



# IMM Quarterly Report: Winter 2019

MISO Independent Market Monitor

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## Highlights and Findings: Winter 2019

- The MISO markets performed competitively this **winter**.
  - ✓ Although gas prices rose 5 percent over last year, real-time energy prices fell 14 percent, moderated by lower average and peak load this quarter.
  - ✓ Market power mitigation was infrequent and offers were competitive overall.
- On January 8 MISO set a new all-time peak wind record output of 16.3 GW.
- MISO issued a Cold Weather Alert for several days in late January and declared Maximum Generation Emergencies on January 30 and 31.
  - ✓ MISO called on LMRs in the North and Central Regions during the event.
  - ✓ Emergency pricing was in effect for multiple hours, and imports responded.
  - ✓ Real-time RSG rose 66 percent over last year and 23 percent over last quarter, as MISO called upon all resources to maintain reliability in the event.
- Day-ahead and real-time congestion fell 52 and 54 percent, respectively, over last year and FTRs were fully funded.
- FERC approved MISO tariff filings to allow more effective access of LMRs as well as MISO's key reforms of Uninstructed Deviation (UD) Thresholds and Price Volatility Make-Whole Payment (PVMWP) Rules.

# Quarterly Summary

		Value	Change <sup>1</sup>			Value	Change <sup>1</sup>		
			Prior Qtr.	Prior Year			Prior Qtr.	Prior Year	
<b>RT Energy Prices (\$/MWh)</b>	●	\$26.87	-22%	-14%	<b>FTR Funding (%)</b>	●	99%	101%	101%
<b>Fuel Prices (\$/MMBtu)</b>					<b>Wind Output (MW/hr)</b>	●	6,644	13%	-8%
Natural Gas - Chicago	●	\$3.22	-4%	5%	<b>Guarantee Payments (\$M)<sup>4</sup></b>				
Natural Gas - Henry Hub	●	\$3.24	-5%	6%	Real-Time RSG	●	\$29.3	23%	66%
Western Coal	●	\$0.70	1%	0%	Day-Ahead RSG	●	\$15.3	42%	38%
Eastern Coal	●	\$1.77	0%	17%	Day-Ahead Margin Assurance	●	\$10.7	3%	-22%
<b>Load (GW)<sup>2</sup></b>					Real-Time Offer Rev. Sufficiency	●	\$0.5	-60%	-50%
Average Load	●	78.1	4%	-2%	<b>Price Convergence<sup>5</sup></b>				
Peak Load	●	101.8	-11%	-4%	Market-wide DA Premium	●	0.0%	-2.7%	2.4%
% Scheduled DA (Peak Hour)	●	99.1%	98.1%	98.7%	<b>Virtual Trading</b>				
<b>Transmission Congestion (\$M)</b>					Cleared Quantity (MW/hr)	●	16,866	8%	9%
Real-Time Congestion Value	●	\$176.9	-42%	-54%	% Price Insensitive	●	36%	35%	35%
Day-Ahead Congestion Revenue	●	\$111.0	-28%	-52%	% Screened for Review	●	1%	1%	1%
Balancing Congestion Revenue <sup>3</sup>	●	-\$1.4	\$0.0	\$0.7	Profitability (\$/MW)	●	\$0.68	\$0.60	\$1.32
<b>Ancillary Service Prices (\$/MWh)</b>					<b>Dispatch of Peaking Units (MW/hr)</b>	●	523	1235	829
Regulation	●	\$8.81	-22%	-12%	<b>Output Gap- Low Thresh. (MW/hr)</b>	●	77	117	115
Spinning Reserves	●	\$2.21	-37%	-18%	<b>Other:</b>				
Supplemental Reserves	●	\$0.54	-42%	-59%					

**Key:**

- Expected
- Monitor/Discuss
- Concern

**Notes:**

1. Values not in italics are the values for the past period rather than the change.
2. Comparisons adjusted for any change in membership.
3. Net real-time congestion collection, unadjusted for M2M settlements.
4. Includes effects of market power mitigation.
5. Values include allocation of RSG.



## Highlights for Winter 2019

### Decrease in Energy Prices and Congestion (Slides 13, 15, 16, 22, 23)

- Natural gas prices rose 5 percent, but real-time prices fell 14 percent because:
  - ✓ Quarterly average and peak load fell 2 and 4 percent, respectively.
  - ✓ Heating degree-days (HDD) in December and January fell 16.8 percent and 3.1 percent, respectively, because overall footprint temperatures were colder in the winter of 2017-2018.
- Day-ahead and real-time congestion fell more than 50 percent this winter:
  - ✓ In 2018, day-ahead congestion was higher than normal in January due to early-month extreme cold and a mid-month South emergency.
  - ✓ The 2019 cold conditions were shorter and impacted just the Midwest region.
  - ✓ Real-time M2M congestion associated with delays in testing M2M fell 73 percent this quarter from last winter due to MISO's improved procedures.

### RDT Flows and Congestion (Slide 25)

- RDT bound frequently South to North due to cold weather in the Midwest.
- MISO has been derating the RDT to ensure the physical transfers do not exceed the scheduling limits in the agreement.
- These derates caused RDT to bind almost 300 MW below its limit on average.



## Highlights for Winter 2019

### **January 30-31 Emergency Event in MISO Midwest (Slides 17 - 21)**

- MISO declared Cold Weather Alerts for Jan. 29 – Feb. 1.
- MISO issued a Max Gen Event in the North and Central Regions on Jan. 30:
  - ✓ Record cold temperatures throughout the footprint affected gas prices and generator operations (second-coldest day in Chicago on record), and
  - ✓ Wind came in significantly under the forecast because the forecast model did not account for low-temperature operational effects on wind turbines.
- The following events unfolded during the operating day on January 30:
  - ✓ Given the unprecedented temperatures, MISO operations had significant concerns about forced outages of generation and transmission.
  - ✓ At 2:38 a.m., MISO declared an Energy Emergency Alert (EEA) Level 1 beginning at 5:00 am, giving MISO access to emergency generation.
  - ✓ At 6:19 a.m., MISO upgraded to an EEA 2 to begin at 8:00 am, which allowed it to deploy roughly 2.5 GW of LMRs in North and Central.
  - ✓ MISO cancelled the LMRs at 11 a.m., and re-deployed ~1 GW of LMRs in just the North zone beginning at 11 a.m.



## Highlights for Winter 2019

### **January 30-31 Emergency Event in MISO Midwest (Slides 17-21)**

- Emergency events on January 30 and 31 (cont.):
  - ✓ MISO downgraded to EEA 1 and cancelled the LMRs at 1:30 pm.
  - ✓ MISO extended the EEA 1 from 1:30 p.m. through noon the following day to maintain access to emergency ranges and offline emergency units (AME).
  - ✓ By 3 p.m., MISO had more than 11.5 GW of supply margin, which fell to roughly 5 GW at 9:15 p.m. and averaged more than 6.5 GW early on Jan. 31.
  - ✓ After 3 p.m., MISO started or extended 198 units totaling 13.3 GW between then and noon January 31 and paid \$8 million in RSG to these units.
  - ✓ These actions are attributable to continued forced outage uncertainty and concerns regarding cycling online resources.
- Net imports increased of almost 10 GW from the day-ahead by noon on Jan. 30, largely due to the effects of MISO's emergency pricing that are discussed on following slide.



## Highlights for Winter 2019

### **Emergency Pricing during the January 30-31 Emergency Event (Slide 20)**

- Emergency pricing had large price effects when the LMRs were deployed.
- Summary of Emergency Pricing and its Effects on January 30:
  - ✓ Emergency MWs are dispatched in the ELMP model with fast-start units.
  - ✓ The purpose of the ELMP model is to determine whether the emergency MWs are needed by ramping up other online resources to displace them.
  - ✓ Because the total emergency MWs (including LMRs) are so large, the ELMP model generally lacks the 5-minute ramp on other units to displace them.
  - ✓ Hence, the default emergency offer set prices consistently above \$600 per MWh from 8 a.m. to 11 a.m. while the bulk of the LMRs were deployed.
- We conducted simulations to remove unneeded LMRs to reduce the ramp demand on other online units and allow ELMP to make better pricing choices.
  - ✓ Prices during the event would have been 61 percent lower in the Midwest Region and 68 percent lower in the South Region on average.
  - ✓ Higher emergency pricing significantly affected RSG and PVMWP.
  - ✓ We have recommended that MISO evaluate the ramp assumptions in ELMP, which could improve pricing in these types of events.



## Highlights for Winter 2019

### **January 30-31 Event Conclusions: Emergency Procedures and Declarations**

- MISO actions during these highly unusual conditions were understandable given the high degree of uncertainty it faced, and ensured reliability.
- These actions led to large supply margins and high uplift costs.
- MISO's requirements and trigger for declaring emergencies in the Midwest are unclear, and we recommend MISO develop a tool for operators to quantify its capacity needs in the Midwest and clarify its emergency procedures.
- This event reaffirmed past recommendations to:
  - a) Allow MISO to call LMRs earlier in the emergency steps, and
  - b) Log the reasons for MISO's emergency declarations and actions.

### **January 30-31 Event Conclusions: Emergency Pricing**

- Emergency pricing has not been optimal in any of MISO's emergencies.
- In this case, it was increased because system ramp limitations prevented the ELMP model from dispatching off the large amount of emergency MWs.
- Establishing emergency offer floors based on a resource's offer has resulted in inefficiently low prices (can also set inefficiently high prices).
- We recommend MISO set fixed emergency default offer floors, and continue to evaluate potential improvements in ELMP's ramp assumptions.





## Highlights for Winter 2019

### Winter Quarter RSG and PVMWP (Slides 37, 38, 39)

- Real-time RSG increased significantly over last year, totaling around \$30 million for the quarter.
  - ✓ Of this, nearly 60 percent was paid between January 30 and February 1.
- Emergency pricing affects RSG and price volatility make-whole payments. Our simulations suggest that the emergency pricing was inefficiently high.
  - ✓ The high emergency pricing decreased RSG and increased PVMWP.
- Based on our simulated emergency prices, we found that more efficient emergency pricing would have led to:
  - ✓ An increase in RSG payments of \$2 million during the event;
  - ✓ A decrease in price volatility make-whole payments of \$3 million;
  - ✓ A net reduction in total uplift of 14 percent.
- On January 31, MISO made the decision to keep several units online to prevent outages by avoiding cycling the units, which resulted in more than \$9 million in RSG.



## Submittals to External Entities and Other Issues

- We responded to FERC questions related to prior referrals and continued to meet with FERC on a weekly basis. We submitted:
  - ✓ Several notifications of other potential tariff violations.
  - ✓ Information on updated prior referrals, including referrals of resources for not providing accurate offers and wind resources due to chronic over-forecasting.
- In FERC Proceedings, we filed comments in two FERC dockets:
  - ✓ One related to PJM's pseudo-tie requirements; and
  - ✓ The other answered PJM's comments related to market monitors' authority.
- We presented Technology Specific Avoidable Costs in the Resource Adequacy Subcommittee in January.
- We presented a Market Report to the ERSC and met with State Regulators on Seams Issues in February.
- We met with FERC on our recommendation on Dynamic Transmission Ratings.

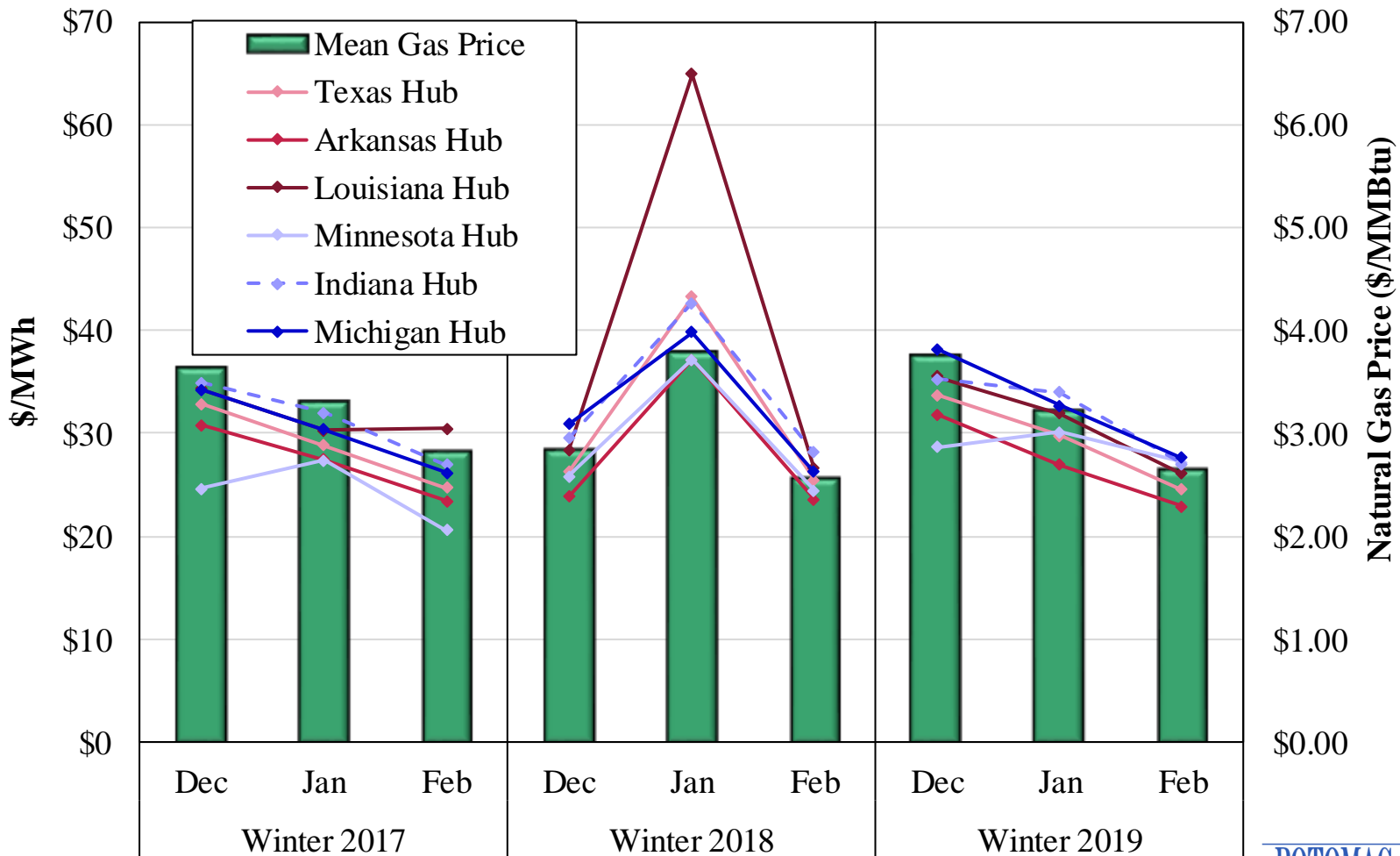


## Submittals to External Entities and Other Issues

- In stakeholder processes, we provided comments on MISO's RAN initiatives.
- We continued working with MISO and Market Participants to clarify operating procedures related to timely updates to real-time offers and we will be participating in MISO's training workshops.
- FERC approved MISO tariff filings to allow more effective access of LMRs, as well as MISO's reform of Uninstructed Deviation (UD) Thresholds and PVMWP Eligibility Rules.
- The reform of the UD thresholds and price volatility make-whole payment rules will be highly beneficial because it will:
  - ✓ Greatly strengthen incentives for MISO's generators to follow dispatch instructions; and
  - ✓ Lower uplift and dispatch costs for MISO's customers.

