



WHITE PAPER

Capacity Performance: Changing the Game in PJM ISO

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The Bottom Line

1. PJM Interconnection LLC's (PJM's) proposed new capacity market mechanisms to better value performance and penalize underperformance will push PJM regional transmission organization's (RTO's) capacity prices up to \$170 to \$200/MW-day for RTO and even higher for some constrained locational deliverability areas (LDAs). Energy prices will be slightly lower in the long term. Low-compliance-cost oil, coal, and nuclear units will be first in line to bid and benefit from these higher prices.
2. We find that the existing fleet can satisfy PJM RTO's new requirements, but only if significant investments are made.
3. Stakeholders must consider their new bidding strategy and adjusted investment plans carefully. New sell-side mitigation rules will result in a dramatic change in the bidding behavior and the dynamics of the auction. Previously, avoided cost recovery (ACR) offer caps drove the bids of existing generation and planned generators trying to outbid existing generators. Now with offer caps up to net cost of new entry (Net CONE), both planned and existing generators will compete on an equal basis to provide the capacity performance (CP) product requirement. Fierce competition will likely drive RTO CP product prices significantly below Net CONE.

Abstract

The severe winter weather during the 2013–2014 “Polar Vortex” pushed the system in PJM closer to the brink than many thought was possible and led to historic price spikes in energy markets. This event shed light on the surprising weakness in the reliability of generation resources and potential flaws in the capacity market mechanisms meant to value both capacity and performance under constrained conditions.¹

In response, PJM has proposed phasing in a new capacity market design that compensates owners for reliability investments and penalizes underperformance. We find that the existing fleet can satisfy PJM RTO's new CP requirements, but only if significant investments are made, especially by gas units lacking dual-fired capacity which may need investments in the range of \$30/MW-day to \$60/MW-day to comply. Based on our assumed cost for firm fuel supply and projected risk premiums, we anticipate that the price of the CP product in the upcoming auction will be in the range of \$170 to \$200/MW-day for RTO and significantly higher (at Net CONE levels) for some constrained MidAtlantic Area Council regions. We also project some concurrent decreases in energy prices.

These broad findings, combined with other implications of the PJM proposal described in this paper, would have significant consequences for market stakeholders. Low-compliance-cost oil, coal, and nuclear units will bid and clear first in the new capacity market, benefitting from higher prices. Gas-fired units without firm supply will in turn need to make significant and costly investments to meet PJM's new requirements. All generators will have to adjust their capacity market bids to factor in a risk premium for underperformance penalties.

¹See Rose, Judah, “Waiting for the Next Polar Vortex,” Public Utilities Fortnightly, June 2014.

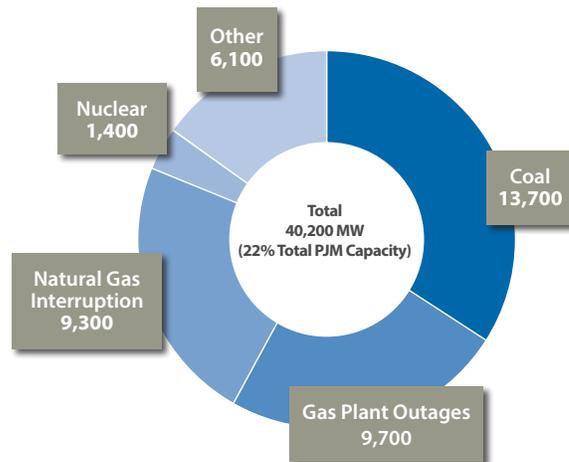


Demand response (DR) resources will face a new regime limiting which resources can participate in capacity markets. And there will be added incentives to locate new planned units closer to (relatively less expensive) fuel supply. ICF continues to work on more detailed analysis for clients to help guide investment choices, asset and reliability-based investment valuation, and market bidding strategies.

The Capacity Underperformance Problem

In January 2014, the Polar Vortex led to two periods of extreme cold from January 6 to 12 and January 17 to 29, during which PJM experienced forced outage rates three times higher than expected. Although mechanical issues caused by extreme cold contributed to many of the forced outages, a substantial portion was due to problems in securing either primary or secondary fuel (see Exhibit 1).

