

A Review of PJM's Reliability Pricing Model

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I. Overview

This paper provides an overview of the PJM Interconnection LLC's (PJM) Reliability Pricing Model (RPM), the prices paid to generators and demand response providers and the extent to which new resources were bid into each auction. The purpose of this paper is to provide an overview of the results of RPM to date, and to highlight concerns, rather than to investigate or propose changes to the specific RPM rules.

The results of the seven auctions held to date provide a portrait of a market that is costing consumers more than needed to ensure reliability and incent demand response, as evidenced by the following outcomes:

- Prices have steadily increased in the transmission-constrained zones, which account for about half of PJM's load,¹ even though resources currently exceed reliability requirements. Within the non-constrained "rest of RTO" region, prices have been relatively low.
- Over 94 percent of revenue is paid to existing generation resources.
- Greater prices within constrained zones have not led to relatively more new supply there than in the "rest of RTO" area.
- PJM has implemented a series of administrative changes to RPM, a number of which are likely to increase prices further, especially in constrained zones.

II. Brief History

Since RPM was initiated in the spring of 2007, seven Base Residual Auctions (BRAs) have been conducted to procure capacity for successive 12-month periods beginning June 2007. Each BRA procures capacity for a "delivery year" as far as three years in the future.² The most recent BRA, held in May 2010, procured capacity for June 2013 through May 2014. Two notable outcomes of these auctions are the steady increase in demand response clearing the auction and the large differential between prices in transmission-constrained areas and the rest of RTO.

Demand response (DR) refers to demand-side resources after they have cleared the auction as capacity.³ Since 1999, PJM has had a requirement that demand-side resources treated as capacity

¹ These zones are largely in the area known as "PJM classic," which is the original mid-Atlantic footprint prior to PJM's expansion that began in 2002. The remaining part of PJM is known as the "rest of RTO."

² Because RPM was only implemented in 2007, the first four auctions for the 2007/8 through 2010/11 delivery years were held between April 2007 and January 2008, providing fewer than three years' lead time.

³ Until the 2012/13 auction, a separate program, called Interruptible Load for Reliability (ILR), procured demand-side resources not offered into the RPM auction. ILR was geared towards shorter-lead time resources. Instead of a three-year advance commitment, as required under RPM, ILR required certification in as little as three months prior to the delivery year. When ILR ended, short-term resources were accommodated by

must agree to interrupt up to 10 times per year and for six hours at a time, with total DR limited to 7.5 percent of peak load.⁴ As discussed below, current levels are approaching this limit.

In each auction, PJM determines whether there are certain transmission-constrained Locational Deliverability Areas (LDAs) to be modeled. An LDA is modeled in the auction if the transmission capacity available to import power from the rest of the RTO (Capacity Emergency Transfer Limit, or CETL) falls below a target ratio with the level needed to import power to meet reliability requirements under a local capacity emergency (Capacity Emergency Transfer Objective, or CETO). The target CETL/CETO ratio was 105 percent for the first five auctions and 115 percent for the last two. Actual CETL/CETO ratios declined between the 2012/13 and 2013/14 auctions for all but one LDA (DPL South), largely due to changes in load and delays in a transmission project.⁵

Whether a zone actually clears the auction as an LDA with a separate price depends upon the supply-and-demand curves for LDA in that auction. An LDA clears at a higher price when some resources would need to be procured from within the LDA at higher cost than the rest of the RTO. But LDAs can still access some of the lower-priced RTO resources through their available transmission capacity. This import capability is reflected in a Capacity Transfer Right (CTR) credit that is subtracted from the initial RPM clearing price.

There are three common LDAs, described below:

- Eastern Mid-Atlantic Area Council (EMAAC): Atlantic City Electric, Delmarva Power, Jersey Central Power and Light Company, PECO Energy Co., Public Service Electric and Gas Company, and Rockland Electric Company.
- Southwestern MAAC (SWMAAC): Baltimore Gas and Electric Company and Potomac Electric Power Co. (PEPCO).
- MAAC: All of SWMAAC and EMAAC, plus Metropolitan Edison Company, Pennsylvania Electric Company, and Pennsylvania Power & Light (PPL). (When SWMAAC or EMAAC clears separately, MAAC only includes the remaining zones.)