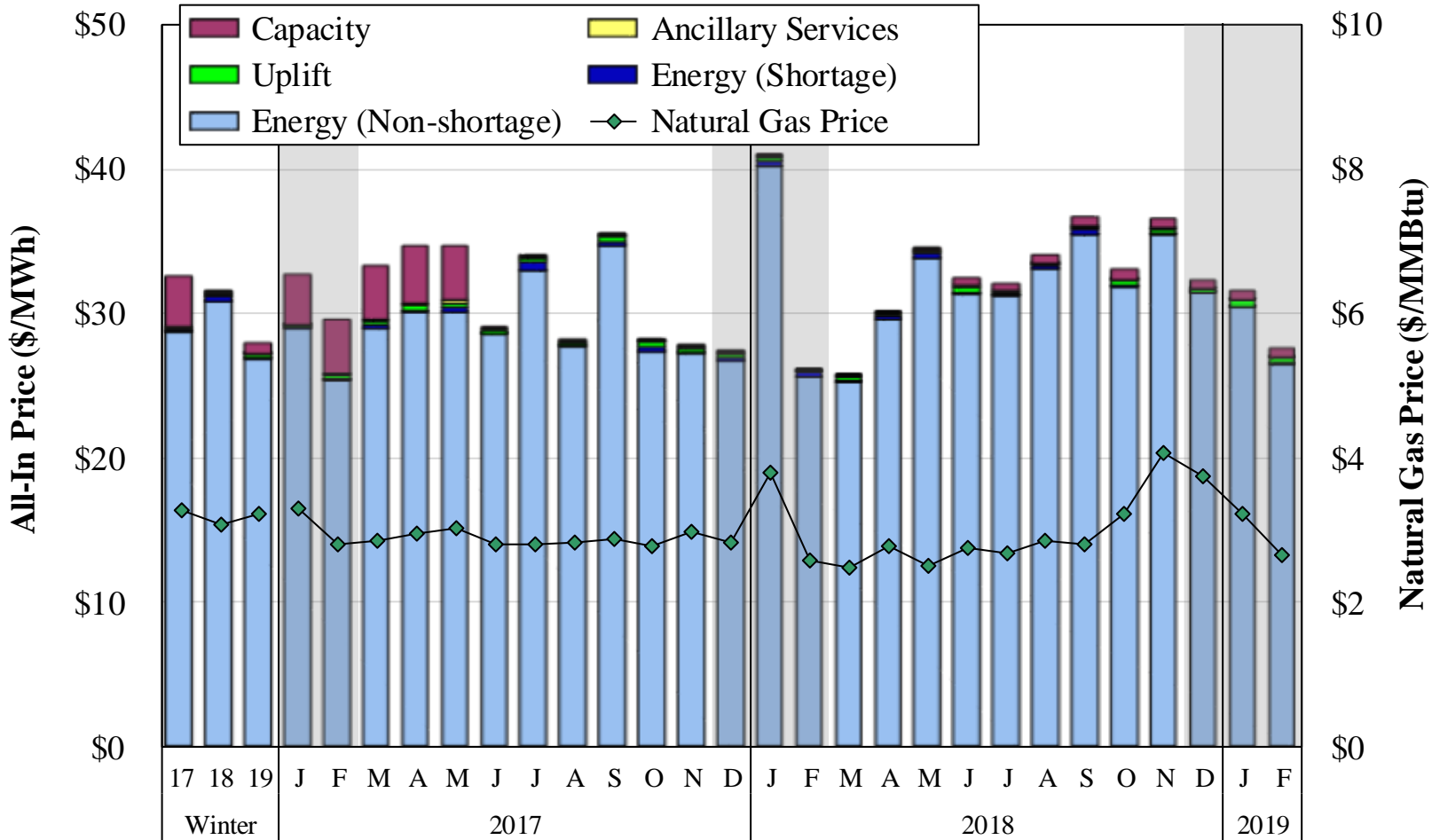


# Day-Ahead Average Monthly Hub Prices Winter 2017 – 2019

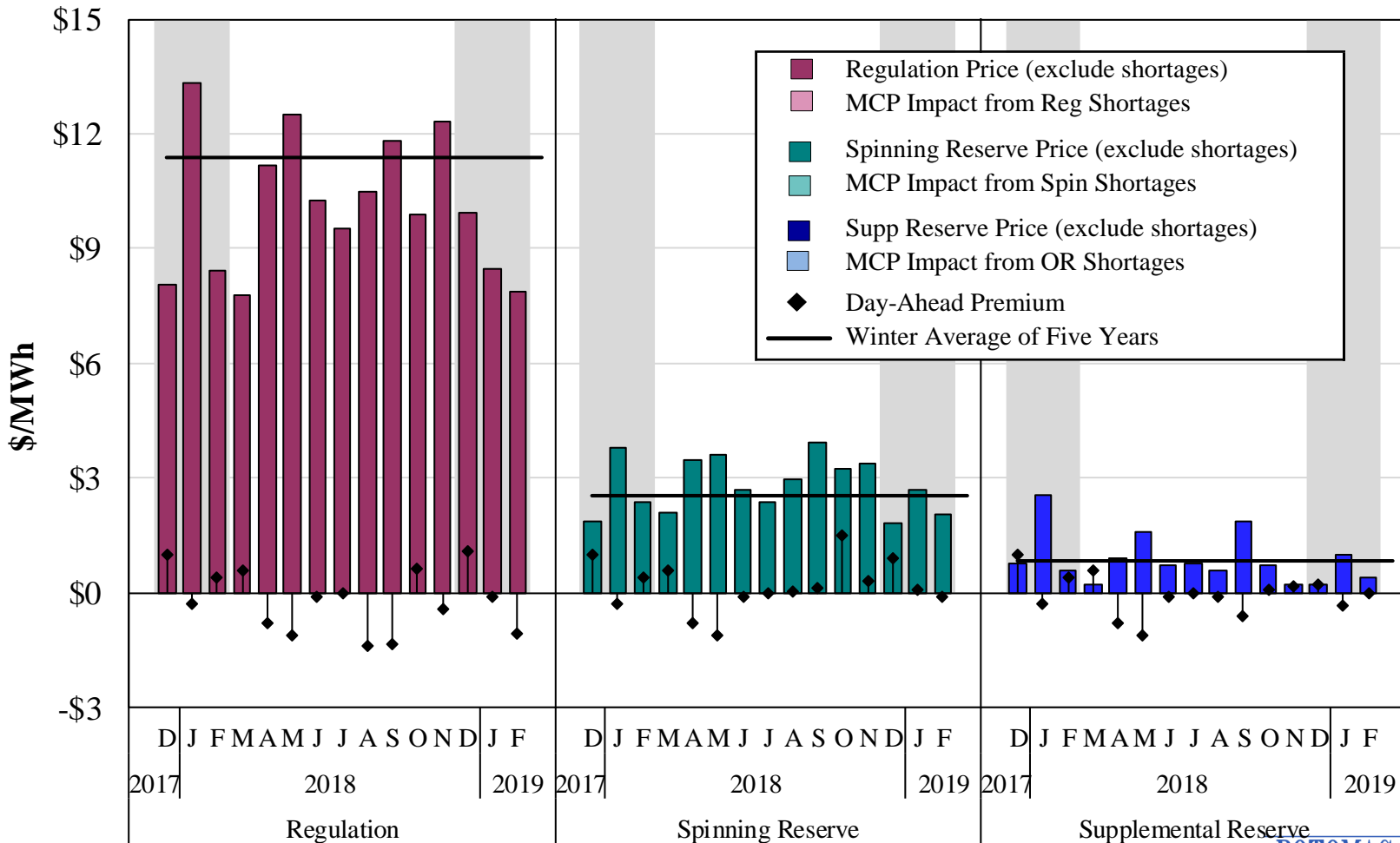




# All-In Price 2017 – 2019

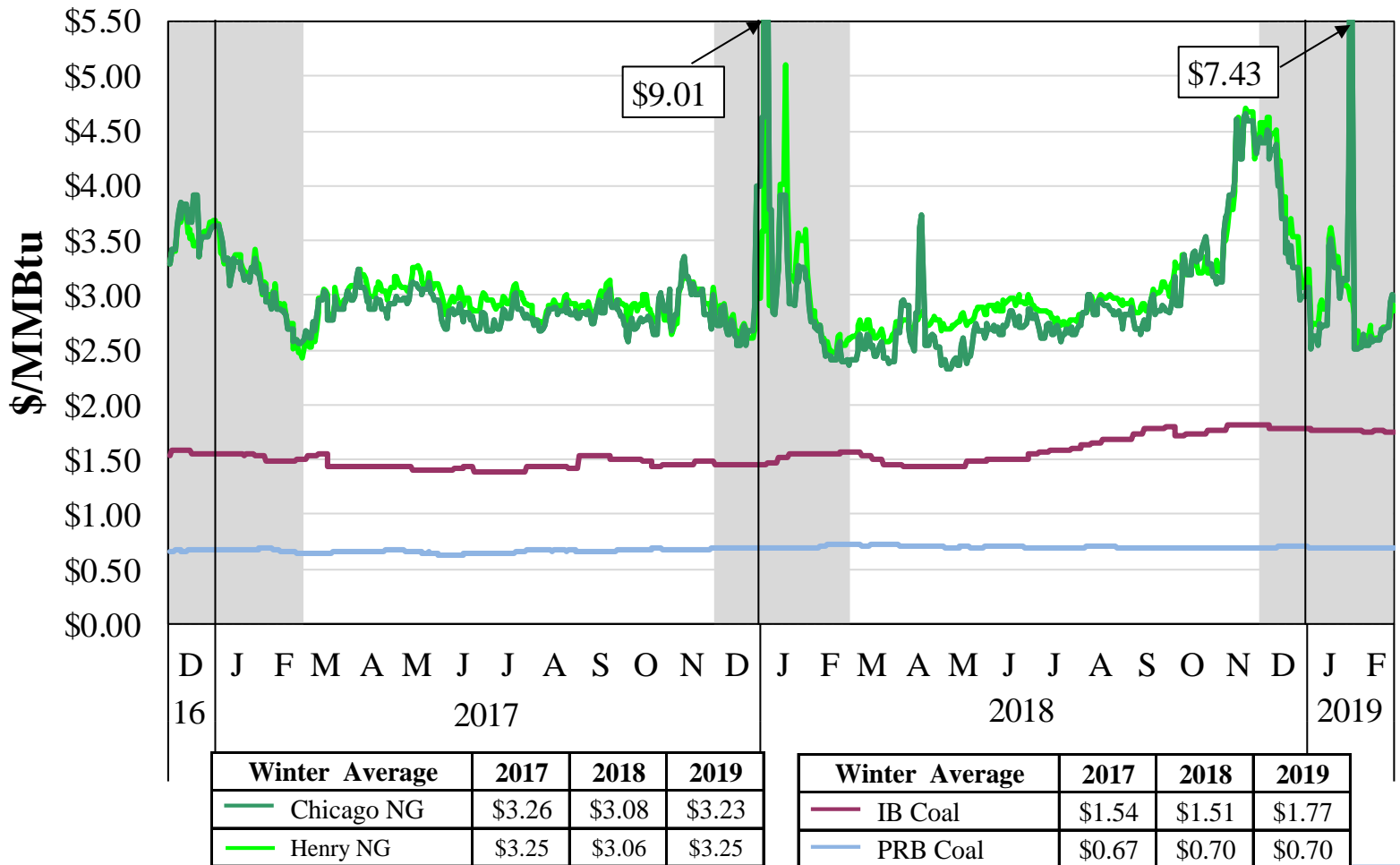


# Monthly Average Ancillary Service Prices Winter 2017 – 2019



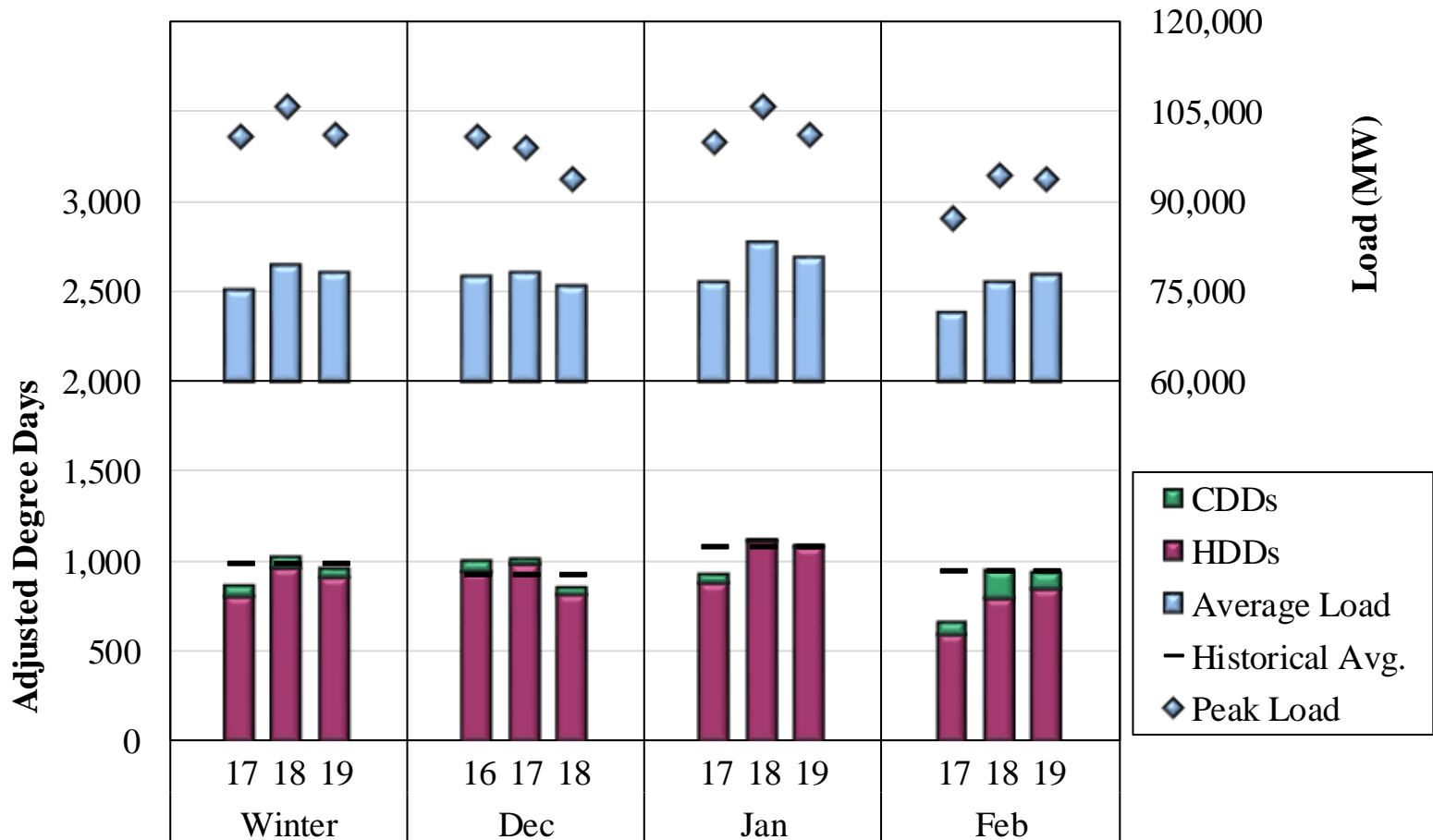


# MISO Fuel Prices Winter 2017 – 2019





# Load and Weather Patterns Winter 2017 – 2019



Note: Midwest degree day calculations include four representative cities in the Midwest: Indianapolis, Detroit, Milwaukee and Minneapolis. The South region includes Little Rock and New Orleans.



