Why am I here?

MARCH 10, 2020

New England's Wholesale Electricity Markets

The Clean Energy Transition and Future Pathways

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PRESIDENT AND CEO

Which Evolutionary Path Is Feasible? Which Is Best for the Region?

- **Maintain the Capacity Market and Make Incremental Improvements:**
  - And eventually implement realistic carbon pricing, either through RGGI, or in energy market?
- **Eliminate the Capacity Market and Accept the Volatility/Risk of an Energy-Only Market:**
  - Texas has structural differences: Single state, policymakers accept volatility and risk, default for load is "unhedged," load is highly price responsive, unlimited balancing energy (natural gas), warm winters
  - Would FERC or the New England States decide on the appropriate scarcity price?
- **States Take Responsibility for Resource Adequacy and Accept Investment Risk:**
  - Implement centralized, regional, integrated resource planning (IRP)? (This would require some form of multi-state compact and a regional planning/procurement agency to finance the resource mix)
  - Authorize Transmission Owners to do full IRP, and to own and/or contract for needed resources, utilizing the TO balance sheet for financing? (e.g., the "Combined Approach" of California or MISO)
- **A New Market-Based and Technology-Agnostic Resource Adequacy Construct?**
  - Aspirational? Ideally, assure resource adequacy by orchestrating forward obligations in a purely financial manner, eliminating administrative burdens and achieving appropriate price formation irrespective of state sponsorship of resources

Which structure will best harness competitive forces and innovation to drive the Clean Energy Transition?

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Existing Resource Adequacy Models: What Are the Cost Recovery and Risk Implications of the Various Resource Adequacy Mechanisms?

	Central Planning (Customers Bear Most Risk)	Combined (Customers Bear Most Risk)	Market Mechanisms (Suppliers Bear Most Risk)	
	Regulated Utilities ensure RA and optimize energy production via economic dispatch	**Utilities/LSEs ensure RA and fuel infr.; Energy Market optimizes energy production**	**Energy, Capacity, Ancillary Mkts ensure reliability**	**Energy and Ancillary Mkts, RA through very high spot price**
ISO/RTO, or Region	WECC (except CA) and SERC regions	California, MISO, SPP	ISO-NE, PJM, NYISO	ERCOT
Reserve Margin Requirement?	Yes (Utility IRP, State regulated)	Yes (Utility/LSE IRP enabled, State regulated; CAISO utilizes cost of service reliability contracts to cover gaps)	Yes (FERC regulated)	No (State sets the scarcity price)
Capital Cost Recovery?	Traditional Cost-of-Service Rate Recovery	State approved cost recovery, net of Energy Market	Energy and Capacity Markets	Energy Market

All models are under scrutiny by their respective jurisdictions

ERCOT's Energy Only Market

Presented to NEPOOL Participants Committee

Beth Garza

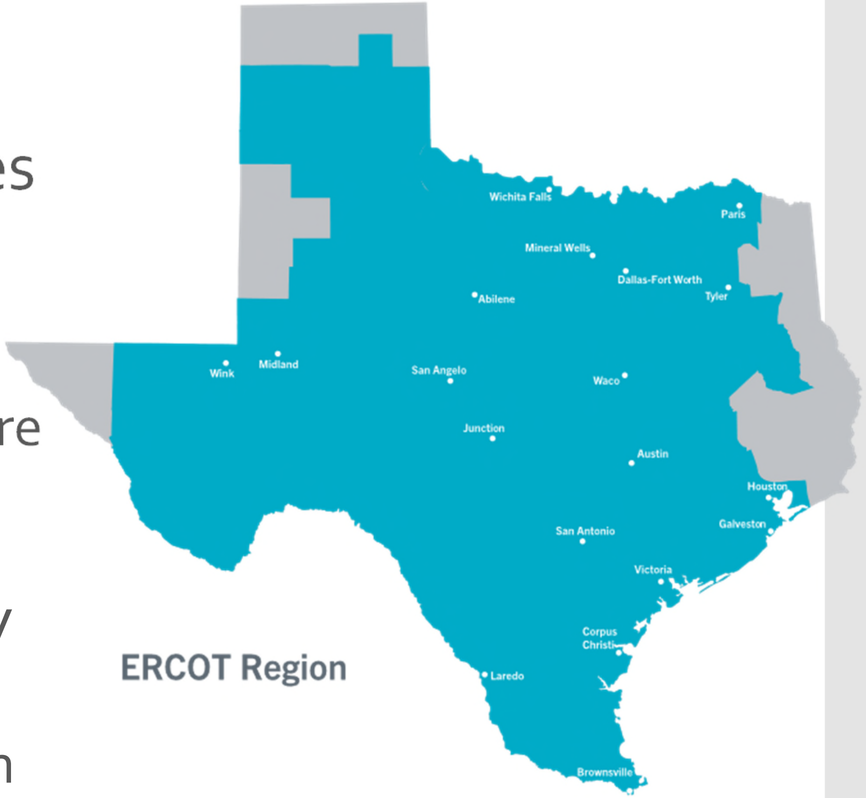
September 3, 2020

Today's Topics

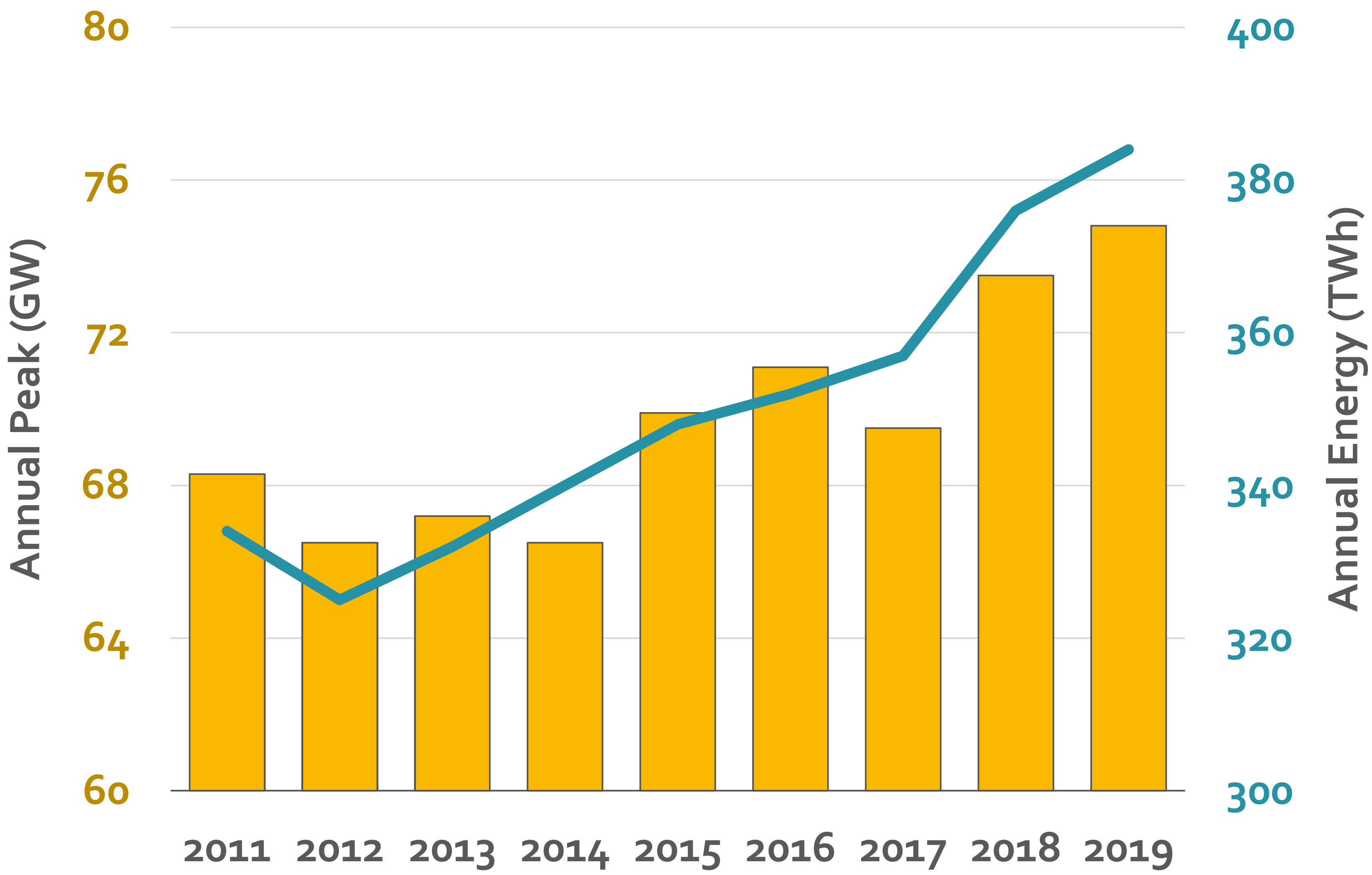
- ERCOT Region Overview
- ERCOT Market Thumbnail
- Market Details
  - Day Ahead
  - Reliability Unit Commitment
  - Real Time
- Ensuring Adequacy

Key aspects of the ERCOT region

- Limited interties
- No FERC jurisdiction over market operations or outcomes
- Retail competition for most of the region since 2002.
  - Municipals and Co-operatives are exempt (~25% of total load)
- Large consumers of electricity across customer classes
  - Typical residential consumption 10-12 MWh/yr, ~10 c/kWh total cost



