WECC Board Meeting Technical Session - Large Loads

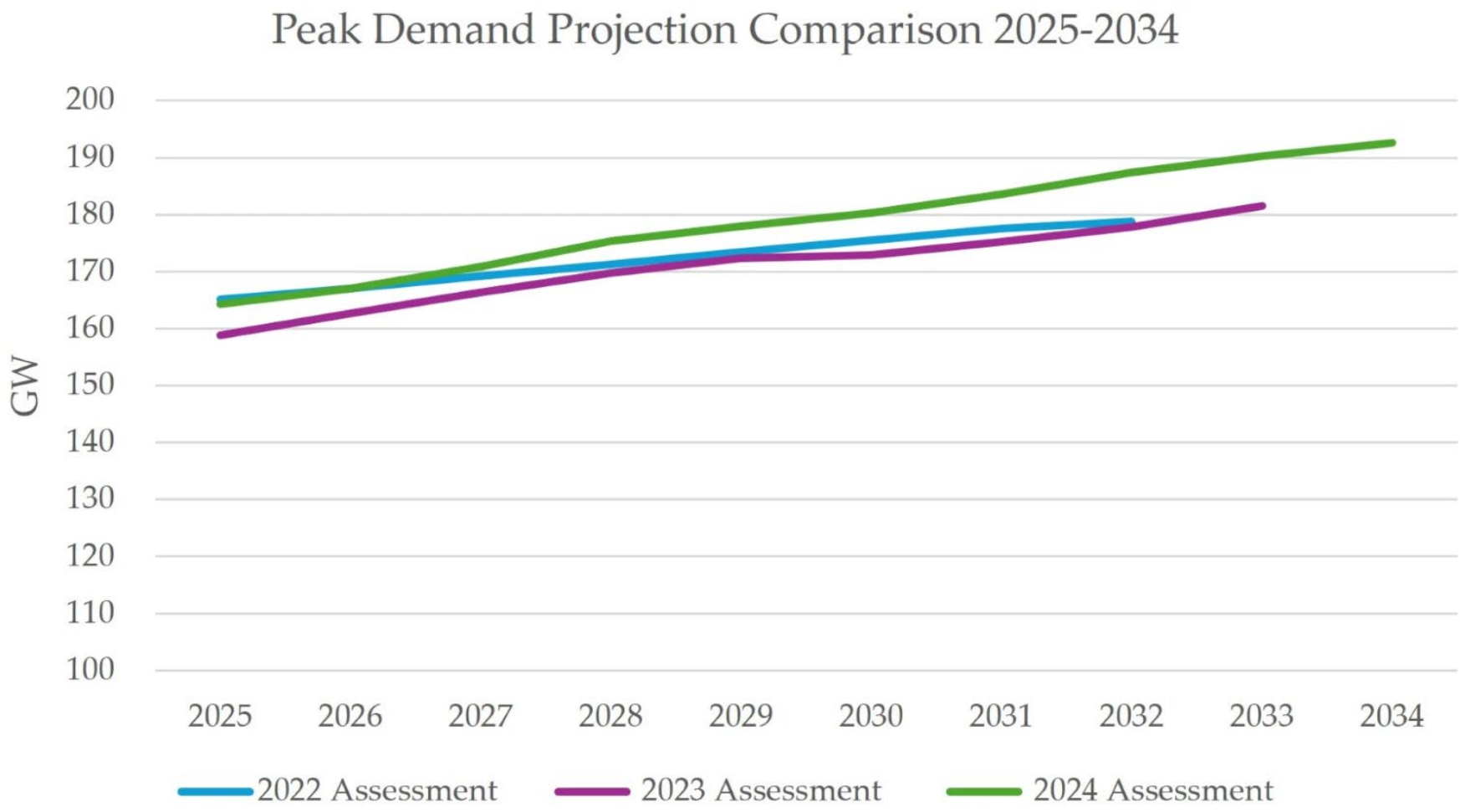
March 11, 2025

Katie Rogers, WECC

Julie Snitman, ERCOT

Gaurav Karandikar, SERC

Load Forecast Growth



What are Large Loads

Medium Commercial Loads (10s of kWs to 10s of MWs)

Entertainment

Campuses

Arenas

Wastewater

Commercial

Large Industrial Loads (10s to 100s of MWs)

Refining

Metals

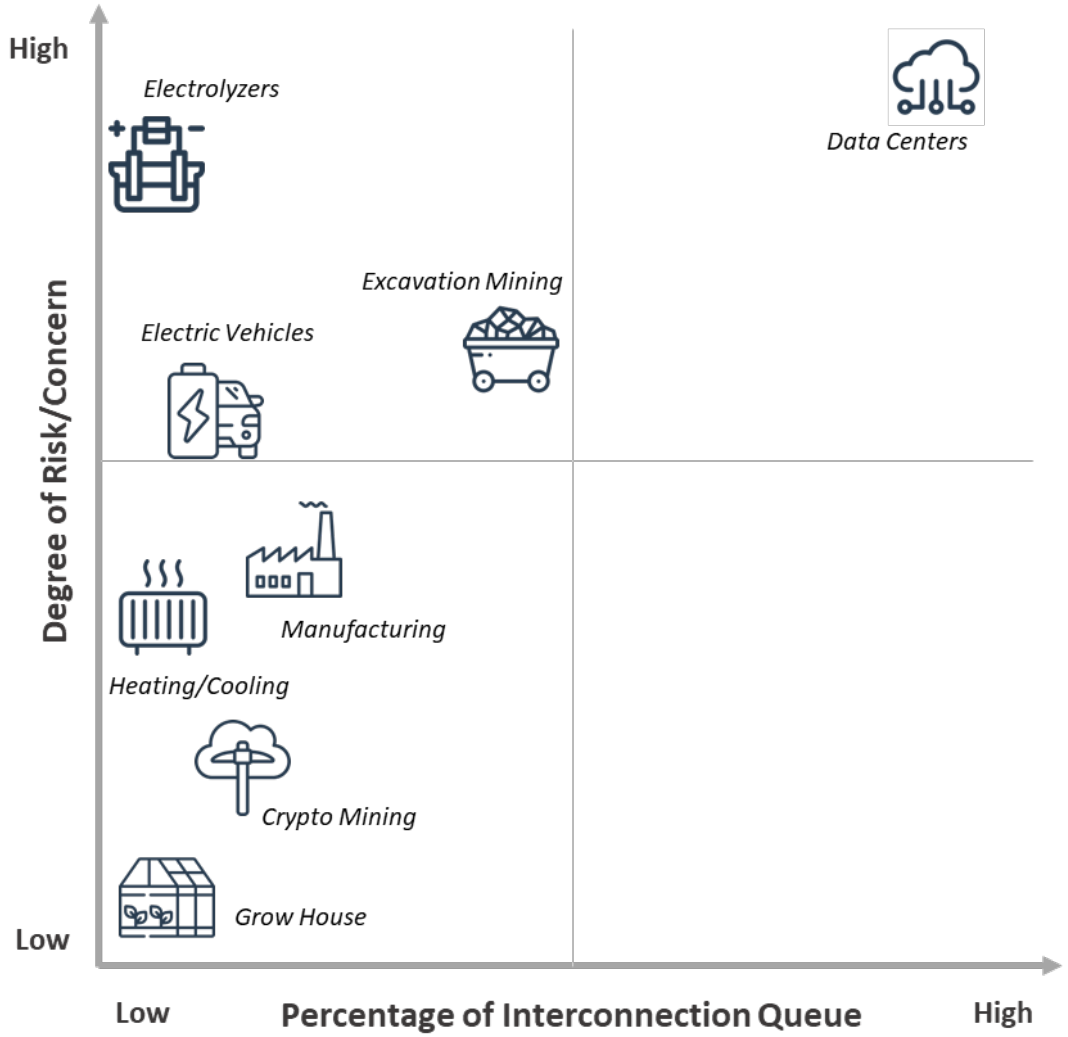
Data Centers

Mining

Chemical

Manufacturing

Interconnection Queues



What Has Changed

	Past	Current
Facility Size:	1 MW to 400 MW	Some surpass 1,000 MW
Load Patterns:	Regular, predictable	May not be predictable
Advanced Notice:	Sufficient time to plan, design, and construct	Minimal, could be ~18 months

