



IMM Quarterly Report: Fall 2020

MISO Independent Market Monitor

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December 8, 2020



Highlights and Findings: Fall 2020

- The MISO markets performed competitively this fall, market power mitigation was infrequent, and conduct was competitive overall.
- Lower load (down 7%) and natural gas prices (down 6%), and higher wind output (up 30%) led to a 14 percent decrease in energy prices from last fall.
 - ✓ Although gas prices increased 16 percent from October to November, real time energy prices fell 13 percent as average wind output rose 25 percent.
- Average and peak load fell 7 and 10 percent, respectively.
 - ✓ Cooler weather in September and early October moderated cooling needs.
 - ✓ MISO estimated that COVID led to a 5 percent reduction in load this fall.
- Significant transmission system damage from Hurricane Laura in late August and impacts from Hurricane Delta in October raised operating concerns.
 - ✓ Lake Charles in the South was severely impacted, and local Conservative Operations was declared for a month to support restoration efforts.
- Gas prices were highly volatile throughout the quarter, falling to \$1.06 per MMBtu in early October and rising almost 200 percent 3 weeks later.
- 2 to 3 GW of planned outages impacted by COVID in the Spring were rescheduled and completed in the fall.

Quarterly Summary

		Value	Change ¹			Value	Change ¹	
			Prior Qtr.	Prior Year			Prior Qtr.	Prior Year
RT Energy Prices (\$/MWh)	●	\$21.87	-10%	-14%	FTR Funding (%)	●	95%	101% 96%
Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	●	9,591	57% 30%
Natural Gas - Chicago	●	\$2.10	19%	-4%	Guarantee Payments (\$M)⁴			
Natural Gas - Henry Hub	●	\$2.26	23%	-8%	Real-Time RSG	●	\$10.2	-39% -32%
Western Coal	●	\$0.67	-1%	-3%	Day-Ahead RSG	●	\$39.6	601% 474%
Eastern Coal	●	\$1.25	0%	-8%	Day-Ahead Margin Assurance	●	\$6.1	-44% -14%
Load (GW)²					Real-Time Offer Rev. Sufficiency	●	\$0.6	-48% -14%
Average Load	●	68.8	-18%	-7%	Price Convergence⁵			
Peak Load	●	96.3	-18%	-10%	Market-wide DA Premium	●	1.7%	-1.1% -2.0%
% Scheduled DA (Peak Hour)	●	99.0%	100.3%	99.3%	Virtual Trading			
Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	●	19,233	15% 19%
Real-Time Congestion Value	●	\$395.4	19%	29%	% Price Insensitive	●	32%	28% 30%
Day-Ahead Congestion Revenue	●	\$204.3	-8%	34%	% Screened for Review	●	1%	1% 1%
Balancing Congestion Revenue ³	●	-\$1.1	\$73.2	-\$4.4	Profitability (\$/MW)	●	\$0.96	\$0.30 \$0.38
Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	●	776	2569 904
Regulation	●	\$9.21	17%	14%	Output Gap- Low Thresh. (MW/hr)	●	178	191 53
Spinning Reserves	●	\$1.82	-5%	-20%	Other:			
Supplemental Reserves	●	\$0.28	-7%	-54%				

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 2020

Hurricane Laura Load Pocket Pricing Issues (Slides 16-17)

- On August 27, Hurricane Laura made landfall as a category 4 hurricane near Lake Charles, doing substantial damage to the transmission system and creating the Hurricane Laura Load Pocket (HLLP).
 - ✓ Multiple generators took outages in anticipation of the storm and several units tripped during the event, causing MISO to shed load in the HLLP.
 - ✓ A week later, MISO implemented revised settlements at \$3500 per MWh (VOLL) for several hours, leading to ~\$90 million in balancing congestion.
- Hurricane Laura effectively created a “dead zone” in the Lake Charles area, destroying a significant amount of distribution system lines and transmission.
 - ✓ Approximately \$10 million in balancing congestion on August 27th was due to dead bus pricing at \$3500 per MWh in the impacted Lake Charles area.
 - ✓ By mid-September, three units were online and able to serve the load, but total restoration of the area was not completed until mid-October.
- We have questions regarding applying the VOLL pricing to “dead buses” outside the HLLP (incl. Lake Charles), which accounts for roughly 25% of the balancing congestion. We are discussing these issues with MISO.



Highlights for Fall 2020

Pricing in the Hurricane Laura Load Pocket and RSG (Slide 29)

- Due to modeling challenges, MISO was unable to price the HLLP in the aftermath consistent with conditions until a week into September.
 - ✓ In early September, industrial load in the area was unable to be served while prices were inefficiently low, averaging around \$20 per MWh on peak.
 - ✓ MISO established a reserve zone and activated a reserve procurement constraint on September 8th so prices could reflect the tight conditions in the region, but by then much of the transmission had been restored and conditions were much less tight.
- Very high day-ahead RSG was incurred as units with high risk-related costs committed in East Texas received over \$30 million in RSG payments.
 - ✓ These units' offers and references reflected a significant risk of outage.
 - ✓ This risk manifested itself when two units tripped after a few days online.
 - ✓ More than \$0.5 million in day-ahead RSG was mitigated in September.



Highlights for Fall 2020

Natural Gas Prices (Slide 13)

- Gas prices were highly volatile throughout the quarter, particularly during October because of hurricane impacts and cooler temperatures.
 - ✓ Hurricane Laura significantly impacted two LNG terminals in Louisiana, putting downward pressure on Henry Hub gas prices.
 - ✓ In mid-October, cooler than normal temperatures in the Midwest caused residential and commercial consumption to triple within two weeks, leading to a significant increase in gas prices in the Midwest.

Hurricane Delta and Associated Pricing (Slides 16)

- On October 10, Hurricane Delta made landfall just east of the area impacted by Hurricane Laura, although the damaged area was less extensive.
 - ✓ Because MISO had established a reserve zone for the HLLP, pricing in the load pocket reflected tight conditions in the area.
 - ✓ There was a \$45 day-ahead premium on October 10-11 to procure reserves in the new reserve zone.
 - In response to prices, some resources returned from outage early and a non-capacity resource switched from ERCOT to MISO.



Highlights for Fall 2020

Wind and the RDT (Slides 15, 21-25)

- MISO experienced several days with record high wind this quarter, and an all-time new wind output peak was set on November 15 at nearly 19 GW, serving one third of all the load.
 - ✓ Installed wind capacity and output grew at 33 and 30 percent from last fall, respectively. Wind set price in 85 percent of constrained market intervals.
 - ✓ More than half of real-time congestion was related to wind.
- Dramatic changes in wind output occurred several times throughout the quarter, underscoring the importance of MISO's wind forecast.
 - ✓ On October 18, wind dropped from 15.5 GW to 1 GW across the day, and on October 16, wind output fell 5.9 GW just ahead of the daily peak hour.
 - ✓ In February, MISO removed the "higher of" logic from its wind forecasts, resulting in a decrease in the average forecast error by more than 80 percent.
- Changes in the regional transfers with the South absorb some of the wind output fluctuations since currently all wind resources are in the Midwest.
 - ✓ RDT flows reversed from 2,000 MW North-to-South to 2,000 MW flowing South-to-North on October 16 in response to changes in the wind.



Submittals to External Entities and Other Issues

- We responded to several FERC questions related to prior referrals and FERC investigations. We continued to meet with FERC on a weekly basis and we responded to several requests for information on market issues.
- In October, we presented our Summer Quarterly Report and our study of the commitment and dispatch practices of coal resources in MISO to the MSC.
- In November we participated in a meeting of Market Monitors and FERC Office of Enforcement Staff on monitoring issues and interaction with OE.
- In November, we presented a summary of MISO South market results and issues to the Entergy Regional State Committee.
- In November, we participated in the annual meeting of the international group of Market Monitors (EISG) to discuss market developments.
- We continue discussing issues with Emergency Pricing and Shortage Pricing with MISO and the MSC.
 - ✓ These discussions included the elimination of offline ELMP pricing, which artificially mutes MISO's shortage pricing.

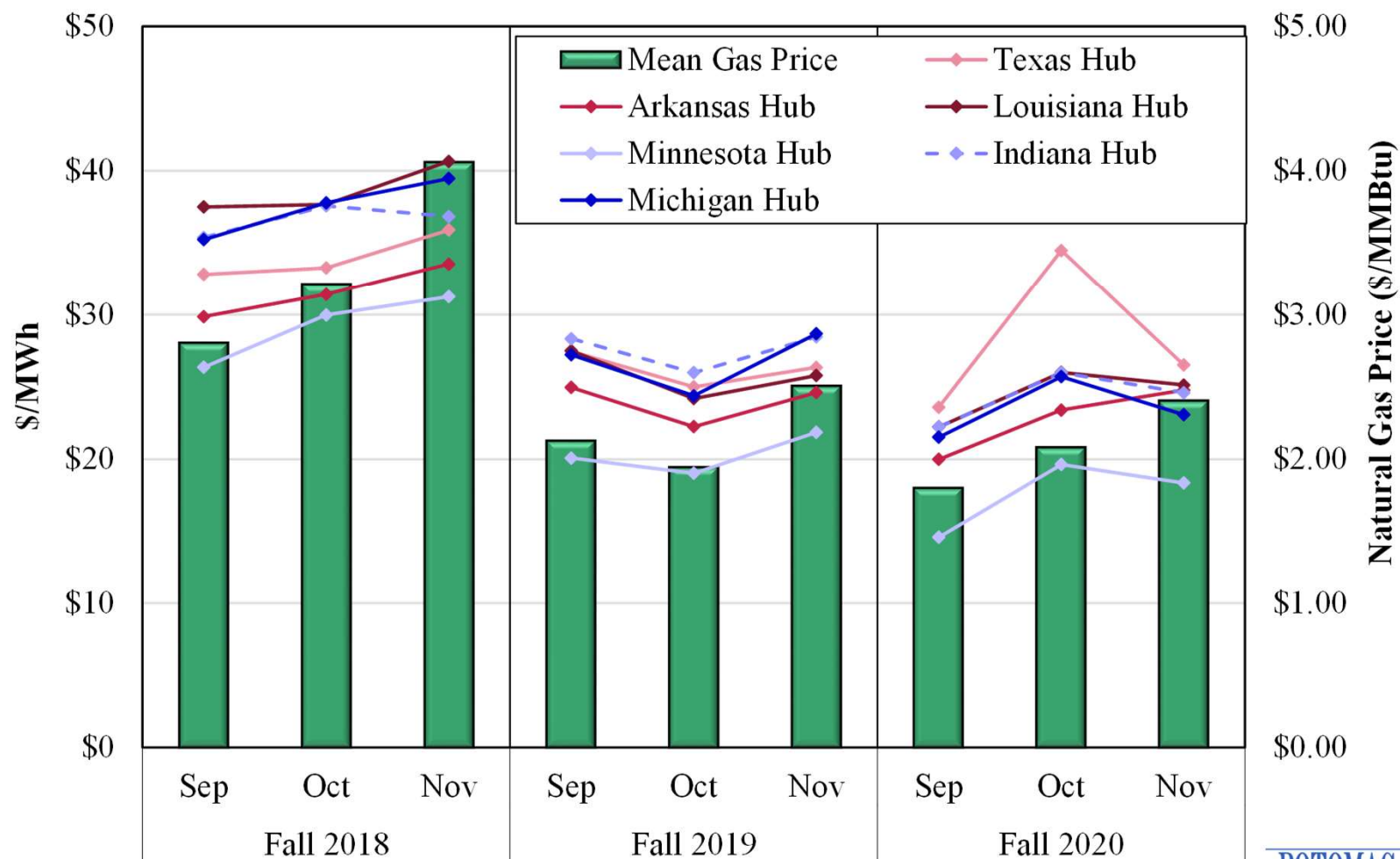


Submittals to External Entities and Other Issues

- During the quarter we continued to discuss development of Ambient Adjusted Rating (AAR) Programs and use of Emergency Ratings with TOs and MISO.
 - ✓ We also met with regulators, and a group including TOs to discuss the IMM recommendations (2015-2 and 2019-3) and a proposal presented by TOs.
 - ✓ We believe these discussions will result in pilot AAR programs and increased submission of Emergency Ratings.
 - ✓ These discussions and our past recommendations are very consistent with FERC's proposed rule to require AARs issued in November (RM20-16).
 - ✓ Additional discussions with these groups are planned in December.
- FERC's proposed rule in November (RM20-16) that is closely aligned with our recommendations to MISO regarding AARs and emergency ratings.
 - ✓ It proposes to require all transmission operators to utilize AARs in the operating timeframe (longer-term functions will still use seasonal ratings).
 - ✓ It proposes to require RTOs to develop the capability to receive AARs from TOs on at least an hourly basis.
 - ✓ Comments are due in January.

