



# IMM Quarterly Report: Winter 2018

MISO Independent Market Monitor

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## Highlights and Findings: Winter 2018

- The MISO markets performed competitively this winter.
  - ✓ Natural gas prices fell by 6 percent over last year, but energy prices increased by 8 percent over the same period due to January weather-related events.
  - ✓ Market power mitigation was infrequent and offers were competitive.
- In January, extremely cold temperatures throughout the footprint affected gas prices, generation outages and performance, and energy prices.
  - ✓ Significant fuel price volatility in late December and early January contributed to high congestion and price volatility.
- On January 17 and 18, MISO declared Maximum Generation Events and took a number of emergency actions in the South.
  - ✓ Temperature-related forced outages contributed to tight conditions on multiple days.
  - ✓ LMRs were scheduled and deployed on both days and MISO took a number of other emergency actions on January 17.
  - ✓ Reliability was maintained, but prices did not efficiently reflect conditions.
- A new wind output record of 15.0 GW was set on January 17.
- Transmission congestion was significantly higher this winter than last year.

# 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>	●	\$31.13	4%	8%	<b>FTR Funding (%)</b>	●	101%	100%	99%
<b>Fuel Prices (\$/MMBtu)</b>					<b>Wind Output (MW/hr)</b>	●	7,217	14%	5%
Natural Gas - Chicago	●	\$3.08	7%	-6%	<b>Guarantee Payments (\$M)<sup>4</sup></b>	●	\$17.7	-25%	50%
Natural Gas - Henry Hub	●	\$3.06	4%	-6%	Real-Time RSG	●	\$11.1	12%	-19%
Western Coal	●	\$0.70	4%	4%	Day-Ahead RSG	●	\$13.7	16%	27%
Eastern Coal	●	\$1.51	1%	-2%	Day-Ahead Margin Assurance	●	\$1.0	-43%	-21%
<b>Load (GW)<sup>2</sup></b>					Real-Time Offer Rev. Sufficiency	●			
Average Load	●	79.4	9%	5%	<b>Price Convergence<sup>5</sup></b>				
Peak Load	●	106.1	-8%	4%	Market-wide DA Premium	●	2.4%	-3.0%	0.2%
% Scheduled DA (Peak Hour)	●	98.7%	98.4%	99.0%	<b>Virtual Trading</b>				
<b>Transmission Congestion (\$M)</b>					Cleared Quantity (MW/hr)	●	15,519	4%	30%
Real-Time Congestion Value	●	\$384.4	-15%	29%	% Price Insensitive	●	35%	30%	30%
Day-Ahead Congestion Revenue	●	\$231.4	14%	56%	% Screened for Review	●	1%	1%	1%
Balancing Congestion Revenue <sup>3</sup>	●	\$6	\$12.8	\$11.4	Profitability (\$/MW)	●	\$1.32	\$0.83	\$0.55
<b>Ancillary Service Prices (\$/MWh)</b>					<b>Dispatch of Peaking Units (MW/hr)</b>	●	831	1023	444
Regulation	●	\$9.98	-1%	5%	<b>Output Gap- Low Thresh. (MW/hr)</b>	●	82	95	92
Spinning Reserves	●	\$2.69	-7%	35%	<b>Other:</b>				
Supplemental Reserves	●	\$1.32	80%	80%					

**Key:**

- Expected
- Monitor/Discuss
- Concern

**Notes:**

1. Values not in italics are the value 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 2018

### Winter Peak: Late Dec '17 / Early Jan '18 (Slides 12, 13, 20, 21, 22)

- Gas prices rose 15 percent in January from the prior year, contributing to a 40 percent increase in energy prices.
- Extremely cold weather throughout the footprint from January 1 to 4 led to:
  - ✓ MISO-wide Cold Weather Alerts and Conservative Operations ending Jan 6.
  - ✓ Winter load peaked on January 2 at 104.7 GW, but was lower than the all-time winter peak load of 109.3 GW during the 2014 Polar Vortex.
  - ✓ Fuel-related generation outages and more than 4 GW of generation that could only be used in an emergency contributed to tight operating conditions on several days.
    - 14 intervals of operating reserve shortages occurred with average prices of \$501/MWh.
  - ✓ Multiple gas pipeline restrictions and high gas prices occurred.
    - Dual-fuel capable units switched to burn oil that was cheaper than gas.
- Cold weather in late December also led to gas price volatility. The Ventura hub price was as high as \$67.50 on three days and affected many units.
- We consulted with multiple participants on generation fuel costs for references and no inappropriate mitigation occurred.





## Highlights for Winter 2018

### **Winter Peak: Jan 17<sup>th</sup>-18<sup>th</sup> in MISO South (Slides 12, 14, 15, 16, 17, 18)**

- Unusually cold weather in the South on January 17 and 18 led to a record winter peak in the South of 32.1 GW on January 17 and emergency events.
- Conditions were extremely tight on January 17 from 6 AM to 1 PM:
  - ✓ MISO's load forecast in the early morning showed a significant capacity deficiency by 9 AM, prompting MISO to declare a Max Gen Alert starting 5 AM .
  - ✓ The actual load was well below the forecast by the peak hours (7 to 9 AM) due to voluntary load curtailments and the initial response from LMRs called at 6 AM.
  - ✓ However, forced outages rose from 5 GW at midnight to almost 7.5 GW by 8:30.
  - ✓ MISO relaxed some of its transmission limits in the South, raising them by roughly 25 percent to increase access to generation.
  - ✓ Because load exceeded supply, MISO exceeded the RDT limit for roughly an hour from 6:45 AM to 7:45 AM, by almost 1000 MW at 7:25 AM.
  - ✓ MISO scheduled emergency transactions beginning at 7:30 AM that exceeded 1000 MW by 9 AM, allowing it to reduce the RDT flows to below the limit.
- MISO declared an emergency for the evening peak and for the morning of the 18<sup>th</sup>, but conditions were not as tight because some units returned from outage.
- Given the supply and demand conditions, all of MISO's actions were necessary to keep the lights on in the South.



## Highlights for Winter 2018

### **Winter Peak: Jan 17<sup>th</sup>-18<sup>th</sup> in MISO South (Slides 12, 14, 15, 16, 17, 18)**

- Day-ahead congestion was much higher than real-time congestion costs.
  - ✓ Emergency actions taken on both days resulted in lower real-time congestion.
  - ✓ Louisiana Hub day-ahead premium exceeded \$1,100 for one hour on Jan 18.
- Findings regarding LMRs:
  - ✓ The LMRs were not obligated to be available (only required in the summer).
  - ✓ Long notification times limit LMRs' value – schedules were low on the 17<sup>th</sup> in the morning peak. MISO declared the event early on Jan 18 to secure them.
  - ✓ It is difficult to tell from observing the load the extent of the LMR response.
  - ✓ This event may underscore the value of reconsidering how MISO quantifies the capacity credit for LMRs in the PRA.
- Findings regarding prices during the event on the 17<sup>th</sup>:
  - ✓ Prices were high when the RDT was violated due to the RDT demand curve.
  - ✓ Emergency procedures raised prices slightly, but much lower than optimal:
    - ELMP did not properly account for RDT flows.
    - The emergency price floor set by a unit offer can be too low or too high.
  - ✓ Adding the regional reserve requirements and pricing any shortages that occur will lead to fully efficient prices.



## Highlights for Winter 2018

### High Congestion (Slides 10, 23, 24, 25, 26)

- Day-ahead and real-time quarterly congestion costs increased 56 and 29 percent, respectively, over last year.
  - ✓ High gas volatility days early in the month, record-high wind production, and emergency conditions the South in January were contributing factors.
  - ✓ More than one quarter of all day-ahead congestion occurred on January 17 and January 18.
- In January, MISO incurred \$162 million in real-time congestion in the Midwest and \$64.5 million in the South.
- More than 40 percent of real-time congestion was attributable to market-to-market constraints.
  - ✓ One constraint impacted by a PJM pseudo-tied unit contributed to \$36 million in congestion in the quarter, and PJM paid MISO \$9.6 million.
  - ✓ Wind units in PJM had the majority of relief on a constraint that contributed to \$29 million in real-time congestion (which is difficult to manage).





## Submittals to External Entities and Other Issues

- We made two new referrals and responded to FERC questions related to prior referrals and continued to meet with FERC on a weekly basis.
  - ✓ A participant provided false information in a Reference Price Consultation.
  - ✓ We also referred a matter related to PJM's failure to perform CMP Study 1 and MISO is evaluating impacts for possible resettlement.
  - ✓ We responded to several data requests related to prior referrals.
  - ✓ We made several notifications of other potential Tariff violations.
- We participated in the following FERC dockets.
  - ✓ We filed a protest related to MISO's refile of its capacity market in an attempt to remedy the design flaw that causes inefficiently low prices.
    - FERC affirmed the design flaw, but the Order ignores the evidence we and others filed.
  - ✓ We assisted MISO in the Order 831 Compliance filing (increasing the Offer Cap), and a modification to the Resource Adequacy Construct to include external resource zones in the PRA.
  - ✓ We submitted comments in the Fast-Start Pricing dockets in NY and PJM.



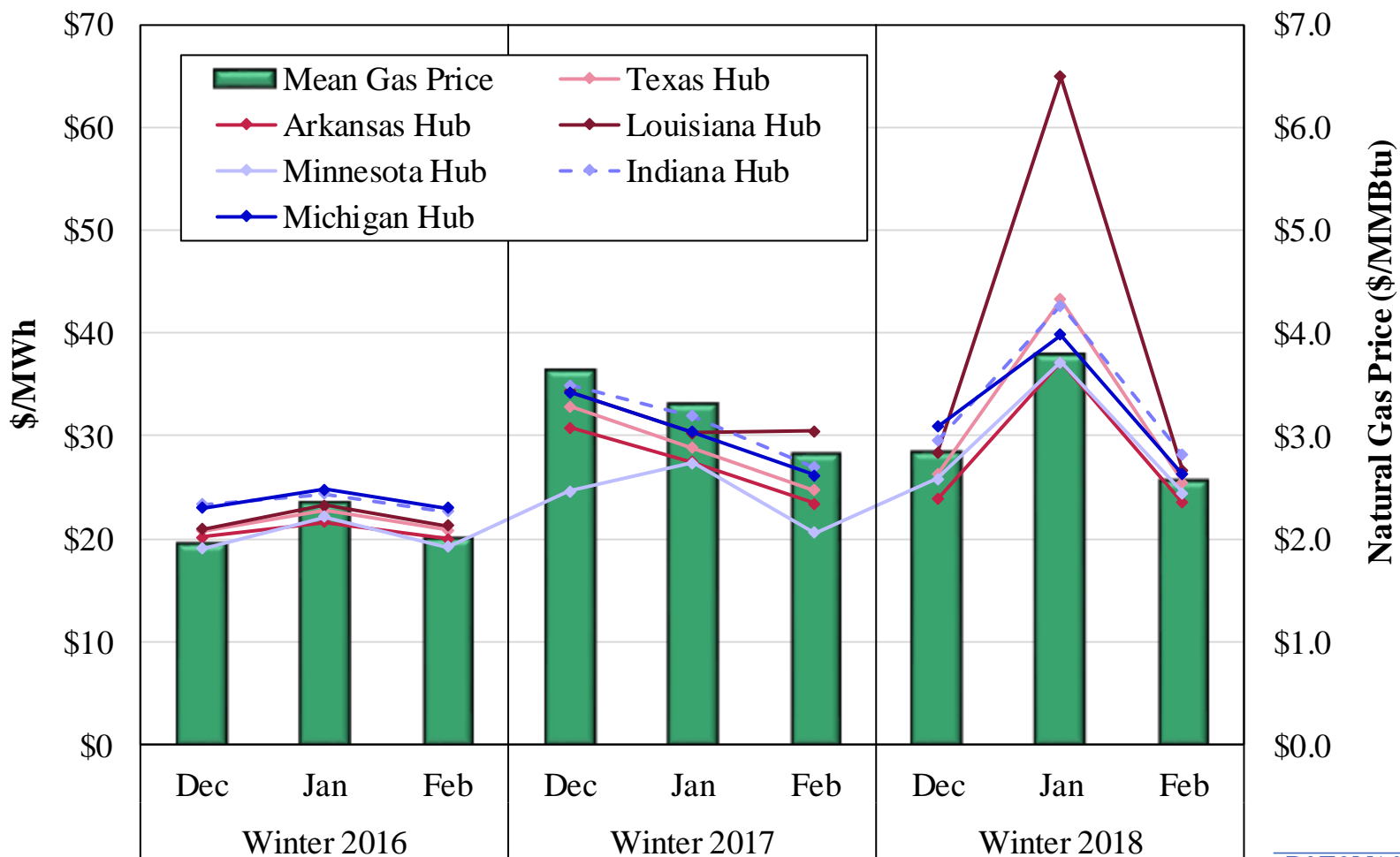


## Submittals to External Entities and Other Issues

- We participated in a number of stakeholder discussions and working groups.
  - ✓ At the MSC and at the ERSC, we discussed concerns with the current RDT commitment tool and the need for improvements to reduce inefficient commitments.
  - ✓ We continued to work with MISO and stakeholders on proposed improvements to the Uninstructed Deviation Thresholds (SOM 2012-2) and improved incentives for PVWMP (SOM 2016-5).
  - ✓ In February, we presented at the RASC meeting to prepare stakeholders for the upcoming PRA.
  - ✓ We participated in the February PJM-MISO JCM Meeting.

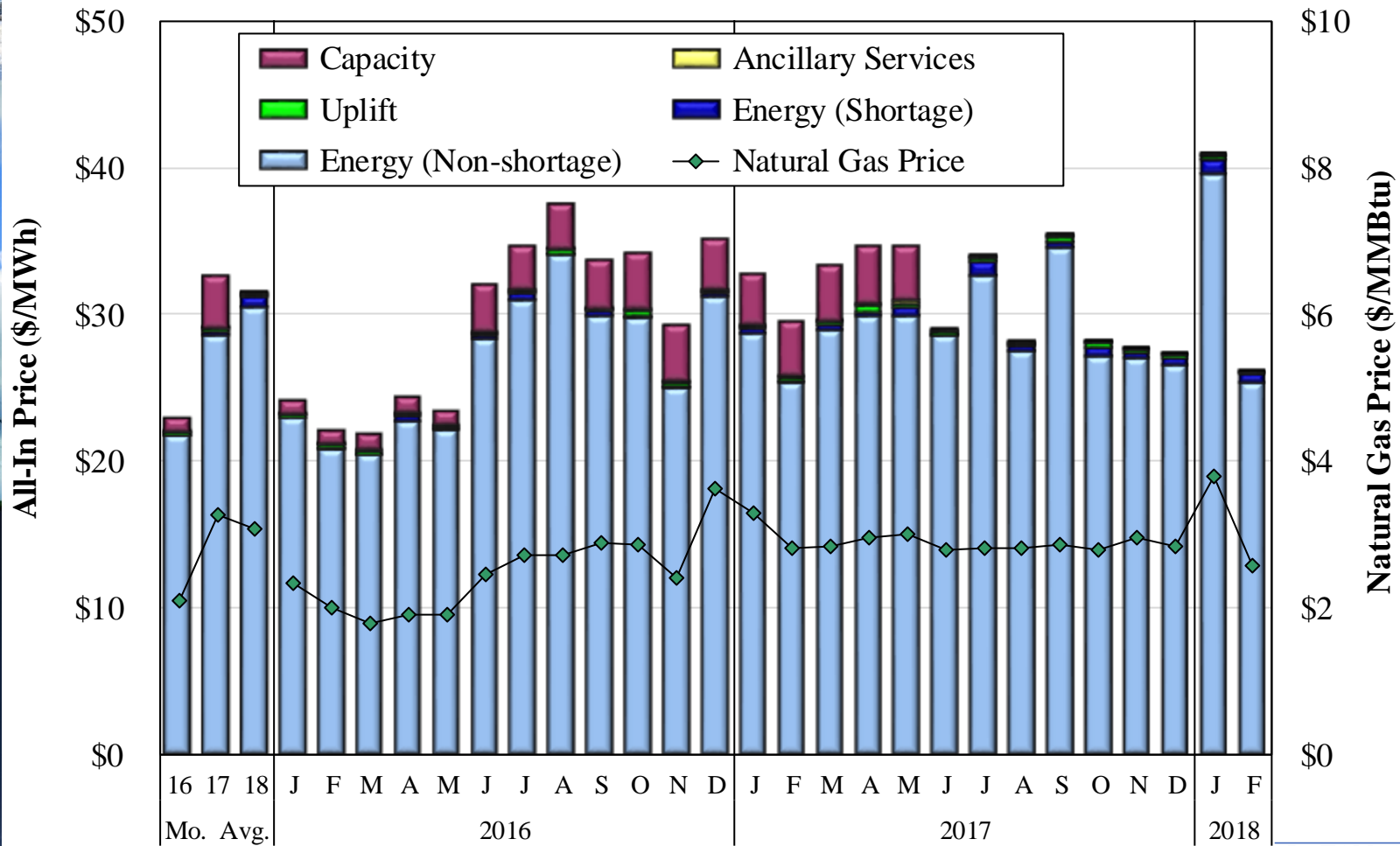


# Day-Ahead Average Monthly Hub Prices Winter 2016 – 2018





# All-In Price Winter 2016 – 2018





## Average Temperatures on January Cold Days

	Hist. Avg.*	January								
		1	2	3	4	5	16	17	18	19
<b>Midwest</b>										
Minneapolis	14.2	-7.2	4.1	3.1	-1.4	-4.0	1.7	14.4	30.7	35.3
Milwaukee	21.8	-1.1	4.6	12.6	5.9	5.1	20.5	15.9	26.0	35.2
Detroit	25.9	8.4	6.7	10.8	8.7	1.5	13.1	12.7	20.7	29.7
Indianapolis	27.2	-3.7	-1.4	12.8	4.6	0.7	2.3	8.3	19.9	30.1
<b>South</b>										
Little Rock	38.9	15.8	16.7	24.0	24.9	29.4	17.0	14.7	24.0	34.3
New Orleans	53.7	31.3	31.5	38.2	38.2	39.7	37.3	27.7	33.4	43.6

Cold Weather Alert (MISO)

Conservative Ops in MISO (Jan 2-5) and South (Jan 16,19)

