IMM Quarterly Report: Winter 2016

MISO Independent Market Monitor

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Potomac Economics

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Quarterly Summary

		Value	Change[1] Prior Qtr.	Change[1] Prior Year
RT Energy Prices ($/MWh)	●	$21.80	*-13%*	*-29%*
Fuel Prices ($/MMBtu)				
Natural Gas - Chicago	●	$2.10	*-13%*	*-40%*
Natural Gas - Henry Hub	●	$2.04	*-13%*	*-34%*
Western Coal	●	$0.55	*-7%*	*-16%*
Eastern Coal	●	$1.36	*-8%*	*-28%*
Load (GW)[2]				
Average Load	●	74.0	*2%*	*-8%*
Peak Load	●	98.2	*-14%*	*-8%*
% Scheduled DA (Peak Hour)	●	98.9%	98.3%	99.5%
Transmission Congestion ($M)				
Real-Time Congestion Value	●	$200.7	*-36%*	*-41%*
Day-Ahead Congestion Revenue	●	$138.4	*-20%*	*-31%*
Balancing Congestion Revenue[3]	●	-$11.1	-$7.4	$1.8
Ancillary Service Prices ($/MWh)				
Regulation	●	$5.46	*-17%*	*-29%*
Spinning Reserves	●	$1.14	*-17%*	*-10%*
Supplemental Reserves	●	$0.44	*-60%*	*-5%*

		Value	Change[1] Prior Qtr.	Change[1] Prior Year
FTR Funding (%)	●	102%	95%	99%
Wind Output (MW/hr)	●	5,731	*6%*	*11%*
Guarantee Payments ($M)[4]				
Real-Time RSG	●	$6.5	*-63%*	*-55%*
Day-Ahead RSG	●	$10.0	*-17%*	*-60%*
Day-Ahead Margin Assurance	●	$6.4	*-20%*	*-36%*
Real-Time Offer Rev. Sufficiency	●	$1.7	*-41%*	*-48%*
Price Convergence[5]				
Market-wide DA Premium	●	2.0%	1.0%	1.2%
Virtual Trading				
Cleared Quantity (MW/hr)	●	11,995	*9%*	*31%*
% Price Insensitive	●	28%	32%	38%
% Screened for Review	●	1%	1%	1%
Profitability ($/MW)	●	$0.58	$0.76	$0.74
Dispatch of Peaking Units (MW/hr)	●	535	979	416
Output Gap- Low Thresh. (MW/hr)	●	42	85	97
Other:				

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.

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Summary of Winter 2016

- Overall, the market performed competitively and reliably this winter.
- Winter 2016 was characterized by a continuing decline in energy prices caused by record low natural gas prices and moderate weather and load.
  - ✓ Gas prices were roughly 40 percent lower this winter, driving system-wide energy prices down almost 30 percent from last year to $21.80 per MWh.
  - ✓ Average and peak load were both down 8 percent from last year as winter conditions were significantly milder than normal in most MISO areas.
- Wind output was high and MISO set a new wind generation record in February.
- The record lows in natural gas prices also contributed to reductions in other costs:
  - ✓ Congestion levels similarly fell 30 to 40 percent in the day-ahead and real-time compared to last winter due to the lower gas prices and mild conditions.
  - ✓ Real-time RSG fell more than 50 percent from last winter even though MISO dispatched more peaking units. At current natural gas prices, peaking units are more economic and more frequently dispatched in-merit order.
  - ✓ Price volatility make-whole payments were down more than 40 percent, due in part to low fuel prices and in part to improvements to the state estimator model.
- The elimination of the SRPBC at the beginning of February contributed to a significant increase in economic transfers between the Midwest and South regions, allowing MISO to capture substantial dispatch savings.

Highlights from Winter 2015

Decline in Fuel and Energy Prices (Slides 9, 11, 12, 20, 21, 25-27)

- Mild winter conditions and the shale gas supplies caused the downward trend in gas prices to continue, affecting many aspects of the market this quarter.
  - ✓ The Chicago and Henry Hub natural gas prices both ended February well below $2 and are the lowest since the start of the market.
- Lower gas and coal prices led to broad reductions in prices and costs this quarter.
  - ✓ Energy prices fell almost 30 percent to the lowest levels since the markets began.
  - ✓ RSG and PVMWP fell 40 to 60 percent as energy prices and volatility decreased. These costs also fell as lower gas prices reduced the spread in costs between gas-fired peaking resources and other types of units.
  - ✓ Congestion also fell 30-40 percent as gas-fired units became more economic to re-dispatch to manage network flows.
- Low gas prices increased utilization of gas-fired units, displacing coal-fired units.
  - ✓ Capacity factors of combined-cycle units averaged 45 percent this quarter, compared to 39 and 26 percent over the past two winters, respectively.
  - ✓ Likewise, capacity factors of MISO's peaking resources averaged 18 percent, up from 14 and 12 percent over the past two winters.
  - ✓ Coal capacity factors averaged roughly 50 percent, down from almost 70 percent two winters ago as they were increasingly displaced by gas and wind.

Highlights for Winter 2016

Regional Transfers (Slide 22)

- The drop in gas prices and the termination of the SRPBC have resulted in significant changes in both the direction and magnitude of the regional flows.
  - ✓ Since the integration of MISO South, prevailing flows have been North-to-South (58 percent of all intervals).
  - ✓ Regional transfers shifted sharply to the South-to-North direction this winter, flowing in that direction in 81 percent for the quarter.
- Per the recent Settlement Agreement, the SRPBC and ORCA were terminated at the beginning of February.
  - ✓ The agreement replaces these constraints with the Regional Directional Transfer (RDT) Constraint which limits flows in the North-to-South direction to 3000 MW and the South-to-North direction to 2500 MW.
  - ✓ As expected, the elimination of the SRPBC has sharply increased economic transfers between the regions.
  - ✓ In December and January, the average flow from South-to-North was 750 MW. This flow more than doubled in February to 1550 MW.

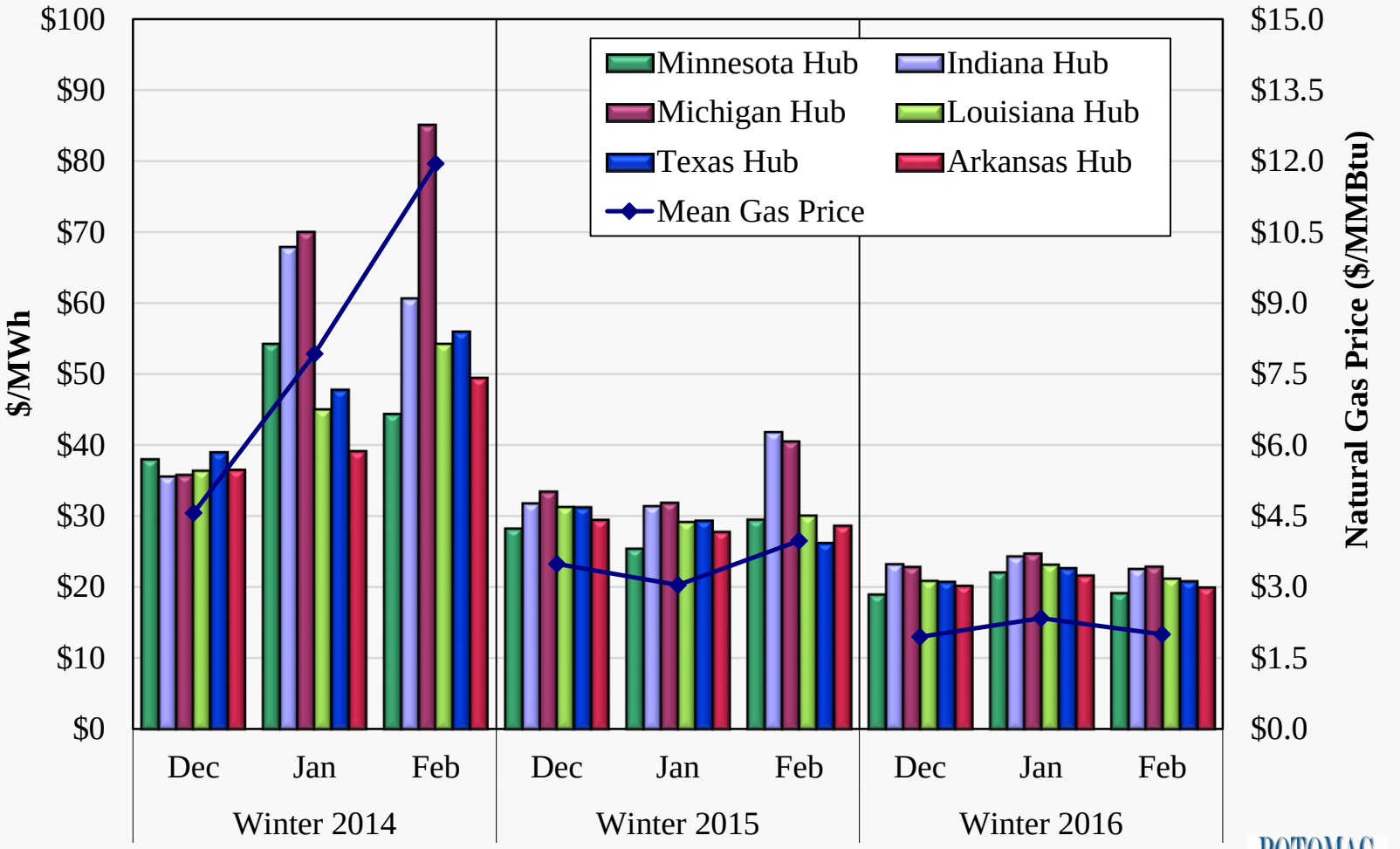
Submittals to External Entities and Other Issues

- We responded to FERC questions related to prior referrals regarding resources failing to update real-time offers and continued to meet with FERC staff on a weekly and monthly basis to discuss market outcomes.
- We filed comments on the MISO and PJM Coordinated Transaction Scheduling proposal. We supported the CTS filing, but asked FERC to mandate a change.
  - ✓ We presented market results from the CTS provisions implementation between NYISO and both PJM and ISO-NE. The results show that the CTS is much more liquid and effective with ISO-NE than with PJM.
  - ✓ We attribute this partly to the charges to CTS transactions, so we recommended that FERC order PJM to eliminate all charges (MISO proposed no charges).
- We presented our Fall Quarterly Report to stakeholders at the MSC.
- We participated in the FERC technical conference on alternative approaches FTR funding and allocating FTR shortfalls.
- We provided comments to MISO and stakeholders on the Ramp Product, and will are working closely with MISO during testing.
- We continued working with MISO and customers to improve transmission ratings provided by transmission owners in order to more fully utilize the network.

Submittals to External Entities and Other Issues

- In December, FERC issued an Order requiring significant changes to the PRA Auction and Module D Reference Methodology.
  - ✓ We worked with MISO to prepare tariff revisions and its compliance filing.
- We continued to work with MISO and PJM to develop proposals for firm capacity delivery procedures as an alternative to pseudo-tying resources to PJM.
  - ✓ The procedures would guarantee the delivery of energy from external capacity resources that have been exported to PJM.
  - ✓ The proposal would provide benefits to all of the parties and address the economic and reliability concerns raised by large quantities of pseudo-ties.
- We continued to work with MISO, PJM and its customers to evaluate near-term improvements that could be made to improve the RTO's interface prices.
  - ✓ We conducted a comparative analysis of two alternatives that have been proposed.
  - ✓ We also comments on a collaborative analysis performed by the RTOs.
- We commented on the capacity market alternatives for competitive retail areas and provided a proposal that would integrate well into MISO's current market.
  - ✓ We recommended that MISO adopt a sloped demand curve and modified limits into the area, and not adopt a mandatory forward procurement structure.