ERCOT Load continues to grow

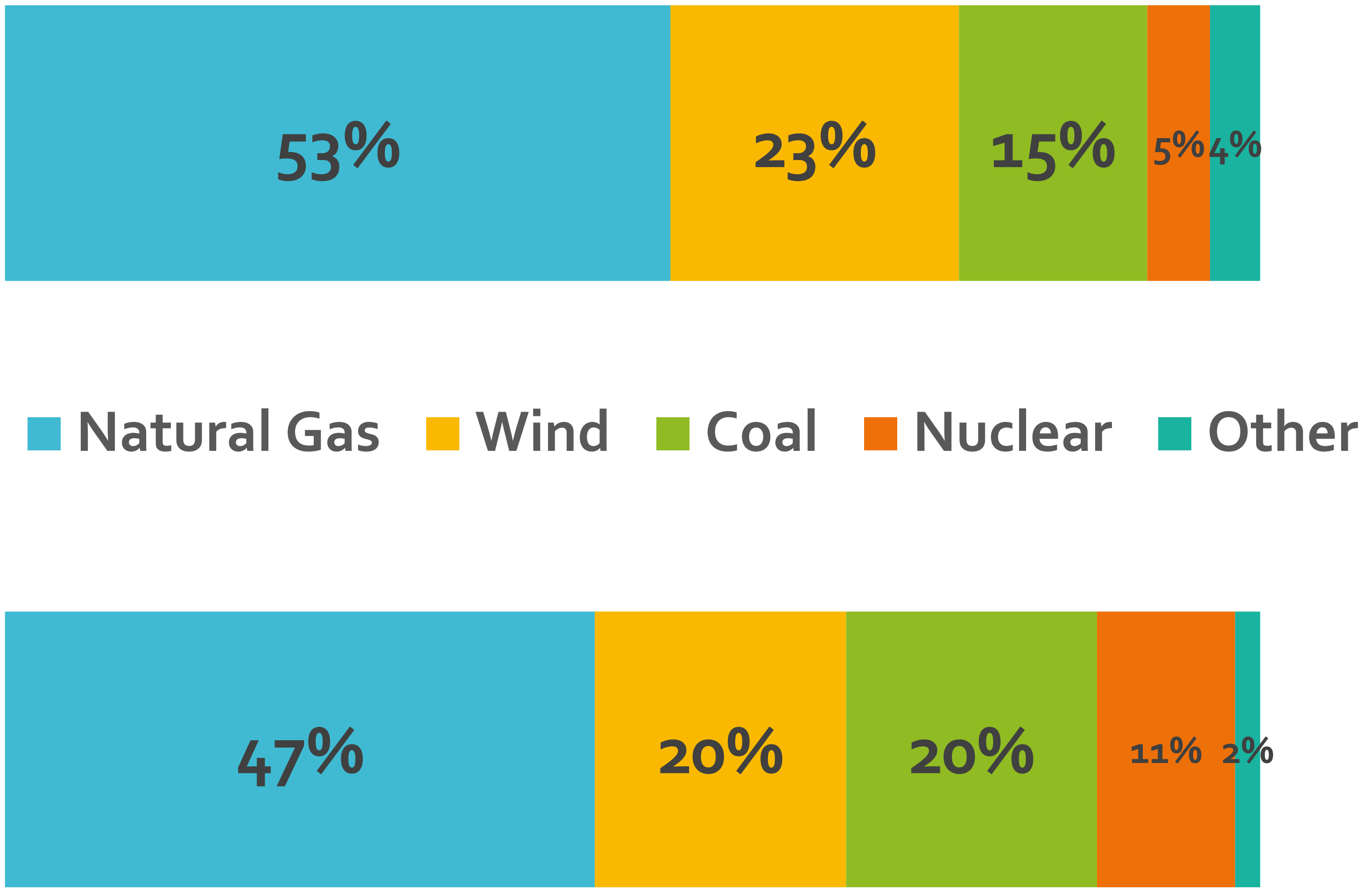


Key aspects of the ERCOT market

- Energy only
  - No market for installed capacity
  - Load serving entities have no requirement to own or procure installed capacity
- Decentralized capacity commitment
  - ERCOT uses daily and hourly RUC to fill any gaps
- Relatively large A/S requirements ~ 5GW +/- 10%
- Potential for very high wholesale electricity prices
  - Offer cap set at $9,000
  - Value of Loss Load (VOLL) deemed to be $9,000
  - RT prices may include contributions from two adders
    - ORDC (Reserve Adder)
    - Reliability Deployment Adder
  - Price is capped (sort of) at $9,000