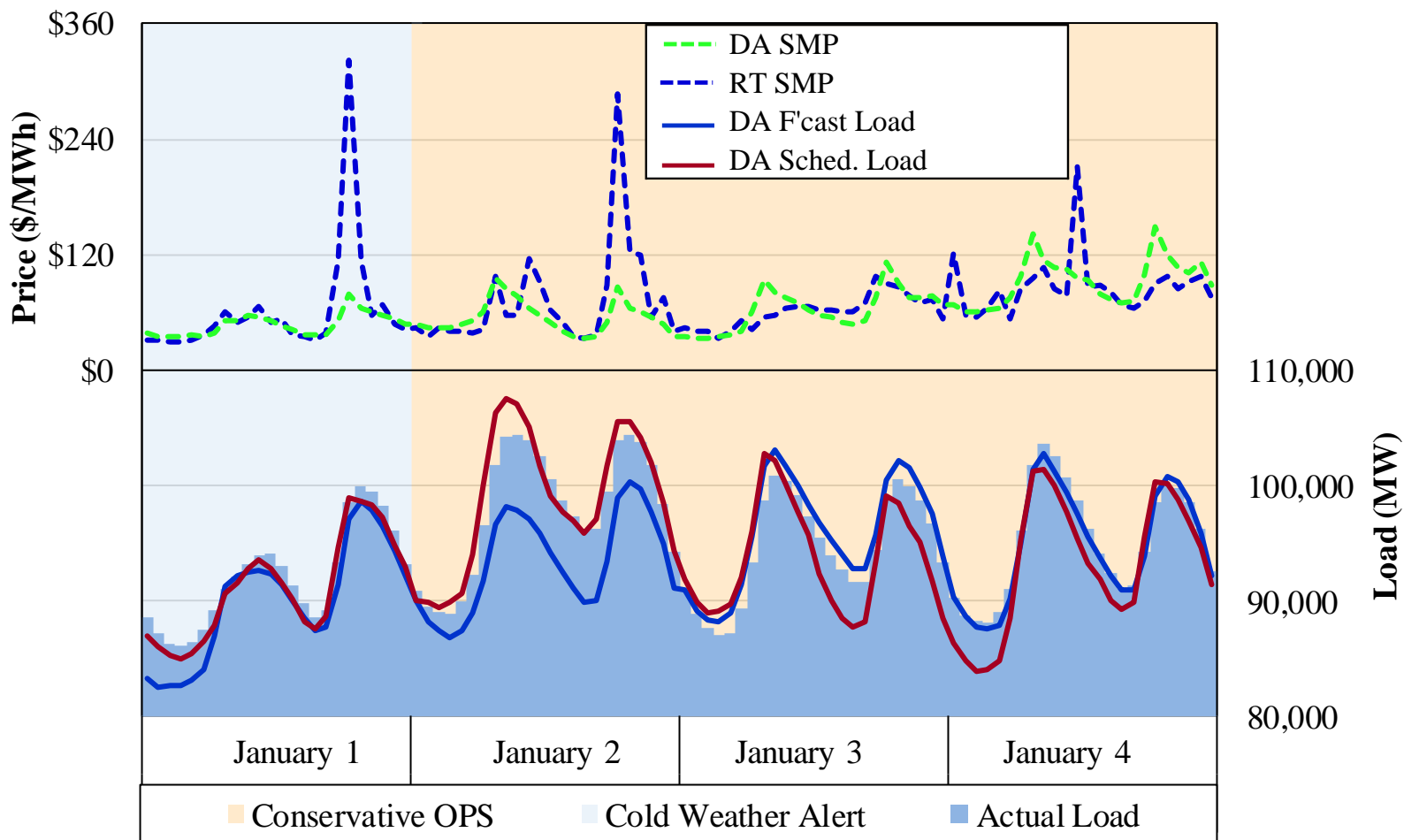
Max Gen Event in South

\* Historical Avg. is average of those days' average temperature from 2008-2017.

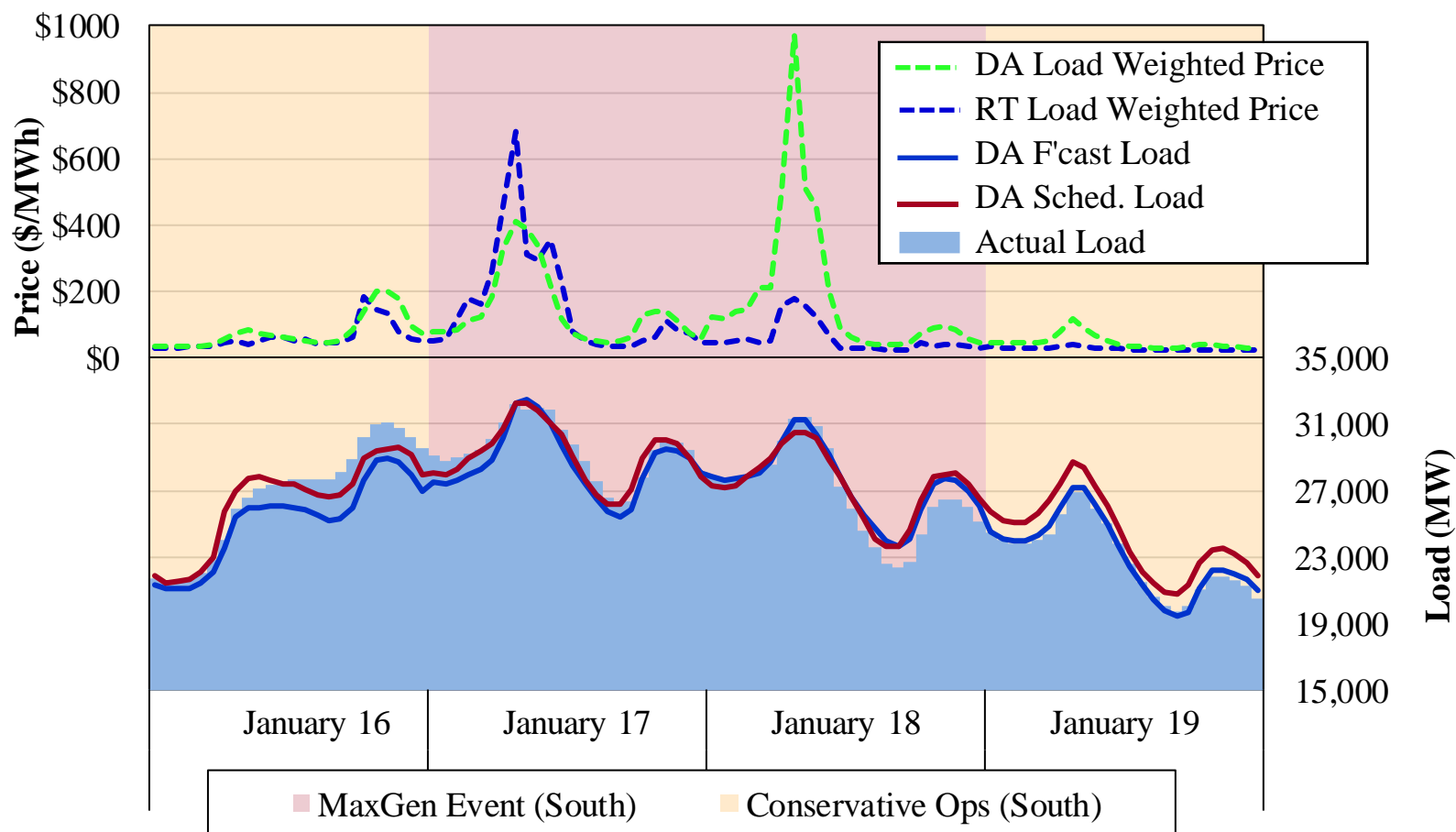


# Cold Weather Alerts and Conservative Ops

## January 1 - 4

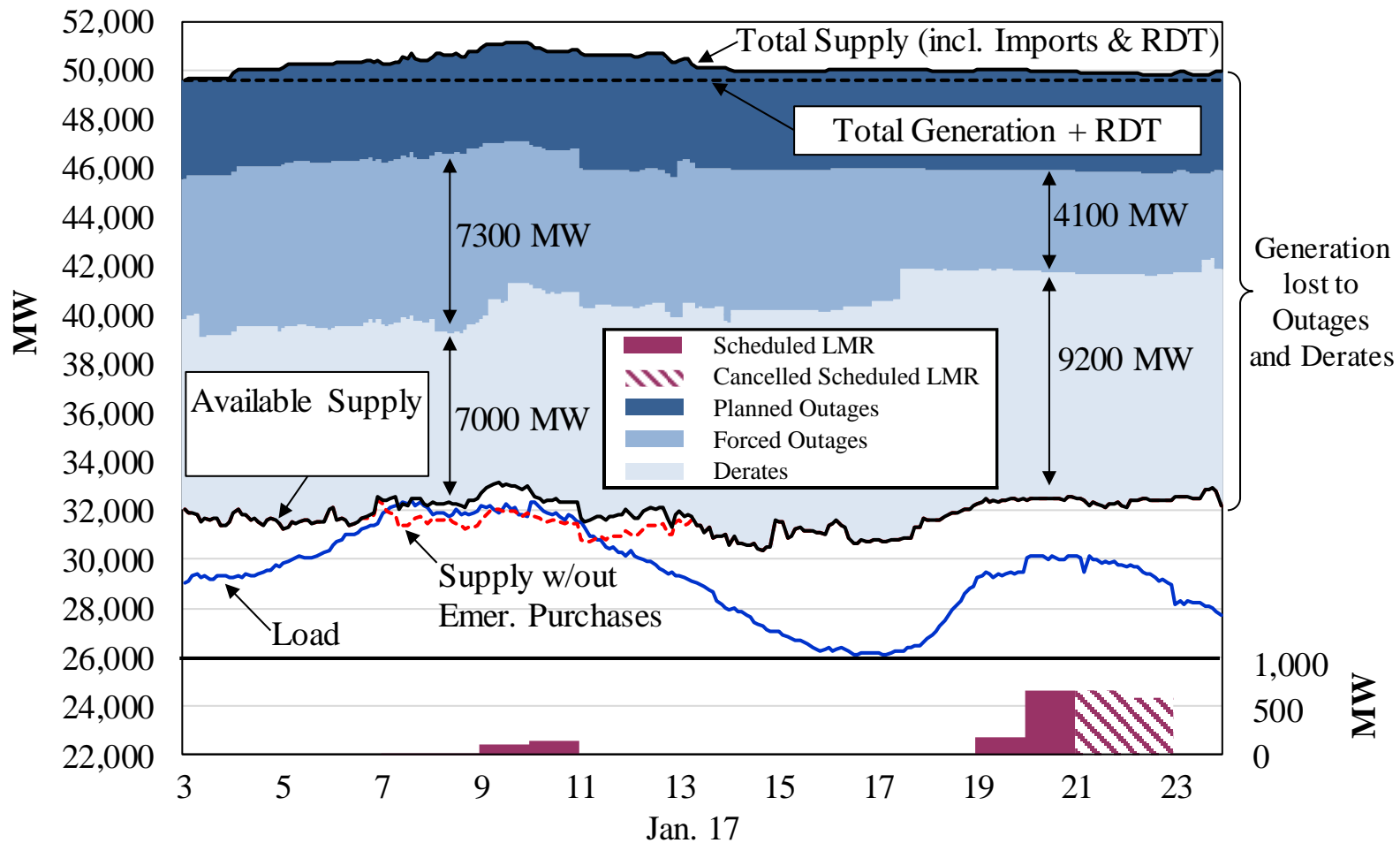


# Conservative Ops and Max Generation Event in MISO South January 17 & 18

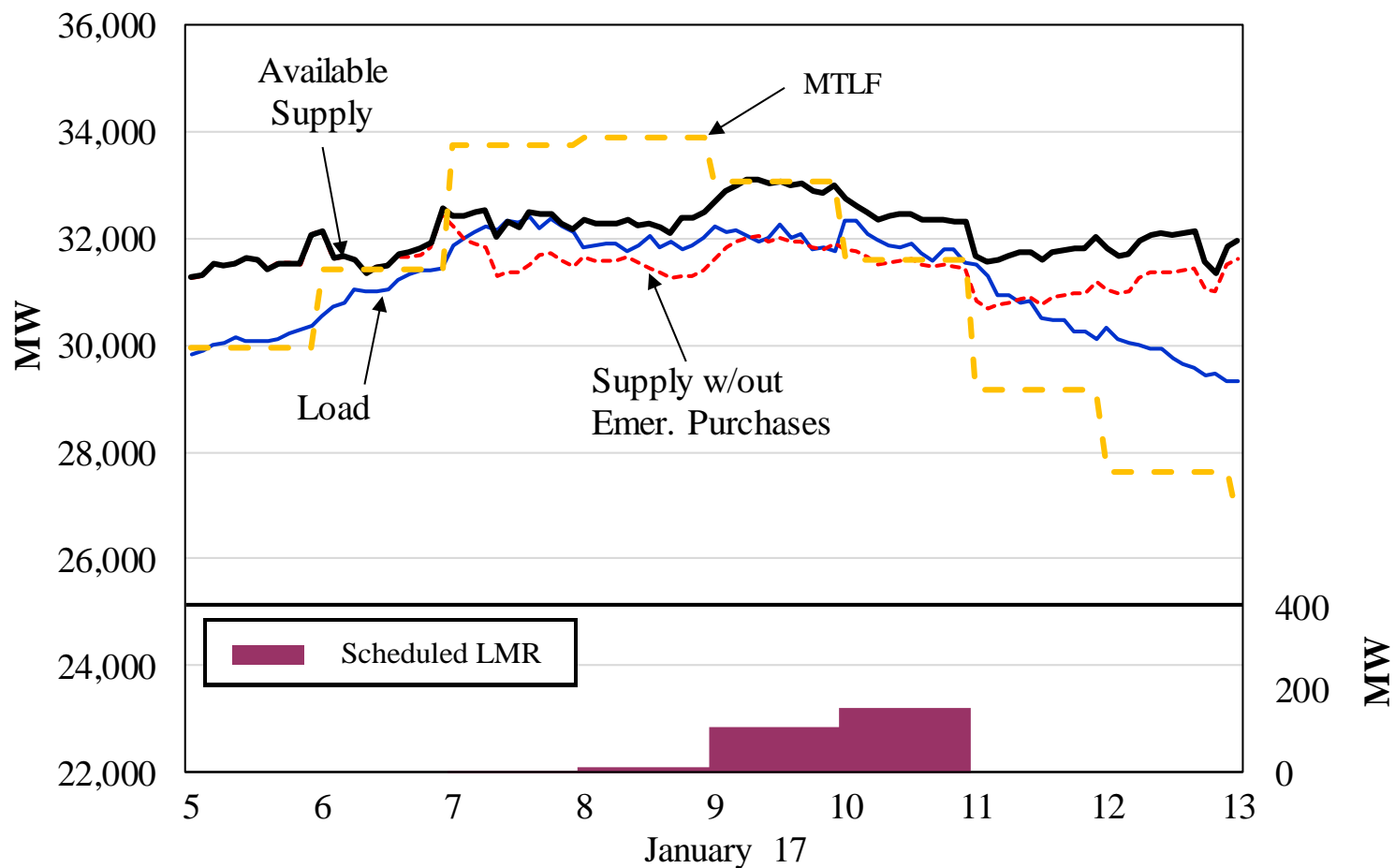




# MISO South Generation and Load January 17



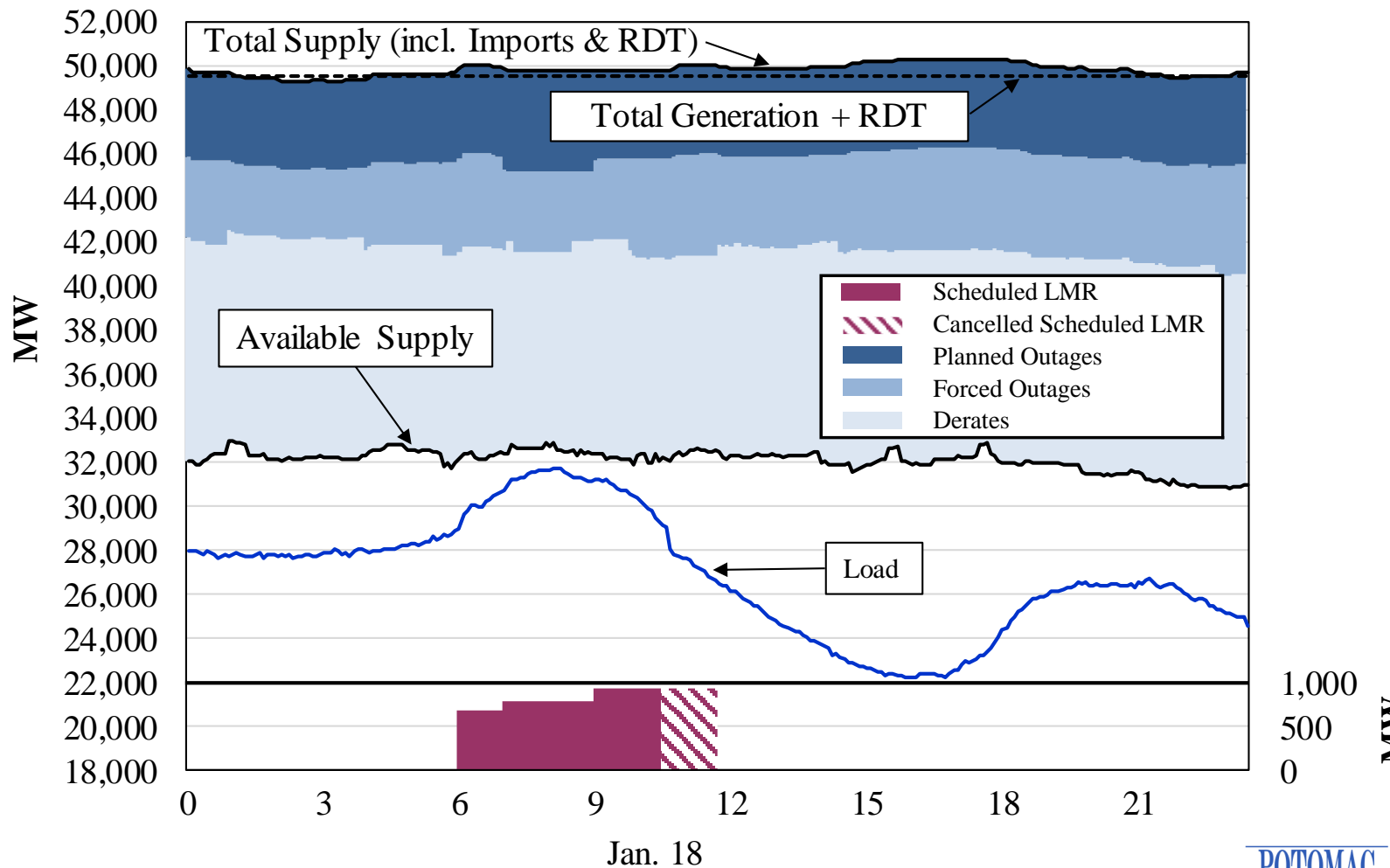
# MISO South Generation and Load January 17 Maximum Generation Event