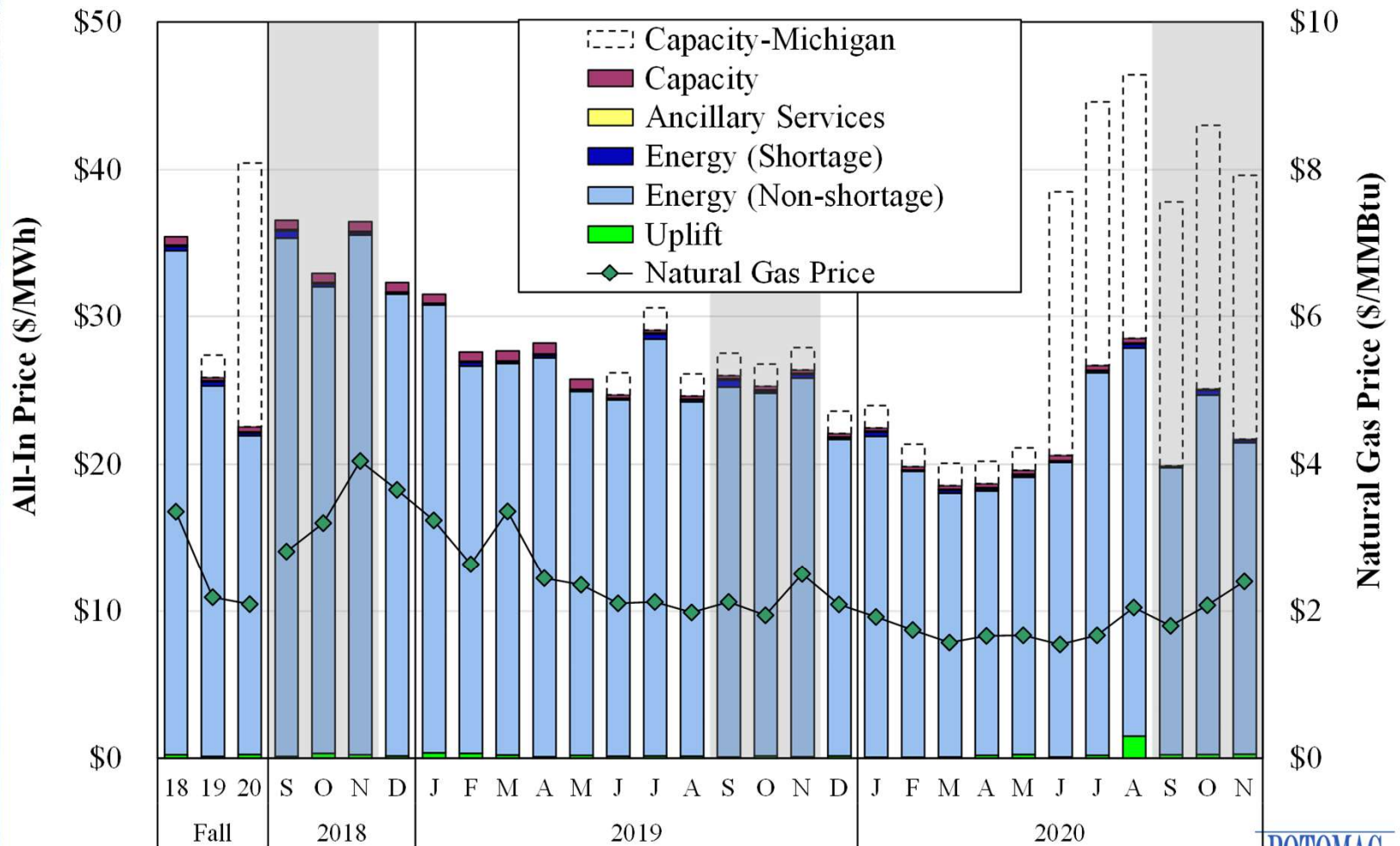


Day-Ahead Average Monthly Hub Prices Fall 2018-2020



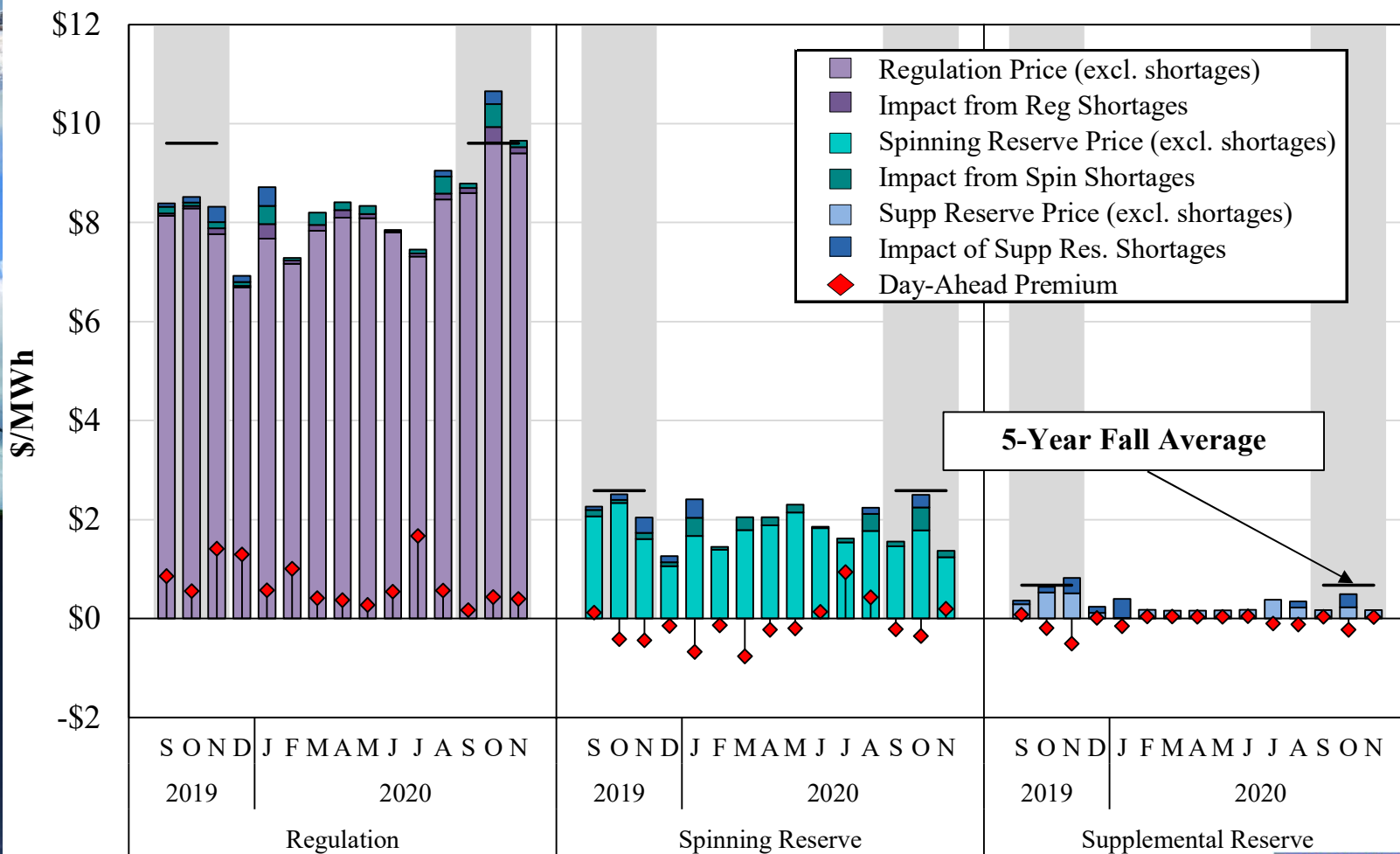


All-In Price Fall 2018 – 2020



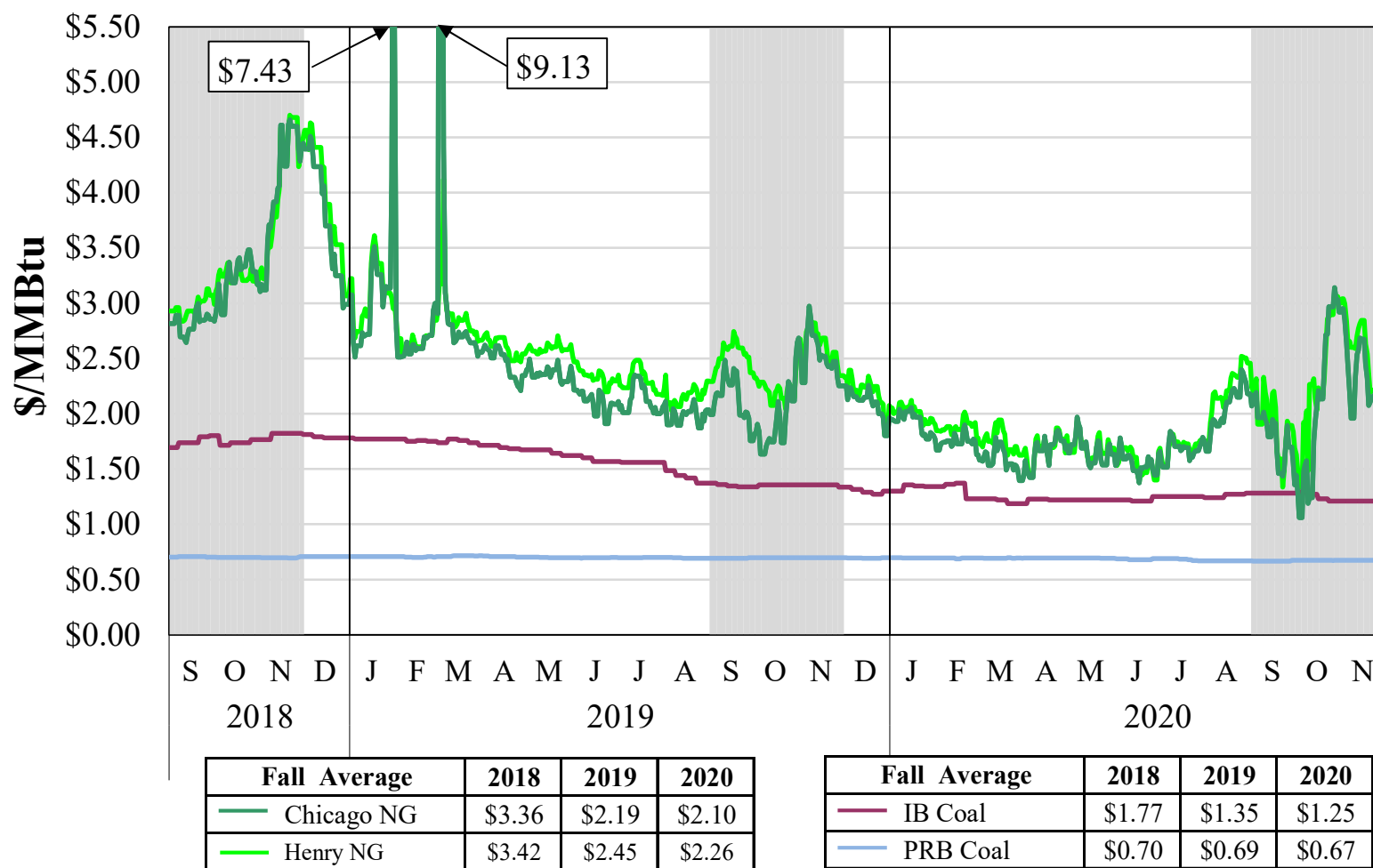


Ancillary Service Prices Fall 2019 – 2020



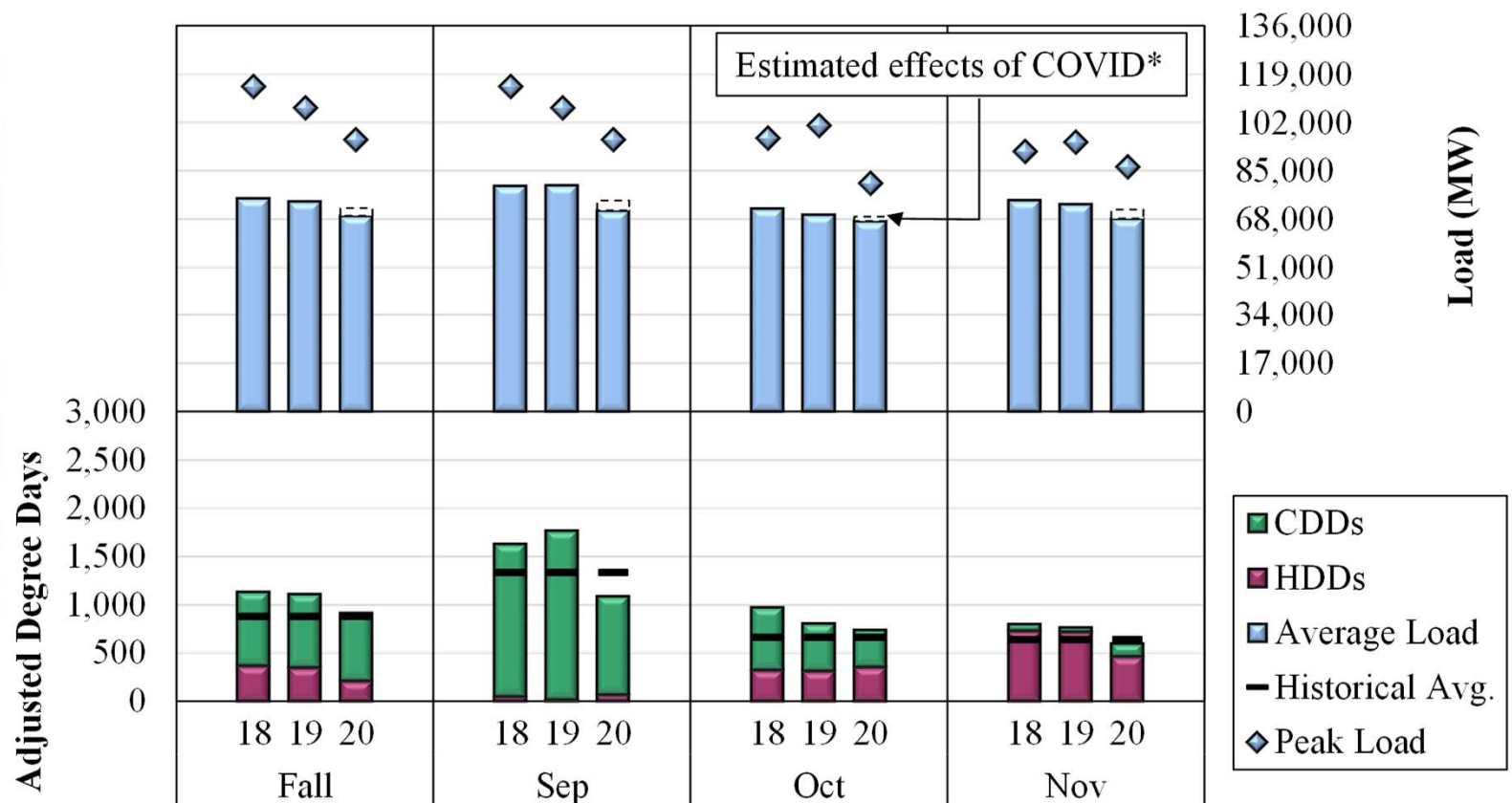


MISO Fuel Prices Fall 2018 – 2020





Load and Weather Patterns Fall 2018 – 2020



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

*Effects estimated by MISO through back-casting using its load forecasting model.

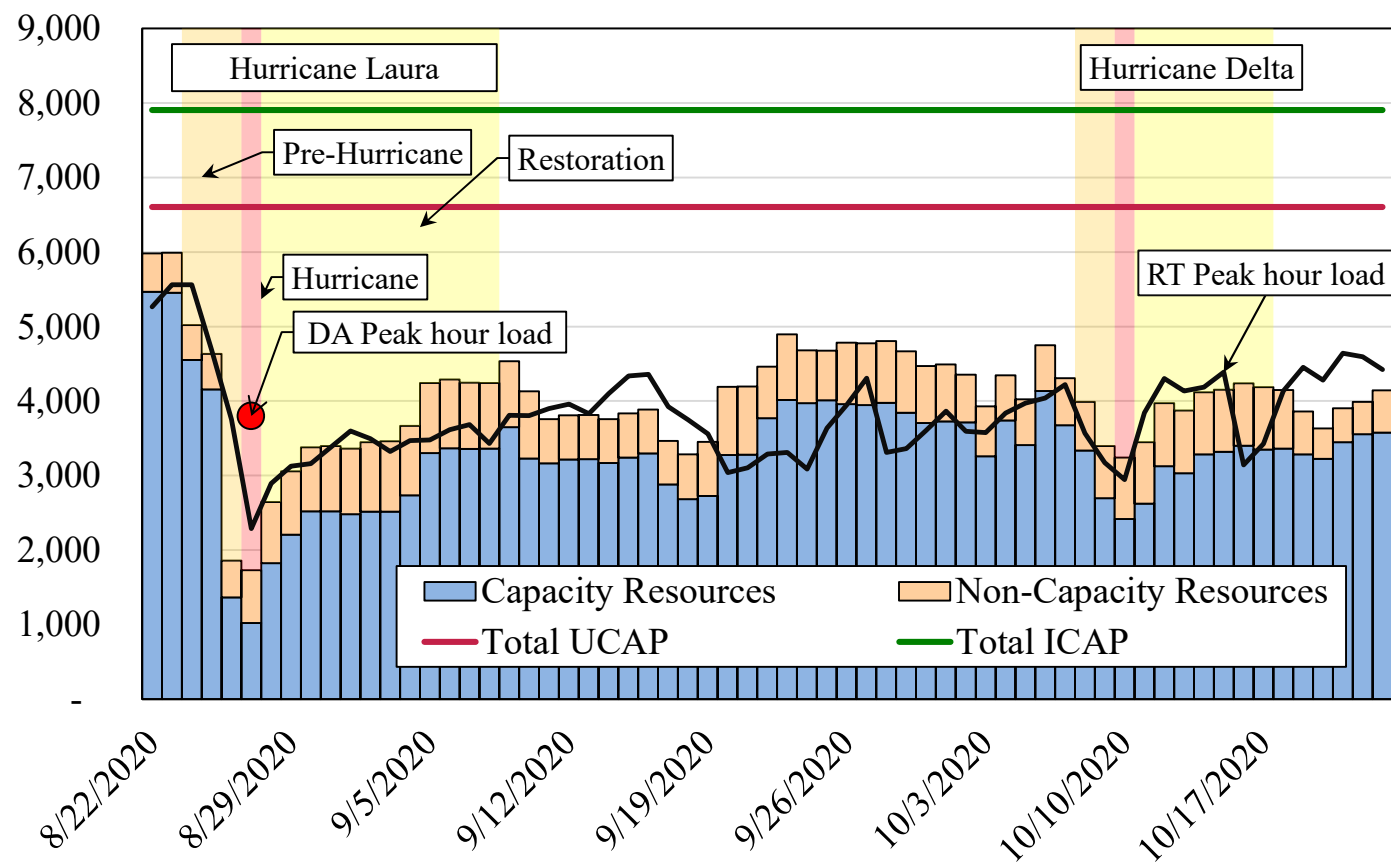
Capacity, Energy and Price Setting Share Fall 2019-2020

