Solar Forecast at ERCOT: Overview and Challenges
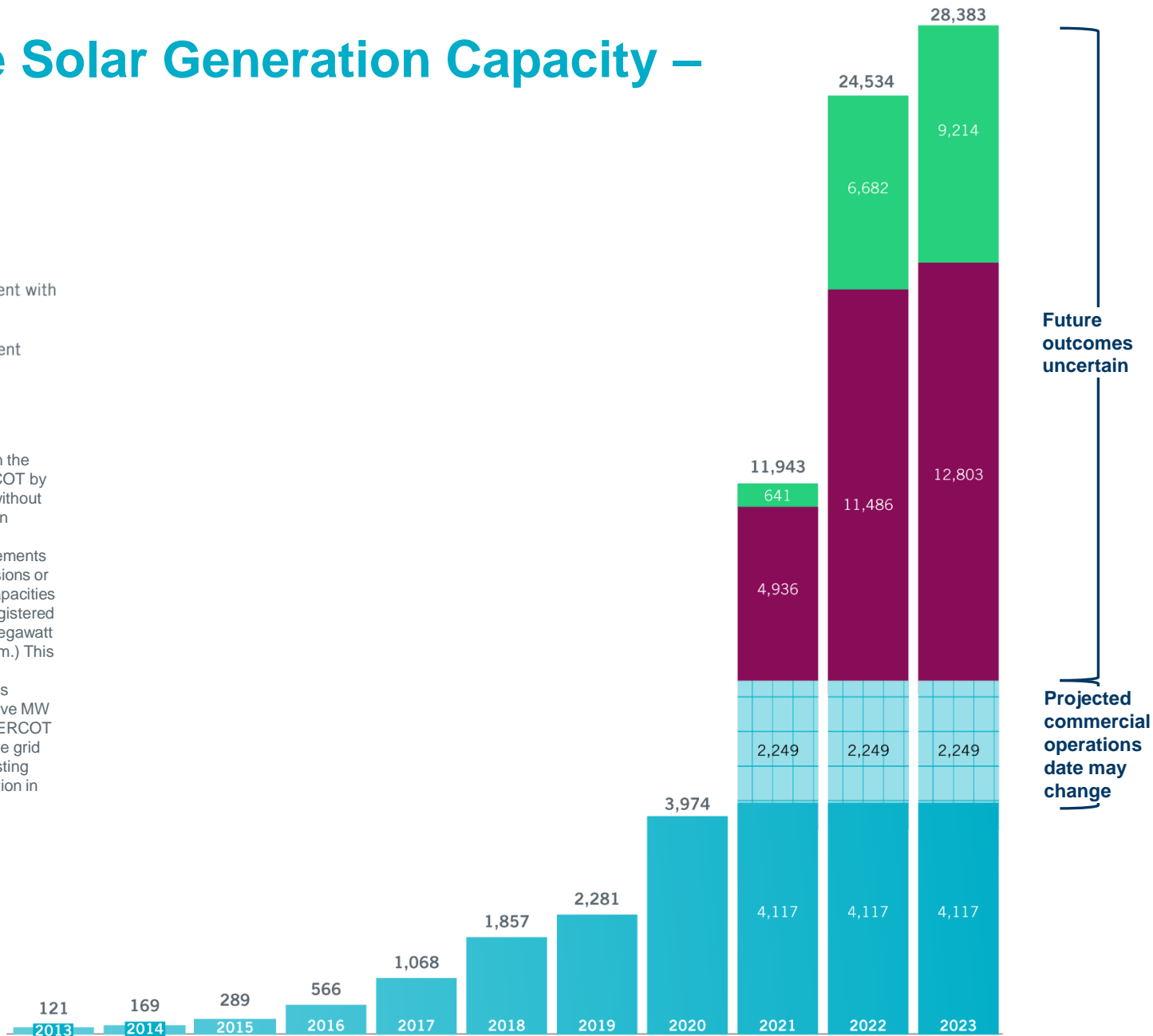
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ERCOT
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DOE Solar Forecasting Workshop

Utility Scale Solar Generation Capacity – March 2021

Legend:

- ■ Cumulative MW Installed
- ▦ Cumulative MW Synchronized
- ■ Signed Interconnection Agreement with Financial Security Posted
- ■ Signed Interconnection Agreement with No Financial Security
- ■ Other Planned

The data presented here is based upon the latest registration data provided to ERCOT by the resource owners and can change without notice. Installed capacities are based on nameplate rating of the commercially operational generation and reflect retirements or rating changes due to facility expansions or repowering as these occur. Installed capacities include only solar facilities that have registered with ERCOT (Those larger than one megawatt and supply power to the ERCOT system.) This chart reports annual planned units with projected Commercial Operations Dates throughout the calendar year. Cumulative MW Synchronized pertains to projects that ERCOT has approved to generate energy for the grid but have not passed all qualification testing necessary to be approved for participation in ERCOT market operations.

