



ESIG 2024 Spring Technical Workshop

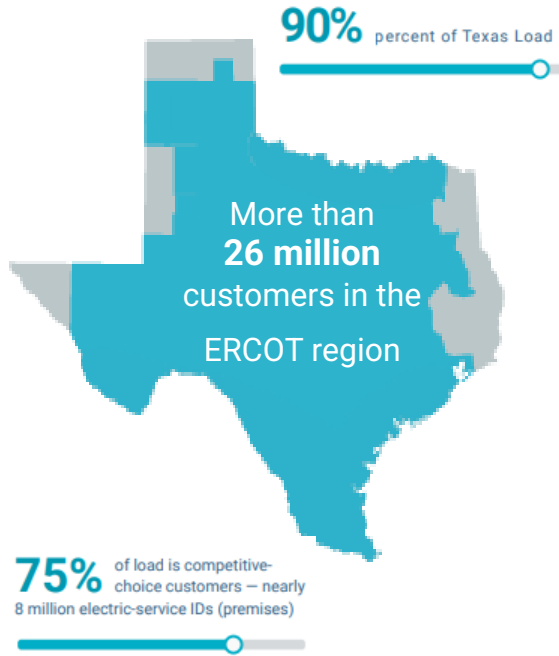
Session 7a: System Planning

ERCOT Reliability, Economic and Resiliency Planning

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ERCOT Facts



1,250+
generating units, including PUNs

54,100+
miles of high-voltage transmission

103,609+ MW
of expected capacity for summer 2024 peak demand

85,508 MW

Record peak demand (August 10, 2023)

2023 Energy Use

*Other includes solar, hydro, petroleum coke (pet coke), biomass, landfill gas, distillate fuel oil, net DC-tie and Block Load Transfer imports/exports and an adjustment for wholesale storage load.



38,835 MW

of installed wind capacity as of January 2024, the most of any state in the nation

27,548 MW

Wind Generation Record (January 7, 2024)

69.15 %

Wind Penetration Record (April 10, 2022)



22,258 MW

of utility-scale installed solar capacity as of January 2024

17,201 MW

Solar Generation Record (Feb. 19, 2024)

41.81 %

Solar Penetration Record (March 10, 2024)



5,242 MW

of installed battery storage as of January 2024

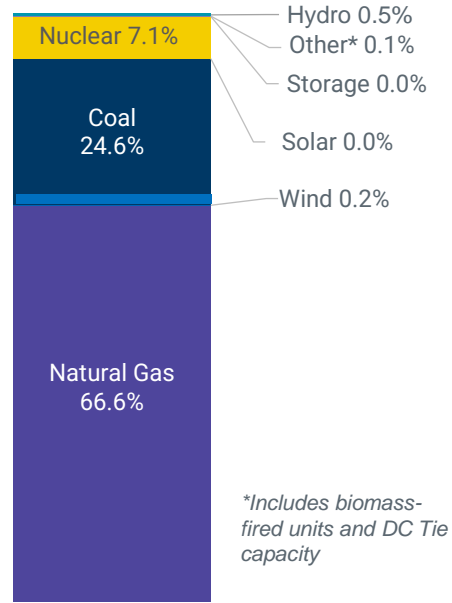
\$3.23 billion

Transmission project endorsed in 2023

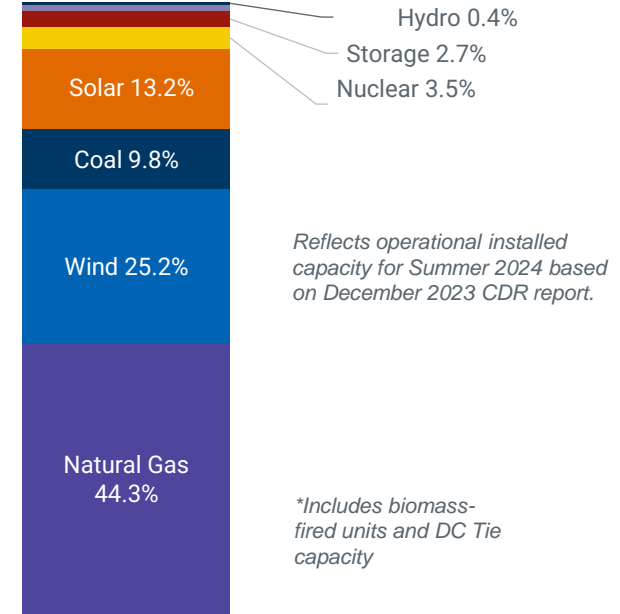


The ERCOT Electric Grid: Capacity and Demand

2000 Generating Capacity



2024 Generating Capacity



2000
All-Time Peak Demand Record

57,606 MW

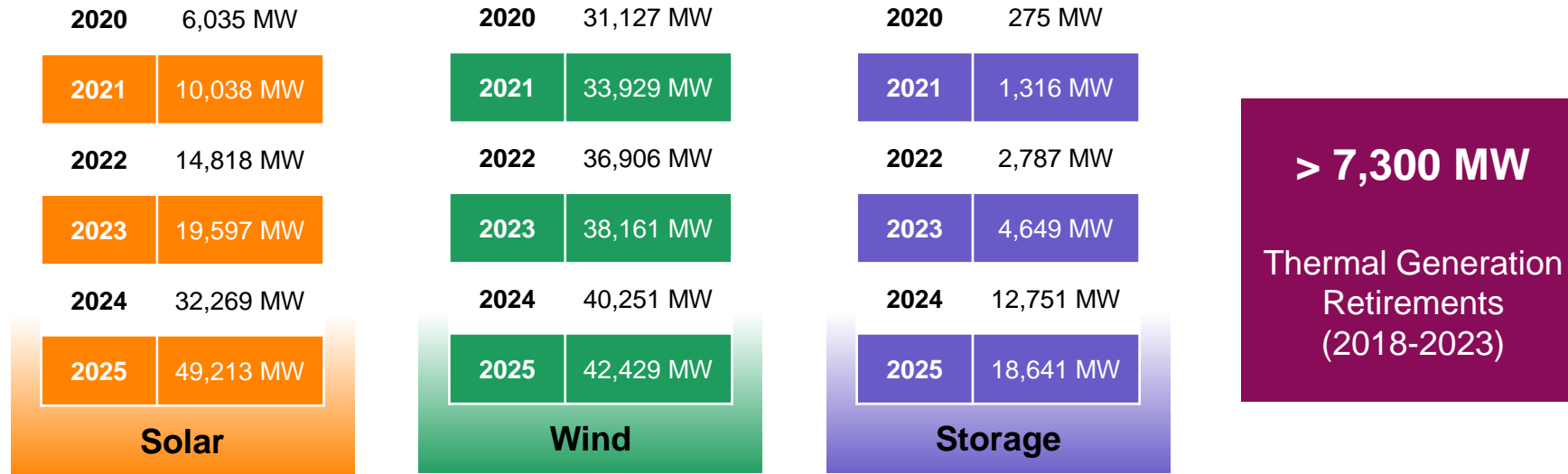
All-Time Peak Demand
Record

85,508 MW

(August 10, 2023)