Fall	Unforced Capacity				Energy Output		Price Setting			
	Total (MW)		Share (%)		Share (%)		SMP (%)		LMP (%)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Nuclear	12,225	12,107	10%	9%	18%	16%	0%	0%	1%	2%
Coal	48,775	46,864	38%	36%	37%	35%	45%	40%	90%	86%
Natural Gas	56,039	58,346	44%	45%	32%	31%	53%	57%	98%	96%
Oil	1,696	1,568	1%	1%	0%	0%	0%	0%	0%	0%
Hydro	3,966	4,034	3%	3%	2%	2%	1%	1%	3%	2%
Wind	3,244	4,429	3%	3%	11%	16%	1%	1%	55%	85%
Other	2,703	2,931	2%	2%	1%	1%	0%	0%	4%	8%
Total	128,647	130,278								



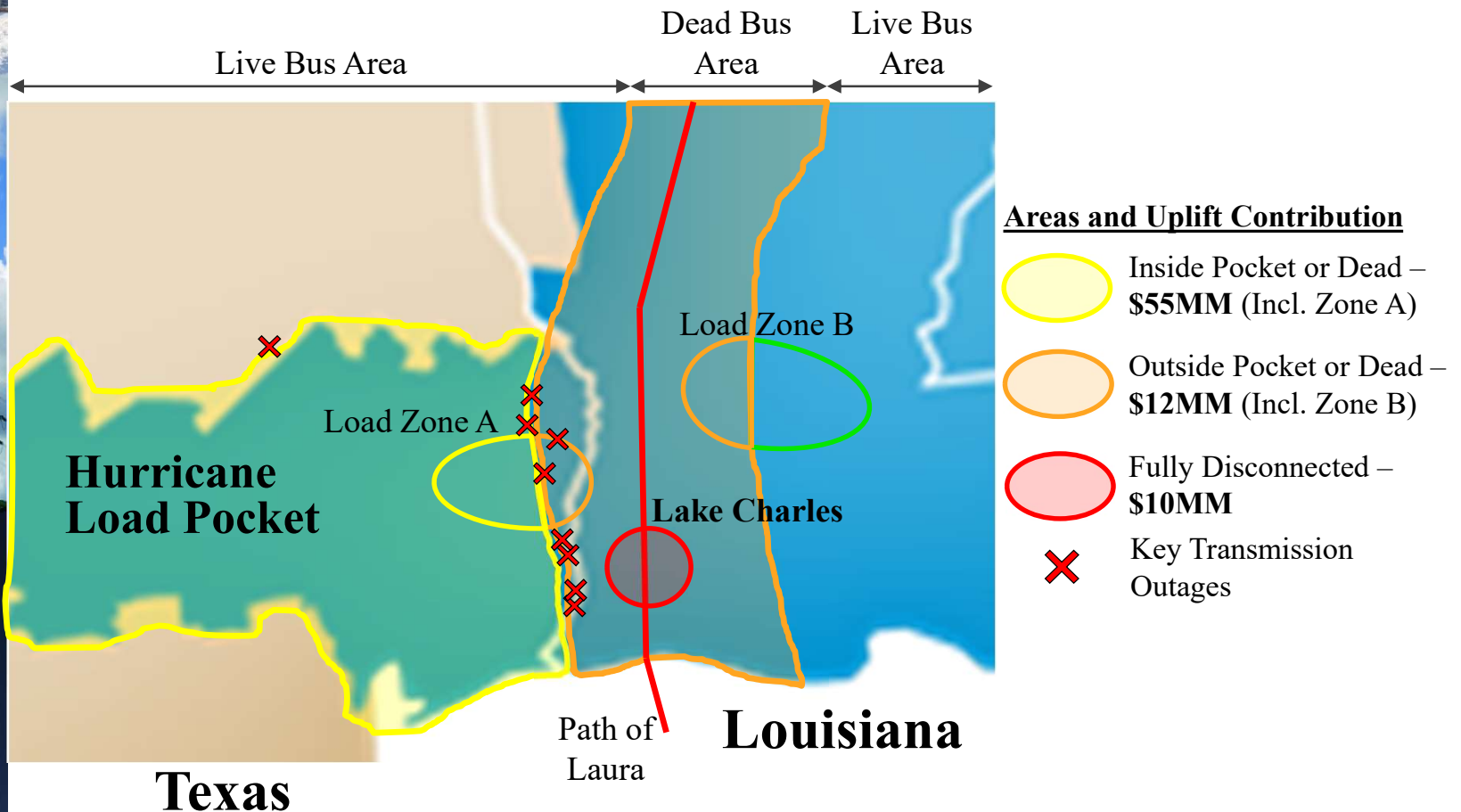
Generation and Load

Hurricane Laura Load Pocket





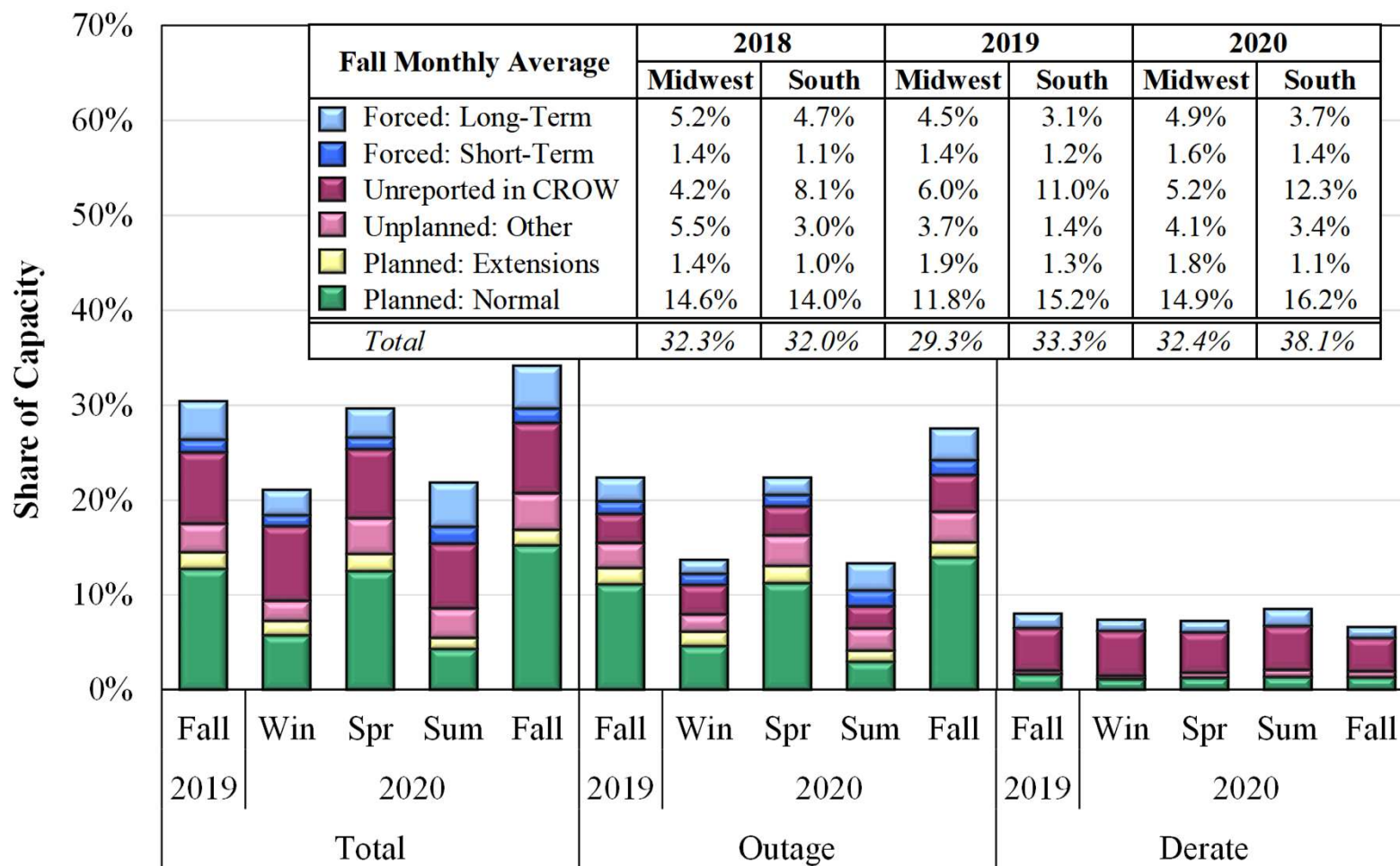
Hurricane Laura Load Pocket and Lake Charles Restoration Area





