PJM Manual 18B:

Energy Efficiency Measurement & Verification

Revision: 03

Effective Date: November 17, 2016

Prepared by
PJM Forward Market Operations

Table of Contents

Approval 5

Current Revision 6

Introduction 7
About PJM Manuals 7
About This Manual 7
Using This Manual 8

Section 1: Overview of Energy Efficiency 10
1.1 Overview of Energy Efficiency 10
1.2 Energy Efficiency Installations & Eligibility 12
1.3 Modeling of an EE Resource in the PJM Capacity Market 13
1.4 Increase in the Nominated EE Value of EE Resource 14
1.5 Early Completion of EE Installations 14

Section 2: Overview of M&V Plan 15
2.1 Description of M&V Plan 15
2.2 General Requirements of M&V Plan 15

Section 3: M&V Plan Components 17
3.1 Initial M & V Plan Components 17
3.1.1 Project Level Components 17
3.1.2 Project Description/Executive Summary 17
3.1.3 Schedule 17
3.2 Measurement Level Components 18
3.2.1 Measurement Description 18
3.2.2 Equipment Specifications and Documentation 18
3.2.3 Measurement and Verification Approach 18
3.2.4 Assumptions 18
3.2.5 Measurement and Verification Activities: Baseline Period 18
3.2.6 Measurement and Verification Activities: Post-Installation Period 19
3.2.7 Calculations & Adjustments 19
3.2.8 Metering Plan 19
3.3 Updated M&V Plan Components 19

Section 4: Post-Installation M&V Report Components 20
4.1 Initial Post-Installation M&V Report Components 20

4.2 Updated Post-Installation M&V Report Components....20

Section 5: Submission and Approval Process....22
5.1 Submittal Requirements....22
5.1.1 Initial Measurement and Verification Plan....22
5.1.2 Updated Measurement and Verification Plans....22
5.1.3 Initial Post-Installation Measurement and Verification Report....22
5.1.4 Updated Post-Installation Measurement and Verification Reports....23
5.2 PJM Approval Process....24
5.2.1 Initial Measurement and Verification Plan....24
5.2.2 Updated Measurement and Verification Plans....24
5.2.3 Post-Installation M&V Reports....25

Section 6: M&V Audit Process....26
6.1 Overview of the M&V Audit....26
6.2 M&V Audit Process Requirements....26
6.3 M&V Audit Charge....27

Section 7: Measurement and Verification Methodologies....28
7.1 Option A: Partially Measured Retrofit Isolation/Stipulated Measurement....28
7.2 Option B: Retrofit Isolation/Metered Equipment....29
7.3 Option C: Whole Facility/Regression....29
7.4 Option D: Calibrated Simulation....30
7.5 Other Acceptable Measurement and Verification Methodologies....30
7.5.1 Engineering Calculations and Audit Results....30
7.5.2 Load Shape Analyses....30

Section 8: Establishing Baseline Conditions....32
8.1 Baseline Requirements for All EE Resources....32
8.2 Requirements for EE Resources Involving New Construction or Major Renovations....33

Section 9: Statistical Significance....34
9.1 Overview of Statistical Significance....34
9.1.1 Requirements....34
9.2 Statistical Sampling....35
9.2.1 General Requirements....35
9.2.2 Sample Size Requirements....35
9.2.3 Sample Size Calculation Requirements....36
9.3 Sample Size Recalibration Based on Monitoring Data....37
9.3.1 Sample Recalibration Requirements....37
9.4 Sampling Over Load Zones....38
9.4.1 Requirements....38

Section 10: Nominated EE Value Calculations.....39
10.1 Overview of Nominated EE Value Calculations.....39
10.2 Nominated EE Value for Weather Sensitive Load.....41
10.3 Reduction in the Final Nominated EE Value.....41

Section 11: Measurement and Monitoring.....43
11.1 Measurement and Monitoring Requirements.....43

Section 12: Measurement Equipment Specifications.....44
12.1 Measurement Equipment Requirements.....44

Appendix A: Illustration of Zonal WTHI and Demand Reduction Calculations.....46

Revision History.....48

Approval

Approval Date: 12/06/2016
Effective Date: 11/17/2016

Jeff Bastian, Manager

Capacity Market Operations Department

Current Revision

Revision 03 (11/17/2016):

- Revisions needed as a result of a Cover to Cover Periodic Review

Introduction

Welcome to the PJM Manual for *Energy Efficiency Measurement & Verification*. In this Introduction you will find information about PJM Manuals in general, an overview of this PJM Manual in particular, and information on how to use this manual.

- What you can expect from the PJM Manuals (see “About PJM Manuals”).
- What you can expect from this PJM Manual (see “About This Manuals).
- How to use this manual (see “Using This Manual”).

About PJM Manuals

The PJM Manuals are the administrative, planning, operating, and accounting procedures of the PJM Interconnection. The manuals are grouped under the following categories:

- Regional Transmission Planning Process
- PJM Energy Market
- Transmission
- Reserve
- Accounting and Billing
- PJM Administration
- Miscellaneous.

About This Manual

The PJM Manual for ***Energy Efficiency Measurement & Verification*** is one of the PJM procedure manuals under the Reserve Manuals category. This manual focuses on the measurement and verification of the Nominated Energy Efficiency Value (i.e., the demand reduction value) of Energy Efficiency (EE) Resources. To demonstrate the Nominated Energy Efficiency Value of an EE Resource, EE Resource Providers must comply with the measurement and verification standards defined in this Manual.

This manual provides the framework for a Measurement and Verification (M&V) Plan for an EE Resource. It serves the following purposes:

- Provide a foundation for an M&V plan utilizing a “best practice” approach, which considers technical accuracy and cost-effectiveness.
- Provide guidance on what is essential for a robust Initial M&V Plan for an EE Resource.
- Describe the components of Initial M&V Plans, Updated M&V Plans and Post-Installation M&V Report Submittals.

This manual also refers to other PJM manuals, which define in detail the operating procedures, obligations, reporting requirements, and accounting procedures established to ensure reliable and efficient capacity market operation.

The PJM Manual for ***Energy Efficiency Measurement & Verification*** consists of several sections and attachments. Both the sections and the attachments are listed in the table of contents beginning on page 2.

PJM used the following reference materials to assist in the development of the PJM Manual for ***Energy Efficiency Measure & Verification***:

- ISO New England Manual for Measurement & Verification of Demand Reduction Value from Demand Resources, Manual M-MVDR, Revision 1, October 2007.
- M&V Guidelines for Federal Energy Projects, Version 3.0, USDOE Federal Energy Management Program, April 2008.
- International Performance Measurement and Verification Protocol: Concepts and Options for Determining Energy and Water Savings, EVO-100000-1-2007.

Intended Audience

The intended audiences for this PJM Manual for Energy Efficiency Measurement & Verification are:

- Applicants to the RAA, OA and OATT Operating Agreement of PJM Interconnection, L.L.C.
- Resource providers and those interested in providing EE Resources that will be made available to provide reliable service to loads within the PJM Region.
- Load Serving Entities (LSEs) for load served in the PJM Region.
- PJM Members
- PJM staff
- Parties that may be responsible for performing a M & V Audit

References

There are other PJM documents that provide both background and detail on specific topics. These documents are the primary source for specific requirements and implementation details. This manual does not replace any of the information in those reference documents. The references for the PJM Manual for *Energy Efficiency Measurement & Verification* are:

- PJM Manual for PJM Capacity Market (M-18)
- Schedule 6 of Reliability Assurance Agreement
- Attachment DD of the Open Access Transmission Tariff

Using This Manual

We believe that explaining concepts is just as important as presenting procedures. This philosophy is reflected in the way we organize the material in this manual. We start each section with the “big picture.” Then we present details, procedures or references to procedures found in other PJM manuals.

What You Will Find In This Manual

- A table of contents that lists two levels of subheadings within each of the sections and attachments
- An approval page that lists the required approvals and a brief outline of the current revision
- Sections containing the specific guidelines, requirements, or procedures including PJM actions and PJM Member actions
- Attachments that include additional supporting documents, forms, or tables
- A section at the end detailing all previous revisions of this PJM Manual.

Section 1: Overview of Energy Efficiency

Welcome to the *Overview of Energy Efficiency* section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- An overview of Energy Efficiency in the PJM Capacity Market (see "Overview of Energy Efficiency")
- Details regarding eligibility of Energy Efficiency installations in the PJM Capacity Market (see "Energy Efficiency Installations and Eligibility")
- Details regarding modeling Energy Efficiency Resources in the PJM Capacity Market (see "Modeling of EE Resources")

1.1 Overview of Energy Efficiency

An Energy Efficiency (EE) Resource is a project that involves the installation of more efficient devices/equipment, or the implementation of more efficient processes/systems, exceeding then-current building codes, appliance standards, or other relevant standards, at the time of installation, as known at the time of commitment, and meets the requirements of Schedule 6 (section M) of the Reliability Assurance Agreement. The EE Resource must achieve a permanent, continuous reduction in electric energy consumption at the End Use Customer's retail site (during the defined EE Performance Hours and during winter performance hours if such EE Resource is a Capacity Performance Resource) that is not reflected in the peak load forecast used for the Auction Delivery Year for which the EE Resource is proposed. The EE Resource must be fully implemented at all times during the Delivery Year, without any requirement of notice, dispatch, or operator intervention.

Because energy efficiency measures are reflected in the peak load forecast for a Delivery Year for which an auction is being conducted, the auction parameters must be adjusted, as described is Section 2.4.5 of Manual 18, for the EE Resource(s) that are proposed for that auction in order to avoid double-counting of the energy efficiency measures. Similarly, if energy efficiency measures are reflected in the peak load forecast for a Delivery Year for which the Unforced Capacity Obligation of an FRR Entity is determined then the FRR Entities' UCAP Obligation must be adjusted, as described is Section 11.2 of Manual 18, for the EE Resource(s) that are used in the FRR Capacity Plan.

