



IMM Quarterly Report: Fall 2021

MISO Independent Market Monitor

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Highlights and Findings: Fall 2021

- The MISO markets performed competitively this fall, market power mitigation was infrequent, and conduct was competitive overall.
- Gas prices more than doubled over last fall, impacting multiple market areas.
 - ✓ Energy and ancillary service prices also more than doubled.
 - ✓ Real-time RSG grew 149 percent because of higher gas costs and real-time commitments. Fuel prices also led to relatively high day-ahead RSG levels.
- Average and peak load increased by 5 and 2 percent compared to last year.
 - ✓ Cooling degree days increased by 90 percent this quarter, while heating degree days fell by 68 percent.
- Average hourly wind output continued to grow, rising by 6 percent compared to last year, and set a new output record of 21.7 GW on November 12.
- Real-time congestion more than doubled from last year to more than three-quarters of a billion dollars because of high gas prices and high wind output.
 - ✓ Approximately half of real-time congestion was attributable to wind output.
 - ✓ One particular wind-impacted constraint accrued \$80 million in real-time congestion, which could be mitigated by network reconfiguration.

Quarterly Summary

		Value	Change ¹			Value	Change ¹	
			Prior Qtr.	Prior Year			Prior Qtr.	Prior Year
RT Energy Prices (\$/MWh)	●	\$50.56	31%	131%	FTR Funding (%)	●	96%	105%
Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	●	10,175	63%
Natural Gas - Chicago	●	\$4.99	40%	138%	Guarantee Payments (\$M)⁴			6%
Natural Gas - Henry Hub	●	\$5.18	41%	130%	Real-Time RSG	●	\$25.3	-43%
Western Coal	●	\$1.40	94%	109%	Day-Ahead RSG	●	\$20.0	30%
Eastern Coal	●	\$3.18	83%	155%	Day-Ahead Margin Assurance	●	\$10.8	-2%
Load (GW)²					Real-Time Offer Rev. Sufficiency	●	\$1.6	47%
Average Load	●	71.9	-16%	5%	Price Convergence⁵			191%
Peak Load	●	98.5	-18%	2%	Market-wide DA Premium	●	-1.8%	0.0%
% Scheduled DA (Peak Hour)	●	98.1%	98.7%	99.0%	Virtual Trading			1.7%
Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	●	19,277	24%
Real-Time Congestion Value	●	\$772.8	79%	121%	% Price Insensitive	●	48%	-22%
Day-Ahead Congestion Revenue	●	\$501.5	72%	145%	% Screened for Review	●	3%	24%
Balancing Congestion Revenue ³	●	\$21.0	\$3.7	-\$1.1	Profitability (\$/MW)	●	\$1.14	2%
Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	●	\$0.74	1%
Regulation	●	\$16.61	45%	80%	Output Gap- Low Thresh. (MW/hr)	●	\$1.14	\$0.83
Spinning Reserves	●	\$3.96	18%	118%	Other:			
Supplemental Reserves	●	\$0.79	-33%	183%				

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 2021

High Gas Prices and Market Impacts (Slides 12-14, 18, 22-23)

- Gas prices and corresponding energy prices more than doubled over last year.
 - ✓ Natural gas storage inventories fell below average levels during the February Arctic Blast and have remained lower than average this year.
 - ✓ Gas prices began climbing from the spring and into the summer because of higher gas demand for electricity and rising LNG exports.
 - ✓ Hurricane Ida in late summer had large impacts on offshore gas production, contributing to a sharper increase in natural gas prices.
- The higher gas prices this quarter affected market outcomes in multiple areas:
 - ✓ Real-time energy prices increased by more than 130 percent;
 - ✓ The ancillary service prices for spin and supplemental reserves rose 118 and 183 percent, respectively, while regulation prices rose 80 percent;
 - ✓ Day-ahead congestion rose nearly 150 percent over last fall;
 - ✓ Real-time congestion more than doubled over last fall as the costs of re-dispatching the system to manage constraints increased significantly; and
 - ✓ Real-time RSG increased 149 percent over last fall, although some of the increases were attributable to conservative commitment practices.



Highlights for Fall 2021

Increased Coal Output, Coal Limitations, and Net Revenues (Slide 17)

- Much higher gas prices made coal resources relatively more economic, resulting in higher output and capacity factors starting in the summer months.
 - ✓ Net revenues (the margin earned over a unit's production costs) increased from roughly \$3 per MWh in prior years to \$14 per MWh after June in 2021.
 - ✓ From June to October, coal generation rose 23 percent over last year.
- Despite higher net revenues, coal unit utilization fell during the fall as a number of resources have experienced substantial input limitations.
 - ✓ Coal is typically transported via railroads -- multiple railroads were impacted by labor shortages and other issues in meeting the surge in demand for coal.
 - ✓ Some coal facilities were impacted by limitations in other supplies, as higher demand drove up costs and reduced the availability of necessary inputs.
- A number of coal facilities have implemented coal conservation measures, reducing their capacity factors during the late fall and likely into the winter.
 - ✓ We are working with these resource owners to ensure reference levels reflect the opportunity costs associated with maintaining winter coal inventory.
 - ✓ This is essential to avoid imposing market power mitigation inappropriately.



Highlights for Fall 2021

Higher Quarterly Congestion (Slides 18-19)

- Real-time congestion doubled over last year to total \$773 million, and a significant portion of this was driven by wind-related constraints.
 - ✓ Higher natural gas prices contributed to the increase because higher gas costs increase the marginal costs of moving generation to manage system flows.
 - ✓ Wind-related congestion continued to grow as 2260 MW of new wind units entered MISO since Dec. 2020, leading to a 6 percent increase in wind output.
- One wind-impacted constraint accrued 10 percent of all congestion.
 - ✓ 13 new wind units put additional forward flows on the constraint.
 - ✓ One key coal unit that could relieve the constraint retired in June and another experienced supply chain issues limiting its ability to generate its full output throughout the quarter.
 - ✓ A reliable and economically efficient reconfiguration exists to substantially reduce this congestion but has rarely been utilized.
 - ✓ \$45 million in FTR shortfalls were attributable to the constraint as an outage was rescheduled after the FTR auction, causing MISO to oversell the FTRs.
 - ✓ The TO is currently upgrading a transmission facility, which will reduce congestion associated with this constraint in the future.



Highlights for Fall 2021

Higher Congestion and Transmission Utilization Opportunities (Slides 20-21)

- Increases in congestion amplify the value of improving transmission utilization.
- We have recommended several improvements to increase utilization:
 - ✓ Expanding the use of Ambient-Adjusted Ratings and Emergency Ratings.
 - ✓ Proactively validating ratings to ensure that ratings reflect the full reliable capabilities of the transmission facility.
 - ✓ Develop a process to identify and implement grid reconfigurations to economically mitigate congestion and to address reliability concerns.
 - ✓ Develop processes to promote and utilize economic grid-enhancing technologies.
- MISO and the TOs have been working since late 2020 to implement a framework to utilize AARs on more transmission facilities.
 - ✓ The TOs initially evaluated facilities with substantial congestion over prior two years, which included roughly 500 transmission elements.



Highlights for Fall 2021

Higher Congestion and Transmission Utilization Opportunities (Slides 20-21)

Our initial assessment of the TO AARs program included in this report shows:

- Most of the AAR benefits being achieved are on the 116 constraints being adjusted prior to the program.
 - ✓ Congestion has only occurred on 23 facilities added under the program.
- Almost \$100 million in benefits were on elements that the TOs asserted are not be adjustable.
 - ✓ This is reasonable for \$10 million of the benefits.
 - ✓ The balance is primarily on transformers that we believe could often be adjustable. A small amount is on recently upgraded elements.
- The largest untapped benefits are in using emergency ratings (\$29 million).
- A more dynamic evaluation of potential new elements would be valuable:
 - ✓ The number of elements “not evaluated” grew sharply throughout 2021 as new transmission elements began binding.
 - ✓ Only relying on past congestion to identify elements to evaluate for AARs will cause the process to not capture some of the available benefits.



Highlights for Fall 2021

High RSG Payments and Real-Time Commitments (Slides 23)

- Real-time RSG more than doubled over last year and day-ahead RSG was also relatively high.
 - ✓ Higher gas prices increased generators' costs and led to higher RSG costs.
 - ✓ Increases in supplemental commitments also contributed to the higher costs.
- MISO incurred over 20 percent of real-time RSG the first 8 days of October.
 - ✓ Unseasonably warm temperatures and low wind were contributing factors.
 - ✓ Oct 3: a large load forecasting error led to high real-time commitments.
 - ✓ Oct 4: MISO declared a Max Gen Alert, incurring over \$2 million in RSG.
- Excluding the restoration-related payments that occurred last year after Hurricane Laura, day-ahead RSG also more than doubled over last fall.
- We continue to examine drivers of large RSG and work closely with MISO to communicate our findings for process improvements. This quarter:
 - ✓ We estimated that roughly 20 percent of the real-time RSG was associated with commitments that were ultimately needed.
 - ✓ Some of the remaining 80 percent of real-time RSG appeared to be needed at the time the commitments were made because of forecast errors, while a large portion could be reduced by improving the commitment process.

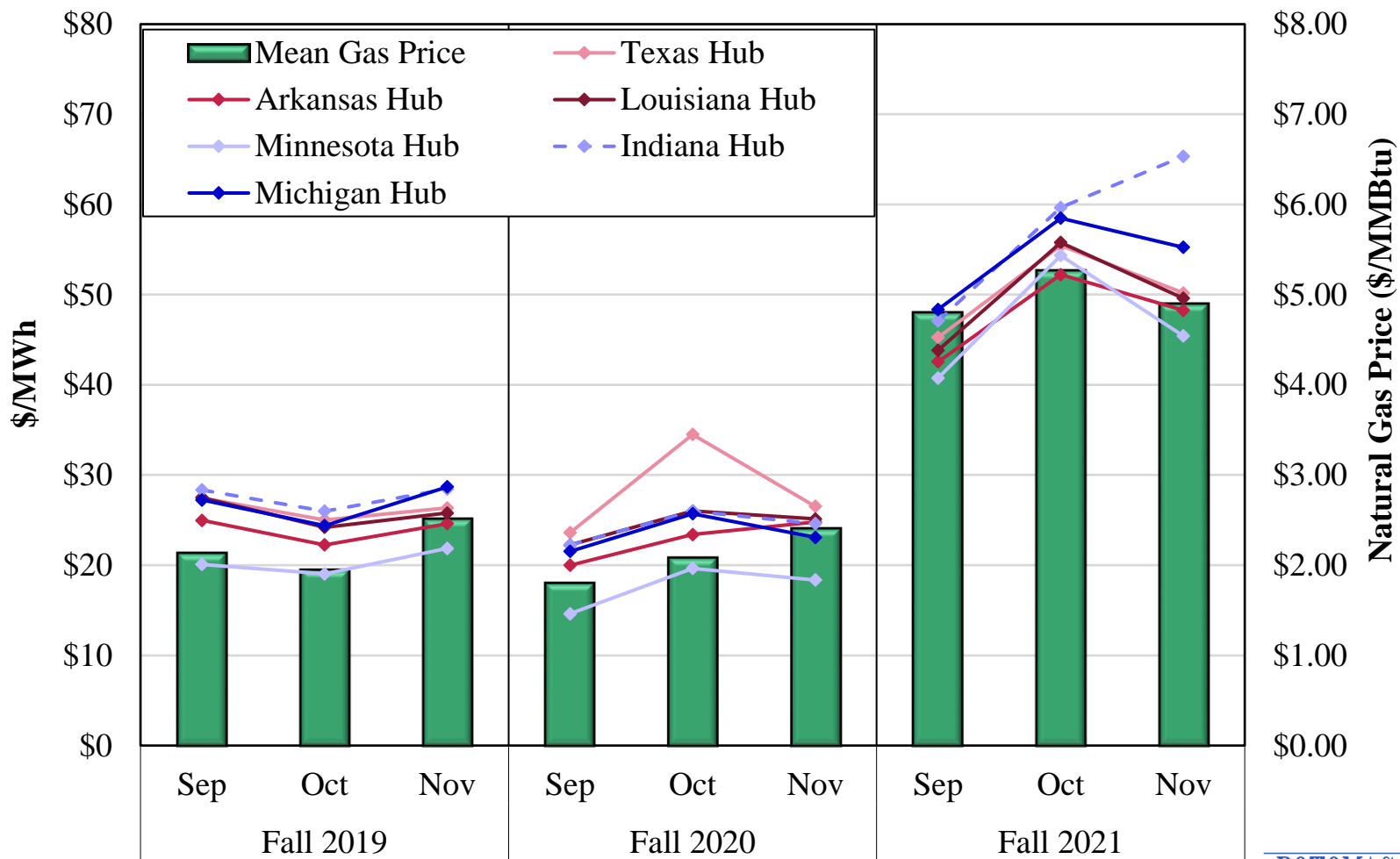


Submittals to External Entities and Other Issues

- We responded to several FERC questions related to prior referrals and FERC investigations, and we responded to requests for information on market issues.
- We filed initial and reply comments in the FERC ANOPR on Transmission Planning, as well as participating in the related technical conference.
- We also participated in a FERC Technical Conference on GETs.
- In September, we presented our Summer Quarterly Report to the Market Subcommittee, and we presented a response to a Board Action item related to observations on undefined M2M constraints during the Feb. Arctic Event.
- In November, we presented a report on market results to the ERSC.
- We continued working with MISO and others on:
 - ✓ Finalizing provisions that will be proposed in the upcoming RAN filing.
 - ✓ Promoting AARs and the use of Emergency Ratings.
 - ✓ Developing processes to identify and implement reconfigurations that can reliably reduce congestion costs.
 - ✓ Reviewing the revised proposal for allocating Firm Flow Entitlements (transmission property rights).

