



IMM Quarterly Report: Fall 2019

MISO Independent Market Monitor

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Highlights and Findings: Fall 2019

- The MISO markets performed competitively this fall, market power mitigation was infrequent, and offers were competitive overall.
- A significant decrease in natural gas prices, combined with lower peak and average load, contributed to a 26 percent reduction in energy prices.
- Temperatures were relatively high early in the quarter but colder than normal later in the quarter, leading to tight conditions in MISO and neighboring areas.
 - ✓ A confluence of events on November 13 caused a shortage in MISO South and the highest daily congestion of the year (more than \$26 million).
- Real-time congestion remained unchanged overall, but it fell 28 percent in the South as a new unit entered in a key location that relieved congestion.
- Wind grew 25 percent from last year and most are using MISO's forecast.

New Quarterly Recommendations

- Develop improved capabilities to receive and validate current and forecasted dynamic ratings from transmission facilities.
- Eliminate the “higher of” logic embedded in the MISO wind forecast that is causing it to be inaccurate and significantly biased.

Quarterly Summary

		Value	Change ¹		Value		Value	Change ¹	
			Prior Qtr.	Prior Year				Prior Qtr.	Prior Year
RT Energy Prices (\$/MWh)	●	\$25.49	-1%	-26%	FTR Funding (%)	●	96%	96%	101%
Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	●	7,383	73%	25%
Natural Gas - Chicago	●	\$2.19	6%	-35%	Guarantee Payments (\$M)⁴				
Natural Gas - Henry Hub	●	\$2.45	8%	-28%	Real-Time RSG	●	\$14.8	1%	-38%
Western Coal	●	\$0.69	0%	-1%	Day-Ahead RSG	●	\$6.9	19%	-36%
Eastern Coal	●	\$1.35	-11%	-24%	Day-Ahead Margin Assurance	●	\$7.1	77%	-32%
Load (GW)²					Real-Time Offer Rev. Sufficiency	●	\$0.6	-6%	-51%
Average Load	●	74.2	-11%	-2%	Price Convergence⁵				
Peak Load	●	107.4	-12%	-7%	Market-wide DA Premium	●	-1.9%	0.2%	-2.7%
% Scheduled DA (Peak Hour)	●	99.3%	99.3%	98.1%	Virtual Trading				
Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	●	15,837	-1%	1%
Real-Time Congestion Value	●	\$306.1	14%	0%	% Price Insensitive	●	35%	35%	35%
Day-Ahead Congestion Revenue	●	\$146.2	0%	-6%	% Screened for Review	●	1%	1%	1%
Balancing Congestion Revenue ³	●	\$3.5	-\$4.6	\$0.0	Profitability (\$/MW)	●	\$0.42	\$0.35	\$0.60
Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	●	904	1775	1235
Regulation	●	\$8.07	5%	-29%	Output Gap- Low Thresh. (MW/hr)	●	53	45	117
Spinning Reserves	●	\$2.27	5%	-35%	Other:				
Supplemental Reserves	●	\$0.61	-2%	-35%					

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 Fall 2019



Energy Prices and Load (slides 14-17)

- Lower fuel prices led to a 26 percent reduction in real-time energy prices compared to last fall and even larger declines in ancillary services prices.
 - ✓ Natural gas prices fell 28 to 35 percent in the South and North, respectively.
 - ✓ Eastern coal prices also fell 24 percent.
- The lower fuel prices together with improvements in uninstructed deviation rules in May led to reductions in make-whole payments of roughly 33 percent.
- Peak load fell 7 percent from last year because MISO did not experience temperatures as hot as last year in September.



Wind Output and Forecasting (slides 27, 28, 29)

- Wind output continues to grow, rising 25 percent from last year and 73 percent from the summer quarter because of seasonal wind changes.
- Roughly 90 percent of wind resources use MISO's wind forecast because of the uninstructed deviation improvements, so the quality of the forecast is key.
- MISO improved the timing of its process in July, but it is still substantially biased because it assumes future output will be the higher of the vendor forecast and current output – this logic should be eliminated ASAP.



Highlights for Fall 2019

Transmission Congestion (Slides 19, 20, 21, 22)

- Although fuel prices and energy prices were down significantly, real-time congestion remained flat compared to last fall.
- In MISO South, real-time congestion fell by more than a quarter.
 - ✓ A new resource came online earlier in the year that relieved key constraints.
- In the Midwest, the 12 percent increase was largely attributable to:
 - ✓ On November 13, planned and unplanned generator outages and high load contributed to the highest daily congestion in the Midwest region for 2019.
 - ✓ \$24 million of the increase in real-time congestion this fall occurred on two proximate constraints that are impacted by non-conforming load and outages.
 - FTR shortfalls associated with these constraints were high due to modeling differences in the FTR market and the day-ahead market.
 - Generation Shift Factor (GSF) cutoffs used in the day-ahead market are not employed in the FTR markets, creating predictable differences.
 - Dropping the GSF cutoff to one percent on those constraints would have reduced the FTR shortfall by \$2.3 million since January.



Highlights for Fall 2019

November 13 in MISO South (Slides 23, 24)

- On November 13, record cold temperatures impacted much of the Southeast, creating challenging operating conditions in neighboring areas.
 - ✓ Temperatures in Little Rock, AR fell to 18°F, almost 30° below the historical average low temperature on that day and set a November record load.
- At 7:10 am, SPP requested that MISO derate the RDT from 3000 to 1500 MW until 10 am in order to reduce flows on multiple violated constraints.
 - ✓ The RDT was violated and binding at \$500 per MWh for 30 minutes, which increased MISO congestion by more than \$800,000.
 - ✓ We do not understand why SPP did not invoke the TLR processes or request that MISO re-dispatch individual generators that could have provided relief.
- Exports were being scheduled from MISO South throughout this period to support neighboring areas, which contributed to tight conditions in the South.
 - ✓ Exports into Southern Company were as high as 1,000 MW when prices exceeded \$1,000 and contributed to a shortage in the South.
 - ✓ For approximately 30 minutes, MISO would not have been able to withstand the largest contingency and maintain flows under 3000 MW from the North.



Highlights for Fall 2019

November 13 in MISO Midwest (Slide 25)

- The loss of a single, critical unit in the Central Region created severe congestion, operational challenges, and high prices.
 - ✓ Eleven constraints were impacted by the loss of the unit, and six of those constraints were in severe violation due to the unit trip.
 - ✓ Congestion associated with this event was more than \$11 million.
 - ✓ There was sharp regional divergence because of the congestion.
 - In the 6 am hour, prices at Indiana Hub averaged \$390 per MWh and prices at Illinois Hub averaged -\$127 per MWh.
- The markets penalized the supplier based on the value of the lost energy.
 - ✓ Prices at the resource's location reached \$3,500 per MWh for one interval and averaged almost \$2,000 per MWh for two hours after the unit tripped.
 - ✓ The resource had to buy back around \$3.5 million in real-time energy.
- MISO did a good job of managing reliability through this event and the market helped by providing good incentives.



Highlights for Fall 2019

Impacts of Online ELMP (Slide 38, 39)

- MISO improved the online ELMP pricing on Nov. 1 by allowing peaking units started in the Day-Ahead market to set prices.
- The average effect of the online ELMP pricing during peak hours was \$0.25 per MWh in September and October.
 - ✓ The incorporation of DA units increased the ELMP pricing effect by an additional \$0.25 per MWh after November 1, based on simulation results.

Impacts of Offline ELMP on Shortage Pricing

- MISO experienced 7 operating reserve shortages spanning 15 intervals.
 - ✓ Sharp increases in load, quickly dropping wind, and unit trips all contributed to these shortages.
- In these cases, MISO's Operating Reserve Demand Curves should set prices, which should have averaged \$1,146 per MWh during these shortages.
- Unfortunately, ELMP eliminates most of MISO's shortage pricing by allowing units that are not turned on to set prices.
 - ✓ Eliminating these shortages reduces the revenues for the flexible resources, which is harmful as these resources are needed to integrate renewables.



Highlights for Fall 2019

Working with TOs to Improve Transmission Ratings

- Adjusting transmission ratings for temperatures (AARs - ambient adjusted ratings) and using short-term emergency (STE) ratings is highly beneficial.
 - ✓ Unrealized benefits from greater use of AAR/STE in 2019 through October are \$80.3 million and averaged roughly \$150 Million annually in 2017 and 2018.
- Per our recommendation from the 2015 State of the Market Report (2015-2), we have been working with MISO and TOs to expand use of AARs and STEs.
 - ✓ Prioritizing based on estimated benefits, we are working with four TOs to scope out programs to include initial set of transmission facilities.
 - ✓ These adjusted ratings can be provided in the real-time market.
 - ✓ We have worked with Entergy to implement such a program over the past few years, which has been very successful.
- We have been discussing these topics with FERC staff for several years.
 - ✓ In this quarter, FERC initiated two technical conferences (AD19-15 and AD19-19) and we have participated on multiple panels in these conferences.



Highlights for Fall 2019

Supporting Development of AAR and STE Ratings Programs

- MISO has the capability to receive updated real-time ratings, but will need to make changes to its systems and processes to enable more dynamic ratings.
 - ✓ **System flexibility:** Allow more rapid addition of facilities for which TOs can provide AARs or dynamic line ratings (reflecting factors other than temperature), including those identified in the outage coordination process.
 - ✓ **Forecasted ratings:** although ratings can be adjusted in the real-time market, new systems are needed to accept or calculate forecasted ratings for use in the day-ahead market, reliability assessments, and FTR markets.
 - ✓ **Grid-Enhancing Technologies (GET):** Additional changes may be needed to facilitate the use of GETs in the operating and planning horizons.
 - ✓ **Improving Validation and Transparency:** MISO should more actively validate transmission ratings, which will require new processes, systems, and the collection of key data (e.g., limiting elements, post-contingent actions, and times associated with the STEs).
- We recommend that MISO begin identifying and implementing these improvements to facilitate greater transmission utilization.



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 participated in a FERC Technical Conferences and submitted comments regarding: AARs/DLRs and Grid Enhancing Technologies.
- We drafted an Affidavit attached by MISO to its filing to create Short-Term Reserve products. We are also filing an answer to protests against the STRs.
- We have been supporting the development of improvements to the market power mitigation measures in Module D of the Tariff, including presentations to MSC and drafting Affidavits for the filing. These changes include:
 - ✓ Improving screens for physical withholding and uneconomic production.
 - ✓ Eliminating exemption from mitigation of non-capacity resources for physical withholding penalty charges.
 - ✓ Improving a number of the specific mitigation thresholds and other provisions.

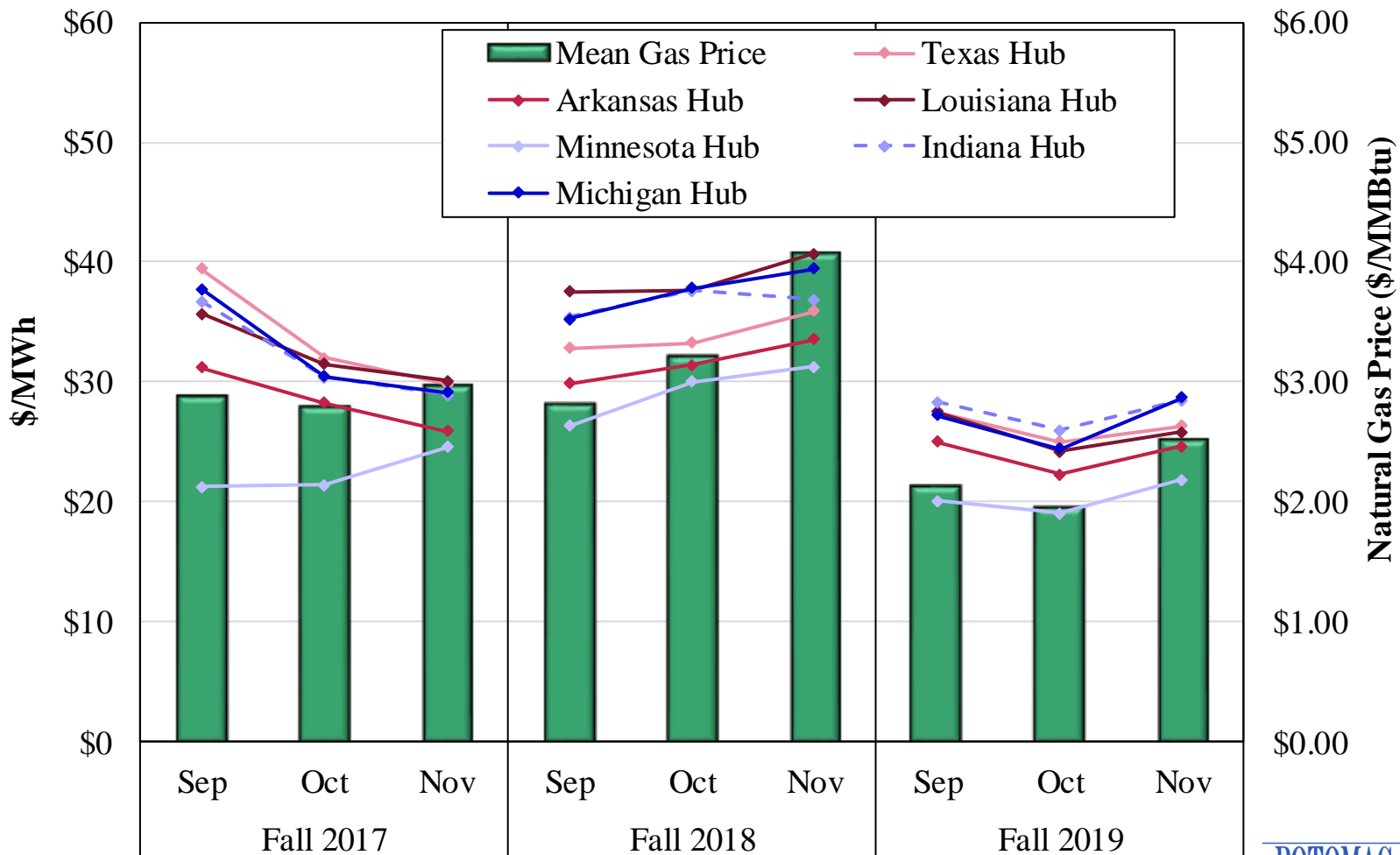


Submittals to External Entities and Other Issues

- In November we presented summary of MISO South market results and issues to the Entergy Regional State Committee.
- In October, we participated in the International Energy Intermarket Surveillance Group – an organization of international market monitors.
- We continued working with the SPP MMU and MISO on the Tier 1 items prioritized for study and have begun planning for Tier 2 items.
 - ✓ Two initial Tier 1 reports have been completed and drafts have been provided to the States: Joint Dispatch Study and Rate Pancaking Study.
 - ✓ The Tier 1 study of market-to-market coordination has been delayed because of SPP data limitations – we hope to complete the study by year end.
- We worked with MISO in its review of its Emergency Event procedures and its identification of “stranded resources” that MISO assumes is unavailable in an emergency because they are behind constraints.
- We have been consulting with MISO and participants in the Resource Adequacy Subcommittee to address the flaw in MISO’s deliverability rules.

