

PJM's "Capacity Performance" Tariff Changes: Estimated Impact on the Cost of Capacity

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This report provides an estimate of the cost impact of PJM’s recent “Capacity Performance” (“CP”) package of changes to its Reliability Pricing Model (“RPM”) capacity construct. The CP rules impose new costs and risks onto capacity providers, leading many of them to offer capacity at higher prices, as PJM has acknowledged.¹ In addition, under the new CP rules, cost-based offer caps, which were in place as a market power mitigation measure, were eliminated, which also contributes to higher clearing prices.

This report estimates the impact of CP on capacity prices and capacity cost for the 2016/17, 2017/18 and 2018/19 delivery years; other potential cost impacts are also briefly discussed. This report does not describe the various changes associated with the Capacity Performance implementation, except as needed for the purposes of the cost estimate. More information on Capacity Performance is available from PJM’s website, for instance at <http://www.pjm.com/markets-and-operations/rpm.aspx>.

Summary of Results

The additional market capacity cost due to the Capacity Performance rules is estimated at \$7.3 billion over the coming three delivery years: \$2.3 billion, \$1.7 billion, and \$3.3 billion for the 2016/17, 2017/18, and 2018/19 delivery years, respectively.

For the 2016/17 and 2017/18 delivery years, special “transition” auctions were recently held to acquire commitments to provide the Capacity Performance capacity product. All of the cost of the commitments resulting from these transition auctions, net of the cost of the extinguished prior RPM commitments, is considered a cost of the CP implementation. For the 2018/19 delivery year, an RPM base residual auction was recently held through which PJM acquired the new CP product to meet 80 percent of the reliability requirement, with the remainder satisfied with non-CP or “Base” resources. This report estimates that the auction, which cleared at \$164.77/MW-day, would have cleared at \$124.23/MW-day, “but for” CP. Based on this estimated clearing price, the total market capacity cost would have been \$3.3 billion less than the \$10.9 billion in market capacity cost that resulted from the auction.

The remainder of this report describes the approach and assumptions underlying these cost estimates.

Total Additional CP Capacity Cost For the 2016/17 and 2017/18 Delivery Years

Through two special “transition incremental” auctions held in August and September 2015, PJM acquired commitments to provide the Capacity Performance product to meet 60% and 70% of the reliability requirements for the 2016/17 and 2017/18 delivery years, respectively.² For cleared resources, the new commitments resulting from these auctions replace any prior commitments to provide RPM capacity. Thus, for each of these auctions, the total additional capacity cost is the total cost of the new CP commitments, minus the total cost of the extinguished prior RPM commitments. These calculations are shown in Tables 1 and 2. While the auctions established single clearing prices for the entire RTO, these calculations include zonal details as necessary to reflect the variation of the prior commitment prices by zone.

PJM had already acquired RPM commitments in excess of its reliability requirements for these two delivery years. The transition auctions further expanded the excess capacity, because some resources that cleared in the transition auctions

¹ PJM, 2018/19 Base Residual Auction Results, p. 29 (“With the transition to the Capacity Performance product, the implied costs of committing to be a Capacity Resource increases [sic] due to the need to make improvements in generator performance during Performance Assessment Hours. These increased costs could be related weatherization, improved maintenance, and costs for fuel assurance. This shifts the supply curve for resources up and leads to higher capacity market prices overall.”) In addition to these costs, the risk of performance-related penalties will likely lead many capacity providers to include a risk premium in their capacity offers.

² A concise summary of the rules applicable to these auctions is available at <http://www.pjm.com/~media/markets-ops/rpm/rpm-auction-info/2016-2018-cp-transition-incremental-auctions-rules-schedule-planning-parameters.ashx>.

had not previously cleared in RPM. While PJM's tariff calls for it to attempt to sell excess cleared capacity back to the market through incremental auctions under some circumstances, there is presently no provision in the tariff for selling back the excess resulting from these CP transition auctions. However, PJM has recently proposed tariff changes to allow such sales.³ If the tariff changes are approved, the excess resulting from these auctions would be offered back in addition to excess resulting

from further load forecast reductions, which, according to the most recent documents, are likely to be substantial.⁴ If, in addition to excess capacity due to load forecast reductions, the additional excess capacity from the transition auctions is offered and clears, it is likely to clear at a very low price. Because the quantities, prices, and cost savings from any such sales are likely to be quite small, no estimate of the potential savings from such sales has been included.

