WIND AND SOLAR FORECASTING PRACTICES AT ERCOT

Nitika Mago
Manager, Balancing Operations Planning
ERCOT

Current Records

Peak Demand Record: 74,820 megawatts (MW)

- Aug. 12, 2019, 4-5 p.m.

Weekend Peak Demand Record: 73,821 MW

- Saturday, Aug. 15, 2020, 5-6 p.m.

Winter Peak Demand Record: 69,812 MW

- Feb. 14, 2021, 6-7 p.m.

Wind Generation Records (instantaneous)

- Output: 22,893 MW
  - Jan. 14, 2021, 7:27 a.m.

- Penetration (load served): 66.47%
  - Mar. 22, 2021 12:46 a.m.
  - Total MW Served by Wind = 31,574 MW
  - System Inertia ~109 GW.s

New records are preliminary, subject to change in final settlement

Recent Monthly Peak Demand Records

2021
- February: 69,812 MW (February 14, 6-7 p.m.)
- June: 69,943 MW (June 14, 3-4 p.m.)*

2020
- April: 55,292 MW (April 8, 4-5 p.m.)
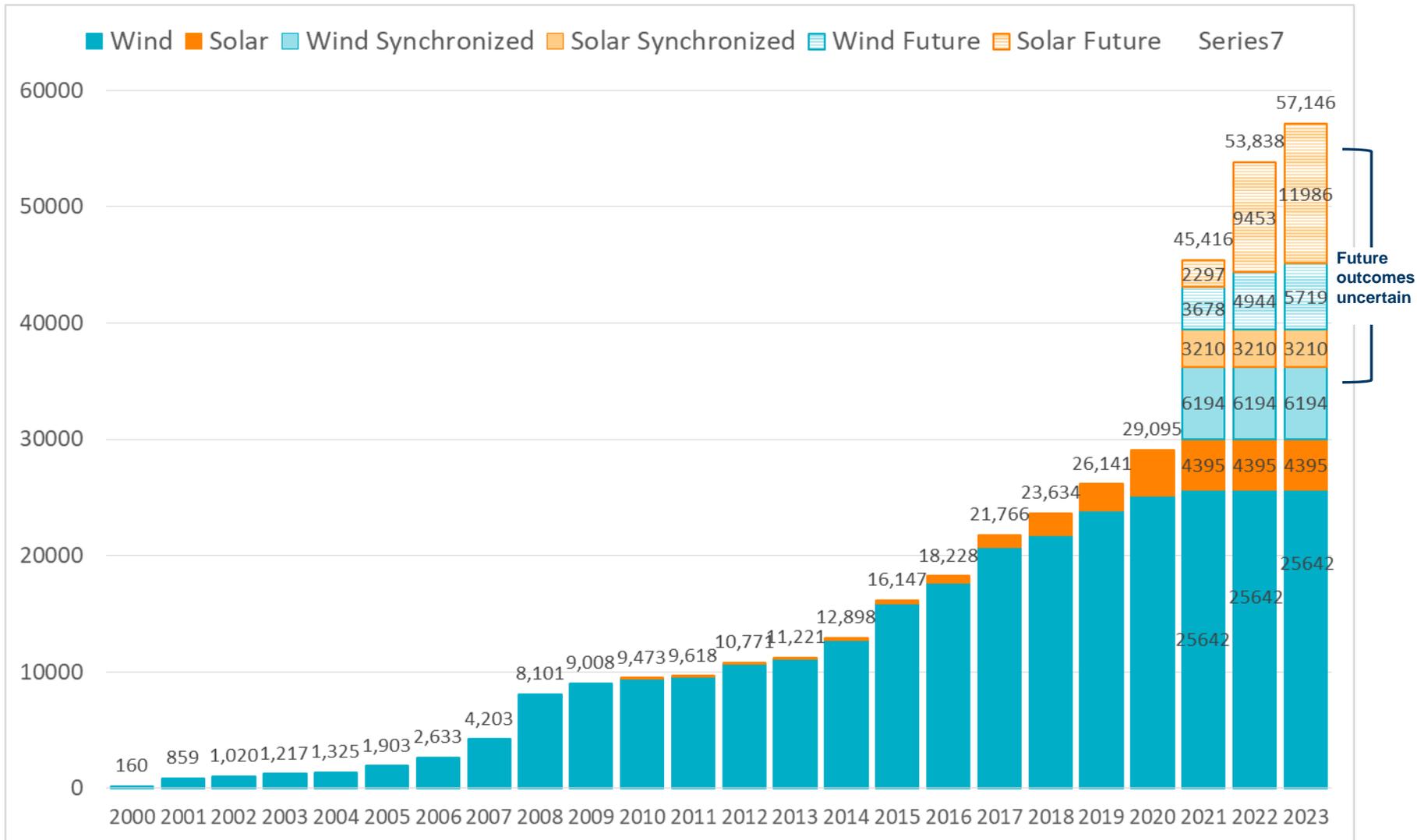- July: 74,344 MW (July 13, 4-5 p.m.)

