



**Report on Existing and  
Potential Electric System  
Constraints and Needs**

December 2022

## Key Takeaways

ERCOT has seen an increased interest in the development of cryptomining loads and other **Large Flexible Loads**, which present unique challenges to the grid. ERCOT is working with stakeholders to develop processes to reliably interconnect these loads. Additionally, **Electric Vehicle** adoption is projected to grow significantly in the near future, driving the need to include their load impact in near-term planning studies.

The ERCOT grid continues to evolve with increased thermal generation **retirement**, rapid growth in transmission-connected **wind**, **solar** and **energy storage** development, and distributed generation. ERCOT is critically evaluating planning processes and pursuing changes necessary to meet challenges associated with the **evolving grid**.

There is increasing interest in **HVDC** line development in the ERCOT region. The HVDC proposals may potentially add a 2 GW connection to the Eastern Interconnection and a 1.5 to 3 GW connection to the Western Interconnection. ERCOT will continue work under the direction of the Public Utility Commission of Texas to perform studies for any HVDC proposals.

Recent legislative changes require significant changes to the transmission **planning criteria** used in ERCOT's evaluation of **economic driven projects** and require ERCOT to conduct a biennial **Grid Reliability Assessment** to assess the grid's reliability in **extreme weather scenarios**.



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# About ERCOT Transmission Planning

**ERCOT supervises and exercises comprehensive independent authority over the planning of transmission projects for the ERCOT system as outlined in the Public Utility Regulatory Act (PURA) and Public Utility Commission of Texas (PUCT) Substantive Rules.** PUCT Substantive Rules further require ERCOT to evaluate and make a recommendation to the PUCT as to the need for any transmission facility over which ERCOT has comprehensive transmission planning authority. ERCOT examines the need for proposed transmission projects based on ERCOT planning criteria and North American Electric Reliability Corporation (NERC) Reliability Standards. Once a project need has been identified, ERCOT evaluates project alternatives based on cost-effectiveness, long-term system needs, and other factors.

The ERCOT Protocols and Planning Guide describe the practices and procedures through which ERCOT meets its requirements related to system planning under PURA, PUCT Substantive Rules, and NERC Reliability Standards.

ERCOT annually performs a planning assessment of the transmission system that is primarily based on two sets of studies:

- The Regional Transmission Plan (RTP) addresses region-wide reliability and economic transmission needs and includes the recommendation of specific planned improvements to meet those needs for the upcoming six years. The public version of the 2022 RTP report is posted on the ERCOT website at: <https://www.ercot.com/gridinfo/planning>.
- Stability studies are performed to assess the angular stability, voltage stability, and frequency response of the ERCOT system. Due to the security-related sensitive nature of the information contained in these study reports, they are not published on the ERCOT website.

ERCOT also conducts the biennial Long-Term System Assessment (LTSA), which is completed in even-numbered years. The LTSA uses scenario-analysis techniques to assess the potential needs of the ERCOT system up to 15 years into the future. The role of the LTSA is to guide near-term planning decisions by providing a longer-term view of system reliability and economic needs. The 2022 Long-Term System Assessment report is posted on the ERCOT website at: <https://www.ercot.com/gridinfo/planning>.

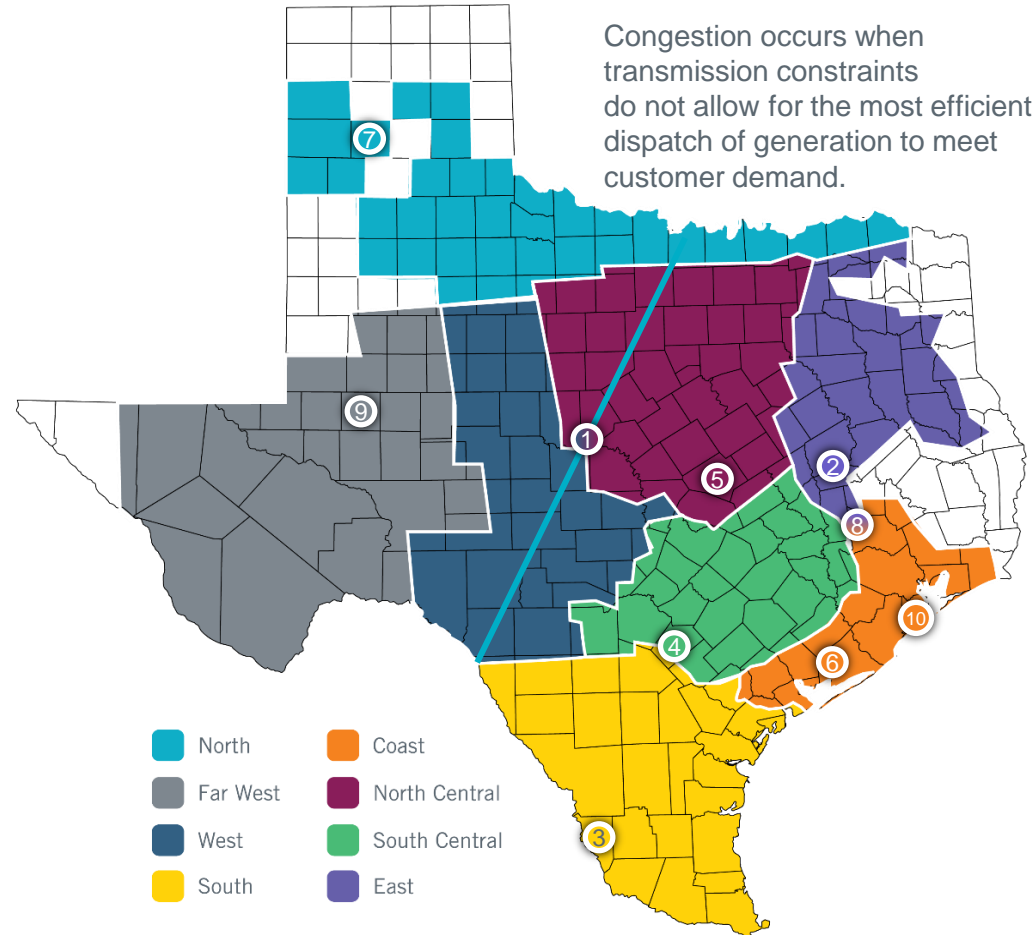
Map	Constraint	Congestion Rent*	Outage Related?
1	West Texas Export Interface	\$293M	-
2	Jewett to Singleton 345-kV Line	\$170M	-
3	North Edinburg to Lobo Interface	\$132M	-
4	Pawnee Switching Station to Calaveras 345-kV Line	\$95M	Planned outages
5	Killeen Switch 345-kV	\$94M	Planned outages
6	Hillje to South Texas Project 345-kV Line	\$86M	Planned outages
7	Panhandle Export Interface	\$52M	-
8	North to Houston Interface	\$80M	-
9	Midland County Northwest Switch to Mockingbird 138-kV Line	\$74M	Planned outages
10	Magnolia Tnp to Seminole Tnp 138-kV Line	\$66M	Planned outages

\*Congestion rent indicates areas of the system where economic transmission projects may be beneficial. It is not an indication of whether a project to reduce specific congestion would or would not meet the ERCOT economic planning criteria.