Table 1: Additional Cost Resulting from the CP Implementation 2016/17 Delivery Year Transition Incremental Auction				
	Rest of RTO excl. ATSI	ATSI	MAAC [1]	Total RTO
Transition Auction Results:				
Total cleared capacity (MW)	74,374.0	4,608.5	16,114.1	95,096.6
Converted commitments	73,350.5	2,133.1	15,367.2	90,850.8
New commitments	1,023.5	2,475.4	746.9	4,245.8
Clearing price (\$/MW-day)	\$134.00	\$134.00	\$134.00	
Cost/MW-day of prior Commitments [2]	\$59.37	\$114.23	\$119.13	
Additional Cost per MW-day:				
Converted commitments [3]	\$74.63	\$19.77	\$14.87	
New commitments	\$134.00	\$134.00	\$134.00	
Auction Additional Cost (\$ million/year):				
Converted commitments	\$1,998.1	\$15.4	\$83.4	\$2,096.9
New commitments	\$50.1	\$121.1	\$36.5	\$207.7
Total:	\$2,048.1	\$136.5	\$119.9	\$2,304.5
<p>[1] PJM's report identified previously committed capacity in the PSEG zone that cleared in the transition auction, despite PSEG having cleared at a higher price in the base residual auction. However, PJM staff explained that this capacity is electrically connected at high voltage and earns the EMAAC price.</p> <p>[2] The 2016/17 base residual auction clearing prices were used as the cost of prior commitments. For a small quantity of cleared resources, the price may have been established in a prior incremental auction.</p> <p>[3] The additional cost is the difference between the auction clearing price and the price of the prior RPM commitment, assumed to be the base residual auction price.</p> <p>Sources: PJM, 2016/17 Capacity Performance Transition Incremental Auction Results, Tables 1 and 2.</p>				

³ PJM Markets and Reliability Committee Meeting, October 1, 2015, Item 6.

⁴ PJM Markets and Reliability Committee Meeting, October 1, 2015, PJM presentation for Item 9, Load Forecast Update, slide 3 (showing further reductions in the forecast of over 4,000 MW for 2016 and 2017).

Total Additional CP Capacity Cost for the 2018/19 Delivery Year

To estimate the impact of the CP implementation on the 2018/19 base residual auction, it is necessary to estimate how the auction would have cleared, had the CP rules not been implemented. Specifically, the goal is to estimate the “But For” clearing prices and quantities that would have occurred had all the other changes to supply and demand taken place, but not the implementation of the CP rules.

The approach was to estimate what the 2018/19 capacity offer supply curve would have been, had CP not occurred, and then to clear this supply curve against the 2018/19 sloped capacity demand curve that was used in the auction. The 2018/19 “But For” supply curve was estimated as follows. First, the slope of the supply curve in the relevant price/quantity range was estimated, based on sensitivity analysis of the prior base residual auction; then the supply curve was shifted based on the actual change in total offered and cleared supply between

Table 2: Additional Cost Resulting from the CP Implementation 2017/18 Delivery Year Transition Incremental Auction

	Rest of RTO	MAAC [1]	Total RTO
Transition Auction Results:			
Total cleared capacity (MW)	73,726.0	38,468.5	112,194.5
Converted commitments	66,575.9	35,601.6	102,177.5
New commitments	7,150.1	2,866.9	10,017.0
Clearing price (\$/MW-day)	\$151.50	\$151.50	
Cost/MW-day of prior Commitments [2]	\$120.00	\$120.00	
Additional Cost per MW-day:			
Converted commitments [3]	\$31.50	\$31.50	
New commitments	\$151.50	\$151.50	
Auction Additional Cost (\$ million/year):			
Converted commitments	\$765.5	\$409.3	\$1,174.8
New commitments	\$395.4	\$158.5	\$553.9
Total:	\$1,160.8	\$567.9	\$1,728.7

[1] PJM's report identified previously committed capacity in the PSEG zone that cleared in the transition auction, despite PSEG having cleared at a higher price in the base residual auction. However, PJM staff explained that this capacity is electrically connected at high voltage and earns the EMAAC price.

[2] The 2017/18 base residual auction clearing prices were used as the cost of prior commitments. For a small quantity of cleared resources, the price may have been established in a prior incremental auction.

