also identified the need for stage 5 project (Faraday - Lamesa - Clearfork - Riverton 345-kV double circuit line addition) identified in the Delaware Basin Load Integration study road map to further address the import needs in the area The forecasted load level for the Delaware Basin area also exceeded the trigger point of 5,422 MW for stage 5 project. The road map developed by the ERCOT Delaware Basin Load Integration study is shown in Figure 9.

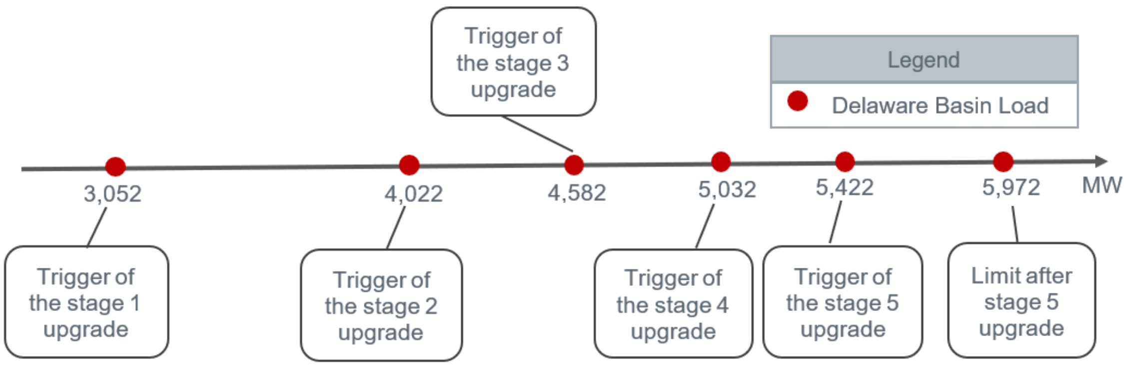


Figure 9: ERCOT Delaware Basin Load Integration Study Road Map

Besides the stage 2 and stage 5 projects, the 2022 RTP also identified the need for the majority of the preferred projects identified in the ERCOT Permian Basin Load Interconnection study, which include 213 circuit miles of 345-kV line upgrade/rebuild, and 123 circuit miles of new 345-kV lines. In addition, significant needs for the 138-kV and 69-kV transmission enhancements were also observed. The integration of the more than 3 GW of large load also brought substantial challenges in voltage support, and the 2022 RTP identified the need for more than 2 GVAr reactive power support devices, including dynamic devices to mitigate local voltage collapse and low voltage issues in the area.

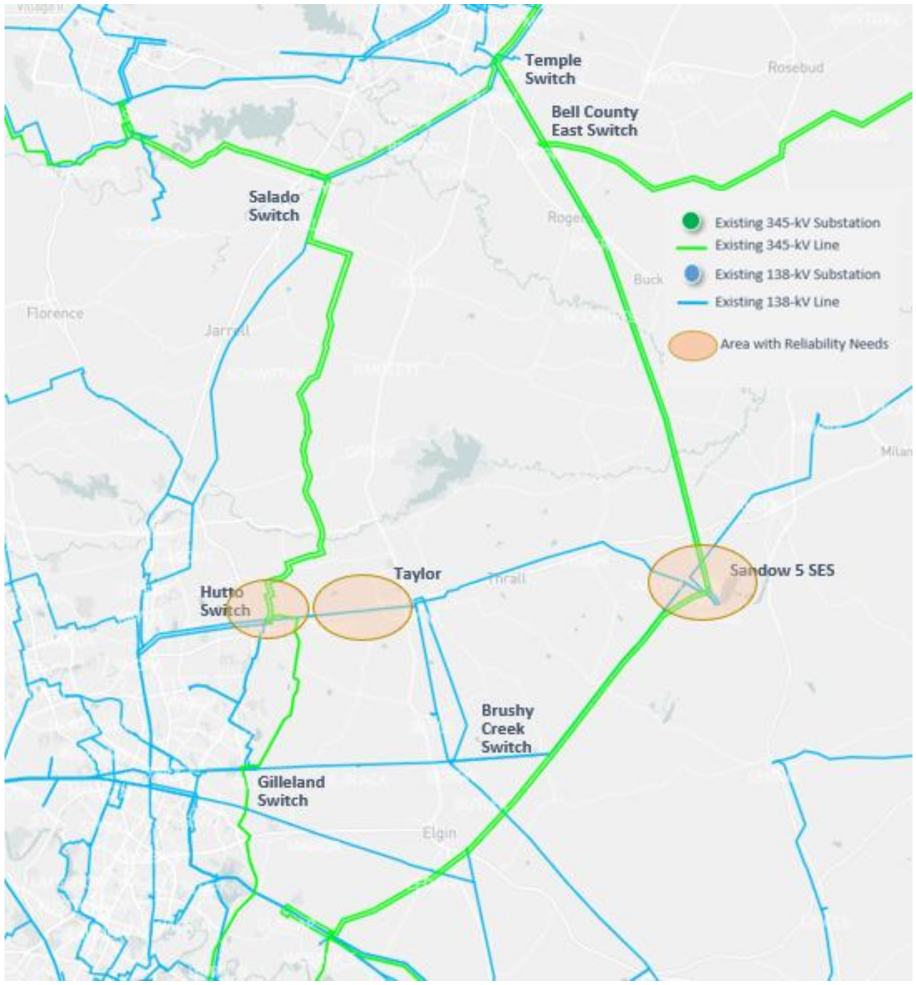
Overall, 55 reliability projects were identified for the West and Far West study region. The noteworthy reliability projects are summarized below. The detailed information can be found in Appendix F.