2019
- March: 60,756 MW (March 5, 7-8 a.m.)
- August: 74,820 MW (Aug. 12, 4-5 p.m.)
- September: 69,122 MW (Sept. 6, 4-5 p.m.)
- October: 65,304 MW (Oct. 2, 4-5 p.m.)
- November 56,446 MW (Nov. 12, 7-8 a.m.)

2018
- January: 65,915 MW (Jan. 17, 7-8 a.m.)
- May: 67,265 MW (May 29, 4-5 p.m.)
- June: 69,123 MW (June 27, 4-5 p.m.)

# Wind and Solar Additions by Year (As Of May 2021)

Wind and Solar Forecast

- ERCOT implemented a centralized forecast for wind in 2009 and for solar in 2016. In 2017, ERCOT contracted a second provider for wind forecasts.

- ERCOT receives an
  - **"Hourly" Forecast** for each wind and solar resource and **Extreme Event Forecast** for each wind resource for next 168-hr at hourly resolution, updated hourly
  - **Intra-hour Forecast** for system level wind and solar potential for next 2-hr, at 5-min resolution, updated every 5-min

- Primary Inputs,
  - Site geo-location, Met tower geo-location,
  - Wind Speed and Temperature Operational limits
  - Telemetered site specific data
  - Scheduled outages & de-rates
  - Generic power curves
  - Weather variables like wind speed/direction, *irradiance*, cloud cover, climatology

HOURLY WIND FORECAST

HOURLY SOLAR FORECAST
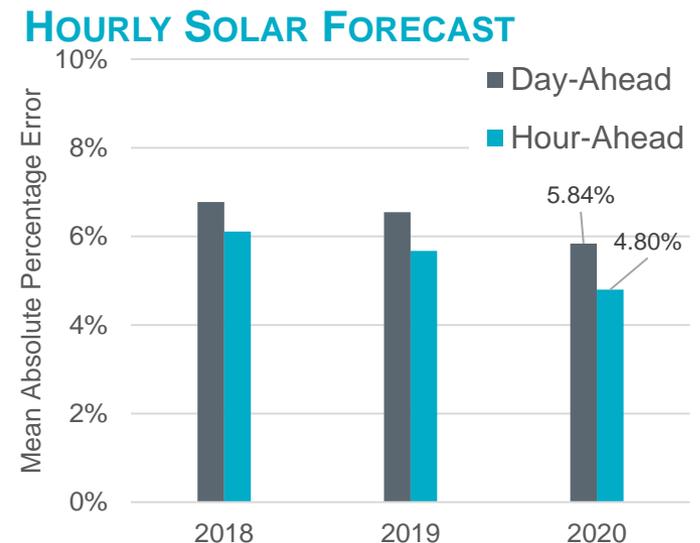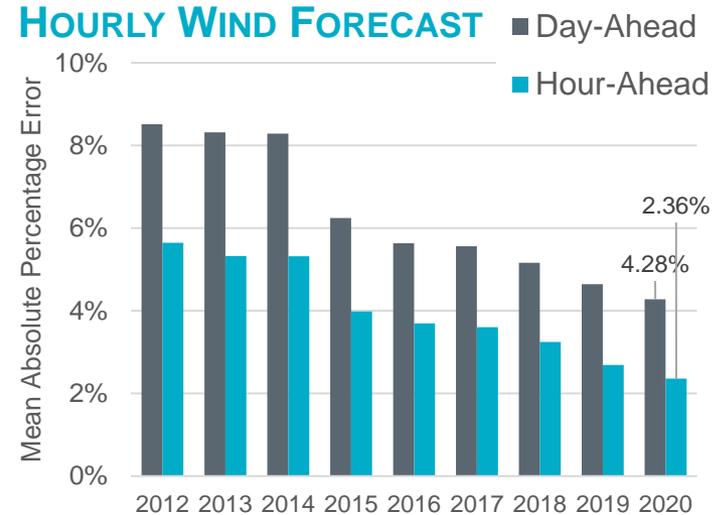
Hour-Ahead Wind Forecast Performance