## Average Temperatures on January Cold Days

	His. Avg.*	Jan-19				Feb-19	
		28	29	30	31	1	2
<b>Midwest</b>							
Detroit	26.3	16.6	20.3	-3.8	-8.0	5.0	21.5
Indianapolis	30.3	30.7	14.1	-0.8	1.0	17.5	26.7
Milwaukee	24.3	19.5	4.7	-12.0	-13.1	6.7	28.1
Minneapolis	17.8	5.2	-5.5	-22.5	-16.6	3.7	23.5
<b>South</b>							
Little Rock	43.8	42.0	32.4	29.3	29.9	41.9	49.7
New Orleans	55.7	53.9	48.9	44.5	51.9	58.0	56.2

 Cold Weather Alert (MISO)

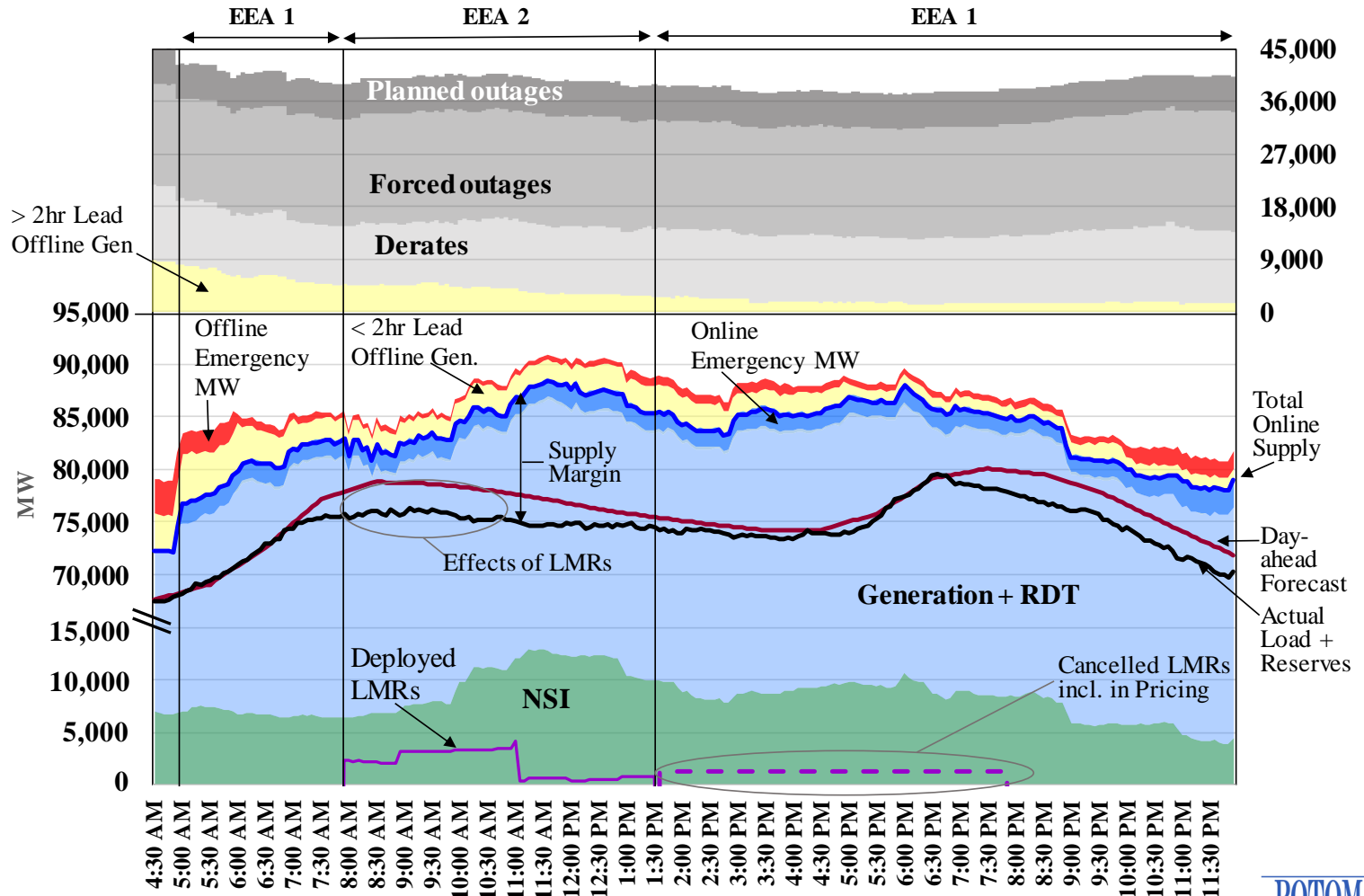
 LG&E/KU issued Conservative Operations Alert

 Max Gen Event (EEA 1-2) in North/Central

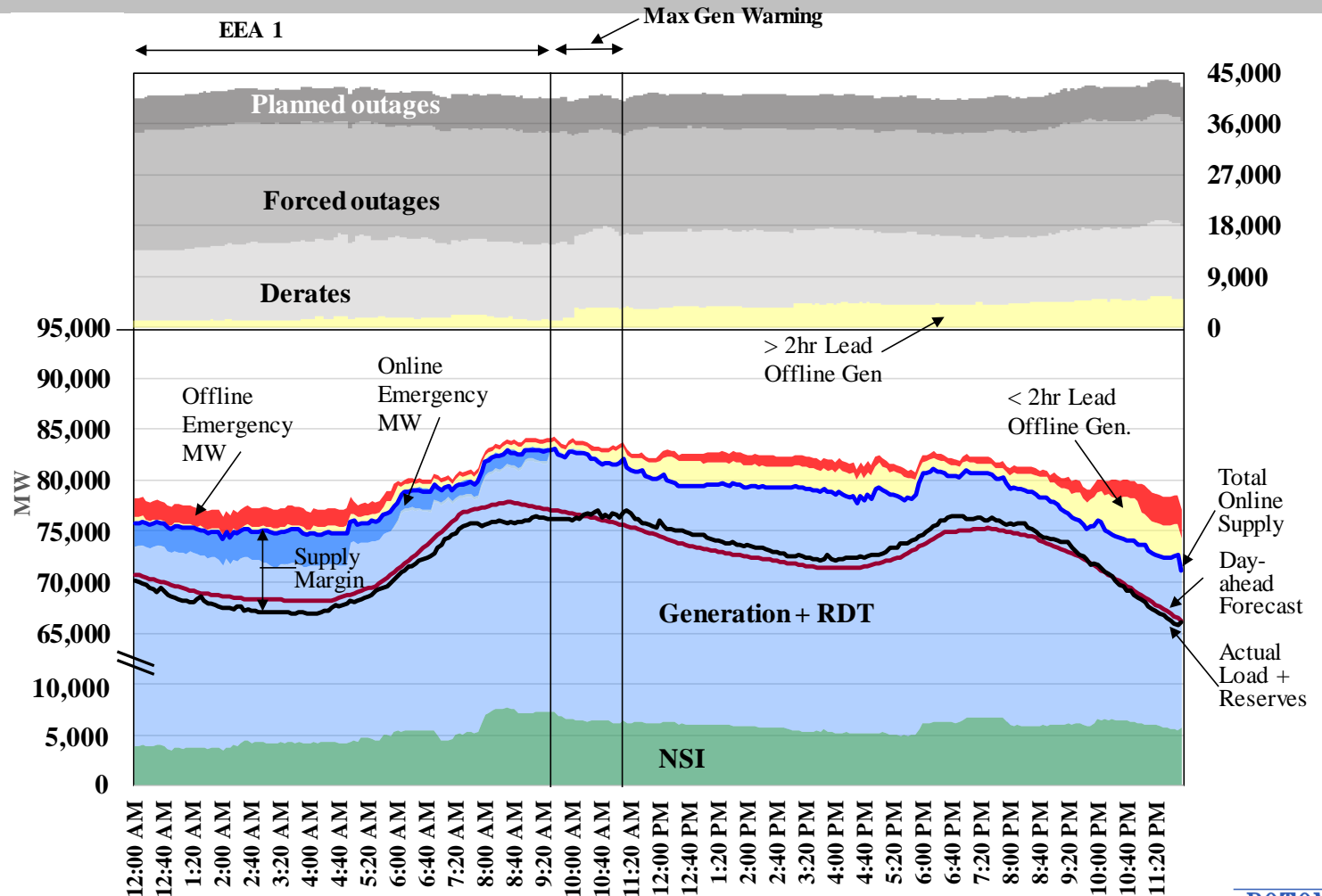
 Max Gen Event(EEA 1) in North/Central

\* Historical Average is average of those days' average temperature from 2009-2018.

# Maximum Generation Event in MISO Midwest January 30

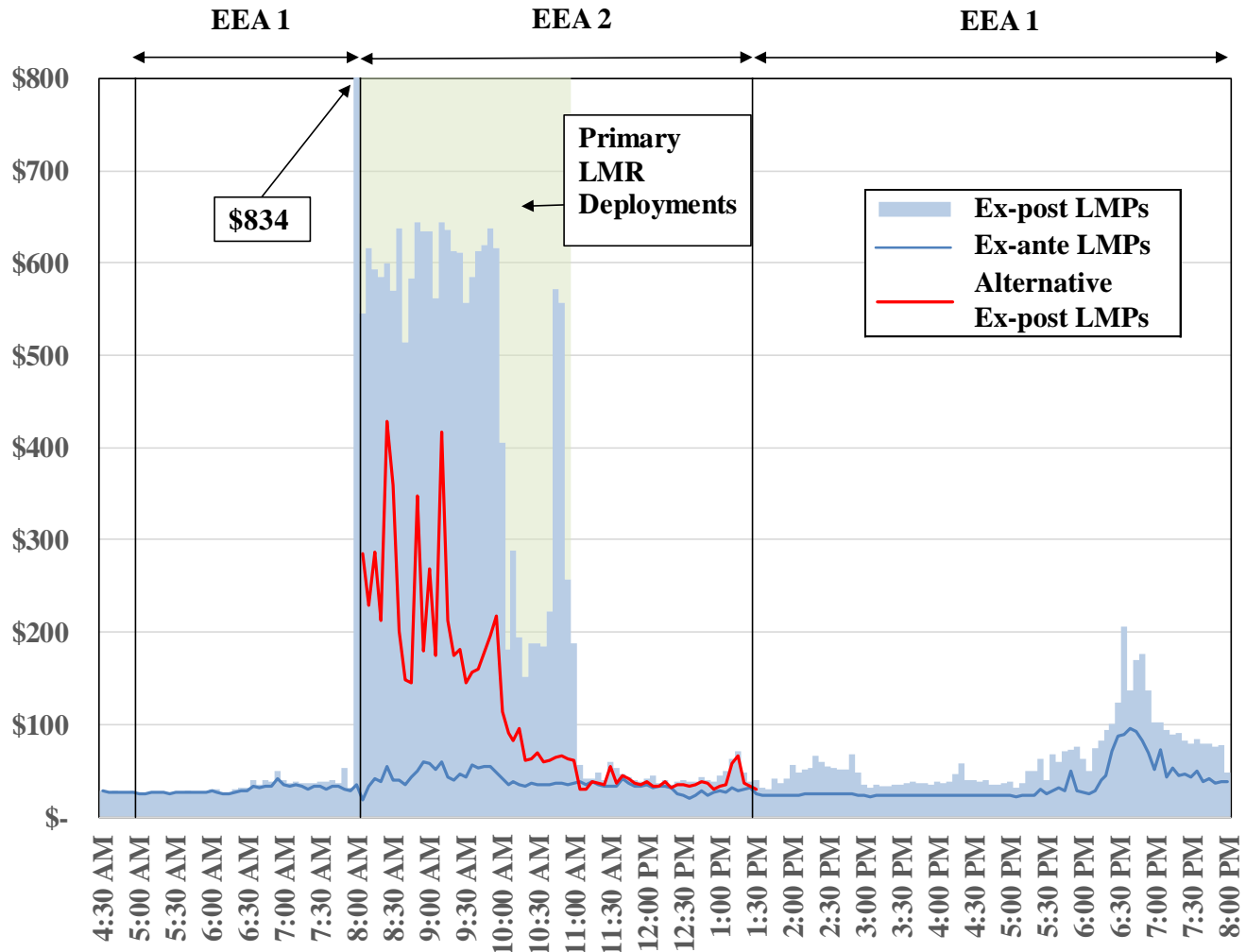


# Maximum Generation Event in MISO Midwest January 31





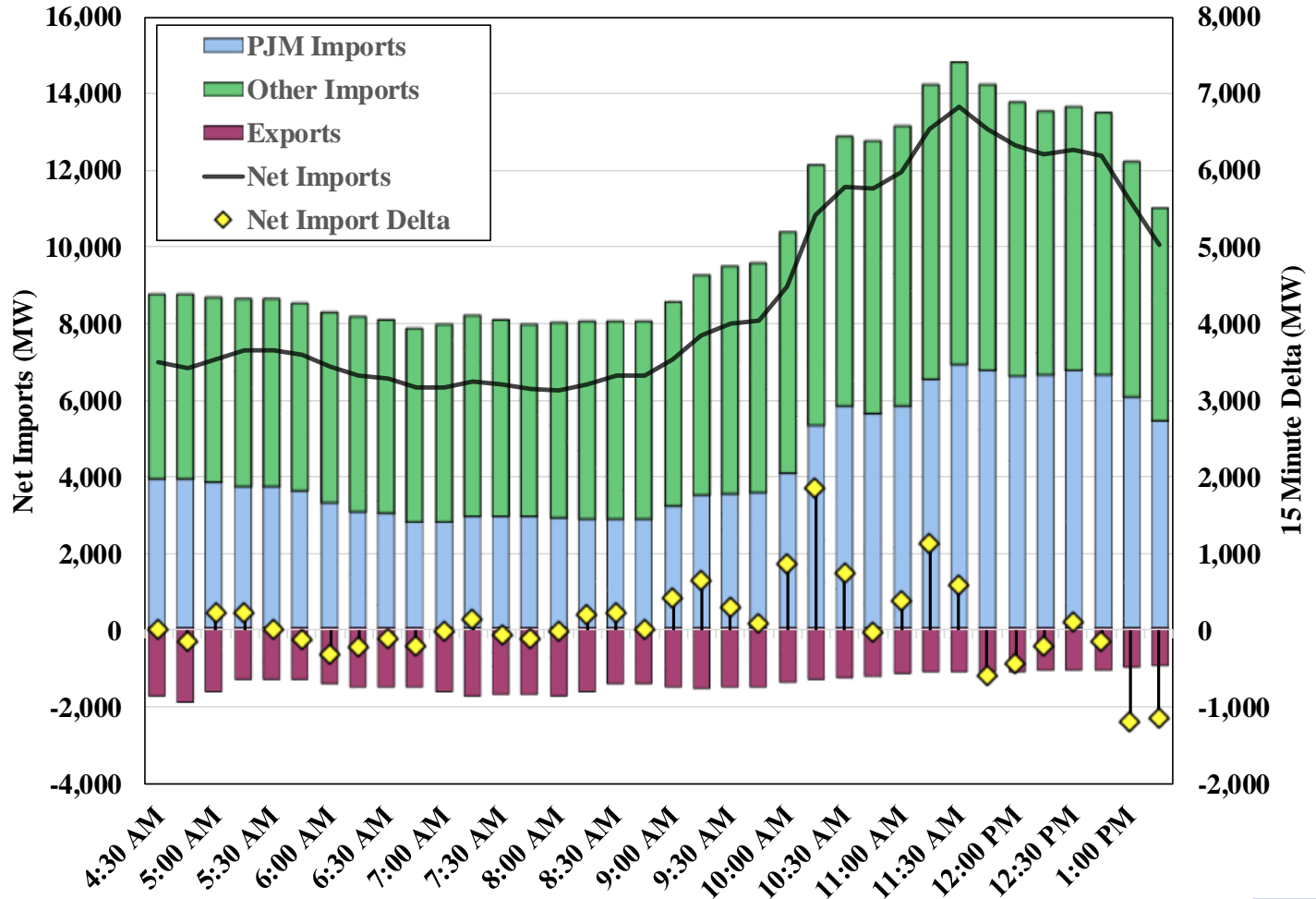
# January 30: Average Real-Time Prices MISO Midwest Hubs