In some years additional smaller LDAs were also modeled or cleared. In the most recent auction, seven LDAs were modeled, and three cleared (MAAC, EMAAC and PEPCO).

removing 2.5 percent of the reliability requirement from the demand curve in the BRA for procurement in later auctions closer to the actual delivery year.

⁴ Demand Resource Saturation Analysis, May 2010, Resource Adequacy Planning Department, PJM, <http://www.pjm.com/~media/committees-groups/committees/oc/20100817/20100817-item-03-demand-response-saturation-report.ashx>.

⁵ 2013/14 RPM Base Residual Auction Planning Parameters, PJM, pp. 3–4, <http://www.pjm.com/markets-and-operations/rpm/~media/markets-ops/rpm/rpm-auction-info/planning-period-parameters-report.ashx>. Load increased in Northern Virginia, and PPL portion of the Susquehanna-Roseland 500 KV project did not satisfy project development milestones.

III. Summary of Auction Results

Table 1 shows the prices in the BRAs for each of the auctions. The net price takes into account the CTR credit and is the actual price paid by load to the capacity resources.⁶ As shown, at least two LDAs cleared in each auction. In only one delivery year—2011/2012—were there no separate LDAs.

Prices have fluctuated in the rest of RTO outside of the LDAs, and have been relatively low in recent years. The rest of RTO clearing price was \$40.80 in the first auction, rose to \$174.29 in the 2010/11 auction (when only one small LDA cleared), fell to \$16.46 in 2012/13 and then rose slightly to \$27.73. Supply curve data for the rest of RTO for the 2012/13 auction shows a good deal more capacity offered at relatively low prices—an additional 6,800 MW of supply was offered above the clearing price but still below \$40.⁷ Therefore, even if supply had risen or demand been lower, prices may not have shown a significant jump.

In contrast to the rest of RTO, prices in the LDAs, representing about half the capacity cleared in the auctions, have been significantly above the RTO price and have increased dramatically. In the most recent auction (2013/14 delivery year) LDA prices were between 73 and 83 percent greater than the prior year, and all LDA prices were more than twice the 2011/12 auction price, when just a single RTO cleared. The 2013/14 auction also produced the greatest disparity between an LDA and RTO price—the \$212.59 spread between EMAAC and the RTO.

An example of the dramatic changes in LDA prices is the MAAC LDA, which cleared at the RTO price of \$110 in 2011/2012, below prior auction prices. MAAC then rose to \$129.63 in 2012/13 and again to \$223.85 in 2013/14, the second highest price to date (other than SWMAAC's clearing price in 2009/10 of \$224.59.)

⁶ The data in the Table were obtained primarily from the Base Residual Auction Results provided by PJM. *See*, <http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx#Item06>. CTR credit data was obtained from Monitoring Analytics analyses of each auction. *See*, <http://www.monitoringanalytics.com>.

⁷ Calculated using data provided on PJM's web site in the aggregated supply curve data; <http://www.pjm.com/markets-and-operations/rpm/~-/media/markets-ops/rpm/rpm-auction-info/2012-2013-bra-aggregated-supply-curve-data.ashx>.