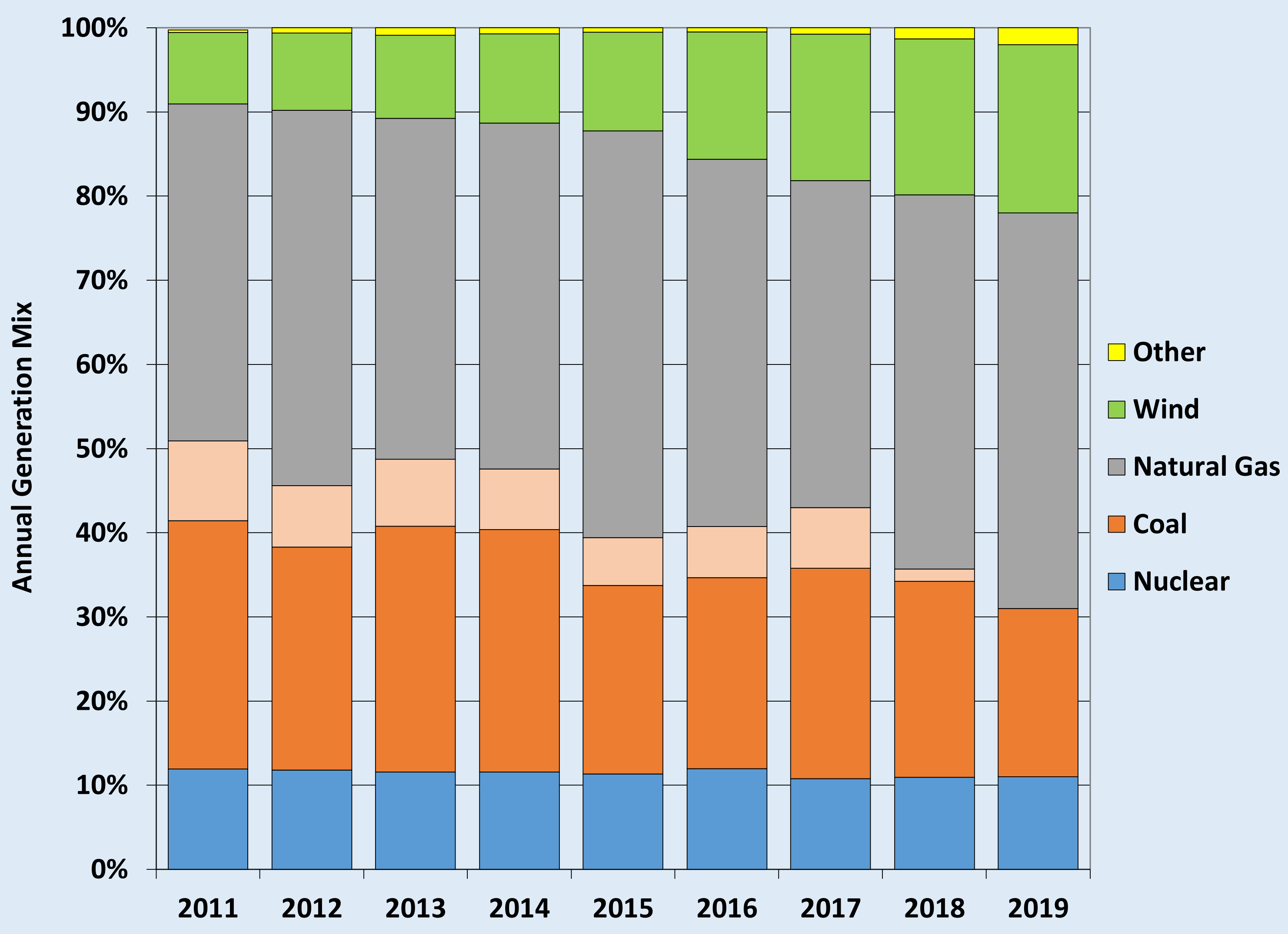
2020 Capacity

2019 Energy

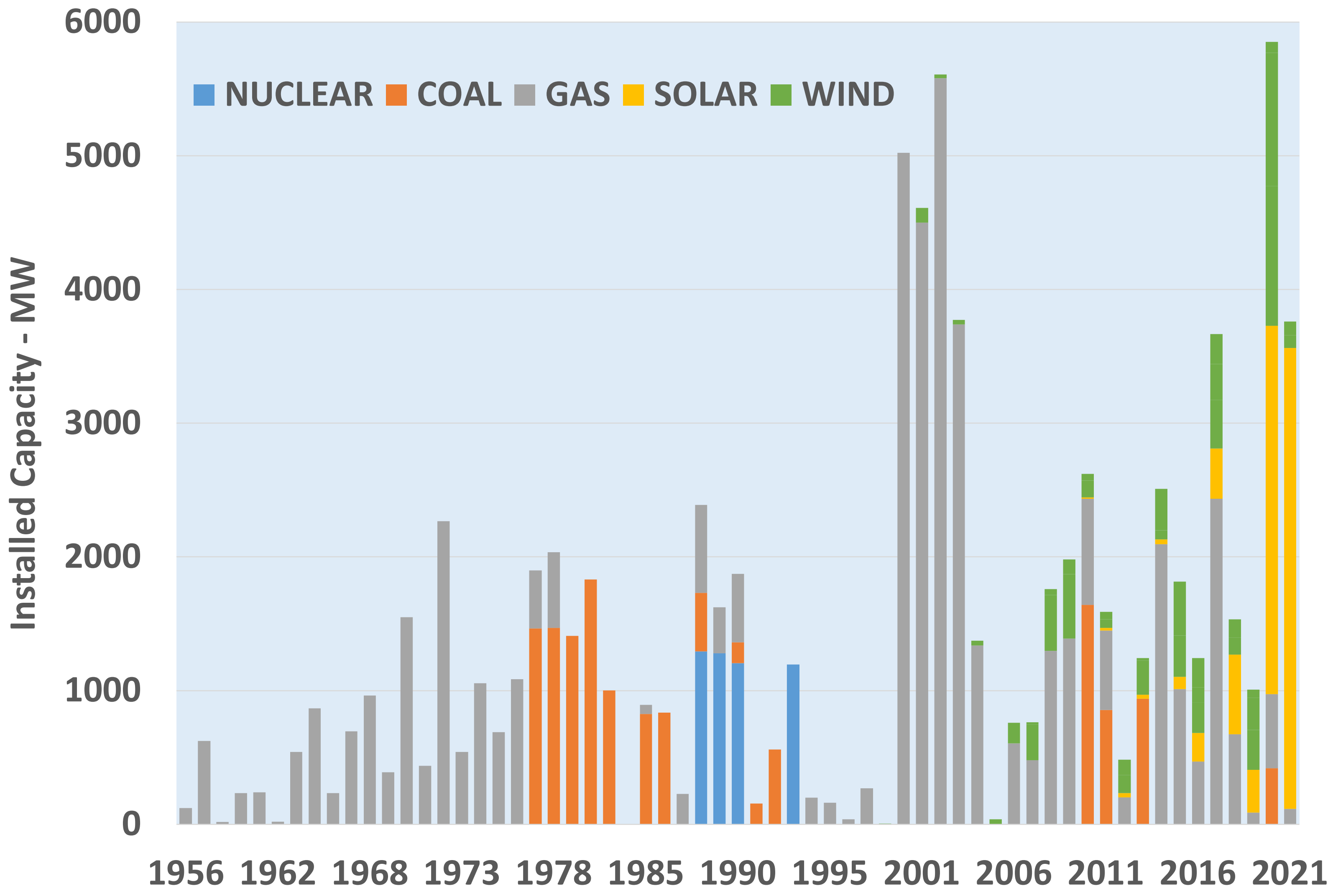


More Wind

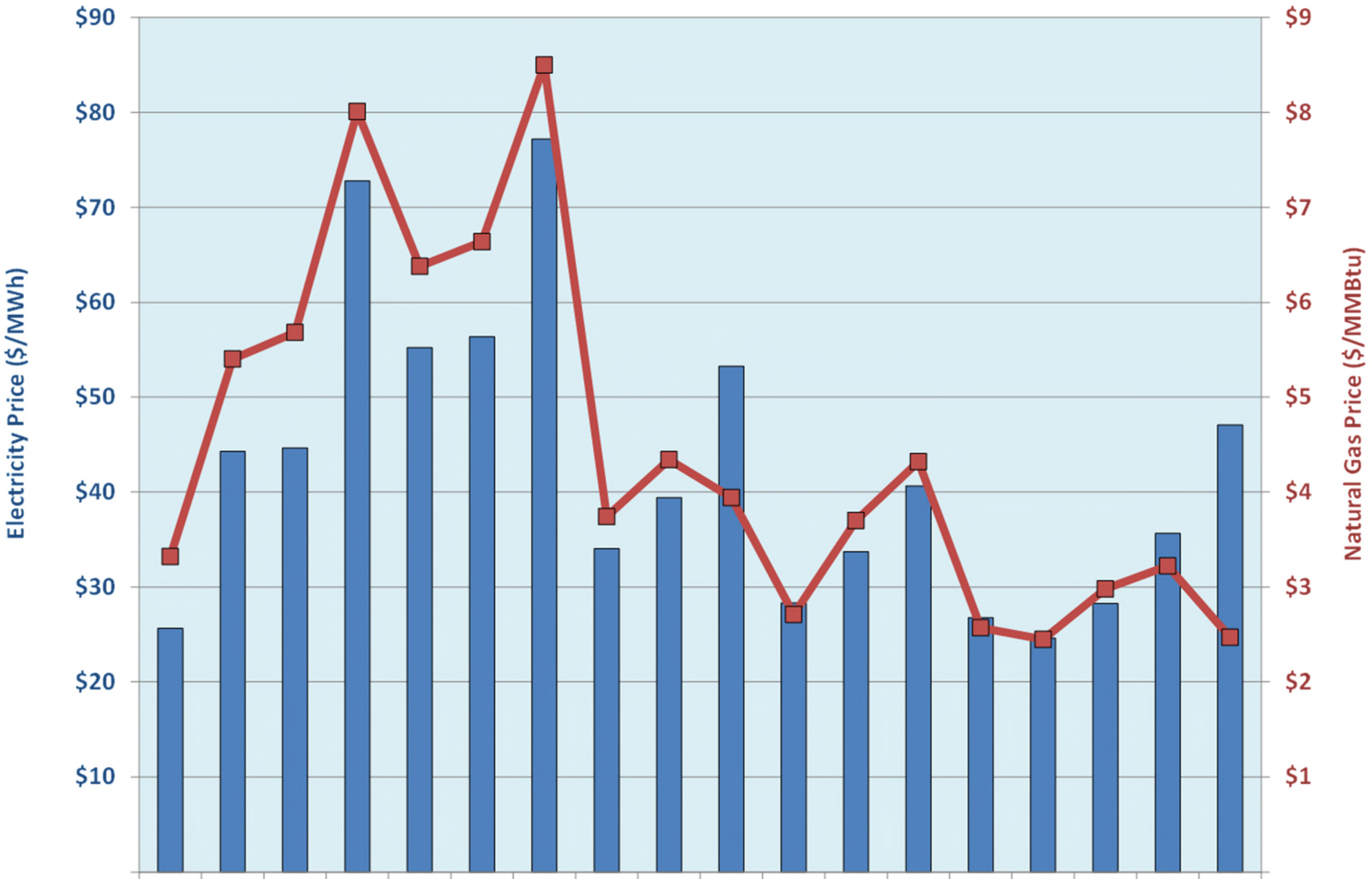
Less Coal



Preferred generation technology has changed through time



Two drivers of real-time electricity prices are natural gas prices and surplus/scarcity of operating reserves

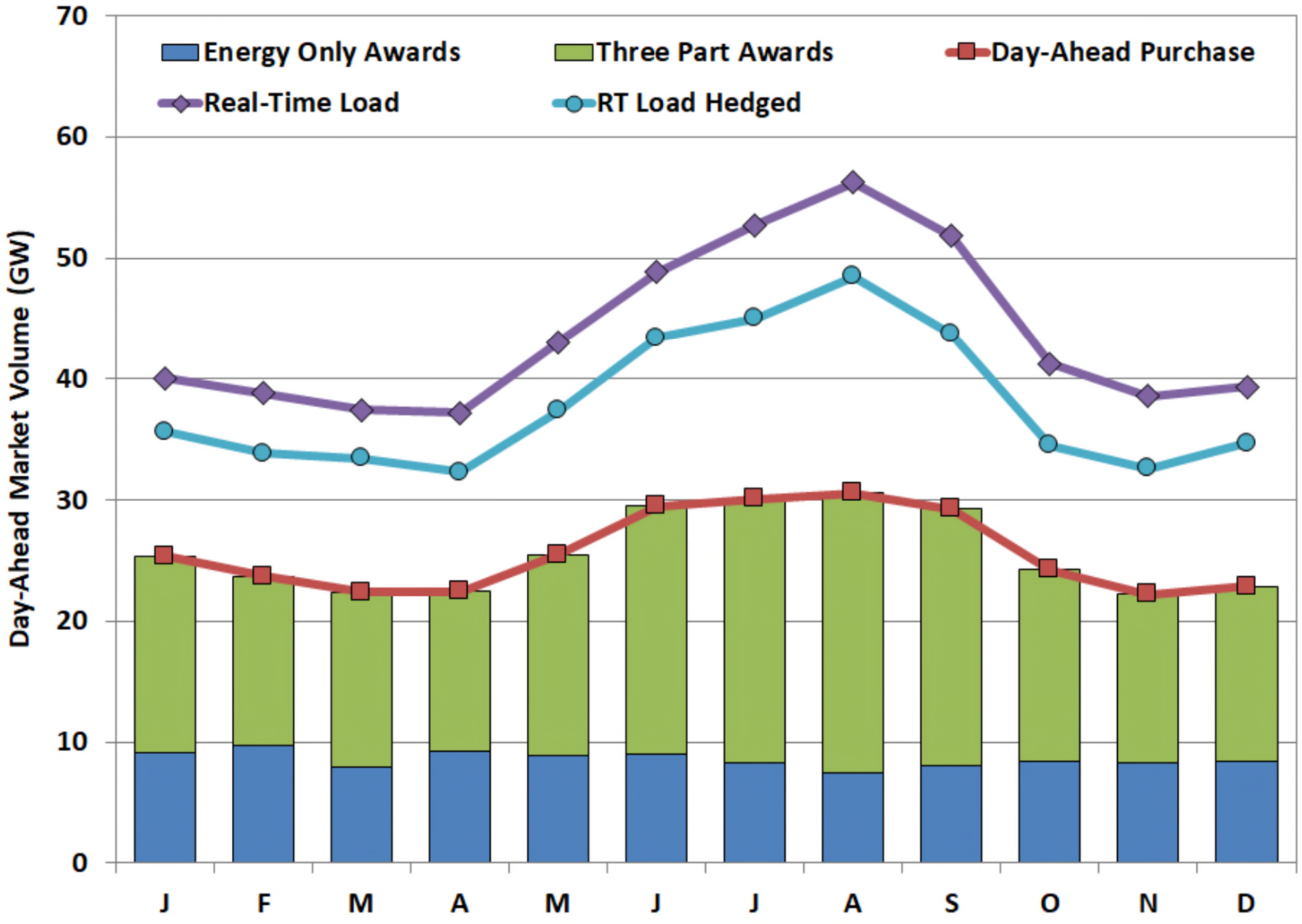


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ERCOT	25.64	44.26	44.64	72.79	55.22	56.35	77.19	34.03	39.40	53.23	28.33	33.71	40.64	26.77	24.62	28.25	35.63	47.06
Gas	3.32	5.40	5.68	8.01	6.38	6.64	8.50	3.74	4.34	3.94	2.71	3.70	4.32	2.57	2.45	2.98	3.22	2.47