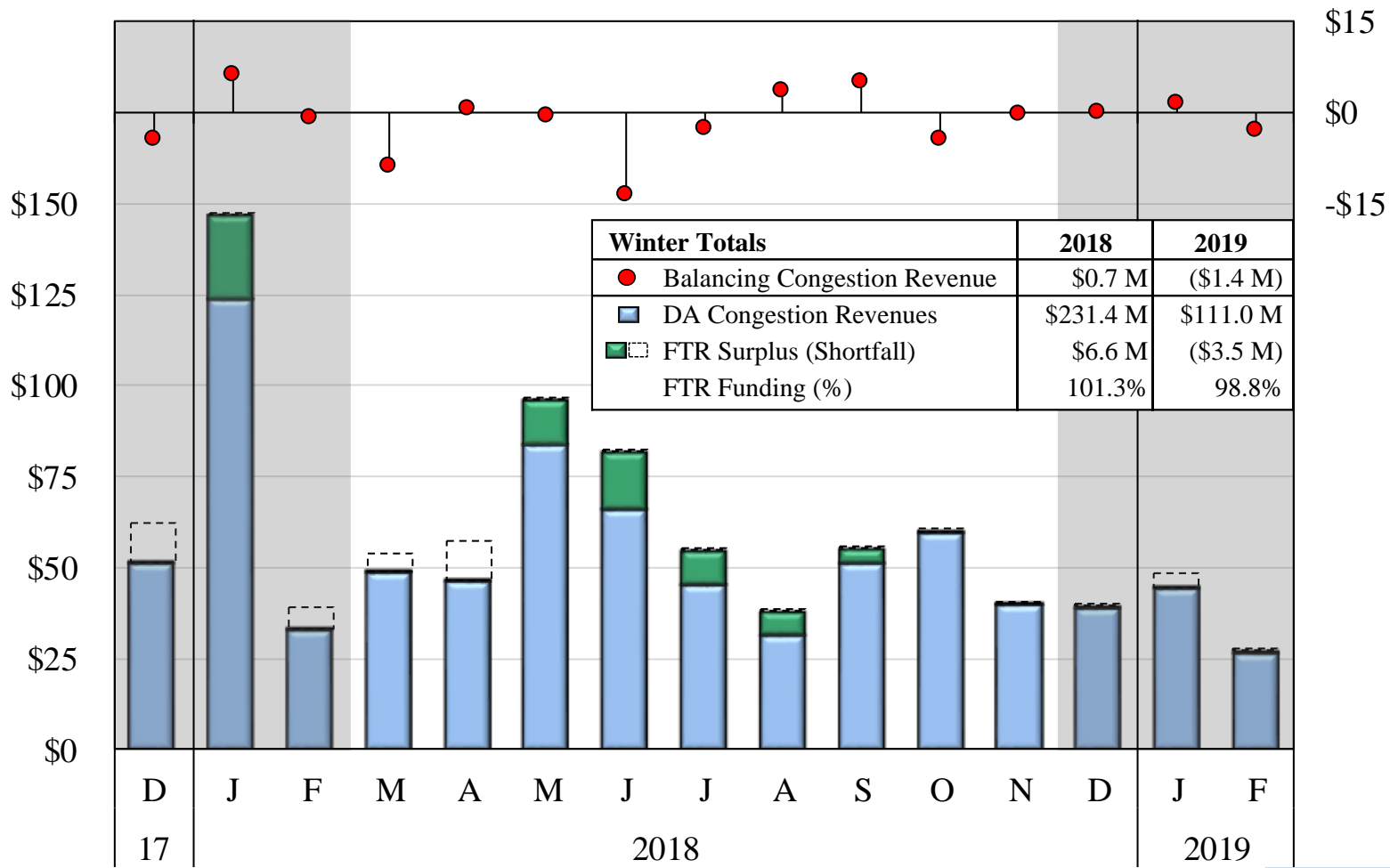
# NSI into MISO

## January 30



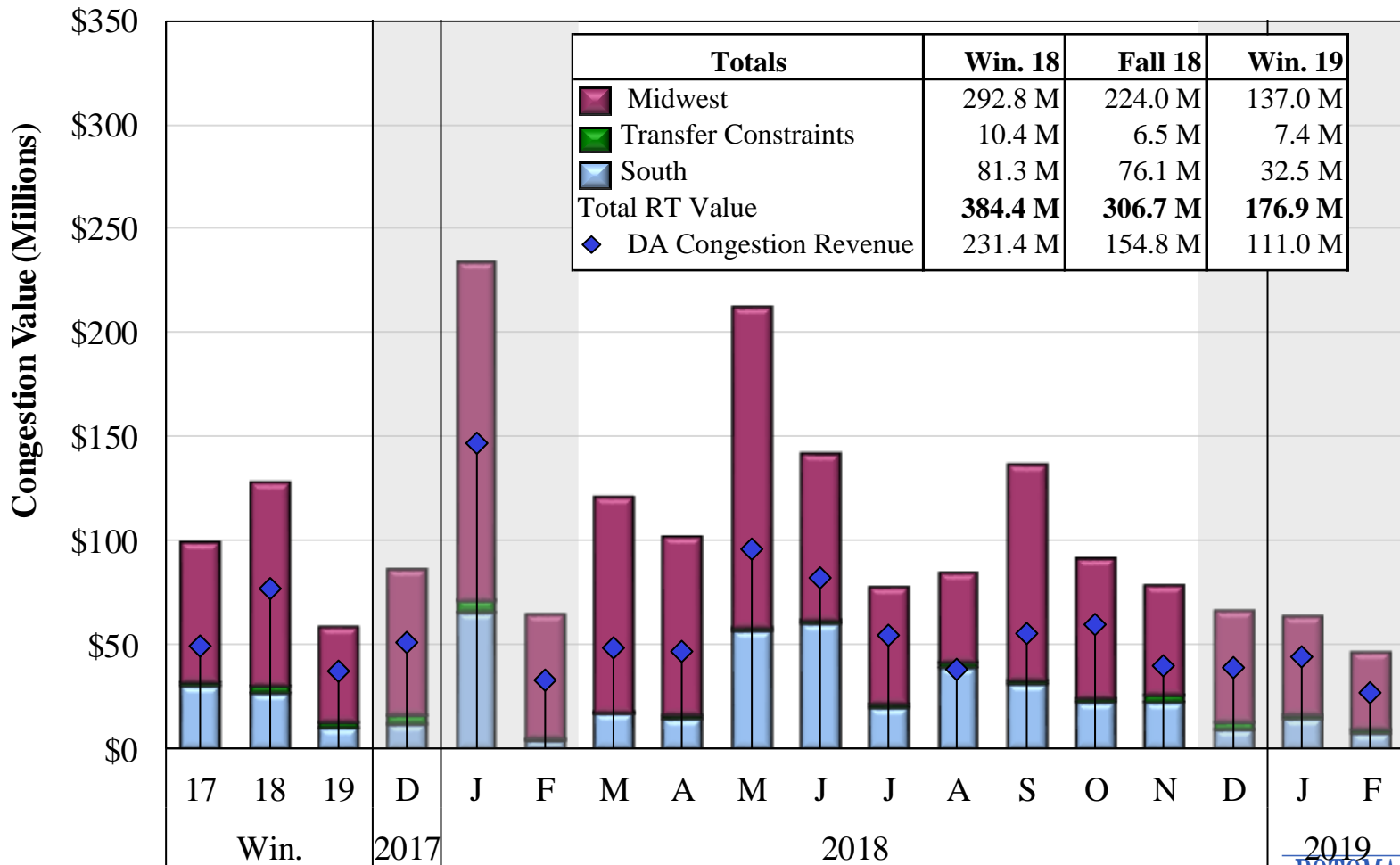


# Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2017 – 2019

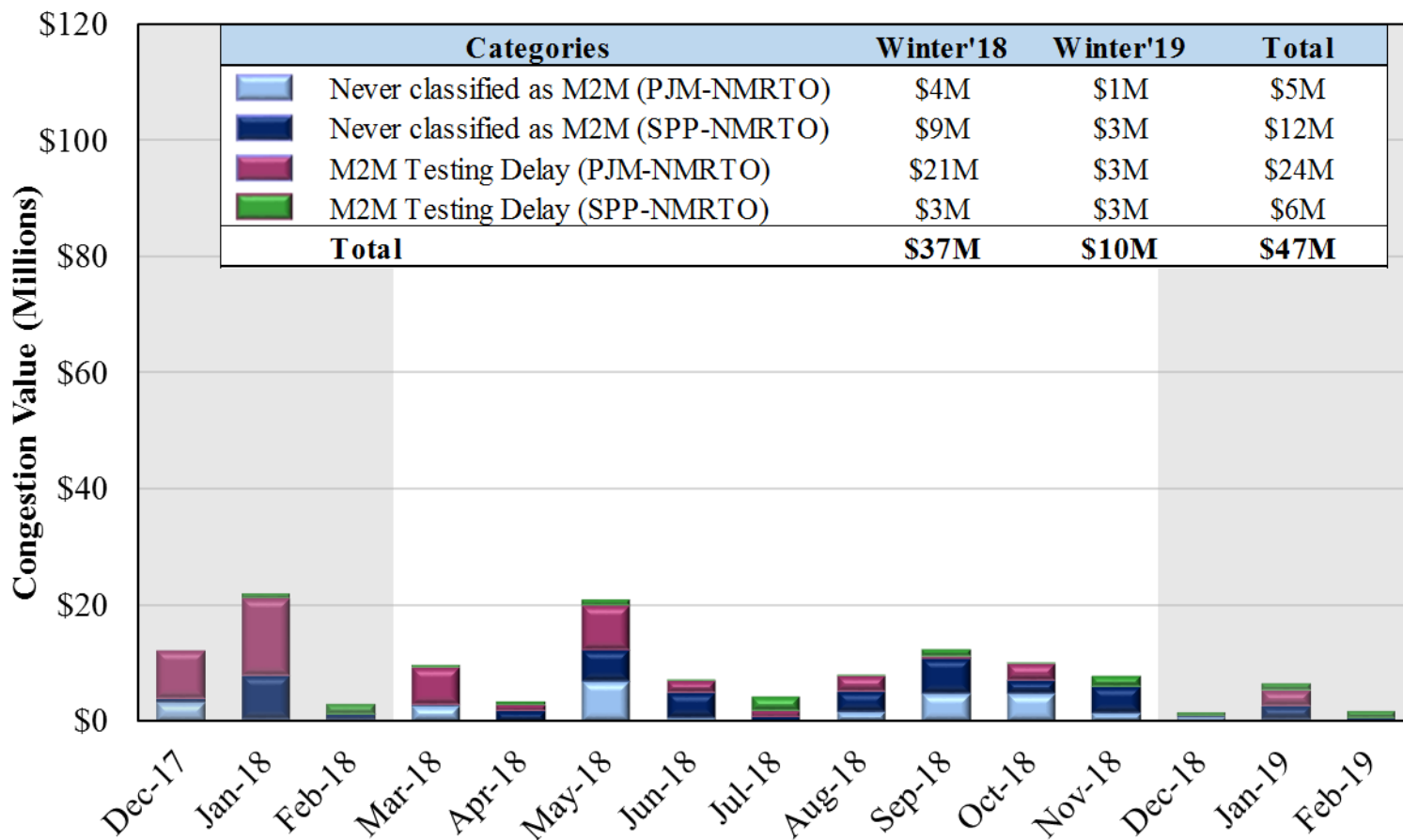




# Value of Real-Time Congestion Winter 2018 – 2019



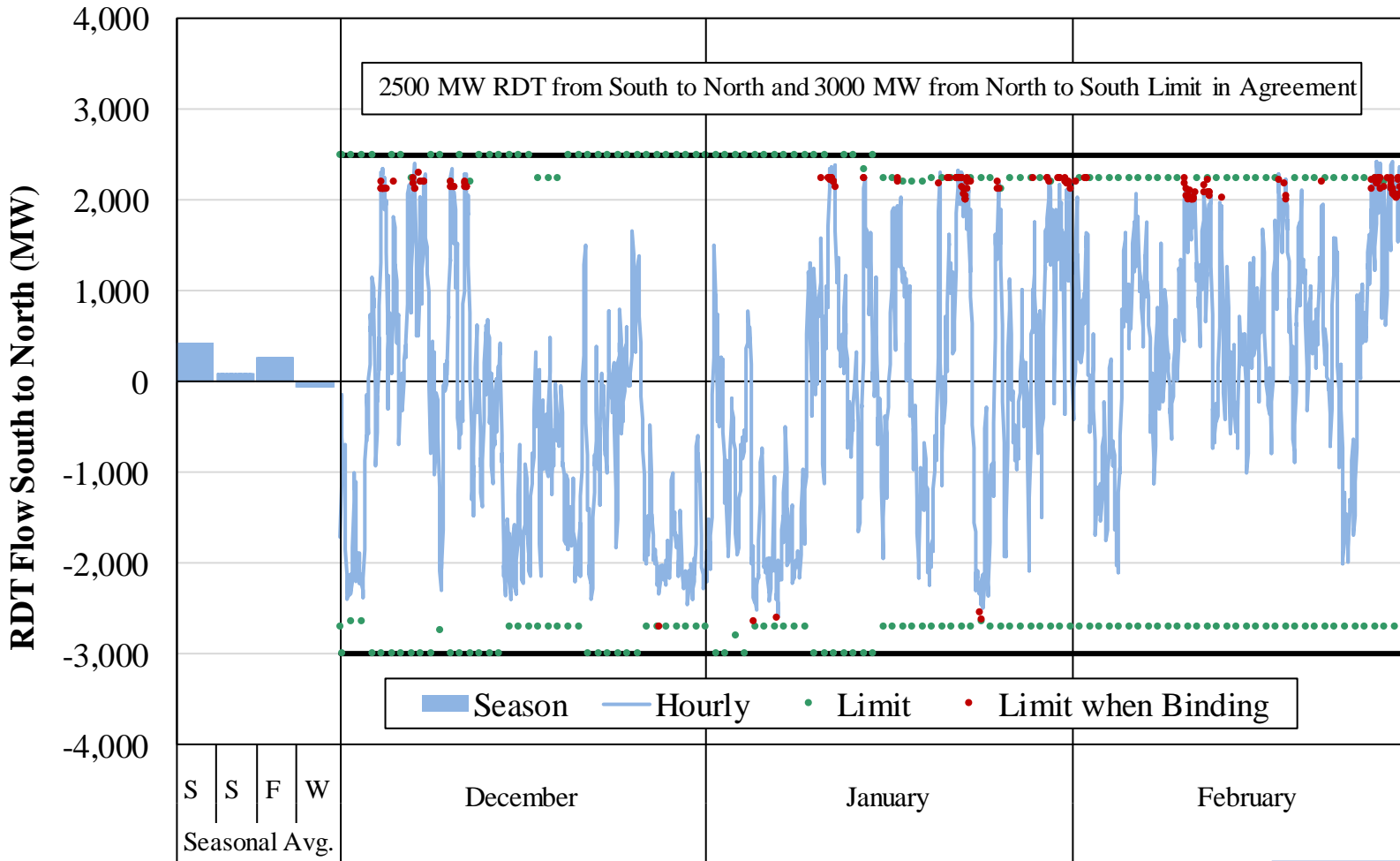
# Inefficient Market-to-Market Congestion Winter 2018 - 2019





