# ESIG 2024 Spring Technical Workshop

Session 7a: System Planning

## ERCOT Reliability, Economic and Resiliency Planning

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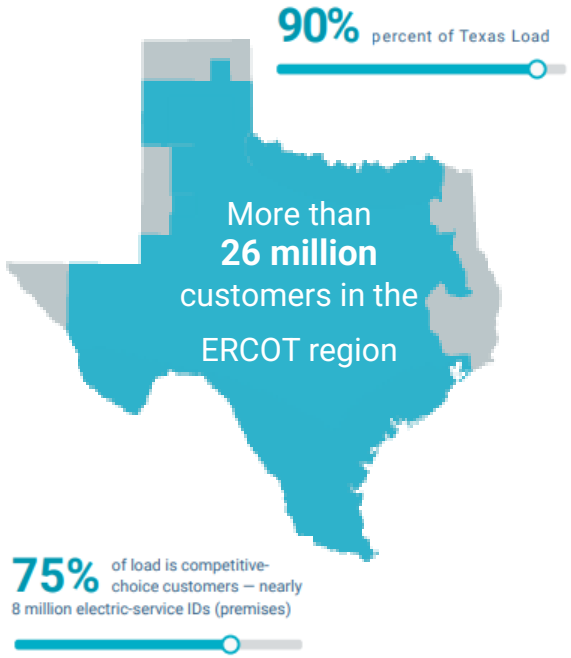
# ERCOT Facts




**1,250+**

generating units, including PUNs

**54,100+**

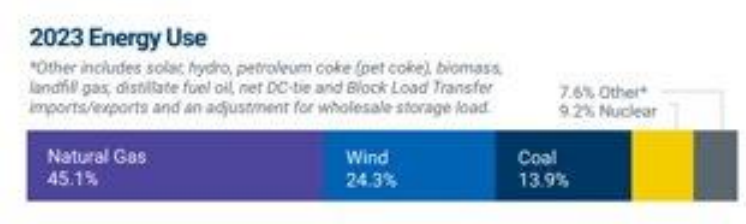
miles of high-voltage transmission

**103,609+ MW**

of expected capacity for summer 2024 peak demand

**85,508 MW**

Record peak demand (August 10, 2023)




**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**

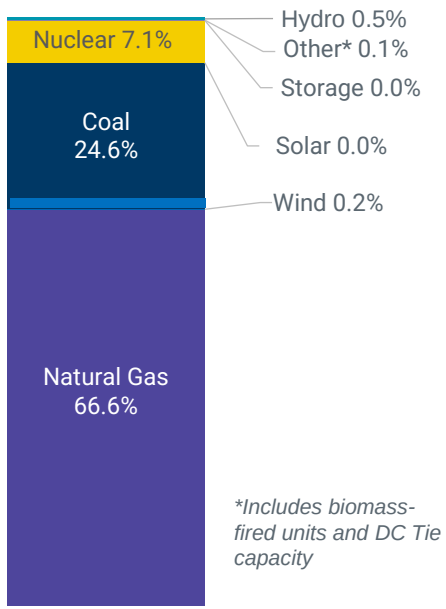
of installed battery storage as of January 2024

**$3.23 billion**

Transmission project endorsed in 2023

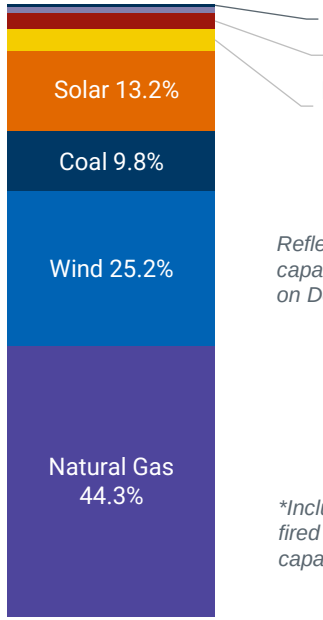
# The ERCOT Electric Grid: Capacity and Demand

## 2000 Generating Capacity




**Includes biomass-fired units and DC Tie capacity*

## 2024 Generating Capacity




*Reflects operational installed capacity for Summer 2024 based on December 2023 CDR report.*