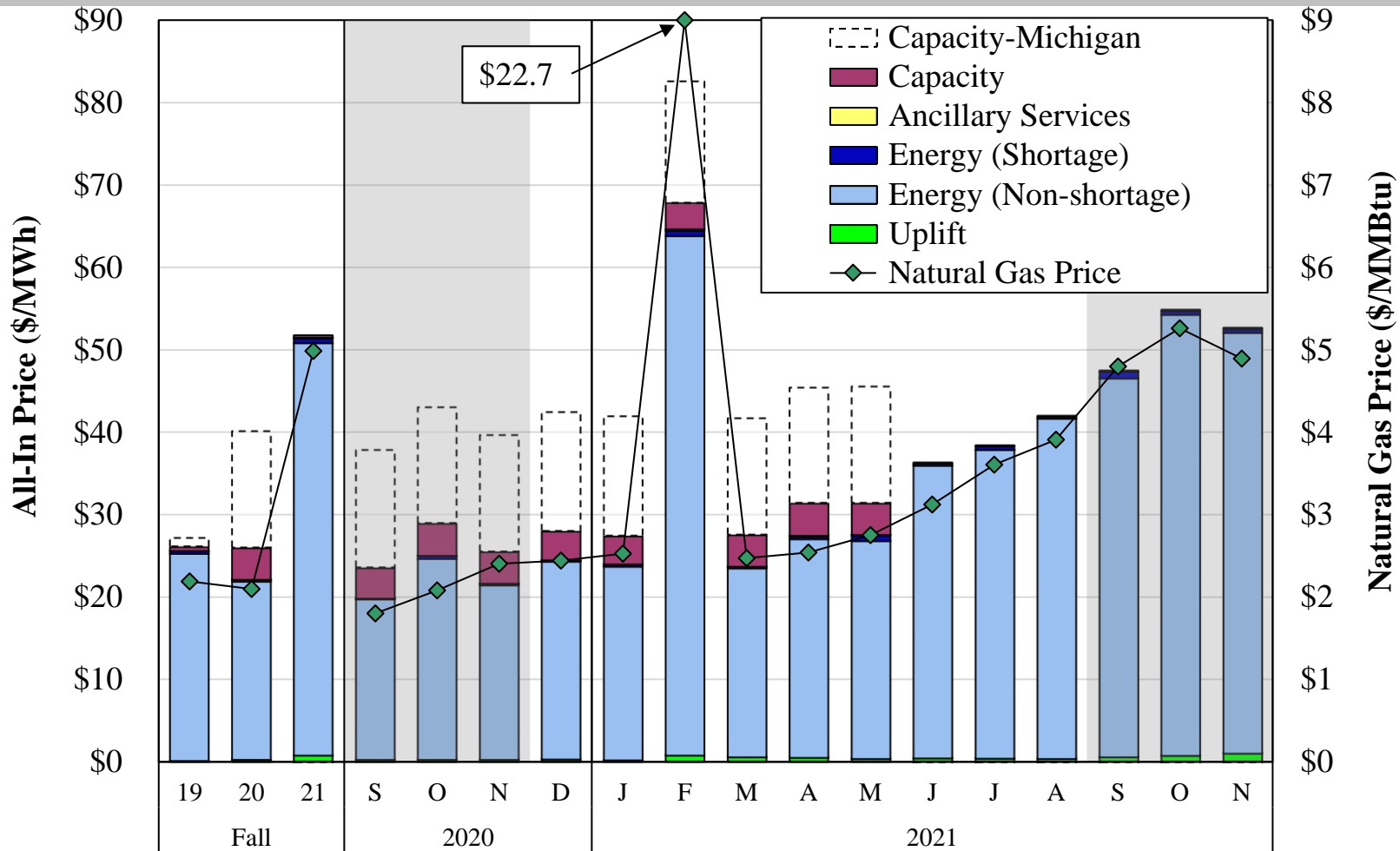


Day-Ahead Average Monthly Hub Prices Fall 2019–2021



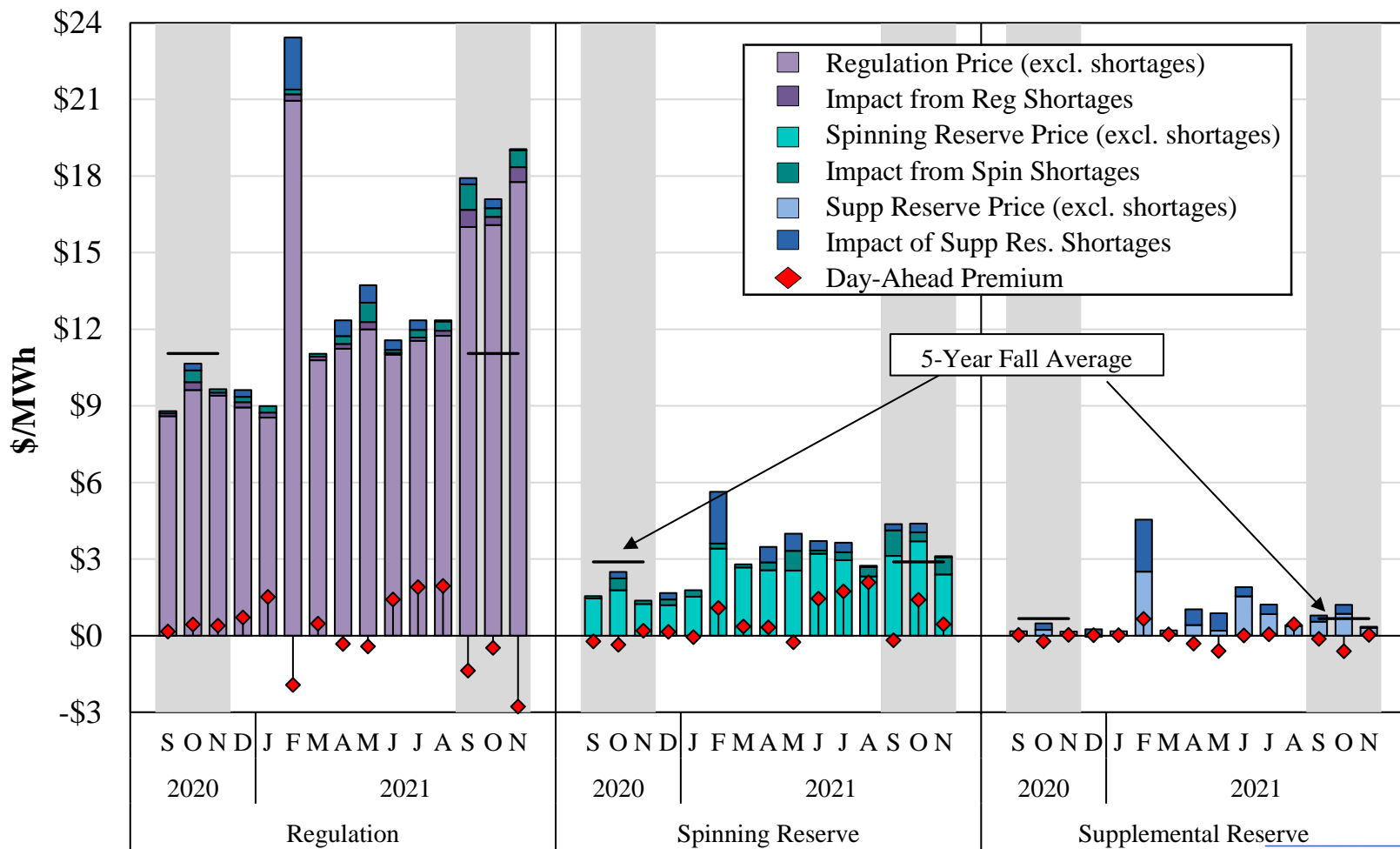


All-In Price Fall 2020 – 2021



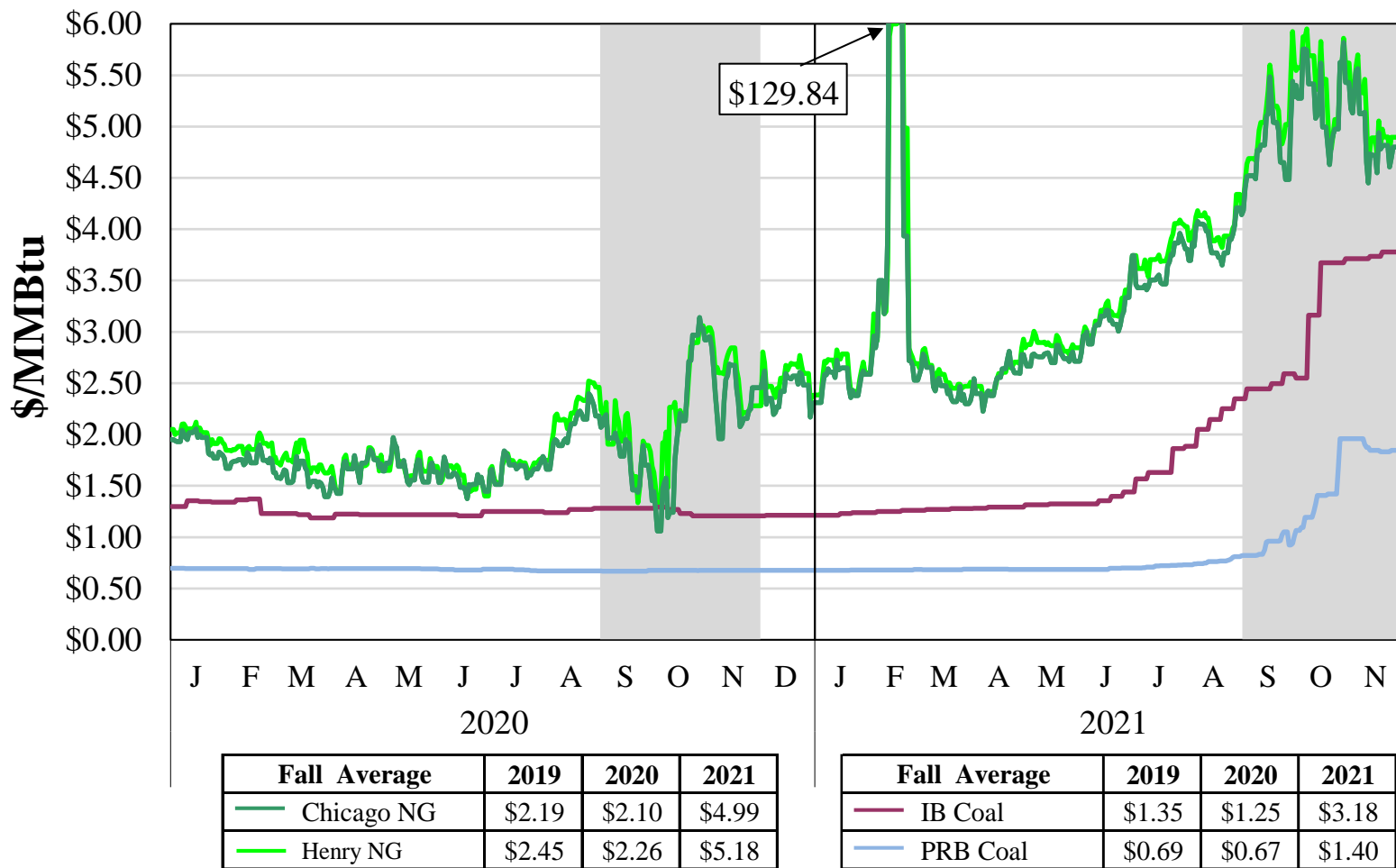


Ancillary Service Prices Fall 2020–2021



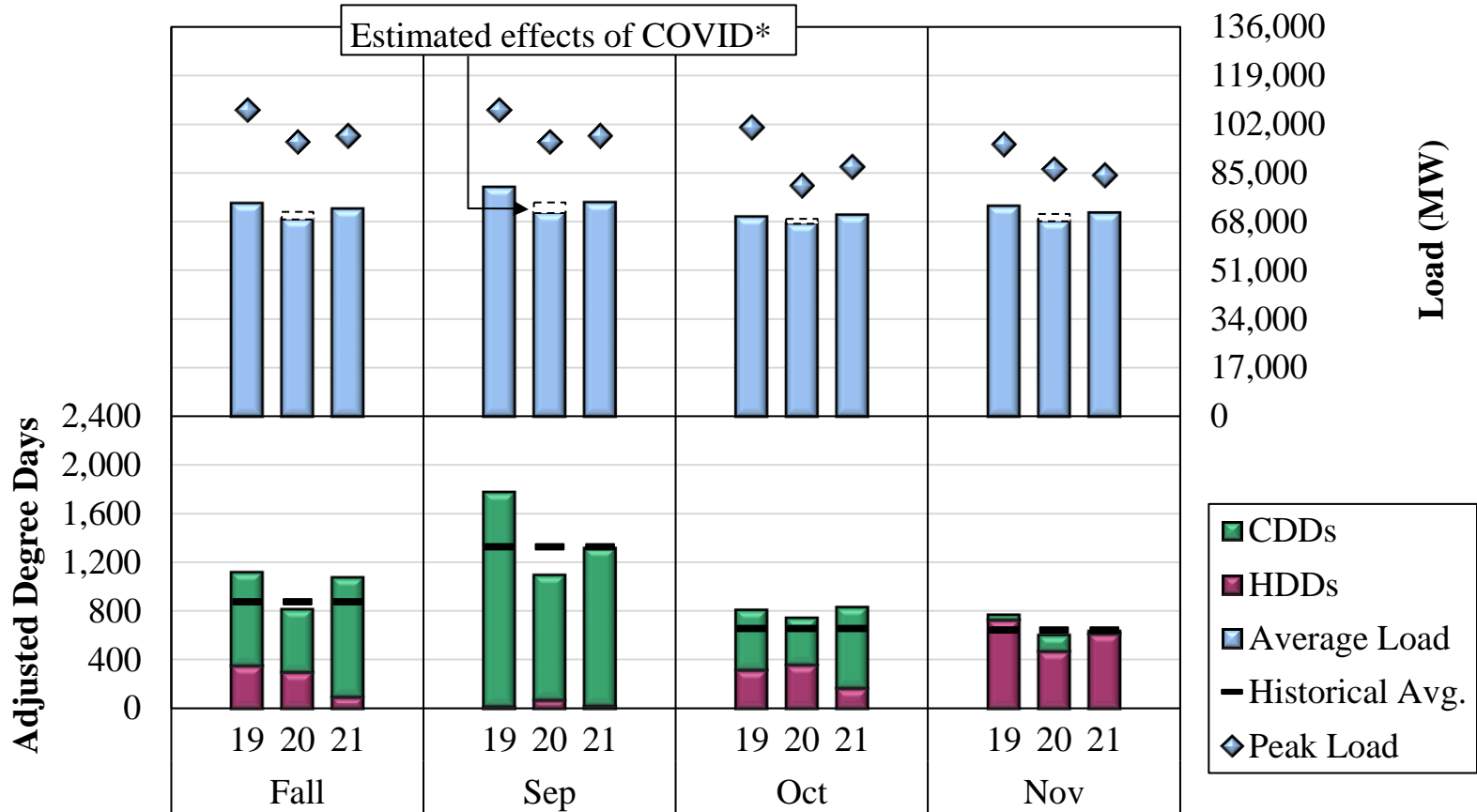


MISO Fuel Prices 2020 - 2021





Load and Weather Patterns Fall 2019–2021



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

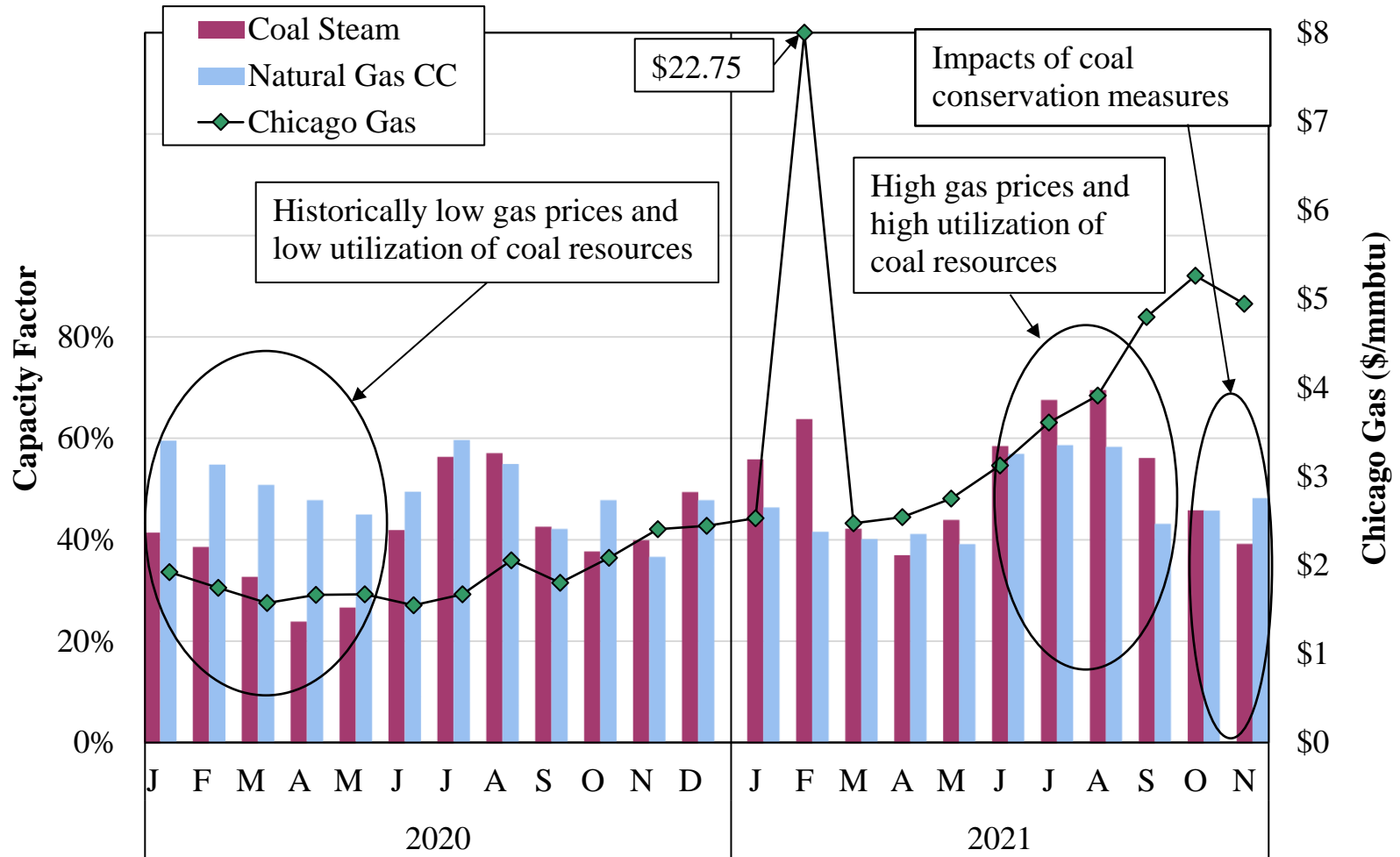
*Effects estimated by MISO through back-casting using its load forecasting model.

Capacity, Energy and Price Setting Share Fall, 2020 - 2021

Fall	Unforced Capacity				Energy Output		Price Setting			
	Total (MW)		Share (%)		Share (%)		SMP (%)		LMP (%)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Nuclear	12,107	11,866	9%	9%	16%	16%	0%	0%	1%	0%
Coal	46,864	46,740	37%	36%	35%	37%	40%	26%	83%	59%
Natural Gas	56,673	58,431	44%	45%	31%	30%	57%	73%	95%	95%
Oil	1,568	1,636	1%	1%	0%	0%	0%	0%	0%	0%
Hydro	4,034	3,671	3%	3%	1%	1%	1%	1%	3%	1%
Wind	3,660	4,304	3%	3%	16%	15%	1%	0%	72%	67%
Other	2,703	3,145	2%	2%	1%	1%	0%	0%	6%	6%
Total	127,608	129,794								

