



# IMM Quarterly Report: Fall 2022

MISO Independent Market Monitor

Carrie Milton  
David B. Patton, PhD.  
Potomac Economics

January 19, 2023



## Highlights and Findings: Fall 2022

- The MISO markets performed competitively this fall – market power mitigation was infrequent, and conduct was highly competitive overall.
- Energy prices rose 13 percent, as gas prices rose 14 percent in the Midwest and 22 percent in the South.
  - ✓ Coal supply chain constraints eased during the quarter, and several resources eliminated coal conservation measures entirely.
- Although average load fell one percent, peak load rose 10 percent.
  - ✓ Above-normal temperatures in September increased cooling demand and the seasonal peak load of 108 GW occurred on the first day of the quarter.
- Despite higher gas prices, day-ahead and real-time transmission congestion were 15 and 18 percent lower than last fall, respectively.
  - ✓ Average hourly wind output rose 14 percent over last year, but congestion caused by wind output fell 4 percent because of a key transmission upgrade.
  - ✓ Hourly wind curtailments averaged 642 MW, down 26 percent from last year.
- Nominal real-time RSG fell 26 percent compared to last year, while day-ahead RSG rose 22 percent because of units committed to support transmission work.

# 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>	●	\$57.15	-34%	13%	<b>FTR Funding (%)</b>	●	104%	114%	96%
<b>Fuel Prices (\$/MMBtu)</b>					<b>Wind Output (MW/hr)</b>	●	11,637	56%	14%
Natural Gas - Chicago	●	\$5.66	-25%	14%	Wind Curtailed (MW/hr)	●	642	127%	-26%
Natural Gas - Henry Hub	●	\$6.33	-20%	22%	<b>Guarantee Payments (\$M)<sup>4</sup></b>				
Western Coal	●	\$0.96	-1%	-32%	Real-Time RSG	●	\$18.7	-63%	-26%
Eastern Coal	●	\$7.44	4%	134%	Day-Ahead RSG	●	\$24.6	6%	22%
<b>Load (GW)<sup>2</sup></b>					Day-Ahead Margin Assurance	●	\$11.9	-50%	12%
Average Load	●	71.5	-17%	-1%	Real-Time Offer Rev. Sufficiency	●	\$1.8	-31%	11%
Peak Load	●	107.9	-12%	10%	<b>Price Convergence<sup>5</sup></b>				
% Scheduled DA (Peak Hour)	●	100.1%	99.1%	98.1%	Market-wide DA Premium	●	2.0%	-0.9%	-1.8%
<b>Transmission Congestion (\$M)</b>					<b>Virtual Trading</b>				
Real-Time Congestion Value	●	\$640.6	-26%	-18%	Cleared Quantity (MW/hr)	●	25,102	19%	30%
Day-Ahead Congestion Revenue	●	\$427.5	-29%	-15%	% Price Insensitive	●	59%	62%	48%
Balancing Congestion Revenue <sup>3</sup>	●	-\$22.3	-\$3.9	\$20.0	% Screened for Review	●	3%	3%	3%
<b>Ancillary Service Prices (\$/MWh)</b>					Profitability (\$/MW)	●	\$0.7	\$1.3	\$1.1
Regulation	●	\$15.65	-17%	-6%	<b>Dispatch of Peaking Units (MW/hr)</b>	●	1,019	2,264	1,302
Spinning Reserves	●	\$3.94	-30%	-1%	<b>Output Gap- Low Thresh. (MW/hr)</b>	●	158	283	688
Supplemental Reserves	●	\$0.65	-79%	-18%					

**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 2022

### Gas and Energy Prices and Coal Conservation Update (Slides 12, 14, 17, 18)

- Energy prices rose 13 percent from last fall, consistent with gas prices that rose 14 and 22 percent at the Chicago Citygate and Henry Hub, respectively.
  - ✓ Energy prices were 34 percent lower than the summer quarter because of falling gas prices, lower load, and a reduction in coal conservation measures.
- Gas prices were volatile this quarter, particularly at Chicago Citygate, ranging from a high of \$8.80 per mmbtu to a low of \$1.62 per mmbtu in early November.
  - ✓ Demand for LNG exports to Europe had fallen as its storage levels had risen to relatively high levels in advance of the winter season.
- Coal supply constraints eased during the quarter, as railroads were able to provide more capacity on routes that serve multiple units in MISO.
  - ✓ The amount of coal capacity conserving coal fell from more than 18 GW at the beginning of the quarter to 8 GW by December 1.
- Net revenues for most types of resources were higher this fall than last fall due to the increase in energy prices.



# Highlights for Fall 2022

## Congestion and FTR Surplus (Slides 19-21)

- Day-ahead and real-time congestion fell 15 and 18 percent, respectively.
  - ✓ Transmission upgrades completed this summer doubled the capacity on a key constraint that had generated substantial congestion last fall.
- FTRs were fully funded, and MISO collected over \$47 million in surplus.
  - ✓ Process changes to the FTR modeling were introduced in the 2021-2022 annual FTR auction and carried forward into the current FTR year.
  - ✓ The surplus indicates that some paths were significantly undersold after both the annual and monthly FTR auctions.
- The quarterly surplus would have higher but for large shortfalls on paths that were over-allocated in MISO's ARR process.
  - ✓ About \$15 million of FTR shortfalls are attributable to a single TO's failure to report known planned transmission outages before the annual auction.
  - ✓ MISO's FTR surplus collections are used to fund shortfalls, so the costs of over-allocations are subsidized by all the other transmission customers.
  - ✓ We are investigating this issue because TOs are obligated to report known transmission outages 12 months in advance.



# Highlights for Fall 2022

## Issues Related to Congestion Along Seams (Slides 28-29)

- On October 1, SPP began a new process for modeling MISO's M2M constraints in its DA market, as required by the JOA between MISO and SPP.
  - ✓ The goal is to promote efficient and reliable commitments by both RTOs that minimize the costs of managing congestion in real time.
  - ✓ The changes made after October 1 have caused SPP to bind the 6 most impactful M2M flowgates in their day-ahead market
  - ✓ By mid-quarter, almost 40 percent MISO's M2M constraints generating real-time congestion in MISO have bound in SPP's day-ahead market.
- Lags in the M2M coordination process have always produced some dispatch volatility but this volatility has been increasing as fast-ramping wind increases.
  - ✓ The most volatile outcomes occur on M2M constraints impacted by wind in both MISO and the coordinating market (both on the SPP and PJM seam).
  - ✓ "Power Swing Software" implemented at the SPP seam is intended to dampen oscillations, but it has frequently not been extremely effective. We have been reviewing these cases and hope to recommend improvements.
  - ✓ MISO and PJM have planned to implement similar software, but this work has not been scheduled.



## Highlights for Fall 2022

### Uplift Costs and MISO Unit Commitments (Slides 23-25)

- Nominal real-time RSG costs fell 26 percent over last fall.
  - ✓ Although we continue to find that a relatively small share of the RSG from intra-day generator commitments was ultimately needed (8 percent this quarter), MISO has made improvements over the past year in their processes.
- We have been working closely with MISO to address concerns related to MISO's commitment procedures and practices.
  - ✓ We provided 19 recommendations for commitment process improvements to reduce inefficient commitments and improve market outcomes.
- Day-ahead RSG rose 22 percent, largely driven by higher VLR commitments.
  - ✓ A significant transmission outage in the North led to daily commitment of a pivotal unit that received more than \$3.5 million in VLR RSG.
  - ✓ Overall, we determined that most of the RSG associated with VLR commitments was warranted.



## Submittals to External Entities and Other Issues

- We responded to several FERC questions related to prior referrals and FERC investigations, and we responded to requests for information on market issues.
  - ✓ We recommended a sanction to MISO for uneconomic production by a resource.
- We continue to meet with MISO and TOs regarding:
  - ✓ Order 881 compliance and related issues on AARs and Emergency Ratings.
  - ✓ The process for economic reconfigurations with stakeholders and MISO.
- We continue to meet with states and stakeholders on the need to reform MISO's PRA demand curve to satisfy the Reliability Imperative.
- In September, we presented material in support of accreditation based on Marginal rather than Average Capacity value to the RASC.
- In October, we participated in multiple panels at the OMS Annual meeting, including a presentation on resource attributes.
- In November, we presented summer and early fall market results to the ERSC.





# Key Market Design Issues

## *Seasonal Capacity Market*

- We are working with MISO on the many adjustments need to MISO's PRA to implement seasonal requirements.
- Some pricing and mitigation process changes are still being developed:
  - ✓ How to adjust prices in a zone when multiple seasons are in shortage;
  - ✓ The process to grant exclusions from market power mitigation – allows units to not offer their capacity or offer it at a very high price.
- We have a serious concern about MISO's seasonal requirements.
  - ✓ MISO's requirements essentially assume that all units with planned outages will be selling capacity – since that would reduce the average availability of capacity purchased, it raises the requirement.
  - ✓ However, if units on long-duration planned outages do not sell, as we expect, the shoulder seasons will be artificially tight and may be short.
  - ✓ Tariff deadlines governing the posting of planning results that underly the requirements have passed – we are exploring potential solutions.



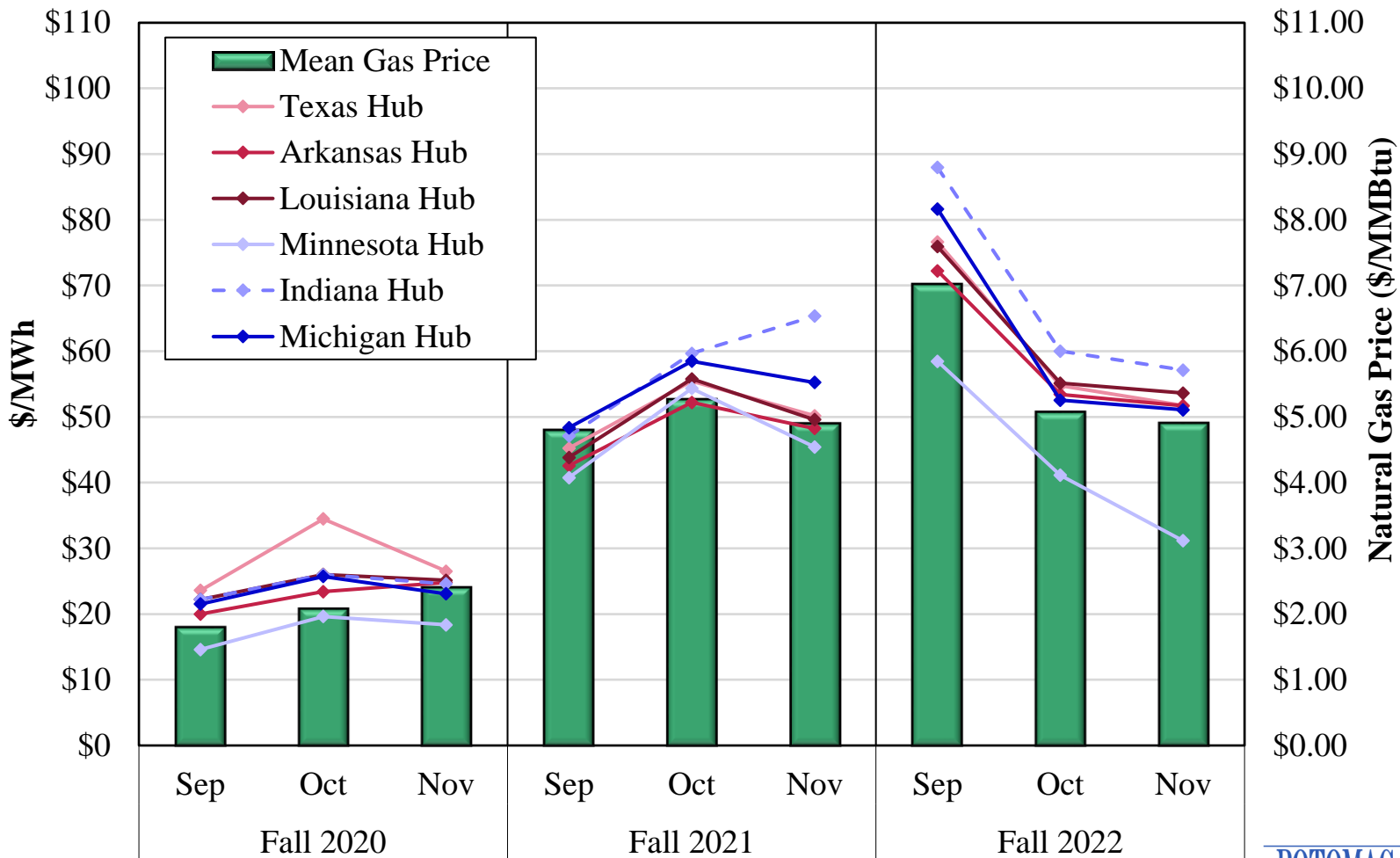
# Key Market Design Issues

## *Attributes and the Future Generation Portfolio*

- We are concerned about the “attributes” project – quantifying attribute “requirements” is not useful.
  - ✓ An infinite combination of individual attributes could be defined that would achieve the same reliability objective.
- To ensure its markets deliver a reliable portfolio, we recommend MISO:
  - 1) Adopt a reliability-based capacity demand curve. This is gaining support and MISO has shifted resources to focus on it.
  - 2) Adopt *marginal* capacity accreditation for non-thermal resources.
    - This is essential to reward more valuable attributes, although very few participants support it.
    - This will ultimately require that MISO improve its planning models to better quantify the marginal value of different types of resources.
  - 3) Improve its shortage pricing.
    - This rewards resources with good attributes because they are more available during shortages.
    - Progress on this recommendation has been very slow.