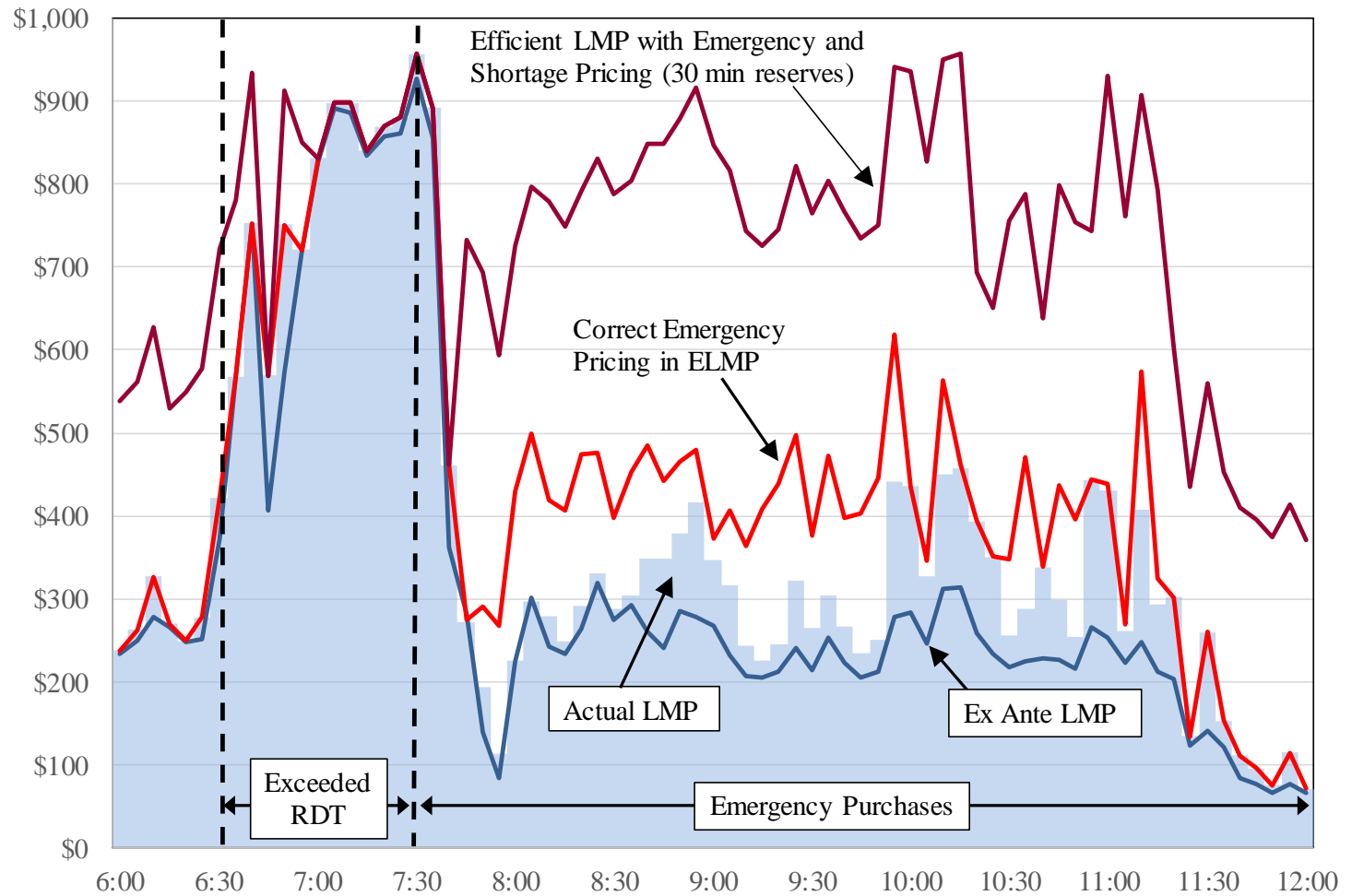


# MISO South Generation and Load January 18, 2018

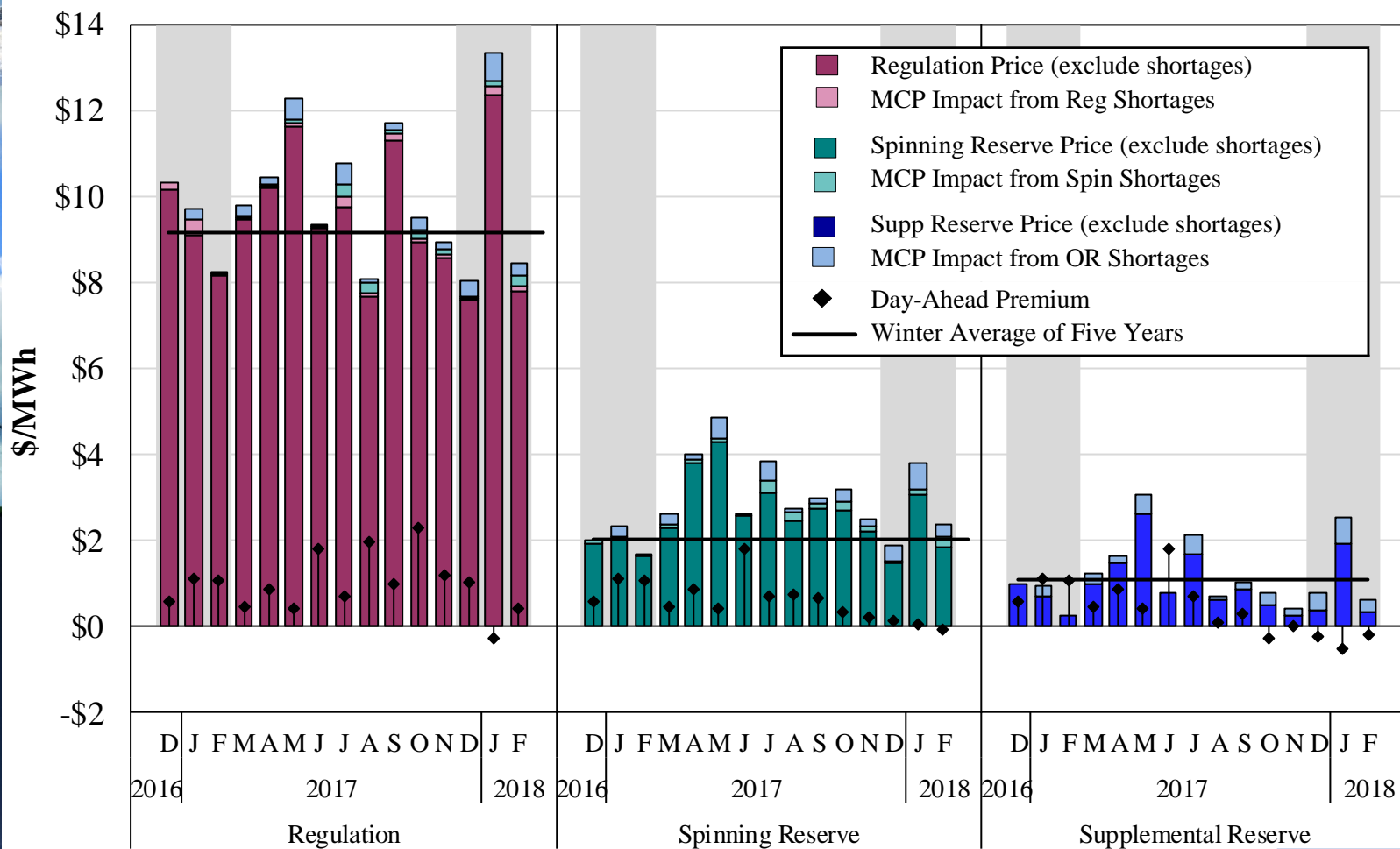




## Pricing on January 17 During Maximum Generation Event

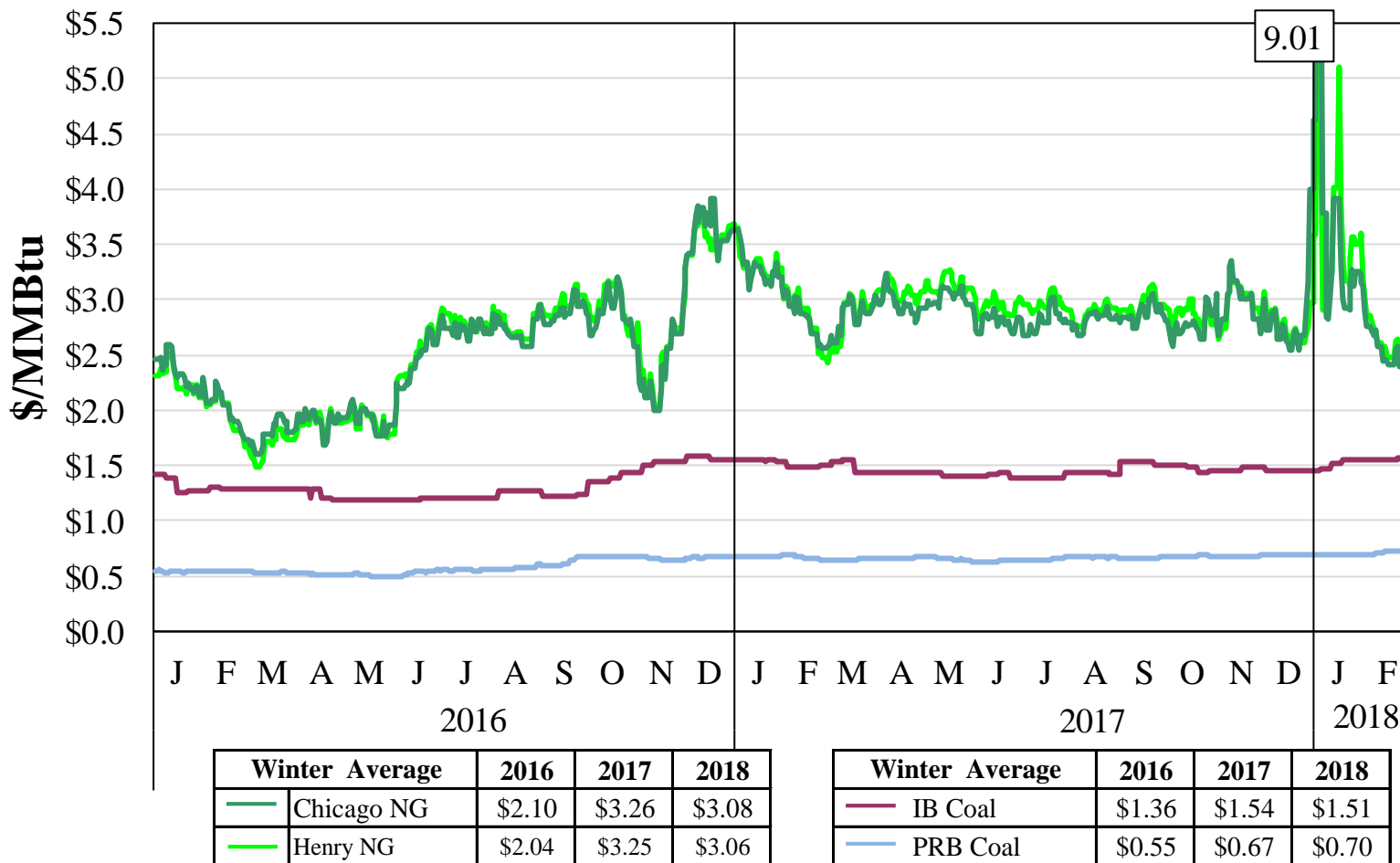


# Monthly Average Ancillary Service Prices Winter 2017 – 2018





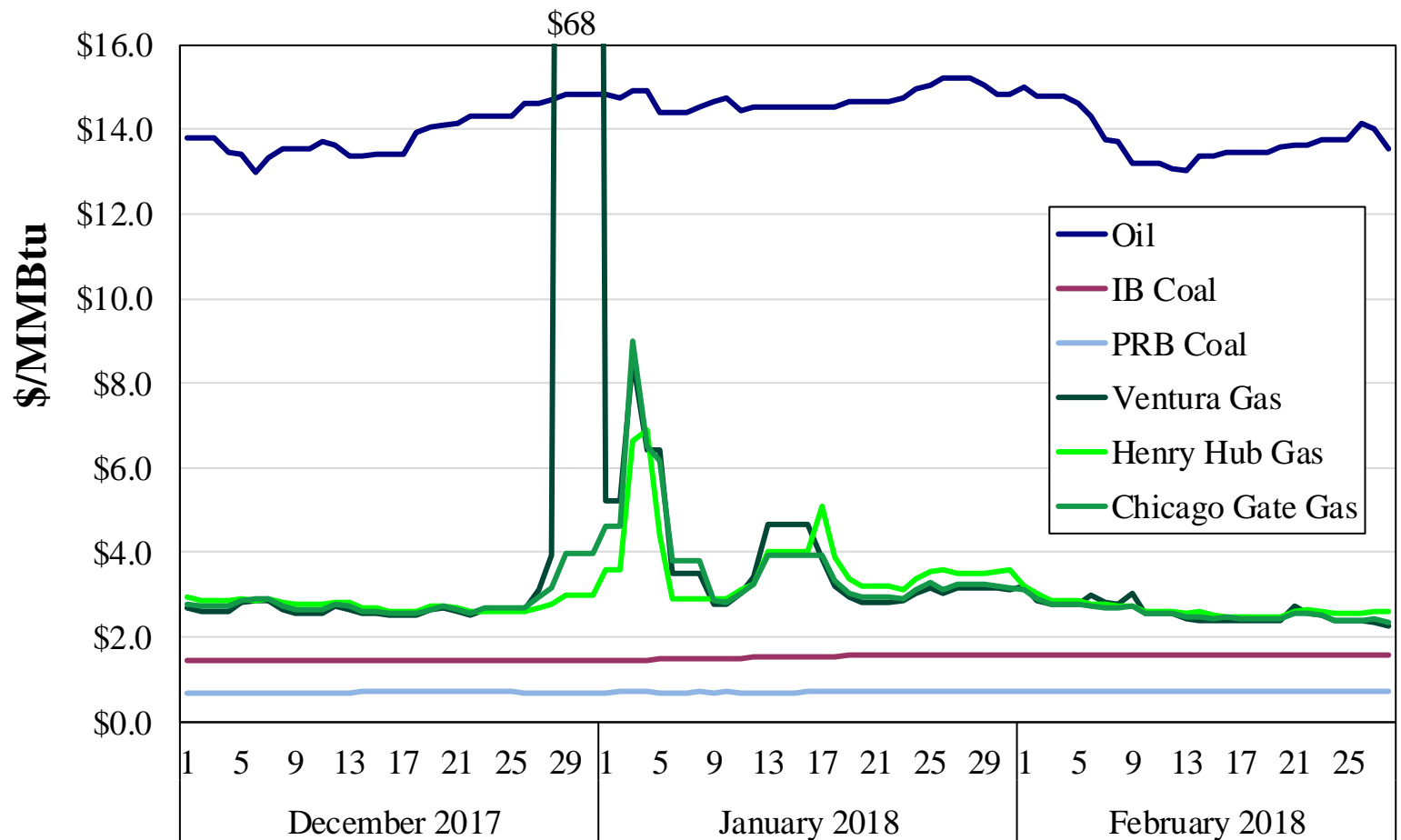
## MISO Fuel Prices 2016 – 2018







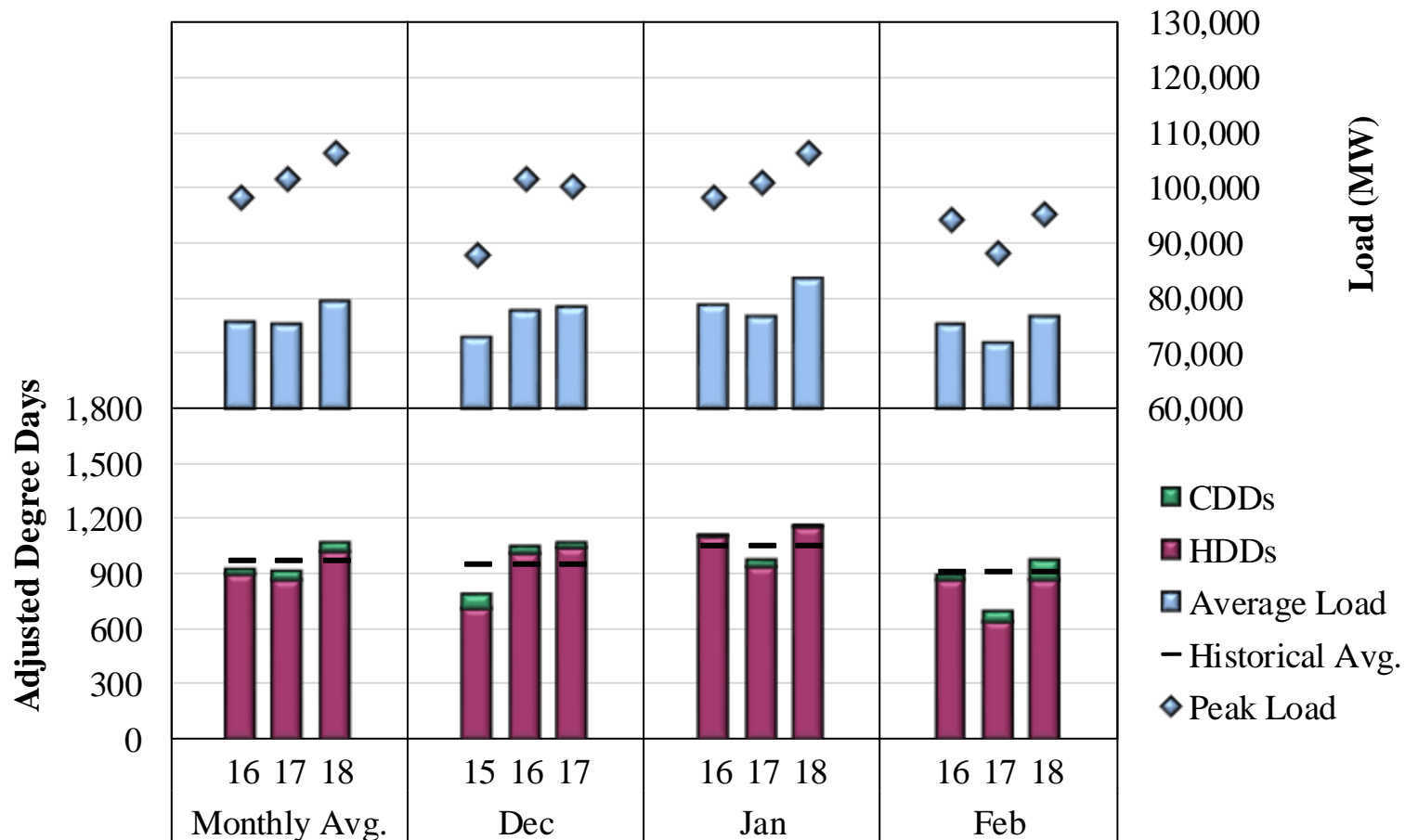
