Energy Efficiency as a Resource in the PJM Capacity Market

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ABSTRACT

In May 2009, the PJM Interchange (PJM) held a Base Residual Auction to establish clearing prices for capacity resources, which for the first time included energy efficiency resources. This was the culmination of an intensive development process. The development, delivery, and issues surrounding the mid-Atlantic's capacity market, known as the Reliability Pricing Model (RPM), are similar in many respects to New England's Forward Capacity Market (FCM). As in New England, the RPM brings new focus and attention to the role of evaluation, measurement and verification (M&V) of energy efficiency programs. This paper briefly documents three aspects of the RPM: the stakeholder process, the market structure, and a comparison of the M&V requirements in the two capacity markets. These elements provide context for consideration of the M&V issues and challenges that energy efficiency providers may face, as well as an appreciation of some of the variations in the capacity markets that exist. Hopefully they will help stimulate and contribute to discussion that can lead to continued evolution of the role for energy efficiency resources and appropriate M&V in meeting regional supply needs.

Introduction

The PJM Interchange (PJM) is an independent, not-for-profit corporation created to oversee the bulk electric power system in all or parts of thirteen mid-Atlantic states and the District of Columbia. Since its inception, PJM has worked with stakeholders, including market participants, state regulators, and other public officials, to ensure that region's electric power system is reliable and meets electric customers' needs. The most recent step toward ensuring this reliability comes through a market solution for attracting new resources and maintaining necessary existing resources. PJM began implementing the Reliability Pricing Model (RPM) in the spring of 2007 pursuant to its Federal Energy Regulatory Commission (FERC)-approved proposal filed in August 2005 and modified in Orders issued by FERC in December 2006 and June 2007.

In May 2009, the PJM Interchange (PJM) held a Base Residual Auction (BRA), to establish clearing prices for capacity resources, which for the first time included energy efficiency resources. This was the culmination of an intensive development process. The development, delivery, and issues surrounding the mid-Atlantic's capacity market, (RPM) are largely similar to New England's Forward Capacity Market (FCM). As in New England, the RPM brings new attention to the role of evaluation, measurement and verification (M&V) of energy efficiency program results. It invites speculation about future directions, such as how large a role can or will efficiency resources have in meeting regional supply needs? Are the M&V requirements likely to drive or shape efficiency programs? One key feature that influenced the unfolding of the RPM and will likely continue to have influence is the stakeholder process. Another is that the PJM and the New England Independent System Operator (ISO) can draw on each others experiences.

The purpose of this paper is to briefly document three aspects of the RPM: the stakeholder process, the market structure, and a comparison of the M&V requirements in New England and the mid-Atlantic capacity markets. These elements can inform consideration of the M&V issues and challenges that energy efficiency providers may face, the variations in the capacity markets, and, hopefully, future discussion on the evolving role for energy efficiency resources and appropriate M&V in meeting regional supply needs.

The Stakeholder Process

The pathway for establishing the eligibility of energy efficiency resources to participate in the PJM forward capacity market led through the PJM stakeholder process. The original order to PJM from FERC on this subject was not a directive to open the capacity market to energy efficiency, but rather to establish a process for considering how the market might be opened to energy efficiency (PJM, Docket Nos. ER05-1410-002, et al, Order 119 FERC ¶ 61,318). Since the most active stakeholders in PJM affairs are market participants, and energy efficiency resources did not yet participate in the market, it was essential for efficiency advocates to engage in the structured process of stakeholder deliberations. Consideration and resolution of this issue took nearly eighteen months.

PJM stakeholder groups are created by any of several senior-level committees of PJM members, and report to the committees that created them. Participation in stakeholder groups is relatively open, but topic areas are so specialized that participation is somewhat self-limiting. On matters relating to RPM, stakeholders such as independent generators, industrial power purchasers, and state consumer advocates all have interests and opinions that ultimately must be reconciled into policy if an open capacity market is to be maintained.

