DRAFT – Most data included through November 28, but settlement data included through November 20.

IMM Quarterly Report: Fall 2015

MISO Independent Market Monitor

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Potomac Economics

December 9, 2015

POTOMAC ECONOMICS

Quarterly Summary

		Value	Change[1] Prior Qtr.	Change[1] Prior Year
RT Energy Prices ($/MWh)		$25.08	*-13%*	*-26%*
Fuel Prices ($/MMBtu)				
Natural Gas - Chicago		$2.41	*-14%*	*-40%*
Natural Gas - Henry Hub		$2.35	*-15%*	*-40%*
Western Coal		$0.59	*1%*	*-14%*
Eastern Coal		$1.48	*-3%*	*-23%*
Load (GW)[2]				
Average Load		72.2	*-14%*	*-3%*
Peak Load		113.9	*-5%*	*2%*
% Scheduled DA (Peak Hour)		99.1%	99.5%	100.6%
Transmission Congestion ($M)				
Real-Time Congestion Value		$312.5	*-9%*	*-23%*
Day-Ahead Congestion Revenue		$172.4	*-12%*	*-24%*
Balancing Congestion Revenue[3]		-$6.9	-$2.6	-$17.7
Ancillary Service Prices ($/MWh)				
Regulation		$6.60	*-7%*	*-38%*
Spinning Reserves		$1.36	*-39%*	*-31%*
Supplemental Reserves		$1.10	*-22%*	*51%*

		Value	Change[1] Prior Qtr.	Change[1] Prior Year
FTR Funding (%)		95%	103%	92%
Wind Output (MW/hr)		5,412	*85%*	*12%*
Guarantee Payments ($M)[4]				
Real-Time RSG		$16.3	*-19%*	*34%*
Day-Ahead RSG		$11.1	*-46%*	*-62%*
Day-Ahead Margin Assurance		$8.1	*3%*	*-38%*
Real-Time Offer Rev. Sufficiency		$2.8	*9%*	*-3%*
Price Convergence[5]				
Market-wide DA Premium		1.8%	*0.4%*	*0.3%*
Virtual Trading				
Cleared Quantity (MW/hr)		11,040	*16%*	*25%*
% Price Insensitive		32%	*34%*	*38%*
% Screened for Review		1%	*1%*	*2%*
Profitability ($/MW)		$0.75	$0.87	$0.89
Dispatch of Peaking Units (MW/hr)		958	*1062*	*367*
Output Gap- Low Thresh. (MW/hr)		85	*110*	*165*
Other:				
SPP M2M Coordination				

Key:
- Expected
- Monitor/Discuss
- Concern

Notes:
1. Values not in italics are the value 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.

Summary of Fall 2015

- Fall 2015 was characterized by moderate weather and a steep decline in energy prices consistent with much lower gas prices.
  - ✓ WOTAB experienced high demand during warm periods early in the quarter.
- Overall, the market performed competitively and reliably this fall.
- Much lower gas prices this fall drove down average system-wide energy prices.
  - ✓ Real-time energy prices fell 26 percent from last year to $25.08 per MWh.
  - ✓ In November, gas prices began the month below $2 per MMBtu and remained low, which is consistent with the very high levels of natural gas storage.
- Congestion levels similarly fell significantly in both the day-ahead and real-time compared to last fall largely because of lower gas prices.
- Real-time RSG increased from Fall 2014 as MISO utilized peaking units more heavily.
  - ✓ Most of increase occurred in September in periods of high loads and underscheduling of load day-ahead.
- Price convergence was mixed, with periods of significant divergence due to congestion into Texas and record levels of wind generation in the North region.
- Market-to-market coordination with SPP has reduced inefficient inter-RTO congestion impacts, but MISO and SPP are trying resolve a number of issues.

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Highlights from Fall 2015

Decline in Fuel and Energy Prices (Slides 8, 9, 11)

- Driven by the continued decline in natural gas prices, energy prices in the fall dropped sharply from the prior quarter and the prior year.
  - ✓ Both Chicago Hub and Henry Hub natural gas prices averaged less then $2.50 per MMBtu during the quarter.
  - ✓ Both gas hubs dropped briefly below $2 in early November and remained low throughout the month, consistent with record levels of natural gas storage.
  - ✓ Average energy prices dropped below $22 per MWh in November.
- The lower gas prices also contributed to lower congestion because most of the generation redispatch to manage network flows involve gas-fired resources.
  - ✓ However, prices in the North and in WOTAB areas were substantially affected by congestion patterns discussed in this report.

Highlights for Fall 2015

Price Spikes at Texas Hub (Slide 8)

- In addition to the price spikes discussed in the October monthly report, the Texas Hub experienced additional periods of high price spikes in November.
  - ✓ In both October and November, the high prices were caused by a combination of forced and planned generation and transmission outages.
  - ✓ Extended price spikes occurred on November 3, 5, and 6 with hourly prices at $350 on November 3 and 5, and above $500 on November 6.
- On the November 5, prices spikes were aggravated by local constraints in conflict with the North-to-South SRPBC constraint.
  - ✓ This occurs when units in MISO South (outside WOTAB) must be ramped down to reduce flows on constraints into WOTAB and this energy is replaced by higher output in the Midwest (this redispatch results in flows over the SRPBC).
  - ✓ It is inefficient for the SRPBC or ORCA (which are not physical constraints) to interfere with MISO's ability to manage physical constraints in MISO South.
- On the November 6, MISO declared a Local Transmission Emergency to commit an Emergency Resource and ultimately recalled a planned transmission outage.

Highlights from Fall 2015

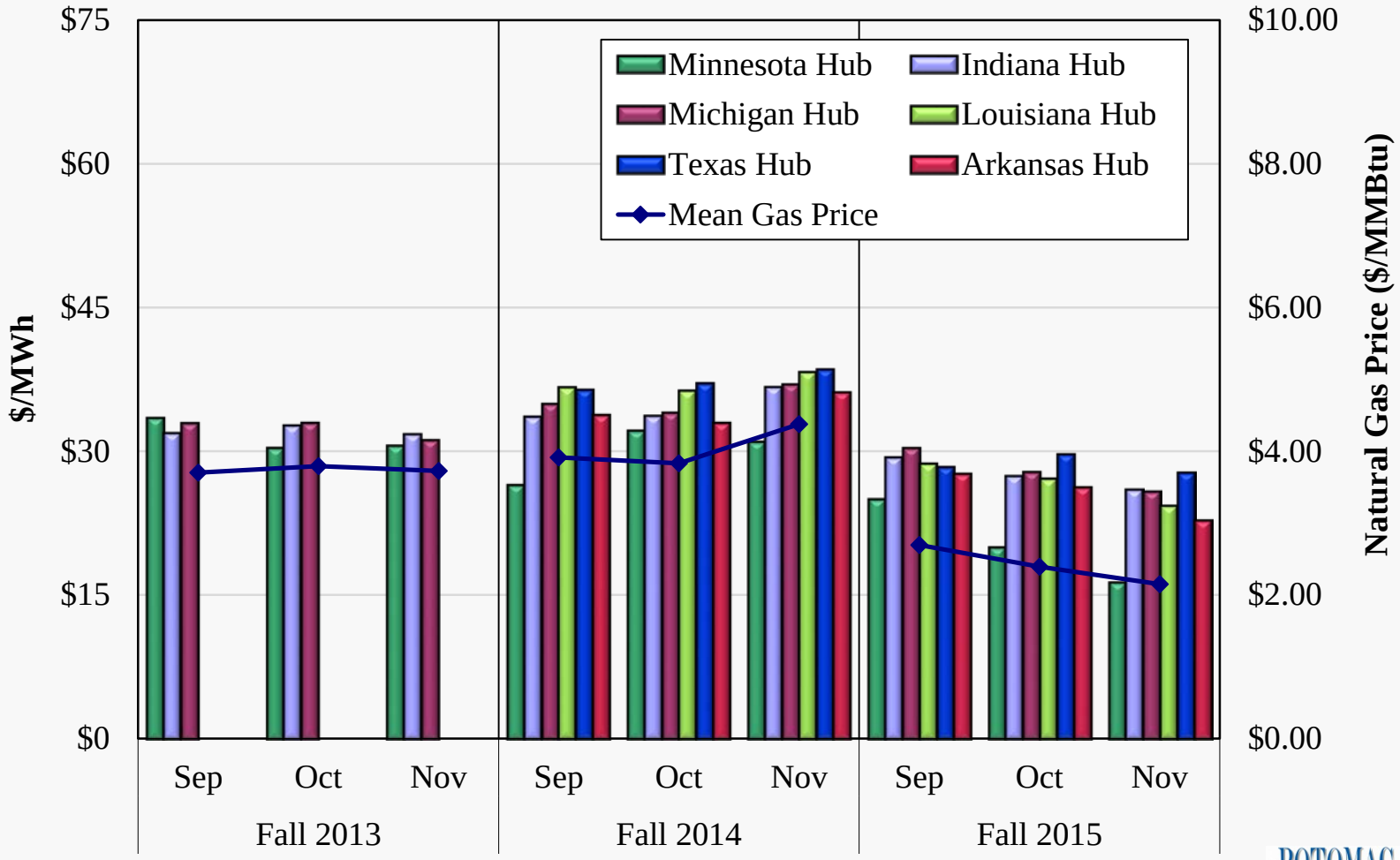
Wind Output and Price Convergence in the North (Slides 13-15)

- In both October and November, day-ahead Minnesota Hub prices were much higher than real-time on many of days.
- Much of the divergence was a result of higher levels of real-time congestion out of the North region because of high real-time wind output.
  - ✓ Real time wind generation set a new record of 12.6 GW on November 19.
  - ✓ During periods of high wind output, congestion was frequently severe enough to generate negative real-time prices at the Minnesota Hub.
  - ✓ Day ahead scheduling of wind was 11 percent lower than real-time wind output.
  - ✓ The lower day-ahead scheduling tends to reduce the congestion out of the North region in the day-ahead market.
- Virtual supply responded to the divergence by scheduling at wind locations in high-wind conditions, offsetting more than half of the under-scheduled wind.
  - ✓ Although these traders did not achieve fully efficient convergence, this activity illustrates one of the many ways virtuals improve the day-ahead market outcomes by mitigating market inconsistencies.

Submittals to External Entities and Other Issues

- We responded to FERC questions related to prior referrals regarding resources failing to update real-time offers and we continued to meet with FERC staff on a weekly and monthly basis to discuss market outcomes.
- We hosted FERC staff at our offices to discuss market monitoring metrics.
- We participated in a FERC technical conference on capacity market design and mitigation in MISO.
  - ✓ We also submitted post-technical conference comments on issues related to MISO demand for capacity, capacity market mitigation, and the pseudo-tie requirements imposed by PJM.
- We participated in the recent PJM-MISO Joint and Common Market Meeting.
  - ✓ We presented proposed firm capacity deliverability procedures as an alternative to PJM's pseudo-tie requirements for external capacity resources.
  - ✓ We also discussed our ongoing analysis of near-term alternatives for interface pricing, which will be completed and discussed with MISO this month.
- We filed comments in support of the recent FERC NOPRs on 5-minute settlements and shortage pricing, recommending that FERC address transmission shortage as well.