Table 1. Summary of RPM Auctions

Year/ LDA	Preliminary Price	CTR credit	Net Price	Change from Prior Year		Cleared Capacity (UCAP MW)	Net New Generation (ICAP MW)	Demand Response (UCAP MW)	Energy Efficiency	Total New Resources	
				\$	%					(MW)	as a % of Cleared
2007/8											
RTO	\$40.80		\$40.80			88,410.2	125.3	63.2		188.5	0.2%
EMAAC	\$197.67	\$20.16	\$177.51			30,797.8	(85.9)	44.7		(41.2)	-0.1%
SWMAAC	\$188.54	\$48.38	\$140.16			10,201.2	(112.0)	19.7		(92.3)	-0.9%
Total						129,409.2	(72.6)	127.6		55.0	0.04%
2008/9											
RTO	\$111.92		\$111.92	\$71.12	174%	88,745.1	134.2	58.3		192.5	0.2%
EMAAC	\$148.80	\$5.29	\$143.51	(\$34.00)	-19%	30,231.3	176.6	168.7		345.3	1.1%
SWMAAC	\$210.11	\$29.53	\$180.58	\$40.42	29%	10,621.2	38.0	309.2		347.2	3.3%
Total						129,597.6	348.8	536.2		885.00	0.7%
2009/2010											
RTO	\$104.82		\$104.82	(\$7.10)	-6%	60,498.0	507.5	79.0		586.5	1.0%
MAAC+APS	\$196.54	\$2.77	\$193.77	\$50.26	35%	62,175.5	378.7	457.6		836.3	1.3%
SWMAAC	\$243.80	\$19.21	\$224.59	\$44.01	24%	9,558.3	(164.1)	356.3		192.2	2.0%
Total						132,231.8	722.1	892.9		1,615.0	1.2%
2010/2011											
RTO	\$174.29		\$174.29	\$69.47	66%	130,670.9	1,566.4	924.1		2,490.5	1.9%
DPL	\$178.57	\$0.30	\$178.27	(\$15.50)	-8%	1,519.7	(92.0)	14.9		(77.1)	-5.1%
Total						132,190.6	1,474.4	939.0		2,413.4	1.8%
2011/2012											
RTO	\$110.00		\$110.00	(\$64.29)	-37%	132,221.5	3,311.3	1,364.9		4,676.2	3.5%

Table 1 (continued)

Year/ LDA	Preliminary Price	CTR credit	Net Price	Change from Prior Year		Cleared Capacity (UCAP MW)	Net New Generation (ICAP MW)	Demand Response (UCAP MW)	Energy Efficiency	Total New Resources	
				\$	%					(MW)	as a % of Cleared

2012/2013

RTO	\$16.46		\$16.46	(\$93.54)	-85%	65,927.8	157.0	2,323.5		2,480.5	3.8%
MAAC	\$133.46	\$3.83	\$129.63	\$19.59	18%	39,135.5	(697.1)	3,085.3		2,388.2	6.1%
EMAAC	\$139.82	\$4.64	\$135.18	\$25.14	23%	26,316.8	186.6	1,638.4		1,825.0	6.9%
DPL -South	\$169.30	\$6.64	\$162.66	\$52.62	48%	1,241.5	(34.8)				
PSEG-North	\$162.87	\$13.22	\$149.65	\$39.61	36%	3,521.9	(812.1)				
Total						136,143.5	(1,200.4)	7,047.2	568.9	5,846.8	4.3%

2013/2014

RTO	\$27.73		\$27.73	\$11.27	68%	88,058.2	825.7	3,410.8	527.4	4,236.5	5.4%
MAAC	\$226.15	\$2.30	\$223.85	\$94.22	73%	29,543.9	(60.2)	2,862.5	92.3	2,802.3	9.5%
EMAAC	\$245.00	\$4.68	\$240.32	\$105.14	78%	30,350.2	(952.1)	2,461.3	23.9	1,509.2	5.0%
PEPCO	\$247.14	\$10.21	\$236.93	\$107.30	83%	4,791.0		547.3	35.8		
Total						152,743.3	(186.6)	9,281.9	679.4	8,548.0	5.6%

Total Increase from 07/08	4,397.0	9,154.3	679.4	14,230.7
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Notes:

RTO and LDA capacity numbers are net of LDAs. For example, MAAC capacity numbers in 2012/13 are net of quantities in EMAAC, DPL, and PSEG.