**Includes biomass-fired units and DC Tie capacity*

## 2000 All-Time Peak Demand Record

**57,606 MW**

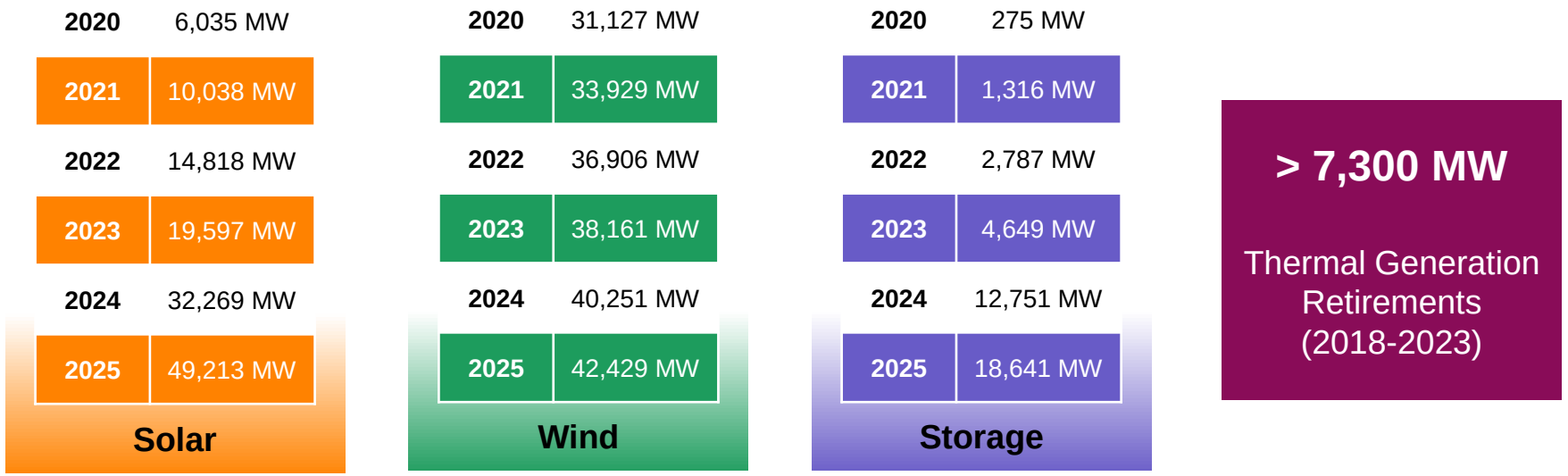
**48% increase**

## All-Time Peak Demand Record

**85,508 MW**

(August 10, 2023)

# The Changing Grid – Generation



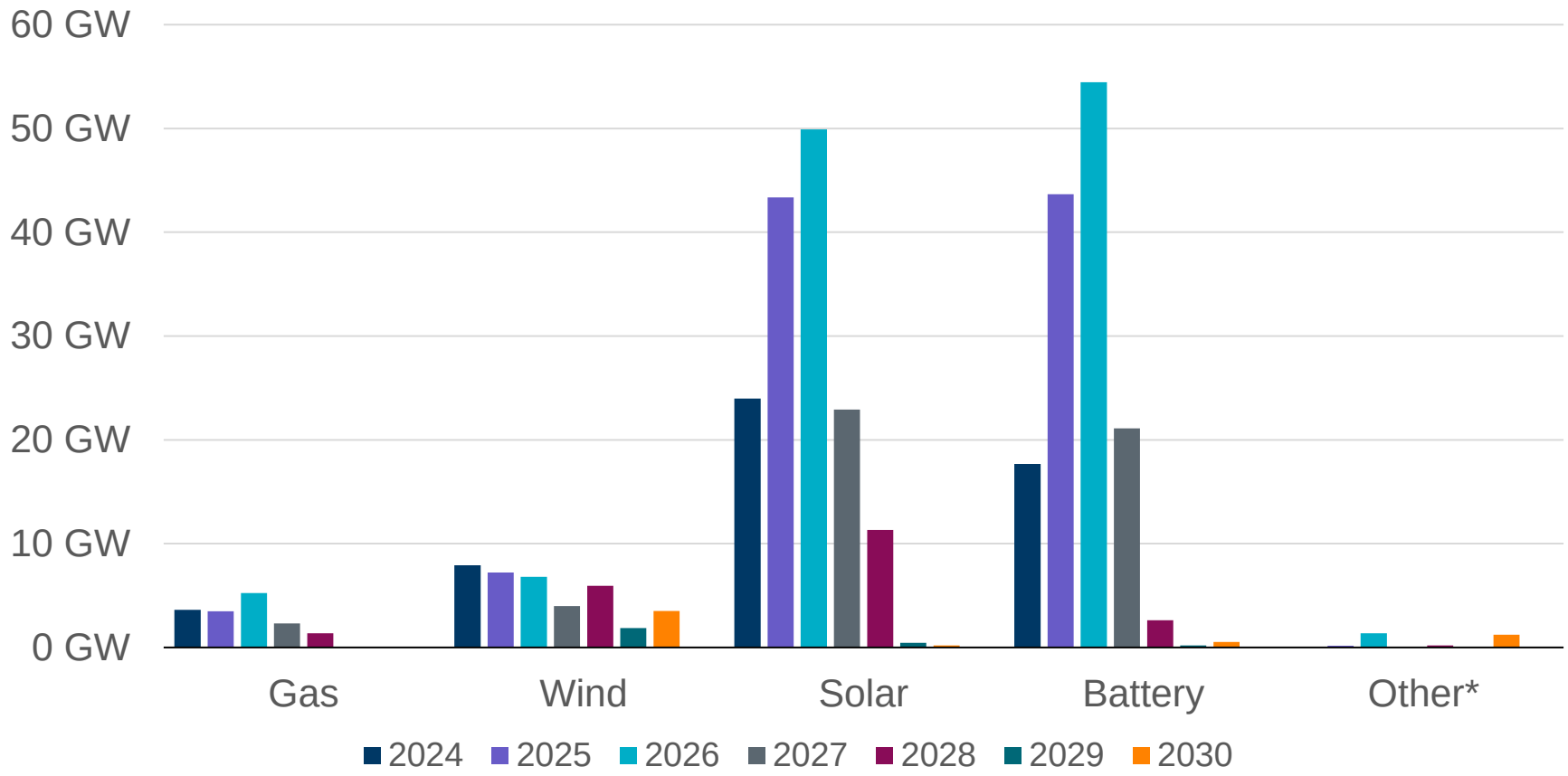

**> 7,300 MW**

Thermal Generation Retirements (2018-2023)