48% increase

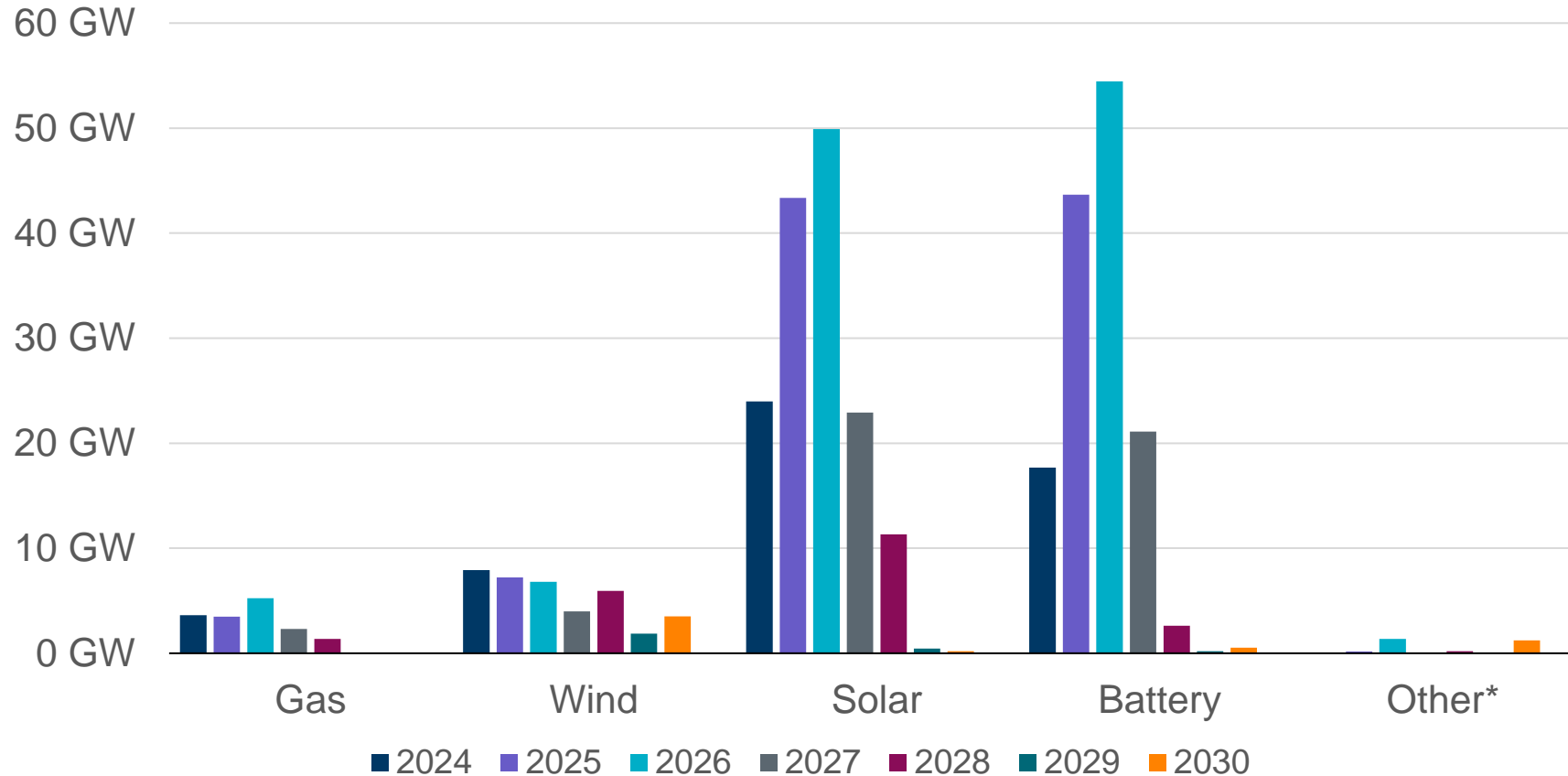
The Changing Grid – Generation



- 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 62 GW of transmission-connected wind, solar, and battery energy storage capacity is expected to be installed by the end of 2023. Total IBR capacity has the potential to exceed 110 GW in 2025.
- Over 7,300 MW of coal and natural gas generation has retired since 2018.

Generation Interconnection Requests

1,783 active generation interconnection requests totaling 348,521 MW as of February 29, 2024
(Solar 152,098 MW, Wind 37,215 MW, Gas 16,022 MW, and Battery 140,219 MW)