Day-Ahead Average Monthly Hub Prices
Fall 2013–2015



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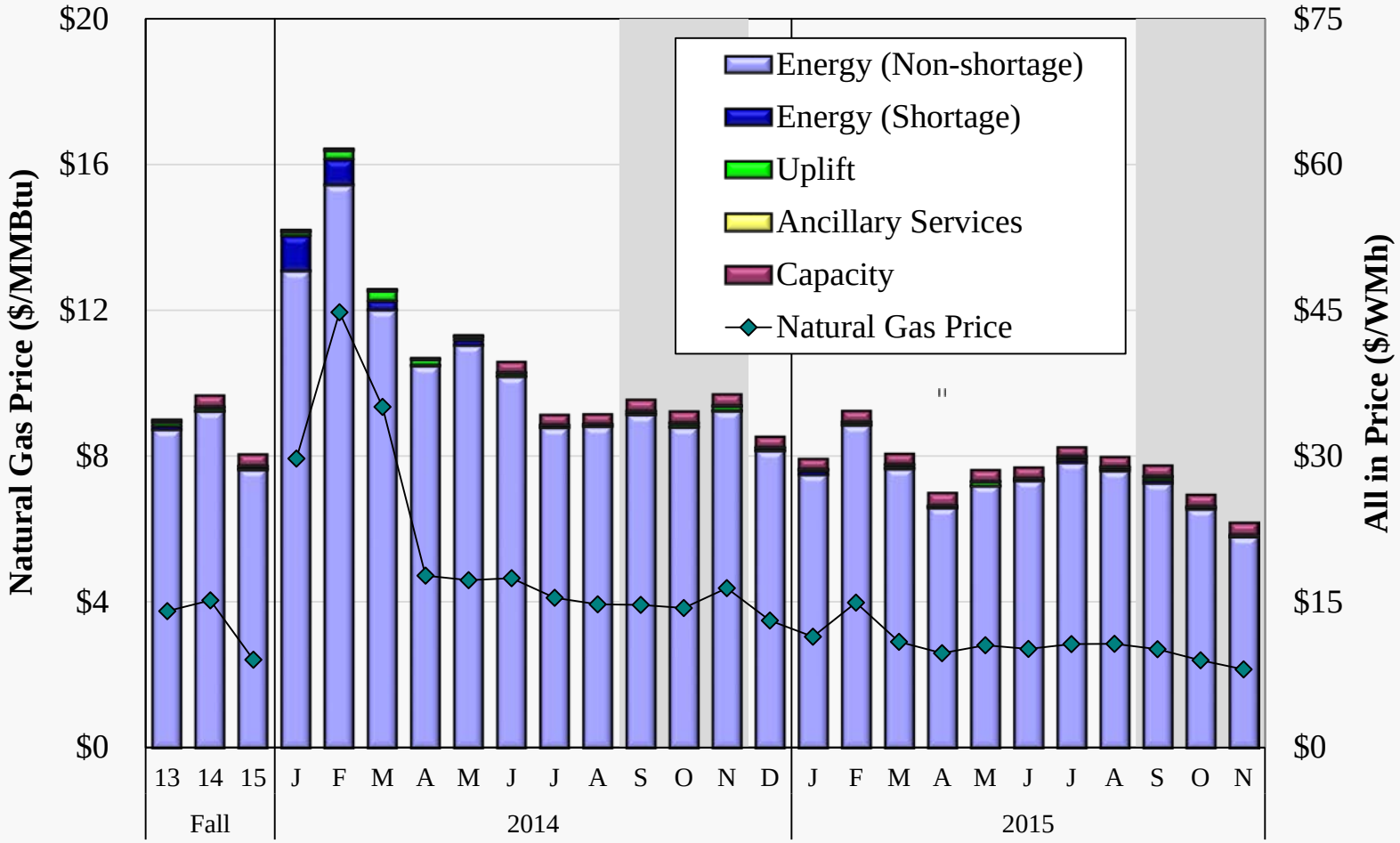
All-In Price
2014 –2015



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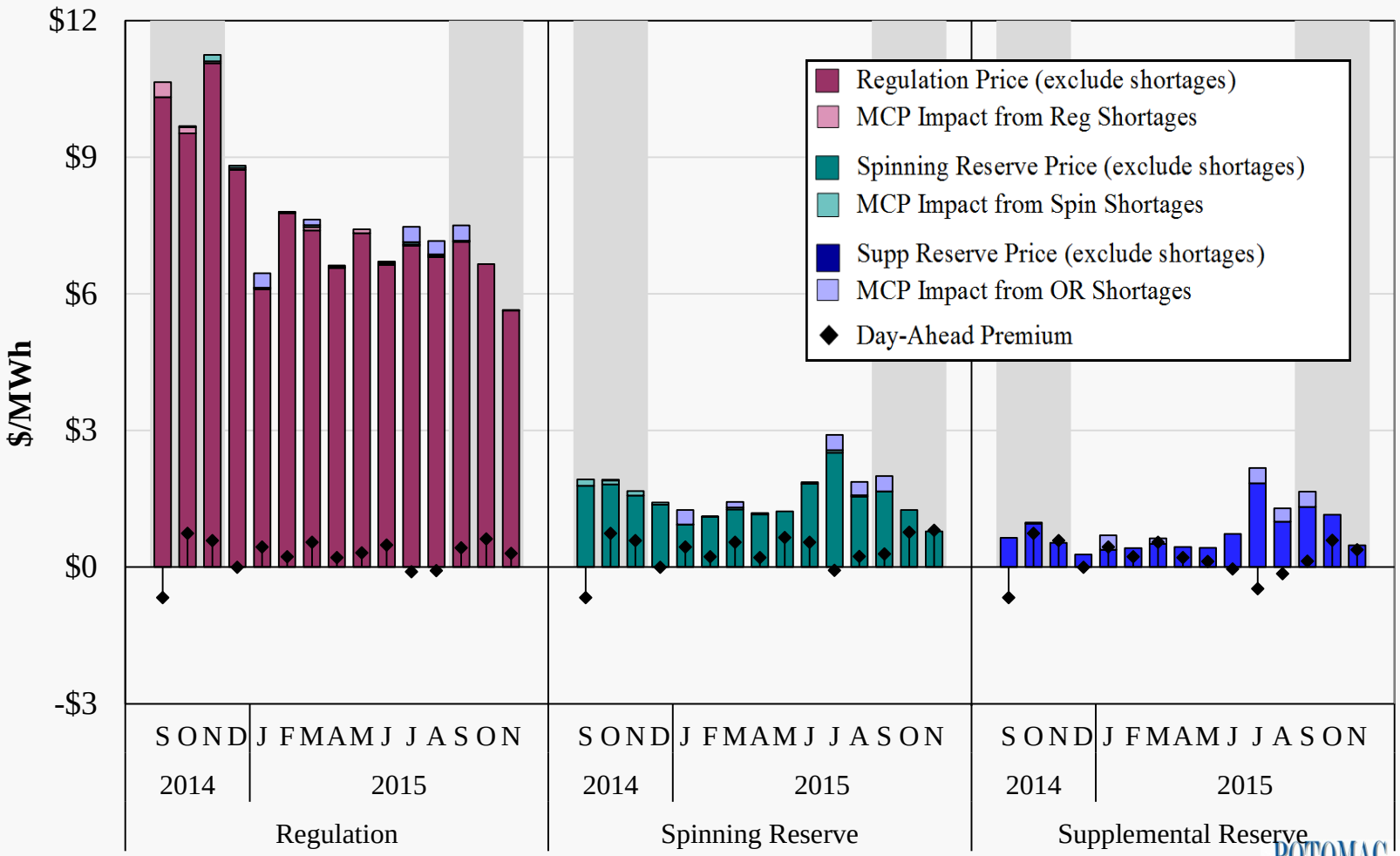
Monthly Average Ancillary Service Prices
Regulation and Contingency Reserves, 2014–2015



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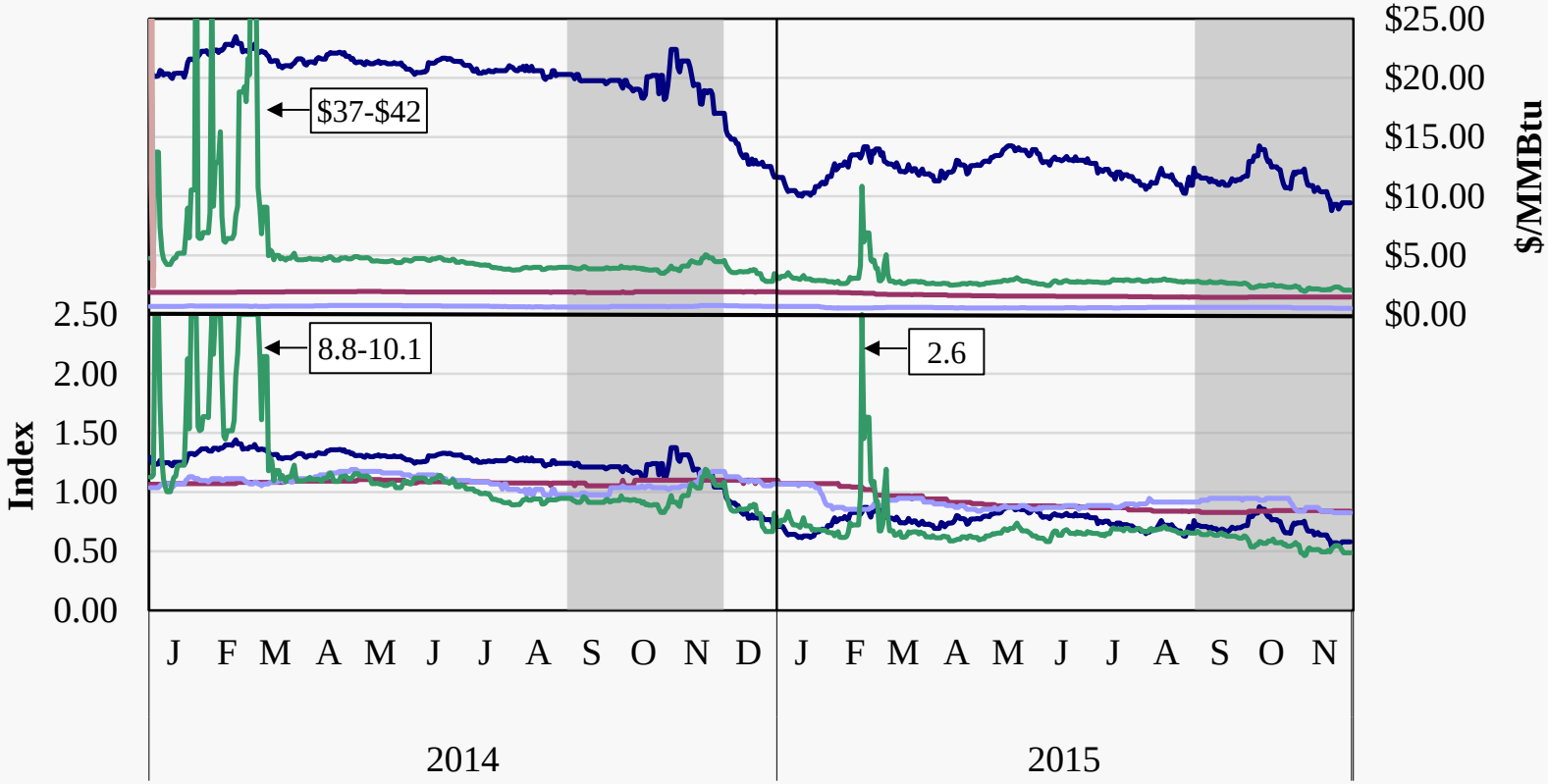
MISO Fuel Prices 2014–2015



Fall Average	2013	2014	2015	Fall Average	2013	2014	2015
Oil	$21.41	$19.62	$11.35	IB Coal	$1.86	$1.91	$1.48
Natural Gas	$3.74	$4.04	$2.41	PRB Coal	$0.63	$0.69	$0.59

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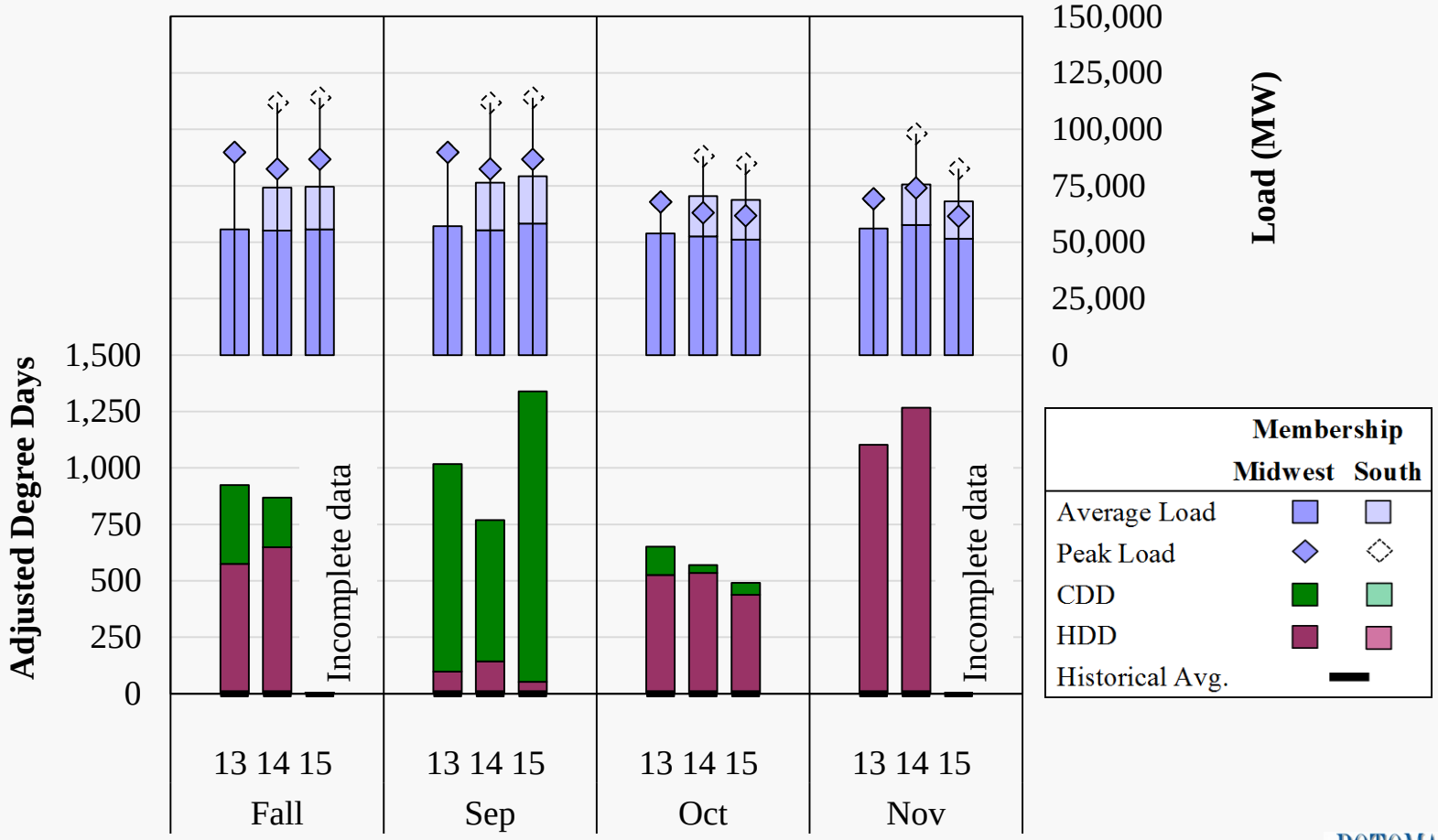
Load and Weather Patterns
Fall 2013–2015