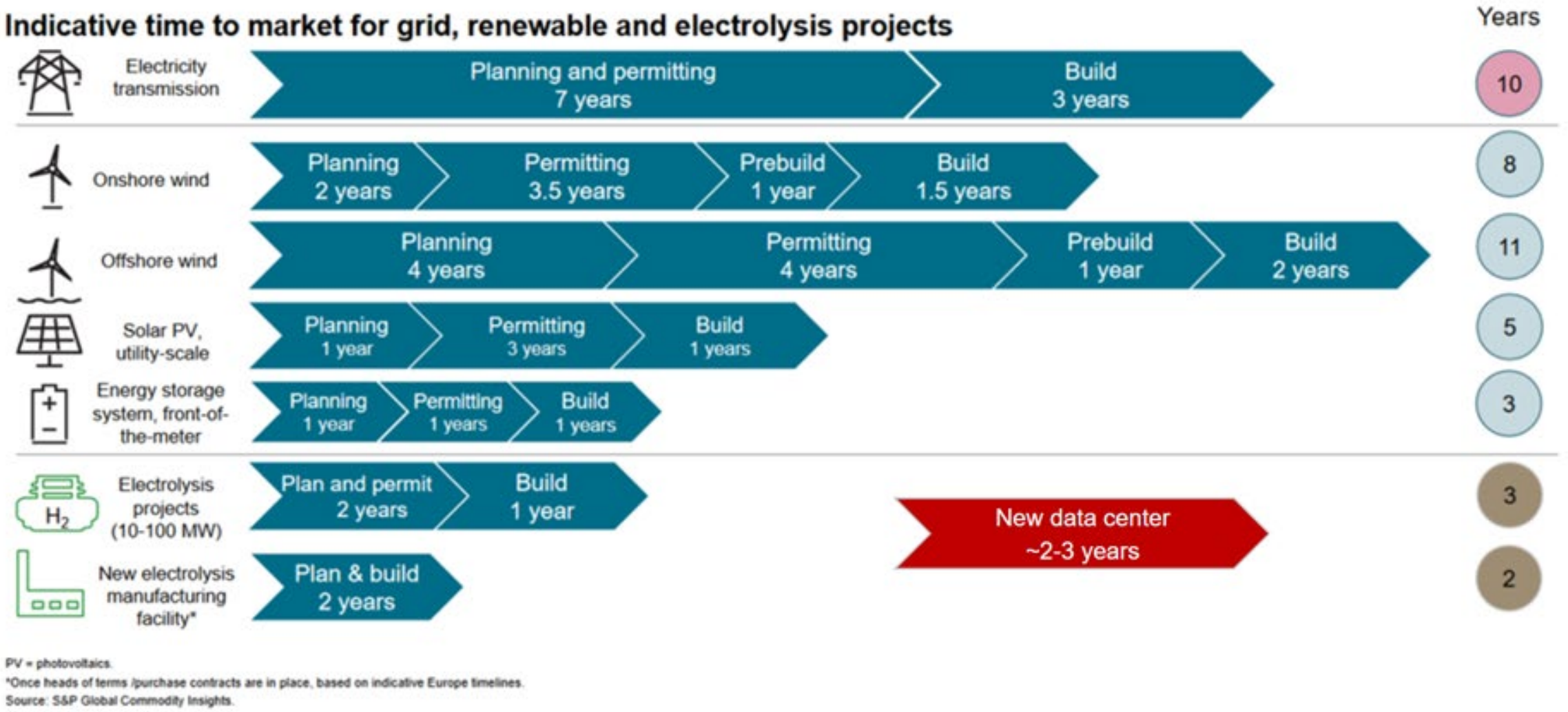
Risk – Demand Forecast Challenges

- Load interconnection queues overloaded – won't all come to fruition
- Lack of operational information and/or data
- May not include electrification efforts (or other aggregate impacts)
- Some may shift load profiles
- Behind-the-meter not always known or accounted for
- Demand response participation

Risk – Accurate Model Challenges

- Lack of data on large load behavior, composition, and performance
- Simplified static load models don't capture the characteristics of large load performances
  - May underestimate impacts during ride-through events
- Lack of phasor domain transient (PDT) and electromagnetic transient (EMT) models

Risk – Misaligned Timelines



Risk – System Planning Challenges

- May exacerbate existing resource adequacy risks
- Distribution system may not be able to keep up with multi-sector electrification
- High uptime limits time available for maintenance

Risk – Variable and Flexible Challenges

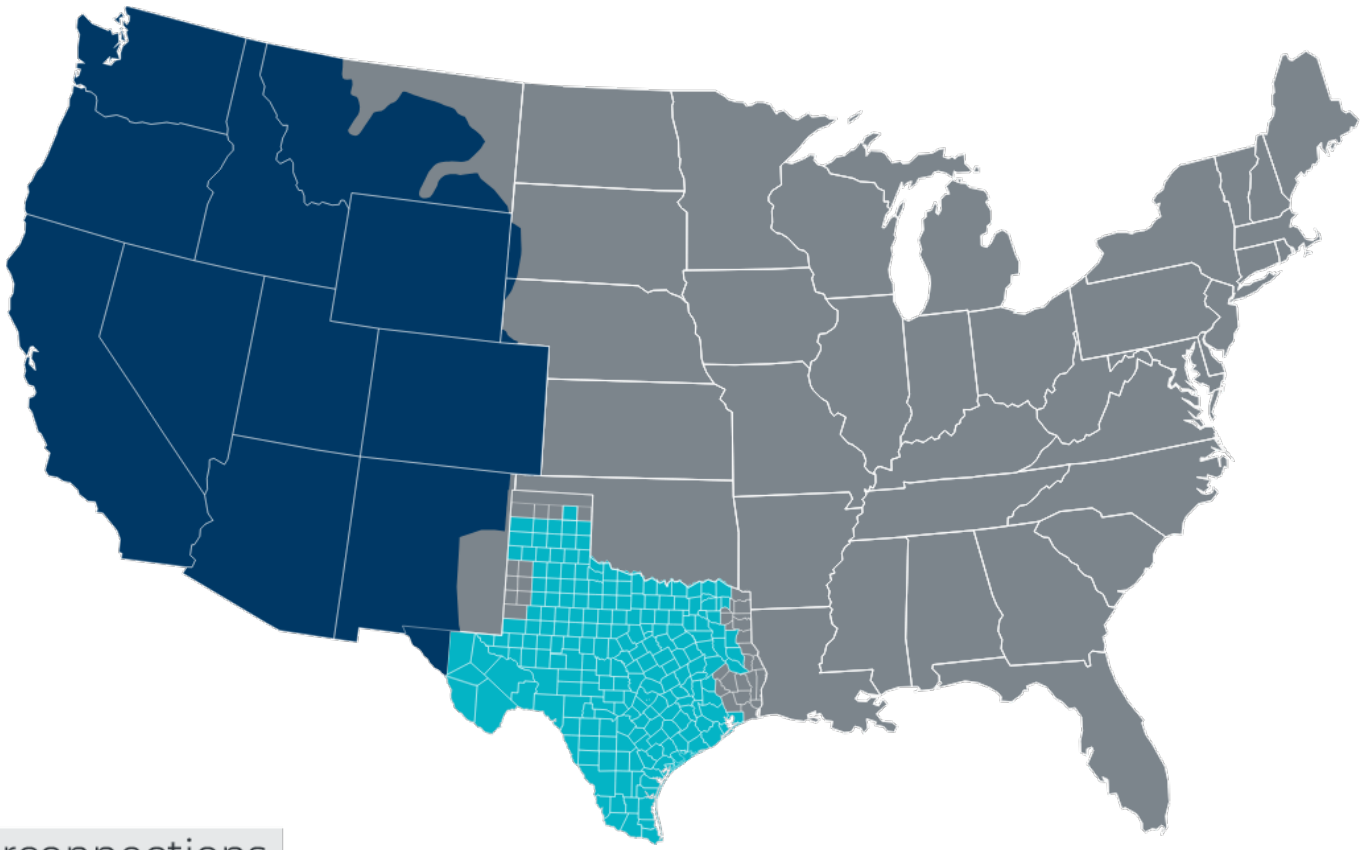
- Increased need for reserves
  - Limits available energy
- Unpredictable behavior and operational characteristics
- Current ramping abilities may not be sufficient for large power fluctuations
- Fast ramps and spikes could cause oscillations, flicker, frequency deviations, oscillations, and other risks