Hour-Ahead Mean Absolute Error (MAE) During Large Down Ramp (> 2000 MW) and High Risk Hours*
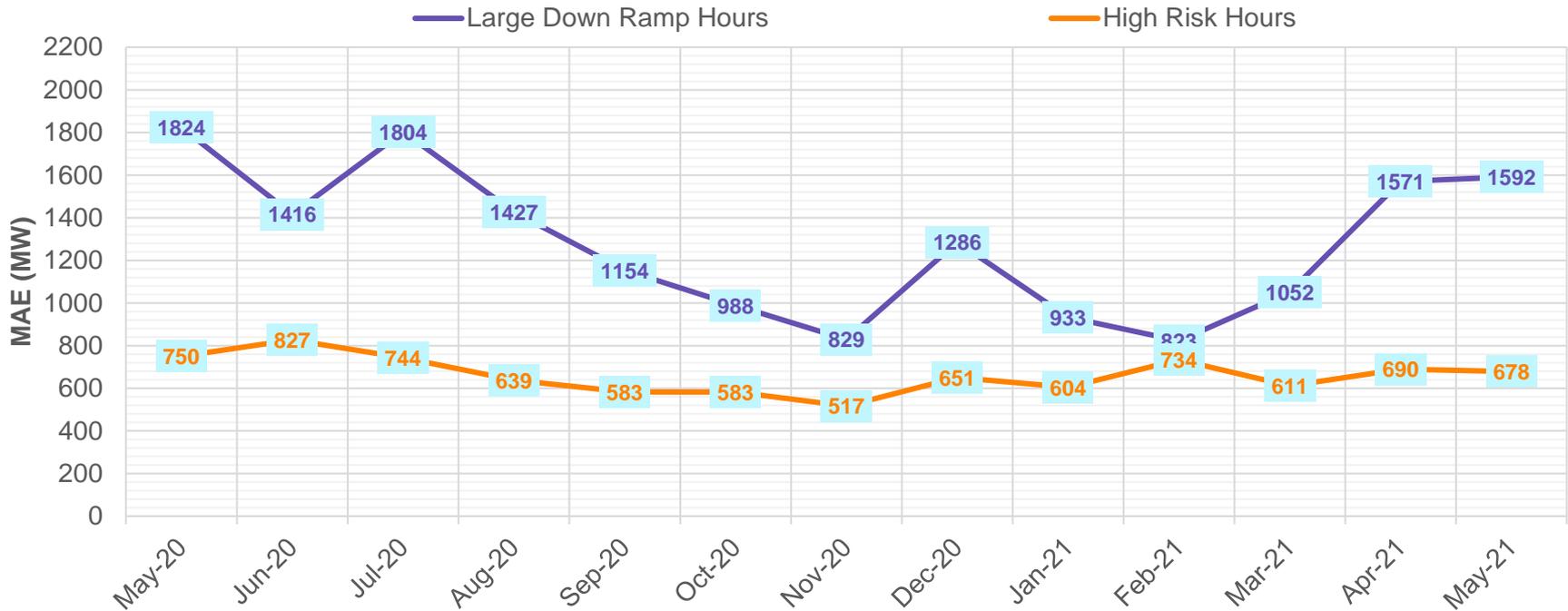
*ERCOT's performance based payment structure for Wind Forecasts with both vendors incentivizes improvements in forecast performance during hours that are of more importance to operational reliability. This approach is a paradigm shift from the "traditional" methodology of measuring wind forecast performance as a singular monthly average metric.