Note that dispatchable demand may be offered as a Demand Resource in the PJM Capacity Market, rather than an Energy Efficiency Resource. Examples of EE Resources are efficient lighting, appliance, or air conditioning installations; building insulation or process improvements; and permanent load shifts that are not dispatched based on price or other factors. For an end-use customer site, the PJM Member that offers the Energy Efficiency Resource into the PJM Capacity Market may be different than the PJM Member that offers a dispatchable load reduction from such site as a Demand Resource into the PJM Capacity Market.

An EE Resource may be used as Capacity Resource in the PJM Capacity Market. Planned energy efficiency projects will be allowed to offer into Reliability Pricing Model (RPM) Auctions or to be committed in a Fixed Resource Requirement (FRR) Alternative Capacity Plan for up to four consecutive Delivery Years.

An EE Resource may be used as Capacity Resource in the PJM Capacity Market. Planned energy efficiency projects will be allowed to offer into Reliability Pricing Model (RPM) Auctions or to be committed in a Fixed Resource Requirement (FRR) Alternative Capacity Plan for up to four consecutive Delivery Years. An EE Resource that clears in an RPM Auction will receive an RPM Auction Credit during the Delivery Year equal to the Resource Clearing Price of the Locational Deliverability Area in which the EE Resource resides times the MW amount cleared.

All of the requirements to offer or commit an EE Resource in the PJM Capacity Market are detailed in PJM Manual for PJM Capacity Market (M-18). One of the major requirements includes the measurement and verification of the EE Resource's Nominated EE Value and Capacity Performance value for the Delivery Year.

The Nominated EE Value is the expected average demand (MW) reduction during the defined EE Performance Hours in the Delivery Year. The EE Performance Hours are between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery Year, that is not a weekend or federal holiday.

Effective with the 2016/2017 Delivery Year, EE Resources that desire to qualify as a Capacity Performance product type shall also have an expected average load reduction during winter performance hours (i.e., all days from January 1 through February 28, inclusive, of such Delivery Year that is not a weekend or federal holiday, between the hour ending 8:00 EPT and hour ending 9:00 EPT, and between the hour ending 19:00 EPT and hour ending 20:00 EPT), that is not less than the Nominated EE Value determined during the defined EE Performance Hours. If the Nominated EE Value determined during the defined EE Performance Hours is greater than the expected average demand during the defined winter hours, the expected demand during the defined winter hours establishes the Nominated EE Value and Capacity Performance value of a Capacity Performance EE Resource. The Capacity Performance value of an EE Resource may not exceed the Nominated EE Value of an EE Resource.

A Measurement & Verification (M&V) Plan describes the methods and procedures for determining the Nominated EE Value of an EE Resource (value based on load reduction provided during EE Performance Hours) and a Capacity Performance value (value based on load reduction provided during EE Performance Hours and winter performance hours) and confirming that the Nominated EE Value and Capacity Performance value is achieved.

An EE Resource Provider must submit an Initial Measurement & Verification Plan for the EE Resource no later than 30 days prior to the RPM Auction in which the EE Resource is to be initially offered, or no later than 30 days prior to the submittal of an FRR Capacity Plan in which the EE Resource is to be initially committed. An EE Resource Provider must submit an Updated Measurement & Verification Plan for the EE Resource no later than 30 days prior to the next RPM Auction in which the EE Resource is eligible and is to be subsequently offered, or no later than 30 days prior to the submittal of the next FRR Capacity Plan in which the EE Resource is to be subsequently committed.

The Nominated EE Value approved by PJM in EE Resource Provider's Initial/Updated M&V Plan establishes the Nominated EE Value that may be offered in an RPM Auction or committed to an FRR Capacity Plan. The Capacity Performance value approved by PJM in an EE Resource Provider's Initial/Updated M&V Plan provides guidance to the EE Resource Provider

on the maximum amount of MWs that may be offered in Capacity Performance Offer Segments or committed as Capacity Performance in an FRR Capacity Plan.

Post-installation of the EE Resource, an EE Resource Provider must submit an Initial Post-Installation M&V Report for the EE Resource prior to the first Delivery Year that the EE Resource is committed to RPM or FRR Alternative. An EE Resource Provider must submit Updated Post-Installation M&V Reports prior to each subsequent Delivery Year that the resource is committed. 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 and Final Capacity Performance of an EE Resource 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 and Capacity Performance value that is used to measure RPM Commitment Compliance during the Delivery Year. Details regarding RPM Commitment Compliance and the associated penalty for failure to deliver the unforced value of an RPM capacity commitment (i.e., Capacity Resource Deficiency Charge) are provided in PJM Manual for PJM Capacity Market (M-18).

PJM reserves the right to audit the results presented in an Initial or Updated Post-Installation M&V Report. The M&V Audit may be conducted any time, including during the defined EE Performance Hours. If the M&V Audit is performed and results finalized prior to the start of a Delivery Year, the Nominated EE Value and Capacity Performance value confirmed by the Audit becomes the Final Nominated EE Value and Capacity Performance value that is used to measure RPM Commitment Compliance during the Delivery Year. If the M&V Audit is performed and results finalized after the start of a Delivery Year, the Nominated EE Value and Capacity Performance value confirmed by the M&V Audit becomes the basis to determine if any incremental RPM Commitment Compliance Shortfall needs to be assessed retroactively from June 1 of the Delivery Year to May 31 of the Delivery Year.

The PJM Manual for *Energy Efficiency Measurement & Verification* establishes the standards and criteria for the Initial M&V Plan, Updated M&V Plans, Initial Post-Installation M&V Report, Updated Post-Installation M&V Reports and the M&V Audit.

1.2 Energy Efficiency Installations & Eligibility

The time period of an Energy Efficiency installation and the date of the peak load forecast used to develop the parameters for an RPM Auction determine whether an installation is eligible to participate as a capacity resource in a particular RPM Auction.

Energy Efficiency installations are eligible to participate in RPM Auctions for four successive Delivery Years as illustrated in the table below. These eligibility requirements pertain to all RPM Auctions conducted after January of 2016 with the following exceptions: Installation Years 2012/13, 2013/14 and 2014/15 may offer into the 2016/17 3rd IA; Installation Years 2013/14 and 2014/15 may offer into the 2017/18 2nd IA; and Installation Year 2014/15 may offer into the 2018/19 1st IA.

Installation Period	Eligible Auctions
June 2015 – May 2016	2016/17 (BRA, 1st IA, 2nd IA, 3rd IA), 2017/18 (BRA, 1st IA, 2nd IA), 2018/19 (BRA, 1st IA), 2019/2020 (BRA)
June prior to DY – May prior to DY	DY (BRA, 1st IA, 2nd IA, 3rd IA), DY+1(BRA, 1st IA, 2nd IA), DY+2 (BRA, 1st IA), DY+3 (BRA)

1.3 Modeling of an EE Resource in the PJM Capacity Market

An EE Resource must be modeled in the eRPM system in order for the EE Resource to participate in the PJM Capacity Market. An EE Resource modeled in the eRPM system shall be an EE project(s) or portion of EE project(s) that represent the installation of EE during a defined installation period of consistent with a Delivery Year period that runs from June 1 of one year to May 31 of the next year. A separate EE Resource must be modeled in the eRPM system for each installation period in order for PJM to keep track of an EE Resource's eligibility. In addition, a separate EE Resource must be modeled for each Transmission Zone in which the installation is located.

A Resource Provider may create a single EE Resource that represents all EE installations during the defined installation period or create multiple EE Resources to represent different types of EE projects that are being installed during the same installation period.

A distinct name must be established for each EE Resource. At least two weeks prior to the initial offering of an EE Resource in an RPM Auction or initial committal of an EE Resource in an FRR Capacity Plan, the EE Resource Provider shall contact PJM at rpm_hotline@pjm.com to establish the name of the EE Resource and to request PJM to model the EE Resource in the RPM system database. Once the EE Resource is modeled in the RPM system database, the EE Resource will appear on the EE Set Up screens under the Auctions area of the eRPM system.

Prior to the commitment of an EE Resource to an FRR Entity's FRR Capacity Plan, PJM submits an EE Modification (EE MOD) in the eRPM system to represent the Nominated EE Value of an EE Resource based on the EE Provider's approved initial/updated M&V Plan. Prior to the Delivery Year, PJM submits EE MODs in the eRPM system to represent the final Nominated EE Value or final Capacity Performance value of a provider's EE Resource for the Delivery Year based on PJM's approval of the provider's Post Installation M&V Report for such Delivery Year. Details regarding EE Modifications are provided in PJM Manual for PJM Capacity Market (M-18) and the eRPM User Guide.

1.4 Increase in the Nominated EE Value of EE Resource

After an EE Resource is initially offered and cleared in a RPM Auction, the Nominated EE Value or Capacity Performance value of the EE Resource may increase due to additional installations planned during the defined installation period. The increase in the Nominated EE Value or Capacity Performance value may be offered into a subsequent Incremental Auction for the same Delivery Year for which the EE resource was originally offered and cleared provided the installation period is still eligible to participate in such Incremental Auction in accordance with Section 1.2. In this case, an Updated M&V Plan documenting the increase in the Nominated EE Value or Capacity Performance value of the EE Resource must be submitted 30 days prior to the Incremental Auction.

