Over-Procurement of Generating Capacity in PJM: Causes and Consequences

Prepared For

Sierra Club

Natural Resources Defense Council

Prepared By

James F. Wilson

Wilson Energy Economics

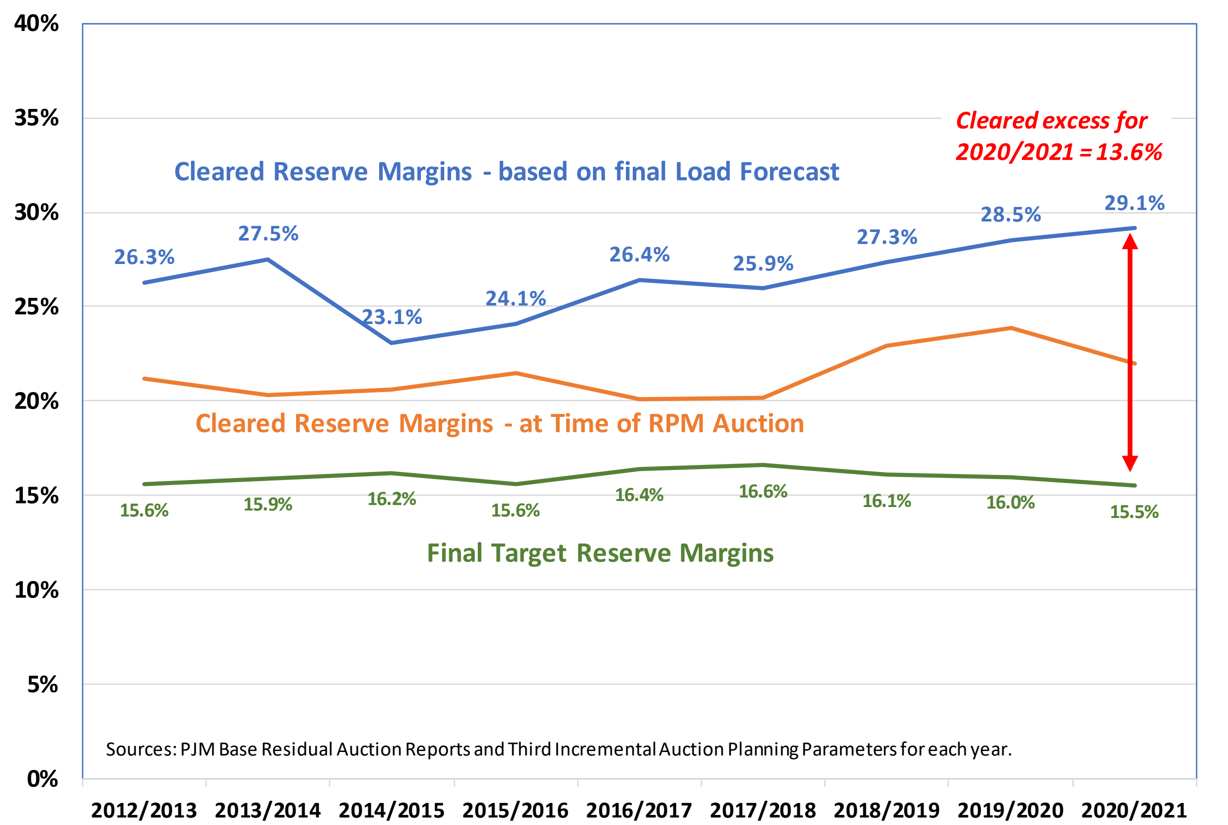
February 2020

I. Executive Summary

PJM Interconnection, LLC ("PJM") is the regional transmission organization ("RTO") that coordinates wholesale electricity markets for part or all of 13 states and the District of Columbia in the Mid-Atlantic area ("PJM Region"). To ensure adequate electric generating capacity to meet customer demands in peak periods, PJM has an administrative mechanism to acquire commitments to provide capacity three years in advance (the Reliability Pricing Model, "RPM"). Through RPM, PJM acquires a total amount of capacity (the "Reliability Requirement") sufficient to meet peak loads plus a "reserve margin," to account for plant outages and other uncertainties. However, RPM has consistently acquired far more capacity commitments than intended or needed, due to auction design features and inaccurate peak load forecasts.

Figure 1 shows that while the target installed reserve margin (green line) is generally around 16% of the forecast peak load, the RPM auctions regularly clear significantly more – equivalent to reserve margins of 20% or more (orange line). And when these cleared reserve margins are re-calculated based on the final, typically lowered, peak load forecast for each delivery year, the reserve margins have been 24% or more for all but one of the years shown (blue line). So while the target reserve margin of about 16% of peak load represents the capacity PJM believes it needs to reliably operate the system, RPM typically results in commitments that are roughly 10% of peak load or more in excess of the target – over 15,000 MW of excess capacity in recent years.

Figure 1: RPM Base Residual Auction Cleared Reserve Margins



Sources: PJM Base Residual Auction Reports and Third Incremental Auction Planning Parameters for each year.

Note that the actual reserve margins and excess capacity are even larger, because the actual, weather-normalized peak loads are generally even lower than the final forecast for each delivery year, and in addition, thousands of MW of additional resources that fail to clear in each RPM auction nevertheless continue to operate as "energy-only" resources on the PJM system. Such uncleared excess capacity is likely to increase in future years; planned changes to the RPM minimum offer price rule ("MOPR") will cause additional resources receiving state support to fail to clear in RPM.[1]

This over-procurement has direct and indirect negative consequences for PJM Region consumers and PJM's wholesale electricity market. It results in consumers paying for more capacity than needed, retaining older capacity that is no longer needed and should be retired, and acquiring new power plants that are not yet needed. The excess capacity also depresses "spot" prices for electricity and for the various ancillary services PJM needs to operate the grid reliably, muting the price signals that are essential to attract the right kinds of resources (such as flexible resources) that are increasingly needed to provide these services.

