Energy Efficiency in Capacity Auctions: A Historical Review of Value

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Executive Summary

Independent system operators (ISOs), also called regional transmission organizations (RTOs), operate and manage generation and transmission assets to maintain reliability in specific regional territories. Two ISOs—PJM and ISO New England (ISO-NE)—procure generating-capacity resources (measured in MWs) by conducting auctions three years before providers must deliver electricity. While other ISOs also conduct capacity auctions or use other capacity market mechanisms, PJM and ISO-NE are the only two mandatory auctions that allow energy efficiency to bid resources into the auction. Energy efficiency resource providers (typically utilities, third-party energy efficiency companies, or governmental agencies) that are awarded contracts are obligated to reduce demand for capacity in the specified delivery year.

This report analyzes the inclusion of energy efficiency in the wholesale power market and provides an historic review of energy efficiency's inclusion in load forecasting and capacity auctions. We also discuss the value of including energy efficiency in retail-level capacity auctions using an example from Baltimore Gas and Electric (BGE). We then explore systemwide price impacts from efficiency. We do not consider demand-response resources. Our analysis finds that including energy efficiency in the PJM and ISO-NE capacity auctions creates direct and indirect monetary savings for both the system and retail customers.

LOAD FORECASTING AND CAPACITY MARKETS

Each ISO's load forecast (adjusted for energy efficiency included in the capacity auctions) informs its reliability requirements, which ensures resource adequacy and determines the amount of capacity needed to meet the region's demand for each capacity auction. Including demand-side resources in the ISOs' load planning forecasts, outside of those included in the capacity auctions, reduces the reserve requirements for capacity procurement; this lets PJM and ISO-NE avoid over-procuring costly capacity assets, thereby reducing capacity and energy prices.

PJM revised its load forecasting methodology for the 2016 load forecast to capture trends in equipment saturation and efficiency. Energy efficiency is modeled in customer end-use load characteristics for heating, cooling, and other activities, weighted for the residential and commercial sectors. PJM adds any energy efficiency resources qualified for the capacity auction back into its load forecast to avoid double counting energy efficiency resources, as the load forecast informs how much capacity is procured through the auction.

ISO-NE calculates energy savings in its load forecast based on future utility energy efficiency budgets and the projected cost of saved energy. ISO-NE has historically over-forecast peak demand by 10–20% and under-forecast energy savings (Peterson and Fields 2017). ISO-NE implemented changes to this methodology in 2017 and proposed further changes for 2018 to more accurately reflect the amount of market efficiency.

VERIFYING DEMAND REDUCTIONS

In both PJM and ISO-NE, energy efficiency is a reliable resource. As with other resources, energy efficiency must meet reliability criteria and is subject to evaluation, measurement, and verification (EM&V) reporting requirements to verify demand reductions. In the ISO-NE calculation of the capacity procured in each auction, resources are assigned an

availability factor based on historic outage rates to maintain grid reliability. Efficiency resources are assigned a 100% availability factor—the highest of any resource. This means that less capacity is needed to meet demand than relying on generation resources alone.

HISTORICAL AUCTIONS RESULTS

In PJM and ISO-NE, the amount of energy efficiency clearing the capacity auctions and the associated payments to energy efficiency providers have steadily increased since efficiency has been allowed to participate. Energy efficiency continues to make up a small percentage of total capacity cleared in the auctions, but it is rising. In the most recent auctions, efficiency accounted for more than 1% of total PJM resources and more than 7.5% of ISO-NE resources. Efficiency likely makes up a larger percentage of total need in ISO-NE than PJM for several reasons, one of which is that ISO-NE provides capacity payments for a measure's full life, while PJM limits capacity payments to four years, even if a measure's life is much longer. Capacity payments from the two auctions to efficiency resource providers have reached more than $1.6 billion over the past 11 years. Figure ES1 shows the total amount of energy efficiency cleared in each auction over time.

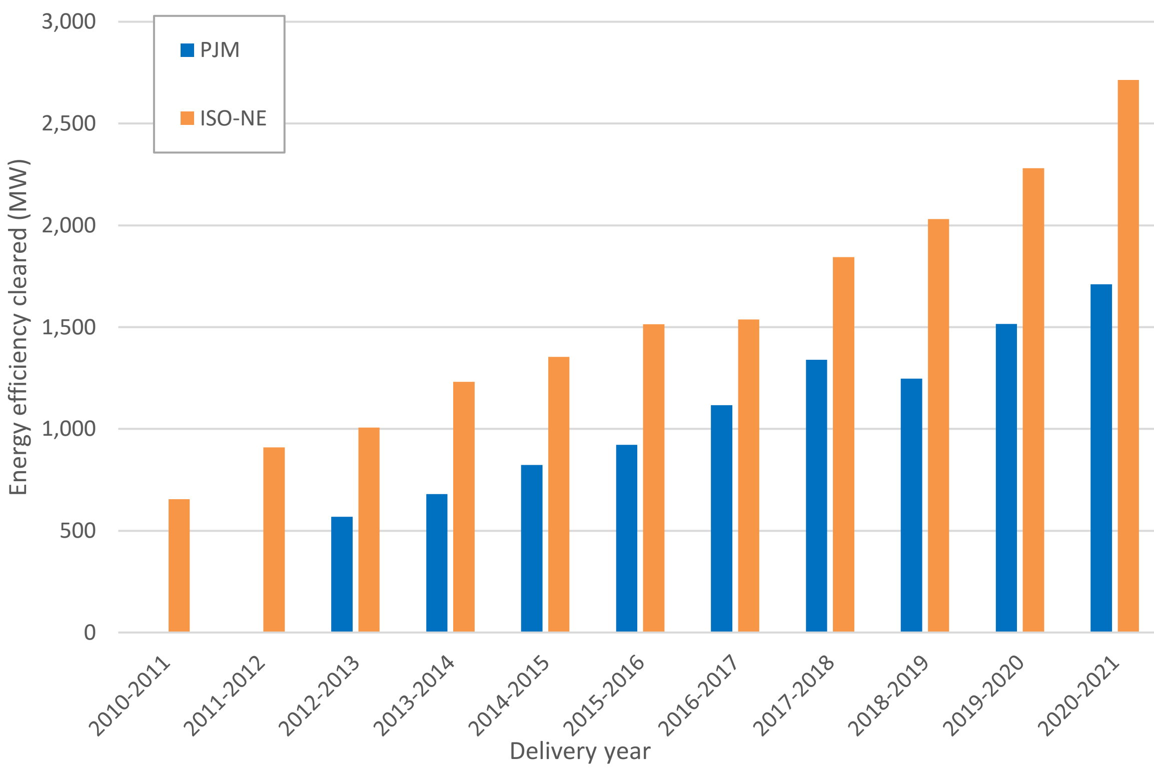

Figure ES1. Energy efficiency cleared in the PJM and ISO-NE capacity auctions. ***Source:*** **PJM 2017a; ISO-NE 2017a and c; DRWG 2017.**

VALUE OF INCLUDING ENERGY EFFICIENCY IN CAPACITY AUCTIONS

In addition to other benefits, including efficiency in the capacity auction also reduces retail electric prices for all customers. We reviewed retail rates for BGE to understand the scope of this effect. The utility procures energy for distribution customers through an auction process. Capacity costs are embedded in suppliers' bids into the retail energy auction. For BGE in the 2017–2018 delivery year, capacity represents an average of approximately 1.7

cents per kWh of generation charges in retail energy prices, and about 13% of BGE's average residential customer's bill. If capacity prices were higher due to reduced energy efficiency, it would result in higher customer bills. For example, if capacity costs increased by 30%, the typical customer summer bill would increase by 4%, or $5. Although this value is small for individual residential customers, the increase is appreciable when considered over the entire service territory.

DEMAND REDUCTION INDUCED PRICE EFFECT (DRIPE)

Reduced demand from efficiency reduces wholesale prices, producing bill savings for electric customers. The demand reduction induced price effect (DRIPE) illustrates price reduction from lower demand by reducing both the number of units procured and the price paid to all resources. This effect occurs due to regional efficiency resources included in capacity auctions, as well as those that are not. Figure ES2 illustrates this effect.

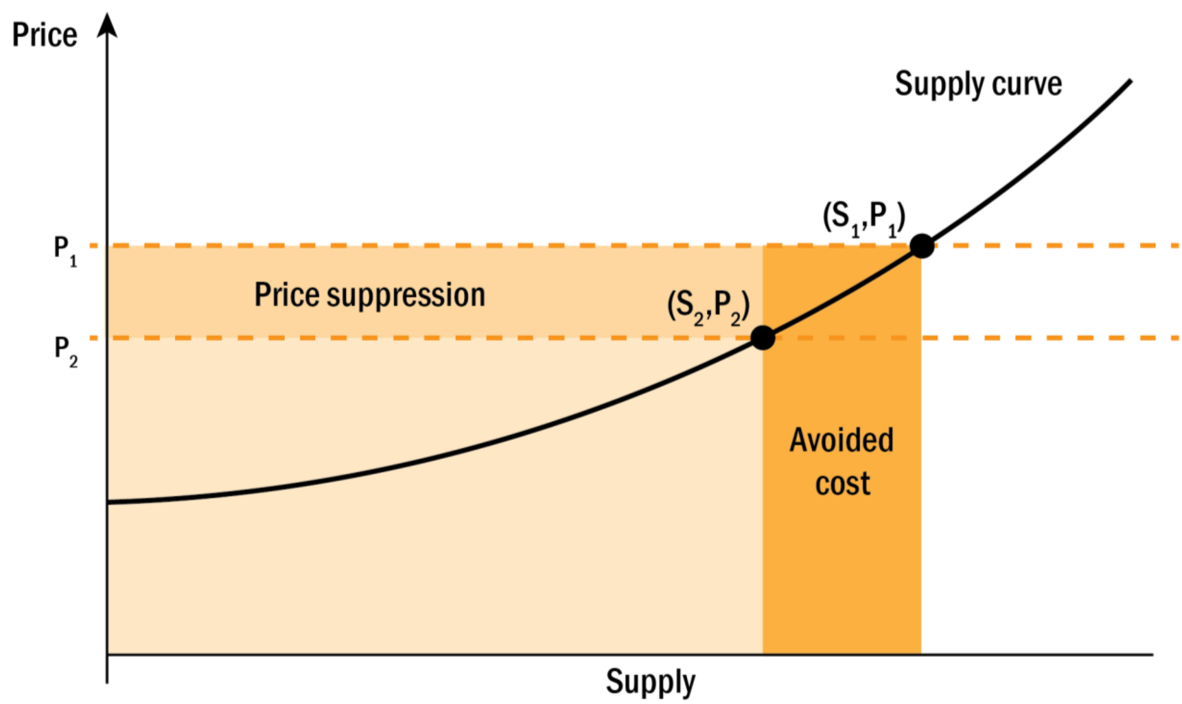

Figure ES2. System supply and price with energy efficiency. *Source:* Chernick and Plunkett 2014.