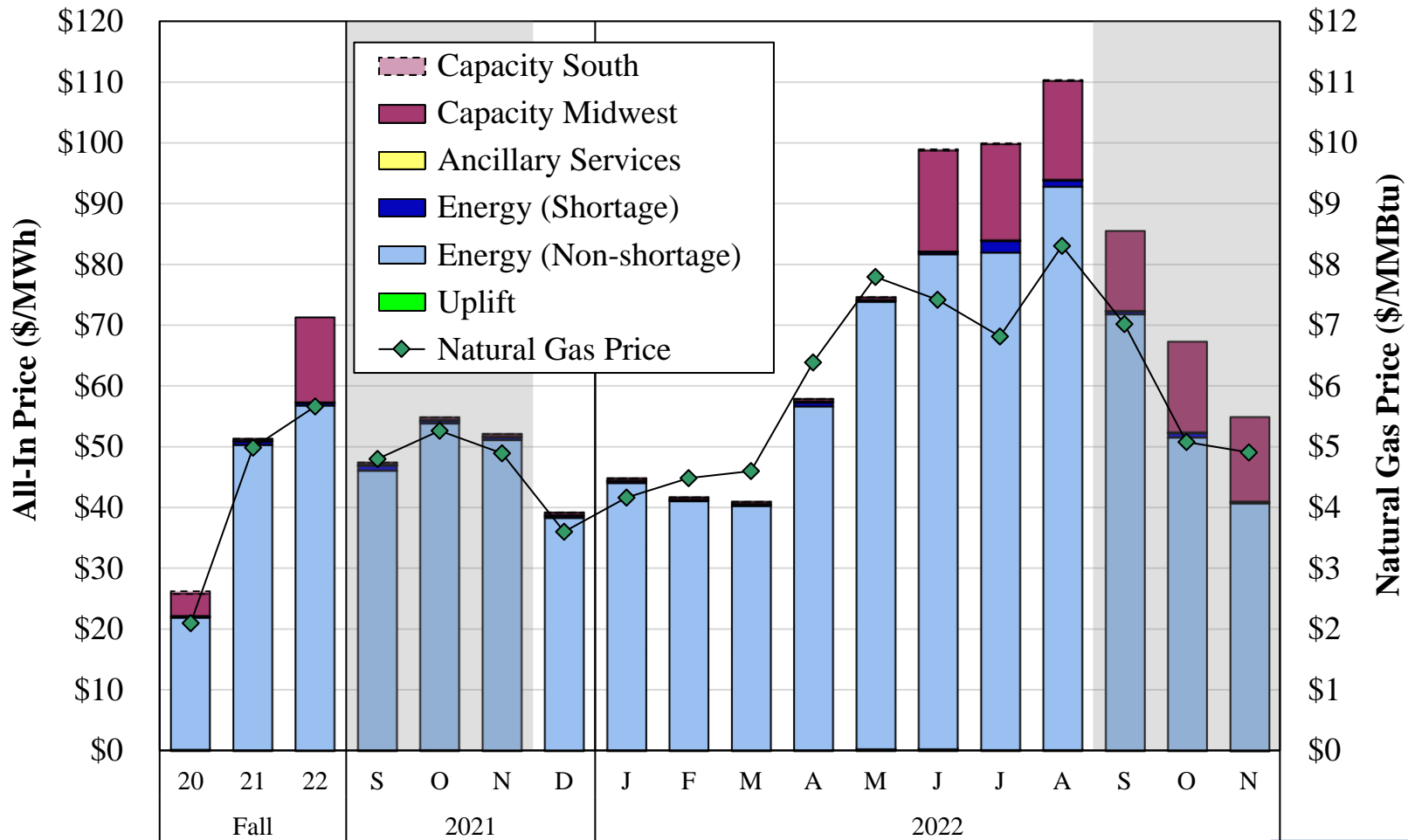


# Day-Ahead Average Monthly Hub Prices Fall 2020–2022



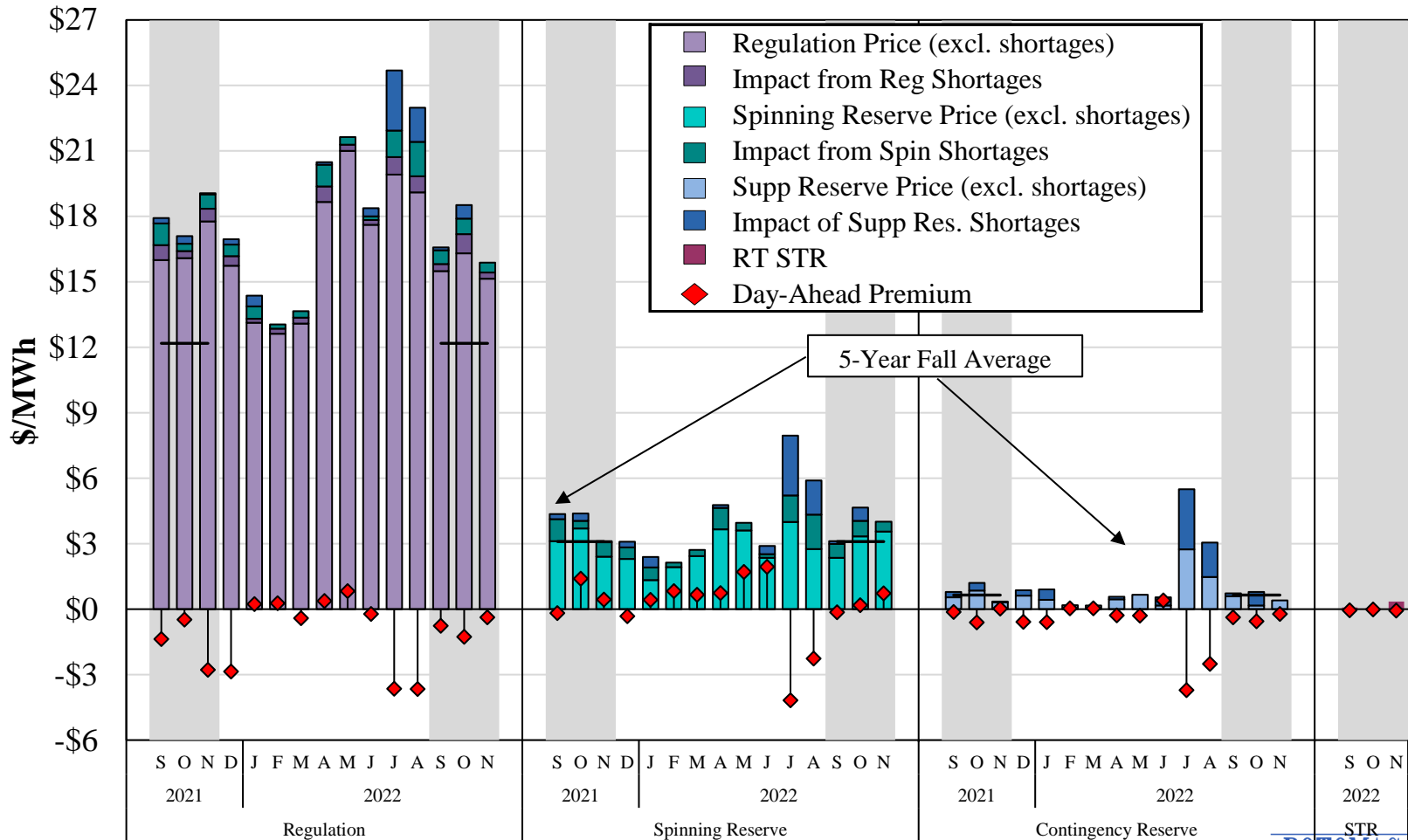


# All-In Price Fall 2020 – 2022



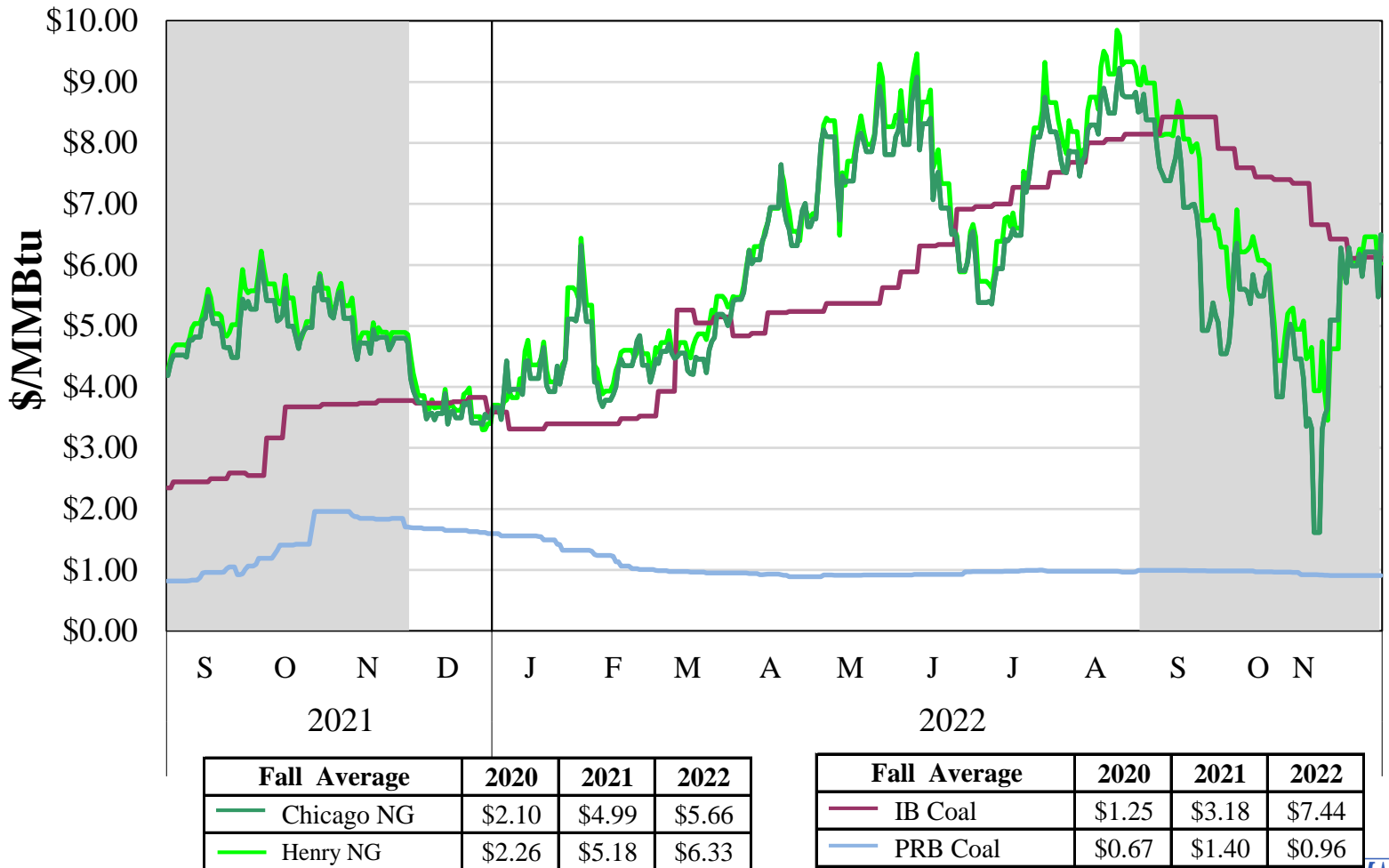


# Ancillary Services Prices Fall 2021–2022

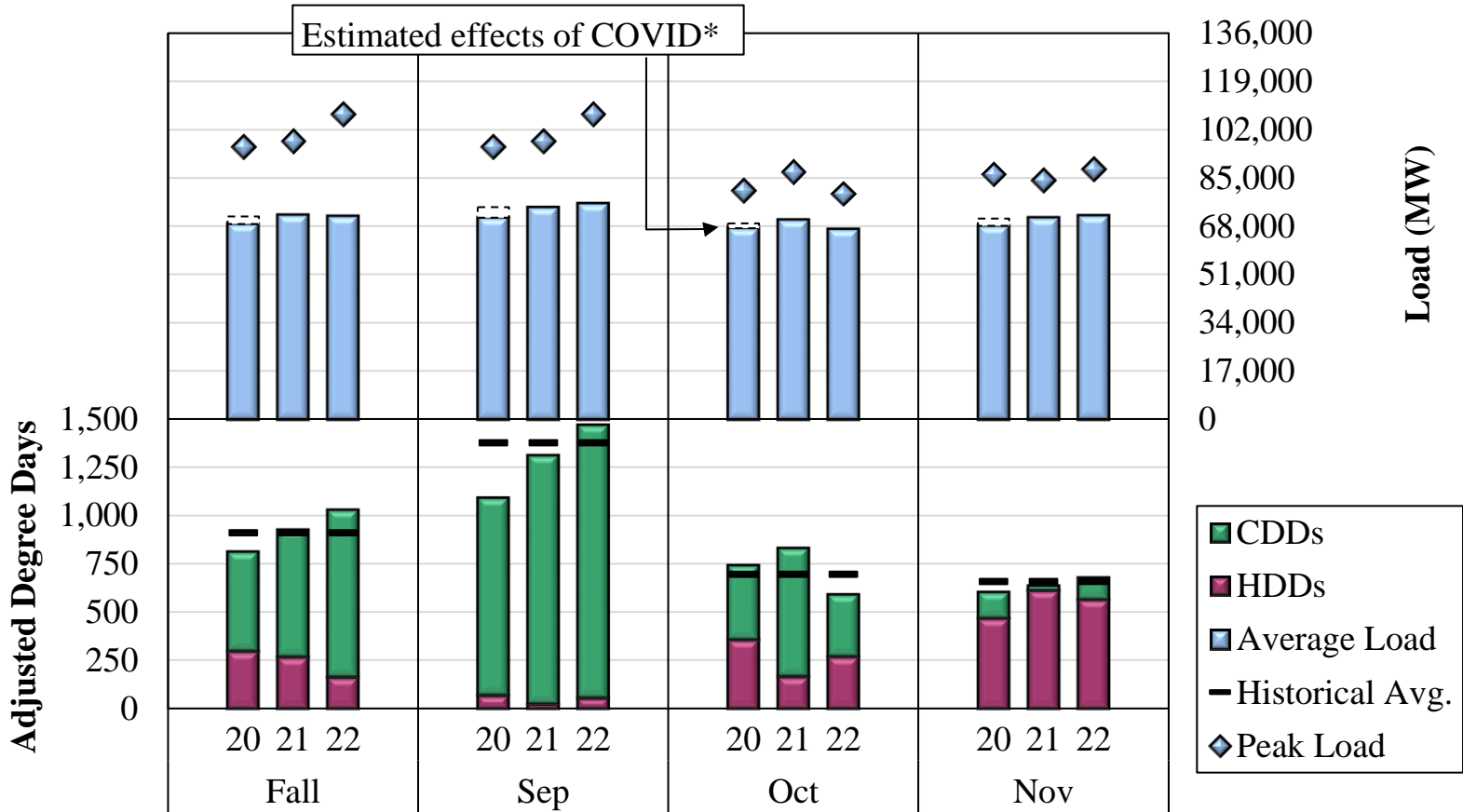




# MISO Fuel Prices 2021–2022



# Load and Weather Patterns Fall 2020–2022



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.

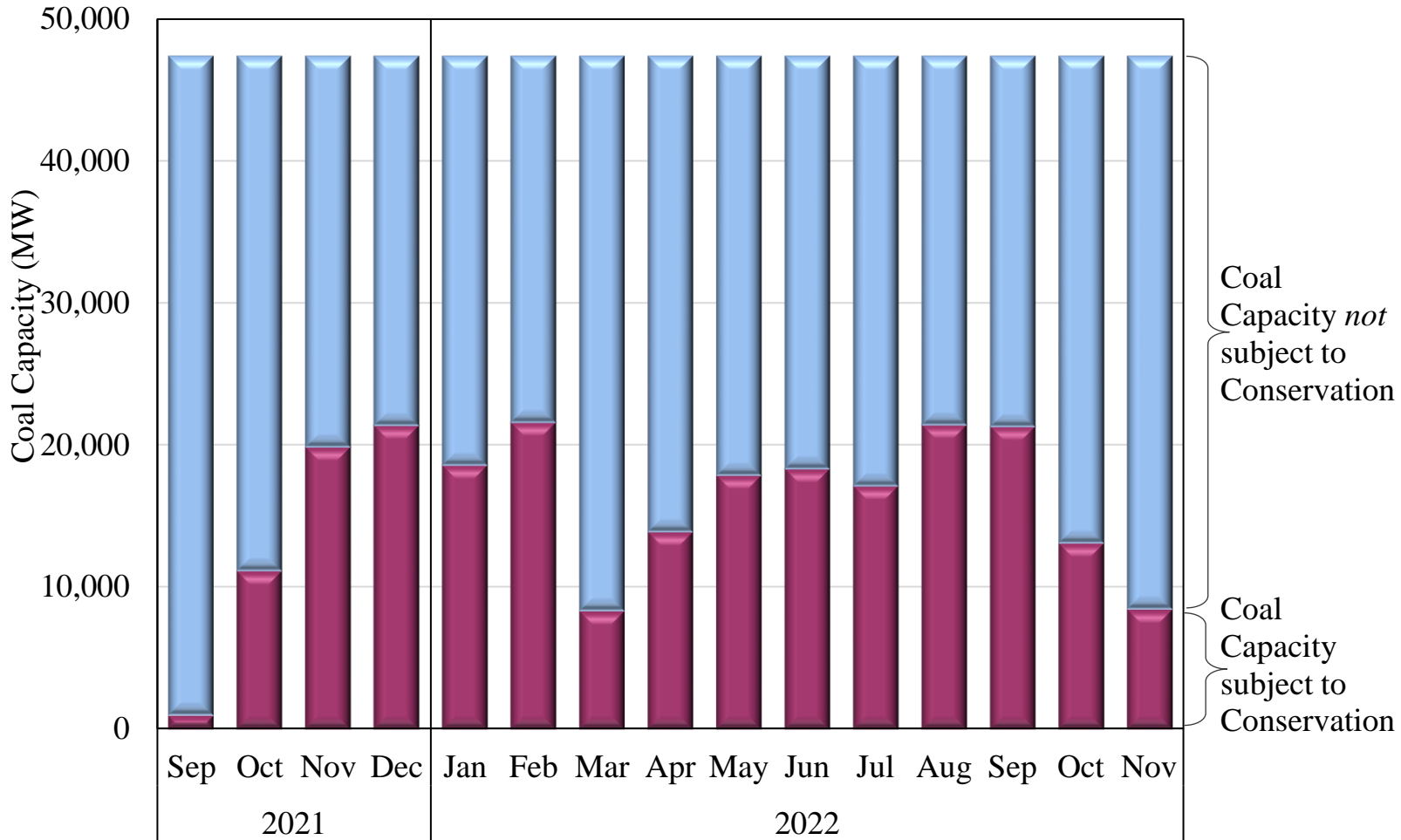
# Capacity, Energy and Price Setting Share Fall 2021–2022