Day Ahead Market

- 3part offers from Resources
- zonal bids and offers (no limits on virtual activity)
- RT Congestion instruments (PTP Obligations)
- A/S offers

Figure 22: Day-Ahead Market Three-Part Offer Capacity



From the 2019 State of the Market Report prepared by Potomac Economics. Available here: *https://www.potomaceconomics.com/document-library/?filtermarket=ERCOT*

Reliability Unit Commitment

- Day Ahead vs Hour Ahead RUC
  - ERCOT operators show great restraint by deferring RUC instructions until as late as possible.
  - With a large, fast-starting combined-cycle fleet, there is little need to commit units day-ahead.
  - RUC'd units are made whole to their costs and any 'extra' revenue is clawed-back
    - 50% claw-back for units with DA offers
    - 100% claw-back for units without
- RUC opt-out
  - A unit receiving RUC instruction may choose to "Opt-out", forgoing make-whole and avoiding claw-back.
  - Recommended for elimination by the IMM

How to get high real-time prices?

"high" refers to the deemed value of having adequate supply to meet demand and operating reserve requirements

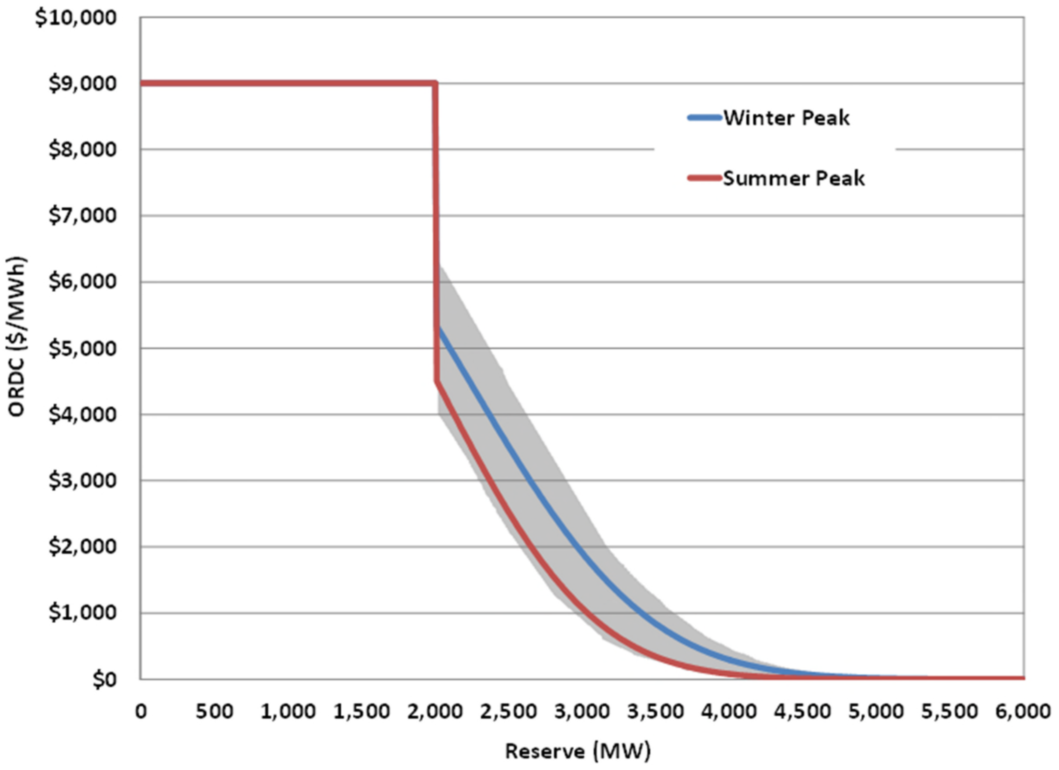
- High offers
  - Generally not effective because the marginal costs to provide are generally lower than the marginal value
- Power Balance Penalty Curve
  - Without real-time co-optimization, there's no economic mechanism for reserves to be converted to energy. Reserves will be adequate until they are not
- ORDC Reserve Adder
  - Surrogate for real-time co-optimization
  - A adder value is derived from the LOLP associated with the level of online and offline reserves, multiplied by VOLL
- Reliability Deployment Price Adder
  - Using a subsequent SCED execution, the price impacts of various reliability actions is determined and added to the real-time price.

ORDC

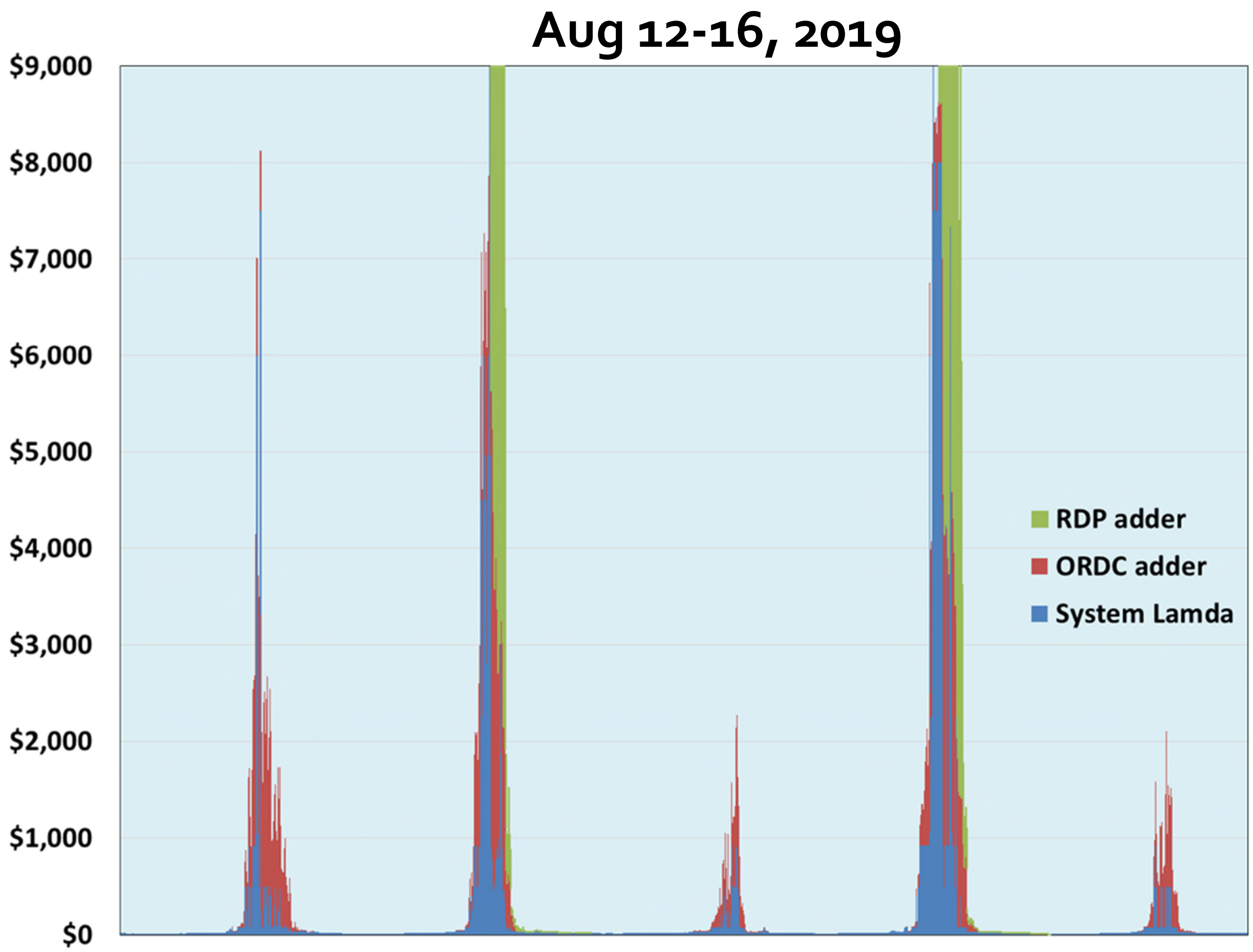
The Operating Reserve Demand Curve (ORDC) is a scarcity pricing mechanism that reflects the loss of load probability (LOLP) at varying levels of operating reserves multiplied by the deemed value of lost load (VOLL).

Selected in 2013 as an easier to implement alternative to real-time co-optimization of energy and ancillary services, the ORDC places an economic value on the reserves being provided, with separate pricing for online and offline reserves.