## Recent Constraints

### Top 10 constraints on the ERCOT system

Oct. 2021 to Sept. 2022, based on real-time data





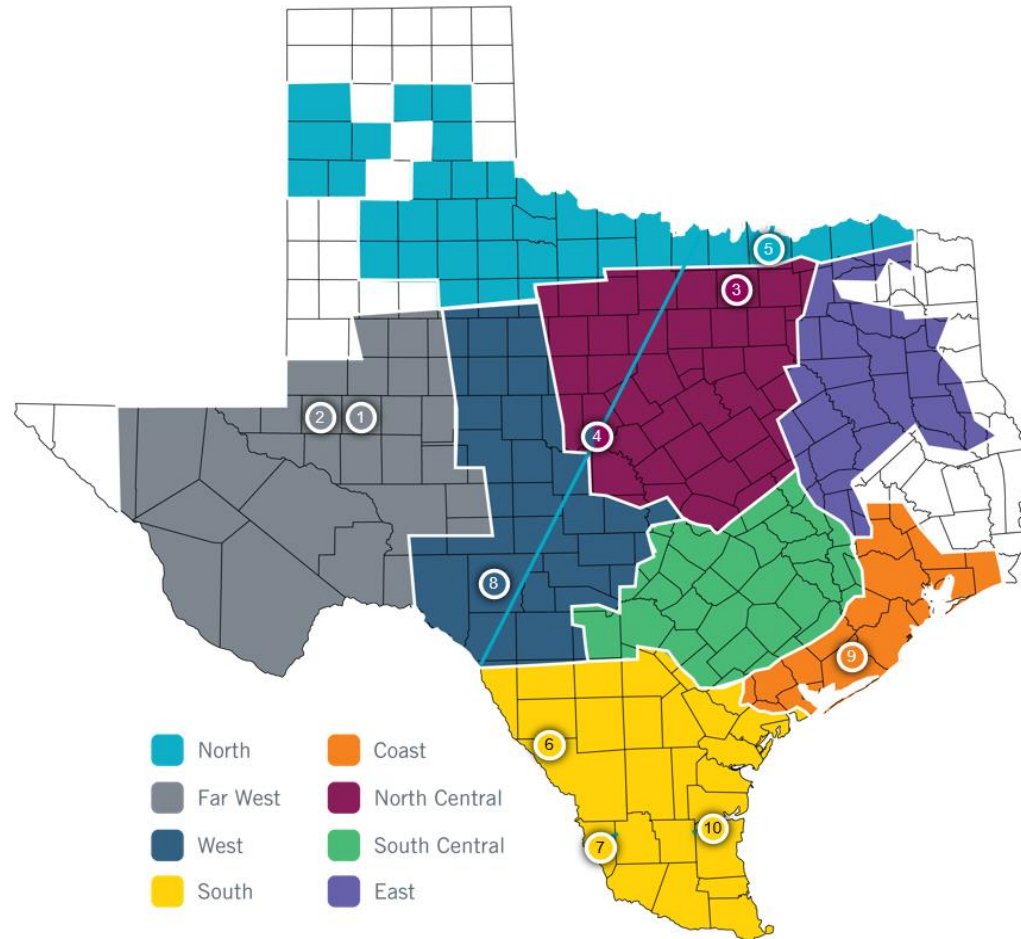
Map	Constraint	Congestion Rent*	
		2024	2027
1	Adobe Meadow to Mockingbird 138-kV line	\$481M	\$161M
2	Odessa EHV Switch to Rexall 138-kV line	\$246M	-
3	Lewisville Switch to Flowermound 345-kV line	\$106M	\$105M
4	West Texas Export Interface	\$97M	\$51M
5	Bells North POI to Haggerty 138-kV line	\$32M	\$58M
6	Piloncillo to North Laredo Switch 138-kV line	\$52M	\$23M
7	North Edinburg to Lobo Interface	\$51M	-
8	Rocksprings to New Barksdale 69-kV line	\$46M	\$0.03M
9	South Texas Project to WA Parish 345-kV line	\$20M	\$43M
10	Nelson Sharpe to Rio Hondo Interface	\$37M	-

\*Congestion rent indicates areas of the system where economic transmission projects may be beneficial. It is not an indication of whether a project to reduce specific congestion would or would not meet the ERCOT economic planning criteria. Planned transmission outages were not included in the analysis.

## Projected Constraints

### Top 10 projected constraints on the ERCOT system for 2024 and 2027

Based on economic analysis conducted for the 2022 RTP

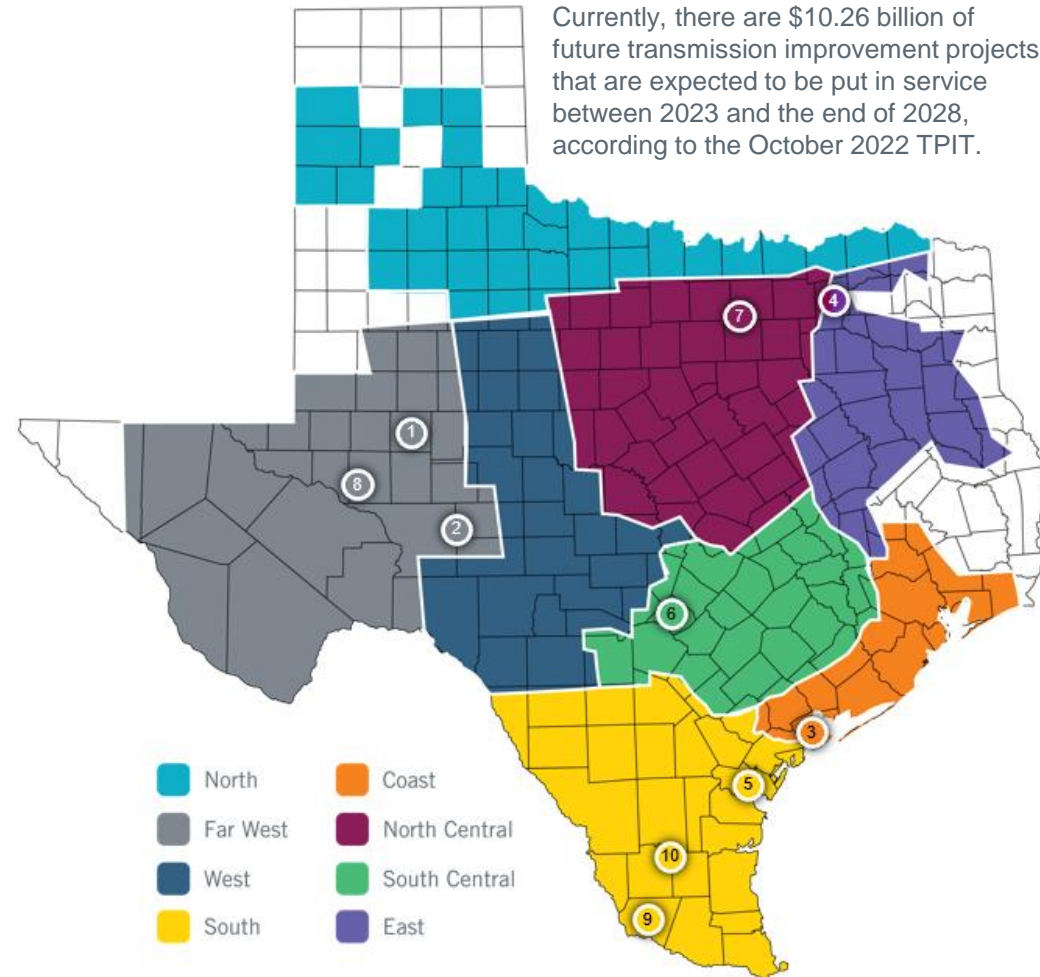


# Planned Improvements

## Top 10 significant improvements on the ERCOT system

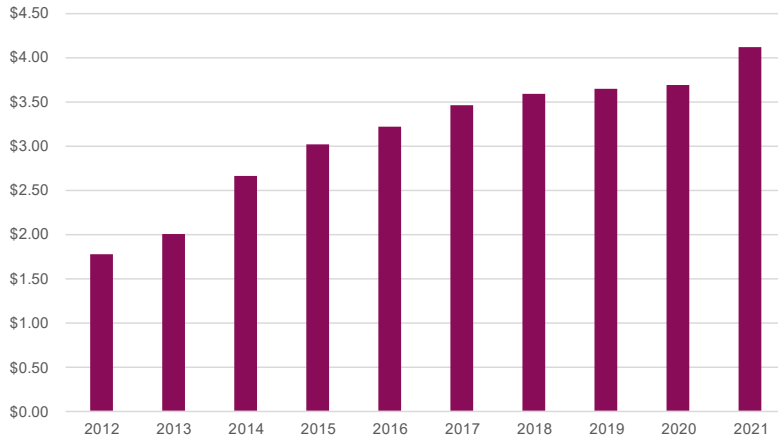
Projects planned for completion within the next six years

Map	Transmission Improvement	In-Service
1	New Bearkat - Longshore 345-kV Line	2023
2	Bakersfield - Big Hill 345-kV Second Circuit Addition	2023
3	Port Lavaca Area Improvement Project	2023, 2025
4	Royse - Commerce 69-kV Line Conversion to 138 kV	2024
5	Corpus Christi North Shore Project	2024
6	Hays Energy - Kendall Corridor Transmission Line Rehabilitation Projects	2024, 2025
7	Roanoke Area Upgrades Project	2025
8	Bearkat - North McCamey - Sand Lake 345-kV Transmission Line Addition Project	2026
9	Second 345-kV Circuit from San Miguel - Palmito	2024
	Loop La Palma into the North Edinburg - Palmito 345-kV Double-Circuit Line	2026
10	Lower Rio Grande Valley System Enhancement Project	2027