DRIPE effects can result in considerable economic benefits. For example, one analysis showed that deploying enough energy efficiency to meet the regulatory standards in Ohio would save $1.3 billion from wholesale capacity price mitigation through the year 2020 (Neubauer et al. 2013). DRIPE is only one benefit of energy efficiency; the net benefits of the investments are much higher.

CONCLUSION

Energy efficiency reliably reduces demand in PJM and ISO-NE. Over the past several years, energy efficiency has increased absolutely and as a percentage of total resources in the regions' capacity auctions. Auction payments provide additional revenue for efficiency providers and drive further investment in efficiency.

Consideration of demand-side resources in the demand forecast also reduces capacity prices. However this approach does not compensate energy efficiency program providers, and therefore does not send an appropriate market signal of demand-side resources' value. Both ISOs can improve forecasting of future energy efficiency resources to avoid unnecessary investments in traditional generation, transmission, and distribution assets. PJM should also recognize efficiency's full value by using estimated measure lives for efficiency portfolios rather than limit efficiency resource participation to a four-year maximum. Beyond the direct value created within capacity auctions, energy efficiency reduces prices systemwide through DRIPE and has numerous other benefits such as job creation and reduced pollution from traditional energy generation.

Introduction

Energy efficiency reduces electric generation, transmission, and distribution costs by reducing customer demand, which leads to lower costs for utilities and smaller bills for customers. Reduced electricity generation creates additional benefits for communities, such as positive health impacts from lower emissions.

To realize these benefits, energy efficiency should be recognized and procured as a viable resource for the energy supply and distribution systems. Capacity auctions are one method that regional transmission organizations (RTOs) and independent system operators (ISOs)[1] use to procure energy resources. These auctions match capacity resource suppliers with regional demand. In some cases, auctions are designed to include energy efficiency and other demand-side resources in the same manner as supply-side resources.

This report focuses on energy efficiency in capacity auctions in PJM and ISO-New England (ISO-NE). These two organizations conduct annual auctions to procure capacity resources; both allow the participation of demand-side resources, including energy efficiency. We first offer an overview here of each ISO's capacity auctions and discuss the rules governing energy efficiency's participation in them. We then present historic results of the capacity auctions, focusing on energy efficiency performance and revenues.

Next, we discuss the benefits of energy efficiency's inclusion in the capacity auctions, focusing on how efficiency is included in the demand forecasting that informs the amount of capacity procured in each auction. As each ISO's demand is reduced due to energy efficiency that is not bid into the auctions, wholesale capacity and energy prices are also reduced. This process lowers costs for all customers in the region. Finally, we present an example of how energy efficiency's ability to reduce wholesale capacity prices also reduces retail rates, relying on data from Baltimore Gas and Electric (BGE). Appendix B provides additional information on the PJM auction's price sensitivity when demand-side resources are included.

While both energy efficiency and demand response can meet capacity needs, here, we focus only on energy efficiency.

Capacity Auctions: Overview

ISOs are quasi-governmental entities that work to balance energy supply and demand in regional zones (APPA 2017). In the United States, there are seven ISOs, each with a unique organizational and operational structure. Not all regions are served by ISOs. Those that are not are served by regional coordinating or reliability organizations that do not meet all requirements to become an ISO, but play a similar role, coordinating electricity supply and demand balances (FERC 2017a). Figure 1 shows the seven US ISOs and the two in Canada.

[1] The terms *RTO* and *ISO* are used interchangeably; in this report, we use ISO throughout for consistency.

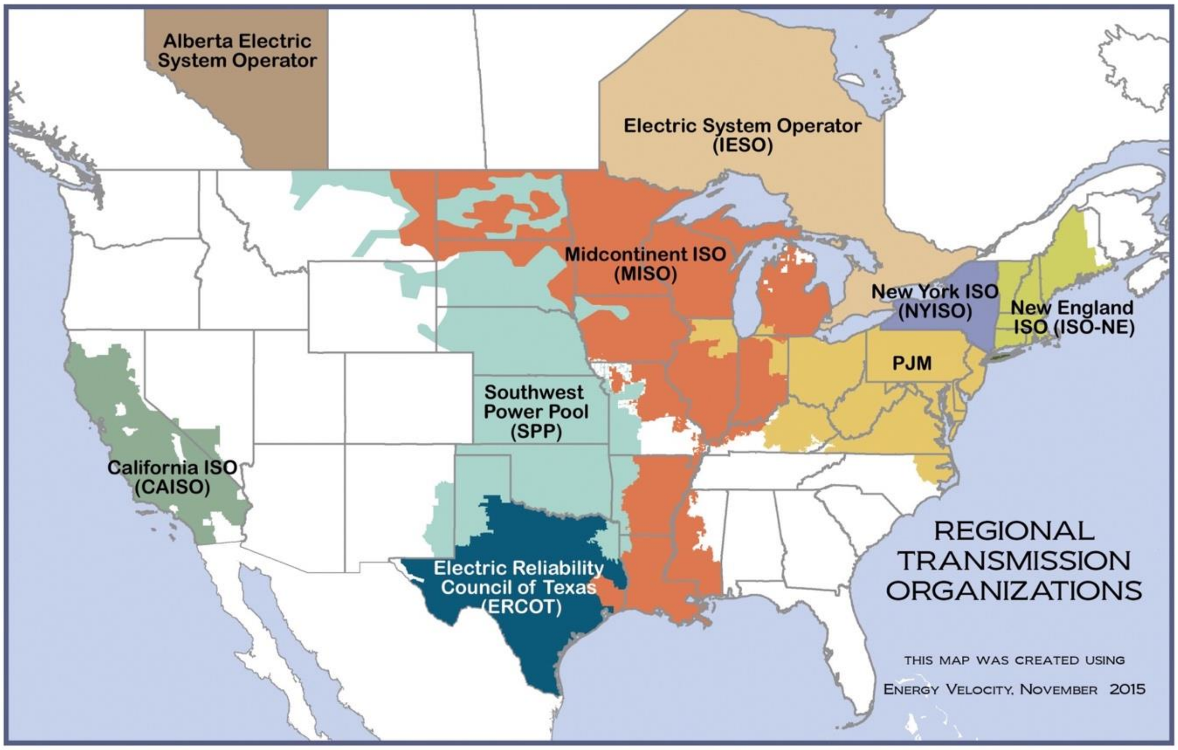

Figure 1. Independent system operators (also called regional transmission organizations). *Source:* FERC 2017b.

A primary ISO function is to maintain system reliability by facilitating the procurement of power resources for the future, also known as generating capacity.[2] Generating capacity includes traditional sources of electricity such as natural gas, nuclear, and coal-fired generation, as well as renewable energy sources such as solar and wind. Capacity may also include customer-side resources, also known as demand-side resources, which typically encompass energy efficiency and demand response.

Capacity auctions are one way that ISOs can cost effectively meet their region's capacity demand and reliability requirements. As the US Federal Energy Regulatory Commission writes, most ISOs "run a capacity market to allow [load serving entities] a way to satisfy their reserve obligation. These markets cover short-term capacity, such as a month, season, or year" (FERC 2015). Three ISOs (PJM, ISO-NE, and New York ISO) hold mandatory capacity auctions to ensure adequate capacity is in place to meet future demand. The Midcontinent ISO (MISO) holds a voluntary capacity auction, while the ISOs in California, the Southwest, and Texas do not hold capacity auctions at all. These organizations opt instead for alternative capacity procurement mechanisms (APPA 2017).

Capacity auctions have various structures. MISO and NYISO hold their auctions shortly before the capacity is required, while PJM and ISO-NE hold their auctions years in advance

[2] *Capacity* is the maximum amount of energy that a unit can generate, often measured in kilowatts (kW) or megawatts (MW); *energy* refers to the amount of electricity actually produced and is measured in kW or MW over time, such as in megawatt-hours (MWh) (PJM 2013).

and include interim auctions to reconcile changes in forecasted supply and demand. The PJM and ISO-NE approach allows suppliers to prepare in advance for supply and demand changes, giving them time to build and replace power-generating units to accommodate the needed capacity.

The level of forecasted capacity demand plus a reserve margin is known as the reliability requirement. In capacity auctions, capacity suppliers bid on the obligation to sell capacity when called upon, or in the case of energy efficiency, the right to reduce demand for capacity. The ISO accepts the lowest-priced resources until the reliability requirement is met. The bid price of the last unit of capacity needed to meet the grid's reliability requirement is called the auction clearing price. Resource providers that submitted bids below the clearing price are all obligated to supply capacity during the delivery year at the clearing price, regardless of their original bids.

Energy Efficiency in PJM's Load Forecast and Reliability Requirement

The load forecast informs PJM's reliability requirement and how much capacity it procures in each auction. Beginning in 2007, PJM began to recognize that it was over-forecasting load. As the economy began to recover from the Great Recession in 2007–2009, PJM found that load was not growing in step with the economy as it had done in the past. To improve its forecasting accuracy, PJM revised its methodology for the 2016 load forecast. According to PJM, the most important methodological change to its model was to add variables that capture trends in equipment saturation and efficiency. Improved efficiency and greater saturation of energy-efficient equipment helps explain why load did not grow with the economy as it had done in the past (PJM 2016a).