The hundreds of voting members that make up PJM are categorized into five sectors – generators, transmission owners, electricity distributors, consumers, and "others" (primarily energy service providers and other consultants). Regardless of the number of entities within a sector, each sector is accorded equal weight in PJM decision-making. When business is conducted by senior-level committees, contested issues are resolved through sector-weighted voting. However, voting in most stakeholder groups is not structured by sector, which means that votes may be highly skewed toward particular groups of participants. New ideas may be hashed out, but where a clear consensus is lacking, competing proposals are advanced together and senior committees must resolve them with a sector-weighted vote. Proposals *initiated* by members require a two-thirds majority vote for approval.

For the first twelve months or so, PJM's consideration of energy efficiency in RPM was somewhat fluid. Initially assigned by staff to the Demand Side Response Working Group, the issue was subsequently moved by staff to the Demand Response Steering Committee, the RPM Working Group, and the Capacity Market Evolution Committee (CMEC). After PJM had filed its recommendations with FERC, an Energy Efficiency Task Force (EETF) was established to consider M&V and other issues that might arise following the first BRA. While many participants were the same in each venue, there were enough differences that key issues and concepts had to be discussed at some length.

The case for opening RPM to energy efficiency was articulated most clearly by consultants for Synapse Energy Economics on behalf of several state consumer advocate offices. Joined by efficiency advocates from the American Council for an Energy Efficient Economy (ACEEE) and the Natural Resources Defense Council (NRDC), and drawing heavily on their experience development of the ISO-New England Forward Capacity Market, Synapse presented the concept, outlined the benefits of energy efficiency, and fielded questions from stakeholders on multiple occasions over the course of a year.

Generation interests were most skeptical about the prospect of energy efficiency integration. Industrial power purchasers were somewhat favorably inclined toward energy efficiency eligibility from the beginning. Distribution utilities held mixed views; some recognized the potential to offer their own energy efficiency programs into the capacity market.

In anticipation of the need for PJM to file a response with FERC in ongoing proceedings regarding the RPM market design, the PJM staff developed a straw proposal on energy efficiency and other key issues pending before FERC. CMEC stakeholders caucused into two competing blocks, a "Buyers Group" representing most consumers and purchasers, including municipal and cooperative distribution utilities, and a "Suppliers Group" representing generators and power marketers. A wide range of issues were at stake, several of which had higher priority for stakeholders than the energy efficiency outcome. Following internal discussion, each of these groups framed competing proposals on each of seven major RPM issues, one of which was energy efficiency eligibility.

The key vote came at the Markets & Reliability Committee (MRC) on November 19, 2008, barely three weeks before PJM's filing deadline with FERC. The Buyers Group proposal, with its accommodation of energy efficiency, edged out the staff proposal and received far more votes than the Suppliers Group proposal. However, lacking the necessary two-thirds majority under the PJM voting system, no proposal was formally approved by PJM stakeholders, and the staff recommendations were ultimately filed with FERC.

The PJM stakeholder process is a novel structure, unlike the committees organized by public legislative bodies. It is not well suited to deciding closely divided issues. However, it is well suited to the process of sifting through complex issues in search of areas of consensus. Stakeholders may be vocal and numerous, but may not carry the day on a contested issue due to the weighted voting structure of the organization. Winning a majority vote may not be sufficient, or necessary; if enough members coalesce around a particular position, the position is likely to be advanced for further consideration.

The Energy Efficiency Task Force, very active early in 2009, was originally envisioned as a group with a finite term of existence. However, by the April 2009 Market Implementation Committee (MIC) meeting when the M&V manual was voted on and approved, the life of this task force had been extended; it will reconvene in the fall to revisit some aspects of the M&V manual and potentially other issues following the first BRA.

Energy Efficiency as a Wholesale Capacity Market Resource for PJM

The RPM, developed by PJM, participants in the wholesale markets, their member states, and industry stakeholders, procures capacity in an auction three years in advance of the delivery year, on a locational basis. This construct allows capacity developers time to plan and construct their resources, and to respond to potentially higher prices for resources where they are more urgently needed, in electrically constrained areas.