Forecast performance during large down ramp (wind ramp > 2000 MW) hours and high risk hours (historic risk of load ramping up and wind ramping down is high) is focused upon. Note that for the purposes of forecast performance measurement every hour in a month is classified as either a large down ramp hour or a high risk hour or something else. Any hour that is a high risk hour wherein a large down ramp was experienced will be tracked as a large down ramp hour.

Noteworthy Renewable Forecast Improvements

- In 2015,
  - Capability to **manually override wind forecast** was acquired. This allowed manual changes to wind forecast when the meteorological conditions are not captured by the forecasting process.

- In 2017,
  - **Reliability Risk Desk** was added in the Control Room.
  - ERCOT started **automatically updating Wind and Solar Current Operating Plans (COPs)** with the most recent forecast. This change ensured that the most recent wind and solar forecast was used in all **Look Ahead Studies** like Outage Coordination, Reliability Unit Commitment and Next Day Study.

- In 2018,
  - **Hourly and Extreme Weather Wind Forecasts** from both vendors were incorporated into ERCOT's EMS. As a part of this implementation, System Operators in the Reliability Risk Desk were given the ability to **"select" active wind forecast** that will be used in Wind COPs.
  - **Intra-hour wind forecast** was integrated into the Security Constrained Economic Dispatch process. This allowed ability to **preposition non-renewable resources in response to an expected wind ramp.**