- 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)**

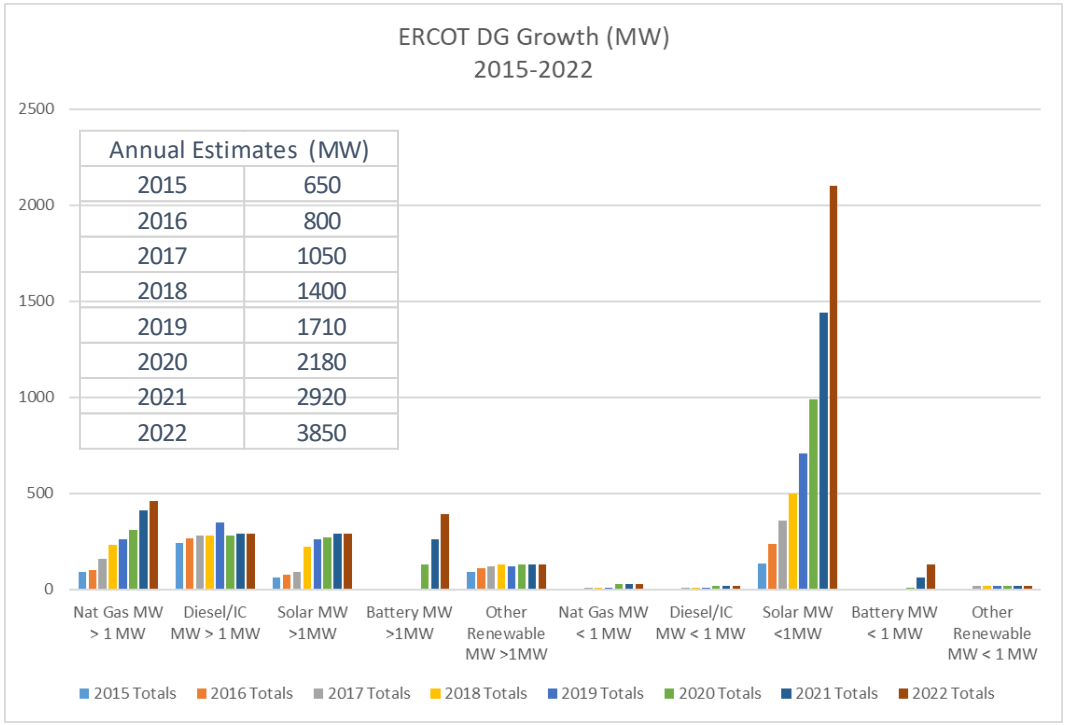


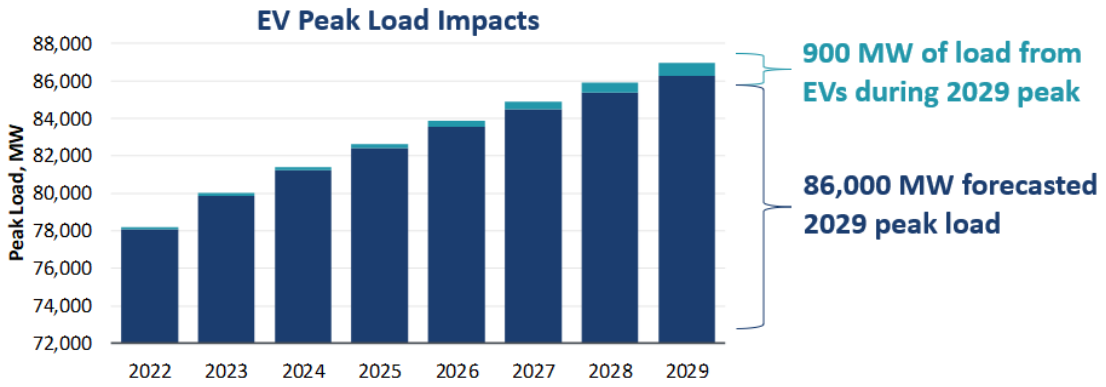

A break-out by zone can be found in the monthly Generator Interconnection Status (GIS) reports available on the ERCOT Resource Adequacy Page: http://www.ercot.com/gridinfo/resource

* 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.

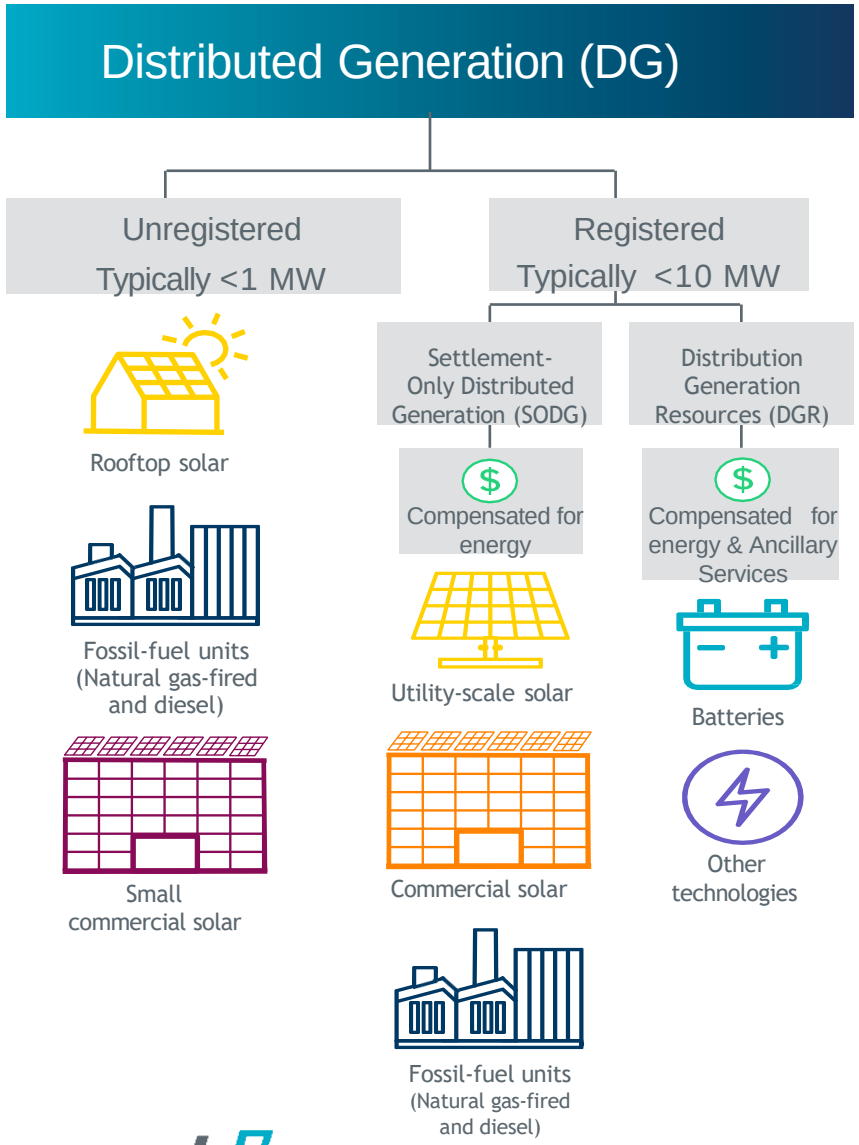
# The Changing Grid – Distributed Generation (DG) & Electric Vehicles (EV)