- Faraday to Lamesa to Clearfork to Riverton 345-kV double-circuit line addition in Borden, Dawson, Andrews, Winkler, Loving and Reeves Counties. This project was also identified as the Stage 5 transmission enhancement in the ERCOT Delaware Basin Load Integration Study. The 2022 RTP identified the need for this project starting in summer 2024 to resolve observed reliability violations. The Delaware Basin load was around 6,500 MW in 2024 under summer peak conditions, which had exceeded the load triggering point of 5,972 MW for stage 5 project identified in the Delaware Basin Load Integration Study.
- Midland County Northwest to Midland East to Falcon Seaboard to Morgan Creek to Tonkawa Switch 345-kV existing circuit rebuild and second circuit addition in Midland, Howard, Mitchell, and Scurry Counties. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.

- Morgan Creek to Longshore to Consavvy to Midessa South to Odessa 345-kV double circuit line upgrade in Mitchell, Howard, Midland, and Ector Counties. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.
- Quail East 345-kV substation addition, Reiter 345/138-kV substation and 345/138-kV transformer additions, and 345-kV double circuit line addition from Reiter to Quail East in Midland County. This project was also identified as an ERCOT-preferred project in the Permian Basin Load Interconnection Study.
- Cedarvale 345/138-kV substation expansion and 345/138-kV transformer additions, and 345-kV double circuit line addition from Cedarvale to Sand Lake in Upton and Ward Counties. This project serves as a placeholder project to address the reliability needs in the area.
- Cholla 345/138-kV substation expansion and 345/138-kV transformer additions with the Wolf Switch to Quarry Field 345-kV double circuit looping into the expanded Cholla substation, and 345-kV double circuit line addition from Cholla to Cedarvale in Ward and Loving Counties. This project serves as a placeholder project to address the reliability needs in the area.
- Consavvy South 345/138-kV substation and 345/138-kV transformer additions, and 345-kV line addition from Consavvy South to Consavvy in Midland County.
- Reactive power support device additions (more than 2000 MVAr) including dynamic devices in the Far West weather zone. This serves as a placeholder project to facilitate the interconnection of the large load in the area.
- Midessa South 345/138-kV transformer upgrade and second 345/138-kV transformer addition in Midland County.

3.1.2 Austin Area Study Findings

Approximately 2 GW of large load located northeast of Austin was incorporated in the 2022 RTP based on ERCOT load review results. Reliability violations were observed on the 138-kV system from Taylor to Hutto, as well as at the 345-kV Hutto Switch and Sandow Switch substations. Potential 345-kV transmission enhancements were needed to reliably interconnect the load. The reliability needs are illustrated in Figure 10.



The following placeholder projects were utilized to address the identified reliability needs:

- Samsung 345/138-kV station and 345/138-kV transformer additions, and 345-kV line addition from Samsung to Hutto Switch in Williamson County.
- Sandow 345/138-kV transformer additions in Milam County.

ERCOT and TSPs are continuing to evaluate additional project options. Future RPG submittals for projects to meet the reliability needs are expected.

3.1.3 San Antonio Area Study Findings

Similar to the 2021 RTP, a group of generators were taken out of service in the RTP base cases prior to receiving a Notification of Suspension of Operations (NSO) based on the Resource Entities' notifications and public statements about their intention to retire those Generation Resources in accordance with Planning Guide Section 3.1.4.1.1(4). The list of affected Generation Resources can be found in the "Generation Resources Unavailable in Planning Studies Prior to NSO" document[10] posted on the ERCOT website.

[10] https://www.ercot.com/mp/data-products/data-product-details?id=PG3-1411-M

In December 2021, the “Howard Road 345/138 kV Switching Station Project” submitted by CPS Energy was accepted by RPG as a first step in addressing the reliability needs in the area that was identified by the 2021 RTP due to the expected generation retirement in the area. Similar to the findings in the 2021 RTP, the 2022 RTP further confirmed that additional transmission enhancements were needed to fully address the reliability needs due to the expected generation retirement. The same placeholder project, which includes the expansion of the Beck Road 345/138-kV substation with new 345/138-kV transformer additions, and the Howard Road to San Miguel 345-kV double-circuit line addition, was used to address the remaining reliability needs in 2022 RTP.

ERCOT and TSPs will continue to evaluate additional project options. RPG submittals for project to meet the remaining reliability needs are expected.