[3] The additional cost is the difference between the auction clearing price and the price of the prior RPM commitment, assumed to be the base residual auction price.

Sources: PJM, 2017/18 Capacity Performance Transition Incremental Auction Results, Tables 1 and 2.

the 2017/18 and 2018/19 base residual auctions. The approach, which is described in further detail in an appendix, resulted in an estimated “But For” clearing

price of \$124.23/MW-day. The resulting “But For” cost estimate for the 2018/19 base residual auction is shown in Table 3.

Table 3: Estimated Additional Cost Resulting from the CP Implementation 2018/19 Delivery Year Base Residual Auction							
	PEPCO	EMAAC	PPL	COMED	Rest of RTO	Rest of SWMAAC	Total
Base Residual Auction Results (actual results):							
Total cleared quantity (MW)	5,478.7	31,069.0	9,526.9	23,320.4	91,739.9	5,702.0	166,836.9
Cleared CP resources	4,875.7	22,970.6	8,380.4	20,564.4	79,264.5	4,544.8	140,600.4
Cleared Base generation	103.0	6,573.5	663.7	891.5	7,475.6	569.8	16,277.1
Cleared Base DR/EE [1]	500.0	1,524.9	482.8	1,864.5	4,999.8	587.4	9,959.4
Clearing price – CP (\$/MW-day)	\$164.77	\$225.42	\$164.77	\$215.00	\$164.77	\$164.77	
Clearing price - Base generation	\$149.98	\$210.63	\$75.00	\$200.21	\$149.98	\$149.98	
Clearing price – Base DR/EE	\$41.09	\$210.63	\$75.00	\$200.21	\$149.98	\$59.95	
Base Residual Auction Total Capacity Cost (actual cost; \$ million):							
CP resources	\$293.2	\$1,890.0	\$504.0	\$1,613.8	\$4,767.1	\$273.3	\$9,341.4
Base generation resources	\$5.6	\$505.4	\$18.2	\$65.1	\$409.2	\$31.2	\$1,034.8
Base DR/EE resources	\$7.5	\$117.2	\$13.2	\$136.3	\$273.7	\$12.9	\$560.8
RPM cost - total	\$306.4	\$2,512.6	\$535.4	\$1,815.2	\$5,450.0	\$317.4	\$10,936.9
“But For” CP Estimated Clearing Quantities, Prices and Cost: [2]							
Total cleared quantity (MW)							168,309.6
Clearing price (\$/MW-day)							\$124.23
RPM “But For” cost - total							\$7,631.9
Estimated Increase in Capacity Cost due to CP, 2018/19 Base Residual Auction:							\$3,305.0
<p>[1] Base DR/EE = Demand Resources and Energy Efficiency offered as Base resources.</p> <p>[2] The determination of the “But For” quantities and prices is documented in the appendix to the report. All resources were assumed to earn the full clearing price (with no zonal prices or discounts for subannual resources).</p> <p>Sources: PJM, 2018/19 Base Residual Auction Results, Tables 3B and 4, and the accompanying spreadsheet.</p>							

A few additional assumptions were adopted for the cost estimate:

1. The Eastern MAAC and ComEd zones cleared at prices higher than the RTO region in the 2018/19 base residual auction. It is assumed that but for the CP rules, these regions, neither of which had separate prices in the 2017/18 base residual auction, would have cleared with the rest of the RTO at \$124.23/MW-day.
2. Without the CP implementation, presumably the Annual and Sub-annual (mainly Extended Summer and Limited demand response) resource categories would have again been used in the auction, potentially resulting in a price discount for a subset of cleared resources. However, for this cost estimate, it was assumed that all resources clear at a single clearing price. This assumption will tend to overstate the likely “But For” cost somewhat, and thereby understate the cost resulting from the CP implementation.

Increase in Capacity Cost Due to CP Beyond 2018/19

The next base residual auction, for the 2019/20 delivery year, would again allow the Base capacity resources to participate, but the quantity would be reduced to a maximum of 10% of the reliability requirement (compared to 20% for 2018/19). The additional cost due to CP for that delivery year might be higher than the estimated additional cost for 2018/19, due to the further reduction in Base product. For the following delivery year, 2020/2021, the Base product is to be eliminated and the entire reliability requirement satisfied with CP resources, which could potentially result in another large increase in the clearing prices and costs due to CP. Estimates of the potential impacts of CP beyond 2018/19 have not been prepared.