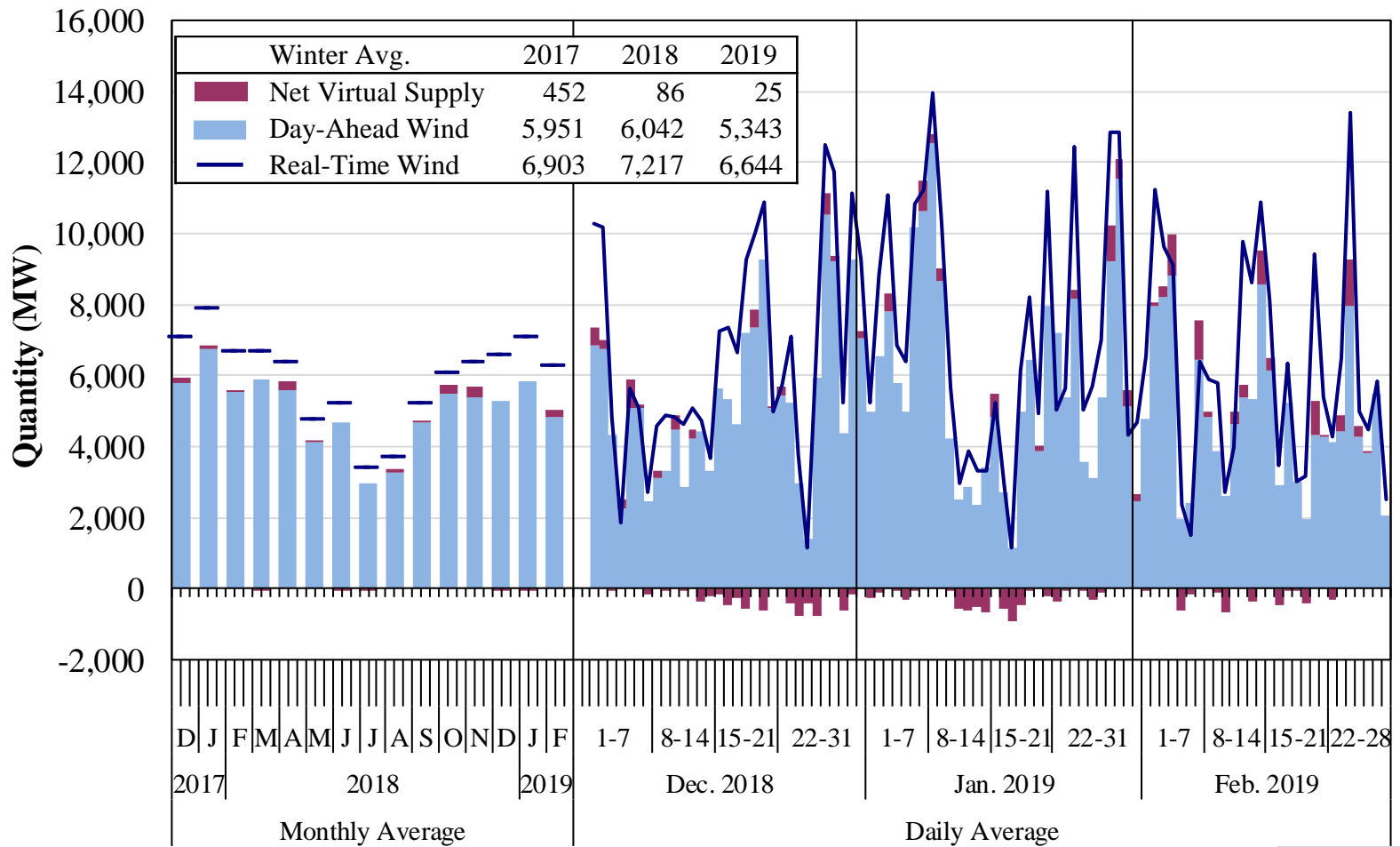


# Real-Time Hourly Inter-Regional Flows Winter 2019



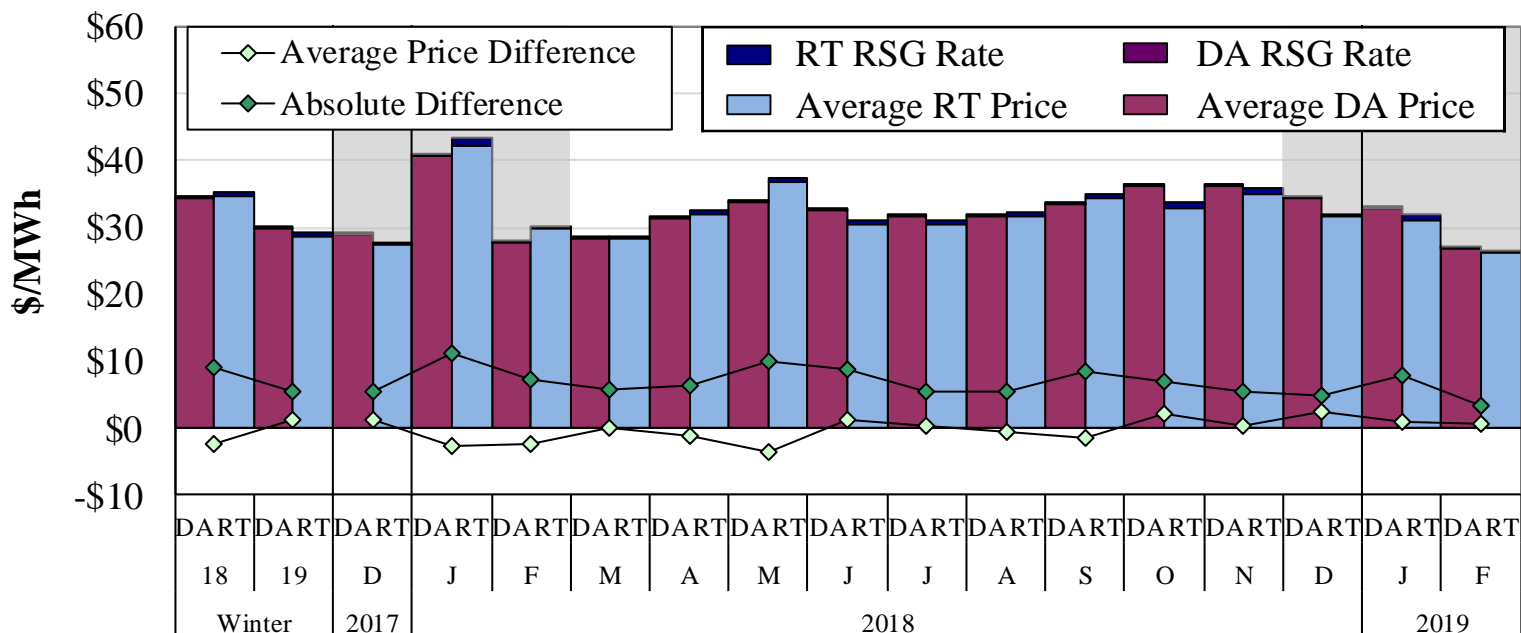


# Wind Output in Real-Time and Day-Ahead Monthly and Daily Average





# Day-Ahead and Real-Time Price Convergence Winter 2018 – 2019

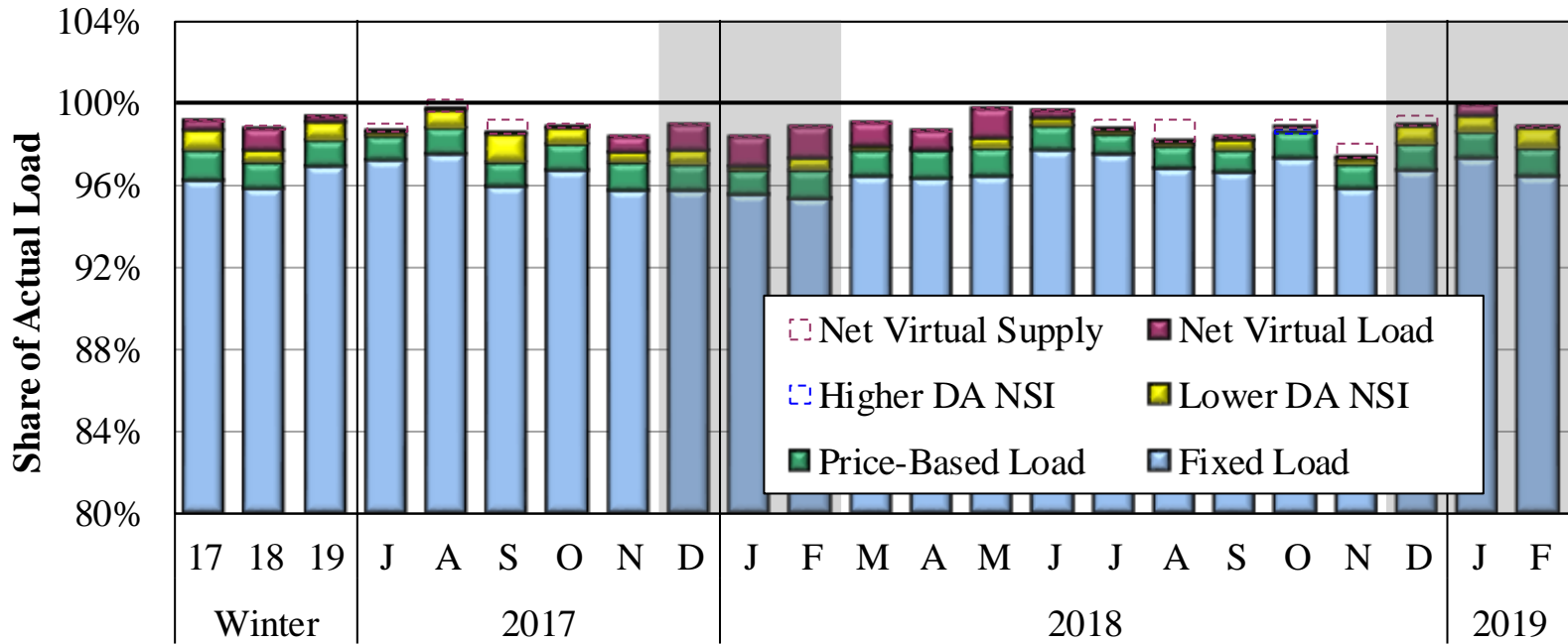


**Average DA-RT Price Difference Including RSG (% of Real-Time Price)**

Indiana Hub	-3	4	4	-6	-8	0	-4	-10	4	2	-2	-4	7	1	7	3	2
Michigan Hub	0	0	2	-2	1	-1	-2	-9	4	1	-4	-5	4	-2	5	-6	1
Minnesota Hub	-1	0	0	3	-6	1	0	-4	-2	3	-4	-6	2	1	4	-4	1
WUMS Area	0	3	2	2	-3	0	-6	-1	-2	-8	1	-4	3	0	7	1	2
Arkansas Hub	-2	1	1	-7	-1	0	-4	4	4	3	-4	-11	3	-1	4	0	-1
Texas Hub	-1	2	4	-5	-1	0	-5	8	2	4	-5	-12	2	-1	3	1	2
Louisiana Hub	4	2	5	-3*	3	0	-3	10	-13	9	-12	-18	4	-5	4	0	1

\* Excluding Jan. 17-18, 2018.

# Day-Ahead Peak Hour Load Scheduling Winter 2018 – 2019

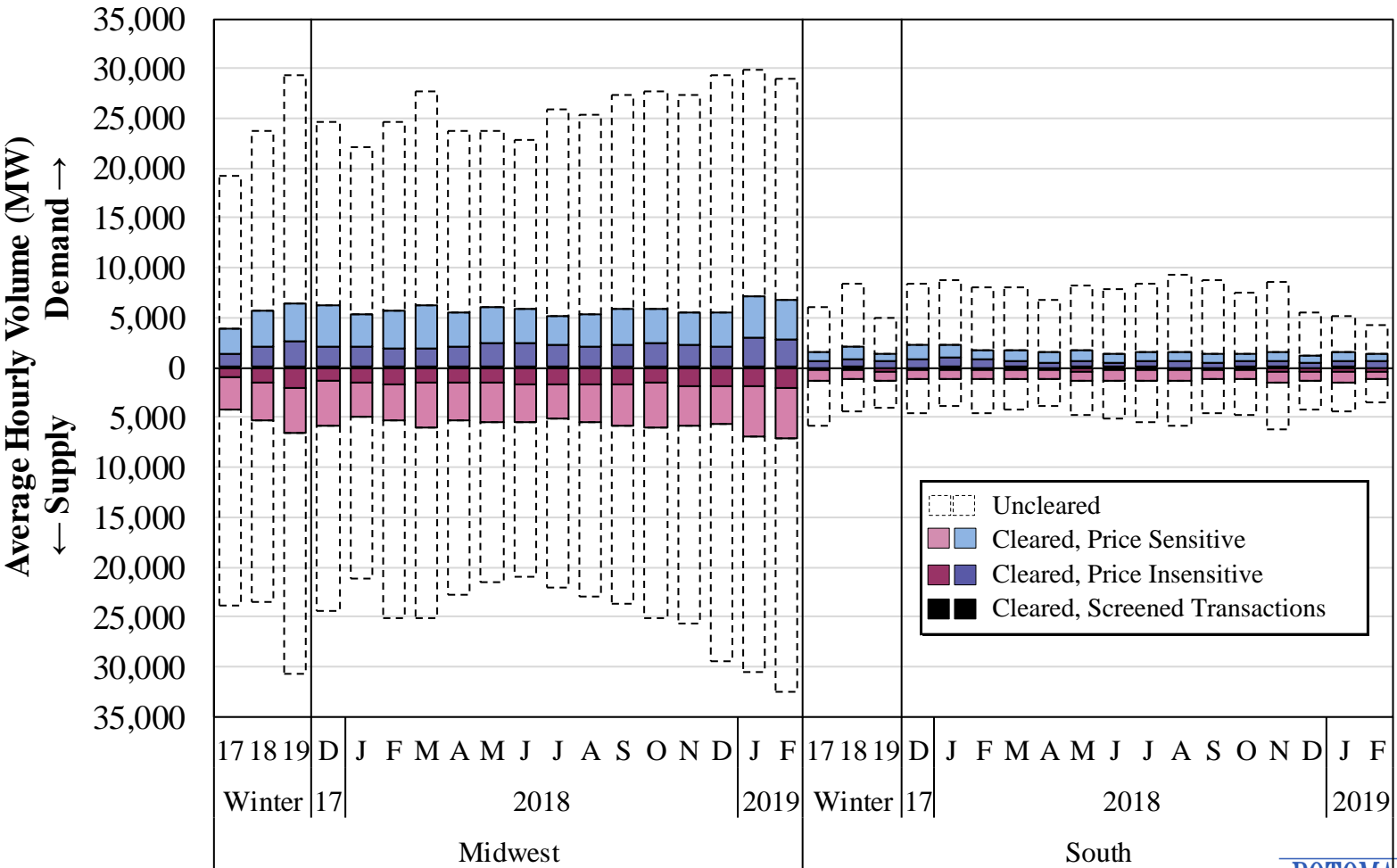


Share of Actual Load (%)

All Hours	99.1	98.7	99.3	99.6	99.9	98.9	98.8	98.6	99.2	98.7	98.6	99.3	98.6	100.0	99.7	99.4	99.3	98.9	99.1	97.5	98.8	99.7	98.9
Peak Hours Midwest	98.4	98.2	98.6	97.3	98.0	98.9	97.6	98.6	98.8	98.1	97.8	99.5	98.3	99.4	99.3	97.9	97.1	97.6	98.1	97.1	98.7	99.2	98.0
Peak Hours South	103.9	101.9	101.7	102.2	102.9	97.4	103.0	101.4	102.1	101.2	102.3	102.0	101.3	101.5	100.4	100.9	100.6	101.0	102.5	100.1	102.2	102.6	100.9