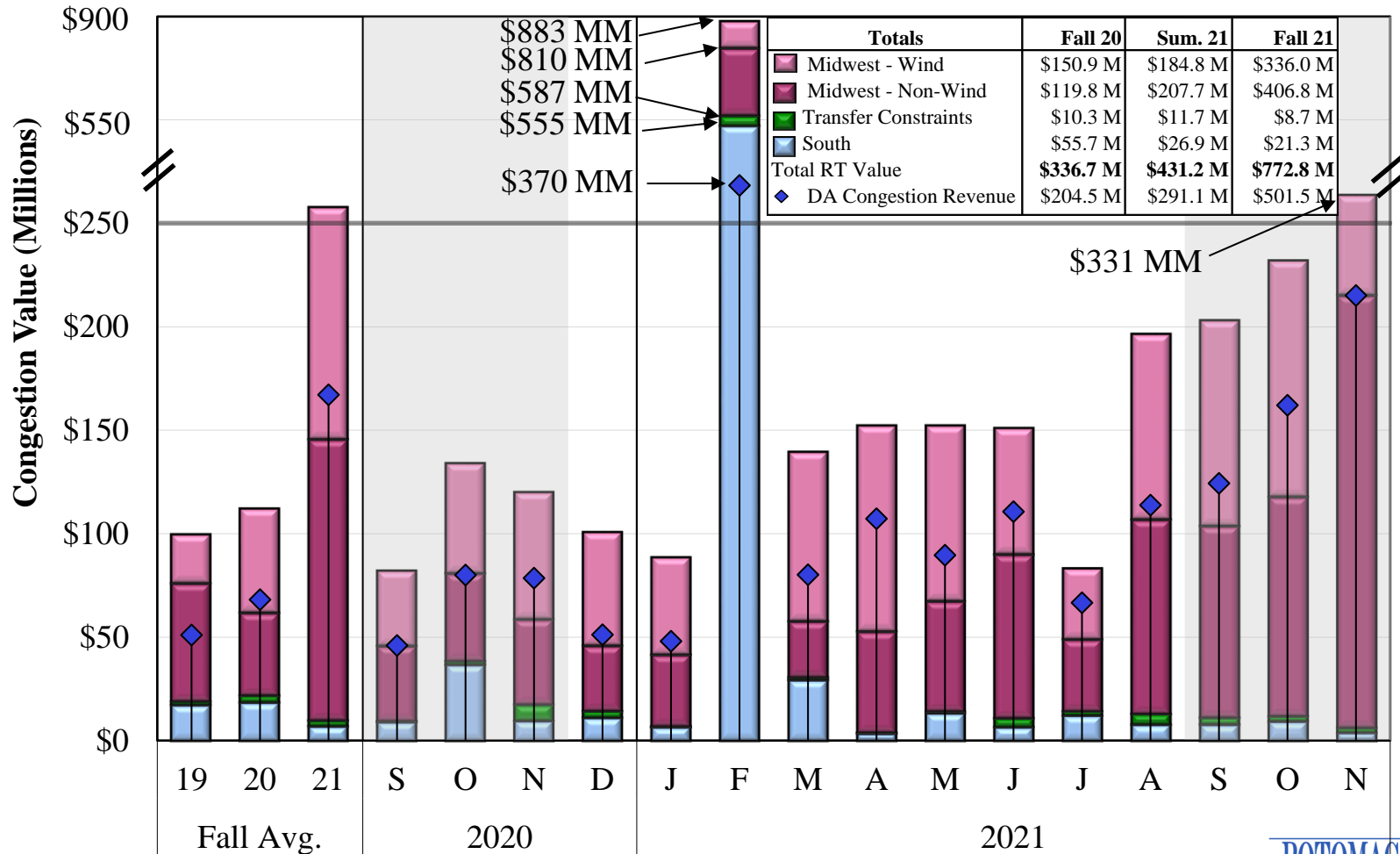


Capacity Factors By Fuel Type 2020–2021



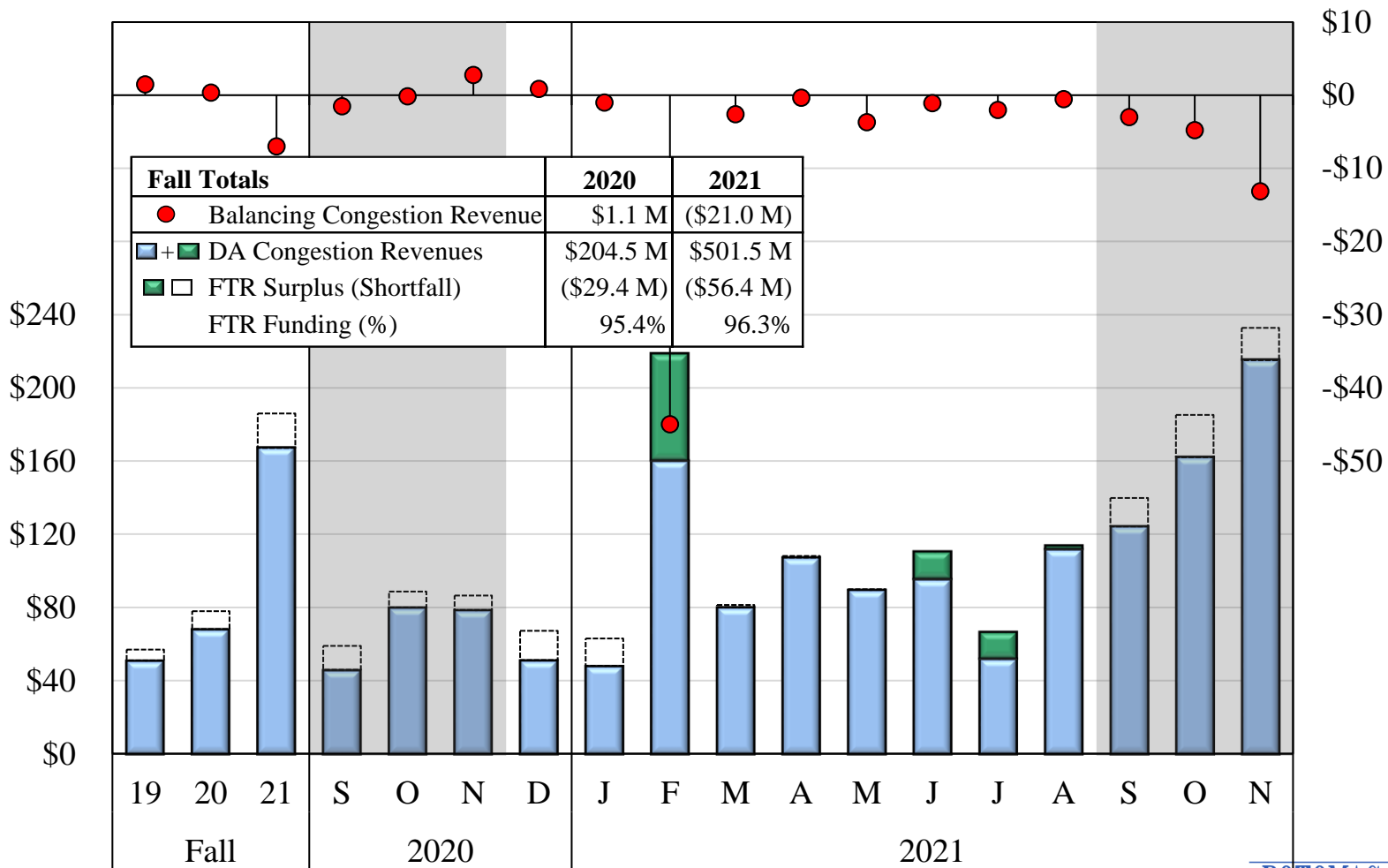


Value of Real-Time Congestion Fall 2020–2021





Day-Ahead Congestion, Balancing Congestion and FTR Underfunding



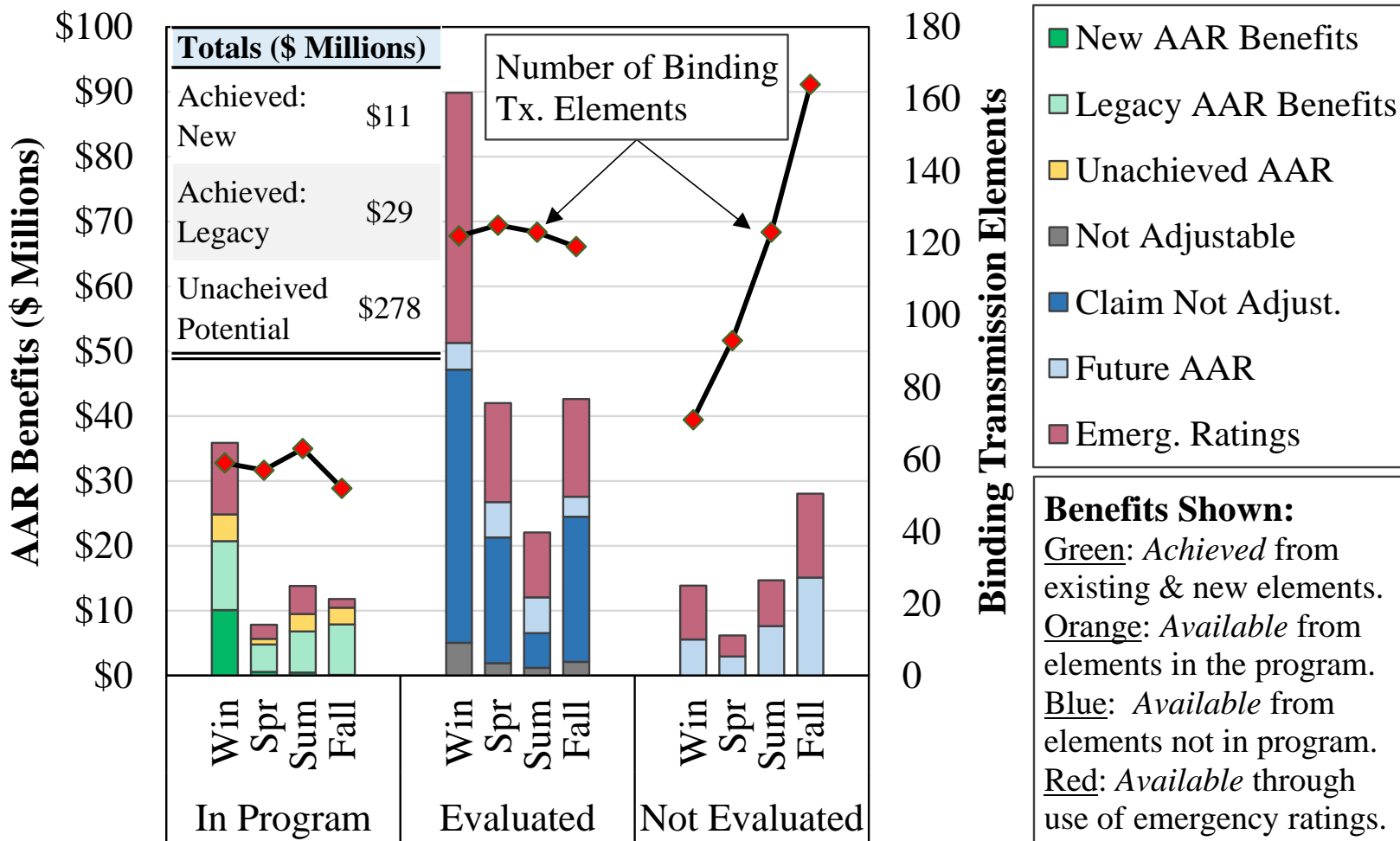


Benefits of Ambient-Adjusted and Emergency Ratings Fall 2020–2021

		Savings (\$ Millions)			# of Facilities for 2/3 of Savings	Share of Congestion
Fall		Ambient Adj. Ratings	Emergency Ratings	Total		
2020	Midwest	\$19.0	\$12.94	\$31.9	16	10.1%
	South	\$1.9	\$3.06	\$5.0	1	12.4%
	Total	\$20.9	\$16.0	\$36.9	17	10.3%
2021	Midwest	\$51.1	\$32.97	\$84.1	21	10.9%
	South	\$0.1	\$1.71	\$1.8	2	6.9%
	Total	\$51.2	\$34.7	\$85.9	23	10.7%