Year	Cumulative MW Installed	Cumulative MW Synchronized	Signed IA with Financial Security Posted	Signed IA with No Financial Security	Total
2013					121
2014					169
2015					289
2016					566
2017					1,068
2018					1,857
2019					2,281
2020					3,974
2021	4,117	2,249	4,936	641	11,943
2022	4,117	2,249	11,486	6,682	24,534
2023	4,117	2,249	12,803	9,214	28,383

Future outcomes uncertain

Projected commercial operations date may change

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Projected New PVGR Capacity in 2021
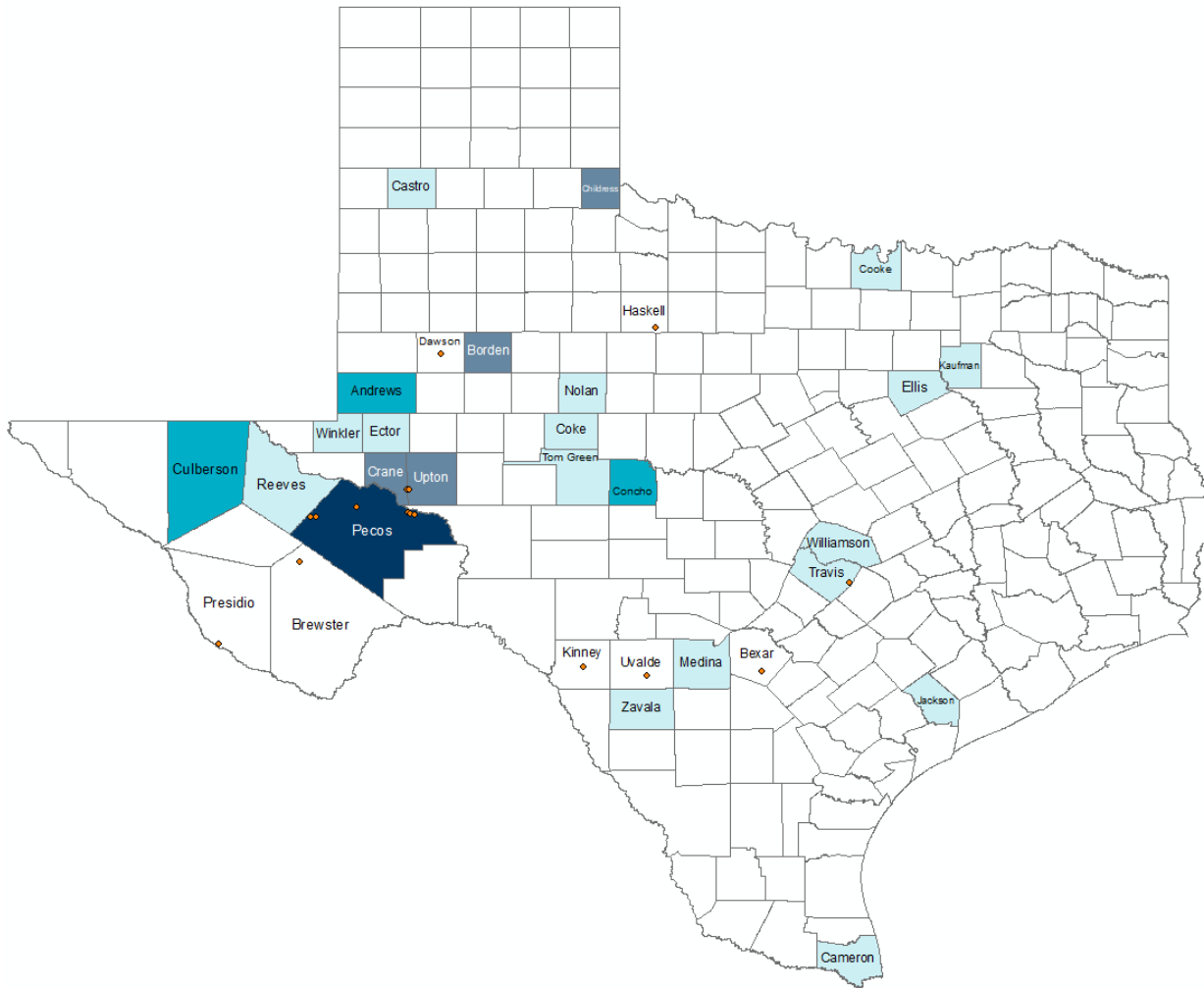
County	Sum of New Capacity (MW)
Pecos	1072
Andrews	677
Wharton	603
Borden	540
Culberson	457
Fort Bend	400
Brazoria	360
Frio	336
Upton	305
Childress	241
Haskell	228
Fannin	208
Zavala	206
Jones	202
Lamar	199
Ector	196
Crane	153
Jackson	150
Kaufman	148
Travis	144
Sterling	115
Cooke	60
Van Zandt	60