## MISO Fuel Prices Winter 2018





# Load and Weather Patterns

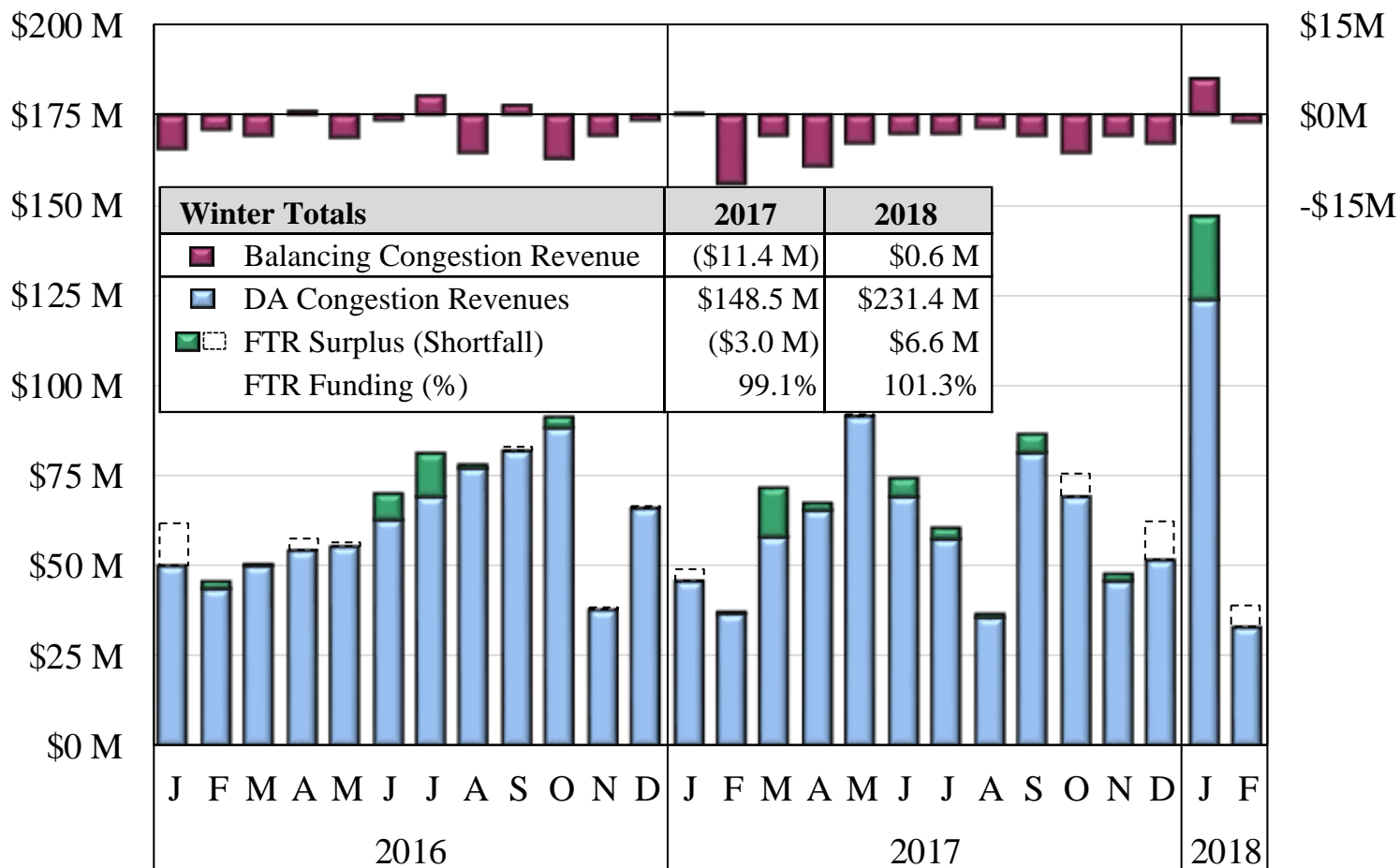
## Fall 2016 – 2018



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.

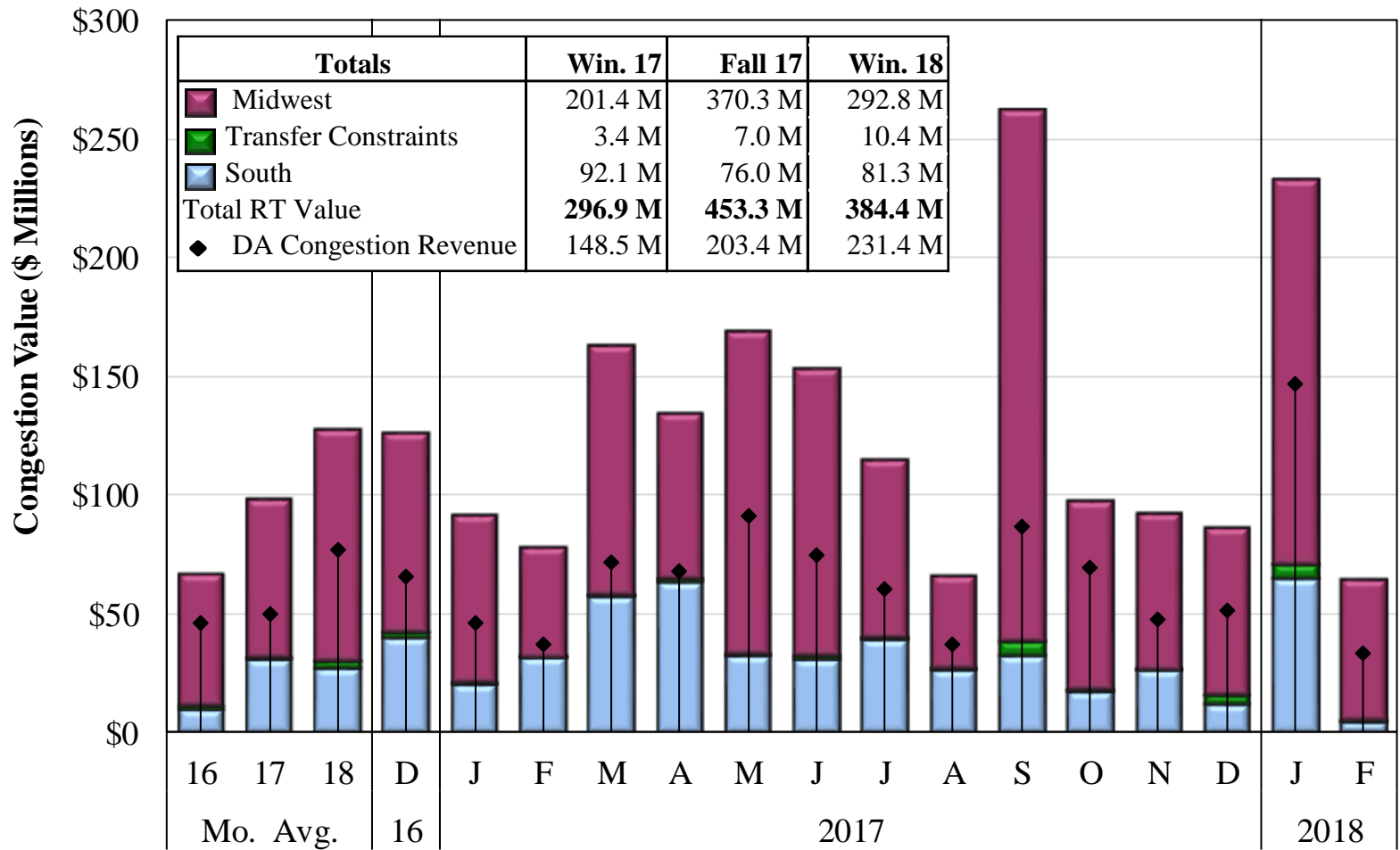


# Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2016 – 2018





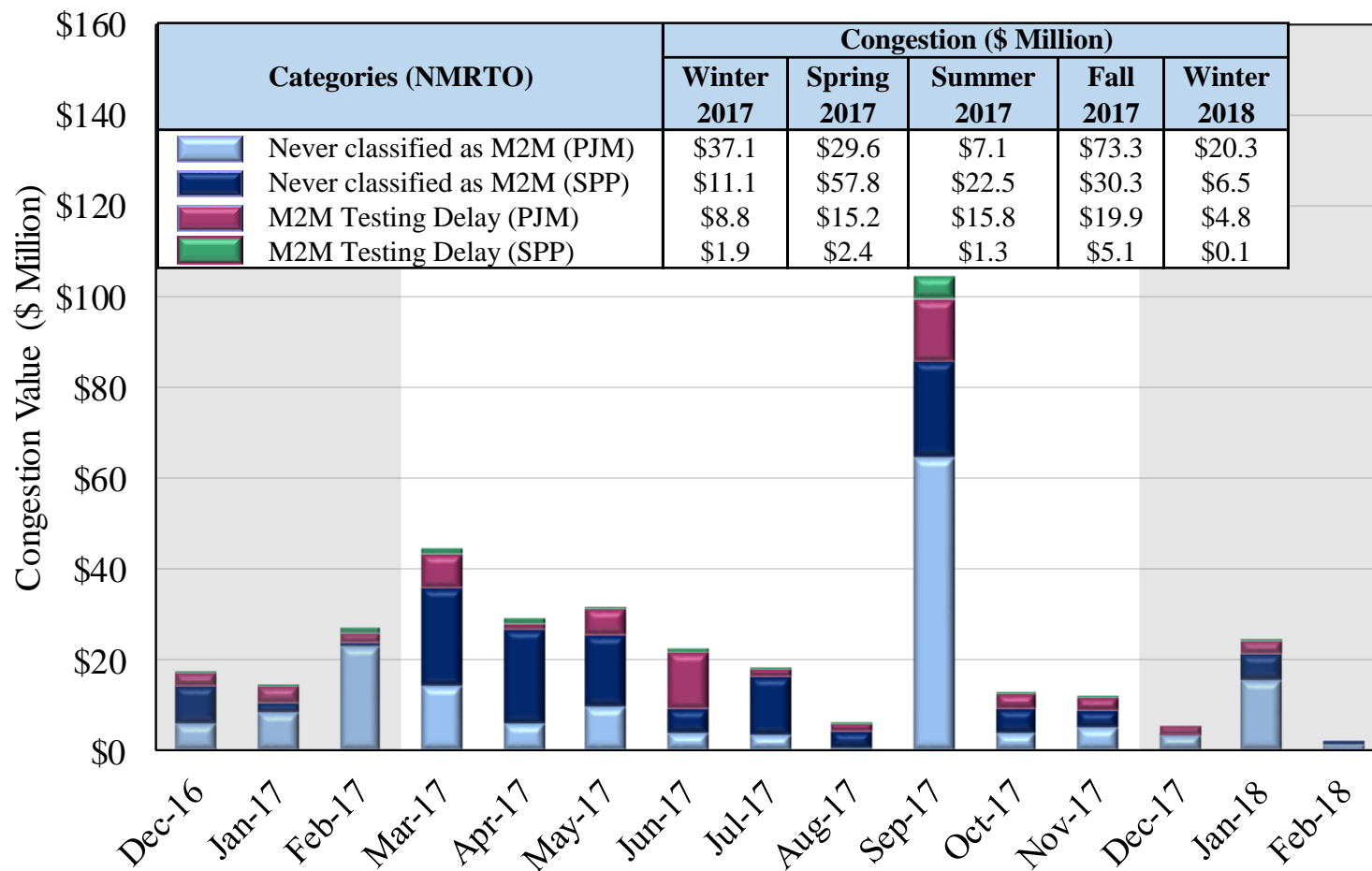
# Value of Real-Time Congestion Winter 2017 – 2018





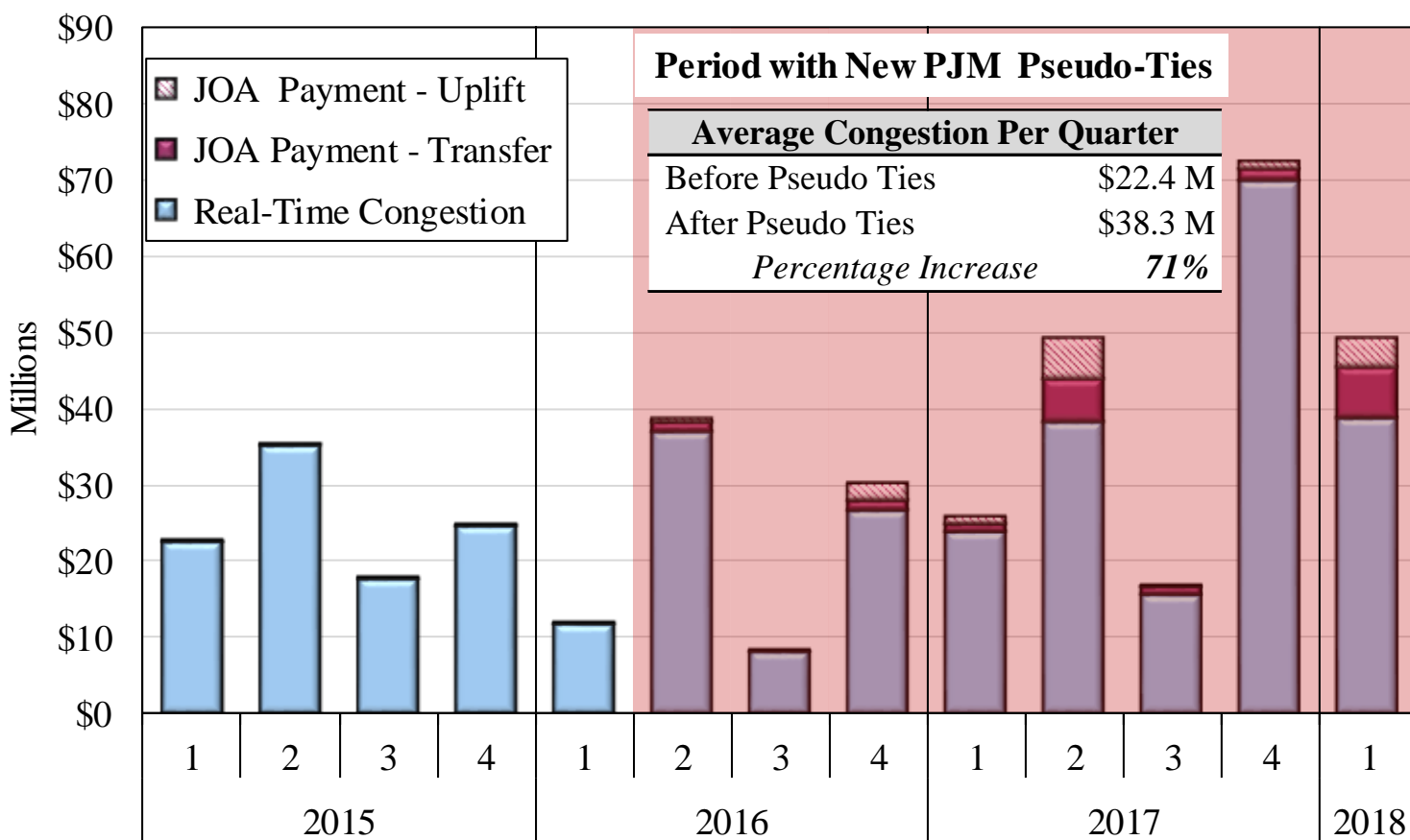
# Market-to-Market Testing and Activation Delay