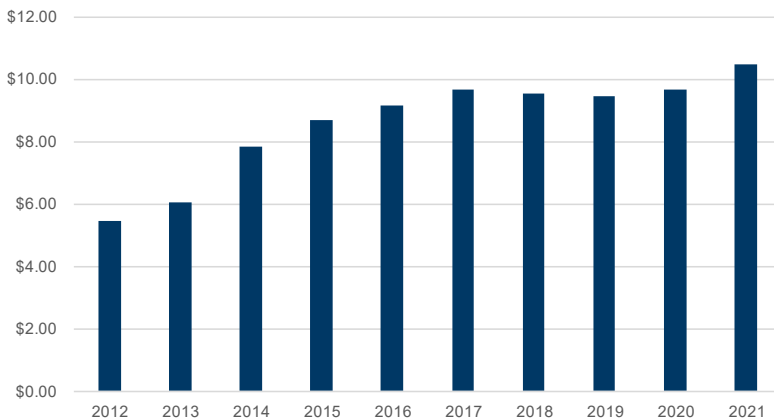
# Transmission Cost Trend

ERCOT Annual Transmission Cost of Service  
(\$ Billion)

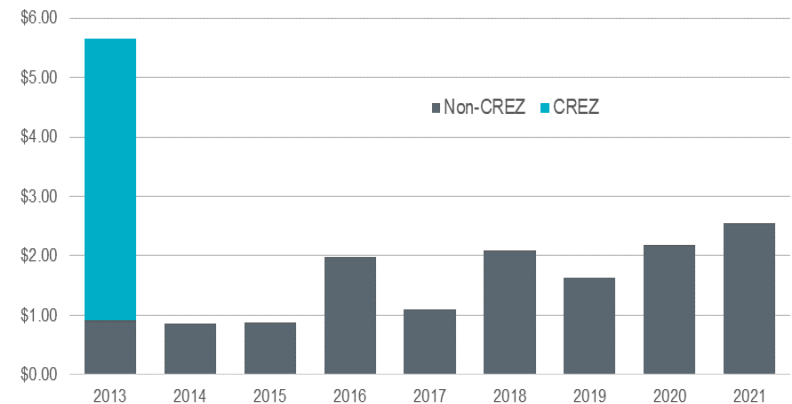


For the ERCOT region, the total Transmission Cost of Service<sup>1</sup> (TCOS), which reflects investment in transmission improvements, has increased in the past several years along with TCOS per MWh.<sup>2</sup>

ERCOT Annual Transmission Cost of Service  
per Total MWh Energy Use  
(\$)



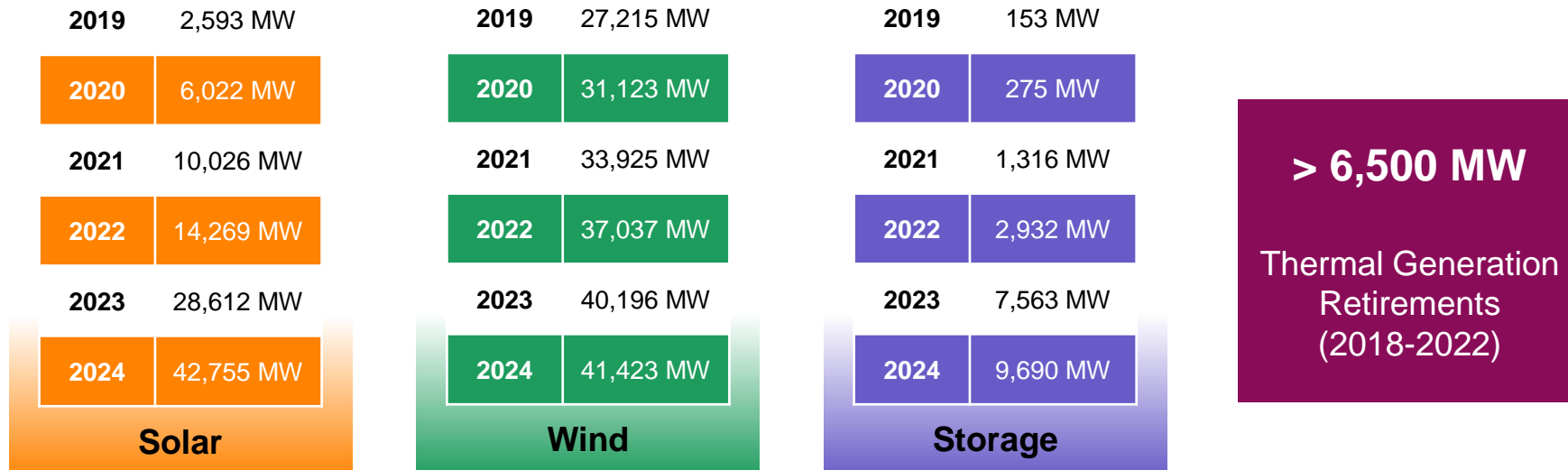
ERCOT Transmission Improvements by In-Service Year  
(\$ Billion)



1. TCOS values are based on [ERCOT's Yearly Wholesale Transmission Service Charges](#) filed with Public Utility Commission of Texas
2. Total MWh Energy Use values are based on [ERCOT's Demand and Energy Report](#) published in ERCOT Market Information System (MIS)



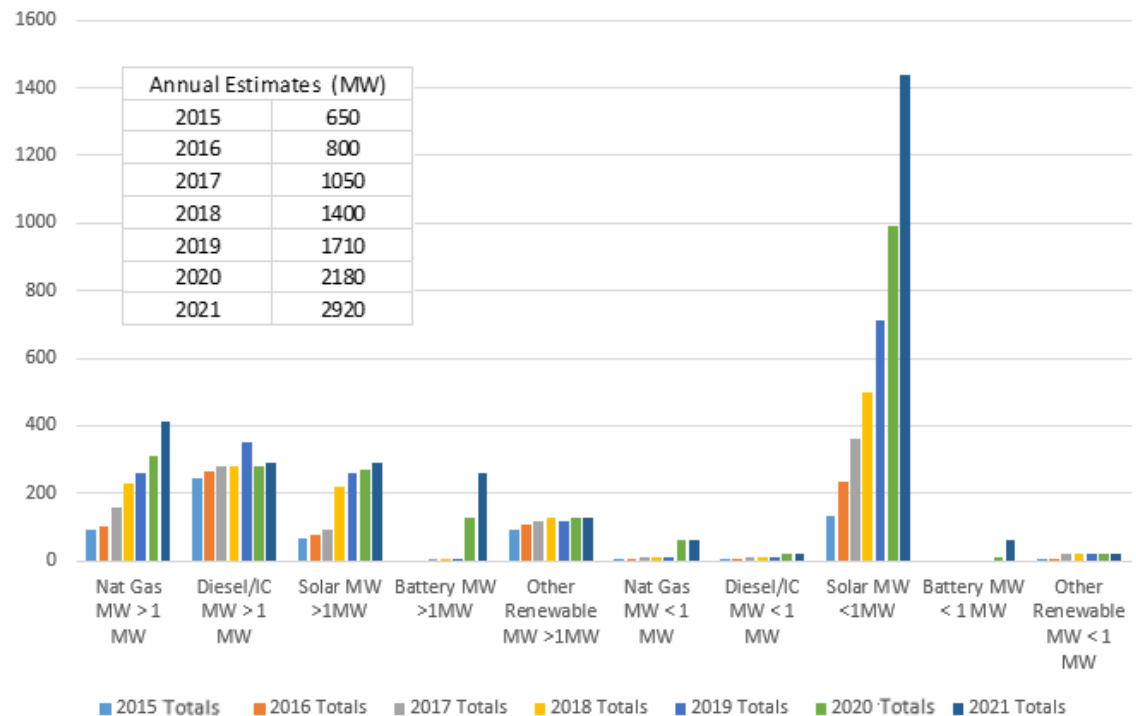
# The Changing Grid - Generation



- ERCOT continues to experience a rapid shift in the type and location of generation available to serve demand.
- Robust growth of inverter-based resources (IBR) has continued. More than 54 GW of transmission-connected wind, solar, and battery energy storage capacity is expected to be installed by the end of 2022. Total IBR capacity has the potential to exceed 93 GW in 2024.
- Over 6,500 MW of coal and natural gas generation has retired since 2018.
- The change in generation mix has also resulted in increased distance between generation sites and demand centers. Retired coal and gas generation were closer to large cities, whereas the most abundant wind and solar resources tend to be in more distant locations.

