



# Market Design Considerations for a High Renewables Future

**Aaron Townsend**

Wholesale Market Operations and Analysis

**Energy Systems Integration Group**

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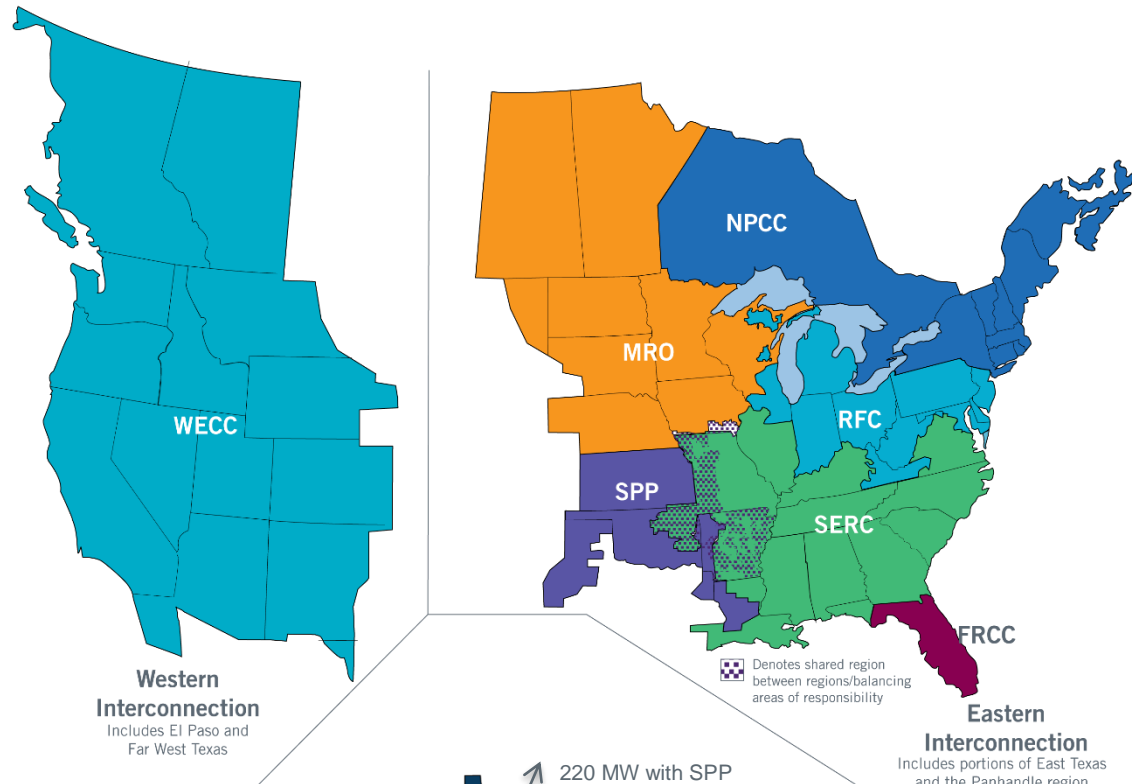
# Outline

- ERCOT facts and figures
- ERCOT's market design—unique features that work well to integrate renewables
  - And how they could be applied elsewhere
- Upcoming changes that will improve ERCOT's ability to integrate renewables