Day-Ahead Average Monthly Hub Prices
Winter 2014–2016



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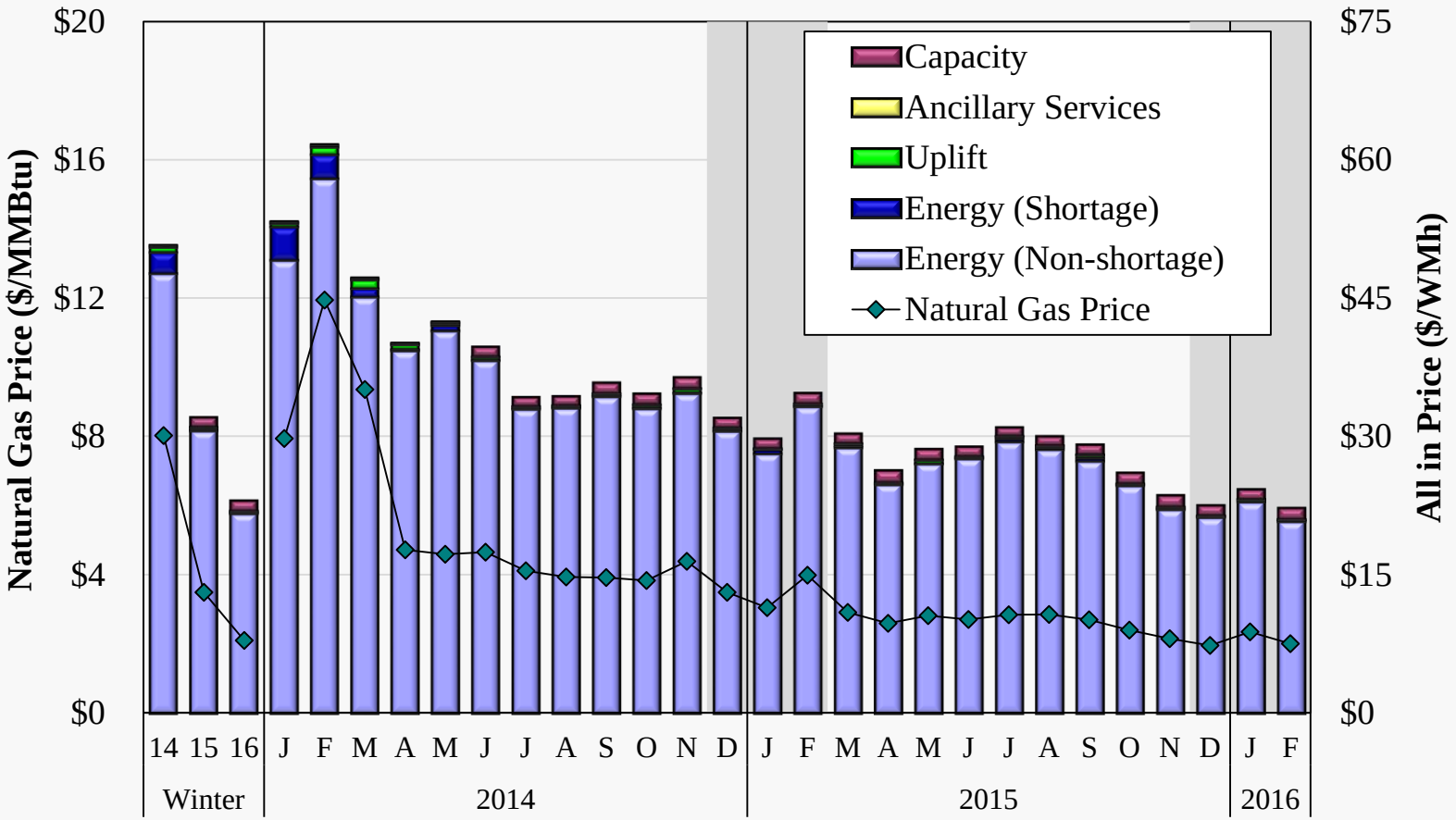
All-In Price
2014 –2016



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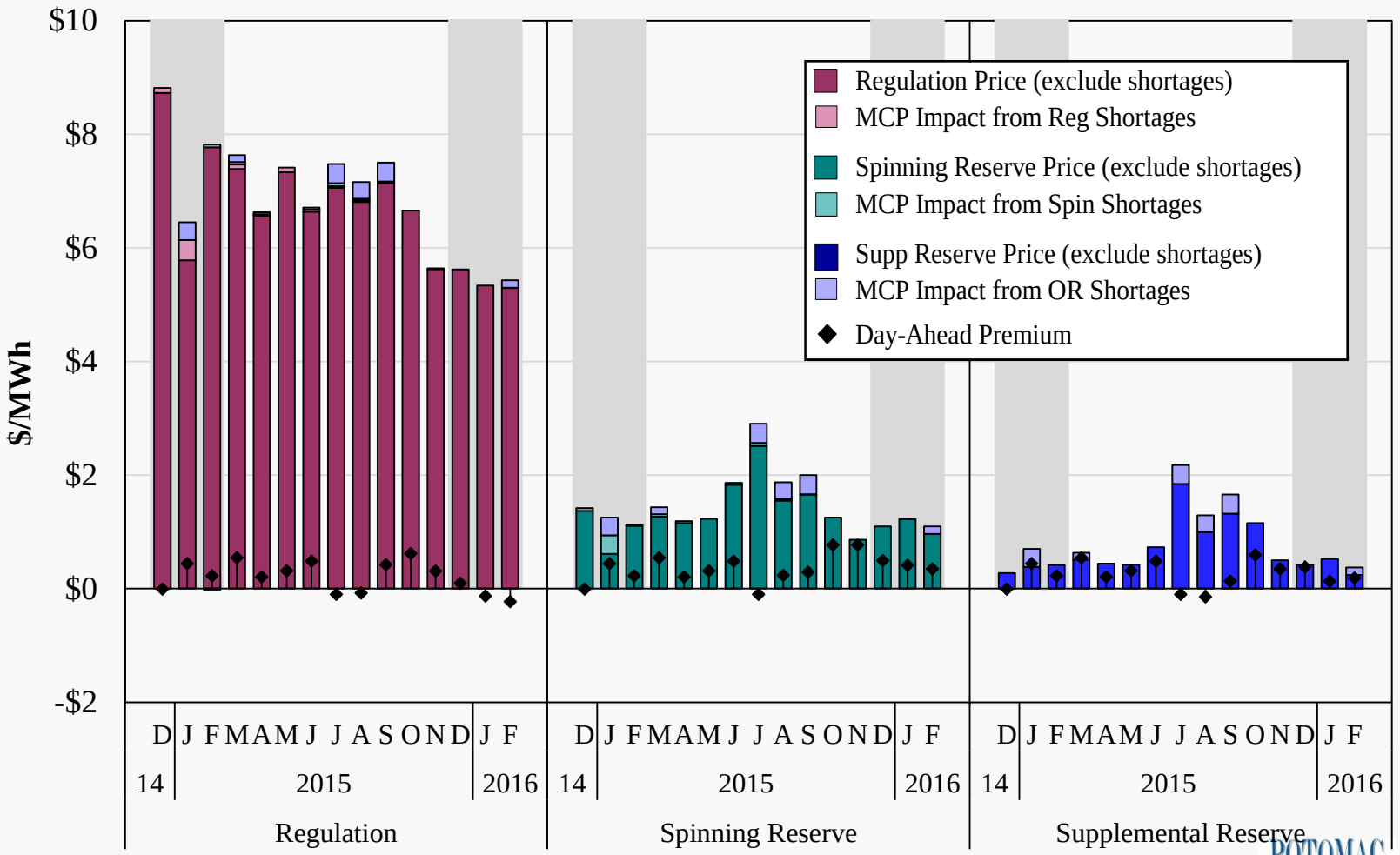
Monthly Average Ancillary Service Prices
December 2014 to February 2016



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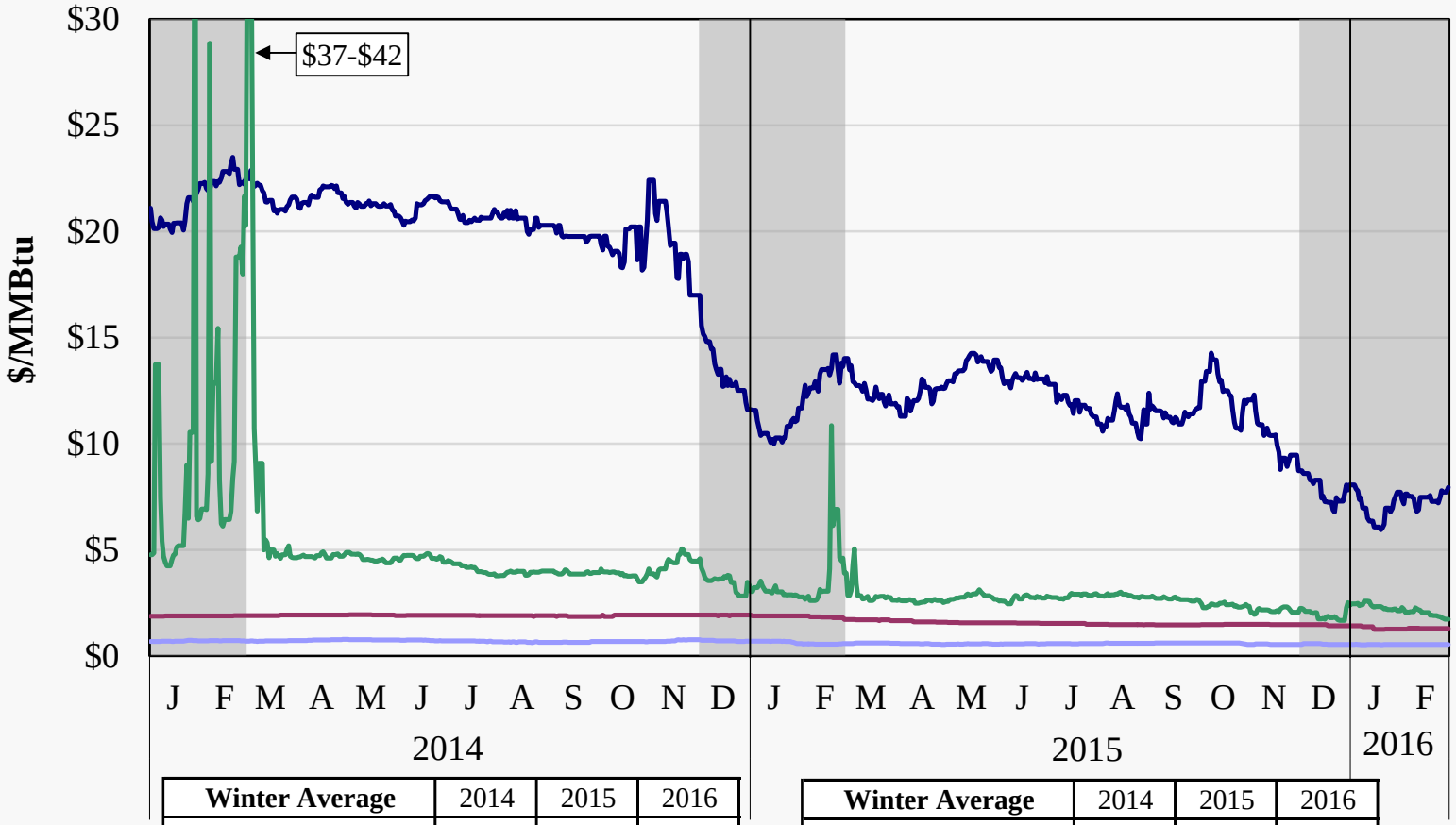
MISO Fuel Prices
2014–2016



Winter Average	2014	2015	2016
Oil	$21.31	$12.43	$7.41
Natural Gas	$8.02	$3.49	$2.10

Winter Average	2014	2015	2016
IB Coal	$1.88	$1.89	$1.36
PRB Coal	$0.70	$0.66	$0.55