# The Changing Grid – Distributed Generation (DG)

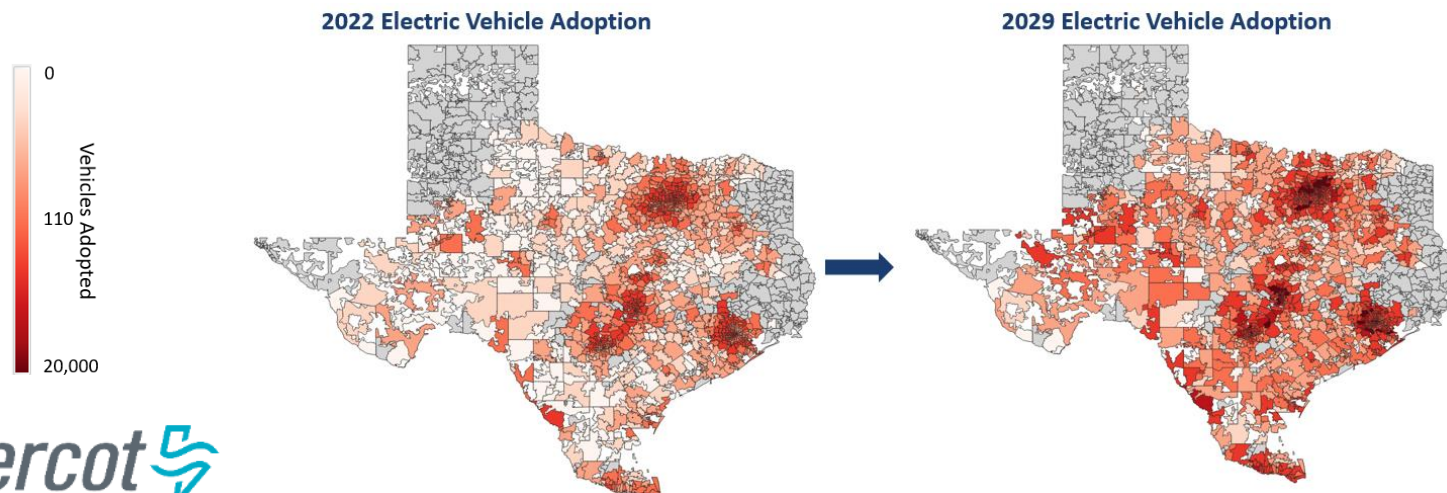
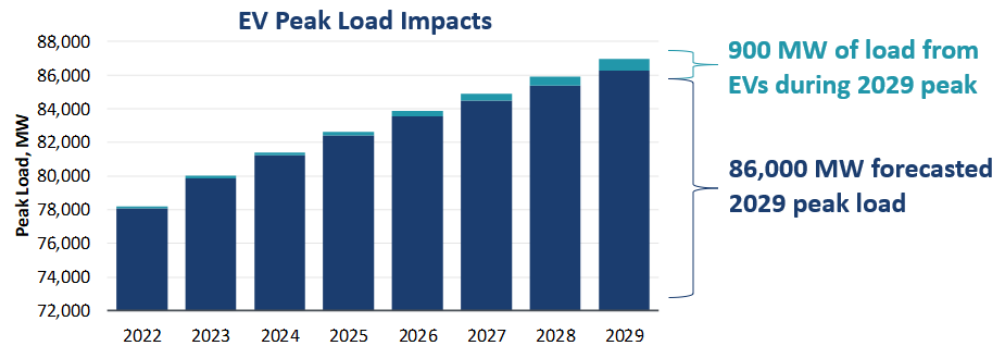
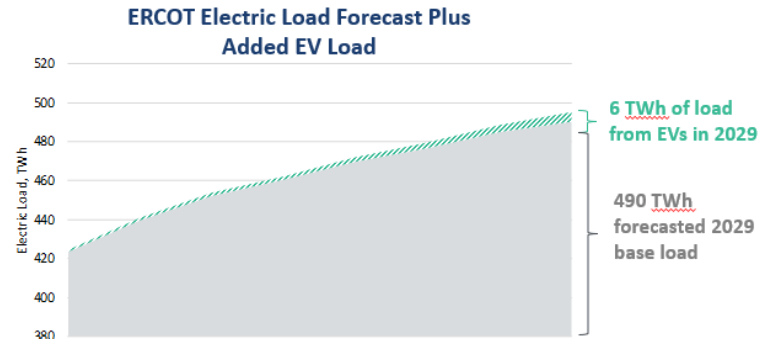
- ERCOT region is experiencing rapid growth in DG, especially solar photovoltaic less than 1 MW, which includes rooftop solar and community solar. Total DG at the end of 2021 is estimated to be more than 2,900 MW.
- It is projected that the installed capacity for rooftop solar may reach 7,519 MW by 2030 for the aggressive scenario, 4,477 MW for the conservative scenario, and 5,861 MW for the moderate scenario.



- ERCOT developed a rooftop solar growth forecast for the 2022 Long-Term load forecast and the impacts of both the operational DGs and projected rooftop solar growth were incorporated in the 2022 Regional Transmission Plan (RTP).
- ERCOT is currently working with TDSPs on data requirements and consistent modeling of DGs for planning studies.

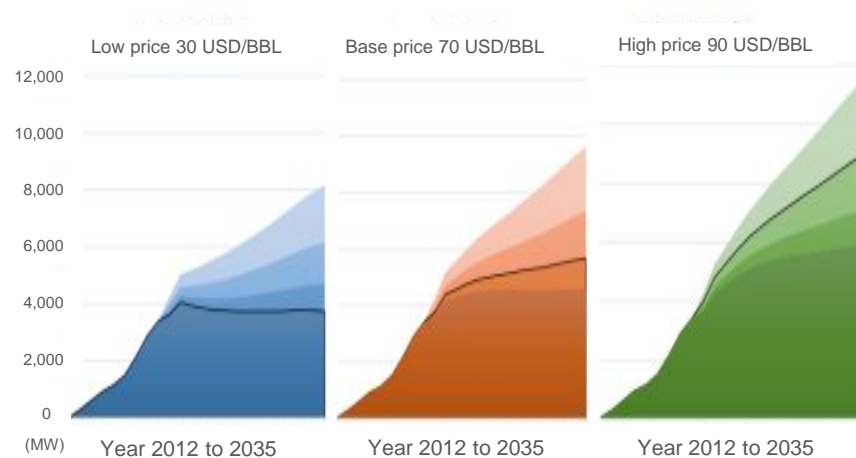
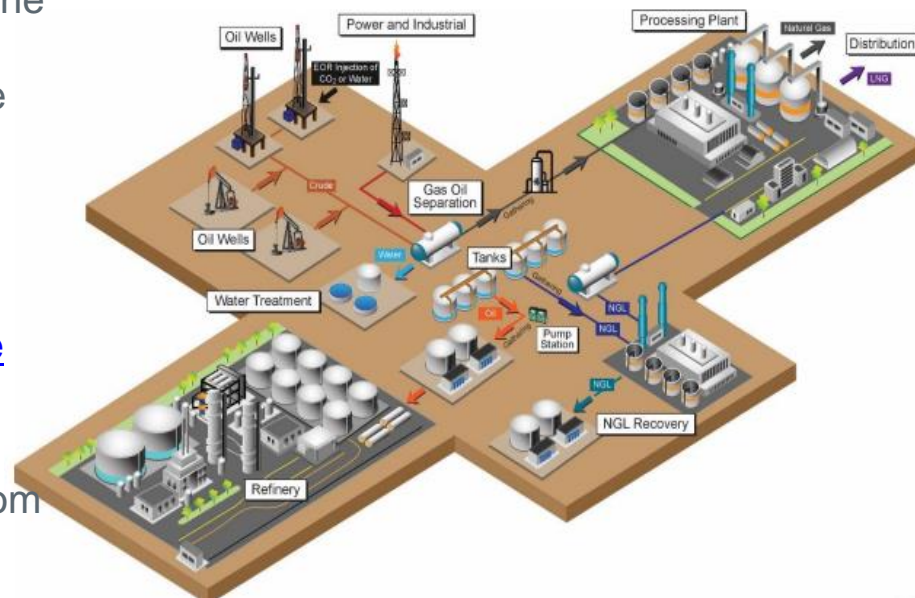
# The Changing Grid – Electrical Vehicles (EV)

- Adoption of EVs is expected to increase significantly in the near future, with 4% of all the vehicles on the road projected to be EV in Texas by 2029 and 6 TWh of load from EV charging by that same year. This signifies a need to include EV load impacts in near-term planning studies.
- ERCOT engaged with TDSPs on the discussion of EV adoption in 2021 and retained the Brattle Group in 2022 to develop a [methodology and process](#) to produce EV load forecasts at the substation level. The substation level EV load impacts will be incorporated into near-term transmission planning studies starting in 2023.