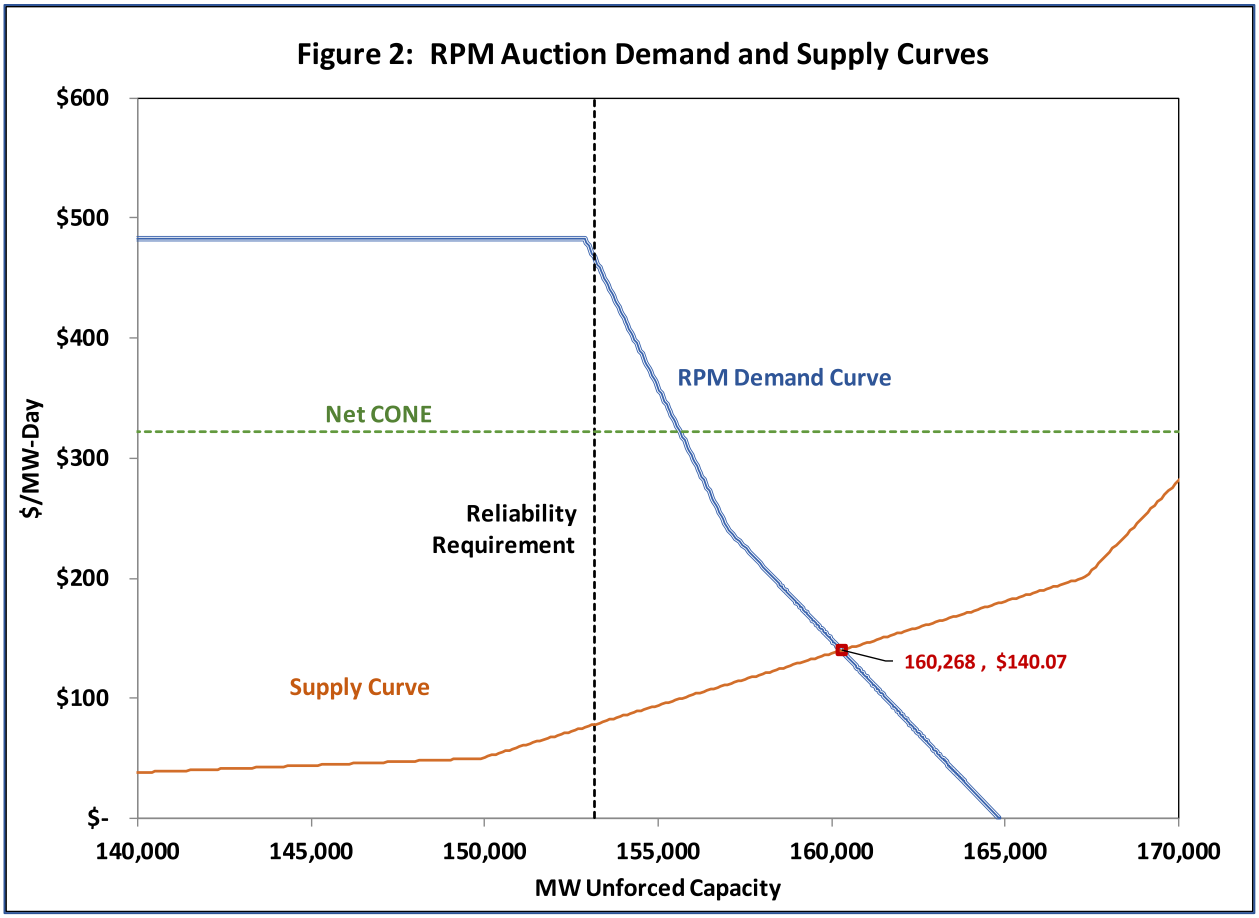
The next section of this paper explains how RPM is supposed to work to acquire the right amount of capacity, while Section III explains four causes of chronic over-procurement. Sections IV and V discuss the consequences of over-procurement and provide estimates of the cost impacts. The final section provides some observations about why chronic over-procurement persists.

II. RPM Design: How It Is Supposed to Procure the Right Amount of Capacity

For most goods and services, producers provide the amount consumers demand and are willing to pay for at any time. For electricity, most consumers pay prices that are fixed for periods of time and do not reflect short-term supply and demand conditions, in particular at times of peak loads when prices should be very high. Because most consumers do not see and respond to price signals when capacity is scarce, there is a concern that competitive wholesale electricity markets create inadequate incentives for sellers to provide the amount of generating capacity needed to meet demand during peak periods, typically the hottest days of summer. In some regions such concerns have led to the establishment of administrative mechanisms such as PJM's RPM capacity construct to provide additional compensation to the capacity that contributes to meeting the target reserve margin and serving peak loads.

Under RPM, PJM holds annual auctions to acquire capacity commitments for the "delivery year" three years into the future (that is, the RPM auction held in May 2018 acquired commitments for the period from June 1, 2021 through May 31, 2022). The RPM auctions use an administrative "demand curve" for capacity based on PJM's forecast of future peak load plus the target reserve margin (the Reliability Requirement). The capacity "supply curve" for the auction is based on price offers from the owners of eligible power plants (demand response and energy efficiency are also eligible to some extent). In the RPM auction, the intersection of the supply curve and administrative demand curve determines a price and cleared quantity for capacity three years into the future. Figure 2 illustrates the RPM demand and supply curves, and clearing point, for the RTO Region, based roughly on the results of the most recent auction (held in May 2018 for capacity to be provided in the 2021/22 delivery year).

[1] FERC Docket No. EL16-49, *Order Approving Tariff Revisions to Address Impacts of State Public Policies on the PJM Capacity Market,* December 19, 2019.



Note that the administrative RPM demand curve is not designed to procure exactly the amount of capacity considered needed – to do that, it would simply be a vertical line at the Reliability Requirement. Instead, the demand curve is sloped, which can result in an amount of cleared capacity greater than or less than the Reliability Requirement. The sloped demand curve also results in clearing prices that are intended to signal whether or not additional capacity is needed on the PJM system. When capacity is relative scarce or expensive (shifting the supply curve up and left), the auction will clear less capacity at a higher price, creating a price signal and incentive for investors to build new power plants. At times when capacity is abundant and low cost (the supply curve shifts down and right), RPM will clear more capacity at a lower clearing price, which discourages new plants and encourages high-cost existing plants to retire.

In principle, the RPM demand curve should be designed to attract just enough new entry to satisfy the Reliability Requirement; that is, at the Reliability Requirement quantity on the demand curve, the price should be the price needed to attract construction of new power plants (this price is called "Net CONE", explained further below). If an excess over the Reliability Requirement clears, the clearing price should be less than Net CONE, and when the Reliability Requirement is not met, the price should exceed Net CONE and attract more new entry. Thus, if the RPM sloped demand curve prices and quantities are set properly, the auction-cleared quantities should tend to remain close to the Reliability Requirement, and the clearing prices generally close to this Net CONE price, with relatively small variations year to year, as the RPM price signals guide entry and exit decisions. Therefore, to achieve the objective of clearing an amount of capacity close to the intended quantity (the Reliability Requirement), the position and shape of the RPM demand curve are critical.

III. Causes of Over-Procurement

As shown in Figure 1 above, the intention for RPM to clear close to the needed amount of capacity has not been realized; instead, very large excesses have cleared. The main causes of the consistent over-procurement are the following:

1. ***Inaccurate Load Forecasts.*** PJM's three-year-forward peak load forecasts have consistently been far too high, resulting in overstated Reliability Requirements; this shifts the RPM demand curve to the right from where it should be.
2. ***Inaccurate Net CONE values.*** PJM's administrative Net CONE values have consistently been far too high; Net CONE is the price parameter of the RPM demand curve, so excessive Net CONE shifts the demand curve higher.
3. ***RPM demand curve position and shape.*** The RPM demand curve is positioned and shaped such that, even if the load forecast, Reliability Requirement, and Net CONE values are accurate, and the auction clears at Net CONE, the demand curve nevertheless procures capacity in excess of the Reliability Requirement.

Together, overstated Reliability Requirements, overstated Net CONE values, and the position of the RPM demand curve lead RPM to clear excessive quantities at excessive prices.

4. ***Over-procurement is not managed.*** While there is plenty of time for any over-procurement that occurs in the RPM auction three years in advance to be corrected, PJM makes such adjustments only to a very limited extent.

These four causes result in over-procurement of capacity relative to the Reliability Requirement. It is also notable that the Reliability Requirement is based on a very conservative planning standard -- "one day in ten years" (an amount of capacity such that a capacity shortage is expected to occur not more than once in ten years). [2] An economically optimal reserve margin that would balance the value of resource adequacy with its cost in the interest of consumers would be lower.[3]

The remainder of this section explains these four causes of over-procurement in greater detail.