Fall	Unforced Capacity				Energy Output		Price Setting			
	Total (MW)		Share (%)		Share (%)		SMP (%)		LMP (%)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
<b>Nuclear</b>	11,866	11,701	9%	9%	16%	17%	0%	0%	0%	0%
<b>Coal</b>	46,341	43,123	36%	34%	38%	31%	26%	27%	59%	66%
<b>Natural Gas</b>	58,334	59,901	45%	47%	30%	32%	73%	72%	94%	89%
<b>Oil</b>	1,636	1,474	1%	1%	0%	0%	0%	0%	0%	0%
<b>Hydro</b>	3,696	3,695	3%	3%	1%	1%	1%	0%	1%	2%
<b>Wind</b>	4,304	4,454	3%	3%	15%	17%	0%	0%	67%	70%
<b>Solar</b>	419	1,037	0%	1%	0%	0%	0%	0%	1%	3%
<b>Other</b>	2,603	2,734	2%	2%	1%	1%	0%	0%	5%	4%
<b>Total</b>	<b>129,199</b>	<b>128,120</b>								





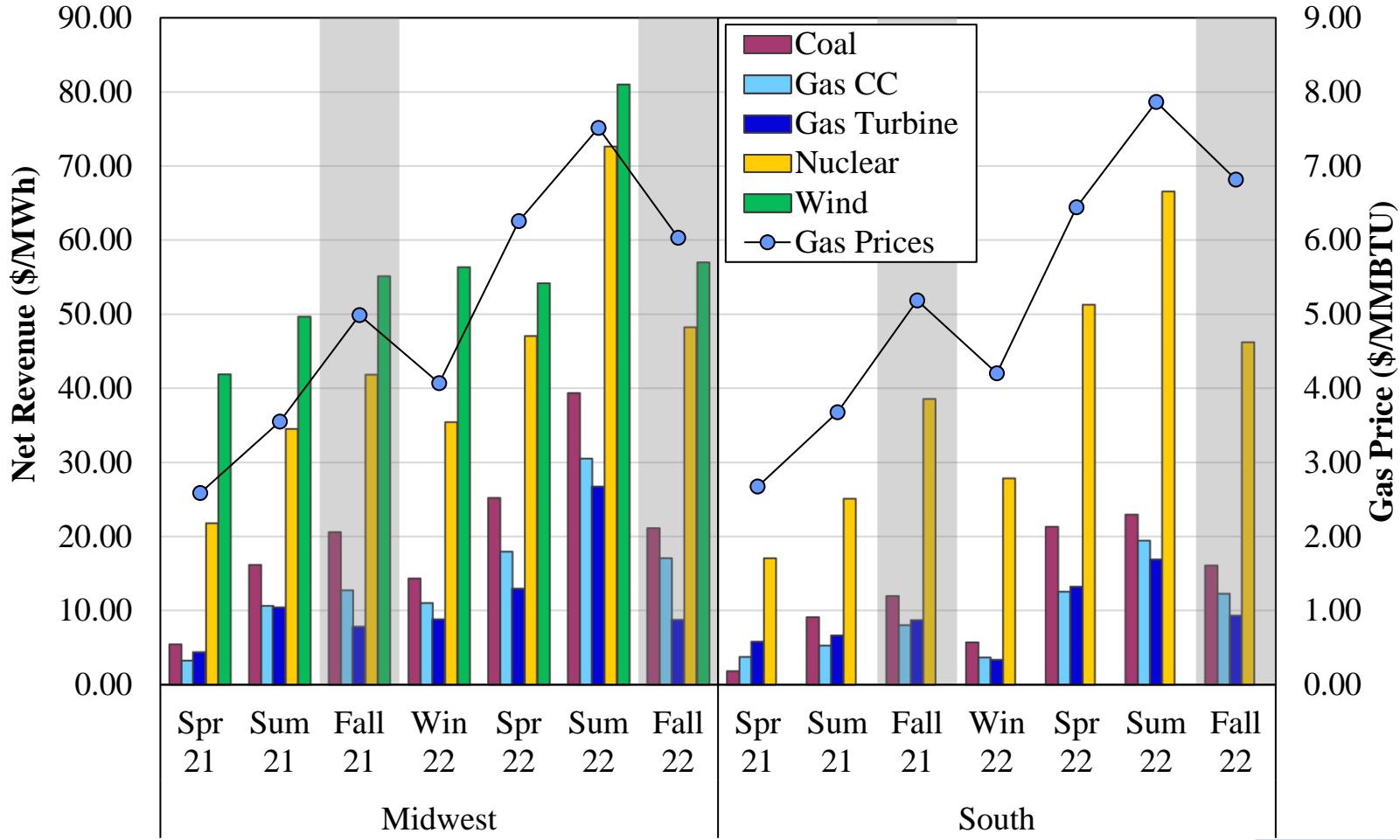
# Coal Conservation 2021–2022





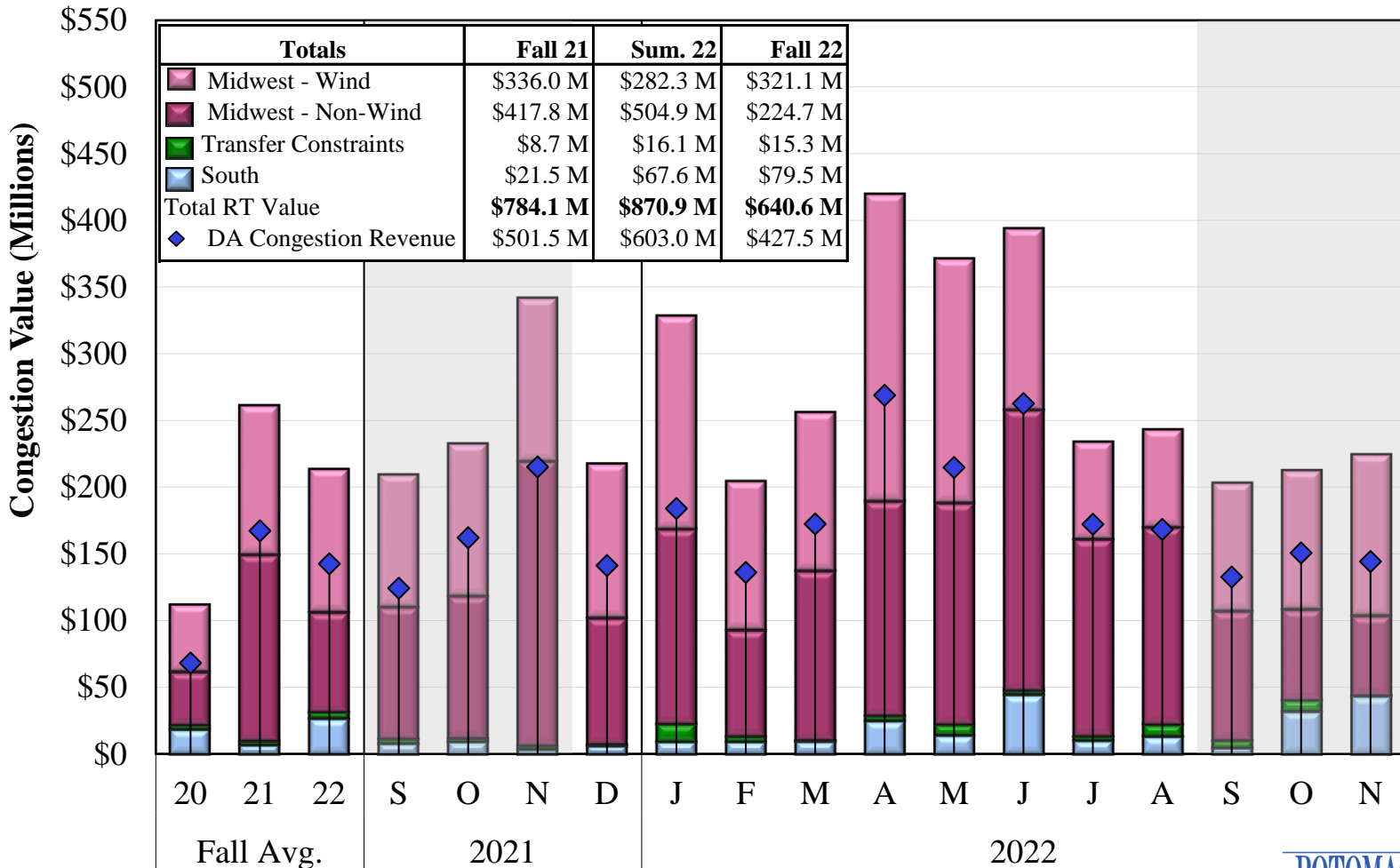
# Net Revenues by Technology

## 2021-2022





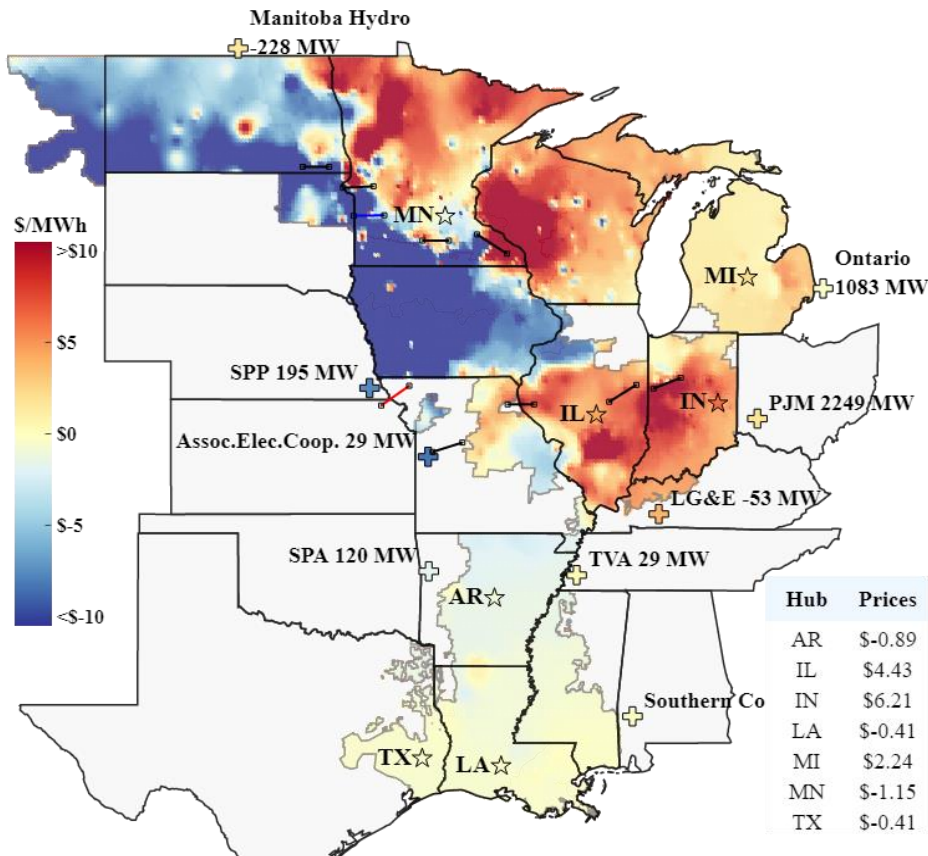
# Value of Real-Time Congestion Fall 2021–2022