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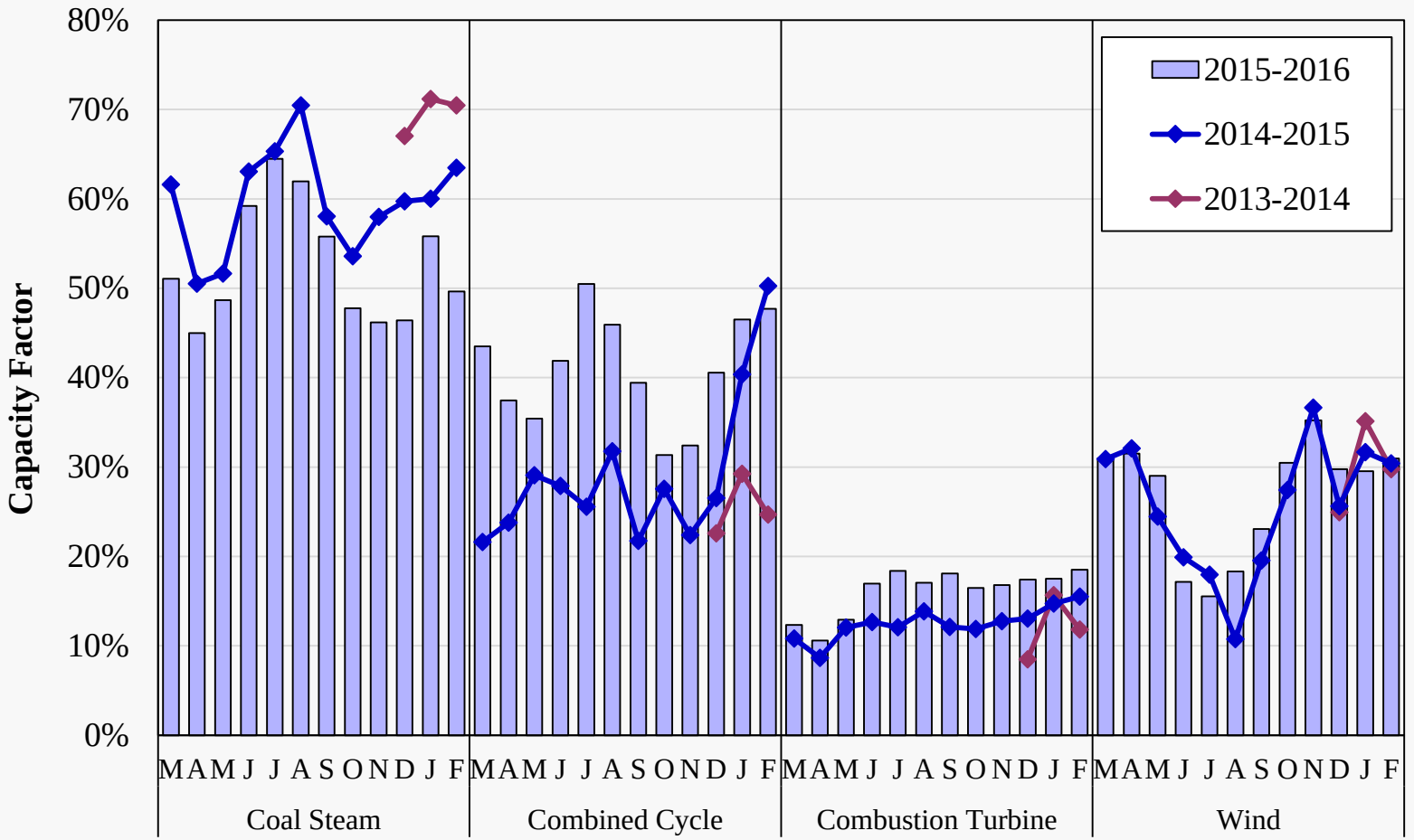
Capacity Factors By Fuel Type
Winter 2014–2016



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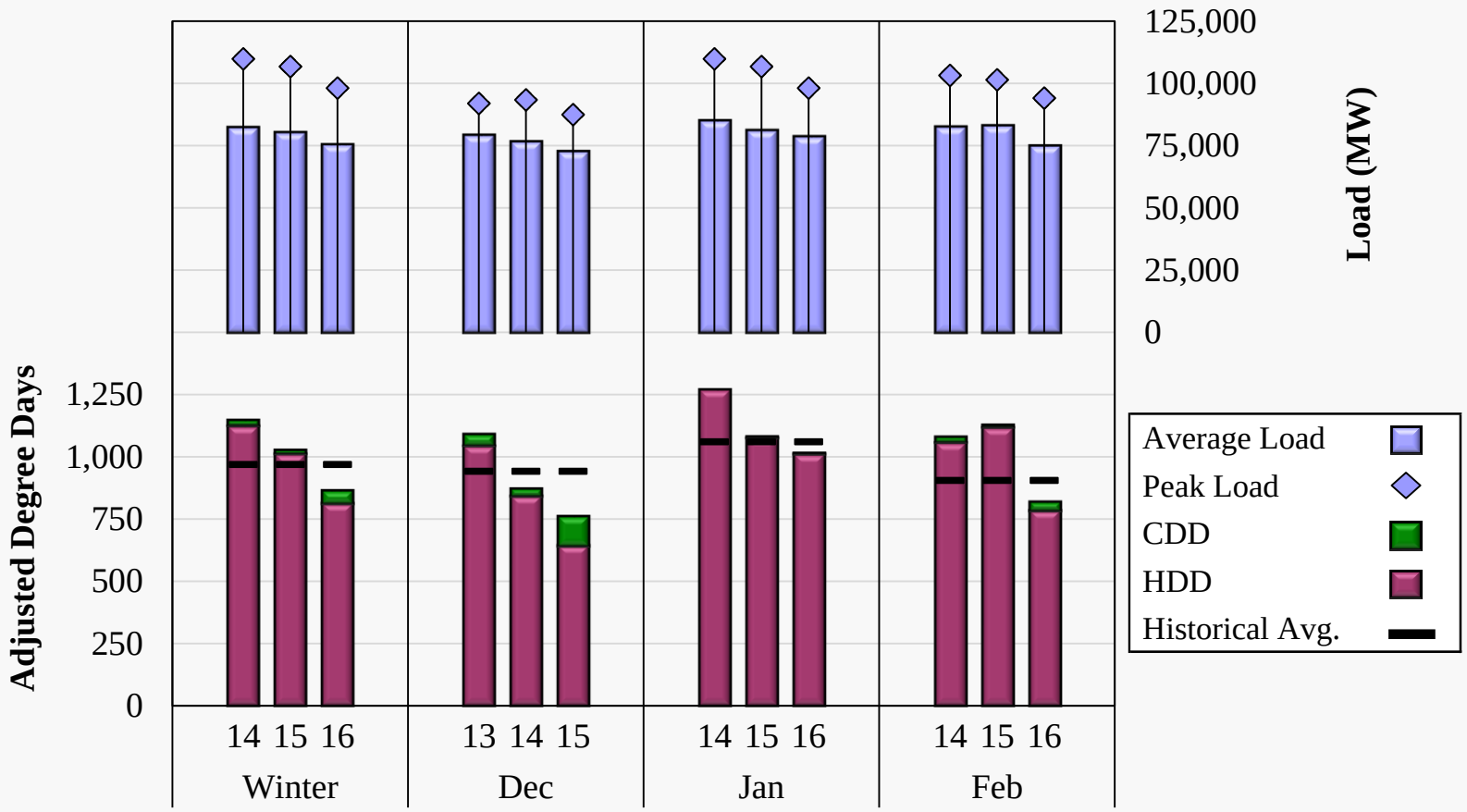
Load and Weather Patterns
Winter 2014–2016



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

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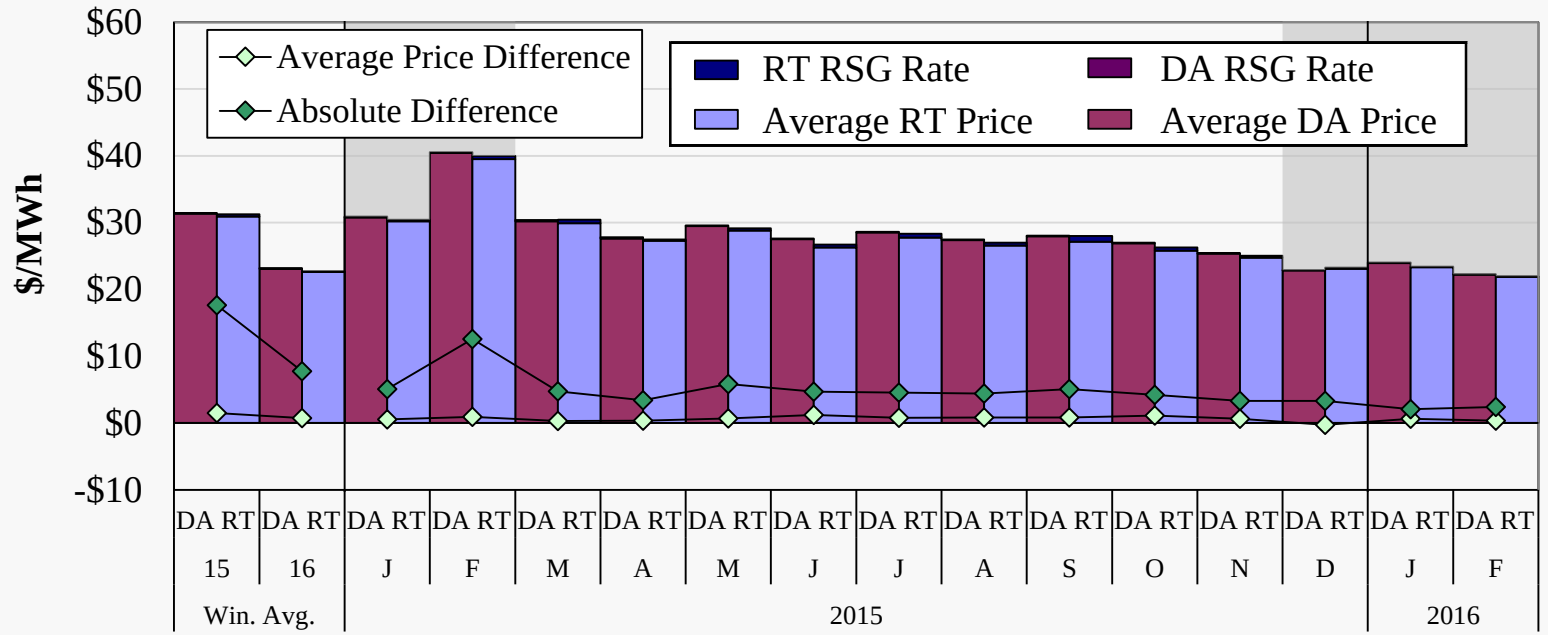
Day-Ahead and Real-Time Price Convergence 2015–2016



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

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

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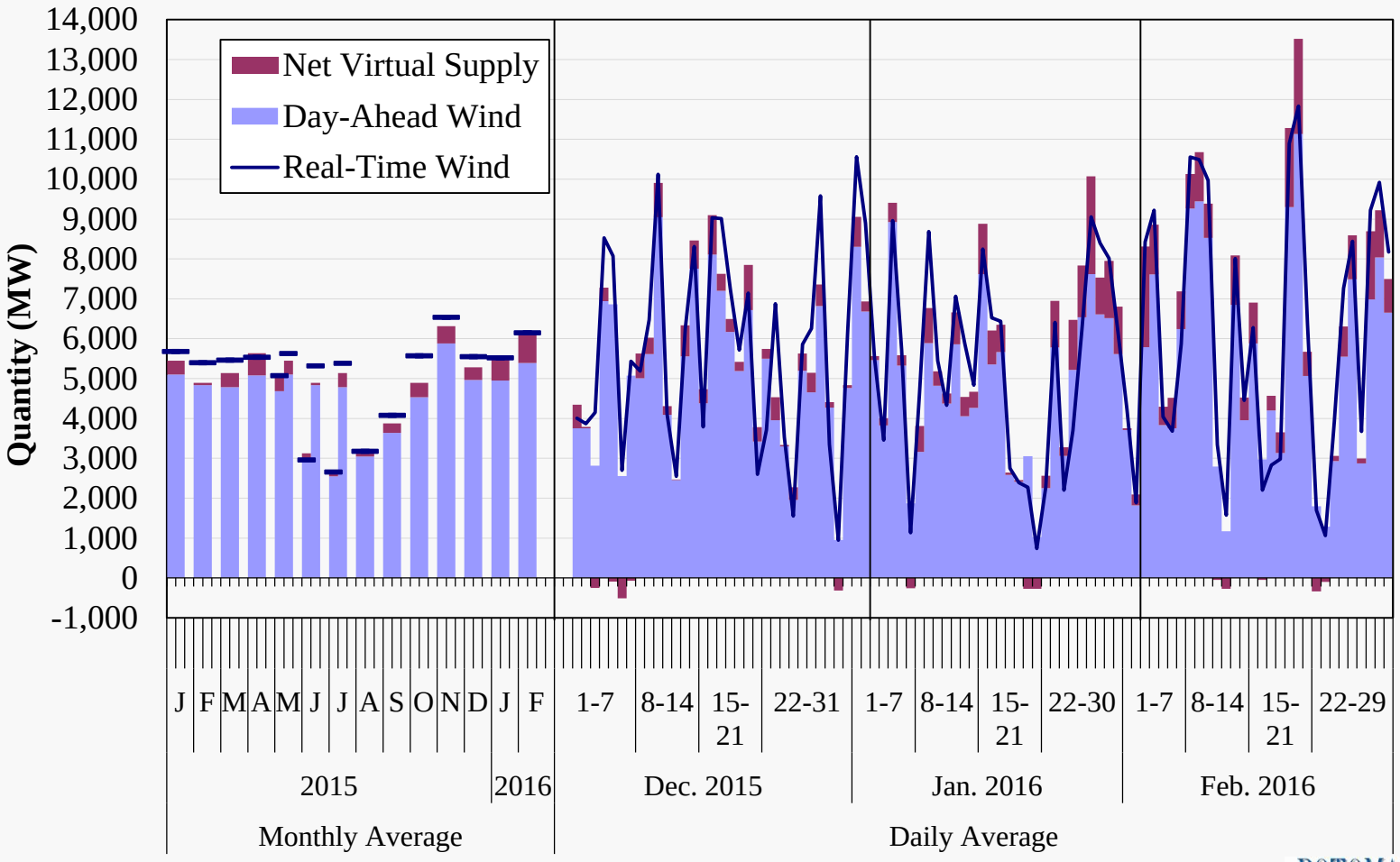
Wind Output in Real-Time and Day-Ahead Markets
Monthly and Daily Average