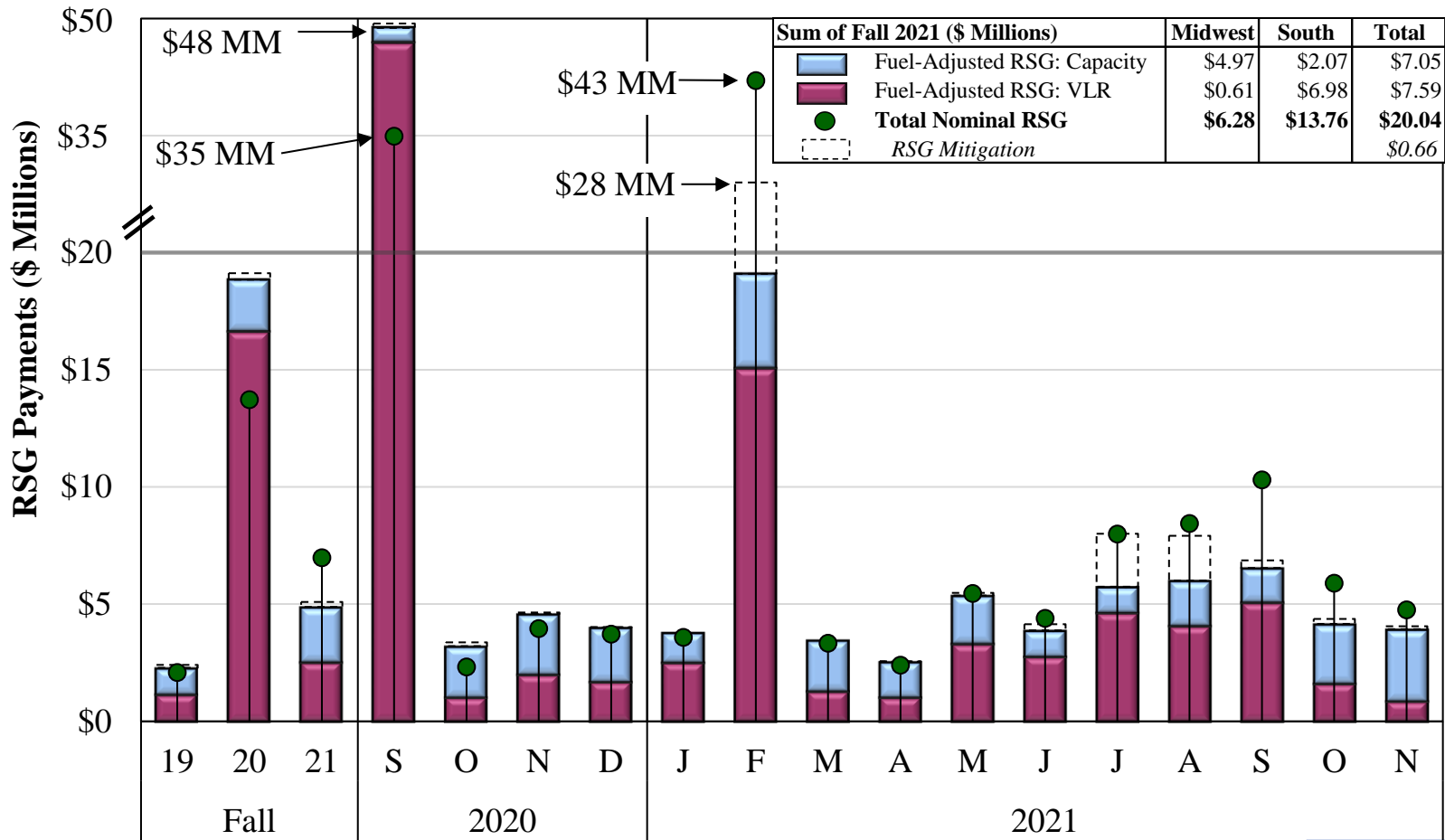
Benefits of AARs and Emergency Ratings

Winter 2020 – Fall 2021



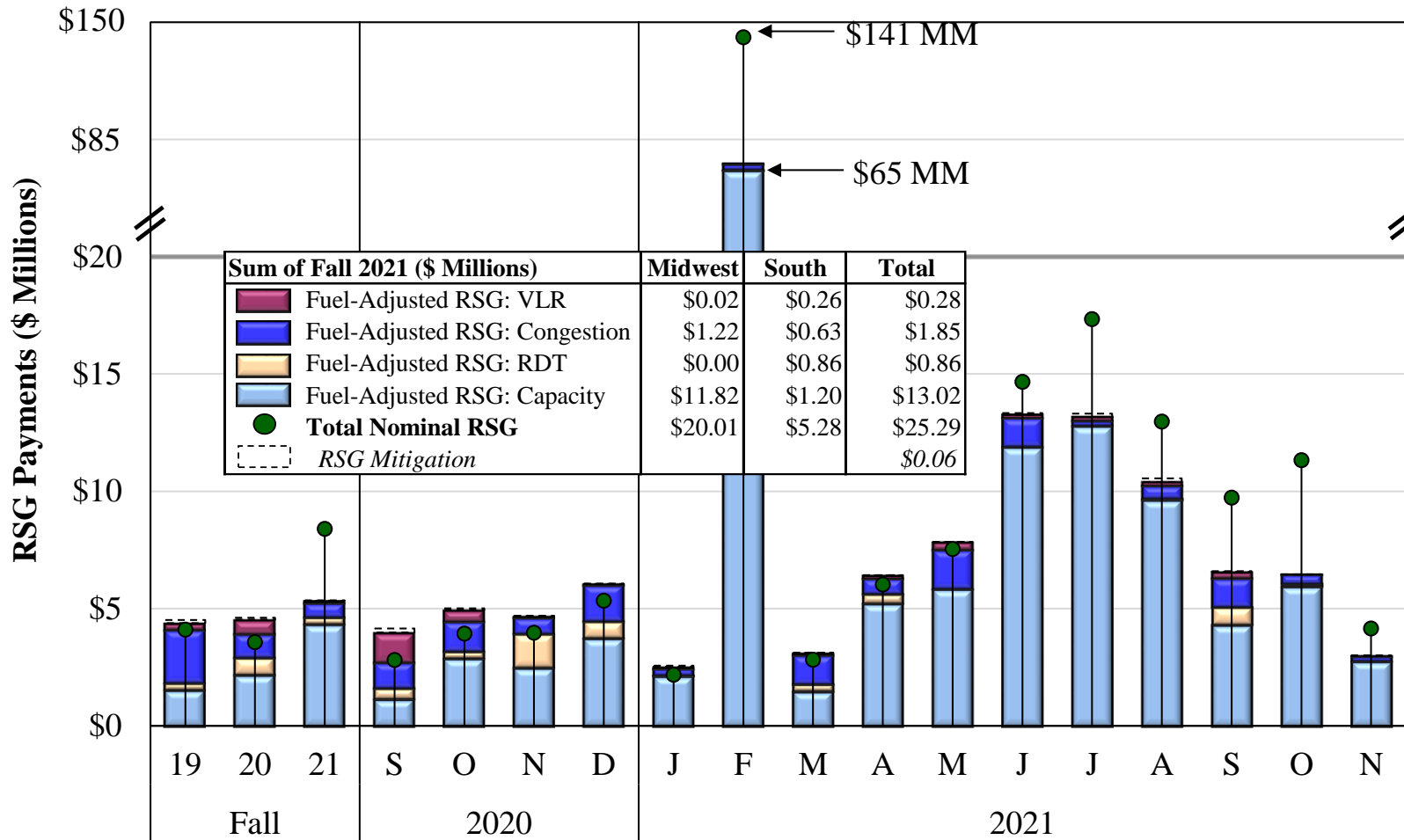


Day-Ahead RSG Payments Fall 2020–2021





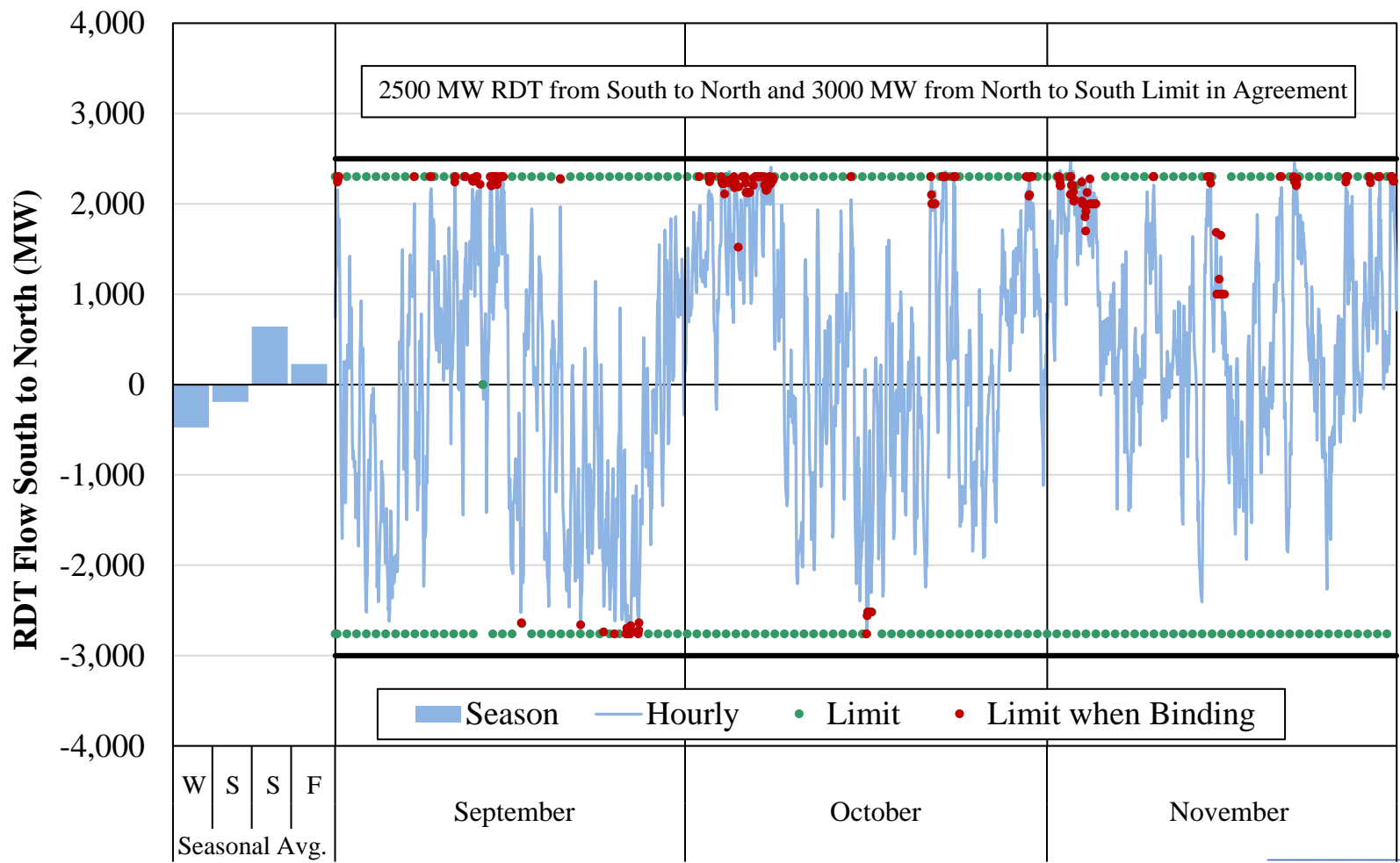
Real-Time RSG Payments Fall 2020–2021





Real-Time Hourly Inter-Regional Flows

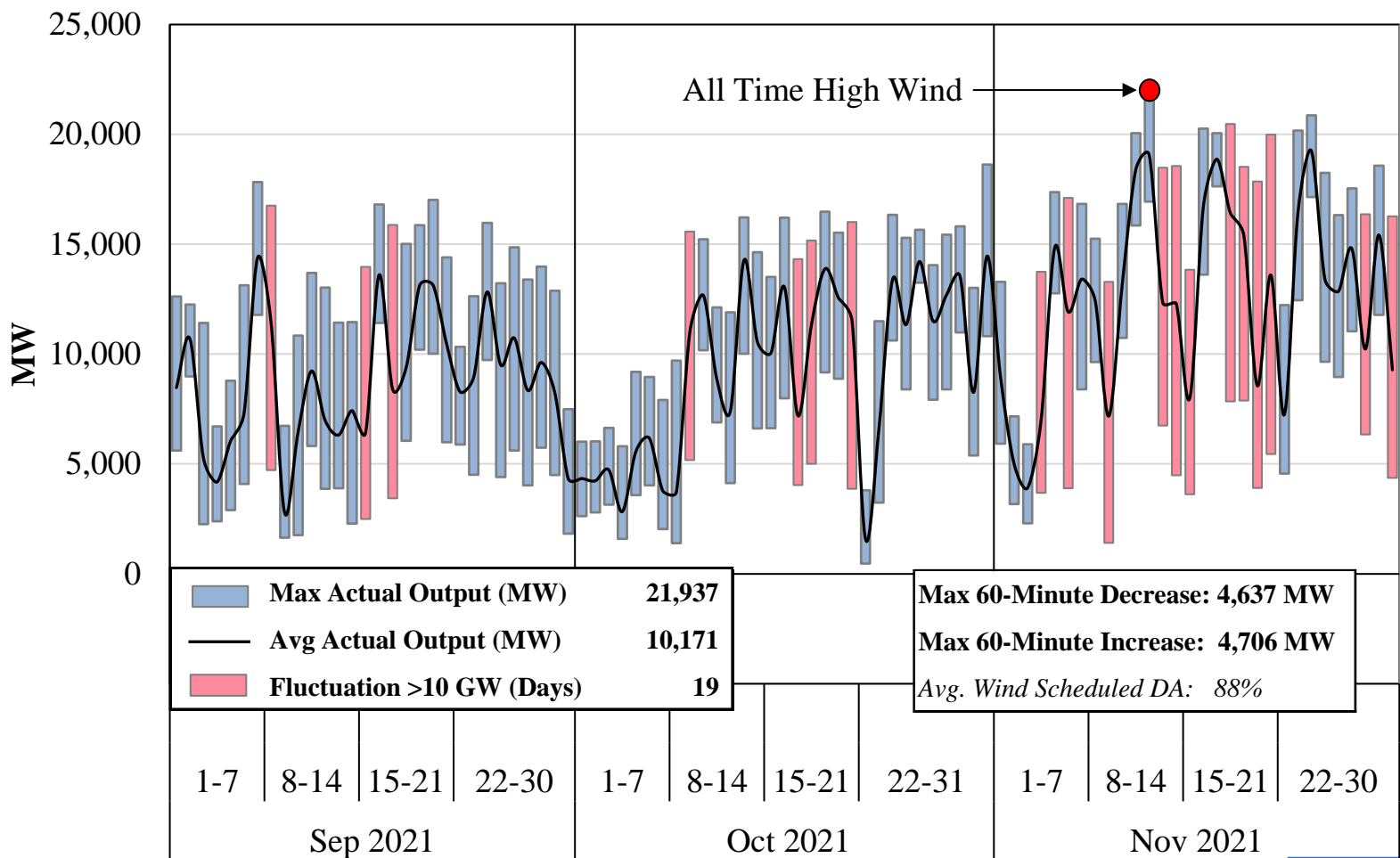
Fall 2021



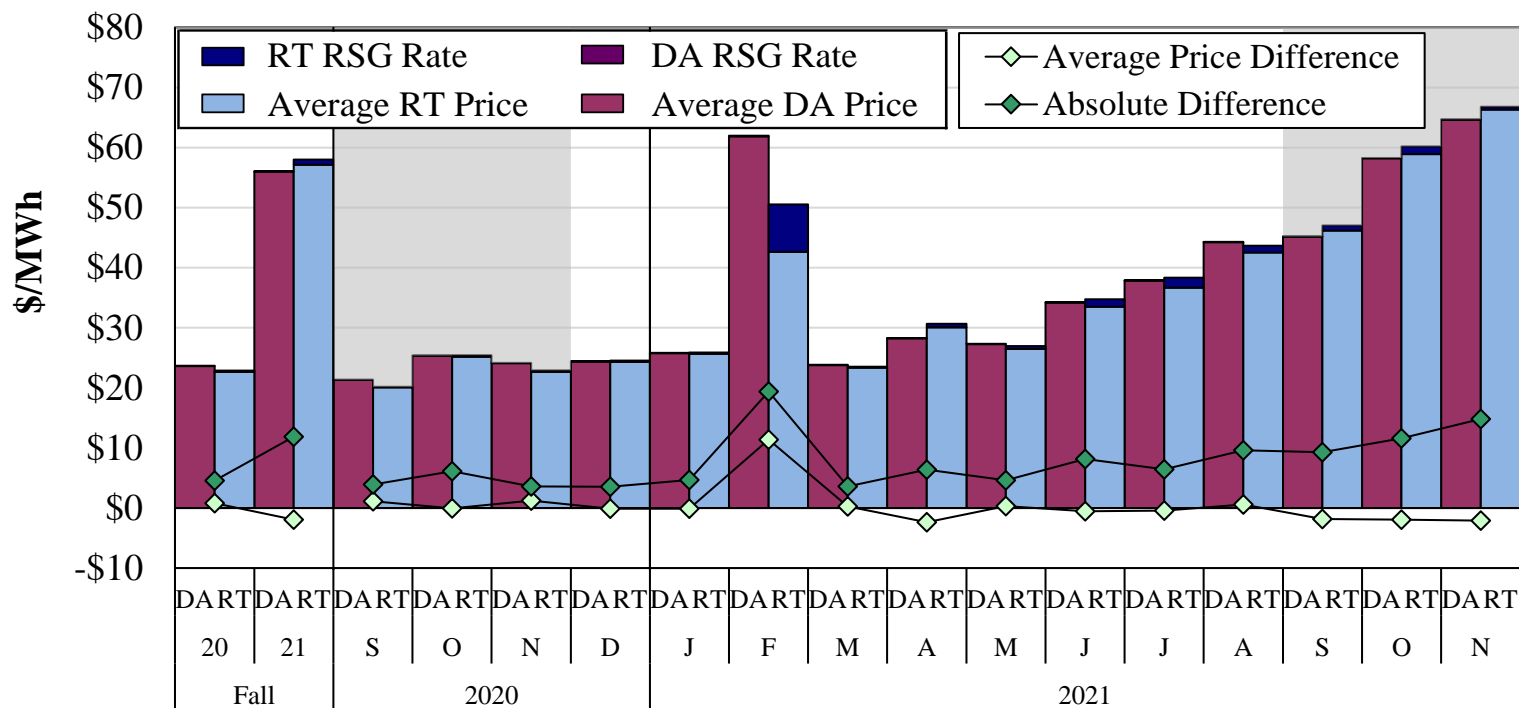


Wind Output in Real Time

Daily Range and Average



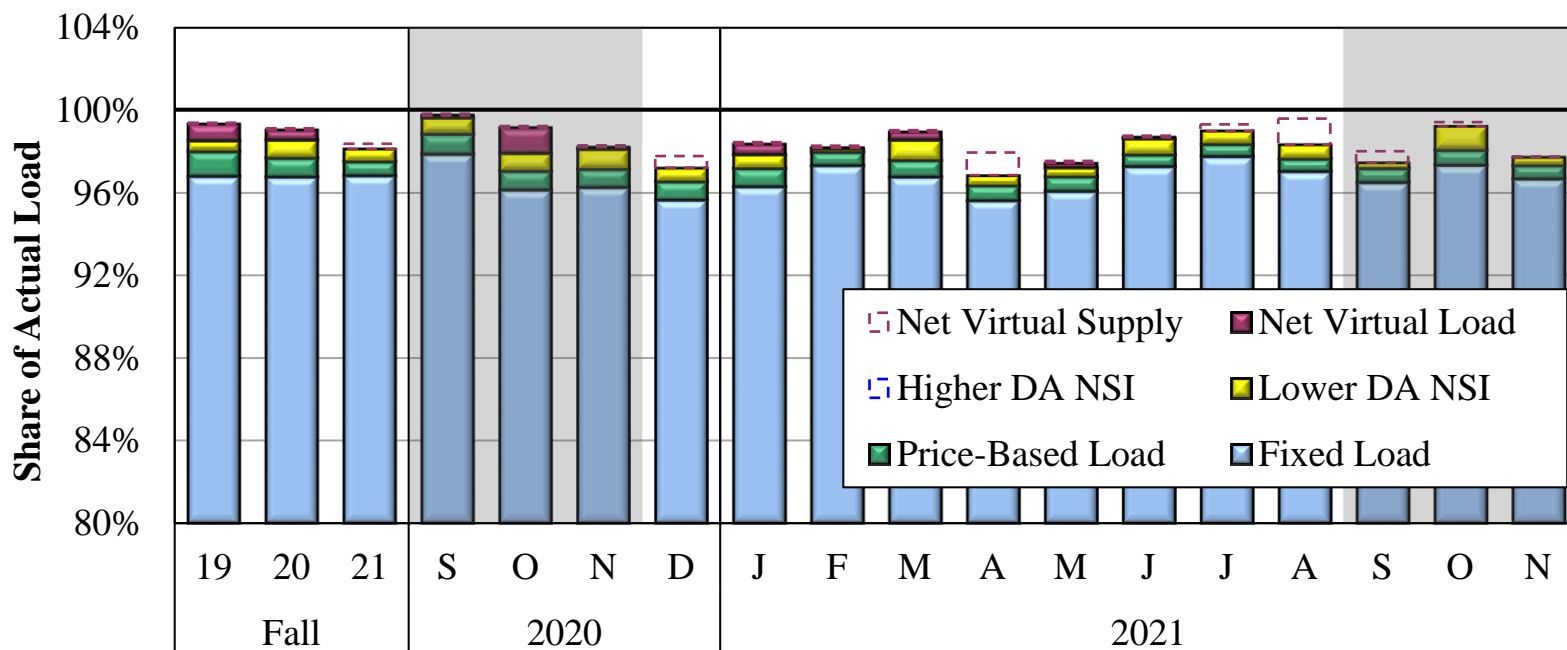
Day-Ahead and Real-Time Price Convergence Fall 2020–2021