---

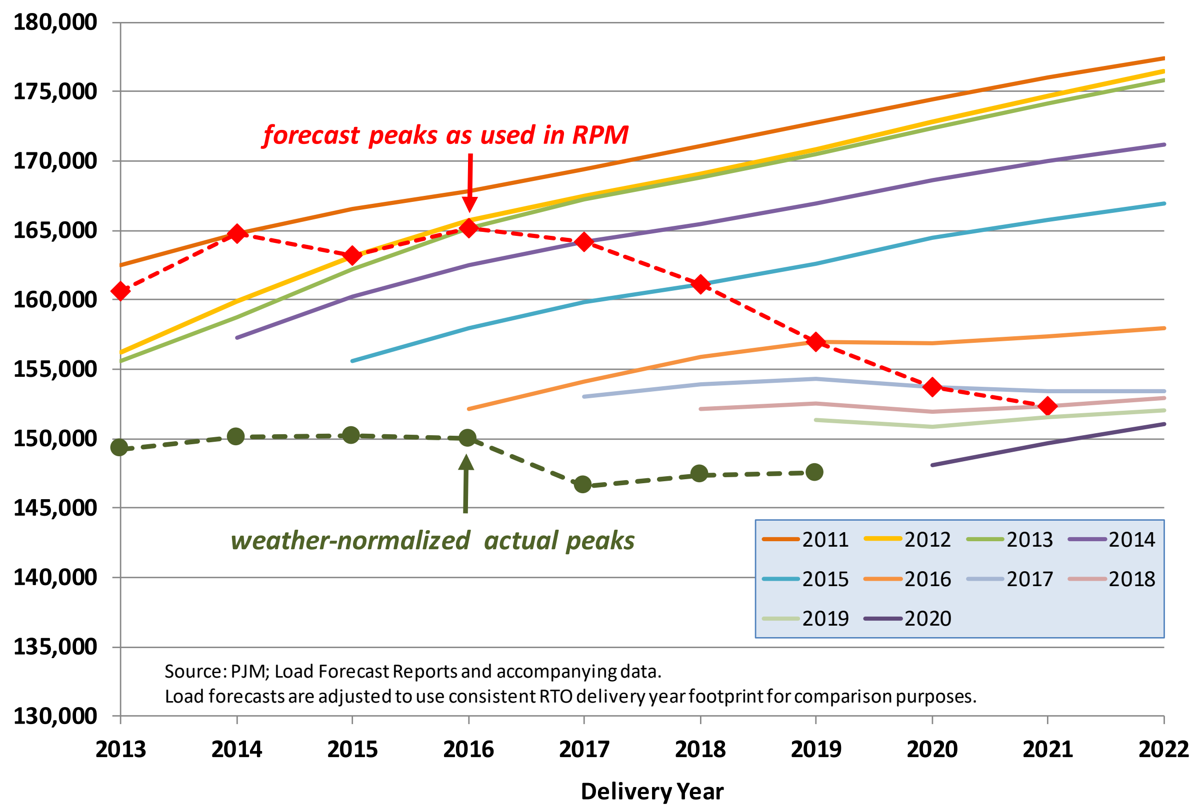
[2] It is sometimes suggested that the "Polar Vortex" event in 2014, during which reserve margins in PJM and elsewhere fell to low levels, indicated that high reserve margins and excess capacity are needed and valuable. However, this is not the case. Due to substantial excess capacity and low prices during *winter* periods for decades preceding this event, there had always been substantial excess capacity in winter, power plant winterization had been neglected, and many gas-fired plants had not arranged for firm fuel supplies. The Polar Vortex brought extreme cold that the region had not seen for decades, and for which power plants were not prepared; the PJM forced outage rate was as high as 22% during the event. Since that time, generation owners and PJM have made many changes to improve power plant performance during extreme cold, and more recent instances of extreme cold have demonstrated the effectiveness of these measures; outage rates have been close to normal levels. As a result, PJM does not consider the Polar Vortex indicative of something that could happen in the future, and in its planning models, PJM estimates the range of possible power plant outage rates under extreme cold excluding data from this abnormal period. See, for instance, *PJM 2019 Reserve Requirements Study* p. 61 (outage data from 2013/14 is dropped and replaced with data from 2014/15).

[3] For further discussion of the "one day in ten years" resource adequacy criterion see, for example, The Brattle Group and Astrape Consulting, *Resource Adequacy Requirements: Reliability and Economic Implications,* prepared for FERC, September 2013; Wilson, James F., *Reconsidering Resource Adequacy, Part 1: Has the one-day-in-10-years criterion outlived its usefulness?,* Public Utilities Fortnightly, April 2010.

1. PJM's Peak Load Forecasts Have Consistently Been Too High

For over a decade, PJM's three-year-forward peak load forecasts used to determine the RPM Reliability Requirements have been far too high. Figure 3 shows PJM's annual peak load forecasts prepared in 2011 to 2020. The actual delivery year peak loads on a weather-normalized basis[4] (the green dashed line) have been about 150,000 MW or lower; if the forecasts are accurate, the forecasts should be close to the weather-normalized values. However, for the 2013/14 through 2018/19 delivery years, the three-year-forward forecast peak loads used to determine the Reliability Requirements for RPM were far higher, over 160,000 MW (the red dashed line in Figure 3). While the forecasts are lower in recent years, the actual weather-normalized peaks have also been lower.

Figure 3: PJM RTO Peak Load Forecasts and Weather-Normalized Actuals



In the years immediately following the recession of 2008-2009, the load forecast errors were largely due to overly optimistic economic forecasts that anticipated a rapid economic recovery. But when the economic forecasts began to reflect moderate economic growth, PJM's over-forecasting of peak loads persisted. The main reason PJM's peak load forecasts have been too high is that they fail to capture an increasingly well-established trend toward more and more efficient use of electricity. Especially over the

[4] Weather-normalized peaks are estimates of what the historical annual peak would have been had it occurred under the typical peak-producing weather, rather than the actual weather at the time of the peak, which may have been relatively extreme or mild. Weather-normalized peaks are the appropriate values to compare to forecast peaks; and if a forecast is accurate, the weather-normalized peaks should be very close to the forecast.

past decade, residential, commercial and industrial electricity consumers have been doing more with less electricity every year, due to the improved energy efficiency of appliances, lighting, buildings, and industrial processes (to name just a few end uses that have become more efficient).

Measures of demographic and economic growth (such as number of households, square feet of commercial space, industrial output, and gross domestic product) have risen rather steadily since 2009 and are expected to continue to rise. Historically, that has meant that electricity demand would also be rising. However, as Figure 3 shows, the ages-old link between demographic and economic growth and electricity growth has been broken, due to increasing energy efficiency. While PJM has made some enhancements to its forecasting methodology over the years to attempt to address this phenomenon,[5] and continues to work on developing its methodology,[6] PJM's peak load forecasting model has failed to fully capture this trend toward increasing efficiency, and its three-year-forward forecasts have generally been 10,000 MW or more too high, as shown in Figure 3.

2. Net CONE Values Have Consistently Been Too High

The price parameter of the RPM demand curve is Net CONE – this is supposed to represent the RPM capacity payment that a new, efficient power plant would need in order to find it profitable to build and operate in the PJM Region. RPM prices above Net CONE are supposed to signal that additional capacity is needed and attract new entry, while prices below Net CONE should signal there is excess capacity, so new entry is not needed and some older, less efficient existing plants can retire.