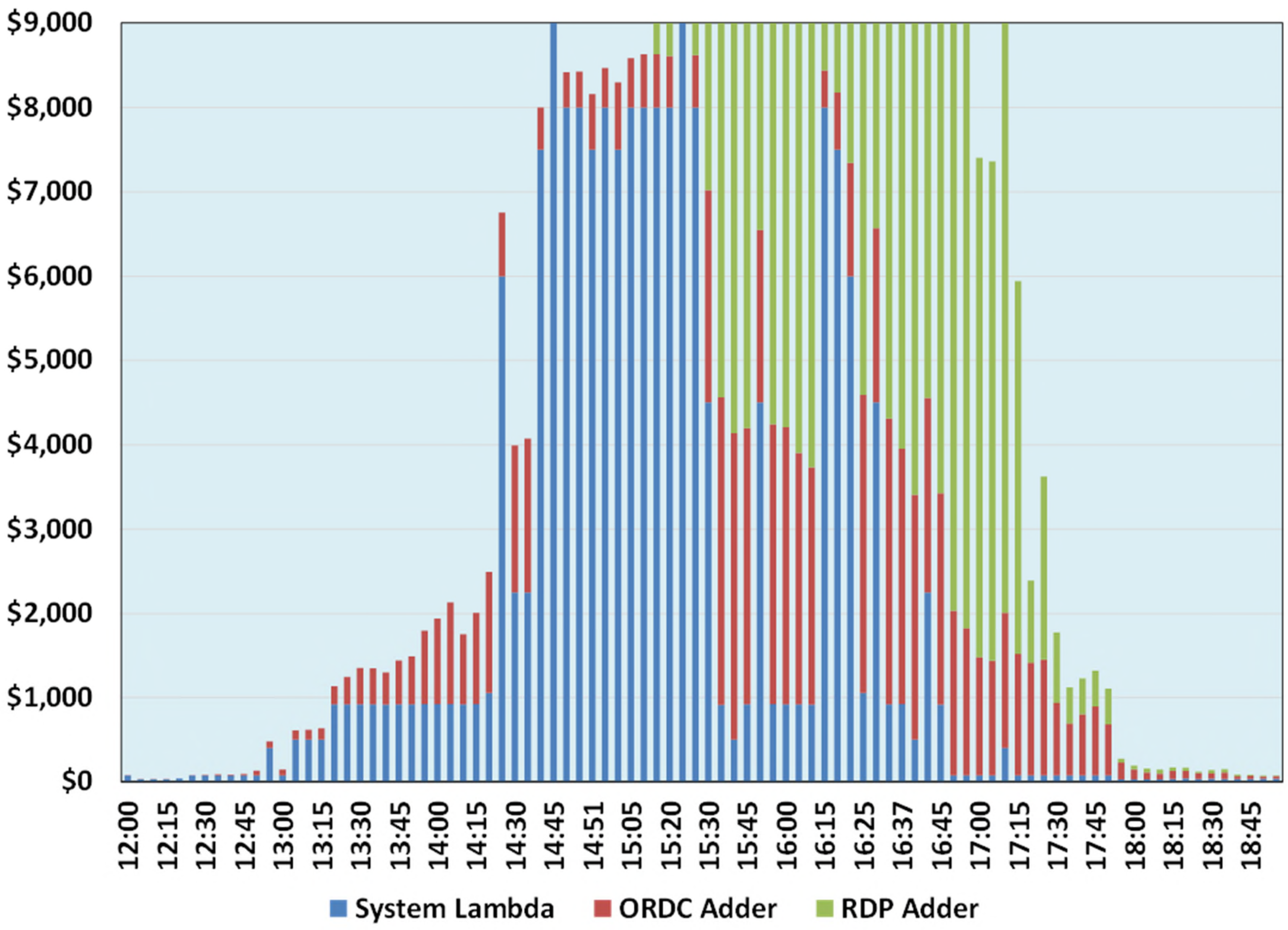
Initial implementation in 2014, with adjustments to curves made in 2019 and 2020.