To forecast load, PJM uses data from the US Energy Information Administration's Annual Energy Outlook. The forecast model is a regression analysis that produces daily load forecasts from variables such as calendar effects, weather, economics, and end-use characteristics (PJM 2017c). Energy efficiency is modeled within the end-use characteristics and is included in multiple places in the overall forecast model. The model's end-use characteristics look at the level of equipment saturation and efficiency relative to 1998 levels. PJM produces three equipment indices for heating, cooling, and other activities, weighted for the residential and commercial sectors. The indices are then used to help derive load shapes in each of PJM's zones. The heating equipment index is used primarily for winter months, when heating drives much of the load shape, and the cooling index is used primarily for summer months, when cooling equipment has a large impact on load shape. The other equipment index is not tied to weather and helps explain base load conditions (PJM 2016a). Including these indices is critical to helping PJM more accurately forecast its load and avoid over-procuring capacity assets at great cost to customers.

Recent evidence from Maryland shows that the load forecast does not fully capture demand reductions. During a discussion on various energy efficiency programs for BGE customers, PJM was asked to use its model to calculate the impacts to BGE's load forecast of 100 MW of peak-demand reduction each year for three years. PJM's calculations resulted in a drop in the modeled peak-load forecast of only approximately 5 MW (Chernick 2016).

The load forecast—adjusted for energy efficiency through an add-back mechanism (described below)—informs PJM's reliability requirement, which ensures resource adequacy and determines the capacity needed to meet the region's demand for each capacity auction. The reliability requirement is expressed as a percentage of the region's peak-load forecast. This percentage is determined by the capacity reserves required to maintain the region's reliability. When PJM revised its load forecasting procedures in 2016 to account for energy efficiency (for the 2019–2020 delivery year), it also developed an energy efficiency add-back mechanism in the reliability requirement. The mechanism accounts for all MWs of energy efficiency that have qualified to bid into the capacity auction, and adds them to the reliability requirement; this avoids double counting energy efficiency resources already included in the peak-load forecast.

PJM's add-back mechanism thus accounts for all energy efficiency resources that qualify for entry into its base residual auction (BRA). Not all of the efficiency that qualified for participation in the 2019–2020 BRA cleared the auction, however, resulting in a slight mismatch in the capacity added back into the load forecast. PJM's market monitor estimates that the mechanism's discrepancies resulted in a 0.2% increase in BRA revenues, or additional payments of $16,025,667 to capacity resources (Monitoring Analytics 2016). To avoid affecting market clearing prices, the market monitor recommends that the amount of capacity added back into the peak-load forecast exactly match the amount of efficiency cleared in each PJM zone.

In recent years, the PJM market monitor has recommended removing energy efficiency and other demand-side resources from the capacity auctions. This recommendation is based on the assertion that demand reductions from demand-side resources are already included in the demand forecast, and therefore do not need to be included in the capacity auction as well. The market monitor asserts that including demand-side resources in the planning forecast also reduces the reserve requirements for capacity procurement, effectively lowering the clearing price through market price reductions. Although proper consideration of demand-side resources in the demand forecast should reduce capacity prices, it does not compensate energy efficiency program providers and therefore does not send an appropriate market signal of demand-side resources' value. This loss of revenue to efficiency providers may decrease the savings delivered, thereby increasing wholesale capacity prices.

ENERGY EFFICIENCY IN ISO-NE'S INSTALLED CAPACITY REQUIREMENT FORECAST

ISO-NE completes its comprehensive system planning for the region with input from many stakeholder groups. This process drives development of the demand curves for each annual forward capacity auction (FCA). The peak-demand forecast considers historical demand, economic data, and weather data.[3] Led by ISO-NE's Energy Efficiency Forecast Working Group, the forecasting process has evolved over time; for example, it included an energy efficiency-specific forecast to the system planning process in 2012, and changed from a vertical to a sloped demand curve for delivery year 2018–2019 (ISO-NE 2016, 2017c).

[3] For additional information, see ISO-NE's capacity, energy, loads, and transmission reports.

To estimate future energy savings and peak-demand reductions, ISO-NE uses energy efficiency data from utilities and program administrators, as well as information on future energy use. Its model uses any known values on qualified existing efficiency resources and newly cleared energy efficiency resources from the forward capacity market (FCM) as the forecast for three years into the future (Rojo 2017). The model calculates energy savings further into the future based on future energy efficiency budgets and the projected cost of saved energy. Until 2017, ISO-NE pro-rated future savings based on the percentage of efficiency budgets that utilities typically spend. Recently, however, it updated its methodology to assume that utilities would fully spend efficiency budgets (Peterson and Fields 2017). The model accounts for projections in energy use and system peak demand. It also includes a production cost escalator to account for increases in saved energy and future uncertainty costs (Peterson and Fields 2017). The forecast does not explicitly account for expiring efficiency measures, which may become more important in the future if expiring resources become larger in scale than new ones (Rojo 2017).

The Energy Efficiency Working Group has proposed changes to the forecast methodology for 2018. To better reflect actual market efficiency values, it proposes that forecasts use clearing results from a reconfiguration capacity auction closer to resource delivery, rather than from the base auction for Year One of the forecast. The group also proposes accounting for expiring efficiency measures (Rojo 2017).

The installed capacity requirement (ICR) is the minimum capacity needed to meet the region's reliability requirements (the target for the FCA). The ICR includes energy efficiency in the peak-load forecast (as described above). To avoid double counting, existing efficiency resources that qualify for the auction and new resources expected to clear it are added back into the load forecast (ISO-NE 2017f). The amount of capacity needed for the ICR is affected by capacity resources' outage rates, as each resource is assigned an availability score based on its historic outrage rates. Efficiency is assigned an availability value of 100% (Neme and Cowart 2014; ISO-NE 2014a). This indicates that if efficiency were not included in the forecast, the overall demand figure would be higher than if all the efficiency were simply replaced with generation resources. This is because generation resources typically do not receive availability values of 100%, and so more capacity would be needed to cover the lost efficiency for reliability purposes. Availability scores for generating resources range from approximately 80% to 94%. Efficiency has the highest availability score of all resources and is thus seen as the most reliable (Neme and Cowart 2014).

A recent study found that ISO-NE has been over-forecasting peak demand while under-forecasting energy efficiency resources (Peterson and Fields 2017). This led to forecast methodology changes implemented in 2017, as well as other proposed changes for 2018. According to the study, ISO-NE has consistently over-forecast peak-demand projections by 10–20%, likely leading to unnecessary investments in upgraded or new transmission and distribution infrastructure. As noted above, the efficiency forecast inputs included a discount for the historical spend rate of efficiency budgets. The forecast also assumed increases in saved energy cost and adjusted the cost for inflation. However ISO-NE did not adjust for inflation in its cost-effectiveness analysis for future programs, thereby reducing the spending power of program administrator budgets. After correcting for these factors, the energy efficiency projection between 2020 and 2025 increased by 700 MW over that time period—enough to offset the construction of two gas combustion turbines (Peterson and Fields 2017). This means that potential construction and operational costs for new power plants may be avoided by updating efficiency forecasting methodology.

THE PJM RELIABILITY PRICING MODEL (RPM) AND BASE RESIDUAL AUCTION (BRA)

In PJM, the capacity auction is called the Reliability Pricing Model (RPM), which consists of the BRA and additional interim auctions. PJM uses the RPM to balance the system reliability requirement (that is, how much capacity is needed to maintain grid reliability) with supply that has bid into the auction. The annual BRA procures a full year's capacity and occurs three years prior to when resource delivery is required. The PJM delivery year runs from June 1 through May 31. The first auction occurred in 2007 for the delivery year 2010–2011.

Following the BRA, interim auctions occur annually until the delivery year. This gives suppliers and the ISO a chance to reconcile any changes that may have occurred in the forecast supply and demand amounts. In addition to the BRA and the interim auctions, participants can buy and sell capacity obligations in the bilateral market directly or through a broker up until resource delivery. Figure 2 shows the RPM auction's basic schedule.

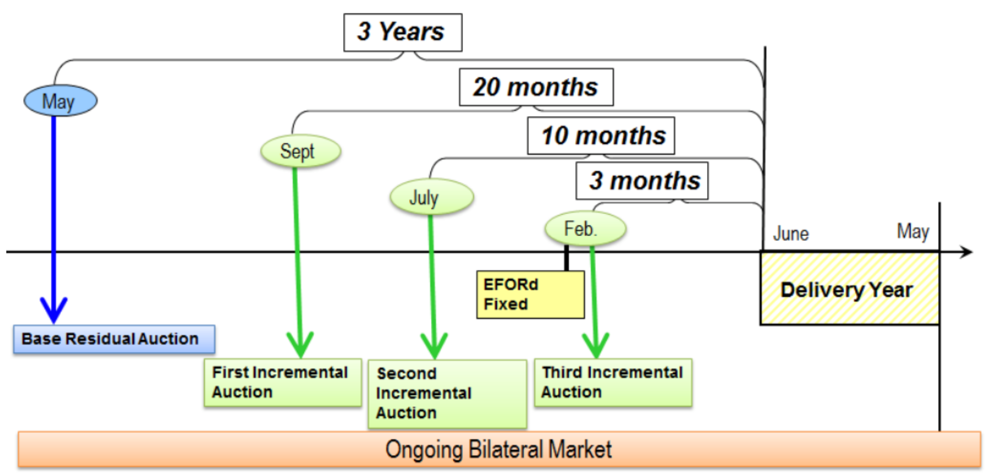

Figure 2. Timeline of RPM auction mechanism. *Source:* PJM 2017d.

The BRA divides its auctions into locational delivery areas (LDAs) based on the differences in energy demand needs and supply constraints for different areas in the ISO territory. Resources not included in a location-constrained LDA are included in what is called the RTO LDA. This LDA's price is functionally a base resource price for the region. Resources may be paid different prices (locational price adders are added to the RTO LDA price) depending on their location and the constraints associated with the LDA.

