

IMM Quarterly Report: Winter 2025

Presented to:

Market Subcommittee

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Potomac Economics

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Winter Summary

- The MISO markets performed competitively, and market power mitigation was infrequent during the winter.
- Energy prices rose 29 percent compared over last winter as average gas prices rose 21 (Chicago) to 41 (Henry Hub) percent partly due to cold weather events.
 - Higher STR requirements to address uncertainty during Winter Storm Enzo led to efficient increases in STR and energy prices during the storm.
 - Peak load rose 1 percent year over year, while average load was up 6 percent.
 - MISO South hit a new all-time winter peak record during Winter Storm Enzo.
 - Ancillary service prices increased more than 30 percent over last winter.
- MISO declared Conservative Operations for Winter Storms Blair, Cora and Enzo but did not need to advance into its emergency procedures.
 - Unseasonably cold conditions in January did not have any major market impacts.
- Day-ahead congestion revenue fell 13 percent, while real-time congestion increased by 4 percent.
- Average hourly wind output was 16 percent higher than last year, and wind curtailments increased 26 percent, averaging 508 MW per hour.

Quarterly Summary

Winter	Value	Change ¹		Value	Change ¹		
		Prior Qtr.	Prior Year		Prior Qtr.	Prior Year	
RT Energy Prices (\$/MWh)	● \$40.57	49%	29%	FTR Funding (%)	● 99%	100%	96%
Fuel Prices (\$/MMBtu)				Wind Output (MW/hr)	● 13,625	17%	16%
Natural Gas - Chicago	● \$3.75	95%	21%	Wind Curtailed (MW/hr)	● 508	-35%	26%
Natural Gas - Henry Hub	● \$3.91	83%	41%	Guarantee Payments (\$M)⁴			
Western Coal	● \$0.81	1%	2%	Real-Time RSG	● \$6.7	73%	-18%
Eastern Coal	● \$1.82	5%	1%	Day-Ahead RSG	● \$12.6	83%	15%
Load (GW)²				Day-Ahead Margin Assurance	● \$10.3	-20%	-4%
Average Load	● 80.0	11%	6%	Real-Time Offer Rev. Sufficiency	● \$0.7	-26%	-64%
Peak Load	● 108.2	1%	1%	Price Convergence⁵			
% Scheduled DA (Peak Hour)	● 99.7%	101.6%	99.8%	Market-wide DA Premium	● 4.0%	0.4%	8.6%
Transmission Congestion (\$M)				Virtual Trading			
Real-Time Congestion Value	● \$531.2	35%	4%	Cleared Quantity (MW/hr)	● 23,771	4%	6%
Day-Ahead Congestion Revenue	● \$323.6	-1%	-13%	% Price Insensitive	● 52%	49%	48%
Balancing Congestion Revenue ³	● \$1.6	-\$8.6	-\$17.6	% Screened for Review	● 2%	2%	2%
Ancillary Service Prices (\$/MWh)				Profitability (\$/MW)	● \$0.8	\$0.4	\$0.3
Regulation	● \$17.66	22%	92%	Dispatch of Peaking Units (MW/hr)	● 1,059	1,684	1,328
Spinning Reserves	● \$2.53	-6%	39%	Output Gap- Low Thresh. (MW/hr)	● 79	33	63
Supplemental Reserves	● \$0.92	23%	452%				
Short-Term Reserves	● \$0.71	267%	776%				

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.

Quarterly Highlights: Winter 2025

Winter Storm Enzo (Slides 40-41)

- On January 21, Winter Storm Enzo moved across MISO's footprint, bringing frigid temperatures, ice, and snowy conditions to MISO South.
 - New Orleans saw 10 inches of snow, more than seen in over 100 years.
 - MISO South experienced a new peak winter load record of 33.1 GW.
- In preparation for the storm, MISO was forecasting high uncertainty and increased its STR requirements by 900 MW in the day-ahead and real-time markets.
 - This improved its ability to handle the uncertainty and the 9 GW of forced outages.
- MISO managed the storm reliably without declaring an emergency or incurring significant costs.
 - Uplift totaled just \$2.6 million, a reduction of more than 90 percent from Winter Storms Uri and Elliott and reduction of two-thirds from Winter Storm Heather.
 - Congestion during Enzo was \$100 million, much lower than in prior storms.
 - The highest average hourly system marginal price was \$334 per MWh.
 - Higher STR requirements led to higher STR clearing prices that were also reflected in the day-ahead and real-time prices, which prompted more imports on Jan. 21.

Quarterly Highlights: Winter 2025

Improvements in Reducing Out-of-Market Congestion Actions (Slide 20)

- We previously discussed concerns with out-of-market actions taken to manage congestion that can lead to significant costs and dispatch inefficiencies.
 - We recommended MISO rely more heavily on the markets to manage difficult constraints and avoid OOM actions, which included capping or manually dispatching wind and solar.
- In 2024, we worked with MISO to develop Congestion Management Guidelines related to OOM congestion actions. MISO also:
 - Provided operator training on these guidelines.
 - Improved the information available to operators on the sources of congestion management difficulties to facilitate better decisions, and
 - Developed metrics to track operators' use of OOM actions.
- MISO's efforts contributed to a remarkable 95 percent reduction in the use of capping and manual dispatch of wind and solar units this winter.

Quarterly Highlights: Winter 2025

The Need to Commit LAC-Recommended Resources (Slides 43-44)

- MISO has significantly reduced inefficient commitments and associated RSG costs.
- However, we are concerned that operators often do not commit resources that are recommended by its Look-Ahead Commitment model that are economic.
 - An example of the effects of not committing resources needed to manage severe congestion occurred on December 12 when one constraint was in violation for more than 9 hours and produced over \$36 million in congestion costs.
 - LAC began recommending starting multiple units from 1:30 to 10:30 am for the constraint before they were ultimately committed.
 - A simulation we performed showed that committing these units would have reduced the congestion by \$9.5 million and significantly reduced the constraint violations.
 - A second example occurred Feb. 19 when a contingency reserve shortage for 30 minutes raised average prices to almost \$1900/MWh. Forecast errors contributed to this shortage, but accepting more LAC recommendations would have reduced it.
- MISO has worked to improve LAC and its recommendations, which are much more trustworthy and are often essential. Further improvements are planned.
 - We encourage MISO to continue to improve its processes for responding to LAC recommendations, particularly those needed to manage congestion.

Quarterly Highlights: Winter 2025

Virtual Trading around Predictable Modeling Issues (Slide 45)

- Modeling inconsistencies have caused day-ahead and real-time prices at some aggregate pricing nodes to vary under specific conditions. This can:
 - Invite low-risk virtual trading that can profit by exploiting the inconsistency; and
 - Generate market shortfalls or uplift costs;
- A modeling inconsistency at one location in one month this quarter:
 - Generated increased virtual revenues by nearly \$8 million and generated profits over \$3 million.
 - Trading volume at this location increased eighteen-fold in the days following the initial appearance of the modeling issue and continued for a few days after it ceased.
- Since the conditions that cause the modeling inconsistencies to generate price differences are unpredictable, it is difficult to forecast the costs of this issue.
- To address these concerns, we continue to recommend that MISO implement changes to better synchronize the definitions of the aggregate pricing nodes from the FTR market through the day-ahead market and into the real-time market.

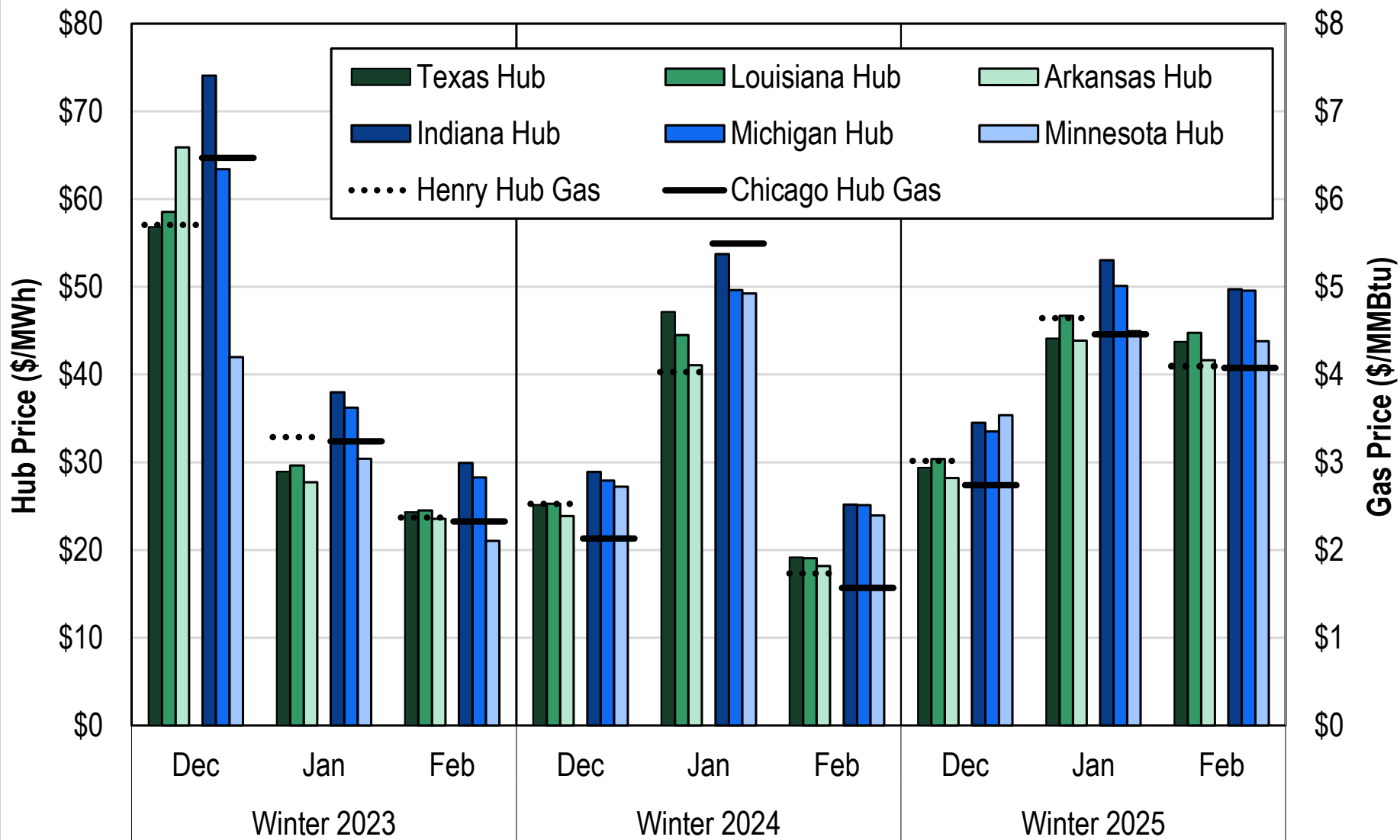
Submittals to External Entities and Other Issues

- During the Winter Quarter, we:
 - Responded to several FERC questions related to prior referrals and FERC investigations, and we responded to requests for information on market issues.
 - Presented the IMM Fall Quarterly report to the MSC and ERSC, and the IMM's comments on MISO's proposed LMR changes to the RASC.
 - Responded to stakeholder feedback on the IMM comments on LMR reforms.
- We worked with MISO on recommended operations improvements.
- We continued to investigate potential tariff violations in the market-to-market coordination of congestion between SPP, PJM and MISO.
- We also continued to support upcoming filings:
 - We provided an affidavit in support of MISO's filing to improve provisions governing Demand Response Resources to address market manipulation vulnerabilities.
- During the Winter Quarter, FERC issued an Order to Show Cause totaling nearly \$1 billion for an energy efficiency provider that we referred for manipulation.