Objective of a Capacity Market

Providing mechanisms to motivate 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. Depending upon the factors that influence peak loads, the highest 10% of the system's demand may occur for as little as 50 hours a year. While power offered to meet peak load will be paid high prices, it is not needed for enough hours to pay for the incremental cost of the infrastructure to support it. In a wholesale market environment, this strategy is too risky for owners of peaking capacity. Historically, Regional Transmission Organizations (RTOs) such as PJM and ISO-NE sought to address this challenge by imposing an installed capacity requirement on load-serving entities, based on their forecasted peak loads and levying a penalty for non-compliance (Jenkins, Neme and Enterline, 2009).

Without a wholesale capacity market, owners of peaking resources would need to charge very high prices during the few hours they could sell their power. A capacity construct pays a set amount to all resources based upon their ability to deliver during peak hours. The long-term payment amount is generally based upon the capital cost of constructing a peaking unit. These capacity revenues offset some of the need for high energy prices during peak load hours. A well functioning capacity market allows all potential suppliers of capacity (both existing and planned) to offer at a price, and purchases a specified quantity at the lowest total cost.

Description of the Reliability Pricing Model

In simple terms, the RPM uses an administratively-determined demand curve, and supply curves based on locational capacity offers from resource providers, to clear the market and establish locational prices for capacity for each delivery year. Electrically constrained regions (such as New Jersey and the coastal areas of Delaware, Maryland and Virginia) may clear at higher prices, and the rest of the PJM region – unconstrained – may clear at a lower price. The resulting capacity prices are expressed in $/MW of capacity per day ($/MW-day). The clearing prices for Delivery Year June 2012-May 2013 were established through a Base Residual Auction (BRA) in May 2009 are shown in Figure 1. In this sixth BRA RPM had, for the first time, the ability to recognize and include energy efficiency measures as resources for meeting peak capacity needs and allowing those resources to compete with traditional power generators in the marketplace. Nearly 600 MW of energy efficiency resources cleared in the May 2009.

Region	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
MAAC	$ 40.80	$ 111.92	$ 191.32	$ 174.29	$ 110.00	$ 133.37
Eastern MAAC	$ 197.67	$ 148.80	$ 191.32	$ 174.29	$ 110.00	$ 139.73
Southwest MAAC	$ 188.54	$ 210.11	$ 237.33	$ 174.29	$ 110.00	$ 133.37
RTO	$ 40.80	$ 111.92	$ 102.40	$ 174.29	$ 110.00	$ 16.46

Figure 1. RPM Auction Results by Subregion

The central feature of the RPM is the establishment of an annual forward capacity auction designed to procure 100% of the region's Reliability Requirement for the PJM power year beginning three years later (PJM's power year runs from June-May). New investment is encouraged by allowing new capacity to set the market clearing price and providing the option of a long-term (up to three-year) price commitment to these new resources. Aapacity is made available at the lowest possible price, as only those bidding at or under the market clearing price will have a capacity commitment and will get paid for delivering.

Eligible Projects. Different types of capacity resources are eligible to participate in the RPM on an equal footing, including: traditional power generation; intermittent resources such as wind, solar, and hydro; imports of capacity from outside the PJM territory; and demand resources, including real-time demand response, load management, distributed generation, and energy efficiency.

RPM Time Line. As indicated in Figure 2, the period of time before each auction is used by resource providers ("project sponsors") to forecast and plan projects, by PJM to forecast the future capacity needs of the region, and by each to work toward qualification of projects to participate in the market. Successful participants in an auction, then implementation projects, in preparation for the delivery period.

