



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

December 2021

Key Takeaways

- The ERCOT system is experiencing **rapid change** in the **resource mix** and increasingly **complex and flexible demand-side technology**. ERCOT is critically evaluating planning processes and pursuing changes necessary to meet challenges associated with the **evolving grid**.

- **Industrial demand growth** remains strong on the ERCOT system, driven in part by oil and gas activity in West Texas and increased interest in **data centers** and **cryptocurrency mining facilities**. ERCOT continues to improve its processes to account for such hard-to-forecast large-scale load additions with short interconnection timelines.

- There is increasing evidence that **new transmission technologies** may need to be adopted to meet the needs of the ERCOT system. ERCOT will continue to evaluate the potential benefits of low-impedance AC transmission, higher voltage levels (e.g., 500 kV), HVDC lines, advanced dynamic reactive power devices with grid-forming capabilities, and other technologies going forward.

- Updates to **planning criteria** may be necessary to ensure the continued **reliability and resiliency** of the ERCOT system. ERCOT is pursuing increased consideration of **high-impact events**, **generation deliverability** criteria, and new criteria focused on resiliency as part of an effort to ensure that appropriate and sufficient planning criteria are in place.



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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 PURA and Public Utility Commission of Texas (PUCT) Substantive Rules. The PUCT Substantive Rules further indicate that the independent organization (IO) shall evaluate and make a recommendation to the PUCT as to the need for any transmission facility over which the IO 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 2020 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 2020 Long-Term System Assessment report is posted on the ERCOT website at: <https://www.ercot.com/gridinfo/planning>.

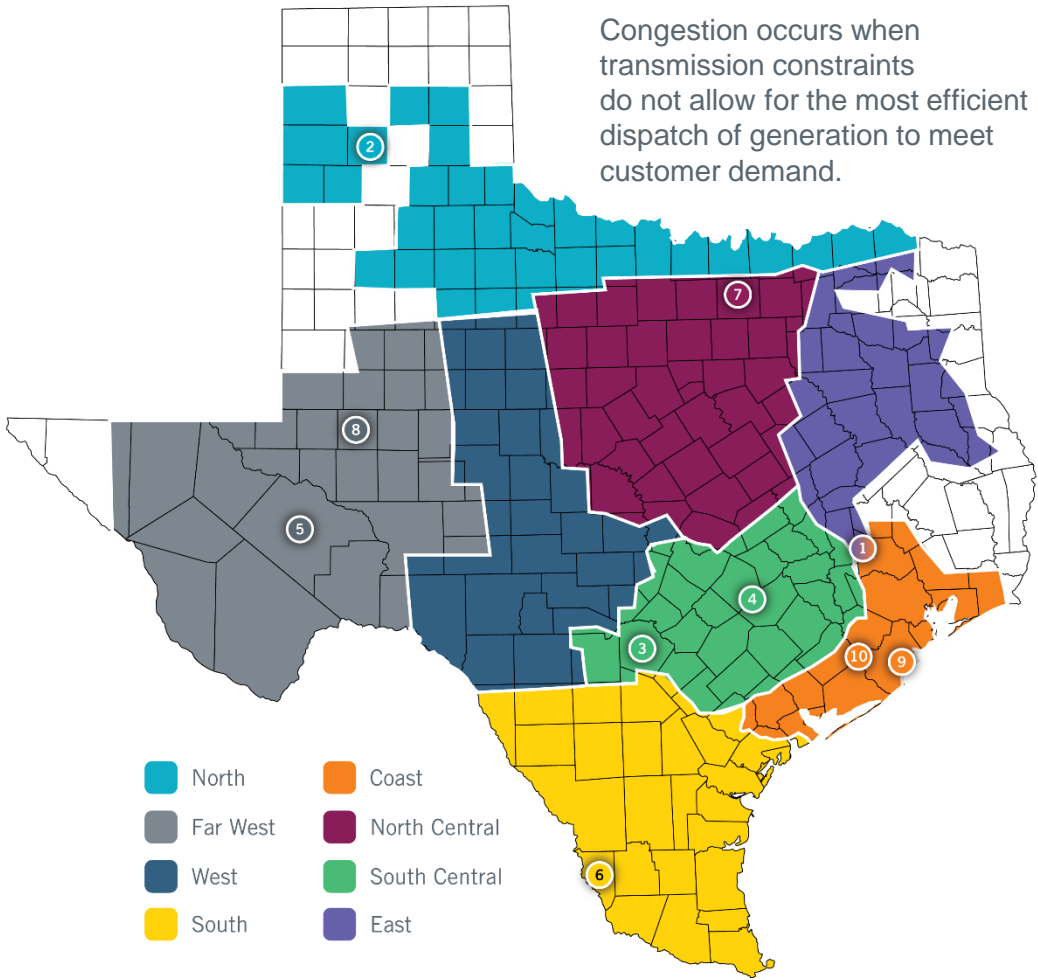
Map	Constraint	Congestion Rent*	Outage Related?
1	North to Houston Interface	\$159M	Planned
2	Panhandle Export Interface	\$154M	Planned
3	Pawnee - Spruce 345-kV Line	\$112M	Forced
4	Fayette Plant 1 and 2 - Winchester 345-kV Line & Winchester - Sim Gideon 138-kV Line	\$82M	Winter Storm Uri
5	Rio Pecos - Lynx - Tombstone 138-kV Lines	\$82M	Planned
6	North Edinburg to Lobo Interface	\$75M	-
7	Highlands TNP - West TNP - TI TNP 138-kV Lines	\$72M	Planned
8	Telephone Road - Tall City 138-kV Line	\$71M	-
9	Oasis - Dow Chemical 345-kV Line	\$62M	Planned
10	South Texas Project - WA Parish 345-kV Line	\$58M	Planned