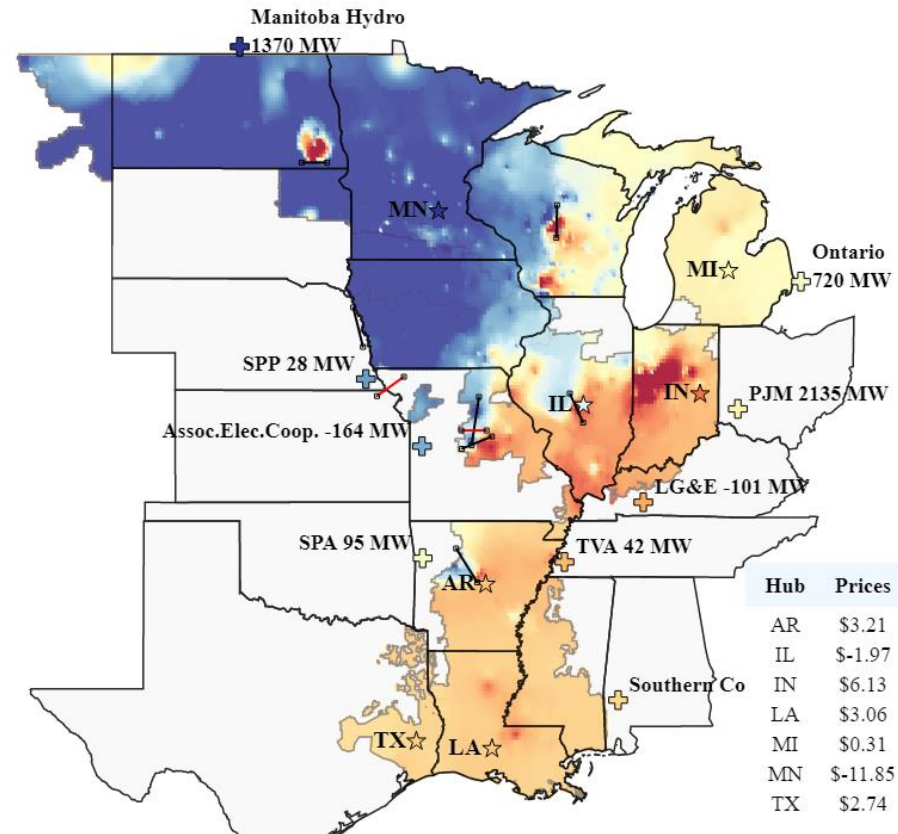


# Average Real-Time Congestion Components Fall 2021–2022

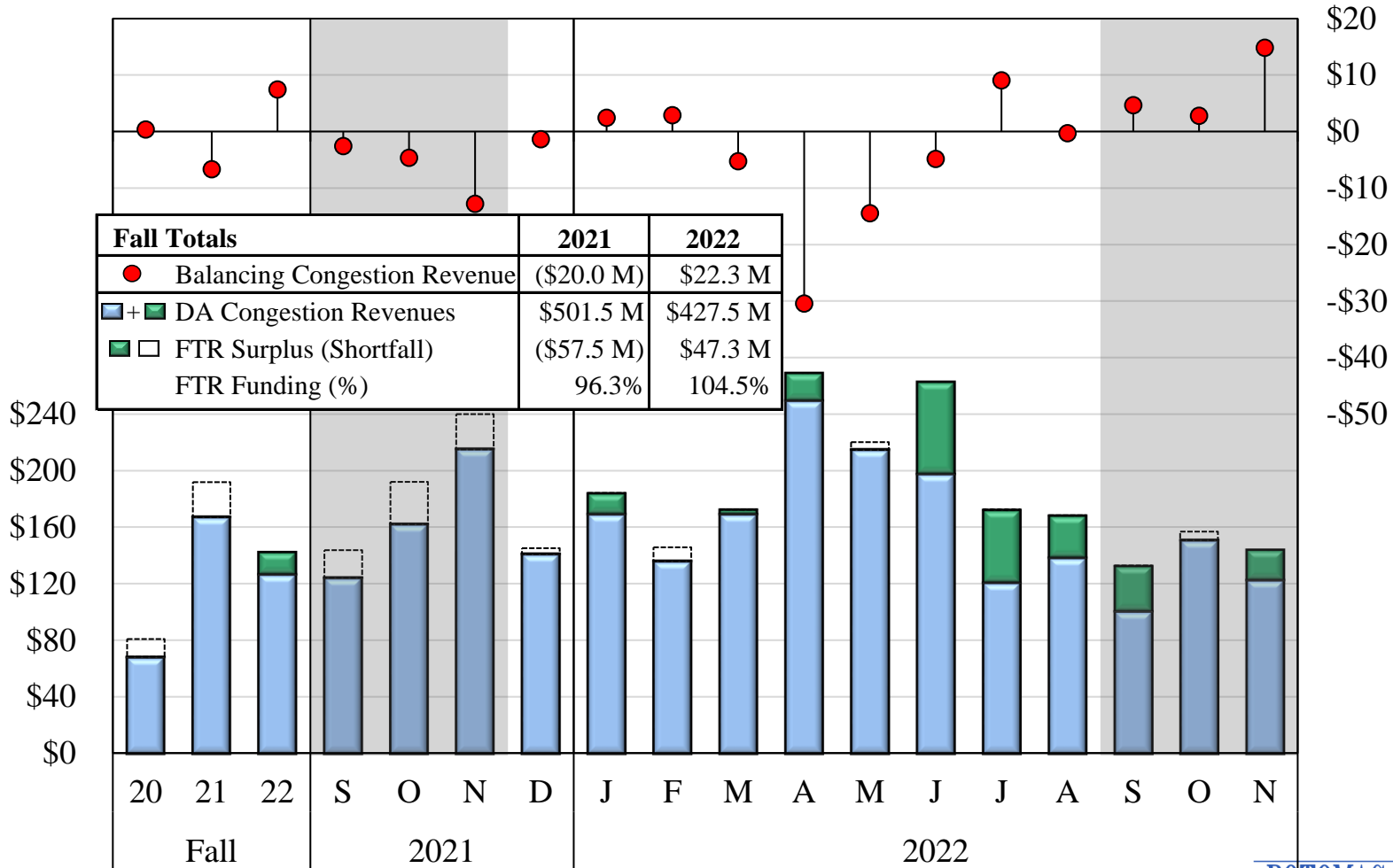
## Fall 2021



## Fall 2022



# Day-Ahead Congestion, Balancing Congestion, and FTR Underfunding



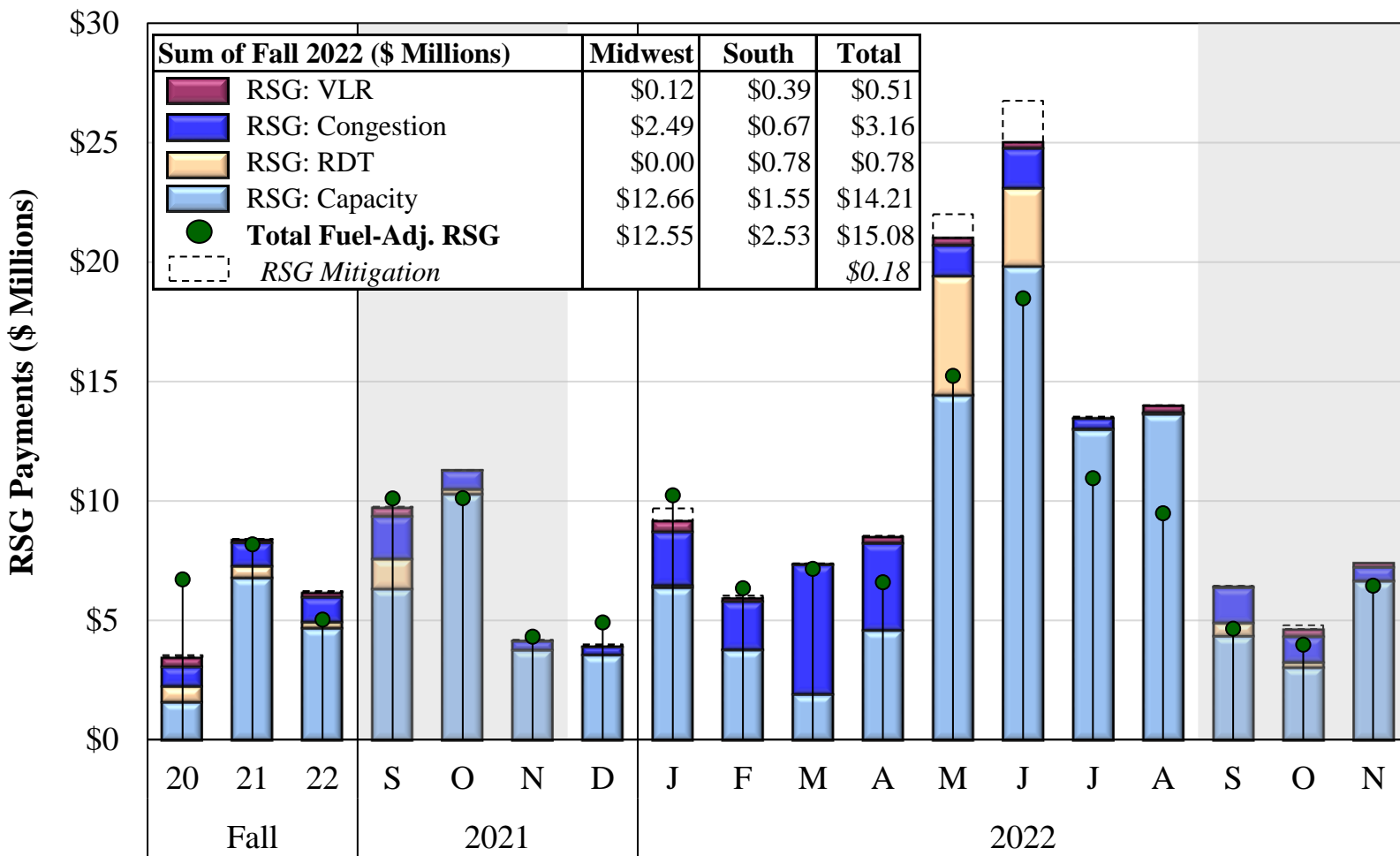
# Benefits of Ambient-Adjusted and Emergency Ratings Fall 2021–2022

Fall	Savings (\$ Millions)			# of Facilities for 2/3 of Savings	Share of Congestion	
	Ambient Adj. Ratings	Emergency Ratings	Total			
<b>2021</b>	<b>Midwest</b>	\$51.5	\$32.94	\$84.4	13	10.9%
	<b>South</b>	\$0.1	\$1.74	\$1.8	1	7.0%
	<b>Total</b>	<b>\$51.6</b>	<b>\$34.7</b>	<b>\$86.2</b>	<b>14</b>	<b>10.8%</b>
<b>2022</b>	<b>Midwest</b>	\$48.8	\$31.30	\$80.1	12	13.7%
	<b>South</b>	\$1.8	\$4.12	\$5.9	1	6.6%
	<b>Total</b>	<b>\$50.6</b>	<b>\$35.4</b>	<b>\$86.0</b>	<b>13</b>	<b>12.8%</b>

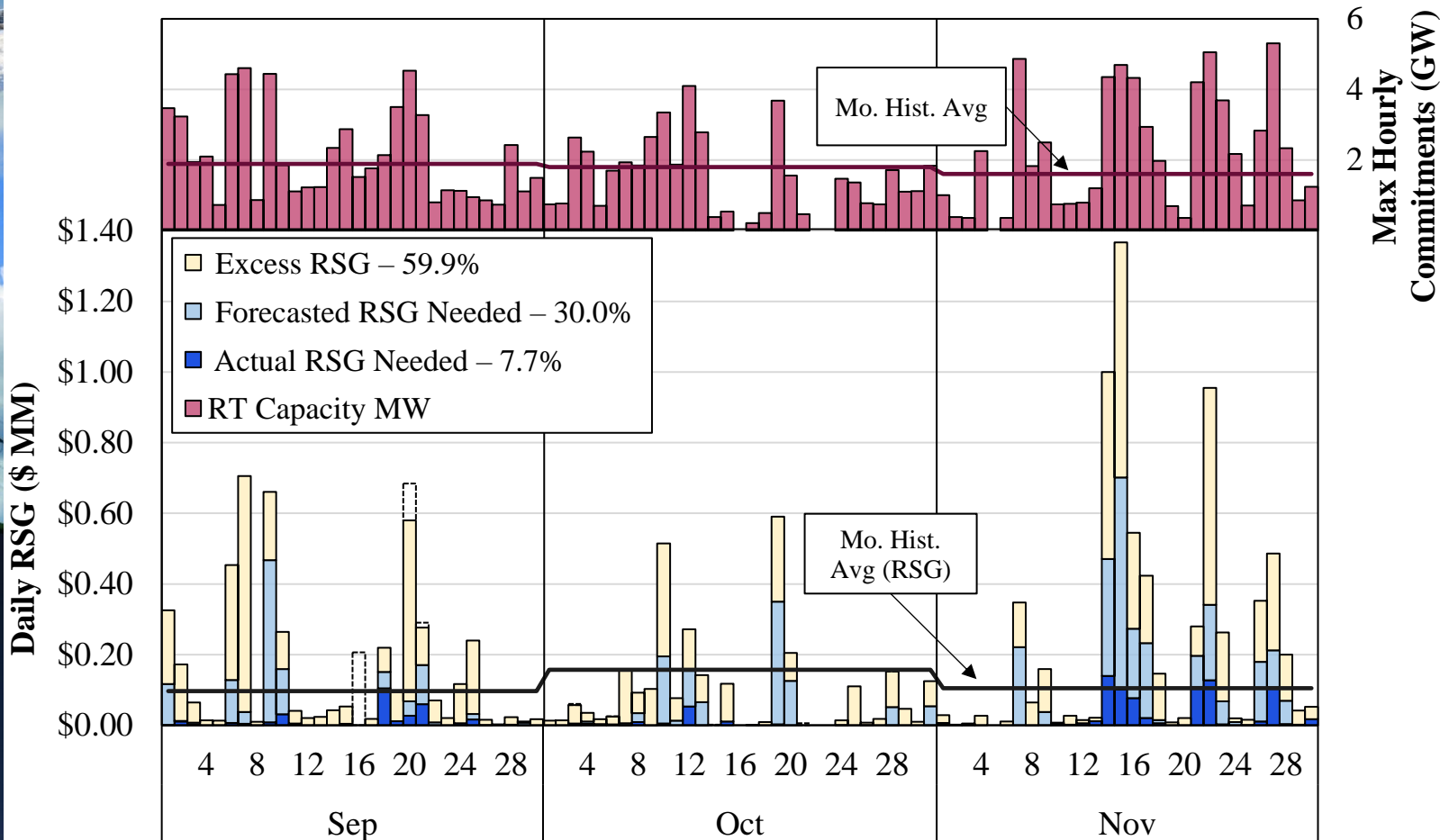


# Real-Time RSG Payments

## Fall 2021–2022



# Real-Time Capacity Commitment and RSG

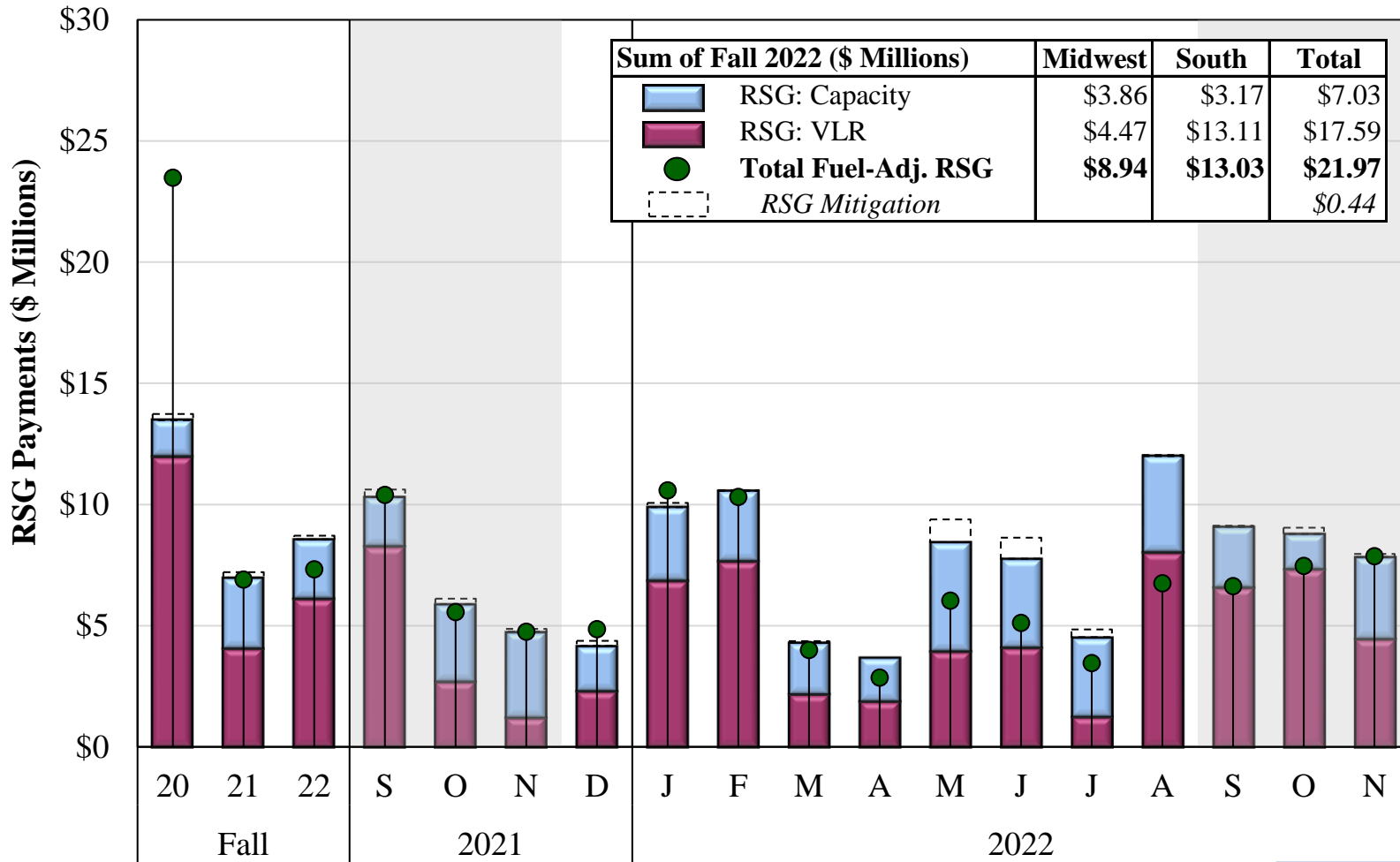


\* 2% of the RSG could not be classified due to gaps in market data and is shown in the transparent bars.