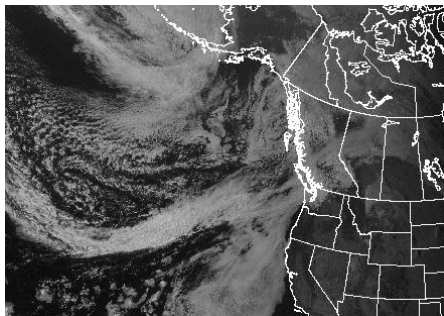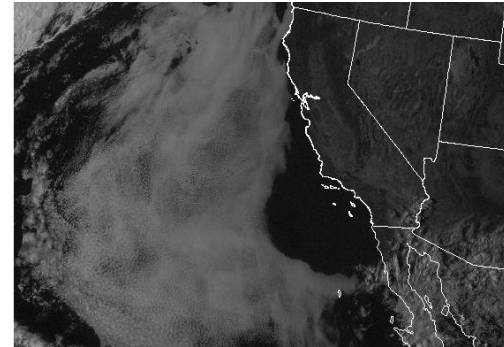# Making the Best Forecast for Various Time Scales

Minutes Ahead
- Cumulus clouds, small-scale cloud structures, fog
- Rapid and erratic evolution; very short lifetimes
- Mostly not observed by current sensor network

Hours Ahead
- Frontal bands, mesoscale bands, fog, thunderstorms
- Rapidly changing, short lifetimes
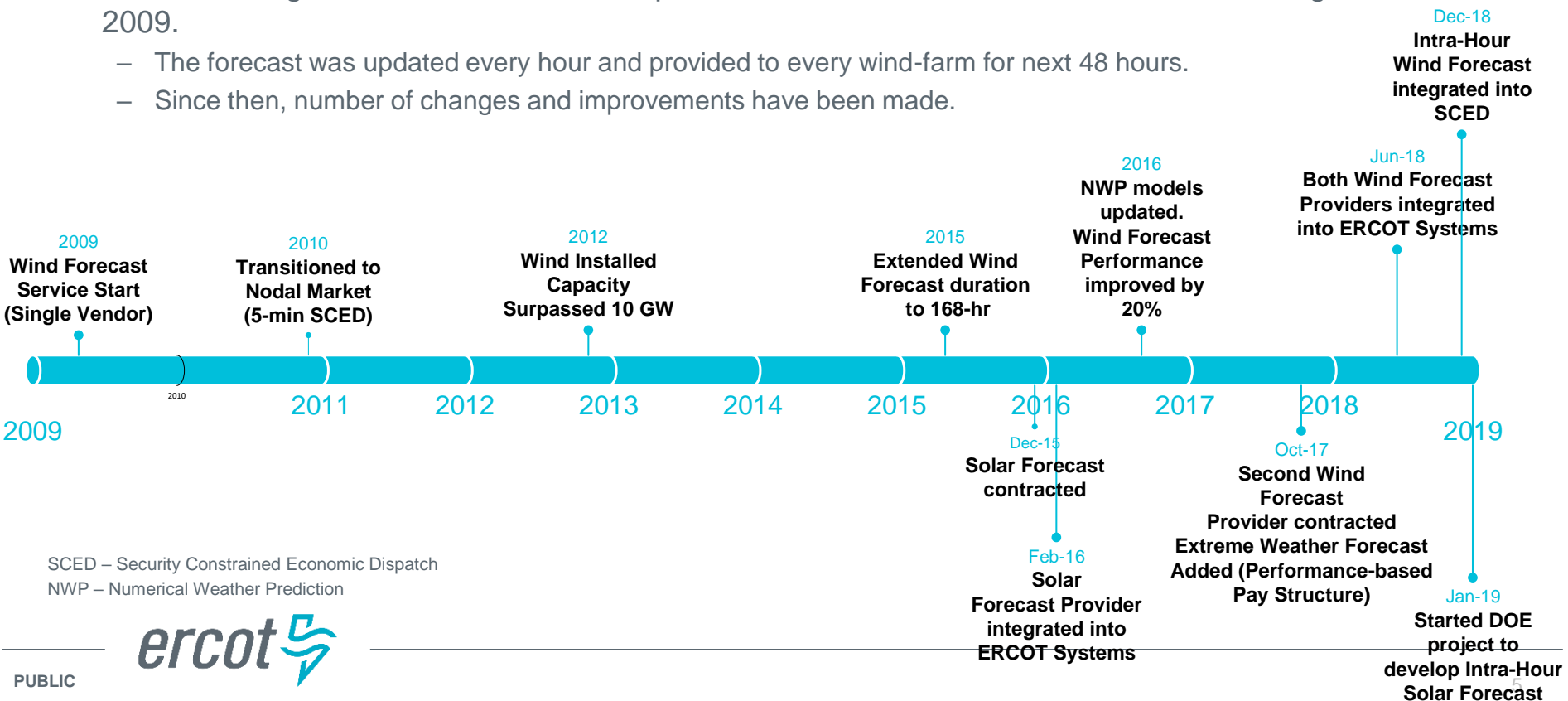- Current sensors detect existence but not structure