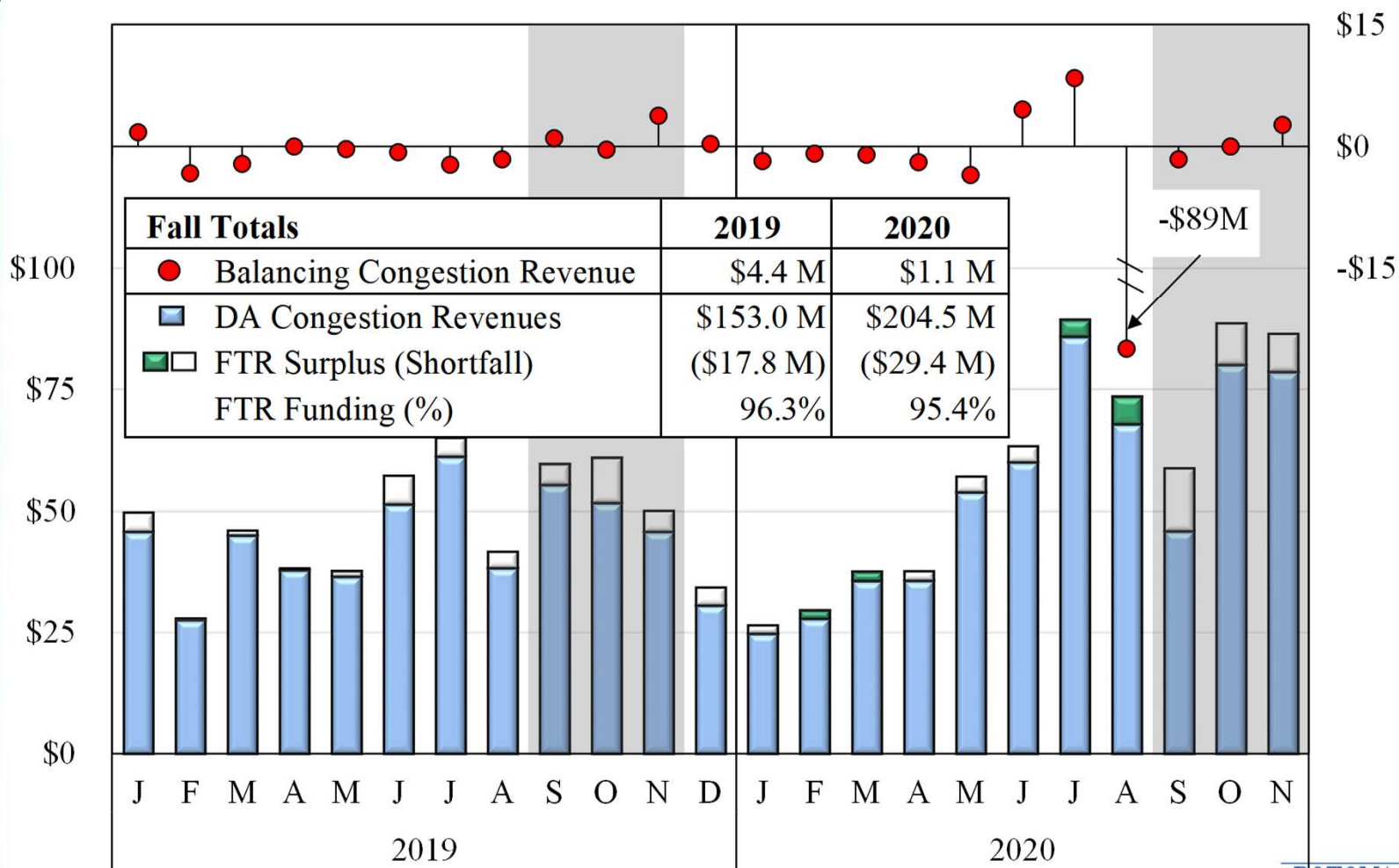
Generation Outages and Deratings

Fall 2019-2020



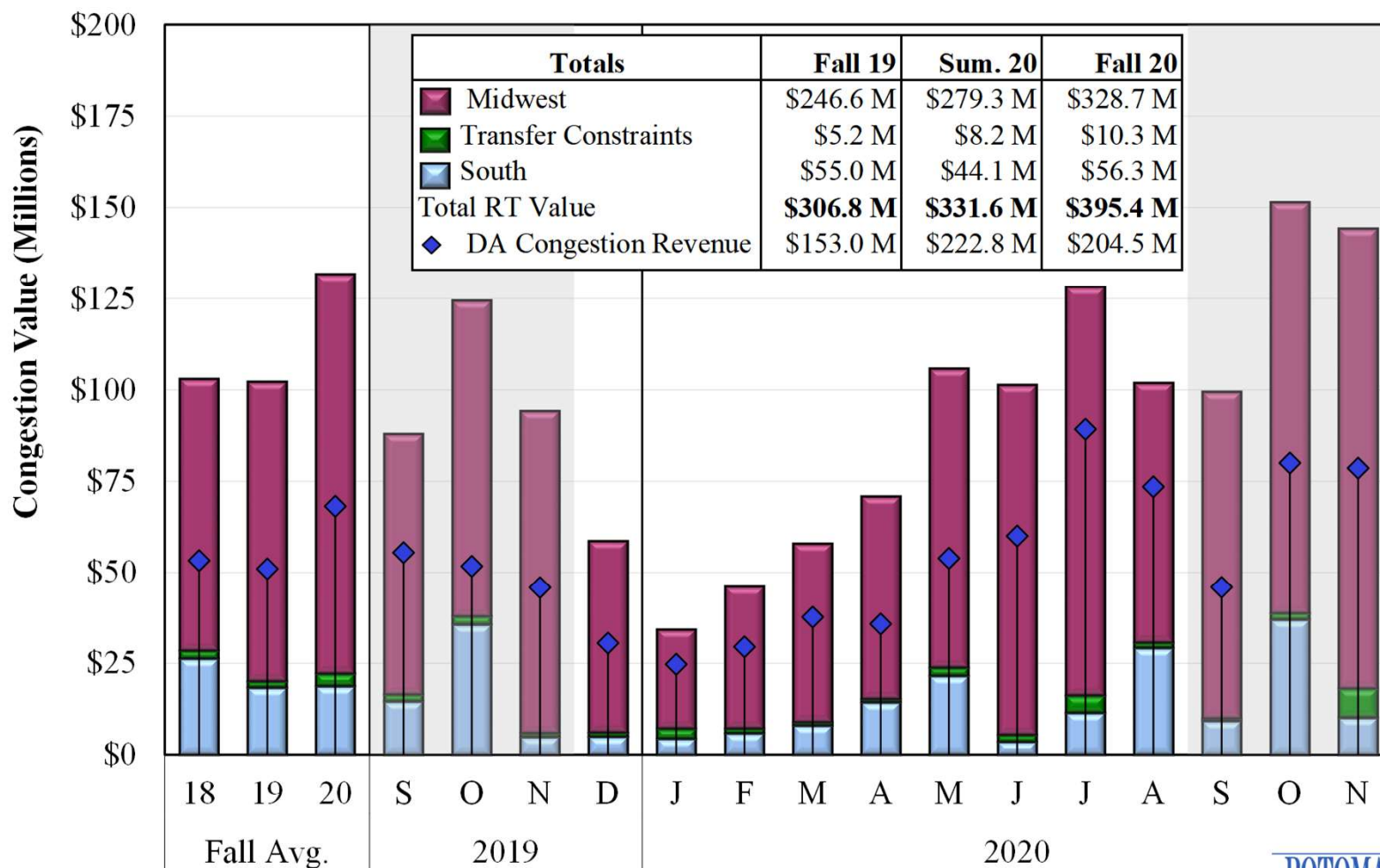


Day-Ahead Congestion, Balancing Congestion and FTR Underfunding



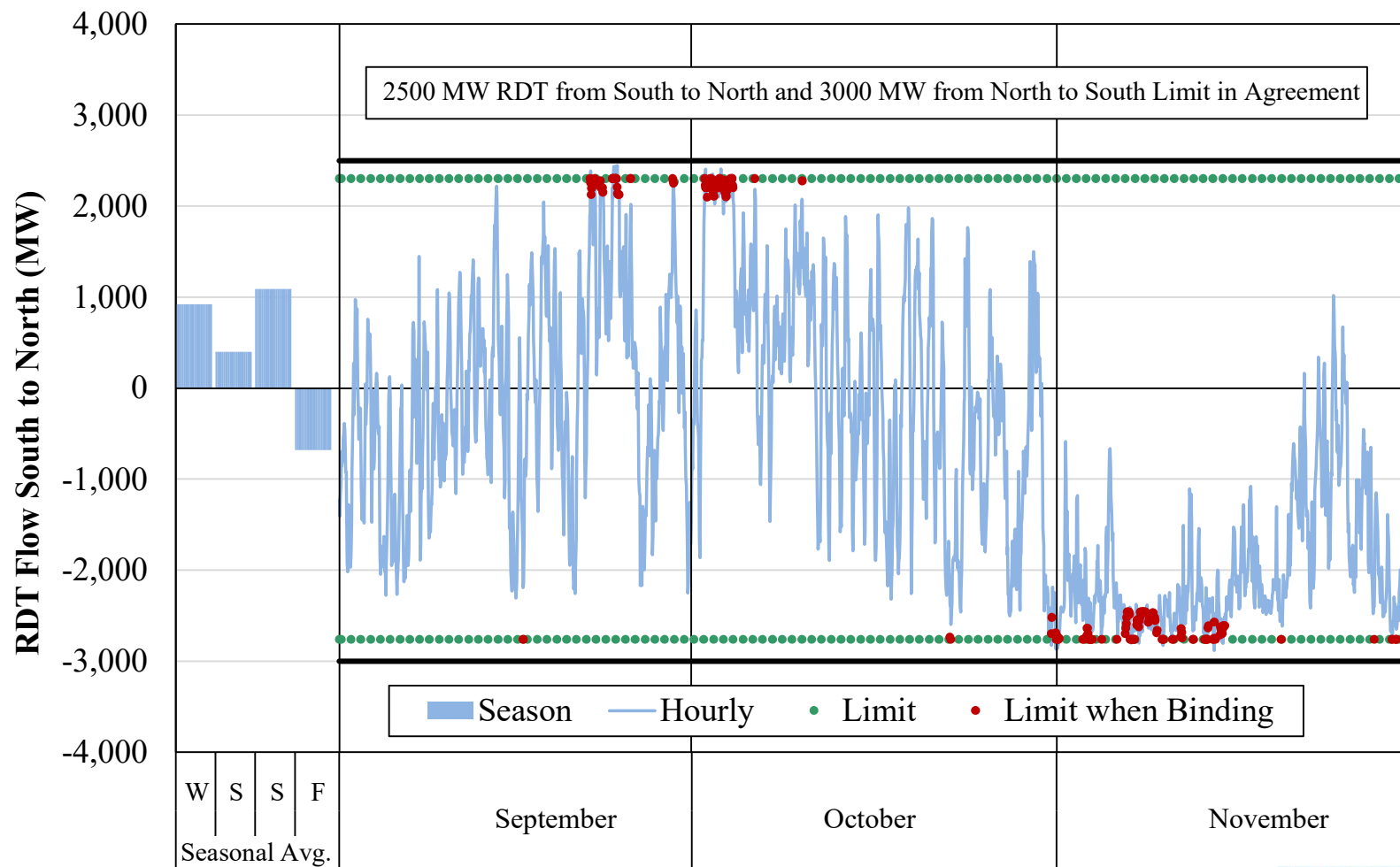


Value of Real-Time Congestion Fall 2019-2020



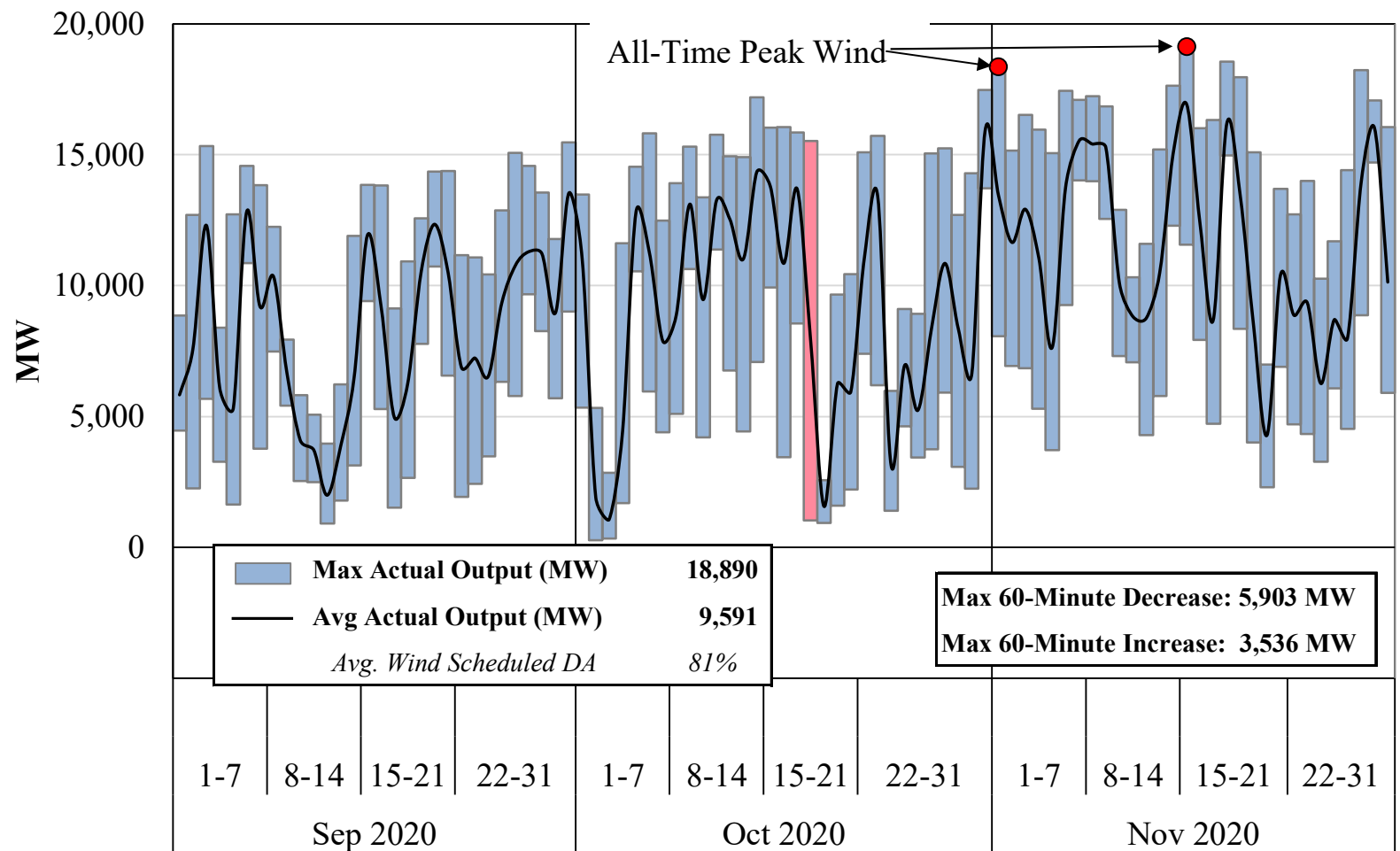


Real-Time Hourly Inter-Regional Flows Fall 2020

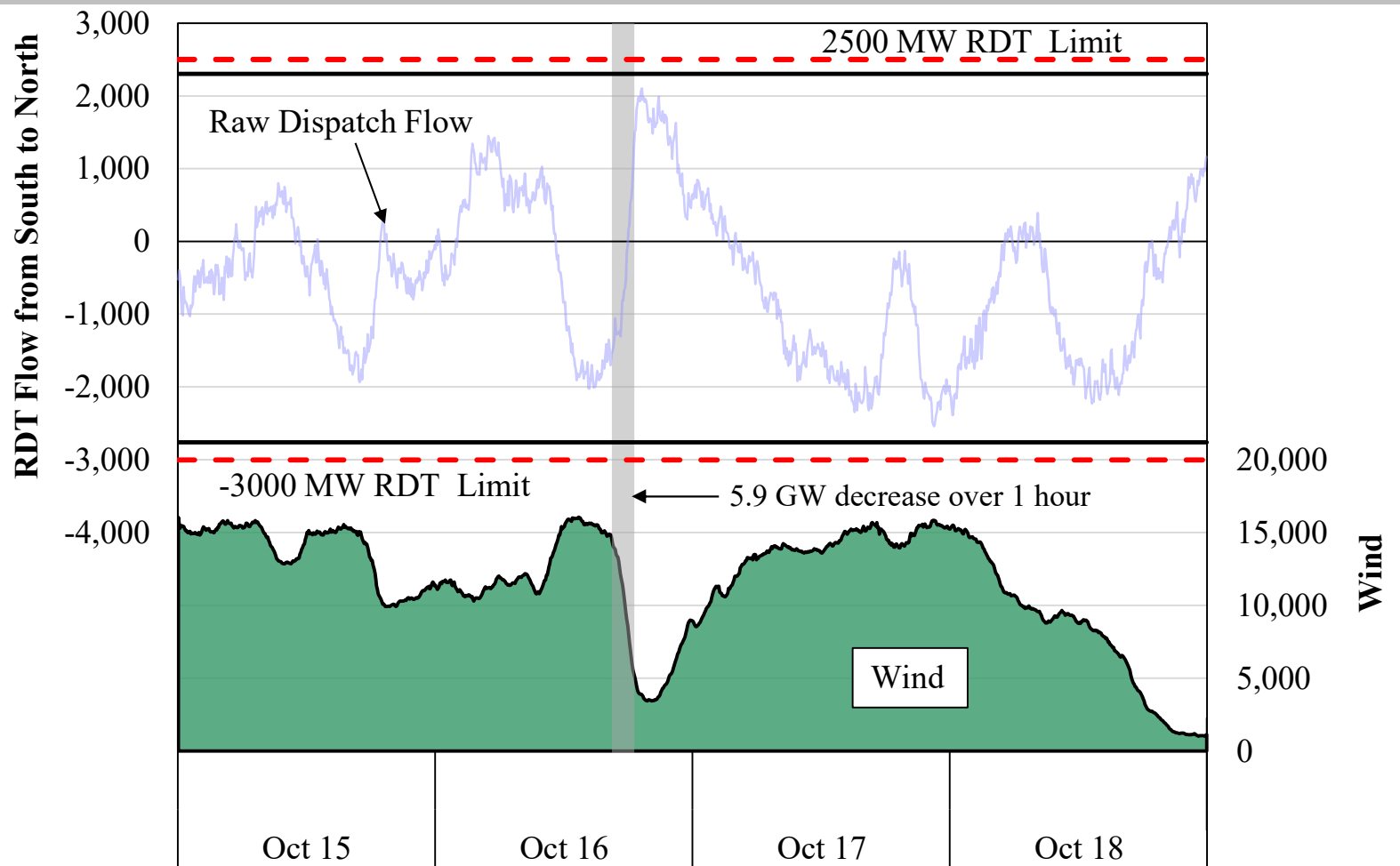




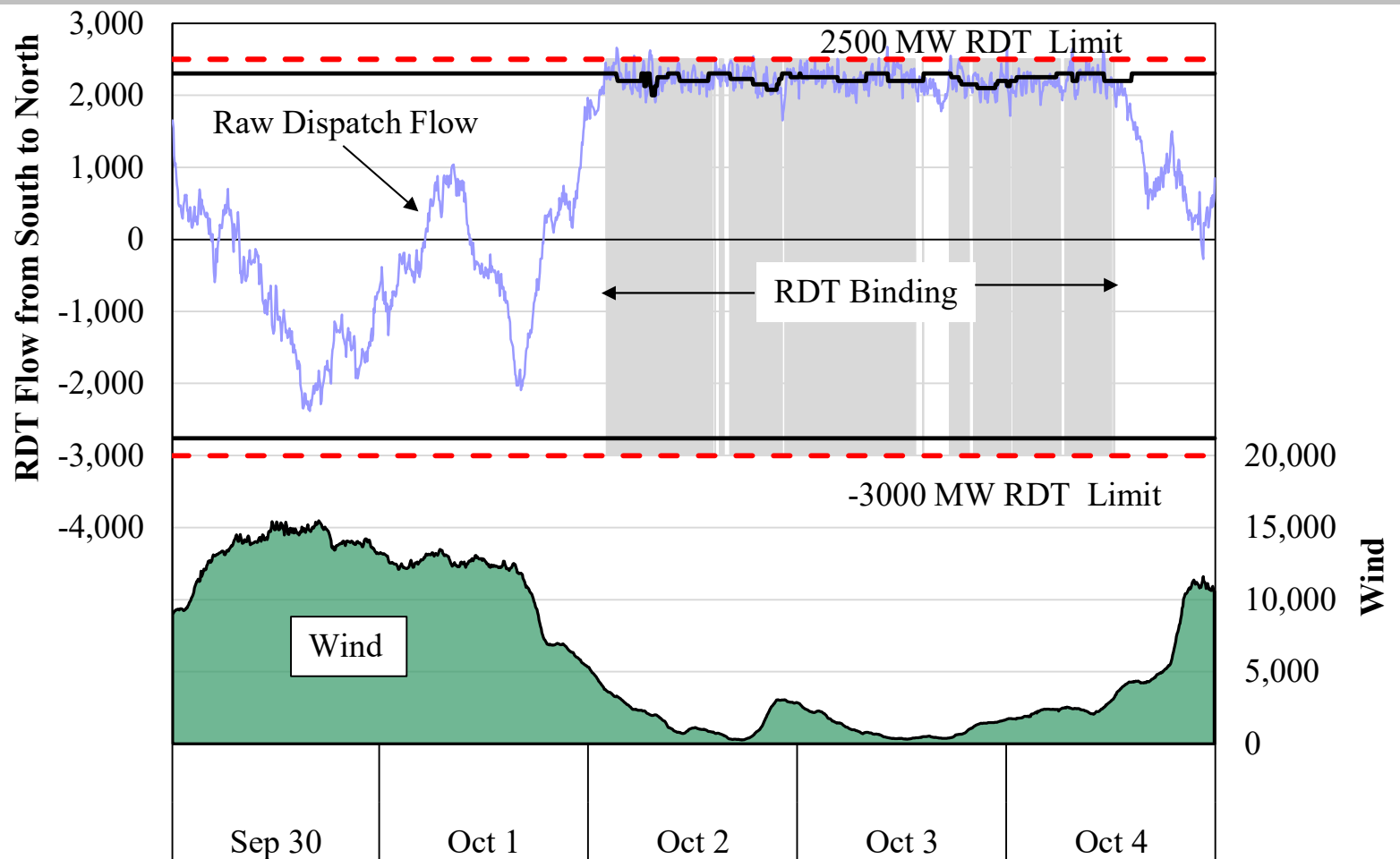
Wind Output in Real-Time Daily Range and Average



Wind and RDT Flows

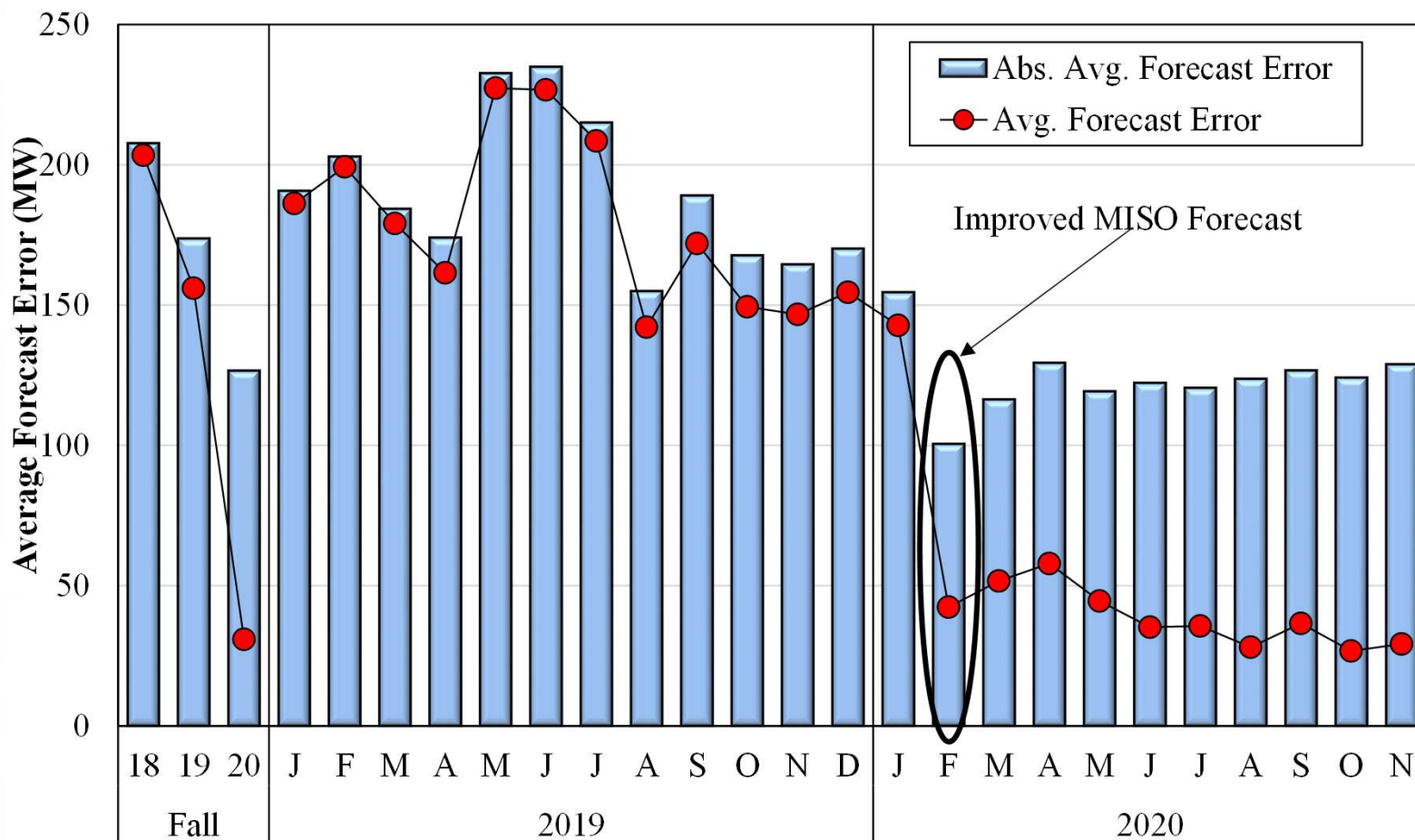


Wind and RDT Flows