*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. 2020 to Sept. 2021, based on real-time data

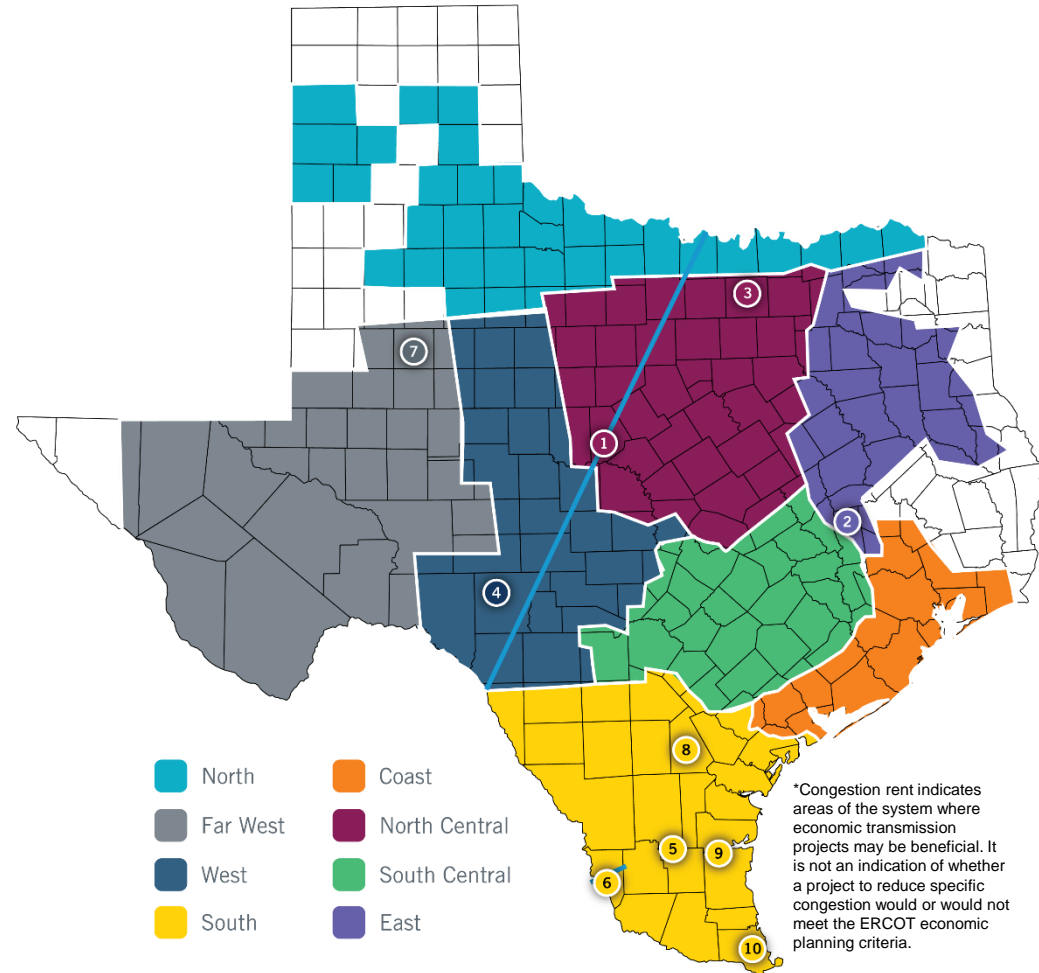


Map	Constraint	Congestion Rent*	
		2023	2026
1	West Texas Export Interface	\$385M	\$412M
2	North to Houston Interface	\$48M	\$139M
3	Highlands TNP to Argyle 138-kV Line	\$130M	\$15M
4	Rock Springs to New Barksdale 69-kV Line	\$78M	\$58M
5	Falfurrias to Premont 69-kV Line	\$34M	\$48M
6	Lobo to North Edinburg Interface	\$36M	\$40M
7	Willow Valley Switch to Gail Sub 138-kV Line	\$2M	\$57M
8	George West Switching Station to Sigmor 138-kV Line	\$30M	\$29M
9	Loyola Sub 138/69-kV Transformer	\$27M	\$30M
10	Burns Sub to Rio Hondo 138-kV Line	\$19M	\$20M

Projected Constraints

Top 10 projected constraints on the ERCOT system for 2023 and 2026

Based on economic analysis conducted for the 2021 RTP



*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.