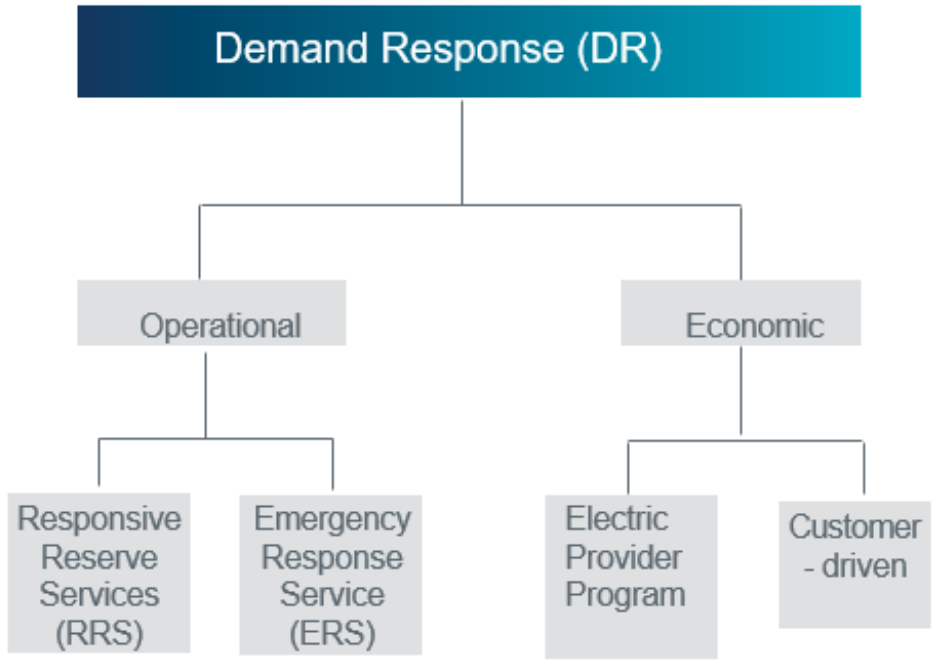
- ERCOT region is experiencing rapid growth in DG, especially solar photovoltaic less than 1 MW, which includes rooftop solar and community solar. Total DG at the end of 2022 is approximately 3850 MW.
- It is projected that the installed capacity for rooftop solar may reach 7,519 MW by 2030 for the aggressive 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.



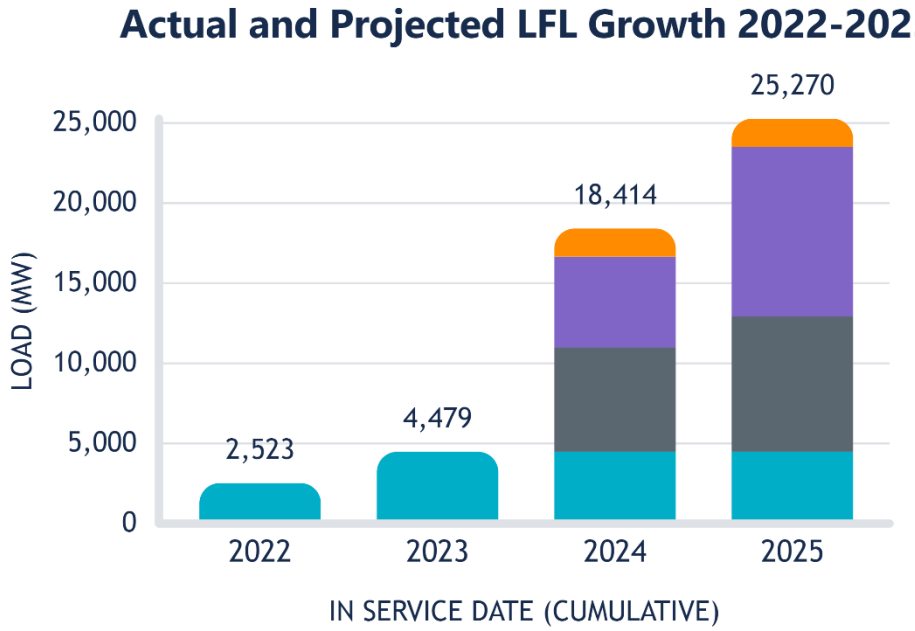
# Distributed Generation (DG) & Demand Response (DR)