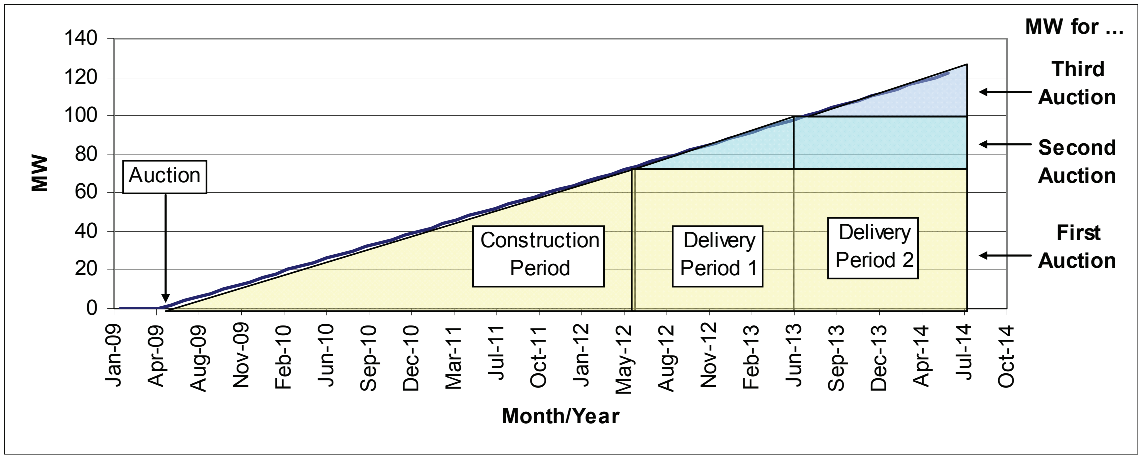

Figure 2. RPM Time Line: Energy Efficiency Resource Example

Planning for and Qualification of Resources. In the months before an auction, sponsors of new projects must determine the level of capacity that can be made available for the next delivery period and the price the project requires from the auction in order to proceed. For efficiency providers who install measures continuously, this means that a forecast must be developed of the portfolio of measures to be installed and associated capacity savings that will accumulate by a date three years in the future. This energy efficiency portfolio must be qualified by PJM to participate in the auction through submission and approval of a formal Qualifications Package, which indicates the project's capacity bid and includes plans for customer acquisition, funding and cost analysis, and measurement and verification.

Before each auction, PJM calculates Reliability Requirement for the region for the upcoming delivery period. This value, based on forecast needs and including a system reserve margin, becomes the capacity target for the auction. PJM is also charged during this time with the activities necessary for the determination of qualification of resources to participate in the auction. Projects are assessed individually and collectively to determine the impact on the region's power system and to ensure that each project qualifies.

Project "Construction. The three-year lead time from auction to delivery period is designed to allow sufficient time for the construction or development of new resources once they receive a price commitment from the auction. For traditional power generation projects, this involves power plant construction. For energy efficiency projects, this is a "ramp-up" period, with capacity reduction growing as measures that make up the project are installed. The capacity bid for the first auction therefore includes savings from measures installed over a three year period. The incremental new capacity available for auctions in subsequent commitment years must include resources that have not been committed in prior auctions. This means that in all future auctions the addition to an efficiency portfolio's capacity offering will generally include savings from measures installed during a 12-month period (June – May of the prior year, as shown in Figure 2).

Measure Decay. All energy efficiency measures have specified measures lives during which they will provide energy and capacity savings, as determined through rigorous EM&V studies. As a project sponsor in a wholesale capacity market, it is the responsibility of the market participant to appropriately account for measure decay in the performance of their capacity resource. Two options exist: retirement of the resource or measure replacement. Retirement involves an indication to PJM that the capacity resource will no longer deliver the specified savings during peak load hours as of a certain future date. In that case, the resource to be "retired" would no longer receive capacity market revenues. This is the equivalent to retiring an aging power plant. Replacement would involve accounting for measure decay by replacing measures at end-of-life with new measures that will continue to produce energy savings during peak load hours.

In the current RPM structure, energy efficiency capacity resources are only eligible for capacity market revenues for four years. As such, they are given an automatic retirement at this point. Since most efficiency measures live over four years, if PJM's measure decay construct changes in the future to allow energy efficiency to receive capacity revenues for the full measure life of the portfolio, project sponsors will have both options available to them.

