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Energy Efficiency Participation in Electricity Capacity Markets – The US Experience

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Acknowledgements

The authors would like to thank Doug Hurley at Synapse and Cheryl Jenkins at VEIC for their valuable contributions to this paper.

How to Cite This Paper

Neme, C., Energy Futures Group, and
Cowart, R., Regulatory Assistance Project. (2014)
Energy Efficiency Participation in Electricity Capacity Markets – The U.S. Experience
Montpelier, VT: The Regulatory Assistance Project.
Available at: http://www.raponline.org/document/download/id/7303

A version of this paper was also published by the Green Alliance in the United Kingdom and is available here: http://www.green-alliance.org.uk/kickstarting_negawatts.php.

This paper was funded by the European Climate Foundation.

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March 2014

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List of Acronyms

ATSI	American Transmission System, Incorporated
FCA	Forward Capacity Auction
ISO	Independent System Operator
ISO-NE	Independent System Operator of New England
M&V	Measurement and Verification

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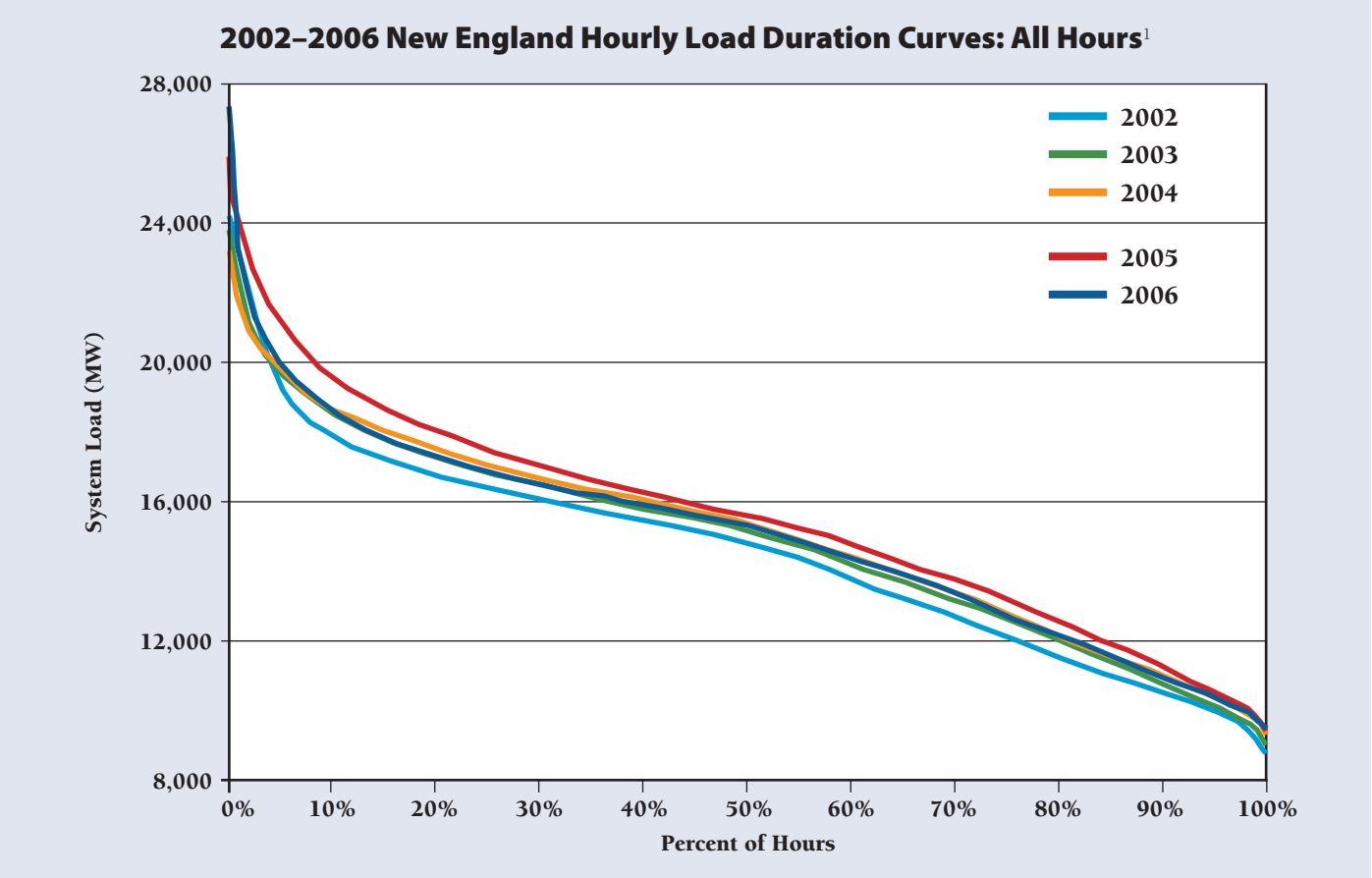
I. Introduction

Motivating power producers to plan for and develop enough capacity to meet the needs of customers during times of peak demand has been a challenge for power planners. The issue at stake is illustrated by the load duration curves for the years 2002 through 2006 for the power pool comprised of the six New England states in the northeastern United States. As Figures 1 and 2 illustrate, a substantial portion of system capacity is needed for a relatively small numbers of hours each year. Indeed, the 50 hours of the year with the greatest demand (i.e., the top 0.6 percent of the hours of the year) have been responsible for seven to ten percent of system capacity needs.