Quarterly Market Results: Winter 2025

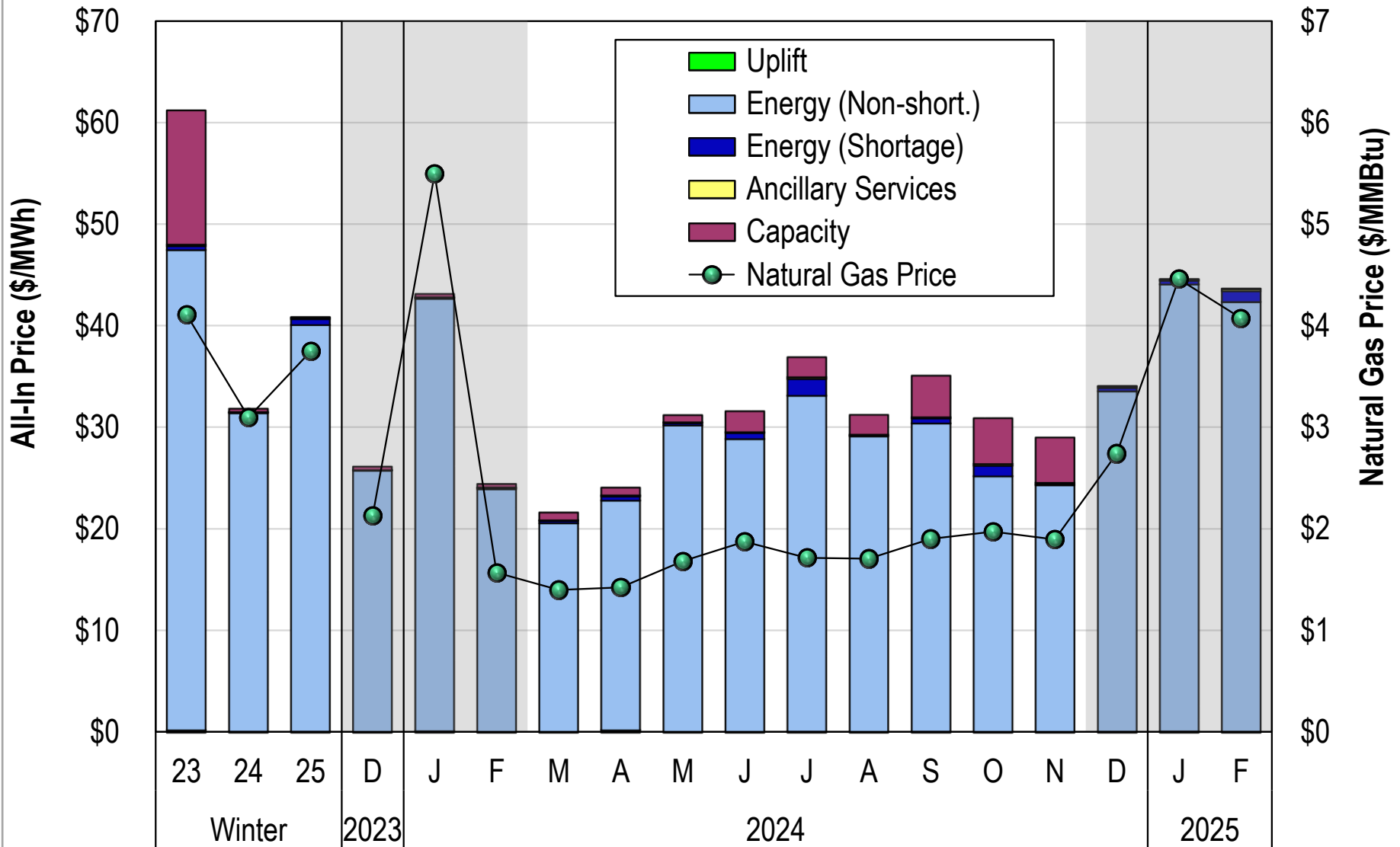
Day-Ahead Average Monthly Hub Prices

Winter 2023–2025



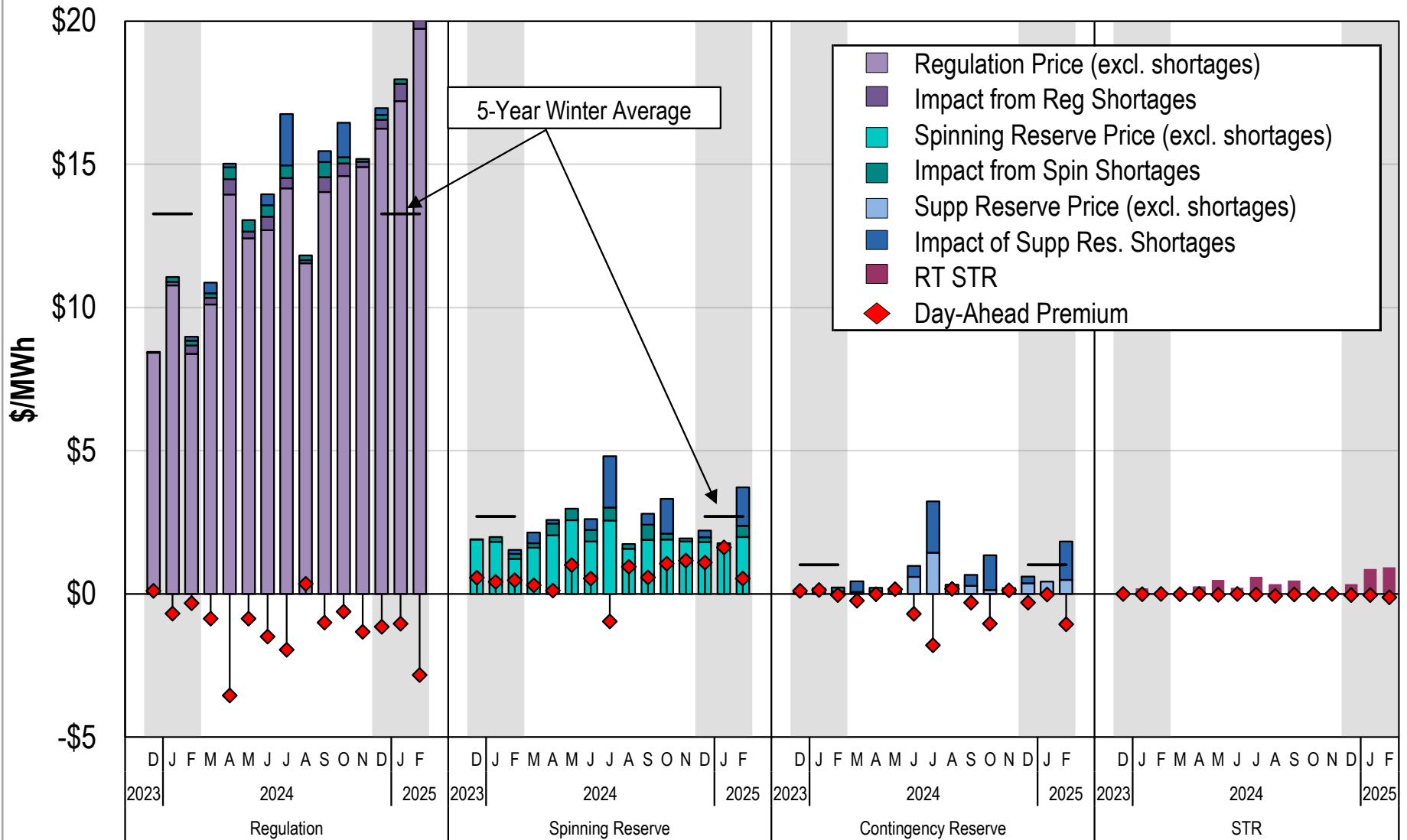
All-In Price

Winter 2023 – 2025



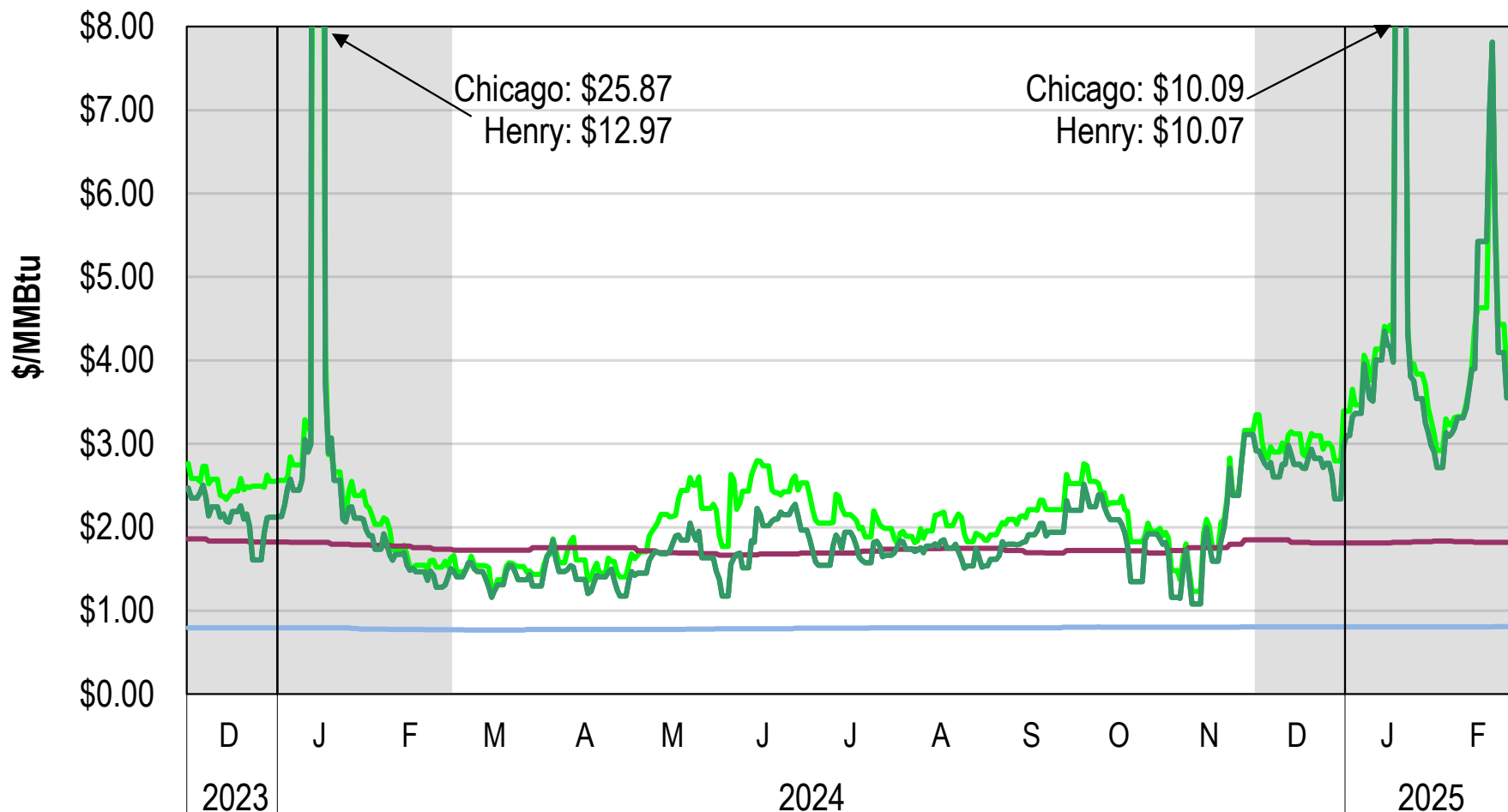
Ancillary Services Prices

Winter 2023–2025



MISO Fuel Prices

2023–2025

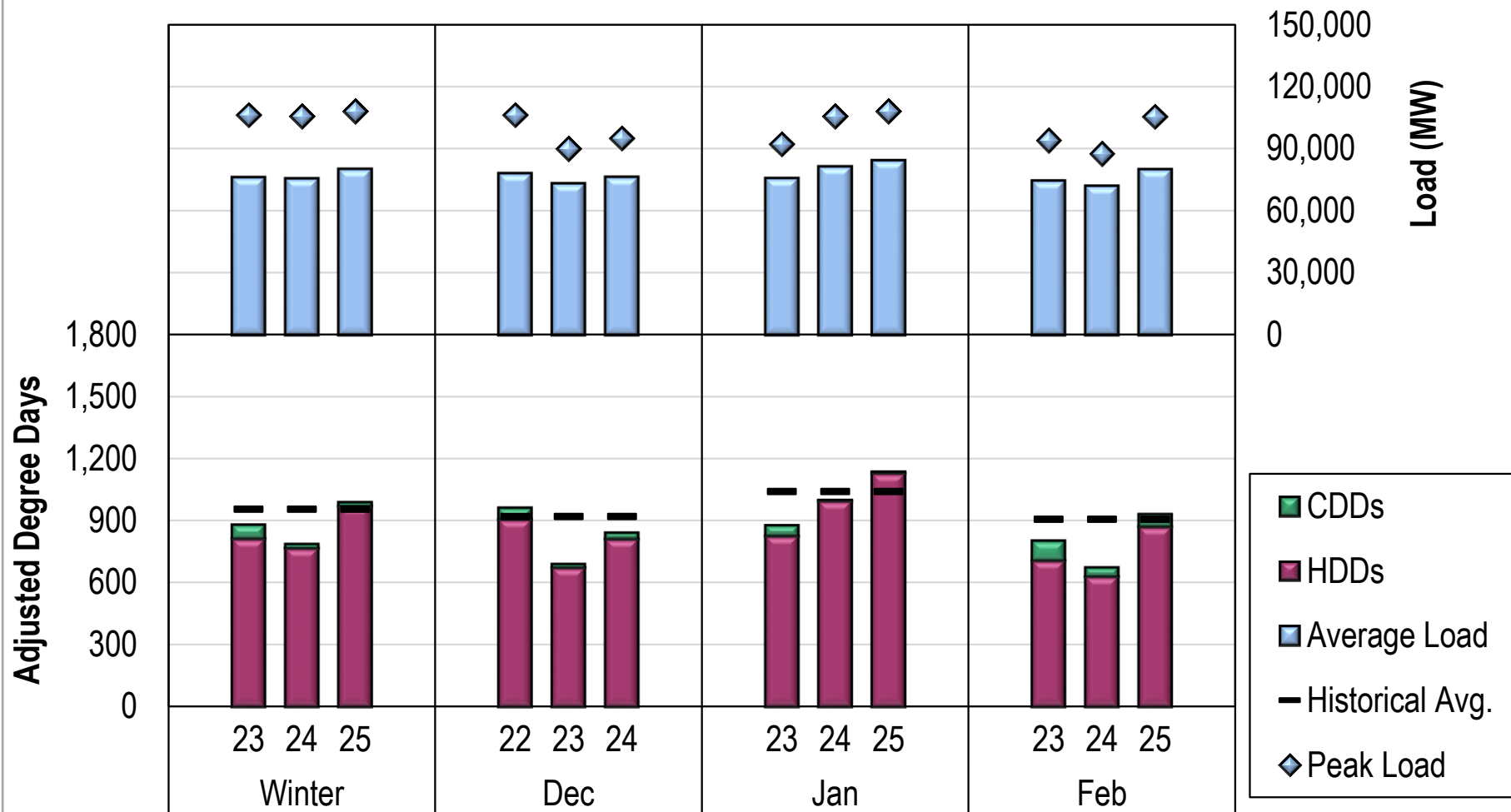


Winter Average	2025	2024	2023
Chicago NG	\$3.75	\$3.10	\$4.11
Henry NG	\$3.91	\$2.78	\$3.85

Winter Average	2025	2024	2023
IB Coal	\$1.82	\$1.80	\$4.92
PRB Coal	\$0.81	\$0.79	\$0.88

Load and Weather Patterns

Winter 2023–2025



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

Capacity, Energy and Price Setting Share

Winter 2024–2025

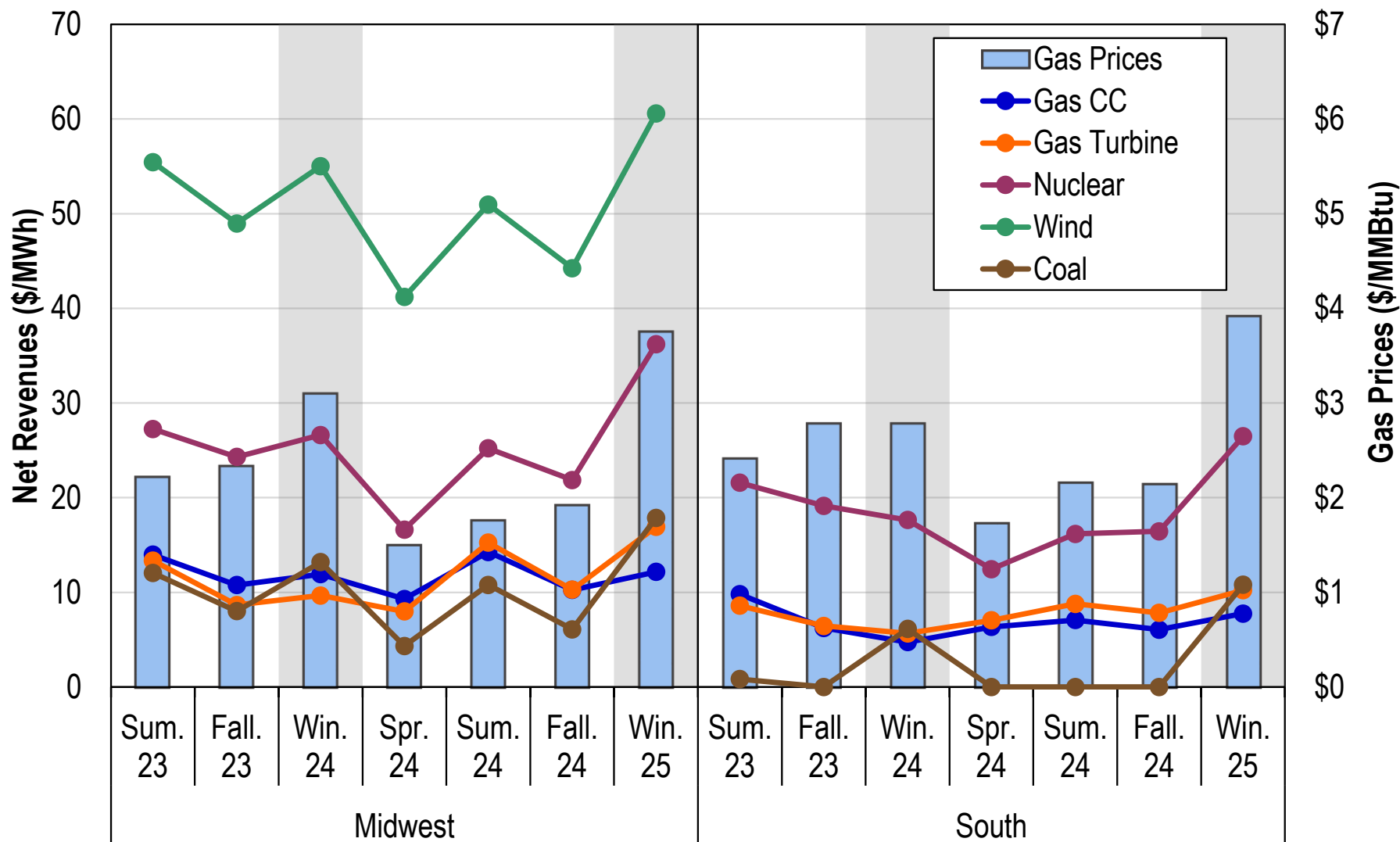
Winter	Unforced Capacity				Energy Output		Price Setting			
	Total (MW)		Share (%)		Share (%)		SMP (%)		LMP (%)	
	2023/24	2024/25	2023/24	2024/25	2023/24	2024/25	2023/24	2024/25	2023/24	2024/25
Nuclear	11,321	11,079	8%	8%	13%	14%	0%	0%	0%	0%
Coal	39,855	37,198	29%	27%	29%	32%	37%	22%	82%	68%
Natural Gas	66,367	64,777	48%	47%	38%	33%	62%	78%	95%	92%
Oil	1,589	1,546	1%	1%	0%	0%	0%	0%	1%	0%
Hydro	3,890	3,652	3%	3%	1%	1%	0%	0%	1%	2%
Wind*	13,071	16,991	10%	12%	16%	17%	0%	0%	53%	61%
Solar**	294	632	0%	0%	1%	2%	0%	0%	2%	3%
Other	723	954	1%	1%	1%	1%	0%	0%	1%	4%
Total	137,109	136,828								

* The capacity factor for wind increased from 40% in winter 23/24 to 53% in winter 24/25.

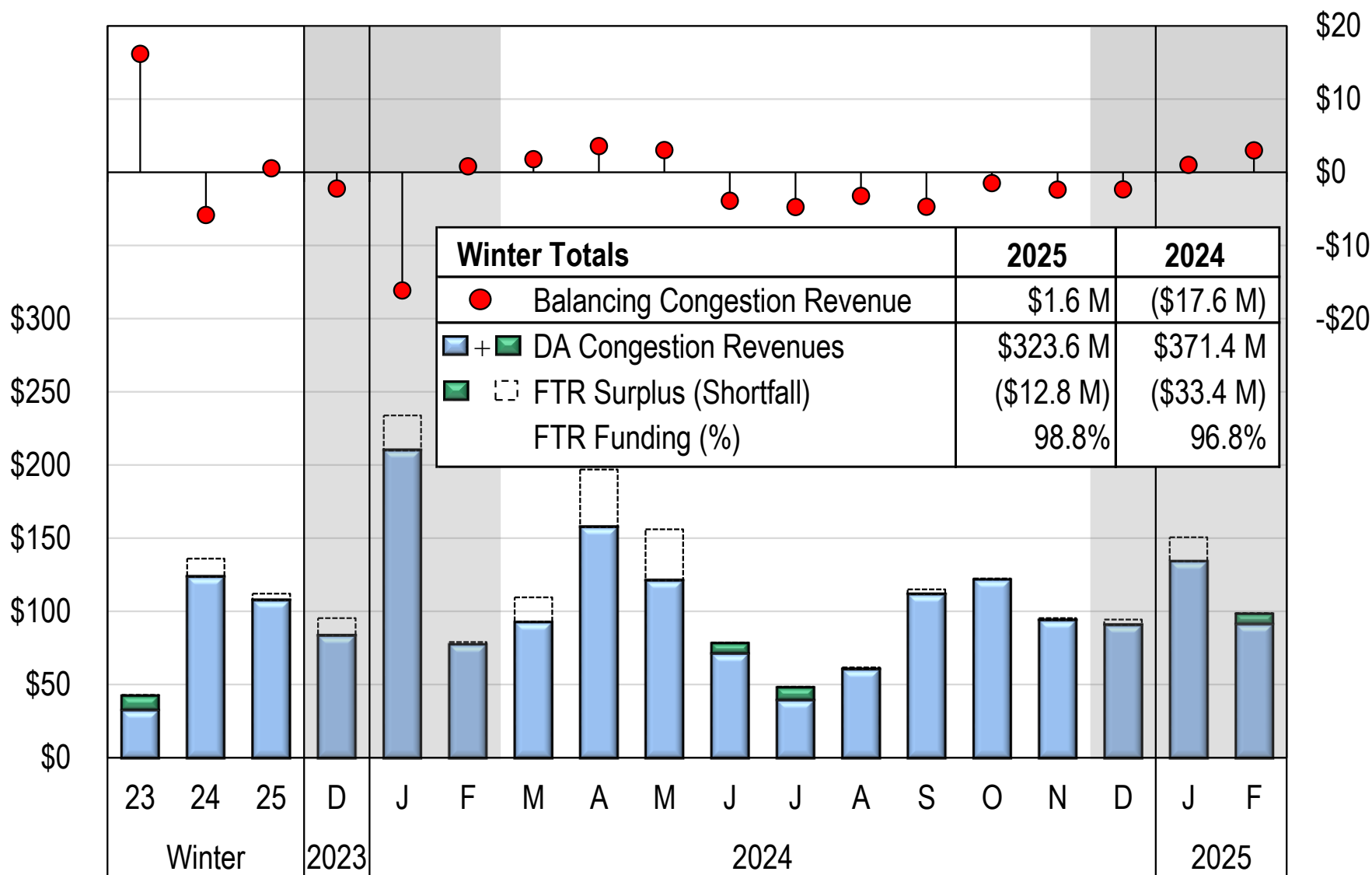
** New solar receives a 5% capacity factor in the winter. Nearly 6 GW nameplate of solar added since last winter.