Measurement and Verification Requirements

The PJM M&V Manual (PJM, 2009) sets forth the measurement and verification requirements to demonstrate the Nominated Energy Efficiency Value[1] of an Energy Efficiency (EE) Resource to be qualified as a Capacity Resource in the PJM Capacity Market starting with the 2012/13 Delivery Year. The manual provides the methodological framework for a Measurement and Verification (M&V) Plan for an EE Resource. An EE Resource Provider must submit an Initial M & V Plan, Updated M & V Plans, an Initial Post-Installation M&V Report and Updated Post-Installation M&V Reports according to a schedule described in the Manual. Failure to submit an Updated Post-Installation M&V Report prior to a subsequent Delivery Year or failure to demonstrate that post-installation M&V activities were performed in accordance with the timeline in the approved M&V Plan will result in a Final Nominated EE Value equal to zero MWs for the Delivery Year. The last Post-Installation M&V Report submitted and approved by PJM prior to the Delivery Year that the EE Resource is committed establishes the final Nominated EE Value that is used to measure RPM Commitment Compliance during the Delivery Year.

The Manual includes: an overview of EE Resources; a detailed description of the required content of the M&V Plans and Reports and the submission, approval and audit processes (Sections 2-6); and the technical requirements pertaining to the methodological approach, baseline conditions, data collection, calculations and statistical accuracy (Sections 7-12). PJM developed the M&V requirements described in the Manual with the assistance of reference materials produced by ISO New England and the U.S. Department of Energy. The following discussion is focused on a comparison of the New England (ISO, 2007) and PJM M&V technical requirements and associated compliance issues.

The technical M&V requirements that are specified in the PJM and ISO-NE manuals can be subdivided into four general areas:

- Methodological Approach
- Baseline Conditions
- Statistical Accuracy
- Measurement Systems

Methodological Approach

The PJM and ISO-NE manuals both adopt a methodological framework based on the International Performance Measurement and Verification Protocol (IPMVP). Both manuals specify four available options:

1. Option A: Partially Measured Retrofit Isolation/Stipulated Measurement
2. Option B: Retrofit Isolation/Metered Equipment
3. Option C: Whole Facility/Regression
4. Option D: Calibrated Simulation

[1] The Nominated Energy Value is similar to the Demand Reduction Value (DRV) referred to in the New England FCM.

The four options recognize the diverse nature of EE Resources and encompass a broad spectrum of M&V techniques that can be utilized depending on the type of resource, the measurement requirements associated with each type of resource and the practical limitations imposed by the cost and technical feasibility of data collection. Both manuals also provide for the use of alternative methods, if it can be demonstrated that the proposed alternative is "equivalent" to one of the four options and that there is a justification for deviation from the specified options. This methodological framework appears to reflect a general consensus regarding M&V "best practice" insofar as diverse stakeholders, including program administrators, regulatory agencies and M&V contractors have raised few concerns regarding the requirements.

Baseline Conditions

The magnitude of an EE Resource is equal to the difference between the average level of consumption with the measure installed during a specified time period and the level of consumption without the measure installed during the same time period. Only the former (installed) condition can be observed and measured at a participating customer facility. The latter (baseline) condition must be assumed or inferred from measured data. Energy efficiency programs are designed to influence two kinds of consumer decision: a) whether to replace or modify equipment that is currently in service and b) the energy consuming characteristics of the new equipment or modifications. "Retrofit" programs promote the replacement/modification of equipment or structures under the assumption that they would not be replaced or modified without the information or incentives provided by the program. "Market-driven" programs seek to influence normal market transactions to promote the installation of equipment that is more efficient than the current product or building design standard. Both elements can be included in the same program.

Both manuals recognize this distinction in terms of different baseline assumptions that can be employed in the calculation of the Nominated Energy Efficiency Value:

- ***"Standard" Baseline:*** *For projects in which equipment (whether failed or not) is replaced by a more efficient equivalent or by an alternative strategy for delivering comparable output, the Baseline Condition shall be the nameplate rating of the equipment meeting the level of efficiency required by applicable State code, Federal product efficiency standard, or standard practice, whichever is most stringent, in place at the time of installation, as known at the time of commitment. If there is no applicable State code or federal standard, then standard practice shall be used as the basis for establishing Baseline Conditions and shall be documented in the M&V Plan.*
- ***"Current Load" Baseline****: For projects in which replacement, modification or removal of equipment and controls in systems or buildings are not planned independently of the Energy Efficiency initiative that is being offered into the RPM Auction, the Baseline Condition is the kW load of the existing equipment across the Performance Hours under pre-retrofit conditions.*