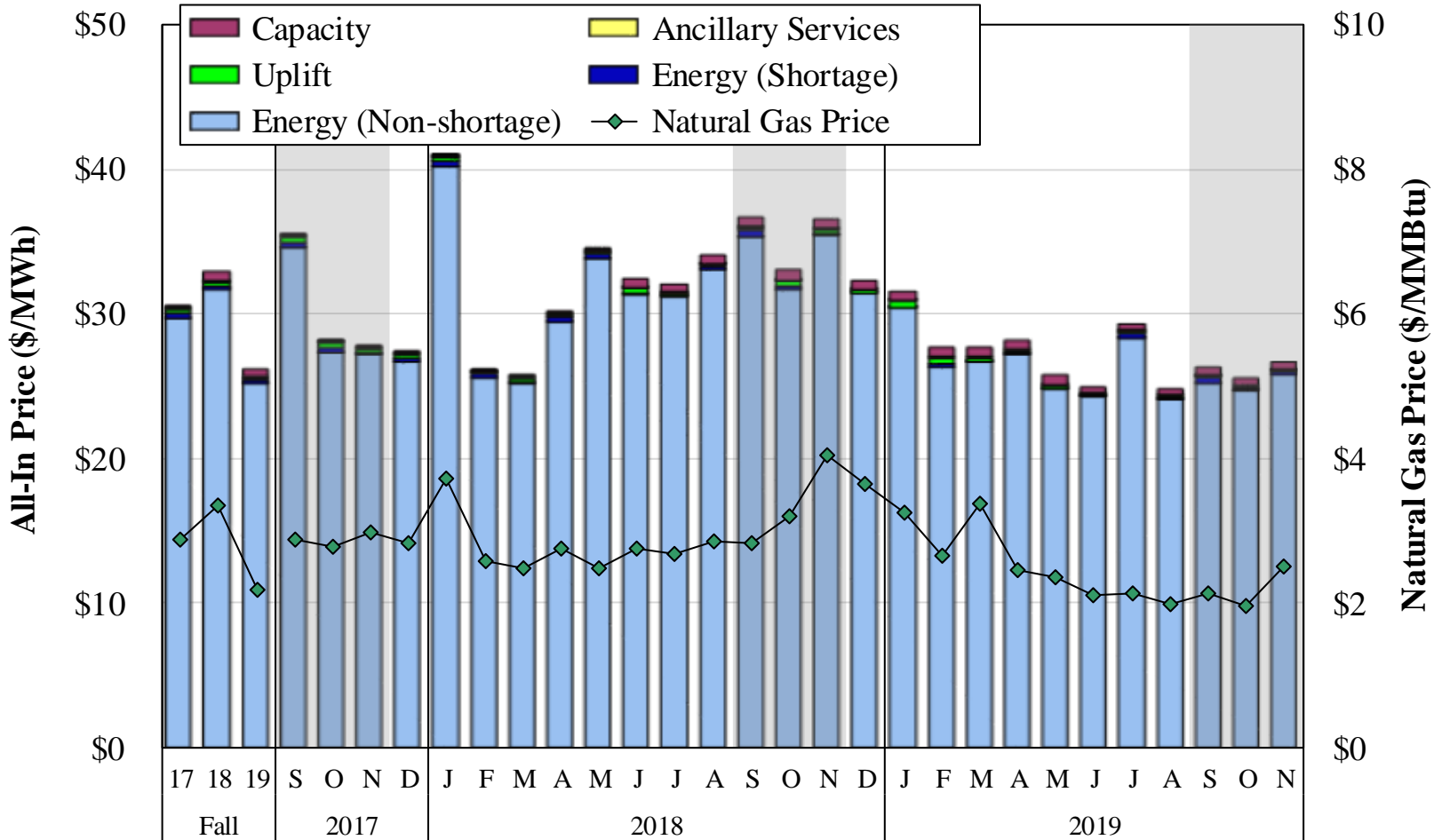


Day-Ahead Average Monthly Hub Prices Fall 2017 – 2019

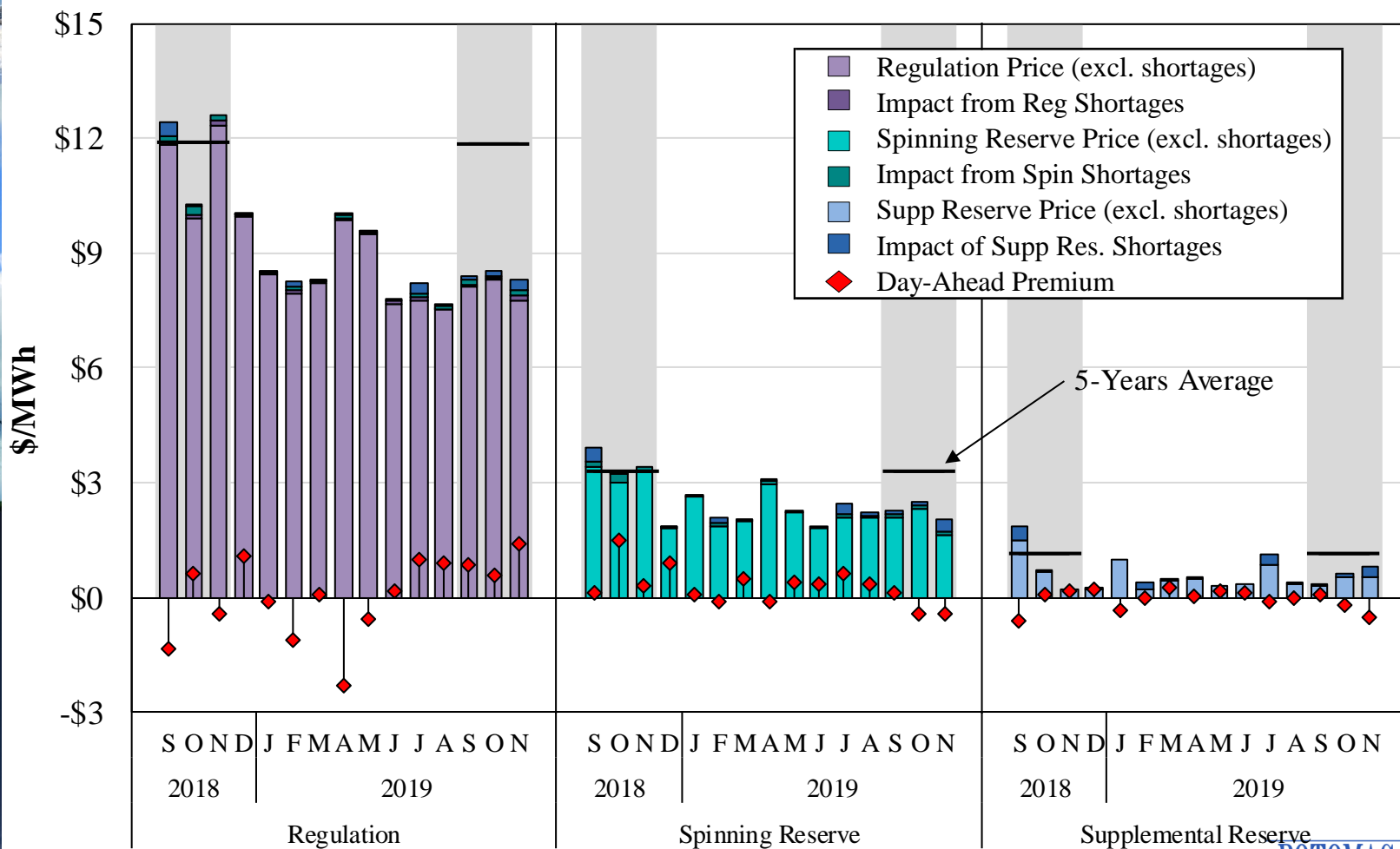




All-In Price Fall 2017 – 2019

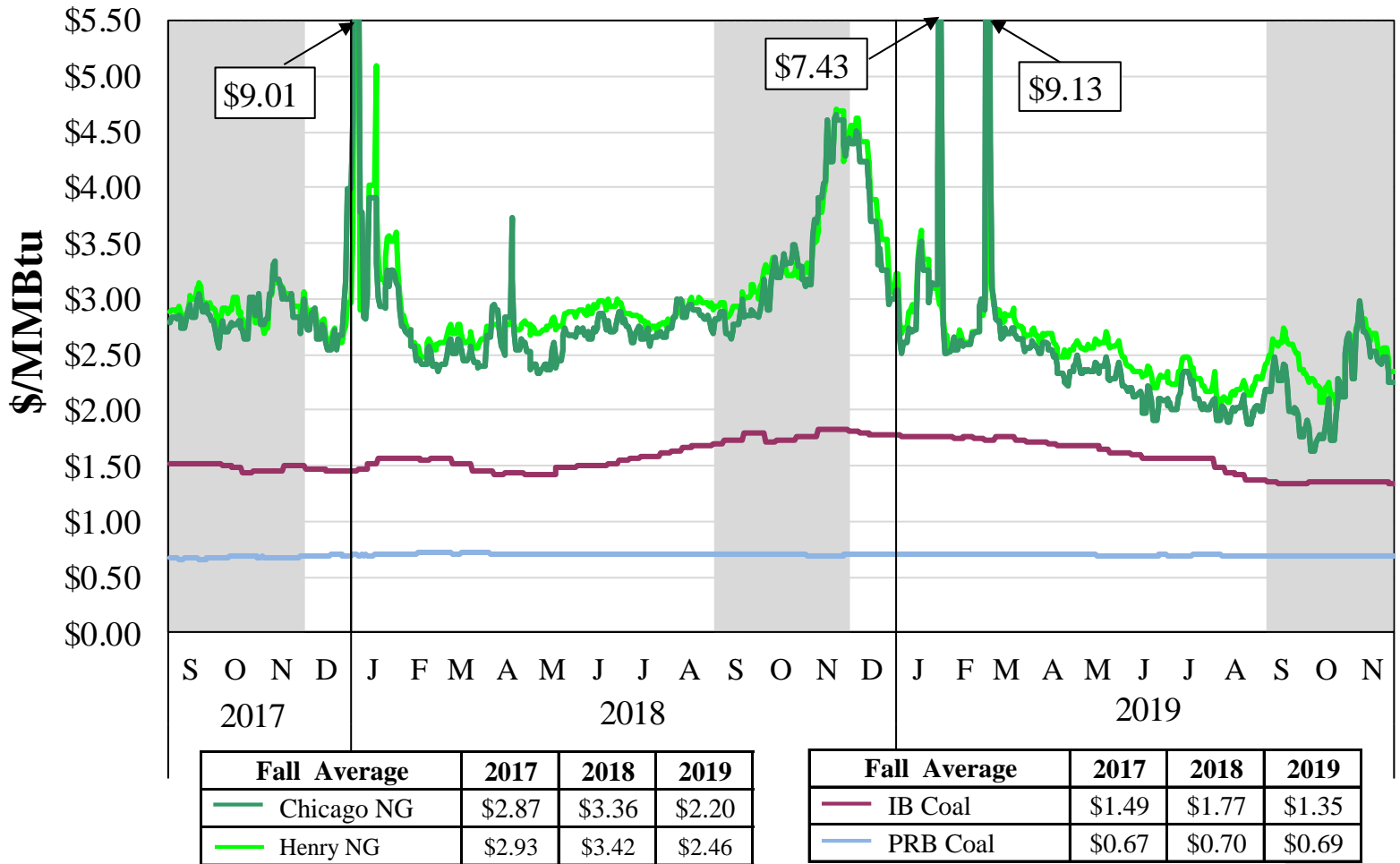


Monthly Average Ancillary Service Prices 2018 – 2019





MISO Fuel Prices 2017 – 2019

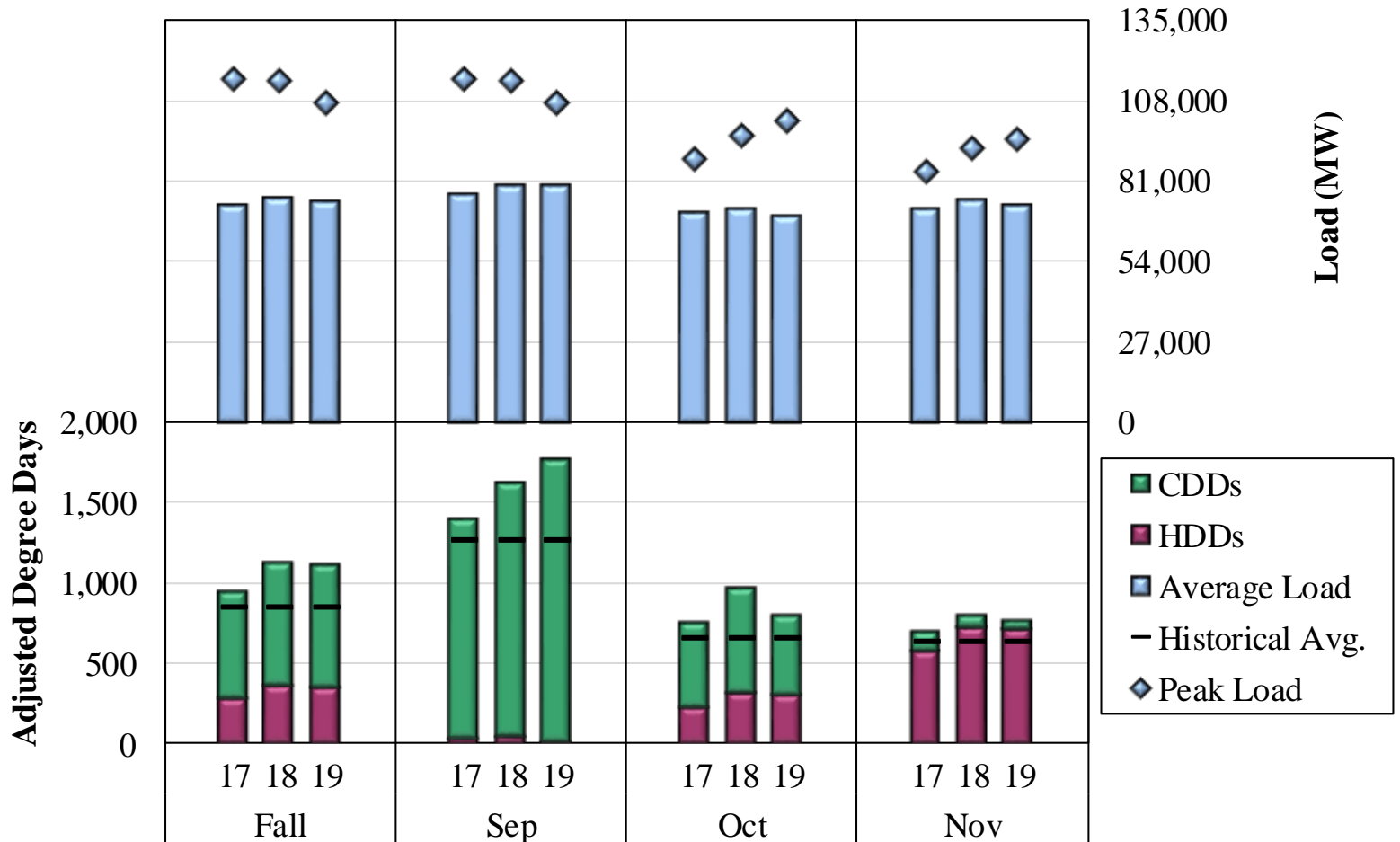


Capacity, Energy and Price Setting Share Fall 2018 – 2019

Fall	Unforced Capacity				Energy Output		Price Setting			
	Total (MW)		Share (%)		Share (%)		SMP (%)		LMP (%)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Nuclear	12,225	12,225	10%	9%	15%	18%	0%	0%	0%	1%
Coal	48,775	48,578	38%	38%	48%	37%	41%	45%	83%	90%
Natural Gas	55,240	56,786	43%	44%	25%	32%	58%	53%	95%	98%
Oil	1,691	1,683	1%	1%	0%	0%	0%	0%	0%	0%
Hydro	3,966	4,036	3%	3%	1%	2%	1%	1%	1%	3%
Wind	3,005	3,214	2%	2%	8%	11%	0%	1%	33%	55%
Other	2,678	2,599	2%	2%	2%	1%	0%	0%	3%	4%
Total	127,580	129,120								



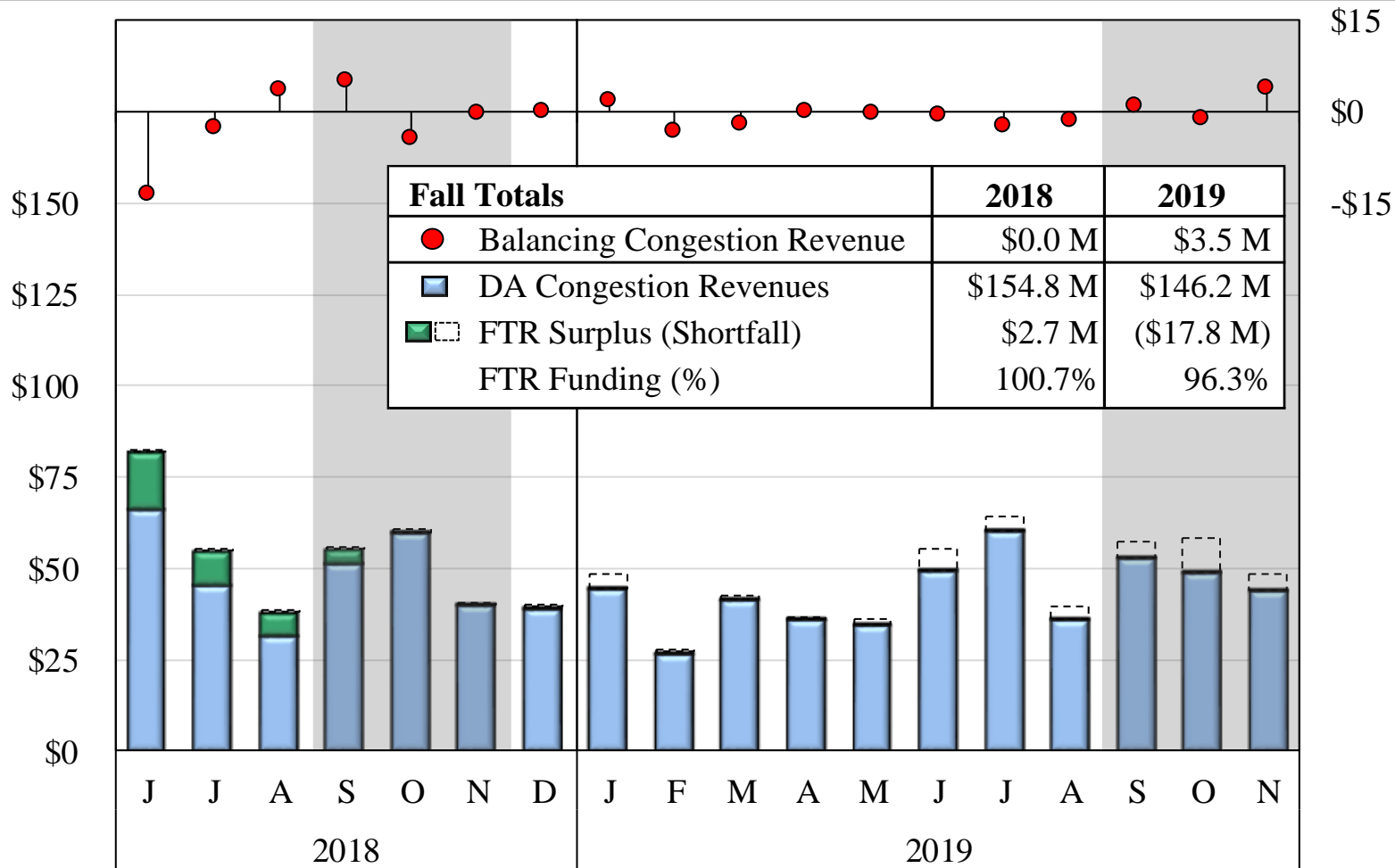
Load and Weather Patterns Fall 2017 – 2019



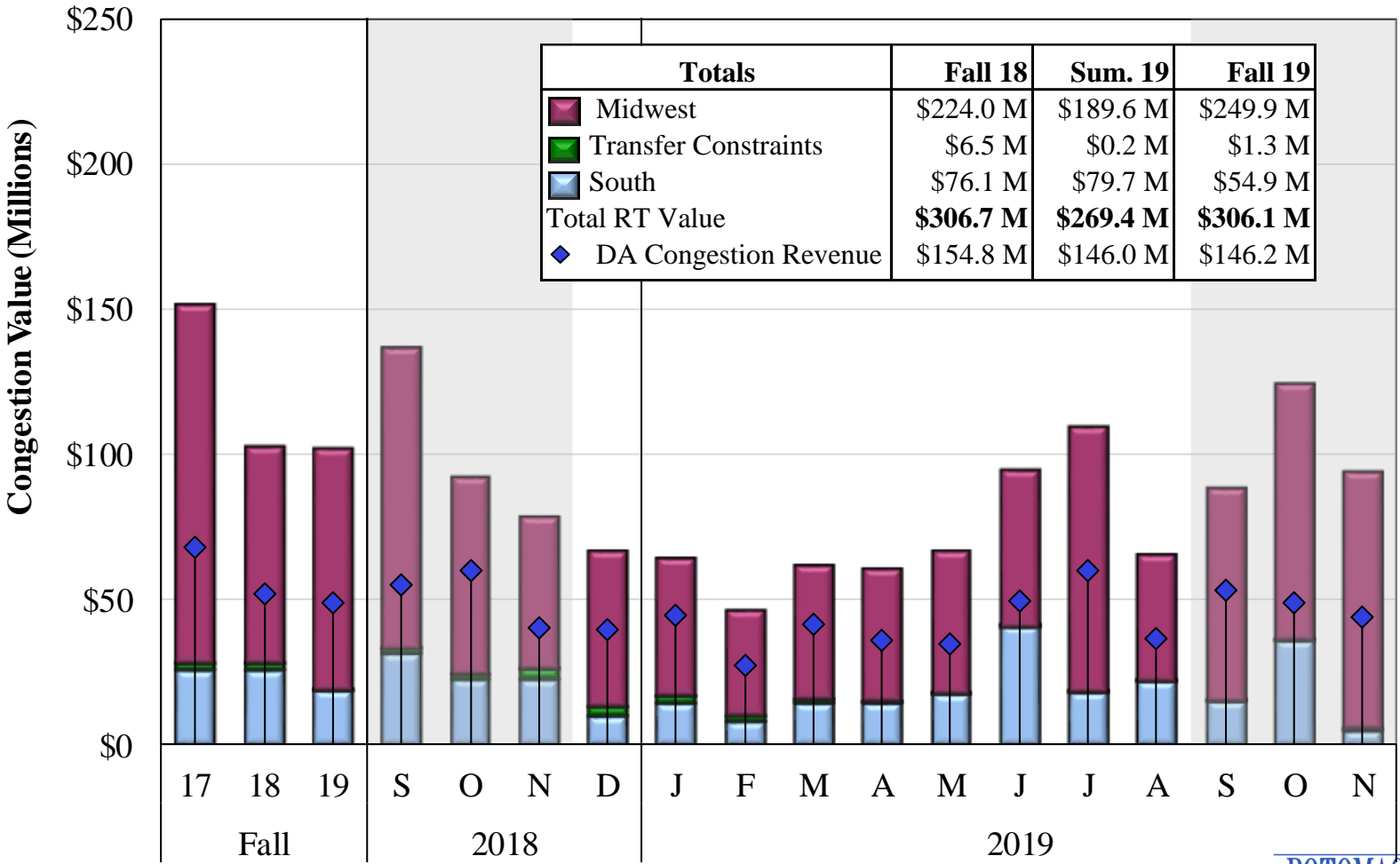
Note: Midwest degree day calculations include four representative cities in the Midwest: Indianapolis, Detroit, Milwaukee and Minneapolis. The South region includes Little Rock and New Orleans.