Net Revenues by Technology

2023-2025

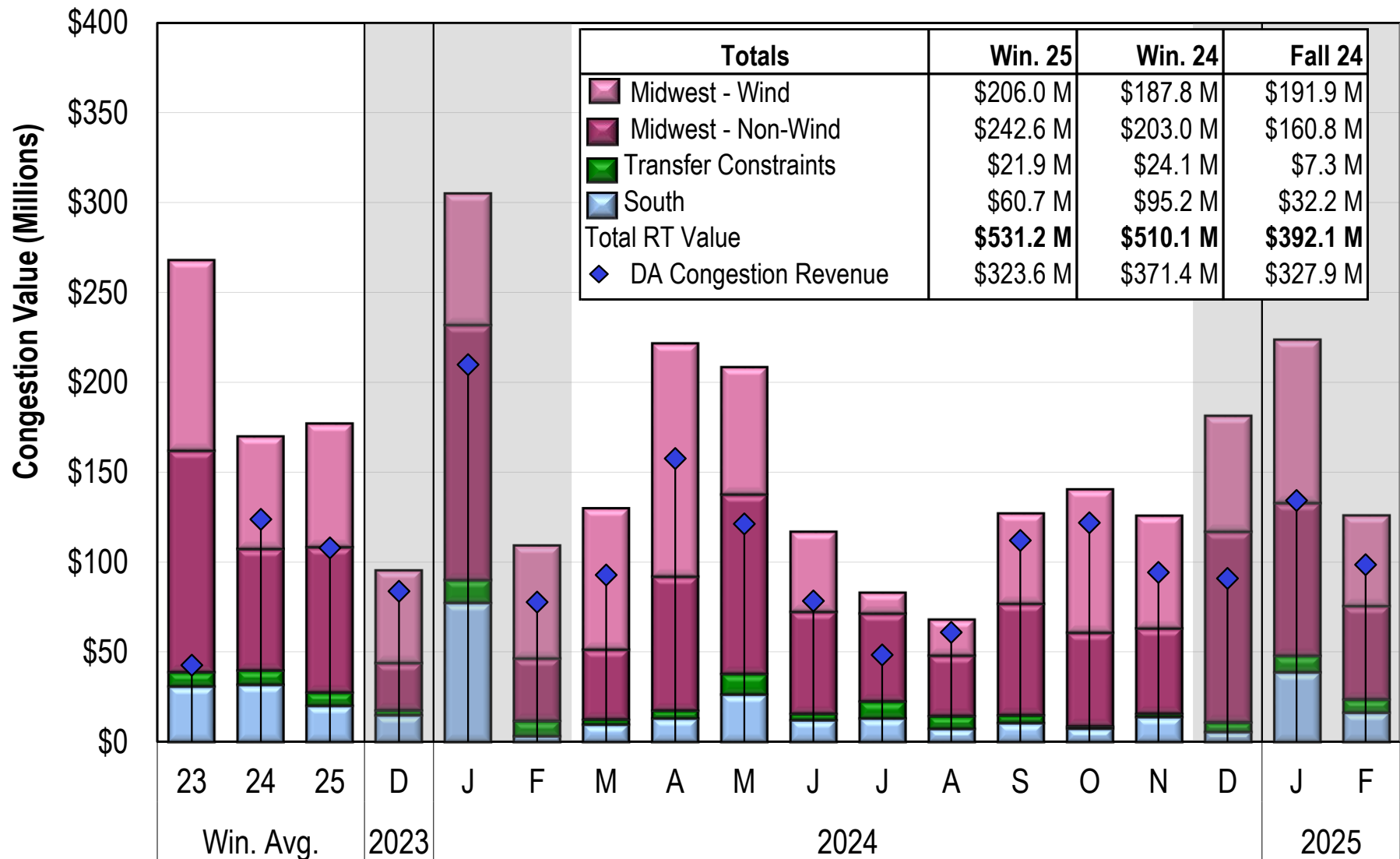


Day-Ahead and Balancing Congestion and FTR Funding



Value of Real-Time Congestion

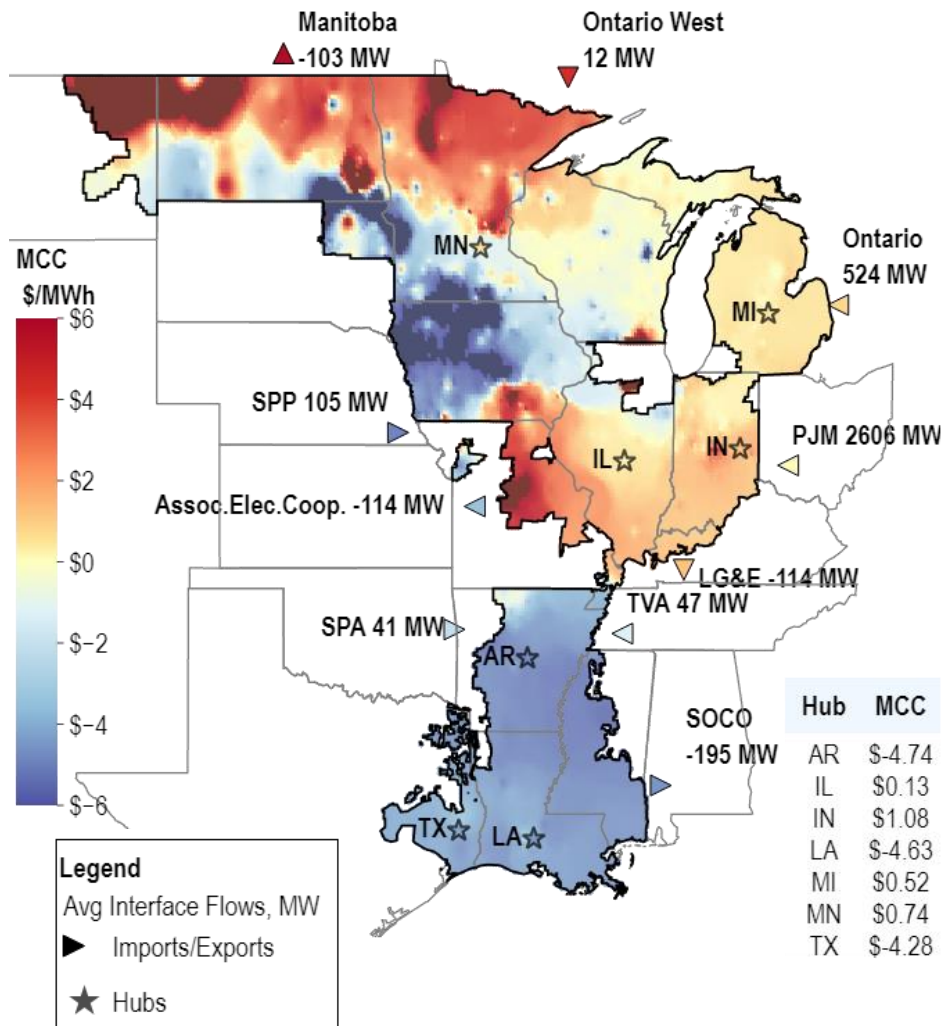
Winter 2023-2025



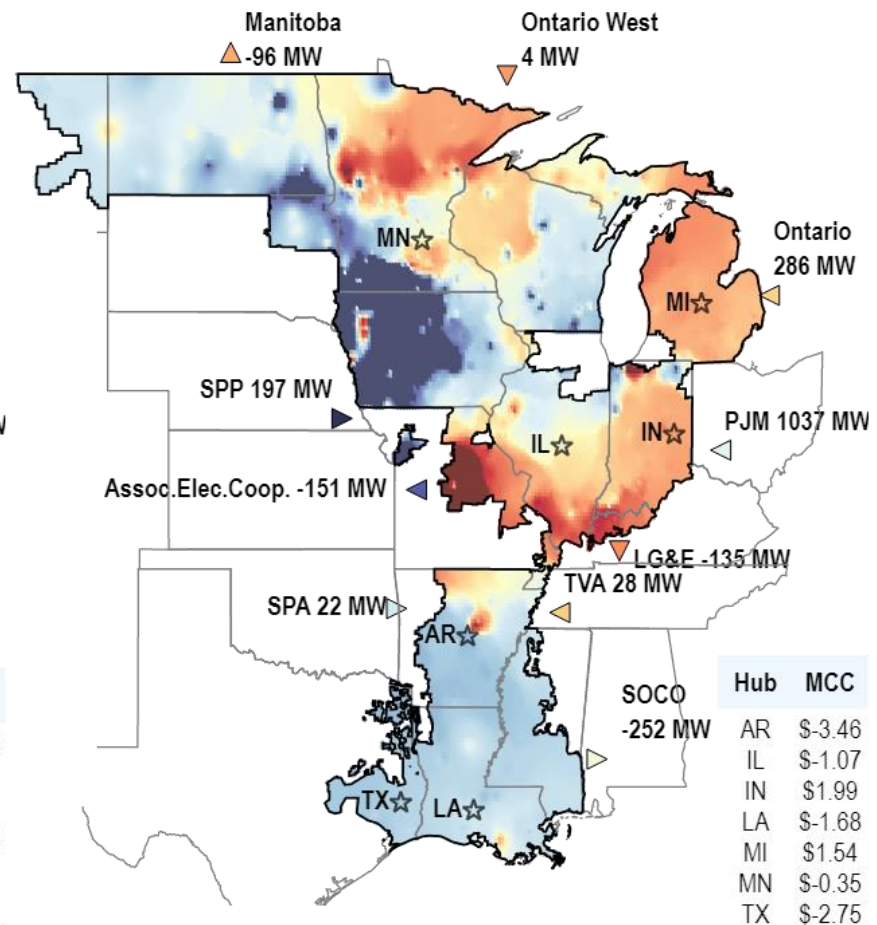
Average Real-Time Congestion Components

Winter 2024 – 2025

Winter 2024

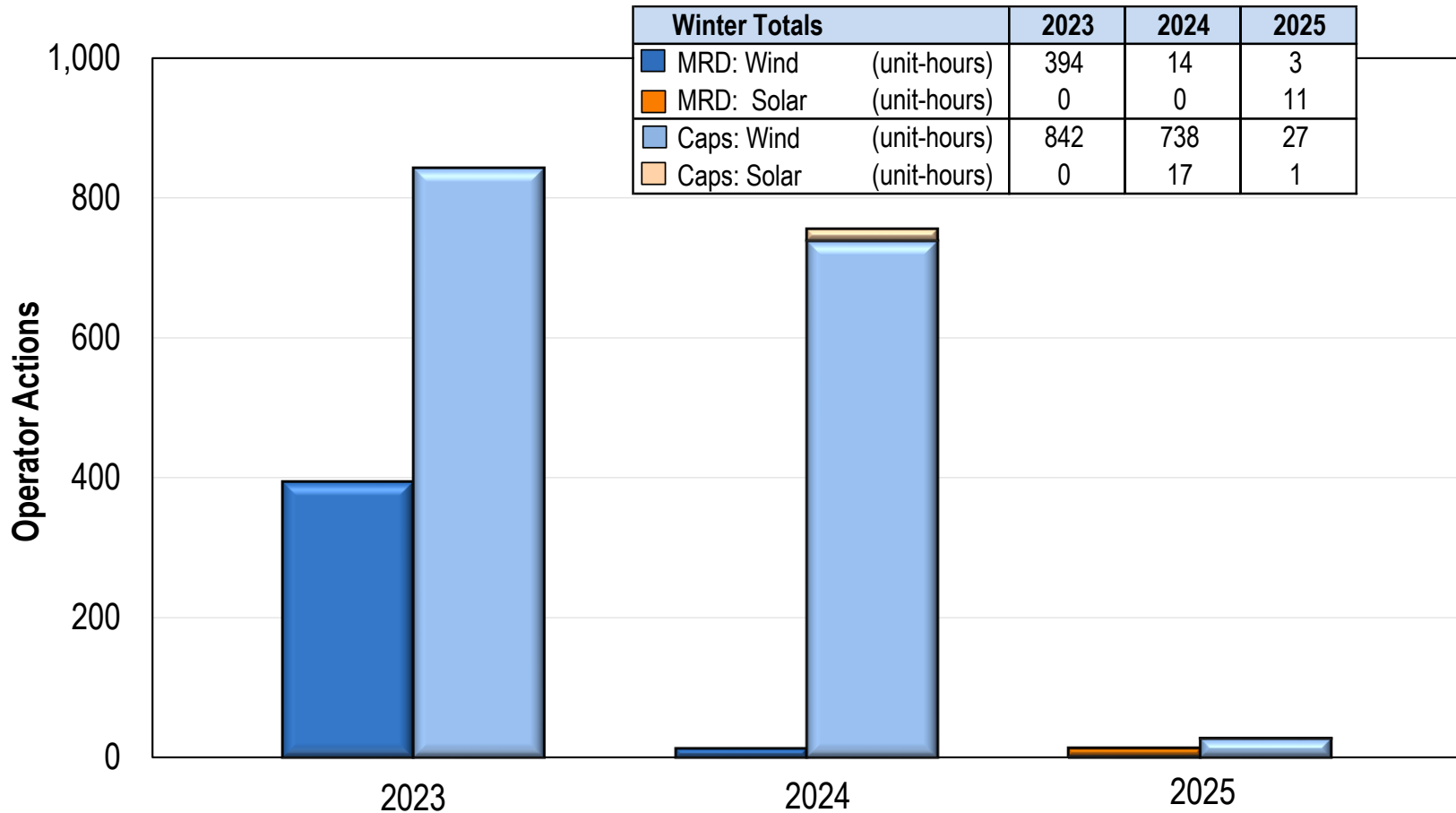


Winter 2025



MISO Operator Actions for Congestion Management

Winter 2023-2025



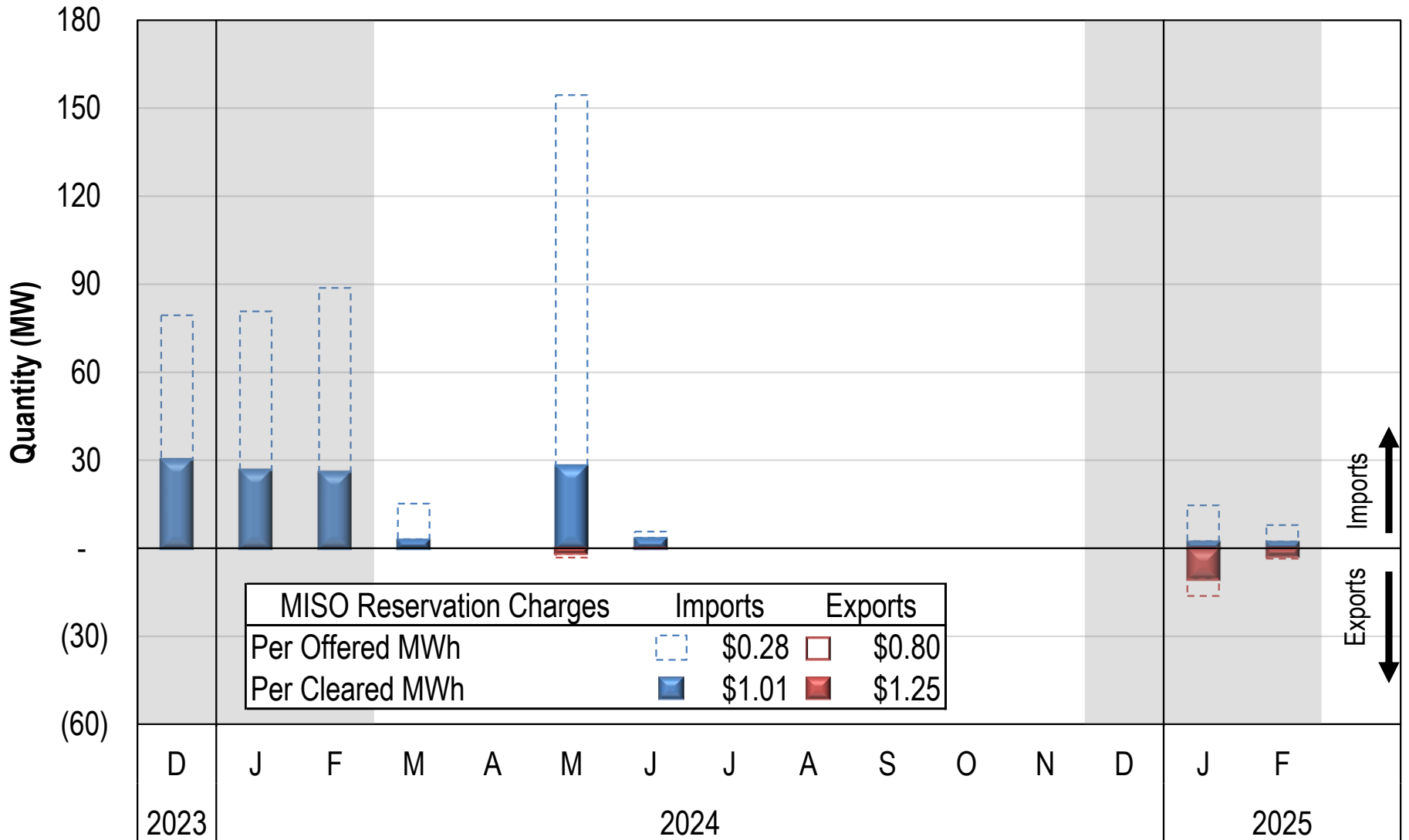
Benefits of Ambient-Adjusted and Emergency Ratings