# 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




| 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

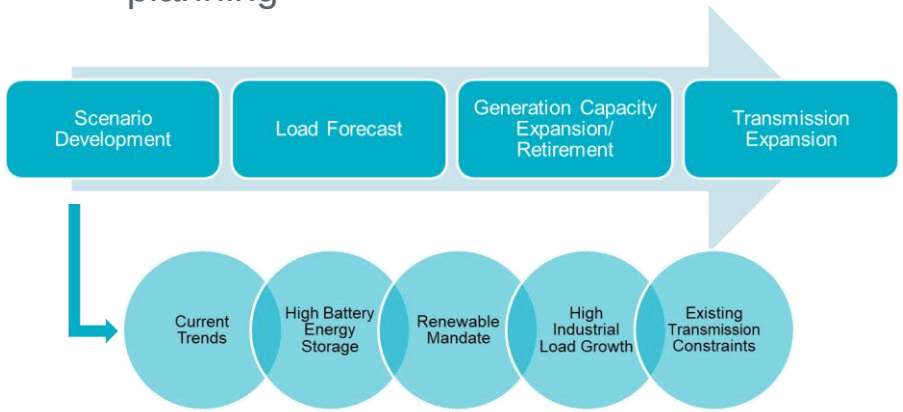
- Stakeholder review of project proposals
- Projects classified into four tiers with different levels of review based on project scope