- In 2021,
  - **Intra-hour solar forecast** was integrated into the Security Constrained Economic Dispatch process. This will allow for the ability to **preposition non-renewable resources in response to an expected solar ramp.**
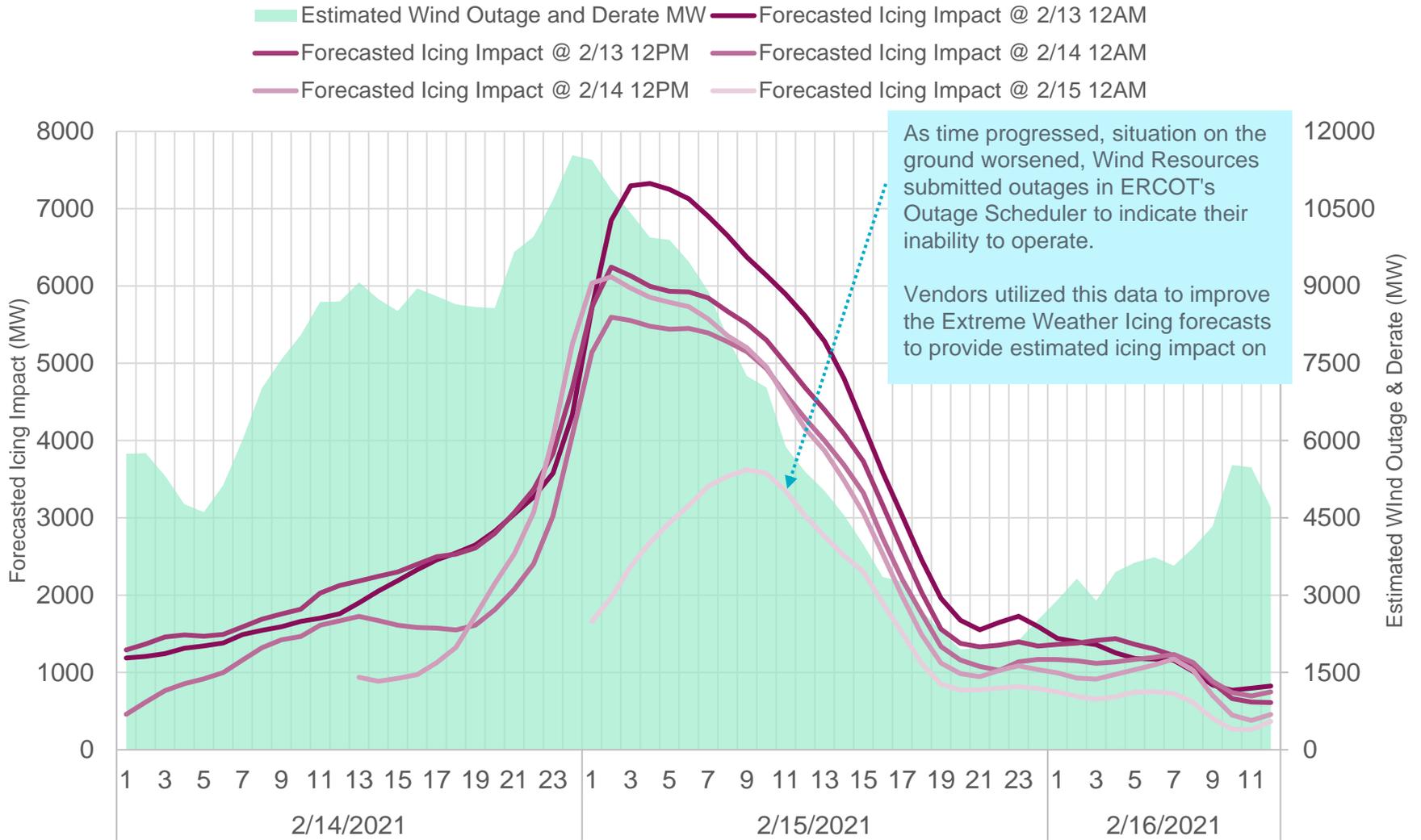
Wind Forecast Selection Dashboard
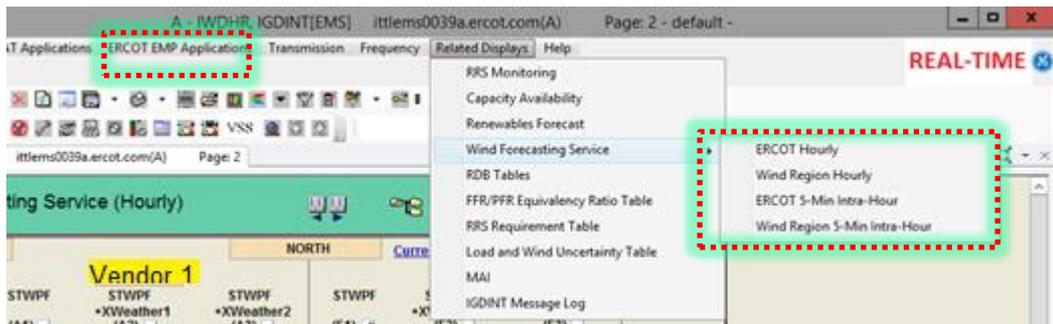
- ERCOT EMS has displays that track the latest Hourly and 5-min Wind Forecast to ERCOT System Operators.

- Via these displays ERCOT System Operators can select an active Hourly and Intra-Hour Wind Forecast.

- Forecast selection methodology in ERCOT EMS mimics the Load Forecast, which is a long established process.

Icing Forecast for Feb 15, 2021

Legend:
- 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

As time progressed, situation on the ground worsened, Wind Resources submitted outages in ERCOT's Outage Scheduler to indicate their inability to operate.

Vendors utilized this data to improve the Extreme Weather Icing forecasts to provide estimated icing impact on

Intra-Hour Solar Forecast in Dispatch

- On June 1, 2021, Intra-hour solar forecast was integrated into ERCOT systems.

- This forecast is used to update the total target dispatch that is fed to Security Constrained Economic Dispatch (SCED) by including a Predicted Solar Ramp Rate (PSRR).

- Effectively, at times when solar is forecasted to ramp down, the dispatch target for SCED is increased. ERCOT SCED does not dispatch wind and solar i.e. it assumes their output will persist. Thus the increased dispatch target used preposition non-wind, non-solar resources in response to anticipated solar ramp.

