ERCOT: Energy Only Market

Julia Matevosyan
Lead Planning Engineer
ERCOT

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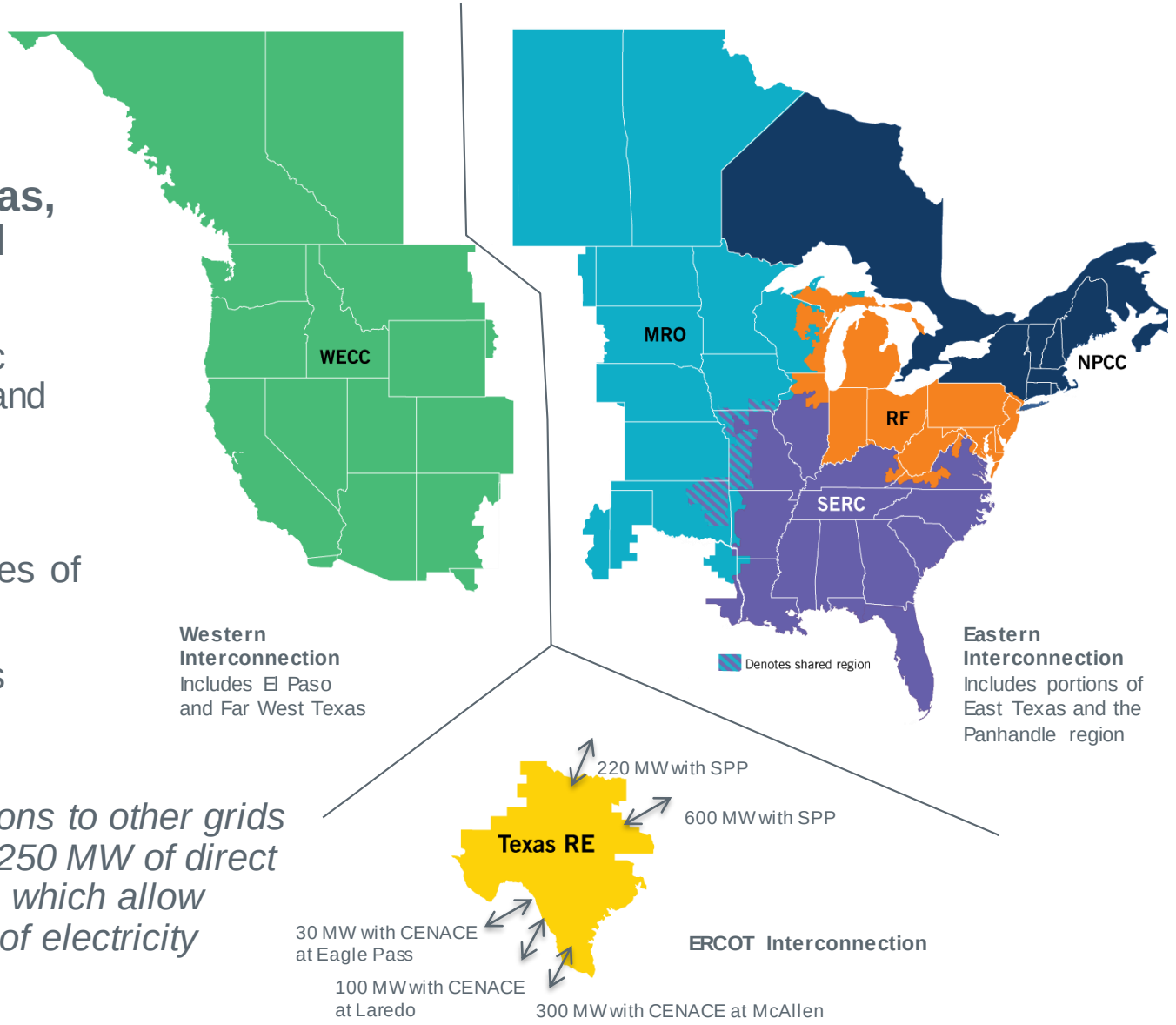
The ERCOT Region

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

- 90% of Texas electric load; 75% of Texas land
- 74,666 MW* peak, August 12, 2019
- More than 46,500 miles of transmission lines
- 650+ generation units (excluding PUNs)



