IMM Quarterly Report: Summer 2021

MISO Independent Market Monitor

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Highlights and Findings: Summer 2021

- The MISO markets performed competitively this summer, market power mitigation was infrequent, and conduct was highly competitive overall.
- Energy prices rose 58 percent from last summer as fuel prices and load rose.
  - ✓ Gas prices doubled from last summer and coal prices rose modestly;
  - ✓ Average and peak load grew 3 and 2 percent, respectively, over last year as the effects of COVID-19 diminished and hotter than normal temperatures occurred.
- Day-ahead and real-time RSG payments more than doubled over last summer to total more than $59 million.
  - ✓ Some of the increase is attributable to higher natural gas prices.
  - ✓ The relatively high RSG points to opportunities for improvement in MISO’s commitment of resources.
- Real-time congestion increased 34 percent over last year.
  - ✓ Over 40 percent of the congestion was attributable to wind generation, although wind output was only slightly higher than last summer.
- Hurricane Ida caused severe damage to the transmission system on August 29.
  - ✓ Shortages were avoided because more load was lost than generation.
  - ✓ Real-time prices were erroneously set to zero at many dead buses from the 29^{th} to the 30^{th}, but MISO made corrections in a timely fashion.

Quarterly Summary

		Value	*Change*[1] Prior Qtr.	*Change*[1] Prior Year
RT Energy Prices ($/MWh)	Monitor/Discuss	$38.49	*50%*	*58%*
Fuel Prices ($/MMBtu)				
Natural Gas - Chicago	Monitor/Discuss	$3.55	*37%*	*102%*
Natural Gas - Henry Hub	Monitor/Discuss	$3.68	*38%*	*101%*
Western Coal	Expected	$0.72	*6%*	*7%*
Eastern Coal	Expected	$1.73	*34%*	*40%*
Load (GW)[2]				
Average Load	Expected	86.0	*27%*	*3%*
Peak Load	Expected	119.9	*22%*	*2%*
% Scheduled DA (Peak Hour)	Expected	98.7%	97.7%	100.3%
Transmission Congestion ($M)				
Real-Time Congestion Value	Monitor/Discuss	$431.2	*-3%*	*34%*
Day-Ahead Congestion Revenue	Monitor/Discuss	$292.6	*6%*	*31%*
Balancing Congestion Revenue[3]	Expected	$4.2	$6.7	$73.2
Ancillary Service Prices ($/MWh)				
Regulation	Expected	$11.44	*0%*	*46%*
Spinning Reserves	Expected	$3.36	*-3%*	*76%*
Supplemental Reserves	Expected	$1.17	*64%*	*291%*

		Value	*Change*[1] Prior Qtr.	*Change*[1] Prior Year
FTR Funding (%)	Expected	105%	100%	101%
Wind Output (MW/hr)	Monitor/Discuss	6,239	*-41%*	*2%*
Guarantee Payments ($M)[4]				
Real-Time RSG	Monitor/Discuss	$43.9	*198%*	*164%*
Day-Ahead RSG	Expected	$15.4	*31%*	*172%*
Day-Ahead Margin Assurance	Expected	$11.4	*71%*	*5%*
Real-Time Offer Rev. Sufficiency	Monitor/Discuss	$1.1	*-18%*	*2%*
Price Convergence[5]				
Market-wide DA Premium	Expected	0.0%	-2.5%	-1.1%
Virtual Trading				
Cleared Quantity (MW/hr)	Expected	15,562	*-12%*	*-29%*
% Price Insensitive	Expected	44%	33%	22%
% Screened for Review	Expected	2%	2%	1%
Profitability ($/MW)	Expected	$0.74	$0.81	$0.32
Dispatch of Peaking Units (MW/hr)	Expected	2,188	648	2569
Output Gap- Low Thresh. (MW/hr)	Expected	209	73	188
Other:				

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.

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Highlights for Summer 2021

Maximum Generation Event on June 10 (Slides 17-18)

- Hotter than normal temperatures led to several Hot Weather Alerts, Capacity Advisories, Conservative Operations and Maximum Generation Alerts.
- On June 10, MISO declared a Midwest Maximum Generation Event Step 2 (EEA2) beginning at 2 pm to obtain 2500 MW of LMRs.
  - ✓ MISO had sent scheduling instructions at 11 am to the LMRs and must declare an emergency 2 hours ahead for the LMRs to be required to perform.
  - ✓ Although LMRs did not set the price, ELMP ramp restrictions led to average prices of $140 per MWh during the event, leading to increased imports.
- We evaluated the conditions on the June 10 Event and found:
  - ✓ It did not appear that the EEA2 was needed to maintain sufficient supply.
  - ✓ The combination of commitments, LMRs and higher imports led to a surplus in the Midwest exceeding 10 GW for most of the event.
  - ✓ MISO paid nearly $2 million in DAMAP payments to resources that had to be held down to make room for the additional supply (and LMRs).
  - ✓ Without the EEA2 and the LMRs, prices would have averaged $50 - $60 per MWh the first 2 event hours and imports would not likely have risen.

Highlights for Summer 2021

High RSG payments and Real-Time Commitments (Slides 19-21)

- Day-ahead and real-time RSG more than doubled over last year.
  - ✓ Higher gas prices increased generators' costs and led to higher RSG costs.
  - ✓ Conditions were tighter on a number of days because of hotter than normal temperatures in June and August, particularly in the Midwest.
  - ✓ More than 30 percent of day-ahead RSG was mitigated for South VLR units.
- Of the $38 million in real-time RSG incurred for Midwest commitments this summer, 41 percent was paid for commitments in just 10 days.
  - ✓ High RSG on these days was due to large quantities of commitments in the Midwest that resulted in high real-time surpluses and relatively low prices.
  - ✓ MISO committed approximately 60 percent more MW in real time this summer compared to prior years while real-time RSG tripled.
- Our evaluation of these commitments and the associated RSG showed that:
  - ✓ 26 percent of the commitments were ultimately needed.
  - ✓ Because of forecast errors and uncertainties, 70 percent appeared to be needed at the time they were made.
  - ✓ The remaining RSG did not appear to be needed – we are working with MISO to evaluate and improve the commitment processes.

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Highlights for Summer 2021

<u>High RSG payments and Real-Time Commitments (Slides 22-23)</u>

- We evaluated the resource commitment patterns throughout the quarter, particularly on the days with the highest RSG.
- Four of the highest RSG days are shown on slide 22, which accounted for more than $9 million of RSG. On these days we found that resources were:
  - ✓ Committed earlier than needed;
  - ✓ Not decommitted after they were no longer needed; and
  - ✓ Committed in larger quantities than needed.
- We are discussing improvements in the commitment process with MISO:
  1) Allowing 10-minute offline units to satisfy real-time capacity needs since they provide almost equivalent reliability value when offline as online.
  2) Deferring commitments that do not need to be made immediately given resources’ start-up times and decommitting them when no longer needed.
  3) Revisiting the real-time capacity (or headroom) requirements to remove excess conservatism.
  4) Revisiting the headroom target in the Look-Ahead Commitment process in ramp-up hours that resulted in excess commitments.

Highlights for Summer 2021

<u>Higher Congestion and Transmission Utilization Opportunities (Slides 24-26)</u>

- Real-time congestion grew 34 percent over last year to total $431 million, and a significant portion of this was driven by wind-related constraints.
  - ✓ Higher natural gas prices contributed to the increase because it increases the marginal costs of moving generation to manage system flows.
  - ✓ 43 percent of congestion was attributable primarily to wind, up from 22 percent last year and 15 percent in 2019.
- As congestion continues to grow, the priority to improve transmission utilization increases. We highlight three key opportunities:
- #1 – Expanding the use of Ambient-Adjusted Ratings and Emergency Ratings:
  - ✓ Potential savings this summer = $38.5 million.
  - ✓ MISO has been working with TOs to expand the use of AARs.
  - ✓ MISO has indicated to the TOs the requirement to provide emergency ratings and that it will require explanations when an emergency rating is not higher than the normal rating to comply with NERC FAC 11.
  - ✓ Progress is being made and our recommended next steps include collecting information on how ratings are calculated/adjusted and improving the processes available to begin adjusting a rating.

Highlights for Summer 2021

<u>Higher Congestion and Transmission Utilization Opportunities (Slides 27-28)</u>

- #2 – Lowering the Generation Shift Factor Cutoff used in the market software.
  - ✓ A generation shift factor reflects how the output of a resource affects the flows on a constraint – a key input to optimally dispatch resources to manage congestion.
  - ✓ It is currently set at 1.5 percent, which raises congestion costs by preventing the market from accessing resources that are economic to manage congestion.
  - ✓ MISO has agreed and will be initiating a phased approach over the next several months to first lower the GSF cutoff to 1 percent and then to 0.5 percent.
  - ✓ This will lower congestion costs substantially and reduce its M2M settlement costs.
- #3 – Implementing Transmission Reconfiguration Options
  - ✓ Transmission flows are primarily controlled by altering the output of resources in different locations. They can also sometimes be altered by reconfiguring the network (e.g., opening a breaker).
  - ✓ The costliest constraint this quarter generated over $57 million in congestion and primarily limits the output of wind resources in the North.
  - ✓ The constraint has a reconfiguration option that, when used, reduces the congestion by roughly two-thirds and reduces wind curtailments, but it is rarely used.
  - ✓ We recommend MISO work with TOs to identify/analyze reconfiguration options and employ them to reduce congestion, rather than only for reliability.

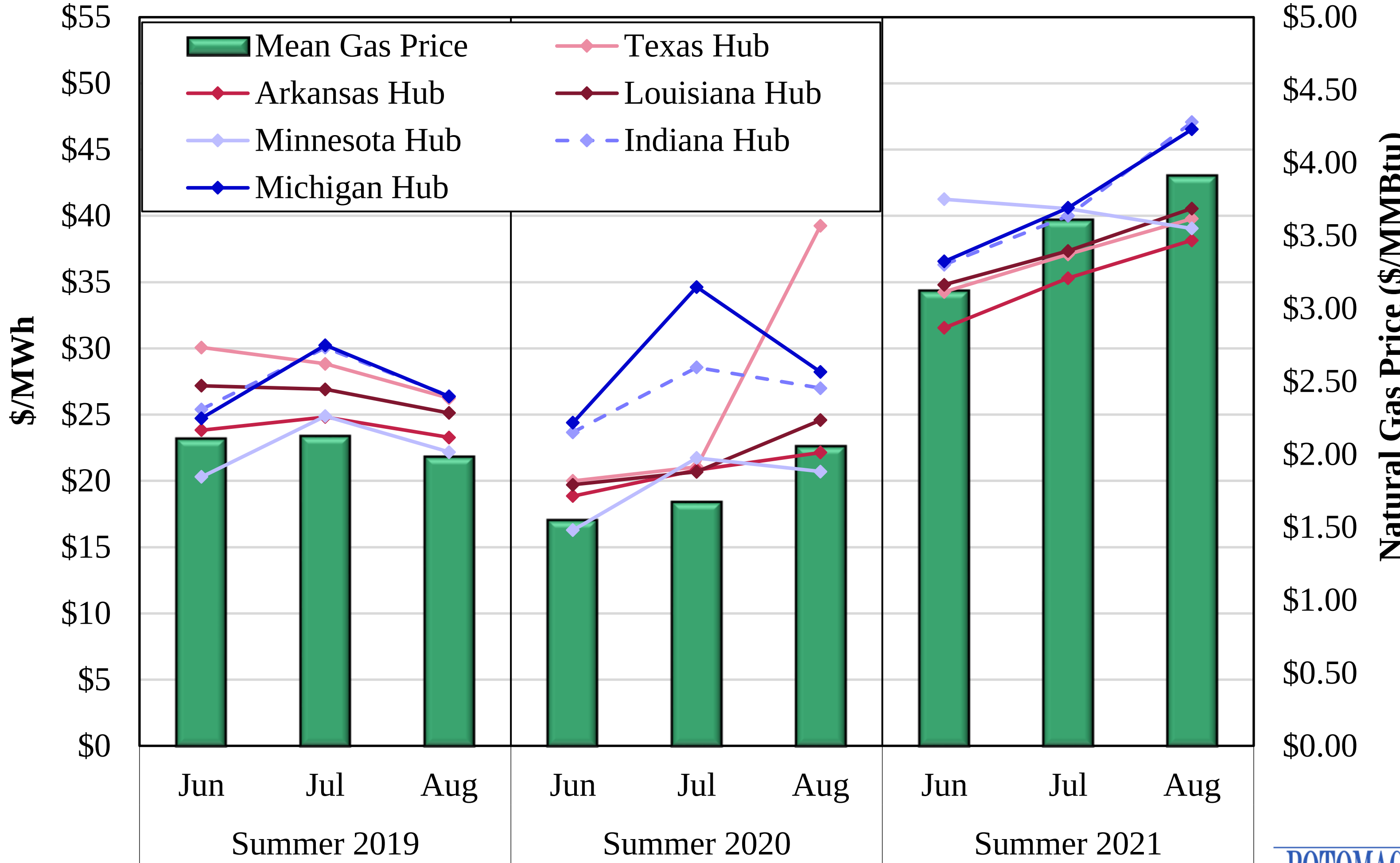
Submittals to External Entities and Other Issues

- 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.
  - ✓ We made several additional referrals and notifications during this period.
  - ✓ We have a number of investigations ongoing.
- We filed comments in the FERC Supplemental NOPR on Transmission Incentive Policy supporting incentives for RTO membership and will be participating in the upcoming workshop on incentives in the same docket.
- In July we presented our Spring Quarterly Report to the Market Subcommittee, and we presented a report on market results to the ERSC.
- We met with OMS to discuss the latest market results, findings, and recommendations.
- We presented the 2020 State of the Market Report to FERC and to the MISO Market Subcommittee.

Submittals to External Entities and Other Issues

- We continued meeting with MISO and RTO working groups on the revised proposal for allocating Firm Flow Entitlements (transmission property rights).
  - ✓ We provided a proposed change currently being studied by the group to more equitably allocate entitlements for facilities MISO’s customers have funded.
  - ✓ Regardless of the outcome we encourage MISO to provide transparent analysis on the results of negotiations to their customers.
- We continued discussing development of Ambient Adjusted Rating (AAR) Programs and use of Emergency Ratings with TOs and MISO.
- We met with MISO and TOs on developing processes to identify and implement reconfigurations that can reliably reduce congestion costs.