THE ISO-NE FORWARD CAPACITY AUCTION (FCA)

ISO-NE uses its FCM to ensure adequate capacity supply is available to meet regional demand. The FCM consists of annual FCAs, which use a Market Clearing Engine algorithm to match demand needs with available capacity supply resources. Within the ISO-NE footprint, any areas determined to be import or export constrained are modeled separately by the Market Clearing Engine. Areas that are constrained are called capacity zones, and may clear at different prices than unconstrained areas, which together are called the rest-of-pool (ROP) zone.

Like the BRA, the FCA is held three years prior to when resource delivery is needed, and procures capacity for a full year. In ISO-NE, this is called a capacity commitment period, and runs from June 1 to May 31. The FCA consists of multiple rounds in which suppliers bid within a predetermined price range. When capacity resources willing to bid within that price range fall below the amount needed to meet the reliability requirement (called the net installed capacity requirement in ISO-NE) the Market Clearing Engine computes a final clearing price.[4] This price will fall within that round's predetermined price range. ISO-NE holds 15 interim reconfiguration auctions (as opposed to PJM's three) with additional bilateral periods that let suppliers transfer their capacity supply obligations between one another.

Energy Efficiency in Capacity Auctions

Including energy efficiency in capacity auctions recognizes that efficiency provides the same value as traditional generation resources. Energy efficiency providers[5] can aggregate their savings to bid into the PJM and ISO-NE capacity auctions. Further, energy efficiency is a key part of load forecasting in these two regions; when adjusted for energy efficiency, these load forecasts inform the amount of capacity procured in each auction.

ENERGY EFFICIENCY IN THE PJM BRA

In 2009, the PJM BRA began including demand-side resources, including demand response and energy efficiency. Still, traditional generation continues to dominate the PJM capacity auction. In PJM, energy efficiency resources are defined to include installing efficient devices and equipment, implementing more efficient processes and systems, and exceeding building codes or other standards (PJM 2017b). These resources "must achieve a permanent, continuous reduction in electric energy consumption at the end use customer's retail site" (PJM 2017b).

Additionally, these reductions must not be reflected in the existing peak-load forecast (PJM 2017b). If energy efficiency resources have already been included, PJM removes from that forecast the total capacity value of approved efficiency resources looking to bid into the auction. PJM claims that this avoids double counting the resources and increases the reliability requirement, meaning that the ISO must procure the additional amount of capacity resources through the auction, whether energy efficiency or not. As stated above, it is not clear that the PJM's claim is accurate, as the load forecast is likely to drastically underestimate the actual amount of energy efficiency that has been achieved. Further, an efficiency resource can participate in only four consecutive delivery year auctions, and thus,

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[4] The net installed capacity requirement is calculated by removing the portion of the total installed capacity requirement that is fulfilled by the Hydro-Quebec interconnection and thus does not need to be purchased in the auction (ISO-NE 2017e).

[5] Energy efficiency providers include utilities, third-party administrators, and other energy efficiency companies. Energy efficiency providers are also sometimes referred to as project sponsors.

implicitly, only four years of capacity value can be claimed, even if the efficiency measures have a longer life. Because the added value of long-life measures is not recognized, it reduces the incentive to invest in such measures.

As with other resources, energy efficiency must meet reliability criteria and is subject to evaluation, measurement, and verification (EM&V) reporting requirements. For PJM, measuring and assuring performance of traditional generating resources is more straightforward than doing so for energy efficiency. PJM asserts that EM&V is important to ensure that efficiency resources are meeting performance obligations. Efficiency resource providers such as utilities and efficiency companies are thus required to submit EM&V plans 30 days prior to each RPM auction in which they are participating. Plans must detail the methodologies used to determine the resource's capacity value, describe why this methodology is appropriate, describe assumptions and variables that affect the resource's value determination and performance, and specify the type of equipment used (PJM 2016b). After the initial EM&V report is accepted, additional EM&V update reports are required 15 days prior to the start of each delivery year for which the resource is committed. Resource suppliers must also permit PJM or independent third parties to conduct post-installation audits.

The rules governing the BRA and the inclusion of demand resources have changed over time. Different capacity products, distinguished by aspects such as resource type and seasonality, have historically received different prices in the auctions. Beginning in 2015 (for the 2018–2019 delivery year), PJM implemented rules for a new capacity auction product known as capacity performance. Capacity performance products must be "capable of sustained, predictable, operation that allows the resource to be available throughout the entire delivery year" rather than seasonally (PJM 2015). By delivery year 2020–2021, all auction resources were required to meet these capacity performance requirements. PJM implemented this change to increase the reliability of capacity resources throughout the year. Resources may bid into the auction as a seasonal resource, but to clear, they must be matched with a resource for the opposite season.

Historical Results: Energy Efficiency in the PJM BRA

We collected data from publicly available sources to evaluate historical amounts and implications of energy efficiency cleared in the BRA. These sources include the PJM website, independent market monitors, and other online publications and market news sources. We extracted energy efficiency data from annual BRA result reports, including amount offered, amount cleared, and clearing prices for each of the LDAs modeled. Through this analysis, we determined the payments provided to energy efficiency suppliers in each auction by multiplying the amount of efficiency cleared by the clearing price within that LDA. Some years have multiple applicable clearing prices for energy efficiency. In these cases, we calculated the percentage cleared of each type, and applied those percentages to create a weighted average clearing price. The percentages used to weight the clearing price for delivery years 2014/2015–2017/2018 include both demand response and energy efficiency because data detailing the amount of each type cleared do not break out these two categories.

We do not consider clearing quantity or price outcomes from the interim auctions or bilateral market trading within PJM because transactions within the bilateral market are often confidential. We also assume that all capacity deliveries are made every year, so we do not account for any penalty payments that may be incurred.

Table 1 and figure 3 shows results from the PJM BRA for delivery years 2012/2013–2020/2021, including the amount of energy efficiency and total capacity cleared, as well as the RTO LDA annual resource clearing price. For delivery years 2012/2013–2016/2017, total capacity cleared in the PJM auction increased by almost 25%. This growth has since leveled out, and the total capacity cleared has remained at approximately 165,000–167,000 MW. Meanwhile, energy efficiency resources clearing the auction have grown since the 2012–2013 delivery year.

Table 1. PJM BRA results summary

Auction year	Delivery year	Efficiency cleared (MW)	Total capacity cleared (MW)	% of efficiency offered that cleared	% of total capacity offered that cleared	RTO LDA clearing price ($/ MW-day)*
2009	2012–2013	568.9	136,144	87%	94%	$16.46
2010	2013–2014	679.4	152,743	90%	95%	$27.73
2011	2014–2015	822.1	149,975	99%	93%	$125.99
2012	2015–2016	922.5	164,561	98%	92%	$136.00
2013	2016–2017	1117.3	169,160	97%	92%	$59.37
2014	2017–2018	1338.9	167,004	100%	93%	$120.00
2015	2018–2019	1246.5	166,837	95%	93%	$149.98
2016	2019–2020	1515.1	167,306	92%	90%	$80.00
2017	2020–2021	1710.2	165,109	76%	90%	$76.53

*The RTO LDA payment rate shows the clearing price for annual RTO LDA products. *Source:* PJM 2017a.

Clearing prices have fluctuated significantly for the RTO LDA resources (the base capacity price for the region), as well as across different types of products and LDAs.[6] In contrast, the percentage of total capacity offered that cleared has remained within the 90–95% range, while the level of cleared efficiency fluctuated within the 76–100% range. This variation may be due to changes in market rules.

For example, in the May 2017 auction, only 76% of the total efficiency offered cleared. This could be because of the new rule that all resources must meet capacity performance product requirements.[7] Seasonal resources can also bid into the auction, but must be matched by

[6] For more information regarding LDA- and resource-specific clearing prices, see Appendix A.

[7] This rule was implemented in 2015 and required that 80% of resources meet capacity requirements for the relevant delivery year. By 2017, the rule had ramped up to apply to 100% of resources. In 2015 and 2016, 71% and 70% of the energy efficiency resources cleared met the capacity performance requirements, respectively.

PJM with a seasonal resource of the opposite season. In this auction, 87% of the annual energy efficiency resources offered cleared, and only 25% of summer efficiency resources cleared. Although the seasonal resources constituted a much smaller portion of the efficiency offered, this is still a considerable resource loss and is likely due to the lack of matching winter resources. In a memo to the Maryland Public Service Commission discussing demand-side resources as a whole, PEPCO stated that, "Because the quantity of available winter resources was lower than the quantity of available summer resources, approximately 30% of the Companies' available summer resources clear[ed] the auction" (PEPCO 2017).

The absolute increase in the quantity of efficiency cleared in this auction is also notable, even with the rule change. The capacity performance rule was implemented in response to the Polar Vortex of 2014, when power interruptions due to extreme weather caused concerns about PJM's future power system reliability (PJM 2015). While the rule change has been seen as a detriment to demand-response resources that are typically seasonal, results show that efficiency—which largely provides a year-round permanent demand reduction—is as reliable as traditional generation for uninterrupted power supply.

Figure 3 shows the total amount of energy efficiency cleared in the PJM RPM for delivery years 2012–2021, as well as the energy efficiency percentage cleared out of that period's total capacity cleared. The 2012–2013 delivery year auction in 2009 was the first year efficiency was included in the auction; since that time, both the absolute amount and the amount of energy efficiency cleared as a percentage of total cleared capacity in the BRA have trended steadily upward. For delivery years 2012/2013–2020/2021, cleared energy efficiency's percentage of the total resources has more than doubled, from 0.42% to 1.04%. The absolute capacity amount has also more than doubled, from less than 600 MW to more than 1,700 MW.