3.1.4 Other Findings

In addition to the reliability analysis summarized in previous sections, a multiple element outage analysis was conducted for contingencies where non-consequential load loss is allowed under NERC Reliability Standard TPL-001-5.1, Table 1. This analysis consisted of:

- corrective action analysis, which identified mitigation measures (such as transformer tap setting changes, switching actions, generator re-dispatch, and load shed) to resolve any overloads and over/under-voltage issues resulting from such contingencies and
- cascading analysis, which identified any contingencies that could result in potential cascade events.

Some planning events and extreme events were screened for detailed analysis, and further investigation performed by ERCOT and affected TPs indicated that none of those events resulted in cascading conditions. ERCOT also studied the loss of multiple generating stations due to the disruption of gas pipelines. The results of the multiple element outage analysis are documented in Appendix I. This appendix includes the list of critical contingencies identified as a result of this analysis and CAPs or recommendations necessary to mitigate the impact of these contingencies. No new SOLs were identified in the 2022 RTP reliability analysis.

ERCOT also performed analysis to study the impact of known outages of generation or transmission facilities planned in the near-term planning horizon per Requirement 2.1.4 of NERC Reliability Standard TPL-001-5.1. ERCOT issued Market Notices[11] to collect known outages information from both TOs and GOs. TOs were required to provide technical rationales for their known outages selection for each study case included in the 2022 RTP. ERCOT developed the technical rationale for the selection of GO-submitted outages to be included in the corresponding study cases. The known outages from the TOs and the GO outages selected based on the ERCOT-developed technical rationale were then incorporated into the base cases to study their impact on system performance

[11] https://www.ercot.com/services/comm/mkt_notices/W-A011422-01
https://www.ercot.com/services/comm/mkt_notices/W-B011422-01

under P0 and P1 contingencies. The study results concluded that no additional violations were caused by the known outages.

In addition to the above analyses, per ERCOT Planning Guide Section 3.1.1.2(3), the 2022 RTP analysis also included a list of transmission facilities that were loaded above 95% of their applicable ratings under normal and contingency events (loss of single generating unit, transmission circuit, transformer, or common tower outage). This list is attached to the report as Appendix J.

3.2. Sensitivity Analysis

Understanding the challenges under various system conditions has become increasingly important with the evolving grid. The rapid growth of wind, solar, and energy storage resources, coupled with increased coal and gas generator retirement, continues to change the resource mix in the ERCOT region. Besides the changes on the generation side, the demand side is also experiencing substantial development, e.g., the robust oil and gas activity in West Texas, the increased interest in cryptocurrency mining facility development, and the expected increase in Electrical Vehicles (EV) adoption. As part of ERCOT's efforts to address the challenges posed by the changing grid, sensitivity analysis is performed as part of the RTP each year. In past RTPs, sensitivities have been performed with various renewable generation output assumptions different from the base case analysis for both the on-peak and off-peak analysis, and with various assumptions for West Texas oil and gas loads. In the 2022 RTP, winter peak load conditions were studied as an on-peak sensitivity to capture any additional challenges the ERCOT region may be facing from the transmission planning perspective. In addition, High Renewable Light Load (HRLL) condition was studied as an off-peak sensitivity. Though the HRLL sensitivity was also performed in the 2020 RTP, with the significant amount of large load additions in the renewable-rich Far West Texas region in the 2022 RTP, this sensitivity was selected again to understand any potential changes that the large load additions might introduce under this system condition. The detailed assumptions and study results are summarized in the following sections and are also available in Appendices B and K, respectively.

3.2.1 ERCOT Coincident Winter Peak Load Conditions

The on-peak sensitivity analysis was performed for years 2024 and 2027 under ERCOT 90th percentile coincident winter peak load conditions. The focus of this sensitivity analysis was to test the robustness of the transmission projects identified under the summer peak load conditions and identify any additional reliability needs to reliably serve the winter peak demand.

The winter peak cases started with the corresponding summer peak cases. Substantial updates were then made to the start cases to represent the winter peak load conditions.

- The load profiles from the 2023 SSWG winter peak case released in October 2021 were used to determine the bus level load distributions in the 2024 and 2027 winter peak cases. The large load additions in the start cases were assumed to stay unchanged. The weather zone level 90th percentile winter peak coincident load forecast was then applied to each weather zone. The total load studied for year 2027 is approximately 93 GW.

- Renewable generation dispatch was set based on historical winter peak data analysis. The capacity factors used for renewable generation are shown in Table 2.

Table 2: Renewable Generation Capacity Factors

Solar	Wind - Coastal	Wind - Other	Wind - Panhandle
4%	15%	52%	68%

- Dynamic ratings for transmission lines and transformers and other appropriate changes were also incorporated to align with the winter peak load conditions.

The study results showed that additional transmission upgrades were needed to ensure the reliable serving of system demand under winter peak conditions. In the winter peak sensitivity cases, the solar generation resources were dispatched up to 4% of their capacity compared with 81% in the summer peak cases. With less generation available in the Far West region, more stress was observed on the import paths and additional import capability was needed to resolve the import issues. In addition, the stage 3 project from the ERCOT Delaware Basin Load Integration study was found to be needed to resolve the observed reliability violations in the Culberson loop area. In the West and Far West study regions, the results indicated that there is a need to accelerate several projects that had been previously identified as needed in later study years to winter 2024. Most of the additional transmission challenges observed in the winter peak sensitivity analysis were concentrated in the West and Far West region. There were also some local upgrades needed in the North Central and South weather zones.