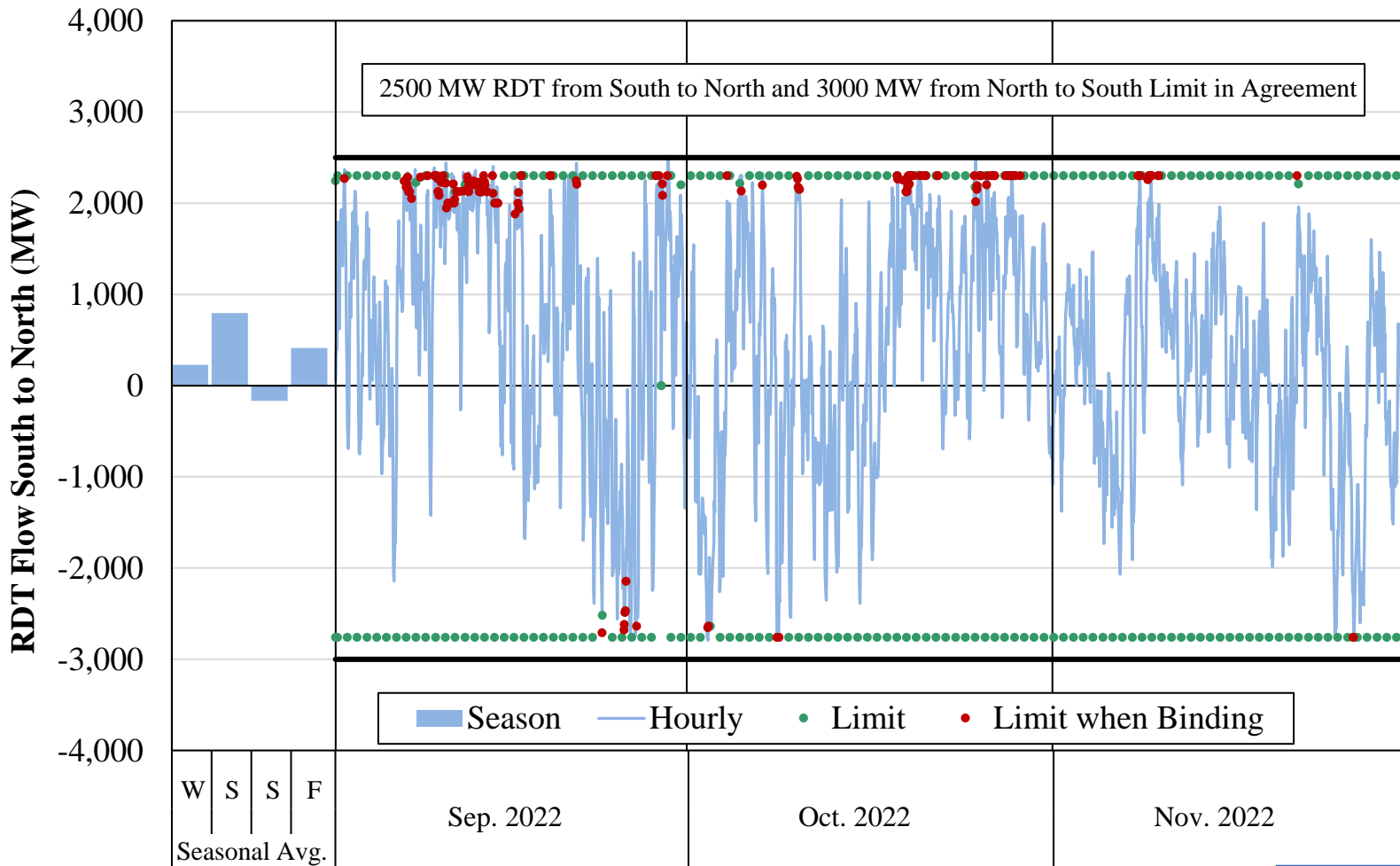
# Day-Ahead RSG Payments

## Fall 2021–2022



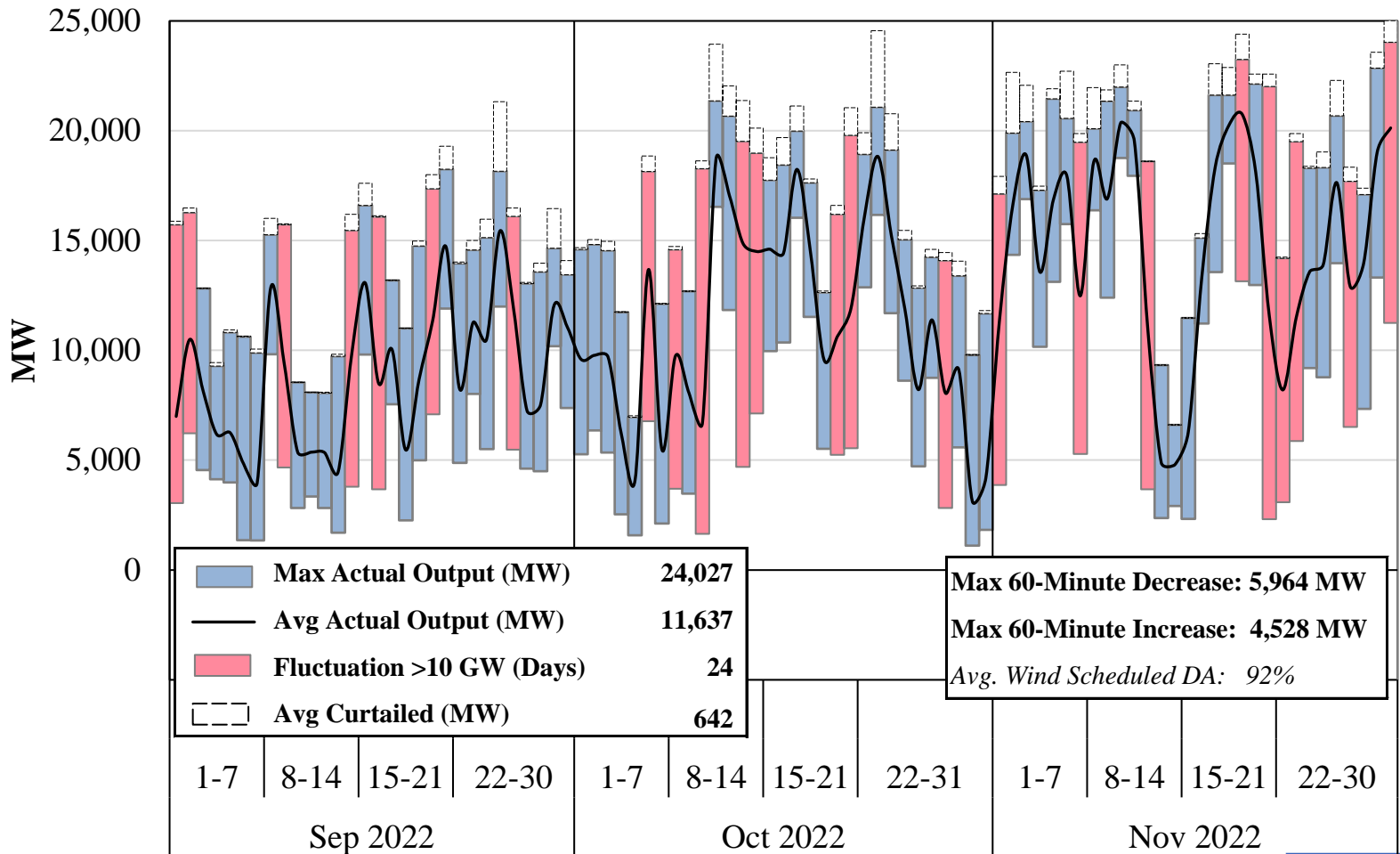


# Real-Time Hourly Inter-Regional Flows Fall 2022



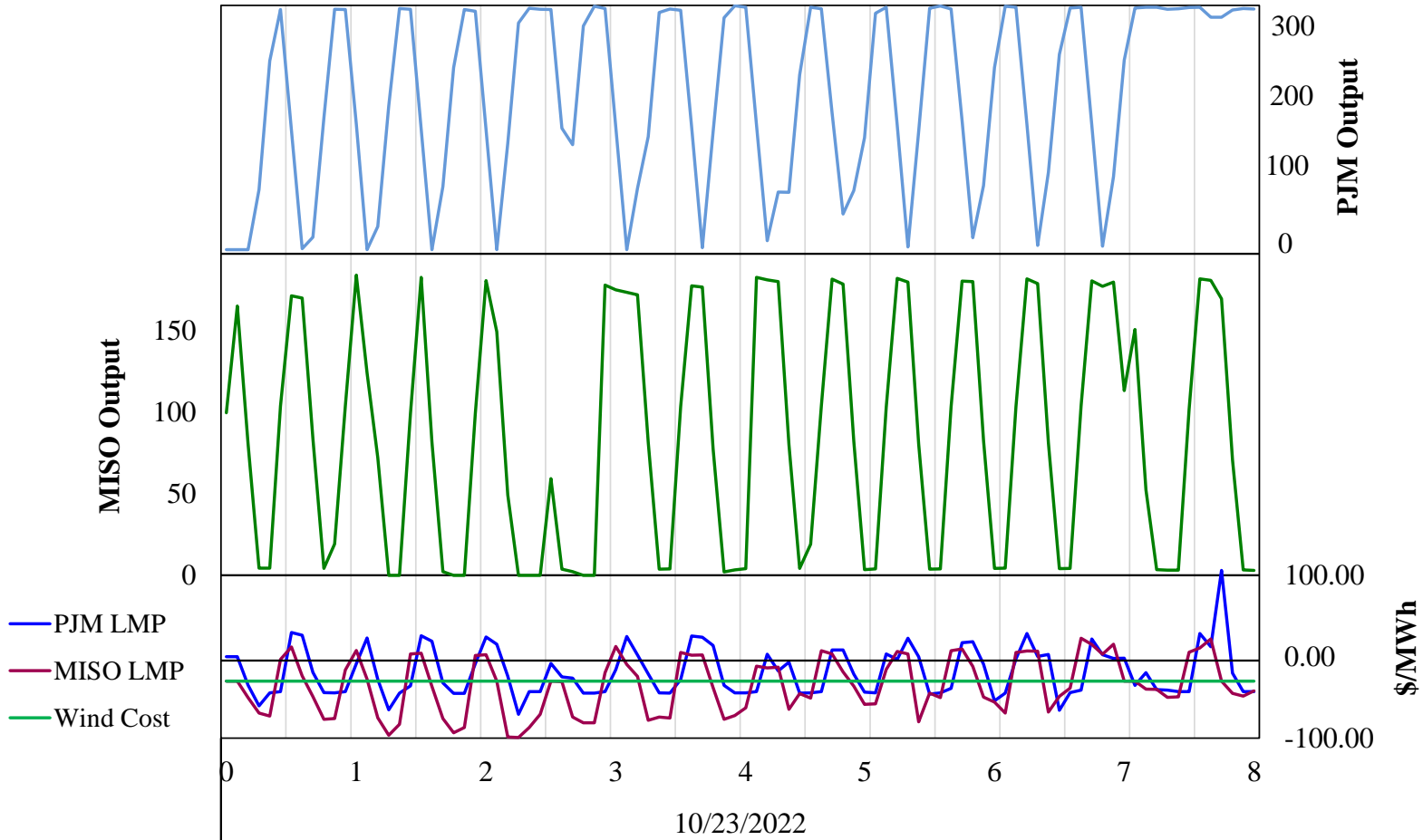


# Wind Output in Real Time Daily Range and Average



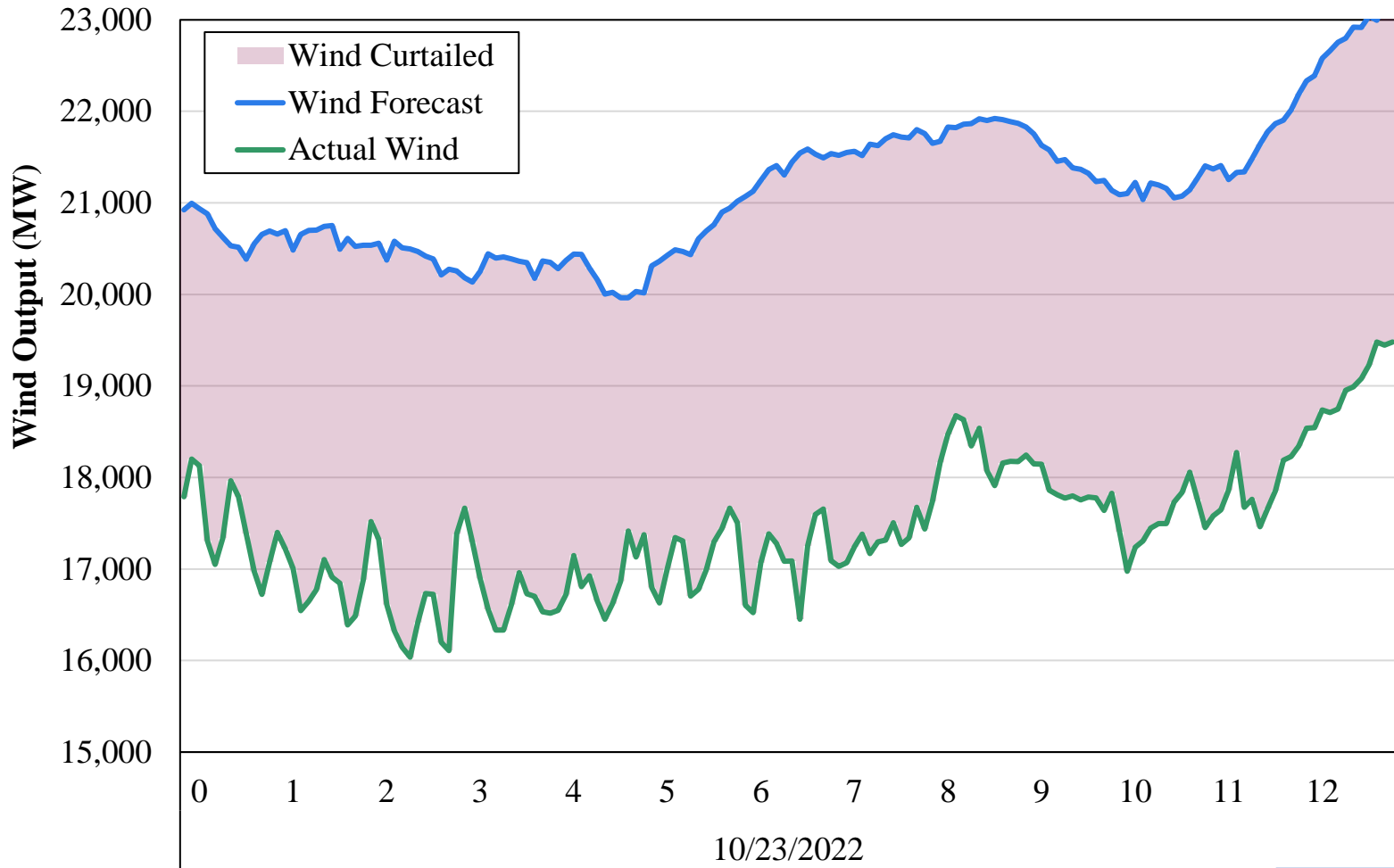


# Dispatch Volatility Caused by M2M Coordination: Oct. 23, 2022



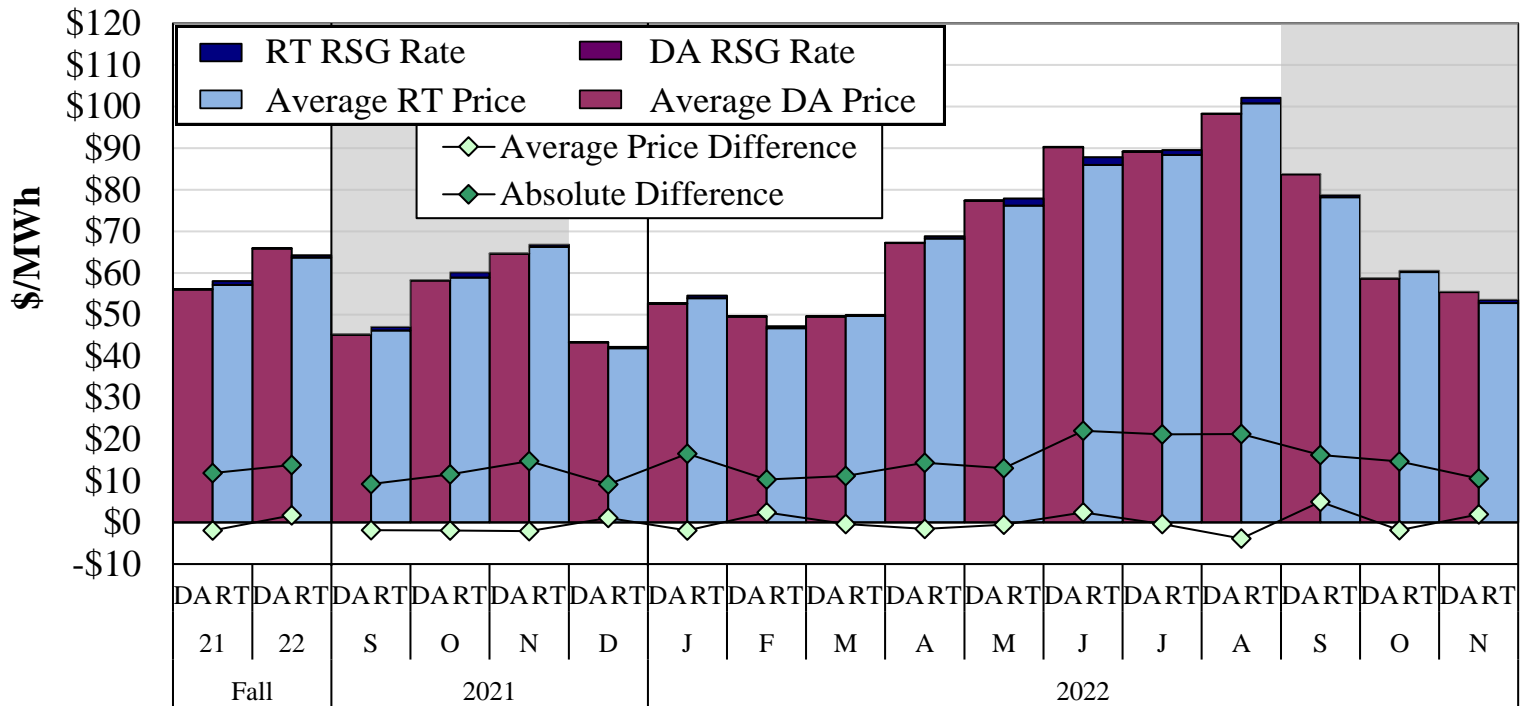


# Aggregate Wind Dispatch Volatility





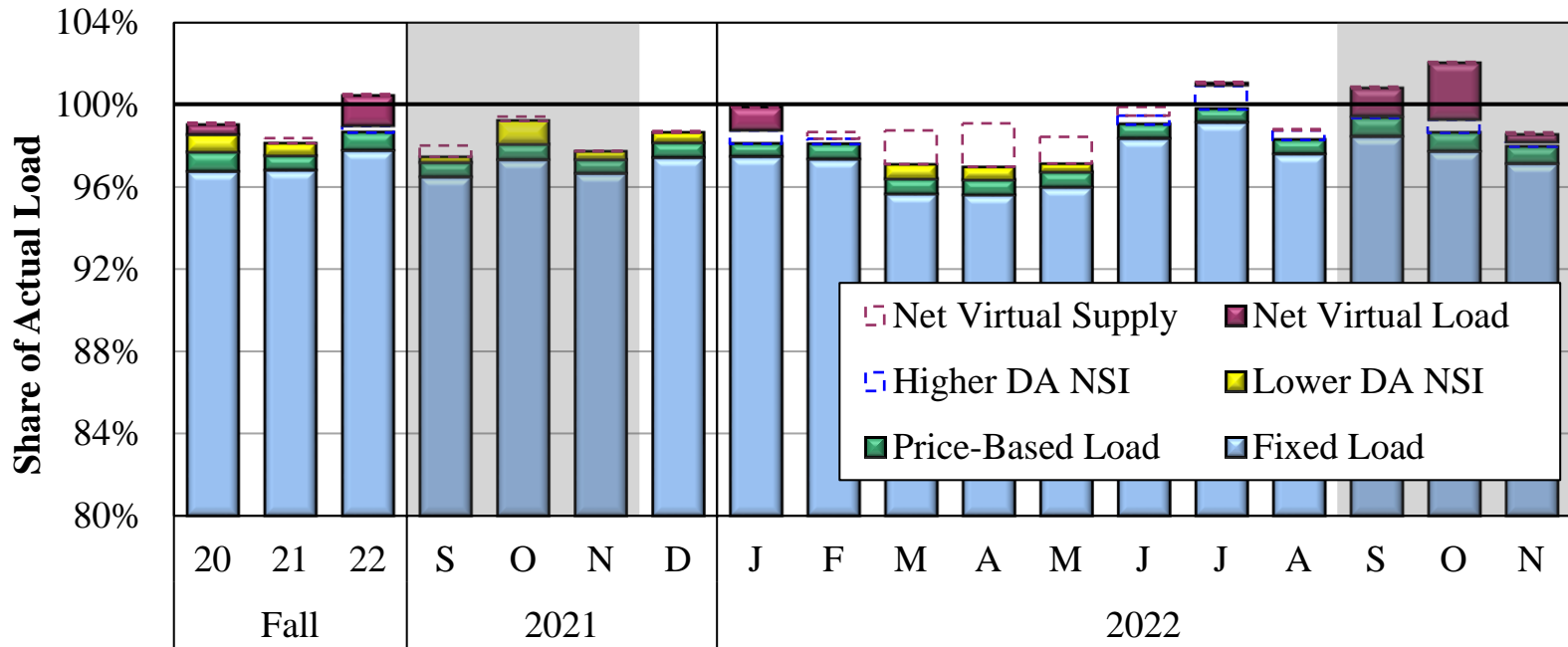
# Day-Ahead and Real-Time Price Convergence Fall 2021–2022



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