Winter 2024–2025

Winter	Savings (\$ Millions)			# of Facilities for 2/3 of Savings	Share of Congestion	
	Ambient Adj. Ratings	Emergency Ratings	Total			
2024	Midwest	\$32.4	\$19.85	\$52.3	5	13.7%
	South	\$8.2	\$5.06	\$13.3	1	14.3%
	Total	\$40.7	\$24.9	\$65.6	6	13.8%
2025	Midwest	\$75.7	\$30.81	\$106.5	2	22.0%
	South	\$5.2	\$4.75	\$9.9	1	12.5%
	Total	\$80.8	\$35.6	\$116.4	3	20.7%

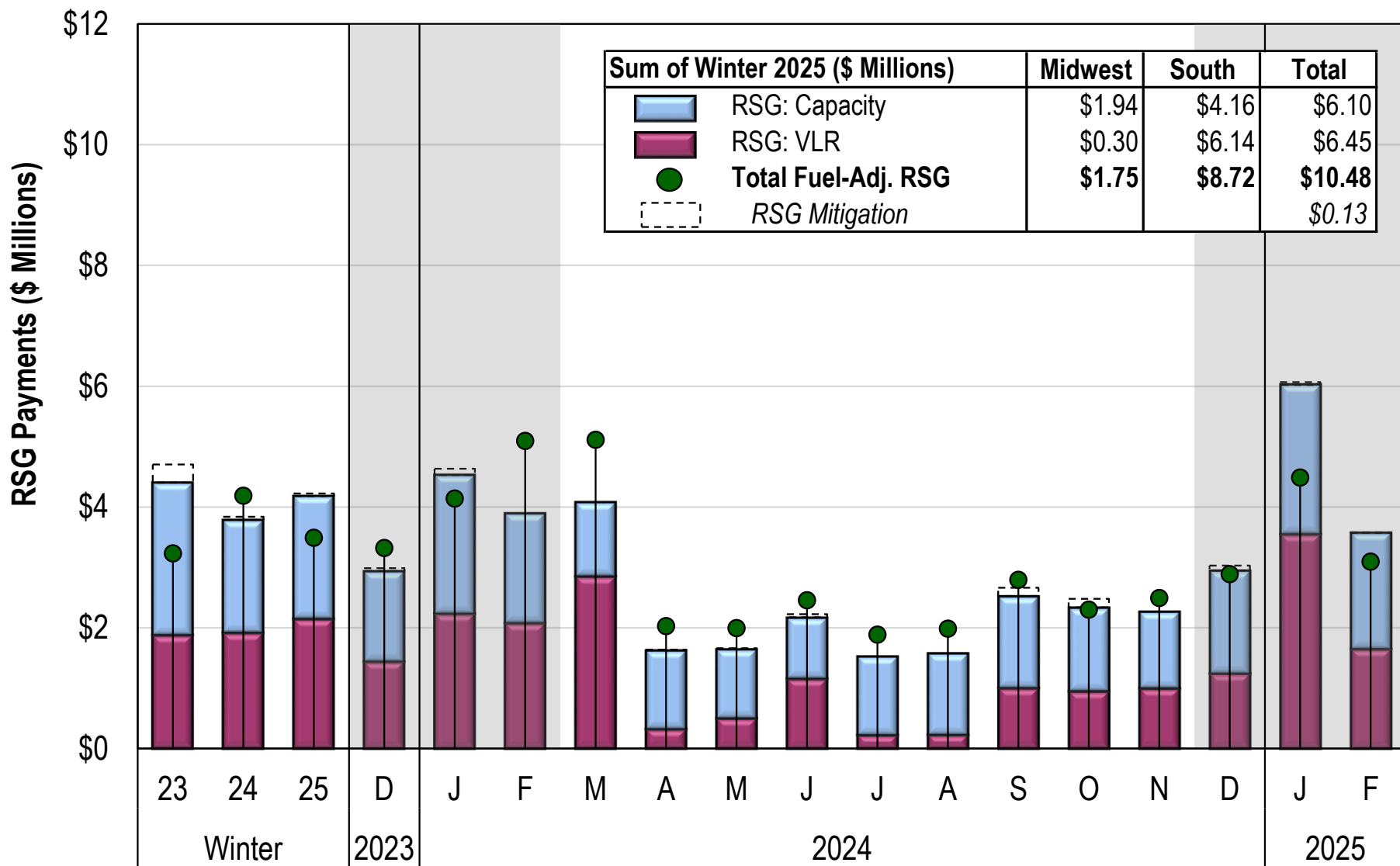
Coordinated Transaction Scheduling (CTS)

Winter 2024–2025



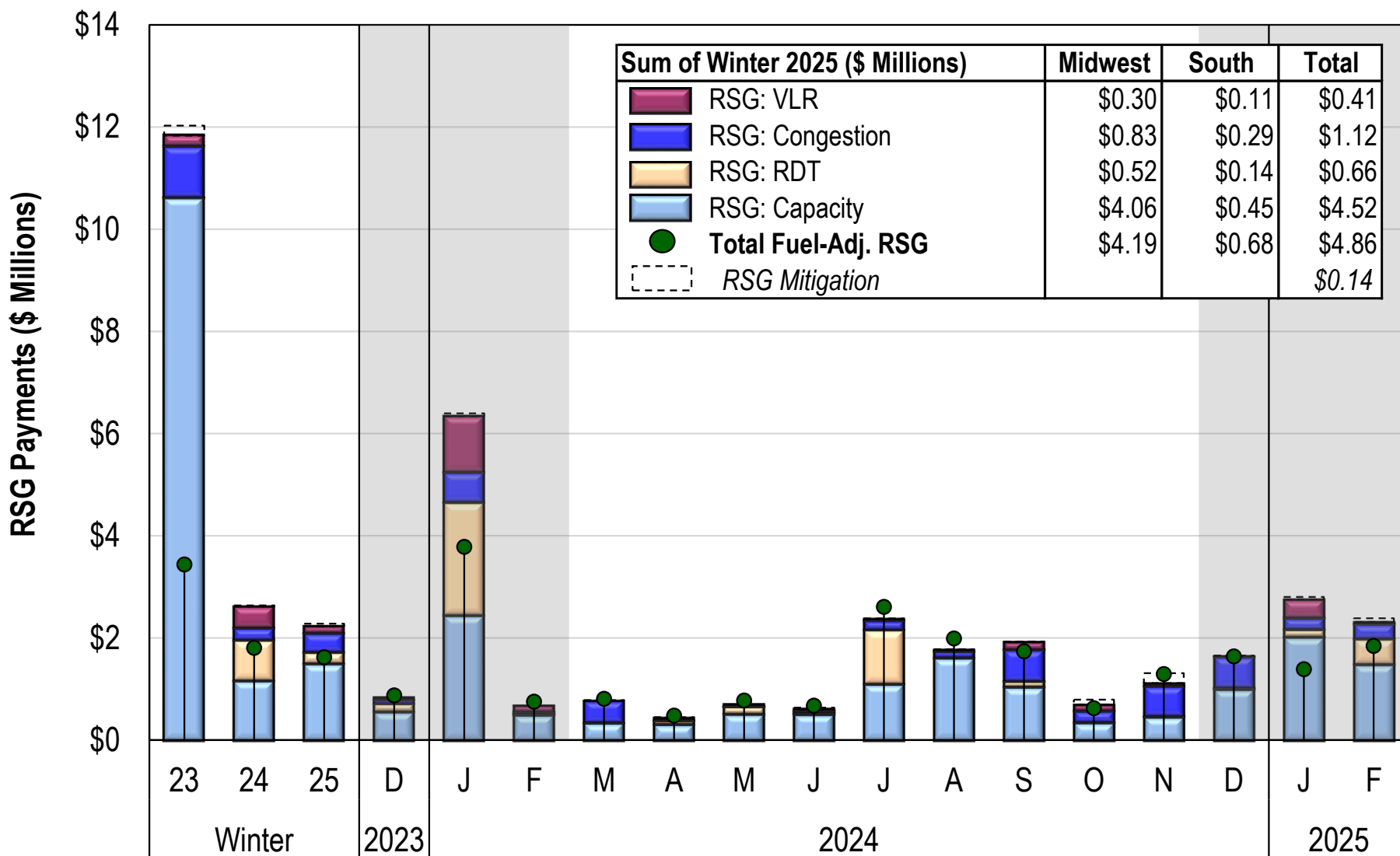
Day-Ahead RSG Payments

Winter 2023–2025



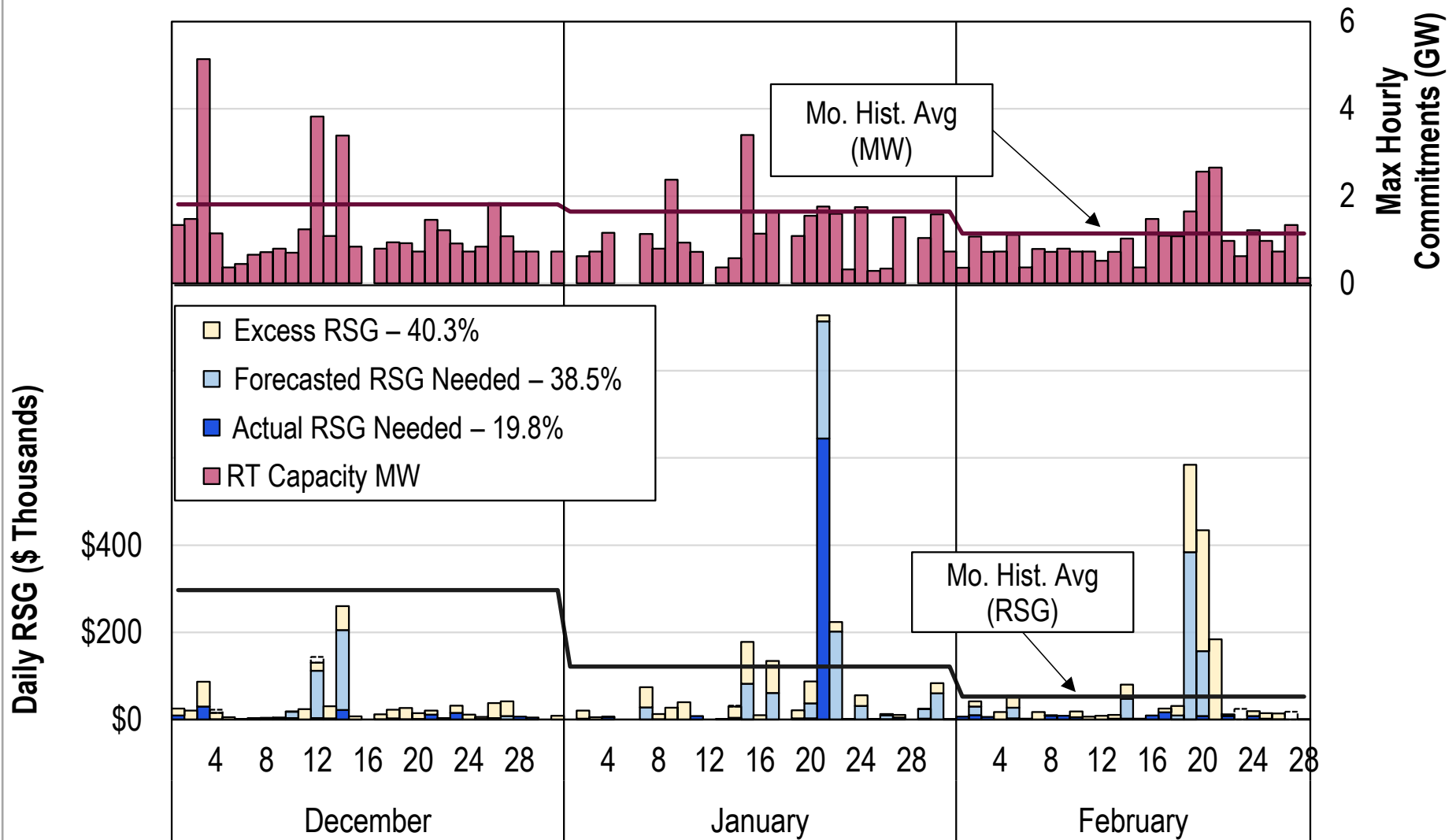
Real-Time RSG Payments

Winter 2024–2025



Real-Time Capacity Commitment and RSG

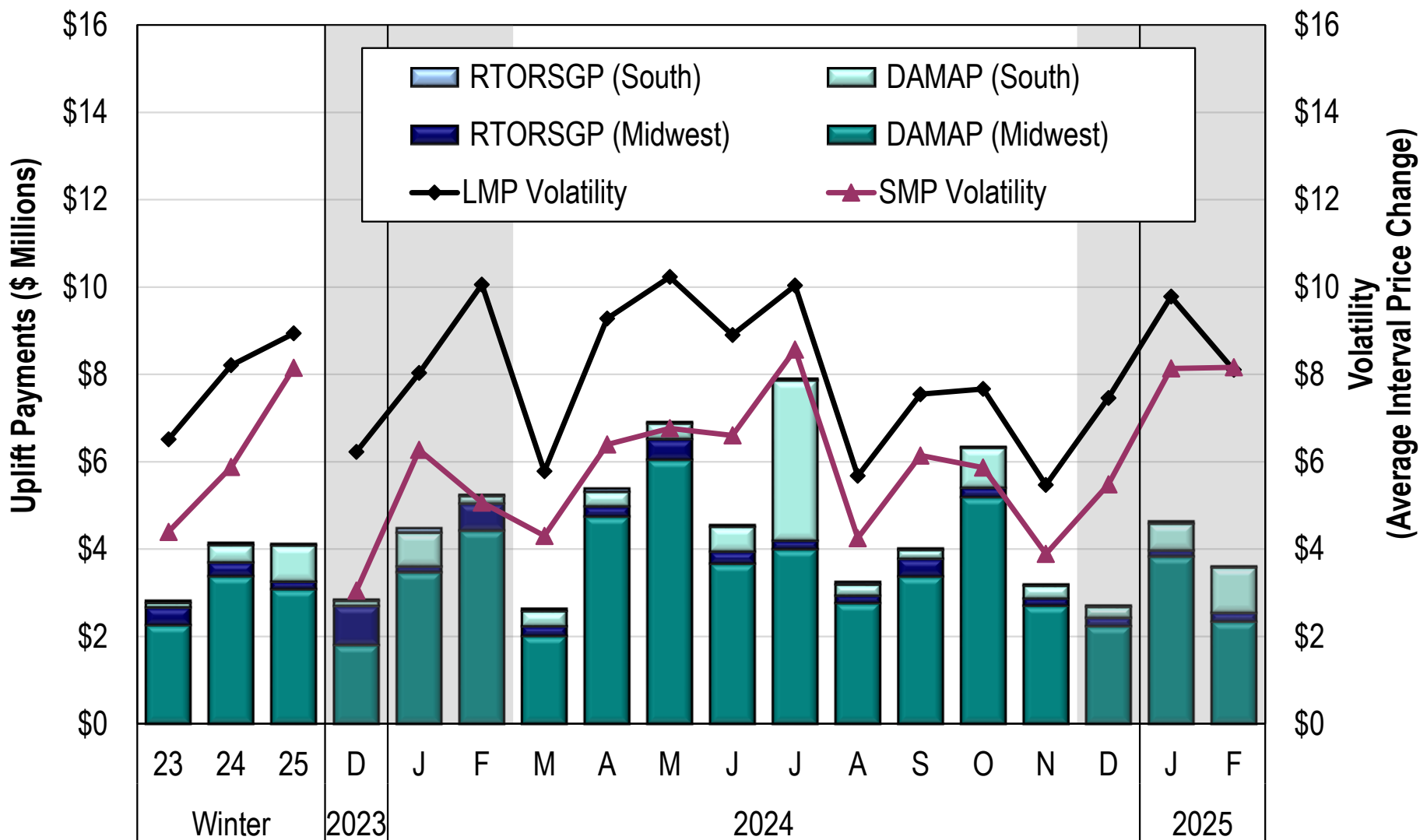
Winter 2025



*1.4% of RSG could not be classified due to gaps in market data and is shown in the transparent bars.