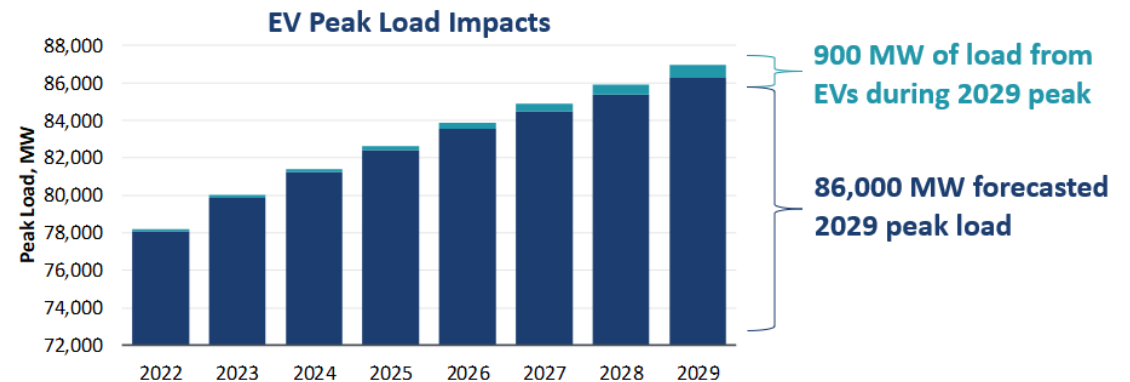
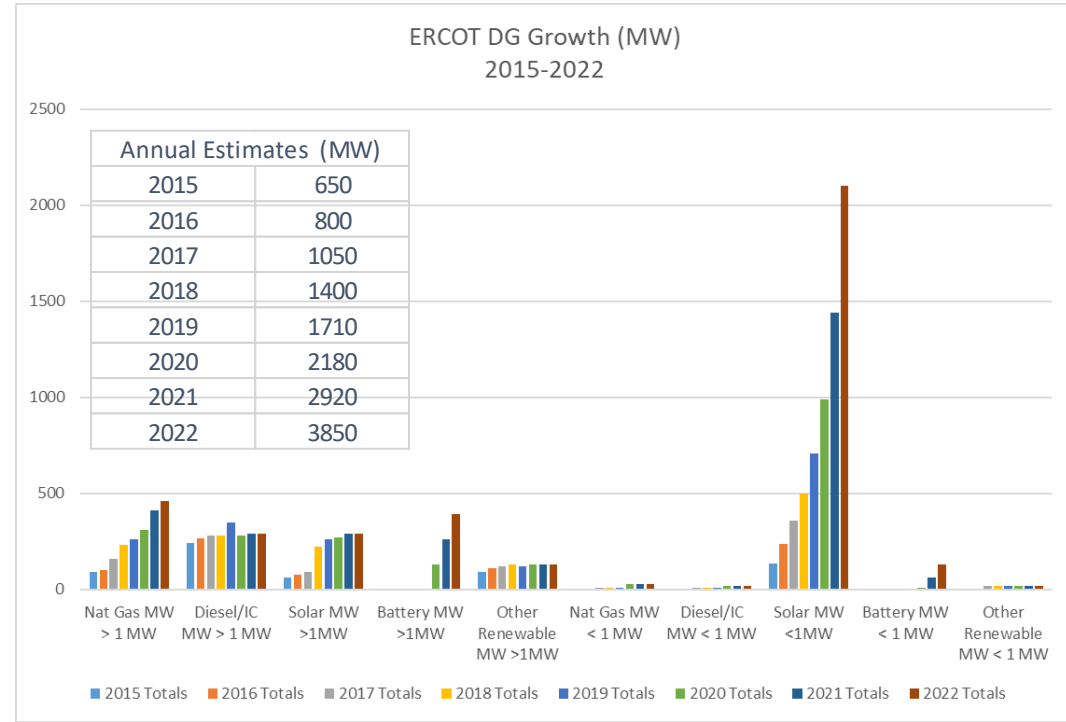


A break-out by zone can be found in the monthly Generator Interconnection Status (GIS) reports available on the ERCOT Resource Adequacy Page: <http://www.ercot.com/gridinfo/resource>

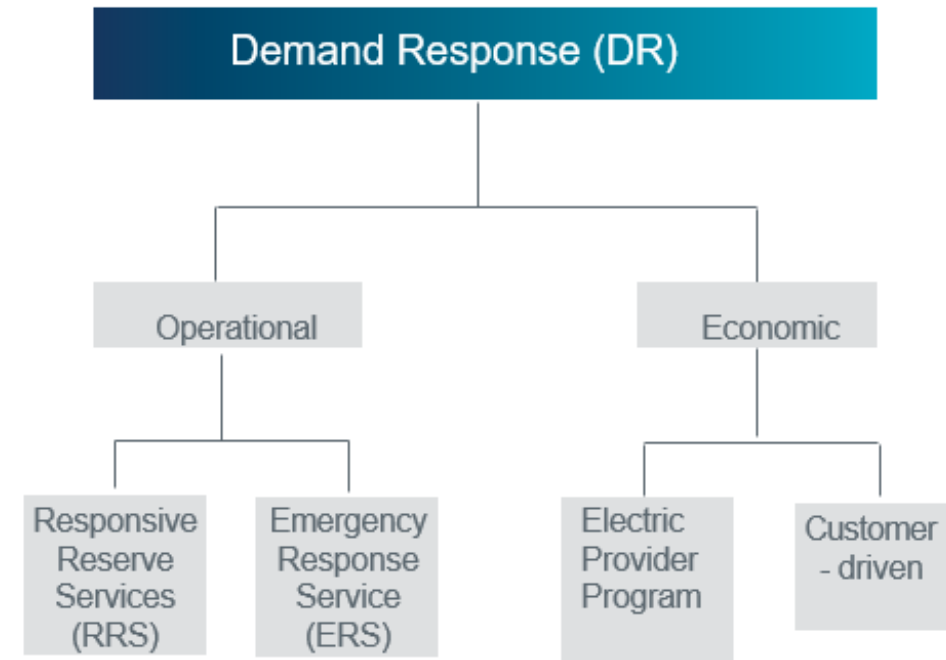
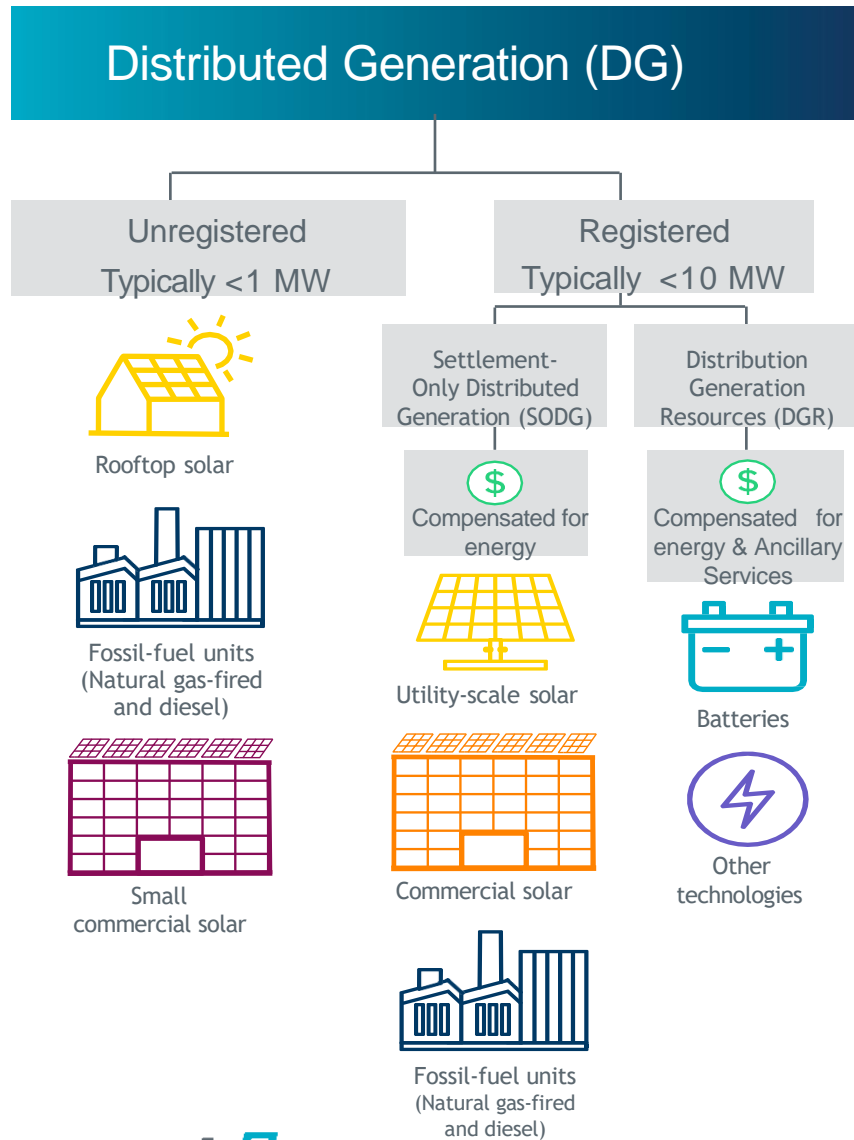
* Other includes petroleum coke (pet coke), hydroelectric, fuel oil, geothermal energy, other miscellaneous fuels reported by developers, and fuel cells that use fuels other than natural gas.