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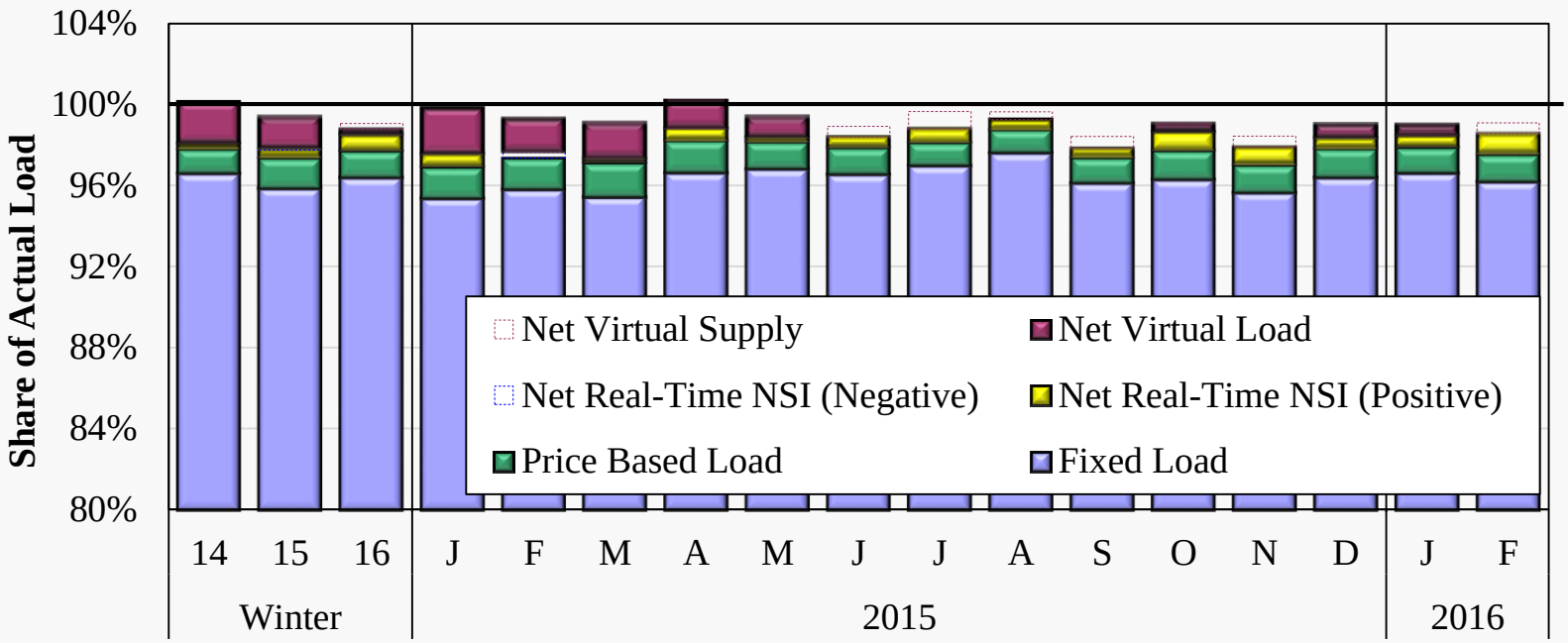
Day-Ahead Peak Hour Load Scheduling
2015–2016



Share of Actual Load (%)

	Winter			2015													2016	
	14	15	16	J	F	M	A	M	J	J	A	S	O	N	D	J	F	
All Hours	100.7	99.1	98.6	99.9	98.9	98.6	99.3	99.4	98.5	99.4	99.6	98.5	98.2	97.9	98.4	99.0	98.2	
Peak Hours Midwest	100.7	99.1	98.6	99.8	99.3	98.6	99.1	98.6	98.3	97.9	98.2	97.0	98.6	99.2	99.7	99.2	98.8	
Peak Hours South	100.7	99.1	98.6	101.8	98.3	101.3	102.6	101.8	98.1	100.6	101.4	99.9	101.0	96.8	99.5	99.1	98.9	

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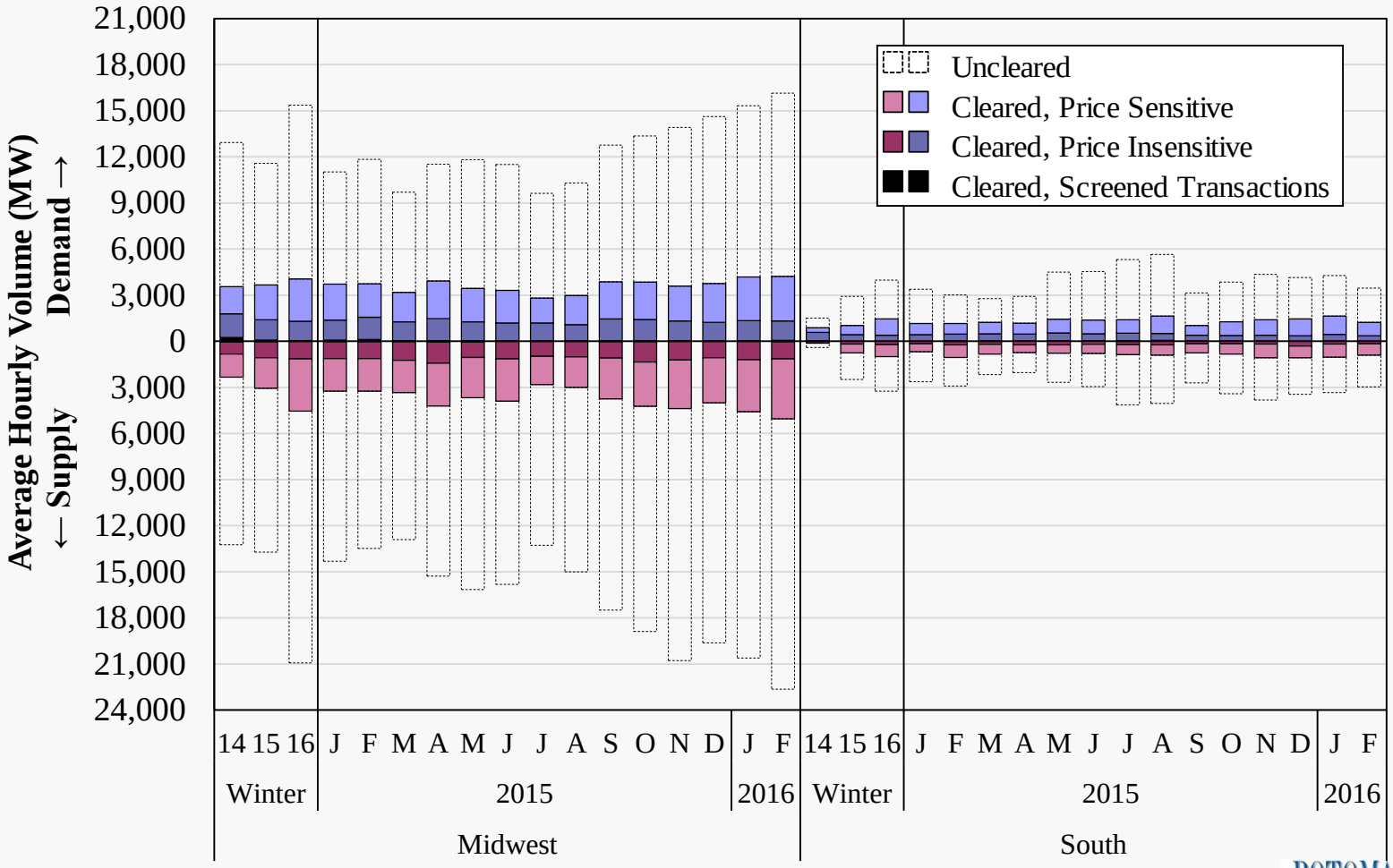
Virtual Load and Supply
2015–2016



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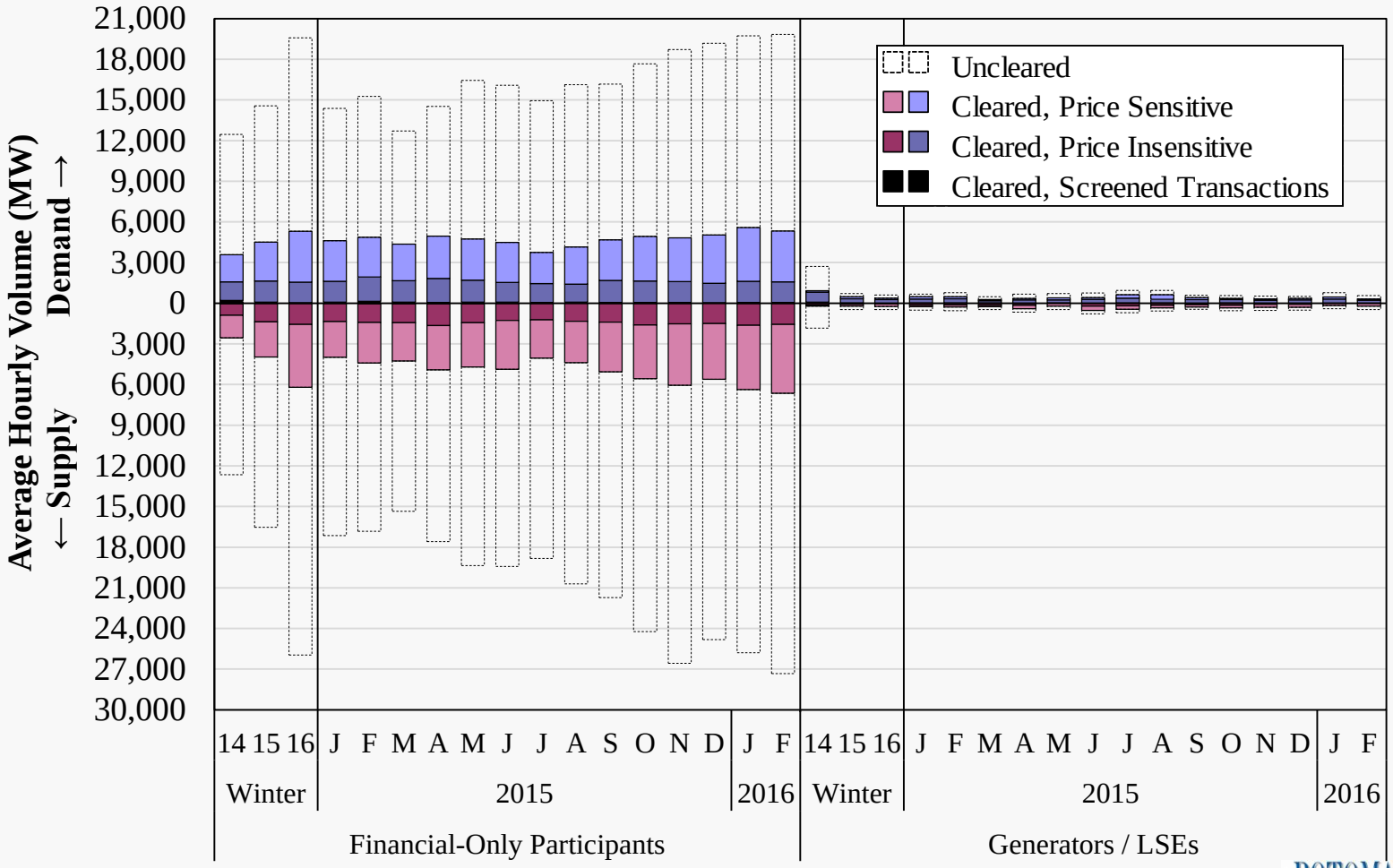
Virtual Load and Supply by Participant Type 2015–2016