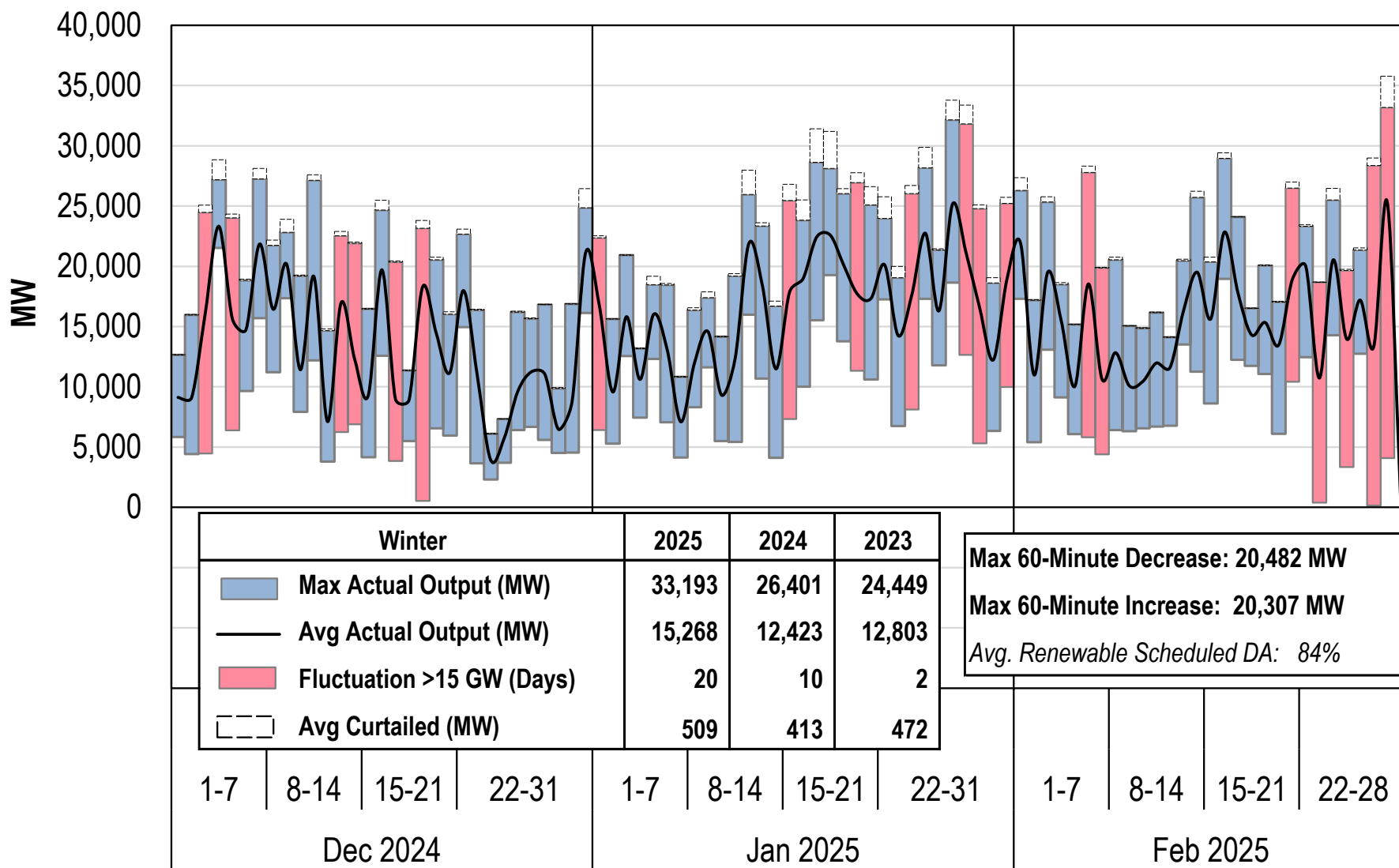
Price Volatility Make Whole Payments

Winter 2023–2025



Wind and Solar Output in Real Time

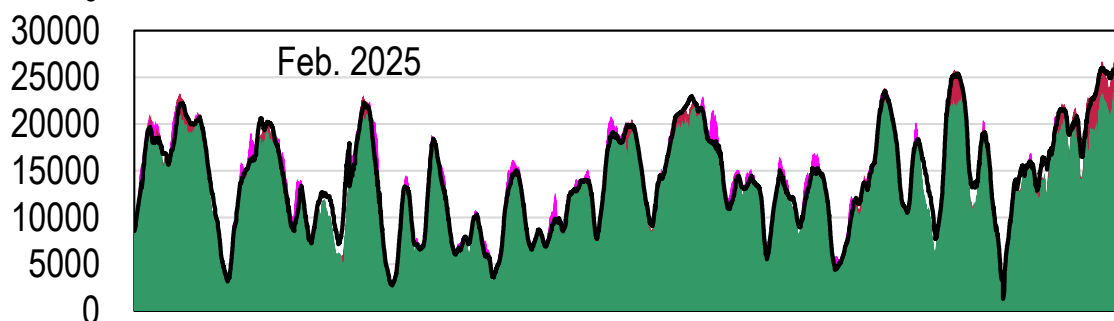
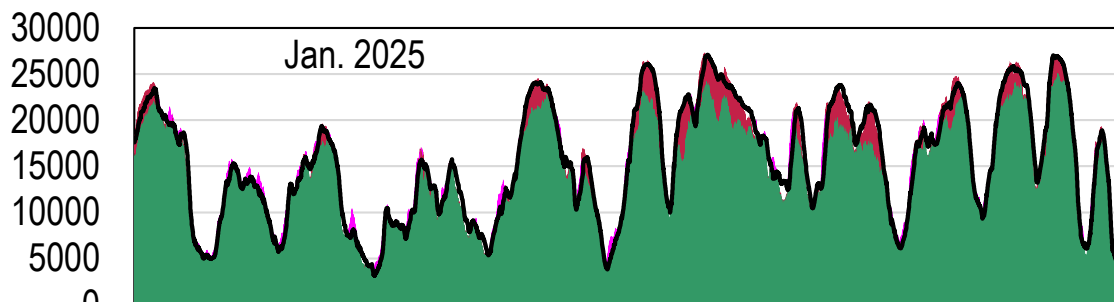
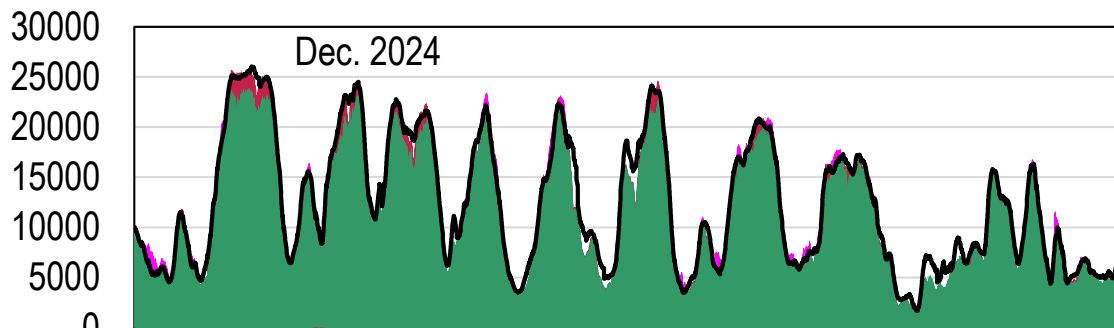
Daily Range and Average



Wind Forecast and Actual Output

Winter 2025

■ Wind
 ■ Curtailed
 ■ Above Forecast
 — 2-3 Hour Out Wind Forecast



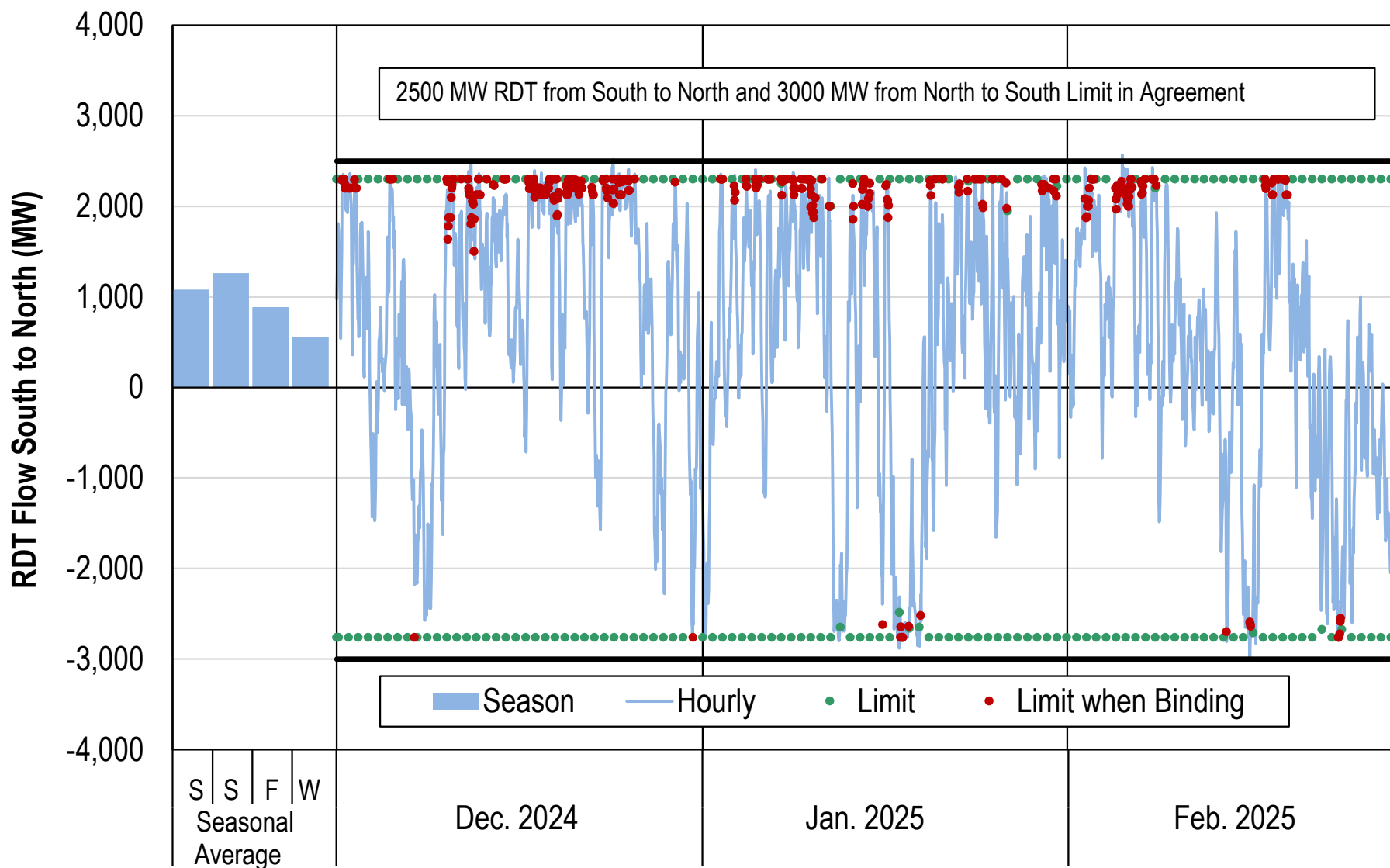
Winter 2025	
Real-Time Wind (MW)	13,625
Day-Ahead Wind (MW)	11,712
Avg Curtailments (MW)	508
Forecast Errors (%)	240.1%
Absolute Errors (%)	1484.0%

Winter 2024	
Real-Time Wind (MW)	11,792
Day-Ahead Wind (MW)	10,136
Avg Curtailments (MW)	402
Forecast Errors (%)	-0.9%
Absolute Errors (%)	8.2%

Fall 2024	
Real-Time Wind (MW)	11,611
Day-Ahead Wind (MW)	10,548
Avg Curtailments (MW)	780
Forecast Errors (%)	0.3%
Absolute Errors (%)	7.6%