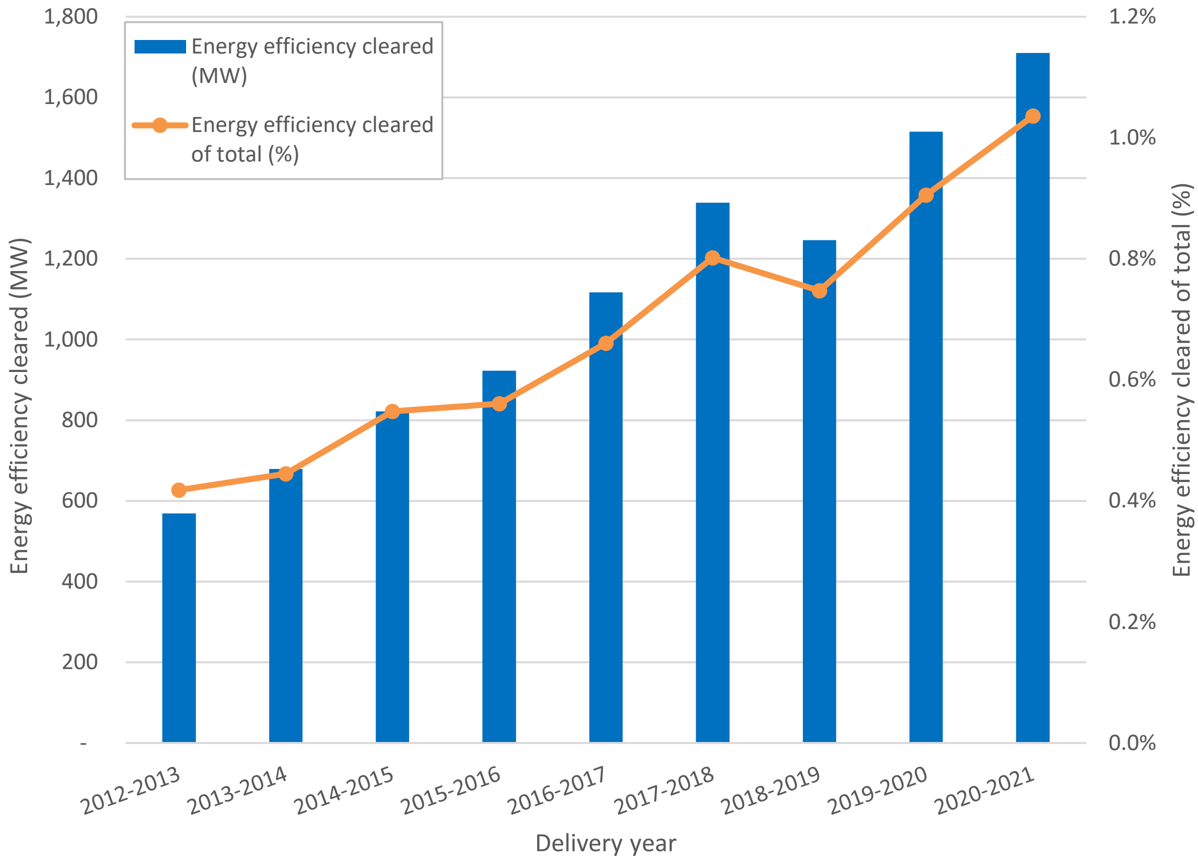

Figure 3. Energy efficiency cleared in the PJM RPM. *Source:* PJM 2017a.

The amount of energy efficiency cleared in the auction translates directly to payments for energy efficiency providers. In each LDA, efficiency resources may receive different payment rates, which affects overall payments to efficiency providers depending on how much efficiency clears in each zone. To illustrate payment rate fluctuations across zones, table 2 shows the rates for the three LDAs—the Mid-Atlantic, Eastern Mid-Atlantic, and RTO LDA zones—that are consistently included in each auction.[8] The table also shows total payments made to energy efficiency resources in the PJM ISO for delivery years 2012/2013–2020/2021.

[8] Resources not included in a location-constrained LDA are included in what is called the RTO LDA.

Table 2. Resource clearing prices by LDA region in PJM and total payments to energy efficiency providers

Delivery year	RTO LDA payment rate* ($/MW-day)	Mid-Atlantic payment rate* ($/MW-day)	Eastern Mid-Atlantic payment rate* ($/MW-day)	Payments to energy efficiency providers
2012–2013	$16.46	$133.37	$139.73	$11,561,513
2013–2014	$27.73	$226.15	$245.00	$18,323,569
2014–2015	$125.54	$127.00	$127.00	$37,776,814
2015–2016	$125.11	$156.57	$156.57	$47,748,214
2016–2017	$59.37	$119.13	$119.13	$34,219,748
2017–2018	$117.04	$117.04	$117.04	$57,067,110
2018–2019	$160.51	$160.51	$221.16	$86,010,807
2019–2020	$93.97	$93.97	$113.74	$79,629,496
2020–2021	$76.53	$86.04	$76.53	$66,961,965
Total				$439,299,235

All prices shown in nominal dollars. *The payment rate is the clearing price. *Source:* PJM 2017a.

Total payments to energy efficiency providers have generally resisted dramatic shifts, even as LDA clearing prices have varied from about $16/MW-day to almost $250/MW-day over time. This is largely because the auction's absolute amount of energy efficiency clearing has been increasing year to year. For example, from the 2015–2016 to 2016–2017 delivery years, the RTO LDA clearing price fell by more than half (56%) and payments to energy efficiency fell 32%. The energy efficiency payments decline was less dramatic than the RTO LDA clearing price drop because the total amount of efficiency cleared increased; also, some of the efficiency that cleared was in LDAs where the clearing price did not fall as acutely, such as in the PEPCO and Southwestern Mid-Atlantic zones. The highest annual energy efficiency payments occurred in the 2018–2019 delivery year, when efficiency payments reached more than $85 million. Over the nine years that BRA has included efficiency, the total value of the cleared efficiency resources has been nearly $440 million.

Additionally, research has shown that energy efficiency is typically more cost effective than generation resources (Molina 2014). Although exact bid information is confidential, bids for resources that did not clear in the auction did not fall below the ultimate clearing price. Table 3 shows the total and the new generation resources offered, and those that did not clear.

Table 3. PJM's total and new generation offered and clearance (MW)

Delivery year	Total generation offered	New generation offered	Total generation not cleared	New generation not cleared	Total efficiency cleared
2012–2013	134,873	ND	6,346	ND	569
2013–2014	147,189	1,670	4,407	0	679
2014–2015	144,109	1,447	9,075	690	822
2015–2016	157,691	7,322	8,885	1,976	923
2016–2017	168,716	6,598	13,082	1,135	1,117
2017–2018	166,205	6,587	11,515	320	1,339
2018–2019	166,910	4,133	12,404	591	1,247
2019–2020	172,071	6,544	16,628	1,014	1,515
2020–2021	171,262	3,144	15,286	320	1,710
Total	1,429,025	37,444	97,626	6,046	9,921

ND indicates that no data were available. Cleared values include both uprates and new units, and may include new units that were offered but did not clear in previous auctions. *Source:* PJM 2017a.

In all but three delivery years, the amount of energy efficiency cleared in the BRA exceeded the amount of new generation that did not clear. Over the course of the nine auctions, new generation offered that did not clear totals more than 6,000 MW.

ENERGY EFFICIENCY IN THE ISO-NE FCA

The ISO-NE FCM has included demand-side resources since its inception in 2010. The ISO-NE Markets Committee includes a Demand Resources Working Group that provides input on all aspects of including demand resources in the ISO's markets and operations. The working group also provides a forum for discussing and collaborating on issues related to the region's demand resources (ISO-NE 2017d).

The FCM separates demand resources into two categories: active and passive. Active demand resources are deployed when needed; examples include demand response and resources that can move their load to backup generators within 30 minutes of notification (ISO-NE 2017f). Passive demand resources provide permanent demand reductions, such as through energy efficiency measures. Passive resources are categorized as either on-peak or seasonal-peak resources based on when they reduce load. Demand resources can participate in the FCM and its reconfiguration auctions up until the measure's life has expired. For most energy efficiency resources, this is longer than the four-year limit imposed in the PJM BRA.

Demand resources in the FCA must comply with M&V requirements. Demand-side resource providers must submit M&V plans before qualifying for participation in the FCA. Further, the plans must be recertified 10 days before any subsequent years' auction qualification deadline. M&V plans must include monthly projections of demand reduction over the project's lifetime, as well as information on the methodology used to calculate load reduction. Plans must also include additional details about project equipment, baseline conditions, monitoring parameters, and other project specifications. Energy efficiency resources must submit monthly M&V summary reports while they are delivering capacity, detailing the projects' demand reduction value for the month. ISO-NE reviews all necessary M&V documents for project qualification (ISO-NE 2014b).

HISTORICAL RESULTS: FCA

We extracted data from the ISO-NE's reports on demand resource measure types cleared in each auction to calculate the amount of energy efficiency resources cleared in each FCA. ISO-NE's Demand Resources Working Group published six annual reports that broke down the amount of each type of demand resource cleared in that year's auction. The reports assign a specific value to the amount of energy efficiency cleared in those years. For years in which the report was not published, we used the overall auction result reports to extract data regarding energy efficiency. Because these reports do not specifically separate energy efficiency from other passive demand resources, we extracted all passive demand resources cleared and removed projects that we judged to be distributed generation based on the project name, leaving only energy efficiency projects. This approach (used for 5 of the 11 years of data) may have resulted in a few project classification errors, but the results should be highly representative of the magnitude of efficiency cleared. The annual FCA results reports list capacity cleared for each month of the year. We used clearing results from June for our calculations, as ISO-NE uses summer qualified capacity in its load forecasts and other calculations.

We calculated payments to energy efficiency suppliers in each auction by multiplying the payment rate by the amount of efficiency cleared. Payment rates and amount of cleared efficiency varied by zone and by whether the project was a new or existing resource.

This report does not take into account outcomes from the interim auctions or bilateral market trading within the ISO-NE market, as most transactions within the bilateral market are confidential. Although this results in a less-than-perfect measure of energy efficiency and its value within these markets, the interim auctions tend to be much smaller in terms of the amount of capacity procured than the base auctions. In addition, we assume that sellers in the ISO-NE auctions have taken the one-year price for resources, rather than the three-year price that is also potentially available, as it is not clear how many providers take the three-year price. We further assume that all capacity deliveries are made every year, so we do not account for any penalty payments that may be incurred.