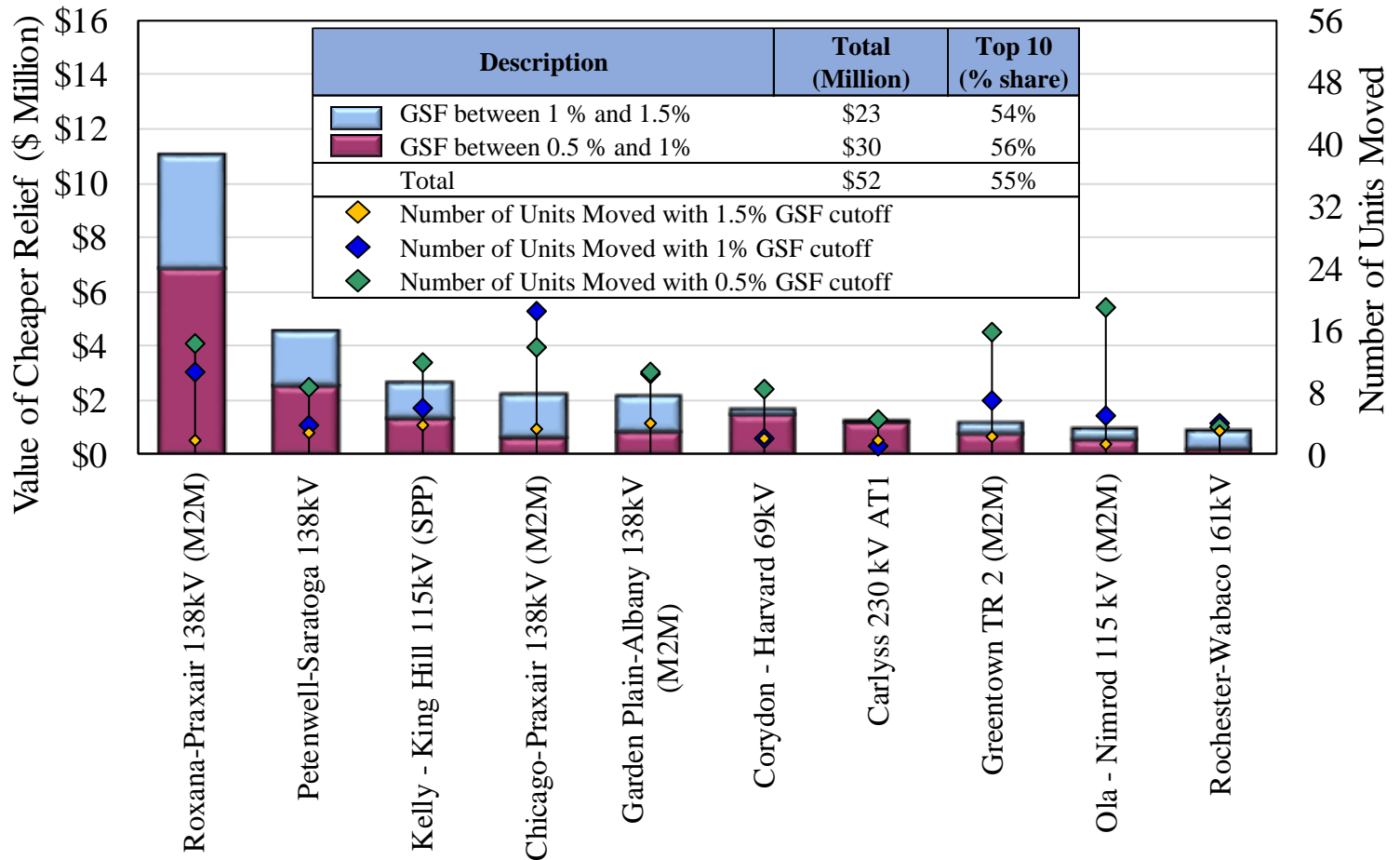
Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2018 – 2019