# The Changing Grid – Demand in Permian Basin

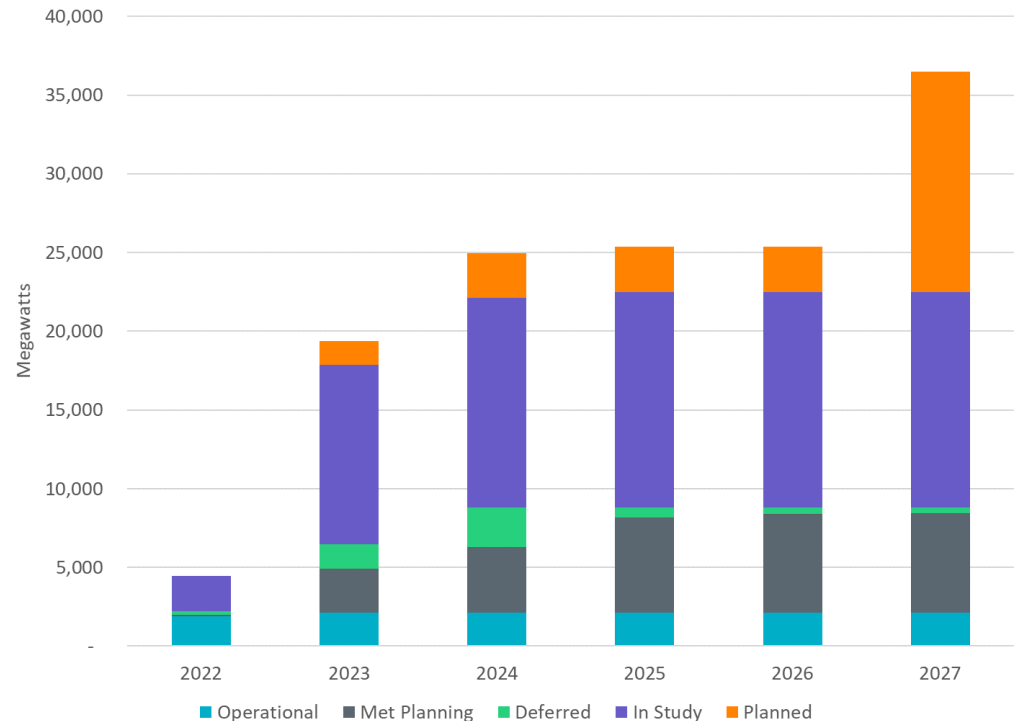
- In 2021, ERCOT began an engagement with the Bureau of Economic Geology (BEG) Tight Oil Resource Assessment (TORA) program at the University of Texas (UT) at Austin to better understand the electricity demand forecast associated with oil and gas activities within Permian Basin.
- The study was complete in May 2022, and [the final report](#) was posted on the ERCOT public website.
- The key findings and conclusions identified from the study are as follows:
  - Continued increase in oil and gas development is expected within Permian Basin
  - Future electricity demand associated with oil and gas may vary depending on market price, level of electrification, and regulation (e.g., emission)
  - Both UT BEG TORA and IHS Markit produced similar electricity demand forecasts related to oil and gas development using similar key assumptions. Based on the comparison, it was determined that the load forecast from [the IHS Markit study](#) produced in 2020 is reasonable for transmission planning studies of the Permian Basin area.



(Assumed Electrification Levels: 10%, 30%, 58%, 97%)

# The Changing Grid - Large Load Interconnection

- ERCOT has seen an increased interest in the development of data centers and cryptocurrency mining facilities. ERCOT has worked with stakeholders to develop processes to reliably integrate large-scale load additions in a timely manner.
- An interim large load interconnection process was developed in 2022 to facilitate the interconnection of those loads.
- ERCOT is currently working on the formal interconnection requirements and process to reliably interconnect large loads.
- The amount of operational large load as of mid-December 2022 is 1,873 MW.



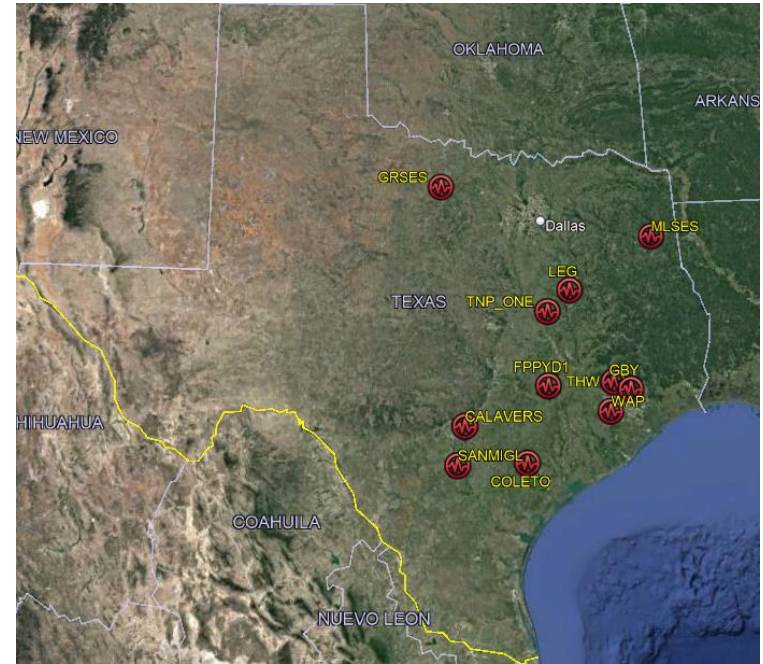
- **Operational** – Projects that are currently in operation and projects that are approved to energize by ERCOT. This category also accounts for staged energization schedules.
- **Met Planning** – Projects that have received approval of the required planning studies.
- **Deferred** – Project MWs that were limited after ERCOT review or for which the project owner has provided an energization schedule.
- **In Study** – Projects that have studies under review by ERCOT.
- **Planned** – Projects that are tracked by ERCOT but that have not yet provided sufficient information to begin review.





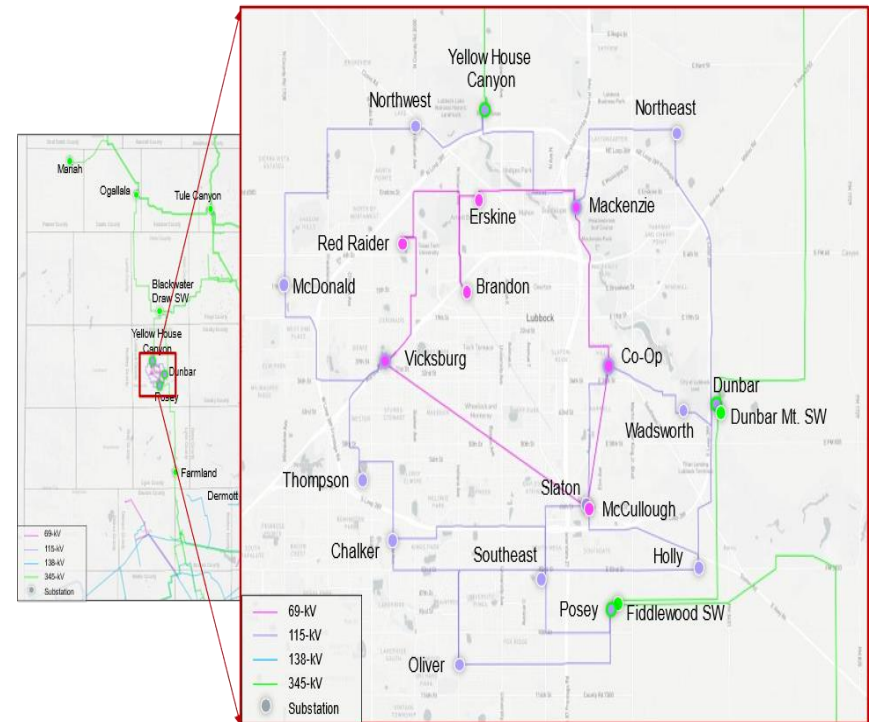
# Impact Analysis of Regional Ozone Transport Rule

- The Cross-State Air Pollution Rule (CSAPR) Federal Implementation Plan (FIP) was proposed by the Environmental Protection Agency (EPA) on April 6, 2022. ERCOT has performed a preliminary analysis of the potential effect the adoption of this rule would have on the ERCOT grid in 2026.
- The analysis assumed the retirement of 10,803 MW (installed capacity) of thermal generation, which included 8,203 MW of coal-fired generation at 7 locations, and 2,600 MW of gas-fired generation at 4 locations.
- Some of the key findings of ERCOT's [preliminary analysis](#) are listed below:
  - \$1.2 to \$1.5 billion in transmission upgrades would be needed to resolve the local reliability issues. In addition, there could be an accelerated need for an additional \$2.7 to \$5.2 billion of transmission improvements to improve the ERCOT regional transfer capability after the retirement of the CSAPR-affected generation.
  - It was estimated that the probability of load shed for summer 2026 increases by almost nine times at 8pm when solar generation becomes unavailable.
  - The approval rate of maintenance outages would be expected to decrease by 1/3 and the gross inertia capacity of the system would be expected to decrease by 13%.