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

# Day-Ahead Peak Hour Load Scheduling Fall 2021–2022

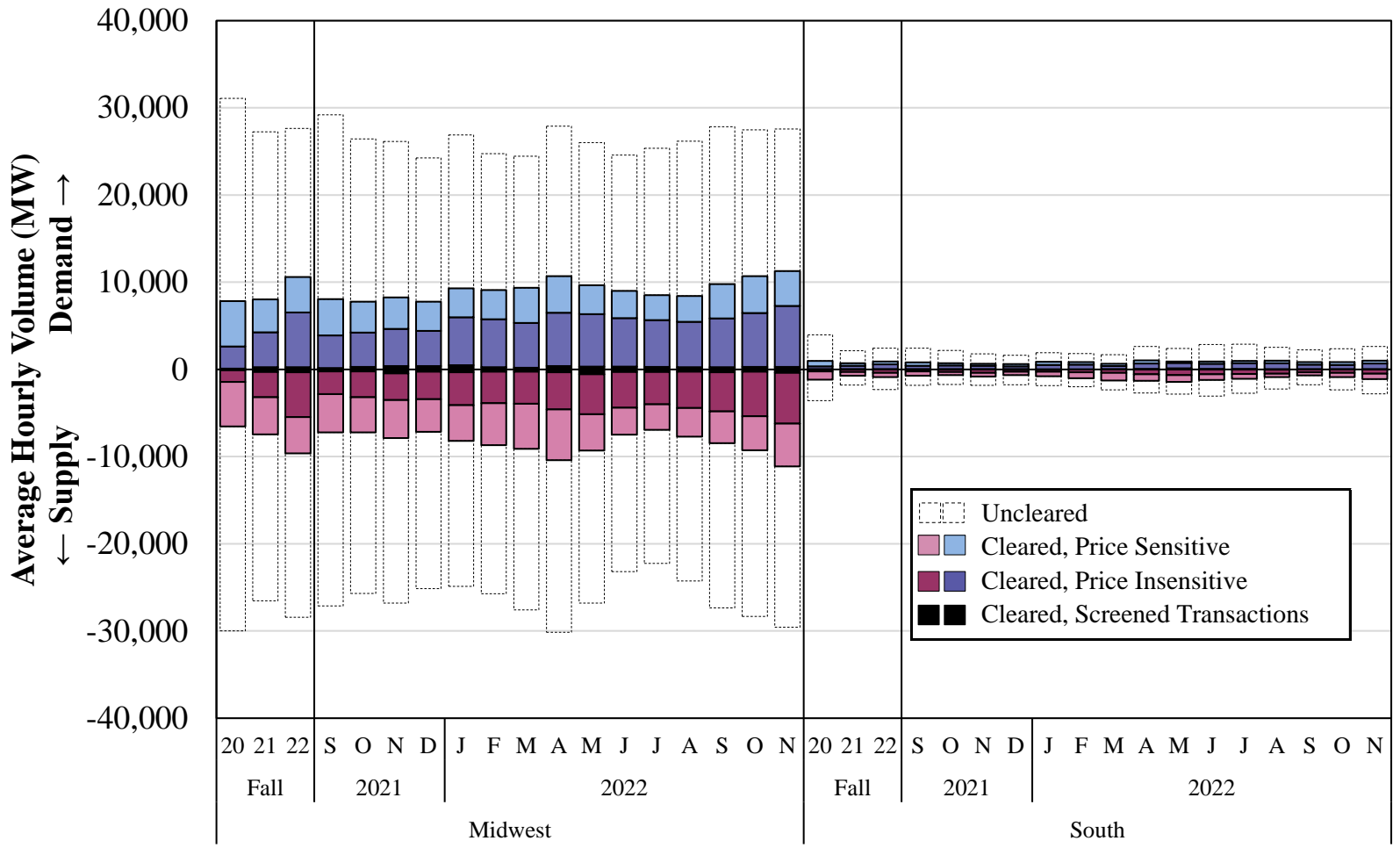


Share of Actual Load (%)

All Hours	98.9	98.4	99.4	98.3	99.2	97.8	98.9	97.8	97.3	97.5	97.6	99.2	99.8	98.9	100.8	99.7	97.6	
Peak Hours Midwest	98.9	97.8	100.5	97.0	98.7	97.6	99.0	99.8	98.1	96.5	96.0	96.2	98.2	99.7	98.4	101.0	101.5	99.0
Peak Hours South	99.7	100.3	100.0	99.3	100.2	101.4	101.3	98.8	100.0	98.8	99.1	99.0	99.7	99.7	98.7	101.8	100.1	98.1



# Virtual Load and Supply Fall 2021–2022

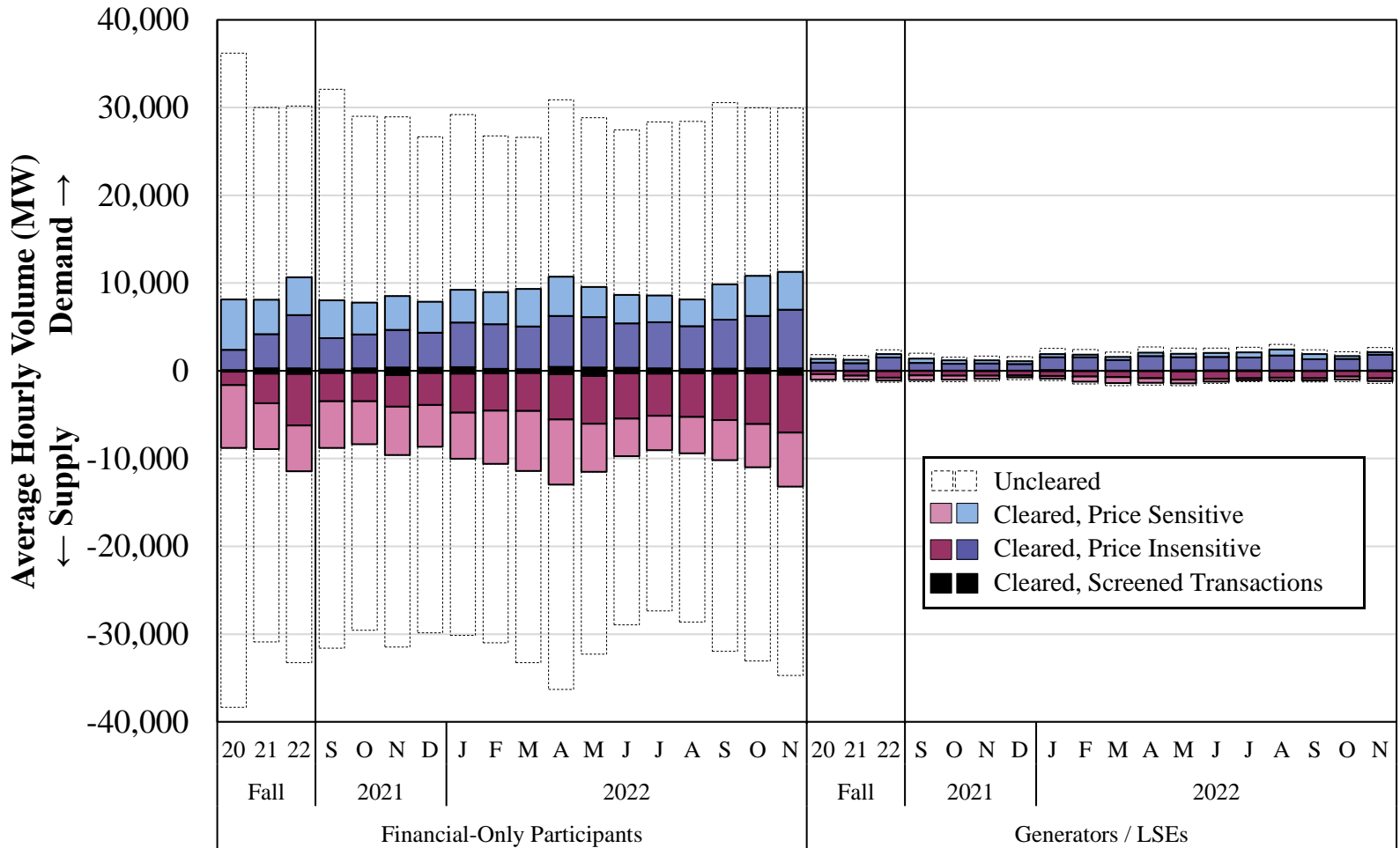






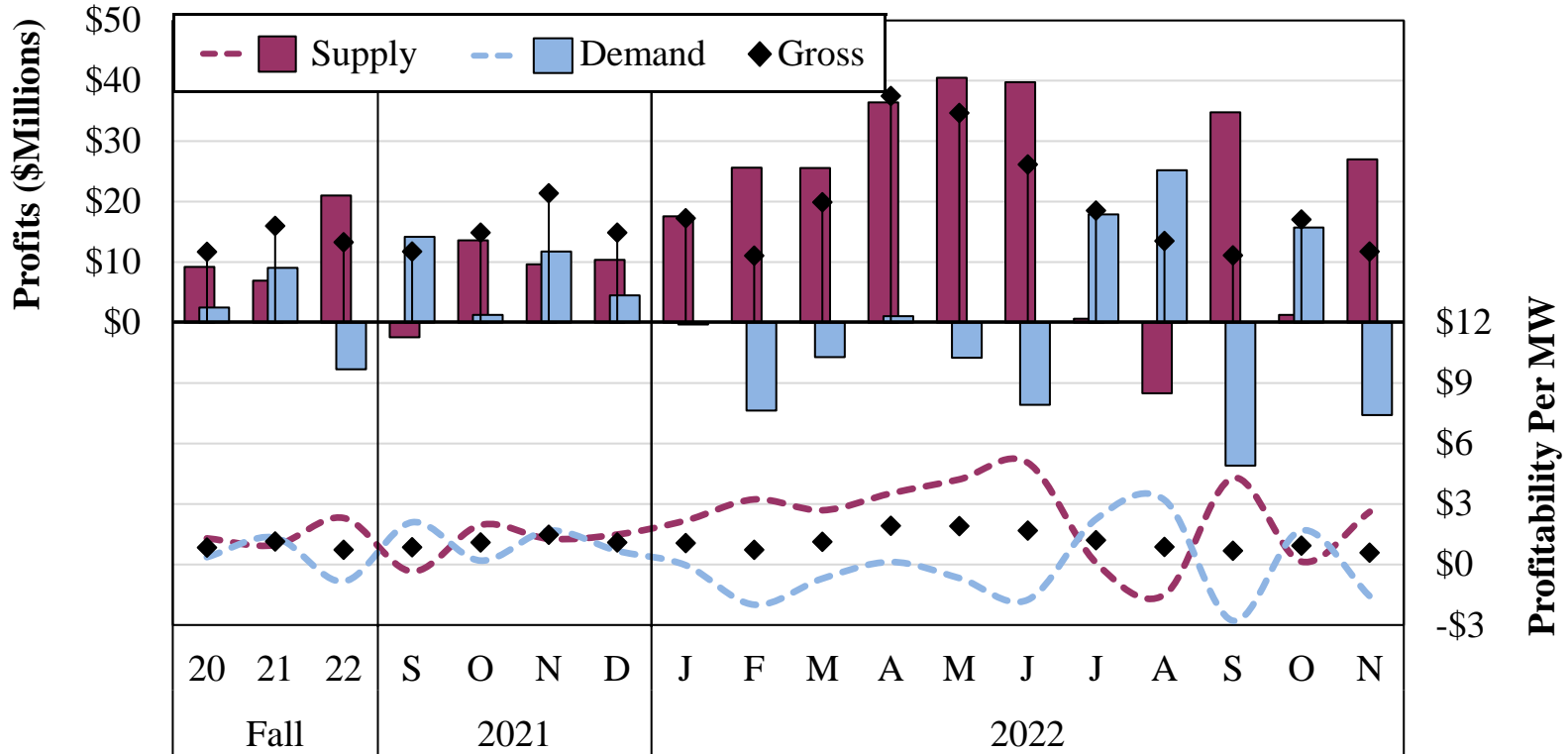
# Virtual Load and Supply by Participant Type