Value of Real-Time Congestion Fall 2017 – 2019

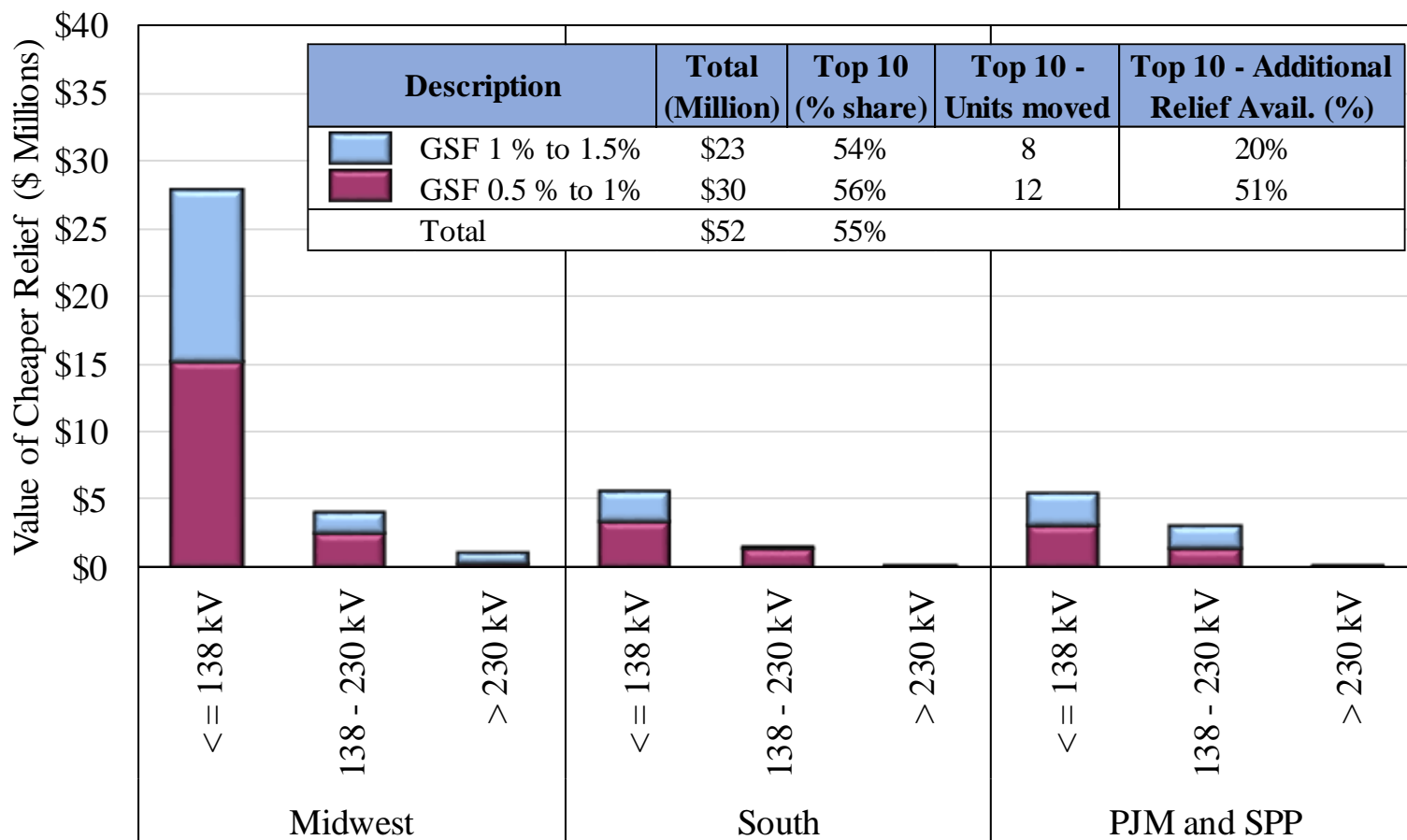


Value of Additional Relief Top 10 Most-Affected Constraints

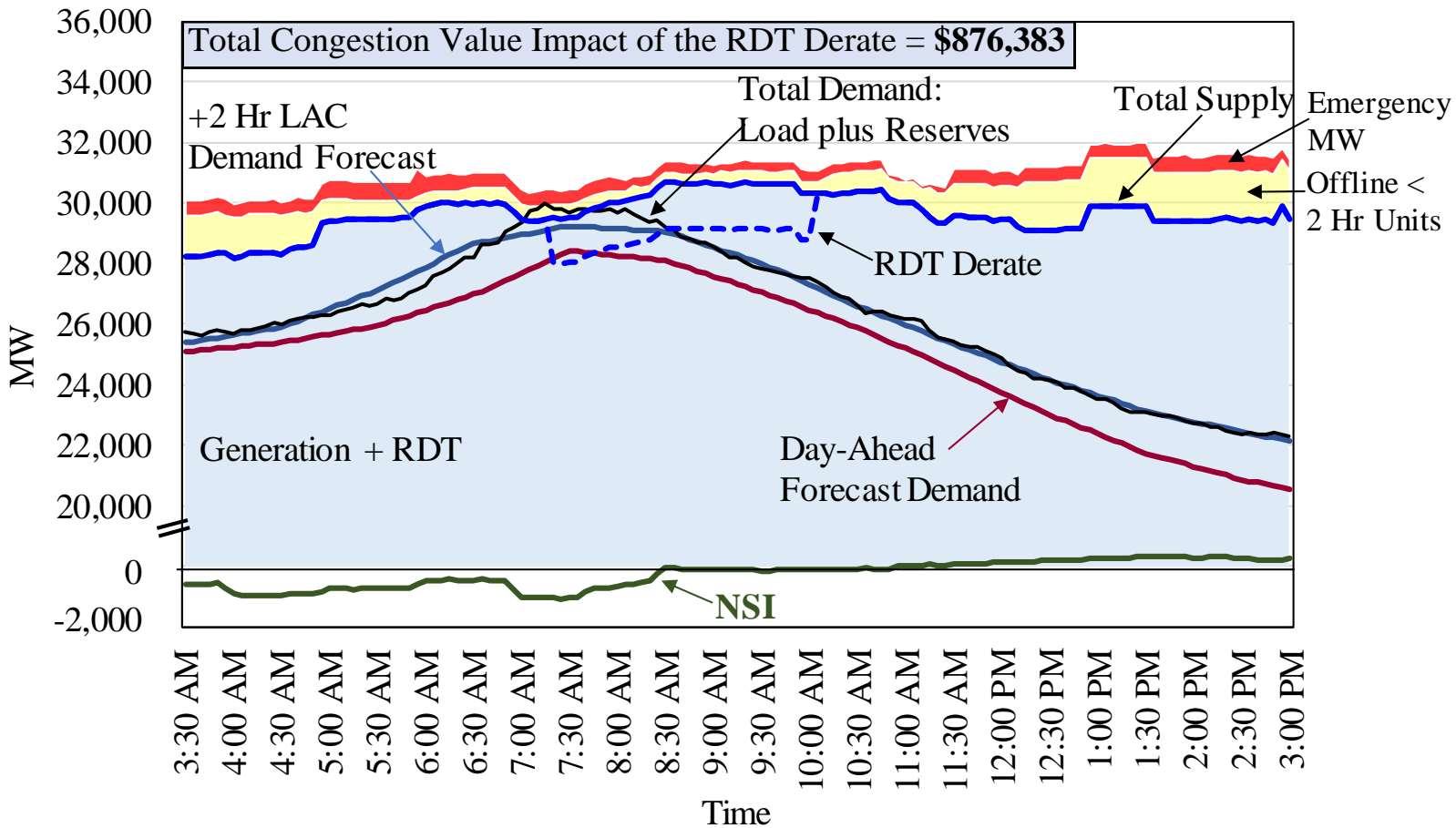




Lowering GSF Cutoff Value of Additional Relief

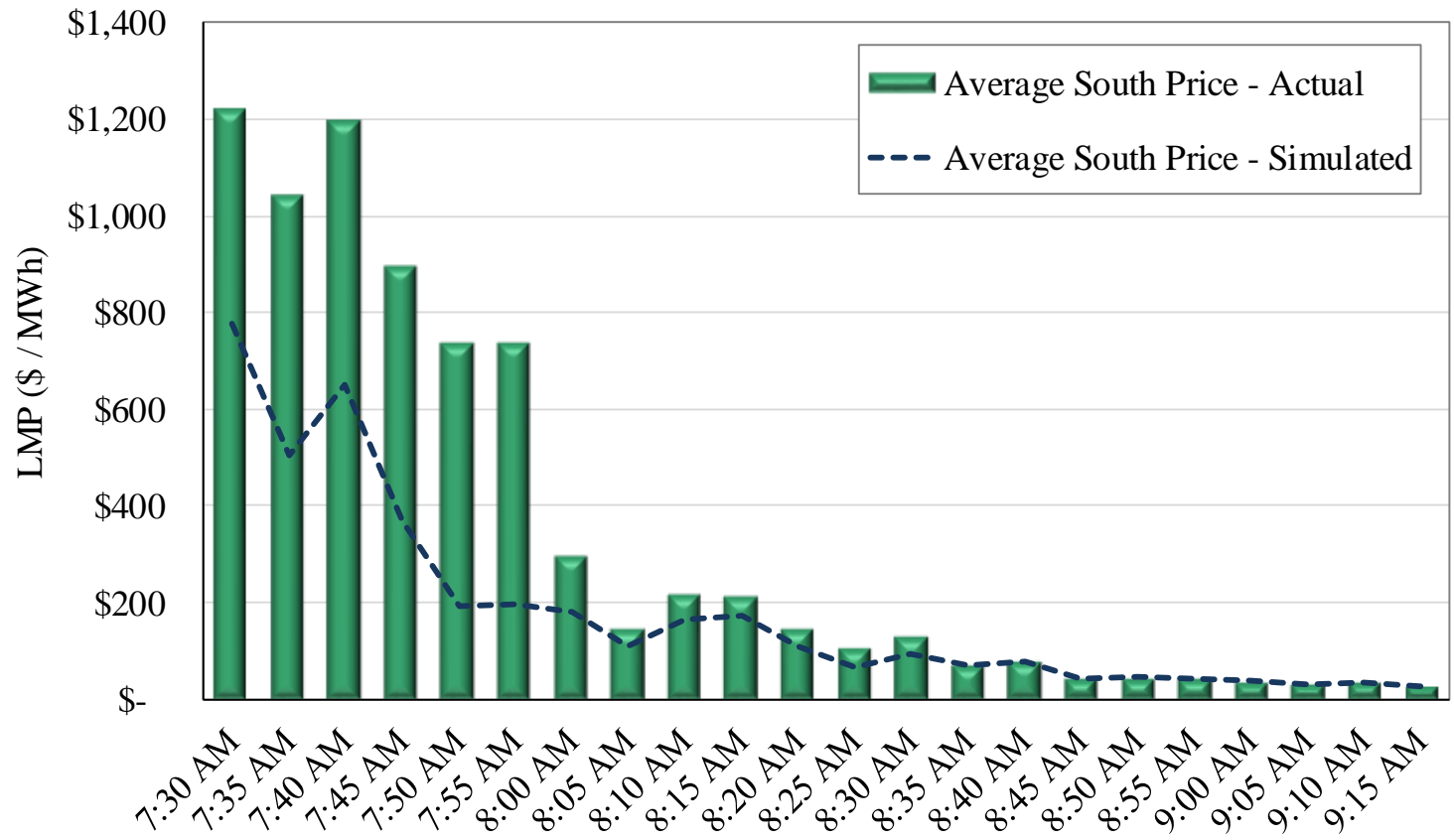


Conditions in MISO South November 13, 2019

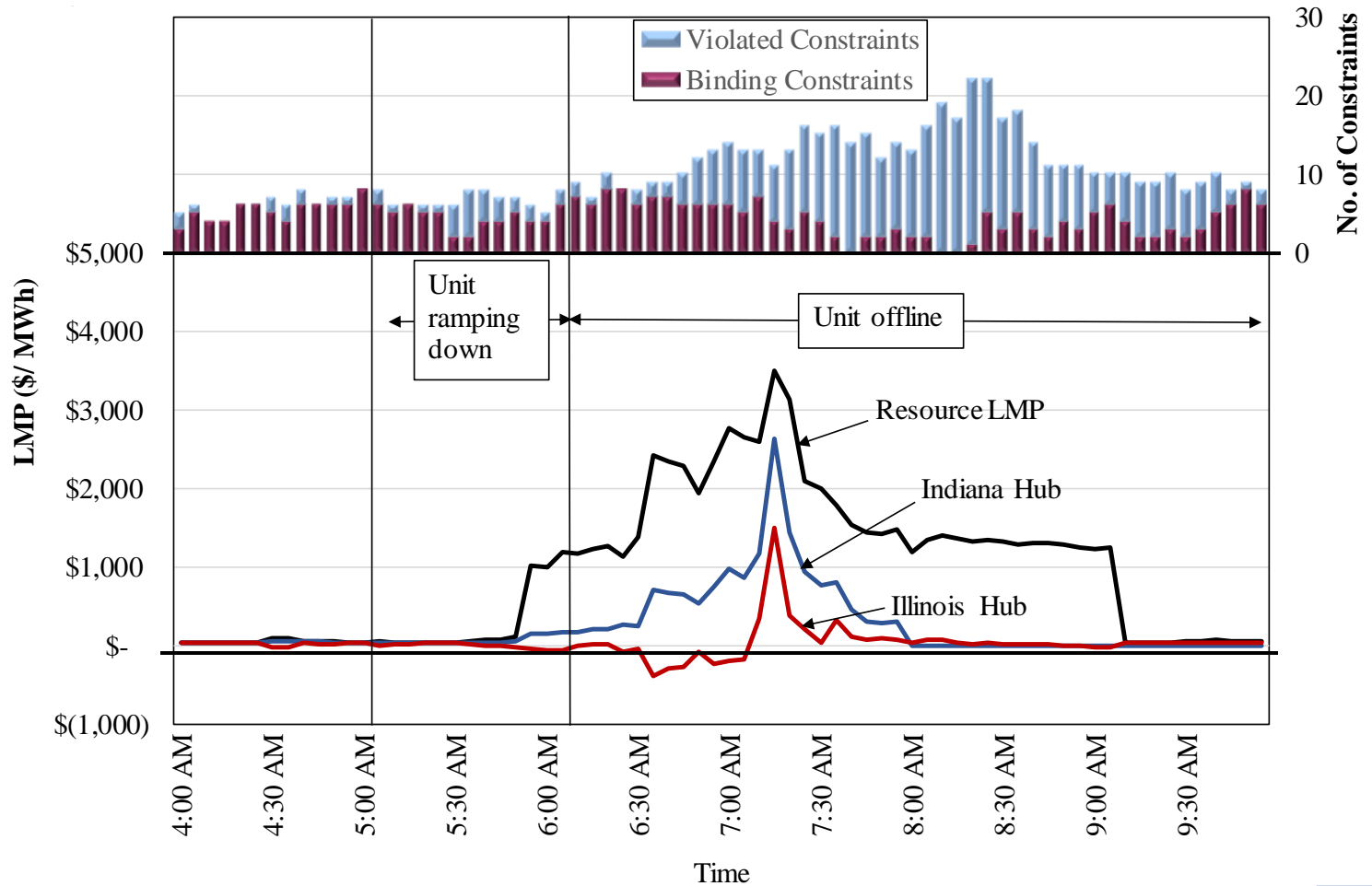




Prices in MISO South November 13, 2019

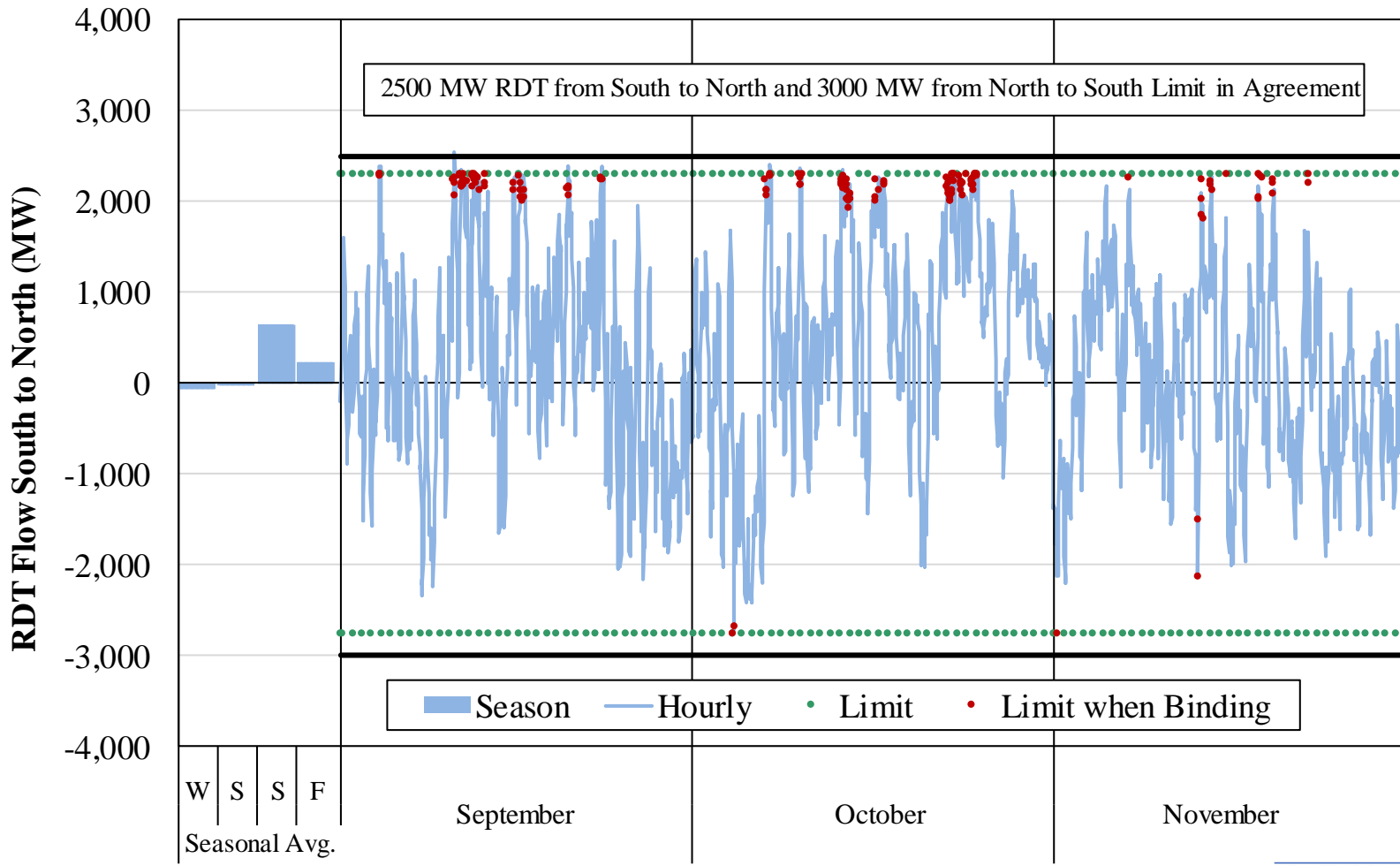


Loss of Unit in MISO Central November 13, 2019



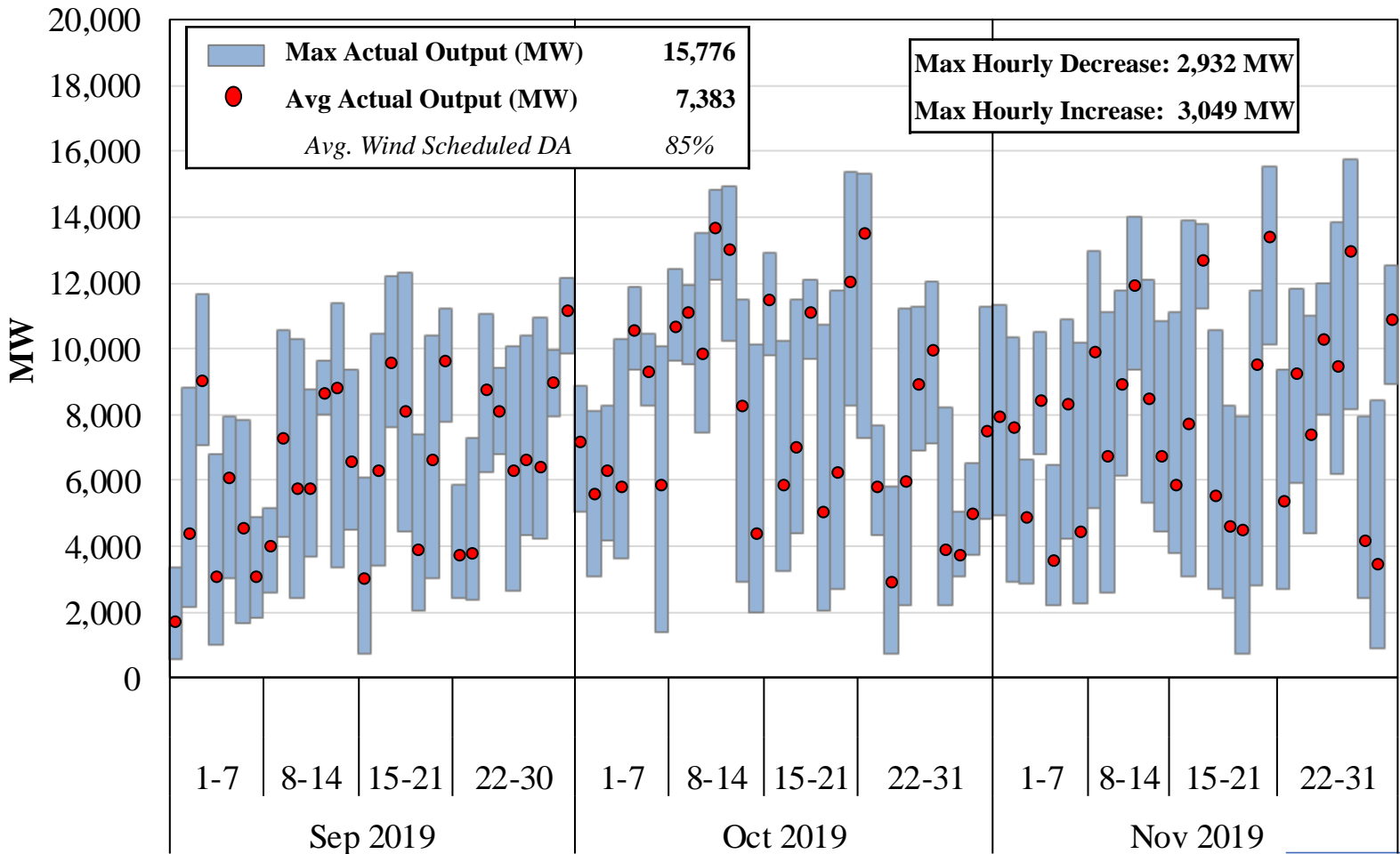


Real-Time Hourly Inter-Regional Flows Fall 2019



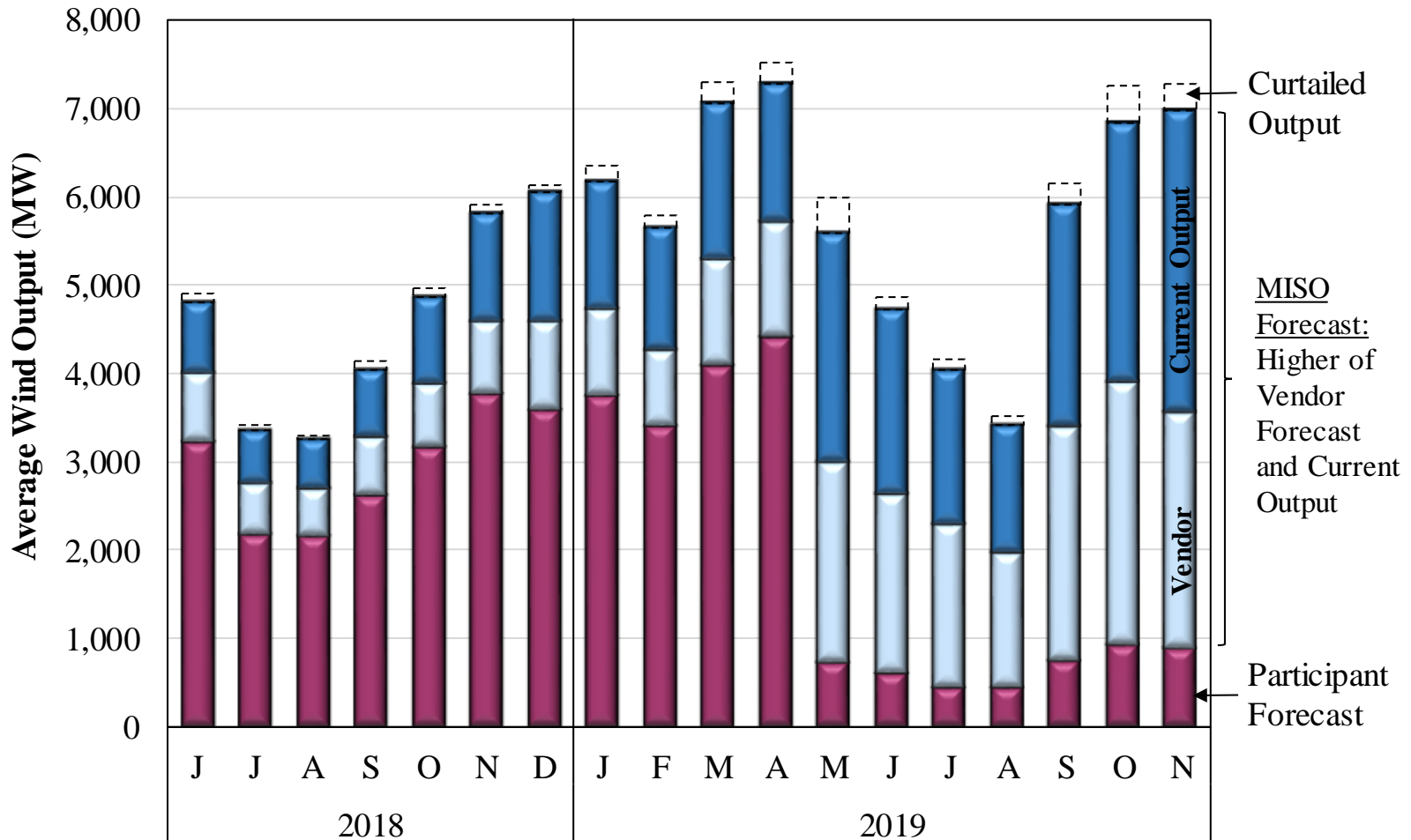


Wind Output in Real-Time Daily Range and Average



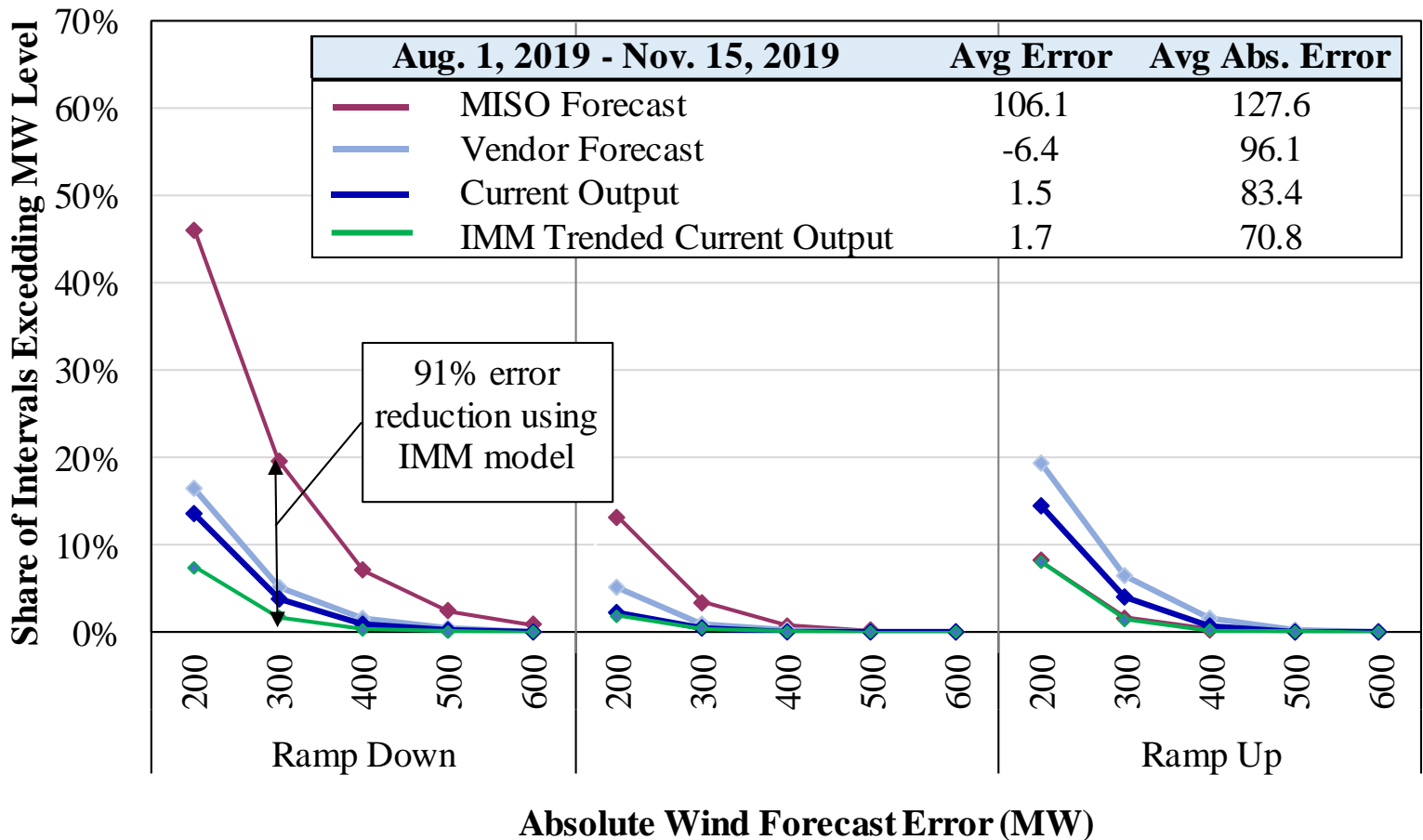


Average Wind Forecasts by Source 2018 - 2019



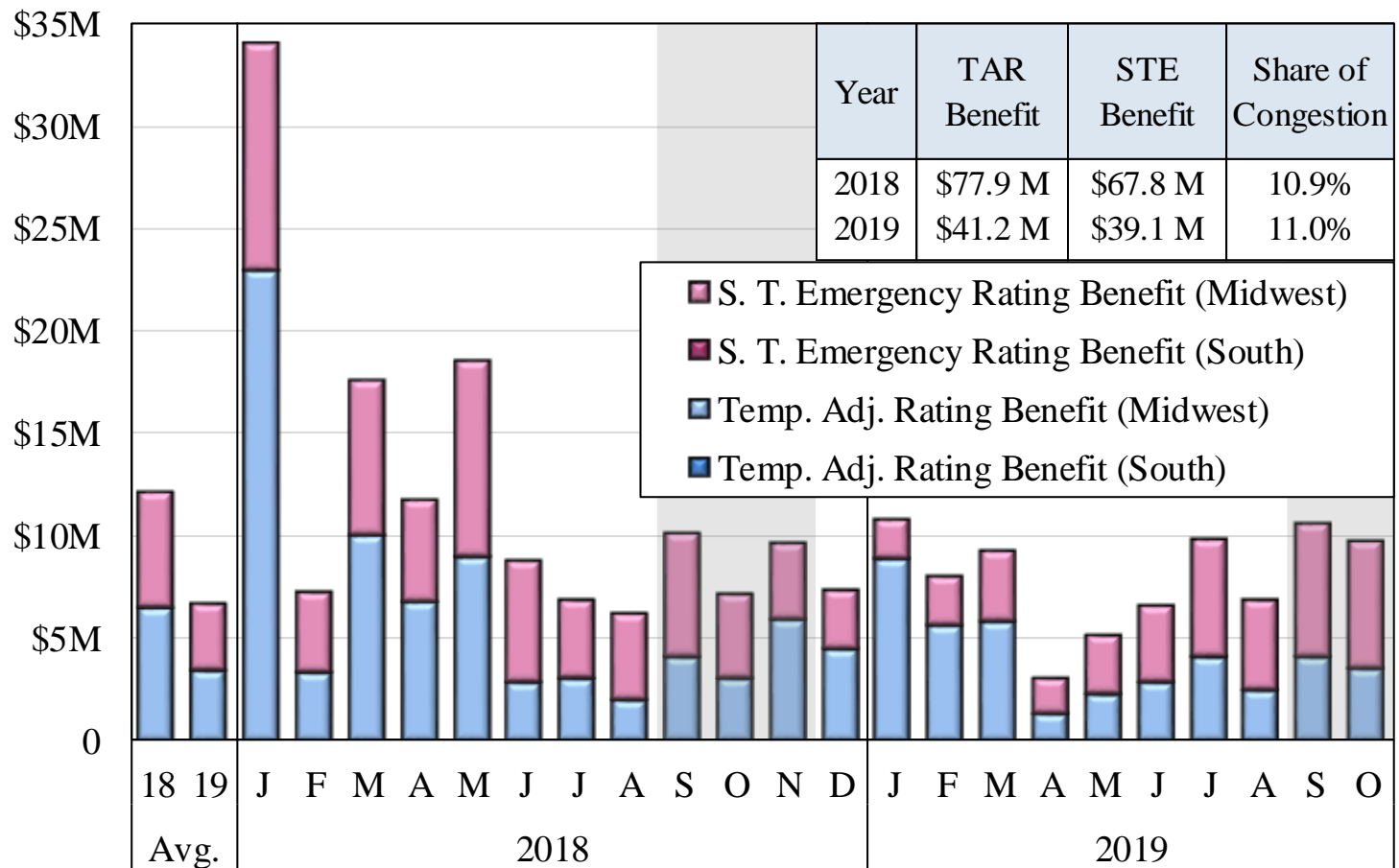
Wind Forecasting Error by Forecast Type

August 1, 2019– November 15, 2019



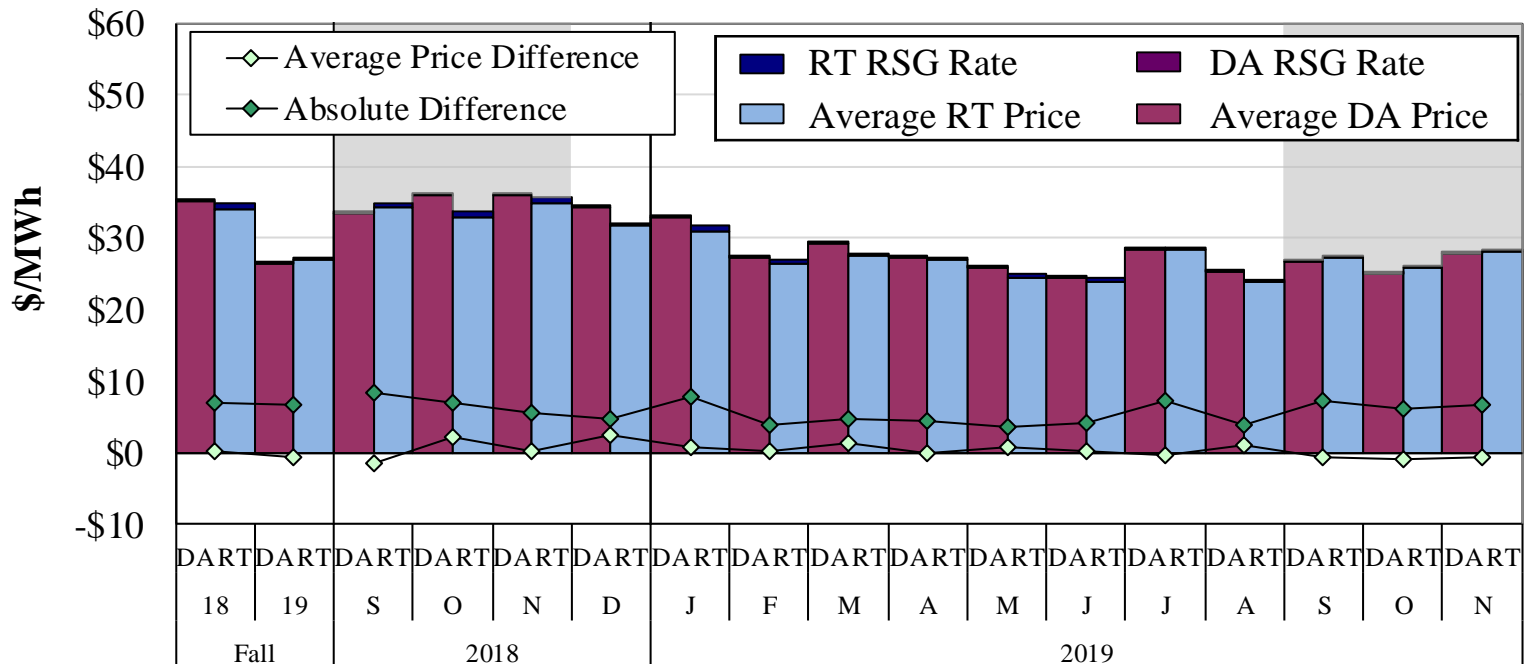


Transmission Ratings Benefits





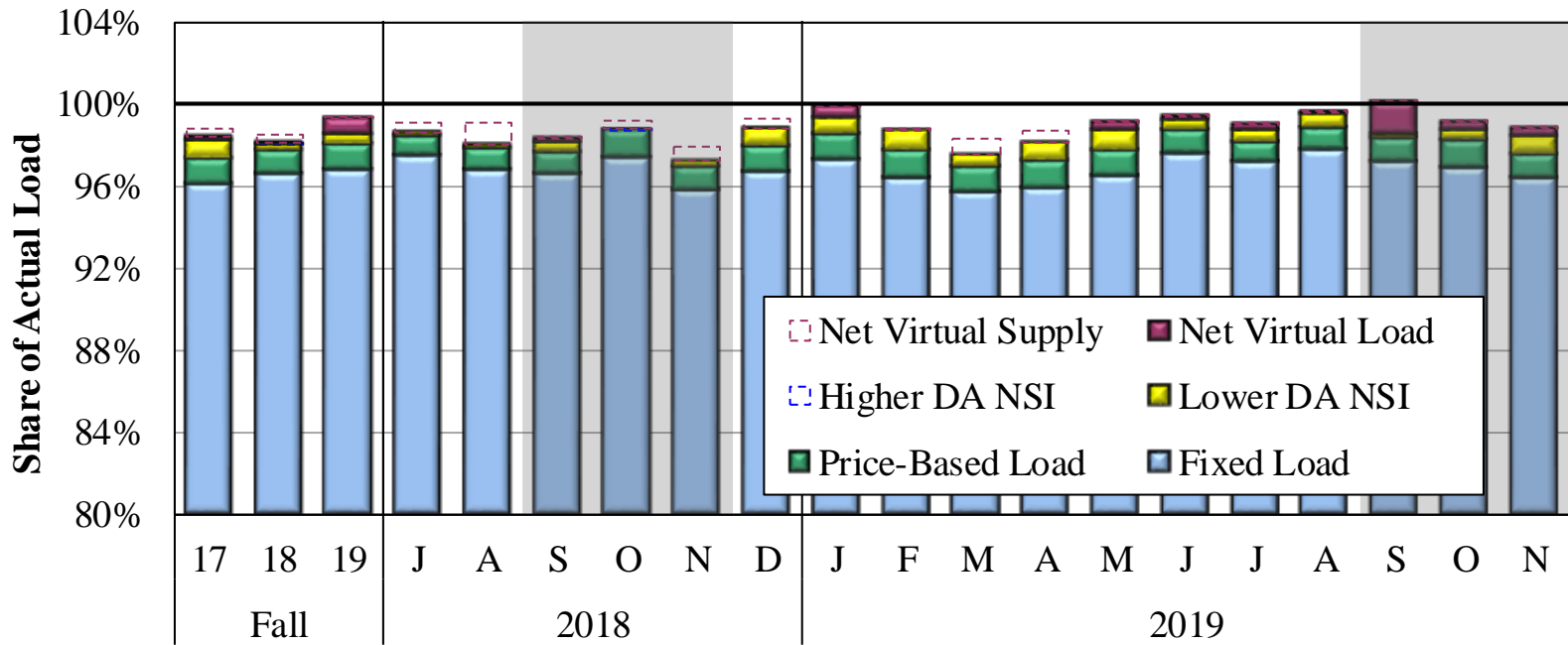