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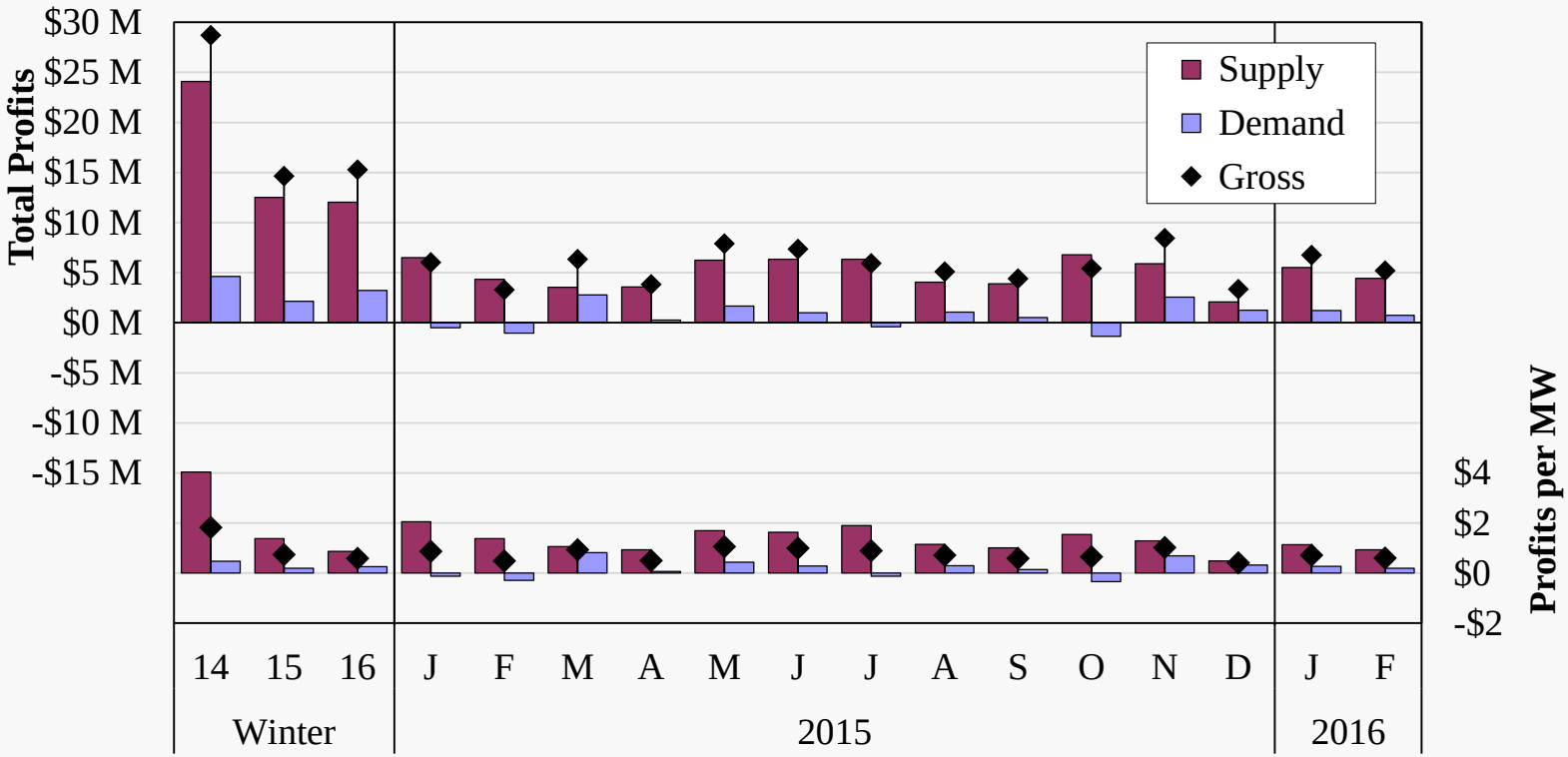
Virtual Profitability
2015–2016



Percent Screened

Demand	6.4	1.9	0.8	1.6	3.0	1.7	1.0	1.7	1.6	1.6	1.7	1.0	1.1	1.4	0.6	0.8	1.0
Supply	2.0	0.9	0.4	0.6	1.0	1.0	0.9	1.0	0.4	0.4	0.2	0.5	0.5	0.4	0.2	0.4	0.5
Total	4.7	1.4	0.6	1.1	2.1	1.4	1.0	1.4	0.9	1.0	1.0	0.8	0.8	0.8	0.4	0.6	0.7

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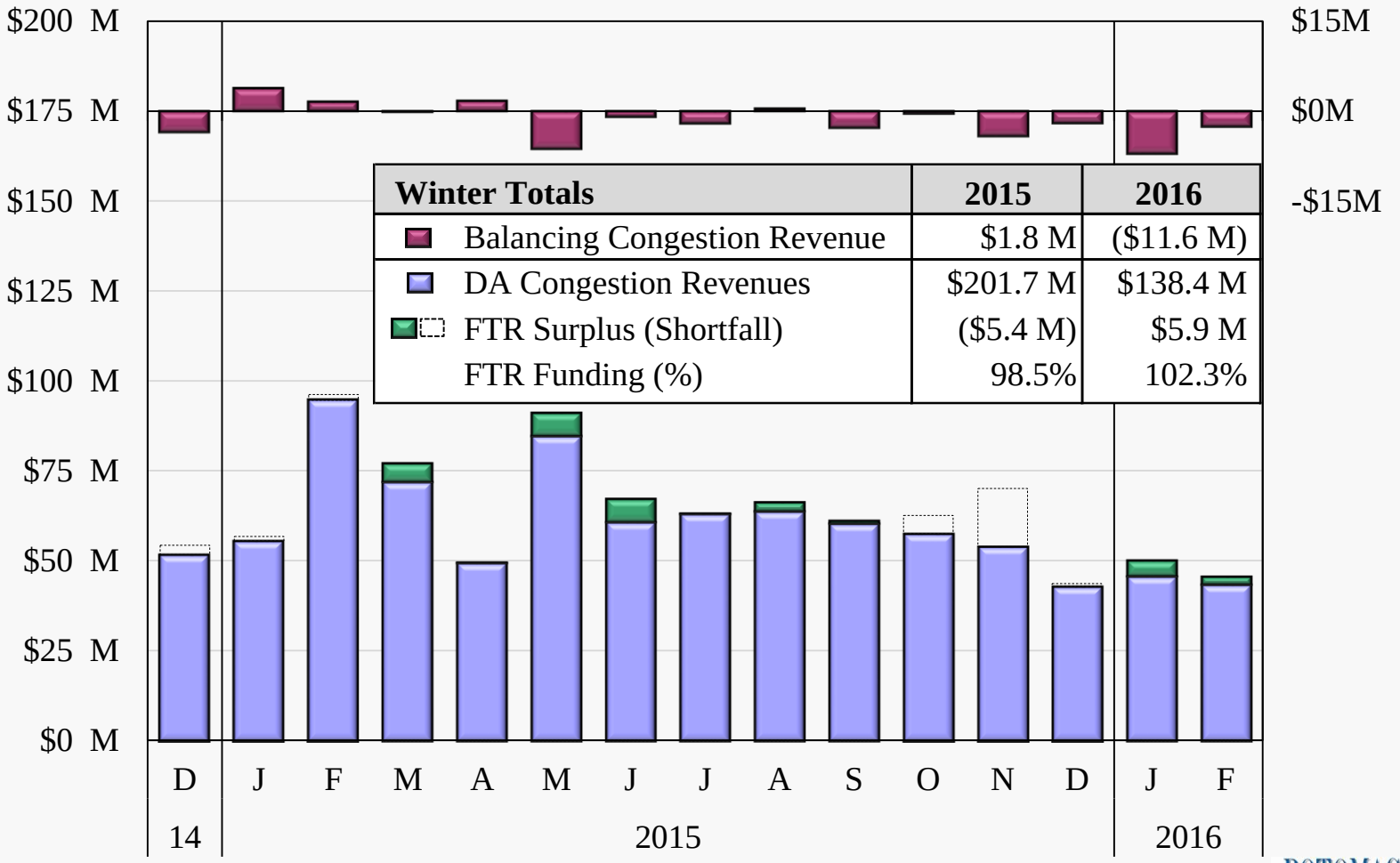
Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2015–2016



Winter Totals	2015	2016
Balancing Congestion Revenue	$1.8 M	($11.6 M)
DA Congestion Revenues	$201.7 M	$138.4 M
FTR Surplus (Shortfall)	($5.4 M)	$5.9 M
FTR Funding (%)	98.5%	102.3%

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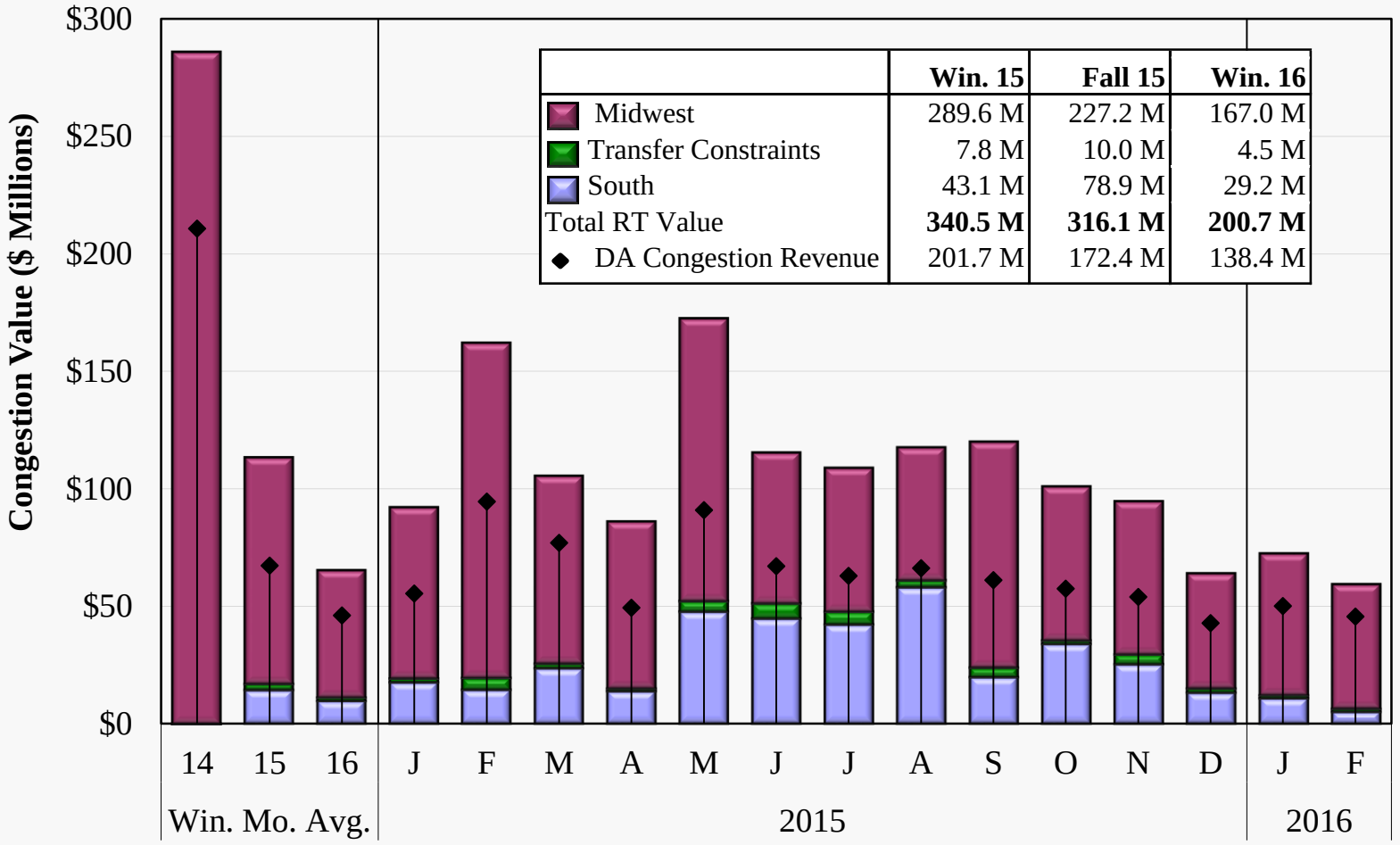
Value of Real-Time Congestion
2015–2016