## Congestion Costs: 2017 - 2018



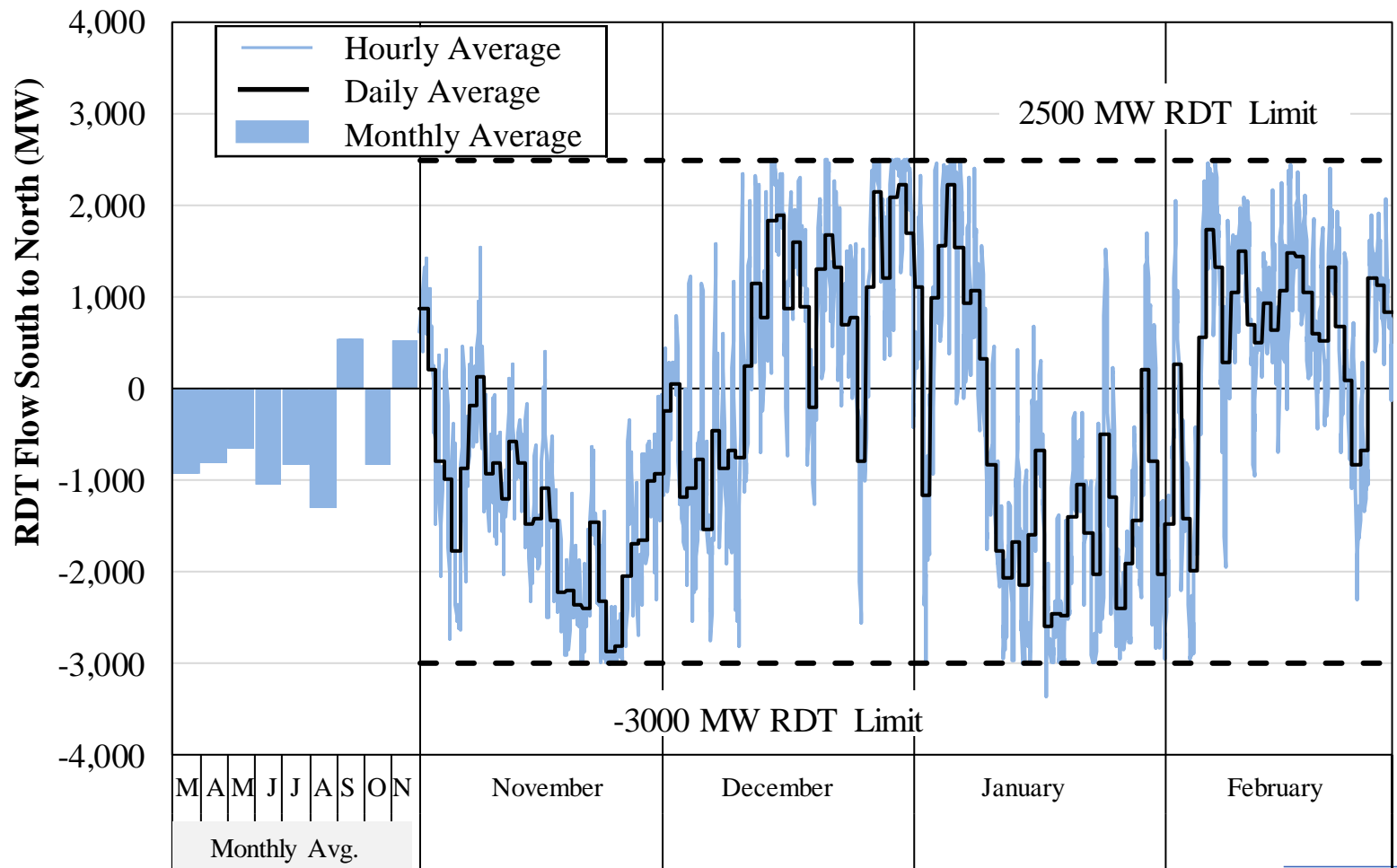


# MISO Congestion Value and JOA Settlement Constraints Impacted by Pseudo-Ties





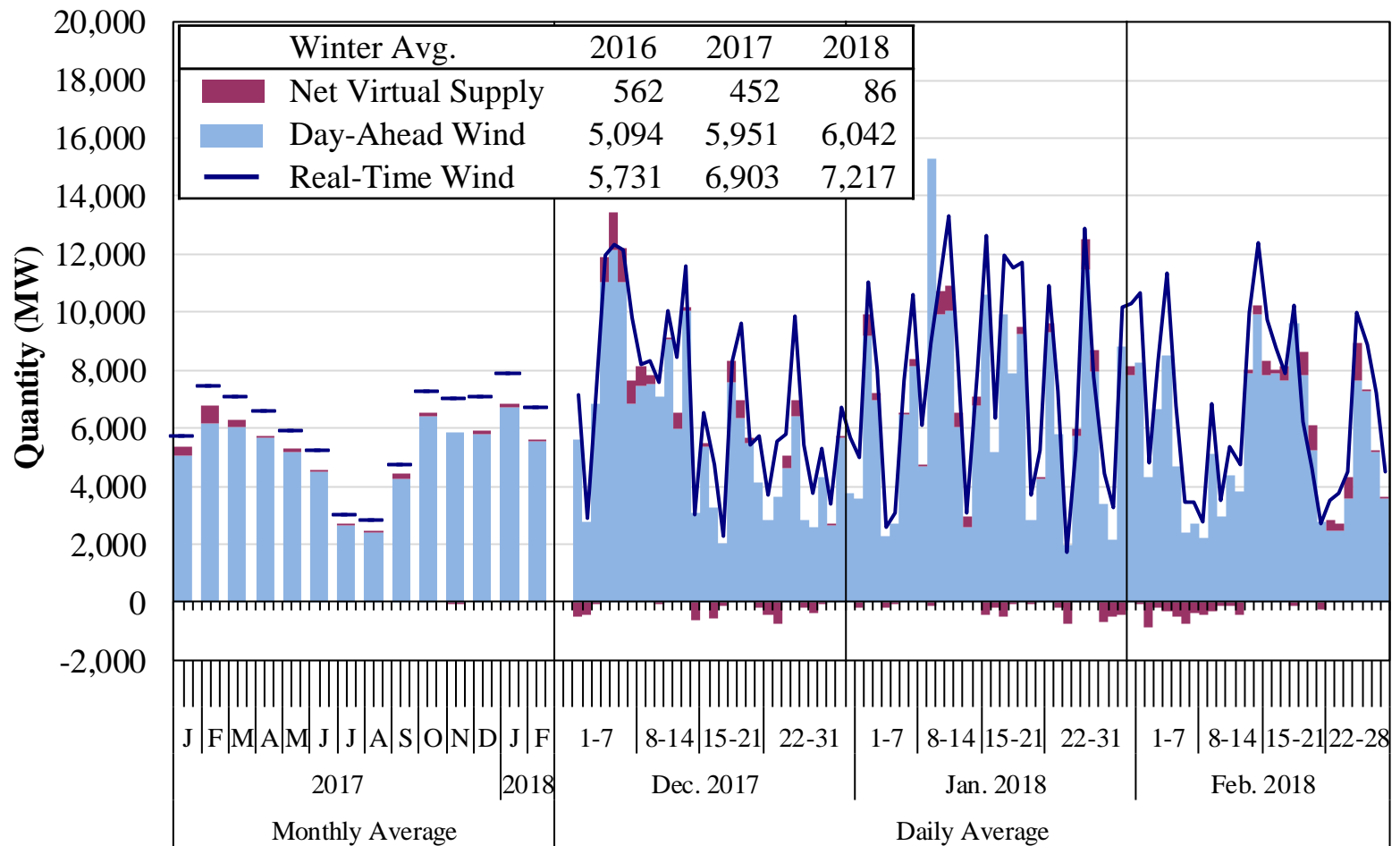
# Real-Time Hourly Inter-Regional Flows 2017 - 2018





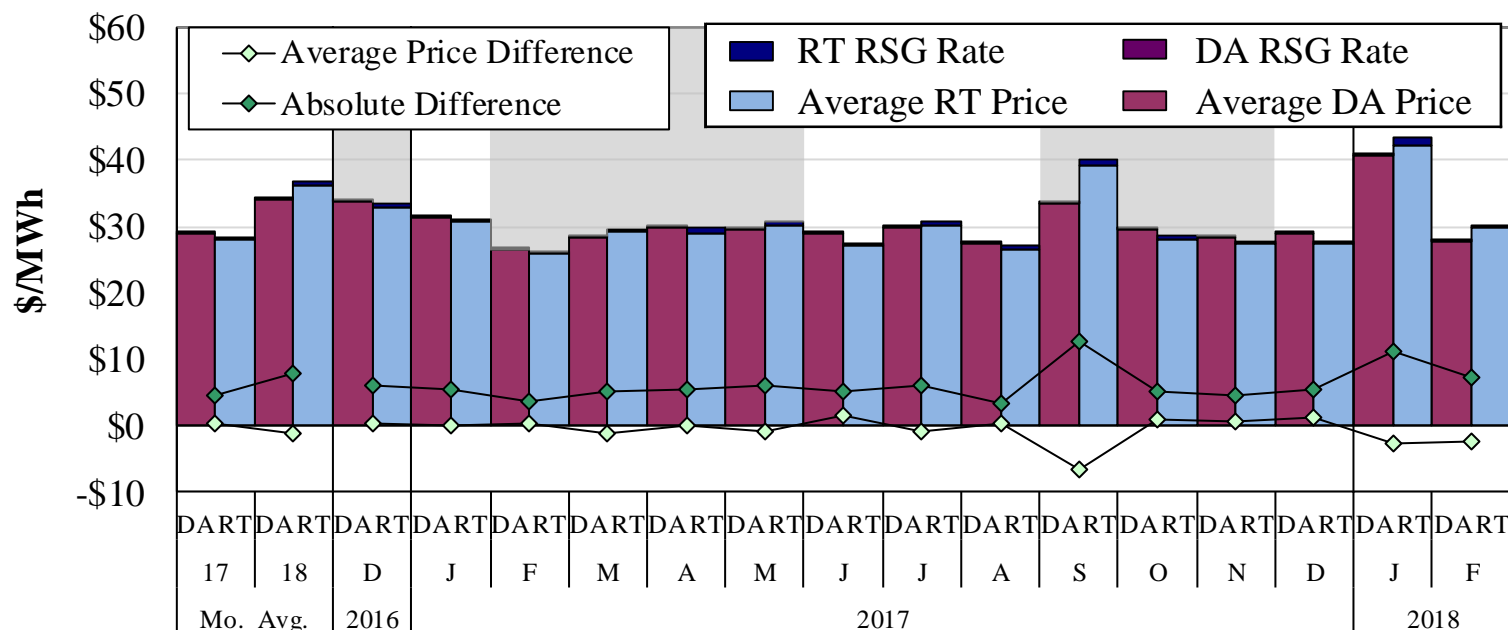
# Wind Output in Real-Time and Day-Ahead

## Monthly and Daily Average





# Day-Ahead and Real-Time Price Convergence Winter 2017 – 2018

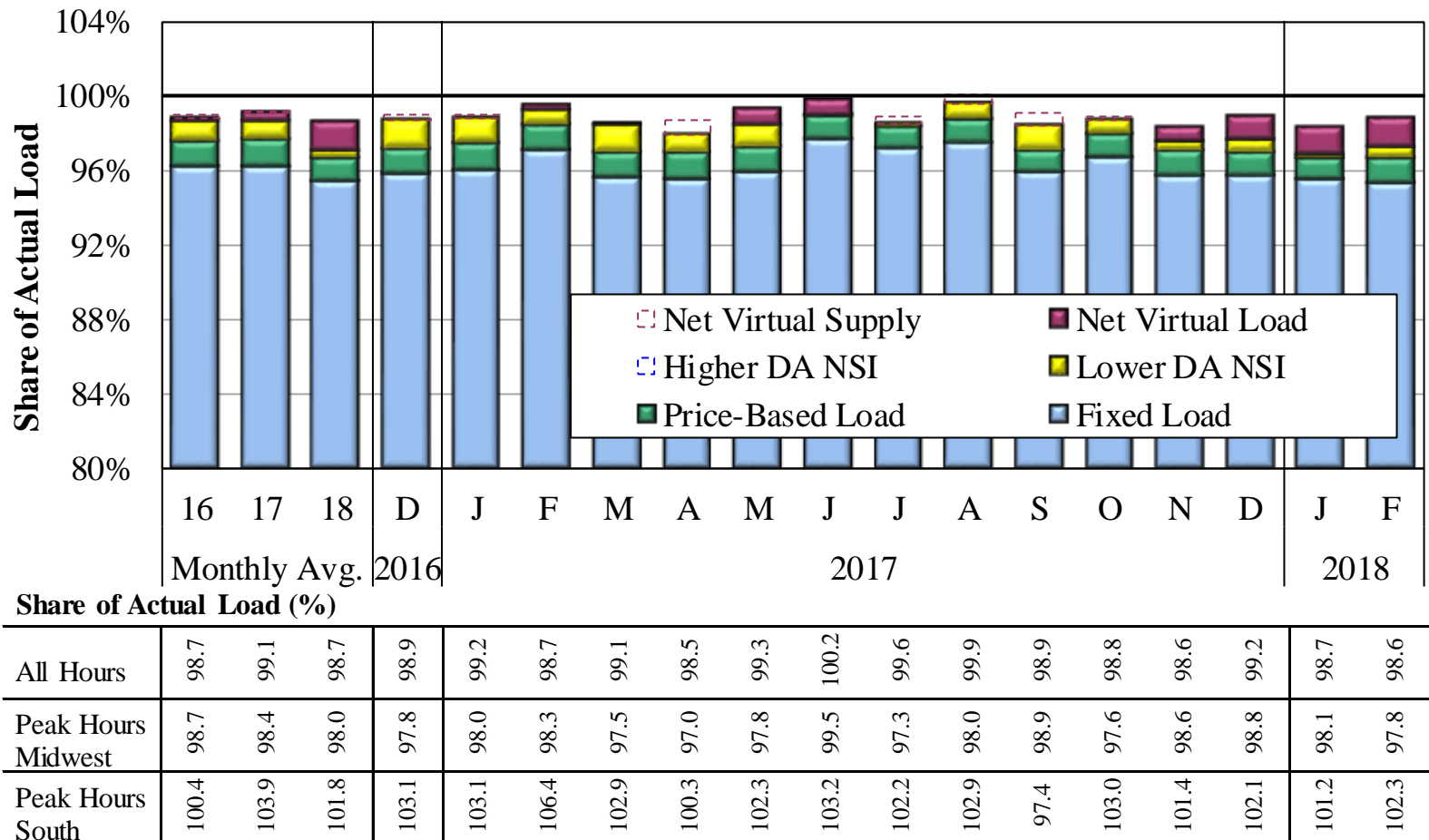


**Average DA-RT Price Difference Including RSG (% of Real-Time Price)**

Indiana Hub	1	-3	1	0	1	-4	0	-3	5	-3	1	-16	3	2	4	-6	-8
Michigan Hub	1	0	2	1	1	-6	-1	-1	0	-3	1	-11	-1	0	2	-2	1
Minnesota Hub	0	-1	-6	3	3	-1	-5	1	5	-7	2	-7	-10	3	0	3	-6
WUMS Area	-3	0	-6	-1	-2	3	-1	3	3	-8	3	-11	0	0	2	2	-3
Arkansas Hub	1	-2	0	1	3	-3	0	2	5	-7	2	-2	5	-3	1	-7	-1
Texas Hub	1	-1	2	-2	3	-2	3	4	-1	-1	3	1	8	-6	4	-5	-1
Louisiana Hub	1	-9	1	1	-2*	2	-4	3	-1	-9	-6	-1	7	-5	5	3*	3

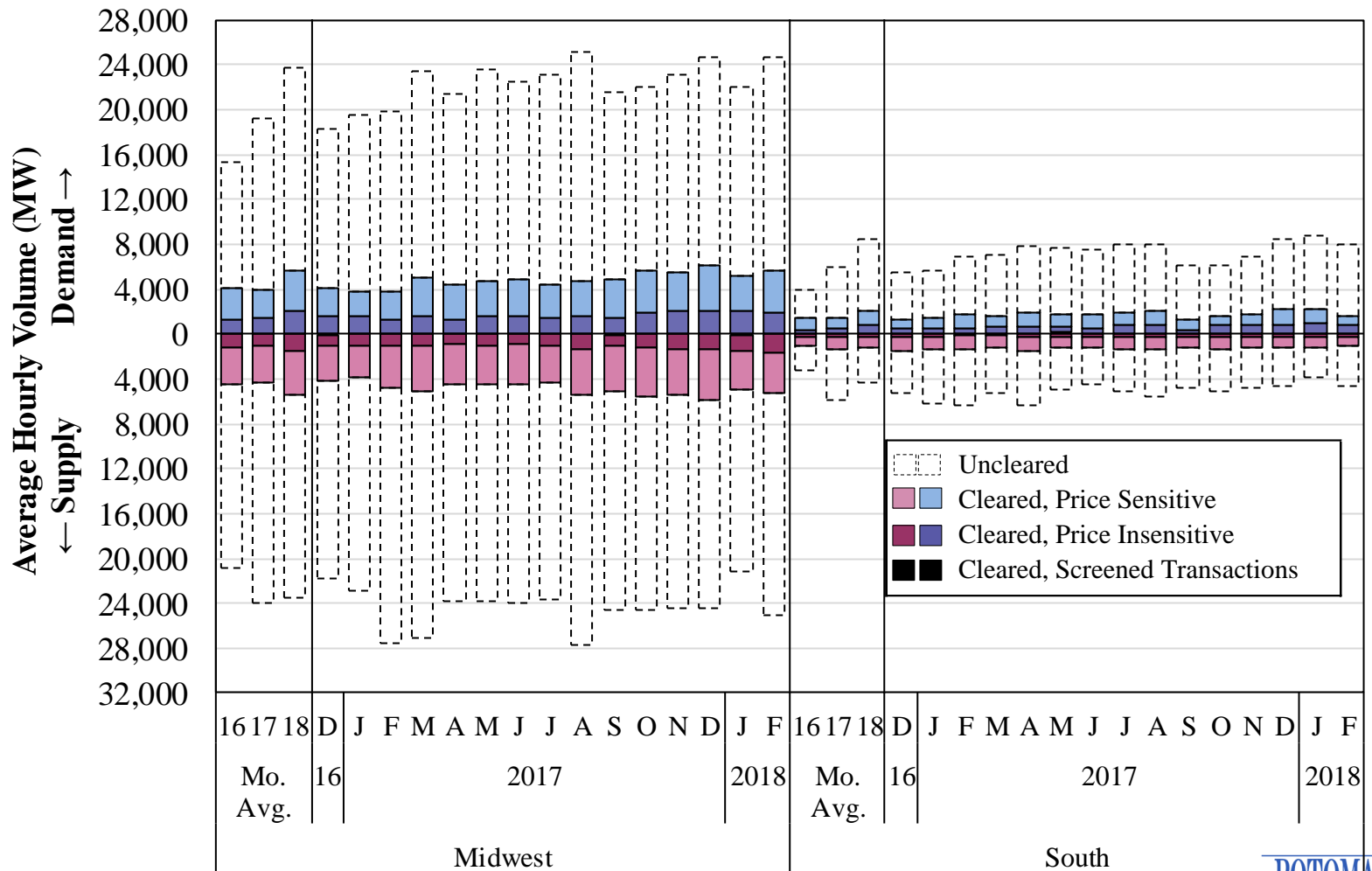
\* Excluding Feb. 7, 2017 and Jan. 17-18, 2018.