Day-Ahead and Real-Time Price Convergence Fall 2018 – 2019



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

Indiana Hub	1	-2	-4	7	1	7	3	1	5	-1	4	1	-1	4	-2	-4	-2
Michigan Hub	-1	-2	-5	4	-2	5	-6	0	4	-2	3	1	-5	4	1	-4	-1
Minnesota Hub	-1	1	-6	2	1	4	-4	-1	4	0	4	2	-3	6	1	0	2
WUMS Area	0	2	-4	3	0	7	1	1	7	-12	6	-6	-11	6	4	-3	5
Arkansas Hub	-3	-3	-11	3	-1	4	0	-3	5	1	6	8	-1	2	-2	-4	-3
Texas Hub	-4	-5	-12	2	-1	3	1	1	7	0	9	1	5	-18	1	-16	-1
Louisiana Hub	-6	0	-18	4	-5	4	3	0	15	9	11	10	0	6	2	1	-3

Day-Ahead Peak Hour Load Scheduling Fall 2017 – 2019



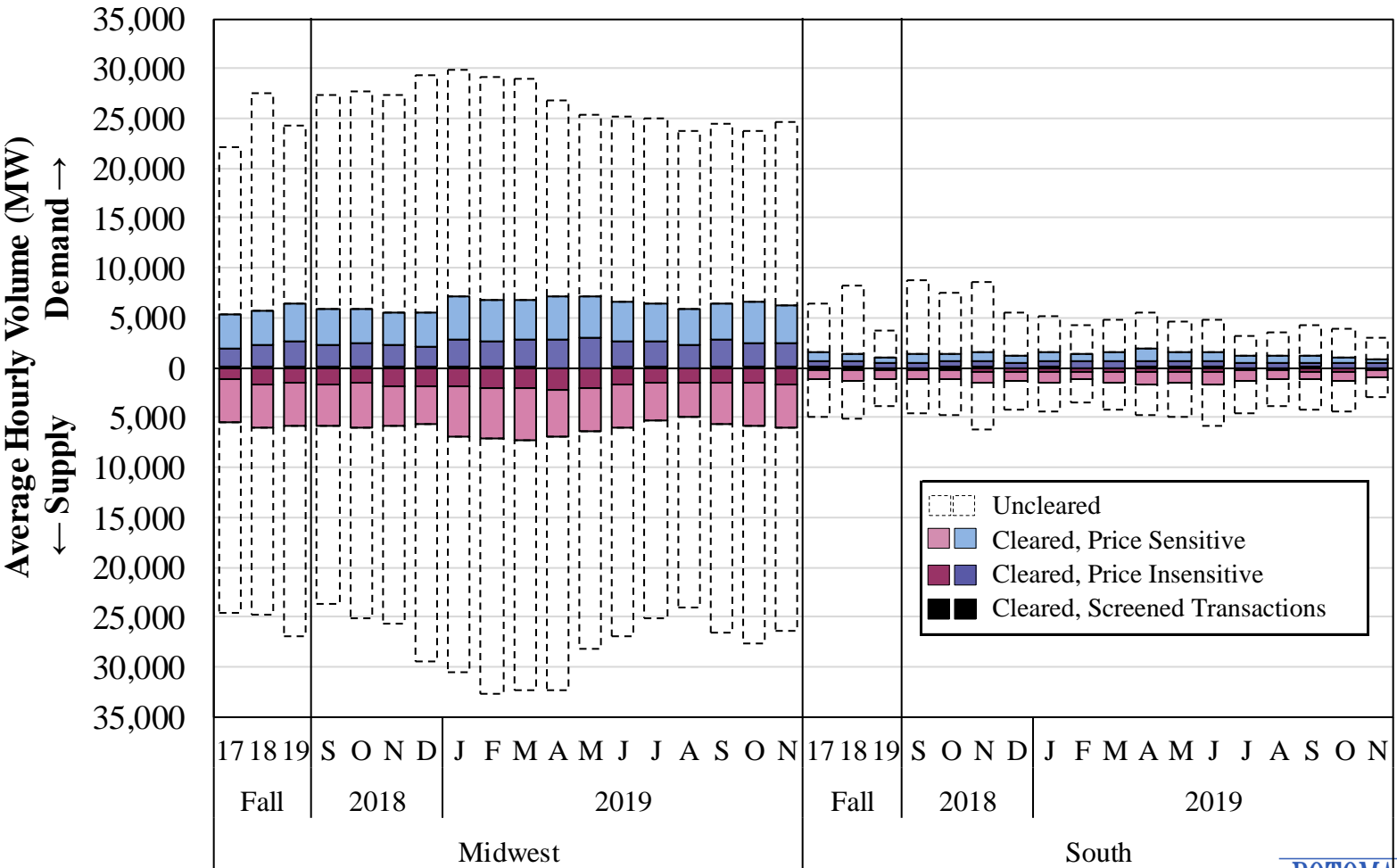
Share of Actual Load (%)

All Hours	98.8	98.5	99.1	99.4	99.3	98.9	99.1	97.5	98.8	99.7	98.8	98.1	98.5	99.0	99.6	99.9	100.1	100.0	98.9	98.5	
Peak Hours Midwest	98.4	97.6	99.0	97.9	97.1	97.6	98.1	97.1	98.7	99.2	97.9	97.1	97.4	98.8	98.8	98.6	99.7	99.9	99.0	98.9	98.2
Peak Hours South	100.6	101.2	100.5	100.9	100.6	101.0	102.5	100.1	102.2	102.6	100.8	99.3	99.9	98.5	100.9	100.2	98.9	100.2	100.6	100.7	