Performance Metric	SCED PSRR (6/1 – 6/21)	Persistence Ramp* (6/1 – 6/21)
Monthly MAE (MW per 5 minutes)	60	85
Monthly MAE when Wind Ramp > 100 MW per 5 minutes	109	185

5-min Predicted Solar Ramp Error (June 2021)
Excluding Intervals where Avg. Solar HSL < 5 MW

■ SCED PSRR ERROR [MW]   ■ Persistent Ramp [MW]

Error in MW per 5 minutes
(Predicted Solar Ramp - Actual Solar Ramp)
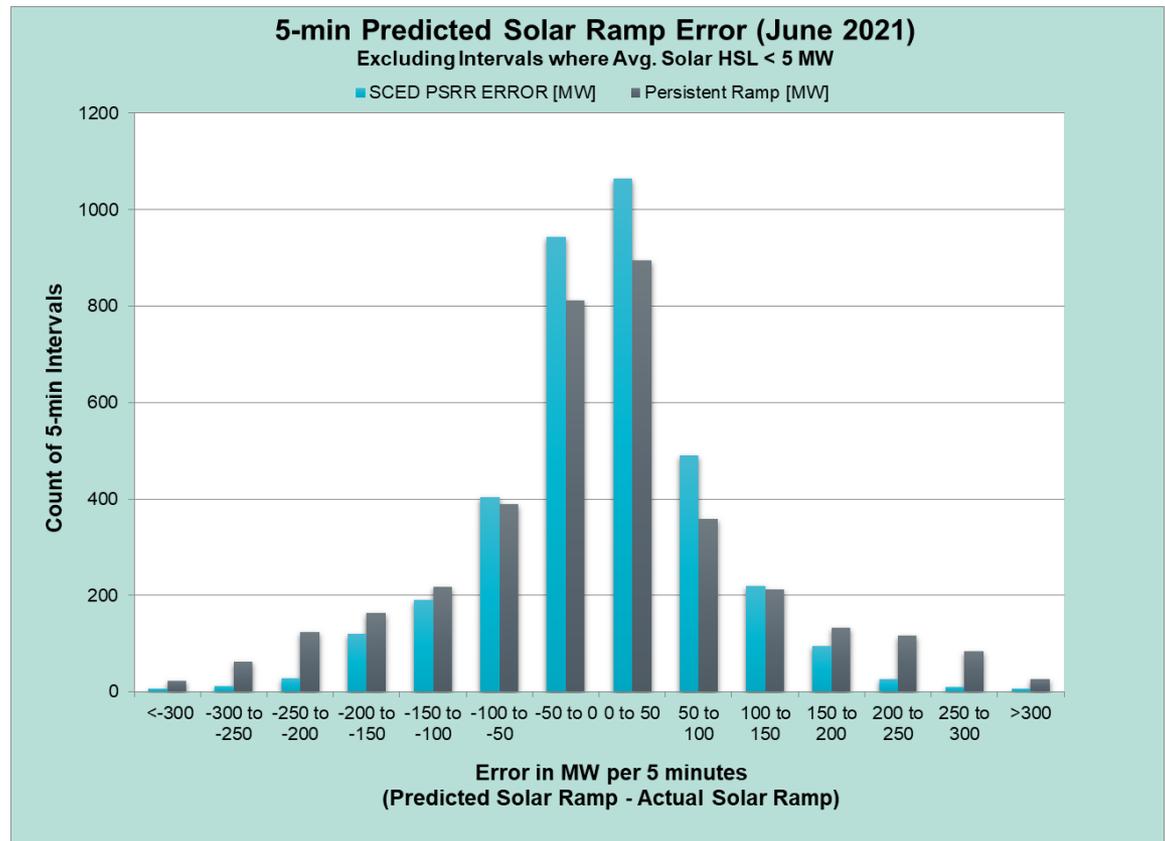
Forecast Presentation Platform