Overall capacity demand in the FCA has leveled off in the past few years. Table 4 shows the level and percentages of demand resources and the total capacity cleared in FCAs 1–11. The table also shows the ROP capacity payment rate for the region's unconstrained areas. The level of demand resources clearing in ISO-NE has fluctuated throughout the time period, from approximately 2,600 to 3,600 MW. It is important to note that demand resources cited in this table include energy efficiency, demand response, and distributed generation; energy efficiency amounts alone are not available. We go into further detail about energy efficiency's inclusion in the FCA below.

Table 4. ISO-NE FCA results summary

Delivery year	Total demand resources cleared (MW)	Total capacity cleared (MW)	% of demand resources offered that cleared	% of total capacity offered that cleared	Rest-of-pool (ROP) capacity payment rate*
2010–2011	2,554	34,077	74%	87%	$4.25
2011–2012	2,936	37,283	71%	87%	$3.12
2012–2013	2,898	36,996	86%	87%	$2.54
2013–2014	3,349	37,501	81%	93%	$2.52
2014–2015	3,590	36,918	87%	94%	$2.86
2015–2016	3,645	36,309	86%	94%	$3.13
2016–2017	2,748	36,220	75%	94%	$2.74
2017–2018	3,041	33,712	93%	97%	$7.03
2018–2019	2,803	34,695	92%	92%	$9.55
2019–2020	2,746	35,567	92%	91%	$7.03
2020–2021	3,211	35,835	90%	89%	$5.30

The ROP capacity payment rate shows the effective payment rate, rather than the capacity clearing price, for the ROP area. *In ISO-NE, the payment rate may differ from the auction clearing price based on adjustments to the clearing price following the auction. *Source:* ISO-NE 2017a and b; DRWG 2017.

The percentage of total capacity cleared in each FCA has fluctuated, ranging from 87% to 97%. This is also true for the percentage of cleared demand resources, which ranges from 71% to 93%. This fluctuation might be due to rule changes and variability in the offered amounts of various resources, such as distributed generation and demand response, as well as normal fluctuations in the total amount of capacity cleared.

Figure 4 shows the total energy efficiency that cleared in the FCA for delivery years 2010–2021, as well as its percentage of the total capacity cleared. Efficiency resource quantities were either taken directly from ISO-NE's Demand Resources Working Group reports or calculated by removing distributed generation projects from all passive demand resources cleared in the FCA results reports.

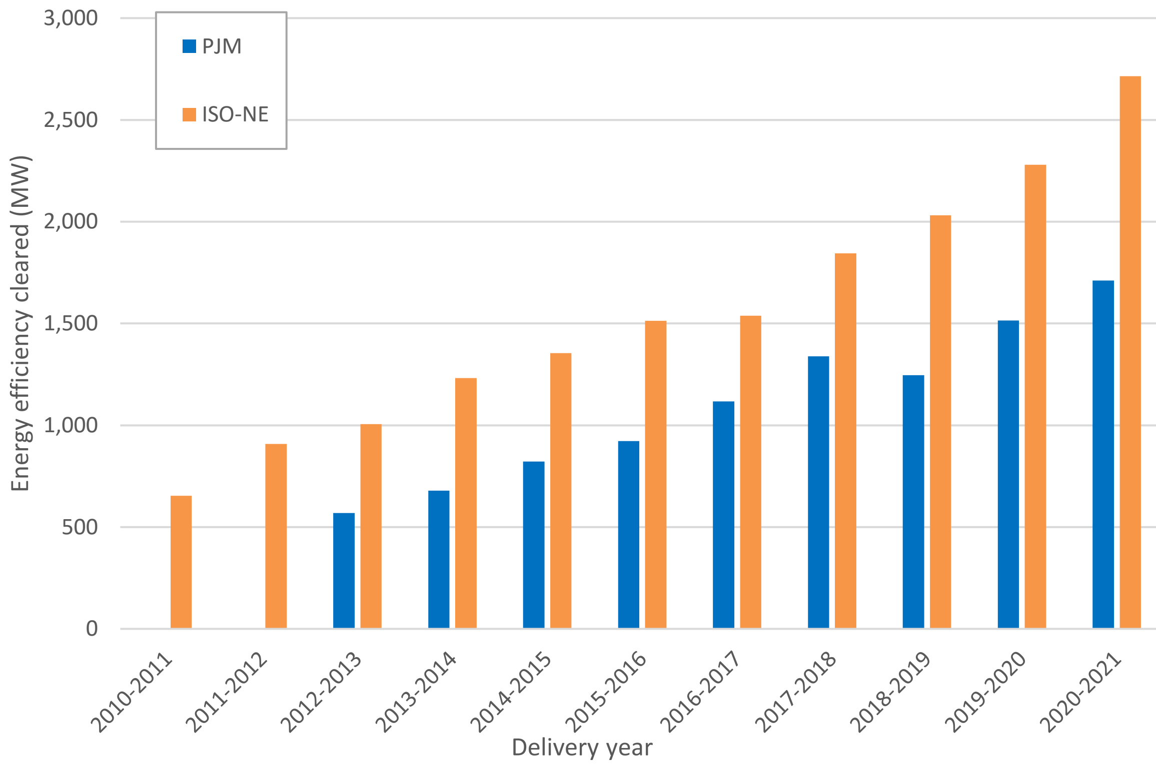

Figure 4. Energy efficiency cleared in ISO-NE. ***Source:*** **ISO-NE 2017a and c; DRWG 2017.**

The amount of energy efficiency clearing the FCA has steadily grown over time, almost quadrupling from the first to the most recent FCA. While the FCA generally has a smaller amount of capacity cleared than the PJM BRA, energy efficiency makes up a much larger percentage of its resources—more than 7.5% of total resources in its most recent auction.

Table 5 shows payments to energy efficiency in ISO-NE, as well as payment rates for the ROP zone.

Table 5. Payments to energy efficiency in ISO-NE FCA

Year	ROP payment rate* ($/kW-month)	Payments to energy efficiency providers
2010–2011	$4.25	$33,413,111
2011–2012	$3.12	$34,006,033
2012–2013	$2.54	$30,606,718
2013–2014	$2.52	$37,188,000
2014–2015	$2.86	$46,382,901
2015–2016	$3.13	$56,833,366
2016–2017	$2.74	$73,235,432
2017–2018	$7.03	$223,263,932

Year	ROP payment rate* ($/kW-month)	Payments to energy efficiency providers
2018–2019	$9.55	$254,312,983
2019–2020	$7.03	$192,354,635
2020–2021	$5.30	$172,547,656
Total		$1,154,144,766

*In ISO-NE, the payment rate may differ from the auction clearing price based on adjustments to the clearing price following the auction. *Source:* ISO-NE 2017a and b and DRWG 2017.

The trend of energy efficiency payments increasing while overall clearing prices decrease reinforces the continuing increase of energy efficiency clearing quantities year to year. Although exact bid information is confidential, bids for resources that do not clear in the auction did not fall below the ultimate clearing price. Table 6 shows the total and new generation resources offered, and those that did not clear.

Table 6. ISO-NE's total and new generation offered and not cleared (MW)

Delivery year	Total qualified generation resources offered	New generation offered	Total generation not cleared	Total new generation not cleared	Energy efficiency cleared
2010–2011	33,800	2,353	2,935	2,313	655
2011–2012	34,700	3,299	2,493	2,142	909
2012–2013	35,466	2,830	3,238	1,160	1,006
2013–2014	33,665	947	2,318	803	1,232
2014–2015	32,863	669	1,424	627	1,354
2015–2016	32,209	133	1,452	54	1,514
2016–2017	32,463	878	822	78	1,538
2017–2018	29,790	30	356	3	1,844
2018–2019	31,666	2,092	1,224	1,032	2,032
2019–2020	33,158	3,130	1,787	1,671	2,280
2020–2021	33,479	1,880	2,090	1,616	2,715

Source: ISO-NE 2017a and b; DRWG 2017.

Beginning in delivery year 2013–2014, the amount of energy efficiency cleared in the auction was more than the amount of new generation offered that did not clear. Also, since delivery year 2014–2015, the amount of energy efficiency cleared has been greater than the total amount of generation offered that did not clear. Since the FCA's launch, new generation offered that did not clear totals to almost 11,500 MW.

Value of Including Energy Efficiency in Capacity Auctions

Including demand resources—and specifically energy efficiency—in capacity auctions directly saves customers money by reducing overall capacity payments. In this section, we review one utility's capacity procurement and cost recovery processes to show how reductions in wholesale capacity prices are reflected in retail electric rates.

CAPACITY MARKET SAVINGS AND CUSTOMER RATE IMPACTS: BALTIMORE GAS AND ELECTRIC

BGE is an investor-owned utility serving more than 1.25 million electric and 650,000 natural gas customers in central Maryland (BGE 2017). It operates within the PJM footprint and does not own or operate generation assets.[9] BGE retail customers can choose an alternate energy supplier, but they also have the option of purchasing electricity from BGE through a standard offer service known as SOS pricing.[10]

SOS pricing is the electricity supply service provided by BGE, which procures the energy through a competitive auction process regulated by the Maryland Public Service Commission. However retail suppliers also include the cost of wholesale capacity in retail energy price offers. Auctions are held twice a year (in October and April) for 25% of the residential and small commercial load each time, and four times a year (in October, January, April, and July) for 100% of the mid-size commercial load each time. The contract term for the residential and small commercial is two years; for the mid-size commercial, the contract term is three months. Ladder electric supply procurements such as these for residential and small commercial loads help mitigate the effect of large wholesale price fluctuations on retail prices.

We reviewed the results of the most recent auction to better understand how changes in wholesale capacity prices affect retail electric prices. The wholesale market capacity cost is embedded in the energy price, but the details of each bid are confidential. We estimated the average cost of capacity per MWh to determine the cost of capacity in retail rates. We gathered data from PJM and BGE for several variables including capacity obligations for residential customers, the BGE zonal price for capacity, and residential volumetric sales. We calculated the capacity cost per MWh by multiplying the clearing price by the capacity obligation for the BGE zone's residential customers. We then divided this value by the total residential electric sales to estimate the cost per MWh. Table 7 shows the cost per MWh for capacity for the past four PJM delivery years.

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[9] Exelon, the ultimate parent company of BGE, does own generation assets.