Virtual Load and Supply

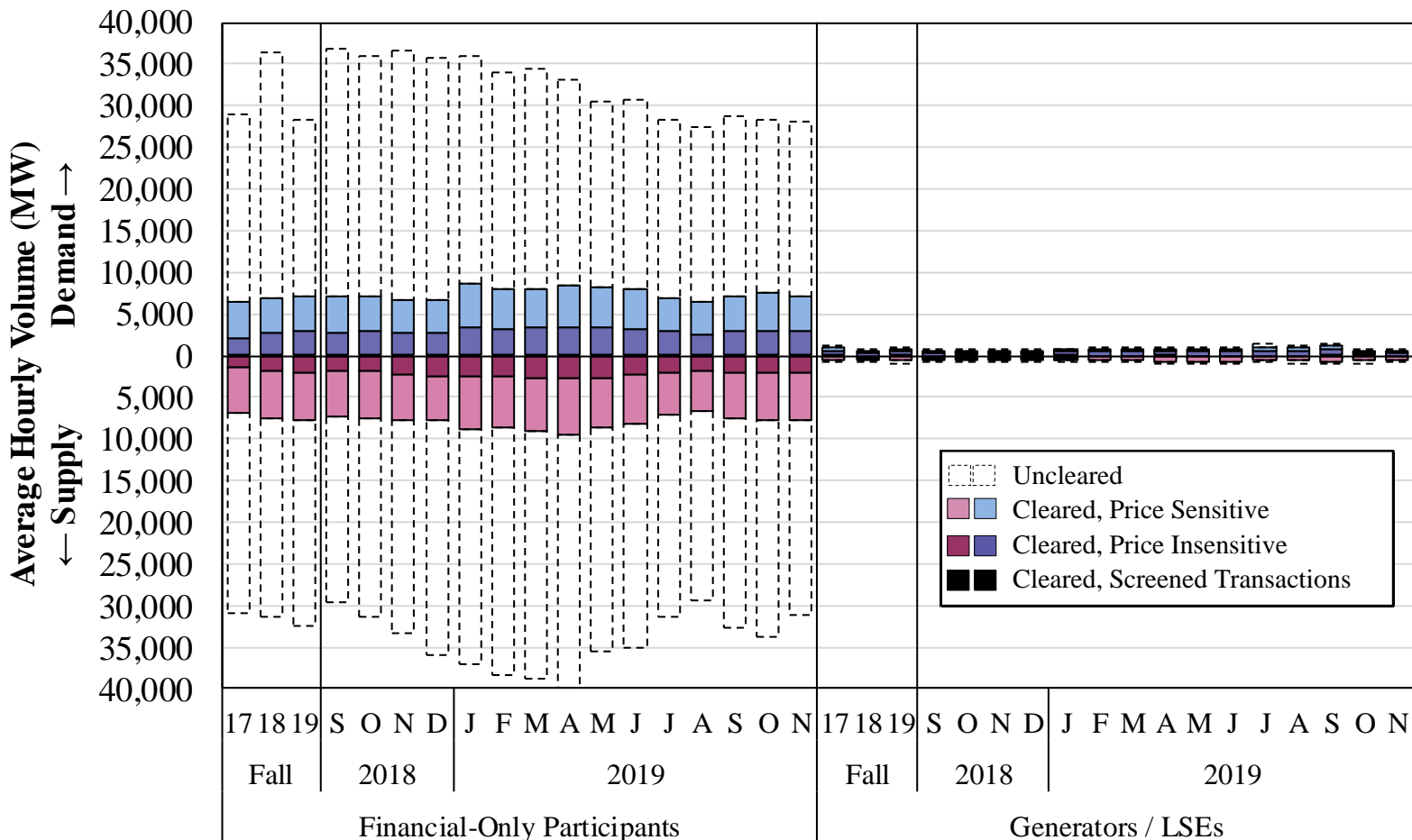
Fall 2017 – 2019





Virtual Load and Supply by Participant Type

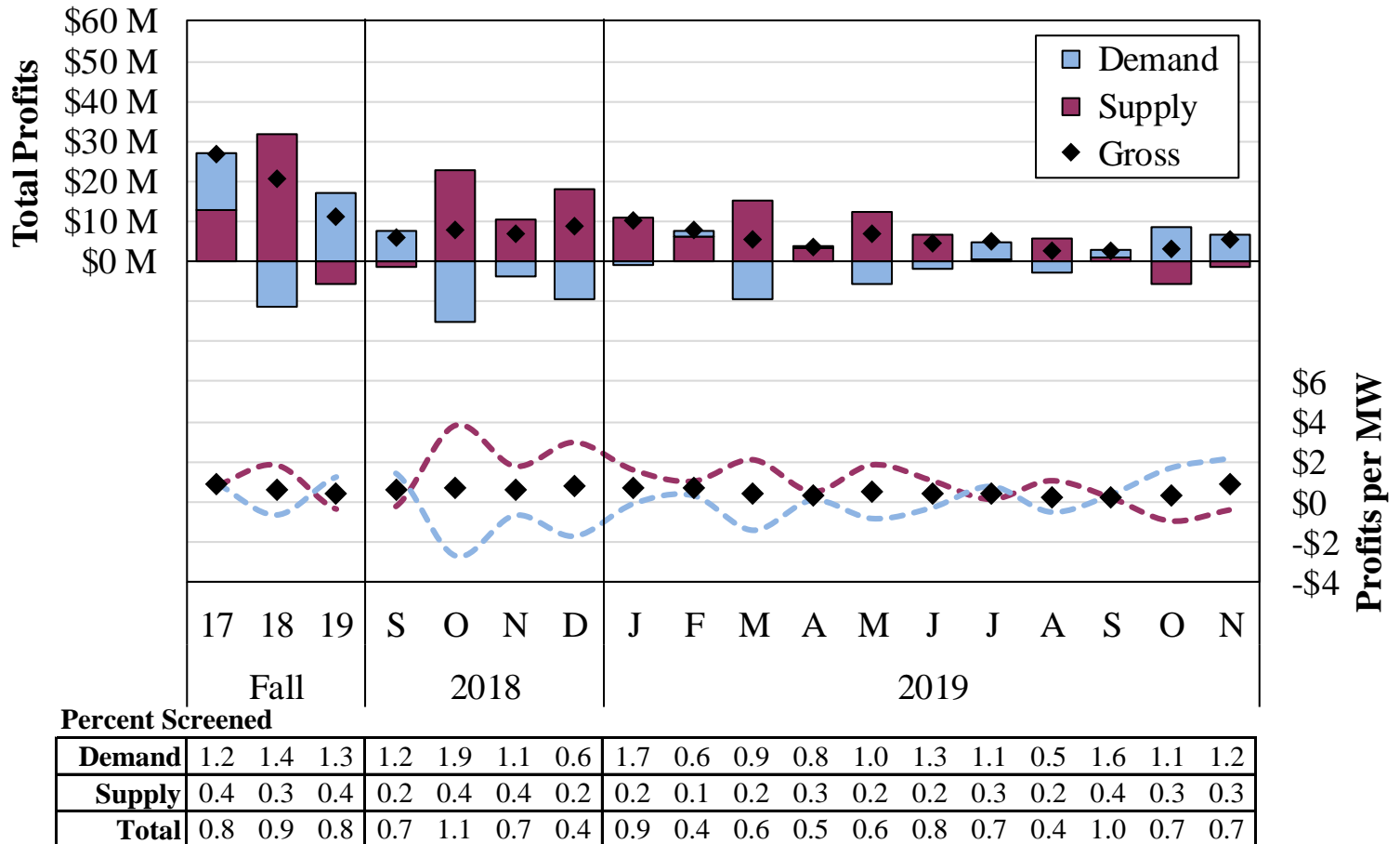
Fall 2017 – 2019



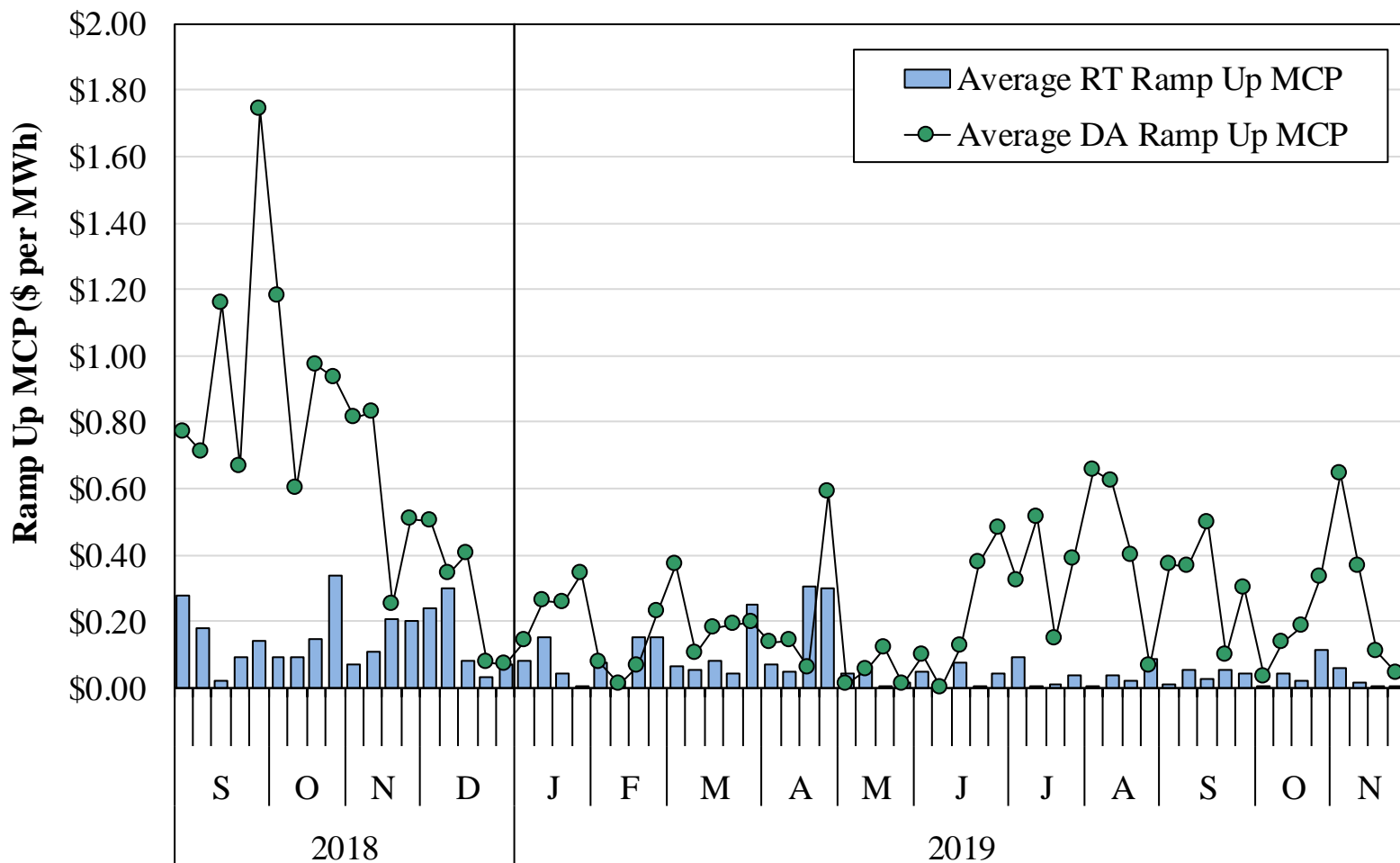


Virtual Profitability

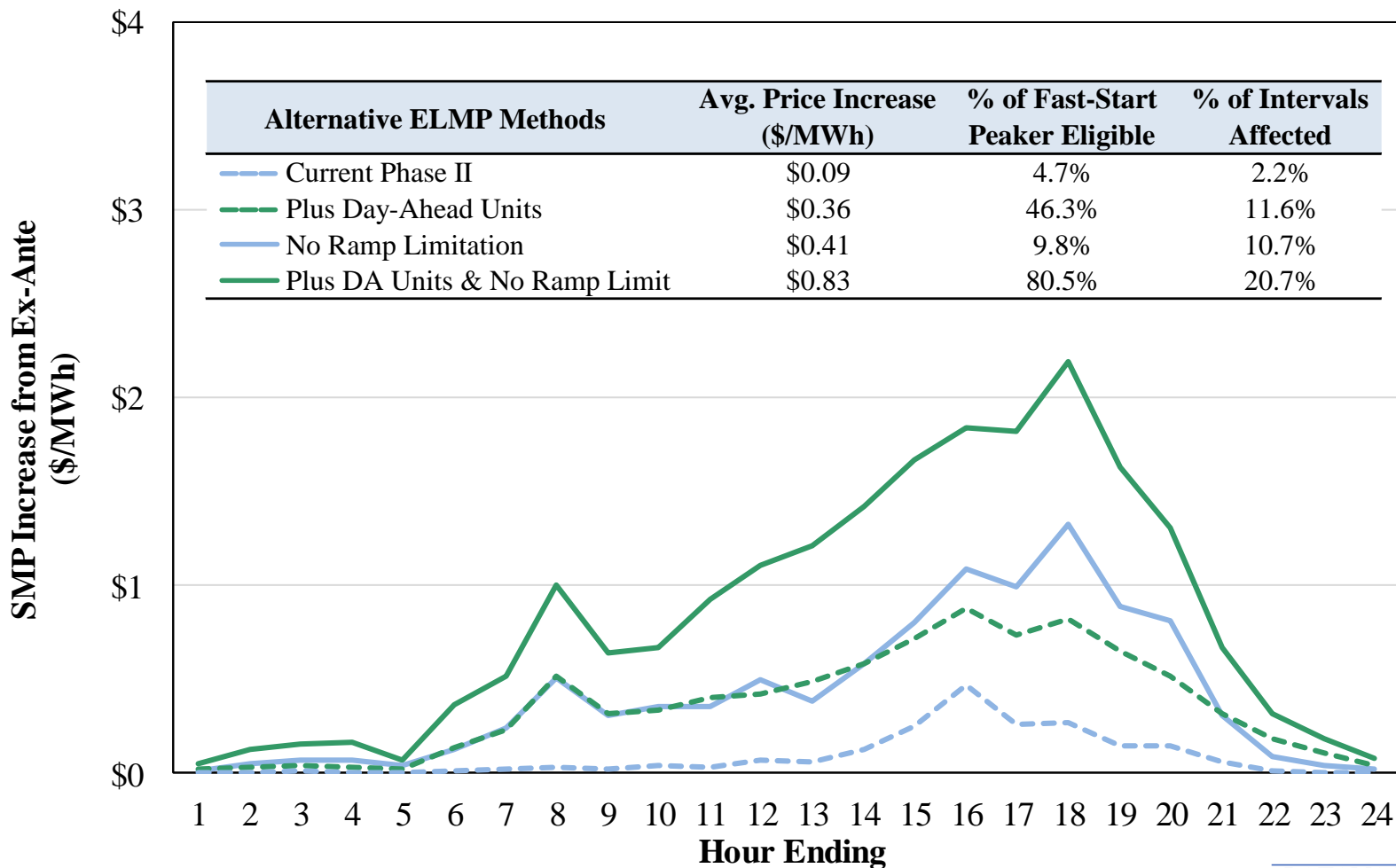
Fall 2017 – 2019



Day-Ahead and Real-Time Ramp Up Price 2018 – 2019

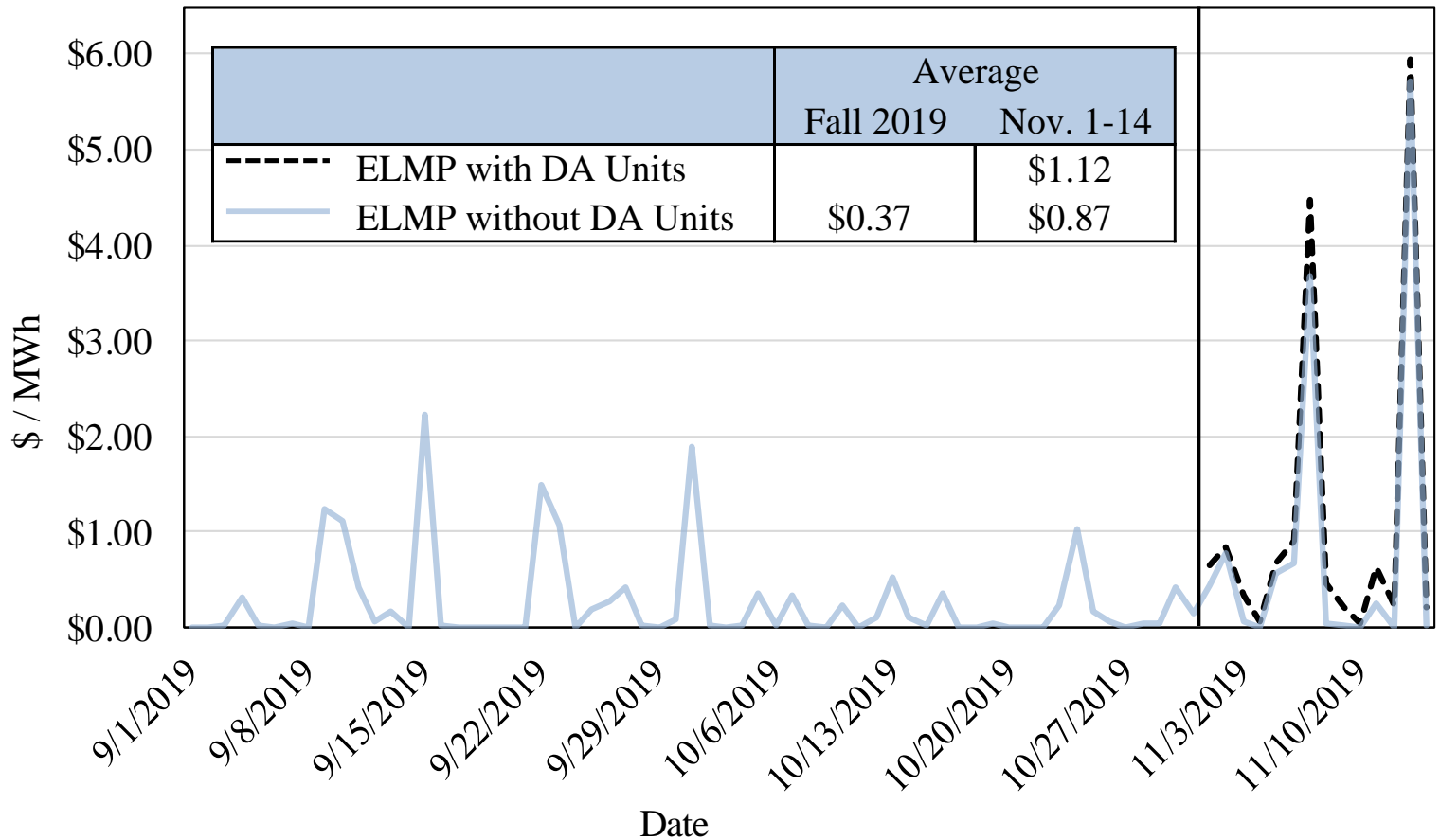


Evaluation of ELMP Assumptions Fall 2019

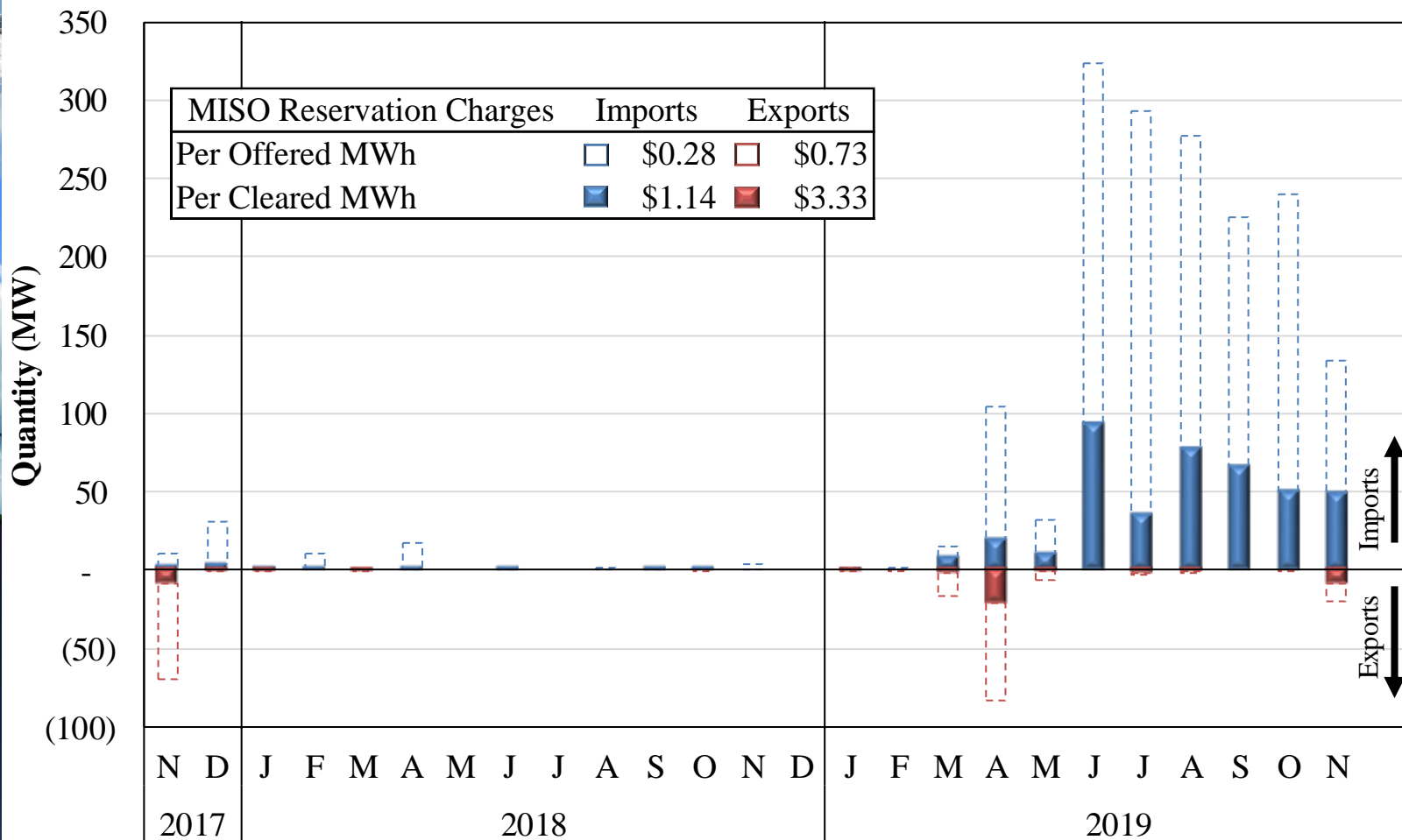




Evaluation of DA Online ELMP Fall 2019

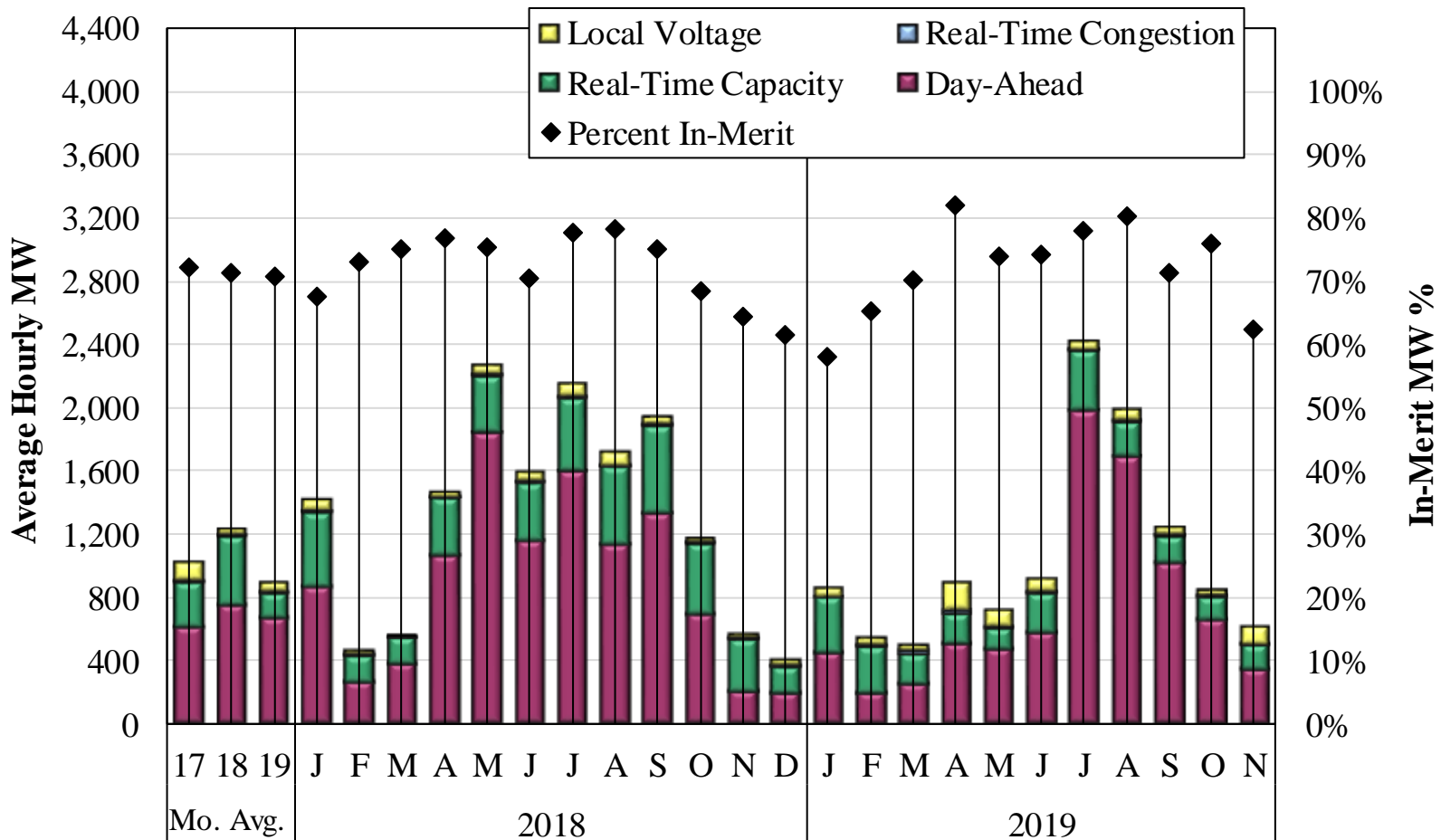


Coordinated Transaction Scheduling (CTS) 2017 – 2019

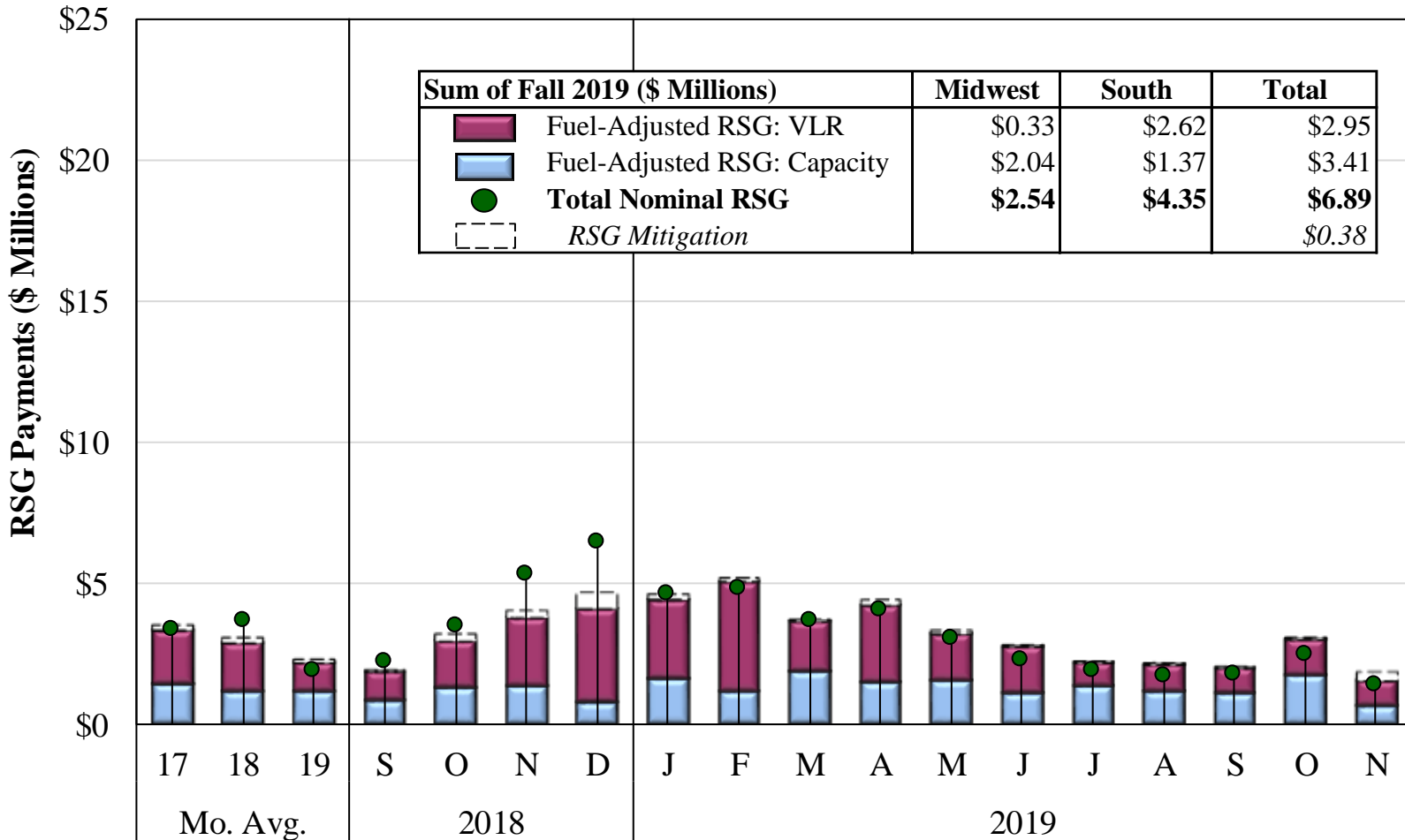