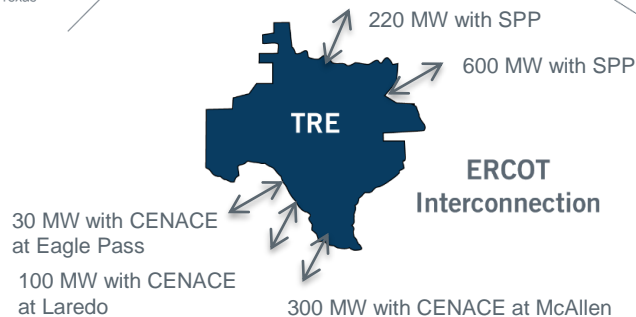
# The ERCOT Region

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

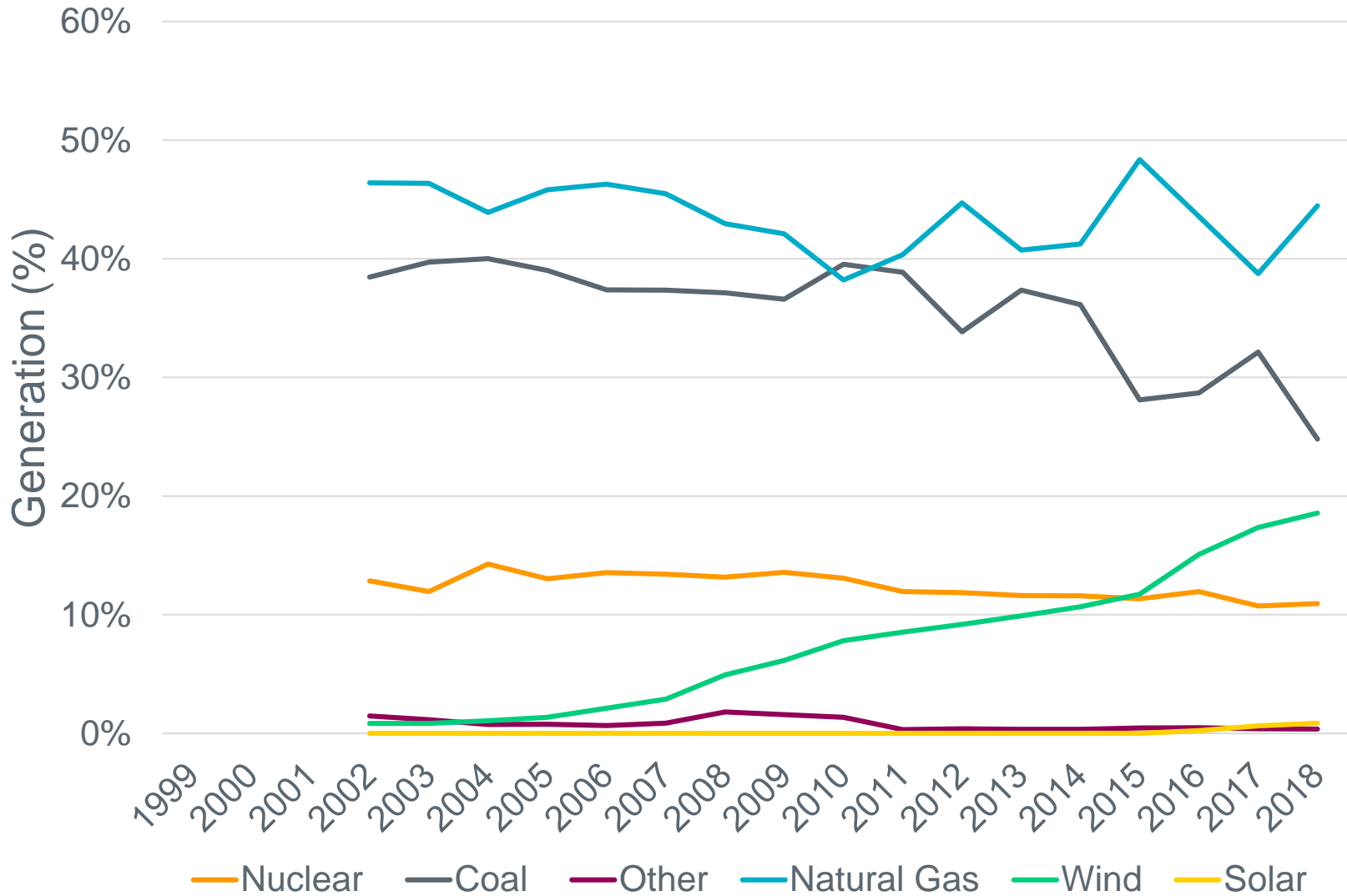
- 90% of Texas electric load; 75% of Texas land