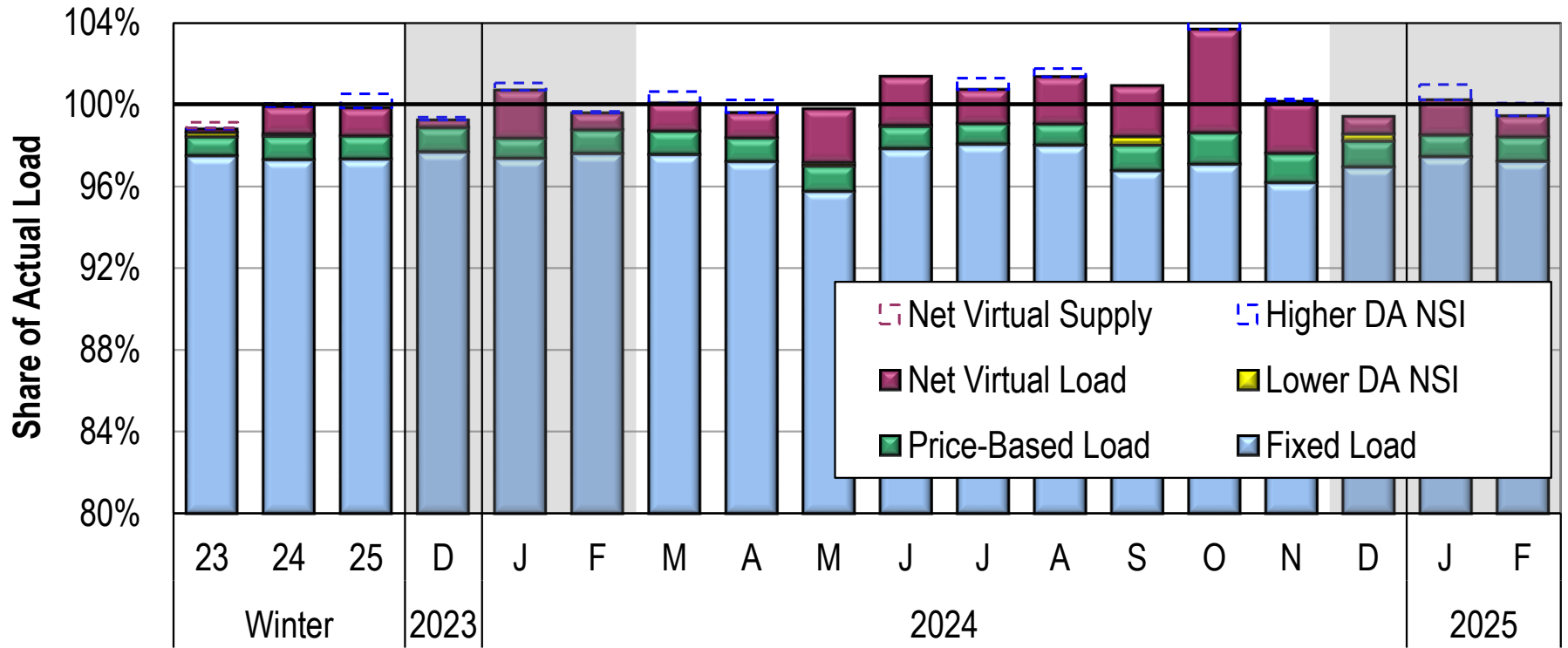
Real-Time Hourly Inter-Regional Flows

Winter 2025



Day-Ahead Peak Hour Load Scheduling

Winter 2023–2025

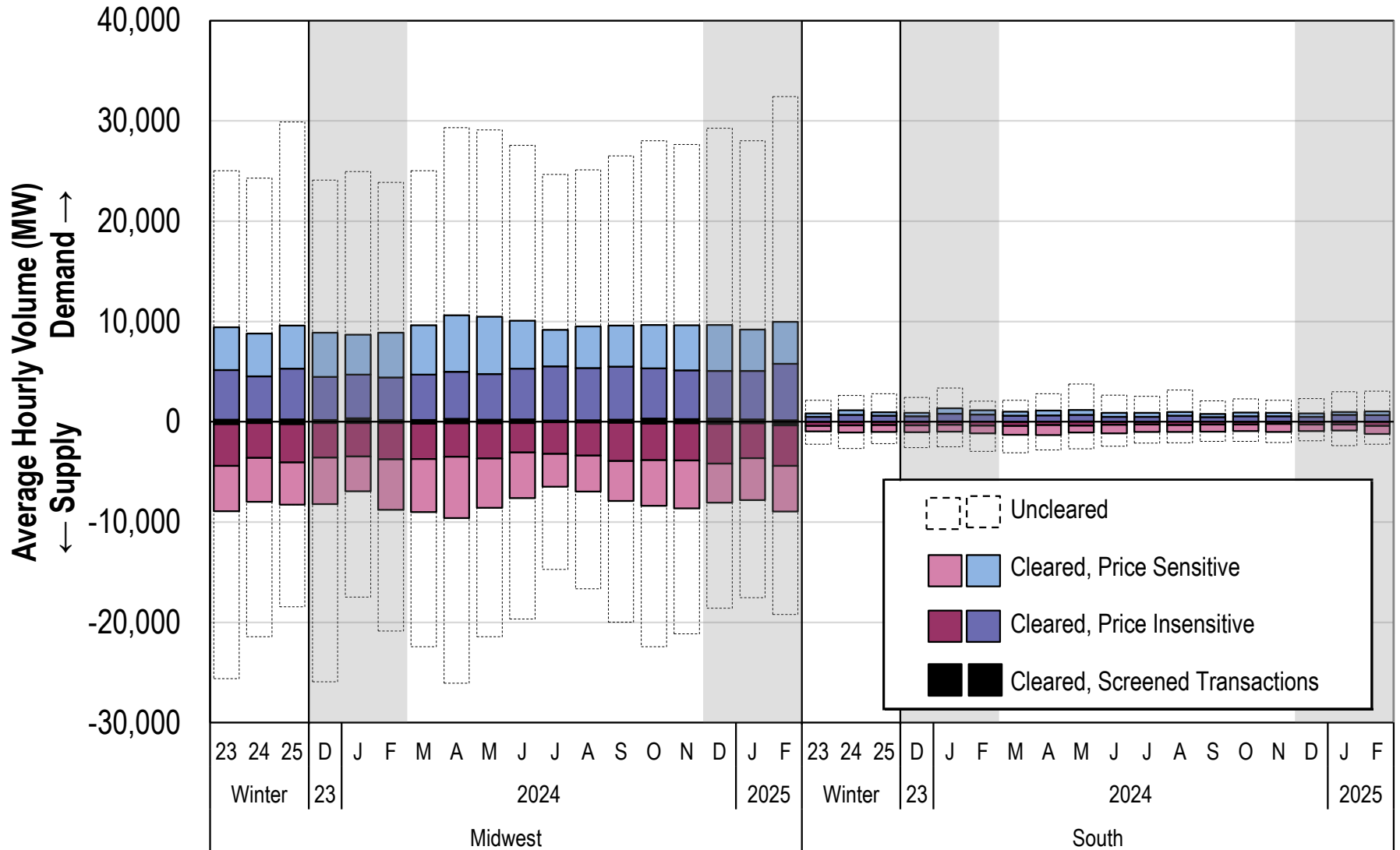


Share of Actual Load (%)

All Hours	98.7	99.8	99.7	98.6	100.5	99.2	99.1	99.3	101.0	101.4	102.0	101.9	100.7	100.4	99.2	99.5	100.2	99.1
Peak Hours Midwest	99.2	100.1	100.0	99.5	100.8	99.9	100.9	99.4	100.3	102.6	101.3	101.9	101.7	105.1	100.5	99.6	100.1	100.0
Peak Hours South	99.8	100.5	101.5	101.3	101.5	99.4	100.8	99.1	100.8	100.7	99.9	100.6	100.2	103.1	100.5	100.7	100.5	102.5

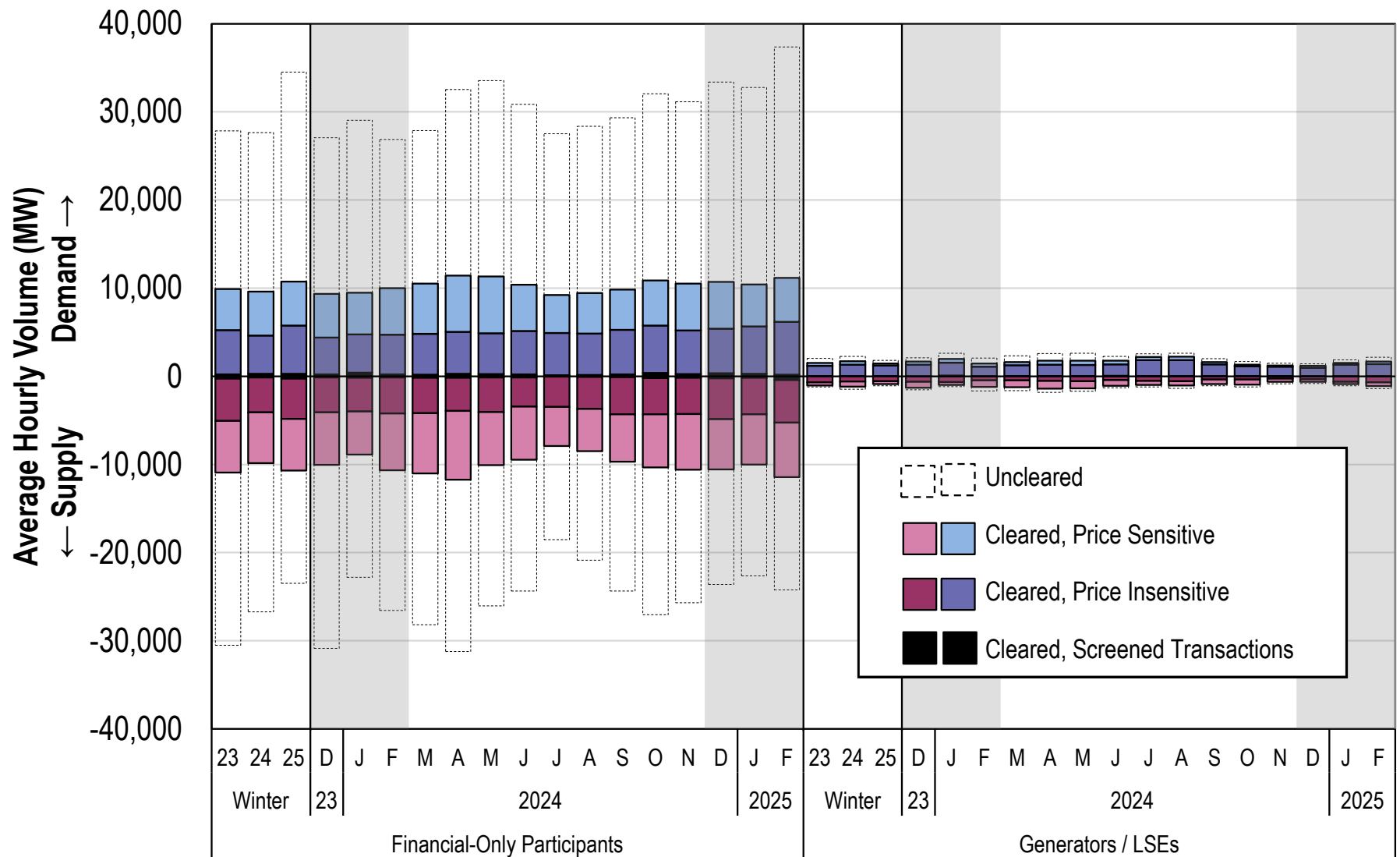
Virtual Load and Supply

Winter 2023–2025



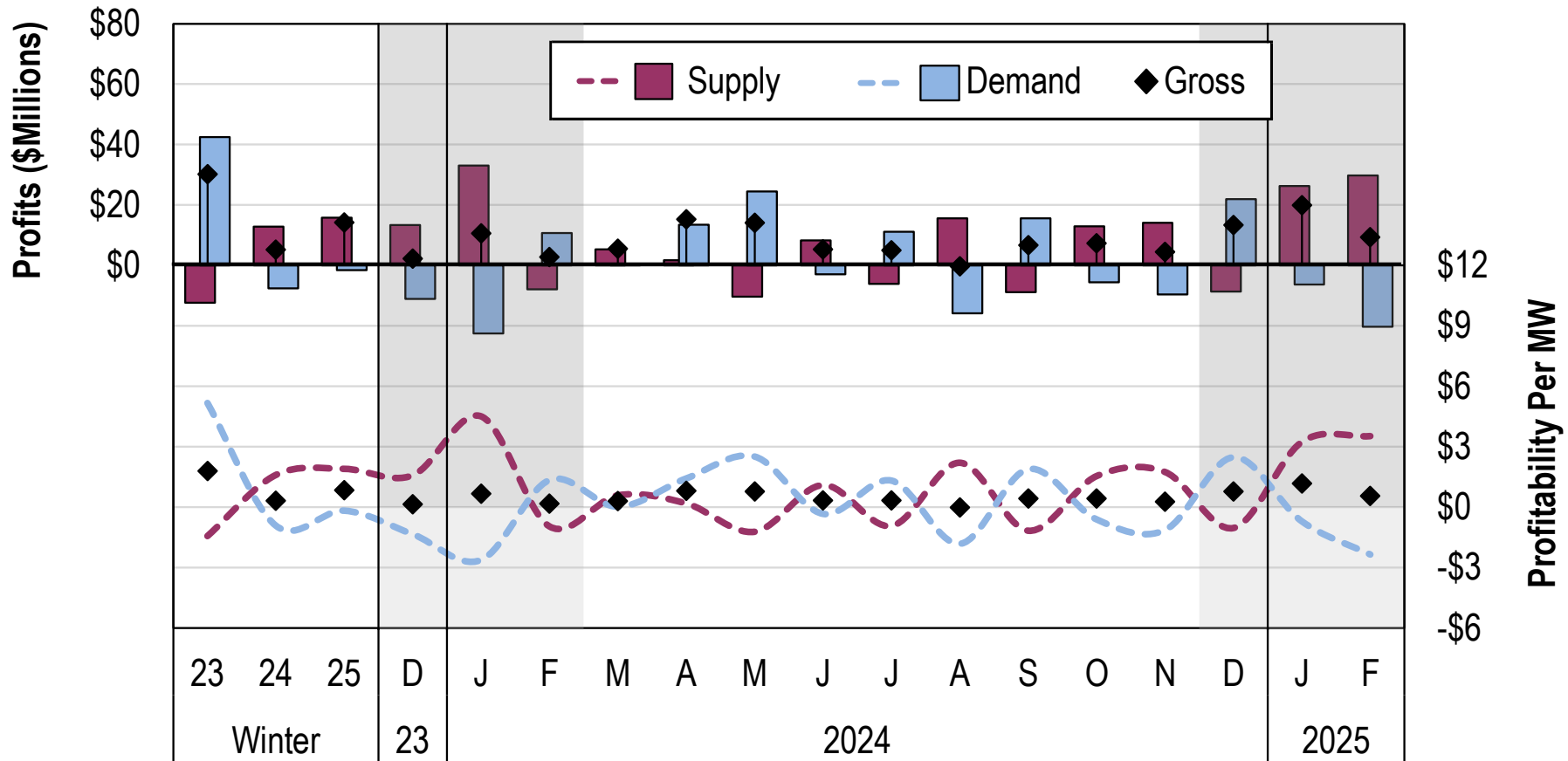
Virtual Load and Supply by Participant Type

Winter 2023–2025



Virtual Profitability

Winter 2023–2025

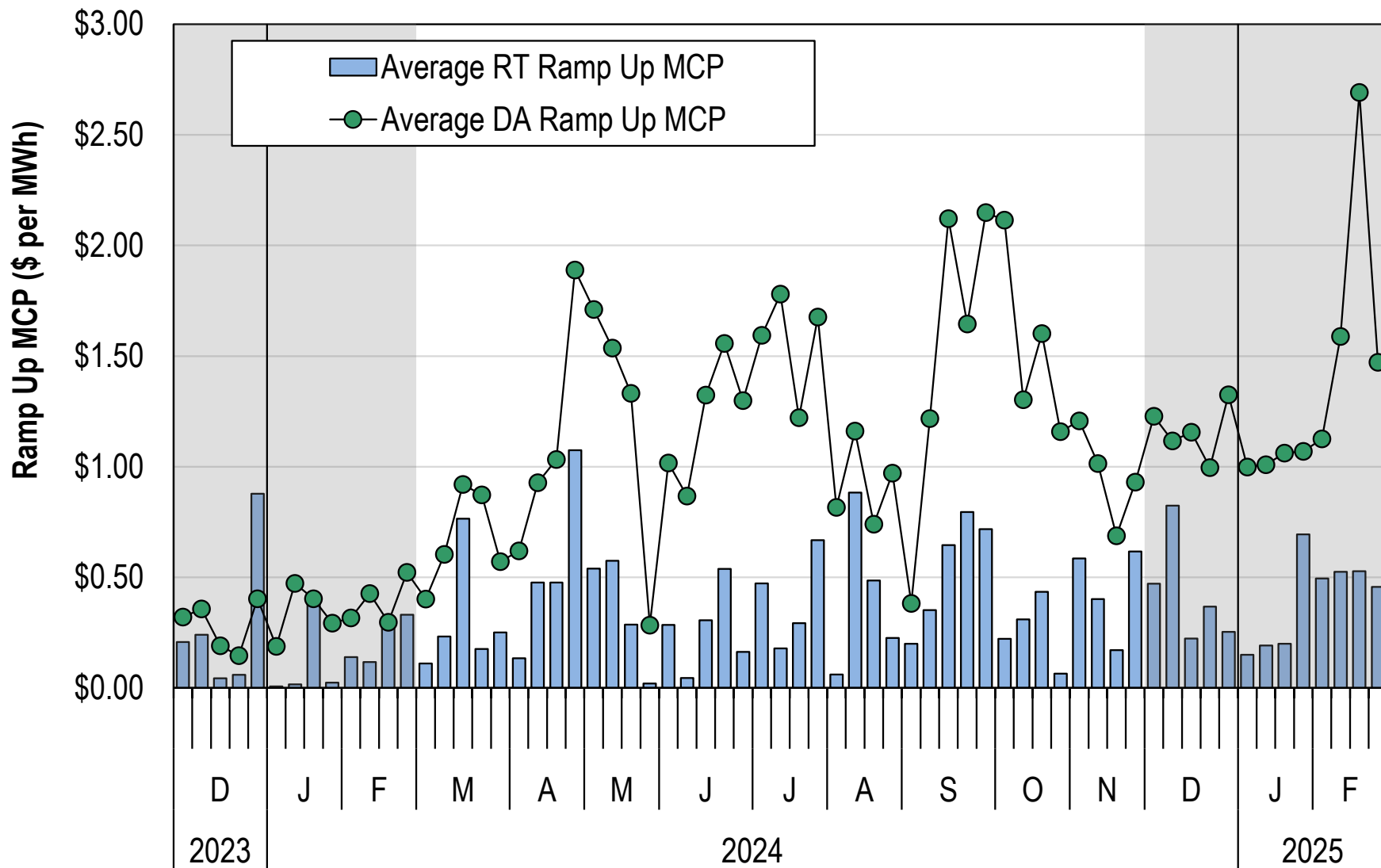


Percent Screened

Supply	2.2	1.4	2.5	1.3	1.7	1.2	1.6	1.3	1.5	1.5	0.7	0.8	0.9	1.9	1.5	2.0	1.7	3.6
Demand	2.2	2.8	2.3	2.0	4.3	2.1	1.6	2.3	2.0	2.2	1.2	1.5	1.9	3.3	2.4	3.1	2.5	1.5
Total	2.2	2.1	2.4	1.7	3.1	1.6	1.6	1.8	1.8	1.9	1.0	1.2	1.4	2.6	1.9	2.6	2.1	2.5