Potential Impact of CP on Other Types of Costs

While the goal of the new CP rules is to encourage improved generator performance, these rules could potentially have impacts on other types of costs. In particular, the CP rules could have impacts on energy costs and on customer outage costs. These potential impacts are briefly discussed in this section.

With respect to energy costs, improved generator performance certainly would have resulted in much lower energy costs during the “polar vortex” period of extreme cold in early 2014, when very high forced outage rates caused price spikes in the PJM energy markets. However, that very extreme period followed nineteen winters during which such extreme cold did not occur, capacity was never scarce during winter, and winter energy prices remained low in PJM. The polar vortex period revealed accumulated fuel and winterization issues at many plants. Apparently, many of these issues were resolved by the winter of 2015, when performance was much improved.⁵ The improved performance in winter 2015 reflects numerous steps taken by market participants and PJM following the polar vortex events, and well before Capacity Performance was approved or implemented.

Looking forward, extreme cold such as occurred during the polar vortex period is quite rare, PJM has substantial excess capacity already committed through May 31, 2019, and generator performance was much improved even before CP, so it is unclear that CP is likely to have a substantial incremental impact on future energy prices. The expected value of the incremental impact of CP on future annual energy prices is likely an order of magnitude lower than the estimated impact on capacity cost developed in this report.

With respect to the potential impact of CP on customer outage cost, this too is likely to be very low for the same reasons. Even during the polar vortex period no load was dropped. With the improved generator performance that occurred before CP, and PJM’s excess capacity, the likelihood of load loss is very low, and the amount by which CP might further reduce this load loss is extremely low. Even assigning a quite high “Value of Lost Load”, the expected value incremental impact of CP on customer outage cost is likely an order of magnitude less than the capacity cost impact.

⁵ PJM, 2015 Winter Report, May 13, 2015 (noting that “[g]enerator performance in February 2015 showed improvement”, and that “[f]or the morning of Feb. 20, 2015, when PJM reached a new all-time winter peak, the forced outage rate was 13.4 percent” compared to 22 percent during the Jan. 7, 2014 peak; p. 5).

Appendix: Methodology for Estimating the 2018/19 Base Residual Auction Clearing Quantity and Price “But For” Capacity Performance

This section explains in further detail how the “But For” CP 2018/19 base residual auction clearing quantity and price (\$124.23/MW-day) were estimated.

The first step was to estimate what the 2018/19 base residual auction capacity supply curve would have been without the CP rules. The actual auction supply curves are not published due to concerns that such information could facilitate anti-competitive conduct.⁶ However, PJM has published sensitivity analyses for the 2017/18 base residual auction that are useful for this purpose (sensitivity analyses for the 2018/19 auction will also be performed, but likely will not be available for months).

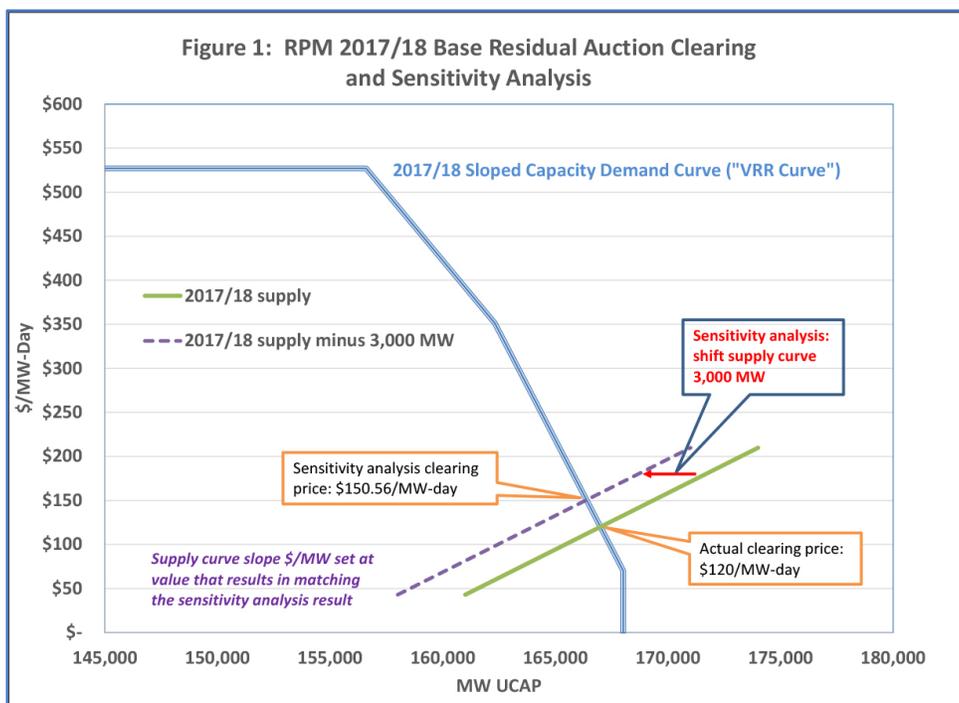
In particular, PJM performed a sensitivity analysis in which 3,000 MW of supply was removed from the RTO supply curve, and the resulting clearing price and quantity were reported.⁷ The clearing price for the RTO region rose from \$120/MW-day to \$150.56/MW-day under this scenario. A supply curve with a slope of \$12.8/1,000 MW is consistent with this result – that is, if such a supply curve clears at \$120/MW-day and is then shifted 3,000 MW,