- 73,308 MW peak, July 19, 2018
- More than 46,500 miles of transmission lines
- 570+ generation units



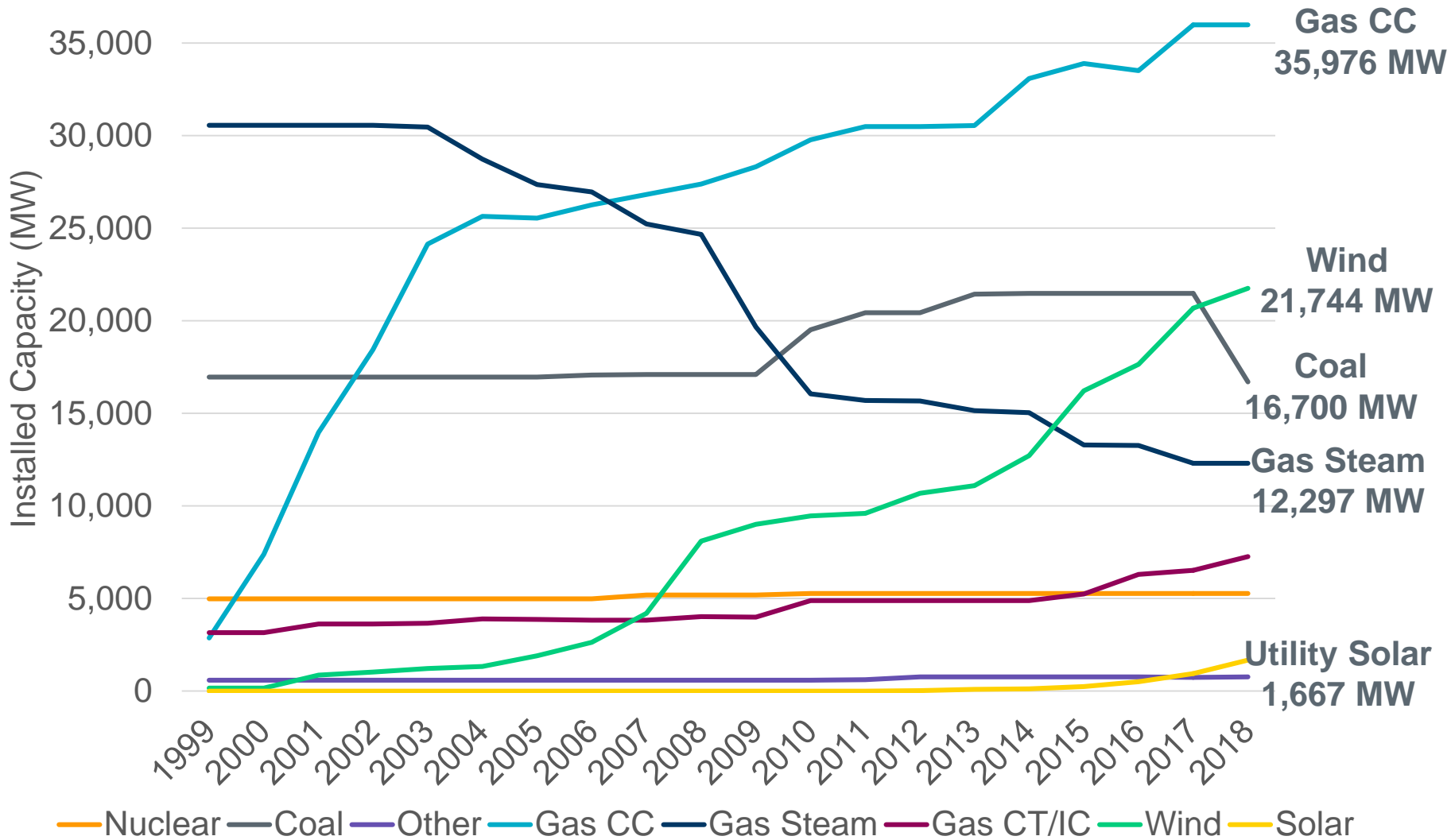
*ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity*