The Changing Grid – Distributed Generation (DG) & Electric Vehicles (EV)

- 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 2022 is approximately 3850 MW.
- 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.
- Adoption of EVs is expected to increase significantly, with 4% of all the vehicles on the road projected to be EV in Texas by 2029. This signifies a need to include EV load impacts in near-term planning studies.



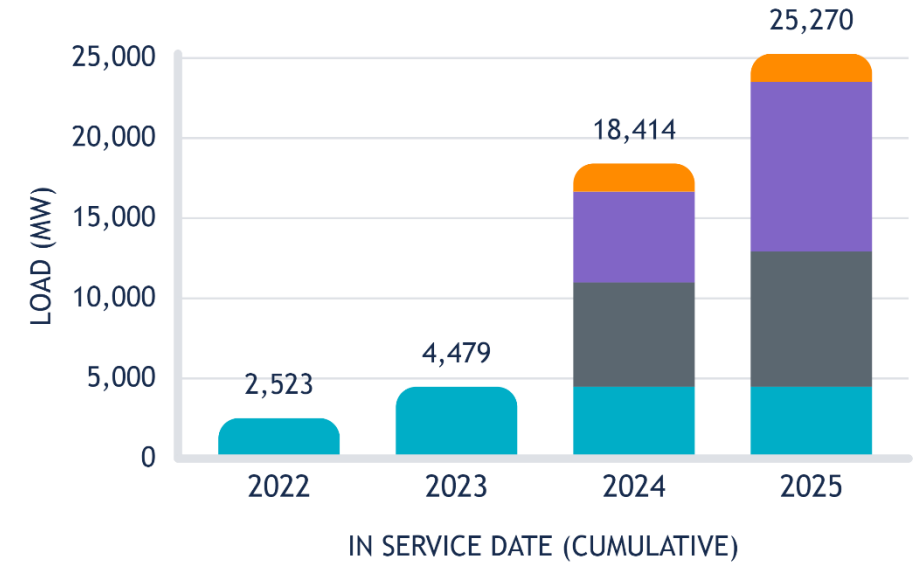
Distributed Generation (DG) & Demand Response (DR)



Growth of Large Load in ERCOT

- ERCOT considers a site with an aggregate Load of 75 MW or greater behind a one or more points of interconnection to be a **Large Load**
- As of February 2024, ERCOT is tracking 25,270 MW of Large Load wanting to energize by end of 2025.
 - 4,479 MW has already been given approval to energize
 - Another 8,437 MW has completed planning review

Actual and Projected LFL Growth 2022-2025



Project Status	2022	2023	2024	2025
No Studies Submitted	-	-	1,750	1,750
Under ERCOT Review	-	-	5,674	10,604
Planning Studies Approved	-	-	6,511	8,437
Approved to Energize	2,523	4,479	4,479	4,479
Total (MW)	2,523	4,479	18,414	25,270

Transmission Planning in ERCOT

1 – 6 Years

10 – 15 Years

Regional Transmission Plan

- Annual system-wide analysis
- Ongoing plan to meet reliability and economic criteria

Regional Planning Group (RPG) Project Review

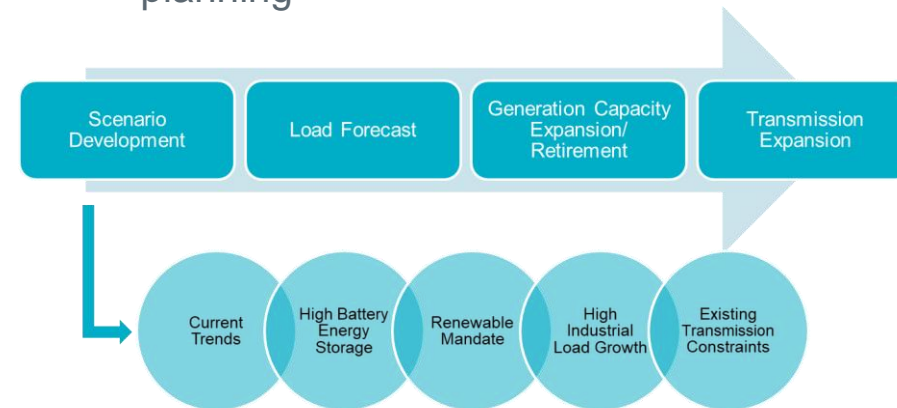
- Stakeholder review of project proposals
- Projects classified into four tiers with different levels of review based on project scope