# Day-Ahead Peak Hour Load Scheduling Winter 2017 – 2018



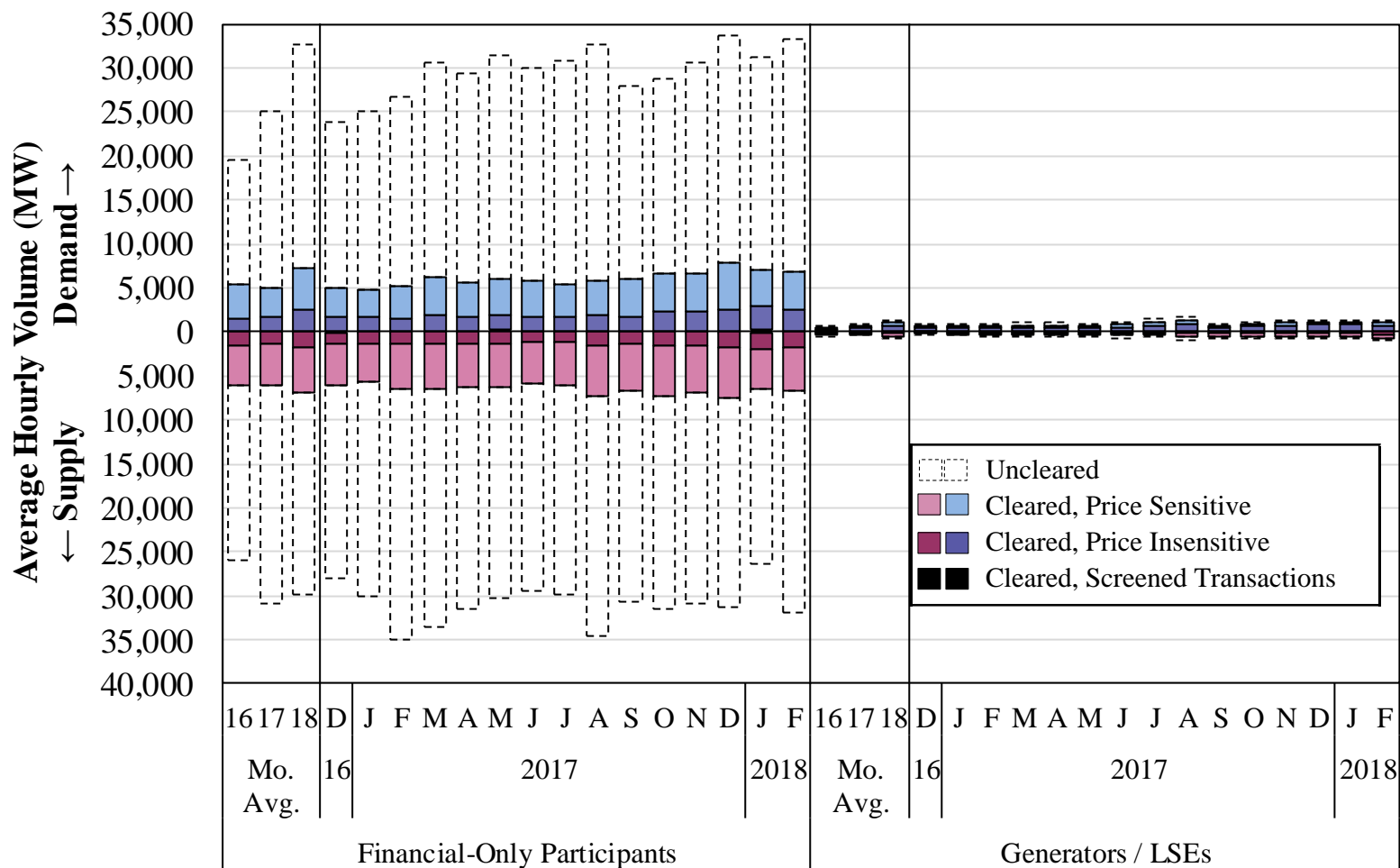


# Virtual Load and Supply Winter 2017 – 2018





# Virtual Load and Supply by Participant Type Winter 2017 – 2018

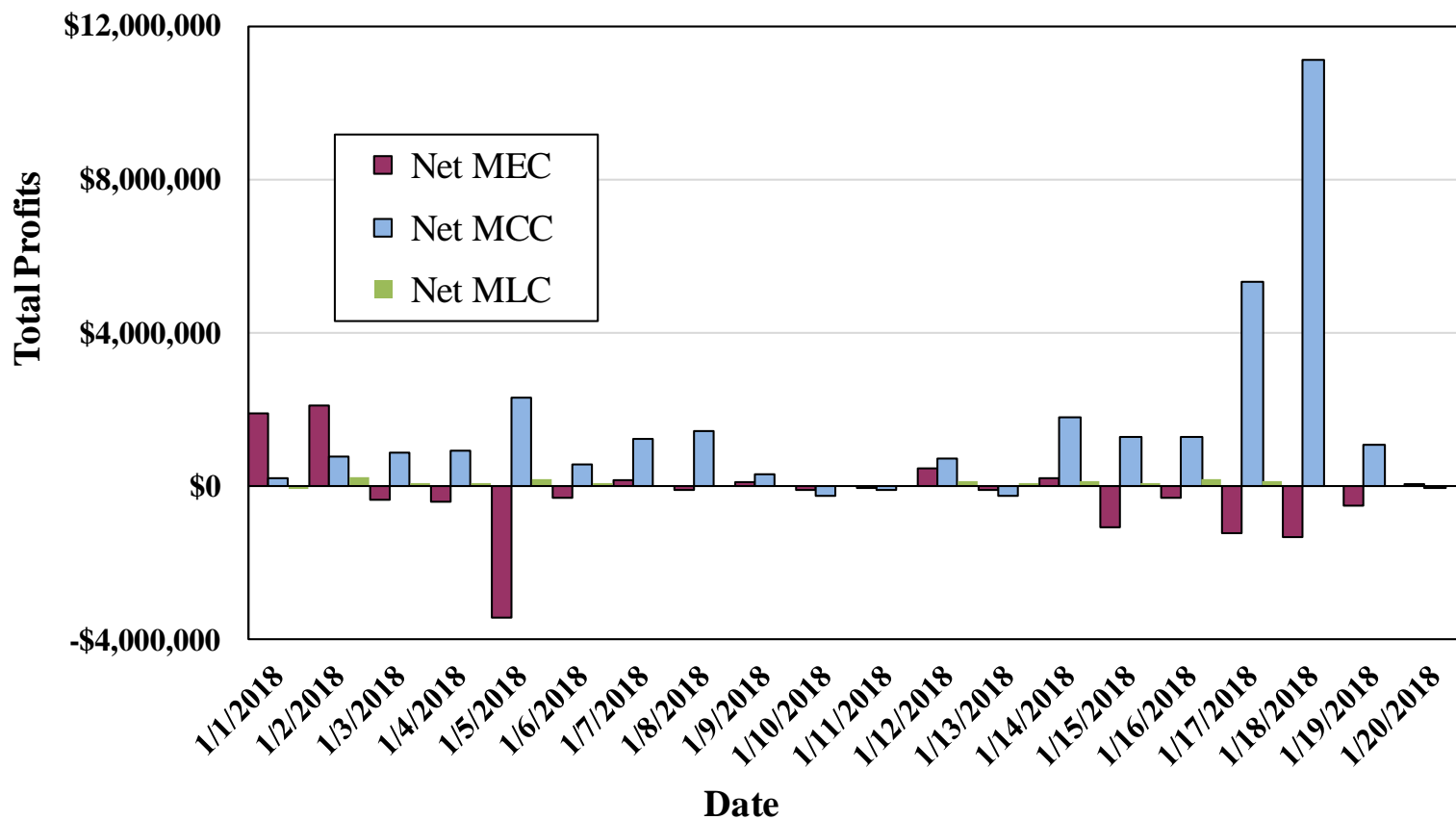






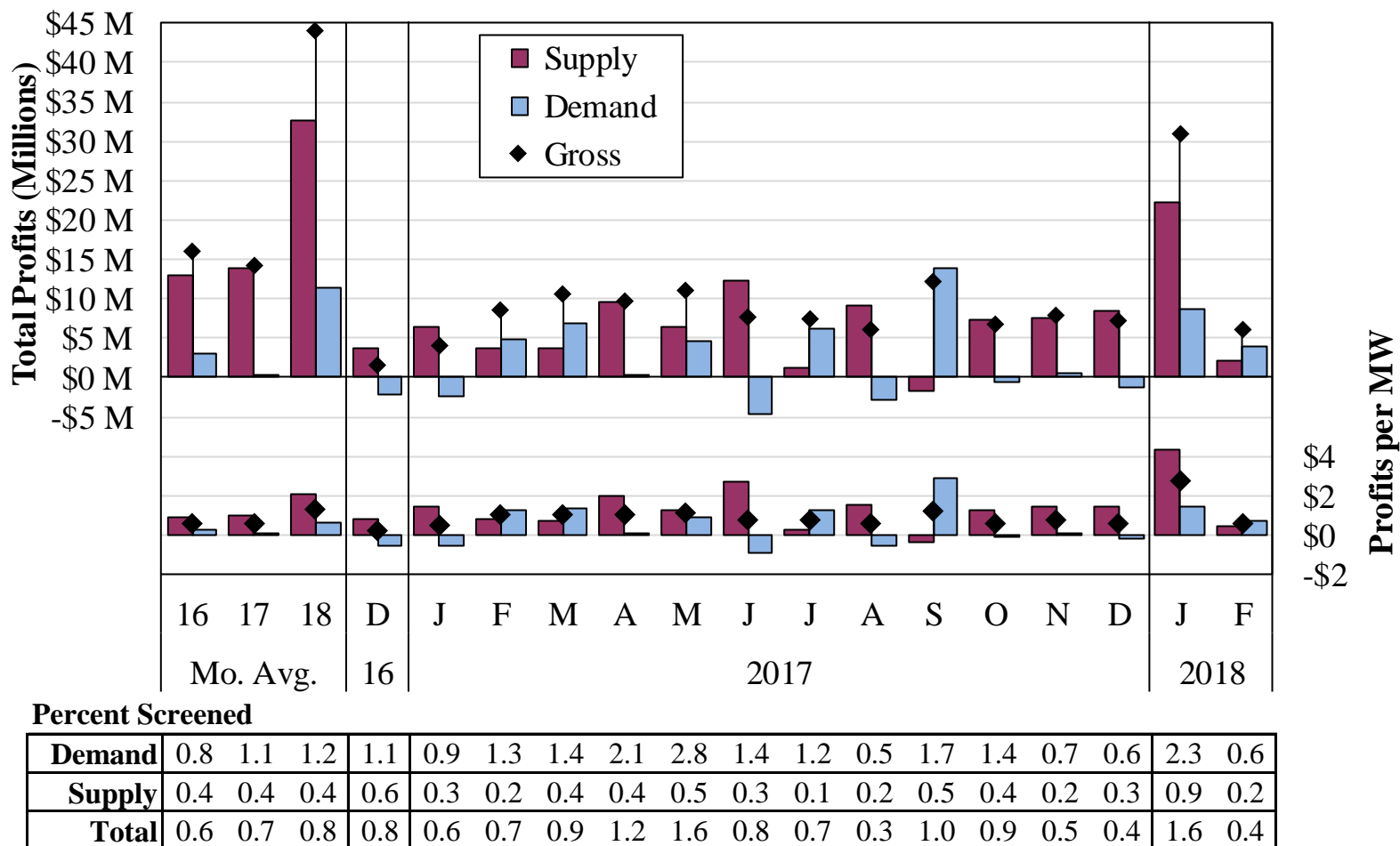
# Virtual Profitability

## January 1 - 20



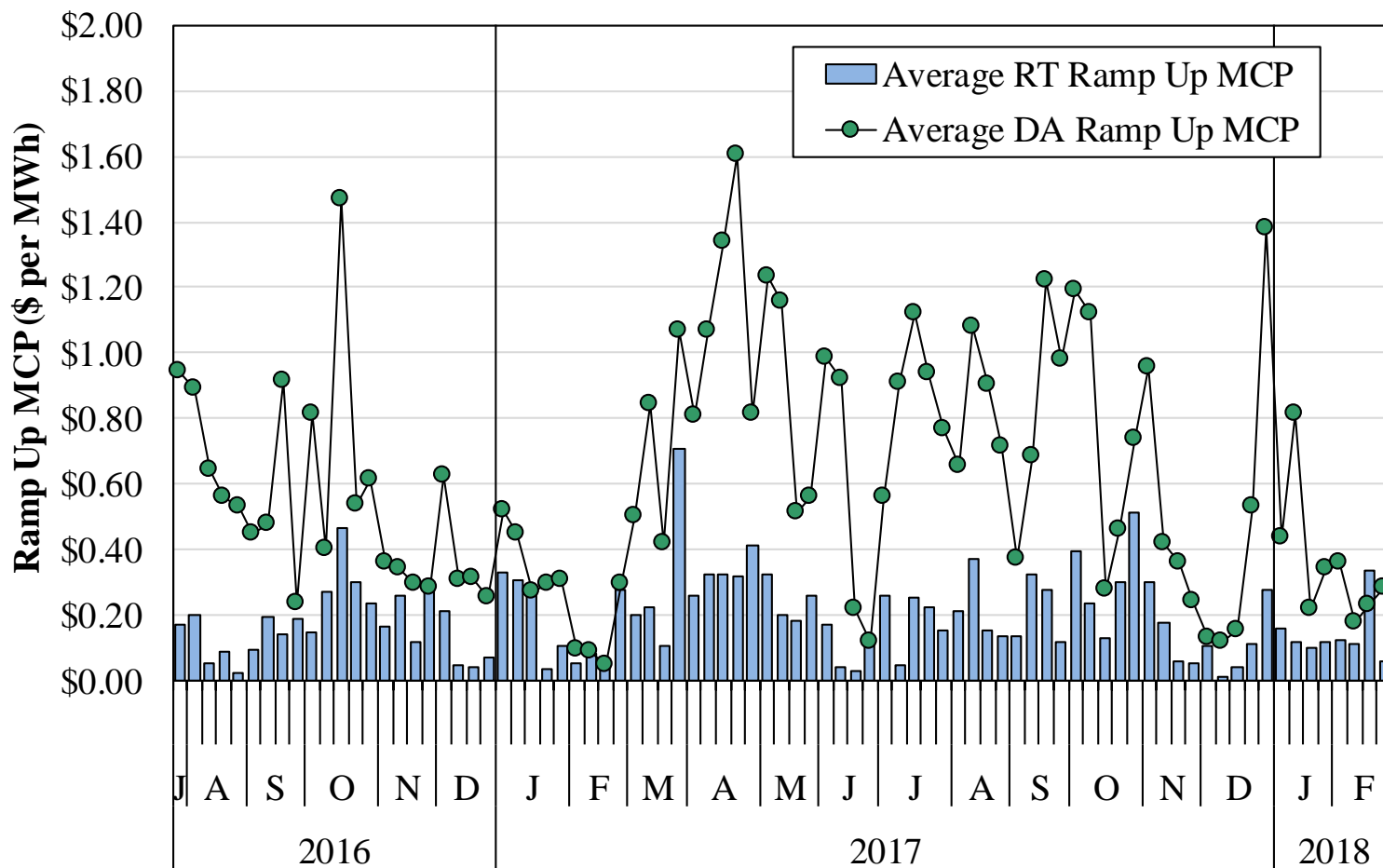


# Virtual Profitability Winter 2017 – 2018



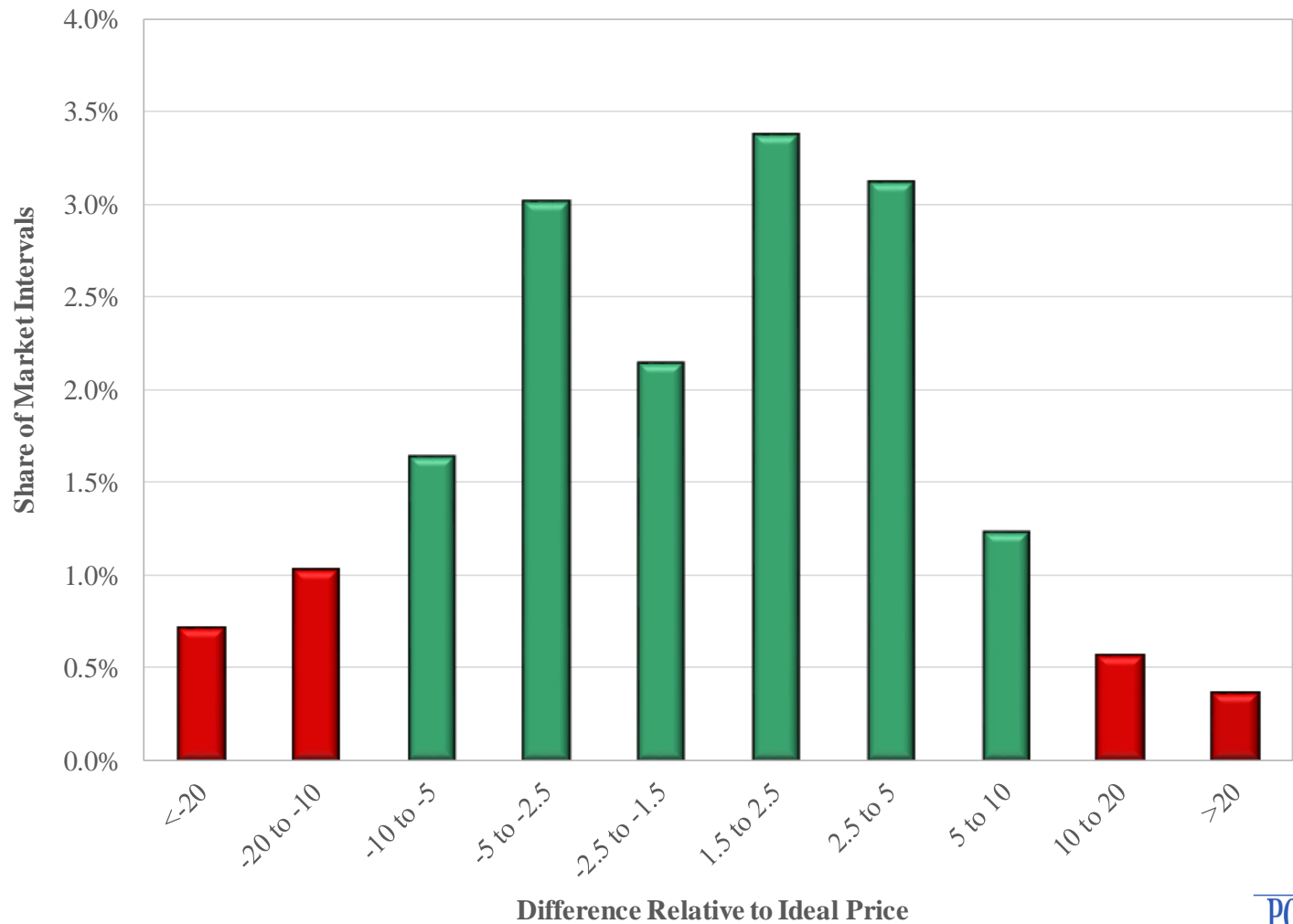