Exhibit 1: Sources of January 7 Evening Peak (7 p.m.) Forced Outage



Source: PJM ISO "Problem Statement on PJM Capacity Performance"

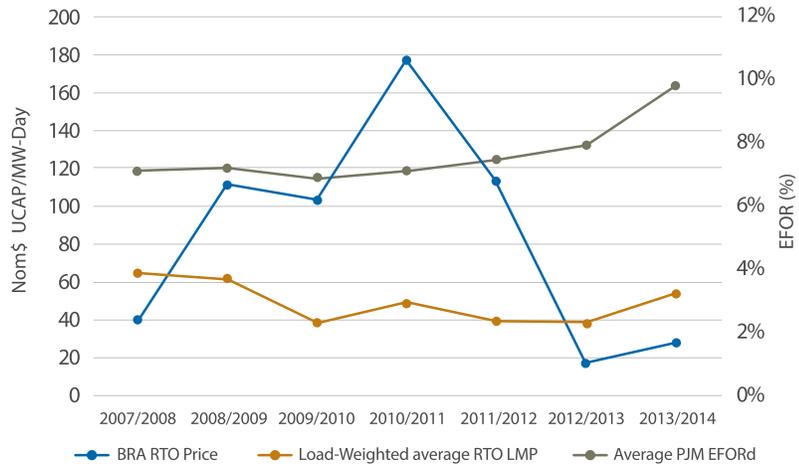
This underperformance of capacity during the Polar Vortex demonstrated that the capacity market had not properly incentivized reliability and firm fuel supply under severe operating conditions. Generation owners find the cost of investments in reliability (e.g., securing a firm gas contract, dual-fire capability, and increased maintenance) to be more expensive than the penalties that could be incurred for underperformance during outage events. The problem is exacerbated even further by several factors:

- The PJM capacity market excuses any outages due to fuel-supply interruptions from penalties.
- Generation owners are not allowed to include the cost of firm fuel supply in supply offers and therefore cannot recover this cost.
- A self-reinforcing effect occurs: Generation owners fear that any incremental reliability-based investment will make them less competitive if other market participants are not making these investments.

All of these issues discourage investments in reliability, and the result is higher-than-expected forced outage rates during stress conditions. Exhibit 2 shows the negative correlation between capacity prices and forced outage rates beginning in the 2011–2012 auction year.



Exhibit 2: Historical PJM Average Forced Outages and Capacity Prices



Source: PJM ISO “Capacity Performance Action Items”

Improving capacity market incentives will be particularly important in the future as more coal plants retire and the market relies even more on gas-fired units—renewables that are either less flexible or require firm fuel supply to be reliable.

In response during the past year, PJM ISO proposed and FERC approved a number of initial changes meant to improve system reliability and optimize participation of DR and energy efficiency resources.² Further individual reform proposals were ultimately shelved, however, in favor of pursuing a more comprehensive and far-reaching restructuring proposal, the CP product.

Capacity Performance Proposal

The most consequential change for capacity in PJM is a major restructuring of the reliability pricing model (RPM) itself with PJM ISO’s new CP product proposed to the Federal Energy Regulatory Commission (FERC) on December 12, 2014 (ER15-623-000). Based on ISO-NE’s Pay-for-Performance Initiative, the CP product would create a two-settlement process where capacity revenue now comprises a base payment plus penalties for underperformance or credits for overperformance during compliance hours (the hours when PJM declares an emergency action (i.e., voltage reduction, or manual load dump warnings or actions)).³

How Payments Are Determined

Penalties or credits would be calculated using performance payments rates (PPRs, expressed in \$/MWh) that reflect the applicable Net CONE (expressed in \$/MW-day) normalized over the compliance hours. The relevant rate would then be applied to the resource’s actual performance, compared with its expected performance in order to calculate the total penalty or bonus.

²These include a) an upper limit of 4 percent of the reliability requirement for limited DR programs and an upper bound of 10 percent for the aggregate amount of limited and extended summer DR, b) stricter registration requirements for demand side management (DSM) resources to ensure that DR resources are valid, and c) capacity import limits on the amount of external generation capacity that can be reliably committed to PJM, both for each of five external source-zones and for the overall RTO.

