



USAGE OF PROBABILISTIC WIND AND SOLAR FORECASTS AT ERCOT

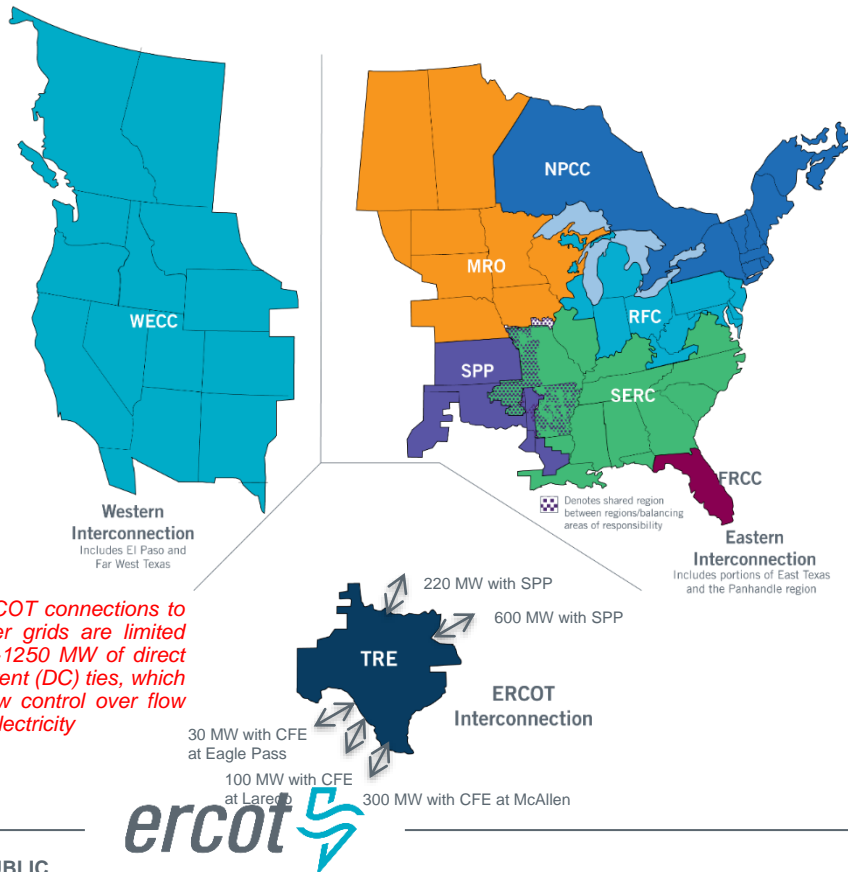
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ESIG PROBABILISTIC FORECASTING USER GROUP

Introduction to ERCOT Region & Company

ERCOT Region

- The interconnected electrical system serving most of Texas, with limited external connections
 - 90% of Texas electric load; 75% of Texas land
 - More than 52,700 miles of transmission lines
 - 570+ generation units



ERCOT Inc.

- The Texas Legislature restructured the Texas electric market in 1999 and assigned ERCOT four primary responsibilities under PURA Section 39.151:
 - Maintain system reliability
 - Facilitate competitive wholesale market
 - Ensure open access to transmission
 - Facilitate competitive retail market
- ERCOT is regulated by the Texas Public Utility Commission (PUC) with oversight by the Texas Legislature.
- Must balance consumer demand in the ERCOT region (load) and the power supplied by companies that generate electricity (generation) while maintaining system frequency of 60 Hz.
- Performs financial settlement for the competitive bulk wholesale power market and administers retail switching for approximately 8 million premises in competitive choice areas

ERCOT is not a market participant and does not own generation or transmission/distribution wires.