The RPM Net CONE parameter has been determined administratively rather than based on market evidence. "CONE" stands for Cost of New Entry, and is set based on a consultant's research into the cost to build a new gas-fired power plant.[7] To calculate "Net" CONE, PJM subtracts out an estimate of the revenues a new power plant can expect to earn selling energy and ancillary services (everything but capacity) in the PJM markets. Thus, Net CONE is intended to represent the annual average shortfall between the (levelized) cost to build a new plant and its expected earnings from all markets other than capacity (for administrative convenience, historical average earnings, rather than a forecast of future earnings, is used for the calculation). The RPM capacity payment is supposed to supply this shortfall (which is sometimes called the "missing money").

However, RPM has consistently cleared at prices far below the administrative Net CONE estimates. Figure 4 shows recent RPM clearing prices for the RTO Region, which tend to vary substantially from year to year, and also a three-year rolling average of the clearing prices, which as the figure shows is quite stable. The three-year rolling average RPM clearing price (hereafter, "Empirical Net CONE") is a market-based estimate of Net CONE – it reflects the RPM clearing prices that are demonstrated to be sufficient to attract and retain enough capacity to clear against the RPM demand curve.

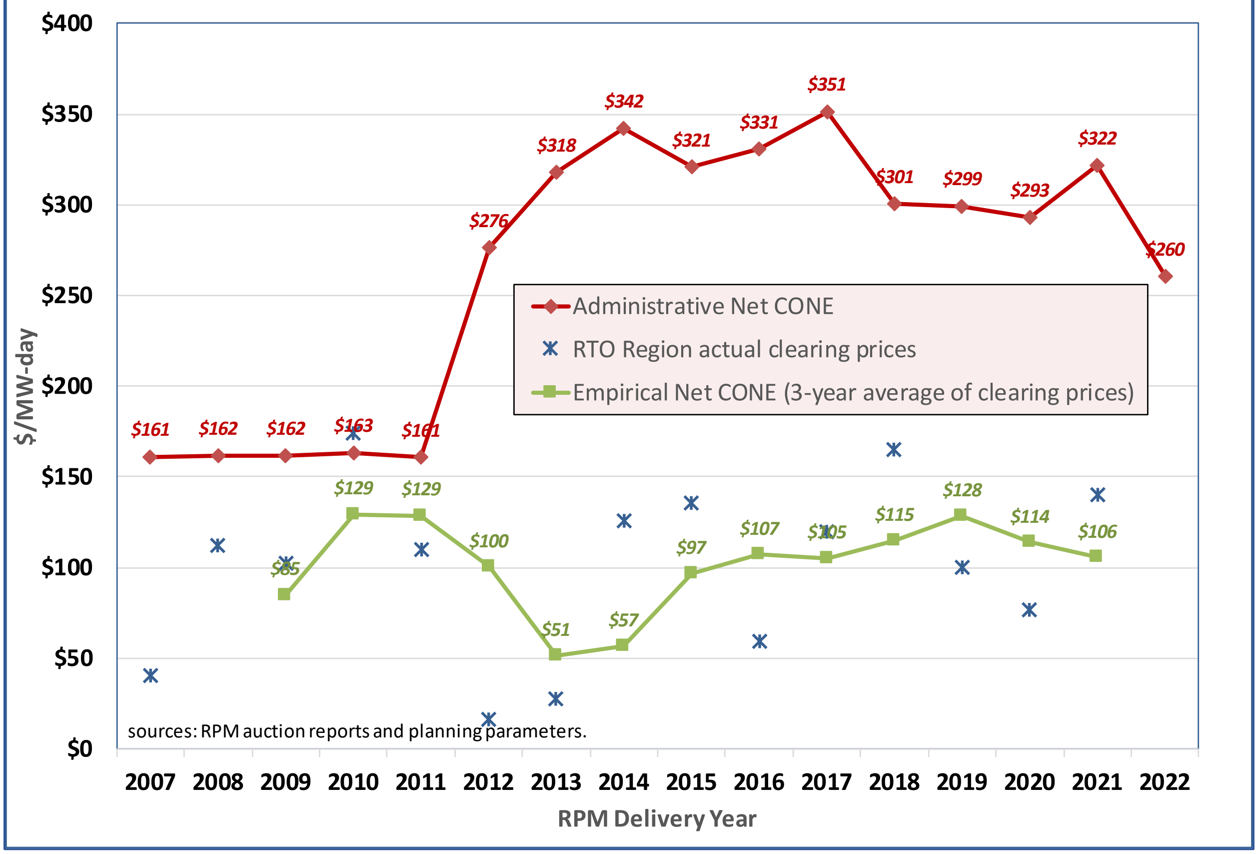
---

[5] The history of revisions to PJM's load forecasting methodology is summarized in *PJM Manual 19: Load Forecasting and Analysis,* Revision: 34, December 5, 2019, pp. 39-44 (Revision History).

[6] See, for instance, Andrew Gledhill, PJM, *Proposed Load Forecast Changes*, PJM Planning Committee meeting September 12, 2019. These changes are reflected in the PJM 2020 load forecast.

[7] See, for instance, The Brattle Group and Sargent & Lundy, *PJM Cost of New Entry Combustion Turbines and Combined-Cycle Plants with June 1, 2022 Online Date*, prepared for PJM Interconnection, L.L.C., April 19, 2018.

Figure 4: RPM Clearing Prices and Net CONE Values (RTO Region)



Over the seven most recent delivery years for which RPM auctions have been held, Empirical Net CONE has varied from just under $100/MW-day to close to $130/MW-day, and averaged about $110/MW-day, as shown in Figure 4. During this period, close to 30,000 MW of new gas-fired power plants have participated in the auction and cleared,[8] while a number of existing plants have retired and/or failed to clear in RPM. Thus, these Empirical Net CONE values result from investors' decisions to build or retire plants (or to develop demand response capability) and the prices they seek from RPM, and are indicative of the "true Net CONE" price needed to attract and maintain sufficient capacity in the PJM Region. PJM's administrative estimates of Net CONE have been more than double the Empirical Net CONE values.

In 2018, PJM's own consultants recommended significant changes to the Net CONE calculation that would have resulted in much lower values (close to Empirical Net CONE).[9] PJM instead opted to make only some relatively minor changes to the Net CONE calcuation. The changes reduced the Net CONE values somewhat, and are reflected in the the Net CONE value for 2022/23 shown in Figure 4 ($260.43/MW-day). However, as Figure 4 shows, even this updated Net CONE value remains roughly double the Empirical Net CONE values. The excessive Net CONE values will continue to result in an RPM demand curve that is set too high, contributing to clearing too much capacity at too high a clearing price.