the resulting clearing price is as identified in the scenario analysis. This analysis is illustrated in Figure 1.

The capacity supply curves are typically not linear but rise at an increasing rate, especially at high price levels. However, PJM’s sensitivity analysis, and the analysis documented here, use only a relatively small segment of the supply curve, over which the quantity ranges by 3,000 MW or less (less than two percent of the entire supply curve offered quantity), so it is reasonable to assume the supply curve is approximately linear within this short segment. In any case, the results are not very sensitive to this assumption.

The next step was to estimate how the supply curve shifted between the base residual auctions for 2017/18 and 2018/19 as indicated by changes in the quantity of capacity offered. PJM reports that for 2018/19, the total supply offered increased by 1,052.7 MW.⁸ However, some of this net incremental supply may have been relatively high cost, so the quantity was reduced by the fraction of offered supply that cleared in the auction, resulting in the assumption that the supply curve shifted by 976 MW. This shift amounts to about one half of one percent of the 178,838.5 MW offered into the 2017/18 base residual auction. This small shift would tend to lower the auction clearing price.

The sloped capacity demand curve (aka Variable Resource



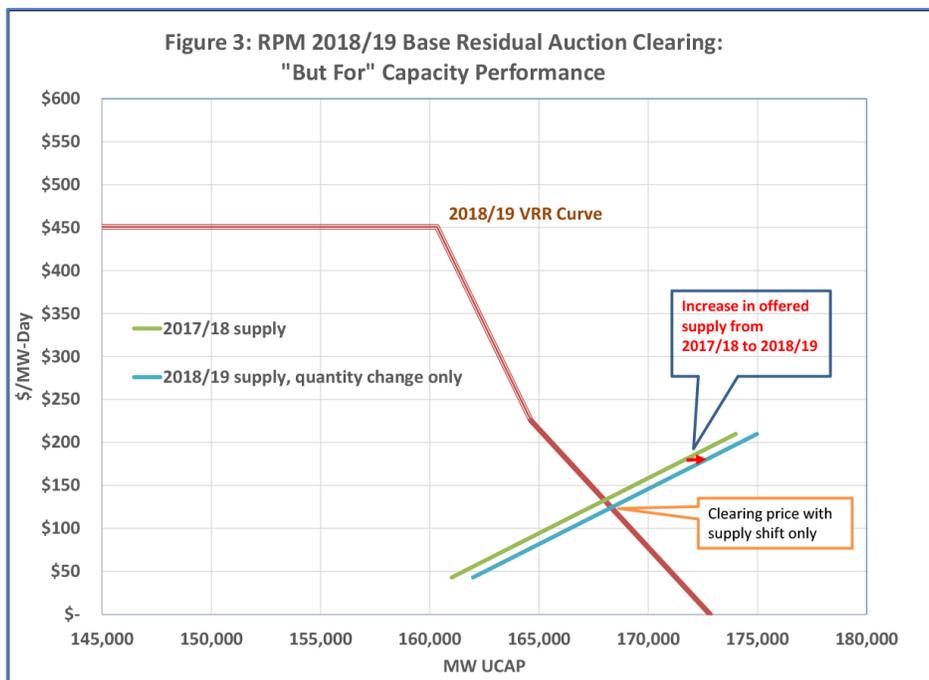
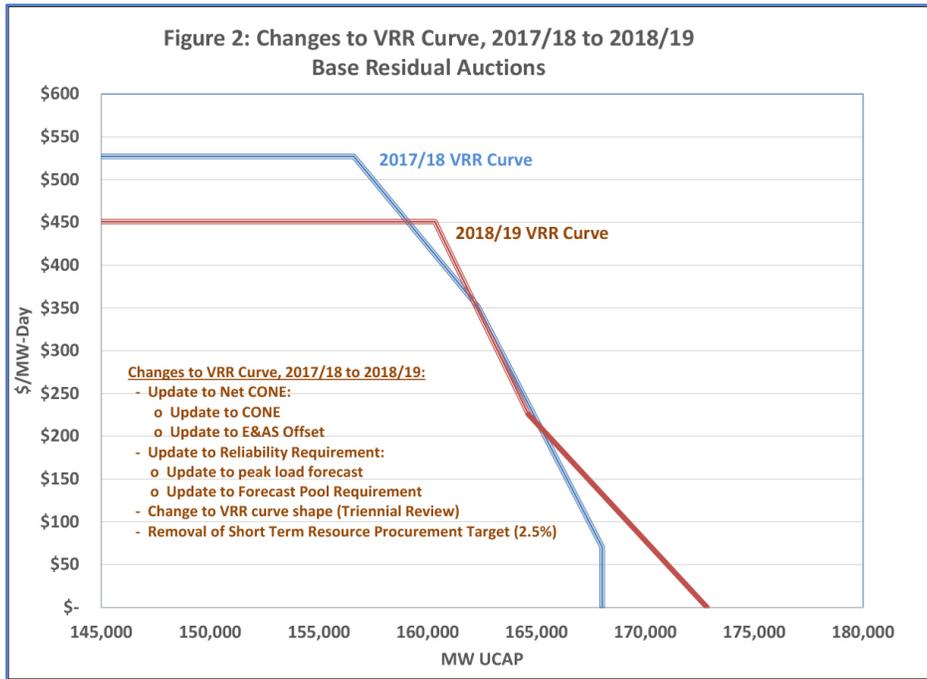
⁶ PJM and the PJM market monitor publish illustrations of supply curves that do not reveal the shape or slope of the actual supply curves. The sensitivity analyses, which are performed using the actual supply curves, reveal the actual slopes of the supply curves over specific ranges.