Large Loads in ERCOT – Observations and Challenges

Julie Snitman
Supervisor, Large Load Integration

WECC Board of Directors Meeting– March 11, 2025

The ERCOT Region



The interconnected electrical system serving most of Texas, with limited external connections

- 90% of Texas electric load; 75% of Texas land
- 85,508 MW peak, August 10, 2023
- More than 54,100 miles of transmission lines
- 1,250+ generation units
  (including Private Use Networks)

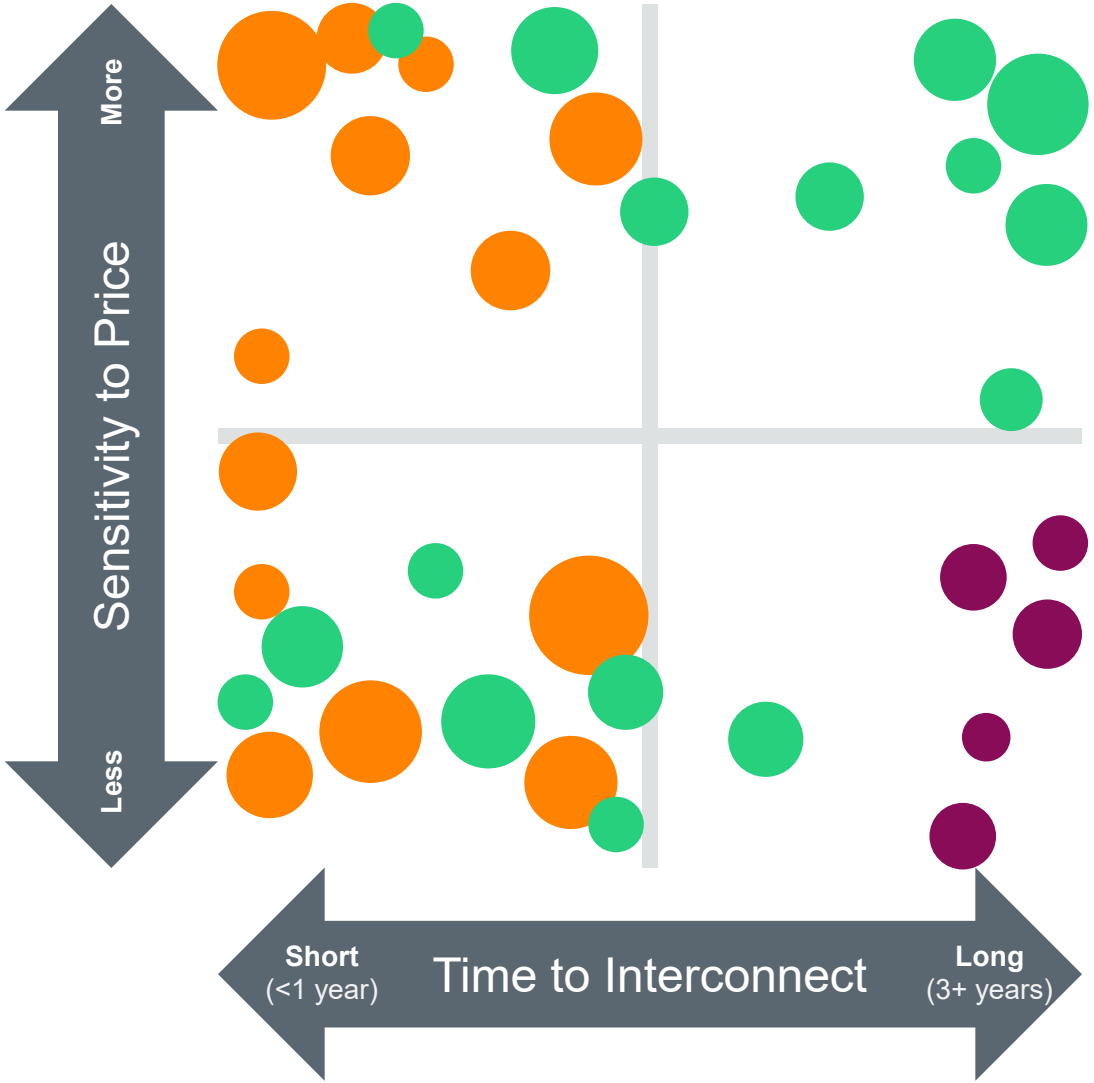
ERCOT connections to other grids are limited to ~1,220 MW of direct current (DC) ties, which allow control overflow of electricity

Large and Flexible Loads - Definitions

- 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**

- ERCOT considers a Load that can raise or lower its consumption in response to wholesale prices or other grid conditions to be a **flexible Load**
  - Some flexible Loads are registered with ERCOT as Load Resources and provide Ancillary Services and/or participate in the Security Constrained Economic Dispatch (SCED)
  - Many other flexible Loads adjust consumption independent of any direction from or coordination with ERCOT

Changing Characteristics of Large Loads Coming to ERCOT



Historical Large Loads

- Typically industrial facilities
- Long timelines to interconnect can be studied by traditional planning processes
- Little price-sensitive behavior in real-time

Current Wave of Large Loads

- Mostly data centers, cryptomining, some oil field Load
- Much shorter timeline to interconnect (months rather than years)
- Some Loads are extremely sensitive to price