Both manuals also recognize that the appropriate baseline assumption depends on the time of installation of the measures that comprise the Energy Efficiency Resource:

- *Replacement of equipment shall be with equipment that is better than the standards in place at the time of installation, as known at the time of commitment. If there is no applicable State code or federal standard, then standard practice shall be used as the basis for establishing Baseline Conditions and shall be documented in the M&V Plan.*

Statistical Accuracy and Precision

The manuals establish criteria for the statistical accuracy and precision of the calculated Nominated EE Value of an EE Resource. In this context, "accuracy" refers to systematic error (bias) and "precision" refers to random error. The accuracy requirement consists of inclusion in the M&V Plan of a description of the methods that will be used to control potential sources of bias in the calculated Nominated EE Value, including accuracy and calibration of the measurement tools, measurement error, engineering model bias, modeler bias, deemed parameter bias, meter bias, sensor placement bias, sample selection bias or non-random selection of equipment and/or circuits to monitor, regression model misspecification, statistical validity, error in measuring variables, autocorrelation, heteroscedasticity, collinearity, outlier data points, and missing data.

The PJM precision criterion is specified to be 10% relative precision at a one-tailed 90% confidence level. The ISO-NE precision criterion is specified to be 10% relative precision at a two-tailed 80% confidence level. As noted in the PJM manual, the two criteria are equivalent in that the standard formula, presented in both manuals, to calculate the required sample size under both criteria utilizes the same critical value of the normal distribution, viz. 1.282. PJM and ISO-NE both adopted this criterion in favor of a more stringent standard, in part, due to the fact that a significant cost reduction can be achieved with a relatively modest loss in precision because the sample size varies with the square of precision.

The following requirement is included in both manuals:

In the absence of a reliable c.v. the EE Resource Provider may use a default c.v. as described in preceding Section. However, once performance data has been collected, the EE Resource Provider shall demonstrate that the level of precision and accuracy is met in the sampling methodology by calculating the relative precision (r.p.) with a new estimate of c.v.

The definition of compliance is important because the PJM manual specifies a formula to de-rate the Nominated EE Value if the required precision is not demonstrated in the Post-Installation M&V Report. In order to meaningfully discuss the notion of compliance with the statistical precision criterion, it is useful to review the technical definition of precision within the context of sampling theory. The relative precision (*rp*) of a sample estimate is a theoretical property of its probability distribution defined as: $rp=1.282 \times (cv/\sqrt{n})$, where *cv* denotes the population coefficient of variation, *n* is the sample size and 1.282 is the critical value discussed above. The precision of the estimate, as defined above, depends on a known quantity, the sample size, and an unknown quantity, the population coefficient of variation. The precision of the estimate is not a function of the sample data and cannot be determined from the sample data. The formula presented in the manuals is used to provide a sample estimate of the statistical precision, i.e. the "calculated" or "achieved" precision, by substitution of a sample estimate of the *cv* in this formula.

A problem arises when a determination of compliance with the precision criterion is based on calculated precision, because the calculated precision is a random variable that depends on the sample data. The formula used to calculate the required sample size, solving the formula above for *n*, is based on an assumed value of the coefficient of variation and the required relative precision. If the assumption is correct and the required sample size is employed in the study, then the sample estimate will have the required precision, regardless of the value of the calculated precision. Compliance in this sense is commonly interpreted to mean that if these methods could be replicated in a large number of independent samples, then in 90% of the samples the estimated value would be within 10% of the population value. The *calculated* precision is also a sample estimate that will vary with repeated sampling and, like the estimated demand reduction, we would expect the estimated precision, on average under repeated sampling, to equal 10%. In fact, compliance in this sense implies that in approximately

50% of repeated samples the *calculated* precision can be expected to exceed 10%, assuming that the sample estimate is unbiased.

An approach to compliance that avoids this problem involves demonstration that the procedures employed to design and select the sample, and the methods to collect and analyze the data could reasonably be expected to result in a sample estimate with the theoretical property specified by the criterion. In practice, compliance can be reviewed in terms of empirical support for the assumed value of the coefficient of variation and the efforts to select an unbiased sample of sufficient size to allow for sample attrition. As part of the compliance review, for example, the formula stated above could be used to calculate the precision based on the actual sample size and either the assumed *cv*, if reasonable, or an alternative assumed value.