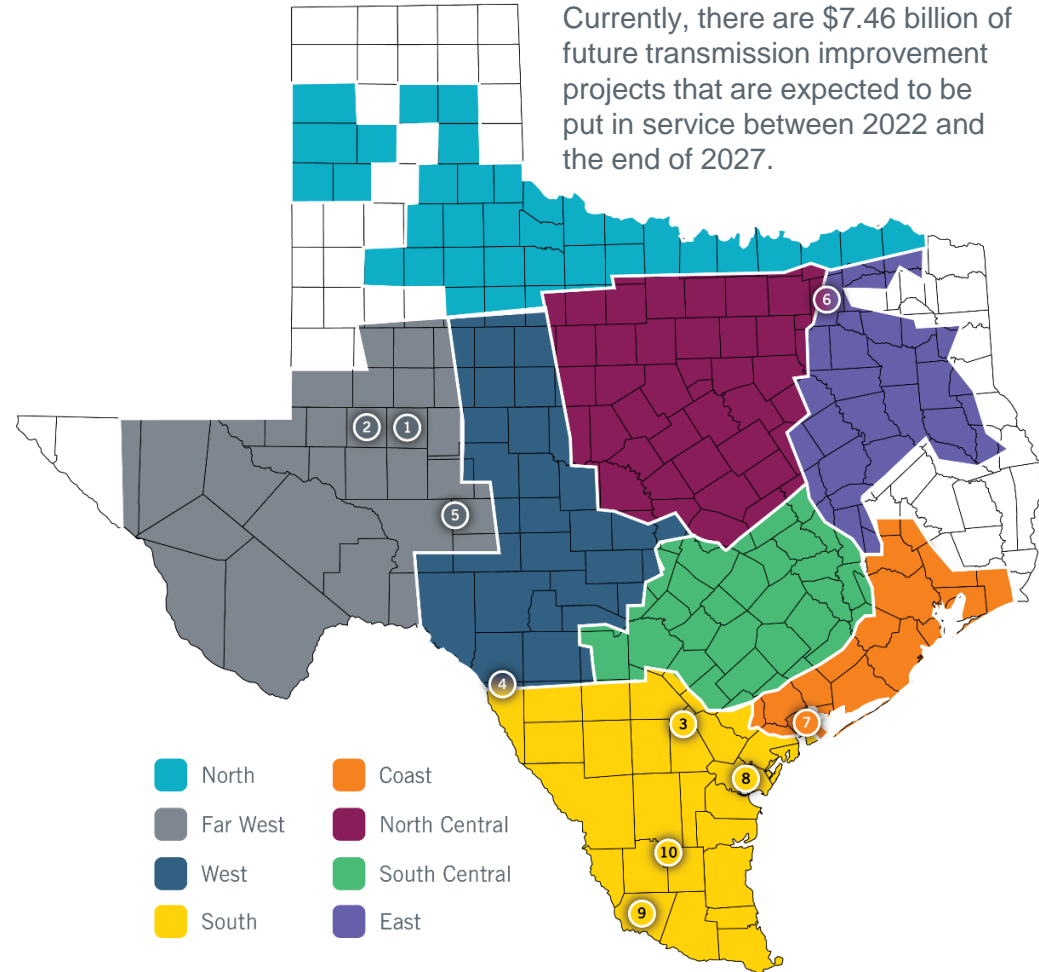
Planned Improvements

Top 10 significant improvements on the ERCOT system

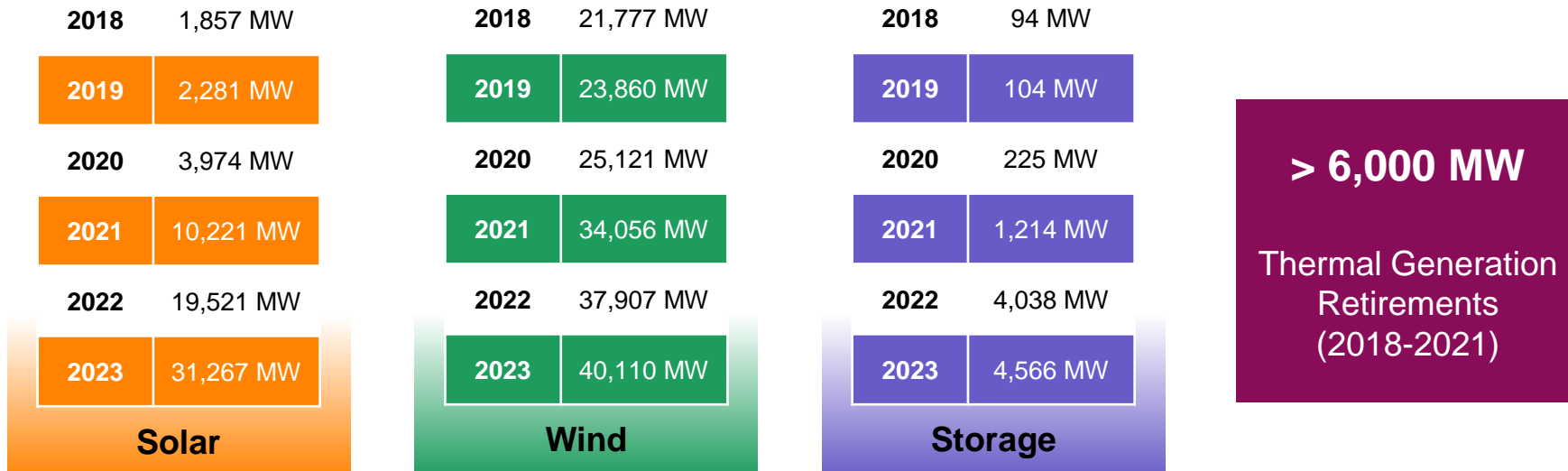
Projects planned for completion within the next six years

Map	Transmission Improvement	In-Service
1	New Bearkat – Longshore 345-kV Line	2022
2	Midland East Area Project	2022
3	Live Oak County Transmission Project	2023
4	New Brackettville – Escondido 138-kV Line	2023
5	Bakersfield to Big Hill 345-kV Second Circuit Addition	2023
6	Royse to Commerce 69-kV Line Conversion to 138 kV	2023
7	Port Lavaca Area Improvement Project	2023
8	Corpus Christi North Shore Project	2024
9	Second 345-kV Circuit from San Miguel to 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

Currently, there are \$7.46 billion of future transmission improvement projects that are expected to be put in service between 2022 and the end of 2027.



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 45 GW of transmission-connected wind, solar, and battery energy storage capacity is expected to be installed by the end of 2021. Total IBR capacity has the potential to exceed 75 GW in 2023.
- Over 6,000 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 - Demand

- Demand growth related to oil and gas activity in the Far West weather zone continues to outpace growth in the rest of the ERCOT system. To account for this rapid growth, ERCOT incorporated a more granular and detailed load forecast for the region into the **2021 RTP**. The load forecast was informed by the results of the TSP-commissioned IHS Markit Study and is consistent with the forecast used for the **Permian Basin Load Interconnection Study** detailed on page 13.