---

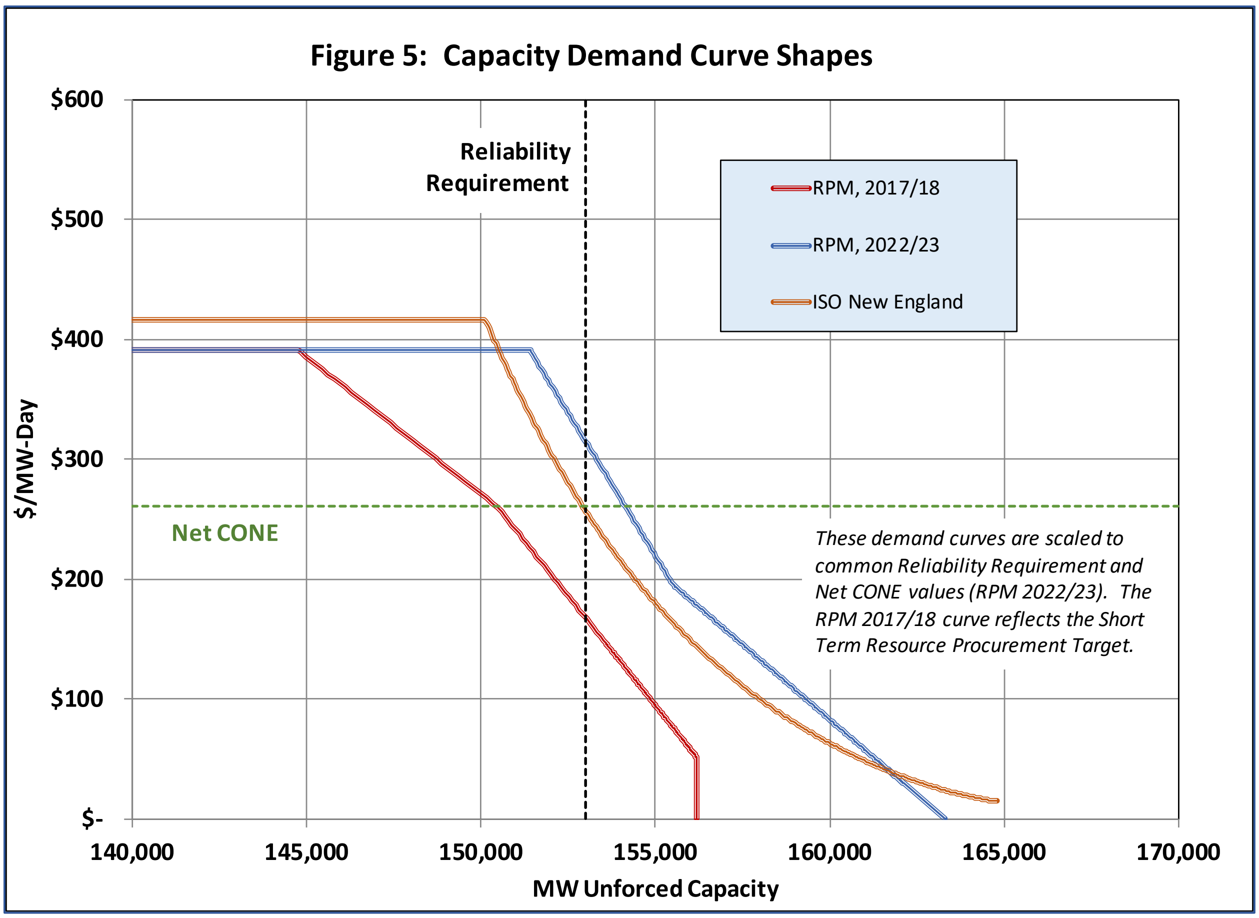
[8] PJM, *2021/2022 Base Residual Auction Results*, Table 8 (Incremental Capacity Additions).

[9] The Brattle Group, *Fourth Review of PJM's Variable Resource Requirement Curve*, prepared for PJM, April 19, 2018, p. 22-23 (strongly recommending a combined cycle unit as the reference unit), and p. iv (using a combined cycle unit as the reference unit would sharply lower Net CONE values).

3. The Capacity Demand Curve Is Shaped and Positioned to Over-Procure

Another contributing factor to over-procurement is the shape and position of the RPM demand curve. As noted above, to clear the target amount of capacity (the Reliability Requirement), a capacity demand curve should align the Net CONE price with this quantity. Other RTO demand curves do this, and the RPM demand curve was initially positioned based on this concept. However, the current RPM demand curve is shaped to acquire an amount in excess of the Reliability Requirement, even if the clearing price is well above Net CONE.

Figure 5 shows the current RPM demand curve shape, the earlier shape, and the demand curve used by ISO New England (an RTO serving the New England region that has a capacity construct similar to RPM). As the figure shows, ISO New England's curve is designed to pass through Net CONE at the Reliability Requirement. Until the 2017/2018 delivery year, PJM's demand curve was shaped to acquire a 1% excess at Net CONE, before application of a 2.5% Short Term Resource Procurement Target ("STRPT"),[10] which shifted the demand curve to the left.



[10] Prior to the 2018/2019 delivery year, a 2.5% "holdback" was employed in the RPM auction, deducted from the Reliability Requirement and shifting the demand curve, to allow acquiring additional, short lead-time resources such as demand response that may only become available closer to the delivery year (the Short Term Resource Procurement Target).

However, after the "polar vortex" period in 2014, PJM changed the shape and position of the RPM demand curve, and eliminated the STRPT, with the objective of clearing more capacity through RPM. The current curve (for the 2022/2023 delivery year) was changed again in 2018, removing the one percent shift.[11] However, the current curve continues to procure excess capacity at Net CONE, as shown in Figure 5.

4. Three-Year-Forward Over-Procurement Is Not Effectively Managed or Mitigated

The RPM construct reflects a desire to acquire capacity commitments years in advance. However, as discussed above, the future capacity needs (based on load forecasts) are uncertain. This same challenge arises in markets for many goods and services – buyers wish to arrange commitments for future supply well in advance of the need, but are somewhat uncertain about the amount that will be needed. Under such circumstances, a sound and common strategy is to contract well in advance for a large fraction of the quantity that is likely to be needed (say, 90% of the total expected need), and plan to procure an additional quantity closer to the time of use, when the need will be clearer, and only if needed. And if a buyer contracts forward for a quantity that later appears to be in excess of the amount needed, commitments can generally be shed to bring the supply down to match the need.

As each RPM delivery year approaches, the peak load forecast and Reliability Requirement are revised, generally downward, as discussed above. As the Reliability Requirement is updated and lowered, the RPM capacity quantity acquired three years forward represents an increasing amount of excess capacity. However, despite three years from the RPM auction to the delivery year, PJM does not pursue an effective strategy for adjusting the forward capacity commitments downward to better match actual needs.

Years ago, RPM was designed to procure somewhat less than the total estimated capacity need on a three-year-forward basis, to allow procuring additional capacity resources closer to each delivery year. The approach was to reduce the Reliability Requirement and shift the RPM demand curve by 2.5% (the STRPT, mentioned above). This reduced the three-year-forward capacity procurement, and when load forecasts were updated and lowered, it often became clear that little if any of the remaining 2.5% was needed, so it often was not procured. However, while this was a useful practice (it moderated excess procurement and capacity prices in the RPM auctions), capacity sellers objected to it, and in 2015 it was discontinued for the 2018/19 and later delivery years.[12]

The RPM construct also calls for additional, "incremental auctions" closer to each delivery year, to allow buyers, sellers and PJM to adjust their capacity commitment quantities. The RPM rules call for PJM to offer to release some capacity commitments through these incremental auctions when the load forecast and Reliability Requirement are updated and lowered.[13] However, capacity demand is typically weak and the clearing prices low in the incremental auctions, and the PJM capacity release rules specify a pricing approach that generally results in releasing only a small portion of the excess capacity.[14]

---

[11] PJM Interconnection L.L.C., 167 FERC ¶ 61,029, April 15, 2019, p. 11 (removing a one percent shift in the demand curve).
[12] PJM Interconnection L.L.C., 151 FERC ¶ 61,208 at P 394.
[13] See, for instance, PJM, *2019/2020 Third Incremental Auction Results*, pp. 10-11 for a description of the rules governing PJM's offers to release committed capacity through the incremental auctions.
[14] See, for instance, PJM, *2019/2020 Third Incremental Auction Results*, Tables 5a and 5b (showing that PJM offered to release 2,575.8 MW of commitments, but only released a net 135.2 MW).