ERCOT's Energy Market & Ancillary Services Overview

- ERCOT operates a 5-min energy-only market in Real Time (\$5,000/MWh price cap with operating reserve scarcity adder)
- ERCOT operates a Voluntary Day-Ahead Market (DAM) that co-optimizes energy and Ancillary Services. ERCOT procures Ancillary Services in DAM.
- ERCOT does not have a capacity market like some of the other ISOs.
- Since implementation of 2010 Nodal energy markets, ERCOT has operated with three types of ancillary services.
 - While the types of Ancillary Services have stayed the same, over the years ERCOT has tweaked the methodology for computing the reserve requirements continuously, to adapt to the evolving needs of the ERCOT grid and to become more efficient in responding to the additional operational risks.
 - ERCOT has recently added a fourth Ancillary Service namely ECRS

Ancillary Service Products

Regulation Service (Reg)

- Reserved capacity that is deployed every 4 seconds to balance supply and demand and maintain frequency close to 60Hz between 5-minute SCED runs.

Responsive Reserve Service (RRS)

- Reserved capacity that is procured to respond to low frequency events typically triggered by generating unit trips.

ERCOT Contingency Reserve Service (ECRS) – recently added

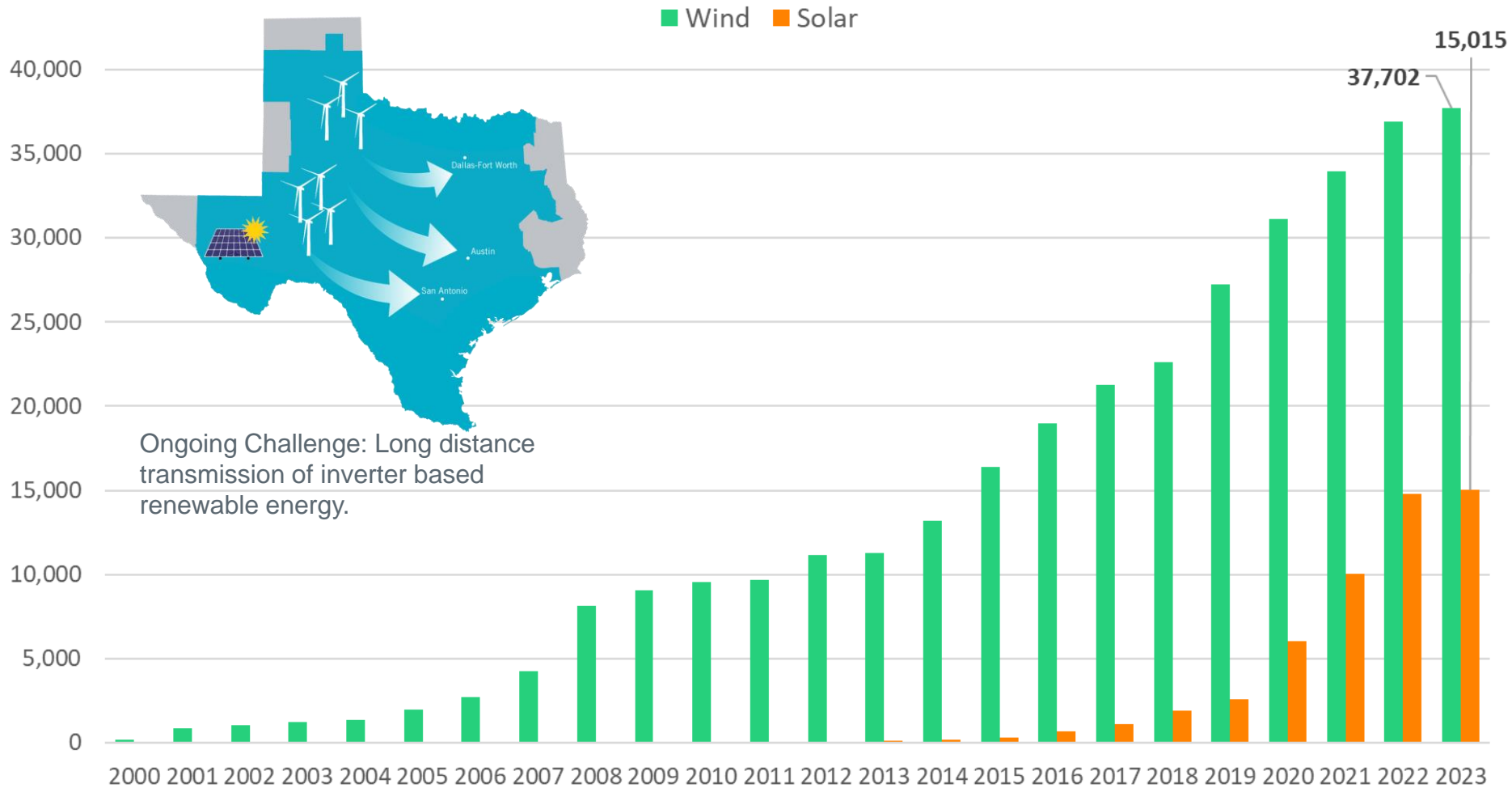
- Capacity that can respond in 10 minutes to recover frequency, cover forecast errors or ramps and replace deployed reserves. 2 hour duration requirement.