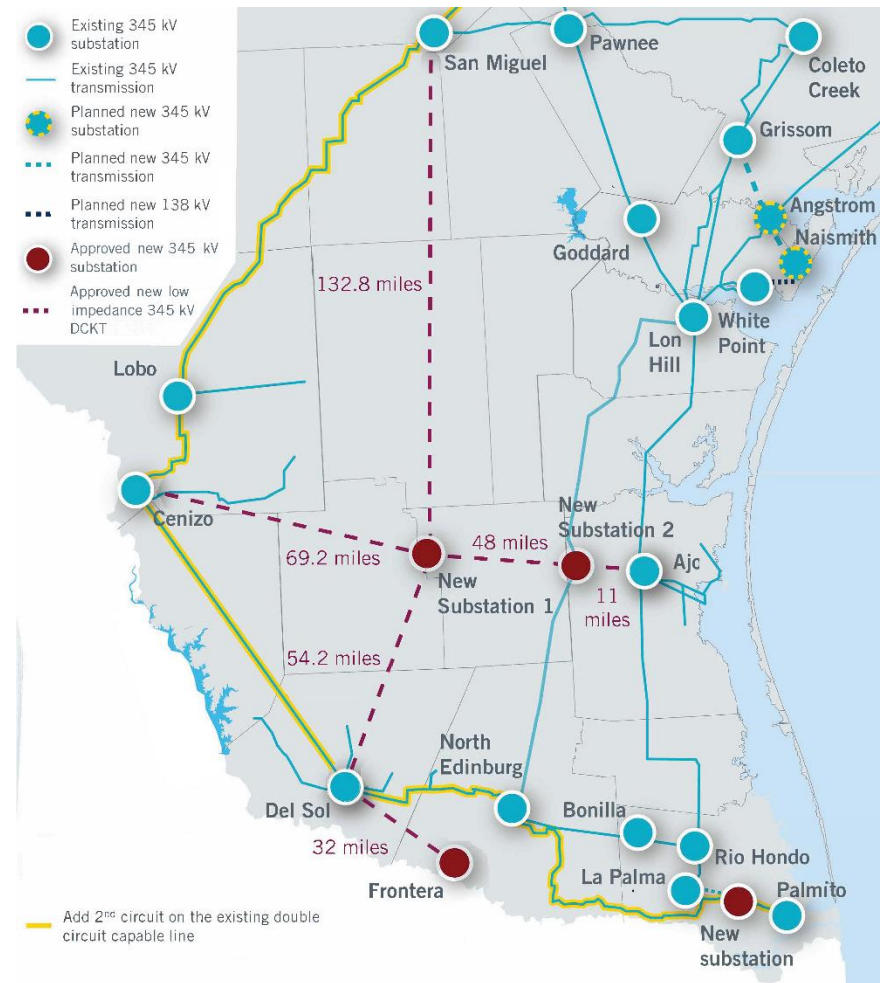
- Interest in developing data centers and new cryptocurrency mining facilities in the ERCOT region is also increasing rapidly. These facilities pose challenges with respect to transmission planning because they tend to be flexible on where they can be located and have accelerated development timeframes compared to many other large loads. ERCOT is evaluating possible changes to transmission planning processes to address those challenges.

- Adoption of electric vehicles (EV) is expected to increase significantly in the near future. The impact of EV growth on load forecasts depends on the adoption rates and charging patterns associated with different types of EV (passenger vehicles, trucks, buses, etc.). ERCOT is developing a process to produce EV load forecasts and expects to use the new forecasts in transmission planning studies starting in 2023.