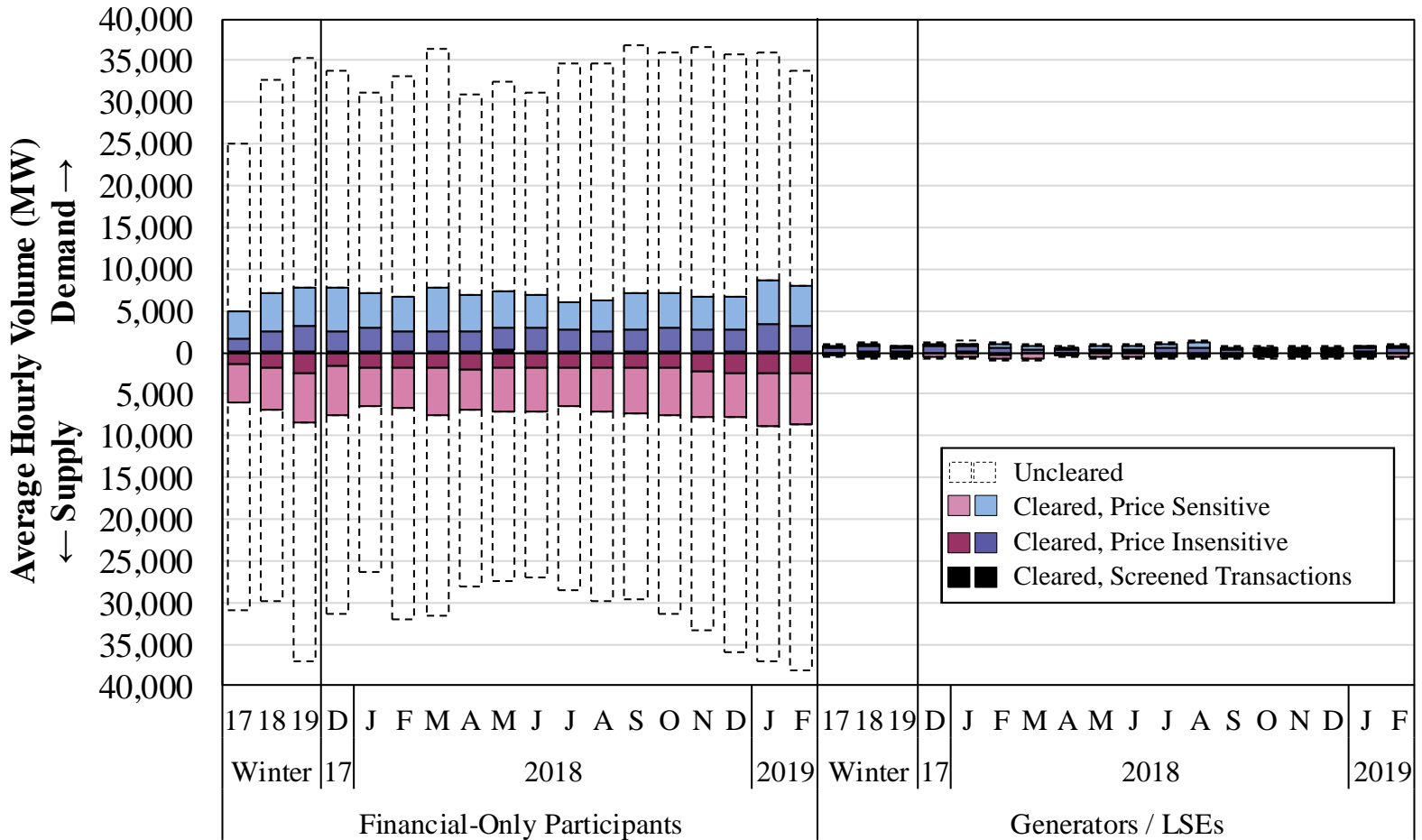


# Virtual Load and Supply Winter 2018 – 2019



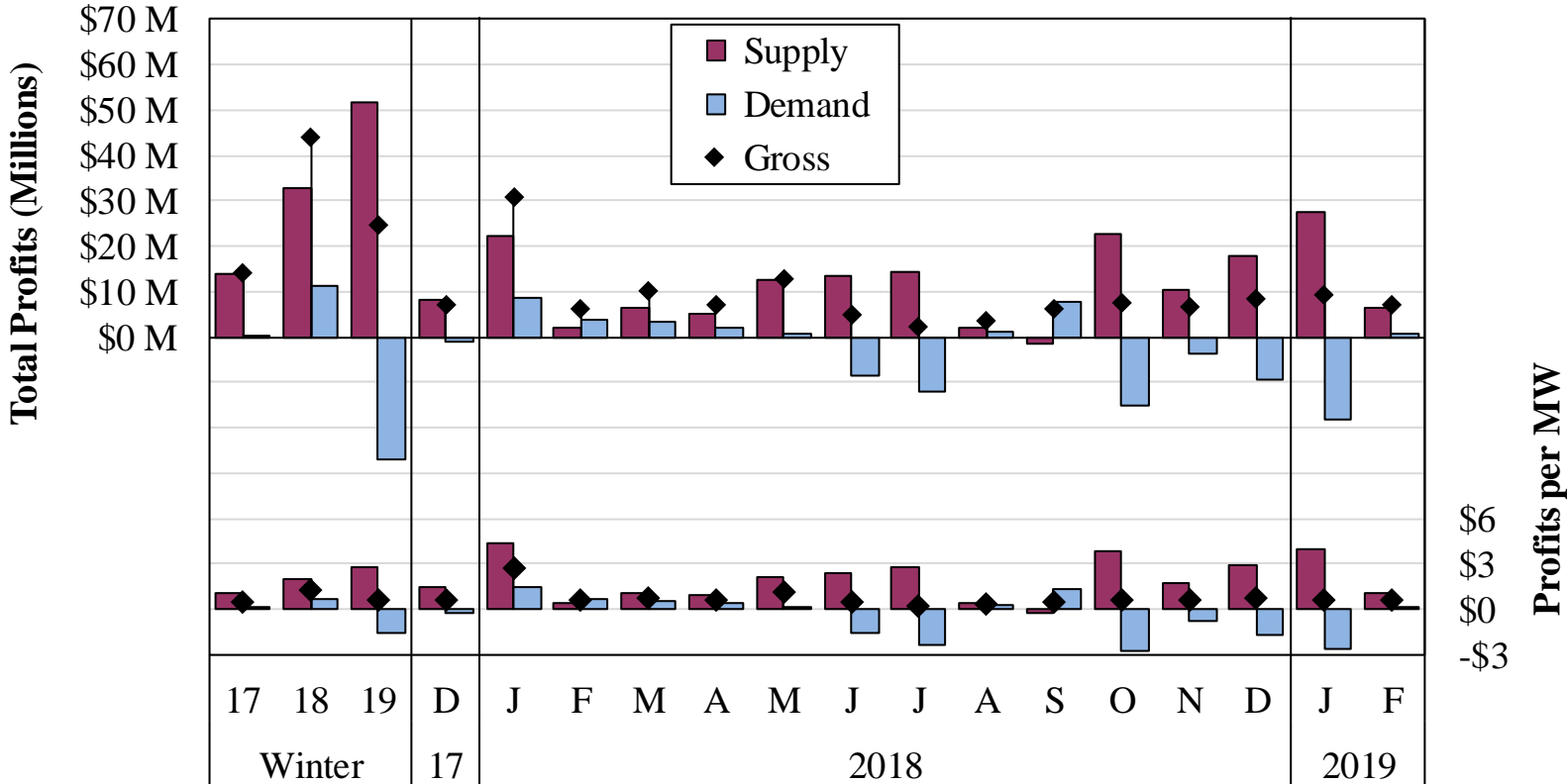


# Virtual Load and Supply by Participant Type Winter 2018 – 2019





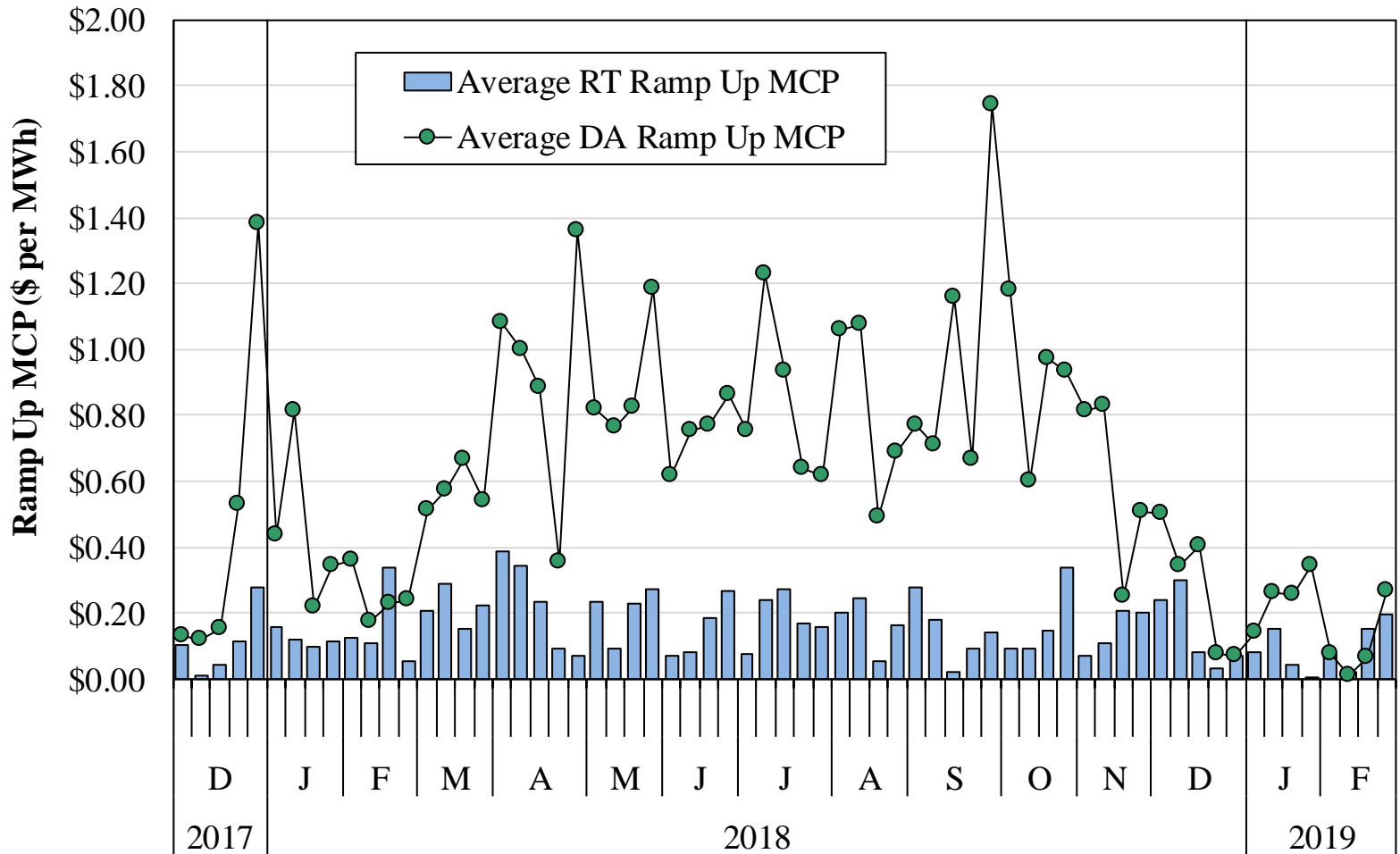
# Virtual Profitability Winter 2018 – 2019



**Percent Screened**

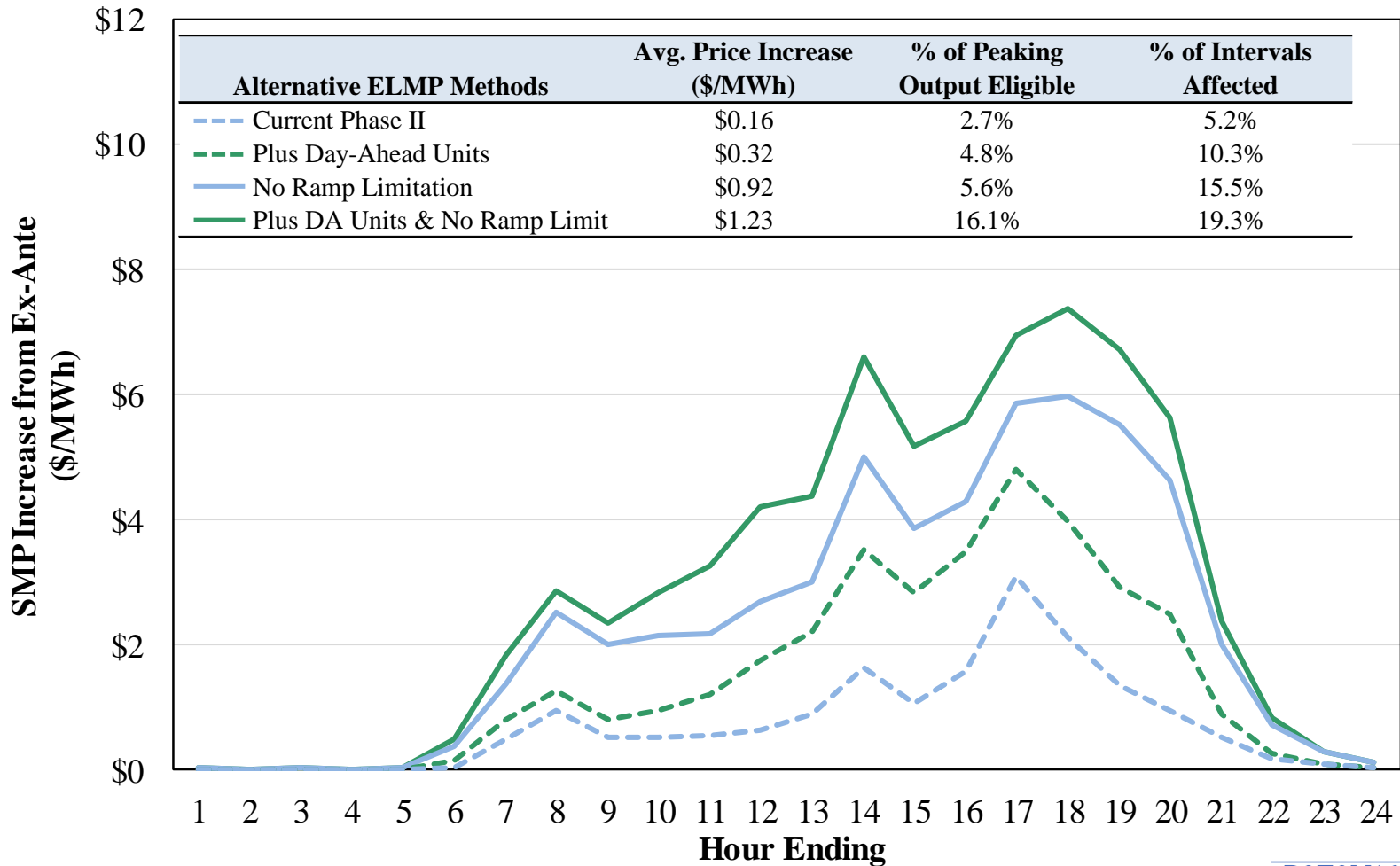
<b>Demand</b>	1.1	1.2	1.1	0.6	2.3	0.6	1.2	1.3	3.1	2.7	2.3	0.8	1.2	1.9	1.1	0.6	1.8	0.6
<b>Supply</b>	0.4	0.4	0.2	0.3	0.9	0.2	0.3	0.4	0.5	0.5	0.4	0.1	0.2	0.4	0.4	0.2	0.2	0.1
<b>Total</b>	0.7	0.8	0.6	0.4	1.6	0.4	0.7	0.8	1.9	1.6	1.3	0.4	0.7	1.1	0.7	0.4	1.0	0.4