Days Ahead
- "Lows and Highs", frontal systems
- Slowly evolving, long lifetimes
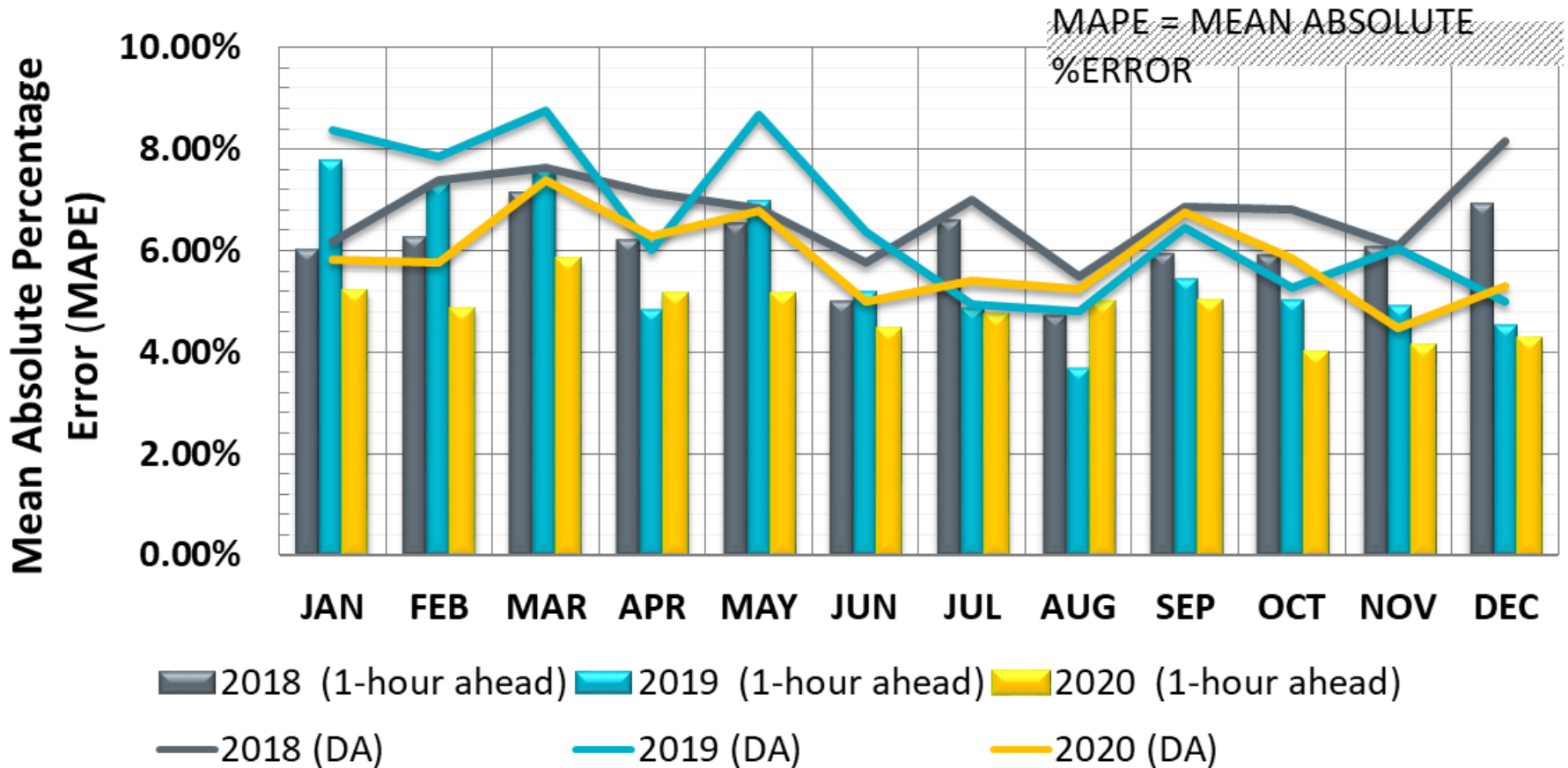- Well observed with current sensor network