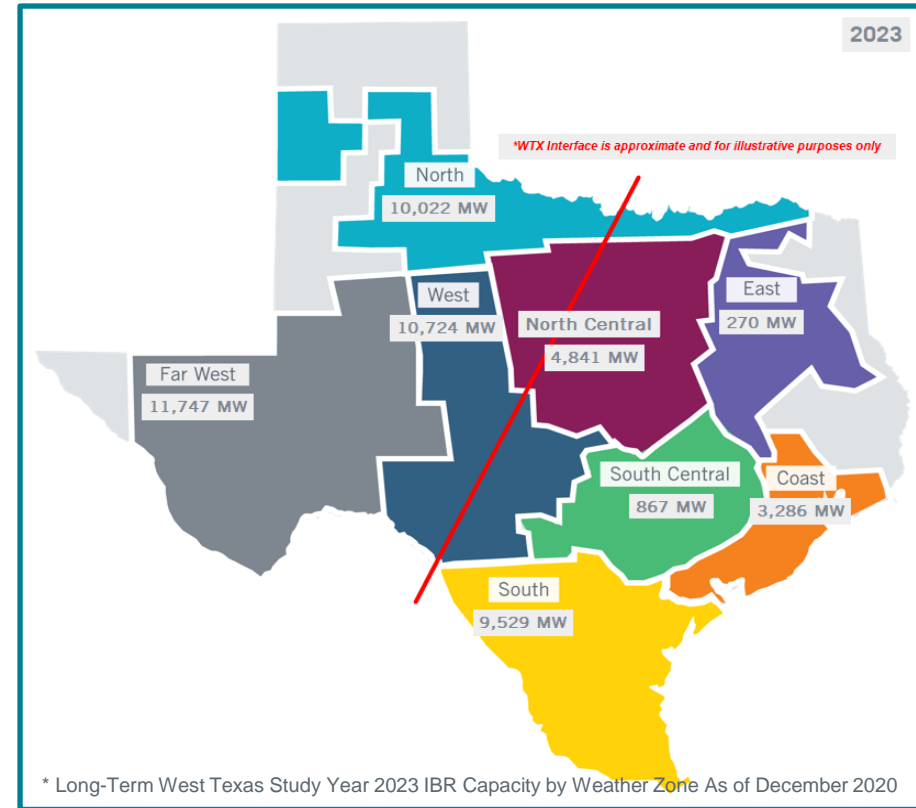
South Texas

- The majority of Lower Rio Grande Valley (LRGV) loads are in Cameron, Hidalgo, Starr, and Willacy counties.
- There is limited existing conventional generation capacity and no planned conventional generation in the LRGV. In addition, more than 7 GW of renewable generation is expected to connect in the LRGV area. Therefore, sufficient transmission capacity is imperative to reliably support the import and export needs for LRGV load growth and generation development.
- ERCOT has identified reliability needs in the LRGV by 2027 under normal conditions and today under high-impact weather conditions beyond Business as Usual (BAU).
- Two major transmission improvement projects were ordered and endorsed in 2021 to meet reliability needs and provide system resilience to the LRGV. The improvements are expected to be implemented by 2027.



West Texas Export

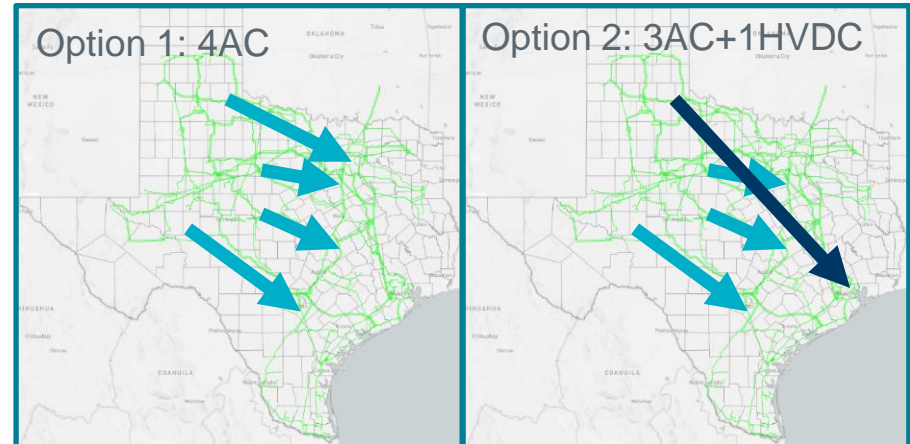
- ERCOT established the West Texas Export Generic Transmission Constraint (GTC) in October 2020 to manage the stability constraint in real-time operations.
- West Texas Export is projected to be a top 10 constraint on the ERCOT system by 2023.
- Renewable generation connected to West Texas could exceed 38 GW by 2023.
- The primary challenges for the West Texas Export stability constraint include:
 - Limited transmission lines for West Texas export power transfer; and
 - Insufficient voltage support.
- ERCOT conducted a Long-Term West Texas Study in 2021 to identify system needs and potential system improvement options to improve West Texas export capability and reduce generation curtailment.