Note: Midwest degree day calculations include four representative cities in the Midwest: Cincinnati, Detroit, Milwaukee and Minneapolis. The South region includes Little Rock and New Orleans.

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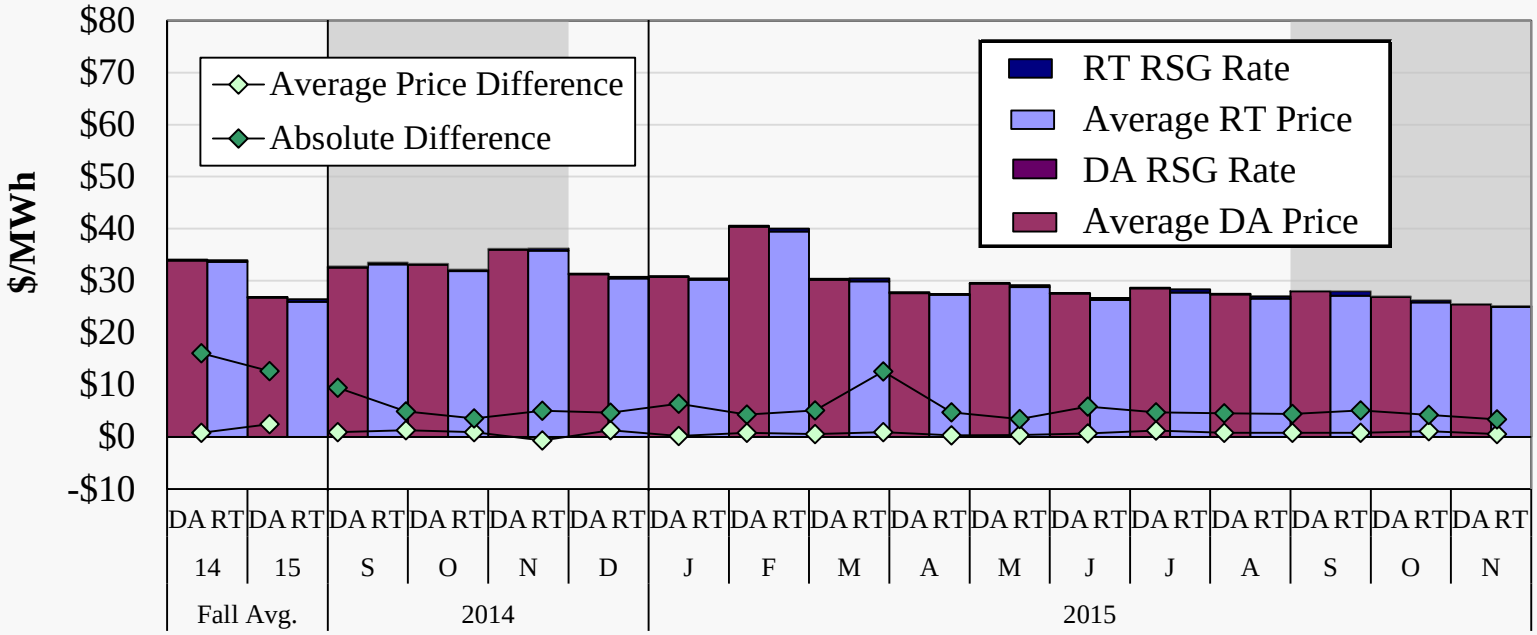
Day-Ahead and Real-Time Price Convergence 2014–2015



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

Indiana Hub	0	2	-2	3	0	2	1	1	0	1	2	3	1	2	0	3	2
Michigan Hub	1	1	-2	3	0	2	7	6	-1	2	0	0	0	0	-3	2	4
Minnesota Hub	2	7	0	3	4	-5	-1	0	-1	2	3	-1	3	0	-2	14	9
WUMS Area	0	1	-5	1	3	1	1	0	2	4	1	3	3	0	1	1	0
Arkansas Hub	-1	3	-4	-1	3	2	-3	3	-3	4	3	3	-3	0	0	0	7
Louisiana Hub	0	2	-4	2	2	4	0	2	-10	-2	0	-10	1	-5	0	0	7
Texas Hub	2	-10	2	1	2	5	-1	1	-5	4	-10	4	0	-7	-2	-12	-15

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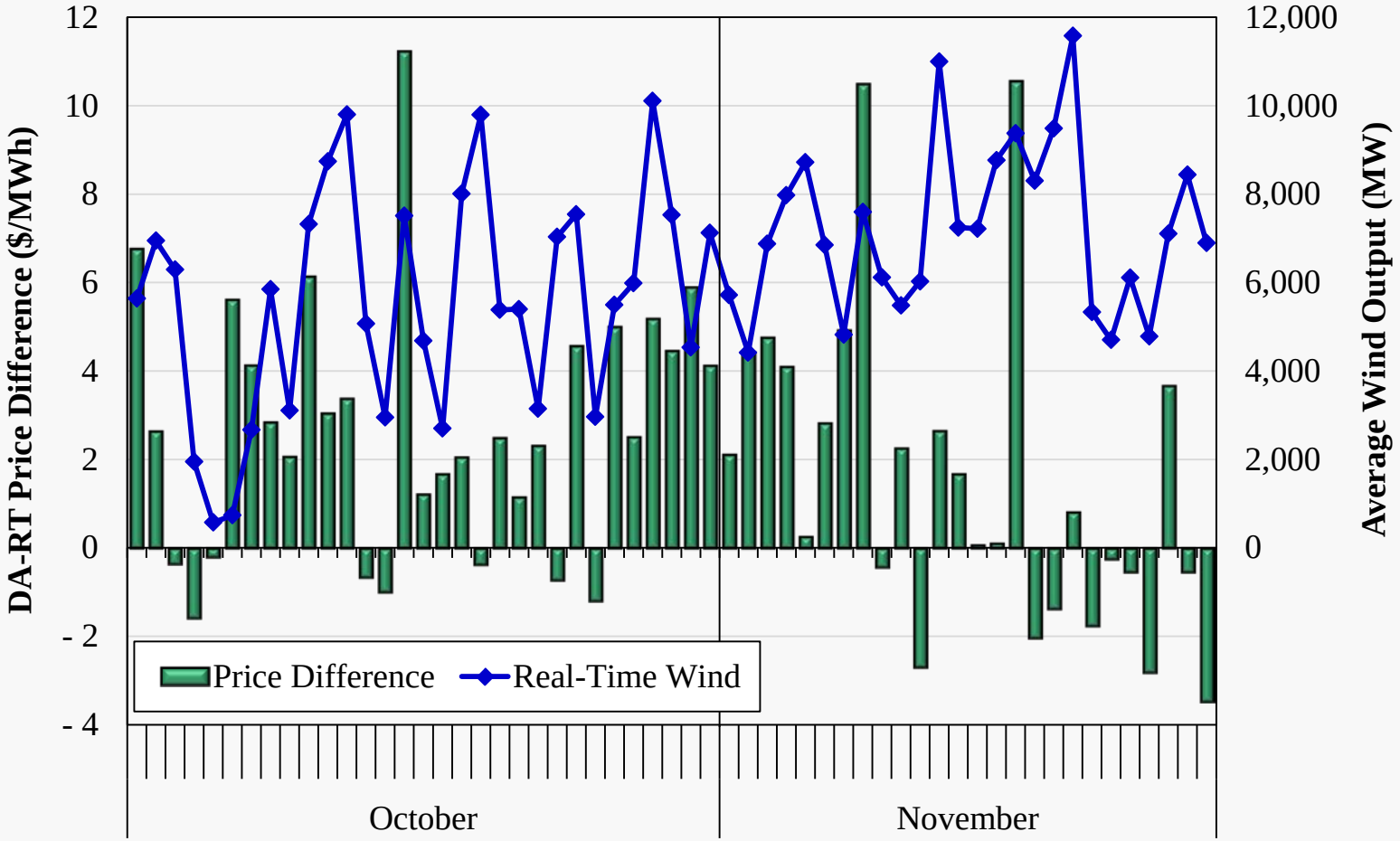
Price Convergence at the Minnesota Hub and Wind Output



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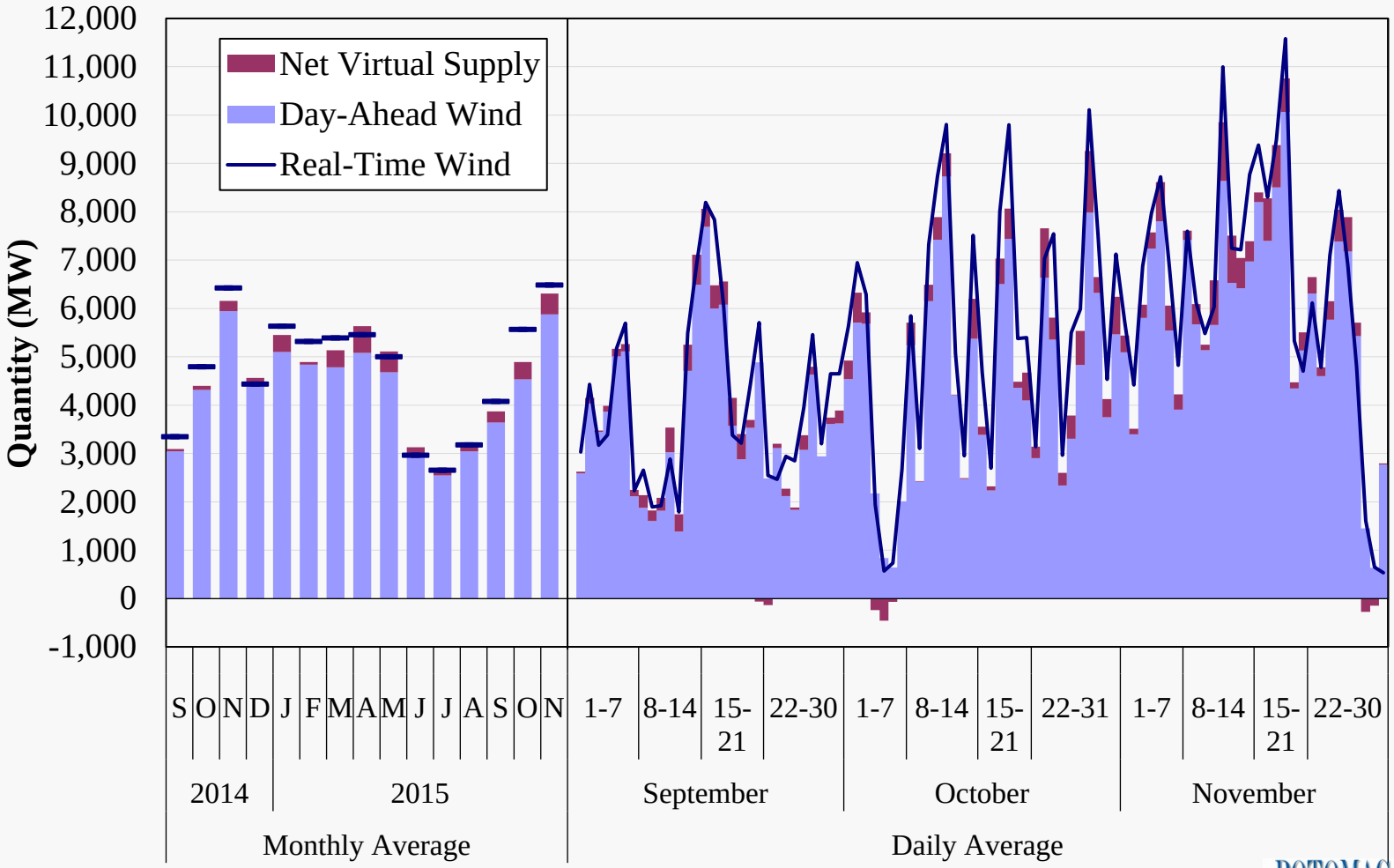
Wind Output in Real-Time and Day-Ahead Markets Monthly and Daily Average