To summarize this section: RPM generally clears a large excess over the Reliability Requirement in the three-year-forward base residual auction, due to excessive administrative Net CONE values and the position of the sloped demand curve; as the delivery year approaches, the load forecast and Reliability Requirement are typically lowered, resulting in the committed capacity representing an ever larger excess over the (updated, lower) Reliability Requirement; and while some commitments may be released, a very large amount of excess capacity is carried into the delivery year and paid for by consumers.

IV. Consequences of Over-Procurement

The chronic over-procurement of capacity in the PJM region through RPM has negative impacts for consumers and markets, including both direct capacity cost impacts and longer-term negative consequences for the wholesale markets. The impacts of over-procurement are of a few different types:

1. Increased Consumer Cost. The direct impact of over-procurement is the increased cost of capacity imposed on consumers. An estimate of this cost impact is developed in the next section.

2. Retaining Old Inefficient Capacity, Bringing in New Unneeded Capacity. By clearing excess capacity, RPM holds onto older, inefficient and often environmentally damaging capacity that should be retired. Clearing excess capacity also pulls in new, typically gas-fired power plants before they are actually needed (RPM has cleared nearly 30,000 MW of new gas-fired capacity in recent auctions, as noted above). By holding onto inefficient existing capacity and committing new gas-fired capacity that isn't actually needed, the over-procurement also works at cross purposes with states' goals to increase renewable resources and demand response.[15]

3. Suppressing Energy and Ancillary Services Prices and Price Signals. The presence of excess capacity on the PJM system also results in excess supply in the short-term (real time and day-ahead) energy and ancillary services markets, which will suppress prices in these markets in some hours. Suppressed prices in the day-ahead and real-time markets prevents them from accurately reflecting the value of resource attributes such as flexibility and ramp speed. This also leads to weaker incentives for price-responsive demand and demand response. The suppressed prices in energy and ancillary services markets is especially damaging at this time, as the resource mix in the PJM Region is in transition, with increasing renewables and demand-side resources. Flexible resource attributes such as ramping ability will become increasingly needed.[16]

While excess capacity may lower the cost to consumers of energy and ancillary services in the near term, these savings may only partially offset the increased capacity cost, while negatively impacting the market price signals and resource incentives needed for an efficient wholesale market.

---

[15] For a summary of the environmental policies of states in the PJM Region see Emma Nix, Economist and Policy Analyst, PJM, *State Energy Policy Scan,* Carbon Pricing Senior Task Force meeting, July 26, 2019, Item 6A, available at https://www.pjm.com/-/media/committees-groups/task-forces/cpstf/20190726/20190726-item-06a-energy-and-environmental-policy.ashx.

[16] Further discussion of the negative impact of over-procurement and suppressed energy and ancillary services prices can be found in Wilson, James F., *"Missing Money" Revisited: Evolution of PJM's RPM Capacity Construct*, prepared for the American Public Power Association, September 2016; also see Rob Gramlich and Michael Hogan, *Wholesale Electricity Market Design for Rapid Decarbonization: A Decentralized Markets Approach,* June 2019.

V. Estimated Impacts of Over-Procurement

The capacity cost impact of over-procurement can be estimated based on recent RPM auction supply and demand details. First, Figure 6 re-creates the supply and demand curves that led to the result for the RTO Region in the most recent auction, for 2021/2022, which cleared at $140/MW-day. The supply curve shown has a slope based on the results of sensitivity analyses performed for the auction.[17]

Figure 6: RPM Auction Result for the RTO Region, 2021/22

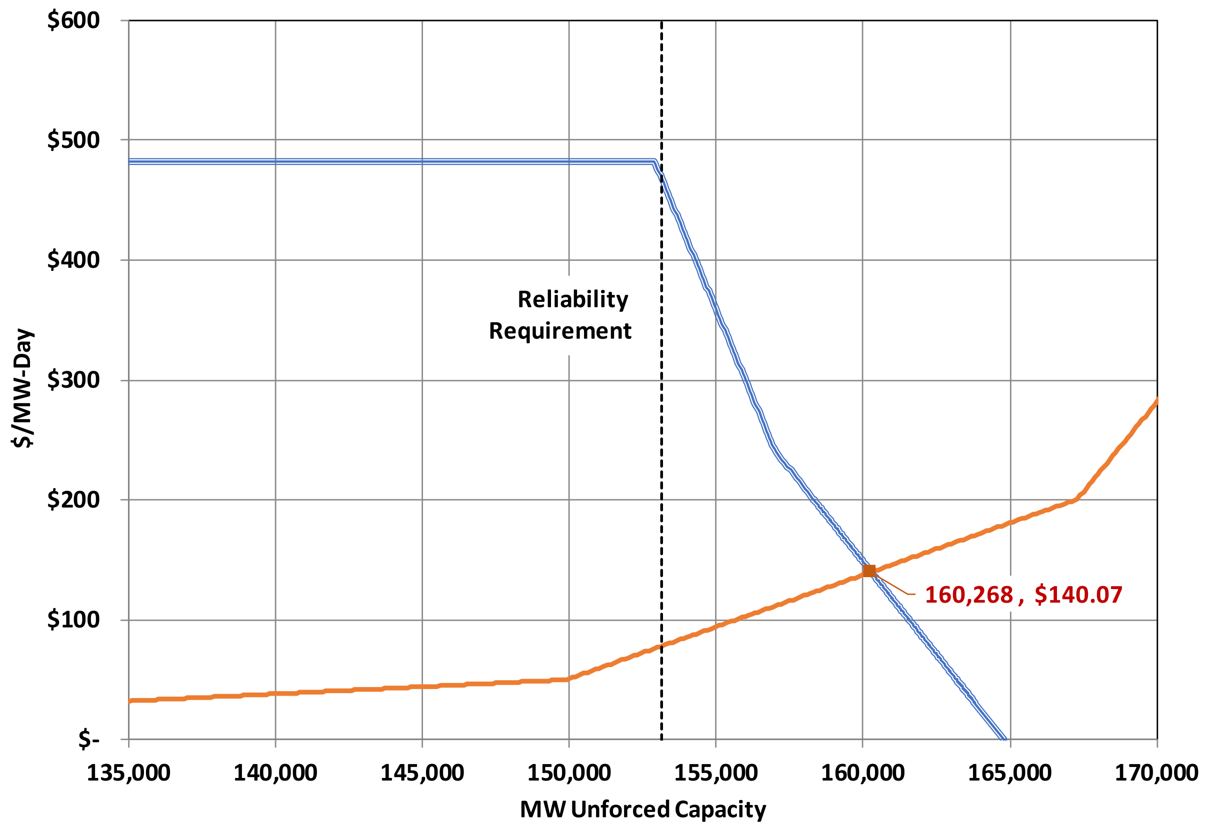
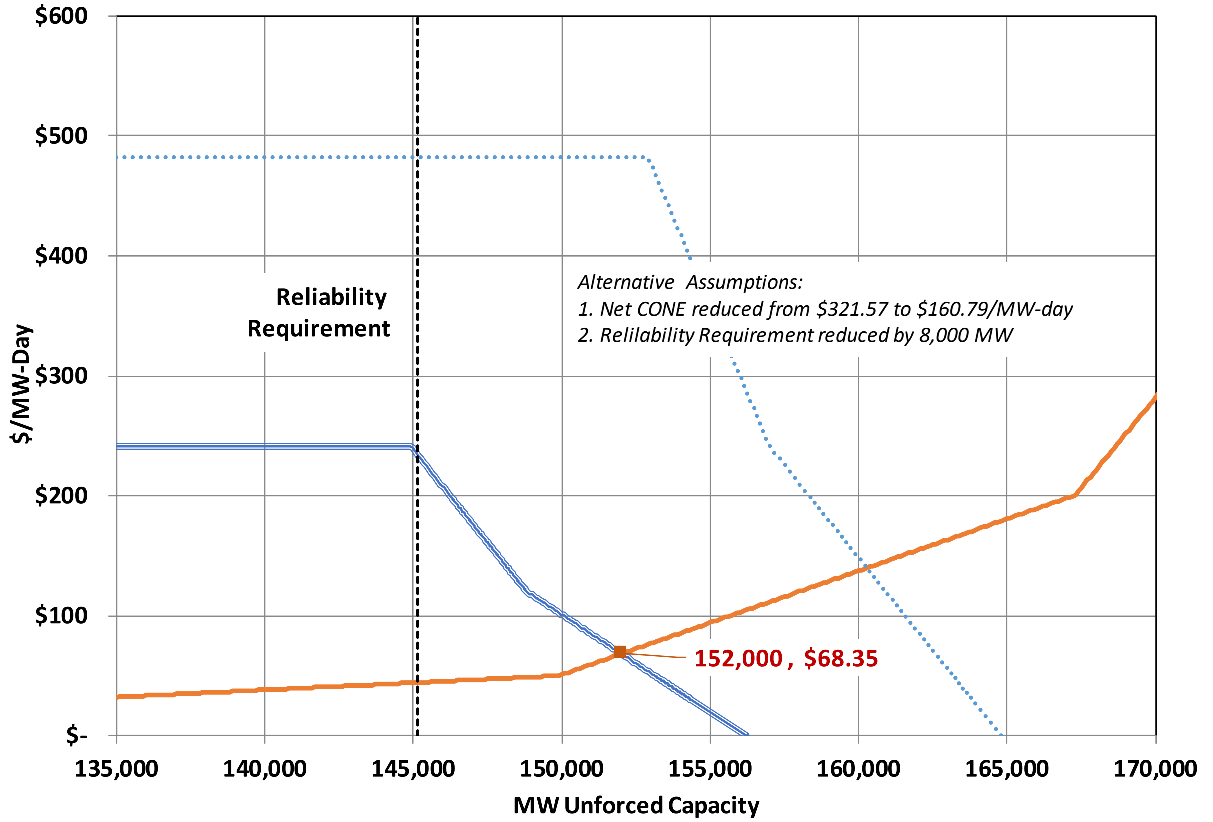