³Under this definition in the last 2013–2014 capacity period, PJM experienced 23 compliance hours. Because it projects more scarcity in the future, PJM ISO proposes to assume a rate of 30 compliance hours for upcoming capacity periods, although it can file to change this assumption at any point.



Expected performance of a CP resource reflects its pro-rata share of the system requirements during compliance hours.

How Penalties and Bonuses are Calculated

For each hour during and emergency action, the performance payment for each resource is calculated based on the following formulas:

$$\text{Performance Payments (\$)} = (\text{MW}_{\text{actual}} - \text{EP}) * \text{PPR}$$

$$\text{EP} = \text{MW}_{\text{cleared}} * (\text{Peak Demand} + \text{Reserve Requirements}) / (\text{MW committed from all resources})$$

$$\text{PPR} = (\text{Net CONE} / 30 \text{ hours}) * 365 \text{ days}$$

EP—Expected Performance

PPR—Performance Payment Rate

However, PJM proposed putting boundaries on the amount of penalty or credit in order to limit risk—annual and monthly stop loss provisions that (after a transition period) would be set at 1.5*Net CONE and 0.5*Net CONE, respectively.

Further Reliability Incentives

To fix some of the lack of incentives for firm supply in the current capacity mechanism, starting with the 2018–2019 base residual auction (BRA), offer caps for CP resources would be set at Net CONE (although PJM would allow higher values to be approved under ACR review), and the existing ACR methodology also would be adjusted to include the cost of firm fuel supply (adjusted fuel availability expense [AFAE]) and the risk premium of CP resources (capacity performance quantifiable risk [CPQR]). The phase-in structure for several reliability incentive mechanisms during the transitional auctions is outlined in Exhibit 3.

Exhibit 3: Transitional Capacity Auction Characteristics

	CP Product				Base Capacity Product
	% of Reliability Requirement	Offer Caps	Performance Payment Rates	Annual Stop Loss	% of Reliability Requirement
2016–2017	60% - procured on voluntary basis in special auction in April 2015	50% of Net CONE	50% of (Net CONE/30)*365	0.75*Net CONE	40%
2017–2018	70% - procured on voluntary basis in special auction in May 2015	60% of Net CONE	60% of (Net CONE/30)*365	0.9*Net CONE	30%
2018–2019 and 2019–2020	80% - in BRA auctions with must offer obligations	Net CONE or higher	(Net CONE/30)*365	1.5*Net CONE	20%
2020–2021+	100% - in BRA auctions with must offer obligations	Net CONE or higher	(Net CONE/30)*365	1.5*Net CONE	20%



Timeline for Implementation and Who Will Qualify

To allow time for resources to improve their reliability along a glide path rather than in a sudden transition, PJM plans to phase in CP during the next five auction periods. In the interim, PJM would maintain an enhanced version of the existing annual capacity product, called the base capacity product. Base capacity resources would only be assessed penalties for underperformance during summer months. Which plants would be CP compliant is not clear, because the proposed PJM rule does not provide hard criteria (only 14 hours start up and 1-hour notification requirements). However, PJM has stated that fossil generators cleared as annual product and expected to be available during the 700 hours of high-peak demand would qualify for CP product. Harsh penalties for misrepresenting qualifications should steer participation.

Demand Response Resources in the CP Proposal

A great deal of attention has been paid to how DR will be treated in future capacity auctions, given the recent legal uncertainties. PJM's CP proposal attempts to maintain the status quo by treating DR programs as resources; however, it plans to eliminate limited DR from all upcoming auctions. It also allows extended summer DR to participate as a base product in the transition auctions subject to a limit of 8.3 percent of peak demand for the RTO. After 2020–2021, however, only annual DR can participate as a CP product. PJM also filed with FERC an alternative treatment for DR resources. In this filing, if the U.S. Supreme Court upholds the District Court Electric Power Supply Association decision, PJM ISO proposed to include DR resources on the demand side, allowing (only) load-serving entities to use DR resources to decrease their RPM requirements.