Non-Spin Reserve Service

- Capacity that can be started in 30 minutes to cover forecast errors, ramps or forced outages and replace deployed reserves until additional resources can be committed. 4 hour duration requirement.

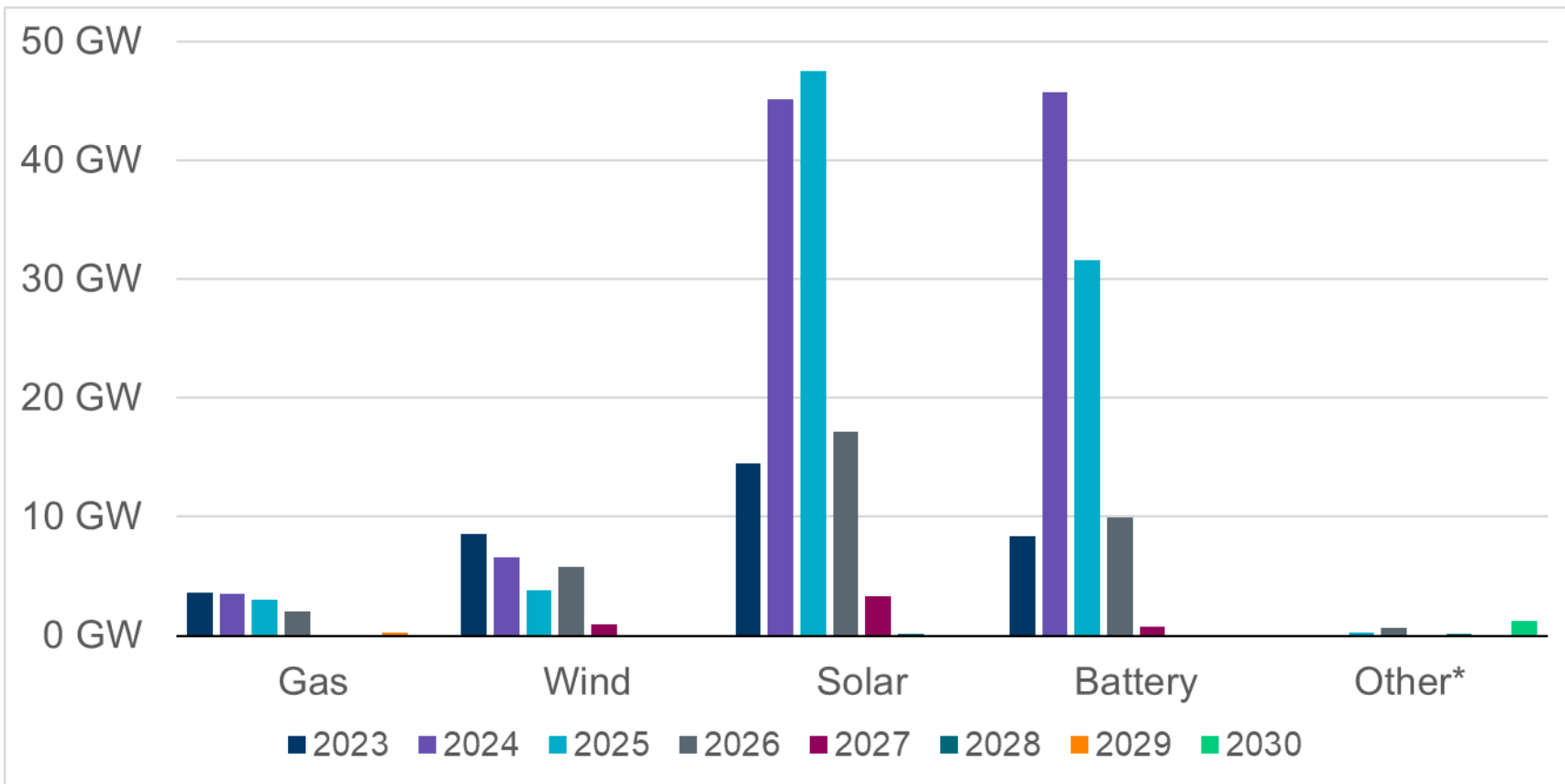
Transmission Connected Wind, Solar Additions (As Of Feb 28, 2023)