Projected Future Large Loads

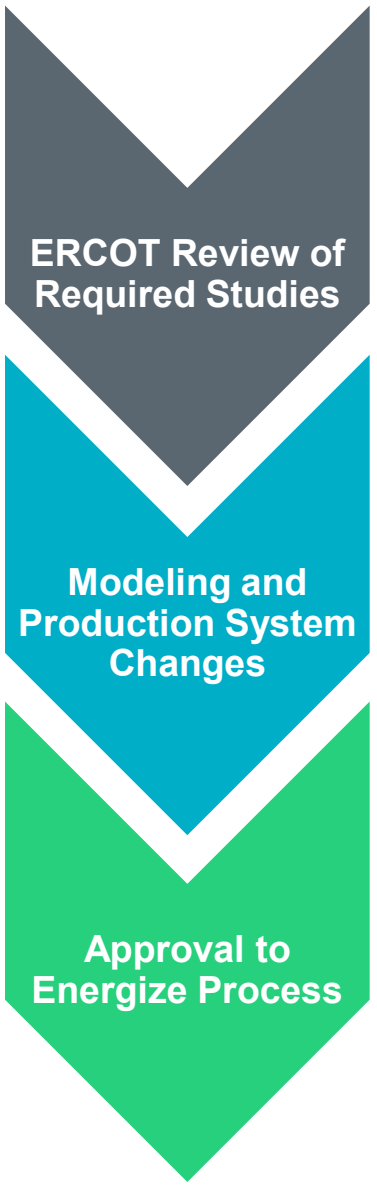
- Data centers, some cryptomining, oil field and some hydrogen production
- Range of interconnection timelines and price sensitivity

Interim Large Load Interconnection Process

- In March 2022, ERCOT implemented an **interim** interconnection process for Large Loads wishing to connect within 2 years or less

- This process
  - Ensures new interconnection requests are studied for reliability as required by NERC FAC standards
  - Identifies new transmission upgrades that are needed to serve the Load
  - Determines the amount of Loads that can be served **reliably** until transmission upgrades are in service and limits the demand to that amount

- ERCOT is proposing to formalize this process on adoption of PGRR115 and NPRR 1234



Interim Large Load Interconnection Process Details

Phase 1
Interconnection Request and Reliability Studies

- Interconnection request made to TSP
- TSP performs reliability studies and identifies upgrades needed to serve the Load
- ERCOT reviews studies and establishes the amount of Load that can be served reliably
  - To achieve the full requested Load, transmission upgrades may be necessary

Netted Loads Only
- RE submits updated Reactive Study that includes the Load

Phase 2
Agreements and Modeling

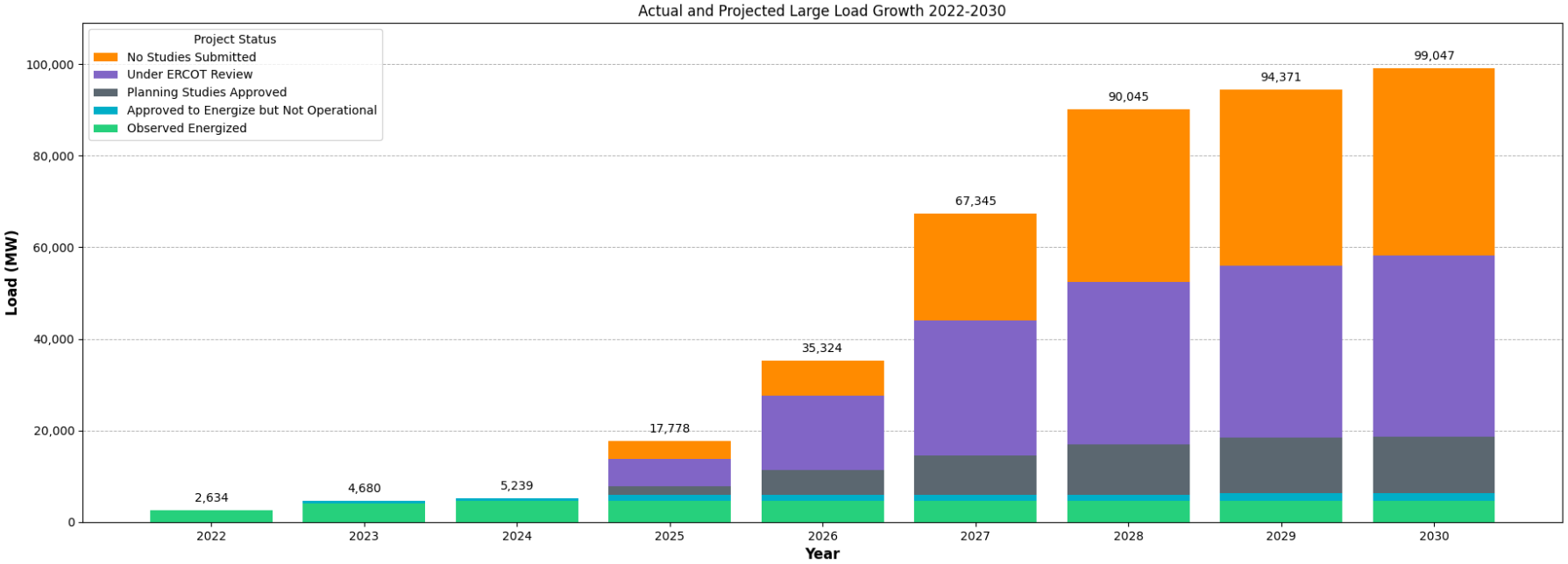
- Customer signs a binding agreement with TSP
- Load is added to ERCOT's planning models and Network Operations Model

Netted Loads Only
- TSP submits ERCOT Polled-Settlement (EPS) Meter design that includes the Load
- New or amended Standard Generation Interconnection Agreement (SGIA) that includes the Load is signed

Phase 3
Approval to Energize

- TSP (or RE for netted loads) requests ERCOT approval to energize the Load
- ERCOT validates Load modeling and telemetry quality
- Load is approved to consume energy up to established ERCOT limit
- After energization, ERCOT monitors Load consumption to ensure limits identified in planning studies are not exceeded

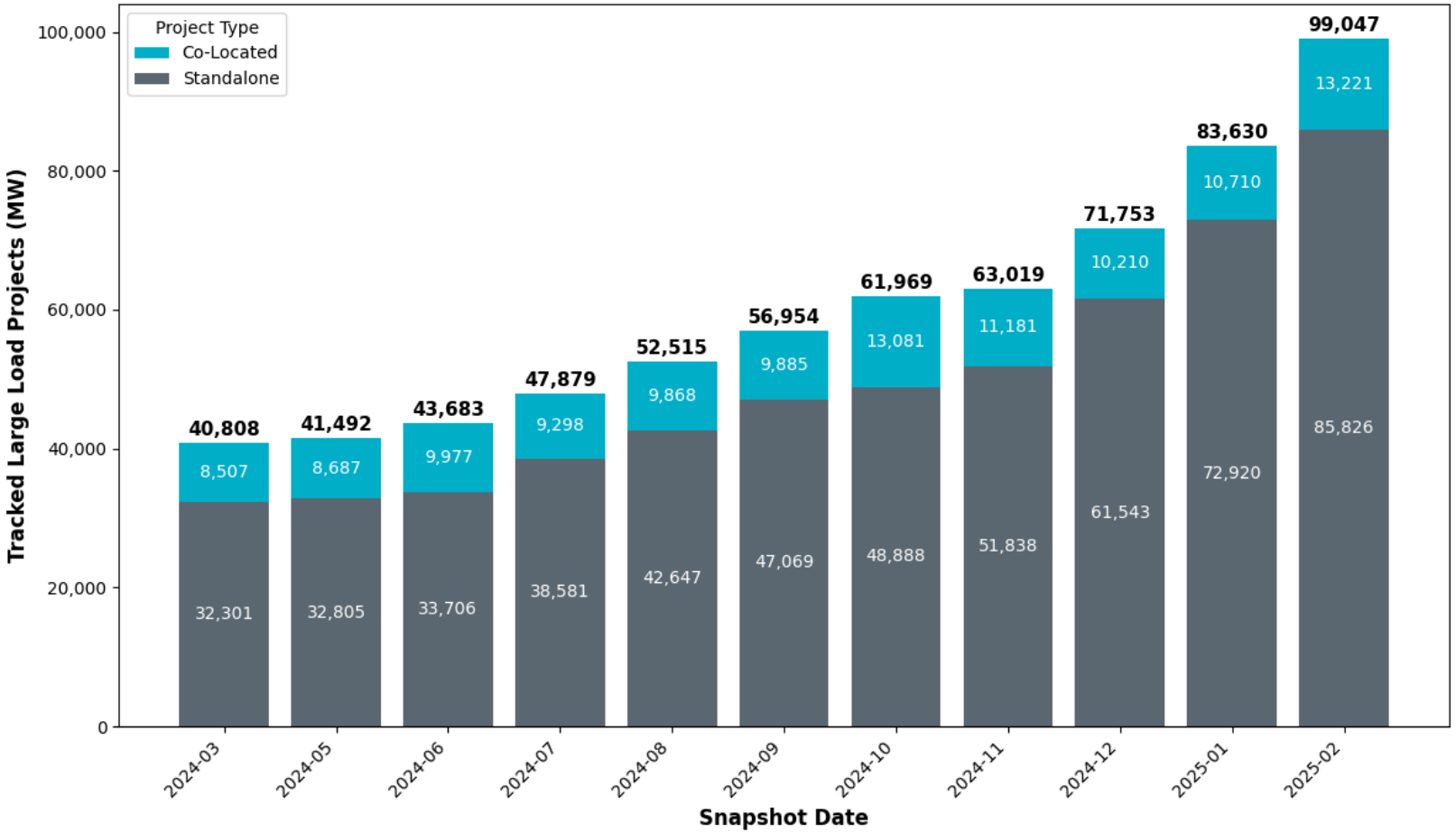
Current Large Load Interconnection Queue