# Day-Ahead and Real-Time Ramp Up Price 2016 – 2018



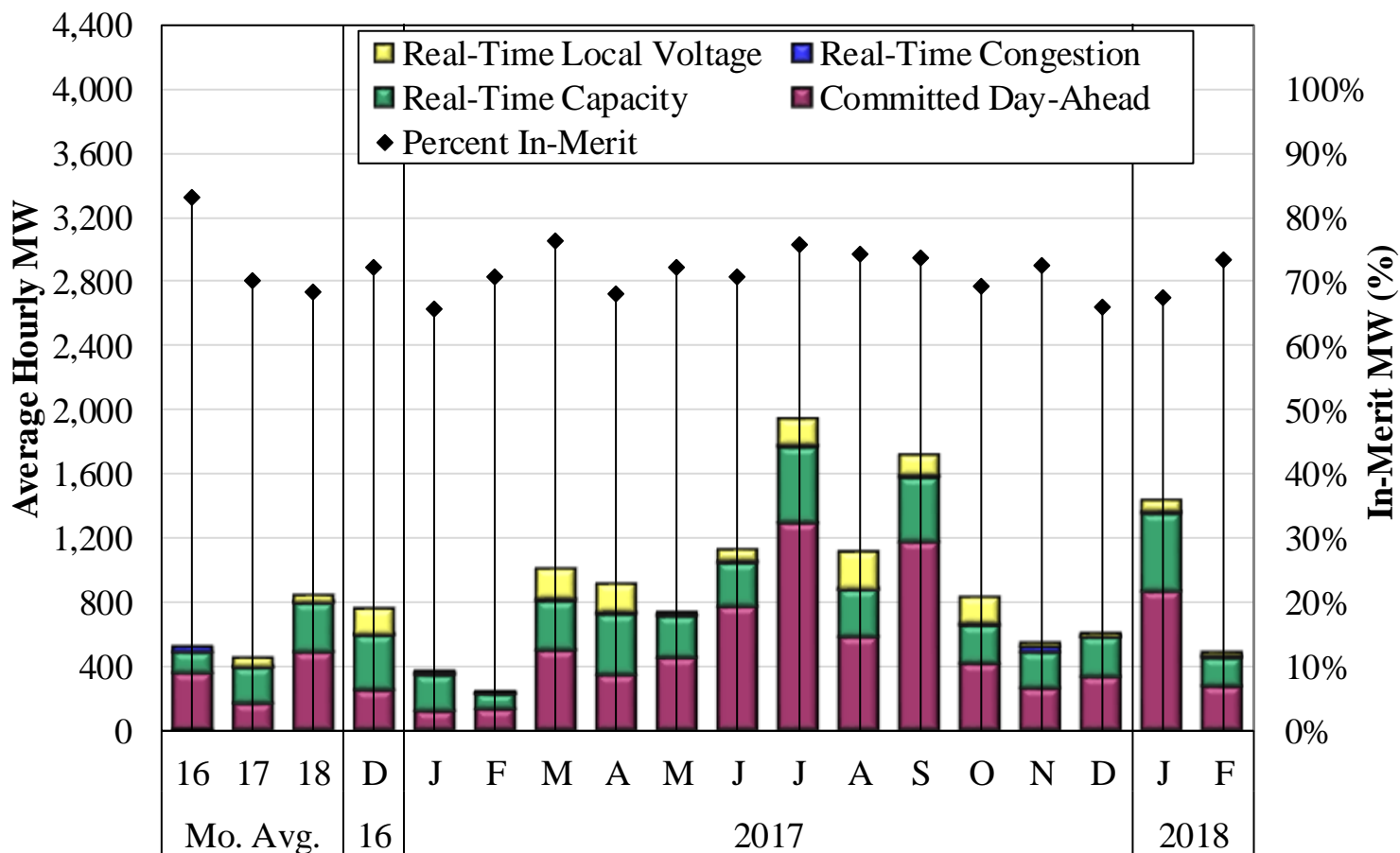


# Interface Pricing with PJM (Common Interface) Winter 2018



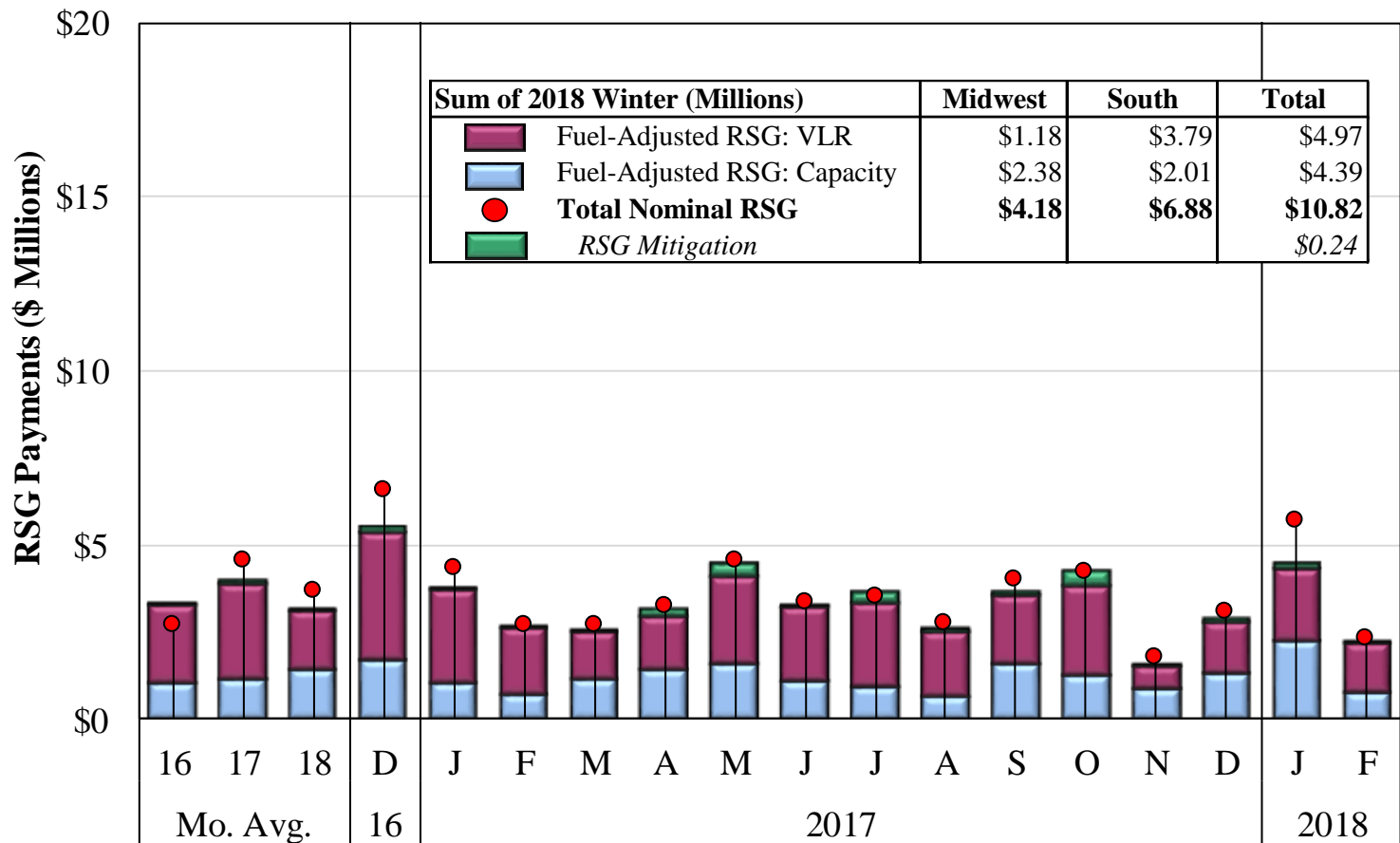


# Peaking Resource Dispatch 2016 – 2018



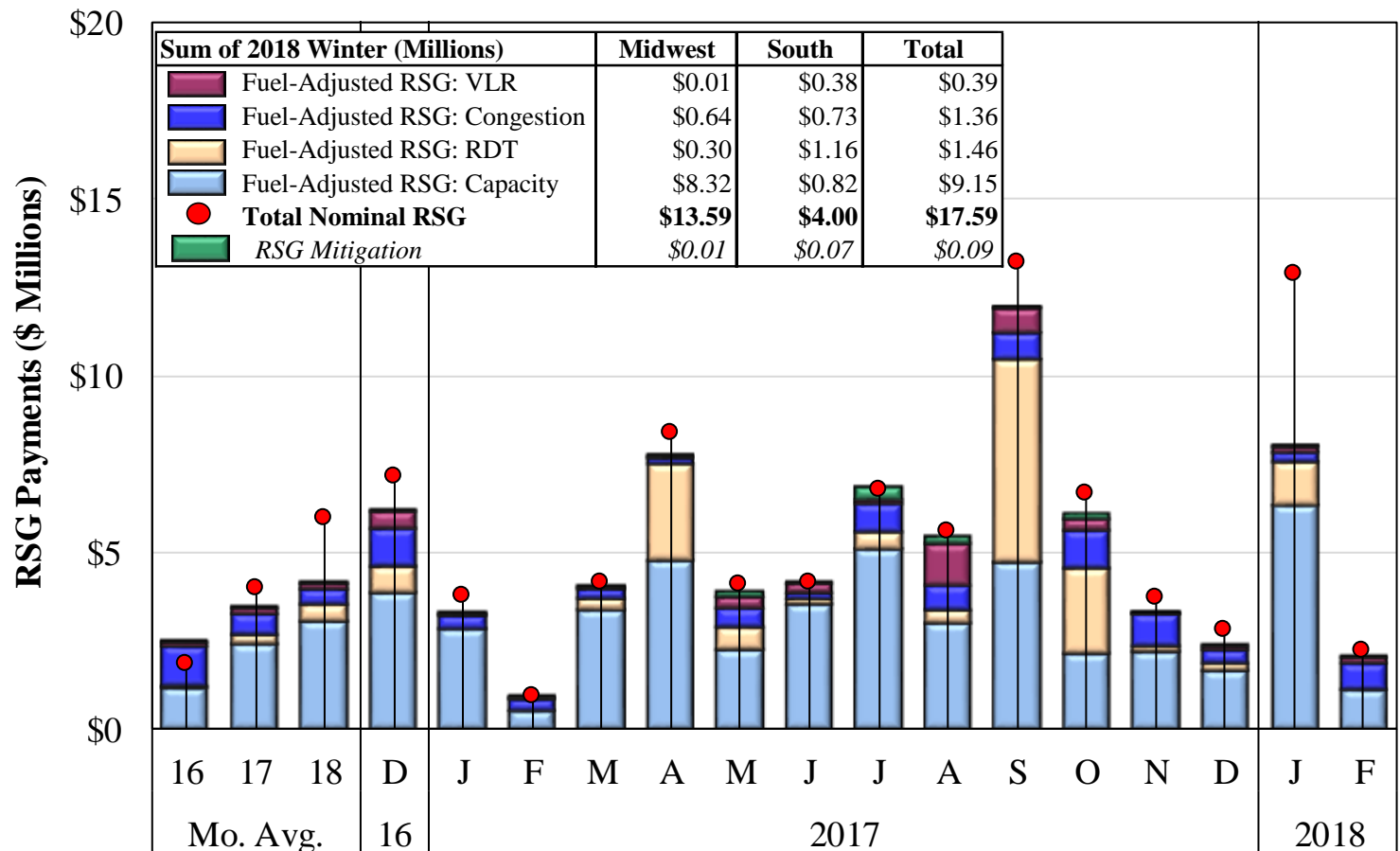


# Day-Ahead RSG Payments 2016 – 2018



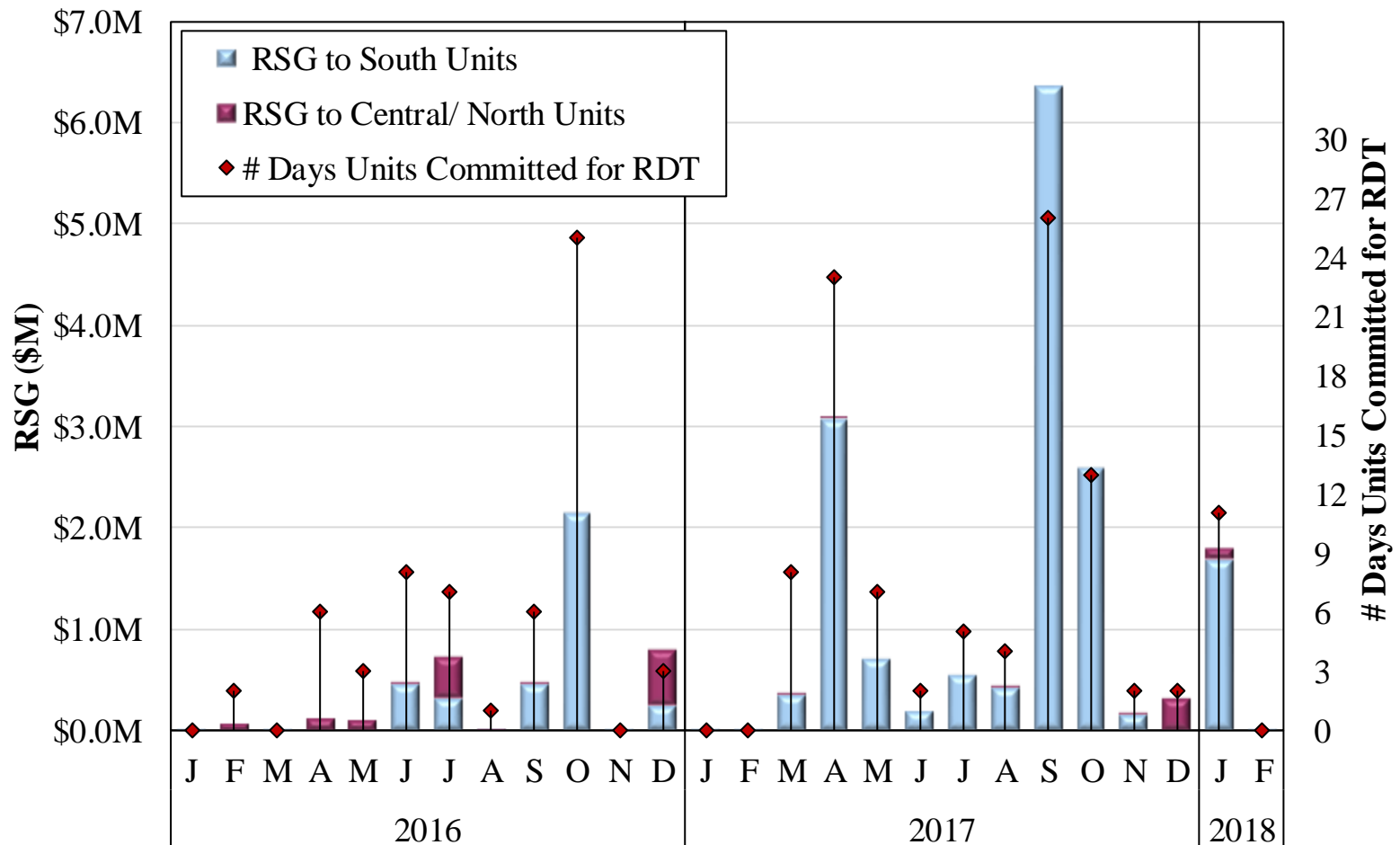


# Real-Time RSG Payments 2016 – 2018





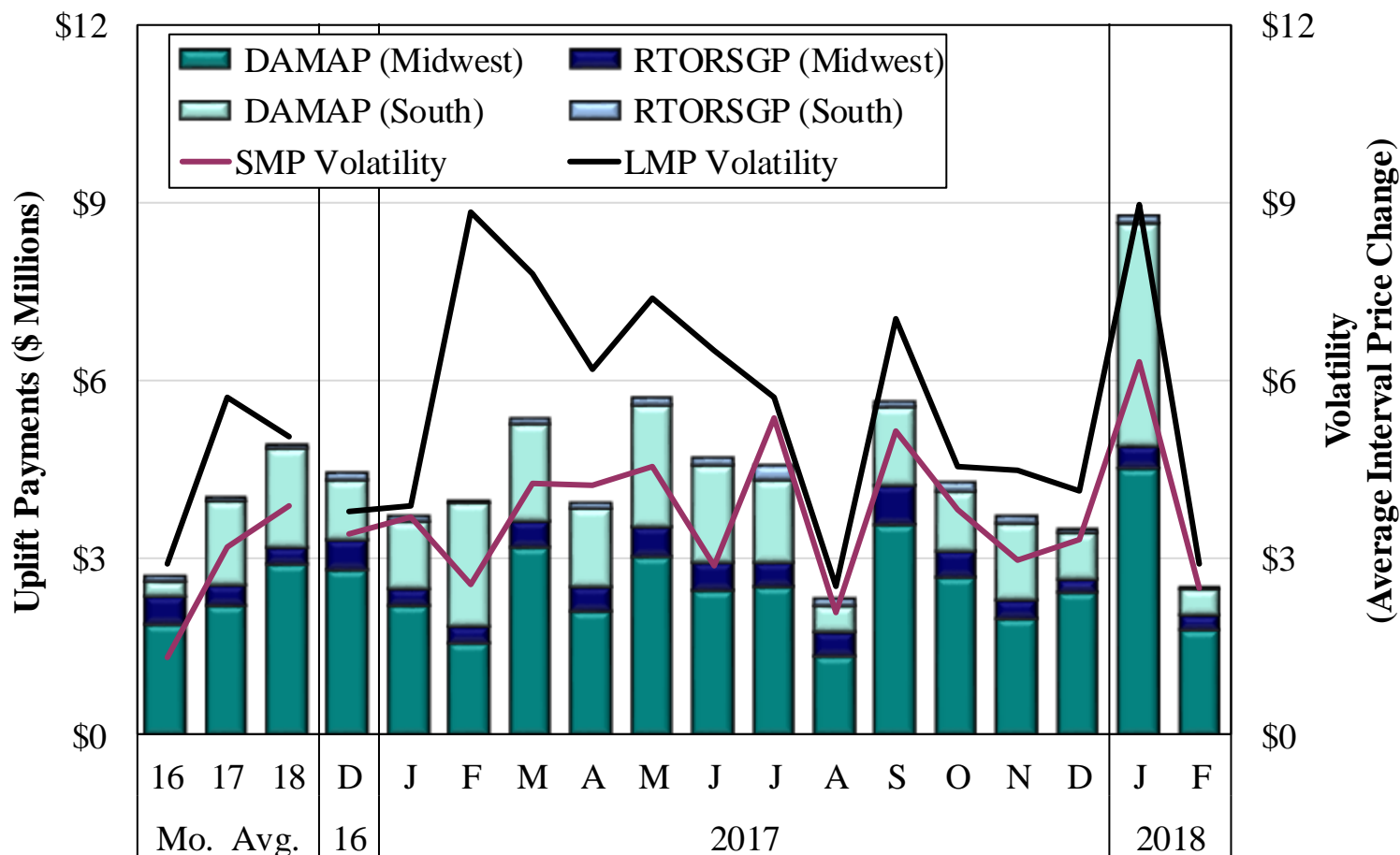
## RDT Commitment RSG Payments 2016 – 2018