Biennial Grid Reliability Assessment

- Grid reliability and resiliency under extreme weather condition

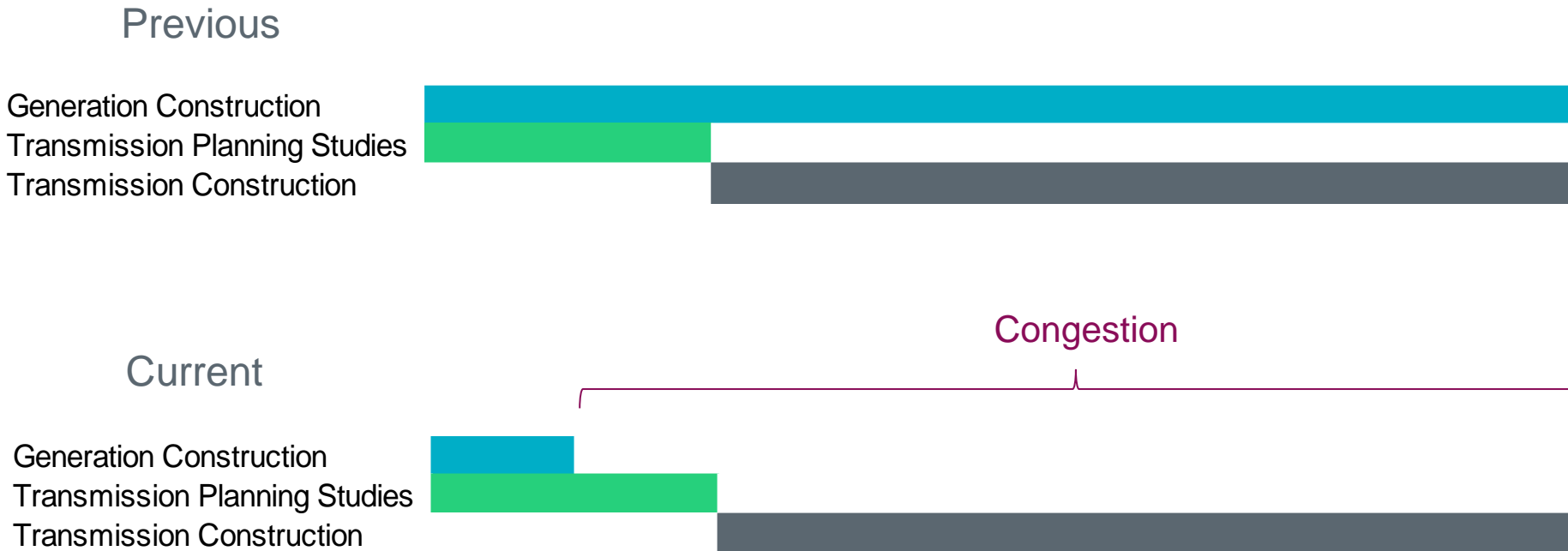
Long-Term System Assessment

- Scenario-based study of future system-wide needs
- Provides guidance for near-term planning



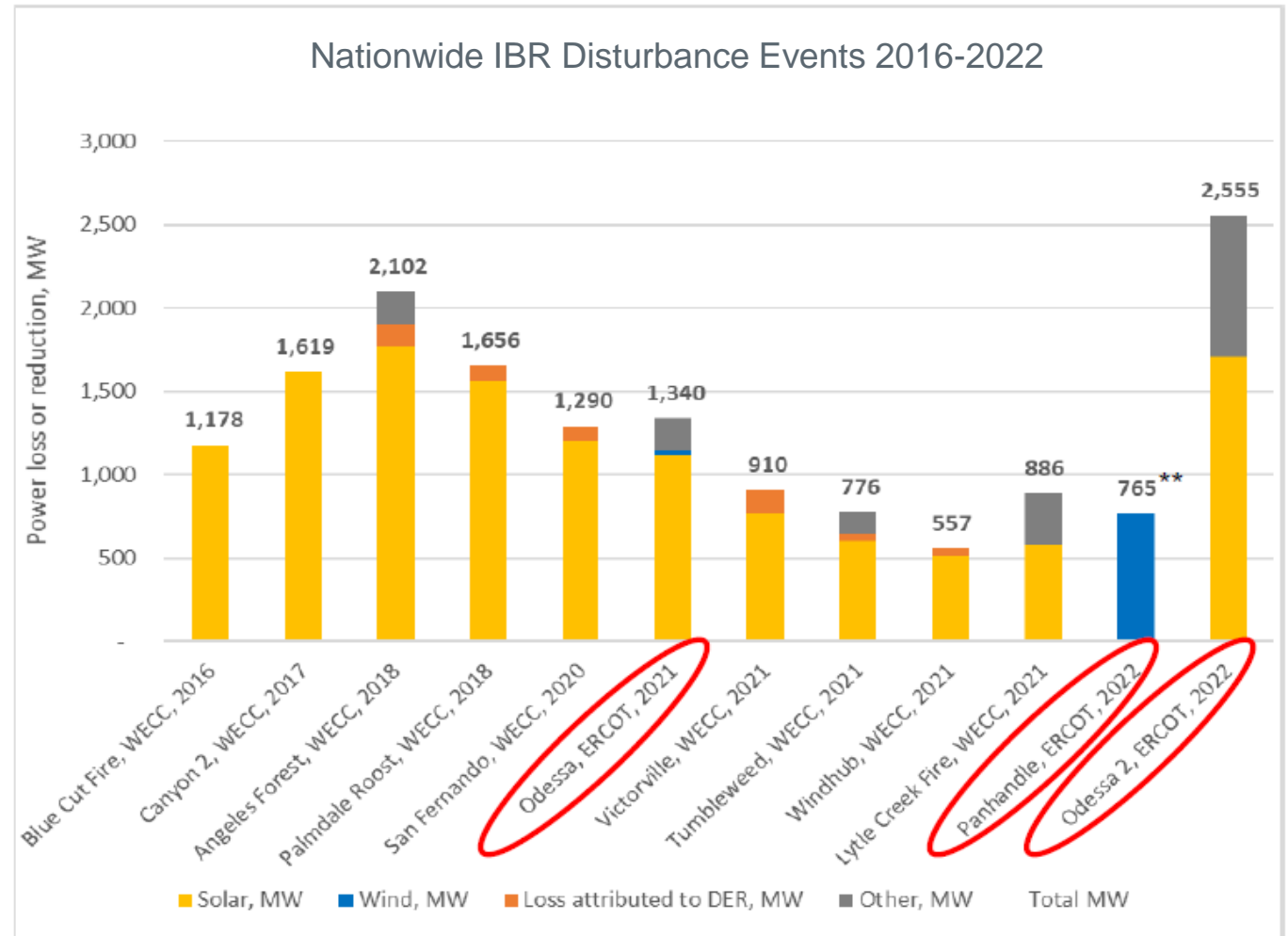
Challenges: Generation and Transmission Timelines