Peaking Resource Dispatch Fall 2017 – 2019

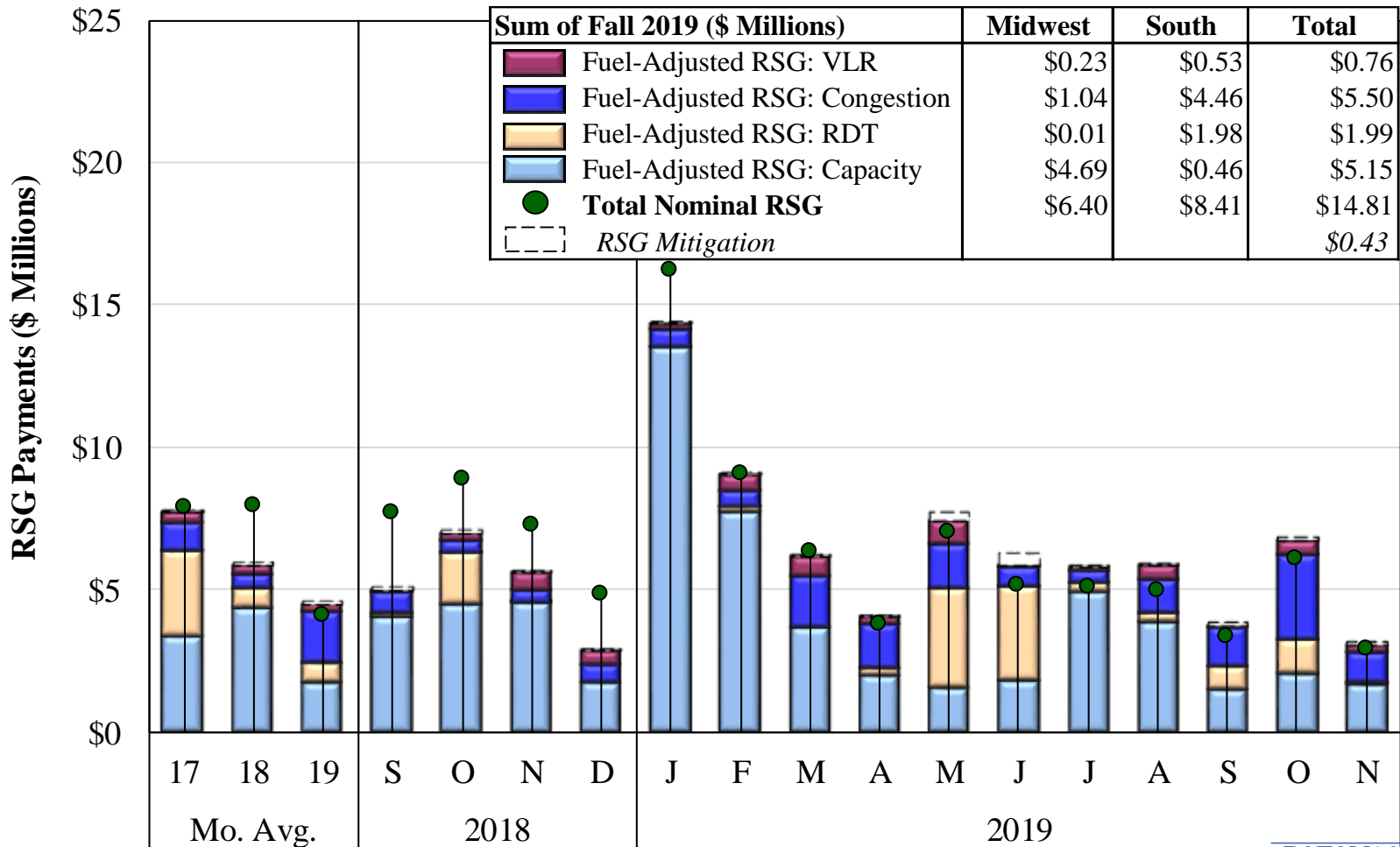


Day-Ahead RSG Payments Fall 2017 – 2019



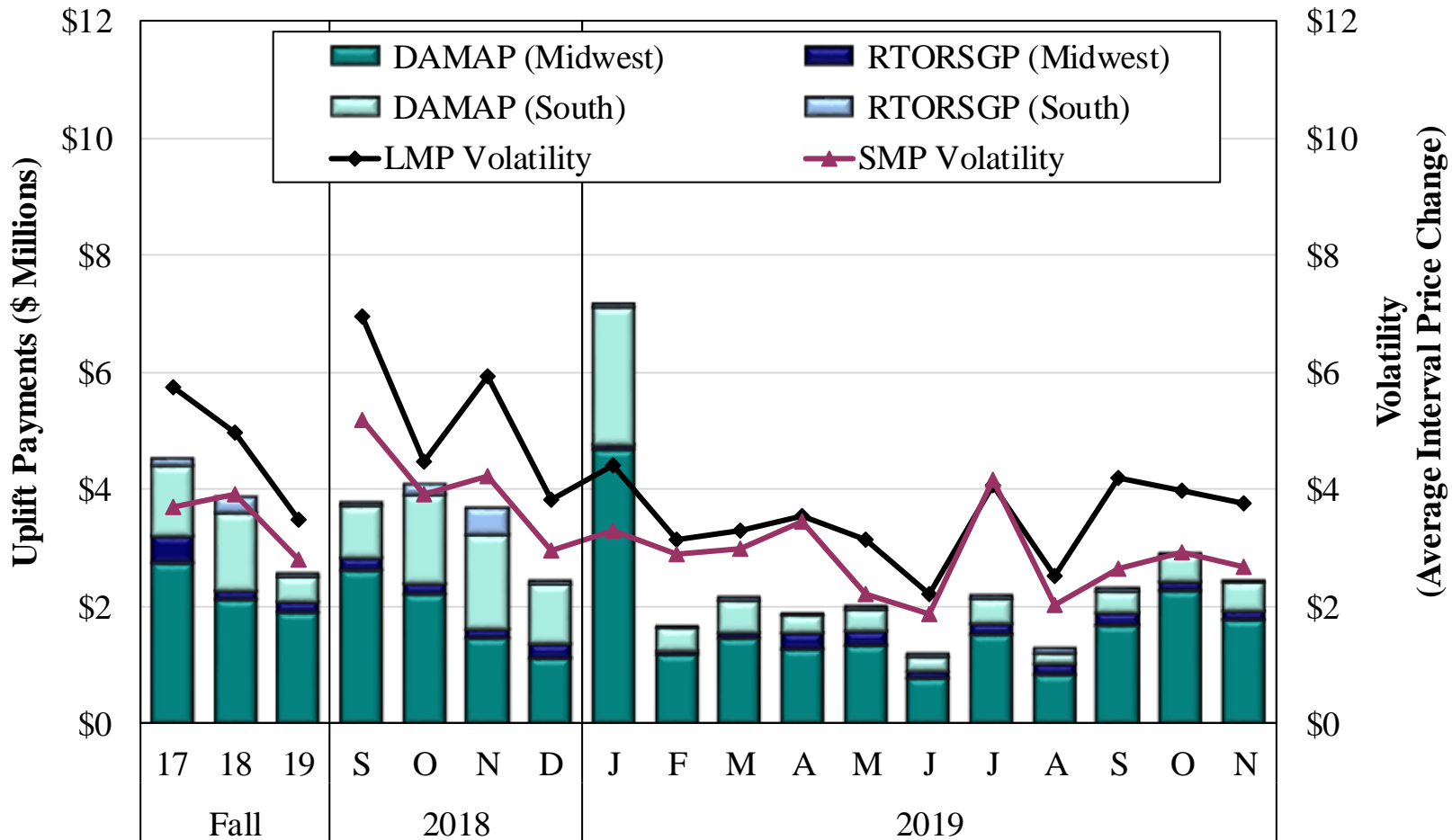


Real-Time RSG Payments Fall 2017 – 2019



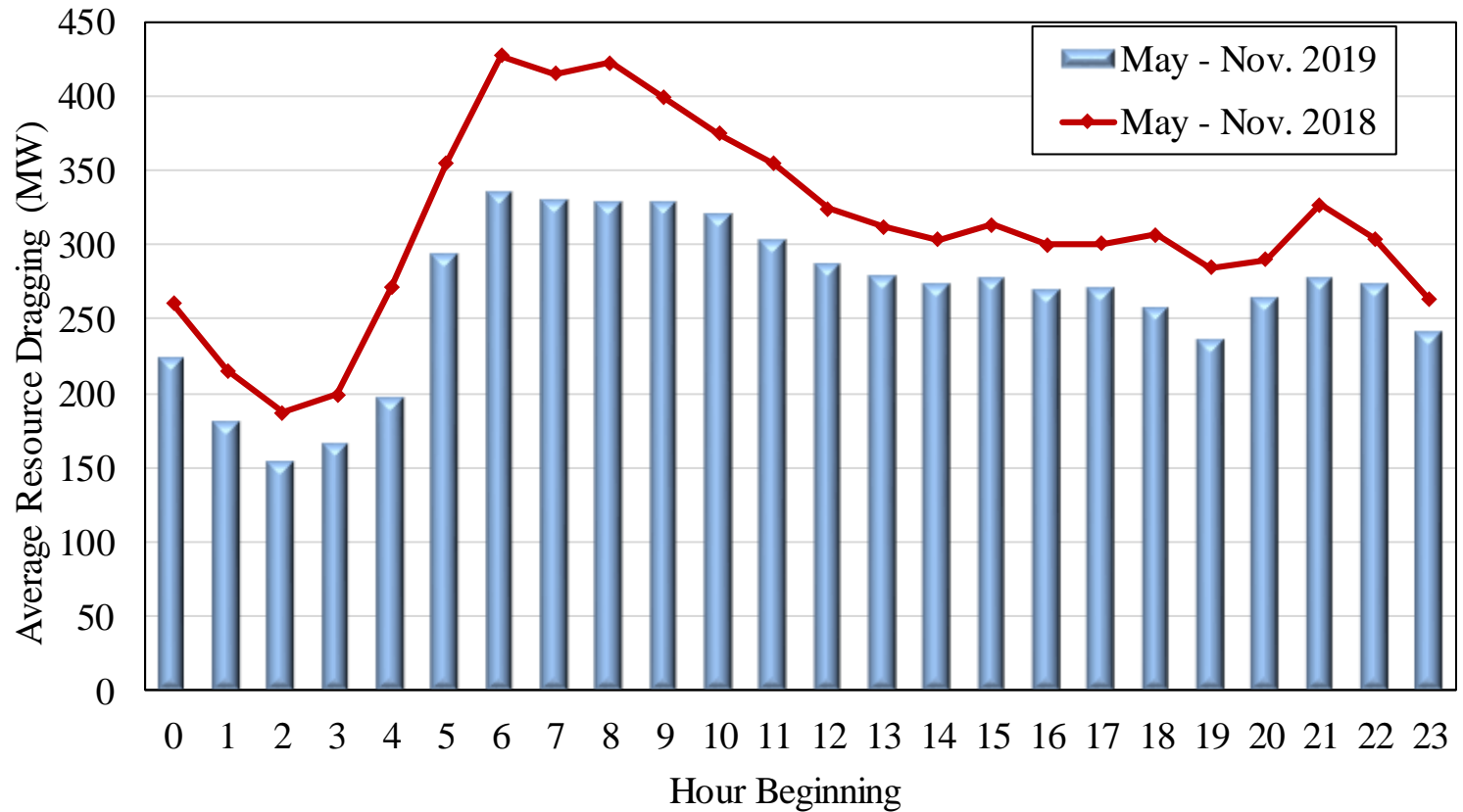


Price Volatility Make Whole Payments Fall 2017 – 2019





Average Resource Dragging by Hour May - November

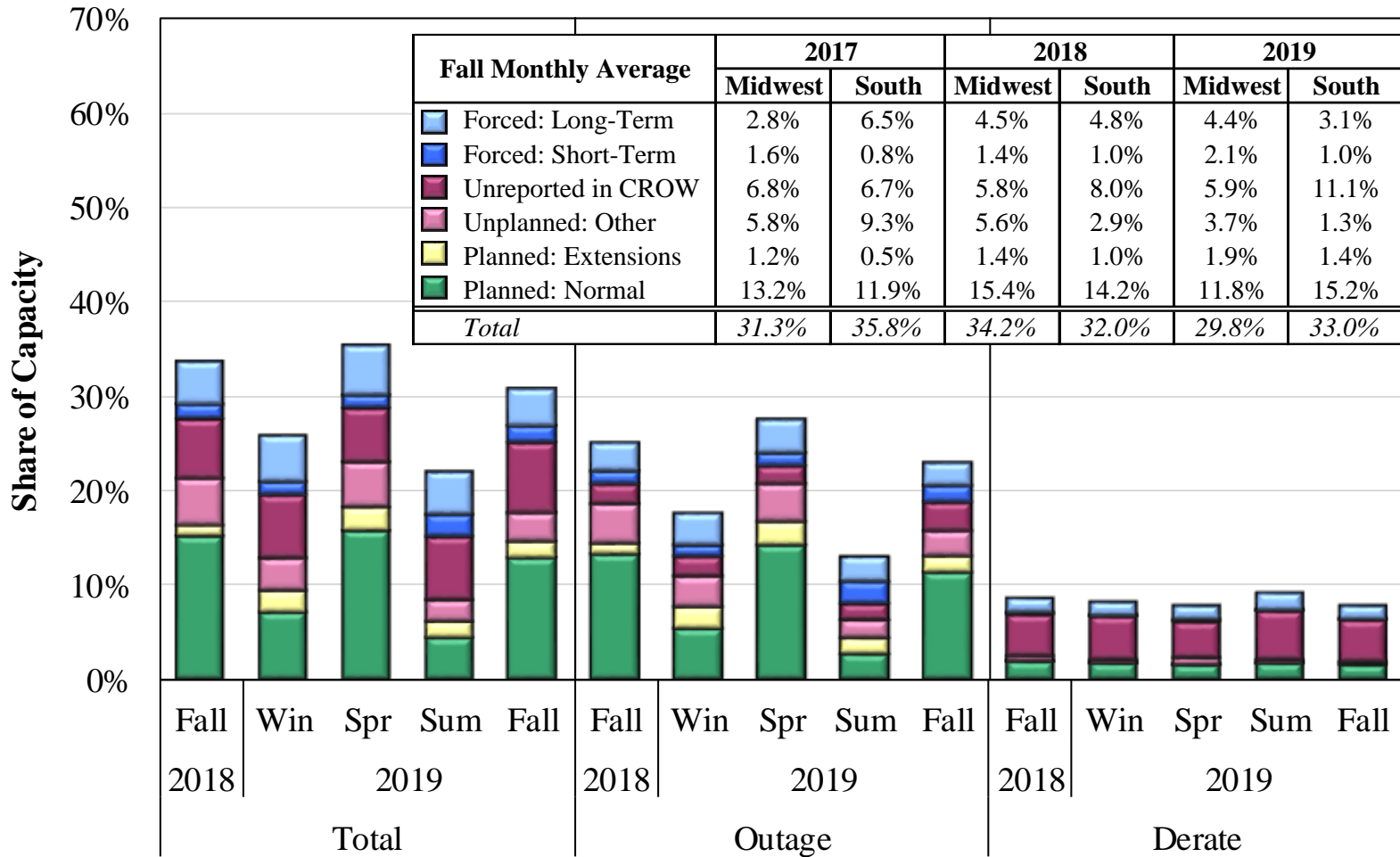


Note: Based on data available through November 15.



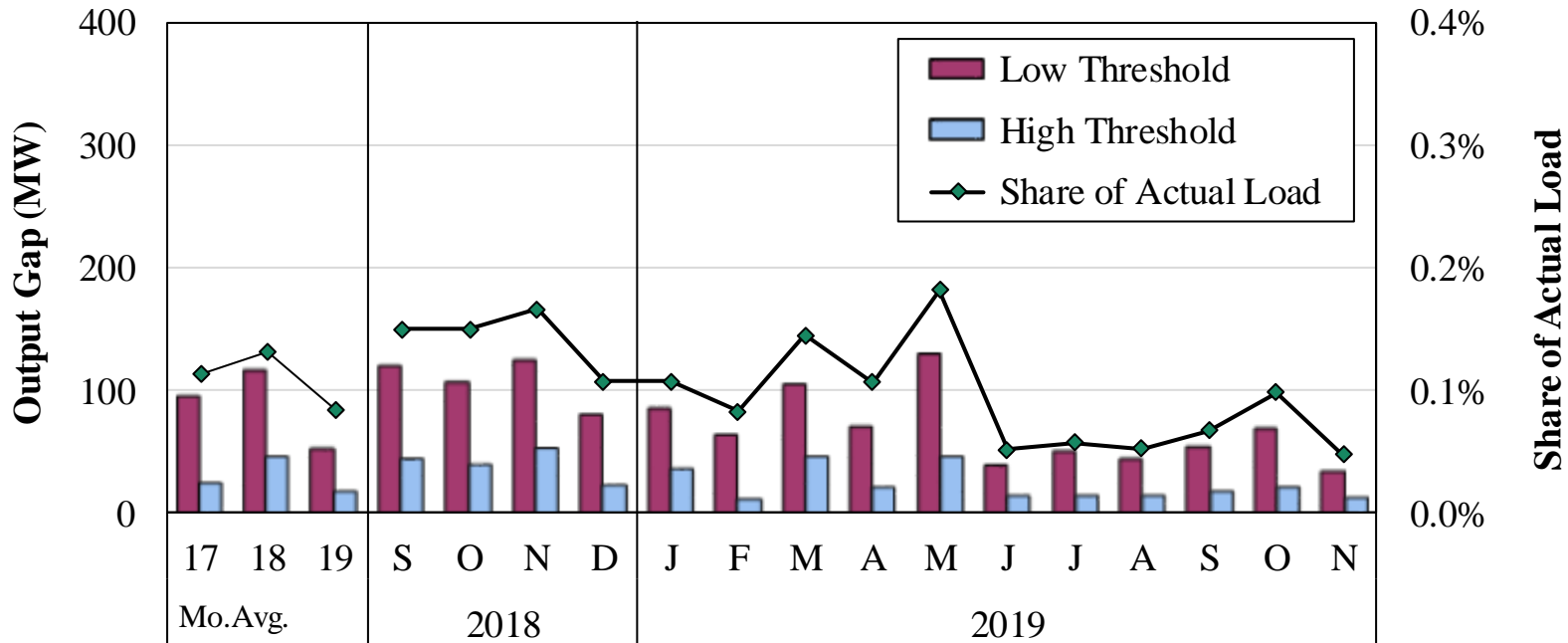
Generation Outage and Derate Rates

Fall 2018 - 2019





Monthly Output Gap Fall 2017 – 2019



Low Threshold Results by Unit Status (MW)