Day-Ahead Average Monthly Hub Prices Summer 2019–2021



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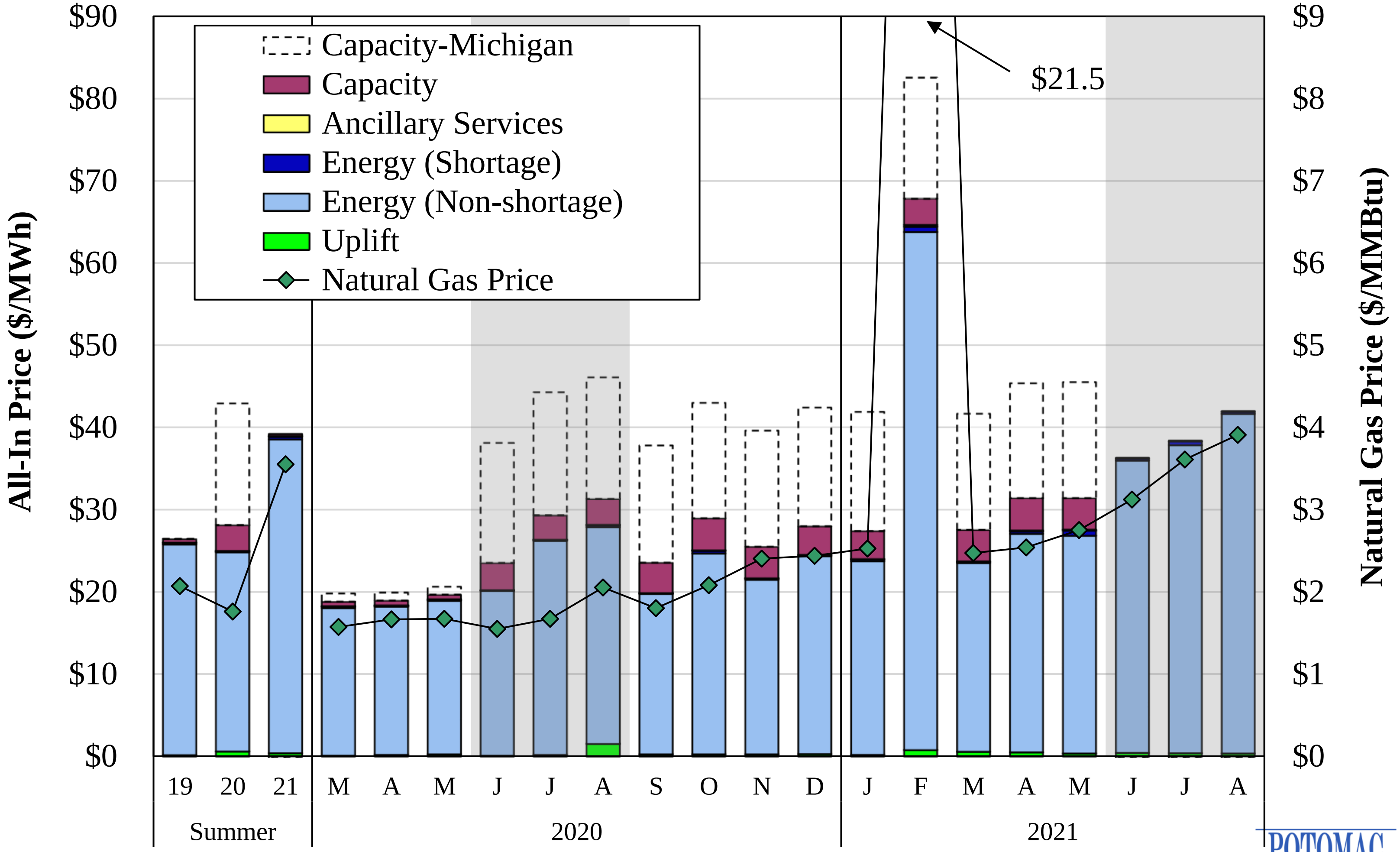
All-In Price
Summer 2020 – 2021



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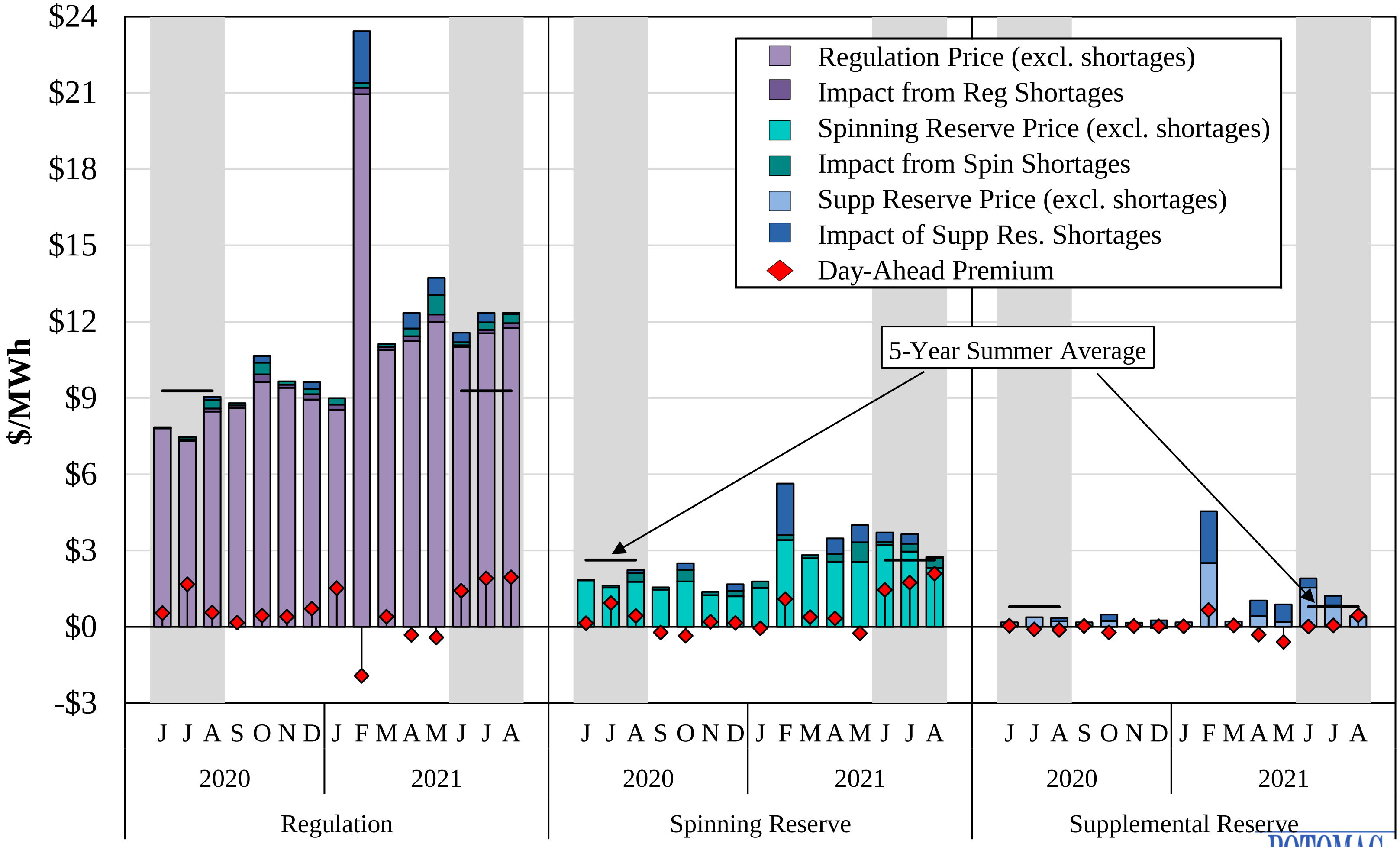
Ancillary Service Prices Summer 2020–2021



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MISO Fuel Prices 2020 - 2021

Summer Average	2019	2020	2021
Chicago NG	$2.07	$1.76	$3.55
Henry NG	$2.27	$1.83	$3.68

Summer Average	2019	2020	2021
IB Coal	$1.52	$1.24	$1.73
PRB Coal	$0.70	$0.68	$0.72

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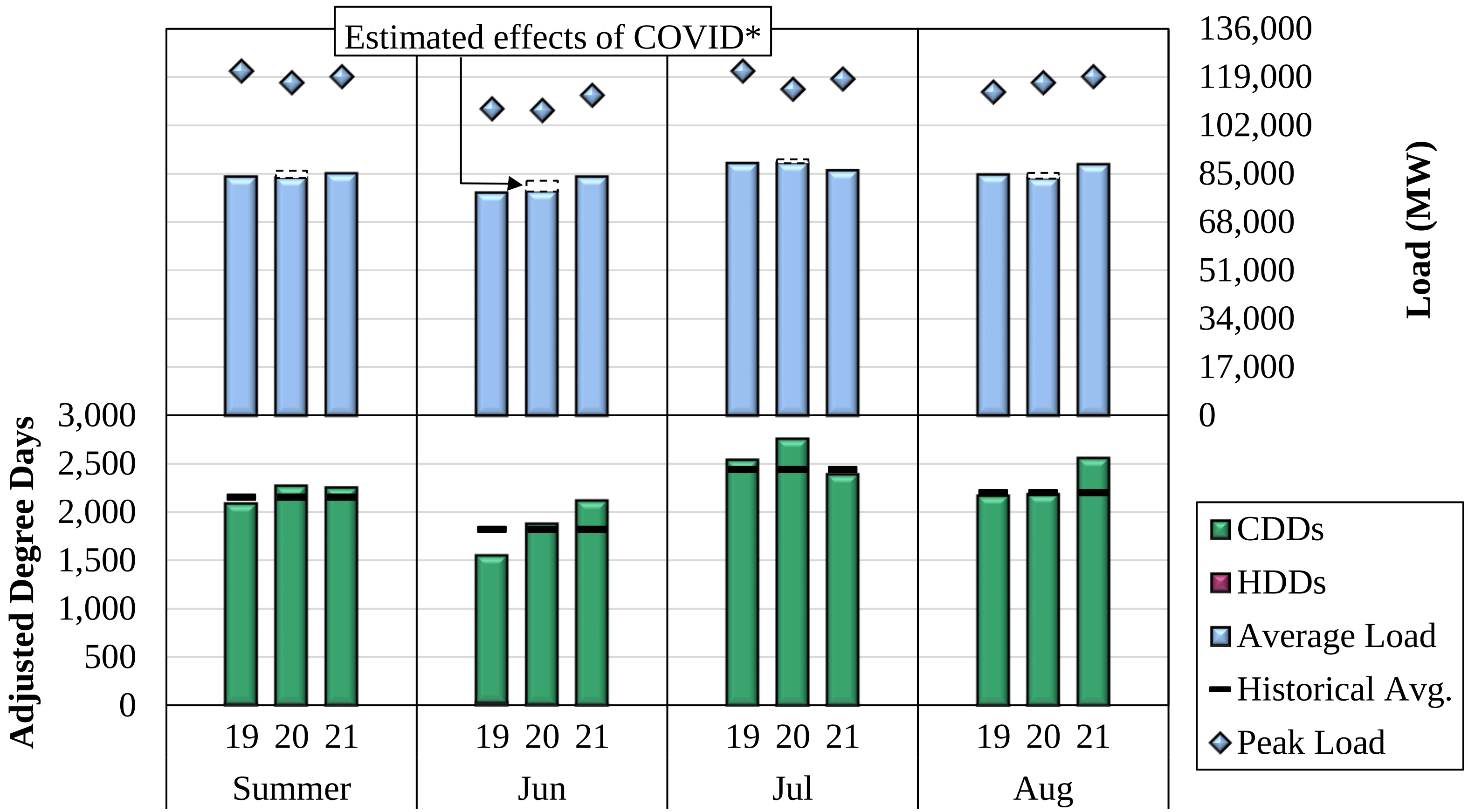
Load and Weather Patterns Summer 2019–2021



Notes: Midwest degree day calculations include four reprentative 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 Summer 2021

Summer	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%	15%	14%	0%	0%	0%	0%
Coal	46,864	46,740	37%	36%	38%	44%	43%	26%	90%	73%
Natural Gas	56,673	58,431	44%	45%	37%	30%	55%	73%	97%	98%
Oil	1,568	1,636	1%	1%	0%	0%	0%	0%	1%	1%
Hydro	4,034	3,671	3%	3%	2%	1%	1%	1%	4%	1%
Wind	3,660	4,304	3%	3%	8%	8%	0%	0%	50%	53%
Other	2,703	3,145	2%	2%	1%	3%	0%	0%	7%	8%
Total	**127,608**	**129,794**								

Average Daily High Temperatures

	Jun-21					Jul-21			Aug-21		
	9	10	11	28	29	4	5	6	19	24	25
Minneapolis	95 (77)	97 (78)	89 (78)	82 (82)	83 (82)	94 (83)	95 (83)	82 (83)	90 (80)	80 (80)	83 (80)
Detroit	87 (78)	87 (79)	88 (78)	90 (82)	91 (82)	91 (83)	92 (83)	93 (83)	85 (81)	90 (80)	89 (80)
Indianapolis	80 (81)	81 (81)	90 (81)	90 (81)	91 (85)	86 (85)	88 (85)	88 (85)	86 (84)	94 (84)	82 (84)
Little Rock	88 (87)	91 (87)	91 (88)	91 (90)	92 (90)	85 (91)	88 (91)	92 (91)	86 (92)	95 (91)	97 (91)
New Orleans	90 (90)	90 (90)	92 (90)	87 (91)	88 (91)	88 (91)	88 (91)	88 (91)	94 (91)	98 (91)	93 (91)
Houston	92 (91)	92 (91)	93 (91)	81 (92)	85 (92)	92 (92)	88 (92)	87 (92)	96 (94)	98 (93)	96 (93)

Notes: 95 (77) means 95 is the current day highest temperature in degrees Fahrenheit, and (77) is the historic average daily high temperature.