ERCOT Wind, Solar Additions by Year (As Of Feb 28, 2023)



Interconnection Queue Capacity by Fuel Type (As of Mar 31, 2023)

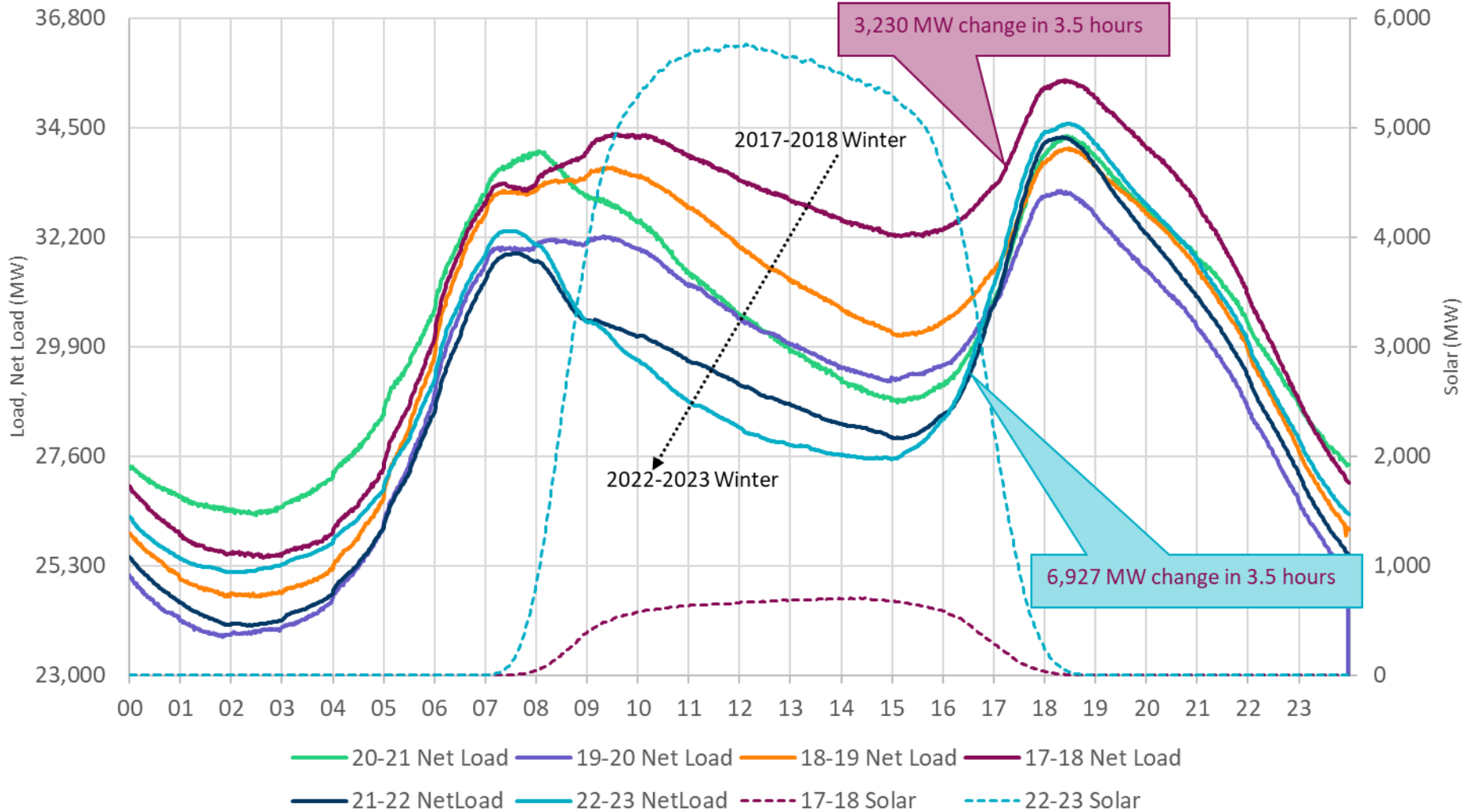
Queue totals: Solar 128 GW (48.3%), Wind 26 GW (9.7%), Gas 13 GW (4.7%), Battery 96 GW (36.4%)
(Excludes capacity associated with Projects designated as Inactive per Planning Guide Section 5.7.6)