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

Indiana Hub	4	-3	6	0	5	-1	0	23	1	-8	1	-2	-1	1	-4	-3	-3
Michigan Hub	3	-2	6	-2	5	-1	0	14	-1	-4	1	-3	0	1	-3	-1	-1
Minnesota Hub	-3	-2	0	-4	-3	-7	-1	6	3	-15	-9	-5	1	1	-7	-2	2
Arkansas Hub	-1	0	3	-5	0	1	3	-14	-3	-6	-1	1	-5	3	-5	-2	5
Texas Hub	7	1	6	9	4	1	0	-10	-6	0	-2	4	-1	3	-4	2	6
Louisiana Hub	2	0	8	-5	1	3	1	-14	-10	0	1	2	0	8	-5	3	3

Day-Ahead Peak Hour Load Scheduling Fall 2020–2021



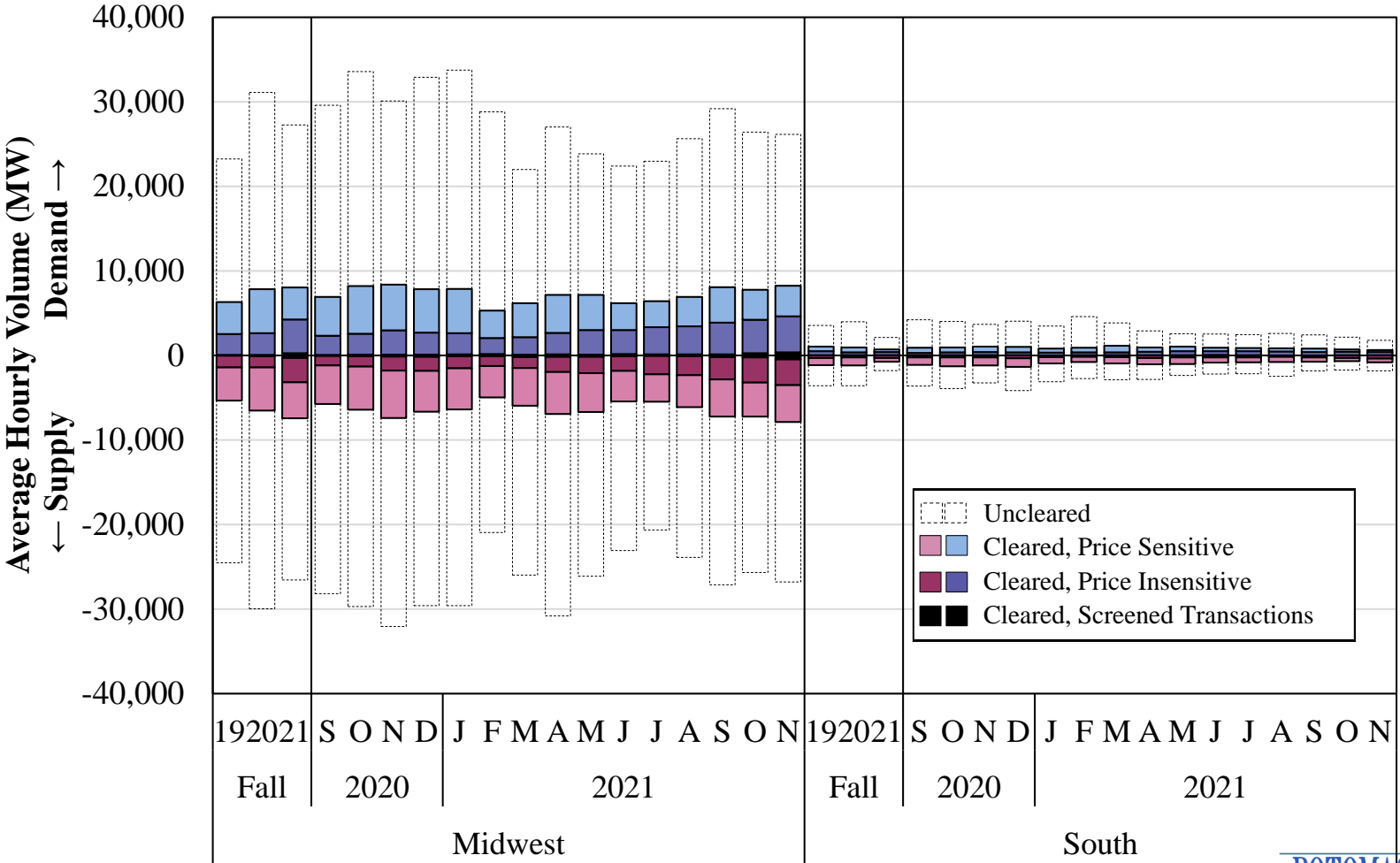
Share of Actual Load (%)

All Hours	99.1	98.9	98.4	99.7	98.8	98.4	97.8	98.5	98.5	98.3	97.2	97.7	98.9	99.7	99.8	98.3	99.2	97.8
Peak Hours Midwest	99.0	98.9	97.8	99.5	98.8	98.5	96.6	98.5	97.4	97.3	96.0	96.5	97.6	98.3	96.9	97.0	98.7	97.6
Peak Hours South	100.5	99.7	100.3	100.0	100.7	98.5	98.2	101.3	103.6	102.3	100.3	99.2	101.6	100.9	101.8	99.3	100.2	101.4



Virtual Load and Supply

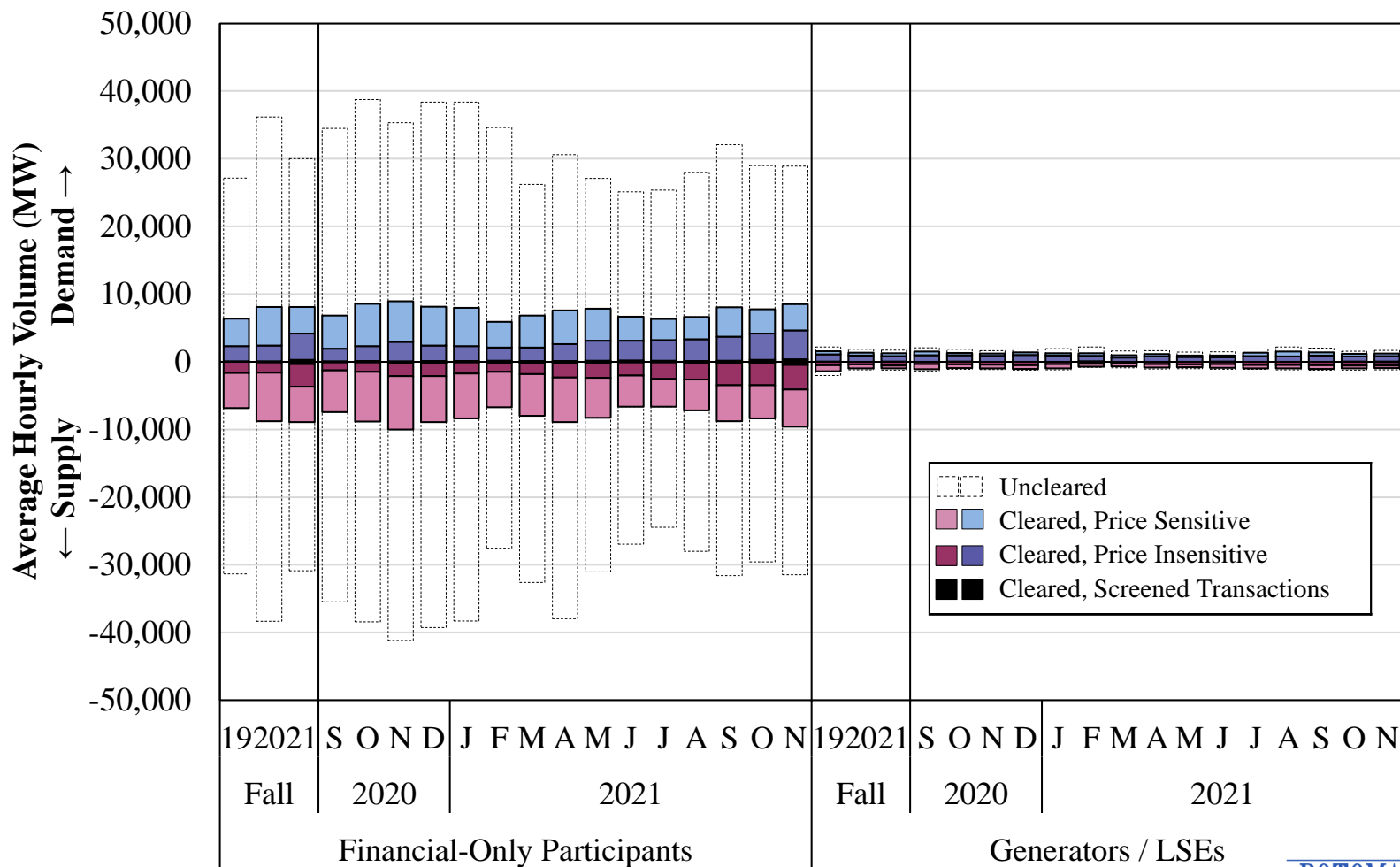
Fall 2020–2021





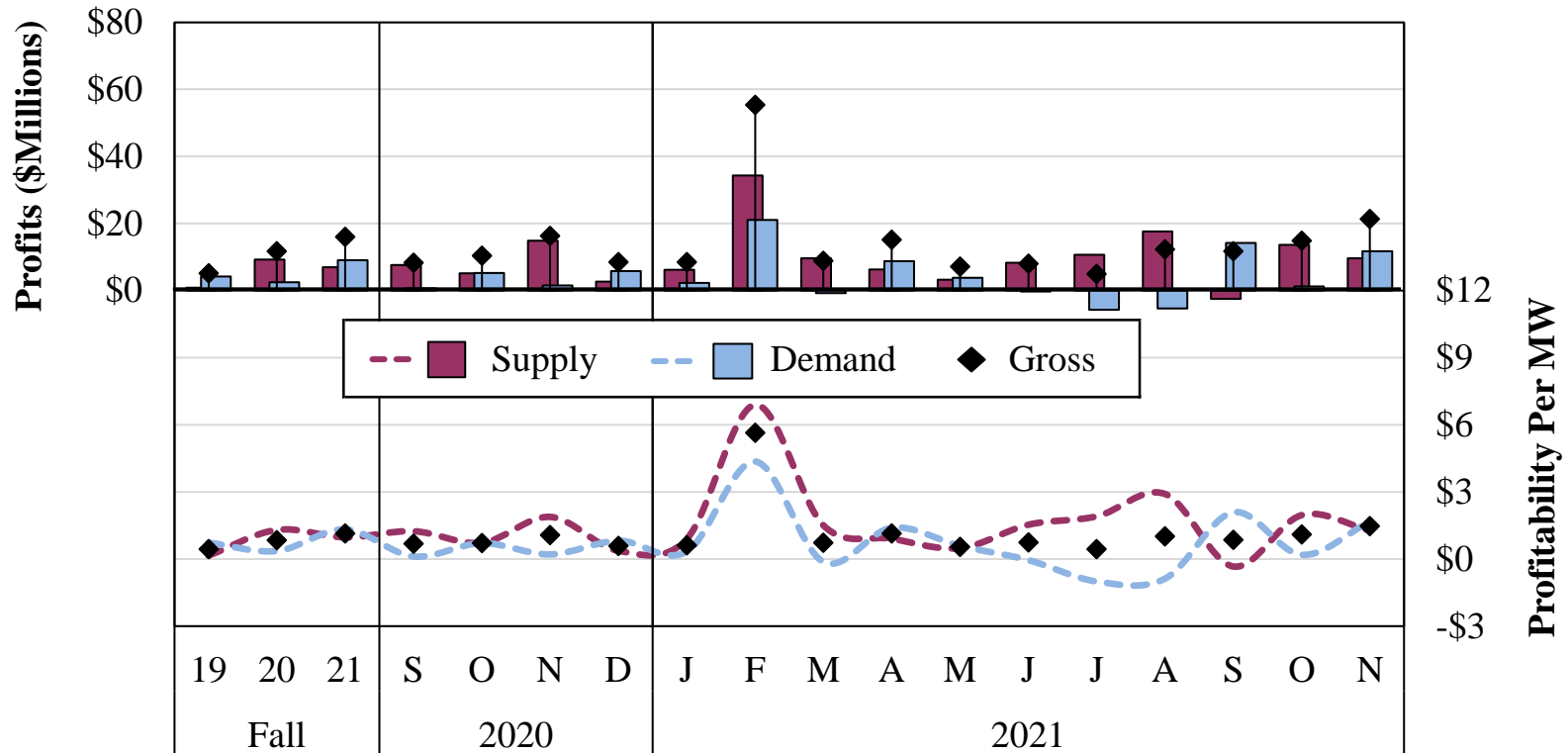
Virtual Load and Supply by Participant Type