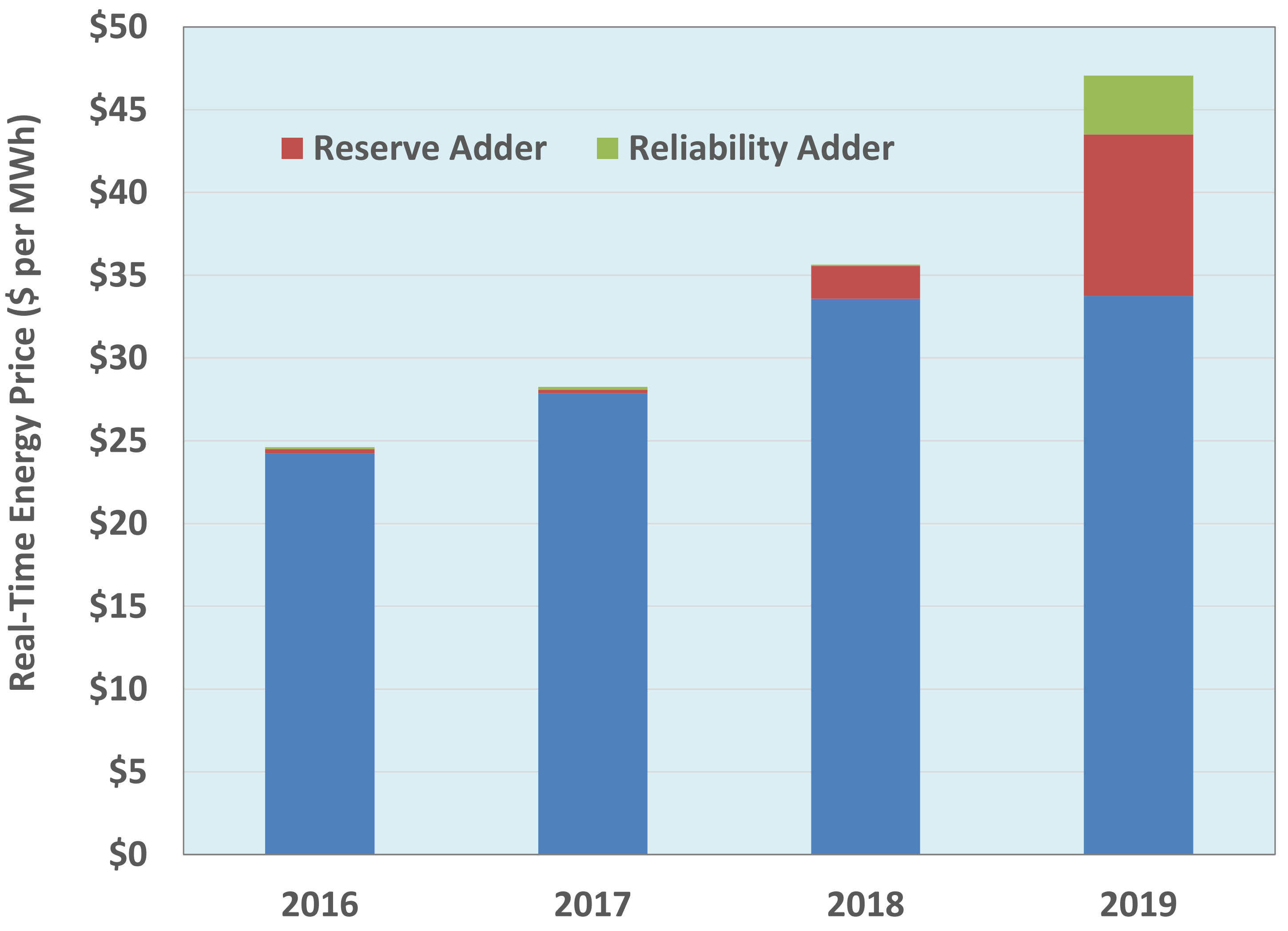
Three components of real-time prices



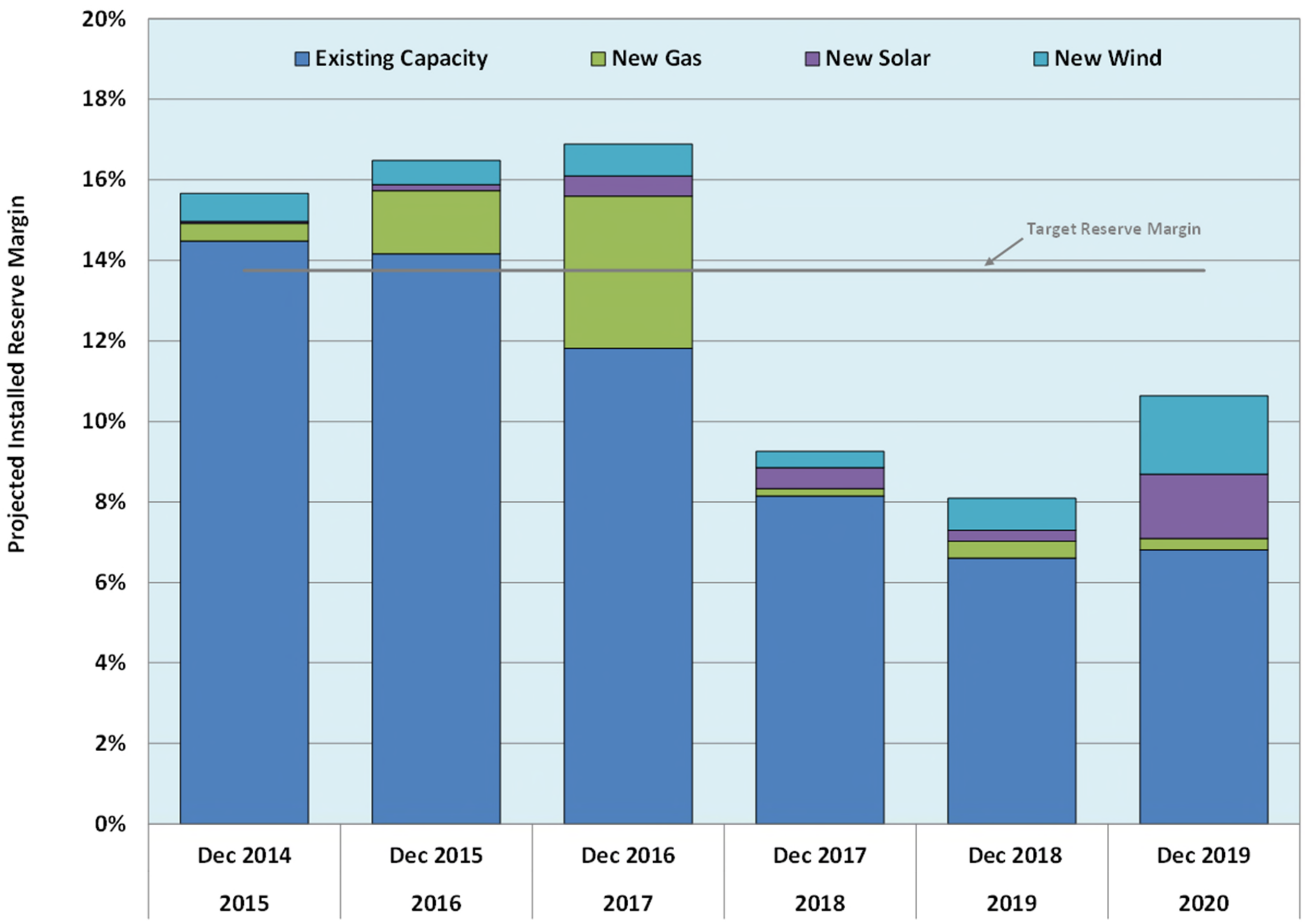
August 15, 2019 real-time prices



Higher prices in 2019 due to contributions from Adders

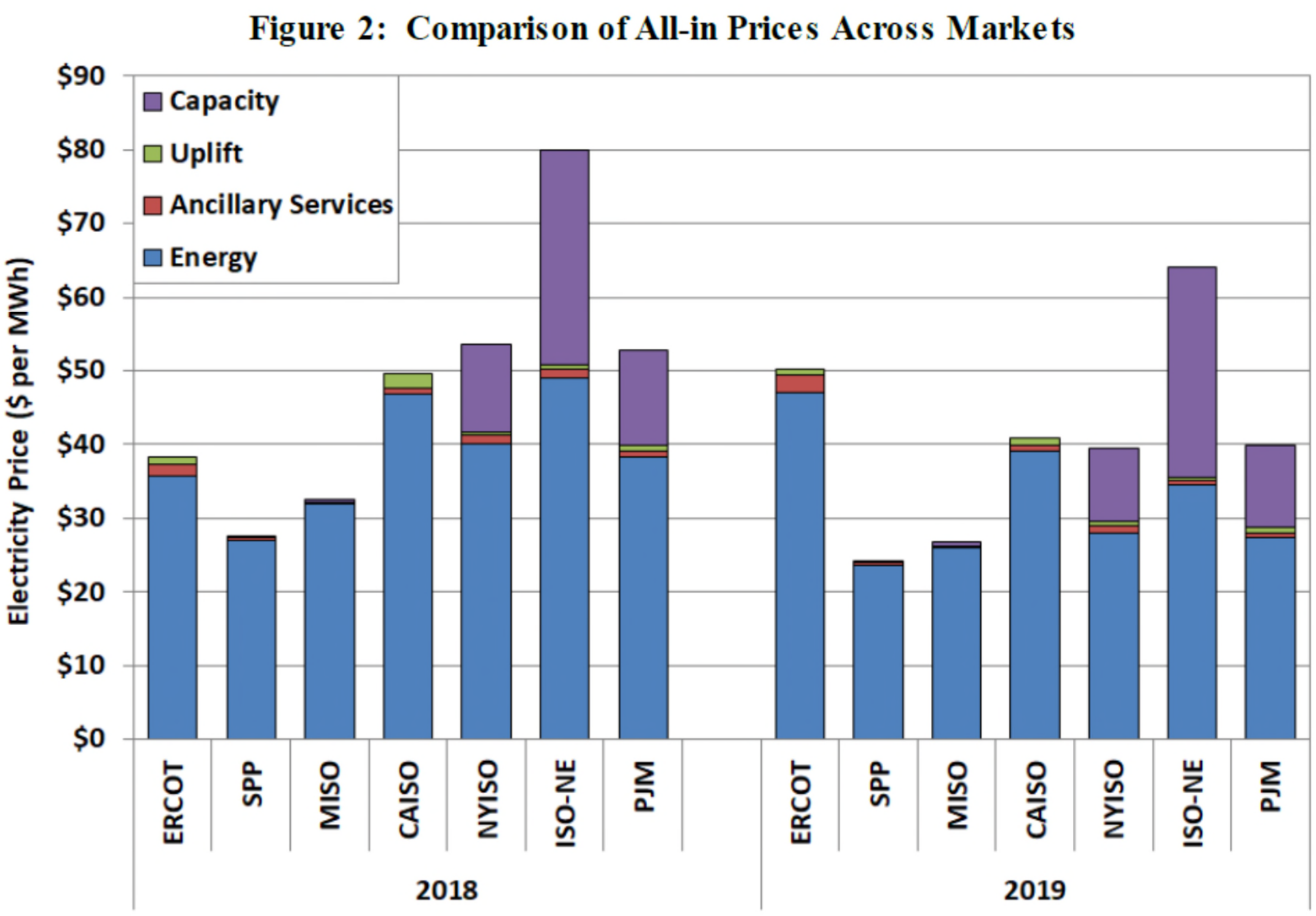


Recent ERCOT installed reserve margins have been very low



Revenues that other markets get from installed capacity markets come from other mechanisms in ERCOT

No free lunch



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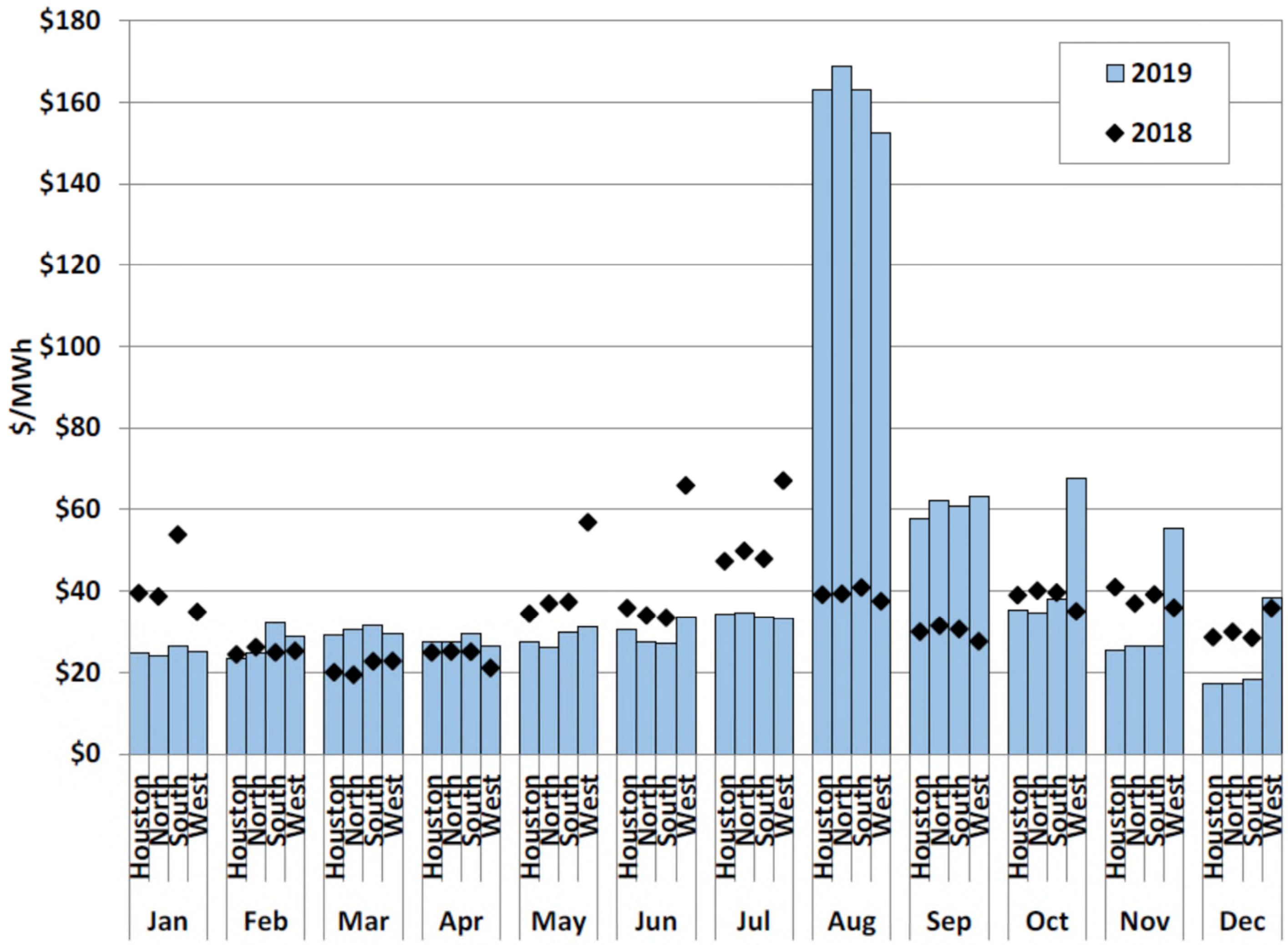
Scarcity events have typically been short duration – high impact

(no guaranties for the future)