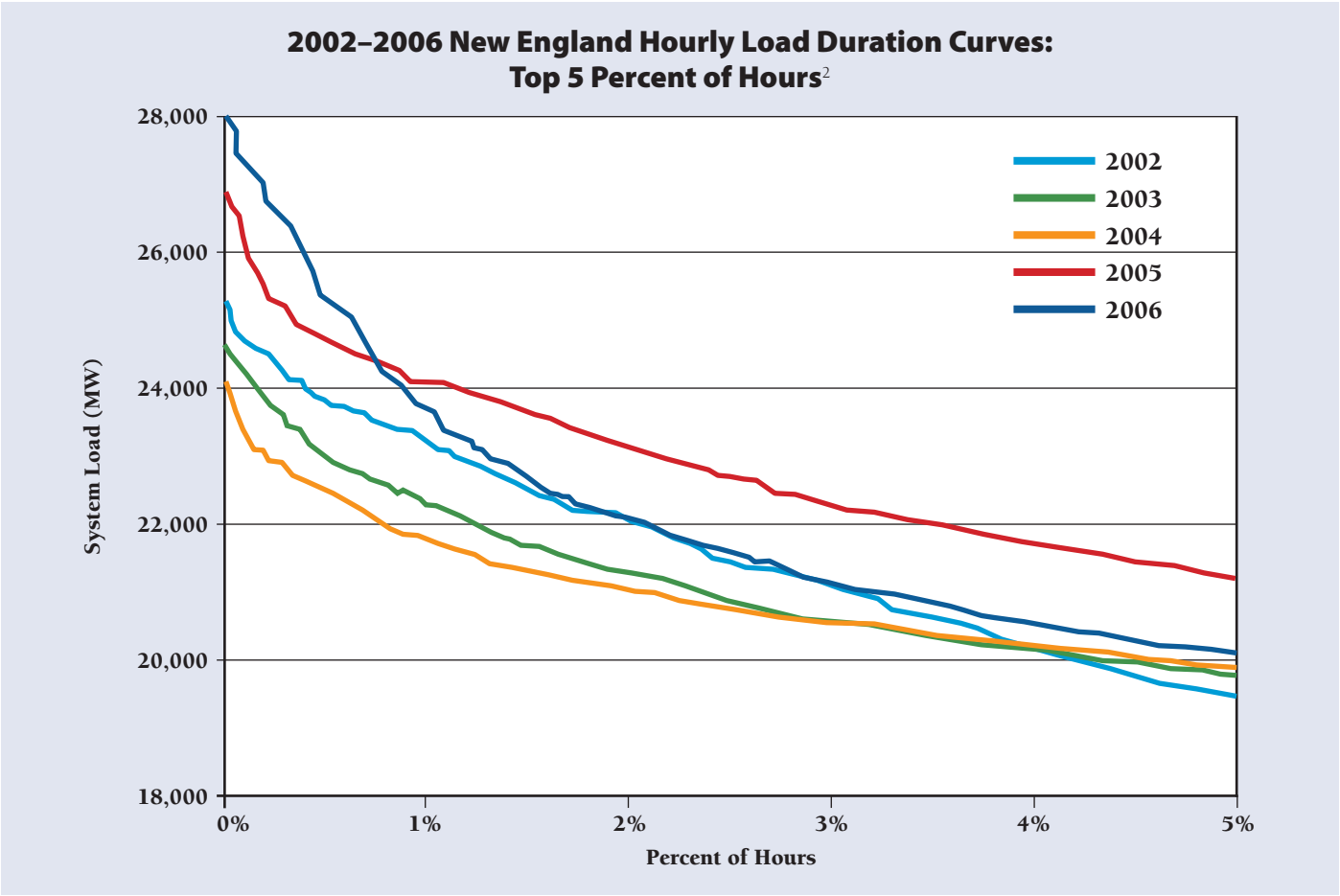
Some have expressed concern that high wholesale electricity prices in those peak hours may not be enough to ensure that sufficient capacity will be made available to meet reliability requirements. To address that concern, several U.S. Regional Transmission Organizations – sometimes called Independent System Operators (ISOs) – have created what are commonly called "capacity

Figure 1



1 ISO New England. (2007, June 11). *2006 Annual Markets Report.* Available at: http://www.hks.harvard.edu/hepg/NEISO2006_annual_markets_report.pdf

Figure 2



markets," in which payments are made for commitments to provide electric capacity during the time of future system peaks and/or capacity shortage situations. Two of those capacity markets – one managed by the ISO for New England (ISO-NE) and another managed by PJM (serving all or parts of 13 mid Atlantic and Midwestern states)[3] – allow efficiency resource providers (as well as providers of other demand resources such as distributed generation and demand response) to participate in the markets and compete with electric generators.

This paper summarizes the rules governing how efficiency resources participate in the ISO-NE and PJM capacity markets, the results of that participation, and lessons learned to date.

2 ISO New England. (2007, June 11). *2006 Annual Markets Report.* Available at: http://www.hks.harvard.edu/hepg/NEISO2006_annual_markets_report.pdf

3 The ISO-NE calls its market a Forward Capacity Market; PJM calls its market the Reliability Pricing Model.

II. Rules Governing Efficiency's Participation in Capacity Markets

Most of the resources that will be offered in capacity markets are generation resources, and the qualification and bidding rules in those markets were initially proposed to accommodate the needs of generation owners. However, with the decision to permit demand-side resources to compete comes the necessity to create rules that fairly respect the reality of those resources as well. Both ISO-NE and PJM have established a number of rules and procedures that govern how efficiency resources participate in their capacity markets. Those rules cover such things as:

- Peak periods of concern;
- The types of measures that can participate;
- How many years efficiency savings can be bid into the markets;
- Minimum size requirements for bidding;
- Prequalification requirements, including measurement and verification (M&V) plans;
- How efficiency resources are paid; and
- Penalties for failing to deliver committed capacity savings.

Each of these is addressed below.

Definition of Peak Periods for Efficiency Measures

The ISO-NE has historically defined its peak period as between 1 and 5 p.m. on summer weekdays; although it is summer peaking, ISO-NE also requires resources that are bid into its capacity market to be able to meet winter peak requirements as well. PJM focuses only on a summer peak period, which it defines as between 2 and 6 p.m. on summer weekdays.[4]

Efficiency Measure Eligibility

Almost any efficiency savings generated through the installation of efficient lighting products, appliances, motors, heating or cooling equipment, thermal envelope improvements to buildings, system controls, and/or other types of "hardware" can be bid into the market, provided that the measure will generate electricity savings at the time of interest to the ISO (i.e., peak periods discussed above) and that the bidder has an approved plan for documenting the savings achieved.

The ISOs' M&V Manuals make clear what baselines must be used for the purpose of calculating savings. Baselines must generally be consistent with what a typical customer would do under the circumstances in which the efficiency measures were installed. For example, for pure retrofit projects such as the addition of insulation to a building, the baseline is the pre-existing condition of the building. On the other hand, for customers whose existing electricity-consuming equipment has failed and needs to be replaced, the baseline must be either government's minimum efficiency standards for new equipment or standard industry practice regarding new equipment purchases, whichever is more stringent.[5]

Bidders do not have to demonstrate that the efficiency upgrades (relative to whatever baselines are appropriate) would not have been installed absent the capacity market, or even absent other programmatic market interventions used to fund investment in the measures. For example, if a new efficient air conditioner is purchased and installed, with 1 kW of peak savings relative to a baseline new air conditioner just meeting government efficiency standards, there is no need to demonstrate that the revenues from

4 ISO-NE defines summer as June through August; PJM, serving a somewhat warmer region, defines summer as June through September.

5 If the existing equipment is still functioning, a case can be made that the customer was persuaded to replace it before it otherwise would have been replaced, and a measurement of actual consumption is available, the pretreatment consumption level can be considered the baseline.

the capacity market were what caused the upgrade to occur. Nor, if the customer also received incentives from a utility-sponsored efficiency program, is there a need to demonstrate that those programmatic incentives caused the upgrade and related savings to occur. In other words, there is no distinction made between program-induced efficiency and efficiency that results from individuals' own actions (what, from an efficiency program's point of view, are called "free riders" in the United States). Put another way, there are no requirements to demonstrate what is commonly termed "additionality" in Europe.

The ISO's rationale for ignoring concerns about additionality is that they do not care why an efficiency measure is installed, only that it is installed and that the installation is reducing peak demand (relative to standard industry practice). They also observe that the additionality concept is not applied to generators. There are many generators that would make themselves available to provide energy at the time of system peak even if there were no capacity market. Those generators are not precluded from participating in, and being paid in, the capacity markets.

The only type of efficiency savings that cannot be bid into the markets is savings from behavioral programs, for example, from initiatives designed to induce episodic conservation behavior (as opposed to equipment and investment decisions) by residential or business customers.

Efficiency Measure Life

The ISO-NE allows efficiency resource providers to bid into the capacity markets and receive payment for cleared efficiency projects for the full expected life of the efficiency savings. For example, if an efficient light bulb is expected to provide savings for five years, the resource can receive capacity payments for all five years. If an efficient motor can be expected to provide savings for 20 years, it can receive capacity payments for 20 years.