1.5 Early Completion of EE Installations

If any of the installations that were intended to make up an EE Resource are to be completed prior to the defined installation period for the EE Resource, the early installations may be eligible to participate in an Incremental Auction for the prior Delivery Year provided the installation period in which the early installations were actually completed is still eligible to participate in the Incremental Auction in accordance with Section 1.2. However, the early installation would still only be eligible for four consecutive years of RPM revenue.

Section 2: Overview of M&V Plan

Welcome to the *Overview of M&V Plan* section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- The description of a M&V Plan for an EE Resource (see “Description of M&V Plan”)
- The general requirements of an M&V Plan for an EE Resource (see “General Requirements of M&V Plan”)

2.1 Description of M&V Plan

The Measurement and Verification (M&V) Plan is a document that defines project-specific M&V methods and techniques that will be used to determine and verify the Nominated EE Value (i.e., the demand reduction during EE Performance Hours) and Capacity Performance value (i.e., the demand reduction considering the EE Performance Hours and winter performance hours) resulting from an EE Resource. A single M&V Plan may be submitted to cover multiple EE Resources. The single M&V Plan must clearly document the Nominated EE Value and Capacity Performance value of each EE Resource covered in the M&V Plan.

In addition to providing accurate and conservative methods to calculate the Nominated EE Value and Capacity Performance value, a good M&V Plan is clear, consistent, and repeatable. All the assumptions, procedures, and data for the M&V Plan should be recorded properly so that they may be easily referenced and verified by others. The data included should be sufficient for a third party to audit the M&V procedures and verify the Nominated EE Value and Capacity Performance value of an EE Resource.

M&V activities include, but are not limited to, site surveys, demand measurements, metering of key variables, data analyses, calculations, and quality assurance procedures. All of these key components need to be adequately detailed in the M&V Plan.

2.2 General Requirements of M&V Plan

An M&V Plan submitted to PJM must include:

1. A summary of the methodologies used to determine the Nominated EE Value and Capacity Performance value.
2. A description of why the methodology or combination of methodologies selected is the most appropriate, relative for its project.
3. A description of any variables that affect the project’s electrical demand (such as outside temperature, time of day, process changes, occupancy, etc.) that will be measured or monitored and used in the determination of the Nominated EE Value during the defined EE Performance Hours and in determination of the Capacity Performance value considering the defined EE Performance Hours and winter performance hours.
4. All substantive assumptions for the project’s Nominated EE Value and Capacity Performance value, including but not limited to, baseline demand consumption, post-installation demand consumption, process changes, and measure life.
5. Specifications of the equipment or types of equipment for projects being installed and/or modified. The information may include, but is not limited to, engineering analysis utilized

to specify equipment, program design measures and or practices, or applications of equipment, measure or practice relative to end use or processes in the facility.

If one or more of the variables that will be measured or monitored and/or assumptions that will be used in the determination of the EE Resource's Nominated EE Value and Capacity Performance value during the defined EE Performance Hours and winter performance hours are not known at the time the EE Resource Provider submits its Initial M&V Plan to PJM for review and approval, the EE Resource Provider may provide alternative information and/or forecasts and indicate the portion of the Nominated EE Value and Capacity Performance value associated with such measurement and monitoring variables and/or assumptions and explain the basis for such forecasts.

The M&V Plan may also include the following:

1. References to engineering best practices in the Measurement and Verification literature, reference reports, or state of the art techniques to demonstrate that its proposed Measurement and Verification approach is appropriate for the Energy Efficiency Resource type and will produce an accurate and reliable Nominated EE Value and Capacity Performance value .
2. A description of the technical capabilities of its project team and subcontractors to implement its proposed methodology.

Section 3: M&V Plan Components

Welcome to the Initial M&V Plan section of the *PJM Manual for Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- Required components of the Initial M&V Plan (see “Initial M&V Plan Components”)
- Required components of an Updated M&V Plan (see “Updated M&V Plan Components”)

3.1 Initial M & V Plan Components

The following are the Project Level and Measurement Level Components that are required to be contained in the Initial M&V Plan. Each Project Level and Measurement Level Component includes a description of the required information.

3.1.1 Project Level Components

The project level components lay the groundwork for obtaining information about the project and provide a shared understanding about its objectives, sponsorship, costs, benefits, timeframes, resources and mandate. All of the Project-level Components of the M&V Plan should be complete in the Initial M&V Plan.

3.1.2 Project Description/Executive Summary

- Company name
- Project name
- Submission date
- Company address and contact information
- Project goals
- Energy Efficiency Application – how it reduces demand during defined EE Performance Hours and winter performance hours if offering/committing as a Capacity Performance EE Resource
- Applicable Energy Efficiency or performance standards (i.e., building codes, appliance standards, or other relevant standards that are in effect at the time of the installation, as known at the time of commitment)
- Anticipated energy and demand reductions for each EE application and total anticipated reductions.
- Location of EE Resource (Transmission zone)
- Anticipated Nominated EE Value and Capacity Performance value of EE Resource

3.1.3 Schedule

- Timeline for EE installation and Measurement and Verification activities.

3.2 Measurement Level Components

The measurement level components define the measurement and verification process(es) selected and provide detailed rationale for the selection. The following measurement level components must be included in the Initial M&V Plan. The information submitted in these components should be refined, when appropriate, with each Updated M&V Plan submittal.

3.2.1 Measurement Description

- Specific details about each EE project
- Demand and energy reductions to be claimed
- Rationale for selected form of measurement

3.2.2 Equipment Specifications and Documentation

- History of equipment to be replaced or modified
- Equipment standards

3.2.3 Measurement and Verification Approach

- Measurement and Verification Option
- General description of approach
- Monitoring parameters and variables
- Monitoring interval and period
- Measurement equipment specifications
- Measurement data collection and management
- Data validation, editing and estimating plan
- Accuracy of Monitoring and Verification method
- Demand reduction uncertainty and confidence level
- Factors most uncertain or difficult to quantify

3.2.4 Assumptions

- Baseline and post-installation assumptions that affect demand and energy consumption (building occupancy schedules, equipment efficiencies, equipment operating strategies, load shapes, weather data, etc.)

3.2.5 Measurement and Verification Activities: Baseline Period

- Who will do M&V Activities
- List of activities before and after installation
- List of variables affecting demand and energy consumption and how they will be quantified
- Critical baseline condition factors

3.2.6 Measurement and Verification Activities: Post-Installation Period

- List of variables affecting demand and energy consumption, variance from baseline case, and how they will be quantified
- Evidence that proper equipment/systems were installed, are operating correctly, and have the potential to generate the predicted demand reduction (verification methods include surveys, inspections, spot measurements, and short-term metering.).
- New equipment surveys
- Critical post-installation condition factors
- Activities to ensure equipment operating as intended

3.2.7 Calculations & Adjustments

- Equations, calculations and analysis procedures for baseline and post-installation demand and energy consumption
- How performance models will be developed
- Description of population(s)
- Sample size calculations
- Method of sampling
- How demand and energy reductions will be calculated
- How adjustments will be made

3.2.8 Metering Plan

- Who will provide and maintain metering equipment
- Specifications of metering equipment, accuracy, calibration procedures
- How data will be collected, maintained and reported
- Accuracy and quality assurance procedures

3.3 Updated M&V Plan Components

An Updated M&V Plan must include any updates to the Project Level & Measurement Level Components that were included in the Initial M&V Plan or prior Updated M&V Plan.

The Updated M&V Plan must include:

- Cover page with list of changes/updates contained in the Updated M&V Plan
- Details of any changes between the prior M&V Plan, including any changes to the project status, and any changes to the demand and energy reductions
- Updated/refined Nominated EE Value and Capacity Performance value calculations, including any baseline adjustments performed.

Section 4: Post-Installation M&V Report Components

Welcome to the *Post-Installation M&V Report Components* section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- Required components of the Initial Post-Installation M&V Report submittals (see "Initial Post-Installation M&V Report Components")
- Required components of the Updated Post-Installation M&V Report submittals (see "Updated Post-Installation M&V Report Components")

4.1 Initial Post-Installation M&V Report Components

Post-installation measurement and verification activities are conducted to ensure that proper equipment/systems were installed, are operating correctly, and have the potential to generate the Nominated EE Value and Capacity Performance value of the EE Resource. Verification methods include surveys, inspections, spot measurements, and short-term metering.

An Initial Post-Installation M&V Report must include any updates to the Project Level & Measurement Level Components that were included in the prior Updated M&V Plan.

The Initial Post-Installation Report should include:

- Cover page with list of changes/updates contained in the Initial Post-Installation M&V Report
- Details of any changes between the prior Updated M&V Plan and as-built conditions, and any changes to the estimated demand and energy reductions
- Detailed list of installed equipment
- Documentation of all post-installation verification activities (verifying that the equipment/systems were installed and are operating)
- Documentation of performance measurements conducted to validate the Nominated EE Value and Capacity Performance value of the EE Resource (if applicable in accordance with the approved M&V Plan)
- Detail any changes to the Nominated EE Value and Capacity Performance value of the EE Resource

A Post-Installation M&V Report template is available on the Capacity Market (RPM) web page of the pjm website.

4.2 Updated Post-Installation M&V Report Components

An Updated Post-Installation M&V Report should include any updates to the Initial Post-Installation Report or a prior Updated Post-Installation Report.

The Updated Post-Installation Report should include:

- Cover page with list of changes/updates contained in the Updated Post-Installation M&V Report

- Documentation of all post-installation verification activities (verifying that the equipment/ systems are still installed and operating)
- Documentation of performance measurements conducted to validate the Nominated EE Value and Capacity Performance value of the EE Resource (if applicable in accordance with the approved M&V Plan)
- Detail any changes to the Nominated EE Value and Capacity Performance value of the EE Resource.