[10] BGE's current SOS pricing is available at bge.com/MyAccount/MyService/Pages/ElectricPriceComparison.aspx.

Table 7. Cost of capacity for retail customers in BGE service territory

Delivery year	$/MWh per $/MWd
2014–2015	$0.117
2015–2016	$0.131
2016–2017	$0.119
2017–2018	$0.114
Average	$0.120

Calculated as described above using data from BGE. MWd = MW-day. *Source:* BGE.

Table 8 shows the average BGE summer residential customer bill, excluding fees, surcharges, and miscellaneous taxes. The data in the table are current from July 28, 2017.

Table 8. Summer monthly bill breakdown for a typical BGE residential customer (925 kWh usage)

Component	Unit	Cost	Total for bill	% of bill
Customer charge	$/month	$7.90	$7.90	7%
Delivery	$/kWh	$0.03462	$32.02	27%
Generation	$/kWh	$0.07475	$69.14	58%
Transmission	$/kWh	$0.01127	$10.42	9%
Total			$119.49	

Excludes fees, surcharges, and miscellaneous taxes. *Source:* BGE.

As the table shows, the average summer bill is approximately $120 per month with almost 60% from generation charges. Assuming that 1.7 cents per kWh of the generation charges are for collection of capacity costs, capacity-related charges make up $15.73, or 13%, of the average bill. The table shows only a summer monthly bill. The non-summer generation rates are slightly lower, so a slightly higher percentage of impacts from capacity charges would occur.

Energy efficiency reduces capacity prices, both as a supply-side resource participating in auctions and as an external force reducing demand. Without energy efficiency or demand response, PJM's capacity prices would be much higher. For example, if capacity prices were 30% higher, the average bill would increase by 4%, or nearly $5. While the percentage increase in the total bill may seem small for most individual customers, $5 can make a difference for a struggling family. Moreover, when examining this value over the entire service territory for a year, the cost savings are nearly $65 million.

Demand Reduction Induced Price Effect

Reduced electricity demand from energy efficiency also lowers capacity and energy prices in the system overall, which is referred to as the demand reduction induced price effect, or DRIPE (SEE Action 2015). DRIPE includes energy efficiency resources clearing capacity auctions, as well as other energy efficiency that occurs naturally or through utility-sector programs. Energy efficiency reduces demand, shifting the system demand curve downward, meaning that fewer units of capacity must be purchased. This, in turn, reduces the market clearing price for capacity. Figure 5 illustrates this concept.

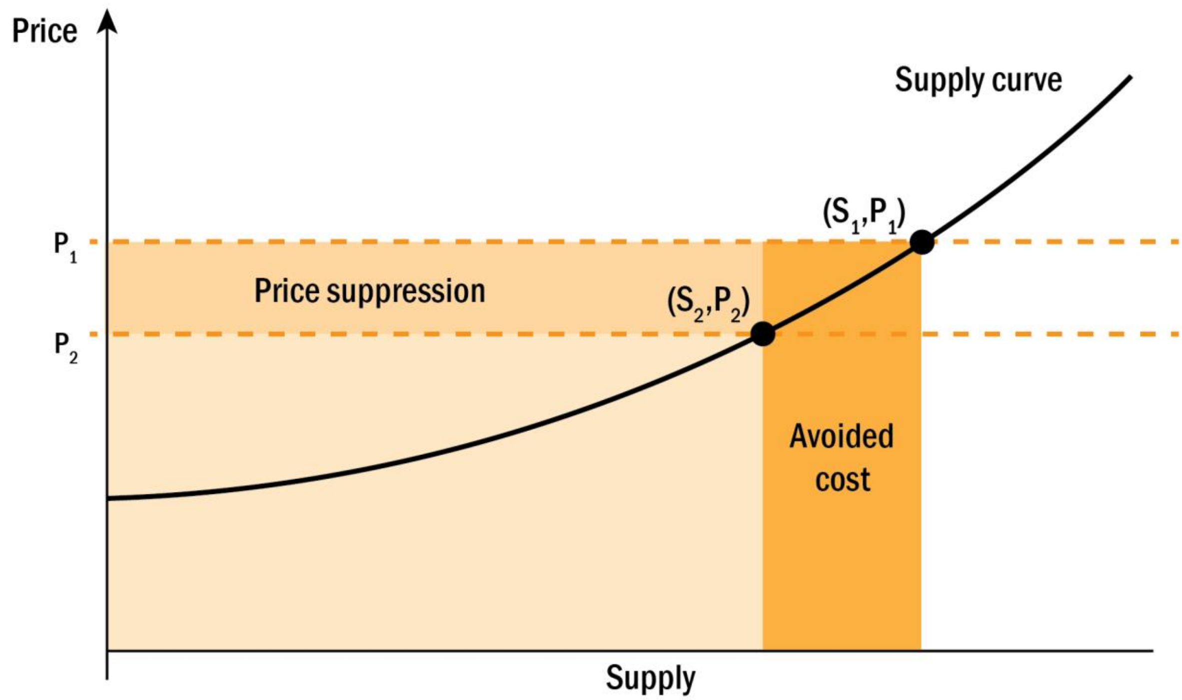

Figure 5. System supply and price with energy efficiency. S_1, P_1 represent the market without energy efficiency price reduction effects. *Source:* Chernick and Plunkett 2014.

This effect is well documented and produces economic benefits through lower costs for energy and capacity. Research shows that DRIPE lowers wholesale electricity prices in almost every case, which should also translate to lower retail rates for utility customers (SEE Action 2015). Although we focus largely on capacity effects, DRIPE affects both energy and capacity prices. *Energy DRIPE* refers to energy market price reductions from reduced electricity usage, while *capacity DRIPE* refers to reductions in capacity market prices due to reduced demand for capacity from energy efficiency (Hornby et al. 2013).

EXAMPLES OF DRIPE

A study of capacity DRIPE in Maryland found total avoided costs ranging from $25.23–940.08 per MW-day saved from measures installed in 2015 (2012 dollars) (Exeter 2014). Across an entire state or RTO system, these savings add to significant cost reductions and savings passed on to customers. For example, one analysis showed that deploying enough energy efficiency to meet regulatory standards in Ohio would save $1.3 billion from wholesale capacity price mitigation through 2020 (Neubauer et al. 2013).

Energy DRIPE also creates financial savings for retail customers. In the Ohio example, it would create $880 million in wholesale energy price mitigation on top of the capacity DRIPE price mitigation. Another study found that in New England, a 1% load reduction in the region reduced off-peak prices by 1.1–1.2% and on-peak prices by 1.9–2.2% (Hornby et al. 2013). Energy DRIPE estimates in Maryland for measures installed in 2015 range from total avoided costs per MWh saved of $1.39–1.88 for off-peak periods, and $1.72–$13.26 in on-peak periods from measures installed in 2015 (2012 dollars) (Exeter 2014). A 2014 analysis of energy DRIPE found that a 1% reduction in load in Illinois and much of the Midcontinent ISO territory would reduce Illinois energy prices by 2% (Chernick and Griffiths 2014).

Including energy efficiency in demand forecasts affects the amount of capacity procured in the auctions. Greater levels of energy efficiency, whether the savings are from utility-sector programs bid into capacity auctions or not, reduces demand and lowers wholesale capacity prices. These cost savings are an additional benefit of energy efficiency and another reason to ensure accuracy of demand forecasts.

Summary and Conclusions

Energy efficiency provides value within the PJM and ISO-NE territories by reducing overall demand in the regions. Reduced demand lowers capacity prices in two ways. First, energy efficiency bid into capacity auctions lowers clearing prices, reducing capacity costs for customers in these RTOs. Second, energy efficiency not bid into the auctions (both naturally occurring and from the utility sector) reduces demand in forecasting, lowering the capacity required in the auction. The DRIPE of efficiency resources both within and outside capacity auctions creates avoided costs for the region's customers, highlighting the importance of including efficiency in load forecasting.

The amount of energy efficiency clearing in the PJM and ISO-NE auctions is steadily increasing, and efficiency is making up a higher percentage of the total capacity cleared year to year. Revenue from these two auctions to energy efficiency providers has approached $1.6 billion over the past 11 years. This additional value stream for energy efficiency suppliers is a market signal for greater investment. The revenue also compensates efficiency suppliers in the same way as other generators.

While both PJM and ISO-NE include energy efficiency in load forecasting, the process is flawed, leading the utilities to over-invest in traditional generation, transmission, and distribution assets. For example, ISO-NE has consistently over-forecast its peak-demand projections by 10–20%, leading to increased spending on unnecessary capacity and traditional infrastructure. PJM had also been over-forecasting demand; it recently adjusted its forecasting methodology to account for higher energy efficiency levels.

In ISO-NE, efficiency resources are assigned a 100% availability factor—that is, less capacity is needed to meet demand compared to meeting the same demand with generation resources. This is because generation resources do not have 100% availability factors and must provide more capacity to meet the same demand. This demonstrates the reliability of energy efficiency as a resource in New England. ISO-NE also provides capacity payments for a measure's full life, while PJM limits capacity payments to a maximum of four years.

Including energy efficiency in capacity auction mechanisms saves customers money. These savings, combined with induced lower price effects at the wholesale and retail levels and indirect effects such as reduced pollution and better health outcomes, indicate that all ISOs should include efficiency in their capacity procurement mechanisms. Efficiency is a reliable and cost-effective resource that should be considered comparable to generation resources in capacity auctions.

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Appendix A. RTO Clearing Price Data

All resource clearing prices and price adders for PJM are in $/MW-day (nominal dollars).