Fall 2020–2021





Virtual Profitability Fall 2020–2021



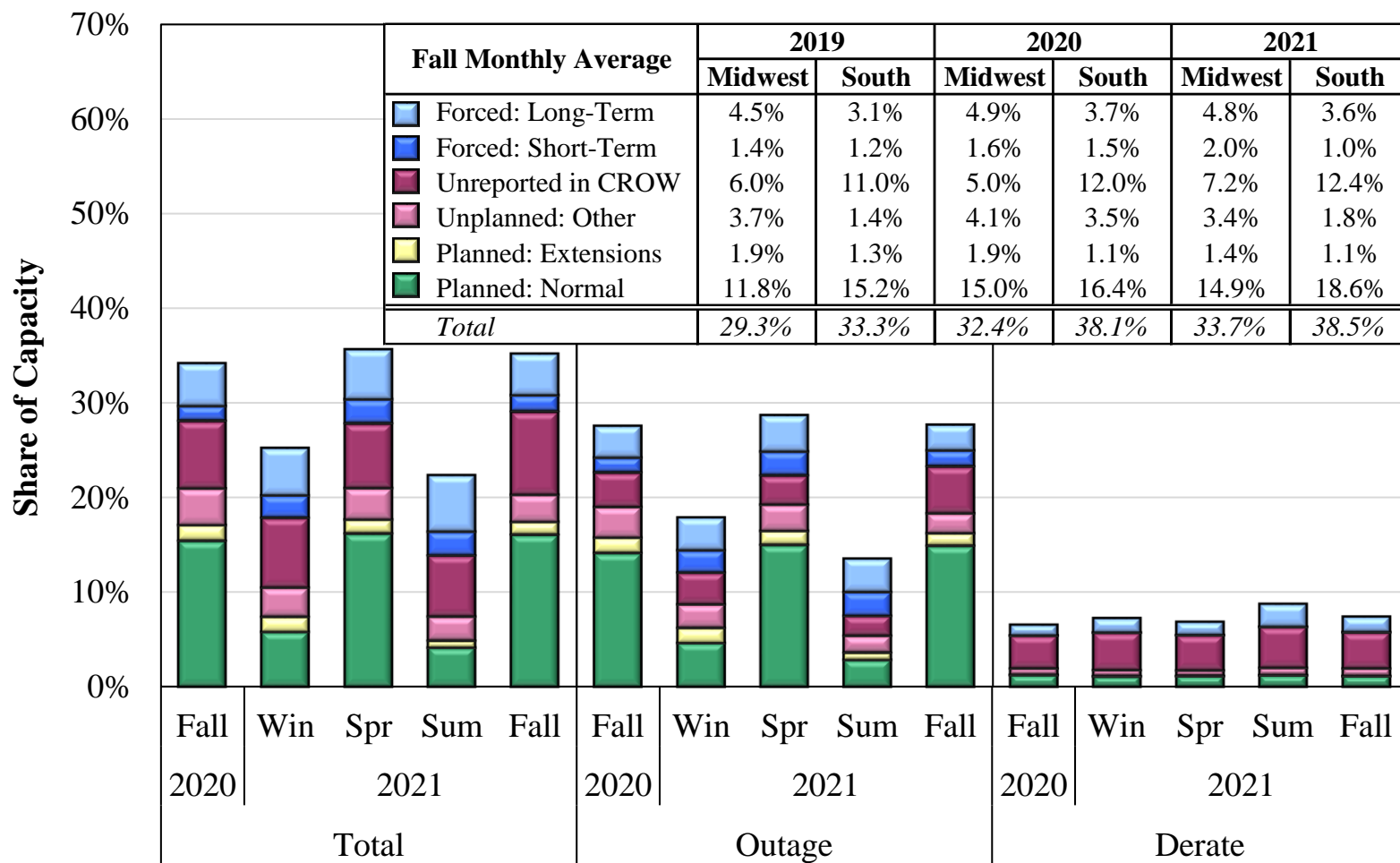
Percent Screened

Supply	0.3	1.1	3.5	0.9	1.0	1.3	1.7	1.0	1.8	2.5	2.0	2.4	1.4	1.4	1.6	2.8	2.7	4.9
Demand	1.2	1.1	3.2	0.8	1.2	1.1	1.3	1.4	3.7	1.4	1.7	1.8	3.0	2.0	1.6	1.7	3.5	4.3
Total	0.8	1.1	3.4	0.9	1.1	1.2	1.5	1.2	2.7	2.0	1.9	2.1	2.2	1.7	1.6	2.3	3.1	4.6