Timeline of Renewable Forecasts

- Prior to centralized wind forecast, ERCOT required Qualified Scheduling Entity (QSE) responsible to provide their output schedules based on expected wind conditions.
  - ERCOT relied on this information to commit other Resources based on what Wind Resources were expected to produce.
  - Different QSEs employed different methodology to create the forecast which was generally highly inaccurate.
  - There were number of instances when relying on QSEs submitted output schedules for wind led to real-time shortage conditions including an Electric Emergency Alert (EEA) event.

- ERCOT changed its market rules and implemented a centralized wind forecast with a single vendor in 2009.
  - The forecast was updated every hour and provided to every wind-farm for next 48 hours.
 - Since then, number of changes and improvements have been made.

Dec-18
Intra-Hour Wind Forecast integrated into SCED

2016
NWP models updated. Wind Forecast Performance improved by 20%

Jun-18
Both Wind Forecast Providers integrated into ERCOT Systems

2009
Wind Forecast Service Start (Single Vendor)

2010
Transitioned to Nodal Market (5-min SCED)

2012
Wind Installed Capacity Surpassed 10 GW

2015
Extended Wind Forecast duration to 168-hr

| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |

Dec-15
Solar Forecast contracted

Oct-17
Second Wind Forecast Provider contracted Extreme Weather Forecast Added (Performance-based Pay Structure)