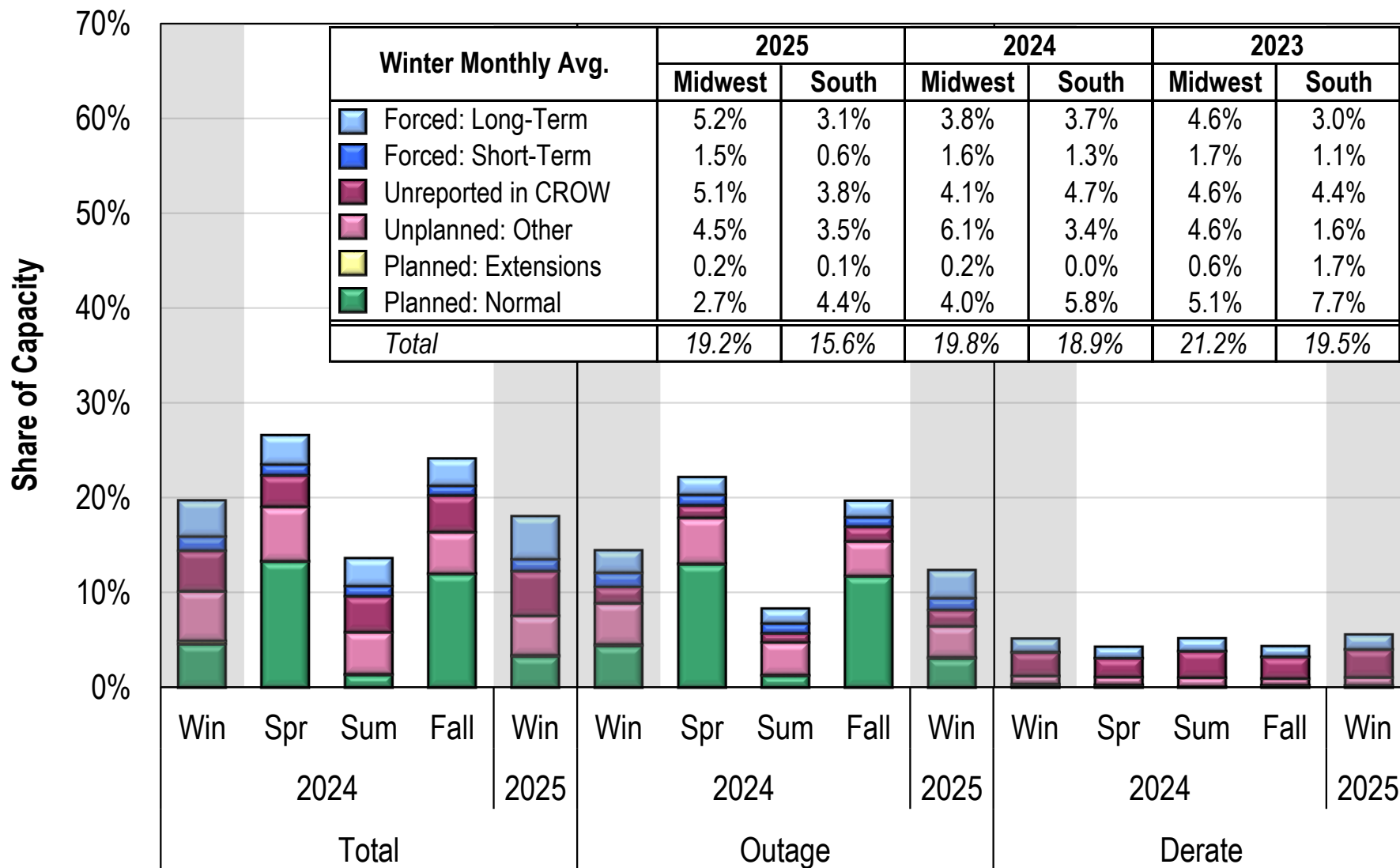
Day-Ahead and Real-Time Ramp Up Price

Winter 2023–2025



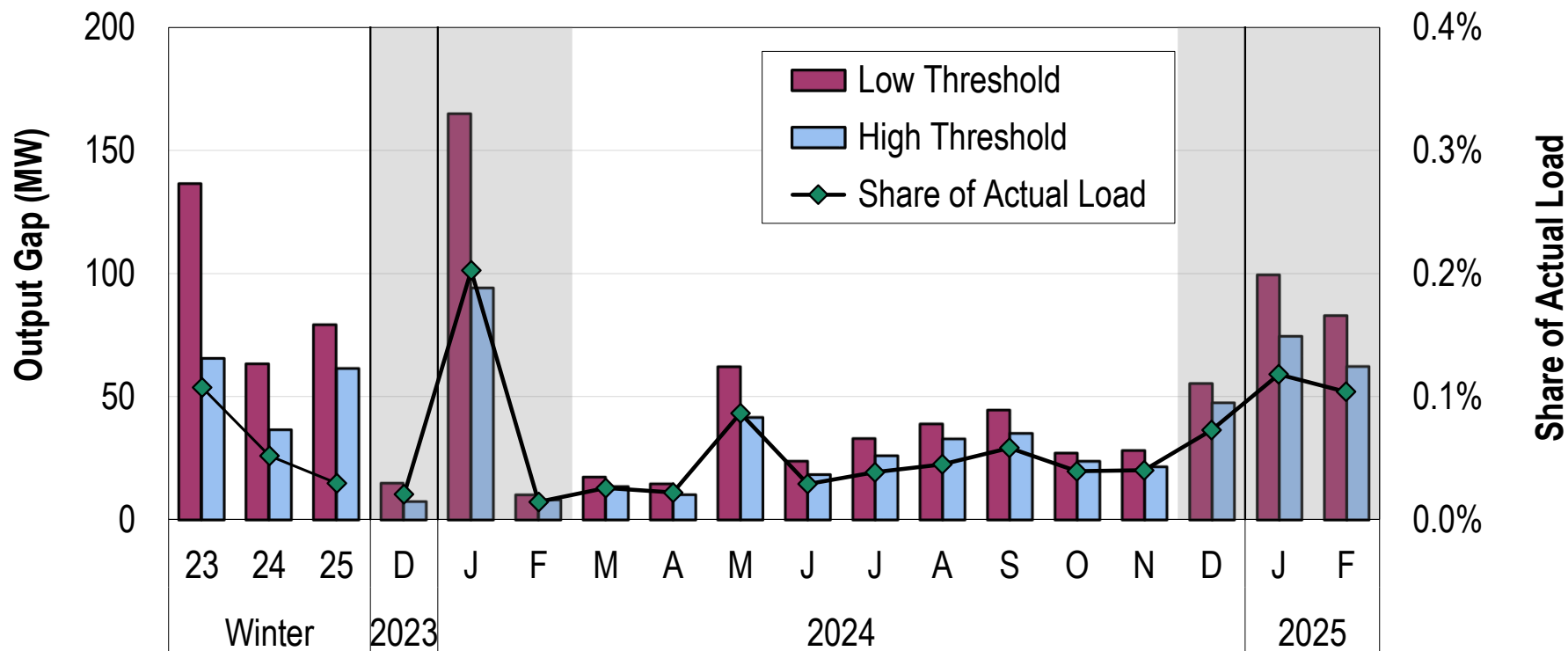
Generation Outages and Deratings

Winter 2023–2025



Monthly Output Gap

Winter 2023–2025



Low Threshold Results by Unit Status (MW)

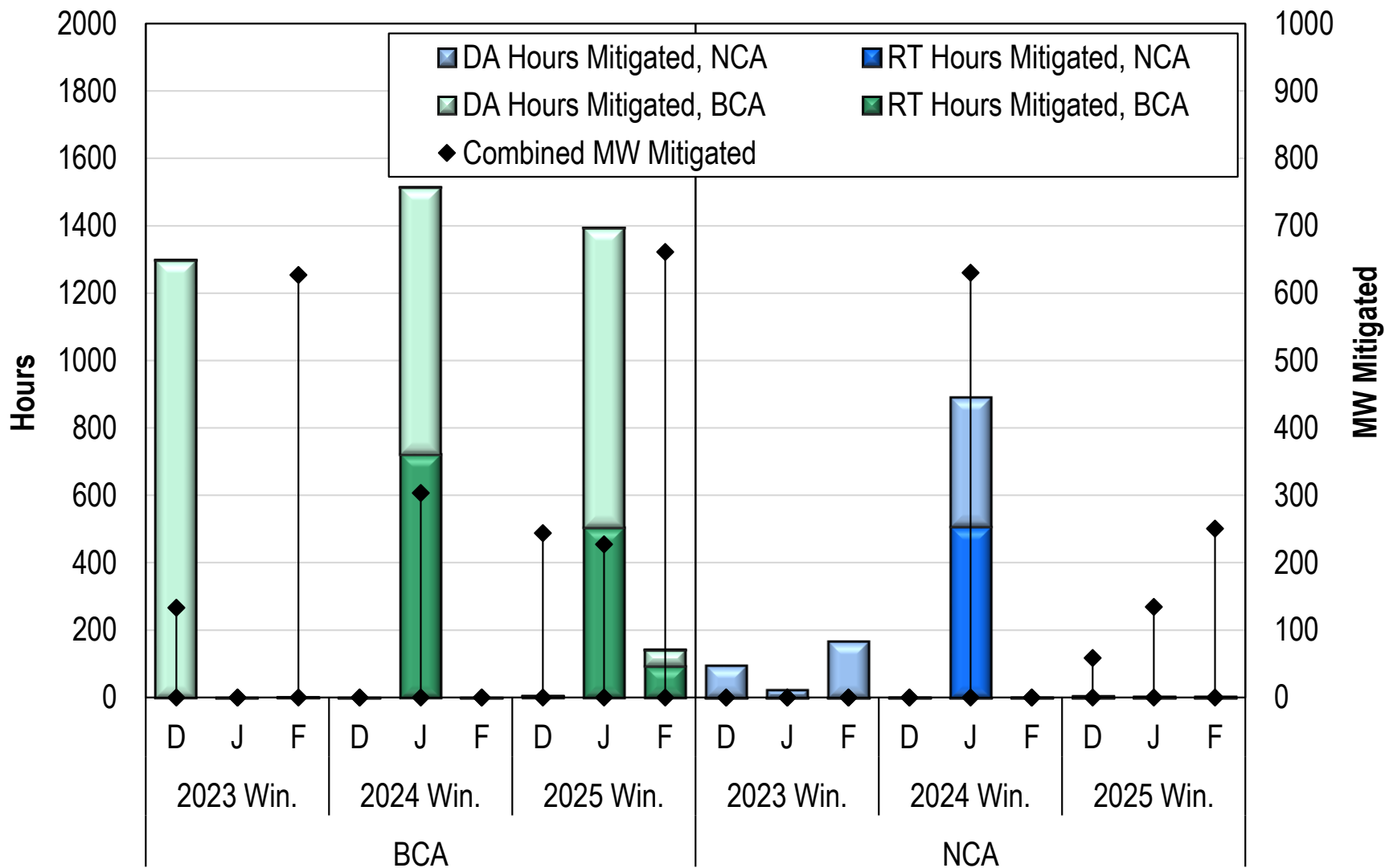
Offline	94	35	61	4	98	3	8	6	56	18	25	31	37	22	24	49	71	62
Online	43	28	19	11	66	7	10	9	6	6	8	7	8	6	4	7	28	21

High Threshold Results by Unit Status (MW)

Offline	55	30	55	4	84	3	6	4	38	14	22	29	31	20	19	44	66	56
Online	10	6	6	3	9	6	7	6	4	5	4	4	4	4	3	3	9	6

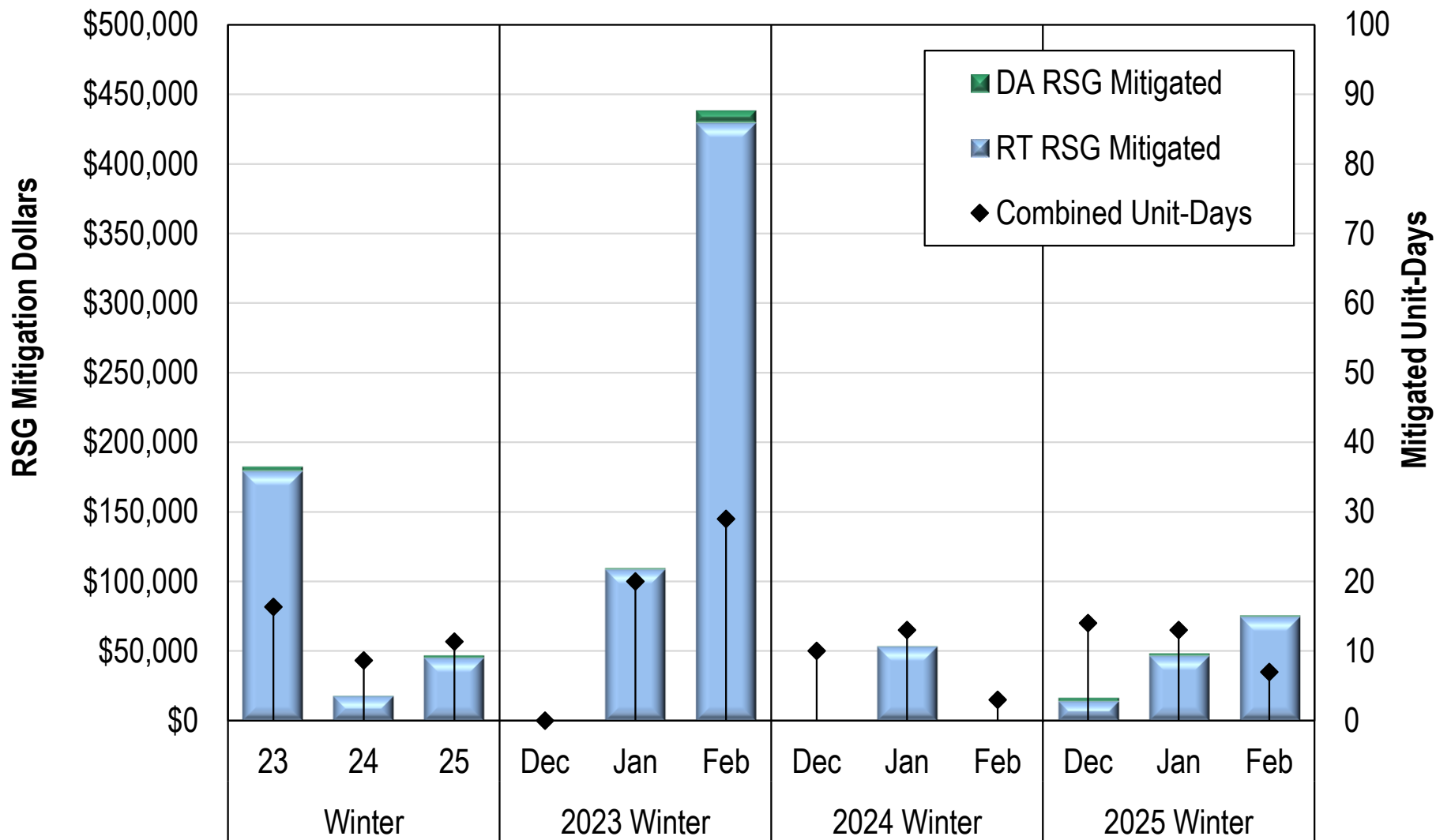
Day-Ahead And Real-Time Energy Mitigation

Winter 2023 - 2025



Day-Ahead and Real-Time RSG Mitigation

Winter 2023 - 2025



Other Key Market Events

Lowest Daily Temperatures

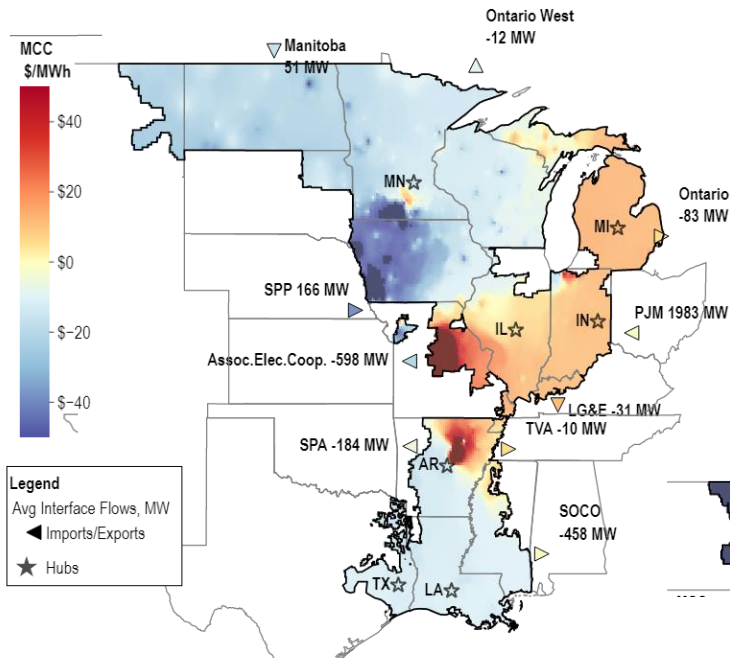
January 2025 Winter Storms

	Hist. Avg.	Jan-2025				
		18	19	20	21	22
Minneapolis	8	-5	-13	-18	-19	7
Des Moines	13	8	-4	-9	-13	16
Detroit	19	22	11	8	2	0
Indianapolis	20	26	4	0	-3	-2
Chicago	18	14	1	-2	-8	0
Little Rock	31	32	18	14	17	13
New Orleans	46	57	35	30	27	23
Houston	46	47	33	29	25	19

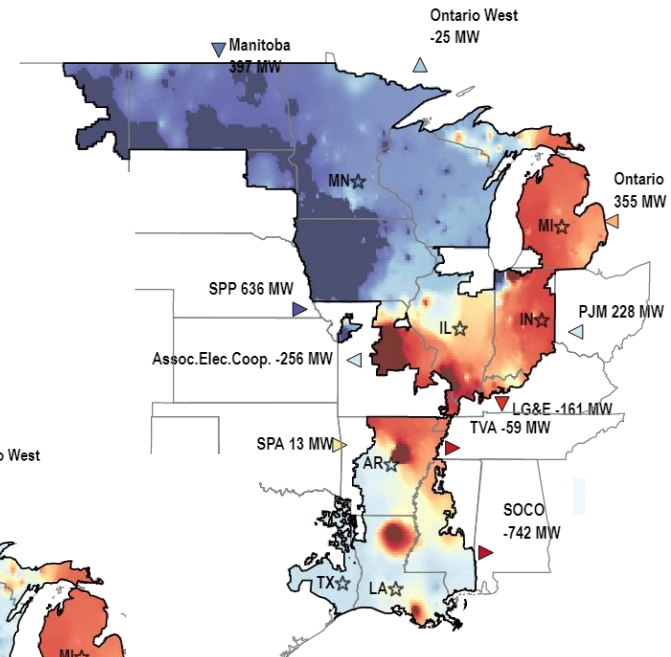
Notes: Pink Background Means Low Temperature Under Historical Average By At Least 10 Degrees Fahrenheit.