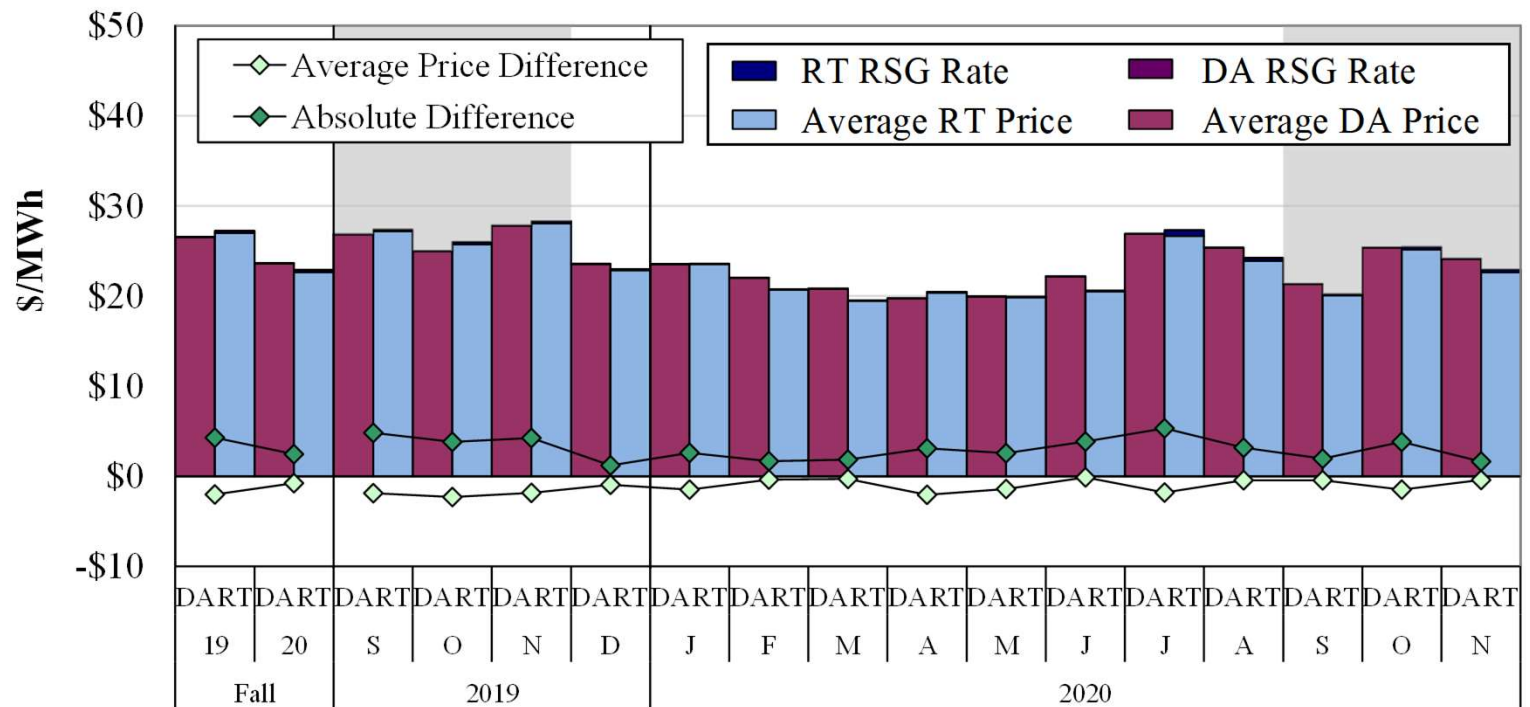


Generation Wind Forecasting Accuracy 2019 - 2020





Day-Ahead and Real-Time Price Convergence Fall 2019-2020

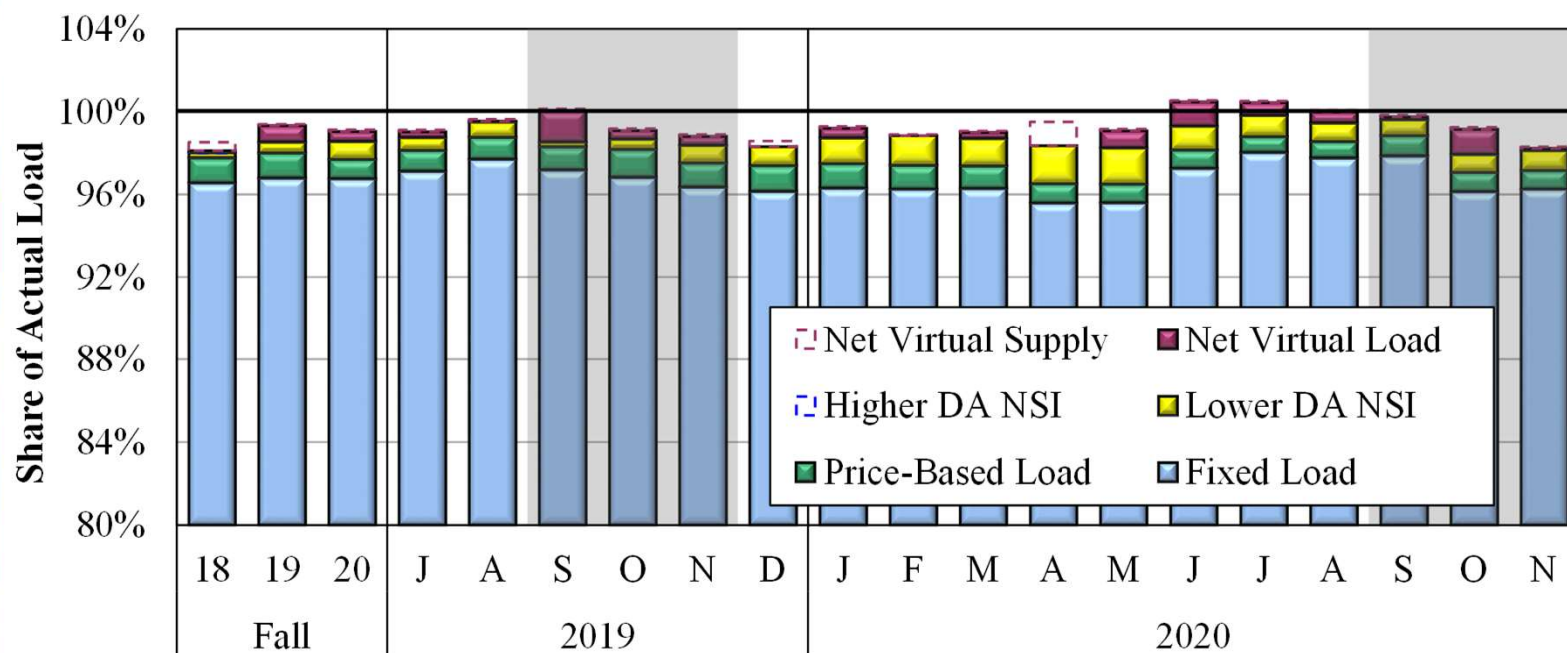


Average DA-RT Price Difference Including RSG (% of Real-Time Price)

Indiana Hub	-2	4	-2	-4	-2	3	0	6	7	-3	0	8	-2	5	6	0	5
Michigan Hub	-2	3	1	-4	-1	3	-1	6	7	-6	4	3	-5	3	6	-2	5
Minnesota Hub	1	-3	1	0	2	5	-4	7	3	1	0	-5	-3	1	0	-4	-3
Arkansas Hub	-3	-1	-2	-4	-3	4	1	4	6	5	6	6	-7	2	3	-5	0
Texas Hub	-5	7	1	-16	-1	4	1	6	10	5	13	7	2	-44	6	9	4
Louisiana Hub	0	2	2	1	-3	2	1	-2	12	4	5	6	1	0	8	-5	1