In contrast, PJM only allows efficiency measures to be treated as a capacity resource for a maximum of four years, regardless of how long the measure is expected to last. PJM's rationale for this limitation is that its forecast of peak demand, and therefore its forecast of future peak capacity needs, will implicitly account for the savings that efficiency resources installed more than four years before they are producing. That view has been criticized by a number of parties who do not believe PJM's peak load forecasting methodology fully captures the impact that efficiency measures installed just four or five years earlier would have on future peak demands. And it inherently undervalues long-lived efficiency assets. However, PJM's policy has not yet changed in response. This limitation is likely to be an important part of the explanation for why efficiency resources play a much smaller role in PJM's capacity market than in the ISO-NE's market (see discussion below).

Minimum Efficiency Resource Size

The ISOs incur transaction costs in validating each bidder's participation in its capacity markets. Thus, to make operation of the markets manageable, they have imposed minimum requirements for participation. The ISO-NE has set a minimum of 100 kW for bidding into its capacity market. Because ISO-NE has eight different load zones (regions) for which capacity is procured and for which there can be different market clearing prices, the 100-kW minimum requirement applies to resources within a particular zone. Put another way, resources from different zones cannot be aggregated together to meet the 100-kW minimum requirement.

PJM has a similar requirement that efficiency projects must be 100 kW or larger. PJM also has many different regions and sub-regions for which capacity is procured and for which there are often different market clearing prices. Thus, the 100-kW minimum requirement applies to resources within a particular PJM zone.

Note that 100 kW is equivalent to the peak savings of approximately 20,000 CFLs or between 500 and 1000 annual MWh of energy savings. With that cutoff, the ISO-NE had fewer than 70 different efficiency resource "projects" (from approximately 25 different companies) clear the market in its first year.[6]

Prequalification Requirements

Both the ISO-NE's and PJM's capacity markets are three-year ahead markets. That is, both forecast capacity needs more than three years in advance and hold auctions to acquire resources three years in advance of the beginning of the prescribed "delivery period." Some months before those auctions, sponsors of new projects, including new efficiency resource projects, need to submit materials to the ISO and receive approval to bid in the markets. In New England, this prequalification

6 Based on analysis of raw data on participation provided to interested parties in a Microsoft spreadsheet by ISO-NE.

package includes a forecast of how much peak savings they will be able to acquire, their plan for and expected cost of acquiring those savings, and an M&V plan that they will use to document the savings achieved. PJM has similar requirements, although they do not require submittal of marketing plans or expected costs of acquiring the efficiency resources.

Measurement and Verification Requirements

The most important element of the prequalifications package is the M&V plan. Both the ISO-NE and PJM have (similar) extensive M&V Manuals that document what efficiency resource providers must do to demonstrate that their resources are real and will reliably deliver savings at the time of system peak. These manuals summarize the methods that can be used to document savings. Consistent with the efficiency industry's International Performance Measurement and Verification Protocols,[7] the manuals permit the following four methods to be used:

A. **Partially Measured Retrofit Isolation/Stipulated Measurement.** This method involves measuring a variable other than electric demand and using that variable in a standard engineering algorithm to estimate savings. Variables in the algorithm may be stipulated based on basic engineering principles, analysis of historic data, or manufacturers' data. This approach is perhaps most applicable to measures for which impacts can be predictable (on average, over large numbers of applications) based on key performance/operational factors (e.g., lighting wattage and/or operating hours).

B. **Retrofit Isolation/Metered Equipment.** This method involves the use of spot or short-term measurement of changes in electric demand at the component or system level. It is most applicable for measurement of levels of savings that are small relative to total facility energy use (i.e., which might not be easily discerned through analysis of total energy consumption at the site).

C. **Whole Facility/Regression.** This method involves analysis of the impact of an efficiency measure on overall facility energy demand. The evaluation is conducted using techniques ranging from simple comparisons of changes in energy bills to multivariate regression analysis. It is perhaps most applicable when the impact of measures, such as insulation, cannot be measured directly.

D. **Calibrated Simulation.** This method involves the use of computer simulation modeling of savings, in which the model has been calibrated to replicate actual energy usage. It is perhaps most commonly used to estimate savings for efficient new construction projects for which, by definition, there is no ability to measure pretreatment electricity use.

In addition, the M&V manuals provide guidance on assumptions that can be used with regard to baseline efficiency, specify levels of statistical precision that studies of peak savings impacts must have, specify how recent any studies being relied upon must be (e.g., no more than five years old for New England), and address a variety of other M&V issues.

The ISO reviews the M&V plans provided by bidder applicants as part of qualifications packages to ensure that they comply with their M&V Manuals. Once resources clear the market and are being delivered, they review documentation from the project sponsors to ensure the reported savings are consistent with the M&V plan and any M&V studies identified by the plan. In the past, expert M&V consultants have been hired to assist with this work. The ISOs reserve the right to "audit" the savings databases and related documentation of the efficiency project sponsors.

Payments for Delivered Capacity Savings

In New England, new resources that clear the market are given a one-time option of locking in the market clearing price for anywhere from one to five years. They will then receive payment of the market clearing price on a monthly basis for that term. For example, if a resource cleared in the 2013 auction for delivery beginning in June of 2016, and elected to lock in that price for five years, then it would receive the 2013 set market clearing price payment every month from June 2016 through May 2021. If the resource was still producing savings for several years after May 2021, and the project sponsor did not elect to delist the project, it would get the market clearing price applicable to the June 2021 through May 2022 period, then the market clearing price applicable to the June 2022 through May 2023 period, and so on.

7 These documents are available at the Efficiency Valuation Organization IPMVP Public Library of Documents: http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379&lang=en

In contrast, PJM pays resources that clear the market at the clearing price for the year in question (i.e., just a one-year "contract"). Resources can clear again in the following year and receive the market clearing price applicable to that year. Although PJM's market clearing prices are defined in terms of dollars per MW-day, its payments are made weekly.

Credit Requirements and Penalties for Failing to Deliver

The ISO-NE requires sponsors of all new resource projects (demand and supply) to provide financial assurance once they qualify to participate in an upcoming auction. The financial assurance is held until ISO-NE determines that the project has been tested and/or verified as meeting its full capacity obligation. If the project has met its full obligation on time, the financial assurance obligation is retired. If the project is not delivered in full and on time, the project owner is forced to acquire resources from other parties to compensate for the shortfall. In addition, the financial assurance continues to be offered until the originally bid project is completed. Should the project not be completed by two years after the initial obligated delivery date, the full amount of financial assurance is collected by the ISO-NE and the resource is terminated. The current financial assurance requirement is a total of $17.11 per kW not delivered.[8]

PJM also requires that prospective bidders provide financial credit in advance of bidding. The credit requirement is set at the highest expected market clearing price. For the 2016–2017 Base Residential Auction, the pre-clearing credit rate was $36.19 per kW.[9] Note that the credit requirement is adjusted after the market clears, based on the market clearing price, so it is common for credit requirements to be reduced after the auction. In addition, PJM imposes a penalty for failing to deliver on capacity commitments. In essence, the bidder does not get paid for the capacity that was not produced and must pay a penalty equal to the greater of (1) 20 percent of the market clearing price; or (2) $20/MW-day.[10] In the event that a project appears "off track," PJM project sponsors can procure alternative resources to offset the shortfall through bilateral contracts with other capacity providers or through supplemental auctions.