Section 5: Submission and Approval Process

Welcome to the *Submission and Approval Process* section of the PJM Manual for the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- Submittal requirements and deadlines for the Initial M&V Plan, Updated M&V Plans, and Post-Installation M&V Reports (see "Submittal Requirements")
- Description of PJM approval process for Initial M&V Plan, Updated M&V Plans, and Post-Installation M&V Reports (see "PJM Approval Process")

5.1 Submittal Requirements

5.1.1 Initial Measurement and Verification Plan

The EE Resource Provider must submit an Initial Measurement & Verification (M&V) Plan for the EE Resource via e-mail to the RPM Hotline at rpm_hotline@pjm.com, no later than 30 days prior to the RPM Auction in which the EE Resource is to be initially offered, or no later than 30 days prior to the submittal of an FRR Capacity Plan in which the EE Resource is to be initially committed.

PJM or an independent third party will review the content of the M&V Plan, and will notify the EE Resource Provider within 10 days of receipt of the Initial M&V Plan whether or not approval of the Initial M&V Plan is granted. If approval is granted, the EE Resource Provider will be permitted to offer the EE Resource into the RPM Auction or commit the EE Resource to an FRR Capacity Plan.

5.1.2 Updated Measurement and Verification Plans

The EE Resource Provider must submit an Updated Measurement & Verification (M&V) Plan for the EE Resource via e-mail to the RPM Hotline at rpm_hotline@pjm.com, no later than 30 days prior to each of the next RPM Auctions in which the EE Resource is to be subsequently offered, or no later than 30 days prior to the each of the next FRR Capacity Plan submittals in which the EE Resource is to be subsequently committed. If an Updated M&V Plan is not submitted prior to the subsequent RPM Auction or FRR Capacity Plan Submittal, the EE Resource will not be permitted to offer the EE Resource into the RPM Auction or commit the EE Resource in an FRR Capacity Plan for the relevant Delivery Year .

PJM or an independent third party will review the content of an Updated M&V Plan, and will notify the EE Resource Provider within 10 days of receipt of the Updated M&V Plan and indicate whether or not approval of the Updated M&V Plan is granted. If approval is granted, the EE Resource Provider will be permitted to offer the EE Resource into the RPM Auction or commit the EE Resource in an FRR Capacity Plan for the relevant Delivery Year.

5.1.3 Initial Post-Installation Measurement and Verification Report

Post-installation of the EE Resource, the EE Resource Provider must submit an Initial Post-Installation M&V Report for the EE Resource via e-mail to the RPM Hotline at rpm_hotline@pjm.com, no later than 15 business days prior to the first Delivery Year that the EE Resource is committed to RPM or FRR Alternative.

PJM or an independent third party will review the content of the Initial Post-Installation M&V Report, and will approve the Final Nominated EE Value and Capacity Performance value for the EE Resource for the first Delivery Year that the EE Resource is committed.

Note:
Failure to submit an Initial Post-Installation M&V Report will result in a Final Nominated EE Value and Final Capacity Performance value equal to zero MWs.

The Final Nominated EE Value or Final Capacity Performance value for the Delivery Year will be reflected in the eRPM system and used in determining the ICAP Owned and final unforced capacity value of the EE Resource for the Delivery Year. If the final unforced capacity value of the EE Resource is greater than its RPM Resource Commitments, the available capacity from the EE Resource may be used as replacement capacity for another EE Resource in the EE Resource Provider's account. Refer to Section 8.2.3 of Manual 18 for further details on the process used to set the ICAP Owned on an EE Resource when the EE Resource has both non-Capacity Performance and Capacity Performance commitments on an EE Resource for the Delivery Year.

RPM deficiency penalties may result if the final unforced capacity value of the EE Resource is less than the unforced capacity commitment associated with that EE Resource. Details regarding RPM Commitment Compliance and associated failure to deliver the unforced value of an RPM capacity commitment (i.e., Capacity Resource Deficiency Charge) are provided in PJM Manual for PJM Capacity Market (M-18). FRR deficiency penalties may result if a reduction in the unforced capacity value of the EE Resource causes the FRR Entity to no longer have sufficient unforced capacity committed in its FRR Capacity Plan to meet its Final Unforced Capacity Obligation for the Delivery Year. Details regarding FRR Capacity Resource Deficiency Charges are also provided in PJM Manual for PJM Capacity Market (M-18).

5.1.4 Updated Post-Installation Measurement and Verification Reports

The EE Resource Provider must submit an Updated Post-Installation M&V Report for the EE Resource via e-mail to the RPM Hotline at rpm_hotline@pjm.com, no later than 15 business days prior to each of the subsequent Delivery Years that the EE Resource is committed to RPM or FRR Alternative.

PJM or an independent third party will review the content of the Updated Post-Installation M&V Report, and will approve the Final Nominated EE Value and Final Capacity Performance value for the EE Resource for the relevant Delivery Year that the EE Resource is committed.

If the EE Resource Provider ***fails*** to submit an Updated Post-Installation M&V Report for a Delivery Year or if the submitted Updated Post-Installation M&V Report fails to demonstrate that post-installation M&V activities were performed in accordance with the timeline in the approved M&V Plan, the Final Nominated EE Value and Final Capacity Performance value will equal zero MWs for the relevant Delivery Year.

The Final Nominated EE Value or Final Capacity Performance value will be reflected in the eRPM system and used in determining the ICAP Owned and final unforced capacity value of the EE Resource for the relevant Delivery Year. Refer to Section 8.2.3 of Manual 18 for further details on the process used to set the ICAP Owned on an EE Resource when the EE Resource has both non-Capacity Performance and Capacity Performance commitments on an EE Resource for the relevant Delivery Year.

RPM deficiency penalties may result if the final unforced capacity value of the EE Resource is less than the unforced capacity commitment associated with that EE resource. Details regarding RPM Commitment Compliance and associated failure to deliver the unforced value of an RPM capacity commitment (i.e., Capacity Resource Deficiency Charge) are provided in PJM Manual for PJM Capacity Market (M-18). FRR deficiency penalties may result if a reduction in the unforced capacity value of the EE Resource causes the FRR Entity to no longer have sufficient unforced capacity committed in its FRR Capacity Plan to meet its Final Unforced Capacity Obligation for the Delivery Year. Details regarding FRR Capacity Resource Deficiency Charges are also provided in PJM Manual for PJM Capacity Market (M-18).

5.2 PJM Approval Process

5.2.1 Initial Measurement and Verification Plan

Upon receipt of an Initial Measurement and Verification Plan, PJM or an independent third party will review the contents of the plan to ensure that the requirements for the Project Level and Measurement Level Components of the Initial M&V Plan were adequately satisfied and the EE Resource meets the criteria for offering an Energy Efficiency Resource into an RPM Auction or committing an Energy Efficiency Resource in an FRR Capacity Plan.

Within 10 days of receipt of the Initial Measurement and Verification Plan, PJM will notify the EE Resource Provider and indicate whether or not the Initial Measurement and Verification Plan is approved or denied.

PJM may deny entry into an RPM Auction or deny inclusion of the EE Resource in an FRR Capacity Plan if the submitted Initial M&V Plan falls short of meeting the requirements.

If an Initial M&V plan is denied, PJM will provide a list of the areas in the Initial M&V Plan that were not adequate to the EE Resource Provider. Initial M&V Plans that are denied by PJM may be corrected and resubmitted no later than 15 days prior to the RPM Auction, or no later than 15 days prior to the submittal of an FRR Capacity Plan. If time does not permit, Initial M&V Plans that are denied by PJM may be corrected and resubmitted for a consideration in a subsequent RPM Auction.

Alternately, PJM may approve a reduced Nominated EE Value based on the Initial M&V Plan and allow entry into the RPM Auction or use of the EE Resource in an FRR Capacity Plan.

5.2.2 Updated Measurement and Verification Plans

Upon receipt of an Updated Measurement and Verification Plan, PJM or an independent third party will review the contents of the plan to determine if the requirements of an Updated M&V Plan were met.

Within 10 days of receipt of the Updated Measurement and Verification Plan, PJM will notify the EE Resource Provider and indicate whether or not the Updated Measurement and Verification Plan is approved or denied.

PJM may deny entry into a subsequent RPM Auction or deny use of the EE Resource in an FRR Capacity Plan if the submitted Updated M&V Plan falls short of meeting the requirements of an Updated M&V Plan.

If an Updated M&V Plan is denied, PJM will provide a list of the areas in the Updated M&V Plan that were not adequate to the EE Resource Provider. Updated M&V Plans that are denied by PJM may be corrected and resubmitted no later than 15 days prior to the RPM Auction,

or no later than 15 days prior to the submittal of an FRR Capacity Plan. If time does not permit, Updated M&V Plans that are denied by PJM may be corrected and resubmitted for a consideration in a subsequent RPM Auction for the same Delivery Year.

Alternately, PJM may approve a reduced Nominated EE Value based on the Updated M&V Plan and allow entry into the RPM Auction or use of the EE Resource in an FRR Capacity Plan.

5.2.3 Post-Installation M&V Reports

Upon receipt of an Initial or Updated Post-Installation M&V Report, PJM or an independent third party will review the contents of the report to determine if the requirements of an Initial or Updated Post-Installation Report were met and approve the Final Nominated EE Value for the Delivery Year. If the Initial or Updated Post-Installation M&V Report is not submitted or if the submitted Initial or Updated Post-Installation M&V Report fails to demonstrate post-installation M&V activities were performed in accordance with the timeline in the approved M&V Plan, the approved Final Nominated EE Value and Final Capacity Performance value will be zero MWs for the relevant Delivery Year.