Winter Storm Enzo Congestion Maps

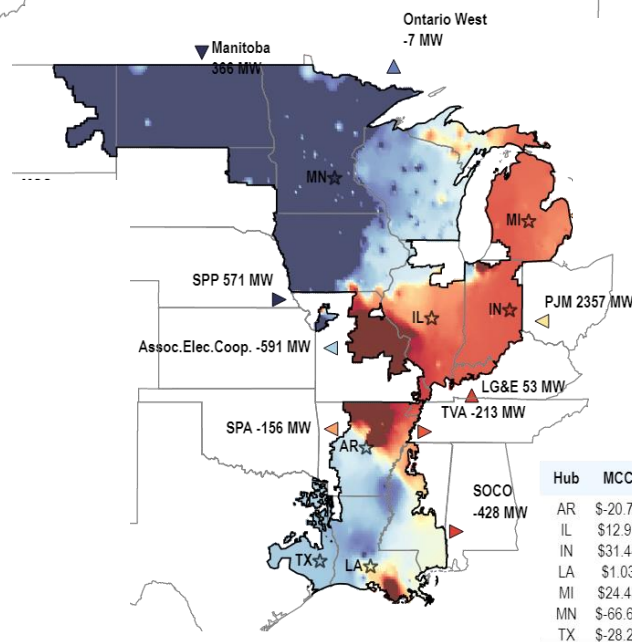
January 20



January 22

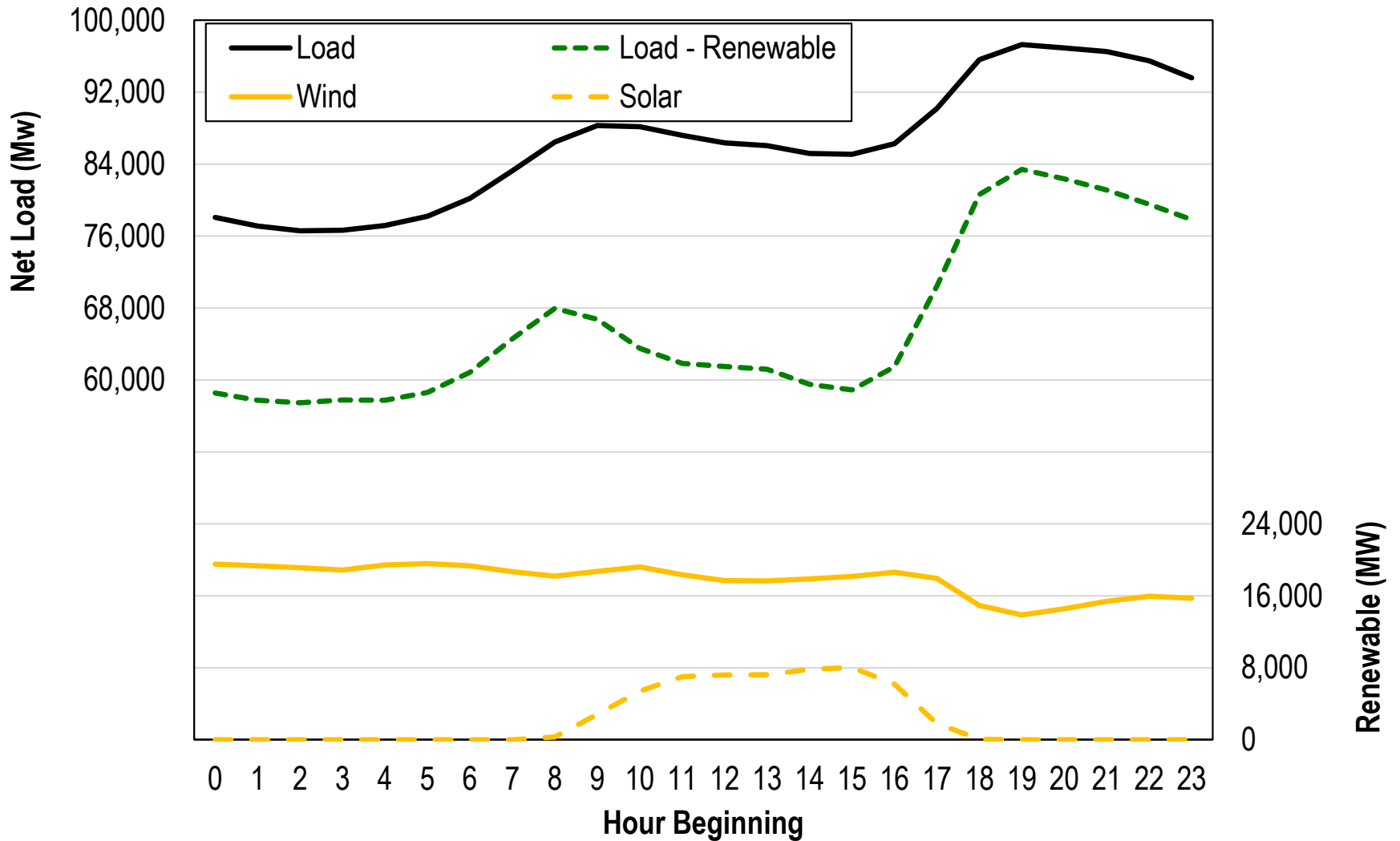


January 21



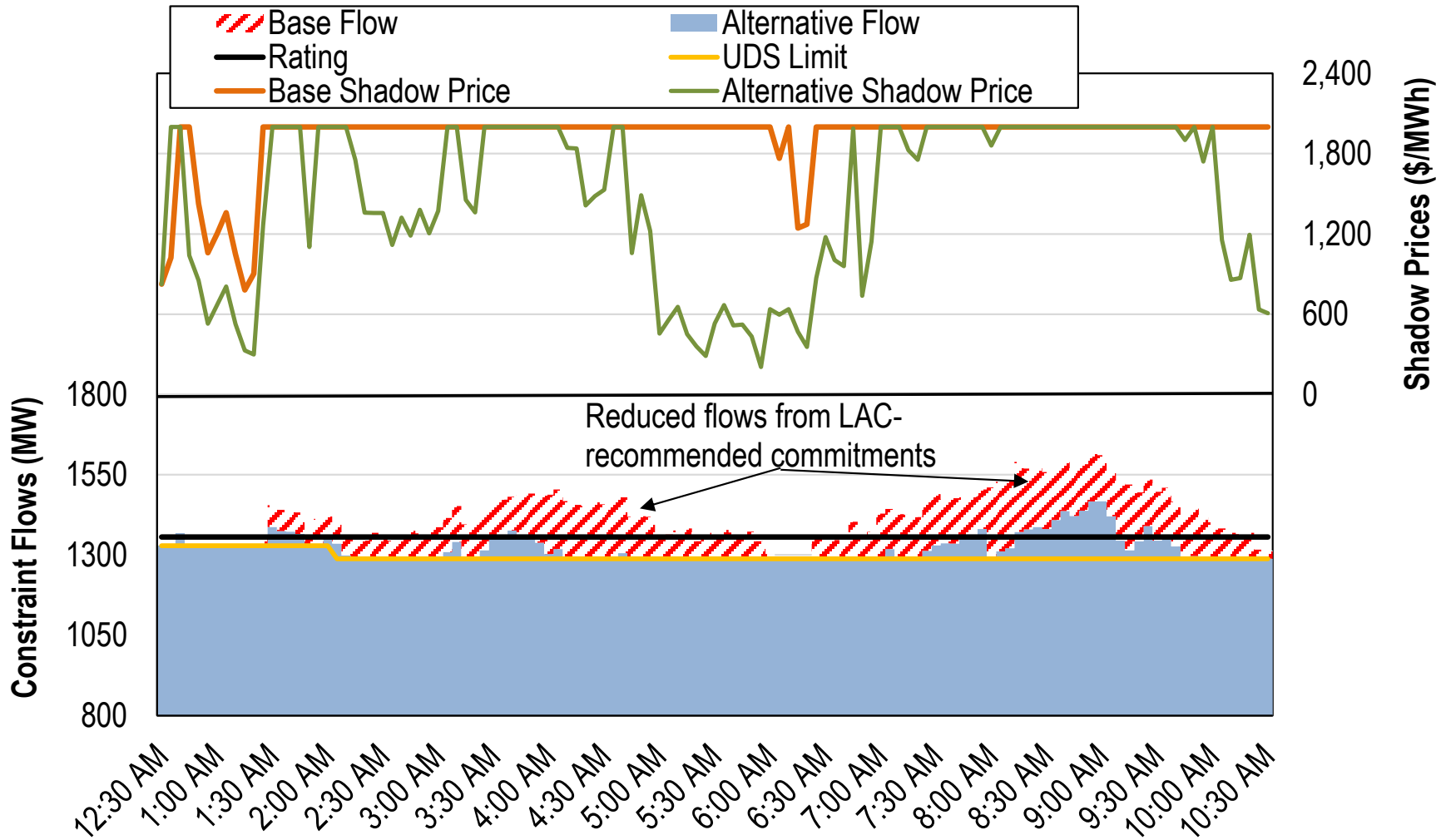
Extreme Net Load Ramp

January 19, 2025



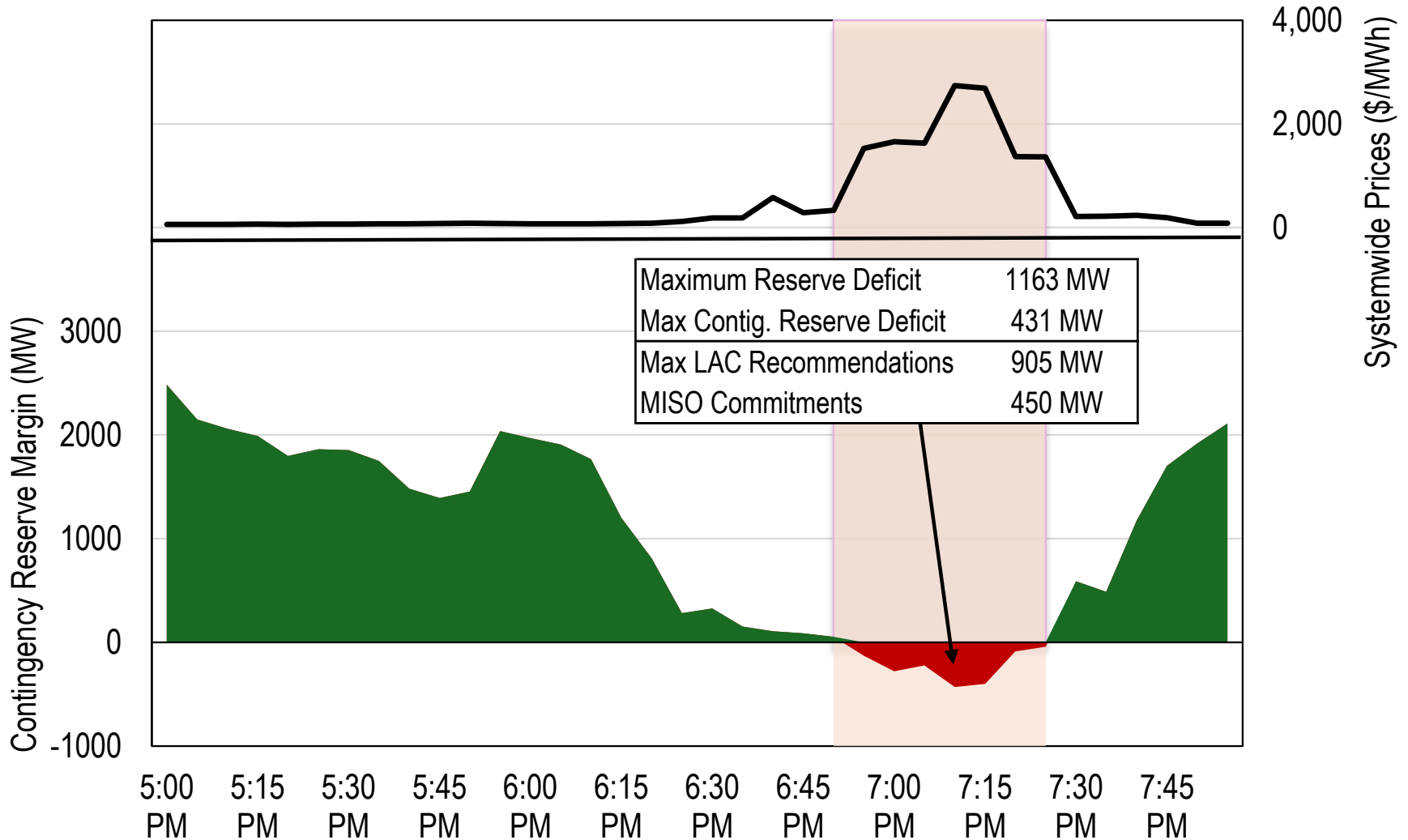
Quad Cities Constraint Commitment Alternative

December 12, 2024



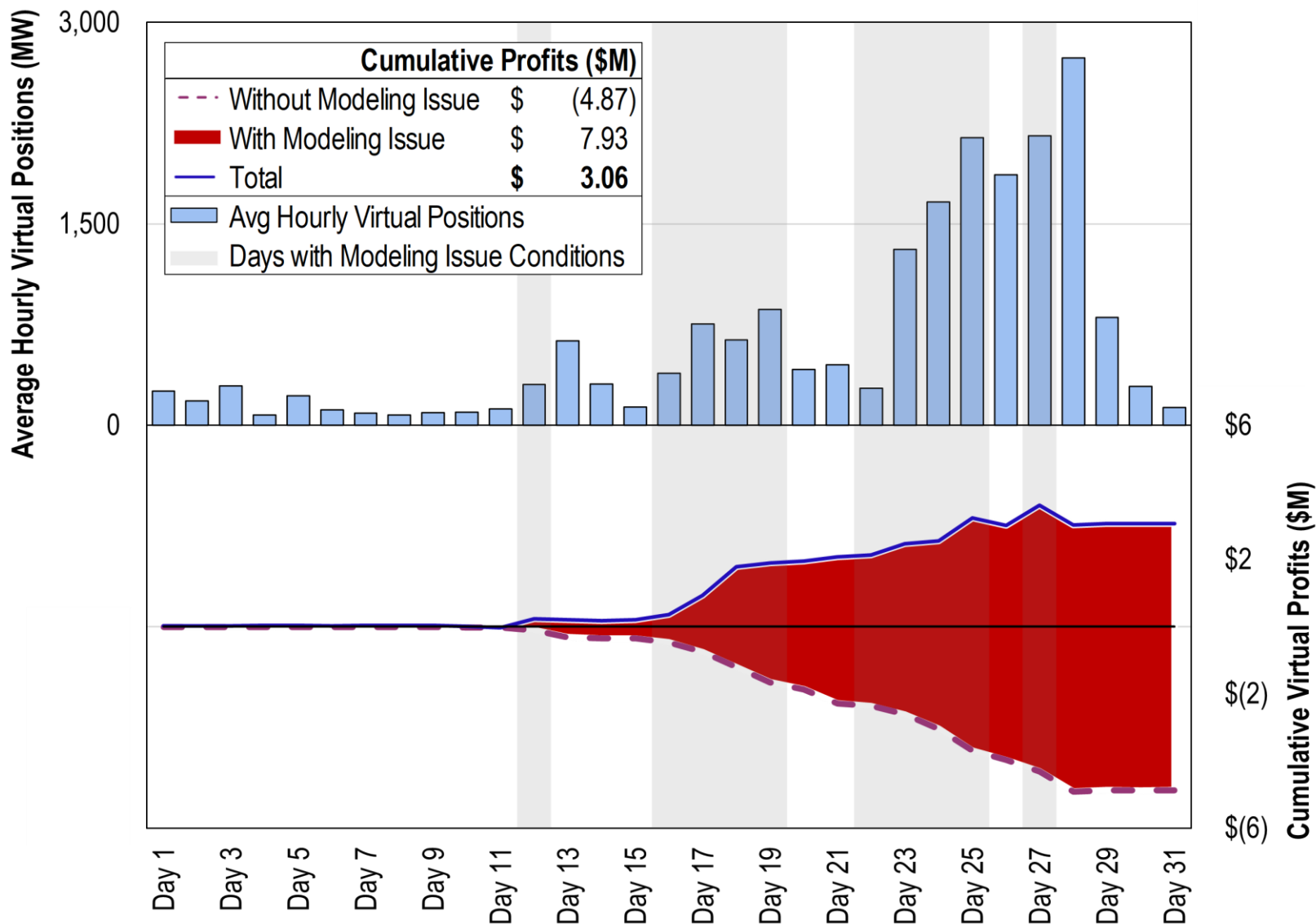
Contingency Reserve Shortage

February 19, 2025



Virtual Trading around Modeling Inconsistency

Hourly Virtual Positions and Cumulative Revenues



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
- UD Uninstructed Deviation
- VLR Voltage and Local Reliability
- WUMS Wisconsin Upper Michigan System