8 Personal communication with Cheryl Jenkins, Vermont Energy Investment Corporation, January 27, 2014.

9 PJM defines the credit requirement in terms of dollars per MW – that is, $36,193.04 for the 2016–2017 BRA (from Excel file titled "Planning Period Parameters," which can be found under the 2016/2017 delivery year at http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx). They are converted to dollars per kW here for comparative purposes.

10 PJM describes its penalty as equal to the market clearing price plus the greater of 20 percent of the market clearing price or $20/MW-day. However, they also say that they pay for the resource you bid into the market even if it is not delivered. Thus, the first part of the penalty is, in essence, taking away the payment you received. The balance – the 20 percent of clearing price or $20/MW-day – is the "net penalty."

III. Results to Date

Participation of Efficiency Resources

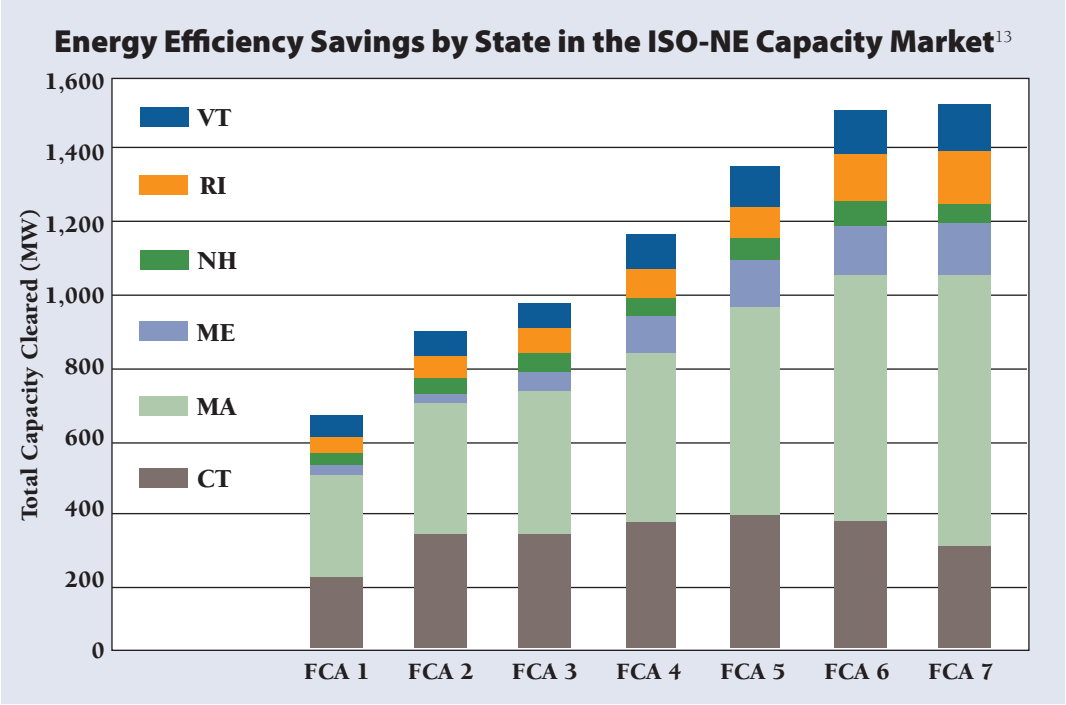
New England

Figure 3 shows the amount of energy efficiency savings that have cleared, by state, in the ISO-NE's capacity market since they were first permitted to participate.[11] In total, participation of efficiency resources in the ISO-NE's forward capacity market has more than doubled over the past seven years, from 655 MW in Forward Capacity Auction (FCA) 1 to 1538 MW in FCA 7. The 1538 MW of efficiency resources that cleared in FCA 7 represented more than half of the demand resources and approximately 4.25 percent of the total capacity that cleared.[12]

As Figure 4 shows, most of the efficiency resources that have cleared each year were bid into the market by electric utilities; almost all of the rest – particularly in recent years – was provided by what the ISO-NE calls "quasi-government" institutions. Almost none of the efficiency resources that have cleared the market, especially in recent years, have been from freestanding "merchant" providers, such as energy service companies, demand response providers, retail suppliers, and the like.

These results are a reflection of two important realities. First, all six New England states have very aggressive energy savings obligations – more aggressive than in any other region of the country. In several of the states, the obligations are to achieve new savings equal to or greater than two percent of system sales each year. In four of the six states (Connecticut, Massachusetts, New Hampshire, and Rhode Island), the energy savings obligations are imposed on distribution utilities. Almost all of

Figure 3



11 The first Forward Capacity Auction (FCA 1) was held in February 2008 for capacity to be delivered in the 12-month period beginning June 2010. Over the next couple of years, the market transitioned to a three-year ahead market. Thus the auction for FCA 7 was held in February 2013 for capacity to be delivered in the 12-month period beginning June 2016. The next auction (FCA 8) will be held in February 2014 for capacity to be delivered in the 12-month period beginning June 2017.

12 Other demand resources included distributed generation and demand response, which together accounted for a little more than 1200 MW of cleared capacity in FCA 7.

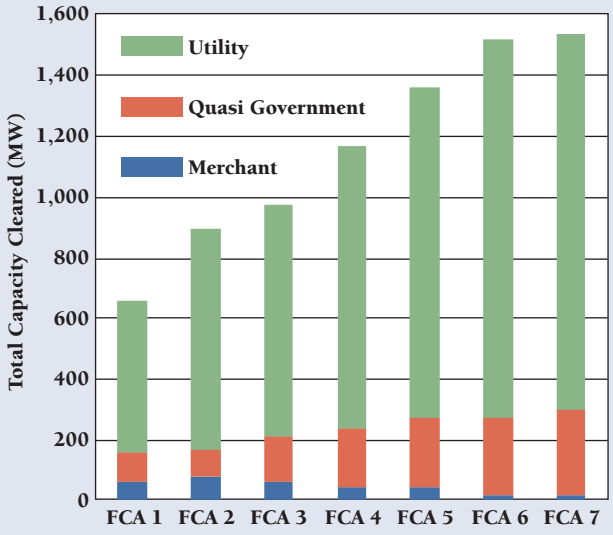
13 Adapted from data and graphic provided by Doug Hurley, Synapse Energy Economics, January 28, 2014.

the "utility" savings bid into the ISO-NE capacity market come from those obligated utilities. In the other two states, energy savings obligations are imposed on either a government agency (Maine) or a non-governmental organization contracted by regulators to deliver efficiency programs (Vermont). The vast majority of what the ISO-NE calls "quasi-government" savings comes from those two obligated entities. It is important to note that energy service companies, i.e. ESCOs, and other "merchant" providers are active in these states – it is just that most of their business is supported through larger utility-wide or statewide efficiency programs for which they act as implementing contractors and/or delivery agents (with the utilities or statewide program administrators owning and bidding the capacity savings into the market). In short, the efficiency savings bid into the ISO-NE capacity market are dominated by savings achieved by entities that are directed by state government policy to invest heavily in efficiency and therefore have substantial sources of revenue other than the capacity market revenue to acquire energy savings.[14]

Those foundational sources of revenue are critically important because the revenues from the capacity market are insufficient, by themselves, to support most energy efficiency projects.[15] For example, in Efficiency Vermont's case, gross revenues from the capacity market will average about $4.5 million over the next three years (i.e., from FCA 5 through FCA 7).[16] However, approximately 30 percent of that revenue is needed to cover the cost of participating in the market, particularly M&V costs.[17] That leaves just a little more than $3 million in net annual revenue. By way of comparison, Efficiency Vermont spent approximately $32 million to acquire electricity savings in 2012. In other words, the net capacity market revenues are probably on the order of ten percent of the cost of acquiring the capacity resources that it is bidding into the market. That is certainly enough to augment its efficiency efforts,[18] but not anywhere close to enough to fully support them.