Figure A3: Average Real-Time Energy Market Prices by Zone



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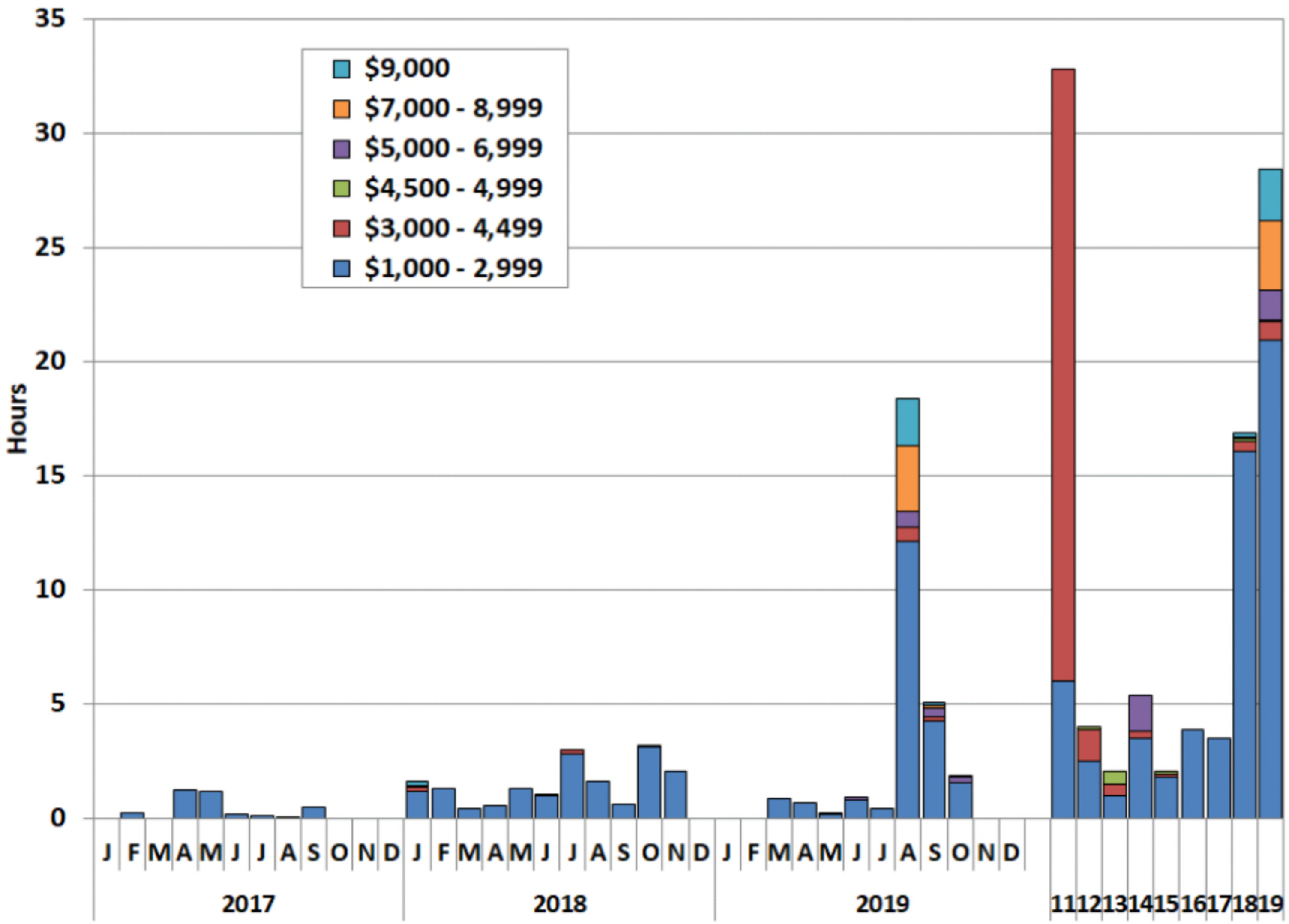
Annual summary of ‘high’ price durations shows 2019 to have been the most extreme since 2011

Figure 13: Duration of High Prices



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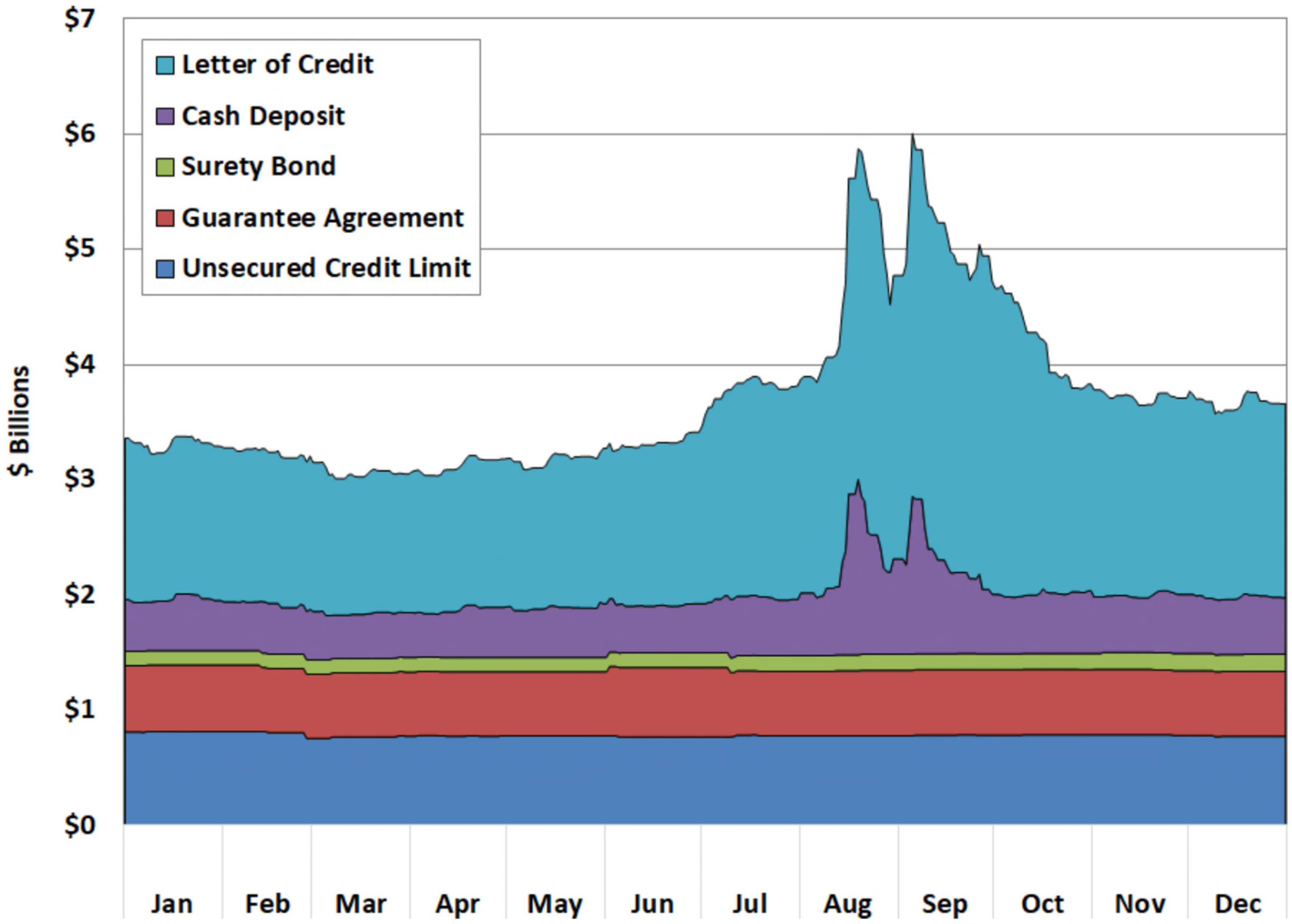
Volatility has a cost

Figure 23: Daily Collateral Held by ERCOT



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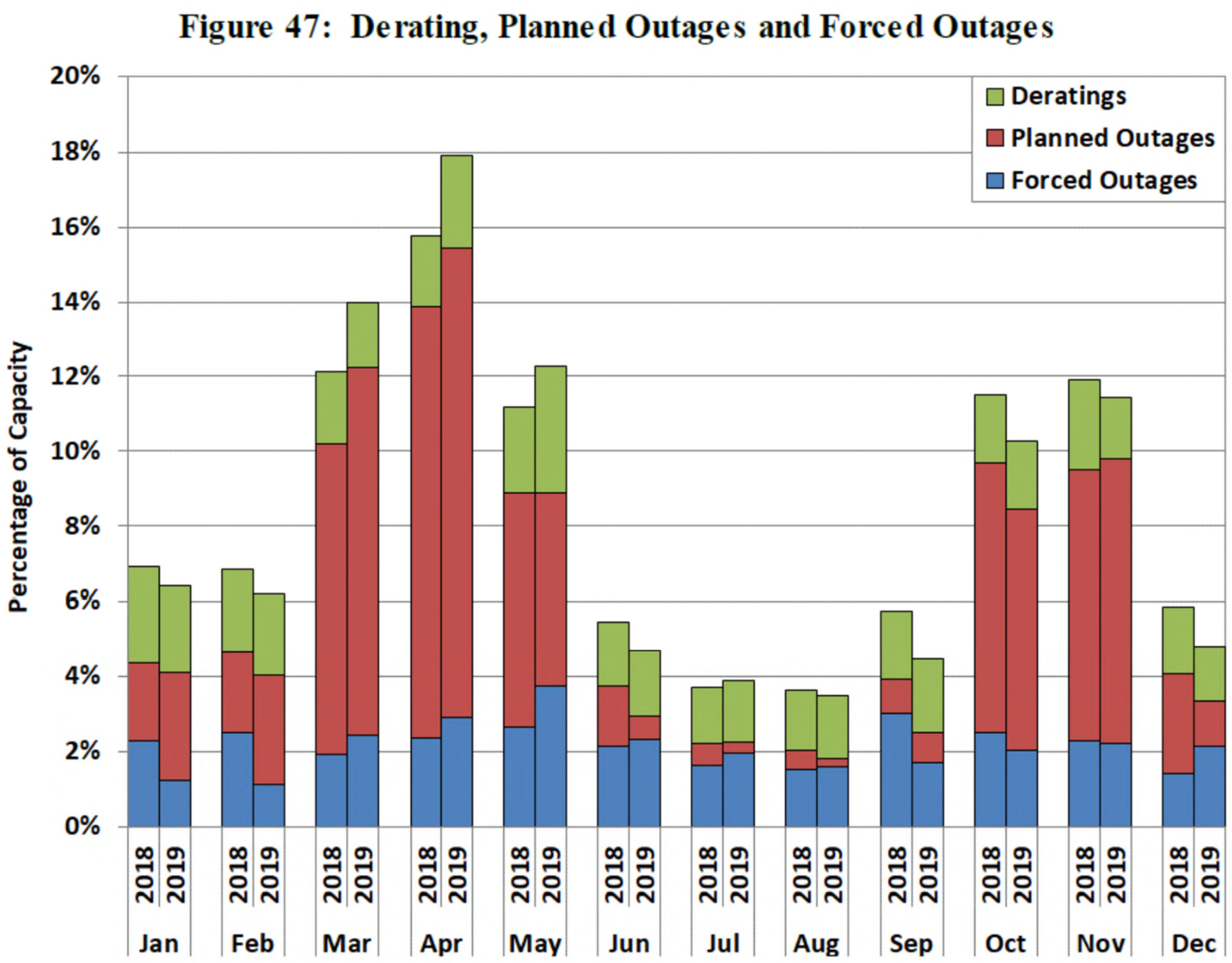
It's all about Incentives