## Biennial Grid Reliability Assessment

- Grid reliability and resiliency under extreme weather condition

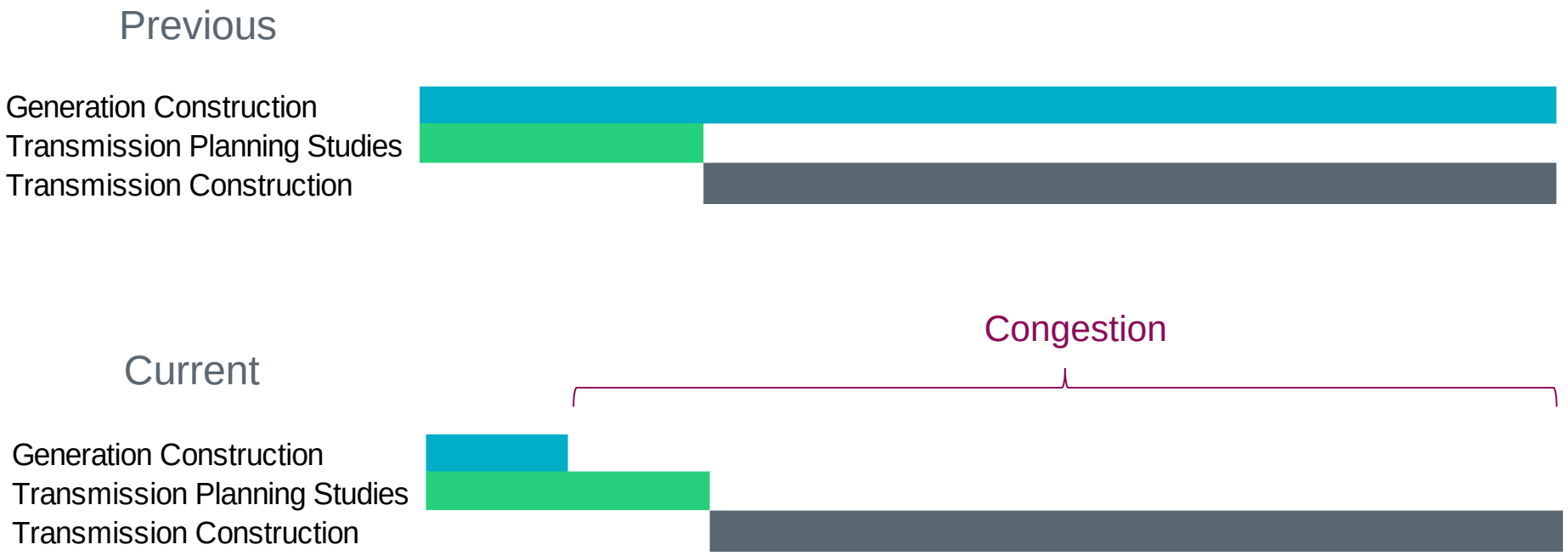
## Long-Term System Assessment

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



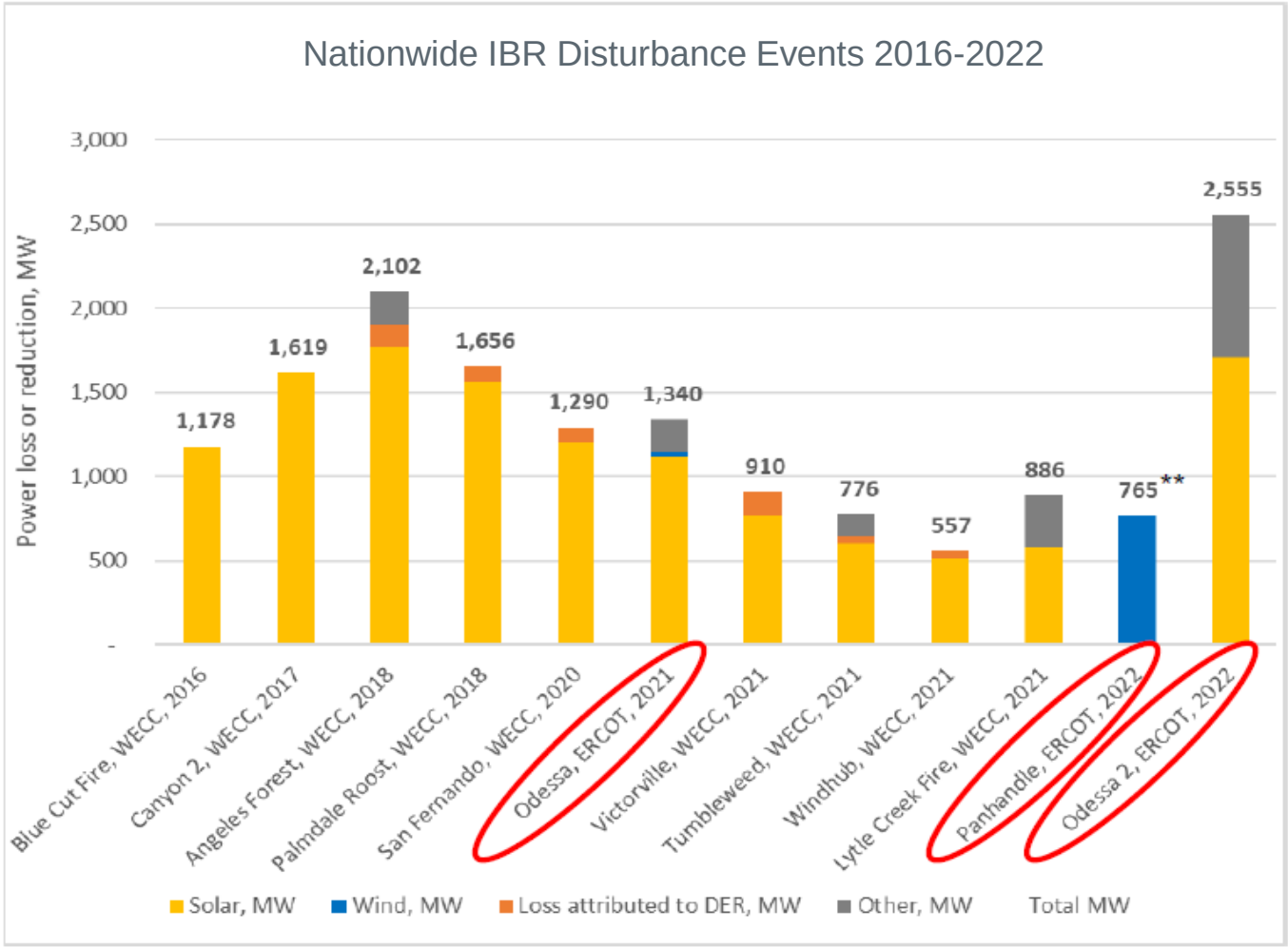
# Challenges: Generation and Transmission Timelines

- 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.



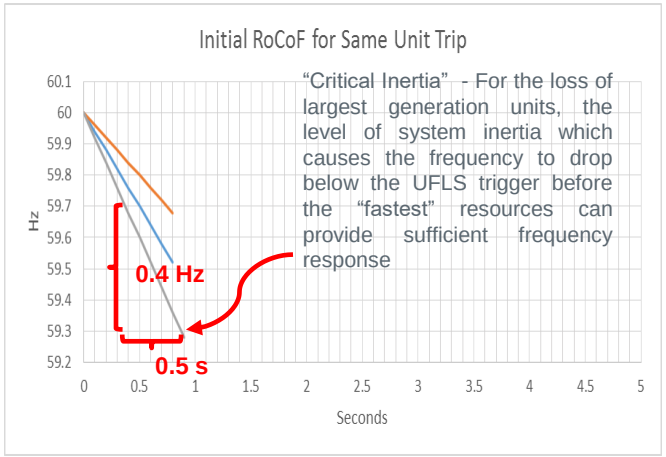
# Inverter-based resources (IBRs) in West Texas

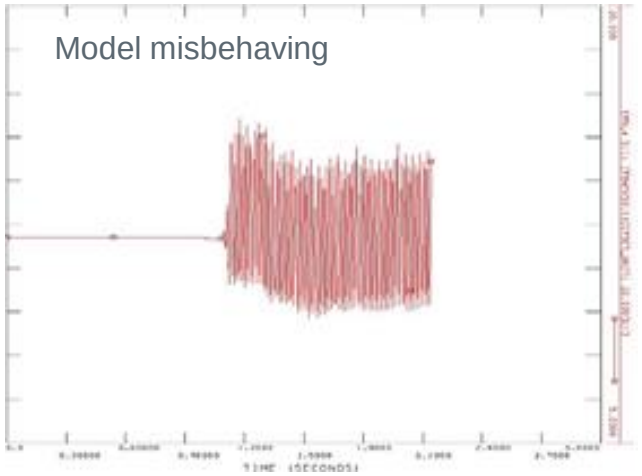
- Inverter-based resources (IBRs) in West Texas have experienced rapid and continued growth.
- Because the West Texas area (WTX) has a prevalence of IBRs and few synchronous generation resources, system strength is low in the area.
- Faults in the area result in widespread low voltages, and potentially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