West Texas Export – Improvement Considerations

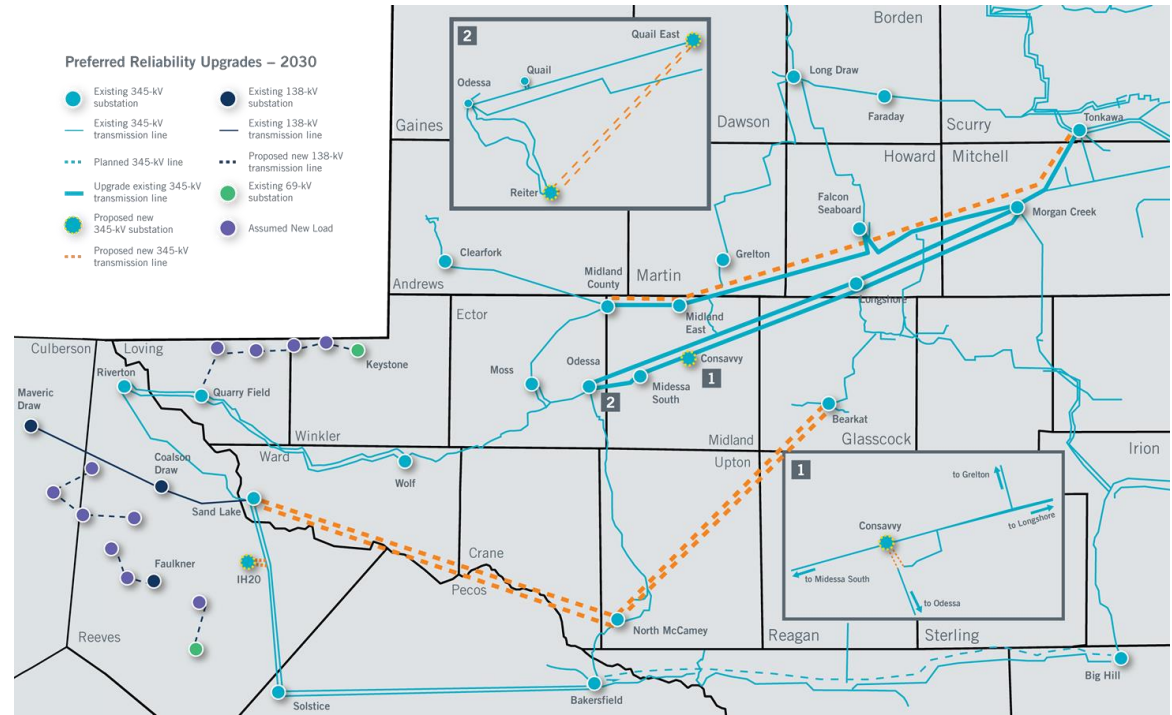
- Various technologies were evaluated to maximize the benefit of new transfer paths to relieve West Texas stability-related export constraints.
- Non-stability constraints (i.e., thermal constraints) also need to be addressed to effectively reduce system congestion and generation curtailment.
- System improvement options were identified that are expected to effectively improve West Texas export transfer limits and reduce congestion.
- ERCOT will continue to evaluate and recommend system improvement options following applicable planning criteria.

Technologies	Notes
Typical 345-kV Line	<ul style="list-style-type: none"> • Not effective for long distance transfer • Requires series compensation and mitigation of Subsynchronous Resonance (SSR) issues
Low impedance 345-kV Line	<ul style="list-style-type: none"> • Adequate transfer capability improvement without series compensation
Typical 500-kV Line	<ul style="list-style-type: none"> • Good transfer capability improvement • Higher cost and right-of-way requirements compared to 345-kV lines
VSC-HVDC Line	<ul style="list-style-type: none"> • Suitable for long distance power transfer • Require further discussion on operation and market-related practices and rules
Dynamic Reactive Devices	<ul style="list-style-type: none"> • Reactive devices alone are not adequate and could increase operational risk