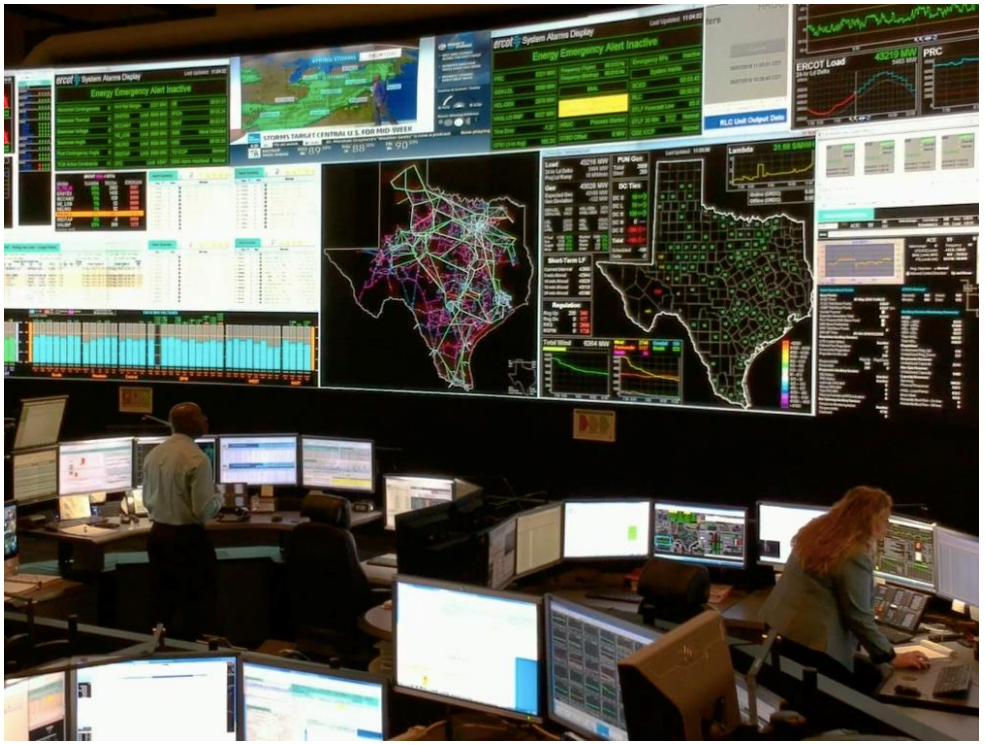
ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity

*preliminary operating data

What is ERCOT?

The Texas Legislature restructured the Texas electric market in 1999 and assigned ERCOT four primary responsibilities:

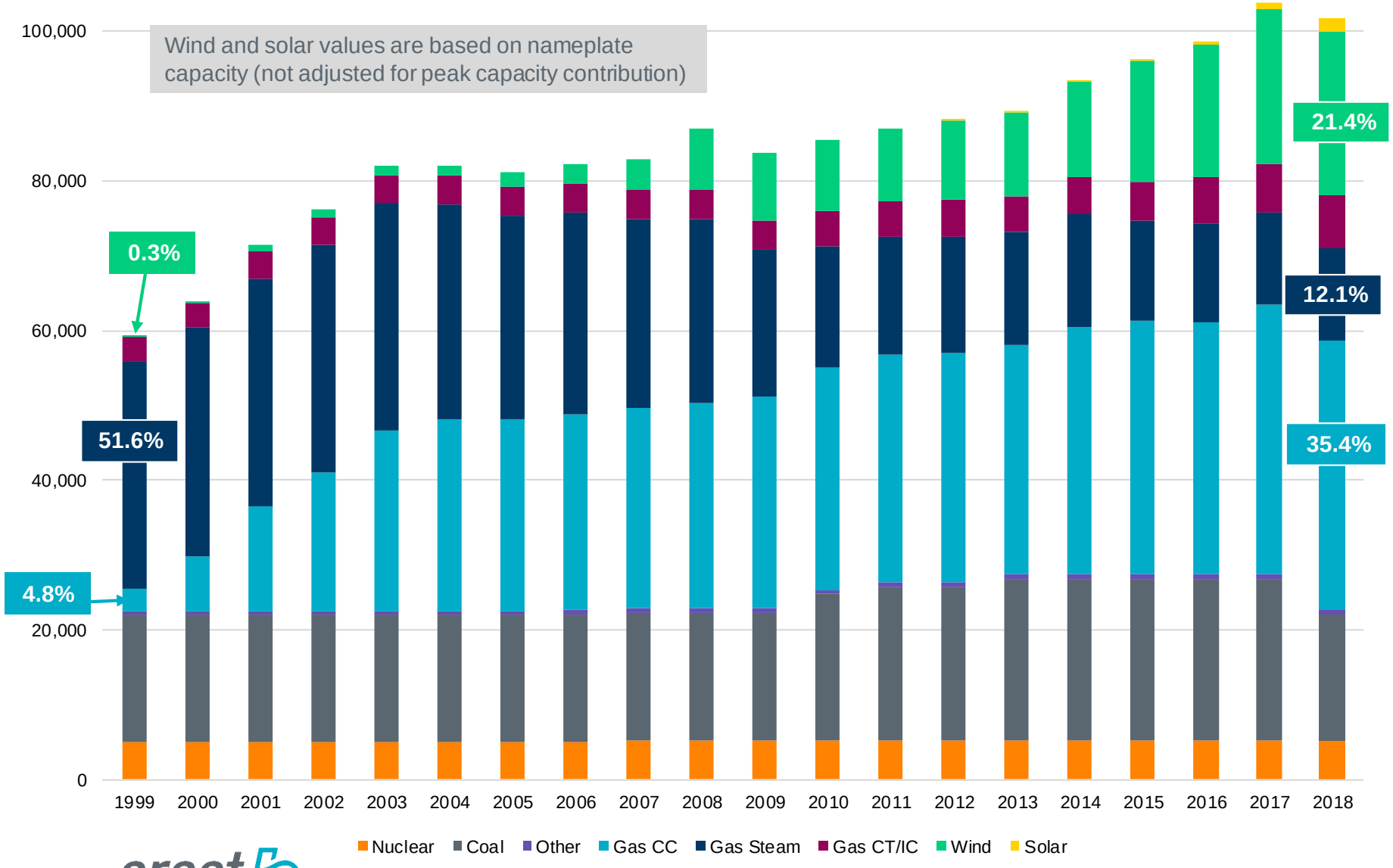
- **System reliability**
- **Competitive wholesale market**
- **Open access to transmission**
- **Competitive retail market**



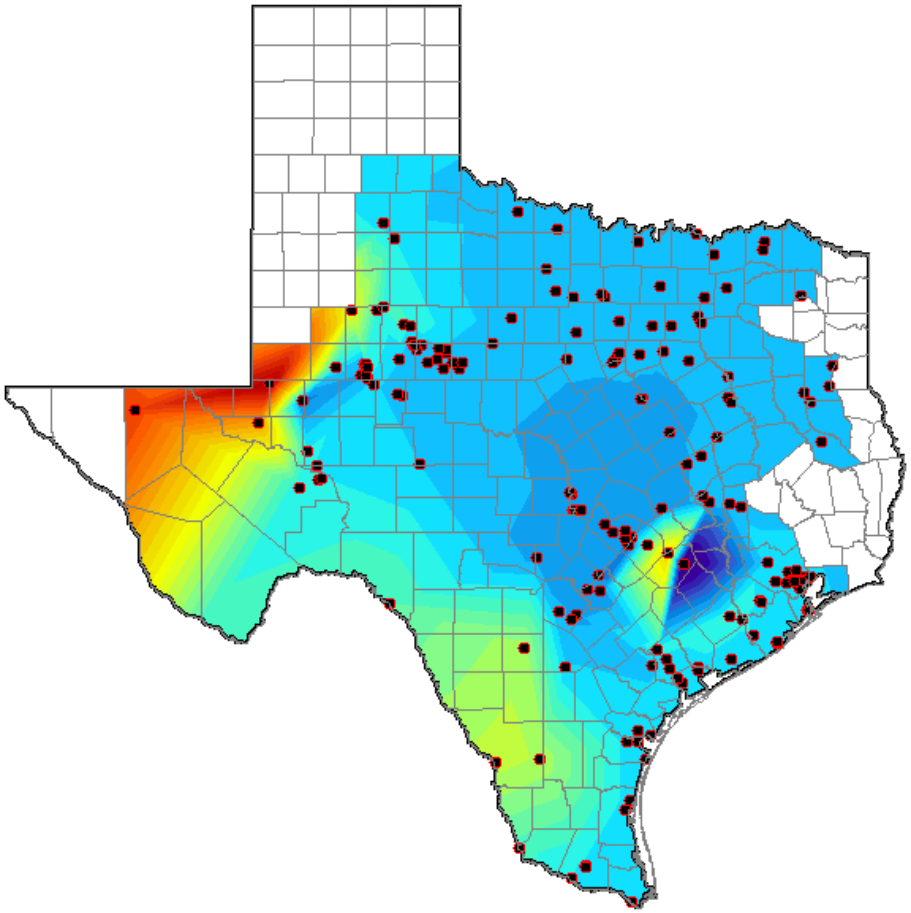
ERCOT is a nonprofit organization that is regulated by the Public Utility Commission of Texas, with oversight by the Texas Legislature.