Day-Ahead Peak Hour Load Scheduling Fall 2019-2020

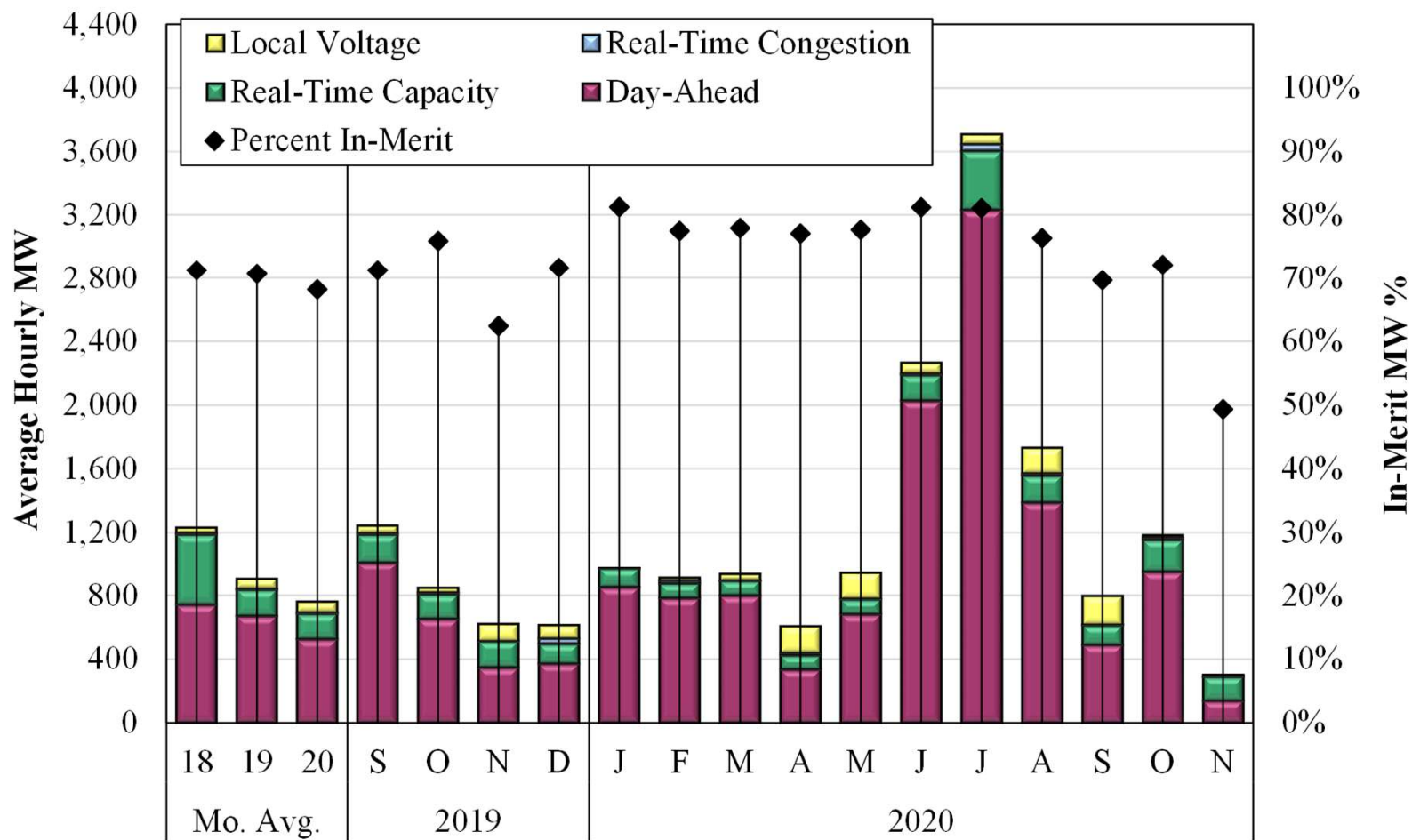


Share of Actual Load (%)

All Hours	98.5	99.1	98.9	99.9	100.1	100.0	98.9	98.5	98.2	99.5	99.0	98.9	99.0	99.5	100.4	101.5	101.0	99.7	98.8	98.4
Peak Hours Midwest	97.6	99.0	98.9	98.6	99.7	99.9	99.0	98.2	98.5	99.6	98.9	100.2	98.2	98.4	99.9	99.8	99.0	99.5	98.8	98.5
Peak Hours South	101.2	100.5	99.7	100.2	98.9	100.2	100.6	100.7	99.1	99.2	98.5	98.2	101.0	101.5	101.2	101.8	102.1	100.0	100.7	98.5