Permian Basin Load Interconnection Study

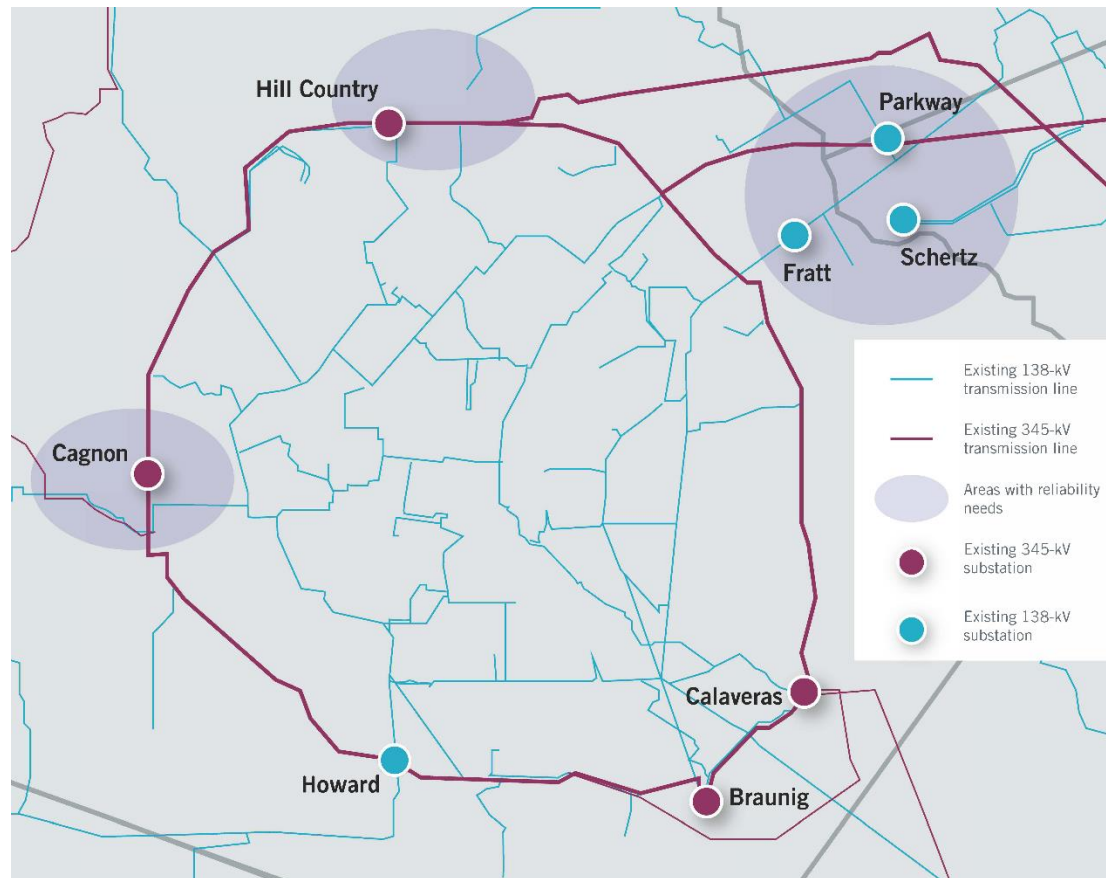
- In 2021, ERCOT, in consultation with TSPs relevant to the Permian Basin area, completed the Permian Basin Load Interconnection Study and identified transmission improvements required to reliably accommodate the projected oil and gas load growth up to 2030 (based on the 2020 IHS Markit study results).
- Significant transmission improvements, including the Stage 2 upgrade identified in the **2019 Delaware Basin Load Integration study**, will be required to reliably serve approximately 10 GW electricity demand in the Permian Basin area by 2030.



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

San Antonio Area

- Significant transmission improvements in the San Antonio area are required to address reliability needs resulting from the combination of future generation retirements and continued robust load growth in the area.
- The **2021 RTP** identified reliability needs on the 138-kV system northeast of San Antonio, as well as on the north and west sides of San Antonio's 345-kV loop.
- The Howard Rd 345/138-kV Switching Station Project was submitted for Regional Planning Group (RPG) review as a first step in addressing those reliability needs.



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

Contacts and Links

Contacts and Information

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

Media

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Links

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

The Market Information System can be accessed through the MIS LOG IN link located at the top of the ERCOT website. Users must obtain a digital certificate for access to this area. Folders in this area include data, procedures, reports, and maps for both operations and planning purposes. Helpful information that can be found on this site includes the following:

- Generation Project Interconnection Information
- Regional Planning Group Information
- Steady-State Base Cases