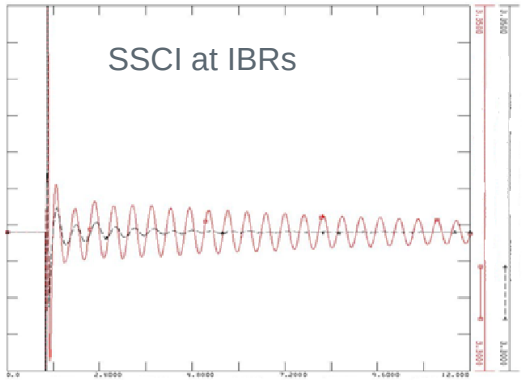


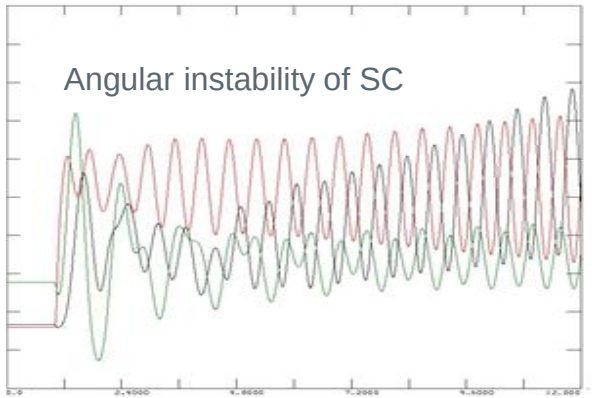
# Increasing System Stability Constraints

- 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.



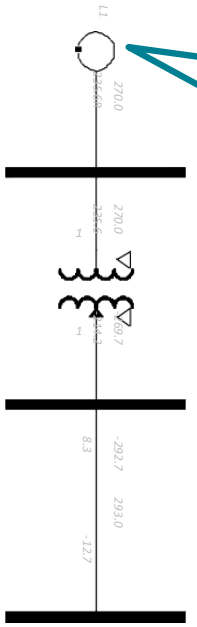



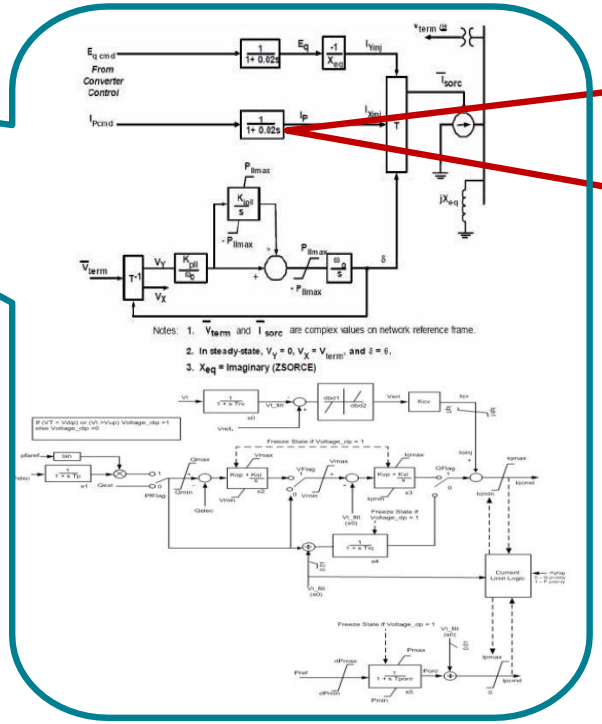
# IBRs - Modeling Complexity

## Power Flow



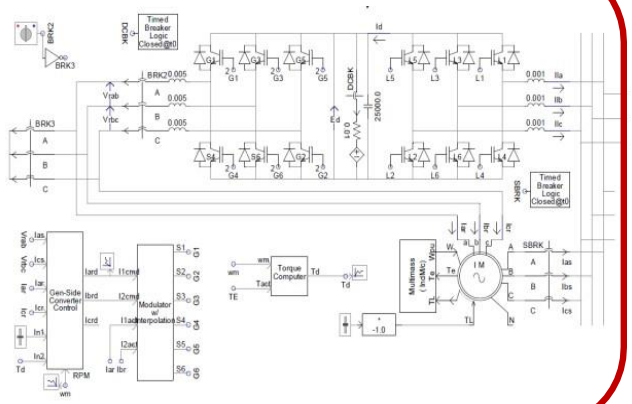
- Algebraic equation with no time step
- 60 Hz
- Positive sequence
- Balanced system
- Steady state
- Solution in < 1 sec
- Tools: PSS/e, PowerWorld, VSAT