A break-out by zone can be found in the monthly Generator Interconnection Status (GIS) reports available on the ERCOT Website.

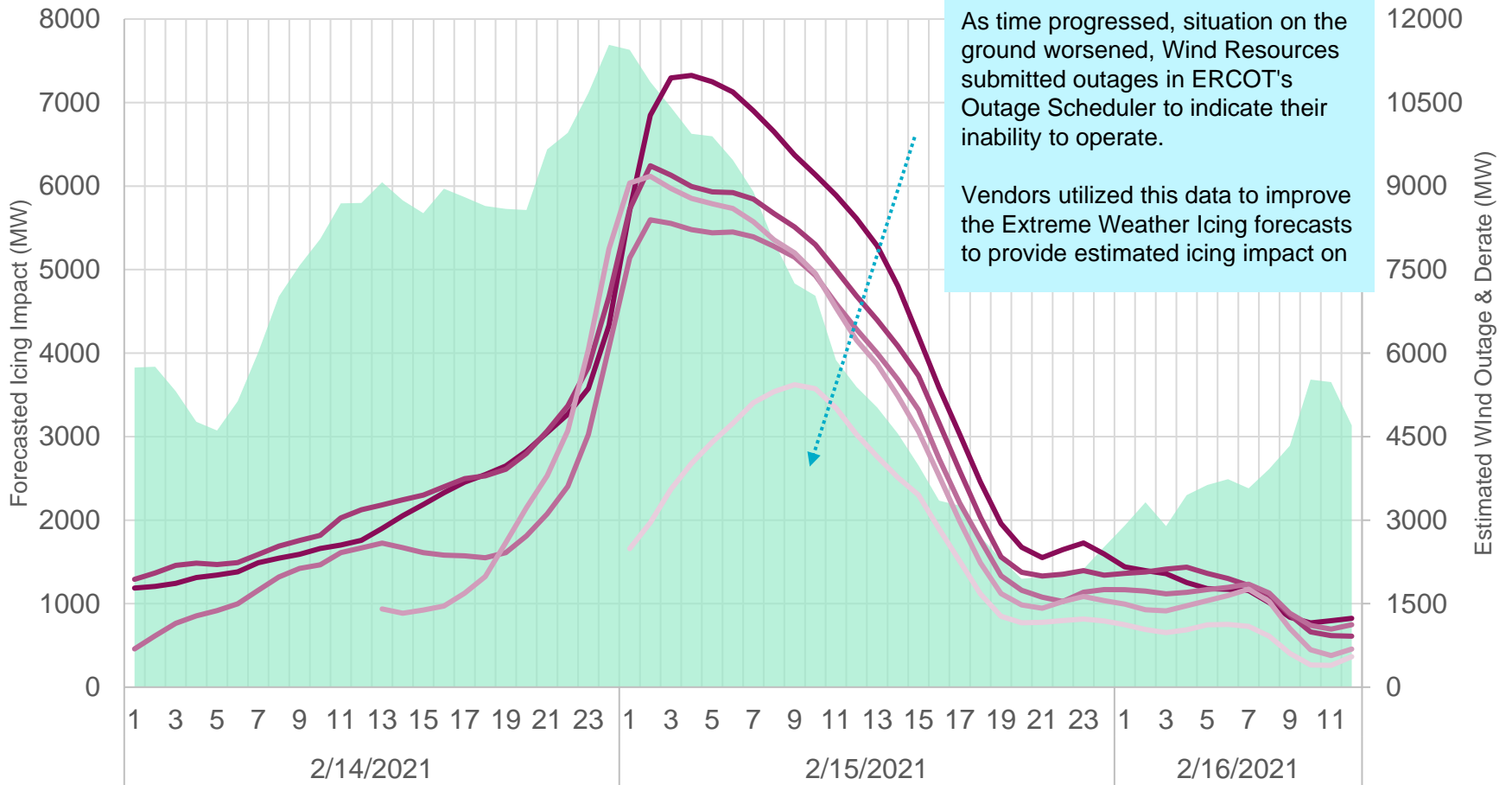
Net Load Profile in last 6 Winters

Winter Net Load, Solar Profile



Icing Forecast for Feb 15, 2021

- Estimated Wind Outage and Derate MW
- Forecasted Icing Impact @ 2/13 12AM
- Forecasted Icing Impact @ 2/13 12PM
- Forecasted Icing Impact @ 2/14 12AM
- Forecasted Icing Impact @ 2/14 12PM
- Forecasted Icing Impact @ 2/15 12AM



Usage of Renewables Forecasting

ANCILLARY SERVICE METHODOLOGY

- **Responsive Reserve (low frequency response)** quantities are set **based on historic inertia**. Higher quantities are procured during period with typically low net load.
- **Regulation (balancing reserves)** quantities are set using **historic net load variability** and adjusted for projected variability increases due to growth in wind and solar capacity.
- **ECRS (10-min reserves) and Non-Spin (30-min reserves)** quantities are set using **30-min Ahead and 6 Hours Ahead historic Net Load forecast error** and adjusted for projected over forecast error increases due to growth in wind and solar capacity. Higher percentile of coverage is used durations with high potential for Net Load up ramps.

WIND AND SOLAR FORECASTING

- **Four Hourly Forecast for next 168 hours:** POE50, POE80, Icing/Extreme weather forecasts
- **5-min Intra-Hour Forecasts for next 2 hours**
- **Four 15-min Probabilistic Forecasts** based on the spread of the ensemble of weather models for next 6-hr: 50th, 85th, 90th, 95th, 98th. *While these are “available” yet to use in a meaningful way.*
- Pay for Performance based payment contracts with most vendors.
- **Meteorologist monitor weather models** to identify periods when the uncertainty in weather may negatively impact reliability and recommend actions to Control Room.