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

ERCOT Installed Capacity (1999-2018)



Market operations at-a-glance



Market participants may submit offers to buy and sell energy on an hourly basis in the voluntary Day-Ahead Market.

In the Real-Time Market, market participants submit offers to provide generation output and bring generation on-line as needed.

Every five minutes, ERCOT's SCED selects the most efficient generation resources to serve customer demand effectively within the limits of the transmission system.

Energy prices reflect the availability of resources during each interval, adjusting as needed to reflect the value of energy during scarcity conditions.

The Real-Time Market is settled every 15 minutes. Generators are paid settlement point prices, which reflect locational prices. Load-serving entities pay load zone prices.

Where We Are Today

- Energy-only market, i.e. no capacity market
- System-Wide Offer Cap (SWCAP) is $9,000/MWh
- Value of Lost Load (VOLL) is $9,000/MWh
- Demand peaks in summer, approximately half of summer peak demand is from residential air conditioning
- Natural gas is the marginal fuel
- Scarcity pricing mechanism based on Operational Reserve Demand Curve (ORDC) – system-wide

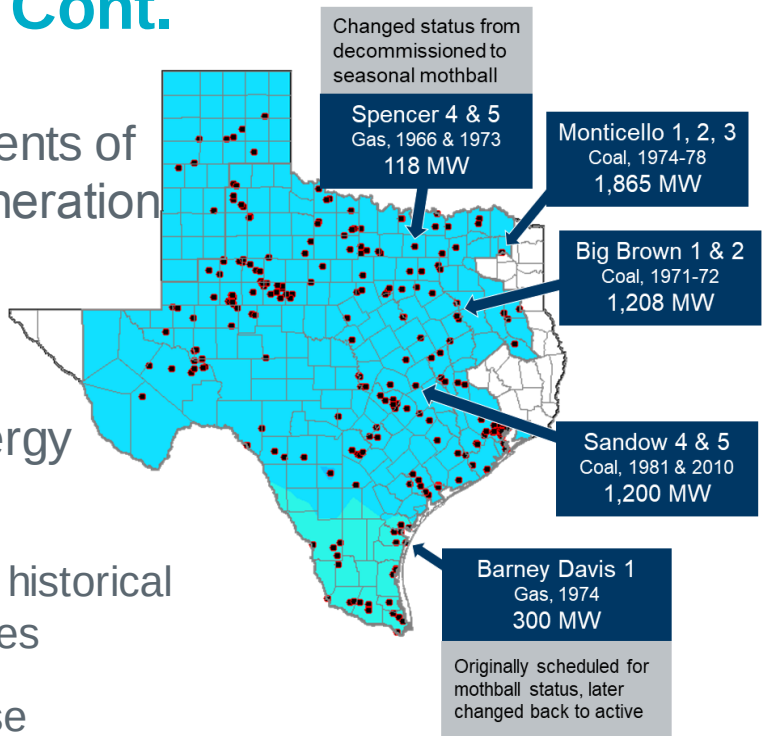
Real-Time Price Adder Based on Operating Reserve Demand Curve (ORDC)

- ORDC was introduced to in 2014 to improve Real-Time scarcity pricing.
- For each SCED interval, ERCOT calculates a Real-Time Reserve Price, an adder based on the available reserves in the ERCOT System and the ORDC.
- The value of ORDC at any given level of available operating reserves is determined as the Loss of Load Probability (LOLP) at that reserve level multiplied by Value of Lost Load (VOLL) minus System Lambda
- The adder to Real-Time Price approximates the pricing outcome of Real-Time energy and Ancillary Service co-optimization since it reflects the incremental value of scarce operating reserves.

Where We Are Today Cont.