# ERCOT Generation (2002-2018)

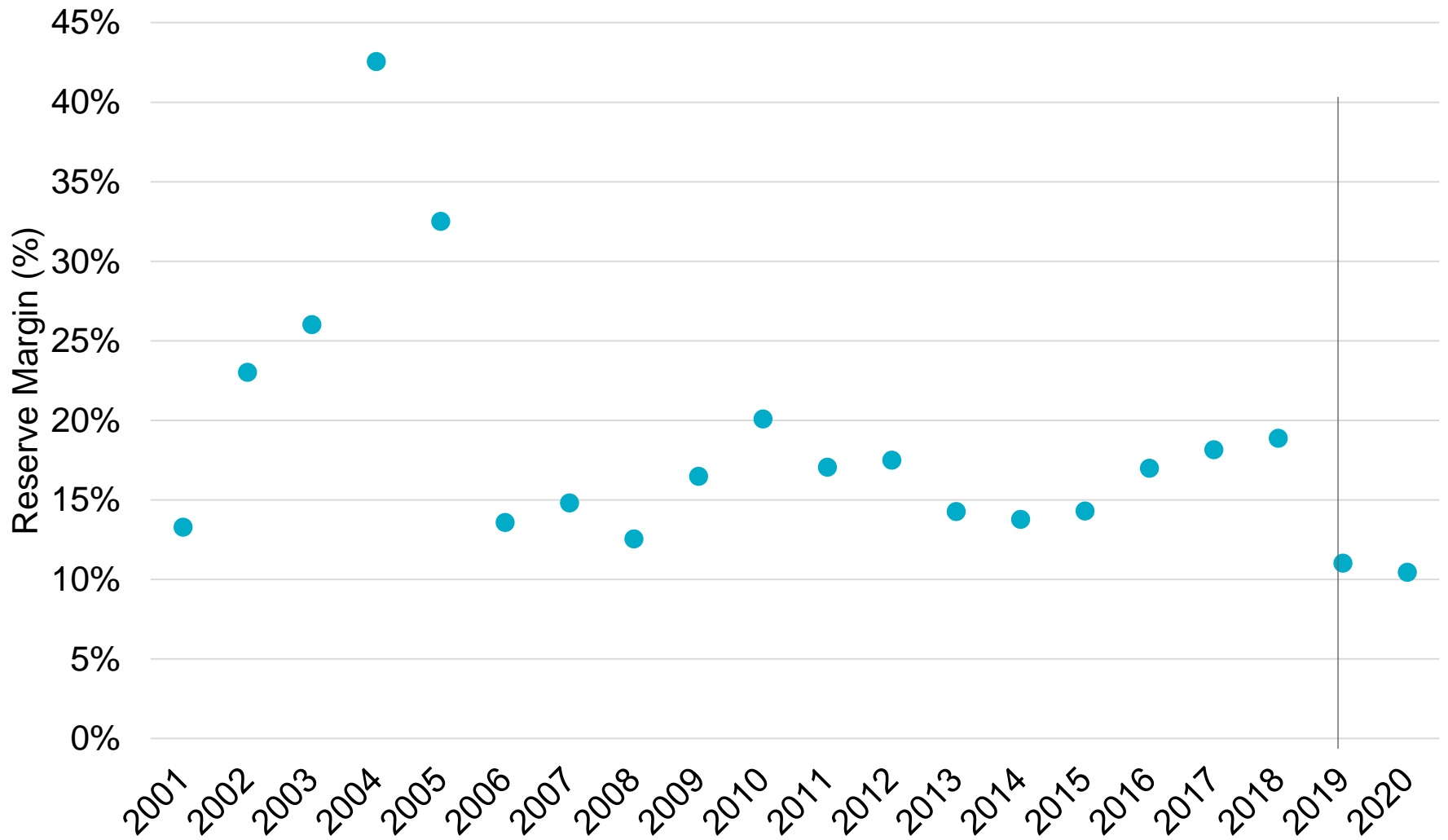


# ERCOT Installed Capacity (1999-2018)

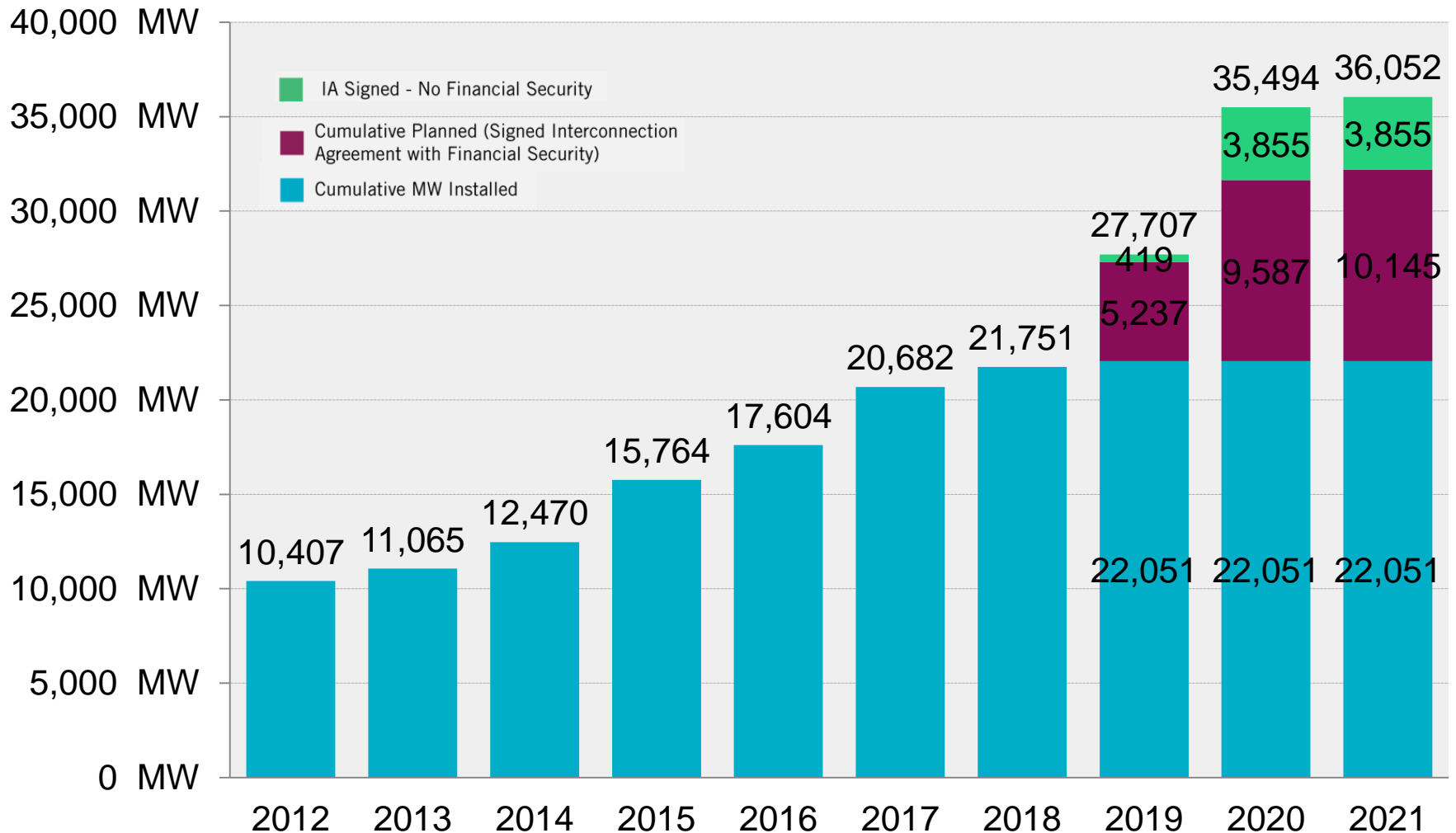


# Capacity, Demand and Reserves Report Reserve Margins

Reserve Margins from Prior-Year May CDRs



# Wind Generation Capacity – as of April 2019



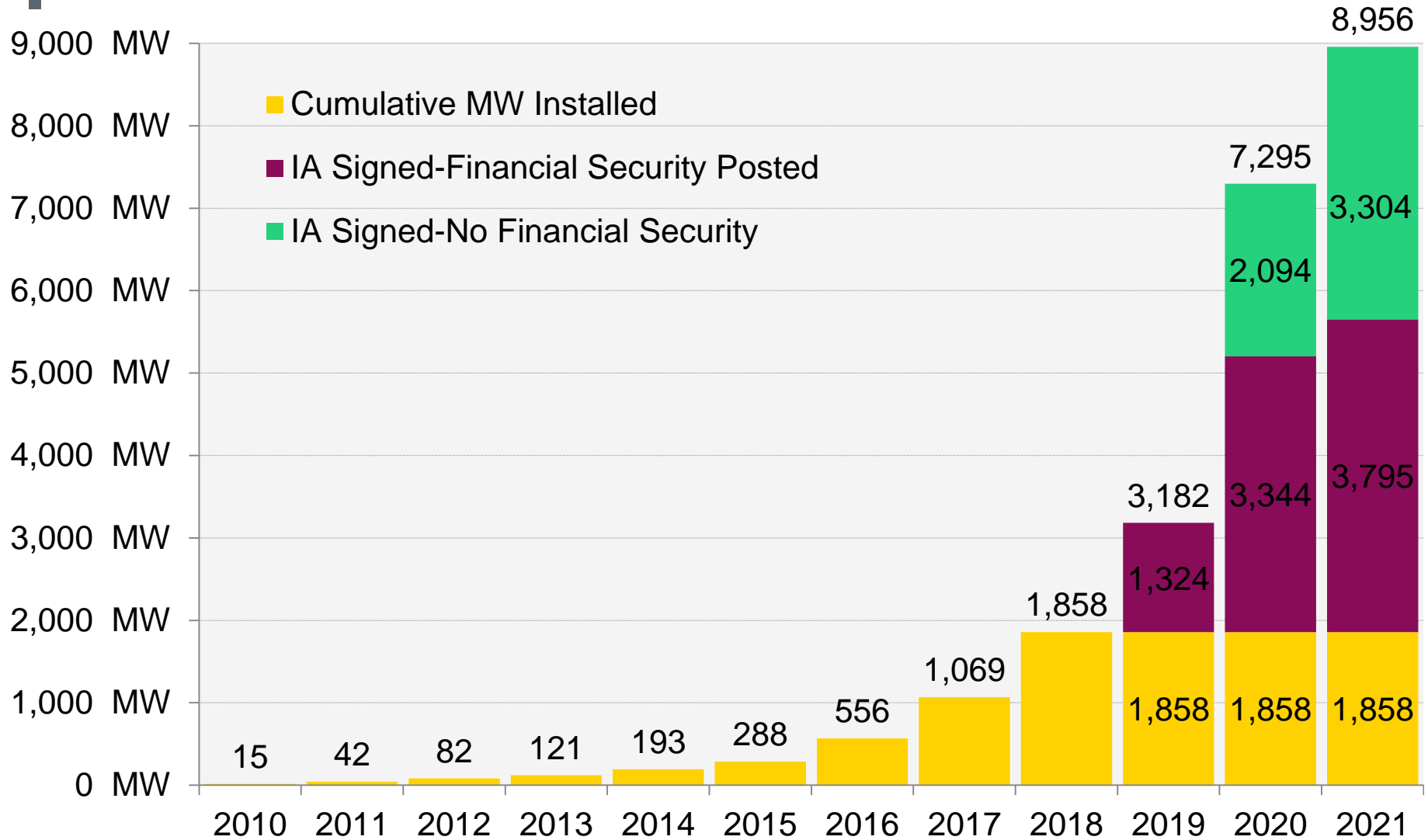
The data presented here is based upon the latest registration data provided to ERCOT by the resource owners and can change without notice. Any capacity changes will be reflected in current and subsequent years' totals. Scheduling delays will also be reflected in the planned projects as that information is received. This chart reflects planned units in the calendar year of submission rather than installations by peak of year shown.

Financial security posted for funding interconnection facilities does not include CREZ security deposits, which are refunded to the Interconnecting Entity when an IA is signed.