# Day-Ahead and Real-Time Ramp Up Price 2017 – 2019

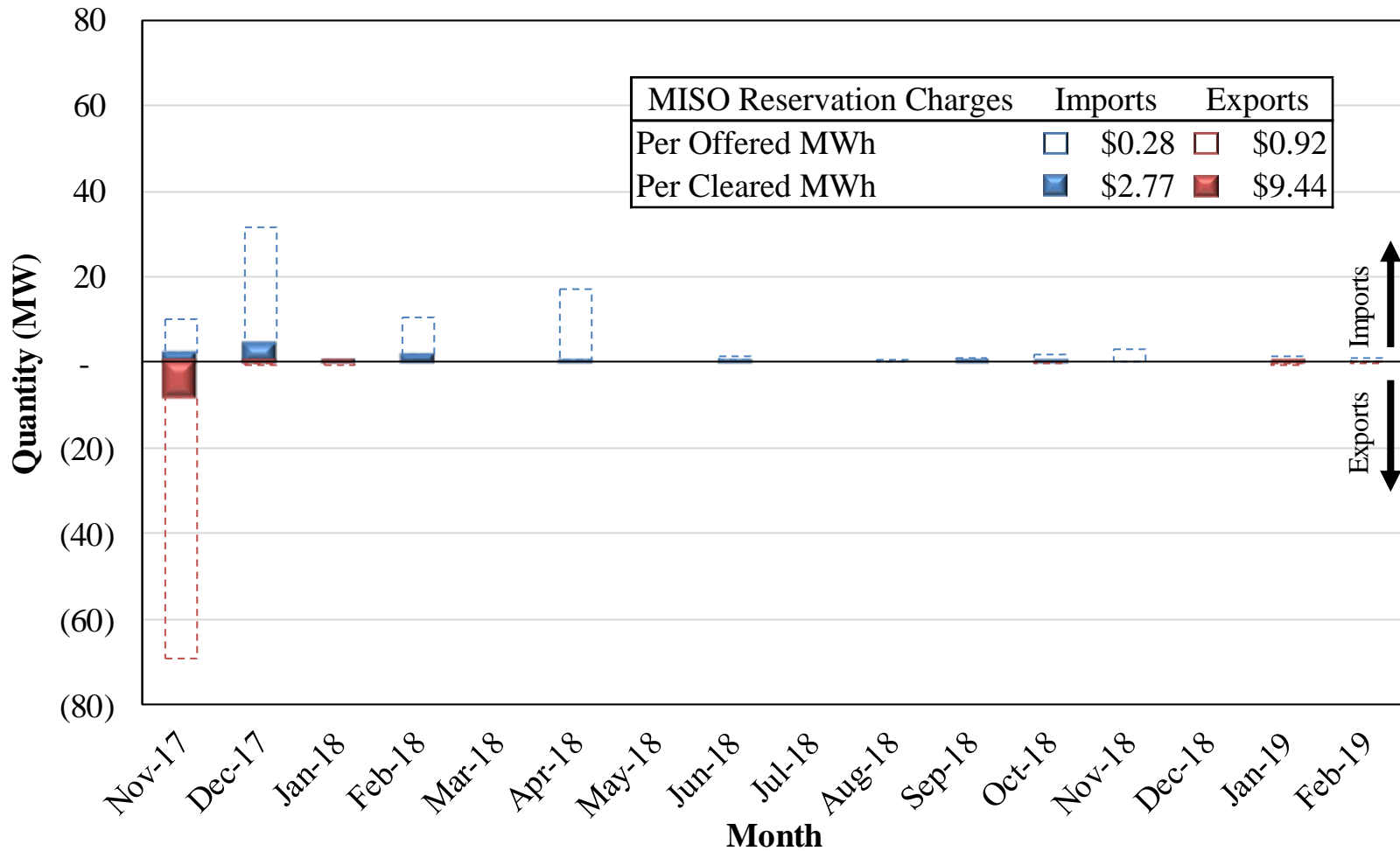




# Evaluation of ELMP Assumptions Winter 2019

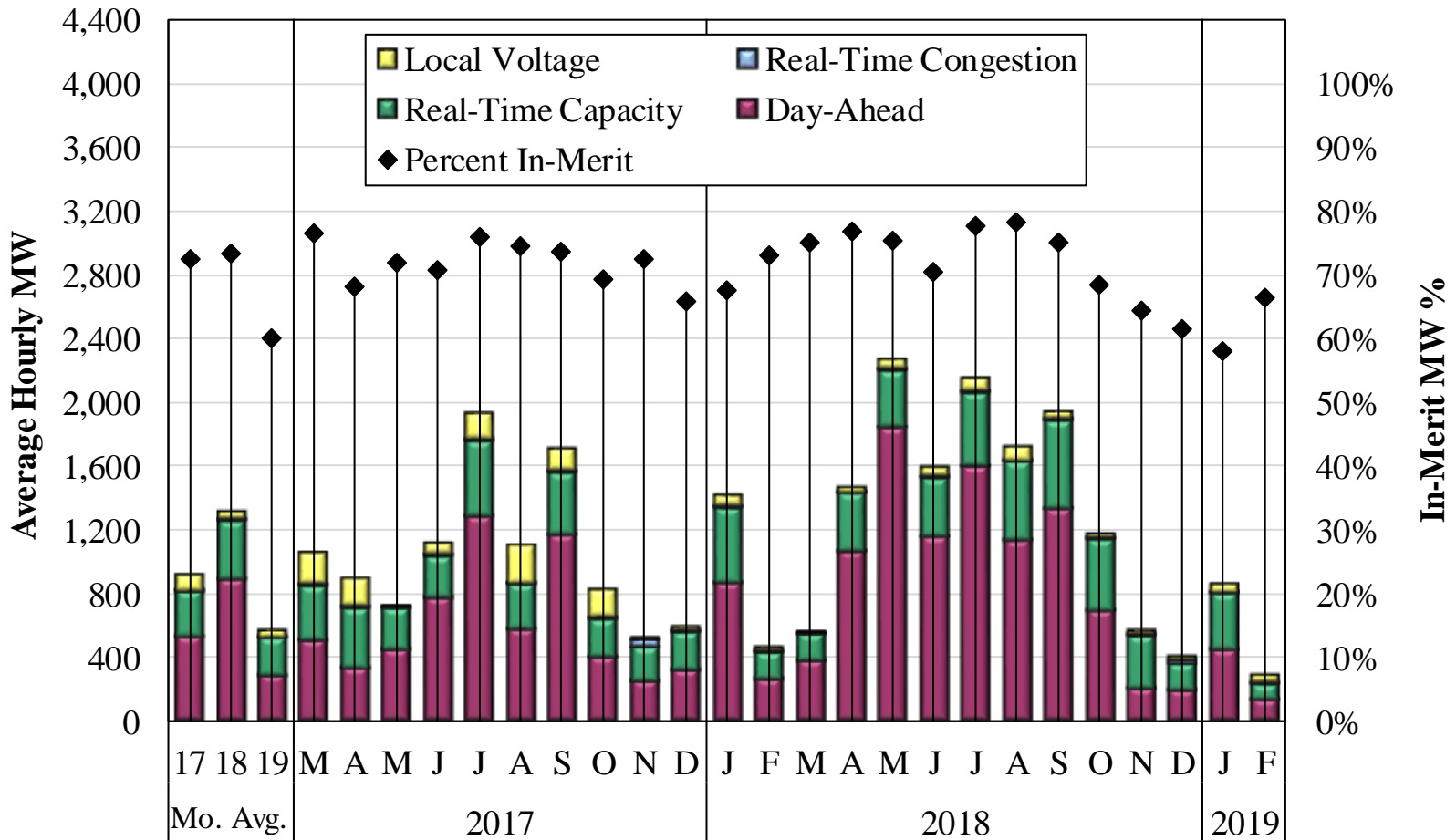


# Coordinated Transaction Scheduling (CTS) Winter 2018 - 2019



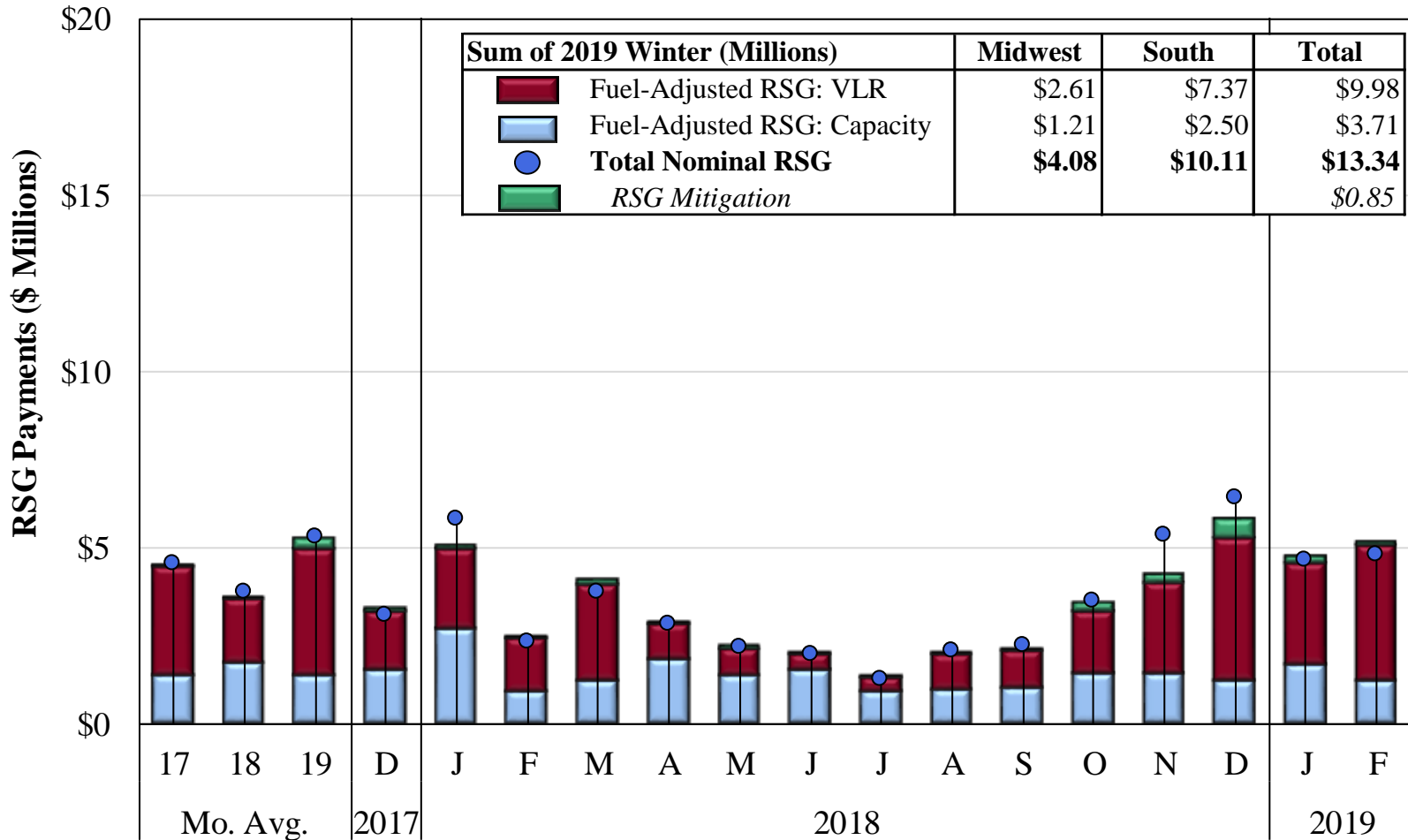


# Peaking Resource Dispatch Winter 2018 – 2019



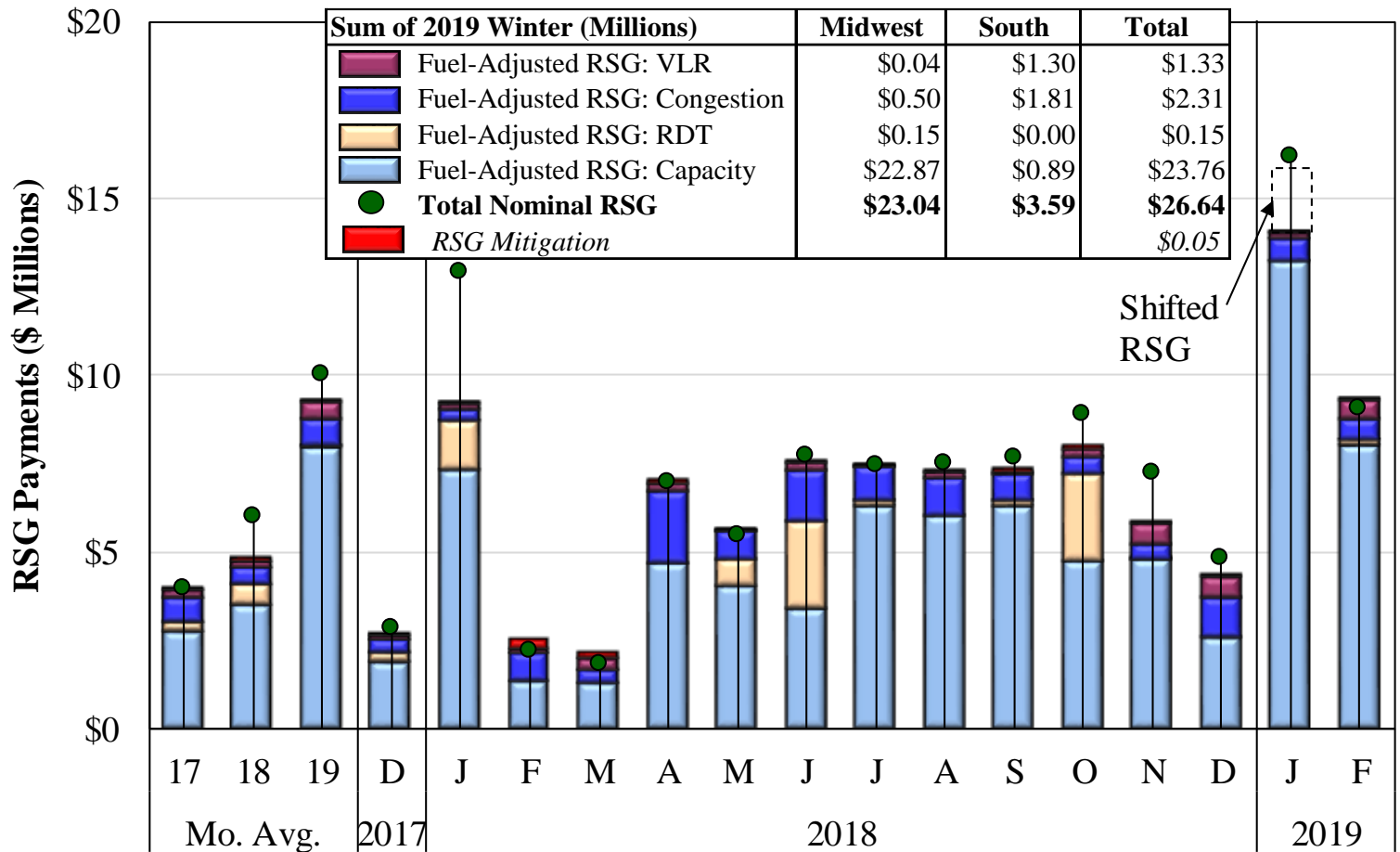


# Day-Ahead RSG Payments Winter 2018 – 2019



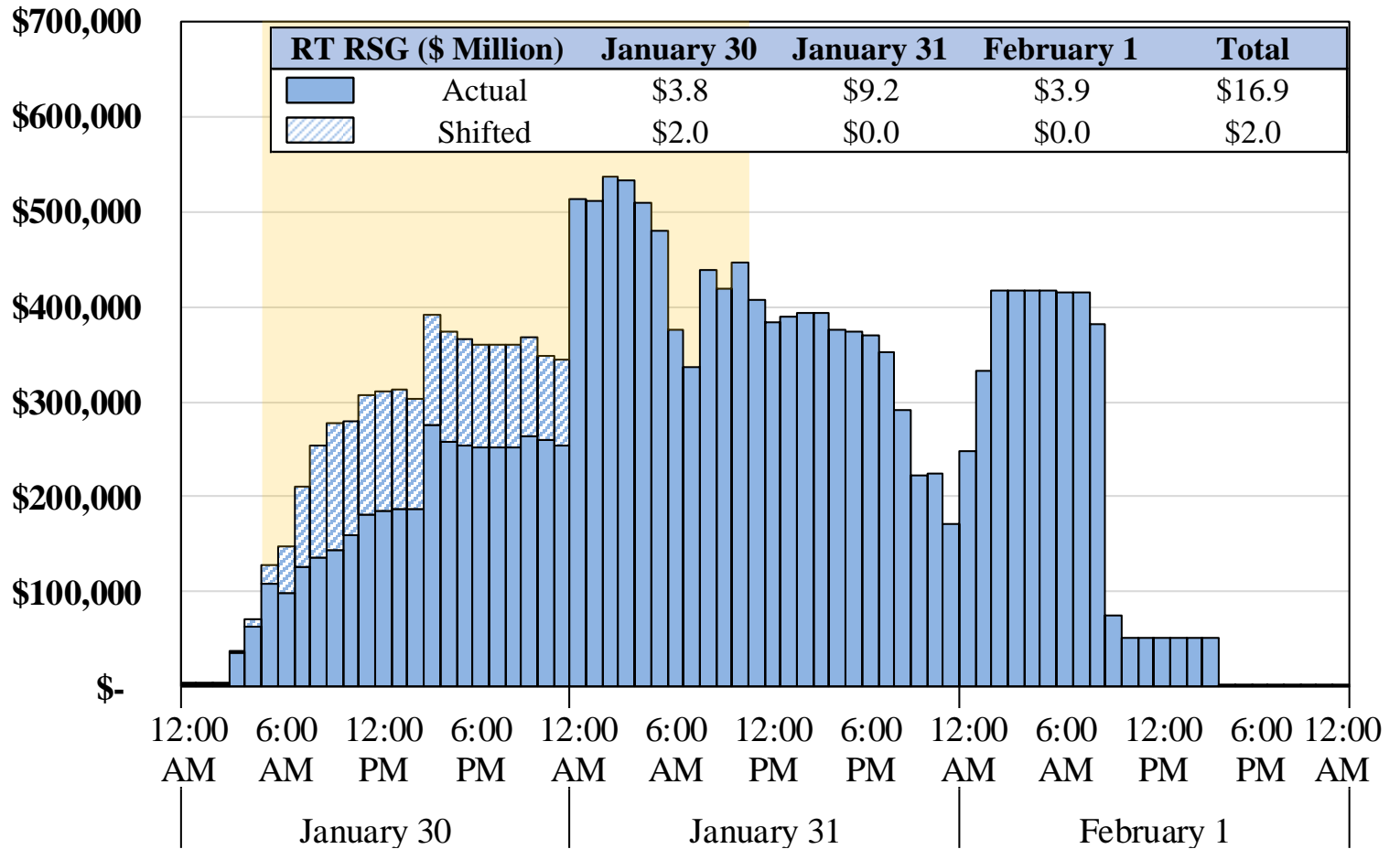


# Real-Time RSG Payments Winter 2018 – 2019

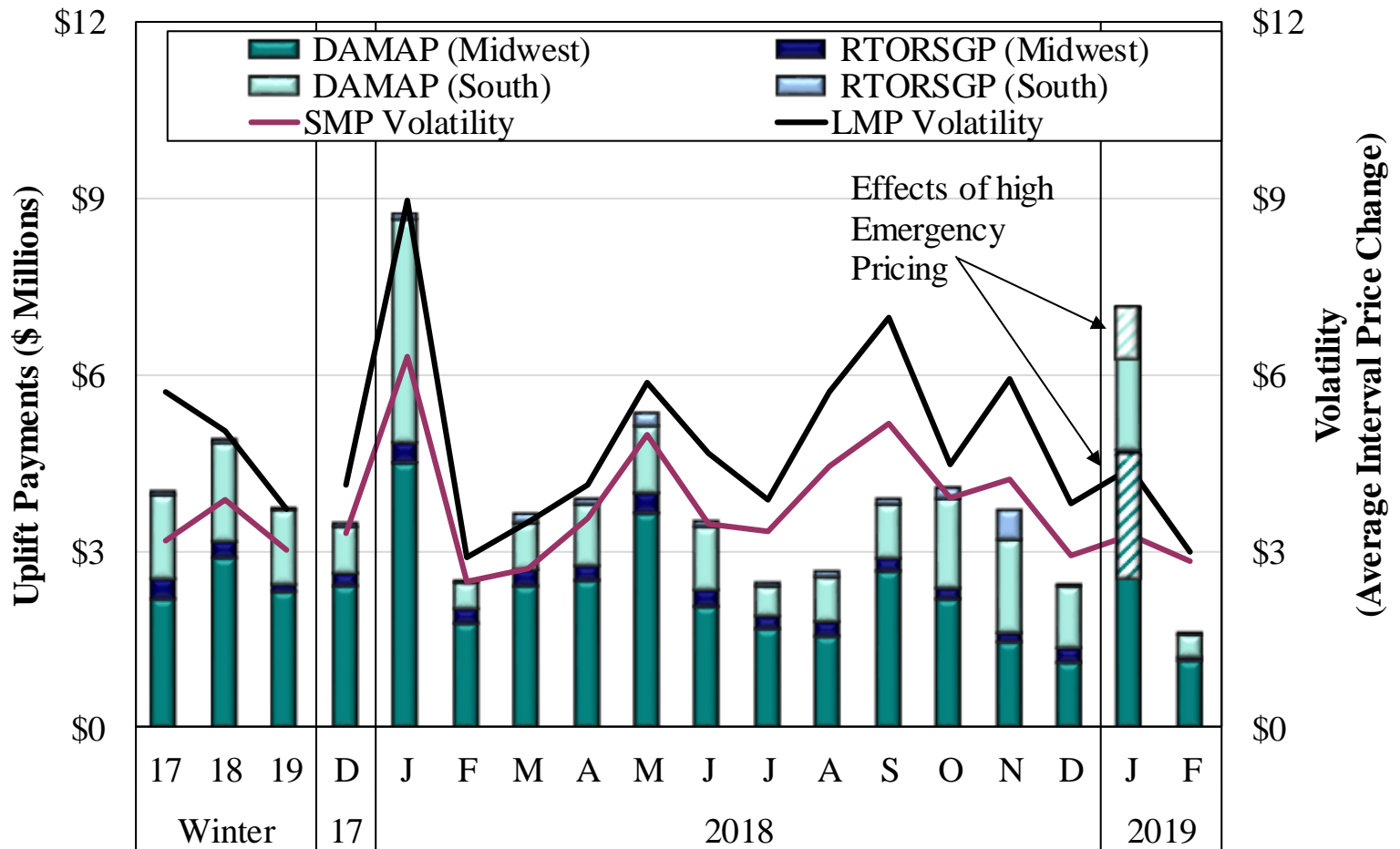




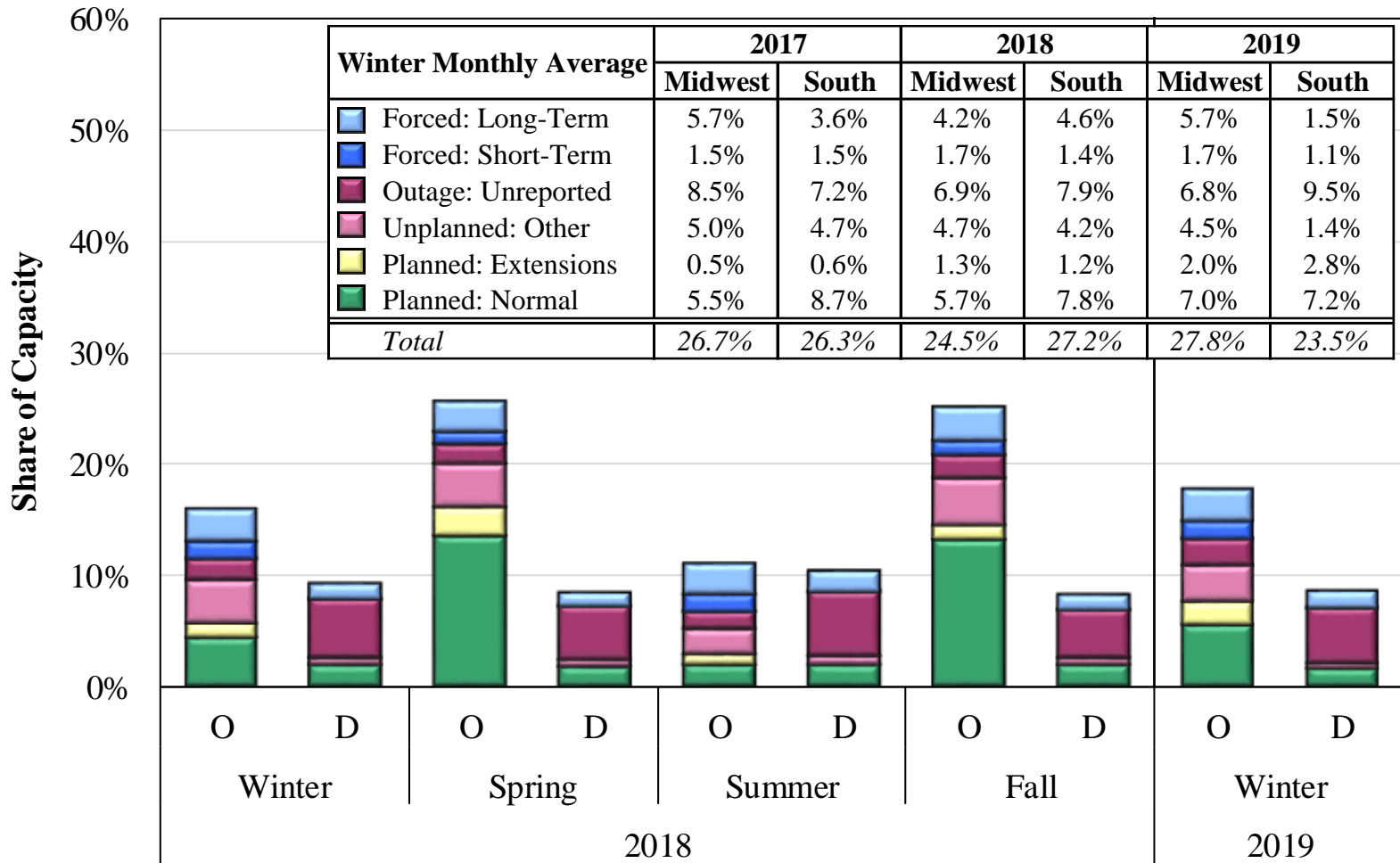
# Real-Time RSG Payments January 30 – February 1



# Price Volatility Make Whole Payments Winter 2018 – 2019



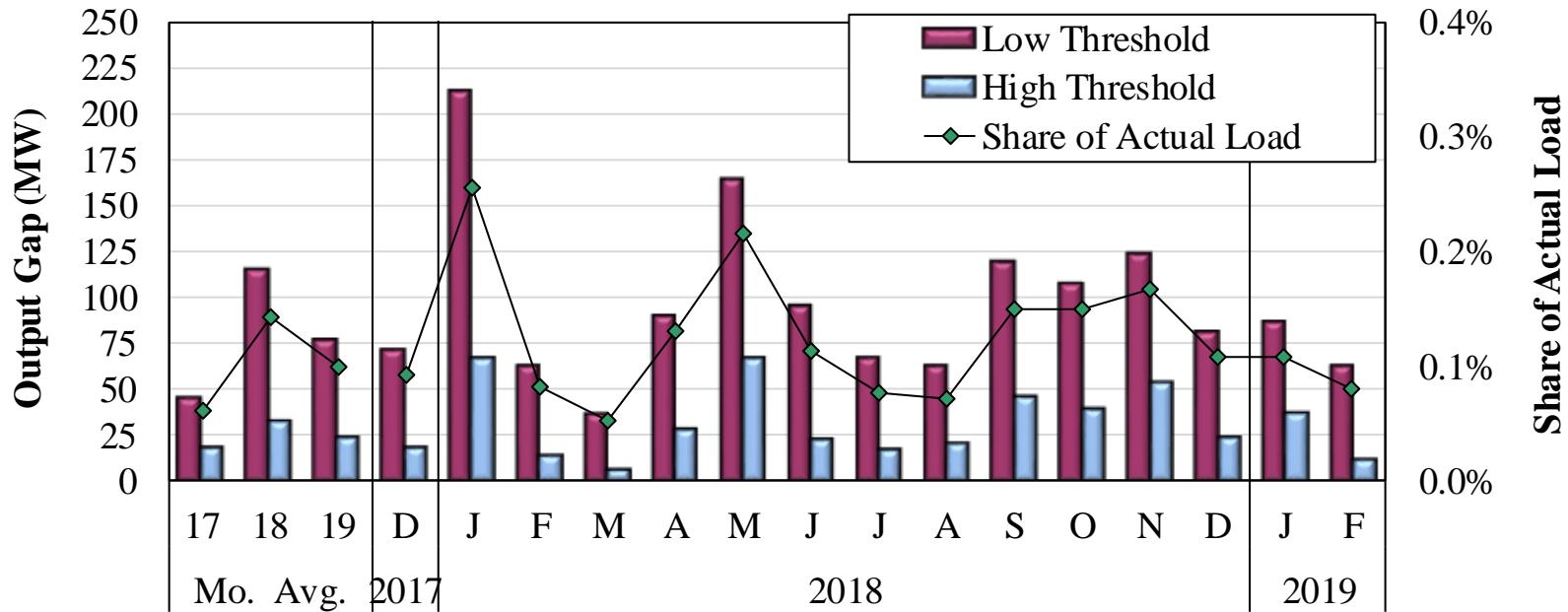
# Generation Outage and Derate Rates Winter 2018 - 2019







# Monthly Output Gap Winter 2018 – 2019



## High Threshold Results by Unit Status (MW)

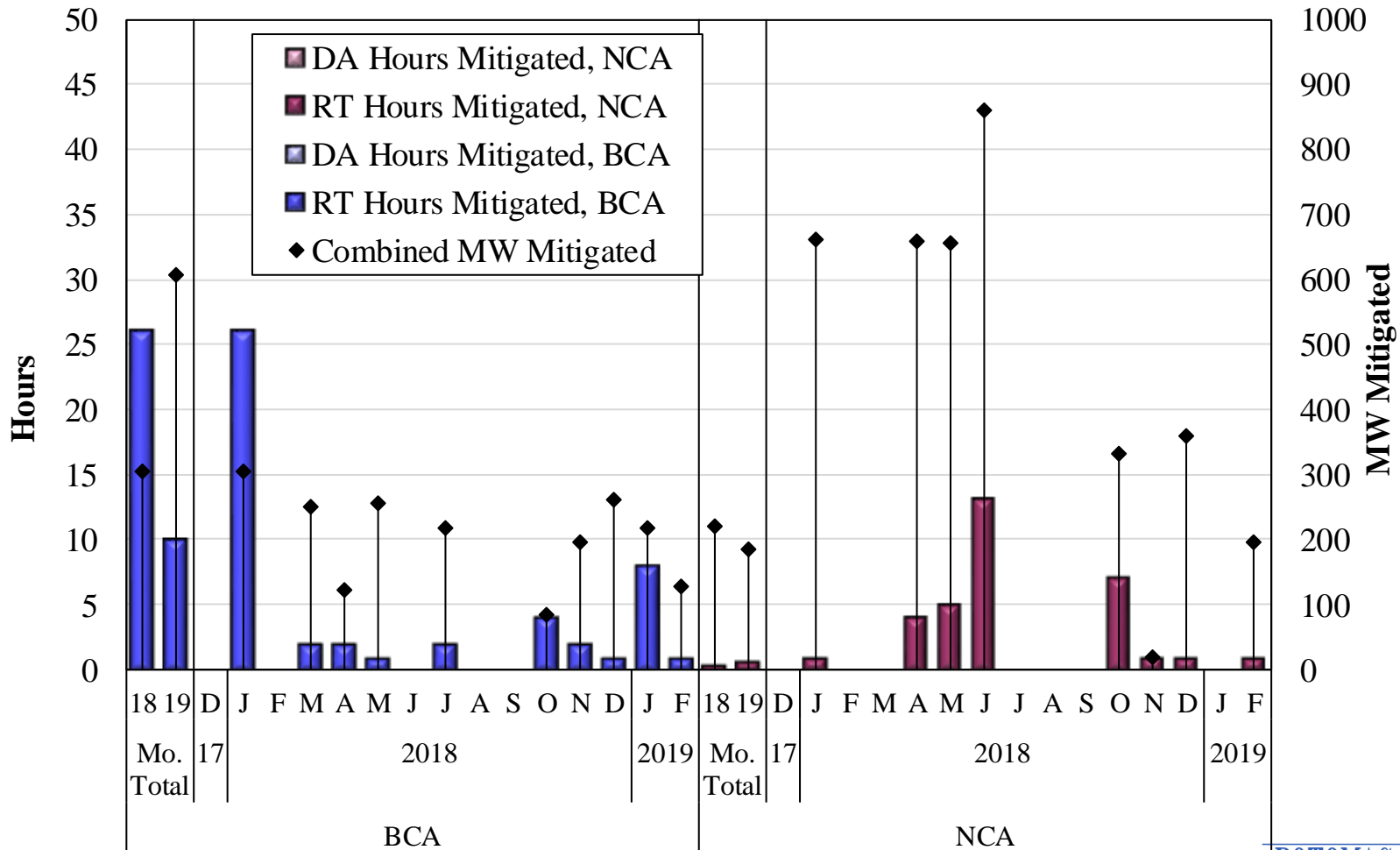
<b>Offline</b>	5	8	13	0	20	0	0	2	33	8	3	8	16	16	5	3	24	2
<b>Online</b>	20	27	12	19	46	14	7	26	33	15	15	13	30	24	48	21	13	10

## Low Threshold Results by Unit Status (MW)

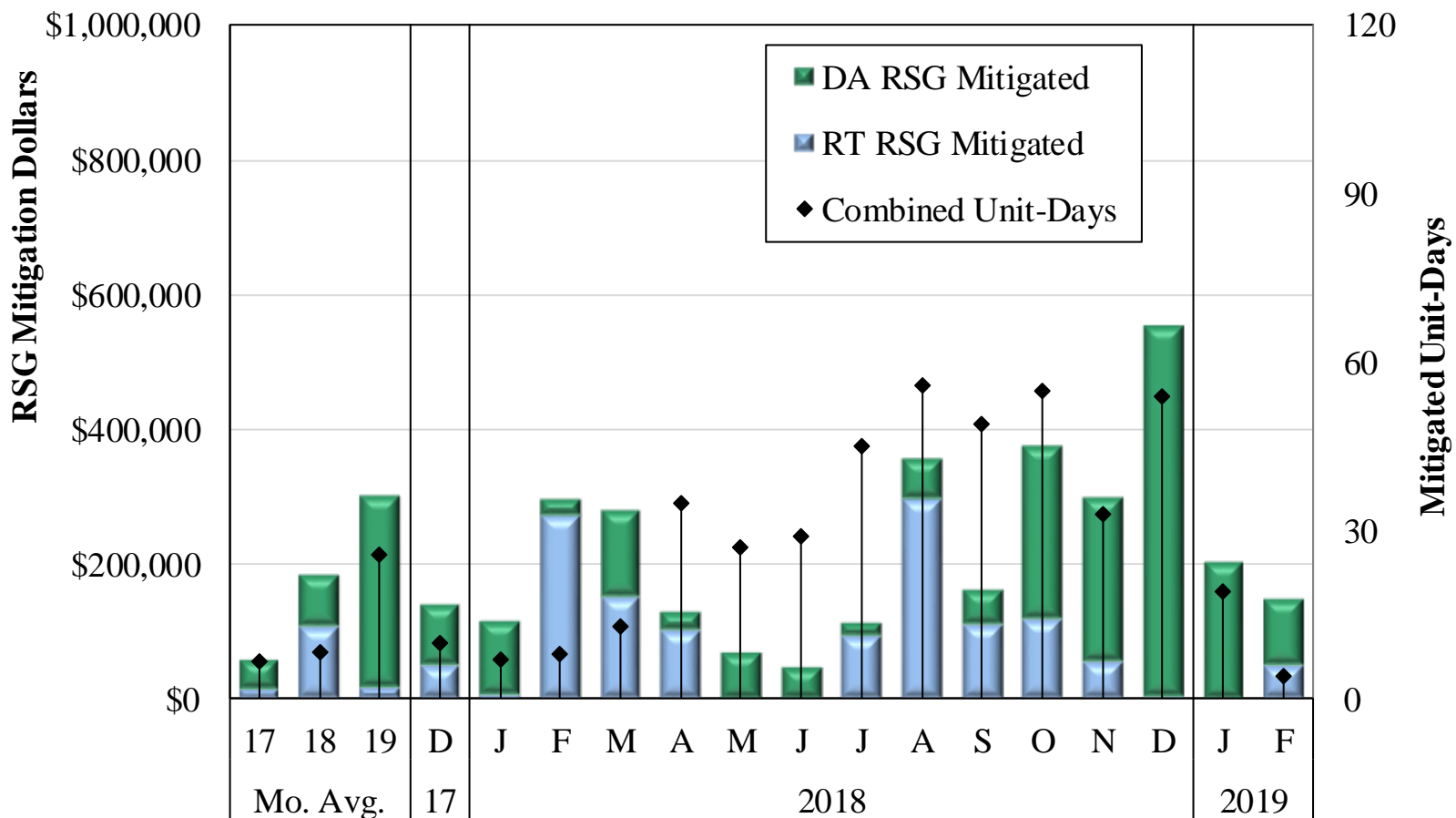
<b>Offline</b>	5	11	16	0	30	0	0	3	40	11	4	8	17	17	6	3	30	2
<b>Online</b>	65	108	59	72	182	63	37	88	124	85	64	55	102	90	118	78	56	61