## Fall 2021–2022





# Virtual Profitability Fall 2021–2022

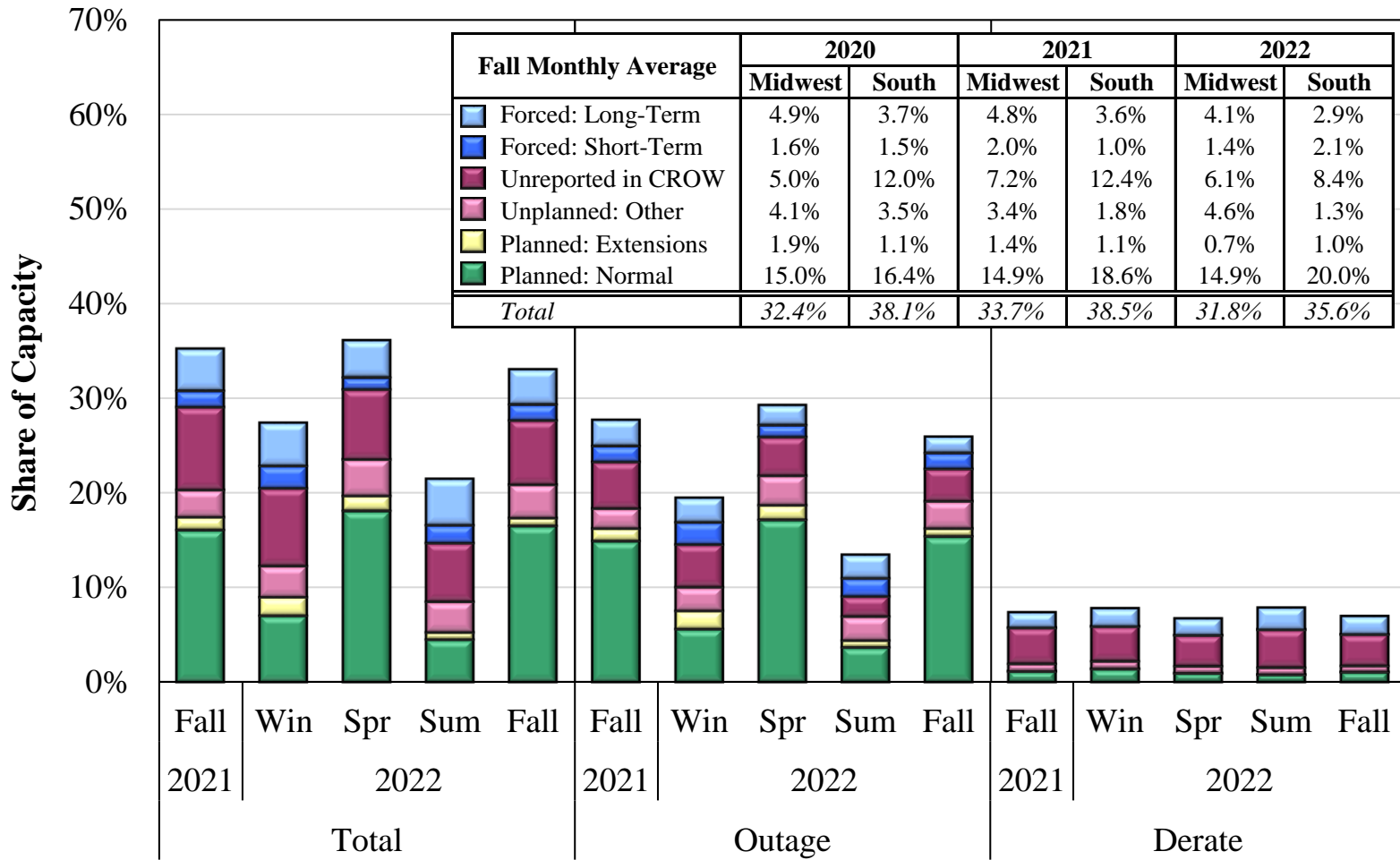


Supply	1.1	3.5	3.1	2.8	2.7	4.9	2.9	3.3	2.6	2.4	3.0	4.9	2.9	3.7	3.3	3.2	2.7	3.3
Demand	1.1	3.2	2.5	1.7	3.5	4.3	4.5	4.4	2.3	1.9	3.8	3.8	3.7	3.2	2.5	2.6	2.6	2.4
Total	1.1	3.4	2.8	2.3	3.1	4.6	3.7	3.9	2.5	2.2	3.4	4.4	3.3	3.4	2.9	2.9	2.6	2.9



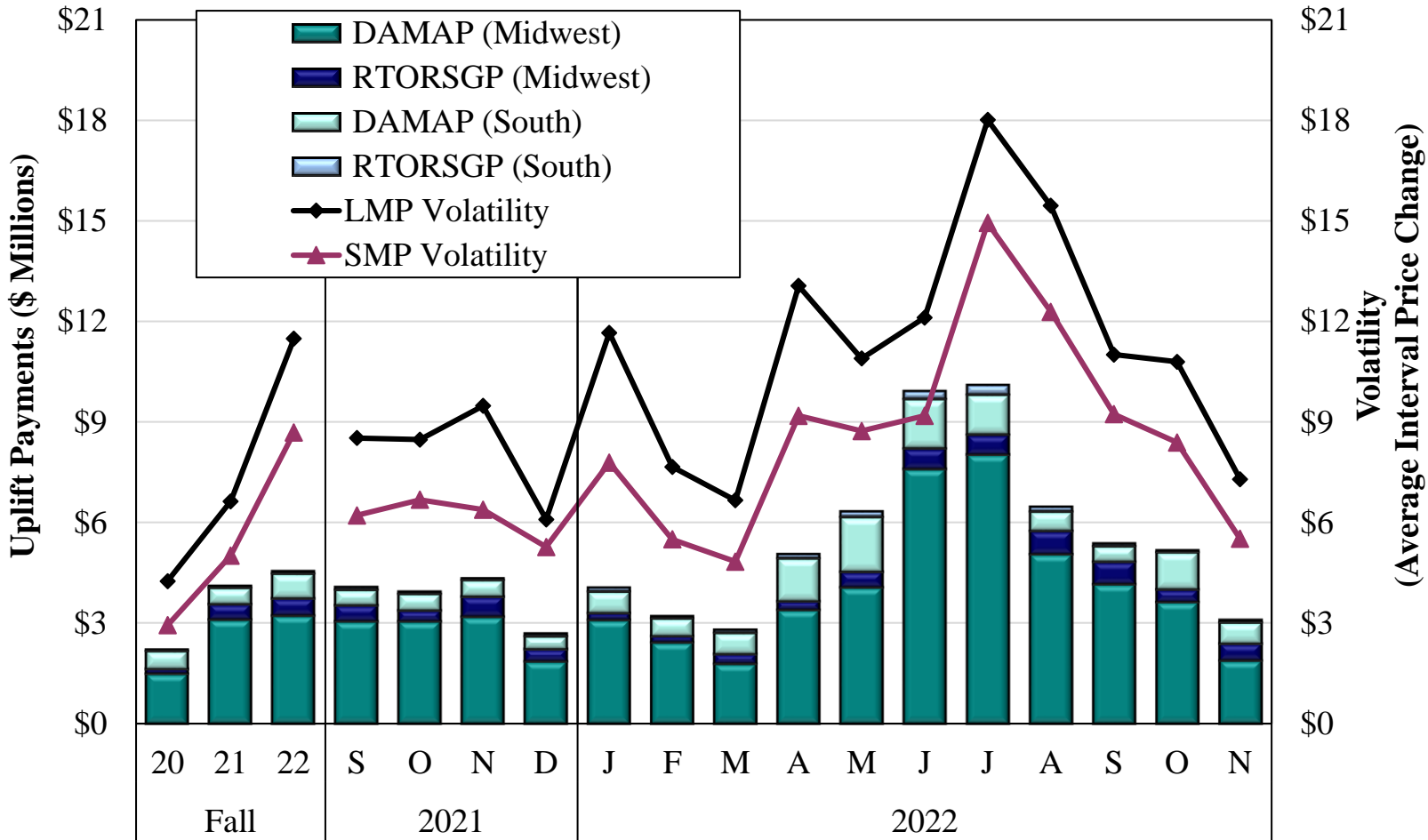
# Generation Outages and Deratings

## Fall 2021–2022

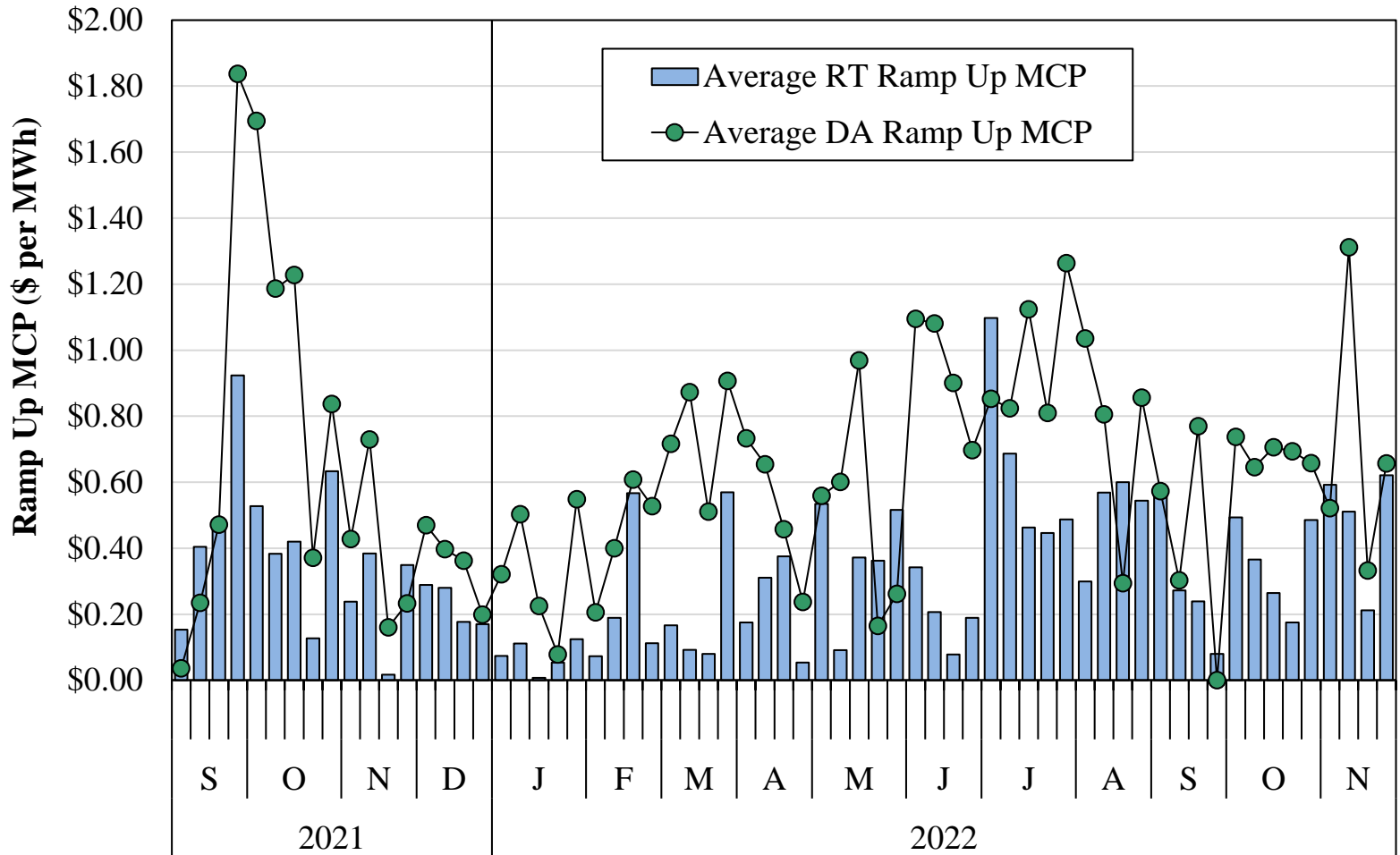




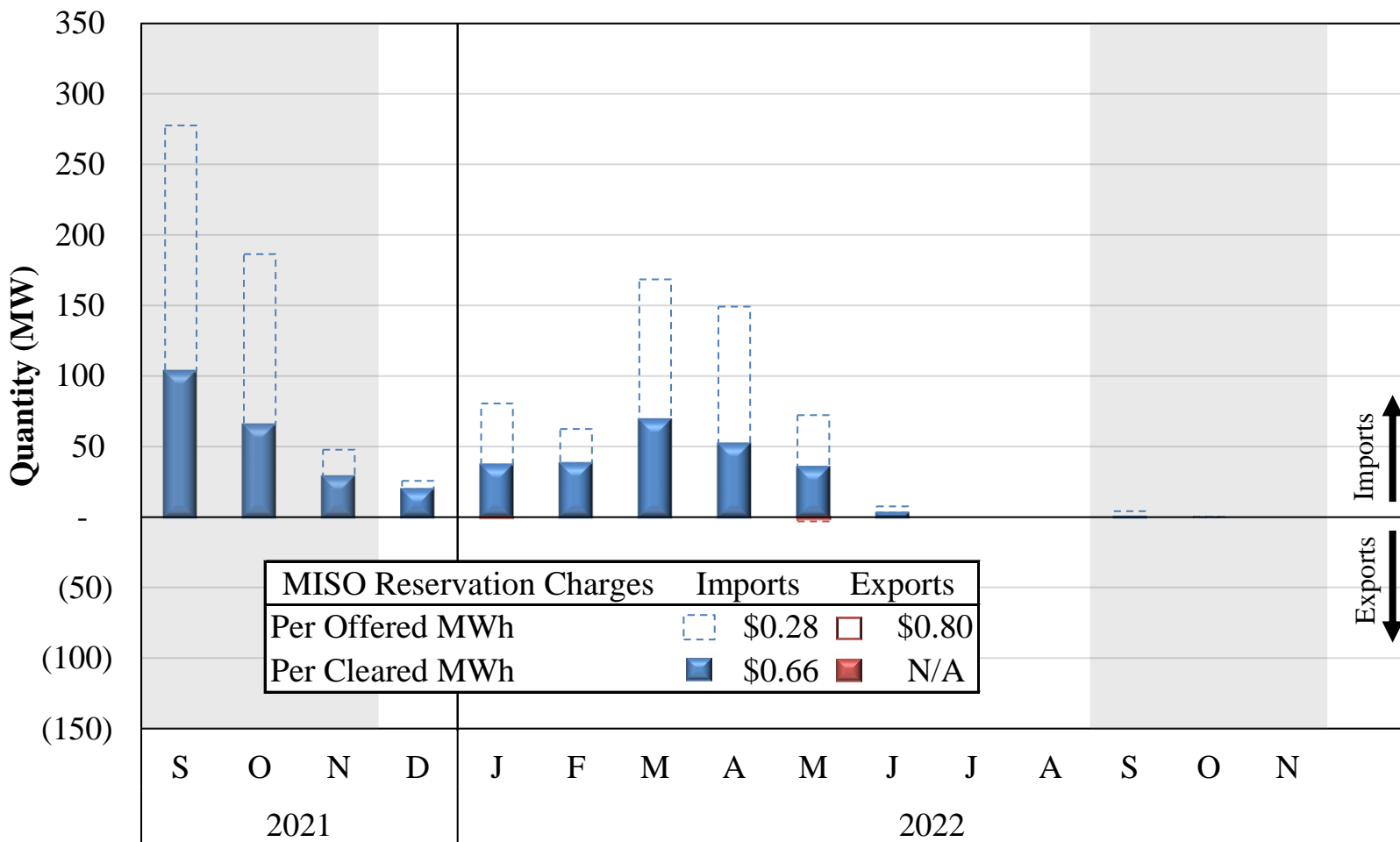
# Price Volatility Make Whole Payments Fall 2020–2022