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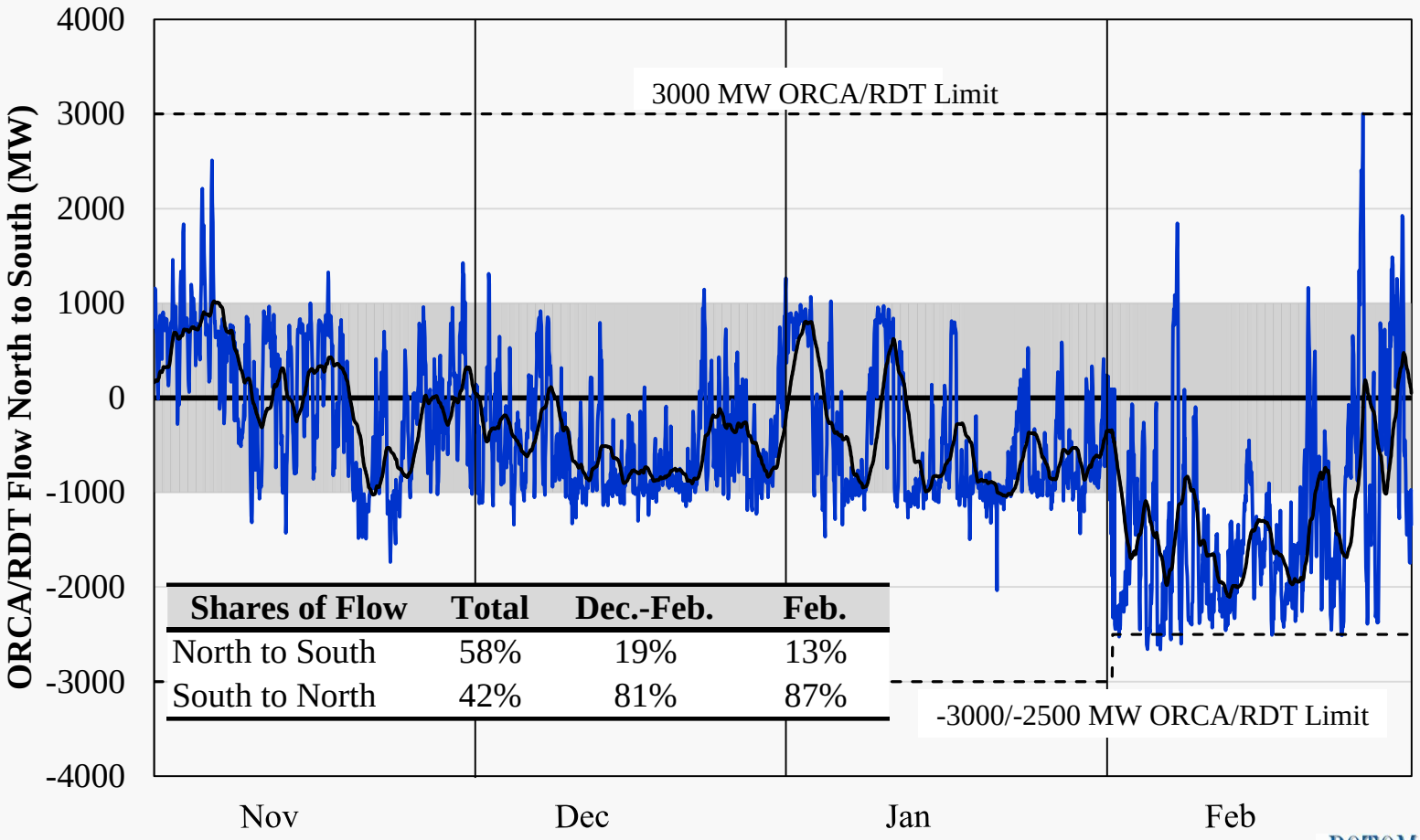
Real-Time Hourly Interregional Flows
Nov. 2015 - Feb. 2016



Shares of Flow	Total	Dec.-Feb.	Feb.
North to South	58%	19%	13%
South to North	42%	81%	87%

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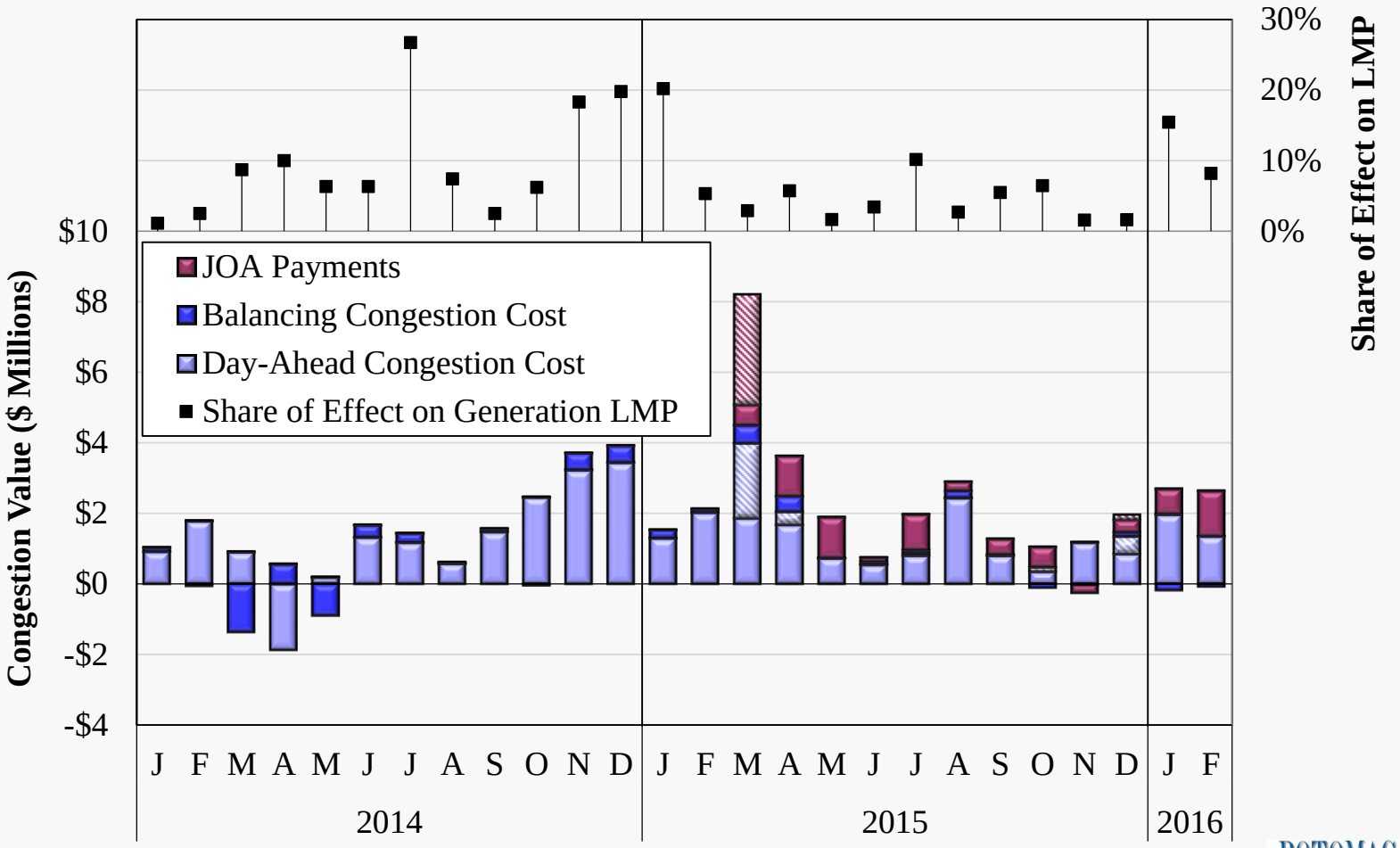
Congestion Costs on SPP Flowgates 2014–2016



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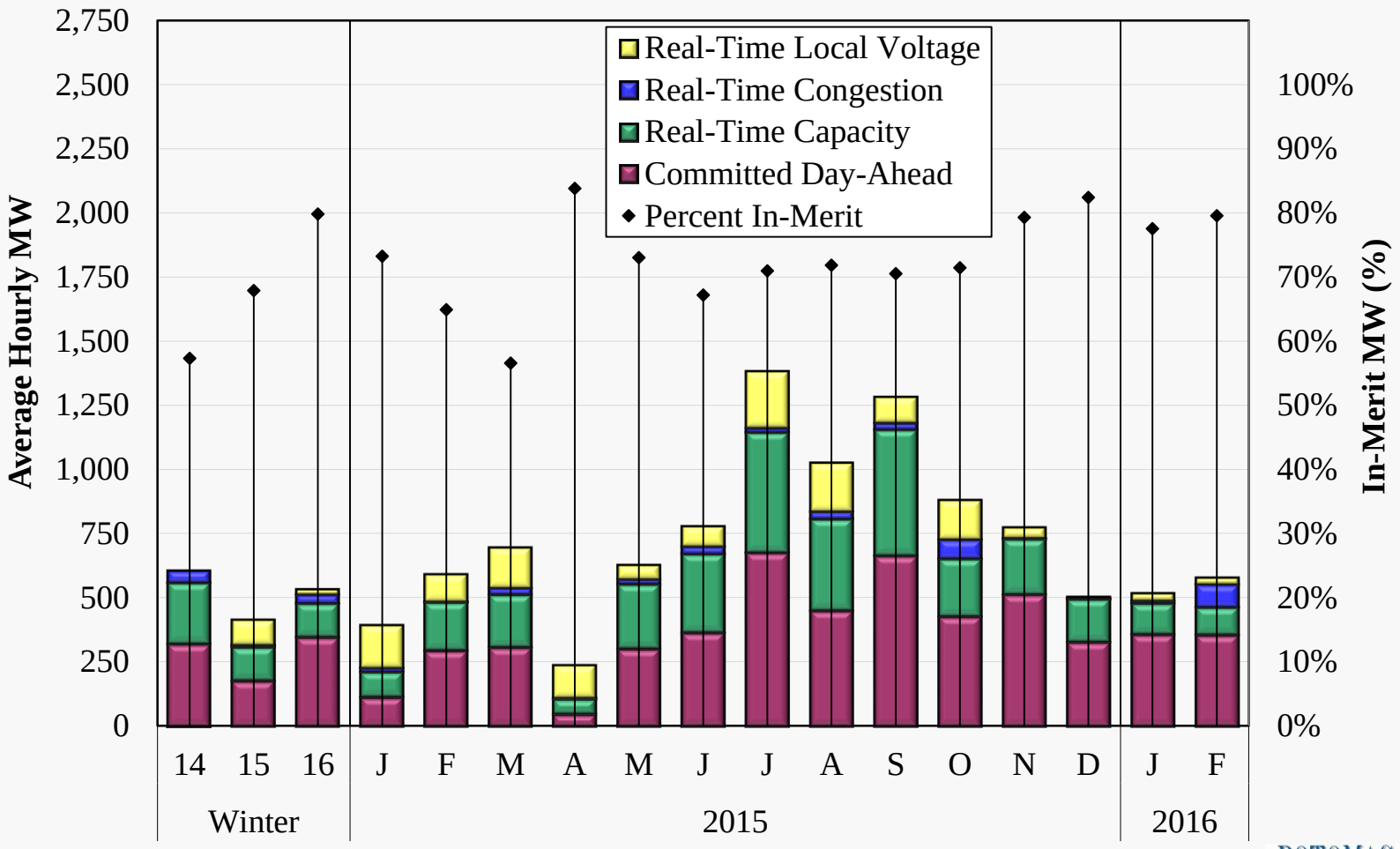
Peaking Resource Dispatch
2015–2016



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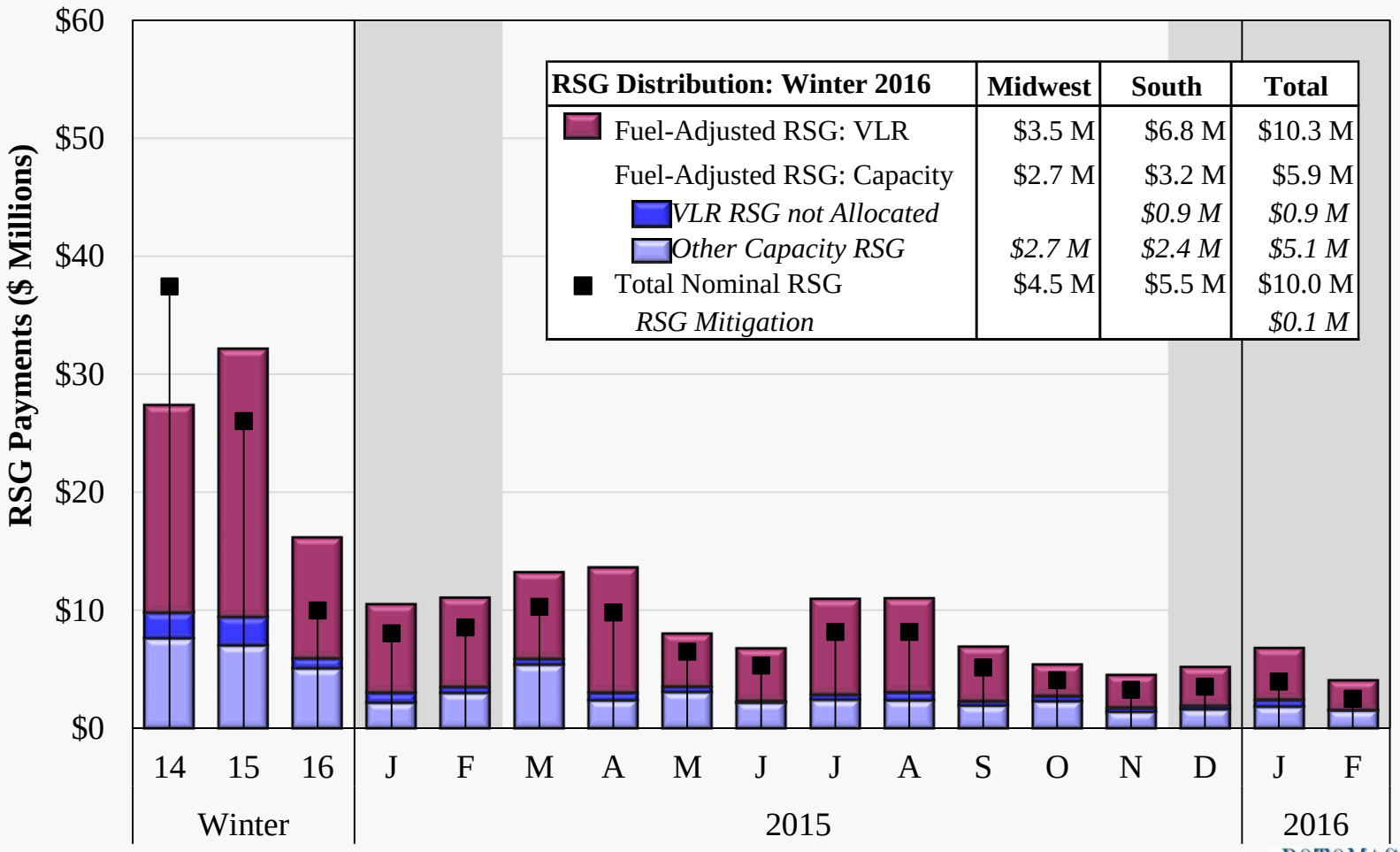
Day-Ahead RSG Payments
2015–2016