- ERCOT is planning to develop a web-based Forecast Presentation Platform (FPP), that envisioned to be used to display/select/monitor all types of load, wind and solar forecasts. Driver for this are,
  - Growing functionality needs
   - As ERCOT's wind and solar fleet grows, there is an increasing need to present more forecast models that capture a wider criteria of impact (ex. 80th probability of exceedance (POE), blended forecast, worst weather impact etc.) to the Control Room.
    - Also as ERCOT's processes for managing and responding to forecast uncertainties evolve, the ERCOT Market Participants have passed rules that require ERCOT Control Room to provide explanations when forecast selections are made that are further away from the average.
  - Current technology limitations
    - ERCOT's EMS vendor has confirmed that fundamental design of EMS dataset is not intended for tracking forecasts and associated functionality needs
    - ERCOT has adopted a policy to reduce the number of customs, where reasonable, in the EMS, in order to reduce the scope/time required for EMS upgrades.

- Scope of FPP
  - Work on wind and solar forecast will be undertaken first.
    - Migrate the existing functionality in EMS for displaying and selecting hourly and intra-hour forecast from to new FPP.
    - Update hourly wind, solar forecast selection display in FPP to include more models.
    - Track the wind, solar forecast performance

- Current target for implementation is before June 2022.

Future Hourly Wind Forecast Selection Display

- Additional three forecasts, namely Wind Generation Resource Power Potential (WGRPP, POE 80), a blended weighted average forecast and Operator "Enterable" forecast will be added into EMS' Hourly Wind Forecast Selection Display.

Active | V1F1 | V1F2 | V1F3 | V1F4[1] | V2F1 | V2F2 | V2F3 | V2F4[1] | B1[2] | O2[3]
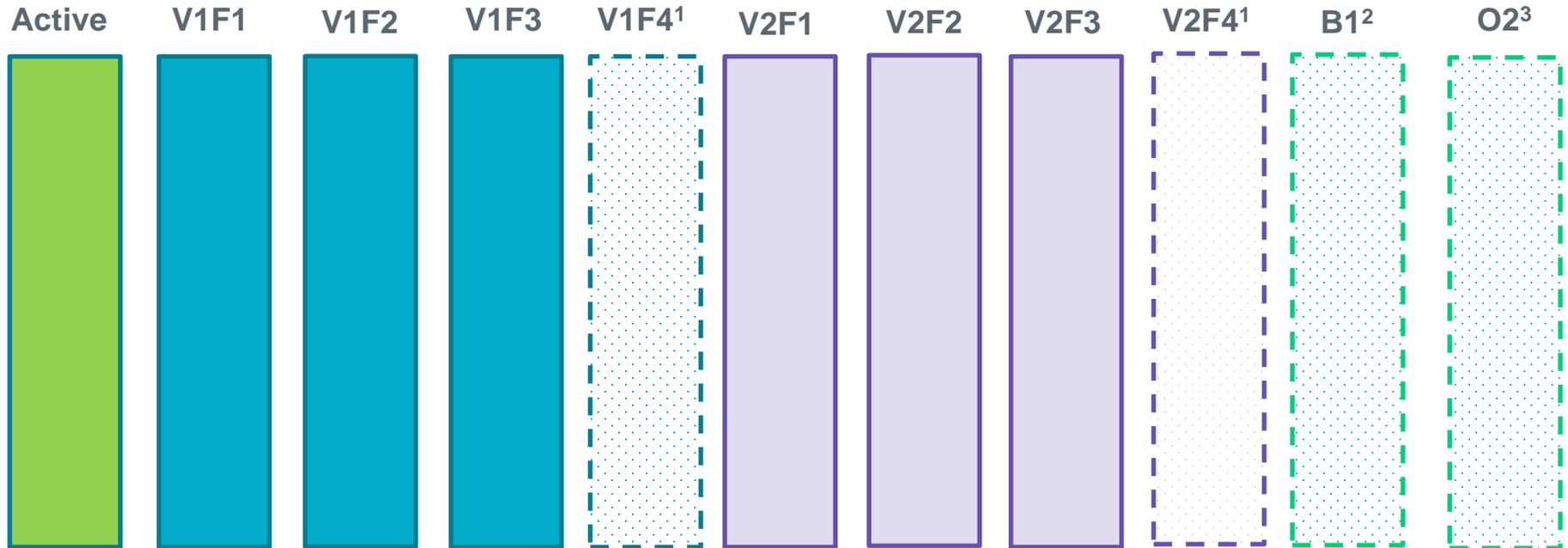
1. A4 and E4 are WGRPP
2. B1 is a blended forecast
3. O2 is a manual override applied to wind forecast for those unaccounted or inaccurate factors in numeral weather models. Following capabilities are must haves:
    - Percentage override (i.e. 80% of 10 GW forecast)
    - Offset override (i.e. -500 MW offset from 10 GW forecast)