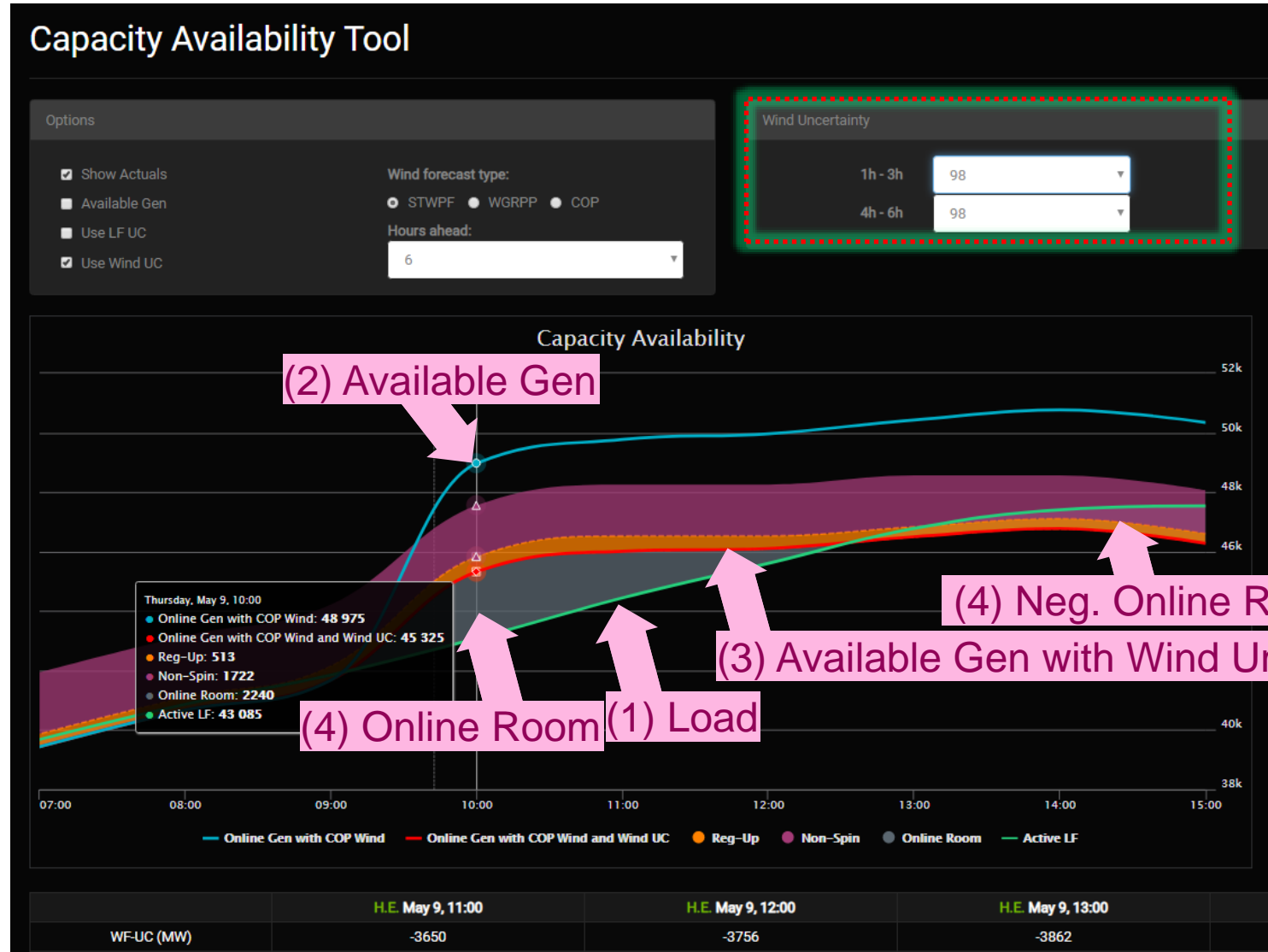
CONTROL ROOM AWARENESS TOOLS

- **PI-based displays to monitor renewable generation and forecast** at resource, region and system level
- **Forecast Presentation Platform** to monitor all renewable forecasts and **select active forecast**.
- **7-day Grid Outlook and next 24-hour Capacity Availability Tools (CAT)** use the **active hourly Wind and Solar forecast** and associated **historic over forecast uncertainties** and help gauge **sufficiency of available dispatchable resources to cover the various possible Net Load Forecasts** over the study horizon and **determine if long lead time unit commitment** is necessary.
- **Intra-hour 5-min Capacity Availability Tool (i-CAT)** uses the active Intra-Hour forecast and help gauge **sufficiency of available dispatchable ramping capability to cover the various possible Net Load Forecasted ramp** over the next 2 hours.