As of April 30, 2019



# Utility Scale Solar Generation Capacity – as of April 2019



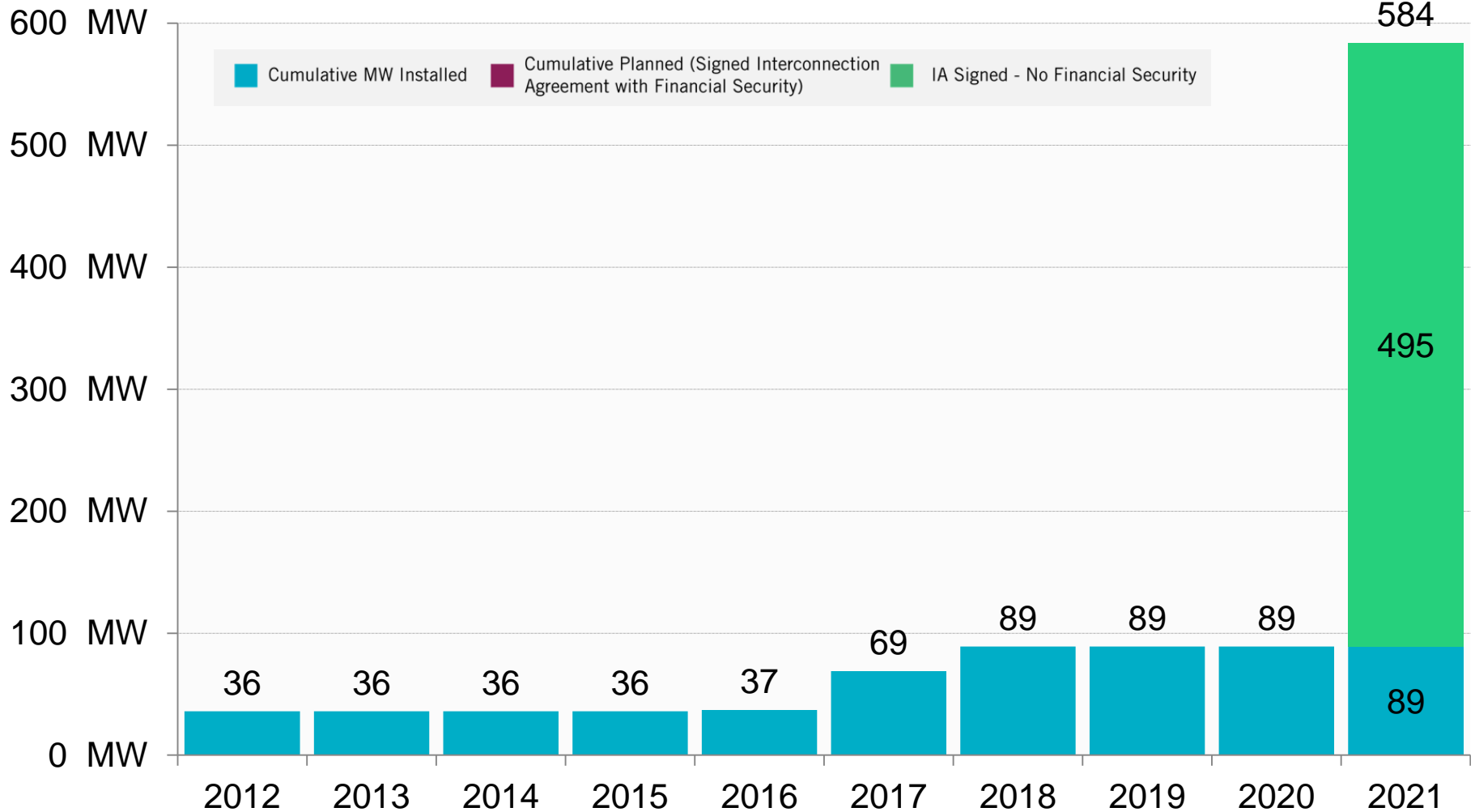
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As of April 30, 2019





# Battery Storage Capacity – as of April 2019



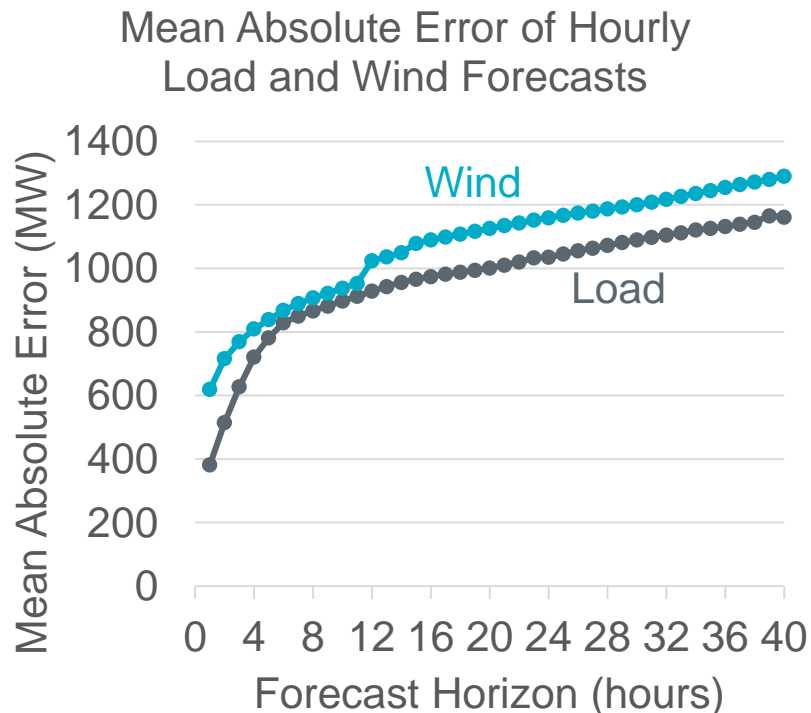
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As of April 30, 2019