## 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

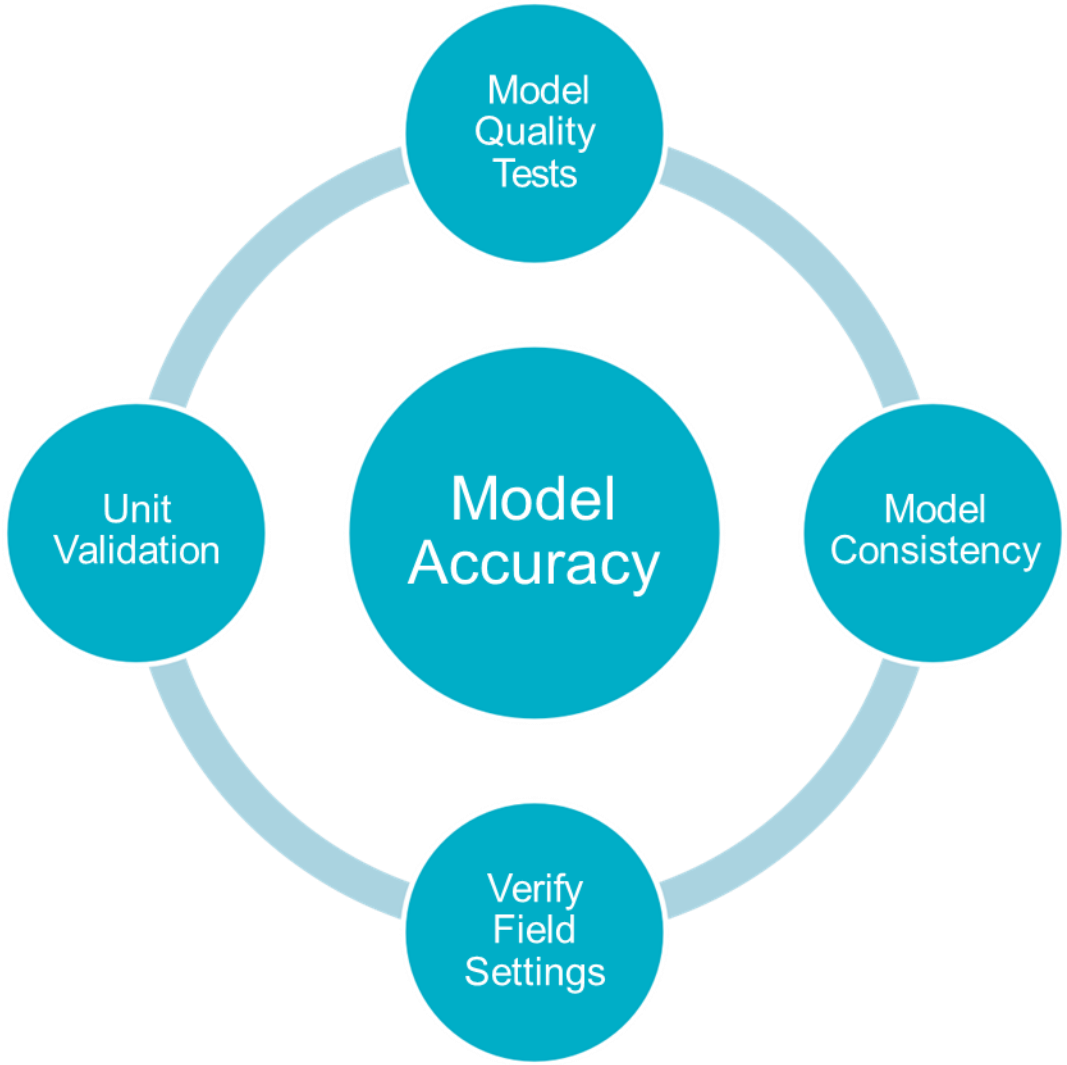
## EMT



- 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

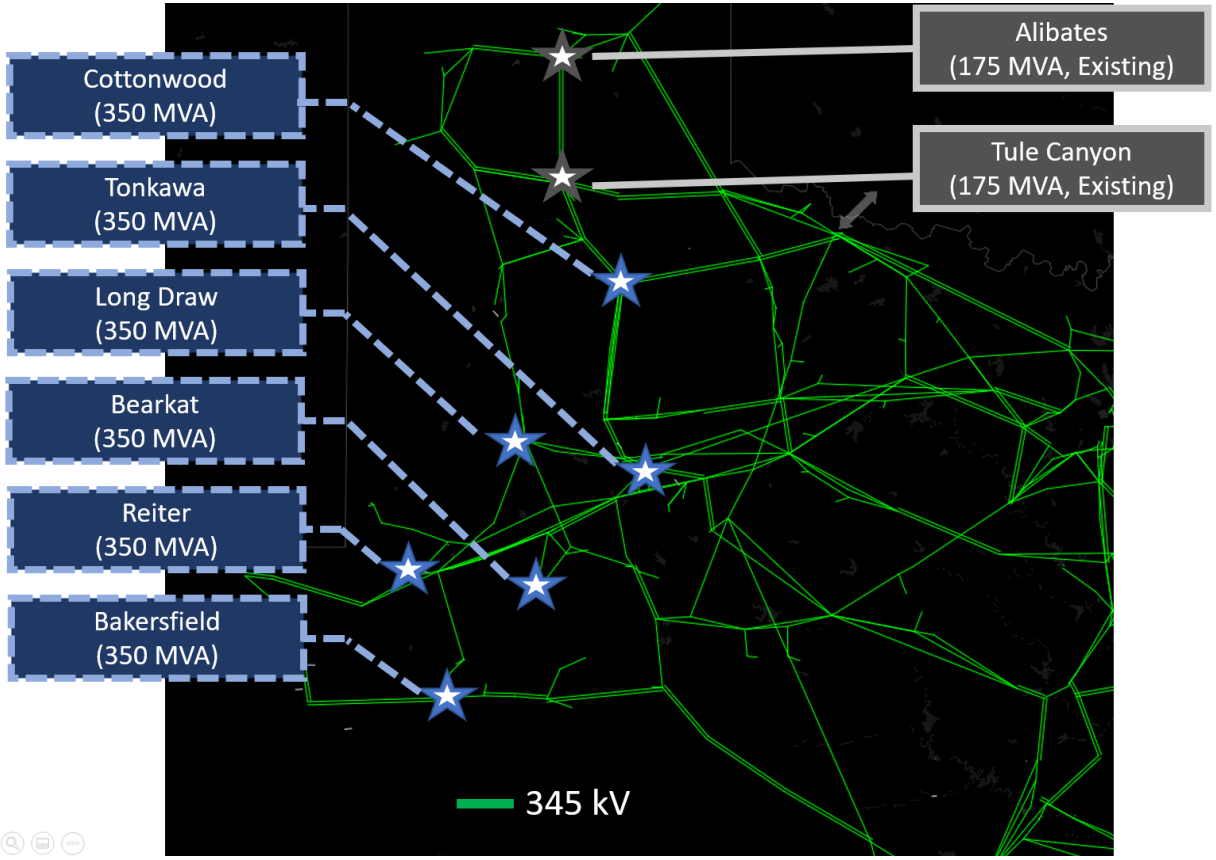
# IBRs - Dynamic Model Performance and Accuracy Improvements

- 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?