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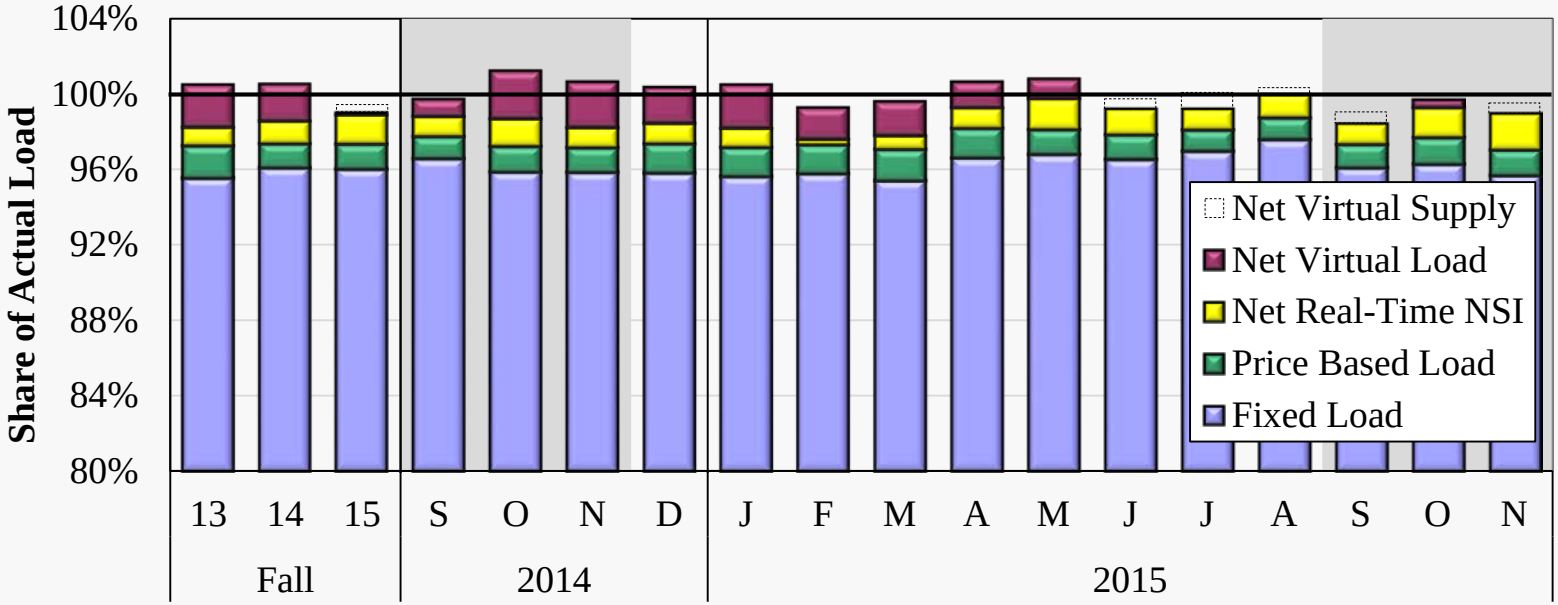
Day-Ahead Peak Hour Load Scheduling 2014–2015



Share of Actual Load (%)

	13	14	15	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
All Hours	99.5	100.1	98.2	99.6	100.0	100.6	99.8	99.9	98.9	98.6	99.3	99.4	98.5	99.4	99.6	98.5	98.2	98.0
Peak Hours Midwest	100.1	100.5	98.4	99.5	100.8	101.3	101.5	100.5	99.4	99.4	99.5	99.4	97.8	97.8	98.4	97.2	98.6	99.3
Peak Hours South		101.2	99.2	101.2	100.9	101.5	100.7	101.8	98.3	101.3	102.6	101.8	98.1	100.6	101.4	99.9	101.0	96.8

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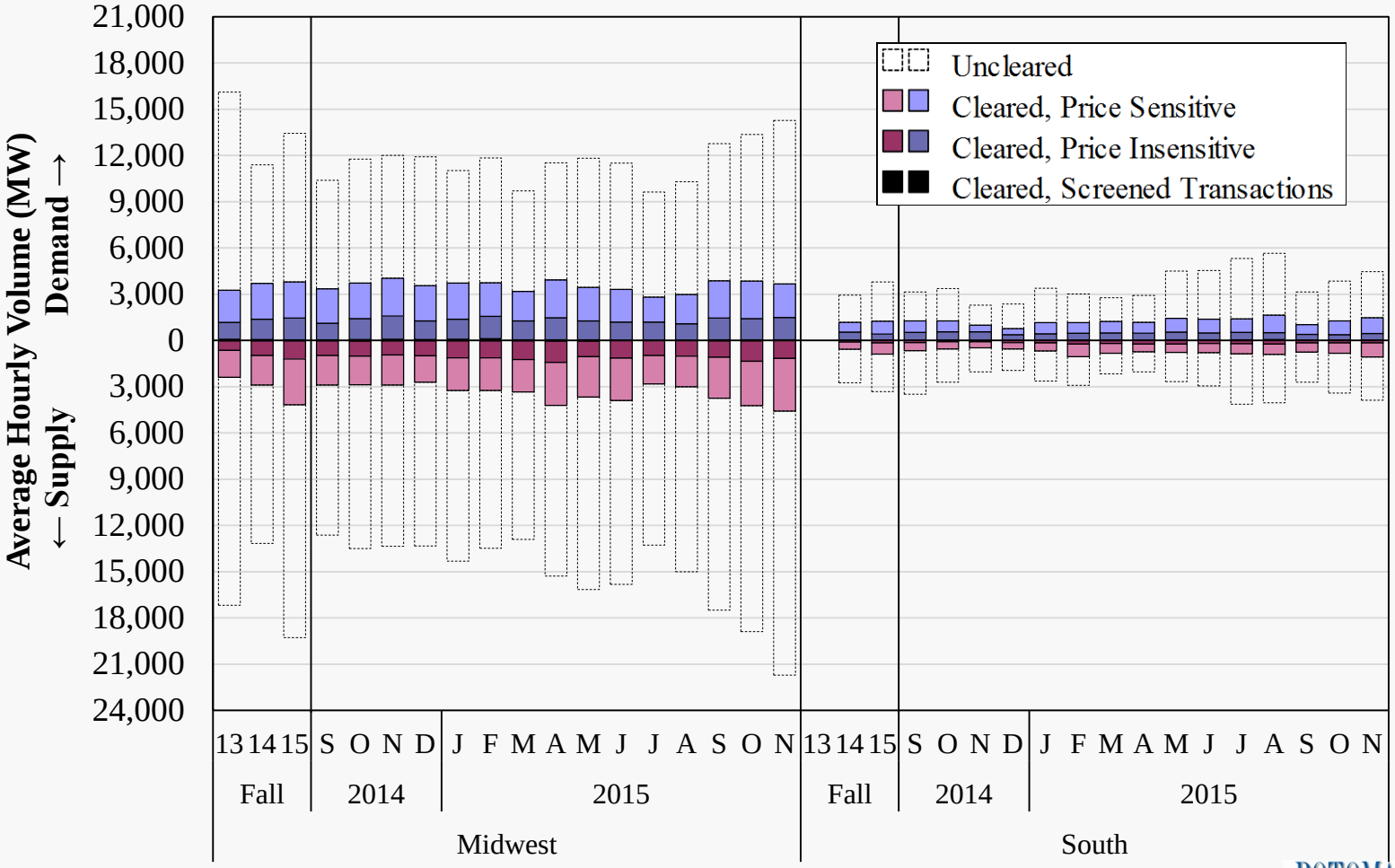
Virtual Load and Supply 2014–2015



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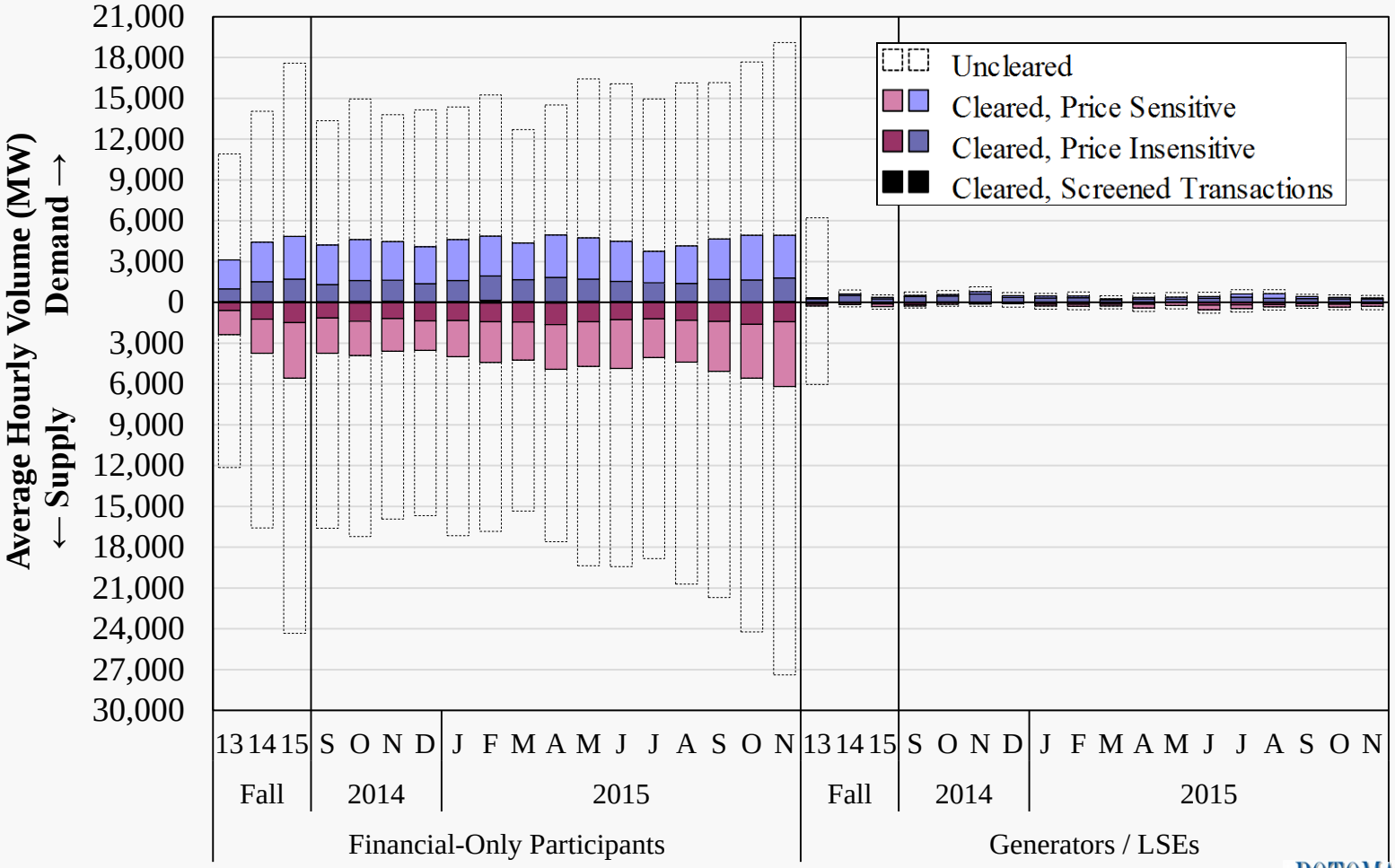
Virtual Load and Supply by Participant Type
Fall 2014–2015