2013/2014 quantities for the RTO increased due to the inclusion of FirstEnergy's affiliate ATSI in the auction.

Data was obtained from the RPM Base Residual Auction Report and Base Residual Auction Results spreadsheet for each year, available at: <http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx#Item07>.

New Generation includes new units, upgrades to existing capacity, and reactivations, net of deactivations and retirements.

New Generation data was only available in ICAP. UCAP numbers account for Equivalent Forced Outage rates, and are therefore lower.

The impact on costs of these higher LDA prices is significant. PJM’s market monitor, Monitoring Analytics, calculated the difference in revenues earned in the 2013/14 auction had there been no LDAs. Under this scenario, total revenues would have been \$3.36 billion instead of \$6.71 billion, a \$3.35 billion difference.⁸ In the press release on the 2013/14 auction, PJM’s justification of the high prices in the LDAs is that the differential “shows the need for increased transmission line capacity into the region” and that “[t]ransmission line additions and upgrades would reduce capacity price differences.”⁹

In contrast to PJM’s assertions, a recent analysis by James F. Wilson of Wilson Energy Economics showed that these price differentials have not led to higher-priced zones attracting or retaining proportionately more capacity than the rest of the RTO region. When comparing MAAC and EMAAC to the rest of the RTO, on a per 1,000 MW of peak load basis, lower levels of generation cleared, and lower amounts of new generation, plant upgrades, demand response, and energy efficiency resources were offered in constrained zones than in the rest of RTO region. Moreover, the rest of RTO had net imports of capacity while the constrained zones only had exports.¹⁰

Table 1 also presents data on new resource development—defined as the increase in generation capacity, demand response, and energy efficiency clearing the auction. While DR has shown significant increases, all new resources combined constituted just 5.6 percent of total cleared capacity in the 2013/14 auction, meaning that over 94 percent of the revenues from this RPM auction will be paid to existing capacity. In prior auctions, the percent of new capacity clearing the auction was even lower, falling below two percent for the first four BRAs.

With the exception of 2010/11, each auction has produced a greater amount of cleared capacity than the prior year, with the greatest increase occurring in 2013/14, largely as a result of the integration of the new ATSI transmission zone associated with FirstEnergy’s move from the Midwest ISO into PJM.

These increases in capacity, however, are greater than what is needed to meet reserve requirements. Monitoring Analytics found that the capacity cleared in the 2013/14 auction, “which represented a reserve margin of 20.2 percent, resulted in net excess of 6,518.3 MW over the reliability requirement of 149,988 MW (Installed Reserve Margin (IRM) of 15.3 percent).”¹¹ Similarly, in the 2012/13 auction, cleared resources represented a reserve margin of 20.9 percent,

⁸ Analysis of the 2013/14 Base Residual Auction, Monitoring Analytics, Revised and Updated, September 20, 2010, p. 20, available at: http://www.monitoringanalytics.com/reports/Reports/2010/Analysis_of_2013_2014_RPM_Base_Residual_Auction_20090920.pdf.

⁹ Renewable Resources Grow in PJM’s RPM Auction, PJM Press Release, May 14, 2010, available at: <http://www.pjm.com/~media/about-pjm/newsroom/2010-releases/20100514-rpm-auction-results-2013-2014.ashx>.

¹⁰ *Direct Testimony of James F. Wilson in Support of First Brief of the Joint Filing Supporters*, filed July 1, 2010, in FERC Docket No. ER10-787, Section V, available at: <http://www.wilsonenec.com/page1.php>.

¹¹ Monitoring Analytics, September 20, 2010, p. 18. Net excesses were also reported in each individual LDA in Tables 18, 19, and 20.

resulting in a net excess of 5,754.4 MW over the reliability requirement of 133,732.4 MW (IRM of 16.2 percent).¹²

DR participation has been steadily increasing in the auctions. In the 2013/14 auction, DR increased by 2,235 MW, of which 394 MW was from the new ATSI transmission zone, which participated in the auction as a result of the integration of FirstEnergy into PJM.¹³ Generation resources have not increased at the same pace as DR, meaning that a larger component of the reliability requirement is being met through DR.