RSG Distribution: Winter 2016	Midwest	South	Total
Fuel-Adjusted RSG: VLR	$3.5 M	$6.8 M	$10.3 M
Fuel-Adjusted RSG: Capacity	$2.7 M	$3.2 M	$5.9 M
VLR RSG not Allocated		*$0.9 M*	*$0.9 M*
Other Capacity RSG	*$2.7 M*	*$2.4 M*	*$5.1 M*
Total Nominal RSG	$4.5 M	$5.5 M	$10.0 M
RSG Mitigation			*$0.1 M*

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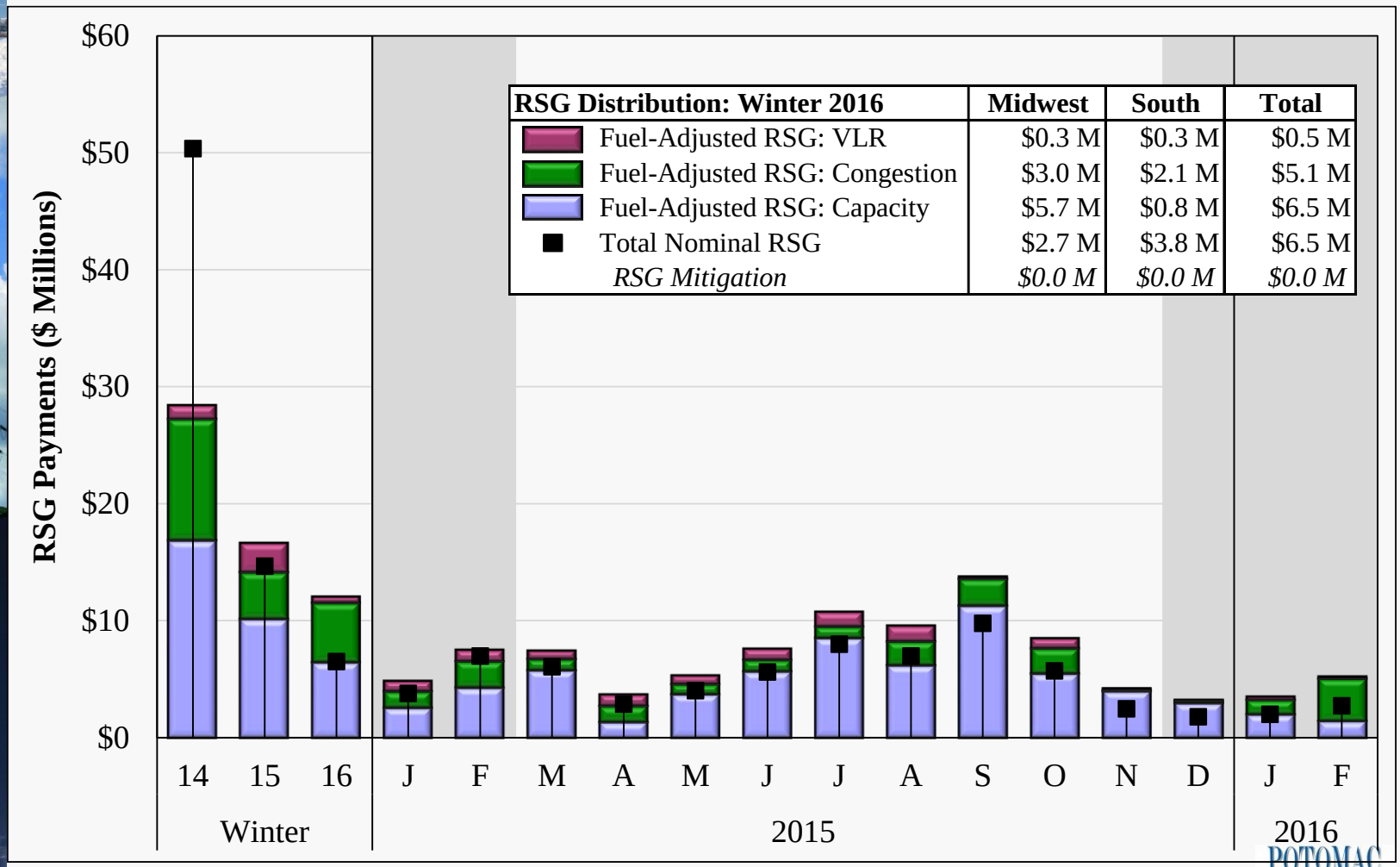
Real-Time RSG Payments
2015–2016



RSG Distribution: Winter 2016	Midwest	South	Total
Fuel-Adjusted RSG: VLR	$0.3 M	$0.3 M	$0.5 M
Fuel-Adjusted RSG: Congestion	$3.0 M	$2.1 M	$5.1 M
Fuel-Adjusted RSG: Capacity	$5.7 M	$0.8 M	$6.5 M
Total Nominal RSG	$2.7 M	$3.8 M	$6.5 M
RSG Mitigation	*$0.0 M*	*$0.0 M*	*$0.0 M*

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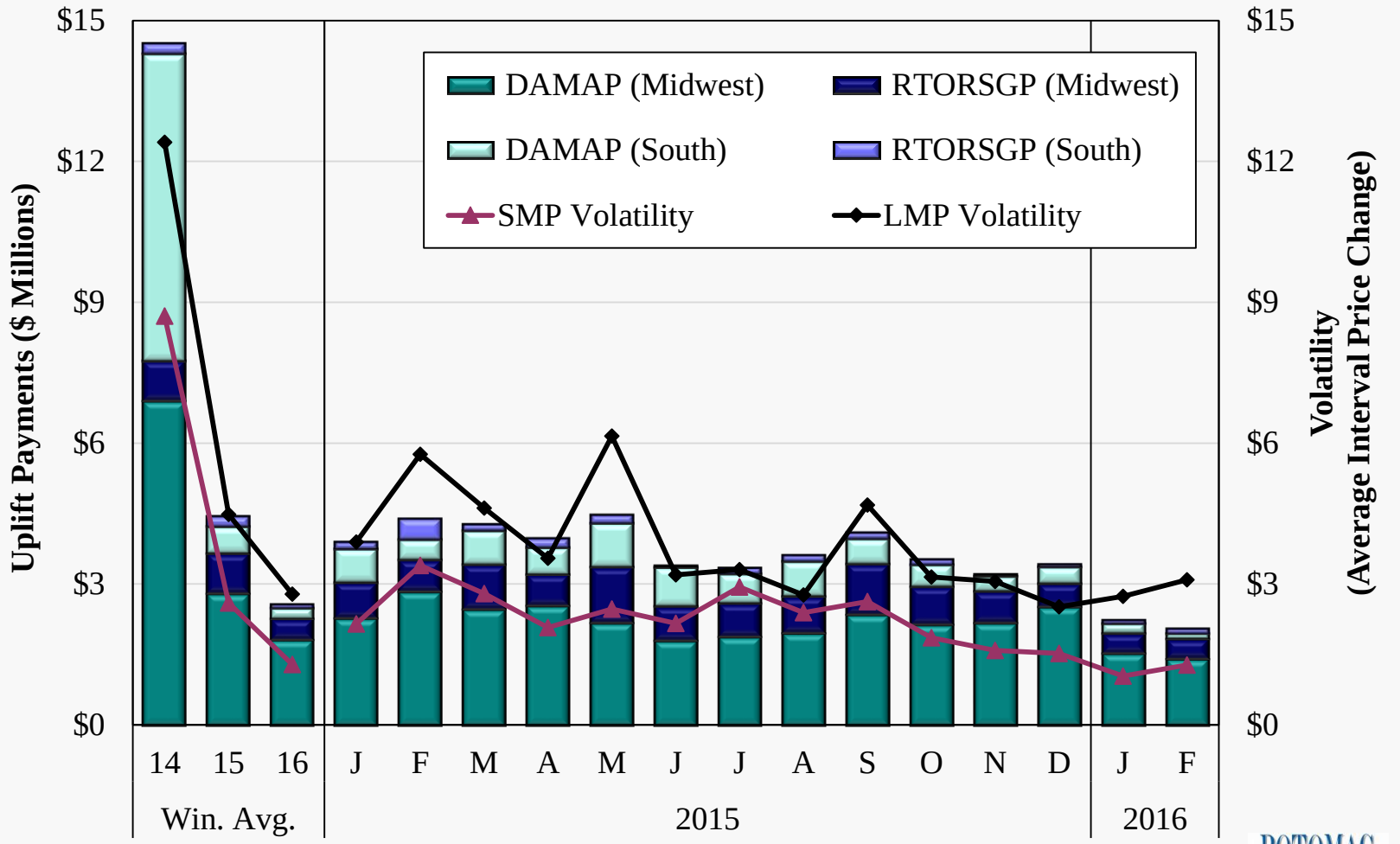
Price Volatility Make Whole Payments 2015–2016



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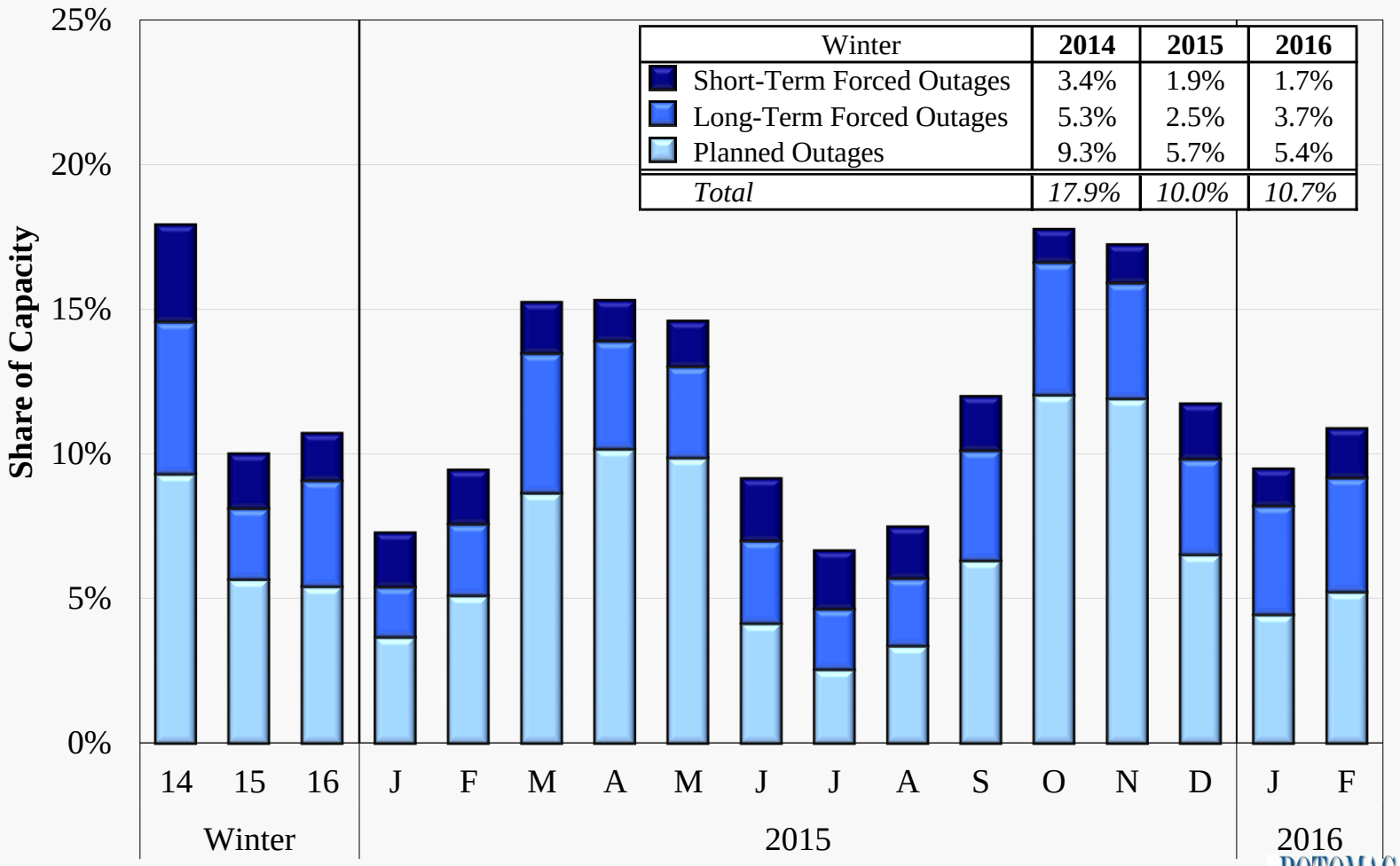
Generation Outage Rates
2015–2016