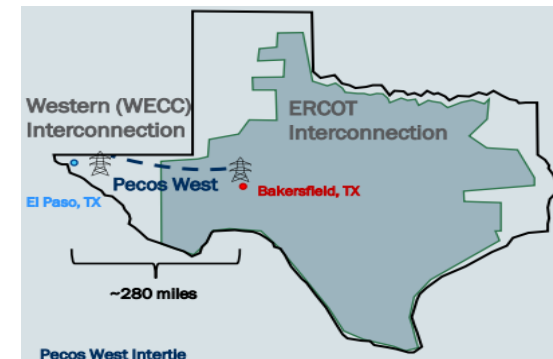
# Lubbock Power & Light (LP&L) Load Integration

- LP&L is a municipally owned electric utility company located in Lubbock County, Texas. The Commission issued its Final Order on March 15, 2018 in Docket No. 47576 approving LP&L's application to connect approximately 70% of its total load to the ERCOT System from SPP. The integration of this initial load into the ERCOT System was completed on May 30, 2021.
- On April 27, 2022, the City of Lubbock, acting by and through LP&L, filed an application (Docket. No. 53529) with the Commission for authority to connect the remaining portion of its load with ERCOT on or before June 1, 2023.
- ERCOT performed [an independent study](#) and found no significant impact due to the load transfer.
- Pending PUC approval of the transfer of the remaining load (estimated to be 183 to 188 MW), the total LP&L Load is estimated to be 609 MW (Year 2024) to 627 MW (Year 2028).



# High Voltage Direct Current (HVDC) Transmission

- ERCOT currently has four asynchronous ties to other grids: two connections to the Eastern Interconnection with a total capacity of 820 MW, and two ties to the Mexican system with a total capacity of 400 MW. These ties allow ERCOT and the connecting grids to exchange power in emergencies and for entities to trade power between the grids on a commercial basis.
- Southern Cross Transmission proposed building a 2,000 MW merchant tie between ERCOT and the Eastern Interconnection via 400-mile HVDC line. As of September 2022, ERCOT reported that it had materially completed its work on the directives assigned to ERCOT by the PUC in Project No. 46304. These include Directive 6 (determination regarding any needed transmission upgrades) and Directive 8 (determination regarding Primary Frequency Response and Voltage Support).
- In 2022, Grid United Texas submitted an application in PUC Docket No. 53758 seeking PUC approval of the [Pecos West Intertie](#), which is a proposed 280-mile, 1,500-MW HVDC transmission line, with potential for expansion up to 3,000 MW, that would connect ERCOT to the Western Interconnection at El Paso by 2029.
- ERCOT plans to conduct a study of the project upon receiving PUC direction of the appropriate study scope.



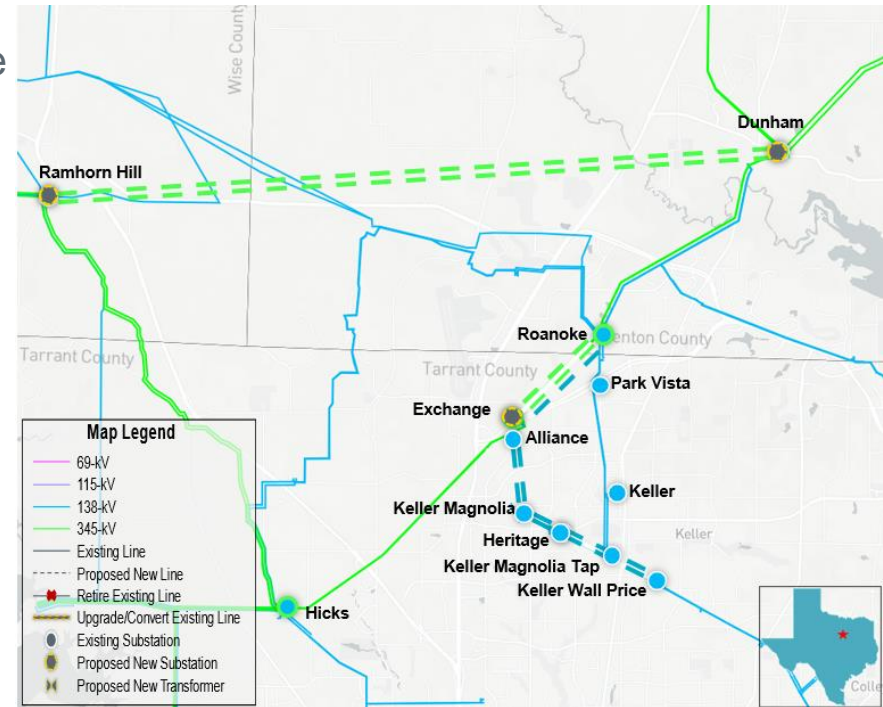
# Recent PUC Rule Changes and Initiatives

- In November 2022, the PUC adopted amendments to Substantive Rule 25.101, relating to certification criteria. These amendments will implement statutory changes introduced by Senate Bill (SB) 1281 and House Bill 5 (HB) 1510 in 2021. Specifically, the new rule will establish a congestion cost savings test for evaluating economic transmission projects; require the commission to consider historical load, forecasted load growth, and additional load seeking interconnection when evaluating the need for additional ERCOT reliability transmission projects; provide exemptions to the certificate of convenience and necessity (CCN) requirements for certain transmission projects; and require ERCOT to conduct a biennial assessment of the ERCOT power grid's reliability and resiliency in extreme weather scenarios. The rule will also allow the PUC to consider the resiliency benefits of a proposed transmission project, as determined by the new biennial assessment conducted by ERCOT, when determining whether to approve the project.
- The PUC also adopted an updated version of Substantive Rule 25.55, regarding weather emergency preparedness, adding new summer weather preparedness requirements and revising winter weather preparedness requirements.
- The PUC has been working with ERCOT and its stakeholders to advance reforms to the Capacity, Demand and Reserves (CDR) and Seasonal Assessment of Resource Adequacy (SARA) reports to provide a more comprehensive assessment of generating resource reliability under extreme weather scenarios and with the increased penetration of wind, solar and energy storage resources.



# Dallas-Fort Worth (DFW)

- The load in the northern Fort Worth/Roanoke – Alliance area has been grown significantly, driven by commercial and industrial development in addition to expansion of residential areas. The significant load growth is expected to continue throughout the planning horizon.
- ERCOT conducted an independent review and identified a reliability need for additional transmission capacity and operational flexibility in the Roanoke area.
- The Roanoke Area Upgrades Project was endorsed in 2022 to meet the reliability needs, provide operation flexibility, and offer improved long-term load-serving capability to the area.
- The cost of these transmission improvements is approximately \$286 million; they are expected to be in service by May 2025.



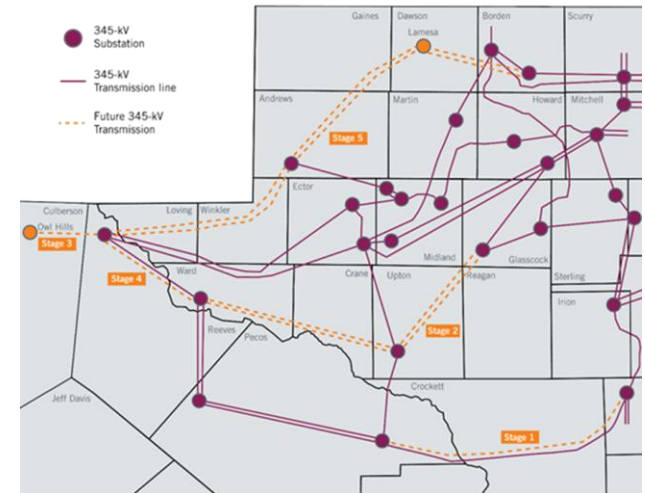
Reliability Upgrades	Unit
New 345-kV Lines	~19 miles
Existing 345-kV Line Upgrades	~ 4 miles
New 345-kV Substations	3
New 345/138-kV Transformers	2
New 138-kV Lines	~ 5 miles
Existing 138-kV Line Upgrades	~ 2 miles