Figure 7 estimates the auction result using conservative estimates of more accurate values for Net CONE and the load forecast and Reliability Requirement. For Figure 7, Net CONE has been reduced by half to $160.79/MW-day. This value still exceeds the Empirical Net CONE levels shown in Figure 4 above, and it exceeds the Net CONE value that would have resulted from PJM's consultants' 2018 recommended changes to the Net CONE calculation, noted above. However, this value is $100 less than the $260.43/MW-day value to be used for 2022/2023.

[17] PJM, *Scenario Analysis for the 2021/2022 Base Residual Auction*, September 2018. The slope is based on the combined impacts of the -6,000 MW and +6,000 MW scenarios.

Figure 7: Alternative Auction Result (RTO Region, 2021/22)

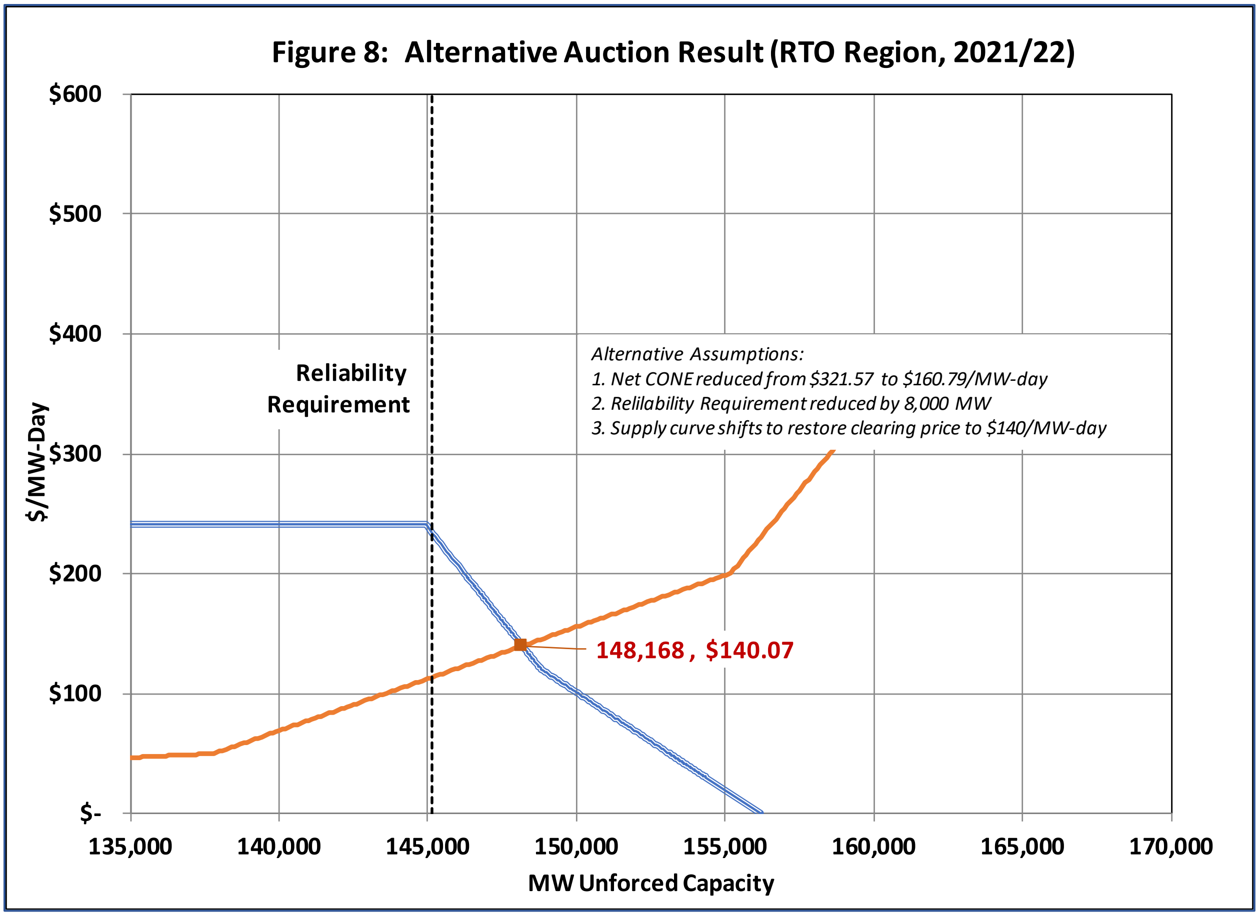


For the analysis show in Figure 7, in addition to the reduction in Net CONE, the Reliability Requirement was reduced by 8,000 MW. This adjustment corrects for most, but not all, of the typical load forecast and Reliability Requirement error over the past decade, shown in Figure 3 above. These alternative assumptions are conservative, and do not fully correct the Net CONE and Reliability Requirement values.