# Day-Ahead And Real-Time Energy Mitigation 2018 – 2019



# Day-Ahead and Real-Time RSG Mitigation 2018 – 2019





## List of Acronyms

- AMP Automated Mitigation Procedures
- BCA Broad Constrained Area
- CDD Cooling Degree Days
- CMC Constraint Management Charge
- CTS Coordinated Transaction Scheduling
- DAMAP Day-Ahead Margin Assurance Payment
- DDC Day-Ahead Deviation & Headroom Charge
- DIR Dispatchable Intermittent Resource
- HDD Heating Degree Days
- ELMP Extended Locational Marginal Price
- JCM Joint and Common Market Initiative
- JOA Joint Operating Agreement
- LAC Look-Ahead Commitment
- LSE Load-Serving Entities
- M2M Market-to-Market
- MSC MISO Market Subcommittee
- NCA Narrow Constrained Area
- ORDC Operating Reserve Demand Curve
- PITT Pseudo-Tie Issues Task Team
- PRA Planning Resource Auction
- PVMWP Price Volatility Make Whole Payment
- RAC Resource Adequacy Construct
- RDT Regional Directional Transfer
- RSG Revenue Sufficiency Guarantee
- RTORSGP Real-Time Offer Revenue Sufficiency Guarantee Payment
- SMP System Marginal Price
- SOM State of the Market
- TLR Transmission Line Loading Relief
- TCDC Transmission Constraint Demand Curve
- VLR Voltage and Local Reliability
- WUMS Wisconsin Upper Michigan System