Project Status	2022	2023	2024	2025	2026	2027	2028	2029	2030
No Studies Submitted	0	0	0	4,034	7,686	23,418	37,576	38,472	40,799
Under ERCOT Review	0	0	0	6,012	16,198	29,364	35,529	37,509	39,639
Planning Studies Approved	0	0	0	1,726	5,435	8,558	10,934	12,084	12,303
Approved to Energize but Not Operational	0	569	623	1,390	1,390	1,390	1,390	1,690	1,690
Observed Energized	2,634	4,111	4,616	4,616	4,616	4,616	4,616	4,616	4,616
Total (MW)	**2,634**	**4,680**	**5,239**	**17,778**	**35,325**	**67,346**	**90,045**	**94,371**	**99,047**

- **Observed Energized –** Projects that have received Approval to Energize from ERCOT Operations and are fully operational. Represented by all time non-simultaneous peak load consumption.
- **Approved to Energize but Not Operational –** Projects that have received Approval to Energize from ERCOT Operations but are not observed to be operational.
- **Planning Studies Approved –** Projects that have received ERCOT approval of required interconnection studies. Any MWs that were not approved are reclassified as No Studies Submitted.
- **Under ERCOT Review –** Projects that have studies under review by ERCOT.
- **No Studies Submitted –** Projects that are tracked by ERCOT but that have not yet provided sufficient information for ERCOT to begin review. Additionally, MWs that were not approved by ERCOT after review of planning studies are included in this category until a path to interconnect these MWs is identified, or the customer cancels the interconnection request.