Section 6: M&V Audit Process

Welcome to the *M&V Audit Process* section of the PJM Manual for the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- An overview of the M&V Audit (see "Overview of the M&V Audit")
- A description of the measurement and verification audit process requirements for an EE Resource Provider (see "M&V Audit Process Requirements").
- Details regarding the M&V Audit Charge (see "M&V Audit Charge")

6.1 Overview of the M&V Audit

PJM or an independent third-party (as directed by PJM) may conduct an audit, at the EE Resource Provider's expense, of the energy efficiency installation prior to or during the Delivery Year. The M&V Audit may be conducted any time, including during the defined EE Performance Hours. If the M&V Audit is performed and results finalized prior to the start of a Delivery Year, the Nominated EE Value and Capacity Performance value confirmed by the Audit becomes the Final Nominated EE Value and Final Capacity Performance value that is used to measure RPM Commitment Compliance during the Delivery Year. If the M&V Audit is performed and results finalized after the start of a Delivery Year, the Nominated EE Value and Capacity Performance value confirmed by the M&V Audit becomes the basis to determine if any incremental RPM Commitment Compliance Shortfall needs to be assessed retroactively from June 1 of the Delivery Year to May 31 of the Delivery Year.

6.2 M&V Audit Process Requirements

1. The EE Resource Provider shall cooperate in any and all unannounced audits or tests of a project conducted by PJM or an independent third-party to verify its compliance with the requirements in this Manual. These audits may be conducted on a periodic basis, or at the PJM's discretion should PJM have a reason to suspect a deficiency in the Resource Provider's compliance with any of the requirements in this Manual. On site audits will be coordinated with the EE Resource Provider and scheduled during normal business hours.
2. The EE Resource Provider shall allow PJM or an independent third-party to audit testing and calibration records, and order and witness the testing of metering and measurement equipment installed pursuant to the EE project's approved M&V Plan.
3. The EE Resource Provider shall allow PJM or an independent third-party to audit any tracking databases used to track when and where the energy efficiency technology was installed.
4. The EE Resource Provider will be responsible for all expenses associated with installing, maintaining, calibrating and testing the metering, data recording and measurement equipment installed pursuant to the project's approved M&V Plan.
5. PJM may accept an audit conducted by the State if the M&V meets all the PJM requirements. The determination will be made case by case basis. Alternatively, the data provided by the State audit may be used to reduce the cost of PJM audit.

6.3 M&V Audit Charge

PJM will provide documentation regarding the cost of the audit no later than two months after the completion of the audit. PJM will assess an M&V Audit Charge to an EE Resource Provider no later than the third billing month after the completion of audit.

Section 7: Measurement and Verification Methodologies

Welcome to the *Measurement and Verification Methodologies* section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- A description of the acceptable measurement and verification methodologies (see "Acceptable Measurement and Verification Methodologies").
- A description of other acceptable methodological techniques (see "Other Acceptable Methodological Techniques").

The following options are considered acceptable Measurement and Verification methodologies:

7.1 Option A: Partially Measured Retrofit Isolation/Stipulated Measurement

Option A may involve an equipment specific retrofit or replacement, new installation or a system level Measurement and Verification assessment. The approach is intended for measures where either performance factors (such as lighting wattage) or operational factors (such as operating hours) can be measured on a spot or short-term basis during baseline establishment and post-installation periods, or for measures for which a measured proxy variable can, in combination with well-established algorithms and/or stipulated factors, can provide an accurate estimate of the Nominated EE Value and Capacity Performance value.

Option A methodology consists of the following:

1. The factors, parameters and/or variables not measured can be stipulated based on assumptions, analysis of historical data, or manufacturer's data. If a stipulated factor is subject to change over the EE Performance Hours or winter performance hours, the EE Resource Provider shall describe how the changes will be factored into the calculation of the Nominated EE Value or Capacity Performance value.
2. Measuring a variable other than electrical demand (MW) and using that variable in the calculation of the demand reduction value. Measurements can include short-term or long-term end-use metering of a variable such as current (amperage) and voltage to calculate demand, equipment operating status (on/off), equipment operating times, equipment quantities (i.e., number of units installed, cubic feet of insulation installed) or facilities served where the Nominated EE Value or Capacity Performance value per facility is constant.
3. An established correlation between the metered/monitored proxy variable and electrical demand (MW). The EE Resource Provider may establish the correlation by conducting short-term monitoring or a series of spot measurements of both stipulated parameters, and correlating the data sets (e.g., by performing a regression analysis) to determine the functional relationship between the two parameters.
4. Engineering correlations may also be specified using documented engineering algorithms or as part of an engineering simulation.
5. Equipment manufacturer's data, equipment data compiled by a recognized industry group or equipment data compiled as part of a State-sponsored demand side

management program (i.e., lighting fixture wattage tables) may be used in combination with the other measurements, variables or factors as described above to calculate Nominated EE Value or Capacity Performance value. Data from a manufacturer must be determined in a manner consistent with standards established by a recognized United States government agency or national recognized industrial manufacturing association.

7.2 Option B: Retrofit Isolation/Metered Equipment

Option B involves a retrofit or system-level Measurement and Verification assessment. The approach is intended for retrofits with performance factors and operational factors that can be measured at the component or system level using interval electrical demand meters, as defined in the Measurement Equipment Specifications Section of this Manual, installed on the affected end-use.

Option B methodology consists of the following:

1. Spot or short-term electrical demand measurements can only be used when variations in operations are not expected to change over the commitment years.
2. When temporal variations are expected, electrical demand measurements must be made over a period of time sufficient to represent performance during the EE Performance Hours and winter performance hours and across the commitment years of the resource.
3. This method may be more appropriate when the electrical loads to be impacted by the project are small relative to the building load, a facility does not currently have whole-premise interval metering, or if end-use electrical demand data can be readily obtained from a building energy management or control system.
4. The EE Resource Provider must take into consideration any interactive effects that may alter electrical loads on other end-use equipment being monitored.

7.3 Option C: Whole Facility/Regression

Option C estimates Nominated EE Value and Capacity Performance value by analyzing the overall energy use in a facility and identifying the impact of the implemented measure on total building or facility energy use patterns. The evaluation of whole-building or facility level metered data is completed using techniques ranging from simple billing comparison to multivariate regression analysis.

Option C methodology consists of the following:

1. Nominated EE Value and Capacity Performance value is measured using whole-premise interval meters.
2. Option C is appropriate for measures that cannot be measured directly, such as insulation or other building envelope measures.
3. Option C should not be used if the Nominated EE Value or Capacity Performance value is expected to be small relative to the total facility load, due to the small “signal-to-noise ratio”.

7.4 Option D: Calibrated Simulation

1. Option D involves calibrated computer simulation models of component or whole building demand and energy consumption to determine measure demand and energy reductions. Engineering simulation models (such as DOE-2) can model both residential buildings (homes, apartments and condominiums) as well as more complex commercial buildings. Operational simulations can be used for industrial processes that take into account the specifics of the process addressed by the energy efficiency actions.
2. Both engineering and operational simulations are made more powerful by calibrating these methods to actual kW and kWh data from the site or process being examined, even if these data are available for a monitoring period shorter than or different from the required EE Performance Hours or winter performance hours. Short-term metering and monitoring are methods that produce data that can be used to adjust engineering simulations.
3. This approach is generally termed "calibrated engineering simulations." Linking simulation inputs to baseline and post-installation conditions completes the calibration. Characterizing baseline and post-installation conditions may involve metering performance and operating factors both before and after the retrofit. Long-term whole-building demand and energy use data may be used to calibrate the simulation(s).

7.5 Other Acceptable Measurement and Verification Methodologies

The EE Resource Provider may propose alternative methodologies not listed above. The EE Resource Provider proposing alternative methodologies shall demonstrate that the alternative methodologies will be equivalent to one of the accepted methodologies described above, and demonstrate justifiable need for deviation from the acceptable methodologies based on unique project requirements.

In addition to the acceptable methodological approaches described above, several methodological techniques may be applied to one or more of the methods described above. The following describe other acceptable methodological techniques.

7.5.1 Engineering Calculations and Audit Results

The EE Resource Provider may use engineering algorithms to calculate the project's Nominated EE Value during the EE Performance Hours and Capacity Performance value considering the EE Performance Hours and winter performance hours. Engineering algorithms must be supplemented with data collected on the energy-consuming equipment effected by the measures.

7.5.2 Load Shape Analyses

The EE Resource Provider may use verifiable measure hourly load shapes to calculate a project's Nominated EE Value during the EE Performance Hours or Capacity Performance value considering the EE Performance Hours and winter performance hours. Measure load shapes must be based on actual metering data, load research, and/or simulation modeling.

Values for monthly or annual energy reductions (whether from engineering calculations, analysis of billing data, simulation modeling or other means described in this Manual) can be combined with information on verifiable measure load shapes to produce values for electrical demand

reduction (MW) during the EE Performance Hours or winter performance hours. Measure load shapes shall be based on actual metering data, load research (current or historic) and/or simulation modeling.

Section 8: Establishing Baseline Conditions

Welcome to the *Establishing Baseline Conditions* section of the PJM Manual for *Energy Efficiency Measurement and Verification*. In this section, you will find the following information:

- A description of general requirements for all EE Resources on establishing, measuring and reporting baseline (see “Baseline Requirements for All EE Resources”).
- A description of requirements for EE Resources involving new construction or major renovations on establishing, measuring and reporting baseline (see “Baseline Requirements for EE Resources involving New Construction or Major Renovations”).

The EE Resource Provider shall describe in its M&V Plan the methodology used to determine Baseline Conditions for the equipment or process comprising the EE project. Baseline Conditions are defined as the MW demand of the equipment or process during defined EE Performance Hours, or the demand that would have existed, in the absence of the energy efficiency project.