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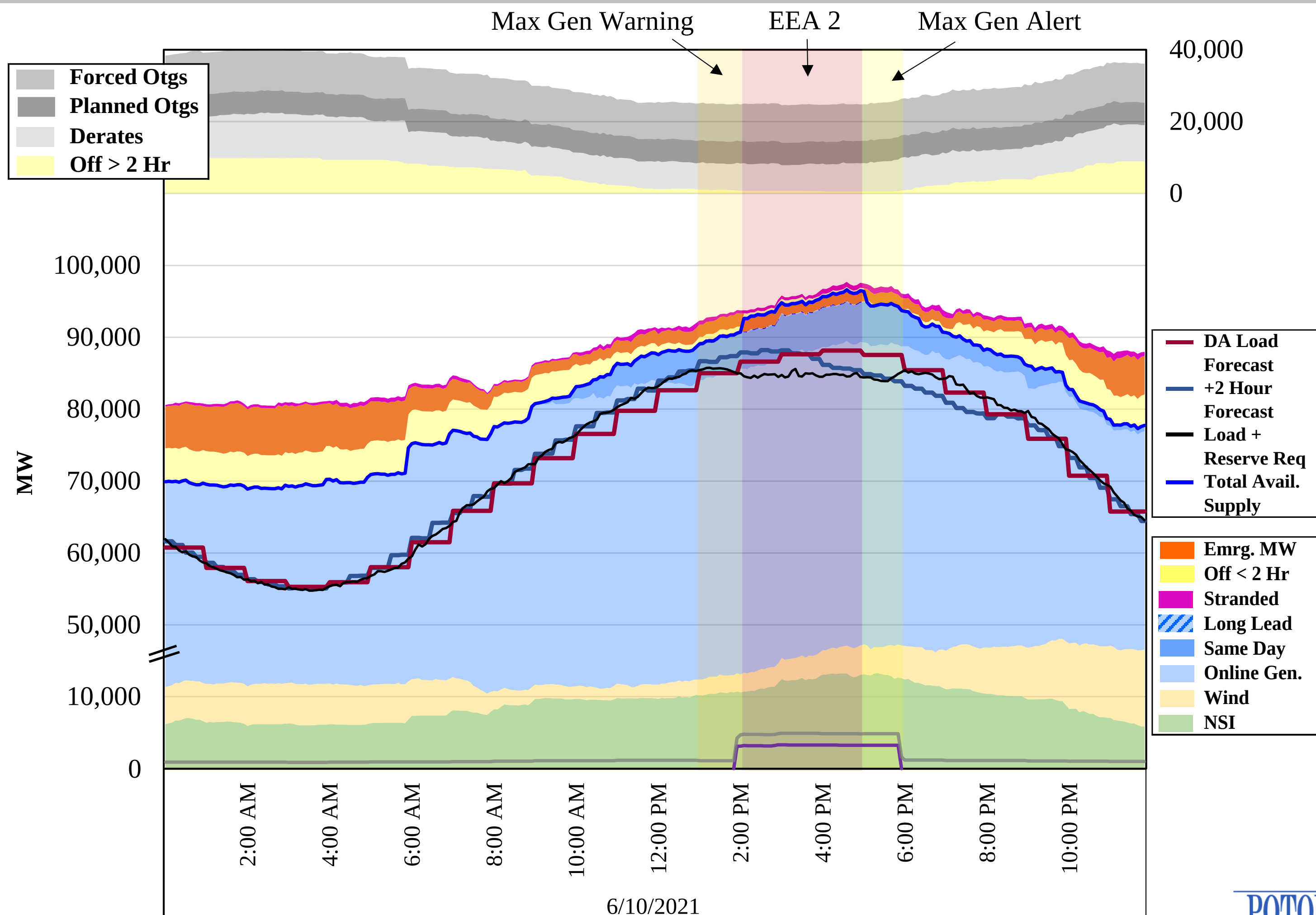
Maximum Generation Event
June 10, 2021



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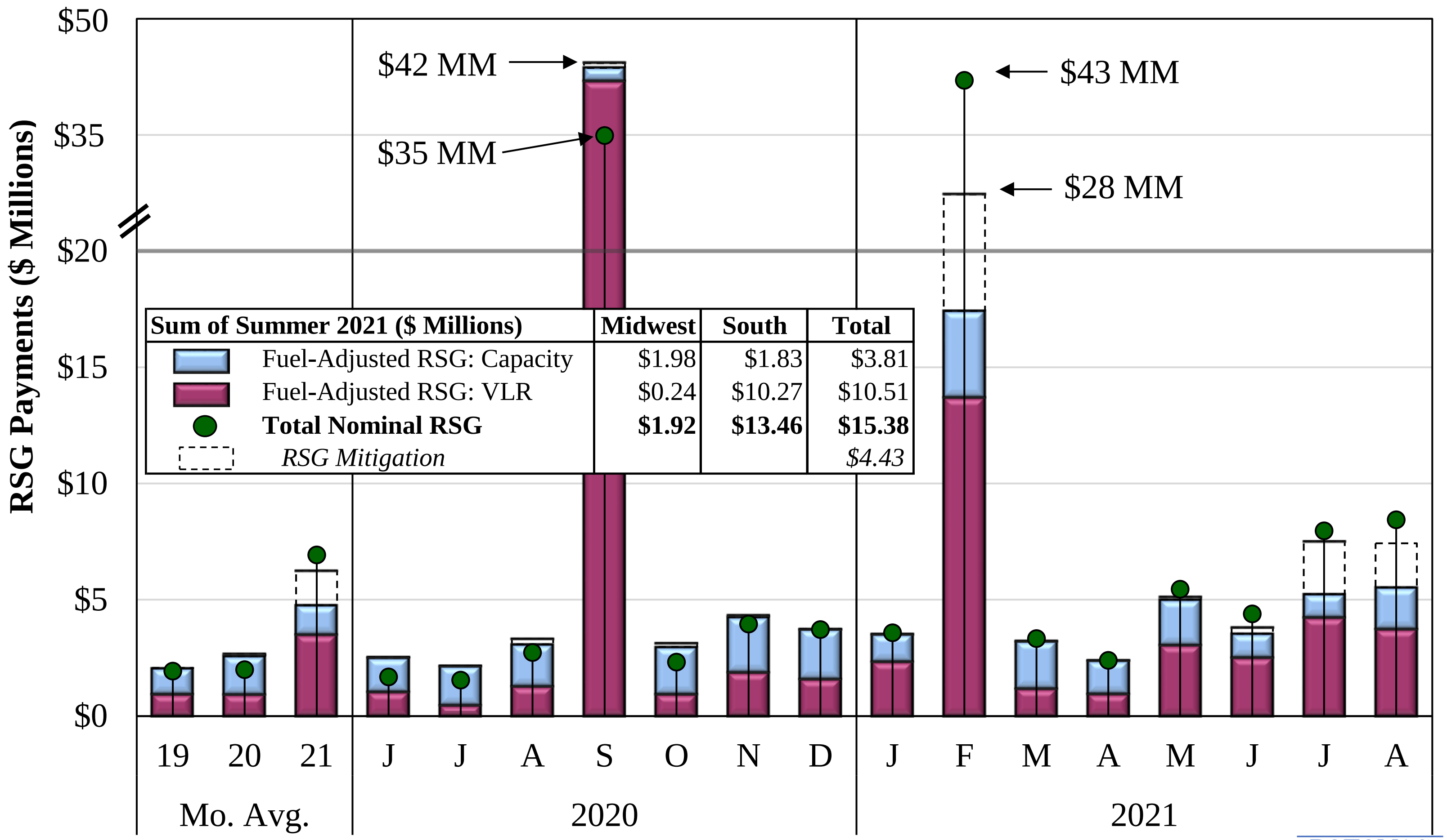
Day-Ahead RSG Payments
Summer 2019–2021



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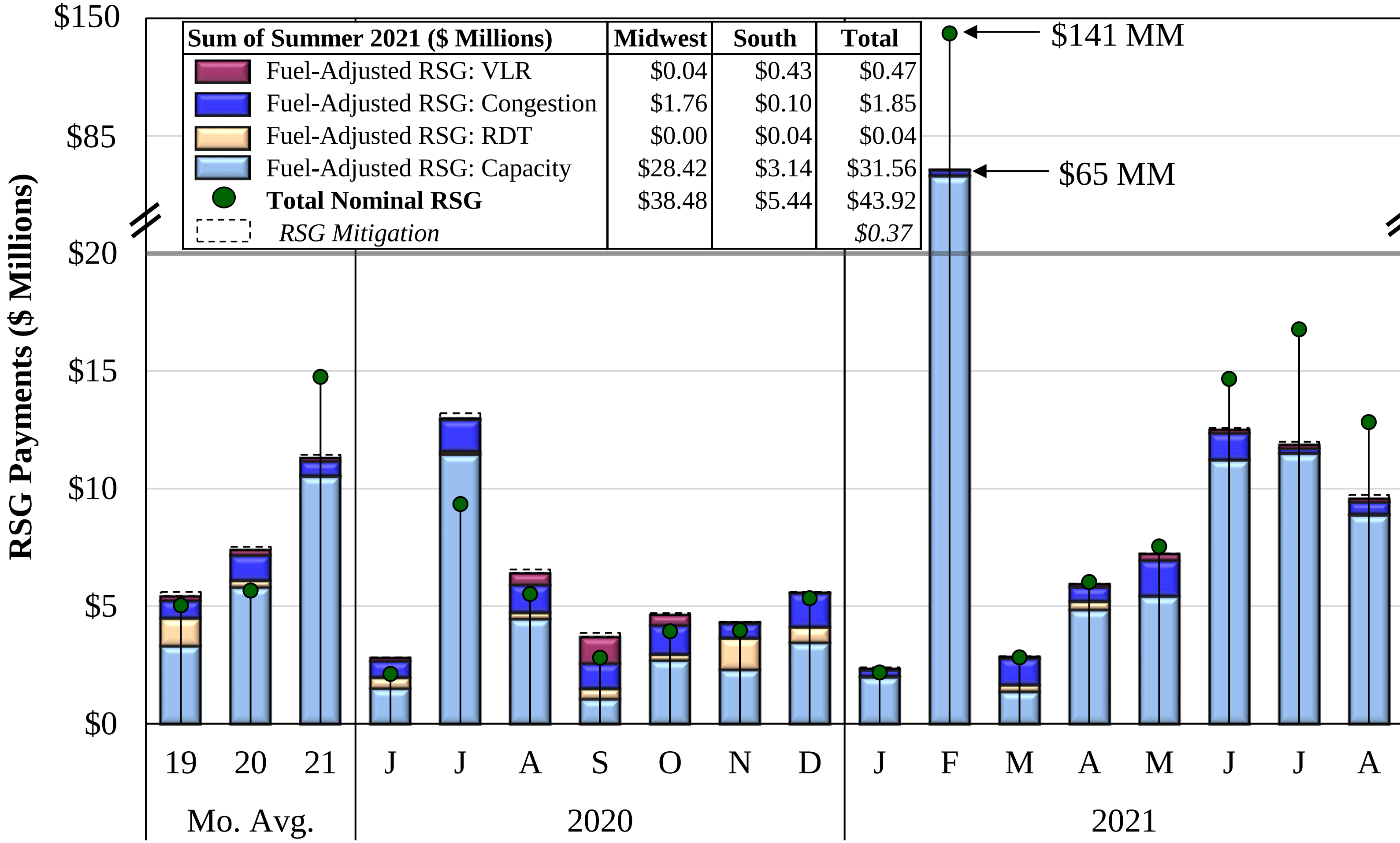
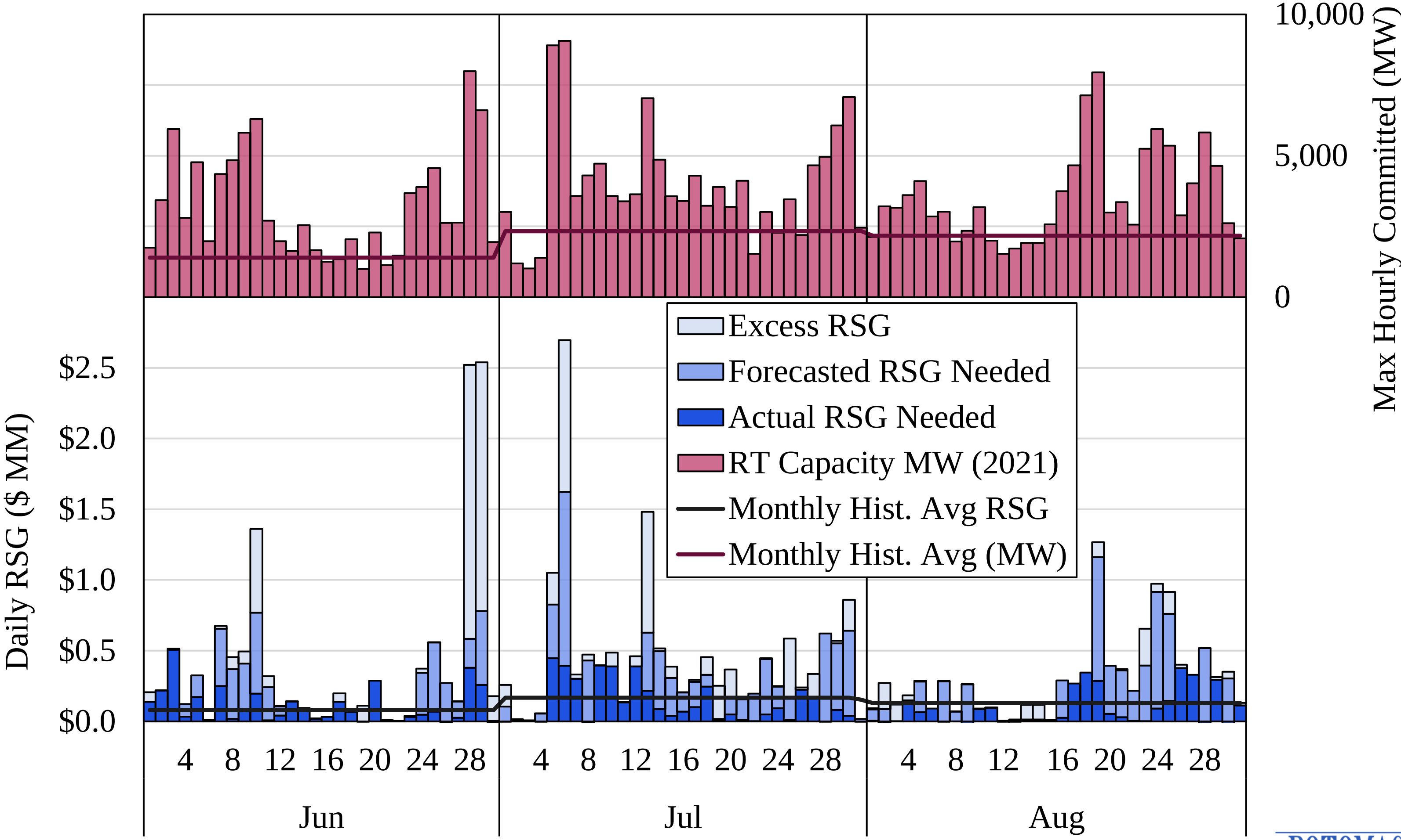
Real-Time RSG Payments
Summer 2020–2021