Feb-16
Solar Forecast Provider integrated into ERCOT Systems

Jan-19
Started DOE project to develop Intra-Hour Solar Forecast

SCED – Security Constrained Economic Dispatch
NWP – Numerical Weather Prediction

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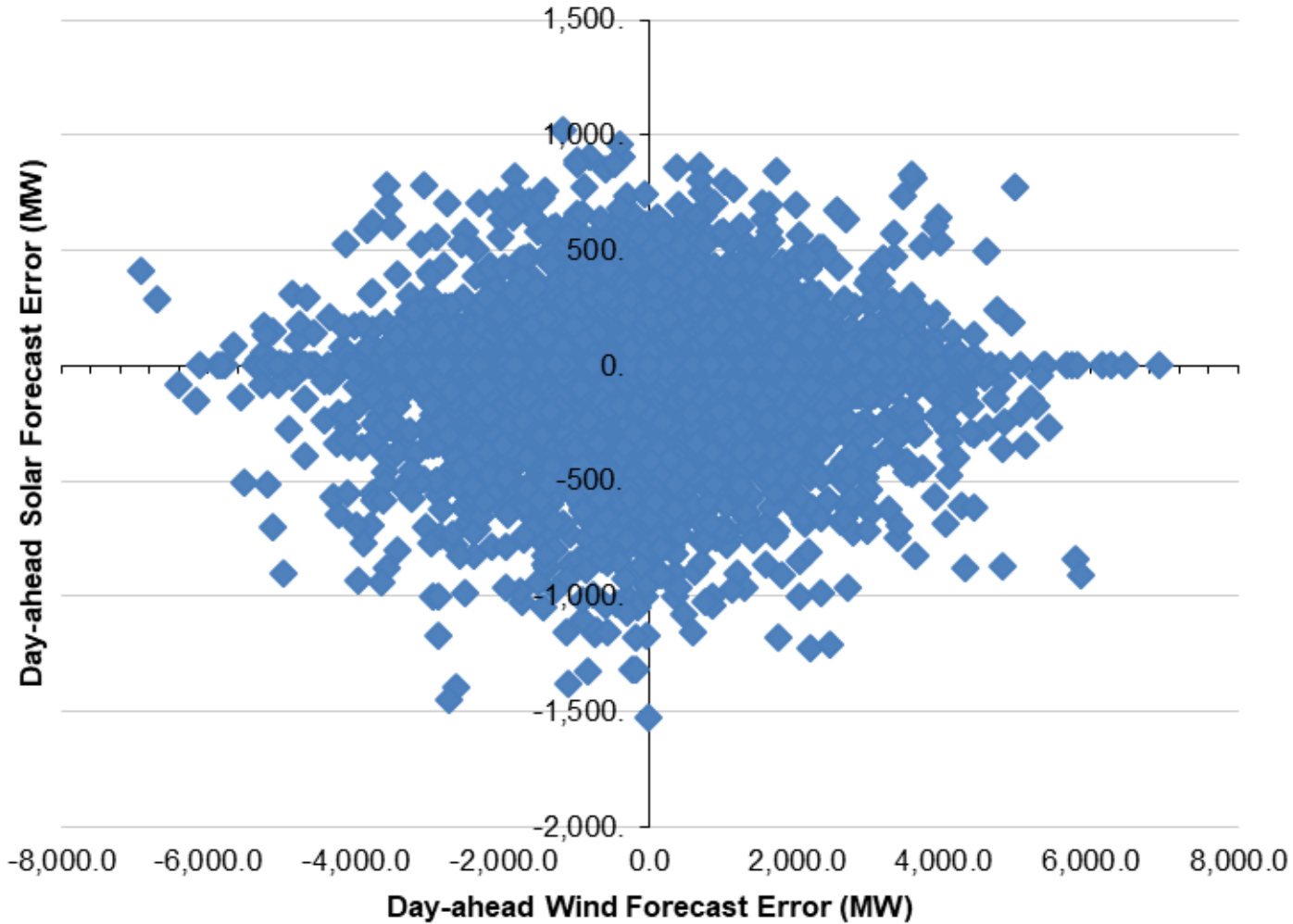# Historical PVGR Forecasting Performance