The EE Resource Provider shall identify in its Measurement and Verification Plan any and all equipment, systems, practices or strategies or type of the aforementioned, whose alteration from its Baseline Condition operation will lead to reduced demand during the EE Performance Hours or winter performance hours.

8.1 Baseline Requirements for All EE Resources

The EE Resource Provider must describe in its Measurement and Verification Plan how it will satisfy each of the applicable requirements listed below.

1. For projects where the demand reduction results from measures involved variable load equipment or equipment whose operation is time-dependent or weather-dependent, the Baseline Conditions must be calculated for each hour across the EE Performance Hours and winter performance hours.
2. ‘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.
3. ‘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 or committed to an FRR Capacity Plan, the Baseline Condition is the kW load of the existing equipment across the EE Performance Hours and winter performance hours under pre-retrofit conditions.

For eligibility to use the ‘Current Load’ Baseline Condition:

1. Document the nature of the project such that it can be reasonably assumed that the replacement, removal or retrofit would not have occurred in the absence of the Energy Efficiency initiative.
2. 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.

8.2 Requirements for EE Resources Involving New Construction or Major Renovations

For new construction or major renovation Projects, the Baseline Conditions shall be equal to the kW load during the applicable EE Performance Hours and winter performance hours of equipment meeting the level of efficiency required by:

1. Applicable State code or Federal product efficiency standard, or
2. Standard practices, provided the EE Resource Provider can document the standard practices in the M&V Plan, if there are no applicable State codes or Federal product efficiency standards.

Section 9: Statistical Significance

Welcome to the *Statistical Significance* section of the PJM Manual for *Energy Efficiency Measurement and Verification*. In this section, you will find the following information:

- An overview of the requirements to meet statistical significance (see “Overview of Statistical Significance”).
- A description of the requirements for statistical sampling (see “Statistical Sampling”).

9.1 Overview of Statistical Significance

The EE Resource Provider must describe in its Measurement and Verification Plan how it will meet or exceed the statistical precision and accuracy standards specified in this Manual. The M&V Plan must demonstrate that the techniques utilized to calculate sample accuracy and precision comply with the methods described in this Manual. The accuracy requirement needs to include a description of how the Measurement and Verification effort will use methods to mitigate and adjust for the potential types of bias applicable to the methods being used in the Measurement and Verification effort. Where monitoring is specified over the Delivery Years in which EE will be offered, the Measurement and Verification plan must also describe how accuracy and precision will be monitored on the sample during the period.

9.1.1 Requirements

1. EE Resource Provider shall include in its M&V Plan a description of how Measurement and Verification efforts address accuracy and precision issues as described in this Manual appropriate for the measurement and verification approach being proposed and strategy to calculate the Nominated EE Value and Capacity Performance value.
2. EE Resource Provider that proposes the use of Measurement and Verification Reference Documents to support estimates including but not limited to, engineering estimates, load profiles, measure life, and coincidence factors, shall provide justification for use appropriate to the Measurement and Verification methodology to calculate the Nominated EE Value and Capacity Performance value.
3. If the Nominated EE Value calculations include an engineering-based direct measurement, measurement of proxy variables or simulations, then the EE Resource Provider shall describe methods to control relevant types of potential bias including, but not limited to: (a) accuracy and calibration of the measurement tools (as described in Section 12 of this Manual); (b) measurement error; (c) engineering model bias; (d) modeler bias; (e) deemed parameter bias; (f) meter bias; (g) sensor placement bias; and (h) sample selection bias or non-random selection of equipment and/or circuits to monitor.
4. If the Nominated EE Value and Capacity Performance value calculations include regression or statistical analyses, then the EE Resource Provider shall describe methods to control relevant types of potential bias including, but not limited to: (a) model misspecification; (b) statistical validity; (c) error in measuring variables; (d) autocorrelation; (e) heteroscedasticity; (f) collinearity; (g) outlier data points; and (h) missing data.

5. If the Nominated EE Value and Capacity Performance value calculations include any form of survey or interview data, the EE Resource Provider shall describe methods to control relevant types of potential bias including, but not limited to: (a) construct validity; (b) sampling frame versus population; (c) selection bias (for a sample and for a census attempt where not all sites within the census received usable data); (d) non-response bias; (e) error in measuring variables; (f) sample homogeneity relative to project (external validity); (g) outlier data points; and (h) missing data.

9.2 Statistical Sampling

The demand reduction value during EE Performance Hours or winter performance hours or other key parameters for a project including multiple installations of similar measures and/or facilities may be developed by sampling the total population of all measure installations. Sampling shall meet **a statistical accuracy and precision of no less than one-tailed 90% confidence level (equivalent to two-tailed 80% confidence level) and 10% relative precision** as described below.

9.2.1 General Requirements

If sampling will be conducted, the EE Resource Provider must describe in its M&V Plan each of the following general sampling conditions:

1. The population to be sampled,
2. The required sample size in accordance with this Manual,
3. The planned sample size, plus contingencies for attrition due to metering equipment failure and the like,
4. All assumptions and calculations for determining the sample size, and
5. The method for selecting sample points.

9.2.2 Sample Size Requirements

If sampling will be conducted, the EE Resource Provider must describe in its Measurement and Verification Plan how it will satisfy each of the requirements listed below for determining the sample size and sample point.

1. If the demand reduction value is estimated from one or more samples, the required sample size(s) must be based upon targeting 10% relative precision at a 90% confidence level. If an EE project consists of multiple sites and/or measures, and the EE Resource Provider uses multiple samples to estimate the aggregated demand reduction value during the EE Performance Hours and to estimate the aggregated demand reduction during winter performance hours in each Zone as the sum of all individual measured demand reduction values, the sampling requirements may be met (1) for each sample or combination of samples used, (2) for the combination of all samples, or (3) by using strata as described below.
2. If the demand reduction value is estimated from a sample drawn from 2 or more strata the overall test sample size must be based upon targeting 10% relative precision with a 90% confidence interval. Strata shall be defined as any subset of the project's population that is based on known information. The concept of strata may include, but is not limited to: programs in a state sponsored demand side management portfolio or subsets of

an entire population of affected equipment at a project site that have similar operating characteristics.

3. All sampling calculations shall incorporate a plan to compensate for potential data loss through:
   a. Over sampling
   b. Sample site replacement in the course of the study,
   c. Demonstration that precision and confidence targets will still be met with a smaller sample size.
4. The EE Resource Provider shall demonstrate the method for controlling bias in sample selection including, but not limited to random sampling, census or rolling census for each sample and strata used.
5. The Coefficient of Variation (c.v.) used to derive the required sample size shall be the measured c.v. for the primary measurement including all its error components.
6. The EE Resource Provider shall demonstrate the method for controlling bias attributed to the c.v. as it relates to sample size determination.
7. If a c.v. from prior Measurement and Verification or Measurement and Verification Reference Documents is not available for the primary measurement applicable to the segments of sites, installed measures, and/or strategy, then the EE Resource Provider shall use a default value for the initial c.v., not less than 0.5 for homogeneous samples (samples from populations that are uniform with respect to some criteria of classification) and 1.0 for heterogeneous samples (samples from populations that are variable with respect to some criteria of classification), until such time that a c.v. can be estimated from the project sample population.
8. If a method such as stratified ratio estimation is used to take advantage of supporting information for the population, the c.v. may be adjusted to take account of the added efficiency of the stratification and estimation methodology.

9.2.3 Sample Size Calculation Requirements

The formulas below are illustrative of the calculation of required sample size and precision. Alternative sample size determination shall meet the minimum requirements set forth in the preceding section and be documented in the Measurement and Verification plan.

The EE Resource Provider shall calculate the sample number designed to achieve a precision of 10% using the following equation, utilizing a t value of 1.282, which corresponds to a one-tailed 90% confidence interval of an infinite population,

$$n' = \left\{ \frac{1.282 \times c.v.}{r.p.} \right\}^2$$

Where:

n'	number of samples in an infinite population
c.v.	coefficient of variation as set by a default value or where it is known
r.p.	relative precision

The sample size (n) for the finite population (N) less than 200 shall be calculated using the following equation,

$$n = \frac{n'}{1 + \frac{n'}{N}}$$

Where:

n'	number of samples in an infinite population

9.3 Sample Size Recalibration Based on Monitoring Data

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.

9.3.1 Sample Recalibration Requirements

The EE Resource Provider shall calculate the relative precision of sampling studies based on the new estimated sample coefficient of variation calculated using the following equations,

$$c.v. = \frac{s}{\bar{x}}$$

Where:

$\bar{x}$	sample mean
s	standard deviation
n'	number of samples in an infinite population

In the case where the finite population (N) is less than 200, the relative precision of the sampling study shall be calculated using the following equation,

$$r.p. = \sqrt{1 - \frac{n}{N}} \times \frac{1.282 \times c.v.}{\sqrt{n}}$$

Where:

n	number of samples in a finite population
N	total number of units in the population

If a method such as stratified ratio estimation is used to take advantage of supporting information for the population, the estimated c.v. and achieved relative precision may be adjusted to take account of the added efficiency of the stratification and estimation methodology.

9.4 Sampling Over Load Zones

If the EE Resource Provider conducts sampling for a population of similar EE Resources spanning multiple Zones, then the EE Resource Provider must describe in its M&V Plan how it will satisfy each of the requirements listed below:

9.4.1 Requirements

The EE Resource Provider shall demonstrate that the accuracy and precision requirements discussed above apply to the overall population of EE Resources being studied, rather than to the project or projects within each individual Zone.

The EE Resource Provider shall demonstrate the method for controlling any bias attributed to sampling across Zones.