- Continued trends of retirements of thermal ('dispatchable') Generation Resources

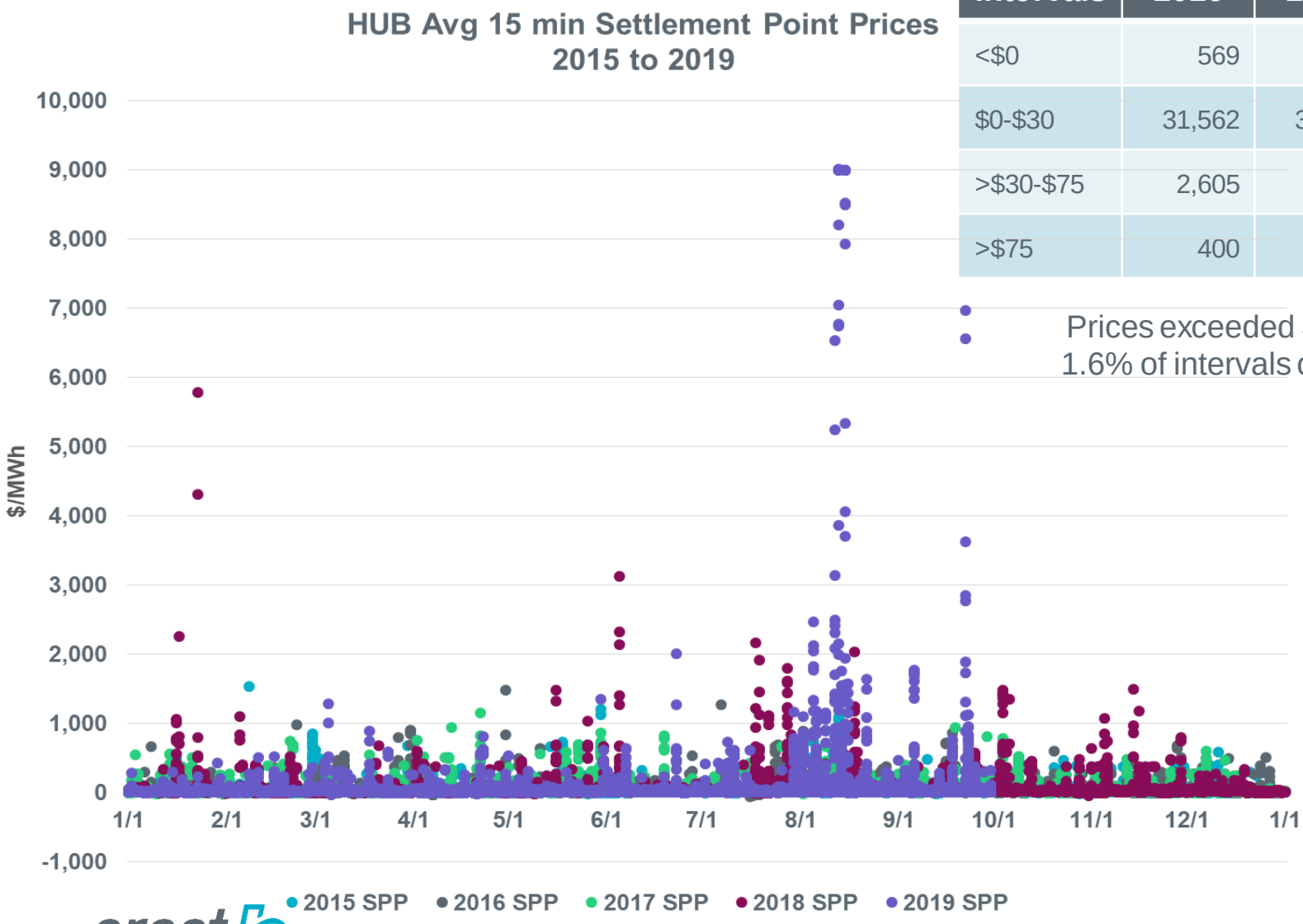
- Persistent low average energy prices
  - Summer weather closer to historical norms, unlike 2011 extremes
  - No active demand response participation in the Real-Time Market
    - There has been growth in retail ('passive') price responsive demand, but true capability unknown due to lack of sufficient history of high prices



- In late 2017, ERCOT received Notices of Suspension of Operations for 10 units, totaling about 4,700 MW of capacity.
- ERCOT studies determined that none of these units are needed for transmission system reliability.