Large Load Queue – Past 12 Months

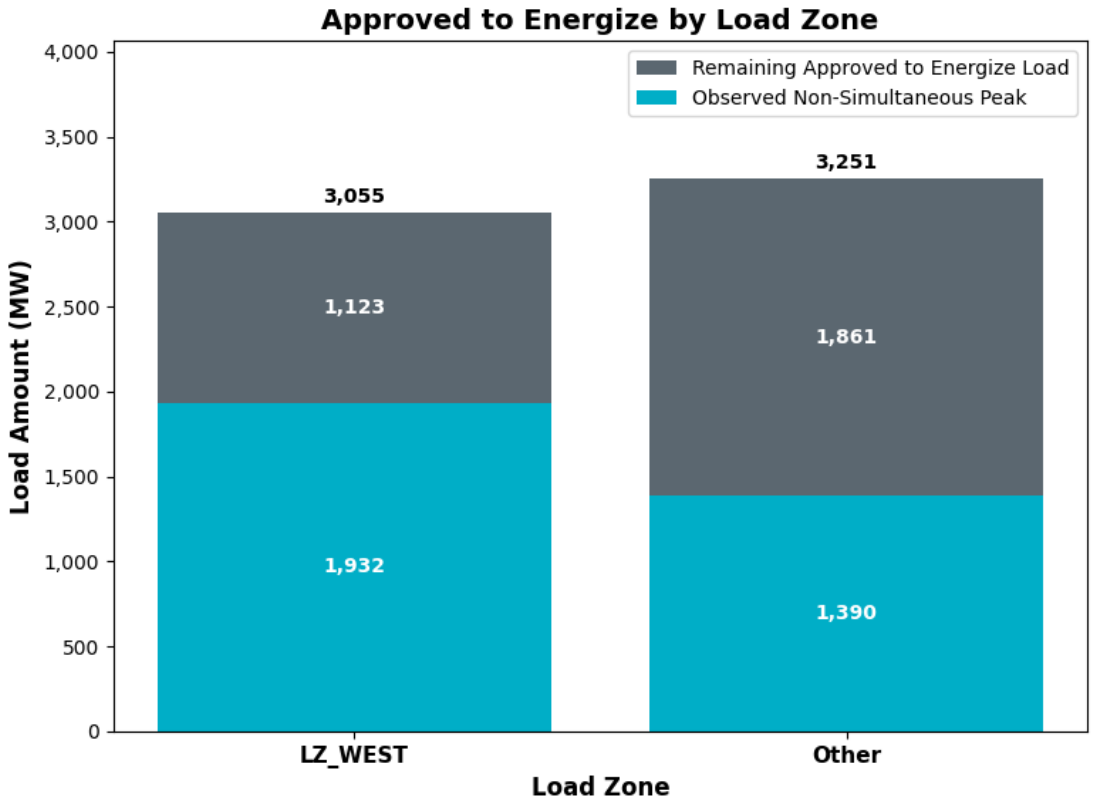


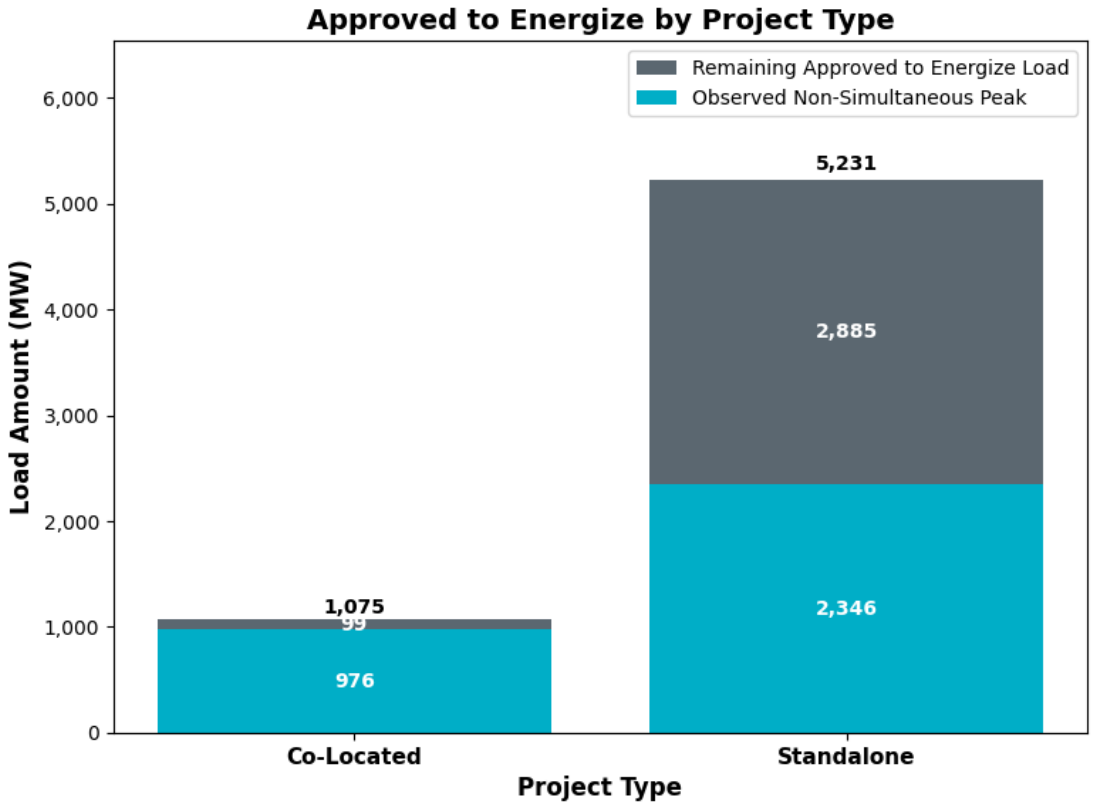
Changes in the past 12 months

- Combination of new standalone and co-located projects, as well as several project cancelations, increased total queue capacity by 15,417 MW.

Loads Approved to Energize – By Zone & Project Type

- Of the total 6,306 MW Approved to Energize,
  - 3,055 MW resides in LZ_WEST and 3,251 MW resides in the other load zones.
  - 5,231 MW consists of standalone projects and 1,075 MW consist of co-located projects.





*Other Includes LZ_NORTH, LZ_SOUTH, and LZ_HOUSTON

Grid Planning Challenges with Large Loads

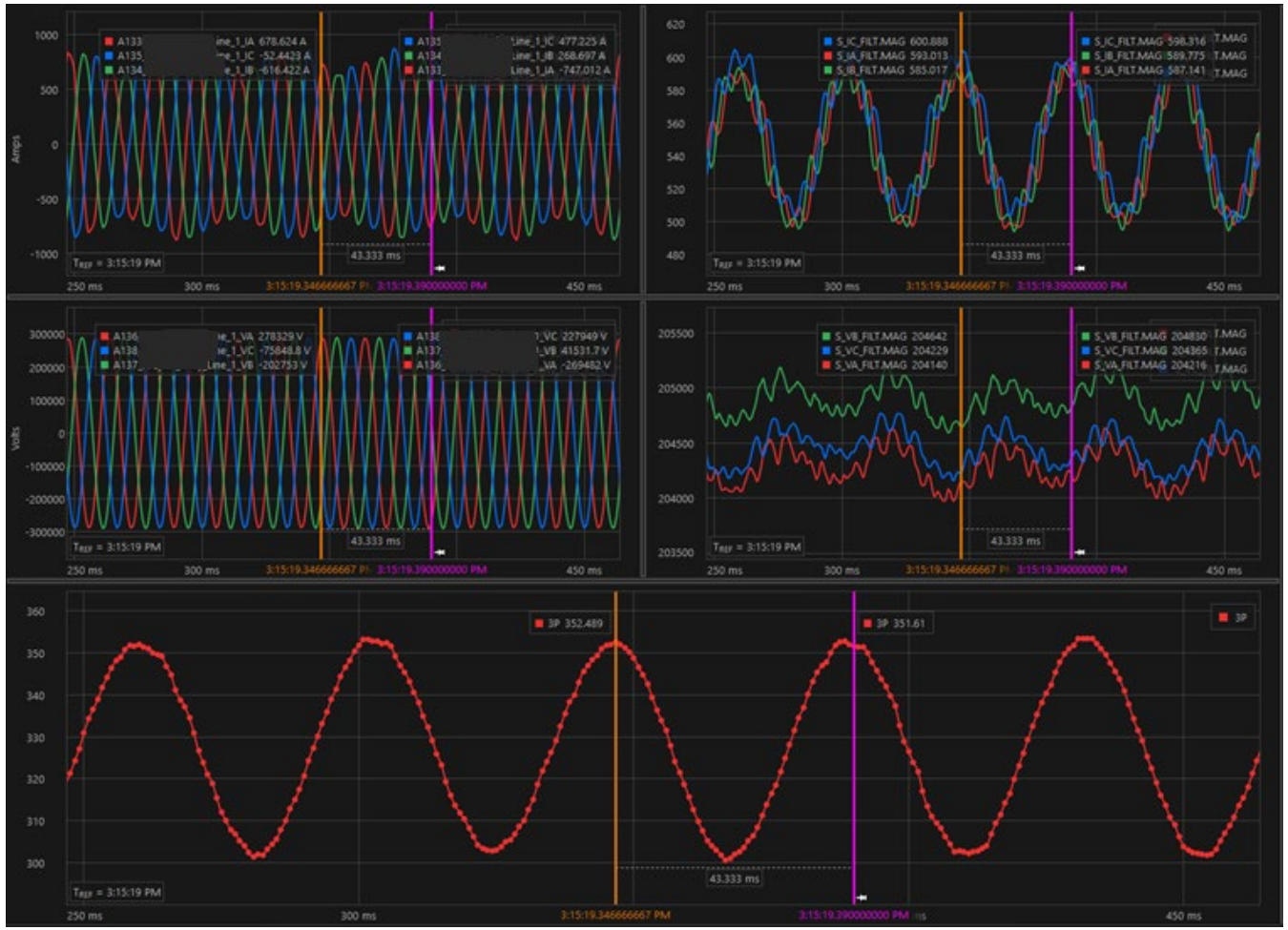
- Far more interconnection requests than available capacity on current grid and uncertainty on which projects will move forward

- How to incorporate large loads into planning studies
  - When should a project be considered “real” enough to include in other planning studies?
  - Should demand flexibility of a load be taken into account?
  - What happens if the grid is upgraded and the load does not materialize?

- Current models do not capture dynamic behavior of power electronic based loads, making accurate studies difficult

Fall 2024 Large Load Oscillation

- In September 2024, ERCOT observed a ~40 MW oscillation from a large load when consumption was above 300 MW
- High resolution data (20 samples/cycle) showed a ~23 Hz oscillation with ~50 MW peak to peak magnitude on Oct. 28
- Root cause was determined to be old firmware on some equipment. Load was limited until firmware was updated.
- **Key Observations**
  - Oscillation was sub-synchronous and could damage nearby generation
  - High resolution measurements were needed to see the oscillations – SCADA was not fast enough
  - ERCOT is concerned AI data centers may exhibit similar oscillations



Final Thoughts – Familiar challenges in a new world

- The ERCOT grid saw many of the same challenges from the rapid growth in wind, solar, and storage over the past 15 years
  - Some of the same solutions may work with large loads

- The historical relationship between loads and the grid is fundamentally different than the relationship between generators and the grid

- New thinking is going to be needed to maintain reliability for all customers while serving these new large loads
  - Large loads also have the potential to be tools for maintaining grid reliability