Section 10: Nominated EE Value Calculations

Welcome to the Nominated EE *Value Calculations* section of the PJM Manual for *Energy Efficiency Measurement and Verification*. In this section, you will find the following information:

- An overview of the requirements to determine the Nominated EE Value (see "Overview of Nominated EE Value Calculations").
- A procedure for determining the Nominated EE Value for weather sensitive loads (see "Nominated EE Value for Weather Sensitive Loads").
- A procedure for reducing the Final Nominated EE Value if the EE Resource fails to meet the precision standards (see "Reduction in the Final Nominated EE Value").

10.1 Overview of Nominated EE Value Calculations

As defined in Section 1, the Nominated EE Value is the expected average demand (MW) reduction during the defined EE Performance Hours in the Delivery Year. The EE Performance Hours are between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery Year, that is not a weekend or federal holiday.

Effective with the 2016/2017 Delivery Year, EE Resources that desire to qualify as a Capacity Performance product type shall also have an expected average load reduction during winter performance hours (i.e., all days from January 1 through February 28, inclusive, of such Delivery Year that is not a weekend or federal holiday, between the hour ending 8:00 EPT and hour ending 9:00 EPT, and between the hour ending 19:00 EPT and hour ending 20:00 EPT), that is not less than the Nominated EE Value determined during the defined EE Performance Hours. If the Nominated EE Value determined during the defined EE Performance Hours is greater than the expected average demand during the defined winter hours, the expected demand during the defined winter hours establishes the Nominated EE Value and Capacity Performance value of a Capacity Performance EE Resource. The Capacity Performance value of an EE Resource may not exceed the Nominated EE Value of an EE Resource.

End-user loads have a consumption pattern depending on the type of customer (residential, commercial, industrial, or other), time of day, day of the week, and season. The consumption pattern is analyzed to determine the expected average demand reduction when electrical devices or systems are replaced by more efficient devices or systems. The demand reduction during the EE Performance Hours or winter performance hours as a fraction of the gross difference between ratings of the current devices and the more efficient devices can vary significantly depending on the consumption pattern. This fraction is referred to as summer or winter Coincidence Factor in the M&V process.

When consumption pattern is weather-sensitive (e.g. air conditioning or electric heat) the determination of average demand reduction may vary significantly depending on the weather conditions (e.g. cool summer or very hot summer, mild winter or extremely cold winter). A normalization method is proposed in the case of weather-sensitive load later in this section to ensure that the demand reduction estimate during EE Performance Hours or winter performance hours is consistent with the method used for other resources.

The EE Resource Provider shall describe in the M&V Plan how the Nominated EE Value (i.e., the demand reduction during the EE Performance Hours) and demand reduction during the winter performance hours will be calculated to establish the Nominated EE Value and Capacity Performance value for the EE Resource. The description must include, where applicable, the following factors used in the calculations:

1. Equations and formulas
2. Assumptions
3. Manufacturers equipment specifications
4. Direct measurement data
5. Indirect measurement data
6. Engineering factors, parameters and other variables

If the one or more of the factors listed above are not known or not available at the time the EE Resource Provider submits its Measurement and Verification Plan to PJM, the EE Resource Provider shall describe when the unknown or unavailable factors will be known and available and how the factors will be used in the Nominated EE Value and Capacity Performance value calculations.

The EE Resource Provider must give consideration to the following items in its M&V Plan:

1. The reported Nominated EE Value and Capacity Performance value shall achieve at least a 10% relative precision at a one-tailed 90% confidence level.
2. If Baseline Conditions are used in the calculation of the Nominated EE Value or Capacity Performance value, the EE Resource Provider must make adjustments to the Baseline Conditions to reflect operating conditions at the time of the EE Performance Hours or winter performance hours.
3. Formulas used by the EE Resource Provider to determine the Nominated EE Value or Capacity Performance value shall include any modifying factors, including, but not limited to, summer or winter Coincidence Factor for the specified EE type and the applicable performance hours, realization rate, and equipment failure rate.
4. If an EE project consists of multiple sites and/or measures, the EE Resource Provider may calculate the aggregated Nominated EE Value during the EE Performance Hours and aggregated Capacity Performance value considering the EE Performance Hours and winter 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.
5. If sampling will be conducted, the project's aggregated demand reduction value in each Zone must be calculated from the measured data of the sample, and the M&V Plan shall describe how this calculation will be performed.

6. Any measurement or monitoring equipment of current (amps) and voltage used to calculate electrical demand must include the power factor of the end-uses in the demand (kW) calculations.

10.2 Nominated EE Value for Weather Sensitive Load

If the demand reduction during the EE Performance Hours is a function of weather conditions the Nominated EE Value shall be based on the Zonal Weighted Temperature Humidity Index (WTHI) Standard posted by PJM. The Nominated EE Value shall be calculated using the relationship between average demand reduction measured during the EE Performance Hours on a day and the WTHI on the day. Alternate approaches may be used with documentation to show that the demand reduction estimate is comparable to the value computed using to the PJM WTHI Standard.

The Zonal WTHI Standard is the mean of the Zonal WTHI values on the days on which PJM peak load occurred in the history since 1998. . The concept of using Zonal WTHI is similar to the concept of adjusting generator rating test results for ambient conditions 'at the time of PJM peak'. PJM posts on its website updated Zonal WTHI Standards each year.

See Appendix A for an illustration of Zonal WTHI calculation and determination of demand reduction at Zonal WTHI Standard for summer weather sensitive load.

If the demand reduction during the winter performance hours is a function of weather conditions, the demand reduction during the winter performance hours shall be based on the Zonal Winter Weather Parameter (Zonal WWP) Standard. The demand reduction during the winter performance hours shall be calculated using the relationship between the average demand reduction measured during the winter performance hours on a day and the Winter Weather Parameter on the day. Winter Weather Parameter equation is defined in Section 3.2 of ***Manual 19: Load Forecasting and Analysis***.

The Zonal WWP Standard is the mean of the Zonal WWP values at the time of the PJM winter peak hour since 1998. PJM posts on its website updated Zonal Winter Weather Parameter Standards each year. To determine the demand reduction for winter weather sensitive load, a similar methodology to the one illustrated in Appendix A is used; however, a Zonal Winter Weather Parameter Standard is used as opposed to a Zonal WTHI Standard.

10.3 Reduction in the Final Nominated EE Value

It would be important to meet the specified precision requirement at the aggregate level of the EE Resource to avoid penalties due to reduction in the value. If the final estimate of the Nominated EE value determined in the Post-Installation M&V Report does not meet the 10% precision standard, the estimated value will be reduced to determine the Final Nominated EE Value.

Final Nominated EE Value =

Estimate of Nominated EE Value *(100 – Achieved Precision) / (100 – Standard Precision) =

Estimate of Nominated EE Value * (100 – Achieved Precision) / (100 – 10%) =

Estimate of Nominated EE Value * (100 – Achieved Precision) / 90.

Examples:

Case 1: Standard Precision met.

Estimate of Nominated EE Value = 10 MW.

Achieved Precision = 10% at one-tailed 90% confidence level.

Final Nominated EE Value = 10 * (100 – 10%) / 90 = 10 MW.

Case 2: Standard Precision not met.

Estimate of Nominated EE Value = 10 MW.

Achieved Precision = 12% at one-tailed 90% confidence level.

Final Nominated EE Value = 10 * (100 – 12%) / 90 = 9.8 MW.

If the estimated demand reduction during the winter performance hours is greater than the estimated demand reduction during the EE Performance Hours, the Capacity Performance value of the EE Resource is set equal to the estimated Nominated EE Value determined based on EE Performance Hours. The method outlined above is used to reduce the Final Nominated Value and becomes the final Capacity Performance value of a Capacity Performance EE Resource when 10% precision standard is not achieved in estimating the demand reduction during the EE Performance Hours.

If the estimated demand reduction during the winter performance hours is less than estimated demand reduction during the EE Performance Hours, the estimated Capacity Performance value of the EE Resource will be reduced (in a similar fashion to the Nominated EE Value) when the 10% precision standard is not achieved in estimating the demand reduction during the winter performance hours.

Final Capacity Performance value =

Estimate of Capacity Performance value *(100 – Achieved Precision) / (100 – Standard Precision) =

Estimate of Capacity Performance value * (100 – Achieved Precision) / (100 – 10%) =

Estimate of Capacity Performance * (100 – Achieved Precision) / 90.

Section 11: Measurement and Monitoring

Welcome to the Measurement and Monitoring section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- A description of the Measurement and Monitoring details that must be included in the M&V Plan (see "Measurement and Monitoring Requirements").

11.1 Measurement and Monitoring Requirements

The EE Resource Provider shall describe in its M&V Plan the variables that will be measured, monitored, counted, recorded, collected, and maintained to determine the project's Nominated Value.

The EE Resource Provider shall describe in its M&V Plan how each of the variables will be measured, monitored, recorded, collected and maintained.

The EE Resource Provider must describe in its M&V Plan how it will satisfy each of the requirements listed below. When equipment manufacturer, model, serial number and age are not readily available, the EE Resource Provider may propose alternative means of acquiring or estimating the information.

1. For projects affecting HVAC Systems, the EE Resource Provider must, at a minimum, collect and maintain the following information:
    a. On HVAC equipment: equipment capacity, quantity, manufacturer, model and serial numbers, and age.
    b. On HVAC system controls: location of zones, temperature set-points, control set-points and schedules, and any special control features.
2. For projects affecting Building Envelope, the EE Resource Provider must, at a minimum, collect, maintain and report on all key variables effecting reductions associated with the measures.
3. For projects affecting Interior or Exterior Lighting Systems, the EE Resource Provider must, at a minimum, collect and maintain the following information: number and types of lamps and ballasts, with nameplate data.
4. For projects affecting Major Electric Consuming Equipment, the EE Resource Provider must, at a minimum, collect and maintain the following information: equipment capacity, quantity, manufacturer, model and serial numbers and age.
5. For projects affecting Weather Sensitive Electrical Loads including HVAC, where temperature, humidity or degree-days will be used in the calculation of demand reduction, the EE Resource Provider shall collect and maintain representative site weather data, either measured on-site or obtained for a nearby site, from the National Climatic Data Center ("NCDC"). On-site measurement equipment must satisfy the requirements described in Section 12.