As a percent of peak load, DR has increased from 1.2 percent in 2006/2007 to 6.3 percent in 2010/2011, approaching the 7.5 percent limit set under PJM's market rules. As a result, PJM recently undertook a study of DR saturation,¹⁴ and recommended increasing the limit to 8.5 percent for the RTO, finding that this level would produce a low probability (10 percent) of a resource being interrupted more than 10 times. Greater limits were proposed by PJM for the specific LDAs.

Table 2 shows the breakdown of the increase in generation. The growth of generation has not followed a clear pattern. For example, when deactivations and retirements are taken into account, generation actually had a net decrease in three of the auctions, including the past two. (This decline, however, was theoretically compensated for by the increase in DR.) Over the past seven auctions, net generation increased by 4,397 MW. Of the total 11,582 MW of gross additions, 45 percent are either reactivation of units or uprates to existing units.

¹² Analysis of the 2012/13 Base Residual Auction, Monitoring Analytics, August 6, 2009, p. 14, *available at*: http://www.monitoringanalytics.com/reports/Reports/2009/Analysis_of_2012_2013_RPM_Base_Residual_Auction_20090806.pdf.

¹³ 2013/14 Base Residual Auction Results, PJM Interconnection, Table 2-A, p. 5, <http://www.pjm.com/markets-and-operations/rpm/~media/markets-ops/rpm/rpm-auction-info/2013-2014-base-residual-auction-report.ashx>.

¹⁴ Demand Resource Saturation Analysis, May 2010, Resource Adequacy Planning Department, PJM, <http://www.pjm.com/~media/committees-groups/committees/oc/20100817/20100817-item-03-demand-response-saturation-report.ashx>.

Table 2. Components of New Generation Cleared in RPM Auctions

Delivery Year	New Units	Reactivated Units	Upgrades	Total Additions	Decreases	Net Increase (Decrease)	Cleared Generation (UCAP)	% New
	(MW of ICAP)							
2007/8	19.0	47.0	536.0	602.0	(674.6)	(72.6)	129,281.6	-0.1%
2008/9	93.1	131.0	500.1	724.2	(375.4)	348.8	129,061.1	0.3%
2009/2010	476.3		796.0	1,272.3	(550.2)	722.1	131,338.9	0.5%
2010/2011	1,027.7	170.7	577.8	1,776.2	(301.8)	1,474.4	131,251.5	1.1%
2011/2012	2,332.5	181.0	1,062.8	3,576.3	(264.7)	3,311.6	130,856.6	2.5%
2012/2013	1,108.0		785.5	1,893.5	(3,093.9)	(1,200.4)	128,527.4	-0.9%
2013/2014*	1,278.2		392.2	1,737.5	(1,924.1)	(186.6)	142,782.0	-0.1%
Total	6,334.8	529.7	4,650.4	11,582.0	(5,260.6)	4,397.3	923,099.1	0.5%
% of Total	55%	5%	40%					
Total New Resources (Net Change in Generation Plus Increase in Cleared DR & EE)					14,231.00			
% of Total Increase in Resources from New Generation					31%			

*Breakdown is in UCAP for 13/14 only. Total for that year is in ICAP.

IV. Recent Changes to RPM

There were several significant changes to RPM that impacted prices in the past two auctions. The most significant are:

2012/13 auction:¹⁵

The following changes in the 2012/1013 auction rules potentially increase prices in the RPM:

- Load in the Duquesne Zone was included in the RTO demand curve for 2012/2013, but was not included in the 2011/2012 RTO demand curve, which increased demand.
- The Net Cost of New Entry (CONE)¹⁶ that serves as the basis for price on the demand curve increased by 56 percent (for the RTO) compared to 2011/2012.
- Two changes increase the likelihood that the remaining auctions will have separately clearing LDAs. First, the threshold for determination of separate modeling as an LDA was increased to a 115 percent CETL/CETO ratio, compared to the previous level of

¹⁵ 2012/13 Base Residual Auction Results, PJM Interconnection, pp. 3–4, <http://www.pjm.com/markets-and-operations/rpm/~media/markets-ops/rpm/rpm-auction-info/2012-13-base-residual-auction-report-document-pdf.ashx>

¹⁶ The demand curve centers around net CONE (CONE net of average market earnings over the past three years) by setting a price equal to net CONE at the quantity of capacity one percentage point above the Reliability Requirement.