The detailed results can be found in Appendix K.

3.2.2 High Renewable Light Load Conditions

Similar to the 2020 RTP, the 2022 RTP includes analysis of high renewable dispatch under light load conditions. This off-peak sensitivity analysis was performed for year 2025. The 2025 minimum load case was used as the start case for this sensitivity. Both the renewable dispatch and the load level were updated based on the assumptions presented to the stakeholders at the August RPG meeting.[12]

In the high renewable off-peak sensitivity analysis, ERCOT started the case with 48.5 GW of renewable output. In order to respect various stability limits and the critical inertia level, the renewable output was reduced to approximately 42 GW, which corresponds to an 80% renewable penetration level. With this assumed penetration level, a few P7 contingencies involving the loss of part of the West Texas export path resulted in reliability violations on some other paths. Adding an additional West Texas export path from West to North Central was needed to resolve the observed issues. ERCOT also identified some additional local transmission solutions to facilitate wind and solar export, in addition to acceptable mitigation actions such as voltage schedule changes, tap setting changes, and generation re-dispatch other than wind and solar. Compared with the 2020 RTP, for which the local needs were concentrated in the South weather zone, the 2022 RTP observed that the

[12] https://www.ercot.com/files/docs/2022/08/04/2022_RTP_Off-Peak_Sensitivity_August_2022_RPG.pdf

transmission needs were in multiple weather zones, including the West, South, and North Central weather zones.

The detailed results can be found in Appendix K.

All the reliability issues observed could be resolved by utilizing renewable curtailment. Since renewable curtailment is a valid mitigation action in operations and planning, the identified transmission solutions will serve as economic project candidates for further economic analysis, rather than being required for reliability purposes.

3.3. Short Circuit Analysis

As indicated in Section 2.2, ERCOT conducted short-circuit analysis for Resource Entity-owned facilities for 2025 summer peak conditions based on the system protection future year base case and shared the results with GOs. GOs reviewed the fault duty information to identify buses with over-dutied breakers along with CAPs.

Table 3 provides a summary of the results of the short-circuit analysis. The study cases and details of the results can be found in Appendix L.

Table 3: Summary of Short-circuit Analysis

Magnitude of Fault Current	Number of buses (3-phase fault)	Number of buses (single-line-to-ground fault)
Below 40 kA	511	521
40 kA ~ 60 kA	74	63
More than 60 kA	2	3

3.4. Long Lead Time Equipment Analysis

In response to ERCOT's request, the TOs provided a list of long lead time equipment based on their spare equipment strategies. All TO-provided BES long lead time equipment outages were studied to determine the impact of unavailability of such equipment for an extended period of time. This analysis was conducted for 2024, 2027, and 2028 summer peak conditions, along with 2025 off-peak conditions. Overall, 32 unique 345/138-kV transformers, 3 unique 345/115-kV transformers, 1 unique 138-kV HVDC transformer, 17 unique 345-kV reactive devices and 2 unique reactive devices at other voltage levels, 2 345-kV synchronous condensers and their transformers, 2 unique 138-kV STATCOMs, 3 unique 345-kV SVCs, and 4 unique 138-kV SVCs were identified as long lead time equipment. NERC category P0, P1, and P2 planning events were studied. The results were shared with the respective TPs. The list of long lead time equipment and study results are provided in Appendix M.

4. Economic Analysis

The 2022 RTP economic analysis was performed using production cost simulation runs for years 2024 and 2027. The start cases used in the economic analysis were the final reliability cases from the 2021 RTP. The start cases were then updated to include all the large load additions in 2022 RTP and the appropriate reliability projects identified in 2022 RTP driven by the large load additions. The input data and initial congestion tables from the 2022 RTP can be found in Appendices D and E. At the time of this analysis, ERCOT's economic criteria[13] for project evaluation was pending. As a result, potential economically driven transmission improvements were not evaluated for the 2022 RTP, and the focus of the economic analysis in the 2022 RTP was to identify the root causes of the top congested transmission elements.

Table 4 provides a system summary of the 2022 RTP economic analysis for years 2024 and 2027.

Table 4: System Summary of 2024 and 2027[14]

Description	Unit	2024	2027
Coincident Peak Load	MW	90,499	93,470
Peak Net Load[15]	MW	75,042	78,408
Minimum Net Load[15]	MW	10,951	10,952
Annual Served Demand	GWh	540,649	568,076
Annual Storage Charging	GWh	1,189	1,377
Annual Transmission Losses	GWh	12,992	13,563
Annual Generation	GWh	554,829	583,016
Load-Weighted Average LMP	$/MWh	28.89	32.12

Figure 11 shows the renewable penetration for the 2024 and 2027 study years. Renewable penetration is defined as the total amount of demand at any given time that is served by wind and solar generation. It appears possible that there may be hours when all ERCOT demand could theoretically be served by wind and solar resources. However, thermal and stability constraints on the transmission system and unit commitment limitations caused the grid simulation software to curtail available wind and solar output. Figures 12 and 13 summarize monthly production and curtailment for wind and solar generation, respectively.