Under the resulting alternative demand curve and the same supply curve, the clearing price would decline from $140/MW-day to $68/MW-day, and the cleared quantity would decline from 160 GW to 152 GW, as shown in Figure 7. The corresponding reduction in capacity cost relative to the actual auction result would be $4.4 billion. (Note: this analysis ignores that some zones had separate prices, where additional savings could occur from more accurate auction parameters.)

However, with the lower demand for capacity represented by this alternative demand curve, it is likely that supply would adjust over time, and less would be offered. Some new plants could be deferred, and some existing plants might retire earlier than they would have otherwise. While such adjustments might take years, ultimately such adjustments would shift the supply curve, and could restore the RPM clearing prices closer to the levels seen in recent auctions and in the Empirical Net CONE values shown above.

Figure 8 is based on the alternative demand curve shown in Figure 7, and the additional assumption that supply is reduced (the supply curve shifts left) to the point where the clearing price is again $140/MW-day (as in Figure 6, the actual result from the most recent auction). Under these assumptions, the reduction in over-procurement is larger, about 12,000 MW, and there is still a savings of about $0.6 billion.



Of course, such a supply adjustment would take time, and supply might not fully adjust to an alternative demand curve. If supply adjusts only half as much as assumed in Figure 8, the clearing price would be $102.85/MW-day, and the savings would be $2.6 billion. The results from all of these cases are summarized in Table 1.

Table 1: RPM 2021/22 Base Residual Auction Scenarios (RTO Region)			
	Cleared Quantity (MW)	Clearing Price ($/MW-day)	Total Capacity Cost ($ bil./year)
Base Case (approximates actual auction; Fig. 6)	160,268	$140.07	$8.2
Scenario: Demand curve uses Net CONE $160/MW-day, Rel. Requirement reduced 8,000 MW (Fig. 7)	152,000	$68.35	$3.8
Savings v. Base Case (Fig. 7 v Fig. 6)	*8,268*	*$71.72*	*$4.4*
Scenario: Same alternate demand curve, supply curve shifts to clear at $140/MW-day (Fig. 8)	148,168	$140.07	$7.6
Savings v. Base Case (Fig. 8 v Fig. 6)	*12,100*	-	*$0.6*
Scenario: Same alternate demand curve, supply curve shifts half as much as in Fig. 8 (no figure for this case)	149,884	$102.85	$5.6
Savings v. Base Case	*10,384*	*$37.22*	*$2.6*

VI. Final Observations: Why Does This Over-Procurement Persist?

This paper has discussed the causes and estimated the impacts of chronic, predictable over-procurement of capacity in PJM. This raises the question: Why do these flawed peak load forecasting methods and capacity construct provisions remain in place? We might expect that resource adequacy mechanisms would be designed with the interests of electricity consumers in mind: consumers are the parties directly affected if resource adequacy is not accomplished and not all demand can be satisfied, and consumers are also the parties who ultimately bear the cost of the policies to acquire capacity.

However, this has not been the case. Consumer interests have generally opposed the policies that have led to over-procurement in PJM stakeholder processes and regulatory proceedings.[18] But RTOs such as PJM are responsible for reliability and resource adequacy, not its cost, and they generally prefer more capacity, committed sooner, and under the most stringent performance requirements. Capacity sellers also prefer market rules that raise capacity procurement quantities and, as a result, increase the capacity auction clearing prices they receive. Thus, the current planning procedures and market rules lead to over-procurement and higher capacity prices, and have not been designed to achieve a reasonable balance in the interests of consumers between the value of more capacity and its cost and other market impacts.

Nor is there much cause for hope that the over-procurement problem will be corrected anytime soon. Recent changes to the Net CONE values, shape of the RPM demand curve, and load forecasting methodology, mentioned earlier in this paper, fall far short of correcting the problem, while a new driver of over-procurement has arisen: the new RPM minimum offer price rule ("MOPR"). The changes to the MOPR will impose very high offer prices on many resources that receive revenues under state programs, including zero-carbon nuclear plants and renewables, and will likely cause many of them to fail to clear in RPM. With these resources effectively pushed out of the RPM supply curve, RPM will clear other, duplicative capacity, and also set a higher clearing price that will falsely signal a need for additional resources. The new MOPR will exacerbate the over-procurement problem.

[18] To note a few efforts: consumer and other interests have engaged actively in stakeholder processes around PJM's load forecast methodology, and there have been two complaints at FERC in this regard over the past decade; consumer interests have also opposed the changes to the RPM demand curve, the removal of the Short Term Resource Procurement Target, the tightening of rules for demand response, and the excessive Net CONE values in the regular RPM quadrennial review process and various other PJM stakeholder processes and FERC proceedings.

Appendix: Further Details of PJM Over-Procurement

Table A-1 provides the details associated with Figure 1 above.

Table A-1: Over-Procurement Details

	Reserve Margins (at time of Base Residual Auction)			Reserve Margins (based on Base Residual Auction quantity, updated load forecasts and target reserves)			
Delivery Year	Target	Cleared	Excess	Target	Cleared	Excess	Excess (GW)
2012/2013	16.2%	21.2%	5.0%	15.6%	26.3%	10.7%	12.3
2013/2014	15.3%	20.3%	5.0%	15.9%	27.5%	11.6%	14.9
2014/2015	15.3%	20.6%	5.3%	16.2%	23.1%	6.9%	9.0
2015/2016	15.4%	20.6%	5.2%	15.6%	24.1%	8.5%	12.0
2016/2017	15.6%	21.5%	5.9%	16.4%	26.4%	10.0%	14.2
2017/2018	15.7%	20.1%	4.4%	16.6%	25.9%	9.3%	13.1
2018/2019	15.7%	20.2%	4.5%	16.1%	27.3%	11.2%	15.7
2019/2020	16.5%	22.9%	6.4%	16.0%	28.5%	12.5%	17.5
2020/2021	16.6%	23.9%	7.3%	15.5%	29.1%	13.6%	18.7

Sources: PJM Base Residual Auction Reports, Third Incremental Auction Planning Parameters.

About the Author

James F. Wilson is an economist and independent consultant doing business as Wilson Energy Economics. He has over thirty-five years of consulting experience in the electric power and natural gas industries. Many of his past assignments have focused on the economic and policy issues arising from the introduction of competition into these industries, including restructuring policies, market design, market analysis and market power. Mr. Wilson has been involved in electricity restructuring and wholesale market design for over twenty years in PJM, New England, Ontario, California, MISO, New York, Russia, and other regions. He has a B.A. from Oberlin College and M.S. in Engineering-Economic Systems from Stanford University.

With regard to resource adequacy planning and capacity market design, Mr. Wilson has been involved in these issues in PJM, New England, California, the Midwest, and other regions. With respect to PJM's RPM capacity construct, he has prepared numerous affidavits, reports, and analyses of RPM and RPM-related issues. He has also been involved in the stakeholder processes around PJM load forecasting and capacity requirements studies for many years. Additional information and Mr. Wilson's CV are available at www.wilsonenec.com.