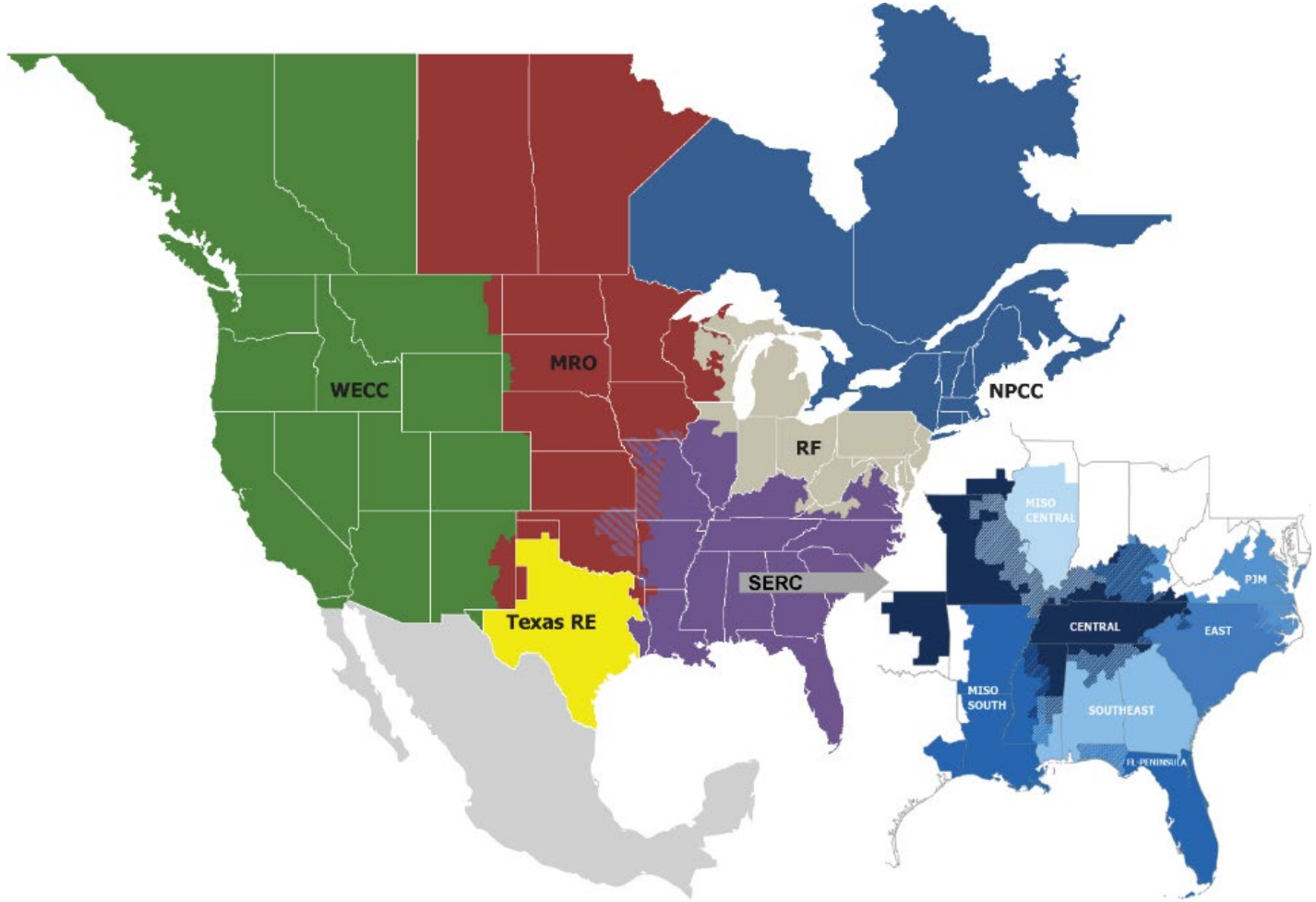
Questions?

Load Growth Risks

March 11, 2025

Gaurav Karandikar
Director, RAPA and Technical Services
SERC Reliability Corporation

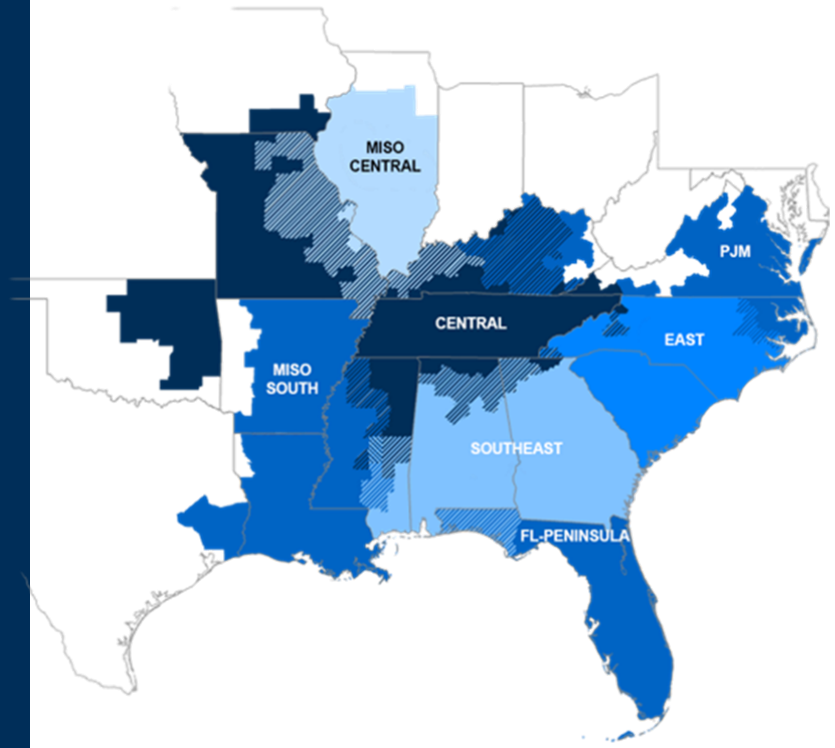
SERC Reliability Corporation



Objectives

- ❑ Projected Growth Areas
- ❑ Primary Demand Drivers
- ❑ Risk Mitigation Strategies

Load Growth Projections (SERC 10-Year Horizon)



	Summer	Winter
MISO-Central CAGR	0.20%	0.13%
Central CAGR	0.39%	0.31%
PJM CAGR	5.19%	4.63%
East CAGR	1.82%	1.47%
Southeast CAGR	1.81%	1.55%
FL-Peninsula CAGR	1.14%	1.06%
MISO-South CAGR	1.53%	1.57%