Generators: Be available when supply is most needed



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It's all about Incentives

Load: Avoid consuming at 'high' prices

Updated Total System Demand Response/Price Response Results

					Survey Results		
Date	Characteristics (all response is in MW for HE 17)	Total System-Level DR/PR	Competitive ERS Load*	TDSP Standard Offer Program	4CP/Near 4CP NOIE and Competitive Response	Price Responsive Demand NOIE + Competitive Market	Peak Rebate/ Direct Load Control
Aug 12	4CP Day	2,223	0	157	2,082	1,865	2
Aug 13	EEA1, Near CP	2,604	472	19	2,136	2,487	146
Aug 14	High Prices, High Load	1,068	0	0	946	979	0
Aug 15	EEA1,Max Prices, High Load	2,114	440	0	1,741	1,489	3
Aug 16	High Prices	1,135	0	0	0	1,039	95

- Some ESI IDs participate in multiple programs.
- The total system level DR, eliminates double counting.
- The program-level response reflects response provided by all ESI IDs on the program.
- *ERS Response is limited to load (no generation) and does not include NOIE response which is approximately 35 MW

Filed by ERCOT on Feb. 6, 2020 in PUCT Docket #49852. Available here:
https://interchange.puc.texas.gov/Search/Documents?controlNumber=49852&itemNumber=10

Parting Thoughts

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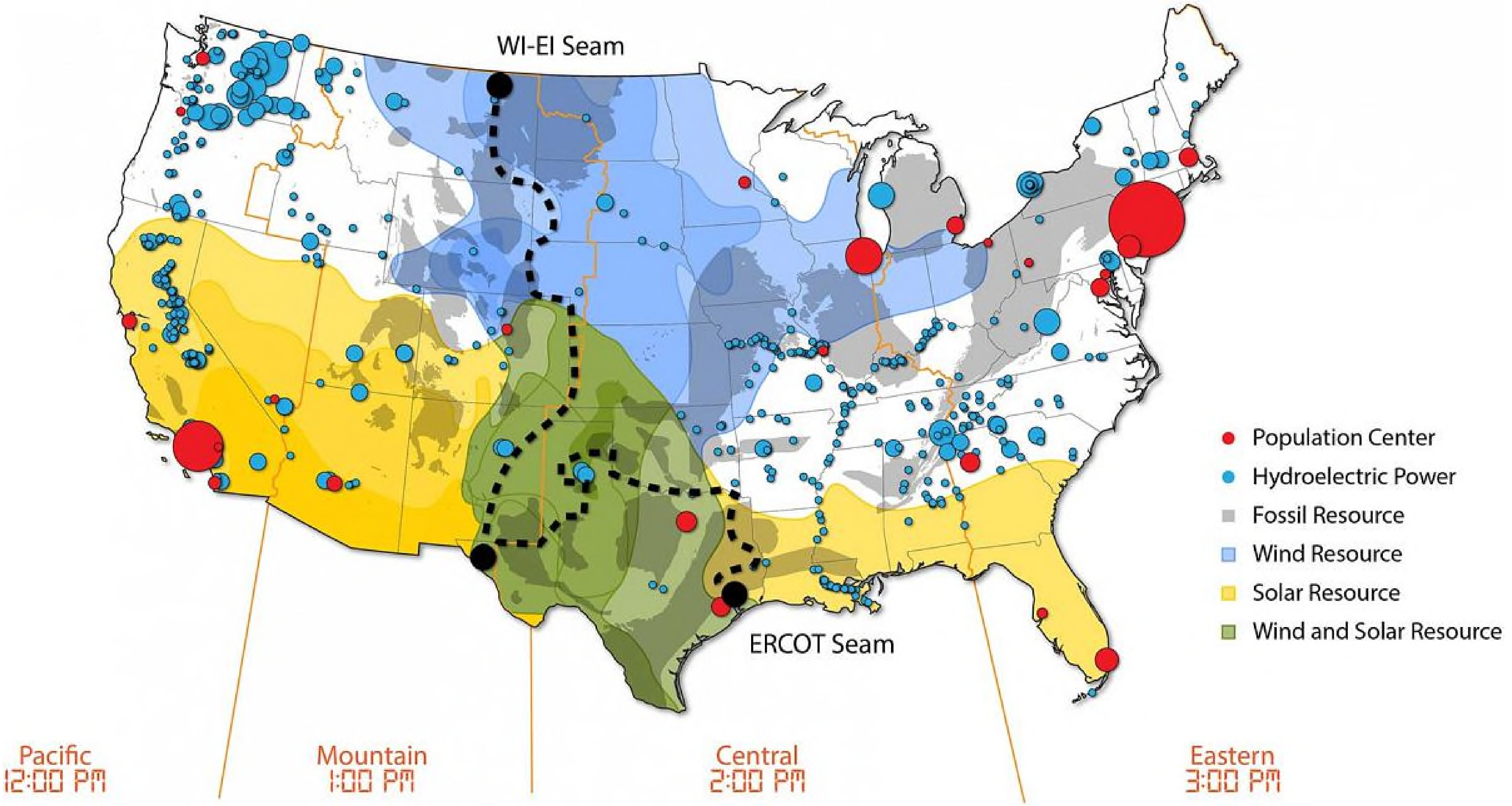
- ERCOT has decarbonized because of low cost wind and solar, enabled by a large transmission buildout.
- What is the value of installed reserves and how much is too much?
- Will technology enable decentralized reliability decisions?
- Texas politicians and regulators have been accepting of periods of very high energy prices. Is that transferable?



From NREL's Interconnections Seam Study. Available here: https://www.nrel.gov/analysis/seams.html

Parting shot….

Key Historical Milestones

mid 1990s

- Wholesale market restructured with simplified Transmission Cost allocation (4CP)
  - All loads pay for all transmission
  - Generators only required to have a step-up transformer
- ERCOT evolves from 3-4 person admin organization to a 30-40 person wholesale scheduling & settlement organization

turn of the century

- 1999: Major Restructuring Legislation (SB7) enacted
  - Utilities required to unbundle
  - Full retail open access in 2002
  - 1^{st} Renewable ‘mandate’
- ERCOT organization expands
  - Membership
  - Board composition
  - Employees, up to 300-400
- 2001: Transition to a single control area (from 10) operating a Zonal wholesale market
- Day Ahead market must be voluntary
- REC market implemented to ensure/support mandate
- Offer cap - $1000/MWh, but “Shame Cap” - $300/MWh, and “small fish swim free”

late 2000's

- Inefficiencies of Nodal market clearing become blatantly obvious
- Reserve margins shrinking

2007:

- PUCT adopts Emergency Interruptible Load Service rule (Emergency Response Service / ERS)
- PUCT directs ERCOT to implement a Nodal Market
- Offer Cap increased to $1500/MWh in 2007, $2250/MWh in 2008, and $3000/MWh after Nodal market implementation

Dec 2010:

- Nodal market implemented

2011 – a heck of a year

- Bitter cold weather in February (just after offer cap increased to $3000/MWh) leads to high prices and rotating outages
- EXTREME heat and drought in the summer results in sustained high prices (but no rotating outages)
- The PUCT initiates proceedings to reassess ERCOT market design and consider either an installed capacity market or a mandatory reserve margin

2012 - 2013

- Offer Cap raised to$4500/MWh in 2012
- Further increases scheduled
  - $5000/MWh in 2013,
  - $7000/MWh in 2014
  - $9000/MWh in 2015
- PUCT Chairman indicates support for a forward capacity market
- Capacity market discussion squelched by a State Senator

2014 - 2015

- Operating reserve demand curve (ORDC or Reserve adder) implemented March 2014
- Reliability Deployments Price Adder (reliability adder – addresses price suppression effects of reliability actions) implemented mid 2015

Historical Milestones CREZ

Early 2000's

- Wind development in West Texas greatly exceeds initial and revised 'mandate'
- Voluntary RECs exceed mandatory ones
- Continual and significant export limitations from windy west Texas to the load centers

2005

- Legislation passed creating the concept of Competitive Renewable Energy Zones, modifying the 'need' requirement for transmission.

2008 – 2010

- Zones established
- Transmission plan (specific lines and endpoints) approved to support 18.5 GW of generation

2010 – 2013

- TSPs selected/assigned, CCN cases heard and decided (180 day timeline requirement), construction

2014

- Last CREZ line put in service
- ~3600 circuit miles
- 186 total projects
- $6.8 Billion construction costs

SCED under-generation Power Balance Penalty Curve