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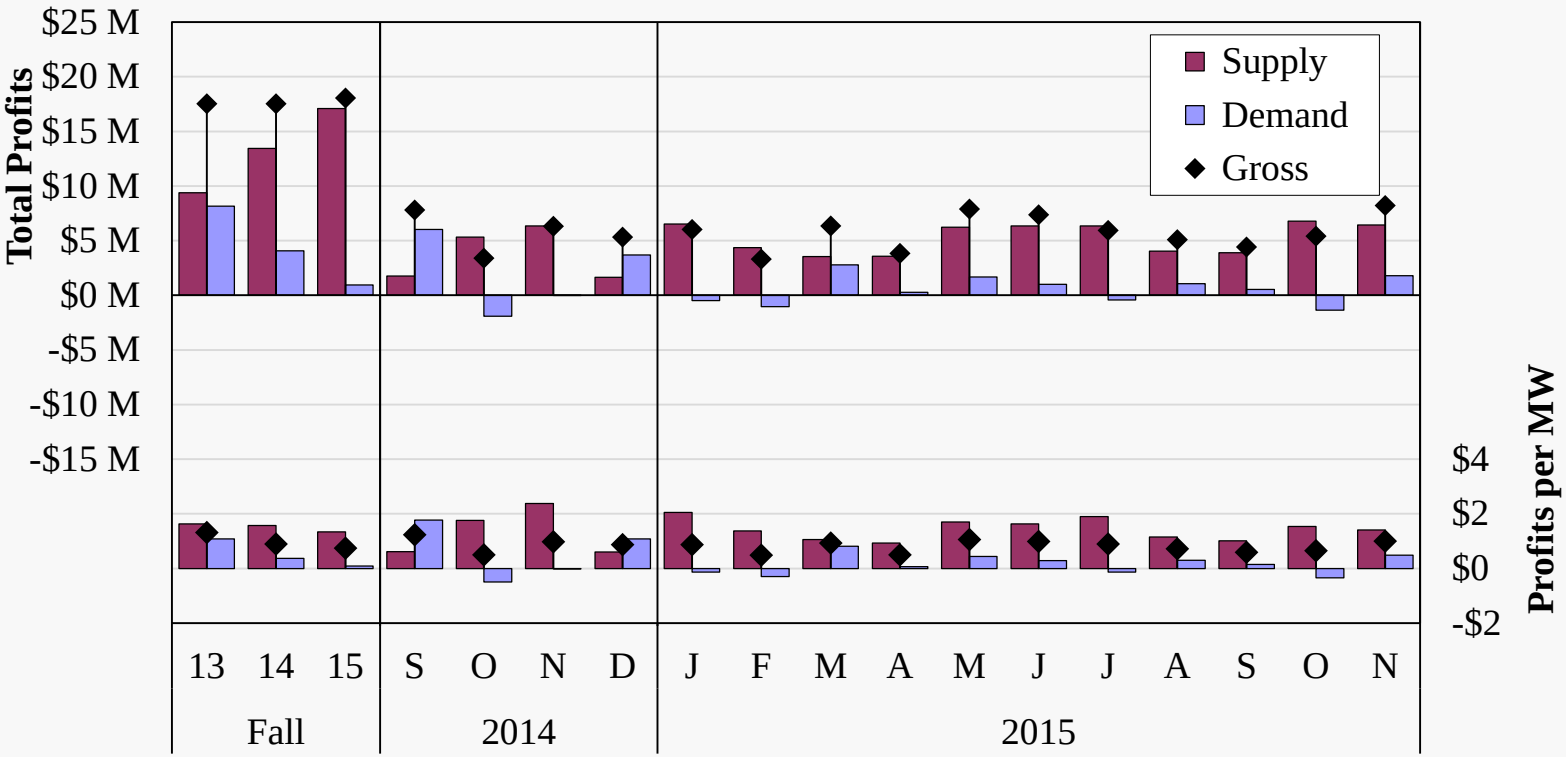
Virtual Profitability
Fall 2014–2015



Percent Screened

Demand	2.3	1.6	1.2	1.3	1.9	1.8	1.2	1.6	3.0	1.7	1.0	1.7	1.6	1.6	1.7	1.0	1.1	1.4
Supply	1.4	1.1	0.5	0.8	1.4	1.0	1.0	0.6	1.0	1.0	0.9	1.0	0.4	0.4	0.2	0.5	0.5	0.4
Total	1.9	1.4	0.8	1.1	1.7	1.5	1.1	1.1	2.1	1.4	1.0	1.4	0.9	1.0	1.0	0.8	0.8	0.9

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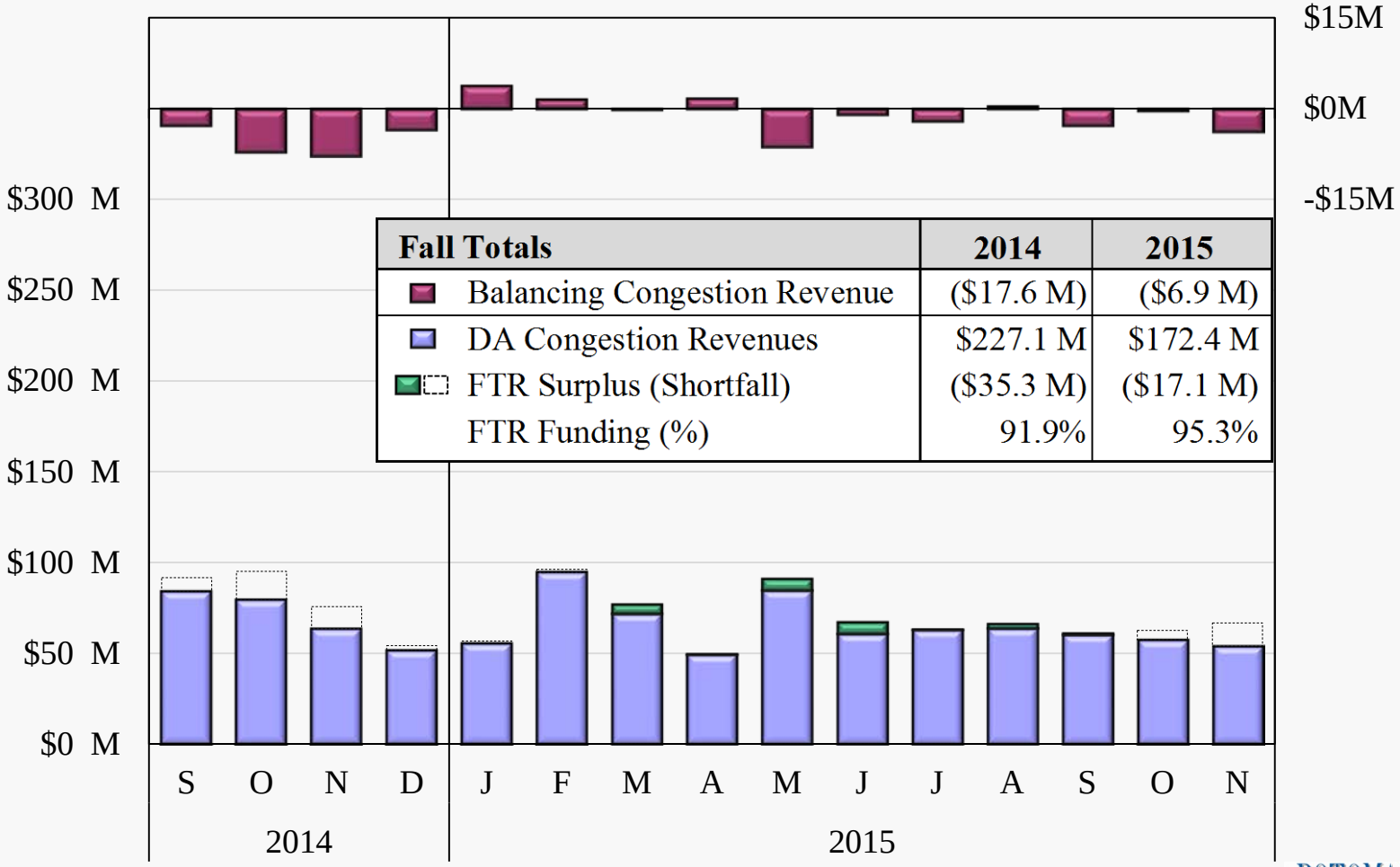
Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2014–2015



Fall Totals	2014	2015
Balancing Congestion Revenue	($17.6 M)	($6.9 M)
DA Congestion Revenues	$227.1 M	$172.4 M
FTR Surplus (Shortfall)	($35.3 M)	($17.1 M)
FTR Funding (%)	91.9%	95.3%

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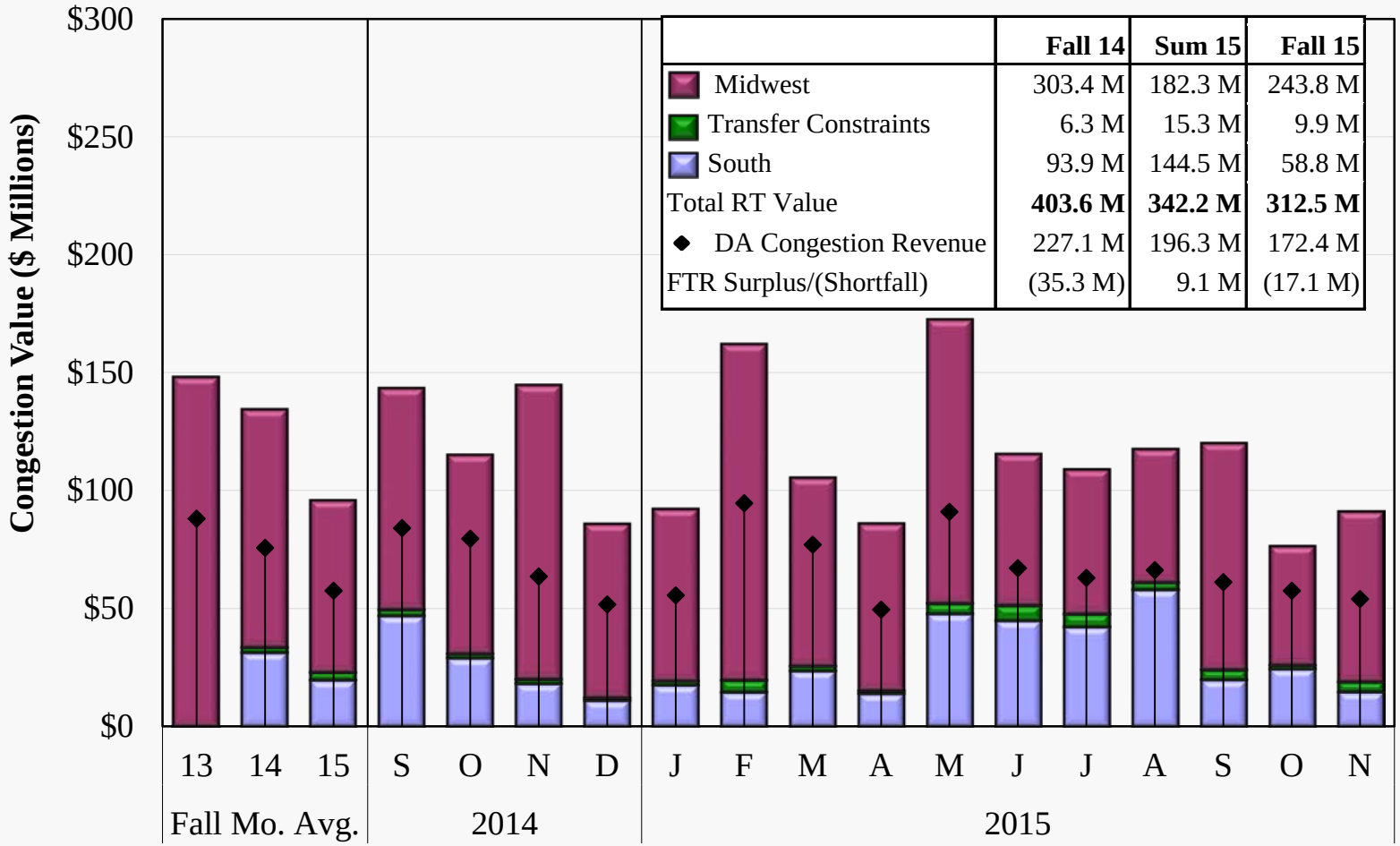
Value of Real-Time Congestion 2014–2015