Non-Spin Operational Reserve

- Non-Spin Reserve is capacity that can be started in 10 or 30 minutes to cover net load forecast errors (NLFE) or net load ramps.

  - Non-spin methodology focuses on historical hours with large 1 Hour Ahead NLFE.

  - Larger protection against NLFE is used in hours with higher risk of net load up ramps.

  - Non-spin quantities are also adjusted for increases in wind & solar over forecast errors as installed wind and solar capacities grow within the year.

Non-Spin

Actual Demand

Forecasted Demand

200 MW Error
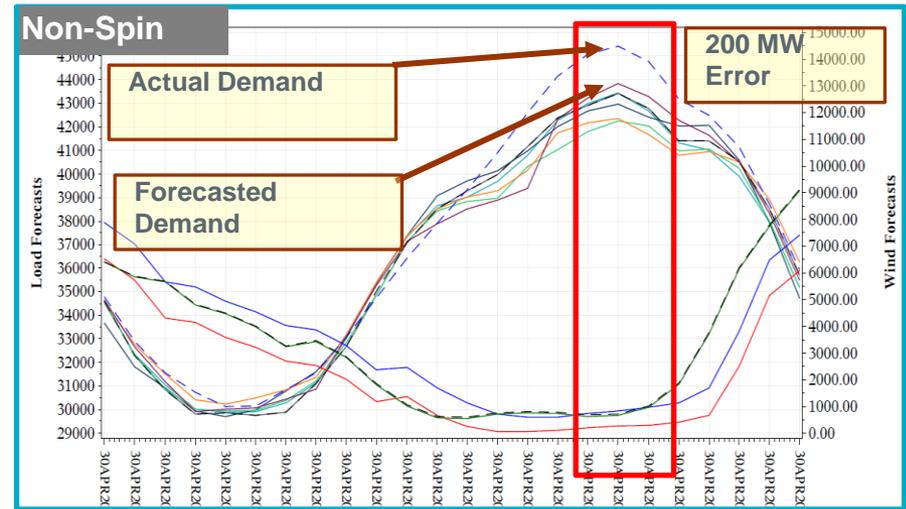
Non-Spin Requirements 2021
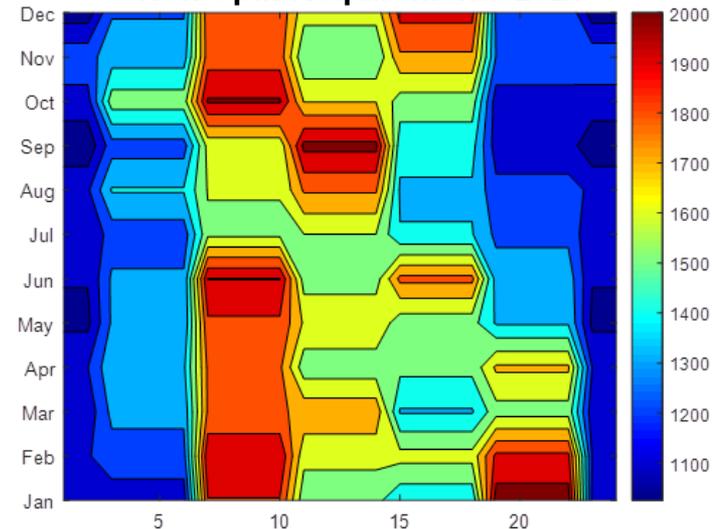
Capacity Availability Tool – "What If" Assessment