Section 12: Measurement Equipment Specifications

Welcome to the *Measurement Equipment Specifications* section of the PJM Manual for *Energy Efficiency Measurement & Verification*. In this section, you will find the following information:

- A description of the Measurement Equipment Specifications details that must be included in the Measurement and Verification Plan (see "Measurement Equipment Requirements").

12.1 Measurement Equipment Requirements

The EE Resource Provider shall describe, to the most practical extent, in its M&V Plan how each measurement, monitoring and/or data recording device will be installed (including its specific location) and operated to measure, monitor and/or record data from each of the parameters and variables described in the M&V Plan pursuant to Section 12 of this Manual.

The EE Resource Provider must describe in its M&V Plan how it will satisfy each of the requirements listed below:

1. All solid-state measurement, monitoring and data recording equipment must meet or exceed the relevant standards set by the American National Standard Institute ("ANSI") or equivalent standard.
2. Measurement, monitoring and data recording equipment that is directly measuring watt-hour, volt-hour, volt-ampere-hours, reactive volt-ampere-hour, and the associated demand components should conform to ANSI or equivalent standards.
3. Instruments or transducers for the analog or digital measurement of volt, volts-squared, amperes, amperes-squared, phase angle, volt-amperes, watts, and reactive volt-amperes should conform to ANSI or equivalent standards.
4. Data recorders that are recording pulses from measurement and monitoring devices must utilize a pulse rate within the resolution capabilities of the recorder.
5. All measurement, monitoring and data recording equipment installed on electric circuits with significant harmonics must meet the relevant standards provided by the Institute of Electrical and Electronics Engineers ("IEEE").
6. Any measurement or monitoring equipment that directly measures electrical demand (kW) must be a true RMS measurement device with an accuracy of no less than 2%.
7. Any measurement or monitoring equipment that directly measures electrical demand from three-phase devices must be installed such that measurements are taken on all three-phases to account for any phase imbalance or an equivalent method that can measure electrical demand using two phases.
8. Any measurement or monitoring equipment that directly measures electrical demand on circuits with significant harmonics must have a digital sampling rate of at least 2.6 kHz as defined in the relevant IEEE Standards.
9. Data recorders must be synchronized in time, within an accuracy of +/- 2 minutes per month, with the National Institute of Standards and Technology ("NIST").

10. All measurement, monitoring and data recording equipment must be calibrated by the EE Resource Provider or its independent calibration contractor in such a way to meet or exceed the International Measurement and Verification Protocol (IPMVP), NIST, or equivalent standard. If a recalibration interval is not specified by its manufacturer, electrical measurement equipment should be recalibrated at least once every two calendar years.
11. The EE Resource Provider must ensure that all measurement, monitoring and data logging equipment shall be maintained in such a way as to meet or exceed industry and manufacturer standards.
12. The EE Resource Provider must maintain documentation on all measurement, monitoring and data recording equipment maintenance and calibration activities. Documentation and records must be maintained.
13. The EE Resource Provider shall provide to PJM, upon request, measurement equipment maintenance, calibration and testing records to demonstrate that the EE Resource Provider's measurement equipment is calibrated and maintained in accordance the requirements described in this Manual.
14. The EE Resource Provider may propose alternative methods to demonstrate the measurement, monitoring and data recording equipment used in the determination of Nominated Value satisfies the accuracy, calibration and maintenance standards described in the Manual.
15. Any measurement, monitoring and data recording equipment that sample continuously and integrate values should collect data at a frequency of one hour or less. For devices that only sample "snapshots" or applications susceptible to data aliasing, one should collect data at a frequency of 15 minutes or less.

Appendix A: Illustration of Zonal WTHI and Demand Reduction Calculations

The Zonal WTHI Standards based on 1998-2008 period are shown in the table below for illustration:

Zone	WTHI Standard		Zone	WTHI Standard
AE	83.3		JCPL	82.8
AEP	81.5		METED	82.4
APS	81.1		PECO	83.1
BGE	83.1		PENLC	80.4
COMED	80.4		PEPCO	83.7
DAYTON	81.6		PL	81.5
DLCo	80.4		PS	82.9
DOM	83.5		RECO	82.9
DPL	83.1		UGI	80.4

THI = (TEMPERATURE_F - 0.55 * (1 - RELATIVE_HUMIDITY_PCT/100) * (TEMPERATURE_F - 58.0)).

WTHI = [(4 * Current Day Maximum THI)+(Previous Day Maximum THI)] / 5

As an example of WTHI calculations, 2007 PJM peak occurred on August 8 when the following weather conditions occurred in BGE Zone:

Maximum THI on August 8: Temperature = 102 F; Relative Humidity = 34%.

THI = 102 – 0.55 * (1 – 34/100) * (102 – 58.0) = 86.03.

Maximum THI on August 7: Temperature = 94; Relative Humidity = 48%.

THI = 94 – 0.55 * (1 – 48/100) * (94 – 58.0) = 83.70.

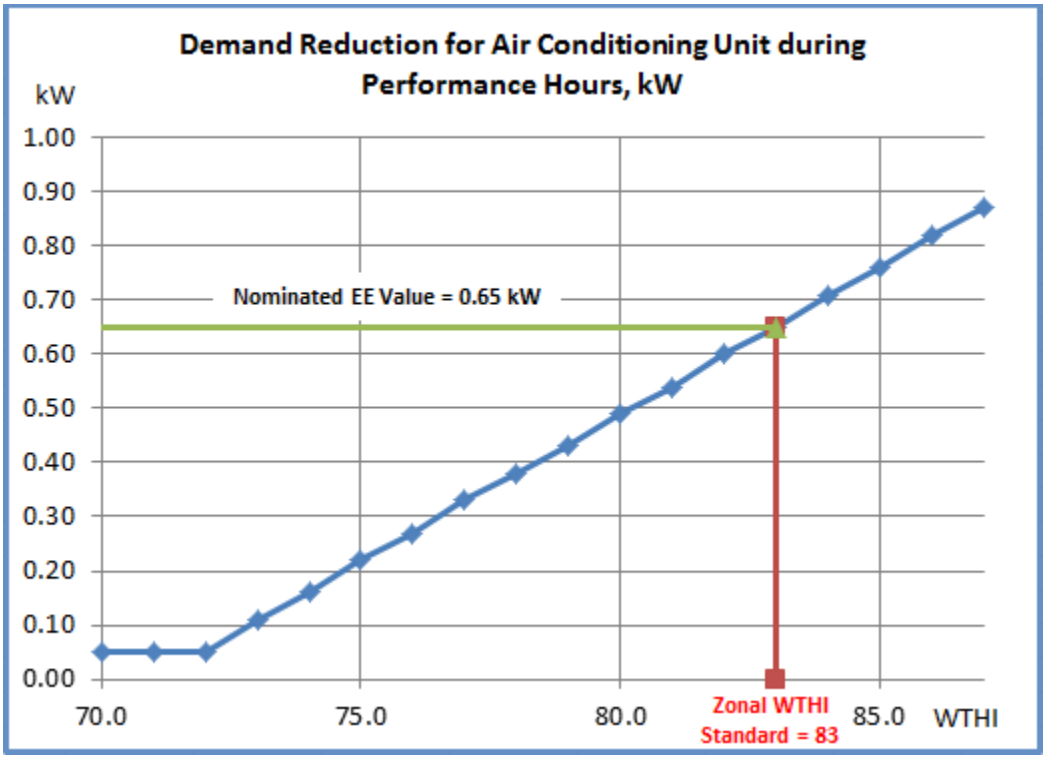
WTHI = [(4 * August 8 WTHI) + (August 7 THI)] / 5 = [(4 * 86.03) + (83.70)] / 5 = 85.56.

The 1998 – 2008 Mean WTHI is calculated in the following table for BGE Zone:

Year	WTHI
1998	83.41
1999	85.78
2000	81.02
2001	84.71

Year	WTHI
2002	82.42
2003	80.63
2004	79.84
2005	83.52
2006	84.65
2007	85.56
2008	82.81
Mean	**83.12**

The determination of Nominated EE Value at Zonal WTHI Standard is illustrated here. An air conditioning unit was replaced with a more efficient unit. Based on the demand patterns of the two air conditioning units, data on the average demand reduction during the EE Performance Hours was collected for days with WTHI ranging from 70.0 to 87.0. The demand reduction vs. WTHI relationship is as shown below. The demand reduction corresponding to the Zonal WTHI of 83.0 provides an estimate of the Nominated EE Value for the efficient air conditioning unit as 0.65 kW.



Revision History

Revision 02 (12/17/2015):

- Revisions to accommodate EE Resource participation in the PJM capacity market when the peak load forecast reflects energy efficiency measures (sections 1.1, 1.2, & 1.3).

Revision 01 (03/01/2010):

- Revisions approved by stakeholders at MRC on November 11, 2009
  - One CSP Rule
- Conforming Revisions for FERC Order ER10-366 accepted on January 22, 2010 and effective January 31, 2010, to include changes to
  - revisions to allow Energy Efficiency Resources to participate in 2011/2012 Deliver Years

Revision 00 (04/23/2009):

This is the initial version of the PJM Manual for Energy Efficiency Measurement & Verification.