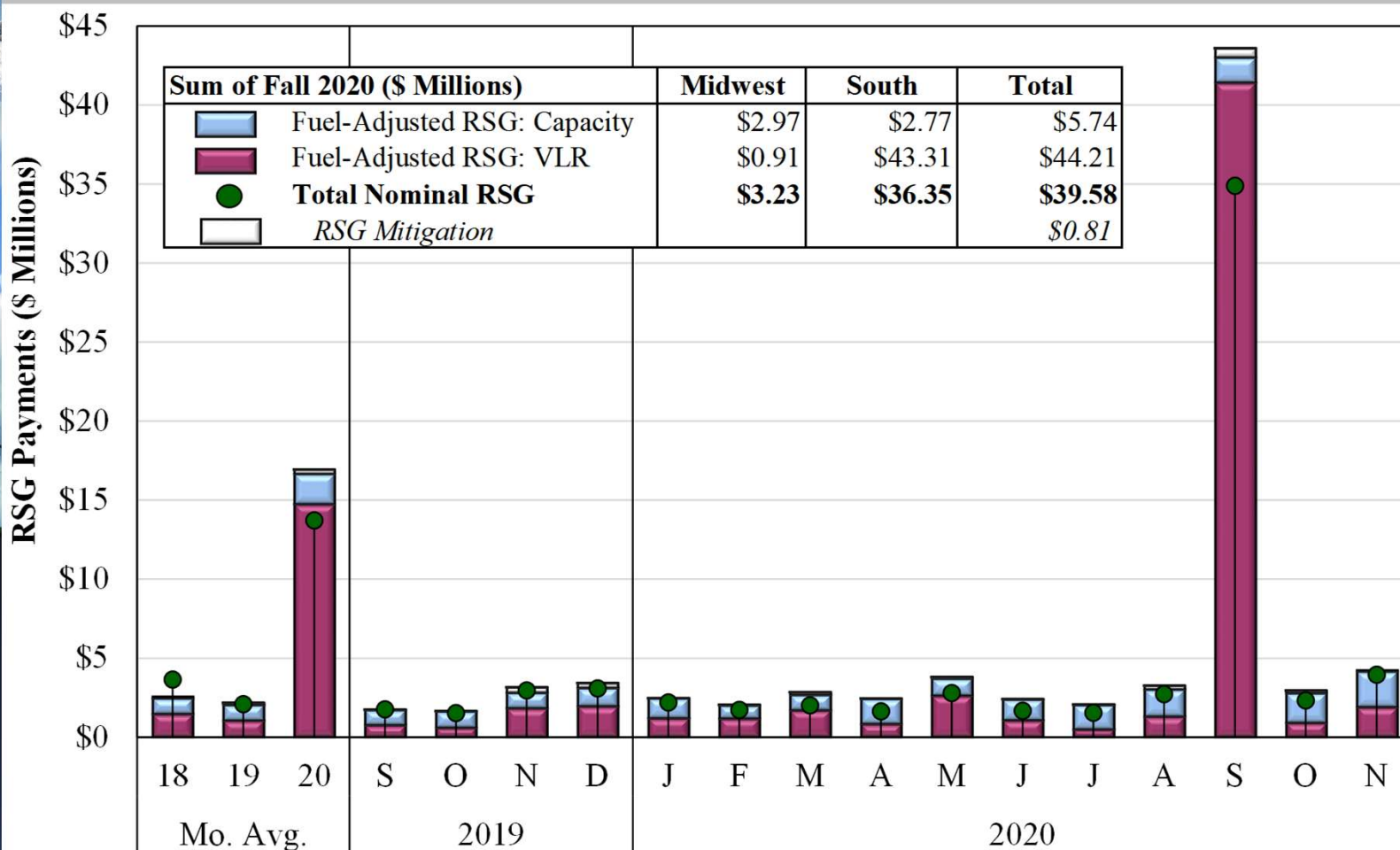


Peaking Resource Dispatch Fall 2019-2020



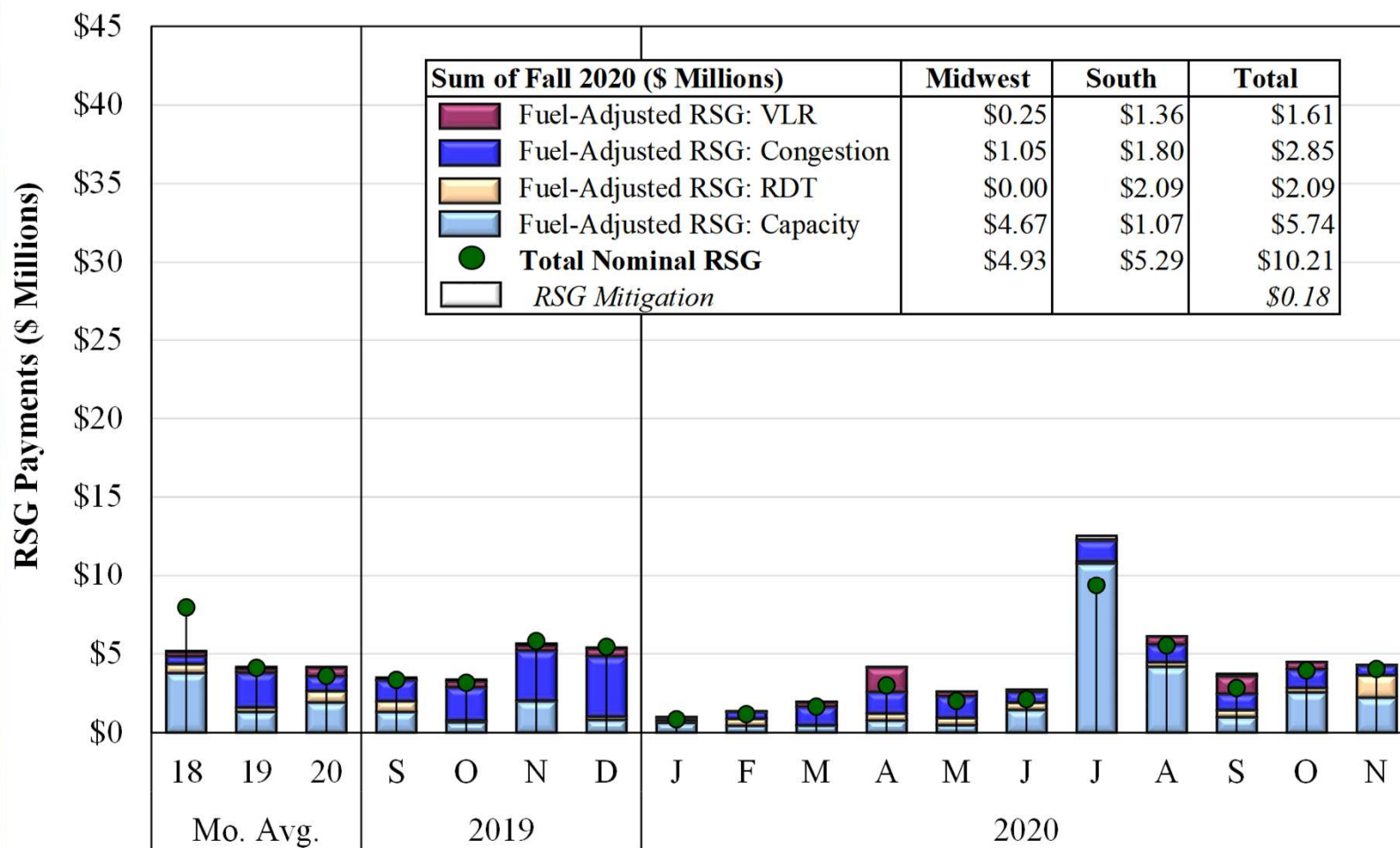


Day-Ahead RSG Payments Fall 2019-2020



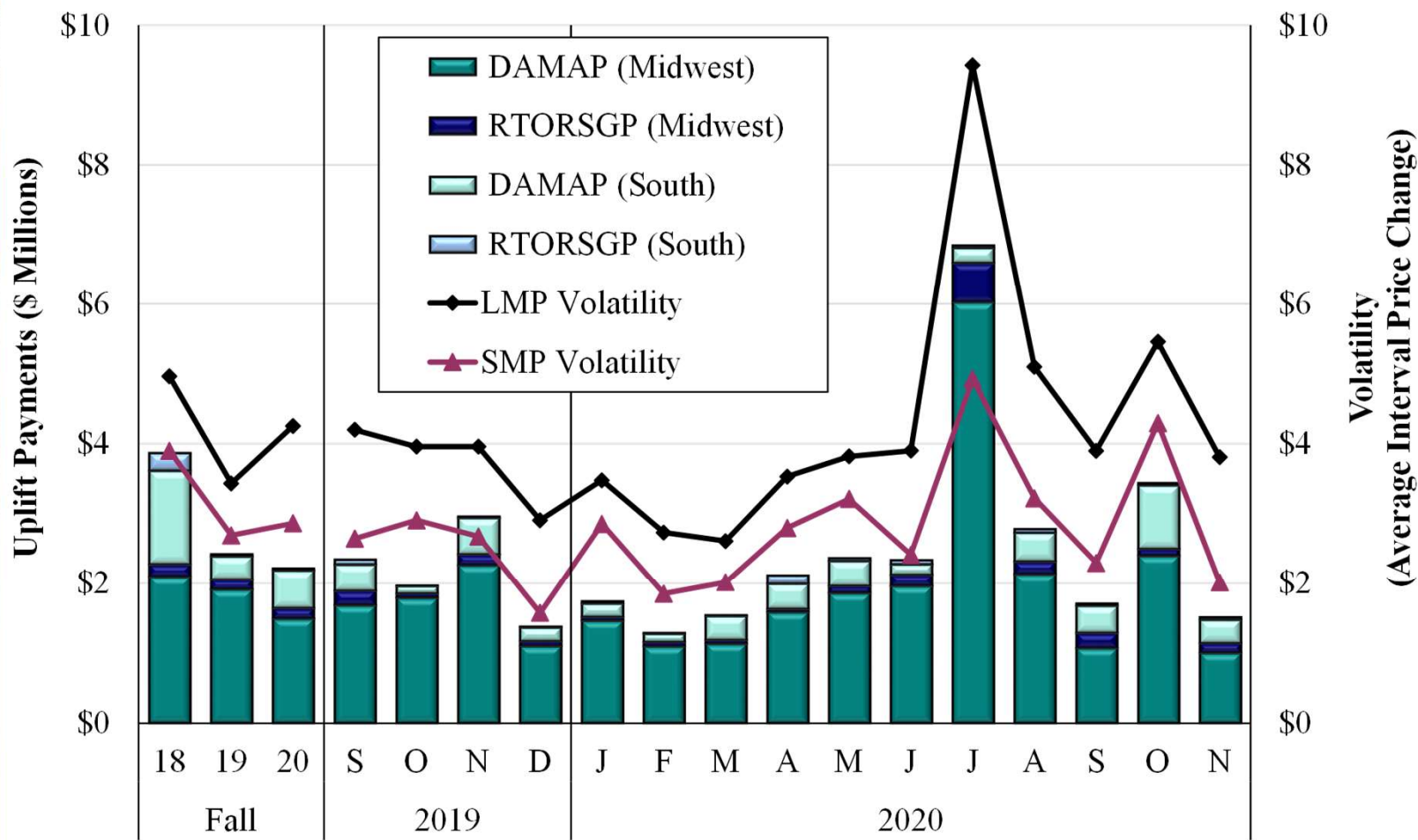


Real-Time RSG Payments Fall 2019-2020





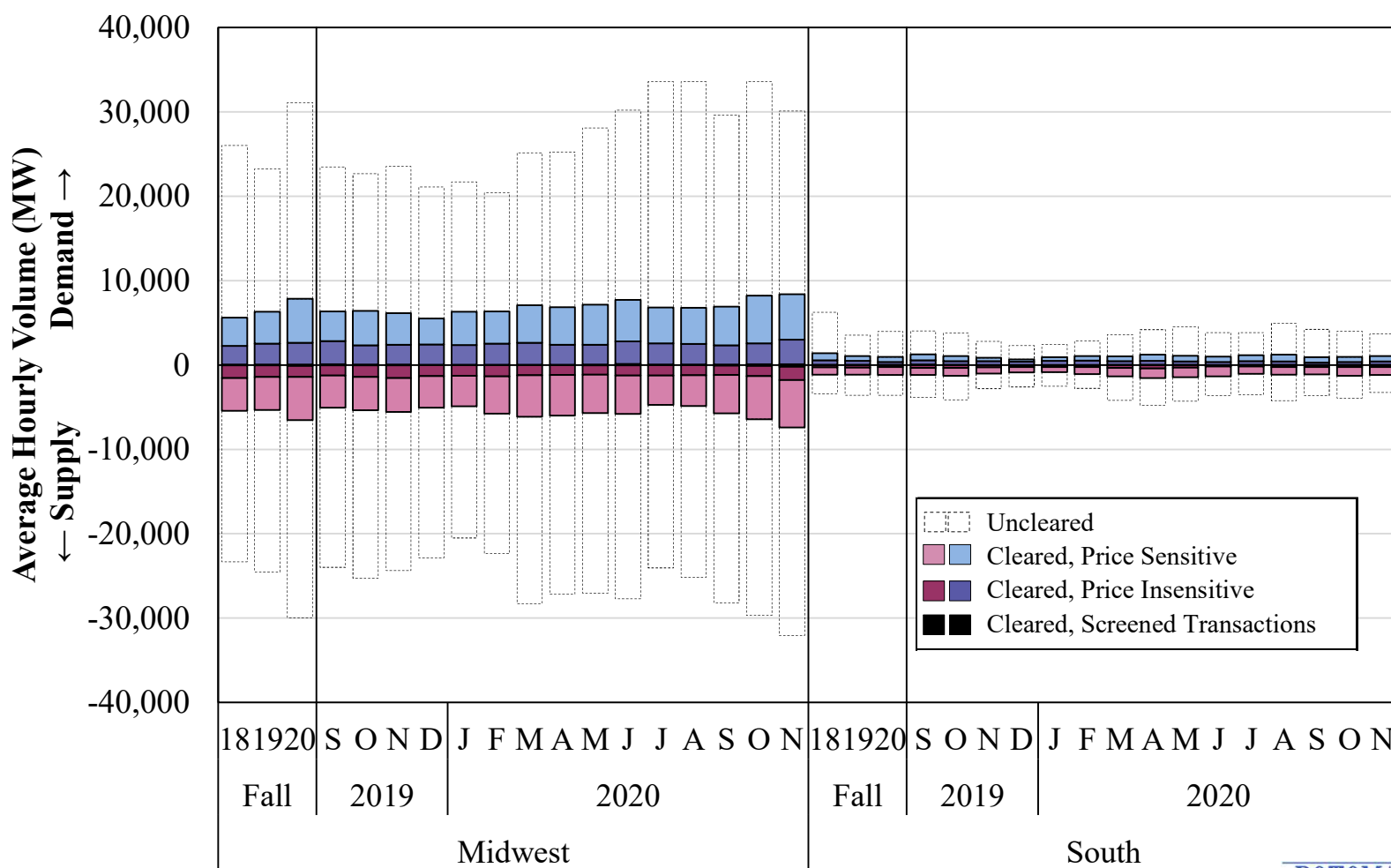
Price Volatility Make Whole Payments Fall 2019-2020