	Fall 14	Sum 15	Fall 15
Midwest	303.4 M	182.3 M	243.8 M
Transfer Constraints	6.3 M	15.3 M	9.9 M
South	93.9 M	144.5 M	58.8 M
Total RT Value	**403.6 M**	**342.2 M**	**312.5 M**
◆ DA Congestion Revenue	227.1 M	196.3 M	172.4 M
FTR Surplus/(Shortfall)	(35.3 M)	9.1 M	(17.1 M)

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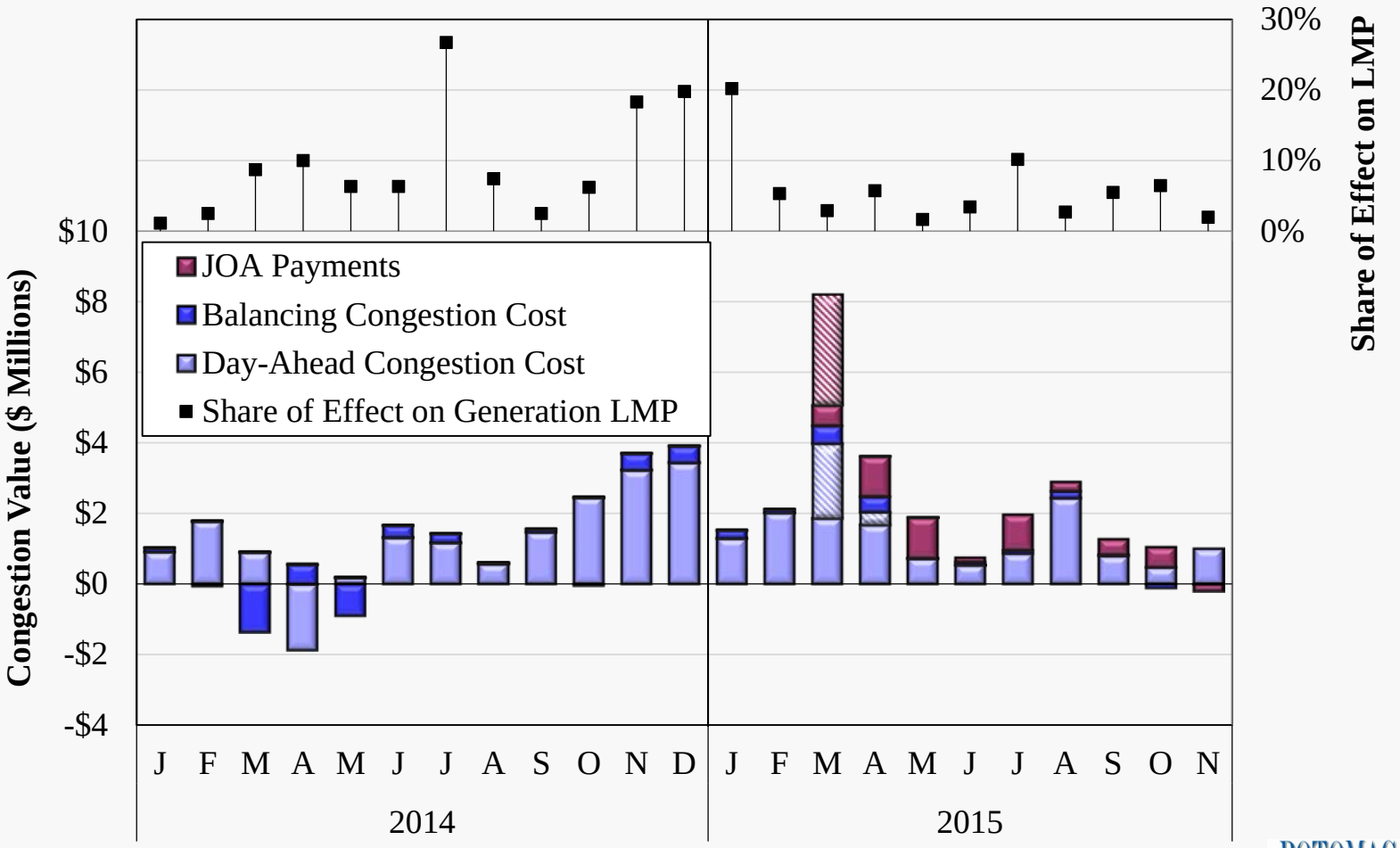
Congestion Costs on SPP Flowgates 2014–2015



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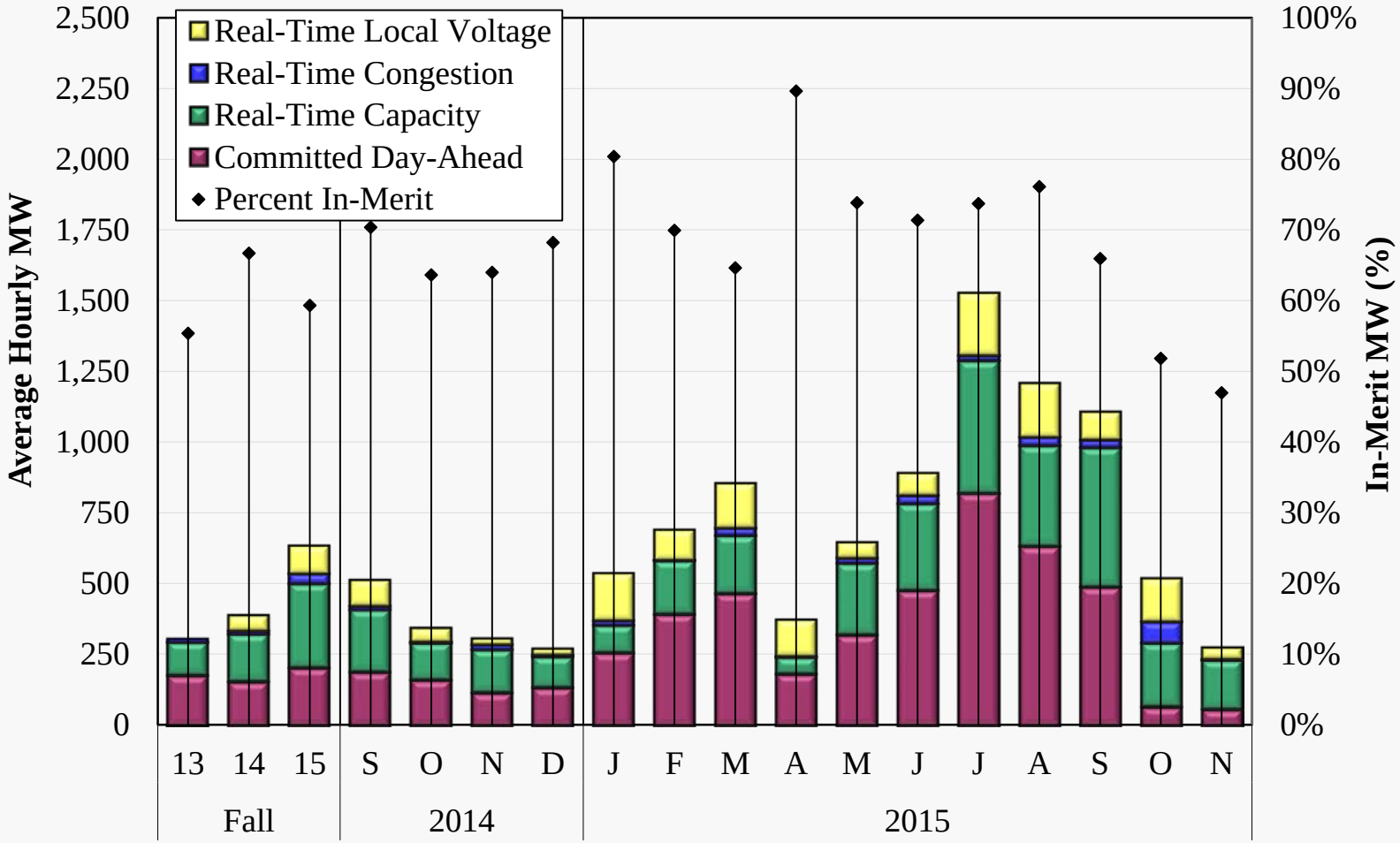
Peaking Resource Dispatch 2014–2015



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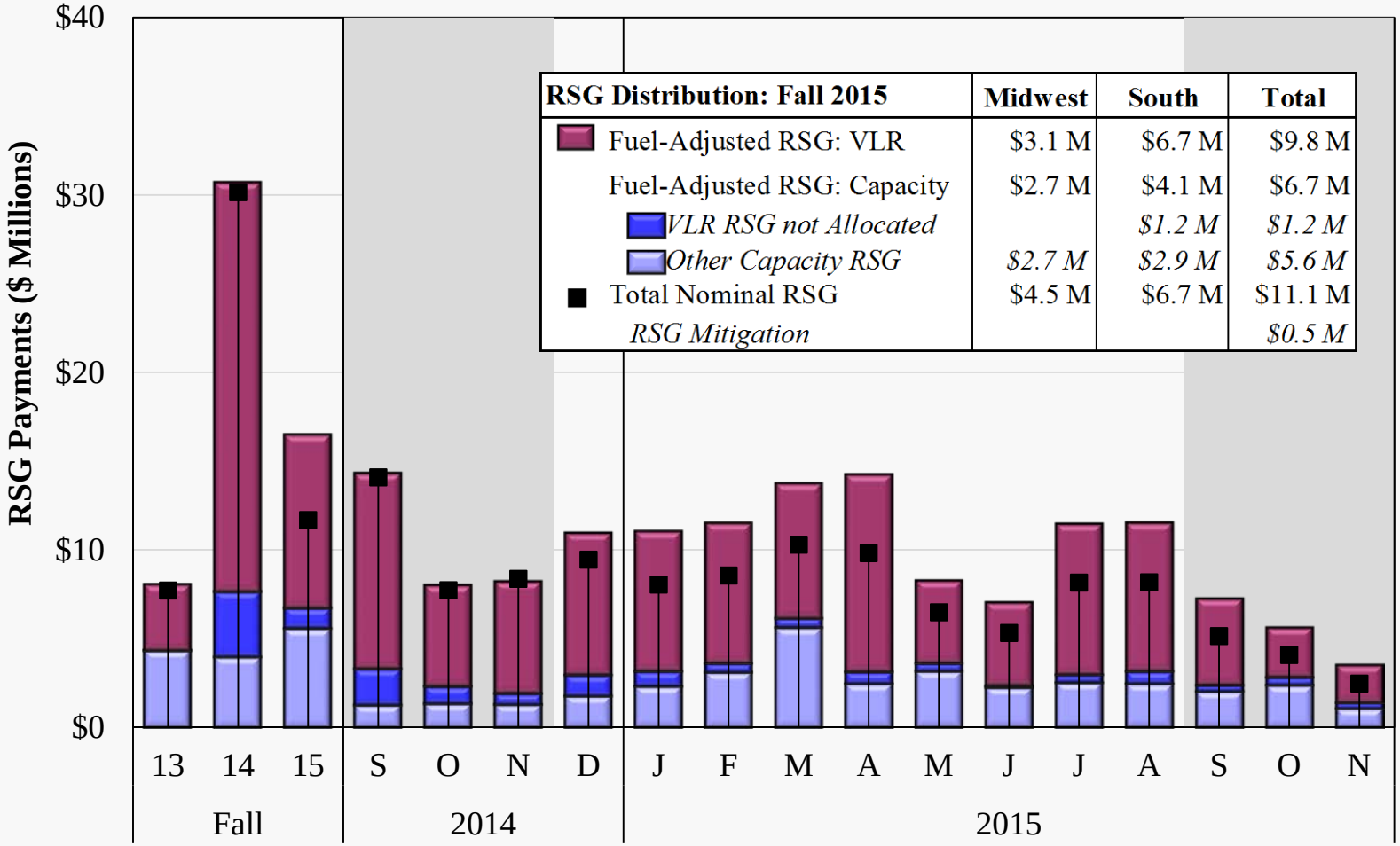
Day-Ahead RSG Payments
Fall 2014–2015



RSG Distribution: Fall 2015	Midwest	South	Total
Fuel-Adjusted RSG: VLR	$3.1 M	$6.7 M	$9.8 M
Fuel-Adjusted RSG: Capacity	$2.7 M	$4.1 M	$6.7 M
VLR RSG not Allocated		*$1.2 M*	*$1.2 M*
Other Capacity RSG	*$2.7 M*	*$2.9 M*	*$5.6 M*
Total Nominal RSG	$4.5 M	$6.7 M	$11.1 M
RSG Mitigation			*$0.5 M*