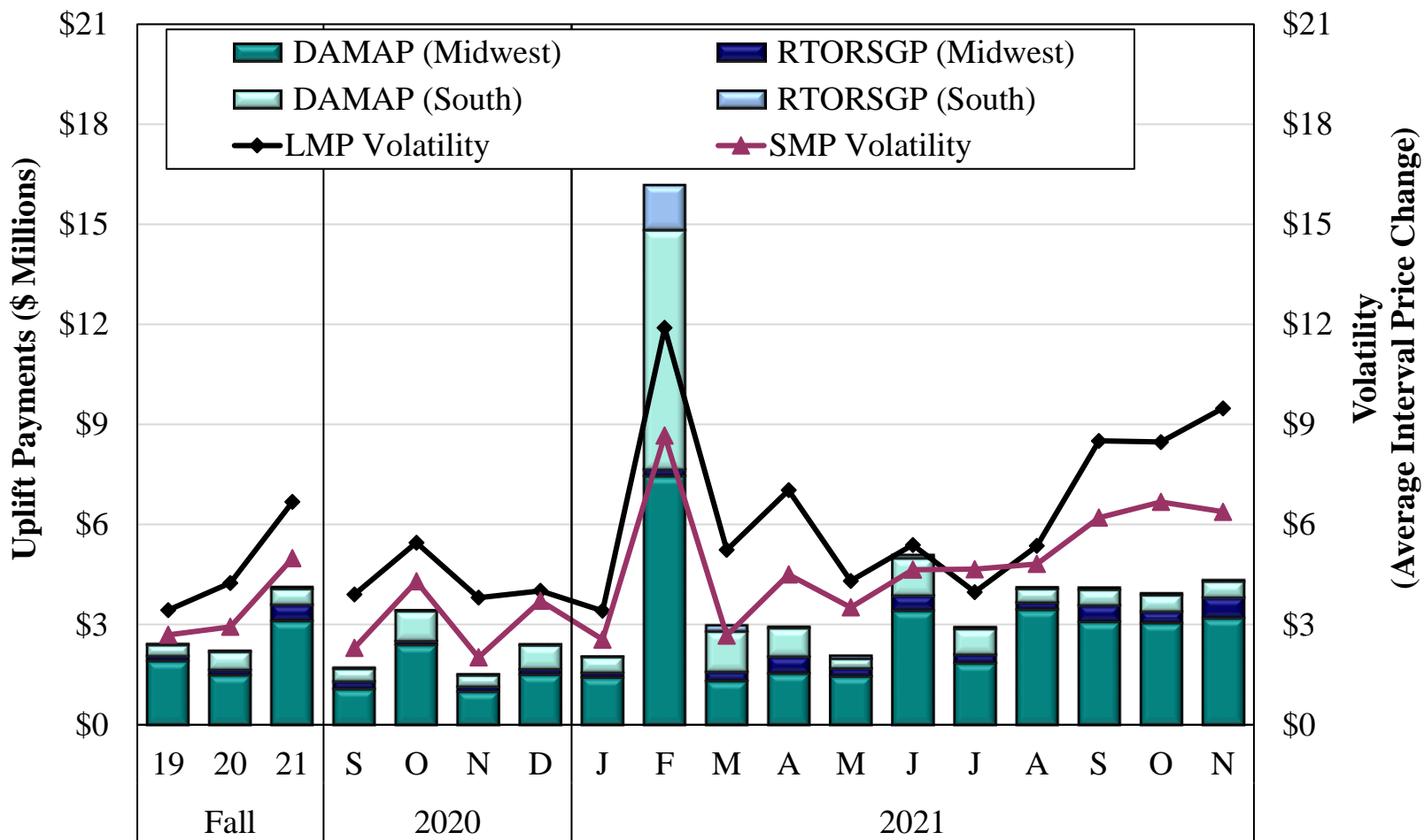
Generation Outages and Deratings

Fall 2020–2021

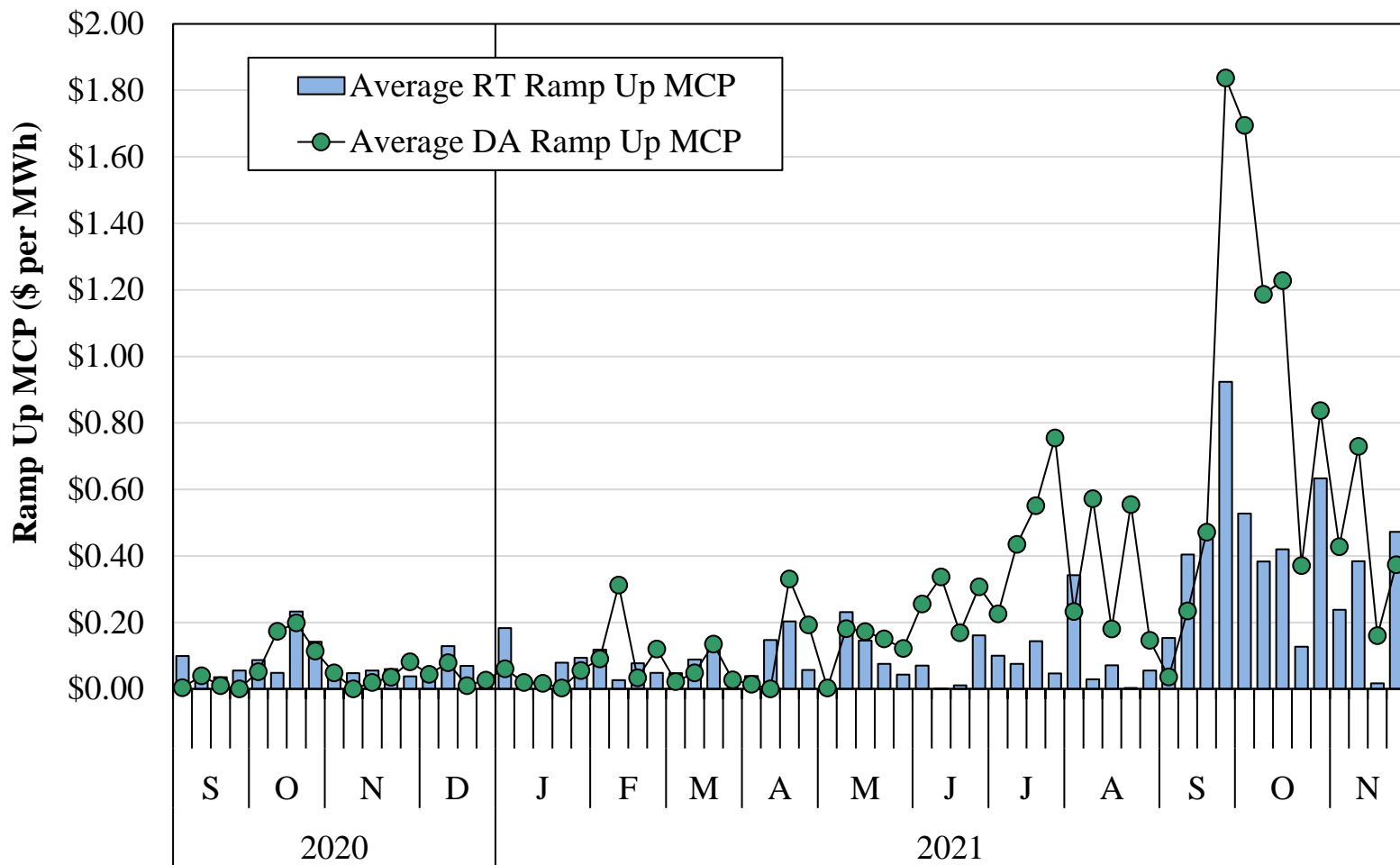




Price Volatility Make Whole Payments Fall 2020–2021

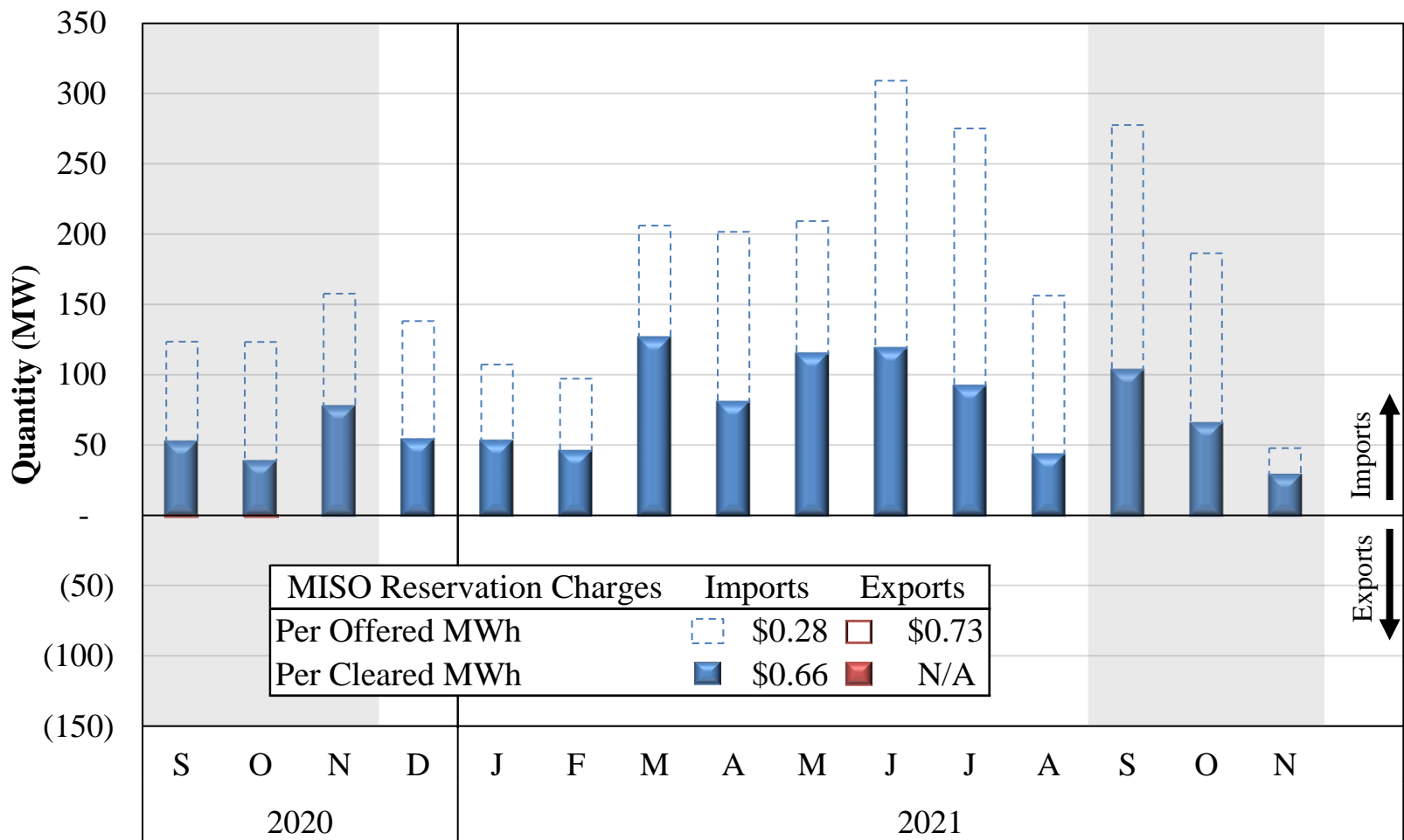


Day-Ahead and Real-Time Ramp Up Price Fall 2020–2021



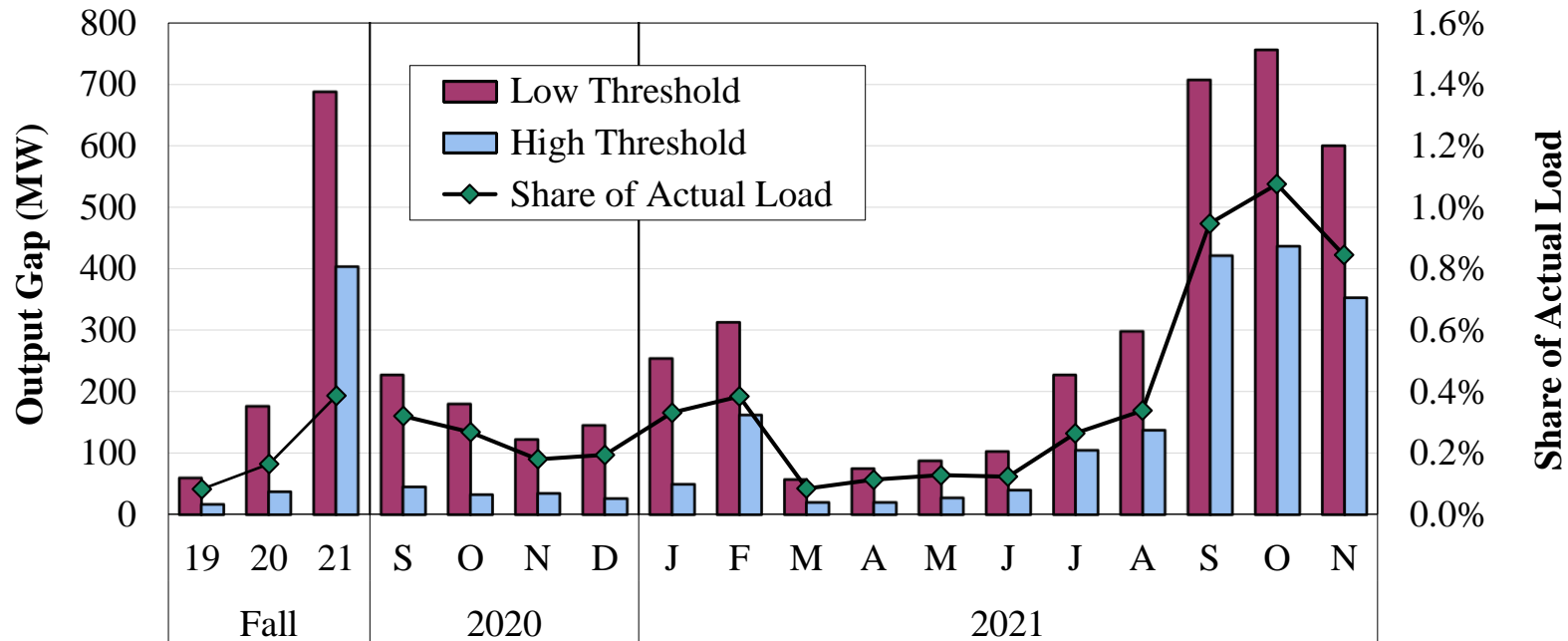


Coordinated Transaction Scheduling (CTS) Fall 2020–2021





Monthly Output Gap Fall 2020–2021



Low Threshold Results by Unit Status (MW)

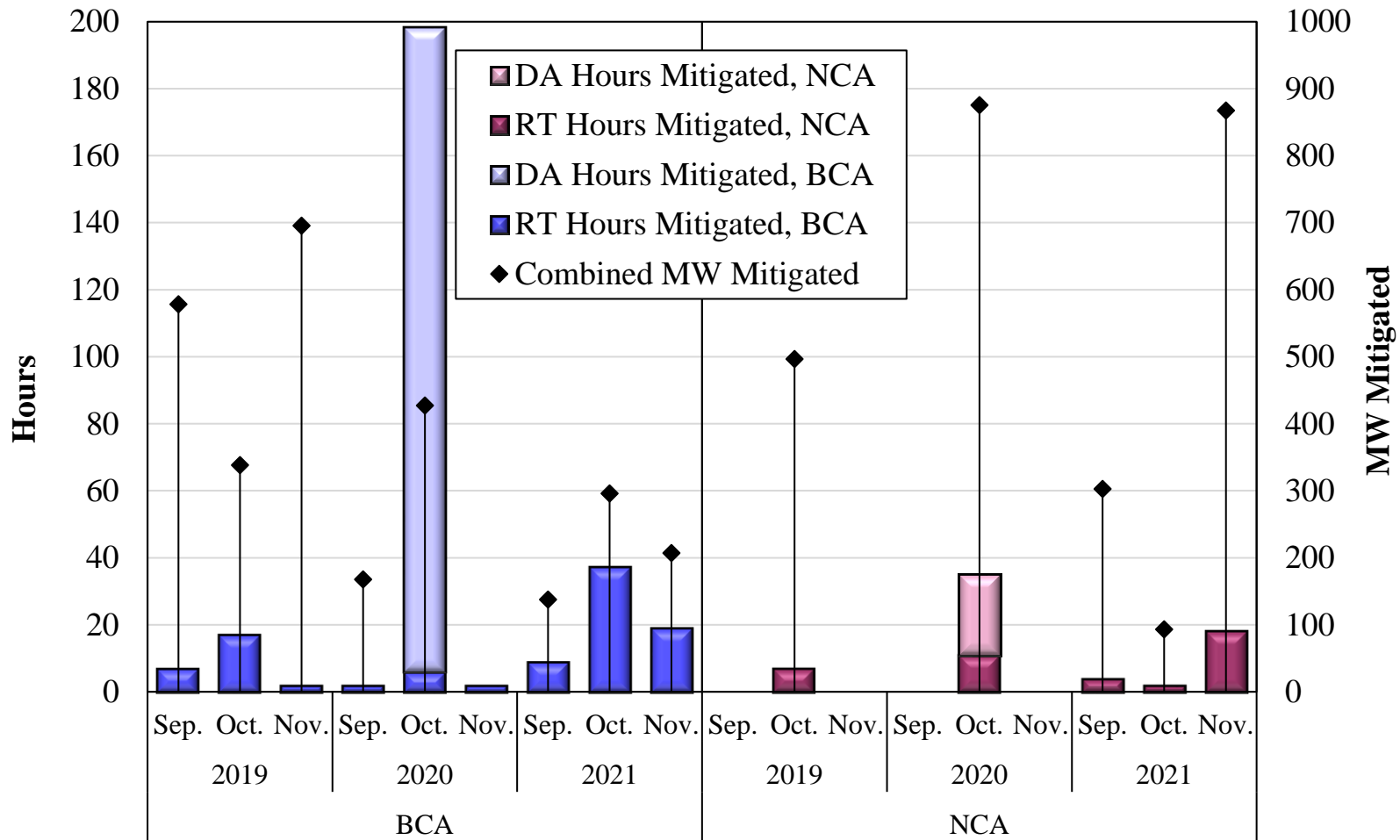