[13] The Commission recently adopted rule amendments establishing these criteria. *See* PUC rulemaking Project No. 53403, *Review of Chapter §25.101 Certification Criteria*, Order Adopting Amendments to 16 TAC 25.101 as Approved at the November 30, 2022 Open Meeting (Dec. 7, 2022); available at: https://interchange.puc.texas.gov/Documents/53403_86_1256975.PDF.

[14] All results are based on the 2013 historical weather year.

[15] Hourly Net Load = Hourly Load Forecast – Hourly Wind Output – Hourly Solar Output

Figure 11: Wind and Solar Penetration

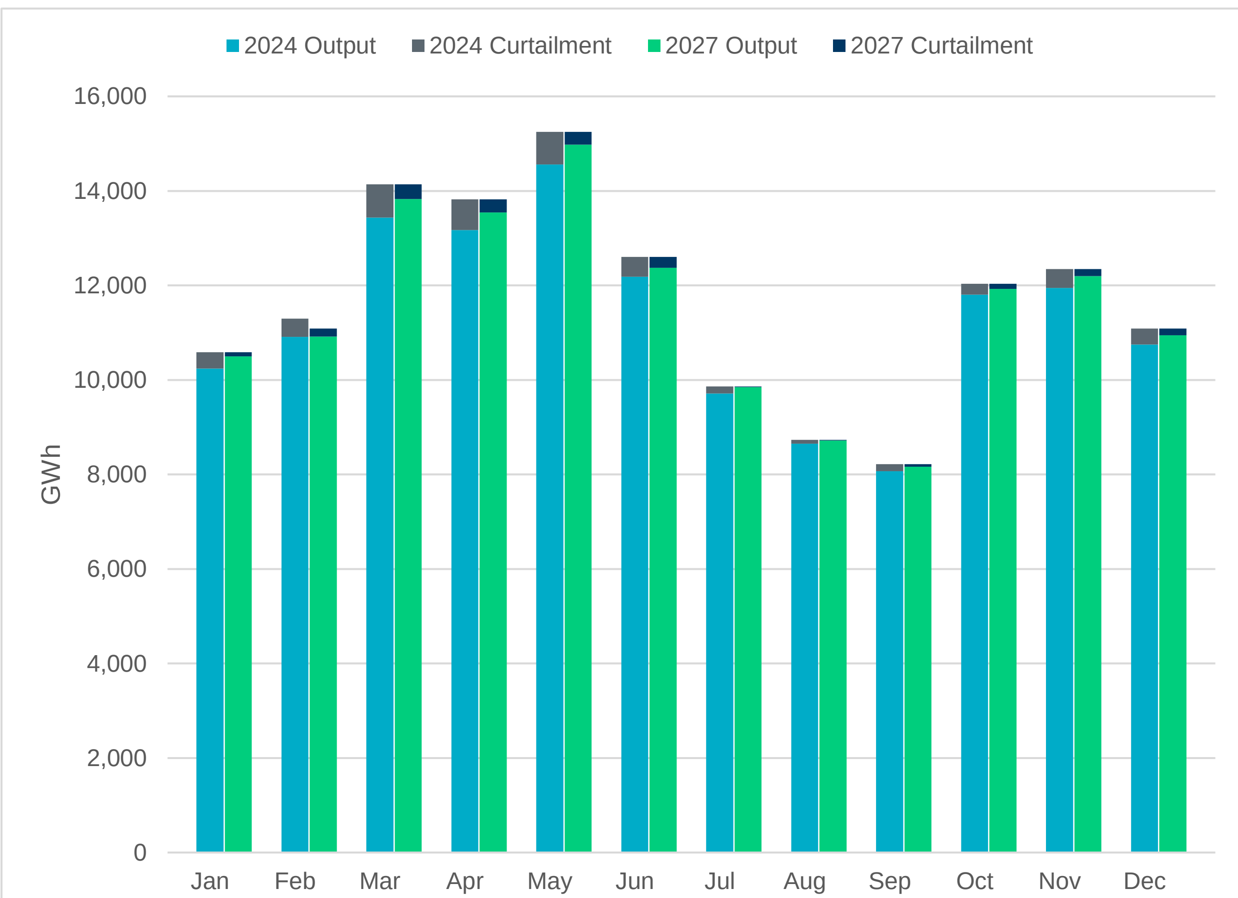


Figure 12: Wind Production and Curtailment

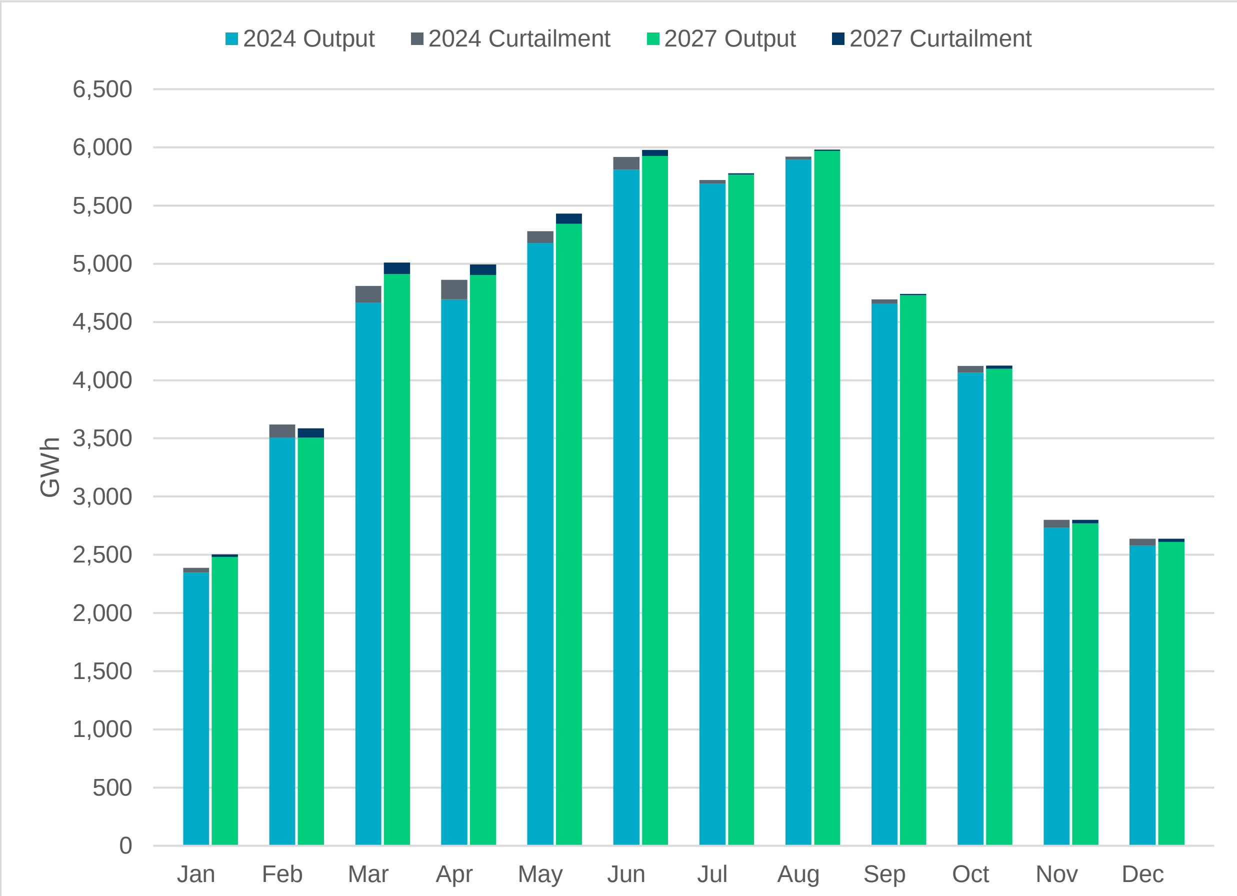


Figure 13: Solar Production and Curtailment

Figures 14 and 15 show the top constraints seen in 2024 and 2027, respectively. The size of each bubble represents the relative capacity of each congested element over the study period.