Figure 4

Energy Efficiency Savings by Type of Organization in the ISO-NE Capacity Market[19]



14 These include efficiency program charges collected on utility bills and carbon revenues from the region's cap-and-trade program (called the Regional Greenhouse Gas Initiative).

15 In New England, the ISO-NE established an artificial floor price for the first seven years of the market. In each of those years the market cleared at the floor price, meaning that market procured more capacity than it needed – roughly ten percent more in FCA 7. Under those conditions, bidders who clear the market were given a choice of either accepting a price for their entire capacity bid that was prorated down or accepting the clearing price for a capacity commitment that was prorated down. In FCA 1, the market clearing price was $4.50/kW-month. It dropped to $3.60/kW-month in FCA 2 and has been either slightly below or above $3.00/kW-month ever since. To put those values in context, recent market clearing prices translate to a value of roughly $0.50 per year for the peak capacity savings associated with an Energy Star-rated residential refrigerator that has an incremental cost of $70 (based on estimated peak savings and incremental measure costs from Efficiency Vermont, "Technical Reference User Manual (TRM): Measure Savings Algorithms and Cost Assumptions," September 14, 2012). Thus, even over the expected 17-year life of the savings from such a measure, the capacity market payments would represent a small fraction of the cost of the measure (particularly if one discounts the value of future payment for both the time value of money and the uncertainty about what the market – if it still exists – will look like many years in the future).

16 Jenkins, C. (2013, October 22). Energy Efficiency in Wholesale Capacity Markets. Presentation at the Energy Foundation Advocates Meeting.

17 Personal communication with Cheryl Jenkins, Vermont Energy Investment Corporation, January 27, 2014.

18 Note that in Efficiency Vermont's case, the capacity market revenues are not actually used to pay for the acquisition of electricity savings as is the case in many other states in the region. Rather, they are invested in programs to promote more efficient use of unregulated fuels such as fuel oil and propane.

19 Adapted from data and graphic provided by Doug Hurley, Synapse Energy Economics, January 28, 2014.

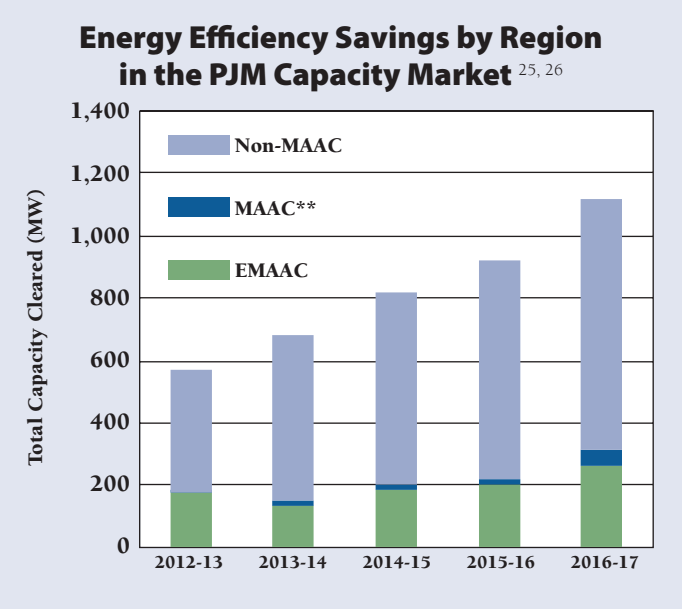
PJM

Figure 5 shows the amount of energy efficiency savings that have cleared, by region, in PJM's capacity market since they were first permitted to participate.[20] In total, participation of efficiency resources in PJM's capacity market has nearly doubled over the past five years, from 569 MW to 1117 MW. The 1117 MW of efficiency resources that cleared in the most recent auction (for the 12 months beginning June 2016) represented about 8 percent of the demand resources and approximately 0.64 percent of the total capacity that cleared.[21]

The portion of peak capacity needs met by efficiency in the PJM region (0.64 percent) is obviously a lot smaller than in New England (4.25 percent). Price does not appear to be a significant factor. Indeed, the weighted average price paid by PJM for 2016–2017 ($31/kW-year)[22] was similar to the prorated price paid by IS0-NE (about $33/kW-year);[23] PJM prices were actually higher, on average, than ISO-NE prices for the two previous years (2014–2015 and 2015–2016). Moreover, 96.6 percent of all efficiency resources qualified to bid in PJM in the most recent auction cleared the market.[24]

Three other factors are likely to explain much of the difference between the two regions. First, although most states served by PJM have energy savings obligations imposed on distribution utilities (or independent entities receiving revenues through the distribution utilities), the magnitude of the obligations is generally smaller – no more than one percent of sales per year in most jurisdictions (compared to the two percent or more in most New England states). Second, unlike in New England, not all of the obligated parties are bidding all of their eligible efficiency savings into the market because of the transaction costs, concerns about risks associated with failure to deliver, or for other reasons. Finally, as noted above, PJM only allows the first four years of savings from an efficiency measure or project to be bid, whereas the ISO-NE allows bidders to be paid for the full life of the savings.

Figure 5



Impacts of Efficiency on Market Clearing Prices

Basic economic theory suggests that broadening the scope of capacity markets to include energy efficiency and other demand resources in capacity markets should lead to reductions in market clearing prices, with attendant benefits to consumers. What follows is a brief discussion of the evidence of such impacts.

20 Adapted from data and graphic provided by Doug Hurley, Synapse Energy Economics, January 28, 2014.

21 The first PJM Base Residual Auction was for capacity to be delivered in the 12-month period beginning June 2012. The next auction will be held in May 2014 for capacity to be delivered in the 12-month period beginning June 2017.

22 PJM reports that 12,408 MW of demand response cleared the most recent auction (PJM, 2016/2017 RPM Base Residential Auction Results).

23 This is the average preliminary zonal net price across all PJM zones (see Excel file titled "2016/2017 Base Residual Auction Results" from http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx) divided by the number of efficiency MWs that cleared in each zone (from http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2016-2017-base-residual-auction-report.ashx).

24 PJM. 2016/2017 RPM Base Residual Auction Results. Available at: http://www.pjm.com/~/media/committees-groups/task-forces/cstf/20130626/20130626-item-03-2016-2017-base-residual-auction-report.ashx

25 Adapted from data and graphic provided by Doug Hurley, Synapse Energy Economics, January 28, 2014.

26 EMAAC generally includes utilities serving the mid Atlantic states of Maryland, Delaware, and New Jersey, as well as the District of Columbia and a portion of eastern Pennsylvania; MAAC includes utilities serving most of the rest of Pennsylvania; non-MAAC includes utilities serving Virginia, West Virginia, Ohio, and portions of Kentucky, Indiana, Michigan, Illinois, and North Carolina.