- The average time from when planned generation meets the requirements to be included in ERCOT planning models to when that generation becomes commercially operational is getting shorter.



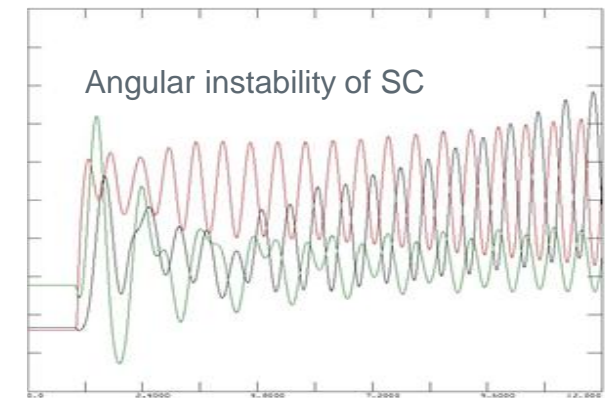
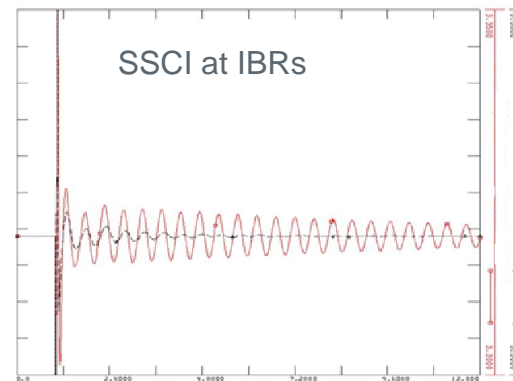
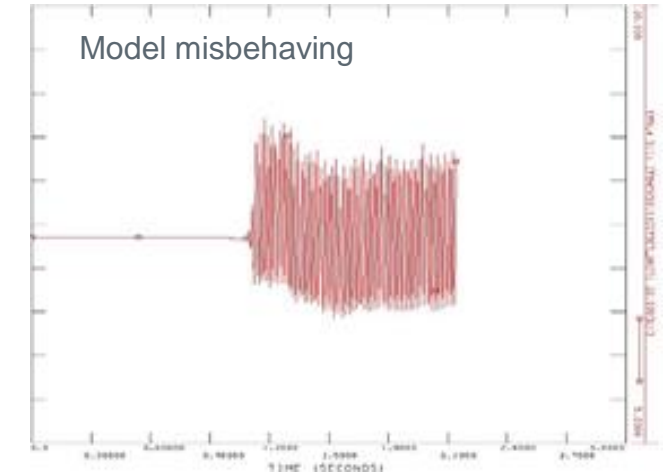
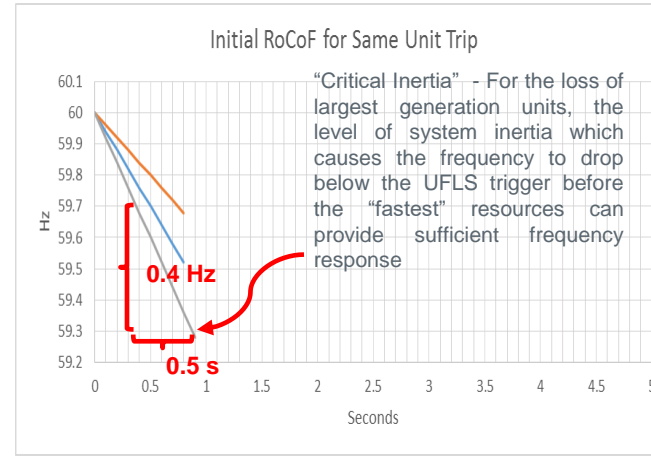
Inverter-based resources (IBRs) in West Texas

- Inverter-based resources (IBRs) in West Texas have experienced rapid and continued growth.
- Because the West Texas area (WTX) has a prevalence of IBRs and few synchronous generation resources, system strength is low in the area.
- Faults in the area result in widespread low voltages, and potentially large number of IBRs do not ride-through these faults (e.g., Odessa events).



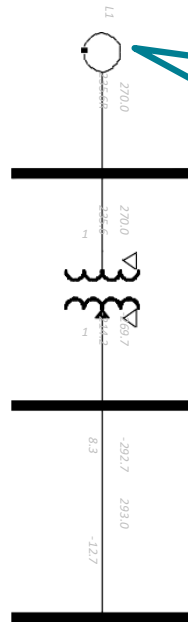
Increasing System Stability Constraints

- High penetration of IBR's resources causes a decrease of synchronous units being online. Frequency response of online generation fleet depends less on governor action and inertia.
- Low system strength.
- Minimum system Inertia.
- Interaction of nearby IBRs' controllers.
- Combination of outages and contingency could lead to a radially connection between a generator and a series capacitor.
- Angular stability of synchronous condenser.