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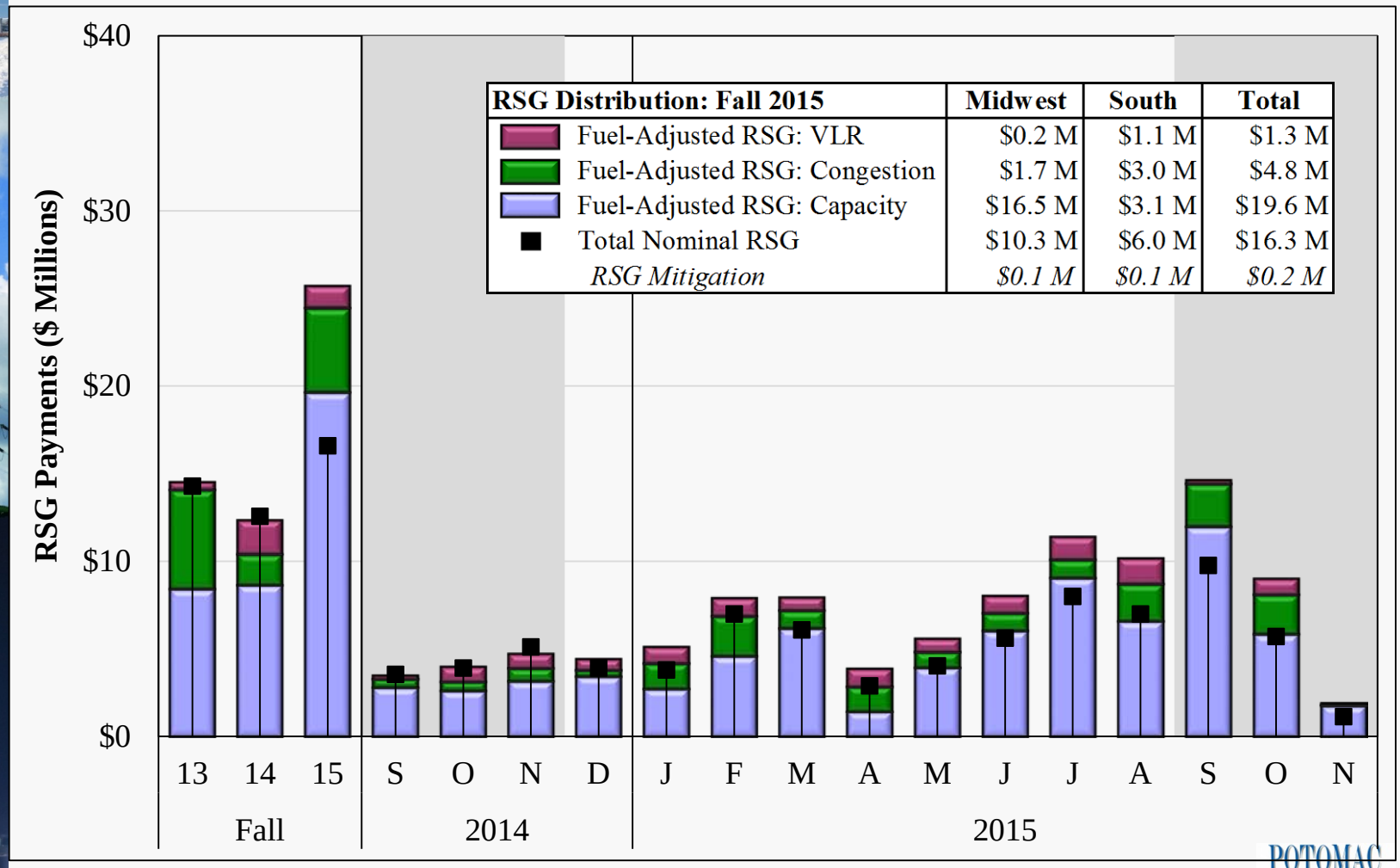
Real-Time RSG Payments
Fall 2014–2015



RSG Distribution: Fall 2015	Midwest	South	Total
Fuel-Adjusted RSG: VLR	$0.2 M	$1.1 M	$1.3 M
Fuel-Adjusted RSG: Congestion	$1.7 M	$3.0 M	$4.8 M
Fuel-Adjusted RSG: Capacity	$16.5 M	$3.1 M	$19.6 M
Total Nominal RSG	$10.3 M	$6.0 M	$16.3 M
RSG Mitigation	*$0.1 M*	*$0.1 M*	*$0.2 M*

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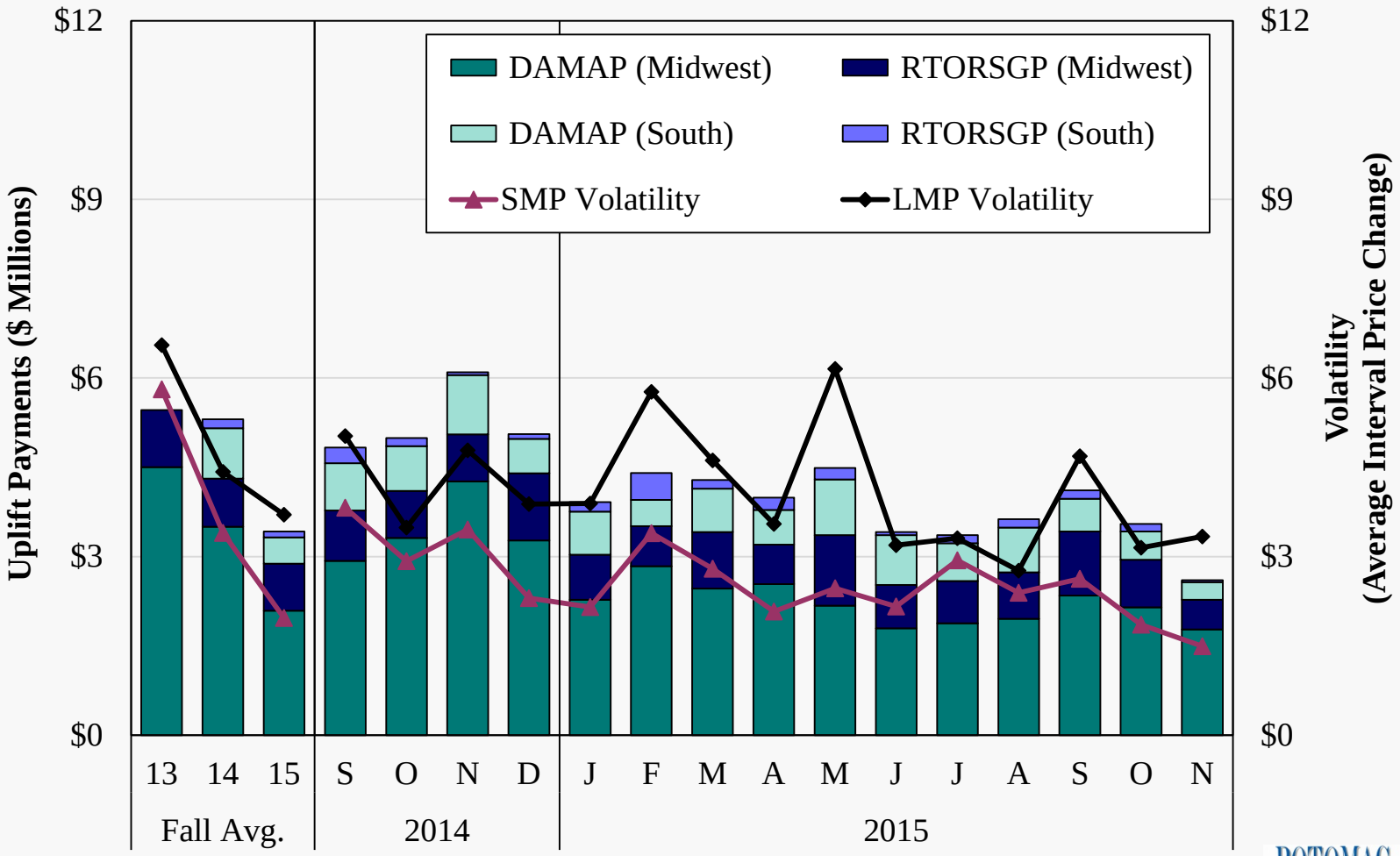
Price Volatility Make Whole Payments 2014–2015



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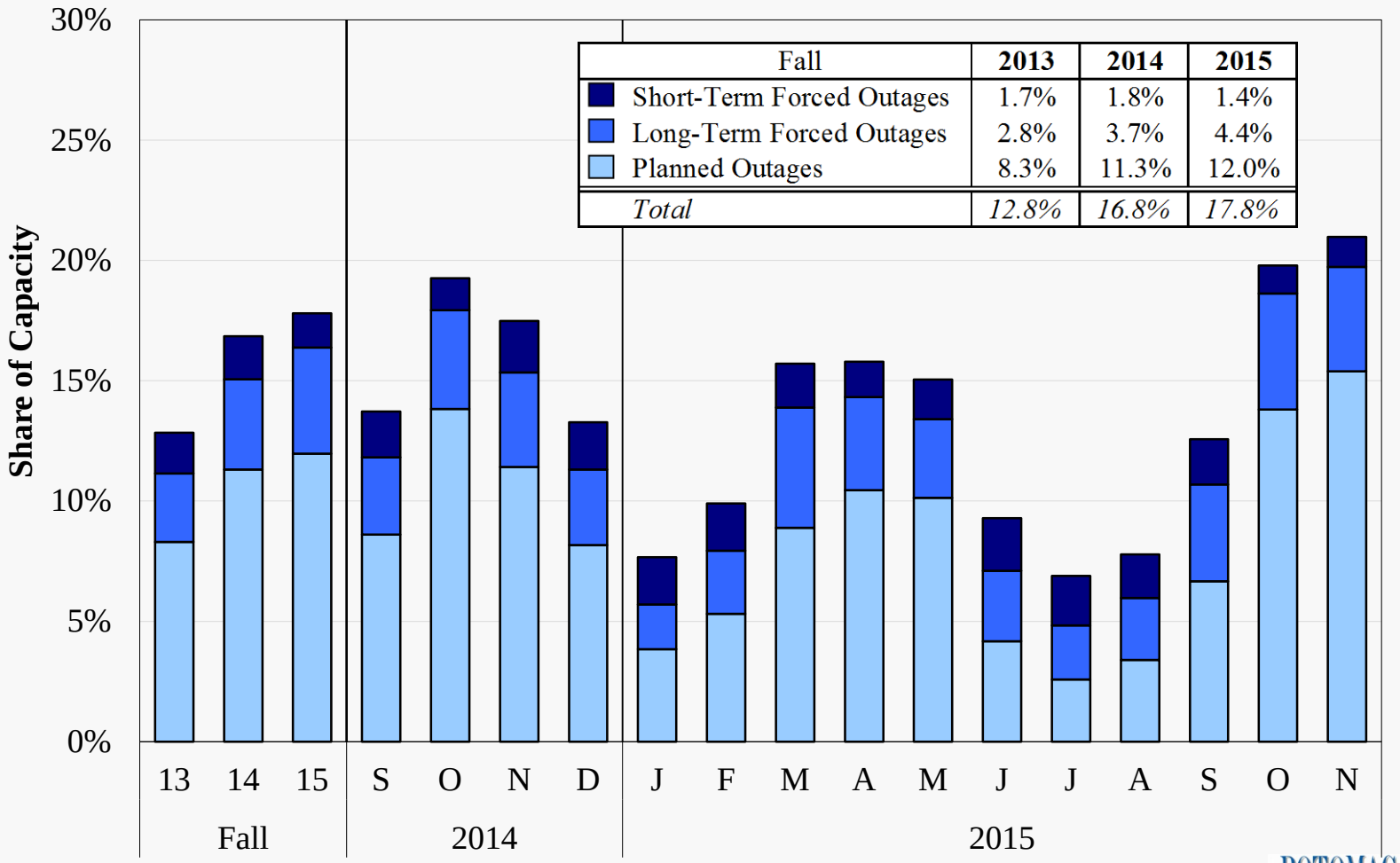
Generation Outage Rates 2014–2015



Fall	2013	2014	2015
Short-Term Forced Outages	1.7%	1.8%	1.4%
Long-Term Forced Outages	2.8%	3.7%	4.4%
Planned Outages	8.3%	11.3%	12.0%
Total	*12.8%*	*16.8%*	*17.8%*