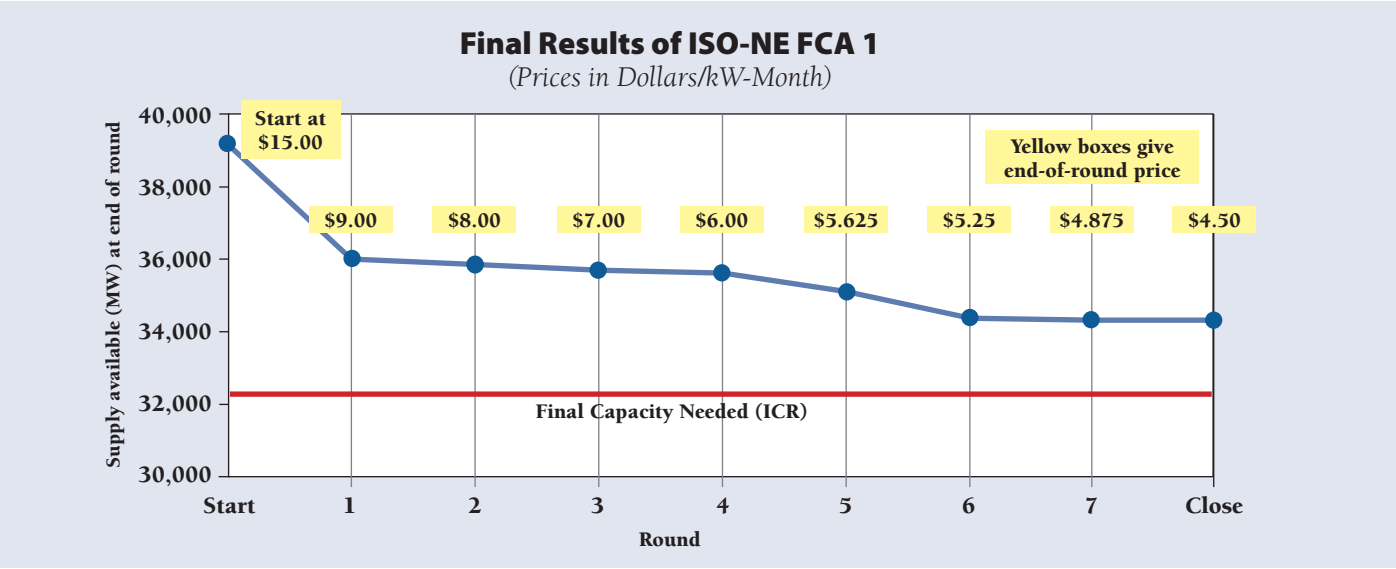
New England

The New England capacity auctions are live, internet-based auctions conducted over several days. Prior to each auction, ISO-NE publishes the capacity they seek to procure in the auction (called their Installed Capacity Requirement). In the first auction for capacity for the summer of 2010, the Installed Capacity Requirement was set at 32,205 MW. The bidding begins with all qualified resources in at the starting price, and proceeds in a "descending clock" auction, with resources withdrawing at prices below what they deem acceptable. Prices continue to fall in each subsequent round as long as there is still excess capacity on offer. The auction ends when there is no longer excess capacity, or for auctions with an administrative floor price, if there is still excess available when the price reaches the floor price.

As an example, the activity from the first New England auction is shown in Figure 6. The auction began with a set starting price of $15.00 per kW per month and 39,155 MW of resources participating. Price bids between $15.00 and $9.00 were registered during the first round of the auction, and the round closed with 35,974 MW still available at $9.00 per kW per month. Bidding continued in this fashion for a total of eight rounds to the administratively set floor price of $4.50 per kW per month, at which there was an excess of 1772 MW.[27] Demand resources, including energy efficiency, made up 2279 MW of the cleared capacity. Thus, without the demand resource participation, the system would have been more than 500 MW short at the prescribed floor price of $4.50/kW-month.[28] As a result, the price would have had to rise to somewhere between $5.25 and $5.625/kW-month – or $0.75 to $1.125/kW-month more than the price at which it cleared with demand resources – to meet the ISO-NE's needs. That translates to between $290 million and $435 million in savings to consumers in just that year. It should be emphasized that these savings are attributable to all demand resources, not just energy efficiency, as efficiency represented about a quarter of the demand resources that cleared the New England market that year. The rest were demand response and behind-the-meter generation.

A similar situation occurred in FCA 6 (for capacity to be delivered beginning the summer of 2015). The market cleared at the prescribed floor price of $3.434/kW-month with 2821 MW of excess capacity. A total of 3628 MW of the cleared capacity were demand resources, including more than 1500 MW of efficiency. Thus, without the demand resource participation, the system would have been nearly 800 MW short at the prescribed floor price.

Figure 6



27 Initially, the excess was estimated at 2047 MW. However, ISO-NE limited the participation of Real Time Emergency Generation to 600 MW, and 875 MW had cleared at the floor price and was included in the initial 2047 MW excess. Thus, the actual excess from other resources was only 1772 MW (ISO New England. Forward Capacity Market Auction (FCA 2010-2011) Results Report. Available at: http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/ccp11/fca11/fca_2010_2011_results.pdf).

28 Jenkins, C., Neme, C., & Enterline, S. Energy Efficiency as a Resource in the ISO New England Forward Capacity Market. Proceedings of the ECEEE 2009 Summer Study, pp 175–183.

As a result, the market would have cleared between $3.86 and $4.29 per kW-month – or $0.43 to $0.86 per kW-month higher.[29] That translates to between $173 million and $345 million in savings to consumers in just that year. Again, these savings are attributable to all demand resources, not just energy efficiency, but efficiency represented about 40 percent of the demand resources that cleared the New England market that year.

As documented above, the inclusion of demand-side resources in capacity markets in New England has lowered capacity prices in multiple auctions and across several years, saving power consumers hundreds of millions of dollars each year. Energy efficiency bidding is responsible for a portion of those savings, one of the many benefits of end-use efficiency in the region.

Price effects in future markets may be even more pronounced for several reasons. First, as noted above, the magnitude of the efficiency resource being bid into the markets has been growing substantially every year. Second, the February 2014 auction (for capacity delivery beginning June 2017) was the first auction without an artificially set floor price. Third, market observers are expecting future auctions to be more supply constrained. Indeed, the market clearing price for new resources in the February 2014 auction ($15.00/kW-month) was three to five times higher than the artificial floor prices at which the market cleared in previous years.[30]

PJM

The impact on New England and PJM capacity prices has not been widely analyzed to date. However, there has been as least some theoretical analysis suggesting that the impacts of not bidding efficiency resources into the market could have significant impacts on prices. For example, testimony filed with Ohio regulators in 2012 suggested that a decision by First Energy (the distribution utility serving the northeastern part of the state of Ohio) *to not bid* approximately 300 MW of efficiency into the PJM 2015/2016 Base Residual Auction for the American Transmission System, Inc. (ATSI) zone could have increased the market clearing price in the zone by as much as $150/MW-day, which would translate to an increased payment by consumers in the zone of as much as $600 million.[31] The testimony made clear that the resulting impact on the market clearing price and the cost to consumers could have been less than that amount, and that it would not be possible to determine what the actual impact would have been without more information on and analysis of the actual bids of other resources that were close to the top of the "bid stack" in the auction. To our knowledge, no such analysis has been conducted.