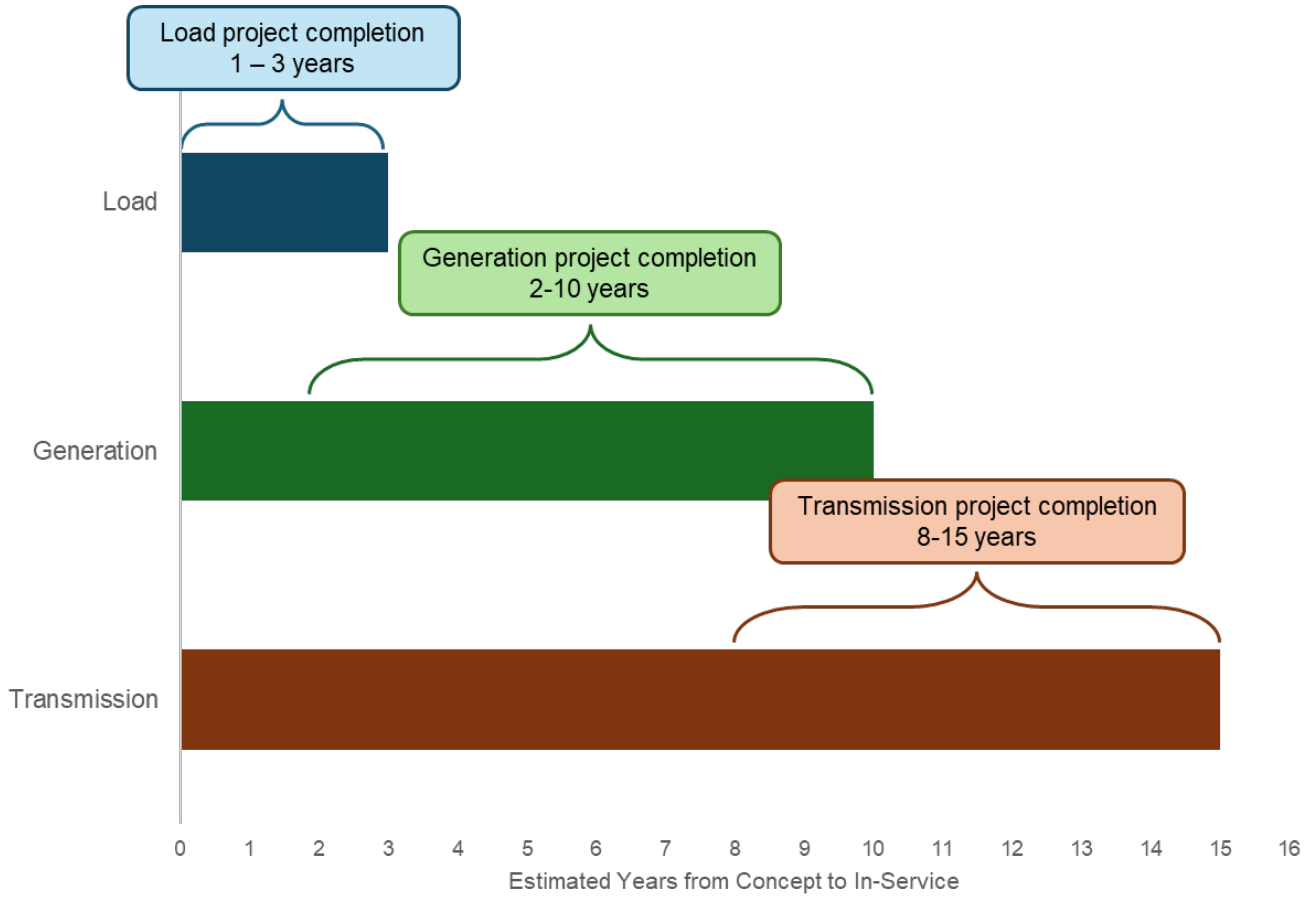
- **Annual Load Growth Rate**
- **Emerging Demand Influences**
- **Data Sources for Projections**

Risk #1 – Reliability Concerns

- **Reliability Under Strain**
- **Aging Infrastructure Concerns**
- **Environmental Vulnerabilities**

Risk #2 – Resource Adequacy & Fuel Mix

- **Fuel Source Reliance**
- **Coal Retirements Impact**
- **Solar Power Integration**



Risk #3 – Economic & Policy Uncertainties

- **Economic Downturn Implications**
- **Supply Chain Disruptions**
- **Regulatory Shift Effects**

Mitigation #1 – Resource & Capacity Planning

Flexible Capacity Resources

Renewable Energy Integration

Transmission Infrastructure Upgrades

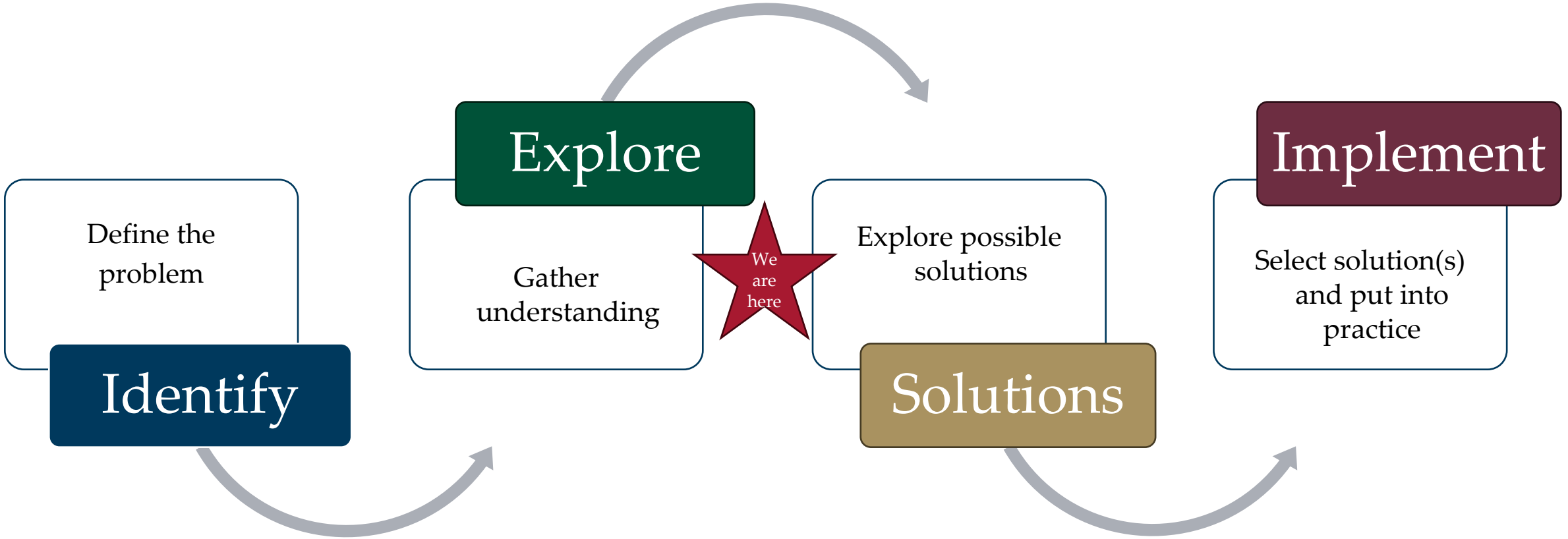
Mitigation #2 – Demand-Side Management & Efficiency

- **Demand-Side Management Strategies**
- **Smart Grid Technology**
- **Real-Time Load Optimization**

Conclusion & Key Takeaways

- **Growth Rates and Reliability Risks**
- **Resource Adequacy Challenges**
- **Key Mitigation Strategies**

Where are we in the process



WECC Action - Education

- WECC Reliability in the West Webinar Series
  - October 2024
  - November 2024
  - February 2025
  - March 2025
- This technical session

WECC Action – Data and Models

- Data Gathering
  - Contract with Elevate Energy Consulting
  - WECC Large Loads Industry Advisory Group
  - Loads and Resources (L&R) data request expansion
- Models
  - Dynamic model development
  - 20 Year production cost model development

WECC Action - Industry Coordination

- NERC Large Loads Task Force
  - Part I: Characteristics and Risks of Emerging Large Loads (Q2 2025)
  - Part II: Assessment of Gaps in Existing Practices, Requirements, and Reliability Standards for Emerging Large Loads (Q4 2025)
- ESIG Large Loads Task Force
  - Data Collection
  - Load Forecasting
  - Interconnection Process and Performance Requirements
  - Modeling Requirements
  - Transmission Planning
  - Wholesale Market Options
  - Resource Adequacy


POWER OUTAGES AREN'T
A LAUGHING MATTER.
THEY'RE TOO DARK.

Questions?

WECC

Electric Reliability and Security for the West

www.wecc.org