Offline	11	8	89	4	8	10	2	0	90	3	0	9	8	27	46	129	103	35
Online	49	169	598	223	172	112	144	254	223	55	75	79	96	201	252	577	652	565

High Threshold Results by Unit Status (MW)

Offline	9	6	60	4	7	7	2	0	70	2	0	8	7	22	38	98	62	19
Online	8	32	342	41	25	28	25	49	91	18	20	20	33	82	100	322	373	333

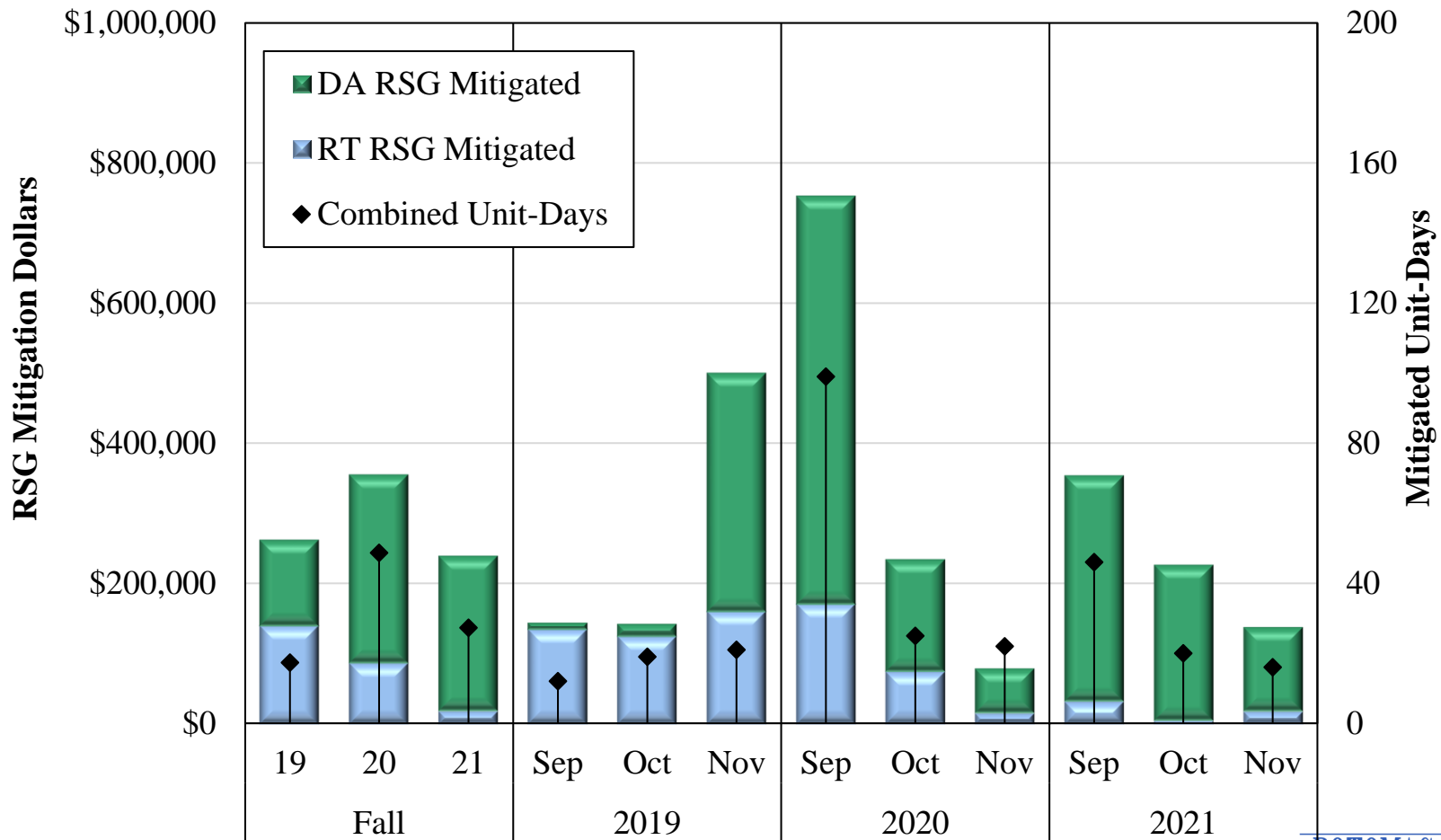


Day-Ahead And Real-Time Energy Mitigation Fall 2020 and 2021





Day-Ahead and Real-Time RSG Mitigation Fall 2019 - 2021





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		