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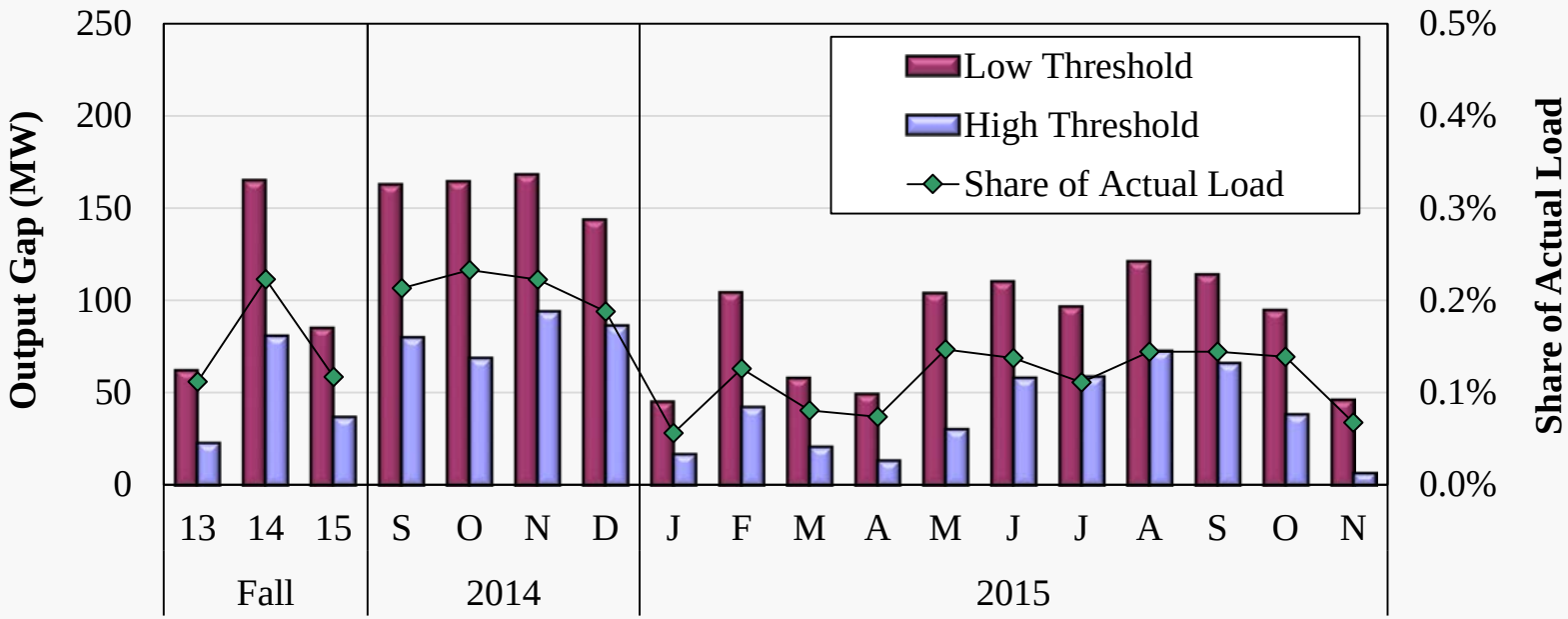
Monthly Output Gap
2014–2015



High Threshold Results by Unit Status (MW)

Offline	11	16	25	20	8	19	50	11	18	5	3	11	34	49	58	50	25	0
Online	12	65	12	60	61	75	36	6	24	16	10	19	24	9	14	16	14	6

Low Threshold Results by Unit Status (MW)

Offline	14	22	30	32	12	21	52	12	33	5	4	15	43	54	66	57	32	0
Online	49	143	56	131	152	147	92	34	72	53	46	90	68	43	56	57	63	46

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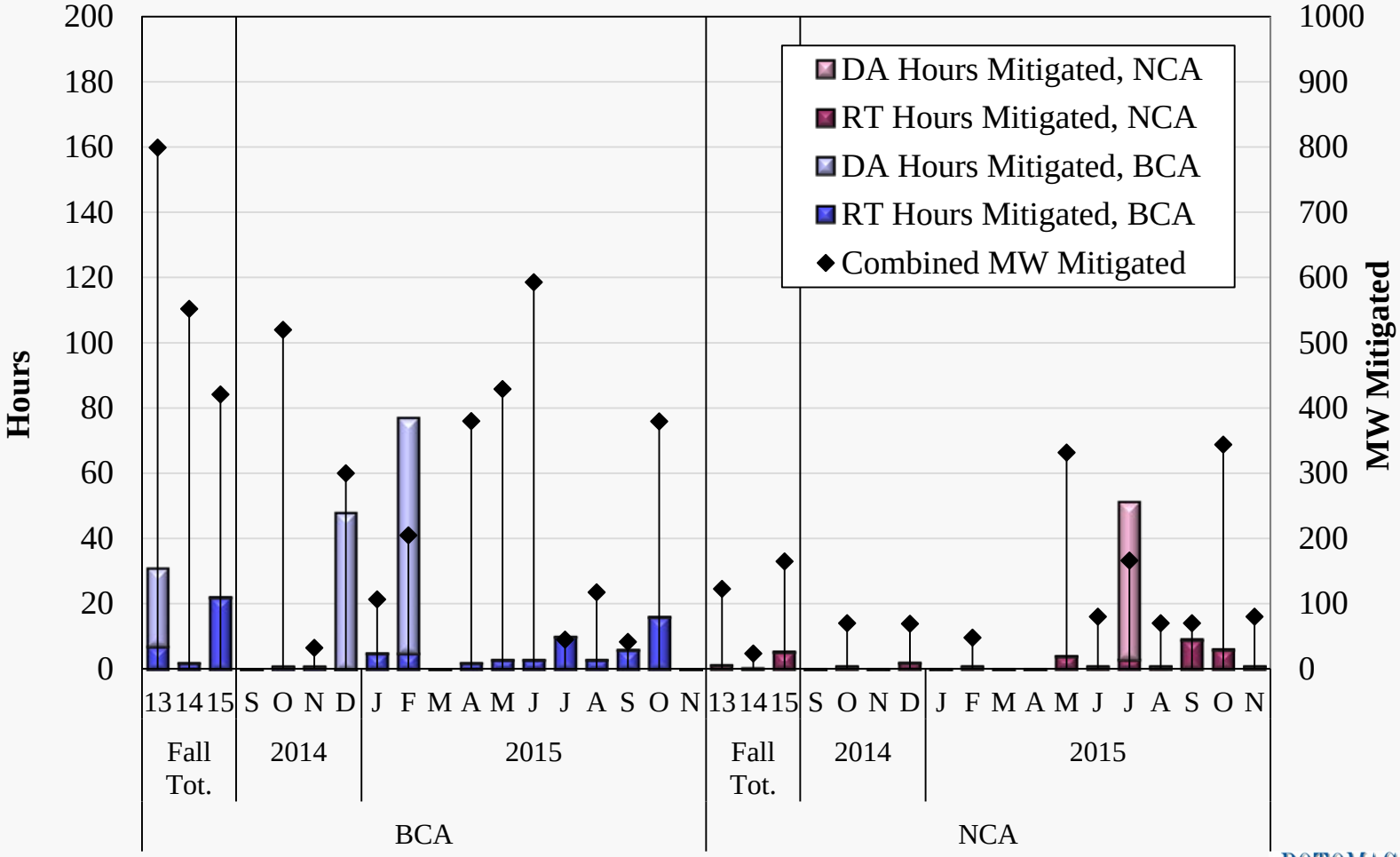
Day-Ahead And Real-Time Energy Mitigation 2014–2015



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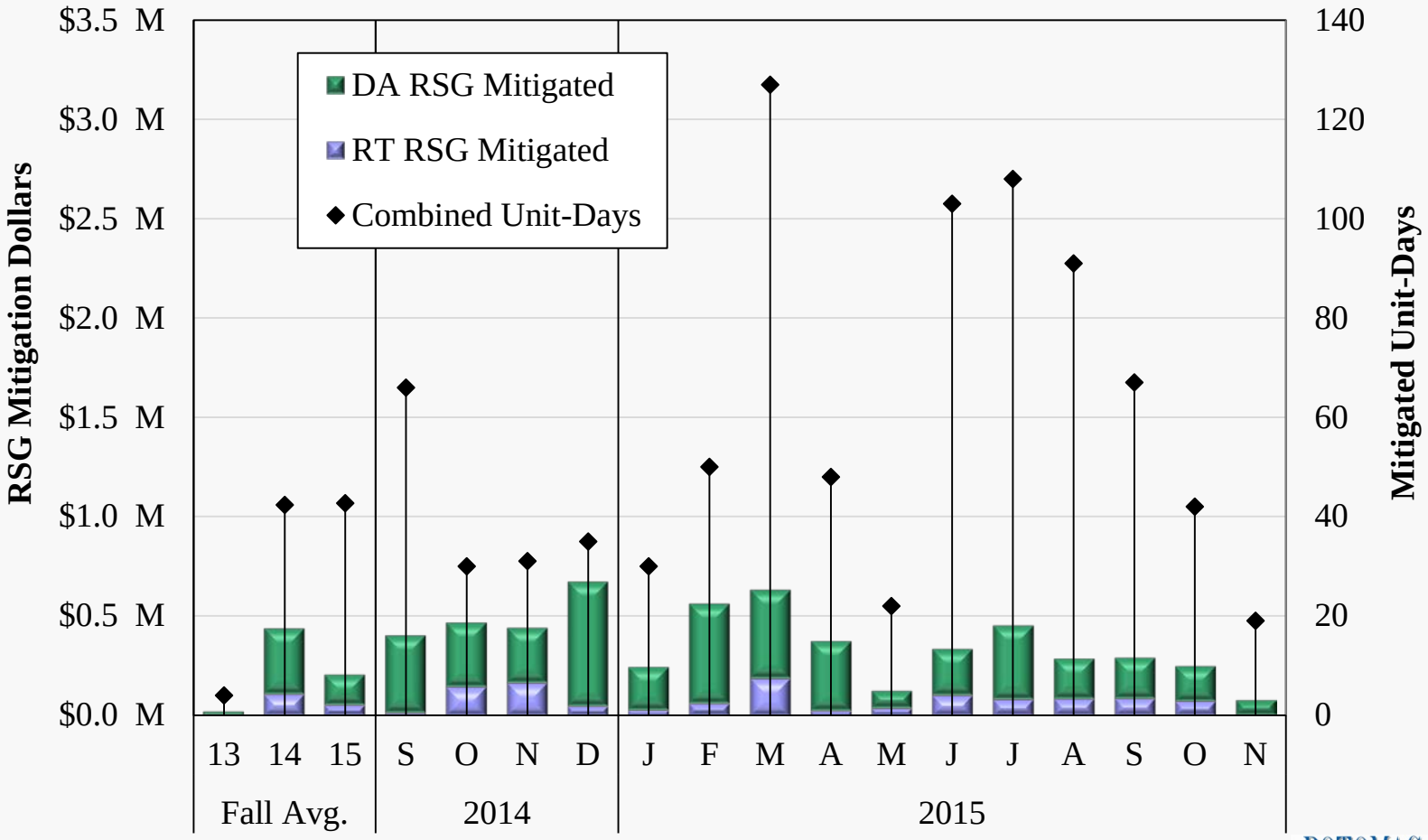
Day-Ahead and Real-Time RSG Mitigation 2014–2015



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List of Acronyms

- ✓ AMP — Automated Mitigation Procedures
- ✓ BCA — Broad Constrained Area
- ✓ CDD — Cooling Degree Days
- ✓ CMC — Constraint Management Charge
- ✓ DAMAP — Day-Ahead Margin Assurance Payment
- ✓ DDC — Day-Ahead Deviation & Headroom Charge
- ✓ DIR — Dispatchable Intermittent Resource
- ✓ HDD — Heating Degree Days
- ✓ 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
- ✓ ORCA — Operations Reliability Coordination Agreement
- ✓ ORDC — Operating Reserve Demand Curve
- ✓ PRA — Planning Resource Auction
- ✓ PVMWP — Price Volatility Make Whole Payment
- ✓ RAC — Resource Adequacy Construct
- ✓ RSG — Revenue Sufficiency Guarantee
- ✓ RTORSGP — Real-Time Offer Revenue Sufficiency Guarantee Payment
- ✓ SMP — System Marginal Price
- ✓ SOM — State of the Market
- ✓ SRPBC — Sub-Regional Power Balance Constraint
- ✓ TLR — Transmission Line Loading Relief
- ✓ TCDC — Transmission Constraint Demand Curve
- ✓ VCA — Voluntary Capacity Auction
- ✓ VLR — Voltage and Local Reliability
- ✓ WPP — Weekly Procurement Process
- ✓ WUMS — Wisconsin Upper Michigan System

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