STUDIES LIKE UNIT COMMITMENT AND REAL TIME SCED DISPATCH

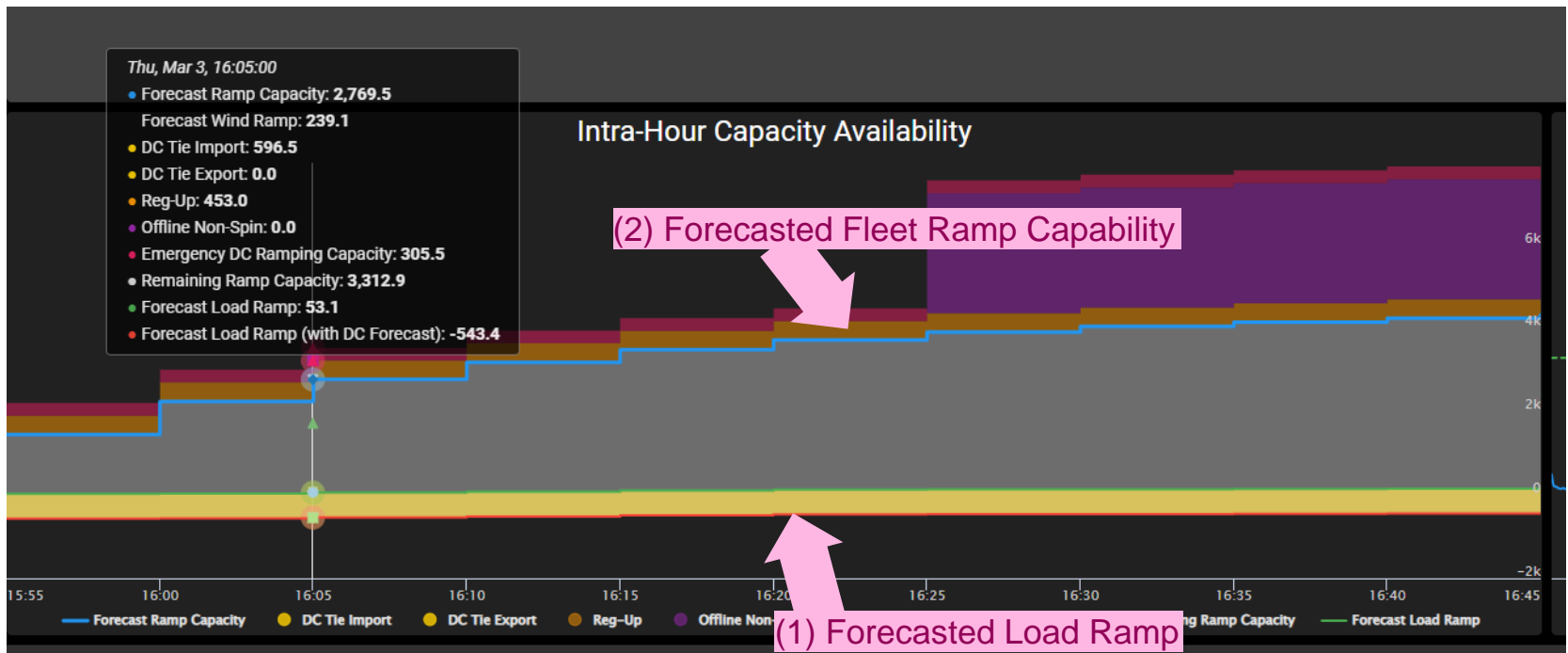
- **Active hourly Wind and Solar forecast** are used in **Reliability Unit Commitment studies** to determine if sufficient capacity is available to cover active forecasted demand plus reserves. Also used in look ahead studies like **Outage Coordination and Next Day Study**.
- **Active Intra-hour 5-min Wind and Solar forecast** are used in **5-min Real Time dispatch** preposition dispatchable Resources in anticipation of wind and solar ramps.

Opportunity for Probabilistic Forecast - Capacity Availability Tool, "What If" Assessment for next 6-12 hours



Opportunity for Probabilistic Forecast - Intra-Hour Capacity Availability Tool, “What If” Assessment for next 2 hours

- Intra-Hour Capacity Availability Tool (iCAT) monitors forecasted net load ramp in the next two hours and measures if the ramping capability of the available thermal fleet is able to cover these.



Summary

- ERCOT has ~57.8 GW* of installed primarily utility scale Inverter based Resources (IBRs). IBRs are also in majority in ERCOT's Interconnection Queue**.
- ERCOT is a summer peaking region (max Load ~80,148 MW from Jul 2022). In addition to planning for the risks associated with operating during peak load, monitoring shoulder months during periods when wind is not blowing, sun is not shining and dispatchable Resources are not available due to outages has also become essential.
- ERCOT has been making continuous improvements to its Operating Plans including
 - adding new forecast models/vendor,
 - changing methodology to compute Ancillary Service quantities,
 - building tools to improve situational awareness around supply availability to meet forecasted demand plus reserves while accounting for forecast uncertainties
- ERCOT is in the early stage of using probabilistic forecasts. ERCOT expects to utilize these forecasts to increase situational awareness in the Control Room of uncertainty of operating a particular day and identifying periods when they may need to take additional actions such as turn on additional dispatchable supply Resources to mitigate the risks associated with operating on that day.