Table A1. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2012–2013

LDA	Capacity offered (MW)	Capacity cleared (MW)	Locational price adder	RCP
DPL-S	1,499	1,242	$82.57	$222.30
EMAAC	32,983	31,080	$6.36	$139.73
MAAC	68,283	65,452	$116.91	$133.37
PS-N	3,420	3,522	$45.27	$185.00
PSEG	7,431	7,194	$0	$139.73
RTO	145,373	136,144	$0	$16.46
SWMAAC	12,396	11,595	$0	$133.36

Table A2. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2013–2014

LDA	Capacity offered (MW)	Capacity cleared (MW)	Locational price adder	RCP
DPL-S	1,612	1,612	$0	$245.00
EMAAC	33,007	32,835	$18.85	$245.00
MAAC	68,338	67,640	$198.42	$226.15
PEPCO	5,289	4,792	$20.99	$247.14
PS-N	4,173	4,159	$0	$245.00
PSEG	8,033	8,019	$0	$245.00
RTO	160,898	152,743	$0	$27.73
SWMAAC	11,768	11,242	$0	$226.15

Table A3. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2014–2015

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
DPL-S	1,600	1,439	$125.47	$136.50	$136.50
EMAAC	34,520	32,554	$125.47	$136.50	$136.50
MAAC	70,885	67,176	$125.47	$136.50	$136.50

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
PEPCO	5,875	5,615	$125.47	$136.50	$136.50
PS-N	4,170	3,818	$213.97	$225.00	$225.00
PSEG	8,184	7,583	$125.47	$136.50	$136.50
RTO	160,486	149,975	$125.47	$125.99	$125.99
SWMAAC	12,458	11,124	$125.47	$136.50	$136.50

Total demand resources for delivery year 2014–2015 are made up of 86% limited resources, 10% extended summer resources, and 4% annual resources.

Table A4. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2015–2016

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
ATSI	11,777	10,668	$304.62	$322.08	$357.00
DPL-S	1,768	8,964	$150.00	$167.46	$167.46
EMAAC	37,226	33,048	$150.00	$167.46	$167.46
MAAC	74,261	65,790	$150.00	$167.46	$167.46
PEPCO	6,235	6,136	$150.00	$167.46	$167.46
PS-N	4,931	3,641	$150.00	$167.46	$167.46
PSEG	8,964	6,730	$150.00	$167.46	$167.46
RTO	178,588	164,561	$118.54	$136.00	$136.00
SWMAAC	12,722	11,000	$150.00	$167.46	$167.46

Total demand resources for delivery year 2015–2016 are made up of 62% limited resources, 35% extended summer resources, and 3% annual resources.

Table A5. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2016–2017

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
ATSI	12,791	8,672	$94.45	$114.23	$114.23
ATSI-C	2,874	2,850	$94.45	$114.23	$114.23
DPL-S	1,764	1,746	$119.13	$119.13	$119.13
EMAAC	34,140	31,522	$119.13	$119.13	$119.13
MAAC	71,608	66,546	$119.13	$119.13	$119.13

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
PEPCO	6,126	6,094	$119.13	$119.13	$119.13
PS-N	4,182	3,702	$219.00	$219.00	$219.00
PSEG	6,784	6,299	$219.00	$219.00	$219.00
RTO	184,380	169,160	$59.37	$59.37	$59.37
SWMAAC	12,386	12,050	$119.13	$119.13	$119.13

Total demand resources for delivery year 2016–2017 are made up of 79% limited resources, 20% extended summer resources, and 1% annual resources.

Table A6. PJM capacity offered and cleared with resource clearing price for 2017–2018

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for limited resources	RCP for extended summer resources	RCP for annual resources
ATSI	12,173	8,977	$106.02	$120.00	$120.00
ATSI-C	2,561	2,549	$106.02	$120.00	$120.00
BGE	4,107	3,351	$106.02	$120.00	$120.00
COMED	26,701	22,551	$106.02	$120.00	$120.00
DPL-S	1,684	1,682	$106.02	$120.00	$120.00
EMAAC	33,706	32,211	$106.02	$120.00	$120.00
MAAC	72,351	68,364	$106.02	$120.00	$120.00
PEPCO	6,134	5,938	$106.02	$120.00	$120.00
PPL	10,728	9,349	$40.00	$53.98	$120.00
PS-N	4,039	3,893	$201.02	$215.00	$215.00
PSEG	6,833	6,111	$201.02	$215.00	$215.00
RTO	178,839	167,004	$106.02	$120.00	$120.00
SWMAAC	12,645	11,693	$106.02	$120.00	$120.00

Total demand resources for delivery year 2017–2018 are made up of 21% limited resources, 65% extended summer resources, and 14% annual resources.

Table A7. PJM capacity offered and cleared with resource clearing price for 2018–2019

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for base demand response and energy efficiency	RCP for base generation	RCP for capacity performance
ATSI	11,086	10,172	$149.98	$149.98	$164.77
ATSI-C	2,590	2,258	$149.98	$149.98	$164.77
BGE	4,225	3,297	$59.95	$149.98	$164.77
COMED	26,276	23,320	$200.21	$200.21	$215.00
DPL-S	1,696	1,694	$210.63	$210.63	$225.42
EMAAC	33,840	31,069	$210.63	$210.63	$225.42
MAAC	73,546	66,071	$149.98	$149.98	$164.77
PEPCO	5,991	5,479	$41.09	$149.98	$164.77
PPL	11,158	9,527	$75.00	$75.00	$164.77
PS-N	3,645	3,168	$210.63	$210.63	$225.42
PSEG	6,939	5,301	$210.63	$210.63	$225.42
RTO	179,891	166,837	$149.98	$149.98	$164.77
SWMAAC	12,621	11,181	$59.95	$149.98	$164.77

Total energy efficiency resources for delivery year 2018–2019 are made up of 29% base resources and 71% capacity performance resources.

Table A8. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2019–2020

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for base demand response and energy efficiency	RCP for base generation	RCP for capacity performance
ATSI	11,848	10,291	$80.00	$80.00	$100.00
ATSI-C	2,487	2,089	$80.00	$80.00	$100.00
BGE	4,101	2,740	$80.30	$80.30	$100.30
COMED	26,589	22,971	$182.77	$182.77	$202.77
DPL-S	1,721	1,599	$99.77	$99.77	$119.77
EMAAC	33,228	30,769	$99.77	$99.77	$119.77
MAAC	74,633	64,915	$80.00	$80.00	$100.00
PEPCO	6,787	6,248	$0.10	$80.00	$100.00
PPL	12,106	9,650	$80.00	$80.00	$100.00
PS-N	3,727	3,205	$99.77	$99.77	$119.77
PSEG	6,634	5,455	$99.77	$99.77	$119.77

LDA	Capacity offered (MW)	Capacity cleared (MW)	RCP for base demand response and energy efficiency	RCP for base generation	RCP for capacity performance
RTO	185,540	167,306	$80.00	$80.00	$100.00
SWMAAC	13,300	11,395	$80.00	$80.00	$100.00

Total energy efficiency resources for delivery year 2019–2020 are made up of 30% base resources and 70% capacity performance resources.

Table A9. PJM capacity offered and cleared with resource clearing price (RCP) by LDA for 2020–2021

LDA	Capacity offered (MW)	Capacity cleared (MW)	Locational price adder	RCP
ATSI	11,705	9,925	$0	$76.53
ATSI-C	2,467	1,858	$0	$76.53
BGE	3,543	22,969	$0	$86.04
COMED	27,437	23,960	$111.59	$188.12
DAY	1,669	1,527	$0	$76.53
DEOK	3,167	2,430	$53.47	$130.00
DPL-S	1,688	1,647	$0	$187.87
EMAAC	31,045	29,608	$101.83	$187.87
MAAC	72,973	65,818	$9.51	$86.04
PEPCO	6,941	4,919	$0	$86.04
PPL	10,930	10,345	$0	$86.04
PS-N	3,359	2,975	$0	$187.87
PSEG	5,700	5,097	$0	$187.87
RTO	183,352	165,109	$0	$76.53
SWMAAC	12,895	10,354	$0	$86.04

Table A10. ISO-NE capacity offered and cleared with payment rates by area

Area	Capacity offered (MW)	Capacity cleared (MW)	Payment rate ($/kW-month)
2010–2011			
ROP/ME	39,165	34,077	$4.25
2011–2012			
ROP/ME	42,777	37,283	$3.12

Area	Capacity offered (MW)	Capacity cleared (MW)	Payment rate ($/kW-month)
2012–2013			
ROP	42,745*	35,146	$2.54
ME		3,598	$2.47
2013–2014			
ROP	40,412*	32,499	$2.52
ME		3,727	$2.34
2014–2015			
ROP/ME	39,360	36,918	$2.86
2015–2016			
ROP/ME	38,601	36,309	$3.13
2016–2017			
ROP	21,633	20,182	$2.74
ME	4,104	3,950	$2.74
CT	9,082	8,371	$2.83
NE MA	3,754	3,716	$15.00
2017–2018			
ROP existing	16,222	15,810	$7.03
ROP new	1,699	1,136	$15.00
ME existing	3,536	3,526	$7.03
ME new	272	229	$15.00
CT existing	9,275	9,184	$7.03
CT new	7	6	$15.00
NE MA new	3,878	3,820	$15.00
2018–2019			
ROP	15,733	13,725	$9.55
CT	10,364	9,802	$9.55
NE MA	4,195	3,927	$9.55
SE MA RI new	353	353	$17.73
SE MA RI existing	6,888	6,888	$11.08
2019–2020			
ROP	26,531	24,218	$7.03
Southeast NE	12,646	11,349	$7.03

Area	Capacity offered (MW)	Capacity cleared (MW)	Payment rate ($/kW-month)
	2020–2021		
ROP	18,465	15,755	$5.30
Northern NE	9,030	8,344	$5.30
Southeast NE	12,926	11,736	$5.30

Appendix B. Value of Demand Resources in the PJM BRA

Analysis of the delivery year 2017–2018 auction provides information on energy efficiency's value in the market. PJM's market monitor ran sensitivity analyses to estimate the auction's end results under various scenarios. The 2017–2018 BRA created more than $7.5 billion in total revenues, or payments to all resource suppliers. Revenues would have been almost $17 billion without the inclusion of any energy efficiency or demand response resources. This means that, without demand-side resources, the auction revenues would have increased by 124%, or more than $9 billion in costs that would have been passed along to customers (Monitoring Analytics 2014). Similarly, in the 2019–2020 auction, revenues would have increased by 30%, or about $2.1 billion without the inclusion of demand response and energy efficiency resources (Monitoring Analytics 2016).