⁷ PJM, Scenario Analysis for the 2017/18 Base Residual Auction, scenario 2, available at <http://www.pjm.com/~media/markets-ops/rpm/rpm-auction-info/2017-2018-bra-scenario-analysis.ashx>.

⁸ PJM, 2018/19 Base Residual Auction Results, Table 6 p. 20.

Requirement, or “VRR” curve) also changed for the 2018/19 base residual auction, due to updates to the Net CONE price parameter; updates to the Reliability Requirement quantity parameter; changes to the shape of the curve; and the removal of the Short Term Resource Procurement Target (aka 2.5% holdback). The 2017/18 and 2018/19 VRR curves are both shown in Figure 2. In the relevant price range, the 2018/19 VRR curve is shifted to the right, which would tend to raise prices.

The next step was to find where the estimated 2018/19 supply curve (with slope as determined using the sensitivity analysis, and shifted based on the slight increase in offered supply) would clear against the actual 2018/19 VRR curve. This step is shown in Figure 3. The resulting clearing price is \$124.23/MW-day. That is, based on the changes in offered supply and in the VRR curve, the 2018/19 base residual auction would have been expected to clear a small amount higher than the \$120/MW-day



price from the 2017/18 auction. The actual auction clearing price was considerably higher (\$164.77/MW-day, or \$40.54/MW-day higher), presumably due to CP.

The estimated “But For” 2018/19 supply curve described above, if shifted upward by \$59.50/MW-day, results in the actual auction clearing price of \$164.77/MW-day. This is illustrated in Figure 4. Thus, according to the assumptions used for this cost estimate, the CP rules caused the supply curve offer prices to rise in the relevant price range by \$59.50/MW-day.