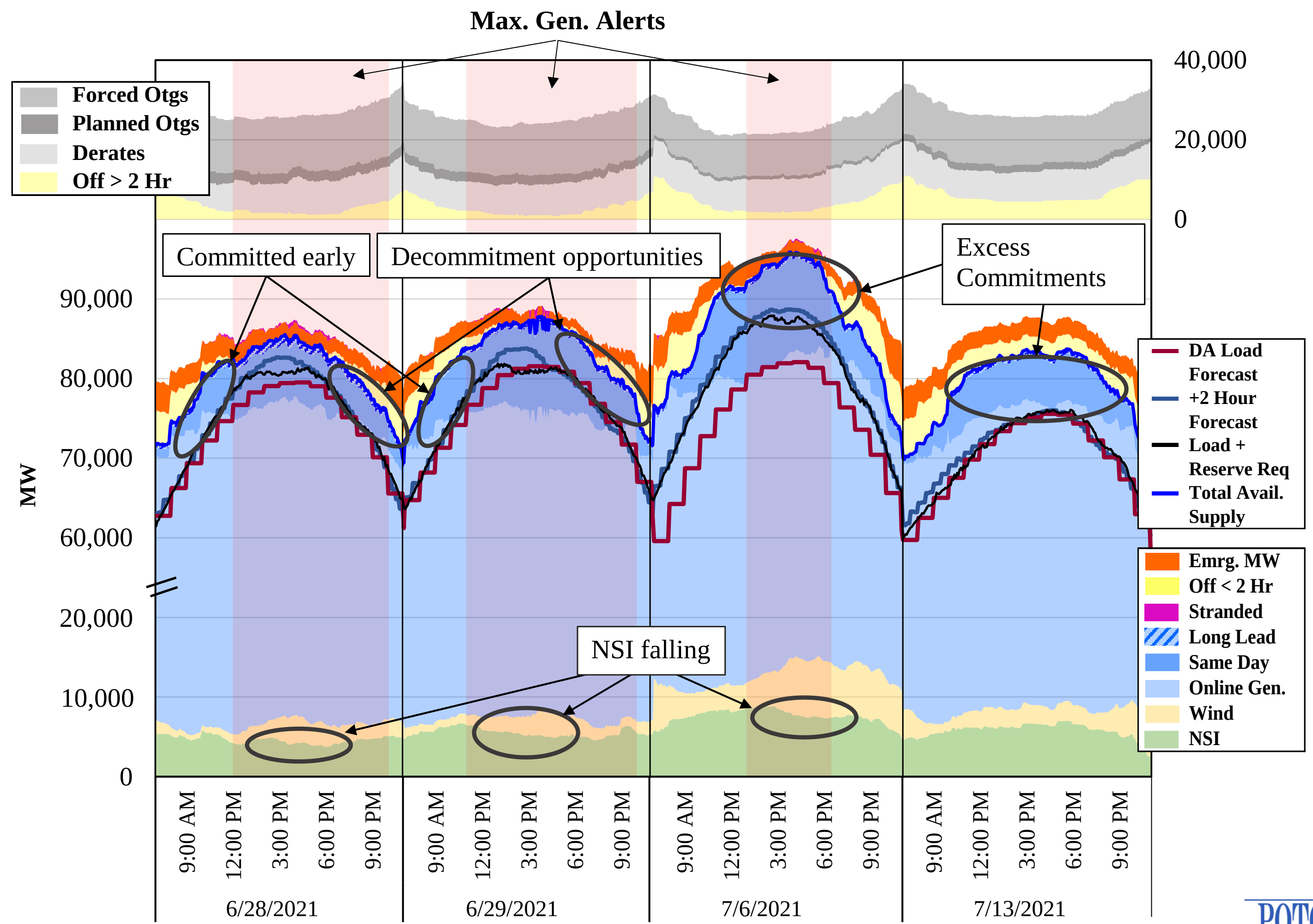


Sum of Summer 2021 ($ Millions)	Midwest	South	Total
Fuel-Adjusted RSG: VLR	$0.04	$0.43	$0.47
Fuel-Adjusted RSG: Congestion	$1.76	$0.10	$1.85
Fuel-Adjusted RSG: RDT	$0.00	$0.04	$0.04
Fuel-Adjusted RSG: Capacity	$28.42	$3.14	$31.56
Total Nominal RSG	$38.48	$5.44	$43.92
RSG Mitigation			*$0.37*

Real-Time Capacity Commitment and RSG

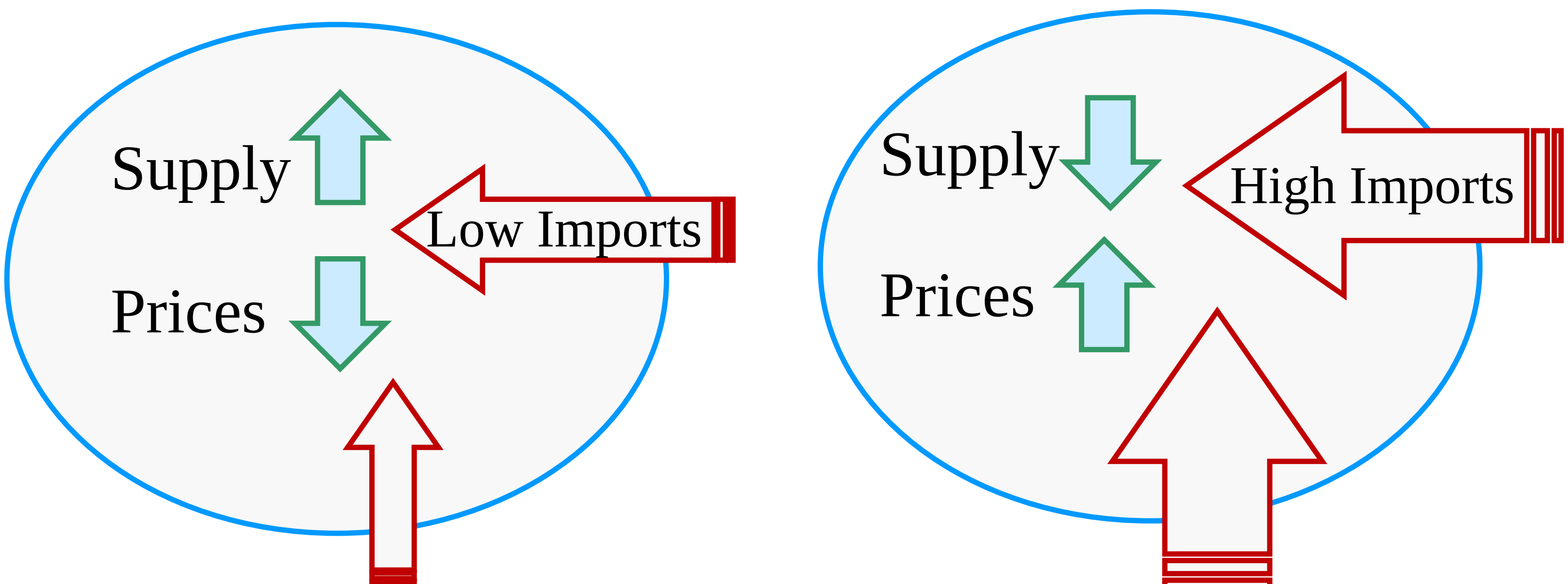


MISO Midwest Capacity Accounting High RSG Days



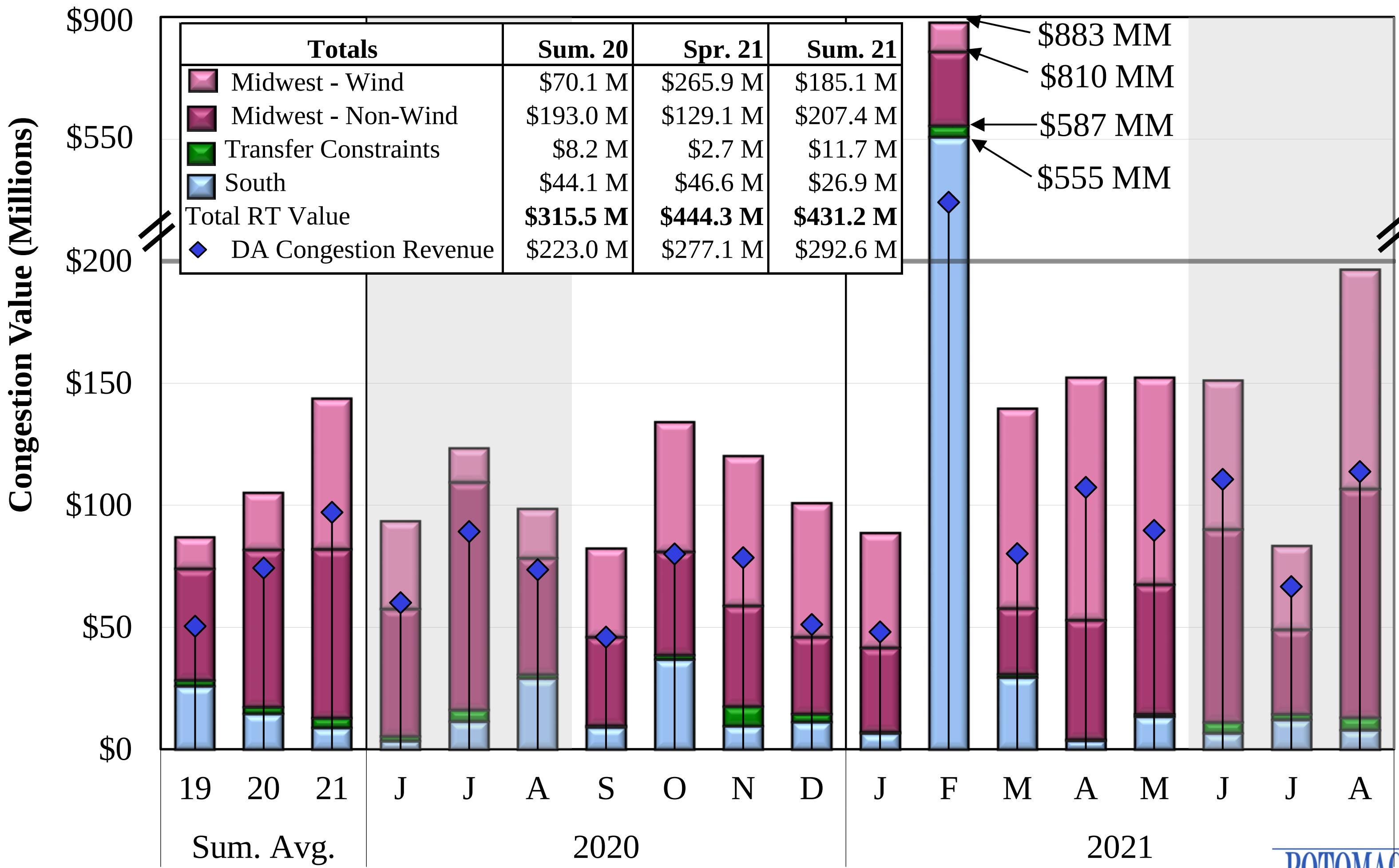
Secondary Effects of Commitment Levels

High Commitment Case **Low Commitment Case**



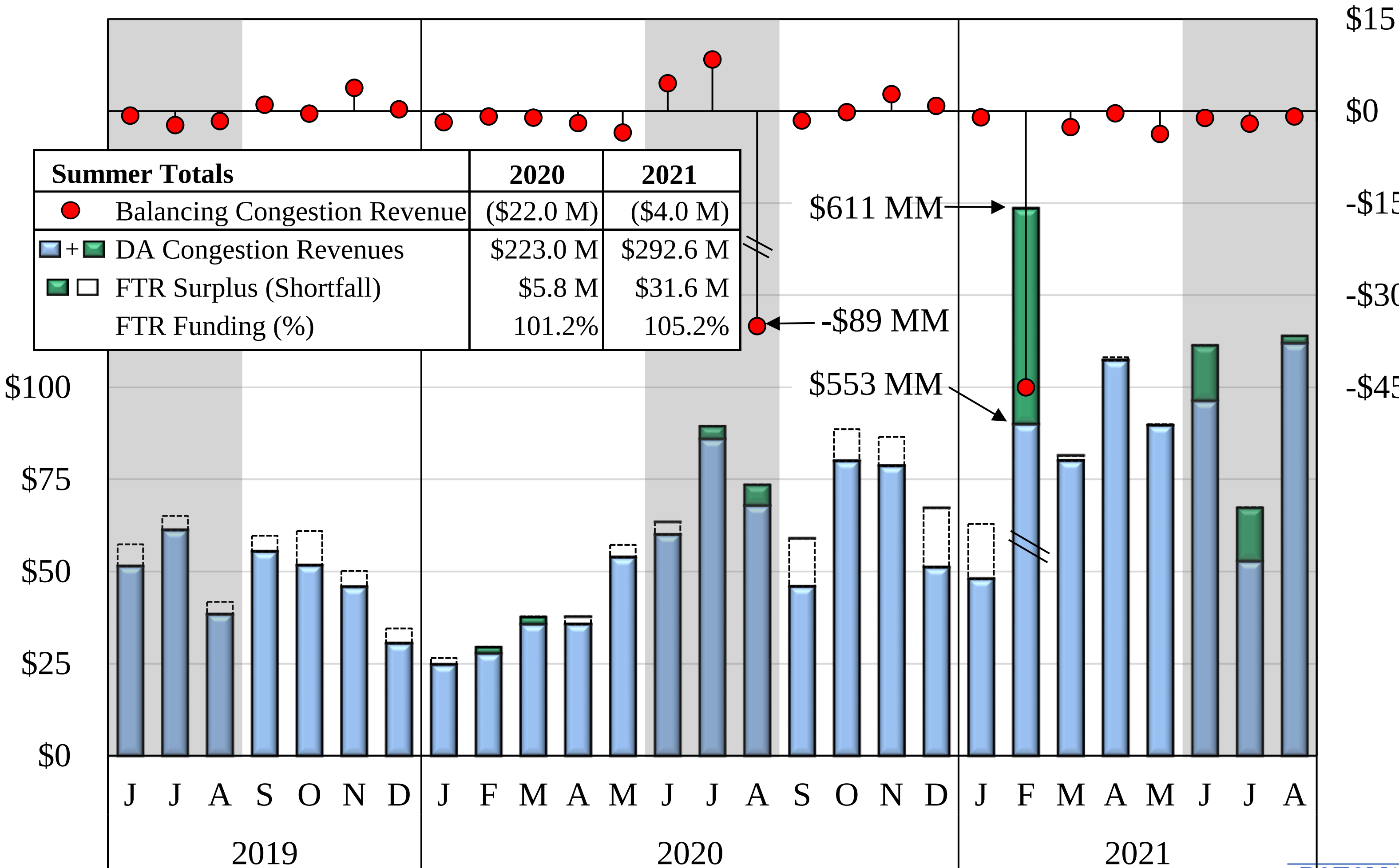
- Commitment processes are important because of their large secondary effects.
- Aggressive commitment practices lower prices, raise RSG and reduce MISO’s ability to rely on the market, including higher net imports.
- Changes to ELMP, short-term reserves and the proposed uncertainty product will all increase prices as the system becomes tight, sending better signals to support net imports.