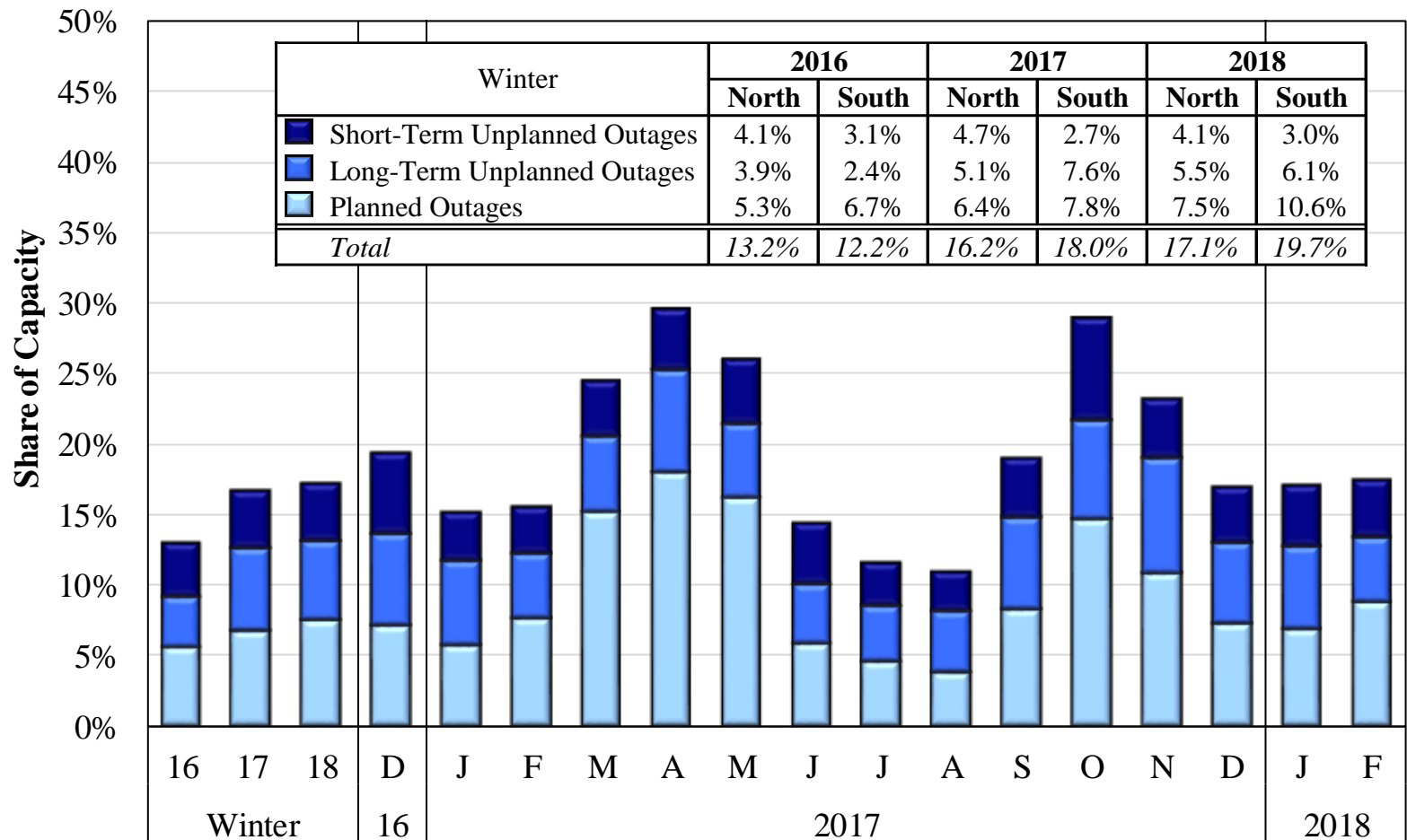


# Price Volatility Make Whole Payments 2016 – 2018





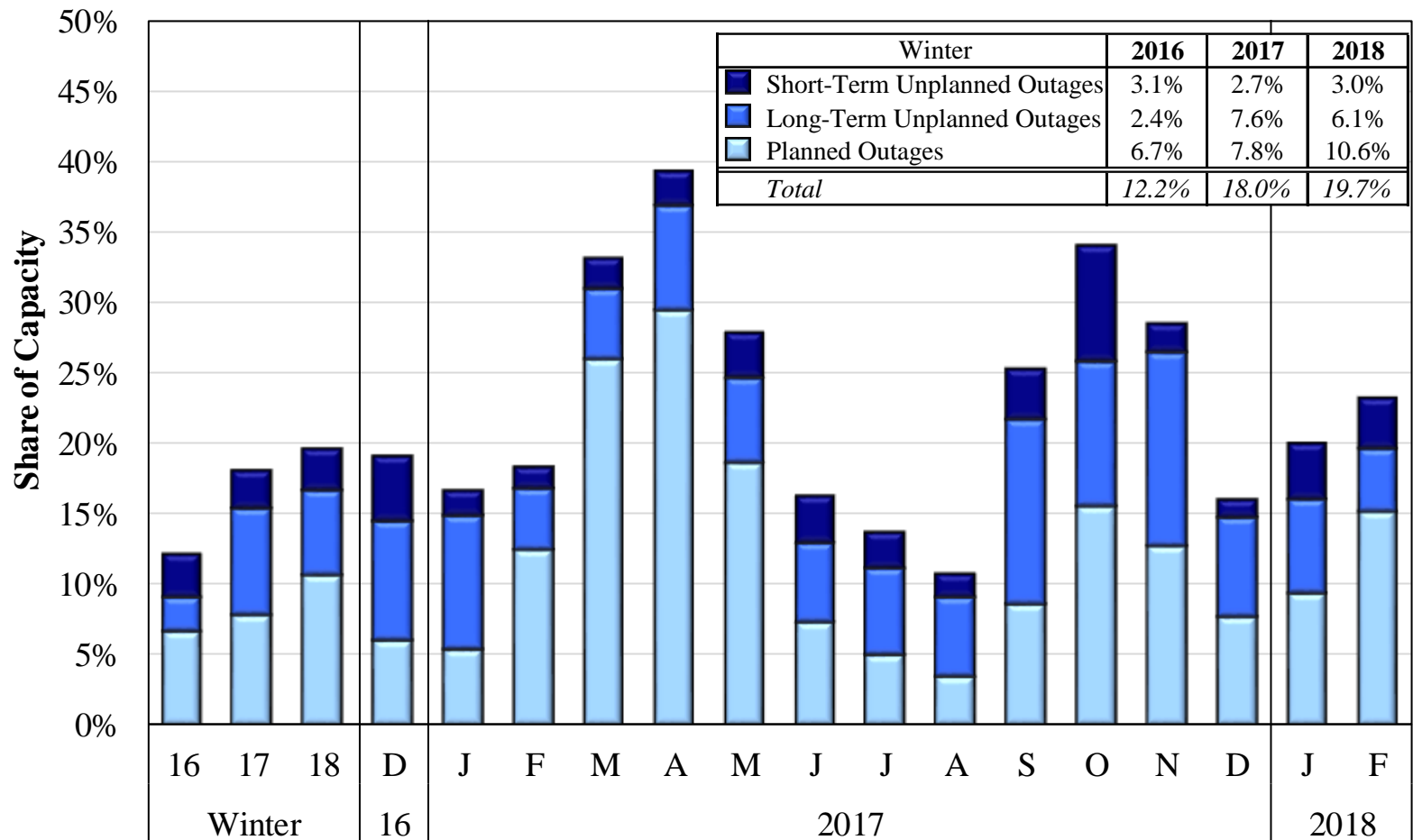
# Generation Outage Rates 2015–2016





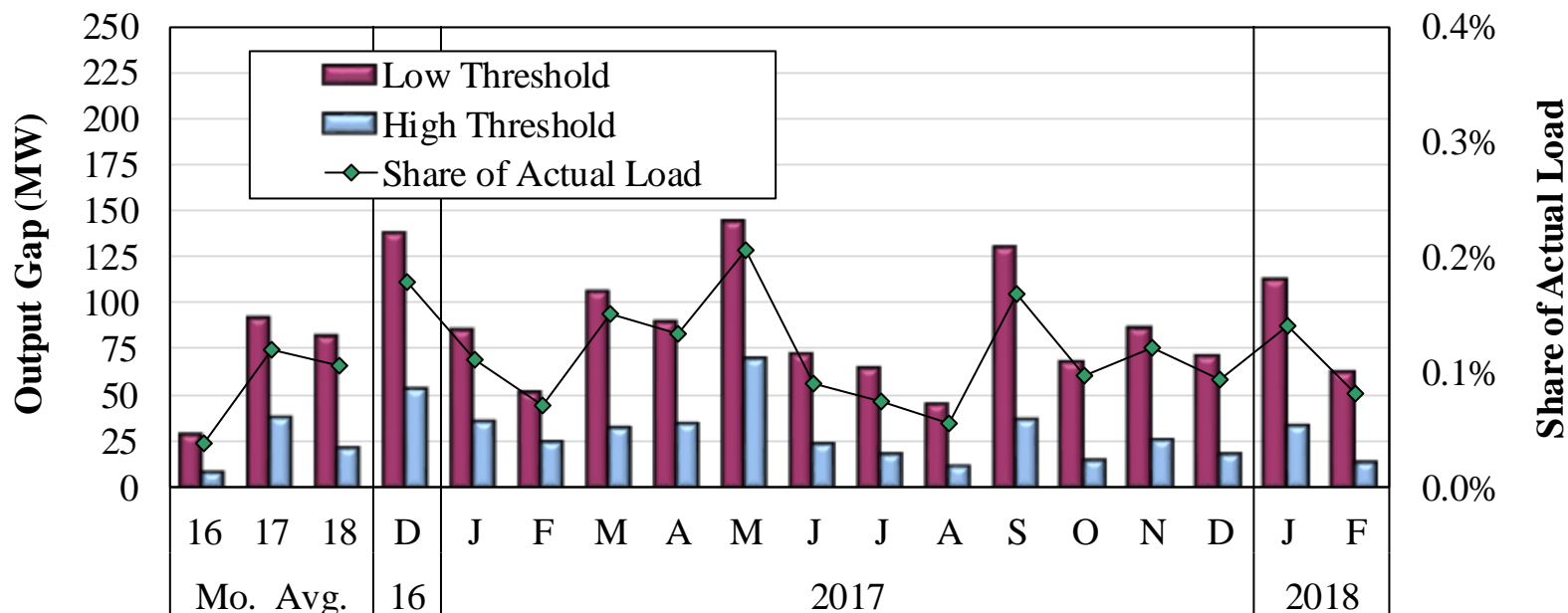
# Generation Outage Rates

## South: 2015–2016





# Monthly Output Gap 2016 – 2018



## High Threshold Results by Unit Status (MW)

Offline	13	6	0	24	13	6	5	11	14	4	2	1	12	0	0	0	0	0
Online	13	20	23	29	23	19	27	24	55	20	16	10	24	15	26	19	33	14

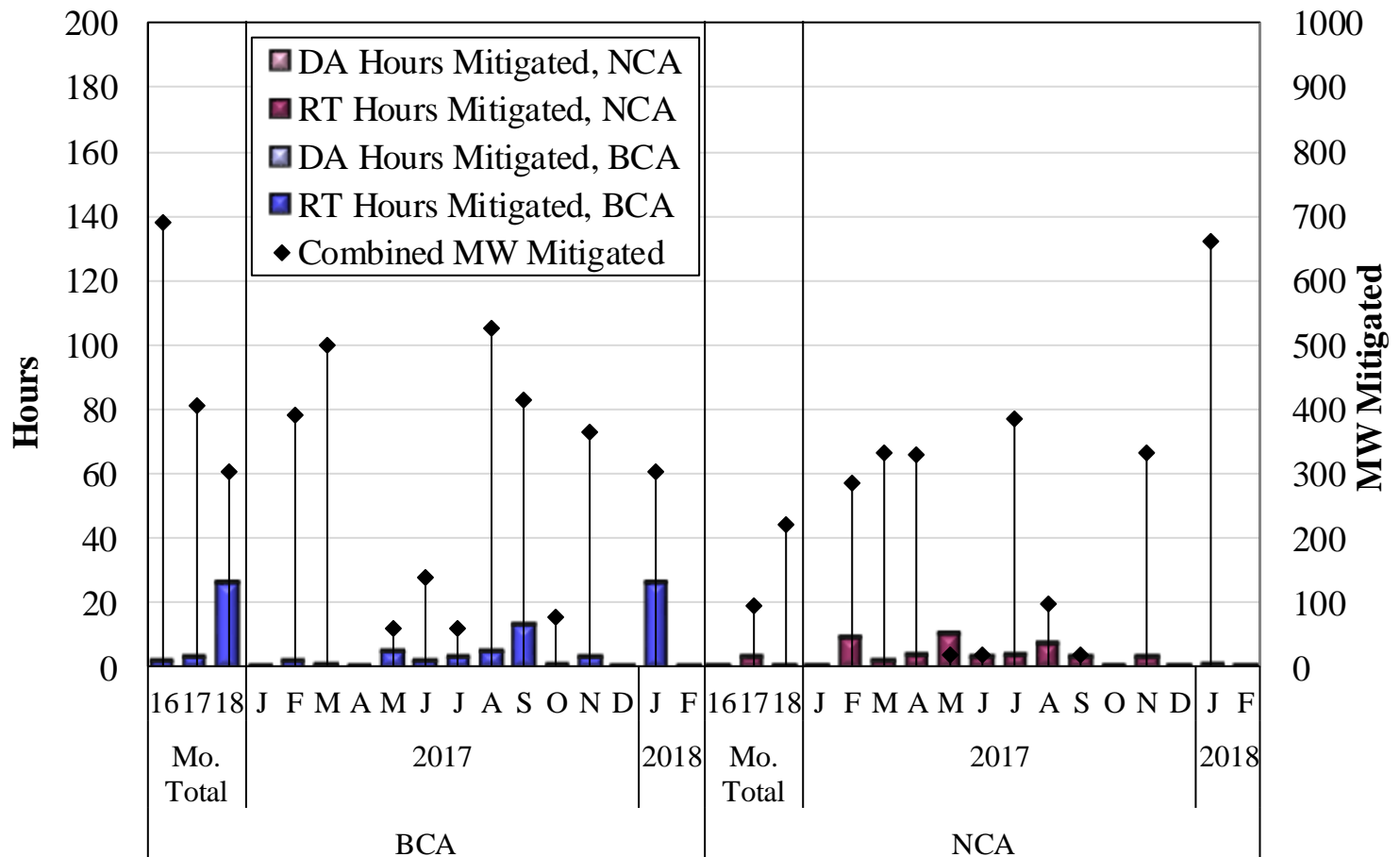
## Low Threshold Results by Unit Status (MW)

Offline	14	6	0	25	13	6	5	11	14	4	2	2	16	0	0	0	0	0
Online	60	63	88	113	72	46	100	79	130	69	63	44	114	68	86	72	113	63

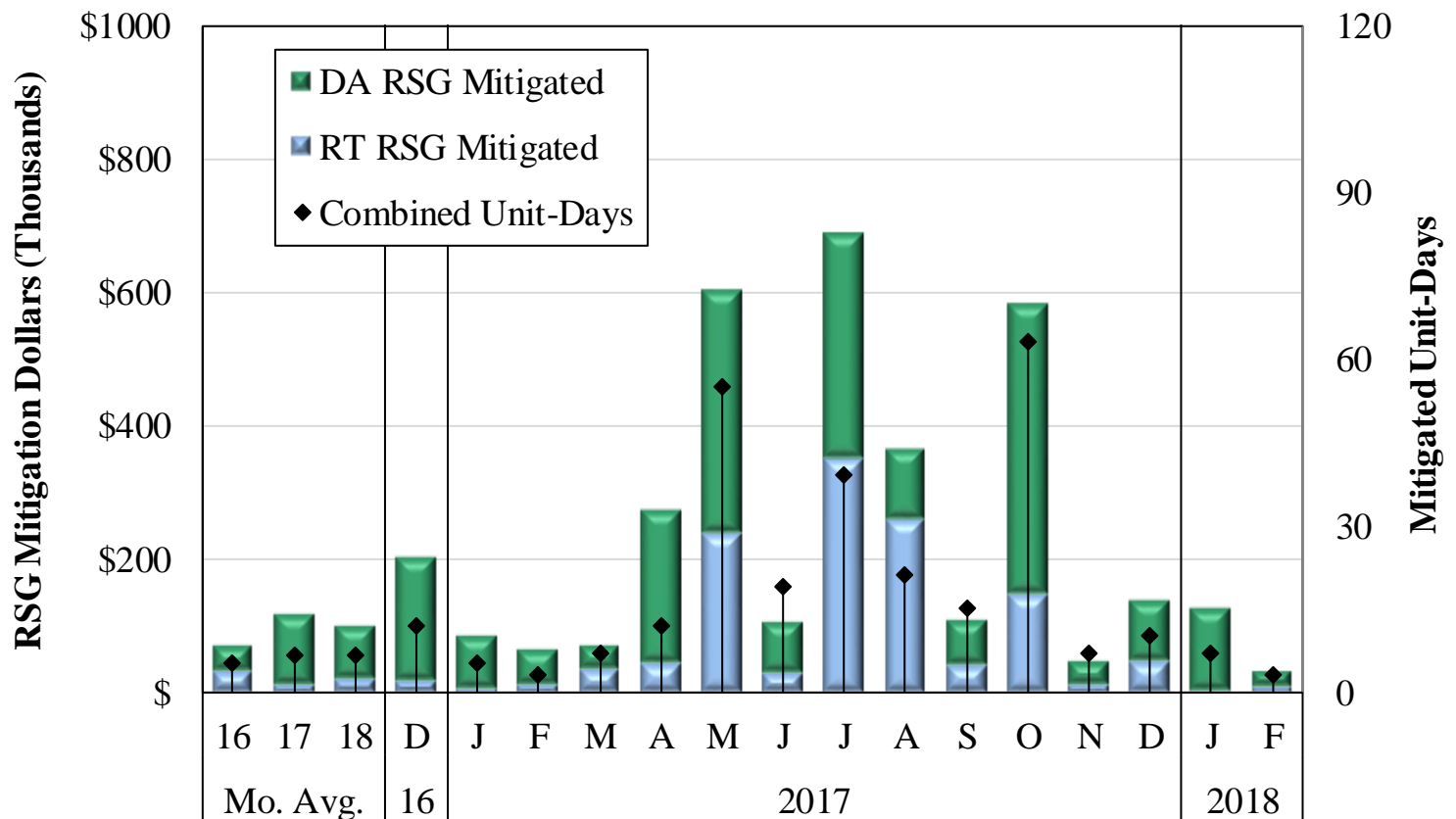




# Day-Ahead And Real-Time Energy Mitigation 2017 – 2018



# Day-Ahead and Real-Time RSG Mitigation 2016 – 2018





## List of Acronyms

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