Reliability of Efficiency Bid into Capacity Markets

All available evidence to date suggests that the efficiency resources that have been bid into and cleared both the New England and PJM capacity markets has been as or more reliably delivered than generation and demand response resources.

New England

ISO-NE has developed its own estimates of the availability of energy efficiency, demand response, and generation resources at the time of system peak. The estimates come in two different forms.

The first is an audit of demand resource participation in the forward capacity market. It suggests that the amount of energy efficiency summer peak demand savings delivered to the system was actually 120.3 percent of what was bid; the impacts in winter months were even better.[32] In other words, efficiency resource providers significantly exceeded their requirements. The same audit concluded that demand response resources had an availability of 95.3 percent.[33]

The second source of estimates comes from the set of

29 ISO-NE. Forward Capacity Market (FCA 6) Result Report. See: http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/ccp16/fca16/fca_6_result_report.pdf

30 ISO-NE. Auction Ends with Slight Shortfall in Power System Resources Need for 2017-2018 in New England: Resource Shortage Pushes up Capacity Market Costs. Press Release; February 5, 2014. Available at: http://www.iso-ne.com/nwsiss/pr/2014/fca8_initial_results_02052014.pdf

31 Direct Testimony of Chris Neme on behalf of the Ohio Sierra Club, before the Public Utilities Commission of Ohio, Case 12-1230-EL-SSO (see testimony at http://dis.puc.state.oh.us/TiffToPDf/A1001001A12E21B44942I39668.pdf and testimony errata sheet at http://dis.puc.state.oh.us/TiffToPDf/A1001001A12F03B90259C81375.pdf).

32 Smith, D., ISO-NE Manager of Demand Resource Administration. DR Performance Update: Summer 2012 Final Results for All DR; December 2012 Initial Results for Passive DR. Power Point Presentation in Holyoke, MA, January 30, 2013, slide 18.

33 Ibid, slide 5.

assumptions that ISO-NE uses regarding the availability of different types of resources when forecasting its future capacity needs. In that analysis, energy efficiency resources are assumed to have an availability of 100 percent.[34] In contrast, real-time demand response has an assumed availability of 89 percent and real-time emergency generation (customer-sited) has an assumed availability of 86 percent.[35] Also, although 94.1 percent of existing generation is assumed to be available, the availability of peaking generation (in at least some key sub-areas) is assumed to be much lower – only 80 percent.[36] Put simply, efficiency is seen as more reliable than any other type of resource, supply-side or demand-side.

It is worth noting that ISO-NE has recently proposed a number of changes to its capacity market. The proposal appears to be primarily in response to concerns that generators have not been sufficiently reliable. Consider the following quote from the ISO-NE's filing with the Federal Energy Regulatory Commission:

> *"…as fully detailed in the testimony of Peter Brandien, the ISO's Vice President of Operations, the ISO has observed and documented pervasive and worsening performance problems among the existing generation fleet in New England. These problems, which are not limited to a single resource or fuel type, fall into three general categories. First, the region's growing dependence on natural gas leaves it extremely vulnerable to interruptions in gas supply, which can occur with little notice and which can affect multiple generators simultaneously. Second, a significant portion of New England's oil and coal units cannot provide reliable backup when gas problems arise due to increased outage rates, start-up problems, and other operational difficulties. Third, across the entire fleet, the ISO is observing increasing outage rates, poor responses to contingencies, and a host of other issues, such as failure to maintain liquid oil inventory, mothballing dual fuel capability, and inadequate staffing."* [37]

PJM

PJM's Independent Market Monitor recently conducted an assessment of the degree to which different kinds of capacity that have been bid into and cleared PJM's capacity market have (1) failed to meet their obligation and therefore been subject to penalties, or (2) only partially met their obligation with their originally planned resources (i.e., have avoided a shortfall by acquiring other resources either directly themselves, through secondary markets, or through other means).[38]

The summary of commitment shortages (i.e., the resources that cleared the market but did not show up as planned, but also did not acquire enough replacement resources to fill their gap) suggests that there is very little "commitment shortage" from any type of resource. For example, in the most recent year for which data were available (2013), the generator shortage was just 21.4 MW (out of more than 148,000), the demand response shortage was just 30.5 MW (out of nearly 11,000), and the energy efficiency shortage was just 13.5 MW (out of approximately 900). Although the shortage for efficiency resources was the greatest in percentage terms, it was still less than 1.5 percent. Presumably because all of these numbers were so small, the report devotes almost no discussion to them.

Instead, the report focuses considerable attention on "net replacements," arguing in its conclusions that the ability of bidders to clear the market without great confidence in their ability to actually acquire the resources that their bids suggest they will acquire – and the resulting reliance on secondary markets to fill the gaps – can inappropriately distort the market. The report clearly demonstrates that the magnitude of such net replacements for energy efficiency is not a concern. In 2012, the net replacement rate of –5.2 percent for energy efficiency was comparable to the rate for generators as a whole (i.e., –5.4 percent) and substantially lower than for

34 Scibelli, M. ISO New England. Proposed Installed Capacity Requirement (ICR) & Related Values for the 2017/2018 Forward Capacity Auction (FCA8). Power Point Presentation in Westborough, MA, September 18, 2013, slide 33 (see values for "on-peak" and "seasonal peak" resources, which covers all energy efficiency bids into the market).

35 Ibid.

36 Ibid, slides 30 and 35.

37 ISO New England Inc. and New England Power pool Filings of Performance Incentives Market Rule Changes, Docket No ER14-1050-000, January 17, 2014, Attachment I-1a. Transmittal letter on behalf of the ISO, p 3. Available at: http://www.iso-ne.com/regulatory/ferc/filings/2014/jan/er14-1050_000_1-17-14_pay_for_performace_part_1.pdf

38 Monitoring Analytics, The Independent Market Monitor for PJM. (2013, September 12). Analysis of Replacement Capacity for RPM Commitments: June 1, 2007 to June 1, 2013. Available at: http://www.monitoringanalytics.com/reports/Reports/2013/IMM_Report_on_Capacity_Replacement_Activity_2_20130913.pdf

demand response (i.e., –25.7 percent). In 2013, energy efficiency was the only resource type with a positive net replacement (+13.3 percent); generators (as a whole) were at –6.1 percent and demand response was at –30.7 percent.

It should be noted that these results cover only two years of any significant participation by efficiency in the PJM market. Also, the magnitude of participation by energy efficiency has been relatively small in comparison to generators and demand response providers. Nevertheless, the results suggest that energy efficiency has been the most reliable of all of the resource types that have cleared the market in recent years.