Real-Time Energy Prices 2016-2019 (to date)

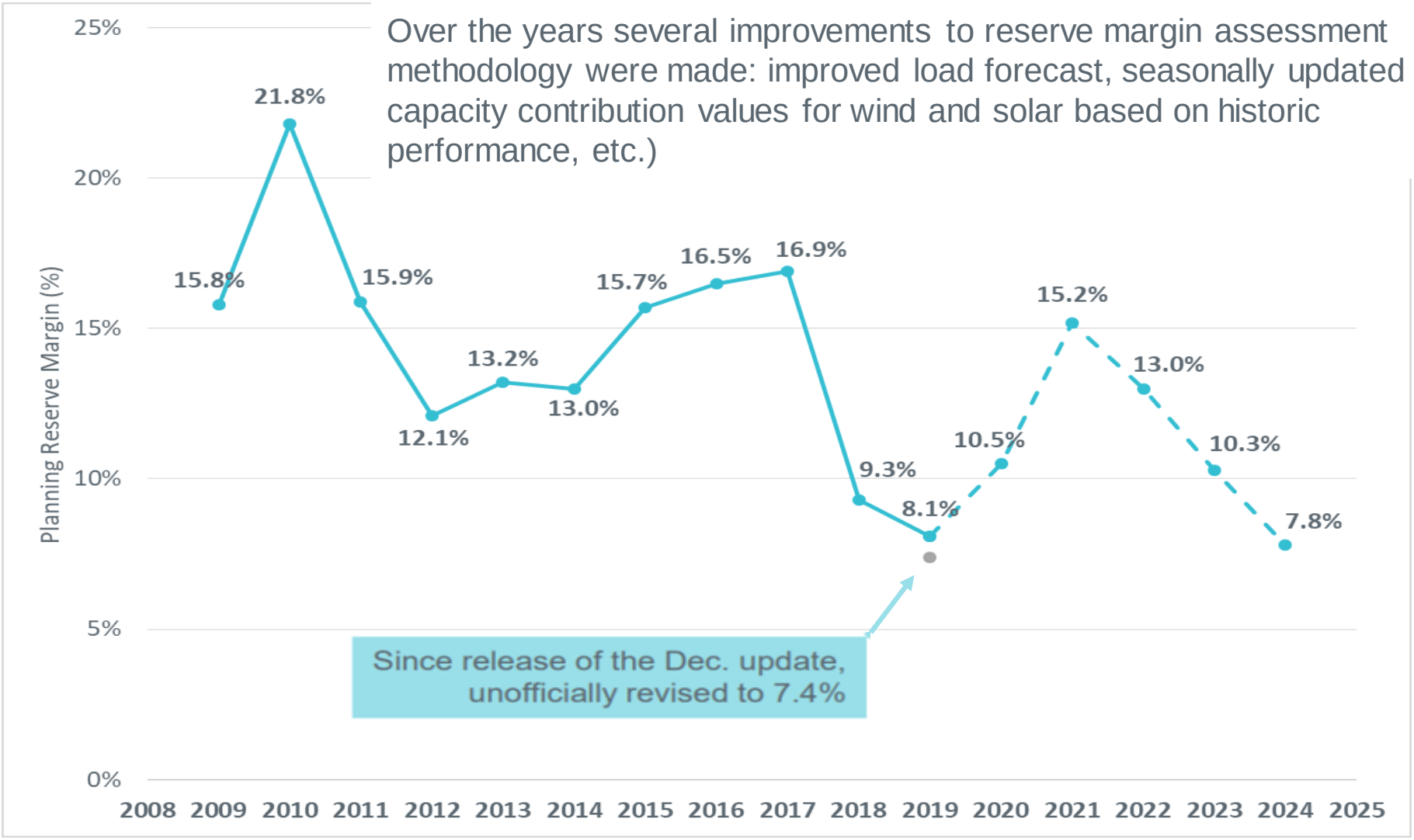
Intervals	2016	2017	2018
<$0	569	235	160
$0-$30	31,562	30,568	27,446
>$30-$75	2,605	3,685	6,691
>$75	400	552	743



Prices exceeded $75/MWh in 1.6% of intervals over 3 years

Historical Summer Reserve Margins (from Dec. CDRs) and Projected Future Summer Reserve Margins (from May 2019 CDR)

Over the years several improvements to reserve margin assessment methodology were made: improved load forecast, seasonally updated capacity contribution values for wind and solar based on historic performance, etc.)