PVGR FORECAST PERFORMANCE

MAE: mean absolute error

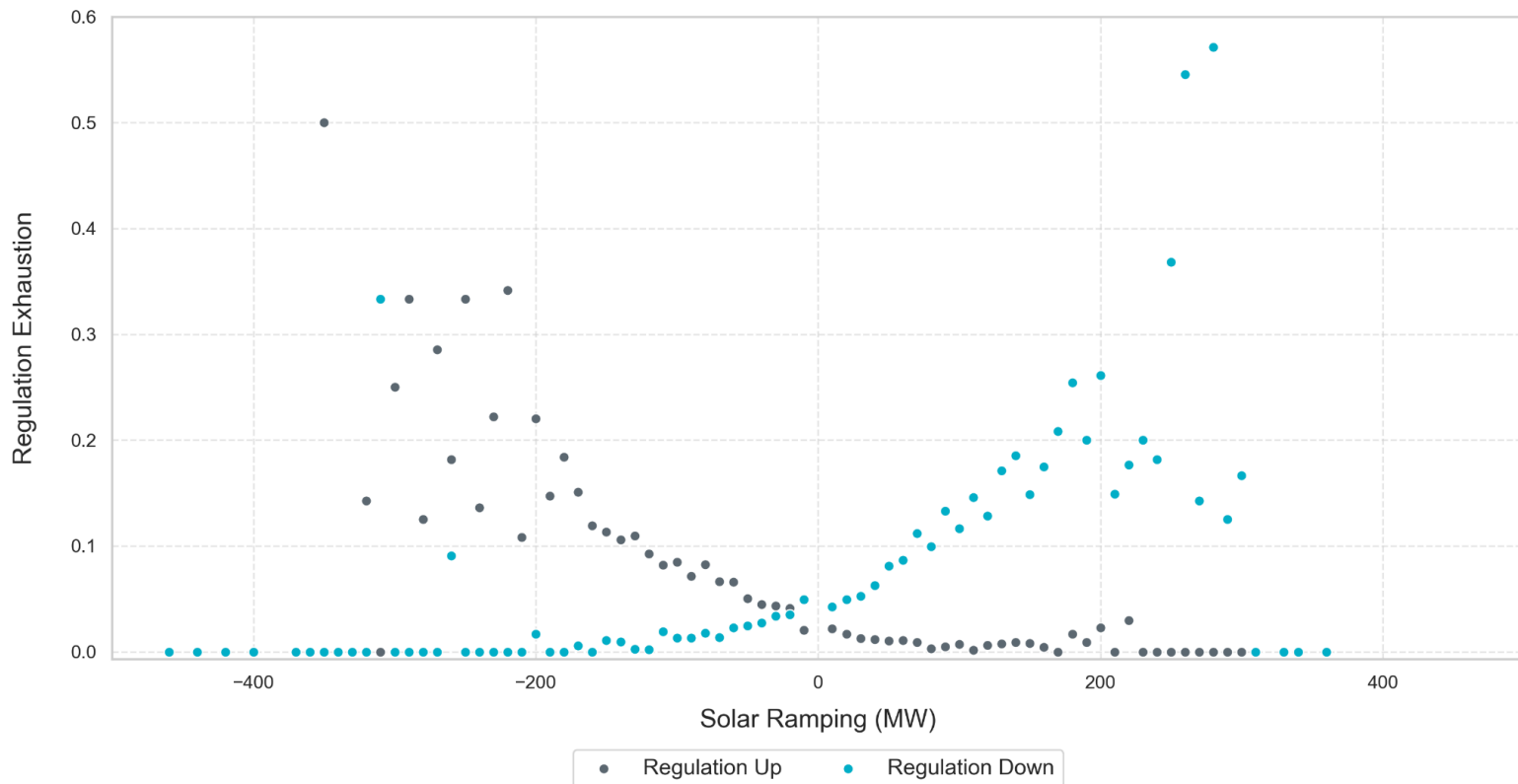# Day-ahead PVGR Forecast Performance (2020)
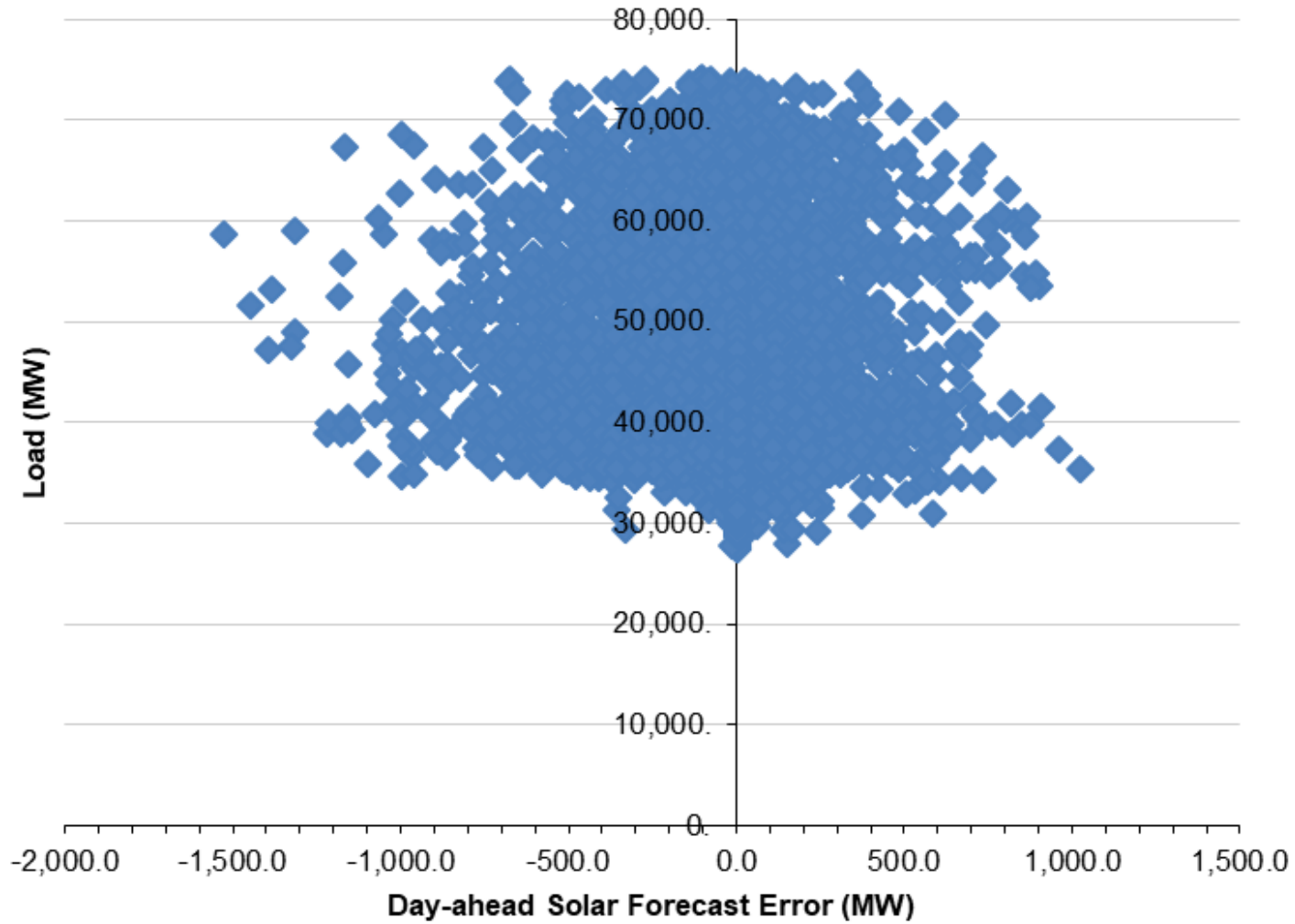
Day-ahead Wind and PVGR Forecasting Error (2020)