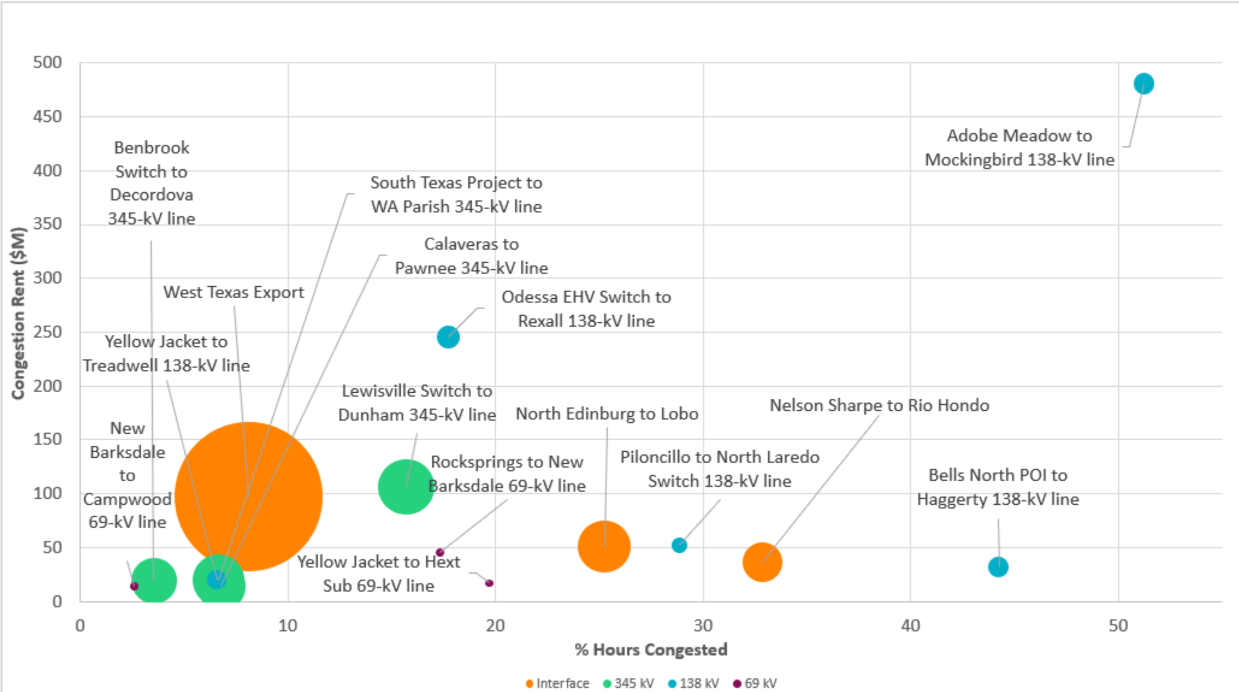


Figure 14: Top Constraints in 2024

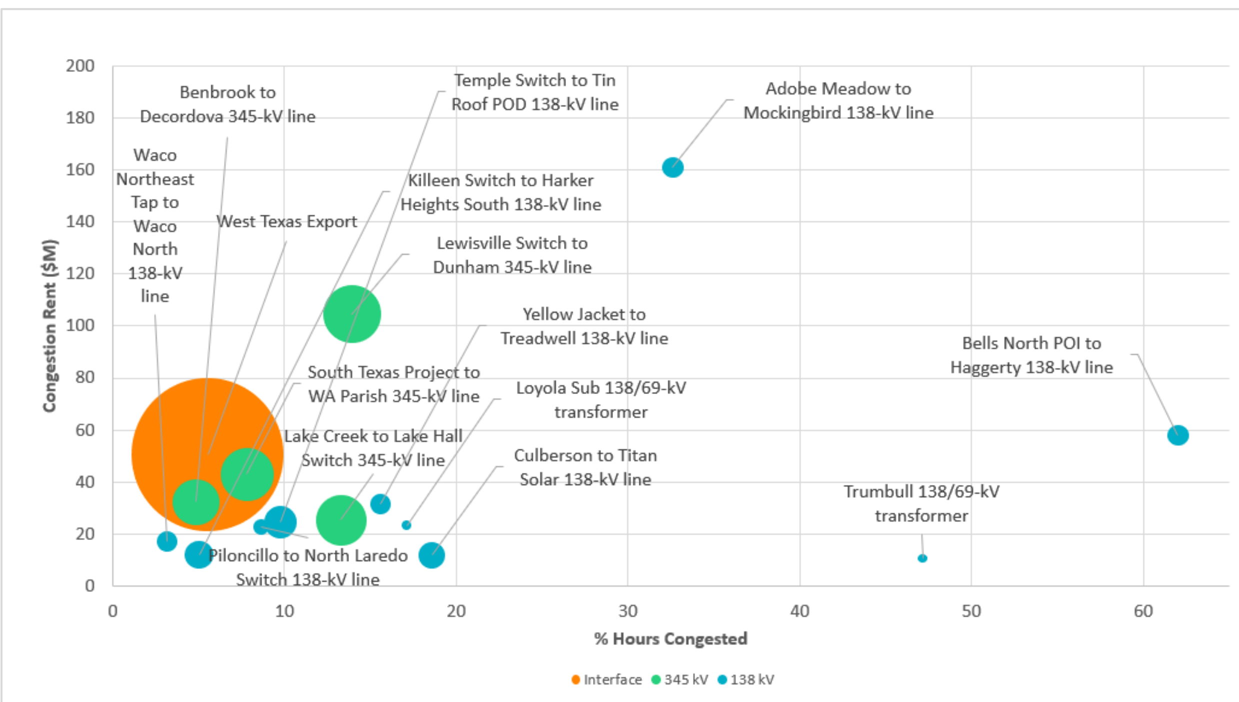


Figure 15: Top Constraints in 2027

The West Texas export interface was one of the top congested elements observed for both the 2024 and 2027 study years. The interface limit used in the 2022 RTP was 11,016 MW based on results from ERCOT's Long-Term West Texas Export Special Study[16]. The interface was congested approximately 8.1% and 5.5% of hours in the 2024 and 2027 study years, respectively. The "Bearkat - North McCamey - Sand Lake 345-kV Transmission Line Addition Project" (stage 2 project from the ERCOT Delaware Basin Load Integration study) submitted by LCRA TSC, Oncor, and WETT was endorsed by ERCOT in 2022 with a projected in-service date of summer 2026. With this project in place in the 2027 study year case, an additional path was established for wind and solar generation from the Delaware Basin to serve the local Far West and West loads, resulting in lower congestion in the 2027 study year compared to 2024. These results also indicated lower congestion compared to real-time congestion witnessed in 2022 because more renewable generation was used to serve the LFLs in the Far West weather zone. Potential improvements to alleviate congestion on the West Texas export interface informed by the results of the Long-Term West Texas Export Special Study may be evaluated in future RTP economic analyses based on the Public Utility Commission of Texas' recently amended rule revising the criteria for evaluating economic-driven projects in response to direction in Senate Bill 1281.[17]

The Lewisville Switch to Dunham 345-kV line was congested approximately 15.7% and 13.9% of hours in the 2024 and 2027 study years, respectively, under the loss of the second Lewisville Switch to Dunham 345-kV line. The congestion on the line was mainly driven by the addition of renewable generation in the North weather zone causing greater power transfers towards the Dallas-Fort Worth area.