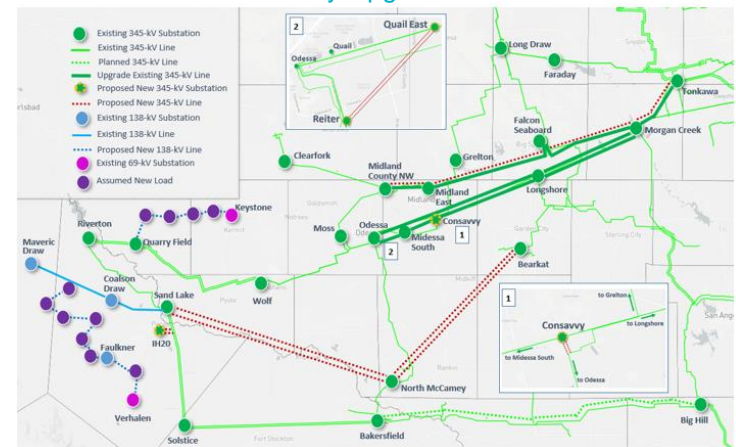
# West Texas

- Besides the rapid oil and gas load growth projected by the [IHS Markit study](#), the 2022 RTP also includes more than 3 GW of large load in West Texas, which brought the total projected load in the Far West weather zone to more than 12 GW under summer peak conditions by 2028.
- In order to serve the projected demand, the following major system improvements identified by ERCOT in previous special studies need to be in place:
  - Bearkat - North McCamey - Sand Lake 345-kV double-circuit line addition<sup>1</sup>
  - Faraday - Lamesa - Clearfork - Riverton 345-kV double-circuit line addition<sup>2</sup>
  - 213 circuit miles of 345-kV line upgrade/rebuild and 123 circuit miles of new 345-kV line<sup>3</sup>
- The 2022 RTP also identified the need to add a significant amount of reactive power support devices in Far West Texas, including dynamic devices to support the interconnection of the large load.

## Delaware Basin Load Integration Study Road Map



## Permian Basin Load Interconnection Study Preferred Reliability Upgrade for 2030



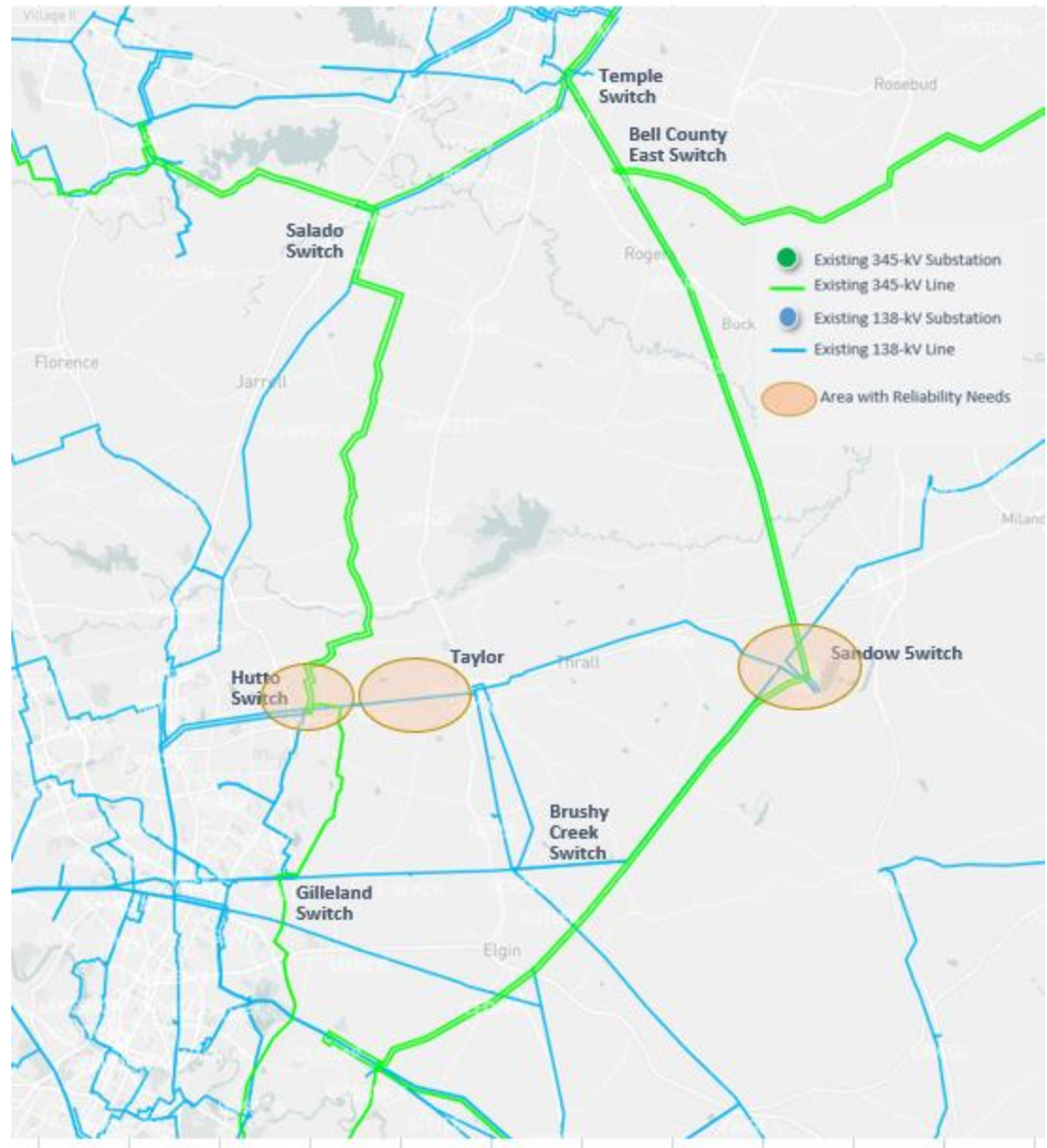
<sup>1</sup> ERCOT Delaware Basin load integration study stage 2 project; endorsed by ERCOT Board in 2022

<sup>2</sup> ERCOT Delaware Basin load integration study stage 5 project

<sup>3</sup> ERCOT Permian Basin load interconnection study preferred projects

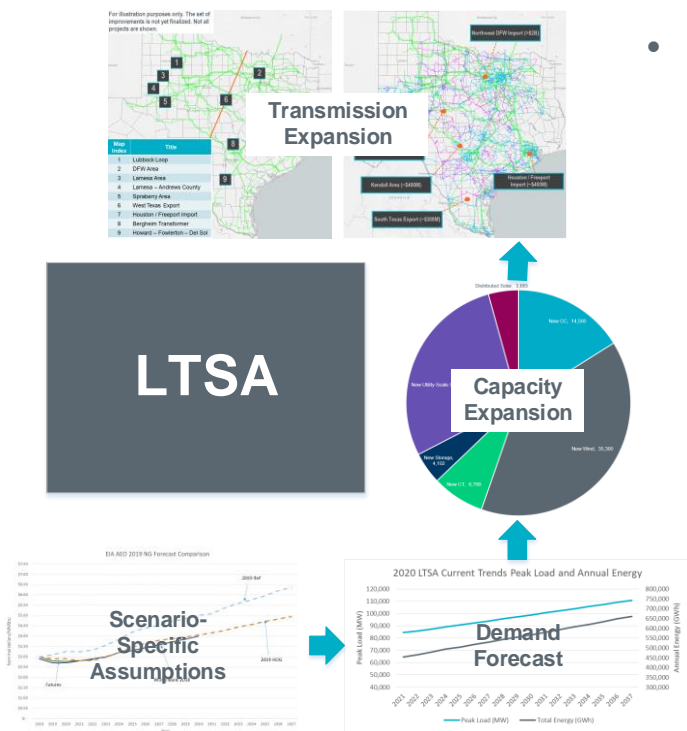
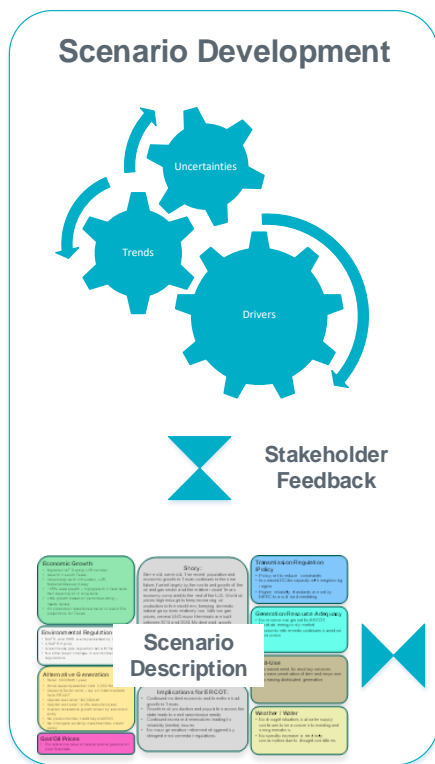
# Austin Area

- The 2022 RTP included approximately 2 GW of large load northeast of the Austin area.
- The 2022 RTP identified reliability needs on the 138-kV system from Taylor to Hutto, as well as at the Hutto Switch and Sandow Switch 345-kV substations.
- Potential 345-kV transmission enhancements are needed to reliably interconnect the load.
- ERCOT and TSPs are continuing to evaluate additional project options.
- Future RPG submittals for projects to meet the reliability needs are expected.