IV. Lessons Learned

There are now more than seven years of experience with bidding of demand resources, including energy efficiency, into the ISO-NE capacity market; there are more than five years of comparable experience with PJM's capacity market. That experience offers a number of key lessons for other jurisdictions that may be considering similar market mechanisms. With respect to the role of energy efficiency, the following are the most important:

1. **Energy efficiency and other demand-side resources can make significant contributions to meeting system peak demands.** This is most apparent in New England, where efficiency resources now account for 4.25 percent of bids clearing the capacity market, a fraction that is growing substantially every year.
2. **The participation of efficiency and other demand resources in capacity markets can lower market clearing prices, with potentially large economic benefits to consumers.** The magnitude of such impacts will vary depending on a number of factors, including the degree to which the system is capacity constrained, whether price floors are put in place or not, the degree to which the rules governing participation of efficiency and other demand resources impose transaction costs on market participants, and whether the full life of efficiency resources are valued.
3. **Participation in capacity markets has given previously skeptical supply planners confidence that efficiency resources are "real" and can be relied upon to meet system needs.** All available data suggest that energy efficiency resource providers are almost universally delivering the resources that they bid and that, in aggregate, bids of efficiency resources have been as reliable as or more reliable than demand response and generation resources. In addition, it is worth noting that in the last couple of years, ISO-NE has made great efforts to better forecast trends in energy efficiency to adjust their own estimates of system needs – not only for capacity, but also for transmission. After completing a recent comprehensive forecast of energy efficiency impacts, it concluded that it could defer ten upgrades of transmission lines previously planned for the states of Vermont and New Hampshire (total combined population of just 1.9 million people) at a cost savings of $260 million.[39]
4. **Participation in capacity markets has resulted in much more detailed understanding of the characteristics of savings.** The need to document not only annual savings, but the specific hours of the year during which savings occur, and to do so in accordance with very strict M&V protocols, has caused efficiency resource providers to invest in a number of sophisticated and detailed studies of many different efficiency measures targeting a large number of different residential and business electricity end uses. This has not only shed light on how much different measures save at the time of system peak (the key consideration for the studies and for participation in capacity markets), but also the role they could play in addressing more localized transmission and distribution system peaks (often peaking at different times than the system as a whole). The studies have even enriched the understanding of the magnitude of annual energy savings. Note that because of their expense, many of these studies are being undertaken collaboratively by multiple utility and non-utility parties.
5. **Capacity markets alone will not lead to substantial investments in efficiency.** Energy efficiency investments provide many different benefits to the electric system. In addition to

39 George, A., Vice President, External Affairs & Corporate Communications, & Rourke, S. J., Vice President, System Planning. (2012, December). ISO on Background: Energy Efficiency Forecast. December 12, 2012 Presentation. Available at: http://www.iso-ne.com/nwsiss/pr/2012/ee_forecast_slides_final_12122012.pdf

reducing peak demands, they reduce investment in transmission and distribution system infrastructure, line losses, fuel and other variable generation expenses, and environmental emissions. Thus, capacity markets only allow investors in efficiency to be monetarily rewarded for a small portion of the value of their investments. As a result, revenues from capacity markets alone will not be enough to support most efficiency investments. That is evident in New England, where the vast majority of the efficiency resources clearing the market are resources being acquired primarily as a result of other government policies (i.e., energy savings obligations). The capacity market revenue – perhaps on the order of ten percent of the cost of meeting the energy savings obligations – only provides a useful supplement to energy savings obligations and/or other efficiency policies. If capacity market prices are volatile, as has been the case in PJM where the average price has varied by a factor of three over the past five years,[40] the ability of such markets to support long-term changes in efficiency investments will be further limited. This should not be construed as an argument for excluding efficiency resources from capacity markets. As the other lessons above make clear, there are considerable benefits from allowing efficiency to participate in such markets. However, it is important to understand that the inclusion of efficiency resources in capacity markets is not a panacea for efficiency. It can be a valuable step to promoting greater market investment in cost-effective efficiency, but other steps must also be taken to get anywhere close to economically optimal levels of investment in efficiency. Such additional steps might include 1) the development of markets that compensate investors for the other benefits of efficiency,[41] 2) regulatory requirements or financial supports such as energy savings obligations, or 3) dedicated revenue sources.

40 The variance has been even more dramatic in some sub-regions. For example, in the ATSI region (mostly northern Ohio), the market clearing price per MW-day went from $27.73 for 2013–2014 to $342.30 for 2015–2016, then back down to $104.48 for 2016–2017.

41 For example, an efficiency feed-in-tariff would compensate efficiency investors for the energy benefits (and perhaps other non-system capacity benefits) of efficiency. For further discussion of this concept, see Neme, C., & Cowart, R. An Energy Efficiency Feed-in-Tariff: Key Policy and Design Considerations. 2013 ECEEE Summer Study Proceedings, pp 305–315; Cowart, R., & Neme, C. Can Competition Accelerate Energy Savings? Options and Challenges for Efficiency Feed-in-Tariffs. *Energy & Environment.* 24(1–2); 2013; and Neme, C., & Cowart, R. (2012, March/April). An Energy Efficiency Feed-in-Tariff: Key Policy and Design Considerations. Montpelier, VT: Regulatory Assistance Project.

Useful Reference Documents and Links

Other Relevant Papers on the Role of Efficiency in Capacity Markets

- Jenkins, C., Neme, C., & Enterline, S. (2009). Energy Efficiency as a Resource in the ISO New England Forward Capacity Market. ECEEE 2009 Summer Study, pp 175–183. Available at: http://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2009/Panel_1/1.313/paper
- Gottstein, M., & Schwartz, L. (2010, May). The Role of Forward Capacity Markets in Increasing Demand-Side and Other Low-Carbon Resources: Experience and Prospects. Montpelier, VT: Regulatory Assistance Project. Available at: www.raponline.org/docs/RAP_Gottstein_Schwartz_RoleofFCM_ExperienceandProspects2_2010_05_04.pdf

PJM Market Rules

- PJM Capacity Market Operations. (2013, November 21). PJM Manual 18: PJM Capacity Market. Revision 20. Available at: http://www.pjm.com/~/media/documents/manuals/m18.ashx
- PJM Forward Market Operations. (2010, March 1). PJM Manual 18b: Energy Efficiency Measurement & Verification. Revision 01. Available at: http://www.pjm.com/~/media/documents/manuals/m18b.ashx

PJM Market Results

- PJM. (2013, May 24). 2016/2017 RPM Base Residual Auction Results. Available at: http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2016-2017-base-residual-auction-report.ashx
- Other annual reports and data can be found under the relevant delivery year at the bottom of the following web page: http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx

ISO New England Market Rules

- ISO New England. (2013, December 17). ISO New England Manual for Forward Capacity Market (FCM). Manual M-20, Revision 14. Available at: http://www.iso-ne.com/rules_proceds/isone_mnls/index.html
- ISO New England. (2013, November 8). ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources. Manual M-MVDR, Revision 5. Available at: http://www.iso-ne.com/rules_proceds/isone_mnls/index.html

ISO New England Market Results

- ISO New England. (2013, May 9). Forward Capacity Market (FCA7) Result Report. Available at: http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/ccp17/fca17/fca_7_result_report.pdf
- ISO New England. (2013, October 24). FCA 7 Auction Results (Total Flows Diagram). Available at: http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/ccp17/fca17/fca_7_cso_flow_diagram.pdf
- Santana, A. (2013, April 3). ISO New England. FCM Update: FCA 7 Results – Demand Resource Measure Type Summary. Available at: http://www.iso-ne.com/committees/comm_wkgrps/mrkts_comm/dr_wkgrp/mtrls/2013/apr32013/fca7_results_measure_type_v2.ppt
- Other annual reports and data can be found under the relevant delivery year at http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/.

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