# Day-Ahead and Real-Time Ramp Up Price Fall 2021–2022

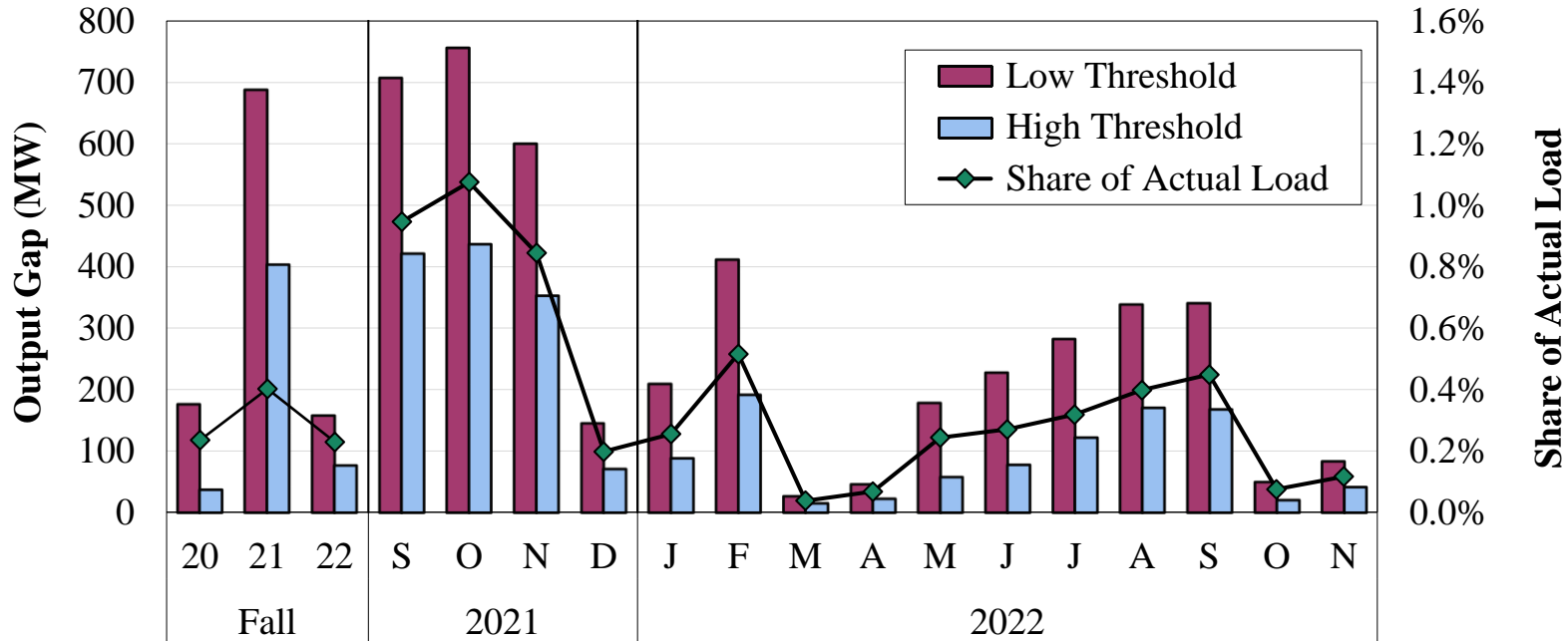


# Coordinated Transaction Scheduling (CTS) Fall 2021–2022





# Monthly Output Gap Fall 2021–2022



**Low Threshold Results by Unit Status (MW)**

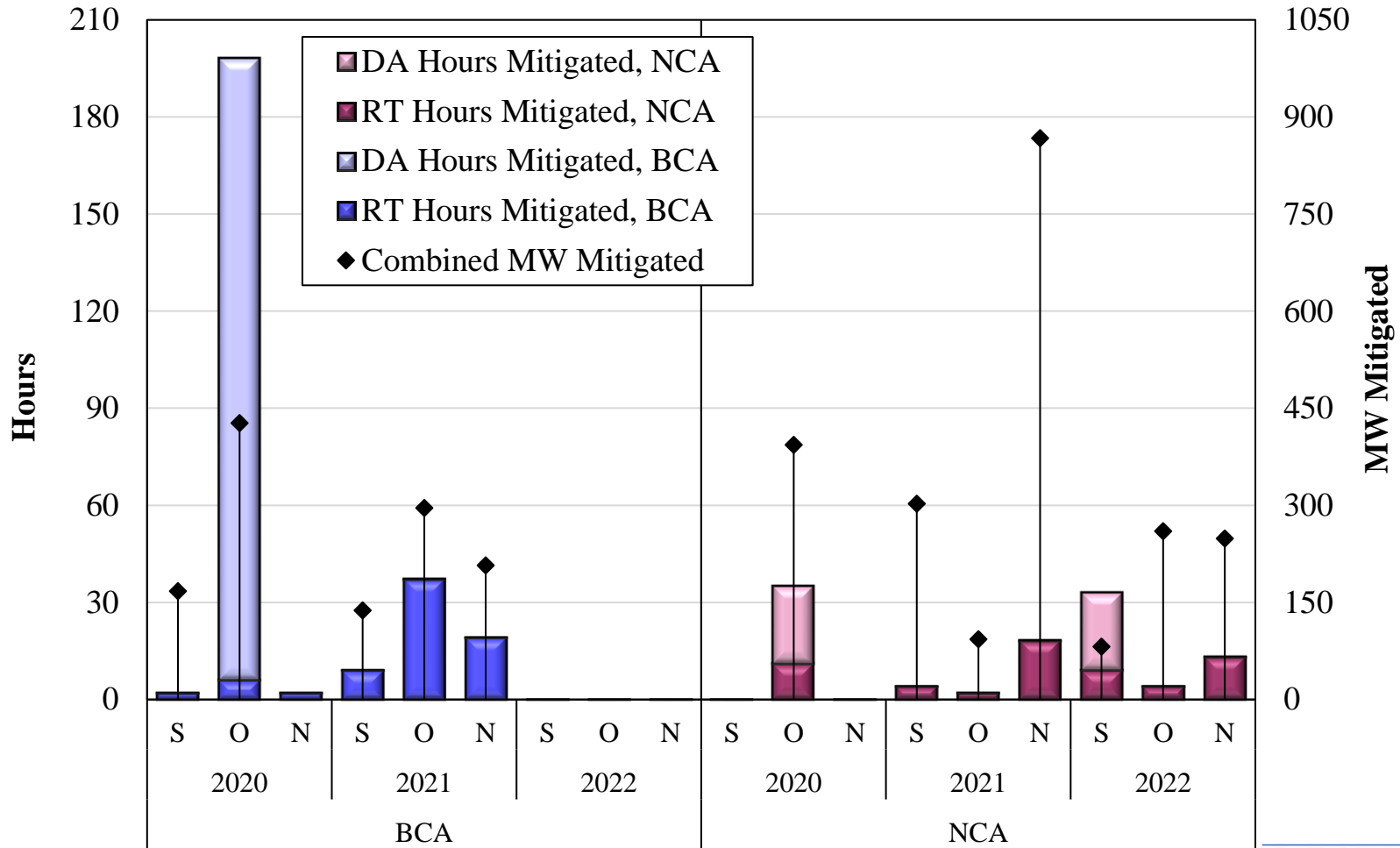
Offline	8	89	110	129	103	35	9	22	24	17	20	103	118	184	238	256	27	47
Online	169	598	48	577	652	565	136	188	387	11	27	75	110	98	100	84	23	36

**High Threshold Results by Unit Status (MW)**

Offline	6	60	66	98	62	19	7	21	20	12	17	51	67	110	156	151	12	36
Online	32	342	10	322	373	333	64	67	171	4	6	7	10	12	14	16	8	6

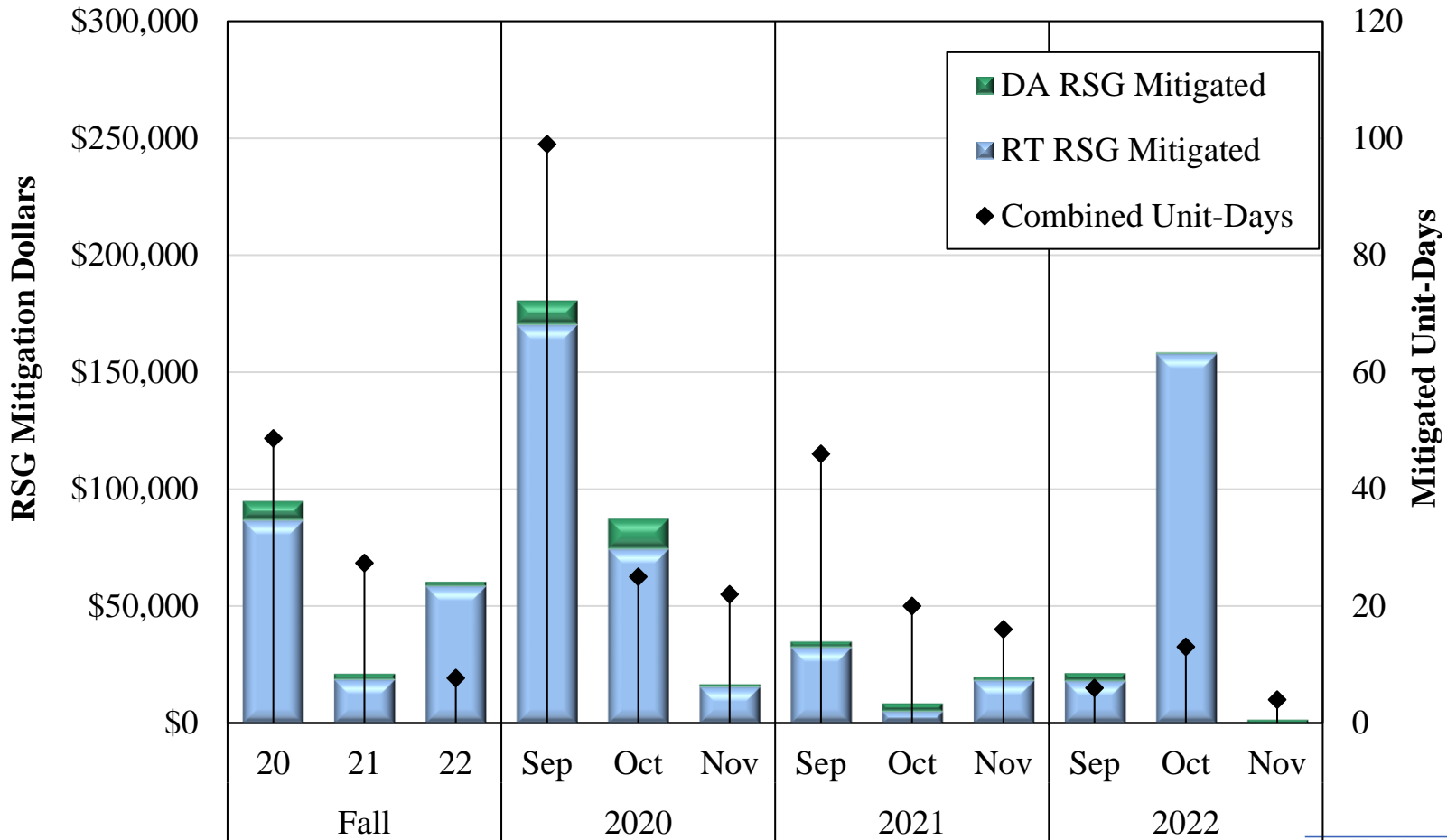


# Day-Ahead And Real-Time Energy Mitigation Fall 2020 - 2022

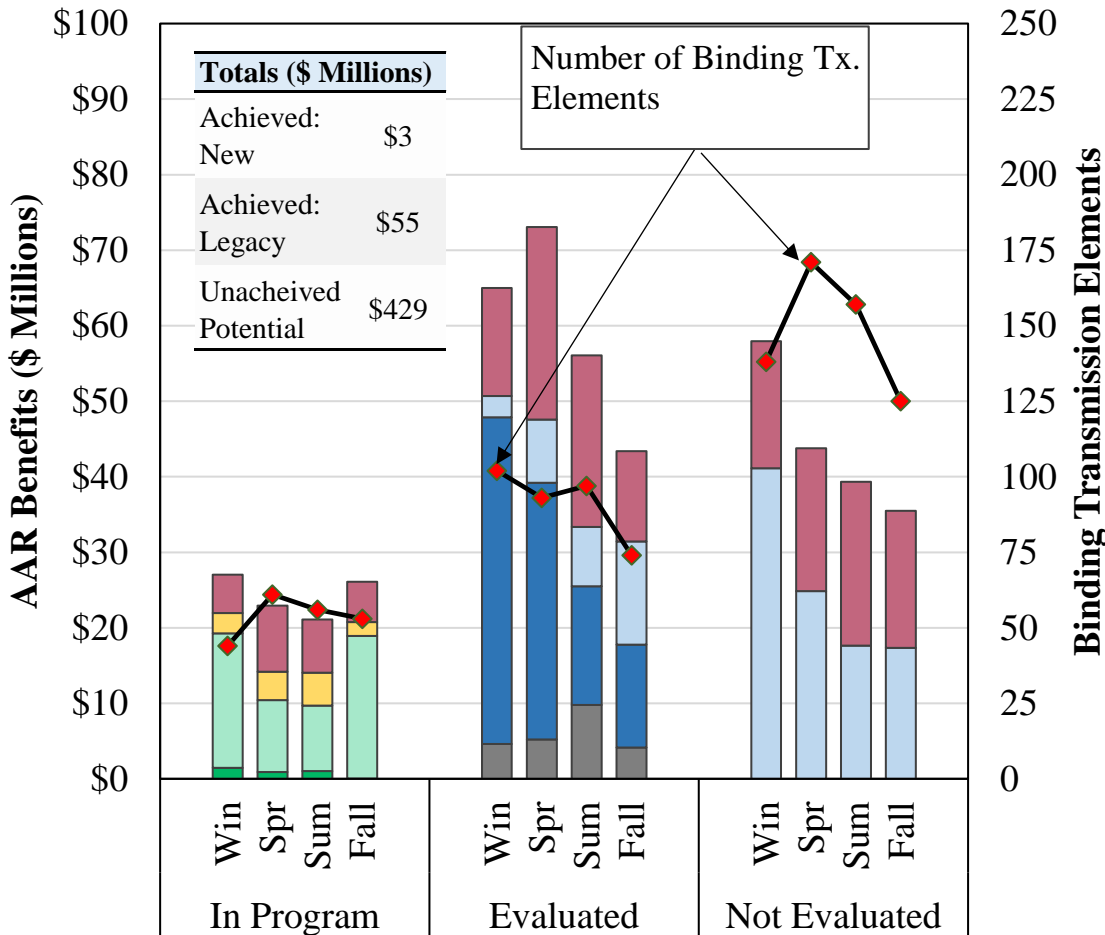




# Day-Ahead and Real-Time RSG Mitigation Fall 2020 - 2022



# Benefits of AARs and Emergency Ratings Winter 2021 – Fall 2022



**Legend:**

- New AAR Benefits
- Legacy AAR Benefits
- Unachieved AAR
- Not Adjustable
- Claim Not Adjust.
- Future AAR
- Emerg. Ratings

**Benefits Shown:**

- Green: Achieved from existing & new elements.
- Orange: Available from elements in the program.
- Blue: Available from elements not in program.
- Red: Available through use of emergency ratings.

# 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
- SMP System Marginal Price
- SOM State of the Market
- STE Short-Term Emergency
- STR Short-Term Reserves
- TLR Transmission Loading Relief
- TCDC Transmission Constraint Demand Curve
- VLR Voltage and Local Reliability
- WUMS Wisconsin Upper Michigan System