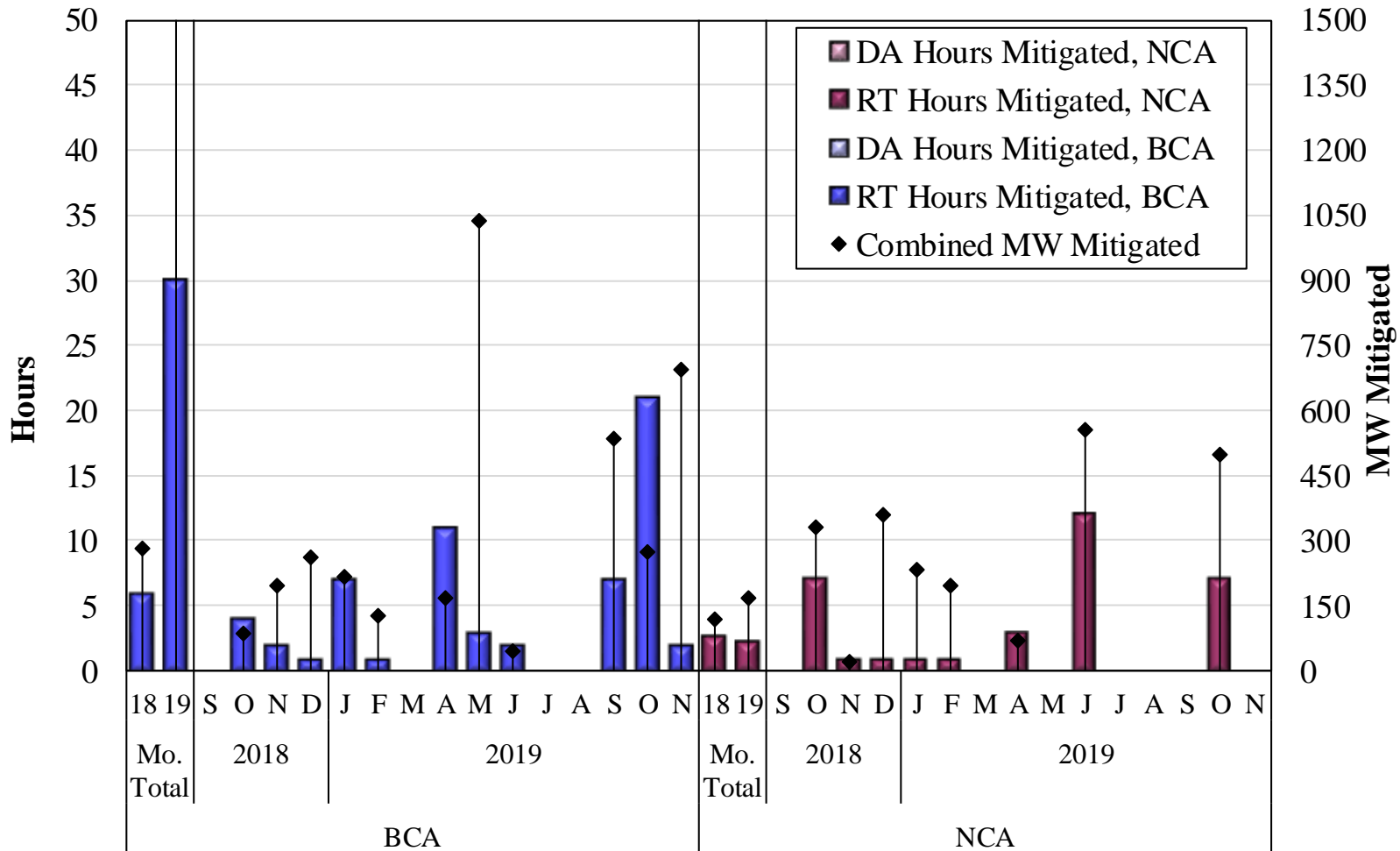
Offline	5	14	12	17	17	6	3	30	2	31	12	15	8	9	9	10	15	10
Online	90	103	41	102	90	118	78	56	63	75	60	114	33	42	36	45	54	25

High Threshold Results by Unit Status (MW)

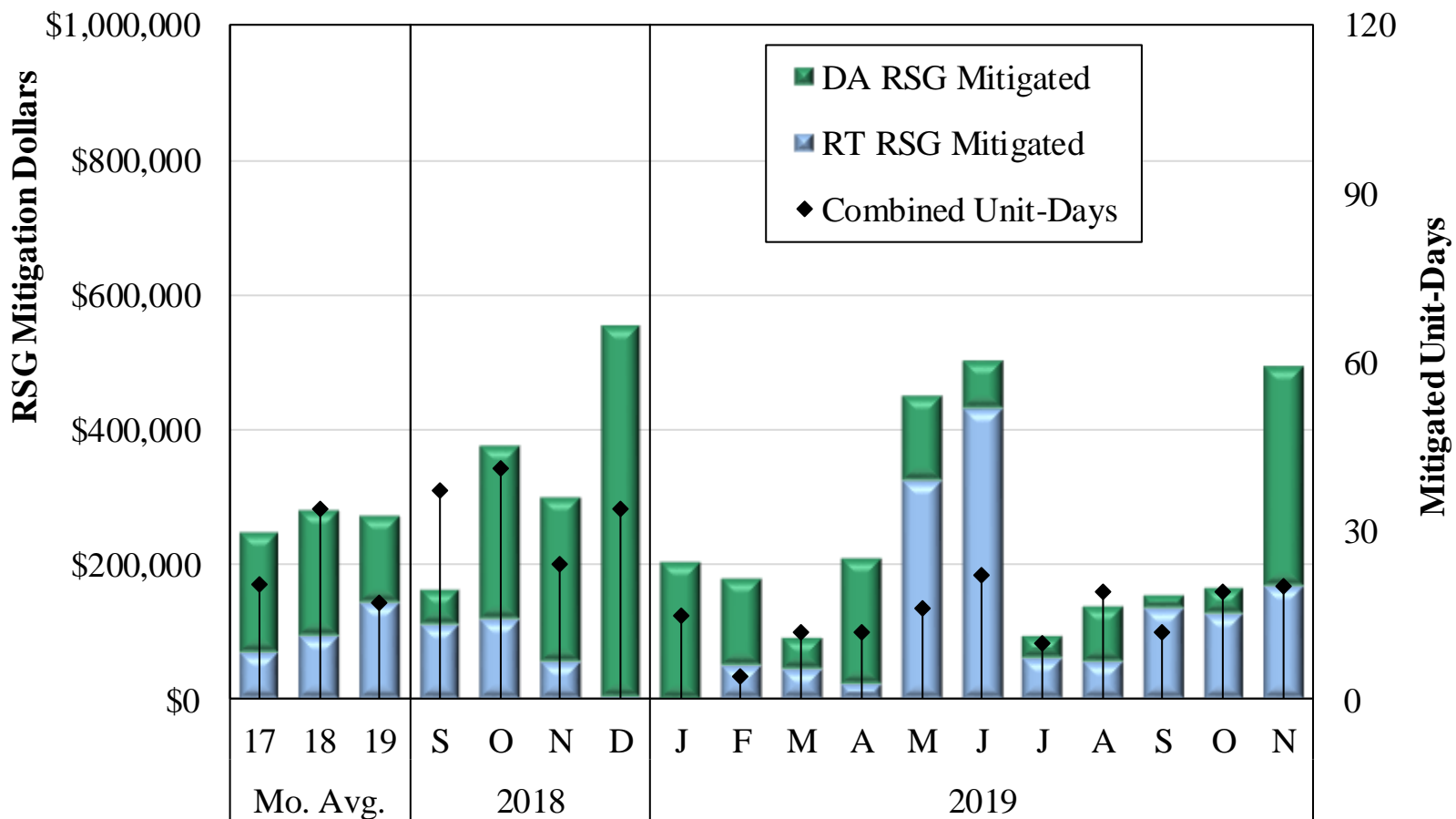
Offline	4	12	10	16	16	5	3	24	2	28	8	10	7	9	8	8	11	10
Online	22	34	9	30	24	48	21	13	11	19	15	36	9	8	7	10	12	4



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



Day-Ahead and Real-Time RSG Mitigation Fall 2017 – 2019



List of Acronyms

- AAR Ambient-Adjusted Ratings
- 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
- STE Short-Term Emergency
- 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