Both manuals provide two options for compliance with precision requirements, summarized as follows:

> *If an EE project consists of multiple sites and/or measures, the EE Resource Provider may calculate the aggregated Nominated EE Value during the Performance Hours in each Zone as the sum of all measured demand reduction values, provided that each measured demand reduction value achieves at least a 10% relative precision at a one-tailed 90% confidence level, or the aggregated (EE Resource level) demand reduction value achieves at least a 10% relative precision at a one-tailed 90% confidence level in each Zone.*

This provision allows the EE Resource Provider the flexibility to design each sample to comply with the criterion or to design the samples such that the aggregate precision is in compliance.

Measurement Equipment Specifications

Both manuals set forth detailed equipment requirements that apply to measurement, monitoring and data recording equipment that are used in all M&V activities described in the M&V Plan. The requirements include conformance with various industry standards published by ANSI, IEEE, IPMVP and NIST, for example, as well as technical specifications related to measurement accuracy. EE Resource Providers must also be prepared to provide documentation of all measurement, monitoring and data recording equipment maintenance and calibration activities. Both manuals provide the option to propose alternative methods to demonstrate compliance with the requirements.

In New England, program administrators working to satisfy the metering requirements set forth in the ISO M&V manual (ISO-MMVDR) commissioned a study (RLW 2008) to help them definecompliance, since the manual was difficult to interpret. As noted in the study, the ISO-MMVDR contains a requirement, not included in the PJM manual, that the accuracy of demand calculations based on measurement of proxy variables be +/- 2%. Some M&V contractors and EE Resource Providers are concerned that this requirement is not consistent with a "best practice" approach to accurate measurement and verification of EE Resources, because literal interpretation could result in the exclusion of valuable data resources and would therefore necessitate recourse to a less accurate methodology. Examples of such data resources include energy management system (EMS) trending data, typical meteorological year (TMY) temperature data and manufacturing production information. Use of generic assumptions or imputed values in lieu of the excluded measured data could produce a less accurate estimate of demand reduction.

This requirement is also unnecessary because the accuracy and precision of proxy variable measurements are addressed in other sections of the manuals. The manuals require that the EE Resource Provider describe methods to control sources of potential bias in the measurement of proxy variables, including the accuracy of measurement tools and measurement error. Proper calibration of measurement equipment, as required by the Measurement Equipment Specifications, effectively mitigates systematic bias in measured data. Proxy variable measurements are typically derived from a statistical sample of buildings drawn from the population that in aggregate defines the demand resource being measured. The statistical precision of an estimate derived from sample data is a measure of the the combined effect of random sampling error and random measurement error on the estimated value. The statistical precision of the estimate, and therefore the magnitude of the error, is controlled by designing a sample that is expected to produce an estimate with the required precision. Evaluation contractors base their judgment of the coefficient of variation employed in the sample design on their experience with similar measurements in comparable populations.

Conclusions

The M&V issues presented in this paper received significant attention from PJM and were shaped by the stakeholder process, in part because they are complex and nuanced; they involve matters of interpretation, and they affect the calculation of the Nominated EE value. The stakeholder process was particularly valuable because applying these concepts to energy efficiency resources requires a deep understanding of energy efficiency programs, something outside the typical experience of RTO and generation supply staff. On the surface the stakeholder process may appear unwieldy, unpredictable, or inefficient, but it is dynamic and it creates opportunities for education and building on experience; hopefully it will continue to have this role as energy efficiency resources and appropriate M&V help meet regional supply needs. It is too soon to determine whether or how the PJM's M&V requirements may affect efficiency programs in the mid-Atlantic.

Having more regions involved in capacity markets would bring more stakeholders, and invite opportunities for possibly more coordination and consistency. Other RTOs may consider implementing something similar. The establishment of regional markets has helped promote increased coordination and consistency in M&V practices within regions. Discussion about national protocols, is also brewing. For example, the North American Energy Standards Board (NAESB) has already worked to establish wholesale market protocols.

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