The Adobe Meadow to Mockingbird 138-kV line was congested approximately 51.2% and 32.6% of hours in the 2024 and 2027 study years, respectively, under the loss of the Midland East to Midland County Northwest Switch 345-kV double circuit line. The congestion on this line is attributable to load growth in the Far West. The addition of the Delaware Basin Stage 2 project in the 2027 study year reduced the congestion on this line in 2027 compared to 2024. The Odessa EHV Switch to Rexall 138-kV line was congested approximately 17.7% of hours in the 2024 study year under the loss of the Moss Switch to Reiter 345-kV line. This line was upgraded in 2027 by the implementation of a Tier 4 transmission project.

Due to increasing renewable generation in the Lower Rio Grande Valley (LRGV) area, the North Edinburg to Lobo interface and Nelson Sharpe to Rio Hondo interface experienced congestion in the 2024 study year. It was observed that the North Edinburg to Lobo interface was congested 25.2% of hours and the Nelson Sharpe to Rio Hondo interface was congested 32.9% of hours in the 2024 study year. The ERCOT Board of Directors endorsed the Lower Rio Grande Valley (LGRV) System Enhancement Project in December 2021 with the projected in-service date of early 2027. The Public Utility Commission of Texas (PUCT) also ordered the construction of a new second circuit on the

[16] https://www.ercot.com/files/docs/2022/01/14/Long-Term-West-Texas-Export-Study-Report.pdf
[17] *See* PUCT Project 53403, Order Adopting Amendments to 16 TAC § 25.101 As Approved at the November 30, 2022 Open Meeting, available at: https://interchange.puc.texas.gov/Documents/53403_86_1256975.PDF.

double-circuit capable 345-kV transmission line that runs from San Miguel to Palmito and new transmission facilities to close the loop from Palmito to North Edinburg. Those improvements for the LGRV area were included in the appropriate years in the 2022 RTP economic planning analysis. With the addition of these improvements, the congestion in the LRGV was no longer seen in the 2027 study year. However, the South Texas Project to WA Parish 345-kV line remained congested 6.7% and 7.8% of hours in the 2024 and 2027 study years, respectively.

Finally, as required by ERCOT Protocols Section 3.10.8.4(3), ERCOT identified additional transmission elements that have a high probability of providing significant added economic efficiency to the ERCOT market using dynamic ratings. Dynamic ratings for the identified elements (listed in Appendix N) have been requested from the associated TOs.

5. Appendices

Index	Description	Document	Access
A	RTP Scope and Process Document	Appendix_A_2022_RTP_Scope_and_Process_Final.pdf <file included in the public version>	Public
B	Input assumptions for the 2022 RTP reliability analysis	Appendix_B_2022_RTP_Reliability_Input_Assumptions.xlsx <file included in the public version>	Public
C	WFW IHS new load interconnection	Appendix_C_2022_RTP_WFW_IHS_New_Load_Interconnection.xlsx <file available in the MIS Secure Area>	MIS Secure
D	Input assumptions for the 2022 RTP economic analysis	Appendix_D_2022_RTP_Economic_Input_Assumptions.xlsx <file included in the public version>	Public
E	Economic analysis start case input and annual constraints	Appendix_E_2022_RTP_Economics_Start_Case_Inputs_Annual_Contraints.zip <file available in the MIS Secure Area>	MIS Secure
F	Reliability Driven Projects	Appendix_F_2022_RTP_Reliability_Projects_Public.xlsx <file included in the public version>	Public
G	Project locations	Appendix_G_2022_RTP_Project_Locations.pdf <file included in the public version>	Public
H	Constraint Management Plans	Appendix_H_2022_RTP_ConstrainstManagementPlans.xlsx <file available in the MIS Secure Area>	MIS Secure
I	Multiple element outage analysis	Appendix_I_2022_RTP_MultipleElementContingencyStudyReportI.docx	N/A
J	Facilities loaded over 95%	Appendix_J_2022_RTP_95%_Exceedance_PG31123.xlsx <file available in the MIS Secure Area>	MIS Secure
K	Sensitivity Analysis Results	Appendix_K_2022_RTP_Sensitivity_Projects.xlsx <file available in the MIS Secure Area>	MIS Secure
L	Short circuit Analysis	Appendix_L_2022_RTP_ShortCircuitStudyCases_DetailedResults.docx <file available in the MIS Secure Area>	MIS Secure
M	Long lead time equipment analysis	Appendix_M_2022_RTP_LongLeadTimeEquipment.docx	N/A
N	Transmission elements proposed to be dynamically rated	Appendix_O_2022_RTP_DynRating_NP3_10_8_4.xlsx <file available in the MIS Secure Area>	MIS Secure