105 percent.¹⁷ Second, EMAAC, SWMAAC, and MAAC regions now must be modeled, along with any other LDA that had a locational price adder in the last auction or that was determined to be likely to have a locational adder.

- The Avoidable Cost Rate (ACR) default values were increased. Suppliers that fail the Market Structure Test are capped at their ACR, and have the choice to submit default values instead of unit-specific ACR data.

The following potentially decreased prices by reducing demand or increasing supply:

- Demand was reduced by shifting 2.5 percent of the load into later auctions.
- Demand response bids increased in the BRAs as a result of the end of the ILR program.
- Two new types of resources, Energy Efficiency and Planned External Generation, were allowed to submit offers.

2013/14 auction:¹⁸

The following changes in the 2013/2014 auction rules tended to increase prices:

- Net CONE increased by 15 percent (for the RTO), 23 percent (for EMAAC) and 29 percent (for MAAC) over 2012/2013 values.
- Existing Demand and EE Resources were no longer required to submit zero-price offers if they were determined to have structural market power, as was the rule in prior auctions.
- The default ACR value was increased compared to the prior year.
- ATSI (FirstEnergy) load and supply was included in the RPM auction. An analysis of the ATSI integration by Monitoring Analytics found that this zone will have a higher peak load obligation than the total available capacity.¹⁹

¹⁷ The CETL/CETO ratios declined for all zones, except for DPL South, between the last two auctions, falling as low as 98 percent for PSEG North. *See*, Analysis of the 2013/14 Base Residual Auction, Monitoring Analytics, Table 23, p. 53.

¹⁸ 2013/14 Base Residual Auction Results, PJM Interconnection, pp. 23–24, *available at*: <http://www.pjm.com/markets-and-operations/rpm/~media/markets-ops/rpm/rpm-auction-info/2013-2014-base-residual-auction-report.ashx>.

¹⁹ *ATSI Integration Capacity Auctions: Delivery Years 2011/2012 and 2012/2013*, Monitoring Analytics, December 2009, *available at*: http://www.monitoringanalytics.com/reports/Reports/2009/IMM_Report_ATSI_Integration_Capacity_Auctions_20091216.pdf.

V. Conclusion

These changes to RPM indicate likely high capacity prices in LDAs in the forthcoming auctions, and continued low prices in the “rest of RTO.” But the data presented here from the auctions raise serious doubts about the success of this locational incentive. Given that generation owners are earning significant amounts of revenue from the high prices in the LDAs, it is counter-intuitive that these companies would have an interest in building additional generation that could lower these locational prices.

PJM has touted the growth of demand-side resources as a primary benefit of RPM. While this growth has been impressive, it is not clear if the amount of money flowing through RPM—and ultimately paid by consumers—was necessary to achieve this goal. Moreover, whether the limit is set at 7.5 percent, 8.5 percent, or some other number, at some point, the ability to rely on DR will decrease, especially if retirement of existing generation units continues or even accelerates.

After seven auctions, and billions of dollars of costs, three significant fundamental questions remain unanswered about RPM:

- How can a market that funnels 94 percent or more of the revenue to existing generation be the best means to foster continued growth of demand-side resources and attract other new resources?
- Can the rates paid by consumers to defray the cost of RPM meet the just and reasonable standard?
- When will PJM and policymakers acknowledge that the theory that locational differentials in prices will incent greater resource development has not borne out in reality?