5-min Exhaustion Rates vs Solar Ramp

- Solar ramp data grouped into 10 MW bins and average Regulation exhaustion taken for each bin*

- Regulation up exhaustion as solar ramps down, Regulation down exhaustion when solar ramps up

Changes to SCED

- Include intra-hour solar forecast into Generation To Be Dispatched (GTBD) to give SCED an indication of how the solar units may ramp.

- Currently: uncurtailed solar units a dispatched to their HSL.
  - Assumes solar will stay the same at their HSL for next 5-min.
  - What if solar ramps?
    - Regulation used to make up for gain/loss of solar MW
      - As the installed capacity of solar grows, regulation could be exhausted more frequently due to solar ramps.
  - What if an FME occurs as the sun is setting?
    - Regulation will be relied upon but depending upon the circumstance frequency recovery could potentially be delayed.

- Equation

GTBD = Total Gen + K1*10*System Load Frequency Bias + K2*[(net non-conforming Load) – (net filtered non-conforming Load)] + K3*5*PLDRR + K4*Regulation Deployed + K5*ACE Integral – K6*5*PWRR + K7*5*DCTRR – K8*5*PSRR

|PSRR| ≤ Max PSRR Feedback

Solar Uncertainty Management and Mitigation for Exceptional Reliability in Grid Operations (SUMMER-GO)

SUMMER-GO will bring probabilistic solar forecasts into ERCOT's real-time operation environment through automated reserve and dispatch tools that increase economic efficiency and improve system reliability.

- Develop accurate, calibrated, and sharp probabilistic solar power forecasts at multiple time-scales & spatial resolutions

- Develop and validate risk-parity economic dispatch for *5-minute dispatch period* through *novel application* of financial planning techniques

- Develop and validate adaptive reserves algorithm to *reduce flexibility and regulation reserves by >25%* and *deploy in ERCOT'S iTest system*

- Produce situational awareness tool, SolarView, to present relevant, timely information and allow for *better decision making*

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy
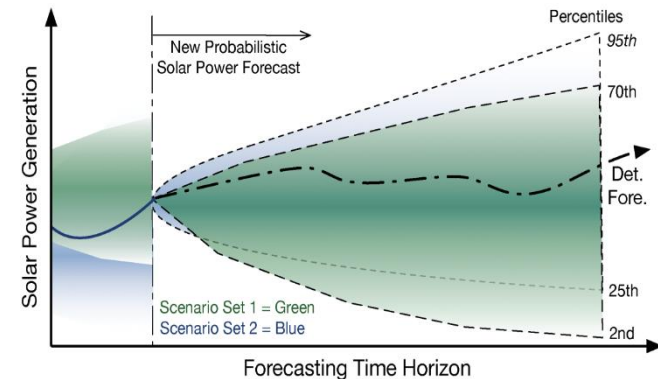
Summary of Solar Forecasting

- Solar forecasting is **essential** to assist with the provision of accurate supply and demand forecast models necessary to increase commercial viability and ensure stability of the electricity grid.

- It should be noted that forecasting solar irradiance and solar power is a **relatively recent** research area and solar forecasting is a very challenging area of research and application.

- Challenges
  - To improve solar forecasting performance for snow, icing, fog
  - To seek new performance statistics to quantify the risk of outliers
  - Wind and solar forecast could be subject to common mode failure as both relay on numerical weather prediction models
  - To develop accurate 5-min solar forecast used in SCED

QUESTIONS??