Value of Real-Time Congestion Summer 2020–2021



Totals	Sum. 20	Spr. 21	Sum. 21
Midwest - Wind	$70.1 M	$265.9 M	$185.1 M
Midwest - Non-Wind	$193.0 M	$129.1 M	$207.4 M
Transfer Constraints	$8.2 M	$2.7 M	$11.7 M
South	$44.1 M	$46.6 M	$26.9 M
Total RT Value	**$315.5 M**	**$444.3 M**	**$431.2 M**
DA Congestion Revenue	$223.0 M	$277.1 M	$292.6 M

Day-Ahead Congestion, Balancing Congestion and FTR Underfunding



Summer Totals	2020	2021
Balancing Congestion Revenue	($22.0 M)	($4.0 M)
DA Congestion Revenues	$223.0 M	$292.6 M
FTR Surplus (Shortfall)	$5.8 M	$31.6 M
FTR Funding (%)	101.2%	105.2%

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

Summer		Savings ($ Millions)			# of Facilites for 2/3 of Savings	Share of Congestion
		Ambient Adj. Ratings	Emergency Ratings	Total		
2020	Midwest	$12.8	$13.67	$26.5	19	9.7%
	South	$0.2	$2.15	$2.4	0	5.4%
	Total	**$13.0**	**$15.8**	**$28.8**	**19**	**9.1%**
2021	Midwest	$17.3	$19.44	$36.7	13	9.0%
	South	$0.3	$1.50	$1.8	3	6.7%
	Total	**$17.5**	**$20.9**	**$38.5**	**16**	**8.9%**

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Benefits of Lowering Generation Shift Factor Cutoff
January 1 – August 31, 2021

Description		Constraints		
		No GSF Cutoff	**1.5% GSF Cutoff**	**Impact**
Future Market	FTR Auction	✔		$55 Million FTR Shortfall (0.5% GSF Cutoff in DA)
	DA Market		✔	
Spot Market	RT Market		✔	$74 Million Unavailable Economic Relief (0.5% Cutoff in RT)
Post RT Market Settlements	M2M Settlements	✔		$40 Million M2M Settlement Payments

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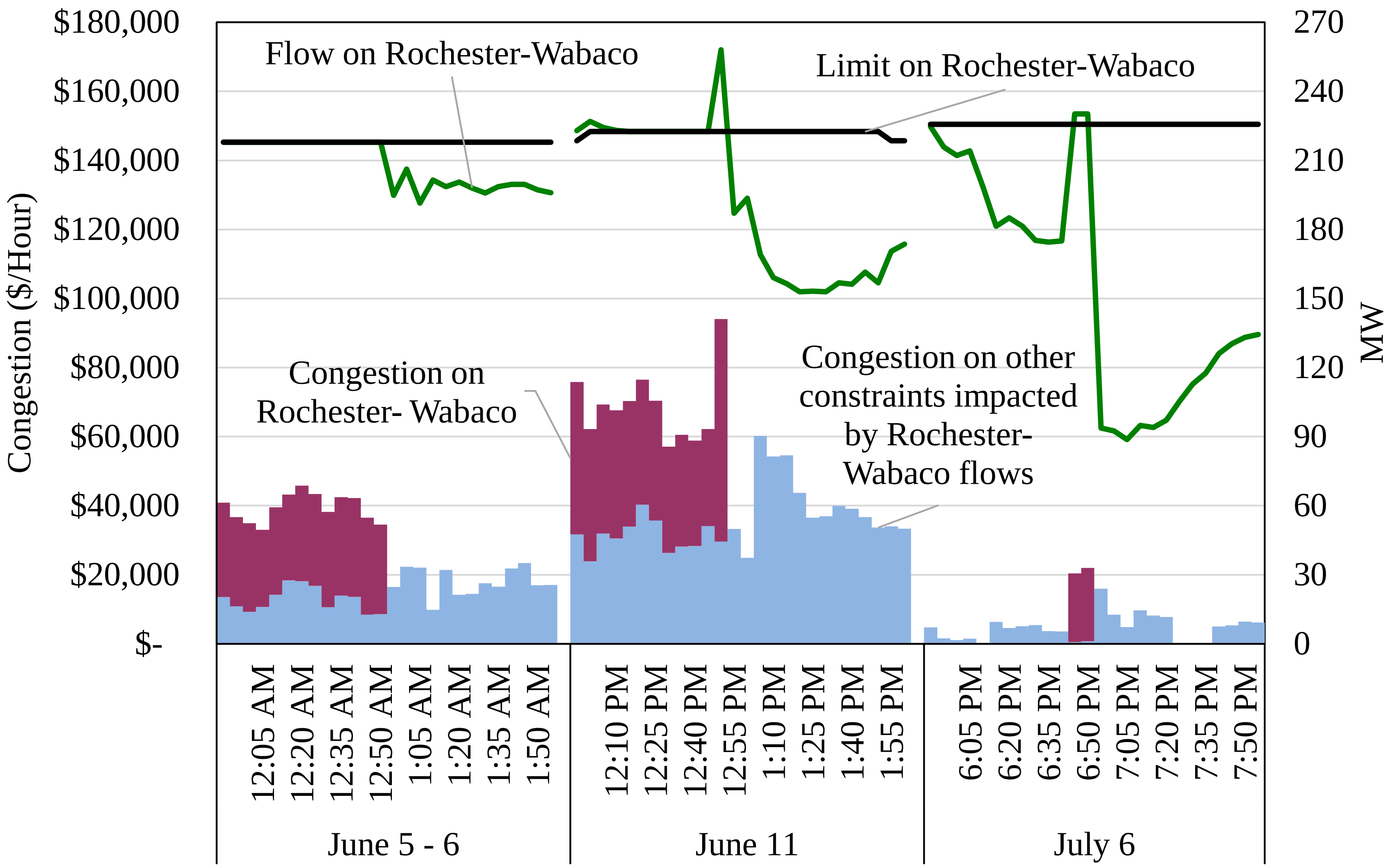
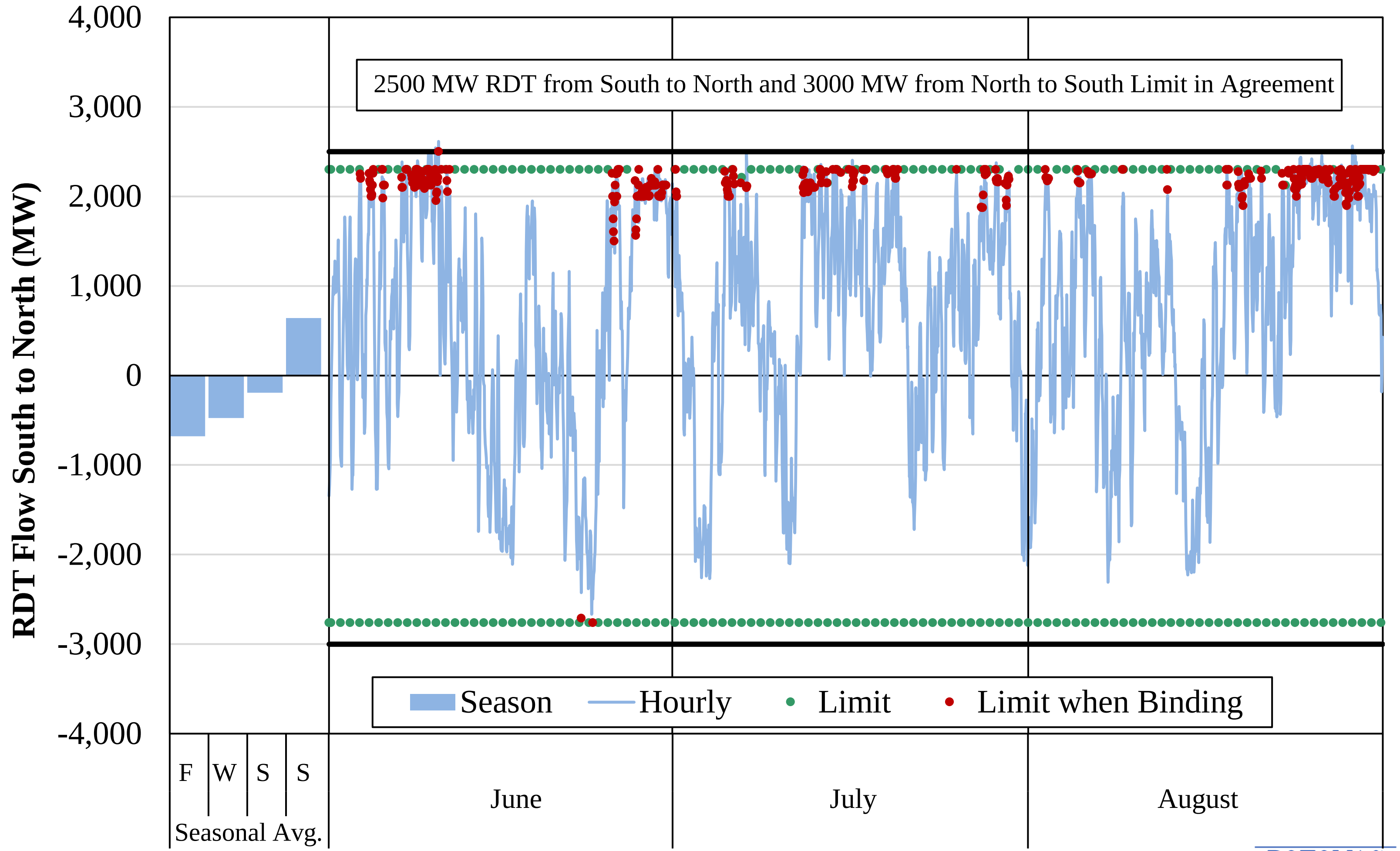
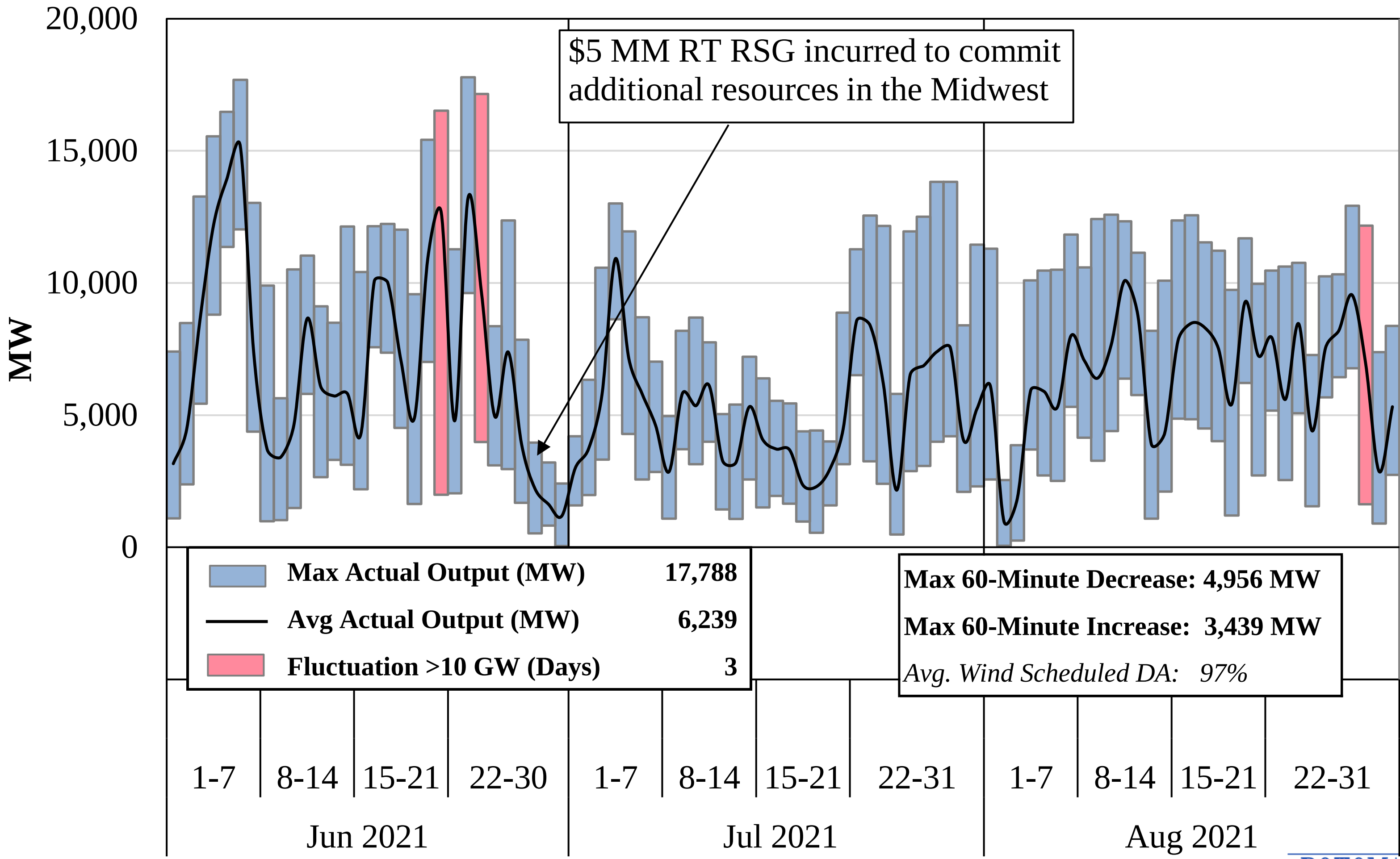
Reconfiguration on Rochester-Wabaco Constraint on Three days