# 2022 Long-Term System Assessment (LTSA)

- ERCOT's 2022 LTSA analyzed potential system needs through 2037.
- ERCOT analyzes different future scenarios in its long-term planning process to account for the inherent uncertainty of planning the transmission system beyond six years.

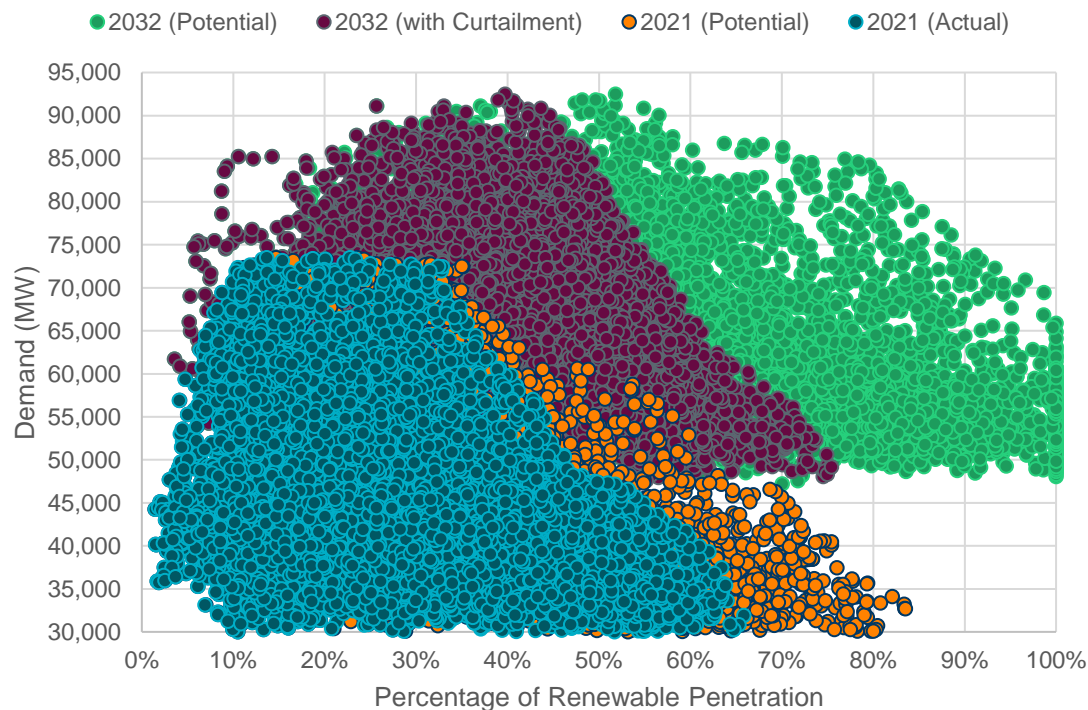


- The following set of future scenarios was developed considering stakeholder feedback received via survey and at Regional Planning Group (RPG) meetings:

- Current Trends
- Expanded System Outlook
- Demand Side Evolution

# 2022 LTSA Renewable Generation Penetration

## LTSA Modeled Solar and Wind Penetration for Every Hour of 2032 Compared to 2021 Historic



Renewable penetration is defined as the percentage of total demand at any given time that is being served by solar and wind generation. The “potential” penetration is based on the available wind and solar irradiance while the “actual” and “with curtailment” values include transmission constraints and other reliability limitations.

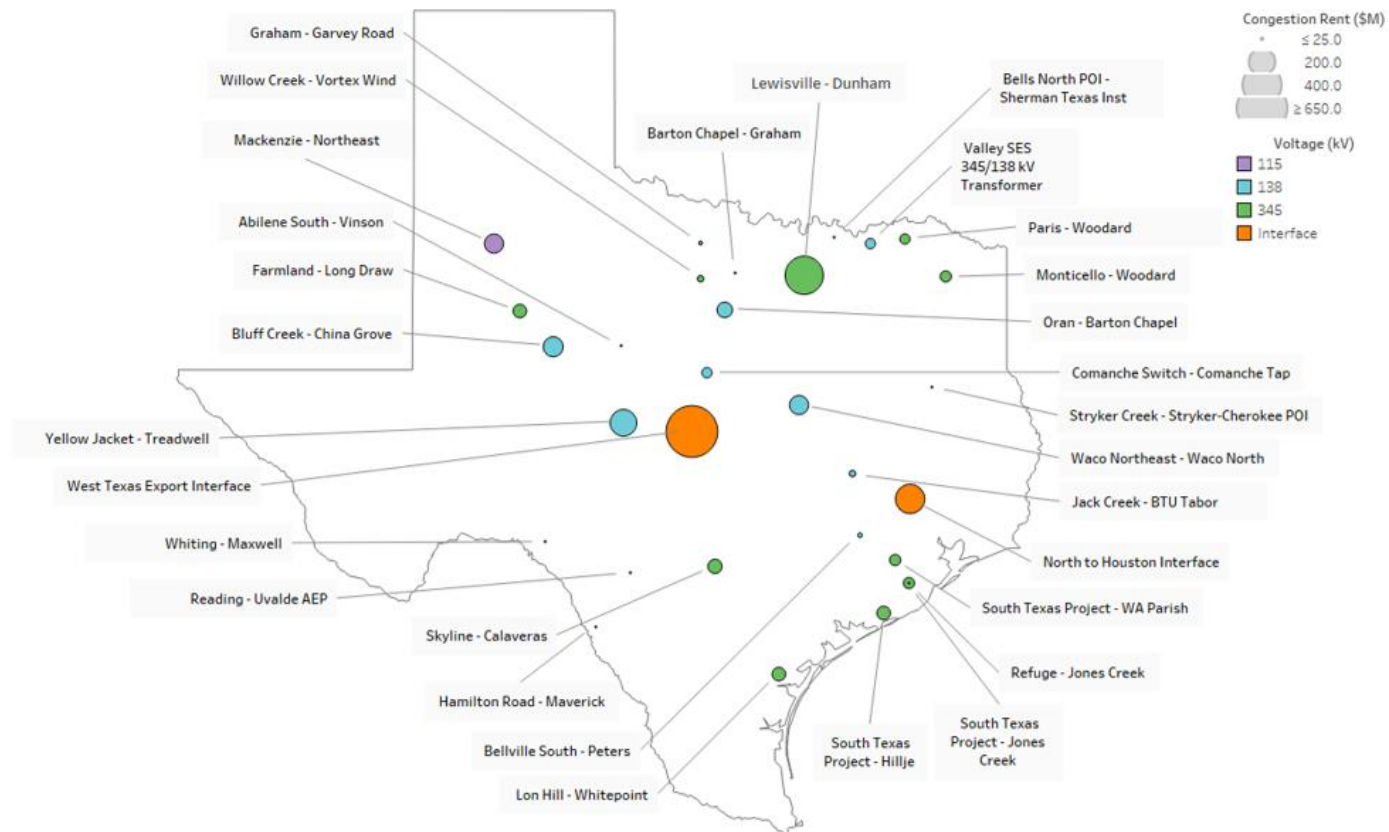
- The results for the LTSA capacity expansion and retirement analysis showed ~20 GW of thermal generation retired and significant growth of renewable generation and natural gas generation in all three scenarios.
- The growth in renewables caused significantly higher penetration of renewable generation compared to recent years.
- The growth in renewable resources and electric vehicle adoption led to not only a shift in stressed system conditions from summer afternoons to later in the day, but also a gradual shift of stressed system conditions to the winter season.



# 2022 LTSA Transmission Constraints

- In 2022 LTSA, it was observed that transmission challenges continued for both exports from renewable-resource-rich regions and imports into demand centers.

## Current Trends Scenario Top Congestion in 2037





# Contacts and Links

## Contacts and Information

For general communications and queries, please submit an information request to:  
<https://www.ercot.com/about/contact/inforequest>

*Media*

[Media@ercot.com](mailto:Media@ercot.com)

*Regulatory and Government Relations*

[GovernmentRelations@ercot.com](mailto:GovernmentRelations@ercot.com)

## Links

ERCOT website: <https://www.ercot.com/>

Market Participants can access additional planning information on the Market Information System (MIS), which can be accessed through the “MIS LOG IN” link located at the top of the ERCOT website. A digital certificate is required to access to this area. Information available on the MIS includes a variety of data, procedures, reports, and maps for both operations and planning purposes, including the following planning-related information:

- Generation project interconnection information
- Regional Planning Group information
- Steady-state base cases