Reserve Margin

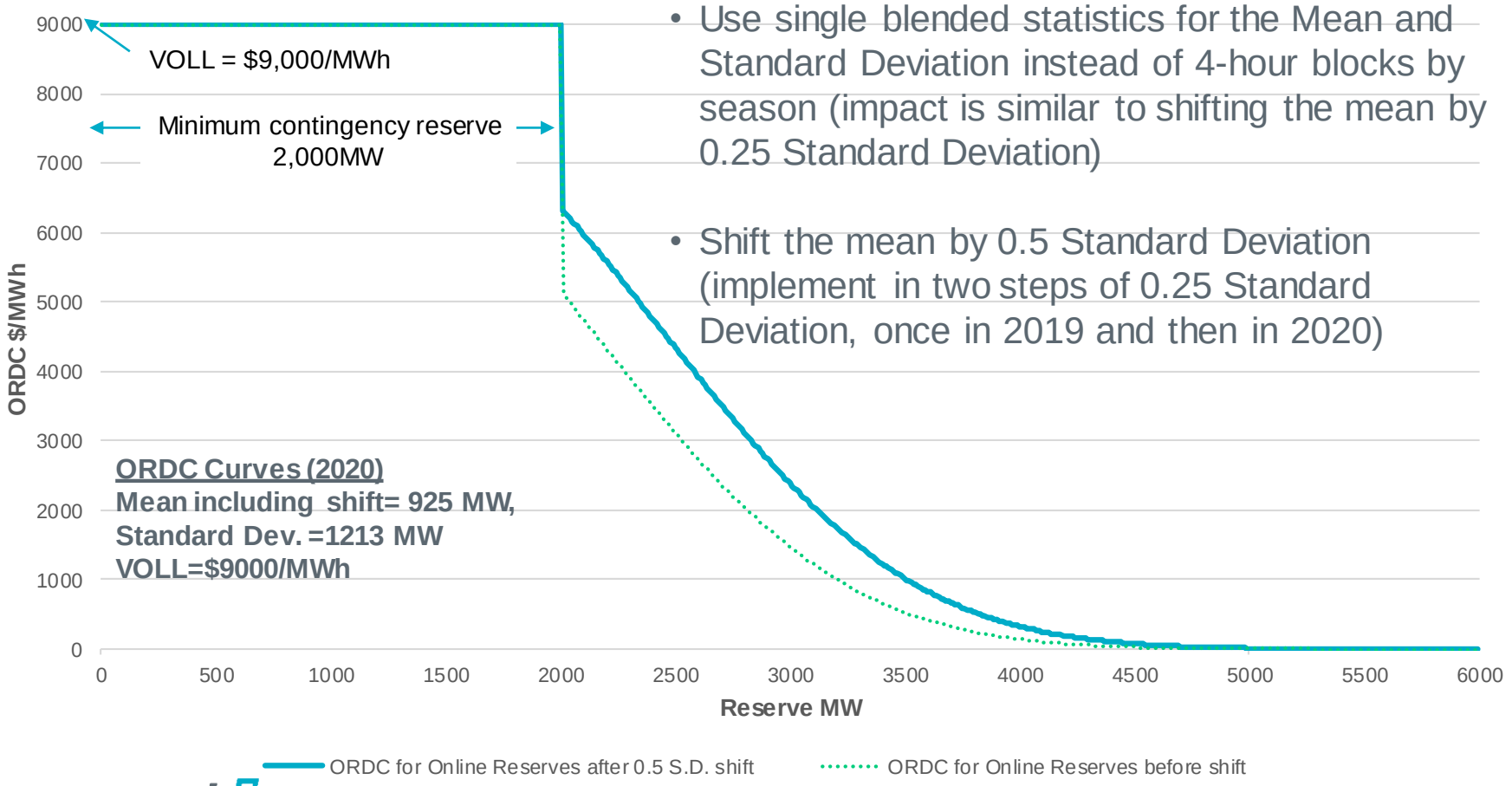
- ERCOT does NOT have a mandated Planning Reserve Margin
- Periodic studies estimate the Market Equilibrium Planning Reserve Margin (MERM) and Economically Optimum Planning Reserve Margin (EORM). 2018 Brattle/Astrape study estimated for 2022:
  - Reserve Margin of 13.5% would be required to meet "1-in-10" criteria (0.1 loss of load events per year)
  - MERM = 10.25%
  - EORM = 9.0%