Real-Time Hourly Inter-Regional Flows
Summer 2021



Wind Output in Real Time
Daily Range and Average



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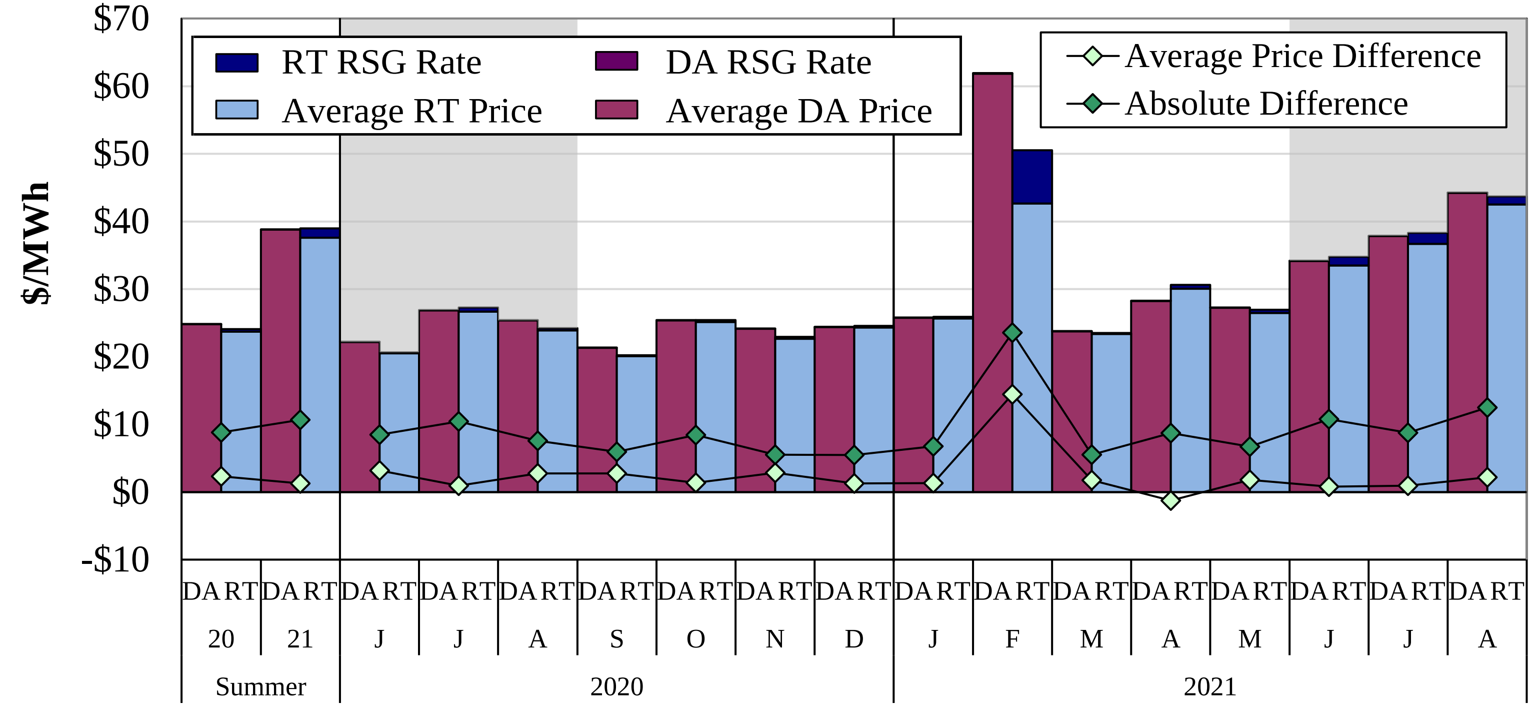
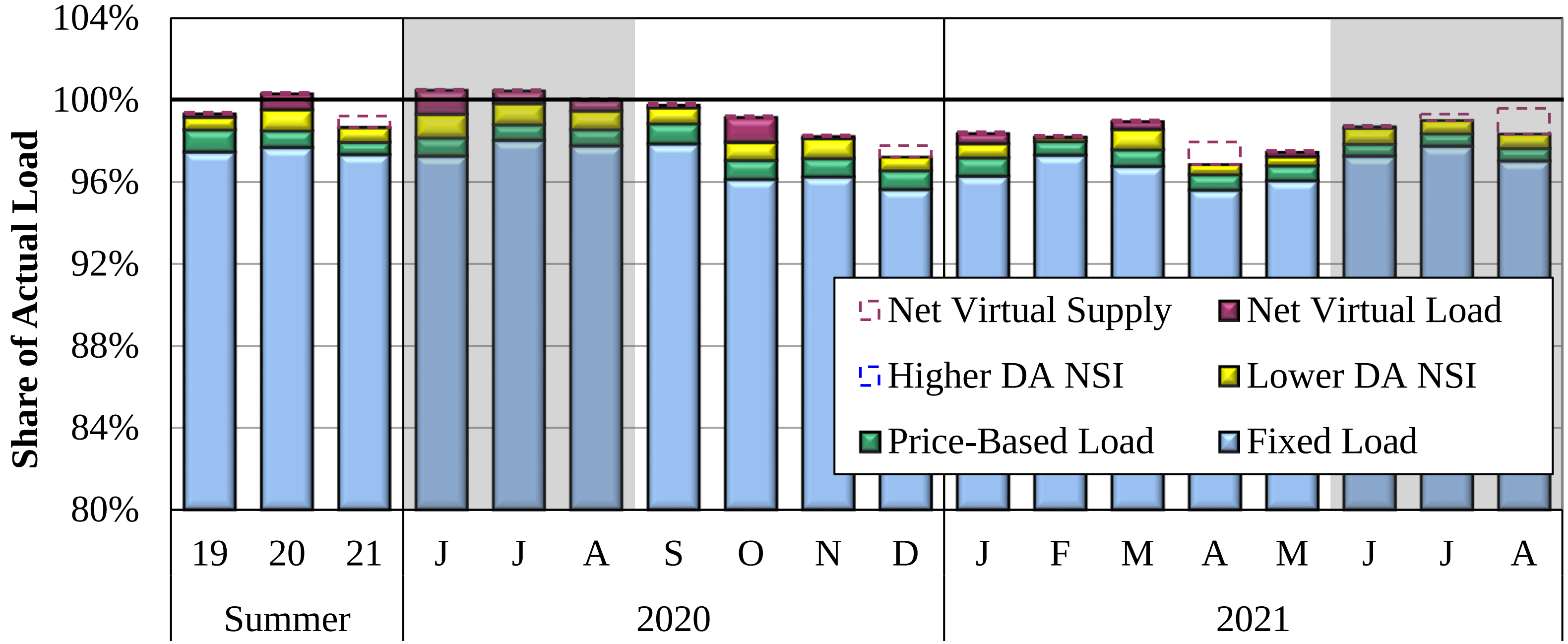
Day-Ahead and Real-Time Price Convergence Summer 2020–2021



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

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

Day-Ahead Peak Hour Load Scheduling Summer 2020–2021



Share of Actual Load (%)

	19	20	21	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
All Hours	99.8	100.9	99.5	100.4	101.5	101.0	99.7	98.8	98.4	97.8	98.5	98.5	98.3	97.2	97.7	98.9	99.7	99.8
Peak Hours Midwest	99.0	99.6	97.6	99.9	99.8	99.0	99.5	98.8	98.5	96.6	98.5	97.4	97.3	96.0	96.5	97.6	98.3	96.9
Peak Hours South	100.0	101.7	101.4	101.2	101.8	102.1	100.0	100.7	98.5	98.2	101.3	103.6	102.3	100.3	99.2	101.6	100.9	101.8

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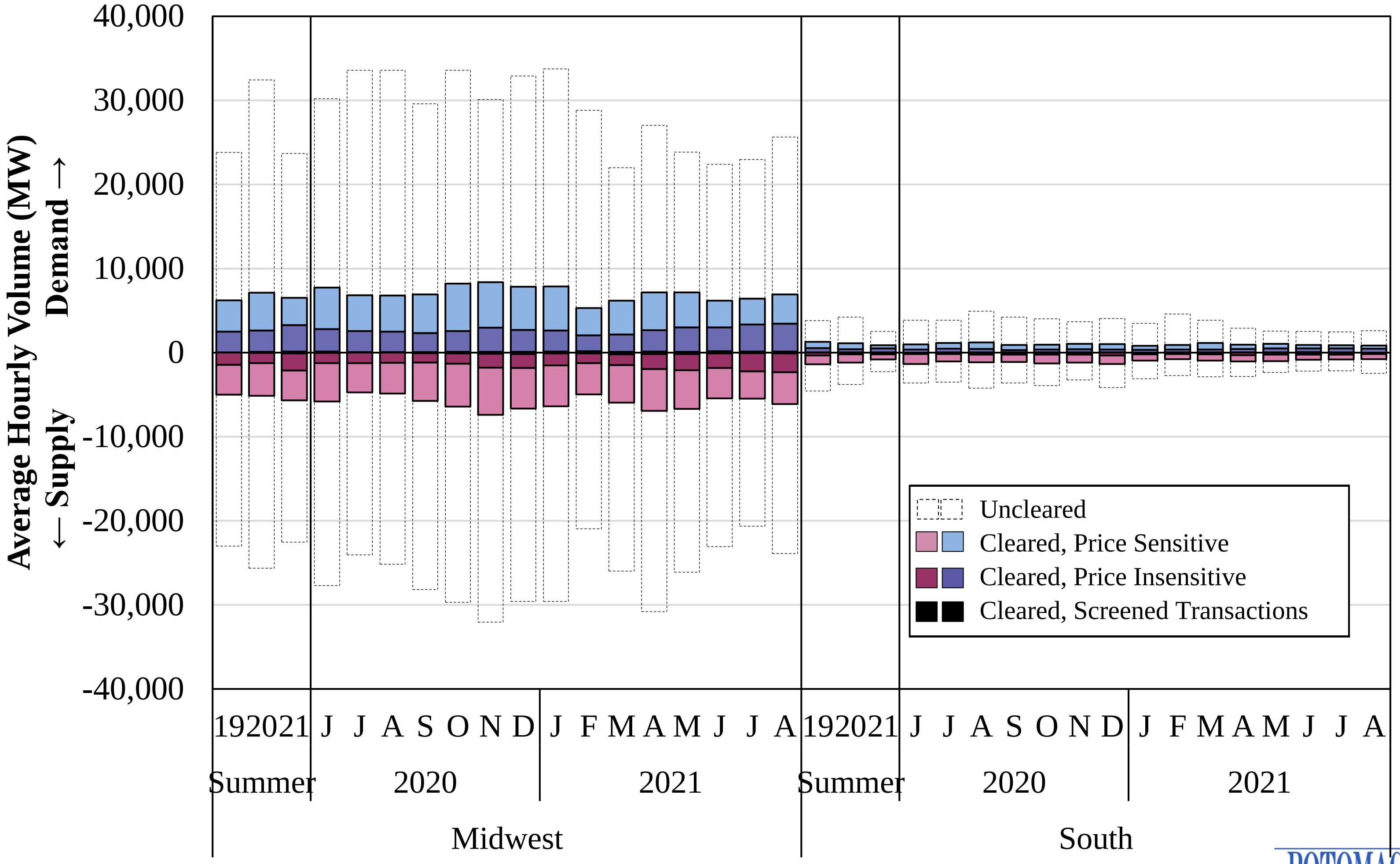
Virtual Load and Supply
Summer 2020–2021



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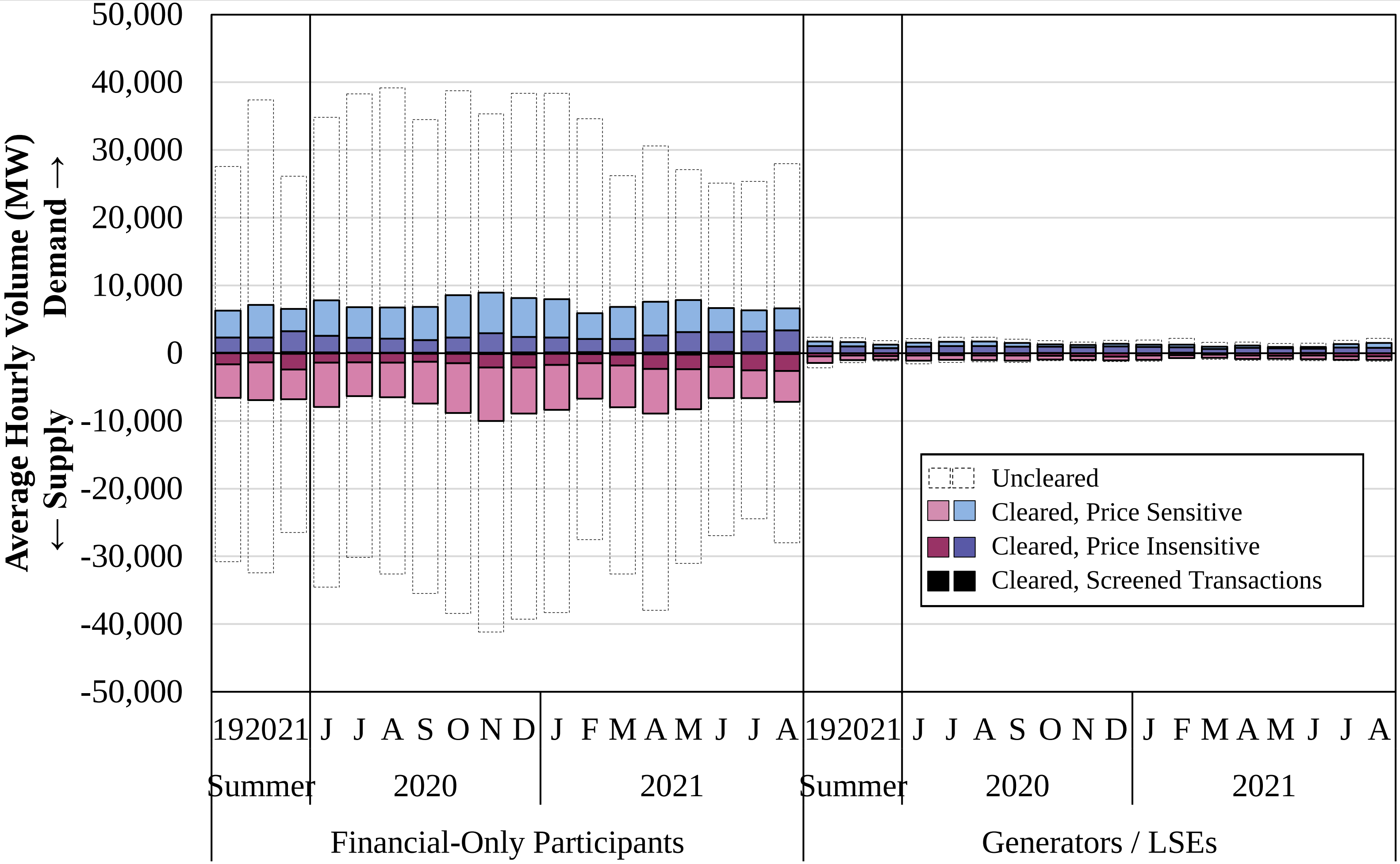
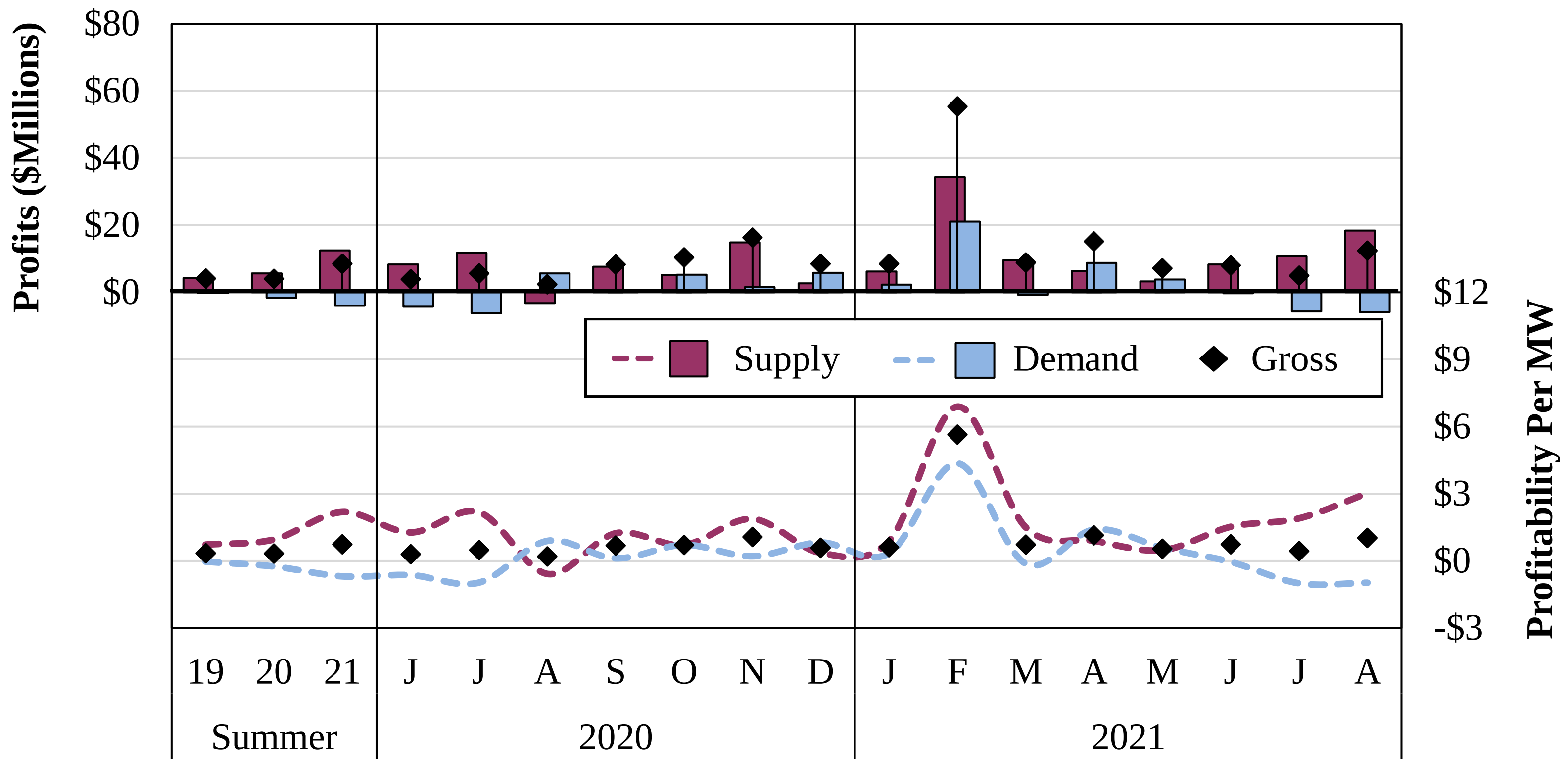
Virtual Load and Supply by Participant Type Summer 2020–2021