Implications of the CP Product: Winners, Losers, and New Investment

We project that PJM's proposal will have significant impacts across the market, including slightly higher Base Capacity prices and much higher capacity prices in the CP product as well as a longer term dip in energy prices. Higher capacity prices will be driven by the fact that not enough low-compliance-cost resources are available to meet PJM's CP requirements. Coal and nuclear units could have a relatively low-compliance cost by making boiler modifications and weatherization investments. Oil units also could offer CP products with relatively little investment, as long as their generation is not restricted by environmental or other ordinances. These types of units will be the first in line to offer and clear the market. But ICF estimates that after accounting for these compliant- and low-compliance-cost units, in the upcoming BRA auction, the PJM RTO still will be short of its CP requirements by approximately 10 GW. Therefore, gas units—many of which would require significant investments to become compliant—also would need to offer CP products.

Those that can already dual fire (or that are planned relatively close to—and can therefore less expensively access—firm gas supply) will have a more manageable compliance cost. However, those without dual-firing capability would have to procure firm gas supply (commodity and firm transportation contracts) or install dual-firing capabilities. For some power plants, firm contracts may not be available, and the only option to qualify as a CP product would be dual firing. The costs of these investments vary widely and can be anywhere from \$30/MW-day to \$60/MW-day or more, depending on location and technology type. Resources would add these investment costs to their bids in the BRA auction, driving up capacity prices. In the longer term, these costs also would affect investment behavior in other ways, as portfolio owners factor in the costs of firm fuel supply into planned locations of new units.

In addition to the investment costs, bids now also would include the risk of performance penalties, further elevating capacity prices. The expected risk premium can be estimated using the NET Cone and resources' historical forced outage rate. For example, a combined cycle (CC) unit with a historical



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forced outage rate of 3.6 percent and a NET Cone of \$300/MW-day would increase its bid by \$11/MW-day or \$4/kW-year. Risk premiums for participation as a base-capacity resource are expected to be lower than those for CP participation because they have a shorter time frame in which to face penalties. A resource would not participate in either auction if the expected cost of nonperformance is higher than its annual capacity revenue, so the risk premiums should be considered as a price floor. With the use of the above costs, ICF simulations indicate CP product prices in the range of \$170 to \$200/MW-day for RTO and significantly higher (closer Net CONE levels) in the constrained Eastern Mid-Atlantic Area Council (EMAAC) regions.

At equilibrium, the price of the base-capacity product PBR and the price of the CP product PCP can be linked with the following formula:

$$PCP = PBR + \text{Cost of secure fuel} + \text{CP Performance Risk Premiums}$$

Although based on the fundamentals, the price of the base-capacity product should be around \$130/MW-day. Depending on the participation of DR resources, the prices of base capacity could be significantly lower. These estimates include the effect of the new demand curve and new CONE values that have been proposed by PJM and filed with FERC as well as the elimination of the short-term procurement target (i.e., 2.5 percent hold-back of reliability requirements for BRA auctions for procurement in incremental auctions).

Although the CP product increases capacity prices, it would lead to lower energy prices for these reasons: (1) more supply from new efficient units (ICF's simulations indicate approximately 5 GW of more new capacity expansion in 2018–2019 period, compared with the capacity expansion without CP implementation) (2) lower energy market bids during peak conditions (CP resources are required to offer their capacity as economic in the day-ahead energy market), and (3) improved performance from existing units (to avoid performance penalties, existing resources would have greater availability and lower forced outage rates, and thereby increase the supply of energy. With a greater supply, all else equal, energy prices would be on average lower).

Conclusions and Next Steps

PJM's proposal would fundamentally alter the incentives and strategies for capacity and energy market participants and their related stakeholders. Individual businesses will need to carefully assess their approach to firm supply and incremental builds. ICF has the expertise and the right modeling tools to help market participants understand and benefit from these dramatic changes in PJM markets. ICF assists market participants in making investment decisions to optimize their position for the new market, assessing the value of reliability investments, formulating bidding strategies, and valuing current or prospective resources in the new market constructs. We help stakeholders to better understand and hedge against risk, and to prepare for future developments as the market continues to evolve and adjust.

For questions, please contact:

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