Generation Interconnection Trends (as of Sept. 30th, 2019)

Fuel Type	Technology Type	SS Completed FIS Started IA	SS Completed FIS Completed IA	TOTAL
Gas	Combined-Cycle	**45**	**290**	1,676
Gas	Combustion Turbine		**435**	5,110
Gas	Internal Combustion Engine			
Gas	Compressed Air Energy Storage			604
Gas	Steam Turbine			15
Gas	Fuel Cell			
Coal				
Wind		**4,554**	**8,858**	34,554
Solar		**5,132**	**3,531**	64,344
Biomass				
Other	Battery			4,452
Other*				313
TOTAL		**9,731**	**13,115**	111,068

Recent Events: Changes to ORDC Parameters

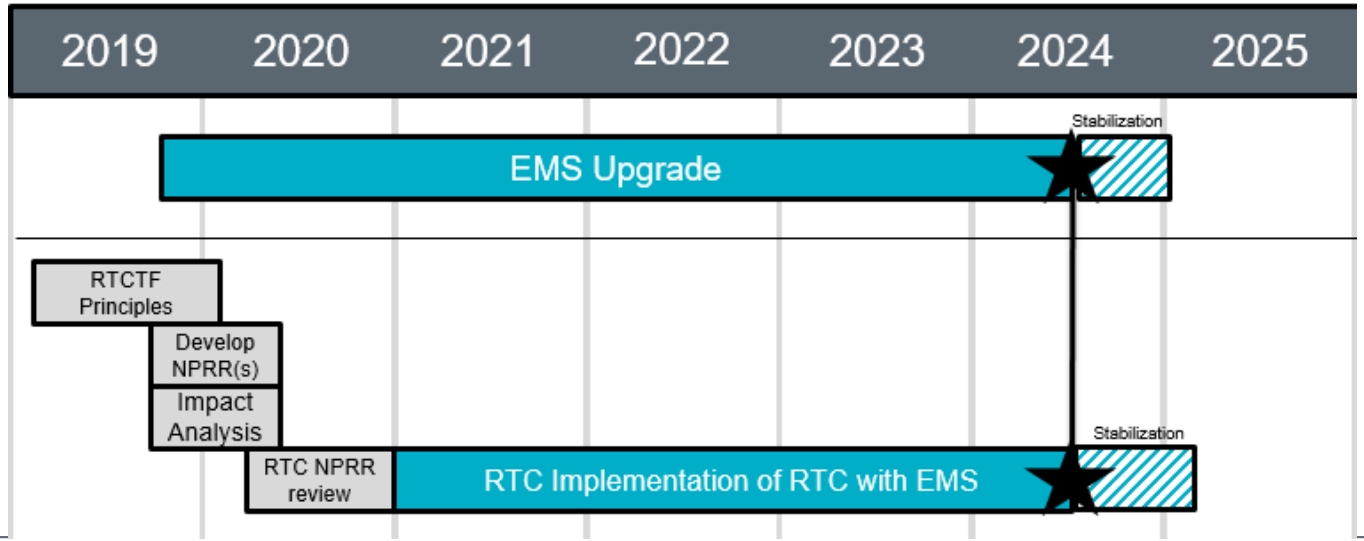
PUCT expressed concern over the declining Planning Reserve Margin and issued a directive in January 2019 to adjust the LOLP parameters (Mean and Standard Deviation) used for ORDC.



- Use single blended statistics for the Mean and Standard Deviation instead of 4-hour blocks by season (impact is similar to shifting the mean by 0.25 Standard Deviation)
- Shift the mean by 0.5 Standard Deviation (implement in two steps of 0.25 Standard Deviation, once in 2019 and then in 2020)

Ongoing work, Real-Time Co-optimization

- In January 2019, PUCT gave ERCOT direction to implement Real Time Co-optimization
- Co-optimizing energy and Ancillary Services (AS) in Real-Time (very 5 minutes) is expected to result in:
  - Reduced overall energy and AS costs
  - More timely and efficient replacement of AS in real time
  - Fewer Reliability Unit Commitments
  - Reduction in manual operator actions
  - More effective congestion management



Thank you! Questions?

Julia Matevosyan

jmatevosjana@ercot.com