Virtual Profitability
Summer 2020–2021

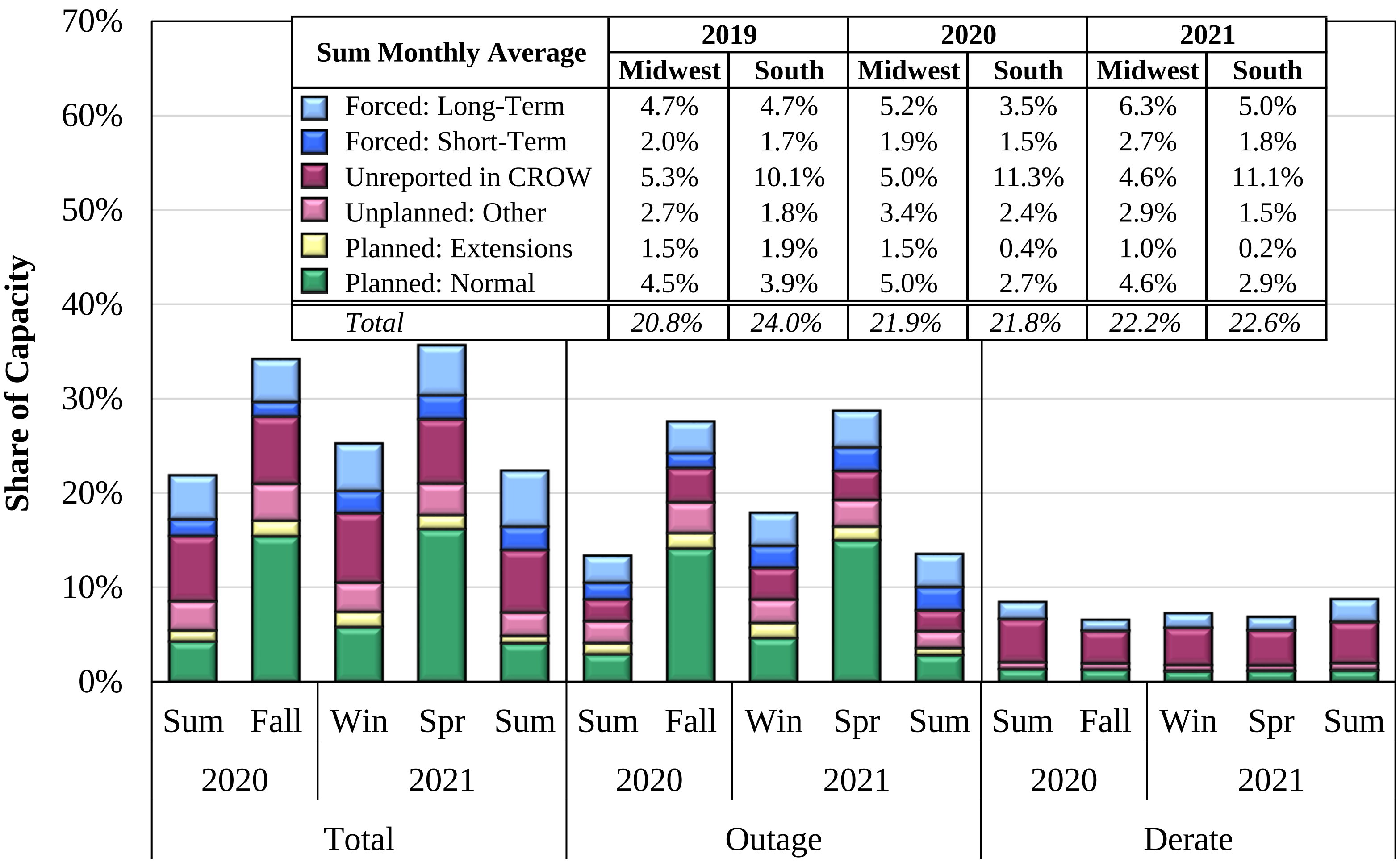


Percent Screened

Supply	0.2	0.4	1.5	0.5	0.3	0.3	0.9	1.0	1.3	1.7	1.0	1.8	2.5	2.0	2.4	1.4	1.4	1.6
Demand	1.0	1.3	2.2	1.6	1.2	1.1	0.8	1.2	1.1	1.3	1.4	3.7	1.4	1.7	1.8	3.0	2.0	1.6
Total	0.6	0.9	1.8	1.0	0.8	0.7	0.9	1.1	1.2	1.5	1.2	2.7	2.0	1.9	2.1	2.2	1.7	1.6

POTOMAC ECONOMICS

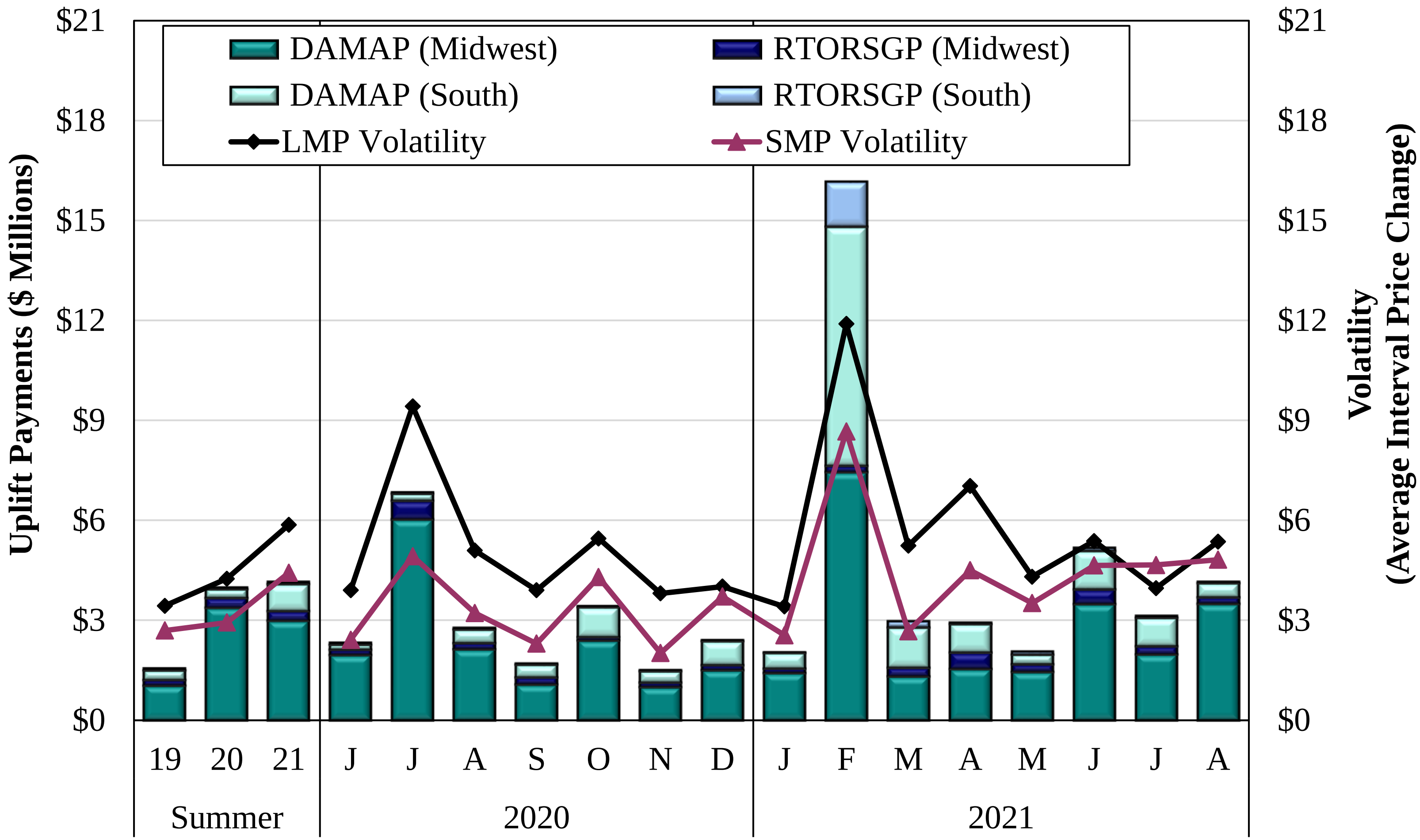
Generation Outages and Deratings 2020–2021



Sum Monthly Average	2019 Midwest	2019 South	2020 Midwest	2020 South	2021 Midwest	2021 South
Forced: Long-Term	4.7%	4.7%	5.2%	3.5%	6.3%	5.0%
Forced: Short-Term	2.0%	1.7%	1.9%	1.5%	2.7%	1.8%
Unreported in CROW	5.3%	10.1%	5.0%	11.3%	4.6%	11.1%
Unplanned: Other	2.7%	1.8%	3.4%	2.4%	2.9%	1.5%
Planned: Extensions	1.5%	1.9%	1.5%	0.4%	1.0%	0.2%
Planned: Normal	4.5%	3.9%	5.0%	2.7%	4.6%	2.9%
Total	*20.8%*	*24.0%*	*21.9%*	*21.8%*	*22.2%*	*22.6%*