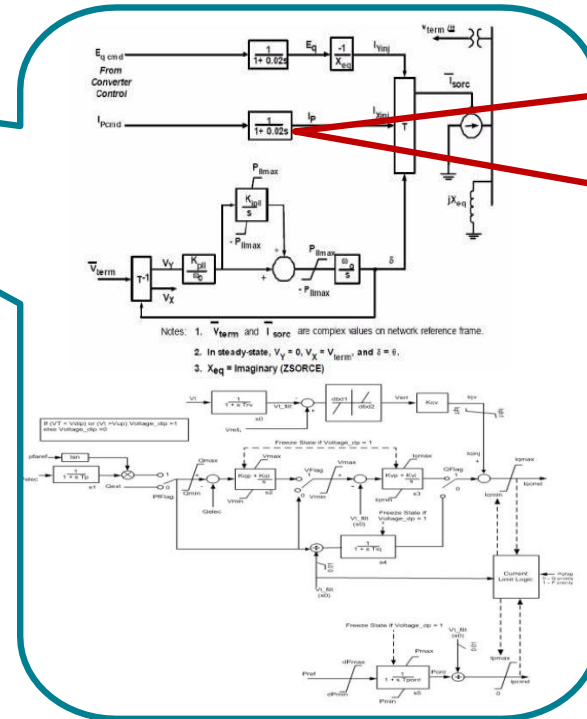
IBRs - Modeling Complexity

Power Flow



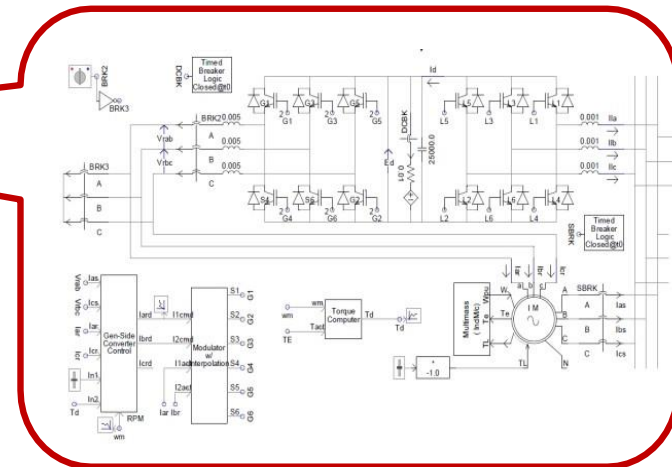
- Algebraic equation with no time step
- 60 Hz
- Positive sequence
- Balanced system
- Steady state
- Solution in < 1 sec
- Tools: PSS/e, PowerWorld, VSAT

Traditional Dynamics



- Time step of 1 ~ 4 ms
- Fundamental frequency assumption
- Positive sequence & balanced system
- Electro-mechanical machine dynamics
- Simulation time: 1 ~ 20 mins
- Tools: PSS/e, PowerWorld, TSAT

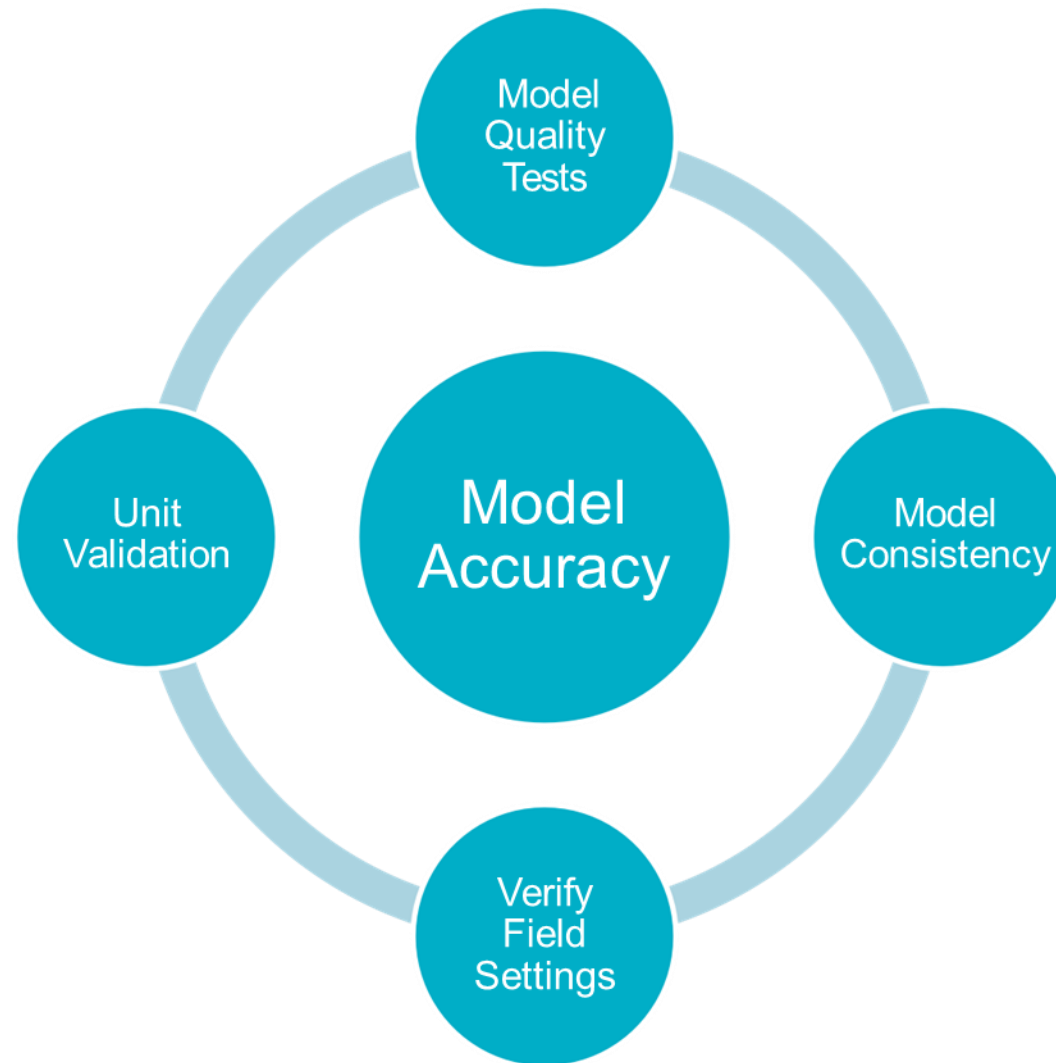
EMT



- Time step of 10 ~ 50 us
- Frequency impacts included
- Full three-phase representation
- Phase imbalances represented
- Fast dynamic controls explicitly modeled
- Need for detailed SSR analysis
- Need for high IBR penetration analysis?
- Simulation time: 10 mins ~ hours
- Tools: PSCAD