Virtual Load and Supply

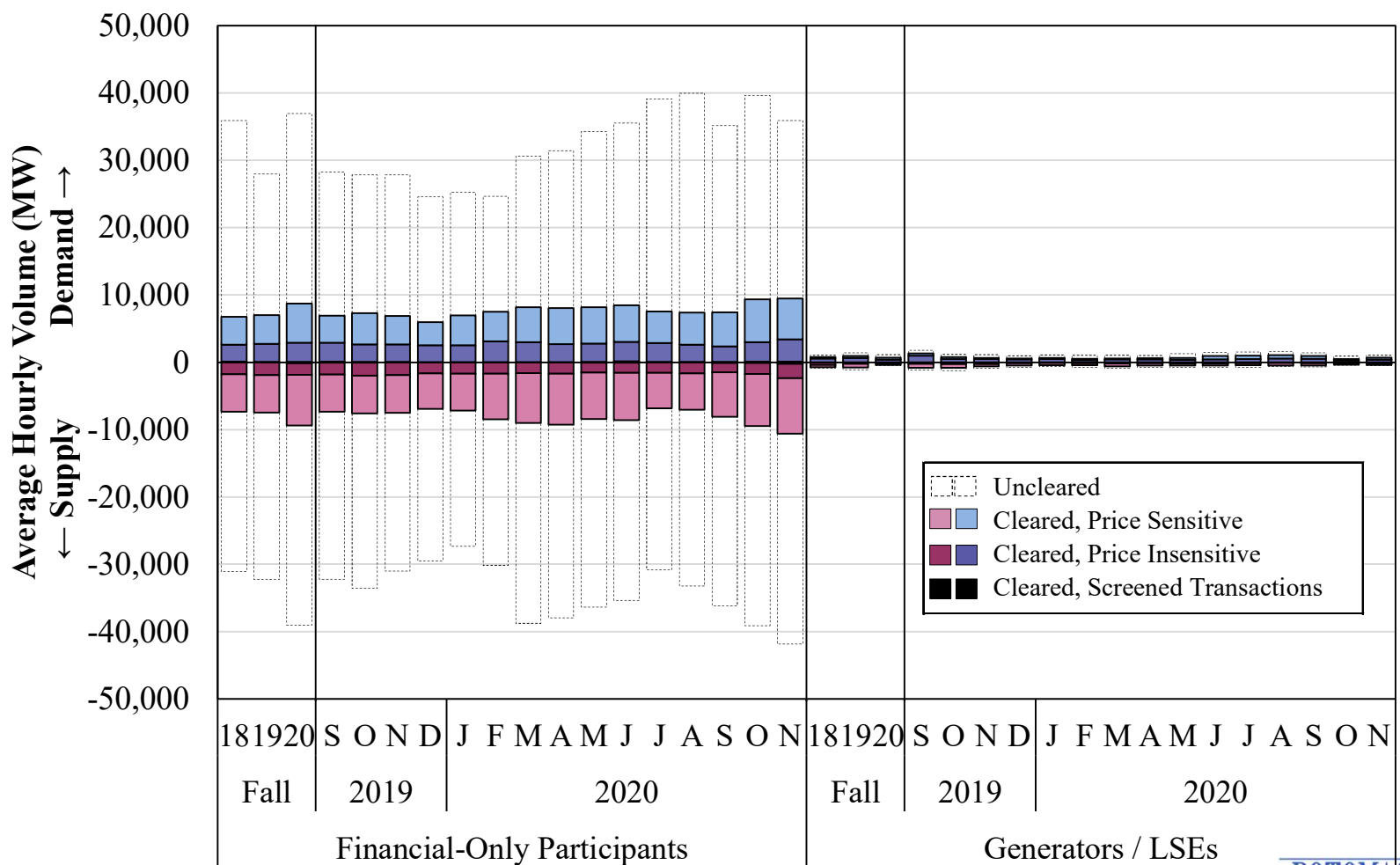
Fall 2019-2020



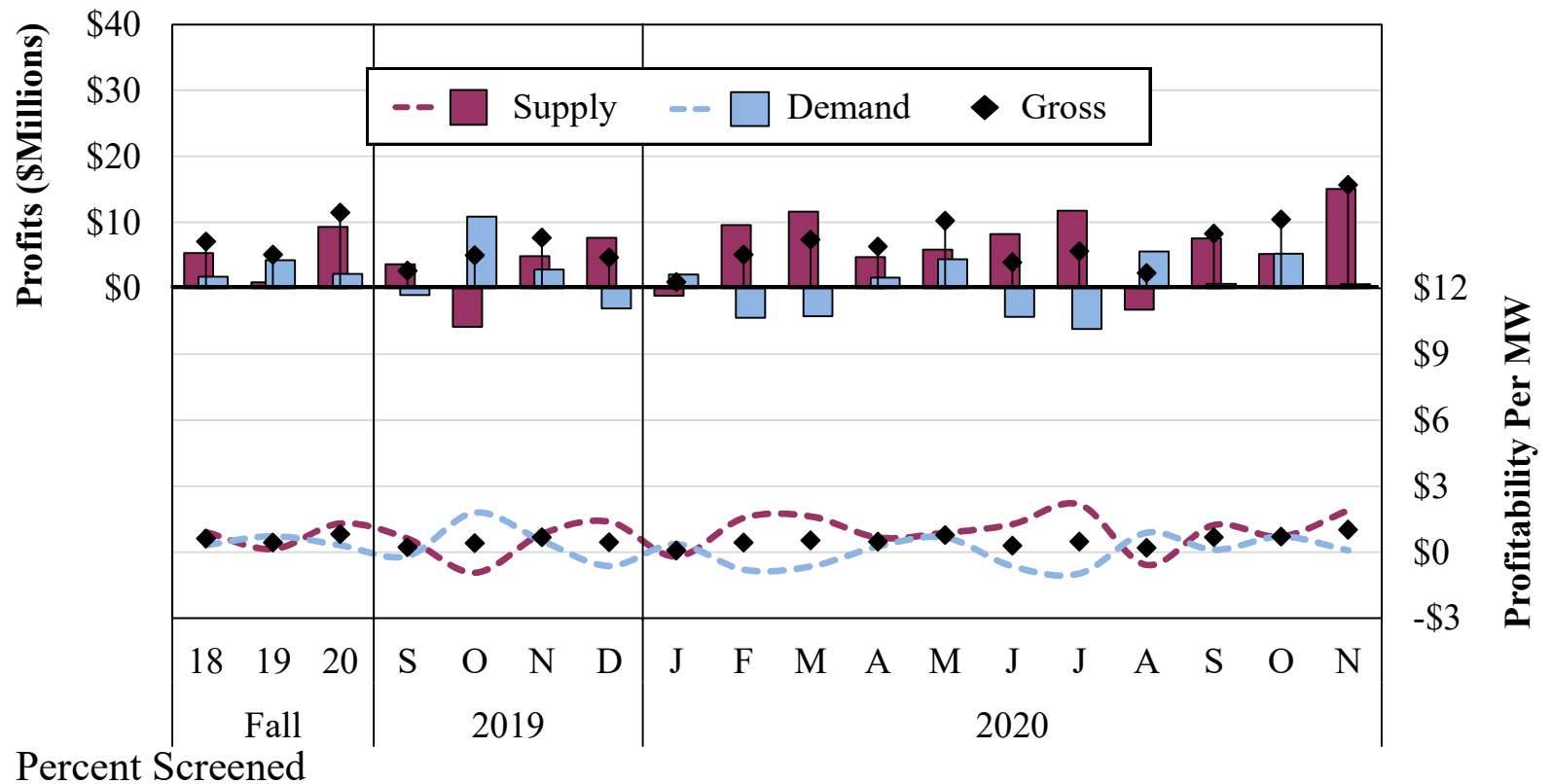


Virtual Load and Supply by Participant Type

Fall 2019-2020

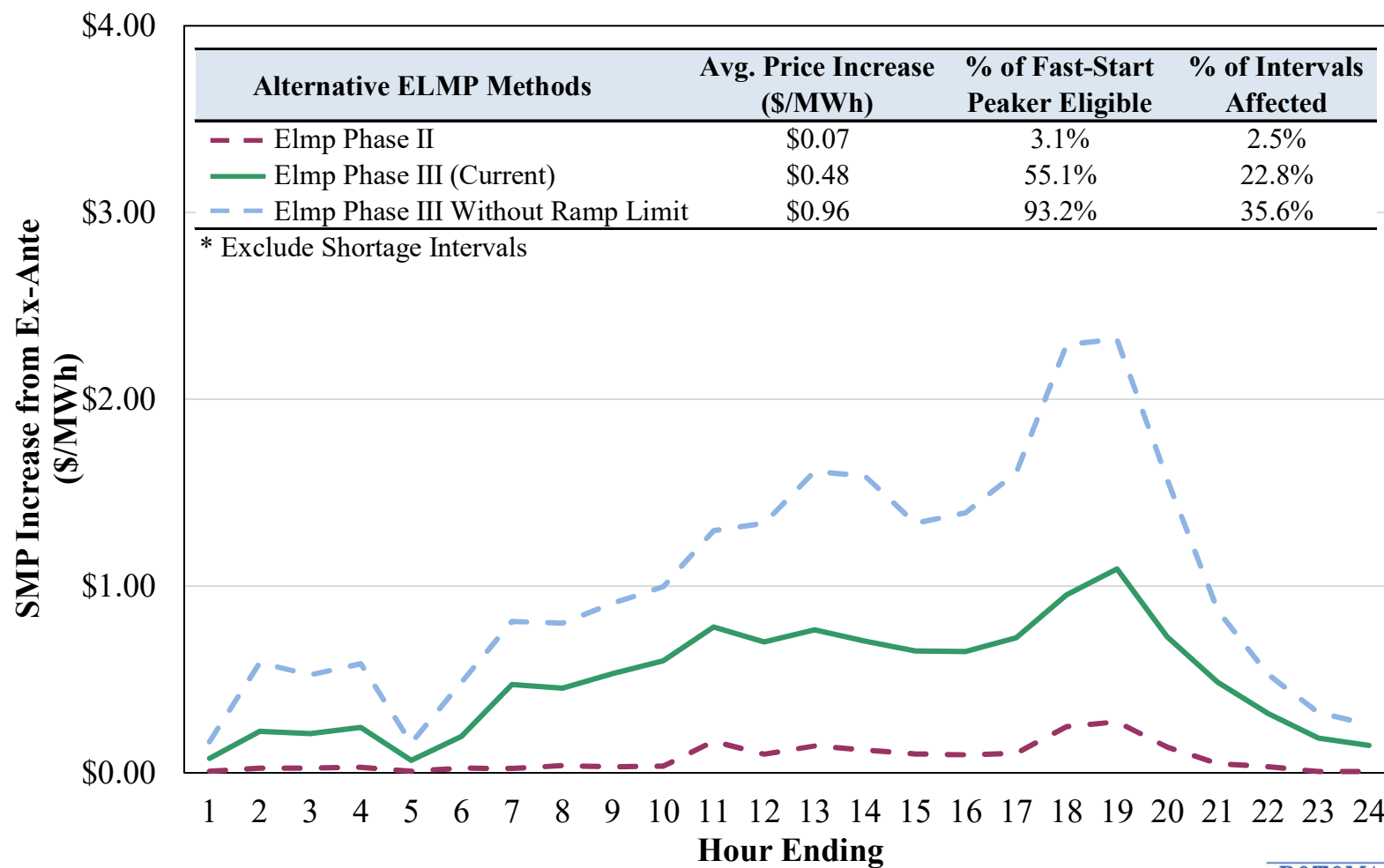


Virtual Profitability Fall 2019-2020



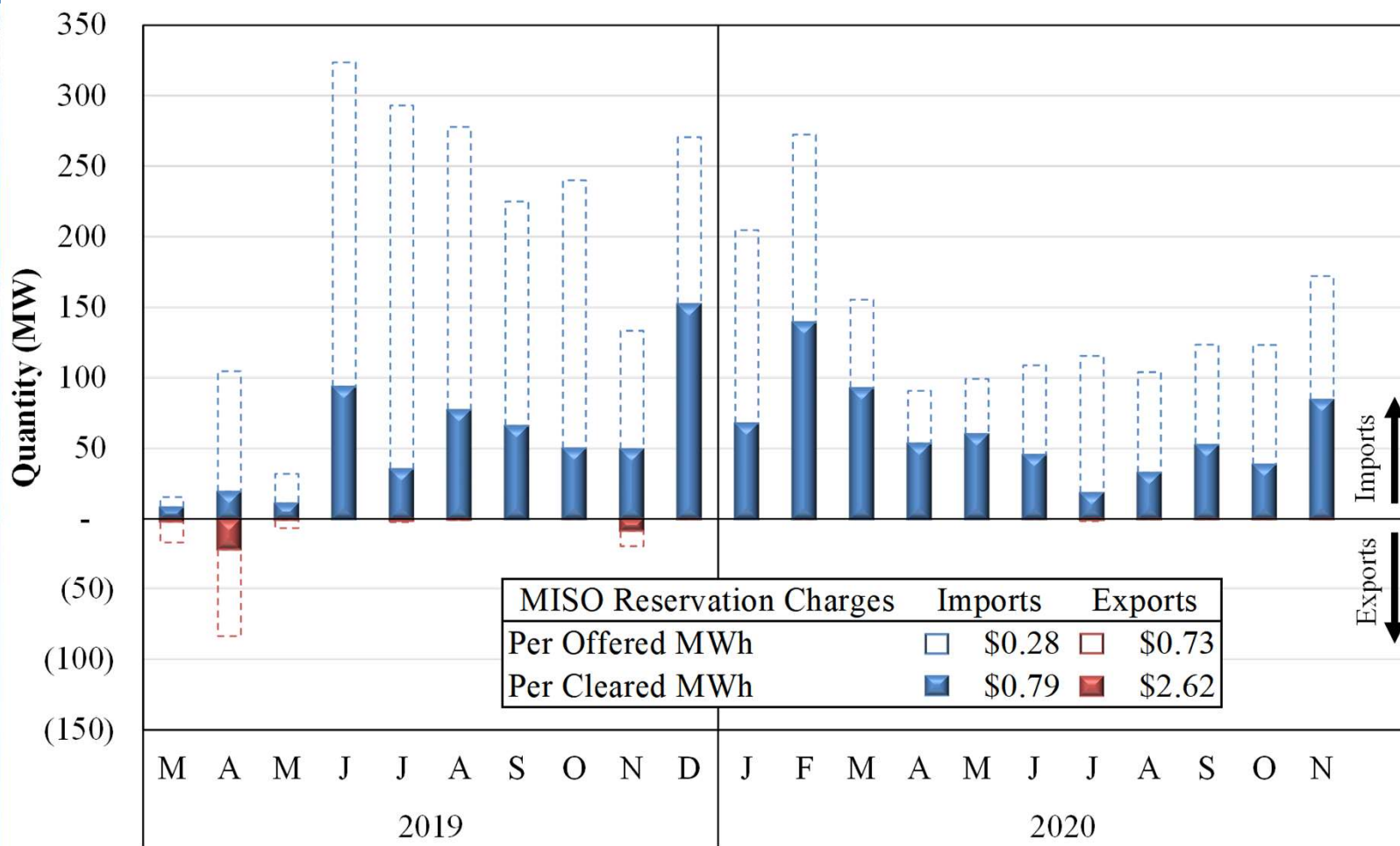


Evaluation of ELMP Assumptions Fall 2020

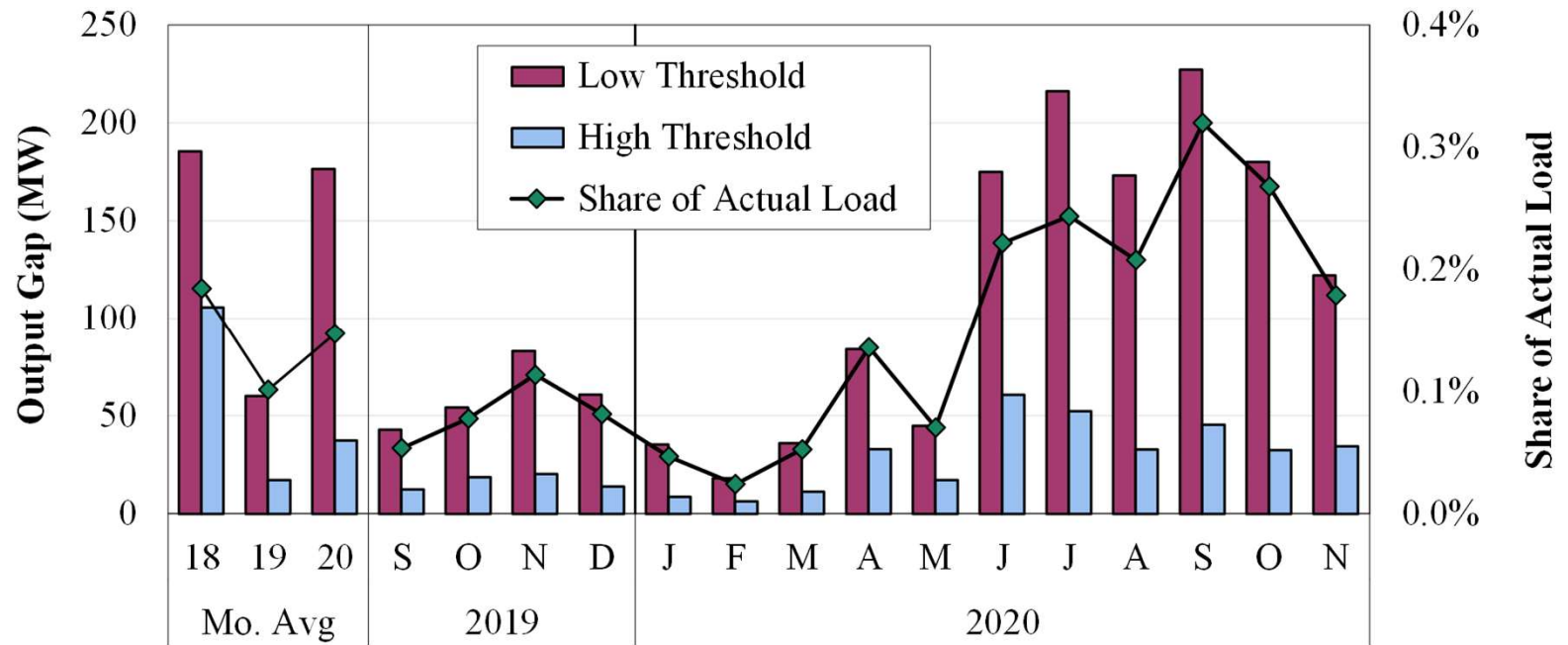




Coordinated Transaction Scheduling (CTS) 2019-2020



Monthly Output Gap Fall 2019-2020



Low Threshold Results by Unit Status (MW)

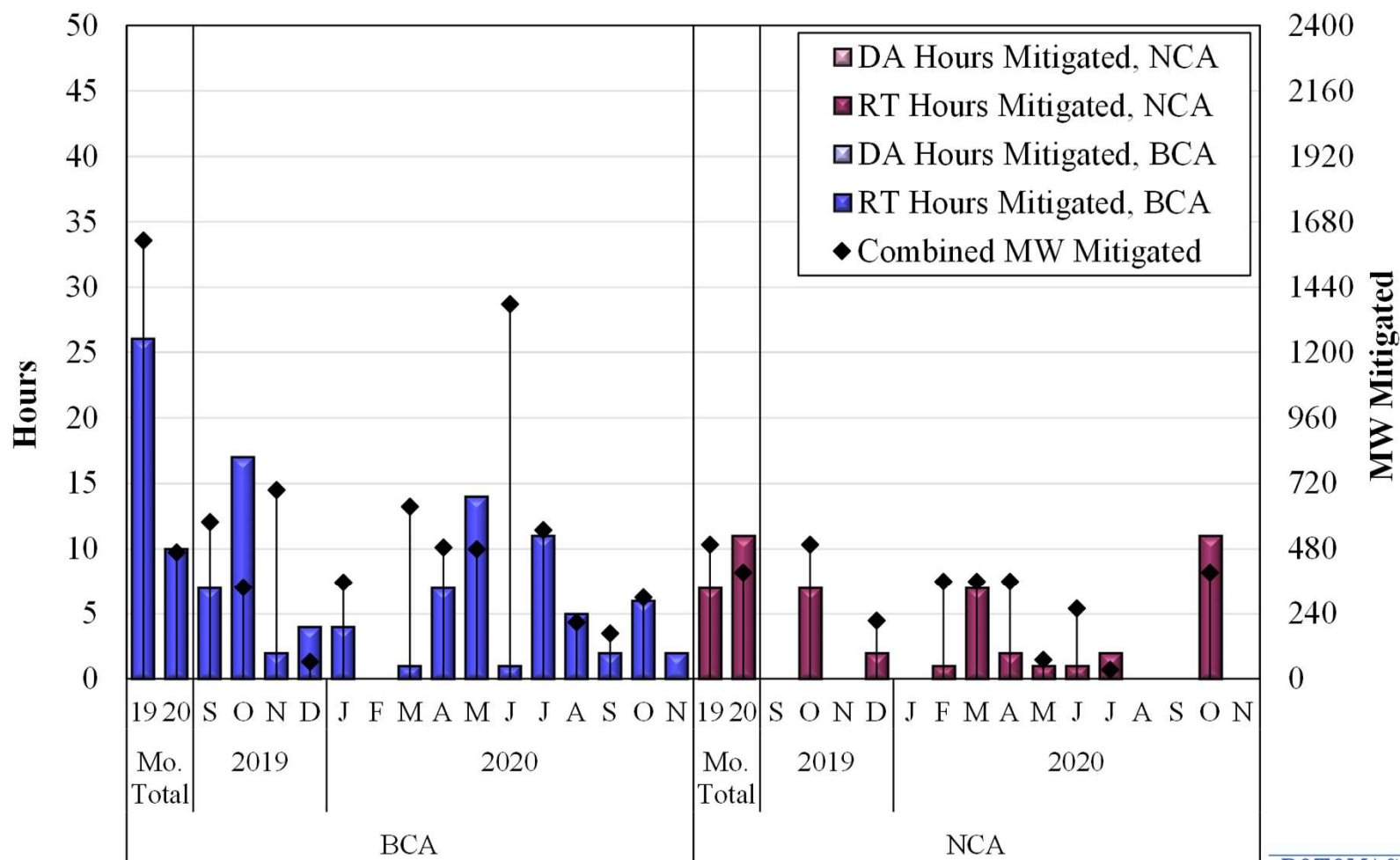
Offline	14	11	7	7	15	10	5	0	0	0	0	3	12	36	18	4	8	10
Online	172	49	169	36	39	73	55	36	18	36	84	42	163	180	156	223	172	112

High Threshold Results by Unit Status (MW)

Offline	12	9	6	6	12	10	5	0	0	0	0	3	11	31	16	4	7	7
Online	93	8	32	7	7	10	9	9	7	11	33	15	50	21	17	41	25	28

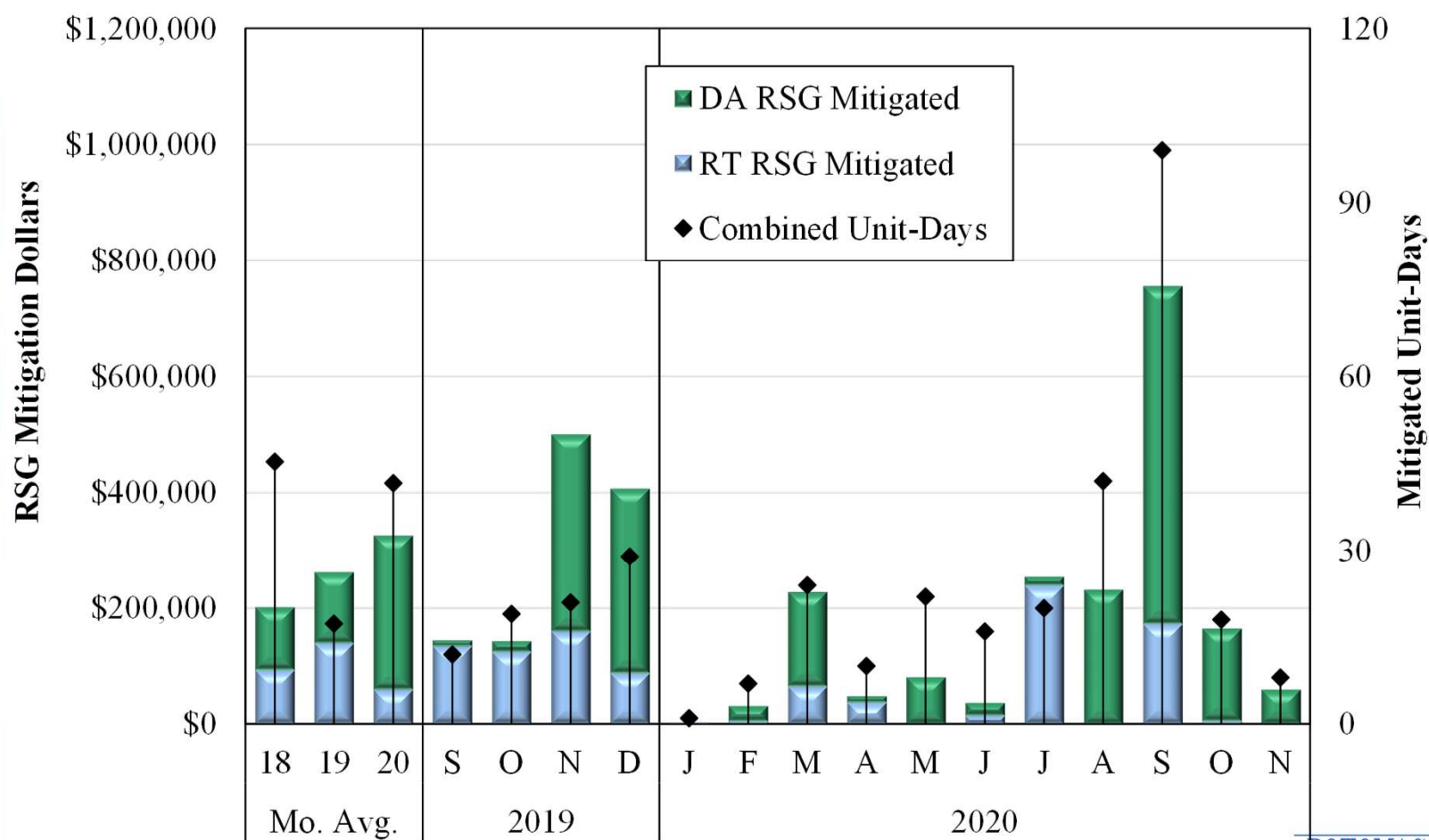


Day-Ahead And Real-Time Energy Mitigation 2019-2020





Day-Ahead and Real-Time RSG Mitigation Fall 2019-2020



List of Acronyms

• AAR	Ambient-Adjusted Ratings	• ORDC	Operating Reserve Demand Curve
• 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
• CTS	Coordinated Transaction Scheduling	• RDT	Regional Directional Transfer
• DAMAP	Day-Ahead Margin Assurance Payment	• RSG	Revenue Sufficiency Guarantee
• DDC	Day-Ahead Deviation & Headroom Charge	• RTORSGP	Real-Time Offer Revenue Sufficiency Guarantee Payment
• DIR	Dispatchable Intermittent Resource	• STE	Short-Term Emergency
• 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 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		