Winter	2014	2015	2016
Short-Term Forced Outages	3.4%	1.9%	1.7%
Long-Term Forced Outages	5.3%	2.5%	3.7%
Planned Outages	9.3%	5.7%	5.4%
Total	*17.9%*	*10.0%*	*10.7%*

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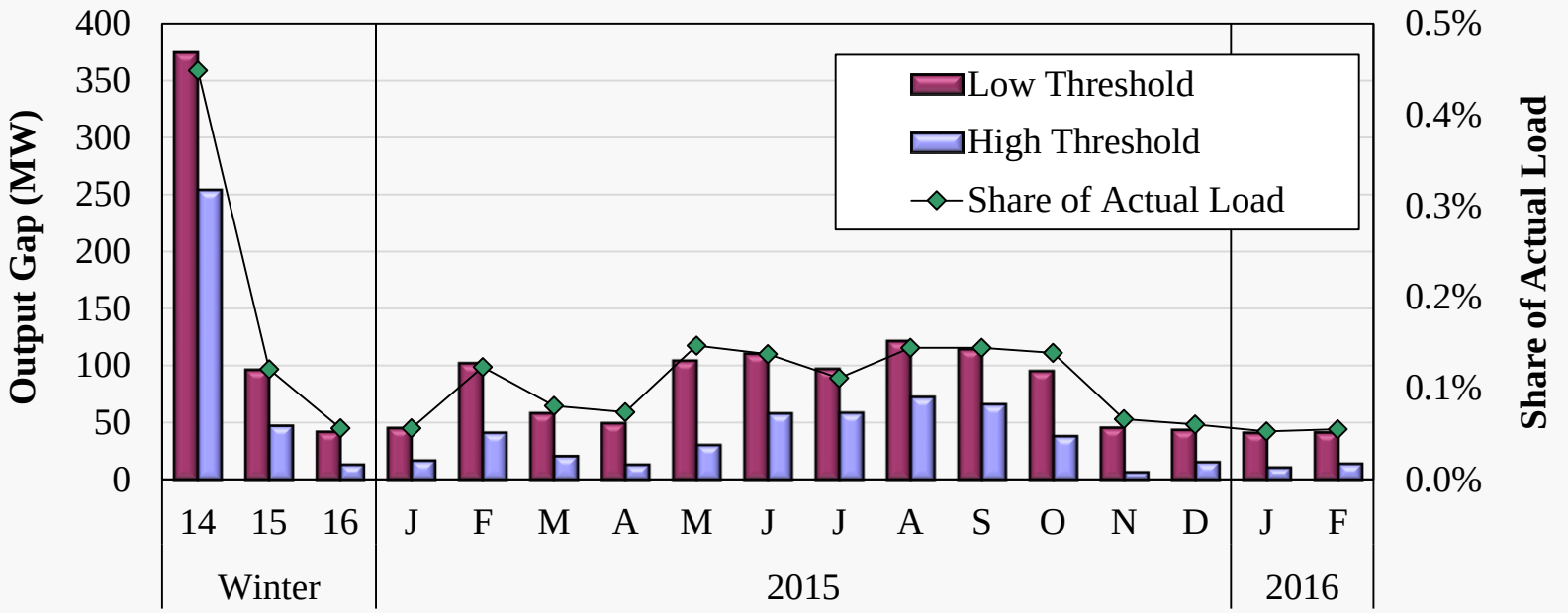
Monthly Output Gap
2015–2016



High Threshold Results by Unit Status (MW)

Offline	201	12	7	11	17	5	3	11	34	49	58	50	25	0	7	5	10
Online	81	13	5	6	24	16	10	19	24	9	14	16	14	6	8	6	5

Low Threshold Results by Unit Status (MW)

Offline	235	18	8	12	32	5	4	15	43	54	66	57	32	0	10	6	11
Online	186	46	33	34	71	53	46	90	68	43	56	57	63	45	34	36	31

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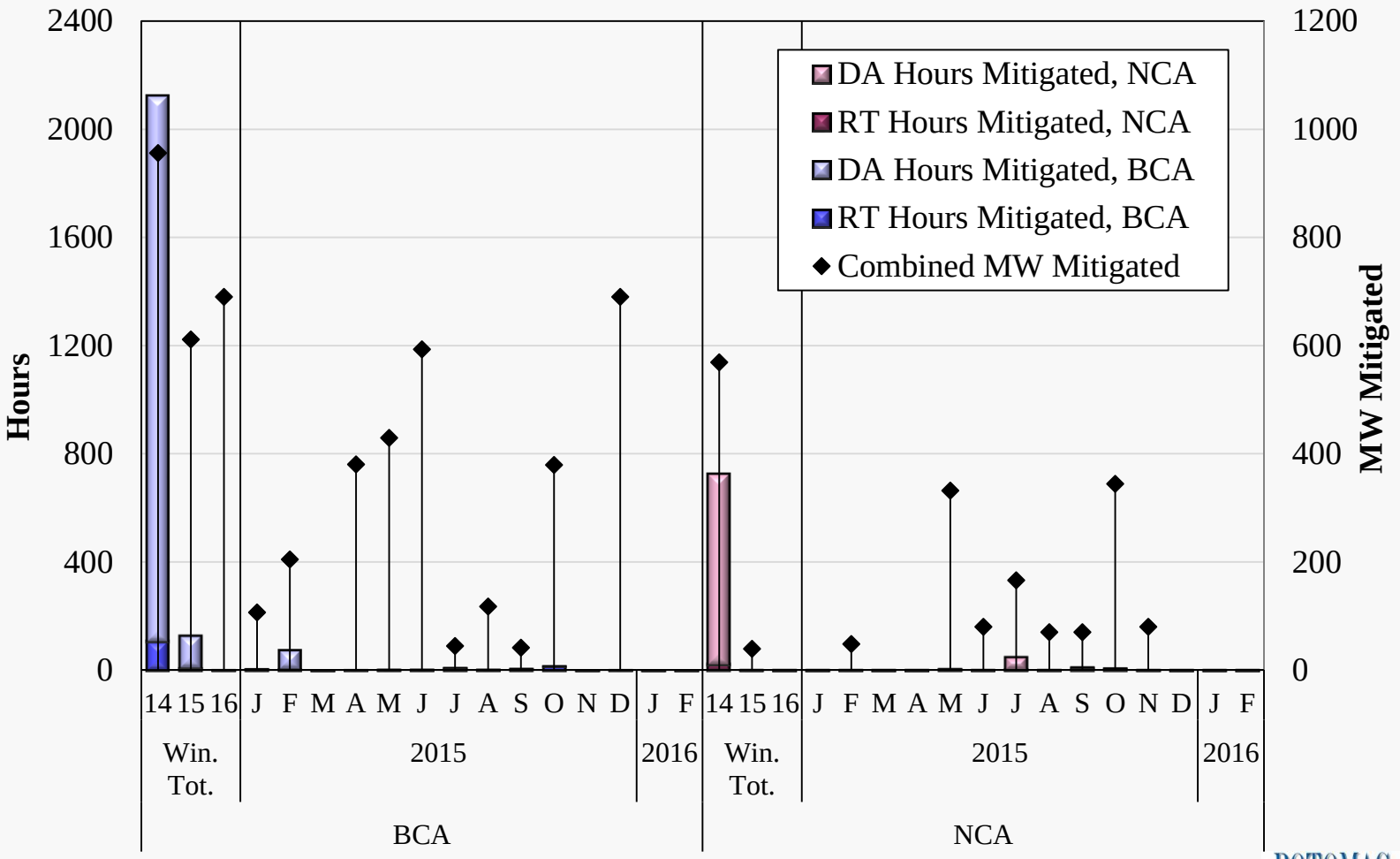
Day-Ahead And Real-Time Energy Mitigation 2015–2016



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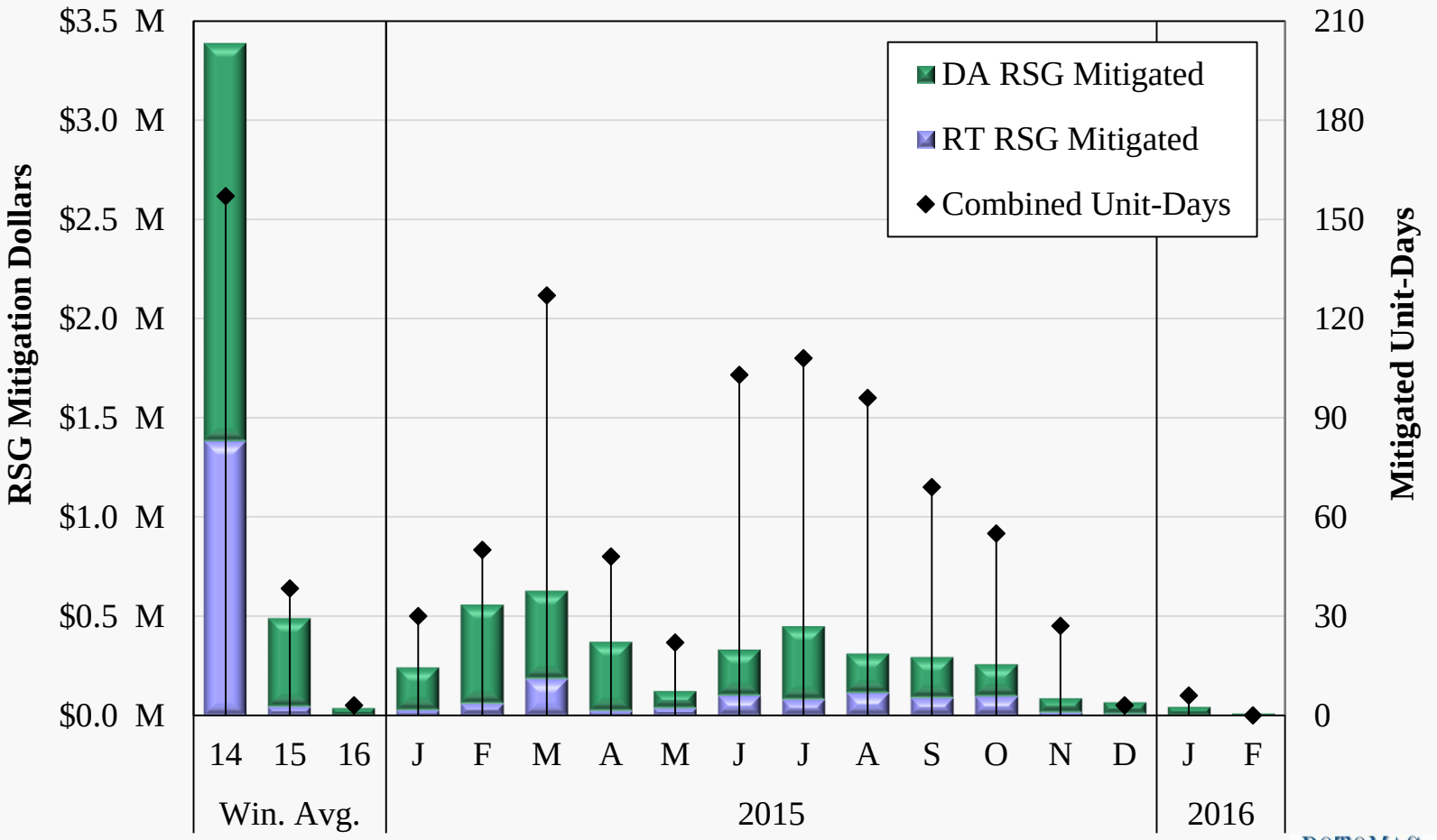
Day-Ahead and Real-Time RSG Mitigation 2015–2016



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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
✓	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
✓	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