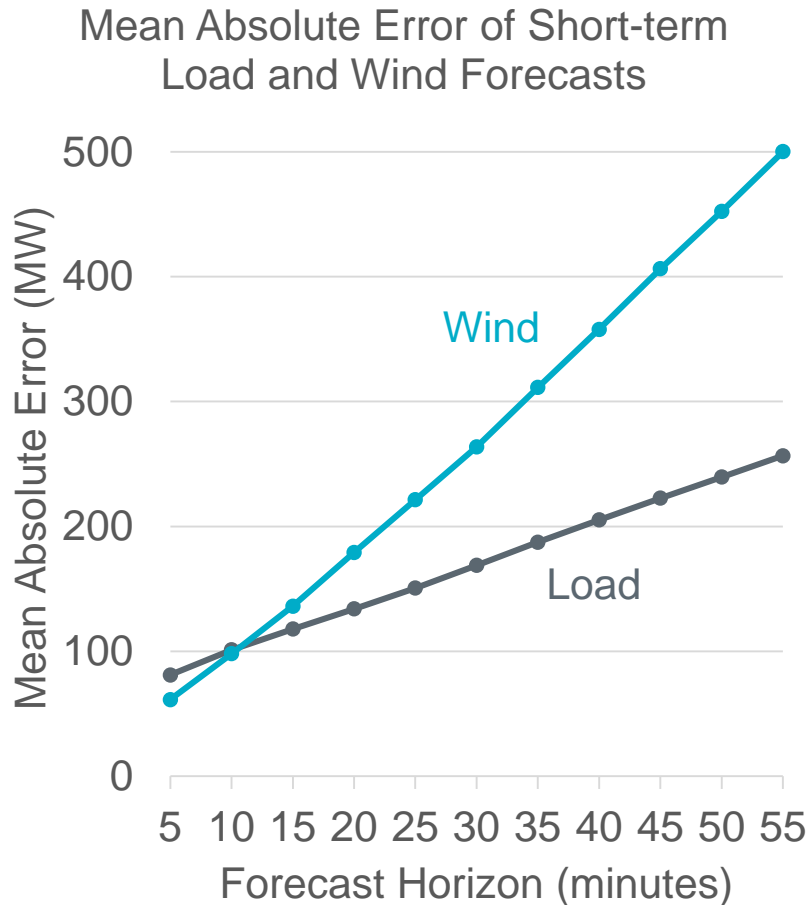
# Feature 1: Flexible Commitment

- Load and wind forecast errors increase with forecast horizon
- Delaying commitment decisions minimizes commitment errors
- DAM energy awards are not physically binding
- Preference for deferring commitment decisions



- Flexible commitment of fleet by Market Participants
- Hourly reliability assessments by ERCOT (RUC)
- Preference for delaying RUC commitment decisions
- Preference given to fast-starting Resources in RUC engine

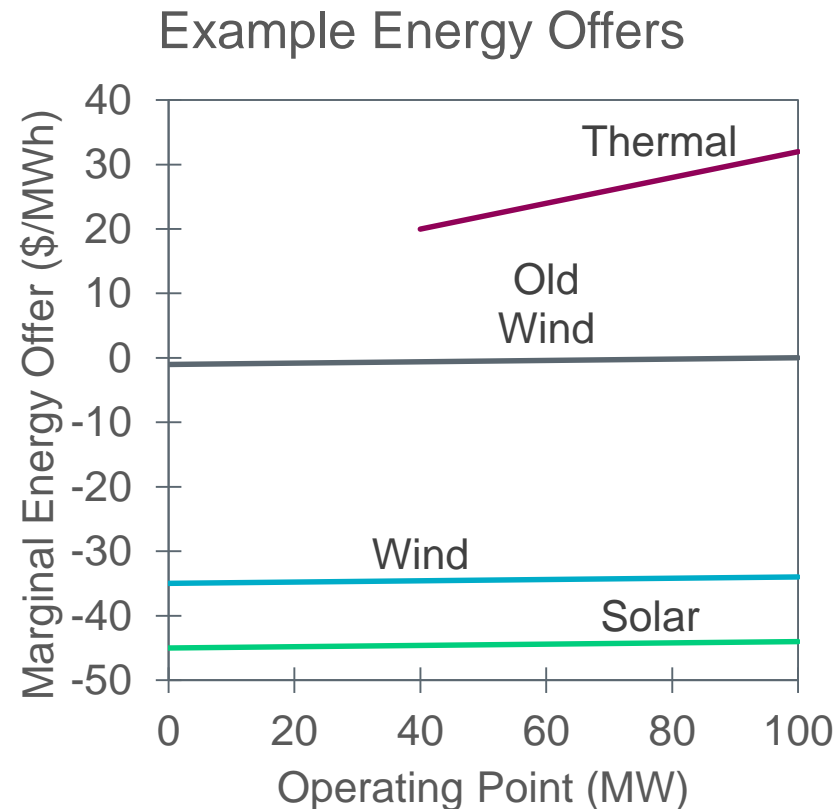
## Feature 2: Prompt Real-Time Dispatch



- SCED's instructions are immediately binding
- Load and wind forecast errors increase linearly with the forecast horizon, so prompt dispatch minimizes dispatch errors due to short-term forecasts
- Prompt dispatch may be better than delayed multi-interval dispatch from both pricing and reserves requirement perspective