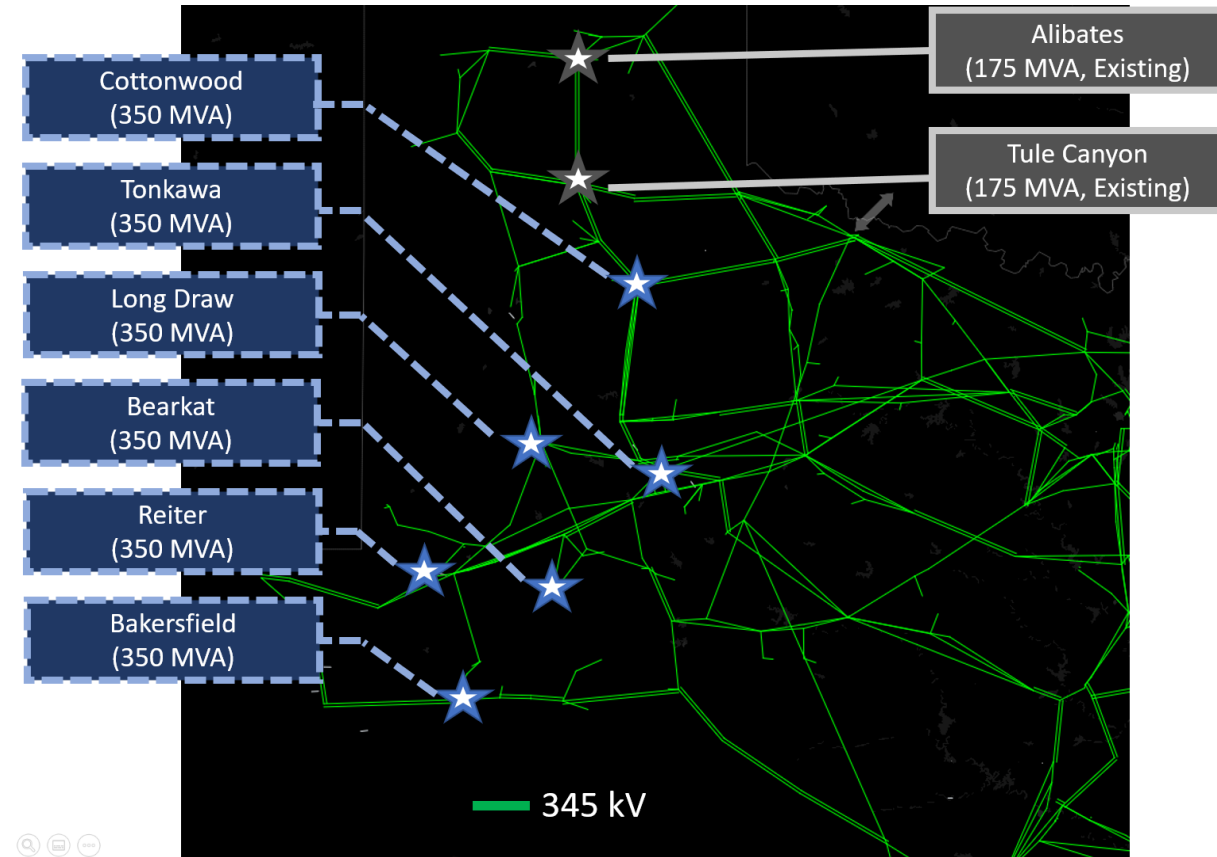
IBRs - Dynamic Model Performance and Accuracy Improvements

- Several ERCOT Planning Guide Revisions (PGRR075 and PGRR085) related to model quality tests (PSS/E, PSCAD), unit model validation, plant verification reports were approved.
- Process to review any proposed modifications to settings and equipment associated with IBRs.
- Participation in industry forum, adoption of standards and best practices.



West Texas – Synchronous Condenser Project

- The project is proposed to strengthen the West Texas system and reduce the reliability risk by:
 - limiting the number of IBRs that would be subjected to conditions that could result in many unit trips for any single fault, as well as providing resilience for IBR control and model uncertainty.
- Approximately 350 MVA capacity at each location (Total six locations).
 - Around 3,600 Ampere (A) of three-phase fault current contribution to the 345-kV point of interconnection (POI).
 - A combined total inertia of 2,000 MW-seconds (MW-s) or above at each location, incorporating synchronous condenser with flywheel for frequency support.
 - Targeted in-service by 2027



ERCOT Grid Resiliency

- Senate Bill 1281 signed by Governor Abbott on June 16, 2021, requires biennial assessment of the ERCOT power grid to assess the grid's reliability in extreme weather scenarios.
- PUCT Rule 25.101 (16 TAC § 25.101), finalized in December 2022, established a new biennial Grid Reliability and Resiliency study is introduced to assess the ERCOT grid's reliability and resiliency in extreme weather scenarios.
- The Grid Reliability and Resiliency will:
 - ❖ Consider the impact of different levels of thermal and renewable generation availability
 - ❖ Identify areas of the state facing significant reliability and resiliency issues
 - ❖ Develop transmission solutions to address the reliability and resiliency issues identified
- The first Grid Reliability and Resiliency study will be conducted in 2024.

Implementation of New Economic Planning Criteria

- Following Senate Bill (SB) 1281, PUCT adopted amendments to Substantive Rule 25.101 to establish a congestion cost savings test for evaluating economic transmission projects;
- Congestion cost savings test development for economic project evaluation
 - ❖ ERCOT retained Energy and Environmental Economic (E3) as an independent consultant for the development of the congestion cost savings test.
 - ❖ E3 recommended the System-Wide Gross Load Cost Test as the best option for the rules and structure of the ERCOT market.
 - ❖ ERCOT in consultation with the PUC staff is working on submitting the needed Revision Requests to implement this new congestion cost savings test.

Questions?