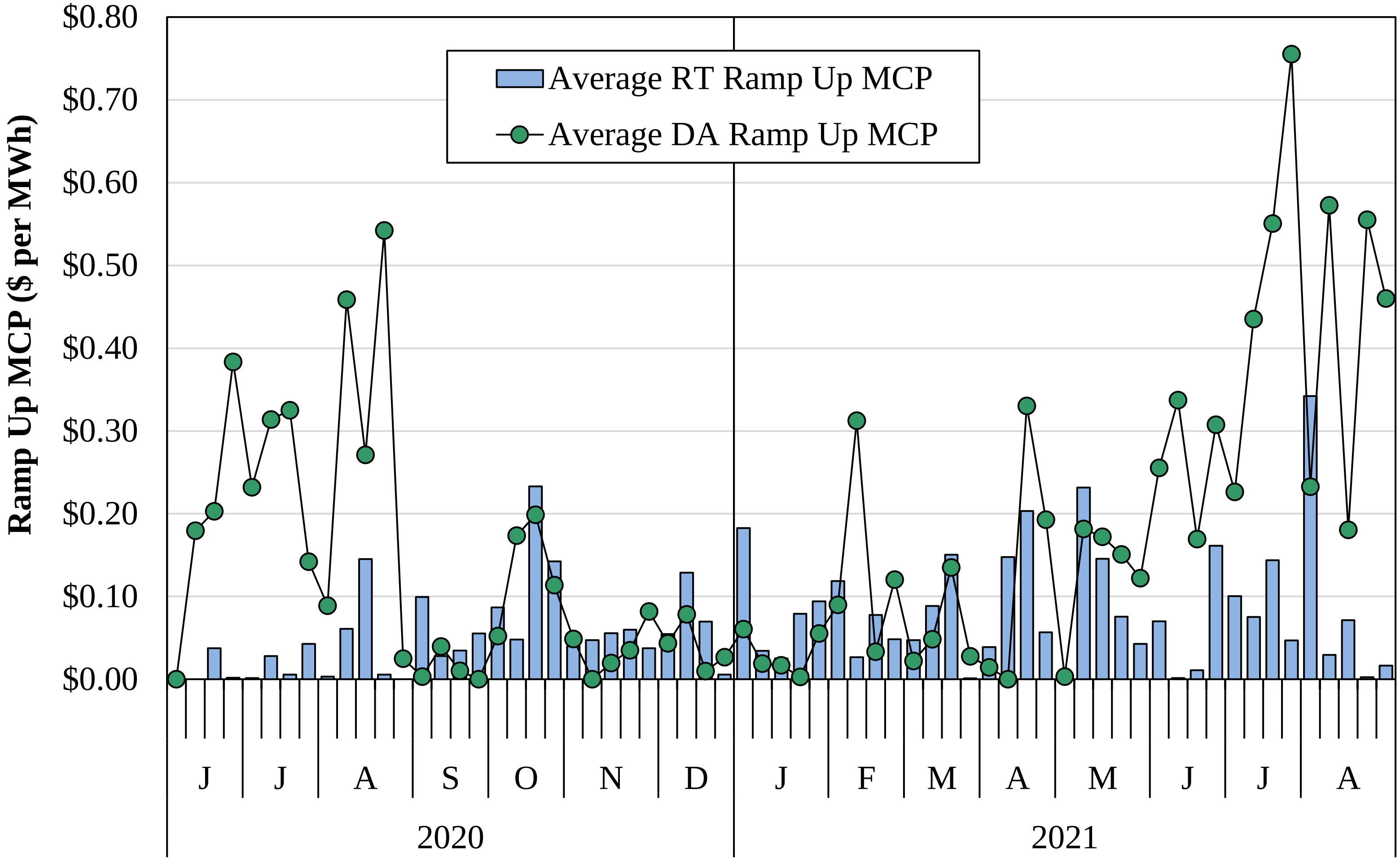
POTOMAC ECONOMICS

Price Volatility Make Whole Payments Summer 2020–2021



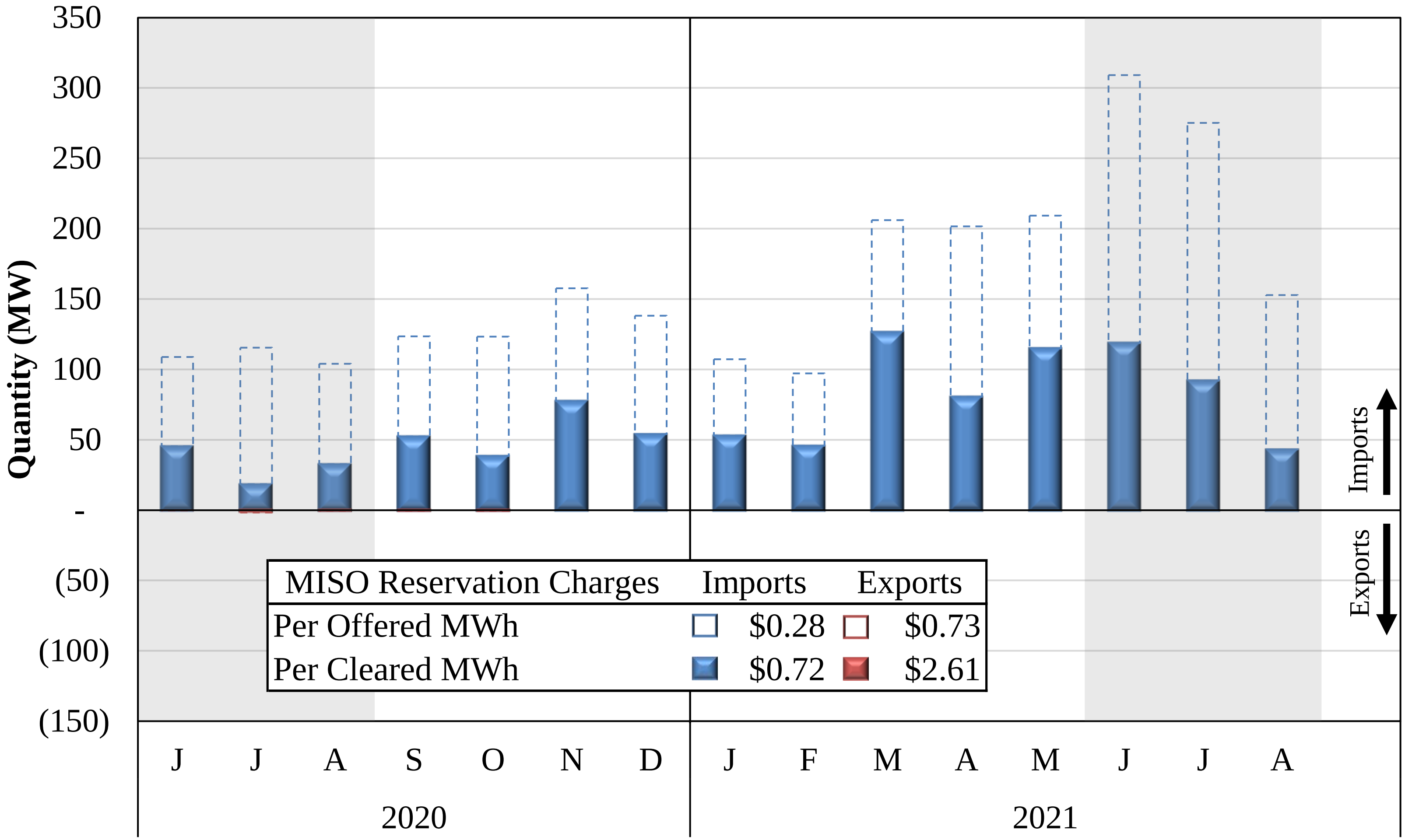
POTOMAC ECONOMICS

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



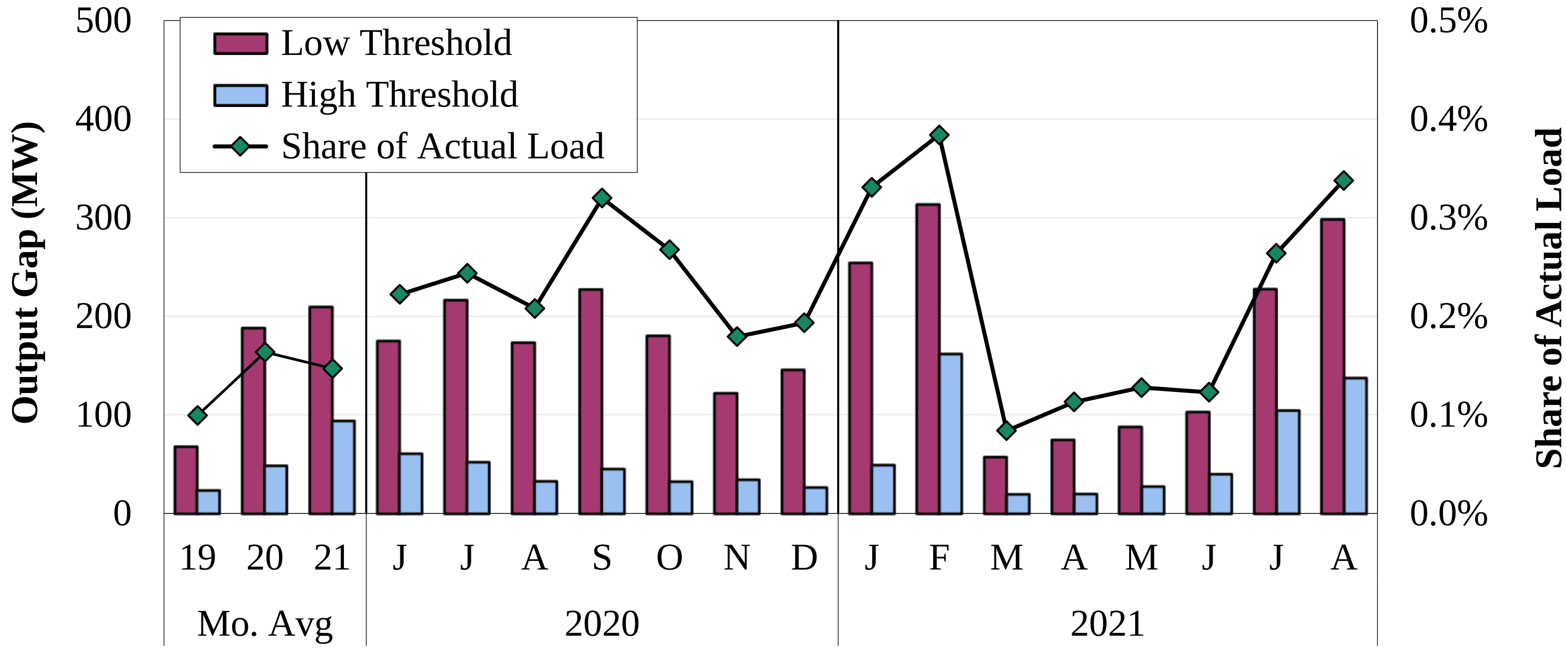
POTOMAC ECONOMICS

Coordinated Transaction Scheduling (CTS) Summer 2020–2021



POTOMAC ECONOMICS

Monthly Output Gap
Summer 2020–2021



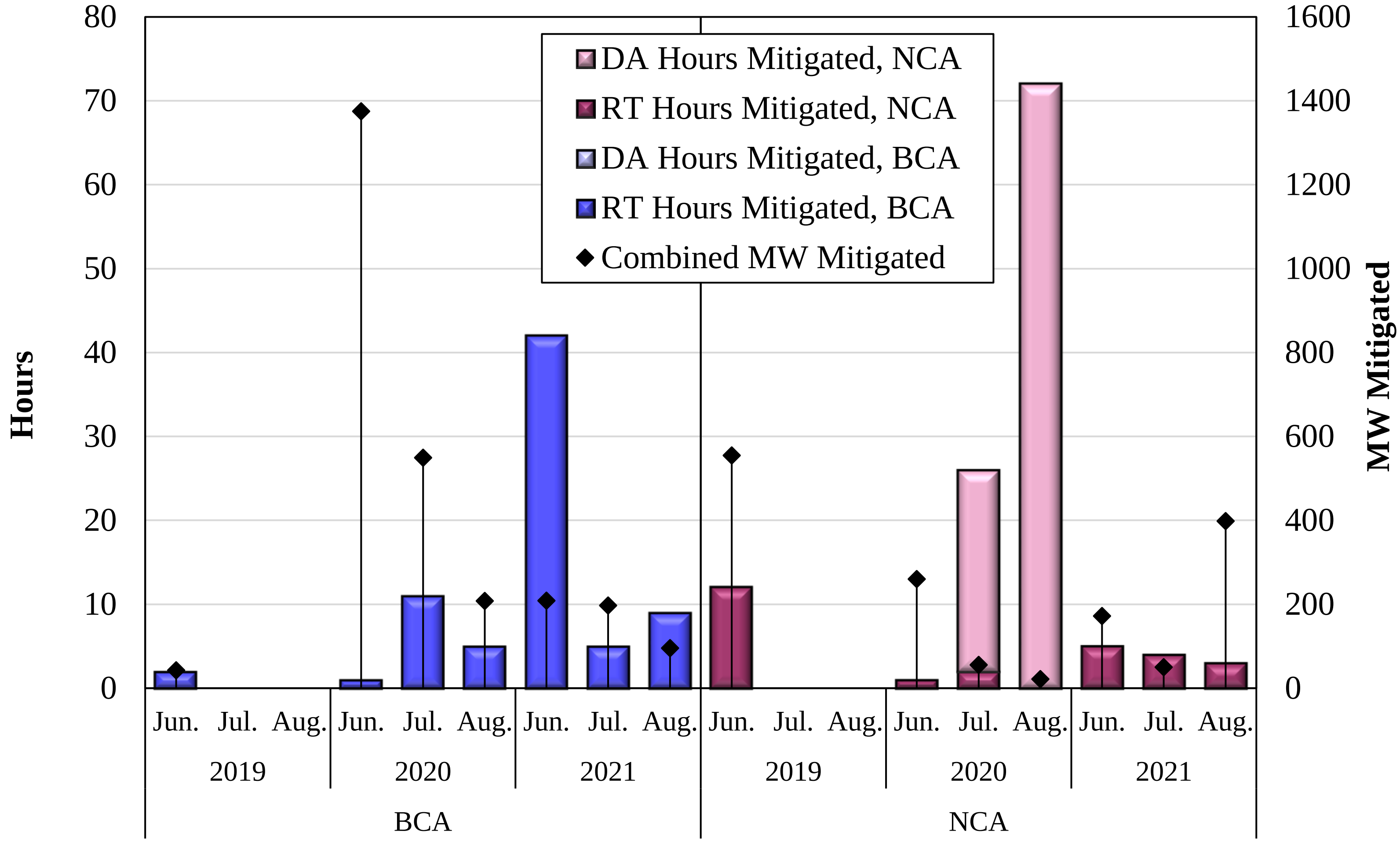
Low Threshold Results by Unit Status (MW)

Offline	8	22	27	12	36	18	4	8	10	2	0	90	3	0	9	8	27	46
Online	60	166	183	163	180	156	223	172	112	144	254	223	55	75	79	96	201	252

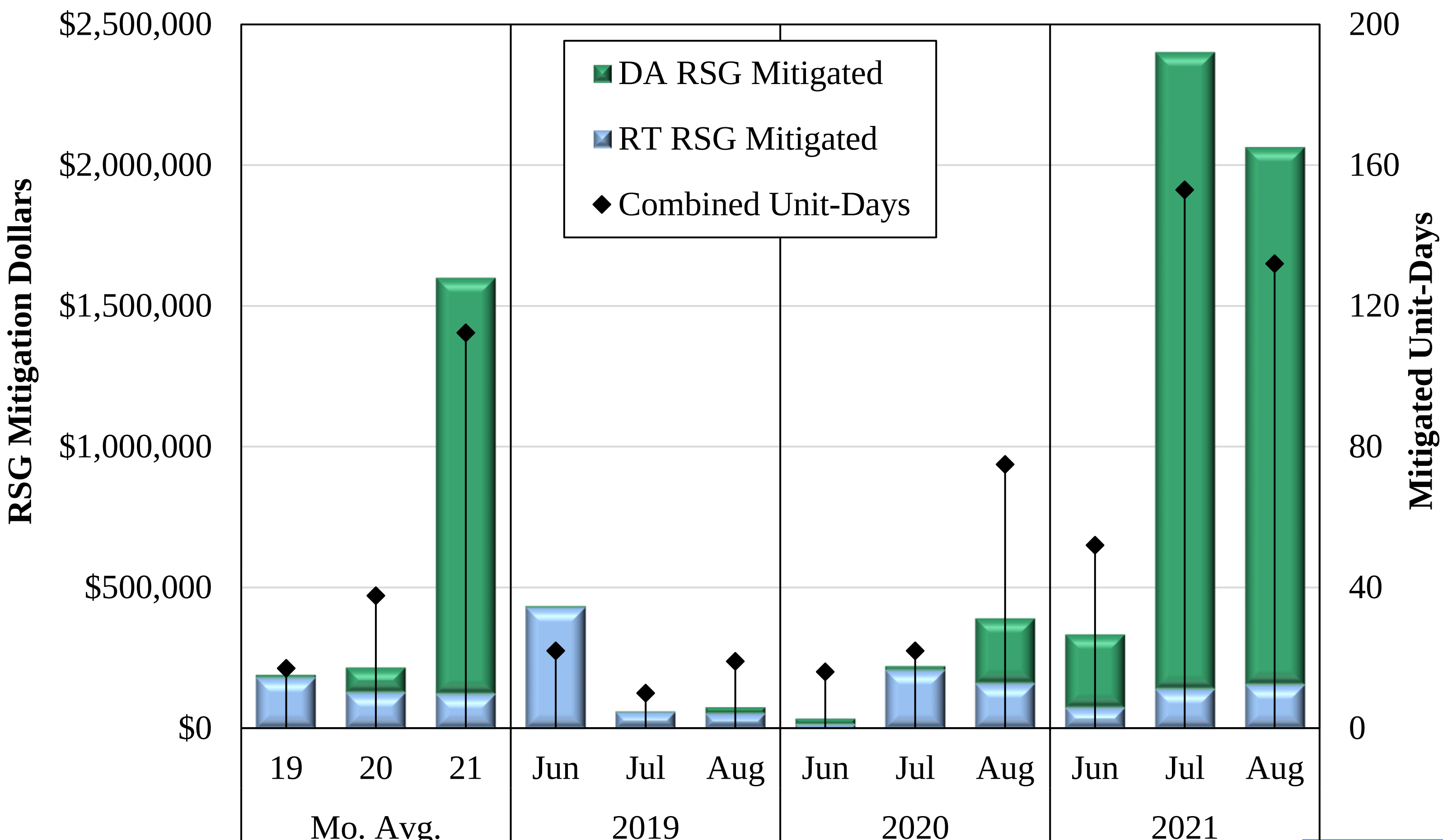
High Threshold Results by Unit Status (MW)

Offline	8	19	22	11	31	16	4	7	7	2	0	70	2	0	8	7	22	38
Online	16	29	71	50	21	17	41	25	28	25	49	91	18	20	20	33	82	100

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



Day-Ahead and Real-Time RSG Mitigation Summer 2020 and 2021



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 Curve 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 Loading Relief
- TCDC Transmission Constraint Demand Curve
- VLR Voltage and Local Reliability
- WUMS Wisconsin Upper Michigan System