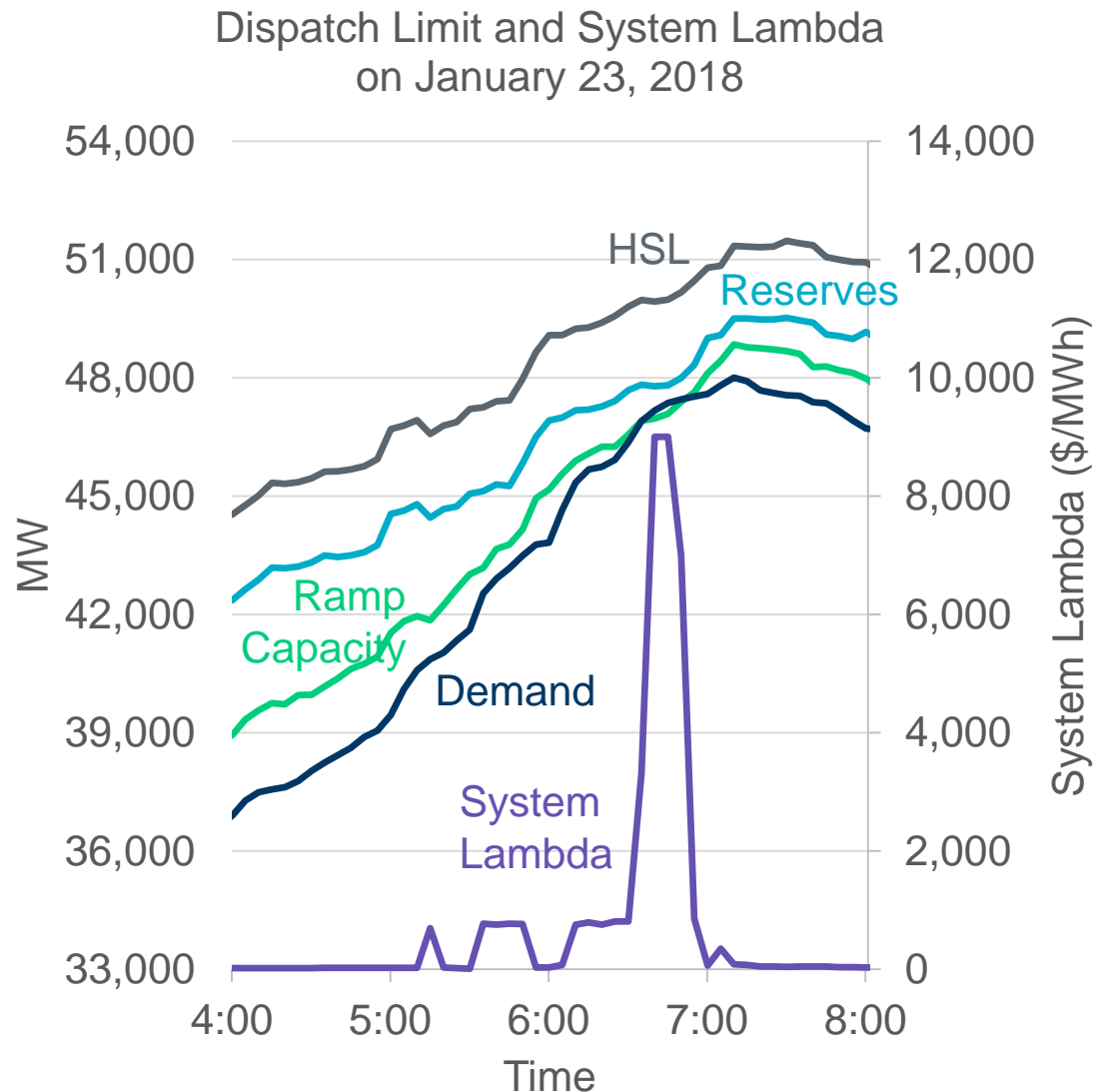
## Feature 3: Economic Dispatch of Renewable Resources

- From the beginning, utility-scale wind and solar were included in SCED and required to dispatch down based on an offer curve
  - No “must-take” rules
- Allows SCED to manage congestion and power balance and set appropriate LMPs



## Feature 4: High Incentives for Real-Time Performance

- \$9,000/MWh prices are not only for scarcity conditions
- High offer cap and power balance penalty curve incentivize fast response of load and generation



# Near-Term Market Improvements in ERCOT

- Nodal pricing for distributed generation
  - Currently paid at load-zone price
  - Seeing rapid growth in distributed generation
  - Will receive its mapped transmission electrical bus price
- Modernization of AS products
  - Splitting single reserve product currently performing both immediate contingency response and 10-minute replacement reserve into two different products
  - Will allow greater participation by short-duration storage resources and fast-starting resources such as reciprocating engines
- Real-time cooptimization
  - DAM and RTM will have identical reserve products

